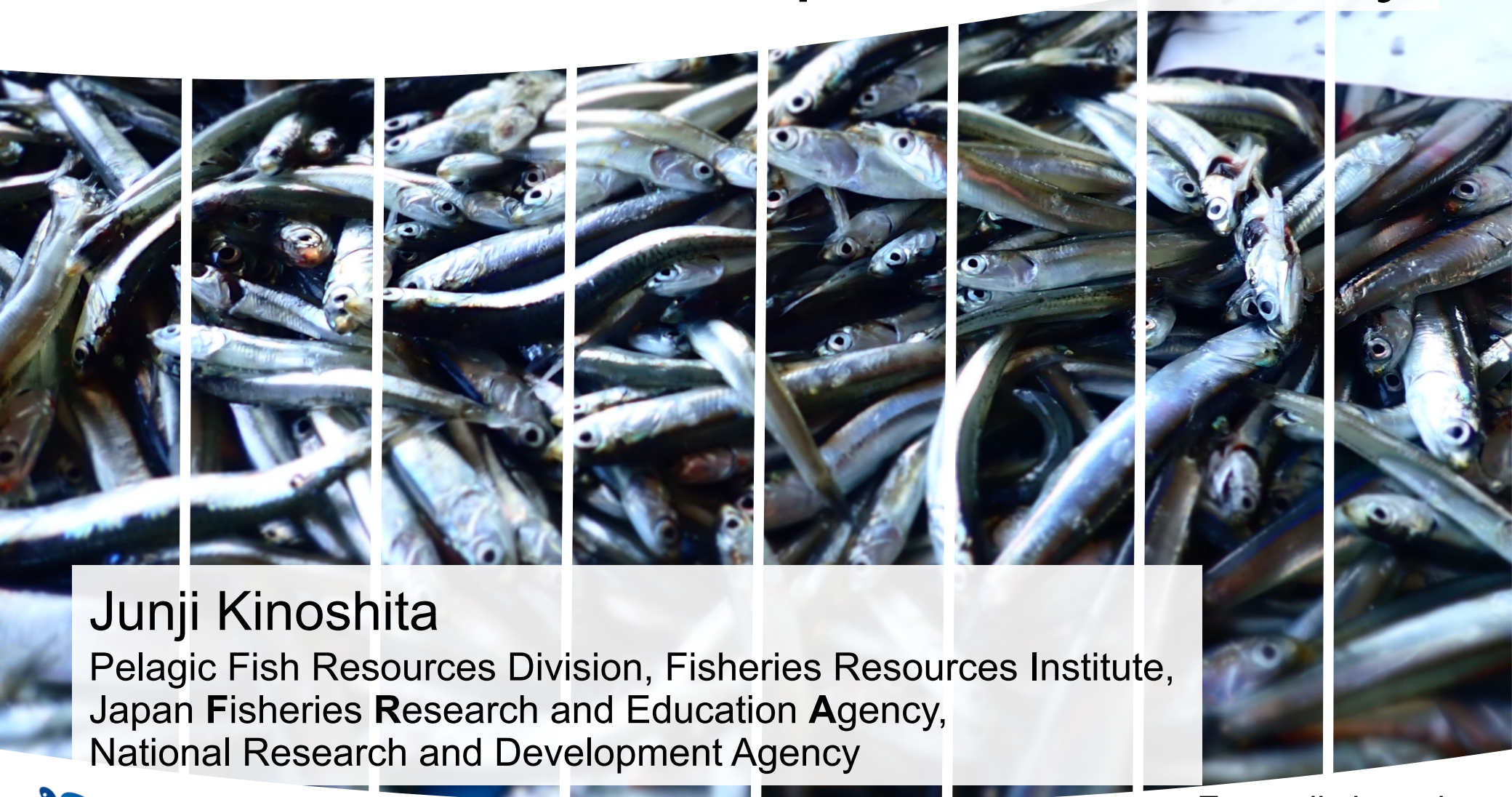


# Pacific Stock of Japanese anchovy



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Fig. 3-1 ← published

unpubl. ← unpublished



# 1. Data

---

a. Catch

b. How to make Catch at age (CAA)

i. The Number of measurements (Body length, Age)

ii. Data availability

iii. Age-length key (ALK) and Length-weight relationship (LWR)

c. Tuning indices

i. Total egg production

ii. CPUE of trawl survey

d. Shirasu (post larvae)



# 1a. Catch

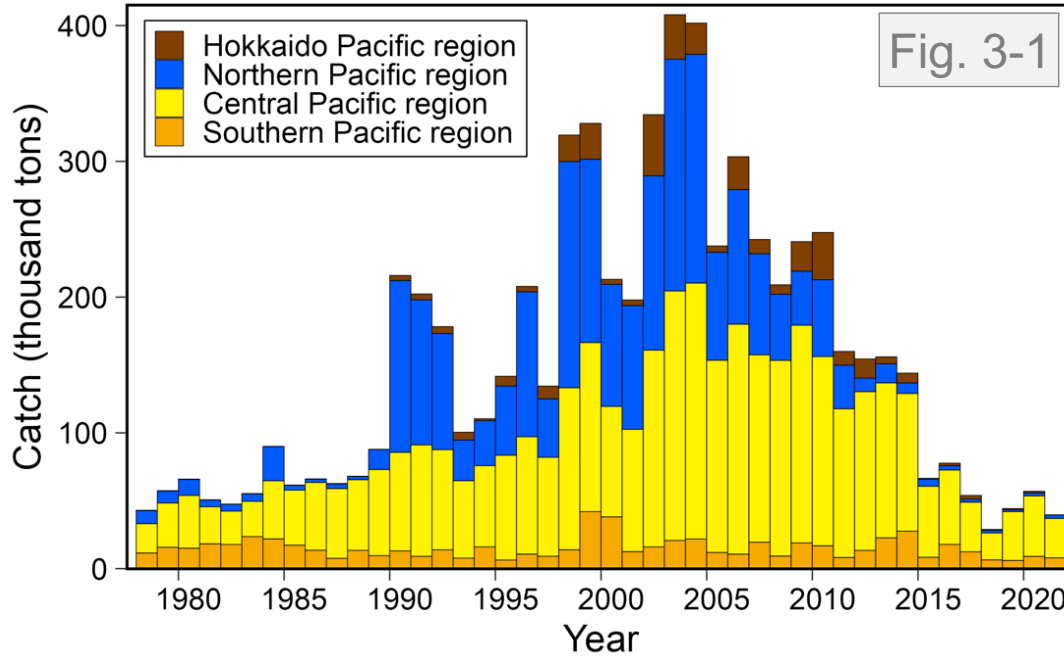
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- Governmental statistics of fisheries (here after **GSF**)
  - ✓ resolution: annual, by prefecture
- Logbook of large-medium-sized purse seines (**PS logbook**)
  - ✓ resolution: daily, by vessel
  - + **Add** the catch in the Sea of Japan by vessels belonging to a prefecture on the Pacific Ocean side.
  - **Subtract** the catch in the Pacific Ocean *vice versa*.

→ Catch in Fig. 3-1 and Table 3-1

- Landing at the major ports (here after **MP**)
  - ✓ resolution: monthly, by prefecture
  - ✓ Catch at age was created based on landing and length composition at MP.
  - ✓ Covering rate is approximately 90% of GSF.

# 1a. Catch



## Dr. Kuriyama's Q12

Q Is it fair to say that catch is based primarily on anchovy abundance? That is, when there are many anchovy, catches are higher? Or are there external market factors that might cause catches to decline even though anchovy are abundant?

## Dr. Teo's Q2

Q Do non-Japanese fisheries catch this stock, especially during high periods?

### Responses to Dr. Kuriyama's Q12

- We expect the catches to basically be proportional to the biomass.
- Anchovy fisheries also target mackerels and Japanese sardines.

### Responses to Dr. Teo's Q2

- We don't have useful information for stock assessment whether other countries caught anchovy during the "high" period.

# Response to Dr. Teo's Q3

Q How do the catch by region in Fig 3-1 relate to the map in Suppl. report Fig 1?

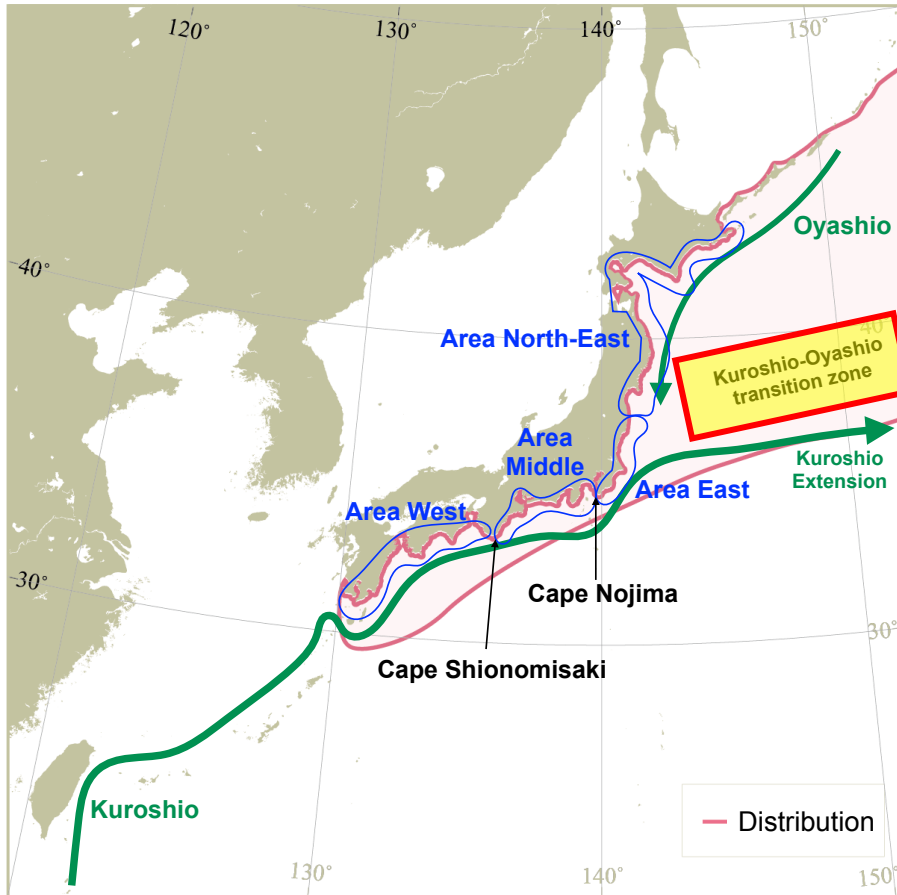
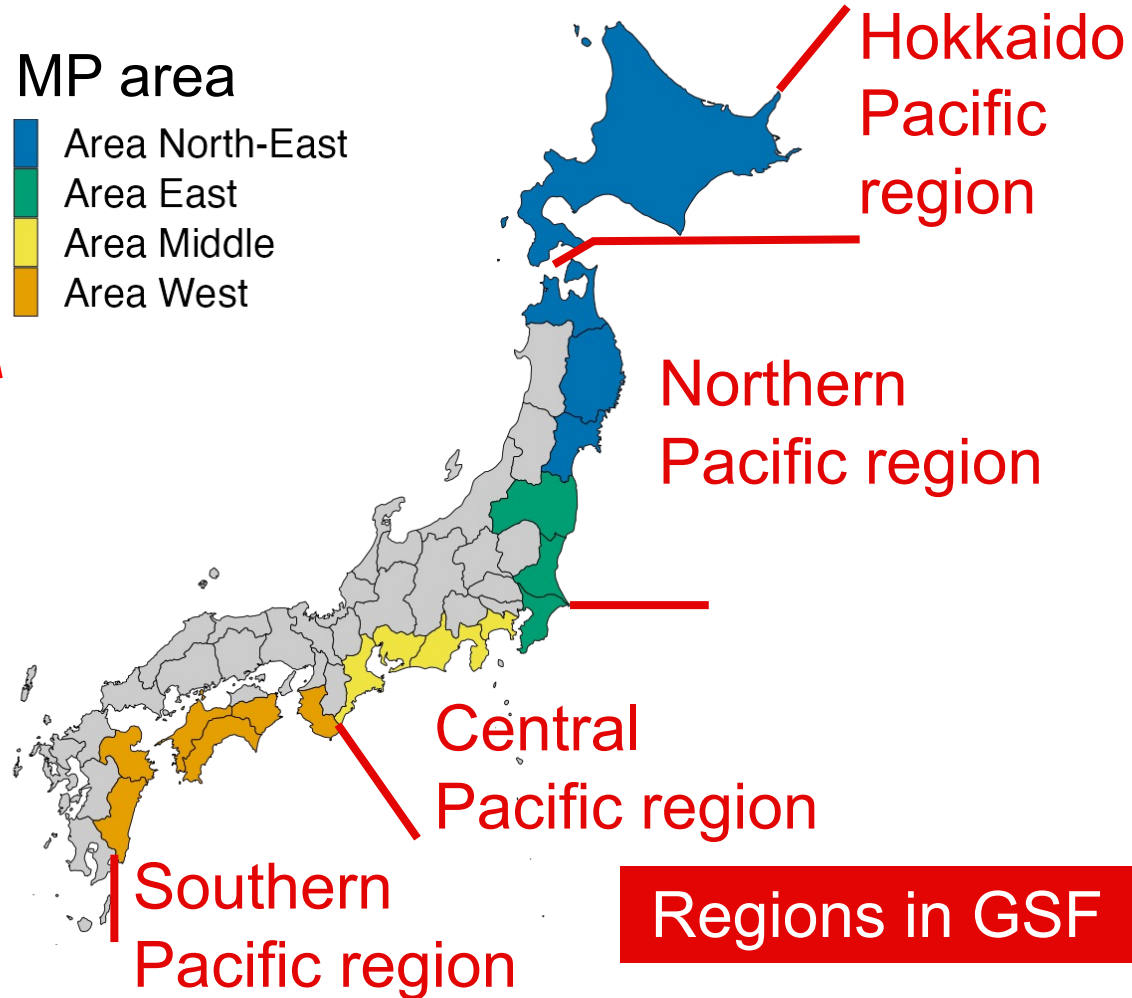
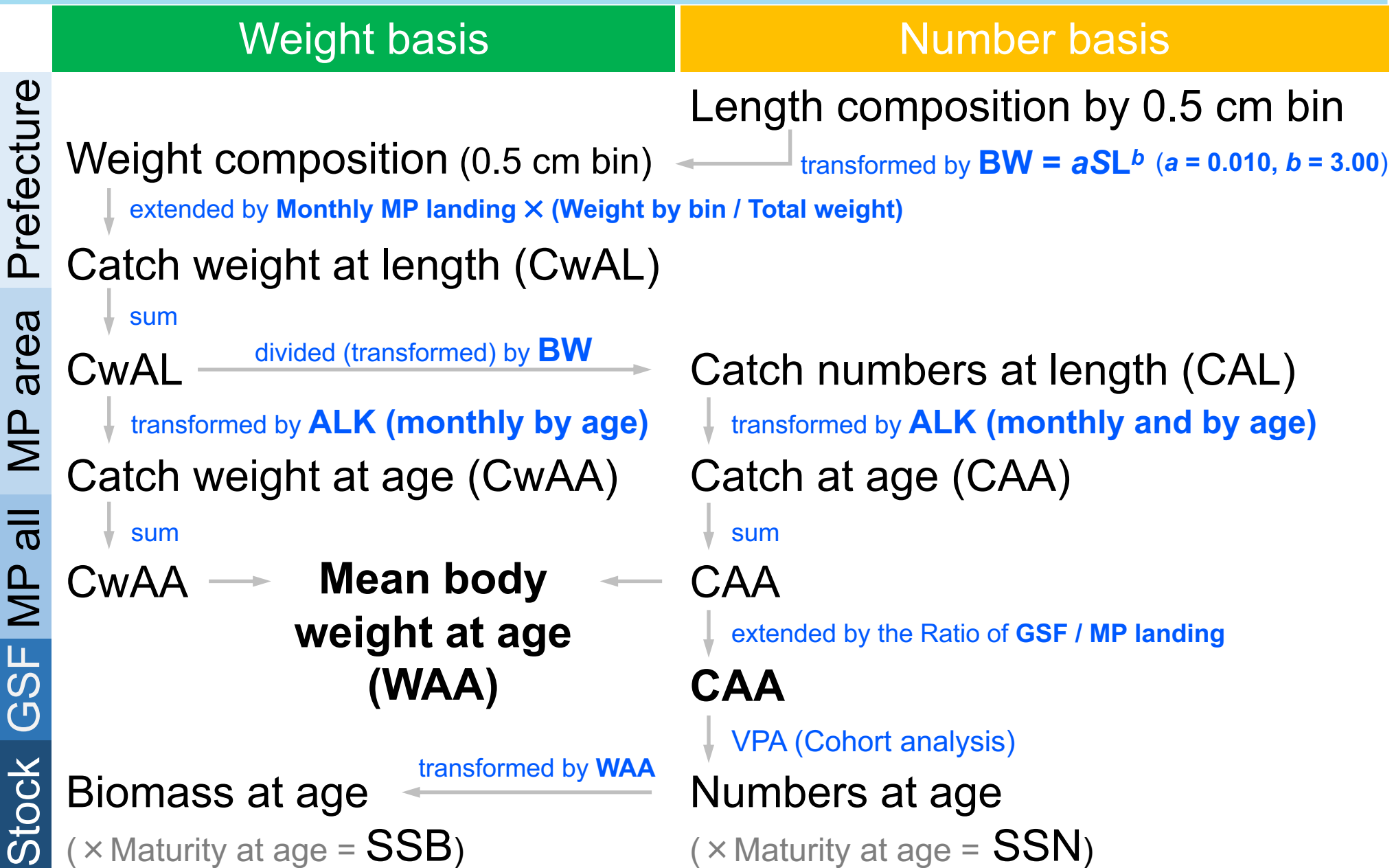


