



Trachurus japonicus

Tsushima Warm Current stock jack mackerel

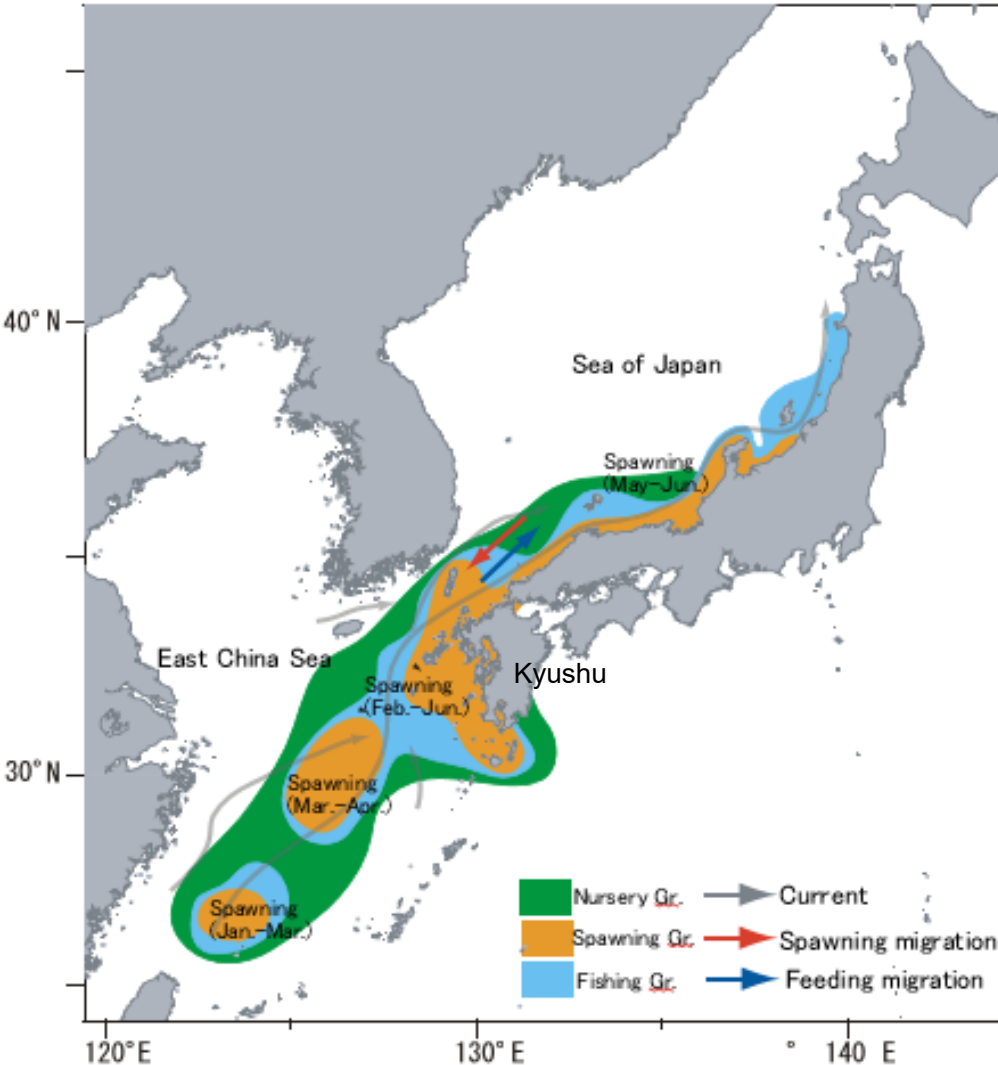


Contents

- **Biology and Stock assessment**
Distribution, Growth, Estimation of Catch at Age, Stock abundance indices, VPA
- Stock-Recruitment Relationships
- Reference points, Kobe-plot
- Harvest Control Rule, Future projection



Distribution



Jack mackerel mainly distributes on the continental shelf region. The main fishing grounds are East China Sea and coastal areas off western Kyushu and Sea of Japan.

The spawning grounds are southern East China Sea area and coastal areas off Kyushu and Sea of Japan.

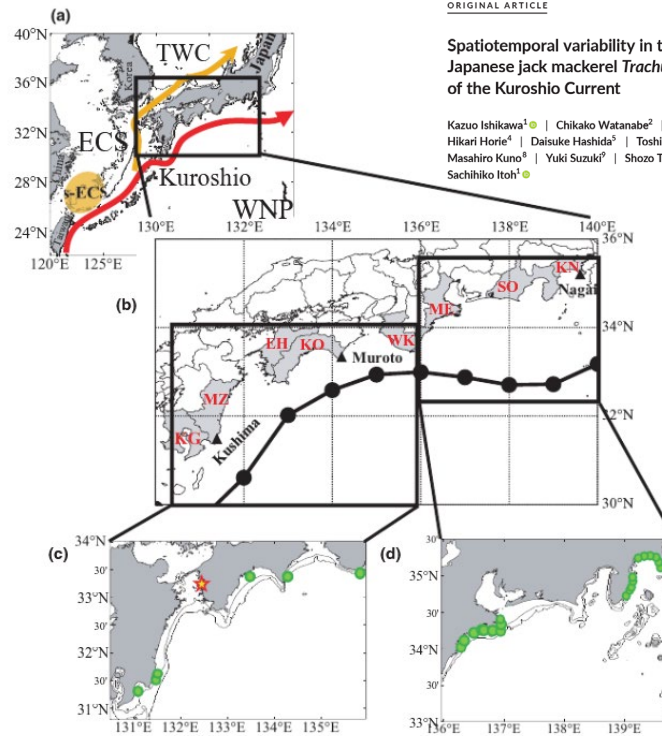
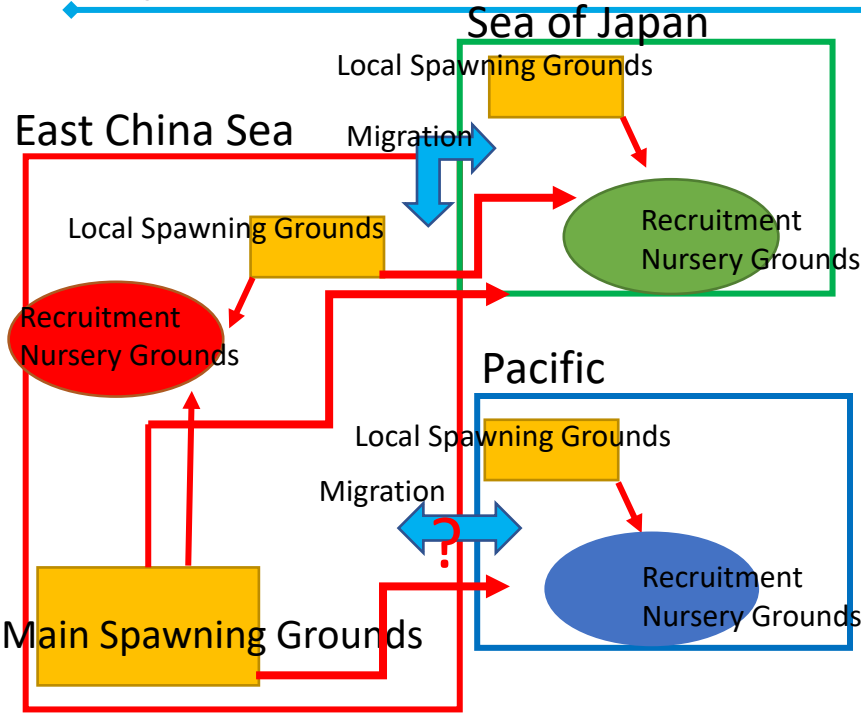


Reviewers Comments

- 1) Similar to the Pacific stock, the spawning grounds for the Pacific and Tsushima stocks suggest that there is substantial overlap in their spawning grounds in the East China Sea. In addition, the text explaining the stock distributions do not provide evidence of stock structure for the two stocks. Therefore, it is not clear that the assumed stock structure is appropriate. Please provide evidence that the stock structures for the Jack Mackerel stocks (Pacific & Tsushima) is appropriate and how the distributions were derived.
- 2) Some Tsushima stock fish are thought to migrate to the Pacific and are caught as Pacific stock fish. Is there any work done to show that and the approximate magnitude of it? Also, was the catch for the two stocks separated on the fishing grounds.



Responses



- 1) Some research surveys and analyses have been conducted. Currently, Jack mackerel in the Pacific could be consisted of East China Sea (main spawning grounds) and Pacific (local spawning grounds). Also, in the Sea of Japan could be consisted of two spawning grounds.
- 1) Distribution of this species in the East China Sea and Sea of Japan is continuous and could be migrated among these areas. However, juvenile and adult fish cannot move from Pacific to East China Sea due to Kuroshio current, but its unclear.
- 2) The magnitude of recruitment from East China Sea to Pacific is unclear. Some works have been conducted.



Reviewers Comments and Responses

- 11) What were the approximate relative amounts of catch in the offshore vs coastal areas?

In 2020, the catch in offshore and coastal area was 39 and 41 thousand tons, respectively.

- 12) It appears that fish were sampled and measured in the coastal areas but not the fish from the offshore area. Instead, for the offshore area, it was assumed that each box was 16 kg and was divided by the number of reported fish in the box to obtain the average weight per fish from a box. This average weight was then converted to length and then an age based on the ALK. For two categories (small and very small), there were no reported numbers of fish per box and it was instead assumed that these fish were either age-0 or age-1 based on time of year. Is my understanding correct?

Correct.

- 13) Using the average weight of fish per box assumes that there is negligible variability in the size of fish within a single box. Is there evidence to support this assumption? Why were the fish in the boxes not sampled instead?

