NPFC-2024-TWG CMSA09-Final Report

North Pacific Fisheries Commission
9th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

17–20 July 2024

Yokohama, Japan (Hybrid)

REPORT

Agenda Item 1. Opening of the Meeting

1. The 9th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA) was held in a hybrid format, with participants attending in-person in Yokohama, Japan, or online via WebEx on 17–20 July 2024. The meeting was attended by Members from Canada, China, the European Union (EU), Japan, the Russian Federation, and the United States of America. The Ocean Foundation attended as an observer. An invited expert, Dr. Joel Rice, participated in the meeting.

2. The meeting was opened by Dr. Kazuhiro Oshima (Japan), the TWG CMSA Chair.

3. Dr. Hiroshi Minami, Deputy Director, Fisheries Stock Assessment Center, Fisheries Resources Institute of Japan welcomed the participants to Yokohama. He thanked the participants for their hard work to prepare for the important task of conducting the NPFC's first chub mackerel assessment, which will inform the appropriate utilization and management of the chub mackerel stock in the future. Dr. Minami wished the participants a successful meeting and a pleasant stay in Yokohama.

4. The Science Manager, Dr. Aleksandr Zavolokin, outlined the procedures for the meeting.

5. Mr. Alex Meyer was selected as rapporteur.

Agenda Item 2. Adoption of Agenda

6. The agenda was adopted (Annex A). The List of Documents and List of Participants are attached (Annexes B, C).

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

3.1 TWG CMSA08

7. The Chair provided an overview of the outcomes and recommendations of the 8th TWG CMSA meeting.

3.2 Intersessional meetings of TWG CMSA

8. The Chair provided an overview of the 1st and 2nd intersessional meetings of the TWG CMSA in 2024, which were held in March and April 2024 (NPFC-2024-TWG CMSA08-RP01 & 02).

9. The Science Manager shared outcomes from the 8th Commission meeting (COM08) and subsequent developments relevant to chub mackerel. The Commission agreed to work intersessionally to continue to update the matrix with the Performance Review Panel recommendations, priorities and timeframes, responsible bodies, activities undertaken to date, and status. The TWG CMSA is requested to provide further input on the status. In relation to the Resolution on Climate Change, since COM08, the FAO has agreed to fund a consultancy on climate change with the NPFC and to appoint Dr. Joel Rice as the consultant. In addition, COM08 revised the Conservation and Management Measure (CMM) for Chub Mackerel. Revisions included the addition of a paragraph stipulating provisional measures, including an annual total allowable catch (TAC) of chub mackerel in the Convention Area, to be taken until the chub mackerel stock assessment is conducted and the CMM is revised accordingly.

Agenda Item 4. Members' fishery status and research activities

10. China presented a review of its chub mackerel fishery and research activities (NPFC-2024-TWG CMSA09-IP03). In 2023, China operated about 95 purse seine and trawl vessels in the Convention Area. The estimated catch in 2023 of chub mackerel and blue mackerel was about 48,850 MT. The distribution of chub mackerel in 2023 was similar to that in 2022 but further to the northeast. The average length of caught individuals was 231 mm, slightly larger than in 2022 (221 mm). The main ages at catch in 2023 were from 1 to 3, similar to 2022. China collects and analyzes fishing logbooks every year, collects samples on fishing vessels and in ports, monitors the monthly ratio of chub mackerel and blue mackerel in catch, and conducts monitoring of biological features. Since 2023, China has increased sample collection for pelagic trawl nets in the North Pacific.

11. Japan presented a review of the recent fishery and stock status of chub mackerel (NPFC-2024-TWG CMSA09-IP04). Japan's catch comes from large-scale purse seine vessels, small-scale purse seine vessels, set nets, and dip nets and other gears. The majority of the catch is from large-scale purse seine vessels. In the fishing year 2023 (FY2023), the catch has been approximately 54,800 MT up to February 2024, which is very low compared to past years.

There is usually substantial catch between November and spring months, with catch in November tending to be high, but that has not been the case in FY2023. Japan's 2023 summer surface trawl survey showed broad distribution of age-0 and age-1 fish offshore. Japan's 2023 autumn surface trawl survey was limited but showed that the distribution of the chub mackerel was offshore. The egg survey shows that the main spawning ground is near the Izu Islands and coastal Japan. Preliminary nominal values of the egg abundance index from 2023 and 2024 showed consecutive declines in egg abundance, suggesting low spawning stock biomass or low levels of reproductive events.

12. Russia provided a brief update on its chub mackerel fishery and research activities. In 2023, the total catch of chub mackerel in the Convention Area was less than 1 MT, landed as part of its traditional species-integrated summer survey. Russia conducted its traditional hydroacoustic and oceanographic survey from August to September, but it was limited to Russian waters and did not take overlap with the Convention Area. In 2024, Russia again conducted its summer survey and the catch of chub mackerel was even lower than in 2023. The catch from the Russian fishery in 2024, as of July, is 960 MT.

Agenda Item 5. Review of results of stock assessment using State-space stock assessment model (SAM)

5.1 Review of Stock Assessment Protocol

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

5.2 Review of data used for stock assessment

14. Japan presented a description of the data that the TWG CMSA agreed to use for the base case stock assessment of chub mackerel in the northwestern Pacific Ocean (NPFC-2024-TWG CMSA09-WP01). The data consist of catch-at-age, weight-at-age, and maturity-at-age since 1970 with different lengths of temporal data from three Members: China, Japan, and Russia.

15. Japan presented a description of the input data that the TWG CMSA agreed to use for the sensitivity analyses of the stock assessment of chub mackerel in the northwestern Pacific Ocean (NPFC-2024-TWG CMSA09-WP02). The data consist of catch-at-age and maturity-at-age since 1970. The sensitivity analyses contain three alternative catch-at-age datasets (1. removal of Chinese catch-at-age from the calendar year (CY) 2015, 2. use of Chinese catch-at-length from CY2016, 3. use of Japanese catch-at-length) and two alternative maturity-at-age datasets (1. mean of Japanese and annual mean of Chinese maturity-at-age, 2. mean of Japanese and seasonal mean of Chinese maturity-at-age).

16. China presented a standardization of catch per unit effort (CPUE) data for chub mackerel caught by the China's lighting purse seine fishery from 2014 to 2022 using a generalized additive model (GAM) (NPFC-2024-TWG CMSA09-WP13 (Rev. 1)). Four groups of independent variables were considered in the CPUE standardization: spatial variables (latitude and longitude), temporal variables (year and month), fishery variables (vessel length) and environmental variables (sea surface temperature (SST) and chlorophyll-a concentration (Chla)). China recommended using the standardized CPUE derived from GAM as an input for the chub mackerel stock assessment.

17. The TWG CMSA agreed to use China's standardized CPUE derived from GAM as an input for the chub mackerel stock assessment.

18. Japan presented a revised working paper on standardized abundance indices for age-0 and age-1 chub mackerel fish from Japan's Northwest Pacific autumn surveys up to 2023 produced using the Vector Autoregressive Spatio-Temporal Model (VAST) model (NPFC-2024-TWG CMSA09-WP06). Japan's standardized abundance indices for age-0 and age-1 chub mackerel from Japan's Northwest Pacific autumn surveys were first presented at TWG CMSA08 and the TWG CMSA agreed to use them as inputs for the stock assessment. At the suggestion of the TWG CMSA, Japan revised these standardized abundance indices after TWG CMSA08 by using slightly revised model configurations for the 1-year-old fish analysis. The revision produced little change in the results.

19. The TWG CMSA agreed to use Japan's revised standardized abundance indices for age-1 fish as inputs for the stock assessment.

20. Japan presented an updated standardization of egg abundances from monthly egg density data obtained by research surveys for the Pacific stock of chub mackerel using the VAST model (NPFC-2024-TWG CMSA09-WP07). These abundance indices were presented at TWG CMSA08 and the TWG CMSA agreed to use Japan's standardized chub mackerel egg abundance index, updated with the July 2023 data, as an input for the stock assessment. As recommended by the TWG CMSA, Japan has since updated the index with the July 2023 data.

21. The TWG CMSA agreed to use Japan's updated standardized chub mackerel egg abundance index as an input for the stock assessment.

22. Russia presented its standardization of CPUE data for chub mackerel caught by its trawl fishery from 2016 to 2023 using GAM (NPFC-2024-TWG CMSA09-WP11). Russia recommended using the standardized CPUE derived from GAM as an input for the stock assessment.

23. The TWG CMSA agreed to use Russia's standardized CPUE derived from GAM in a sensitivity analysis for the chub mackerel stock assessment.

5.3 Confirmation of setting and specification of SAM

24. The TWG CMSA reviewed the setting and specification of SAM as part of its review of the initial stock assessment results under agenda item 5.4 below.

5.4 Review of stock assessment results

5.4.1 Stock biomass, recruitment, spawning stock biomass, fishing mortalities, etc.

5.4.2 Model diagnostics and sensitivity analysis

25. Japan presented an initial base case stock assessment for chub mackerel in the Northwest Pacific Ocean in 2024 using a state-space age-structured (assessment) model (SAM) (NPFC-2024-TWG CMSA09-WP03 (Rev. 1)). Estimated total biomass and spawning stock biomass (SSB) declined from high levels in the 1970s to low levels in the 1980s, remained at low levels in the 1990s and early 2000s, and increased in the late 2000s. A strong year-class in 2013 led to a significant increase in total biomass and SSB, which peaked in 2017 and declined slightly until 2022, with recent abundance levels estimated to be lower than those of the 1970s. Model diagnostics showed that a few parameters had strong correlations and large uncertainties with other parameters, while the retrospective analysis showed a moderately large positive bias in total biomass, so there is room for further improvement on these issues.

26. Japan presented analyses of the sensitivity of the chub mackerel stock assessment in 2024 to observation and model uncertainty in the Northwest Pacific Ocean (NPFC-2024-TWG CMSA09-WP04). The sensitivity analysis scenarios with data up to 2022 or model settings without considering additional process errors showed results that were not significantly different from the base case, indicating that estimates by the base case are relatively robust to these uncertainties. However, scenarios using Japan's indices up to the latest available year, 2023, yielded results that differed significantly from the base case, representing the most pessimistic scenario with recent SSB being low and fishing pressure being high. This was primarily due to the low values of Japan's indices in 2023. Comparative analysis of predictive skill between the base case and this sensitivity scenario demonstrated higher accuracy in short-term forecasting for the sensitivity scenario. Therefore, Japan suggested that it is crucial to consider the results of the sensitivity scenario using the latest information from Japan's index thoroughly when considering recent stock status, conducting risk assessments from future projections, and making scientific management recommendations.

27. The TWG CMSA discussed a number of potential concerns regarding the SAM stock

assessment model configuration as it was initially presented by Japan. These concerns included the fit of the models to some indices, the practice of fixing process error for ages 1+, estimation of a power parameter within the CPUE observation model, retrospective patterns in the predicted indices, and the stock-recruitment relationship. The TWG CMSA also discussed some additional model diagnostics and plots that could be added to the stock assessment analyses. The TWG CMSA explored ways to address these issues, including additional model runs using different stock-recruitment relationships and modification of SAM to estimate age-specific processes errors of age 1 and older fish. Japan conducted additional runs and modifications of the model, expanded diagnostics, and presented the results for the TWG CMSA's review. Based on the results, the draft setting and specification of SAM was prepared (Annex D), to be finalized in conjunction with the finalization of the stock assessment report.

28. The TWG CMSA discussed and agreed on which stock assessment model scenarios to highlight in the executive summary of the stock assessment, including the selection of 4 models: 1) Estimate process error for only age 0 (recruitment) ; 2) Estimate process error for all age groups; 3) Estimate process error for only age 0 and use Japanese indices up to FY2023; and 4) Estimate process error for all age groups and use Japanese indices up to FY2023. Model 2) was selected as the base case. All models may still be considered and discussed in the final stock assessment report and future meetings.

29. The TWG CMSA discussed which year to set as the terminal year for the base case stock assessment. Japan suggested that its abundance indices up to 2023 should also be included as these are the latest available data. China noted that the inclusion of these indices involves large uncertainty related to assumptions about the biological parameters and expressed concern about their inclusion in the base case stock assessment. Therefore, the TWG CMSA maintained its previous decision, made at TWG CMSA08 and reaffirmed in the intersessional meetings since then, to set 2022 as the terminal year in the base case. The TWG CMSA agreed to include Japan's abundance indices up to 2023 as a sensitivity analysis.

30. The TWG CMSA noted the value of including the most up-to-date data in stock assessments and agreed that although it did not include the most recent past year's abundance indices in the base case for the stock assessment (2023), this did not preclude it from doing so in future stock assessments. The TWG CMSA also held preliminary discussions on the possibility of adjusting the timing of its meetings to later in the calendar year, for example holding the data preparatory meeting in summer and the stock assessment meeting immediately prior to the SC meeting in December, so as to be able to more easily incorporate data from the most recent past year into stock assessments. The TWG CMSA agreed to discuss this matter further intersessionally.

