REPORT OF THE TWENTY-FOURTH MEETING OF THE INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN

PLENARY SESSION

19-24 July 2023
Victoria, Canada

ISC24 Group, Victoria, British Columbia, Canada, June 22, 2024

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ACRONYMS AND ABBERVIATIONS

Names and FAO Codes of ISC Species of Interest in the North Pacific Ocean

FAO Code	Common English Name	Scientific Name
	TUNAS	
ALB	Albacore	*Thunnus alalunga*
BET	Bigeye tuna	*Thunnus obesus*
PBF	Pacific bluefin tuna	*Thunnus orientalis*
SKJ	Skipjack tuna	*Katsuwonus pelamis*
YFT	Yellowfin tuna	*Thunnus albacares*
	BILLFISHES	
BIL	Other billfish	Family *Istiophoridae*
BLM	Black marlin	*Makaira indica*
BUM	Blue marlin	*Makaira nigricans*
MLS	Striped marlin	*Kajikia audax*
SFA	Sailfish	*Istiophorus platypterus*
SSP	Shortbill spearfish	*Tetrapturus angustirostris*
SWO	Swordfish	*Xiphias gladius*
	SHARKS	
ALV	Common thresher shark	*Alopias vulpinus*
BSH	Blue shark	*Prionace glauca*
BTH	Bigeye thresher shark	*Alopias superciliosus*
FAL	Silky shark	*Carcharhinus falciformis*
LMA	Longfin mako	*Isurus paucus*
LMD	Salmon shark	*Lamna ditropis*
OCS	Oceanic whitetip shark	*Carcharhinus longimanus*
PSK	Crocodile shark	*Pseudocarcharias kamonharai*
PTH	Pelagic thresher shark	*Alopias pelagicus*
SMA	Shortfin mako shark	*Isurus oxyrinchus*
SPN	Hammerhead spp.	*Sphyrna* spp.

ISC Working Groups

Acronym	Name	Chair
ALBWG	Albacore Working Group	Sarah Hawkshaw (Canada)
BILLWG	Billfish Working Group	Michelle Sculley (U.S.A.)
PBFWG	Pacific Bluefin Working Group	Shuya Nakatsuka (Japan)
SHARKWG	Shark Working Group	Mikihiko Kai (Japan)
STATWG	Statistics Working Group	Jenny Suter (U.S.A)

Other Abbreviations and Acronyms that may be Used in the Report

CDS	Catch documentation scheme
CIE	Center for Independent Experts
CKMR	Close-kin mark-recapture
CMM	Conservation and Management Measure
CPFV	Charter passenger fishing vessel
CPUE	Catch-per-unit-of-effort
CSIRO	Commonwealth Scientific and Industrial Research Organization
DWLL	Distant water longline
DWPS	Distant-water purse seine
EEZ	Exclusive economic zone
EPO	Eastern Pacific Ocean
F	Fishing mortality rate
FAD	Fish aggregation device
FAO	Fisheries and Agriculture Organization of the United Nations
FL	Fork length
HCR	Harvest control rule
HMS	Highly migratory species
H_{MSY}	Harvest rate at MSY
IATTC	Inter-American Tropical Tuna Commission
ISC	International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean
ISSF	International Seafood Sustainability Foundation
LFSR	Low fecundity spawner recruitment relationship
LTLL	Large-scale tuna longline
LRP	Limit reference point
MSE	Management strategy evaluation
MSY	Maximum sustainable yield
NC	Northern Committee (WCPFC)
NRIFSF	National Research Institute of Far Seas Fisheries (Japan)
OFDC	Overseas Fisheries Development Council (Chinese Taipei)
PICES	North Pacific Marine Science Organization
PIFSC	Pacific Islands Fisheries Science Center (U.S.A.)
SAC	Scientific Advisory Committee (IATTC)
SC	Scientific Committee (WCPFC)
SG-SCISC	Study Group on Scientific Cooperation of ISC and PICES
SPC-OFP	Oceanic Fisheries Programme, Secretariat of the Pacific Community
SPR	Spawning potential ratio, spawner per recruit
SSB	Spawning stock biomass
$SSB_{F=0}$	Spawning stock biomass at a hypothetical unfished level
$SSB_{CURRENT}$	Current spawning stock biomass
SSB_{MSY}	Spawning stock biomass at maximum sustainable yield
STLL	Small-scale tuna longline

t, mt	Metric tons, tonnes
WCNPO	Western Central and North Pacific Ocean
WCPFC	Western and Central Pacific Fisheries Commission
WPO	Western Pacific Ocean
WWF	World Wildlife Fund for Nature - Japan
GRT	Gross registered tons

REPORT OF THE TWENTY-THIRD MEETING OF THE INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN

PLENARY SESSION

19-24 June 2024

Highlights of the ISC24 Plenary Meeting

The 24th ISC Plenary session was held in-person in Victoria, British Columbia, Canada June 19-24, 2024. The meeting was attended by Members from Canada, Chinese Taipei, Japan, Korea, Mexico and the United States as well as a representative from the Western and Central Pacific Fisheries Commission (WCPFC). Observers from Monterey Bay Aquarium, Pew Charitable Trusts, and the World Wildlife Fund-Japan, also attended the ISC24 Plenary session in-person. The Plenary reviewed results, conclusions, new data, and updated analyses of the Billfish, Albacore, Shark, and Pacific Bluefin tuna working groups. The ISC24 Plenary noted the thoughtful and thorough research completed to improve the assessments of the Pacific Blue Tuna (PBF) and Shortfin Mako Shark (SMA) between ISC23 and ISC24. The ISC24 Plenary endorsed the PBF and SMA benchmark stock assessments and considers them to be the best available scientific information on these stocks. Although reference points have not been established for PBF, the ISC24 Plenary notes that stock biomass is estimated in 2022 to be above the second rebuilding target (20%$SSB_{F=0}$) established by the IATTC-WCPFC-NC Joint Working Group, several years in advance of the rebuilding timeline of 2031. . The PBF stock is not subject to overfishing relative to some of F-based reference points proposed for tuna species, including $F_{20\%SPR}$. Limit and target reference points have not been established for SMA, but the stock is not overfished and is not experiencing overfishing relative to MSY-based reference points. The ISC24 Plenary re-iterated stock status and conservation information provided at ISC23 for North Pacific Ocean Albacore Tuna (NPO ALB), North Pacific Ocean Blue Shark (NPO BSH), North Pacific Ocean Swordfish (NPO SWO), Pacific Blue Marlin (BUM), and Western and Central North Pacific Ocean Striped Marlin (WCNPO MLS). The STATWG continues to catalogue ISC data and make data and assessment files more accessible and available for use by researchers external to the ISC. A process and non-disclosure agreement for sharing stock assessment data and files with external parties was approved by ISC23 and was successfully implemented twice between ISC23 and ISC24. A significant accomplishment since ISC23 was the successful conduct of an external peer review process of the 2023 WCNPO MLS benchmark stock assessment, supported by the ISC Vice-Chair, Dr. Robert Ahrens. The conclusions and recommendations of the review panel were considered by the ISC24 Plenary and it is clear that these recommendations will benefit future BILLWG assessments and assessments undertaken by other WGs. Administrative support provided by the WCPFC Secretariat was instrumental in the implementation of this process. The ISC24 Plenary also began discussing climate change and the incorporation of climate change considerations into the information and advice provided to the IATTC and WCPFC. . All ISC Members are actively conducting climate change research and the importance of climate change is recognized by Members, who agreed to engage in a fuller discussion on a framework for incorporating climate change into ISC activities at ISC25. The ISC WGs were tasked with compiling information on the ways in which they have begun to incorporate climate considerations into their stock assessments as well as the data they believe would be required in order to do so in the future and come prepared to present that information to ISC25. Lastly, there was an important discussion on the use of tools and applications to support Open Science with respect to ISC stock assessments and data. Some WGs are already engaged in Open Science and the ISC24 Plenary tasked the STATWG to explore the logistical requirements and governance to support Open Science and report its findings to the ISC25 Plenary. The MOU with the North Pacific Fisheries Commission (NPFC) has been agreed and awaits signing by both Parties, which the ISC Chair expects to complete by September 2024. The ISC work plan for 2024-25 does not include any benchmark stock assessments but it does include an indicator analysis for NPO BSH, continuing to advance biological sampling for billfish and shark species, information gathering on climate change initiatives and discussion of a framework for the ISC, reporting on the logistical requirements and governance to support Open Science in the ISC, continued implementation of enhancements to the database and website management, continuing the process of formalizing the ISC, and beginning to plan for the third peer review of the ISC function and process. Sarah Hawkshaw (CAN) was elected for a second term as Chair of the ALBWG and Yuichi Tsuda (JPN) was elected for his first term as Vice-Chair of the ALBWG. Michael Kinney (U.S.A.) was elected to a first term as Chair of the SHARKWG and Yesuko Semba (JPN) was elected to a first term as Vice-Chair of the SHARKWG. There were no leadership changes in the PBFWG, the BILLWG and the STATWG. Elections for the Chair and Vice-Chair of the ISC were conducted and Robert Ahrens (U.S.A.) was elected to his first term as Chair Shuya Nakatsuka (JPN) was elected to his first term as Vice-Chair of the ISC. The next Plenary meeting will be hosted by Korea and is tentatively planned for June 18-23, 2025, at a location and venue to be determined.

1 INTRODUCTION AND OPENING OF THE MEETING

1.1 Introduction

The ISC was established in 1995 through an intergovernmental agreement between Japan and the United States (U.S.A.). Since its establishment and first meeting in 1996, the ISC has undergone a number of changes to its charter and name (from the Interim Scientific Committee to the International Scientific Committee) and has adopted a number of guidelines for its operations. The two main goals of the ISC are (1) to enhance scientific research and cooperation for conservation and rational utilization of the species of tuna and tuna-like fishes that inhabit the North Pacific Ocean during a part or all of their life cycle; and (2) to establish the scientific groundwork for the conservation and rational utilization of these species in this region. The ISC is made up of voting Members from coastal states and fishing entities of the region as well as coastal states and fishing entities with vessels fishing for highly migratory species in the region, and non-voting Members from relevant intergovernmental fishery and marine science organizations, recognized by all voting Members.

The ISC provides scientific advice on the stocks and fisheries of tuna and tuna-like species in the North Pacific Ocean (NPO) to the Member governments and regional fisheries management organizations. Fishery data tabulated by ISC Members and peer-reviewed by the species and statistics Working Groups (WGs) form the basis for research conducted by the ISC. Although some data for the most recent years are incomplete and provisional, the total catch of highly migratory species (HMS) by ISC Members estimated from available information is more than 500,000 metric tons (t) annually and is dominated by tropical tuna species. Retained catches of priority NPO species monitored in 2023 by ISC Member countries were 28,433 t of North Pacific albacore tuna (NPO ALB), 18,058 t of Pacific bluefin tuna (PBF), 8,770 t of North Pacific swordfish (SWO), 1,714 t of North Pacific striped marlin (MLS), 4,841 t of Pacific blue marlin (BUM), 1,196 t of North Pacific shortfin mako shark (SMA) and 30,210 t of North Pacific blue shark (BSH).[1] The total estimated retained catch of these seven species is 93,221 t, or approximately 107% of the 2022 total estimated catch of 86,837 t. Annual catches of priority stocks throughout their ranges reported by ISC Members are shown in the catch tables at the end of this report (see Section 183).

1.2 Opening of the Meeting

The Twenty-fourth Plenary session of the ISC (ISC24) was convened in Victoria, British Columbia, Canada, at 9:00 a.m. on 20 June 2024 by the ISC Chair, J. Holmes. A roll call confirmed the participation of delegates from Canada, Chinese Taipei, Japan, Republic of Korea, Mexico, and U.S.A. A representative from the Western and Central Pacific Fisheries Commission (WCPFC) Secretariat was also present (**ISC/24/ANNEX/01**). Representatives from Monterey Bay Aquarium, Pew Charitable Trusts, and World Wildlife Fund for Nature-Japan were present as observers.

[1] FAO three-letter species codes are used throughout this report interchangeably with common names.

ISC Member China, as well as the non-voting Members, the Fisheries and Agriculture Organization of the United Nations (FAO), North Pacific Marine Science Organization (PICES), and Secretariat of the Pacific Community (SPC), while extended an invitation, did not attend the Plenary.

2 ADOPTION OF AGENDA

The proposed agenda for the session (**ISC/24/ANNEX/02**) was considered and adopted. C. Dahl was assigned lead rapporteur duties. A list of meeting documents is contained in **ISC/24/ANNEX/03**.

A list of common abbreviations and acronyms used by the ISC is provided in the preface to this report.

3 DELEGATION REPORTS ON FISHERY MONITORING, DATA COLLECTION AND RESEARCH

3.1 Canada

S. Hawkshaw presented the Canada National Report (**ISC/24/PLENARY/04**). Canada has one fishery for highly migratory species in the Pacific Ocean, a troll fishery targeting juvenile north Pacific Albacore Tuna (*Thunnus alalunga*). Category I, II, and III data submitted to the ISC from the 2023 fishing season are summarized in this report. The Canadian fleet consisted of 79 vessels and operated only within the Eastern Pacific Ocean, in 2023. No vessels from the Canadian fleet operated in the Central and Western Pacific Ocean in 2023. The Canadian troll fishery operates in coastal waters, predominantly within the Canadian and United States exclusive economic zones (EEZ). In 2023, however, the Canadian fleet did not have access to fishing in the United States EEZ due to the absence of a fishing regime for 2023 under the bilateral tuna treaty between the countries. A small proportion of the catch and effort did occur outside the Canadian EEZ, in high seas waters. The provisional 2023 estimates of total catch and effort in the Eastern Pacific Ocean are 1,143 t and 2,100 vessel-days, respectively. This represents the lowest catch and effort in the time series, which begins in 1995. . This low catch and effort is partially due to no fishing in the United States EEZ; however, the catch and effort in the Canadian EEZ also decreased by 59.4% and 35%, respectively, relative to 2022, largely due to poor market conditions and high fuel prices. The remaining catch and effort occurred in adjacent high seas waters, which increased only slightly relative to 2022. The catch rate (CPUE) decreased from 0.89 t/v-d in 2022 to 0.54 t/v-d in 2023, the lowest catch rate since 2018. Approximately 86% of the Albacore catch occurred in the favorable water temperature band of 16-19 °C in 2023. Thirty-one (31) vessels measured 7,179 fork lengths in 2023 for a sampling rate of 4.3% of the reported catch. Fork lengths ranged from 47 to 92 cm, having a mode at 68 cm corresponding to 2-year-old fish and a smaller mode around 80 cm corresponding to 3-year-old fish. Mean length was 69.9 cm, which is similar to previous years.

Discussion

The decline in catch and effort in 2023 was likely mainly driven by low prices, prompting harvesters to pursue other opportunities. In addition, the lack of agreement on a fishing regime under the Canada-U.S. Albacore Treaty in 2023 likely impacted the Canadian fishery since the majority of Canadian catch and effort has occurred in US waters in recent years. It was also noted that fishery demographics in Canada are aging and it may be that as participants age out of the fishery there is not a comparable influx of new, younger participants, which is contributing to reduced effort.

Although seabird bycatch was reported in 2023, it was noted that seabird bycatch is not an unusual occurrence in the Canadian fishery. To date, seabird species are not identified in logbooks although Fisheries and Oceans Canada is discussing developing a seabird identification guide for fishers along with a requirement to report seabird bycatch species in logbooks.

Warmer coastal waters in 2023 may explain the increase in PBF bycatch in Canadian waters but more analysis will be needed to confirm any such relationship. It was also noted that another warm water species, SKJ, has also appeared occasionally in catches from the Canadian fleet over the past decade.

3.2 Chinese Taipei

R.-F. Wu presented the Chinese Taipei national report (**ISC/24/PLENARY/05**). Taiwanese tuna fisheries in the North Pacific Ocean mainly comprise tuna longline and tuna purse seine fisheries, and other small-scale fisheries operating off waters of Taiwan, such as harpoon, set net, and gillnet. More than 90% of tuna and tuna-like species catch of Taiwanese fisheries in the North Pacific Ocean are from tuna longline and purse seine fisheries. The tuna longline fisheries consist of large-scale tuna longline vessels (over 100 GRT - LTLL) and small-scale tuna longline vessels (less than 100 GRT- STLL). The number of fishing vessels of these two fisheries were 124 and 685, and the catches of tuna and tuna-like species catches in the North Pacific Ocean were 7,804 t and 13,511 t in 2023, respectively. Twenty-four (24) vessels participated in the tuna purse seine fishery and reported a catch of 168,637 t in the Pacific Ocean in 2023. Forty-four observers were deployed on tuna longline vessels operating in the Pacific Ocean, including eight on LTLL vessels and 37 on STLL vessels in 2023 with one observer conducting two observation trips on a LTLL vessel and a STLL vessel. Taiwanese scientists conducted nine scientific projects on the stock status of tuna and tuna-like species, and the impacts of mitigation measures on the bycatch species in the Pacific Ocean under funding support from the Taiwan Fisheries Agency in 2023.

Discussion

A question was asked about the increase in the size of the STLL and LTLL fleets in 2023. It was noted that the increase in the count of LTLL vessels is partially an artifact of the current classification scheme, which divides small- and large-scale vessels by gross tonnage. Vessel refitting has resulted in vessels increasing above the 100 gross tonnage threshold without any change in other characteristics, such as engine size or fishing gear. In the future the classification scheme may be revised to address what is essentially an artifact of the current scheme.

Changes in fishing areas in 2023 relative to 2022 were noted. El Niño conditions in 2023 expanded the purse seine fishing grounds eastward while declining catch rates for tropical tunas prompted small-scale tuna longliners to shift northward and target sharks.

3.3 Japan

H. Kiyofuji presented the Japan National Report (**ISC/24/PLENARY/06**). Japanese tuna fisheries consist of three major fleets (longline, purse seine, and pole-and-line), and other fisheries including troll, driftnet, and set-net fisheries. The number of active longline vessels in the NPO shows a declining trend in all size categories, with 252 vessels in 2023, almost half of the number active in 2006. The number of purse seiners is stable, at around 70 vessels. The number of pole and line vessels in the over 50 GRT size category is declining, with a total of 55 vessels active in 2023, less than half of the active vessels in 2006. The distribution of fishing effort did not show a significant difference between 2022 and 2023 in the three main fisheries. The total catch of tunas excluding SKJ caught by Japanese fisheries in the NPO was 71,141 t in 2022 and 65,055 t in 2023. The total catch of tunas including SKJ caught by Japanese fisheries in the NPO was 189,683 t in 2022 and 177,371 t in 2023. The total catch of SWO and MLS was 4,844 t in 2022 and 6,515 t in 2023. In addition to these fisheries descriptions, the Japan National Report briefly describes Japanese research activities on tuna and tuna-like species in the Pacific Ocean in 2023, including a larvae/juvenile research cruise; spawning behavior of PBF captured during research cruise; a troll survey of age-0 PBF; technical development for close-kin-mark-recapture (CKMR) analysis of PBF; and tagging of striped marlin, skipjack and albacore.

Discussion

Both the longline and troll fisheries reported bimodal length-frequency distributions for ALB in 2023. It was noted that the possible bimodal distribution of sampled ALB length frequencies may reflect a strong year class entering fisheries or changes in fleet dynamics.

Changes in the composition of the Japanese fishing fleets were discussed. The decline in the size of fishing fleets is likely to due to lower revenues and higher operating costs. It is less clear whether demographic factors, as mentioned in relation to the Canadian ALB fleet, are a factor, because the Japanese fishing industry has been actively recruiting new entrants.

A question was asked about target switching within a section of the PL fleet operating in the Kuroshio current area off of eastern Japan. In response, it was noted that there is no evidence of target switching between SKJ and ALB in the Japanese pole-and-line fleet in recent years.

During the JPN report it was noted that 12-20 days of data were available from pop-up satellite tag (PSAT) tags applied to MLS. The short time series of PSAT data is a consequence of researchers' relative inexperience with tag deployment using a harpoon from a vessel rather than bringing the fish onboard to secure the tag. More experience with tag deployment method should result in more secure deployment of PSATs on MLS and longer time series becoming available.

The development of the PBF troll recruitment survey was discussed. The PBFWG uses an index from this survey outside of the assessment model to inform the identification of trends in recruitment for the PBF stock.

3.4 Korea

Y. Kwon presented the Korea national report (**ISC/24/PLENARY/07**). Korean distant water tuna and tuna-like fisheries in the Pacific Ocean consist of longline and purse seine fisheries. In 2023, there were 96 active longline vessels and 22 active purse seine vessels in the Pacific Ocean. These two types of Korean fisheries harvested 118,113 t of tuna and tuna-like species in the North Pacific Ocean in 2023. PBF is harvested by some coastal and offshore fisheries in Korean waters. The offshore large purse seine fishery harvested 448 t in 2023, accounting for 65.2% of the total domestic catch. In 2023, the catch of large PBF accounted for 50% of the total catch of PBF. Korea has been collecting PBF tissue samples for the CKMR program since 2016, mostly from fish caught by the offshore large purse seine fishery. The National Institute of Fisheries Science has collected PBF tissue samples since 2022 in preparation for a standardized PBF CKMR program. In 2021 and 2022, PBF eggs and larvae were collected in the East Sea, providing valuable insights into the distribution and reproductive patterns of this species. The following year, in 2023, the presence of PBF eggs and larvae was confirmed to be widespread, from the southern waters of Jeju to the southern waters of the East Sea. These findings are significant as they contribute to our understanding of the PBF population dynamics in the region. Although not included in the National Report, summary information on the high seas drift gillnet fishery will be provided as requested by ALBWG for their stock assessment. The gillnet fishery data has been sourced from fishing vessel logbooks from 1979 to 1992, and a database is currently being built. The logbooks contain information on catch amounts by species, CPUE, and catch locations by vessel. The reporting coverage is nearly 100%, except for the year 1992.

<u>Discussion</u>

Korea is making good progress in compiling and conducting quality control on high seas drift gillnet data from the 1979-1992 period. These data will be provided to the ISC once the source data are processed and incorporated into a national database.

The catch of PBF in the coastal set net fishery is controlled by the province-based assignment of catch limits. PBF are allocated to nine provinces located along the east coast of Korea, with 32% of them catching PBF in 2023. Set net operators can stage their nets to permit or avoid PBF catch.

3.5 Mexico

M. Betancourt presented the Mexico National Report (**ISC/24/PLENARY/08**). The report was created in collaboration between IMIPAS (formerly known as INAPESCA) and FIDEMAR, which runs the observer program onboard tuna purse seine vessels in the Eastern Pacific Ocean. Shark researchers have been participating in the SHARKWG providing data as well as CPUE indices estimated using data from a pelagic longline fishery, particularly for shortfin mako shark. This information was updated for the 2023 stock assessment.

Swordfish is the only billfish species that may be caught and retained under commercial fishing permits in Mexico and is targeted beyond 50 miles from the west coast of the Baja California peninsula. Some effects of a possible change in fishing strategies related to the start of longline sets is described in the report, between the Mazatlán fleet in southern Mexico and the Ensenada fleet in the north. The latter fleet makes more night sets in order to catch species other than sharks (such as SWO) with an associated decrease in the catch of SMA.

YFT is the main target tuna species of the Mexican fleet, with PBF being the third largest component of tuna species in Mexican catch. Purse seine catch of PBF is conducted with an observer onboard all trips; low numbers of artisanal vessels began participating in this fishery in 2023. The government allocated 300 t from the catch limit authorized to Mexico for artisanal vessels. So far, very few permits have been given, and the 2023 catch was 8 t. CKMR sampling continues, but no plan has been made to analyze the samples.

<u>Discussion</u>

It was clarified that the quota and catch of PBF in the artisanal fishery is deducted from the authorized catch limit set by the IATTC.

It was noted that Mexico is interested in collaborating with other countries on the PBF CKMR analytical methodology.

3.6 U.S.A.

J. Suter presented the U.S.A. National Report (**ISC/24/Plenary/09**). Various U.S. fishing fleets harvest tuna and tuna-like species in the NPO. Large-scale commercial purse seine, albacore troll, and longline fisheries operate both in coastal waters and in the high seas. Small-scale commercial fisheries generally operate in coastal waters along the North American coast using purse seine, gillnet, harpoon, troll, handline, and hook-and-line gears and around the archipelagos of Hawaii, Guam, CNMI, and American Samoa using troll and handline gears. Recreational sport fisheries also operate in these areas, including guided (charter) trips. In some areas, fishers may sell fish and retain fish for personal use. Overall, the range of U.S. fisheries harvesting tuna and tuna-like species in the NPO is extensive, from coastal waters of North America to the U.S. territories of Guam, CNMI, and American Samoa in the WCPO, and from the equatorial region to the upper reaches of the North Pacific Transition Zone.

NOAA Fisheries continued research on Pacific tunas and associated species at its Southwest and Pacific Islands Fisheries Science Centers in 2023, often in collaboration with scientists from other organizations. Stock assessment research on tuna and tuna-like species was conducted primarily through collaboration with participating scientists of the International Scientific Committee (ISC) for Tuna and Tuna-Like Species in the NPO and international Regional Fisheries Management Organizations. Three noteworthy studies will help improve stock assessments, including an analysis by Hoyle et al. (2024) on good practices for standardizing catch per unit effort and by Lee et al. (2024) on good practices for estimating and using length-at-age along with a reproductive study by Humphreys and Brodziak (2024) on the striped marlin in the central North Pacific Ocean. Research studies were also conducted on fishery monitoring, socioeconomics, biology, and oceanographic studies including research on tunas, billfishes, and bycatch species in the U.S. Pacific coastal and high-seas fisheries. NOAA Fisheries scientists also produced reports summarizing monitoring data collected for longline, purse seine, and small-boat fisheries.

Highlighted research includes studies that examine the validation of band pair deposition rates for common thresher sharks (Spear et al. 2024),[2] the divergent responses of highly migratory species to climate change in the California Current (Lezama-Ochoa et al. 2024), micronekton (Domokos et al. 2023) and scattering layers (Arostegui et al. 2023) that create structure and aggregate predators in the open ocean; effects of warming oceans on food webs (Gomes et al. 2024; Reum et al. 2024; Welch et al. 2023), and foraging studies on swordfish (Preti et al. 2023) and albacore tuna (Gleiber et al. 2023). In addition, Frawley et al. (2023) examined factors that drive longline fisheries interactions with North Pacific albacore tuna.

Discussion

It was explained that the lack of agreement in 2023 on a fishing regime under the U.S.-Canada Albacore Treaty had less impact on the U.S. fleet, because most catch has occurred within the U.S. EEZ in recent history. The very low NPO ALB catches in 2023 were likely caused by a combination of low CPUE, low effort, and low prices.

There was interest in obtaining more information on the location and size composition of PBF catch in the U.S. longline fishery given where that fleet operates.

4 REPORT OF THE CHAIR

ISC scientists have been busy since the ISC Plenary last met face-to-face at ISC23 in Kanazawa, Japan. Highlights in 2023-2024 include benchmark stock assessments of PBF and North Pacific SMA and the implementation of the newly approved external peer review process to conduct a pilot review of the WCNPO MLS benchmark assessment completed in 2023. An important milestone for the ISC was the PBFWG reporting that PBF had achieved the second rebuilding target (20%$SSB_{F=0}$) identified by the IATTC-WCPFC-NC Joint Working Group seven years in advance of the timeline set for rebuilding. The ALBWG and the BILLWG, while not completing stock assessments in 2024, were heavily engaged in research to improve their assessment processes and models and implement a management strategy evaluation process to evaluate harvest strategy options. The ISC Vice-Chair and the BILLWG successfully applied the new external peer-review policy approved by ISC23 to the 2023 WCNPO MLS assessment and received important feedback that will help guide future assessment processes. An MOU with the North Pacific Fisheries Commission (NPFC) was negotiated and remains to be signed but is a step towards formalization of the ISC. Data management, the catalogue and inventory of the ISC database, and development of the website and data enterprise system continue to be advanced under the leadership of the STATWG Chair and Vice-Chair, and several data requests from external third parties were completed using the non-disclosure and agreement process approved at ISC23.

While the ISC continues to advance its scientific mission on many fronts, we cannot afford to waiver from the goal of providing the best available scientific information on the seven stocks of highly migratory species of interest to the ISC. The ISC is an independent science-focused organization that continuously seeks to improve its scientific excellence. The ISC as it presently

[2] Refer to the bibliography in the U.S.A. National Report.

exists is in large part a testament to the success of those efforts and the unwavering dedication and integrity of ISC scientists, especially the WG Chairs and Vice-Chairs who volunteer their time, and the support of their senior managers who, in many cases, are the Heads of Delegation. At the same time, the breadth and scope of our research, scientific partnerships, and visibility are expanding and will continue to do so in the coming years. This expansion is particularly evident as ISC scientists are also being drawn into providing decision-support analysis and tools in the form of management strategy evaluation or some stripped down version of this process.

This meeting will be my last as ISC Chair so I will take the opportunity to provide some observations on the future. The range and scope of activities undertaken by the ISC and ISC scientists is growing as are our relationships with other organizations (IATTC, WCPFC, NPFC), but ISC organization support for these activities is limited and this is why I believe that formalizing the ISC should continue to be top of mind for everyone – we need creative solutions and a champion, that can get it done. We are seeing ISC scientists engaged in decision-support analysis such as MSE. These processes are resource and time intensive and it is prudent for the ISC to consider how deeply engaged we can and want to be in the delivery of these kinds of services, i.e., develop a policy or rules of engagement. Scientifically, the ISC should consider a review of its stock assessment framework, which has focused on a single base-case model and consider the strengths and weaknesses of an ensemble model approach. We also should be considering how we are reporting on uncertainty in modelling results and consider standardization of approaches to assist managers and stakeholders interpreting our outputs. Climate change and the impacts of climate change on stocks are top of mind for many agencies now. Eventually the IATTC and WCPFC are going to want and need climate-related stock status and conservation information. The ISC should be leading this discussion and should be engaging now on the understanding that it takes time to develop the understanding that will be needed in the future. Finally, conducting external peer reviews of ISC stock assessments remains very much top of mind for the credibility of ISC science and with financial support from the United States, a review of the WCNPO MLS assessment was conducted. What is a sustainable model financially and administratively in the future? With these and other observations in mind, the ISC should consider mapping out the third peer review of ISC function and process. Peer reviews of ISC functions are expected to occur every 5 years and the last one occurred in 2018-19, so we are overdue for the next review. While I hoped to have discussions aimed at identifying the focus and process for the next peer review over the past year, it did not happen, but it is becoming urgent to engage in this process to keep the ISC moving forward.

Managing ISC activities continues to be challenging because the ISC relies on in-kind contributions from its Members rather than monetary contributions to support a “Secretariat” to oversee day-to-day operations of the organization. While the Office of the Chair takes on the role of a Secretariat, with much in-kind help from the United States and Japan, owing to undefined funding it cannot provide full support. The Working Groups depend on in-kind contributions from Members who elect to participate in specific Working Groups, particularly those Members who serve as Chairs and Vice-Chairs. Day-to-day operations of the Office of the Chair have been supported by the U.S., and to a lesser extent Canada, and Japan has supported the operations of the ISC website and database. Member countries with scientists serving as chairpersons of the Working Groups have contributed to supporting administrative services of the Working Groups. This support is vital to the ability of the ISC to deliver its scientific mandate and is greatly appreciated.

I close this report by thanking all my colleagues who have worked on ISC tasks and who have provided the support to ISC and the Office of the Chair in advancing the objectives and purpose of the organization. The leadership of Robert Ahrens, Vice-Chair, in taking on the external review of the MLS assessment and his advice and gentle prodding to do things is appreciated, as well as the services of Stephanie Flores and my Executive Assistants in Canada, Michelle Kartz and Alyssa Stout. Special thanks and appreciation are owed to the Chairs and Vice-Chairs of the Working Groups, namely Sarah Hawkshaw and Steve Teo, Michelle Sculley and Yi-Jay Chang, Shuya Nakatsuka and Sui-Kai Chang, Mikihiko Kai and Michael Kinney, and Jenny Suter and Kirara Nishikawa, who provided unselfish leadership in guiding the work of the Working Groups and kept the ISC moving and delivering the best available scientific information for north Pacific highly migratory species. I am indebted to Sarah Hawkshaw and Elizabeth Joyce for their time and effort in organizing ISC24 and making sure it goes smoothly. Finally, thanks to all of you for contributing to another successful year for ISC and for your support and service.

5 REPORT OF SPECIES WORKING GROUPS AND REVIEW OF ASSIGNMENTS

5.1 Albacore

S. Hawkshaw presented the activities and report of the Albacore Working Group (ALBWG; **ISC/24/ANNEX/08**). The Plenary was reminded that the last benchmark stock assessment for NPO ALB was completed in 2023 and the next benchmark stock assessment will be produced in 2026. The intersessional tasks of the ALBWG included conducting research to improve the NPO ALB stock assessment; updating the abundance index for female SSB used in the 2023 stock assessment; and addressing the two requests from the WCPFC (WCPFC NC Harvest Strategy 2023-01) and the IATTC (IATTC Resolution C-23-02): 1. Update criteria for identifying exceptional circumstances for NPO ALB and 2. Advise how fishing intensity should be interpreted to actual management under the adopted harvest strategy.

The ALBWG held an intersessional workshop in March 2024 at the Fisheries and Oceans Canada (DFO) Institute of Ocean Sciences, in Victoria, Canada. The objectives of this workshop were to: 1) make progress on improvements to biological modelling, data collection and reporting, and abundance index improvements; 2) address tasks for the ALBWG from ISC plenary and RFMOs (updated abundance index, update exceptional circumstances, options to translate fishing intensity); and 3) discuss code archiving and MSE modelling training.

During the workshop, the ALBWG reviewed several modelling improvement analyses and made a work plan to continue to make progress for the next workshop in 2025 and updates for the next stock assessment. The ALBWG also reviewed the updates to the CPUE standardization for the Japanese longline (JPLL) fishery in Q2 and A2, which included two additional years of data and improved uncertainty estimates. The ALBWG agreed that this updated analysis did not show any evidence for changes to the stock status and conservation information that was provided at ISC23. The ALBWG has had some turnover in membership recently and are working toward training and archiving of our software code and analyses so that it can be collaborated on more cooperatively and transparently. The ALBWG has started by using the GitHub platform for this collaboration. Additionally, the ALBWG has had some brief training on the recent MSE software developed for NPO ALB and the WG is starting to plan for the future development and iterations of the MSE approach.

The ALBWG updated the criteria for identifying exceptional circumstances presented at the ISC23 plenary based on implementation of adopted harvest control rules (HCRs) in the current harvest strategy. Indicators were updated under the implementation element in the criteria table in the document (**ISC/24/ANNEX/08/Attachment 5**):

Element	Indicator	Range	Evaluation Schedule
Stock and Fleet Dynamics	Depletion stock biomass ($SSB/SSB_{current, F=0}$)	In any year estimates fall outside the range of uncertainty simulated by the operating models (OMs) used in the most recent MSE (accepted by the ALBWG in 2021)	Benchmark stock assessment every 3 years
	Fishing intensity ($F_{\%SPR}$) where SPR is the spawning potential ratio		
	Changes in fleet dynamics	Any substantial differences from the structure and parameterization used in the OMs of the most recent MSE (accepted by the ALBWG in 2021)	As new evidence and research is presented and accepted by the ALBWG
	Biological parameters		
Application	Stock assessment	Stock assessment is not producible or estimates are unreliable	Benchmark stock assessment every 3 years
Implementation	Fishing intensity ($F_{\%SPR}$)	The fishing intensity is different from what is prescribed by the HCR, given the uncertainty range that was simulated by the most recent MSE (accepted by the ALBWG in 2021)	Benchmark stock assessment every 3 years
	Realized catch or effort	If a TAC/TAE is implemented and the realized catch or effort exceeds the TAC/TAE by greater than 20%	Benchmark stock assessment every 3 years

Both the IATTC and WCPFC also requested that the ISC provide advice on how fishing intensity should be translated to management controls (catch or effort) under the adopted harvest strategy. The ALBWG produced an advice document (**ISC/24/ANNEX/08/Attachment 6**) with the following recommendations:

1. It should be noted that both RFMOs currently maintain fishing effort for NPO ALB at or below the average of 2002 – 2004 levels (e.g., IATTC Resolution C-05-02) and that they have maintained the fishing impact on NPO ALB around or below the target reference point of 45% F%SPR.
2. The ALBWG cautions that the fleet-specific catch and effort reduction per unit of SPR presented in this document [see Figs. 1, 2 in **ISC/24/ANNEX/08/Attachment 6**] will likely change if stock conditions (i.e., recruitment and/or selectivity or availability patterns) change in the future and it is recommended that the relationships presented in the advice be reevaluated if reference points are exceeded for the stock (i.e., if the SSB falls below the threshold or limit reference points for NPO ALB (30%$SSB_{current,F=0}$ and 14%$SSB_{current,F=0}$) or if exceptional circumstances are identified.
3. All fleet groups exhibited strong relationships between catch and SPRs. The relationships for the surface fleet groups (Japan Pole-and-line - JPPL and Eastern Pacific Ocean Surface Fleet - EPOSF) were slightly more variable and uncertain than for the longline fleet groups, due to these fleets predominantly catching juvenile fish (Ages 2 – 4). However, there was still high correlation between catch and SPRs for these fleets. Based on these results the ALBWG recommends that changes in fishing intensity required by the NPO ALB harvest strategy can potentially be translated into catch reductions for all fleet groups.
4. The relationships between effort and SPRs were found to be fleet-specific and tended to be more variable and often less correlated than for catch and SPR. However, the fleet groups using surface gears (i.e., JPPL and EPPOSF) exhibited moderately strong relationships between effort and SPRs. In addition, it should be noted that the WCPFC has adopted a management procedure for WCPO SKJ in the WCPO (WCPFC CCM 2022-01) and the JPPL fishery, which targets primarily SKJ, is managed using effort controls under that management procedure CMM. It should also be noted that the JPPL fleet group exhibited a stronger relationship between effort and SKJ catch, as compared to ALB catch. The ALBWG therefore recommends that changes in fishing intensity required by the NPO ALB harvest strategy can potentially be translated into changes in effort for the management of surface fleet groups, JPPL and EPOSF.

