North Pacific Fisheries Commission

6th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

REPORT

5 - 8 September 2022

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North Pacific Fisheries Commission
6th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment

5 - 8 September 2022
WebEx

REPORT

Agenda Item 1. Opening of the Meeting

1. The 6th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA) of the North Pacific Fisheries Commission (NPFC) took place in the format of video conferencing via WebEx, and was attended by Members from Canada, China, the European Union (EU), Japan, and the Russian Federation. An invited expert, Dr. Joel Rice, participated in the meeting.

2. The meeting was opened by the TWG CMSA Vice Chair, Dr. Kazuhiro Oshima (Japan), who chaired the meeting on behalf of the TWG CMSA Chair, Dr. Vladimir Kulik (Russia), who was unable to attend the meeting. The Science Manager, Dr. Aleksandr Zavolokin, outlined the procedures for the meeting. Mr. Alex Meyer was selected as rapporteur.

Agenda Item 2. Adoption of Agenda

3. The TWG CMSA agreed to add a new agenda item, Agenda Item 9.3 Selection of Chair and vice-Chair, to the provisional agenda.

4. The revised provisional 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 5th TWG CMSA

5. The Vice Chair provided an overview of the 5th TWG CMSA meeting and its recommendations.

3.2 Intersessional meetings of SWG OM

6. The Lead of the Small Working Group on Operating Model (SWG OM), Dr. Shota Nishijima (Japan), provided a brief overview of the discussions of the 3rd and 4th intersessional meetings

of the SWG OM. He provided more details under agenda 4.1.

7. The Science Manager presented the outcomes and recommendations from the 1st meeting of the joint SC-TCC-COM Small Working Group on Management Strategy Evaluation for Pacific saury (SWG MSE PS01).

Agenda Item 4. Stock assessment model for chub mackerel

4.1 Progress of the intersessional works

8. The SWG OM Lead provided a detailed summary of the progress made in the intersessional period, including in the SWG OM03 (NPFC-2022-TWG CMSA06-WP06) and SWG OM04 (NPFC-2022-TWG CMSA06-WP07) meetings. The SWG OM has revised the pseudo data, distributed a new version of the OMutility package and continued to improve it, and conducted the calculations of performance measures for the candidate models.

9. The SWG OM Lead presented a list of errors/problems in the work conducted so far for correction and improvement by the TWG CMSA. The pseudo data used by KAFKA were not the most recently updated data, and therefore the results presented for the KAFKA model should not be evaluated at this stage. To progress the analysis, Russia will submit estimates using the correct pseudo data by 25 September. The invited expert noted that if results from any model are not received by 1 November 2022, then those results cannot be evaluated and presented in accordance with the schedule.

10. China and Japan shared the latest input and output data to/from the newest version of OMutility for all their models for cross-checking via the NPFC Collaboration site. Russia is requested to do the same when the results are available.

4.2 Data generation by PopSim as input to the candidate stock assessment models

11. The invited expert reported the results of the re-estimation of the pseudo data using PopSim as input to the candidate stock assessment models. The re-estimation was conducted based on various technical improvements suggested by the SWG OM. The outputs from the BSSPM model have different interpretation because the BSSPM could not be used as a data generation model and therefore cannot be evaluated in the 'self-test'. BSSPM could return the performance measures of total biomass, exploitation ratio and depletion statistics, which were not identical with those from the age-structured stock assessment models.

12. China asked Members whether Mohn's rho in the retrospective analysis needed to be calculated using OMutility. Japan suggested using OMutility because the weighted average F is not outputted within ASAP and performance measures should be standardized among Members.

4.3 Report on the performance of the candidate stock assessment models and options to rank them

13. China presented the results of fitting ASAP to pseudo data and performance measures for the chub mackerel operating model (NPFC-2022-TWG CMSA06-WP12).

14. China presented the results of fitting BSSPM to pseudo data and performance measures for the chub mackerel operating model (NPFC-2022-TWG CMSA06-WP13).

15. Japan presented a calculation of performance measures by fitting VPA and SAM to pseudo data for chub mackerel in Northwestern Pacific (NPFC-2022-TWG CMSA06-WP08 (Rev. 1)).

