



North Pacific Fisheries Commission

NPFC-2017-TWG CMSA01-Final Report

**1st Meeting of the Technical Working Group
on Chub Mackerel Stock Assessment
REPORT**

4-5 December 2017

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North Pacific Fisheries Commission
1st Meeting of the Technical Working Group on Chub Mackerel Stock
Assessment

4-5 December 2017

Vladivostok, Russia

REPORT

Agenda Item 1. Opening of Meeting

1. The 1st Meeting of the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA01) took place in Vladivostok, Russia on 4-5 December 2017, and was attended by Members from China, Japan, and the Russian Federation.
2. The meeting was opened by the Science Manager, who outlined the objective and procedures for the meeting.
3. Russia welcomed the participants to Vladivostok and hoped that the meeting would yield fruitful discussions.

Agenda Item 2. Selection of Chair and Rapporteur

4. The Science Manager proceeded with the selection of the Chair and Rapporteur. Dr. Oleg Katugin (Russia) was unanimously selected as the Chair of the TWG CMSA. Mr. Alexander Meyer was selected as Rapporteur.

Agenda Item 3. Adoption of Agenda

5. The agenda was adopted without amendment (Annex A). The participants agreed to finalize the Terms of Reference for the TWG CMSA under Agenda Item 4, and defer discussions on the Work Plan and Data List for Stock Assessment to Agenda Item 9. Document List (Annex B) and Participants List (Annex C) are attached to the report.

Agenda Item 4. Finalization of the Terms of Reference and Work Plan of the TWG CMSA

6. The Science Manager provided an update on the intersessional work conducted on the draft Terms of Reference and Work Plan (NPFC-2017-TWG CMSA01-WP01).
7. The participants discussed and revised the draft Terms of Reference. The participants endorsed

the Terms of Reference for TWG CMSA. (Annex D).

Agenda Item 5. Brief overview of chub mackerel biology, fisheries and management based on the results of the Chub Mackerel Workshop and 3rd Commission meeting

8. The Science Manager briefed the participants on the past Chub Mackerel Workshop and 3rd Commission meeting and pointed out Paragraph 7 of CMM 2017-07 for chub mackerel which tasks the Scientific Committee (SC) and TWG CMSA to conduct a stock assessment of chub mackerel as soon as possible, in accordance with the Terms of Reference agreed by the TWG CMSA at this meeting, even if such assessment is provisional, and provide advice and recommendations to the Commission.
9. Japan presented the future tasks in the stock assessment for chub mackerel (NPFC-2017-TWG CMSA01-WP04).

Agenda Item 6. Review and evaluation of fishery-dependent and fishery-independent data available for stock assessment

6.1 Data availability

10. Russia presented its data list for stock assessments, covering catch, size composition and length-weight relationship in 2016 (NPFC-2017-TWG CMSA01-WP03).
11. Japan presented its data availability, covering different categories of data, description, years, sample size, data coverage and potential issues of using such data (NPFC-2017-TWG CMSA01-WP04). Japan identified the need to conduct full reviews of length and age data sets, estimate catch at age with its uncertainties, and obtain reliable abundance indices by standardizing catch per unit effort (CPUE) for survey and commercial data.
12. The participants developed and endorsed a template for the potentially available data for stock assessment of chub mackerel (Annex E). The participants agreed to work intersessionally to fill out the template in as much detail as possible, by 10 March 2018, for submission to the SC.
13. Russia presented the results of Russian fisheries for chub mackerel in 2016 (NPFC-2017-TWG CMSA01-WP08), noting that it had stopped fishing mackerel in 1988 and only recommenced fishing in 2015.
14. Russia presented the relationship between oceanographic conditions and distribution of mackerel in the Northwest Pacific, based on the data of TINRO-Center fisheries-independent surveys in 2014-2016 (NPFC-2017-TWG CMSA01-WP09), and noted the usefulness of salinity and type of water mass as an indicator of suitable habitat.

