NORTHERN COMMITTEE
EIGHTEENTH REGULAR SESSION

ELECTRONIC MEETING
8am-12am, 4-6 October 2022, Japan Standard Time

Report of the 22nd Meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

WCPFC-NC18-2022/IP-01

ISC[1]

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

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

PLENARY SESSION

12-18 July 2022
Kona, Hawaii, USA

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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 Hankshaw (Canada)
BILLWG	Billfish Working Group	Hirotaka Ijima (Japan)
PBFWG	Pacific Bluefin Working Group	Shuya Nakatsuka (Japan)
SHARKWG	Shark Working Group	Mikihiko Kai (Japan)
STATWG	Statistics Working Group	Felipe Carvalho (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

ISC22 Plenary Session in-person Participants. Participants were asked to remove their masks for the photo. Photo taken at Outrigger Resort and Spa, Kona, Hawaii on July 18, 2022.

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

PLENARY SESSION

12-18 July 2022

Highlights of the ISC22 Plenary Meeting

The 22nd ISC Plenary, was held in-person in Kona, Hawaii, USA, July 12-18, 2022. The meeting was attended by Members from Canada, Chinese Taipei, Japan, Korea, Mexico and the United States as well as the Inter-American Tropical Tuna Commission and Western and Central Pacific Fisheries Commission representatives. Observers from Monterey Bay Aquarium/Duke University, Pew Charitable Trusts, and the Western Pacific Fisheries Management Council, World Wildlife Fund-Japan, and Wild Oceans also attended the ISC22 Plenary session either in-person or virtually. 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 Pacific Bluefin Tuna (PBF) update assessment and the north Pacific Ocean Blue Shark (BSH) benchmark stock assessment and considers both assessments to be the best available scientific information on these stocks. Reference points have not been established for either the PBF or BSH stocks by the WCPFC or the IATTC. The PBF stock is likely overfished relative to the potential biomass-based reference points (20%SSB_0) adopted for other tuna species but overfishing is not likely occurring relative to many F-based reference points proposed for tuna species. This change in status relative to the 2020 assessment results reflects the recovery occurring in this stock. The NPO BSH stock is likely (>50% probability) not in an overfished condition relative to MSY-based reference points and overfishing of the stock is very likely (>90% probability) not occurring relative to MSY-based reference points. A benchmark assessment for WCNPO MLS was attempted but a serious issue with the choice of growth curve, which affects the perception of stock status, led the Plenary to conclude that the results were not a suitable basis for new stock status and conservation information. The Plenary decided to forward advice from the 2019 assessment while the growth curve issue is resolved and a new assessment is conducted for ISC23. The Plenary endorsed the BILLWG plan to conduct a WCNPO SWO assessment which includes SWO from the northern EPO stock as a result of cooperative efforts to redefine SWO stock boundaries in the Pacific Ocean. The Plenary re-iterated stock status and conservation information provided at ISC21 for North Pacific Albacore (NPALB), WCNPO Swordfish (SWO), Eastern Pacific Ocean Swordfish (EPO SWO), Pacific Blue Marlin (BUM), WCNPO Striped Marlin (MLS), and North Pacific Shortfin Mako Shark (SMA). 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 work plan for 2022-23 includes benchmark stock assessments of NPALB, WCNPO MLS and WCNPO SWO, continuing to advance biological sampling for billfish and shark species with a status update on efforts to date, providing technical workplans for the PBF MSE process and feedback on management objectives, developing a data and stock assessment file request process and procedures, continued implementation of enhancements to database and website management, reviewing the operation and functions of the MOU and MOC with the WCPFC and IATTC, respectively, continuing the process of formalizing the ISC, and beginning to plan for the third peer review of the ISC function and process. Shuya Nakatsuka (JPN) was re-elected to his second term as Chair of the PBFWG and Hirotaka Ijima (JPN) and Yi-Jay Chang (TWN) were re-elected to their second terms as Chair and Vice-Chair of the BILLWG. Mi-Kyung Lee (KOR) is the current Vice-Chair of the STATWG, which will be confirmed by election during the intersessional period. Elections for the Chair and Vice-Chair of the ISC will be conducted at the next Plenary meeting, which will be hosted by Japan, July 12-17, 2023, at a location and venue to be determined.

1 INTRODUCTION AND OPENING OF THE MEETING

1.1 Introduction

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

The ISC provides scientific advice on the stocks and fisheries of tuna and tuna-like species in the North Pacific Ocean 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 in excess of 500,000 metric tons (t) annually and dominated by the tropical tuna species. Catches of priority species monitored in 2021, by ISC Member countries were 69,505 t of North Pacific albacore tuna (NPALB, *Thunnus alalunga*), 14,766 t of Pacific bluefin tuna (PBF, *T. orientalis*), 5,269 t of North Pacific swordfish (SWO, *Xiphias gladius*), 1,661 t of North Pacific striped marlin (MLS, *Kajikia audax*), 4,173 t of Pacific blue marlin (BUM, *Makaira nigicans*), 1,040 t of North Pacific shortfin mako shark (SMA, *Isurus oxyrinchus*) and 17,078 t of North Pacific blue shark (BSH, *Prionace glauca*). [1] The total estimated catch of these seven species is 113,492 t, or approximately 91% of the 2021 total estimated catch of 125,009 t. Annual catches of priority stocks throughout their ranges reported by ISC Members are shown in Table 18-1 through Table 18-7.

1.2 Opening of the Meeting

The Twenty-second Plenary session of the ISC (ISC22) was convened in Kona, Hawaii, USA, at 09:00 on 12 July 2022 by the ISC Chairman, J. Holmes. A roll call confirmed the participation of delegates from Canada, Chinese Taipei, Japan, Mexico, Republic of Korea, and U.S.A. (**ISC/22/ANNEX/01**). Representatives from Monterey Bay Aquarium, Pew Charitable Trusts, and World Wildwide Fund for Nature-Japan were present as observers.

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

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

2 ADOPTION OF AGENDA

The proposed agenda for the session (**ISC/22/ANNEX/02**) was considered and adopted. C. Dahl was assigned lead rapporteur duties. A list of meeting documents is contained in **ISC/22/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 2021 (**ISC/22/PLENARY/04**). Canada has one fishery for HMS in the Pacific Ocean, a troll fishery targeting juvenile north Pacific albacore tuna (*Thunnus alalunga*). Category I, II, and III data from the 2021 fishing season are summarized in this report. The Canadian fleet consisted of 112 vessels in 2021 and operated primarily within the eastern Pacific Ocean. One vessel from the Canadian fleet operated in the Central and western Pacific Ocean in 2021. The Canadian troll fishery continues to be largely coastal in its operations, occurring predominantly within the Canadian and United States exclusive economic zones (EEZs). Only a small proportion of catch and effort in 2021 occurred outside the Canadian and U.S. EEZs. Provisional 2021 estimates of catch and effort in the eastern Pacific Ocean are 2,399 t and 3,660 vessel-days, respectively, which represent only a 1 % increase in catch and 10.9 % increase in effort relative to 2020. The proportion of the 2021 catch and effort in Canadian waters decreased only slightly to 69.8 % and 72 % from 71.5 % and 77 % in 2020, respectively. Proportion of catch and effort in US waters in 2021 increased to 28.2 % and 25.6 % from 19.6 % and 17.4 % in 2020, respectively. The remaining catch and effort occurred in adjacent high seas waters. The catch rate (CPUE) decreased by 8.9 % in 2021 relative to 2020. Approximately 92 % of the Albacore catch occurred in a water temperature band of 15-18 °C in 2021. Thirty-eight (38) vessels measured 10,392 fork lengths in 2021 for a sampling rate of 2.6 % of the reported catch. Fork lengths ranged from 50 to 95 cm, having a dominant mode around 60 cm corresponding to 2-year-old fish and a smaller mode around 80 cm corresponding to 3-year-old fish. Mean length was 68.1 cm, which is similar to the mean length observed in 2020.

Discussion

The relatively low incidental catch/bycatch of PBF by Canadian vessels (eight fish) was noted. Canada observed that comparable levels of PBF catch have been recorded in the past but not in recent years. Historically Canadian vessels have reported the majority of their PBF bycatch when operating in U.S. waters, off the coast of Oregon, and only rarely in Canadian waters. Canada is examining recreational fishery data to determine whether a comparable increase in PBF catch occurred, which could suggest greater availability of this species to Canadian fisheries.

3.2 Chinese Taipei

R.-F. Wu presented the Chinese Taipei national report (**ISC/22/PLENARY/05**). Chinese Taipei tuna fisheries in the North Pacific Ocean mainly comprise tuna longline and tuna purse seine fisheries, and other small-scale fisheries operating in the waters of Chinese Taipei, such as harpoon, set net, and gillnet. More than 90 % of the tuna and tuna-like species catch by Chinese-Taipei fisheries in the North Pacific Ocean are from tuna longline and purse seine fisheries. The tuna longline fisheries consist of large-scale tuna longline vessels (LTLL, over 100 gross registered tons, GRT) and small-scale tuna longline vessels (STLL, less than 100 GRT). The number of fishing vessels of these two fisheries were 85 and 787, and the catches of tuna and tuna-like species catches in the North Pacific Ocean in 2021 were 5,396 t and 17,539 t, respectively. The tuna purse seine fishery consisted of 29 vessels with a total catch of 215,354 t in the Pacific Ocean in 2021. Fifty-four observers were deployed on tuna longline vessels operating in the Pacific Ocean in 2021, including 19 on LTLL vessels and 35 on STLL vessels. Chinese Taipei 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 under funding support from the Chinese Taipei Fisheries Agency in 2021.

Discussion

Given the diversity of species caught in Chinese Taipei longline fisheries, information on target species by fleet and set depth would be useful. Chinese Taipei noted that there are some LTLL fishing vessels operating in high latitude areas targeting ALB, while others mainly operate in equatorial areas fishing for tropical tuna. As for the STLL fleet, some of them seasonally target shark in high latitude areas, while those which mainly target tropical tuna and tuna-like species also have ALB bycatch, and when fishing in the area between 15º and 30º N latitude, increase in ALB catch have been observed. LTLL primarily targets tropical tuna while STLL is more complicated in terms of diverse targeting strategies including sharks, marlin, and tropical tunas.

In response to a question about the reason for PBF catch increases, Chinese Taipei noted that some distant water STLL vessels have returned to waters around Chinese Taipei to target PBF. Chinese Taipei also explained that PBF catch increases are due to the recovery of the PBF resource as evidenced by the sharp increase of CPUE. Chinese Taipei also explained that catches are managed through a catch limit with monitoring through its domestic catch documentation scheme (CDS) and the number of vessels authorized to target PBF.

3.3 Japan

S. Nakatsuka presented the Japan national report (**ISC/22/PLENARY/06**). Japanese tuna fisheries consist of three major fleets (longline, purse seine, and pole-and-line), and other miscellaneous fisheries including troll, driftnet, and set-net fisheries. The number of active longline vessels in the North Pacific Ocean (NPO) shows a declining trend in all size categories, with 253 vessels in 2021, almost half of the number active in 2006. The number of purse seiners is relatively 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 56 vessels active in 2021, less than half of the active vessels in 2006. The distribution of fishing effort did not show a significant difference between 2020 and 2021 in the three main fisheries. The total catch of tunas, excluding skipjack, by Japanese fisheries in the North Pacific Ocean was 166,340 t in 2020 and 185,242 t in 2021. The total catch of tunas including skipjack, by Japanese fisheries in the NPO was 196,647 t in 2020 and 212,248 t in 2021. The total catch of swordfish and striped marlin was 7,519 t in 2020 and 4,113 t in 2021. In addition to these fisheries descriptions, the report briefly introduced Japanese research activities on tuna and tuna-like species in the Pacific Ocean in 2021, including a larvae/juveniles 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 swordfish and sharks, and tagging for skipjack and albacore.

Discussion

In response to a question, Japan noted that the biggest impact of the Covid-19 pandemic has been on distant water fisheries that need to carry observers and make foreign port calls. Data collection has been hampered somewhat because of ports that have restricted access by outsiders, but the Japanese Fisheries Research and Education Agency has taken a flexible approach to find ways to maintain data collection at a satisfactory level.

3.4 Korea

D. Kim presented the Korean national report (**ISC/22/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 23 active purse seine vessels in 2021. The number of longline vessels has remained below 100 since 2015, and the number of purse seine vessels remained the same as the previous year. The two Korean fisheries harvested 46,762 t of tuna and tuna-like species in the NPO in 2021. The total catch of the longline fishery was 16,950 t, a 21 % increase over 2020, while the purse seine fishery harvested 29,812 t, a 36 % decrease year to year. The longline fishery mainly targeted bigeye and yellowfin tunas whose catch accounted for 55.9 % and 31.8 % of the total catch in 2021. The dominant species in the purse seine fishery was skipjack tuna (72.1 %), followed by yellowfin tuna (26.0 %) and bigeye tuna (1.9 %). 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 422 t of PBF in 2021, which accounted for 83 % of the total domestic catch. In 2021, the catch of large PBF (30kg or greater) accounted for 11 % of the total catch.

Discussion

Responding to question about close kin mark recapture work, there has been limited collaboration among members. In this regard, Korea requested that clear guidance or protocols on collaborative work for CKMR with member countries be prepared. Along with this point, Korea also explained that they currently need additional time to conduct standardized work to be able to develop different types of information of gene markers, including microsatellite DNA and single-nucleotide polymorphism (SNP), for PBF CKMR.

3.5 Mexico

M. Dreyfus presented the Mexican national report (**ISC/22/PLENARY/08**). Purse seine vessels account for the majority of Mexican tuna catch in the Eastern Pacific Ocean (EPO). The fleet is quite stable at around 50 vessels in the past 15 years. The majority of purse seine vessels targeting PBF are of 400 m^3 carrying capacity or higher and all have 100 % observer coverage. Catch composition is about 70-80 % YFT, followed by SKJ as complementary catch. The majority of this catch goes to canning. PBF catch has been subject to catch quotas and is being monitored with onboard observers on all trips. All the PBF is transported alive to farming pens and size sampling is done with stereoscopic underwater cameras, which is the information provided to scientists to generate size composition of the catch. In 2021, the average size was 140 cm and the highest size mode was 154 cm. Sampling for CKMR analysis continues. Regarding sharks, an update on BSH catches through 2020 was presented. Management for tunas and sharks is according to regulations stemming from IATTC resolutions. In addition, the most important domestic regulation for sharks is a three-month fishery closure.

Discussion

It was explained that the three-month closure for shark fisheries is intended to protect pupping grounds.

3.6 U.S.A.

M. Seki presented the U.S. national report (**ISC/22/PLENARY/09**). The Pacific Ocean produces about 71 % of the global tuna catch. Within in the Pacific Ocean, about 78 % of the tuna catch is from the Western Pacific. U.S. catch of major tuna species in the NPO was 61,537 t in 2021. The tuna catch was composed of SKJ (58 %), YFT (10 %), BET (20 %) and ALB (7 %). The U.S. purse seine fishery in the NPO accounted for 69 percent of the tuna catch, followed by the longline fishery (17 %) and albacore troll fishery (7 %). There were 19 U.S. purse seine vessels that caught 42,734 t of which 82 % was SKJ in 2021 compared to 35 vessels that caught 63,912 t in 2020. The 2019-2021 purse seine catches are considered preliminary because the species composition of juvenile YFT and BET have not been adjusted. In 2020, 146 U.S. longline vessels fishing in the NPO caught 11,373 t of tuna. NPO longline BET and SWO catches in 2021 were 7,138 t and 690 t, respectively. There were only 311 U.S. albacore troll vessels in the NPO, the fewest since 1991 when there were 172 vessels. The 2021 albacore troll catch was 4,211 t composed almost exclusively of albacore. Albacore catches have declined in the last five years.

Discussion

It was requested that more information on the catch of PBF in recreational fisheries be included in future U.S. national reports.

It was noted that the decrease in the size of the U.S. purse seine fleet was primarily due to vessels reflagging to other countries.

The decline in the number of vessels participating in the U.S. ALB fishery is driven by the capacity for vessels to easily switch in and out of this fishery, because it is not subject to license limitations. The Covid-19 pandemic may have had some impact on participation, but there is no information to confirm this hypothesis.

4 REPORT OF THE ISC CHAIR

ISC Scientists have been busy since the ISC Plenary last met face-to-face and I reported to you at ISC19 in Taipei, Taiwan. Since that time we, and the rest of the world, have been dealing with the COVID-19 pandemic and we still aren't finished with it – it may become a fact of life going forward. I urge you to follow the COVID protocols in place for this meeting and protocols put in place by health professionals in your countries.

In 2020, the ALBWG and PBFWG produced benchmark assessments of NPO ALB and PBF, respectively. The BILLWG responded to requests for information from the WCPFC Northern Committee (NC) on Western and Central North Pacific Ocean (WCNPO) MLS and was preparing for a benchmark assessment of Pacific BUM. The SHARKWG conducted a sensitivity analysis on NPO BSH and recommended changes to the BSH and SMA assessment cycles that the ISC20 Plenary accepted. Finally, proposals for an external review process for ISC stock assessments was discussed in response to the report on peer review of the function and process and stock assessment of the ISC that was delivered between ISC18 and 19.

Highlights in 2021 included the final report of the albacore management strategy evaluation (MSE) process, a benchmark Pacific BUM assessment and a NPO SMA indicator analysis. The catalogue and inventory of the ISC database, and development of the website and data enterprise system continue to be advanced under the leadership of the STATWG Chair and Vice-Chair, despite changes in these positions. Conducting external reviews of ISC stock assessments remains very much top of mind, but progress is difficult to achieve.

In the past year, the PBFWG has delivered an update assessment of PBF, the BILLWG has delivered a benchmark assessment of MLS and the SHARKWG has delivered a BSH benchmark assessment for review and approval at ISC22. The process to formalize the structure/existence of the ISC continues, but it is not quick, and our discussion on an external peer review process for ISC stock assessments also continues.

A lot was accomplished between ISC19 and ISC22 in a virtual context. Working virtually is a difficult way to proceed but the WGs did it and did it well. I am proud of what they did on behalf of the ISC.

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 WG Chairs and Vice-Chairs who volunteer their time, and the support of their senior managers who, in many cases, are the Heads of Delegation. At the same time, the breadth and scope of our research, scientific partnerships, and visibility are expanding and will continue to do so in the coming years. I committed at ISC21 to propose some revisions to the ISC Operations Manual and I note that the MOU with the WCPFC-NC and MOC with the

IATTC both have a clauses specifying a full review of their terms and operation every three years. So there is an opportunity to consider how to address mission creep in the ISC in a strategic and comprehensive way.

The last peer review of ISC function and process occurred in 2018 and resulted in improvements to the stock assessment process with the establishment of a regular schedule of assessments and standardized reporting of assessment results. While not all of the recommendations have been implemented, it is time for the ISC to begin mapping out the third peer review of ISC function and process. Over the next year, I will be discussing ideas with the ISC Plenary to identify the focus and process for the next peer review.

Lastly, in this age of transparency and accountability, I have some proposals for the ISC Operations Manual to provide substance to the role of external observers to the ISC Plenary.

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, owing to undefined funding it cannot provide full support. The Working Groups depend on in-kind contributions from Members who elect to participate in specific Working Groups, particularly those Members who serve as Chairs and Vice-Chairs. Day-to-day operations of the Office of the Chair have been supported by the U.S., and to a lesser extent Canada, and Japan has supported the operations of the ISC website and database. Member countries with scientists serving as chairpersons of the Working Groups have contributed to supporting administrative services of the Working Groups. This support is vital to the ability of the ISC to deliver its scientific mandate and is greatly appreciated.

I am currently in the middle of my second term as ISC Chair; 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 Shui-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. I am indebted to Kirara Nishikawa, the Data Administrator and Webmaster, for keeping me up to date on communications and data issues. Finally, I would like to acknowledge the unsung heroes of ISC22 – Sarah Shoffler and Emily Crigler – for their professional assistance and dedicated service to the ISC in ensuring that this meeting occurs in a safe and healthy manner and that tasks that I need to do are completed. 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 ASSIGNMENT

5.1 Albacore

S. Hawkshaw presented the ALBWG report (**ISC/22/ANNEX/11**). The working group held a virtual workshop May 9-12, 2022, to review and discuss the progress made by working group members on model improvements for the 2023 assessment. Sixteen scientists from Canada, Chinese Taipei, Japan, USA, IATTC and SPC participated at this working group. The objectives for this workshop meeting were to review the findings from the evaluations carried out by WG members, addressing the research recommendations identified in the 2020 assessment and to develop an approach to incorporate findings into the albacore assessment model to be used for the 2023 assessment. Three working papers (**ISC/22/ALBWG-01/01, 02, 03**) and two presentations were reviewed and discussed by the working group.

The ALBWG Chair summarized the progress made by the WG towards addressing each of the research recommendations identified during the 2020 stock assessment, including:

1. Further investigation of the F01 fishery because there appears to be a mixture of two fisheries (one on juveniles and one adults) in this fishery;
2. Evaluate adult indices from the Japanese longline fisheries in southern areas (Areas 2 and 4), especially with respect to incorporating size data into the standardization process using a spatiotemporal process and/or data from alternative seasons;
3. Evaluate potential juvenile indices from the Japanese longline fisheries in northern areas (Areas 1, 3, and 5), the Japanese pole-and-line and/or EPO surface fisheries;
4. Collect sex-specific age-length samples using a coordinated biological sampling plan to improve current growth curves, and examine regional and temporal differences in length-at-age;
5. Collect sex ratio data by fishery using a coordinated biological sampling plan;
6. Evaluate and document historical high seas drift gillnet catch by member countries; and
7. Examine the 2020 assessment model and projection software in detail.

The WG encouraged the authors of all the analyses presented at the workshop to continue their work, incorporating suggestions from the WG discussions, and final results will be discussed at the next WG meetings in September and November 2022.

Work assignments for ALBWG members were developed and work plans for the assessment period were also developed. The ALBWG proposes the following work plans and schedule for 2022/23:

Date	Location/Method	Task/Event
Aug 9-17, 2022 - EPO Aug 10-18, 2022 - WPO	Online	WCPFC SC18
Oct 3-5, 2022 - EPO Oct 4-6, 2022 - WPO	Online	WCPFC NC18
Sept 2022	Online	ALBWG workshop (Review working paper)
Nov 2022	Yokohama, Japan (tentative)	ALBWG workshop (Assessment data preparation)
Early 2023	La Jolla, US (tentative)	ALBWG workshop (Stock assessment)

Discussion

Time varying selectivity of the Japanese pole and line fishery was discussed. The Japanese pole and line fishery catches large amounts of NPO ALB and exhibits multi-modal size compositions that vary greatly between quarters and years. Therefore, the ALBWG used highly flexible and time-varying selectivities to remove the appropriate catch-at-age in the model. However, these highly variable selectivities, as well as other factors, resulted in the ALBWG deciding not to use the index from this fishery in the assessment. The ALBWG was therefore interested in incorporating spatial and temporal processes into the standardization model of this fishery.