16. The invited expert presented the results of the self- and cross-tests for ASAP, SAM, VPA, and KAFKA. Regarding KAFKA, he explained that the results were only being shown for illustrative purposes and should not be considered because they were calculated using old data. Regarding BSSPM, he explained that, due to the nature of the model, cross-tests could, to some extent, be conducted, but not a self-test. The invited expert invited the TWG CMSA to consider the results and to decide on the scenarios on which to base the performance measures, the priority performance measures, and the parameterizations of the performance metrics.

17. Japan presented a simple comparison between the estimated and true parameters of performance measures and metrics for ASAP, SAM and VPA to produce a rough overview of each estimation model's characteristics. Based on the results, Japan suggested that performance measures related to MSY (B_{MSY} and F_{MSY}) could be given a lower priority because their estimates become unstable depending on the assumption of the stock-recruitment relationship.

18. Japan presented a summary of the performance metrics in self-tests and cross-tests of ASAP, SAM and VPA. Based on the results, Japan suggested that SAM showed the best prediction ability based on calculations of the simple geometric mean of median absolute error (MAE), and that different weighting of performance measures will be possible.

19. China expressed its appreciation for the work done by Japan but pointed out that in order for the TWG CMSA to be able to fully consider the results, this information should be submitted in the form of formal papers.

20. Regarding the scenarios on which to base the performance measures, the invited expert recommended selecting one, or at most two scenarios, potentially A and B. Comprehensive review of scenarios C-F is encouraged to inform the relative consistency of models across scenarios. Because the TWG CMSA was unable to determine which scenario would be more

appropriate, it agreed to use Scenarios A and B as the base cases with each being given equal weight.

21. The TWG CMSA held discussions on the prioritization of performance measures and formulated a preliminary list of performance measures prioritized by tier. The TWG CMSA agreed to continue to work intersessionally towards finalizing the list.

22. The TWG CMSA agreed that, apart from KAFKA, the testing of the candidate stock assessment models using the pseudo data is complete and that analysis of the results of the testing is possible.

4.4 Ranking of the candidate stock assessment models

23. The TWG CMSA agreed that none of the candidate stock assessment models outperformed all the others for all scenarios and across all performance measures, so it needs to select the model that performs best among the candidates. The invited expert noted that a tiered approach to ranking candidate performance measures was presented at the SWG OM04 and was re-presented in this TWG CMSA06 meeting. To facilitate an objective ranking of candidate stock assessment models, the invited expert urged the group to select priority performance measures and metrics to facilitate the selection of the stock assessment model.

24. The invited expert suggested that the SAM model may be the best of the candidate models because of the low relative bias in the results, which was supported by Japan. However, some Members did not agree that the SAM model was the best and pointed out that there are still issues with it that need to be further considered.

25. The TWG CMSA agreed that the KAFKA model could not be ranked as its results were not yet available.

26. The TWG CMSA held initial discussions on a format for summarizing the quantitative and qualitative aspects of the candidate models. The TWG CMSA agreed to work intersessionally to finalize the format for the qualitative aspects by November 2022.

4.5 Selection of the model for chub mackerel stock assessment

27. Japan considered that it is possible to select the best-performing model as scheduled based on the available information and recommendation provided by the invited expert. However, some other Members considered that further analysis of the results is necessary to reach the conclusion. The TWG CMSA was unable to reach consensus on the selection of a model for the chub mackerel stock assessment and agreed to continue analyses and discussions of the test.

For doing so, it was agreed to conduct intersessional work to select priority performance measures and performance metrics for more structured comparison of the candidate models.

28. The TWG CMSA agreed to select one base stock assessment model, while recognizing that, if appropriate, an ensemble approach could be taken, whereby multiple versions of the same base stock assessment model, e.g., with different assumptions or specifications, could be used to conduct the stock assessment.

29. The TWG CMSA agreed that the selection of the base stock assessment model does not preclude the development and consideration of other potential stock assessment models in the future. If another potential stock assessment model is demonstrated to outperform the initial stock assessment model, the new model could be used in combination with or replace the initial model.

4.6 Recommendations and timelines for future work

30. The TWG CMSA drafted a timeline of tasks leading up to the TWG CMSA07 meeting (Annex D).

Agenda Item 5. Development of data for the stock assessment of chub mackerel

5.1 Research activities and review of biological parameters

31. No new information was presented.

5.2 Review of fishery (catch-at-age, weight-at-age, maturity-at-age, if possible) data based on a quarterly calendar

32. China presented its chub mackerel fishery data based on a quarterly calendar (NPFC-2022-TWG CMSA06-WP03 (Rev. 1)). The data consist of quarterly catch-at-age, weight-at-age and maturity-at-age for 2018 to 2021.

