IATTC SAC 11

6.f ISC report on New Benchmark Stock Assessment;

ISC PBFWG

2020/10/28

2020 PBF benchmark stock assessment

- Meeting logistics
  - Data prep: November 18th to 23rd 2019 at La Jolla, U.S.A.
    - New CPUE standardization method, New Size composition
    - Growth modeling with New observation
    - Alternative settings of the population dynamics model
  - Assessment: March 2nd to 12th and April 2nd 2020 at Shimizu, Japan.
    - As a measure to the outbreak of COVID-19, an online connection to the meeting was arranged for the overseas participants.
    - Finalize the model setting and conduct the assessment and projections
    - Develop the drafts of stock status and conservation information
  - ISC Plenary 20: July 15th to 20th (Online Meeting)
    - Adopt the stock assessment report and develop the stock status and conservation information
- Report
  - Stock Assessment Report; IATTC SAC INF-H

Major modifications in Data and Modeling

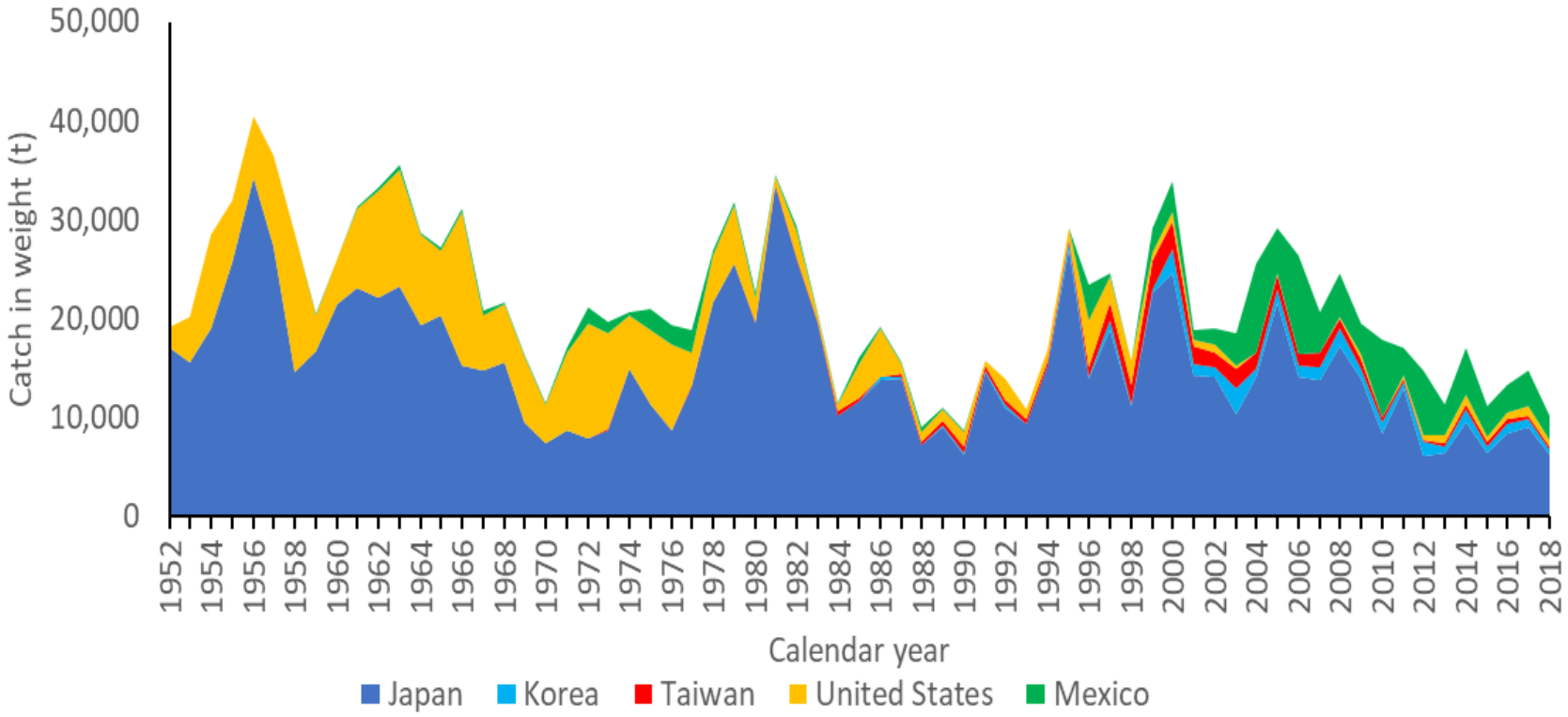
- Data
  - from July 1952 to June 2019 (Add 2 years data)
  - Spatio-temporal modeling for the standardization of JpLL CPUE.
  - Newly available size data for LL, PS and recreational fishery.
  - Include the amount of discard in the assessment.
- Modeling
  - Update the stock synthesis from version 3.24f to 3.30.14.08.
  - More detailed modeling of fishery by disaggregating fleets by gear, country, or season.
  - Improve modeling selectivity to reduce the seasonal or annual residuals of the size composition.
  - Additional efforts to reduce the number of parameters estimated.
- Projection
  - Bias correction between the bootstrap replicates and point estimates.

Overview of 2020 assessment model

- A fully integrated model (Stock Synthesis-Version 3.30)
  - Length-based, age-structured (0-20+) model
  - From 1952 to 2018 fishing year (July 1952 to June 2019)
- Pan-Pacific Assessment
  - No-spatially defined model (Area as Fleet approach)
- Input Data
  - Catch Time series from 25 fisheries (fleets)
  - Size composition data from 19 fisheries
  - 3 CPUEs (Twn & Jpn Longlines, Jpn Troll)
- Given biological traits (Growth, Maturity, Reproduction, M)
- Estimate initial conditions, population scale, catchability of the index fleets, recruitments, and fishery selectivity

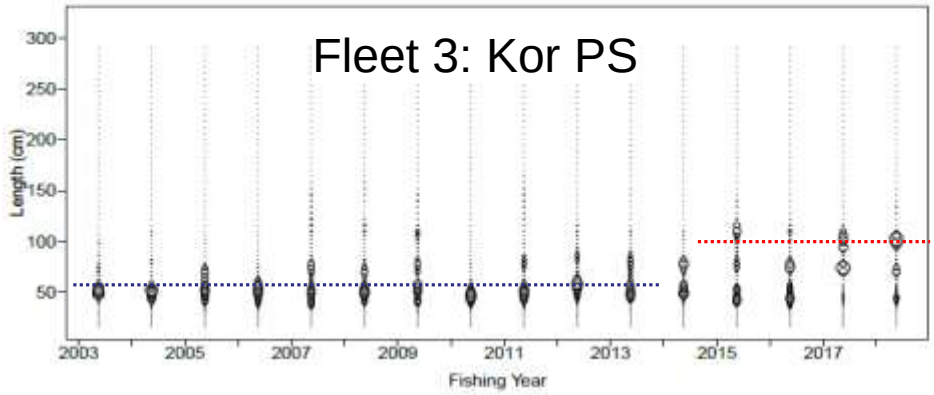
Catch time series

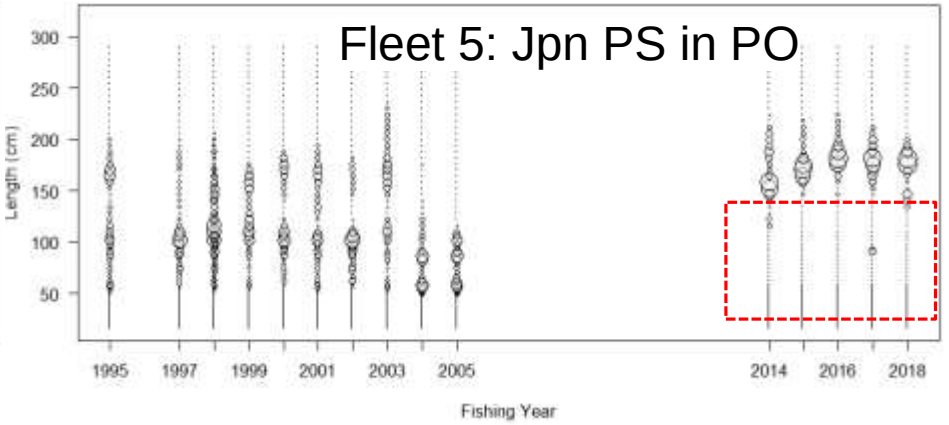
- Data submission
  - Data were submitted from the ISC members through the WG scientists.
  - Catch by the non-ISC members were collected from the publicized data by the WCPFC.