The ALBWG proposed the following schedule for continuing to address workplan tasks and starting the next stock assessment cycle for 2024-26:

Date	Location	Task/Event
April 2024	Online	Follow up WG meeting
June, 2024	La Jolla, USA	IATTC SAC
June, 2024	Canada	ISC Plenary
July, 2024	Japan	NC20
Early 2025	*Tentatively* Chinese-Taipei	Model improvement workshop
Late 2025	TBD	ALBWG workshop: Data Preparation

Next benchmark assessment 2026	TBD	ALBWG workshop: Stock Assessment 2026

Elections were held during the ALBWG modelling improvements workshop. Yuichi Tsuda (Japan) was elected as Vice-Chair of the ALBWG for a 3-year term (2024-27). The ALBWG thanked Steven Teo for his seven years (2017-24) as the Vice-Chair and his significant work in this leadership role. Sarah Hawkshaw (Canada) was re-elected for a second term (2024-27) as the Chair of the ALBWG.

Discussion

Investigation of size-based abundance indices was discussed. This approach is of interest as an alternative to the fleets-as-areas approach that is currently used, considering that multiple cohorts of different life history stages (juveniles and adults) are often caught in the same areas. This CPUE standardization approach uses logbook data sorted by fish size. It was cautioned that size sampling data (length and/or weight) would have to be of high confidence for this new approach. A working paper discussing this method is forthcoming. Progress on this new methodology will be presented at ISC25.

It was noted that an analysis of NPO ALB larval distribution is currently being conducted by Japan. The ALBWG will discuss incorporation of the results of this analysis into the understanding of NPO ALB spawning seasonality in the stock assessment at their next modelling improvements workshop.

Although high seas driftnet catch data are unlikely to be available for the next benchmark stock assessment, the ALBWG plans to conduct simulations to evaluate the risk of not including these data in the stock assessment.

The Plenary discussed at length the extraordinary circumstances criteria developed by the ALBWG and reported in **ISC24/ANNEX/08/Attachment 5** (table shown above) focusing on the implementation element, especially the fishing intensity indicator. The language was modified to clearly specify what criteria would trigger extraordinary circumstances. **The ISC24 Plenary supported the criteria for exceptional circumstances for NPO ALB developed by the ALBWG and recommends their suitability for the harvest strategies adopted by the RFMOs.**

The ISC24 Plenary sought clarity on the ALBWG's recommendations on interpreting the fishing intensity metric in terms of catch and effort. With regard to the relationships between fishing intensity and catch and/or effort, it was noted that the slope of the relationship and therefore the actual numbers in terms of required reductions in catch and effort, will likely change with changes in stock and fleet dynamics and the analysis would need to be redone. The NPO ALB stock has been in a healthy state (above the threshold reference point, 30% $SSB_{current, F=0}$) for the majority of its history; therefore, if reference points are breached, then this event could be evidence of extraordinary circumstances and a reevaluation of the performance of the HCR would likely be required.

The ALBWG stressed that care should be taken in presenting these results to managers because the fleet-specific fishing intensity figures shown are marginal values and are not independent of the other fleets and therefore they should not be used to directly allocate catch or effort reductions to specific fleets . **The ISC24 Plenary supported the ALBWG advice on interpreting the fishing intensity metric in the North Pacific albacore tuna harvest strategy in terms of catch and effort management measures.**

5.2 Pacific Bluefin Tuna

S. Nakatsuka, Chair of the PBFWG, reported on its activities for the past year (**ISC/24/ANNEX/04/10**). The PBFWG conducted a benchmark stock assessment of PBF this year. To complete the task, the WG held two meetings: a data-preparatory meeting in November 2023 and a stock assessment meeting in March-April 2024, and successfully completed the benchmark stock assessment. The WG also held a half-day meeting in Victoria prior to the Plenary to confirm its reports to the Plenary.

The data-preparatory meeting was held on November 27 – December 1, 2023, online. The PBFWG reviewed input data and model settings for the stock assessment and identified several points for further consideration in completing the benchmark assessment, including the development of various CPUE standardization methods for Taiwanese longliners, the possibility of updating Japanese longline CPUE, the review of Japanese survey CPUE for recruitment, and the investigation of the causes of the retrospective pattern in the past assessment model. The WG also discussed the further development of the PBF MSE, including the development of an uncertainty grid of reference operating models (OMs), a review of the modeling options for the use of estimation models (EMs), and how to tweak the east-west impact ratio in the MSE.

The stock assessment meetings were held February 29 to March 8 and April 11 and 12, 2024, in Kaohsiung, Taiwan, and online. Building on the previous assessment models, the PBFWG successfully developed the new benchmark stock assessment model. The new model is consistent with previous assessment models, while demonstrating improvements in model diagnostics, particularly in the retrospective pattern, and flexibility under various model assumptions. The WG considered the results of the newly developed model the best scientific information available and prepared draft conservation information based on it. The WG also continued the development of the PBF MSE. The WG has been developing the PBF MSE package, with a final report and results to be available in 2025. The PBFWG has already obtained all required inputs from the IATTC-WCPFC JWG and the technical work is proceeding according to the timeline. The general PBF MSE simulation framework has been developed, the OM based on the 2024 stock assessment was developed, reference and robustness sets were identified, and a preliminary comparison of alternative EM formats were conducted. This information will be presented at JWG 9 in July 2024.

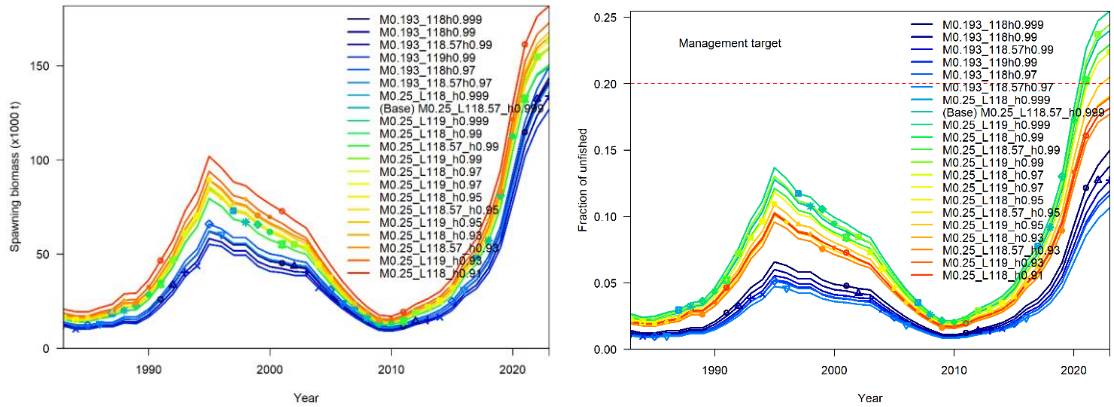


Figure 1. Current reference set of OMs for PBF MSE. Left: absolute abundance, right: relative abundance.

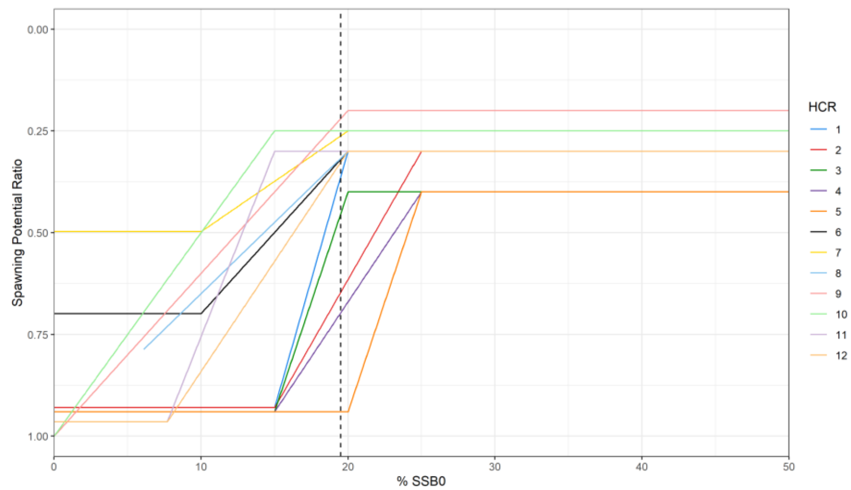


Figure 2. Illustration of candidate HCRs provided by IATTC-WCPFC NC JWG.

The IATTC-WCPFC NC JWG recently requested that the ISC conduct further projections under additional harvesting scenarios based on the 2024 stock assessment in order to facilitate more productive discussions at its upcoming July 10-13 meeting. PBFWG members conducted the requested projections and presented the results at the half-day WG meeting. The PBFWG reviewed and approved the results. The results were presented to the Plenary for its approval together with the assessment results (see Section 1 below).

<u>Discussion</u>

This consistency in trajectories across OMs (Figure 1) reflects the internal consistency of the current stock assessment, which serves as the basis for the OM ensemble. Differences in the trajectory of projections mainly reflect uncertainty in biological parameters.

It was noted that the inclusion of preliminary CKMR estimates as an abundance index in the previous model results showed similar results to the model without CKMR. The CKMR abundance estimates have mainly confirmed estimates derived from the stock assessment and to date have not been incorporated into the stock assessment model. This discussion sparked a recommendation that the ISC organize a workshop or some other mechanism to provide an update of Members' work on CKMR research. An update on the progress of CKMR could be added to a future Plenary meeting agenda. Japan noted that a journal paper is forthcoming documenting the methods that they are using.

The MSE process for the coming year was discussed and clarified. The need for stakeholder engagement opportunities, organized by both Members and the JWG was underscored, with the opportune time being between November 2024 and April 2025, which is when the PBFWG intends to compile the results of the MSE. One concern expressed by the WG Chair is that the specification of fleet selectivity creates a de facto allocation of fishing opportunity in the MSE. There was a comment that the implications of using recent selectivity patterns needs to be made clear to managers when presenting the results.

5.3 Billfish

M. Sculley, BILLWG Chair, provided a summary of BILLWG activities over the last year (**ISC/24/ANNEX/09, 11**). The BILLWG had two in-person hybrid meetings and multiple virtual meetings in 2024. The WG met in Taipei, Chinese Taipei April 15-19, 2024, to conduct a peer review of the 2023 WCNPO striped marlin assessment. Delegates from Japan, Chinese Taipei, USA, SPC, and IATTC participated in person or virtually in both meetings. Three external reviewers met with members of the WG to discuss recommendations for improvements that can be implemented for the 2027 WCNPO MLS assessment. The WG also had a biological workshop and meeting April 20-23, 2024, in Taipei, Chinese Taipei. Ten members participated in person and six additional people participated virtually. A total of four working papers and 10 presentations related to the progress of the International Billfish Bio-sampling (IBBS) Program and additional projections for the 2023 WCNPO MLS assessment were discussed. The discussion around the IBBS Program highlighted the need for additional billfish samples in the EPO.

The WG also discussed 10 projection scenarios to be provided to the WCPFC to support rebuilding plans for the WCNPO MLS stock (**ISC/24/ANNEX/09**). The 10 scenarios are based on the 2023 WCNPO MLS stock assessment (**ISC/23/ANNEX/14**) and consist of six catch scenarios and four fishing mortality scenarios. These new projections show that the stock would meet the targets of the rebuilding plan (rebuild to 20%$SSB_{F=0}$ by 2034 with a 60% probability) with relatively small decreases in catch relative to recent average levels.

The WG does not have an assessment scheduled for 2025, but intends to have an intersessional meeting in Honolulu, Hawaii, January 13-17, 2025. The WG intends to discuss ongoing research on billfish, progress of the IBBS Program, and progress on recommendations from the WCNPO MLS peer review.

Discussion

The Plenary noted that two projections for fishing mortality limits and six projections for catch based limits were provided that meet the requirements of the rebuilding plan, which is a 60% probability that the SSB is greater than 20%$SSB_{F=0}$ in 2034, including two runs that have a 120 cm EFL size limit with low (0.2) and high (0.4) survivorship probability for fish released. In contrast, two F scenarios projecting at F_{MSY} and $F_{status\ quo}$ (the average F from 2018-2020) did not meet the rebuilding plan requirements.

The ISC24 Plenary noted that these projections are based on the 2023 stock assessment and therefore agreed that the stock status and conservation information from the 2023 assessment would not be changed.

The ISC24 Plenary also agreed to provide a brief summary of these results to WCPFC SC as part of MLS discussion. In doing so, it needs to be clarified that ISC conservation information for MLS was maintained, that the additional projections are provided as supplementary information, which are stochastic projection results based on the 2023 stock assessment, and that the next MLS assessment results could change when the WG addresses the recommendations of external peer review (see Section 7.1).

5.4 Shark

M. Kai, SHARKWG Chair, provided a summary of SHARKWG activities over the past year (**ISC/24/ANNEX/05, 06, 07, and 12**). The SHARKWG held four meetings in relation to the benchmark stock assessment for North Pacific SMA.

First, an eight-day hybrid meeting was held at Fishery Resources Institute in Yokohama, Kanagawa, Japan, November 29-Dec 7, 2023 (**ISC/24/ANNEX/05**). Sixteen participants from Canada, Chinese Taipei, IATTC, Japan, Mexico and the U.S. were participated. The focus of the SHARKWG meeting were mainly data preparation for the stock assessment of North Pacific SMA in 2024. The WG considered the likely fisheries responsible for SMA removals and which fisheries could be candidates to produce a representative index of either juveniles or mature adults. The WG also identified key uncertainties that should be accounted for in the upcoming assessment: stock structure, biological uncertainty, inability to sample large females, uncertainty in catches, model start period, and choice of a representative index.

Second, a three-day virtual meeting was held January 23-25, 2024, with 17 participants from Canada, China, Chinese Taipei, IATTC, Japan, Mexico, and the U.S (**ISC/24/ANNEX/06**). The focus of the SHARKWG meeting was mainly to finalize the data preparation. The WG determined the biological parameters and fishery data of Stock Synthesis (SS3) used in the upcoming stock assessment for SMA.

Third, a five-day in-person meeting was held at Southwest Fisheries Science Center in La Jolla, U.S., February 5-9, 2024 (**ISC/24/ANNEX/07**). There were seven participants from IATTC, Japan, and the U.S. The meeting mainly focused on conditioning of the SS3 model. The WG reviewed the predicted steepness based on the 10%, 90%, and median values of M (juvenile, male, and female) as well as combinations of fecundity and maturity parameters. The WG updated the version of SS3 using the previous datasets in 2018 assessment except for the length-weight relationships parameter, which was corrected. Similar outcomes were obtained without issues. The WG also decided on hypotheses that determined which combination of abundance indices was used.

Fourth, a five-day hybrid meeting was held at Pacific Islands Fisheries Science Center in Honolulu, Hawaii, April 29-May 3, 2024 (**ISC/24/ANNEX/12**). There were 15 participants from Canada, Chinese Taipei, Japan, Mexico, and the U.S. The WG agreed to use a model ensemble approach based on a Bayesian state-space production model (BSPM) due to the lack of model convergences in SS3 when updated fishery and biological data are inputs. The WG also agreed to use four abundance indices (two U.S., one Taiwan, and one Japan) and four catch scenarios (low-F, mid-F, high-F and F based on fishing effort of longline). The WG further agreed to use two alternative sets of priors for intrinsic growth rate (r), initial depletion (x0), and shape parameter (B_{MSY}/K). Finally, the WG completed the stock assessment and drafted proposed stock status and conservation information for North Pacific SMA.

In June 2024, the outgoing WG Chair, M. Kai of Japan, completed his final term, and M. Kinney of the U.S. was elected Chair, and Y. Semba of Japan was elected Vice-Chair. Both the new Chair and Vice-Chair will serve at least one three-year term.

The outgoing WG Chair expressed appreciation to all participants in the SHARKWG meetings for their hard work at the meetings.

The SHARKWG proposed the following tentative meeting schedule to accomplish its future work.

Potential Timing	Location	Purpose
Jan/Feb2025	Yokohama/Kesennuma, Japan	Indicator analysis for blue shark

The WG Chair provided an update on points of contact for the SHARKWG by country/organization.

Discussion

It was noted that next year’s workplan focuses on an indicator analysis for NPO BSH to be completed during a single meeting.

6 STOCK STATUS AND CONSERVATION INFORMATION

6.1 North Pacific Albacore

S. Hawkshaw, ALBWG Chair, noted that the last stock assessment was conducted in 2023, and the next assessment is planned for 2026 and she recommended the stock status and conservation information for NPO ALB presented at ISC23. The ISC24 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC23, which was based on the 2023 stock assessment (**ISC/23/ANNEX/08**, see Section 6.1.2, pp. 17-27 in the **ISC23 Plenary Report**) with minor updates and the omission of accompanying figures and tables.

6.1.1 Stock Status and Conservation Information

Stock Status

Estimated summary biomass (males and females at age-1+) declined at the beginning of the time series until 2004. Subsequently, the summary biomass fluctuated without a trend until 2018, after which the biomass rapidly increased to historically high levels. It should be noted that the high summary biomass estimates during 2018-2021 were highly uncertain and should be treated with caution. These high summary biomass estimates were due to historically high recruitment estimates in 2017 (~433 million fish; 95% CI: 194 – 671 million fish). However, recruitment estimates in the last 5 years (2017-2021) were highly uncertain and should be treated with caution. Estimated female SSB exhibited a similar population trend to the summary biomass, albeit with a lag of several years, and showed an initial decline until 2007 followed by fluctuations without a clear trend through 2021.

The average fishing intensity during 2018-2020 was estimated to be $F_{59\%SPR}$ (95% CI: $F_{72\%SPR}$ – $F_{46\%SPR}$), which was relatively moderate and resulted in a population with an SPR of approximately 59%. Instantaneous fishing mortality at age (F-at-age) was similar in both sexes through age-5, peaking at age-4 and declining to a low at age-6, after which males experienced higher F-at-age than females up to age 12. Juvenile albacore aged 2 to 4 years comprised approximately 64% of the annual catch-at-age in numbers between 1994 and 2021 due to the larger impact of surface fisheries (primarily troll, pole-and-line), which remove juvenile fish, relative to longline fisheries, which primarily remove adult fish.

Stock status is depicted in relation to the target ($F_{45\%SPR}$), threshold ($30\%SSB_{current,\ F=0}$), and limit ($14\%SSB_{current,\ F=0}$) reference points. The estimated female SSB has never fallen below the threshold and limit reference points since 1994, albeit with large uncertainty in the terminal year (2021) estimates. However, the estimated fishing intensity for 5 years (1999, 2002, 2003, 2004, and 2007) exceeded the target reference point. Even when alternative hypotheses about key model uncertainties such as growth were evaluated, the point estimate of female SSB in 2021 (SSB_{2021}) did not fall below the threshold and limit reference points, although the risk increases with the more extreme assumption. In contrast, estimated average fishing intensity during 2018-2020 ($F_{2018\text{-}2020}$) did exceed the target reference point under one of these alternative hypotheses but did not exceed the average fishing intensity during the 2002-2004 period.

The SSB_{2021} was estimated to be approximately 54% (95% CI: 40 – 68%) of $SSB_{current,\ F=0}$ and 1.8 (95% CI: 1.3 – 2.3) times greater than the estimated threshold reference point (Figure 6; Table 1). The estimated current fishing intensity ($F_{2018\text{-}2020}$) was estimated to be $F_{59\%SPR}$ (95% CI: $F_{72\%SPR}$ – $F_{46\%SPR}$) and was lower than both the $F_{45\%SPR}$ target reference point and the average fishing intensity during the 2002-2004 period.

Based on these findings, the following information on the status of the NPO ALB stock is provided by the ISC24 Plenary:

1. **The stock is likely not overfished relative to the threshold ($30\%SSB_{current,\ F=0}$) and limit ($14\%SSB_{current,\ F=0}$) reference points adopted in the WCPFC and IATTC harvest strategies (WCPFC Harvest Strategy 2023-01; IATTC Resolution C-23-02);**

2. **The stock is likely not experiencing overfishing relative to the adopted target reference point ($F_{45\%SPR}$), which is the fishing intensity that results in the stock producing a SPR of approximately 45%; and**
3. **Current fishing intensity ($F_{2018\text{-}2020}$) is lower than the average fishing intensity from the 2002-2004 period (the reference level for IATTC Resolution C-05-02 and WCPFC CMM 2019-03).**

<u>Conservation Information</u>

Two harvest scenarios were projected to evaluate impacts on the management objectives of the IATTC and WCPFC for this stock: 1) maintain SSB above the limit reference point, with a probability of at least 80% over the next 10 years; 2) maintain depletion of total biomass around the historical (2006-2015) average depletion over the next 10 years; and 3) maintain fishing intensity at or below the target reference point with a probability of at least 50% over the next 10 years (WCPFC HS 2023-01; IATTC Resolution C-23-02). As a larger cohort is estimated in the latest period of the assessment, all projections show a steep increase of SSB in the first year.

The constant fishing intensity scenario showed that the current fishing intensity ($F_{2018\text{-}2020}$) is expected to result in female SSB increasing to 90,098 t (95% CI: 23,218 – 156,978 t) by 2031. Over the next 10 years, there was: 1) a 97.7% probability of the female SSB remaining above the 14%$SSB_{current,\ F=0}$ LRP for all 10 years; 2) a 72.0% probability of the total biomass (age-1+) being above the average of 2006-2015 for any year; and 3) a 95.5% probability of the fishing intensity remaining at or below the $F_{45\%SPR}$ TRP for any year.

The randomly resampled fishing intensity scenario showed that when future fishing intensity is similar to the 2005 – 2019 period, female SSB is expected to increase to 87,669 t (95% CI: 22,219 – 153,119 t) by 2031. Over the next 10 years, there was: 1) a 98.1 % probability of the female SSB remaining above the 14%$SSB_{current,\ F=0}$ LRP for all 10 years; 2) a 69.5 % probability of the total biomass (age-1+) being above the average of 2006 – 2015 for any year; and 3) a 79.6 % probability of the fishing intensity remaining at or below the $F_{45\%SPR}$ TRP for any year.

Based on these findings, the following conservation information is provided by the ISC24 Plenary for the NPO ALB stock:

1. **If fishing intensity over the next 10 years is maintained at the current fishing intensity ($F_{2018\text{-}2020}$), then female SSB is expected to remain around 54%$SSB_{current,F=0}$ (90,098 t), with a 97.7% probability that female SSB will remain above the 14%$SSB_{current,\ F=0}$ LRP for all 10 years and the harvest strategy management objectives of the IATTC and WCPFC (IATTC Resolution C-23-02; WCPFC Harvest Strategy 2023-01) will likely be met; and**
2. **If fishing intensity over the next 10 years is similar to the 2005 – 2019 period, then female SSB is expected to decrease to 52%$SSB_{current,\ F=0}$ (87,669 t), with a 98.1 % probability that female SSB will remain above the 14%$SSB_{current,\ F=0}$ LRP for all 10 years and the harvest strategy management objectives of the IATTC and WCPFC (IATTC Resolution C-23-02; WCPFC Harvest Strategy 2023-01) will likely be met.**

<u>Discussion</u>

It was noted that NPO ALB has historically been lightly exploited so not much information on the production function and stock response at higher exploitation levels is available.

The WCPFC noted that the WCPFC Conservation and Management Measure (CMM 2019-03) describes the stock status based on the limit reference point adopted by the Commission (20%$SSB_{current\ F=0}$), and WCPFC HS 2023-01 describes the limit reference point as 14% of the dynamic unfished spawning stock biomass (14%$SSB_{current,F=0}$) for the purpose of the North Pacific albacore tuna harvest strategy.

The Plenary also requested clarifying language be added to the stock status information regarding the interpretation of fishing intensity in the target reference point ($F_{45\%SPR}$).

6.2 Pacific Bluefin Tuna Stock Status and Conservation Information

6.2.1 Stock Assessment

H. Fukuda, PBFWG lead modeler, summarized the results of the 2024 PBF benchmark stock assessment (**ISC/24/ANNEX/13**).

1. Stock Identification and Distribution

Pacific bluefin tuna (*Thunnus orientalis*) has a single Pacific-wide stock managed by both the WCPFC and the IATTC. Although found throughout the NPO, spawning grounds are recognized only in the WPO. A portion of each cohort makes trans-Pacific migrations from the WPO to the EPO, spending up to several years of its juvenile life stage in the EPO before returning to the WPO.

2. Catch History

While there are few PBF catch records prior to 1952, PBF landing records are available dating back to 1804 from coastal Japan and to the early 1900s for U.S. fisheries operating in the EPO. Based on these landing records, PBF catch is estimated to be high from 1929 to 1940, with a peak catch of approximately 47,635 t (36,217 t in the WPO and 11,418 t in the EPO) in 1935; thereafter catches of PBF dropped precipitously due to World War II. PBF catches increased significantly in 1949 as Japanese fishing activities expanded across the North Pacific Ocean. By 1952, a more consistent catch reporting process was adopted by most fishing nations and estimated annual catches of PBF fluctuated widely from 1952-2022 (Figure 3). During this period reported catches peaked at 40,383 t in 1956 and reached a low of 8,653 t in 1990. The reported catch in 2021 and 2022 was 15,107 t and 17,458 t, respectively, including non-member countries of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). Catch management measures were implemented by Regional Fisheries Management Organizations (RFMOs) beginning in 2011 (WCPFC in 2011 and IATTC in 2012) and became stricter in 2015. While a suite of fishing gears has been used to catch PBF, the majority of the catch is currently made by purse seine fisheries (Figure 4). Catches during 1952-2022 were predominantly composed of juvenile PBF; the catch of age 0 PBF has increased significantly since the early 1990s but declined as the total catch in weight declined since the mid-2000s and due to stricter control of juvenile catch (Figure 3 and Figure 5).

3. Data and Assessment

Population dynamics were estimated using a fully integrated age-structured model (Stock Synthesis (SS) v3.30) fitted to catch (retained and discarded), size-composition, and catch-per-unit of effort (CPUE) based abundance index data from 1983 to 2023, provided by Members of the ISC, the PBFWG, and non-ISC countries obtained from the WCPFC official statistics. Life history parameters included a length-at-age relationship from otolith-derived ages and natural mortality estimates from a tag-recapture study and empirical-life history methods.

In 2024, the PBFWG conducted a benchmark stock assessment. The PBFWG critically reviewed all aspects of the model, and some modifications were made to improve the model. A total of 26 fleets were defined for use in the stock assessment model based on country/gear/season/region stratification until the end of the fishing year 2022 (June 2023). Quarterly observations of catch and size compositions, when available, were used as inputs to the model to describe the removal processes. Annual estimates of standardized CPUE from the Japanese distant water, offshore, and coastal longline; the Chinese Taipei longline; and the Japanese troll fleets were used as measures of the relative abundance of the population. The CPUE of Japanese longline (adult index) after 2020 and Japanese troll (recruitment index) after 2010 were not included in the model, as these observations may be biased due to additional management measures in Japan. The assessment model was fitted to the input data in a likelihood-based statistical framework. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status and to develop stock projections.

One of the major changes made in this assessment is that the PBFWG decided to shorten the stock assessment model by starting in 1983 instead of 1952. This adjustment was implemented because more reliable data are available after 1983. Additionally, the adoption of a shorter model period enhances flexibility and can accommodate diverse productivity assumptions. This flexibility is an important feature as this model will be used in the upcoming PBF management strategy evaluation (MSE). The PBFWG confirmed that the results and management quantities of the longer period model and the shorter period model are consistent and that the change in the duration of the assessment model does not affect the management advice (Figure 6). A simple update of the 2022 stock assessment with new data estimated slightly higher relative biomass after 2011, reflecting an underestimating tendency of the past model (Figure 6). Other changes include refined parameterization of selectivity to reduce model residuals and shortening of the recruitment index from 1983-2016 to 1983-2010. The truncation of the recruitment index was supported by various analyses as described in the main body of the assessment report and was considered appropriate to reduce the SSB retrospective bias (Mohn's ρ for 10 years-retrospective analysis in the base case is -0.06), which was observed in several previous assessment models. After these modifications, the base-case model fits better to the input data and shows good prediction skill (the root mean square error of the Taiwanese longline CPUE for the predicted 7-year period was 0.24, see Figure 7). The PBFWG therefore concluded that the model is appropriate for generating management advice. Due to those changes, recent relative biomass was scaled up to some extent (see Figure 6) as the retrospective bias was reduced.

After conducting thorough reviews and implementing necessary modifications, the PBFWG found that the 2024 base-case model is consistent with the previous assessment results, that it fits the data well, that the results are internally consistent among most of the data sources, and that the model has improved overall by addressing the issues previously identified. The model diagnostics have confirmed that the base-case model captures the production function of PBF well, thus its estimated biomass scale is reliable, and that the model has good predictability. Based on these findings, the PBFWG concluded that the 2024 assessment model reliably represents the population dynamics and provides the best available scientific information for the PBF stock.

The recruitment index based on the Japanese troll CPUE has proven to be an informative indicator of recruitment in PBF assessments. However, the PBFWG found that the catchability of the recruitment index may have been affected by the adoption of a new licensing system and an increase in troll catch for farming operations after 2010, as well as management interventions after 2016. In addition, an examination of model diagnostics suggested that fitting to the recruitment index after 2010 degraded model prediction skill and increased the SSB retrospective pattern. Therefore, for this assessment, the PBFWG extended the approach of the 2022 assessment and terminated the recruitment index after 2010. This was considered appropriate, because even in the absence of a recruitment index, the model still has other reliable and mutually consistent data to estimate SSB and recruitments, in particular the adult indices.

Although recruitment is well estimated for most of the time series, the recruitment estimates in the terminal period (2019-2022) are more uncertain than other years (Figure 8), which is also shown in the retrospective analysis of recruitment. The recruitment estimate in the terminal year (2022) is uninformed by data and was hence based on the stock recruitment relationship and close to the estimated unfished recruitment. Therefore, recent recruitment estimates should be treated with caution.

Additional evidence on recent recruitment trends was examined by the PBFWG using the newly developed standardized CPUE index from the Japanese troll monitoring program for 2011-2023 (Figure 10). Although the PBFWG concluded that it was premature to include this index in the base-case model, this index is believed to provide a good qualitative indication of recruitment trends. With regard to the recent low recruitment period estimated by the base-case model (2019-2021), the monitoring index showed relatively low recruitment in 2019 and 2020, but relatively high recruitment in 2021-2023. Based on this evidence and the uncertainty in the retrospective analysis of recruitment previously noted, the PBFWG considered the 2021 recruitment estimate from the base-case model to be less reliable. Therefore, the PBFWG decided to start using resampled historical recruitment from 2021, rather than 2022, for the projections.

This decision, in effect, means that the recruitment in 2021 is assumed to be around the historical average, and if in fact it is lower than assumed, though the PBFWG believes it unlikely from the survey index (Figure 10), the near-term projection results would become more pessimistic.

Estimated age-specific fishing mortalities (F) on the stock during the periods of 2012-2014 and 2020-2022, compared with 2002-2004 estimates (the reference period for the WCPFC Conservation and Management Measure), are presented in Figure 11.

The WCPFC and IATTC adopted an initial rebuilding biomass target (the median SSB estimated for the period from 1952 through 2014) and a second rebuilding biomass target (20%$SSB_{F=0}$ under average recruitment) but not a fishing mortality reference level. The previous (2022) assessment estimated the initial rebuilding biomass target ($SSB_{MED1952-2014}$) to be 6.3%$SSB_{F=0}$ and the corresponding fishing mortality expressed as SPR of $F_{6.3\%SPR}$ (Table 2). The Kobe plot shows that the point estimate of the SSB_{2022} was 23.2%$SSB_{F=0}$ and that the recent (2020-2022) fishing mortality corresponds to $F_{23.6\%SPR}$ (Table 1 and Figure 12). The apparent increase in F in the terminal period compared to the historical low in 2018 ($F_{37.1\%SPR}$) is a result of low recruitment in this period. As noted, the recruitment estimates in recent years are more uncertain and this result needs to be interpreted with caution.

Figure 13 depicts the historical impacts of the harvest by the fleets on the PBF stock, showing the estimated biomass when fishing mortality from the respective fleets is zero. Note that trends in fishery impact back to 1970 were computed using the base-case model extended to 1952. Historically, the WPO coastal fisheries group has had the greatest impact on the PBF stock, but since about the early 1990s the WPO purse seine fishery group targeting small fish (ages 0-1) has had a greater impact and the effect of this group in 2022 was greater than any of the other fishery groups. The impact of the EPO fisheries group was large before the mid-1980s, decreasing significantly thereafter. The WPO longline fisheries group has had a limited effect on the stock throughout the analysis period because the impact of a fishery on a stock depends on both the number and size of the fish caught by each fleet; i.e., catching a high number of smaller juvenile fish can have a greater impact on future spawning stock biomass than catching the same weight of larger mature fish. In 2022, the estimated cumulative impact proportion between WPO and EPO fisheries is about 83% and 17%, respectively. There is greater uncertainty regarding discards than other fishery impacts because the impact of discarding is not based on observed data. Currently, the amount of discard mortality is assumed to be 6% of the reported release in EPO and 5% of the catch in WPO.

Discussion

It was noted that recruitment values were resampled from the entire historical time series for the projection scenarios and that the PBFWG considers this approach appropriate that the stock has recovered above 20% of $SSB_{F=0}$.

Discard rates are an important uncertainty in the assessment that should be resolved. In the first instance, Members can increase monitoring to improve discard estimates. The stock assessment included a sensitivity analysis doubling the assumed discard rate and the MSE will incorporate alternative assumptions about discards.

The treatment of CPUE indexes in the assessment model was discussed. It was noted that the Japan longline index shows an anomalous decrease after management interventions were implemented in fishing year 2020 and that part of the time series was not used. Likewise, changes in the targeting strategy in the troll fishery, from supplying the sashimi market to grow-out operations, affected that index and prompted values after 2010 to be excluded from the assessment. There is also an uncertain level of discards in the troll fishery once it began supplying grow-out operations. The Taiwan longline index is valuable because of the length of the time series, but future management interventions and their impact on the assessment would be challenging to resolve. Spatial statistical techniques offer an approach that could partially address the challenge associated with changes to individual indices.

The plausibility of the assumed steepness value of 0.99 was discussed. Although a lower steepness value, such as 0.97, could produce a working model, the PBFWG chose to continue using 0.99 given the lack of sufficient justification to change the previous assumption.

The value of an external review was noted, though concern was raised of a possible conflict with MSE workload. Any review would need to be carefully scheduled.

The timing and related workload resulting from the request for the PBFWG to analyze additional catch projection scenarios (**ISC/24/ANNEX/13/Appendix 2**) was discussed. Ideally, such requests should come in during preparation of the assessment, but they were prompted only when the assessment results were made publicly available for the June 2024 IATTC SAC meeting.

The ISC24 Plenary adopted the 2024 PBF benchmark stock assessment, including additional projection results, and considers it to be the best available scientific information to be used to support stock status and conservation recommendations for the stock.