33. Japan presented its chub mackerel fishery data based on a quarterly calendar (NPFC-2022-TWG CMSA06-WP02). The data consist of quarterly catch-at-age and weight-at-age from 2010 to 2020 and quarterly maturity-at-age from 2006 to 2020. Japan explained that due to the current data availability, it could only reproduce quarterly catch-at-age and weight-at-age data on a fishing year basis (July to June of the following year) since 2010. Japan also pointed out that catch-at-age and weight-at-age can change significantly depending on when age is incremented, so it is important for the TWG CMSA to clarify how this should be done.

34. Russia informed the TWG CMSA that it is currently preparing its quarterly fishery data for 2016 to 2021. The preliminary data have been prepared and are currently being checked. Catch

generally occurs in Q2 to Q4, with the maximum catch in Q4. The age determination is conducted using an age-length key developed by Japan.

35. Japan presented a plot comparing the quarterly weight-at-age data from China and Japan. Japan pointed out that there is a large gap between China's and Japan's weight data for ages 0 to 3. Japan further explained that, if the age of China's weight-at-age data for each age-class is reduced by 1, the data seem to match Japan's data. Japan suggested that this indicates that the difference may be due to the different date that Japan and China use to increment age (Japan: July 1; China: January 1). Russia also pointed out the importance of using the same approach to determine when age is incremented.

5.3 Updates and improvements to the standardized abundance indices and other data for use in the stock assessment

36. China presented a standardization of CPUE data for chub mackerel from 2014 to 2020 (NPFC-2022-TWG CMSA06-WP14) using a generalized linear model (GLM) and a generalized additive model (GAM). China recommended using the standardized CPUE derived from GAM as input for the stock assessment.

37. The TWG CMSA reminded all Members that it is important that they follow the CPUE Standardization Protocol for Chub Mackerel when next updating their CPUE standardizations.

38. The TWG CMSA discussed methods for extracting the yearly standardized CPUE and evaluating the associated uncertainty. The TWG CMSA agreed that Members could correspond via email to determine how to extract the yearly standardized CPUE prior to the next TWG CMSA meeting to be held in spring 2023.

39. The TWG CMSA discussed the method by which China extracts chub mackerel data from aggregated mackerel (i.e., blue mackerel and chub mackerel) data. China explained that it has calculated the annual proportions of blue mackerel and chub mackerel catch based on samples taken from its purse seine fishery and that blue mackerel accounts for roughly 6 to 15% of the aggregated mackerel data, but that this information has not been incorporated in the CPUE and catch-at-age data. The TWG CMSA requested China to submit a document on the annual proportion of blue mackerel and chub mackerel catch in order to be able to refer to that information in the data preparation for the chub mackerel stock assessment.

40. Japan presented a standardization of the abundance index for recruitment of chub mackerel from 2002 to 2021 (NPFC-2022-TWG CMSA06-WP11 (Rev. 1)). The year trends of the recruitment indices were derived from standardized CPUE, by applying the delta-GLM-tree

models to the data from surface trawl surveys in summer (June and July; 2002-2021) and autumn (September and October; 2005-2021). Japan recommended using the standardized recruitment survey indices derived from delta-GLM-tree as input for the stock assessment.

41. Japan presented a standardization of CPUE data from the dip-net fishery targeting mature chub mackerel from 2003 to 2021 using delta GLM (NPFC-2022-TWG CMSA06-WP09). Japan recommended using the standardized CPUE derived from this fishery as the abundance index of spawning biomass for the stock assessment.

42. Japan presented a standardization of monthly egg survey data from 2005 to 2021 as an abundance index for spawning stock biomass of chub mackerel using the vector autoregressive spatio-temporal (VAST) model (NPFC-2022-TWG CMSA06-WP10). Japan recommended using the standardized monthly egg survey data derived from VAST as input for the stock assessment.

5.4 Recommendations for future work

43. The TWG CMSA agreed to:
    (a) continue submission and comparison of the quarterly fishery data on schedule (Annex E).
    (b) follow the CPUE Standardization Protocol of the TWG CMSA and standardize how to extract yearly CPUE.
    (c) separate fishery data such as catch-at-age and abundance indices by chub mackerel and blue mackerel.
    (d) hold further discussions on standardizing how to increment chub mackerel age for the stock assessment.