Fig.1 from Supplement report on CAA



# 1b. How to make Catch at age



# 1b-i. Number of measurements

unpubl.

## ■ Length composition

- Scaled length

Area	Mean of annual total (range)
North-East	17,000 (2,900–54,000)
East	16,000 (2,100–82,000)
Middle	9,300 (4,900–15,000)
West	10,000 (4,100–21,000)

## ■ Age determination

- Data in 2000–2017
- Scale reading

Area (prefecture)	Total in the period
North-East (Hokkaido)	2,464
East 1 (Ibaraki)	14,415
East 2 (Chiba)	9,062
West (Kochi)	279

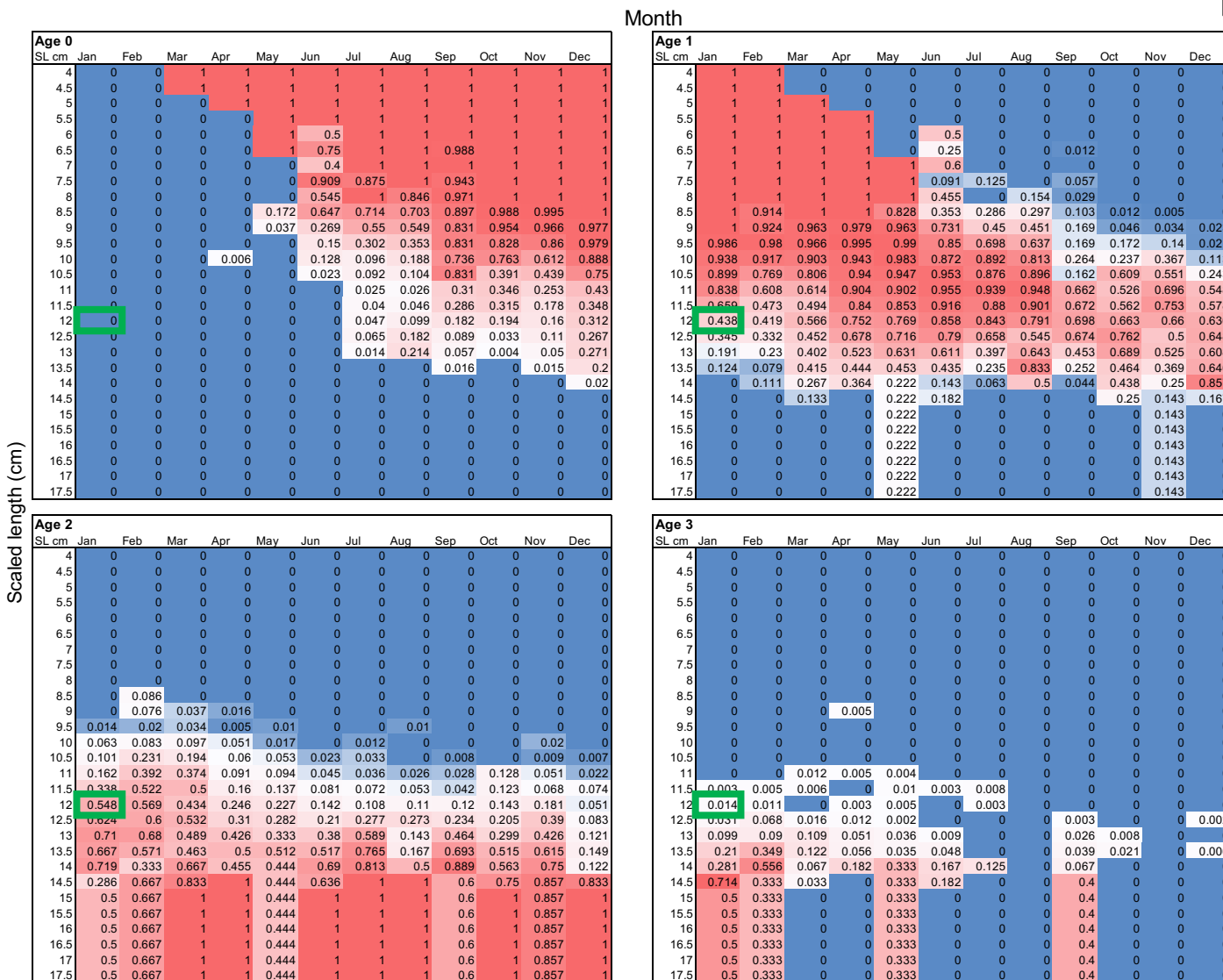
Responses to Dr. Teo's Q10,  
Dr. Kuriyama's Q6

- ✓ Aging error has not been investigated.
- ✓ Sampling frequencies are basically at least once a month but vary by prefecture or by year.



# 1b-iii. Age-length key (ALK)

## Responses to Dr. Teo's Q5 and 9



■ When there are 1000 fish of 12 cm in January, those 1000 fish are assigned:

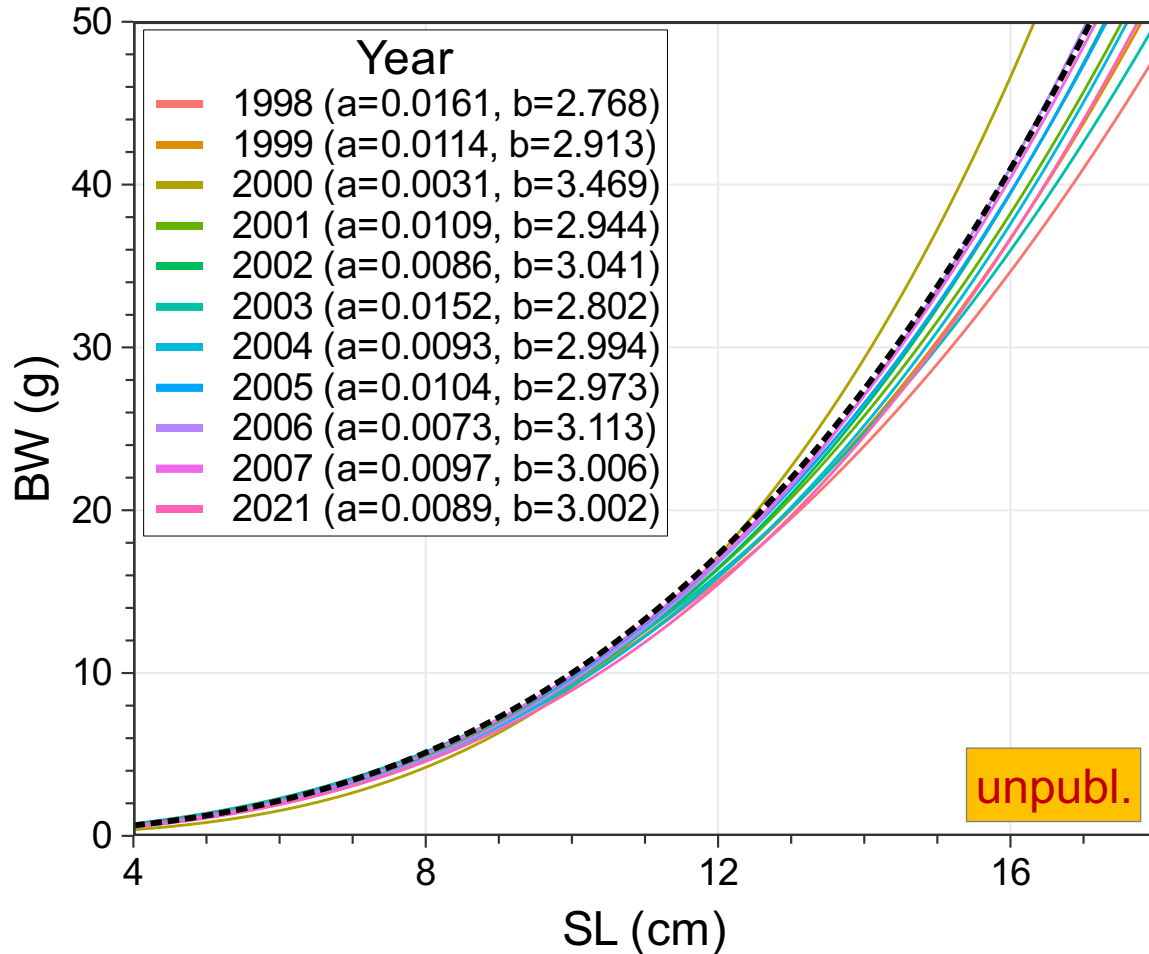
- zero fish as age-0
- 438 fish as age-1
- 548 fish as age-2
- 14 fish as age-3

■ It is difficult to create fine-scale ALKs such as annual and by area because of data limitations.

■ This ALK is used for all areas and for all years.

Fig.3 from Supplement report on CAA

# 1b-iii. Length-weight relationship (LWR)



- The black dashed line indicates  $BW = 0.01 \times SL^{3.00}$ .
- This LWR is used for all areas and for all years since 2008.
- **Mean  $\pm$  S.D.** of the parameters  $a$  and  $b$  in the equation  $BW = aSL^b$  from 1998 to 2007.  
 $a: 0.0102 \pm 0.0037$   
 $b: 3.002 \pm 0.194$

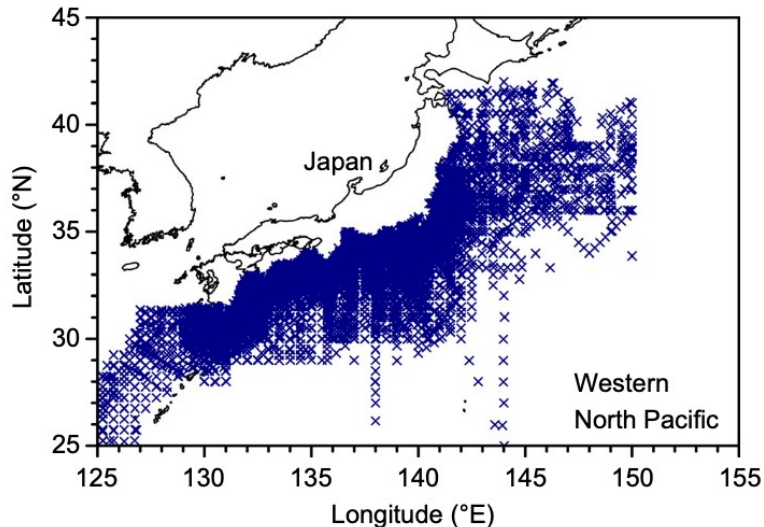
Responses to Dr. Teo's Q6–10, Dr. Kuriyama's Q6 and Q19

- We are currently in the process of reorganizing the data and will continue to improve CAA using fine-scale LWR.

