



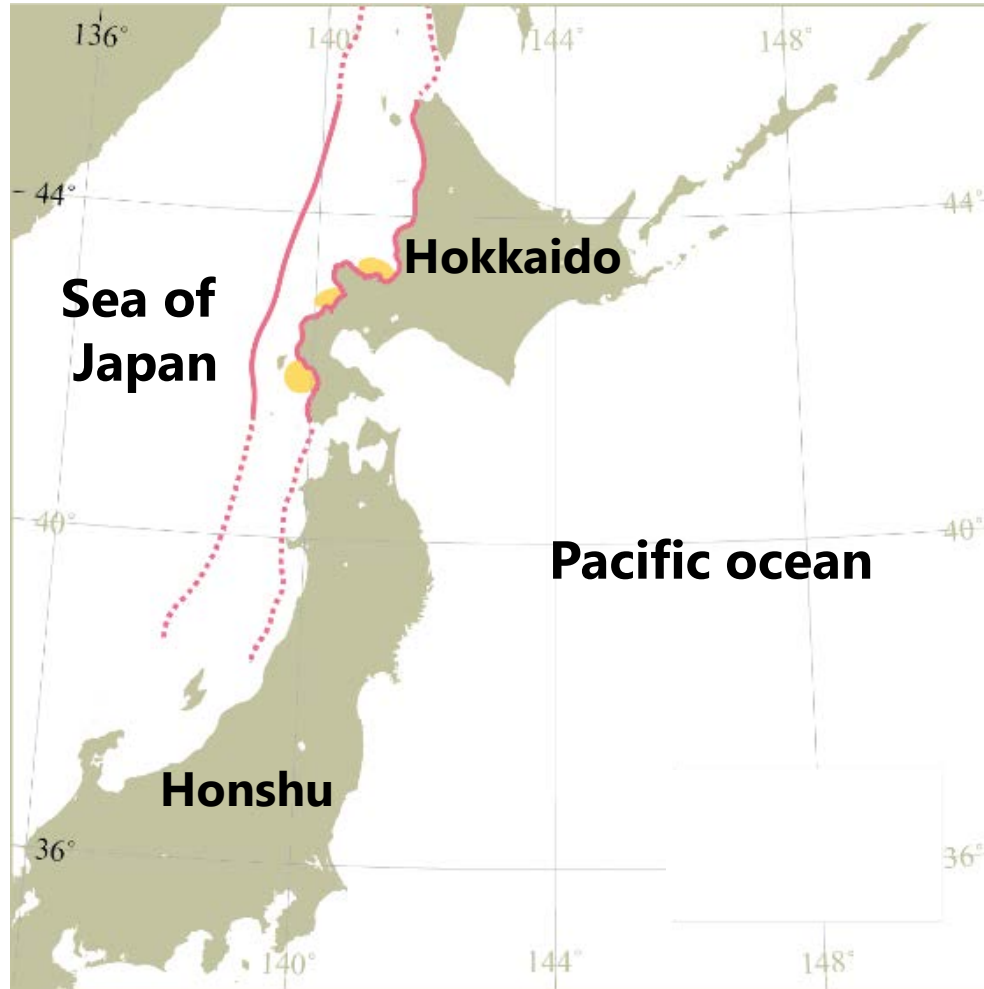
**Stock Assessment of Walleye Pollock
Northern Sea of Japan Stock in 2020**

Contents

- **Biology and Stock assessment**
Distribution, Catch at age, Abundance indices, Natural mortality, ridge VPA
- Stock-Recruitment Relationships
- Reference points, Kobe-plot
- Harvest Control Rule, Future projection

Distribution

P14, Figure 2-1

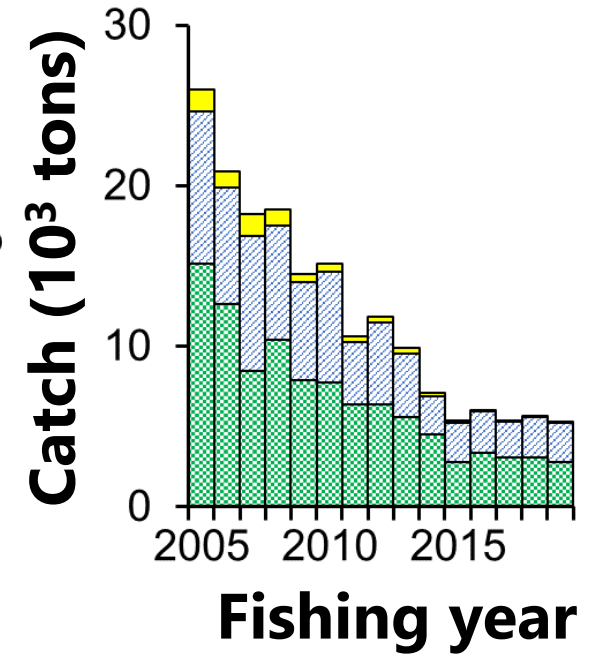
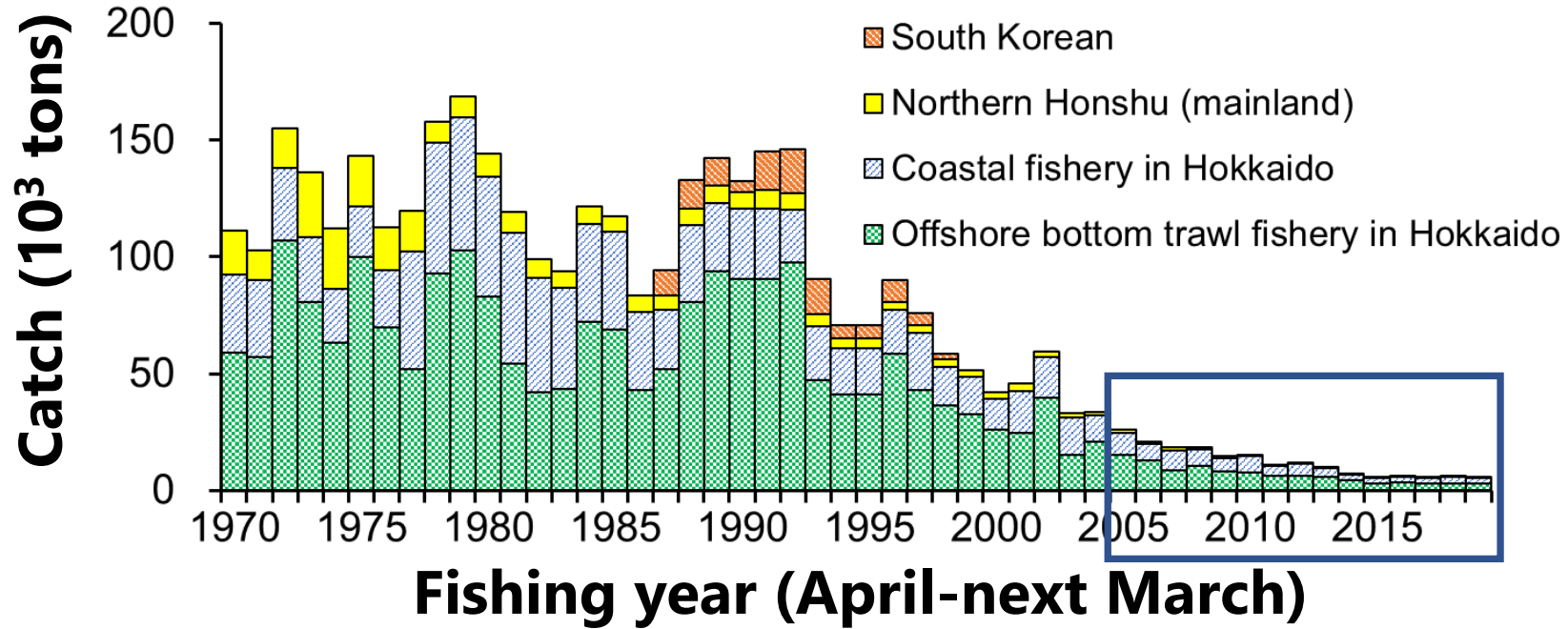


- Distribution range
- Spawning grounds

Spawning season
Dec.–Mar.
Peak (Jan.–Feb.)

Catch

P15, Figure 3-1



Reviewer's Comment #01

Clarify whether catches used in each assessment represent all sources of catch taken from the assessed area. Are catches by all foreign fisheries accounted for, or are there other sources of mortality (e.g., discarded catch), that could bias the total catch estimates? The VPA model assumes that catches are known exactly, so sources of bias in the catch estimates should be minimized to avoid bias in derived reference points and projections.

Response to the comment #01

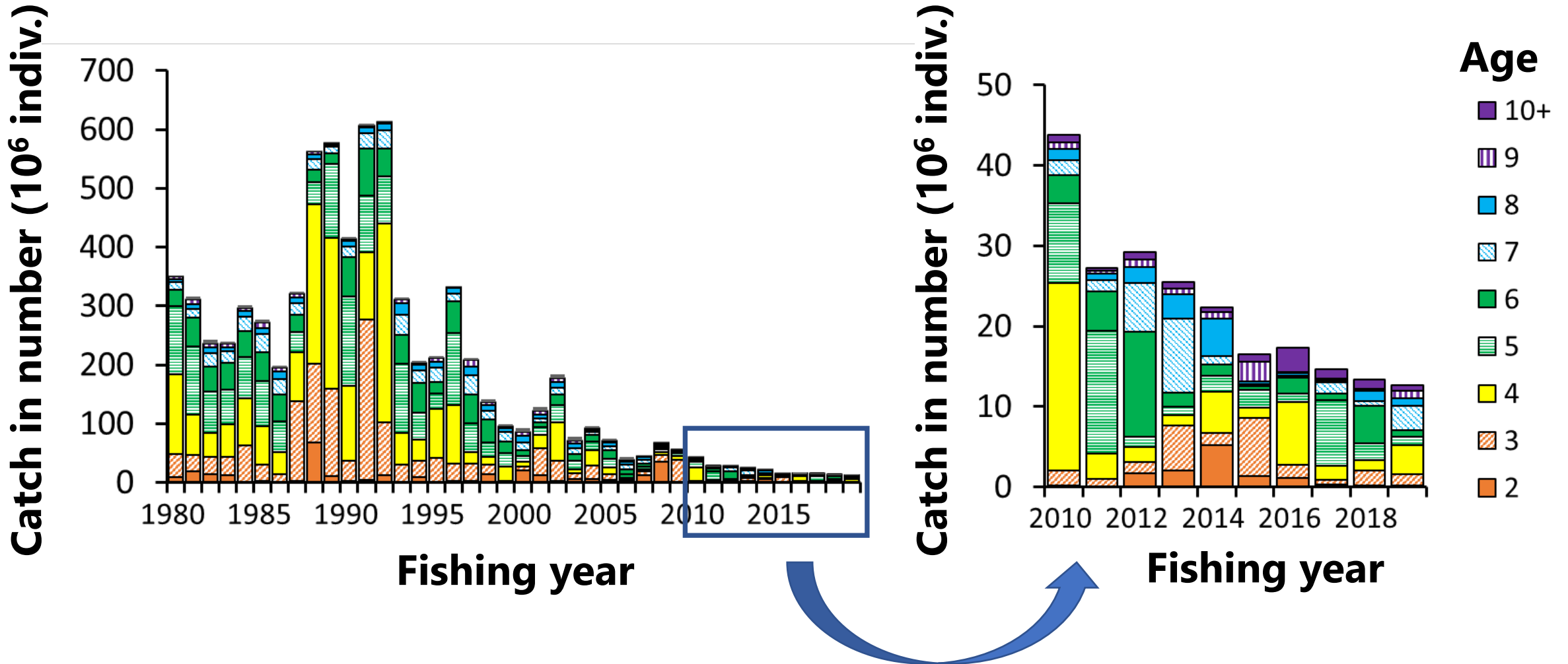
Two main reasons for not including Russian catches in Western Sakhalin

- Russian catches are non-disclosure
- Russian catches contain two population of walleye pollock

There are no data about discarded catch

Catch-at-age

P16, Figure 3-2



Reviewer's Comment #02

Provide additional details regarding the sampling programs that were used to estimate catch at age. In addition to the total catch (question #1, above), the method used to allocate catches to individual age classes in a given year should be documented in the assessment or in an appendix to the assessment. Sample sizes and average age by major fleet, year, and area would be useful.

Response to the comment #02

Few fish stocks have a sampling program for the catch at age (CAA) estimation in their stock assessment reports. The CAA of this stock is calculated by prefectural fisheries research institute in Hokkaido. Sampling is performed for each type of fishery and each major landing port to obtain the age composition. We do not use age-length keys. We examine the validity of the sample allocation for CAA estimation in prior to the stock assessment every year. The next slides show the sample allocation for the 2019 fishing season.

Response to the comment #02

Offshore bottom trawl fishery

Catch (kg)

Port

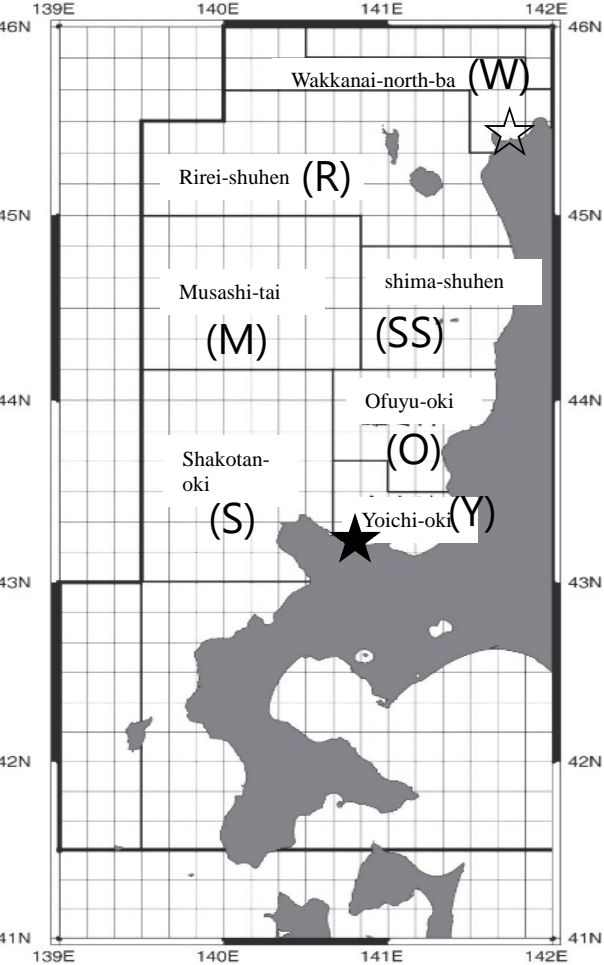
W: Wakkanai ☆

O: Otaru ★

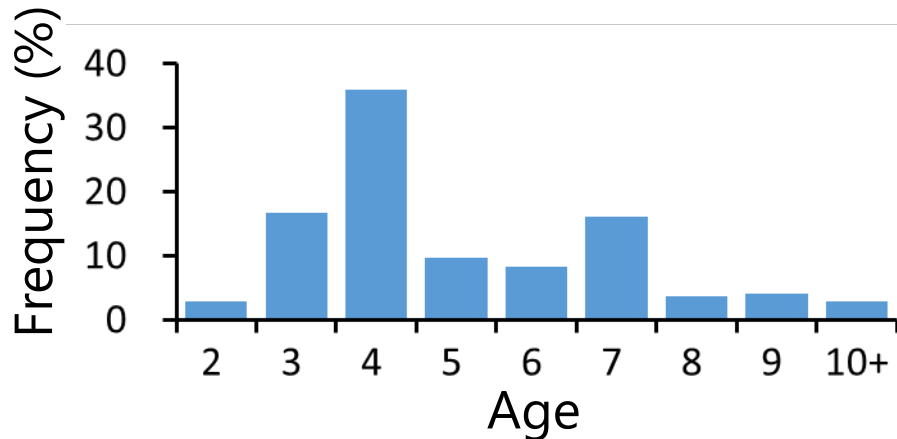
Port /local fishing zone

Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Sum

W / W	2122			88				88089	107066	33178	117446	347,989	
W / R	18556	83132						978	258845	89987	230920	682,418	
W / M		185166					4385			45	48	189,644	
W / SS												0	
O / SS	295260	76540										371,800	
O / O	704830						18270	343460				1,066,560	
O / M		72750										72,750	
O / S		37140										37,140	
Sum	1,020,768	454,728	0	88	0	0	0	22,655	432,527	365,911	123,210	348,414	2,768,301