Agenda Item 6. Future projection of chub mackerel

44. The TWG CMSA reviewed the table of possible options for the basic specifications for conducting future projections for chub mackerel agreed to at the TWG CMSA05 meeting. The TWG CMSA agreed that no revisions are currently required.

Agenda Item 7. Biological reference points

7.1 Candidate biological reference points for chub mackerel

45. The invited expert presented a list of candidate biological reference points for chub mackerel using the consultancy report *Review of Target and Limit Reference Points* by Dr. Laurence Kell as reference (NPFC-2022-TWG CMSA06-WP05).

46. Japan presented the general rules used for setting reference points in Japan and the reference

points used for the Japanese domestic chub mackerel stock assessment. Japan explained that domestic stock assessments are categorized based on the level of uncertainty, and reference points are set according to the category. In the case of chub mackerel, the reference points are SB_{MSY} (average spawning biomass when average catch achieves the maximum (MSY) under stochastic projections under constant fishing mortality, selectivity, and assumed stock-recruitment relationship with stochastic deviations), F_{MSY} (fishing mortality coefficient when achieving SB_{MSY}), and $SB_{0.6MSY}$. Japan suggested that the TWG CMSA could apply a similar system as the Japanese one and select reference points after evaluating the uncertainties in the estimation of the reference points.

47. Based on the presentations, the TWG CMSA compiled a table of candidate biological reference points for chub mackerel (Annex F).

Agenda Item 8. Review of the Work Plan of the TWG CMSA

48. The TWG CMSA reviewed and updated the Work Plan of the TWG CMSA (NPFC-2022-TWG CMSA06-WP01 (Rev. 1)).

Agenda Item 9. Other matters

9.1 Timeline and intersessional activities before TWG CMSA07

49. The timeline and intersessional activities before TWG CMSA07 are as described in Annexes D and E.

50. The TWG CMSA expressed its appreciation for the valuable contributions and support of the invited expert. The invited expert agreed to extend the term of his consultancy through the TWG CMSA07 meeting so that he can continue to support the development of the operating model and testing of stock assessment models.

9.2 Observer Program

51. The Science Manager reminded the TWG CMSA that the SC has tasked all its subsidiary bodies, including the TWG CMSA, with reporting the data needs and outlining methods (e.g., human or electronic observers) that could be used to collect the necessary data at SC07 and summarized the relevant discussions from the TWG CMSA05 meeting.

52. The TWG CMSA noted that an observer program might be able to fill potential data gaps, but that observer data do not seem to be highly important to the work of the TWG CMSA. The TWG CMSA noted that the assessment of non-targeted species likely does not fall within the ToR of the TWG CMSA. The TWG CMSA requested the Secretariat to prepare a paper with the relevant background information and to present it at the next TWG CMSA meeting to

facilitate fuller discussions.

9.2.1 Review of data or data description on fisheries bycatch in the chub mackerel fisheries

53. China presented a description of the bycatch in its chub mackerel fisheries (NPFC-2022-TWG CMSA06-WP04). The most common bycatch species are Japanese sardine, squids and Pacific saury.

54. Russia informed the TWG CMSA that there is mainly a mixed-stock Russian fishery targeted at mackerels and Japanese sardine. Bycatch pelagic species may include Japanese anchovy, sea bream and squids.

9.3 Selection of Chair and vice-Chair

55. The TWG CMSA recommended that the SC select Dr. Kazuhiro Oshima (Japan) to serve as the TWG CMSA Chair.

56. The TWG CMSA recommended that the SC select Dr. Qiuyun Ma (China) to serve as the TWG CMSA Vice-Chair.

9.4 Other issues

57. No other issues were discussed.

Agenda Item 10. Recommendations to the Scientific Committee

58. The TWG CMSA agreed:
    (a) To continue to work intersessionally towards finalizing the list of priority performance measures and metrics, including the relative importance between self-tests and cross-tests.
    (b) To continue analyses and discussions toward the selection of a model for the chub mackerel stock assessment.
    (c) To select a base stock assessment model(s) for evaluation at the next TWG CMSA meeting through intersessional discussions.
    (d) To continue submission and comparison of the quarterly fishery data on schedule (Annex E).
    (e) To follow the CPUE Standardization Protocol of the TWG CMSA and standardize how to extract yearly CPUE.
    (f) To separate fishery data such as catch-at-age and abundance indices by chub mackerel and blue mackerel.
    (g) To hold further discussions on standardizing how to increment chub mackerel age for the stock assessment.

