North Pacific Fisheries Commission

4th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

REPORT

22-25 June 2021

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North Pacific Fisheries Commission
4th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

22-25 June 2021
Video conference

REPORT

Agenda Item 1. Opening of the Meeting

1. The 4th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA) of the North Pacific Fisheries Commission (NPFC) took place in the format of video conferencing via WebEx, and was attended by Members from Canada, China, Japan, the Russian Federation, and the United States of America. An invited expert, Dr. Joel Rice, participated in the meeting. The European Union (EU) and the Pew Charitable Trusts (Pew) attended as observers.

2. The meeting was opened by the TWG CMSA Chair, Dr. Vladimir Kulik (Russia). Mr. Alex Meyer was selected as rapporteur.

Agenda Item 2. Adoption of Agenda

3. The Agenda was adopted without revision (Annex A). The List of Documents and Participants List are attached (Annexes B, C).

Agenda Item 3. Overview of the recommendations and outcomes of previous NPFC meetings relevant to chub mackerel

3.1 3rd TWG CMSA and 5th SC meetings

4. The Chair provided an overview of the recommendations made by the 3rd TWG CMSA meeting, which the 5th Scientific Committee (SC) meeting endorsed with slight modifications and recommended to the Commission meeting.

3.2 6th Commission meeting

5. The Science Manager, Dr. Alex Zavolokin, reported that the 6th Commission meeting adopted the majority of the TWG CMSA-related recommendations made by the SC. However, regarding the recommendation that the Commission give guidance on how to move forward,

including the setting of management objectives for the development of the management strategy evaluation (MSE), the Commission decided to change the primary target for MSE development from chub mackerel to Pacific saury. As for the recommendation that reporting requirements be changed such that Convention Area chub mackerel fisheries be required to report bycatch of pelagic species, the Commission agreed to defer discussions to its next meeting, due to time limitations.

3.3 Intersessional meetings of SWG OM

6. The SWG OM Lead, Dr. Shota Nishijima (Japan), provided an overview of the discussions and outcomes of the intersessional meeting of the SWG OM. The Lead outlined the issues related to developing an operating model and input data which require further discussions at the TWG CMSA meeting.

Agenda Item 4. Toward development of Management Strategy Evaluation (MSE)

4.1 Update on intersessional work towards MSE

7. The Science Manager reported that no further progress on an MSE process for chub mackerel has been made since the last TWG CMSA meeting.

4.2 Recommendations and timelines for future work

8. The TWG CMSA discussed recommendations and timelines for future work under Agenda Item 9.

Agenda Item 5. Review of Terms of Reference and Protocols of the TWG CMSA

5.1 Terms of Reference

9. The TWG CMSA reviewed the Terms of Reference and determined that no revisions are currently required.

5.2 CPUE Standardization Protocol

10. The TWG CMSA reviewed the CPUE Standardization Protocol and determined that no revisions are currently required.

5.3 Stock Assessment Protocol

11. The TWG CMSA reviewed the Stock Assessment Protocol and determined that no revisions are currently required.

5.4 Protocol for the Operating Model Development

12. The TWG CMSA reviewed the Protocol for the Operating Model Development and determined

that no revisions are currently required.

Agenda Item 6. Review of Member's fisheries and research activities

6.1 Description of fisheries, inter alia, fishing seasons and fishing grounds

6.2 Research activities

13. Japan presented an updated description of its chub mackerel fisheries (NPFC-2021-TWG CMSA04-WP02). Japan's chub mackerel fisheries consist of large-scale (≥ 40 GRT) and small-scale (<40 GRT) purse seiners, set nets, and dip nets. Annual catch data showed a decadal variation. The largest catch is by large-scale purse-seiners. The monthly catch showed a periodic change annually over the recent decade. Catch starts to increase after the July-to-October period, when it is at its lowest annually, before peaking from the 4th quarter to the 1st quarter of the following year. The spawning season, from January to June, corresponds to the second half of the fishing year, such that the recruitment of age-0 fish occurs in the first half of the fishing year. Japan applied a fishing year reflecting this seasonal catch variation and biological background in its domestic stock assessment and recommended that the NPFC consider incorporating such a fishing year when developing the benchmark chub mackerel stock assessment.

14. The TWG CMSA discussed Japan's suggestion and noted that China, Russia, and Japan each have different fishing seasons. China and Russia explained that they manage chub mackerel based on a calendar year, rather than a fishing year, and pointed out that there could be problems developing calendar-year-based management measures from a stock assessment based on a fishing year. Japan pointed out that other regional fisheries management organizations (RFMOs) have been able to apply a fishing year for the stock assessment but the calendar year for developing management measures, for example in the case of Pacific bluefin tuna. A calendar illustrating the spawning season of chub mackerel and China, Japan and Russia's fishing seasons is attached as Annex D.