✓ Age composition of 57~1206 fish

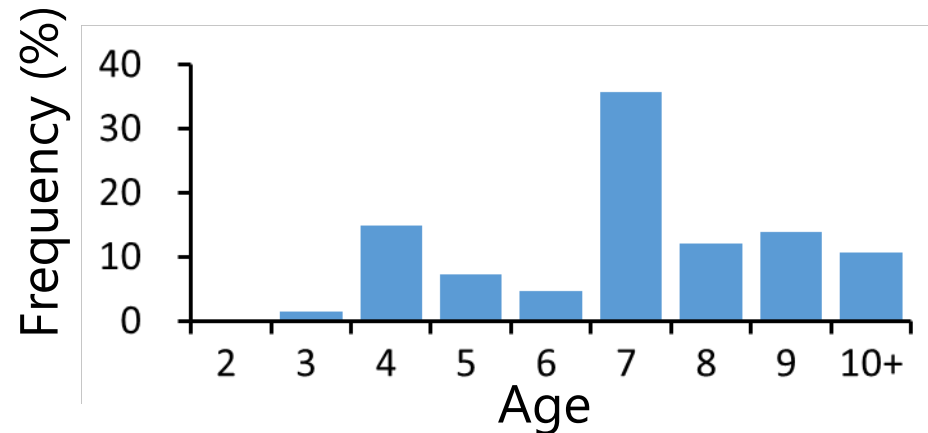


Response to the comment #02

Coastal fishery Gill net, Longline, Shrimp beam trawl, etc. Catch (kg)

North	Area / method	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Sum
		Soya / Gill net etc.	3558.9	41933.4	29641.9	12723.4	6288.9	4059.5	2556	7186.1	3650	15520.4	2744.9	1170.9
Rumoi / Shrimp trawl etc.	22903	4800					11400	10658	14475	9840	19695	5452.5	7047	106,271
Shiribeshi.N/ Gill net etc.	7990	858	165	141	75	527	1606	81888.7	202362.6	236021.9	66145.1	163199.8	760,980	
Shiribeshi.S/ Longline									25130	26505	23955			75,590
Shiribeshi.S/ Gill net etc.	94077.8	3110.2	432.6	297.7	2795.1	466.7	1179.8	181.1	141255.9	352435.2	135586	31262.9	763,081	
Hiyama/ Longline									29989	235649	182985	139779		588,402
Hiyama/ Gill net etc.										3				3
Ohsima/ Gill net etc.						60				75			2970	3,105
Sum		128,530	50,702	30,300	13,162	9,159	16,453	16,075	158,850	619,266	830,613	349,708	205,651	2,428,466
South														

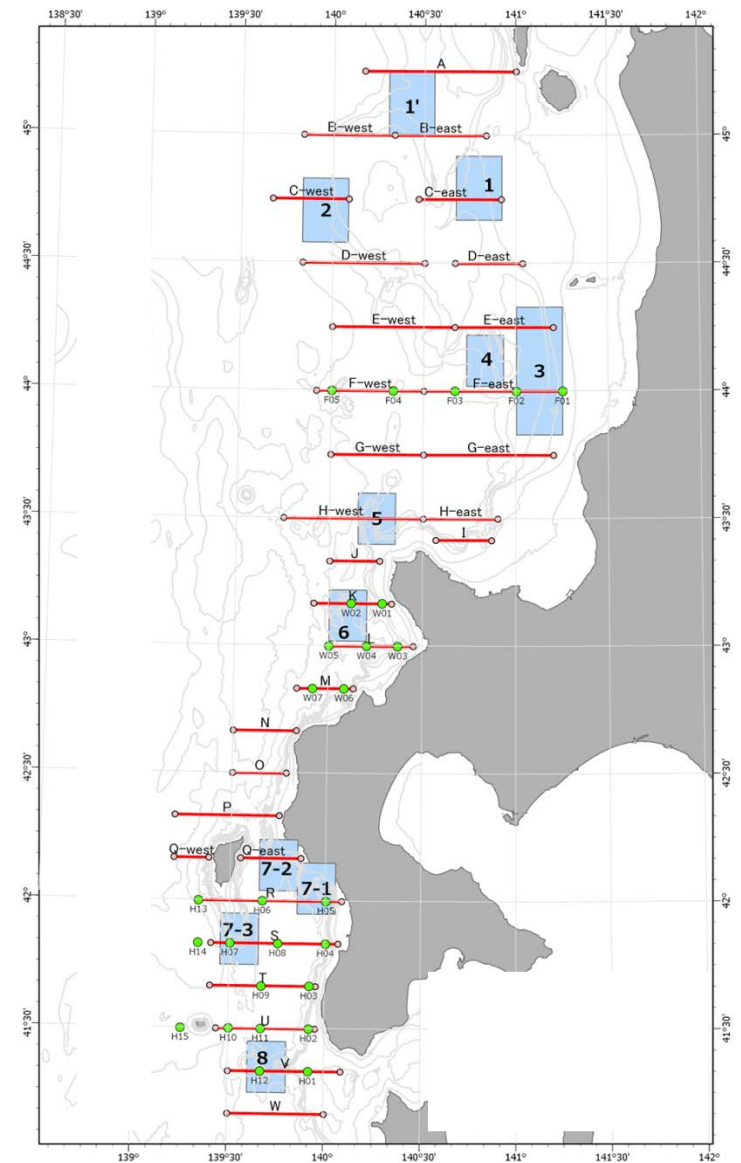
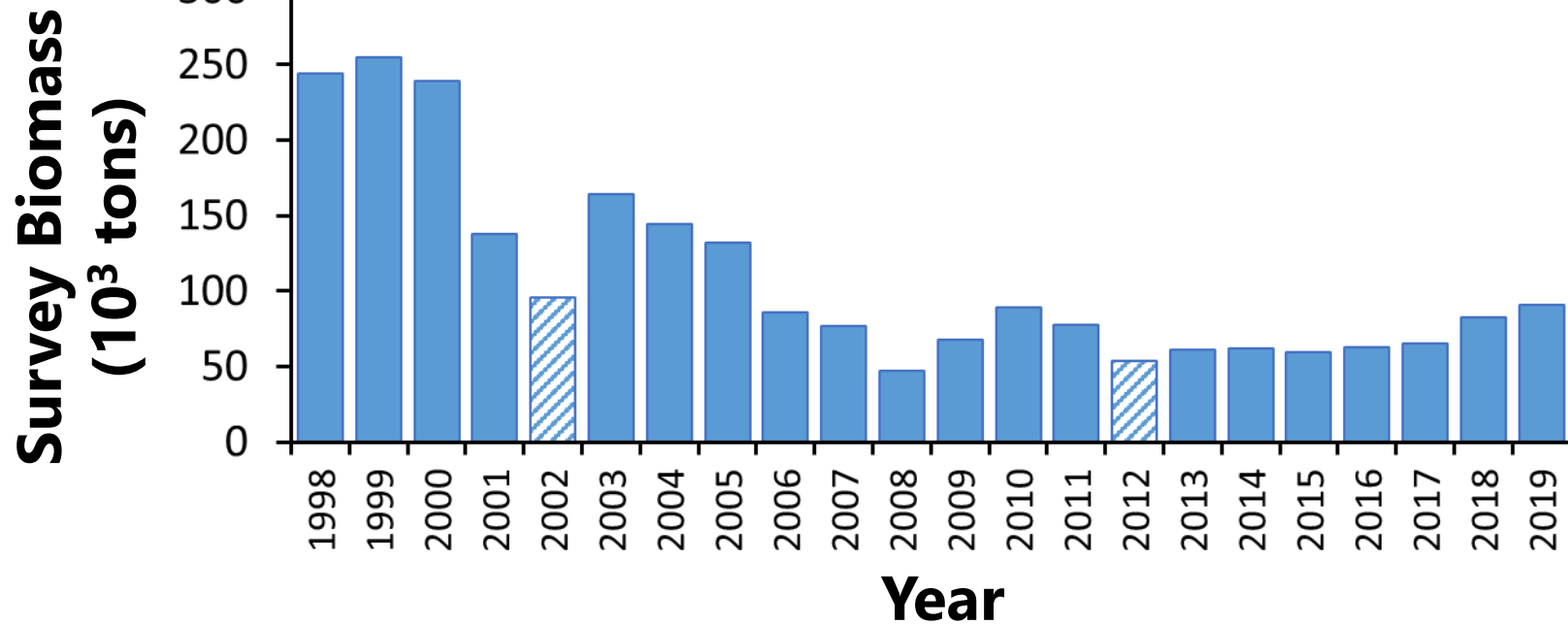
✓ Age composition of 63~600 fish



Abundance index P16, Figure 4-1

Spawning biomass in October

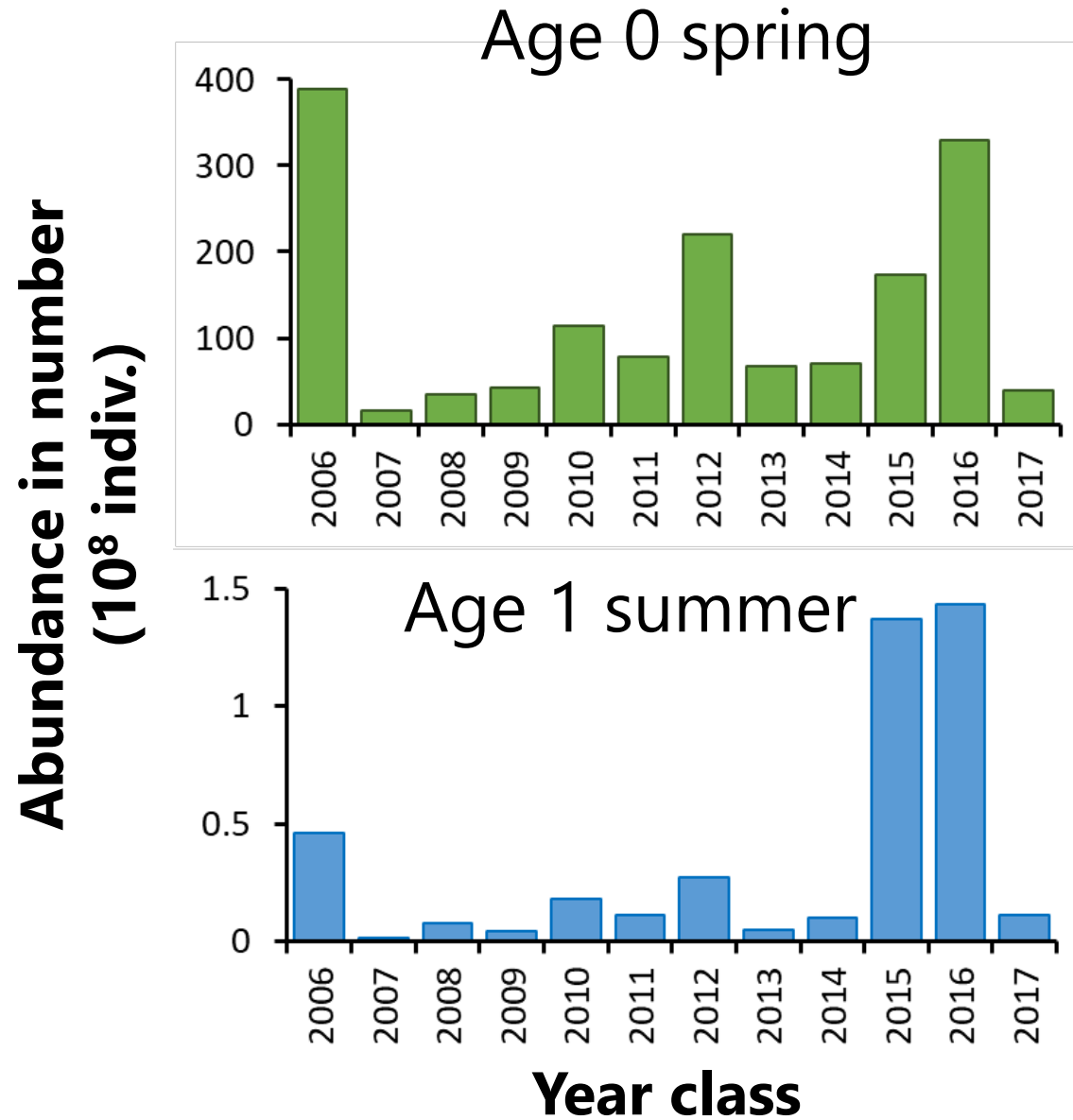
Acoustic and bottom trawl survey



- Acoustic survey lines
- Bottom trawl survey area

Abundance indices

P.17, Figure 4-2
modified



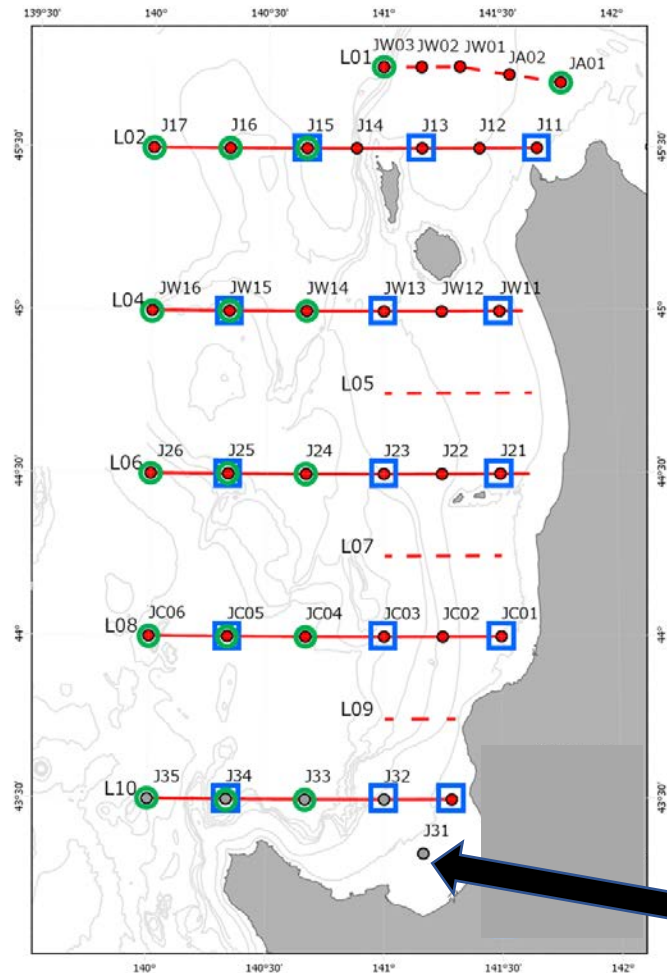
Reviewer's Comment #09

I would appreciate an explanation of Figure 4-2, the changes in age-0 and age-1 fish from the recruitment survey. I expected a large cohort of age-0 fish (such as 2006) to appear as a large cohort of age-1 fish in 2007, but maybe I am misinterpreting the figures. My understanding is that the abundance of age-1 fish is used as the index for age-2 fish in the tuning procedure. If cohort abundance does not carry through to successive years, then the age-1 index may not be representative of age-2 fish that 'recruit' to the model.

