Agenda Item 4. Review of reports and recommendations from the Technical Working Group on Chub Mackerel Stock Assessment (TWG CMSA) and the Small Scientific Committees (SSC BFME, SSC NFS, and SSC PS)

4.1 Technical Working Group on Chub Mackerel Stock Assessment



Process of 1<sup>st</sup> stock assessment by TWG CMSA

Dec 2017 TWG CMSA01

Mar 2019 TWG CMSA02 SA model candidates

Sep 2023 TWG CMSA07 Selection of SA model  $\rightarrow$  SAM

Jan 2024 TWG CMSA08 Data preparation

Jul 2024 TWG CMSA09 Completion of SA

# TWG CMSA08 meeting

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**D**Dates 22-25 Jan 2024 **D**Place Niigata, Japan

**D**Participants

- Chair
- Canada
- China
- EU 11
- Japan
- Russia
- USA
- Invited expert
- Rapporteur •
- Secretariat

#### 

✓ Data preparation

✓ Model settings & specification



# TWG CMSA09 meeting

Dates 17-20 Jul 2024

Place Yokohama, Japan

Participants

- Chair
- Canada
- China
- EU
- Japan
- Russia
- USA
- Observer
- Invited expert
- Rapporteur
- Secretariat

#### 

 $\checkmark$  Completion of 1<sup>st</sup> stock assessment



#### **Recommendations of TWG CMSA09 meeting**

63. The TWG CMSA recommended that the SC:

- (a) Recommend that the Commission note the status of the chub mackerel stock and management advice provided in paragraphs [37-42].
- (b) Endorse the stock assessment executive summary (Annex F) and stock assessment report (to be submitted to SC intersessionally).
- (c) Adopt the Work Plan of the TWG CMSA (NPFC-2024-TWG CMSA09-WP08 (Rev. 2)).
- (d) Adopt the updated species summary for chub mackerel (Annex H).
- (e) Consider the TWG CMSA's comments on the NPFC Performance Review Recommendations that concern chub mackerel (NPFC-2024-SC09-WP01 (Rev. 1)).
- (f) Continue to hire an invited expert to support the TWG CMSA in 2025.

Stock Assessment of Chub Mackerel in the Northwest Pacific Ocean

- Online meeting was held on 6 Dec for finalization of adoption of the SA report.
- It was posted to the NPFC website on 11 Dec.
  - Revised version, posted on 12 Dec.

#### Stock Assessment of Chub Mackerel in the Northwest Pacific Ocean

North Pacific Fisheries Commission 9th Meeting of the Technical Working Group on Chub Mackerel Stock Assessment July 2024 Yokohama, Japan (Hybrid)



NPFC-2024-SC09-WP20 (Rev. 1)

# Chub mackerel





Mean length vs age

#### Mean weight vs age



- Longevity is approx. age 8.
- Age at 1<sup>st</sup> mature is age 2 or 3. All fish get matured at age 4.
- Decadal change in growth was observed.

#### Catch in weight by Member from 1970 to 2023

- China: Light purse seine and pelagic trawl in CA
- Japan: Purse seine and set net in Japan national waters
- Russia: Mainly in Russia national waters, mid-water trawl, purse seine and bottom trawl gears with operations in the Japanese national waters.



## Age specific data

- Fishing year: July to June
- Stock assessment model: State-space Stock Assessment Model (SAM)
- Stock assessment period: FY1970 (CY1970 Q2) to FY2022 (CY2023 Q2)

	CHINA		JAF	PAN	RUSSIA		
Data	Starting year	Terminal year	Starting year	Terminal year	Starting year	Terminal year	
CAL	2016 Q1 (CY)	2023 Q2 (CY)	1970 Q3 (CY)	2023 Q2 (CY)	2016 Q2 (CY)	2023 Q2 (CY)	
ALK	2018 Q1 (CY)	2023 Q2 (CY)	1970 Q3 (CY)	2023 Q2 (CY)	-	-	
САА	2015 Q1 (CY)*1	2023 Q2 (CY)	1970 Q3 (CY)	2023 Q2 (CY)	2014 Q1 (CY)*1	2023 Q2 (CY)	
WAA	2018 Q1 (CY)	2023 Q2 (CY)	1970 Q3 (CY)	2023 Q2 (CY)	2016 Q2 (CY)	2023 Q2 (CY)	
MAA	2018 Q1 (CY)	2023 Q2 (CY)	1970 Q3 (CY)	2023 Q2 (CY)	-	-	