6.2.2 Stock Status and Conservation Information

4. Stock Status and Conservation Information

The base-case model results show that: (1) spawning stock biomass (SSB) fluctuated throughout the assessment period (fishing years 1983-2022); (2) the SSB steadily declined from 1996 to 2010; (3) the SSB has rapidly increased since 2011; (4) fishing mortality ($F_{\%SPR}$) decreased from a level producing about 1% of SPR[3] in 2004-2009 to a level producing 23.6% of SPR in 2020-2022; and (5) SSB in 2022 increased to 23.2% of $SSB_{F=0}$[4], achieving the second rebuilding target by WCPFC and IATTC in 2021. Based on the model diagnostics, the estimated biomass trend throughout the assessment period is considered robust. The SSB in 2022 was estimated to be 144,483 t (Table 1 and Figure 6), more than 10 times of its historical low in 2010. An increase in immature fish (0-3 years old) is observed in 2016-2019 (Figure 9), likely resulting from reduced fishing mortality on this age group. This led to a substantial increase in SSB after 2019. The method to estimate confidence interval was changed from bootstrapping in the previous assessments to normal approximation of the Hessian matrix.

Historical recruitment estimates have fluctuated since 1983 without an apparent trend (Figure 8). Stock projections assume that future recruitment will fluctuate around the historical (1983-2020

[3] SPR (spawning potential ratio) is the ratio of the cumulative spawning biomass that an average recruit is expected to produce over its lifetime when the stock is fished at the current fishing level to the cumulative spawning biomass that could be produced by an average recruit over its lifetime if the stock was unfished. $F_{\%SPR}$: F that produces % of the spawning potential ratio (i.e., 1-%SPR).

[4] SSBF=0 is the expected spawning stock biomass under average recruitment conditions without fishing.

FY) average recruitment level. Previously, no significant autocorrelation was found in recruitment estimates, supporting the use of randomly resampled recruitment from the historical time series. In addition, now that SSB has recovered to 23.2%$SSB_{F=0}$, the PBFWG considers the assumption that the future recruitment will fluctuate within the historical range to be reasonable. The PBFWG also confirmed that the distributions of historical recruitment from the updated long-term model (1952-2022) and the present base-case model (1983-2022) are comparable.

Stock Status

PBF spawning stock biomass (SSB) has increased substantially in the last 12 years. These biomass increases coincide with a decline in fishing mortality, particularly for fish aged 0 to 3, over the last decade. The latest (2022) SSB is estimated to be 23.2% of $SSB_{F=0}$ and the probability that it is above 20%$SSB_{F=0}$ is 75.9%. **Based on these findings, the following information on the status of the PBF stock is provided by the ISC24 Plenary**:

1. **No biomass-based limit or target reference points have been adopted for PBF, but the PBF stock is not overfished relative to 20%$SSB_{F=0}$, which has been adopted as a biomass-based reference point for some other tuna species by the IATTC and WCPFC. SSB of PBF reached its initial rebuilding target (SSB_{MED} = 6.3%$SSB_{F=0}$) in 2017, seven years earlier than originally anticipated by the RFMOs, and its second rebuilding target (20%$SSB_{F=0}$) in 2021; and**
2. **No fishing mortality-based reference points have been adopted for PBF by the IATTC and WCPFC. The recent (2020-2022) F%SPR is estimated to be 23.6% and thus the PBF stock is not subject to overfishing relative to some of F-based reference points proposed for tuna species (Table 2), including F20%SPR.**

Conservation Information

After the steady decline in SSB from 1996 to the historically low level in 2010, the PBF stock has started recovering, and recovery has been more rapid in recent years, coinciding with the implementation of stringent management measures. The 2022 SSB was 10 times higher than the historical low and is above the second rebuilding target adopted by the WCPFC and IATTC, which was achieved in 2021. The stock has recovered at a faster rate than anticipated when the Harvest Strategy to foster rebuilding (WCPFC HS 2017-02) was implemented in 2014. The fishing mortality (F%SPR) in 2020-2022 is at a level producing 23.6%SPR. According to the requests from WCPFC and IATTC, future projections under various scenarios were conducted. The projection scenarios and their results, including projected yield are shown in Tables 3, 4, and 5 and Figure 14. In addition, the results of additional projections which were requested by the IATTC-WCPFC NC JWG are provided in Appendix 2 of the stock assessment report (**ISC/24/ANNEX/13**).

Based on these findings, the following information on the conservation of the PBF stock is provided by the ISC24 Plenary:

1. **The PBF stock is recovering from the historically low biomass in 2010 and has exceeded the second rebuilding target (20%$SSB_{F=0}$). The risk of SSB falling below**

7.7%$SSB_{F=0}$ (interim LRP for tropical tunas in IATTC) at least once in 10 years is negligible;

2. **The projection results show that increases in catches are possible. However, the risk of falling below the second rebuilding target will increase with larger increases in catch;**
3. **The projection results assume that the CMMs are fully implemented and are based on certain biological and other assumptions. For example, these future projection results do not contain assumptions about discard mortality. Discard mortality may need to be considered as part of future increases in catch; and**
4. **Given the uncertainty in future recruitment and the influence of recruitment on stock biomass as well as the impact of changes in fishing operations due to the management, monitoring recruitment and SSB should continue. Research on a recruitment index for the stock assessment should be pursued, and maintenance of a reliable adult abundance index should be ensured. In addition, accurate catch information is the foundation of good stock assessment.**

Discussion

For the sake of clarity in the discussion of stock status, the language proposed by the WG was simplified to remove the term fishing intensity.

In the conservation information section, an explanation was added about the source of the referenced 7.7% SSB_0 threshold.

Table 1. Total biomass, spawning stock biomass, recruitment, spawning potential ratio, and depletion ratio of Pacific bluefin tuna (*Thunnus orientalis*) estimated by the base-case model, for the fishing years 1983-2022.

Year	Total Biomass (mt)	Spawning Stock Biomass (mt)	Recruiment (x1000 fish)	Spawning Potential Ratio	Relative biomass over $SSB_{F=0}$
1983	31,993	15,429	11,827	3.7%	2.5%
1984	34,852	13,898	8,176	7.1%	2.2%
1985	38,514	14,280	9,207	4.6%	2.3%
1986	38,713	15,925	8,094	1.8%	2.6%
1987	36,385	16,934	6,956	10.4%	2.7%
1988	40,630	19,967	8,977	16.4%	3.2%
1989	47,141	20,590	4,187	18.1%	3.3%
1990	57,723	26,079	21,138	22.1%	4.2%
1991	75,302	34,208	7,400	13.2%	5.5%
1992	84,406	43,037	4,375	16.8%	6.9%
1993	93,667	55,854	3,985	19.0%	9.0%
1994	103,163	64,267	30,951	12.0%	10.3%
1995	116,349	79,269	15,247	7.3%	12.7%
1996	109,419	75,121	17,967	9.2%	12.1%
1997	108,955	68,311	11,344	7.5%	11.0%
1998	104,534	66,696	15,469	5.2%	10.7%
1999	100,748	60,915	21,993	5.6%	9.8%
2000	94,830	57,366	13,910	1.9%	9.2%
2001	82,675	54,907	16,944	9.6%	8.8%
2002	83,931	51,822	13,375	6.3%	8.3%
2003	79,217	49,650	6,748	2.3%	8.0%
2004	70,699	41,296	27,619	1.3%	6.6%
2005	65,488	33,668	15,323	0.6%	5.4%
2006	51,886	26,737	13,854	1.1%	4.3%
2007	45,705	20,791	23,619	0.5%	3.3%
2008	44,337	16,082	21,038	1.0%	2.6%
2009	39,232	12,526	7,983	1.7%	2.0%
2010	37,537	12,275	17,593	2.8%	2.0%
2011	39,632	14,236	13,822	5.8%	2.3%
2012	43,506	17,447	7,663	9.6%	2.8%
2013	48,901	19,711	14,239	7.6%	3.2%
2014	54,166	22,690	4,882	15.9%	3.6%
2015	62,945	28,019	13,367	20.9%	4.5%
2016	77,523	37,762	16,040	21.5%	6.1%
2017	94,213	44,541	11,417	31.4%	7.2%
2018	118,007	56,986	9,991	37.1%	9.2%
2019	146,407	74,734	7,485	29.5%	12.0%
2020	168,571	104,243	6,828	28.4%	16.8%
2021	182,567	131,729	8,275	20.5%	21.2%
2022	186,632	144,483	11,467	21.9%	23.2%
Median (1983-2022)	73,000	35,985	11,647	8.4%	5.8%
Average (1983-2022)	78,528	44,112	12,769	11.5%	7.1%
Unfished (Equilibrium)	785,281	622,254	13,261	100%	100%

Table 2. Ratios of the estimated fishing mortalities (Fs and 1-SPRs for 2002-04, 2012-14, 2020-2022) relative to potential fishing mortality-based reference points, and terminal year SSB (t) for each reference period, and depletion ratios for the terminal year of the reference period for Pacific bluefin tuna (*Thunnus orientalis*) from the base-case model. F_{max}: Fishing mortality (F) that maximizes equilibrium yield per recruit (Y/R). Fxx%SPR: F that produces a given % of the unfished spawning potential (biomass) under equilibrium conditions.

Reference Period	Fmax	(1-SPR)/(1-$SPR_{xx\%}$)				Estimated SSB for terminal year of each period (ton)	Depletion rate for terminal year of each period (%)
		$SPR_{20\%}$	$SPR_{25\%}$	$SPR_{30\%}$	$SPR_{40\%}$		
2002-2004	1.88	1.21	1.29	1.38	1.61	41,296	6.6%
2012-2014	1.24	1.11	1.19	1.27	1.48	22,690	3.6%
2020-2022	0.84	0.95	1.02	1.09	1.27	144,483	23.2%

Table 3. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*).

Harvesting scenarios											
Reference No	Scenarios				Catch limit in the projection				Specified fishery impact at 2034		Note
	WCPO		EPO		WCPO		EPO				
	Small	Large	Small	Large	Small	Large	Small	Large	WCPO	EPO	
1	Status quo (WCPFC CMM2023-02, IATTC Resolution 21-05)				4,475	7,859	3,995		-	-	JWG's request 1(NC19 Summary Report, Attachment E; Maintaining the current CMM)
2	Maintaining the current CMM assuming maximum transfer utilizing the conversion factor				3,236	9,799	3,995		-	-	JWG's request 02 (Maximum utilization of transfer from small fish catch limit to large fish catch limit using the conversion factor).
3	No fishing allowed				0	0	0		-	-	JWG's request 03 (No fishing)
4	Status quo +60%	Status quo +60%	Status quo +60%		7,310	12,424	6,392		-	-	JWG's request 04-1 (scenario achieving 20%SSB0 with 60%probability by pro-rata change in catch).
5	Status quo	Status quo +180%	Status quo +180%		4,475	21,555	11,186		-	-	JWG's request 04-2 (scenario achieving 20%SSB0 with 60%probability by proportional change in catch among the WCPO large fish catch limit and EPO total catch limit).
6	Status quo +20%	Status quo +163%	Status quo +108%		5,420	20,235	8,310		-	-	JWG's request 04-3 (scenario achieving 20%SSB0 with 60% probability by maintaining the total catch proportion between WCPO and EPO as status quo while limiting the catch limit increase for WCPO small fish as 20% of its original catch limit).
7	Status quo +30%	Status quo +131%	Status quo +92%		5,893	17,789	7,670		-	-	JWG's request 04-4 (scenario achieving 20%SSB0 with 60% probability by maintaining the total catch proportion between WCPO and EPO as status quo while limiting the catch limit increase for WCPO small fish as 30% of its original catch limit).
8	Status quo +30%	Status quo +30%	Status quo +190%		5,893	10,142	11,586		70	30	JWG's request 05-1 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 70% and 30% while maintaining the catch proportion of small and large fish in WCPO as status quo).
9	Status quo +55%	Status quo +55%	Status quo +80%		7,074	12,044	7,191		80	20	JWG's request 05-1 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 80% and 20% while maintaining the catch proportion of small and large fish in WCPO as status quo).
10	Status quo +10%	Status quo +130%	Status quo +190%		4,948	17,751	11,586		70	30	JWG's request 05-2 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 70% and 30% while maintaining the catch proportion of small fish in WCPO lower than that of status quo).
11	Status quo +40%	Status quo +120%	Status quo +80%		6,015	17,540	7,191		80	20	JWG's request 05-3 (explored constant catch scenario achieving 20%SSB0 with 60% probability and fishery impact ratio between WCPO and EPO as 80% and 20% while maintaining the catch proportion of small fish in WCPO lower than that of status quo).
12	SPR30%				-				-	-	SPR30% Scenario F1719 multiplied 1.4

* The numbering of Scenarios is different from those given by the IATTC-WCPFC NC Joint WG meeting.

* Fishing mortality in scenario 3 was kept at zero. The catch limit for scenario 12 is calculated to achieve SPR 30% and allocated to fleets proportionately.

* The Japanese unilateral measure (transferring 250 mt of the catch upper limit from that for small PBF to that for large PBF during 2022-2034) is reflected in the projections.

Table 4. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*) and their probability of achieving various target levels by various time schedules based on the base-case model.

Harvesting scenarios							Performance indicators								
Reference No	Scenarios				Specified fishery impact		Median SSB at 2034	Fishery impact ratio of WPO fishery at 2034	Fishery impact ratio of EPO fishery at 2034	Probability of achiving the 2nd rebuilding target at 2041	Risk to breach $SSB_{7.7\%F=0}$ at least once by 2041	Probability of overfishing compared to 20%SSB0 at 2041	Probability of overfishing compared to 25%SSB0 at 2041	Probability of overfishing compared to 30%SSB0 at 2041	Probability of overfishing compared to 40%SSB0 at 2041
	WCPO		EPO												
	Small	Large	Small	Large	WCPO	EPO									
1	Status quo (WCPFC CMM2023-02, IATTC Resolution 21-05)				-	-	287,844	78%	22%	100%	0%	0%	1%	4%	20%
2	Maintaining the current CMM assuming maximum transfer utilizing the conversion factor				-	-	308,868	77%	23%	100%	0%	0%	0%	1%	10%
3	No fishing allowed				-	-	536,653	86%	14%	100%	0%	0%	0%	0%	0%
4	Status quo +60%	Status quo +60%	Status quo +60%		-	-	158,658	82%	18%	61%	8%	39%	57%	71%	89%
5	Status quo	Status quo +180%	Status quo +180%		-	-	143,211	71%	29%	60%	19%	40%	57%	71%	90%
6	Status quo +20%	Status quo +163%	Status quo +108%		-	-	148,332	78%	22%	60%	18%	40%	56%	69%	89%
7	Status quo +30%	Status quo +131%	Status quo +92%		-	-	156,324	80%	20%	63%	14%	37%	53%	67%	87%
8	Status quo +30%	Status quo +30%	Status quo +190%		70	30	158,245	69%	31%	61%	14%	39%	55%	68%	88%
9	Status quo +55%	Status quo +55%	Status quo +80%		80	20	162,242	79%	21%	63%	9%	37%	54%	69%	88%
10	Status quo +10%	Status quo +130%	Status quo +190%		70	30	147,825	70%	30%	60%	19%	40%	57%	70%	89%
11	Status quo +40%	Status quo +120%	Status quo +80%		80	20	153,985	80%	20%	61%	14%	39%	56%	69%	88%
12	SPR30%				-	-	190,088	77%	23%	99%	0%	1%	14%	43%	91%

* The numbering of Scenarios is different from those given by the IATTC-WCPFC NC Joint WG meeting and is the same as Table 3.
* Recruitment is resampled from historical values.

Table 5. Expected yield for Pacific bluefin tuna (*Thunnus orientalis*) under various harvesting scenarios based on the base-case model.

Reference No	Harvesting scenarios								Expected catch							
	Scenarios				Catch limit in the projection				2029				2034			
	WCPO		EPO		WCPO		EPO		WPO		EPO		WPO		EPO	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Commercial	Sport	Small	Large	Commercial	Sport
1	Status quo (WCPFC CMM2023-02, IATTC Resolution 21-05)				4,475	7,859	3,995		4,184	8,219	4,010	1,797	4,179	8,232	4,011	2,005
2	Maintaining the current CMM assuming maximum transfer utilizing the conversion factor				3,236	9,799	3,995		3,256	9,884	4,016	1,933	3,256	9,895	4,018	2,189
3	No fishing allowed				0	0	0		0	0	0	0	0	0	0	0
4	Status quo +60%	Status quo +60%	Status quo +60%		7,310	12,424	6,392		6,509	13,111	6,348	996	6,540	12,969	6,332	926
5	Status quo	Status quo +180%	Status quo +180%		4,475	21,555	11,186		4,386	21,718	11,223	1,033	4,383	20,799	11,224	1,055
6	Status quo +20%	Status quo +163%	Status quo +108%		5,420	20,235	8,310		5,388	20,361	8,321	1,030	5,394	19,989	8,330	1,035
7	Status quo +30%	Status quo +131%	Status quo +92%		5,893	17,789	7,670		5,727	17,911	7,669	1,035	5,739	17,717	7,673	1,026
8	Status quo +30%	Status quo +30%	Status quo +190%		5,893	10,142	11,586		5,488	10,540	11,562	993	5,508	10,420	11,556	950
9	Status quo +55%	Status quo +55%	Status quo +80%		7,074	12,044	7,191		6,594	12,521	7,194	1,011	6,620	12,456	7,196	953
10	Status quo +10%	Status quo +130%	Status quo +190%		4,948	17,751	11,586		4,704	18,017	11,581	1,020	4,707	17,667	11,589	1,025
11	Status quo +40%	Status quo +120%	Status quo +80%		6,015	17,540	7,191		5,991	17,424	7,197	1,027	6,006	17,233	7,205	1,000
12	SPR30%				-				4,820	18,091	5,607	715	4,812	19,436	5,668	733

* Korean catch reflects the recent catch proportion for small and large, thus expected catches do not match with catch allocations

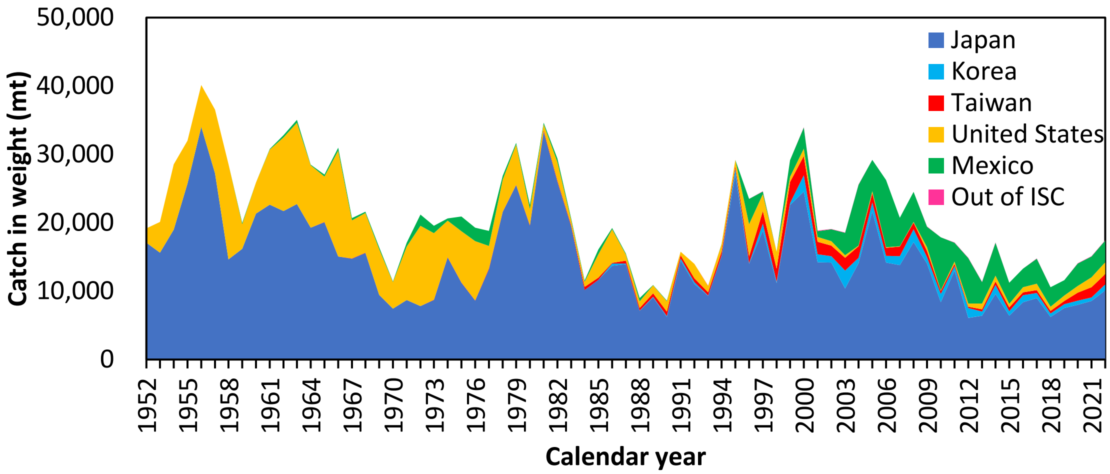


Figure 3. Annual catch (tons) of Pacific bluefin tuna (*Thunnus orientalis*) by ISC member countries from 1952 through 2022 (calendar year) based on ISC official statistics.

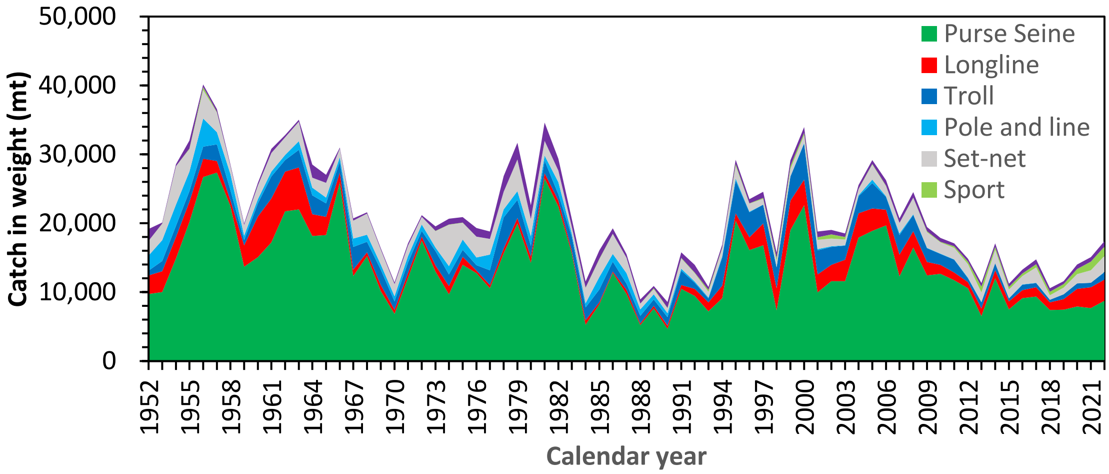


Figure 4. Annual catch (tons) of Pacific bluefin tuna (*Thunnus orientalis*) by gear type by ISC member countries from 1952 through 2022 (calendar year) based on ISC official statistics.

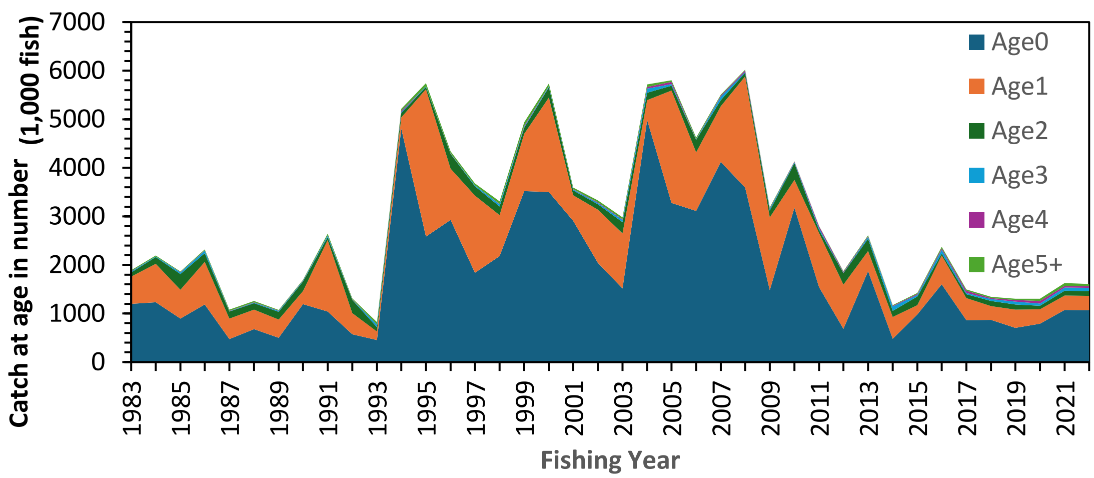


Figure 5. Estimated annual catch-at-age (number of fish) of Pacific bluefin tuna (*Thunnus orientalis*) by fishing year estimated by the base-case model (1983-2022).

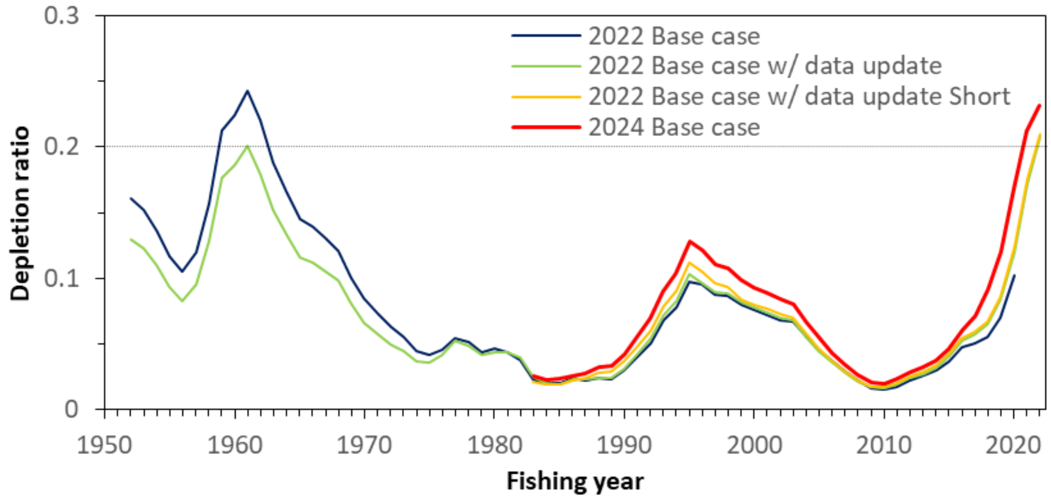


Figure 6. Comparison of the trajectory of relative biomass ($SSB/SSB_{F=0}$, depletion ratio) of the assessment models bridging from the 2022 base-case to the 2024 base-case (2022 base-case, 2022 base-case with data-update, 2022 base-case with data-update Short (1983-), and the 2024 base-case model). The 2022 base-case with data-update and 2022 base-case with data-update Short (1983-) almost overlap towards the end. SSB is spawning stock biomass and $SSB_{F=0}$ is the expected SSB under average recruitment conditions without fishing. The horizontal line represents $20\%SSB_{F=0}$ (the second biomass rebuilding target).

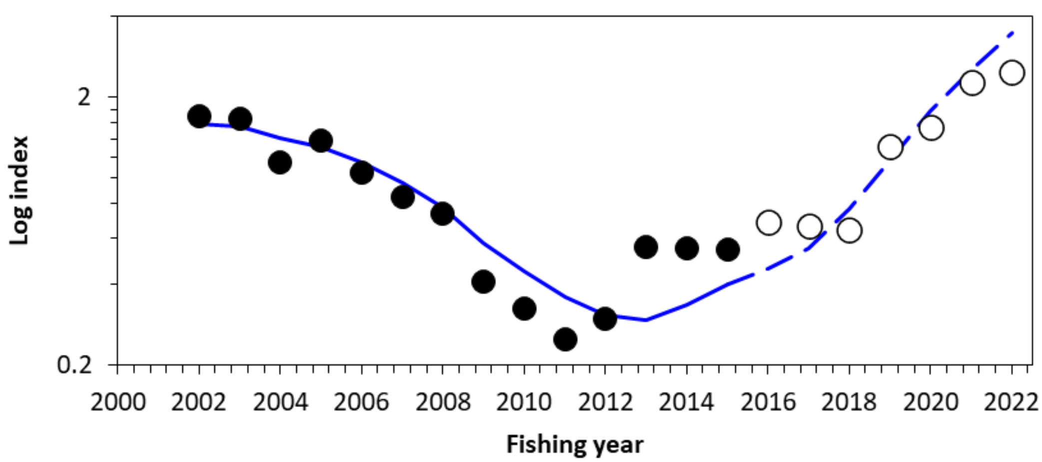


Figure 7. Result for hindcasting of the recent 7 years (2016-2022) based on the catch at age. The expected (blue solid line) and predicted (blue dashed lines) Taiwanese longline CPUE index from the age-structured production model, where CPUE observations were removed for the recent 7 years. The solid circles represent the observations used in the model, and open circles represent the missing values.

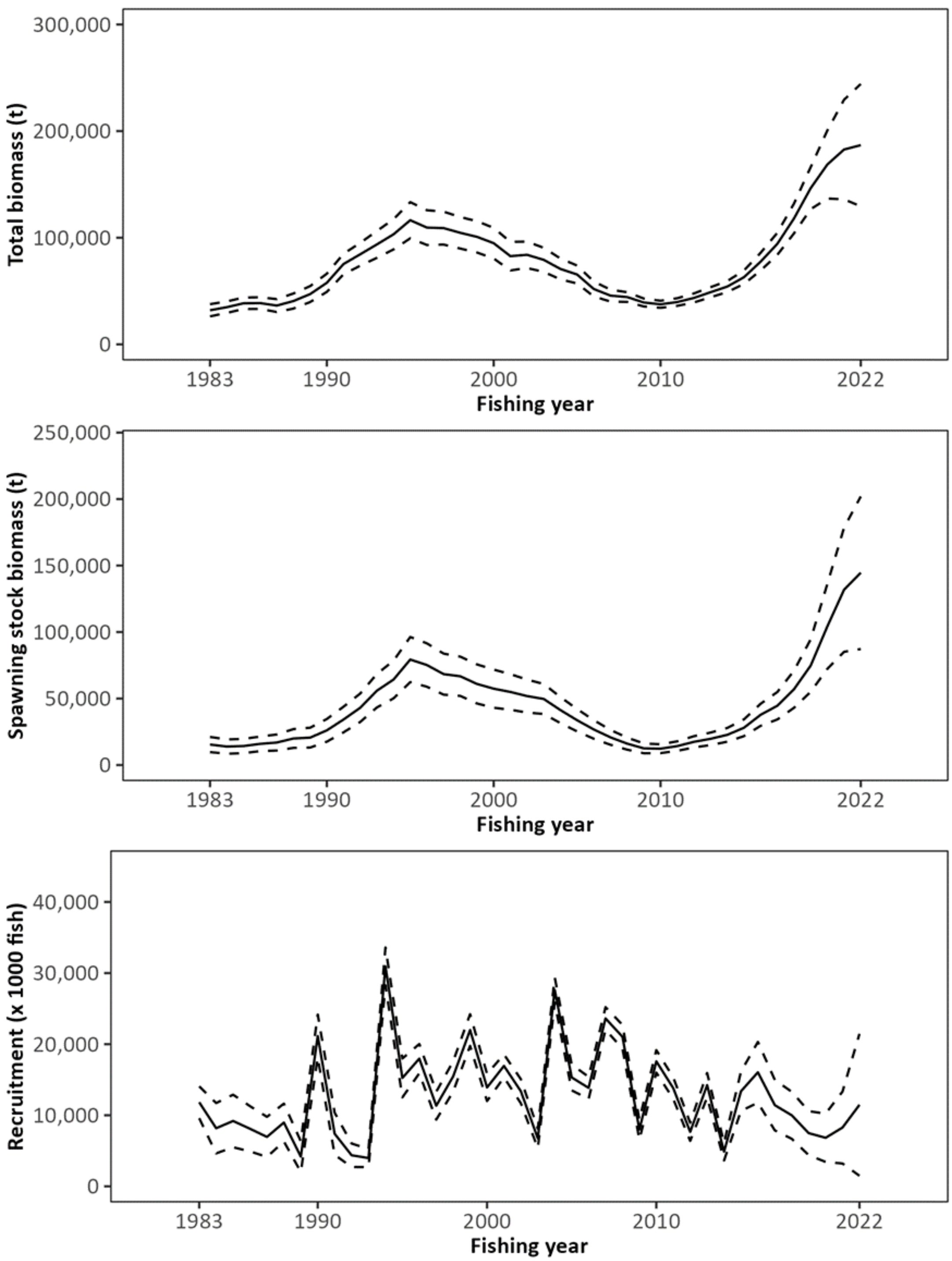


Figure 8. Trajectory of total stock biomass (top), spawning stock biomass (middle), and recruitment (bottom) of Pacific bluefin tuna (*Thunnus orientalis*) (1983-2022) estimated from the base-case model. The solid line is the point estimate, and dashed lines delineate the 90% confidence interval. The method used to estimate the confidence interval was changed from bootstrapping in the previous assessments to the normal approximation of the Hessian matrix.

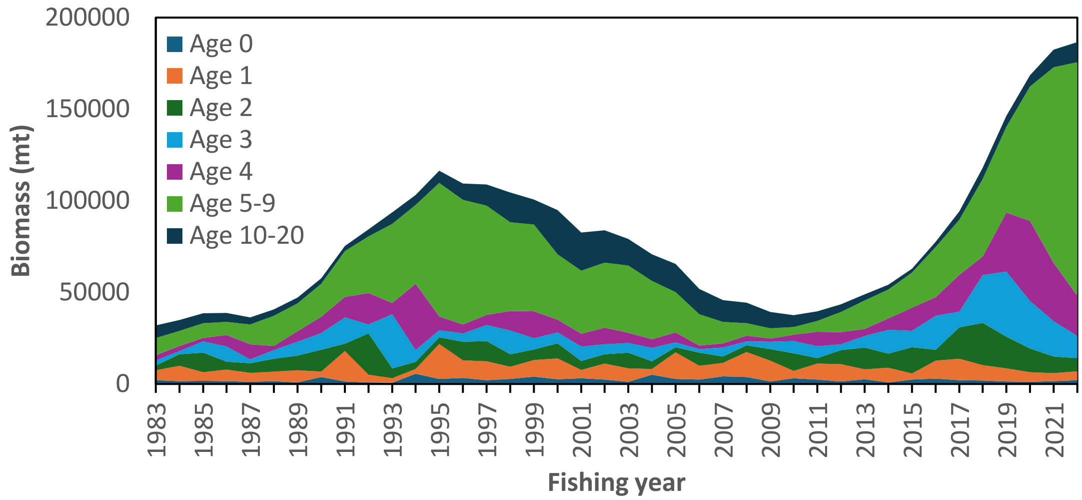


Figure 9. Total biomass (tons) by age of Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model (1983-2022). Note that the recruitment estimates for 2019-2022 are more uncertain than for other years.

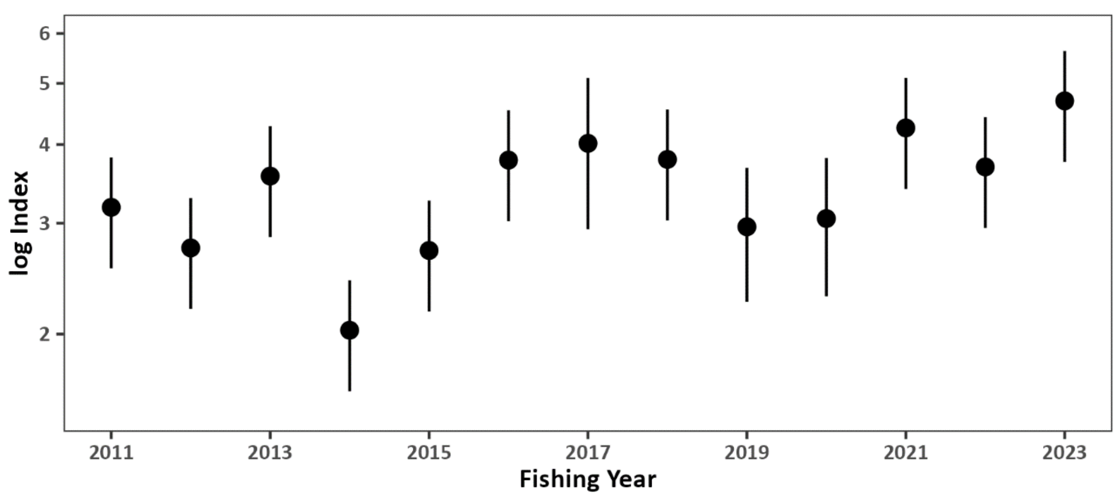


Figure 10. Standardized CPUE index from the Japanese recruitment monitoring program (2011-2023). The bar represents the 95% confidence interval.