Because size of this fish was sorted at fish market, variation of the size in a box could be small.

- 14) I may be misreading it but Eqn 1 looks wrong. Please check. Also, not sure about the use of Eqn 1. Seems like Eqn 2 is enough. Also, I assume that the χ is in proportion?

Correct.

- 15) The length-weight relationship used to convert catch in weight to catch in numbers appears to be fixed. This assumes that this does not vary by space and time. Is there evidence to support this assumption?

The length-weight relationship was fixed through the year, we have checked this every year.

- 16) Was any aging done to develop the ALKs or were these based on growth models? If there was aging done, please show the aging data relative to the ALKs.
- 17) If the ALKs were based on growth models, please show the growth models and the uncertainty and variability in the growth models (and the data if possible).
- 18) If the ALKs were based on aging, please show the aging data and the estimated aging error.

(Response to questions 16-18) ALK dependent on the von Bertalanffy growth model.



Reviewers Comments and Responses

- 19) It appears that cohort slicing was used to convert lengths to ages. Cohort slicing assumes that a single length can only be assigned to a single age. This is likely inappropriate. Instead, the ALK should be used to assign a single length into multiple ages with different probabilities, based on the aging data or growth model. Based on aging done in the EPO, small pelagic fish like sardine and mackerels with the same length often have different ages, especially after age-0. Please show the aging data to support that assumption.

ALK is made by empirical information, we can change this if the growth model was changed.

- 20) Please overlay the length histograms for a single year over the ALKs in Appendix 2. And show it for several years.

Please see next slide figures.

- 21) Looks like there were 2 growth patterns (and corresponding ALKs) by space but assumed to be no variability between years. Is my understanding correct? Please show evidence to support the assumption of no growth (and corresponding ALK) variability between years. From what I have seen of aging done in the EPO on sardines and mackerels, the growth and ALKs vary quite a lot between years. For the Pacific stock, studies are being done to address this problem. Is the same being done for the Tsushima stock?
- 22) In addition, age selectivity of each fishery also affects the ALK. It is common for each fishery to have separate ALKs. Therefore, it would be useful to have studies comparing the ALKs between fisheries in the future, especially for different gears.

(Response to question 21 & 22) No clear annual difference on the growth model.

(Response to question 22) Yes, we agree.



Response to comment no20.

Nearshore area: Kyushu-
West&Central Sea of Japan

Nearshore area: North Sea of Japan

FL(cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	FL(cm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	2	52	6	19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	20	289	40	47	15	1	1	0	0	0	0	0	0	0	0	3	0	0	0	0
6	1	7	13	2	40	190	128	114	69	9	1	0	0	0	0	0	0	0	0	4	53	17	0	0	0
7	1	84	108	32	73	33	367	314	247	146	15	0	0	0	0	0	0	0	0	43	141	69	0	0	0
8	2	102	167	74	35	7	346	378	325	294	144	11	0	0	0	0	0	0	0	83	248	67	5	0	0
9	8	31	169	204	117	6	854	1283	736	287	342	93	0	0	0	0	0	0	0	60	228	232	69	12	4
10	42	16	83	189	171	2	316	281	193	278	261	237	0	0	0	0	1	0	0	7	92	278	192	91	47
11	108	2	42	73	179	28	540	610	245	186	141	329	0	0	0	0	0	0	0	23	118	177	193	60	60
12	209	2	11	35	173	48	368	519	248	347	235	196	0	0	0	0	0	0	0	15	11	264	53	53	53
13	367	16	66	53	56	41	218	125	469	587	266	134	0	0	0	0	0	0	0	0	2	53	134	86	86
14	281	141	115	170	64	51	87	22	434	303	352	341	0	0	0	0	0	0	0	14	76	104	91	60	95
15	168	269	89	204	129	87	13	26	127	83	230	421	0	0	0	0	0	0	0	15	52	51	23	18	24
16	278	220	202	147	237	165	67	111	77	100	160	224	0	0	0	0	0	0	0	16	29	13	19	60	5
17	295	363	178	218	406	403	133	245	114	106	114	178	0	0	0	0	0	0	0	17	12	17	30	25	25
18	172	311	167	146	352	417	229	441	231	195	113	139	0	0	0	0	0	0	0	18	16	42	38	64	64
19	140	212	242	187	310	381	298	317	273	276	206	162	0	0	0	0	0	0	0	19	18	41	29	48	48
20	174	206	252	138	285	368	248	160	214	261	239	215	0	0	0	0	0	0	0	20	32	52	17	44	44
21	290	247	203	139	171	193	206	151	143	141	179	247	0	0	0	0	0	0	0	21	45	31	0	35	35
22	285	183	126	115	152	90	181	207	104	63	148	237	0	0	0	0	0	0	0	22	39	16	0	75	75
23	131	70	81	57	151	43	119	312	161	80	116	215	0	0	0	0	0	0	0	23	8	10	0	72	72
24	45	65	51	35	122	63	84	286	158	119	156	173	0	0	0	0	0	0	0	24	4	5	0	90	90
25	26	83	35	40	89	76	61	166	118	137	154	124	0	0	0	0	0	0	0	25	1	3	0	05	05
26	41	58	43	56	94	62	72	91	94	149	192	97	0	0	0	0	0	0	0	26	0	3	0	90	90
27	20	59	36	49	115	50	75	62	94	176	133	97	0	0	0	0	0	0	0	27	0	5	0	47	47
28	19	45	51	9	114	44	67	40	77	125	64	114	0	0	0	0	0	0	0	28	0	3	0	10	10
29	14	40	30	7	106	83	53	21	22	78	13	71	0	0	0	0	0	0	0	29	0	1	0	5	5
30	11	15	19	0	89	120	39	25	10	52	10	31	0	0	0	0	0	0	0	30	0	0	0	31	31
31	6	3	14	1	65	123	43	13	1	42	23	41	0	0	0	0	0	0	0	31	0	0	0	0	0
32	0	0	8	1	58	88	26	13	3	23	23	33	0	0	0	0	0	0	0	32	0	0	0	0	0
33	1	0	20	7	81	51	23	11	4	15	10	34	0	0	0	0	0	0	0	33	0	0	0	1	1
34	1	0	19	7	71	25	25	7	7	8	8	46	0	0	0	0	0	0	0	34	0	0	0	0	0
35	0	0	19	9	54	14	27	2	2	3	3	36	0	0	0	0	0	0	0	35	0	0	0	0	0
36	0	2	13	4	34	5	20	1	0	1	1	27	0	0	0	0	0	0	0	36	0	0	0	0	0
37	0	3	5	1	28	1	9	0	1	0	0	10	0	0	0	0	0	0	0	37	0	0	0	0	0
38	0	0	4	4	15	2	9	0	0	0	1	3	0	0	0	0	0	0	0	38	0	0	0	0	0
39	0	3	2	0	14	0	1	0	0	0	0	4	0	0	0	0	0	0	0	39	0	0	0	0	0

- 20) This figures overlapped ALKs and measured size frequencies in 2019. The ALK at two areas are slightly different. The side bars represents size distributions of jack mackerel in each area in 2019.



Maturation

Age and maturation of jack mackerel *Trachurus japonicus* in the East China Sea

Mari Yoda · Tetsuro Shiraishi · Ryuji Yukami · Seiji Ohshimo

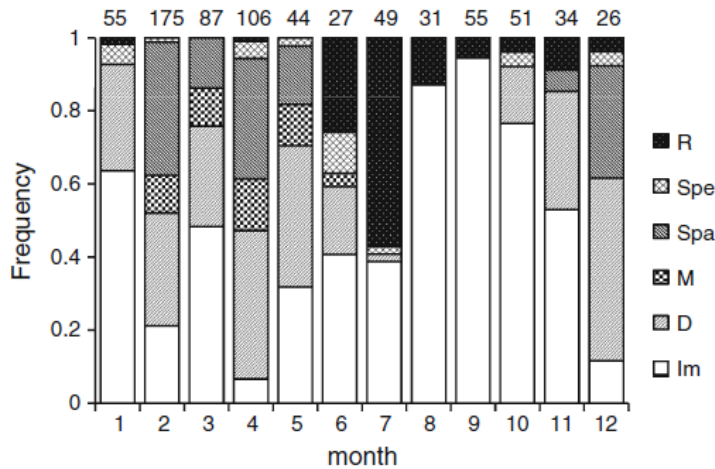
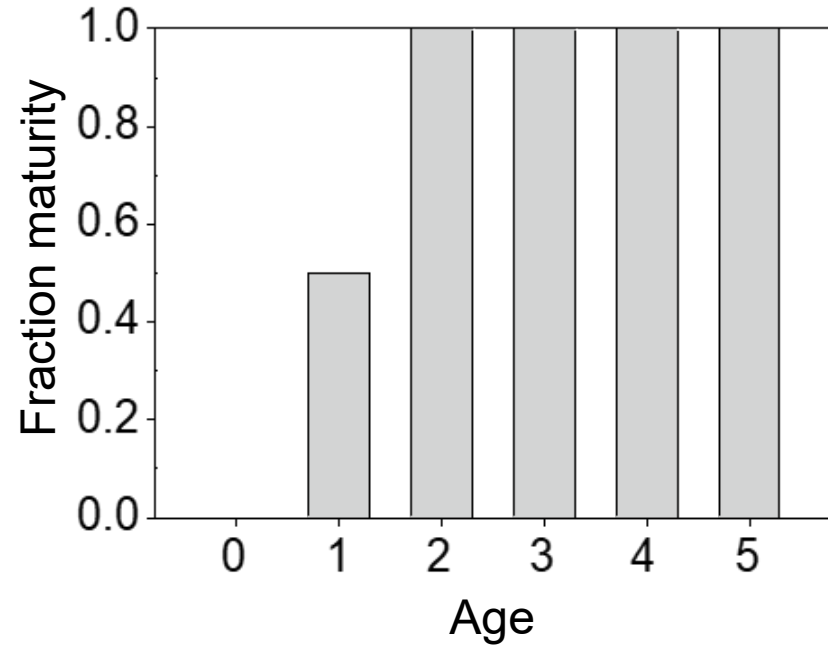