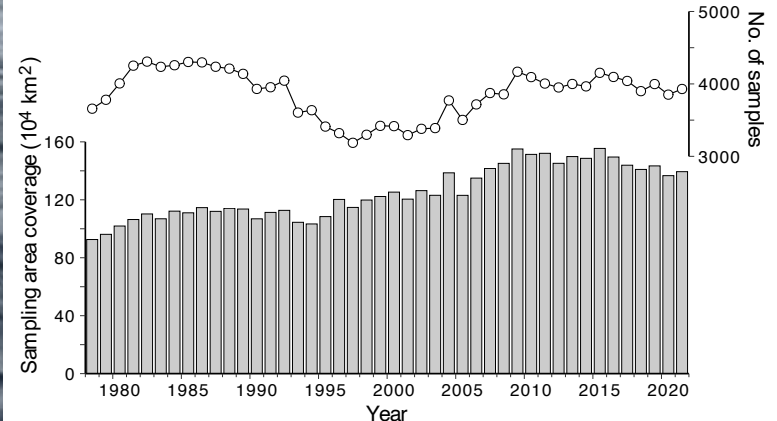
# 1c-i. Tuning indices: Total egg production

## Responses to Dr. Teo's Q14, Dr. Kuriyama's Q2

- Total egg production (**TEP**) method (e.g. Oozeki et al. 2007)
- Aggregated by 30 arc-minutes grid
- Survey method standardized across the region
- Annual meeting for sharing the survey information
- Data managed in a database and available from 1978



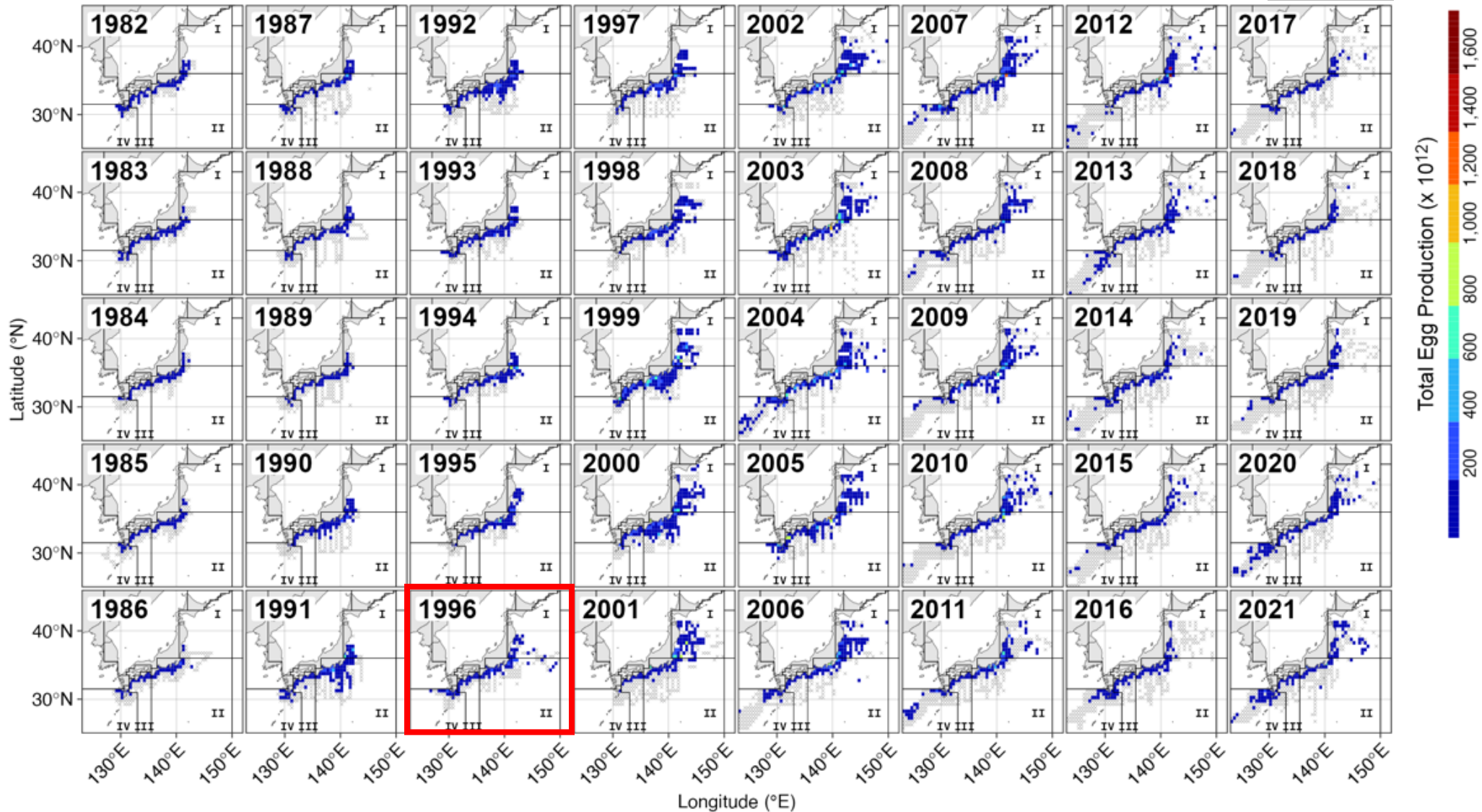
Cited from Takasuka et al. 2019



# Response to Dr. Teo's Q12 and Dr. Kuriyama's Q2

■ Horizontal distribution of TEP and survey points each year

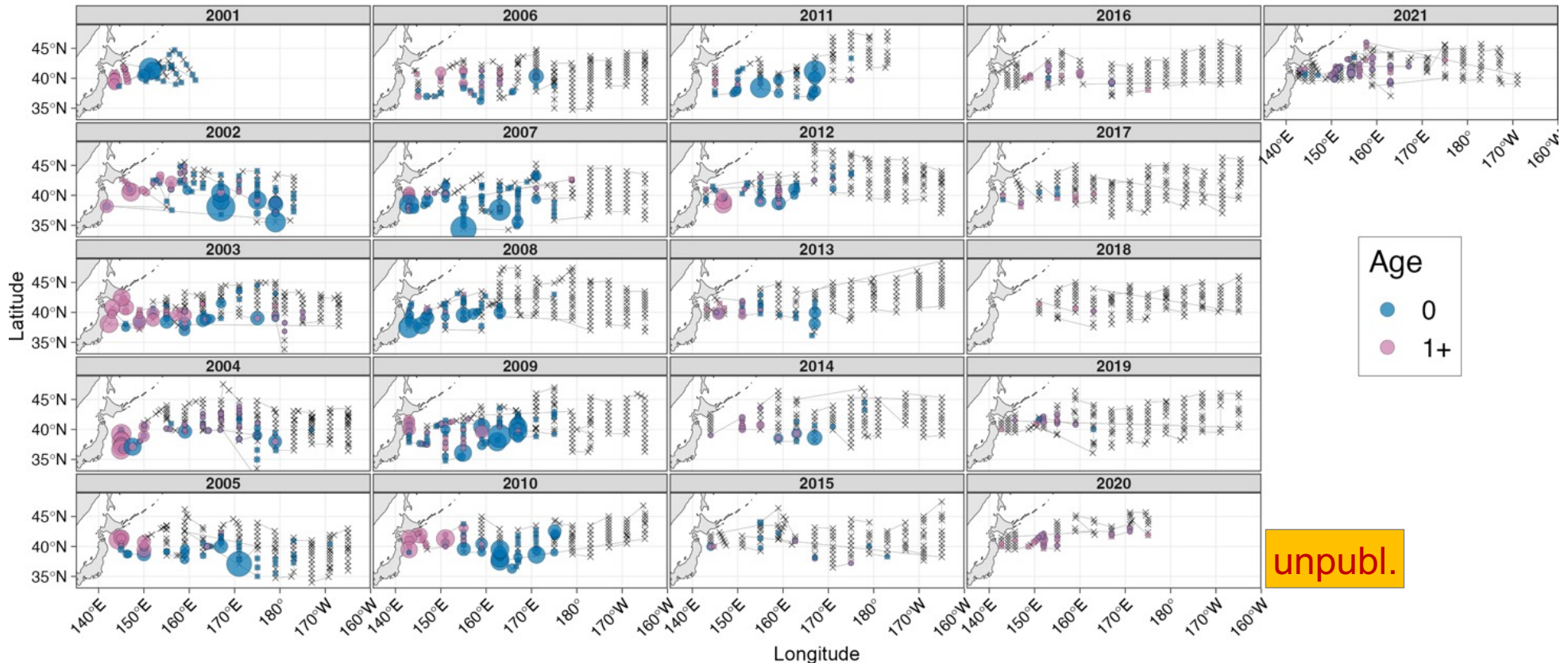
unpubl.



# 1c-ii. Tuning indices: CPUE of trawl survey

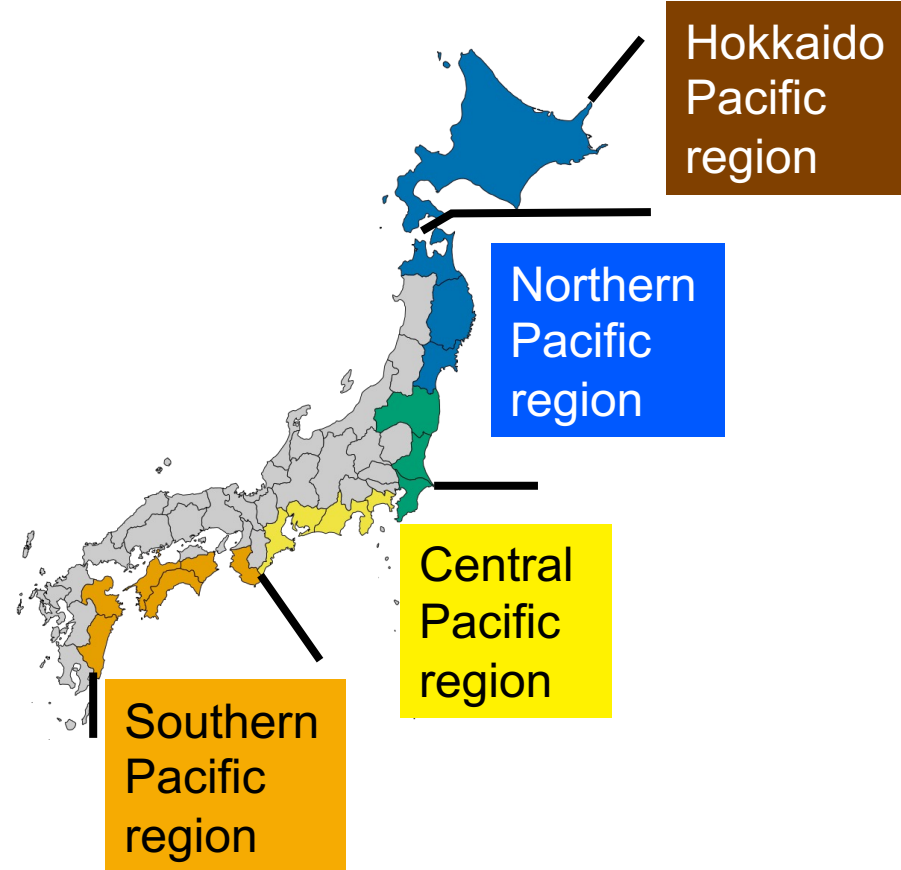
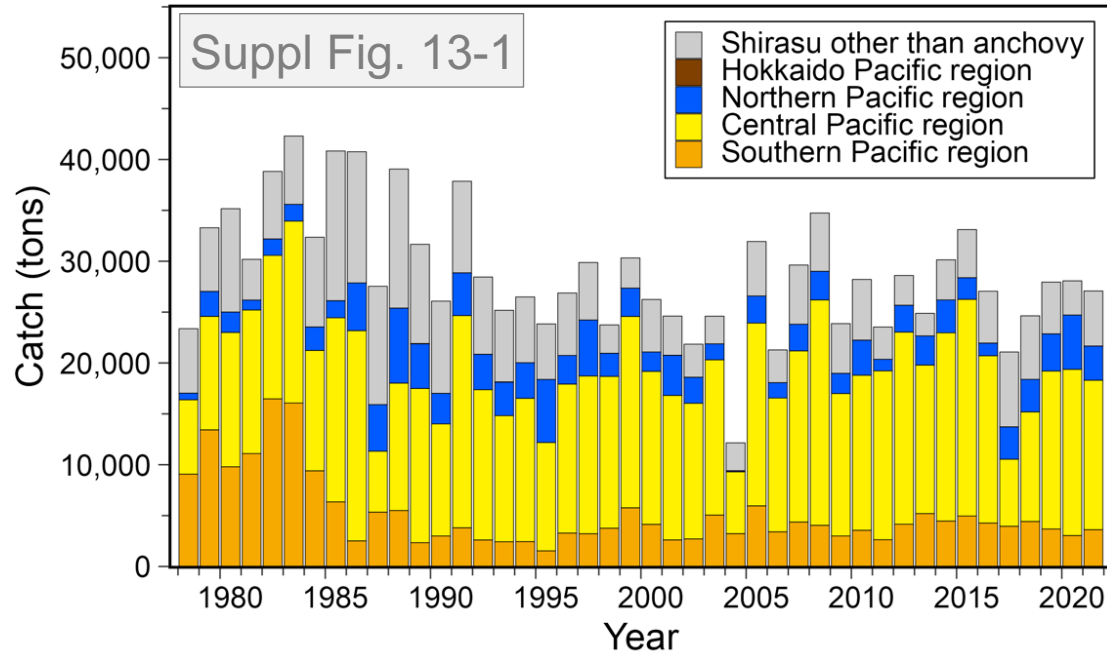
- Surface trawl (Net openings: ca. 25 m, towing speed: 4–5 knots)
- June–July (in **Northward migration** season)
- Data available from 2001

Responses to Dr. Teo's Q17–19,  
Dr. Kuriyama's Q5, 7 and 10



- Age is estimated based on body length.
  - ✓ Age-0 (used for tuning) : SL < 10.5 cm
  - ✓ Age-1+ (not used for tuning) : SL ≥ 10.5 cm

# 1d. Shirasu (post larvae)



- The catch is mostly 20,000-25,000 tons and has relatively low interannual fluctuations.

