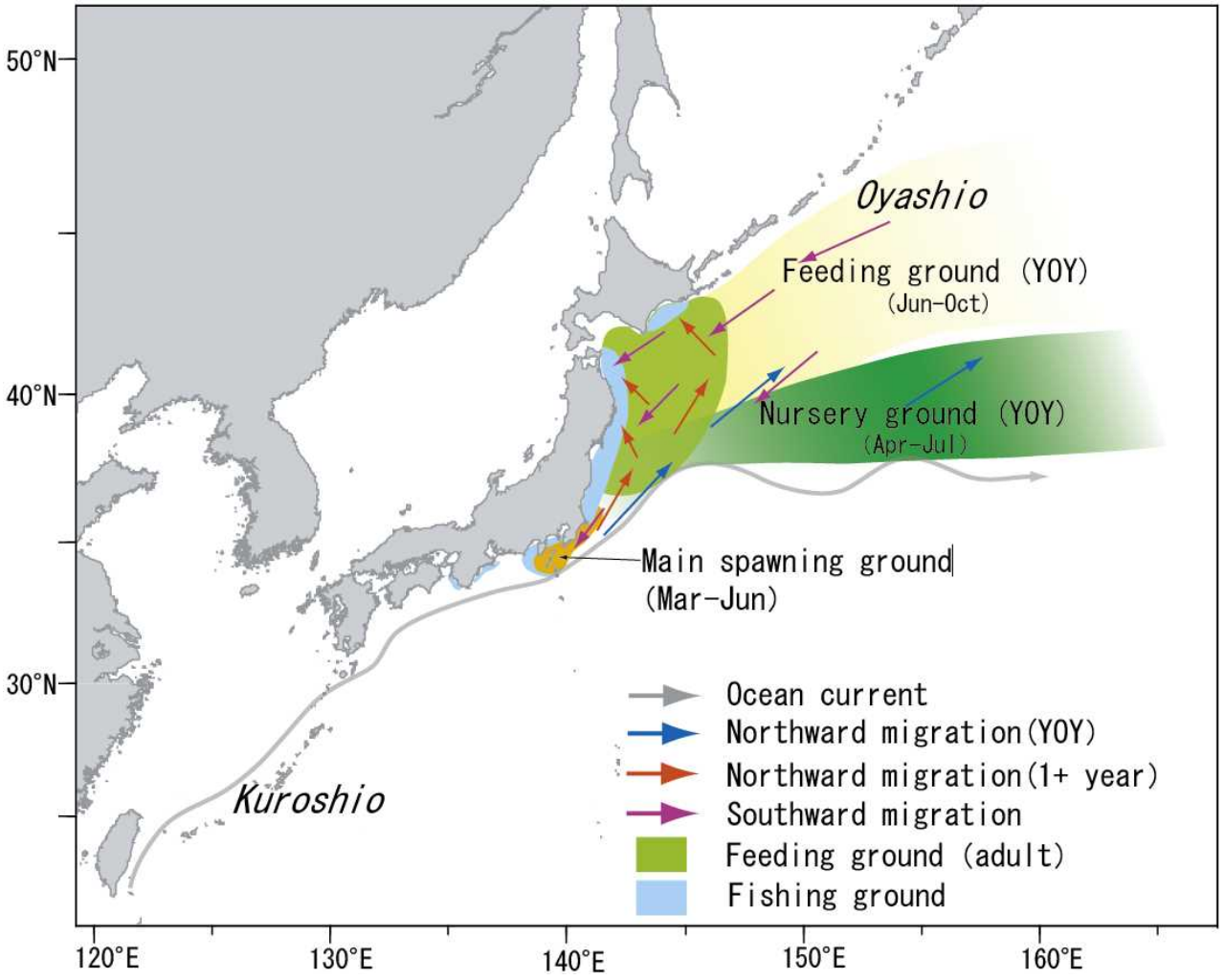
