North Pacific Fisheries Commission

2nd Meeting of the Small Scientific Committee on Pacific Saury
REPORT

21-22 April 2017

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North Pacific Fisheries Commission
2nd Meeting of the Small Scientific Committee on Pacific Saury

21-22 April 2017
Shanghai, China

REPORT

Agenda Item 1. Opening of Meeting

1. The 2nd Meeting of the Small Scientific Committee on Pacific Saury (SSC PS) took place in Shanghai, China on 21-22 April 2017, and was attended by Members from China, Japan, the Republic of Korea, the Russian Federation, and Chinese Taipei, and the United States of America had an advisor present. Vanuatu attended as an observer. The meeting was opened by Dr. Toshihide Iwasaki (Japan) who served as the SSC PS Chair.

2. Dr. Xinjun Chen, Professor and Dean of the College of Marine Science, Shanghai Ocean University, offered opening remarks on behalf of the host Member. Dr. Chen welcomed the participants and highlighted importance of ensuring the sustainability and healthy stock of Pacific saury. He expressed his hope that the meeting would yield fruitful discussions, and contribute to the conservation and management of Pacific saury.

Agenda Item 2. Adoption of Agenda

3. The participants proposed a new agenda item, Agenda Item 8. Future Work and New Information. Under the aforementioned agenda item, Russia proposed to present its alternative stock assessment, and Japan proposed to present its future working plan.

4. Korea proposed the presentation of its report on the Pacific saury data collection template under Agenda Item 7. Data Collection and Management.

5. The revised agenda was adopted.

Agenda Item 3. Meeting Arrangements

6. The Science Manager Dr. Aleksandr Zavolokin outlined the meeting schedule and Mr. Alexander Meyer was selected as Rapporteur.

Agenda Item 4. Review of Fisheries through Presentation of Annual Reports

7. The participants reviewed their respective Pacific saury fisheries in the Convention Area and EEZs referring to NPFC01-2017-AR-Annual Summary Footprint – Pacific saury.

8. Vanuatu reported that its total catch of Pacific saury in 2016 was 7,331 tons. Vanuatu had 4 vessels in the Convention Area in 2016.

9. China noted that Japan's catch data for 2014 were still preliminary. Japan explained that the preliminary data were based on port data and that it needed the ocean log books to finalize the data. China suggested that Japan compare the preliminary and final data for all years up to and including 2013 to verify the quality of the preliminary data.

10. Total catch of Pacific saury in 2016 was 362 thousand tons which is similar to 2015.

Agenda Item 5. Stock Status of Pacific Saury

5.1 Reports of the previous meetings on Pacific saury stock assessment and recommendations

5.1.1 Previous meeting reports

11. The Chair of the Technical Working Group on Pacific Saury Stock Assessment (TWG PSSA), Dr. Mitsuo Sakai (Japan), presented the reports of the Pacific Saury Stock Assessment workshop (WS PSSA) and TWG PSSA meeting, as well as recommendations made by the TWG PSSA (NPFC-2017-TWG PSSA01-Final Report).

12. The TWG PSSA Chair reported that the WS PSSA, held in Busan from 13 to 15 December 2016, reviewed the Pacific saury fisheries status and assessment, agreed to a catch per unit effort (CPUE) standardization protocol, agreed on the Bayesian state-space biomass dynamic model as a base model, agreed to a maximum sustainable yield (MSY) approach with FMSY and BMSY as reference points, approved a stock assessment protocol, and agreed that Members should submit CPUE standardization documents.

13. The TWG PSSA Chair reported that the 1st TWG PSSA meeting, held in Yokohama from 20 to 22 February 2017, explored three base-case scenarios with differing survey catchability of the Japanese survey biomass index and conducted a sensitivity analysis without using the Japanese survey biomass index.