Response to the comment #09

I hope you are satisfied with the explanation on the previous slide.

Age 0 spring (pelagic larvae and juveniles, 10-30 mm SL)

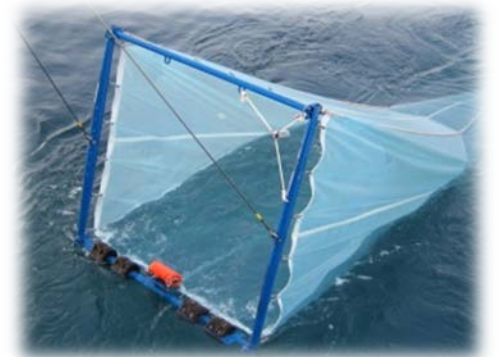


Acoustic survey lines

- Interval: 30 nmi (30 minutes at latitude)
- From 140 degrees east longitude to as close to the coast as possible

Frame trawl (2 × 2 m) surveys

> 1 time for each survey station



- Acoustic survey lines
- Frame trawl survey station

Ishikari Bay

Age 1 summer

Acoustic survey lines

Interval: 15 nmi

Water depth: 100~500 m

Bottom trawl surveys

2~5 times for each area



- Acoustic survey lines
- Bottom trawl survey area

Reviewer's Comment #03

Describe how indices of abundance are calculated, and provide tables of sample size (number of hauls, trips, etc.) by year and area for each index. Are survey indices derived from design-based estimators, or are model-based methods (e.g., generalized linear models) used to derive annual estimates? If model-based methods are used, describe the model selection procedure and diagnostics for the final model.

Response to the comment #03

All abundance indices used for tuning of VPA are design-based estimators.

Reviewer's Comment #07

Are uncertainty estimates available for the annual indices of spawning biomass and recruitment? The years and point estimates are provided in Appendix Tables 4-1 and 4-2, but standard errors of the annual survey estimates would help interpret perceived changes over time, and could potentially be used as relative weights in the tuning process.

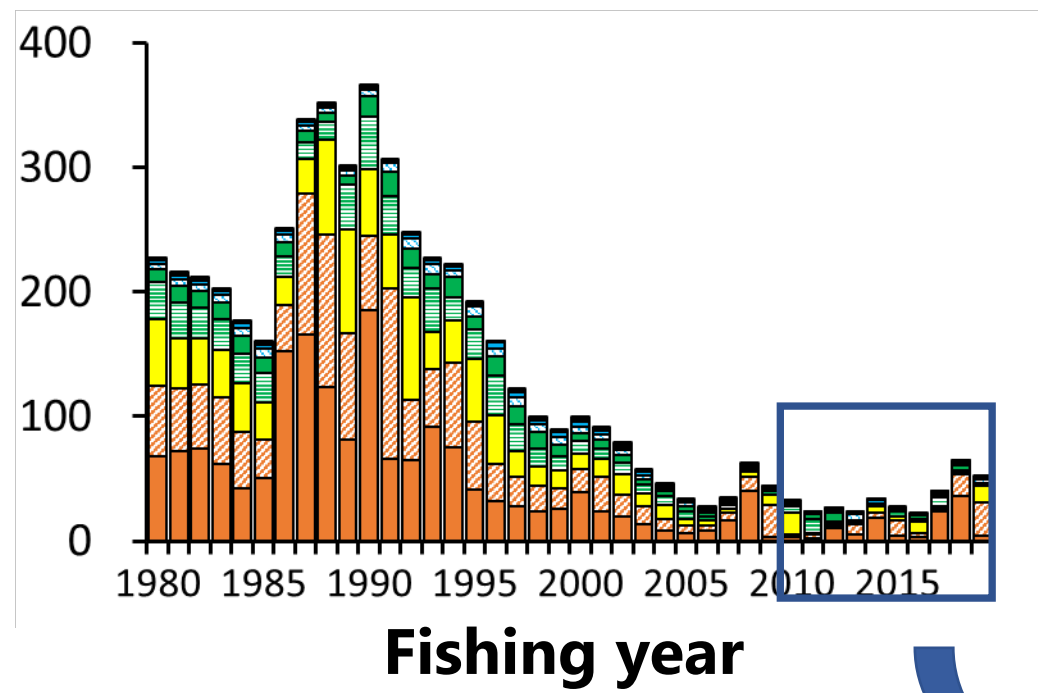
Response to the comment #07

No. because we do not calculate standard errors for all abundance indices. How should we calculate standard errors of the estimates of acoustic and trawl surveys? Geostatistical methods?

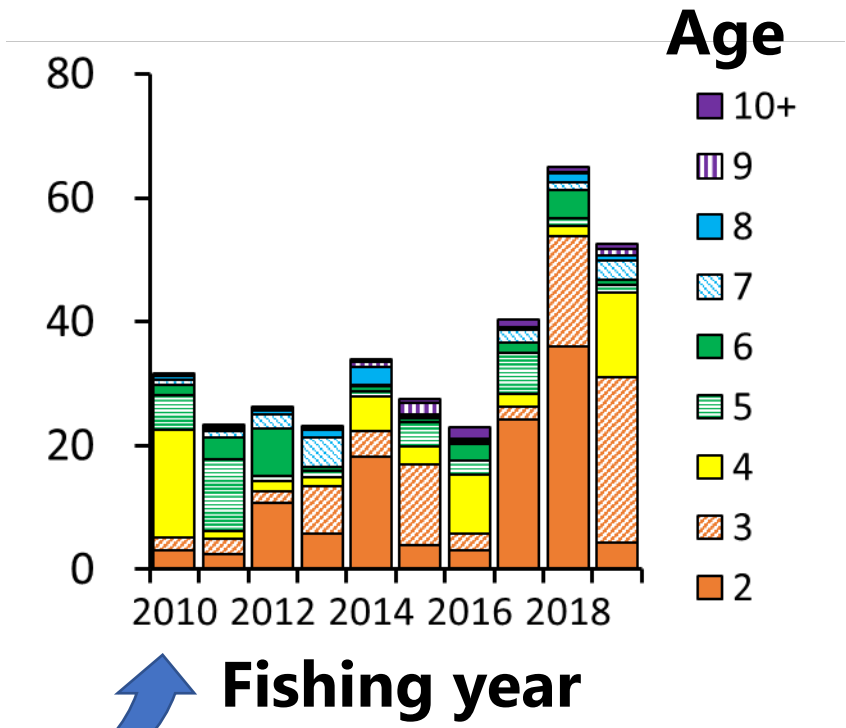
Number-at-age

P17, Figure 4-3

Number at age (10⁶ indiv.)

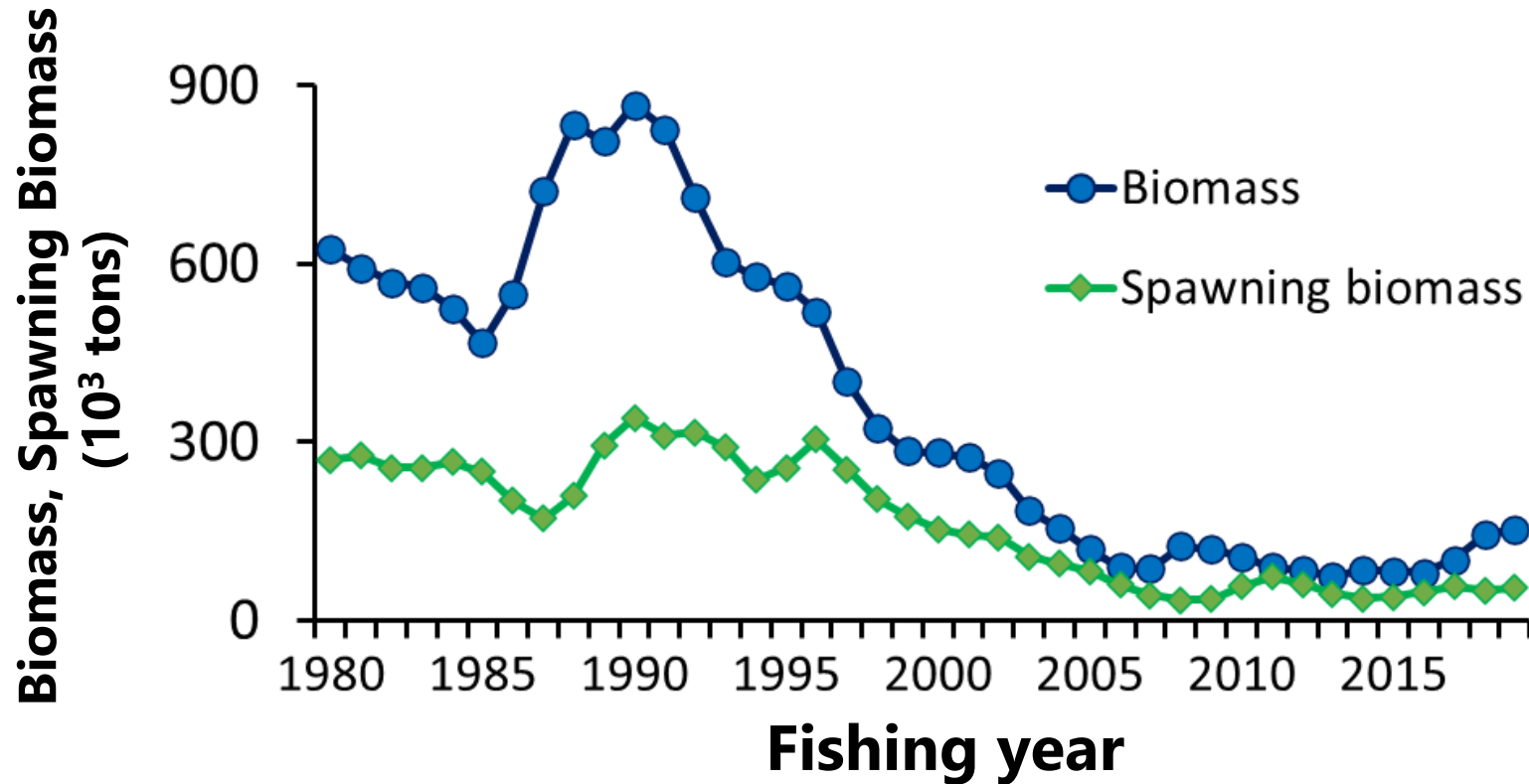


Number at age (10⁶ indiv.)



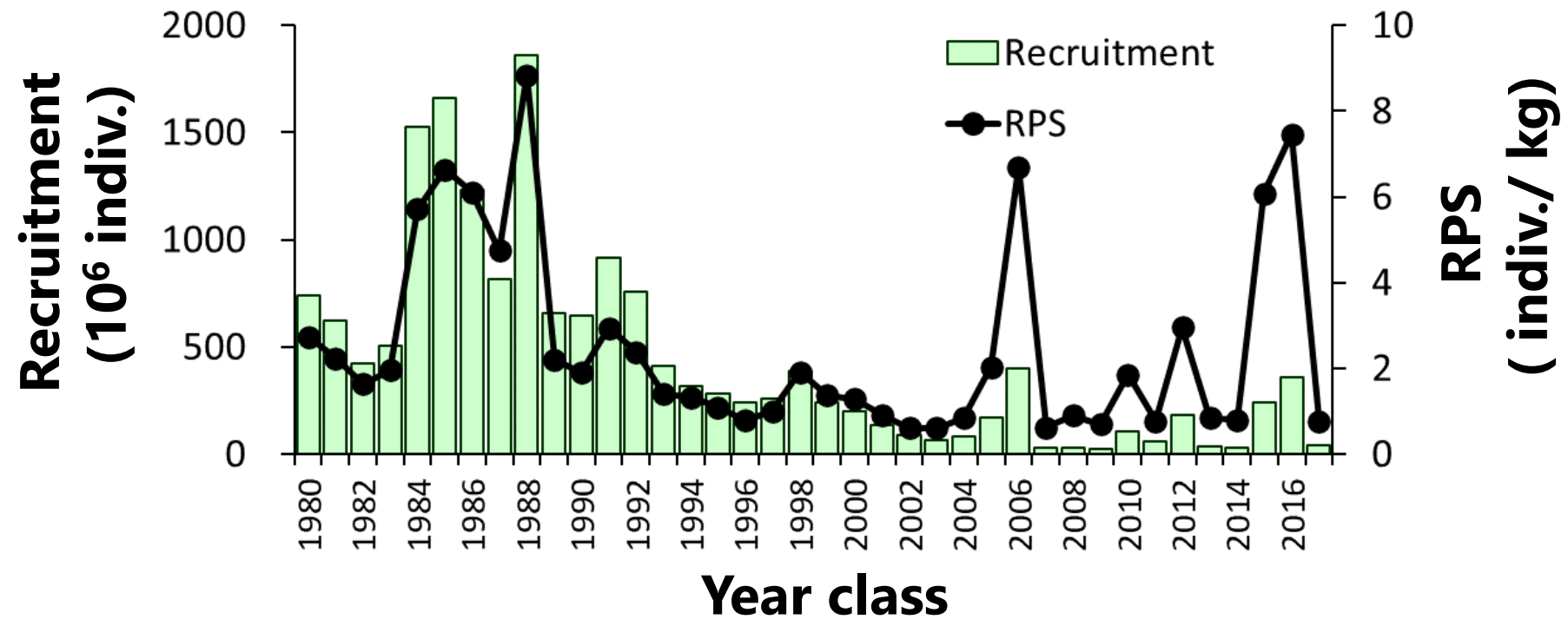
Biomass, Spawning biomass

P18, Figure 4-4



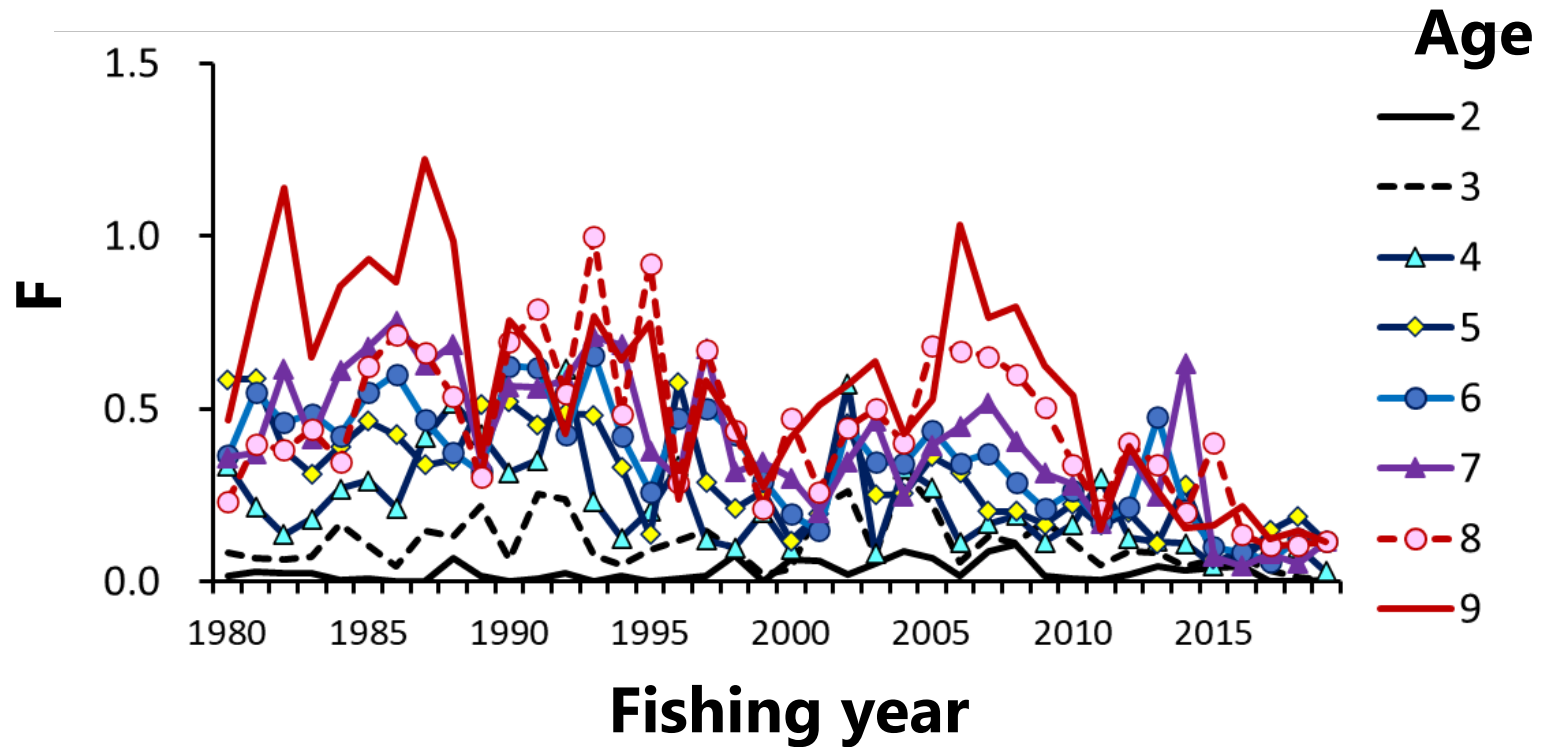
Recruitment and Recruitment per spawning (RPS)

P18, Figure 4-5 modified



Fishing mortality (F)

P19, Figure 4-7



Reviewer's Comment #05

Plots of spawning biomass versus time and associated reference points for reasonable alternative values of M (e.g., upper and lower bounds) would be useful to help communicate the implications of error in this parameter on management advice. Methods for deriving M are inconsistent among stocks. Standardization of estimation methods is preferred if no specific reasons are given for using a particular method.