5.5 Draft summary of stock assessment results

31. The TWG CMSA drafted a summary of the stock assessment results. See the executive summary of the chub mackerel stock assessment report in Annex F.

32. China presented a stock assessment that it conducted for research using the age-structured assessment program (ASAP) based on the latest aggregated dataset and the agreed scenarios for chub mackerel in the North Pacific Ocean (NPFC-2024-TWG CMSA09-WP12 (Rev. 1)). A total of 12 scenarios were run in ASAP, including two base cases of different natural mortality and 10 other sensitivity cases considering various CPUE, maturity and catch-at-age data. The results indicated that there is no significant difference of abundance, SSB and fishing mortality estimates among all scenarios. The trend of SSB was similar with the results from SAM, which was high before 1980, decreased to a very low value between 1980 and 2010, then recovered and stayed at high values in the recent decade. Preliminary projections were also conducted, providing estimates of catch and SSB in the next ten years under different fishing mortality and TAC.

33. The TWG CMSA encouraged China to continue to develop the stock assessment model and suggested the following as potential future work:
    (a) Conduct retrospective analyses for recruitment in the model.
    (b) Check whether data from the correct time-lag has been used for calculating recruitment from SSB.
    (c) Create a residual plot of catch-at-age data.

Agenda Item 6. Future projections and biological reference points

6.1 Confirmation of projection methods and scenarios

34. The TWG CMSA reviewed the projection methods and scenarios as part of its review of the projection results under agenda item 6.2 below.

6.2 Review of projection results

35. Japan presented methods for calculating various commonly used biological reference points and stochastic future projections and the results based on the parameters estimated in the chub mackerel stock assessment (NPFC-2024-TWG CMSA09-WP05). Japan also evaluated the historical spawning potential of the stock by calculating unexploited spawning biomass (SSB0) per recruit (SPR0) based on annually changing weight and maturity. The calculated SPR0 shows that the spawning potential of this stock has significantly decreased to half the historical average during the most recent 7 years. The varying and decreasing SPR0 results in varying and decreasing estimates of SSB0 and SSB achieving maximum sustainable yield (SSB_{MSY}). Because the stock-recruitment relationship estimated in the stock assessment model indicates

very weak density dependence in the ranges historically observed with low steepness, the estimated SSB0 and SSB_{MSY} were extreme extrapolations, which may have resulted in these estimates being somewhat uncertain and unrealistic.

36. Japan presented the results of additional calculations of commonly used biological reference points and future projections based on the TWG CMSA's suggestions. Based on the results, the draft options for the basic specifications for conducting future projections for chub mackerel were prepared (Annex E), to be finalized in conjunction with the finalization of the stock assessment report.

6.3 Draft of management advice based on the results of projection and biological reference points

37. The chub mackerel stock in the Northwest Pacific Ocean has experienced large changes in biological parameters over the time period of the model. The main temporal changes are a recent decrease in maturity at age, along with a recent decrease in the weight at age, both of which were observed to change over the model time period to cause temporal changes of biological reference points. Maximum sustainable yield (MSY)-based reference points are highly variable over the time series of the assessment because the weight- and maturity- at age of chub mackerel has varied widely (Annex F, Figures 3 and 4), which impacts the productivity of the stock. Unfished spawning biomass per recruit (SPR0) represents the theoretical equilibrium productivity per fish assuming no fishing. SPR0 has varied remarkably over time (Annex F, Figure 5).

38. In addition, as there is little recruitment compensation in the stock-recruitment relationship within the range of historically observed SSB and recruitment (Annex F, Fig. 8), estimates of biomass-based MSY reference points are extreme explorations that are highly sensitive to model configuration.

39. Because of the above reasons, commonly used reference points such as MSY-related or SPR-related reference points vary over time and are uncertain, and they are potentially misleading with respect to stock status. For example, the MSY based reference points have varied by the assumption of biological parameters to be used (Annex F, Table 1). The exploitation rates corresponding to the MSY was 10% when assuming biological parameters during the whole historical period, but it dropped to 5% when using the most recent 7 years biological parameters.

40. As such, at this time, the TWG CMSA does not recommend the use of MSY-based reference points for management advice. Instead, the TWG CMSA provides information of current estimates of chub mackerel SSB and F (average 2020-2022) relative to the minimum, 25th, 50th, 75th and maximum value of the SSB and F values over the entire time period (1970-2022;

Annex F, Table 2). Values relating to the most recent time period (2016-2022) are also shown in order to describe the current stock relative to recent conditions.

41. The abundance estimated by the Japanese egg survey and the CPUEs from the Japanese dipnet and Russian trawl decreased over recent years, showing that they were simultaneously reduced to about half the level of recent years in 2023. The sensitivity run of the stock assessment model including Japanese CPUE for 2023 shows substantial decline in biomass and SSB in FY2022 and further in FY2023 and higher fishing mortality in the last few years (Annex F, Figure 7).

42. Given the uncertainty in biological parameters in future, which have a large impact on the projection results, the TWG CMSA considers it is not appropriate to provide long-term harvesting recommendations at this time. A short-term (towards 2028) projection was undertaken to assess the effects of varying catch levels, ranging from 50 to 400 thousand tons, based on the most recent seven years' biological data (Annex F, Figure 9) and the entire time series of biological data (Annex F, Figure 10) for management considerations. Projections based on the most recent seven years' biological data showed that Fcur leads to future constant decline of SSB and it is necessary to reduce current fishing mortality (Annex F, Table 3).

Agenda Item 7. Stock assessment report

7.1 Review of draft executive summary

7.1.1 Stock status

7.1.2 Management advice

7.1.3 Others

43. The TWG CMSA drafted the executive summary of the chub mackerel stock assessment report (Annex F).

7.2 Review of draft stock assessment report

7.3 Work assignments to finalize the report towards SC09 meeting

44. The TWG CMSA agreed to work intersessionally to finalize the stock assessment report and submit it to the SC09 meeting. See Annex G for a detailed timeline.

Agenda Item 8. Data collection and management

8.1 Data provision templates

45. The TWG CMSA reviewed the data provision templates from SC08 (NPFC-2023-SC08-IP13 (Rev 1)). The TWG CMSA had no specific feedback about the templates. The TWG CMSA encouraged Members to continue to review and test the templates and provide their feedback by the 9th Scientific Committee meeting (SC09). The TWG CMSA noted that upon endorsement by SC09 these data provision templates will be used by SC's subsidiary groups

for data sharing.

46. The TWG CMSA suggested that the templates could eventually be used not only for standardized data reporting, but also for the establishment of a database. The TWG CMSA noted that when establishing and managing such a database, consideration should be given to ensuring appropriate data access restrictions.

8.2 Data inventory

47. The Secretariat presented a data inventory policy and a data inventory table summarizing chub mackerel data submitted by Members (NPFC-2024-TWG CMSA09-WP10).

48. The TWG CMSA noted the approach being taken by the Secretariat to develop the data inventory and had no specific feedback.

8.3 Update on GitHub repository and user manual

49. The Data Coordinator, Mr. Sungkuk Kang, provided an update on the GitHub repository and user manual (NPFC-2024-TWG CMSA09-IP02). He explained that the Secretariat officially submitted the application for the GitHub Nonprofit Plan on 5 February 2024. However, the Secretariat was informed that due to a high volume of tickets, the approval process may be delayed. The Secretariat will continue to try to get the approval from GitHub for the use of the Nonprofit Team Plan. As a contingency plan, the Secretariat has established a GitHub Free Plan to be used until then. The Secretariat has also developed a user manual that is available on the NPFC website and can be continuously enhanced based on feedback from Members.

8.4 Observer program

50. The Science Manager informed the TWG CMSA that the Commission requested that the SC provide guidance to the Technical and Compliance Committee (TCC) on what level of observer coverage would be needed on fishing vessels and what kinds of data would need to be collected to achieve the scientific objectives of a regional observer program (ROP). Following this, the SC Chair has requested the SC's subsidiary bodies, including the TWG CMSA, to consider the scientific objectives, data needs, and level of observer coverage, and to come to SC09 prepared to discuss these. In addition, the TCC Chair has asked the SC and its subsidiary bodies to answer the following questions: 1. Are there different needs for the different fisheries regarding data collection? 2. What new data would the SC prioritize/need from a ROP? 3. What new data would be nice to have (i.e. not needed/priority)? 4. Whether this data could be collected through electronic monitoring (EM)? 5. Whether the observer needs to be a scientist, or can data be collected by a non-scientist?

51. The Science Manager reminded the TWG CMSA that some Members have noted that an ROP could be supplemented with national observer programs and presented a summary table showing the existence and type of Members' national observer programs in the Convention Area and adjacent exclusive economic zones (EEZs) (NPFC-2024-SC09-WP02).

52. The TWG CMSA agreed that to further improve the chub mackerel stock assessment, it is important to collect more detailed catch data, particularly more detailed age-specific biological data, throughout the range of the distribution of this species, as well as information for distinguishing between chub mackerel and blue mackerel in catch. Such data could not be collected through e-monitoring. The TWG CMSA also noted that if chub mackerel are being transshipped, it is possible that they may not be subject to Members' port sampling schemes and biological data are therefore not being collected from them.

53. The TWG CMSA noted that in order to provide advice on the level of observer coverage, it would need to have a better understanding of each Member's national observer programs and sampling schemes. The Science Manager informed the TWG CMSA that it has already compiled some information describing Members' national observer programs and sampling schemes (NPFC-2024-SC09-WP02) and suggested that Members provide their feedback to the Secretariat on what kind of additional information they would like to know.

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

54. The TWG CMSA reviewed and updated the Work Plan of the TWG CMSA (NPFC-2024-TWG CMSA09-WP08 (Rev. 2)).

55. The TWG CMSA reviewed the NPFC Performance Review recommendations that concern chub mackerel and the status of responses (NPFC-2024-SC09-WP01) and agreed with the updated responses drafted by the Chair and Secretariat.

Agenda Item 10. Other matters

10.1 Timeline and intersessional activities before TWG CMSA10

56. The TWG CMSA drafted a timeline of tasks leading up to TWG CMSA10 (Annex G).

10.2 Species summary

57. The TWG CMSA reviewed and updated the species summary for chub mackerel (NPFC-2024-TWG CMSA09-WP09 (Rev. 2)). The TWG CMSA recommended that the SC adopt the updated species summary (Annex H).

10.3 Invited expert

58. The TWG CMSA expressed its appreciation for the valuable support of the invited expert, Dr. Joel Rice. The TWG CMSA recommended that Dr. Rice be invited to the meetings of the TWG CMSA in 2025 and assist the TWG CMSA in drafting the stock assessment report intersessionally.

10.4 Election of Chair and vice-Chair

59. The TWG CMSA re-elected Dr. Kazuhiro Oshima to serve as its Chair for another two-year term.

60. The TWG CMSA re-elected Dr. Qiuyun Ma to serve as its Vice-Chair for another two-year term.

10.5 Other issues

61. The consultant, Dr. Jihwan Kim, presented the results of a study on the effects of Kuroshio Current variability and Pacific Decadal Oscillation (PDO) on the recent decline in chub mackerel catch in the Northwestern Pacific in the 2020s (NPFC-2024-TWG CMSA09-IP01). Results indicate that variations in the path of the Kuroshio Current around southern Japan and its extension significantly correlate with chub mackerel catch fluctuations, rather than upper-ocean temperature variability in the feeding and nursery grounds along the east coast of Japan. Additionally, the results underscore the influence of PDO-driven ocean processes on Kuroshio Meandering and its extension, which may establish biologically adverse conditions affecting spawning success and consequently, catch and abundance.

Agenda Item 11. Recommendations to the Scientific Committee

62. The TWG CMSA agreed to:
    (a) update the setting and specification of SAM (Annex D).
    (b) update the basic specifications for conducting future projections for chub mackerel (Annex E).
    (c) continue to work intersessionally in accordance with the agreed timeline (Annex G).

63. The TWG CMSA recommended that the SC:
    (a) recommend that the Commission note the status of the chub mackerel stock and management advice provided in paragraphs [37-42].
    (b) endorse the stock assessment executive summary (Annex F) and stock assessment report (to be submitted to SC intersessionally).
    (c) adopt the Work Plan of the TWG CMSA (NPFC-2024-TWG CMSA09-WP08 (Rev. 2)).
    (d) adopt the updated species summary for chub mackerel (Annex H).
    (e) consider the TWG CMSA’s comments on the NPFC Performance Review

recommendations that concern chub mackerel (NPFC-2024-SC09-WP01 (Rev. 1)).

(f) continue to hire an invited expert to support the TWG CMSA in 2025.

Agenda Item 12. Adoption of Report

64. The report was adopted by consensus.

Agenda Item 13. Close of the Meeting

65. The Chair thanked the participants for their hard work and cooperation.

66. The TWG CMSA thanked the Chair for his leadership, the Secretariat and invited expert for their support, and Japan for hosting the meeting.