14. TWG-PSSA coordinated stock assessment analysis by employing the Bayesian state-space biomass dynamic models. The models account for process error in addition to observation error in the biomass indices such as standardized CPUE series for commercial fisheries submitted

by Members as well as fishery-independent survey by Japan. Based on the TWG PSSA recommendations (Paragraph 33), following three base-case scenarios differing in survey catchability (q) of the Japanese survey biomass index were explored: 1) including CPUEs and q prior defined from 0 to 1, 2) including CPUEs and q prior fixed at 1, 3) including CPUEs and q prior defined from 0 to larger than 1 (free q). The TWG PSSA also had a lengthy discussion of the caveats associated with using Japan's survey data because the survey q tended to have a value larger than 1, which suggests that the survey biomass may be overestimated due to possible herding by the trawl gear or extrapolating fish abundance to the unfished regions with less abundant Pacific saury. Therefore, a sensitivity analysis was conducted without using the Japanese survey biomass index (excluding survey q).

5.1.2 Review of stock status report

15. Along with the specification agreed in the 1st TWG PSSA meeting, China, Japan, and Chinese Taipei conducted analyses. Comparison of the estimated parameters by three Members is shown in the Table in Annex D. Mean MSY (x10,000 mt) evaluated by China, Japan and Chinese Taipei ranged from 50.65 to 59.35, 51.4 to 62.2, and 54.23 to 60.67 respectively. B2016/BMSY (>1) and F2015/FMSY (<1) values calculated by all members showed a healthy stock status.

16. Based on the model results, 1) China concluded that the exploitable biomass was above BMSY and the current fishing mortality is below FMSY, suggesting that the Pacific saury was not overfished and is not experiencing overfishing. 2) Chinese-Taipei concluded that the current stock status Pacific saury does not appear to have been overfished or to have experienced overfishing and is likely within the green quadrant. The stock assessment concludes that Western North Pacific saury is healthy and is sufficient to sustain recent exploitation levels. 3) Japan's results show that the current biomass level is likely above the level of BMSY for all scenarios and the current fishing intensity level is likely lower than FMSY for all scenarios.

17. The participants discussed the inclusion of environmental factors in the stock assessment. The participants noted that a number of environmental factors were incorporated in the CPUE standardization, but acknowledged that it was necessary to determine the main environmental factors.

18. Korea suggested that predation information should be included in the stock assessment. China suggested that ecosystem changes need to be monitored, and that if there were any dramatic increase in predation that impacted stock, predator abundance needs to be considered in the stock assessment.

5.2 Pacific saury stock status

19. The SSC PS concluded that despite small variations among the three stock assessments and among the three base-case scenarios it is likely that the Pacific saury stock is not overfished with median B2016/BMSY varying from 1.16 to 1.46 and it is likely that overfishing is not occurring with median F2015/FMSY varying from 0.40 to 0.69. The sensitivity run, which excludes the survey data, also supports this conclusion with median B2016/BMSY varying from 1.19 to 1.34 and median F2015/FMSY varying from 0.50 to 0.65.

Agenda Item 6. Review of the CMM 15-02 for Pacific saury

6.1 Review of implementation of the CMM 15-02 and its effects to the stock

20. The participants reviewed CMM 2015-02 and discussed whether or not it was necessary to revise it.

21. The participants recommend maintaining CMM 2015-02 in its current form and not expanding fishing efforts in 2018.

6.2 Any other actions required for the conservation and management

22. The participants suggested that more data on the impact of illegal, unreported and unregulated (IUU) fishing and bycatch, and catch discarding on Pacific saury stock in the North Pacific Ocean were needed.

6.3 Advice and recommendations in accordance with Article 10 subparagraph 4(b)

23. Japan presented information for considering a time/area-based CMM for Pacific saury (NPFC-2017-SSC PS02-WP02). In light of the sudden decrease in the biomass of Pacific saury in 2010 in the area west of 162°E, as identified by surface trawling research cruises, Japan decided to analyze the migration ecology of Pacific saury. Based on comparison of the survey data in June-July and August-December, Japan suggested that, as a precautionary step, Members should consider conservation of age-0 fish by not extending commercial fishery grounds to the area in which age-0 fish are abundantly distributed.

24. Chinese Taipei commented that the distribution of age-0 fish required further research.

25. The participants encouraged the conducting of further research to better understand the Pacific saury spatial/temporal dynamics by age in the North Pacific Ocean.

Agenda Item 7. Data Collection and Management

7.1 Data collection templates (Corresponding Group)

26. On behalf of the Corresponding Group, Korea presented the updated data collection templates (NPFC-2017-SSCPS02-WP05).