The role of prediction skill in the suite of model diagnostics used in the assessment was discussed. Overall, the ALBWG considered that the NPO ALB assessment model exhibited good model diagnostics. However, discussions during a recent workshop on model diagnostics suggested that the interpretation of the model diagnostics may be inconsistent and depend on the context of the model. One promising approach appeared to be testing the prediction skill of the model by examining the Mean Absolute Scaled Error (MASE) of hindcasted models.

The ISC Plenary endorse the ALBWG workplan for 2022-23.

5.2 Pacific Bluefin Tuna

S. Nakatsuka presented the PBFWG report (**ISC/22/ANNEX/06/08**). The PBFWG has been tasked with completing an update stock assessment of Pacific bluefin tuna in 2022 and held two online workshops for data preparation on 14-21 December 2021 and for the stock assessment on 8-18 March 2022. At the data workshop, the WG reviewed updated input data for the new stock assessment and concluded that a portion of the Japanese abundance index should not be included due to possible bias from management measures. The WG successfully completed the update stock assessment using data up to July 2021 and recommends it as the best available scientific information for PBF.

The PBFWG also discussed the scientific framework for an MSE of PBF, which fishery managers have asked ISC to complete by 2024. This year the WG reviewed an assessment model with short-term data (1983-present). The short-term model was consistent with the current assessment model and yet allows more flexible assumptions than the current assessment model, which is important for addressing plausible uncertainties with the MSE process. The WG agreed to use this model as a basis for the development of the operating models for the PBF MSE. The WG also considered it appropriate to use the framework of the ALB MSE for evaluation of management procedures. The WG discussed the timing for the MSE and stock assessment. The next benchmark assessment is scheduled for 2024 while the initial results from the MSE process were also requested to be completed in 2024. The PBF stock is projected to be close to the second rebuilding target in the 2022 fishing year, and the WG considers that the stock assessment work is its priority. The WG sought Plenary endorsement of this prioritization, which would be conveyed to fishery managers.

The PBFWG also discussed the possible benefit of close-kin mark recapture (CKMR) research for its stock assessment as requested by ISC21 and concluded that while the strength of CKMR is to provide information on the absolute biomass of fishery resource, the WG is confident that the current PBF assessment provides a reasonable and appropriate estimate of absolute biomass level based on various model diagnostic results and thus considers that the need for CKMR is currently low for the stock. However, CKMR can potentially provide useful information on absolute biomass or the biology of the stock and may become valuable in future assessments or the MSE of PBF. Therefore, while currently there is no plan to include CKMR into the stock assessment, the WG encourages its members to continue CKMR research and exchange information at future WG meetings for further collaboration.

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

The PBFWG proposed schedule for 2022/23 as follows:

Meeting	Dates	Location	Goals
NC-IATTC-JWG	July 11-13, 2022 - EPO July 12-14, 2022 - WPO	Online	Provide stock assessment results and update MSE progress
WCPFC SC18	Aug 9-17, 2022 – EPO Aug 10-18, 2022 - WPO	Online	Provide stock assessment results
WCPFC NC18	Oct 3-5, 2022 - EPO Oct 4-6, 2022 - WPO	Online	
PBF Workshop	November	Online	Discuss structure of MSE
WCPFC 18	Nov 28-Dec 6, 2022 - EPO Nov 29 – Dec 7, 2022 - WPO	TBD	
PBF Workshop	Spring	TBD	Discuss possible revision of stock assessment model and MSE

Discussion

While CKMR is now a lower priority for the PBFWG, ISC Plenary Members support the continued collection of tissue samples and the development of analytical techniques in support of CKMR. Collaboration and information sharing was encouraged.

The need to validate alternatives to the Japanese troll recruitment and longline indexes was emphasized. Japan is discussing internally how to address the problem of continuing to use abundance indices when management interventions changes fishery performance. This problem is not restricted to PBF fisheries; other WGs are also experiencing a similar challenge.

Work on the MSE by the PBFWG was extensively discussed. The PBFWG Chair noted that it cannot work on the next benchmark assessment and the MSE simultaneously in 2024. However, substantial work can be accomplished in the remainder of this year and in 2023. The PBFWG Chair is confident that at least a prototype of an operating model ensemble can be developed over the next year, which could be used to test alternative management procedures. For this work to be feasible, the number of alternative procedures (reference points and harvest control rules) will need to be limited in scope compared to what has been put forward in the past by the Joint IATTC-WCPFC-NC Working Group on the Management of Pacific Bluefin Tuna (JWG).

Methods to evaluate other harvest strategy features related to allocation of harvest opportunity between fisheries targeting small and large fish and between the EPO and WCPO will need to be developed. It is likely that further input from managers, through the JWG, on the specifics of these types of management procedures will be necessary for the development of the MSE. The JWG will also have to provide a set of operational management objectives that can be incorporated into the MSE as performance indicators.

Japan has hired a full-time analyst to assist with the MSE, and the U.S. has offered MSE analyst technical assistance on a limited basis based on staff availability and funding. With these staff resources, past concerns about the capacity of the ISC to conduct the MSE have been addressed for the initial MSE tasks. In addition, the JWG is in the process of providing management objectives for the MSE process. It was also noted that the JWG has taken responsibility for stakeholder engagement, which was a task shouldered by the ISC during the ALB MSE. All these developments are expected to facilitate timely advancement of the PBF MSE.

Finally, in response to a question on the rationale for developing the shorter time series model to be used in the MSE operating model, it was noted that the full time series used in the stock assessment is constrained by the need to explain recruitment and catches at widely varying levels of stock abundance. This constraint means that it is impractical to explore alternative productivity assumptions on results.

The ISC Plenary endorse the proposal to focus on delivering the upcoming benchmark stock assessment in 2024 as a priority and the initial MSE results to managers and stakeholders in 2025 and approved the PBFWG workplan for 2022-23.

5.3 Billfish

H. Ijima, BILLWG Chair, presented WG report for 2021-2022. The BILLWG held three workshops (**ISC/22/ANNEX/05**, **ISC/22/ANNEX/09**):

1. Data preparatory meeting for the WCNPO striped marlin stock assessment;
2. Stock assessment for the WCNPO striped marlin; and
3. Inter-sessional meeting of the BILLWG on 9 July 2022.

The BILLWG discussed 11 working papers and three presentations in the data preparatory meeting for WCNPO MLS. The BILLWG focused on the biological parameters and updated the 2019 growth curve and maturity ogive. In addition, the BILLWG set the growth curves reported for Southwest Pacific and Eastern Pacific striped marlin stocks as alternatives to explore the uncertainty of biological parameters.

The BILLWG addressed the WCNPO MLS stock assessment and achieved consensus on data and model improvements. However, during the intersessional meeting, the BILLWG discussed the reasons for the significant difference between the 2019 and 2022 stock assessment results. Based on this discussion, the BILLWG recognized that the results are most sensitive to biological parameter differences, particularly the growth curve.Sun et al. (2011)[2] concluded that the Richards curve is the best growth assumption for the WCNPO MLS stock. However, in the 2011, 2015, and 2019 stock assessments, the SS3 model could not use the Richards curve directly and as a result the Richards curve of Sun et al. (2011) was transformed into a von Bertalanffy growth curve. In response to a perceived issue with whether the 2022 assessment model could adequately represent growth, the BILLWG agreed to use the standard von Bertalanffy growth curve reported by Sun et al. (2011), although the rationale for the change was not fully documented, and this may have contributed significantly to the differences in the 2019 and 2022 results. The BILLWG noted that SS3 can now use the Richards curve directly and will focus on exploring this option in the next year. If the BILLWG wants to compare to the base case model, then it will need to tune the model to achieve convergence. Depending on the adjustments, the result may change as follows:

1. Converge and get similar results;
2. Converge and get completely different results; or
3. Despite adjustments, convergence may not be achieved.

Considering these discussions, the BILLWG concluded that the results produced were not a suitable basis for stock status or conservation advice and recommended the following workplan:

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

1. Present 2022 WCNPO MLS modeling as a work in progress at ISC22 and the August 2022 WCPFC Scientific Committee (SC18) meeting;
2. Recommend that ISC22 carry forward 2019 stock status and conservation information;
3. 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 SS model, for presentation to ISC23;
4. If there is a failure to get a stable and converged model using the Richard's growth curve, the WG would refocus on a von Bertalanffy approach going forward; and
5. Conduct a benchmark assessment of WCNPO SWO building on the 2018 WCNPO SWO assessment for ISC23.

The BILLWG confirmed the new stock boundary of WCNPO SWO stock that was presented in **ISC/21/ANNEX/08**.

Segment	**Latitude**	**Longitude**	**Latitude**	**Longitude**
1	0º	90º E	0º	165º W
2	0º	165º W	5º N	165º W
3	5º N	165º W	5º N	150º W
4	5º N	150º W	10º N	150º W
5	10º N	150º W	10º N	~80º W

The BILLWG held elections for Chair and Vice-Chair. Hirotaka Ijima and Yi-Jay Chang have been reappointed as Chair and Vice-Chair of the BILLWG.

The BILLWG is planning four workshops as follows.

Year	**Month**	**Meeting**	**Remarks**
2022	Aug 9-17 – EPO Aug 10-18 - WPO	WCPFC SC	
2022	Oct 3-5 - EPO Oct 4-6 - WPO	WCPFC NC	
2022	Dec	WCPFC Commission	
2022	Nov	Data preparatory meeting for SWO	Venue: Yokohama Japan
2022	Nov	Biological study workshop	Venue: Yokohama Japan
2022	Nov	Continue workshop for MLS stock assessment	Venue: Yokohama Japan
2023	Mar	Benchmark Stock Assessment meeting for SWO	Venue: TBD

Discussion

The ISC Plenary did not consider the current MLS modeling to be a suitable basis for new stock status and conservation information in part because the perception of stock status is quite different from the 2019 assessment. The Plenary discussed how to respond to the WCPFC request for input on the rebuilding plan. Going forward the focus will be to evaluate the growth assumptions in the 2022 assessment with the objective of producing an assessment that can be adopted at the ISC23. However, the development of a dynamic B0 reference point is a major accomplishment of the current assessment effort and will be of use to fishery managers in rebuilding plan development. Based on this work, a 20-year time window is recommended for the calculation of dynamic B0 reference points and projections. On the need to reevaluate this time window during each assessment, it was noted that it is important to consider conditions at the time the assessment is conducted to determine whether the time window is still appropriate.

The ISC Plenary concluded that the BILLWG should present the modeling work to the WCPFC-SC and WCPFC-NC meetings. The presentation should note that the base-case model, sensitivity or projection results are preliminary and do not form the basis for stock status and conservation information for the stock. A new assessment is expected to deliver stock status and conservation information in 2023. The report that is posted on the ISC website will also have to be changed accordingly. This action is important to avoid confusion on the advice going forward to the WCPFC-NC.

The ISC Plenary endorsed the BILLWG workplan for 2022-23.

5.4 Shark

M. Kai, SHARKWG Chair, provided a summary of SHARKWG activities over the past year (**ISC/22/ANNEX/04/07/10**). The focus of the SHARKWG was on NPO BSH with the goal of completing a benchmark stock assessment by ISC22. This benchmark stock assessment was requested in response to the ISC20 Plenary approving a change in the schedule for benchmark stock assessments of BSH and SMA in the NPO from three to five years between assessments. The SHARKWG met virtually 9-12, 16-17, and 19 November 2021, to conduct the data preparatory meeting for the benchmark stock assessment of the NPO BSH stock. The SHARKWG also held an online pre-assessment meeting 1-4 March 2022 for the decisions and discussions on the model settings, model diagnostics, and a suite of scenarios for the sensitivity analysis and future projections. The SHARKWG convened the web-meeting 19-22 and 26-28 April to conduct the benchmark stock assessment of the BSH.

The WG Chair briefly presented highlights of the WG meetings to the Plenary; **ISC/22/ANNEX/04/07/10** contains the report of the online full SHARKWG meetings. The WG Chair expressed appreciation to all participants in the SHARKWG meetings for their hard work at the meetings on the BSH benchmark stock assessment (**ISC/22/ANNEX/12**). The SHARKWG completed a very thorough and rigorous, fully integrated North Pacific BSH benchmark assessment that is based on the most complete fishery and biological data compiled for NPO BSH to date in addition to new “ensemble” modeling approach.

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

Potential Timing	Location	Purpose
Dec 5-9, 2022	Japan or web-meeting (depending on COVID-19 situation)	Improvement of fishery and biological data, and developments of data analysis and modeling approach for sharks.

Discussion

The ISC Plenary approved the SHARKWG workplan for 2022-23.

6 STOCK STATUS AND CONSERVATION INFORMATION

6.1 Pacific Bluefin

6.1.1 Pacific Bluefin Tuna Stock Assessment

S. Nakatsuka, the Chair of the PBFWG, presented a detailed report on the results of the PBF stock assessment conducted in March 2022 (**ISC/22/ANNEX/13**). As this assessment was a data update assessment, the WG developed the base-case model, which is basically consistent with the 2020 PBF assessment, with the most recent two years (2019-2020 FY).

Stock Identification and Distribution

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

Catch History

While there are few Pacific bluefin tuna (PBF) catch records prior to 1952, PBF landings records are available dating back to 1804 from coastal Japan and to the early 1900s for U.S. fisheries operating in the EPO. Based on these landing records, PBF catch is estimated to be high from 1929 to 1940, with a peak catch of approximately 47,635 t (36,217 t in the WPO and 11,418 t in the EPO) in 1935; thereafter catches of PBF dropped precipitously due to World War II. PBF catches increased significantly in 1949 as Japanese fishing activities expanded across the North Pacific Ocean. By 1952, a more consistent catch reporting process was adopted by most fishing nations and estimated annual catches of PBF fluctuated widely from 1952 to 2020 (Figure 6-1). During this period reported catches peaked at 40,383 t in 1956 and reached a low of 8,653 t in 1990. The reported catch in 2019 and 2020 was 11,557 t and 13,779 t, respectively, including non-member countries of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). Management measures were implemented by Regional Fisheries Management Organizations (RFMOs) beginning in 2011 (WCPFC in 2011 and IATTC in 2012) and became stricter in 2015. While a suite of fishing gears have been used to catch PBF, the majority of the catch is currently made by purse seine fisheries (Figure 6-2). Catch of PBF has been predominantly composed of juvenile PBF (age 0-2) throughout the assessment period. The catch of age 0 PBF has increased significantly since the early 1990s but declined as the total catch in weight declined since the mid-2010s due to stricter control of juvenile catch (Figure 6-1 and Figure 6-3).

Data and Assessment

Population dynamics were estimated using a fully integrated age-structured model (Stock Synthesis (SS) v3.30) fitted to catch (retained and discarded), size-composition, and catch-per-unit of effort (CPUE) based abundance indices data from 1952 to 2020 fishing years (FY; from July to June of the following year), provided by Members of the ISC, Pacific Bluefin Tuna Working Group (PBFWG) and non-ISC countries obtained through the Secretariat of the Pacific Community (SPC). Life history parameters included a length-at-age relationship from otolith-derived ages and natural mortality estimates from a tag-recapture study and empirical-life history methods. The assessment model is a single-area model and assumes "areas-as-fleets" fishery selectivity. The 2022 base-case model maintained most of the model structure and settings from the previous benchmark assessment in 2020.

A total of 25 fleets were defined for use in the stock assessment model based on country/gear/season/region stratification until the end of the 2020 FY (June 2021). Quarterly observations of catch and size compositions, when available, were used as inputs to the model to describe the removal processes. Annual estimates of standardized CPUE from the Japanese distant water, off-shore and coastal longline, the Taiwanese longline, and the Japanese troll fleets were used as measures of the relative abundance of the population. The CPUE data from Japanese longline (adult index) in 2020 and Japanese troll (recruitment index) after 2016 were not included in the model as these observations may be biased due to the additional management measures implemented in Japan. The assessment model was fitted to the input data in a likelihood-based statistical framework. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status and to develop stock projections.

After implementing minor improvements and refinements, the PBFWG found that the 2022 base-case model is consistent with the 2020 assessment results, that it fits the data well and the results are internally consistent among most of the data sources. Based on the model diagnostics, it was concluded that the model captures the production function of PBF well, thus its estimated biomass scale is reliable and the model has good predictability. Based on these observations, the PBFWG concluded that the 2022 assessment model reliably represents the population dynamics and is the best available scientific information for the PBF stock.

The base-case model results (Table 6-1), reported by fishing year (FY) unless otherwise specified, show that: (1) spawning stock biomass (SSB) fluctuated throughout the assessment period (1952-2020); (2) the SSB steadily declined from 1996 to 2010; (3) the SSB has increased since 2011 resulting in the 2020 SSB being back to the 1996 level; (4) total biomass after 2011 continued to increase with an increase in young fish, creating the 2nd highest biomass peak in the assessed history in 2020; (5) fishing mortality ($F_{\%SPR}$), which declined to a level producing about 1% of SPR[3] in 2004-2009, returned to a level producing 30.7% of SPR in 2018-2020; and (6) SSB in 2020 was 10.2% of $SSB_{F=0}$, an increase from the 5.6% of $SSB_{F=0}$ estimated for 2018 in the 2020 assessment (2018 was the last year of the 2020 assessment). Based on the model diagnostics, the estimated biomass trend for the last 40 years is considered robust although SSB prior to the 1980s is uncertain due to data limitations. The SSB in 2020 was estimated to be around 65,464 t (Table 6-1 and Figure 6-4), which is a 30,000 t increase from 2018 according to the base-case model. An increase of young fish (0-2 years old) biomass was observed in 2016-2020 (Figure 6-5), likely resulting from low fishing mortality on those fish (Figure 6-6) and is expected to accelerate the recovery of SSB in the future even further.

Figure 6-7 depicts the historical impacts of the harvest by fleet on the PBF stock, showing the estimated biomass when fishing mortality from the respective fleets is zero. The impact of the EPO fisheries group was large before the mid-1980s, decreasing significantly thereafter. From the mid-1980s to the late 1990s, the WPO coastal fisheries group has had the greatest impact on the PBF stock. Since the introduction of the WPO purse seine fishery group targeting small fish (ages 0-1), the impact of this group has rapidly increased, and the impact in 2020 was greater than any of the other fishery groups. The WPO longline fisheries group has had a limited effect on the stock throughout the analysis period because the impact of a fishery on a stock depends on both the number and size of the fish caught by each fleet; i.e., catching a high number of smaller juvenile fish can have a greater impact on future spawning stock biomass than catching the same weight of larger mature fish. In 2020, the estimated cumulative impact proportion between WPO and EPO fisheries is about 83% and 17%, respectively. There is greater uncertainty associated with the dead discards than other fishery impacts because the impact of discarding is not based on observed data (unseen catches in Figure 6-7).

Historical recruitment estimates have fluctuated since 1952 without an apparent trend (Figure 6-4). Currently, stock projections assume that future recruitment will fluctuate around the historical (1952-2019 FY) average recruitment level after the initial rebuilding target is reached. No significant autocorrelation was found in recruitment estimates, supporting the use in the projections of recruitment sampled at random from the historical time series. In addition, now that SSB has recovered to be larger than the historical median, the PBFWG considers that the assumption that future recruitment will fluctuate within the historical range is reasonable. The recruitment index based on the Japanese troll CPUE has proven to be an informative indicator of recruitment in PBF assessments. However, the present assessment does not use the recruitment index for the recent period (2017-2020) due to a possible change in catchability caused by a change in fishing operations following management intervention as well as operational changes

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

Due to a lack of data to inform trends in recent recruitment, the mean recruitment estimates for 2017-2020 are primarily estimated by the stock-recruitment relationship and are more uncertain than for other years. If recruitment in this period is below average, then the projections would be more pessimistic, while the impact on the current status would be minimal as those cohorts have not grown to contribute to the SSB. The PBFWG, therefore, investigated the projection results based on a model which includes the recruitment monitoring survey CPUE index for the recent period, which are slightly more pessimistic for recruitment in the terminal years of the assessment than the average recruitment. This analysis provided slightly more pessimistic results as compared to those using the base-case model, but the estimated effects on SSB are not sufficient to necessitate modification of the present management advice based on the base-case model. Note that the PBFWG decided not to include the recruitment monitoring index in the base case assessment as, due to its short duration (2017-2020), the PBFWG was unable to assess its reliability and consistency with other data sources in the model.

Estimated age-specific fishing mortalities (F) on the stock during the periods of 2011-2013 and 2018-2020 compared with 2002-2004 estimates (the reference period for the WCPFC Conservation and Management Measure) are presented in Figure 6-6. A substantial decrease in estimated F is observed in ages 0-2 in 2018-2020 FY relative to the previous years.

Biological Reference Points

The WCPFC and IATTC have adopted an initial rebuilding target (the median SSB estimated for the period from 1952 to 2014) and a second rebuilding target (20%SSB_0 under average recruitment) but did not implement any fishing mortality reference level. The 2022 assessment estimated the initial rebuilding biomass target ($SSB_{MED1952\text{-}2014}$) to be 6.3%$SSB_0$ and the corresponding fishing mortality expressed as SPR of $F_{6.3\%SPR.}$ The Kobe plot shows that the point estimate of the SSB_{2020} was 10.2%SSB_0 (i.e., SSB was approximately 50% of 20%SSB_0) and that the recent (2018-2020) fishing mortality corresponds to $F_{30.7\%SPR}$, reaching the historical lowest level (Table 6-1 and Figure 6-8). Although no reference points have been adopted to evaluate the status of PBF, an evaluation of stock status against some common reference points shows that the stock is overfished relative to the biomass-based limit reference points adopted for other species in WCPFC (20%SSB_0), but that the 2018-2020 fishing mortality was lower than the F corresponding to that reference point (20%SPR) ((1-$SPR_{2018\text{-}2020}$)/(1-$SPR_{20\%}$)=0.87 in Table 6-2. The PBFWG also investigated the impact of the alternative model incorporating the recruitment monitoring index on the estimation of stock status. This model estimated SSB to be 10.7%SSB_0 in 2020 and $F_{27.9\%SPR}$ in 2018-2020. Biomass and SPR estimates from this model do not differ substantively from the base-case model.

Projections

The PBFWG conducted projections based on the base-case model under several harvest scenarios and time schedules as requested by the RFMOs. The results are shown in Table 6-3 – Table 6-5 and Figure 6-9. Under all examined scenarios the second rebuilding target of WCPFC and IATTC, rebuilding to 20%SSB_0 by the 2029 fishing year (FY) (10 years after reaching the initial rebuilding target) with at least 60% probability, is reached, and the risk of SSB falling below the historical lowest observed SSB at least once in 10 years is negligible. Also, amongst the projection scenarios assessed, Scenario 5 (the conversion of small fish quota to large fish quota at the current conversion factor of 1.47) achieved the second highest SSB when the second rebuilding target was met and after 10 years relative to the old CMM, Scenario 10 (Table 6-4). The Kobe chart of the projection results shows that PBF SSB will recover to the 2nd rebuilding target due to reduced fishing mortality (Figure 6-10). In scenarios 6-9 where future impact ratios between WPO and EPO are specified by the RFMOs, the recovery probability or impact ratio was approximated during the search for the appropriate increase levels. More specifically, those scenarios were tuned to achieve the 2^{nd} rebuilding target (10 years after achieving the initial rebuilding target) with 60% probability, and as a result, the catch increases are much more aggressive than other scenarios.