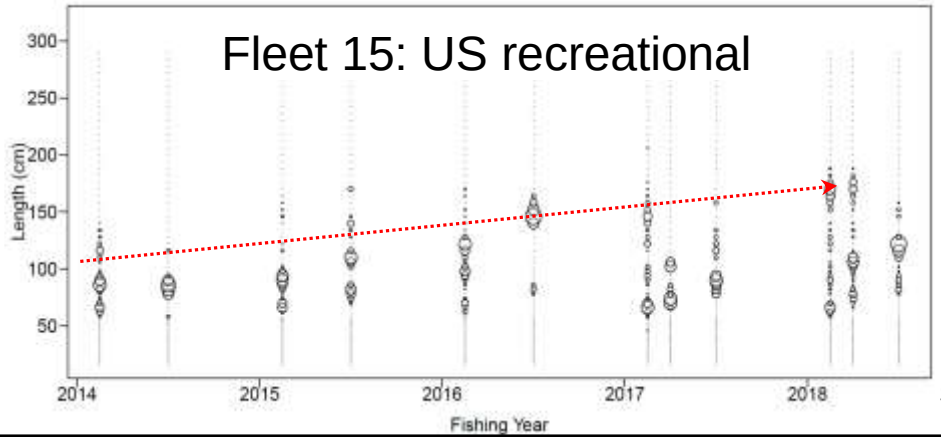


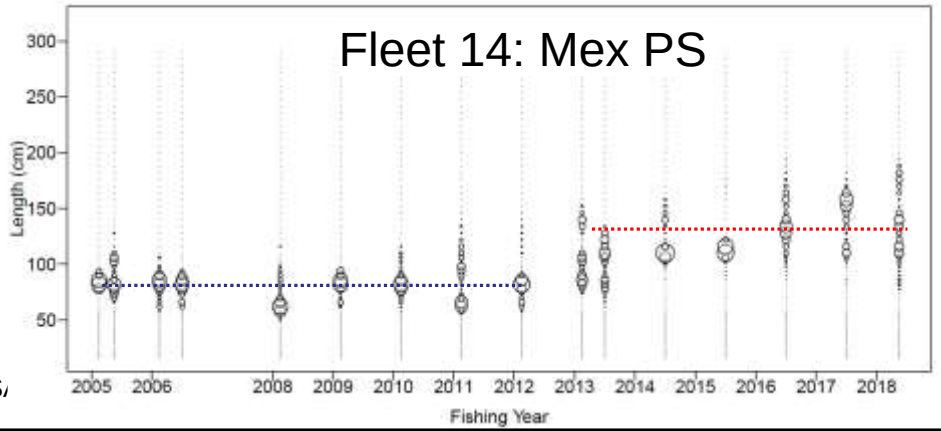
Size Composition

- Composition data were available for 18 out of 25 fleets
- New data are available for Jpn LL, PS, Kor PS, and US sports.
- Larger size of PBF were observed recently in some fisheries.
  - Domestic management, Economical purpose, or Change in the availability