27. The participants discussed the proposed data collection templates, but were unable to reach a consensus. The participants agreed to modify the proposed data collection templates as necessary to meet the requirements for stock assessment and management.

28. Japan presented its proposed data collection and data format for age/size structured models for Pacific saury (NPFC-2017-SSC PS02-WP01). Japan emphasized the importance to collect age and size data for future stock assessment.

7.2 Updated data on Pacific saury catches (Secretariat)

29. The Science Manager presented updated data on Pacific saury catches (NPFC-2017-SSC PS02-WP03 (Rev 1)). He informed Members that this is the most accurate data set on Pacific saury catches which the Commission has to date and encouraged Members to further improve catch figures when possible. The revised data set including Vanuatu's catch for 2013-2016 shall be posted on the NPFC website (Members Area).

Agenda Item 8. Future Work and New Information

30. Russia presented alternative Pacific saury assessment methods (NPFC-2017-SSC PS02-WP04), namely using a stock production model incorporating covariates (ASPIC), a stochastic surplus production model in continuous time (SPiCT), and a production model in discrete time (COMBI4). ASPIC and COMBI4 produced similar results for B2016/BMSY and F2015/FMSY to those obtained by the TWG PSSA. SPiCT estimates, however, were less optimistic with regard to B2016/BMSY and F2015/FMSY and contained major uncertainties. Therefore, Russia suggested that all Members provide monthly estimates of CPUE indices and catches to improve inputs for SPiCT, the use of which can help to overcome at least the discrepancy of multidirectional tendencies in CPUE indices, which possibly occur due to the differences in time and consequently space for fishing operations among Members.

31. Chinese Taipei commented on the adequacy of using the continuous surplus production model and the inclusion of observation error in catch in the SPiCT model.

32. Japan presented a proposal for improving the current production model, towards conducting the second step stock assessment for Pacific saury (NPFC-2017-SSC PS02-WP01). Japan

suggested that age/size structured models could help improve the accuracy of the estimated number of age-1 individuals, estimate egg production based on proportion of maturity by age, and estimate the recruitment of age-0 fish in the following year. Japan proposed conducting research on the appropriateness of such models. To do so, the total number of individuals by age and the total number of fished individuals is needed. Japan therefore requested that Members collect such data. Furthermore, research on migration ecology and spatio-temporal analysis of distribution patterns are necessary for effective stock assessment and appropriate utilization of Pacific saury. Japan therefore proposed that Members report the number of fished individuals by age, month and fishing ground.

33. The participants agreed to continue conducting stock assessments with the Bayesian state-space bio-mass dynamics models (BSSBDMs), although the participants also agreed that BSSBDMs are provisional base models. Therefore, the participants agreed to conduct further research on ways to improve the base model, including examining age/size structured models, as well as the inclusion of additional data, such as biological factors, environmental factors, and catch discarding data, towards conducting benchmark stock assessments.

34. Korea suggested that an observer program could improve the accuracy of age and size data. Japan explained practical difficulties for Japan in conducting such a program. The Chair reminded that discussion of an observer program would be held at the SC meeting and advised that the discussion be deferred to the SC meeting.

35. The participants agreed to continue the work of the TWG PSSA and endorsed the terms of reference for the TWG PSSA for 2017-2021 (Annex E). The participants requested the approval of the selected Chair of the TWG PSSA, Dr. Toshihide Kitakado (Japan), as well as the time and place of the next meeting, be deferred to the SC meeting.

36. The participants agreed to independently peer review the Pacific saury stock assessment at a timing and format that are to be determined at a future SSC PS meeting.

Agenda Item 9. Suggestions for the SC Research Plan and 5-year Work Plan

37. The participants discussed suggestions for the SC Research Plan (NPFC-2017-SC02-WP01) and the 5-year work plan (NPFC-2017-SC02-WP05). The participants agreed to the areas of work related to Pacific saury proposed in the SC Research Plan in principle, adding minor editorial revisions (Annex F). The participants revised the Pacific saury section of the 5-year work plan (Annex F).

38. The participants discussed Japan's suggestion on special project fund items for Pacific saury projects (NPFC-2017-SC02-WP06). The participants recommend to SC to consider budget for meeting costs of TWG PSSA and travel cost for 1 or 2 participants of each Member. Rough costs were estimated at 20,000 USD per year to be further adjusted by FAC for further consideration by the Commission.