15. The TWG CMSA considered four possible options for addressing the issue of fishing year, as described below, and agreed to discuss them further at the next meeting:
    (a) Apply a fishing year beginning in July
    (b) Apply a fishing year beginning in April
    (c) Apply the calendar year
    (d) Apply a fishing year beginning in July for Japan and Russia, and the calendar year for China

16. Japan was requested to review and update its annual footprint data for chub mackerel by the

next TWG CMSA meeting as there seemed to be inconsistency between catch and effort data reported by Japan to the Secretariat. Japan clarified that mackerels are caught as bycatch by Japanese bottom trawlers operating in the Convention Area, which is why the catch but not the effort of those vessels is shown in the annual footprint data.

17. Russia presented an update of its chub mackerel fisheries with results for 2020 (NPFC-2021-TWG CMSA04-WP10). The 2020 Russian mackerel fishery situation was similar to that in 2019, with catch peaking during autumn and early winter. Over the past three years, annual catch has declined slightly. Russia conducted a trawl survey in the upper epipelagic zone off the Kuril Islands in August and early September 2020, and found a similar distribution of chub mackerel to 2019.

18. China presented a review of its chub mackerel fishery and research activities (NPFC-2021-TWG CMSA04-WP18) and the distribution of its catch of chub mackerel in 2020 (NPFC-2021-TWG CMSA04-WP15). In 2020, China operated a light-purse seine fishery and a small pelagic trawl fishery in the Convention Area. 51 purse seine vessels operated for a total of 8,459 fishing days and 2 trawl vessels operated for a total of 296 fishing days. In 2020, total catch was 94,256 tons and the majority of the catch occurred at around 40-43° north latitude and 150-154° east longitude. China collects and analyzes fishing logbooks every year and sends research specialist staff to fishing vessels or ports to collect sample data. It is also providing annual training for fishermen and enterprises via the Technical Group of Mackerel Fish. In future, China intends to strengthen its collection of fishery-dependent biological data for assessment of mackerel resources.

Agenda Item 7. Development of the operating model for the stock assessment of chub mackerel

7.1 Review of key considerations and specifications from the TWG CMSA03 meeting

19. The TWG CMSA reviewed the key considerations and specifications from the 3rd TWG CMSA meeting.

20. Japan presented updated age-common and age-specific natural mortality (M) estimators obtained from life-history parameters for chub mackerel in the northwestern Pacific Ocean (NPFC-2021-TWG CMSA04-WP05). Based on newly added data, which showed smaller fork lengths for five years of age and older, the growth coefficient (K) and asymptotic fork length ($L\infty$) were estimated to be higher and lower, respectively, than the estimates Japan presented at TWG CMSA02 (NPFC-2019-TWG CMSA02-WP01 (Rev. 2)). The updated M values obtained from equations such as Pauly and Jensen were higher than previous ones because of the higher growth coefficient; accordingly, the median value of M among various estimators

was also higher. Japan also estimated age-specific M including age 0 using Gislason estimators. Japan suggested applying the median of updated estimators as the age-common M (0.53) and the updated Gislason estimates as the age-specific M (0.80 for age 0, 0.60 for age1, 0.51 for age 2, 0.46 for age 3, 0.43 for age 4, 0.41 for age 5, and 0.40 for age 6+), for rerunning candidate stock assessment models under the scenarios of operating models for the chub mackerel stock assessment.

21. China suggested that the TWG CMSA also consider time-varying M. Japan suggested that considering time-varying M is an issue toward the benchmark stock assessment rather than the development of the operating model.

22. China expressed its concern on the lack of goodness of fit for the von Bertalanffy growth function (VBGF) using updated data, which may affect the calculation of natural mortality with empirical estimators and consequentially bias the stock assessment results. China also suggested that Japan apply other growth functions to fit the growth of chub mackerel. On the lack of goodness of fit for VBGF, Japan responded that the goodness of fit by year class is not so bad according to Figure A2 in NPFC-2021-TWG CMSA04-WP05. Japan also explained that applying other growth function is possible but cannot be used to estimate M since M estimator uses parameters specific to VBGF.