67. The meeting closed at 18:15 on 20 July 2024, Yokohama time.

Annexes

Annex A – Agenda

Annex B – List of Documents

Annex C – List of Participants

Annex D – Draft settings and specification of SAM

Annex E – Draft options for the basic specifications for conducting future projections for chub mackerel

Annex F – Executive summary of the stock assessment of chub mackerel

Annex G – Timeline and intersessional activities before the TWG CMSA10 meeting

Annex H – Species summary for chub mackerel

Annex A

Agenda

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Annex B

List of Documents

MEETING INFORMATION PAPERS

Symbol	Title
NPFC-2024-TWG CMSA09-MIP01 (Rev.2)	Meeting Information
NPFC-2024-TWG CMSA09-MIP02	Provisional Agenda
NPFC-2024-TWG CMSA09-MIP03 (Rev. 2)	Annotated Indicative Schedule

WORKING PAPERS

Symbol	Title
NPFC-2024-TWG CMSA09-WP01	The data description for the base case stock assessment of chub mackerel *Scomber japonicus* in the northwestern Pacific Ocean
NPFC-2024-TWG CMSA09-WP02	The data description of input data used for the sensitivity analyses of the stock assessment of chub mackerel *Scomber japonicus* in the northwestern Pacific Ocean
NPFC-2024-TWG CMSA09-WP03 (Rev.1)	Base case stock assessment for chub mackerel in Northwest Pacific Ocean in 2024
NPFC-2024-TWG CMSA09-WP04	Sensitivity of the chub mackerel stock assessment in 2024 to observation and model uncertainty in the Northwest Pacific Ocean
NPFC-2024-TWG CMSA09-WP05	Biological reference points and future projections with the results of stock assessment for the Pacific chub mackerel
NPFC-2024-TWG CMSA09-WP06	Revised Standardized Abundance Indices for Ages 0 and 1 Fish of Chub Mackerel from Northwest Pacific Autumn Surveys up to 2023
NPFC-2024-TWG CMSA09-WP07	Standardizing monthly egg survey data as an abundance index for spawning stock biomass of chub mackerel in the Northwest Pacific
NPFC-2024-TWG CMSA09-WP08 (Rev. 2)	TWG CMSA Work Plan, 2024-2028
NPFC-2024-TWG CMSA09-WP09 (Rev. 2)	Species Summary for Chub Mackerel
NPFC-2024-TWG CMSA09-WP10	Scientific data management system: data inventory
NPFC-2024-TWG CMSA09-WP11	Standardized CPUE of Chub mackerel (*Scomber japonicus*) caught by the Russia's trawls fishery up to 2023
NPFC-2024-TWG CMSA09-WP12 (Rev. 1)	Stock assessment based on age-structured assessment program for Chub mackerel in the

	North Pacific Ocean 2024
NPFC-2024-TWG CMSA09-WP13 (Rev. 1)	Standardized CPUE of Chub mackerel (*Scomber japonicus*) caught by the China's lighting purse seine fishery up to 2022
NPFC-2024-SC09-WP01 (Rev. 1)	Performance Review Recommendations update
NPFC-2024-SC09-WP02 (Rev. 1)	Report on the existing observer programs of NPFC Members and those of other RFMOs

INFORMATION PAPERS

Symbol	Title
NPFC-2024-TWG CMSA09-IP01	Effects of Kuroshio Current Variability and Pacific Decadal Oscillation on Recent Decline in Chub Mackerel (*Scomber japonicus*) Catch in the Northwestern Pacific in the 2020s
NPFC-2024-TWG CMSA09-IP02	Update on GitHub Repository and User Manual
NPFC-2024-TWG CMSA09-IP03	Review of chub mackerel fishery in China and research activities
NPFC-2024-TWG CMSA09-IP04	Recent fishery and stock status of chub mackerel from Japan

REFERENCE DOCUMENTS

Symbol	Title
NPFC-2023-SC08-IP13 (Rev 1)	Biological Data Provision Template
TWG CMSA08 Report	8th TWG CMSA meeting report
NPFC-2024-TWG CMSA09-RP01	Summary of the 1st Intersessional Meeting of the Technical Working Group on Chub Mackerel Stock Assessment
NPFC-2024-TWG CMSA09-RP02	Summary of the 2nd Intersessional Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

Annex C

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Draft settings and specification of SAM

(to be finalized as part of the finalization of the stock assessment report)

Model configuration	Parameter	Option(s) addressed after input data fixed by TWG CMSA09	Potential option(s) requiring revision or development (long-term work)	Note
Recruitment	$N_{0,y}$	Parameterized Beverton-Holt stock-recruitment relationship with α and β estimated in the model	• Beverton-Holt stock-recruitment relationship with fixed parameters such as α and β or steepness parameter h, exploring the fit of the model to a range of values that would give low, intermediate, and high steepnesses that seem plausible • Bent hockey-stick SRR • Consider other possible options	Analyzing HS SRR is difficult in SAM
Catchability or proportionality constant for abundance indices	q_k	Assume constant	Consider time-varying catchability	

Nonlinear coefficient for abundance indices	b_k	Searching the best option(s) about how constraints are imposed on which indices based on AIC etc		
Years of F random walk	-	Include the Markov process for all years as the base case		
Correlation of age classes in F random walk	ρ	Using a simple function of age difference ($\rho^{\lvert a-a'\rvert}$)		
Process errors in numbers older than age 0	ω_a $(a>0)$	• Fix at a very small value (0.01) • Estimate process errors for age 1 and older (adopted as the base case)	Need a self-test for the model with process errors for age 1 and older estimated (mid-term work)	
SD in F random walk	σ_a	Searching the best option(s) about how constraints are imposed on which age classes based on AIC etc	Consider other structures of random errors	
SD in measurement errors of catch at age	τ_a	Searching the best option(s) about how constraints are imposed on which age classes based on AIC etc	Consider other structures of random errors	
SD in measurement errors of abundance indices	v_a	Assuming different measurement errors among abundance indices	Consider other structures of random errors	

Number of fleets	-	Single fleet (explore calculation of F by fleet to fit to the Chinese and Russian fishery CPUEs)	Multiple	• A relatively large revision is required • Extension to multi-fleets may be useful in fitting fishery-dependent CPUE and for management purpose
Natural mortality	*M*	• Age-common M (0.5) • Age-specific M (0.80 for age 0, 0.60 for age 1, 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+) (adopted as the base case) • Likelihood profiles on natural mortality	Time varying M	
Maturity-at-age		• Jpn MAA (base case) • Using the average of Chn MAA and Jpn MAA as a sensitivity scenario	Incorporate density dependence in weight growth and maturity	
Catch-at-age	$C_{a.y}$	• See Annex D, CMSA08 Report • Conduct sensitivity analysis by excluding 2015 data • Conduct sensitivity analyses for the other two scenarios for catch-at-age data for China in 2015	Put different weights based on data uncertainty	SAM allows missing data in catch-at-age
Weight-at-age		To compute total biomass and SSB using an average, weighted by age-specific catch number with the same ratio across		

		all years (FY2014–FY2022) by Member, of Chn, E/WJpn and Rus WAA		
Summer survey index (age 0)		Used for SA (NPFC-2024-TWG CMSA08-WP06 Rev 1)		
Autumn survey indices (ages 0, 1)		Used for SA (NPFC-2024-TWG CMSA09-WP06)	Compare the effect of assuming an autoregressive process or an independent and identically distributed process in the CPUE standardization	
Egg abundance (SSB)		Used for SA (NPFC-2024-TWG CMSA09-WP07)		
Dipnet fishery (SSB)		Agreed to be used for SA (NPFC-2024-TWG CMSA08-WP03)		
Chinese fishery CPUE		Used for SA (NPFC-2024-TWG CMSA09-WP13)		
Russian fishery CPUE		Used as a sensitivity scenario (NPFC-2024-TWG CMSA09-WP11)		

Annex E

Draft options for the basic specifications for conducting future projections for chub mackerel

(to be finalized in conjunction with the finalization of the stock assessment report)

Items	Option for base case	Option for future	Issue to be clarified
Type of simulation	**Stochastic (3000 times)**		Model uncertainty, Management objective Deterministic run is not recommended (random effects are estimated, so deterministic run is not appropriate)
Duration	Short (5 years after introduction of management)	**Medium (5-10 years) or Long (> 10 years),** Equilibrium (related to projection levels of Fref)	Ask the COM to consider management objective and methods. Consider appropriate duration for chub mackerel
Start year for incorporating management	2024		
Catch or F levels	Constant catch	HCR	Management Method, HCR, Include terminal year's F or not
Estimation of catch from terminal year (FY 2022) to current year (FY 2023)	**recent F**	Last year of harvest, Average of 2 or 3 recent years	
Other parameters (not recruitment)	**Parameter estimates without uncertainty**	Parameter estimates with uncertainty (future study)	

Process error other than Age 0	Consider as stochasticity with the estimated variances in SAM when it is estimated		Note that SAM includes process error on all ages
Recruitment level	Model-based approach using S-R relations (**BH**)	Empirical approach by resampling past recruitments (what duration?)	Model uncertainty
Error structure in recruitment	**Parametric with process error**	Non-parametric (resampling of deviations)	Future work could consider that future recruitment is lower and possibly link to an environmental signal
Biological parameters	**Recent 7 years average (after the year when maturity has dropped) and all year's average as sensitivity**	Possible density dependent relationship	

Note: Bold font indicates recommended settings for projections.

Annex F

Executive summary of the stock assessment of chub mackerel

Background information

Chub mackerel (*Scomber japonicus*) in the Northwest Pacific Ocean (NWPO) is distributed from the coast of southern Japan to offshore waters of Kuril Islands. It is considered that both adults and juveniles are distributed as far east as the 170-degree East longitude line. The feeding migration of adults has expanded to the northeast recently, and since 2018 the distribution of adults during summer and fall has reached 47-degree North, 166-degree East, east offshore of Kuril Island. The spawning ground is known to be located within the range of the Japanese Exclusive Economic Zone (EEZ), with the main spawning ground located in Izu Island waters.

Chub mackerel are harvested by China, Japan and Russia (Figure 1). Chinese light purse seine and pelagic trawl fisheries are operated in the NPFC Convention Area. Japanese chub mackerel fisheries consist mainly of purse seine and set net fisheries within the Japanese national waters. Russian chub mackerel fisheries mainly operated in the Russian national waters consist of mid-water trawl, purse seine and bottom trawl gears with operations in the Japanese national waters. The historical total landings have largely fluctuated and recently decreased from approximately 516,000 mt in 2018 to 151,000 mt in the most recent calendar year (CY) 2023. The Conservation and Management Measure for chub mackerel (CMM 2024-07) includes a catch limit of 100,000 mt set in the Convention Area for each of the 2024 and 2025 fishing seasons.

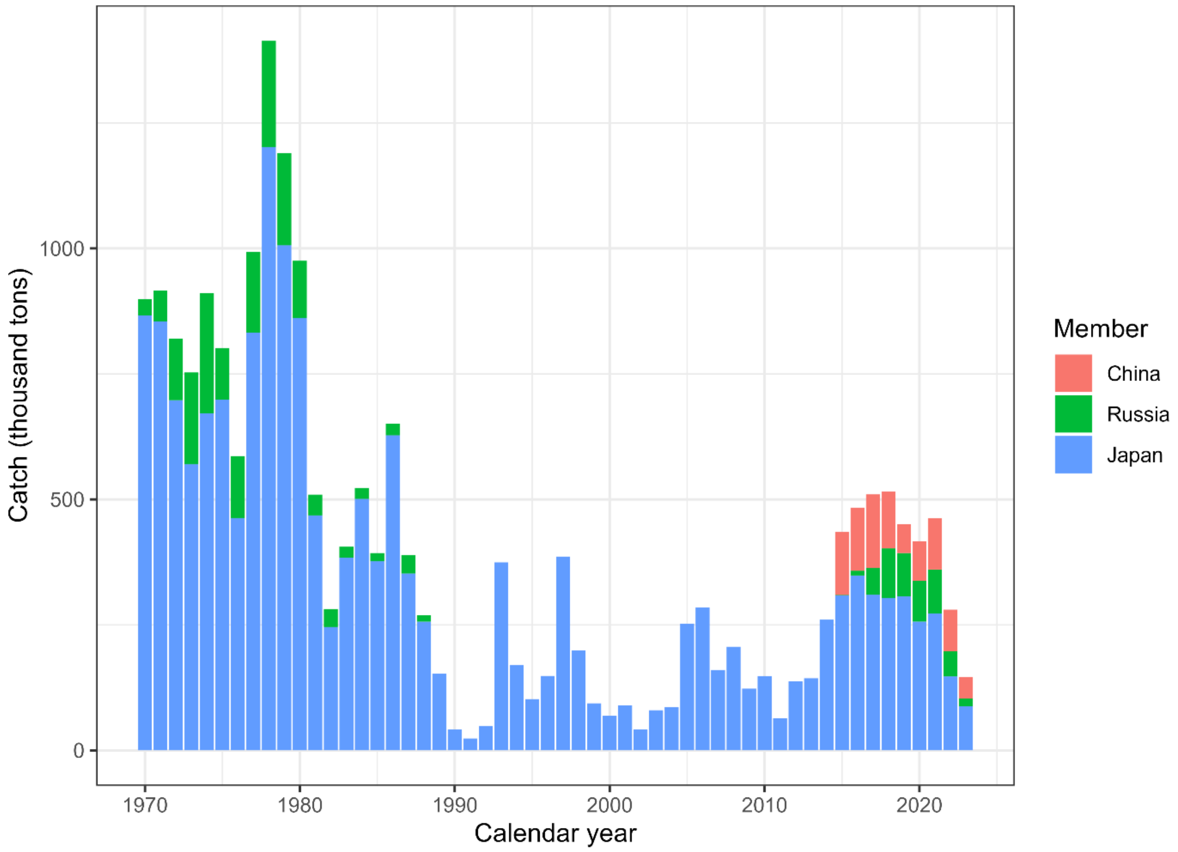

Figure 1. Historical chub mackerel catch in weight by Member. The provisional Chinese catch for 2023 is estimated using the historical ratio for chub mackerel and blue mackerel.

