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

WCPFC-SC19-2023/GN-WP-03

ISC[1]

[1] International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

FINAL

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

PLENARY SESSION

12-17 July 2023
Kanazawa, Japan

ISC23 Plenary Group, Oyama Jinja Shrine, Kanazawa, Japan, July 13, 2023

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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

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PLENARY SESSION

12-17 July 2023

Highlights of the ISC23 Plenary Meeting

The 23rd ISC Plenary session was held in-person in Kanazawa, Japan, July 12-17, 2023. 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. Observers from Monterey Bay Aquarium, Pew Charitable Trusts, and the World Wildlife Fund-Japan, also attended the ISC23 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 ISC Plenary endorsed the North Pacific Ocean Albacore (NPO ALB), North Pacific Ocean Swordfish (NPO SWO) and Western and Central North Pacific Striped Marlin (WCNPO MLS) benchmark stock assessments and considers these assessments to be the best available scientific information on these stocks. Reference points have been established by the WCPFC and/or the IATTC for the NPO ALB and WCNPO MLS stocks, but not for the NPO SWO stock. The NPO ALB stock is likely not overfished relative to the adopted threshold and limit reference points, and the stock is likely not experiencing overfishing relative to the target reference point. The WCNPO MLS stock is very likely overfished (>99% probability) and overfishing is likely occurring (>66% probability) relative to 20%$SSB_{F=0}$ based reference points. While no reference points have been established for NPO SWO, relative to MSY-based reference points, overfishing is very likely not occurring (>99% probability) and the NP SWO stock is very likely not overfished (>99% probability). The Plenary noted that this assessment combines the former WCNPO and N EPO stocks into one NPO SWO stock as agreed by scientists from the ISC, IATTC, and SPC. The ISC23 Plenary reviewed an analysis of the spatial distribution of NPO SWO catch and effort north and south of 20°N in response to an NC18 request and noted that catch was roughly equally distributed above and below 20°N, while effort was much higher to the south. However, the effort figures to the south are uncertain as they include estimated effort from Indonesia and Vietnam rather than reported effort for logbooks or observed by other means. The Plenary re-iterated stock status and conservation information provided at ISC22 for Pacific Bluefin Tuna (PBF), Blue Shark (BSH), Shortfin Mako Shark (SMA) and Pacific Blue Marlin (BUM). The STATWG continues to make progress in cataloguing ISC data and making data and assessment files more accessible and available for use by researchers external to the ISC. The ISC Plenary discussed and approved a non-disclosure agreement prepared by the STATWG for data sharing with external parties. The STATWG, ALBWG and SHARKWG identified the importance of understanding and storing data from high seas drift gillnet catches (both squid and large-mesh gillnets) that were collected prior to the United Nations ban on this gear in 1993. The Plenary agreed with the proposal to store these data in machine readable form and to the development metadata explaining the data and describing uncertainties in their interpretation. The Plenary discussed preliminary results of WCPFC Project 113 on ensemble modeling and communicating uncertainty in stock assessments and will consider incorporating the recommendations from this project into ISC assessments at ISC24. The Plenary also discussed incorporating climate change considerations into stock assessments and the information and advice going forward to managers. The importance of climate change is recognized by Plenary members, who agreed to engage in a fuller discussion on a framework for incorporating climate change into ISC activities at ISC24. A proposed MOU with the North Pacific Fisheries Commission (NPFC) was reviewed by the Plenary, which tasked the ISC Chair with negotiating some changes in the language before considering approval at ISC24. The ISC work plan for 2023-24 includes benchmark stock assessments of PBF and SMA, continuing to advance biological sampling for billfish and shark species, information gathering on climate change initiatives and discussion of a framework for the ISC, ongoing discussions on the proposed MOU with the NPFC, 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. Steve Teo (U.S.A.) was extended for one year as Vice-Chair of the ALBWG, Shui-Kai Chang (TWN) was reelected to his second term as Vice-Chair of the PBFWG, Michelle Sculley (U.S.A.) was elected to her first term as Chair of the BILLWG and Jenny Suter (U.S.A.) and Kirara Nishikawa (JPN) were elected to their first terms as Chair and Vice-Chair of the STATWG, respectively. Elections for the Chair and Vice-Chair of the ISC were conducted and John Holmes was reelected ISC Chair until 2024. Robert Ahrens (U.S.A.) was elected to his first term as Vice-Chair of the ISC. The next Plenary meeting will be hosted by Canada and is tentatively planned for June 19-24, 2024, 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 tuna and tuna-like fishes that inhabit the North Pacific Ocean during 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. Catches of priority NPO species monitored in 2022 by ISC Member countries were 47,856 t of North Pacific albacore tuna (NPO ALB, *Thunnus alalunga*), 17,420 t of Pacific bluefin tuna (PBF, *T. orientalis*), 6,660 t of North Pacific swordfish (SWO, *Xiphias gladius*), 1,450 t of North Pacific striped marlin (MLS, *Kajikia audax*), 4,225 t of Pacific blue marlin (BUM, *Makaira nigricans*), 811 t of North Pacific shortfin mako shark (SMA, *Isurus oxyrinchus*) and 20,992 t of North Pacific blue shark (BSH, *Prionace glauca*).[1] The total estimated catch of these seven species is 99,414 t, or approximately 88% of the 2021 total estimated catch of 113,492 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 (Section 18, Tables 18-1 to 18-7).

1.2 Opening of the Meeting

The Twenty-third Plenary session of the ISC (ISC23) was convened in Kanazawa, Japan, at 14:00 on 12 July 2023 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 Secretariat was also present. (**ISC/23/ANNEX/01**). Representatives from Monterey Bay Aquarium, Pew Charitable

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

Trusts, and World Wildlife Fund for Nature-Japan were present as observers. The Executive Secretary of the North Pacific Fisheries Commission also attended.

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/23/ANNEX/02**) was considered and adopted. In doing so the Plenary noted agenda item 6.5 should be changed to NPO SWO based on new stock boundaries, initial discussion of climate change should be added as agenda item 10, and discussion of schedules for the Northern Committee, Pacific Bluefin Joint Working Group, and WCPFC Scientific Committee meetings should precede agreement on the time and place of the next ISC meeting (ISC24). C. Dahl was assigned lead rapporteur duties. A list of meeting documents is contained in **ISC/23/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 a summary of Category I, II, and III data from Canadian fisheries for highly migratory species in 2022 (**ISC/23/PLENARY/04**). Canada has one fishery for highly migratory species in the Pacific Ocean, a troll fishery targeting juvenile NPO ALB (*Thunnus alalunga*). Category I, II, and III data from the 2022 fishing season are summarized in this report. The Canadian fleet consisted of 118 vessels and operated primarily within the eastern Pacific Ocean, in 2022. No vessels from the Canadian fleet operated in the Central and western Pacific Ocean in 2022. The Canadian troll fishery continues to be largely coastal in its operations, occurring predominantly within the Canadian and United States exclusive economic zones (EEZ). Only a small proportion of catch and effort occurred outside the Canadian and U.S. EEZs, in high seas waters, in 2022. The provisional 2022 estimates of catch and effort in the eastern Pacific Ocean are 3,639 t and 4,073 vessel-days, respectively, which represent a 50.4% increase in catch and 10.5% increase in effort relative to 2021. Although the 2022 catch and effort increased in the Canadian EEZ, the proportion of the total 2022 catch and effort in the Canadian EEZ decreased slightly to 67.7% and 69.9% from 70.1% and 72.3% in 2021, respectively. The proportion of the total catch and effort in the U.S. EEZ in 2022 increased slightly to 31% and 27.8% from 27.9% and 25.4% in 2021, respectively. The remaining catch and effort occurred in adjacent high seas waters. The catch rate (CPUE) increased from 0.66 in 2021 to 0.89 in 2022, the highest since 2014. Approximately 89% of the Albacore catch occurred in the favorable water temperature band of 16-19 °C in 2022. Sixty (60) vessels measured 16,791 fork lengths in 2022 for a sampling rate of 2.8% of the reported catch. Fork lengths ranged from

52 to 93 cm, with a mode around 68 cm corresponding to 2-year-old fish. Mean length was 68.4 cm, which is similar to the mean length observed in 2021.

Discussion

The large increase in CPUE in 2022 was discussed. Anecdotal information from harvesters suggests that ALB were more available to the fishery. To date, no clear relationship to environmental drivers has been identified.

3.2 Chinese Taipei

R.-F. Wu presented the Chinese Taipei national report (**ISC/23/PLENARY/05**). Taiwanese tuna fisheries in the North Pacific Ocean are comprised of tuna longline and tuna purse seine fisheries, and other small-scale fisheries operating in the waters of Taiwan such as harpoon, set net, and gill net. More than 90 percent of tuna and tuna-like species catch in Taiwanese fisheries in the NPO are from tuna longline and purse seine fisheries. The tuna longline fisheries consist of large-scale tuna longline vessels (LTLL; over 100 GRT) and small-scale tuna longline vessels (STLL; less than 100 GRT). The number of fishing vessels of these two fisheries were 108 and 608, and the catches of tuna and tuna-like species in the NPO were 7,231 t and 16,400 t in 2022, respectively. The number of tuna purse seine fishing vessels was 26 with catch of 210,878 t in the Pacific Ocean in 2022. Thirty-nine observers were deployed on tuna longline vessels operating in the Pacific Ocean, including four on LTLL vessels and 35 on STLL vessels in 2022. Taiwanese scientists conducted four 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 with funding support from the Taiwan Fisheries Agency in 2022.

Discussion

The targeting preferences of LTLL versus STLL vessels were discussed. Two components of the LTLL fleet can be identified: vessels targeting ALB and vessels targeting BET. STLL target YFT and BUM. The decline in observer coverage on longline vessels was attributed to the Covid pandemic. It was also noted that more observers have been deployed to STLL vessels in 2017 and 2018 due to the resurgence of piracy in the Indian Ocean.

3.3 Japan

S. Nakatsuka presented the Japan national report (**ISC/23/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 281 vessels in 2022, 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 2022, less than half of the active vessels in 2006. The distribution of fishing effort did not show a significant difference between 2021 and 2022 in the three main fisheries. The total catch of tunas excluding SKJ caught by Japanese fisheries in the NPO was 83,834 t in 2021 and 71,141 t in 2022. The total catch of tunas including SKJ caught by Japanese fisheries in the NPO was 266,985 t in 2021 and 189,683 t in 2022. The total catch of SWO and MLS was 6,240 t in 2021 and 4,844 t in 2022. In addition to these fisheries descriptions, the report briefly described Japanese research activities on tuna and tuna-like species in the Pacific Ocean in 2021, including a larvae/juvenile research cruise, a troll survey of age-0 PBF, tissue sampling and technical development for close-kin-mark-recapture (CKMR) analysis of PBF, port sampling and the onboard research program in Kesennuma fishing port, tagging and biological sample collection for SWO and sharks, and tagging for SKJ and ALB.

Discussion

It was clarified that the dashed line in the figure showing recent purse seine fishing effort reflects the removal of coastal purse seine fishing effort from the compilation of effort data, because those vessels do not target tunas. The long-term decline in longline fishing effort is due to a variety of factors including reduced availability of the target species BET, increased costs, and labor shortages. The increase in ALB catch was touched on but it was suggested that it would be better explained under the presentation of the latest stock assessment (see section 6.1). The availability of recreational catch data of PBF was queried. Recreational catch is included in the "other" category and is estimated to be about 10 t per year.

The new PBF age-0 troll survey was discussed. This survey method, which involves contracting with vessels to catch PBF, began in 2022, because the reliability of the previous survey was adversely affected by management controls on catch applied since 2016. Over time, correlation of the new index with cohorts entering fisheries should hopefully demonstrate the reliability of this methodology. The dynamics of the PBF spawning ground off the Joban area were discussed. Survey results, including the capture of mature females and larvae on many occasions, show that the spawning in this area is not opportunistic, confirming that it is a third spawning area. However, because of the dominant Kuroshio Current in this area, one would expect eastward larval transport. How larvae move to inshore areas around Japan is not understood.

3.4 Korea

H. Lee presented the Korea national report (**ISC/23/PLENARY/07**). Korean distant water tuna and tuna-like fisheries in the Pacific Ocean consist of a longline fishery and a purse seine fishery. There were 94 active longline vessels and 22 active purse seine vessels in 2022. The number of longline vessels remained below 100 since 2015, and the number of purse seine vessels remained the same as the previous year. The two Korean fisheries harvested 87,991 t of tuna and tuna-like species in the NPO in 2022. The total catch of the longline fishery was 13,831 t, an 18% decrease over 2021, while the purse seine fishery harvested 74,160 t, a 149% increase year-to-year. The longline fishery targeted BET and YFT whose catch accounted for 44.6% and 22.0% of the total catch in 2022. The dominant species of the purse seine fishery was SKJ (83.1%), followed by YFT (16.4%) and BET (0.5%). PBF is harvested by some coastal and offshore fisheries in the Korean waters. The offshore large purse seine fishery operating in the waters surrounding Jeju Island—the largest domestic PBF fishery—harvested 654 tons of PBF in 2022, which accounted for 74.2% of the total domestic catch. In 2022, the catch of large PBF (30kg or greater) accounted for 59% of the total catch.

Discussion

It was clarified that catches reported by Korea are for the NPO only and it was noted that in comparison to other regions, EPO catch has increased substantially.

3.5 Mexico

M. Dreyfus presented the Mexico national report (**ISC/23/PLENARY/08)**. Mexico has been participating in ISC specifically for PBF-related work but in the recent past shark scientists from INAPESCA have been also actively cooperating with the SHARKWG.

Catch data for sharks in Mexico used to be reported only in two aggregated size categories, but in 2011 reporting catch by species became mandatory. There are two main ports related to longline operations, one in the north on the Baja California peninsula (Ensenada) and one in the central area (Mazatlán). The catch is composed of BSH, SMA, SWO, and FAL, depending on the area of operation. Basic management at the national level includes a three-month closure.

Mexico's tuna fishery operates in a vast area in the EPO, most of the YFT and SKJ catches are from the NPO, and the fleet is stable in size. All vessels over 400 cubic meters well volume capacity carry an observer on all fishing trips. Also, all vessels catching PBF carry an observer in all operations during the fishing season, which only lasts a few weeks in January, closing when the catch is close to the limit established by IATTC Resolutions.

Mexico continues CKMR sampling as established by the ISC, has about 400 samples to date, and has agreed that it will continue to collect and store samples.

Discussion

The recreational fishery in Mexican waters was discussed. Mexico does not have a domestic recreational fishery although U.S. recreational vessels enter Mexican waters to fish but return to U.S. ports (U.S. recreational catch in Mexican waters is reported as part of domestic U.S. recreational catch). There may be some amount of opportunistic and unreported PBF catch by individual recreational fishers in small vessels, but it cannot be effectively monitored.

3.6 U.S.A.

K. Koch presented the U.S.A. national report (**ISC/23/PLENARY/09**). U.S.A. fishing fleets harvest tuna and tuna-like species in the NPO from coastal waters of North America to the archipelagoes of Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa in the Western and Central Pacific Ocean (WCPO). Small-scale gillnet, harpoon, pole-and-line, troll, and handline fleets operate primarily in coastal waters, whereas large-scale purse seine, albacore troll, and longline fleets, which account for most of the tuna catches, operate both within the U.S.A. EEZ and on the high seas. Thousands of small-scale troll and handline vessels operate in waters of the tropical Pacific Ocean; however, these fleets account for a small fraction of the total tuna catch.

Several highly migratory species exempted fishing permit (EFP) fishery programs have been developed in recent years by the National Marine Fisheries Service (NMFS) of the National

Oceanic and Atmospheric Administration (NOAA Fisheries) to evaluate alternative gears and methods to target SWO and other highly migratory species (HMS) in the Eastern Pacific Ocean (EPO). EFPs are issued for "limited testing, public display, data collection, exploratory fishing, compensation fishing, conservation engineering, health and safety surveys, environmental cleanup, and/or hazard removal purposes" [50CFR600.745(b)] that would otherwise be prohibited by regulation. NMFS has been prioritizing EFPs in the EPO for alternative fishing gears that will have minimal bycatch and are economically viable. NOAA Fisheries actively conducted research in 2022 on Pacific tunas and associated species at its Southwest and Pacific Islands Fisheries Science Centers and also 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 ISC and international Regional Fisheries Management Organizations.

Fishery monitoring and socioeconomic research was also conducted on tunas, billfishes, and bycatch species in the U.S.A. Pacific coastal and high-seas fisheries. As in previous years, fishery monitoring and angler effort information were compiled in 2022, and economic performance indicators in the Hawaii longline and small-boat fisheries were assessed. NOAA Fisheries successfully completed biological and oceanographic studies on tunas, billfishes, and sharks in 2022, and research on their fisheries and how to improve their stock assessments. Highlighted research includes: the relationship of pelagic predators and anticyclonic eddies, the relationship between tuna and ocean biogeochemistry, the incorporation of uncertainty in biological parameters for stock assessments, the influence of El Niño-Southern Oscillation on tuna longline catch, the evaluation of PBF reproduction in the southern California Current Ecosystem, the life history and feeding ecology of PBF, and the feeding ecology and diets of ALB and SWO.

Discussion

The history of the U.S. longline fishery was briefly reviewed. It developed in the 1980s targeting tuna using deep-set gear. A shallow-set fishery grew rapidly in the late 1980s and 1990s but has been declining since the early 2000s in part due to restrictions to mitigate harvest impacts on sea turtles. The value of research demonstrating that PBF are not spawning in the EPO was noted along with research on PBF migration patterns, which should have direct relevance to management questions.

4 REPORT OF THE CHAIR

ISC Scientists have been busy since the ISC Plenary met at ISC22 in Kona, Hawai'i. Highlights in 2022 include benchmark stock assessments of NPO ALB and NPO SWO (combining the former EPO N stock with the WCNPO stock), and the completion of a WCNPO MLS benchmark assessment. While the PBFWG did not conduct an assessment, it was engaged in research to improve the assessment and implement a management strategy evaluation (MSE) process to evaluate harvest strategy options. The SHARKWG engaged in research to improve shark stock assessments that will benefit the planned shortfin mako shark benchmark assessment that will be presented to ISC24. Data management, the catalogue and inventory of the ISC database, development of the website and data enterprise system continue to be advanced under the leadership of the STATWG Chair and Vice-Chair, including a non-disclosure process and agreement that will be discussed at ISC23.

The process to formalize the structure/existence of the ISC continues, but it is not quick; this year we reviewed a draft MOU with the North Pacific Fisheries Commission, that if accepted could be a component of formalizing the structure of the ISC, as are the MOU and MOC with the WCPFC and IATTC, respectively. Conducting external reviews of ISC stock assessments remains very much top of mind, but again, progress has been difficult to achieve. The United States has provided an external review process proposal for consideration at ISC23 that I hope will help move the ISC forward on this important topic.

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 northern stocks of highly migratory species. The ISC is an independent science-focused organization that continuously seeks to improve its scientific excellence. The ISC as it presently exists is in large part a testament to the success of those efforts and the unwavering dedication and integrity of ISC scientists, especially the Working Group 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 shift or 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. The ALBWG has completed an MSE process and the PBFWG is now beginning to provide support for an MSE process. 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.

It is time for the ISC to begin mapping out the third peer review of ISC function and process. Peer reviews of ISC functions are expected to occur every five 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 in-kind help from the United States and Japan, but 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 appreciated.

I am finishing my second term as ISC Chair and the ISC enters a period of transition to a new Chair/Vice-Chair, the timing of the Plenary Session and a process for external peer-review of stock assessments; time moves relentlessly on. 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 support of Shui-Kai Chang, Vice-Chair, for his advice, and gentle prodding to do things is appreciated, as well as the services of Stephanie Flores and my Executive Assistant in Canada, Michelle Kartz. Special thanks and appreciation are owed to the Chairs and Vice-Chairs of the working groups, namely Sarah Hawkshaw and Steve Teo, Hirotaka Ijima and Yi-Jay Chang, Shuya Nakatsuka and Sui-Kai Chang, Mikihiko Kai and Michael Kinney, and Felipe Carvalho and Mi-Kyung Lee, 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 Kirara Nishikawa, the Data Administrator and Webmaster, for keeping me up to date on communications and data issues. Both Kirara Nishikawa and Hiromu Fukuda are the unsung heroes of ISC23 as they spent much time and effort to organize this event and make 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 reports of the ALBWG (**ISC/23/ANNEX/06, 07**) and reminded the plenary of the tasks that the ALBWG worked on over the past year, particularly completing a new benchmark stock assessment for NPO ALB, which incorporated consideration of newly adopted management objectives and reference points, as well as developing preliminary criteria for identifying exceptional circumstances that would result in suspending or modifying the harvest strategy adopted by NC18 and the IATTC.

In 2022/23 the ALBWG held two hybrid workshops and three virtual meetings. The first ALBWG workshop was a data preparation workshop in December 2022 in Yokohama, Japan (**ISC/23/ ANNEX/06**), with 10 scientists from Canada, Chinese Taipei, Japan, U.S.A., and IATTC. During this workshop, the ALBWG reviewed updated input data from all countries, proposed CPUE indices to be included in the stock assessment model, potential model parameterization, assumptions, and diagnostic tools for the base-case model and updates to the future projection software. The ALBWG also discussed how to incorporate into the assessment process, the new management objectives, and reference points for NPO ALB adopted by the IATTC and WCPFC in 2022 (WCPFC HS 2022-01 and IATTC Resolution C-22-04):

Management Objectives

a) Maintain Spawning Stock Biomass (SSB) above the Limit Reference Point (LRP), with a probability of at least 80% over the next 10 years;
b) Maintain depletion of total biomass around historical (2006-2015) average depletion over the next 10 years;
c) Maintain fishing intensity (F) at or below the target reference point with a probability of at least 50% over the next 10 years; and

d) To the extent practicable, management changes (e.g., catch and/or effort) should be relatively gradual between years;

Reference Points

a) Target reference point (TRP) = F45%, which is the fishing intensity (F) level that results in the stock producing 45% of spawning potential ratio (SPR);
b) Threshold reference point ($SSB_{threshold}$) = 30%$SSB_{current,F=0}$, which is 30% of the dynamic unfished spawning stock biomass; and
c) Limit reference point (LRP) =14%$SSB_{current,F=0}$, which is 14% of the dynamic unfished spawning stock biomass.

During this workshop, the ALBWG also drafted the preliminary criteria for identifying exceptional circumstances for NPO ALB (**ISC/23/ANNEX/06/Attachment 5)**, to be reviewed by the plenary at ISC23, and discussed a plan for the storage of high seas drift gillnet data with the STATWG.

The ALBWG held a stock assessment workshop in March 2023 in La Jolla, U.S.A. (**ISC/23/ANNEX/07**), with 11 scientists from Canada, Chinese Taipei, Japan, U.S.A., and IATTC. During the meeting, the ALBWG reviewed data sources and preparation methods that had been identified during the data preparation workshop, discussed details of the base case model for the 2023 stock assessment, incorporated newly adopted IATTC and WCPFC management objectives and reference points into stock status and conservation recommendations and evaluated stock status using preliminary criteria for identifying exceptional circumstances. The ALBWG also drafted a work plan for 2023-26 during this meeting which included plans to address new tasks for the ALBWG from the NC19 meeting and further work on exceptional circumstances and model improvements. The next benchmark stock assessment for NPO ALB is planned for 2026.

The ALBWG proposed the following schedule for 2023-26:

Date	Location	Task/Event
July 2023	Japan	ISC Plenary
TBD	Virtual	NC19: Update following ISC Plenary
August 2023	Palau	SC19: Stock assessment virtual presentation
Early 2024	Canada (*tentatively)*	Complete requests from NC19, updates to exceptional circumstances, biological modeling, data collection, and index improvements, investigate potential bias of Covid-19 pandemic safety protocols on recent years of data and MSE modeling tutorial
June/July 2024	Canada	ISC24
Early 2025	TBD	Model improvements meeting
Late 2025 (November)	TBD	Data preparation workshop
Next benchmark assessment 2026 (March/April)	TBD	Stock assessment workshop

An election was held during the stock assessment workshop and Steve Teo was re-elected as vice chair of the ALBWG for a one-year extension until ISC24. Steve Teo was first elected vice chair of the ALBWG in July 2017 and completes his second term in 2023. The ALBWG Chair encouraged the group to start thinking of candidates to serve in this position in the future.