The PBFWG evaluated projection results of sensitivity models with lower mortality, larger asymptotic length in the von Bertalanffy growth function, lower steepness, or the recent recruitment monitoring index fit. Though projection results from these lower productivity models are more pessimistic than those from the base-case model, the PBFWG concluded that the current advice is robust to these alternative model assumptions.

The projection results assume that the CMMs are fully implemented and are based on certain biological and other assumptions. For example, these future projection results do not contain assumptions about discard mortality. Although the impact of discards on SSB is small compared to other fisheries (Figure 6-7), discards should be considered in future harvest scenarios. Given the uncertainty in future recruitment and the influence of recruitment on stock biomass as well as the impact of changes in fishing operations due to the management, monitoring recruitment and SSB should continue.

A future Kobe chart and impacts by fleets estimated from projections under the current management scheme are provided in Figure 6-10 and Figure 6-11, respectively. Because the projections include catch limits, fishing mortality ($F_{x\%SPR}$) is expected to decline, i.e., SPR will increase, as biomass increases. The same information for all harvest scenarios are provided in the main body of the assessment report (**ISC/22/ANNEX/13**).

Discussion

The loss of the Japanese troll recruitment index and the longline CPUE index was again discussed. It was noted that management interventions affecting the utility of these types of indices is not uncommon. It was suggested that perhaps the ISC organize a workshop to develop guidelines around how to deal with these problems.

It was clarified that second rebuilding target is scaled to equilibrium SSB_0.

The Joint IATTC and WCPFC-NC Working Group on the Management of Bluefin Tuna (JWG) during its sixth session[4] requested that the ISC analyze the impacts of a transfer of 10% of the

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[4] See Annex E in WCPFC-NC 2021. Northern Committee Seventeenth Regular Session, Summary Report, 5-7 October 2021.

small fish limit to the large fish limit using a conversion factor of 0.68:1 small:large. The projection results in the update assessment show that the current conversion of small fish catch to large fish catch at the rate of 1.47 does not have negative effects on the stock recovery.

Further work to more accurately quantify discard mortality in the PBF fishery was encouraged. It was noted that mortality rates may vary depending on specific conditions, such as the number of PBF that need to be released from the net. If there are a lot of PBF in the net they are generally released by opening the net while if there are only a few more handling of individual fish may be involved, contributing to a higher discard mortality rate.

Likewise, improved reporting of catch in Japanese recreational fisheries was encouraged.

The Plenary reviewed the draft stock status and conservation information recommended by the PBFWG. It was noted that the fact that overfishing is no longer occurring is not explicitly mentioned due to the lack of adopted reference points, even though this conclusion is reasonable based on generally accepted reference points for tuna species.

The ISC Plenary endorsed the PBFWG response to the request posed by the Sixth Session of the JWG.

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

6.1.2 Stock Status and Conservation Advice

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:

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, 5 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 (Table 6-3), including $SPR_{20\%}$.**

Conservation Advice

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 in the time series.

Based on these findings, the following information on the conservation of the Pacific bluefin tuna stock is provided:

1. **The PBF stock is recovering from the historically low biomass in 2010 and has exceeded the initial rebuilding target ($SSB_{MED1952-2014}$) 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, these 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 the 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.**

Table 6-1. Total biomass, spawning stock biomass, recruitment, spawning potential ratio, and depletion ratio ($SSB/SSB_{F=0}$) of Pacific bluefin tuna (*Thunnus orientalis*) estimated by the base-case model, 1952-2020 FY.

Year	Total Biomass (t)	Spawning Stock Biomass (t)	Recruitment (1,000 fish)	Spawning Potential Ratio	Depletion Ratio
1952	134,789	103,359	14,008	11.6%	16.1%
1953	136,421	97,912	20,617	12.9%	15.2%
1954	146,892	88,019	34,911	7.9%	13.7%
1955	156,701	75,353	13,343	11.4%	11.7%
1956	176,167	67,818	33,476	15.8%	10.5%
1957	193,973	77,053	11,635	10.8%	12.0%
1958	202,415	100,943	3,203	19.5%	15.7%
1959	209,868	136,650	7,709	23.9%	21.2%
1960	202,700	144,704	7,554	17.3%	22.5%
1961	194,047	156,534	23,235	3.4%	24.3%
1962	177,257	141,792	10,774	10.9%	22.0%
1963	166,291	120,933	27,842	6.6%	18.8%
1964	154,459	106,314	5,689	7.5%	16.5%
1965	142,916	93,572	10,955	3.0%	14.5%
1966	120,164	89,589	8,556	0.1%	13.9%
1967	105,483	83,751	10,951	1.1%	13.0%
1968	91,650	77,872	14,356	1.4%	12.1%
1969	80,731	64,561	6,450	8.6%	10.0%
1970	74,490	54,181	7,182	2.9%	8.4%
1971	66,467	47,017	12,407	1.3%	7.3%
1972	64,098	40,725	22,890	0.3%	6.3%
1973	62,899	35,510	11,251	5.6%	5.5%
1974	65,165	28,711	13,983	6.3%	4.5%
1975	65,978	26,420	11,223	8.9%	4.1%
1976	65,030	29,152	8,071	3.1%	4.5%
1977	74,864	35,066	25,589	3.7%	5.4%
1978	76,566	32,974	14,317	5.0%	5.1%
1979	73,608	27,866	12,876	8.2%	4.3%
1980	72,844	29,713	6,554	6.2%	4.6%
1981	57,749	27,591	13,360	0.3%	4.3%
1982	40,714	24,235	6,454	0.0%	3.8%
1983	33,472	14,773	10,090	6.0%	2.3%
1984	37,662	12,895	9,063	5.3%	2.0%
1985	39,805	12,957	9,654	2.7%	2.0%
1986	34,473	15,316	7,939	1.1%	2.4%
1987	32,080	14,105	5,980	8.2%	2.2%
1988	38,238	15,059	9,483	11.0%	2.3%
1989	42,074	14,888	4,291	14.6%	2.3%
1990	57,971	18,994	17,436	18.4%	3.0%
1991	69,431	25,290	10,617	9.8%	3.9%
1992	76,142	32,456	3,968	14.7%	5.0%
1993	83,395	43,890	4,430	16.8%	6.8%
1994	97,472	50,177	29,319	13.5%	7.8%
1995	93,999	62,246	16,012	5.2%	9.7%
1996	96,300	61,563	17,964	8.8%	9.6%
1997	90,121	56,179	11,082	6.0%	8.7%
1998	95,748	55,612	16,075	4.2%	8.6%
1999	91,805	51,374	22,755	3.4%	8.0%
2000	76,307	48,461	14,385	1.7%	7.5%
2001	77,426	46,059	17,302	9.5%	7.2%
2002	75,311	43,899	13,541	5.7%	6.8%
2003	67,904	43,152	7,157	2.3%	6.7%
2004	65,640	35,881	27,746	1.4%	5.6%
2005	55,074	29,159	15,118	0.7%	4.5%
2006	43,314	23,294	13,540	1.1%	3.6%
2007	42,659	18,424	22,227	0.5%	2.9%
2008	38,290	13,716	21,072	0.6%	2.1%
2009	33,985	10,195	8,277	1.2%	1.6%
2010	36,969	9,761	17,952	2.4%	1.5%
2011	38,817	11,183	13,526	4.9%	1.7%
2012	42,482	13,902	7,169	8.2%	2.2%
2013	52,764	16,313	13,169	5.7%	2.5%
2014	53,075	19,185	3,641	11.1%	3.0%
2015	59,220	23,640	8,653	12.5%	3.7%
2016	69,494	30,516	16,690	12.8%	4.7%
2017	82,681	32,538	10,895	21.9%	5.1%
2018	103,849	35,741	11,145	28.3%	5.6%
2019	129,972	45,173	11,843	28.8%	7.0%
2020	156,517	65,464	11,316	35.1%	10.2%
Median(1952-2020)	74,864	35,881	11,635	6.2%	5.6%
Average(1952-2020)	89,353	49,845	13,390	8.3%	7.7%

Table 6-2. Ratios of the estimated fishing mortalities (Fs and 1-SPRs for 2002-04, 2011-13, and 2018-2020) relative to potential fishing mortality-based reference points, terminal year SSB (t) for each reference period, and depletion ratio (SSB/SSBF=0) for the terminal year of the reference period for Pacific bluefin tuna (*Thunnus orientalis*) from the base-case model. Fmax: Fishing mortality (F) that maximizes equilibrium yield per recruit (Y/R). F0.1: F at which the slope of the Y/R curve is 10% of the value at its origin. Fmed: F corresponding to the inverse of the median of the observed R/SSB ratio. Fxx%SPR: F that produces a given % of the unfished spawning potential (biomass) under equilibrium conditions.

Reference Period	Fmax	F0.1	Fmed	(1-SPR)/(1-$SPR_{xx\%}$)				Estimated SSB for terminal year of each period (ton)	Depletion rate for terminal year of each period (%)
				$SPR_{10\%}$	$SPR_{20\%}$	$SPR_{30\%}$	$SPR_{40\%}$		
2002-2004	1.96	2.89	1.16	1.08	1.21	1.38	1.61	35,881	5.6%
2011-2013	1.54	2.27	0.87	1.04	1.17	1.34	1.56	16,313	2.5%
2018-2020	0.75	1.14	0.33	0.77	0.87	0.99	1.15	65,464	10.2%

Table 6-3. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*).

Reference No	Harvesting scenarios: Catch upper limit increments from status quo, WCPO Small	WCPO Large	EPO Commercial	Catch limit in the projection, WCPO Small	WCPO Large	EPO Commercial	Note
1	New CMM			4,475	7,860	3,995	NC request (paragraph 1; New CMM) WCPFC CMM 2021-02, IATTC Resolution C-21-05
2	New CMM	+500 tons	+500 tons	4,475	8,360	4,495	NC request (Paragraph 1, Appendix table 1st line)
3	10% increase on the New CMM			4,948	8,621	4,395	NC request (Paragraph 1, Appendix table 2nd line)
4	20% increase on the New CMM			5,420	9,382	4,794	NC request (Paragraph 1, Appendix table 3rd line)
5	-580 tons	+853 tons	New CMM	3,895	8,713	3,995	NC request (paragraph 3; conversion factor scenario). Transferring 10% (JPN) and 25% (KOR) of small fish catch quota to their largefish catch quota with the defined conversion factor (1.47).
6	+30%	+30%	+190%	5,893	10,143	11,586	NC request (Achieving 2nd rebuilding target at 10 years after achieving initial rebuilding target in 60 % probability. Fishery impact ratio at rebuilding year is 75:25. Additional quota is assigned proportionally for the WPO fisheries and independently for the EPO commercial fisheries. The balance of additional quota between the WPO and EPO is adjusted to achieve the given fishery impact ratio between them.)
7	New CMM	+130%	+190%	4,475	17,752	11,586	NC request (Achieving 2nd rebuilding target at 10 years after achieving initial rebuilding target in 60 % probability. Fishery impact ratio at rebuilding year is 75:25. Additional quota is assigned only for the WPO large fish fisheries and EPO commercial fisheries. The balance of additional quota between the WPO and EPO is adjusted to achieve the given fishery impact ratio between them)
8	+60%	+60%	+90%	7,310	12,425	7,591	NC request (Achieving 2nd rebuilding target at 10 years after achieving initial rebuilding target in 60 % probability. Fishery impact ratio at rebuilding year is 80:20. Additional quota is assigned proportionally for the WPO fisheries and independently for the EPO commercial fisheries. The balance of additional quota between the WPO and EPO is adjusted to achieve the given fishery impact ratio between them.)
9	New CMM	+230%	+90%	4,475	25,362	7,591	NC request (Achieving 2nd rebuilding target at 10 years after achieving initial rebuilding target in 60 % probability. Fishery impact ratio at rebuilding year is 80:20. Additional quota is assigned only for the WPO large fish fisheries and EPO commercial fisheries. The balance of additional quota between the WPO and EPO is adjusted to achieve the given fishery impact ratio between them)
10	Old CMM (50% of 2002-04 average level)	Old CMM (2002-04 average level)	Old CMM	4,475	6,841	3,300	Old CMM
11	0	0	0	0	0	0	0 catch for all fisheries

* The Reference number of the Scenario is different from those given by the IATTC-WCPFC NC Joint WG meeting.

* Fishing mortality for scenario 1 is specified as the average level of age-specific fishing mortality during 2002-2004, which is the reference years in the WCPFC. Higher levels of the fishing mortality are specified for other scenarios to fulfill their quota in those projections.

* The Japanese unilateral measure (transferring 250 mt of catch upper limit from that for small PBF to that for large PBF during 2020-2034) is reflected in the projections.

Table 6-4. Future projection scenarios for Pacific bluefin tuna (*Thunnus orientalis*) and their results on the base-case model. 2nd rebuilding target is 20%$SSB_{F=0}$. SSB_{loss} is the lowest SSB observed.

Harvesting scenarios					Peformance indicators						
Reference No	WCPO		EPO		The fishing year expected to achive the 2nd rebuilding target with >60% probability	Risk to breach SSB_{loss} at least once by 2030	Probability of achiving the 2nd rebuilding target at 10 years after achieving initial rebuilding target [2029]	Median SSB at 10 years after achieving initial rebuilding target [2029]	Median SSB at 2034	Fishery impact ratio of WPO fishery at 10 years after achieving the initial rebuilding target [2029]	Fishery impact ratio of EPO fishery at 10 years after achieving the initial rebuilding target [2029]
	Small	Large	Small	Large							
1	New CMM				2023	0%	98.8%	262,795	307,336	81.1%	18.9%
2	New CMM	500 tons increase on the New CMM	500 tons increase on the New CMM		2023	0%	98.2%	256,170	298,867	80.3%	19.7%
3	10% increase on the New CMM				2023	0%	96.9%	245,333	280,687	82.3%	17.7%
4	20% increase on the New CMM				2023	0%	94.0%	227,183	253,598	83.4%	16.6%
5	-580 tons	+853 tons	New CMM		2023	0%	99.3%	269,289	319,863	80.2%	19.8%
6	+30%	+30%	+190%		2023	0%	64.1%	154,417	150,121	75.5%	24.5%
7	New CMM	+130%	+190%		2029	0%	60.0%	147,931	157,963	75.2%	24.8%
8	+60%	+60%	+90%		2023	0%	61.3%	147,275	135,698	80.6%	19.4%
9	New CMM	+230%	+90%		2030	0%	58.6%	145,058	160,473	78.3%	21.7%
10	Old CMM (50% of 2002-04 average level)	Old CMM (2002-04 average level)	Old CMM		2023	0%	99.4%	272,845	320,885	82.1%	17.9%
11	0	0	0		2022	0%	100.0%	478,465	578,729	83.0%	17.0%

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

* Recruitment is resampled from historical values.

Table 6-5. Expected yield for Pacific bluefin tuna (*Thunnus orientalis*) under various harvesting scenarios based on the base-case model.

Reference No	Harvesting scenarios: Catch upper limit increments from status quo – WCPO Small	WCPO Large	EPO Commercial	Catch upper limit in the projection – WCPO Small	WCPO Large	EPO Commercial	Future expected catch 2024 – WCPO Small	WCPO Large	EPO Commercial	EPO Sport	2034 – WCPO Small	WCPO Large	EPO Commercial	EPO Sport
1	New CMM			4,475	7,860	3,995	4,496	7,884	4,008	1,228	4,497	7,922	4,012	1,540
2	New CMM	500 tons increase on the New CMM	500 tons increase on the New CMM	4,475	8,360	4,495	4,496	8,366	4,506	1,216	4,496	8,419	4,510	1,513
3	10% increase on the New CMM			4,948	8,621	4,395	4,965	8,610	4,404	1,189	4,965	8,674	4,407	1,430
4	20% increase on the New CMM			5,420	9,382	4,794	5,434	9,307	4,801	1,150	5,435	9,413	4,802	1,318
5	-580 tons	+853 tons	New CMM	3,895	8,713	3,995	3,916	8,749	4,009	1,250	3,917	8,787	4,013	1,616
6	+30%	+30%	+190%	5,893	10,143	11,586	5,892	10,181	11,521	996	5,889	10,018	11,247	924
7	New CMM	+130%	+190%	4,475	17,752	11,586	4,492	17,733	11,552	1,012	4,491	17,144	11,486	1,079
8	+60%	+60%	+90%	7,310	12,425	7,591	7,240	12,502	7,594	979	7,211	12,073	7,512	841
9	New CMM	+230%	+90%	4,475	25,362	7,591	4,494	23,864	7,601	1,030	4,493	24,055	7,597	1,160
10	Old CMM (50% of 2002-04 average level)	Old CMM (2002-04 average level)	Old CMM	4,475	6,841	3,300	4,497	6,866	3,317	1,243	4,497	6,888	3,319	1,580
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0

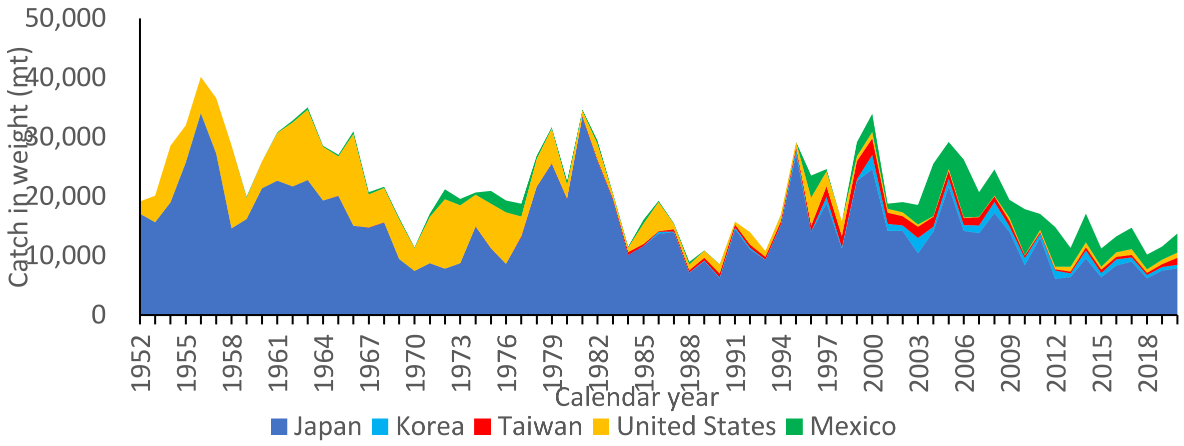


Figure 6-1 . Annual catch (ton) of Pacific bluefin tuna (*Thunnus orientalis*) by ISC member countries from 1952 through 2020 (calendar year) based on ISC official statistics.

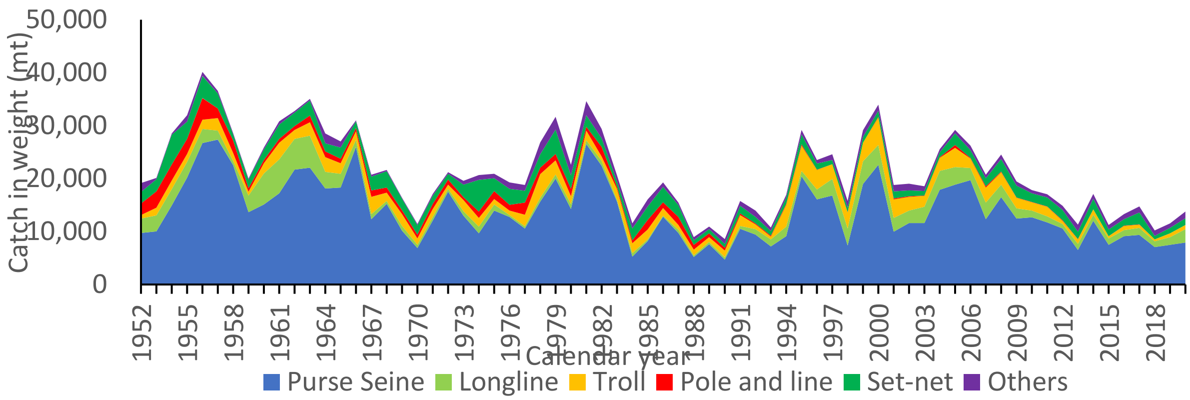


Figure 6-2 . Annual catch (ton) of Pacific bluefin tuna (*Thunnus orientalis*) by gear type by ISC member countries from 1952 through 2020 (calendar year) based on ISC official statistics.

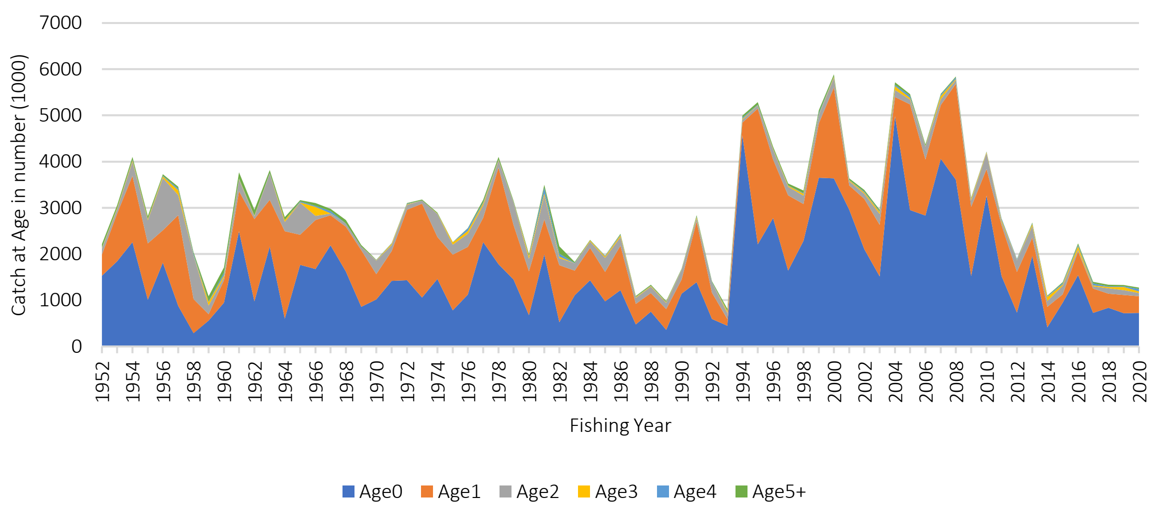


Figure 6-3 . Estimated annual catch-at-age (number of fish) of Pacific bluefin tuna (*Thunnus orientalis*) by fishing year by the base-case model (1952-2020).