Stock assessment model
A state-space stock assessment model (SAM) was agreed to be used for the chub mackerel stock assessment by the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA). SAM accounts for observation errors in catch-at-age data and abundance indices. It uses age-specific data on catch numbers, stock weight, and maturity rate in each year. Recruitment was defined as numbers at age 0, and spawning stock biomass (SSB) was calculated through multiplication of numbers-at-age by maturity-at-age and weight-at-age. SAM consists of two subparts: a population dynamics model and an observation model.

Age-structured population dynamics for chub mackerel estimated by SAM are driven through survival processes such as natural and fishing mortalities, and reproduction is calculated by a Beverton-Holt stock recruitment relationship. Fishing mortality coefficients by year and age group are assumed to follow a multivariate random walk, consequently allowing estimation of time-varying selectivity.

In the observation model of SAM, the catch-at-age is estimated though the fitting of the Baranov equation to the observed catch-at-age under a lognormal error distribution. SAM also fits to abundance indices with a lognormal error assumption. Non-linear relationships to population abundance estimates were estimated for abundance indices specific to ages 0 and 1, linear relationships were applied to the other abundance indices.

Data and biological parameters used in the assessment model
Data are included from the NPFC Convention Area and Members' EEZs.

A fishing year (FY) starting from July and ending in June of the following year was applied in the stock assessment of chub mackerel. The TWG CMSA agreed for the stock assessment period to be FY1970 to FY2022. Seven age groups of ages 0 to 5 and 6+ were defined in the stock assessment. The historical catch-at-age, which was constructed from the quarterly data from each Member, is shown in Figure 2. Time series of mean weight-at-age are illustrated in Figure 3. Annual maturity-at-age with decadal time-varying changes is shown in Figure 4. These data were available up to FY2022.

Although seven time series were available, only six time series of abundance indices were used during model development (Figure 5): relative number of age 0 fish from the summer survey by Japan; relative number of age 0 fish from the autumn survey by Japan; relative number of age 1 fish from the autumn survey by Japan; relative SSB from the egg survey by Japan; relative SSB from the dip-net fishery by Japan; and relative vulnerable stock biomass from the light purse-seine fishery by China.

Russian CPUE data were not used for model development although the abundance indices from Japan and Russia were available until FY2023 and until FY2022 for China. While the FY2023 Japanese abundance indices were not used for the base case, as agreed in the TWG CMSA08, they were used for sensitivity runs.

An age-specific natural mortality (M), corresponding to 0.80 for age 0, 0.60 for age 1, 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+, is applied for the stock assessment by the TWG CMSA.

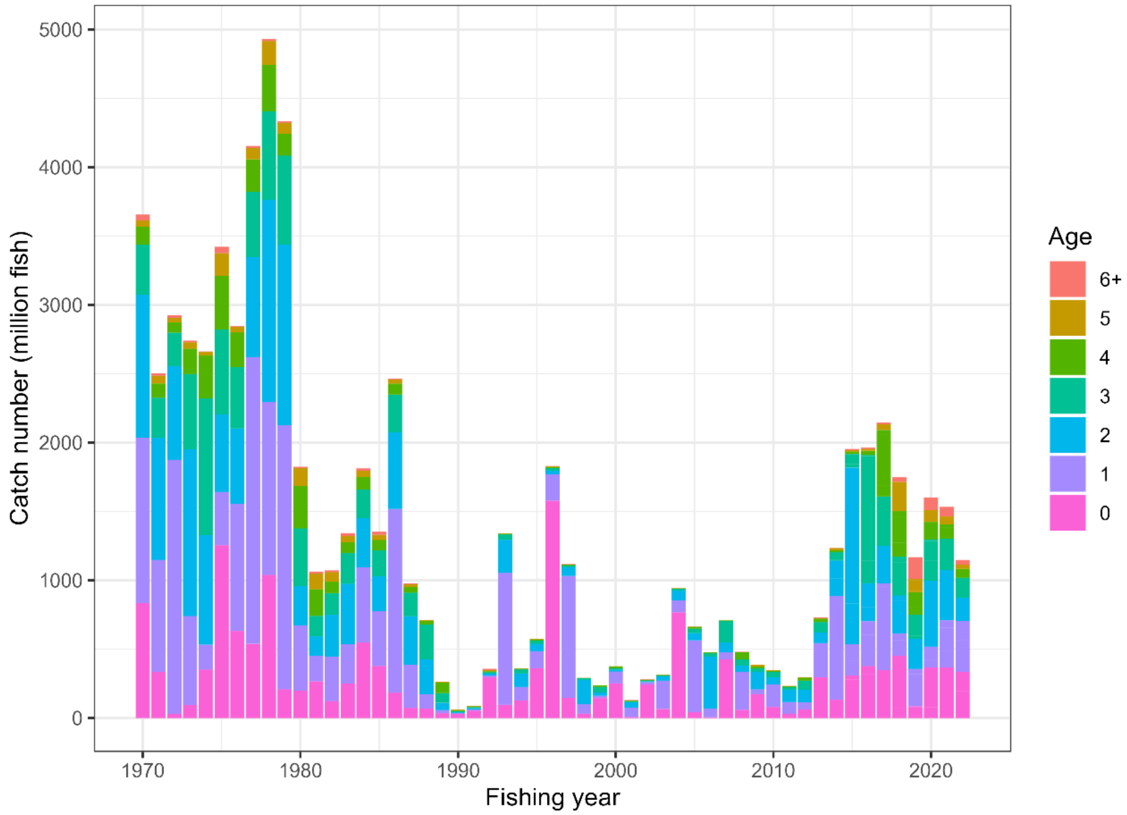

Figure 2. Historical observed catch-at-age.

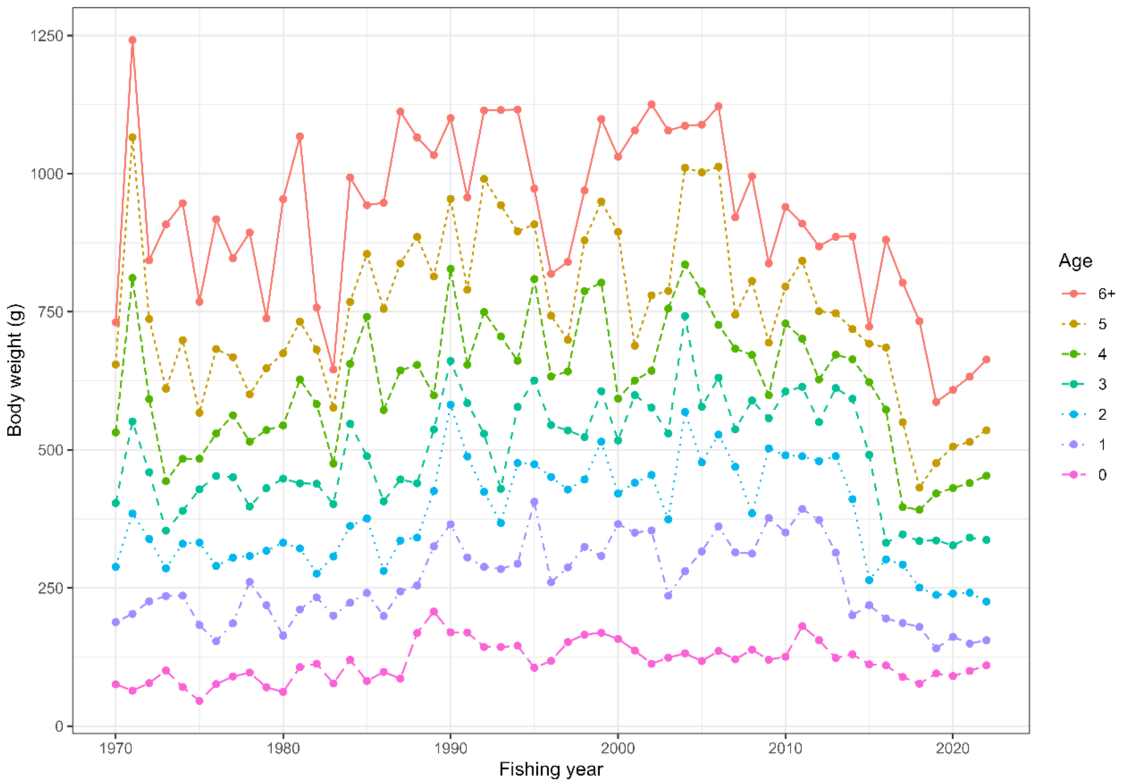

Figure 3. Time series of weight-at-age.

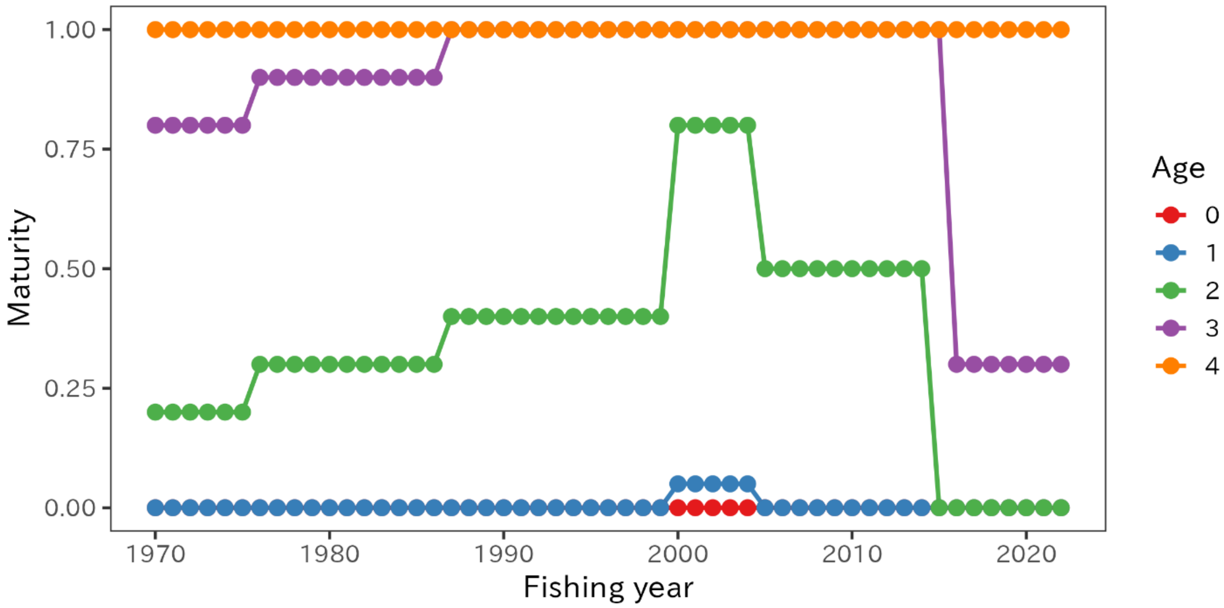

Figure 4. Time series of maturity-at-age. Ages are simplified up to age 4 due to the similarity of maturity at age 4 and above.

