North Pacific Fisheries Commission

NPFC-2019-SSC PS05-Final Report

5th Meeting of the Small Scientific Committee on Pacific Saury REPORT

13-16 November 2019

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North Pacific Fisheries Commission
5th Meeting of the Small Scientific Committee on Pacific Saury

13-16 November 2019
Shimonoseki, Japan

REPORT

Agenda Item 1. Opening of the meeting

1. The 5th Meeting of the Small Scientific Committee on Pacific Saury (SSC PS05) took place in Shimonoseki, Japan on 13-16 November 2019, and was attended by Members from Canada, China, Japan, the Republic of Korea, the Russian Federation, Chinese Taipei, and Vanuatu. The meeting was opened by Dr. Toshihide Kitakado (Japan) who served as the SSC PS Chair.

2. Dr. Kaoru Nakata, Executive Director of the Japan Fisheries Research and Education Agency, welcomed the participants to Shimonoseki on behalf of the host Member. She pointed out that Pacific saury is an important species for the NPFC and highlighted the important role of the SSC PS. Lastly, she expressed her hope that the participants would work together effectively and achieve fruitful results.

3. Vanuatu pointed out that the 2019 Pacific saury fishing season has been challenging and that it shares the concern of other Members about the status of the Pacific saury stock. Vanuatu expressed its hope that the participants can work together effectively to prevent the declining trend of the stock. At the same time, Vanuatu urged the participants to take into account the fact that Vanuatu is a small island developing state that still needs to develop its Pacific saury fishery.

Agenda Item 2. Adoption of Agenda

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

Agenda Item 3. Overview of the outcomes of previous NPFC meetings

3.1 TWG PSSA04 meeting

3.2 SSC PS04 and SC04 meeting

5. The Chair presented the outcomes and recommendations from the TWG PSSA03, TWG PSSA04, SSC PS04 and SC04 meetings.

3.3 COM05 meeting and CMM 2019-08

6. The Science Manager, Dr. Aleksandr Zavolokin, presented the outcomes and recommendations from the COM05 meeting and an overview of CMM 2019-08.

3.4 Joint PICES-NPFC workshop

7. The co-convener of the Joint PICES-NPFC workshop on the influence of environmental changes on the distribution and population dynamics of Pacific saury, Dr. Chris Rooper, presented the outcomes and recommendations from the workshop (NPFC-2019-SSC PS05-IP01). The topic session on small pelagics proposed for the 2020 PICES Annual Meeting was accepted by PICES.

Agenda Item 4. Review of a proposed "Terms of References of the SSC PS" and existing protocols

4.1 Terms of Reference of the SSC PS

8. The participants drafted a provisional Terms of Reference for the SSC PS (Annex D) that can be modified as necessary in the future. The SSC PS *recommended* to the SC to endorse the proposed Terms of Reference for the SSC PS.

4.2 CPUE Standardization Protocol

9. The participants reviewed and revised the CPUE Standardization Protocol (Annex E), including the development of a document template for presenting standardized CPUEs of Pacific saury. The SSC PS *recommended* to the SC to endorse the revised CPUE Standardization Protocol.

4.3 Stock Assessment Protocol

10. The participants reviewed the Stock Assessment Protocol. The participants determined that no revisions are currently necessary but recognized that it may be necessary to update the Protocol in the future when age/size/stage-structured stock assessment models are developed.

Agenda Item 5. Review of Members' fishery status including 2019 fishery

11. China presented its fisheries activities. Total catch fluctuated from 2013 to 2018. The catch in 2018 was over 90,000 tons. From 2016 to 2018, the number of fishing vessels and days has been decreasing. In 2018, there were 49 active vessels in the Convention Area and 5,057 fishing days. China uses a logbook system and the 2019 logbook data will be available once they are processed.

12. Russia presented its fisheries activities. From 2016 to 2018, the percentage of catch in national waters has decreased from about 80% to 30% and that in the Convention Area has

correspondingly increased. In 2018, the distribution of the Pacific saury fishing fleet was very broad, encompassing both national waters and high seas. In 2019, the vessels have mostly moved around searching for catch, rather than staying and fishing in one place. There have been up to 4 active vessels each month. The total catch for 2019 as of early November is approximately 2,300 tons, which is extremely small compared to past years.

13. Korea presented its fisheries activities. There were 11 active vessels in 2019, compared to 12 active vessels in 2018. In the 2019 fishing season, fishing vessels have shifted eastwards compared to the past. Annual catch has been declining in the past decade. The lowest amount of catch was recorded in 2015. Catch has improved twice in the last three years. However, the monthly catch in 2019 has been lower compared to 2018 for each month so far. The total catch for 2019 so far is approximately 7,000 tons and it will likely be lower than in 2018.

14. Japan presented its fisheries activities. The annual catch peaked at approximately 350,000 tons in 2008 but has continued to decline since then. The total catch in 2018 was 128,531 tons. The fishing ground has shifted offshore since 2010. In 2019, the total catch after August has been about 20,000 tons, the worst on record since 1958. The fishing grounds were mainly in the high seas. The percentage of age-1 fish (>29cm) has been about 55%.

15. Chinese Taipei presented its fisheries activities. In 2019, there are 91 active vessels and total catch is only approximately 67,000 tons, until October. In 2018, for the same period, there were 85 active vessels and total catch was approximately 147,000 tons. Monthly CPUE in 2019 was lower in July and August compared to previous years. In general, total CPUE has decreased in 2019 compared to 2018.

16. Vanuatu presented its fisheries activities. There have been 4 active vessels each year since 2015. Catch reached a record high of 8,231 tons in 2018. The current estimated catch amount for 2019 is 2,430 tons.

17. The participants pointed out that it would be useful to understand the dynamics of Members' Pacific saury fleets and suggested that Members could, on a voluntary basis, include a single short paragraph in their Annual Reports or SSC PS meeting documents about general fishing patterns, movement of vessels, and any changes in the size composition of vessels.

18. The participants reviewed the compiled data on Pacific saury catches in the Northwestern Pacific Ocean (NPFC-2019-SSC PS04-WP01 (Rev 2)) and agreed to use the data for the stock assessment (Annex F).

Agenda Item 6. Review of fishery-independent abundance indices

6.1 Review of outcomes of Japanese biomass survey including 2019 estimate

19. Japan presented the outcomes of its annual fisheries-independent survey for Pacific saury, including the 2019 estimate (NPFC-2019-SSC PS05-WP08). The biomass was estimated based on the swept area method (Kidokoro et al. 2018) and was 1,646,000 tons, about 70% of that in 2018. There were also differences in the distribution pattern of age-0 and age-1 fish, with age-1 fish being caught mostly in waters from 160 degrees east longitude to 170 degrees west longitude, and most age-0 fish being caught east of 175 degrees west longitude.

20. The participants noted that there seems to be a synchronization between the annual change in the estimated number of age-0 fish and age-1 fish, with a one-year lag, which supports the decision to develop an age/size/stage-structured model. The predictive power of the correlation between age-0 fish and age-1 fish in the Japanese survey should be investigated and discussed at the next meeting.

21. The participants reaffirmed that the Japanese biomass estimates are key inputs for the Pacific saury stock assessment and strongly encouraged Japan to continue to conduct its biomass surveys.

6.2 Technical aspects

6.2.1 Investigation and refinement of q_biomass

22. Japan presented research on the inclusion of the variance of catchability of biomass survey gear into the CV estimation for biomass.

23. Russia welcomed the new experimental efforts on catchability efficiency estimation in the scientific surveys (q1) initiated by Japan and suggested to revisit the calculation of q1 in the previous observations. According to the data published by Naya et al. (2010), a beta distribution fits observations better than Gaussian distribution and may be a useful assumption in future analyses.

24. The participants considered q_biomass and discussed base case scenarios for the stock assessment update, with updated q values. See agenda 8.1 for details.

25. Japan presented preliminary research for the re-estimation of the fishing efficiency of trawl nets. Japan showed that underwater cameras can be used to record fish escaping from the trawl net and that Acoustic Zooplankton Fish Profiler can be used to estimate the catchability of trawl nets.

26. The participants encouraged Japan to continue its work for re-estimating the fishing efficiency of trawl nets and submit a paper to a future meeting of the SSC PS.