Discussion

The challenge of presenting complex MSE results to managers was discussed. An empirical approach to MSE could be simpler but there are few examples upon which to draw. The Plenary adopted the exceptional circumstances criteria proposed by the ALBWG (**ISC/23/ANNEX/06/Attachment 5)** but noted that additional updating was needed as NC19 approved a harvest control rule a week prior to the ISC23 Plenary. Exceptional circumstances apply when stock observations fall outside the range of outcomes produced by the MSE scenarios and trigger a review of the harvest strategy components. It was agreed that exceptional circumstances should not be defined in specific, quantitative terms or their application could become too complex. Identifying exceptional circumstances likely will be tied to the production of a new stock assessment. It was also recognized that documentation of the MSE process and access to the associated models and software is crucial given that the scientists involved in its development may no longer be in the WG when the exceptional circumstances trigger is reached.

5.2 Pacific Bluefin Tuna

S. Nakatsuka presented the PBFWG report. The PBFWG held an online workshop in November 2022 (**ISC/23/ANNEX/16**) and a face-to-face workshop in March 2023(**ISC/23/ANNEX/04**). The PBFWG did not have a stock assessment planned and instead held two workshops for the development of the MSE and discussions for the upcoming benchmark stock assessment in 2024.

In 2022, the IATTC-WCPFC NC PBF Joint Working Group (JWG) requested that the ISC develop a technical workplan for the PBF MSE process. Accordingly, the PBFWG is working on a schedule to provide the final results to the JWG in 2025 for the selected Harvest Control Rules (HCRs) for PBF. The PBFWG decided to construct the MSE framework based on the base-case model of the upcoming 2024 assessment and has narrowed the range of uncertainties that will be considered in the Operating Models. It is anticipated that the operating models chosen will be those that meet a suite of diagnostic criteria determined by the PBFWG.

The WG also considered the Estimation Model as a part of MSE. In order to assess many candidate HCRs, the WG is evaluating a simplified model-based HCR. The WG also reviewed preliminary performance of candidate HCRs and noted several observations. First, among more than 100 HCRs currently proposed, there are certain HCRs that exhibit similar performance. Second, future fishery impact in the WCPO/EPO would not change very much unless a rule to substantially change the ratio between the WCPO and EPO catch is incorporated into a HCR. The ISC does not have the capacity to conduct a search for a given impact ratio between WCPO and EPO, so stakeholders are requested to evaluate HCR performance based on MSE output on the impact ratio, or to provide a specific candidate HCR to address the issue. These observations were communicated to the JWG in July 2023 before the ISC23, and the JWG narrowed down the proposed HCRs and clarified the management objectives for the stock with respect to the WCPO/EPO catch ratio.

S.K. Chang was re-elected as Vice-Chair of the PBFWG for a second term.

The PBFWG proposed the following meeting schedule:

- November 27th to December 1st, 2023 (On-line) – Data preparation meeting for the 2024 assessment and some technical discussion about the MSE; and
- February 29th to March 7th, 2024 (In-person, Taiwan) – Benchmark Assessment meeting.

Discussion

The Plenary sought clarification on the choice of the probability associated with the target reference point (TRP). A probability of 60% was initially proposed at the Eighth JWG Meeting but one Member raised a concern that this would theoretically make it difficult to achieve a TAC consistent with F_{TARGET}. A 50% probability is more likely to result in catches at the TRP over the long term. Concern was expressed about the potential number of MSE outputs, which may make it difficult for managers to reach consensus on a particular HCR. It was noted that there are currently 24 candidate HCRs evaluated against 11 performance indicators. The PBFWG considers this number of HCRs to be tractable both in terms of computer processing time and utility in decision-making. Development of the MSE is underway with the goal of having results available by the time the stock reaches its second rebuilding target. It will support the development of a long-term harvest strategy; the JWG/NC adopted an interim harvest strategy applicable during the interim period after the second rebuilding target is met and the long-term harvest strategy is developed and implemented.

A question was asked about reduced uncertainty in SSB arising from the proposed 20-year time series for input into the simplified estimation model. It was noted that the PBFWG is confident that shorter time series of inputs to the MSE Operating Model will capture enough variability in SSB to adequately represent uncertainty in stock dynamics.

A question was asked about the absence of otolith samples from the EPO used in developing the growth curve for PBF. The lack of otolith aging data from the EPO should not present a problem in understanding stock productivity, because all age classes are found in WCPO. Furthermore, U.S.A. and Japanese scientists are collaborating on supplementing age data with EPO samples.

The Plenary agreed with the PBFWG work plan to address requests made by JWG08 and NC19.

5.3 Billfish

H. Ijima, BILLWG Chair, presented the WG report for 2022-2023. The BILLWG held four workshops:

1. Swordfish Data Preparation Workshop Nov 28-30 to Dec 5, 2022 (**ISC/23/ANNEX/09, 13**);
2. Striped Marlin Stock Assessment Workshop, December 2-5, 2022 (**ISC/23/ANNEX/13**);
3. Biological Research Workshop, December 14-15, 2022 (**ISC/23/ANNEX/12**); and
4. Swordfish Stock Assessment Workshop April 11-17, 2023 (**ISC/23/ANNEX/10**).

At the NPO SWO data preparation meeting, seven working papers and one presentation were discussed, and decisions were made on the data set and biological parameters to be used in the stock assessment. In this stock assessment, there were some changes in the data, such as catch and standardized CPUE, due to the change in stock boundaries. However, the WG decided that the biological parameters would continue to be those values used in the previous stock assessment. Japan, Taiwan, and the United States are studying the biological parameters jointly. The WCNPO MLS stock assessment was also conducted over two days. The WG held several web meetings prior to the stock assessment to estimate the parameters of the growth curve to be used in SS3 using the data from Sun et al. (2011)[2], based on the 2022 agreement. Multiple parameterizations of von Bertalanffy and Richards curves were evaluated. The Richards curve produced a less accurate fit to the data than the von Bertalanffy curve. Thus, the WG used the revised von Bertalanffy curve for predicting MLS mean length-at-age. A stock assessment was conducted using these results. In addition, the setting of the recruitment deviation, the CPUE indices included, and the weighting of the length composition data were changed compared to the 2022 iteration of the model. The WG conducted a biological studies workshop and confirmed each country's otolith removal and processing methods. It also confirmed the method of dorsal fin processing. The WG conducted an in-person NPO SWO stock assessment meeting and it responded to the request from the NC18 to compile the catch and effort for NPO SWO north and south of 20°N.

The BILLWG held elections for the Chair and elected Michelle Sculley to her first term as Chair. Yi-Jay Chang has two more years of his term as Vice-Chair.

Discussion

Noting that the form of the growth curve is a major source of uncertainty for the WCNPO MLS assessment, the BILLWG Chair estimated that a revised growth curve could be produced within five years and incorporated into the next stock assessment. In the coming year, the BILLWG will produce an expanded suite of projection results to support the development of a rebuilding plan for WCNPO MLS as requested by WCPFC16 and plans to prepare for a potential peer review of the 2023 WCNPO MLS assessment. The new stock boundaries for NPO SWO will be presented to the NC.

5.4 Shark

M. Kai, SHARKWG Chair, provided a summary of SHARKWG activities over the past year (**ISC/23/ANNEX/05**). The SHARKWG held a four-day hybrid meeting 8-12 December 2022 at the Fishery Resources Institute in Shimizu, Shizuoka, Japan. Canada, Chinese-Taipei, Japan, Mexico, and U.S.A. scientists participated in this SHARKWG meeting. The meeting focused mainly on the appropriateness of the ensemble approach used for the stock assessment of NPO BSH (**ISC/22/ANNEX/12**) and reviews of the fishery data and biological parameters used in the

[2] Sun, C.-L., W.-S. Hsu, N.-J. Su, S.-Z. Yeh, Y.-J. Chang and W.-C. Chiang. 2011. Age and growth of striped marlin (*Kajikia audax*) in waters off Taiwan: A revision. ISC Billfish Working Group Workshop Report ISC/11/BILLWG-2/07. 12 p.

previous stock assessment for NPO SMA with a view toward the upcoming benchmark stock assessment in 2024. In addition, the SHARKWG reviewed the indicator-based analysis and discussed the methodology to determine thresholds for the indicators that could be used to identify when the stock assessment timeline needs to be shortened. The SHARKWG also held unofficial online meetings 18 May and 29 June 2023 to discuss the conceptual model for the upcoming benchmark stock assessment of SMA.

The WG Chair briefly presented highlights of the WG meetings to the Plenary; **ISC/23/ANNEX/05** contains the full report of the SHARKWG meetings. The 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 plans.

Potential Timing	Location	Purpose
7-15, Nov. 2023 (JP time)	Yokohama, Japan	Data preparatory meeting of stock assessment for SMA
6-10, Feb. 2024 (JP time)	La Jolla, U.S.	Pre-stock assessment for SMA
16-20, Apr. 2024 (JP time)	La Jolla, U.S.	Stock assessment for SMA

Discussion

Methods for combining SMA CPUE indices were discussed. Given that trends in the indices are now substantially different, the composite index used in the previous assessment will be reviewed and there may be a need for a new approach. For SMA, unaccounted for catches in various high seas driftnet fisheries will be estimated for the assessment for the first time.

6 STOCK STATUS AND CONSERVATION INFORMATION

6.1 North Pacific Albacore

6.1.1 Stock Assessment

S. Teo, ALBWG Vice Chair and lead modeler, summarized results of the benchmark NPO ALB stock assessment (**ISC/23/ANNEX/08**). There were four main changes to the base case model compared to the previous assessment in 2020. 1) Increased uncertainty was imposed on the size composition and abundance index data for 2020 and 2021, because fishery operations and data collection protocols were likely affected by COVID-19 safety protocols. 2) Two JPLL fleets were further subdivided nominally into juvenile and adult fleets to improve model fits and diagnostics. 3) A new adult abundance index was developed from the JPLL fleet in Area 2, Quarter 2 and used as the abundance index. 4) Selectivity patterns for the two main JPPL fleets were modified to have only a single time block (2016-2021) due to model convergence issues. Sensitivity of results to the model structure changes listed above are illustrated with a model using a similar structure to the base case model in the 2020 assessment, albeit with the same data as this assessment.

During the modeling period (1994-2021), the total reported catch of NPO ALB reached a peak of about 119,000 t in 1999 and then declined in the early 2000s, followed by a recovery in later years. However, catches have dropped to low levels during two out of the last three years of the time series, with catches of about 43,000 t in 2019 and 2021. Surface gears (e.g., troll, pole-and-line), which primarily harvest juvenile ALB, have typically accounted for the majority of the ALB catch.

All NPO ALB catch and size composition data from ISC member (Canada, China, Chinese Taipei, Japan, Korea, and the U.S.A.) and non-member countries were compiled for the assessment. The fleet structure was similar to the 2020 assessment, but an attempt was made to improve model fits and diagnostics by further subdividing the JPLL fleets operating in Areas 1 and 3 during Quarter 1 nominally into juvenile and adult fleets. Four relative abundance indices (standardized CPUE) were provided by Japan and the U.S.A. Based on a thorough review of all fishery data and preliminary model runs, the ALBWG fitted the base case model to one abundance index: the standardized CPUE of the JPLL fleet operating in Area 2 during Quarter 2 (F12 index; 1996-2021). This index was chosen because it represented the best information on trends for adult age-classes of female ALB, had good contrast, and age-structured production model (ASPM) analyses showed the index was informative on both population trends and scale. Previous assessments used an index from the JPLL fleet in the same area but from Quarter 1, which is the primary ALB-targeting season. However, a re-examination of the data concluded that trends in the adult age-classes of female ALB were likely better represented by the Quarter 2 CPUE.

The NPO ALB stock was assessed using a length-based, age-, and sex-structured Stock Synthesis (SS; Version 3.30.21) model over the 1994-2021 period. Biological parameters such as growth and natural mortality (M), were the same as for the 2017 and 2020 assessments. Sex-specific growth curves were used because of sexually dimorphic growth, with adult males attaining a larger size-at-age than females after maturity. Sex-specific M-at-age vectors were developed from a meta-analysis, with a sex-combined M that scaled with size for ages 0-2, and sex-specific M fixed at 0.48 and 0.39 yr^{-1} for age-3+ females and males, respectively. The steepness of the Beverton-Holt stock-recruitment relationship was assumed to be 0.9, based on two prior analyses. The base case model was fitted to the F12 index and all representative size composition data in a likelihood-based statistical framework. However, based on preliminary analyses, the ALBWG concluded that fishery operations and data collection protocols in 2020 and 2021 were likely affected by COVID-19 safety protocols. Therefore, increased uncertainty was imposed on the size composition and abundance index data for those two years to reflect these effects. All but one fleet (U.S.A. longline) were assumed to have dome-shaped length selectivity patterns. Age-based selectivity for ages 1-5 were also estimated for surface fleets (primarily troll and pole-and-line) to address age-based changes in juvenile albacore availability and movement. Preliminary models with annually varying age-selectivities for the two main JPPL fleets resulted in models without positive, definite Hessian matrices. However, models without any time varying age-selectivities matched the expected catch-at-age poorly and had poor ASPM diagnostics. Therefore, the ALBWG developed a model with a single age-selectivity time block for the two main JPPL fleets near the end of the historical period. This model adequately matched the catch-at-age data and had good ASPM diagnostics. Selectivity patterns were also assumed to vary for fleets during periods consistent with important changes in fishing operations. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status. Several sensitivity analyses were conducted to evaluate changes in model performance or the range of uncertainty resulting from changes in model parameters, including growth, natural mortality, stock-recruitment steepness, selectivity patterns, and data weighting.

An ASPM diagnostic analysis showed that the estimated catch-at-age and fixed productivity parameters (growth, mortality, and stock-recruitment relationships with and without annual recruitment deviates) were able to explain trends in the primary index. Based on these findings, the ALBWG concluded that the base case model was able to estimate the stock production function and the effect of fishing on the abundance of the NPO ALB stock. Similar to the 2017 and 2020 assessments, the link between catch-at-age and the primary index adds confidence to the data used and the results of the assessment. Due to the moderate exploitation levels relative to productivity, the production function was weakly informative about NPO ALB stock size, resulting in asymmetric uncertainty in the absolute scale of the stock, with more uncertainty in the upper limit of the stock than the lower limit. It is important to note that the primary aim of estimating the female SSB in this assessment was to determine whether the estimated SSB was lower than the adopted limit and threshold reference points. Since the lower bound is better defined, it adds confidence to the ALBWG's evaluation of stock condition relative to these reference points.

The WCPFC and IATTC are the tuna RFMOs that manage the NPO ALB stock in the WCPO and EPO, respectively, and have adopted similar harvest strategies and biological reference points for this stock (WCPFC HS 2022-01; IATTC Resolution C-22-04). These harvest strategies include target, threshold, and limit reference points. The target reference points are $F_{45\%SPR}$, which is the fishing intensity that results in the stock producing a SPR of approximately 45%. The threshold and limit reference points are $30\%SSB_{current,\ F=0}$ and $14\%SSB_{current,\ F=0}$, respectively, which are 30% and 14% of the current, dynamic SSB under zero fishing, and hence fluctuates with changes in recruitment. Importantly, three of the management objectives in the harvest strategies are to: 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 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. In addition, both RFMOs have current management measures (WCPFC CMM 2019-03; IATTC Resolution C-05-02) that maintain albacore fishing effort at or below the average effort levels during the 2002-2004 period.

Two 10-year projection scenarios, constant $F_{2018\text{-}2020}$ and randomly resampled F scenarios, were used to evaluate the impacts of fishing on the management objectives of IATTC and WCPFC. The randomly resampled F scenarios had F-at-age that were randomly sampled from 2005-2019. This 2005-2019 period was chosen as representative of the variability in F-at-age on NPO ALB, after both IATTC and WCPFC put in place current management measures (WCPFC CMM 2019-03; IATTC Resolution C-05-02) that maintain albacore fishing effort at or below the average effort levels during the 2002-2004 period.

Future recruitment was sampled from a distribution consistent with the expected recruitment variability (σ_R = 0.46) of the recruitment time series (1994-2021) in the base case model. The sex-specific F-at-age time series was estimated from the base case model and used to remove ALB from the appropriate age and sex in the projected populations. Projections started in 2022 and continued for 10 years through 2031. The projected female SSB, fishing intensity, $SSB/14\%SSB_{current,F=0}$ ratios, and total biomass (age-1+) were calculated for each projection. Four hundred (400) initial populations were simulated by sampling from a multivariate normal distribution consistent with the estimated N-at-age in 2021 and its variance-covariance matrix. Each initial population was subsequently projected using 400 runs for 10 years. Each run used a random 10-year recruitment vector that was resampled from the distribution of expected future recruitment, which incorporated uncertainty in the stock-recruitment relationship, and expected recruitment variability. Depending on scenario, the F-at-age used was either based on the average F-at-age during the 2018-2020 period, or randomly resampled from the 2005-2019 period. The projected F-at-age included the uncertainty in the F-multipliers but not the estimated selectivity. A total of 160,000 (400 x 400) runs were performed for each projection scenario. As a large cohort is estimated in the latest period of the assessment, all projections show a steep increase in SSB in the first year.

The ALBWG noted that the lack of sex-specific size data, uncertainty in growth and natural mortality, uncertainty in the impacts of COVID safety protocols on fishery operations and data collection, and the simplified treatment of the spatial structure of NPO ALB population dynamics are important sources of uncertainty in the assessment.

The adopted harvest strategies of WCPFC and IATTC for NPO ALB included the identification of exceptional circumstances during the stock assessment which would trigger changes to, or a suspension of the harvest strategy adopted for the stock. The ALBWG developed and considered the preliminary criteria for identifying exceptional circumstances for NPO ALB and did not find compelling evidence of exceptional circumstances with respect to the conservation and management of this stock. At this time, the ALBWG stresses that the preliminary criteria are still incomplete and newly adopted HCRs from NC19 (which occurred one week prior to the ISC23 Plenary session) will be used to develop criteria for implementation indicators for future evaluation of exceptional circumstances.

Discussion

Some of the model diagnostic results were surprising, possibly because estimated recruitment spiked in 2017. The ASPM generally resulted in better fits to the data, which also occurred when size data were down weighted in the base case model. Model fits were fairly consistent with respect to the scale of stock size.

Modifications of the phase plot representing stock status (dubbed the “La Jolla” plot) were suggested that could better highlight areas of concern (relative to fishing intensity and SSB).

It was suggested that the fact that fishing intensity is currently well below the target level should be referenced in the conservation information.

Efforts to improve sex sampling were mentioned with U.S.A. indicating funding has been received to increase its sample rate. Genetic sex identification is a work in progress and currently has an error rate of about 10%.

The way that fishing intensity is represented (%SPR or 1-SPR) could cause confusion, especially with ratios scaled to reference points. How to interpret such ratios (i.e., whether values greater than 1.0 are "good" or "bad") should be made clear when reporting results.

The ISC Plenary adopted the updated NPO ALB 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.

6.1.2 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 (Figure 1A). 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 (Figure 1A). These high summary biomass estimates were due to historically high recruitment estimates in 2017 (~433 million fish; 95% CI: 194 – 671 million fish) (Figure 1C). 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 (Figure 1B).

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 (Figure 2). Juvenile albacore aged 2 to 4 years comprised approximately 64% of the annual catch-at-age in numbers between 1994 and 2021 (Figure 3) 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 (Figure 4).

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 (Figure 5A – the "La Jolla" plot; Table 1). 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 five 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 (Figure 5B). In contrast, estimated average fishing intensity during 2018-2020 ($F_{2018-2020}$) 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 (Figure 5B; Table 1).

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 ($F_{2018-2020}$) 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 (Figure 6; Table 1).

Based on these findings, the following information on the status of the NPO ALB stock is provided by the ISC23 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 by the WCPFC and IATTC;**
2. **The stock is likely not experiencing overfishing relative to the adopted target reference point ($F_{45\%SPR}$); and**
3. **Current fishing intensity ($F_{2018-2020}$) 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).**

Conservation Information

Two harvest scenarios were projected to evaluate impacts on achieving the management objectives for this stock, which are: 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 2022-01; IATTC Resolution C-22-04). 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 at current fishing intensity ($F_{2018-2020}$), female SSB is expected to increase 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 (Figure 7).

The randomly resampled fishing intensity scenario showed that at future fishing intensity 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 (Figure 8).

Based on these findings, the following conservation information is provided by the ISC23 Plenary for the NPO ALB stock:

1. **If fishing intensity over the next ten years is maintained at the current fishing intensity ($F_{2018-2020}$), 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 ten years and the management objectives of the IATTC and WCPFC will likely be met.**

2. **If fishing intensity over the next ten 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 ten years and the management objectives of the IATTC and WCPFC will likely be met.**

Table 1. Estimates of maximum sustainable yield (MSY), female spawning stock biomass (SSB), fishing intensity (F), and reference point ratios for NP ALB for: 1) the base case model; 2) two important sensitivity models due to uncertainty in growth parameters; and 3) a model representing an update of the 2020 base case model to 2023 data. SSB_0, $SSB_{current, F=0}$ and SSB_{MSY} are the expected female SSB of a population in the equilibrium, unfished state; in the current, dynamic, unfished state; and at MSY, respectively. The Fs in this table are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR. SPR is the ratio of the equilibrium SSB per recruit that would result from the estimated F-at-age relative to that of an unfished population. Depletion is calculated as the proportion of the age-1+ biomass during the specified period relative to an unfished age-1+ equilibrium biomass. The model representing an update of the 2020 base case model is similar to but not identical to the 2020 base case model due to changes in data preparation and model structure.

Quantity	Base Case	Growth CV = 0.06 for L_{inf}	Growth All parameters estimated	Update of 2020 base case model to 2023 data*
MSY (t)	121,880	93,167	144,792	97,777
SSB_{MSY} (t)	23,154	18,133	30,435	18,756
SSB_0 (t)	165,567	128,155	198,913	132,570
SSB_{2021} (t)	70,229	35,418	101,161	36,909
$SSB_{current, F=0}$ (2021 estimate)	129,581	97,368	155,542	93,808
$SSB_{2021}/SSB_{current, F=0}$	0.54	0.36	0.65	0.39
$SSB_{2021}/30\%SSB_{current, F=0}$	1.81	1.21	2.17	1.31
$SSB_{2021}/14\%SSB_{current, F=0}$	3.87	2.60	4.65	2.81
† $Depletion_{2021}/Depletion_{2006\text{-}2015}$	1.34	1.33	1.37	1.30
§ $F_{\%SPR, 2018\text{-}2020}$ (%SPR)	59.0	41.4	70.4	43.2
§ $F_{\%SPR, 2011\text{-}2020}$ (%SPR)	55.0	36.6	63.8	37.9
¶ $F_{\%SPR, 2018\text{-}2020}/F_{\%SPR, MSY}$	2.04	1.42	2.78	1.47
¶ $F_{\%SPR, 2011\text{-}2020}/F45_{\%SPR}$	1.22	0.81	1.42	0.84
¶ $F_{\%SPR, 2018\text{-}2020}/F45_{\%SPR}$	1.31	0.92	1.56	0.96
¶ $F_{\%SPR, 2018\text{-}2020}/F_{\%SPR, 2002\text{-}2004}$	1.48	1.63	1.40	1.25

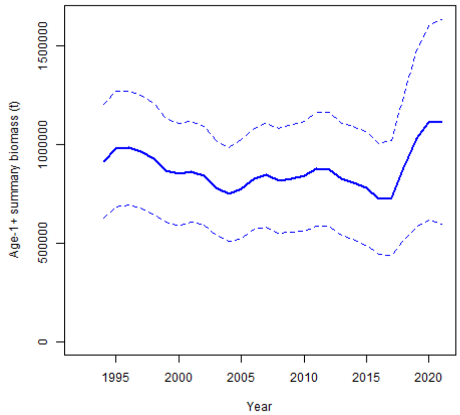
* Model may not have converged and uncertainty estimates were unreliable because of the lack of a positive, definite Hessian matrix.