## Abundance indices

Member	Gear/Survey	Ages	Starting year	Terminal year
CHINA	Lighting purse seine	Multiple ages	2015 FY	2022 FY
	Summer trawl survey	Age 0 (Recruitment)	2002 FY	2022 (2023) FY*
		Age 0 (Recruitment)	2005 FY	2022 (2023) FY*
JAPAN	Autumn trawi survey	Age 1	2005 FY	2022 (2023) FY*
	Egg survey	SSB	2005 FY	2022 (2023) FY*
	Dip net	SSB	2003 FY	2022 (2023) FY*
RUSSIA (For Sensitivity)	Trawl	Multiple ages	2016 FY	2022 (2023) FY

\*The 2023 JPN indices were used for sensitivity runs

## Input data used for base case



The 2023 JPN abundance indices were not used in the base case scenario.

## Natural mortality

- Age-common M, 0.5 (year<sup>-1</sup>)
- Age-specific M (year<sup>-1</sup>)
  - Age 0, 0.80
  - Age 1, 0.60
  - Age 2, 0.51
  - Age 3, 0.46
  - Age 4, 0.43
  - Age 5, 0.41
  - Age 6+, 0.40



#### List of mathematical notations for SAM

Symbol	Туре	Description
а	Index	Age class (from 0 to 6+)
у	Index	Fishing year (from 1970 to 2022)
k	Index	Fleet ID for abundance index (from 1 to 6)
$C_{a,y}$	Data	Observed catch number at age <i>a</i> in a year <i>y</i>
$W_{a,y}$	Data	Stock weight at age <i>a</i> in a year <i>y</i> (also used as catch weight for simplicity)
$g_{a,y}$	Data	Maturity at age <i>a</i> in a year <i>y</i>
M <sub>a,y</sub>	Data	Natural mortality coefficient at age <i>a</i> in a year <i>y</i>
$N_{a,y}$	RE	Number at age <i>a</i> in a year <i>y</i>
$F_{a,y}$	RE	Fishing mortality coefficient at age <i>a</i> in a year <i>y</i>
$\omega_a$	FE	SD for the process error in number at age <i>a</i>
$\sigma_a$	FE	SD for the process error in <i>F</i> at age <i>a</i>
ρ	FE	Correlation coefficient in MVN of <i>F</i> random walk between adjacent age classes
$ au_a$	FE	SD for the measurement error in catch at age <i>a</i>
$q_k$	FE	Catchability coefficient for abundance index k
$\nu_k$	FE	SD for the measurement error in abundance index k
$b_k$	FE	Nonlinear coefficient for abundance index k
α	FE	Slope of stock-recruitment relationship at the origin
β	FE	Strength of density dependence in stock-recruitment relationship
$\hat{C}_{a,y}$	DQ	Predicted catch number at age <i>a</i> in a year <i>y</i>
$\hat{s}_{a,y}$	DQ	Selectivity at age a in a year y

Random effects, RE; fixed effects, FE; and derived quantities, DQ

#### Model settings for base case scenario

- 1. All the six abundance indices have difference standard deviations (SDs) for observation errors,
- 2. The nonlinear coefficients are estimated for the age-0 index from the Japanese summer survey, the age-0 index from the Japanese autumn survey, and the age-1 index from the Japanese autumn survey, while they are fixed at 1 (i.e., linear) for the other indices,
- 3. SDs of catch-at-age observation errors differ for ages 0-1, ages 2-3, ages 4-5, and ages 6+,
- 4. SDs of F random walk process errors differ between ages 0-1 and ages 2-6+, and
- 5. SDs of N process errors differ for age 0, age 1, ages 2-4, and ages 5-6+.

#### Representative scenarios including base case

No.	Run#	Settings	
1	B2	Estimate process error for only age 0 (recruitment)	
2	S28-ProcEst	Estimate process error for all age groups Base case	Э
3	S32-JP23	Estimate process error for only age 0 and use Japanese indices up to FY2023	
4	S34-ProcEst23	Estimate process error for all age groups and use Japanese indices up to FY2023	

Scenario - S28-ProcEst - B2-Mage - S34-ProcEst23 - S32-JP23indics

Quantitative estimates from 4 representative case runs

Base case: S28-ProcEst



# Fit to observed catch at age



## Fit to abundance indices





#### Results on retrospective analysis



#### Results on retrospective forecasting



#### Decadal change of spawning potential (SPR0)







#### Stock recruitment relationship



### List of reference point candidates for CM

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

## Stock status of CM

- MSY-related or SPR-related reference points vary over time and are uncertain, and they are potentially misleading with respect to stock status.
- TWG CMSA provides information of current estimates of chub mackerel SSB and F (average FY2020-FY2022) relative to the minimum, 25th, 50th, 75th and maximum value of the SSB and F values over the entire time period (FY1970-FY2022).