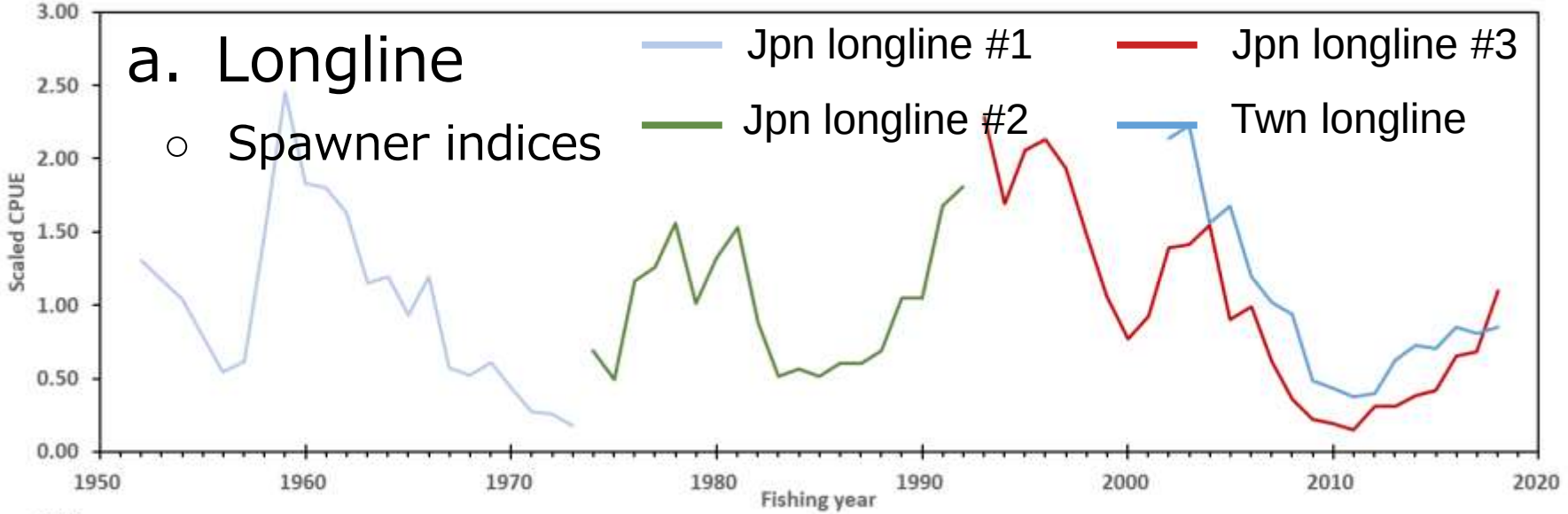


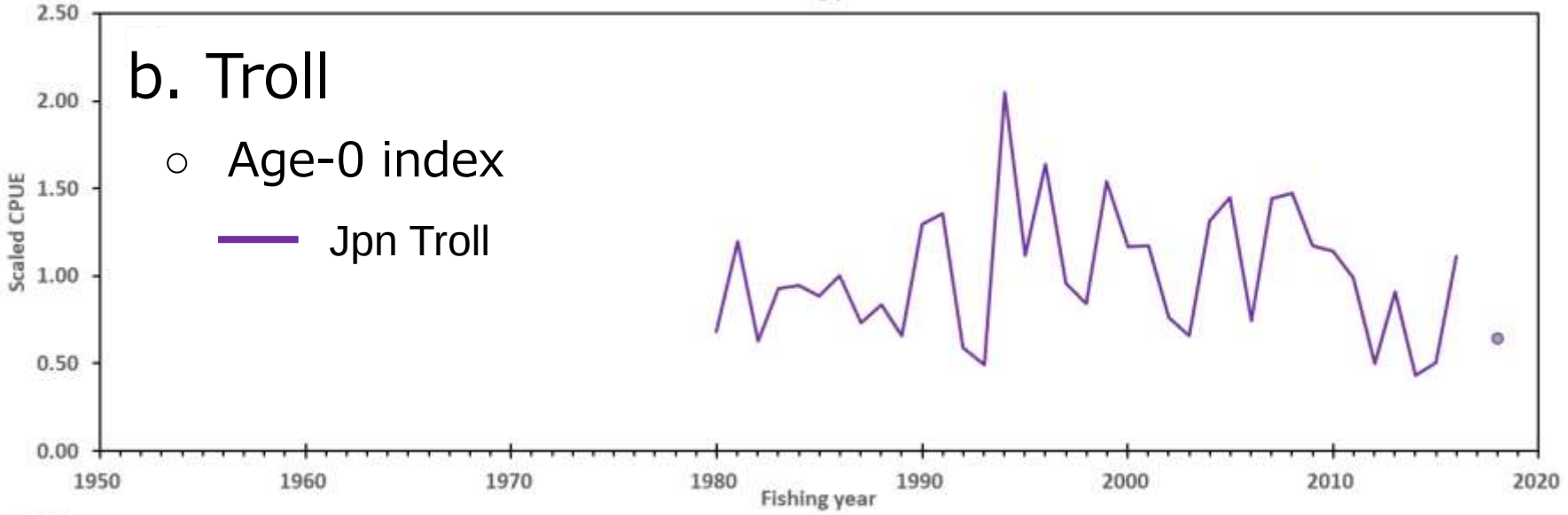






Catch per Unit of Effort based abundance index



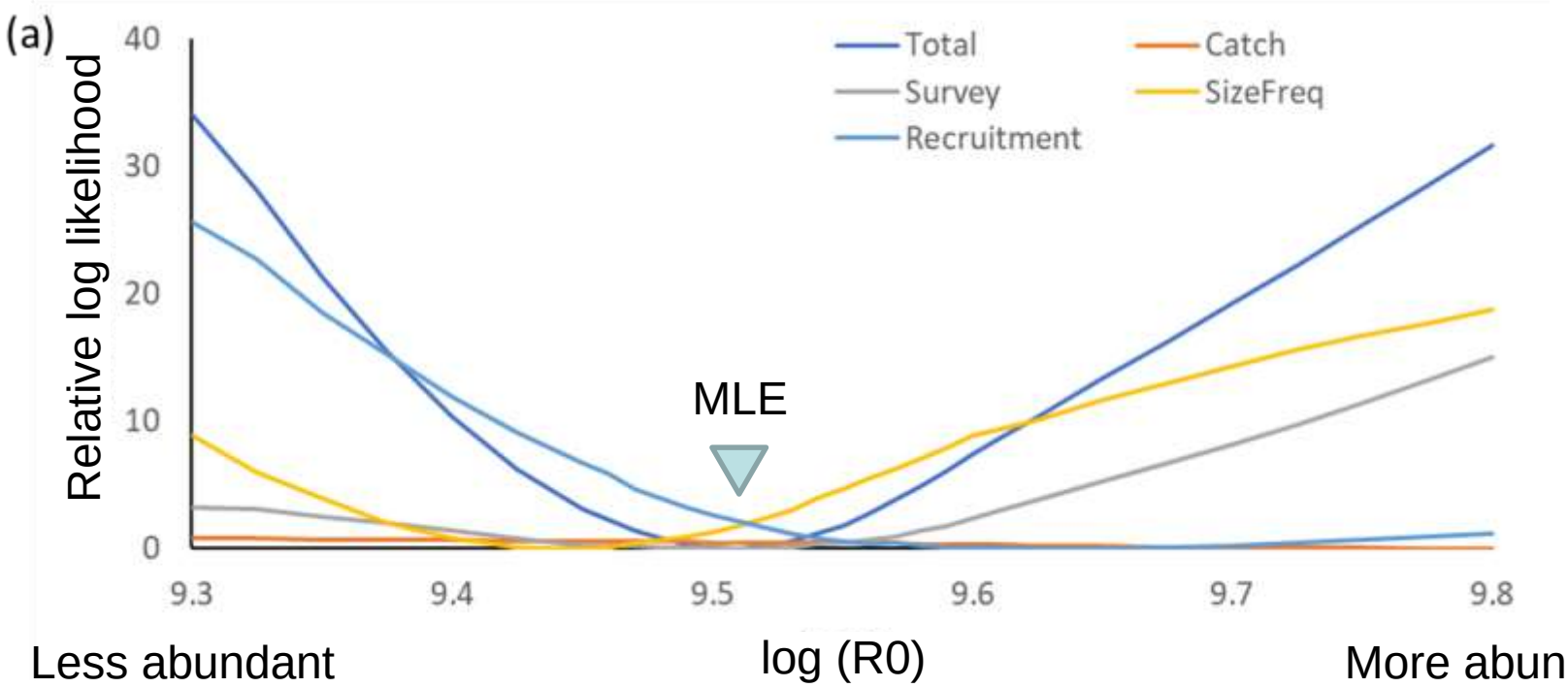


Model Diagnostics and Sensitivity analysis

- Model diagnostics
  - Model Convergence
  - Age Structured Production Model
  - Likelihood profile over population scale
  - Retrospective analysis
  - Adequacy of Model fits to the observed data
- Sensitivity runs
  - Natural Mortality
  - Reproduction (Maturity, Steepness, SigmaR)
  - No asymptotic selectivity fleet in the model
  - Data (Fleet 1 comp data, discard catch)
  - Data weighting

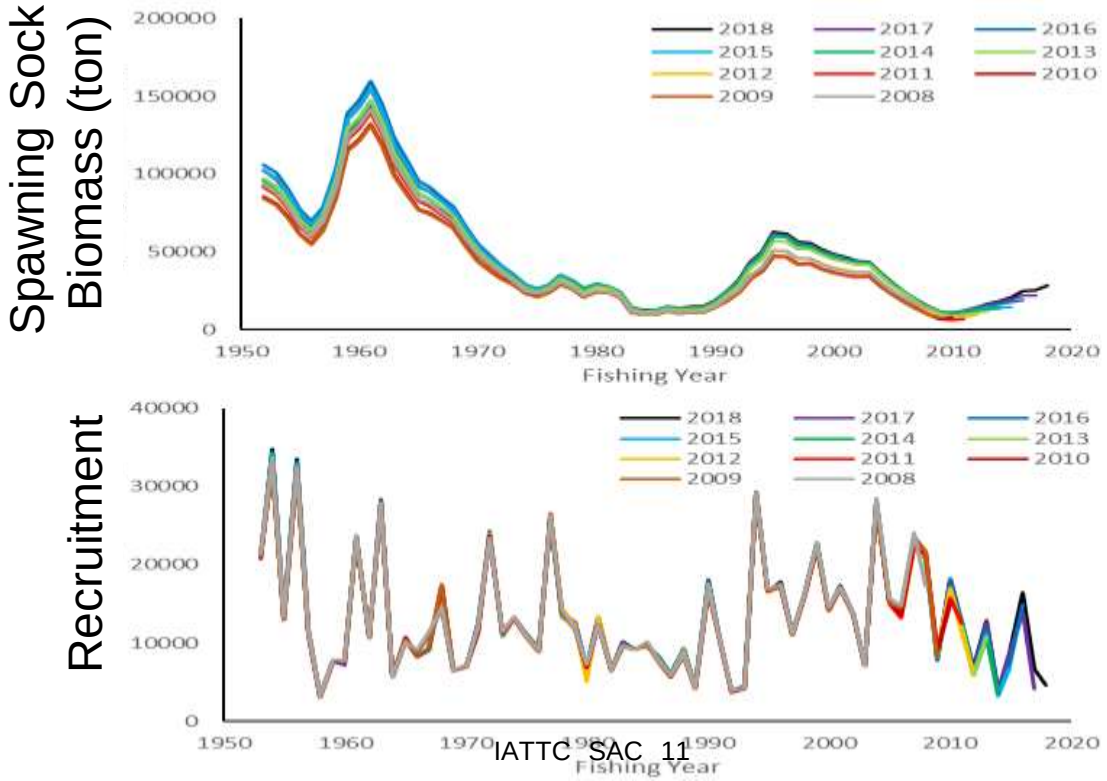
Likelihood profiles over fixed scaling parameter

- Each component marked the lowest likelihood at the range of maximum likelihood estimate (MLE) of Log R_0 (= 9.51).
  - CPUE (9.51), Size comp. (9.45), Recruitment Penalty (9.625)
  - Consistency regarding the population scale estimates.



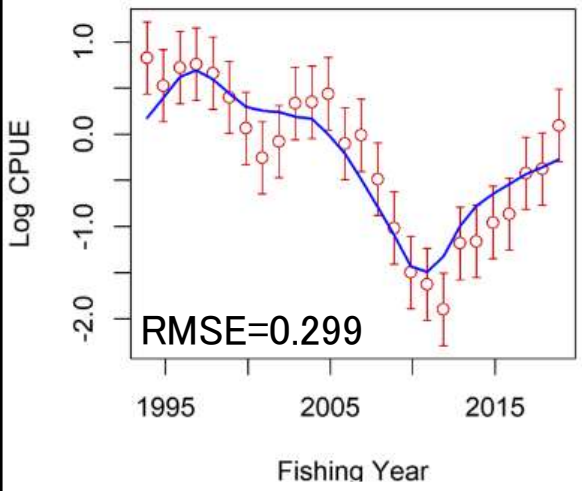
Retrospective Analysis

- The WG considered that the retrospective analysis do not show an evidence of significant model misspecification although there is a small trend of underestimation in terminal SSB.
- There is no substantial retrospective pattern in recruitment except the 2017 data point when the reliable age-0 index was not available.