6.2.2 Review of simulation results

27. Japan presented a preliminary report on a simulation experiment framework for evaluating fishery-independent survey designs for Pacific saury (NPFC-2019-SSC PS05-WP16). Japan conducted a simulation experiment framework to evaluate whether it is possible to reduce sampling effort in fishery-independent surveys for Pacific saury, while maintaining high reliability in biomass estimates.

28. The participants encouraged Japan to continue to conduct research towards developing and refining the biomass survey design. Survey cost should be considered in future analyses.

6.2.3 Review of spatio-temporal modelling

29. Japan presented research involving the application of a Vector Autoregressive Spatio-Temporal (VAST) model to Japanese fishery-independent survey data for predicting annual changes in spatio-temporal distribution and annual abundance indices for age-0 and age-1 Pacific saury from 2003 to 2017 (NPFC-2019-SSC PS05-WP17). The predicted annual distribution patterns indicated that the center of distribution for age-0 fish had shifted slightly to the east since 2010 and that density for age-1 fish had decreased over time. The predicted annual abundance index for age-0 fish indicated a similar trend with the nominal values, while the predicted age-1 abundance index showed a higher value than the nominal values, particularly in 2005 and 2007, due to the high predicted density in the northern area, where there was no sampling.

30. The participants recognized that exercises such as Japan's application of VAST to the Japanese fishery-independent survey data can serve as the basis for future simulations to test survey designs and stopping rules. They suggested that Japan incorporate possible environmental factors such as sea surface temperature (SST) into the VAST model, which would be useful for understanding the stock dynamics, and also that Japan work in collaboration with other Members to develop a suite of designs to be tested. The participants highlighted the importance of considering the biological realism of the model projection.

6.3 Conclusion as inputs for stock assessments

31. The participants reviewed and agreed to use the updated biomass estimate from the Japanese fishery-independent survey for Pacific saury for the stock assessment (Annex F).

6.4 Recommendations for future work

32. Recommendations for future work are given in paragraphs 26, 28 and 30.

Agenda Item 7. Review of fishery-dependent abundance indices

7.1 Member's CPUE standardization up to 2018 fishery

33. China presented a standardization of CPUE data for Pacific saury from 2013 to 2018 using a generalized linear model (GLM) and a generalized additive model (GAM) on the assumption of lognormal distribution of errors (NPFC-2019-SSC PS05-WP01). China recommended using the standardized CPUE derived from GAM as the input for the stock assessment.

34. The participants agreed to use China's standardized CPUE derived from GAM as the input for the stock assessment.

35. Chinese Taipei presented a standardization of CPUE data for Pacific saury from 2001 to 2018 using GLM and GAM on the assumption of lognormal distribution of errors (NPFC-2019-SSC PS05-WP02). Chinese Taipei recommended using the standardized CPUE derived from GAM as input for the stock assessment.

36. The participants agreed to use Chinese Taipei's standardized CPUE derived from GAM as the input for the stock assessment.

37. Korea presented a standardization of CPUE data for Pacific saury from 2001 to 2018 using GLM (NPFC-2019-SSC PS05-WP05). Korea recommended using the standardized CPUE derived from GLM as input for the stock assessment.

38. The participants agreed to use Korea's standardized CPUE derived from GLM as the input for the stock assessment.

39. Japan presented a standardization of CPUE data for Pacific saury from 1994 to 2018 using GLM (NPFC-2019-SSC PS05-WP06). Japan recommended using the standardized CPUE derived from GLM as input for the stock assessment.

40. The participants agreed to use Japan's standardized CPUE derived from GLM as the input for the stock assessment.

41. Russia presented a standardization of CPUE data for Pacific saury from 1994 to 2018 using GLM (NPFC-2019-SSC PS05-WP07). Russia recommended using the standardized CPUE derived from GLM as input for the stock assessment.

42. The participants agreed to use Russia's standardized CPUE derived from GLM as the input for

the stock assessment.

43. The finalized table of abundance indices is attached to the report as Annex F.

44. The participants suggested that including the interactions between SST, and temporal and spatial factors and environmental covariates other than SST in CPUE standardization is worth exploring in the future.

45. The participants recognized the need to continue to study ways to incorporate inter-annual changes in spatio-temporal distribution driven by environmental factors in the CPUE standardization.

7.2 Progress on collaborative work for development of joint CPUE

46. Chinese Taipei presented research on the standardization of joint CPUE data for Pacific saury from 2001 to 2017 using conventional and geostatistical approaches (NPFC-2019-SSC PS05-WP10). There is no clear difference in the annual trends of the standardized CPUE indices derived from VAST and GLM, but VAST produces a model with a higher R^2 than GLM and performs better than the GLM with less residuals departing from zero and smaller residual variance. Chinese Taipei therefore recommended to use VAST for deriving the standardized joint index as improved input data in the stock assessment.

47. The participants recognized the value of the work done by Chinese Taipei to produce a joint CPUE standardization for Pacific saury from 2001 to 2017 and agreed to build on this work by updating joint CPUE standardizations at SSC PS06. They also noted that it would be useful to further analyze the interaction between Member fleet and other variables. All Members agreed to submit their 2018 data and Japan, Korea, Russia and Vanuatu agreed to submit their 2019 data by 14 February 2020. Other Members fishing for Pacific saury will provide their 2019 data once they become available and are validated by the SSC PS07 meeting. It was also agreed that the collaboration group submit an updated joint CPUE index for 2001-2019 no later than March 14.

48. The participants agreed to include the updated joint CPUE index for 2001-2019 for sensitivity analyses to supplement the 2020 stock assessment and that, due to time constraints, the sensitivity analyses using the joint CPUE index can be shown at SSC PS06.

49. The participants agreed to share, on the Collaboration website (https://collaboration.npfc.int/), the code developed to produce the joint CPUE standardization for Pacific saury with other Members for joint analyses (TWG PSSA04-WP01, 03, 05, 06; SSC PS05-WP12).

50. The participants agreed to produce nominal monthly CPUE by age and submit it to SSC PS06, if possible, recognizing that this information can be used as an interim proxy for age-based CPUE, towards the analysis and development of age/size/stage-structured models for Pacific saury stock assessment.

51. The Data Coordinator, Mr. Mervin Ogawa, reported on the progress of an ongoing project for the development of the spatial/temporal map of Members' Pacific saury catch and effort (NPFC-2019-SSC PS05-WP21). The Secretariat has revised the map and implemented all recommendations made by Members thus far.

52. The participants requested the Secretariat to add the isotherms of 8^{o} and 18^{o} Celsius on the map of Members' Pacific saury catch and effort, to visualize the optimal temperature range of Pacific saury.

7.3 Recommendations for future work

53. Recommendations for future work are given in paragraphs 44, 45, 47, 48, 49 and 50.

Agenda Item 8. Stock assessment using "provisional base models" (BSSPM)

8.1 Review of the key considerations and recommendations from the TWG PSSA04 meeting

54. Japan presented an evaluation of the possibility of estimating systematic changes in catchability in the interim stock assessment model, BSSPM (NPFC-2019-SSC PS05-WP15 (Rev. 1)). The results showed that a dynamic change in catchability might be estimated well for some scenarios if the assumption in the relative biomass is correct, but if it is not correct, there may be some potential bias in the estimation of catchability and biomass. Japan recommended paying more attention to such exercises before finalizing the 2020 stock assessment.

55. The participants were informed about the study conducted by Japan on the trial application of JABBA (Just Another Bayesian Biomass Assessment) to Pacific saury stock assessment (NPFC-2019-SSC PS05-WP19). Japan tried to use JABBA to mimic the latest stock assessment results for Pacific saury produced by the TWG PSSA and was able to show similar results. It therefore suggested that JABBA could be one of the candidates for the shared stock assessment model for Pacific saury.

56. The participants revised base case scenarios from the previous stock assessment. The participants agreed to conduct a stock assessment update with two new base cases and four sensitivity analyses (Annex G).

57. The participants revised the template for stock assessment status information used in the previous stock assessment (Annex H).

8.2 General implication of BSSPM results for management of Pacific saury: merits and limits of BSSPM assessment

58. Participants deferred the discussion of the implication of BSSPM results for management of Pacific saury to the next meeting.