Stock Status Summary Table					
	SSB	Total Biomass	Recruitment (Million		
	(Thousand MT)	(Thousand MT)	Individuals)	F Exploitation SPR	<u>R_0</u>
2022 Estimate	447	2,825	9,839	0.23 0.089 17	1.1
Current (Average 2020-2022)	526	2,888	11,097	0.28 0.119 16	<u>5.4</u>
Values relative to the all years of the	SSB	Total Biomass	Recruitment (million		
time series (i.e. 1970-2022)	(Thousand MT)	(Thousand MT)	individuals)	F Exploitation SPR	R_0
Historical Minimum (Min)	45	172	365	0.23 0.071 1	155
Historical 25 percentile (25%)	97	634	1,308	0.36 0.136 2	266
Historical Median (Med)	335	1,566	4,353	0.61 0.185 3	344
Historical 75 percentile (75%)	744	3,177	9,839	0.71 0.25 3	379
Historical Maximum (Max)	1,394	6,050	23,579	1.11 0.422 5	501
Ratios Relative to 1970-2022	Stoc	k Status Related t	o Biomass	Stock Status Related to Fishing Intensity	
Current /Historical Minimum	11.694	16.81	30.436	1.21 1.674 1.0	067
Current /25%_Historical	5.418	4.554	8.483	0.79 0.874 0.6	622
Current /Med_Historical	1.569	1.844	2.55	0.47 0.643 0.4	481
Current /75%_Historical	0.707	0.909	1.128	0.40 0.475 0.4	436
Current /Max_Historical	0.377	0.477	0.471	0.25 0.282 0	).33
	SSB	Total Biomass	Recruitment (million		
Values relative to 2016-2022	(Thousand MT)	(Thousand MT)	individuals)	F Exploitation SPR	R_0
Recent Minimum (Min)	447	2,825	6,043	0.23 0.089 15	5.0
Recent 25th percentile (25%)	486	2,919	10,154	0.26 0.112 16	52.5
Recent Median (Med)	620	3,018	11,077	0.29 0.123 16	57.5
Recent75 percentile (75%)	748	3.605	12.622	0.30 0.130 17	7.6
		-,	/		

Ratios Relative to 2016-2022	Stock Statu	us Related to Biom	ass	Stock Status Rela	ted to Fishing Inter	nsity
Current / Recent Min	1.18	1.02	1.84	1.21	1.34	1.07
Current /25%_Recent	1.08	0.99	1.09	1.10	1.06	1.02
Current /Med_Recent	0.85	0.96	1.00	0.98	0.97	0.99
Current /75%_Recent	0.70	0.80	0.88	0.94	0.91	0.93
Current /Max_Recent	0.68	0.70	0.48	0.92	0.83	0.76

# Results on future projection

Constant catch (50 to 400 thousand ton) scenario

Probability that future SSB on July 1, at the beginning of the fishing year, is above latest (FY2022) SSB under the base case scenario.

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

#### Mean biological parameters in recent 7 years



#### Mean biological parameters in entire time series



#### Harvest recommendation

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

#### Caveat: Issues recently found in the input data

- ✓ Recently we recognized gaps in annual catch between sum product of CAA and WAA on a quarterly basis and the Annual Summary Footprint.
- ✓ Prompt report indicated the gaps were not negligible.
- ✓TWG CMSA will communicate how to address the issue and resolve the gap, intersessionally.
- ✓TWG CMSA is able to resolve the input data and update the stock assessment results before the COM-09 meeting in March. The Chair will communicate those to the SC Chair so that it can let the Commission know about the updated results.



#### Technical Working Group on Chub Mackerel Stock Assuagement (TWG CMSA)

Chair: Dr. Kazuhiro Oshima (Japan)

#### Chub mackerel NW & CA





#### Assessment



#### **Comments on Status**

- Total catch decreased in last two years.
- Total effort was stable after 2014.
- SSB decreased after 2018 when it reached a peak since 2000s.
- Recent SSB (2020-2022) is above historical median.
- Fishing mortality showed stable trend during last decade.