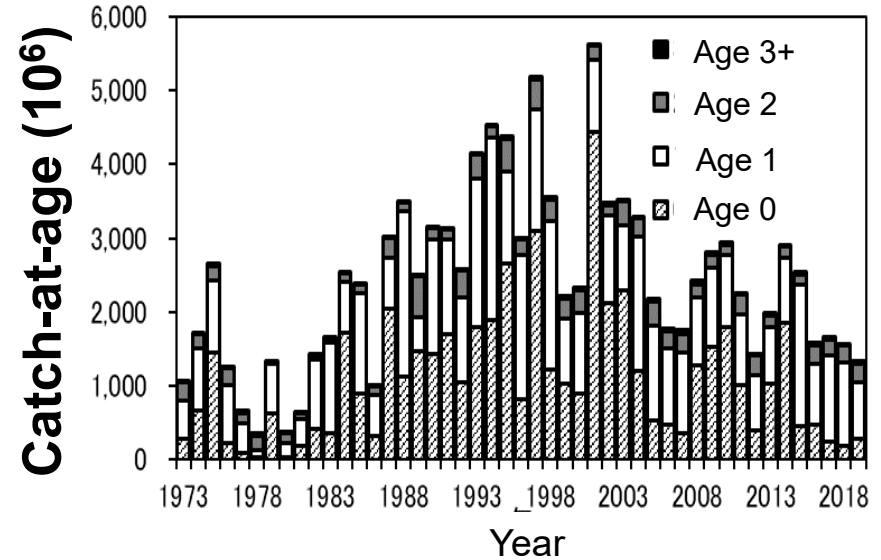
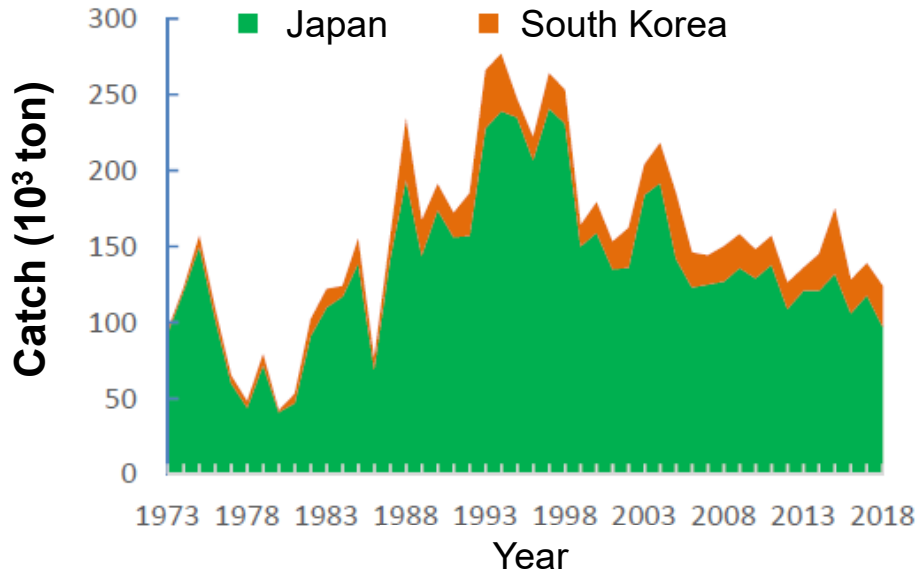
Fig. 6 Monthly changes in the frequency of occurrence of various maturity stages of ovaries of jack mackerel. *D* Developing stage, *Im* immature stage, *M* mature stage, *R* resting stage, *Spa* spawning stage, *Spe* spent stage



FRA samples small pelagic fish species every year, and analyzes maturation characteristics based on histological methods of small pelagic fish.



Catch and Catch-at-age



Jack mackerel is exploited mainly by Japanese and Korean fisheries in the East China Sea and Sea of Japan. Age 0 and 1 fish are mainly caught.



Reviewers Comments and Responses

- 3) The doc states that non-Japanese fisheries have large catches of the Tsushima stock but these catches were not included. Including all removals is critical for the stock assessment. It appears catches from South Korea were included but not Taiwan and China. Is that correct? If so, please explain why catch from Taiwan and China were not included. Were there any other sources of removals for this stock that were not included (e.g., North Korea)?

The catch amount in China and Taiwan have been reported, the catch amount in China in 2019 was about 40 thousand tons.

- 4) Are there any estimates of catch or effort from these non-Japanese fisheries that capture this stock? Looks like there are some FAO data on China's catch but these were not used. Why?

The catch report in China delayed a year. Furthermore, monthly catch amount, fishing grounds and size component in Chinese catch are unclear.

- 5) Based on the FAO data, the magnitude of China's catch of the stock may exceed that of Japan. Would that be correct?

Its suggest that the information from China have large uncertainties. Then, Chinese information cannot be incorporated into our model.

- 6) If these catches are not available but are large, it may be more appropriate to use other methods to assess and manage the stock. Were these considered? For example, data poor and catch-free models or indicator analysis or just base the management on surveys like sardine stocks in Europe and South Africa.

We appreciate your valuable suggestions. We will try to conduct "data poor and catch-free models" or "indicator analysis" by the next full stock assessment.



Procedures of tuned VPA

Fundamental part

$$N_{a+1,y+1} = N_{a,y} \exp(-F_{a,y} - M)$$

$$F_a^{new} = \ln \left\{ 1 + \frac{C_a}{N_{a+1}} \exp(-M) \frac{F_a + M}{F_a} \frac{1 - \exp(-F_a)}{1 - \exp(-F_a - M)} \right\}$$

$$F_{3+,y} = \alpha F_{2,y}$$

N : Stock number, a : age, y : year, F : fishing mortality
 M : natural mortality 0.5/year, α : coefficient (0.3)

Tuning part

$$-\ln L = \sum_k \sum_y \left[\frac{[\ln I_{k,y} - (b_k \ln N_{k,y} + \ln q_k)]^2}{2\sigma_k^2} - \ln \left(\frac{1}{\sqrt{2\pi}\sigma_k} \right) \right]$$

$$I = q_k N_{k,y}^{b_k}$$

N : Stock number, I : abundance index
 y : year



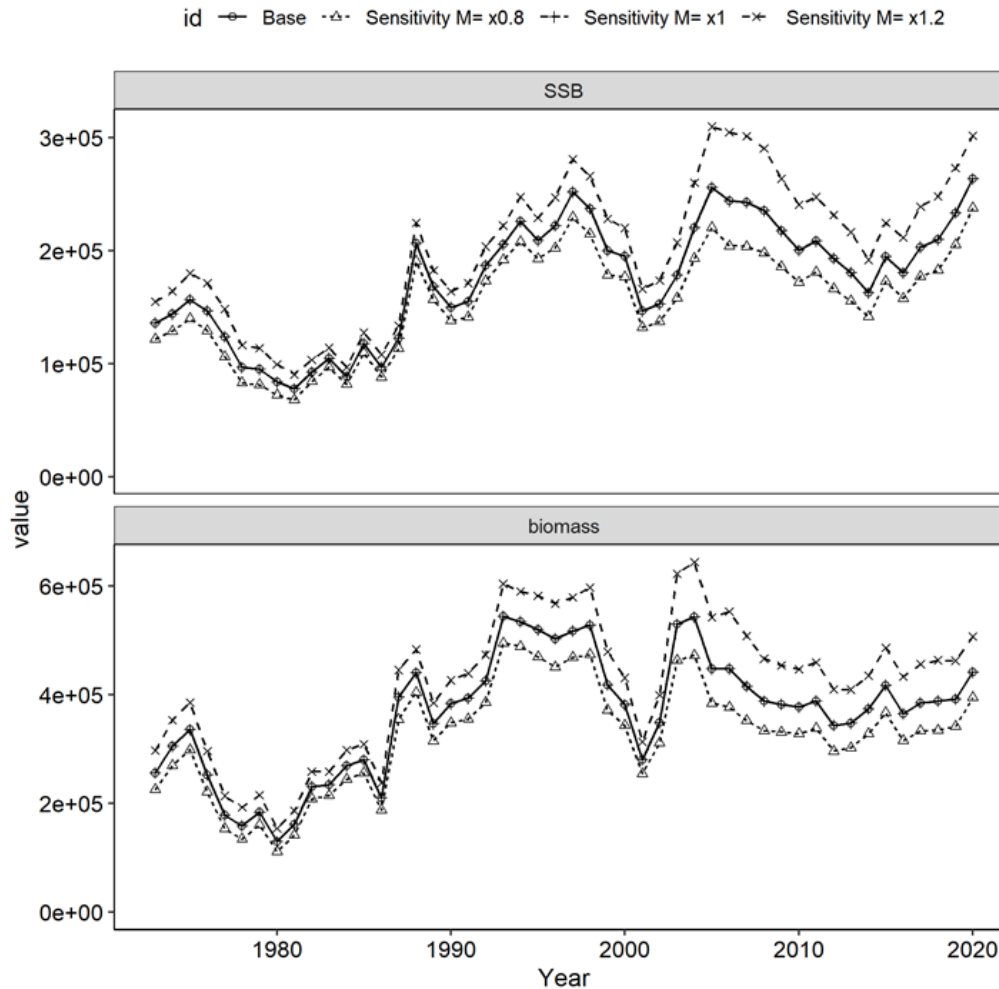
Reviewers Comments

- 27) Using Hoenig, the assumed maximum age of 5 years is inconsistent with an M of 0.5 per year (you would need a max age of about 10 or 11 years to get M of 0.5 per year). I am unfamiliar with Tanaka 1960.
- 28) Given that there has been more recent and more appropriate meta-analysis of natural mortality relationships (i.e., Hamel 2015) than Tanaka 1960, there is a need to explain why using the relationship in Tanaka 1960 is the best scientific information available.
- 29) Even if using Tanaka 1960 is appropriate, the range of sensitivity for M (0.4 to 0.6) does not likely cover the uncertainty in the Tanaka 1960 meta-analysis. If using Tanaka 1960, it would be important to calculate the prediction interval for the relationship (Hamel 2015).
- 30) Please show the model diagnostics for the VPA model. Retrospective pattern and fit to the indices. Also please show model results when not fitting to the indices, and fitting to each index in turn (this is to look at the influence of each index).