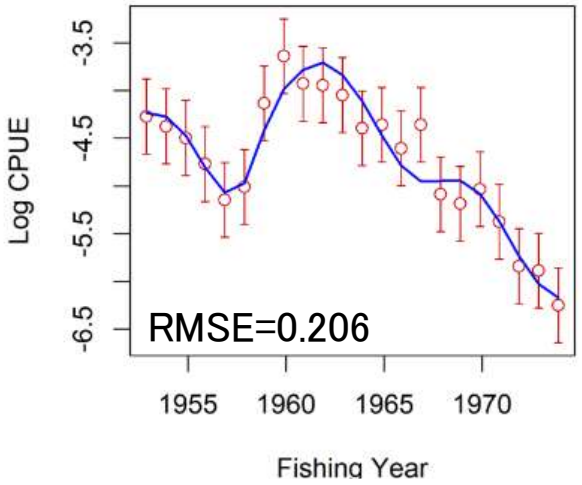


Goodness of fit to CPUEs

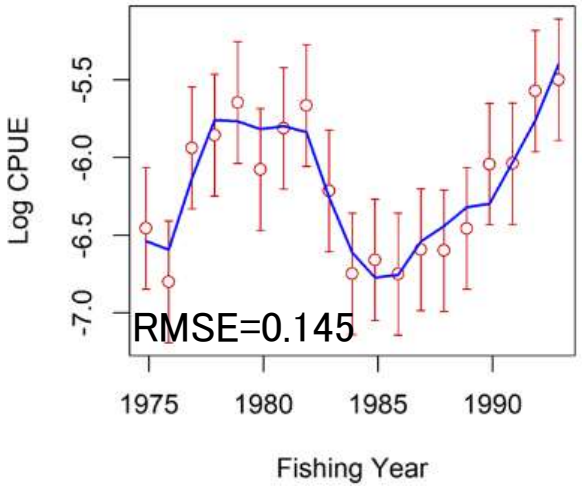
S1: Jpn Longline (1993-2018)



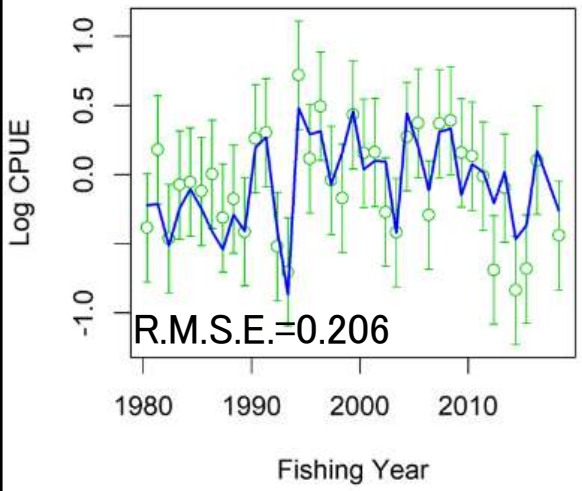
S2: Jpn Longline (1952-1973)



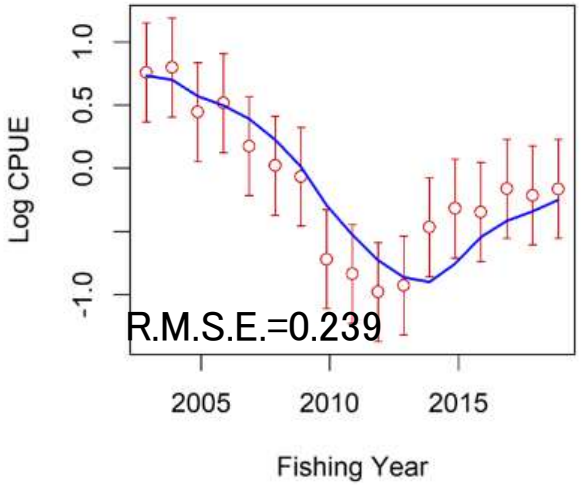
S3: Jpn Longline (1974-1992)



S5: Jpn Troll (1980-2018)

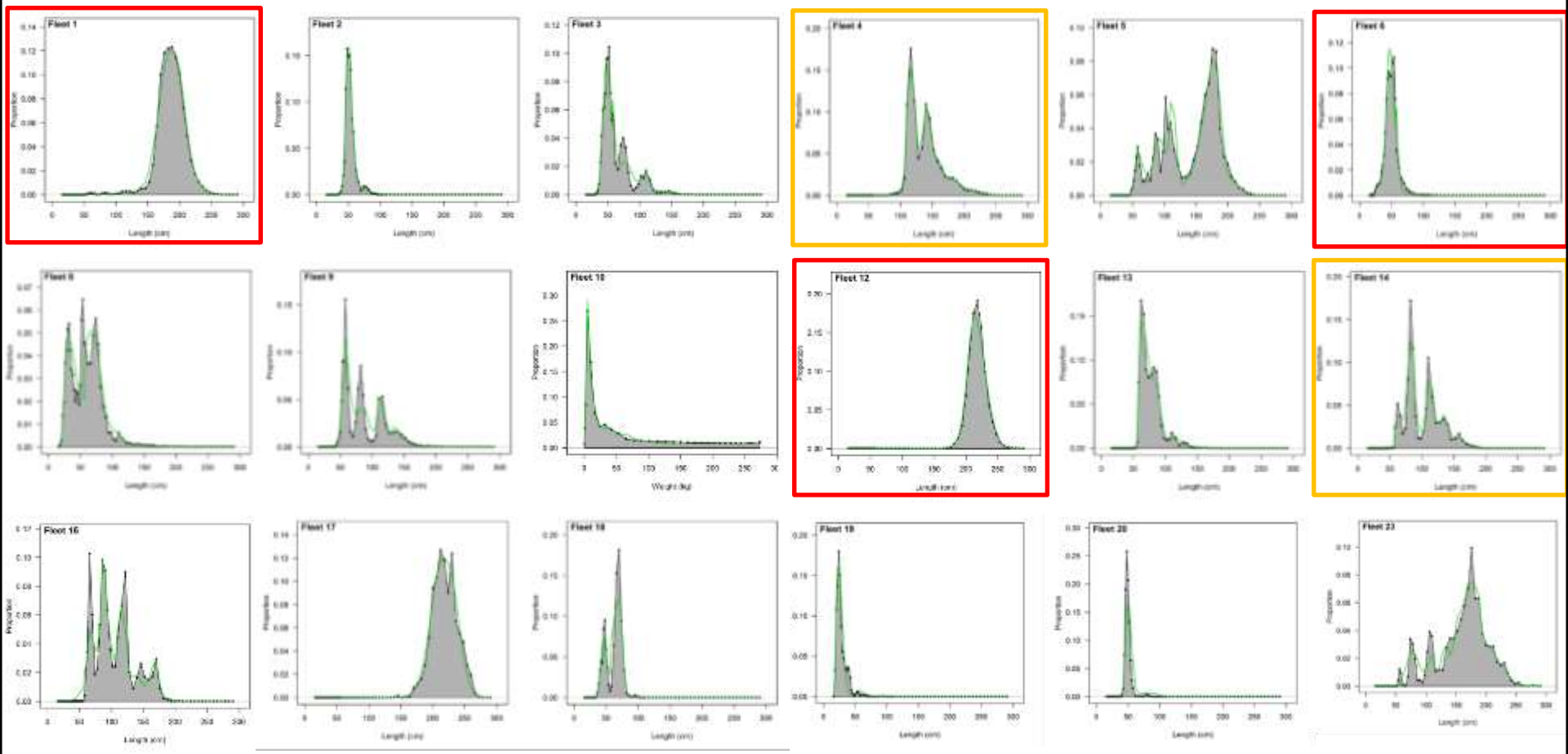


S9: Twn Longline (2002-2018)