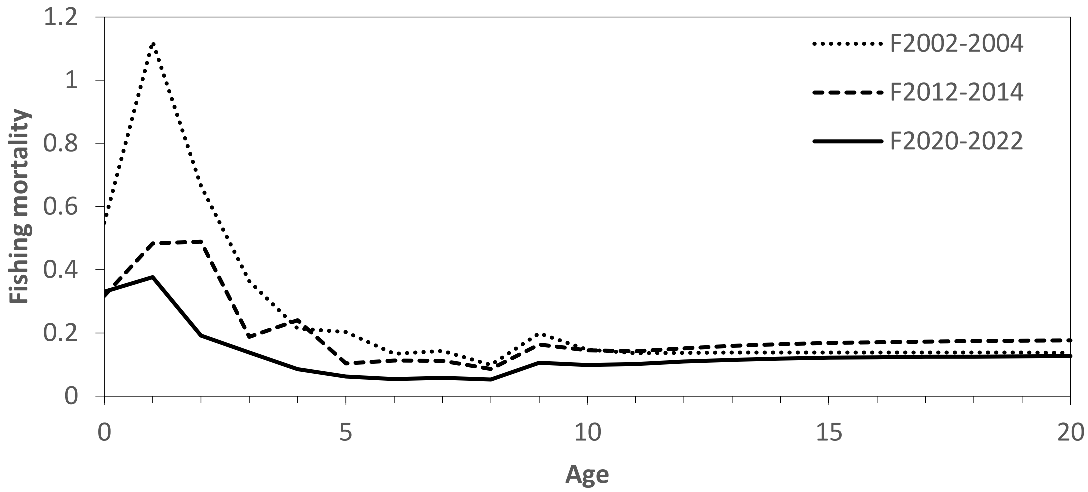


Figure 11. Geometric means of annual age-specific fishing mortalities (F) of Pacific bluefin tuna (*Thunnus orientalis*) for 2002-2004 (dotted line), 2012-2014 (dashed line), and 2020-2022 (solid line).

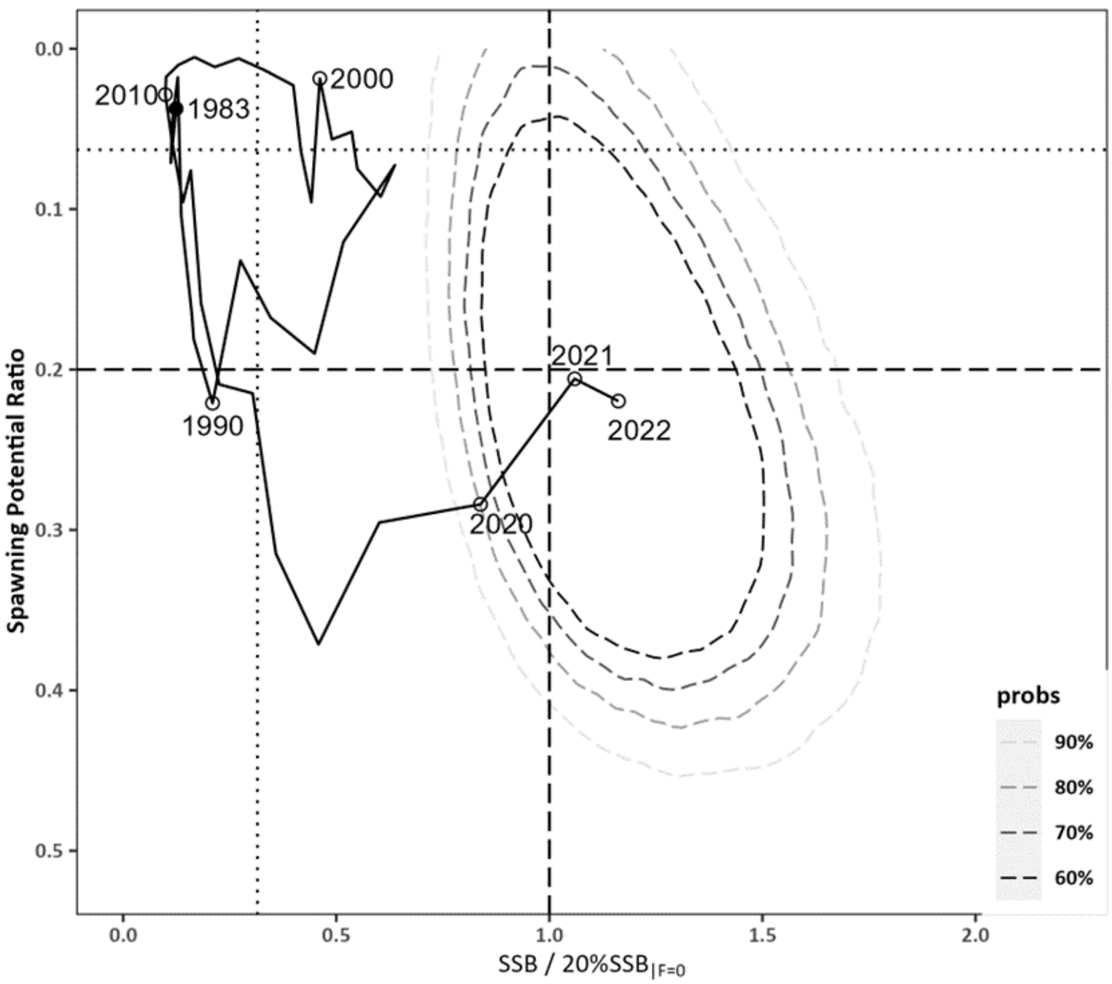


Figure 12. Kobe plot for Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model for 1983 to 2022. The X-axis shows the annual SSB relative to 20%$SSB_{F=0}$ and the Y-axis shows the spawning potential ratio (SPR) as a measure of fishing mortality. Vertical and horizontal dashed lines show 20%$SSB_{F=0}$ (which corresponds to the second biomass rebuilding target) and the corresponding fishing mortality that produces SPR, respectively. Vertical and horizontal dotted lines show the initial biomass rebuilding target (SSB_{MED} = 6.3%$SSB_{F=0}$) and the corresponding fishing mortality that produces SPR, respectively. SSB_{MED} is calculated as the median of estimated SSB over 1952-2014 from the 2022 assessment. The apparent increase of F in the terminal period is a result of low recruitment in this period. As noted, the recruitment estimates in recent years are more uncertain and this result needs to be interpreted with caution. Contour plots represent 60% to 90% of two probability density distributions in SSB and SPR for 2022. The method used to estimate the confidence interval was changed from bootstrapping in the previous assessments to resampling from the multi-variate log-normal distribution. The probability distribution for the area where SPR is below zero is not shown as such SPR values are not biologically possible.

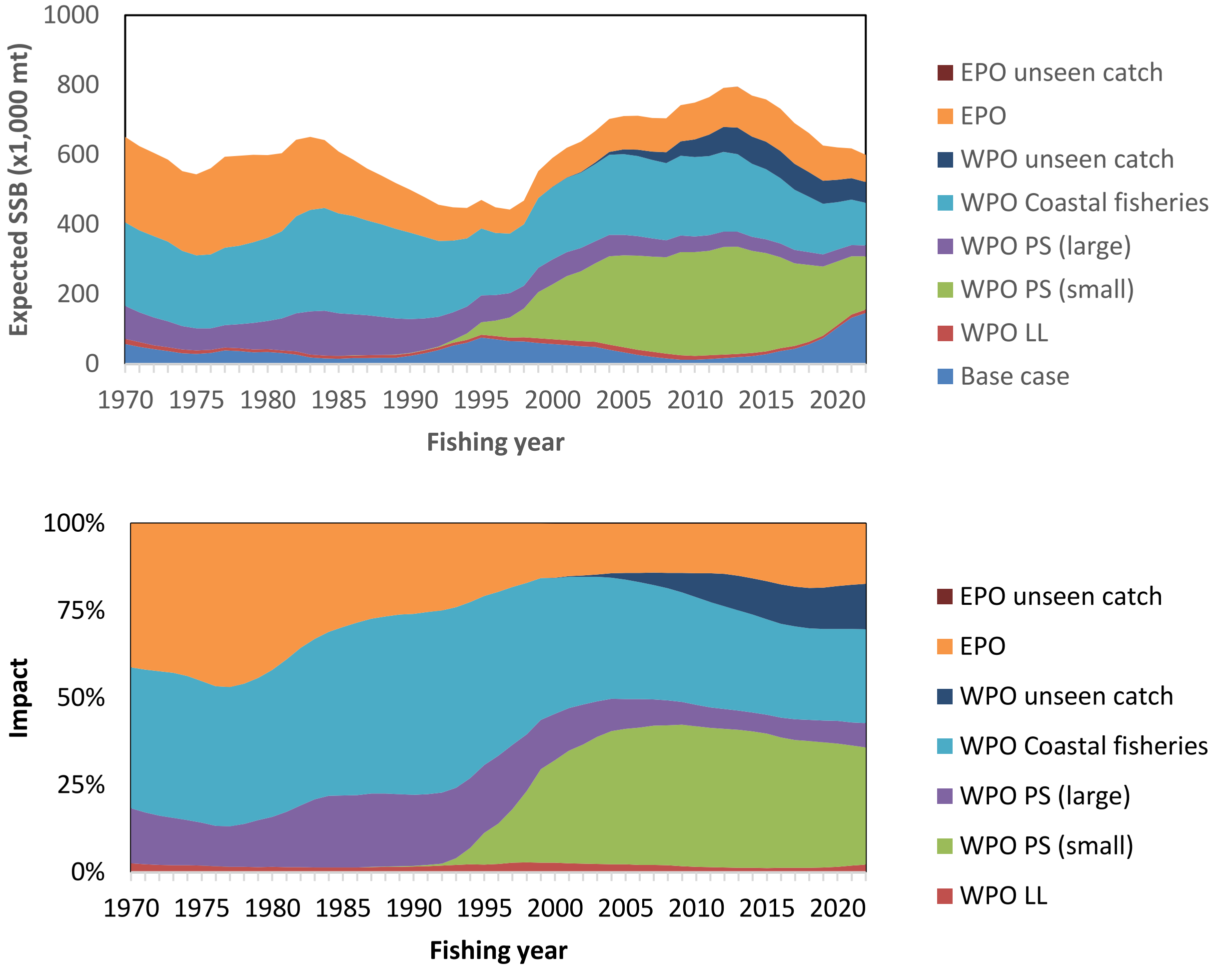
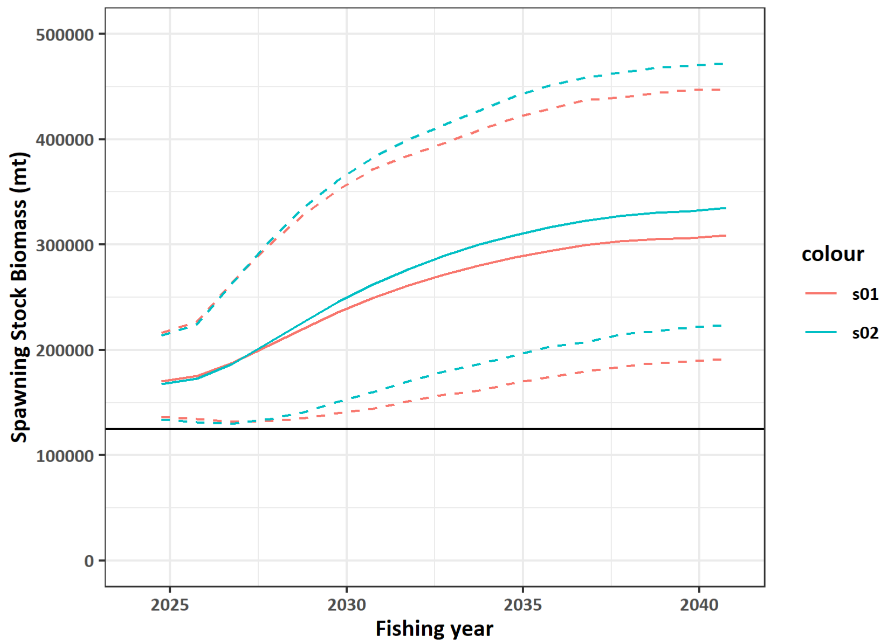


Figure 13. The trajectory of the spawning stock biomass of a simulated population of Pacific bluefin tuna (*Thunnus orientalis*) when zero fishing mortality is assumed, estimated by the base-case long-term model. (top: absolute SSB, bottom: relative SSB). In 2022, the estimated cumulative impact proportion between WPO and EPO fisheries is about 83% and 17%, respectively. Fisheries group definition: WPO longline fisheries: F1-4. WPO purse seine fisheries for large fish: F5-7. WPO purse seine fisheries for small fish: F8-11. WPO coastal fisheries: F12-19. EPO fisheries: F20-23. WPO unaccounted fisheries: F24, 25. EPO unaccounted fisheries: F26. For exact fleet definitions, please see the 2024 PBF stock assessment report. Although larger PBF have been caught by the Korean offshore large-scale purse seine in recent years, this fleet is included in "WPO PS (small)" because of their historical selectivity.



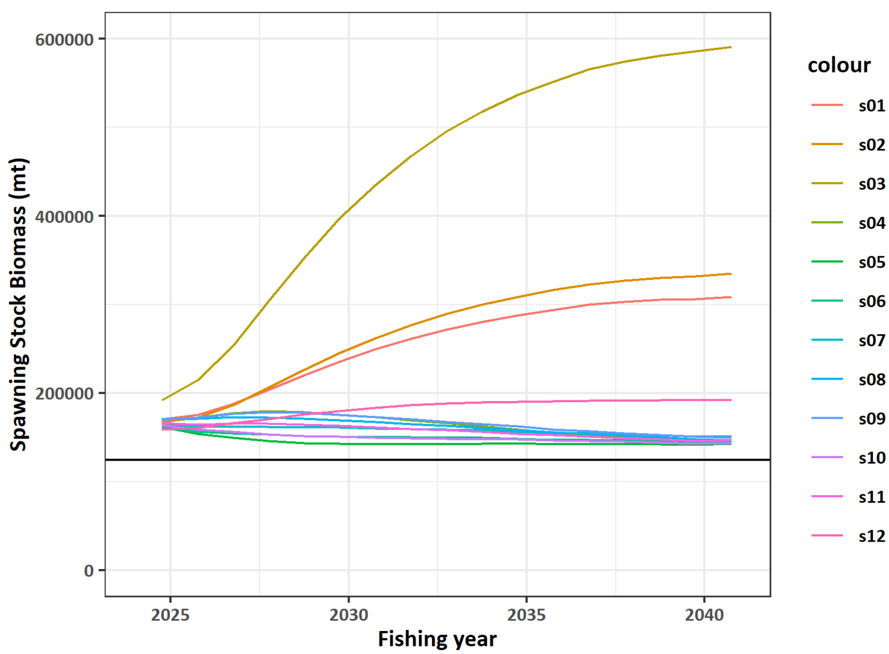


Figure 14. Comparisons of various projection results for Pacific bluefin tuna (*Thunnus orientalis*) obtained from projection results. (Top) Median of scenarios 1 and 2 (solid lines) and their 90% confidence intervals (dotted lines). (Bottom) Median of all harvest scenarios examined from Table 3. The horizontal line represents the second rebuilding target.

6.3 Blue Shark

Since a new stock assessment was not produced in 2024, M. Kai, SHARKWG Chair, presented the stock status and conservation information adopted by the ISC23 Plenary. The ISC24 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC23, which was based on the 2022 stock assessment (see Section 6.3.1 pp. 52-54 in the ISC22 Plenary Report) with slight modifications in the special note section and the omission of accompanying figures and tables, and the inclusion of updated catch information.

The Plenary noted that the average annual catch of BSH by ISC members in 2021-2023 was 23,060 t. Catches in 2022 and 2023 were 20,847 t and 30,210 t, respectively.

6.3.1 Stock Status and Conservation Information

Stock status

The median of the annual spawning stock biomass (SSB) from the model ensemble had a steadily decreasing trend until 1992 and a slightly increasing trend until recent years. The median of the annual F from the model ensemble gradually increased in the late 1970s and 1980s and suddenly dropped around 1990, which slightly preceded the high-seas drift gillnet fishing ban, after which it has been slightly decreasing. The median of the annual age-0 recruitment estimates from the model ensemble appeared relatively stable with a slightly decreasing trend over the assessment period except for 1988, which shows a large pulse. The historical trajectories of stock status from the model ensemble revealed that North Pacific BSH had experienced some level of depletion and overfishing in previous years, showing that the trajectories moved through the overfishing zone, overfished and overfishing zone, and overfished zone in the Kobe plots relative to MSY-based reference points. However, in the last two decades, median estimates of the stock condition returned to the bottom-right quadrant of the Kobe plot.

Based on these findings, the following information on the status of the NPO BSH stock is provided by the ISC24 Plenary:

1. **Target and limit reference points have not been established for pelagic sharks in the Pacific Ocean. Stock status is reported in relation to MSY-based reference points;**

2. **Median female SSB in 2020 (SSB_{2020}) was estimated to be 1.170 of SSB_{MSY} (80th percentile, 0.570 - 1.776) and is likely (63.5% probability) not in an overfished condition relative to MSY-based reference points;**

3. **Recent annual F ($F_{2017-2019}$) is estimated to be below F_{MSY} and overfishing of the stock is very likely (91.9% probability) not occurring relative to MSY-based reference points; and**

4. **The base case model results show that there is a 61.9% joint probability that NPO BSH stock is not in an overfished condition and that overfishing is not occurring relative to MSY-based reference points.**

<u>**Conservation information**</u>

Stock projections of biomass and catch of NPO BSH from 2020 to 2030 were performed assuming four different harvest policies: $F_{current}$ (2017-2019), F_{MSY}, $F_{current}$+20%, and $F_{current}$-20% and evaluated relative to MSY-based reference points.

Based on these findings, the following conservation information for NPO BSH is provided by the ISC24 Plenary:

1. **Future projections in three of the four harvest scenarios ($F_{CURRENT}$ (2017-2019), $F_{CURRENT}$+20%, and Fcurrent-20%) showed that median BSH SSB in the NPO will likely increase; the F_{MSY} harvest scenario led to a decrease in median SSB.**

2. **Median estimated SSB of BSH in the NPO will likely (>50 probability) remain above SSB_{MSY} in the next 10 years for all scenarios except F_{MSY}; harvesting at F_{MSY} decreases SSB below SSB_{MSY}; and**

3. **There remain some uncertainties in the time series based on the quality (observer versus logbook) and timespans of catch and relative abundance indices, limited size composition data for several fisheries, the potential for additional catch not accounted for in the assessment, and uncertainty regarding life history parameters. Continued improvements in the monitoring of BSH catches, including recording the size and sex of sharks retained and discarded for all fisheries, as well as continued research into the biology, ecology, and spatial structure of BSH in the North Pacific Ocean are recommended.**

<u>**Special Note**</u>

1. The SHARKWG notes that uncertainty in stock status in the current assessment is likely still underrepresented as the model ensemble did not consider key uncertainties such as natural mortality or stock-recruitment resilience which are not well-known for many shark species.

6.4 Shortfin Mako Shark

6.4.1 Stock Assessment

N. Ducharme-Barth, SHARKWG lead modeler, summarized the results of the 2024 benchmark stock assessment of NPO SMA (**ISC/24/ANNEX/14**). An indicator analysis was performed previously in 2015 and an integrated, age-based stock assessment using the Stock Synthesis (SS3) modeling platform was conducted in 2018. Revisions to historical catch data and removal of the early relative abundance index made it challenging to reconcile the recent catch and index data with the biological assumptions, and a strategic decision was made to use a Bayesian State-Space Surplus Production Model (BSPM) for the 2024 assessment to model stock status from 1994-2022.

Stock Identification and Distribution

Current and previous stock assessment frameworks have assumed that SMA represent a single, distinct, and well-mixed stock in the NPO. Within the NPO there is strong evidence to suggest, based on the presence of neonates (pups), distinct parturition sites: eastern (Southern California Bight and Baja California) and western (waters east of Japan). Research within the Pacific shows that female SMA may exhibit parturition site fidelity, which could lead to discrete population structure even if male gene flow exists. The available information appears to support the differentiation between separate NPO and South Pacific Ocean SMA stocks but more work is needed to identify the stock structure in the NPO (e.g., single well-mixed stock, or multiple stocks with varying connectivity as a result of females exhibiting site fidelity with distinct parturition sites).

Catch History

Fisheries have likely interacted with SMA in the NPO since the early 20th century, and certainly post-World War II with the expansion of industrial longlining into the high seas. However, fisheries impacts in terms of catch are highly uncertain as data on shark catches were largely unavailable prior to 1975 and species-specific records of shark catch were unavailable prior to 1994 for key fisheries. Species specific catch of sharks is available post-1994 however these catches are also uncertain given inconsistent reporting of shark catch and discards in commercial logbooks.

The previous assessment compiled catch data for two periods, 1975-1993 and 1994-2016. When updating catches through 2022 for the current assessment, driftnet catches for the early period (1975-1993) were substantially revised and resulted in early period catches being lower than catches in subsequent periods. This data revision made it difficult to explain recent period (1994-2022) increases in CPUE, and a decision was made to model stock status from 1994-2022. Within the modeled period, catch generally increased from ~50,000 individuals per year in 1994 to ~80,000 individuals per year in 2022 (~94,000 individuals per year, average 2018-2022; Figure 14). Catches in the modeled period come predominantly from longline fisheries though catch from artisanal fisheries in Mexico and China make up an important component of the catch in more recent years.

Data and Assessment

As a first step, a conceptual model was developed to organize understanding of NPO SMA, identify plausible hypotheses for stock dynamics and fisheries structures, and to highlight key uncertainties (Figure 15). Using the conceptual model as a guide, a BSPM was developed to model the population from 1994-2022 in order to provide stock status information. Catch was aggregated into a single fishery and the model was fit to alternative standardized catch-per-unit-effort (CPUE) data (Figure 16), representing relative trends in abundance, provided by Japan, Chinese Taipei, and U.S.A. Population dynamics are governed by a simplified parameter set: population carrying capacity, maximum intrinsic rate of increase, initial depletion relative to carrying capacity, and the shape of the production function. Informative priors were developed using numerical simulation based on NPO SMA biological characteristics in combination with a prior pushforward analysis. Additional estimated parameters included observation, process, and fishing mortality error terms. Alternate configurations of the BSPM were developed to deal with uncertainty in catch estimates. Given that the BSPM simplifies the population dynamics, an age-structured simulation was developed to assess the possible level of bias when applying the BSPM.

An ensemble of 32 BSPMs was used to provide stock status and management advice. Models within the ensemble were defined based on alternate prior configurations, treatment of catch, and choice standardized CPUE index used in model fitting. Models meet the convergence criterion were retained in the final ensemble (28 of 32 models), and the joint posterior distribution across models was used to characterize stock status.

Future Projections

Stochastic future projections were conducted for each BSPM in the ensemble. The SHARKWG used 4 exploitation U based scenarios to conduct 10-year future projections for NPO SMA: the average exploitation rate from 2018-2021 $U_{2018-2021}$, $U_{2018-2021} + 20\%$, $U_{2018-2021} - 20\%$, and the exploitation rate that produces maximum sustainable yield U_{MSY}. Future projections were conducted using each set of parameters from the posterior distribution of BSPM models. The process error in the forecast period was resampled from the estimated values of process error from the model estimation period.

Key Uncertainties

Key uncertainties were identified through the conceptual model and development of the assessment model. While the model ensemble attempts to integrate over some of these uncertainties (catch, standardized index, biology - through alternative priors), future work and research is needed in order to improve understanding of:

- *Stock structure in the NPO*: multiple parturition sites raises the possibility that multiple stocks exist depending on the level of genetic exchange between parturition sites;
- *Biology (age, growth, reproduction, and natural mortality)*: aging is uncertain due to differences in applied methodologies, and limited utility of vertebral aging for large-sized individuals. A general lack of observations for large mature females complicates understanding of biology;
- *Population scale*: Increasing trends in both the standardized CPUE and catch over the modeled period provide very little information from which to infer population scale;
- *Population trend*: There are no fisheries that operate across the entire range of SMA in the NPO and there are no fisheries that regularly capture and observe large females. This poses a challenge for modeling and indexing the status of the reproductive component of the stock; and
- *Catch*: Fisheries related mortality (e.g., catch) is uncertain in the recent period due to uncertainties in how interactions with sharks (retained catch, live discards, and dead discards) are reported in commercial logbooks, and is highly uncertain prior to 1994 due to the lack of species-specific shark information for many fisheries.

6.4.2 Research Needs

Future research is needed to resolve many of the highlighted uncertainties with the model and the input data. Research priorities include:

- Scoping study to develop and evaluate a genetic sampling plan for CKMR;
- Improving aging estimates and methods used for determining age;
- Improving catch estimates: Fishery removals should be calculated as the sum of landed catch, dead discards, and live discards which eventually succumb to release mortality for all fleets which interact with NPO SMA;
- Applying a joint spatiotemporal analysis of operational longline data to improve the spatial representativeness of the index;
- Standardizing size composition if they are not collected representatively relative to either fishery removals or the population; and
- Building on the BSPM and age-structured simulation by developing a Bayesian age-structured estimation model.

Discussion

The Bayesian prior for initial depletion was discussed. It was explained that it was determined using the same filtering technique used for the R_{MAX} prior.

The exclusion of four models from the ensemble which did not converge, did not affect the weighting scheme or the eventual results.

The intent for the next assessment to use an age structured model within a Bayesian statistical framework was noted by the ISC24 Plenary.

It was noted that fisheries do not select for mature females, because the stock is not a target species. Therefore, that segment of the population is not present in the data. The application of CKMR techniques could be crucial to resolving this data gap. Alternatively, closed loop simulation may help to explore some of these uncertainties.

The ISC24 Plenary adopted the NPO SMA benchmark stock assessment and considers it to be the best available scientific information to be used to support stock status and conservation recommendations for the stock.

6.4.3 Stock Status and Conservation Information

Stock Status

The current assessment provides the best scientific information available on North Pacific shortfin mako shark (SMA) stock status. Results from this assessment should be considered with respect to the management objectives of the WCPFC and the IATTC, the organizations responsible for management of pelagic sharks caught in international fisheries for tuna and tuna-like species in the Pacific Ocean. Target and limit reference points have not been established for pelagic sharks in the Pacific Ocean. In this assessment, stock status is reported in relation to maximum sustainable yield (MSY).

A BSPM ensemble was used for this assessment; therefore, the reproductive capacity of this population was characterized using total depletion (D) rather than spawning abundance as in the previous assessment. Total depletion is the total number of SMA divided by the unfished total number (i.e., carrying capacity). Recent D ($D_{2019-2022}$) was defined as the average depletion over the period 2019-2022. Exploitation rate (U) was used to describe the impact of fishing on this stock. The exploitation rate is the proportion of the SMA population that is removed by fishing. Recent U ($U_{2018-2021}$) is defined as the average U over the period 2018-2021.

During the 1994-2022 period, the median D of the model ensemble in the initial year D_{1994} was estimated to be 0.19 (95% CI: credible intervals = 0.08-0.44), and steadily improved over time and $D_{2019-2022}$ was 0.60 (95% CI = 0.23-1.00) (Table 6. and Figure 17). Although there are large uncertainties in the estimated population scale, the best available data for the stock assessment are four standardized abundance indices from the longline fisheries of Japan, Taiwan, and the US; and all four indices indicate a substantial (>100%) increase in the population during the assessment period. The population was likely heavily impacted prior to the start of the modeled period (1994), after which it has been steadily recovering. It is hypothesized that the fishing impact prior to the modeled period was likely due to the high-seas drift gillnet fisheries operating from the late 1970s until it was banned in 1993, though specific impacts from this fishery on SMA are uncertain as species specific catch data are not available for sharks. Consistent with the estimated trends in depletion, the exploitation rates were estimated to be gradually decreasing from 0.023 (95% CI = 0.004-0.09) in 1994 to the recent estimated exploitation rate ($U_{2018-2021}$) of 0.018 (95% CI = 0.004-0.07). The decreasing trends in estimated exploitation rates were likely due to the increase in estimated population size being greater than increases in the observed catch.

The median of recent D ($D_{2019-2022}$) relative to the estimated D at MSY (D_{MSY} = 0.51, 95% CI = 0.40-0.70) was estimated to be 1.17 (95% CI = 0.46-1.92) (Table 6. and Figure). The recent median exploitation rate ($U_{2018-2021}$) relative to the estimated exploitation rate at MSY (U_{MSY} = 0.05, 95% CI =0.03-0.09) was estimated to be 0.34 (95% CI = 0.07-1.20) (Table 6. and Figure). Surplus production models are a simplification of age-structured population dynamics and can produce biased results if this simplification masks important components of the age-structured dynamics (e.g., index selectivities are dome shaped or there is a long time-lag to maturity). Simulations suggest that under circumstances representative of the observed SMA fishery and population characteristics (e.g., dome-shaped index selectivity, long lag to maturity, and increasing indices), the BSPM ensemble may produce biased results. Representative simulations suggested that the $D_{2019-2022}$ estimate has a positive bias of approximately 7.3 % (median). The trajectories of stock status from the model ensemble revealed that North Pacific SMA had experienced a high level of depletion prior to the start of the model and was likely overfished in the 1990s and 2000s, relative to MSY reference points (Figure).

Based on these findings, the following information on the status of the NPO SMA is provided by the ISC24 Plenary:

1. **No biomass-based or fishing mortality-based limit or target reference points have been established for NPO SMA by the IATTC or WCPFC;**

2. **Recent median D ($D_{2019-2022}$) is estimated from the model ensemble to be 0.60 (95% CI = 0.23-1.00). The recent median $D_{2019-2022}$ was 1.17 times D_{MSY} (95% CI = 0.46-1.92) and the stock is likely (66% probability) not in an overfished condition relative to MSY-based reference points;**

3. **Recent U ($U_{2018-2021}$) is estimated from the model ensemble to be 0.018 (95% CI = 0.004-0.07). $U_{2018-2021}$ was 0.34 times (95% CI = 0.07-1.20) U_{MSY} and overfishing of the stock is likely not occurring (95% probability) relative to MSY-based reference points;**

4. **The model ensemble results show that there is a 65% joint probability that the North Pacific SMA stock is not in an overfished condition and that overfishing is not occurring relative to MSY based reference points; and**

5. **Several uncertainties may limit the interpretation of the assessment results including uncertainty in catch (historical and modeled period) and the biology and reproductive dynamics of the stock, and the lack of CPUE indices that fully index the stock.**

Conservation Information

Stock projections of depletion and catch of North Pacific SMA from 2023 to 2032 were performed assuming four different harvest policies: $U_{2018-2021}$, U_{MSY}, $U_{2018-2021} + 20\%$, and $U_{2018-2021} - 20\%$ and evaluated relative to MSY-based reference points (Figure 19). Based on these findings, the following conservation information is provided:

1. **Future projections in three of the four harvest scenarios ($U_{2018-2021}$, $U_{2018-2021} + 20\%$, and $U_{2018-2021} - 20\%$) showed that median D in the North Pacific Ocean will likely (>50% probability) increase; only the U_{MSY} harvest scenario led to a decrease in median D.**

2. **Median estimated D of SMA in the North Pacific Ocean will likely (>50% probability) remain above D_{MSY} in the next 10 years for all scenarios except U_{MSY}; harvesting at U_{MSY} decreases D towards D_{MSY} (Figure 19).**

3. **Model projections using a surplus production model may oversimplify the age structured population dynamics and as a result could be overly optimistic.**

Discussion

Presentation of the bias adjusted results in the recommendations was discussed. It was agreed that it would be clearer to only use the unadjusted values within the recommendations.

Table 6. Summary of reference points and management quantities for the model ensemble. Values in parentheses represent the 95% credible intervals when available. Note that exploitation rate is defined relative to the carrying capacity.

Reference points	Symbol	Median (95% CI)
Unfished conditions		
Carrying capacity	K (1000s sharks)	12,541 (4,164 - 52,684)
MSY-based reference points		
Maximum Sustainable Yield (MSY)	C_{MSY} (1000s sharks)	338 (134 - 1,338)
Depletion at MSY	D_{MSY}	0.51 (0.40 - 0.70)
Exploitation rate at MSY	U_{MSY}	0.055 (0.027 - 0.087)
Stock status		
Recent depletion	$D_{2019-2022}$	0.60 (0.23 - 1.00)
Recent depletion relative to MSY	$D_{2019-2022}/D_{MSY}$	1.17 (0.46-1.92)
Recent exploitation	$U_{2018-2021}$	0.018 (0.004-0.07)
Recent exploitation relative to MSY	$U_{2018-2021}/U_{MSY}$	0.34 (0.07-1.20)

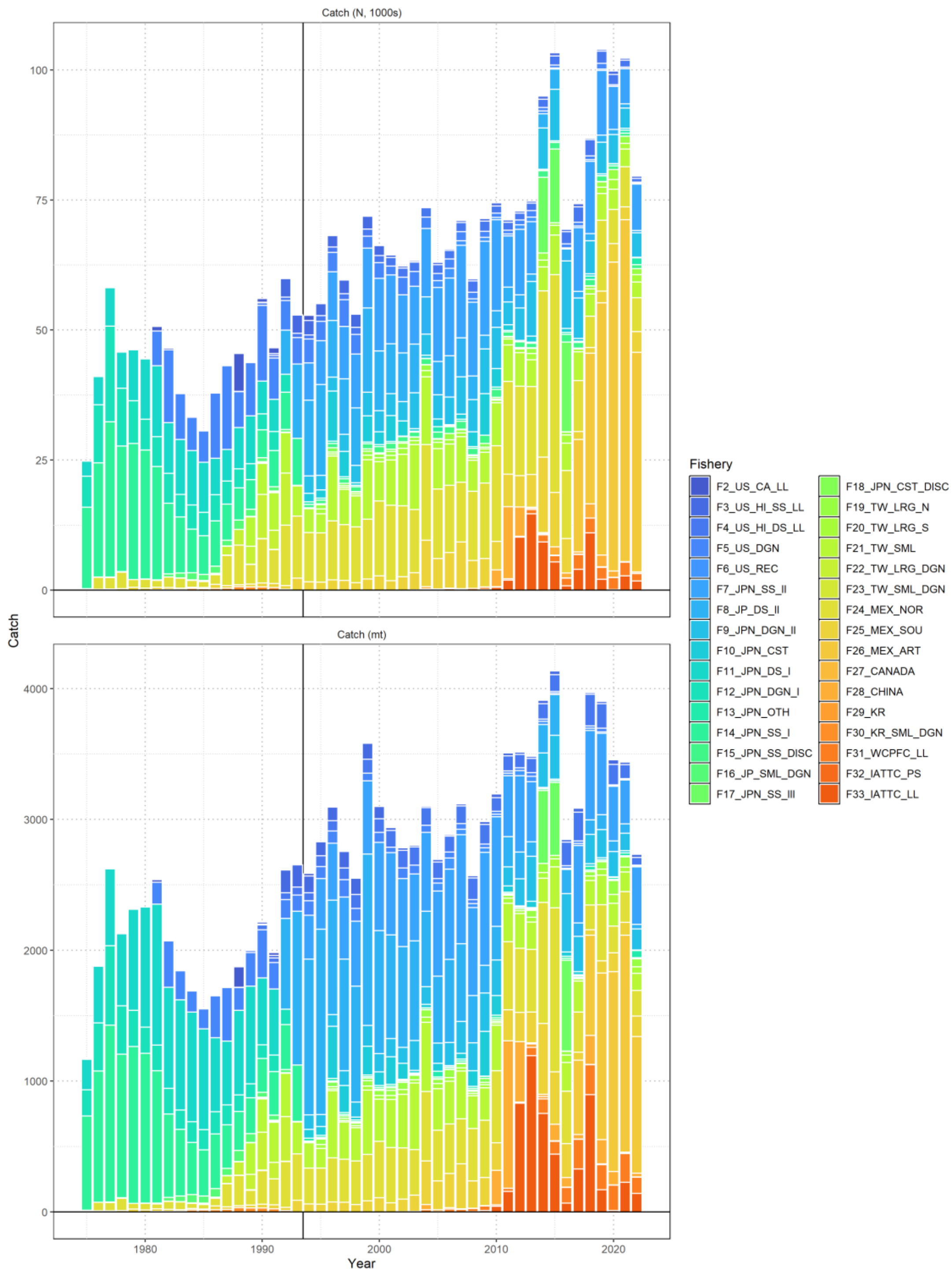


Figure 14. Catch by fishery as assembled by the SHARKWG. Upper panel is catch in numbers (1000s) and lower panel is catch in biomass (mt). The vertical black line indicates the start of the assessment period in 1994.