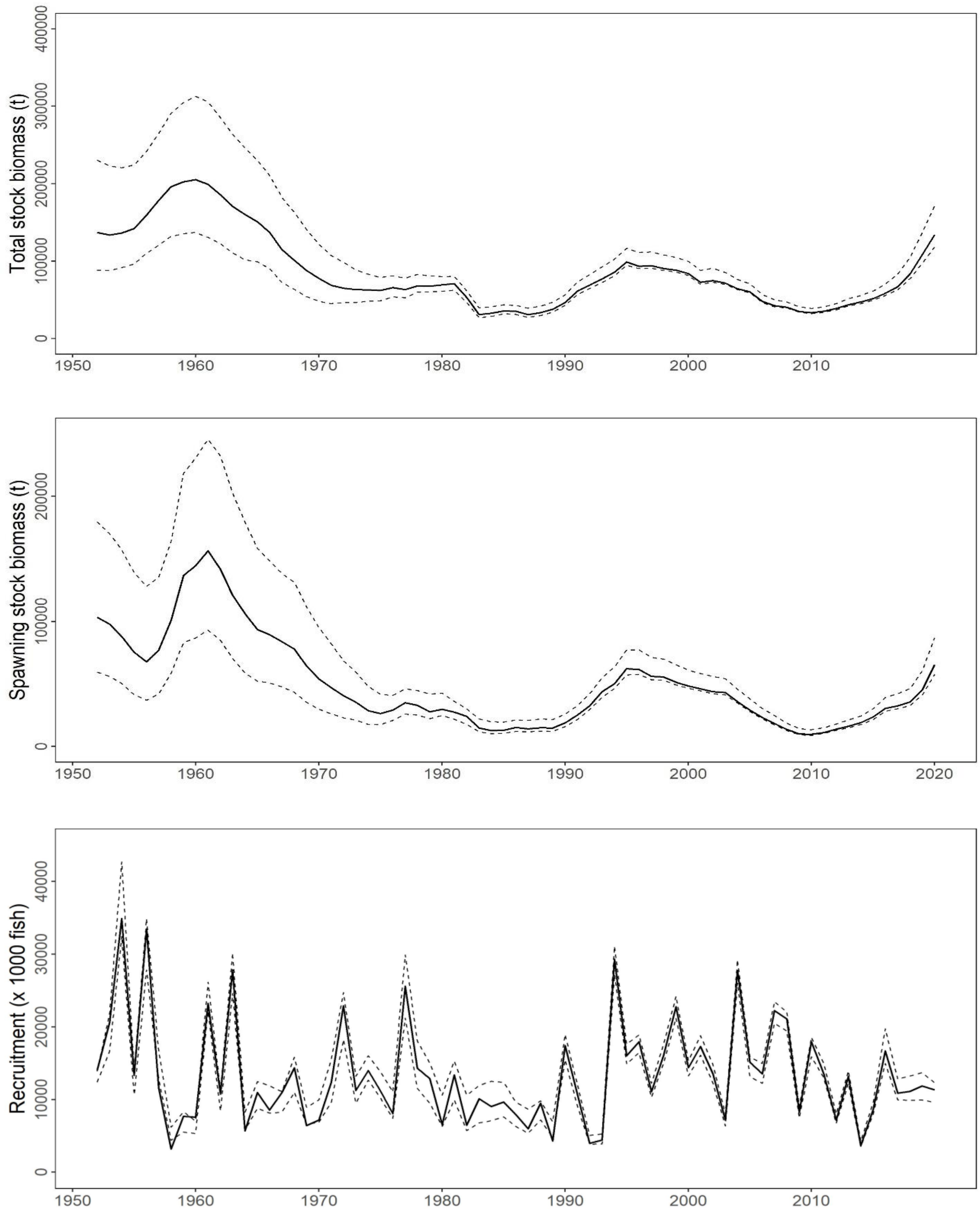


Figure 6-4. Maximum likelihood estimates of total stock biomass (top), spawning stock biomass (middle), and recruitment (bottom) of Pacific bluefin tuna (*Thunnus orientalis*) (1952-2020) estimated from the base-case model. The solid line represents the point estimates and dashed lines delineate the 90% confidence interval by bootstrapping. Note that the bootstrap confidence interval may not capture the full uncertainty around the recruitment estimates for 2017-2020.

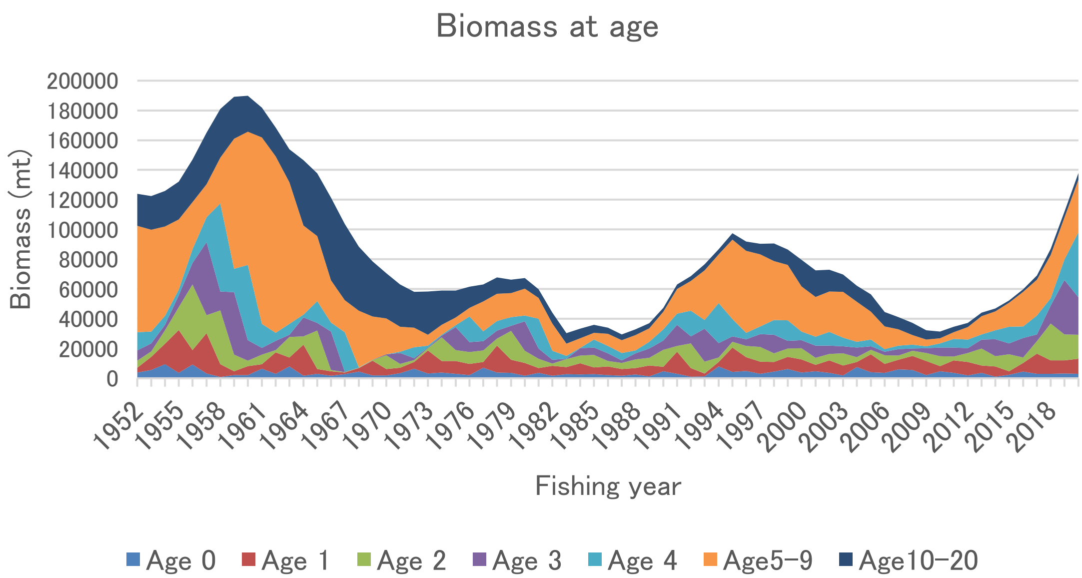


Figure 6-5. Total biomass (tonnes) by age of Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model (1952-2020). Note that the recruitment estimates for 2017-2020 may be more uncertain than in other years.

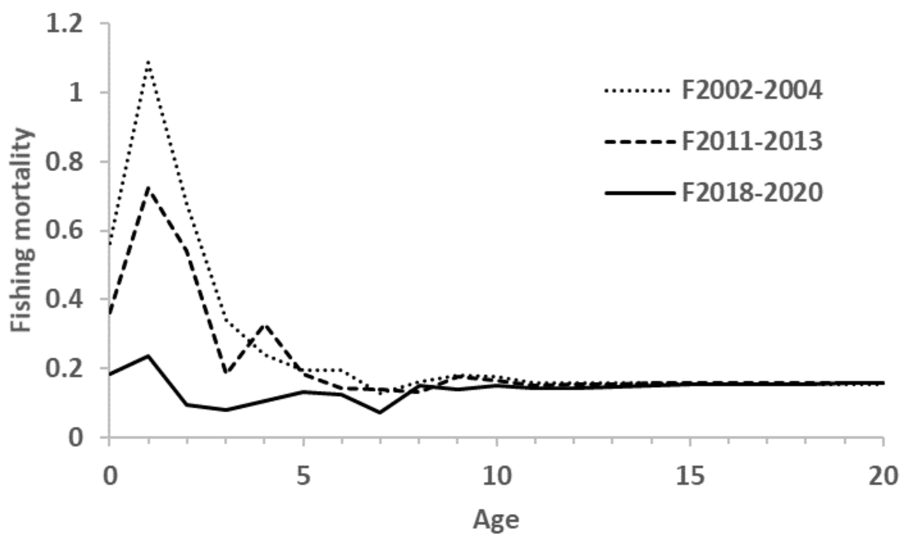
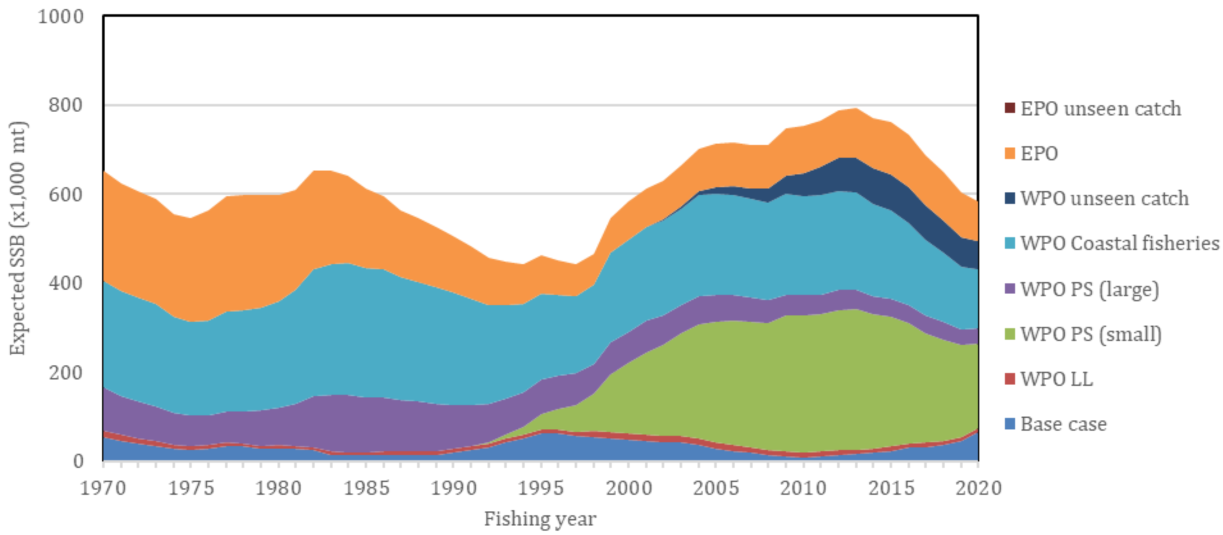


Figure 6-6. Geometric means of annual age-specific fishing mortalities (F) of Pacific bluefin tuna (*Thunnus orientalis*) for 2002-2004 (dotted line), 2011-2013 (broken line), and 2018-2020 (solid line).



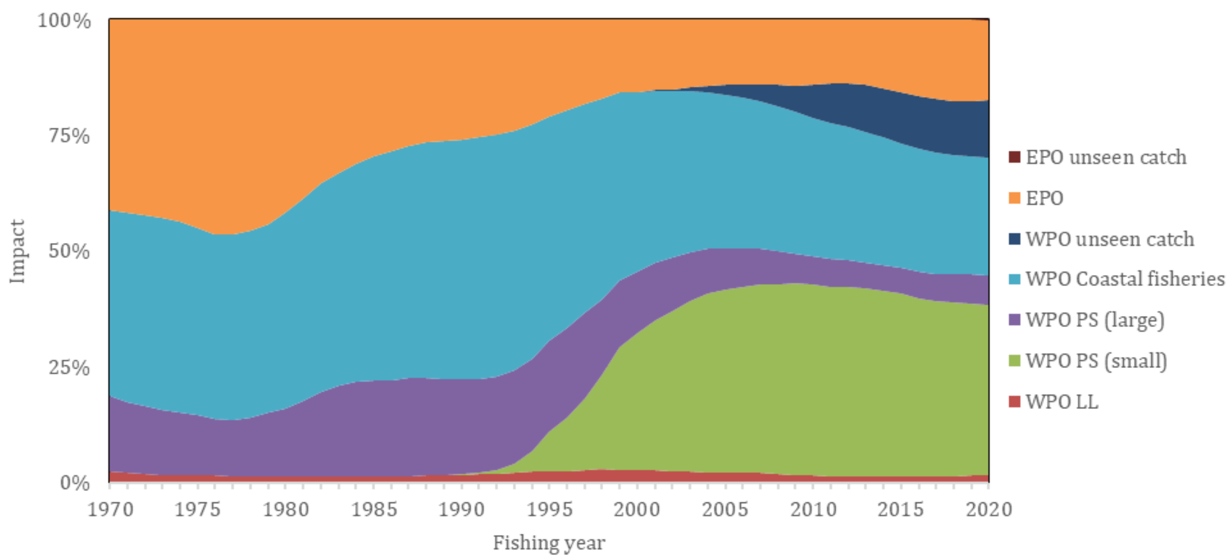


Figure 6-7. The trajectory of the spawning stock biomass of a simulated population of Pacific bluefin tuna (*Thunnus orientalis*) when zero fishing mortality is assumed, estimated by the base-case model. (top: absolute SSB, bottom: relative SSB).

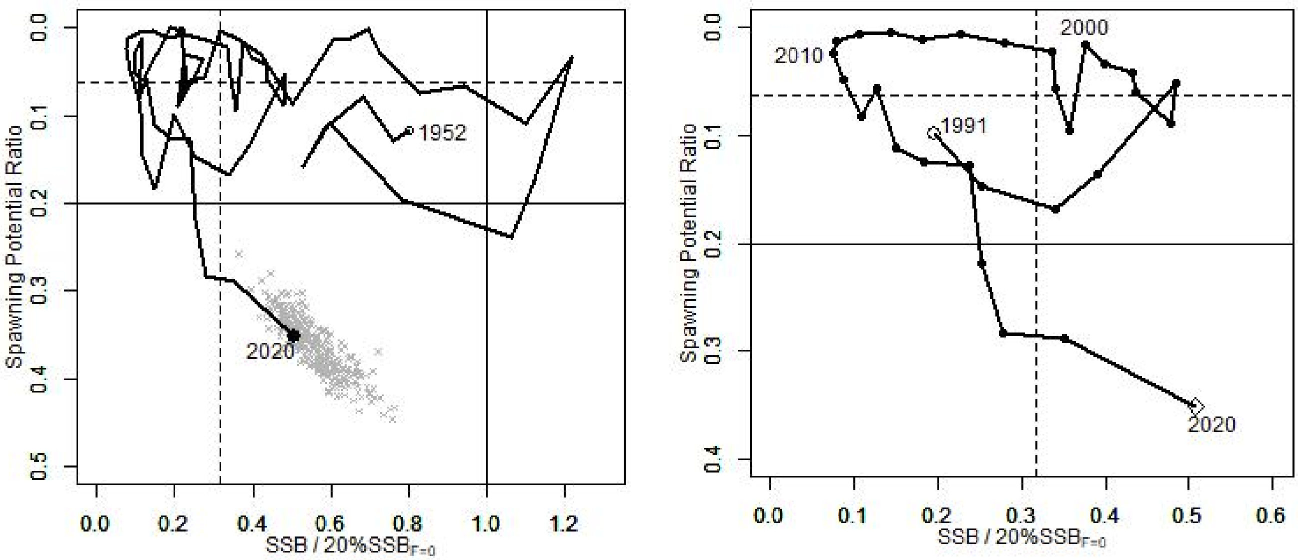


Figure 6-8. Kobe plots for Pacific bluefin tuna (*Thunnus orientalis*) estimated from the base-case model. The X-axis shows the annual SSB relative to 20%SSB$_{F=0}$ and the Y-axis shows the spawning potential ratio (SPR) as a measure of fishing mortality. Vertical and horizontal solid lines in the left figure show 20%SSB$_{F=0}$ (which corresponds to the second biomass rebuilding target) and the corresponding fishing mortality that produces SPR, respectively. Vertical and horizontal broken lines in both figures show the initial biomass rebuilding target (SSB$_{MED}$ = 6.3%SSB$_{F=0}$) and the corresponding fishing mortality that produces SPR, respectively. SSB$_{MED}$ is calculated as the median of estimated SSB in 1952-2014. The left figure shows the historical trajectory, where the open circle indicates the first year of the assessment (1952), the solid circle indicates the last year of the assessment (2020), and grey crosses indicate the uncertainty of estimates in 2020 using bootstrapping. The right figure shows the trajectory of the last 30 years.

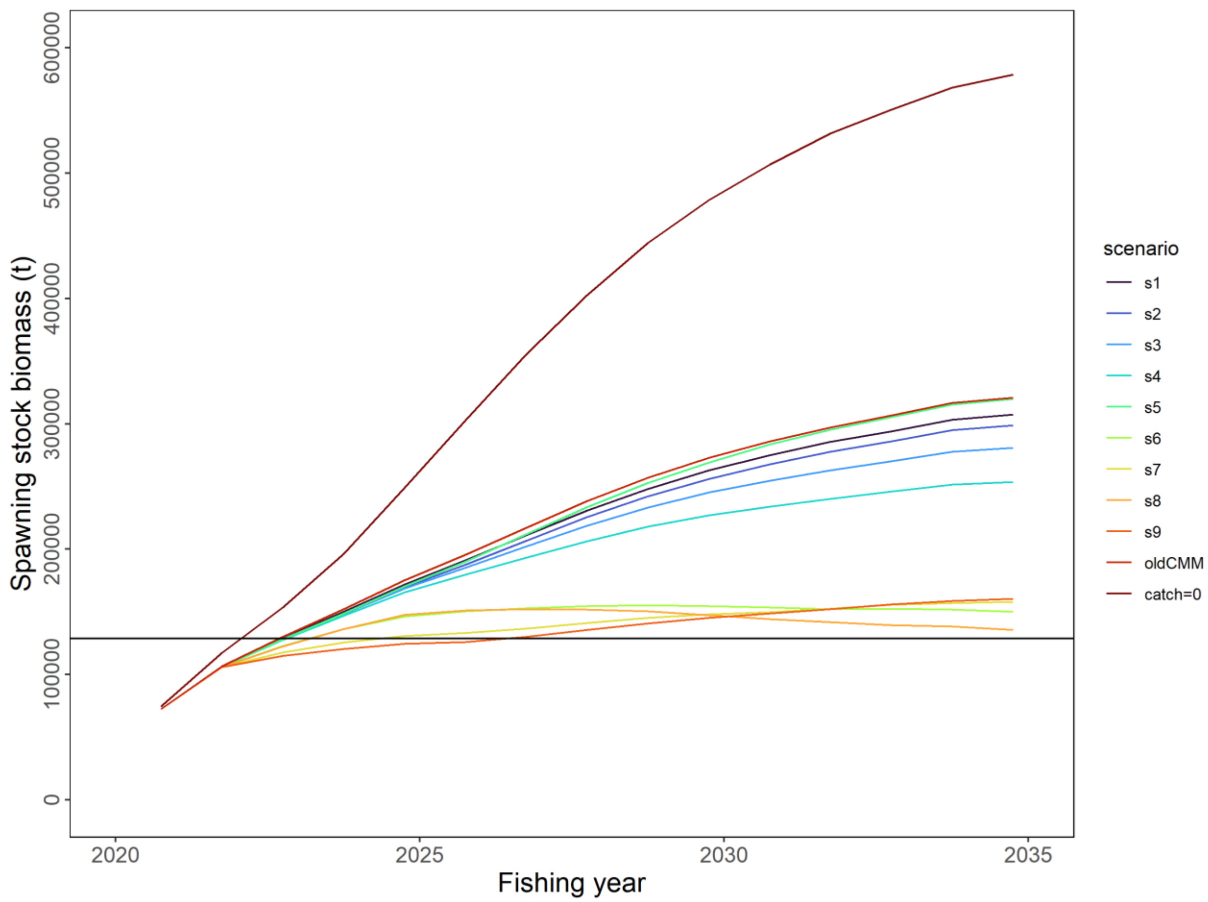


Figure 6-9. Comparisons of various projected median SSB for all harvest scenarios examined for Pacific bluefin tuna (*Thunnus orientalis*) obtained from projection results. The black horizontal solid line shows the second rebuilding target for this species (20%$SSB_{F=0}$).

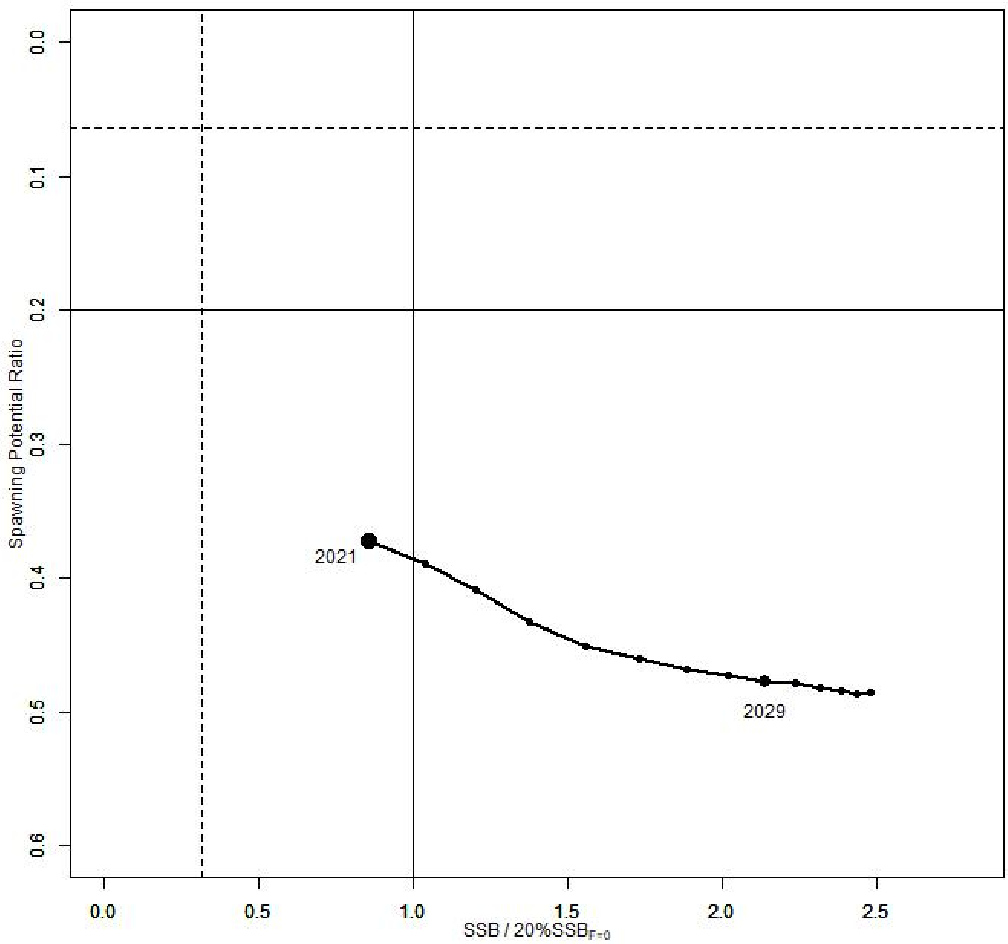


Figure 6-10. "Future Kobe Plot" based on the median estimates of SSB and SPR from the projections for Pacific bluefin tuna (*Thunnus orientalis*) from Scenario 1 in Table 6-3.