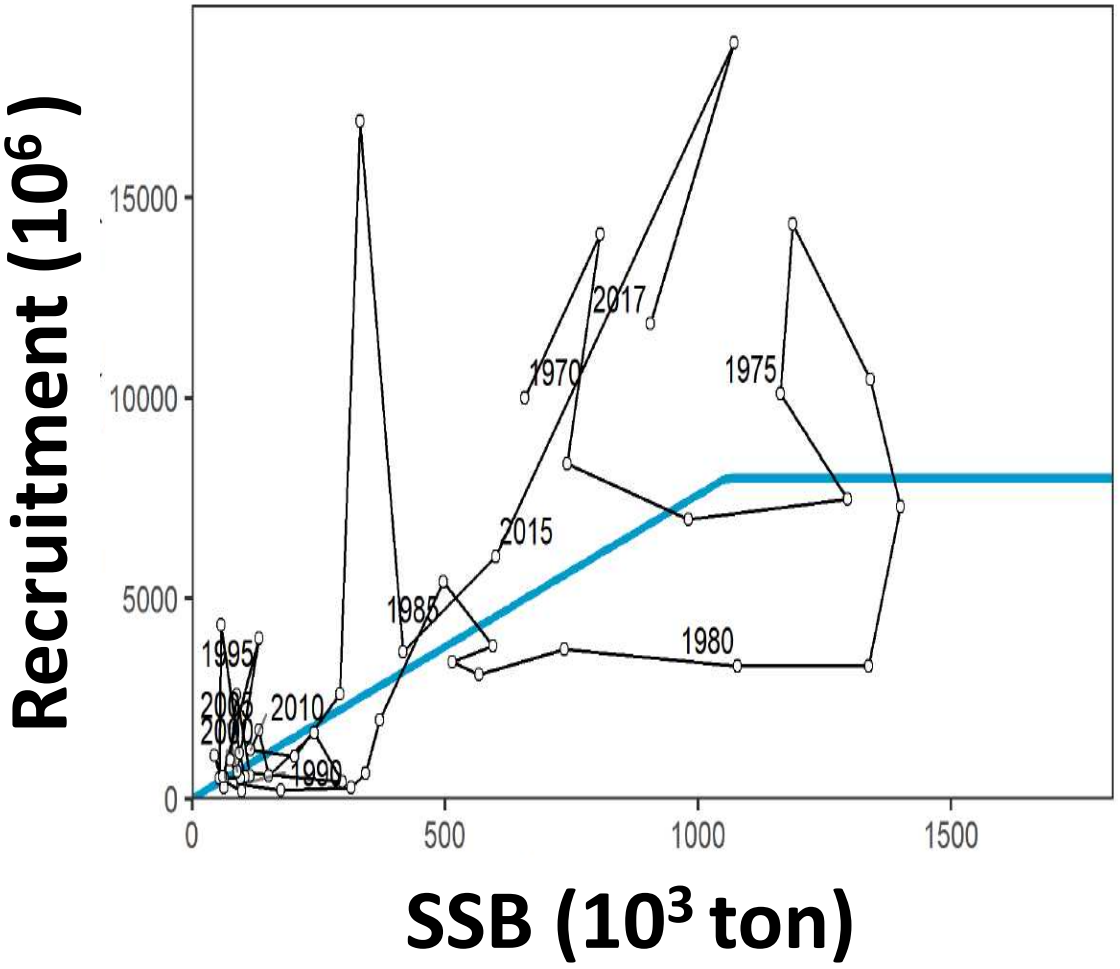
Pacific stock of chub mackerel