Reviewer's Comment #08




The natural mortality rate (M) is assumed to be 0.25 per year for ages 3 and above, and 0.3 for age 2 fish. Please provide a rationale for these values, including any ageing studies done for the assessment or from the literature, comparisons with similar stocks, and methods for estimation of M . The authors indicate that individuals of age 10 and above have been caught. Based on recent meta-analyses (e.g. Then 2014, Hamel 2015) M estimates based on $\sim 5/A_{\max}$ are in common use, which would suggest a value closer to $M=0.5$. The value in the assessment is more consistent with a maximum age of 25 years. Regardless, since M is not known with precision and affects estimates of F (and therefore abundance), model runs with alternative values for M would help managers understand risks associated with uncertainty in M .

Response to the comments #05 and #08

Natural mortality

$M=0.3$ for age 2

$M=0.25$ for age 3 and above

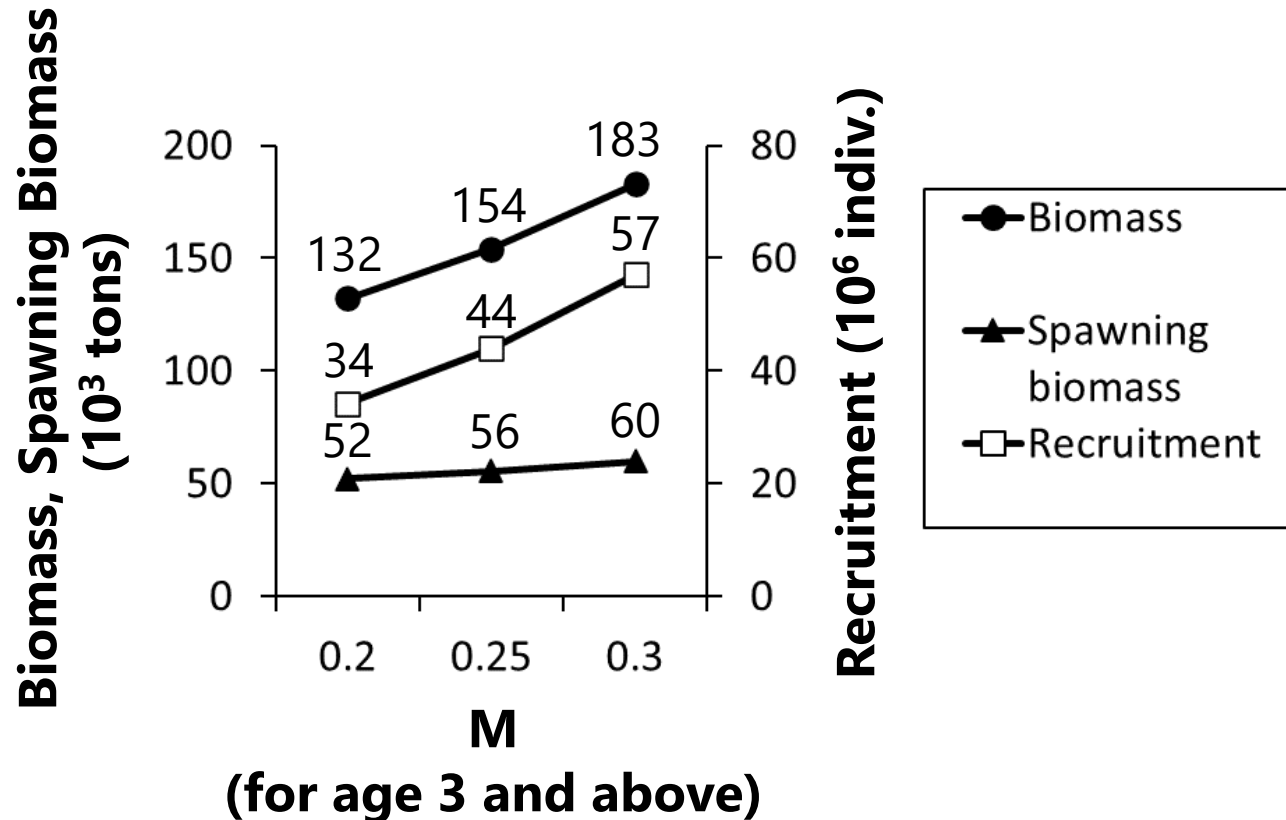
- Using the same values as the Japanese Pacific stock
- Observed maximum age : 18 years old (Kooka, 2012)
 - $\sim 5/A_{max}$  $M=0.28$
- Hoenig's model (1983)  $M=0.23$ (Kooka, 2012)
- Pauly's model (1980)  $M=0.20$ (female), 0.23 (male) (Kooka, 2012)
- As you indicated, “M is not known with precision and affects estimates of F (and therefore abundance)”, thus we will continue working to improve.

Response to the comments #05 and #08

Sensitivity test of M

P19, Figure 4-6
modified

Biomass, Spawning biomass, and Recruitment
in the 2019 fishing season



Reviewer's Comment #04

The Ridge VPA defines a penalty term (the square of F) with a weight (λ) that is chosen to minimize retrospective bias. The assessments provide plots showing the retrospective bias given the chosen weight (e.g., Appendix Figure 2-2 on page 32 of the WP-NSJ assessment). However, it would be helpful to see how fits to each abundance index change for alternative values of λ . I suggest plotting fits to each index using three values of λ : 1) the λ that minimizes the retrospective bias (this is already done), 2) $\lambda=0$, and 3) $\lambda=0.99$. The purpose of this is to show how fits to the abundance indices are affected by minimization of the retrospective bias.

Response to the comment #04

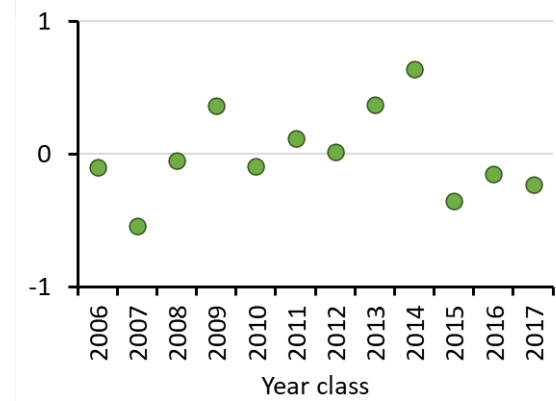
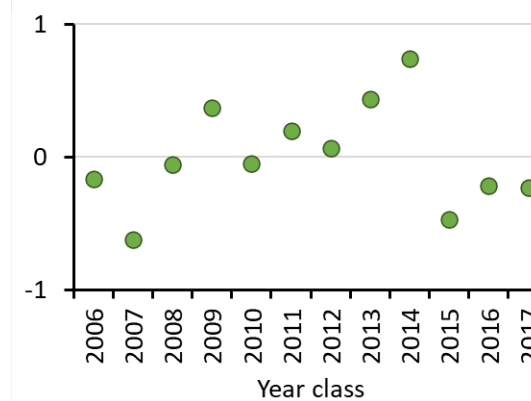
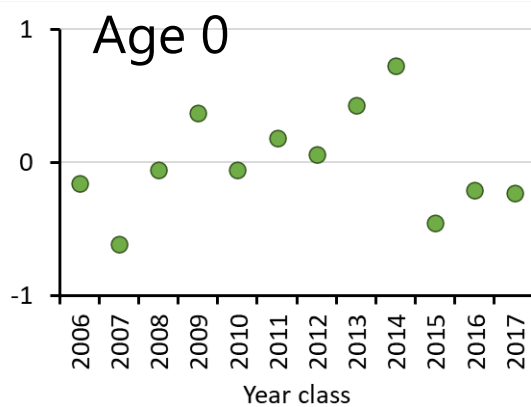
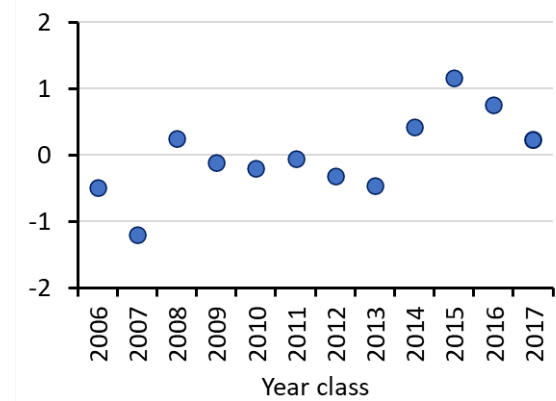
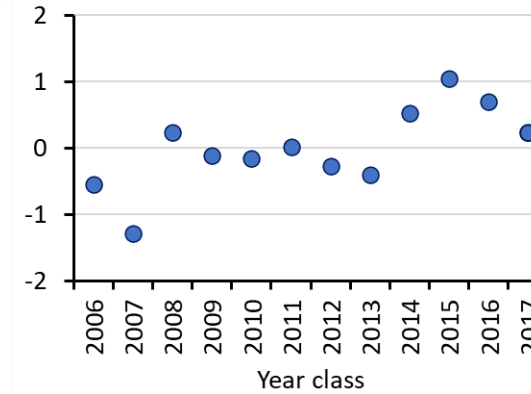
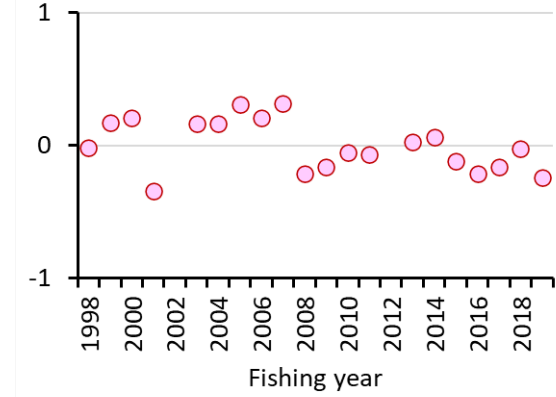
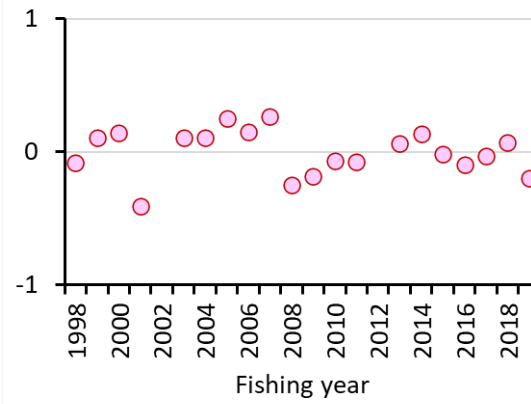
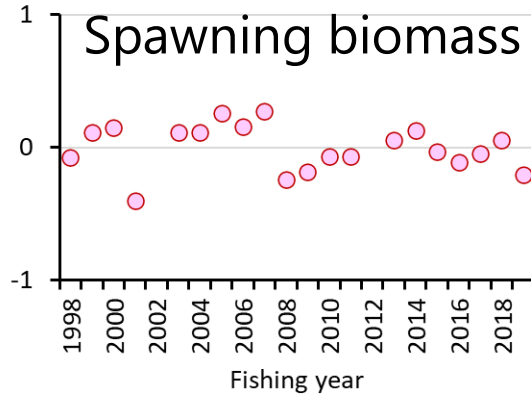
P30, Appendix figure 2-1 modified

$\lambda = 0.878$

$\lambda = 0$

$\lambda = 0.99$

$\ln(\text{observed value}) - \ln(\text{expected value})$

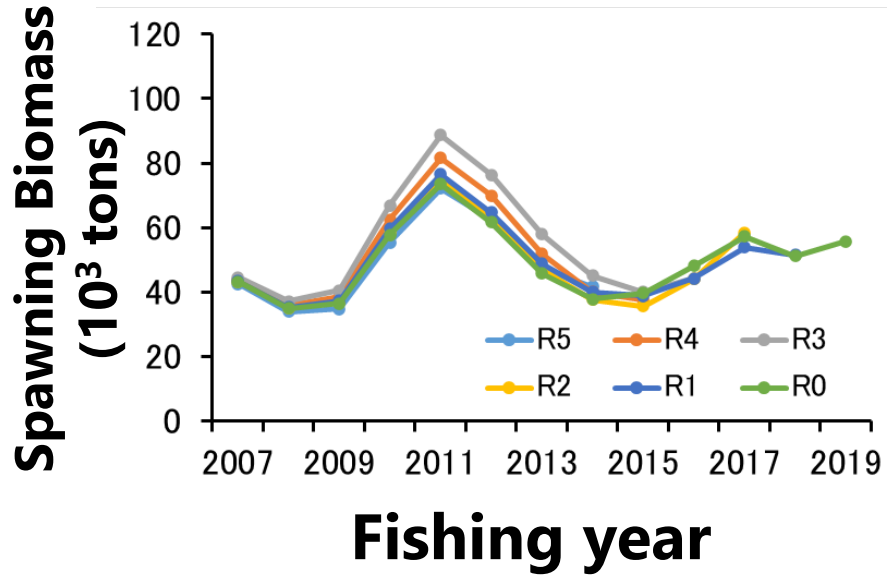


Response to the comment #04

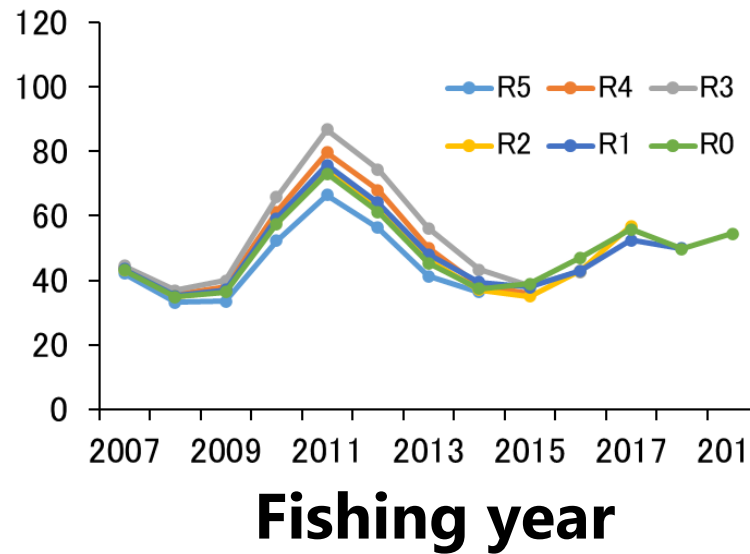
Retrospective pattern of Spawning Biomass

P31, Appendix figure 2-2 modified

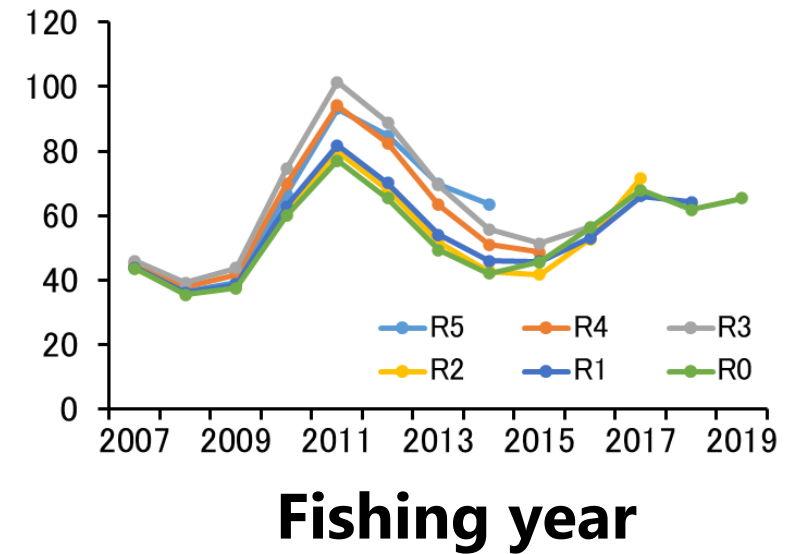
$$\lambda = 0.878$$



$$\lambda = 0$$



$$\lambda = 0.99$$



Reviewer's Comment #06

Provide justification for the weights (W_k) given to each index of abundance. For example, the WP-NSJ assessment assigns a weight of 10 to the spawning biomass index, and a weight of 1 to the recruitment index.