## Responses to Dr. Teo's Q4, Dr. Kuriyama's Q11

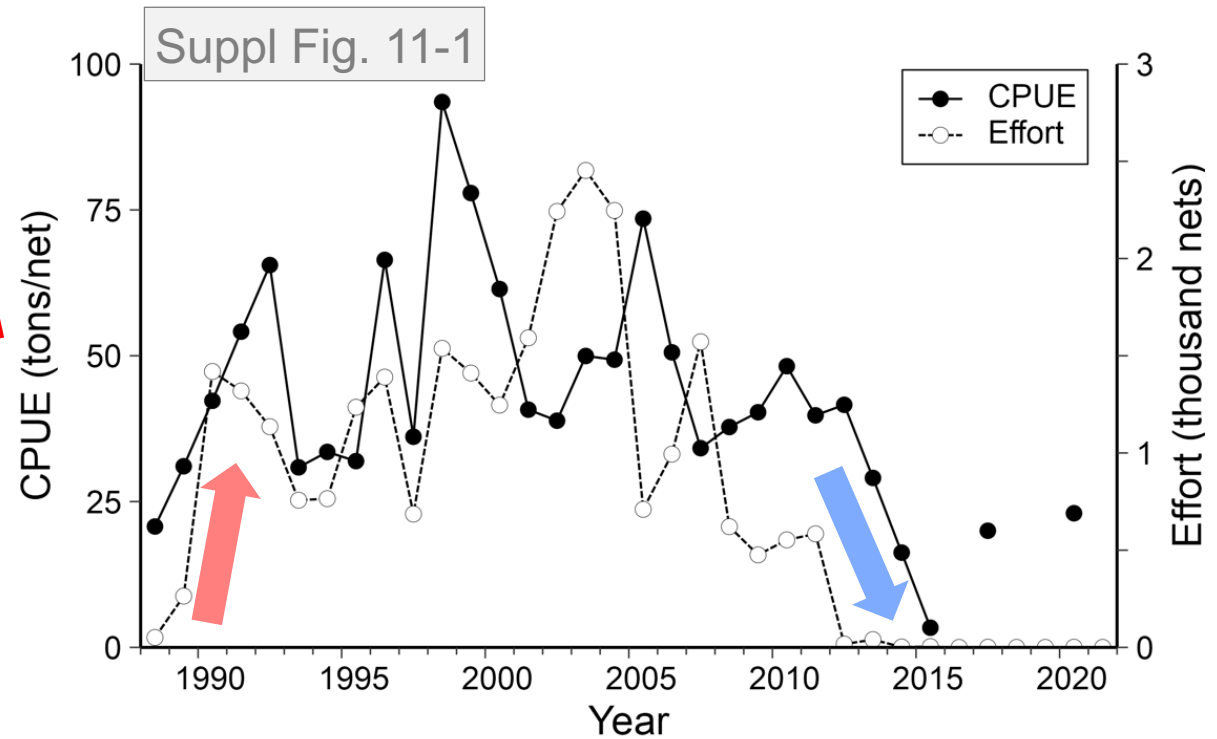
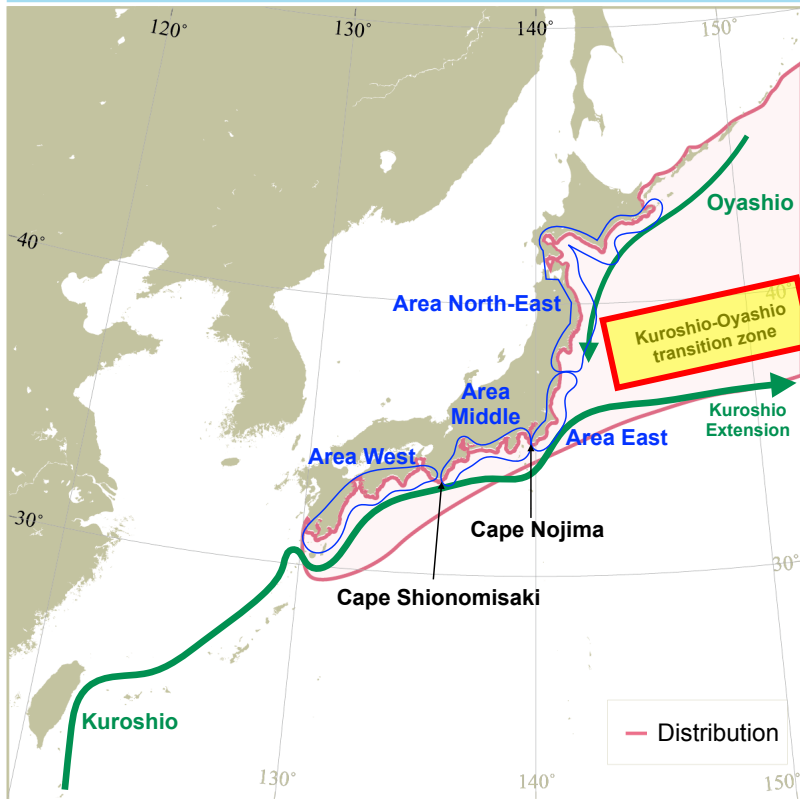
- We attempted to take the shirasu (post larvae) to the VPA, but no adequate results were obtained (extremely high recruitment).
- Therefore, we do not include shirasu in the assessment due to the difficulty of assuming their natural mortality rates.

## 2. Biology

---

- a. Stock structure and horizontal distribution
- b. Natural mortality
- c. Maturity at age (Maturity ogive)

## 2a. Stock structure and horizontal distribution



### ■ High recruitment period:

Anchovies are widely distributed in the Kuroshio-Oyashio transition zone (KOTZ).

### ■ Normal recruitment period:

Anchovies are distributed in near coast areas and sparsely in KOTZ.

### Responses to Dr. Teo's Q1 and Q11

- During the high recruitment period, offshore schools were also caught by large-and-medium-sized purse seine.
- Fisheries operations dramatically changed in the early 2010s.

## 2b. Natural mortality

- Quinn and Deriso (1999), Pauly (1980)

$$\ln(M) = -0.0152 - 0.279 \times \ln(L_{\infty}) + 0.6543 \times \ln(K) + 0.4634 \times \ln(T)$$

$$L_{\infty} = 17.0 \text{ cm}, K = 0.67, T = 21.1^{\circ}\text{C}$$

$$\therefore M = 1.412$$

→

Age	0	1	2	3
M	1.0	1.0	1.6	1.9

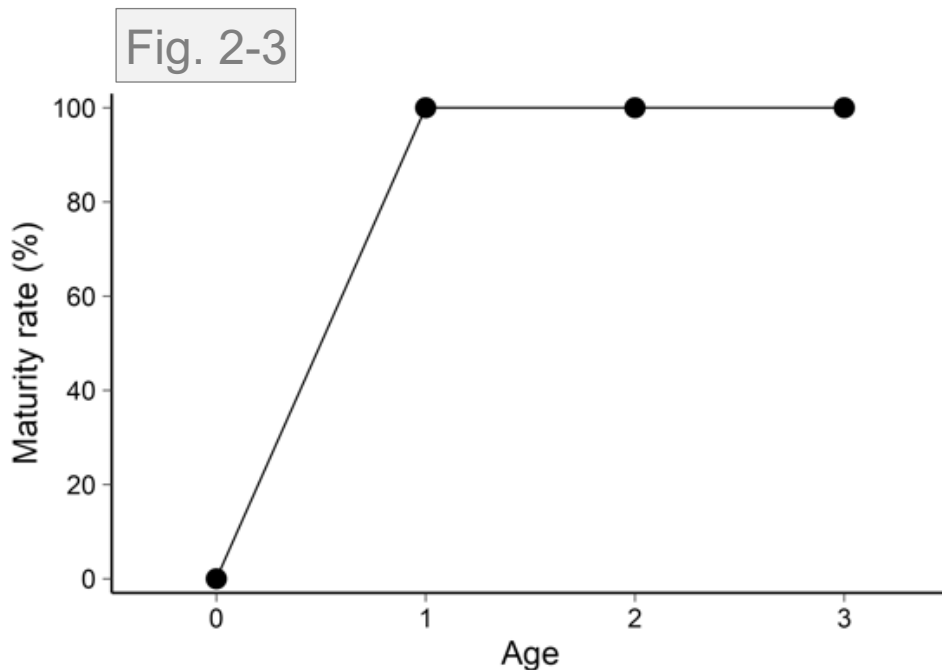
### Responses to Dr. Teo's Q22, Dr. Kuriyama's Q3 and Q4

- Referring to the bathtub curve idea in Chen and Watanabe (1989).
- Subjection to strong predation pressure even at older ages by cetaceans, skipjack and so on.
- We assume that older aged fish accumulate exhaustion by reproductive activities.

## 2c. Maturity at age (Maturity ogive)

### Dr. Kuriyama's Q8

Q Based on the text provided in the maturation section it seems that some proportion of age 0 fish might be mature. Please provide more justification for the assumption that age-0 is immature and age-1 is 100% mature. The maturity ogive will impact the SSB values and can be influential in the cohort analysis and subsequently calculation of reference points.



### Responses to Dr. Teo's Q24, Dr. Kuriyama's Q8 and Q20

- This figure does not mean that no anchovies mature until at least 13 months after birth.
- It means that 0% maturity of age-0 fish indicates their low contribution to the recruitment each year, even if there are matured age-0 fish.

### 3. Model and diagnostics (Stock status)

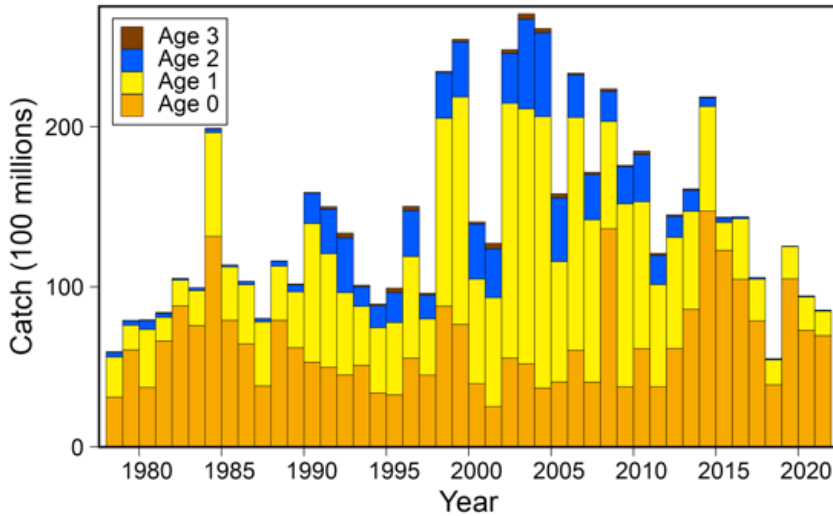
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- a. Model
- b. Estimates of model parameters
- c. Main results of stock assessment and model diagnostics
  - i. Main results of stock assessment
  - ii. Model diagnostics (data fitting, retrospective analysis)
- d. M sensitivity
- e. Preliminary models (Appendix 8)

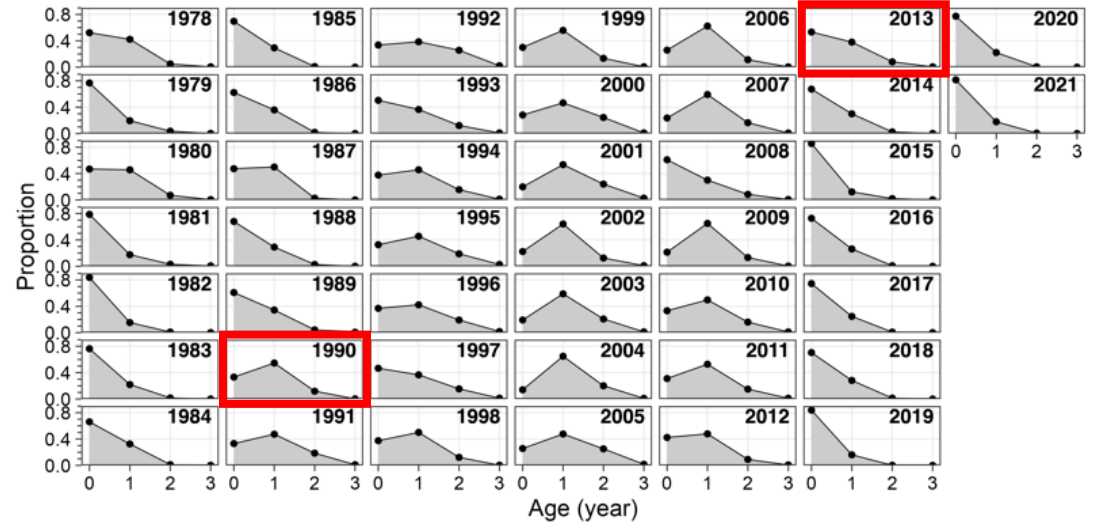
# 3a. Model (1/2): Input data

## Catch-at-age

Fig. 3-2

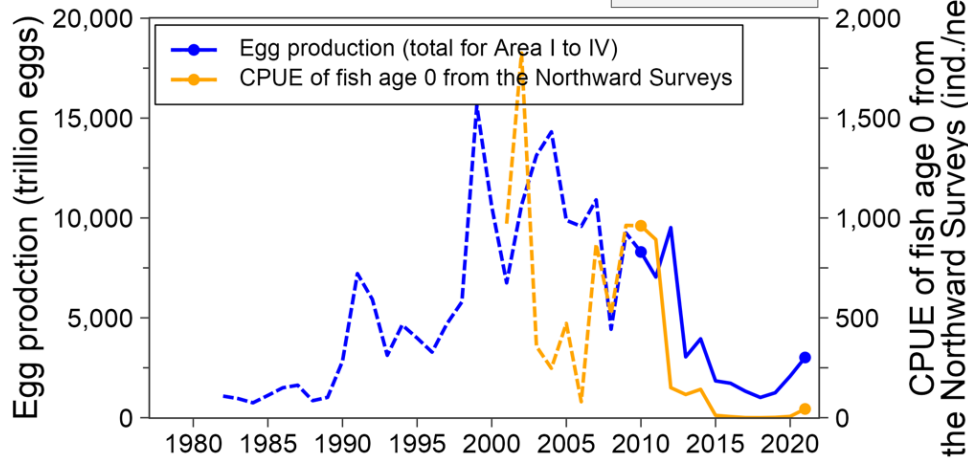


## Response to Dr. Kuriyama's general Q4



## Tuning indices

Fig. 4-1a



## Responses to Dr. Kuriyama's Q17

- Cohort analysis starts from 1978.

## Responses to Dr. Kuriyama's general Q5

- We can not present confidence intervals since we did not standardized tuning indices.

## Responses to Dr. Teo's Q11, 20, and 30

- Using the tuning indices only from 2010 onward is to coincide with the normal recruitment period (solid lines in the left graph).

# 3a. Model (2/2): Equations

## ■ Fundamental part (Pope 1972)

$$N_{a,t} = N_{a+1,t+1} \exp(M_a) + C_{a,t} \exp\left(\frac{M_a}{2}\right) \quad (a = 0, 1, 2)$$

$$N_{3,t} = \frac{N_{2,t} C_{3,t}}{C_{2,t}} \exp\left(\frac{M_3 - M_2}{2}\right)$$

$$F_{a,t} = -\ln \left\{ 1 - \frac{C_{a,t} \exp\left(\frac{M_a}{2}\right)}{N_{a,t}} \right\} \quad (a = 0, 1, 2)$$

$$F_{3,t} = F_{2,t}$$

$$N_{a,T} = C_{a,T} \exp\left(\frac{M_a}{2}\right) \frac{1}{1 - \exp(-F_{a,T})} \quad (a = 0, 1, 2, 3)$$

## ■ Tuning part Ridge VPA (Okamura et al. 2017), non-linear fitting (Hashimoto et al. 2018)

$$(1 - \lambda) \sum_{k=1}^p \sum_t \left[ \frac{\left\{ \ln(I_{k,t}) - \ln(q_k X_{k,t}^{b_k}) \right\}^2}{2\sigma_k^2} - \ln\left(\frac{1}{\sqrt{2\pi}\sigma_k}\right) \right] + \lambda \sum_{a=0}^2 \left( F_{a,2021} - \frac{1}{3} \sum_{t=2019}^{2021} \hat{F}_{a,t} \right)^2$$

↓ **Penalty parameter** ↑ **Non-linear coef.** ↓ **Terminal F**  
↑ **catchability** ↓  $\lambda=0.66$   
↑ **Deviaton of residuals used for index weighting**

## 3b. Estimates of model parameters

---

Under the conditions:  $\lambda = 0.66$  and 2010-onward

Parameter	TEP	CPUE of trawl survey
q	2.013	4.506e-30
b	0.624	6.689
$\sigma$	0.216	0.972
Terminal F	Age-0: 0.312, Age-1: 0.364, Age-2 and 3: 0.139	

- q of CPUE of trawl survey is smaller than that of TEP because of a larger nonlinear coefficient b.