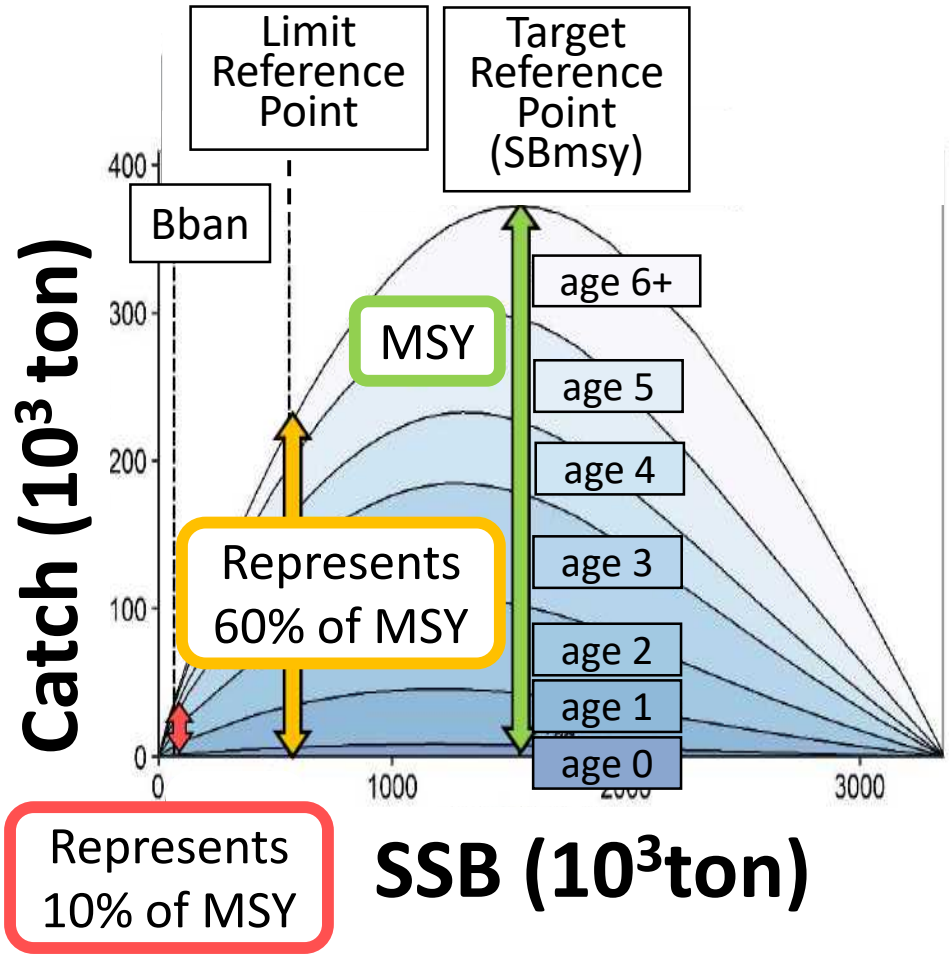
Distribution



Stock-Recruitment Relationship

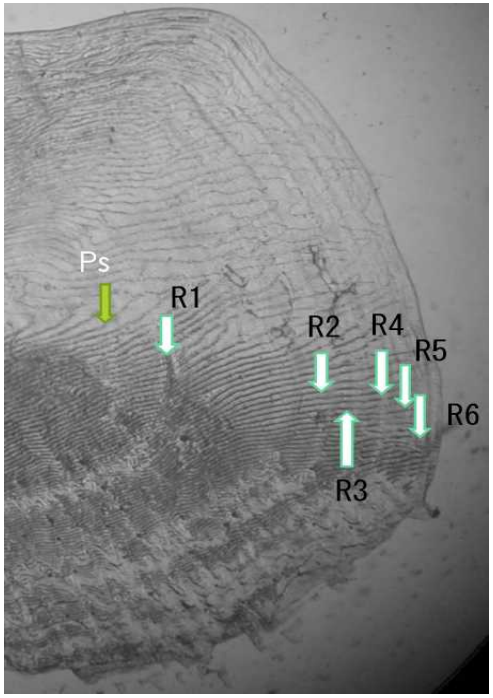


Reference Points



Reference Points	Catch (10^4ton)	SSB (10^3ton)
Target (SBmsy)	37	1545
Limit	22	562
Bban	4	67