7.2 Review of stock assessment results (VPA, ASAP, KAFKA, SAM)

23. China presented an updated stock assessment based on age-structured assessment program (ASAP) for the operating model for chub mackerel in the North Pacific Ocean (NPFC-2021-TWG CMSA04-WP01). The biomass of chub mackerel stayed at a high level before 1980, then declined to a low value, before recovering from 2010, with a similar trend for abundance and spawning stock biomass (SSB). Fishing mortality during 1985-2005 was high for chub mackerel and stock abundance was very low.

24. Japan suggested that the very low estimates of SSB_{MSY} may be due to the high steepness value used for the stock-recruitment relationship and that the results of the Kobe plots may be misleading. Furthermore, Japan pointed out that an issue with ASAP is that it assumes that the recruitment age is 1, but the actual recruitment age of chub mackerel is 0 and suggested appropriately applying a post-hoc analysis of stock-recruitment relationship after the running of ASAP.

25. The invited expert suggested that China conduct a likelihood profile on a global scaling parameter or choice of steepness to investigate their influence on the results.

26. The TWG CMSA suggested presenting preliminary results of the BSSPM at the next SWG OM meeting.

27. Japan presented the updated results of tuned virtual population analysis (VPA) and state-space assessment model (SAM) under the determined scenarios to include biological uncertainties on natural mortality, weight, and maturity (NPFC-2021-TWG CMSA04-WP08). The recent abundance estimates in VPA were much higher than those in the SAM and the recent fishing pressure was lower in the VPA. The scenarios under the highest maturity and weight estimated higher SSB in recent years and larger retrospective biases of SSB than the other scenarios in both SAM and VPA. The application of a continuous hockey-stick stock-recruit model enabled estimation of feasible biological reference points. A few potential problems were found in both SAM and VPA: (1) the abundance indices from China and Russia were extremely hyper-stable against vulnerable stock size, (2) depletion statistics such as SSB/SSB0 and SSB/SSB_{MSY} were highly sensitive to the choices of stock-recruit function, and (3) the MSY-based reference points were moderately sensitive to the biological parameters of maturity- and weight-at-age.

28. China noted the retrospective patterns and large Mohn's rho values for the SAM and VPA results. China suggested that these could be due to misspecifications of survey catchability and natural mortality and that Japan try different specifications of those parameters to see if they reduce the retrospective patterns. Japan agreed to do so, while expressing the view that the retrospective patterns are likely due to different assumptions of weight-at-age and maturity-at-age.

29. Russia presented an updated preliminary chub mackerel stock assessment using a KAFKA model (NPFC-2021-TWG CMSA04-WP09). The preliminary chub mackerel SSB estimation is 3,035,000 t for 2019 and 2,246,000 t for 2020. Japan pointed out that Russia used the two SSB indices and analyzed a single base-case scenario, and requested that Russia use all six abundance indices and analyze all six scenarios at the next meeting of the SWG OM. Russia was requested to continue to develop the KAFKA model and run it for all determined scenarios and all agreed abundance indices, as well as to share the technical details of the model.

7.3 Review of assumptions and parameters from the stock assessment models

7.4 Review of major sources of uncertainty to be included in the operating model

30. The TWG CMSA reviewed the stock assessment model assumptions and parameters, and major sources of uncertainty to be included in the operating model.

31. Regarding the natural mortality scenario, the TWG CMSA agreed to use the previous estimates of M (NPFC-2019-TWG CMSA02-WP01 (Rev. 2)). For age-0 M in Gislason1, an extrapolated value was calculated (0.57; using a second order polynomial from the values of age-1 – 0.47; age-2 – 0.38; age-3 – 0.32; age-4 – 0.28; age-5 – 0.26; age-6+ – 0.24).

32. Regarding the maturity-at-age and weight-at-age scenarios, the TWG CMSA agreed to keep the three existing scenario settings (average, highest, lowest).

33. The TWG CMSA formulated an updated table of stock assessment model settings (Annex E).

7.5 Review of scenarios for the operating model

34. The TWG CMSA reviewed and revised the table of scenarios for the operating model (Annex F). The TWG CMSA added a column of "Weight" to Annex F, which is indicative of a future weighting scheme that may be developed if multiple scenarios are adopted for the evaluation of the fit of stock assessment models to the operating model.

7.6 Review of the rules for prioritization of the performance measures

35. The invited expert proposed guiding questions for the interpretation of the performance measures, suggested possible initial performance measures, and highlighted the importance of model diagnostics (NPFC-2021-TWG CMSA04-WP14).

36. The TWG CMSA reviewed the table of performance measures for evaluating the stock assessment models agreed to at TWG CMSA03 while considering the invited expert's suggestions and formulated a table of priority performance measures for evaluating the stock assessment models (Annex G).