8.3 Review of the results of improved model, if any

59. No model improvements were tested.

8.4 Review of updated stock assessment results based on BSSPM (if available during the meeting)

60. No updated stock assessment results were produced.

8.5 Timeline until SSC PS in 2020 spring meeting for updating BSSPM assessment

8.6 Recommendations for future work

61. The participants agreed to conduct a stock assessment update with two new base cases and four sensitivity analyses (Annex G).

Agenda Item 9. Biological information on Pacific saury

9.1 Review of comprehensive report from Japan

62. Japan presented a comprehensive report on biological information on Pacific saury, including stock identity, early life history, feeding habits and predators, growth, distribution and migration, maturation, and natural mortality (NPFC-2019-SSC PSSA05-WP13).

63. The participants discussed the biological information presented by Japan and noted the importance of determining whether or not Pacific saury mortality is related to maturity.

64. The participants reaffirmed the importance of biological information as key inputs for the development of age/size/stage-structured models for the Pacific saury stock assessment.

65. The participants were encouraged to conduct experiments to study the maturation and spawning processes of Pacific saury reared in captivity, as these processes are very important for understanding the biology of the species and incorporating that knowledge in the modeling of population dynamics.

9.2 Review of any other documents/papers

66. Chinese Taipei presented a quantification of the spatio-temporal dynamics of Pacific saury in

the Northwestern Pacific Ocean between 2001 and 2017 using the VAST model (NPFC-2019-SSC PS05-WP12). The results indicated that, over time, the spatial distribution of Pacific saury has gradually shifted eastward from coastal and offshore waters. Chinese Taipei investigated this shift and found that it cannot be explained by any single environmental variable or climatic index, nor the linear combination thereof.

67. Some suggestions about improving the predictive power of the VAST model by reducing correlation among predictor variables were discussed.

68. The participants discussed the possibility to publish cooperative research in peer-review journals using the joint CPUE data, in compliance with the NPFC Interim Regulation for Management of Scientific Data and Information.

69. Chinese Taipei presented an estimation of the length and age compositions of Pacific saury in the Northwest Pacific Ocean during the fishing season in 2018 (NPFC-2019-SSC PS05-WP11). The results indicated spatial and temporal changes in Pacific saury size and age structure during the fishing season. Chinese Taipei therefore suggested that the length composition data from this study could be used as input data of a particular fleet in the integrated stock assessment model.

70. The participants encouraged Chinese Taipei to continue conducting estimates of the length and age compositions of Pacific saury, while working to improve the sampling method and optimize the sample size.

9.3 Distribution and migration patterns of juvenile Pacific saury

71. Japan gave a presentation on the distribution of age-0 fish and conservation of younger fish (NPFC-2019-SSC PS05-WP13). Members have previously considered several definitions of "juvenile" Pacific saury. From the perspective of conserving juvenile fish, Japan considered "juvenile" Pacific saury to be those young fish which are large enough to be fished, a good proxy for which is age-0 fish. Because of the low selectivity of stick-held dip nets, it is impossible to control for size of fish caught. A more effective way to protect age-0 fish is to consider an area closure. There tends to be a higher abundance of age-0 fish compared to age-1 fish in eastern areas. Furthermore, in recent years, most age-0 fish within the biomass survey area were found east of 165 degrees east longitude and did not migrate westward extensively until the following summer.

72. The participants encouraged Japan to conduct further research, including analyzing the impact of area closures at different longitudes on the spawning biomass and identifying the longitude

where age-0 fish comprise half the catch using a logistic model.

9.4 Recommendations for future work

73. Recommendations for future work are given in paragraphs 65, 70 and 72.

Agenda Item 10. Exploration of stock assessment models other than existing "provisional base models"

10.1 Data invention/availability (including the identification of potential covariates)

74. Japan presented an estimation of catch at size for Pacific saury caught by the Japanese stick-held dip net fishery based on interview data, length frequency data, and landings for 10-day periods (NPFC-2019-SSC PS05-WP14).

75. Chinese Taipei presented an enumeration of commercial size category, body length distribution, and age composition for Pacific saury caught by the Chinese Taipei stick-held dip net fishery, as available information for the estimation of catch-at-age/size data (NPFC-2019-SSC PS05-WP03 and 04). Chinese Taipei is also developing an image-based measurement approach that can be easily used across multiple months and vessels to measure the knob length of Pacific saury directly within commercial boxes to enhance the quality of datasets and to reduce the time and financial limitations currently hindering the acquisition of robust assessments.

76. The participants noted that stereo cameras and automated image analysis could be an efficient and effective means of collecting length data from commercial catch.

77. The participants reviewed and updated the table of data availability on size composition and catch/CPUE for Pacific saury (Annex I).

78. The participants agreed on specifications and timelines for submitting data on size composition and catch for Pacific saury (Annex J) and revised the template for sharing data (Annex K). The participants agreed to submit data on size composition and catch for Pacific saury, in accordance with the specifications and template, up to 2018 at SSC PS06, and submit the 2019 data at SSC PS07. The deadline for submission of 2018 data is 14 February 2020.

79. The participants agreed to submit papers detailing their protocols for estimating the length composition and age composition of Pacific saury, as well as the sample size over time, to SSC PS06.

80. Japan agreed to share age-length keys for Pacific saury with other Members.

81. The participants agreed to conduct research on spatio-temporal variation in Pacific saury growth, towards determining a spatio-temporal scale for an age-length key that is consistent with the species biology.

10.2 Discussion on age/size/stage-structured models

82. Japan presented a trial calculation of natural mortality estimators for Pacific saury (NPFC-2019-SSC PS05-WP18). The calculated estimators were distributed over a relatively large range, between 1.71 and 2.75. Japan noted the need to carefully consider whether the processes for deriving these estimators are consistent with the physiology of Pacific saury, before incorporating them in age/size/stage-structured models.

83. The participants encouraged Japan to model seasonal growth function, considering the speed of growth of age-0 Pacific saury that have and have not experienced maturity.

84. The Chair presented a simplistic monthly age-structured model as an example to initiate discussions on the development of new models of the population dynamics of Pacific saury.

85. The participants were encouraged to propose new population dynamics models, taking into account the data availability and biology of Pacific saury, and to present the statistical formulation and biological assumptions of the proposed models at SSC PS06.

10.3 Development of data sharing protocol

86. The participants reaffirmed that any data sharing should be conducted in accordance with the Interim Regulations for Management of Scientific Data and Information.

10.4 Initial discussion on simulation setting

87. The participants agreed that simulation studies may be useful for evaluating the performance of any new models. They also recognized that simulation models could form the basis for the future development of operating models for the MSE framework.

10.5 Recommendations for future work

88. Recommendations for future work are given in paragraphs 76, 78, 79, 81, 83 and 85.

Agenda Item 11. Toward setting of biological reference points (RPs) and development of Management Strategy Evaluation (MSE)

11.1 Review of RPs report

11.2 Investigation of reasonable options of RPs

11.3 Initial discussion on MSE for Pacific saury

11.4 Recommendations for future work

89. The participants agreed to discuss a timeline for developing the MSE at SSC PS06, if time allows.

90. The participants suggested that, given that Pacific saury is a short-lived species, and in light of the influence and fluctuation of environmental factors, dynamic RPs are likely to be appropriate. They noted that the NPFC-PICES collaborative framework may be a useful platform for exploring dynamic RPs.