Average fits to Size Compositions

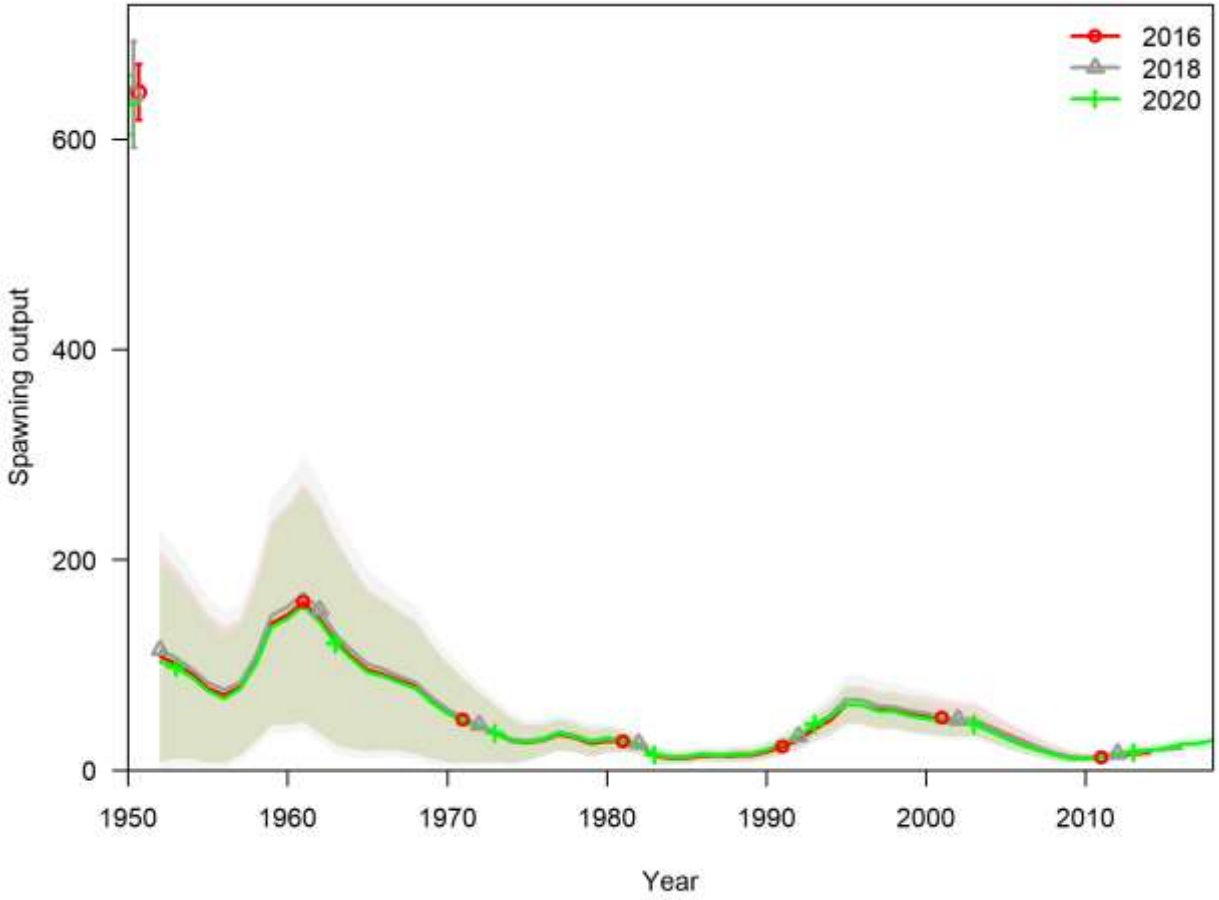
- The base-case model fits the size modes in data.
- The average effective sample sizes are larger than the average input sample sizes, indicating precise reconciliation of the assessment model.



Assessment results

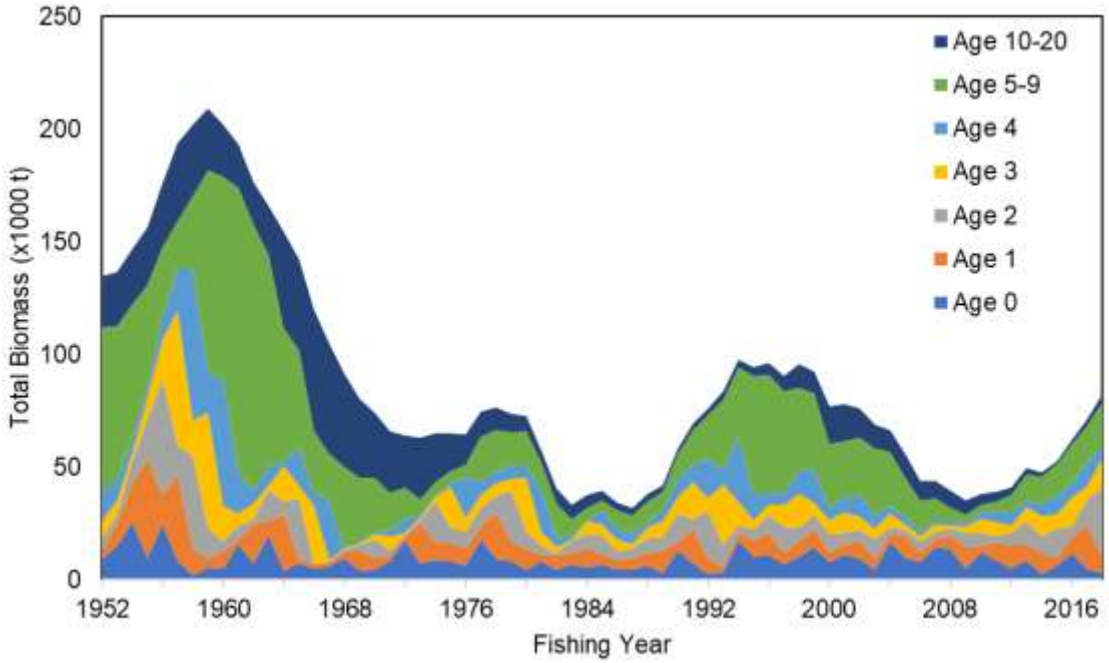
Comparisons of SSB with the past assessments

- The 2020 base-case model produced estimated dynamics that were very consistent with those from the past assessments.



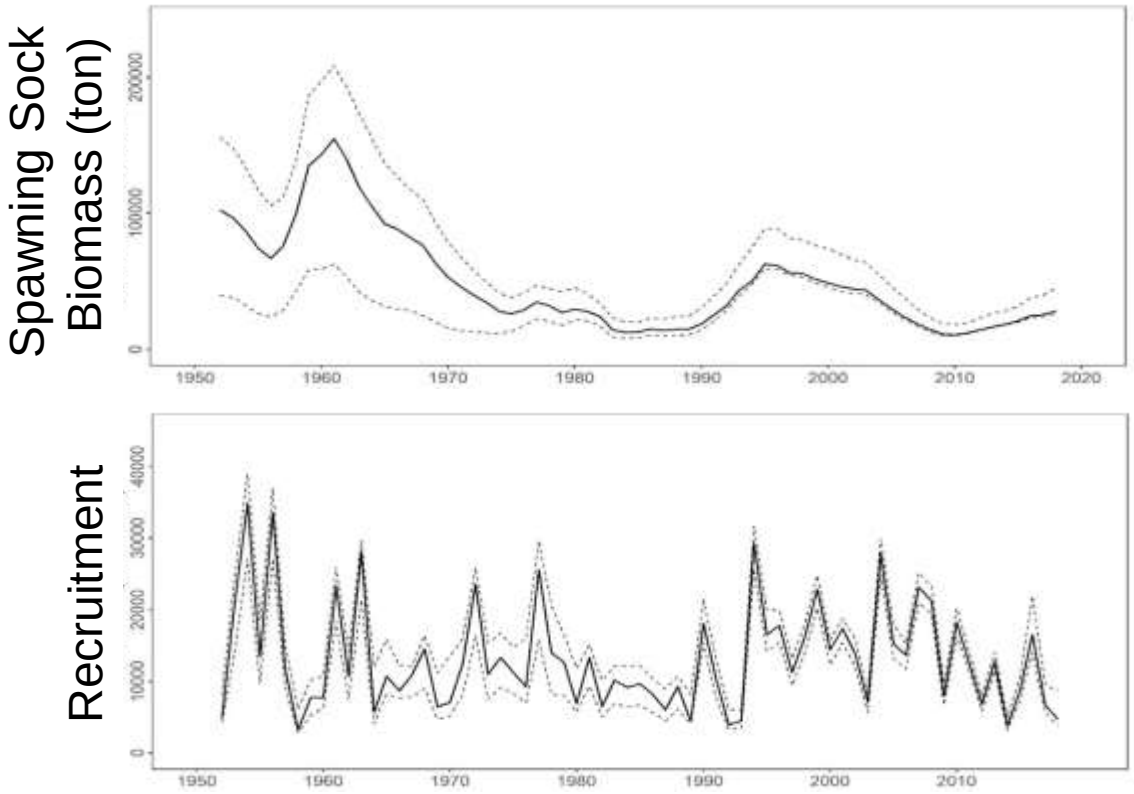
Total stock biomass (age specific)

- Base case model derived consistent results with the previous assessment.
  - Total stock biomass showed a gradual increase since 2009, and particularly for the recent 3 years, there is an increase of young fish (0–2 years old).
  - Total biomass in 2018 exceeded the historical median with an increase in immature fish.
  - This was likely resulting from low fishing mortality on those young fish and is expected to accelerate the recovery of SSB in the future.