7.7 Technical aspects of using POPSIM-A as an operating model for testing chub mackerel stock assessment models

37. The TWG CMSA discussed the technical aspects of using POPSIM-A as an operating model for testing chub mackerel stock assessment models.

7.8 Finalization of specification of the operating model for testing chub mackerel stock assessment models

38. The TWG CMSA finalized the specification of the operating model for testing chub mackerel stock assessment models and agreed that the timeframe of the pseudo-data would be from 1970-2019 and that the number of generated pseudo-data for each scenario would be 100. The TWG CMSA agreed that the scenarios presented in Annex F would be considered.

7.9 Recommendations and timelines for future work

39. The TWG CMSA reviewed the timeline for future work as agreed by the SWG OM during the intersessional period and agreed on the need to hold an additional SWG OM meeting in late August 2021 to update and rerun the candidate stock assessment models before the generation of pseudo-data by the invited expert. The TWG CMSA discussed the tasks to be completed before the SWG OM meeting and drafted a revised timeline for inclusion in the Work Plan of the TWG CMSA (Annex H).

40. The TWG CMSA tasked the SWG OM to review the results of the updated stock assessment models. The TWG CMSA agreed that if the updated stock assessment results for all agreed scenarios (except BSSPM) are not provided to the SWG OM meeting, the model will be excluded from the list of candidate stock assessment models. For BSSPM, description of model configuration and stock assessment results with the base case scenario is to be provided.

Agenda Item 8. Development of data for the stock assessment of chub mackerel

8.1 Data inventory (catch, size, abundance indices, etc.) and updates

41. Russia presented its methodology for calculating catch- and weight-at-age data for chub mackerel (NPFC-2021-TWG CMSA04-WP11). Size data were collected from research surveys in 2016-2020 as well as from fishery observers. Fish fork length was measured, and some fish were weighed. Weight-length relationships by 3-month periods and years were compiled. Age composition of catch was calculated using weight-length relationships and Japanese age-length keys (ALKs) for the northeastern region.

42. Russia was requested to present an abundance index from its research survey at the next TWG CMSA meeting.

43. China presented a description of its available data (NPFC-2021-TWG CMSA04-WP16). China explained its methodologies for sampling, ALK development, and estimating catch-at-age from the ALK, and presented its data for length and age distribution, length-weight relationship, catch-at-age, and number-at-age.

44. The TWG CMSA suggested that China clarify the methodology of ALK development and use year-specific ALK.

45. The TWG CMSA reviewed and updated the table of potentially available data for stock assessment of chub mackerel (Data availability for CMSA).

8.2 Standardized fishery-dependent/independent indices

46. Japan presented the standardized CPUE of its commercial dip-net fishery targeting spawners of chub mackerel in the northwestern Pacific Ocean using delta GLM (NPFC-2021-TWG CMSA04-WP03).

47. Japan presented its standardized monthly egg survey data using the vector autoregressive spatio-temporal (VAST) model for use as an abundance index for SSB of chub mackerel in the northwestern Pacific Ocean (NPFC-2021-TWG CMSA04-WP04).

48. Japan presented a standardized abundance index for recruitment of chub mackerel in the northwestern Pacific Ocean derived by applying delta-GLM-tree models to data from summer (June and July) and autumn (September and October) surface trawl surveys (NPFC-2021-TWG CMSA04-WP06).

49. China presented the standardized CPUE for chub mackerel caught by its lighting purse seine fishery up to 2019 using GAM (NPFC-2021-TWG CMSA04-WP17).

50. The TWG CMSA encouraged China to improve its CPUE standardization and the documentation of the standardization methodology by the next TWG CMSA meeting. A list of potential improvements was communicated and it was agreed that progress would be made to resolve these intersessionally.

51. Russia was encouraged to submit a CPUE standardization document to the next TWG CMSA meeting.

8.3 Biological information

52. Japan presented an analysis of the maturity-at-age of chub mackerel under different stock levels in the northwestern Pacific Ocean (NPFC-2021-TWG CMSA04-WP07). The timing of maturity was variable depending on the stock levels. The maturation length was consistent throughout the different stock levels. Since the growth rate is affected by the density-dependent effect, the variation of the timing to reach the length at maturity is also density-dependent. Since maturity-at-age is variable based on the density, Japan recommended that density-dependent maturity-at-age be incorporated in the chub mackerel stock assessment.

8.4 Observer Program

53. The Science Manager presented a summary of Members' views on the potential establishment

of an observer program for chub mackerel (NPFC-2021-TWG CMSA04-WP13 (Rev. 1)).

