



North Pacific Fisheries Commission

NPFC-2020-TWG CMSA03-Final Report

3rd Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

REPORT

11-14 November 2020

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North Pacific Fisheries Commission
3rd Meeting of the Technical Working Group on Chub Mackerel Stock
Assessment

11-14 November 2020

Video conference

REPORT

Agenda Item 1. Opening of the Meeting

1. The 3rd 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. Tom Carruthers, participated in the meeting. The European Union (EU), the North Pacific Anadromous Fish Commission (NPAFC), and the Pew Charitable Trusts (Pew) attended as observers.
2. The meeting was opened by the TWG CMSA Chair, Dr. Oleg Katugin (Russia), who outlined the objectives and procedures for the meeting. Mr. Alex Meyer was selected as rapporteur.

Agenda Item 2. Adoption of Agenda

3. The TWG CMSA agreed to discuss the process for selecting a new Chair and a Vice-Chair under Agenda Item 11.3.
4. 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 2nd TWG CMSA and 4th SC meeting

3.2 5th Commission meeting and CMM 2019-07

5. The Chair provided an overview of the recommendations made by the 2nd TWG CMSA meeting, which the 4th Scientific Committee (SC) meeting and 5th Commission meeting adopted.

3.3 Intersessional meeting of TWG CMSA

6. The Chair provided an overview of the outcomes of the intersessional meeting of the TWG CMSA.

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

4.1 Update on intersessional work towards MSE

7. Dr. Tom Carruthers, invited expert, presented an updated demonstration MSE for chub mackerel using open-source tools (NPFC-2020-TWG CMSA03-WP11). Chub mackerel stock assessment can be readily converted to operating models for rapid MSE analysis. Demonstration management procedures (MPs) and operating models provided promising performance outcomes. A wider range of operating model scenarios should be considered, potentially including alternative future recruitment scenarios. It is also important to carefully establish an organized MSE process, three key aspects of which are having a clear problem statement, having a clear division of roles among three principal groups (1. Oversight, 2. User and 3. Technical), and having a clearly defined roadmap.

4.2 Recommendations and timelines for future work

8. As possible first steps, Dr. Carruthers suggested beginning open and iterative discussions among the various stakeholders about metrics and performance evaluation, as well as the key sources of uncertainties.
9. The TWG CMSA recognized that the first priority should be given to the development of the operating model and stock assessment of chub mackerel and guidance from the Commission would be helpful to move the process forward.
10. Pew suggested that the TWG CMSA request the Commission to provide management objectives for the chub mackerel fishery that the TWG CMSA could translate into performance metrics, and that scientist-manager dialog groups, an approach taken by other regional fisheries management organizations (RFMOs), may be an appropriate way to create an iterative process for advancing MSE discussions.
11. The TWG CMSA agreed to continue its work on MSE for chub mackerel with managers and stakeholders. To that end, the TWG CMSA agreed to continue discussions about technical aspects of the development of the MSE and request the Commission to give guidance on how to move forward, including the setting of management objectives.
12. The TWG CMSA recommended hiring an external expert for the development of the MSE.

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

5.1 Terms of Reference

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

5.2 CPUE Standardization Protocol

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

5.3 Stock Assessment Protocol

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

5.4 Protocol for the Operating Model Development

16. 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

17. China presented a review of its chub mackerel fisheries and research activities (NPFC-2020-TWG CMSA03-IP02). China operates a light-purse seine fishery (>95%) and a small pelagic trawl fishery (<5%). The number of fishing vessels increased from 2014 to 2016 and has decreased since then. CPUE has slightly increased every year since 2016. China's fishing effort was stable in 2018 but decreased in 2019. China has been collecting biological data and conducting research on the relationship between weight and fork length, feeding levels, and age identification/composition. It is also providing training for fishermen and enterprises. As for future research, China intends to strengthen collection of fishery-dependent biological data, conduct in-depth study of mackerel otoliths on the high seas, and collect data for assessment of mackerel resources. Based on its research, China concluded that the dominant length size of chub mackerel is 190-320 mm and the dominant age groups are 1, 2 and 3.
18. A Member requested an explanation of the decrease in fishing vessels of China in 2019 and whether the total fishing effort such as total fishing days also decreased in 2019. The Member also suggested that further investigation of those issues is needed.
19. Japan presented an update on its chub mackerel fishery and the stock status (NPFC-2020-TWG CMSA03-IP01). Japan presented catch and catch-at-age data used for its domestic stock