Agenda Item 12. Other matters

12.1 Draft agenda and priority issues for next meeting

91. The participants recognized the following as priorities for the next meeting:
    (a) Conduct regular update of stock assessment and develop recommendations to the Commission to improve conservation and management
    (b) Review survey plans of Japanese biomass survey in 2020
    (c) Review proposal for developing new stock assessment models and refine data requirement
    (d) Finalize initial data set and assumptions for initial trials of conditioning of new stock assessment models
    (e) Review RPs report and start investigation of reasonable actions

12.2 Other

92. No other matters were discussed.

Agenda Item 13. Adoption of the Report

93. The SSC PS05 Report was adopted by consensus.

Agenda Item 14. Close of the Meeting

94. The meeting closed at 12:04 on 16 November 2019.

Annexes:

Annex A – Agenda
Annex B – List of Documents
Annex C – List of Participants
Annex D – Terms of Reference for the Small Scientific Committee on Pacific Saury (SSC PS)
Annex E – CPUE Standardization Protocol for Pacific Saury
Annex F – Updated total catch, CPUE standardizations and biomass estimates for the stock

assessment of Pacific saury

Annex G – Specifications of the BSSPM for the updated stock assessment

Annex H – Template for stock status information and future projection

Annex I – Data availability on size composition and catch/CPUE for Pacific saury

Annex J – Specifications and timelines for submitting data on size composition and catch for Pacific saury

Annex K – Template for sharing data on size composition and catch for Pacific saury

Annex A

Agenda

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- 3.1 TWG PSSA04 meeting
- 3.2 SSC PS04 and SC04 meeting
- 3.3 COM05 meeting and CMM 2019-08
- 3.4 Joint PICES-NPFC workshop

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- 4.1 Terms of References of the SSC PS
- 4.2 CPUE Standardization Protocol
- 4.3 Stock Assessment Protocol

Agenda Item 5. Review of Member's fishery status including 2019 fishery

Agenda Item 6. Review of fishery-independent abundance indices
- 6.1 Review of outcomes of Japanese biomass survey including 2019 estimate
- 6.2 Technical aspects
  - 6.2.1 Investigation and refinement of q_biomass
  - 6.2.2 Review of simulation results
  - 6.2.3 Review of spatio-temporal modelling
- 6.3 Conclusion as inputs for stock assessments
- 6.4 Recommendations for future work

Agenda Item 7. Review of fishery-dependent abundance indices
- 7.1 Member's CPUE standardization up to 2018 fishery
- 7.2 Progress on collaborative work for development of joint CPUE
- 7.3 Recommendations for future work

Agenda Item 8. Stock assessment using "provisional base models" (BSSPM)
- 8.1 Review of the key considerations and recommendations from the TWG PSSA04 meeting
- 8.2 General implication of BSSPM results for management of Pacific saury: merits and limits of BSSPM assessment
- 8.3 Review of the results of improved model, if any
- 8.4 Review of updated stock assessment results based on BSSPM (if available during the meeting)
- 8.5 Timeline until SSC PS in 2020 spring meeting for updating BSSPM assessment
- 8.6 Recommendations for future work

Agenda Item 9. Biological information on Pacific saury
- 9.1 Review of comprehensive report from Japan
- 9.2 Review of any other documents/papers

9.3 Distribution and migration patterns of juvenile Pacific saury
9.4 Recommendations for future work

Agenda Item 10. Exploration of stock assessment models other than existing “provisional base models”
10.1 Data invention/availability (including the identification of potential covariates)
10.2 Discussion on age/size/stage-structured models
10.3 Development of data sharing protocol
10.4 Initial discussion on simulation setting
10.5 Recommendations for future work

Agenda Item 11. Toward setting of biological reference points (RPs) and development of Management Strategy Evaluation (MSE)
11.1 Review of RPs report
11.2 Investigation of reasonable options of RPs
11.3 Initial discussion on MSE for Pacific saury
11.4 Recommendations for future work

Agenda Item 12. Other matters
12.1 Draft agenda and priority issues for next meeting
12.2 Other

Agenda Item 13. Adoption of Report

Agenda Item 14. Close of the Meeting

Annex B

List of Documents

MEETING INFORMATION PAPERS

Document Number	Title
NPFC-2019-SSC PS05-MIP01	Details for the 5th Meeting of the Small Scientific Committee on Pacific Saury
NPFC-2019-SSC PS05-MIP02	Provisional Agenda
NPFC-2019-SSC PS05-MIP03 (Rev. 2)	Annotated Indicative Schedule

REFERENCE DOCUMENTS

Document Number	Title
	Terms of Reference for the Technical Working Group on Pacific Saury Stock Assessment
	Interim Regulations for Management of Scientific Data and Information
	CPUE Standardization Protocol for Pacific Saury
	Review of Target and Limit Reference Points
	Stock Assessment Protocol for Pacific Saury
	SSC PS Work Plan

WORKING PAPERS

Document Number	Title
NPFC-2019-SSC PS05-WP01 (Rev. 1)	Standardization of CPUE data of Pacific saury (*Cololabis saira*) caught by the Chinese stick-held dip net fishery
NPFC-2019-SSC PS04-WP01 (Rev 2)	Compiled data on Pacific saury catches in the NWPO
NPFC-2019-SSC PS05-WP02	CPUE standardization of Pacific saury (*Cololabis saira*) for the Chinese Taipei's stick-held dip net fishery in the Northwestern Pacific Ocean from 2001-2018
NPFC-2019-SSC PS05-WP03	Enumeration of commercial size category, body length distribution, and age composition of the Pacific saury caught by the Chinese Taipei's saury fishery in 2018

NPFC-2019-SSC PS05-WP04	Pacific saury data: catch&effort and catch by length and size category by Chinese Taipei
NPFC-2019-SSC PS05-WP05	Standardized CPUE of Pacific saury (*Cololabis saira*) for the Korean stick-held dip net fishery in Northwest Pacific during 2001 to 2018
NPFC-2019-SSC PS05-WP06	Standardized CPUE of Pacific saury (*Cololabis saira*) caught by the Japanese stick-held dip net fishery up to 2018
NPFC-2019-SSC PS05-WP07	CPUE standardization for the Pacific saury Russian catches in the Northwest Pacific Ocean
NPFC-2019-SSC PS05-WP08	Update of biomass estimate through Japanese fishery independent survey for Pacific saury in 2019
NPFC-2019-SSC PS05-WP09	2018 Pacific saury catch and effort data_Korea
NPFC-2019-SSC PS05-WP10	Joint CPUE standardization of the Pacific saury in the Northwest Pacific Ocean during 2001-2017 by using the conventional and geostatistical approaches
NPFC-2019-SSC PS05-WP11	Estimation of the length and age compositions of Pacific saury *Cololabis saira* in the Northwest Pacific Ocean during the fishing season in 2018
NPFC-2019-SSC PS05-WP12	Modelling the spatio-temporal dynamics of Pacific saury in the Northwestern Pacific Ocean by using a Vector-Autoregressive Spatio-Temporal Model
NPFC-2019-SSC PS05-WP13	A review of the biology for Pacific saury, *Cololabis saira*, in the North Pacific Ocean
NPFC-2019-SSC PS05-WP14	Estimation of catch at size (CAS) for Japanese stick-held dip net fishery
NPFC-2019-SSC PS05-WP15 (Rev. 1)	Evaluation of possibility of estimating systematic changes in catchability in the state-space production model
NPFC-2019-SSC PS05-WP16	Preliminary report on simulation experiment framework to evaluate fishery-independent survey designs of Pacific saury
NPFC-2019-SSC PS05-WP17	Application of spatiotemporal model to fishery-independent survey data for Pacific saury
NPFC-2019-SSC PS05-WP18	A trial calculation of natural mortality estimators for Pacific saury
NPFC-2019-SSC PS05-WP19	Trial application of JABBA to Pacific saury stock assessment
NPFC-2019-SSC PS05-WP20	2018 Pacific saury catch and effort data_Russia
NPFC-2019-SSC PS05-WP21	Pacific Saury Catch and Effort Map

INFORMATION PAPERS

Document Number	Title
NPFC-2019-SSC PS05-IP01	Joint PICES-NPFC Workshop: The influence of environmental changes on the potential for species distributional shifts and population dynamics of Pacific saury
NPFC-2019-SSC PS05-IP02	Data availability on size composition and catch/CPUE for Pacific saury
NPFC-2019-SSC PS05-IP03	Pacific Saury Fishery in China
NPFC-2019-SSC PS05-IP04	Fishery Status in Japan
NPFC-2019-SSC PS05-IP05	Pacific saury (*Cololabis saira*) caught by the Korean stick-held dip net fishery from 2001 to 2019 Oct
NPFC-2019-SSC PS05-IP06	Fishery Status of Pacific Saury in 2019 Chinese Taipei
NPFC-2019-SSC PS05-IP07	Pacific Saury Fishery Status in Vanuatu