59. The TWG CMSA recommended the following to the SC:
    (a) The TWG CMSA recommended the Work Plan of the TWG CMSA (NPFC-2022-TWG CMSA06-WP01 (Rev. 1)).
    (b) The TWG CMSA recommended that the SC select Dr. Kazuhiro Oshima (Japan) to serve as the TWG CMSA Chair.
    (c) The TWG CMSA recommended that the SC select Dr. Qiuyun Ma (China) to serve as the TWG CMSA Vice Chair.
    (d) The TWG CMSA recommended extending the consultancy agreement with the external expert to support the TWG CMSA in selecting a model for stock assessment of chub mackerel in 2023.
    (e) The TWG CMSA requested the SC to provide clarification on whether national waters fall under the scope of the task assigned by the SC to its subsidiary bodies of reporting the data needs and outlining methods that could be used to collect the necessary data.

Agenda Item 11. Adoption of Report

60. The report was adopted by consensus.

Agenda Item 12. Close of the Meeting

61. The meeting closed at 12:50 on 8 September 2022, Tokyo time.

Annexes

Annex A – Agenda

Annex B – List of Documents

Annex C – List of Participants

Annex D – Timeline of intersessional work toward the selection of a model for stock assessment of chub mackerel

Annex E – Timeline for submission of fishery data and abundance indices

Annex F – Reference points used by other Regional Fisheries Management Organizations and some NPFC Members

Annex A

Agenda

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4.3 Report on the performance of the candidate stock assessment models and options to rank them

4.4 Ranking of the candidate stock assessment models

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5.1 Research activities and review of biological parameters

5.2 Review of fishery (catch-at-age, weight-at-age, maturity-at-age, if possible) data based on a quarterly calendar

5.3 Updates and improvements to the standardized abundance indices and other data for use in the stock assessment

5.4 Recommendations for future work

Agenda Item 6. Future projection of chub mackerel

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7.1 Candidate biological reference points for chub mackerel

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9.1 Timeline and intersessional activities before TWG CMSA07

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9.2.1 Review of data or data description on fisheries bycatch in the chub mackerel fisheries

9.3 Selection of Chair and vice-Chair

9.4 Other issues

Agenda Item 10. Recommendations to the Scientific Committee

Agenda Item 11. Adoption of Report

Agenda Item 12. Close of the Meeting

Annex B

List of Documents

MEETING INFORMATION PAPERS

Symbol	Title
NPFC-2022-SSC PS09-MIP01	Meeting Information
NPFC-2022-TWG CMSA06-MIP02	Provisional Agenda
NPFC-2022-TWG CMSA06-MIP03 (Rev. 1)	Annotated Indicative Schedule

WORKING PAPERS

Symbol	Title
NPFC-2022-TWG CMSA06-WP01 (Rev. 1)	TWG CMSA Work Plan, 2022-2026
NPFC-2022-TWG CMSA06-WP02	Japanese fishery data based on a quarterly calendar
NPFC-2022-TWG CMSA06-WP03 (Rev. 1)	Preliminary quarterly data for 2021 China
NPFC-2022-TWG CMSA06-WP04	Data description on fisheries bycatch in the chub mackerel fisheries in China
NPFC-2021-TWG CMSA06-WP05	Summary of the report “Review of Target and Limit Reference Points” By Laurence T. Kell (2019)
NPFC-2021-TWG CMSA06-WP06	3rd Meeting of the Small Working Group on Operating Model for Chub Mackerel Stock Assessment
NPFC-2021-TWG CMSA06-WP07	4th Meeting of the Small Working Group on Operating Model for Chub Mackerel Stock Assessment
NPFC-2022-TWG CMSA06-WP08 (Rev. 1)	Calculation of performance measures by fitting VPA and SAM to pseudo data for chub mackerel in Northwestern Pacific
NPFC-2021-TWG CMSA06-WP09	Standardizing CPUE of Japanese commercial dip-net fishery targeting spawners of chub mackerel in the Northwest Pacific
NPFC-2022-TWG CMSA06-WP10	Standardizing monthly egg survey data as an abundance index for spawning stock biomass of chub mackerel in the Northwest Pacific
NPFC-2022-TWG CMSA06-WP11 (Rev. 1)	Standardizing abundance index for recruitment of chub mackerel in the Northwest Pacific
NPFC-2022-TWG CMSA06-WP12	The fitting results of ASAP to pseudo data and performance measures for operating model of Chub mackerel