assessment, which is based on the fishing year beginning in July. Japan pointed out that chub mackerel recruitment begins in July, and the difference between the calendar year and the life history needs to be noted and understood. Catch in the 2019 fishing year was 283,000 tons, slightly lower than 2017 and 2018, and consisted of age-0 to age-6+ fish. The strong 2013-year-class continues to be highly present. Japan also presented a diagram to clarify the inconsistency between the calendar year and chub mackerel life history and fishing.

20. Japan agreed to update its catch and effort data in both its EEZ and the Convention Area in the Japanese annual summary footprint.
21. Russia presented an update of its chub mackerel fisheries with results for 2019 and preliminary results for 2020 (NPFC-2020-TWG CMSA03-WP12). In 2019, the number of fishing days increased only slightly compared to 2018. Chub mackerel catch by Russian vessels was 98,812 tons in 2018, and 86,592 tons in 2019. Russia conducted a trawl survey in the upper epipelagic layer off the south Kuril Islands within the Russian EEZ in August and early September 2020. Foraging mackerel were observed throughout the entire research area, except for the Oyashio Current during maximum warming of surface water. Maximum chub mackerel catches were associated with high-density concentrations of zooplankton in the northeastern part of the survey area in the northern Subarctic Front.

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 CMSA02 meeting

22. The TWG CMSA reviewed the key considerations and specifications from the 2nd TWG CMSA meeting.

7.2 Review of availability and quality of data shared by the Members

23. Dr. Shota Nishijima, the lead of the Small Working Group on Operating Model (SWG OM), presented a compilation and summary of Members' data for operating models of the chub mackerel in the northwestern Pacific Ocean (NPFC-2020-TWG CMSA03-WP04). The following were identified as key issues to be resolved ahead of conducting a benchmark stock assessment: missing catch-at-age and weight-at-age data in Chinese data, inconsistency of weight-at-age among Members, inconsistency of maturity-at-age among Members, difference of age composition in catch among Members, how to use abundance indices especially those of China and Russia, and standardization of abundance indices from China and Russia.
24. In response to the presentation, China will consider improving catch-at-age data and standardizing CPUE. Russia stated that difficulty exists for CPUE standardization.

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

25. China presented a preliminary stock assessment based on age-structured assessment program (ASAP) for the operating model for chub mackerel in the North Pacific Ocean (NPFC-2020-TWG CMSA03-WP09 (Rev. 1)). Chub mackerel biomass stayed at a high level in the 1980s then declined to a low value, before recovering from 2005 and then declining again in recent years, 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. The Kobe plots revealed that the stock of chub mackerel was almost in the red zone, indicating this stock has been overfished and subject to overfishing in the last 50 years. The availability and quality of data for chub mackerel have a large influence on the stock assessment results and model performance.
26. The TWG CMSA discussed data and model configurations to be used, such as abundance indices, recruitment age, and selectivity of ASAP.
27. Japan presented the results of the application of virtual population analysis (VPA) and state-space assessment model (SAM) to the shared data of chub mackerel in the northwestern Pacific Ocean (NPFC-2020-TWG CMSA03-WP05). The past estimates by VPA and SAM were similar, but VPA estimated higher abundances and lower fishing impact than SAM. Both models did not show serious retrospective biases. The absolute values of MSY-based reference points (MSY , SSB_{MSY}) were very different between the two models but the relative values (SSB_{MSY}/SSB_0 , $\%SPR_{MSY}$) were quite robust. The MSY-based reference points are sensitive to the choice of stock-recruitment relationship. The stock assessment results are relatively robust against the choice of natural mortality although recent estimates are slightly different.
28. The TWG CMSA discussed the reason for the difference of recent estimates between VPA and SAM, and the high values of recruitment indices in 2018. Japan explained that the survey area, design and gear did not change through the analyzed period.
29. Russia presented a chub mackerel stock assessment using a KAFKA model (NPFC-2020-TWG CMSA03-WP10). Catch data from China, Japan, and Russia, and standardized abundance indices for recruitment and SSB were used. The data were grouped into eight fleets. A total of 15 scenarios were formed.
30. The SWG OM lead presented a comparison of the stock assessment outputs from the three working papers including the estimates of biomass, exploitation rate, recruitment and SSB