54. The TWG CMSA considered the summary and held further discussions. Most Members noted the necessity of an observer program for chub mackerel and its value in filling data gaps and aiding the stock assessment process. However, some Members expressed the view that it would be premature to establish an observer program at this time. The TWG CMSA agreed on the need for further discussions, including the possible objectives of an observer program and the types of data that could be collected.

55. Pew expressed its strong support for the development of a regional NPFC observer program, highlighting its scientific benefits. Pew encouraged the TWG CMSA to identify types of data that could be collected by such a program, as requested by the SC.

56. The TWG CMSA revisited the recommendation made at TWG CMSA03 that reporting requirements be changed such that Convention Area chub mackerel fisheries be required to report bycatch of pelagic species. The TWG CMSA recognized the scientific value of reporting bycatch of pelagic species but could not reach consensus on revising the CMM.

8.5 Recommendations for future work

57. The TWG CMSA agreed to continue discussions towards potentially developing an observer program for chub mackerel.

58. The TWG CMSA agreed to continue discussions on the reporting of bycatch of pelagic species by Convention Area chub mackerel fisheries.

Agenda Item 9. Review of the Work Plan of the TWG CMSA

59. The TWG CMSA reviewed and updated the Work Plan of the TWG CMSA (NPFC-2021-TWG CMSA04-WP12 (Rev. 2)).

60. The TWG CMSA recommended hiring an external expert to continue the work to develop an operating model (PopSim) and test chub mackerel stock assessment models, if needed, in the next year.

Agenda Item 10. Other matters

10.1 Next TWG CMSA meeting

61. The TWG CMSA suggested that two meetings be held in 2022, possibly in spring and fall, with the specific dates and meeting format to be determined intersessionally via correspondence.

10.2 Other matters

62. No other matters were discussed.

Agenda Item 11. Recommendations to the Scientific Committee

63. The TWG CMSA agreed:
    (a) To hold further discussions on aggregating data by fishing year and/or calendar year.
    (b) To rerun the models using the latest determined scenarios for the operating model by the next SWG OM meeting (Annex F).
    (c) To use the revised performance measures for evaluating the stock assessment models in the development of the operating model (Annex G).
    (d) To update the standardized abundance indices and other data for use in the stock assessment and provide a standardized abundance index of Russian fishery.

64. The TWG CMSA recommended the following to the SC:
    (a) The TWG CMSA recommended the Work Plan of the TWG CMSA (NPFC-2021-TWG CMSA04-WP12 (Rev. 2)).
    (b) The TWG CMSA recommended hiring an external expert to continue the work to develop an operating model (PopSim) and test chub mackerel stock assessment models, if needed, in the next year.
    (c) The TWG CMSA recommended holding two meetings in 2022, possibly in spring and fall, with the specific dates and meeting format to be determined intersessionally via correspondence.

Agenda Item 12. Adoption of the Report

65. The report was adopted by consensus.

Agenda Item 13. Close of the Meeting

66. The meeting closed at 15:24 on 25 June 2021, Tokyo time.

Annexes

Annex A – Agenda
Annex B – List of documents
Annex C – Participants list
Annex D – Calendar of the spawning season of chub mackerel and fishing seasons of China, Japan and Russia

Annex E – Settings of the stock assessment models used for the conditioning of operating models

Annex F – Scenarios for operating models

Annex G – Priority performance measures for evaluating the stock assessment models

Annex H – Flowchart for the development of operating models and testing stock assessment models

Annex A

Agenda

Agenda Item 1. Opening of the Meeting

Agenda Item 2. Adoption of Agenda

Agenda Item 3. Overview of the recommendations and outcomes of previous NPFC meetings relevant to chub mackerel

- 3.1 3rd TWG CMSA and 5th SC meeting
- 3.2 6th Commission meeting
- 3.3 Intersessional meetings of SWG OM

Agenda Item 4. Toward development of Management Strategy Evaluation (MSE)

- 4.1 Update on intersessional work towards MSE
- 4.2 Recommendations and timelines for future work

Agenda Item 5. Review of Terms of Reference and Protocols of the TWG CMSA

- 5.1 Terms of Reference
- 5.2 CPUE Standardization Protocol
- 5.3 Stock Assessment Protocol
- 5.4 Protocol for the Operating Model Development

Agenda Item 6. Member's fisheries information and research activities

- 6.1 Description of fisheries, inter alia, fishing seasons and fishing grounds
- 6.2 Research activities

Agenda Item 7. Development of the operating model for the stock assessment of chub mackerel