MEETING REPORTS

Document number	Title
NPFC-2019-TWG PSSA04-Final Report	Report of the 4th Meeting of the Technical Working Group on Pacific Saury Stock Assessment
NPFC-2019-SSC PS04-Final Report	Report of the 4th Meeting of the Small Scientific Committee on Pacific Saury
NPFC-2019-SC04-Final Report	Report of the 4th Scientific Committee Meeting
NPFC-2019-COM05-Final Report	Report of the 5th Commission Meeting

Annex C

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Annex D

Terms of Reference for the Small Scientific Committee on Pacific Saury (SSC PS)

1. To review fishery data
    - Catch series
    - Age/size composition data
    - Others
2. To review fishery-dependent and fishery-independent indices
    - Review/update the existing CPUE Standardization Protocol
    - Review/update the indices
    - Evaluate the quality of the indices
    - Recommendation for future work
3. To review and update biological information/data
    - Stock structure
    - Growth
    - Reproduction and maturity schedule
    - Natural mortality
    - Migration pattern
    - Others
4. To update the stock assessment using "provisional base models" (i.e. Bayesian state-space production models)
    - Review the existing Stock Assessment Protocol
    - Simple update (including projection and evaluation of reference points as well as diagnosis)
    - Consideration of scenarios (for base and sensitivity)
    - Assessment of uncertainties and the implications for management
    - Evaluation/improvement (if necessary) of the models
    - Recommendation of the research for future work
5. To explore stock assessment models other than existing "provisional base models"
    - Data invention/availability (including the identification of potential covariates)
    - Initial (and continued) discussion on age-/size/stage-structure models
    - Identification of lack of information/data gaps and limitations
    - Recommendation of the research for future work
6. To facilitate data- and code- sharing processes
7. To review/improve the presentation of stock assessment results (including stock status summary reports in a format to be determined by the Working Group)
8. To explore the design of the Management Strategy Evaluation framework.

Annex E

CPUE Standardization Protocol for Pacific Saury

The use of CPUE in a stock assessment implicitly assumes that CPUE is proportional to stock abundance/biomass. However, many factors other than stock abundance/biomass may influence CPUE. Thus, any other factors, other than stock abundance/biomass, that may influence CPUE should be removed from the CPUE index. The process of reducing/removing the impacts of these factors on CPUE is referred to as CPUE standardization.

The following protocol is proposed for the CPUE standardization:

(1) Conduct a thorough literature review to identify key factors (i.e., spatial, temporal, environmental, and fisheries variables) that may influence CPUE values;

(2) Determine temporal and spatial scales for data grouping for CPUE standardization;

(3) Plot spatio-temporal distributions of fishing efforts and catch to evaluate spatio-temporal patterns of fishing effort and catch;

(4) Calculate correlation matrix to evaluate correlations between each pair of those variables;

(5) Identify potential explanatory variables based on (1)-(4) as well as interaction terms to develop full model for the CPUE standardization;

(6) Fit candidate statistical models to the data (e.g., GLM, GAM, Delta-lognormal GLM, Neural Networks, Regression Trees, Habitat based models, and Statistical habitat based models);

(7) Evaluate the models using methods such as likelihood ratio, AIC/BIC and cross validation;

(8) Evaluate if distributional assumptions are satisfied and if there is a significant spatial/temporal pattern of residuals in CPUE standardization modeling;

(9) Extract yearly standardized CPUE and standard error by a method that is able to account for spatial heterogeneity of effort, such as least squares mean or expanded grid. If the model includes area and the size of spatial strata differs or the model includes interactions between time and area, then standardized CPUE should be calculated with area weighting for each time step. Model with interactions between area and season or month requires careful consideration on a case by case basis;

(10) Recommend a time series of yearly standardized CPUE and associated uncertainty;

(11) Plot nominal and standardized CPUEs over time;

(12) This protocol can be used for joint CPUE standardization.

DOCUMENT TEMPLATE FOR PRESENTING STANDARDIZED CPUE OF PACIFIC SAURY

Title: Standardized CPUE of Pacific saury (*Cololabis saira*) caught by the MEMBER's stick-held dip net fishery up to 20XX

Author's Name(s)

Affiliation(s)

Background of the Pacific saury fishery

- Description of the Pacific saury fishery of corresponding member.

METHOD

The data

- Spatial and temporal patterns of catch and effort (Fig. 1)
- Available covariates with explanation on resolution and coverage (Table 1)
- Correlations among the variables (Fig. 2)
- If there are any candidate environmental covariates, describe explanations and the reason for including them.

Full model description and model selection

- Type and assumptions of the model
- Response and explanatory variables and interactions
- Assumed error distribution
- Formulation of full model
- Model selection method

Yearly trend extraction

- How to extract yearly trend from the selected model
- How to evaluate uncertainty of the extracted trend, if necessary

RESULT and DISCUSSION

- Result of the model selection, at least for the full, null and best models (Table 2)
- Interpretation of the selected model
- Model diagnosis: Analysis of deviance table (Table 3), tendencies of the residuals (Fig. 3) and percentage of the deviance explained
- The extracted yearly trend (Table 4), comparing with the nominal CPUE (Fig. 4)
- Further discussion

REFERENCES

APPENDICES

- **Appendix I:** Checklist for the CPUE standardization protocol
- Further information in forms of description, figures, or table

Table 1 Summary of explanatory variables used in GLM*.

Variables		Number of categories	Detail	Note
Year	*Year*	25	1994–2018	
Month	*Month*	5	August–December	
Fishing area	*Area*	5	I–V	*see* Fig. 1
Vessel size	*Grt1*	10	$Grt<20$, $20\leqq Grt<40$, ..., $180\leqq Grt<200$ tons	at intervals of 20 tons
	Grt2	5	$Grt<40$, $40\leqq Grt<80$, ..., $160\leqq Grt<200$ tons	at intervals of 40 tons
Sea surface temperature	*Sst1*	12	$Sst<10$, $10\leqq Sst<11$, ..., $20\ ^{o}C\leqq Sst$	at intervals of 1°C
	Sst2	5	$Sst<10$, $10\leqq Sst<13$, ..., $19\ ^{o}C\leqq Sst$	at intervals of 3°C

**All of the tables and figures in this document template are presented as an example.*

Table 2 Result of model selection

No	$\eta(t_i)$	ϕ	Adj. R^2	Dev. expl. %	BIC	*d*
1	$\beta_0+\beta^{Y}_{year_i}$	0.84	0.122	13.9	211201	26
2	$\beta_0+\beta^{Y}_{year_i}+\beta^{M}_{month_i}$	0.83	0.132	15.1	210828	29
3	$\beta_0+\beta^{Y}_{year_i}+\beta^{M}_{month_i}\middle|\beta^{Y}_{year_i}$	0.79	0.155	18.7	210330	97
4	$\beta_0+\beta^{Y}_{year_i}+\beta^{M}_{month_i}\middle|\beta^{Y}_{year_i}+\beta^{V}_{Idves_i}$	0.73	0.194	23.0	**209391**	148
5	$\beta_0+\beta^{Y}_{year_i}+\beta^{M}_{month_i}+\beta^{V}_{Idves_i}$	0.76	0.171	19.3	209958	80

β_0 – intercept, $\beta^{Y}_{year_i}$ – coefficient of *i*-th year ($year_i$), $\beta^{M}_{month_i}$ – coefficient of *i*-th month ($month_i$), $\beta^{V}_{Idves_i}$ – coefficient of *i*-th unique ID of a vessel ($Idves_i$).

Table 3 Analysis of deviance table

	SS	Df	F	Pr(>F)	Signif. codes
Year	453.8	24	39.35	< 2.2e-16	***
Month	117.3	1	244.06	< 2.2e-16	***
Grt1	265.9	7	79.03	< 2.2e-16	***
Sst2	51.1	4	26.60	< 2.2e-16	***
Year:Month.int	1067.4	72	30.85	< 2.2e-16	***
Year:Area.int	296.3	48	12.85	< 2.2e-16	***
Year:Grt.int	258.6	48	11.21	< 2.2e-16	***
Month.int:Area.int	45.4	6	15.734	< 2.2e-16	***
Month.int:Grt.int	33.5	6	11.624	4.74E-13	***
Area.int:Grt.int	39.4	6	13.651	1.50E-15	***
Residuals	19277.7	40113			

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 4 Nominal and standardized CPUEs of Japanese stick-held dip net fishery for Pacific saury from 1994 to 2018.