Response to the comment #06

$$(1 - \lambda) \times \sum_k \sum_y \left[W_k \times [\ln(I_{k,y}) - \ln(q_k N_y)]^2 \right] + \lambda \times \sum_{a=2}^9 (F_{a,Y})^2$$

At first, the weight ratio was 8 : 1 (SB index : R (age 1) index)

And then, the weight ratio was 10 : 1 (SB index : R (age 0&1) index)

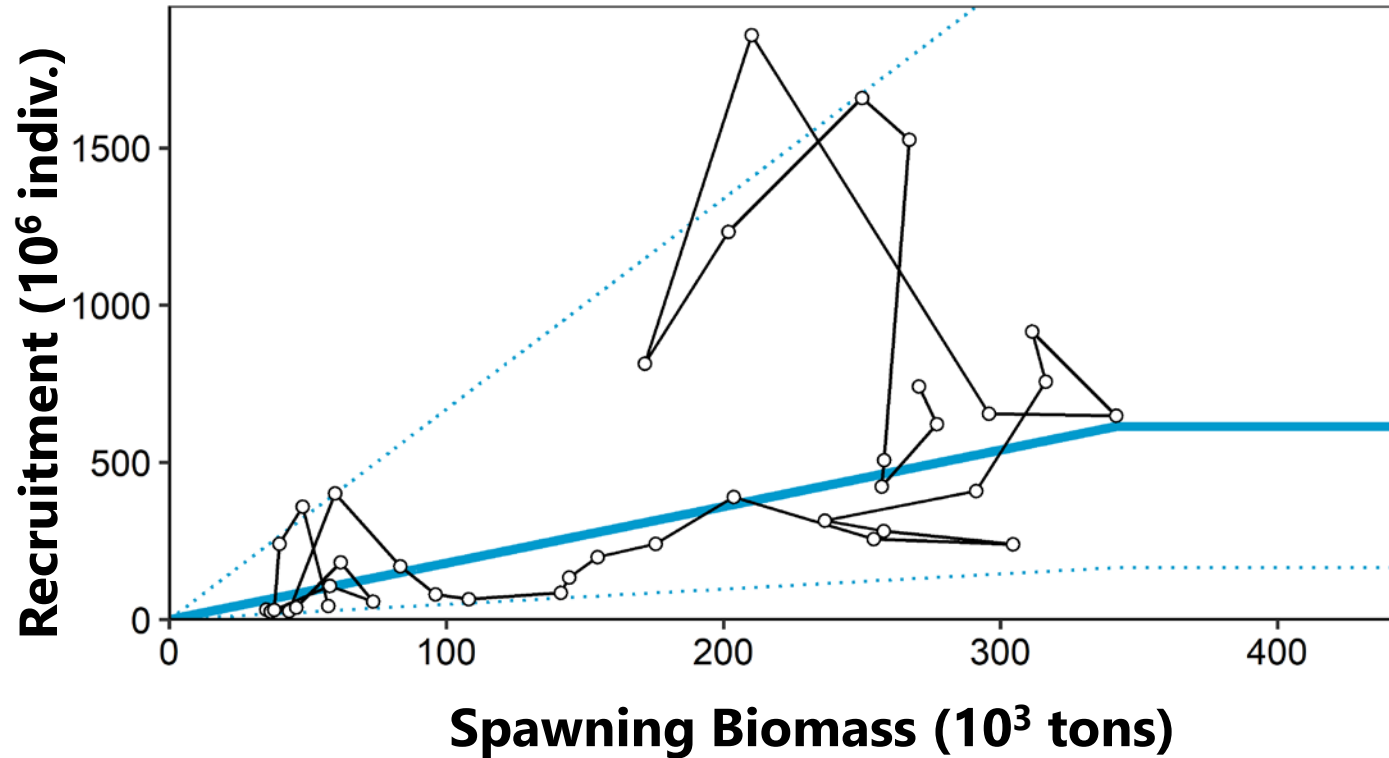
We plan to make a trial calculation using the method of Hashimoto et al. 2018, which is adopted in the Japanese Pacific stock.

Contents

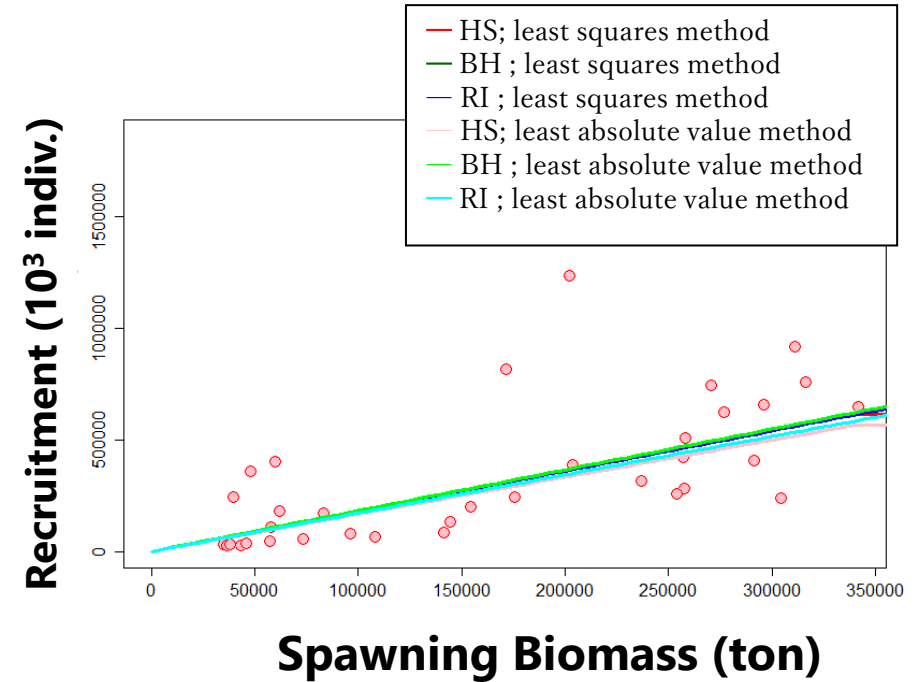
- **Biology and Stock assessment**
Distribution, Maturation, Natural mortality, Catch at age, Stock abundance indices, VPA
- **Stock-Recruitment Relationships**
- Reference points, Kobe-plot
- Harvest Control Rule, Future projection

Stock-Recruitment Relationships (2020 updated)

P71, Appendix figure10-1



P72, Appendix figure10-2

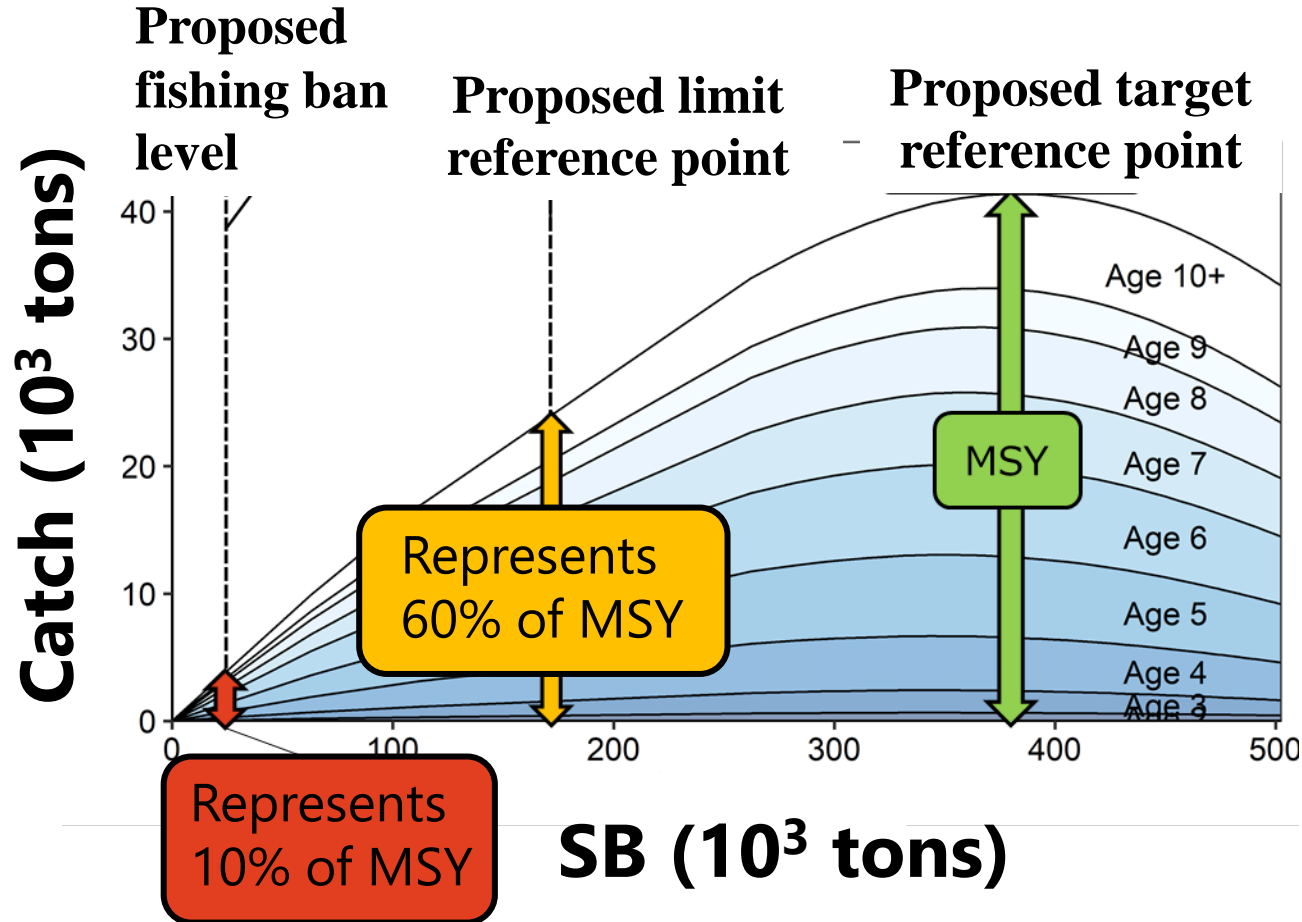


S-R relationship	Optimization method	a	b	S.D.
Hockey stick	Least squares method	1.797	341,743	0.799

Contents

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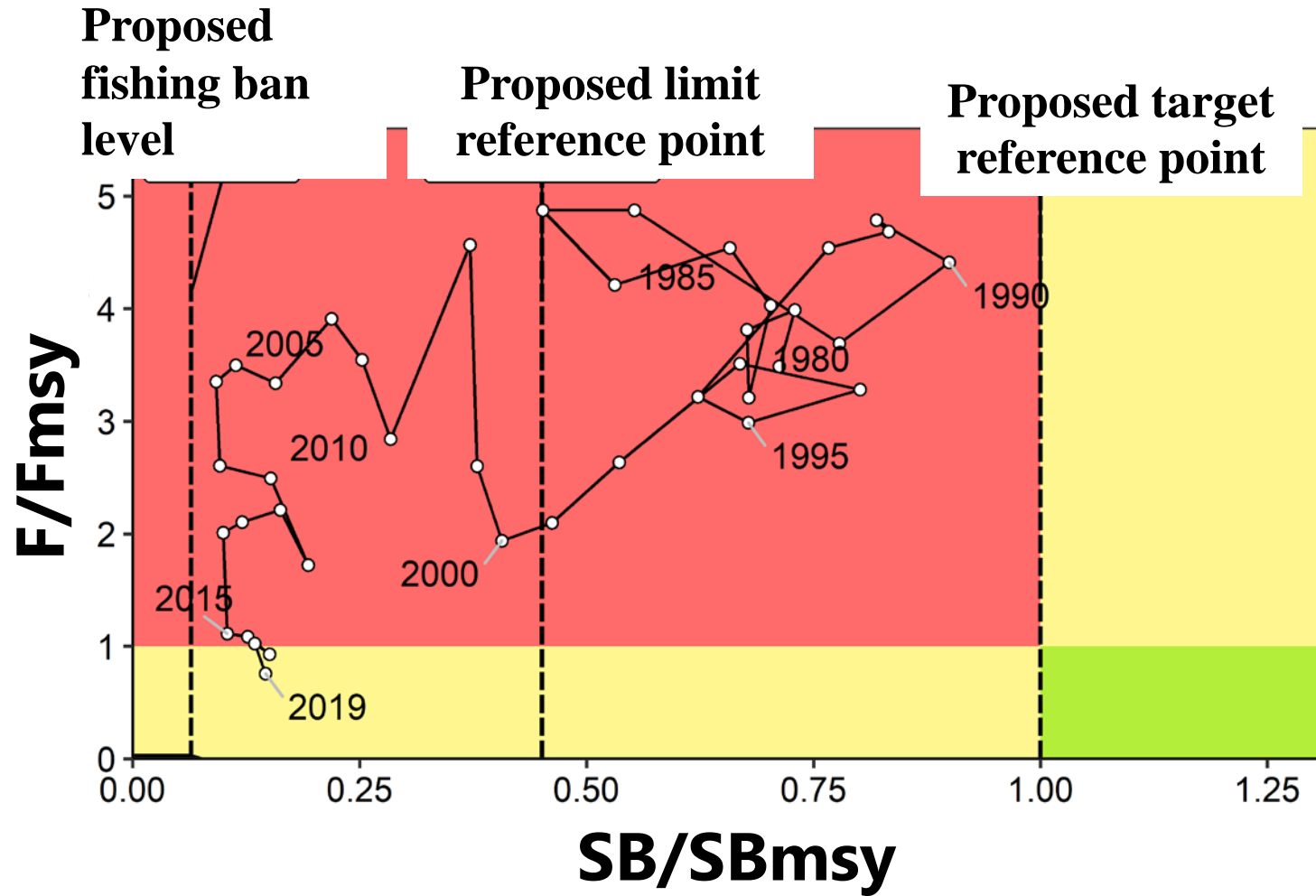
Reference Points (2020 updated)