- 7.1 Review of key considerations and specifications from the TWG CMSA03 meeting
- 7.2 Review of updated stock assessment results (VPA, ASAP, KAFKA, SAM)
- 7.3 Review of assumptions and parameters from the stock assessment models
- 7.4 Review of major sources of uncertainty to be included in the operating model
- 7.5 Review of scenarios for the operating model
- 7.6 Review of the rules for prioritization of the performance measures
- 7.7 Technical aspects of using POPSIM-A as an operating model for testing chub mackerel stock assessment models

7.8 Finalization of specification of the operating model for testing chub mackerel stock assessment models

7.9 Recommendations and timelines for future work

Agenda Item 8. Development of data for the stock assessment of chub mackerel

8.1 Data inventory (catch, size, abundance indices, etc.) and updates

8.2 Standardized fishery-dependent/independent indices

8.3 Biological information

8.4 Observer Program

8.5 Recommendations for future work

Agenda Item 9. Review of the Work Plan of the TWG CMSA

Agenda Item 10. Other matters

10.1 Next TWG CMSA meetings

10.2 Other issues

Agenda Item 11. Recommendations to the Scientific Committee

Agenda Item 12. Adoption of Report

Agenda Item 13. Close of the Meeting

Annex B

List of documents

MEETING INFORMATION PAPERS

Symbol	Title
NPFC-2021-TWG CMSA04-MIP01	Meeting Notice and Information
NPFC-2021-TWG CMSA04-MIP02	Provisional Agenda
NPFC-2021-TWG CMSA04-MIP03 (Rev. 1)	Annotated Indicative Schedule

REFERENCE DOCUMENTS

Symbol	Title
	POPSIM-A as an operating model for testing North Pacific chub mackerel stock assessment models
	Data availability for CMSA

WORKING PAPERS

Symbol	Title
NPFC-2021-TWG CMSA04-WP01	Update stock assessment based on ASAP (age-structured assessment program) for Chub mackerel in the North Pacific Ocean
NPFC-2021-TWG CMSA04-WP02	Description on Japanese chub mackerel fisheries with emphasis on those seasonality and fishing grounds
NPFC-2021-TWG CMSA04-WP03	Standardizing CPUE of Japanese commercial dip-net fishery targeting spawners of chub mackerel in the Northwest Pacific
NPFC-2021-TWG CMSA04-WP04	Standardizing monthly egg survey data as an abundance index for spawning stock biomass of chub mackerel in the Northwest Pacific
NPFC-2021-TWG CMSA04-WP05	Update on natural mortality estimators for chub mackerel in the Northwest Pacific Ocean
NPFC-2021-TWG CMSA04-WP06	Standardizing abundance index for recruitment of chub mackerel in the Northwest Pacific
NPFC-2021-TWG CMSA04-WP07	Maturity at age of chub mackerels under different stock level in the northwestern Pacific Ocean
NPFC-2021-TWG CMSA04-WP08	Re-analysis of Virtual Population Analysis and

	State-Space Assessment Model for Operating Models of Chub Mackerel Stock Assessment in NPFC
NPFC-2021-TWG CMSA04-WP09	Preliminary chub mackerel stock assessment using KAFKA model
NPFC-2021-TWG CMSA04-WP10	Stock and fishing of chub mackerel (*Scomber japonicus*) by Russian vessels in 2020
NPFC-2021-TWG CMSA04-WP11	Catch and weight at age of chub mackerel in Russia
NPFC-2021-TWG CMSA04-WP12 (Rev. 2)	TWG CMSA Work Plan, 2021-2025
NPFC-2021-TWG CMSA04-WP13 (Rev. 1)	Members' views on an observer program for chub mackerel
NPFC-2021-TWG CMSA04-WP14	Candidate performance measures for testing chub mackerel stock assessment models
NPFC-2021-TWG CMSA04-WP15	Monthly catch data and the maps and description of China' fishing grounds
NPFC-2021-TWG CMSA04-WP16	Content of the document for data on biological information on the chub mackerel
NPFC-2021-TWG CMSA04-WP17	Standardized CPUE of Chub mackerel (*Scomber japonicus*) caught by the China's lighting purse seine fishery up to 2019
NPFC-2021-TWG CMSA04-WP18	Review of chub mackerel fishery in China and research activities