Responses to Dr. Teo's Q26, Dr. Kuriyama's Q16 and general Q3

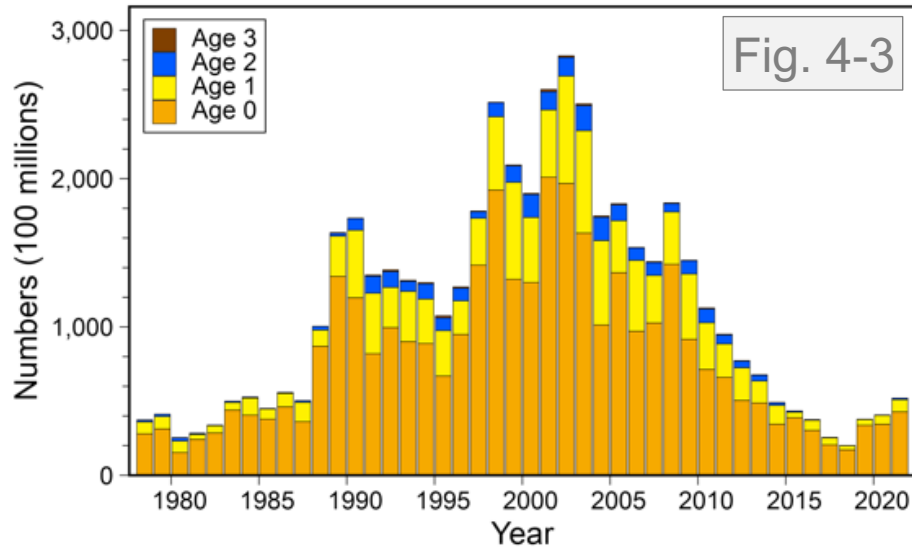
- We can not indicate the uncertainties of parameters.

Responses to Dr. Teo's Q21

- We have not verified the variation of q between regimes.

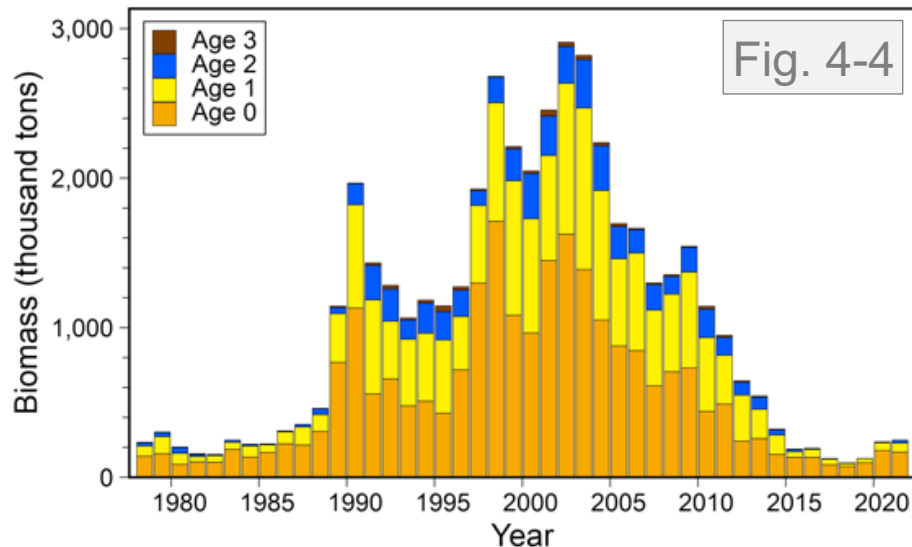
# 3c-i. Main results of stock assessment

## Numbers at age

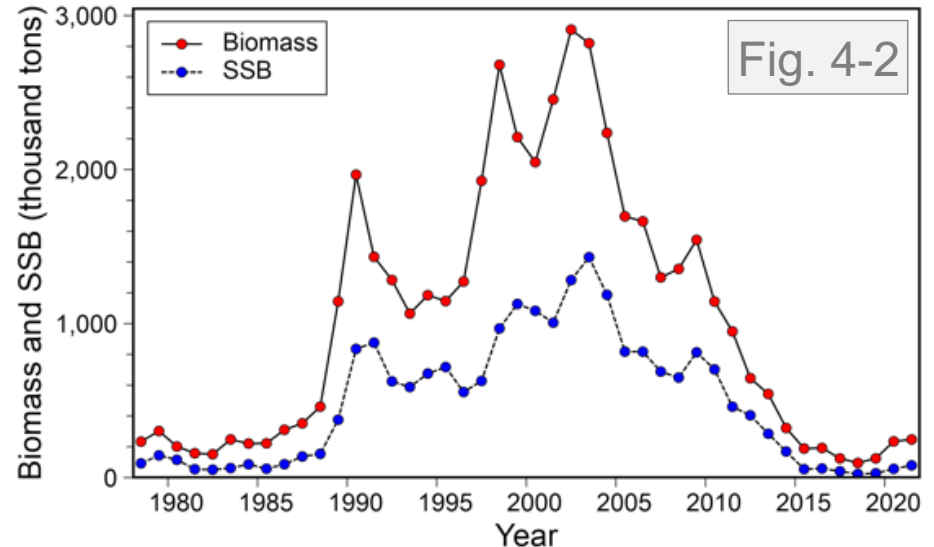


- The majority of this stock are age-0 and age-1 fish.
- Spawning biomass is equal to the biomass of age-1 fish and older.

## Biomass at age

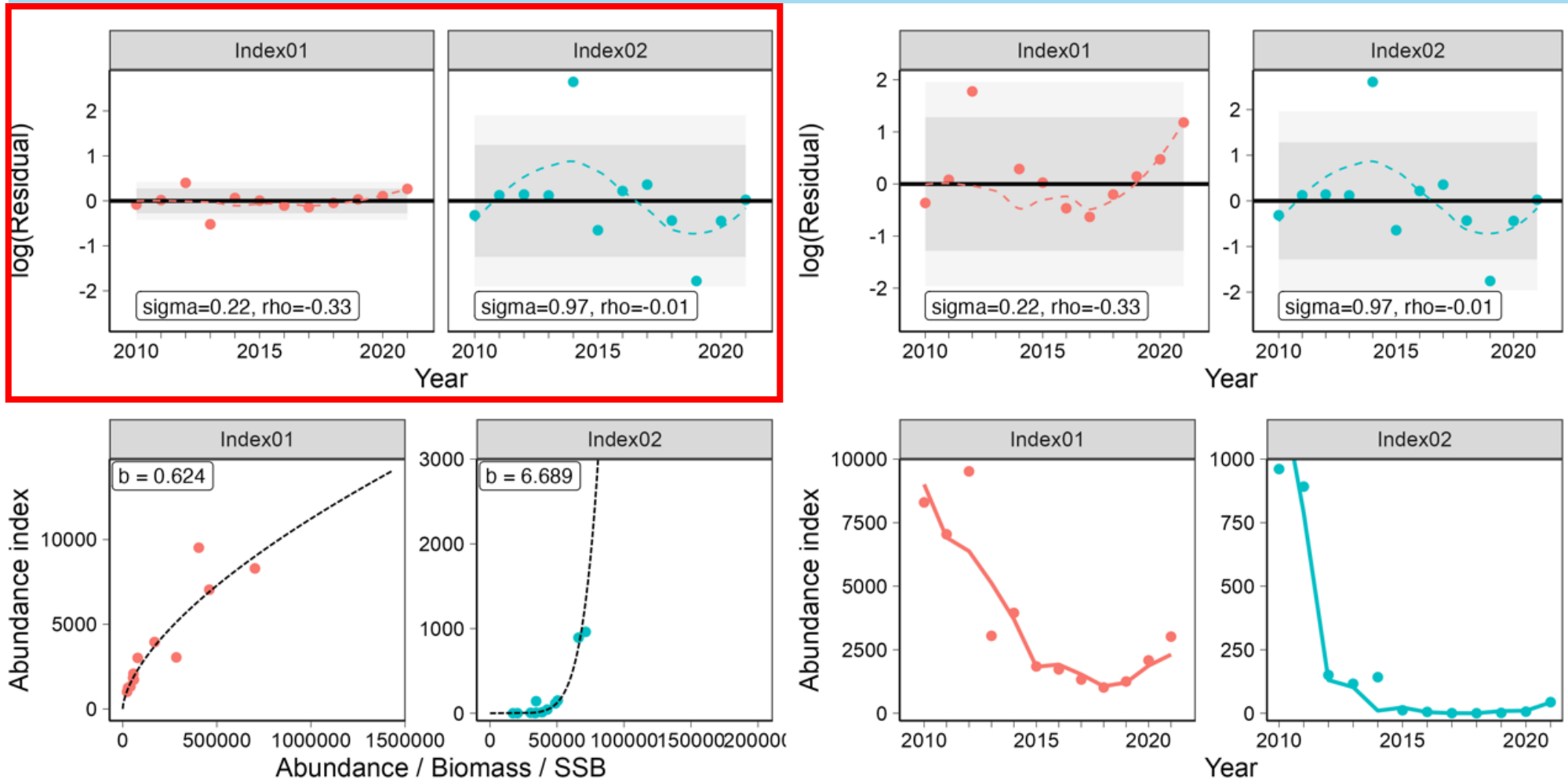


## Total and spawning biomass



# 3c-ii. Model diagnostics: Data fitting

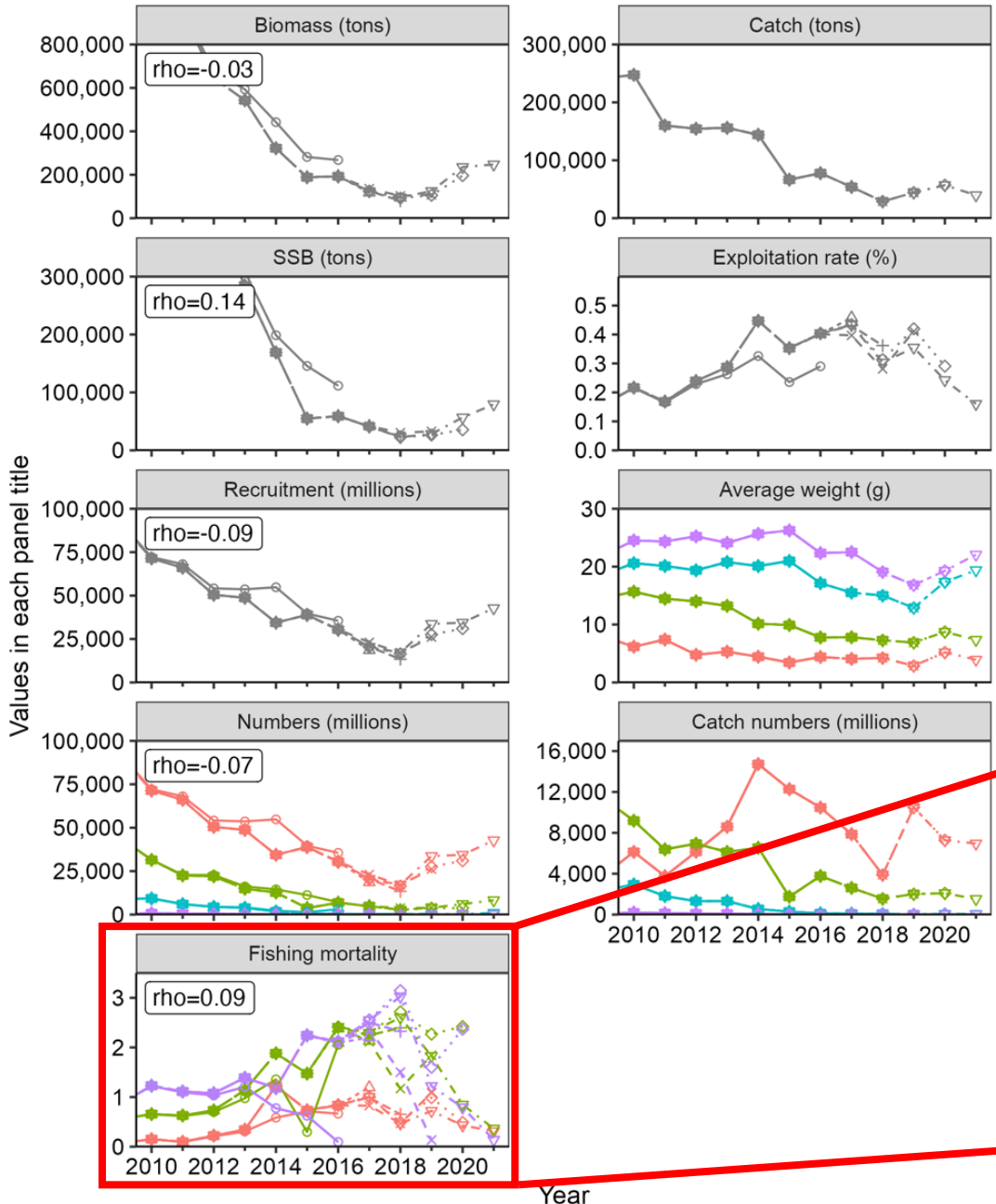
Suppl Fig. 2-2



- TEP ( $\sigma = 0.22$ , "Index01" in the above graphs) has a smaller  $\sigma$  than CPUE of trawl survey ( $\sigma = 0.97$ , "Index02").
- TEP has relatively greater weight as index.