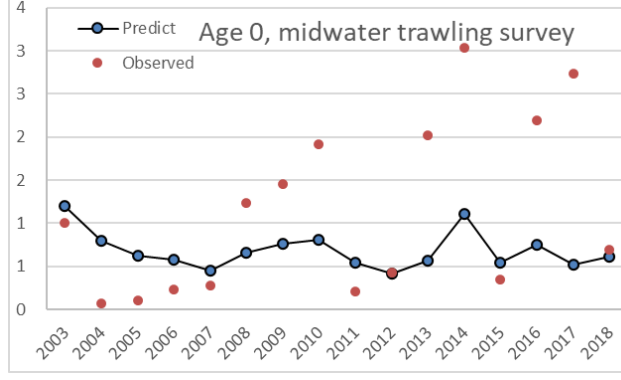
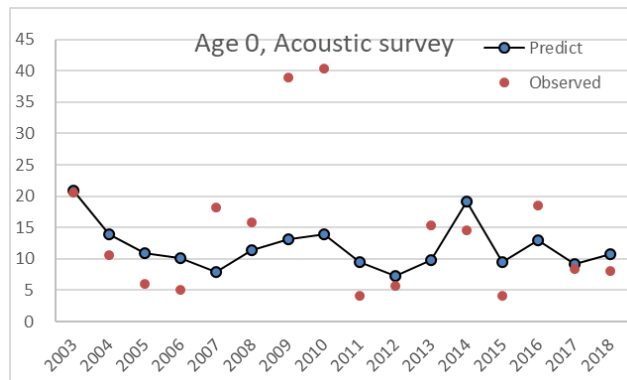
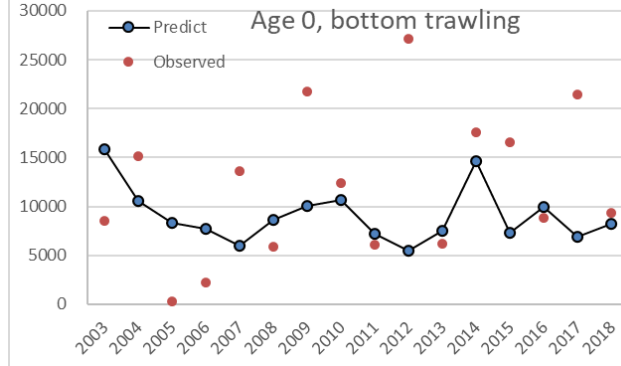
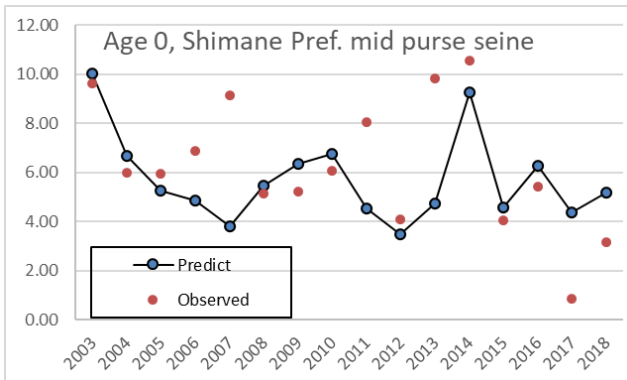
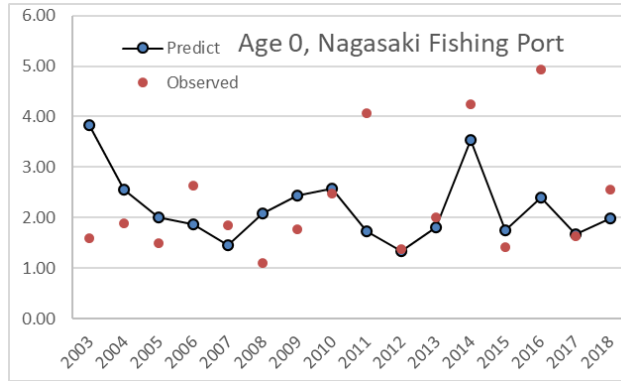
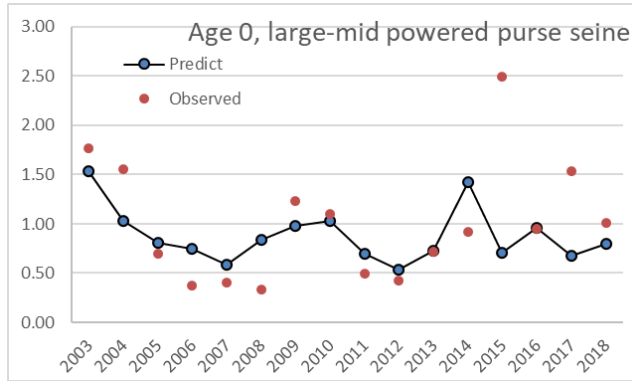
Responses

- Our institute just start the discussion on about the natural mortality.
- We have conducted the sensitivity test about the natural mortality. When the natural mortality change 0.1, the stock size and spawning stocks size differ about 20%.



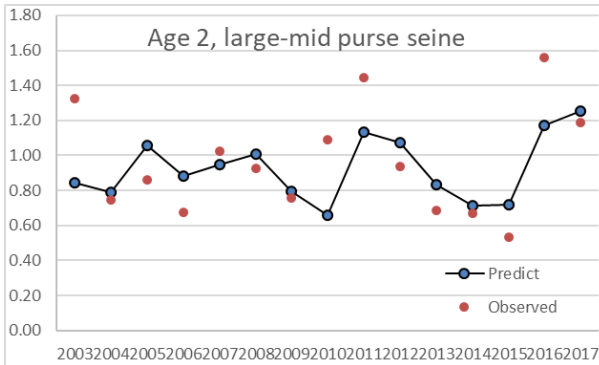
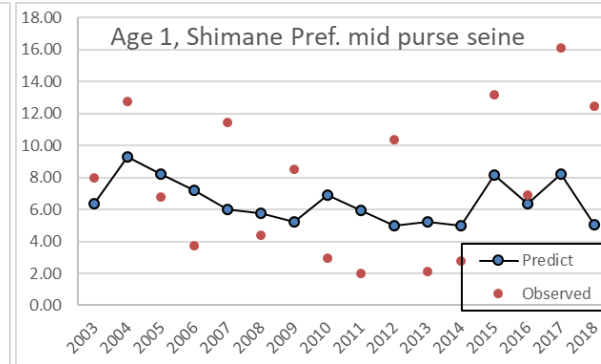
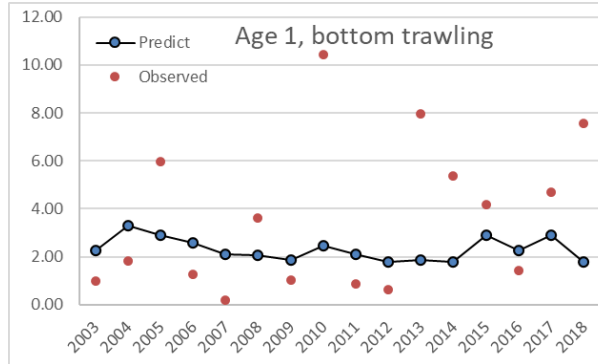
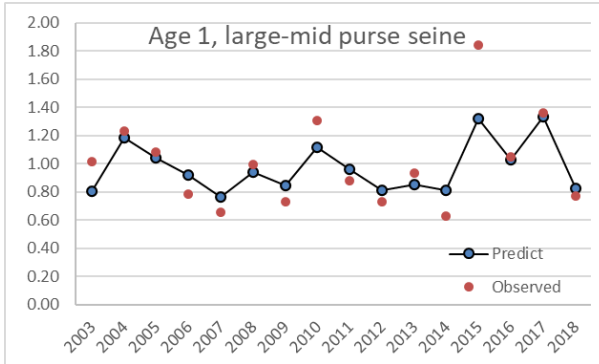


Abundance indices: Age 0

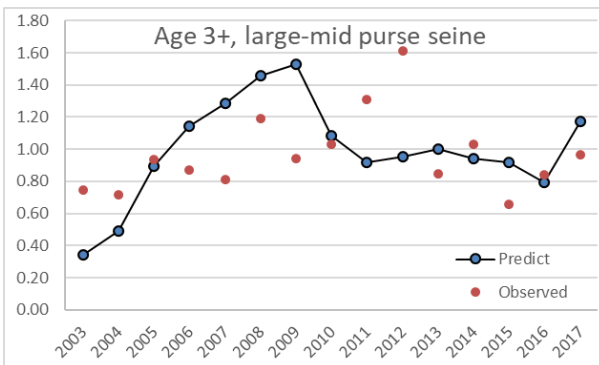




Abundance indices: Age 1,2 and 3+



There are six abundance indices for age 0, three for age 1, and one index for age 2 and 3+.