Agenda Item 10. Other matters

Selection of next Chair

39. The participants agreed to the extension of the term of the current Chair, Dr. Toshihide Iwasaki.

Agenda Item 11. Recommendations to the Scientific Committee

40. Noting the stock status of Pacific saury (Annex D), the SSC PS recommends the following to the SC:
    a. Maintain CMM 15-02 in its current form and do not expand fishing effort in 2018.
    b. Collect more data on the impact of IUU fishing, bycatch, and catch discarding on Pacific saury stock in the North Pacific Ocean.
    c. Conduct further research to better understand the Pacific saury stock structure in the North Pacific Ocean.
    d. Modify the proposed data collection templates as necessary to meet the requirements for stock assessment and management.
    e. Continue to update stock assessments with the provisional base production model.
    f. Conduct further research on ways to improve the provisional base model, towards conducting benchmark stock assessments.
    g. Continue the work of the TWG PSSA and endorse the terms of reference for the TWG PSSA for 2017-2021 (Annex E).
    h. Endorse the new Chair of the TWG PSSA, Dr. Toshihide Kitakado, and identify the place and time of the next meeting.
    i. Independently peer review the Pacific saury stock assessment at a timing and format that are to be determined at a future SSC PS meeting.
    j. Include the suggestions for the areas of work and the 5-year work plan (Annex F) in the Research Plan.
    k. Consider budget for meeting costs of TWG PSSA and travel cost for 1 or 2 participants of each Member. Rough costs were estimated at 20,000 USD per year to be further adjusted by FAC for further consideration by the Commission.

Agenda Item 12. Next Meeting

41. The participants request the guidance of the SC for determining the date and location of the

next meeting.

Agenda Item 13. Adoption of the Report

42. The report was adopted by consensus.

Agenda Item 14. Close of the Meeting

43. The SSC PS meeting closed at 17:28 on 22 April 2017.

Annexes

Annex A – Agenda

Annex B – List of Documents

Annex C – Participants List

Annex D – Executive Summary of the Pacific saury stock assessment report

Annex E – Terms of Reference for the Technical Working Group on Pacific Saury Stock Assessment

Annex F – Suggestions from SSC PS for the SC Research Plan

Annex A

North Pacific Fisheries Commission
2nd Meeting of the Small Scientific Committee on Pacific Saury
21-22 April 2017
Shanghai, China

Agenda

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Agenda Item 2. Adoption of Agenda

Agenda Item 3. Meeting arrangements

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Agenda Item 5. Stock status of Pacific saury
- 5.1 Reports of the previous meetings on Pacific saury stock assessment and recommendations
- 5.2 Pacific saury stock status

Agenda Item 6. Review of the CMM 15-02 for Pacific saury
- 6.1 Review of implementation of the CMM 15-02 and its effects to the stock
- 6.2 Any other actions required for the conservation and management
- 6.3 Advice and recommendations in accordance with Article 10 subparagraph 4(b)

Agenda Item 7. Data collection and management
- 7.1 Data collection templates (Corresponding Group)
- 7.2 Updated data on Pacific saury catches (Secretariat)

Agenda Item 8. Future Work and New Information

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Agenda Item 14. Close of the Meeting

Annex B

LIST OF DOCUMENTS

MEETING INFORMATION PAPERS

Symbol	Title
NPFC-2017-SC02-MIP01	Meeting Notice and Information
NPFC-2017-SSC PS02-MIP02	Provisional Agenda
NPFC-2017-SSC PS02-MIP03	Provisional Annotated Agenda
NPFC-2017-SSC PS02-MIP04	Indicative Schedule
NPFC-2017-SSC PS02-MIP05	Provisional List of Documents