15. Russia pointed out that the size structure of chub mackerel from fisheries-independent surveys reflects the size structure of chub mackerel from fisheries data and is useful for stock assessment purposes.

6.2 Data quality and sources of uncertainty

16. The participants discussed sources of data uncertainty, including IUU catch, bycatch, discards, and different types of CPUE among Members resulting from differences in fishing gear and practices among Members.

6.3 Data sharing

17. As information for the discussions on data sharing, the Science Manager presented the North Pacific Fisheries Commission's (NPFC) Interim Guidance for Management of Scientific Data used in Stock Assessments adopted by the Commission in July 2017 and outlined that it provides the basis for the sharing of scientific data among Members.
18. The participants recognized the necessity to share data for the chub mackerel stock assessment and agreed that such data should only be shared within the TWG CMSA and be disseminated in accordance with the above Interim Guidance.

Agenda Item 7. Review and evaluation of fishery-dependent and fishery-independent indices

7.1 Quality of the indices

19. Russia presented its work on the CPUE standardization for its historical catch of chub mackerel in the Northwest Pacific Ocean (NPFC-2017-TWG CMSA01-WP02).
20. Japan presented its work to standardize abundance indices for recruitment and spawning stock biomass of the chub mackerel in the Northwest Pacific (NPFC-2017-TWG CMSA01-WP05). Japan has conducted three analyses of CPUE standardization for chub mackerel. The standardized CPUEs have been used as abundance indices for tuned virtual population analysis (VPA) in Japan's latest stock assessment of chub mackerel. High priority of model development should be put on age-structured stock assessment models.
21. The participants discussed the issue relating to the definition of SSB and recruitment and also suggested that further exploration for defining the age of the recruitment is necessary.

7.2 Protocol for CPUE Standardization

22. The participants discussed and revised the draft CPUE Standardization Protocol (NPFC-2017-TWG CMSA01-WP06 (Rev. 1)). The participants endorsed the CPUE Standardization

Protocol for Chub Mackerel (Annex F).

Agenda Item 8. Stock assessment of chub mackerel

8.1 Review of existing stock assessment methods

8.2 Discussion on potential models for chub mackerel stock assessment

23. Japan presented on existing methods and potential models for chub mackerel stock assessment (NPFC-2017-TWG CMSA01-WP04). Japan reviewed the features of biomass dynamics models, delay-difference models, virtual population analysis, statistical catch-at-age methods, and integrated analysis. Japan suggested using a tuned VPA as the fundamental platform and exploring extensions from the model.
24. China presented a comparison of conventional and state-space production models in fisheries stock assessment and management using jumbo flying squid data as a case study (NPFC-2017-TWG PSSA02-WP09). The state space model performed better in terms of accuracy and precision of parameter estimates, but the error estimate could be biased and imprecise and the conventional model performed better in this regard.
25. China pointed out that Bayesian state-space production model would be a useful tool for potential validation when there is uncertainty in catch-at-age data. China also suggested that by using the same types of data, models such as statistical catch-at-age model are supposed to have equal chance to be used as a candidate model. It is not appropriate to determine a base model without testing other models.
26. The participants discussed potential models for the chub mackerel stock assessment and agreed that using an age-structured model is a common goal. The participants proposed four potential models for the chub mackerel stock assessment: a VPA model, a statistical catch-at-age model, a cohort model with Kalman filter, and a state-space production model.
27. The participants agreed to develop the operating model to test the four proposed stock assessment models in accordance with the Stock Assessment Protocol for Chub Mackerel (Annex G). The operating model should be reviewed externally. The participants agreed to informally establish a small working group to conduct this work with the following representatives: Ms. Bai Li, Dr. Alexander Mikheyev, and Dr. Shota Nishijima. The work for the operating models will be conducted intersessionally.
28. Japan stated that, based on its many years of experience managing the chub mackerel stock and collecting various related data, and from the perspective of using the best available data, the VPA model should be given first priority. Furthermore, no satisfactory rationale has been given

for the use of models other than the VPA model and such models are unacceptable.