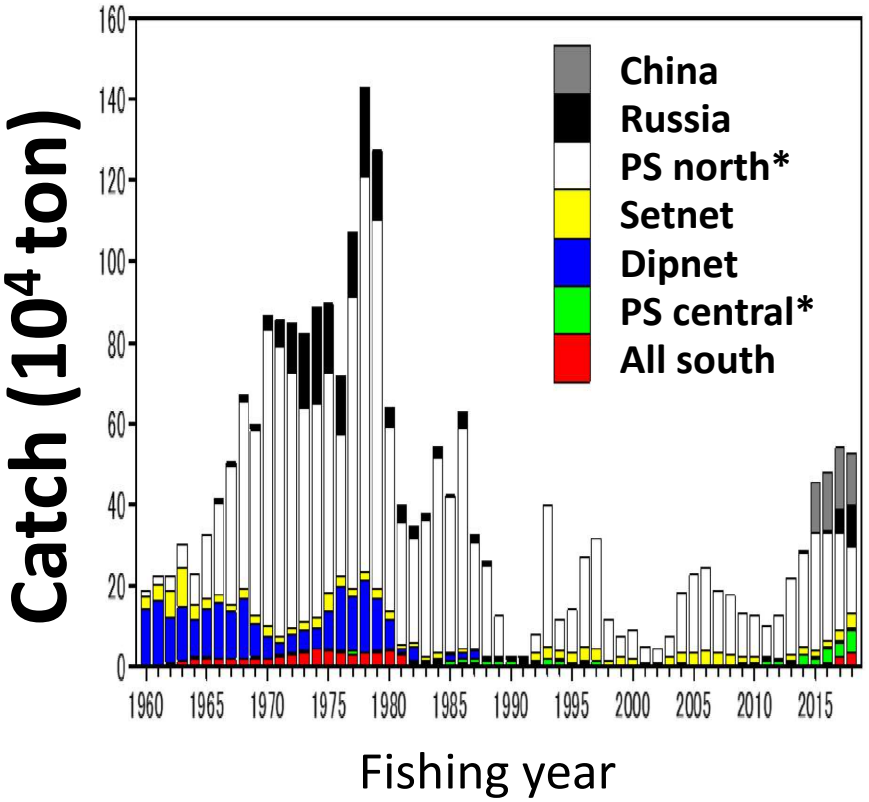
Age-Length Key

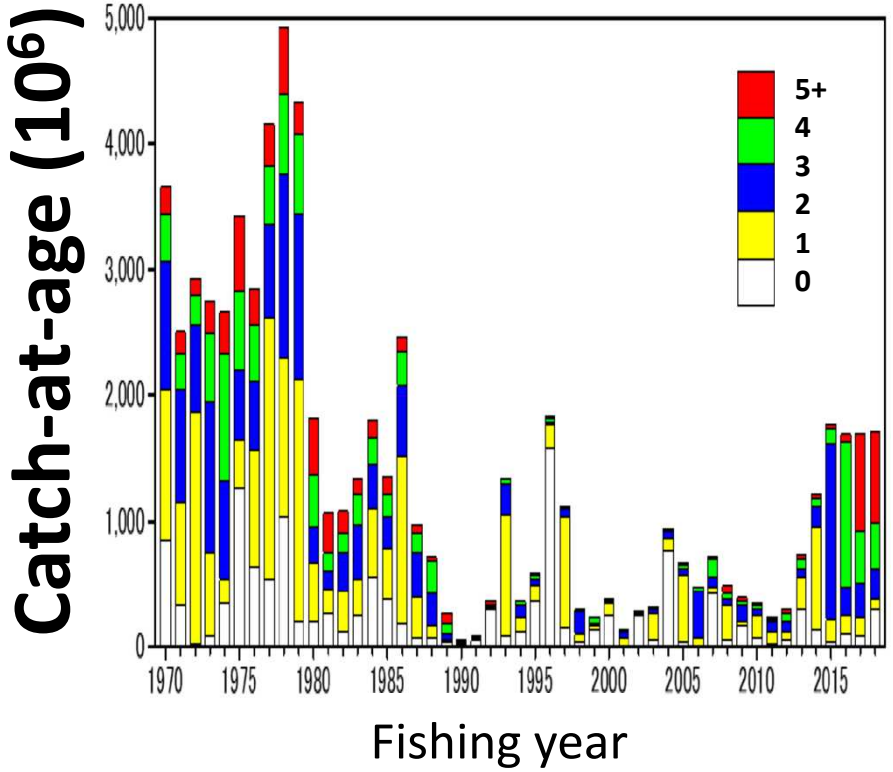


Age	FL (cm)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	sum
Jan - Mar																												
0																												0
1		4	1	3	1					3																		12
2									2	14	10	12	15	6	2													61
3							1	2	10	11	19	18	39	18	16	6	3		1									144
4									2	6	12	32	48	39	38	15	13	6	4	1								216
5											5	23	45	53	30	21	14	12	5	10	2	3	2	1				226
6											3	8	13	20	20	15	10	4	6	5	7	6	3		2			122
7+																		1	1	1			2					5
sum		4	1	3	1	0	1	2	14	34	49	93	160	136	106	57	40	23	17	17	9	9	7	1	2	0	0	786
Apr - Jun																												
0																												0
1		8	5	1		1																						15
2					1	2	4	2	2	2	3	2	1	1														20
3							1	2	4	4	6	15	18	10	11	2	1											74
4										1	2	8	22	18	12	18	9	2	1									93
5											2	9	12	19	16	15	12	6	6	2	8	1						108
6												5	9	16	25	14	7	3	1	2	3	5	3					93