REFERENCE DOCUMENTS

Symbol	Title
	Convention on the Conservation and Management of High Seas Fisheries Resources in the North Pacific Ocean
	NPFC Rules of Procedure
CMM 15-02	CMM15-02_Conservation and Management Measure for Pacific Saury
CMM 2016-01	CMM On Information Requirements For Vessel Registration
CMM 2016-02	CMM To Establish A List Of Vessels Presumed To Have Carried Out IUU Activities In The NPFC CA
CMM 2016-03	CMM On The Interim Transshippment Procedures For The NPFC
CMM 2016-04	CMM On Vessels Without Nationality
CMM 2016-05	CMM For Bottom Fisheries And Protection Of VMEs In The NW Pacific Ocean
CMM 2016-06	CMM For Bottom Fisheries And Protection Of VMEs In The NE Pacific Ocean
CMM 2016-07	CMM For Chub Mackerel

WORKING PAPERS

Symbol	Title
NPFC-2017-SSC PS02-WP01	Japan's Proposal On The Second Step Stock Assessment For Pacific Saury
NPFC-2017-SSC PS02-WP02	Japan's Consideration On Time/Area-Based Conservation And Management Measure For Pacific Saury
NPFC-2017-SSC PS02-WP03 (Rev. 1)	Compiled Data On Pacific Saury Catches In The Northwestern Pacific Ocean (1950-2016)
NPFC-2017-SSC PS02-WP04	Alternative stock assessments of Pacific saury in the western North Pacific Ocean
NPFC-2017-SSC PS02-WP05	Progress Report on the Pacific Saury (PS) Data Collection Template
NPFC-2017-SC02-WP01	Draft 2017-2021 Research Plan

INFORMATION PAPERS

Symbol	Title

OBSERVER PAPERS

Symbol	Title

REPORTS FROM WORKING GROUPS AND SSCs

Symbol	Title
NPFC-2016-WS PSSA01-Final Report	PSSA Workshop Final Report
NPFC-2017-TWG PSSA01-Final Report	TWG PSSA Meeting Final Report

ANNUAL REPORTS

Symbol	Title
NPFC-2017-AR Canada	2016 Annual Report of Canada
NPFC-2017-AR China	2016 Annual Report of China
NPFC-2017-AR Japan (Rev 1)	2016 Annual Report of Japan (Rev 1)
NPFC-2017-AR Korea	2016 Annual Report of Republic of Korea
NPFC-2017-AR Chinese Taipei	2016 Annual Report of Chinese Taipei
NPFC-2017-AR Russia	2016 Annual Report of Russian Federation
NPFC-2017-AR United States of America	2016 Annual Report of United States of America
NPFC-2017-AR-Annual Summary Footprint – Pacific Saury	Annual Summary Footprint For Pacific Saury Fisheries In The NPFC Area Of Competence

Annex C

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Annex D

PACIFIC SAURY STOCK ASSESSMENT

1. Executive Summary

This report provides an analysis and evaluation of the current status of Pacific saury (*Cololabis saira*) stock in the North Pacific Ocean through the stock assessment procedures by employing the Bayesian state-space biomass dynamic model. The saury is widely distributed from the subarctic to the subtropical regions of the North Pacific Ocean, while their fishing grounds are limited to the west of 165 ^{0}E. However, the main fishing grounds differ among Members (China, Japan, Korea, Russia and Chinese Taipei,). For example, the Convention Area is the main fishing ground for China, Korea and Chinese Taipei while Japan and Russia fish mainly in their own EEZs. This report summarizes the results of the meeting of the Technical Working Group for Pacific saury stock assessment (TWG PSSA), held at Yokohama from 20-22 February 2017 and further analyses made by TWG PSSA

TWG-PSSA conducted stock assessment analysis by employing the Bayesian state-space biomass dynamic models. The models account for process and model errors in addition to observation errors in the biomass indices such as standardized CPUE series for commercial fisheries by Members as well as fishery-independent survey by Japan. Based on the TWG PSSA recommendations (Paragraph 33), following three base-case scenarios differing in survey catchability (q) of the Japanese survey biomass index were explored: 1) including CPUEs and q prior defined from 0 to 1, 2) including CPUEs and q prior fixed at 1, 3) including CPUEs and q prior defined from 0 to larger than 1 (free q). A sensitivity analysis was conducted without using the Japanese survey biomass index (excluding survey q).