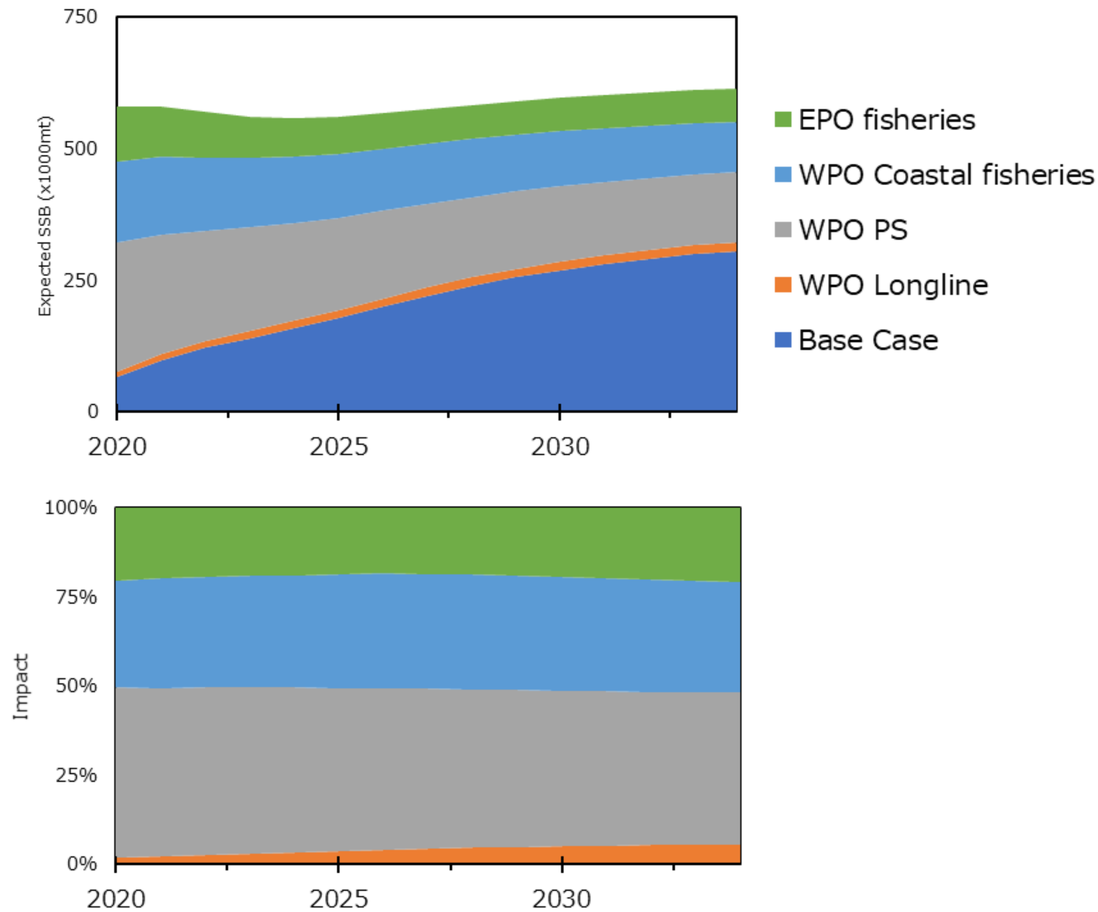


Figure 6-11. "Future impact plot" from projection results for Pacific bluefin tuna (*Thunnus orientalis*) from Scenario 1 of Table 6-3. The top figure shows absolute biomass and the bottom figure shows relative impacts. The impact is calculated based on the expected increase of SSB in the absence of the respective group of fisheries.

6.2 Albacore Stock Status and Conservation Information

S. Hawkshaw, ALBWG Chair, summarized the recommendations on stock status and conservation for NPO ALB from the last stock assessment presented at ISC20. The last stock assessment was conducted in 2020 and the next assessment is planned for 2023. Given there have been no updates to the NPO ALB stock assessment, and no additional substantive information has been presented to the ALBWG this year to suggest a change in stock status, the ALBWG recommends carrying forward the stock status and conservation information from ISC21. **The ISC Plenary endorsed this recommendation.**

The Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC21, which was based on the 2020 stock assessment (see Section 3.1.2 pp. 13-15 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables.

Stock Status

Estimated female SSB exhibits an initial decline until 2003 followed by fluctuations without a clear trend through 2018. The estimated average SPR (spawners per recruit relative to the unfished population) during 2015 – 2017 is 0.50 (95% CI: 0.36 – 0.64), which corresponds to a moderate fishing intensity (i.e., 1-SPR = 0.50). The WCPFC-NC, which manages this stock together with the IATTC, adopted a biomass-based LRP in 2014 of 20% of the current spawning stock biomass when F=0 ($20\%SSB_{current, F=0}$). The $20\%SSB_{current, F=0}$ LRP is based on dynamic biomass and fluctuates depending on changes in recruitment.

Stock status is depicted in relation to the LRP ($20\%SSB_{current, F=0}$) for the stock and the equivalent fishing intensity ($F_{20\%}$; calculated as $1\text{-}SPR_{20\%}$). Fishing intensity (F, calculated as 1-SPR) is a measure of fishing mortality expressed as the decline in the proportion of the spawning biomass produced by each recruit relative to the unfished state. The Kobe plot shows that the estimated female SSB has never fallen below the LRP since 1994, albeit with large uncertainty in the terminal year (2018) estimates. The SSB_{2018} was estimated to be 58,858 t (95% CI: 27,751 – 89,966 t) and 2.30 (95% CI: 1.49 – 3.11) times greater than the estimated LRP threshold of 25,573 t (95% CI: 19,150 – 31,997 t). Current fishing intensity, $F_{2015\text{-}2017}$, calculated as $1\text{-}SPR_{2015\text{-}2017}$, is 0.50 (95% CI: 0.36 – 0.64;).

Based on these findings, the following information on the status of the north Pacific albacore stock is provided:

1. **The stock is likely not overfished relative to the limit reference point adopted by the Western and Central Pacific Fisheries Commission ($20\%SSB_{current, F=0}$), and**
2. **No F-based reference points have been adopted to evaluate overfishing. Stock status was evaluated against seven potential reference points. Current fishing intensity ($F_{2015\text{-}2017}$) is likely at or below all seven potential reference points.**

Conservation Information

Two harvest scenarios were projected to evaluate impacts on future female SSB: F constant at the 2015-2017 rate over 10 years ($F_{2015-2017}$) and constant catch[5] (average of 2013-2017 = 69,354 t) over 10 years. Although the projections appear to underestimate the future uncertainty in female SSB trends, the probability of breaching the LRP in the future is likely small if the future fishing intensity is around current levels.

The following conservation information is provided:

1. **If a constant fishing intensity ($F_{2015-2017}$) is applied to the stock, then median female spawning biomass is expected to increase to 62,873 t and there will be a low probability of falling below the limit reference point established by the WCPFC by 2028; and**
2. **If a constant average catch ($C_{2013-2017}$ = 69,354 t) is removed from the stock in the future, then the median female spawning biomass is also expected to increase to 66,313 t and the probability that SSB falls below the LRP by 2028 will be slightly higher than the constant fishing intensity scenario.**

The constant catch harvest scenario projected in the last stock assessment used the average catch from 2013-2017, which was 69,354 t. Since 2017, the total NPO ALB catch has been below the $C_{2013-2017}$ average, except for in 2020 when the estimated total catch was 70,401 t. The preliminary estimate of total catch in 2021 is estimated to be 69,505 t, which is close to the $C_{2013-2017}$ average.

6.3 Blue Shark

6.3.1 Stock Assessment

N. Ducharme-Barth, the lead modeler, presented the results of the stock assessment for NPO BSH conducted by the SHARKWG (**ISC/22/ANNEX/12**). The last stock assessment was conducted in 2017. A fully integrated, size-based, age-, and sex-structured model was used in 2022 and included updated time series data through 2020 (catch, abundance indices, and sex-specific length composition from multiple fisheries), incorporation of new biological information, consideration of an alternative CPUE (catch-per-unit-effort) hypothesis for the late model period, and adoption of an ensemble modeling approach.

Stock Identification and Distribution

Blue sharks (BSH) are widely distributed throughout the temperate and tropical waters in the Pacific Ocean. The ISC SHARKWG recognizes two stocks in the North and South Pacific

[5] It should be noted that the constant catch scenario is inconsistent with current management approaches for north Pacific albacore tuna adopted by the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC).

Oceans, respectively, based on biological and fishery evidence. Relatively few BSH are encountered in the tropical equatorial waters separating the two stocks. Tagging data demonstrate long distance movements and a high degree of mixing of BSH across the North Pacific Ocean. However, there is evidence of spatial and temporal structure by size and sex.

Catch History

Catch records for BSH in the North Pacific Ocean are limited and, where lacking, have been estimated using statistical models and information from a combination of historical landing data, fishery logbooks, observer records, and research surveys. In these analyses, estimated BSH catch data refer to total dead removals, including retained catch and dead discards. Estimated catch data in the North Pacific Ocean date back to 1971, although longline and driftnet fisheries targeting tunas and billfish earlier in the 20^{th} century likely caught BSH. The nations catching most BSH in the North Pacific Ocean include Japan, Chinese Taipei, Mexico, and the USA, and account for more than 90 % of the estimated catch over the assessment period (Figure 6-12). Estimated catches of BSH were highest from 1976 to 1989, with an estimated peak catch of approximately 70,895 t in 1981. Over the past decade, BSH estimated catches in the North Pacific Ocean have stabilized to an average of 29,613 t annually during the 2011 to 2020 period (26,468-34,097 t). While a variety of fishing gears catch BSH, most are caught in longline fisheries (89-97 % of total catch) after the ban on high-seas driftnet fisheries in 1993.

Data and Assessment

Annual catch estimates were derived for a variety of fisheries by nation. Catch and size composition data were grouped into 20 fisheries from 1971 to 2020. Standardized CPUE data used to measure trends in relative abundance were provided by Chinese Taipei, Japan, Mexico, the Secretariat of the Pacific Community (SPC) Oceanic Fisheries Programme, and the USA.

The BSH in the North Pacific Ocean was assessed using a fully integrated, size-based, age-, and sex-structured model, Stock Synthesis (SS3; V3.30.19.01), fit to time series of standardized CPUE and sex-specific size composition data. Sex-specific growth curves and natural mortality rates were used to account for the sexual dimorphism of adult BSHs. A low-fecundity stock-recruitment relationship (SR) was used in the previous assessment to explain the lower survival ratio before recruitment after partition. ISC SHARKWG, however, recognized that more research is needed before the SR option is fully operationalized in this assessment because the parameters (α and β) of the low-fecundity SR were based on strong assumptions relating to the unfished stock-recruitment relationship. The ISC SHARKWG therefore determined to use a Beverton-Holt SR, which has been commonly used in the assessment of BSH and other pelagic sharks in other oceans.

Input parameter values for models considered in the ensemble were chosen based on the best available information regarding the life history of BSH in the North Pacific Ocean and knowledge of the historical catch time series and existing fishery data. Standardized CPUE from the Japanese Kinkai shallow (Japanese offshore and distant-water longline shallow-set) fleets that operate out of Hokkaido and Tohoku ports for the early period (1976-1993) was used for all models in the ensemble (S5 index; Figure 6-13**)** For the late period (1994-2020), two indices were considered as measures of relative population abundance in the model ensemble: the Japanese Kinkai shallow index (S6; Figure 6-13) and a Dynamic Factor Analysis (DFA) composite index (S11; Figure 6-13). The composite-CPUE was derived using DFA applied to three candidate indices: Hawaii deep-set longline index; Chinese Taipei large-scale longline index (LTLL); Japanese research and training vessel deep-set longline. The Japanese Kinkai shallow longline index comes from a fishery that seasonally targets BSH and covers a wide operational area in the main distribution area of BSH, encounters BSH across a large size range, and has a long operational period. The DFA-derived CPUE index combines three indices that show similar trends in CPUE and are derived from observer data or research and training vessel data. The combined index represents fisheries that primarily target tunas via deep-setting behavior across a broad range of the central Pacific Ocean and typically select larger individuals relative to the Japanese shallow-set index.

Models were 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 across the three models in the ensemble and to develop stock projections.

A model ensemble was used because a comparison of model fits to the Japanese Kinkai shallow longline index (S6) used in the previous assessment and model fits to the composite-CPUE index (S11), as well as other commonly used model diagnostics (fit comparisons, residual analysis, R_0-profile, Age-Structured-Production-Model, Retrospective analysis, and Jitter analysis), did not conclusively identify a better model. Both models showed retrospective bias in the estimation of absolute biomass and fishing mortality. This issue was improved in the composite-CPUE model by down weighting the large input sample sizes for the Chinese Taipei small scale longline (STLL) length composition data in 2018 and 2020. Accordingly, the composite-CPUE model was separated into two hypotheses with and without the down-weighting of the Chinese Taipei size data from the STLL fishery in 2018 and 2020. Based on the results of these analyses, uncertainty regarding the choice of BSH abundance indices led to a three-model ensemble approach for this assessment. The model ensemble assumed equal weighting (50%) for the two CPUE hypotheses, with the composite CPUE hypothesis further separated into two sub-hypotheses with equal weighting (each 25% of the total ensemble weight) for the models with and without down-weighting of the Chinese Taipei size data from the STLL fishery.

Stock projections of biomass and catch for BSH in the North Pacific Ocean from 2021 to 2030 were conducted assuming four alternative fishing mortality (F) scenarios: 1) status quo F ($F_{CURRENT}$, 2017-2019); 2) F at the maximum sustainable yield (MSY) (F_{MSY}); 3) 20% higher F than average value ($F_{20\%plus}$); 4) 20% lower F than average value ($F_{20\%minus}$). Recruitment was assumed to follow the SR with sigma-R and selectivity parameters fixed to the value from the terminal year in 2020.

Uncertainty in stock status for the main assessment and projection periods was characterized across the ensemble using 100,000 samples from a multivariate lognormal (MVLN) parametric bootstrap. The median for each management quantity and associated uncertainty (e.g., 80th percentile) was derived from the combined distribution of samples from the three models to more completely capture the structural and estimation uncertainty in stock status. Additionally, 27 one-off sensitivity analyses were conducted across the ensemble with alternative data/parameters to explore uncertainty in the input data and life history parameters that were not already captured in the three ensemble models.

Discussion

The plenary agreed to the change to the stock-recruitment relationship from the low fecundity stock-recruitment relationship (LSFR) to the Beverton-Holt SR, and the plenary acknowledged that further study is needed to apply the LFSR to this stock. The Plenary confirmed with the WG that for the future projection where F is set at the MSY level the biomass went below B_{MSY}. It was clarified that this result was obtained because catch was much higher at MSY in that scenario and because terminal biomass was above B_{MSY}. Additionally, there is a lag between removing the catch and estimated biomass.

It was agreed that probability statements related to stock status should be expressed in a consistent way.

Because the F_{MSY} harvest scenario in the projections produces substantially different results in terms of fishing mortality and spawning stock biomass, the ISC Plenary agreed that the conservation information should note those differences in addition to reporting the ensemble results.

The ISC Plenary endorsed the north Pacific BSH stock assessment and considers it to be the best available scientific information for the stock, noting the concerns expressed by the SHARKWG in their special comments after the Conservation Information.

6.3.1 Stock Status and Conservation Advice

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 (Figure 6-14-**A, B**). 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 (Figure 6-14-**C, D**). 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 (Figure 6-14-**E)**. The historical trajectories of stock status from the model ensemble revealed that North Pacific BSH had experienced some level of depletion and overfishing in previous years, showing that the trajectories moved through the overfishing zone, overfished and overfishing zone, and overfished zone in the Kobe plots relative to MSY-based reference points (Figure 6-15). However, in the last two decades, median estimates of the stock condition returned to the bottom-right quadrant of the Kobe plot. Estimates of key management quantities for the North Pacific blue shark SS3 stock assessment model ensemble are shown in Table 6-6.

Based on these findings, the following information on the status of the NPO BSH is provided:

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 was estimated to be 1.170 of SSB_{MSY} (80^{th} 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.**

Conservation information

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. Projected SSB trajectories for the alternative management scenarios are shown in Table 6-7 and Figure 6-16.

Based on these findings, the following conservation information is provided:

1. **Future projections in three of the four harvest scenarios ($F_{current}$ (2017-2019), $F_{current}$+20%, and $F_{current}$-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 North Pacific Ocean 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} (Figure 6-16); and**
3. **There remain some uncertainties in the time series based on the quality (observer vs. 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.**

The Plenary noted that the average annual catch of BSH by ISC members in 2017-2019 was 24,090 t. Catches in 2020 and 2021 were 23,816 t and 17,078 t, respectively, lower than the three-year average. As ISC member countries account for at least 90% of the overall catch, these figures are believed to provide a reliable estimator of catch in North Pacific BSH.

Special note

The decision to adopt an ensemble modeling approach instead of a single base-case modeling approach was made late in the assessment model development process when it became apparent that there was no clear best base-case model. A consensus on adopting a model ensemble approach was reached and the SHARKWG showed flexibility in adapting to the challenges imposed by the late change on its identification, understanding, development, and discussion of appropriateness of the candidate models. Although timelines can be adjusted to give more opportunity for discussion of key model developments, the SHARKWG should maintain the flexibility shown in the current assessment to adapt to unforeseen aspects of model development.

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.

Table 6-6. Estimates (median and 80th percentiles) of key management quantities for the North Pacific blue shark SS3 stock assessment model ensemble.

Management Quantity	Unit	Model Ensemble	80th percentile of bootstrapping
B_0*	t	1,214,595	
SSB_0*	t	222,736	
$\ln(R_0)$*	numbers	9.559268	
SSB_{1971}*	t	158,324	
SSB_{1972}	t	149,903	104,977 – 223,884
SSB_{2020}	t	92,954	38,695 – 179,870
SSB_{MSY}*	t	83,545	
F_{1971}*	per year	0.36	
F_{1971}	per year	0.26	0.16 - 0.42
$F_{2017\text{-}2019}$	per year	0.33	0.18 - 0.74
F_{MSY}*	per year	0.76	
SSB_{2020}/SSB_{MSY}		1.17	0.570-1.776
$F_{2017\text{-}2019}/F_{MSY}$		0.445	0.236-1.011
$P(SSB_{2020}>SSB_{MSY})$		63.5%	
$P(F_{2017\text{-}2019}<F_{MSY})$		91.9%	
$P(SSB_{2020}>SSB_{MSY}$ and $F_{2017\text{-}2019}<F_{MSY})$		61.9%	

**The weighted mean across the ensemble is given for these quantities since it is unavailable from the parametric bootstrap.*

Table 6-7. Projected trajectory (median) of spawning stock biomass (in metric tons) for alternative harvest scenarios.

Year	Average F +20%	F_{MSY}	Average F -20%	Average $F_{2017\text{-}2019}$
2021	91,469	92,158	91,707	91,613
2022	90,826	85,954	92,096	91,489
2023	91,044	83,524	93,902	92,240
2024	93,878	82,681	98,034	94,718
2025	95,195	81,283	102,324	97,349
2026	99,385	81,482	106,332	99,853
2027	101,943	81,391	110,446	103,502
2028	104,333	81,296	114,099	105,987
2029	106,374	81,005	117,424	108,386
2030	108,041	80,770	120,542	110,949

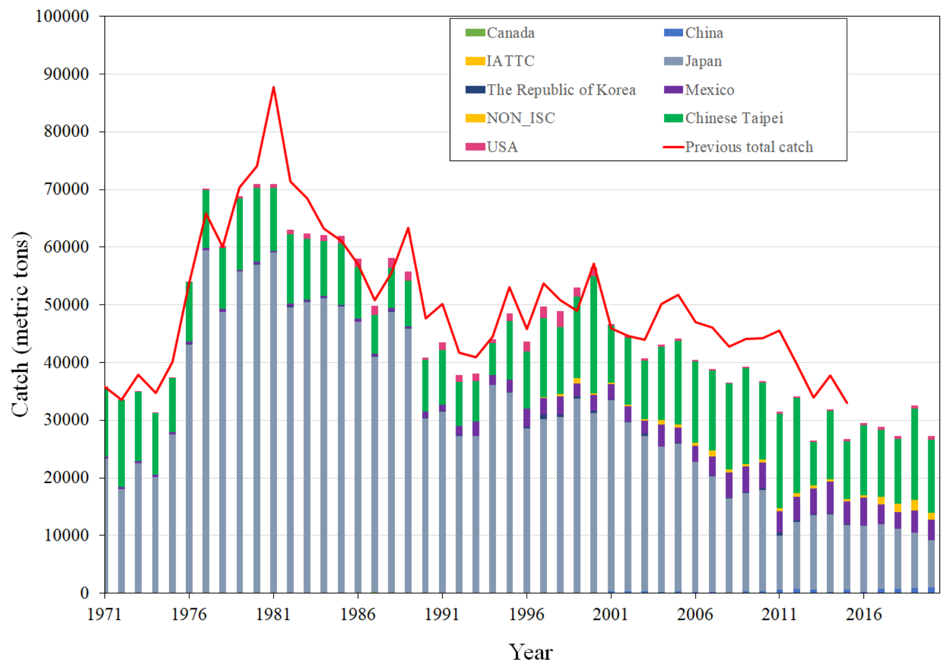


Figure 6-12. Total catch (total dead removals) of North Pacific blue shark by nation or region.