(NPFC-2020-TWG CMSA03-IP03). The estimates for past years were similar, but estimates for recent years were very different among the stock assessment models.

7.4 Assumptions and parameters from the stock assessment models

31. The TWG CMSA compiled a table of the stock assessment model settings (Annex D).
32. The TWG CMSA agreed to use the merged data, rather than per-fleet data, for the development of the operating model.

7.5 Major sources of uncertainty to be included in the operating model

33. The TWG CMSA agreed that uncertainties regarding natural mortality, weight-at-age, and maturity-at-age should be incorporated into scenario settings.
34. The TWG CMSA determined that two sets of natural mortality will be used:
 - (a) The median of various estimators ($M=0.41$)
 - (b) Age-specific M based on Gislason estimator
35. The TWG CMSA requested Japan to provide the age-specific M including age 0 from recalculation of Japan's data.

7.6 Determination of scenarios for the operating model

36. The TWG CMSA determined three scenarios for weight- and maturity-at-age (lowest, average, and highest).
37. The TWG CMSA agreed to analyze six scenarios for operating models as shown in Annex E.
38. The TWG CMSA agreed that all six abundance indices (China's fishery, Japan's recruitment surveys in summer and fall, Japan's egg survey, Japan's dip-net fishery and Russia's trawl fishery) will be used in all the models for all the scenarios.
39. The TWG CMSA reviewed and revised a table of performance measures for evaluating the stock assessment models (Annex F). The time periods for depletion statistics and relative fishing mortality in evaluating the performance are still an open question, and the TWG CMSA agreed to determine them at the next TWG CMSA meeting.

7.7 POPSIM-A as an operating model for testing chub mackerel stock assessment models (final report)

40. The TWG CMSA reviewed and adopted the final report on PopSim-A operating models for chub mackerel by the consultant, Dr. Larry Jacobson.

7.8 Recommendations and timelines for future work

41. The TWG CMSA agreed to rerun the models using the determined scenarios for datasets for review at the next TWG CMSA meeting.

42. If necessary and possible, the TWG CMSA agreed to hold web meetings of the SWG OM intersessionally before the next TWG CMSA meeting to assess Members' progress in the development of the stock assessment model for the operating model.

43. The TWG CMSA reaffirmed the need to hire an external expert to continue the work to develop an operating model (PopSim) and test chub mackerel stock assessment models.

Agenda Item 8. Review of fishery-dependent and fishery-independent data

8.1 Update on data availability

44. Japan presented its catch, weight, and maturity at age data for chub mackerel (NPFC-2020-TWG CMSA03-WP02). Japan introduced its methodology for estimating catch, weight, and maturity at age with the results, explaining that it has long used tuned-VPA for its domestic stock assessment of chub mackerel, for which these estimations are essential. Japan also pointed out that a strong year class shifts the size-at-age, that its age-length key strongly relies on stock demographics and therefore constant development of the age-length key is critical. Japan also pointed out that maturity-at-age relies on the stock level and the maturity patterns in the recent years are changing. Japan pointed out that an adequate amount of length, weight and age samples is critical.

45. China presented a description of its available data (NPFC-2020-TWG CMSA03-WP06). China introduced its sampling methodology and its work to develop an age-length key, and presented its data for length and age distribution, length-weight relationship and catch-at-age.