8.3 Development of Stock Assessment Protocol

29. The participants discussed and revised the draft Stock Assessment Protocol (NPFC-2017-TWG CMSA01-WP07 (Rev 1)). The participants endorsed the Stock Assessment Protocol for Chub Mackerel (Annex G).

Agenda Item 9. Next steps towards chub mackerel stock assessment and next TWG CMSA meeting

30. The participants discussed and revised the draft 2017-2021 Work Plan for TWG CMSA (Annex H). The participants developed the outline of the TWG CMSA Work Plan, and agreed to add further details to the Work Plan intersessionally, by 10 March 2018, for submission to the SC. They also agreed to update the plan as necessary based on the progress of the modeling work.

31. The participants recommended to hold the next TWG CMSA meeting in the last quarter of 2018.

Agenda Item 10. Other matters

32. No other matters were discussed at the TWG CMSA01.

Agenda Item 11. Recommendations to the Scientific Committee

33. The following recommendations were made:

- a. The TWG CMSA endorsed its Terms of Reference (Annex D).
- b. The TWG CMSA endorsed a template for the potentially available data for stock assessment of chub mackerel (Annex E).
- c. The TWG CMSA recognized the necessity to share data for the chub mackerel stock assessment and agreed that such data should only be shared within the TWG CMSA and be disseminated in accordance with the Interim Guidance for Management of Scientific Data used in Stock Assessments.
- d. The TWG CMSA endorsed the CPUE Standardization Protocol for Chub Mackerel (Annex F).
- e. The TWG CMSA agreed that using an age-structured model is a common goal. The participants proposed four potential models for the chub mackerel stock assessment: a VPA model, a statistical catch-at-age model, a cohort model with Kalman filter, and a state-space production model.
- f. The TWG CMSA endorsed the Stock Assessment Protocol for Chub Mackerel (Annex G).
- g. The TWG CMSA agreed to develop the operating model to test the four proposed stock assessment models in accordance with the Stock Assessment Protocol (Annex G). The TWG CMSA recommended the SC to ensure the external review of the operating model.

- h. The TWG CMSA recommended to SC to consider adoption of the 2017-2021 Work Plan for TWG CMSA finalized intersessionally by the TWG CMSA members (Annex H).
- i. The TWG CMSA recommended to hold its next meeting in the last quarter of 2018.

Agenda Item 12. Adoption of the Report

34. The TWG CMSA01 Draft Report was adopted by consensus.

Agenda Item 13. Close of the Meeting

35. The TWG CMSA01 closed at 20:05 on 5 December 2017. The participants expressed their gratitude for the skilled facilitation of the TWG CMSA Chair.

Annexes

Annex A – Agenda

Annex B – List of Documents

Annex C – Participants List

Annex D – Terms of Reference for the Technical Working Group on the Chub Mackerel Stock Assessment (TWG CMSA)

Annex E – Template for potentially available data for chub mackerel stock assessment

Annex F – CPUE Standardization Protocol for Chub Mackerel

Annex G – Stock Assessment Protocol for Chub Mackerel

Annex H – Draft 2017-2021 Work Plan for TWG CMSA

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Agenda Item 7. Review and evaluation of fishery-dependent and fishery-independent indices

7.1 Quality of the indices

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8.1 Review of existing stock assessment methods

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LIST OF DOCUMENTS**MEETING INFORMATION PAPERS**

Symbol	Title
NPFC-2017-TWG CMSA01-MIP01 (Rev. 1)	Meeting Information
NPFC-2017-TWG CMSA01-MIP02	Provisional Agenda
NPFC-2017-TWG CMSA01-MIP03	Provisional Annotated Agenda
NPFC-2017-TWG CMSA01-MIP04 (Rev. 3)	Indicative Schedule
NPFC-2017-TWG CMSA01-MIP05 (Rev. 1)	Provisional List of Documents