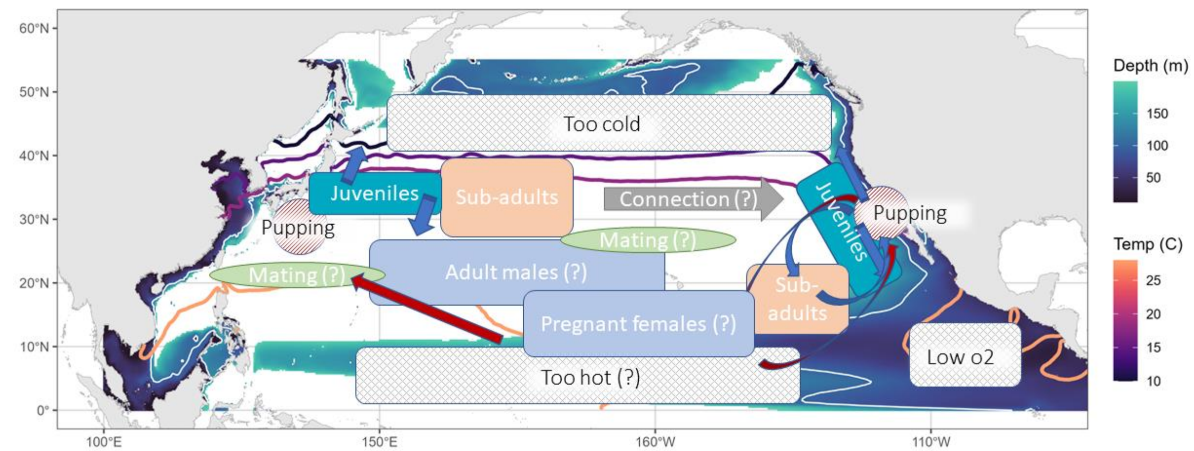


Figure 15. Conceptual model for NPO SMA. Contour lines (warm colors) are shown for the average annual $10^{\circ}, 15^{\circ}, 18^{\circ}$, and 28°C sea surface temperature isotherms. Background shading (cooler colors) shows the depth of the oxygen minimum zone ($3\ mL/L$), a white isocline indicates a depth of 100m which could be limiting based on SMA vertical dive profiles.

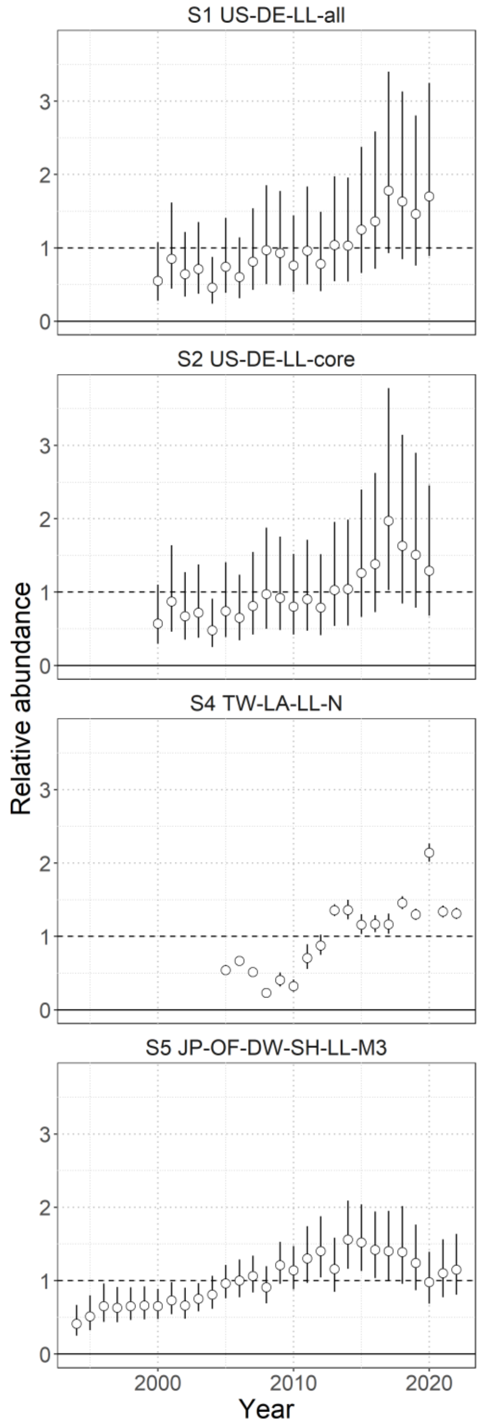


Figure 16. Standardized indices of relative abundance used in the stock assessment model ensemble. Open circles show observed values (standardized to mean of 1; black horizontal line) and the vertical bars indicate the observation error (95% confidence interval).

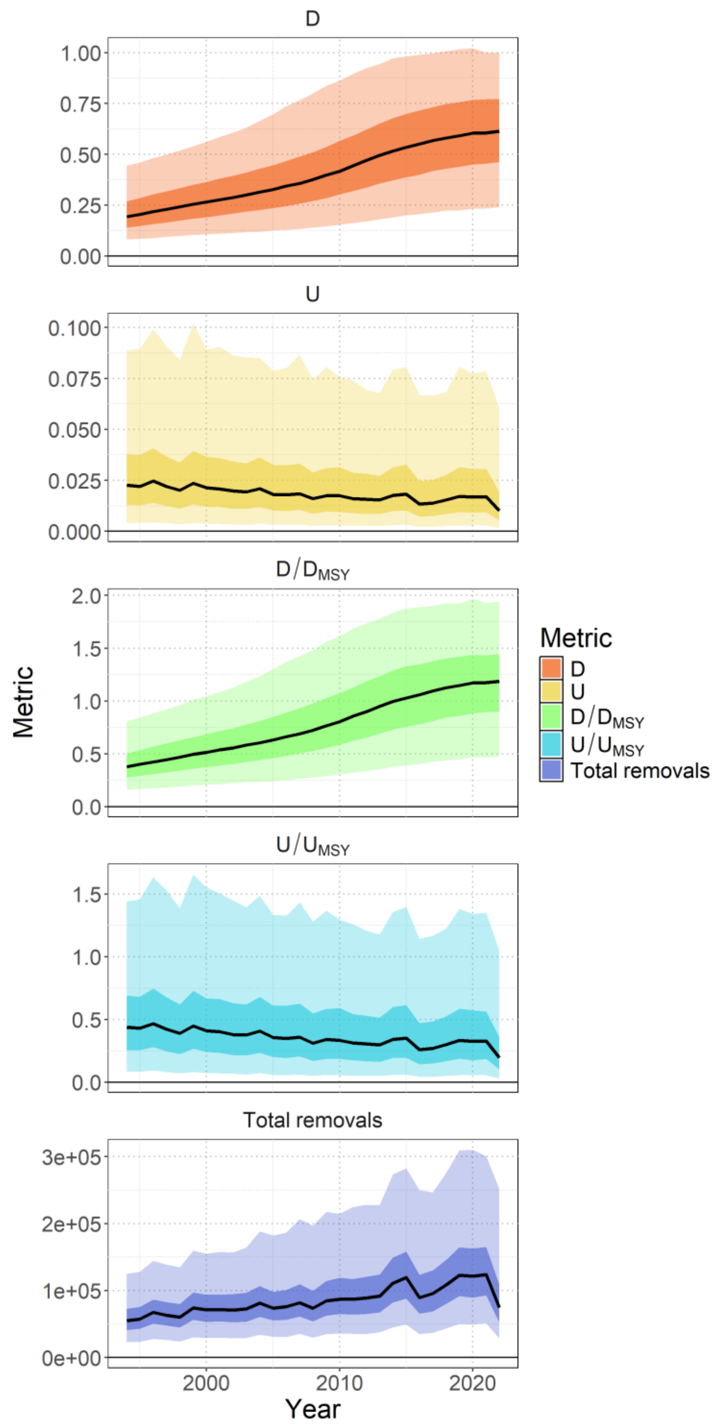


Figure 17. Time series (solid lines) of estimated: depletion (D), exploitation rate (U), depletion relative to the depletion at maximum sustainable yield (D/D_{MSY}), exploitation rate relative to the exploitation rate that produces MSY (U/U_{MSY}), and total fishery removals (numbers). Darker shading indicates 50% credible interval and lighter shading indicates 95% credible interval.

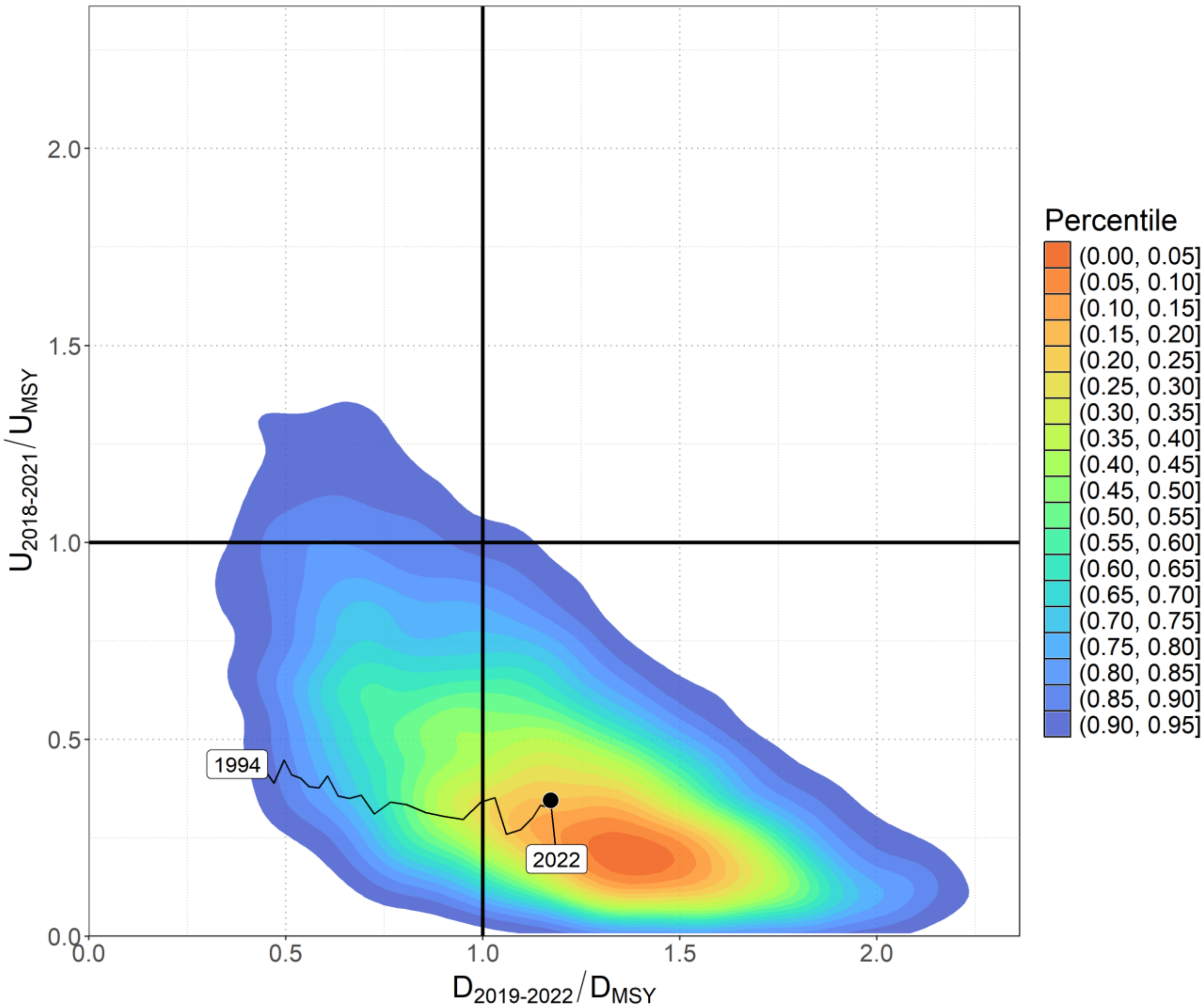


Figure 18. Kobe plot showing the bivariate distribution (shaded polygon) average recent depletion relative to the depletion at MSY ($D_{2019-2022}/D_{MSY}$) against the average recent exploitation rate relative to the exploitation rate at MSY ($U_{2018-2021}/U_{MSY}$). The median of this bivariate distribution is shown with the solid black point. The time series of annual D_t/D_{MSY} versus U_t/U_{MSY} is shown from 1994 to 2022.

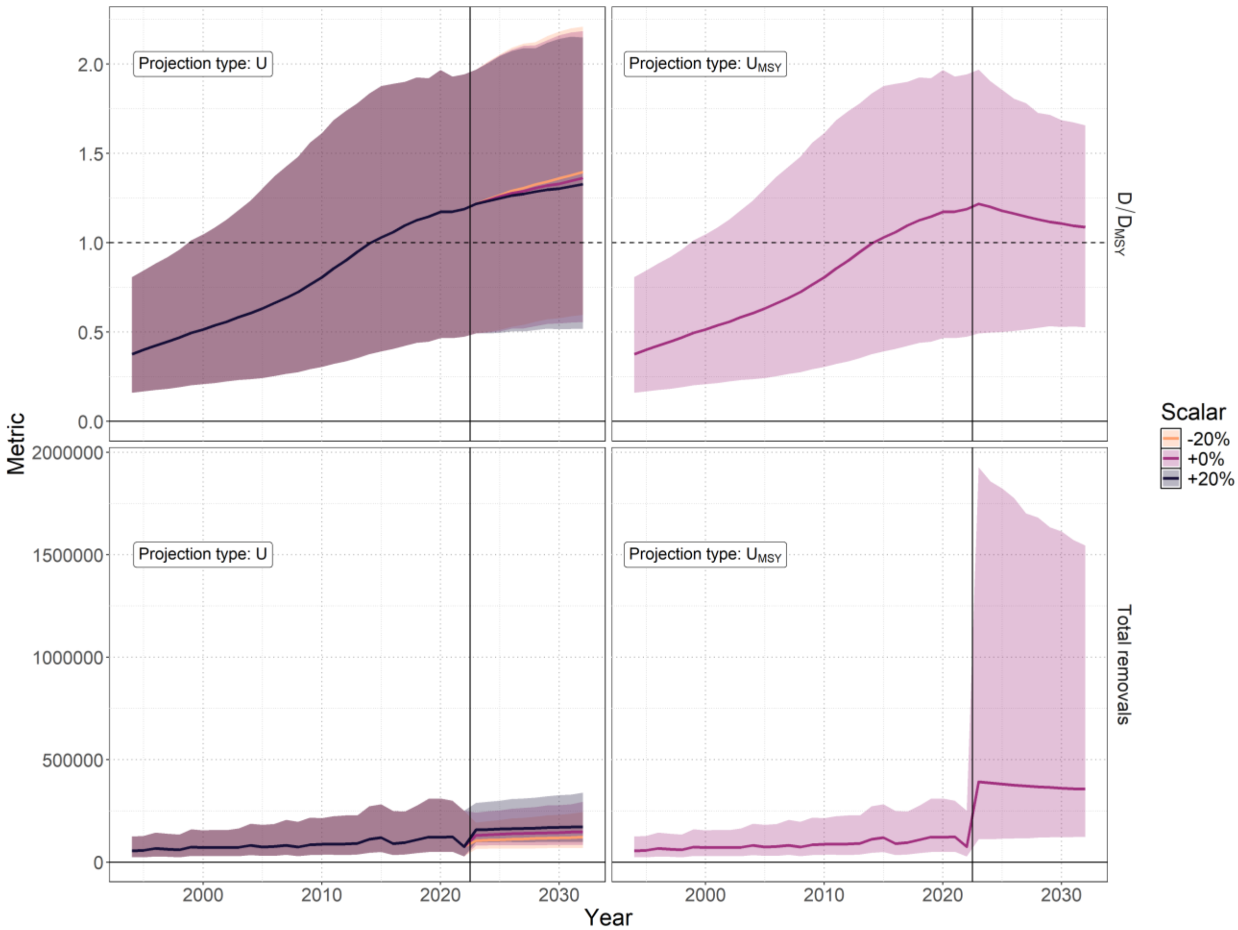


Figure 19. Stochastic stock projections of depletion relative to MSY (D/D_{MSY}) and catch (total removals) of North Pacific SMA from 2023 to 2032 were performed assuming four different harvest rate policies: $U_{2018-2021}$, $U_{2018-2021} + 20\%$, $U_{2018-2021} - 20\%$, and U_{MSY}. The 95% credible interval around the projection is shown by the shaded polygon.

6.5 North Pacific Swordfish

Since a new NPO SWO stock assessment was not produced in 2024, M. Sculley, BILLWG Chair, presented the stock status and conservation information adopted by the ISC23 Plenary. The ISC24 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC23, which was based on the 2023 stock assessment (see Section 6.5.2, pp. 35-42 in the ISC23 Plenary Report) with the omission of accompanying figures and tables.

6.5.1 Stock Status and Conservation Information

Stock Status

Estimates of population biomass fluctuated around an average of 80,800 t during 1975-2021 and was estimated to be 88,800 t in 2021. Initial estimates of female spawning stock biomass (SSB) averaged around 27,600 t in the late 1970s. SSB was at its highest level of 35,778 t in 2021 and was at its minimum of 22,415 t in 1981. Overall, spawning stock biomass has been relatively stable for the entirety of the assessment period. Estimated F (arithmetic average of F for ages 1 – 10) decreased from 0.17 $year^{-1}$ in 1978 to a minimum of 0.09 $year^{-1}$ in 2021. It averaged roughly F=0.09 yr^{-1} during 2019-2021 or about 51% of F_{MSY} with a relative fishing mortality of F/F_{MSY} = 0.49 in 2021. Fishing mortality has been below F_{MSY} since the beginning of the assessment time period and has had a declining trend with the exception of a high peak in 1998 coinciding with high catch by the U.S. longline fleet. Recruitment (age-0 fish) estimates averaged approximately 838,000 individuals during 1975-2021. While the overall pattern of recruitment varied, there was no apparent trend in recruitment strength over time. Overall, total annual catch is declining, CPUE is increasing, and recruitment is relatively stable.

WCPFC16 established a limit reference point for the exploitation rate of NPO SWO of F_{MSY}. $SSB_{F=0}$ was set to equal the average of the last 5 years dynamic B_0 assuming no fishing during those years. NPO SWO reference points will be provided with reference to MSY and with reference to $20\%SSB_{F=0}$.

Based on these findings, the following information on the status of the NPO SWO stock is provided by the ISC24 Plenary:

1. **When the status of NPO SWO is evaluated relative to MSY-based reference points, the 2021 SSB of 35,778 mt is 220% of SSB_{MSY} (16,000 mt) and the 2019-2021 F is about 49% below F_{MSY}; and**

2. **Relative to MSY-based reference points, overfishing is very likely not occurring (>99% probability) and the NPO SWO stock is very likely not overfished (>99% probability).**

Conservation Information

Projections started in 2022 and continued through 2031 under five levels of fishing mortality. The five fishing mortality stock projection scenarios were: (1) F at $20\%SSB_{(F=0)}$ which was calculated from the mean dynamic SSB in the 5 years, (2) $F_{(2008-2010)}$ which are the reference years for the proposed CMM for NPO SWO, (3) F_{Low} at $F_{30\%SPR}$, (4) F_{MSY}, and (5) F status quo (average F during 2019-2021). Results show the projected female spawning stock biomass and the catch biomass under each of the scenarios.

Based on these future projections, the following conservation information for NPO SWO is provided by the ISC24 Plenary:

1. **The NPO SWO stock has produced annual yields of around 11,500 mt per year since 2016, or about 2/3 of the MSY catch amount;**

2. **NPO SWO stock status is positive with no evidence of F above F_{MSY} or substantial depletion of spawning potential; and**

3. **It was also noted that retrospective analyses show that the assessment model appears to underestimate spawning potential in recent years.**

6.6 Pacific Blue Marlin Stock Status and Conservation Information

Since the Pacific BUM stock was last assessed in 2021, M. Sculley, BILLWG Chair, presented the stock status and conservation information adopted by the ISC23 Plenary. The ISC24 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC23 Plenary unchanged, which was based on the 2021 stock assessment.

6.6.1 Stock Status and Conservation Information

Stock Status

Stock status, biomass trends, and recruitment of Pacific BUM for both models in the ensemble had similar trends, although the estimates of initial conditions are different. All reported results are the model-averaged estimates from the ensemble model unless otherwise noted. Estimates of population biomass declined until the mid-2000s, increased again until 2021, and has been relatively flat until the present. The minimum spawning stock biomass is estimated to be 17,592 t in 2006 (5% above SSB_{MSY}, the spawning stock biomass to produce MSY, 95% C.I. 14,512-20,703 t, SSB/SS_{MSY} 95% C.I. 0.70-1.01). In 2019, SSB = 24,272 t and the relative SSB/SSB_{MSY} = 1.17 (95% C.I. 0.87-1.51). Combined median fishing mortality on the stock (average F on ages 1-10) is currently below F_{MSY}. It averaged roughly F = 0.13 yr^{-1} during 2017-2019, or 40% below F_{MSY}, and in 2019, F=0.11 yr^{-1} with a relative fishing mortality of F/F_{MSY} = 0.50 (95% C.I. 0.37-0.69). Median fishing mortality has been below F_{MSY} every year except 2003 to 2006. The predicted value of the spawning potential ratio (SPR, the predicted spawning output at current F as a fraction of unfished spawning output) is currently $SPR_{2017-2019}$ = 31% for the combined model, which is above the SPR required to produce MSY (17%). Recruitment was relatively consistent throughout the assessment time period, with occasional pulses in recruitment, but no notable periods of below-average recruitment. No target or limit reference points have been established for Pacific BUM under the auspices of the WCPFC. Pacific BUM is expected to be highly productive due to its rapid growth and high resilience to reductions in spawning potential.

Although fishing mortality has approached MSY and exceeded MSY from 2003 to 2006, the biomass of the stock has remained above MSY. With continued decreases in Pacific BUM catch and fishing effort, the stock is expected to remain within MSY limits. When the status of BUM is evaluated relative to MSY-based reference points, the 2019 spawning stock biomass of 24,272 t is 17% above SSB_{MSY} (20,677 t, 95% C.I. -13% to +50%) and the 2017-2019 fishing mortality is 50% below F_{MSY} (95% C.I. 37% to 69%).

Based on these findings, the following information on the status of the Pacific BUM stock is provided by the ISC24 Plenary:

1. **No target or limit reference points have been established for BUM by the IATTC and the WCPFC;**

2. **Female spawning stock biomass was estimated to be 24,241 t in 2019, or about 17% above SSB_{MSY} and 17% above $20\%SSB_0$;**

3. **Fishing mortality on the stock (average F, ages 1 to 10) averaged roughly F = 0.13 during 2016-2019, or about 40% below F_{MSY} and 28% below $F_{20\%SSB0}$; and**

4. **Blue marlin stock status based on the ensemble model shows that relative to MSY-based reference points, overfishing was very likely not occurring (>90% probability) and Pacific BUM is likely not overfished (81% probability).**

<u>**Conservation Information**</u>

The Pacific BUM stock has produced annual yields of around 18,800 mt per year since 2015, or about 90% of the MSY catch. Pacific BUM stock status from the ensemble model shows that the current median spawning biomass is above SSB_{MSY} and that the current median fishing mortality is below F_{MSY}. However, uncertainty in the stock status indicates a 19% chance of Pacific BUM being overfished relative to SSB_{MSY}. Both the old and new growth models show evidence of spawning biomass being above SSB_{MSY} and fishing mortality being below F_{MSY} during the last 5 years. Catch biomass has been declining for the last 5 years, and therefore the stock has a low risk of experiencing overfishing or being overfished unless fishing mortality increases to above F_{MSY} based upon stock projections. However, it is also important to note that retrospective analyses show that the assessment model tends to overestimate biomass and underestimate fishing mortality in recent years, in part due to rapid changes in longline CPUE.

Based on these findings, the following conservation information is provided for the Pacific BUM stock by the ISC24 Plenary:

1. **There is no evidence of excess fishing mortality above F_{MSY} ($F_{2016\text{-}2019}$ is 40% of F_{MSY}) or substantial depletion of spawning potential (SSB_{2019} is 17% above SSB_{MSY});**

2. **It is important to note that retrospective analyses show that the assessment model appears to overestimate spawning stock biomass in recent years; and**

3. **The results show that projected female spawning biomass is expected to increase under the $F_{status\ quo}$ and $F_{30\%}$ harvest scenarios and decline to SSB_{MSY} under the**

High F and F_{MSY} harvest scenarios. The probability that the stock is overfished or overfishing occurring by 2029 under each harvest scenario is low.

6.7 WCNPO Striped Marlin

Since the WCNPO MLS stock was last assessed in 2023, M. Sculley, BILLWG Chair, presented the stock status and conservation information adopted by the ISC23 Plenary. The ISC24 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC23, which was based on the 2023 stock assessment (see Section 6.7.2, pp. 46-49 in the ISC23 Plenary Report) with the omission of accompanying figures and tables.

6.7.1 Stock Status and Conservation Information

Stock Status

Estimates of population biomass from the base case fluctuated around an average of 11,300 t during 1977 2020 and was estimated to be 7,300 t in 2020. Initial estimates of female SSB averaged around 4,700 t during the 1977-1979 period. SSB was at its highest level of 5,096 m t in 1977, and declined to lowest level, 1,080 t, in 2011. The time series of SSB during 2011-2020 averaged about 1,200 metric tons (Table 4), or about 33% of the dynamic 20 year $20\%SSB_{F=0}$ and about 42% of SSB_{MSY} (Table 5). Overall, SSB exhibited a strong decline during 1992-1998 and has stabilized to an average of about 1,400 t through the 2000s. Estimated fishing mortality (arithmetic average of F for ages 3-12) increased from 0.53 yr^{-1} in 1977 to a peak of 1.42 yr^{-1} in 1998, and subsequently declined to 0.58 yr^{-1} in 2020. It averaged roughly F=0.68 yr^{-1} during 2018-2020 or about 28% above $F_{20\%SSBF=0}$ and 8% above F_{MSY}, with a relative fishing mortality of $F/F_{20\%SSBF=0}$ = 1.09 in 2020. Fishing mortality has been above $F_{20\%SSBF=0}$ and F_{MSY} since the beginning of the assessment time period but has had a declining trend since 1998. Recruitment (numbers of age 0 fish) estimates averaged approximately 366,000 during the 1977-2020 period. While the overall pattern of recruitment from 1977 to 2020 varied, there was an apparent declining trend in recruitment strength over time with higher recruitments observed during the 1977-1992 period and lower recruitments from 2000 to the present.

Recruitment from 2001 to 2020 averaged about 225,000 age 0 fish, which was 60% of the 1977 2020 average. The WCPFC has requested that the BILLWG to provide estimates of stock status for WCNPO MLS relative to biological reference points based on 20% of a dynamic SSB_0 estimate ($SSB_{(F=0)}$), where SSB_0 is the moving average of the last 20 years SSB_0 estimates. Despite the relatively large L_{50}/L_{inf} ratio for WCNPO MLS, 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 average since 2000. Although fishing mortality has decreased since 2000, two decades of low recruitment combined with consistent landings of immature fish have inhibited increases in spawning biomass since 2001.

Based on these findings, the following information on the status of the WCNPO MLS stock is provided by the ISC24 Plenary:

1. **When the status of WCNPO MLS is evaluated relative to dynamic 20%$_{SSBF=0}$ based reference points, the 2020 spawning stock biomass of 1,696 t is 54% below 20%$SSB_{F=0}$ (3,660 t) and the 2018-2020 fishing mortality is about 28% above $F_{20\%SSB(F=0)}$; and**

2. **Therefore, relative to 20%$SSB_{F=0}$ based reference points, the WCNPO MLS stock is very likely to be overfished (>99% probability) and is likely to be subject to overfishing (>66% probability).**

Conservation Information

Stock projections for WCNPO MLS were conducted using two deterministic scenarios for future recruitment: the expected stock recruitment relationship and the average recruitment in the last 20 years (2001-2020). Projections started in 2021 and continued through 2040. Five levels of fishing mortality with the two recruitment scenarios and the ten catch levels with only the 20-year average recruitment scenario were applied for projections. The five fishing mortality scenarios were: F status quo (average F during 2018 2020), F_{MSY}, F at 20%$_{SSBF=0}$, F_{High} at the highest 3-year average during 1977-2017 (1998-2000), and F_{Low} at $F_{30\%}$. The ten catch level scenarios were: No catch (F=0), 500 t catch, 1,000 t catch, 1,500 t catch, 2,000 t catch, 2,300 t catch, 2,400 t catch, 2,500 t catch, 3,000 t catch, and 3,500 t catch.

Twenty results show the projected female spawning stock and catch biomasses under each scenario. When recruitment is assumed to be consistent with the stock recruitment relationship, then only two fixed F scenarios result in the WCNPO MLS stock rebuilding beyond SSB_{MSY} and 20%$SSB_{F=0}$: F_{Low} and $F_{20\%SSB(F=0)}$. In contrast, when recruitment is assumed to be the average over the last 20 years (2001-2020), none of the fixed F scenarios result in the stock rebuilding to or beyond $F_{20\%SSBF=0}$ and only one scenario, F_{Low}, resulted in the stock rebuilding above the SSB_{MSY} level (Figure 20b). Constant catch scenario results are different that the constant F projection results. At catch levels less than 2,400 t, the projections show that the WCNPO MLS stock rebuilds beyond the SSB_{MSY} and 20%$SSB_{F=0}$ levels by 2040.

The assumed recruitment levels for projections vary substantially for the two scenarios, with the average recruitment from the stock recruitment curve around 350,000 individuals per year and the recruitment from the low recruitment scenario around 225,000 individuals per year. In the past, the WG has recommended that management measures consider the low recruitment scenarios as the projections using the stock recruitment curve do not consider the long-term declining trend in recruitment (ISC21). If spawning biomass rebuilds to the target, which is about equal to the average spawning biomass observed during the 1977-1989 period, then recruitment may be expected to return to the high levels observed during the 1977-1989 period or about 2 fold higher than current recruitment. The WG intends to provide additional stochastic ensemble projection results considering model uncertainty, as requested by WCPFC16. One of the important axes of uncertainty will be the assumptions on future recruitment.

Based on these findings, the following information on the conservation of the WCNPO MLS stock is provided by the ISC24 Plenary:

1. **It is recommended that catch should be kept at or below the recent level (2018-2020 average catch = 2,428 t); and**

2. **The results of deterministic projections show that when catches are 2,400 t, or less, the stock is expected to recover above SSB_{MSY} and near the 20% $SSB_{F=0}$ reference level by 2040, or sooner at the lower catch levels under a low recruitment regime (3,660 t).**

<u>**Special Comments**</u>

While the WG agreed upon a base case model for WCNPO MLS, there is concern about the reliability of the base case results for providing conservation advice due to uncertainty in growth, Japanese driftnet catches and initial conditions of the model. The ISC22 Plenary requested that the WG continue working on the 2022 WCNPO MLS base case model, with a focus on the growth parameters, particularly incorporating the Richard's four parameter growth curve directly into the SS3 model, for presentation to ISC23. The WG concluded that a revised von Bertalanffy growth curve rather than the Richard's curve was the best information available at this time for use in the 2023 base case model, while highlighting the suite of sensitivity runs to show the sensitivity of the model to changes in the growth curve; see the list and description of the sensitivity runs in Table 12 in **ISC/23/ANNEX/14**). The sensitivity runs show that the growth curve assumption may affect the interpretation of stock status. The WG also noted a concern that the estimation of initial F and thus the virgin biomass scale is largely affected by the selection of the growth curve, as the initial catch remains uncertain.

The WG recognized that substantial uncertainties have been discussed and documented in this stock assessment report (**ISC/23/ANNEX/14**). The high seas drift net catch data are highly uncertain owing to availability of limited records, life history parameters, such as growth, have been estimated from limited data, and stock is subject to mixing with other management areas, as revealed by genetic analyses. The WG evaluated the fit of several growth assumptions to the data and other diagnostics. The WG found that the stock assessment results showed large differences in estimated biomass among various growth curves. Future improvements of the growth curve are expected due to incoming data from the ongoing International Billfish Biological Sampling program, which will be followed by continued biological research and model development to address other sources of uncertainty.

7 EXTERNAL PEER REVIEW OF 2023 WCNPO STRIPED MARLIN STOCK ASSESSMENT

7.1 Reviewer Comments and Working Group Responses

The review of the 2023 WCNPO MLS benchmark stock assessment resulted in a consensus report prepared by Dr. Hiromu Fukuda, Dr. Simon Hoyle, and Dr. Ian Stewart with support from the review chair Dr. Robert Ahrens (**ISC/24/ANNEX/11**). The in-person review meeting took place April 15-19, 2024, at the Institute of Oceanography, National Taiwan University (IONTU), Chinese Taipei. The review panel noted two key features associated with uncertainty in the 2023 WCNPO MLS assessment (**ISC/23/ANNEX/14**). These features were: 1) an apparent change in the level of estimated recruitment (population scale) before and after the mid-1990's, and 2) insufficient age at length data for older fish to estimate the growth curve. Many of the recommendations associated with the terms of reference provided recommendations related to complication within the assessment as a result of these two main challenges. The recommendations associated with each term of reference are highlighted in summary overview and greater detail can be found in the attached review report (**ISC/24/ANNEX/11**).

TOR 1 - Review the information available on Pacific MLS stock structure and conceptual model and provide any recommendations for changing WCNPO MLS stock boundaries or to the fleet structure.

- Simplify the Japanese fleet structure. The panel recommends not using the CPUE component in the current finite mixture model as a primary determinant for fleet structure. More focus should be given to operation level information to define the fleet structure as the primary objective should be to ensure a consistent fleet- specific selectivity. The key determinant of the fleet structure should be the size structure of the catch. Any fleet categorization should not simply be determined by the model output.
- For all fleets, a better understanding of the spatial and temporal structure should be explored to understand the patterns of CPUE, size, targeting, fleet structure and vessel turnover.
- Continue to pursue genetic research to understand mixing between the genetically distinct population. This research should encompass the whole Pacific. There is an opportunity to utilize the genetic samples from the current IBSS program. This may require some modifications to the current sampling programs to ensure that genetic samples meet the requirements for the questions being pursued.
- The WG should explore the use of an index fishery approach which would link to an exploration of a unified CPUE analysis.

TOR 2 - Model inputs, commenting on the adequacy and appropriateness of data sources and data inputs to the stock assessment.

Growth: review the approach to estimation of growth parameters and consider the implications of potential regional variations in growth.

- Understanding the interaction between growth and selectivity is perhaps the most critical aspect of improving the assessment. The review panel recognized that there is a deficiency of samples at older ages and this has consequences in the estimation of a growth model.
- The WG should explore the possibility of fitting the growth model within the assessment, together with the inclusion of conditional length-at-age data. There is the option to use a fleet currently in the assessment for selectivity or to create another fleet for this purpose.
- The panel notes that the current IBSS project is a significant step in resolving growth uncertainty and this project should continue to be well supported. The spatial evaluation of growth is supported by the panel and careful consideration to how spatial growth applies to fleet structure and the interpretation of length data is needed.
- Should there be delays in the production of a new growth curve then effort needs to be put into resolving the potential age bias of using spines to produce the growth curve.

- There needs to be continuing effort to resolve growth curves across space, sex, time, and genetic origin.

Catch: review the treatment of the catch data, especially with regard to catch prior to 1993, when the driftnet catch level is highly uncertain due to unspecified species attribution and spatial extent.

- Efforts should be made to continue to improve the full historical time series of catch and associated uncertainty, even if the full catch time series is not used in the model. This would include an evaluation of the reported catch by other nations and whether or not reported catches make sense given fleet effort and area specific catch rates of reference nations. As an example, given the fishing effort of one nation in specific locations, if the CPUE of another nation was used would you estimate the same scale of catch.
- Efforts to improve the characterization (spatial location) and associated uncertainty in the driftnet data would increase confidence in these data and should be pursued.
- Efforts should be taken to understand discarding in all fleets. A potential starting point is the comparison of discarding between observed / training vessels and logbooks.
- The reporting of MLS may not have been consistent across vessels and fleets. Efforts should be made to more fully understand if there are reporting biases in all fleets. A potential starting point is the comparison of MLS reporting rates between observed / training vessels and logbooks, at a reasonable spatial and temporal resolution.

Size composition: review the approach for pre-treatment of size composition data (i.e., reweighting), how size composition is weighted for the likelihood function, and how decisions are made to determine which size data are included.

- Length frequency should be explored in detail at the national level for full historical time series. Methodologically this would include the application of a standardization method to understand the factors that cause spatial and temporal variability in the size data. This would allow a more complete understanding of the spatial and temporal nature of the data, how it relates to population size structure and fleet structure, and the standardization of size data should an index fishery be used.
- The US shallow set longline length data should be removed from the length composition data to resolve the discontinuity in the selectivity as a result of the fishery changes that occurred in the early 2000s.
- Weight data should be used for the Taiwanese fleet instead of the length data since the length data may not always be measured but can be estimated. The conversion from weight to length should be done outside the model using the fleet-specific length weight relationship. The panel acknowledged that the length-weight relationship in the model is the Taiwanese fleet's relationship but still recommended doing this conversion external to the assessment model. Consider inputting these data as generalized compositions to allow for bin sizes that can span potentially rounded weights.
- Bootstrapping or a model-based approach should be used to establish initial sample sizes external to the model to account for the properties of the underlying data.