Proposed Reference Points	Spawning Biomass (10^3 tons)
Target (SB_{msy})	380
Limit (SB_{0.6msy})	171
Bban (SB_{0.1msy})	25

Kobe plot (2020 updated)

P73, Appendix figure 10-5 a)



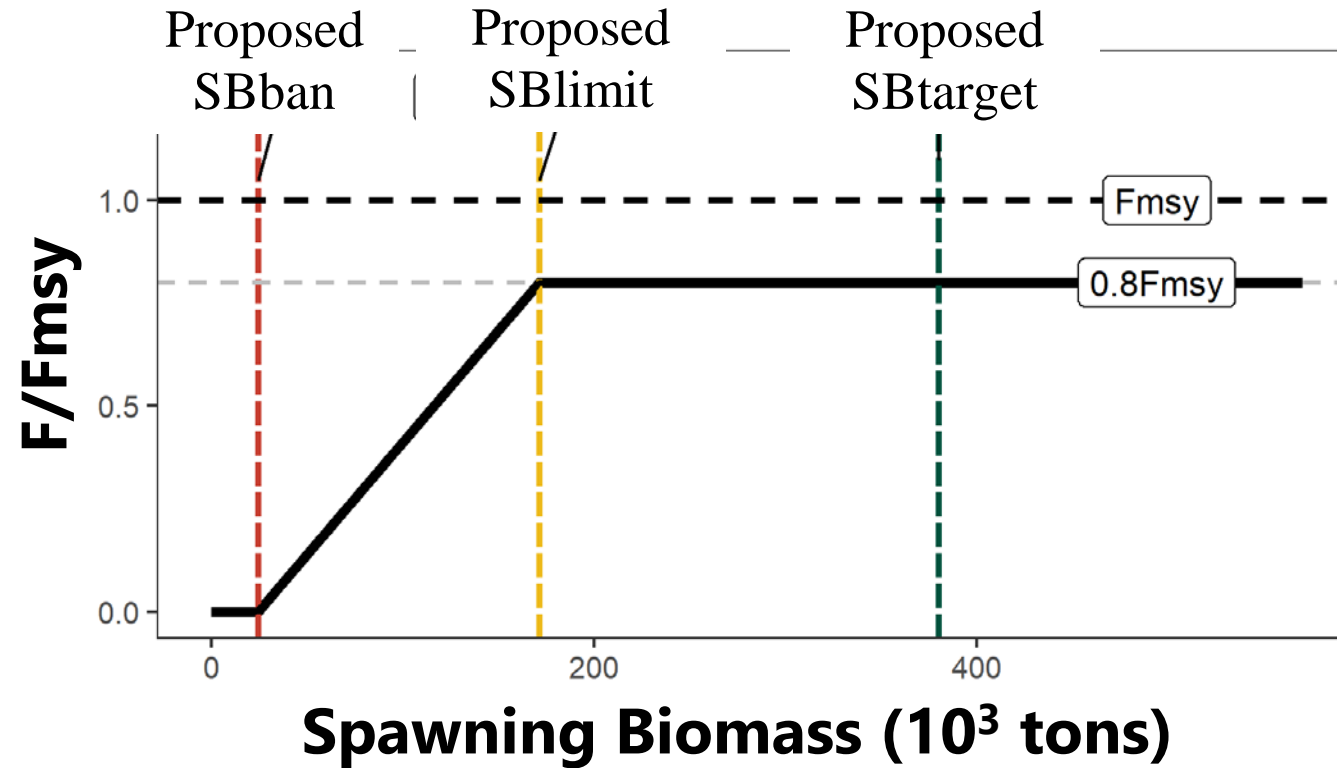
Contents

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- **Harvest Control Rule, Future projection**

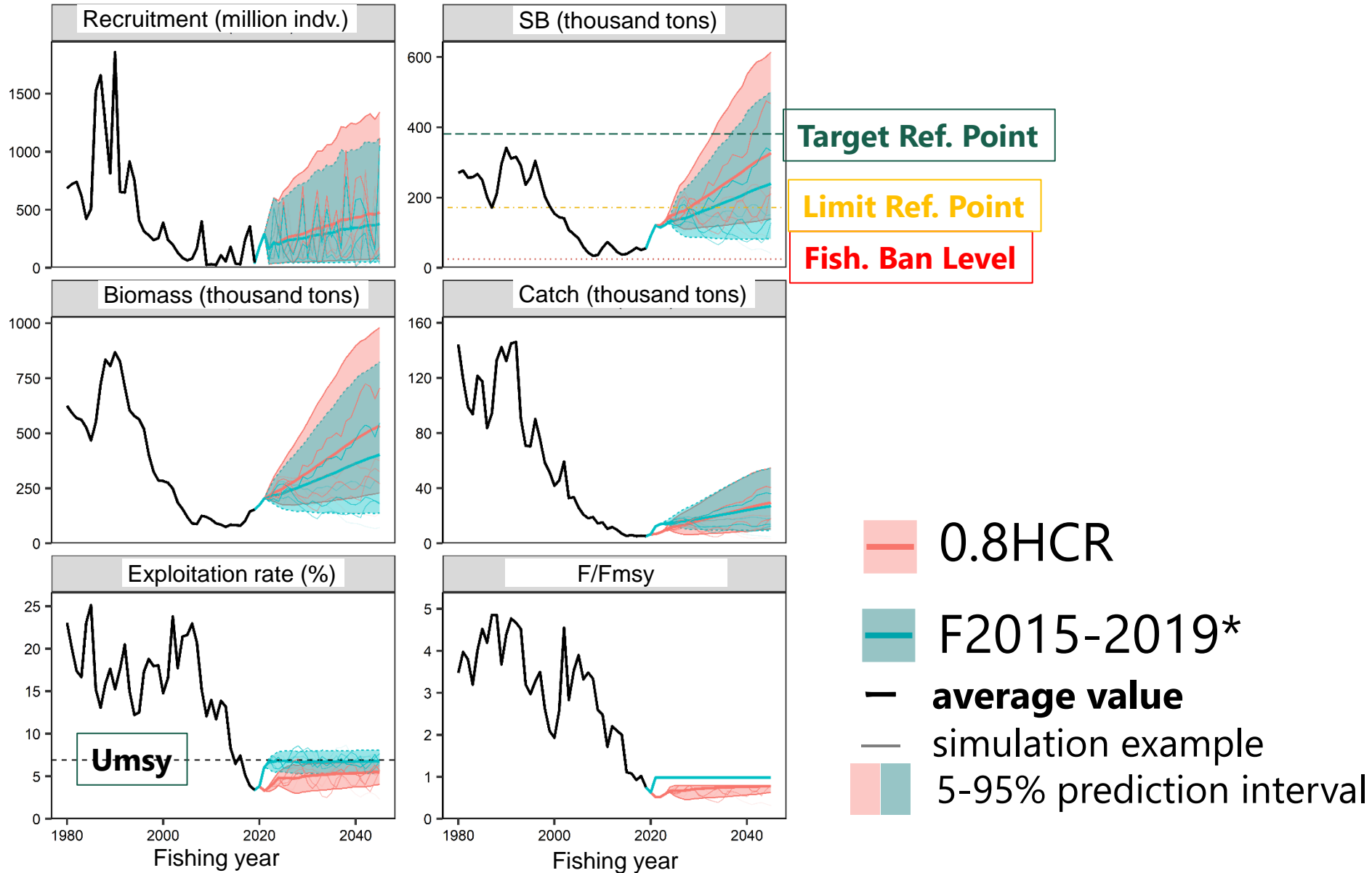
Proposed HCR (2020 updated)

P75, Appendix figure 10-6 a)

When $\beta=0.8$



Future Projection 1



Future Projection 2

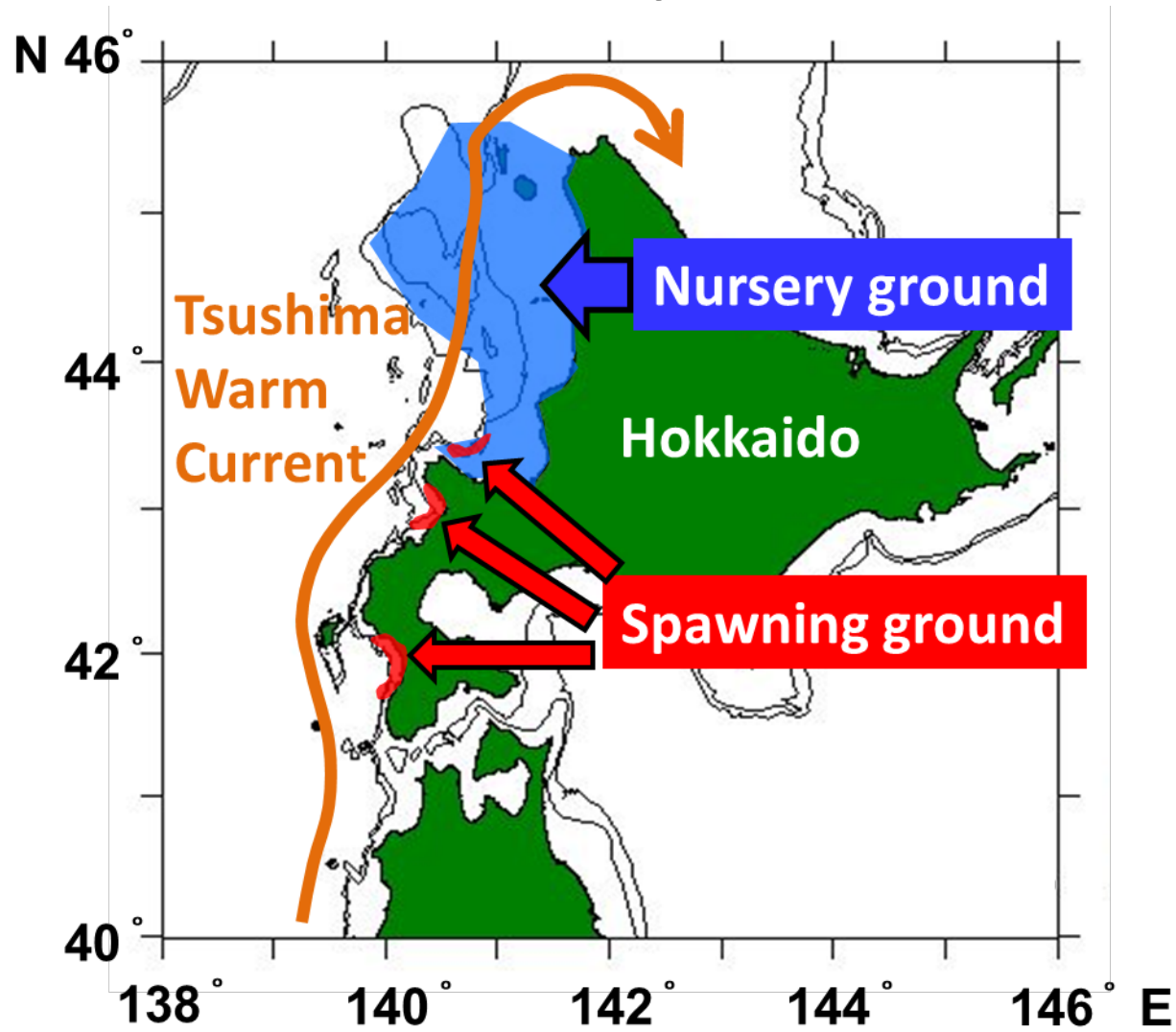
Probability (%) for spawning biomass to exceed the proposed target reference point

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
1.0	0	0	0	0	0	0	0	0	0	0	1	1	2	12	24
0.9	0	0	0	0	0	0	0	0	0	0	1	1	2	16	31
0.8	0	0	0	0	0	0	0	0	0	1	1	2	3	21	39
0.7	0	0	0	0	0	0	0	0	0	1	1	2	3	27	49
0.6	0	0	0	0	0	0	0	0	0	1	2	3	4	35	59
0.5	0	0	0	0	0	0	0	0	1	1	2	4	6	43	69
0.4	0	0	0	0	0	0	0	0	1	1	3	5	7	53	78
0.3	0	0	0	0	0	0	0	0	1	2	3	6	10	61	86
0.2	0	0	0	0	0	0	0	0	1	2	4	8	12	70	91
0.1	0	0	0	0	0	0	0	1	1	3	6	10	16	78	96
0	0	0	0	0	0	0	0	1	2	3	7	13	20	86	98

Probability (%) for spawning biomass to exceed the proposed limit reference point

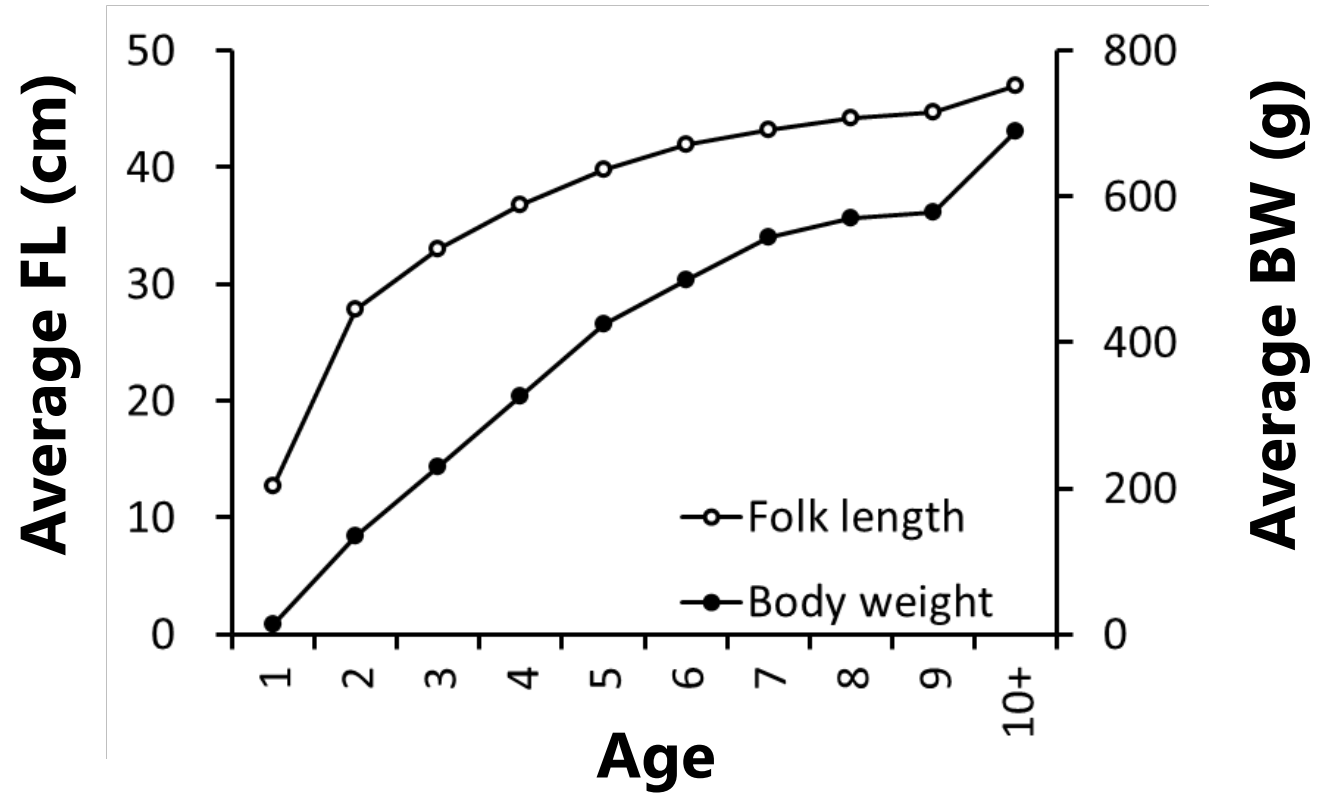
β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2041	2051
1.0	0	0	0	0	0	2	12	22	25	31	37	43	46	70	82
0.9	0	0	0	0	0	2	14	24	28	35	42	48	51	76	87
0.8	0	0	0	0	0	3	16	28	32	39	48	53	57	82	92
0.7	0	0	0	0	0	3	18	31	36	44	53	59	63	87	95
0.6	0	0	0	0	0	4	21	35	41	49	59	65	69	91	97
0.5	0	0	0	0	0	6	25	39	46	55	65	71	75	94	99
0.4	0	0	0	0	0	7	29	45	52	61	71	76	81	97	99
0.3	0	0	0	0	0	10	35	50	57	67	77	82	86	98	100
0.2	0	0	0	0	0	14	42	58	64	73	82	87	90	99	100
0.1	0	0	0	0	0	21	50	66	70	79	87	91	93	100	100
0	0	0	0	0	0	32	60	73	78	85	91	94	96	100	100