† A value of >1 for the depletion ratio indicates higher age-1+ biomass in 2021 relative to the 2006 – 2015 period.

§ Higher %SPR values indicate lower fishing intensity levels.

¶ Values of >1 for ratios of $F_{\%SPR}$ to $F_{\%SPR}$-based reference points indicate fishing intensity levels lower than the reference points.

A.



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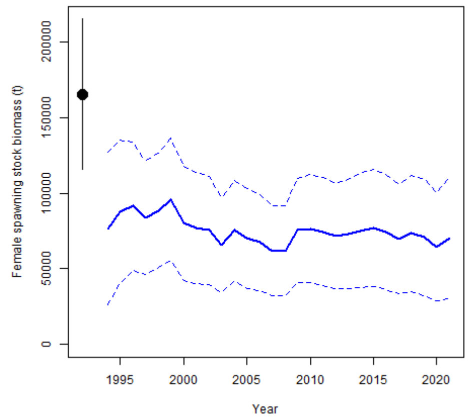

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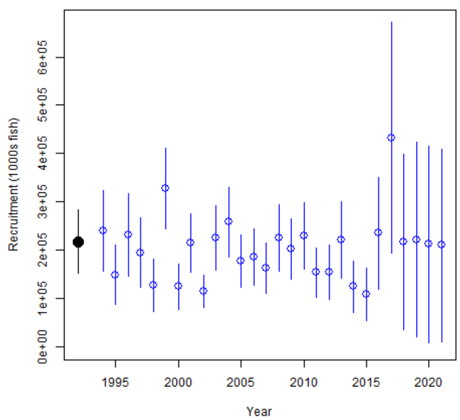


Figure 1. Maximum likelihood estimates of (A) age-1+ biomass (B), female spawning biomass (SSB), and (C) age-0 recruitment of NPO ALB (*Thunnus alalunga*). Dashed lines (A and B) and vertical bars (C) indicate 95% confidence intervals. Closed black circle and error bars in (B) and (C) are the maximum likelihood estimate and 95% confidence intervals of unfished female spawning biomass, SSB0, and unfished recruitment, respectively, at equilibrium.

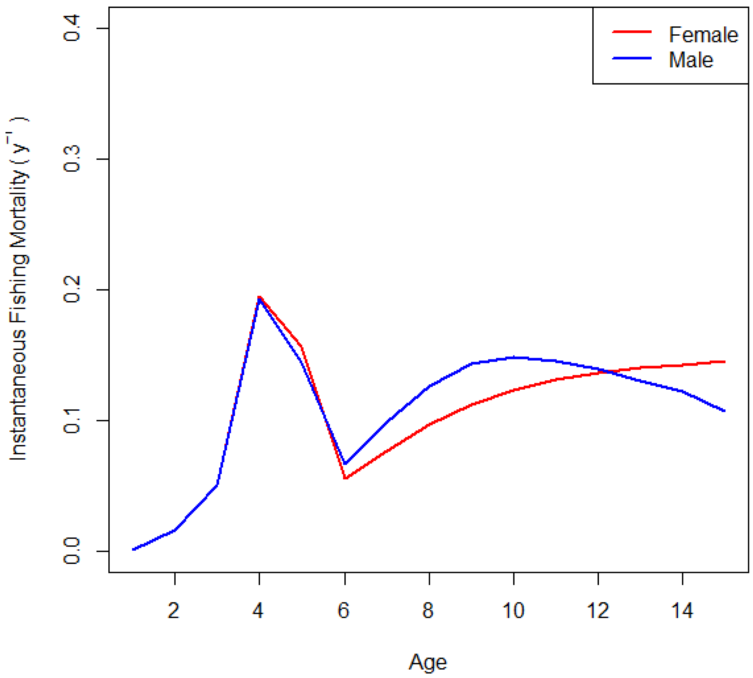


Figure 2. Estimated sex-specific instantaneous fishing mortality-at-age (F-at-age) for the 2023 base case model, averaged across 2018-2020.

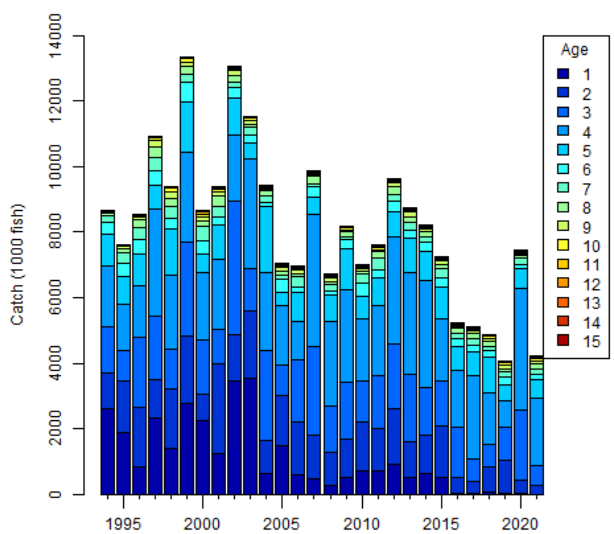


Figure 3. Historical catch-at-age of NPO ALB (*Thunnus alalunga*) estimated by the 2023 base case model.

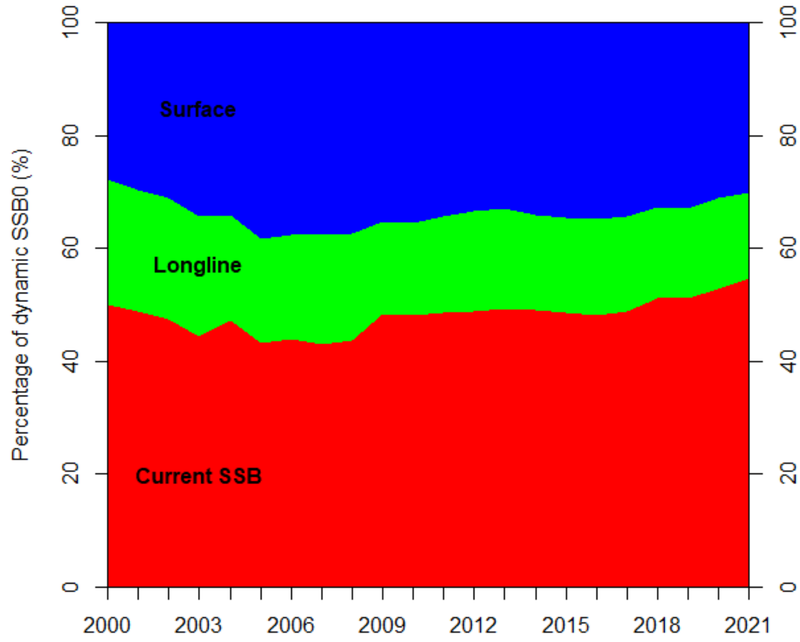


Figure 4. Fishery impact analysis on NPO ALB (*Thunnus alalunga*) showing female spawning biomass (SSB) (red) estimated by the 2023 base case model as a percentage of dynamic, unfished female SSB ($SSB_{current,\ F=0}$). Colored areas show the relative proportion of fishing impact attributed to longline (green) and surface (blue) fisheries (primarily troll and pole-and-line gear but including all other gears except longline).

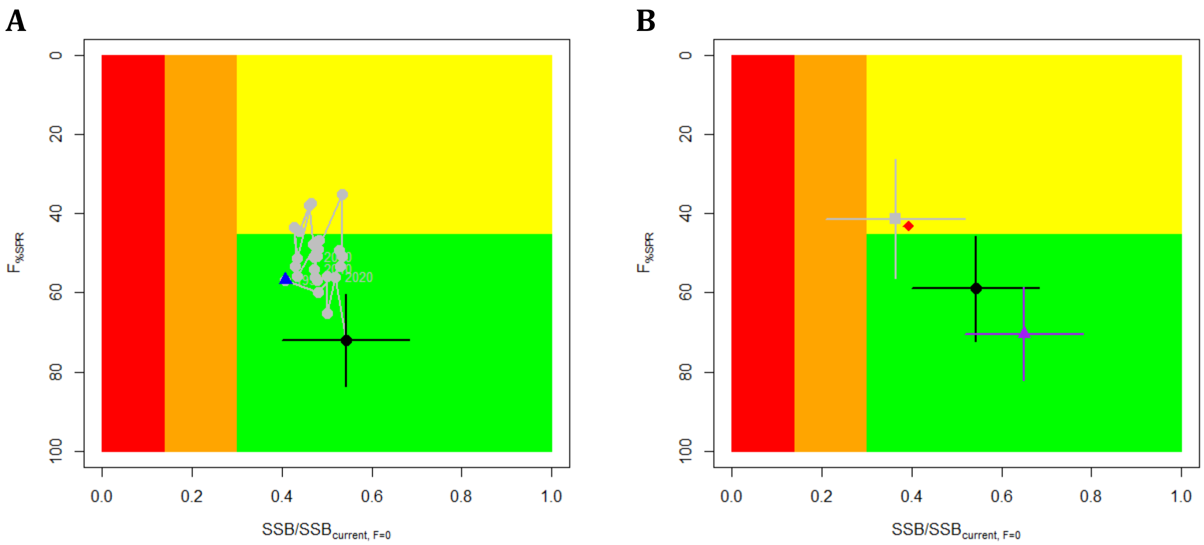


Figure 5. (A) Stock status phase plot showing the status of the NPO ALB (*Thunnus alalunga*) stock relative to the biomass-based threshold (30%$SSB_{current, F=0}$) and limit (14%$SSB_{current, F=0}$) reference points, and fishing intensity-based target reference point ($F_{45\%SPR}$) over the modeling period (1994 – 2021). Blue triangle indicates the start year (1994) and black circle with 95% confidence intervals indicates the terminal year (2021). (B) Stock status plot showing current stock status and 95% confidence intervals of the base case model (black circle), an important sensitivity run of CV = 0.06 for L_{inf} in the growth model (gray square), an important sensitivity run with an estimated growth model (purple triangle), and a model representing an update of the 2020 base case model to 2023 data (red diamond). 95% confidence intervals are not shown for the update of the 2020 base case model (red diamond) because the model did not have a positive definite Hessian matrix and uncertainty estimates were unreliable. Red zones in both panels indicate female SSBs falling below the limit reference point while the orange zones indicate female SSBs between the threshold and limit reference points. Green zones indicate female SSBs above the threshold reference point and fishing intensity levels below the target reference point. Yellow areas indicate female SSBs above the threshold reference point and fishing intensity levels above the target reference point. The Fs in this figure are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR. SPR is the ratio of the equilibrium SSB per recruit that would result from the estimated F-at-age relative to that of an unfished population. A higher %SPR indicates lower fishing intensity. Current fishing intensity values and $SSB/SSB_{current,F=0}$ ratios in (B) were calculated as the average during 2018-2020 (F%SPR, 2018-2020) and 2021 (SSB2021/$SSB_{current, F=0}$), respectively. The model representing an update of the 2020 base case model is similar to but not identical to the 2020 base case model due to changes in data preparation and model structure.

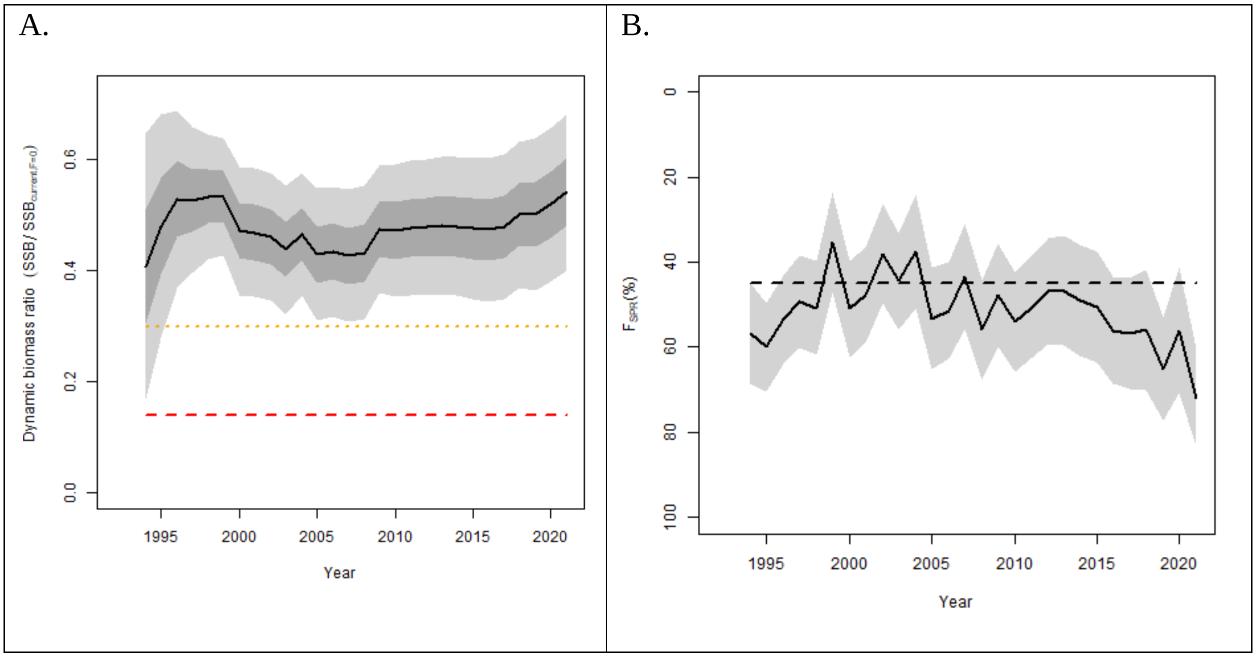


Figure 6. (A) Estimated dynamic biomass ratio ($SSB/SSB_{current,\ F=0}$) of NPO ALB relative to biomass-based threshold ($30\%SSB_{current,\ F=0}$) (orange dotted line) and limit ($14\%SSB_{current,\ F=0}$) reference points (red dashed line) over the modeling period (1994 – 2021); and (B) estimated fishing intensity relative to the fishing intensity-based target reference point ($F_{45\%SPR}$) over the modeling period (1994 – 2021). Light and dark gray areas indicate 95% and 60% confidence intervals, respectively. The limit reference point is considered to be breached if the lower bound of the 60% confidence intervals overlaps the limit reference point.

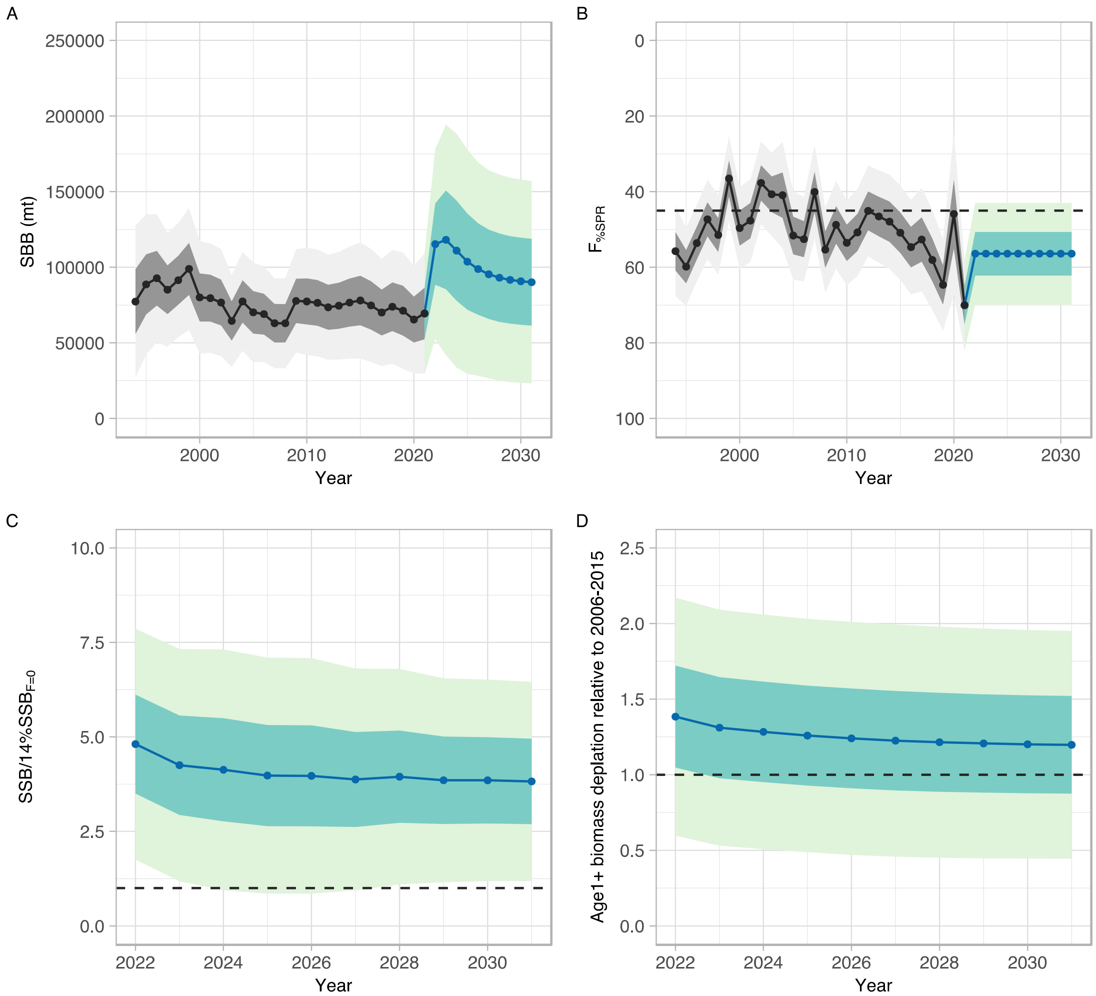


Figure 7. Future projection results under a constant fishing intensity ($F_{2018\text{-}2020}$) harvest scenario. Solid lines indicate mean values, uncertainty ranges indicate 60% and 95% confidence intervals, and the dashed line is the reference point, respectively. (A) Annual changes in spawning biomass; (B) Interannual changes in fishing mortality ($F_{\%SPR}$); (C) Projected ratios to the limit reference point thresholds; and (D) Projected ratios to management targets for the total biomass.

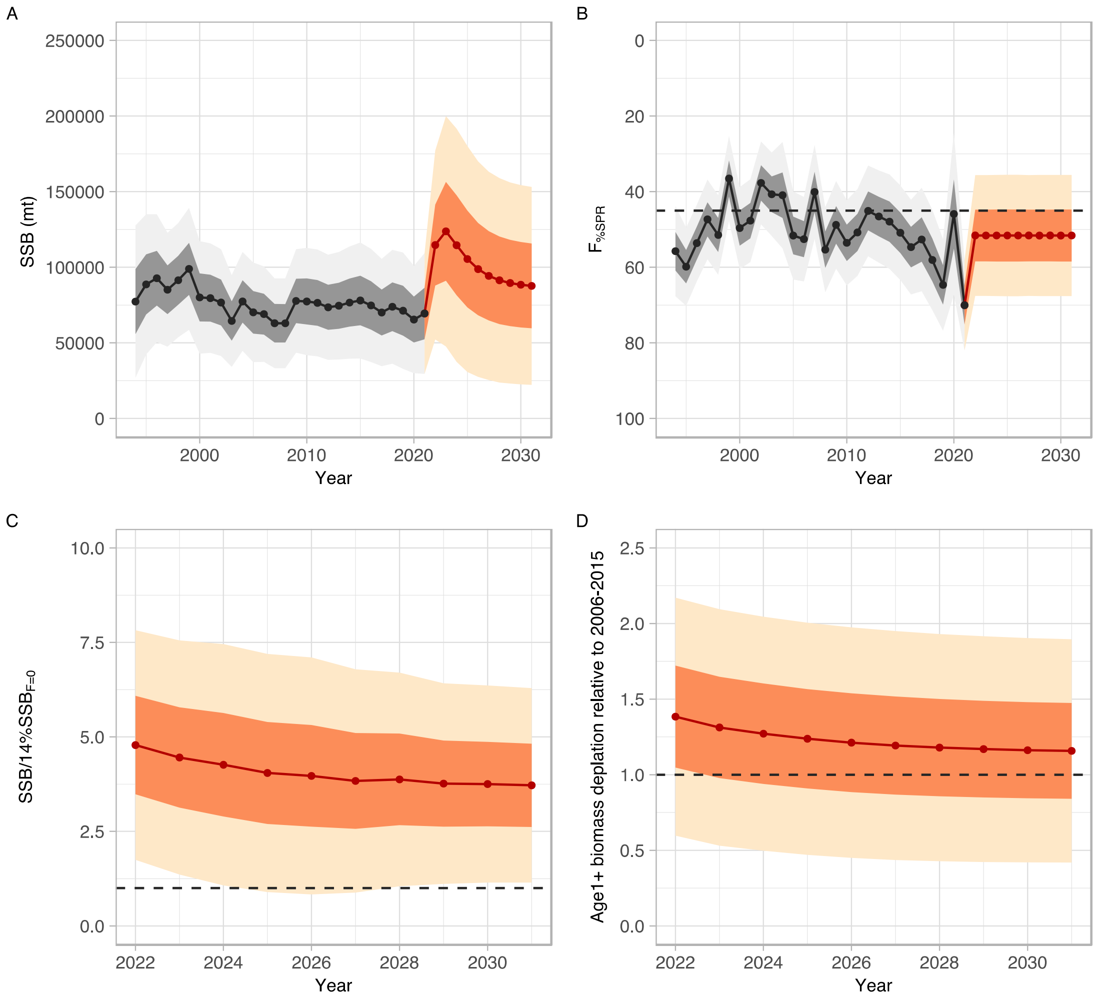


Figure 8. Future projection results under a randomly sampled F (2005-2019) scenario. Solid lines indicate mean values, and uncertainty ranges indicate 60% and 95% confidence intervals, and the dashed line is the reference point, respectively. (A) Annual changes in spawning biomass; (B) Interannual changes in fishing mortality ($F_{\%SPR}$); (C) Projected ratios to the limit reference point thresholds; and (D) Projected ratios to management targets for the total biomass.

6.2 Pacific Bluefin Tuna Stock Status and Conservation Information

S. Nakatsuka, PBFWG Chair, noted that the last stock assessment was conducted in 2022, and the next assessment is planned for 2024 and he summarized the recommendations on stock status and conservation for PBF presented at ISC22. The PBFWG reviewed recent catch data, indices and other information and concluded that these data do not support any changes in the stock status (see Figure 8). Based on this conclusion, the PBFWG recommends carrying forward the stock status and conservation information from ISC22. **The ISC23 Plenary endorsed this recommendation.**

The Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC22, which was based on the 2022 stock assessment (see Section 6.1.2, pp. 33-34 in the ISC22 Plenary Report) unchanged, except for the omission of accompanying figures and tables.

Stock Status

PBF spawning stock biomass (SSB) has gradually increased in the last 10 years, and the rate of increase is accelerating. These biomass increases coincide with a decline in fishing mortality, particularly for fish aged 0 to 3, over the last decade. The latest (2020) SSB is estimated to be 10.2% of SSB_0.