CPUE: review the standardization methods and spatio-temporal structure of the CPUE data for each fleet, and the decision process for data weighting and exclusion of indices from the model.

- Make every effort to not split CPUE series (see discussion in Hoyle et al. 2024).
- If the time period of the assessment includes the period with high seas driftnet fishing as early longline fishing, effort should be made to standardize Japanese longline CPUE without splitting its time series since this could be a data source of the population dynamics bridging before and after 1994.
- Investigate the potential for monofilament branchlines and other technological advances that may have affected Japanese CPUE during the 1980s.
- Use the annual variance estimates from the CPUE standardization as a starting point for model inputs. These can be rescaled but should reflect the differences in precision among years within each series. Where necessary, either iterate or estimate additional variance such that the model fit (RMSE - root mean squared error) is consistent with the average input standard error by fleet.
- For the Taiwanese CPUE series, omit data before 2006 until there is confidence that these data can be used to provide reliable information. Explore the data for the period prior to 2006 to identify factors that may have caused the jump in CPUE.
- 2003-2005.
- When there are conflicting CPUE series covering the same period, and these conflicts cannot be resolved, they should be included in alternative model scenarios rather than combining them in the same model. This assumes that consideration has been given to the nature of the conflict and that the conflict is not due to a model misspecification (e.g., an error in the fleet designation)
- Provide full diagnostics for all CPUE series that may be included in the assessment, including residual plots, effect plots (i.e., the effect of the covariate on the expected CPUE), and influence (i.e., the impact of the covariate on the index over time) plots.
- Develop joint CPUE series across nations and multiple fleets, to address the
- following issues:
    - Provide indices that cover the majority of the stock across the whole time series. Such an approach would help to limit the effect of contracting spatial coverage in some of the fleets. It is unclear what impact declining spatial coverage has on the estimation of annual random fields even when only a portion of the random fields are used in standardization.
    - Provide a single series using consistent methods for data cleaning and model fitting, rather than multiple series that may conflict.
    - Develop a shared understanding among the collaborators.

Data inputs: identify and provide recommendations on the key areas for improvement in

- Continue to improve the full historical time series of catch, regardless of whether the full catch is used in the model, more fully understand and characterize discarding in all fleets, more fully understand and account for reporting discrepancies in all fleets.
- The range contraction of some of the fleets highlights the importance of information sharing across fleets and nations. Consideration is needed to ensure that biological

information used to make inferences at the population level has the appropriate spatial coverage.
- Age sampling for a fleet could provide better estimates of population scale.

Other life history parameters: review the other life history parameters used weight length, maturity, natural mortality, stock-recruitment, etc.) for internal consistency and appropriateness for the WCNPO stock.

- There have been developments in how to estimate life-history parameters. New life history data has been and is being collected. Revisiting the life history values used in the model in light of this new information and approaches should be considered, with the goal of internal consistency across the development of the full suite of parameters used in the model.
- There is evidence to suggest a west to east difference in maturity. Note also that samples from spawning areas may not be representative of the population-level maturity ogive. Consideration should be given to addressing these differences by establishing a CPUE-weighted maturity ogive.
- The IBBS project collecting information on growth, maturity, and genetics is a significant step to helping understand the spatial distribution of the underlying life history characteristics and needs continued support to ensure success.
- The steepness prior should be updated to account for changes in the input parameters. It is important to allow for uncertainty in the values of all input parameters and uncertainty about the structure of the stock recruitment relationship, which may result in a flatter prior.
- New information on growth and maturity will require natural mortality to be updated. Given the potential for spatially varying life history values, spatial consideration will need to be given to how to weight such information appropriately in the estimation of these values.

TOR 3 - Model configuration, assumptions, and settings

Fleet structure: review fleet definitions and spatio-temporal structure of catch, CPUE, and size composition inputs.

- See recommendation in previous sections.

Selectivity: review selectivity assumptions and settings.

- The population level size bins should be reduced from 5 cm (to 1 or 2 cm) as this has the potential to provide a smoother likelihood surface where selectivity is highly dome shaped. This does not mean that the bins for the fleet specific length frequency data need to be reduced.
- Consider setting the parameter defining the width of the top of domed selectivity curves to span at least 2 population size bins.
- Given the structure of the area-implicit assessment model, a fleet assumed as an asymptotic selectivity should be chosen based on the observed data (i.e., empirical selectivity method). The panel recommends fleet 18, the TWN DWLL, as this fleet has

the largest observed fish, though this may be revisited after the data source has been changed from length frequency to weight frequency observations.

- Aim to remove time blocks from the selectivity parameterization of the Japanese and US fleets.
- Explore more flexible selectivity for the US longline fleet in order to better fit the bimodal size-composition information. There is also the potential to use an age- based selectivity of this fleet given the apparent length-based modal progression seen in the data.
- Review parameter and asymptotic variance estimates from all selectivity curves and reparametrize where there is no apparent information (e.g., Size_DblN_descend_se_F16_US_LL(16) in the 2023 base case model).
- Consider reducing the range of the lower and higher bounds for selectivity parameters (especially those that are logistic transformed) and adjusting the phasing to achieve more reliable convergence. Ideally this would reduce/remove the need for a .par file and assist profile and jitter analysis convergence.

Initial equilibrium conditions: review the estimation of initial equilibrium catch and fishing mortality, recommend if the BILLWG should be estimating the equilibrium conditions (as in the 2023 model) or fixing them and running sensitivity runs to evaluate the sensitivity of these conditions (as in the 2019 model).

- As in the 2023 assessment, the initial conditions should be estimated. This includes recruitment deviations for the initial age structure and initial F.

Uncertainty: review the approach used to represent uncertainty in model-derived management quantities, considering structural, model and input data uncertainty.

- The review panel felt that the workgroup did a good job of presenting the sensitivity of the results.
- The panel recommends the adoption of an ensemble model approach. The ensemble should consider growth, assessment start year, steepness, catch uncertainty, and conflicting time series. Growth should be ensembled based on observed spatial differences in growth if they are identified to exist. Model start should be ensembled if there is no possibility of linking the early and late parts of the CPUE time series. (A 1977 + and a 1994+ model). Steepness could be by selecting three steepness values that represent a plausible range of steepness for the species. Uncertainty in catch should be incorporated by including ensembles with high/low, and best estimates. Should conflicting (e.g., JPN vs. TWN) CPUE time series not be resolved the assessment should be over these conflicting time series.
- The full time series (a 1952+ model) of catch should be included at least as a sensitivity run.
- Some simulation work would be required to understand the details of how, if it is present, spatial differences in life history characteristics should be accounted for within an assessment model. Best practices have not been determined.

Start year: review the suitability of the current start year (1977) and suggest potential alternatives, such as 1994 (the start of the high seas driftnet moratorium).

- The panel would prefer the model to begin in 1977, combined with improved long term catch time series, and with a CPUE series the same length as the assessment period. If discrepancies are not resolved between early and late assessment periods then a model such as the one starting in 1994 was recommended for inclusion in an ensemble approach.

Alternative models: review the use of SS3 as the modeling software and determine if it is an adequate tool for the assessment.

- The review panel supports the use of an age-structured production model to provide a good diagnostic tool for the current assessment framework.
- There is a notable reality that the reliance of the assessment on length composition data and the nature of the growth pattern results in challenges in determining the scale of the population. Consideration should be given to the use of close-kin approaches to estimate population scale.

TOR 4 - Model diagnostics

Review the suitability of the diagnostics used and reported for the assessment.

- Check convergence of all models, to avoid incorrect inferences from models that have not converged. The results of models that have not converged should not be reported, or included as sensitivity runs.
- Given that stock rebuilding has been evaluated based on future projection, longer term (i.e., an assessment cycle or generation time) hindcasting could be conducted to determine the prediction skill of the model.
- Continue to use a broad suite of metrics to characterize model suitability.
- Consider the absolute scale of the residuals from diagnostic plots and reweight data sets accordingly (e.g., some of the size data residuals were notably larger than others).

Consider the diagnostics provided for the 2023 WCNPO MLS assessment and provide guidance on follow-up work where the diagnostics suggest issues, i.e., data conflicts.

- The panel felt that the diagnostics provided were helpful.
- As noted earlier, data sets that are in conflict such as CPUE time series should not be included in the same model but accounted for in an ensemble approach.

The driver of the pattern of higher fishing mortality after the high-seas driftnet fishery was banned in 1993.

- The flat CPUE through the high catch period is scaled independently of the later period where length frequency data is fit. This appears to have forced the model into a domain where it needs to be highly responsive to recruitment deviations as well as fishery removals to fit the data. The adoption of the review panel’s recommendations related to selectivity and continuity of time series should change this pattern. The response of the model to these changes as demonstrated by the additional runs requested suggest these are productive areas of exploration.

Evaluate the adequacy of the sensitivity analyzes in regard to completeness and incorporation of results. Recommend improvements to the communication of the sensitivity run results (plots, tables, and/or text)

- The panel found the sensitivity analysis presented by the workgroup to be quite comprehensive.
- The use of non-zero sum recruitment deviations is a reasonable sensitivity check. However, the use of non-zero sum recruitment deviation can cause a difference between the time-series and the reference point and therefore the reference point would need to be calculated based on the net result of the recruitment deviations.

TOR 5 - Comment on the proposed reference points and management parameters (e.g., MSY, FMSY, SSBMSY, 20%SSBF = 0); if possible and feasible, estimate values for alternative reference points or alternative methods of determining the appropriate reference years for the dynamic B0 calculations.

- Recommend calculating and reporting both the 20-year moving average as well as the annual dynamic B0 so that the trends can be compared.
- Recommend averaging relative Fs over the last 3-5 years but not including the terminal year for the calculation of FSSB20% rather than using the terminal year.
- The panel suggests continued reporting of additional status metrics such as %SPR or 1-SPR.
- The panel recommends reviewing the standards outlined by the WCPFC and considering the adoption of the same approach.

TOR 6 - Suggest research priorities to improve our understanding of essential population and fishery dynamics, necessary to formulate best management practice, with the identification of priorities to improve future assessments.

- The development of an age validated growth curve is essential to improve the reliability of the assessment model.
- Consider exploring requirements for CKMR.
- Continue to develop a more comprehensive understanding of the genetic structure of the entire Pacific as well as the genetic composition of the removals.
- Implement CKMR approaches should they prove to be tractable for the population.
- Simulation work to understand the best assessment approaches to deal with a complex fishery and life history spatial structure.

TOR 7 - Comment on whether the stock assessment methods, results, and assessment decision process are clearly and accurately presented in the detailed report of the stock assessment.

- The review panel found the reporting of the process to be well documented, appreciated the extensive supporting material, and was highly appreciative of the effort.
- Some of the supporting documentation in the working group papers would benefit from greater detail in the decisions made and well as the diagnostics used. It would be helpful to have this information within these documents. This is important for the development of both CPUE time series and size data. Encourage analysts to follow standard guidelines

for documenting these analyses, and development of standards for data areas without them. We also encourage coordination across groups so that they follow similar approaches.

- Recommend working with the institutions involved with the assessment and reporting process to ensure that personnel are afforded the time to fully explore data analyses and report comprehensively on the findings.

7.2 Review Process Debrief

The ISC24 Plenary agreed that the peer review was successful and had great value. Future institutionalization of the process was discussed. Coordination with the WCPFC Secretariat and endorsement by the full Commission for peer reviews is essential. An avenue to explore is for the Commission to impose a contribution assessment on NC members to support peer reviews for northern species rather than relying on relatively ad hoc contributions from Members.

The ISC24 Plenary agreed that the BILLWG should draft a formal response to the peer review recommendations to be reviewed at ISC25. This response should include a prioritization of the tasks emanating from the recommendations.

The ISC24 Plenary also tentatively agreed that the next peer review should focus on PBF and could be conducted in the interim between completion of the MSE and the start of the next benchmark stock assessment currently scheduled for 2027.

8 INCORPORATING CLIMATE CHANGE CONSIDERATIONS INTO INFORMATION TO MANAGERS

8.1 National Reports

8.1.1 Canada

Climate change is having a significant impact on Canadian fish stocks and fisheries in the Pacific Ocean and it is becoming more evident over time (DFO 2013; Hunter and Wade 2015). Climate change is expected to result in physical changes such as increasing sea surface temperature, marine heat waves, rising sea level, salinity changes, ocean acidification, and deoxygenation, all of which affect Canadian fisheries. Canada is taking action to build resilience to the impacts of climate change through several initiatives linked by key goals to act on climate change and its impacts and to conserve and protect the oceans (DFO 2023). In 2011, the Canadian government initiated the Aquatic Climate Change and Adaptation Services Program (ACCASP) to improve understanding of climate change and prepare for climate-related changes. A key activity under the ACCASP was to advance understanding of the vulnerability of commercial species to the impacts of climate change and to develop a strategy to incorporate this knowledge into fisheries stock assessments. In the Pacific Ocean, potentially major impacts of climate change have already been noted in Canadian waters, including changes in species distributions (e.g., increased bycatch in recent years of tropical tuna species and Pacific bluefin tuna in Canadian waters), changes in recruitment and abundance (e.g., effects of recent marine heat wave (2014-2016) in Canadian waters (Free et. al., 2023), changes in community compositions (e.g., shifts in zooplankton diversity to include more southern species), and changes in fish growth (e.g., smaller sizes at age observed in a number of species).

In 2018, a national review process was used to develop a framework for incorporating climate change considerations into fisheries stock assessments (Pepin et. al., 2020). The results of this review launched Canada's commitment to an Ecosystem Approach to Fisheries Management (EAFM) initiative in 2019. This initiative is aimed at developing a national framework to operationalize incorporating ecosystem variables (including climate, oceanographic and ecological factors) in order to enable climate-ready decision-making and better inform stock and individual fishery-focused management decisions. Canadian scientists have started to initiate several monitoring and research activities to document and further understand how changes in population dynamics and species distributions are linked to changing ocean conditions (e.g., State of the Pacific Ocean Reports and Ocean Networks Canada). Additionally, Canadian scientists have started to refine modelling initiatives that incorporate potential long term climate scenarios to improve forecasting and assess risk in decision making (e.g., Pacific Herring EAFM case study (Pepin et. al., 2023).

North Pacific albacore tuna are a highly migratory species and are only present seasonally in Canadian waters. The distribution of this species is highly influenced by oceanic conditions, including temperature and ocean productivity fronts. It is therefore highly likely that climate change will influence the timing and spatial distribution of the feeding migrations of albacore that enter into Canadian waters. Spawning and rearing of albacore may be expected to occur further north in Canadian waters as a response to water temperature increases. However, there is currently no clear definitive evidence of a direct impact of climate change on albacore in Canadian waters. The complexity in interpreting the trend of albacore in Canadian waters is in part due to the use of fishery dependent data to examine these relationships. Throughout the time series of catch and effort there have been spatial changes in the operation of the fishery, as well as economic drivers of effort. Additionally, there is currently no in-season monitoring and initial estimates of catch or effort are not available until a few months after the fishery ends. The Canadian government is working toward implementing a fleet-wide vessel monitoring system (VMS) in order to effectively monitor, control and enforce safe, responsible, and sustainable practices in real time. Data pertaining to catch locations are currently only provided in the logbooks without independent verification or sufficient detail to support localized spatial analysis of stock and fishing dynamics. VMS data will also be critical in supporting the analytical work done by the ISC to advance the assessment and incorporate climate-driven changes in fishing activity.

Full literature citations in this reporting can be found in the National Report of Canada (**ISC/24/PLENARY/04**).

8.1.2 Chinese Taipei

R.-F. Wu briefly introduced the research projects conducted by Taiwanese scientists on climate change, which include "Long-term observations of interannual and decadal variation of sea surface temperature in the Taiwan Strait," "Association between the interannual variation in the oceanic environment and catch rates of bigeye tuna (*Thunnus obesus*) in the Atlantic Ocean," and "Preliminary study on the relation between chub mackerel (*Scomber japonicus*)," and

"Oceanic thermal fronts and net primary production associated with longline catches of albacore (*Thunnus alalunga*) in the southern Indian Ocean." The Taiwan government has not yet incorporated climate change conditions in fishery management measures.

8.1.3 Japan

H. Kiyofuji provided climate change related information and research activities by the Fisheries Research Institute of Japan. The annual average SST around Japan has increased by +1.28℃ over the last 100 years and the relatively cold water Oyashio area has likely shrunk in recent years. Two scientific papers were referred to documenting the extensive marine heat wave in the western north Pacific Ocean resulting in a shift of Japanese coastal fisheries fishing grounds. Climate change related activities in the Fisheries Resources Institute were briefly mentioned.

8.1.4 Korea

Korea publishes an annual Climate Change and Fisheries Report for managers and policymakers. This report includes information on signs of extreme climate change and response measures, distribution changes in fish species in Korean waters due to climate change, and ecosystem-based fisheries research.

Korea's proactive approach to climate change includes monitoring six key factors: high water temperature, jellyfish, red tide, ocean acidification, hypoxia, and fish diseases. A new Fisheries Disaster Response Team has been established in response to extreme weather conditions. This team operates an Early Warning System to predict signs of extreme climate events, guiding the fishing industry in preparation. These efforts are part of Korea's commitment to minimizing the impact of climate change on fisheries.

Climate change has led to winners and losers in Korean waters. For instance, walleye pollock (*Gadus chalcogrammus*) and squid are among the species adversely affected. Despite the successful aquaculture of pollock and the release of juvenile fish into the sea, rising water temperatures in Korean waters have forced these species to migrate northward in search of colder waters, posing challenges for commercial operations when they cross international borders. Squid, in particular, have experienced a rapid decrease in catch, making it difficult to search for schools of fish. On the other hand, yellowtail (*Seriola quinqueradiata*) and PBF are considered winners of climate change. The increased transport of the Tsushima Warm Current and rising water temperatures along the East Sea of Korea have led to increased migration and catches of these species. In response, the National Institute of Fisheries Science regularly surveys the Tsushima Warm Current transport, eggs, and larvae of PBF to study the correlation with the stock condition.

To address fishermen's concerns about changes in target species due to climate change, the Korean government is considering policies to relax or deregulate fishing gear and method regulations. This is part of the fisheries modernization project scheduled to begin in 2027. It includes policies to support fishers in line with Total Allowable Catch (TAC) management goals for all species, introducing a catch documentation scheme (CDS), electronic reporting (ER), and electronic monitoring systems (EMS).

Ecosystem-based fisheries resource research has been conducted since 2018 to predict fluctuations in fisheries resources in response to climate and ecosystem changes.

8.1.5 Mexico

The presentation for Mexico focused on three documents related to the climate change adaptation to different fisheries in Mexico. The first technical report, "Adaptation Strategies to the impacts of Climate Change by Coastal Fishermen in the State of Nayarit, Mexico" analyzes and identifies the problematic of the warming of the ocean surface in this region. The key points were that fishers are already reporting an impact on their catches, and also have reported a higher storm frequency. This report focused on providing solutions, such as creating alternative economic support and workshops to generate strategies of adaptations. The second study presented was about the potential effect of climate change on six shark species listed in the CITES appendices. This work involved collaboration between IMIPAS and Western Australia Fisheries scientists. A vulnerability analysis based on exposure, sensitivity, and adaptive capacity of each species from different greenhouse gas emission scenarios was developed in order to project future conditions in 2100 under several climate change scenarios. The risk exposure was assessed for each scenario, providing a comprehensive view of how different levels of climate change might affect shark species in the Gulf of California. Pelagic thresher shark (PTH) is at high risk based on the "nursery areas" found in coastal areas, because the species depends on those habitats. Silky shark (FAL) and longfin mako shark (LMA), based on a "trophic level" parameter, also present high risk. The last scientific paper summarized in the presentation consisted of a model that predicted the recruitment of yellowfin tuna based on oceanographic parameters, using a nonlinear autoregressive network model with exogenous inputs (NARX). This model included four scenarios based on different levels of greenhouse gas emissions. Recruitment projections, using climate-change scenarios, predict generally more favorable conditions, given the higher temperatures projected in the Pacific. Nonetheless, this result should be interpreted with caution.

8.1.6 U.S.A

NOAA Fisheries is currently working nationwide to implement a new initiative called the Climate, Ecosystems, and Fisheries Initiative (CEFI). CEFI is a cross-NOAA effort to build nationwide, operational ocean modeling and decision support systems needed to reduce impacts, increase resilience, and help adapt to changing ocean conditions. The hope is that this system will provide decision makers with the actionable information and capacity they need to prepare for and respond to changing climate conditions in the future.

The goal of CEFI is to address four core requirements for climate-ready decision-making for marine resources:

1. Robust forecasts and projections of ocean and Great Lakes conditions for use in developing climate-informed advice;
2. Operational capability to assess risks, evaluate options, and provide robust advice on adapting to changing conditions;
3. Decision-maker capability to use climate-informed advice to reduce risks and increase the resilience of resources and the people that depend on them; and

4. Continuous validation and innovation through observations and research

In the Pacific, initial CEFI efforts will be focused on regional downscaling of the oceans surrounding California and the Hawaiian Islands archipelago (including the main and northwest Hawaiian Islands) with coupled fisheries and socioeconomic modeling efforts. The modeling effort will focus on a range of timescales, including hindcasts of the recent 30-year period, short term forecasts (1 year in the future with updated predictions seasonally), decadal outlooks (conditions over the next 10 years, updated annually), and long-term projections under future greenhouse-gas emissions scenarios.

The physical circulation model applied will include dynamic biogeochemical properties (e.g., nutrients, oxygen, and carbon cycling with several plankton functional types) that will provide input for higher-trophic-level ecosystem models of target and non-target species. Short-term predictions and long-term projections of species abundance and distribution will be used in fisher location-choice models, trip-cost and trip-distance models, and market price models.

One of the ultimate goals will be to take the models developed through CEFI and operationalize real-time and near real-time data to predict potential impacts of climate change to fish and fisheries, using both long-term and short-term projections. This is similar to the idea behind Eco-Cast, which is a tool that has been created to help fishers and managers evaluate how to allocate fishing effort to maintain target fish catch while minimizing bycatch of protected or threatened species. EcoCast uses habitat suitability models and satellite-derived environmental data to predict where broadbill swordfish and three bycatch species (leatherback turtle, blue shark, and California sea lion) are likely to be each day. Daily EcoCast maps help fishers identify fishing spots to minimize fisheries bycatch and maximize fisheries target catch.

The ‘Future Seas’ project (https://future-seas.com) is a collaborative, interdisciplinary effort to explore potential impacts of climate change on U.S. west coast fisheries and to evaluate strategies for managing those impacts. The project focuses on enhancing climate-ready management by linking high-resolution ocean models of the California Current System. with ecological and social models. The end goal is to produce coupled climate-ecological-social models to evaluate management strategies resilient to future change in the California Current System. To date they have used four types of coupled social-ecological models applied for ecosystem-based management including: Management Strategy Evaluation (MSE), fisher behavior, social vulnerability, and end-to-end. This first phase of the project has focused on quantifying rates of change in the physical and biogeochemical environment and the potential impacts of this change on three U.S. West Coast fisheries, as well as exploring strategic climate-ready management options to increase their sustainability. The ocean projections are produced by a high-resolution ocean model coupled to a biogeochemical model and are available for use in any type of coupled modeling, which provide recommendations and lessons learned for climate-ready management in the California Current System that could be directly applicable to other efforts in this region.

Further information on recent climate-change related publications is included in the U.S. National Report to ISC24 (**ISC/24/PLENARY/09**).

Discussion

The Plenary asked questions about and discussed national reports. Common themes in the discussion included clarifying observed climate change impacts, particularly in relation to changes in the distribution of managed stocks, and cooperation between agencies collecting climate-related environmental data and fisheries agencies.

8.2 Building a Framework Discussion

The Plenary queried the WGs about efforts to incorporate climate change related information into their work. Differences in effects related to differing life histories were recognized. Lack of data is a major concern and may become more acute as fishery-dependent data becomes more limited for a variety of reasons. There will be a need for greater collaboration in data gathering to bridge these gaps. The IBBS Program was cited as an example. The tradeoffs between the use of dynamic versus static reference points was mentioned, with the former having possible salience in the face of climate driven environmental change. The ISC would not advocate for a particular approach but could communicate to managers the tradeoffs involved in their use.

The ISC24 Plenary tasked all ISC Working Groups with compiling information on the ways in which they have already begun to incorporate climate considerations into ISC stock assessments as well as the data they believe would be required in order to do so in the future and come prepared to present that information to ISC25. WGs should consider incorporating climate change into conceptual model development for benchmark stock assessments where practical.

The ISC24 Plenary agreed that the incoming Chair will develop a matrix that WGs may fill out to facilitate the information collection and reporting tasks at ISC25.

9 OPEN SCIENCE PROPOSAL FOR ISC

The U.S.'s proposal for adopting an Open Science Framework for ISC Stock Assessments was put forward to the ISC24 plenary **(ISC/24/PLENARY/12**). The overarching goal of this proposal is to support and continue the shifts in methodology and culture surrounding our stock assessments through the adoption of Open Science practices. Individual working groups are already implementing practices of Open Science to make the stock assessment model development process more efficient, collaborative, and transparent. Establishing ISC-wide guidelines and standardized workflows, as well as creating an ISC GitHub to provide a central location to store assessment model code and outputs, would help to continue the momentum of pushing towards an open science framework. The proposed year 1 implementation plan recommended to the plenary includes scoping the available software and platforms and producing guidelines for use and best practices that can be agreed upon by the plenary. Additionally, GitHub training for all interested ISC scientists would be offered in the first year to address any knowledge gaps and enhance collaboration within working groups. During the scoping period, it will be crucial to address challenges and concerns such as privacy and security guidelines, resource allocation and management, and culture shifts in science practices.

Discussion

Members noted potential barriers to the use of collaboration sites such as GitHub due to current government policies. However, it was recognized that several of the WGs have already established GitHub repositories to support conducting stock assessments. Some of these repositories are already publicly available although not advertised. **The ISC24 Plenary recommended that a section be added to the ISC website listing the available repositories and providing contacts for each repository.** Since the ISC website is housed in a Government of Japan server, Japan's policies on linking will determine whether or not a direct link from the ISC website to the GitHub repositories can provided. Since no information is available at present on these policies, the simplest action is to list a point of contact for each repository (likely the relevant WG Chair) that researchers could contact to obtain access information. It was also recommended that all these repositories include a statement qualifying the appropriate use of files accessed through the repositories. At the same time, it is important to continue to archive model and data files in the ISC data warehouse as they provide the authoritative record of the assessments on which stock status and conservation information is based. It was also noted that program files for MSE should also be stored in ISC database along with assessment files.

The ISC24 Plenary endorsed the proposed year 1 implementation plan, which was further discussed as part of the STATWG report (Section 12.1), because the Plenary tasked them with organizing the proposed training and carrying out scoping of the governance and logistical requirements for implementing an open science framework. The ISC24 Plenary also requested that Japan provide feedback at ISC25 on whether or not direct links to GitHub are permissible from Government of Japan servers.

10 FORMALIZATION OF ISC

The Chair noted that no progress has been made on formalization of the ISC over the past year but recommended that the Plenary revisit the issue each year to continue exploring possible formalization arrangements. It was recognized that an inter-governmental MOU is likely not the best approach and **Members were charged with gathering information to support the exploration of alternative arrangements intersessionally in advance of ISC25.** The mechanism used to support the MLS stock assessment peer review, involving the WCPFC Secretariat, was noted as a possible basis for exploring alternative formalization options.

11 ISC-NORTH PACIFIC FISHERIES COMMISSION MEMORANDUM OF UNDERSTANDING

The Chair summarized the contents of the MOU and noted that it will be signed in the near future.

12 REVIEW OF STATISTICS AND DATABASE ISSUES

12.1 STATWG Report

J. Suter, STATWG Chair, reviewed activities in the 2023-2024 workplan adopted at the ISC23 (**ISC/24/ANNEX/15**). All of the work items were completed in the past year.

The STATWG agreed there is an ongoing need for the STATWG to provide the functions of (1) maintaining the ISC database and the quality of data submitted by members; (2) maintaining the proper function of ISC website and the archiving of the stock assessment files; and (3) supporting internal data sharing and protocols for external data requests. Although these functions were mostly performed by the DA, the STATWG is responsible for overseeing these functions and providing recommendations to the ISC Plenary.

The STATWG members developed the following work plan for 2024-2025:

1. The DA will continue to distribute the ISC data inventory for Category I, II, and III to ISC Data Correspondents for review by September 30, 2024. The DA will then distribute the ISC data inventory to Chairs of the species WG by October 15 and publish on the ISC website by October 31, 2024;
2. The DA will continue to archive stock assessment files from all 2023-2024 ISC assessments, which are required to be submitted by Chairs of species WG by November 1, 2024;
3. After the Data Correspondents have reviewed and updated their metadata prior to the ISC22 Plenary, this metadata will be published on the ISC researcher's website by August 31, 2024. For 2023-2024, the DA will continue to distribute the WG member's new metadata by March 30, 2025. The Data Correspondents will review and update their new metadata by July 1, 2025, prior to the ISC25 Plenary, and this new metadata will be published on the ISC researcher's website by August 31, 2025;
4. The DA and the Chair of the STATWG will annually review the responsibilities, duties, and deliverables of the DA to ensure that they are accurate and practical, and revise them as necessary;
5. During the Plenary, the ISC24 Plenary tasked the STATWG Chair with organizing the proposed training and scoping the governance and logistical requirements for implementing an open science framework for the ISC, including the use of GitHub. The STATWG Chair will work closely with all WG chairs and DMs on this assignment; and
6. The STATWG Steering Group will hold an intersessional meeting or conference call/webinar January 2025.

<u>Discussion</u>

The Plenary continued its discussion of the Open Science initiative under this agenda item. The discussion delved into various logistical issues around creating a general ISC GitHub site, the relevance of current policies requiring non-disclosure agreements, and an overview of materials that WGs have already posted to GitHub repositories. **The Plenary agreed that the WG DMs should be members of the STATWG to further the assignment on scoping an open science**

framework. It was decided that only a subset of the STATWG, as a task force, would take on the work related to the Open Science initiative.

12.2 Total catch tables

K. Nishikawa, the Database Administrator, presented the annual catch tables for ISC Member countries for 2022-2023. The catch tables were prepared for the following ISC species of interest: NPO ALB, PBF, NPO SWO, WCNPO MLS, , Pacific BUM, NPO BSH, and NPO SMA. The catch tables were generated from the ISC database and are based on Category I data (retained catch and released catch, when available) submitted by Data Correspondents for the major fisheries in the North Pacific Ocean of the member countries. Graphs of the historical catch by country were also presented for each species. Statistics for mean, minimum, and maximum catch were also presented for each species for the latest 5 years. The complete catch tables are included at the end of this Plenary Report and serve as the official ISC catch tables (see Section 18).

13 REVIEW OF MEETING SCHEDULE

13.1 Time and Place of ISC25

Korea offered to host ISC25 at a location to be determined, tentatively scheduled for June 18-23, 2025.

13.2 Time and Place of Working Group Intercessional Meetings

The Plenary reviewed and adopted the schedule of intersessional meetings found on the following pages.

	Month	ALBWG	BILLWG	PBFWG	SHARKWG	STATWG	PLENARY	WCPFC	IATTC
2024	July							JWG PBF July 10-13, 2024 Hokkaido, Japan	
								NC20 July 15-16, 2024 Hokkaido, Japan	
	Aug							SC20 Aug 14-21 Manila, Philippines	
	Sept								102ND Meeting Sep 2-6, 2024 Panama
	Oct								
	Nov			MSE Webinar Nov 5-8					
	Dec							WCPFC21 Dec 1-6 Fiji	
2025	Jan		Research Wksp Jan 13-17 Honolulu, HI		BSH Indicator Analysis Yokohama/ Kesennuma, Japan	Virtual Meeting			
	Feb								
	Mar	Research Workshop Chinese-Taipei							
	Apr			MSE Workshop Dates TBD La Jolla, USA					
	May								16th SAC Meeting
	June			**0.5 d**	**0.5 d**	**0.5 d**	**[June 18-23] Republic of Korea**		
	July							NC21	

14 ADMINISTRATIVE MATTERS

14.1 ISC Chair and Vice Chair Elections

Robert Ahrens (USA) was elected Chair to replace the outgoing Chair, John Holmes. Shuya Nakatsuka (Japan) was elected Vice Chair to replace outgoing Vice Chair, Robert Ahrens.

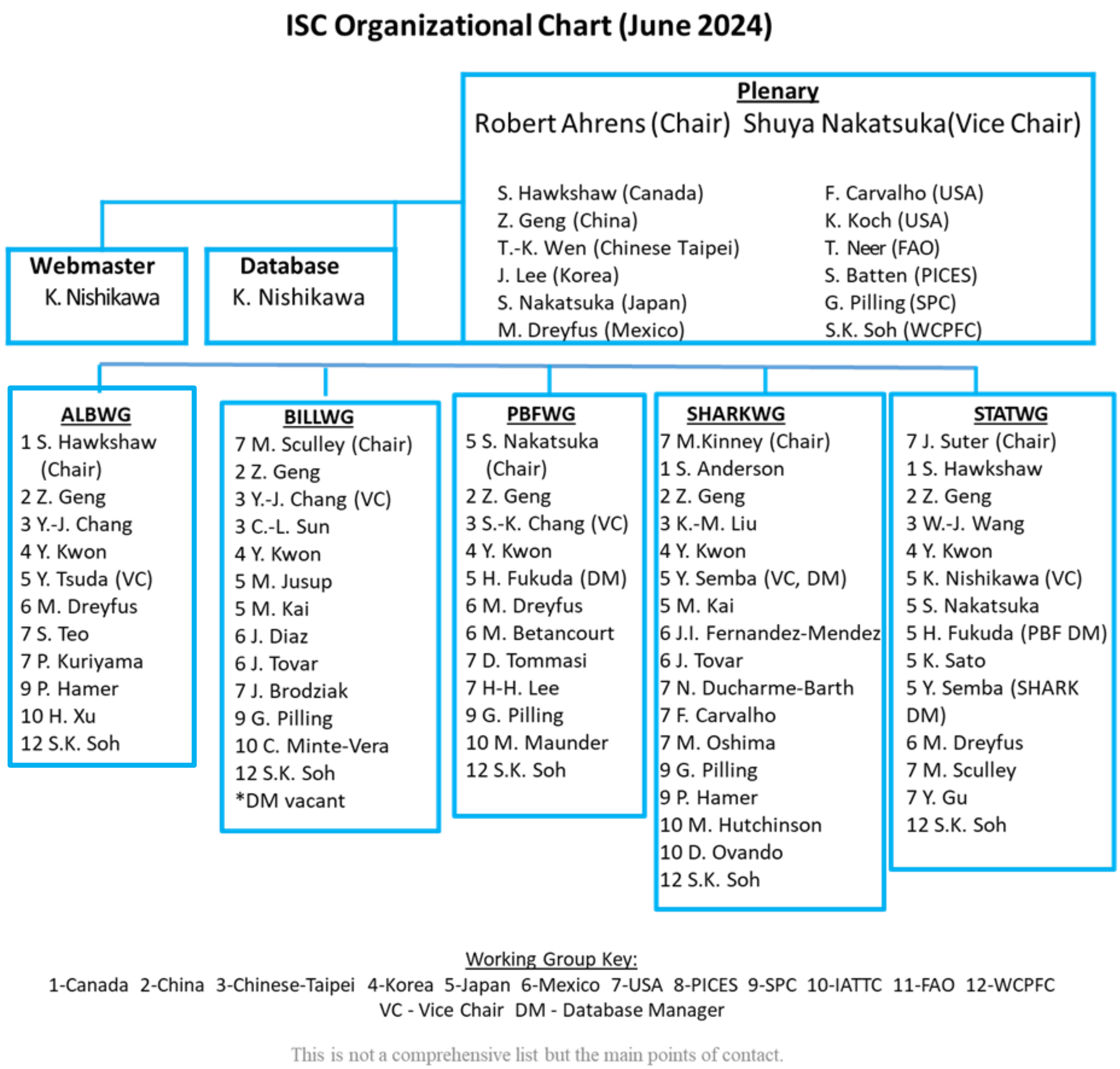
14.2 Work Group Election results

The Plenary confirmed the following officers and terms:

Title	Name	First Election Date	First Term	Second Election Date	Second Term	First Extension	Second Extension
ISC Chair	Robert Ahrens	Jun-24	2024-2027				
ISC Vice Chair	Shuya Nakatsuka	Jun-24	2024-2027				
ALBWG Chair	Sarah Hawkshaw	May-21	2021-2024	Apr-24	2024-2027		
ALBWG Vice-Chair	Yuichi Tsuda	Jul-24	2024-2027				
BILLWG Chair	Michelle Sculley	Jul-23	2023-2026				
BILLWG Vice-Chair	Yi-Jay Chang	Jul-19	2019-2022	Jul-22	2022-2025		
PBFWG Chair	Shuya Nakatsuka	Mar-19	2019-2022	Jul-22	2022-2025		
PBFWG Vice-Chair	Shui Kai Chang	Nov-19	2020-2023	Jul-23	2023-2026		
SHARKWG Chair	Michael Kinney	Jun-24	2024-2027				
SHARKWG Vice-Chair	Yasuko Semba	Jun-24	2024-2027				
STATWG Chair	Jenny Suter	Jul-23	2023-2026				
STATWG Vice-Chair	Kirara Nishikawa	Jul-23	2023-2026				

14.3 ISC Organization Chart

The Plenary reviewed the organizational chart shown below and updated personnel to reflect current participation.