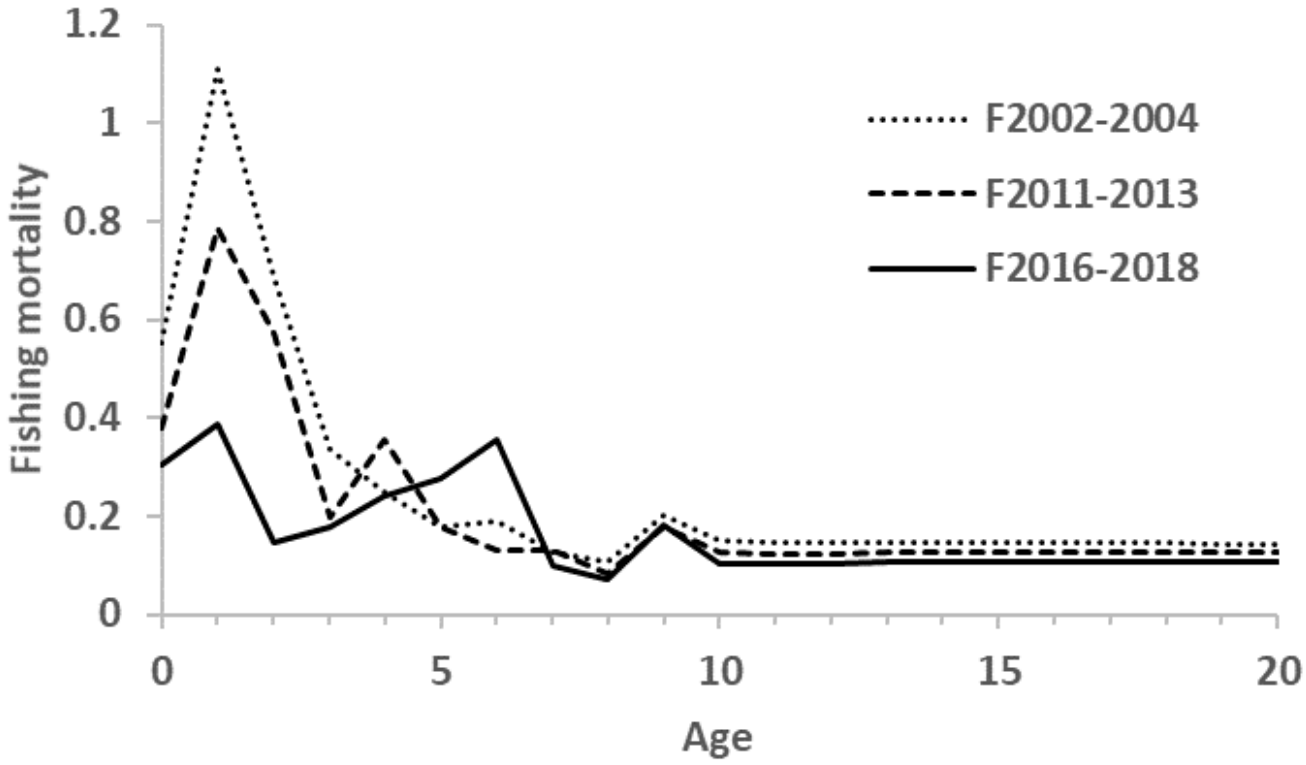
SSB and Recruitment

- SSB fluctuated over time; declined during 1996–2010, and increased since 2011.
  - 2018 SSB was estimated to be 28,000 tons (4.5%SSB_0)
- Recruitment estimates fluctuated widely without an apparent trend.
  - Recruitments in 2017–18 were lower than the historical average.
    - Higher uncertainty due to the limited data (e.g. no age-0 index for 2017)



Age specific fishing mortality

- Substantial decrease of F is observed in ages 0–2 in 2016–2018.
- Note that stricter management measures in IATTC and WCPFC have been in place since 2015.

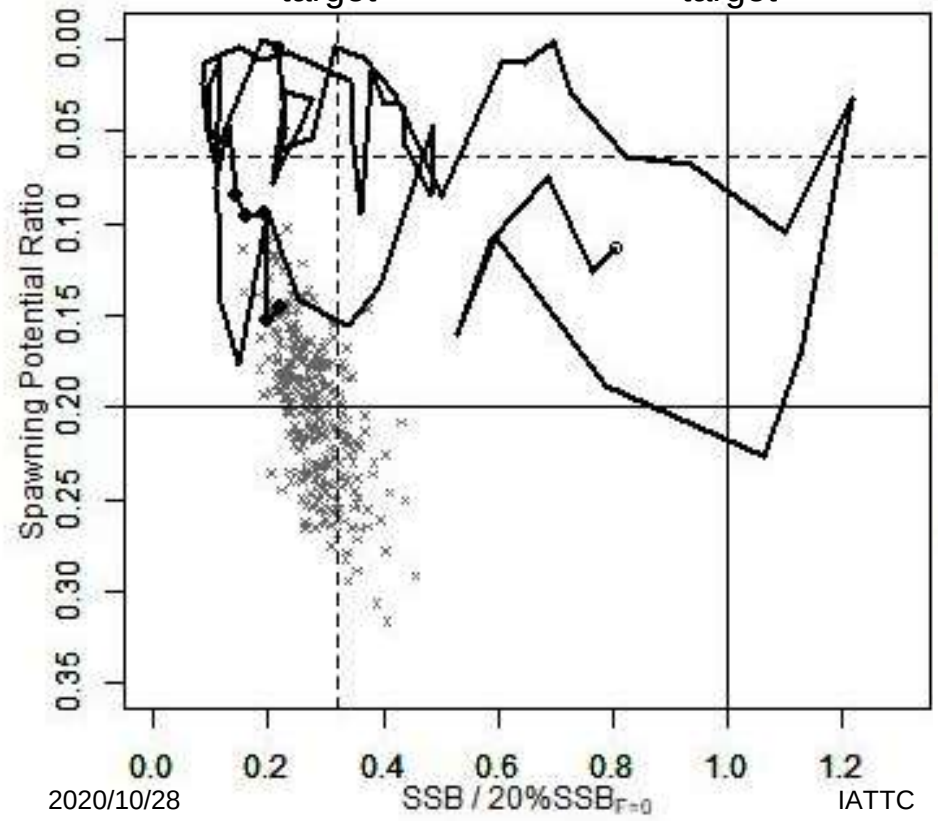


Stock Trajectory

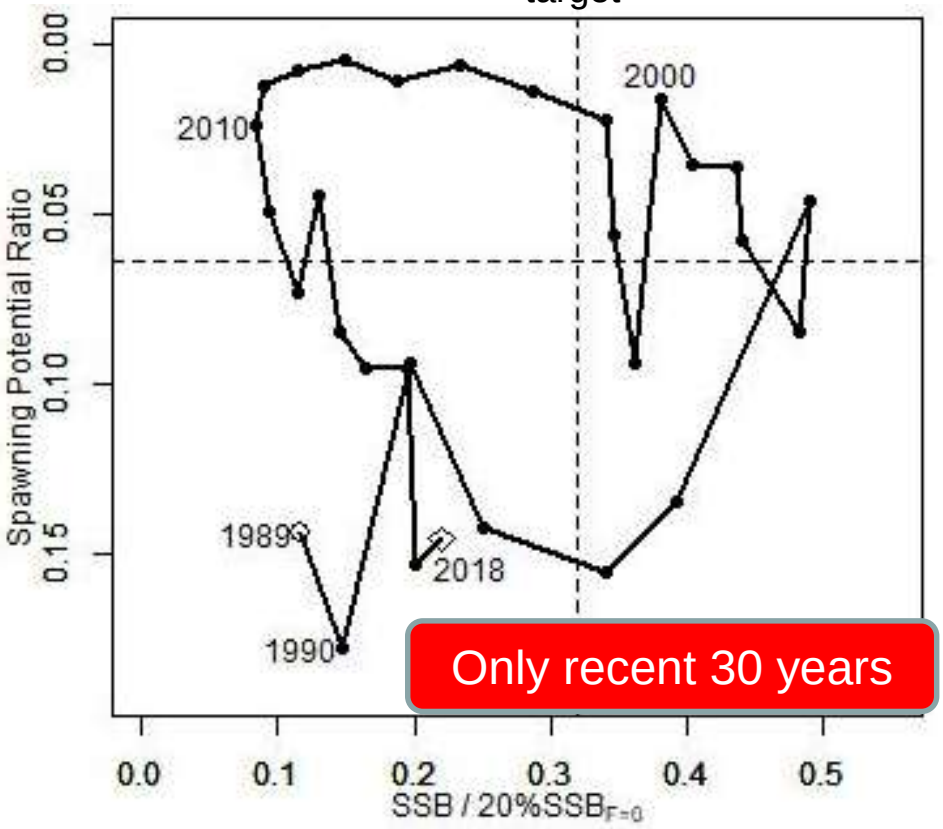
Reference period	F_{max}	$F_{0.1}$	F_{med}	(1-SPR)/(1-SPRxx%) SPR10%	SPR20%	SPR30%	SPR40%	Estimated SSB for terminal year of each period (ton)	Depletion rate for terminal year of each period (%)
2002-2004	1.92	2.84	1.14	1.08	1.21	1.38	1.61	36,701	5.80
2011-2013	1.54	2.26	0.89	1.05	1.18	1.35	1.57	16,703	2.64
2016-2018	1.14	1.65	0.57	0.95	1.07	1.23	1.43	28,228	4.46