Based on these findings, the following information on the status of the Pacific bluefin tuna stock is provided by the ISC23 Plenary:

1. **No biomass-based limit or target reference points have been adopted for PBF, but the PBF stock is overfished relative to the potential biomass-based reference points (20%SSB_0) adopted for other tuna species by the IATTC and WCPFC. On the other hand, SSB reached its initial rebuilding target (SSB_{MED} = 6.3%SSB_0) in 2019, five years earlier than originally anticipated by the RFMOs; and**
2. **No fishing mortality-based reference points have been adopted for PBF by the IATTC and WCPFC. The recent (2018-2020) $F_{\%SPR}$ is estimated to produce a fishing intensity of 30.7%SPR and is below the level corresponding to overfishing for many F-based reference points proposed for tuna species, including $SPR_{20\%}$.**

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, consistent with the implementation of stringent management measures. The 2020 SSB was above the initial rebuilding target but remains below the second rebuilding target adopted by the WCPFC and IATTC. However, stock recovery is occurring at a faster rate than anticipated by managers when the Harvest Strategy to foster rebuilding (WCPFC HS 2017-02) was implemented in 2014. The fishing mortality ($F_{\%SPR}$) in 2018-2020 has been reduced to a level producing 30.7%SPR, the lowest observed fishing mortality in the time series.

Based on these findings, the following information on the conservation of the PBF stock is provided by the ISC23 Plenary:

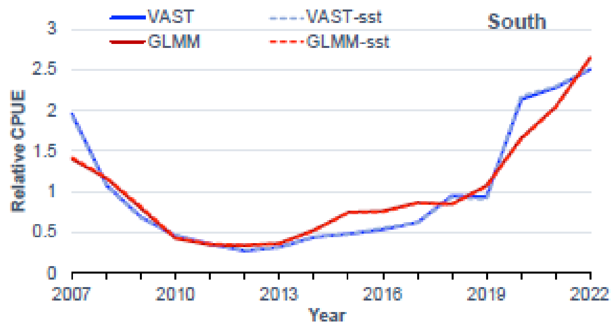
1. **The PBF stock is recovering from the historically low biomass in 2010 and has exceeded the initial rebuilding target ($SSB_{MED1952\text{-}2014}$) five years earlier than expected. The rate of recovery is increasing and under all projection scenarios evaluated, it is very likely the second rebuilding target (20%SSB_0 with 60% probability) will be achieved (probabilities > 90%) by 2029. The risk of SSB falling below the historical lowest observed SSB at least once in 10 years is negligible;**
2. **The projection results show that increases in catches are possible without affecting the attainment of the second rebuilding objective. Increases in catch should consider both the rebuilding rate and the distribution of catch between small and large fish;**
3. **The projection results assume that the CMMs are fully implemented and are based on certain biological and other assumptions. For example, the future projection results do not contain assumptions about discard mortality. Although the impact of discards on SSB is small compared to other fisheries, discards should be considered in future harvest scenarios;**
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 management, monitoring recruitment and SSB should continue and research on a recruitment index for the stock assessment should be pursued; and**
5. **The results of projections from sensitivity models with lower productivity assumptions show that this conservation information is robust to uncertainty in stock productivity.**

Stock Status Update

To confirm whether any unexpected behavior in the stock occurred, the PBFWG checked the most recent catch and abundance indices for spawners and recruitment in March 2023 (Figure 9).

- The retained catches in 2022 by the ISC member countries were within the catch assumed in the future projection of the latest stock assessment.
- The spawner index showed a continuous increasing trend and the recruitment index showed high variability from low to high.

The ISC23 Plenary concluded that there is no new information that necessitates revising the existing stock status or conservation information for PBF.



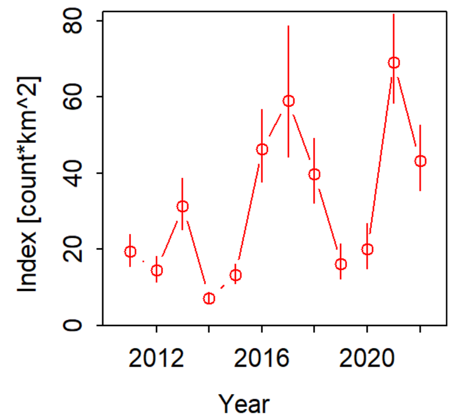


Figure 9. Trends in the spawner index (left, Yuan et al., 2023)[3] and recruitment index (right, Fujioka et al., 2023)[4] for PBF.

6.3 Blue Shark Stock Status and Conservation Information

Since a new stock assessment was not produced in 2023, M. Kai, SHARKWG Chair, presented the stock status and conservation information adopted by the ISC22 Plenary. The ISC23 Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC22, which was based on the 2022 stock assessment (see Section 6.3.1 pp. 52-54 in the ISC22 Plenary Report) unchanged, except for the omission of accompanying figures and tables, and with a revision in the notes section, and the inclusion of updated catch information.

The Plenary noted that the average annual catch of BSH by ISC members in 2019-2021 was 22,869 t. Catches in 2020 and 2021 were 23,821 t and 16,970 t, respectively.

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

[3] Yuan, T.-L., Chang, S.-K., Chang, Y.-J. 2023. CPUE standardization for Taiwanese PBF fisheries using delta-GLMM and VAST, incorporating SST and size data. Working paper submitted to the Pacific bluefin tuna working group workshop held March 21-24, 2023, Tokyo, Japan; ISC/23/PBFWG-1/02.

[4] Fujioka, K., Asai, S., Tsukahara, Y., Fukuda, H., and Nakatsuka, S. 2023. Recruitment abundance index of immature Pacific bluefin tuna, derived from real-time monitoring survey data of troll fisheries. Working paper submitted to the Pacific bluefin tuna working group workshop held in March 21-24, 2023, Tokyo, Japan; ISC/23/PBFWG-1/03.

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 ISC23 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 ($F_{2017\text{-}2019}$) 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 ISC23 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 ten 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 decision to adopt an ensemble modeling approach instead of a single base-case model was made late in the assessment model development process when it became apparent that there was no clear best base-case model. Ensemble modeling can be an appropriate approach for characterizing structural uncertainty in stock assessments. The WG is continuing to investigate its application to NPO BSH and will be considering the most appropriate methods for selecting candidate models and setting the relative model weights.
2. 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. In the future the SHARKWG will ensure that the model ensemble is informed by the sensitivity analyses.

6.4 Shortfin Mako Shark Stock Status and Conservation Information

M. Kai, SHARKWG Chair, noted that SMA was last assessed in 2018 and an indicator analysis was completed in 2021. The Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC21 (see Section 3.4.3, pp. 46-47 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables. As with BSH, the Plenary requested inclusion of updated catch information for SMA.

The ISC Plenary notes that the average annual catch of SMA by ISC members was 1,392 t in the 2013-2015 period and decreased to an average annual catch of 1,119 t in 2019-2021. Catches in 2020 and 2021 were 1,144 t and 807 t, respectively.

<u>Stock Status</u>

The reproductive capacity of the North Pacific SMA stock was calculated as spawning abundance (SA; i.e., number of mature female sharks) rather than spawning biomass, because the number of pups produced is not related to female size (i.e., larger female sharks do not produce more pups). Spawning potential ratio (SPR) was used to describe the impact of fishing on this stock. The SPR of this population is the ratio of SA per recruit under fishing to the SA per recruit under virgin (or unfished) conditions. Therefore, 1-SPR is the reduction in the SA per recruit due to fishing and can be used to describe the overall impact of fishing on a fish stock.

Based on these findings, the following information on the status of the NPO SMA stock is provided by the ISC23 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; and**

2. **The results from the base case model and six sensitivity analyses that represent the most important sources of uncertainty in the assessment show that the NPO SMA stock is likely (>50%) not in an overfished condition and overfishing is likely (>50%) not occurring relative to MSY-based abundance and fishing intensity reference points.**

<u>Conservation Information</u>

Stock projections of biomass and catch of NPO SMA from 2017 to 2026 were performed assuming three alternative constant fishing mortality scenarios: 1) $F_{CURRENT}$ (2013-2015), average of 2013- 2015 (F2013-2015); 2) F2013-2015 + 20%; and 3) F2013-2015 - 20%.

Based on these future projections, the following conservation information for the NPO SMA stock is provided by the ISC23 Plenary:

1. **In scenarios where fishing mortality remains constant at $F_{2013\text{-}2015}$ or is decreased by 20%, then spawner abundance (SA – the number of mature female sharks) is expected to increase gradually.**
2. **If fishing mortality is increased by 20% relative to $F_{2013\text{-}2015}$, then SA is expected to decrease in the final years of the projection; and**
3. **It should be noted that, given the uncertainty in fishery data and key biological processes within the model, especially the stock recruitment relationship, the models' ability to project into the future is highly uncertain.**

6.5 North Pacific Swordfish

6.5.1 Stock Assessment

M. Sculley, BILLWG lead modeler, presented the 2023 NPO SWO stock assessment (**ISC/23/ANNEX/11**).

<u>Stock Identification and Distribution</u>

The NPO SWO stock area was defined to be the waters of the North Pacific Ocean contained in the WCPFC Convention Area bounded by the equator and the waters of the IATTC Convention Area north of 10°N (Figure 10). All available fishery data from the stock area were used for the stock assessment. For the purpose of modeling observations of CPUE and size composition data, it was assumed that there was an instantaneous mixing of fish throughout the stock area on a quarterly basis. The stock was modeled using a fleets-as-areas approach with separate catch and index fleets for the WCNPO and EPO region delineated in (Figure 10).

<u>Catches</u>

The NPO SWO catches were high from the 1970s to the 1980s averaging about 14,000 t per year during 1975-1990, peaked with unusually high catches in 1998-2000, and then generally declined to the current levels around 11,000 t. Catches by most fleets have generally declined, while minor catches by other WCPFC countries have generally increased, except in in the last three years (Figure 11). Overall, longline fishing gear has accounted for the vast majority of NPO SWO catch.

Data and Assessment

Catch and size composition data were collected from ISC Members and the WCPFC and IATTC. Standardized CPUE data used to measure trends in relative abundance were provided by Chinese Taipei, Japan, and U.S.A. The NPO SWO stock was assessed using an age- and length-structured assessment Stock Synthesis (SS3) model fit to time series of standardized CPUE and size composition data. Life history parameters for growth and maturity were updated for this benchmark stock assessment. The value for stock-recruitment steepness used for the base case model was $h = 0.9$. The assessment model was fit to relative abundance indices and size composition 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. Several sensitivity analyses were conducted to evaluate the effects of changes in model parameters, including natural mortality rate at age, stock-recruitment steepness, growth curve parameters, and female length at 50% maturity, as well as uncertainty in the input data and model structure.

Biological Reference Points

MSY-based biological reference points were computed for the base case model with SS3 (Table 2). The point estimate of annual catch at F_{MSY} was calculated to be 14,924 t. The point estimate of the spawning biomass to produce MSY (adult female biomass) was 16,388 t. The point estimate of F_{MSY}, the fishing mortality rate to produce SSB_{MSY} (average fishing mortality on ages 1 – 10) was 0.18 yr^{-1} and the corresponding equilibrium value of spawning potential ratio at SSB_{MSY} was 19%.

Projections

Stock projections for NPO SWO were conducted using SS3. No recruitment deviations nor log-bias adjustment were applied to the future projections. Projections are reported as the mean and standard deviation around 100 bootstrapped model runs for each scenario. 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 five years; (2) $F_{(2008\text{-}2010)}$, which is average F for the reference years in 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).

Discussion

The ISC23 Plenary endorsed the NPO SWO assessment and considers it to be the best available scientific information for the stock.

6.5.2 Stock Status and Conservation Information

Stock Status

Estimates of population biomass fluctuated around an average of 80,800 t during the 1975-2021 period and was estimated to be 88,800 t in 2021 (Figure 12a). 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 (Figure 12b). Estimated F (arithmetic average of F for ages 1 – 10) decreased from 0.17 yr^{-1} in 1978 to a minimum of 0.09 yr^{-1} in 2021 (Figure 12c). 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 the 1975-2021 period. While the overall pattern of recruitment varied, there was no apparent trend in recruitment strength over time (Figure 12d). 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}. $SSB_{F=0}$, 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 ISC23 Plenary:

1. **Female spawning stock biomass was estimated to be 35,778 mt in 2021, with a relative SSB ratio of SSB/SSB_{MSY} = 2.18 in 2021;**

2. **Estimated F (arithmetic average of F for ages 1 – 10) averaged roughly F=0.09 yr^{-1} during 2019-2021 with a relative fishing mortality of F/F_{MSY} = 0.49 in 2021; and**

3. **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, Figure 13).**

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 most recent five years, (2) $F_{(2008\text{-}2010)}$ 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 (Table 3; Figure 14, Figure 15).

Based on these future projections, the following conservation information for NPO SWO is provided by the ISC23 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 (Figure 13); and**

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

<u>Special Comments</u>

The lack of sex-specific size data and the simplified treatment of the spatial structure of swordfish population dynamics remained as two important sources of uncertainty for improving future assessments.

<u>Swordfish Catch Distribution</u>

In response to a request from the WCPFC-NC, the BILLWG used WCPFC and IATTC public domain data and yearbooks to compile NPO SWO catch and effort north and south of 20°N (Figure 16). The WG did not use 2021 data because the data sets were preliminary. Much of the SWO catch is from longlines, and only longlines are available for effort. The effort south of 20°N includes and accounts for a large proportion of the statistics for Vietnam and Indonesia. However, the longline effort for Indonesia and Vietnam has been estimated because the logbook coverage for these fleets varies substantially over time. Recently, catches by the longline fishery in the 0-10°N area of the eastern Pacific have increased. Gillnet fishing conducted in the waters around Vietnam is also responsible for the increase in catch south of 20°N.

Table 2. Estimated biological reference points derived from the Stock Synthesis base case model for North Pacific swordfish where F is the instantaneous annual fishing mortality rate, SPR is the annual spawning potential ratio, SSB is spawning stock biomass, and $SSB_{(F=0)}$ indicates the average 5-year SSB_0 estimate, $20\%SSB_{(F=0)}$ is the associated reference point, and MSY is the maximum sustainable yield reference point.

Reference Point	Estimate
$F_{20\%SSB(F=0)}$ (age 1-10)	0.16
F_{MSY} (age 1-10)	0.18
F_{2021}	0.09
$F_{2019-2021}$	0.09
$SSB_{F=0}$	95,732
$20\%SSB_{F=0}$	19,146
SSB_{MSY}	16,388
SSB_{2021}	35,778
$SSB_{2019-2021}$	34,899
$C_{20\%SSB(F=0)}$	14,815
C_{MSY}	14,924
$C_{2019-2021}$	10,653
$SPR_{20\%SSB(F=0)}$	22%
SPR_{MSY}	19%
SPR_{2021}	44%
$SPR_{2019-2021}$	43%

Table 3. Projected median values of Western and Central North Pacific swordfish spawning stock biomass (SSB, t) and catch (t) under five constant fishing mortality rate (F) and two recruitment scenarios during 2021-2040.

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Scenario 1: $F_{20\%SSB(F=0)}$										
SSB	40,457	38,288	36,295	35,452	35,425	35,611	36,064	36,387	36,264	36,478
Catch	16,906	14,986	13,531	13,120	13,298	13,612	13,875	14,053	14,161	14,220
Scenario 2: $F_{1998-2000}$										
SSB	41,567	40,422	38,952	38,309	38,371	38,565	39,133	39,534	39,336	39,625
Catch	14,302	13,389	12,608	12,428	12,656	12,967	13,224	13,399	13,509	13,572
Scenario3:LowF($F_{SPR30\%}$)										
SSB	42,268	42,368	41,811	41,756	42,235	42,712	43,610	44,300	44,162	44,705
Catch	11,370	11,249	11,096	11,255	11,623	11,990	12,263	12,445	12,557	12,631
Scenario 4: F_{MSY}										
SSB	38,291	34,051	31,164	29,979	29,800	29,894	30,225	30,452	30,322	30,473
Catch	23,395	17,817	14,992	14,169	14,264	14,565	14,812	14,966	15,052	15,095
Scenario 5: $F_{Status\ Quo}$ (Average $F_{2019-2021}$)										
SSB	38,828	35,056	32,339	31,201	31,036	31,138	31,489	31,733	31,602	31,765
Catch	21,803	17,218	14,723	13,981	14,082	14,379	14,627	14,785	14,875	14,921

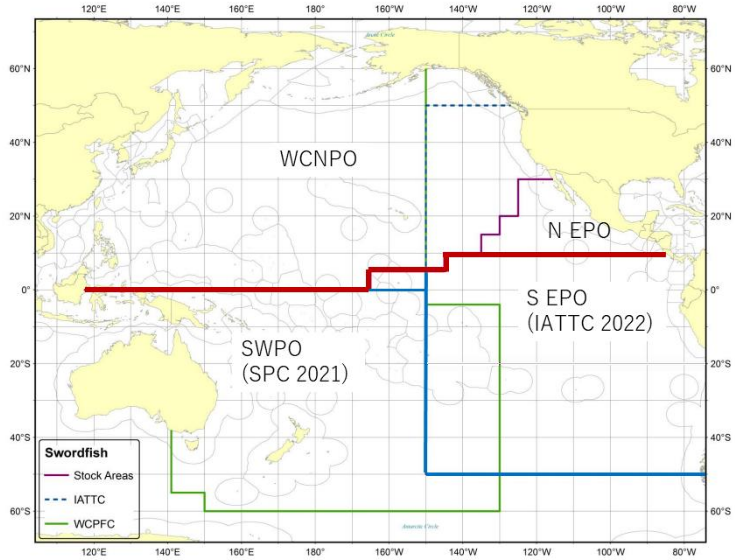


Figure 10. Swordfish stock boundaries for the 2023 NPO SWO assessment showing the Western and Central North Pacific Ocean (WCNPO) and Northeastern Pacific Ocean (N EPO) management units. Spatial structure is treated implicitly using fleets as areas. The new stock boundary for NPO SWO assessment is the area above the red line.

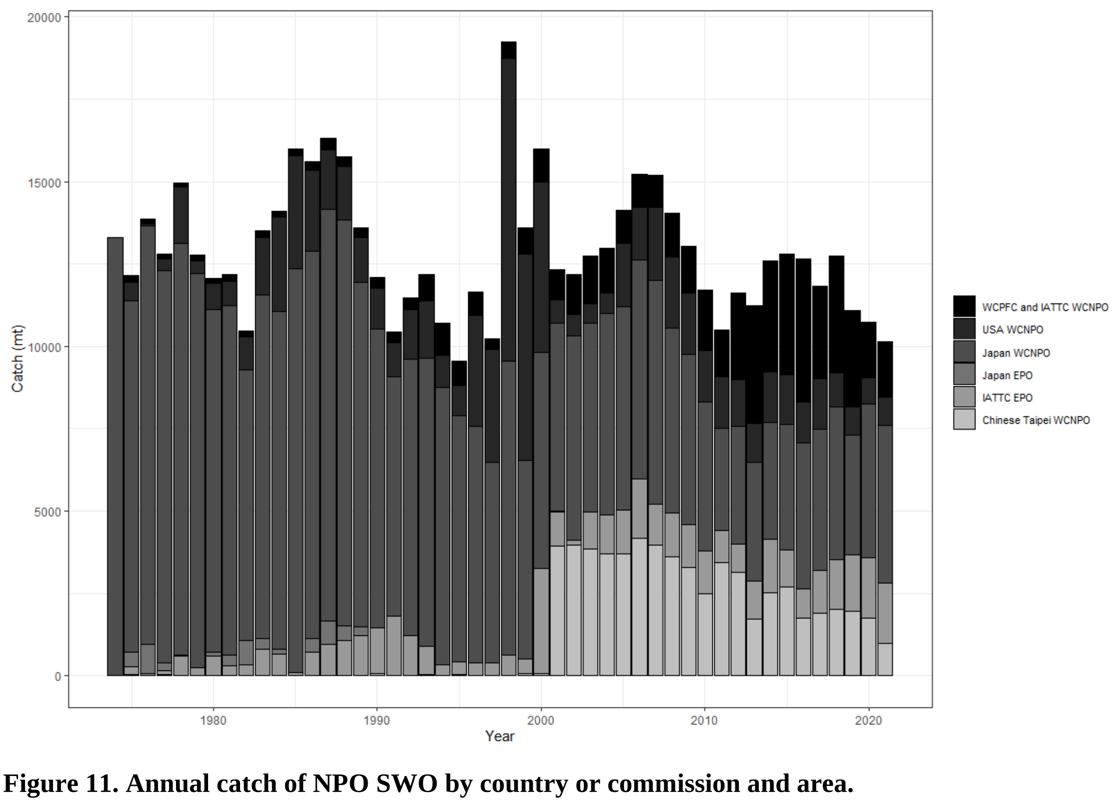


Figure 11. Annual catch of NPO SWO by country or commission and area.

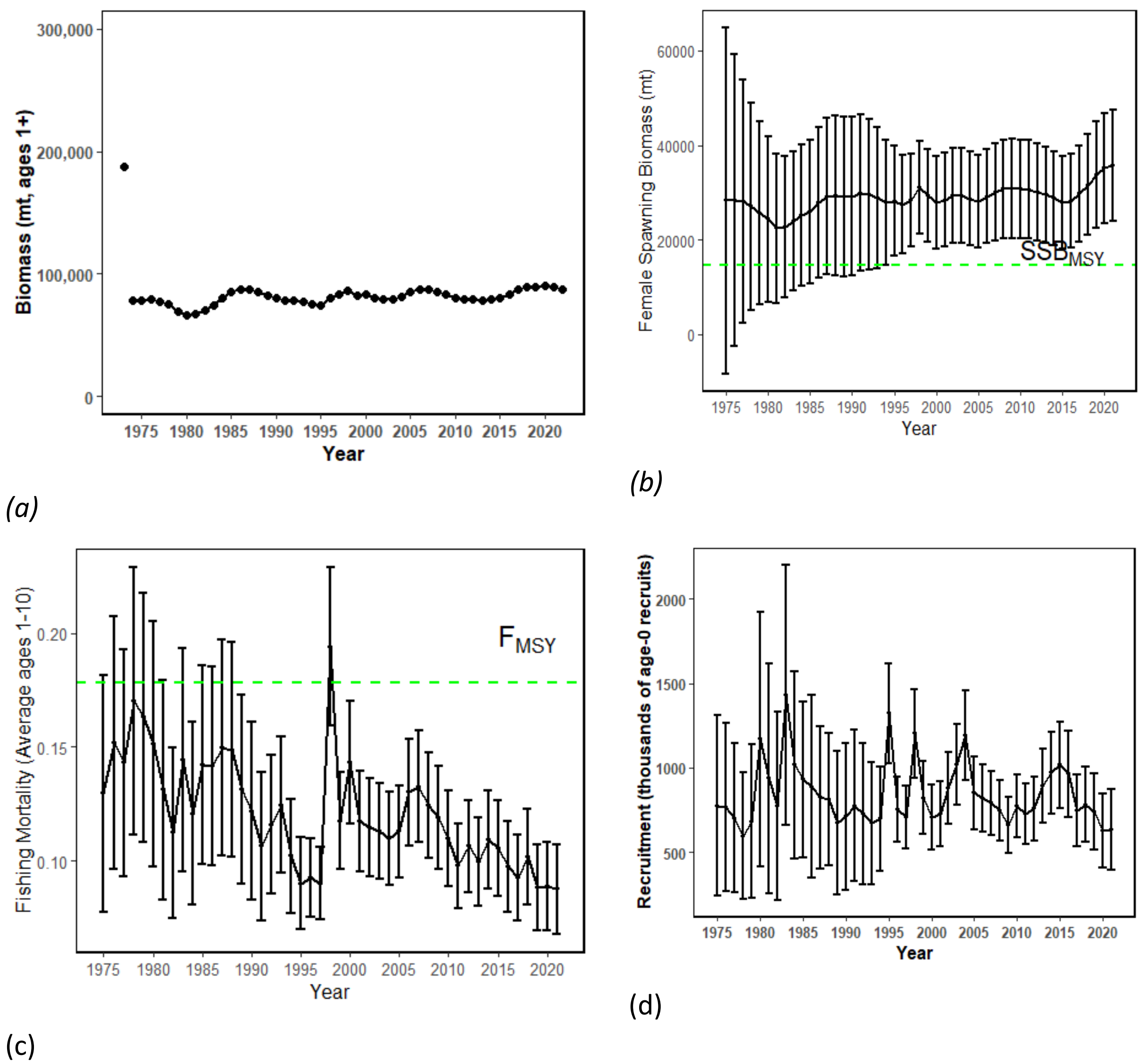


Figure 12. Time series of estimates of (a) population biomass (age 1+), (b) spawning biomass, (c) instantaneous fishing mortality (average for age 1-10, yr^{-1}), and (d) recruitment (age-0 fish) for NPO SWO (*Xiphias gladius*) derived from the 2023 stock assessment. The circles represents the maximum likelihood estimates by year for each quantity and the error bars represent the uncertainty of the estimates (95% confidence intervals), green dashed lines indicate the dynamic SSB_{MSY} and F_{MSY} reference points.