# 3c-ii. Model diagnostics: Retrospective analysis

Suppl Fig. 2-1 (redrawn)



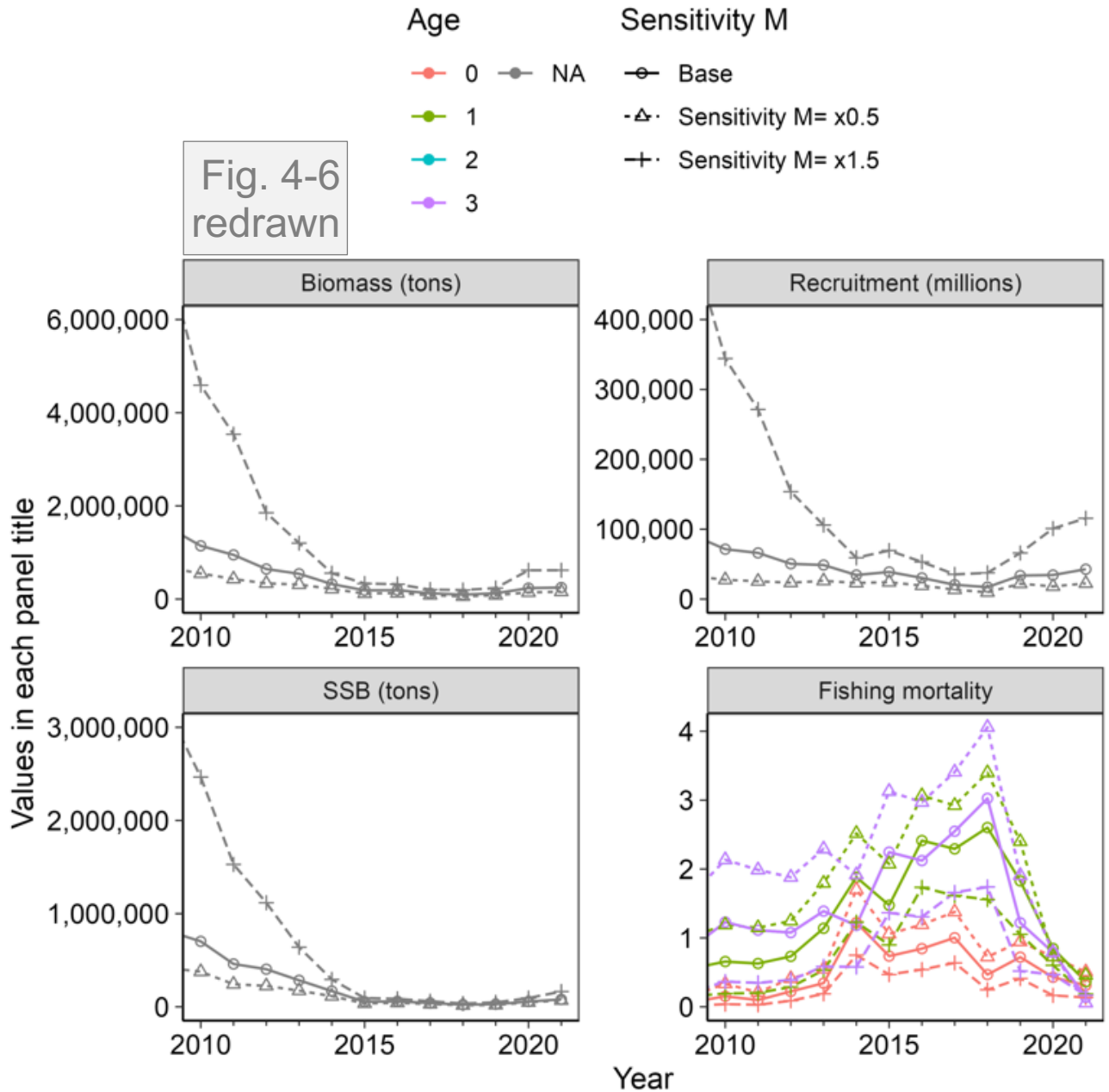
■ A large retrospective pattern occurred in 2016.

Responses to Dr. Teo's Q28

■ This feature is also seen in the other  $\lambda$  scenarios shown in Appendix 8.

# 3d. M sensitivity

Fig. 4-6 redrawn



## Responses to Dr. Kuriyama's Q18

- Left figures show zoomed-out y-axes, which differs from the report.

## Responses to Dr. Teo's Q23, Dr. Kuriyama's Q14

- Sensitivity analyses other than scale up and down (x0.5, x1.5) were not performed.
- Reference points when M is changed has not been calculated.

# 3e. Preliminary models (1/3)

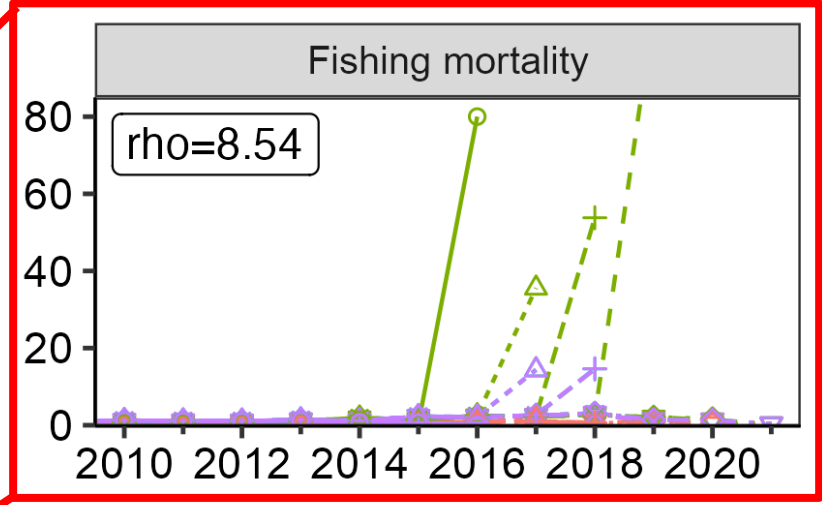
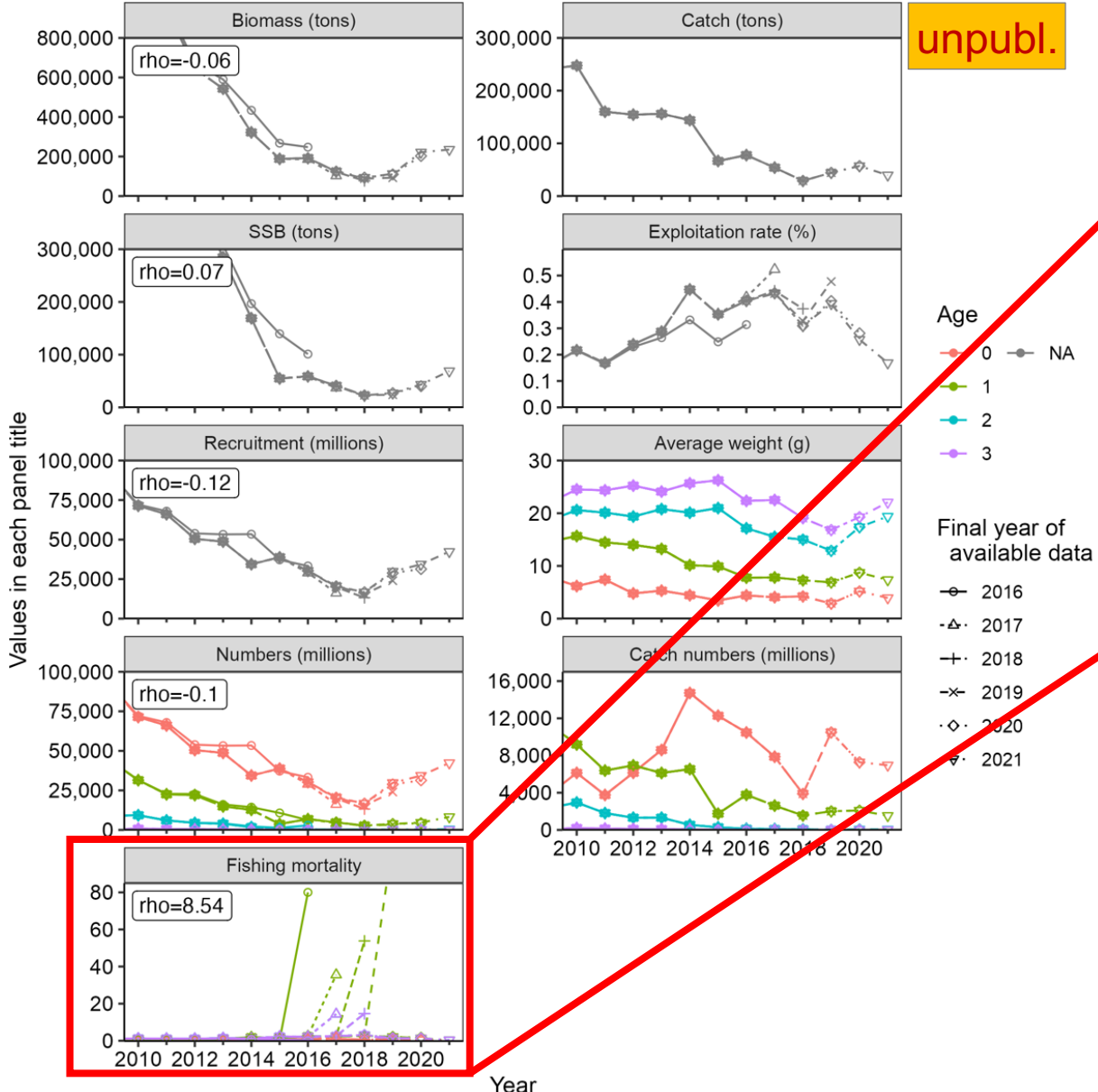
Q There were clearly a large number of preliminary models that were run and decisions made to come up with a base model. However, the documentation is not very clear on the problems faced and why the decisions were made to help with those problems. Please go through the development process step by step and explain the problems and the decisions made to come up with the base model.

Steps	Problems
1 VPA	<ul style="list-style-type: none"><li>● Too large F for age-2 and age-3 fish</li><li>● Too large exploitation rate</li></ul>
2 Tuned VPA ( $\lambda = 0$ ): tuned by TEP and CPUE of trawl survey	<ul style="list-style-type: none"><li>● Too high Mohn's <math>\rho</math> of F</li></ul>
3 Ridge VPA ( $0 < \lambda < 1$ )   terminal F estimated by: maxF vs. allF <a href="#">Suppl Table 8-2</a>	<ul style="list-style-type: none"><li>● Weak tuning effect in maxF models, namely similar results to non-tuned VPA</li></ul>
4 Ridge VPA ( $0 < \lambda < 1$ )   under "allF" tuned by: All-year vs. 2010-onward <a href="#">Suppl Table 8-1</a>	<ul style="list-style-type: none"><li>● abs(Mohn's <math>\rho</math> of F) were higher than 0.2 in the most of the all-year models</li></ul>

■ As a result, we adopted **ridge VPA** with **allF** estimation method and tuned **2010-onward**.

# 3e. Preliminary models (2/3)

## Retrospective analysis under $\lambda = 0$ , "allF", and 2010-onward.



■ Mohn's  $\rho$  of Fishing mortality was over-estimated in particular age-1 and older fish.

## 3e. Preliminary models (3/3)

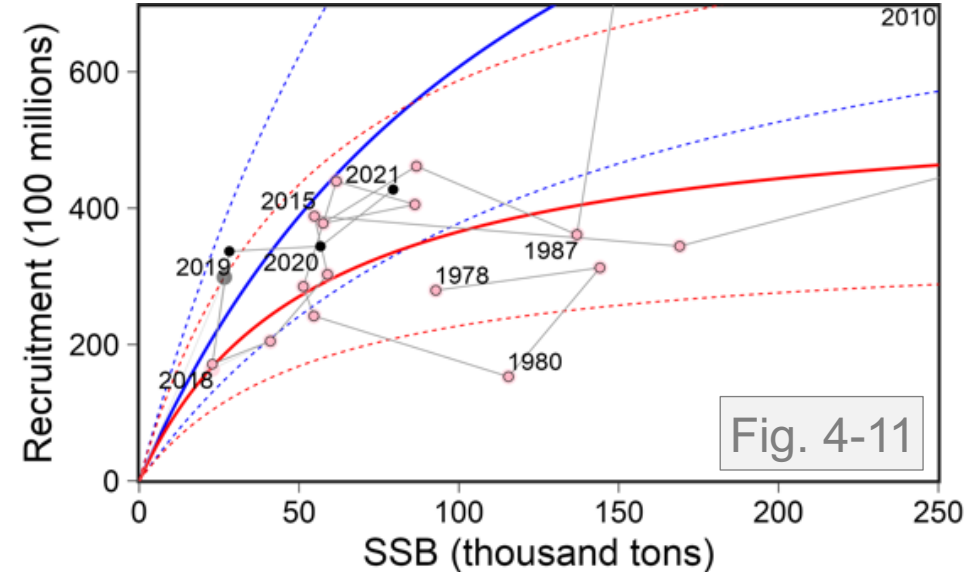
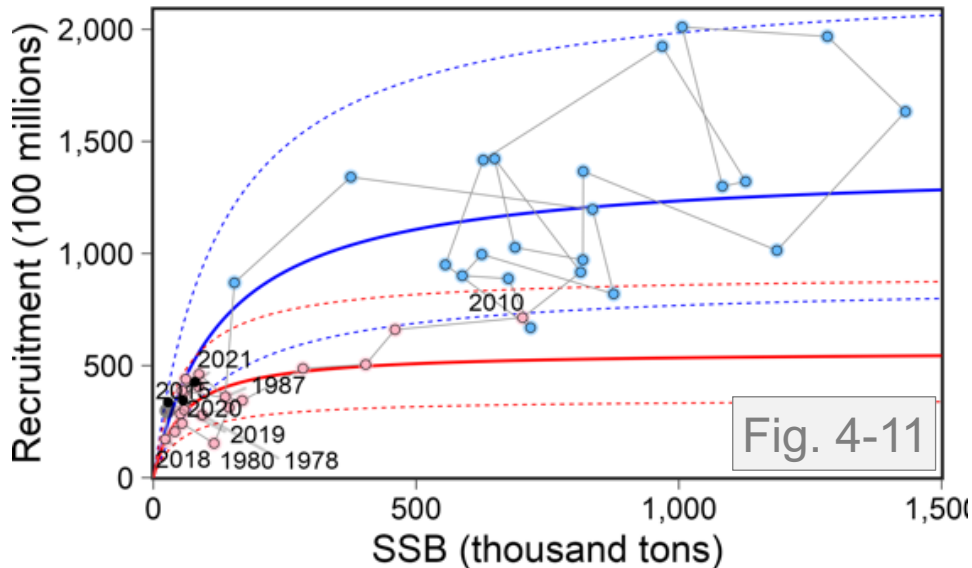
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### Responses to Dr. Teo's Q32

Q In Suppl Table 8-2, there were some models with maxF and allF estimation method. Please clarify the difference.

- The affixes ("maxF" or "allF") represent differences of the method to estimate terminal F.
- "maxF" indicates the method to estimate a terminal F of the oldest (age-3) fish. In these models, selectivity in the terminal year was used as the latest three-year mean of fishing mortality from VPA.
- "allF" indicates the method to estimate terminal Fs from age-0 to -2.
- Note that Fs for age-2 and age-3 fish were assumed to be the same ( $\alpha = 1$ ) regardless of the estimation methods ( $F_{3,t} = F_{2,t}$ ).

# 4. Stock-Recruitment



## Responses to Dr. Teo's Q34

Q How is the split between normal and high years decided?

- A Year breaks were referred to Kurota et al. (2020), which detected regimes by STARS.
- Normal recruitment period is from 1978 to 1987 and 2010–onward (red lines).
  - High recruitment period is from 1988 to 2009 (blue lines).

Kurota et al. (2020) Fish. Res. vol.221 p.105353

## Responses to Dr. Teo's Q35

Q How long is the current “normal” regime expected to continue?