Comparison of estimated parameters by China, Japan and Chinese Taipei are shown in the Table 8-1. Mean MSY (x10,000 mt) evaluated by China, Japan and Chinese Taipei ranged from 50.65 to 59.35, 51.4 to 62.2, and 54.23 to 60.67 respectively. For the base-case scenario-3 (S3, free q), estimation of q value was above 1. B_{2016}/B_{MSY} (>1) and F_{2015}/F_{MSY} (<1) values calculated by all members showed a healthy trend.

Based on the model results, 1) China concluded that the exploitable biomass was above B_{MSY} and the current status of stock indicates that the Pacific saury was not overfished and is not experiencing overfishing. 2) Chinese-Taipei concluded that based on the current stock status Pacific saury did not appear to be overfished and is not experiencing overfishing. 3) Japan results shows that the biomass level is currently above the level of MSY for any scenarios and concluded that the continuation of the current catch level may not cause severe decline in the population size in the next decade, but recommended a status quo level or reduction of catch to keep the population size above the MSY level.

Table 8-1 Summary of the estimated key parameters and management quantities by China, Japan, and Chinese Taipei, based on three scenarios.

Scenarios	Parameters	China		Japan		Chinese Taipei	
		mean	median	mean	median	Mean	median
S1 (q 0-1)	K (10,000 mt)	790.26	704.00	579.4	511.2	462.80	444
	r	1.03	0.77	0.965	0.704	0.73	0.61
	Shape (s, Z, M)	0.57	0.32	0.729	0.569	0.99	0.79
	B_{1980}/K	0.14	0.32	0.185	0.175	0.19	0.18
	MSY (10,000 mt)	59.35	57.07	62.2	59.5	60.67	58.34
	F_{MSY}	0.19	0.18	0.251	0.248	0.33	0.32
	B_{MSY} (10,000 mt)	346.66	310.1	265.5	237.1	224.8	216.70
	B_{1980} (10,000 mt)	105.98	97.91	102.7	91.8	88.38	82.92
	B_{2015} (10,000 mt)	356.63	333.1	364.9	328.5	307	292.60
	F_{1980}	0.25	0.24	0.269	0.259	0.36	0.34
	F_{2015}	0.11	0.11	0.108	0.110	0.13	0.13
	q5 (Biomass)	0.77	0.79	0.779	0.815	0.82	0.85
	B_{2016}/K	0.51	0.52	0.702	0.680	0.7	0.7
	B_{2016}/B_{MSY}	1.16	1.18	1.529	1.463	1.44	1.44
	F_{2015}/F_{MSY}	0.64	0.58	0.522	0.433	0.43	0.4
S2 (q=1)	K (10,000 mt)	615.85	527.80	466.6	414.3	390.8	381
	r	1.13	0.89	1.022	0.765	0.76	0.65
	Shape (s, Z, M)	0.56	0.33	0.74	0.49	1.08	0.85
	B_{1980}/K	0.14	0.14	0.173	0.167	0.19	0.18
	MSY (10,000 mt)	54.48	52.91	56.4	54.9	57.19	55.05
	F_{MSY}	0.22	0.22	0.281	0.279	0.36	0.35
	B_{MSY} (10,000 mt)	268.16	237.40	213.5	197.6	192.30	189.10
	B_{1980} (10,000 mt)	78.66	75.43	75.4	72.3	72.39	69.77
	B_{2015} (10,000 mt)	261.56	260.00	264.2	263.5	246.50	243.70
	F_{1980}	0.32	0.32	0.341	0.329	0.45	0.42
	F_{2015}	0.14	0.14	0.139	0.137	0.16	0.16
	q5 (Biomass)	1	1	1	1	1	1
	B_{2016}/K	0.5	0.52	0.657	0.641	0.68	0.68
	B_{2016}/B_{MSY}	1.13	1.16	1.421	1.375	1.38	1.38
	F_{2015}/F_{MSY}	0.70	0.64	0.543	0.496	0.47	0.45
S3 (free q)	K (10,000 mt)	457.96	409.8	310.70	267.80	223.8	200.1
	r	1.28	1.13	1.212	0.993	0.97	0.9
	Shape (s, Z, M)	0.56	0.36	0.827	0.676	0.17	1.68
	B_{1980}/K	0.14	0.14	0.164	0.158	0.18	0.18
	MSY (10,000 mt)	50.65	48.66	51.40	49.70	54.23	53.04
	F_{MSY}	0.29	0.28	0.394	0.390	1	0.69
	B_{MSY} (10,000 mt)	200.97	178.80	144.30	125.50	117.8	108.80
	B_{1980} (10,000 mt)	63.39	55.79	49.30	42.90	40.98	34.95
	B_{2015} (10,000 mt)	210.86	189.20	169.80	147.90	131.4	113.70
	F_{1980}	0.46	0.43	0.571	0.555	2.83	1.14
	F_{2015}	0.21	0.19	0.244	0.244	0.59	0.37
	q5 (Biomass)	1.46	1.37	1.774	1.802	2.46	2.16
	B_{2016}/K	0.51	0.51	0.623	0.604	0.66	0.67
	B_{2016}/B_{MSY}	1.15	1.16	1.317	1.266	1.22	1.22
	F_{2015}/F_{MSY}	0.72	0.69	0.640	0.610	0.58	0.53
Sensitivity test S4 (no biomass)	K (10,000 mt)	536.15	454.75	375.7	303.3	216	189.2
	r	1.25	1.07	1.143	0.939	0.96	0.89
	Shape (s, Z, M)	0.56	0.35	0.823	0.673	1.86	1.87
	B_{1980}/K	0.14	0.31	0.167	0.16	0.18	0.18
	MSY (10,000 mt)	52.92	50.16	54.5	51.8	55.64	54.26
	F_{MSY}	0.27	0.26	0.365	0.359	1.07	0.76
	B_{MSY} (10,000 mt)	234.01	199.45	173.6	14.3	116.2	106.5
	B_{1980} (10,000 mt)	70.52	61.14	60.3	48.4	39.57	33.63
	B_{2015} (10,000 mt)	244.98	217.90	217.1	174.4	132	113.3
	F_{1980}	0.43	0.39	0.51	0.492	2.99	1.23
	F_{2015}	0.18	0.17	0.208	0.207	0.59	0.38
	q5 (Biomass)	NA	NA	NA	NA	NA	NA
	B_{2016}/K	0.52	0.53	0.654	0.637	0.69	0.7
	B_{2016}/B_{MSY}	1.17	1.19	1.384	1.34	1.25	1.26
	F_{2015}/F_{MSY}	0.69	0.65	0.59	0.562	0.54	0.5