14.4 North Pacific Marine Science Organization (PICES) Annual Meeting Observer

R. Ahrens (U.S.A. and incoming ISC Chair) provisionally agreed to serve as an ISC observer at the next PICES Annual Meeting, October 26 – November 1, 2024, in Honolulu, Hawai'i, U.S.A.

14.5 Intersessional Working Group Tasks

- All WG to respond to NC20 requests and provide information for ISC25 review and approval.
- ALBWG to conduct workshop on research to improve the stock assessment.
- PBFWG to Conduct MSE webinar and MSE workshop to develop technical aspects of MSE and hold stakeholder and manager workshop(s) to review results and present initial results to ISC25 Plenary for review and approval.
- BILLWG to conduct workshop on biological research for billfish species and provide an update on progress of the billfish biological sampling program at ISC25.
- SHARKWG to conduct indicator workshop for BSH and present results to ISC25 Plenary for review and approval.
- The DA to distribute the ISC data inventory to ISC Data Correspondents for review by September 30, 2024, and to Species WG Chairs by October 15, 2024
- The DA to publish the ISC data inventory on the ISC website by October 31, 2024;
- The DA to archive PBF and SMA assessment files from all 2023-2024 ISC assessments.
- Metadata for national fisheries updated and published by DA on ISC researcher's website by August 31, 2024.
- STATWG Chair to lead the development of governance and logistical requirements for the application and use of "Open Science" within the ISC and report to ISC25 Plenary for consideration.
- STATWG Steering Group to conduct an intersessional meeting in January 2025 to complete its work plan (format, location, and dates to be determined).

15 OBSERVER COMMENTS AND RECOMMENDATIONS

Observers from the Pew Charitable Trusts, Monterey Bay Aquarium, and World Wildlife Fund-Japan participated in the ISC24 Plenary Session and were provided with an opportunity at the end of each day to ask questions and provide comments and recommendations to the Plenary and Working Groups. Their comments and observations over four sessions are summarized below based on content provided by the Observers. These comments have been edited so that they conform to the style of this report, but the content has not been changed.

The Pew Charitable Trusts appreciated the opportunity to attend as an observer and provided the following comments to the ISC plenary:

On Pacific bluefin tuna, Pew remarked that it is encouraging to note the ISC's progress in developing the Management Strategy Evaluation (MSE) and the expectation that the analysis will be ready for the meeting of the Joint Working Group (JWG) in 2025. Pew encouraged the ISC to recommend the JWG hold a stakeholder meeting to present initial results and gather feedback before the MSE is finalized. Pew also encouraged ISC members to hold national level consultations with stakeholders. Both would be helpful in building understanding and eventual agreement on a long-term management procedure for Pacific bluefin tuna.

Pew also noted the results of the 2024 stock assessment for Pacific bluefin tuna, which estimated that the stock has surpassed the second rebuilding target. Pew said the results demonstrate the value of years of productive international cooperation to improve the status of Pacific bluefin tuna. Pew urged that cooperation to continue to adopt a management procedure to secure the long-term health of the stock and urged members to support a peer review of the Pacific bluefin tuna stock assessment, using experts independent from the ISC. Pew said a peer review would yield valuable insights, as did a peer review for the north Pacific striped marlin assessment. In light of the concerns expressed by the plenary for potential resourcing constraints, Pew suggested the ISC develop a schedule for peer reviews for all stock assessments, which could be adjusted as necessary but would help members identify priorities and resource needs.

On north Pacific albacore tuna, Pew welcomed the ongoing work to develop exceptional circumstances for the management procedure but expressed concern for the ISC's efforts to translate fishing intensity into units of catch/effort. Pew encouraged the ISC to provide the RFMOs (WCPFC and IATTC) with a table showing TAC/TAE, as appropriate, at the fleet level, at levels of fishing intensity that would correspond to reference points in the adopted harvest control rule. Pew said the information would be helpful for managers, who still need to operationalize the management procedure into on-the-water controls for catch and/or effort. Although the current level of fishing intensity does not imply any actions might need to be made in the near future to exert greater management control on the fishery to avoid breaching the target reference point, this is exactly the time to ensure the management procedure can be operationalized before a crisis occurs.

On north Pacific striped marlin, Pew welcomed the analysis containing the updated rebuilding scenarios and asked whether the ISC considered developing alternative scenarios that would reflect changes in longline gear?

On climate change, Pew welcomed the topic being introduced with a question on "what do we need to know to help develop resilient, adaptable management strategies." Pew suggested the ISC also needs to consider how it should operate to achieve the goal of developing those strategies. Pew remarked that it will take new ways of doing business – ways that are not new in the production of scientific information – but might be new to how the ISC is accustomed to working. As such, Pew urged the ISC to seek out additional sources of data and information, establish greater mechanisms for sharing and collaboration among members, and provide greater openness in the operations of the ISC for the people and groups in society who have an interest in the ISC's work.

Monterey Bay Aquarium would like to thank the ISC Chair and Delegations for the opportunity to attend the Plenary Meeting and to provide comments. We would like to acknowledge all the work done by the working groups to provide precautionary scientific advice to managers and note the positive conservation impact this has had. Particularly, we would like to commend the ISC for their completion and implementation of the Northern Albacore MSE and harvest strategy. We would also like to commend the PBF Working Group for their identification of and support for recovery plans for Pacific Bluefin Tuna, resulting in a solid rebound in the population of the depleted stock. In order to maintain the gains made over the past years, we urge the Committee to continue work on a PBF MSE and provide strong advice to managers to adopt a permanent, precautionary harvest strategy for this species.

The ISC should also work to increase data reporting for all sources of mortality for all species under its purview. This should include accounting for discards, recreational catch, and IUU, where it occurs. To this end, the Committee should encourage the Northern Committee and its representative states to adopt greater observer (human and electronic) coverage in chronically unobserved and under observed fisheries, particularly those operating on the high seas.

Monterey Bay Aquarium would also like to commend the ISC on their push to understand and incorporate the effects of climate change on North Pacific highly migratory fish stocks. We believe the best way to “pre-adapt” management to the difficult to predict impacts of climate change is to develop robust harvest strategies for NC managed fish stocks. The limited ability for management structures to react quickly to changes in biology argues for pre-agreed, proactive management procedures, which would force managers to act immediately once changes are observed.

Lastly, we call on the ISC to increase transparency in their operating process. This would include making it easier for outside experts to participate in working group discussions, increasing independent review of the working groups, and making non-confidential data available for review and use.

The World Wildlife Fund (WWF) welcomes the recovery of the PBF stock to the second rebuilding target level. This stock declined to a historical low abundance around 2010 and was in a critical situation. Since then, it has recovered to the target earlier than planned and the scientific information provided by ISC contributed to this process.

To accelerate the transformation to sustainable fisheries in the future, the ISC needs more collaboration among the working groups and member countries. For example, surveys of PBF larvae and eggs are currently conducted by Japan and the Republic of Korea, and there is a possibility that more accurate scientific information could be obtained by closer collaboration among these two countries.

In ISC, lack of data and poor data still make it difficult to conduct some stock assessments. Therefore, WWF suggests that the ISC request WCPFC and IATTC managers implement Electronic Monitoring systems, Catch Documentation Scheme (CDS) and increasing observer coverage, and provide managers with details on what is needed to improve the accuracy and precision of stock assessments with new technologies, such as EM.

16 ADOPTION OF REPORT

The Report of the ISC24 Plenary session was adopted by the Members.

17 CLOSE OF MEETING

The meeting was closed at 12:15 PM June 24, 2024.

18 CATCH TABLES

Table 18-1. North Pacific albacore (*Thunnus alalunga*) retained and released catches (in metric tonnes) by ISC member fisheries, 1952-2022. "0"; Fishing effort was reported but no catch. "0" - Fishing effort was reported but no catch; "+" - Below 499kg catch; "-" - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year	JPN						KOR			MEX		
		Set-net	Drift gill-net	Longline	Others	Not specified	JPN Total	Longline	Purse seine	KOR Total	Others	Sport	MEX Total
Retain	1951	78	10	7,361	4,131	98	11,678						
	1952	68	-	9,042	2,569	12	11,691						
	1953	21	-	10,873	1,407	107	12,408						
	1954	18	-	12,659	813	121	13,611						
	1955	37	-	13,093	821	160	14,111						
	1956	31	-	14,606	775	73	15,485						
	1957	18	-	14,305	858	70	15,251						
	1958	31	-	18,567	1,069	67	19,734						
	1959	31	-	17,302	891	44	18,268						
	1960	67	1	20,109	1,191	30	21,398						
	1961	15	2	19,766	1,335	30	21,148						
	1962	15	-	10,685	1,371	44	12,115						
	1963	17	-	10,420	747	59	11,243						
	1964	16	4	7,760	1,006	66	8,852						
	1965	14	-	8,861	1,908	208	10,991						
	1966	11	-	9,979	1,728	45	11,763						
	1967	12	-	11,067	891	38	12,008						
	1968	14	-	10,046	1,539	50	11,649						
	1969	11	-	9,712	1,557	56	11,336						
	1970	9	-	7,751	1,748	39	9,547						
	1971	37	1	7,387	473	48	7,946	0		0			
	1972	1	55	7,327	282	22	7,687	0		0			
	1973	23	720	7,574	121	29	8,467	0		0			
	1974	16	1,304	6,669	190	29	8,208	0		0			
	1975	18	2,672	7,677	205	60	10,632	0		0			
	1976	14	3,488	8,845	313	182	12,842	0		0			
	1977	7	2,344	9,301	201	73	11,926	0		0			
	1978	22	2,475	9,069	130	111	11,807	0		0			
	1979	15	983	9,692	161	49	10,900	0		0			
	1980	15	1,746	6,898	398	30	9,087	135		135			
	1981	9	1,848	7,841	129	61	9,888	0		0			
	1982	7	1,257	6,998	195	59	8,516	166		166			
	1983	9	1,033	8,752	166	32	9,992	47		47			
	1984	13	1,053	8,411	117	98	9,692	27		27			
	1985	10	1,133	10,387	191	69	11,790	12		12			
	1986	9	1,264	9,815	123	47	11,258	18		18			
	1987	11	1,051	10,411	87	45	11,605	50		50			
	1988	8	1,234	9,317	173	19	10,751	27		27			
	1989	10	1,596	7,492	362	21	9,481	7		7			
	1990	4	1,074	6,598	128	13	7,817	46		46		-	-
	1991	5	498	5,690	153	20	6,366	37		37		-	-
	1992	6	887	8,505	381	16	9,795	32		32		-	-
	1993	4	292	9,777	309	44	10,426	27		27		-	-
	1994	4	421	8,723	308	37	9,493	4		4		-	-
	1995	7	561	7,809	423	34	8,834	9		9		-	-
	1996	4	428	7,983	597	45	9,057	15		15		-	-
	1997	5	365	8,216	346	62	8,994	99		99		-	-
	1998	2	471	7,423	476	68	8,440	153		153		-	-
	1999	5	724	6,606	416	47	7,798	131		131		-	-
	2000	5	808	7,301	497	49	8,660	202		202	602	-	602
	2001	15	732	7,840	230	30	8,847	438		438	516	-	516
	2002	11	1,164	7,195	201	29	8,600	438		438	215	-	215
	2003	4	1,198	6,439	149	28	7,818	380		380	237	-	237
	2004	4	1,062	6,904	229	30	8,229	410		410	268	-	268
	2005	3	956	6,653	187	337	8,136	403		403	234	-	234
	2006	5	796	7,690	244	343	9,078	465		465	328	-	328
	2007	2	829	8,125	122	368	9,446	453		453	172	-	172
	2008	3	648	6,189	173	349	7,362	794		794	242	-	242
	2009	3	682	6,007	239	249	7,180	993		993	394	-	394
	2010	8	494	5,400	110	230	6,242	662		662	222	-	222
	2011	2	193	4,022	10	233	4,460	962		962	-	-	-
	2012	8	371	4,034	59	288	4,760	856		856	-	-	-
	2013	13	290	4,248	163	291	5,005	1,071		1,071	-	-	-
	2014	7	269	4,381	0	291	4,948	829		829	-	-	-
	2015	3	277	5,099	204	281	5,864	776		776		-	-
	2016	2	303	5,605	169	256	6,335	582		582		-	-
	2017	3	291	4,837	274	289	5,694	583		583			
	2018	5	230	5,015	480	267	5,997	708		708			
	2019	6	242	3,910	339	210	4,707	468		468			
	2020	7	290	5,317	179	305	6,098	312		312			
	2021	4	301	4,231	270	251	5,057	267		267			
	2022	4	459	3,366	313	283	4,425	447		447			
	2023	4	459	4,582	313	283	5,641	590		590			
tain catch total		965	46,339	615,547	41,063	8,457	712,371	15,131		15,131	3,430	0	3,430
Release	2010												
	2011												
	2018							+		+			
	2019							+		+			
	2020							+		+			
	2021							0		0			
	2022							+		+			
	2023							0	0	0			
Release total								1	0	1			
Total		965	46,339	615,547	41,063	8,457	712,371	15,132	0	15,132	3,430	0	3,430

Table 18-1. Continued.

Catch disposition	Year	TWN							USA										Total
		Set-net	Gill-net (not specified)	Harpoon	Longline	Others	Purse seine	TWN Total	Drift gill-net	Harpoon	Handline	Longline	Pole and line	Troll	Hook-and-line	Other	Purse-seine	USA Total	
Retain	1951																		11,678
	1952																		11,691
	1953				-			-											12,408
	1954				-			-											13,611
	1955				-			-											14,111
	1956				-			-											15,485
	1957				-			-											15,251
	1958				-			-											19,734
	1959				427			427											18,695
	1960				520			520											21,918
	1961				318			318											21,466
	1962				494			494											12,609
	1963				343			343											11,586
	1964				358			358											9,210
	1965				331			331											11,322
	1966				489			489											12,252
	1967	-	-	5	646	30		681											12,689
	1968	-	8	3	763	1		775											12,424
	1969	-	1	6	843	-		850											12,186
	1970	-	1	5	904	-		910		612		5						617	11,074
	1971	-	-	3	992	-		995		99		1						100	9,041
	1972	-	-	12	862	-		874		171								171	8,732
	1973	-	-	113	860	6		979		399								399	9,845
	1974	-	-	98	881	38		1,017		406								406	9,631
	1975	-	-	152	928	1		1,081		557								557	12,270
	1976	-	-	159	636	35		830		42								42	13,714
	1977	-	2	139	578	-		719		318		17						335	12,980
	1978	-	3	10	546	-		559		1,699		9						1,708	14,074
	1979	-	5	24	668	4		701		329		7						336	11,937
	1980	-	4	72	613	1		690	160	566		5						731	10,643
	1981	-	3	18	658	4		683	473	271		3	2					749	11,320
	1982	-	3	46	856	-		905	945	156		5	3	6		1		1,116	10,703
	1983	-	3	164	783	-		950	1,693	58		5	2	3		1	1	1,763	12,752
	1984	43	5	259	733	-		1,040	2,647	104		15	49				26	2,841	13,600
	1985	3	29	166	566	61		825	2,990	305	4	2				104		3,405	16,032
	1986	3	1	201	456	6		667	2,069	291	4	2				109		2,475	14,418
	1987	-	-	187	1,331	3		1,521	1,529	235	4	24				31		1,823	14,999
	1988	-	1	80	777	183		1,041	1,376	198	6	24				64		1,668	13,487
	1989	3	2	61	1,541	35		1,642	1,243	62	7	218				56		1,586	12,716
	1990	4	2	118	1,452	88		1,664	1,131	64	5	2,437				43		3,680	13,207
	1991	4	2	205	1,430	56		1,697	944	20	6	4,535				44		5,549	13,649
	1992	12	1	287	1,494	33		1,827	1,356	75	1	5,762				47		7,241	18,895
	1993	13	3	194	1,228	100		1,538	1,412	168	4	5,936				161		7,681	19,672
	1994	12	3	211	1,155	9		1,390	792	157	4	3,807				24		4,784	15,671
	1995	6	2	14	1,185	203		1,410	771	97	6	2,981				29		3,884	14,137
	1996	10	2	19	710	1	-	742	761	81	5	2,848				15		3,710	13,524
	1997	8	1	27	1,397	1	-	1,434	708	84	7	3,393				11		4,203	14,730
	1998	15	9	17	1,198	-	-	1,239	931	48	7	3,681				19		4,686	14,518
	1999	5	5	51	1,455	+	-	1,516	606	81	9	4,329				27		5,052	14,497
	2000	5	6	74	3,716	-	-	3,801	649	90		4,834				33		5,606	18,871
	2001	8	18	64	4,853	-	-	4,943	375	52		1,969				19		2,415	17,159
	2002	16	8	1	5,400	1	-	5,426	302	90		1,524				3		1,919	16,598
	2003	8	3	-	4,771	-	-	4,782	216	107	10	1,958				11		2,302	15,519
	2004	7	6	1	4,248	2	-	4,264	182	69	7	1,185				44		1,487	14,658
	2005	5	3	16	3,964	2	-	3,990	220	77	5	1,622				5		1,929	14,692
	2006	7	2	49	4,382	3	-	4,443	443	71	4	1,211				5		1,734	16,048
	2007	2	2	20	4,099	2	-	4,125	490	59	5	1,735		1				2,290	16,486
	2008	3	6	39	3,745	+	-	3,793	405	48	6	2,014				19		2,492	14,683
	2009	83	7	31	3,550	-	-	3,671	253	50	5	1,817		0		0		2,125	14,363
	2010	6	4	42	2,844	-	-	2,896	62	37	3	1,676				18		1,796	11,818
	2011	8	17	52	3,577	1	+	3,655	119	24	5	1,623				90		1,861	10,938
	2012	3	15	30	3,746	+	-	3,794	118	5	6	1,395		1		1		1,526	10,936
	2013	2	8	-	2,846	1	-	2,857	95	6	6	1,270		1		7		1,385	10,318
	2014	4	4	-	2,817	+	+	2,825	127	6	7	1,665		1	0	4		1,811	10,413
	2015	4	4	-	3,199	-	-	3,207	101	5	5	1,515		1	0	12		1,639	11,486
	2016	2	3	+	2,054	1	-	2,059	183	26	4	1,092			1	42		1,348	10,324
	2017	+	3	-	2,194	+	+	2,197	180	28	6	1,618		+	1	44		1,876	10,350
	2018	1	+	-	2,124	+	-	2,125	148	10	3	1,053		1	0	67		1,281	10,111
	2019	2	+	-	2,113	+	-	2,115	52	11	3	734		0	1	186		987	8,278
	2020	3	+	-	1,868	+	-	1,871	35	6	2	543			1	125		711	8,993
	2021	1	-	-	1,067	-	-	1,068	14	7	1	684		0	2	54		761	7,154
	2022	1	-	-	1,109	3	-	1,113	29	33	1	928		0	2	26		1,019	7,004
	2023	1	-	-	1,572	3	+	1,576	37	36	1	856			1	31		963	8,770
tain catch total		323	220	3,545	110,263	917	0	115,268	29,370	8,706	175	76,572	56	16	10	1,632	27	116,563	962,763
Release	2010																0	0	0
	2011																0	0	0
	2018																		+
	2019																		+
	2020																		+
	2021																		0
	2022																		+
	2023																		0
Release total																	0	0	1
Total		323	220	3,545	110,263	917	0	115,268	29,370	8,706	175	76,572	56	16	10	1,632	27	116,563	962,764

Table 18-2. Pacific bluefin tuna (*Thunnus orientialis*) retained and released catches (in metric tonnes) by ISC member fisheries, 1952-2022. "0" - Fishing effort was reported but no catch; "+" - Below 499kg catch; "-" - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year	JPN							KOR					MEX		
		Set-net	Longline	Pole and line	Troll[1]	Others	Purse seine	JPN Total	Set-net	Longline	Purse seine	Trawl	KOR Total	Others	Purse seine	MEX Total
Retain	1952	2,145	2,694	2,198	667	1,700	7,680	17,084						-	-	-
	1953	2,335	3,040	3,052	1,472	160	5,570	15,629						-	-	-
	1954	5,579	3,088	3,044	1,656	266	5,366	18,999						-	-	-
	1955	3,256	2,951	2,841	1,507	1,151	14,016	25,722						-	-	-
	1956	4,170	2,672	4,060	1,763	385	20,979	34,029						-	-	-
	1957	2,822	1,685	1,795	2,392	414	18,147	27,255						-	-	-
	1958	1,187	818	2,337	1,497	215	8,586	14,640						-	-	-
	1959	1,575	3,136	586	736	167	9,996	16,196						32	171	203
	1960	2,032	5,910	600	1,885	369	10,541	21,337						-	-	-
	1961	2,710	6,364	662	3,193	599	9,124	22,652						-	130	130
	1962	2,545	5,769	747	1,683	293	10,657	21,694						-	294	294
	1963	2,797	6,077	1,256	2,542	294	9,786	22,752						-	412	412
	1964	1,475	3,140	1,037	2,784	1,884	8,973	19,293						-	131	131
	1965	2,121	2,569	831	1,963	1,106	11,496	20,086						-	289	289
	1966	1,261	1,370	613	1,614	129	10,082	15,069						-	435	435
	1967	2,603	878	1,210	3,273	302	6,462	14,728						-	371	371
	1968	3,058	500	983	1,568	217	9,268	15,594						-	195	195
	1969	2,187	878	721	2,219	195	3,236	9,436						-	260	260
	1970	1,779	607	723	1,198	224	2,907	7,438						-	92	92
	1971	1,555	697	938	1,492	317	3,721	8,720		0			0	-	555	555
	1972	1,107	512	944	842	197	4,212	7,814		0			0	-	1,646	1,646
	1973	2,351	838	526	2,108	636	2,266	8,725		0			0	-	1,084	1,084
	1974	6,019	1,177	1,192	1,656	754	4,106	14,904		0			0	-	344	344
	1975	2,433	1,061	1,401	1,031	808	4,491	11,225		3			3	-	2,145	2,145
	1976	2,996	320	1,082	830	1,237	2,148	8,613		5			5	-	1,968	1,968
	1977	2,257	338	2,256	2,166	1,052	5,110	13,179		0			0	-	2,186	2,186
	1978	2,546	648	1,154	4,517	2,276	10,427	21,568		3			3	-	545	545
	1979	4,558	729	1,250	2,655	2,429	13,881	25,502		0			0	-	213	213
	1980	2,521	811	1,392	1,531	1,953	11,327	19,535		0			0	-	582	582
	1981	2,129	590	754	1,777	2,653	25,422	33,325		0			0	-	218	218
	1982	1,667	718	1,777	864	1,709	19,234	25,969		0	31		31	-	506	506
	1983	972	217	356	2,028	1,117	14,774	19,464		0	13		13	-	214	214
	1984	2,234	142	587	1,874	868	4,433	10,138		1	4		5	-	166	166
	1985	2,562	105	1,817	1,850	1,175	4,154	11,663		0	1		1	-	676	676
	1986	2,914	102	1,086	1,467	719	7,412	13,700		0	344		344	-	189	189
	1987	2,198	211	1,565	880	445	8,653	13,952		13	89		102	-	119	119
	1988	843	157	907	1,124	498	3,605	7,134		0	32		32	1	447	448
	1989	748	209	754	903	283	6,190	9,087		0	71		71	-	57	57
	1990	716	267	536	1,250	455	2,989	6,213		0	132		132	-	50	50
	1991	1,485	218	286	2,069	650	9,808	14,516		0	265		265	-	9	9
	1992	1,208	513	166	915	1,081	7,162	11,045		0	288		288	-	0	0
	1993	848	812	129	546	365	6,600	9,300		0	40		40	-	0	0
	1994	1,158	1,206	162	4,111	398	8,131	15,166		0	50		50	2	63	65
	1995	1,859	678	270	4,778	586	18,909	27,080		0	821		821	-	11	11
	1996	1,149	901	94	3,640	570	7,644	13,998		0	102		102	-	3,700	3,700
	1997	803	1,300	34	2,740	811	13,152	18,840		0	1,054		1,054	-	367	367
	1998	874	1,255	85	2,876	700	5,391	11,181		0	188		188	-	1	1
	1999	1,097	1,157	35	3,440	709	16,173	22,611		0	256		256	35	2,369	2,404
	2000	1,125	953	102	5,217	689	16,486	24,572		0	2,401	0	2,401	99	3,019	3,118
	2001	1,366	791	180	3,466	782	7,620	14,205		0	1,176	10	1,186	-	863	863
	2002	1,100	841	99	2,607	631	8,903	14,181		0	932	1	933	2	1,708	1,710
	2003	839	1,237	44	2,060	446	5,768	10,394		0	2,601	0	2,601	43	3,211	3,254
	2004	896	1,847	132	2,445	514	8,257	14,091		0	773	0	773	14	8,880	8,894
	2005	2,182	1,925	549	3,633	548	12,817	21,654		0	1,318	9	1,327	-	4,542	4,542
	2006	1,421	1,121	108	1,860	777	8,880	14,167		0	1,012	3	1,015	-	9,806	9,806
	2007	1,503	1,762	236	2,823	657	6,840	13,821		0	1,281	4	1,285	-	4,147	4,147
	2008	2,358	1,390	64	2,377	770	10,221	17,180		0	1,866	10	1,876	15	4,407	4,422
	2009	2,236	1,080	50	2,003	575	8,077	14,021		0	936	4	940	-	3,019	3,019
	2010	1,603	890	83	1,583	495	3,742	8,396		0	1,196	16	1,212	-	7,746	7,746
	2011	1,651	837	63	1,820	283	8,340	12,993		0	670	14	684	1	2,731	2,732
	2012	1,932	673	113	570	343	2,462	6,093		0	1,421	2	1,423	1	6,668	6,669
	2013	1,415	784	8	904	529	2,771	6,411	1	-	604	0	605		3,154	3,154
	2014	1,907	683	5	1,023	499	5,456	9,573	6		1,305	-	1,311		4,862	4,862
	2015	1,242	648	8	413	431	3,645	6,386	1		676		677		3,082	3,082
	2016	1,228	691	54	778	508	5,095	8,354	3		1,024	2	1,030		2,709	2,709
	2017	2,221	913	49	605	665	4,540	8,993	3		734	6	743		3,643	3,643
	2018	645	700	9	371	431	4,049	6,205	7		523	5	535		2,840	2,840
	2019	951	1,002	+	720	372	4,464	7,509	36		542	3	581		2,249	2,249
	2020	1,342	1,416	1	760	532	3,960	8,011	35		567	3	605		3,285	3,285
	2021	1,742	1,512	+	653	512	4,198	8,617	84		425	+	509		3,027	3,027
	2022	2,126	1,599	13	1,079	593	4,702	10,112	221		654	6	881		3,194	3,194
	2023	1,889	1,556	24	1,160	593	4,570	9,792	215		448	5	668	8	3,399	3,407
Retain catch total		140,363	98,886	54,825	134,501	50,697	590,259	1,069,531	613	25	28,863	106	29,607	253	119,401	119,654
Total		140,363	98,886	54,825	134,501	50,697	590,259	1,069,531	613	25	28,863	106	29,607	253	119,401	119,654

Table 18-2. Continued.

Catch disposition	Year	TWN Set-net	TWN Gill-net (not specified)	TWN Drift gill-net	TWN Longline	TWN Others	TWN Purse seine	TWN Total	USA Drift gill-net	USA Longline	USA Pole and line	USA Troll	USA Hook and Line	USA Others	USA Purse seine	USA Sport	USA Total [4]	Total
Retain	1952														2,076	2	2,078	19,162
	1953														4,433	48	4,481	20,110
	1954														9,537	11	9,548	28,547
	1955														6,173	93	6,266	31,988
	1956														5,727	388	6,115	40,144
	1957														9,215	73	9,288	36,543
	1958														13,934	10	13,944	28,584
	1959										56				3,506	13	3,575	19,974
	1960										+				4,547	1	4,548	25,885
	1961										16				7,989	23	8,028	30,810
	1962										+				10,769	25	10,794	32,782
	1963										28				11,832	7	11,867	35,031
	1964										39				9,047	7	9,093	28,517
	1965				54			54			11	+		66	6,523	1	6,601	27,030
	1966				-			-			12				15,450	20	15,482	30,986
	1967				53			53			+				5,517	32	5,549	20,701
	1968				33			33			8				5,773	12	5,793	21,615
	1969				23			23			9				6,657	15	6,681	16,400
	1970				-			-			+				3,873	19	3,892	11,422
	1971				1			1			+				7,804	8	7,812	17,088
	1972				14			14			3			42	11,656	15	11,716	21,190
	1973				33			33			5	+		20	9,639	54	9,718	19,560
	1974				47	15		62			+	+		30	5,243	58	5,331	20,641
	1975				61	5		66			83			1	7,353	34	7,471	20,910
	1976				17	2		19			22	+		3	8,652	21	8,698	19,303
	1977				131	2		133			10			3	3,259	19	3,291	18,789
	1978				66	2		68			4			2	4,663	5	4,674	26,858
	1979				58	-		58			5			1	5,889	11	5,906	31,679
	1980				114	5		119			+			24	2,327	7	2,358	22,594
	1981				179	-		179	4		+	10		+	867	9	890	34,612
	1982			2	207	-		209	9		1			+	2,639	11	2,660	29,375
	1983			2	175	-	9	186	31		59			2	629	33	754	20,631
	1984			-	477	8	5	490	6	1	5			18	673	49	752	11,551
	1985			11	210	-	80	301	8					20	3,320	89	3,437	16,078
	1986			13	70	-	16	99	16					41	4,851	12	4,920	19,252
	1987			14	365	-	21	400	2					18	861	34	915	15,488
	1988			37	108	25	197	367	4					46	923	6	979	8,960
	1989			51	205	3	259	518	3					18	1,046	112	1,179	10,912
	1990			299	189	16	149	653	11					81	1,380	65	1,537	8,585
	1991			107	342	12	-	461	4	2				+	410	92	508	15,759
	1992			3	464	5	73	545	9	38				14	1,928	110	2,099	13,977
	1993				471	3	1	475	32	42				29	580	283	966	10,781
	1994				559	-		559	28	30				1	906	86	1,051	16,891
	1995				335	2		337	20	29				+	657	245	951	29,200
	1996	-	-		956	-	-	956	43	25		2		+	4,639	40	4,749	23,505
	1997	-	-		1,814	-	-	1,814	58	26		1		48	2,240	131	2,504	24,579
	1998	-	-		1,910	-	-	1,910	40	54		128		59	1,771	422	2,474	15,754
	1999	-	-		3,089	-	-	3,089	22	54		20		88	184	408	776	29,136
	2000	-	1		2,780	1	-	2,782	30	19		1		11	693	319	1,073	33,946
	2001	-	2		1,839	2	-	1,843	35	6		6		1	292	344	684	18,781
	2002	-	3		1,523	1	-	1,527	7	2		1		2	50	613	675	19,026
	2003	-	10		1,863	11	-	1,884	14	1				3	22	355	395	18,528
	2004	-	1		1,714	2	-	1,717	10	1				+		50	61	25,536
	2005	1	-		1,368	1	-	1,370	5	1				1	201	73	281	29,174
	2006	1	-		1,149	-	-	1,150	1	1				+		94	96	26,234
	2007	2	8		1,401	-	-	1,411	2	+				+	42	12	56	20,720
	2008	1	1		979	-	-	981	1	+				+		63	64	24,523
	2009	1	10		877	-	-	888	3	1		0		2	410	156	572	19,440
	2010	29	7		373	-	-	409	1	0				0		88	89	17,852
	2011	16	7		292	1	-	316	18	0		0		100		225	343	17,068
	2012	2	-		210	2	-	214	4	0		0		38		400	442	14,841
	2013	2	1		331	-	-	334	7	1		0		3		809	820	11,324
	2014	38	4		483	-	-	525	5	+		+	2	-	401	420	828	17,099
	2015	25	1		552	-	-	578	4	+			7	-	86	400	498	11,221
	2016	-	+		454	-	-	454	9	1		0	31	-	316	372	728	13,275
	2017	-	-		415	+	-	415	1	1		+	18	+	466	463	950	14,744
	2018	+	3		381	+	-	384	18	1		+	31	4	12	535	600	10,565
	2019	2	2		486	2	-	492	10	2		1	36	1	226	483	758	11,589
	2020	1	-		1,149	-	-	1,150	28	2		+	87	1	116	742	975	14,025
	2021	+	+		1,478	-	-	1,478	55	1		+	116	3	43	1,293	1,510	15,142
	2022	1	+		1,496	-	-	1,497	20	2		0	149	1	198	1,579	1,948	17,633
	2023	1	+		2,117	-	-	2,118	16	2		+	163	3	3	1,887	2,073	18,058
Retain catch total		123	61	539	38,540	128	810	40,201	654	345	376	170	639	850	243,145	15,042	261,220	1,520,213
Total		123	61	539	38,540	128	810	40,201	654	345	376	170	639	850	243,145	15,042	261,220	1,520,213

Table 18-3. Annual retained and released catches of swordfish (*Xiphias gladius*) in metric tonnes for fisheries monitored by ISC member countries for assessments of the North Pacific Ocean stock, 1951-2022. "0"; Fishing effort was reported but no catch. "0" - Fishing effort was reported but no catch; "+" - Below 499kg catch; "-" - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year	JPN						KOR			MEX		
		Set-net	Drift gill-net	Longline	Others	Not specified	JPN Total	Longline	Purse seine	KOR Total	Others	Sport	MEX Total
Retain	1951	78	10	7,361	4,131	98	11,678						
	1952	68	-	9,042	2,569	12	11,691						
	1953	21	-	10,873	1,407	107	12,408						
	1954	18	-	12,659	813	121	13,611						
	1955	37	-	13,093	821	160	14,111						
	1956	31	-	14,606	775	73	15,485						
	1957	18	-	14,305	858	70	15,251						
	1958	31	-	18,567	1,069	67	19,734						
	1959	31	-	17,302	891	44	18,268						
	1960	67	1	20,109	1,191	30	21,398						
	1961	15	2	19,766	1,335	30	21,148						
	1962	15	-	10,685	1,371	44	12,115						
	1963	17	-	10,420	747	59	11,243						
	1964	16	4	7,760	1,006	66	8,852						
	1965	14	-	8,861	1,908	208	10,991						
	1966	11	-	9,979	1,728	45	11,763						
	1967	12	-	11,067	891	38	12,008						
	1968	14	-	10,046	1,539	50	11,649						
	1969	11	-	9,712	1,557	56	11,336						
	1970	9	-	7,751	1,748	39	9,547						
	1971	37	1	7,387	473	48	7,946	0		0			
	1972	1	55	7,327	282	22	7,687	0		0			
	1973	23	720	7,574	121	29	8,467	0		0			
	1974	16	1,304	6,669	190	29	8,208	0		0			
	1975	18	2,672	7,677	205	60	10,632	0		0			
	1976	14	3,488	8,845	313	182	12,842	0		0			
	1977	7	2,344	9,301	201	73	11,926	0		0			
	1978	22	2,475	9,069	130	111	11,807	0		0			
	1979	15	983	9,692	161	49	10,900	0		0			
	1980	15	1,746	6,898	398	30	9,087	135		135			
	1981	9	1,848	7,841	129	61	9,888	0		0			
	1982	7	1,257	6,998	195	59	8,516	166		166			
	1983	9	1,033	8,752	166	32	9,992	47		47			
	1984	13	1,053	8,411	117	98	9,692	27		27			
	1985	10	1,133	10,387	191	69	11,790	12		12			
	1986	9	1,264	9,815	123	47	11,258	18		18			
	1987	11	1,051	10,411	87	45	11,605	50		50			
	1988	8	1,234	9,317	173	19	10,751	27		27			
	1989	10	1,596	7,492	362	21	9,481	7		7			
	1990	4	1,074	6,598	128	13	7,817	46		46		-	-
	1991	5	498	5,690	153	20	6,366	37		37		-	-
	1992	6	887	8,505	381	16	9,795	32		32		-	-
	1993	4	292	9,777	309	44	10,426	27		27		-	-
	1994	4	421	8,723	308	37	9,493	4		4		-	-
	1995	7	561	7,809	423	34	8,834	9		9		-	-
	1996	4	428	7,983	597	45	9,057	15		15		-	-
	1997	5	365	8,216	346	62	8,994	99		99		-	-
	1998	2	471	7,423	476	68	8,440	153		153		-	-
	1999	5	724	6,606	416	47	7,798	131		131		-	-
	2000	5	808	7,301	497	49	8,660	202		202	602	-	602
	2001	15	732	7,840	230	30	8,847	438		438	516	-	516
	2002	11	1,164	7,195	201	29	8,600	438		438	215	-	215
	2003	4	1,198	6,439	149	28	7,818	380		380	237	-	237
	2004	4	1,062	6,904	229	30	8,229	410		410	268	-	268
	2005	3	956	6,653	187	337	8,136	403		403	234	-	234
	2006	5	796	7,690	244	343	9,078	465		465	328	-	328
	2007	2	829	8,125	122	368	9,446	453		453	172	-	172
	2008	3	648	6,189	173	349	7,362	794		794	242	-	242
	2009	3	682	6,007	239	249	7,180	993		993	394	-	394
	2010	8	494	5,400	110	230	6,242	662		662	222	-	222
	2011	2	193	4,022	10	233	4,460	962		962	-	-	-
	2012	8	371	4,034	59	288	4,760	856		856	-	-	-
	2013	13	290	4,248	163	291	5,005	1,071		1,071	-	-	-
	2014	7	269	4,381	0	291	4,948	829		829	-	-	-
	2015	3	277	5,099	204	281	5,864	776		776		-	-
	2016	2	303	5,605	169	256	6,335	582		582		-	-
	2017	3	291	4,837	274	289	5,694	583		583			
	2018	5	230	5,015	480	267	5,997	708		708			
	2019	6	242	3,910	339	210	4,707	468		468			
	2020	7	290	5,317	179	305	6,098	312		312			
	2021	4	301	4,231	270	251	5,057	267		267			
	2022	4	459	3,366	313	283	4,425	447		447			
	2023	4	459	4,582	313	283	5,641	590		590			
tain catch total		965	46,339	615,547	41,063	8,457	712,371	15,131		15,131	3,430	0	3,430
Release	2010												
	2011												
	2018							+		+			
	2019							+		+			
	2020							+		+			
	2021							0		0			
	2022							+		+			
	2023							0	0	0			
Release total								1	0	1			
Total		965	46,339	615,547	41,063	8,457	712,371	15,132	0	15,132	3,430	0	3,430

Table 18-3. Continued.