7+																1	11	8	7	10	5	4	6	6	3		1	62
sum		8	5	1	1	3	5	4	6	7	13	39	62	64	64	50	40	19	15	14	16	10	9	6	3	0	1	465
Jul - Sep																												
0		1																										1
1		5	4	14	13	13	3																					52
2			3	5	20	17	12	7	5	3	2	1																75
3						1		4	5	3	3	7	7	3	1													34
4											1		1	2	4	2	5	1	2					1				19
5													1	1	4	6	6	4	3		4	1	2	1	1			34
6														1	2	4	1	3	5		1	2			1			20
7+																							2	1		1		4
sum		6	7	19	33	31	15	11	10	6	6	8	9	7	11	12	12	8	10	0	5	3	4	3	2	1	0	239
Oct - Dec																												
0		2	14	4	5	3	1																					29
1			3	9	34	16	26	14	4																			106
2				1	1	2	9	5	2	3	5	9	13	9	5													64
3								1	2	1	5	4	13	11	9	10												56
4											1	2	11	12	13	7	6	1										53
5													4	6	15	10	7	1	2			1						46
6											1		3	6	12	19	5	4	1	1		1		1				54
7+																1	3	3	3	3	2	2	1					18
sum		2	17	14	40	21	36	20	8	4	12	15	44	44	54	47	21	9	6	4	2	4	1	1	0	0	0	426