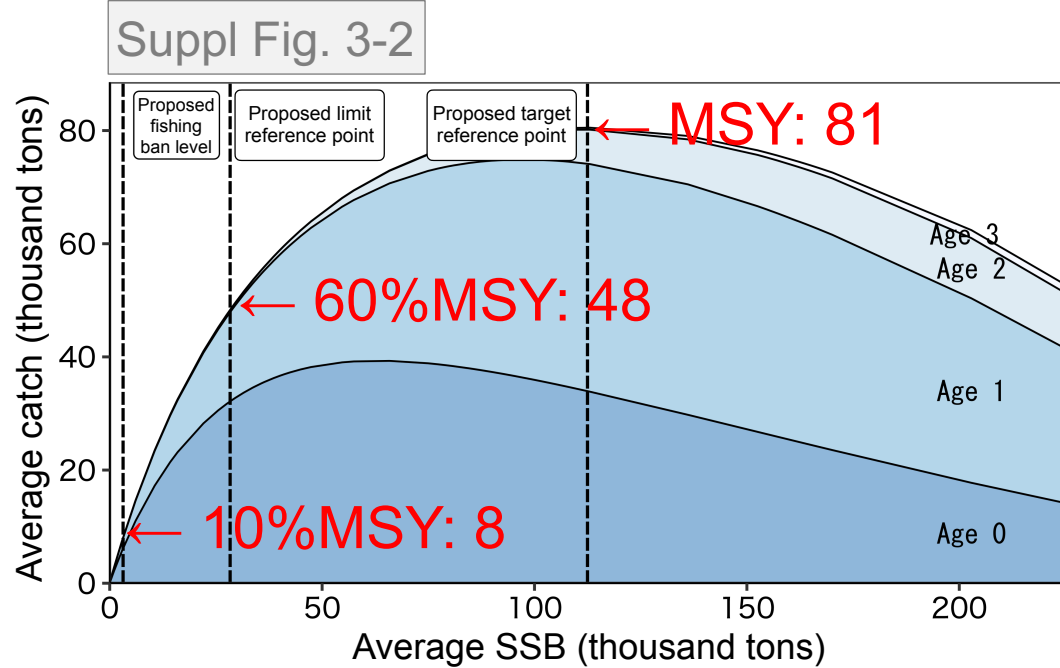
- A Out-of-phase fluctuations between Japanese anchovy and Japanese sardine in the Northwest Pacific have switched in approximately 20-year cycles, but it's unclear whether the same cycles will continue.

# 5. Projections

---

- a. Reference points
- b. Kobe plot
- c. Harvest Control Rule
- d. Future projection

# 5a. Reference points



Reference point	SSB ( $10^3$ ton)
Target (MSY)	112
Limit (60%MSY)	28
Ban (10%MSY)	3

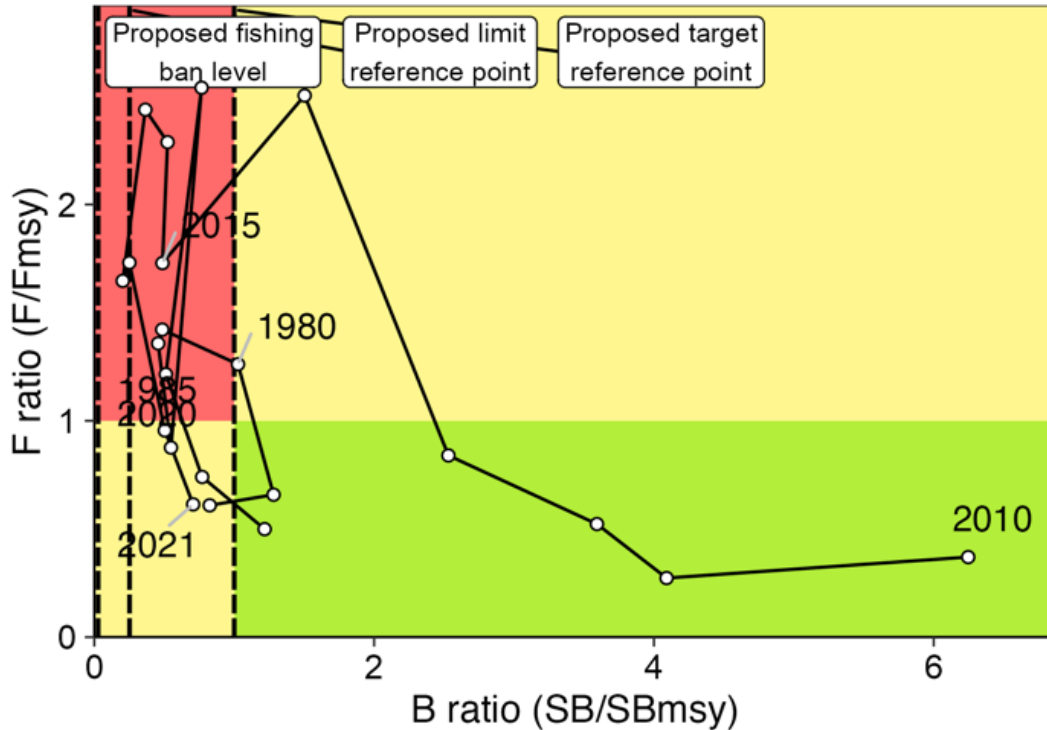
c.f.)  $SSB_{2021}$ :  $79 \times 10^3$  tons

## Responses to Dr. Kuriyama's Q13

**Q** How is uncertainty in the data fed into the model uncertainty? Similarly how does this feed in to the uncertainty in reference points?

**A** The data uncertainties are not taken into the model uncertainties. Therefore, it is also unclear the impact on the reference points.

## 5b. Kobe plot



Suppl Fig. 3-1

### Responses to Dr. Kuriyama's Q1

- The points from 1988 to 2009 are excluded from the Kobe plot because they are in the high recruitment period.

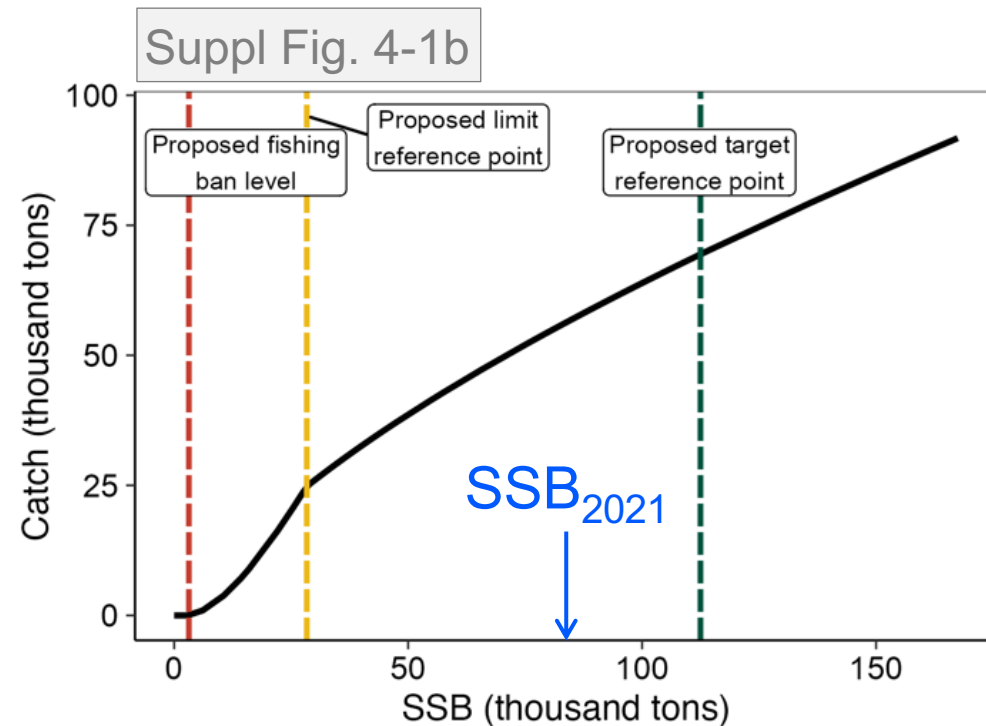
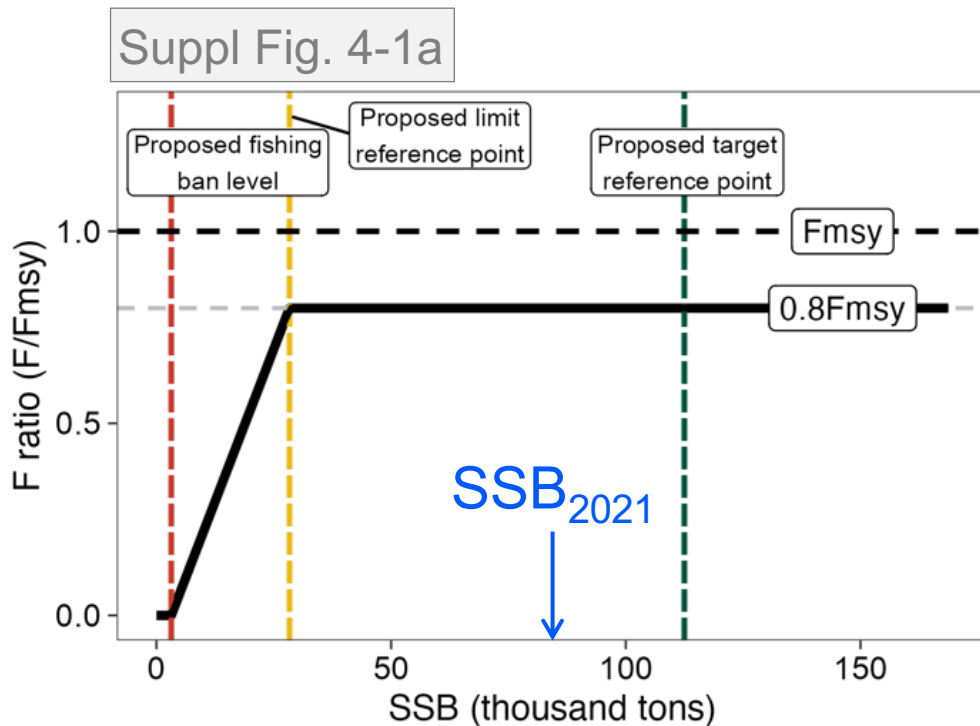
### Responses to Dr. Kuriyama's Q15

**Q** In section 4.(7), what is the selectivity of F in each year used for the SPR calculations?

- First, calculate %SPR with selectivity, weight-at-age, and maturity-at-age for each year (%SPR<sub>t</sub>).
- Second, find the multiplier (X<sub>t</sub>) to F<sub>t</sub> that corresponds to %SPR<sub>MSY</sub>.
- $F_{ratio} = F_t / (F_t * X_t) = 1 / X_t$

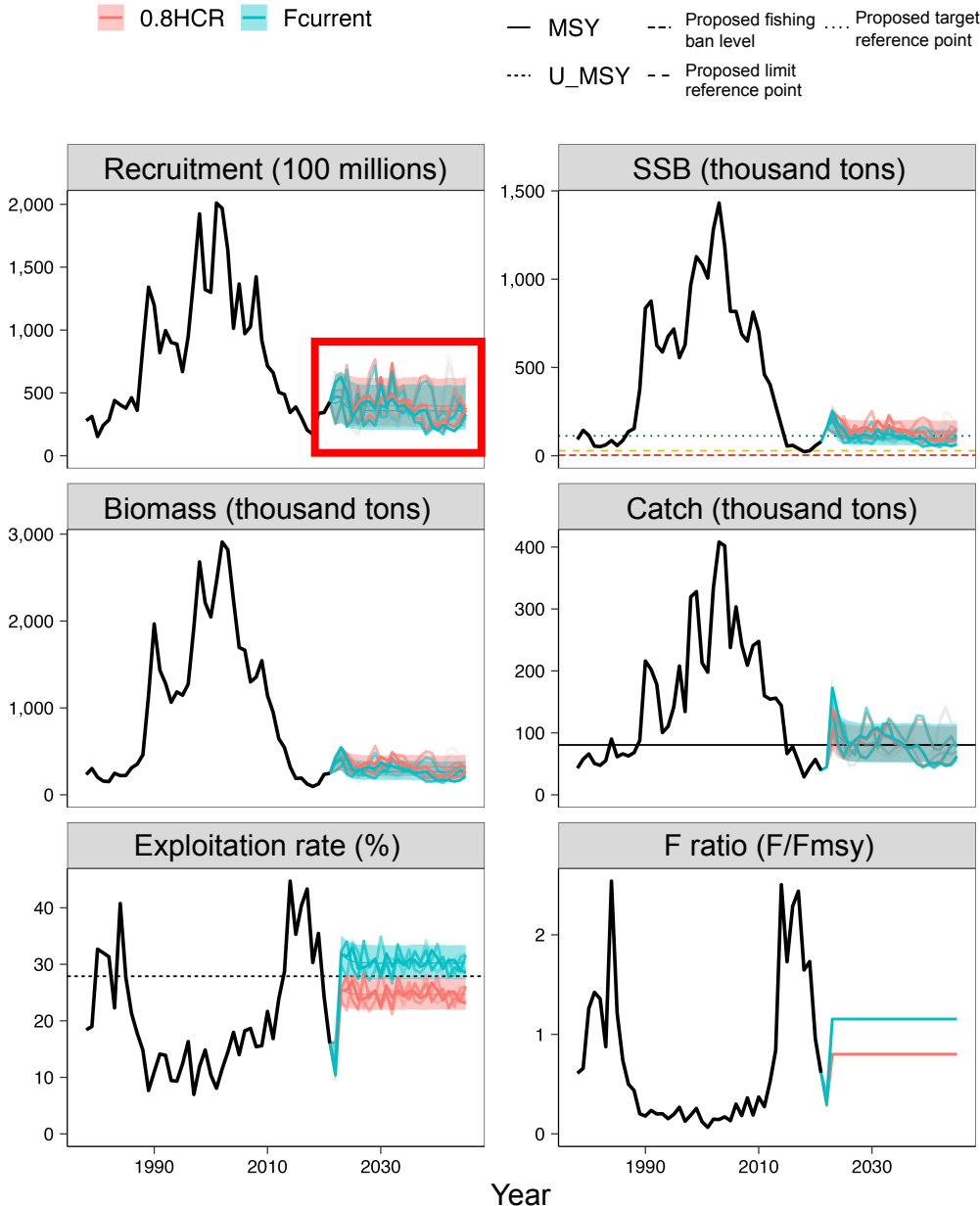
# 5c. Harvest Control Rule

$$F_t = \begin{cases} 0 & \text{if } SB_t < SB_{ban} \\ \beta \gamma(SB_t) F_{msy} & \text{if } SB_{ban} \leq SB_t < SB_{limit} \\ \beta F_{msy} & \text{if } SB_{limit} \leq SB_t \end{cases} \quad \gamma(SB_t) = \frac{SB_t - SB_{ban}}{SB_{limit} - SB_{ban}}$$



- Here shows the default HCR ( $\beta = 0.8$ , bold lines) because the Stakeholder meeting has not been finished.