Initial rebuilding target

second rebuilding target



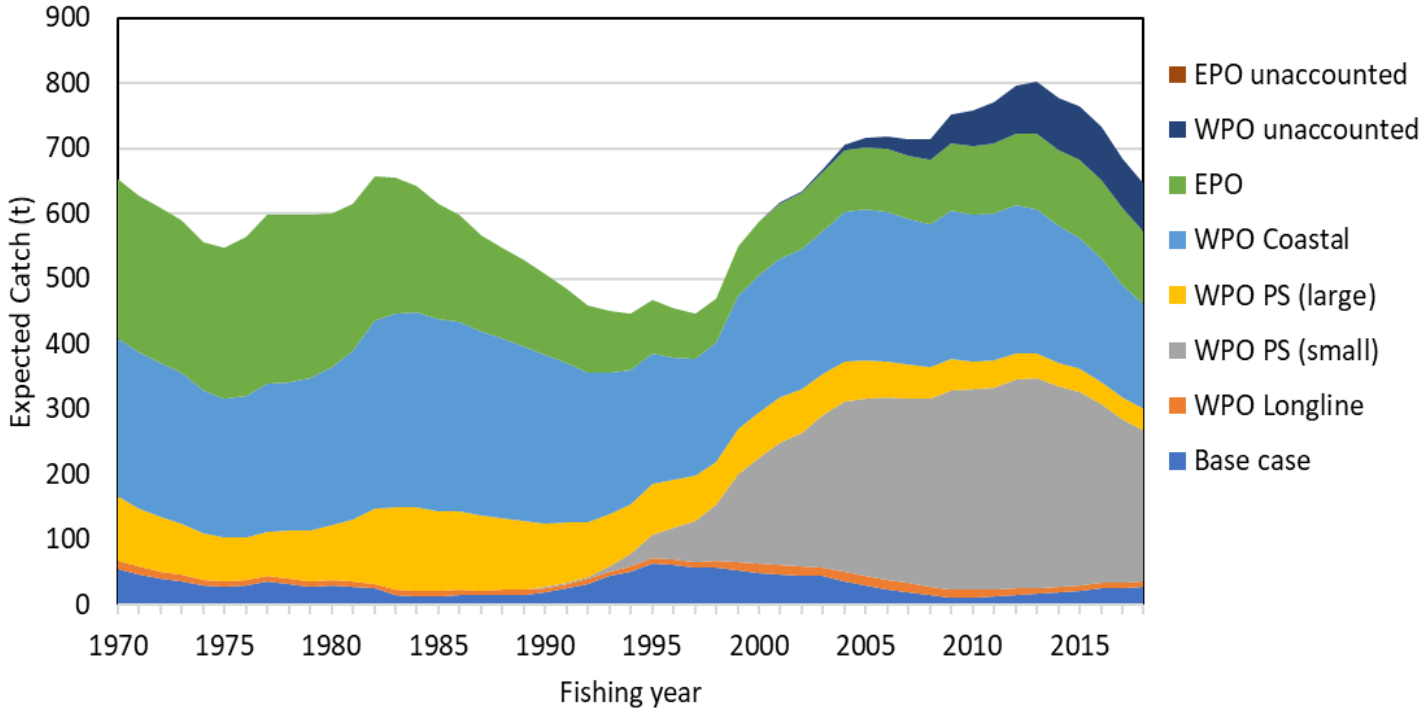
Initial rebuilding target



Only recent 30 years

Fishery impact plot

- Historically, the WPO coastal fisheries has had the greatest impact.
- Since about the mid-2000s, the WPO purse seine fleets targeting small PBF (age 0-1), have had the greatest impact.
- The impact of the EPO fishery was large before the mid-1980s, decreasing significantly thereafter.



Future Projection

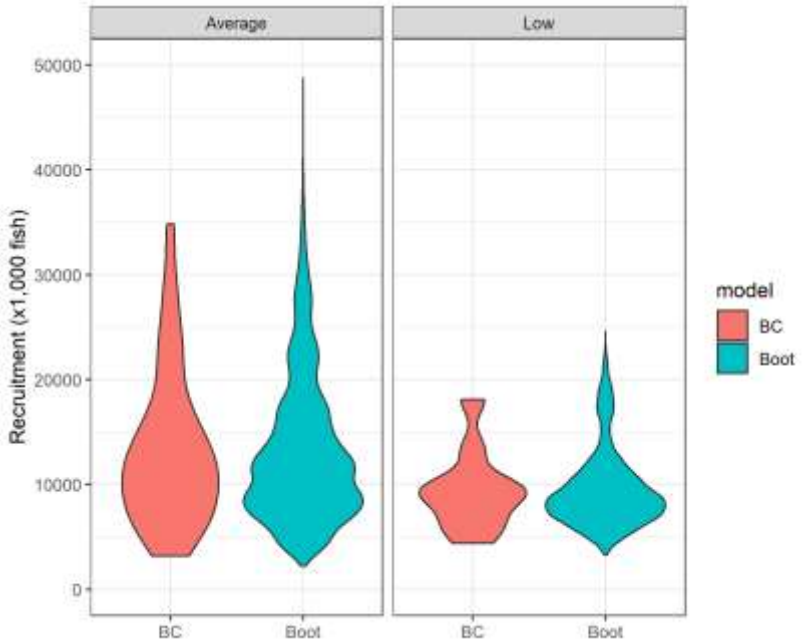
Projection model overview

- Age-structured forward projection model (*ssfuturePBF*)
  - Identical model structure with the stock assessment of PBF
  - Age-specific quarterly Fishing mortality of each fleet were assumed to be past particular year in the assessment (e.g. 2002-04).
  - Catch upper limit could be set to depict a management measure.
- Projection time period
  - From 2018 to 2034
  - Initial condition (2018) was based on the stock assessment result.
- Uncertainty
  - 300 bootstrap replicates followed by 20 recruitments resampling.
- Typical outputs
  - Future Biomass, Future catch, Probabilities achieving rebuilding targets.

Future Harvest scenarios and recruitment assumption

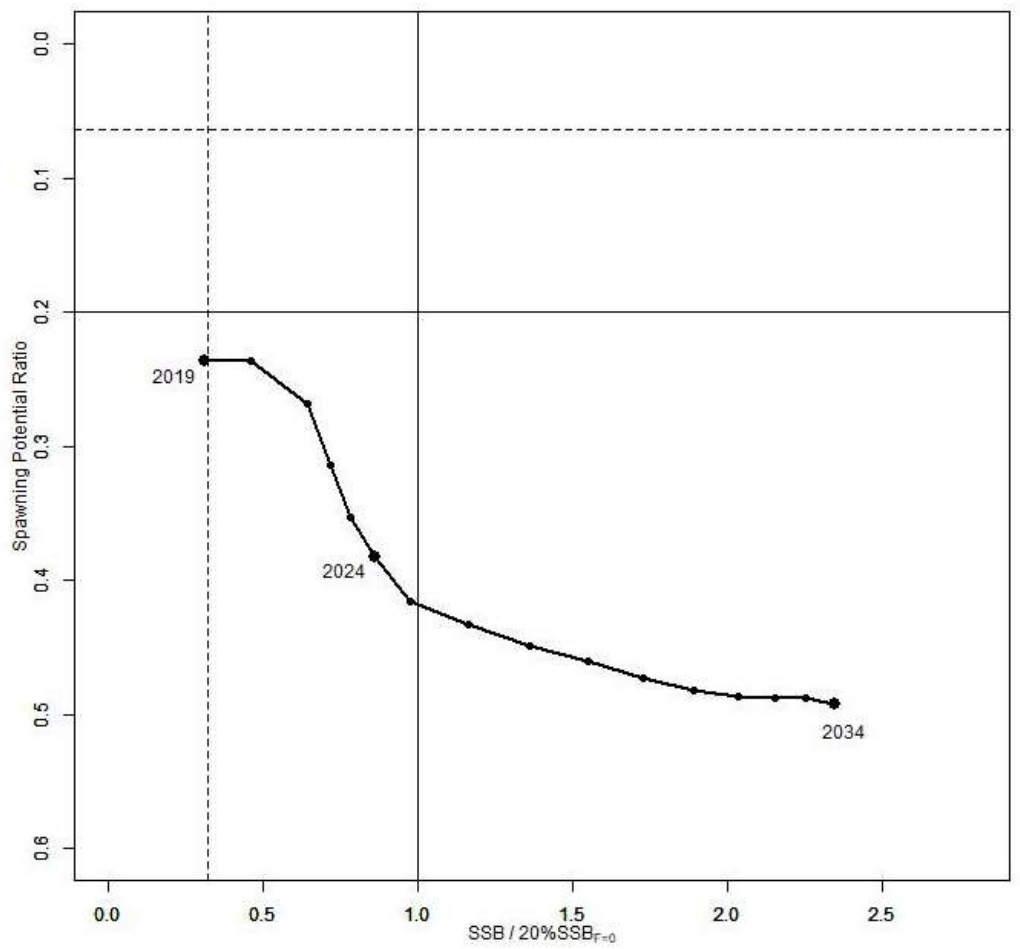
- Harvesting Scenarios (Table S-3)
  - One mimicking a current CMMs (Scenario 1 and 2)
  - Requests from two RFMOs (Scenarios 3-14)
  - No catch (Potential of stock recovering; Scenario 15)

- Recruitment assumptions
  - Resampling from low recruit until the stock meets the historical average SSB (Initial target).