Spawning grounds & nursery ground in recent years



Age and growth

P14, Figure 2-2



Age 1 : 10-20 cm FL

Age 2 : 25-30 cm FL

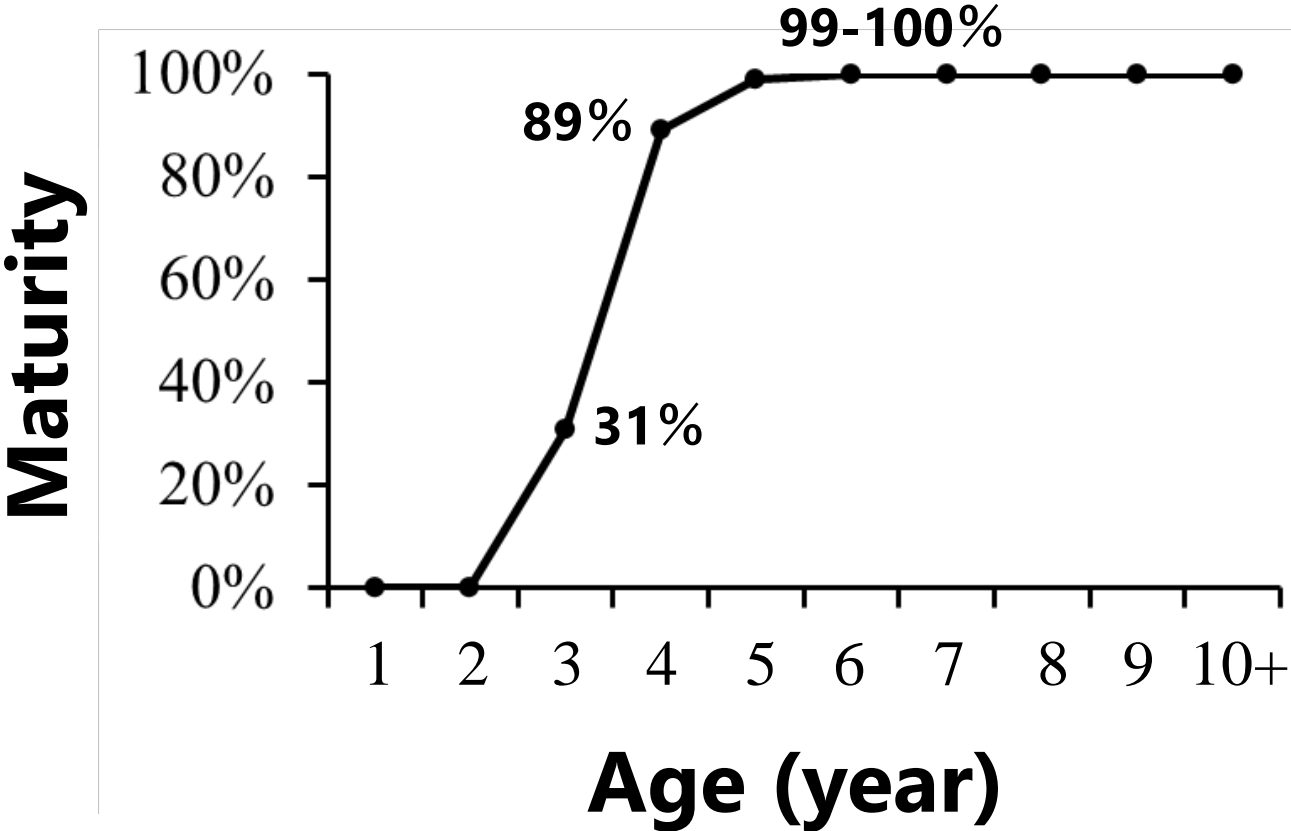
Age 3 : 30-35 cm FL, 200 g BW

Age 4 : 35-40 cm FL, 300 g BW

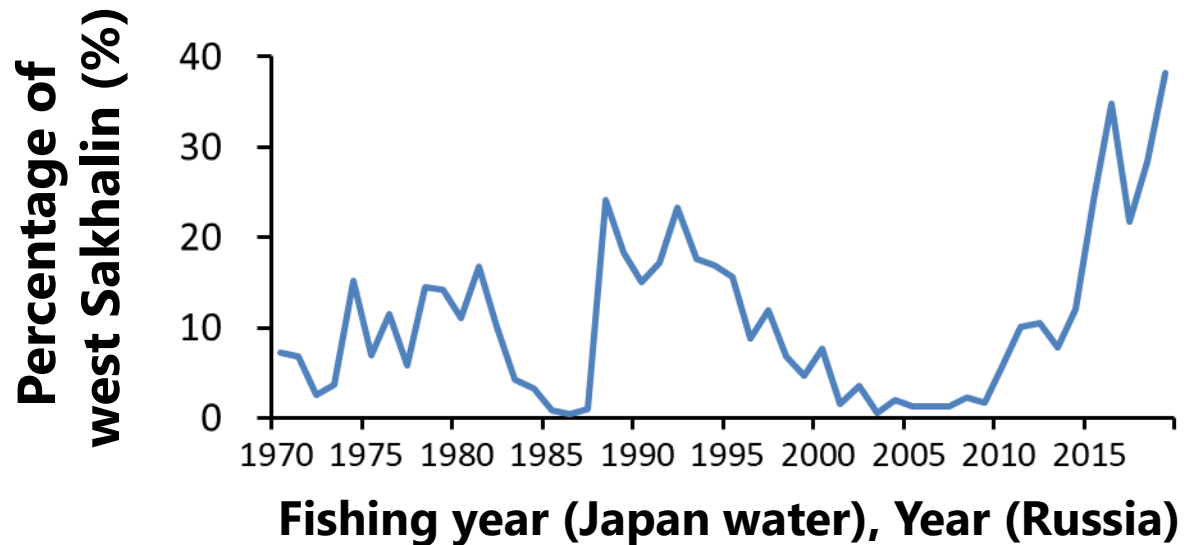
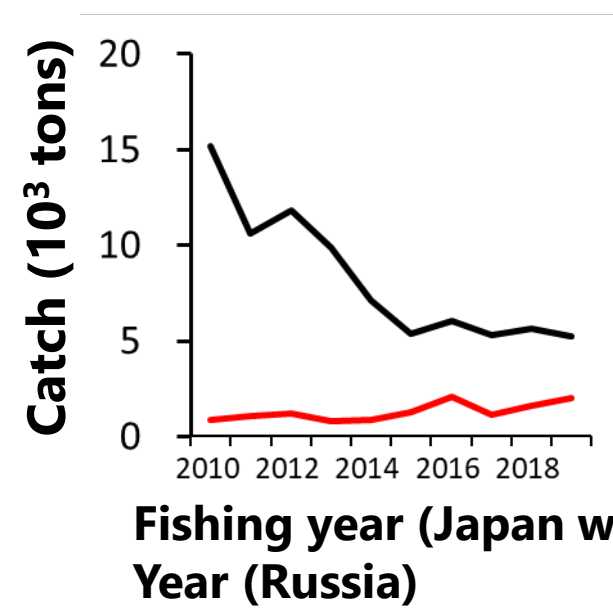
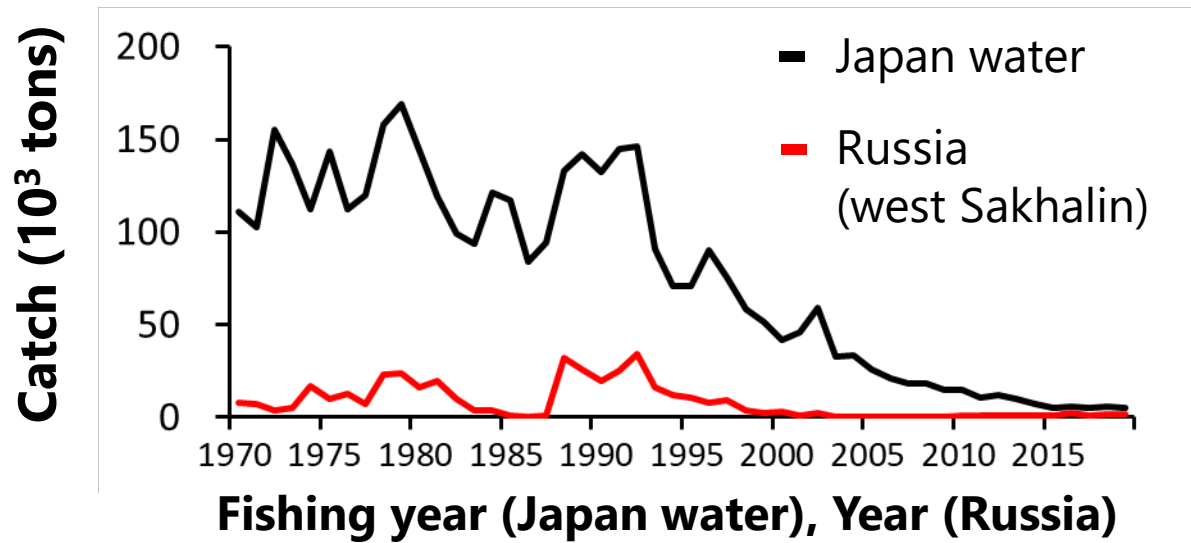
Age 5 and above : >40 cm FL, >400g BW

Maturity (female)

P15, Figure 2-3



Catch



Source of the catch in west Sakhalin
1970-2015: Varkentin & Sergeeva (2017)
2016-2019: RussianTAC

Coastal fishery in 2019 fishing year

Length composition

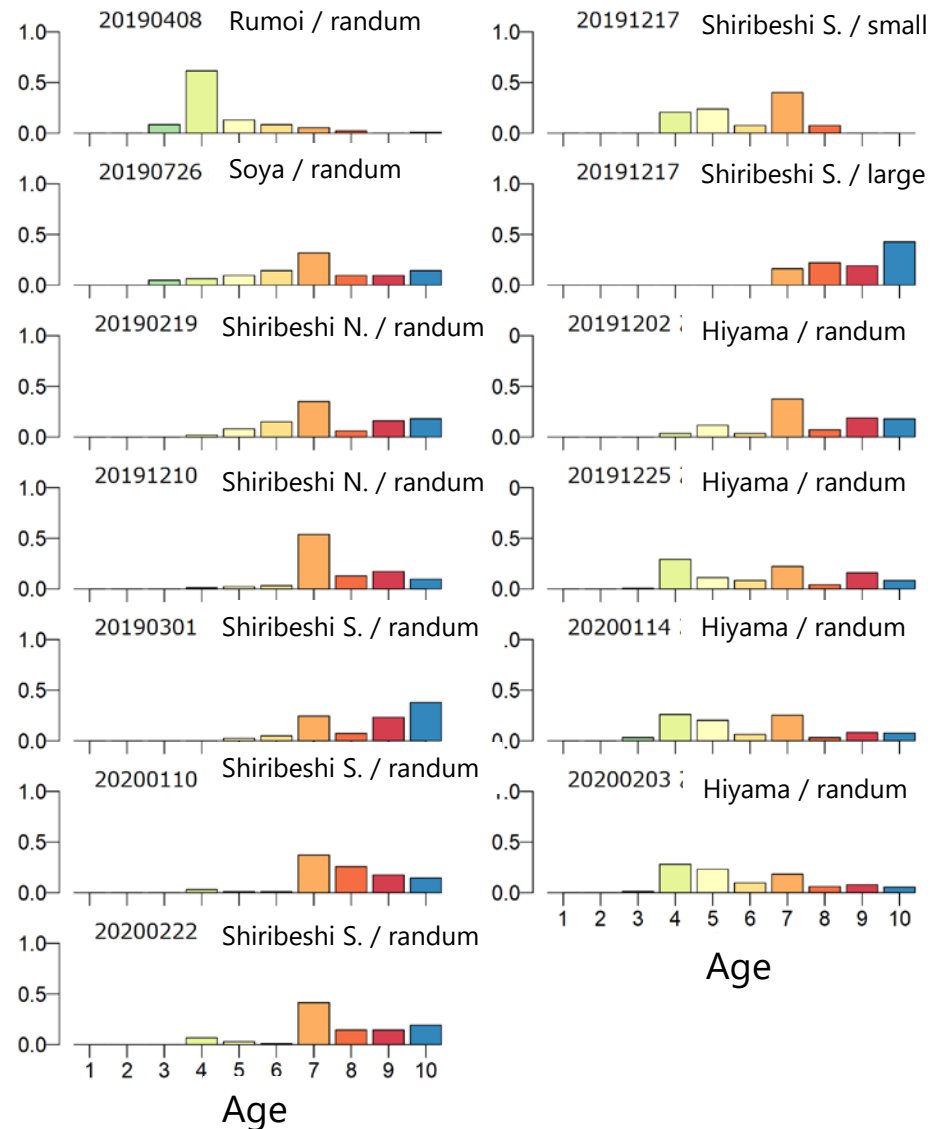
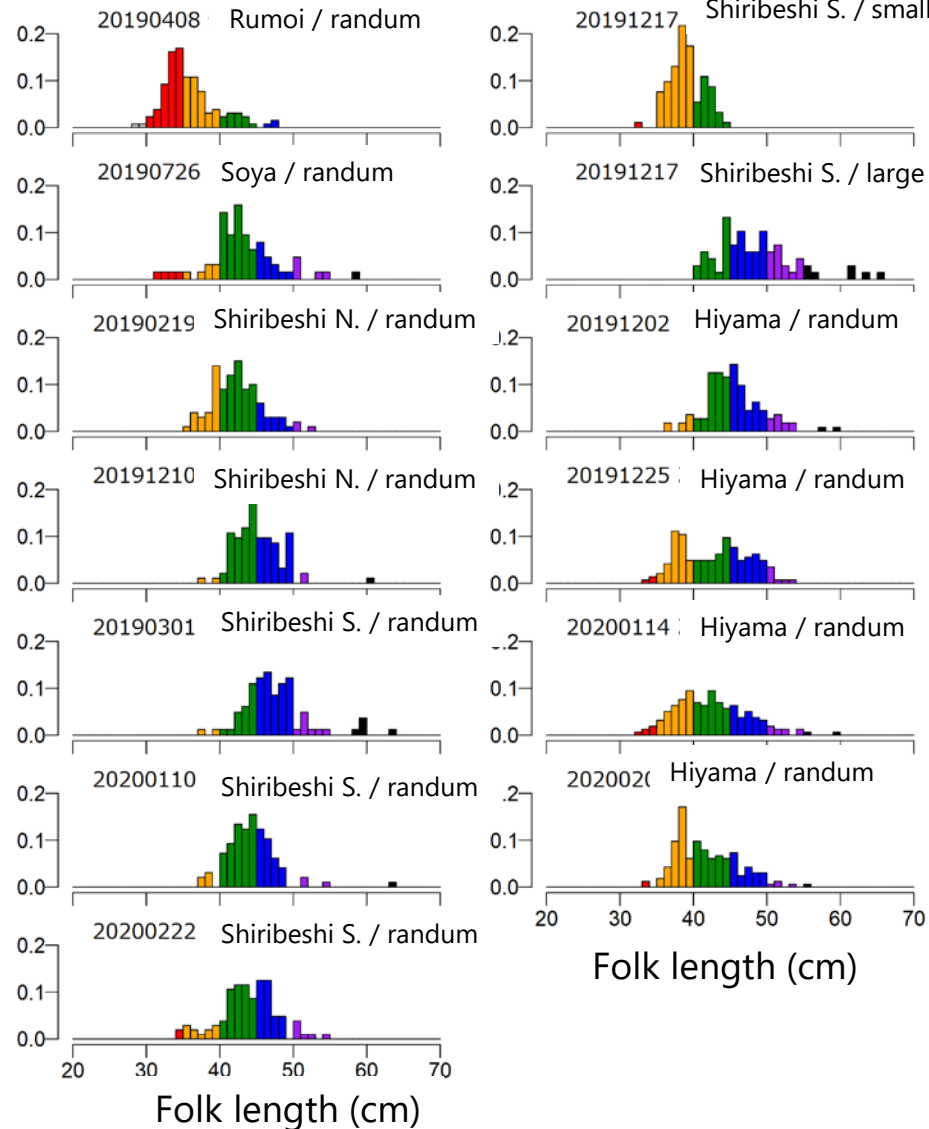
Age composition