Annex E

Terms of Reference for the Technical Working Group on Pacific Saury Stock Assessment (TWG PSSA) for 2017-2021

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 protocol
   - Review/update the indices
   - Recommendation of future works
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 existing protocol
   - Simple update (including projection and evaluation of reference points as well as diagnosis)
   - Consideration of scenarios (for base and sensitivity)
   - Assessment of uncertainty and its implication of management
   - Evaluation/improvement (if necessary) the models
   - Recommendation of the research for future works
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 and limits
   - Recommendation of the research for future works
6. To facilitate data- and code- sharing processes
7. To review/improve presentation of stock assessment results (including stock status summary report in a format to be determined by the Working Group)
8. To explore the design of MSE framework

Annex F

North Pacific Fisheries Commission
Scientific Committee

Draft 2017-2021 Research Plan

3.1 Stock Assessments

3.1.1. Pelagic fish stock assessment
Areas of work

- Completion of ~~provisional~~ stock assessment for Pacific saury and development of the framework and timeline for its regular improvement and update
- Conducting stock assessment for other priority species considering their top-down prioritization (Chub mackerel - Spotted mackerel - Japanese sardine - Neon flying squid - Japanese flying squid) and available funds and capacity
- Identification of data ~~needs~~gaps, determination of activities to ~~meet~~ address those ~~needs~~ gaps and development of standards and mechanisms for data collection and verification

ANNEX I

Five-Year Work Plan for each Priority Area

1. Stock assessments for target fisheries and bycatch species

	2017	2018	2019	2020	2021
Pacific saury	Completed stock assessment (provisional) through TWG PSSA meeting	Update stock assessment and recommendations to Commission to improve conservation and management of Pacific saury	Update/benchmark stock assessment and recommendations to Commission to improve conservation and management of Pacific saury	Update/benchmark stock assessment and recommendations to Commission to improve conservation and management of Pacific saury	Update/benchmark stock assessment and recommendations to Commission to improve conservation and management of Pacific saury