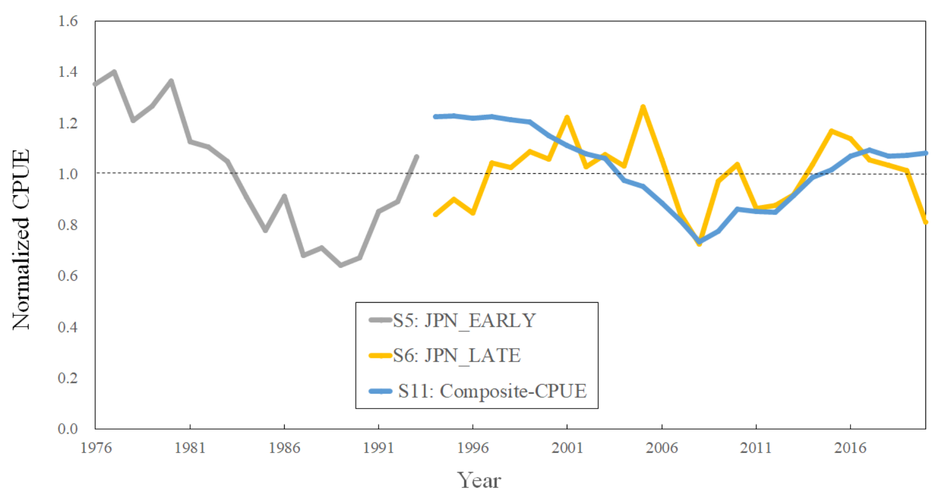


Figure 6-13. Annual standardized CPUE of North Pacific blue shark during 1976 through 1993 (Japanese Kinkai shallow longline: JPN_EARLY) and two standardized CPUE time series of blue shark between 1994 and 2020 (Japanese Kinkai shallow longline: JPN_LATE, DFA_LATE with Hawaii deep-set longline, Taiwanese large-scale longline and Japanese research and training vessel)

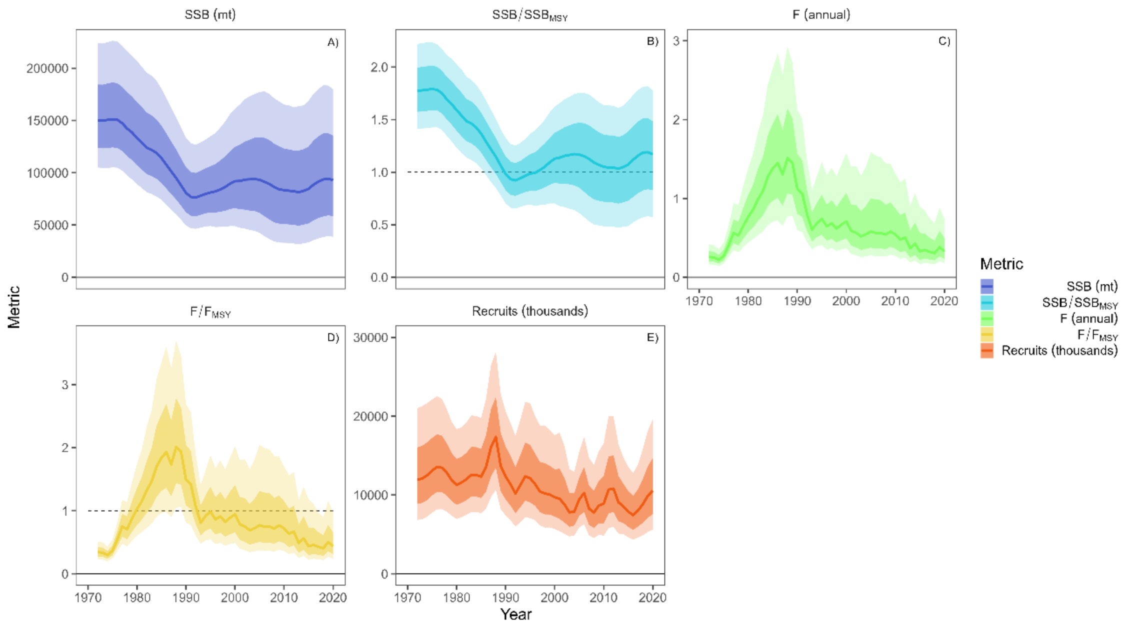


Figure 6-14. Results of the SS3 stock assessment model ensemble: (upper left) estimated female spawning stock biomass (SSB; metric tons) relative to MSY level (horizontal broken line); (upper middle) estimated fishing mortality (sum of F's across all fishing fleets) relative to MSY level (horizontal broken line); (upper right) estimated female SSB; (lower left) estimated fishing mortality (sum of F's across all fishing fleets); (lower middle) estimated age-0 recruits. Light and dark shaded areas of all figures denote 80 and 50% percentiles around the median estimate, respectively.

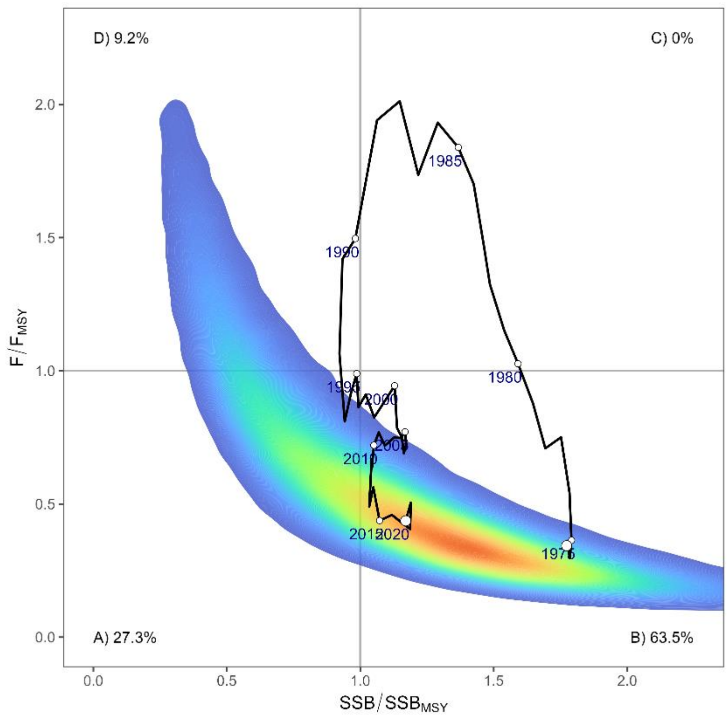


Figure 6-15. Kobe plots of the historical trends in estimates of relative fishing mortality (F) and spawning stock biomass (SSB) of North Pacific blue shark between 1971-2020 for the ensemble model and the density plot of the uncertainty (warmer color indicates higher probability of the stock status). Each zone denotes the stock status of a) overfished and not overfishing zone, b) not overfishing and not overfished zone, c) overfishing and not overfished zone, and d) overfishing and overfished zone relative to MSY reference points.

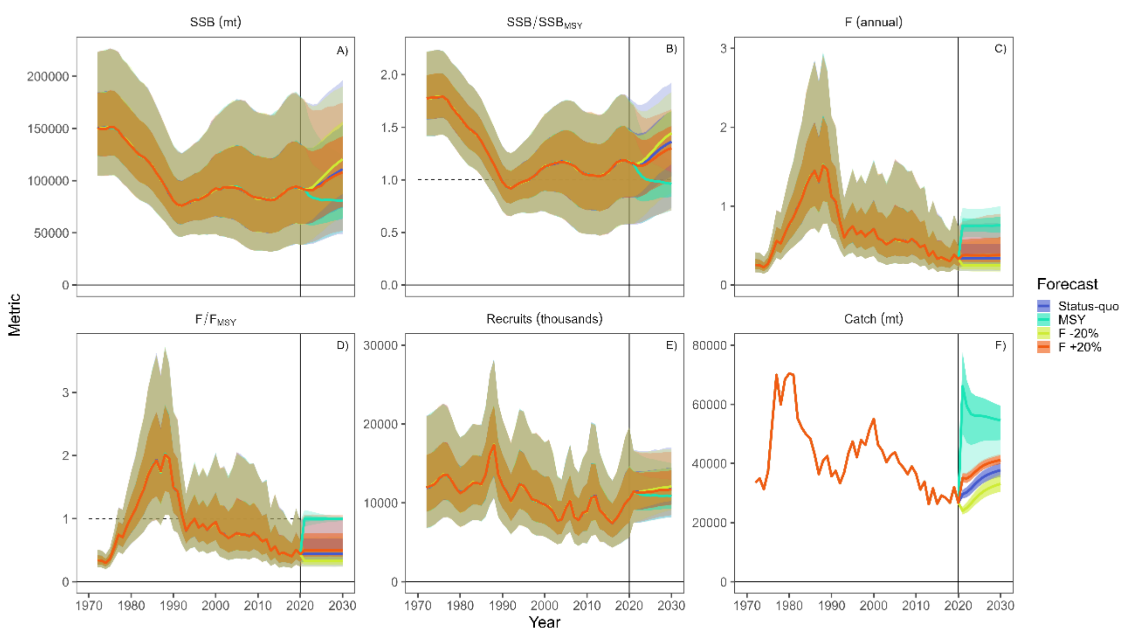


Figure 6-16. Comparison of future projected north Pacific blue shark female spawning stock biomass (SSB) under different fishing mortality (*F*) harvest policies (*status quo*, +20%, -20%, and F_{MSY}) using the SS reference case model. *Status quo* fishing mortality was based on the average from 2017-2019.

6.4 Shortfin Mako Shark Stock Status and Conservation Information

M. Kai, the SHARKWG Chair, noted that the NPO SMA stock was last assessed in 2018 and an indicator analysis was conducted in 2021.

Based on the conclusions of the SMA indicator analysis, the Plenary agreed to forward the stock status and conservation information adopted at ISC21 (see Section 3.4.4, pp. 46-48 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables.

Stock Status

The reproductive capacity of the NPO 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.

The following information on SMA stock status is provided:

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.**

Conservation Information

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 ($F_{2013-2015}$); 2) $F_{2013-2015}$ + 20%; and 3) $F_{2013-2015}$ - 20%.

Based on these future projections, the following conservation information is provided:

1. **In scenarios where fishing mortality remains constant at $F_{2013-15}$ 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 $F_{2013-2015}$, 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.**

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 1,180 t from 2016-2019. Catches in 2020 and 2021 were 1,101 t and 1,040 t, respectively, lower than the three-year average.

6.5 Western and Central North Pacific Swordfish Stock Status and Conservation Information

H. Ijima, the BILLWG Chair, noted that the WCNPO SWO stock was last assessed in 2018 and that the next assessment is planned for 2023.

The Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC21 (see Section 3.4.4, pp. 34-36 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables and slight clarifying modifications.

Stock Status

Estimates of total stock biomass of WCNPO SWO show a relatively stable population, with a slight decline until the mid-1990s followed by a slight increase since 2000. Population biomass (age-1 and older) averaged roughly 97,919 t in 1974-1978, the first 5 years of the assessment time frame, and has declined by only 20% to 71,979 t in 2016. Female SSB was estimated to be 29,403 t in 2016, or about 90% above SSB_{MSY}. Fishing mortality on the stock (average F, ages 1 – 10) averaged roughly F = 0.08 yr^{-1} during 2013-2015, or about 45% below F_{MSY}. The estimated SPR (the predicted spawning output at the current F as a fraction of unfished spawning output) is currently SPR_{2016}= 45%. Annual recruitment averaged about 717,000 fish during 2012-2016, and no long-term trend in recruitment was apparent. Overall, the time series of spawning stock biomass and recruitment estimates show a stable spawning stock biomass and a fluctuating pattern without trend for recruitment. The Kobe plot depicts the stock status relative to MSY-based reference points for the base case model and shows that spawning stock biomass declined to almost the MSY level in the mid-1990s, but SSB has remained above SSB_{MSY} throughout the time series.

Biomass status is based on female SSB in the 2018 benchmark assessment, whereas in the 2014 update assessment biomass status was based on exploitable biomass (effectively age-2+ biomass). It is also important to note that retrospective analyses show that the assessment model appears to underestimate spawning stock biomass in recent years.

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

1. **There are no currently agreed upon reference points for the WCNPO SWO stock;**

2. **The WCNPO SWO stock has produced annual yields of around 10,200 t per year since 2012, or about two-thirds of the MSY catch amount; and**
3. **Overall, the WCNPO SWO stock is not likely overfished (SSB_{2016} is 87% above SSB_{MSY}) and is not likely experiencing overfishing ($F_{2013\text{-}2015}$ is 45% of F_{MSY}) relative to MSY-based or 20% of unfished spawning biomass-based reference points.**

Conservation Information

Stock projections were conducted using a two-gender projection model. The five stock projection scenarios were: (1) $F_{current}$ (2013-2015), (2) F_{MSY}, (3) F at 20%$SSB_{F=0}$, (4) $F_{20\%}$, and (5) $F_{50\%}$. These projection scenarios were applied to the base case model results to evaluate the impact of alternative levels of fishing intensity on future spawning biomass and yield for WCNPO SWO. The projected recruitment pattern was generated by stochastically sampling the estimated stock-recruitment model from the base case model. The projection calculations employed model estimates for the multi-fleet, multi- season, size- and age-selectivity, and structural complexity in the assessment model to produce consistent results.

Based on these findings, the following conservation information is provided:

1. **The results show that projected female spawning biomass is expected to increase under all of the harvest scenarios, with greater increases expected under lower fishing mortality rates; and**
2. **Similarly, projected catch is expected to increase under each of the five harvest scenarios, with greater increases expected under higher fishing mortality rates.**

6.6 Eastern Pacific Swordfish Stock Status and Conservation Advice

H. Ijima, the BILLWG Chair, noted that the EPO SWO stock was last assessed in 2018. No further assessments are planned as stock boundaries have changed and the fish in this stock will be included in a southern EPO SWO stock and the WCNPO stock (see Discussion below). The ISC Plenary reviewed and agreed to forward the stock status and conservation information adopted at ISC21 (see Section 3.3.5, pp. 36-38 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables.

Stock Status

Exploitable biomass (age 2+) of the EPO SWO stock decreased during the 1969-1995 period and increased from 31,000 t in 1995 to over 60,000 t by 2010, generally remaining above B_{MSY}. Harvest rates were initially low, have had a long-term increasing trend, and likely exceeded H_{MSY} in 1998, 2002, 2003, as well as in 2012, the terminal year of the last stock assessment.

Based on these findings, the following information on the status of the EPO SWO stock is provided:

1. **No target or limit reference points have been established for the EPO SWO stock under the auspices of the IATTC. Stock status is assessed relative to MSY-based reference points;**
2. **The Kobe plot shows that overfishing likely occurred (>50%) relative to potential MSY-based reference points in the late 1990s and early 2000s and from 2010 to 2012; and**
3. **There was a 55% probability that overfishing occurred in 2012, but there was less than a 1% probability that the stock was overfished relative to MSY-based reference points.**

<u>Conservation Information</u>

The risk analyses for harvesting a constant catch of EPO SWO during 2014-2016 showed that the probabilities of overfishing and becoming overfished increased as projected catch increased in the future. Maintaining the current (2010-2012) catch of EPO SWO of approximately 9,700 t would lead to a 50% probability of overfishing in 2016 and a less than 1% probability of the stock being overfished in 2016.

Based on these findings, the following conservation information is provided:

1. **For the EPO SWO stock, overfishing may have occurred (<50% probability) from 2010 to 2012, and the average yield of roughly 10,000 t in those years, or almost two times higher than the estimated MSY, is not likely to be sustainable in the long term;**
2. **While biomass of the EPO stock appears to be nearly twice B_{MSY}, any increases in catch above recent (3-year average 2010-2012) levels should consider the uncertainty in stock structure and unreported catch; and**
3. **The stock boundaries for SWO in the Pacific have been redefined with the cooperation of SPC and IATTC. The Southern EPO SWO assessment (IATTC) and the WCNPO SWO assessment (ISC) will account for the fish caught in this stock for future assessments. The BILLWG will conduct a WCNPO SWO assessment in 2023, after which the ISC will no longer provide advice on the EPO SWO stock.**

<u>Discussion</u>

The Plenary discussed the proposed changes in stock boundaries for Pacific SWO stocks that were agreed to by the IATTC, SPC and ISC scientists (Figure 6-18). The BILLWG Chair explained that the proposed change to the stock boundaries is based on new movement information from tagging studies (Sepulveda et al. 2020[6], BILLWG discussion summarized in **ISC/21/ANNEX/08**). It was also noted that there may be some stock mixing between WCNPO

[6] Sepulveda, C.A,, Wang, .M, Aalbers, S.A., and Alvarado-Bremer, J.R., 2020. Insights into the horizontal movements, migration patterns, and stock affiliation of California swordfish. Fisheries Oceanography 29:152-168.

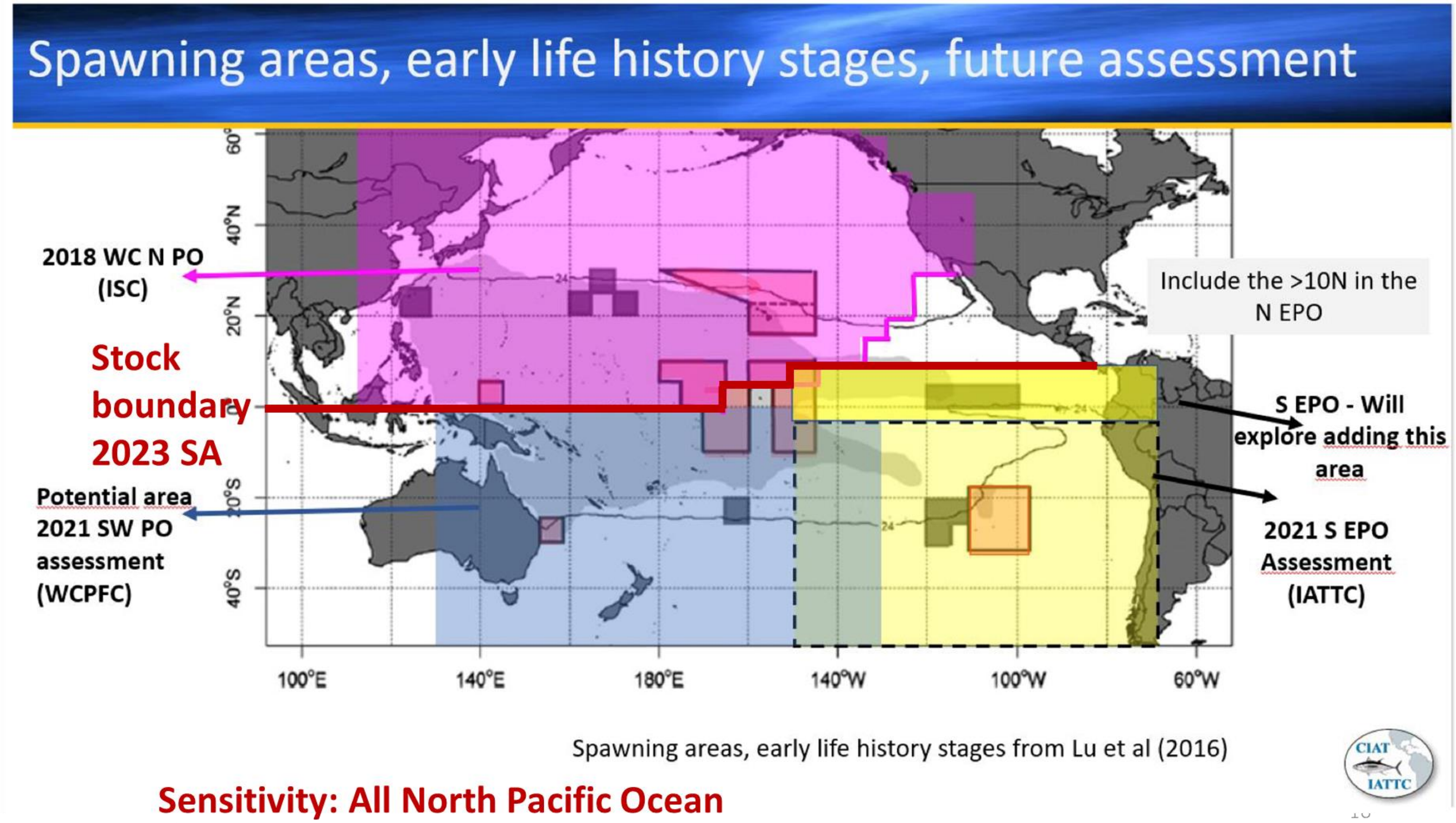


Figure 6-17. New boundaries for the WCNPO, Southern EPO and SW Pacific SWO stocks. SWO in the white triangle area north of the S EPO stock will be included in the next WCNPO SWO assessment conducted by the ISC.

and EPO SWO in the roughly triangular area defined by the current stock boundary, 10˚N latitude, and the coast of the Americas. The IATTC is planning to conduct an assessment for the EPO stock south of 10˚N latitude and east of 150˚W longitude (Figure 6-17). The BILLWG will conduct a WCNPO SWO assessment including the EPO area southeast of the current stock boundary to the Americas as a separate area.

The Plenary noted that the current stock status and conservation advice for EPO SWO, carried forward from ISC21, is based on the pre-existing stock boundary and is inconsistent with stock boundaries proposed for future assessments in the north and south EPO.

6.7 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 and slight clarifying modifications.

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 were 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 have been relatively flat until the present. The minimum spawning stock biomass is estimated to be 17,592 mt in 2006 (5% above SSB_{MSY}, the spawning stock biomass to produce MSY, 95% C.I. 14,512-20,703 mt, SSB/SSB_{MSY} 95% C.I. 0.70-1.01). In 2019, SSB = 24,272 mt 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 $F = 0.13$ during 2017-2019, or 40% below F_{MSY}, and in 2019, F=0.11 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. Blue marlin is expected to be highly productive due to its rapid growth and high resilience to reductions in spawning potential. Although fishing mortality has approached MSY and exceeded MSY from 2003 to 2006, the biomass of the stock has remained above MSY. With continued decreases in Pacific BUM catch and fishing effort, the stock is expected to remain within MSY limits. When the status of BUM is evaluated relative to MSY-based reference points, the 2019 spawning stock biomass of 24,272 t is 17% above *SSB_{MSY}* (20,677 t, 95% C.I. -13% to +50%) and the 2017-2019 fishing mortality is 50% below F_{MSY} (95% C.I. 37% to 69%).

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

1. **No target or limit reference points have been established for Pacific blue marlin by the WCPFC or the IATTC;**
2. **Female spawning stock biomass was estimated to be 24,241 mt in 2019, or about 17% above SSB_{MSY} and 17% above 20%SSB_0;**
3. **Fishing mortality on the stock (average F, ages 1 to 10) averaged roughly F = 0.13 during 2016-2019, or about 40% below F_{MSY} and 28% below $F_{20\%SSB0}$; and**
4. **Blue marlin stock status from the ensemble model indicates that relative to MSY-based reference points, overfishing was very likely not occurring (>90% probability) and Pacific blue marlin 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. BUM stock status from the ensemble model indicates that the current median spawning biomass is above SSB_{MSY} and that the current median fishing mortality is below F_{MSY}. However, uncertainty in the stock status indicates a 19% chance of Pacific BUM being overfished relative to SSB_{MSY}. Both the old and new growth models show evidence of spawning biomass being above SSB_{MSY} and fishing mortality being below F_{MSY} during the last 5 years. Catch biomass has been declining for the last 5 years, and therefore the stock has a low risk of experiencing overfishing or being overfished unless fishing mortality increases to above F_{MSY} based upon stock projections. However, it is also important to note that retrospective analyses show that the assessment model tends to overestimate biomass and underestimate fishing mortality in recent years, in part due to rapid changes in longline CPUE.

Based on these findings, the following conservation information is provided:

1. **It is very unlikely that the stock is overfished (SSB_{2019} is 17% above SSB_{MSY}) or that overfishing is occurring ($F_{2016-2019}$ is 40% of F_{MSY}) relative to MSY-based reference points;**
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 that overfishing is occurring by 2029 under each harvest scenario is low (<50% probability).**

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 Billfish Sampling program to improve those estimates.**

Discussion

The Plenary tasked the BILLWG to provide a status update on the biological sampling program for ISC23.

6.8 WCNPO Striped Marlin

6.8.1 Stock Assessment

H. Ijima, the BILLWG Chair, provided a detailed presentation of data and modeling improvements and their performance developed for assessing the WCNPO MLS stock.

The ISC22 Plenary reviewed the new WCNPO MLS modeling and considers it a work in progress but not a completed assessment from which stock status and conservation information can be formulated. This new work includes some important improvements to address previously recognized uncertainties in the data and model, but a significant issue was identified with the choice of growth curve that affects the perception of stock status. Until this issue is resolved, the ISC22 Plenary cannot provide stock status and conservation information based on the 2022 modeling and in the interim will bring forward information from the 2019 assessment with some updates. **The ISC22 Plenary approved the BILLWG workplan to explore the growth curve and complete a benchmark WCNPO MLS assessment for approval at ISC23 (see Section 5.3).**

Stock Identification and Distribution

The WCNPO MLS (*Kajikia audax*) stock area was defined to be the waters of the NPO 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. 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.