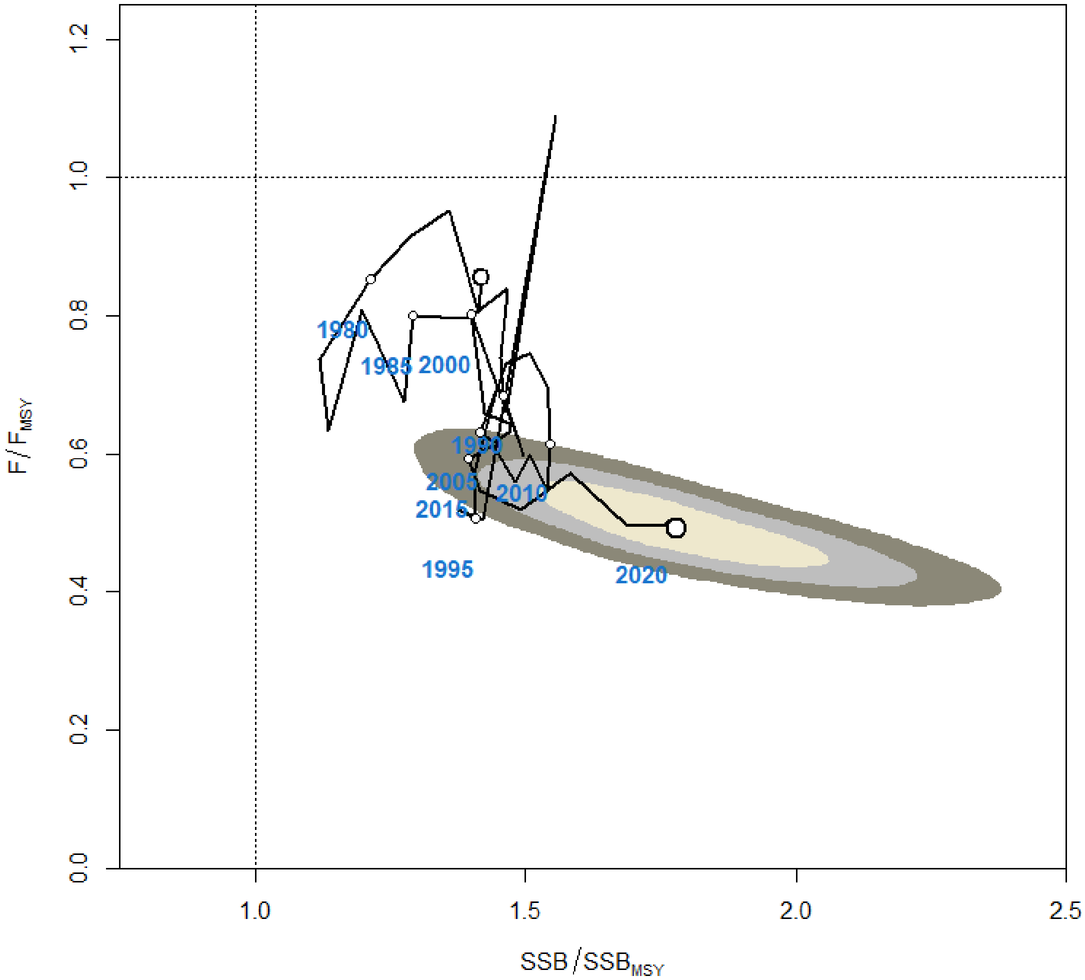


Figure 13. Kobe plot of the time series of estimates of relative fishing mortality (average of age 1-10) and relative spawning stock biomass of NPO SWO (*Xiphias gladius*) during 1977-2020. The first white dot indicates 1975, subsequent dots are in 5-year increments. Shading indicates 50%, 80%, and 95% confidence intervals, respectively.

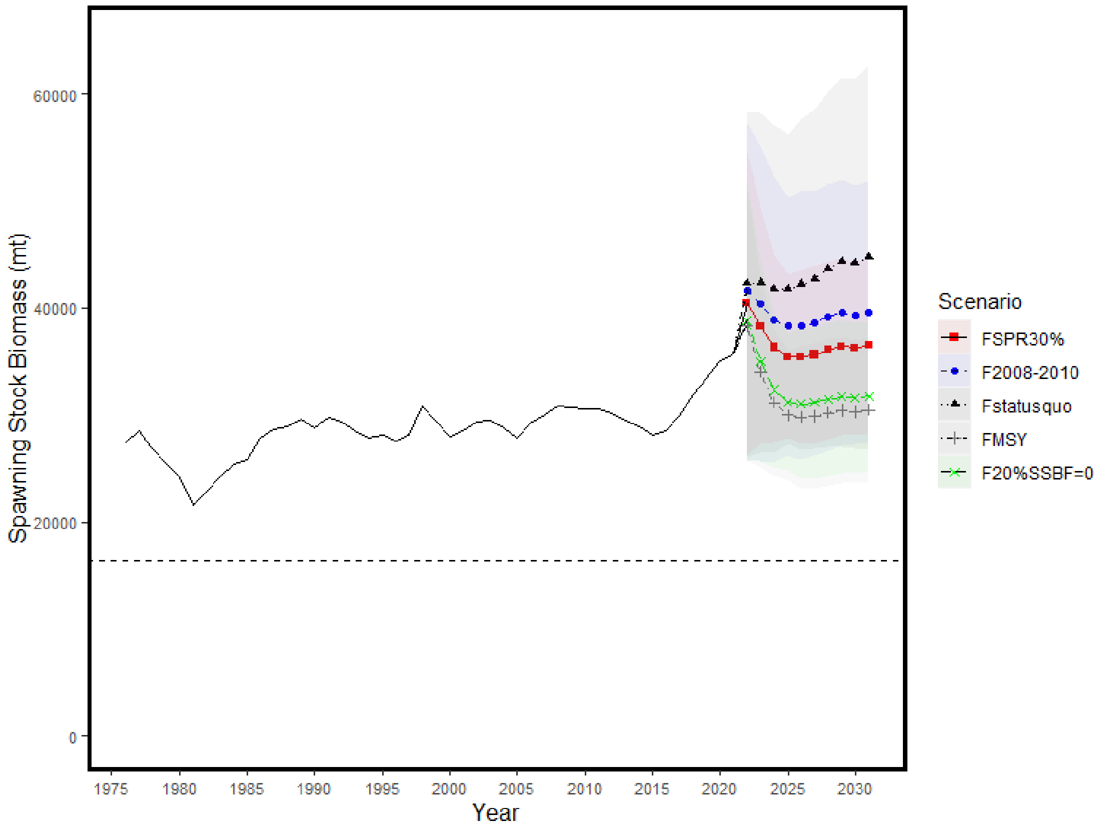


Figure 14. Historical and projected trajectories of spawning biomass from the NPO SWO base case model based upon F scenarios. Dashed line indicates the spawning stock biomass at SSB_{MSY}. The list of projection scenarios can be found in Table 3.

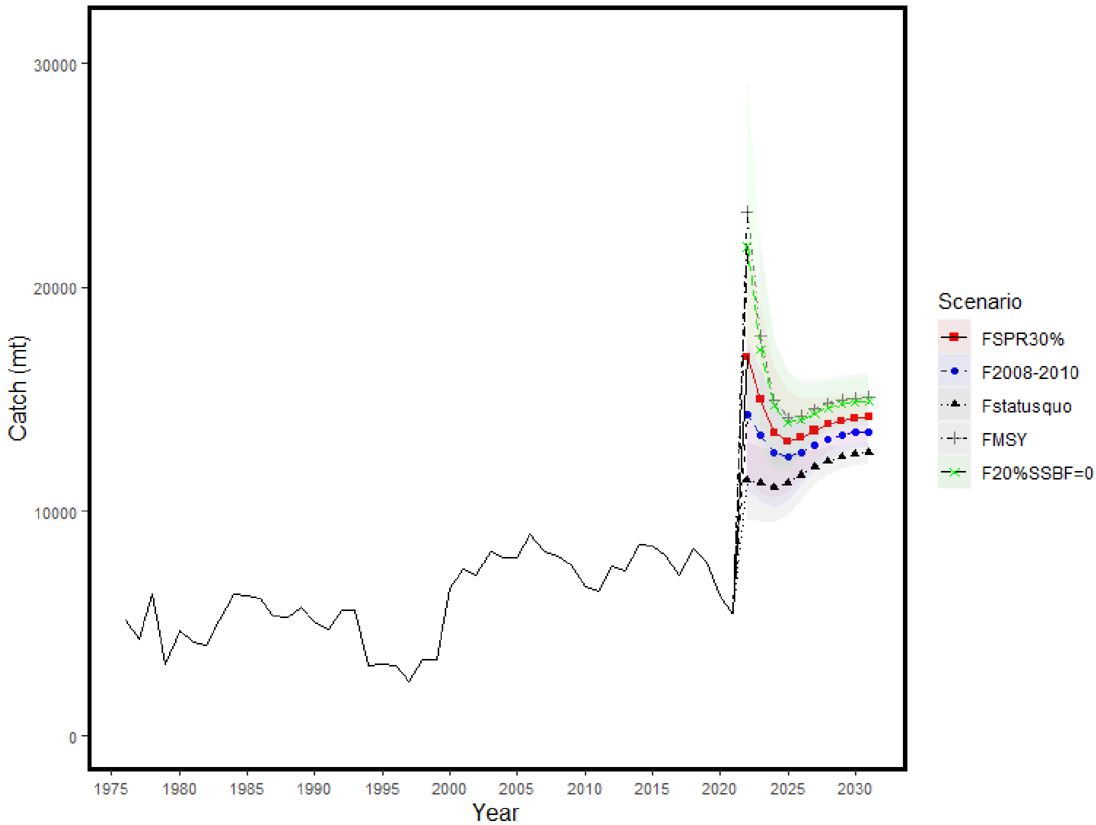


Figure 15. Historical and projected trajectories of catch from the NPO SWO base case model based upon F scenarios. The list of projection scenarios can be found in Table 3.

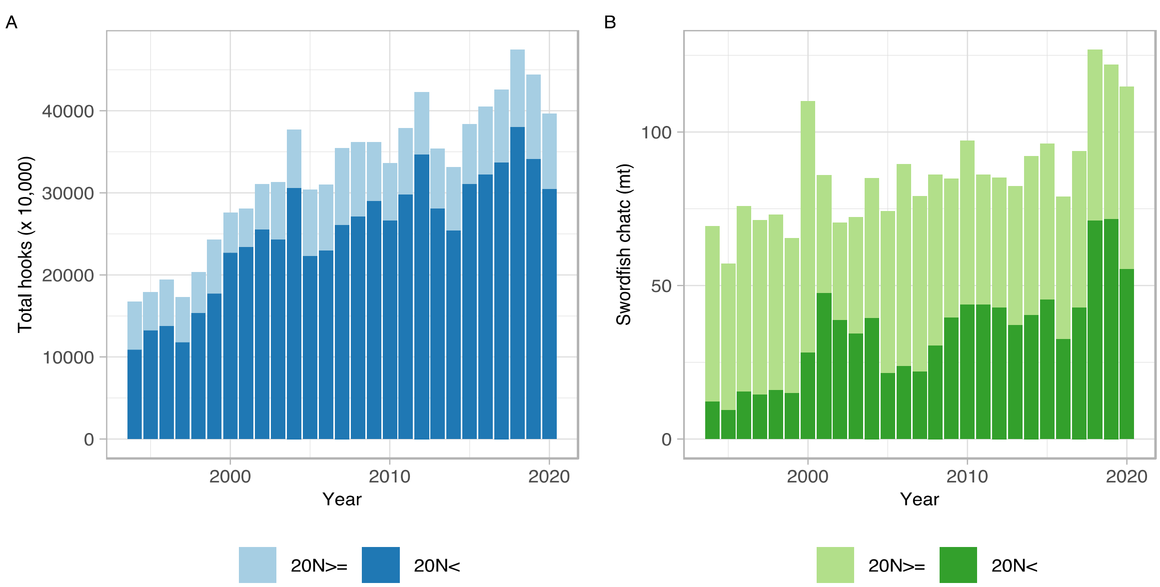


Figure 16. Distribution of fishing effort (A) and catch (B) for NPO SWO north and south of 20° N. latitude.

6.6 Pacific Blue Marlin Stock Status and Conservation Information

H. Ijima, the BILLWG Chair, noted that Pacific BUM stock was last assessed in 2021.

The Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC21 (see Section 3.3.3, pp. 25-36 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables.

Stock Status

Stock status, biomass trends, and recruitment of Pacific BUM (*Makaira nigricans*) 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 SSB_{2019} of 24,272 t is 17% above SSB_{MSY} (20,677 t, 95% C.I. -13% to +50%) and $F_{2017-2019}$ is 50% below F_{MSY} (95% C.I. 37% to 69%).

Based on these findings, the following information on the status of the WCNPO BUM stock is provided by the ISC23 Plenary:

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

2. **Female SSB 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 yr^{-1} during the 2016-2019 period, 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).**

__Conservation Information__

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 five years. Catch biomass has been declining for the last five 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 ISC23 Plenary:

1. **There is no evidence of excess fishing mortality above F_{MSY} ($F_{2016-2019}$ 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.**

__Special Comments__

1. **Uncertainty regarding the choice of BUM growth curve led to the ensemble model approach for this assessment.** The BILLWG recognized that there is considerable uncertainty in input CPUE data in the recent years and life history parameters, especially growth. The BILLWG considered an extensive suite of model formulations and associated diagnostics for developing the assessment models. Overall, the BILLWG found issues with both the new growth and old growth model diagnostics and sensitivity runs that are consistent with the presence of data conflicts, but none of the model diagnostics show that the results of either model were invalid. It is recommended model development work to reduce data conflicts and modeling uncertainties continue and that input assessment data be reevaluated to improve the time series.

2. **It is recommended that biological sampling to improve life history parameter estimates continue to be collected and ISC countries participate in the BILLWG International Biological Sampling program to improve those estimates.**

6.7 WCNPO Striped Marlin

6.7.1 Stock Assessment

H. Ijima, BILWG Chair, presented the WCNPO MLS benchmark stock assessment (**ISC/23/ANNEX/14**).

Stock Identification and Distribution

The WCNPO MLS (*Kajikia audax*) stock area was defined to be the waters of the North Pacific Ocean contained in the WCPFC Convention Area bounded by the equator and 150°W. All available fishery data from the stock area were used for the stock assessment. It was assumed that there was an instantaneous mixing of fish throughout the stock area on a quarterly basis to model observations of CPUE and size composition data.

Catches

The WCNPO MLS catches were high from the 1970s to the 1990s averaging about 7,200 t per year during 1977-1999 and have decreased to an annual average of 2,500 t during 2018-2020 (Table 4). Catches by Japanese fleets have decreased and catches from the U.S. and Chinese Taipei have varied without trend, while minor catches by other WCPFC countries have generally increased (Figure 17). Overall, longline fishing gear has accounted for the vast majority of WCNPO MLS catches since the 1990s while catches by the Japanese driftnet fleet were predominant during 1977 to 1993.

Data and Assessment

Catch and size composition data were collected from ISC countries (Chinese Taipei, Japan, and U.S.A.) and the WCPFC. Standardized CPUE data used to measure trends in relative abundance were provided by Chinese Taipei, Japan, and U.S.A. The WCNPO MLS stock was assessed using an age- and length-structured assessment Stock Synthesis (SS3) model fit to time series of standardized CPUE and size composition data. Life history parameters for growth and maturity were updated for this benchmark stock assessment. The value for stock-recruitment steepness used for the base case model was h = 0.87. The assessment model was fit to relative abundance indices and size composition 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. Several sensitivity analyses were conducted to evaluate the effects of changes in model parameters, including natural mortality rate at age, stock-recruitment steepness, growth curve parameters, and female length at 50% maturity, as well as uncertainty in the input data and model structure.

Biological Reference Points

Biological reference points were computed for the base case model with SS3. The reference points were based upon 20% of the dynamic B_0 ($SSB_{F=0}$) averaged over the last 20 years (2001-2020), which corresponds to about 4 mean generation times for WCNPO MLS. The point estimate of annual catch at the dynamic 20%$SSB_{F=0}$ was calculated to be 4,468 t. The point estimate of the spawning biomass to produce 20%$SSB_{F=0}$ (adult female biomass) was 3,660 t. The point estimate of $F_{20\%SSB(F=0)}$, the fishing mortality rate to produce 20% of $SSB_{(F=0)}$ (average fishing mortality on ages 3 – 12) was 0.53 and the corresponding equilibrium value of spawning potential ratio at 20%$SSB_{F=0}$ was 22%.

Projections

Stock projections for WCNPO-MLS were conducted using SS3.30. No recruitment deviations nor log-bias adjustment were applied to the future projections. The absolute future recruitments were based on two recruitment scenarios: the expected stock-recruitment relationship and the average recruitment in the last 20 years (2001-2020). Projections started in 2020 and continued through 2040 under 5 levels of fishing mortality and the two recruitment scenarios. The five fishing mortality stock projection scenarios were: (1) F status quo (average $F_{2018\text{-}2020}$), (2) F_{MSY}, (3) F at 20%$SSB_{F=0}$, (4) F_{High} at the highest 3-year average during 1975-2017 (1998-2000), and (5) F_{Low} at $F_{30\%}$.

Discussion

The ISC Plenary endorsed the WCNPO MLS assessment and considers it to be the best available scientific information for the stock.

6.7.2 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 (Figure 18a). 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 its 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 (Figure 18b; Table 4). 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 (Figure 18c; Table 4). It averaged roughly F=0.68 yr^{-1} during the 2018-2020 period or about 28% above $F_{20\%SSB(F=0)}$ and 8% above F_{MSY}, with a relative fishing mortality of $F/F_{20\%SSB(F=0)}$ = 1.09 in 2020 (Table 5). Fishing mortality has been above $F_{20\%SSB(F=0)}$ 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 (Figure 18d).

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 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 of 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 (Figure 18d; Table 4). 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 ISC23 Plenary:

1. **When the status of WCNPO MLS is evaluated relative to dynamic $20\%_{SSB(F=0)}$ 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 $F_{20\%SSB(F=0)}$ (Table 5); 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; Figure 19).**

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 (Table 6) and the ten catch levels with only the 20-year average recruitment scenario (Table 7) 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 (Table 6 and Table 7; **Error! Reference source not found.** and Figure). 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 $F_{20\%SSB(F=0)}$ (Figure 20a). 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 $F_{20\%SSB(F=0)}$ 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 (Figure 20c).

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 (Figure 18d). 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 ISC23 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 projection 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).**

Special Comments

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 (Figure ; 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. The high seas drift net catch data are highly uncertain owing to limited record availability, the estimation of life history parameters, such as growth, from limited data, and the mixing of the stock 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.

Table 4. Reported catch (t) used in the stock assessment along with annual estimates of population biomass (age-1 and older, t), female spawning biomass (t), relative female spawning biomass ($SSB/20\%SSB_{F=0}$), recruitment (thousands of age-0 fish), fishing mortality (average F, ages-3 – 12), relative fishing mortality ($F/F_{20\%SSB(F=0)}$), and spawning potential ratio of Western and Central North Pacific striped marlin.

Year	2014	2015	2016	2017	2018	2019	2020	Mean[1]	Min[1]	Max[1]
Reported Catch	2,745	3,272	2,456	2,256	2,177	2,695	2,412	5,383	2,177	10,912
Population Biomass	7,142	6,476	5,944	5,506	5,316	6,831	7,339	11,283	5,316	19,463
Spawning Biomass	1,142	1,293	1,305	1,238	1,223	1,158	1,696	2,266	1,081	5,118
Relative Spawning Biomass	0.31	0.35	0.35	0.33	0.33	0.31	0.46	0.61	0.29	1.38
Recruitment (age 0)	102,169	196,286	138,584	150,045	299,538	215,884	263,519	366,217	89,526	711,480
Fishing Mortality	0.77	0.91	0.70	0.74	0.69	0.77	0.58	0.89	0.53	1.42
Relative Fishing Mortality	1.46	1.70	1.31	1.39	1.30	1.45	1.09	1.67	1.00	2.67
Spawning Potential Ratio	0.14	0.11	0.16	0.16	0.16	0.14	0.20	0.13	0.06	0.23

3. [1] During 1977-2020

Table 5. Estimates of biological reference points along with estimates of fishing mortality (F), spawning stock biomass (SSB), recent average yield (C), and spawning potential ratio (SPR) of WCNPO MLS, derived from the base case model assessment model, where $SSB_{F=0}$ indicates the average 20-year dynamic B_0 estimate, $20\%SSB_{F=0}$ is the associated reference point, and MSY indicates the maximum sustainable yield reference point.

Reference Point	Estimate
$F_{20\%SSB(F=0)}$ (age 3-12)	0.53
F_{MSY} (age 3-12)	0.63
F_{2020} (age 3-12)	0.58
$F_{2018-2020}$	0.68
$SSB_{F=0}$	18,300 t
$20\%SSB_{F=0}$	3,660 t
SSB_{MSY}	2,920 t
SSB_{2020}	1,696 t
$SSB_{2018-2020}$	1,359 t
$C_{20\%SSB(F=0)}$	4,468 t
MSY	4,512 t
$C_{2018-2020}$	2,428 t
$SPR_{20\%SSB(F=0)}$	22%
SPR_{MSY}	18%
SPR_{2020}	20%
$SPR_{2018-2020}$	17%

Table 6. Projected median values of WCNPO MLS spawning stock biomass (SSB, t) and catch (t) under five constant fishing mortality rate (F) and two recruitment scenarios during 2021-2040. For scenarios which have a 50% probability of reaching the target of 20%$SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion. Note that 20%$SSB_{F=0}$ is 3,660 t.

Year	2021	2022	2023	2024	2025	2030	2040	Year when target achieved
Scenario 1: $F_{20\%SSB(F=0)}$, F_{Btgt}; Stock – Recruitment Curve								
SSB	2084	2412	2775	3071	3275	3620	3658	NA
Catch	2624	3041	3461	3803	4039	4426	4468	
Scenario 2: Highest F (Average $F_{1998-2000}$); Stock – Recruitment Curve								
SSB	2032	2217	2464	2663	2796	3017	3043	NA
Catch	3080	3386	3729	3997	4174	4461	4494	
Scenario 3: Low F ($F_{30\%}$); Stock – Recruitment Curve								
SSB	2390	3059	3758	4367	4825	5675	5783	2024
Catch	1807	2293	2770	3177	3477	4009	4072	
Scenario 4: F_{MSY}; Stock – Recruitment Curve								
SSB	2062	2369	2712	2991	3182	3504	3540	NA
Catch	2685	3090	3502	3836	4064	4439	4481	
Scenario 5: $F_{Status\ Quo}$ (Average $F_{2018-2020}$); Stock – Recruitment Curve								
SSB	2026	2291	2593	2837	3005	3289	3322	NA
Catch	2795	3170	3550	3854	4062	4406	4445	
Scenario 6: $F_{20\%SSB(F=0)}$, F_{btgt}; 20-year Average Recruitment								
SSB	2084	2343	2411	2392	2371	2351	2351	NA
Catch	2623	2886	2952	2924	2896	2871	2871	
Scenario 7: Highest F (Average $F_{1998-2000}$); 20-year Average Recruitment								
SSB	2032	2149	2130	2077	2046	2023	2022	NA
Catch	3080	3182	3131	3056	3014	2986	2986	
Scenario 8: Low F ($F_{30\%}$); 20-year Average Recruitment								
SSB	2390	2979	3296	3414	3456	3483	3484	NA
Catch	1806	2177	2368	2430	2447	2453	2454	
Scenario 9: F_{MSY}; 20-year Average Recruitment								
SSB	2062	2301	2355	2331	2308	2287	2287	NA
Catch	2684	2932	2987	2952	2921	2895	2895	
Scenario 10: $F_{Status\ Quo}$ (Average $F_{2018-2020}$); 20-year Average Recruitment								
SSB	2026	2225	2254	2220	2194	2171	2171	NA
Catch	2794	2996	3016	2968	2932	2905	2905	

Table 7. Projected median values of WCNPO MLS spawning stock biomass (SSB, t) under ten constant catches with low recruitment scenarios during 2021-2040. For scenarios that have a 50% probability of reaching the target of 20%$SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion. Note that 20%$SSB_{F=0}$ is 3,660 mt.