REFERENCE DOCUMENTS

Symbol	Title
CMM 2017-07	CMM For Chub Mackerel
NPFC-2017-AR-Annual Summary Footprint – Chub & Spotted mackerels	2016 – Annual summary footprint for chub mackerel and spotted mackerel in the North Pacific Fisheries Commission Area of Competence
	Interim Guidance for Management of Scientific Data Used in Stock Assessments

WORKING PAPERS

Symbol	Title
NPFC-2017-TWG CMSA01-WP01 (Rev. 2)	Draft Terms of Reference for the Technical Working Group on the Chub Mackerel Stock Assessment (TWG CMSA), draft 2017-2021 Work Plan and draft Data List for stock assessments
NPFC-2017-TWG CMSA01-WP02	CPUE standardization for the Pacific chub mackerel historical catch in the Northwest Pacific Ocean (Russia)
NPFC-2017-TWG CMSA01-WP03	Draft Data list for stock assessments (Russia)
NPFC-2017-TWG CMSA01-WP04	Current and future tasks in the stock assessment for chub mackerel in NPFC (Japan)
NPFC-2017-TWG CMSA01-WP05	Standardizing abundance indices for recruitment and spawning stock biomass of the chub mackerel in the Northwest Pacific (Japan)
NPFC-2017-TWG CMSA01-WP06 (Rev. 2)	Protocol for CPUE standardization
NPFC-2017-TWG CMSA01-WP07 (Rev. 3)	Stock assessment protocol
NPFC-2017-TWG CMSA01-WP08	Results of Russian fisheries for Chub mackerel in 2016 (Russia)
NPFC-2017-TWG CMSA01-WP09	Oceanographic conditions in NW Pacific and distribution of mackerel (Russia)
NPFC-2017-TWG PSSA02-WP09	A comparison of conventional and state-space production models in fisheries stock assessment and management (China)

INFORMATION PAPERS

Symbol	Title
NPFC-2017-TWG CMSA01-IP01 (Rev. 1)	Population dynamics of chub mackerel in the western North Pacific Ocean (Japan)
NPFC-2017-TWG CMSA01-IP02	Biology and life history of chub mackerel in the western north Pacific oceans (Japan)
NPFC-2017-TWG CMSA01-IP03	Stock assessment of chub mackerel in the western North Pacific Ocean (Japan)

REPORTS FROM WORKING GROUPS AND SSCs

Symbol	Title
NPFC-2017-WS CM01-Final Report	Chub Mackerel Workshop Final Report

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Terms of Reference for the Technical Working Group on the Chub Mackerel Stock Assessment (TWG CMSA)

1. To review and evaluate fishery data
 - Catch and efforts (including spatial-temporal distribution of landings and discards)
 - Age/size composition data
 - Evaluation of data quantity, data quality, sources of uncertainty
 - Others
 - Recommendation for future works

2. To review and evaluate fishery-dependent and fishery-independent indices
 - Evaluate/update sampling design for fishery-independent survey
 - Characterize the source of uncertainty for the fishery-dependent and fishery-independent data
 - Review/update the CPUE standardization Protocol
 - Conduct CPUE standardization
 - Review and update fishery-dependent and fishery-independent indices
 - Recommendation for future works

3. To review and update biological and other information/data relevant to stock assessment
 - Stock structure
 - Growth
 - Reproduction and maturity schedule
 - Natural mortality
 - Migration pattern
 - Environmental influences (e.g. oceanographic, habitat, or species interactions)
 - Others
 - Evaluation of data quantity, data quality, sources of uncertainty
 - Recommendation for future works

4. To conduct the stock assessment
 - Review existing/potential stock assessment methods or develop new methods
 - Application of candidates of stock assessment models and comparison of the results (if needed)
 - Determine models for the chub mackerel stock assessment
 - Conduct stock assessment following the Stock Assessment Protocol
 - Create the scientific advice on management based on the results of the stock assessment

- Recommendation for future works

5. To facilitate data- and code- sharing processes
6. To review/improve presentation of stock assessment results (including stock status summary report in a format to be determined by the Working Group)
7. To develop Management Strategy Evaluation framework