Catches

WCNPO MLS catches were high from the 1970's to the 1990's averaging about 7,200 t per year during 1977-1999, and have decreased to an annual average of 2,500 t during 2018-2020. Catches by Japanese fleets have decreased and catches from the US and Chinese Taipei have varied without trend, while minor catches by other WCPFC countries have generally increased (Figure 6-18). Overall, longline fishing gear has accounted for the vast majority of WCNPO MLS catches since the 1990's while catches by the Japanese driftnet fleet were predominant during the 1977 to 1993 period.

Data and Assessment

Catch and size composition data were collected from ISC countries (Japan, Chinese Taipei, and USA) and the WCPFC. Standardized catch-per-unit effort data used to measure trends in relative abundance were provided by Japan, USA, and Chinese Taipei. The WCNPO MLS stock was assessed using an age- and length-structured assessment Stock Synthesis model fit to time series of standardized CPUE and size composition data. Life history parameters for growth and female maturity at length were changed for this preliminary benchmark stock assessment. The value for stock-recruitment steepness used for the base case model was $h = 0.87$ as in the previous benchmark assessment. The assessment model was fitted to relative abundance indices (Figure 6-19) 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

The WCPFC at WCPFC18 requested that the BILLWG provide reference points based upon a dynamic B_0 calculation. The BILLWG concluded that a 20 year period should be used to estimate dynamic B_0 reference points. Therefore potential reference points will be reported as 20% of the $SSB_{F=0}$, where $SSB_{F=0}$ is averaged over the last 20 years (2001-2020), which corresponds to about 4 mean generation times for WCNPO MLS.

Projections

Stock projections for WCNPO MLS will be conducted using SS3.30 with no recruitment deviations or log-bias adjustment applied. The absolute future recruitments are based on two recruitment scenarios: the expected stock-recruitment relationship and the average recruitment in the last 20 years. Projections will start in 2020 and continued through 2040 under five levels of fishing mortality and the two recruitment scenarios. The five fishing mortality stock projection scenarios were: (1) $F_{current}$ (average F during 2018-2020), (2) F_{MSY}, (3) F at $20\%SSB_{(F=0)}$, (4) F_{High} at the highest 3-year average during 1975-2017, and (5) F_{Low} at $F_{30\%}$.

<u>Discussion</u>

There was considerable discussion about the change in the growth curve used in the assessment, which produced substantially different results from the last assessment. Two issues with the 2022 MLS modeling were the focus of this discussion: (1) an insufficiently documented change to the growth curve used in the modeling; and (2) a sensitivity run substituting the 2019 biological parameters into the 2022 model that failed to achieve model convergence. First, Sun et al. (2011) concluded the Richards growth curve is the best growth assumption for WCNPO MLS. However, in the 2011-2019 assessments, the SS3 modeling platform could not use the Richards curve directly and thus the Richards curve of Sun et al. (2011) was transformed into a von Bertalanffy growth curve. The 2022 assessment used the von Bertalanffy curve from Sun et al. (2011) rather than the transformed Richards growth curve. The current version of SS3 is able to directly use the Richards growth curve in the assessment model.

Second, the sensitivity run using the 2019 biological parameters was intended to provide a bridging analysis between 2019 and 2022 work. In order to complete this comparison of the base case model, the model would need to be adequately tuned.

The WG did not achieve consensus on the use of the new growth curve and therefore the current modeling is considered a work in progress until more information can be gathered to determine the appropriate growth curve to use. Because the ISC Plenary considered this work as an uncompleted assessment, discussion focused on the upcoming presentation to WCPFC SC18. It was agreed that a general overview of the assessment should be presented with a statement that results are preliminary. It was also agreed the stock status and conservation advice from the 2019 assessment would be maintained until the 2023 benchmark is completed and accepted.

The ISC Plenary endorsed the improvements to the data, modeling and structural assumptions used in the2022 WCNPO MLS modeling, but considers it a work in progress and so will indicate that the results are preliminary at this time. The Plenary endorsed the WG recommendation to calculate dynamimc B_0 based on a 20-year period, 2001-2020.

6.8.2 Stock Status and Conservation Information

The Plenary agreed to forward the stock status information that was adopted by ISC21 (see Section 3.3.6, pp. 38-40 in the ISC21 Plenary Report) unchanged, except for the omission of accompanying figures and tables and slight clarifying modifications. Furthermore, the Plenary agreed to a modification of the conservation information adopted by ISC21 in light of clarifications regarding the rebuilding plan initiated by the WCPFC. The ISC Plenary also reiterates the concerns expressed by the BILLWG in their special comments about the stock assessment (**ISC/19/ANNEX/11**) that are reproduced below.

<u>Stock Status</u>

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

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

1. **There are no established reference points for WCNPO MLS; and**
2. **Results from the base case assessment model show that under current conditions the WCNPO MLS stock is likely overfished (>50% probability) and is likely subject to overfishing (>50% probability) relative to MSY-based reference points.**

Conservation Information

The status of the WCNPO MLS stock shows evidence of substantial depletion of spawning potential (SSB_{2017} is 62% below SSB_{MSY}), however fishing mortality has fluctuated around F_{MSY} in the last four years. The WCNPO MLS stock has produced average annual yields of around 2,100 t per year since 2012, or about 40% of the MSY catch amount. However, the majority of the catch are likely immature fish. All the projections show an increasing trend in spawning stock biomass during the 2018-2020 period, with the exception of the high F scenario under the short-term recruitment scenario. This increasing trend in SSB is due to the 2017 year class, which is estimated from the stock-recruitment curve and is more than twice as large as recent average recruitment.

Based on these findings and the ISC conclusion on recruitment scenarios, the following conservation information is provided:

1. **In response to a request from NC15, both long-term and short-term recruitment scenarios were evaluated. The ISC concluded that the short-term recruitment model was the most appropriate model to use for conducting stochastic stock projections for WCNPO MLS because the time trend in the recruitment is not captured by the long-term recruitment scenario;**
2. **If the stock continues to experience recruitment consistent with the short-term recruitment scenario (2012-2016), then catches must be reduced to 60% of the WCPFC catch quota from CMM 2010-01 (3,397 t) to 1,359 t in order to achieve a 60% probability of rebuilding to 20%SSB_0=3,610 t by 2022. This change in catch corresponds to a reduction of roughly 37% from the recent average yield of 2,151 t. Note that the rebuilding target of 3,160 t identified in this statement is not expressed as a dynamic B_0 calculation; and**
3. **WCPFC18 requested that the BILLWG provide WCNPO Striped Marlin reference points for a rebuilding plan (Attachment L, WCPFC16 Summary Report) using a dynamic B_0 estimate of 20%$SSB_{F=0}$. The BILLWG concluded that WCNPO Striped Marlin reference points will be provided with reference to MSY and with reference to 20%$SSB_{F=0}$ averaged over the recent 20-year time frame (2001-2020).**

It was noted that retrospective analyses (**ISC/19/ANNEX/11**) show that the assessment model appears to overestimate spawning potential in recent years, which may mean the projection results are ecologically optimistic.

Special Comments

The WG achieved a base-case model (in 2019) using the best available data and biological information. However, the WG recognized uncertainty in some assessment inputs including drift gillnet catches and initial catch amounts, life history parameters such as maturation and growth, and stock structure.

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

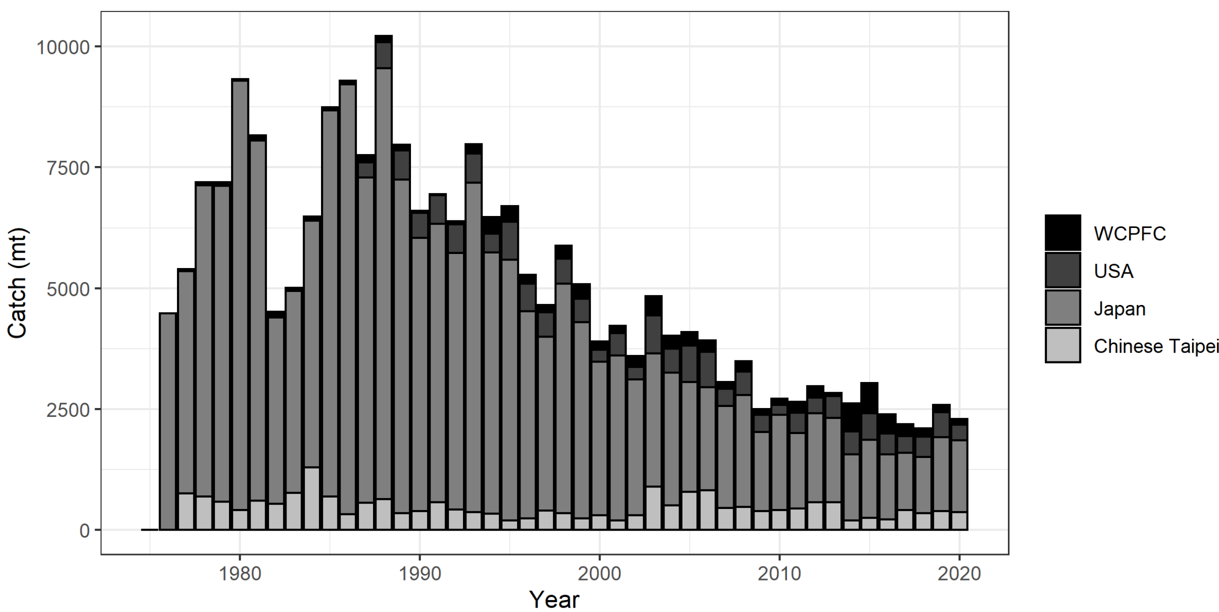


Figure 6-18. Annual catch biomass (t) of Western and Central North Pacific striped marlin (*Kajikia audax*) by country for Japan, Chinese Taipei, the U.S.A., and all other countries during 1977-2020.

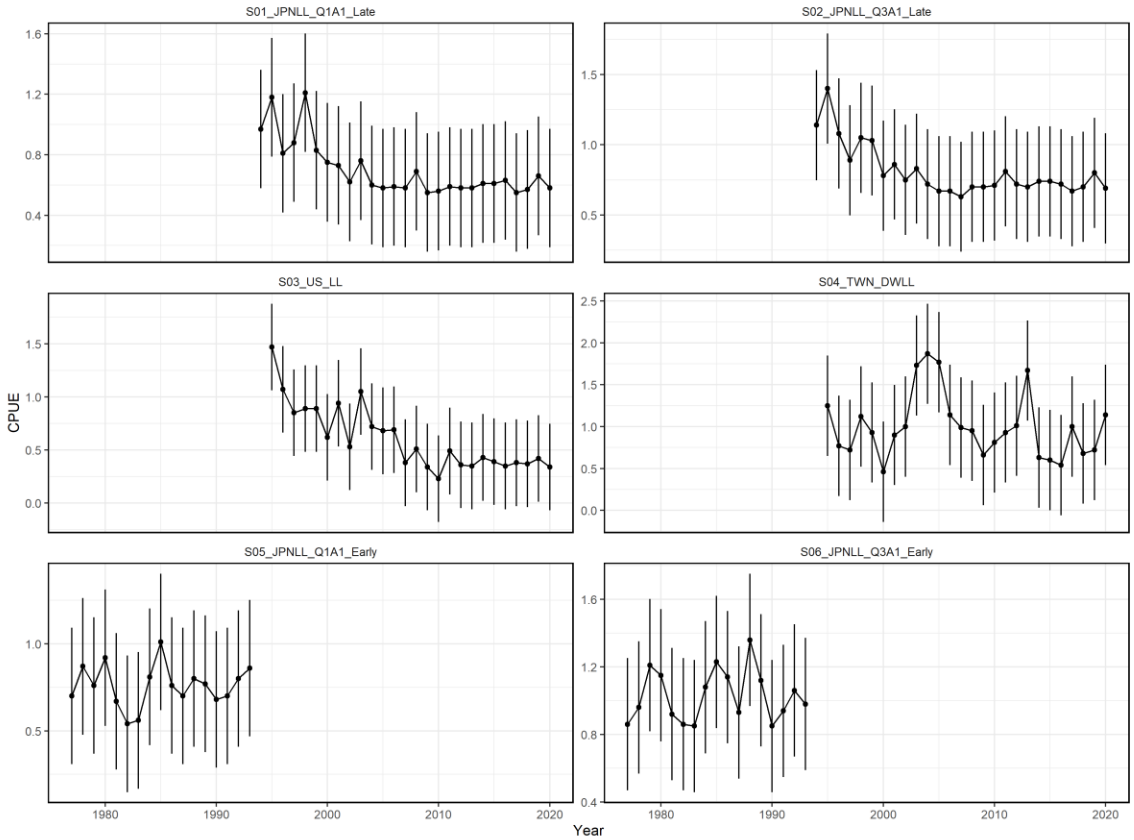


Figure 6-19. Time series of annual standardized indices of catch-per-unit-effort (CPUE) for the for each fleet in the base-case assessment model for the Western and Central North Pacific striped marlin. Index values were rescaled by the mean of each index for comparison purposes.

7 ISC PEER REVIEW OF STOCK ASSESSMENTS

The ISC Plenary revisited the U.S. proposal on an ISC stock assessment review process (**ISC/22/PLENARY/10**). There was some discussion around the advantages and feasibility of a review process that would occur before Plenary versus one occurring after. The discussion touched on the possibility of an internal review process in order to resolve issues with stock assessments that working groups have been unable to address. This would be a way to avoid circumstances where problems with an assessment means that the Plenary is unable to adopt it and could be a simpler, more streamlined process compared to external review. The difficulty with adding a review process (whether internal or external) prior to Plenary has to do with the time involved if the assessments are to be timely with respect to input data.

It was also noted that it would not be feasible to conduct external reviews of all assessments and there would need to be a set of criteria to determine which assessments should be subject to external review.

The ISC Chair proposed to consult with Members in the coming months and bring a detailed proposal for an internal review process to ISC23 for discussion and potential adoption. **The ISC Plenary agreed to this proposal.**

8 FORMALIZATION OF ISC

The U.S. presented background information on the history of the ISC and activities to date aimed at formalization of the ISC function.

The ISC was established in 1995 through a press release jointly issued by Japan and the U.S. In that sense there is no formal, foundational instrument constituting the ISC as an organization. In 2005 the ISC entered into a science provision arrangement with the WCPFC-NC based on an MOU signed by the ISC Chair.

The costs and benefits of constituting the ISC under a formal instrument were discussed at length. It was pointed out that the current arrangement allows flexible and voluntary engagement by participating entities and has been proven effective in terms of the provision of scientific work. A formal instrument is likely to take several years to negotiate and would likely involve government departments, such as foreign affairs, that are separate from fishery management line agencies. On the other hand, the current informal arrangement hinders participation, as is the case of China, and can make it more difficult to allocate funds to support participation by scientists and initiate other functions, such as external peer review of stock assessments.

The Plenary focused on exploring an instrument that could be signed at the fishery agency level within respective governments, which might be a middle ground between a formal instrument adopted at the ministerial level and the current informal arrangement. This approach would have a narrower objective than previously explored. It was noted that even a simple science bilateral agreement can take several years to negotiate so the easier route is to formalize science and data functions first before establishing a funding mechanism. No matter the course, an important reason for formalizing ISC function is to clearly establish membership beyond the U.S. and Japan, who were the signatories of the original instrument.

It was agreed that each Member should discuss with their respective governments and report back at ISC23. In doing so, functions like biological sampling programs (such as the one established by the BILLWG) should be considered.

The ISC Chair also encouraged members to bring forward examples of MOUs that have been used in comparable forums that would be reviewed at ISC23.

9 MOU (WCPFC-NC) AND MOC (IATTC) REVIEW AND TASKING

The ISC Chair noted that both the MOU and MOC have clauses specifying a review of the terms and operation of each document every three years. **The ISC Plenary tasked the ISC Chair to review the MOU and MOC and report his findings at ISC23**.

10 THIRD PEER REVIEW OF ISC FUNCTION AND PROCEDURES - PREPARATIONS

The Plenary agreed to task the Chair to develop a proposal for the third peer review and report back at ISC23.

11 ISC OPERATIONS MANUAL PROPOSALS

The Chair reviewed proposed changes to the Operations Manual previously circulated as **ISC/22/PLENARY/12**. Members provided suggested additional edits to the Manual. The ISC Plenary approved and endorsed the proposed changes to its Operations Manual. The revised document will be posted on the ISC Website after the ISC Plenary meeting ends.

12 REVIEW OF STATISTICS AND DATABASE ISSUES

12.1 STATWG Report

F. Carvalho, the STATWG Chair, reviewed activities in 2021-2022 workplan adopted at ISC21 (**ISC/22/ANNEX/15**). Eight of the ten items of the workplan were completed in the past year. The uncompleted items include:

- The STATWG will pursue harmonizing the ISC data submission formats with those used by the WCPFC and the IATTC; and
- 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 members developed the following work plan for 2022-2023:

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, 2022. 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, 2022;
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, 2022;
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, 2022. For 2021-2022, the DA will continue to distribute the WG member's new metadata by March 30, 2023. The Data Correspondents will review and update their new metadata by July 1, 2023 prior to the ISC23 Plenary, and this new metadata will be published on the ISC researcher's website by August 31, 2023;
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 2023 to conduct work to complete this work plan; and
6. The STATWG Chair, Vice-Chair and other interested parties will continue to develop a NDA for data sharing requests. This NDA will incorporate comments from ISC22 and will be reviewed at the next STATWG meeting. A standard operating protocol will be developed to handle data sharing requests, which will include ISC point of contact information.

Discussion

The STATWG reviewed stock assessment sharing protocols across organizations. A question was asked about the formality or lack of formality of these protocols. The process varies across RFMOs. For example, ICCAT has a formal complex process, whereas the IATTC and WCPFC are essentially open access after a requestor submits an online request. When asked, the STATWG had no advice on best practices in this area.

The ISC Plenary reviewed the STATWG recommendations and approved them with further discussion (see below) of the protocol for sharing confidential stock assessment data including non-disclosure agreement.

The ISC Plenary endorsed the STATWG proposal to hold two meetings, in January 2023 and just prior to ISC23. It was noted that Chair and Vice Chair elections need to be held at the January 2023 intersessional meeting.

12.2 Protocol for Sharing Confidential Stock Assessment Data Including Non-Disclosure Agreement

The ISC Plenary had a lengthy discussion of the development of a formal process for responding to requests for confidential data used in ISC stock assessments. This includes consideration of a non-disclosure agreement (NDA), which has been discussed at previous Plenary meetings.

It was agreed that there should be a single, easily identified point of entry for the data request process. This could be a point of contact, such as the Data Administrator, supplemented by a web form posted on the ISC website. Such a web-based form would facilitate gathering information about the request relevant to a decision about data provision. This could include information about the requester, the specific data being requested, and the use of the data. The ISC, through the WG Chairs and the DA, will need to develop metadata and make that information easily accessible to aid in data requests. To date, informal data requests have typically been fielded by the relevant WG Chair. Going forward any requests made by the route should be redirected to the single point of contact, such as the DA.

Once a request has been made, there needs to be an internal process to review the request, decide whether to provide the requested data, and then provide the data to the requester. The decision about data provision could be made by the relevant WG Chair in consultation with the ISC Chair. Overall, it was emphasized that the process should be efficient and not result in undue delay.

The need for and specific terms of a non-disclosure agreement (NDA) were discussed in relation to the draft that was previously circulated. Some members felt the current draft was overly prescriptive and cumbersome while others emphasized the importance of having clearly articulated contractual parameters governing the use of ISC data by external parties. It was also noted that the informational elements of the draft NDA (e.g., information about the requester and the data requested) could be used in developing the aforementioned data request processes, such as a web form. It was noted that a more formal NDA would address clear attribution by data users.

The Plenary tasked the STATWG to develop a proposed process for fielding data requests and continue to work on drafting the NDA to bring back to ISC23. In further revising the proposed NDA the STATWG should consider how its terms could be simplified. As noted above, any proposed process developed by the STATWG needs to include both mechanisms to gather information about the request and the development of metadata that would help requesters identify what data are available.

12.3 Total catch tables

K. Nishikawa, the Database Administrator, presented the annual catch tables for ISC Member countries for 2020-2021. The catch tables were prepared for the following ISC species of interest: albacore, Pacific bluefin tuna, swordfish, striped marlin, blue marlin, blue shark, and shortfin mako shark. The catch tables were generated from the ISC database, and are based on Category I data (retained catch and released catch, when available) submitted by Data

Correspondents for the major fisheries in the North Pacific Ocean of the member countries. Graphs of the historical catch by country were also presented for each species. Statistics for mean, minimum and maximum catch were also presented for each species for the latest five years. The complete catch tables are included at the end of this Plenary Report and serve as the official ISC catch tables.

13 REVIEW OF MEETING SCHEDULE

13.1 Time and Place of ISC23

It was agreed that ISC23 will be held 12-17 July 2023 in Japan with the specific venue to be determined. The STATWG requested a one-day meeting in advance and the ALBWG and BILLWG will have half-day meetings in advance of ISC23. The ISC Chair noted that the WG Chairs/Vice-Chairs and Heads of Delegation meetings will occur on the morning of July 12th and the Plenary meeting will begin in the afternoon of July 12th.

13.2 Time and Place of Working Group Intercessional Meetings

A draft schedule of proposed intersessional meetings was reviewed and amended. Proposed ISC WG and RFMO meetings are shown in the table below. Although some WG meetings are proposed to be in person, they may be switched to an online format due to continuing travel restrictions. WG Chairs were asked to confirm with the ISC Chair the dates for their proposed meetings as soon as possible so the information can be posted on the ISC website.

	Month	ALBWG	BILLWG	PBFWG	SHARKWG	STATWG	PLENARY	WCPFC	IATTC
2022	**July**							JWG PBF July 11-13 (EPO) July 12-14 (WPO) Online	
	Aug							SC18 Aug 9-17 (EPO) Aug 10-18 (WPO) Online	99th & 100th Meetings Aug 1-5 Phoenix, AZ USA
	Sept	Online Dates TBD							
	Oct							NC18 Oct 24-26 EPO Oct 25-27 WPO Online	
	Nov	Data Prep Workshop Mid-Nov Dates TBD Yokohama	WCNPO SWO Data Prep Biol. Study WCNPO MLS Assessment Workshop Yokohama End of Nov Dates TBD						
	Dec			MSE Tech Dev Workshop Location/Dates TBD	Research and Shark Modeling Improvements Workshop Dec 5-9 Japan, specific location TBD			WCPFC18 Nov 28-Dec 6 EPO Nov 29-Dec 7 WPO	

	Month	ALBWG	BILLWG	PBFWG	SHARKWG	STATWG	PLENARY	WCPFC	IATTC
2023	**Jan**					Steering Comm Location/Dates TBD			
	Feb								
	Mar	Assessment Workshop Location/Date TBD							
	Apr		WCNPO SWO Stock Assess Workshop Location/Dates TBD	Assessment Improvement Workshop Location/Dates TBD					
	May								14th SAC Meeting Dates TBD
	June								
	July	0.5 day (July 11)	0.5 day (July 11)			1 day (July 10)	July 12 - 17 July 12 AM (HOD + Chairs)		

14 ADMINISTRATIVE MATTERS

14.1 Work Group Election results

The ISC Plenary reviewed the current WG Chair and Vice-Chair terms as shown below and in **ISC/22/PLENARY/11**. It was noted that the BILLWG Chair and Vice-Chair were reelected for their second three-year terms. The PBFWG Chair was also reelected to his second three-year term. M. Lee is the acting Vice Chair of the STATWG until elections are held in January 2023 acting In the upcoming year the STATWG will hold officer elections.