Annex C

List of participants

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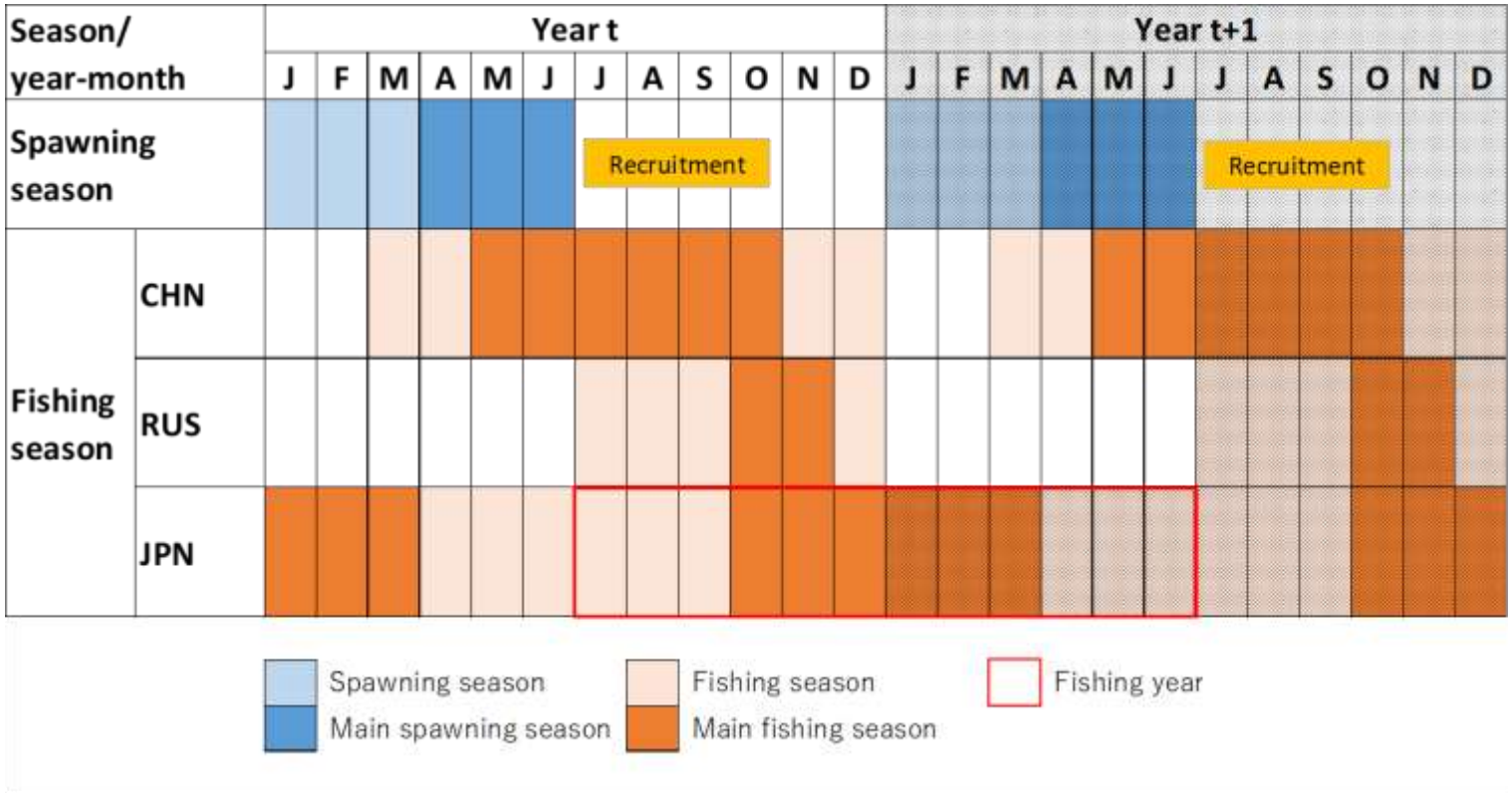
Annex D

Calendar of the spawning season of chub mackerel and fishing seasons of China, Japan and Russia



Annex E

Settings of the stock assessment models used for the conditioning of operating models

Settings/Models	VPA	SAM	ASAP	KAFKA
General characteristics	Backward calculation, no specific assumption in SR relationship and fisheries selectivity. No errors in catch at age. Penalty in estimating the terminal year's F.	Forward calculation, flexible assumption in SR relationship, and ability to estimate several random effects in fishing mortality	Forward calculation, Beverton-Holt SR relationship (recruitment is 1 age-old), separable assumption in fishing mortality	Backward calculation + Kalman filter, no specific assumption in SR relationship and fisheries selectivity. No errors in catch at age.
Total catch weight	Simple summation of catch at age * weight at age			
Error in total catch weight	No error	Sum of predicted catch number at age (no error)	Lognormal error	No error
Catch at age data	Merged	Merged	Merged	Merged
Error of catch at age or catch composition	No error	Lognormal error	Multinomial	No error
Abundance index fitted	All six abundance indices	All six abundance indices	All six abundance indices	Only two SSB indices
Abundance index error	Lognormal error	Lognormal error	Lognormal error	Normal
Estimation of nonlinear parameter of hyper stability/depletion	Yes	Yes	No	No
Natural mortality scenario	Previous M values (Takahashi et al. 2019) to be used. M at age 0 is extrapolated at 0.57. Gislason 1 to be used.			
Maturity-at-age scenario	Keeping the three scenario settings (average, highest, lowest)			
Weight-at-age scenario	Keeping the three scenario settings (average, highest, lowest)			
Recruitment age	0	0	1	0
Stock recruitment assumption	Continuous HS (post-hoc analysis)	Continuous HS	BH	No
Steepness	Estimated (post-hoc analysis)	Estimated (post-hoc analysis)	Fixed at 0.99	No est