Template for potentially available data for chub mackerel stock assessment

Category and data sources	Description	Years with available data	Average sample size/year or data coverage	Potential issues to be reviewed
JAPAN				
Catch statistics				
Purse seine fishery	Official statistics, reports from fisheries associations and markets	Official statistics: 1950-2016, other reports: 1970-2017	Coverage=100%	The chub mackerel catches are estimated from chub and spotted mackerel catches based on port sampling data for purse seine and set net fisheries
Dip net fishery				
Set net				
Size composition data				
Length measurements	Port sampling by 17 local fishery institutes in 17 prefectures	1970-2017	20,000-120,000 (average 40,000) fish/year (ca. 100 measurements per sampling)	Data coverage review
Aging	Port sampling by 17 local fishery institutes in 17 prefectures	1970-2017	500-1000 fish/year	Data coverage review
Catch at age (CAA)	Estimate CAA from the above data	1970-2017	Age-length keys are created approximately by quarter and local regions	Evaluate uncertainty of catch at age, especially on changes of growth depending on recruitment abundance

Abundance indices (survey)				
Spring survey for recruitment	Mainly for sardine and chub mackerel, mid-water trawl	1995-2017	30-60 stations/year	Review survey protocol and conduct standardization
Summer survey for recruitment	Mainly for saury, mid-water trawl	2001-2017	60-80 stations/year	
Autumn survey for recruitment	Mainly for sardine and chub mackerel, mid-water trawl	1995-2017	30-60 stations/year	
Year-round for egg density	Almost all local fishery institutes join this survey program. NORPAC net. Not only for chub mackerel.	1978-2017	ca. 6000 stations in total, 1000-4000 stations with chub mackerel eggs/year	
Abundance indices (commercial)				
Dip net fishery	Log book data are collected from fishermen in Kanagawa prefecture (ca. 1/3 of the total)	2003-2017	10-100/year	Standardization, recently the fishing effort decrease, reliability??
RUSSIA				
...				
CHINA				
...				

CPUE Standardization Protocol for Chub Mackerel

CPUE is catch per unit effort obtained either from fishery independent or fishery dependent data. The use of CPUE in a stock assessment implicitly assumes that CPUE is proportional to stock abundance/biomass. However, many factors other than stock abundance/biomass may influence CPUE. Thus, any other factors, other than stock abundance/biomass, that may influence CPUE should be removed from the CPUE index. The process of reducing/removing the impacts of these factors on CPUE is referred to as CPUE standardization.

The following protocol is proposed for the CPUE standardization:

- (1) Conduct a thorough literature review to identify potential explanatory variables (i.e., spatial, temporal, environmental, and fisheries variables) that may influence CPUE values;
- (2) Plot spatio-temporal catch, effort and nominal CPUE distributions and determine temporal and spatial resolution for CPUE standardization;
- (3) Make scatter plots (for continuous variables) and/or box plots (for categorical variables) and present correlation matrix if possible to evaluate correlations between each pair of those variables;
- (4) Describe selected explanatory variables based on (1)-(3) to develop full model for the CPUE standardization;
- (5) Specify model type and fit the data to the assumed statistical models (i.e., GLM, GAM, Delta-lognormal GLM, Neural Networks, Regression Trees, Habitat based models, and Statistical habitat based models);
- (6) Evaluate and select the best model(s) using methods such as likelihood ratio test, information criteria, cross validation etc.;
- (7) Evaluate if distributional assumptions are satisfied and if there is a consistent spatial/temporal distribution of residuals in CPUE standardization modeling; (i.e. residual plots along with predicted values and important explanatory variables, check dispersion assumption)
- (8) Present estimated relationship between dependent variable and independent variables. Check whether it is interpretable.
- (9) Extract yearly standardized CPUE and evaluate associated uncertainty.
- (10) Plot nominal and standardized CPUEs over time. When the trends between nominal and standardized CPUE are largely different, explain the reasons (e.g. spatial shift of fishing efforts), whenever possible.