Catch and Catch-at-age

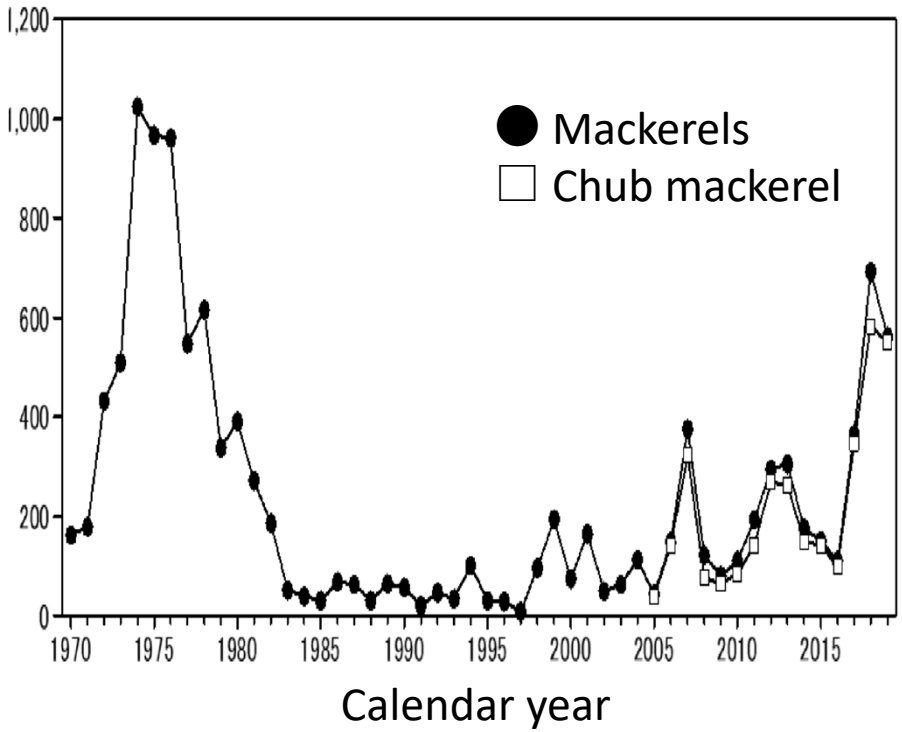
* PS: Purse Seine



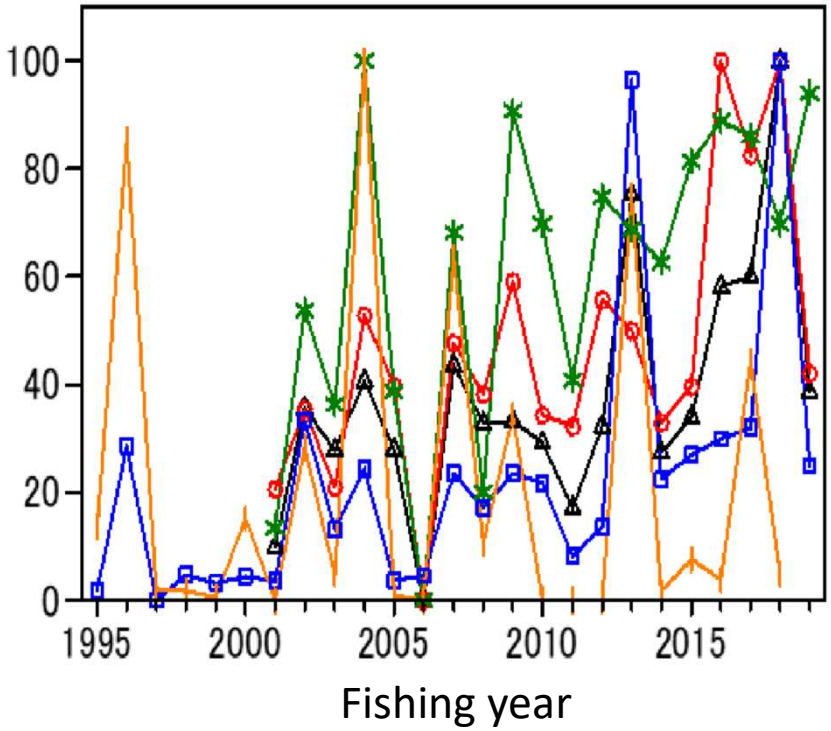


Egg abundance and Recruitment indices

Egg abundance (10^{12})