Sigma R	Estimated (post-hoc analysis)	Estimated (post-hoc analysis)	Estimated	No est
Fleet configuration	Merged	Merged	Merged	Merged
Selectivity assumption	Independent age specific F	Age specific F with random walk	Age specific selectivity	Age specific fishing rate fi_at=1-exp(-F_at)
Objective function (error structure)	Lognormal observation errors in abundance indices + ridge penalty to reduce retrospective bias	Lognormal observation errors in abundance indices and catch at age, and random effects of lognormal recruitment variability and F random walk process	Lognormal observation errors in abundance indices and total catch, multinomial in catch composition	Normal observation errors in abundance indices
Others			Post-hoc analysis of SR relationship is suggested (if possible)	The feasibility to use the other indices needs confirmation

Note: Shaded rows indicate common settings among all models.

Annex F

Scenarios for operating models

DATASET	SCENARIO	M	WEIGHT-AT-AGE	MATURITY-AT-AGE	CATCH (AT-AGE)	ABUNDANCE INDEX	FLEET	WEIGHT
A	Base-case 1	0.41	Average	Average	Sum	All six	Single	Higher
B	Base-case 2	Gislason1*	Average	Average	Sum	All six	Single	Higher
C	Highest weight and maturity 1	0.41	Highest	Highest	Sum	All six	Single	Lower
D	Highest weight and maturity 2	Gislason1*	Highest	Highest	Sum	All six	Single	Lower
E	Lowest weight and maturity 1	0.41	Lowest	Lowest	Sum	All six	Single	Lower
F	Lowest weight and maturity 2	Gislason1*	Lowest	Lowest	Sum	All six	Single	Lower

*As specified in paragraph 31.

Annex G

Priority performance measures for evaluating the stock assessment models

			Measure Available				
Measure	**Necessity**	Priority	VPA	ASAP	KAFKA	SAM	BSSPM
State Variables							
B (whole years)	Compulsory	Yes	Yes	Yes	Yes	Yes	Yes
R (whole years)	Compulsory	Yes	Yes	Yes	Yes	Yes	No
F (whole years)	Compulsory	Yes	Yes	Yes	Yes	Yes	No
Exploitation Rate			Yes	Yes	Yes	Yes	Yes
Biological Reference Points							
F%SPR	Compulsory, if possible	Yes	Yes	Yes	Yes	Yes	No
F0.1, FMAX	Compulsory, if possible	Yes	Yes	Yes	Yes	Yes	No
B_{MSY}	Compulsory, if possible	TBD	Yes*	Yes*	Yes*	Yes	Yes
F_{MSY}	Compulsory, if possible	TBD	Yes*	Yes*	Yes*	Yes	Yes
Depletion Statistics							
SSB/max(SSB) (periods**)	Compulsory	TBD	Yes	Yes	Yes	Yes	No
B/max(B) (periods**)	Compulsory	Yes	Yes	Yes	Yes	Yes	Yes
SSB/median(SSB) (periods**)	Compulsory	TBD	Yes	Yes	Yes	Yes	No
B/median(B) (periods**)	Compulsory	Yes	Yes	Yes	Yes	Yes	Yes
***Relevant Time period for Depletion Statistics*	*Average by decade, 1970's-2020.*						
Retrospective analysis (e.g.Mohn's rho) 7 years	Compulsory	Yes	Yes	Yes	Yes	Yes	Yes

Notes and Questions:

The MSY related Performance measures would be kept, and reported, but not at the highest priority.

How to rank or utilize the results in comparison of the performance measures.

How to calculate annual F. Average of F-at-age, weighted by catch, or number?

Check the performance of SSB & B.

**by post hoc analysis*

Annex H

Flowchart for the development of operating models and testing stock assessment models