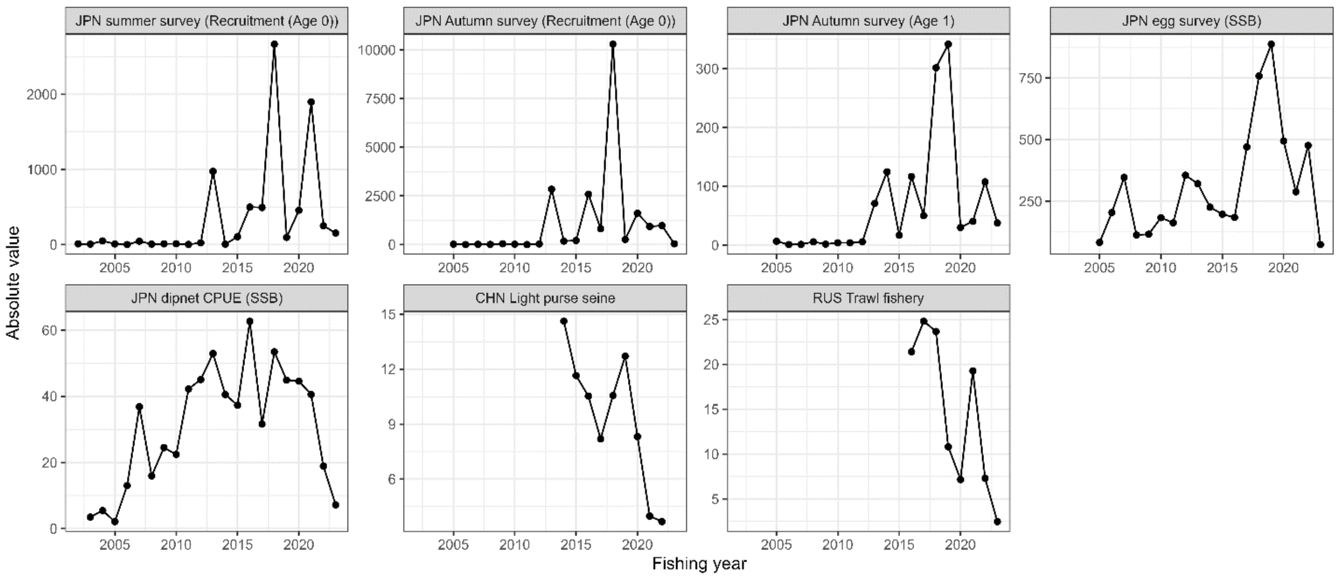

Figure 5. Time series of abundance indices. The Russian CPUE data were not used in model estimation.

Stock assessment scenarios

In order to improve the SAM fit to abundance indices and retrospective patterns, the TWG CMSA recognized the necessity of introduction of estimation of process error in survival of age groups older than age 0. The TWG CMSA also considered inclusion of FY2023 from the Japanese abundance indices, which had a large impact on the stock status of the most recent years. As a result, the following four scenarios were employed as representative cases:

1) B2, Estimate process error for only age 0 (recruitment);
2) S28-ProcEst, Estimate process error for all age groups;
3) S32-JP23, Estimate process error for only age 0 and use Japanese indices up to FY2023; and
4) S34-ProcEst23, Estimate process error for all age groups and use Japanese indices up to FY2023

TWG CMSA agreed to select S28-ProcEst as a base case scenario because of the better diagnostics than the model only with recruitment process error and agreement of data usage up to FY2022. The other three scenarios were employed to show possible range of uncertainty.

Reference points

Using stock assessment results from the base case scenario, the TWG CMSA calculated commonly used biological reference points such as F%SPR (30%, 40%, 50%, 60% and 70%), F0.1, maximum sustainable yield (MSY)-based reference points, i.e. F_{MSY} and SSB_{MSY}, with mean biological parameters and selectivity of current F (mean F in FY2020 to FY2022). In particular, the biological parameters such as weight-at-age and maturity-at-age used for calculation of biological reference points are assumed as the average values during the most recent 7 years (FY2016 to FY2022), which represents the recent change in biological parameters. As a control, the average of the biological parameters was calculated over the stock assessment period. Reference points for the base case scenario are listed in Table 1.

Description of specification of future projections

The population dynamics model for stochastic future projections is the same as is used in SAM. The future harvesting scenario was predetermined as a total catch of 50, 100, 150, 200, 300 and 400 thousand tons after FY2023, compared with another future harvesting scenario under Fcur.

Future biological parameters are assumed to equal the average of the recent seven years. Mean biological parameters for the entire model time period (FY1970-FY2022) are used as a control.

Stock status overview

The chub mackerel stock in the NWPO has experienced large changes in biological parameters over the time period of the model. The main temporal changes are a recent decrease in maturity at age, along with a recent decrease in the weight at age, both of which were observed to change over the model time period to cause temporal changes of biological reference points. MSY-based reference points are highly variable over the timeseries of the assessment because the weight- and maturity-at age of chub mackerel has varied widely (Figures 3 and 4), which impacts the productivity of the stock. Unfished spawning biomass per recruit (SPR0) represents the theoretical equilibrium productivity per fish assuming no fishing. SPR0 has varied remarkably over time (Figure 6).

In addition, as there is little recruitment compensation in the stock-recruitment relationship within the range of historically observed SSB and recruitment (Figure 8), estimates of biomass-based MSY reference points are extreme explorations that are highly sensitive to model configuration.

Because of the above reasons, commonly used reference points such as MSY-related or SPR-related reference points vary over time and are uncertain, and they are potentially misleading with respect to stock status. For example, the MSY-based reference points have varied by the assumption of biological parameters to be used (Table 1). The exploitation rates corresponding to the MSY was 10% when assuming biological parameters during the whole historical period, but it dropped to 5% when using the most recent 7 years biological parameters.

As such, at this time, the TWG CMSA does not recommend the use of MSY-based reference points for management advice. Instead, the TWG CMSA provides information of current estimates of chub mackerel SSB and F (average FY2020-FY2022) relative to the minimum, 25th, 50th, 75th and maximum value of the SSB and F values over the entire time period (FY1970-FY2022; Table 2). Values relating to the most recent time period (FY2016-FY2022) are also shown in order to describe the current stock relative to recent conditions.

The abundance estimated by the Japanese egg survey and the CPUEs from the Japanese dipnet and Russian trawl decreased over recent years, showing that they were simultaneously reduced to about half the level of recent years in FY2023. The sensitivity run of the stock assessment model including Japanese CPUE for FY2023 shows substantial decline in biomass and SSB in FY2022 and further in FY2023 and higher fishing mortality in the last few years (Figure 7).

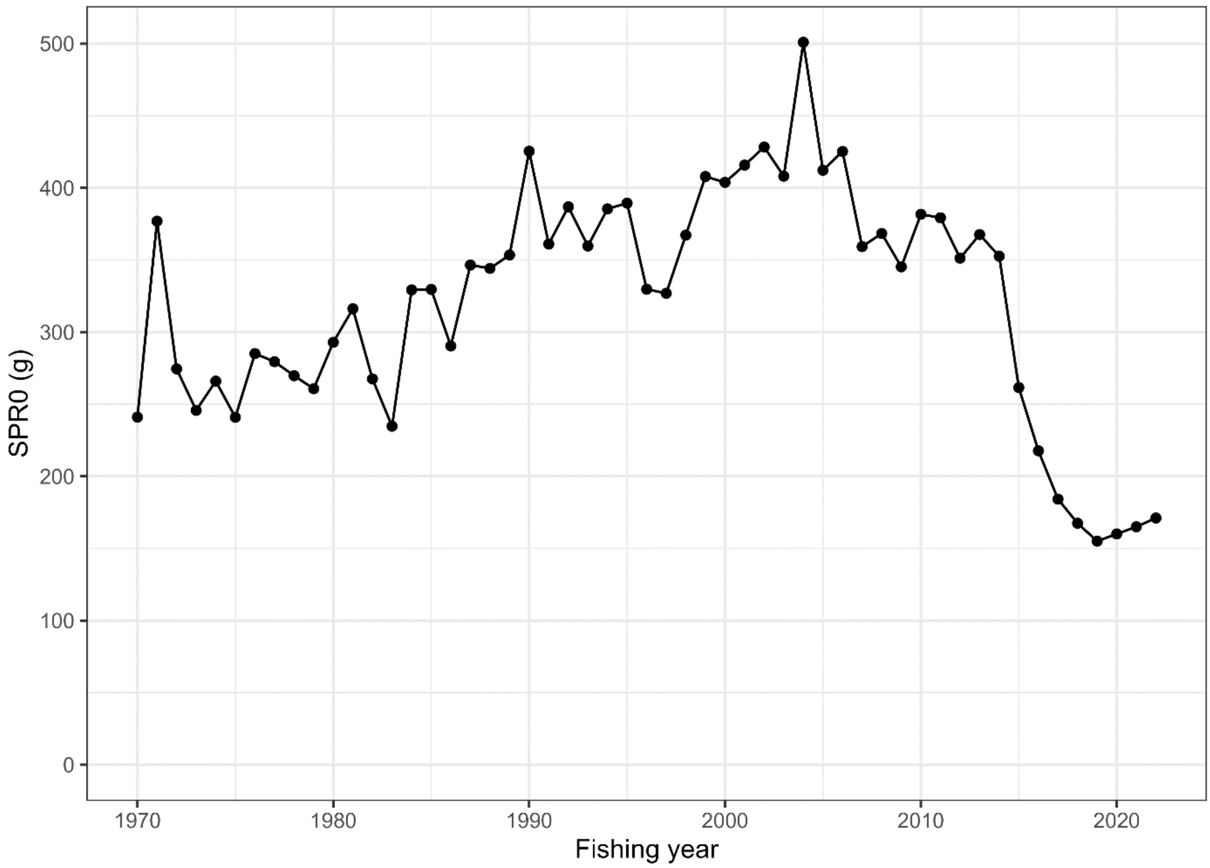

Figure 6. Trajectories of spawners per recruit without fishing (SPR0).

Table 1. Reference points for the base case scenario (S28-ProcEst). Reference point values in this table are calculated by holding Fcur the same for all calculations, but by varying the time period (either FY2016-FY2022 or FY1970-FY2022) over which the biological parameters are estimated. Refer to Glossary in the stock assessment report for the definitions.

Biological parameters used	**FY2016-FY2022**	FY1970-FY2022
	S28-ProcEst	S28-ProcEst
current%SPR	**28.3**	40.3
Fmed/Fcur	**0.478**	1.629
F0.1/Fcur	**1.344**	1.344
FpSPR.30.SPR/Fcur	**0.942**	1.498
FpSPR.40.SPR/Fcur	**0.673**	1.010
FpSPR.50.SPR/Fcur	**0.484**	0.696
FpSPR.60.SPR/Fcur	**0.342**	0.475
FpSPR.70.SPR/Fcur	**0.230**	0.311
F_{MSY}/Fcur	**0.258**	0.668
B_{MSY}	**9396.157**	17179.502
SSB_{MSY}	**2904.704**	6084.597
h	**0.358**	0.501
SSB0	**7123.476**	17441.919
SSB_{MSY}/SSB0	**0.408**	0.349
F_{MSY}SPR	**0.673**	0.511
MSY	436.8467	1713.406
MSY/B_{MSY} (exploitation rate at MSY)	0.046	0.10

Table 2. Stock status summary from the base case scenario.

Stock Status Sumary Table	SSB (thousand mt)	Biomass (thousand mt)	Recruitment (million individuals)	F	Exploitation	SPR_0
2022 Estimate	454	2,882	9,839	0.243	0.095	171.1
Current (Cur average 2020-2022)	533	2,935	11,097	0.306	0.124	165.4
Values relative to the all years of the time series (i.e. 1970-2022)	**SSB (thousand mt)**	**Biomass (thousand mt)**	**Recruitment (million individuals)**	**F**	**Exploitation**	**SPR_0**
Historical Minimum (Min)	45	172	365	0.13	0.073	155
Historical 25 percentile (25%)	97	634	1,308	0.24	0.137	266
Historical Median (Med)	335	1,566	4,353	0.35	0.187	344.1
Historical 75 percentile (75%)	744	3,177	9,839	0.43	0.249	379.2
Historical Maximum (Max)	1,394	6,050	23,579	0.82	0.417	500.9
Ratios Relative to 1970-2022	Stock Status Related to Biomass			Stock Status Related to Fishing intensity		
Cur/Historical Minimum	11.859	17.081	30.436	2.30	1.699	1.067
Cur/25%_Historical	5.494	4.628	8.483	1.27	0.905	0.622
Cur/Med_Historical	1.591	1.874	2.55	0.88	0.663	0.481
Cur/75%_Historical	0.717	0.924	1.128	0.72	0.498	0.436
Cur/Max_Historical	0.383	0.485	0.471	0.37	0.297	0.33
Values relative to 2016-2022	**SSB (thousand mt)**	**Biomass (thousand mt)**	**Recruitment (million individuals)**	**F**	**Exploitation**	**SPR_0**
Recent Minimum (Min)	447	2,825	6,043	0.09	0.233	155.0
Recent 25th percentile (25%)	486	2,919	10,154	0.11	0.256	162.5
Recent Median (Med)	620	3,018	11,077	0.12	0.287	167.5
Recent75 percentile (75%)	748	3,605	12,622	0.13	0.300	177.6
Recent Maximum (Max)	774	4,108	22,898	0.14	0.306	217.7
Ratios Relative to 2016-2022	Stock Status Related to Biomass			Stock Status Related to Fishing intensity		
Cur/ Recent Min	1.19	1.04	1.84	3.43	0.53	1.07
Cur/25%_Recent	1.10	1.01	1.09	2.72	0.48	1.02
Cur/Med_Recent	0.86	0.97	1.00	2.50	0.43	0.99
Cur/75%_Recent	0.71	0.81	0.88	2.35	0.41	0.93
Cur/Max_Recent	0.69	0.71	0.48	2.14	0.40	0.76