# 5d. Future projection (1/3)



(Shaded areas: 5 to 95% prediction interval, thin solid lines: average value, thick solid lines: some of simulation results)

## Forward calculation

$$N_{s,t} = \begin{cases} R(SB_t|a, b) & s = S_{min} \\ N_{s-1,t-1} \exp(-M_{s-1,t-1} - F_{s-1,t-1}) & S_{min} < s \leq S_{max} \end{cases}$$

### Responses to Dr. Teo's Q38, Kuriyama's Q22

- Only recruitment uncertainty is considered in the projections.
- Usage of the normal recruitment SRR provides relatively low future recruitment.

### Responses to Dr. Kuriyama's Q23

Age	0	1	2	3
BW (g)	4.7	10.0	17.8	23.6

- Body weights are averages for all years except 1988–2009 (i.e., high recruitment period).

# 5d. Future projection (2/3)

## ■ Probability of exceeding the proposed target reference point ( $SB_{MSY}$ ) (%)

$\beta$	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2043	2053
1.0	0	100	99	76	58	51	47	46	45	45	45	46	45	45	45
0.9	0	100	99	83	69	64	61	61	59	59	59	60	60	59	59
0.8	0	100	99	89	80	76	74	74	73	73	74	74	73	73	73
0.7	0	100	99	93	88	86	86	85	85	85	85	85	85	84	85
0.6	0	100	99	96	94	93	93	93	93	93	93	93	93	93	93
0.5	0	100	99	98	98	97	98	97	97	98	98	98	97	97	97
0.4	0	100	99	99	99	99	99	99	99	99	99	99	99	99	99
0.3	0	100	99	100	100	100	100	100	100	100	100	100	100	100	100
0.2	0	100	99	100	100	100	100	100	100	100	100	100	100	100	100
0.1	0	100	99	100	100	100	100	100	100	100	100	100	100	100	100
0.0	0	100	99	100	100	100	100	100	100	100	100	100	100	100	100
F2019-2021	0	100	99	64	41	32	29	28	27	26	27	27	27	26	27

□ In FY2022SA, management was going to start in 2023.

## ■ Probability of exceeding the proposed limit reference point ( $SB_{0.6MSY}$ ) (%)

$\beta$	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2043	2053
1.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.6	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.4	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.3	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.2	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
F2019-2021	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Responses to Dr. Teo's Q36, Kuriyama's Q21

- The current projection rule requires 30-year projections.
- The 30-year projection has no relation to the frequency of stock assessment meetings. Stock assessment meetings are held annually.

# 5d. Future projection (3/3)

## ■ Mean SSB (thousand tons)

β	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2043	2053
1.0	79	156	191	138	122	117	115	114	113	113	113	113	<b>113</b>	113	113
0.9	79	156	191	146	132	128	126	125	124	124	124	124	<b>124</b>	124	124
0.8	79	156	191	155	143	139	137	137	136	136	136	136	<b>137</b>	136	136
0.7	79	156	191	165	155	152	151	150	150	150	150	150	<b>150</b>	149	149
0.6	79	156	191	175	169	167	166	166	165	165	166	165	<b>166</b>	165	165
0.5	79	156	191	187	184	184	183	183	183	183	183	183	<b>183</b>	182	183
0.4	79	156	191	199	201	203	203	203	203	203	203	203	<b>204</b>	202	203
0.3	79	156	191	213	221	225	226	227	226	226	227	227	<b>227</b>	226	226
0.2	79	156	191	228	243	250	252	254	253	253	254	254	<b>254</b>	253	253
0.1	79	156	191	244	269	280	284	285	285	285	286	286	<b>286</b>	284	285
0.0	79	156	191	262	299	314	320	322	322	322	323	323	<b>324</b>	322	323
F2019-2021	79	156	191	127	109	103	101	99	99	98	99	98	<b>99</b>	98	98

■ SBtarget: 112 x 10<sup>3</sup> ton

## ■ Mean catch (thousand tons)

β	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2043	2053
1.0	40	45	116	93	85	83	82	81	81	81	81	81	<b>81</b>	80	80
0.9	40	45	109	90	84	82	81	81	80	80	80	80	<b>80</b>	80	80
0.8	40	45	101	87	82	81	80	79	79	79	79	79	<b>79</b>	79	79
0.7	40	45	92	83	79	78	78	77	77	77	77	77	<b>77</b>	77	77
0.6	40	45	82	77	75	75	74	74	74	74	74	74	<b>74</b>	74	74
0.5	40	45	72	70	70	70	70	69	69	69	69	69	<b>69</b>	69	69
0.4	40	45	60	62	62	63	63	63	63	63	63	63	<b>63</b>	63	63
0.3	40	45	47	51	53	53	53	53	53	53	54	54	<b>54</b>	53	53
0.2	40	45	33	38	40	40	41	41	41	41	41	41	<b>41</b>	41	41
0.1	40	45	17	21	22	23	23	23	23	23	24	24	<b>24</b>	23	23
0.0	40	45	0	0	0	0	0	0	0	0	0	0	<b>0</b>	0	0
F2019-2021	40	45	126	95	86	83	81	81	80	80	80	80	<b>80</b>	80	80

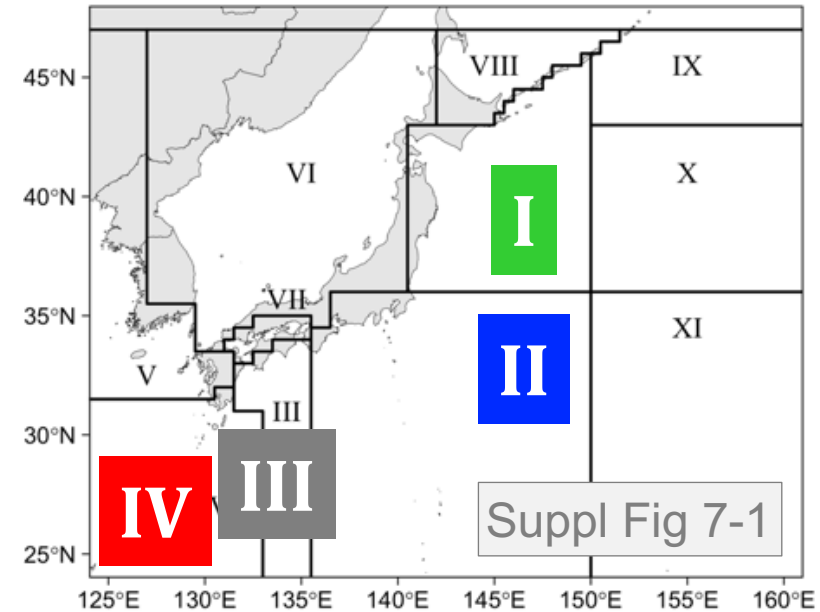
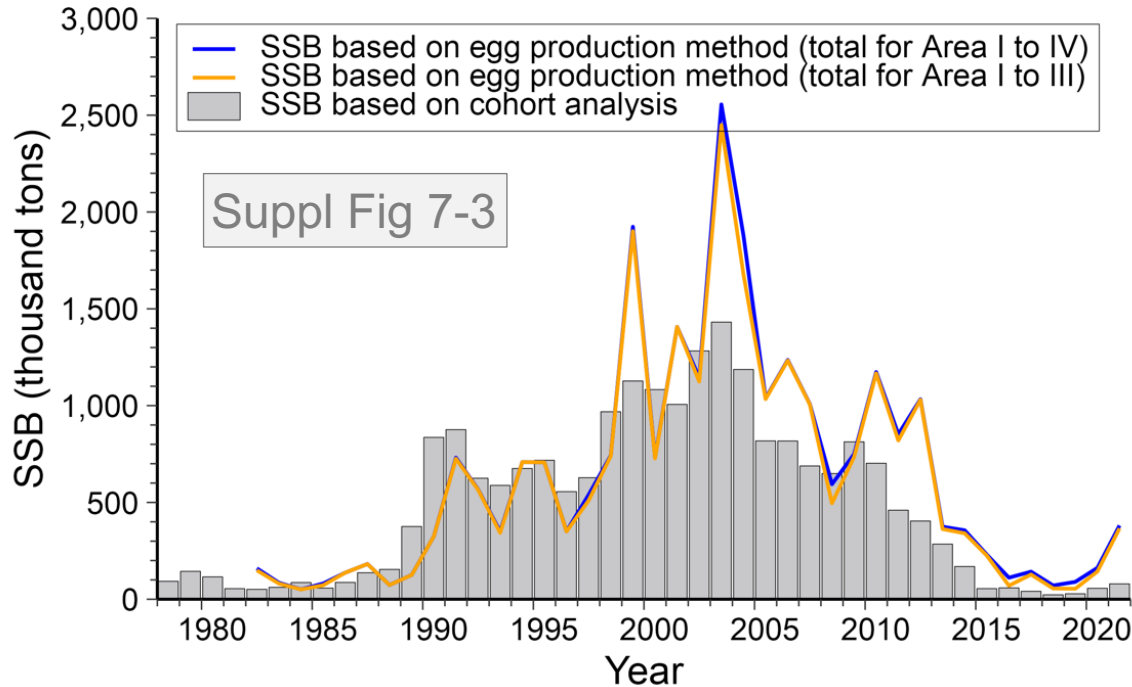
↑ Candidates for ABC in FY2022SA.

$$C_{a,t} = (1 - e^{-F_{a,t}})N_{a,t}e^{-\frac{M_a}{2}}$$

Suppl Table 5-1

Age	BW (g)	Selectivity	F <sub>msy</sub>
0	4.7	0.27	0.38
1	10.0	0.89	1.23
2	17.8	1.00	1.39
3	23.6	1.00	1.39

# 6. Others : Estimation of spawning biomass by TEP



- Apply batch fecundity equations in Takasuka et al. (2005).
- This method has the advantage of allowing us to estimate spawning biomass by region and by month (Suppl Table 7-2).

Takasuka et al. (2005) Fish. Res. vol.76 p.475–482

## Responses to Dr. Teo's Q15 (partly related to Q13)

Q There is uncertainty in the relationships used to estimate the SSB from the surveys, as well as the survey data. If these uncertainties are included in the calculations, what are the uncertainties in the resulting index?

A The estimates are not used for tuning.

# Response to Dr. Teo's Q16, and Q33

## Data – Tuning indices

Q Are there acoustic surveys for coastal pelagic species?

A Acoustic survey data are not currently available for our stock assessment. The data obtained by R/V surveys exist but have some issues being unable to separate from other species. Some stocks use acoustic survey data for stock assessment, such as the Tsushima Warm Current stock of Japanese jack mackerel.

## Model and Diagnostics

Q 33) Have there been attempts at using statistical catch-at-age or integrated models?

A No. We have done neither.

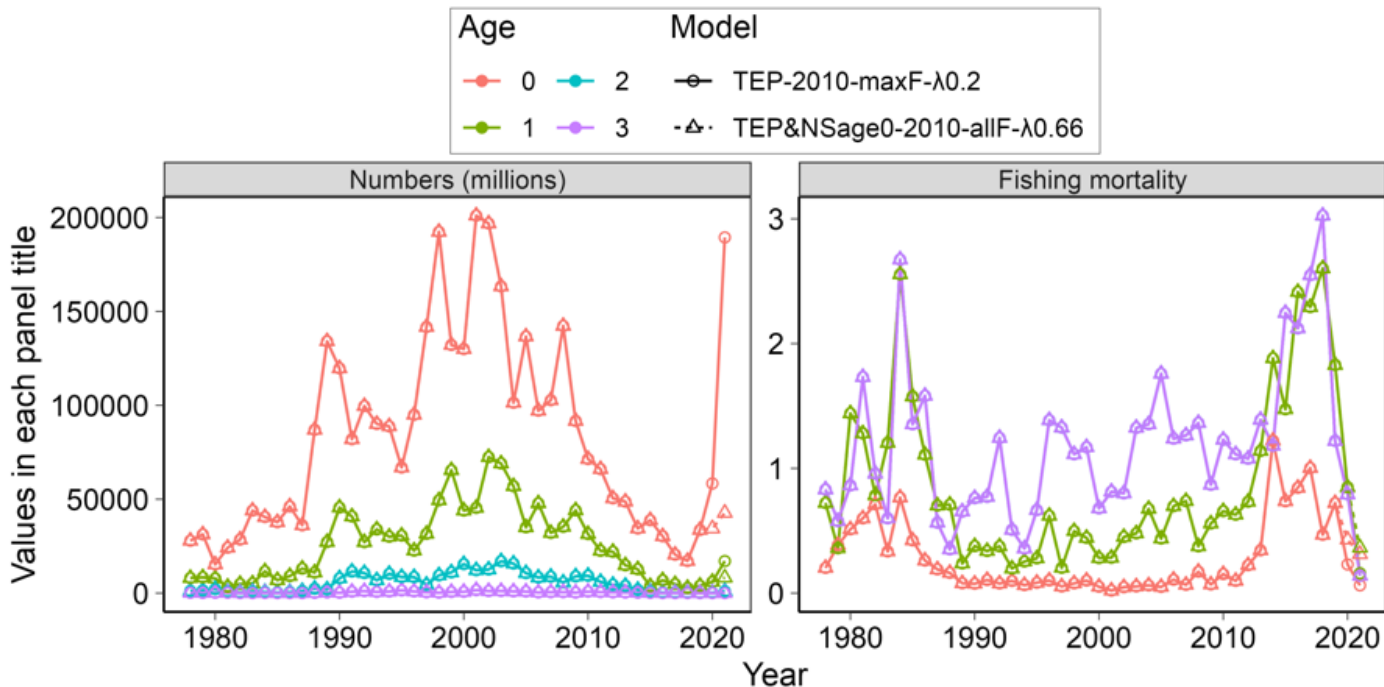
# Response to Dr. Teo's Q31

unpubl.

## Model and Diagnostics

Q Also, it may be reasonable to fit only the egg production index. So why fit to both?

A Although we did not show it in the FY2022SA report, we have tried a preliminary calculation fitting only the TEP with  $\lambda$  in increments of 0.1. However, those estimates resulted in very high recruitment.



## Comparison of $F_{\text{terminal}}$

Age	Model tuned by TEP	The model adopted in FY2022SA
0	0.06	0.31
1	0.16	0.36
2	0.14	0.14
3	0.14	0.14

# Response to Dr. Teo's Q37

## Projections

- Q Doing 1 and 2 year projections are important for management. What is the prediction skill of these short term predictions? For example, if the model ends in 2017, how do the 1 and 2 year predictions from that model compare with the estimates for 2018 and 2019? And so on.
- This stock is a short-lived species and the catch is mainly age-0 fish.
- Therefore, we do not expect short-term forecasts to be highly accurate.

## Others

**Q** What are the potential improvements for this assessment?

**A** The following are considered high priorities.

1. Update of ALK
2. Update of LWR
3. Search for coastal fisheries CPUE as candidate of tuning indices
4. Standardization of TEP and Age-0 CPUE of trawl survey in northward migration season