Reviewers Comments and Responses

- 23) The data set table shows that there were 6 recruitment and 3 age-specific indices used as tuning indices. However, there are not enough details to review the indices. Please provide details on each index (e.g., spatial and temporal coverage, survey design, standardization procedure and diagnostics) and why they were used to tune the model.

Stock structure of Jack mackerel is complex, then many surveys have been conducted. Therefore, we have many stock indices for Jack mackerel.

- 24) It appears that all available indices were just thrown into the model without much thought, which is not a good idea. Please explain why so many indices were used and the thought process behind fitting each of these indices in the model.

Dynamics of local stock abundance indices were different, because stock structure of this species is complex.

- 25) Were the indices weighted during the model fitting? If not, there is an implicit assumption that all indices were equally representative of the stock as a whole. There were indices from different gears and fisheries and likely spatial coverage, and some were standardized and others were nominal, and some were surveys. Therefore I am not sure it is a good idea to assume all of them were equally representative of the stock as a whole. Please support this assumption.

In 2019 stock assessment, weighting is applied using the magnitude of variance of each index.

Model fittings are shown in this presentation.

- 26) It appears that only a few of the indices were standardized. If the nominal indices were used, this assumes that catchability is constant for those indices for all years. Please support this assumption.

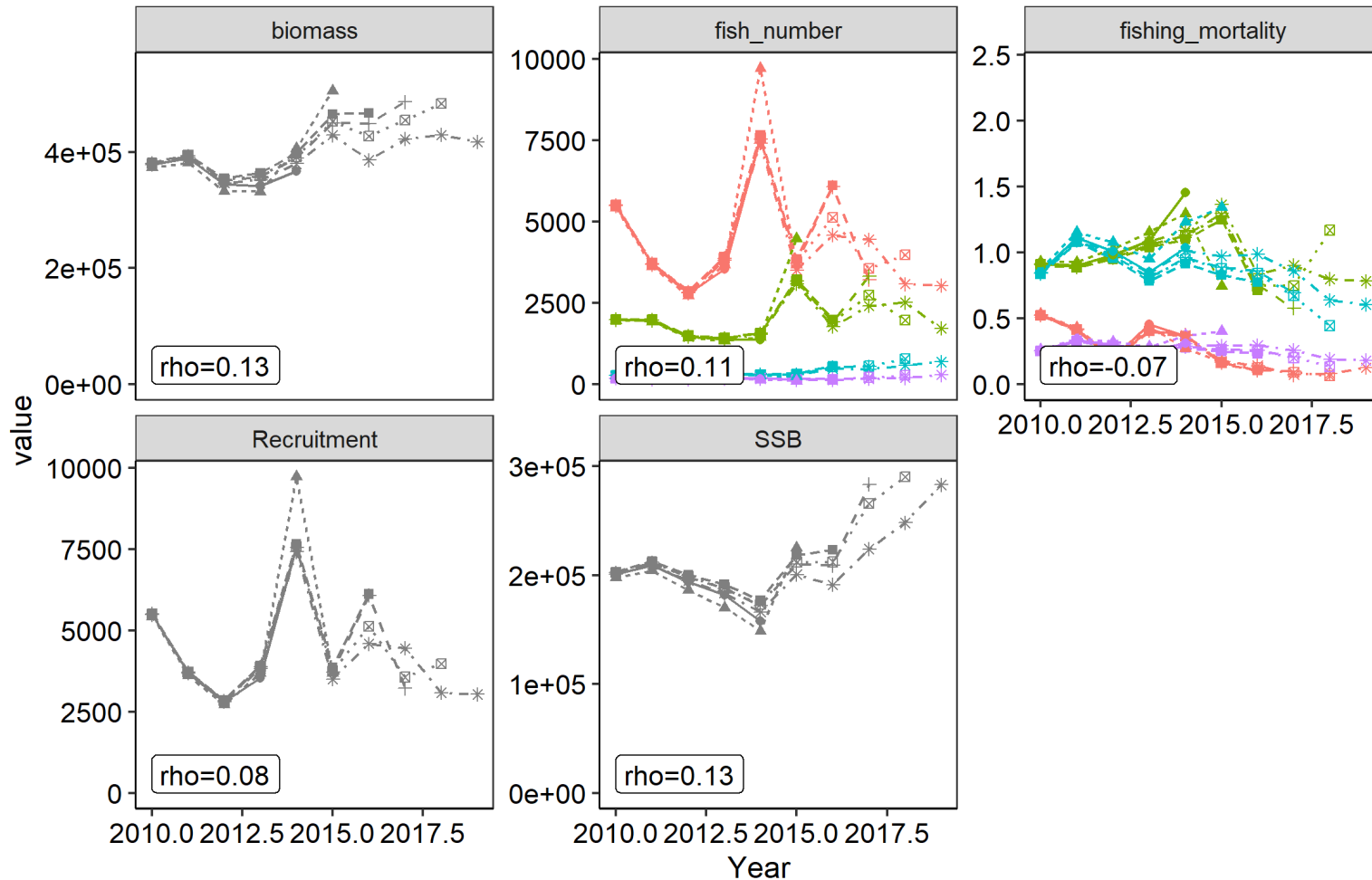
Standardization is necessary, yes, we agree.

Standardization of some CPUEs will be conducted by next stock assessment.