Year	Nominal CPUE (metric ton / hauls)	Standardized CPUE	CV (%)	95% CI	
				Lower	Upper
1994	5.38	2.93	3.53	2.74	3.14
1995	4.41	2.16	6.53	1.90	2.44
1996	2.40	1.62	4.69	1.48	1.77
1997	4.77	3.58	12.93	2.79	4.63
1998	1.44	1.02	3.86	0.94	1.09
1999	1.45	0.75	3.97	0.70	0.81
2000	2.18	1.37	4.38	1.26	1.49
2001	3.18	2.06	5.64	1.84	2.32
2002	1.93	1.15	5.66	1.02	1.29
2003	3.21	2.17	4.27	2.01	2.37
2004	3.65	2.51	3.95	2.33	2.71
2005	6.63	4.38	4.05	4.03	4.72
2006	6.03	3.93	4.30	3.61	4.28
2007	7.81	4.05	4.31	3.73	4.40
2008	7.81	4.93	4.06	4.56	5.31
2009	4.60	3.58	4.43	3.29	3.92
2010	2.73	1.49	3.66	1.37	1.59
2011	4.45	2.36	4.01	2.19	2.55
2012	3.65	2.31	4.31	2.12	2.52
2013	3.04	1.43	3.88	1.33	1.55
2014	5.42	2.49	3.64	2.32	2.67
2015	2.65	1.34	4.43	1.23	1.46
2016	2.82	1.50	5.94	1.33	1.68
2017	1.40	1.08	4.23	1.00	1.17
2018	2.96	1.40	3.91	1.30	1.52

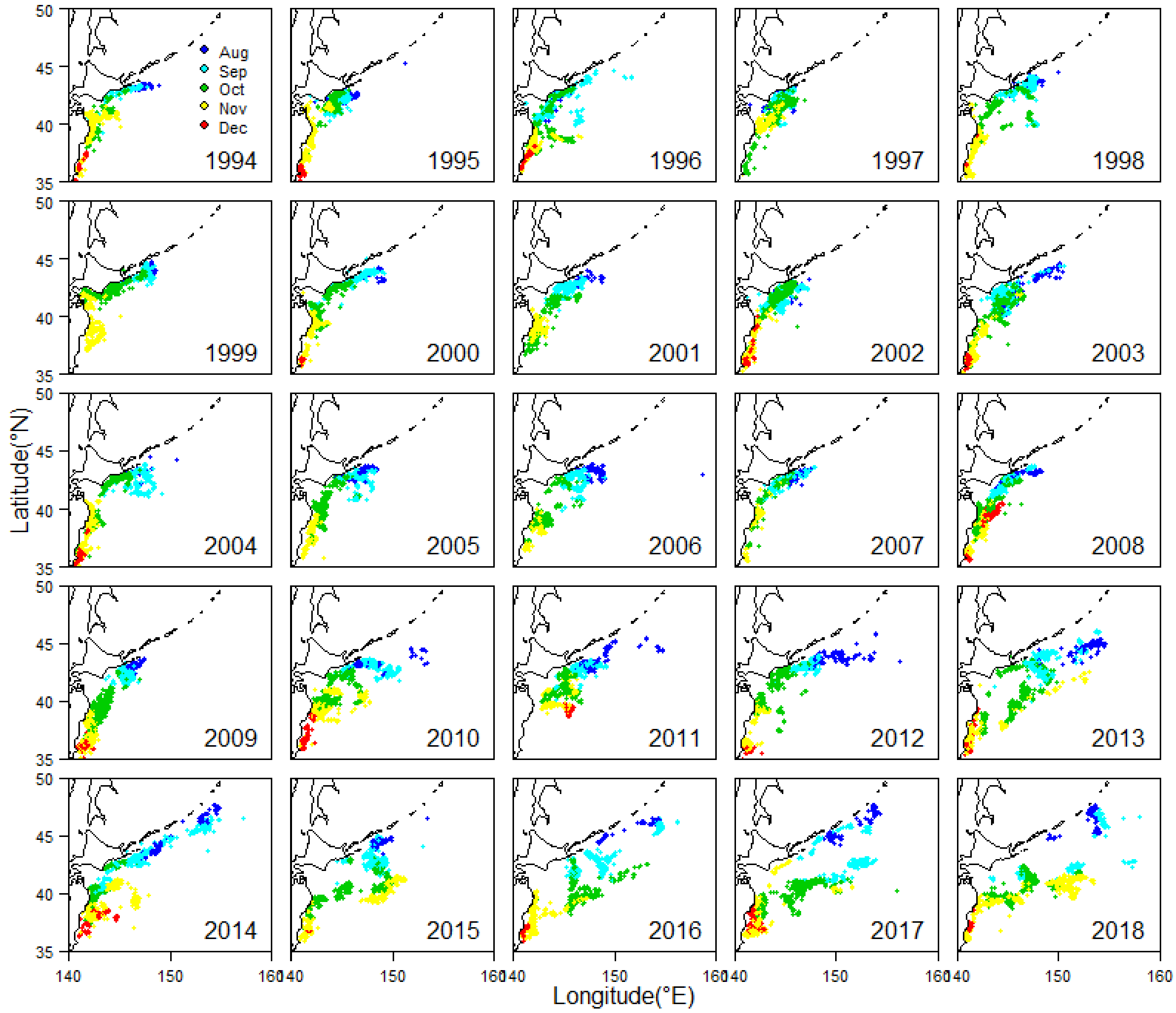

Fig. 1 Inter-annual variation of monthly fishing ground of Japanese stick-held dip net fishery for Pacific saury from 1994 to 2018.

Fig. 2 Correlation matrix of explanatory variables used in the analysis.

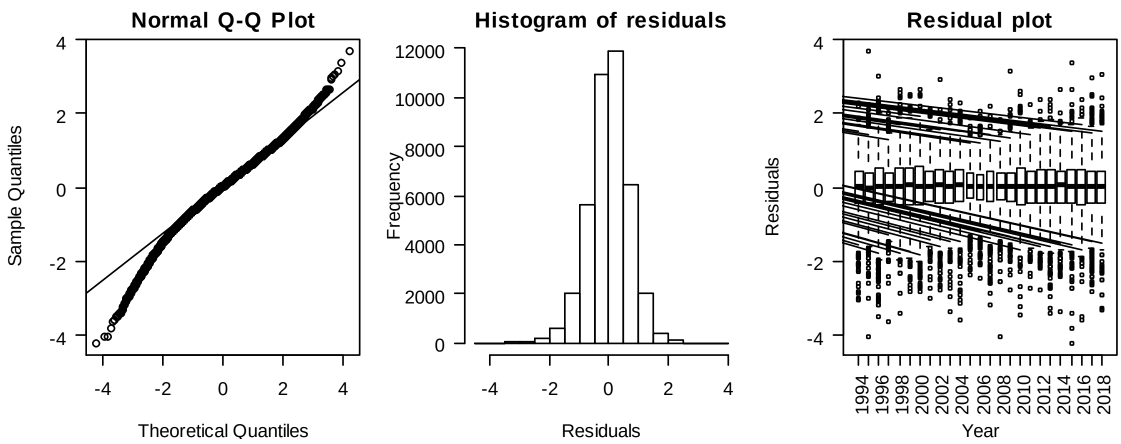

Fig. 3 Q-Q plot, histogram of residuals and residual plots across years for the best GLM.