46. Members agreed to present monthly catch data and the maps of their fishing grounds at the next TWG CMSA meeting.

47. Russia presented the average weight-at-age data. Russia pointed out the large body weight of chub mackerel observed in Russia's fishery.

48. The TWG CMSA discussed inconsistencies between Members' data, including:

- (a) Data aggregation by fishing year as opposed to calendar year.
- (b) Differences in weight-at-age related to density-dependent effect and other factors.
- (c) Differences in maturity-at-age

49. To resolve the aforementioned inconsistencies, the TWG CMSA agreed to share biological information, such as age-length keys if possible and weight-length relationship. The TWG CMSA agreed to work intersessionally, through the SWG OM, to address the above issues (paragraph 48) and other data-related matters. The SWG OM will report the outcomes of data preparation to the next TWG CMSA meeting.

8.2 Data collection templates

50. The TWG CMSA agreed to discuss data collection and data sharing intersessionally.

8.3 Observer Program

51. The TWG CMSA discussed the potential establishment of an observer program for chub mackerel and requested the Secretariat to work intersessionally to compile TWG CMSA members' views regarding the necessity/objective of such a program and potential issues.

Agenda Item 9. Review and evaluation of fishery-dependent and fishery-independent indices

9.1 Fishery-dependent indices

9.2 Fishery-independent indices

52. Japan presented a review and update of its fishery-independent and fishery-dependent indices for chub mackerel (NPFC-2020-TWG CMSA03-WP03). Japan provided four potential abundance indices of the chub mackerel in the Northwestern Pacific: two recruitment indices derived from research surveys in summer and autumn; an index of SSB from egg surveys off the Pacific coast of Japan, and a fishery-dependent SSB index. All indices are standardized and have time series longer than or equal to 15 years. Strong year classes were observed in 2013, 2016 and 2018. The indices provide useful information for the stock assessment of the Pacific chub mackerel.

9.3 Recommendations for future work

53. Recommended future work is described in the TWG CMSA Work Plan.

Agenda Item 10. Review of the Work Plan of the TWG CMSA

54. The TWG CMSA reviewed and updated the Work Plan of the TWG CMSA (NPFC-2020-TWG CMSA03-WP01 (Rev. 1)).

55. The TWG CMSA reviewed and revised the flowchart for the development of the operating model and testing stock assessment models (Annex G).

Agenda Item 11. Other matters

11.1 European Union's application

56. The TWG CMSA reviewed the application of the European Union for the development of its chub mackerel fishery in the NPFC Convention Area (NPFC Circular #006/2020).

57. The TWG CMSA requested the EU to update its Fisheries Operation Plan with the following information, preferably before the upcoming SC meeting:

- (a) Impact assessment for sea turtle bycatch
- (b) Reference to the most up-to-date Japanese domestic stock assessment for chub mackerel
- (c) More detailed information about specific gear configurations, such as mesh sizes

58. The TWG CMSA discussed the potential increase in fishing effort arising from the EU's accession to the NPFC.

59. In considering the EU's application, the TWG CMSA also discussed the importance of reporting bycatch of pelagic species and recommended that reporting requirements be changed such that Convention Area chub mackerel fisheries be required to report bycatch of pelagic species (in weight or numbers, by species).

11.2 Next TWG CMSA meetings

60. The TWG CMSA recommended holding two meetings to conduct the stock assessment for chub mackerel in the 2021 fiscal year. The TWG CMSA suggested that the meetings be held in spring 2021 and winter 2021/2022, respectively, with the specific dates and meeting format to be determined intersessionally via correspondence.

11.3 Other matters

61. Dr. Katugin expressed his intention to resign from his position as Chair and the TWG CMSA requested the SC to elect a new Chair and a Vice-Chair.

Agenda Item 12. Recommendations to the Scientific Committee

62. The TWG CMSA agreed:

- (a) To continue its work on MSE for chub mackerel with managers and stakeholders.
- (b) To continue discussions about technical aspects of the development of the MSE.
- (c) To use the revised performance measures for evaluating the stock assessment models in

the development of the operating model (Annex F).