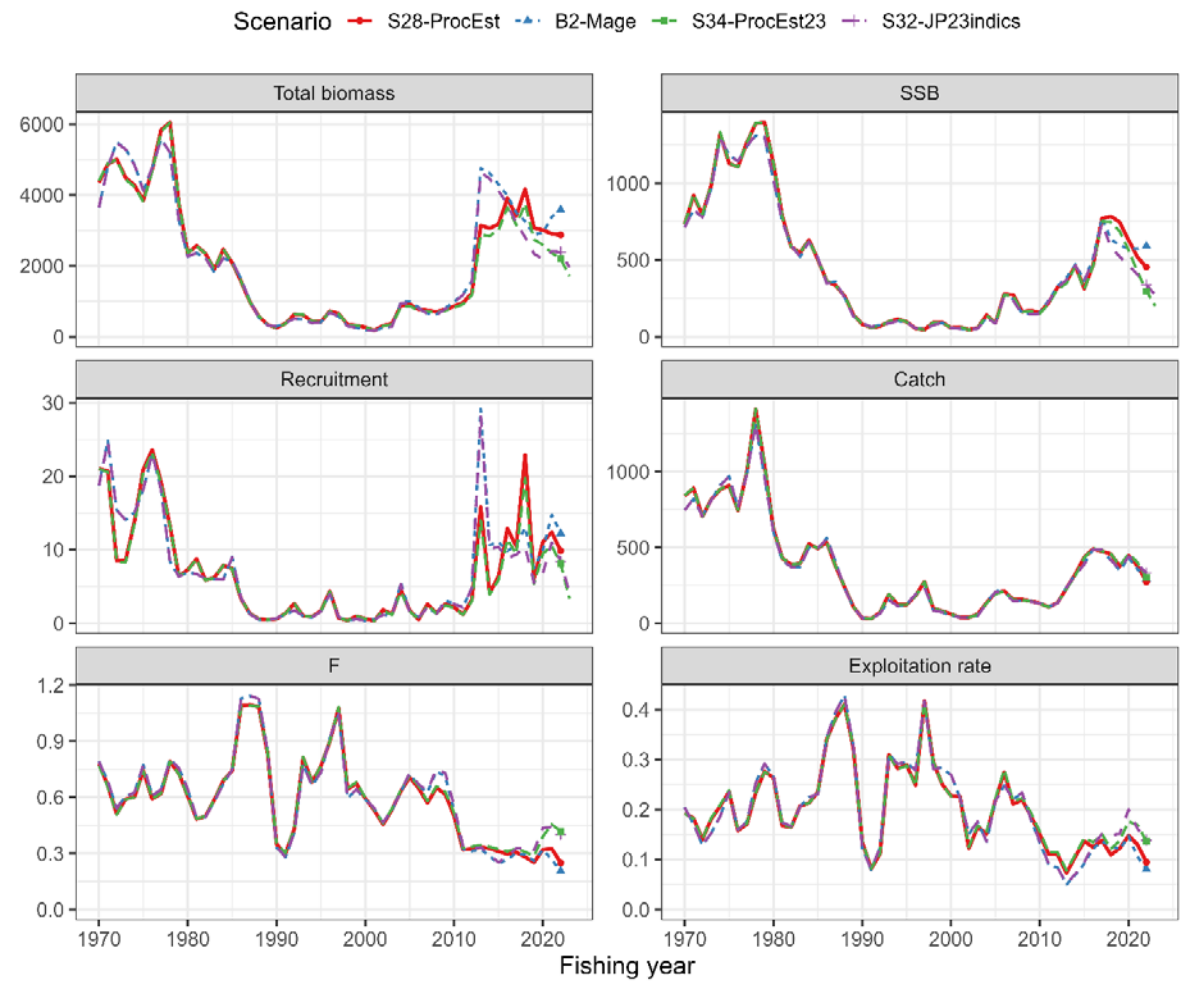

Figure 7. Time series of estimates of total biomass (thousand mt), SSB (thousand mt), recruitment (billion fish), catch (thousand mt), mean fishing mortality (F) and exploitation rate (catch divided by total biomass) under the four representative scenarios. S28-ProcEst was selected as the base case scenario.

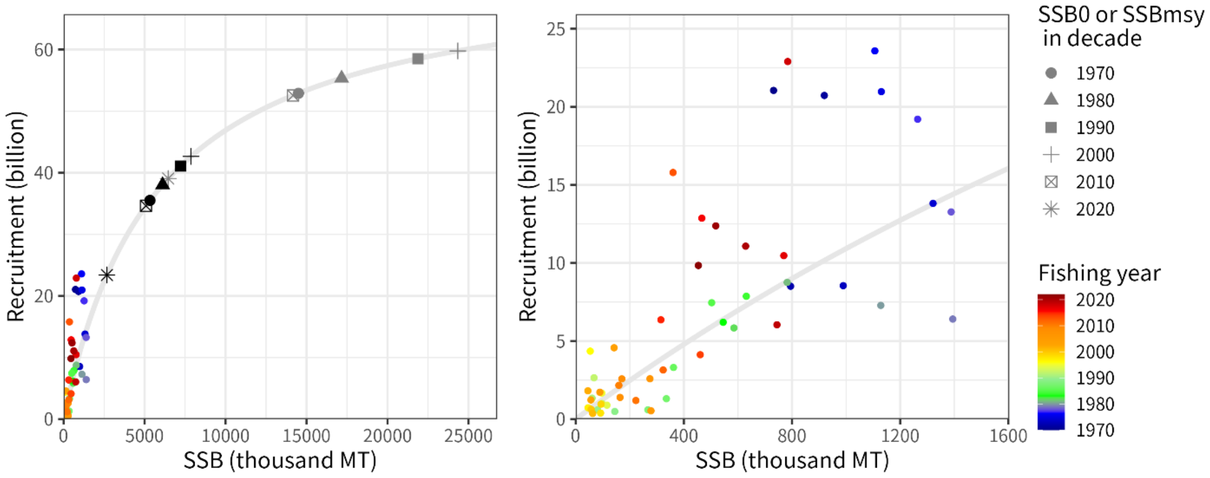

Figure 8. Estimated stock-recruitment curve (gray lines) and estimated SSB and number of recruits (colored circles). Although both figures are same, in the left figure, estimated SSB0 (equilibrium spawning biomass without fishing, gray symbols) and SSB_{MSY} (black symbols) by decade are overlapped. The reference points are calculated using biological parameters averaged during the decades. The right panel also shows estimated recruitment and SSB by year along with the estimated stock recruitment curve.

Total biomass, Spawning Stock Biomass

The time series of estimated chub mackerel total biomass and SSB from the base case model used to inform managers generally declined from the 1970s through the 1990s and the stock began to recover in the early 2000s, peaking in FY2018, after which it has generally declined over the last decade (total biomass and SSB are shown in Figure 7 and Table 2). The level of SSB in the 1970s was estimated to be approximately 1,104 thousand mt on average. SSB for FY2022 is estimated to be 450 thousand mt for the base case but varies from 300 thousand to 590 thousand mt among the sensitivity cases.

Recruitment

Time series of estimated recruitment (age-0, billions of fish) abundance is presented in Figure 7 and summary values in Table 2 for the base model. The level of recruitment in the 1970s was estimated to be high (~16 billion individuals on average) and that in the most recent decade (FY2013-FY2022) was also high (=11 billion on average).

Stock-recruitment relationship

Although the estimated stock recruitment relationship has not changed over time, the estimated average by decade of the SSB0 (equilibrium spawning biomass without fishing, blue symbols) and SSB_{MSY} (red symbols) are varied and decreased to the lowest points of the time series owing to the changes of biological parameters (Figure 8).

Exploitation status

Estimated rates of exploitation (fishing year catch/fishing year total biomass) time series generally fluctuated between 5 and 20% and followed the estimated Fs over time, with annual removal rates that ranged from roughly 10 to 30% over the modeled timeframe (Figure 7), with some larger annual removals in excess of 40%.

Harvest Recommendations

Given the uncertainty in biological parameters in future, which have a large impact on the projection results, the TWG CMSA considers it is not appropriate to provide long-term harvesting recommendations at this time. A short-term (towards FY2028) projection was undertaken to assess the effects of varying catch levels, ranging from 50 to 400 thousand tons, based on the most recent seven years' biological data (Figure 9) and the entire time series of biological data (Figure 10) for management considerations. Projections based on the most recent seven years' biological data showed that Fcur leads to future constant decline of SSB and it is necessary to reduce current fishing mortality (Table 3).

Data and Research needs

The assessment results, including projections, are dependent on biological parameters and processes which are uncertain. Therefore, future studies should be focused on collecting and analyzing biological information, e.g., maturity-at-age, weight-at-age, which would improve the assessment. Fisheries-dependent data, such as fleet-specific catch-at-age, are also critical to develop Member-specific fishing fleet and age-specific abundance indices.

A critically important recommendation that should be carried out in 2-3 years is to develop a harvest control rule (HCR) specific to this stock via a Management Strategy Evaluation (MSE) process. This HCR should be dynamic and able to adjust annual total catches depending on the stock abundance as well as the target and limit reference points. During the process of the development of MSE, uncertainties in parameter estimates, time-varying or density-dependent biological parameters, and stock-recruitment assumptions should be considered.

Timely collection of biological information and further research on biological parameters and processes, including the effect of environment and climate change, are critically important to facilitate the accurate estimation of reference points.

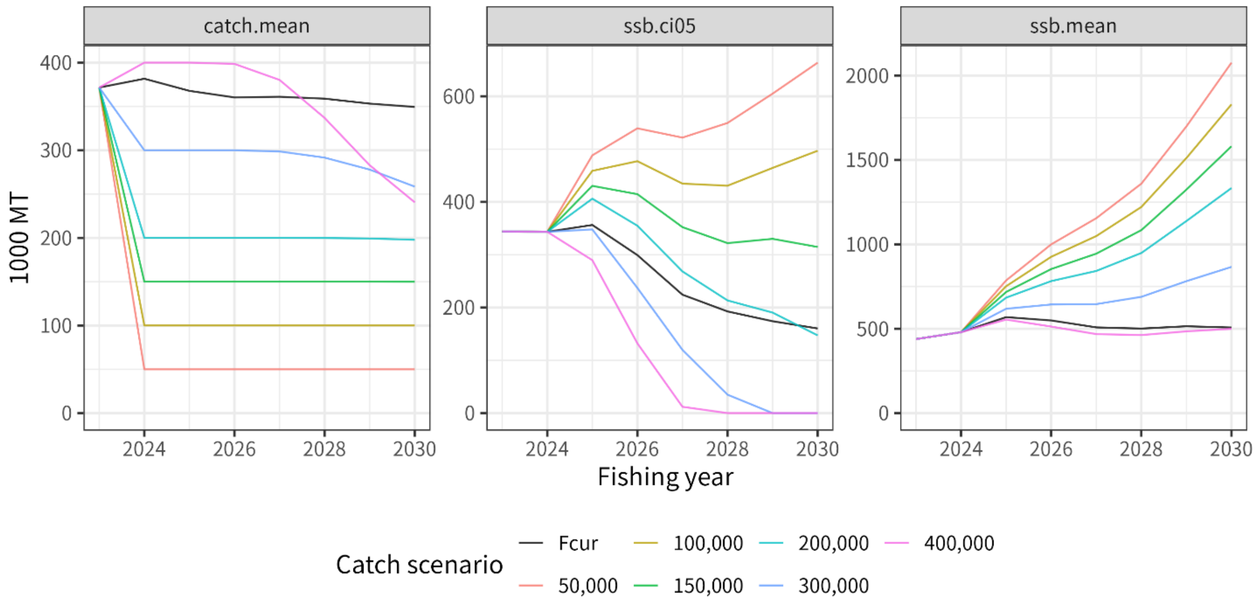

Figure 9. Future trajectories of mean catch(left), 5% lower limit of predictive interval for SSB (middle) and mean SSB (right) with mean biological parameters in recent 7 years. Numbers and “Fcur” in “Catch scenarios” indicate total amount of catches (mt) in constant catch scenario and current fishing morality, respectively.