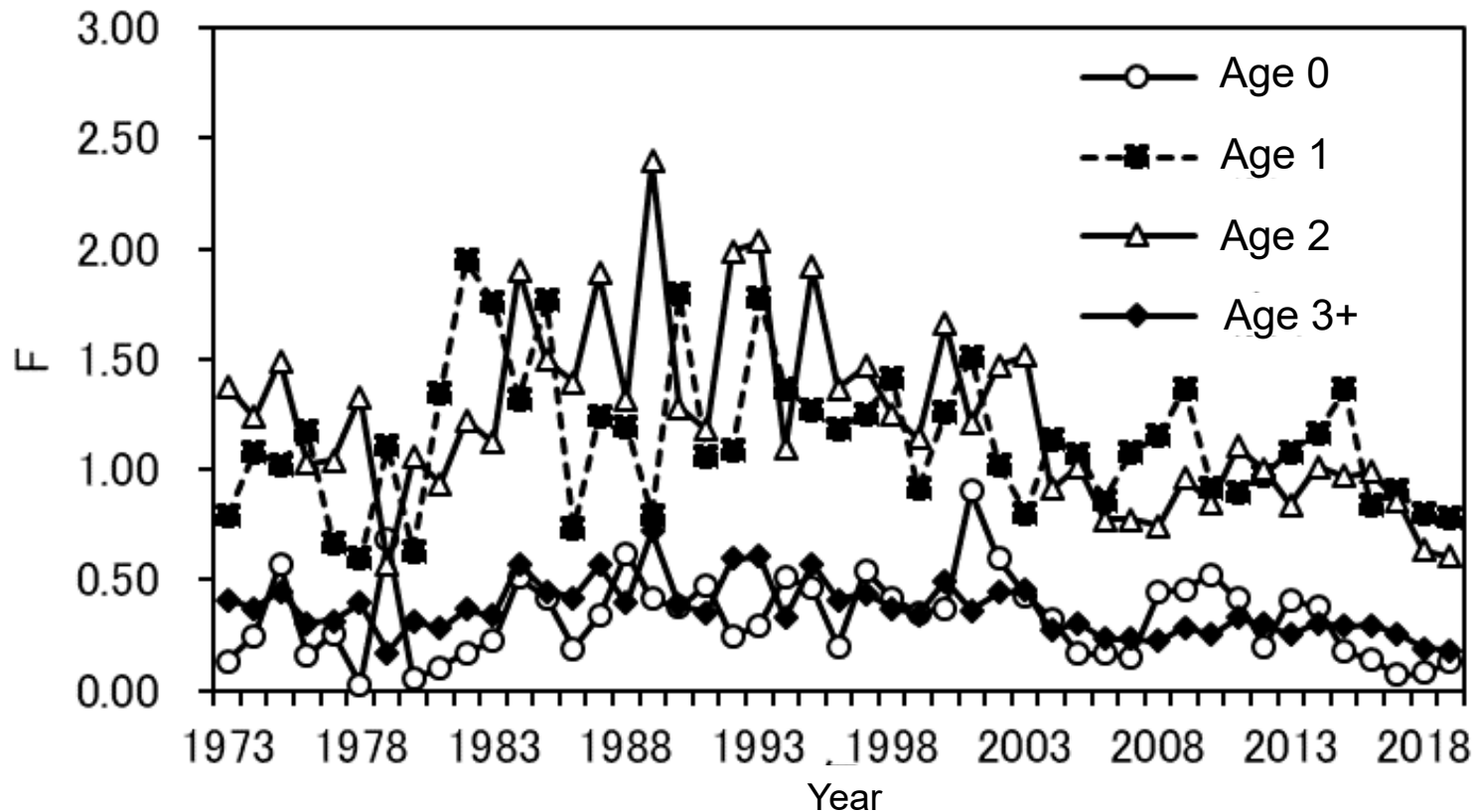
Retrospective analysis

age 0 2 NA 1 3 id 2014 2016 2018 2015 2017 2019





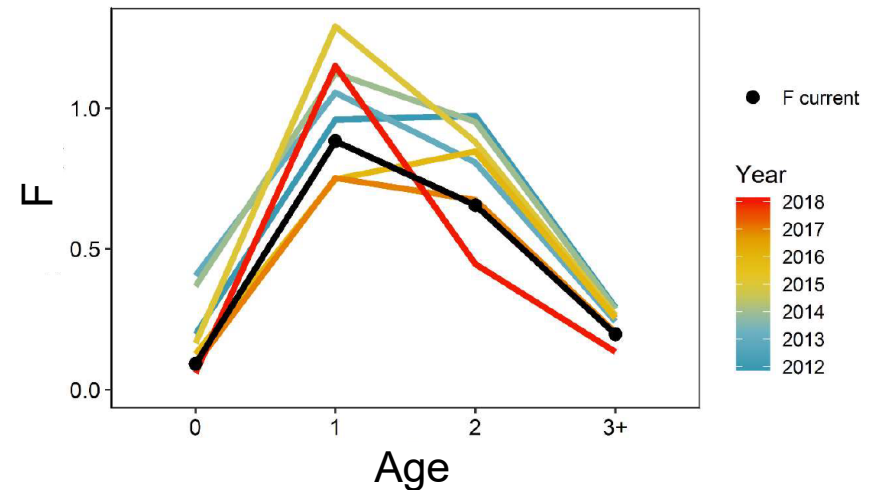
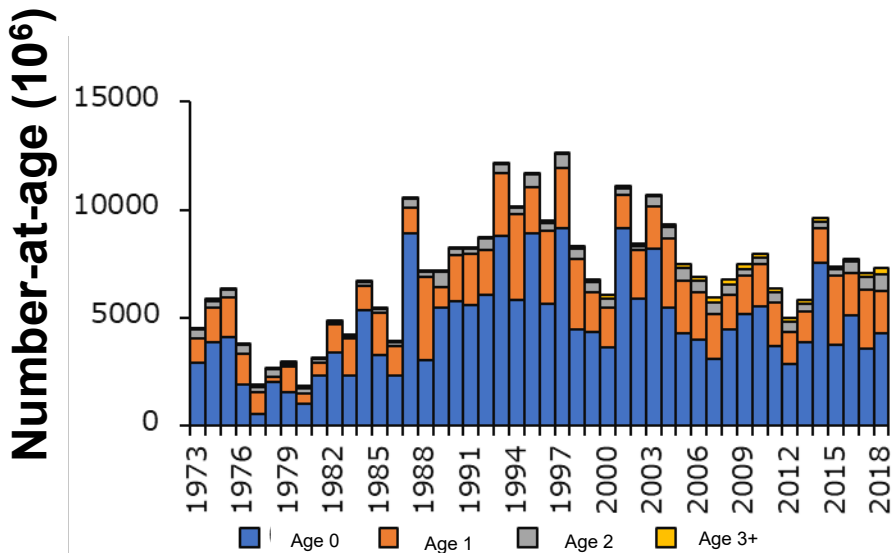
Fishing mortality at age



Fishing mortality in the 1980s was relatively higher than those of the other year periods, and the fishing mortality has gradually decreased.



Number-at-age and selectivity



Age 0 and 1 fish were dominant, the total stock number of Jack mackerel was at a low level in the late 1970s and gradually increased until the mid-1990s. After the 1990s, the total stock number was almost stable with some fluctuations. Fishing mortality at each age (selectivity) was the highest at age 1.



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Stock-Recruitment Relationship : Evaluation

- **Data set**

- 1) **SSB & Recruitment values (1973 – 2017)**

These values in 2018 were removed because the most recent values have large uncertainties.

- **Estimate parameters**

- 1) **Stock-Recruitment Relationship**

- a) Hockey-stick (HS), b) Ricker (RI), c) Beverton-Holt (BH)

- 2) **Optimization methods**

- a) least absolute value method (L1), b) least square method (L2)

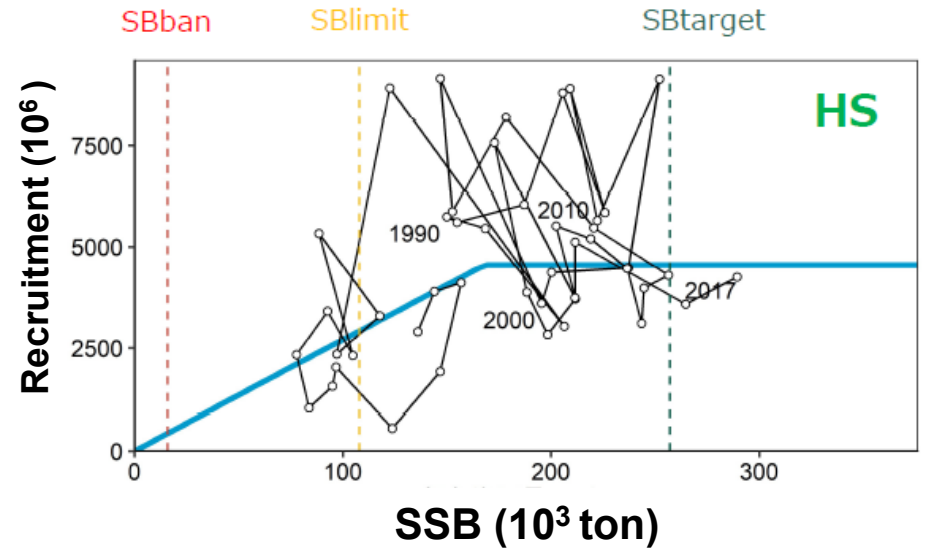
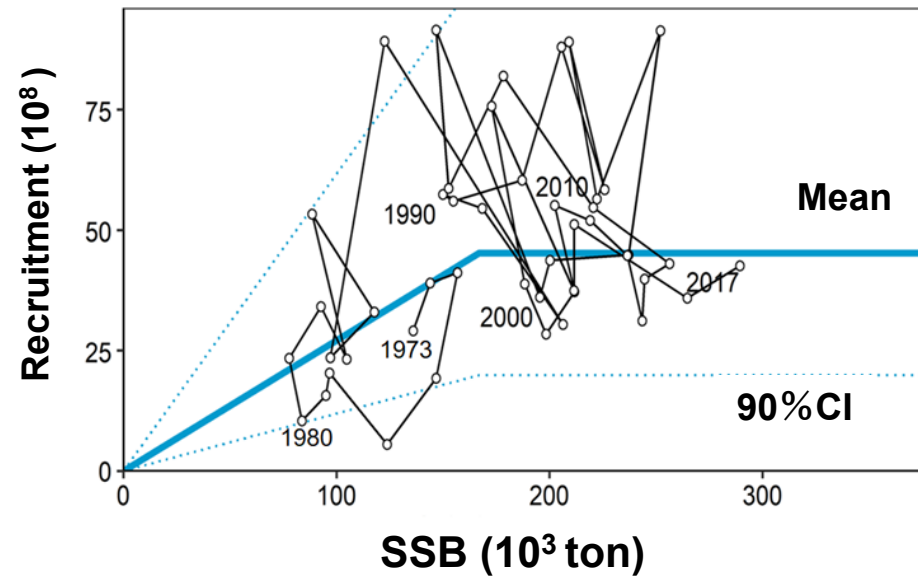


Stock-Recruitment Relationship : Evaluation

S-R rel.	Optimization method	pars.a	pars.b	pars.sd	pars.rho	AICc	deltaAIC(AI C_AR - AIC_noAR).1	Autocorrelation
HS	L1	0.027093	166970.4	0.499608		0 65.32322	NA	No
HS	L1	0.027093	168005.9	0.4613	0.271831	65.32322	-1.5931	Two step
HS	L2	0.027191	177808.6	0.482606		0 68.71992	NA	No
HS	L2	0.027191	177808.6	0.462586	0.24513	68.71992	-0.89589	Two step
RI	L1	0.034523	1.77E-06	0.523826		0 69.58343	NA	No
RI	L1	0.034523	1.77E-06	0.475469	0.264324	69.58343	-1.35648	Two step
BH	L1	0.035437	2.25E-06	0.525529		0 69.87547	NA	No
BH	L1	0.035437	2.25E-06	0.477311	0.265162	69.87547	-1.37059	Two step
RI	L2	0.032705	1.66E-06	0.495151		0 71.02958	NA	No
RI	L2	0.032705	1.66E-06	0.474914	0.25716	71.02958	-1.17937	Two step
BH	L2	0.0329	2.00E-06	0.495904		0 71.16623	NA	No
BH	L2	0.0329	2.00E-06	0.476363	0.255109	71.16623	-1.12237	Two step



Stock-Recruitment Relationship : Results



We selected HS (hockey-stick) relationships due to low AICc values. Based on this SR relationship, the SBtarget was calculated.



Reviewers Comments and Responses

- 31) The 3 SRRs evaluated are reasonably close and would probably need higher SSB levels to better evaluate. Not surprisingly, MSY-based stock status is sensitive to the SRR used. For the Pacific stock, a weighted average of SRRs was used. Why not do the same here?

As we explained you stock structure of Jack mackerel, SRR in the Pacific stock is too complex but Tsushima current stock is simpler than Pacific.

As mentioned above reason, we did not consider to apply the weighted average SRRs for Tsushima current stock.

We selected the best model based on AICc values, to use HS SRR has the lowest AICc value.

- 32) It appears that the SSB and recruitment estimates from the VPA were assumed to be known without error. This may not be a reasonable assumption. Please explain this assumption.

Yes, SSB and recruitment from VPA were assumed to be without error.

We have started to error will incorporated into the model.