Gill net, Shrimp trawl

Long line

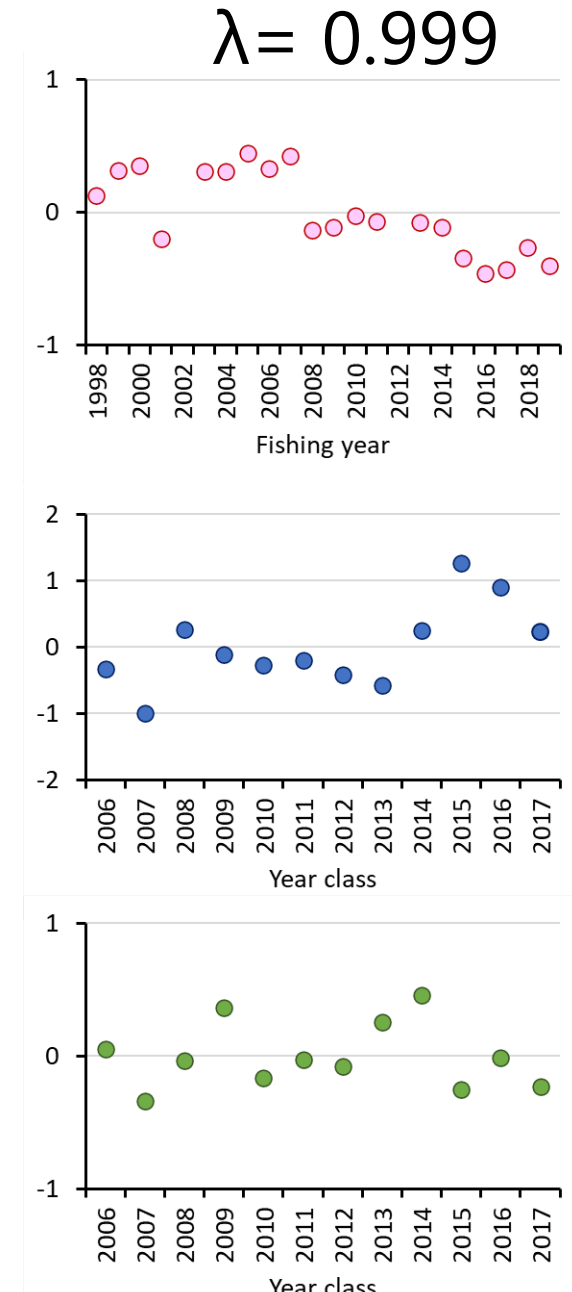
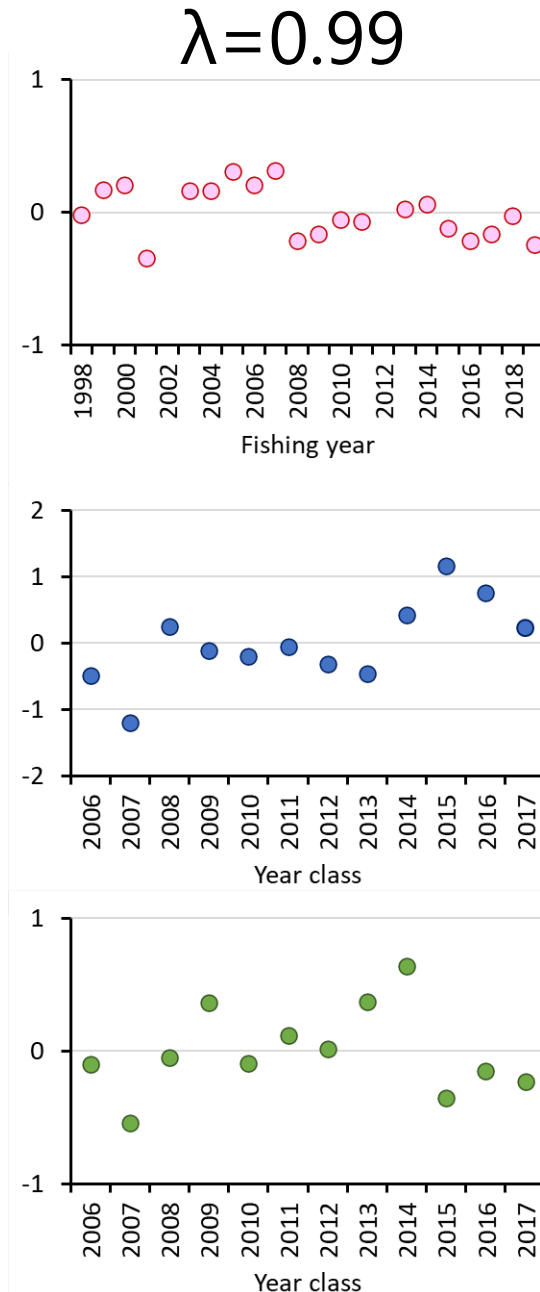
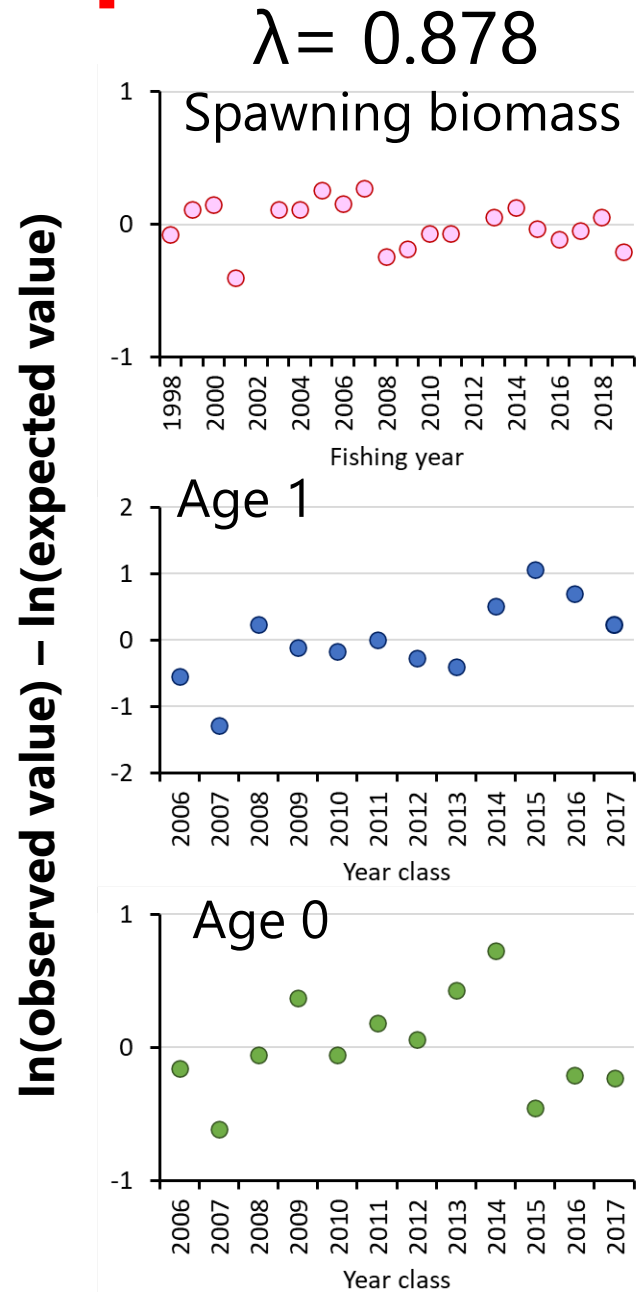
Gill net, Shrimp trawl

Long line



Response to the comment #04

P30, Appendix figure 2-1 modified

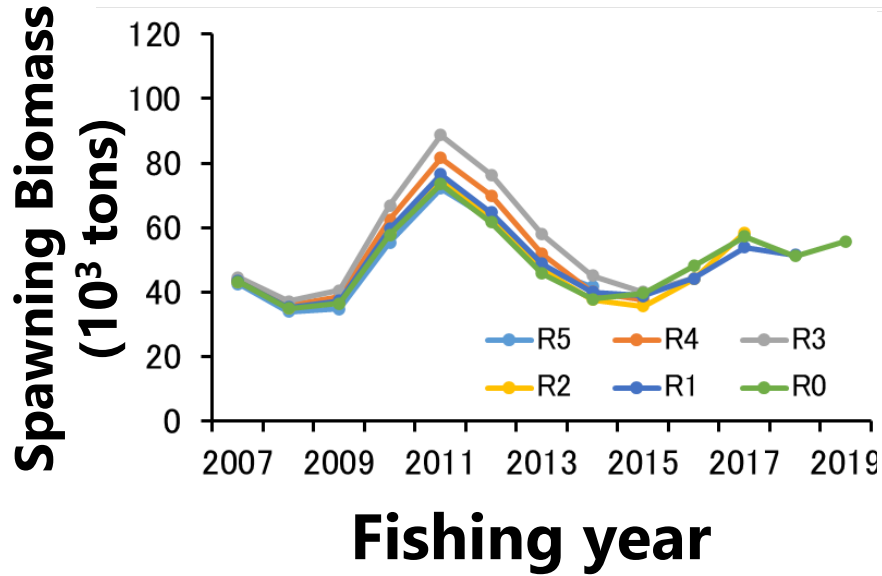


Response to the comment #04

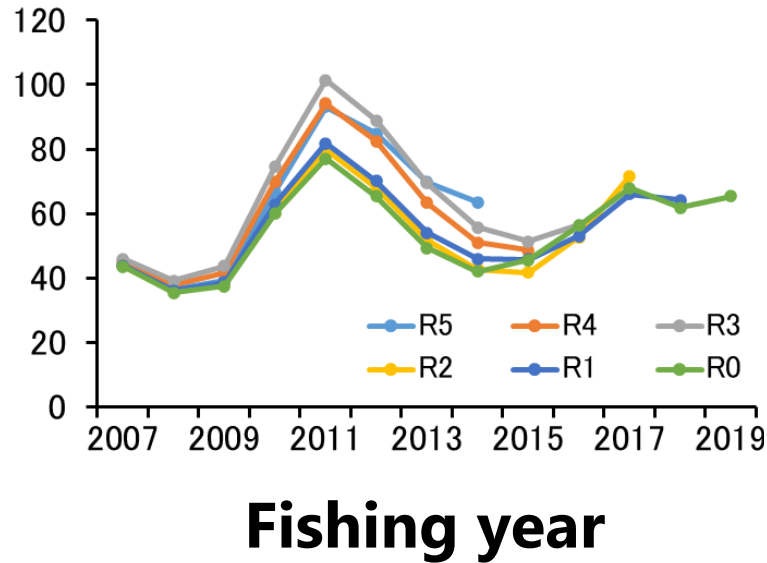
Retrospective pattern of Spawning Biomass

P31, Appendix figure 2-2 modified

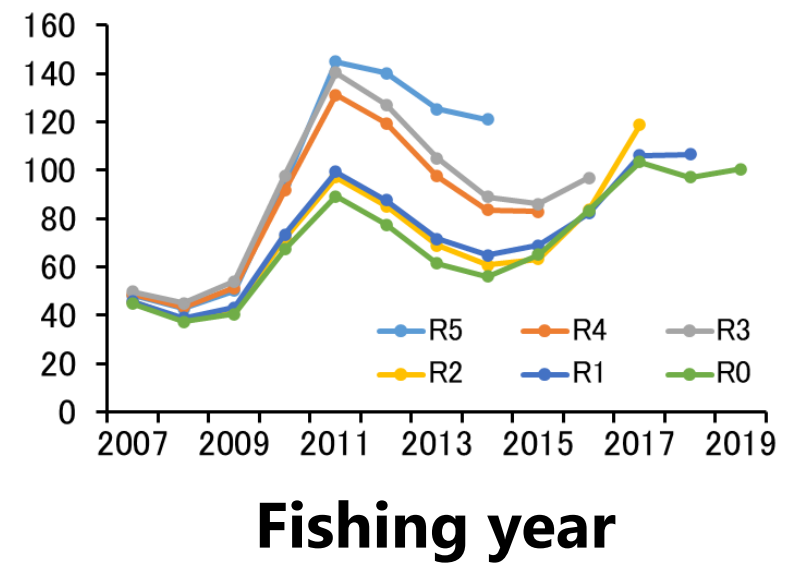
$$\lambda = 0.878$$



$$\lambda = 0.99$$



$$\lambda = 0.999$$

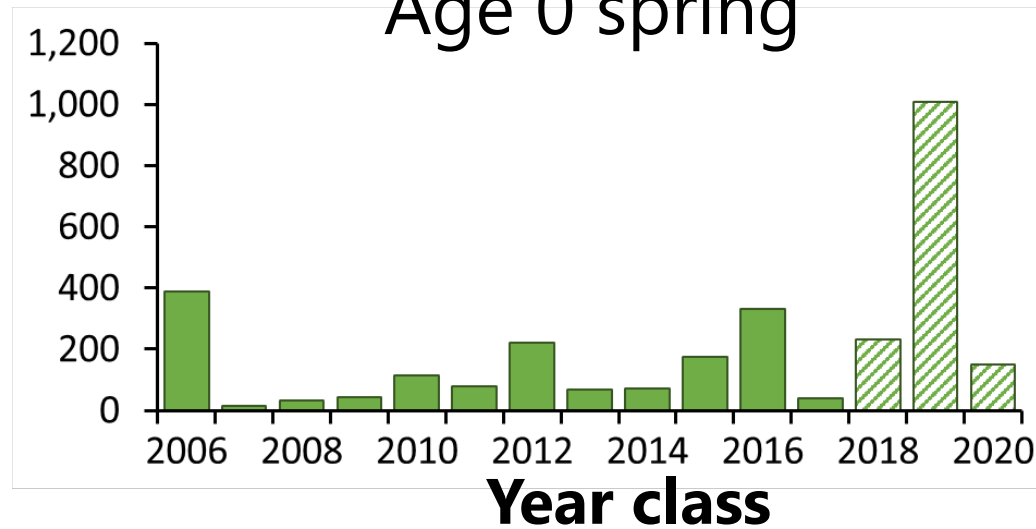


Abundance indices

P45, Appendix table 4-2 &
P47, Appendix table 4-3

Abundance in number
(10^8 indiv.)

Age 0 spring



Age 1 summer