Abundance indices



numbers index from the early summer survey

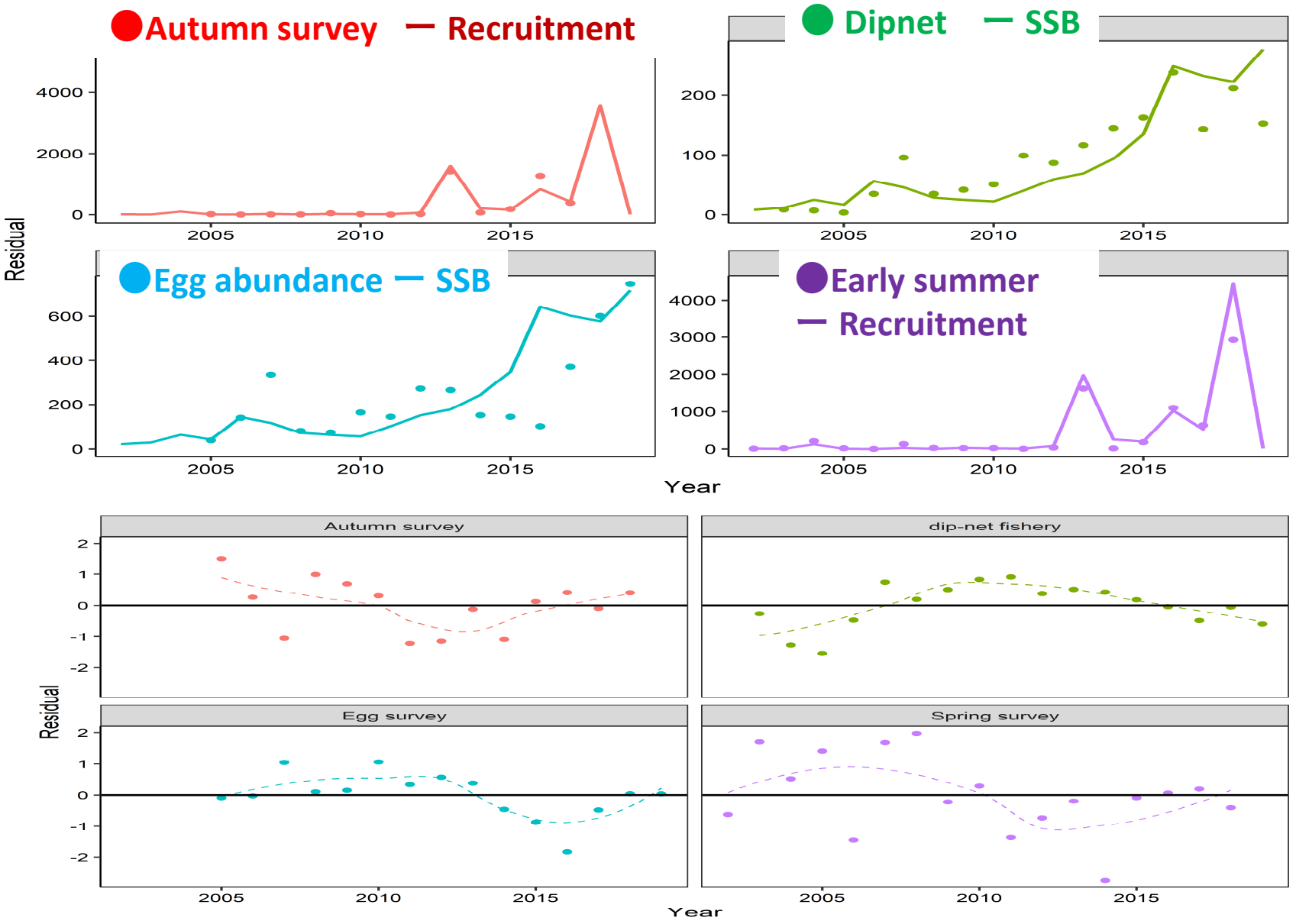
occurrence index from the early summer survey