- (d) To rerun the models using the determined base-case scenarios for operating model by the next TWG CMSA meeting. The base-case scenarios use the merged catch-at-age data, all 6 abundance indices (China's fishery, Japan's recruitment surveys in summer and fall, Japan's egg survey, Japan's dip-net fishery and Russia's trawl fishery), and the biological parameters including 6 different scenarios (Annex E).
- (e) To share available biological data and age-length-key intersessionally to fill the data gap.
- (f) To standardize CPUE for the use of stock assessment for all abundance indices.

63. The TWG CMSA recommended the following to the SC:

- (a) The TWG CMSA recommended to request the Commission to give guidance on how to move forward, including the setting of management objectives for the development of the MSE.
- (b) The TWG CMSA recommended hiring an external expert for the development of the MSE.
- (c) 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.
- (d) The TWG CMSA recommended the adoption of the final report on PopSim-A operating models for chub mackerel.
- (e) The TWG CMSA recommended the Work Plan of the TWG CMSA (NPFC-2020-TWG CMSA03-WP01 (Rev. 1)).
- (f) The TWG CMSA recommended that reporting requirements be changed such that Convention Area chub mackerel fisheries be required to report bycatch of pelagic species (in weight or numbers, by species).
- (g) The TWG CMSA recommended holding meetings in spring 2021 and winter 2021/2022, with the specific dates and meeting format to be determined intersessionally via correspondence.
- (h) The TWG CMSA requested the SC to elect a new Chair and a Vice-Chair.

Agenda Item 13. Adoption of the Report

64. The report was adopted by consensus.

Agenda Item 14. Close of the Meeting

65. The meeting closed at 12:59 on 14 November 2020, Tokyo time.

Annexes:

Annex A – Agenda

Annex B – List of documents

Annex C –List of participants

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

Annex E – Scenarios for operating models

Annex F – Performance measures for evaluating the stock assessment models

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

Agenda

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- 3.3 Intersessional meeting of TWG CMSA

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

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- 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. Review of Member's fisheries and 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 CMSA02 meeting
- 7.2 Review of availability and quality of data shared by the Members
- 7.3 Review of stock assessment results (VPA, ASAP, KAFKA, SAM)
- 7.4 Assumptions and parameters from the stock assessment models
- 7.5 Major sources of uncertainty to be included in the operating model
- 7.6 Determination of scenarios for the operating model
- 7.7 POPSIM-A as an operating model for testing chub mackerel stock assessment models (final report)
- 7.8 Recommendations and timelines for future work

Agenda Item 8. Review of fishery-dependent and fishery-independent data

- 8.1 Update on data availability
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- 8.3 Observer Program

Agenda Item 9. Review and evaluation of fishery-dependent and fishery-independent indices

- 9.1 Fishery-dependent indices
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- 9.3 Recommendations for future work

Agenda Item 10. Review of the Work Plan of the TWG CMSA

Agenda Item 11. Other matters

- 11.1 European Union's application
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Agenda Item 12. Recommendations to the Scientific Committee

Agenda Item 13. Adoption of Report

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List of documents

MEETING INFORMATION PAPERS

Symbol	Title
NPFC-2020-SC05-MIP01(Rev. 1)	Details for the virtual meetings of the Scientific Committee and its subsidiary bodies
NPFC-2020-TWG CMSA03-MIP02	Provisional Agenda
NPFC-2020-TWG CMSA03-MIP03 (Rev. 2)	Annotated Indicative Schedule

REFERENCE DOCUMENTS

Symbol	Title
NPFC-2017-TWG CMSA01-WP02	CPUE standardization for the Pacific chub mackerel historical catch in the Northwest Pacific Ocean
NPFC-2020-TWG CMSAint01-Summary	Summary of the 1st Intersessional Meeting of the Technical Working Group on Chub Mackerel Stock Assessment
	Data availability for CMSA (Potentially available data for chub mackerel stock assessment)
NPFC-2019-TWG CMSA02-Final Report	TWG CMSA02 meeting report
NPFC-2019-SC04-Final Report	SC04 meeting report
NPFC-2019-COM05-Final Report	Report of the 5th Commission meeting
CMM 2019-07	CMM 2019-07 for Chub Mackerel
NPFC CIRCULAR #006/2020	Application of the EU to accede to the NPFC Convention (Letter to the Commission Chair)
	Application of the EU to accede to the NPFC Convention (Fisheries Operation Plan and impact assessment)
	Application of the EU to accede to the NPFC Convention (NPFC Circular# 006/2020)
	Terms of Reference of the TWG CMSA
	CPUE Standardization Protocol for Chub Mackerel
	Stock Assessment Protocol for Chub Mackerel