NPFC-2022-TWG CMSA06-WP13	The fitting results of BSSPM to pseudo data with performance measures for Chub mackerel operating model
NPFC-2022-TWG CMSA06-WP14	Standardized CPUE of Chub mackerel (*Scomber japonicus*) caught by the China's lighting purse seine fishery up to 2020

Annex C

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Annex D

Timeline of intersessional work toward the selection of a model for stock assessment of chub mackerel

Month	Events	Notes
2022 Nov	Email communication	Start discussions toward finalizing performance measures/metrics
Dec	SC07	
2023 Jan	Email communication	Finalize performance measures/metrics
Feb		Submit documents
Mar	Intersessional meeting (2-3 days)	Rank the candidate stock assessment models and select a model for chub mackerel stock assessment
Apr		
May		
June	TWG CMSA07	Formalize the selection of the stock assessment model; Data preparation

Annex E

Timeline for submission of fishery data and abundance indices

Month	Fishery data (CAA, WAA, Maturity-at-age)	Abundance indices
2022 Nov	Email communication to discuss aging methods and rules among Members	
Dec		
2023 Jan		Email communication to share methods of how to extract yearly CPUE
Feb	Submission of data up to 2021 from each Member	
Mar	Email communication to discuss how to aggregate fishery data provided by each Member	Sharing of draft documents
Apr		
May	Submission of documents; Aggregation of data submitted by Members	Submission of documents
June	TWG CMSA07 (Discussion about data submission up to 2022)	TWG CMSA07

Annex F

Reference points used by other Regional Fisheries Management Organizations and fisheries management bodies

Management Group		Species	Reference Point	Notes
ICES	Precautionary Approach		B_{PA}	95th percentile of Blim.
ICES	Advice Rule (AR)		FMSY and MSYBtrigger	FMSY is the fishing mortality for a given fishing pattern and current environmental conditions that gives the long-term MSY.
ICES		Short Lived Species	MSY Bescapement and Fcap	$MSY_{Btrigger}$ is the lower bound of SSB fluctuation around B_{MSY} Yearly catch advice corresponds to the estimated stock biomass in excess of MSY Bescapement, but constrained to allow a fishing mortality that is no higher than Fcap. (Additional rules apply)
Kobe Framework			Fmsy and Bmsy	
WCPFC	Tier 1		FMSY and BMSY	where a reliable and precise estimate of steepness is available
WCPFC	Tier 2		FSPR and 20% of SSB0	where uncertainty in steepness is high, but the key biological (natural mortality, maturity) and fishery (selectivity) variables are reasonably well estimated
WCPFC	Tier 3		20%SBF=0, the spawning stock biomass in the absence of fishing derived from a stock assessment.	Does not include an F-based limit reference point if the key biological and fishery variables are not well estimated

Australian Small Pelagic Fishery	Tier 1		maximum exploitation rate of 15% of estimated spawning biomass from a recent DEPM survey	Based on the daily egg production method (DEPM) with high quality information on stock status
Australian Small Pelagic Fishery	Tier 2		7.5% of the estimated spawning biomass	Based on the daily egg production method (DEPM) with moderate information on stock status
Australian Small Pelagic Fishery	Tier 3		500 t	when information is lacking
SPRFMO		Jack Mackerel	0.8BMSY and BMSY	F depends on where the stock is relative to 0.8BMSY
US and Canada		Pacific Herring	0.75B0	Target Reference Point
Japan	1A (including chub mackerel in the Pacific)	Chub mackerel	SBmsy and Fmsy as target. SB0.6msy is the threshold for decreasing F below the threshold.	Age-structured model. When reliable and robust MSY reference points can be estimated
Japan	1B		F%SPR, F0.1, Fmax and corresponding spawning biomass is target. SBmin or 0.1SB0 is the threshold.	Age-structured model. When reliable and robust MSY reference points cannot be estimated because of large uncertainties of stock-recruitment relationship