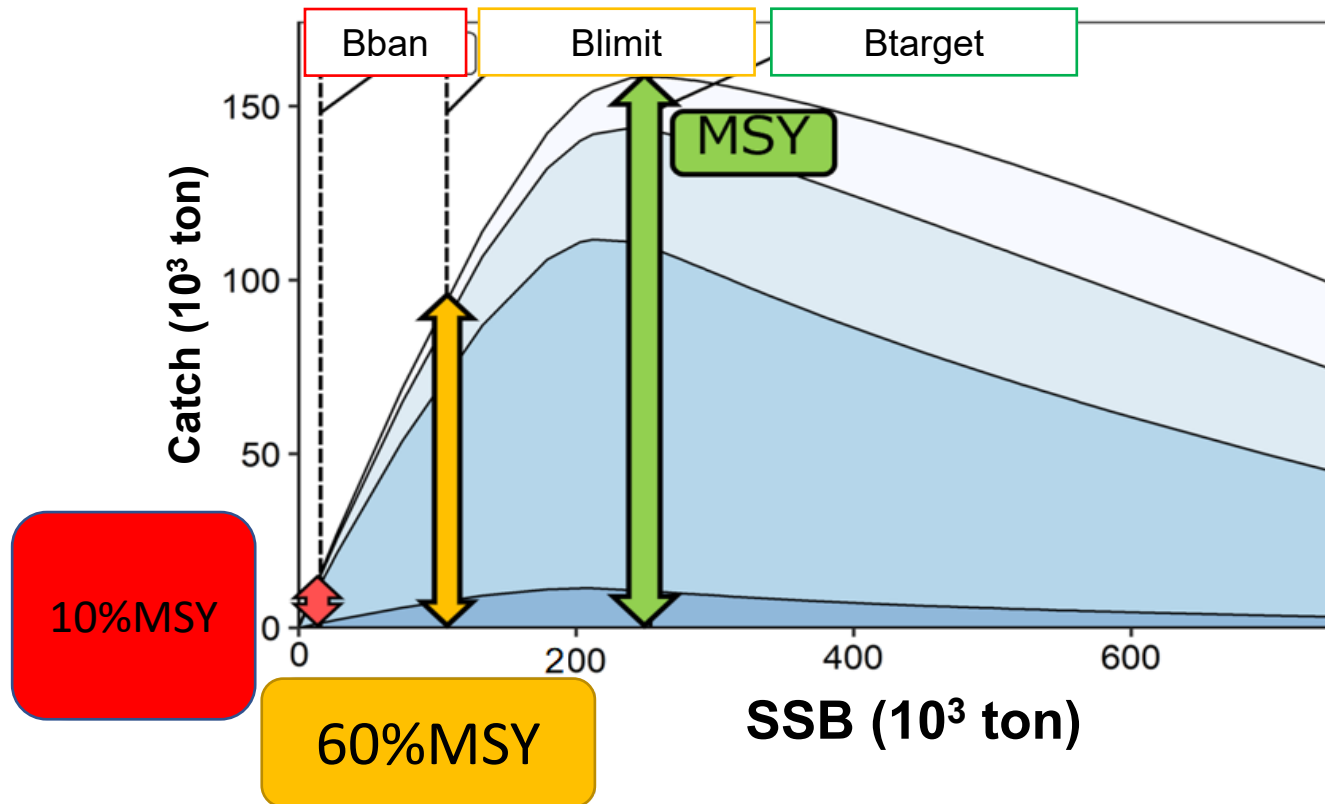


Contens

- **Biology and Stock assessment**
Distribution, Growth, Estimation of Catch Number at Age, Stock abundance indices, VPA
- **Stock-Recruitment Relationships**
- **Reference points, Kobe-plot**
- **Harvest Control Rule, Future projection**



Reference Points



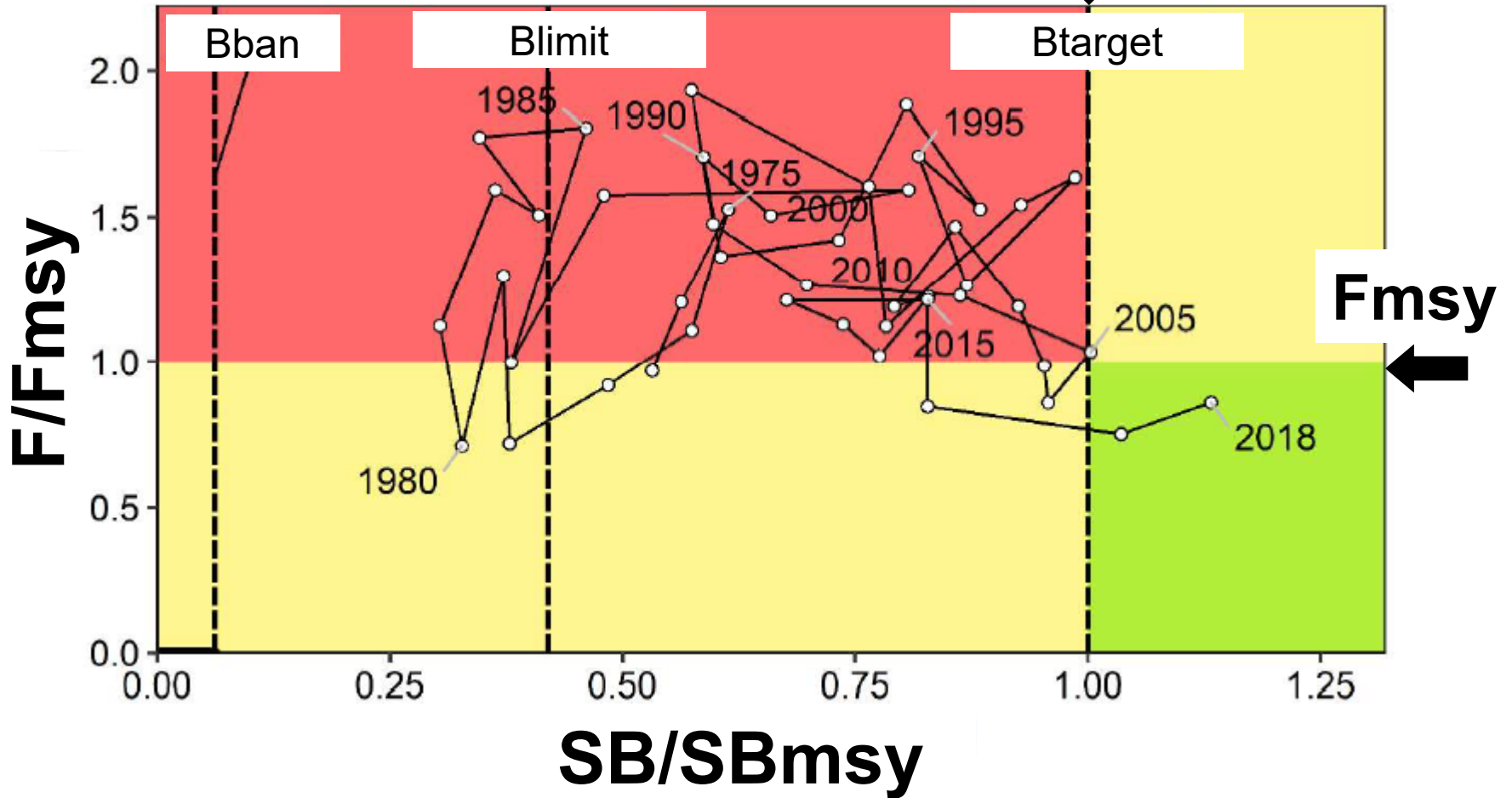
Reference Points	Expected Catch (10 ³ ton)	SSB (10 ³ ton)
B_{target} (SBmsy)	158	254
B_{limit}	95	107
B_{ban}	16	16



Kobe plot



Target Reference
Point (SBmsy)