	Protocol for development of operating model
NPFC-2020-AR-Annual Summary Footprint – Chub & Spotted Mackerels	Summary tables of chub mackerel catch and effort
	POPSIM-A as an operating model for testing North Pacific chub mackerel stock assessment models

WORKING PAPERS

Symbol	Title
NPFC-2020-TWG CMSA03-WP01 (Rev. 1)	TWG CMSA Work Plan for 2020-2025
NPFC-2020-TWG CMSA03-WP02	Catch, weight, and maturity at age of the chub mackerel of Japan
NPFC-2020-TWG CMSA03-WP03	Review and update on fishery-independent and fishery-dependent indices of the chub mackerel of Japan
NPFC-2020-TWG CMSA03-WP04	Compilation and Summary of Shared Data for Operating Models of the Chub Mackerel in the North western Pacific
NPFC-2020-TWG CMSA03-WP05 (Rev. 1)	Application of Virtual Population Analysis (VPA) and State-space Assessment Model (SAM) to the Shared Data of Chub Mackerel in the Northwest Pacific
NPFC-2020-TWG CMSA03-WP06	Content of the document for data description
NPFC-2020-TWG CMSA03-WP07	Data Description Japan
NPFC-2020-TWG CMSA03-WP08	Data Description Russia
NPFC-2020-TWG CMSA03-WP09 (Rev. 1)	Preliminary stock assessment based on ASAP (age-structured assessment program) for Chub mackerel in the North Pacific Ocean
NPFC-2020-TWG CMSA03-WP10	Chub mackerel stock assessment using KAFKA model (report for the intersessional period 2019-2020)
NPFC-2020-TWG CMSA03-WP11	Demonstration Management Strategy Evaluation for Chub Mackerel Using Open-Source Tools
NPFC-2020-TWG CMSA03-WP12	Fishing for chub mackerel (<i>Scomber japonicus</i>) by Russian trawl vessels in 2019 and preliminary results on fishing in 2020

INFORMATION PAPERS

Symbol	Title
NPFC-2020-TWG CMSA03-IP01	Recent fishery and stock status of chub mackerel from Japan
NPFC-2020-TWG CMSA03-IP02	Review of chub mackerel fishery in China and research activities
NPFC-2020-TWG CMSA03-IP03	Comparison of the stock assessment outputs from ASAP, KAFKA, VAP and SAM

List of participants

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

Model	VPA	VPA	SAM	SAM	ASAP	ASAP	KAFKA	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.	
Scenario	M=0.41	Giaslon1	V=0.41	Giaslon1	Merged	By fleet	M=0.41 no observations	M=0.41 fleet4
Total catch weight	Simple summation of catch at age * weight at age							
Error in total catch weight	No error	No error	Sum of predicted catch number at age (no error)				No error	
Catch composition	No error in catch number at age		Lognormal error in catch number at age		Merged age composition	Only from Japan's age composition	No error in catch number at age	
Catch at age	Merged		Merged		Merged	By nation	Merged catch	