Catch disposition	Year	TWN Set-net	TWN Gill-net (not specified)	TWN Harpoon	TWN Longline	TWN Others	TWN Purse seine	TWN Total	USA Drift gill-net	USA Harpoon	USA Handline	USA Longline	USA Pole and line	USA Troll	USA Hook-and-line	USA Other	USA Purse-seine	USA Total	Total
Retain	1951																		11,678
	1952																		11,691
	1953				-			-											12,408
	1954				-			-											13,611
	1955				-			-											14,111
	1956				-			-											15,485
	1957				-			-											15,251
	1958				-			-											19,734
	1959				427			427											18,695
	1960				520			520											21,918
	1961				318			318											21,466
	1962				494			494											12,609
	1963				343			343											11,586
	1964				358			358											9,210
	1965				331			331											11,322
	1966				489			489											12,252
	1967	-	-	5	646	30		681											12,689
	1968	-	8	3	763	1		775											12,424
	1969	-	1	6	843	-		850											12,186
	1970	-	1	5	904	-		910		612		5						617	11,074
	1971	-	-	3	992	-		995		99		1						100	9,041
	1972	-	-	12	862	-		874		171								171	8,732
	1973	-	-	113	860	6		979		399								399	9,845
	1974	-	-	98	881	38		1,017		406								406	9,631
	1975	-	-	152	928	1		1,081		557								557	12,270
	1976	-	-	159	636	35		830		42								42	13,714
	1977	-	2	139	578	-		719		318		17						335	12,980
	1978	-	3	10	546	-		559		1,699		9						1,708	14,074
	1979	-	5	24	668	4		701		329		7						336	11,937
	1980	-	4	72	613	1		690	160	566		5						731	10,643
	1981	-	3	18	658	4		683	473	271		3	2					749	11,320
	1982	-	3	46	856	-		905	945	156		5	3	6		1		1,116	10,703
	1983	-	3	164	783	-		950	1,693	58		5	2	3		1	1	1,763	12,752
	1984	43	5	259	733	-		1,040	2,647	104		15	49				26	2,841	13,600
	1985	3	29	166	566	61		825	2,990	305	4	2				104		3,405	16,032
	1986	3	1	201	456	6		667	2,069	291	4	2				109		2,475	14,418
	1987	-	-	187	1,331	3		1,521	1,529	235	4	24				31		1,823	14,999
	1988	-	1	80	777	183		1,041	1,376	198	6	24				64		1,668	13,487
	1989	3	2	61	1,541	35		1,642	1,243	62	7	218				56		1,586	12,716
	1990	4	2	118	1,452	88		1,664	1,131	64	5	2,437				43		3,680	13,207
	1991	4	2	205	1,430	56		1,697	944	20	6	4,535				44		5,549	13,649
	1992	12	1	287	1,494	33		1,827	1,356	75	1	5,762				47		7,241	18,895
	1993	13	3	194	1,228	100		1,538	1,412	168	4	5,936				161		7,681	19,672
	1994	12	3	211	1,155	9		1,390	792	157	4	3,807				24		4,784	15,671
	1995	6	2	14	1,185	203		1,410	771	97	6	2,981				29		3,884	14,137
	1996	10	2	19	710	1	-	742	761	81	5	2,848				15		3,710	13,524
	1997	8	1	27	1,397	1	-	1,434	708	84	7	3,393				11		4,203	14,730
	1998	15	9	17	1,198	-	-	1,239	931	48	7	3,681				19		4,686	14,518
	1999	5	5	51	1,455	+	-	1,516	606	81	9	4,329				27		5,052	14,497
	2000	5	6	74	3,716	-	-	3,801	649	90		4,834				33		5,606	18,871
	2001	8	18	64	4,853	-	-	4,943	375	52		1,969				19		2,415	17,159
	2002	16	8	1	5,400	1	-	5,426	302	90		1,524				3		1,919	16,598
	2003	8	3	-	4,771	-	-	4,782	216	107	10	1,958				11		2,302	15,519
	2004	7	6	1	4,248	2	-	4,264	182	69	7	1,185				44		1,487	14,658
	2005	5	3	16	3,964	2	-	3,990	220	77	5	1,622				5		1,929	14,692
	2006	7	2	49	4,382	3	-	4,443	443	71	4	1,211				5		1,734	16,048
	2007	2	2	20	4,099	2	-	4,125	490	59	5	1,735		1				2,290	16,486
	2008	3	6	39	3,745	+	-	3,793	405	48	6	2,014				19		2,492	14,683
	2009	83	7	31	3,550	-	-	3,671	253	50	5	1,817		0		0		2,125	14,363
	2010	6	4	42	2,844	-	-	2,896	62	37	3	1,676				18		1,796	11,818
	2011	8	17	52	3,577	1	+	3,655	119	24	5	1,623				90		1,861	10,938
	2012	3	15	30	3,746	+	-	3,794	118	5	6	1,395		1		1		1,526	10,936
	2013	2	8	-	2,846	1	-	2,857	95	6	6	1,270		1		7		1,385	10,318
	2014	4	4	-	2,817	+	+	2,825	127	6	7	1,665		1	0	4		1,811	10,413
	2015	4	4	-	3,199	-	-	3,207	101	5	5	1,515		1	0	12		1,639	11,486
	2016	2	3	+	2,054	1	-	2,059	183	26	4	1,092			1	42		1,348	10,324
	2017	+	3	-	2,194	+	+	2,197	180	28	6	1,618		+	1	44		1,876	10,350
	2018	1	+	-	2,124	+	-	2,125	148	10	3	1,053		1	0	67		1,281	10,111
	2019	2	+	-	2,113	+	-	2,115	52	11	3	734		0	1	186		987	8,278
	2020	3	+	-	1,868	+	-	1,871	35	6	2	543			1	125		711	8,993
	2021	1	-	-	1,067	-	-	1,068	14	7	1	684		0	2	54		761	7,154
	2022	1	-	-	1,109	3	-	1,113	29	33	1	928		0	2	26		1,019	2,579
	2023	1	-	-	1,572	3	+	1,576	37	36	1	856			1	31		963	3,129
tain catch total		323	220	3,545	110,263	917	0	115,268	29,370	8,706	175	76,572	56	16	10	1,632	27	116,563	962,763
Release	2010																0	0	0
	2011																0	0	0
	2018																		+
	2019																		+
	2020																		+
	2021																		0
	2022																		+
	2023																		0
Release total																	0	0	1
Total		323	220	3,545	110,263	917	0	115,268	29,370	8,706	175	76,572	56	16	10	1,632	27	116,563	962,764

Table 18-4. Annual retained and released catches of striped marlin (*Kajikia audax*) in metric tonnes for fisheries monitored by ISC member countries for assessments of the WCNPO stock, 1951-2022. "0" - Fishing effort was reported but no catch; "+" - Below 499kg catch; "-" - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year	JPN						KOR			MEX	
		Set-net	Drift gill-net	Longline	Others	Not specified	JPN Total	Longline	Purse seine	KOR Total	Sport	MEX Total
Retain	1951	92	-	3,167	1,149	39	4,447					
	1952	203	-	3,623	1,321	40	5,187					
	1953	126	-	2,185	793	36	3,140					
	1954	82	-	3,120	938	67	4,207					
	1955	106	-	3,110	850	82	4,148					
	1956	133	-	3,788	1,822	41	5,784					
	1957	71	-	3,308	2,312	76	5,767					
	1958	82	3	4,383	2,704	127	7,299					
	1959	87	2	4,308	2,905	200	7,502					
	1960	161	4	3,963	1,689	87	5,904					
	1961	161	2	4,589	1,538	98	6,388					
	1962	197	8	5,849	1,607	108	7,769					
	1963	92	17	6,197	1,527	292	8,125					
	1964	81	2	14,346	2,223	41	16,693					
	1965	81	1	11,621	2,640	73	14,416					
	1966	226	2	8,531	1,313	31	10,103					
	1967	82	3	11,825	1,394	75	13,379					
	1968	71	0	16,143	914	58	17,186					
	1969	71	3	9,147	2,516	81	11,818					
	1970	55	3	13,867	824	153	14,902					
	1971	61	10	11,891	1,674	307	13,943	0		0		
	1972	72	243	7,988	827	94	9,224	0		0		
	1973	80	3,265	7,107	476	146	11,074	0		0		
	1974	90	3,112	7,076	581	104	10,963	0		0		
	1975	105	6,534	5,605	492	89	12,825	0		0		
	1976	37	3,561	5,414	441	107	9,560	0		0		
	1977	103	4,424	3,290	337	107	8,261	0		0		
	1978	93	5,593	4,227	210	243	10,366	0		0		
	1979	66	2,532	5,948	327	133	9,006	0		0		
	1980	80	3,467	6,990	397	59	10,993	73		73		
	1981	88	3,866	4,377	385	69	8,785	0		0		
	1982	52	2,351	5,666	476	128	8,673	102		102		
	1983	124	1,867	4,052	547	156	6,746	49		49		
	1984	144	2,333	3,901	398	177	6,953	39		39		
	1985	81	2,363	4,632	499	153	7,728	13		13		
	1986	131	3,584	7,336	343	103	11,497	14		14		
	1987	102	1,888	8,731	244	167	11,132	15		15		
	1988	63	2,211	7,030	400	205	9,909	16		16		
	1989	47	1,664	5,834	345	145	8,035	24		24		
	1990	65	1,945	3,496	287	193	5,986	1		1	-	-
	1991	56	1,329	4,045	320	131	5,881	7		7	-	-
	1992	71	1,204	4,212	137	95	5,719	53		53	-	-
	1993	27	828	5,200	308	373	6,736	568		568	-	-
	1994	73	1,443	4,196	218	92	6,022	556		556	-	-
	1995	58	970	5,337	139	86	6,590	307		307	-	-
	1996	39	703	3,791	25	88	4,646	429		429	-	-
	1997	34	813	3,523	61	68	4,499	1,017		1,017	-	-
	1998	34	1,092	3,761	123	147	5,157	635		635	-	-
	1999	28	1,126	3,163	66	90	4,473	433		433	-	-
	2000	41	1,062	2,269	165	91	3,628	536		536	-	-
	2001	51	1,077	2,322	150	36	3,636	253		253	-	-
	2002	80	1,264	1,565	182	28	3,119	187		187	-	-
	2003	41	1,064	1,858	135	27	3,125	205		205	-	-
	2004	23	1,339	1,701	33	34	3,130	75		75	-	-
	2005	28	1,214	1,231	35	35	2,543	136		136	-	-
	2006	30	1,190	1,162	33	32	2,447	55		55	-	-
	2007	21	970	1,171	20	38	2,220	46		46	-	-
	2008	26	1,302	1,009	43	28	2,408	29		29	-	-
	2009	17	821	809	34	39	1,720	22		22	-	-
	2010	20	913	1,061	26	36	2,056	18		18	-	-
	2011	30	347	1,306	32	26	1,741	48		48	-	-
	2012	52	597	1,336	33	34	2,052	33		33	-	-
	2013	39	336	1,496	19	34	1,924	65		65	-	-
	2014	35	173	1,155	0	22	1,385	82		82	-	-
	2015	37	287	1,441	37	27	1,829	44		44	-	-
	2016	25	308	1,056	41	32	1,462	61		61	-	-
	2017	28	241	977	23	28	1,297	81		81		
	2018	28	278	886	52	36	1,280	70		70		
	2019	29	241	1,140	61	39	1,510	48		48		
	2020	37	155	1,141	32	25	1,390	60		60		
	2021	31	95	909	60	17	1,112	66		66		
	2022	27	138	603	71	23	862	66		66		
	2023	27	138	616	71	23	875	90		90		
Retain catch total		5,167	81,921	325,108	45,450	6,650	464,296	6,727		6,727	0	0
Release	2010											
	2011											
	2016								+	+		
	2018							+	2	2		
	2019											
	2020											
	2021							0		0		
	2022							0		0		
	2023								0	0		
Release total								+	2	2		
Total		5,167	81,921	325,108	45,450	6,650	464,296	6,727	2	6,729	0	0

Table 18-4. Continued.

Catch disposition	Year	TWN Set-net	TWN Gill-net (not specified)	TWN Harpoon	TWN Longline	TWN Others	TWN Purse seine	TWN Total	USA Handline	USA Longline	USA Troll	USA Others	USA Purse seine	USA Sport	USA Total	Total
Retain	1951															4,447
	1952													23	23	5,210
	1953					0		0						5	5	3,145
	1954					0		0						16	16	4,223
	1955					0		0						5	5	4,153
	1956					0		0						34	34	5,818
	1957					0		0						42	42	5,809
	1958				543	387		930						59	59	8,288
	1959				391	354		745						65	65	8,312
	1960				398	350		748						30	30	6,682
	1961				306	342		648						24	24	7,060
	1962				332	211		543						5	5	8,317
	1963				560	199		759						68	68	8,952
	1964				392	175		567						58	58	17,318
	1965				355	157		512						23	23	14,951
	1966				370	180		550						36	36	10,689
	1967	-	0	141	387	63		591						49	49	14,019
	1968	-	40	134	333	34		541						51	51	17,778
	1969	-	5	159	573	28		765						30	30	12,613
	1970	-	8	175	495	6		684						18	18	15,604
	1971	-	16	101	449	18		584						17	17	14,544
	1972	-	1	124	389	1		515						21	21	9,760
	1973	-	4	115	569	20		708						9	9	11,791
	1974	-	7	53	674	58		792						55	55	11,810
	1975	-	7	86	796	3		892						27	27	13,744
	1976	-	9	61	379	70		519						31	31	10,110
	1977	-	9	207	541	3		760						41	41	9,062
	1978	-	7	70	618	1		696						37	37	11,099
	1979	2	18	104	458	0		582						36	36	9,624
	1980	-	39	92	284	1		416						33	33	11,515
	1981	-	25	70	508	0		603						60	60	9,448
	1982	-	26	112	404	0		542						41	41	9,358
	1983	-	31	144	555	39		769						39	39	7,603
	1984	-	16	314	965	0		1,295						36	36	8,323
	1985	1	6	152	513	23		695			18			42	60	8,496
	1986	-	13	119	179	16		327			19			19	38	11,876
	1987	1	2	132	414	16		565	1	272	29			28	330	12,042
	1988	7	12	70	464	80		633		504	54			30	588	11,146
	1989	-	23	124	192	10		349	+	612	24			52	688	9,096
	1990	12	16	207	139	21		395	+	538	27			23	588	6,970
	1991	-	81	173	290	32		576	+	663	41			12	716	7,180
	1992	-	11	163	220	24		418	1	459	37			25	522	6,712
	1993	3	7	132	226	0		368	1	471	67			11	550	8,222
	1994	4	5	176	138	11		334	+	326	35			17	378	7,290
	1995	4	5	67	110	6		192	+	543	52			14	609	7,698
	1996	3	8	30	188	6	-	235	1	418	53			20	492	5,802
	1997	3	9	33	351	0	-	396	1	352	37			21	411	6,323
	1998	6	16	19	304	0	-	345	+	378	26			23	427	6,564
	1999	5	8	26	197	0	-	236	1	364	27			12	404	5,546
	2000	6	18	29	315	1	-	369		200	15			10	225	4,758
	2001	5	16	30	250	0	-	301		351	44			+	395	4,585
	2002	8	15	6	477	0	-	506	+	226	30			+	256	4,068
	2003	5	27	11	922	+	-	965	+	538	29			+	567	4,862
	2004	5	10	7	522	2	-	546	2	376	31			+	409	4,160
	2005	9	9	5	783	9	-	815	+	511	20			+	531	4,025
	2006	-	30	117	741	+	-	888	+	611	21			+	632	4,022
	2007	-	29	141	301	0	-	471		276	13			+	289	3,026
	2008	-	43	168	270	2	-	483		427	14				441	3,361
	2009	-	46	92	262	0	-	400		258	10				268	2,410
	2010	-	42	131	253	3	-	429		165	19				184	2,687
	2011	1	27	95	343	4	0	470		362	16				378	2,637
	2012	+	34	114	443	1	+	592		282	11				293	2,970
	2013	+	24	197	372	+	+	593		398	8				406	2,988
	2014	+	5	64	140	+	1	210		426	12			1	439	2,116
	2015	1	4	28	228	+	-	261		493	11	0			504	2,638
	2016	-	3	21	214	+	1	239	+	390	12				402	2,164
	2017	+	7	41	389	-	-	437		406	6				413	2,227
	2018	+	5	27	330	-	+	362		465	12				477	2,188
	2019	-	8	26	373	-	+	407		545	13		1		559	2,524
	2020	+	9	25	353	-	-	387		336	10				345	2,182
	2021	+	9	23	270	+	-	302		247	8				255	1,735
	2022	+	30	32	298	3	+	363		283	9		1		293	722
	2023	+	30	32	482	3	+	547	+	195	6				202	839
Retain catch total		91	970	5,347	26,280	2,973	2	35,663	8	14,667	926	0	2	1,484	17,087	523,773
Release	2010												1		1	1
	2011												0		0	0
	2016						1	1								1
	2018						+	+								2
	2019						1	1								1
	2020						+	+								+
	2021															0
	2022						+	+								+
	2023						+	+								+
Release total							2	2					1		1	5
Total		91	970	5,347	26,280	2,973	4	35,665	8	14,667	926	0	3	1,484	17,088	523,778

Table 18-5. Annual retained and released catches (metric tonnes, whole weight) of Pacific blue marlin (*Makaira nigricans*) by ISC Member Country fishery in the North Pacific Ocean, north of the equator 1953-2022. “0” - Fishing effort was reported but no catch; “+” - Below 499kg catch; “-“ - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

		JPN		KOR			MEX		TWN							USA						
Catch disposition	Year	Longline	JPN Total	Longline	Purse seine	KOR Total	Sport	MEX Total	Set-net	Gill-net (not specified)	Harpoon	Longline	Others	Purse seine	TWN Total	Handline	Longline	Troll	Others	Purse seine	USA Total	Total
Retain	1953											-			-							0
	1954											-			-							0
	1955											-			-							0
	1956											-			-							0
	1957											-			-							0
	1958											887			887							887
	1959											781			781							781
	1960											948			948							948
	1961											703			703							703
	1962											628			628							628
	1963											691			691							691
	1964											934			934							934
	1965											1,016			1,016							1,016
	1966											957			957							957
	1967								-	-	317	898	167		1,382							1,382
	1968								-	30	649	1,433	120		2,232							2,232
	1969								-	58	465	1,232	103		1,858							1,858
	1970								1	21	604	1,385	70		2,081							2,081
	1971	5,461	5,461	0		0			-	13	473	1,331	118		1,935							7,396
	1972	6,772	6,772	0		0			-	14	490	1,205	50		1,759							8,531
	1973	6,453	6,453	0		0			-	12	275	1,650	265		2,202							8,655
	1974	6,545	6,545	0		0			1	6	355	2,144	146		2,652							9,197
	1975	4,374	4,374	0		0			-	3	421	2,638	207		3,269							7,643
	1976	5,018	5,018	0		0			-	9	511	1,315	162		1,997							7,015
	1977	4,780	4,780	0		0			-	11	391	1,183	110		1,695							6,475
	1978	5,900	5,900	0		0			1	15	364	1,633	7		2,020							7,920
	1979	5,949	5,949	0		0			3	19	362	1,646	164		2,194							8,143
	1980	5,613	5,613	155		155			-	35	444	1,185	170		1,834							7,602
	1981	5,518	5,518	0		0			-	35	313	1,840	69		2,257							7,775
	1982	6,051	6,051	351		351			-	7	306	2,139	120		2,572							8,974
	1983	4,796	4,796	82		82			-	26	741	2,122	127		3,016							7,894
	1984	6,248	6,248	155		155			-	22	960	1,789	111		2,882							9,285
	1985	5,164	5,164	45		45			9	11	747	1,187	43		1,997			145			145	7,351
	1986	5,922	5,922	86		86			4	90	839	1,723	107		2,763			220			220	8,991
	1987	5,370	5,370	89		89			12	9	973	4,627	1		5,622		51	261			312	11,393
	1988	5,054	5,054	133		133			20	8	658	2,822	589		4,097		102	266			368	9,652
	1989	5,117	5,117	50		50			10	14	640	2,691	9		3,364		356	326			682	9,213
	1990	4,116	4,116	44		44	-	-	3	24	427	1,749	143		2,346		378	295			673	7,179
	1991	4,094	4,094	75		75	-	-	4	50	338	2,288	152		2,832		297	346			643	7,644
	1992	3,721	3,721	60		60	-	-	25	40	432	3,786	110		4,393		347	260			607	8,781
	1993	4,600	4,600	36		36	-	-	44	41	400	4,135	82		4,702		339	311			650	9,988
	1994	5,832	5,832	2		2	-	-	12	30	206	3,007	7		3,262		362	298			660	9,756
	1995	5,907	5,907	0		0	-	-	15	36	895	3,896	5		4,847		570	315			885	11,639
	1996	3,260	3,260	10		10	-	-	13	35	270	3,337	10	-	3,665		467	409			876	7,811
	1997	3,697	3,697	145		145	-	-	5	48	194	3,683	-	-	3,930		487	378			865	8,637
	1998	3,438	3,438	335		335	-	-	8	59	91	3,624	1	-	3,783		395	242			637	8,193
	1999	3,751	3,751	164		164	-	-	21	32	135	3,417	-	-	3,605		357	293			650	8,170
	2000	3,606	3,606	96		96	-	-	24	40	186	4,131	2	-	4,383		314	235			549	8,634
	2001	3,594	3,594	166		166	-	-	18	57	229	4,733	-	-	5,037		399	291			690	9,487
	2002	2,976	2,976	152		152	-	-	13	63	32	4,448	6	-	4,562		264	225	1		490	8,180
	2003	2,836	2,836	158		158	-	-	20	107	52	7,685	4	-	7,868		363	210			573	11,435
	2004	2,977	2,977	226		226	-	-	14	93	36	6,672	9	-	6,824		283	188	5		476	10,503
	2005	2,506	2,506	303		303	-	-	8	65	48	7,630	16	-	7,767		337	187			524	11,100
	2006	2,414	2,414	217		217	-	-	12	15	30	5,729	-	-	5,786		409	160			569	8,986
	2007	2,016	2,016	120		120	-	-	3	17	20	5,117	+	-	5,157	1	262	127			390	7,683
	2008	2,096	2,096	219		219	-	-	10	16	15	5,477	1	-	5,519	1	349	198			548	8,382
	2009	1,840	1,840	224		224	-	-	9	12	9	4,638	1	-	4,669	1	360	15			376	7,109
	2010	2,457	2,457	257		257	-	-	5	27	15	4,959	1	-	5,007	2	306	148			456	8,177
	2011	2,343	2,343	684		684	-	-	3	18	17	4,625	9	2	4,674	2	373	199			574	8,275
	2012	2,019	2,019	587		587	-	-	6	13	16	4,097	+	12	4,144	2	298	141			441	7,191
	2013	2,179	2,179	963		963	-	-	2	6	16	4,607	+	9	4,640	3	406	137			546	8,328
	2014	1,903	1,903	801		801	-	-	4	11	124	4,861	5	7	5,012	4	535	159		1	699	8,415
	2015	1,622	1,622	531		531	-	-	3	14	177	4,306	+	3	4,503	3	631	196			830	7,486
	2016	1,581	1,581	1,116	+	1,116	-	-	3	23	158	3,398	3	4	3,589	2	562	163			728	7,014
	2017	1,414	1,414	1,453		1,453			-	7	138	3,977	+	6	4,128	3	687	155		3	849	7,844
	2018	1,271	1,271	1,336		1,336			-	11	108	3,501	-	10	3,630	3	664	166		2	835	7,072
	2019	1,245	1,245	981		981			-	22	99	3,359	+	4	3,484	5	901	176		3	1,085	6,795
	2020	930	930	673		673			2	30	115	1,955	+	-	2,102	3	531	111		3	648	4,353
	2021	1,063	1,063	678		678			2	30	107	2,098	1	1	2,239	3	382	128		2	515	4,495
	2022	944	944	520		520			2	80	128	2,247	9	+	2,466	3	445	117		1	565	4,495
	2023	1,033	1,033	868		868			2	80	128	2,284	9	2	2,505	3	338	94		2	436	4,841
Retain catch total		197,386	197,386	15,346	0	15,346	0	0	376	1,720	17,689	188,819	3,621	60	212,285	44	14,906	8,291	6	17	23,264	448,280
Release	2010																			1	1	1
	2011																			6	6	6
	2012																					
	2013													5	5							5
	2014																					
	2015				+	+								3	3							3
	2016				1	1								4	4							5
	2017													6	6							6
	2018			1	1	2								6	6							8
	2019			+		+								5	5							5
	2020			0		0								5	5							5
	2021			+		+								2	2							2
	2022			+	2	2								3	3							5
	2023			2	4	6								6	6							12
Release total				3	8	11								45	45					7	7	63
Total		197,386	197,386	15,349	8	15,357	0	0	376	1,720	17,689	188,819	3,621	105	212,330	44	14,906	8,291	6	24	23,271	448,343

Table 18-6. Retained and released catches (metric tonnes, whole weight) of blue sharks (*Prionace glauca*) by ISC Member Country fishery in the North Pacific Ocean, north of the equator, 1985-2022. “0” - Fishing effort was reported but no catch; “+” - Below 499kg catch; “-“ - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year	JPN Set-net	JPN Drift gill-net	JPN Longline	JPN Others	JPN Not specified	JPN Total	KOR Longline	KOR Purse seine	KOR Total	MEX Others	MEX Total	TWN Longline	TWN Total	USA GND	USA LLD	USA LTR	USA LX	USA MIS	USA RG	USA Total	Total
Retain	1985														-						1	1
	1986														1						2	2
	1987														1						2	2
	1988														-						3	3
	1989																				6	6
	1990														-						20	20
	1991														-						1	1
	1992														1						2	2
	1993														-						0	0
	1994	15	582	35,437	18	4	36,055								-						12	36,067
	1995	12	487	34,246	10	4	34,759								-						5	34,764
	1996	11	478	28,054	18	4	28,564								-						0	28,564
	1997	14	603	29,582	7	6	30,212								-						0	30,212
	1998	12	616	29,863	5	4	30,499								-						1	30,500
	1999	12	834	32,816	6	2	33,671								-						0	33,671
	2000	12	736	30,497	10	1	31,257								-						0	31,257
	2001	12	737	32,380	9	2	33,140				-	-									0	33,140
	2002	11	768	28,465	13	1	29,258				-	-									0	29,258
	2003	11	1,350	25,631	12	2	27,006				-	-			-						0	27,006
	2004	12	1,202	23,910	7	3	25,135				-	-									0	25,135
	2005	+	1,321	24,307	13	2	25,643				2,721	2,721									0	28,364
	2006	5	1,204	21,363	2	2	22,576				2,765	2,765									0	25,341
	2007	5	1,323	18,655	19	2	20,004				3,324	3,324			9	8					17	23,345
	2008	+	944	15,374	14	1	16,333				4,355	4,355				7					7	20,695
	2009	+	1,208	15,889	4	1	17,102				4,423	4,423	11,541	11,541	1	9					11	33,077
	2010	4	962	16,504	9	1	17,481				4,469	4,469	7,670	7,670	-	7					7	29,627
	2011	12	771	8,566	1	3	9,353				3,719	3,719	13,117	13,117		13					13	26,202
	2012	2	1,085	10,463	3	3	11,555				4,108	4,108	10,606	10,606		16					16	26,285
	2013	6	1,103	11,860	4	2	12,976	75		75	4,494	4,494	6,321	6,321		1	0				1	23,867
	2014	4	1,060	12,361	0	2	13,426	100		100	5,502	5,502	8,151	8,151		0	-			-	0	27,179
	2015	21	697	10,500	+	2	11,220	53		53			8,551	8,551						-	0	19,824
	2016	26	1,832	9,507	1	2	11,367						8,563	8,563		0				0	0	19,930
	2017	4	1,366	9,795	+	1	11,166	8		8			11,121	11,121						+	1	22,296
	2018	40	1,236	9,111	0	1	10,388	4		4			11,761	11,761					3	+	3	22,156
	2019	35	1,149	8,448	0	1	9,633	4		4			18,165	18,165		+			14	+	15	27,816
	2020	59	1,119	7,072	1	2	8,253	0		0			15,566	15,566		0			3	+	3	23,822
	2021	25	1,484	7,774	1	1	9,285	2		2			8,835	8,835					2	+	2	18,124
	2022	29	1,062	6,893	0	1	7,985	0		0			12,859	12,859				0	3	+	3	20,847
	2023	29	1,062	6,893	0	1	7,985						22,222	22,222					2	+	2	22,224
Retain catch total		409	29,319	555,322	187	64	585,302	246		246	39880	39880	175,049	175,049	13	61	0	0	81	2	157	800,633
Release	2015							0		0												0
	2016							8		8												8
	2017							11		11												11
	2018							58		58												58
	2019							12		12												12
	2020							22		22												22
	2021							20		20												20
	2022							33		33												33
	2023							36	0	36												36
Release catch total								202	0	202												202
Total		409	29,319	555,322	187	64	585,302	447	0	447	39,880	39,880	175,049	175,049	13	61	0	0	81	2	157	800,835

Table 18-7. Retained and released catches (metric tonnes, whole weight) of shortfin mako sharks (*Isurus oxyrhinchus*) by ISC Member country fishery in the North Pacific Ocean, north of the equator, 1985-2020. “0” - Fishing effort was reported but no catch; “+” - Below 499kg catch; “-“ - Unreported catch or catch information not available. * - Data from the most recent years are provisional.

Catch disposition	Year					KOR		MEX		TWN			USA										
		Drift gill-net	Longline	Others	JPN Total	Longline	KOR Total	Others	MEX Total	Longline	Purse seine	TWN Total	Drift gill-net	Harpoon	Handline	onglin	Trol	ook and lin	Others	Purse-seine	Sport	USA Total	Total
Retain	1985							43	43				129	1					19			149	192
	1986							84	84				250	1					59			310	394
	1987							197	197				208	3					188			399	596
	1988							248	248				106	3					214			323	571
	1989							135	135				117	1					137			255	390
	1990							288	288				229	3					141			373	661
	1991							228	228				125	1					91			217	445
	1992							376	376				118	3					19			140	516
	1993							442	442				87	1					32			120	562
	1994	110	1,416	22	1,548			336	336				80	1					46			127	2,011
	1995	93	1,710	15	1,818			333	333				79	1					14			94	2,245
	1996	91	1,626	18	1,735			413	413				85	1					9			95	2,243
	1997	114	1,474	17	1,605			401	401				118	3					11			132	2,138
	1998	117	1,327	13	1,457			386	386				85	1					12			98	1,941
	1999	158	1,922	14	2,094			439	439				52	0					9			61	2,594
	2000	140	1,688	16	1,844			539	539				64	+					12			12	2,395
	2001	140	1,640	16	1,796			491	491				30	1					10			41	2,328
	2002	122	1,387	5	1,514			488	488				69	+					12			81	2,083
	2003	229	1,298	6	1,533			471	471				57	+					9			66	2,070
	2004	134	1,284	1	1,419			865	865				38	1					13			52	2,336
	2005	155	1,354	43	1,552			609	609				25	1					8			34	2,195
	2006	178	1,474	6	1,658			641	641				38	+					7			45	2,344
	2007	244	1,628	15	1,887			689	689				37	+					6			43	2,619
	2008	212	1,291	14	1,517	-	-	609	609				27	1					5			33	2,159
	2009	294	1,633	1	1,928	-	-	653	653	78		78	21	1			0		7			29	2,688
	2010	272	1,445	20	1,737	-	-	760	760	54		54	10	0					10			20	2,571
	2011	146	820	11	977	-	-	758	758	208		208	8	0					8			16	1,959
	2012	206	967	2	1,175	-	-	715	715	74		74	9	0			0		11			20	1,984
	2013	345	755	9	1,109	8	8	711	711	107		107	16	0					12			28	1,955
	2014	263	1,054	3	1,320	8	8	-	-	119		119	7	0		53	+	3	6		9	78	1,525
	2015	334	1,112	11	1,457					322		322	7			58		1	4			71	1,850
	2016	446	1,268	16	1,730	+	+			220		220	12	0	1	70	+	1	4		+	89	2,038
	2017	271	874	10	1,155	+	+			187		187	13	+		71	+	1	5			89	1,431
	2018	223	995	28	1,246	+	+			265		265	11			60	+	1	5			78	1,589
	2019	214	883	3	1,100	+	+			273		273	7			47	0	1	20		0	74	1,447
	2020	194	549	16	759	+	+			247		247	3	1		16		1	3			23	1,029
	2021	133	474	23	630	+	+			196		196	5	+		5		1	2			13	839
	2022	161	618	41	820	0	0			206		206	2			2		1	2			7	1,032
	2023	161	618	41	820					362		362	6			2		1	6			14	1,196
Retain catch total		5,900	36,584	456	42,940	16	16	13,348	13,348	2,918		2,918	2,390	30	1	384	1	11	1,187		9	4,013	63,235
Release	2011																			0		0	0
	2012										-	-											0
	2016					1	1																1
	2018					1	1																1
	2019					1	1																1
	2020					1	1																1
	2021					+	+																0
	2022					+	+																0
Release catch total						3	3				-	-								0		0	3
Total		5,889	24,773	396	31,057	20	20	13,348	13,348	2,918	0	2,918	2,390	30	1	384	1	11	1,187	0	9	4,013	51,356