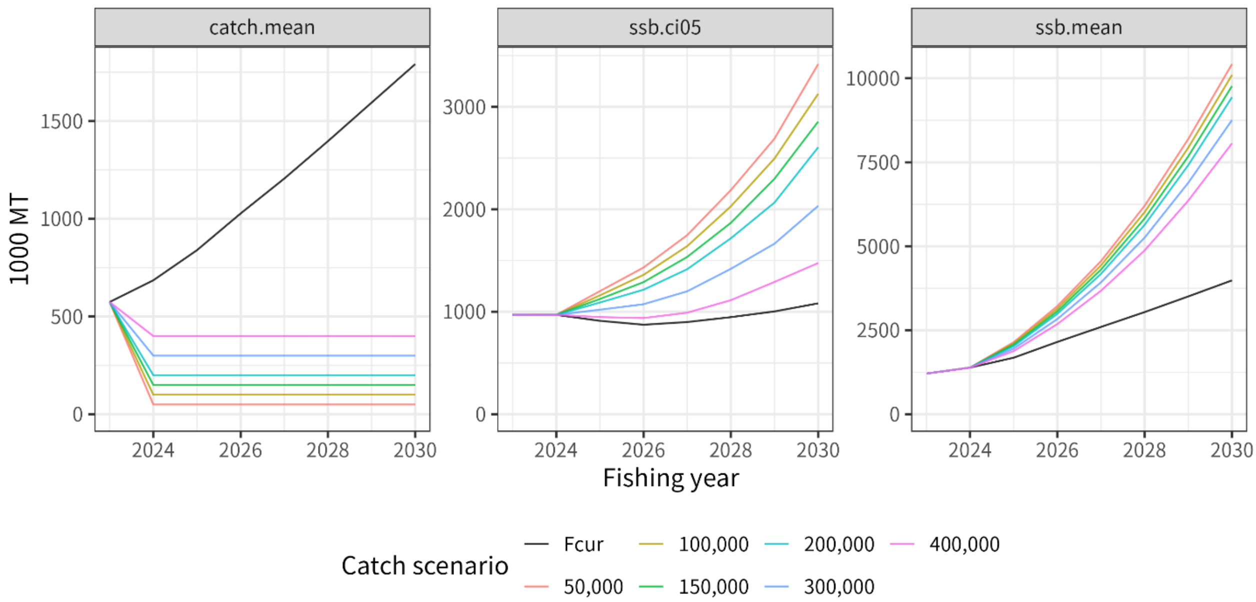

Figure 10. Future trajectories of mean catch (left), 5% lower limit of predictive interval for SSB (middle) and mean SSB (right) with mean biological parameters for the entire time series. Numbers and “Fcur” in “Catch scenarios” indicate total amount of catches (mt) in constant catch scenario and current fishing morality, respectively.

Table 3. Probability that future SSB on July 1, at the beginning of the fishing year, is above latest (FY2022) SSB under the base case scenario. The projection towards FY2028 is shown below.

Catch level	FY2025	FY2026	FY2027	FY2028
Fcur	76	64	48	44
50	97	99	98	98
100	96	96	94	94
150	93	92	88	88
200	89	87	80	78
300	79	70	58	56
400	66	49	38	36

Annex G

Timeline and intersessional activities before the TWG CMSA10 meeting

<table>
<tr><th colspan="2">Month</th><th>SA report</th><th>Catch@Age</th><th>Weight@Age</th><th>Maturity@Age</th><th>Abundance indices</th><th>SAM/Future projection</th></tr>
<tr><td rowspan="3">Aug</td><td>Early</td><td rowspan="7">Email communication</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Late</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Sep</td><td>Early</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Late</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Oct</td><td>Early</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td colspan="6" rowspan="2">One/two-day(s) intersessional meeting (Finalization and adoption of SA report; Discussion on rescheduling TWG CMSA meetings to reflect the latest information)</td></tr>
<tr><td>Late</td></tr>
<tr><td rowspan="3">Nov</td><td>Early</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Late</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Dec</td><td>Early</td><td colspan="6"></td></tr>
<tr><td>Mid</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>17-20</td><td colspan="6">SC09 (SSC BFME 9-11 Dec; SSC PS Dec 11-16)</td></tr>
<tr><td>Late</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Jan</td><td>Early</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td></td><td>Submit CAL and CAA up to 2nd quarter 2024 by 10 Nov</td><td>Submit WAA up to 2nd quarter 2024 by 10 Nov</td><td>Submit MAA up to 2nd quarter 2024 by 10 Nov</td><td>Submit updated standardized abundance indices up to FY2023 (FY2024 if possible)</td><td></td></tr>
<tr><td>Late</td><td colspan="6">Working paper due</td></tr>
<tr><td rowspan="3">Feb</td><td>Early</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mid</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>17-20</td><td colspan="6">TWG CMSA10</td></tr>
</table>

Annex H

Species summary for chub mackerel

Chub mackerel (*Scomber japonicus*)

Common names:

鲐鱼, Taiyu (China)

マサバ, Masaba (Japan)

고등어, Godeungeo (Korea)

Японская скумбрия, Yaponskaya skumbriya (Russia)

白腹鯖, Bai-Fu-Qing (Chinese Taipei)

Management

Active NPFC Management Measures

The following NPFC conservation and management measure (CMM) pertains to this species:

- CMM 2024-07 For Chub Mackerel

Available from https://www.npfc.int/cmm-2024-07-chub-mackerel

Management Summary

The current conservation and management measure (CMM) for Chub mackerel specifies catch limits. The CMM states that Members and Cooperating non-Contracting Parties currently harvesting Chub mackerel should refrain from expansion of the number of fishing vessels authorized to fish Chub mackerel in the Convention Area.

Additionally, the Commission established the annual total allowable catch of chub mackerel in the Convention Area as a provisional measure until the Scientific Committee adopts NPFC stock assessment of chub mackerel and the Commission accordingly revises this CMM. The annual total allowable catch of chub mackerel in the Convention Area, excluding the amount in paragraph 11, shall be set at 94,000 tons for each of the 2024 and 2025 fishing seasons. Of this annual total allowable catch, the catch for trawlers shall not exceed 14,000 tons and the catch for purse seiners shall not exceed 80,000 tons for each of the 2024 and 2025 fishing seasons. China shall not authorize more than 3 trawlers and the EU shall not authorize more than 1 trawler to conduct fishing operations at the same time. In addition to the above fishing opportunities, the EU shall be entitled to fish an additional 6,000 tons of chub mackerel for each of the 2024 and 2025 fishing seasons.

To comply with this provisional measure, Members of the Commission shall report to the Executive Secretary, in electronic format, their monthly catches of chub mackerel in the Convention Area.

Convention/Management Principle	Status	Comment/Consideration
Biological reference point(s)	●	The TWG CMSA agreed to base its future discussions on the following candidate biological reference points: (a) F-based reference points i. F_{MSY} ii. $F_{\%SPR}$ iii. $F_{0.1}$, F_{max} (b) Biomass-based reference points (including SSB, summary biomass, etc.) i. B_{MSY} ii. $\%B_0$ iii. Certain historical level of B
Stock status	○	Status determination criteria not established.

Catch limit		100,000 mt for CA
Harvest control rule		Not established.
Other		Encouragement to refrain from expansion, in the Convention Area, of the number of fishing vessels.

OK Intermediate Not accomplished Unknown

Assessment

The Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA) completed the first stock assessment at its 9th meeting in July 2024. A State-space Stock Assessment Model (SAM) was used for the stock assessment. China, Japan and Russia submitted age-specific input data and abundance indices up to the 2022 fishing year (June 2023) for the base case scenario. The TWG agreed on the stock assessment results (see TWG CMSA09 report for details).

Japan annually conducts an assessment on the Pacific stock of Chub mackerel using tuned VPA (Yukami et al. 2024).

Data

Surveys

China has been conducting a five-year scientific survey program using its fishery research vessel "Song Hang" with mid-trawl as the main survey gear in the NPFC convention area from 2021 to 2025 (Ma et al. 2023).

Japan annually conducts two mid-water trawls surveys in summer (2001-2024) and autumn (1995-2023) that serve information on recruitment abundance indices of age-0 fish to the Japanese domestic stock assessment of the Pacific stock of Chub mackerel (Table 1) (Yukami et al. 2024). The autumn mid-water trawl survey also provides age-1 fish abundance indices for the stock assessment. Japan also conducts a year-round egg survey providing egg density as index of spawning stock biomass for the stock assessment. The survey protocol can be found at Oozeki et al. (2007).

Russia has conducted a summertime acoustic-trawl survey since 2010 that examines mid-water and upper epipelagic species including Chub mackerel.

Fishery

China, Japan and Russia catch Chub mackerel (Figure 1). China harvests this species dominantly by light purse seine fishery in the NPFC Convention Area. A smaller component of the catch is taken by pelagic trawl. Chinese catch statistics on mackerels in the NPFC Convention Area are available from 2015. The Chinese mackerel fisheries in the NPFC Convention Area initiated in 2014 mainly caught the three fish species such as Chub mackerel, blue mackerel, and Japanese sardine (Zhang et al. 2023). Blue mackerel catch accounts for 6% to 15.2%, about 10% on average, in the mackerels catch up to 2021. In 2022, the proportion increased to 22.5%.

Japan's fishery for Chub mackerel occurs inside their Exclusive Economic Zone (EEZ) and is mostly conducted by large purse seine vessels (≥50% of the catch). Additional components of the fishery include set nets, dip nets and other gears. Proportion of Chub mackerel catch in mackerels catch is obtained through extensive port sampling. The Chub mackerel catch accounts for 69% to 91%, 84% on average, of the mackerels catch in 2014-2023.

The Russian fisheries catching mackerels are operated in their EEZ and is prosecuted primarily by mid-water trawling (>90% of the catch), with a smaller component of the catch coming from purse seiners and bottom trawlers. The Russian mackerels catch, comprising approximately 100% of Chub mackerel, are available in the NPFC Annual Summary Footprint since 2014.

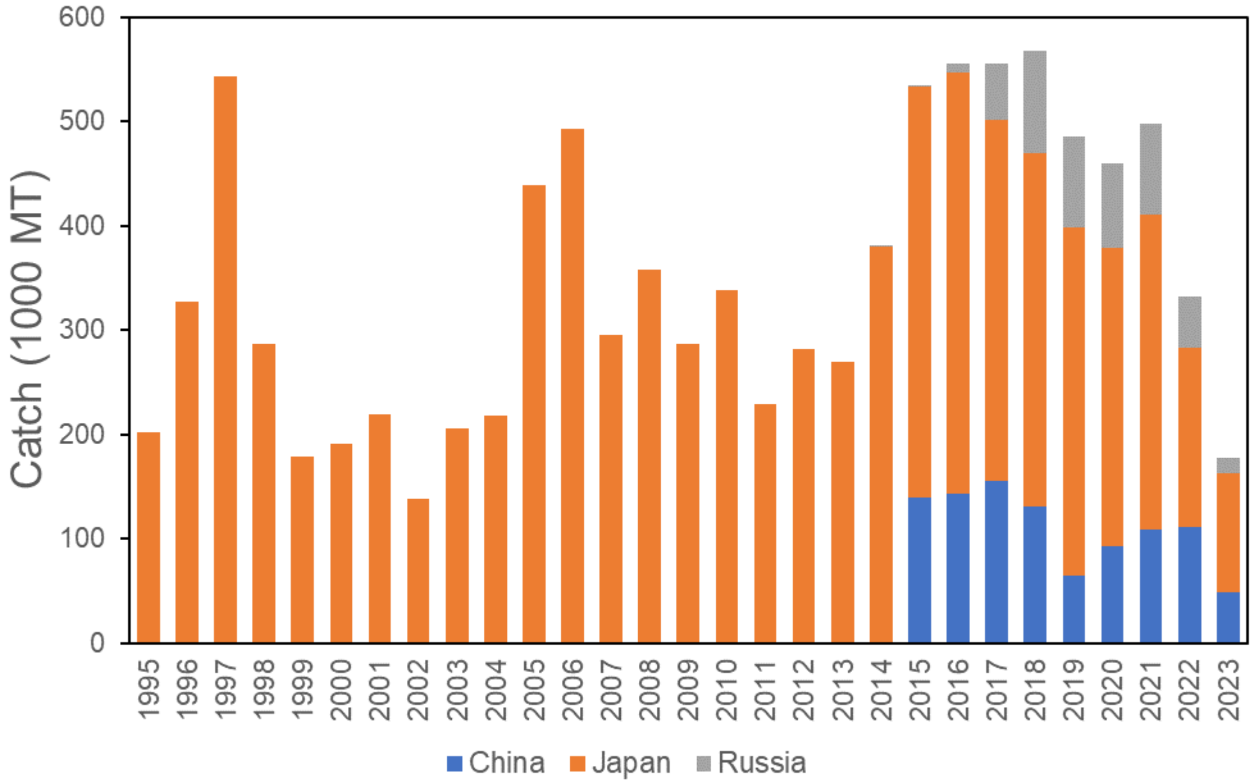

Figure 1. Historical catch of mackerels obtained from annual summery footprint of Chub and Blue mackerels.

Other NPFC Members (Canada, EU, Korea, Chinese Taipei, USA and Vanuatu) do not have Chub mackerel catch records in the NPFC Convention Area.