Year	2021	2022	2023	2024	2025	2030	2040	Year when target achieved
Scenario 11: No catch; 20-year Average Recruitment								
SSB	3,097	4,809	6,370	7,587	8,486	10,304	10,644	2022
Scenario 12: 500 mt catch; 20-year Average Recruitment								
SSB	2,907	4,350	5,639	6,629	7,358	8,858	9,159	2022
Scenario 13: 1,000 mt catch; 20-year Average Recruitment								
SSB	2,719	3,892	4,915	5,679	6,236	7,405	7,660	2022
Scenario 14: 1,500 mt catch; 20-year Average Recruitment								
SSB	2,537	3,454	4,213	4,771	5,160	5,986	6,182	2023
Scenario 15: 2,000 mt catch; 20-year Average Recruitment								
SSB	2,361	3,030	3,540	3,874	4,106	4,607	4,738	2024
Scenario 16: 2,300 mt catch; 20-year Average Recruitment								
SSB	2,258	2,783	3,152	3,368	3,509	3,809	3,895	2026
Scenario 17: 2,400 mt catch; 20-year Average Recruitment								
SSB	2,224	2,703	3,026	3,204	3,316	3,551	3,619	NA
Scenario 18: 2,500 mt catch; 20-year Average Recruitment								
SSB	2,190	2,623	2,901	3,042	3,126	3,297	3,347	NA
Scenario 19: 3,000 mt catch; 20-year Average Recruitment								
SSB	2,026	2,238	2,303	2,274	2,230	2,104	2,058	NA
Scenario 20: 3,500 mt catch; 20-year Average Recruitment								
SSB	1,868	1,881	1,779	1,631	1,505	1,202	1,083	NA

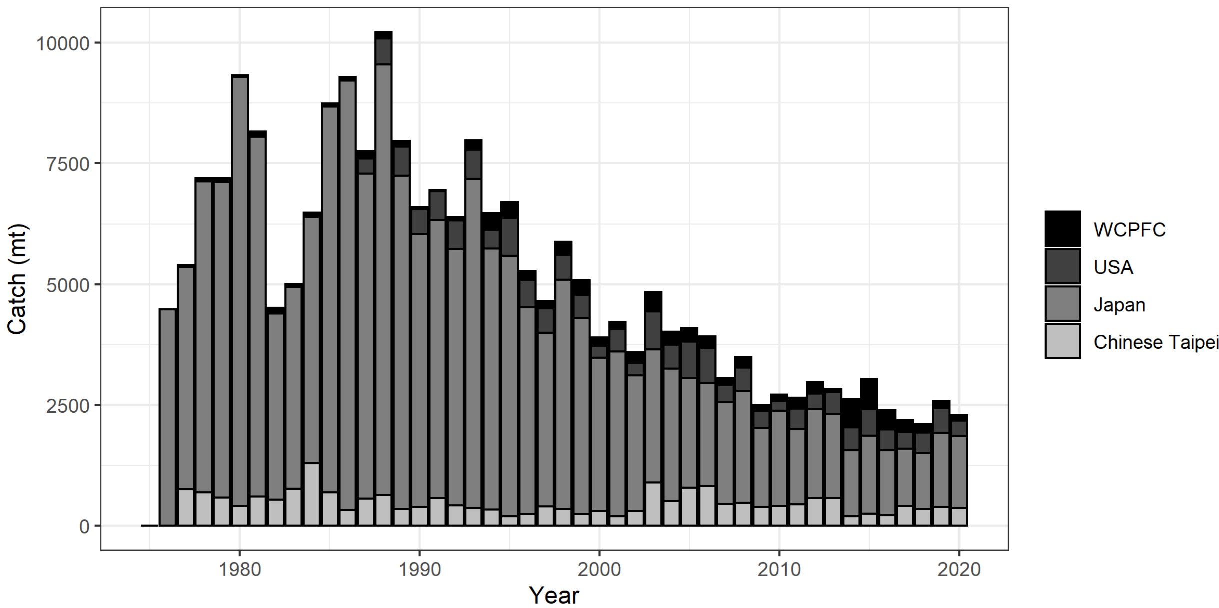


Figure 17. Annual catch biomass (t) of WCNPO MLS (*Kajikia audax*) by country for Japan, Chinese Taipei, the U.S.A., and all other countries during 1977-2020.

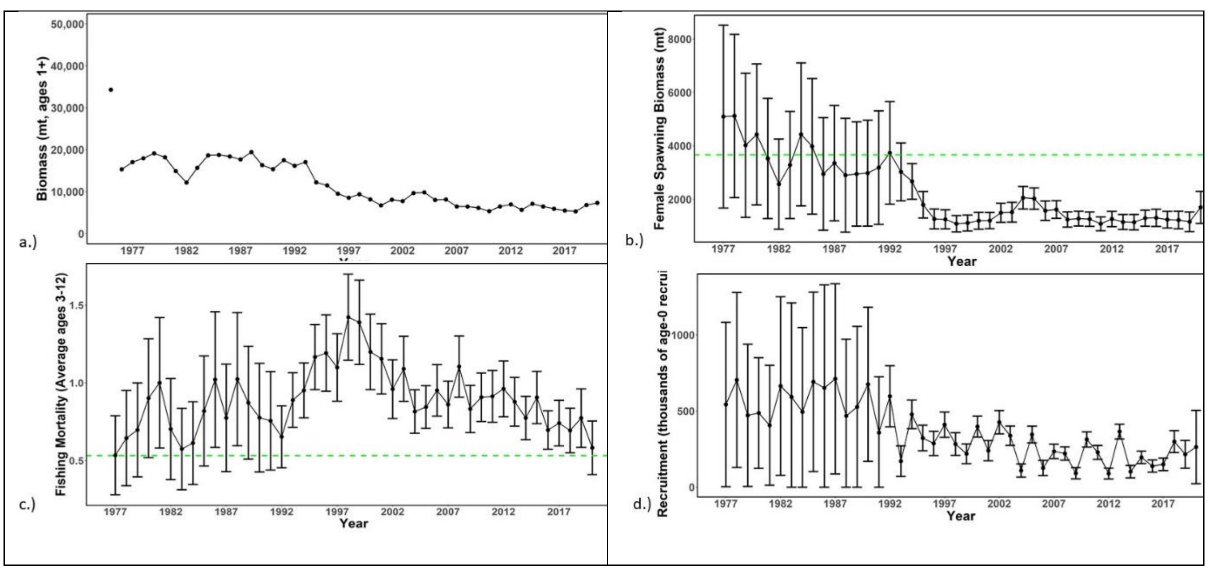


Figure 18. Time series of estimates of (a) population biomass (age 1+), (b) spawning biomass, (c) instantaneous fishing mortality (average for age 3-12, year^{-1}), and (d) recruitment (age-0 fish) for WCNPO MLS (*Kajikia audax*) derived from the 2023 stock assessment. The circles represents the maximum likelihood estimates by year for each quantity and the error bars represent the uncertainty of the estimates (95% confidence intervals), green dashed lines indicate the dynamic 20%$SSB_{F=0}$ and $F_{20\%SSB(F=0)}$ reference point.

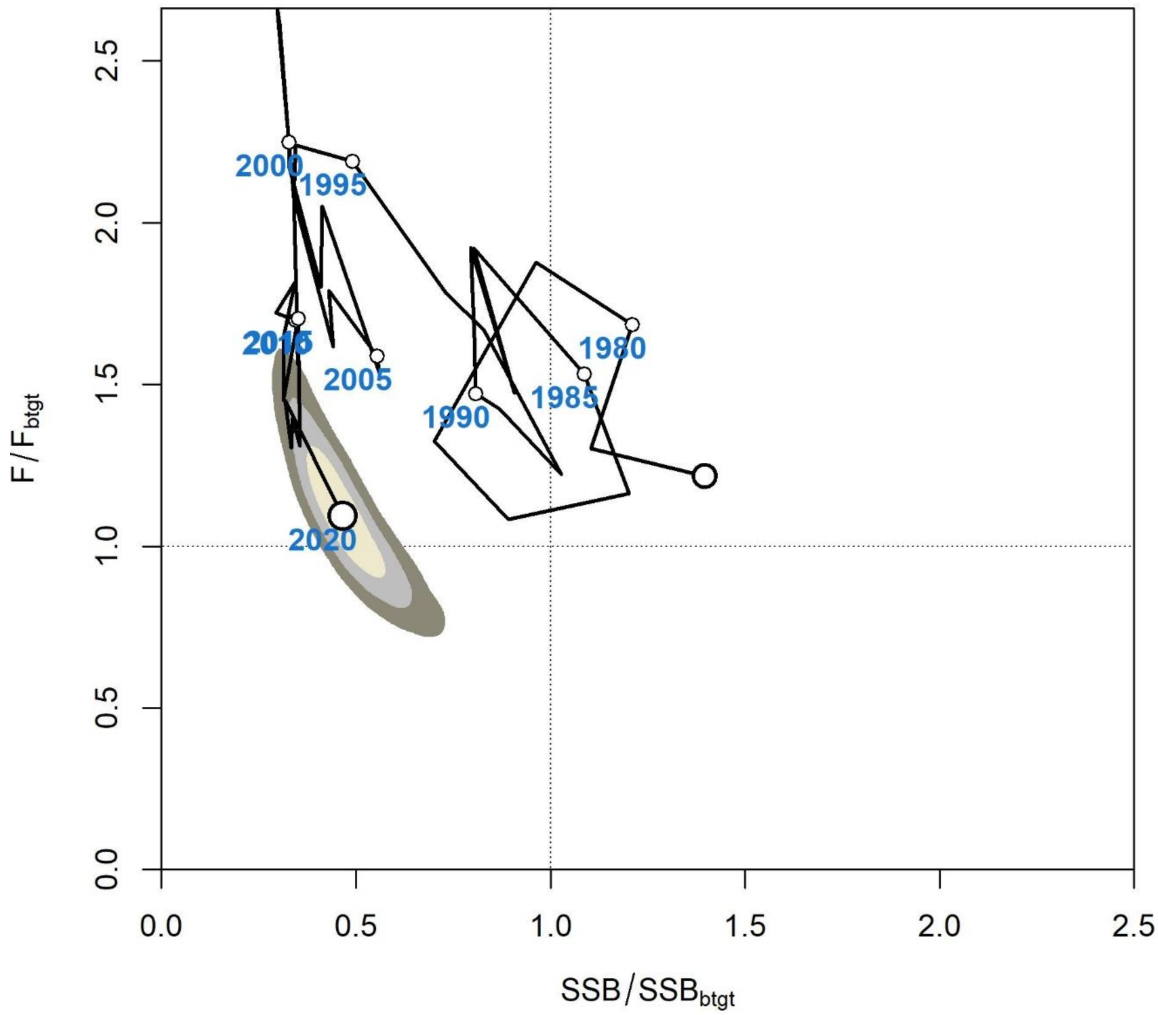


Figure 19. Majuro plot of the time series of estimates of relative fishing mortality (average of age 3-12) and relative spawning stock biomass of WCNPO MLS (*Kajikia audax*) during 1977-2020. F_{btgt} and SSB_{btgt} refer to $F_{20\%SSB(F=0)}$ and $20\%SSB_{F=0}$, respectively. The first white dot indicates 1977, subsequent dots are in 5-year increments. Shading indicates 50%, 80%, and 95% confidence intervals, respectively.

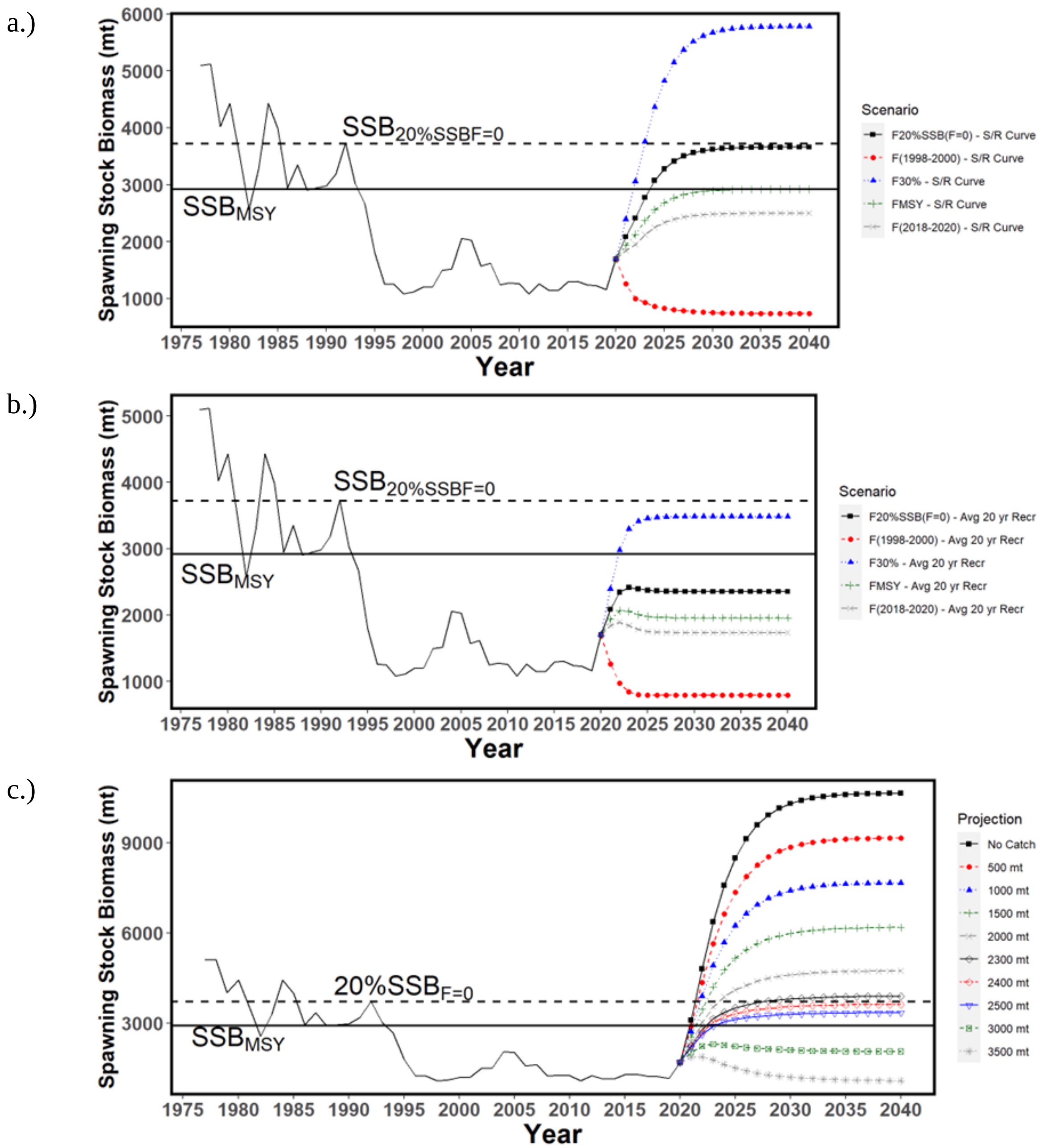


Figure 20. Historical and projected trajectories of spawning biomass from the WCNPO MLS base case model based upon: (a) F scenarios projected spawning biomass using recruitment estimated from the stock-recruitment curve; (b) F scenarios projected spawning biomass using average recruitment from 2001-2020. (c) Catch scenarios projected spawning biomass using average recruitment from 2001-2020. Dashed line indicates the spawning stock biomass at the dynamic 20%$SSB_{F=0}$ reference point. Solid line indicates the spawning stock biomass at SSB_{MSY}. The list of projection scenarios can be found in Tables 6 and 7.

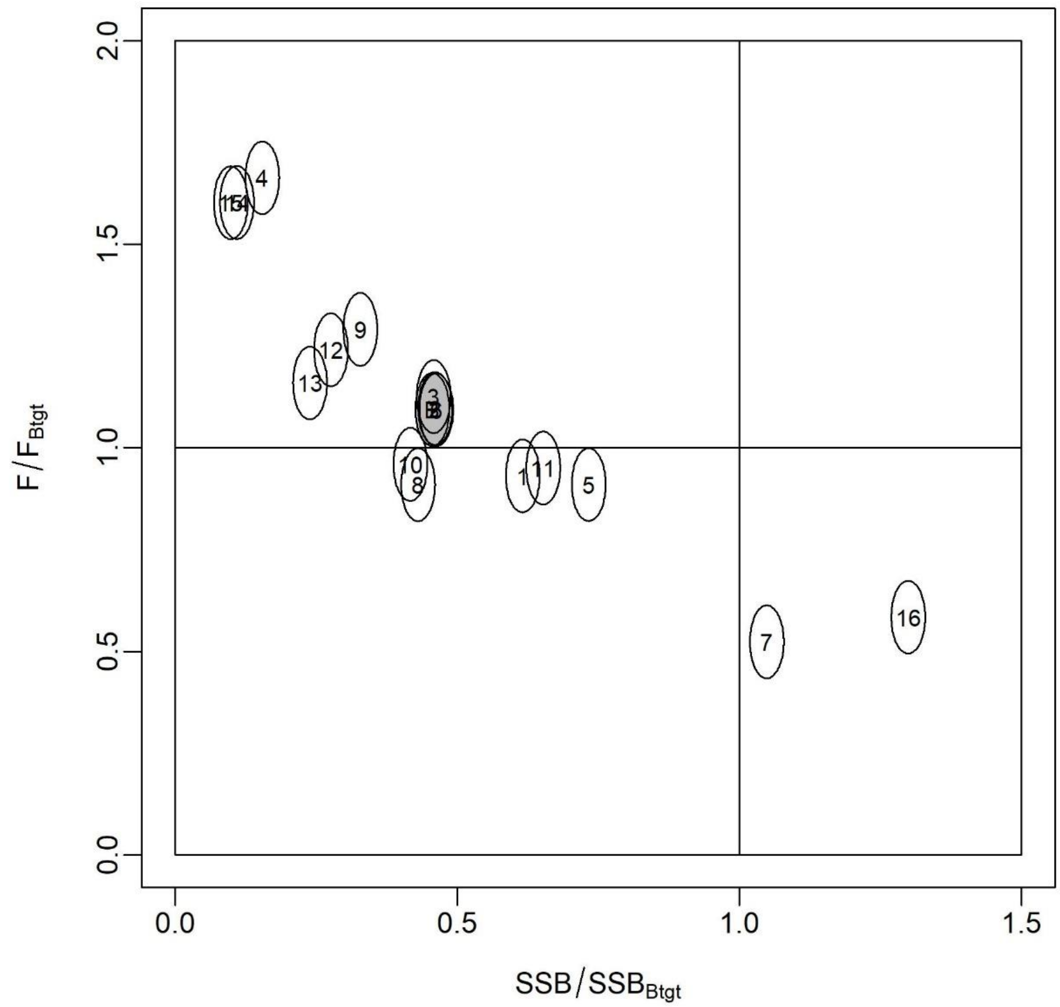


Figure 21. Majuro plot showing the terminal year stock status for the base-case model (gray circle, B) and the 16 sensitivity runs used to evaluate the sensitivity of the model to various model assumptions. Models 12, 13, 15, and 16 are all sensitivity runs on assumptions on growth. See Table 12 in the stock assessment report (ISC/23/ANNEX/14) for the full list and description of the sensitivity runs.

7 ENSEMBLE MODEL APPROACHES FOR PRESENTING UNCERTAINTY

H. Kiyofuji presented an overview of WCPFC Project 113, *Further development of ensemble model approaches for presenting stock assessment uncertainty*. The following summary is drawn from the report of this project, which will be presented to the SC19 meeting in Koror, Palau, August 16-24, 2023.

Model weighting is a central issue in stock assessments because the retention or rejection of models, as well as relative weights given to models and their respective uncertainties can strongly affect quantities measuring risk of available management options. There are no explicit terms of reference currently in the WCPFC that guide the development and subsequent weighting of model ensembles. Consequently, a range of approaches for developing stock assessment models and model ensembles have been employed, ranging from single base-case stock assessments with relatively few key sensitivities to grid-based ensembles with a large number of models. Other assessments employed intermediate approaches that consider a more limited number of models.

Work for WCPFC project 113 aimed to provide both general and specific review components, in order to develop recommendations about the presentation of stock assessment and management advice uncertainty by the WCPFC scientific committee. The terms of reference for the general review were to:

1. Review and summarize the various approaches used for characterizing uncertainty in WCPFC stock assessments for tuna, billfish, and sharks over the last 5 years;
2. Describe how uncertainty was communicated in the context of management risks and its influence on decision-making processes used by the WCPFC; and
3. Comment on the suitability of the recent approaches to characterizing uncertainty for the management systems, including the harvest strategy approach.

The specific review aimed to:

1. Critically review the ensemble approach that was applied for the 2021 southwest Pacific Ocean swordfish assessment (SC17-SA-WP-04, Ducharme-Barth et al. 2023)[5] to capture both 'structural' and 'estimation' uncertainty;
2. Conduct a similar review of the approaches used in SC18-SA-WP-03 (Report on WCPFC Project 107b: Improved stock assessment and structural uncertainty grid for Southwest Pacific BSH); and
3. Considering the above reviews, provide recommendations for model ensemble construction, model retention, and weighting of models included within ensembles in the context of the WCPFC tuna, billfish, and shark assessments.

The expected outcomes for the project were to:

1. Provide a basis for stock assessment teams to better consider and apply alternative approaches for characterizing stock assessment uncertainty (including model selection and weighting) across the WCPFC tuna, billfish, and shark assessments;
2. Provide guidance to the Scientific Committee (SC) on the approaches for capturing assessment uncertainty in the provision of management advice; and
3. Ultimately provide managers and stakeholders with a better understanding of the implications of alternative approaches to characterizing uncertainty for their perceptions of risk.

[5] Ducharme-Barth, N.D., and Vincent, M.T. 2023. Focusing on the front end: A framework for incorporating uncertainty in biological parameters in model ensembles of integrated stock assessments. Fish. Res. 255, 106452.

Given these terms of reference, the two most recent assessments for all stocks considered by the WCPFC SC were reviewed using a structured approach. The review focused on the stock status and management advice as provided by SC. It considered how uncertainty was addressed through the use of ensembles and sensitivities, and whether these were ultimately used in management advice. In addition to the review, the project team conducted discussions with SPC and ISC working groups, in order to better understand the rationale for approaches to dealing with stock assessment uncertainty.

While there were clear and long-standing differences between the ISC and SPC approaches to dealing with stock assessment uncertainty, the project team also noted a recent rapprochement of approaches. While ISC working groups have traditionally presented a single base-case model with various levels of uncertainty for management advice, recent management advice from ISC assessments (e.g., NPO BSH, Pacific BUM) included a more explicit consideration of alternative models and estimation uncertainty, i.e., an ensemble model approach. Conversely, SPC assessments had previously employed a sometimes-large number of models in "structural uncertainty grids," without explicit consideration for a single best model, often considering all models in the grid equally plausible. However, more recent assessments have attempted to constrain these model grids to sets of plausible models and have explored metrics to weight models.