The current ISC Chair and Vice-Chair terms expire in 2023 so Members should anticipate elections for those offices at ISC23.

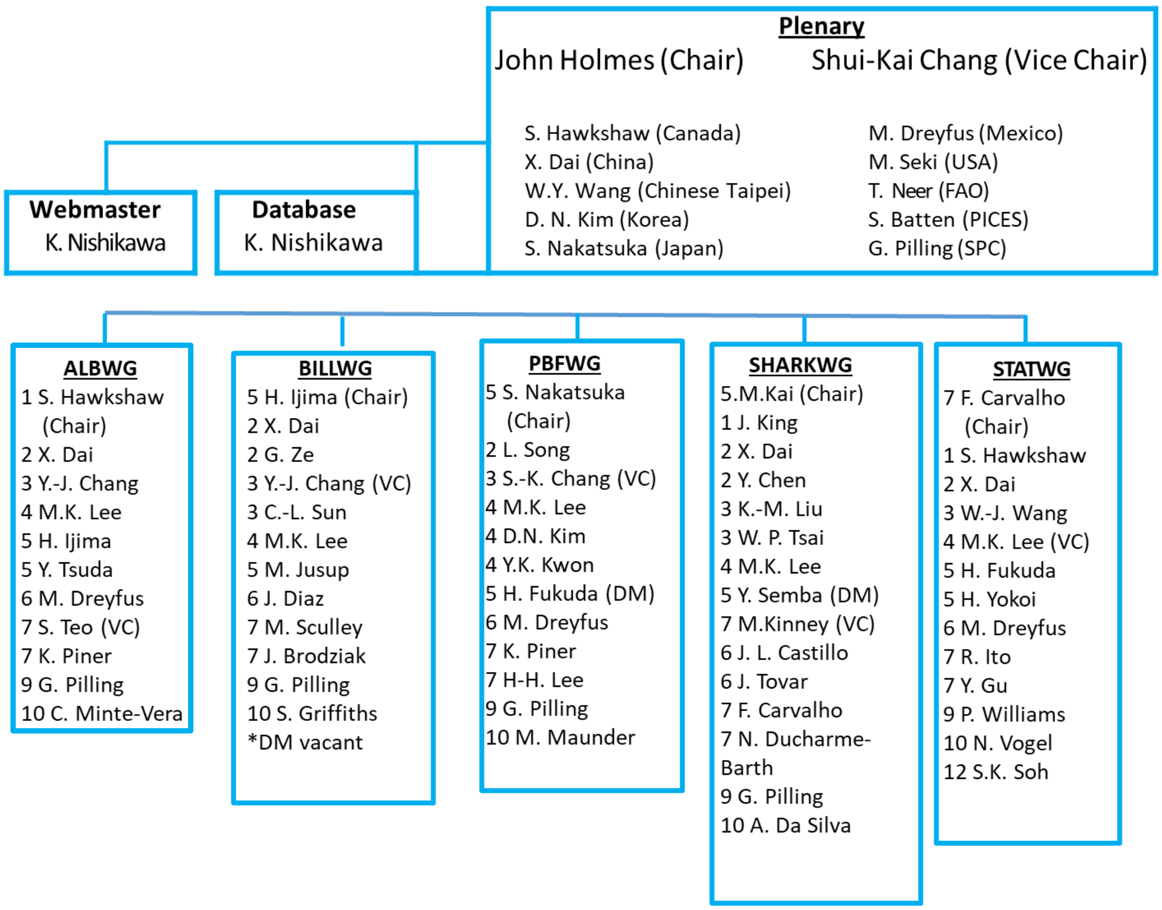
Title	Name	First Election Date	First Term	Second Election Date	Second Term
ISC Chair	John Holmes	July 2017	2017-2020	July 2020	2020-2023
ISC Vice Chair	Shui-Kai Chang	July 2017	2017-2020	July 2020	2020-2023
ALBWG Chair	Sarah Hawkshaw	May 2021	2021-2024		
ALBWG Vice-Chair	Steve Teo	July 2017	2017-2020	April 2020	2020-2023
BILLWG Chair	Hirotaka Ijima	July 2019	2019-2022	July 2022	2022-2025
BILLWG Vice-Chair	Yi-Jay Chang	July 2019	2019-2022	July 2022	2022-2025
PBFWG Chair	Shuya Nakatsuka	March 2019	2019-2022	July 2022	2022-2025
PBFWG Vice-Chair	Shui Kai Chang	Nov 2019	2020-2023		
SHARKWG Chair	Mikihiko Kai	April 2018	2018-2021	July 2020	2021-2024
SHARKWG Vice-Chair	Michael Kinney	April 2018	2018-2021	July 2020	2021-2024
STATWG Chair	Felipe Carvalho	June 2021	2021-2024		
STATWG Vice-Chair*	Mi Kyung Lee	July 2022	2022-2023		

*Acting until election are held in January 2023.

14.2 ISC Organization Chart

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

ISC Organizational Chart (July 2022)



Working Group Key:
1-Canada 2-China 3-Chinese Taipei 4-Korea 5-Japan 6-Mexico 7-USA 8-PICES 9-SPC 10-IATTC 11-FAO 12-WCPFC
VC - Vice Chair DM - Database Manager

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

14.3 PICES AGM Observer

M. Seki (U.S.A.) volunteered to be the ISC observer at the next PICES annual general meeting, September 23 to October 2 in Busan, Korea.

14.4 Intersessional Tasks

- The BILLWG will provide an update on the biological sampling program they have been conducting
- The STATWG will provide more detail about a data request procedure, including a non-disclosure agreement (both simplified and complex)
- The PBFWG will provide an update on the MSE
- The Chair will compile information on the PBF MSE into one document, including the a TOR developed by the JWG for PBF Management
- The Chair will review the terms and operation of the MOU and MOC
- The Chair will canvas members about ideas for the focus of a third peer review of the ISC function and process
- The Chair will consult with Members about methods to formalize the ISC. Two models will be examined: a formal MOU and a more informal scientific cooperation agreement at the agency level. The ISC Chair requests that members provide examples of scientific cooperation agreements, if available and permitted, that will be used to draft a “strawman” proposal for the ISC.

14.5 Other Matters

None.

15 OBSERVER COMMENTS AND RECOMMENDATIONS

Several observers participated in the ISC22 Plenary Sessions in-person and online. The Observers participating in-person were provided with an opportunity at the end of each day to ask technical 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 their content has not been changed.

Pew expressed disappointment that the 2024 date originally requested by the Northern Committee for the completion of the PBF MSE could not be achieved (Agenda 5.2). However, the ISC's preparatory work during the previous year to develop operating models for the MSE was a positive development. Pew also welcomed the news that the ISC now has the knowledge and resources to complete the MSE and urged it to meet the new timeframe of producing preliminary results in 2025. Given PBF's history of significant depletion, and its ecological and economic value, the up-front investment in the MSE will pay dividends in the long term. To make further progress, Pew urged the ISC to develop a technical work plan for the completion of the MSE and further develop the list of uncertainties for inclusion in the operating model. Regarding uncertainties, in addition to steepness, growth and natural mortality, Pew also urged the ISC to consider including two other sources of uncertainty: 1) other sources of fishing mortality, such as discarded and unrecorded catch, and 2) maturity. Finally, Pew urged the ISC to consider consulting external experts, noting that there may be lessons learned from other bluefin MSEs that may add value and/or reduce the ISC's workload.

Pew welcomed the USA's proposal for the ISC to seek external peer reviews of ISC stock assessments and the chair's tasking to provide options on a way forward for the consideration of ISC23 (Agenda 8.1). Conducting an external peer review of a stock assessment is an effective practice used by other scientific institutions that led to improvements in their products and/or increased confidence in them. Pew urged the ISC to adopt this practice and commit to sharing the result of any external review publicly to allow any interested party to read the result, as is also the practice at other scientific bodies.

Pew welcomed the work to update the ISC operations manual to clarify that observers shall have access to all plenary documents and that their comments will be included in reports of annual plenary meetings (Agenda 13). Pew urged the ISC to consider how to promote greater transparency in the meetings of ISC working groups, such as permitting observers to attend those meetings, as they do at stock assessment-related meetings of other bodies, such as the SPC's pre-assessment workshop and ICCAT working groups, without controversy. Observers, like members, support the mission of the ISC and want the ISC to be successful. In addition, observers possess resources, expertise and ideas that could be of use to the operations of the ISC.

WWF welcomes the progress on PBF MSE development with reference to MSE procedure for albacore. In addition, WWF calls for further improvement to data accuracy and the prevention IUU (Illegal, Unreported and Unregulated) fishing, which affects data collection. The ISC should recommend to management agencies that they consider the use of methods such as electronic monitoring, electronic reporting, a catch documentation scheme and improving observer coverage for tuna longline operations. To further improve the accuracy of stock assessment data, WWF recommends that the ISC request cooperation from China, which has not participated in ISC meetings and not submitted data to the ISC for many years.

16 ADOPTION OF REPORT

The Report of the Meeting was provisionally adopted pending review of the section on the STATWG Report. The STATWG report was reviewed and approved by email on July 27, 2022 and the meeting report is considered adopted.

17 CLOSE OF MEETING

The meeting was closed at 12:20 PM July 18, 2022.

18 CATCH TABLES

Table 18-1. North Pacific albacore (*Thunnus alalunga*) catches (in metric tons) by ISC member fisheries, 1952-2018. "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	2,356	2,356	25	7	12,655	36,638	784	159	5,961	56,229	56	56			
	2021	2,399	2,399	25	7	12,535	36,638	784	159	5,961	56,109	275	275			
Retain catch total		136,287	136,287	2,545	110,298	1,345,645	2,078,692	16,305	23,606	100,863	3,677,954	31,843	31,843			
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			
Release total		81	81									+	+			
Total		136,368	136,368	2,545	110,298	1,345,645	2,078,692	16,305	23,606	100,863	3,677,954	31,843	31,843	0	0	0

Table 18-1. Continued.

Catch disposition	Year	TWN Set-net	TWN Gill-net (not specified)	TWN Longline	TWN Others	TWN Purse seine	TWN Total	USA Drift gill-net	USA Handline	USA Longline	USA Pole and line	USA Troll	USA Others	USA Purse seine	USA Sport	USA Total	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	0	49	209		13,401			1,042	14,701	74,060
	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	8,218	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	163		7,517	8		260	7,950	70,401
	2021	1	-	5,953	-	-	5,954		5	236		4,209	64		253	4,768	69,505
Retain catch total		17	46,237	144,265	1,095	1	191,615	801	864	18,037	52,932	1,107,638	1,086	4,197	49,654	1,235,208	5,274,013
Release	2013																1
	2014																7
	2015																14
	2016																2
	2017																2
	2018																18
	2019																13
	2020																2
	2021																22
Release total																	81
Total		17	46,237	144,265	1,095	1	191,615	801	864	18,037	52,932	1,107,638	1,086	4,197	49,654	1,235,208	5,274,094

Table 18-2. Pacific bluefin tuna (*Thunnus orientialis*) catches (in metric tons) by ISC member fisheries, 1952-2018. "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	Troll	KOR Total[2]	Others	Purse seine	MEX Total
Retain	1952	2,145	2,694	2,198	667	1,700	7,680	17,084							-	-	0
	1953	2,335	3,040	3,052	1,472	160	5,570	15,629							-	-	0
	1954	5,579	3,088	3,044	1,656	266	5,366	18,999							-	-	0
	1955	3,256	2,951	2,841	1,507	1,151	14,016	25,722							-	-	0
	1956	4,170	2,672	4,060	1,763	385	20,979	34,029							-	-	0
	1957	2,822	1,685	1,795	2,392	414	18,147	27,255							-	-	0
	1958	1,187	818	2,337	1,497	215	8,586	14,640							-	-	0
	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							-	-	0
	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	-	0	1,311		4,862	4,862
	2015	1,242	648	8	413	431	3,645	6,386	1		676		0	677		3,082	3,082
	2016	1,228	691	54	778	508	5,095	8,354	3		1,024	2	0	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	4,050	6,206	7		523	5		535		2,482	2,482
	2019	941	1,002	0	720	372	4,464	7,499	36		542	3		581		2,249	2,249
	2020	1,234	1,416	1	760	502	3,960	7,873	35		567	3		605		3,266	3,266
	2021	1,642	1,436 [3]	0	653	445	4,198	8,374	84		422	3		509		3,026	3,026
Retain catch total		136,131	95,655	54,787	132,262	49,414	580,988	1,049,237	177	25	27,761	95		28,057	245	112,430	112,675
	Total	136,131	95,655	54,787	132,262	49,414	580,988	1,049,237	177	25	27,761	95	0	28,057	245	112,430	112,675

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	0		+	2	-	401	420	828	17,099
	2015	25	1		552	-	-	578	4	0			7	-	86	400	499	11,221
	2016	-	+		454	-	-	454	9	1		0	31	-	316	372	728	13,275
	2017	-	-		415	+	-	415	1	1		+	18	+	466	463	950	14,745
	2018	+	3		381	+	-	384	18	1		+	31	4	12	528	594	10,201
	2019	2	2		486	2	-	492	10	2		1	36	1	226	479	754	11,575
	2020	1	-		1,149	-	-	1,150	28	2		+	87	1	116	716	949	13,842
	2021	1	-		1,478	-	-	1,479	55	1		+	115	3	43	1,161	1,378	14,766
Retain catch total		122	61	539	34,927	128	810	36,587	618	341	376	170	327	846	242,944	11,408	257,029	1,483,586
Total		122	61	539	34,927	128	810	36,587	618	341	376	170	327	846	242,944	11,408	257,029	1,483,586

Table 18-3. Annual catch of swordfish (*Xiphias gladius*) in metric tons for fisheries monitored by ISC member countries for assessments of North Pacific Ocean stocks, 1951-2018. "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.

		JPN						KOR		MEX		
Catch disposition	Year	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	5,012	204	281	5,777	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	664	664			
	2019	6	242	3,897	339	210	4,694	468	468			
	2020	7	290	5,273	179	305	6,054	392	392			
	2021	7	290	2,315	179	305	3,096	335	335			
tain catch total		960	45,410	605,626	40,346	7,945	700,287	14,198	14,198	3,430	-	3,430
Release	2010											
	2011											
	2018							+	+			
	2019							+	+			
	2020							+	+			
	2021							0	0			
Release total								1	1			
Total		960	45,410	605,626	40,346	7,945	700,287	14,199	14,199	3,430	-	3,430

Table 18-3. Continued.

		TWN							USA										
Catch disposition	Year	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				-			0											12,408
	1954				-			0											13,611
	1955				-			0											14,111
	1956				-			0											15,485
	1957				-			0											15,251
	1958				-			0											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	11,399
	2016	2	3	+	2,054	+	-	2,059	183	26	4	1,092			1	42		1,348	10,324
	2017	+	3	0	2,194	+	+	2,197	180	28	6	1,618		0	1	44		1,877	10,350
	2018	1	+	0	2,124	+	-	2,125	148	10	3	1,053		1	0	67		1,281	10,067
	2019	2	+	0	2,113	+	-	2,115	52	11	3	734		0	1	186		987	8,265
	2020	3	+	0	1,868	+	-	1,871	35	6	2	543			1	125		711	9,028
	2021	3	+	0	1,067	+	-	1,070	13	7	1	690		0	2	54		768	5,269
tain catch total		323	220	3,545	107,582	911	+	112,581	29,303	8,637	172	74,794	56	16	6	1,575	27	114,587	944,996
Release	2010																0	0	0
	2011																0	0	0
	2018																		+
	2019																		+
	2020																		+
	2021																		0
Release total																	0	0	1
Total		323	220	3,545	107,582	911	+	112,581	29,303	8,637	172	74,794	56	16	6	1,575	27	114,587	944,997

Table 18-4. Annual catch of striped marlin (*Kajikia audax*) in metric tons for fisheries monitored by ISC member countries for assessments of North Pacific Ocean stocks, 1951-2018. “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	1,237	61	39	1,607	48		48		
	2020	37	155	1,216	32	25	1,465	74		74		
	2021	37	155	767	32	25	1,016	82		82		
Retain catch total		5,119	81,705	323,919	45,280	6,612	462,635	6,601		6,601		
Release	2010											
	2011											
	2016								+	+		
	2018							+	2	2		
	2019											
	2020											
	2021							0		0		
Release total								0	2	2		
Total		5,119	81,705	323,919	45,280	6,612	462,635	6,601	2	6,603	0	0

Table 18-4. Continued.

Catch disposition	Year	TWN							USA							Total
		Set-net	Gill-net (not specified)	Harpoon	Longline	Others	Purse seine	TWN Total	Handline	Longline	Troll	Others	Purse seine	Sport	USA 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	2,165
	2017	+	7	41	389	-	-	437		406	6				413	2,227
	2018	+	5	27	330	-	+	362		465	12				477	2,189
	2019	-	8	26	373	-	+	407		545	13		1		559	2,621
	2020	+	9	25	353	-	-	387		336	10				345	2,271
	2021	+	9	25	270	-	-	304		250	9				259	1,661
Retain catch total		91	910	5,285	25,500	2,967	2	34,755	8	14,191	911	0	1	1,484	16,596	520,587
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
Release total							2	2					1		1	5
Total		91	910	5,285	25,500	2,967	4	34,757	8	14,191	911	0	2	1,484	16,597	520,592

Table 18-5. Retained catches (metric tons, whole weight) by ISC Member countries of blue marlin (*Makaira nigricans*) by fishery in the North Pacific Ocean, north of the equator 1953-2020. "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.

		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	1,373		1,373			-	11	108	3,501	-	10	3,630	3	664	166		2	835	7,109
	2019	1,282	1,282	981		981			-	22	99	3,359	+	4	3,484	5	901	176		3	1,085	6,832
	2020	952	952	848		848			2	30	115	1,955	+	-	2,102	3	531	111		3	648	4,550
	2021	558	558	854		854			2	30	115	2,098	+	1	2,246	3	382	127		2	515	4,173
Retain catch total		194,963	194,963	14,346	0	14,346			372	1,560	17,441	184,288	3,602	58	207,321	38	14,125	8,080	6	14	22,262	438,892
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							
Release total				1	2	3								36	36							
Total		194,963	194,963	14,347	2	14,349	0	0	372	1,560	17,441	184,288	3,602	94	207,357	38	14,125	8,080	6	14	22,262	438,892

Table 18-6. Retained catches (metric tons, whole weight) by ISC Member countries of blue sharks (*Prionace glauca*) 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						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	19,825
	2016	26	1,832	9,507	1	2	11,367					8,563	8,563		0		0	0	0	19,330
	2017	4	1,366	9,795	+	1	11,166	8	8			11,121	11,121				1	+	2	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	9,634	4	4			18,165	18,165		+		14	+	15	27,817
	2020	59	1,119	7,072	1	2	8,252	0	0			15,561	15,561		0		3	+	3	23,816
	2021	59	1,119	7,072	1	2	8,252	2	2			8,822	8,822				2	+	2	17,078
Retain catch total		413	27,893	547,728	185	64	576,284	246	246			139,950	139,950	13	61	0	66	1	141	756,511
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
Release catch total								132	132											132
Total		413	27,893	547,728	185	64	576,284	378	378	0	0	139,950	139,950	13	61	0	66	1	141	756,644

Table 18-7. Retained catches (metric tons, 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	975	21	1,119			336	336				80	1					46			127	1,582
	1995	103	958	15	1,075			333	333				79	1					14			94	1,502
	1996	101	1,149	17	1,268			413	413				85	1					9			95	1,776
	1997	127	1,044	16	1,187			401	401				118	3					11			132	1,720
	1998	130	920	13	1,063			386	386				85	1					12			98	1,547
	1999	176	1,374	14	1,564			439	439				52	0					9			61	2,064
	2000	156	1,107	15	1,278			539	539				64	+					12			76	1,893
	2001	156	1,154	15	1,325			491	491				30	1					10			41	1,857
	2002	122	964	5	1,090			488	488				69	+					12			81	1,659
	2003	229	971	6	1,205			471	471				57	+					9			66	1,742
	2004	134	927	1	1,062			865	865				38	1					13			52	1,979
	2005	155	1,022	43	1,219			609	609				25	1					8			34	1,862
	2006	178	1,062	6	1,246			641	641				38	+					7			45	1,932
	2007	244	1,187	15	1,446			689	689				37	+					6			43	2,178
	2008	212	1,017	14	1,243	-	-	609	609				27	1					5			33	1,885
	2009	294	1,231	1	1,527	-	-	653	653	78		78	21	1			0		7			29	2,287
	2010	272	981	20	1,273	-	-	760	760	54		54	10	0					10			20	2,107
	2011	163	717	11	891	-	-	758	758	208		208	8	0					8			16	1,873
	2012	229	706	2	938	-	-	715	715	74		74	9	0			0		11			20	1,747
	2013	345	743	9	1,097	8	8	711	711	107		107	16	0					12			28	1,951
	2014	263	755	3	1,021	8	8	-	-	119		119	7	0		53	+	3	6		9	78	1,218
	2015	334	847	11	1,193					322		322	7			58		1	4			71	1,585
	2016	446	998	16	1,459	+	+			220		220	12	0	1	70	+	1	4		0	89	1,757
	2017	271	686	10	967	+	+			187		187	13	0		71	+	1	5			90	1,244
	2018	223	843	28	1,094	+	+			265		265	11			60	0	1	5			78	1,437
	2019	214	823	3	1,040	+	+			273		273	7			47	0	1	21		0	75	1,388
	2020	194	625	12	831	+	+			247		247	3	1		16		1	3			23	1,101
	2021	194	625	12	831	+	+			196		196	5 [1]	0		5 [1]		1 [1]	2			13	1,040
Retain catch total		5,789	26,411	351	32,550	16	16			2,350		2,350	2,381	30		381	1	10	1,180		9	3,993	52,239
Release	2011																			0		0	0
	2012										-	-											0
	2016					1	1																1
	2018					1	1																1
	2019					1	1																1
	2020					1	1																1
	2021					+	+																0
Release catch total						3	3																3
Total		5,789	26,411	351	32,550	20	20	0	0	2,350	0	2,350	2,381	30	0	381	1	10	1,180	0	9	3,993	52,242