Abundance index fitted*	4 Japanese indices (2-5)		4 Japanese indices (2-5)		4,7,9	4, 5,7,9	no indices	1 index (fleet4)
Natural mortality assumption	0.41	Gislason 1	0.41	Gislason 1	Gislason 1	Gislason 1	0.41	0.41
Maturity assumption	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data
Weight at age	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data	Merged share data
Recruitment age	0	0	0	0	1 (=>0)	1 (=> 0)	0	0
Stock recruitment assumption	No explicit assumption but estimate the relationship outside the model	No explicit assumption but estimate the relationship outside the model	Random-walk but estimate the relationship outside the model	Random-walk but estimate the relationship outside the model	Beverton-Holt	Beverton-Holt	No explicit assumption	
Steepness	Estimated outside using HS	Estimated outside using HS	Estimated outside using HS	Estimated outside using HS	Est. R0 and steepness	Est. R0 and steepness	no est.	no est.
Sigma R	Estimated outside using HS	Estimated outside using HS	Estimated outside using HS	Estimated outside using HS	Est. sigma R	Est sigma R	no est.	no est.
Fleet configuration	Merged	Merged	Merged	Merged	Merged	By nation	Merged	Merged

Selectivity assumption	Independent age specific F	Independent age specific F	Age specific F with random walk	Age specific F with random walk	Age specific selectivity	Age specific selectivity	Age specific fishing rate $f_{i,t}=1-\exp(-F_{i,t})$	
Estimation of nonlinear parameter of hyper stability/depletion	Yes	Yes	Yes	Yes	No	No	No	No
Objective function (error structure)	Lognormal observation errors in abundance indices + ridge penalty to reduce retrospective bias	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 randomwalk process	Lognormal observation errors in abundance indices and catch at age, and random effects of lognormal recruitment variability and F randomwalk process	Lognormal observation errors in abundance indices and total catch, multinomial in catch at age		Normal observation errors in abundance indices	

* Indices: 2 and 3 - Japan's recruitment surveys in summer and fall, 4 - Japan's egg survey, 5 - Japan's dip-net fishery, 7 - China's fishery, 9 - Russia's trawl fishery.

Scenarios for operating models

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

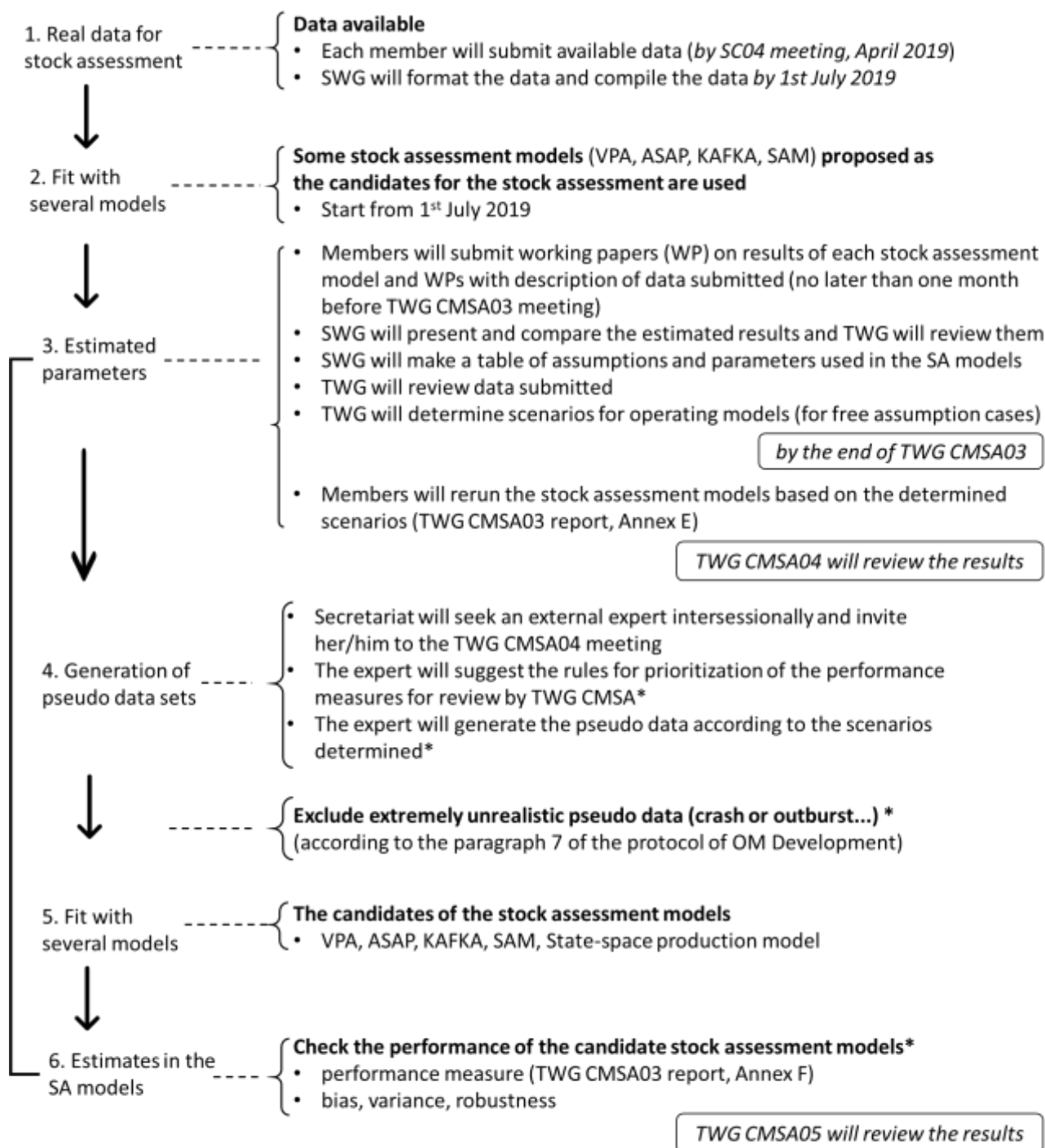
Performance measures for evaluating the stock assessment models