F_{msy}



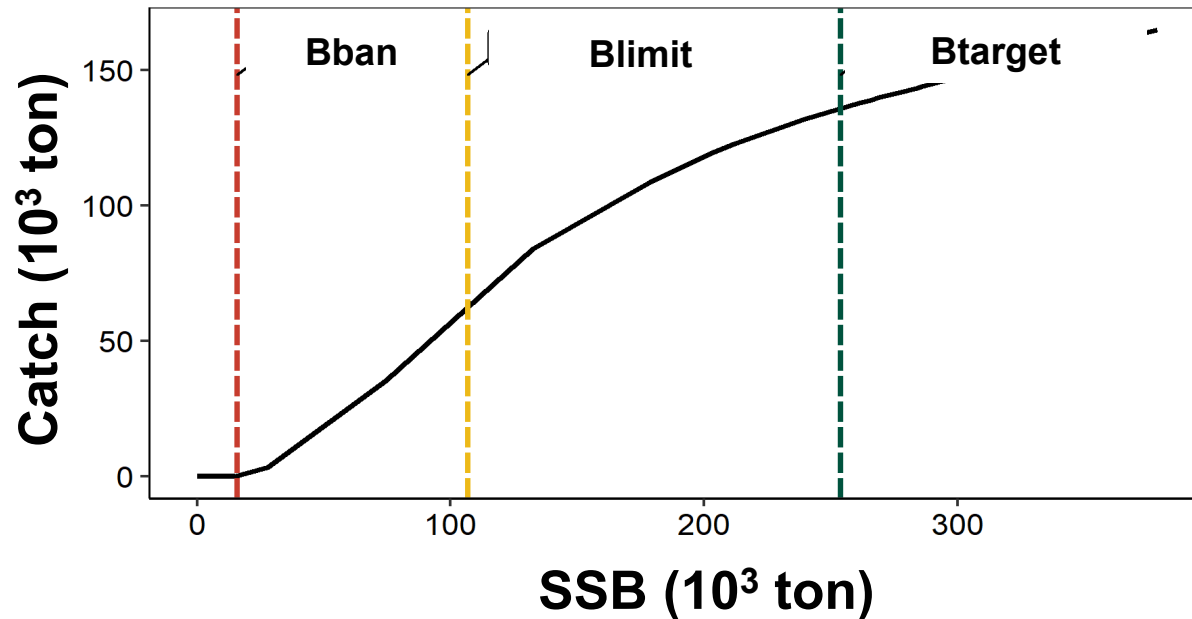
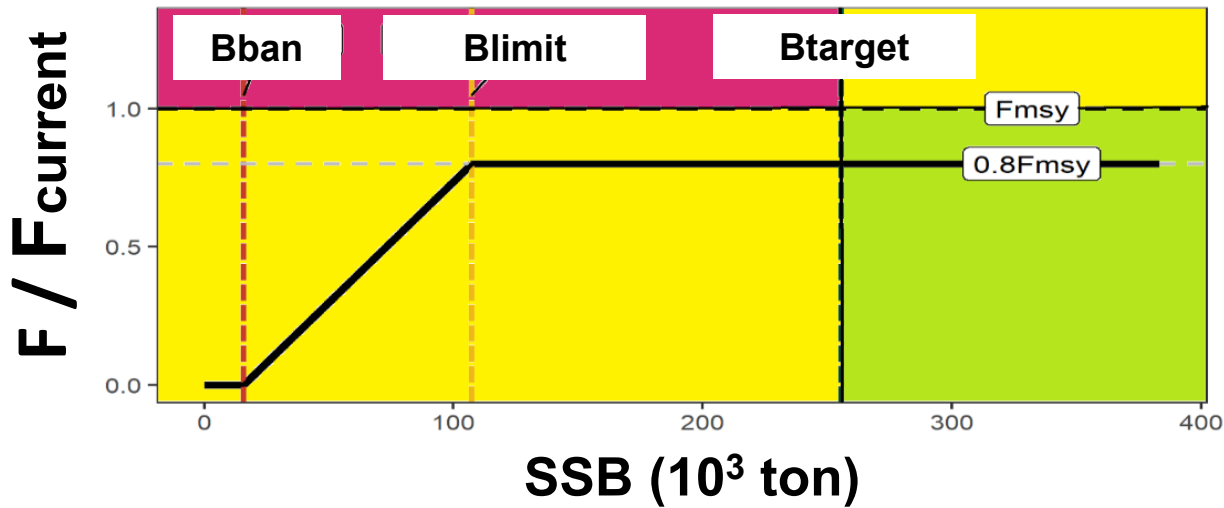


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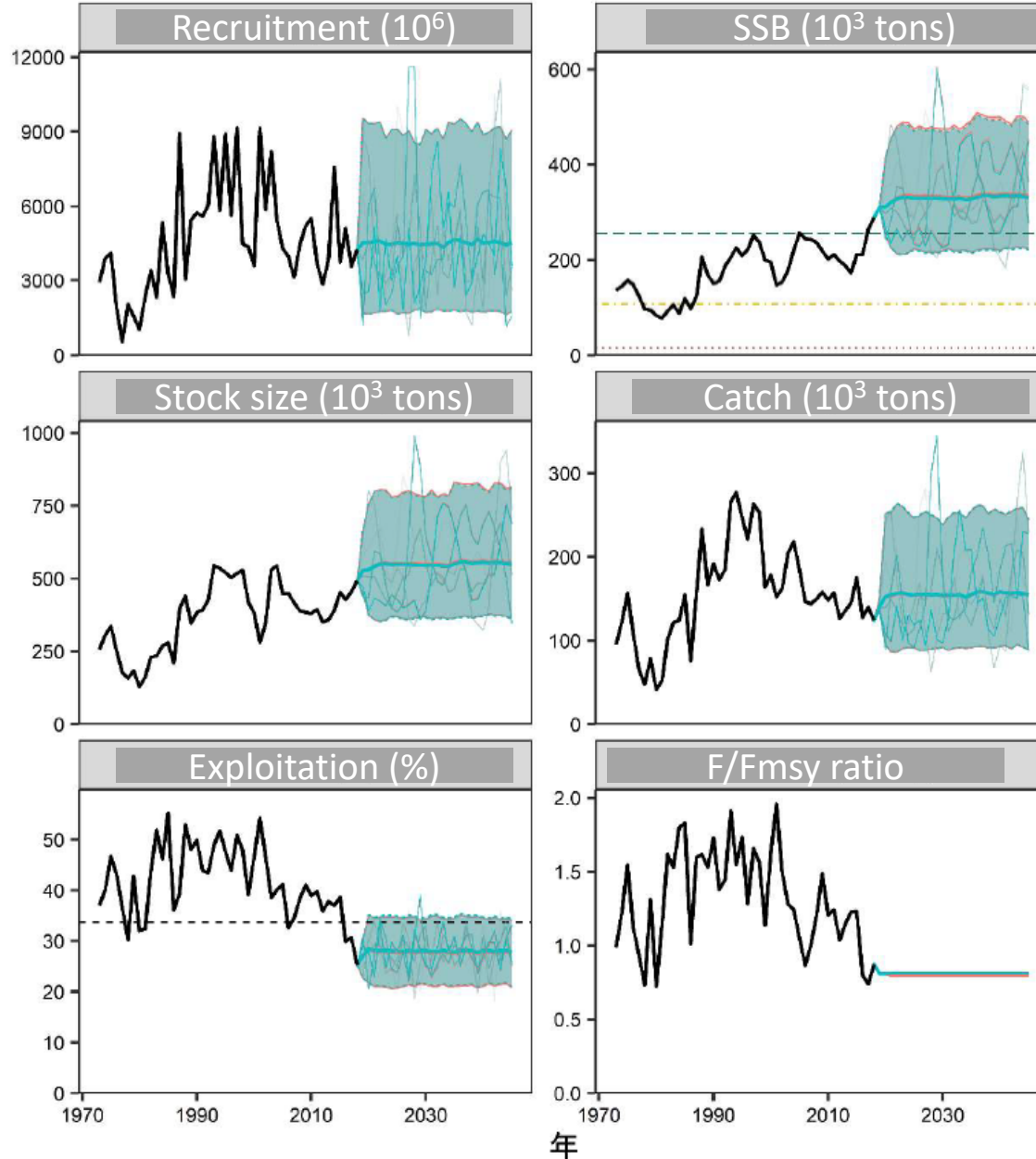


Harvest Control Rule





Future Projection: Graphs





Future Projection: Probability

Probability (%) of future SSB exceeding the target reference point

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
1.0	100	94	83	67	59	53	49	46	48	47	48	47	45	48	47
0.9	100	94	83	74	71	69	67	67	67	66	67	68	68	68	68
0.8	100	94	83	82	81	84	84	83	84	83	85	85	85	87	85
0.7	100	94	83	86	89	93	95	95	95	94	95	95	95	96	96
0.6	100	94	83	91	95	98	99	99	99	99	99	98	99	99	99
0.5	100	94	83	94	98	99	100	100	100	100	100	100	100	100	100
0.4	100	94	83	97	100	100	100	100	100	100	100	100	100	100	100
0.3	100	94	83	98	100	100	100	100	100	100	100	100	100	100	100
0.2	100	94	83	99	100	100	100	100	100	100	100	100	100	100	100
0.1	100	94	83	100	100	100	100	100	100	100	100	100	100	100	100
0.0	100	94	83	100	100	100	100	100	100	100	100	100	100	100	100

Probability (%) of future SSB exceeding the limit reference point

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
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



Future Projection: SSB and Catch

SSB (10^3ton)

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
1.0	311	311	321	294	279	268	262	260	259	258	257	256	256	261	263
0.9	311	311	321	311	305	299	295	294	293	293	292	291	291	296	298
0.8	311	311	321	329	335	335	334	334	334	334	334	333	332	338	340
0.7	311	311	321	349	369	377	380	382	383	383	383	382	382	389	390
0.6	311	311	321	371	409	428	435	440	442	443	444	443	443	451	452
0.5	311	311	321	395	455	487	502	510	515	517	518	518	517	527	528
0.4	311	311	321	421	509	558	583	595	603	607	609	610	609	621	621
0.3	311	311	321	450	571	643	680	700	712	719	722	723	723	737	737
0.2	311	311	321	482	643	743	798	827	845	856	862	864	864	881	881
0.1	311	311	321	516	727	864	941	983	1,010	1,026	1,035	1,039	1,041	1,061	1,061
0	311	311	321	554	826	1,009	1,115	1,174	1,213	1,237	1,250	1,257	1,261	1,287	1,286

Catch (10^3ton)

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
1.0	141	152	179	169	166	161	160	160	160	159	159	158	158	161	164
0.9	141	152	167	163	162	159	157	158	158	157	158	157	157	160	162
0.8	141	152	153	156	157	155	154	155	155	154	154	154	154	157	159
0.7	141	152	139	147	150	149	149	150	150	149	150	149	149	152	154
0.6	141	152	123	136	141	141	141	143	143	142	143	142	142	145	147
0.5	141	152	107	123	129	131	131	133	133	133	133	133	133	135	137
0.4	141	152	89	107	114	117	118	119	120	120	120	120	120	122	124
0.3	141	152	69	87	95	98	100	101	102	102	102	102	102	104	105
0.2	141	152	48	63	71	74	75	77	78	78	78	78	78	79	80
0.1	141	152	25	35	40	42	43	44	44	45	45	45	45	46	46
0	141	152	0	0	0	0	0	0	0	0	0	0	0	0	0



Reviewers Comments and Responses

- 33) Was the N-at-age in the terminal year of the VPA model assumed to be known without error? If so, please explain this assumption.

Yes, to estimate the N-at-age in the terminal year of the VPA model was deterministic.

SCAA or same model will be evaluated in next full stock assessment.