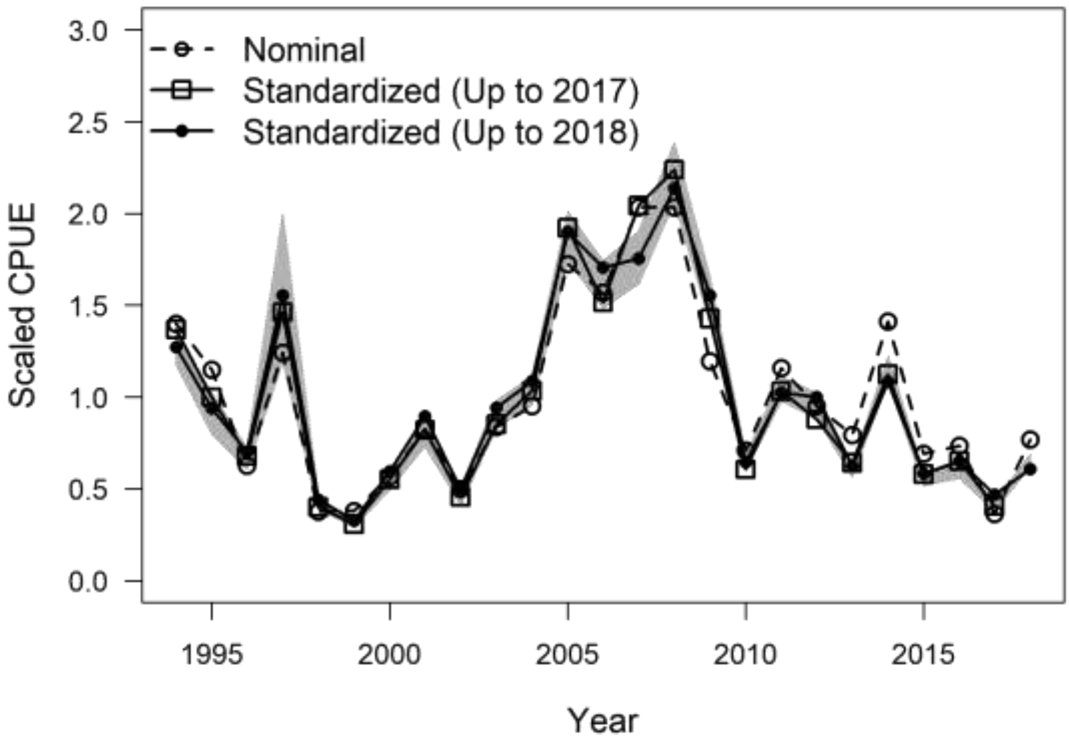

Fig. 4 A scaled nominal CPUE series and two scaled standardized CPUE series with catch and effort data up to 2017 and 2018. Gray zone indicates 95% confidence band for the standardized CPUE up to 2018.

Updated total catch, CPUE standardizations and biomass estimates for the stock assessment of Pacific saury

Year	Total catch (metric tons)	Biomass JPN (Observed biomass)*	CPUE_ CHN (metric tons per day)	CPUE JPN_early (metric ton per net haul)	CPUE JPN_late (metric tons per net haul)	CPUE KOR (metric tons per day)	CPUE RUS (metric tons per day)	CPUE CT (metric tons per net haul)
1980	238510			0.72				
1981	204263			0.63				
1982	244700			0.46				
1983	257861			0.87				
1984	247044			0.81				
1985	281860			1.4				
1986	260455			1.13				
1987	235510			0.97				
1988	356989			2.36				
1989	330592			3.06				
1990	435869			1.95				
1991	399017			3.13				
1992	383999			4.32				
1993	402185			3.25				
1994	332509				2.93		16.9	
1995	343743				2.16		20.2	
1996	266424				1.62		16.1	
1997	370017				3.58		11.7	
1998	176364				1.02		12.4	
1999	176498				0.75		12.6	
2000	286186				1.37		17.1	
2001	370823				2.06	7.15	21.1	1.79
2002	328362				1.15	8.58	20	1.59
2003	444642	1,068.6			2.17	12.78	35.9	2.29
2004	369400	965.4			2.51	9.04	47.1	1.57
2005	473907	905.9			4.38	14.16	49.6	1.93
2006	394093	764.0			3.93	13.47	34.6	1.34
2007	520207	647.1			4.05	12.39	43.2	2.12

2008	617509	871.8			4.93	16.65	42.4	2.73
2009	472177	651.7			3.58	8.69	21.3	1.46
2010	429808	471.0			1.49	11.94	23.7	1.89
2011	456263	648.6			2.36	8.97	28.5	2.35
2012	460544	421.6			2.31	8.12	24.4	2.66
2013	423790.3	654.1	14.01		1.43	8.84	22.2	3.05
2014	629576.4	505.5	16.27		2.49	14.22	25.3	3.55
2015	358882.7	422.0	17.78		1.34	6.35	16.5	3.29
2016	361687.6	357.5	9.36		1.5	9.2	17.9	2.77
2017	262639.4	176.6	8.57		1.08	6.03	8.6	1.86
2018	439079.0	420.0	15.96		1.4	7.67	26	3.26
2019	238510**	294.7						

* Observed biomass corresponds to $\sum_i^N (d_i \cdot A_i)$, where d_i and A_i denote mean density and area in stratum i.

** Preliminary catch statistics.

Specifications of the BSSPM for the updated stock assessment

	New base case (NB1)	**New base case (NB2)**	**Sensitivity case (NS1, NS2)**	**Sensitivity case (NS3, NS4)**
Initial year	1980	1980	1980	1980/2001
Biomass survey	B_obs = B_est*q1 ~ LN(log(q*B), s^2) q~U(0, 1)	Same as left	q~U(0, 2)	q~U(0, 1) 2003-2019
CPUE	CHN(2013-2018) JPN_early(1980-1993) (with time-varying q) JPN_late(1994-2018) KOR(2001-2018) RUS(1994-2018) CT(2001-2018)	CHN(2013-2018) JPN_late(1994-2018) KOR(2001-2018) RUS(1994-2018) CT(2001-2018)	Two sets as on the left for NS1 and NS2 respectively	NS3: Joint CPUE 2001-2019 (no JPN_early) NS4: Joint CPUE 2001-2019 and JPN_early
Variance component	Variances of logCPUEs are assumed to be common and 6 times of that of logbiomass	Variances of logCPUEs are assumed to be common and 5 times of that of logbiomass	Same as base cases 1 and 2, respectively	Same weight between biomass and joint CPUE
Hyper-depletion/ stability	A common parameter for all fisheries but JPN_early, with a prior distribution, b ~ U(0, 1) but [b_JPN_early=1]	A common parameter for all fisheries with a prior distribution, b ~ U(0, 1)	Same as base cases 1 and 2, respectively	b ~ U(0, 1)
Prior for other than q_biomass	Own preferred options	Own preferred options	Own preferred options	Own preferred options

Template for stock status information and future projection

Table 1. Description of symbols used in the stock assessment

Symbol	Description
C_{2018}	Catch in 2018
$AveC_{2016\text{-}2018}$	Average catch for a recent period (2016–2018)
$AveF_{2016\text{-}2018}$	Average harvest rate for a recent period (2016–2018)
F_{2018}	Harvest rate in 2018
F_{MSY}	Annual harvest rate producing the maximum sustainable yield (MSY)
MSY	Equilibrium yield at FMSY
F_{2018}/F_{MSY}	Average harvest rate in 2018 relative to FMSY
$AveF_{2016\text{-}2018}/F_{MSY}$	Average harvest rate for a recent period (2016–2018) relative to FMSY
K	Equilibrium unexploited biomass (carrying capacity)
B_{2018}	Stock biomass in 2018 estimated in the model
B_{2019}	Stock biomass in 2019 estimated in the model[b]
$AveB_{2017\text{-}2019}$	Stock biomass for a recent period (2017–2019) estimated in the model[b]
B_{MSY}	Stock biomass that will produce the maximum sustainable yield (MSY)
B_{MSY}/K	Stock biomass that produces the maximum sustainable yield (MSY) relative to the equilibrium unexploited biomass[a]
B_{2018}/K	Stock biomass in 2018 relative to K[a]
B_{2019}/K	Stock biomass in 2019 relative to K[a,b]
$B_{2017\text{-}2019}/K$	Stock biomass in the latest time period (2017-2019) relative to the equilibrium unexploited stock biomass[a,b]
B_{2018}/B_{MSY}	Stock biomass in 2018 relative to BMSY[a]
B_{2019}/B_{MSY}	Stock biomass in 2019 relative to BMSY[a,b]
$B_{2017\text{-}2019}/B_{MSY}$	Stock biomass for a recent period (2017–2019) relative to the stock biomass that produces maximum sustainable yield (MSY) [a,b]

[a]calculated as the average of the ratios,

[b]Japanese biomass survey available but no CPUE available in 2019.