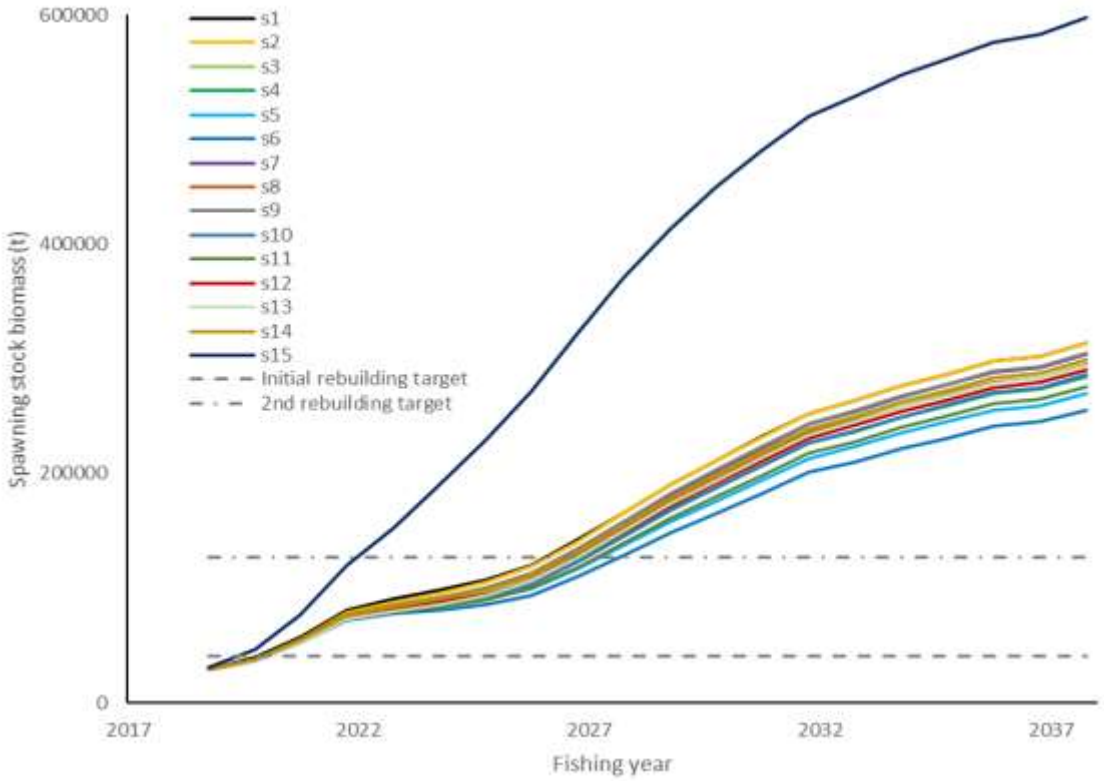
Stock trajectory for projected biomass and F

- The projection results show that PBF SSB recovers to the biomass-based rebuilding targets due to reduced fishing mortality by applying catch limits as the stock increases.



Projection Results

- Scenario 1 (Status quo) has the highest prospect of recovery among all the examined scenarios except for the zero removals scenario.
- Under all examined scenarios the rebuilding targets of WCPFC and IATTC is reached and the risk of SSB falling below SSB_{loss} in 10 years is negligible.



Second rebuilding target (20%SSB0)

Initial rebuilding target ($SSB_{med\ 1952\text{-}2014}$)

Summary of the assessment

- The model generally fits all the available data well and is internally consistent given the assumption of the population dynamics, and results were consistent with the past assessments.
- The ISC20 adopted that the 2020 assessment results were the best available science information.
- The assessment results showed a decrease in Fishing mortality, in particular for young fish, and increases of SSB as well as the immature fish.
- Projections indicated that the initial and second rebuilding targets of WCPFC and IATTC is reached in higher probability prescribed in the WCPFC_HS_2017-02 under all the examined harvest scenarios and recruitment assumption.

Stock Status and Conservation information

Stock Status (1)

The WCPFC and IATTC adopted an initial rebuilding biomass target (the median SSB estimated for the period from 1952 through 2014) and a second rebuilding biomass target (20%$SSB_{F=0}$ under average recruitment), without specifying a fishing mortality reference level. The 2020 assessment estimated the initial rebuilding biomass target ($SSB_{MED1952-2014}$) to be 6.4%$SSB_{F=0}$ and the corresponding fishing mortality expressed as $F_{6.4\%SPR}$. The Kobe plot shows that the point estimate of the SSB_{2018} was 4.5%$SSB_{F=0}$ and the recent (2016–2018) fishing mortality corresponds to $F_{14\%SPR}$. 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 biomass-based limit reference points adopted for other species in WCPFC (20%$SSB_{F=0}$) and fishing mortality has declined but not reached the level corresponding to that reference point ($F_{20\%SPR}$).

Stock Status (2)

The PBF spawning stock biomass (SSB) has gradually increased in the last 8 years (2011–2018). Young fish (age 0–2) shows a more rapid increase in recent years. These changes in biomass coincide with a decline in fishing mortality over the last decade. Based on these findings, the following information on the status of the Pacific bluefin tuna stock is provided:

1. **The latest (2018) SSB is estimated to be 4.5% of $SSB_{F=0}$, which is an increase from 4.0% estimated for 2016 (the terminal year in the previous assessment). No biomass-based limit or target reference points have been adopted for PBF. However, the PBF stock is overfished relative to the potential biomass-based reference points (SSB_{MED} and $20\%SSB_{F=0}$) adopted for other tuna species by the IATTC and WCPFC.**

2. **The recent (2016–2018) $F_{\%SPR}$ is estimated to produce 14%SPR. Although no fishing mortality-based limit or target reference points have been adopted for PBF by the IATTC and WCPFC, recent fishing mortality is above the level producing 20%SPR. However, the stock is subject to rebuilding measures including catch limits and the capacity of the stock to rebuild is not compromised, as shown by the projection results.**

Conservation information (1)

After the steady decline in SSB from 1995 to the historically low level in 2010, the PBF stock has started recovering slowly, consistent with the management measures implemented in 2014–2015. The spawning stock biomass in 2018 was below the two biomass rebuilding targets adopted by the WCPFC while the 2016–18 fishing mortality ($F_{\%SPR}$) has reduced to a level producing $14_{\%SPR}$.

The projection results based on the base-case model under several harvest and recruitment scenarios and time schedules requested by the RFMOs are shown in the tables and figures of the SAR. The projection results show that PBF SSB recovers to the biomass-based rebuilding targets due to reduced fishing mortality by applying catch limits as the stock increases. In most of the scenarios, the SSB biomass is projected to recover to the initial rebuilding target (SSB_{MED}) in the fishing year 2020 (April of 2021) with a probability above the 60% level prescribed in the WCPFC CMM 2019-02.

Conservation information (2)

A Kobe chart and impacts by fleets estimated from future projections under the current management scheme are provided for information. Because the projections include catch limits, fishing mortality ($F_{x\%SPR}$) is expected to decline, i.e., SPR will increase, as biomass increases. Further stratification of future impacts is possible if the allocation of increased catch limits among fleets/countries is specified.

1. **Under all examined scenarios the initial goal of WCPFC and IATTC, rebuilding to SSB_{MED} by 2024 with at least 60% probability, is reached and the risk of SSB falling below historical lowest observed SSB at least once in 10 years is negligible.**
2. **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 the harvest scenarios.**
3. **Given the low SSB, the uncertainty in future recruitment, and the influence recruitment has on stock biomass, monitoring recruitment and SSB should continue so that the recruitment level can be understood in a timely manner.**

Thank you for your attention !