While there is currently no best practice identified to weight models, or to deal with uncertainty in stock assessment more broadly, a useful middle-ground may nevertheless exist where uncertainty is explicitly acknowledged and explored, and reporting is standardized to allow consistent management advice with respect to the uncertainties considered for each assessment. In order to illustrate some of our observations and recommendations, a set of simulations was set up. The simulation setup was designed to illustrate and highlight differences in approaches to uncertainty characterization, rather than to be a realistic representation of typical stock assessments.

On the basis of our reviews and simulations, we developed a set of recommendations relating to the use of model ensembles for management advice, as well as the communication of assessment uncertainty.

Ensembles:

1. Develop joint priors and explicit rationales for grid axes AND their values;
2. Either draw from, or weight prior axes over parameters according to the joint prior. Prior probabilities for structures can be considered prior plausibility of data or model structures exists);
3. Include parameter and estimation uncertainty when considering management advice (MA);
4. Where possible, express priors for model outcome space to avoid *post-hoc* selection/weighting. Where *post-hoc* weighting is necessary (unexpected outcomes), it should be proposed by analysts - while the decision to accept ensembles still lies with SC, SC should not construct alternative grids "on the fly;" and

5. It should be clear what uncertainties the grids address - suggest a clearer terminology around uncertainty (see next set of recommendations).

Communicating uncertainty

1. Develop a template for reporting management advice and uncertainties (see NZ plenary, ICES advice);

2. Agree on terminology and a set of required measures (ideally probabilities relative to reference points); and

3. Clear communication about quality of information determining stock status (SS) and MA;

    a. Qualification and quantification of uncertainties:

        i. Data quality,

        ii. Model/population - structural uncertainty (note the use of "structural" here refers to models with different likehoods, rather than different parameter values), and

        iii. Key parameters (parameter and estimation uncertainty),

    b. Key uncertainties and potential impacts; and

    c. Standardized table format to help managers easily key in on key quantities (working on example);

With respect to the third recommendation, develop research/workplans to address key uncertainties.

<u>Discussion</u>

After hearing the presentation, the ISC23 Plenary recommended that following presentation of this review to the WCPFC SC19 meeting in August 2023, the ISC develop recommendations for the presentation of uncertainty and associated management advice consistent with those adopted by the WCPFC SC.

8 CLIMATE CHANGE CONSIDERATIONS

The ISC has been tasked with considering how to incorporate climate change advice into its management recommendations by NC19. The ISC Chair proposed that ISC intersessionally develop a plan to address this task, which then can be considered at ISC24. He suggested this could be accomplished through the preparation of a "strengths/weaknesses/opportunities/threats" (SWOT) analysis. Plenary recommended that Members include information on climate change research in their national reports for ISC24 in a section summarizing domestic efforts to address climate change effects in their fishery management processes. The Plenary tasked the ISC Chair with contacting other scientific organizations/RFMOs to compile information on their approach to climate change. Based on this information, a discussion at ISC24 will occur to begin developing a climate change framework for ISC stock assessments and management information.

9 PEER REVIEW OF ISC STOCK ASSESSMENTS

E. Crigler (U.S.A.) reviewed the revised proposal put forward by the U.S.A. for a peer review process for ISC stock assessments (**ISC/23/PLENARY/10**).

Previous ISC Plenary discussions centered on whether the review process should occur before or after Plenary. The former timing means that the peer review would contribute to a Plenary decision on whether an assessment should be used to provide management advice. The latter timing would facilitate ongoing improvement of assessments. For a variety of reasons, including the timing of assessments and the Plenary, a post-Plenary review process was deemed more appropriate, and therefore, the goal of these reviews is to seek feedback on improvements to ISC stock assessments.

The Plenary also discussed the composition of the peer review panel in terms of prior involvement with ISC, speaking to the concept of "independent review." Fully independent reviewers (e.g., drawn for NOAA's Center for Independent Experts) would incur a financial cost while agency personnel from Members would only incur an in-kind cost borne by that Member. The Plenary also considered the use of WGs members not involved in the stock assessment. The Plenary concluded that any review panel should include at least one fully independent member, but other panelists could be drawn from Member agencies or WG members not involved in the assessment under review.

The ISC Chair noted that not all process issues can be resolved without conducting a pilot run, with lessons learned contributing to refinement of the process for future reviews. He suggested that the WCNPO MLS assessment be the subject of the first review under this process as recommended by the BILLWG. Not every assessment needs to be subject to peer review, but over time reviews should cover the range of species the ISC assesses. The Plenary would make the final decision on what assessments should be subject to peer review, based on recommendations from the WGs.

The ISC23 Plenary adopted the U.S. proposal and agreed to apply it to the WCNPO MLS assessment, with the proviso that the review would start when funding is secured. Further work by the Vice Chair and the WGs will be necessary to implement the process and determine the financial commitment that will be required to complete the review.

The ISC will post the approved peer review process on its website.

10 FORMALIZATION OF ISC

The ISC Chair briefly reviewed past Plenary discussions of this topic, which date back to at least 2012. Members noted the significant procedural barriers domestically to acceding to a formal instrument such as a memorandum of understanding (MOU). Despite the challenges associated with a more formal arrangement, Plenary recognized clear benefits such as the establishment of a permanent secretariat and more robust participation by Members. The concept of a more achievable, less formal instrument emerged. This instrument could be in the form of a letter of commitment from domestic agency heads. Members were asked to investigate whether their domestic agencies have entered into any less formal arrangements that could serve as a model for the ISC.

11 DRAFT ISC-NORTH PACIFIC FISHERIES COMMISSION MEMORANDUM OF UNDERSTANDING

The Plenary reviewed the draft ISC-North Pacific Fisheries Commission (NPFC) memorandum of understanding (MOU) (**ISC/23/PLENARY/12**) and had an initial discussion of the contents. The NPFC Executive Secretary described the genesis of the proposed MOU, noting that the NPFC has concluded MOUs with several other RFMOs. He emphasized that it would be a non-binding instrument in terms of any commitment of human or financial resources.

Given concerns raised about some of the draft language, the Chair asked that each Member, through its head of delegation, provide him with comments and edits on the draft text according to a schedule he will set. The Chair and the NPFC Executive Secretary will then prepare a revised draft of the MOU for further review and potential adoption at ISC24.

12 REVIEW OF STATISTICS AND DATABASE ISSUES

12.1 STATWG Report

F. Carvalho, the STATWG Chair, reviewed activities in the 2022-2023 workplan adopted at ISC22. Seven of the eight items of the workplan were completed in the past year. The uncompleted item is:

- The STATWG Steering Group will hold an intersessional meeting or conference call/webinar January 2023 to conduct work to complete this work plan.

The STATWG members agreed there is an ongoing need for the STATWG with functions of (1) maintaining the ISC database and the quality of data submitted by members; (2) maintaining the proper function of ISC website; and (3) internal data sharing and developing protocols for answering external data requests. Although these functions were partially performed by the DA, the STATWG is responsible for overseeing these functions and providing a link to the ISC Plenary as well as recommending appropriate actions when needed, with collective efforts by all members and chairs of all species WGs.

The STATWG held elections for Chair and Vice Chair. Jenny Suter (U.S.A.) was elected Chair, and Kirara Nishikawa (JPN) was elected Vice Chair.

The STATWG members developed the following work plan for 2023-2024:

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, 2023. 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, 2023;

2. The DA will continue to archive stock assessment files from all 2021-2022 ISC assessments, which are required to be submitted by Chairs of species WG by November 1, 2023;

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, 2023. For 2022-2023, the DA will continue to distribute the WG member's new metadata by March 30, 2024. The Data Correspondents will review and update their new metadata by July 1, 2024, prior to the ISC24 Plenary, and this new metadata will be published on the ISC researcher's website by August 31, 2024;

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. The STATWG Steering Group will hold an intersessional meeting or conference call/webinar January 2024 to conduct work to complete this work plan; and

The STATWG will develop a protocol to store the historical observer data and effort data from the high seas large mesh and squid drift gillnet fisheries. The STATWG will collaborate with WGs using these data in the development of metadata describing how the uncertainties in these data sets are interpreted by the ISC and this metadata will be part of the data storage protocol. **The ISC Plenary agreed that the ISC is the appropriate organization to store the historical the observer and effort data from the high seas large mesh and squid drift gillnet fisheries and tasked the STATWG to develop a protocol.**

12.2 Non-Disclosure Agreement

The Plenary reviewed a draft non-disclosure agreement (NDA) prepared by the STATWG as an online form and the process for approval (**ISC/23/STATWG/WP/01**). This NDA is intended to facilitate the sharing of ISC stock assessment data and files with external scientists. The Plenary requested some changes to the terms and conditions and obligation language on the draft NDA. **After reviewing the revised language, the Plenary approved the form and process for approval of data requests and agreed to post the form on the ISC website.**

12.3 Total Catch Tables

F. Carvalho, STATWG Chair, presented the historical annual catches by species for ISC Member countries. K. Nishikawa, DA, prepared the catch tables for the following ISC species of interest: NPO ALB, PBF, NPO SWO, WCNPO MLS, Pacific BUM, NPO BSH, and NPO SMA. The complete catch tables are included at the end of this Plenary Report (Section 18) and serve as the official ISC catch tables.

13 REVIEW OF MEETING SCHEDULE

13.1 Time and Place of ISC24

The ISC23 Plenary considered the request from NC19 to schedule ISC24 so that it precedes NC20, which is anticipated to be held in early July 2024. The ISC23 Plenary agreed that sequencing the ISC meeting prior to the NC annual meeting is important for NC to have the most up to date scientific information for decision making. After discussing the timing of WG meetings and the provision of reports, the Plenary provisionally decided that ISC24 will occur June 19-24, 2024. Canada offered to host the meeting on Vancouver Island, British Columbia, at a location to be determined at a later date.

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
2023	**July**							JWG PBF July 3-5 Fukuoka, Japan	
								NC19 July 6-7 Fukuoka, Japan	
	Aug							SC19 Aug 16-24 Koror, Palau	101st Meeting Aug 7-11 Victoria, Canada
	Sept								
	Oct								
	Nov			Nov 27-Dec 1 Data Prep Online	SMA Data Prep Nov 7-15 Yokohama				
	Dec							WCPFC18 Dec 4-8 Cook Islands	
2024	**Jan**					Steering Comm Location/Dates TBD			
	Feb			Feb 29-Mar 7 Stock Assess Location: Taiwan	SMA Pre-Assess Feb 6-10 La Jolla				

	Month	ALBWG	BILLWG	PBFWG	SHARKWG	STATWG	PLENARY	WCPFC	IATTC
	Mar	Research Wkshp Canada- Date & Time TBD							
	Apr		Biological & WCNPO MLS Wkshp Time & Location TBD		SMA Stock Assess Apr 6-10 La Jolla				
	May								15th SAC Meeting
	June			0.5 d	0.5 d	0.5 d	June 19-24		
	July								NC20

14 ADMINISTRATIVE MATTERS

14.1 ISC Chair and Vice Chair Elections

John Holmes was re-elected ISC Chair for a one-year term. Robert Ahrens (USA) was elected Vice Chair to replace the outgoing Vice Chair Shui-Kai Chang.

14.2 Work Group Election results

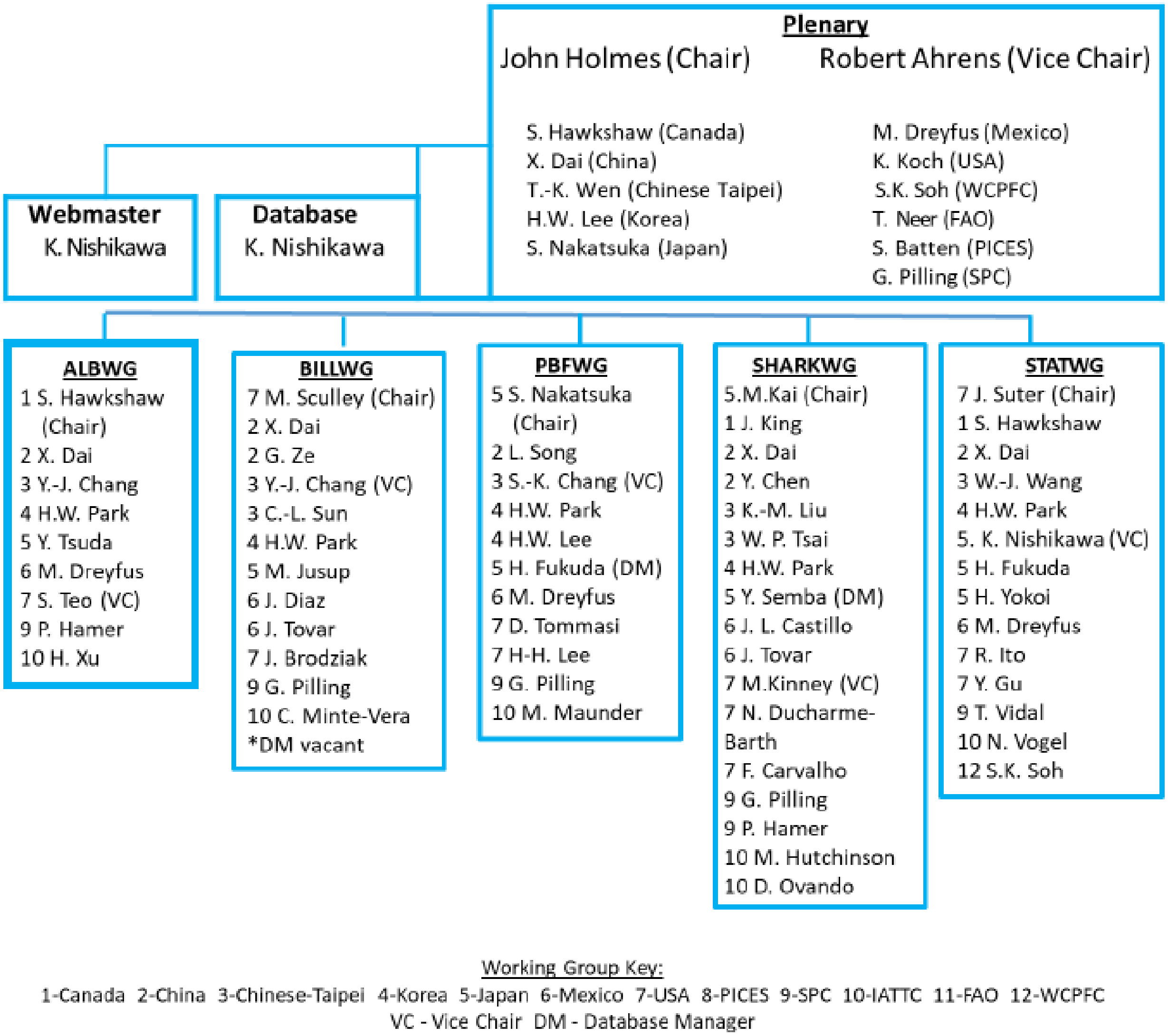
The Plenary confirmed the following officers and their terms of office:

Title	Name	First Election Date	First Term	Second Election Date	Second Term	First Extension	Second Extension
ISC Chair	John Holmes	Jul-17	2017-2020	Jul-20	2020-2023	2024	
ISC Vice Chair	Robert Ahrens	Jul-23	2023-2026				
ALBWG Chair	Sarah Hawkshaw	May-21	2021-2024				
ALBWG Vice-Chair	Steve Teo	Jul-17	2017-2020	Apr-20	2020-2023	2024	
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	Mikihiko Kai	Apr-18	2018-2021	Jul-21	2021-2024		
SHARKWG Vice-Chair	Michael Kinney	Apr-18	2018-2021	Jul-21	2021-2024		
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.

ISC Organizational Chart (July 2023)



This is not a comprehensive list but the main points of contact.

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

K. Koch (U.S.A.) provisionally agreed to serve as an ISC observer at the next PICES Annual Meeting, 23-27 October 2023, in Seattle, Washington, U.S.A.

14.5 Intersessional Working Group Tasks

- The PBFWG will conduct a benchmark assessment of PBF.
- The SHARKWG will conduct a benchmark assessment of NPO SMA.
- The BILLWG, with the ISC Vice-Chair, will plan and conduct an external peer-review of the 2023 WCNPO MLS stock assessment.
- The ALBWG will conduct research to improve the ALB stock assessment and update the abundance index for female SSB.
- The ISC Chair will canvas members about the focus of a third peer review of the ISC function and process.
- The ISC Chair will negotiate with the Executive Secretary of the NPFC on language in the proposed MOU based on feedback from Members.
- The ISC Chair will continue to consult with Members about methods to formalize the ISC, particularly examples of less formal methods than an MOU.
- The ISC Chair will request information from other scientific organizations/RFMOs on efforts to incorporate climate change considerations into their scientific activities and management advice.

15 OBSERVER COMMENTS AND RECOMMENDATIONS

Observers from the Pew Charitable Trusts, Monterey Bay Aquarium, and World Wildlife Fund-Japan participated in the ISC23 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.

Monterey Bay Aquarium thanks the ISC for the opportunity to participate in the 2023 Plenary meeting. We would like to acknowledge the tremendous progress the ISC has made on several fronts in recent years, including developing an MSE for NPO ALB, initiating work on the PBF MSE and candidate harvest control rules, and updating stock assessments on NPO SWO, WCNPO MLS and Pacific BUM, and NPO BSH and NPO SMA. It is notable that much of this work was completed without a formal funding mechanism, relying on in-kind contributions in personnel and support for meetings from member states.

While the non-formalized nature of the ISC is unique among tuna RFMO scientific bodies, we feel there are several areas where ISC is out of step with best scientific practices at international fisheries bodies. Particularly, we feel the ISC should make efforts to increase transparency and participation by non-government scientists and observers at both the data preparatory and stock assessment meetings. Increased transparency will serve to build confidence in ISC assessments among the wider scientific community, while greater non-government scientist participation will help to ensure a diversity of voices are heard and the latest science is used in ISC stock assessments.

While Monterey Bay Aquarium would like to acknowledge and fully supports efforts made by the ISC to develop an independent review process, we feel this will not fully address transparency concerns. The proposed timing of these reviews, occurring post-plenary, will preclude their use in modifying stock assessments before adoption. Additionally, it seems as though the proposed purpose of these independent reviews is to comment on choice of modeling framework and interpretation of results, and not to address biological input parameters. This approach would lead to another missed opportunity to ensure all science was considered during the ISC stock assessment process.

The Pew Charitable Trusts appreciated the opportunity to attend ISC23 as an observer. Pew is encouraged to hear the progress made in developing operating models for the PBF MSE. Pew remains concerned that the ISC WGs do not permit observer participation and urged the ISC to consider including non-governmental scientists in the discussions of the PBF working group, particularly those discussions that pertain to the MSE, given that transparency and stakeholder involvement are hallmarks of the MSE process, including with respect to the technical development of the MSE. The PBF Joint Working Group does not offer sufficient time to discuss the details of the MSE, such as its structure and assumptions. Regarding the inputs to the MSE, Pew urged the PBF working group to include a range of values for maturity and steepness. In particular, Pew noted that the lowest value of the range under consideration for steepness is greater than the values applied in other MSEs for bluefin and SKJ tunas. It is important that the MSE allows for plausible changes in fishery dynamics and a range of uncertainties to be considered so the best performing management procedure can be selected. Lastly, Pew asked whether variability in recruitment would be considered in the MSE to address the possibility that the recent positive recruitment estimates do not materialize or recur in the future?

Pew thanked the ISC members for their work on the WCNPO MLS assessment but expressed concern that nearly four years after the WCPFC adopted an interim rebuilding plan for the stock, no actions have been taken to recover it. Pew notes the latest assessment shows that during the past 20 years, female SSB has remained at an extremely low level, even as catch of the species has declined. Additional measures to recover WCNPO MLS are urgently needed. Pew urged the ISC to provide clear scientific advice after completing the additional work planned for 2024 to enable managers to act as soon as possible to recover the stock.

Pew expressed its appreciation for the completion of the stock assessment of NPO SWO and the ongoing work related to the NPO ALB management procedure. Pew noted that the NPO SWO assessment should be useful for the IATTC and WCPFC as they have agreed to discuss developing reference points for NPO SWO. Pew remarked that it agreed with Japan that criteria used to define an exceptional circumstance for NPO ALB do not have to be overly specific to be useful. However, Pew urged the ISC to clarify the process once an exceptional circumstance is identified, including thinking in advance about the types of actions that it should advise managers to take, based on the level of severity of the exceptional circumstance. Finally, Pew asked about the involvement of managers and noted their feedback would be important in finalizing the exceptional circumstances guidance.

WWF welcomed the completion of the WCNPO MLS stock assessment and the provision of stock status and conservation information that was not agreed upon at the ISC22 Plenary. This stock has been declining for many years and the new ISC Conservation advice, which is necessary for stock managers to make decisions, should lead to a sustainable fishery.

Lack of data and poor data quality make stock assessments difficult to complete for many species and are a major factor of uncertainty in the results. The ISC should request that WCPFC strengthen data collection standards and requirements and implement a Catch Documentation Scheme (CDS), electronic monitoring systems (EM) on vessels and improve observer coverage, which can prevent IUU fishing.

16 ADOPTION OF REPORT

The Report of the ISC23 Plenary session was adopted by the Members.

17 CLOSE OF MEETING

The meeting was closed at 11:45 AM July 17, 2023.