Table 2. Summary of reference points based on the 20,000 MCMC iterations (10,000 times 2 new base case models)

Appendix Table 1. Summary of reference points based on the 10,000 MCMC iterations for new base case model 1

Appendix Table 2. Summary of reference points based on the 10,000 MCMC iterations for new base case model 2

Symbol	Mean	Median	Lower 10th	Upper 10th
C_{2018}				
$AveC_{2016-2018}$				
$AveF_{2016-2018}$				
F_{2018}				
F_{MSY}				
MSY				
F_{2018}/F_{MSY}				
$AveF_{2016-2018}/F_{MSY}$				
K				
B_{2018}				
B_{2019}				
$AveB_{2017-2019}$				
B_{MSY}				
B_{MSY}/K				
B_{2018}/K				
B_{2019}/K				
$B_{2017-2019}/K$				
B_{2018}/B_{MSY}				
B_{2019}/B_{MSY}				
$B_{2017-2019}/B_{MSY}$				

Table 3. Description of symbols used in stock assessment models

Symbol	Description	Axis
r	Intrinsic growth rate	NB1-NB2; NS1-NS4
qCHN	Catchability CHN	Ditto
qJPN1	Time-varying catchability JPN1	NB1, NS1
qJPN2	Catchability JPN2	NB1-2, NS1-NS4
qKOR	Catchability KOR	Ditto
qRUS	Catchability RUS	Ditto
qCT	Catchability CT	Ditto
qBio	Catchability JPN biomass	Ditto
M	Shape parameter	Ditto
σcom	Common observation SD of log CPUE	Ditto
σBio	Observation SD of log JPN biomass	Ditto
τ	Process error	Ditto
b	Hyperstability of 1994-2017 CPUE	Dittos

Appendix Table 3. Summary of parameter estimates based on the 10,000 MCMC iterations base case model

Symbol	Mean	Median	Lower 10th	Upper 10th
r				
K				
qCHN				
qJPN1				
qJPN2				
qKOR				
qRUS				
qCT				
qBio				
Shape				
σ				
σBio				
τ				
FMSY				
BMSY				
MSY				
b				

DIAGNOSTICS

- o Standardized residuals of CPUEs and JPNbio for each of 2 new base case models (in Appendix)
- o Retrospective plots removing data for years 2019-2014. Each run should replicate the terminal year in base case models with survey biomass only in last year. Single plot for each model (in Appendix). Time trajectories for Bratios and Fratios with 2,000 MCMC iterations for each of the retrospective years.

TIME SERIES PLOT

- Time series of biomass (with reference lines of K and BMSY), harvest rate (with reference line of FMSY), Bratio (B/Bmsy)[a], Fratio (F/Fmsy)[a], B/K[a],
- Plot posterior median of each base case model (10,000 MCMC iterations) in one figure
- Plot the posterior median over all 2 base case models (20,000 MCMC iterations) in one figure with 80% credible intervals.

[a]calculated as the median (with 80% C.I.) of the ratios

KOBE PLOT

- Kobe plot showing median Fratio2018 and Bratio2018 calculated from 2 new base case models (10,000 MCMC iterations of each base case model).
- Kobe plot showing average 2016-2018 Fratio and average 2017-2019 Bratio calculated from 2 new base case models (10,000 MCMC iterations of each base case model).
- Kobe plot showing 1980-2018 time series of median Fratio and Bratio. Each point is the median value calculated from 20,000 MCMC iterations (10,000 MCMC iterations of each new base case model).
- o With the contour of 80% C.I. in the 2018 and pie chart of the proportion of 20,000 MCMC iterations in each of four quadrants.

FUTURE PROJECTION

- Recent catch projection
- o Average of 2016-2018
- Projections assuming constant catch during 2020-2023. All scenarios assume 2019 catch equals X metric tons which is the average of 2016-2018 catches
- o +30% of X
- o +20% of X

- +10% of X
- X (average of 2016-2018)
- -10% of X
- -20% of X
- -30% of X
- No catch

- Projection years
  - 2020-2024
- Projection plot (over 2 new base case models)
  - Median of biomass trajectories (1980-2024) from 8 catch scenarios. Results of each scenario are median of 20,000 MCMC iterations calculated over 2 new base case models.
- Risk table (over all 2 models)
  - Columns (probability of each quadrant of the Kobe plot)
  - Rows (8 catch scenarios)

Data availability on size composition and catch/CPUE for Pacific saury

(updated by SSC PS05 in November 2019)

Length composition	China	Japan	Korea	Russia	Chinese Taipei	Vanuatu
Size category	1cm bin	a) Com fish: 1cm bin b) Survey: 1cm bin	a) Catch by size group (3 classes) b) 1cm	a) Catch by size group (3 classes) b) Catch by size group (5 classes) c) 1cm	a) Catch by size group (5 classes) b) Catch by size group (6 classes) c) 1cm	Catch by size group (6 classes)
Period of data	2013-	a) 1950- b) 2003-	a) 2001-2015 b) 2001-	a) 1956- b) 1960- c) 2003-	a) 2001-2008 b) 2009- c) 2006-	2013-
Sampling fraction	little	a) 5,000 (/yr) b) 100 (/sampling station)	a) 20-100%* b) a little	a), b), c) sample size 3,700-56,700	a), b) 100%* c) sample size 360-400 (/yr)	100%*
Spatial coverage	Fishing grounds in CA	a) mostly in NW b) Lat 38-48N & Long 143E-165W	a),b) Fishing grounds in CA	a), b), c) Mostly in fishing grounds in Russian EEZ	a), b), c) Fishing area in CA	Fishing area in CA
Temporal coverage	By month (Aug-Oct)	a) by day (Aug-Dec) b) by sampling occasion (Jun)	a),b) By month in fishing season (May-Dec)	a), b) by year c) by month (Aug-Nov)	a), b) by month (Jun-Dec) c) by month (Oct-Nov)	By month (Jul-Nov)
Comment			*from log book		*from log book	*from log book
Catch/CPUE	China	Japan	Korea	Russia	Chinese Taipei	Vanuatu
Spatial coverage	By 1-deg grid in CA	NW and CA (1-deg grid)	By 1-deg grid in CA	NW and CA (1-deg grid)	By 1-deg grid in CA	By 1-deg grid in CA
Temporal coverage	By month (Aug-Dec)	By month (Aug-Dec)	By month (May-Dec)	By month (Aug-Nov)	By month (Jun-Dec)	By month (Jul-Nov)

Specifications and timelines for submitting data on size composition and catch for Pacific saury

Member	Year		Type of data			Resolution of data	Deadline for data submission		
	From	To	Total catch Number of fish in each mesh	Size composition by 1cm	Total weight by market size category		Total catch Number of fish in each mesh (**-2018**)	Size composition in each mesh (**2019**)	Total catch Number of fish in each mesh (**2019**)
China	2014	2018	○	○		1 month 1*1°grid	Late Jan 2020		
Japan	2000	2018	○	○			Late Jan 2020	Late Mar 2020	Late Jul 2020
Korea	2001	2018	○		○		Mid Feb 2020		
Russia	2000	2018	○	○			Mid Feb 2020	Late Mar 2020	
Chinese Taipei	2007	2018	○	○	○		Mid Feb 2020	Late Jul 2020	
Vanuatu	2013	2018	TBD		○				

Template for sharing data on size composition and catch for Pacific saury

Member	Year	Month	Duration (Month, Early, Middle, Late, Date)	Center of grid		Mesh size of Grid	Catch amount (metric ton)	Effort		Estimated catch by ages (N. Individuals)		Measurement length (FL, TL, KnL, BL)	Estimated catch by length class in each 1cm (N. Individuals)																						Total weight by market size category					
				Latitude (°N)	Longitude (°E)			Total operation days for all vessels	Total net hauls for all vessels	Age-0	Age-1		<15	15≤	16≤	17≤	18≤	19≤	20≤	21≤	22≤	23≤	24≤	25≤	26≤	27≤	28≤	29≤	30≤	31≤	32≤	33≤	34≤	35≤	EX-large	No.1	No.2	No.3	No.4	No.5