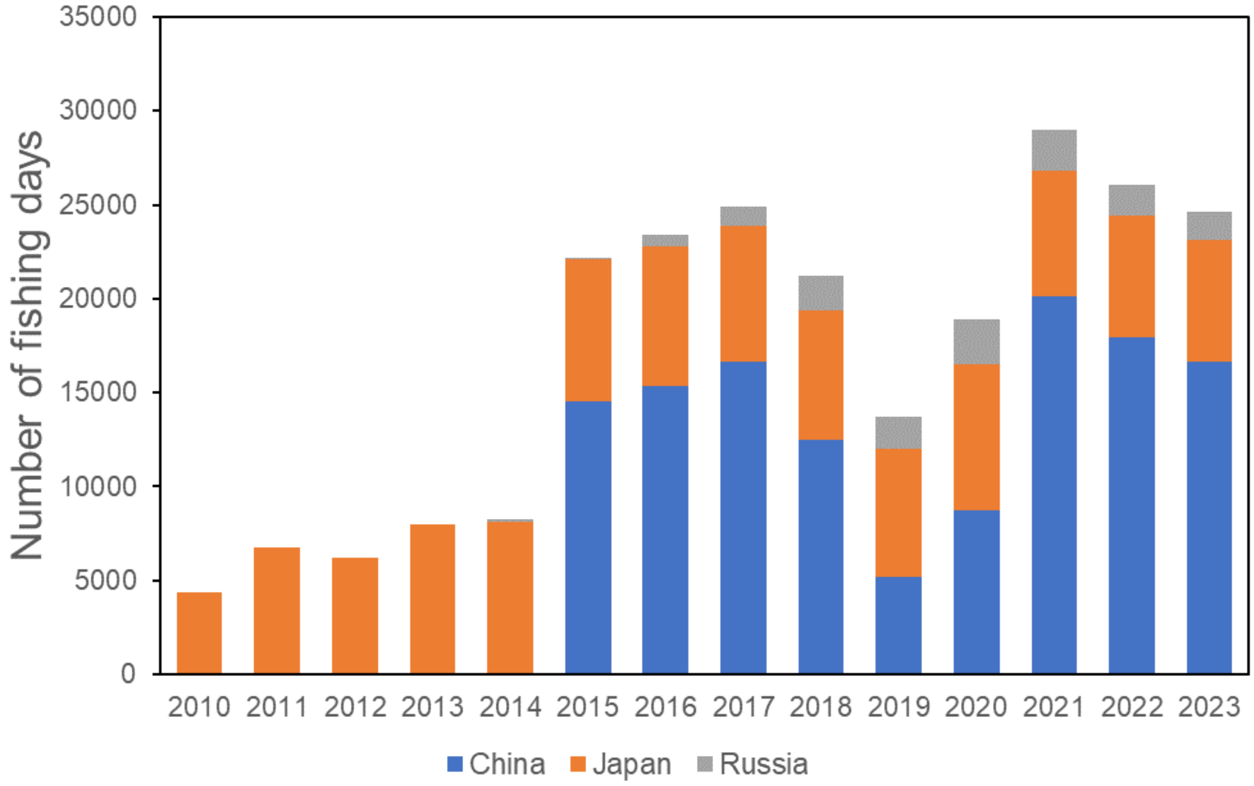

Figure 2. Historical fishing effort for mackerels obtained from annual summary footprint of Chub and Blue mackerels.

Biological collections

China has collected length frequency data of commercial catch through onboard and port samplings since 2016. Aging of the samples has been started since 2017.

Japan also collects length, weight, maturity and age data from the survey and fishery to support their stock assessment.

Russian length frequency and aging data of commercial catch are available since 2016. The length frequency data obtained through research surveys are available since 2010.

Table 1: Data availability from Members regarding Chub mackerel.

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 Dip net fishery Set net	Official statistics, reports from fisheries associations and markets	Official statistics: 1950-2023, other reports: 1970-2023	Coverage=100%	The Chub mackerel catches are estimated from Chub and blue mackerel catches based on port sampling data for purse seine and set net fisheries. No detailed information of the ratio is presented.
Size composition data				
Length measurements	Port sampling by 17 local fishery institutes in 17 prefectures	1970-2023	20,000-120,000 (average 40,000) fish/year (ca. 100 measurements per sampling)	Detailed information in NPFC-2020-TWG CMSA03-WP02.
Aging	Port sampling by 17 local fishery institutes in 17 prefectures	1970-2023	500-1000 fish/year	Detailed information in NPFC-2020-TWG CMSA03-WP02.
Catch at age (CAA)	Estimate CAA from the above data	1970-2023	Age-length keys are created approximately by quarter and local regions	Evaluate uncertainty of catch at age; Changes of growth depending on recruitment abundance is

				reviewed in NPFC-2022-TWG CMSA05-IP06 and published as Kamimura et al (2022, https://doi.org/10.1093/icesjms/fsab191)
Abundance indices (survey)				
Spring survey for recruitment	Mainly for sardine and Chub mackerel of pre-recruits. This research is conducted for biological research of early life history. Mid-water trawl	1995-2023	30-60 stations/year	Too early for the use of abundance index
Summer survey for recruitment	Mainly for saury, mid-water trawl	2001-2023	60-80 stations/year	Detailed information on data and standardization is in NPFC-2022-TWG CMSA06-WP11 (Rev.1). Detailed sampling design and method are shown in Hashimoto et al. (2020, https://doi.org/10.1007/s12562-020-01407-3).
Autumn survey for recruitment and age 1 fish	Mainly for sardine and Chub mackerel, mid-water trawl	1995-2023	30-60 stations/year	Detailed information on data and standardization for recruitment is in NPFC-2022-TWG CMSA06-WP11 (Rev.1). That for

				age 1 has not been presented.
Year-round for egg density	Almost all local fishery institutes join this survey program. NORPAC net. Not only for Chub mackerel.	1978-2023 (2005-, species identification between Chub and blue mackerel)	ca. 6000 stations in total, 1000-4000 stations with Chub mackerel eggs/year	Detailed information on data and standardization is in NPFC-2022-TWG CMSA06-WP10
Abundance indices (commercial)				
Dip net fishery	Log book data are collected from fishermen in Kanagawa prefecture since 2003 and Shizuoka prefecture since 2013 (ca. 10 and 90% of total dip net catch in 2017, respectively)	2003-2023	10-100/year	Detailed information on its data and standardization is in NPFC-2022-TWG CMSA06-WP09
RUSSIA				
Catch statistics				
Purse seine fishery	Official statistics, reports from fisheries associations	Official statistics: 1980-1993, 2015-2023, 1994-2014 (no data available); publications: 1970-2023	Coverage 1980-1993 ?%; Coverage 2015-2023 =100%	Data coverage details to be reviewed
Pelagic trawl fishery				
Size composition data				
Length measurements	Sampling from commercial fishing vessels. Sampling during research surveys.	2016-2023 2010-2023	1,000-10,000 fish/year (ca. 100 measurements per sampling)	Data coverage details to be reviewed
Aging	Sampling during	2016-2023	300-500	Details to be

	research surveys and from commercial fishing vessels		fish/year	reviewed
Catch at age (CAA)	Estimate CAA from the above data	2016-2023	Age-length keys are to be developed	Evaluate uncertainty of catch at age, especially on changes of growth depending on recruitment abundance
Abundance indices (survey)				
Summer trawl and acoustic (echointegration) surveys to assess pelagic fish abundance and recruitment	Mid-water upper epipelagic surveys	2010-2023 (June-July) 2015-2023 (July-September)	60-80 stations/year 60-80 stations/year	Changes in abundance and migration patterns; development survey protocol and conduct standardization
Abundance indices (fishery)				
Daily reports of catch by each vessel	Target (>50%) Mid-water trawls	2015-2023 May-December		Test the effect of targeting
CHINA				
Catch statistics				
Purse seine fishery	Official statistics, reports from annual report	Official statistics：2014-2023	Coverage=100%	The Chub mackerel catches are from the fishing catch provided by the fishery company
Trawl fishery	Official statistics, reports from annual report	Official statistics: 2014-2023	Coverage=100%	Catches are from the fishing catch provided by the fishery company
Size composition data				
Length	Port sampling by	2016-2022	550-800	Details to be

measurements	Institute and technology group.		fish/year	reviewed
Length measurements	Purse seine vessel sampling from commercial vessel	2016-2022	530-1050 fish/year	Details to be reviewed
Aging	Sampling during research surveys and from commercial fishing vessels	2017-2022	30-180 fish/year	Details to be reviewed
Abundance indices (commercial)				
Purse seine fishery	Purse seine logbook (Technical group for Chub mackerel Fishery, Distant-water Fishery Society of China)	2014-2022 April-December	10-105/year	Review survey protocol and conduct standardization

Special Comments

None

Biological Information

Distribution

The Pacific stock of Chub mackerel is distributed from the southern coastal waters on the Pacific side of Japan to offshore area off the Kuril Islands (Figure 3). This stock corresponding to straddling one is harvested in both national waters of Japan and Russia and the NPFC Convention Area. Adult fish spawn in Izu Islands waters in spring and then engage northward feeding migration to waters of Sanriku to east Hokkaido from summer to autumn.

Life history

Longevity of Chub mackerel is estimated to be 7 or 8 years old. There was the oldest record of 11 years old. It is known that growth of this stock could be changed according to recruitment abundance and oceanic environment (Watanabe and Yatsu 2004). Recent decrease in mean weight by age was highly likely induced by feeding competition in conjunction with intra-/inter-specific increase of density resulted from biomass increases of Chub mackerel and Japanese sardine (Kamimura et al. 2021). Adult female spawns more than once during a spawning season. Maturity at age was changed depending on changes in growth (Watanabe and Yatsu 2006).

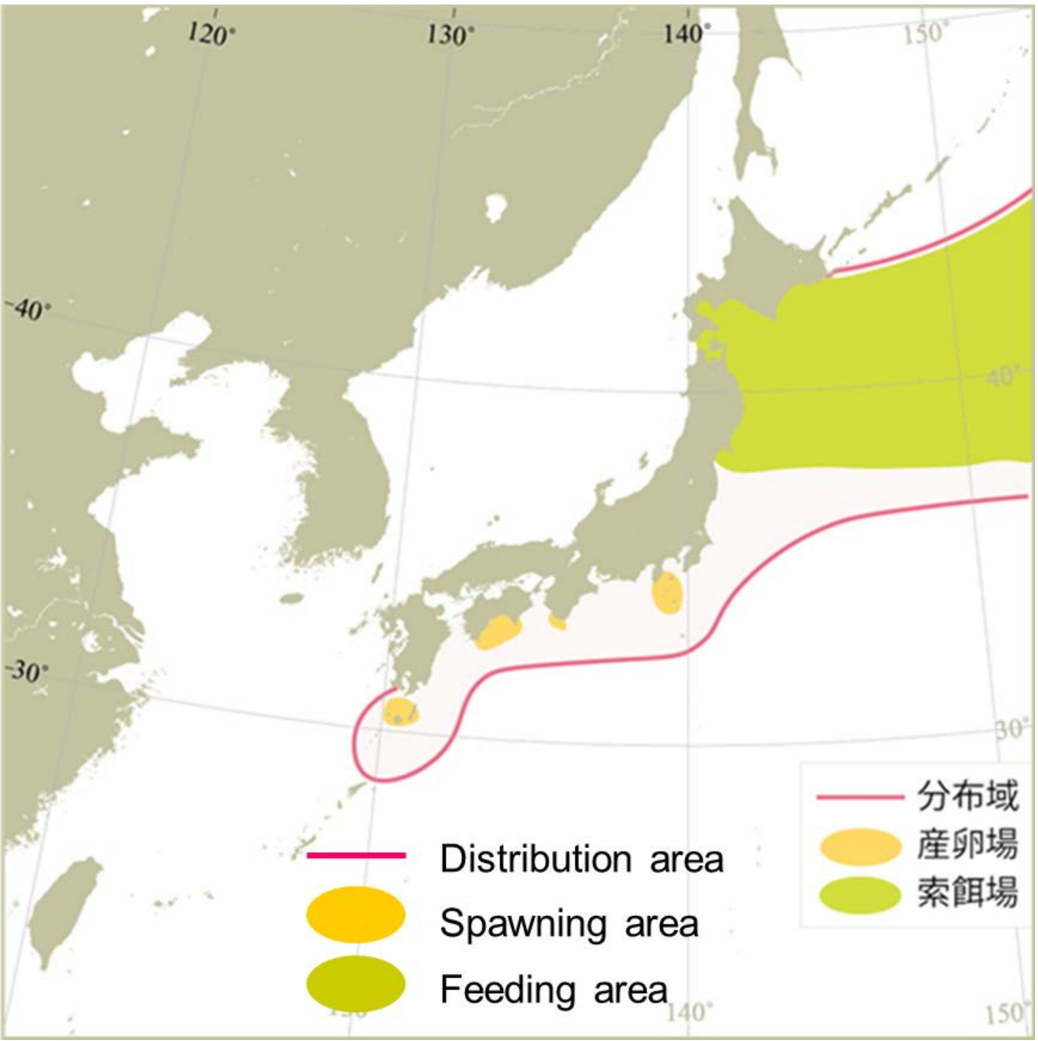

Figure 3. Map of distribution of Chub mackerel in the North Pacific (Yukami et al. 2024).

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