Measure	Necessity	Statistics				
<i>State Variables</i>						
B (whole years)	Compulsory	median	mean	SE	%bias	RMSE
SSB (whole years)	Compulsory if possible	median	mean	SE	%bias	RMSE
R (whole years)	Compulsory if possible	median	mean	SE	%bias	RMSE
F (whole years)	Compulsory if possible	median	mean	SE	%bias	RMSE
Selectivity at age (whole years)	Compulsory if possible	median	mean	SE	%bias	RMSE
Catch	Compulsory if possible	median	mean	SE	%bias	RMSE
Exploitation rate (catch/total biomass)	Compulsory	median	mean	SE	%bias	RMSE
<i>Basic Biological Parameters</i>						
B0	if possible	median	mean	SE	%bias	RMSE
Steepness	if possible	median	mean	SE	%bias	RMSE
<i>Biological Reference Points</i>						
Bmsy	if possible	median	mean	SE	%bias	RMSE
SBmsy	if possible	median	mean	SE	%bias	RMSE
Fmsy	if possible	median	mean	SE	%bias	RMSE
F%SPR	Compulsory if possible	median	mean	SE	%bias	RMSE
F0.1, Fmax	Compulsory if possible	median	mean	SE	%bias	RMSE
<i>Depletion Statistics</i>						
SSB/max(SSB) (periods*)	Compulsory if possible	median	mean	SE	%bias	RMSE

SSB/SSB0 (periods*)	if possible	median	mean	SE	%bias	RMSE
SSB/SSBmsy (periods*)	if possible	median	mean	SE	%bias	RMSE
B/max(B) (periods*)	Compulsory if possible	median	mean	SE	%bias	RMSE
B/B0 (periods*)	if possible	median	mean	SE	%bias	RMSE
B/Bmsy (periods*)	if possible	median	mean	SE	%bias	RMSE
<i>Relative fishing mortality</i>						
F/Fmsy (e.g. average for the last 3 years*)	if possible	median	mean	SE	%bias	RMSE
F/F%SPR (periods*)	Compulsory if possible	median	mean	SE	%bias	RMSE
F/F0.1, F/Fmax (periods*)	Compulsory if possible	median	mean	SE	%bias	RMSE
Retrospective analysis (e.g. Mohn's rho)	if possible					

* To be proposed intersessionally and determined at the TWG CMSA04 meeting

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



* By an external expert