18 CATCH TABLES

Table 18 1. North Pacific albacore (*Thunnus alalunga*) 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	CAN		JPN								KOR		MEX		
		Troll	CAN Total	Set-net	Drift gill-net	Longline	Pole and line	Troll	Others	Purse seine	JPN Total	Longline	KOR Total	Others	Purse seine	MEX Total
Retain	1936															
	1937															
	1938															
	1939	129	129													
	1940	2	2													
	1941	35	35													
	1942															
	1943	13	13													
	1944	210	210													
	1945	648	648													
	1946	196	196													
	1947	36	36													
	1948	984	984													
	1949	1,012	1,012													
	1950	961	961													
	1951	86	86													
	1952	71	71	55	-	26,687	41,787	-	237	154	68,920			-	-	-
	1953	5	5	88	-	27,777	32,921	-	132	38	60,956			-	-	-
	1954			6	-	20,958	28,069	-	38	23	49,094			-	-	-
	1955			28	-	16,277	24,236	-	136	8	40,685			-	-	-
	1956	170	170	23	-	14,341	42,810	-	57	0	57,231			-	-	-
	1957	80	80	13	-	21,053	49,500	-	151	83	70,800			-	-	-
	1958	17	17	38	-	18,432	22,175	-	124	8	40,777			-	-	-
	1959	8	8	48	-	15,802	14,252	-	67	0	30,169			-	-	-
	1960	74	74	23	-	17,369	25,156	-	76	0	42,624			-	-	-
	1961	212	212	111	-	17,437	18,639	-	268	7	36,462			39	2	41
	1962	141	141	20	-	15,764	8,729	-	191	53	24,757			0	0	0
	1963	4	4	4	-	13,464	26,420	-	218	59	40,165			0	31	31
	1964	1	1	50	-	15,458	23,858	-	319	128	39,813			-	0	-
	1965	5	5	70	-	13,701	41,491	-	121	11	55,394			-	0	-
	1966	3	3	64	-	25,050	22,830	-	585	111	48,640			-	0	-
	1967	15	15	43	-	28,869	30,481	-	520	89	60,002			-	-	-
	1968	44	44	58	-	23,961	16,597	-	1,109	267	41,992			-	-	-
	1969	161	161	34	-	18,006	31,912	-	925	521	51,398			-	0	-
	1970	1,028	1,028	19	-	16,222	24,263	-	498	317	41,319			-	0	-
	1971	1,365	1,365	5	-	11,473	52,957	-	354	902	65,691	0	0	-	0	-
	1972	390	390	6	1	13,022	60,569	-	638	277	74,513	0	0	0	100	100
	1973	1,746	1,746	44	39	16,760	68,767	-	486	1,353	87,449	4	4	-	0	-
	1974	3,921	3,921	13	224	13,384	73,564	-	891	161	88,237	91	91	0	1	1
	1975	1,400	1,400	13	166	10,303	52,152	-	230	159	63,023	7,050	7,050	0	1	1
	1976	1,331	1,331	15	1,070	15,812	85,336	-	270	1,109	103,612	2,212	2,212	5	36	41
	1977	111	111	5	688	15,681	31,934	-	365	669	49,342	500	500	0	3	3
	1978	278	278	21	4,029	13,007	59,877	-	2,073	1,115	80,122	669	669	0	1	1
	1979	53	53	16	2,856	14,186	44,662	-	1,139	125	62,984	0	0	0	1	1
	1980	23	23	10	2,986	14,681	46,742	-	1,177	329	65,925	592	592	0	31	31
	1981	521	521	8	10,348	17,878	27,426	-	699	252	56,611	0	0	0	8	8
	1982	212	212	11	12,511	16,714	29,614	-	482	561	59,893	4,874	4,874	0	0	0
	1983	200	200	22	6,852	15,094	21,098	-	99	350	43,515	366	366	0	0	0
	1984	104	104	24	8,988	15,053	26,013	-	494	3,380	53,952	1,925	1,925	6	107	113
	1985	225	225	68	11,204	14,249	20,714	-	339	1,533	48,107	2,789	2,789	35	14	49
	1986	50	50	15	7,813	12,899	16,096	-	640	1,542	39,005	3,833	3,833	0	3	3
	1987	56	56	16	6,698	14,668	19,082	-	173	1,205	41,842	1,624	1,624	0	7	7
	1988	30	30	7	9,074	14,688	6,216	-	170	1,208	31,363	799	799	0	15	15
	1989	104	104	33	7,437	13,031	8,629	-	433	2,521	32,084	561	561	0	2	2
	1990	155	155	5	6,064	15,785	8,532	-	248	1,995	32,629	29	29	0	2	2
	1991	140	140	4	3,401	6,664	7,103	-	395	2,652	20,219	4	4	0	2	2
	1992	302	302	12	2,721	19,042	13,888	-	1,522	4,104	41,289	1	1	0	10	10
	1993	139	139	3	287	29,933	12,797	-	897	2,889	46,806	2	2	0	11	11
	1994	1,998	1,998	11	263	29,565	26,389	-	823	2,026	59,077	2	2	0	6	6
	1995	1,761	1,761	28	282	29,050	20,981	856	78	1,177	52,452	13	13	0	5	5
	1996	3,321	3,321	43	116	32,440	20,272	815	127	581	54,394	157	157	0	21	21
	1997	2,166	2,166	40	359	38,899	32,238	1,585	135	1,068	74,324	404	404	0	53	53
	1998	4,177	4,177	41	206	35,755	22,926	1,190	104	1,554	61,776	225	225	0	8	8
	1999	2,734	2,734	90	289	33,339	50,369	891	62	6,872	91,912	98	98	57	0	57
	2000	4,531	4,531	136	67	29,995	21,550	645	86	2,408	54,887	15	15	33	70	103
	2001	5,248	5,248	78	117	28,801	29,430	416	35	974	59,851	63	63	18	0	18
	2002	5,379	5,379	109	332	23,585	48,454	787	85	3,303	76,655	111	111	0	28	28
	2003	6,847	6,847	69	126	20,907	36,114	922	85	627	58,850	146	146	0	29	29
	2004	7,857	7,857	30	61	17,341	32,255	772	54	7,200	57,713	77	77	0	104	104
	2005	4,829	4,829	97	154	20,465	16,133	665	234	850	38,598	419	419	0	0	0
	2006	5,833	5,833	55	221	21,168	15,400	460	42	364	37,710	134	134	0	109	109
	2007	6,040	6,040	30	226	22,381	37,768	519	44	5,682	66,650	136	136	0	40	40
	2008	5,464	5,464	101	1,531	19,092	19,060	549	34	825	41,192	400	400	-	10	10
	2009	5,693	5,693	33	149	21,995	31,172	410	43	2,076	55,878	95	95	-	17	17
	2010	6,527	6,527	42	24	21,167	19,561	588	37	330	41,749	107	107	-	25	25
	2011	5,385	5,385	50	12	20,956	25,704	443	78	480	47,723	78	78	-	0	-
	2012	2,484	2,484	48	26	22,828	33,742	610	129	4,193	61,576	156	156	0	0	0
	2013	5,088	5,088	36	14	19,839	33,568	302	211	1,988	55,958	173	173		0	0
	2014	4,780	4,780	24	11	19,973	29,433	197	197	2,009	51,844	116	116		0	0
	2015	4,391	4,391	17	138	21,013	21,294	239	167	1,072	43,940	38	38		0	0
	2016	2,842	2,842	28	19	16,549	14,435	148	128	3,679	34,986	56	56		0	0
	2017	1,831	1,831	48	40	17,309	20,891	107	119	1,251	39,765	202	202		0	0
	2018	2,717	2,717	13	35	13,192	17,875	78	70	3,039	34,302	101	101			
	2019	2,402	2,402	27	9	12,216	8,508	543	95	1,045	22,443	65	65			
	2020	2,376	2,376	25	7	12,656	36,638	784	159	5,961	56,230	56	56			
	2021	2,419	2,419	11	3	17,889	11,136	428	232	180	29,879	275	275			
	2022	3,639	3,639	11	3	17,889	11,136	428	232	180	29,879	173	173			
Retain catch total		139,966	139,966	2,542	110,297	1,368,889	2,064,326	16,377	23,911	95,262	3,681,604	32,016	32,016	193	913	1,106
Release	2013	1	1													
	2014	7	7													
	2015	14	14													
	2016	2	2													
	2017	2	2													
	2018	18	18									+	+			
	2019	13	13													
	2020	2	2													
	2021	22	22									0	0			
	2022	7	7									0	0			
Release total		88	88									+	+			
Total		140,054	140,054	2,542	110,297	1,368,889	2,064,326	16,377	23,911	95,262	3,681,604	31,843	31,843	193	913	1,106

Table 18-1. Continued.

Catch disposition	Year	TWN						USA									Total
		Set-net	Gill-net (not specified)	Longline	Others	Purse seine	TWN Total	Drift gill-net	Handline	Longline	Pole and line	Troll	Others	Purse seine	Sport	USA Total	
Retain	1936											442				442	442
	1937											1,681				1,681	1,681
	1938											8,594				8,594	8,594
	1939											8,586				8,586	8,715
	1940											6,603				6,603	6,605
	1941											5,412				5,412	5,447
	1942											10,678				10,678	10,678
	1943											17,071				17,071	17,084
	1944											23,957				23,957	24,167
	1945											17,886				17,886	18,534
	1946											10,955				10,955	11,151
	1947											12,235				12,235	12,271
	1948									45		22,457				22,502	23,486
	1949									33		24,901				24,934	25,946
	1950									27		32,746				32,773	33,734
	1951									24		15,629				15,653	15,739
	1952									46		23,843			1,373	25,262	94,253
	1953									23		15,740			171	15,934	76,895
	1954									13		12,246			147	12,406	61,500
	1955									9		13,264			577	13,850	54,535
	1956									6		18,751			482	19,239	76,640
	1957									4		21,165			304	21,473	92,353
	1958									7		14,855			48	14,910	55,704
	1959									5		20,990			+	20,995	51,172
	1960									4		20,100			557	20,661	63,359
	1961									5	2,837	12,055	1		1,355	16,253	52,968
	1962									7	1,085	19,752	1		1,681	22,526	47,424
	1963									7	2,432	25,140			1,161	28,740	68,940
	1964									4	3,411	18,388			824	22,627	62,441
	1965									3	417	16,542	1		731	17,694	73,093
	1966									8	1,600	15,333			588	17,529	66,172
	1967	-	-	330	189		519			12	4,113	17,814			707	22,646	83,182
	1968	-	-	216	283		499			11	4,906	20,434			951	26,302	68,837
	1969	-	-	65	423		488			14	2,996	18,827			358	22,195	74,242
	1970	-	-	34	59		93			9	4,416	21,032			822	26,279	68,719
	1971	-	-	20	52		72			11	2,071	20,526			1,175	23,783	90,911
	1972	-	-	187	-		187			8	3,750	23,600			637	27,995	103,185
	1973	-	-	-	-		-			14	2,236	15,653			84	17,987	107,186
	1974	-	-	486	-		486			9	4,777	20,178			94	25,058	117,794
	1975	-	-	1,240	-		1,240			33	3,243	18,932	10		640	22,858	95,572
	1976	-	-	686	-		686			23	2,700	15,905	4		713	19,345	127,227
	1977	-	-	572	-		572			37	1,497	9,969			537	12,040	62,568
	1978	-	-	6	-		6			54	950	16,613	15		810	18,442	99,518
	1979	-	-	81	-		81				303	6,781			74	7,158	70,277
	1980	-	1	249	20		270				382	7,556			168	8,106	74,947
	1981	1	-	143	12		156			25	748	12,637			195	13,605	70,901
	1982	-	-	38	9		47			105	425	6,609	21		257	7,417	72,443
	1983	-	-	8	1		9			6	607	9,359			87	10,059	54,149
	1984	-	1	-	-		1			2	1,030	9,304		3,728	1,427	15,491	71,586
	1985	1	-	-	2		3	2				6,422	118	26	1,176	7,744	58,917
	1986	-	-	-	-		-	3				4,713	66	47	196	5,025	47,916
	1987	2	2,514	-	-		2,516	5		150		2,772	139	1	74	3,141	49,186
	1988	6	7,389	-	-		7,395	15		307		4,221	76	17	64	4,700	44,302
	1989	-	8,350	40	-		8,390	4		248		1,896	10	1	160	2,319	43,460
	1990	-	16,701	4	39		16,744	29		177		2,733	20	71	24	3,054	52,613
	1991	-	3,398	12	-		3,410	17		312		1,917	20		6	2,272	26,047
	1992	-	7,866	-	-		7,866			334		4,626	40		2	5,002	54,470
	1993	-	-	5	-		5			438		6,325	194		25	6,982	53,945
	1994	-	-	83	-		83	38		544		11,068	66		106	11,822	72,988
	1995	-	-	4,280	-		4,280	52		882		8,302	4		102	9,342	67,853
	1996	-	-	7,596	-	-	7,596	83		1,185		17,150	10	11	88	18,527	84,016
	1997	-	-	9,456	-	-	9,456	60		1,653		14,458	12	2	1,018	17,203	103,606
	1998	-	-	8,810	-	-	8,810	80		1,120		14,577	15	33	1,208	17,033	92,029
	1999	-	-	8,393	-	-	8,393	149		1,542		10,451	61	48	3,621	15,872	119,066
	2000	-	-	8,842	-	-	8,842	55		940		9,834	24	4	1,798	12,655	81,033
	2001	-	1	8,684	+	-	8,685	94		1,295		11,543	39	51	1,635	14,657	88,522
	2002	-	-	7,965	-	-	7,965	30		525		11,003	13	4	2,357	13,932	104,070
	2003	-	-	7,166	-	-	7,166	16		524		14,246	8	44	2,214	17,052	90,090
	2004	-	-	4,988	-	-	4,988	12		361		13,630	3	1	1,506	15,513	86,252
	2005	-	-	4,472	-	-	4,472	20		296		8,654	1		1,719	10,690	59,008
	2006	-	-	4,317	-	-	4,317	3		270		12,642	+		385	13,300	61,403
	2007	-	+	2,916	-	-	2,916	4	94	250		11,911	+	77	461	12,797	88,579
	2008	-	-	3,069	-	-	3,069	1	28	354		11,762	+		418	12,563	62,698
	2009	-	-	2,378	-	-	2,378	4	97	203		12,343	+	31	944	13,622	77,683
	2010	+	-	2,818	-	-	2,818	5	53	421		11,691	0		862	13,032	64,258
	2011	+	1	3,434	2	-	3,437	5	84	708		10,147	0		421	11,365	67,988
	2012	2	2	2,643	-	-	2,647	8	253	660		14,152	2		1,212	16,287	83,150
	2013	1	+	4,427	-	-	4,428	5	46	317		12,312	0		839	13,519	79,166
	2014	1	1	2,617	+	-	2,619	+	49	209		13,401			1,042	14,700	74,059
	2015	1	2	3,020	4	-	3,027	1	62	227		11,597	2		932	12,820	64,216
	2016	+	+	3,406	-	-	3,406	1	24	248		10,759	0		675	11,708	52,998
	2017	-	5	4,333	-	-	4,338	0	35	95		7,432	14		372	7,947	54,084
	2018	-	-	4,514	+	-	4,514		20	87		7,729			381	8,217	49,851
	2019	-	5	5,454	+	1	5,460		10	104		7,767	4		1,364	9,249	39,618
	2020	1	-	3,809	-	-	3,810		3	156		7,516	8		260	7,943	70,415
	2021	-	+	5,953	+	-	5,953		5	226		4,209	64		248	4,753	43,279
	2022	-	+	4,856	+	-	4,856	1	5	201		8,450	65		587	9,309	47,856
Retain catch total		16	46,237	149,121	1,095	1	196,470	801	869	18,221	52,932	1,116,088	1,151	4,197	50,236	1,244,495	5,295,657
Release	2013																1
	2014																7
	2015																14
	2016																2
	2017																2
	2018																18
	2019																13
	2020																2
	2021																22
	2022																7
Release total																	81
Total		16	46,237	149,121	1,095	1	196,470	801	869	18,221	52,932	1,116,088	1,151	4,197	50,236	1,244,495	5,295,738

Table 18-2. Pacific bluefin tuna (*Thunnus orientialis*) 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.

		JPN							KOR					MEX		
Catch disposition	Year	Set-net	Longline	Pole and line	Troll[1]	Others	Purse seine	JPN Total	Set-net	Longline	Purse seine	Trawl	KOR Total[2]	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	0	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	1,551	0	653	440	4,198	8,585	84		422	3	509		3,027	3,027
	2022	2,126	1,587 [3]	13	1,079	605	4,702	10,112	221		654	6	881		3,194	3,194
Retain catch total		138,475	97,357	54,801	133,341	50,044	585,689	1,059,707	398	25	28,415	101	28,939	245	116,002	116,247
Total		138,475	97,357	54,801	133,341	50,044	585,689	1,059,707	398	25	28,415	101	28,939	245	116,002	116,247

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				-			0			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				-			0			+				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	479	754	11,585
	2020	1	-		1,149	-	-	1,150	28	2		+	87	1	116	750	983	14,033
	2021	+	+		1,478	-	-	1,478	55	1		+	116	3	43	1,249	1,466	15,065
	2022	+	+		1,496	-	-	1,496	20	2		0	149	1	198	1,367	1,737	17,420
Retain catch total		121	61	539	36,423	128	810	38,082	638	342	376	170	476	846	243,142	12,904	258,894	1,501,868
Total		121	61	539	36,423	128	810	38,082	638	342	376	170	476	846	243,142	12,904	258,894	1,501,868

Table 18-3. Annual catch 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	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	4,296	270	251	5,122	267	267			
	2022	4	301	3,259	270	251	4,085	447	447			
Retain catch total		961	45,722	610,923	40,707	8,142	#######	14,541	14,541	3,430	0	3,430
Release	2010											
	2011											
	2018							+	+			
	2019							+	+			
	2020							+	+			
	2021							0	0			
	2022							+	+			
Release total								1	1			
Total		961	45,722	610,923	40,707	8,142	#######	14,542	14,542	3,430	-	3,430

Table 18-3. Continued.

Catch disposition	Year	TWN							USA										
		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	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	+	-	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	+	67		1,281	10,110
	2019	2	+	-	2,113	+	-	2,115	52	11	3	734		+	1	186		987	8,277
	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		+	2	54		762	7,219
	2022	1	-	-	1,109	-	-	1,110	29	32	1	927		+	2	27		1,018	6,660
Retain catch total		322	220	3,545	108,691	911	0	113,689	29,333	8,669	174	75,715	56	15	8	1,602	27	115,598	953,714
Release	2010																0	0	0
	2011																0	0	0
	2018																		+
	2019																		+
	2020																		+
	2021																		0
	2022																		+
Release total																	0	0	1
Total		322	220	3,545	108,691	911	+	113,689	29,333	8,669	174	75,715	56	15	8	1,602	27	115,598	953,714

Table 18-4. Annual catch 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	915	60	17	1,118	66		66		
	2022	31	95	558	60	17	761	66		66		
Retain catch total		5,144	81,740	324,453	45,368	6,621	463,326	6,637	0	6,637	0	0
Release	2010											
	2011											
	2016								+	+		
	2018							+	2	2		
	2019											
	2020											
	2021							0		0		
	2022							0		0		
Release total								0	2	2		
Total		5,144	81,740	324,453	45,368	6,621	463,326	6,637	2	6,639	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	1,741
	2022	+	9	23	298	+	+	330		283	9		1		293	1,450
Retain catch total		91	919	5,306	25,798	2,967	2	35,083	8	14,471	920	0	2	1,484	16,885	521,931
Release	2010												1		1	1
	2011												0		0	0
	2016						1	1								1
	2018						+	+								2
	2019						1	1								1
	2020						0	0								0
	2021															0
	2022						+	+								0
Release total							2	2					1		1	5
Total		91	919	5,306	25,798	2,967	4	35,085	8	14,471	920	0	3	1,484	16,886	521,936

Table 18-5. Retained catches (metric tonnes, whole weight) by ISC Member countries of Pacific blue marlin (*Makaira nigricans*) by 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	1,071	1,071	678		678			2	30	107	2,098	1	1	2,239	3	382	128		2	515	4,503
	2022	754	754	520		520			2	30	107	2,247	1	+	2,387	3	444	116		1	564	4,225
Retain catch total		196,171	196,171	14,478	0	14,478	0	0	374	1,590	17,540	186,535	3,604	58	209,701	41	14,568	8,196	6	15	22,826	443,176
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			+	2.43	2.43								3	3							5
Release total				1	4	5								39	39					7	7	51
Total		196,171	196,171	14,478	4	14,483	0	0	374	1,590	17,540	186,535	3,604	97	209,740	41	14,568	8,196	6	22	22,833	443,227

Table 18-6. Retained catches (metric tonnes, whole weight) by ISC Member countries of blue sharks (*Prionace glauca*) by 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						KOR		MEX		TWN		USA						Total
		Set-net	Drift gill-net	Longline	Others	Not specified	JPN Total	Longline	KOR Total	Others	MEX Total	Longline	TWN Total	Drift gill-net	Longline	Troll	Others	Sport	USA Total	
Retain	1985													-			1		1	1
	1986													1			1		2	2
	1987													1			1		2	2
	1988													-			3		3	3
	1989																6		6	6
	1990													-			20		20	20
	1991													-			1		1	1
	1992													1			1		2	2
	1993													-			-		0	0
	1994	15	582	35,437	18	4	36,055							-			12		12	36,067
	1995	12	487	34,246	10	4	34,759							-			5		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		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		1		11	33,077
	2010	4	962	16,504	9	1	17,481			4,469	4,469	7,670	7,670	-	7		0		7	29,627
	2011	12	771	8,566	1	3	9,353			3,719	3,719	13,117	13,117		13		0		13	26,202
	2012	2	1,085	10,463	3	3	11,555			4,108	4,108	10,606	10,606		16		0		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	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	0	19,930
	2017	4	1,366	9,795	+	1	11,166	8	8			11,121	11,121				1	+	1	22,296
	2018	40	1,236	9,111	+	1	10,388	4	4			11,761	11,761					3	3	22,156
	2019	35	1,149	8,448	+	1	9,633	4	4			18,165	18,165		0			14	14	27,816
	2020	59	1,119	7,072	1	2	8,253	0	0			15,566	15,566		0			3	3	23,821
	2021	25	1,484	6,620	1	1	8,131	2	2			8,835	8,835					2	2	16,970
	2022	25	1,484	6,620	1	1	8,131	0	0			12,859	12,859				0	3	3	20,992
Retain catch total		405	29,741	553,895	186	64	584,291	246	246			152,827	152,827	13	61	0	54	24	153	777,397
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
Release catch total								166	166											166
Total		405	29,741	553,895	186	64	584,291	411	411	0	0	152,827	152,827	13	61	0	54	24	153	777,562

Table 18-7. Retained catches (metric tonnes, whole weight) by ISC Member countries of shortfin mako sharks (*Isurus oxyrhinchus*) by 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	JPN Drift gill-net	JPN Longline	JPN Others	JPN Total	KOR Longline	KOR Total	MEX Others	MEX Total	TWN Longline	TWN Purse seine	TWN Total	USA Drift gill-net	USA Harpoon	USA Handline	USA Longline	USA Troll	USA Hook and line	USA Others	USA Purse-seine	USA 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	123	748	18	889			336	336				80	1					46			127	1,352
	1995	103	985	13	1,102			333	333				79	1					14			94	1,529
	1996	101	1,152	14	1,267			413	413				85	1					9			95	1,775
	1997	127	877	15	1,020			401	401				118	3					11			132	1,553
	1998	130	667	12	809			386	386				85	1					12			98	1,293
	1999	176	1,051	13	1,241			439	439				52	0					9			61	1,741
	2000	156	1,020	14	1,189			539	539				64	+					12			12	1,740
	2001	156	1,132	14	1,301			491	491				30	1					10			41	1,833
	2002	122	803	5	930			488	488				69	+					12			81	1,499
	2003	229	849	6	1,083			471	471				57	+					9			66	1,620
	2004	134	920	1	1,054			865	865				38	1					13			52	1,971
	2005	155	938	43	1,135			609	609				25	1					8			34	1,778
	2006	178	996	6	1,180			641	641				38	+					7			45	1,866
	2007	244	1,041	15	1,299			689	689				37	+					6			43	2,031
	2008	212	968	14	1,194	-	-	609	609				27	1					5			33	1,836
	2009	294	1,201	1	1,496	-	-	653	653	78		78	21	1			0		7			29	2,256
	2010	272	917	20	1,208	-	-	760	760	54		54	10	0					10			20	2,042
	2011	163	648	11	823	-	-	758	758	208		208	8	0					8			16	1,805
	2012	229	716	2	948	-	-	715	715	74		74	9	0			0		11			20	1,757
	2013	345	700	9	1,054	8	8	711	711	107		107	16	0					12			28	1,908
	2014	263	784	3	1,051	8	8	-	-	119		119	7	0		53	+	3	6		9	78	1,256
	2015	334	553	11	898					322		322	7			58		1	4			71	1,291
	2016	446	1,020	16	1,481	+	+			220		220	12	0	1	70	+	1	4		0	89	1,790
	2017	271	702	10	983	+	+			187		187	13	+		71	+	1	5			89	1,259
	2018	223	862	28	1,114	+	+			265		265	11			60	0	1	5			78	1,456
	2019	214	843	3	1,059	+	+			273		273	7			47	0	1	20		0	74	1,407
	2020	194	664	16	874	+	+			247		247	3	1		16		1	3			23	1,144
	2021	133	442	23	599	+	+			196		196	5	+		5		1	2			12	807
	2022	133	442	23	599	0	0			206		206	2 [1]			2 [1]		1 [1]	2			7	811
Retain catch total		5,861	24,641	378	30,880	16	16	11,307	11,307	2,556	0	2,556	1,015	13 0	1	383	0	10	281	0	9	1,648	46,407
Release	2011																			0		0	0
	2012										-	-											-
	2016					1	1																1
	2018					1	1																1
	2019					1	1																1
	2020					1	1																1
	2021					+	+																+
	2022					+	+																+
Release catch total						3	3																3
Total		5,861	24,641	378	30,880	19	19	11,307	11,307	2,556	0	2,556	1,015	13	1	383	0	10	281	0	9	1,648	46,410