Stock Assessment Protocol for Chub Mackerel

The following procedures were proposed for Pacific chub mackerel stock assessment and adopted at the 1st meeting of the Technical Working Group on Chub Mackerel Stock Assessment in December 2017.

- (1) Identify the data that will be needed and available to the stock assessment;
- (2) Evaluate quality, quantity, and potential error sources of available data (e.g., catch at age, weight at age, length at age), life-history parameters (e.g., natural mortality, growth, and maturity), and abundance indices;
- (3) Determine the framework of operating model for extensive simulation tests with the inclusion of potential uncertainties of observed data and life-history parameters;
- (4) Create base case scenarios and alternative scenarios for the stock assessment models by the operating model;
- (5) External review of the operating model and improvement of the operating model, if needed;
- (6) Develop multiple stock assessment models and conduct the performance tests by applying the models to the data generated from the operating model;
- (7) Select the best candidate model(s) for the full stock assessment of Pacific chub mackerel;
- (8) Apply the selected model(s) to the full data set of Pacific chub mackerel;
- (9) Conduct diagnostics of model convergence, plot and evaluate residual patterns, conduct sensitivity analyses, compare prior and posterior distributions for key model parameters (if using Bayesian approach), and evaluate biological implications of the estimated parameters;
- (10) Develop retrospective analysis to verify whether any possible systematic inconsistencies exist among model estimates of biomass and fishing mortality; likelihood profiles by each data component is also useful to find systematic inconsistencies;
- (11) Review and finalize stock assessment results;
- (12) Review and estimate biological reference points and associated uncertainties;
- (13) Identify target and limit reference points;
- (14) Determine if the stock is “overfished” and “overfishing”, for example using the Kobe plot;
- (15) Develop alternative harvest control rule (HCR) for the projection (e.g., 5-year projection);
- (16) Conduct risk analysis for each level of fishing impacts and each HCR to develop decision tables with alternative state of nature;
- (17) Provide stock status, decision tables, and scientific advice on HCR to SC.

Draft 2017-2021 Work Plan for TWG CMSA

Year	Tasks	Progress/Comment	Meeting/Activity
2017	<p>Review of Members' national research on stock status and fisheries;</p> <p>Establishment of TWG CMSA;</p> <p>Development of TORs, Work Plan and Data List</p>	<p>Done</p> <p>Done/Adopted by the Commission</p> <p>TORs are done. Work Plan and Data List are in progress.</p>	<p>Chub mackerel workshop, 16-17 Feb;</p> <p>2nd SC meeting (proposal), 3rd Commission meeting;</p> <p>Proposal at the 3rd Commission meeting; Intersessional work on the TORs; TWG CMSA meeting, 4-5 Dec</p>
2018	<p>Report outputs by TWG CMSA01</p> <p>Discussion of the framework for the operating model, list of data required for SA</p> <p>Data preparation and data sharing for scientific SA/ CPUE standardization/show results of the intersessional work on the operating model/ proposal of SA model candidates</p>		<p>3rd SC meeting, 4th Commission meeting;</p> <p>Intersessional</p> <p>TWG CMSA02</p>
2019	<p>Development and completion of the operating model and the external review</p>		<p>Intersessional</p>

	<p>Present outputs by TWG to SC</p> <p>Test performance of SA model candidates to select the best model(s)/Finalize the data used for the SA</p>		<p>4th SC meeting, 5th Commission meeting;</p> <p>TWG-CMSA03</p>
2020	<p>Preliminary SA with the selected model(s) and provision of advice and recommendations to the SC</p> <p>Present outputs by TWG to SC with emphasis on management advice from the preliminary SA</p>		<p>TWG CMSA04</p> <p>5th SC meeting, 6th Commission meeting;</p>
2021	<p>Update/Improvement of the assessment and provision of advice and recommendations to the SC</p> <p>Present outputs by TWG to SC with emphasis on management advice</p>		<p>TWG CMSA05</p> <p>6th SC meeting, 7th Commission meeting;</p>