average length index from the early summer survey

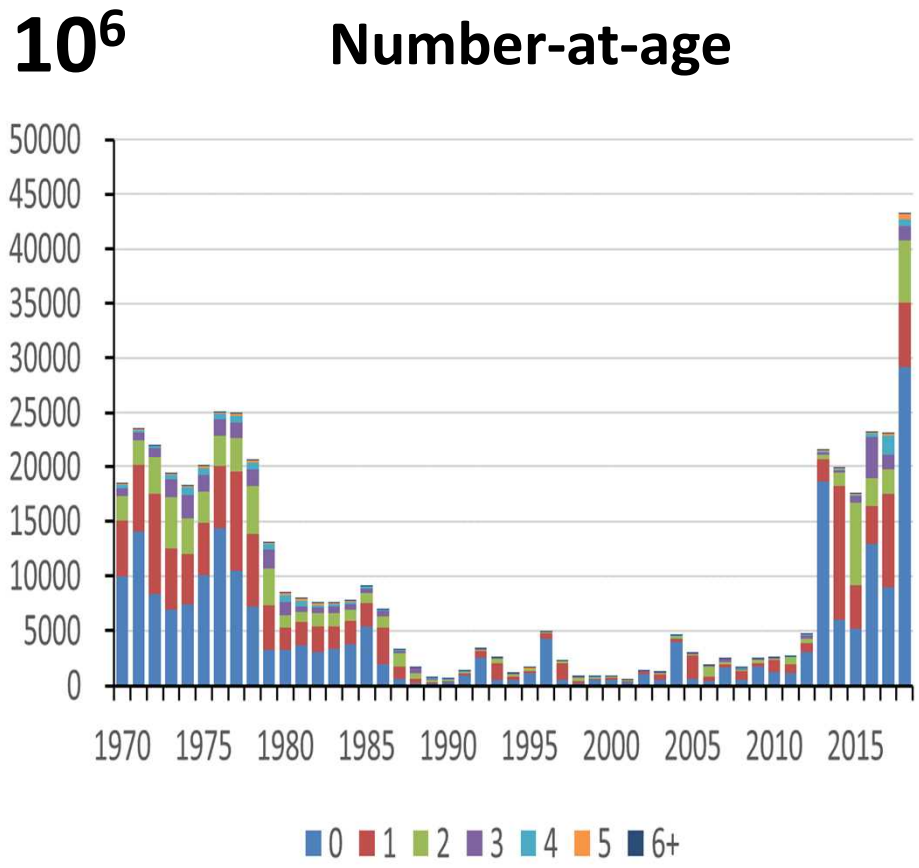
index from the autumn survey

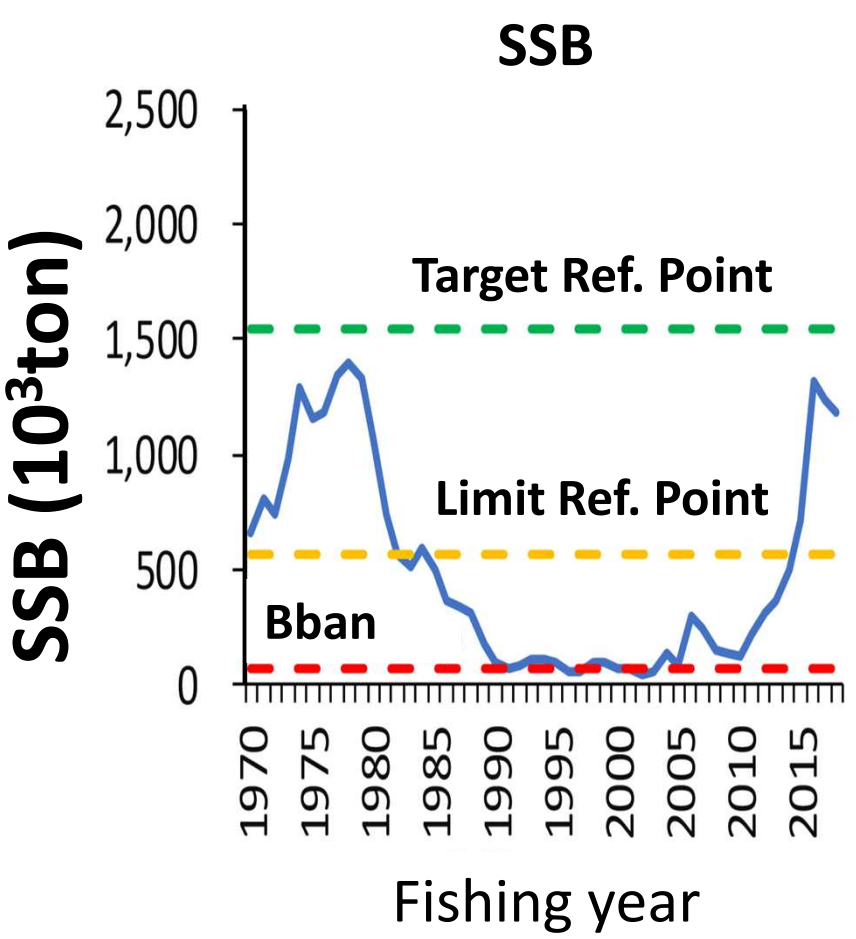
wintering abundance of age-0

Data Fit

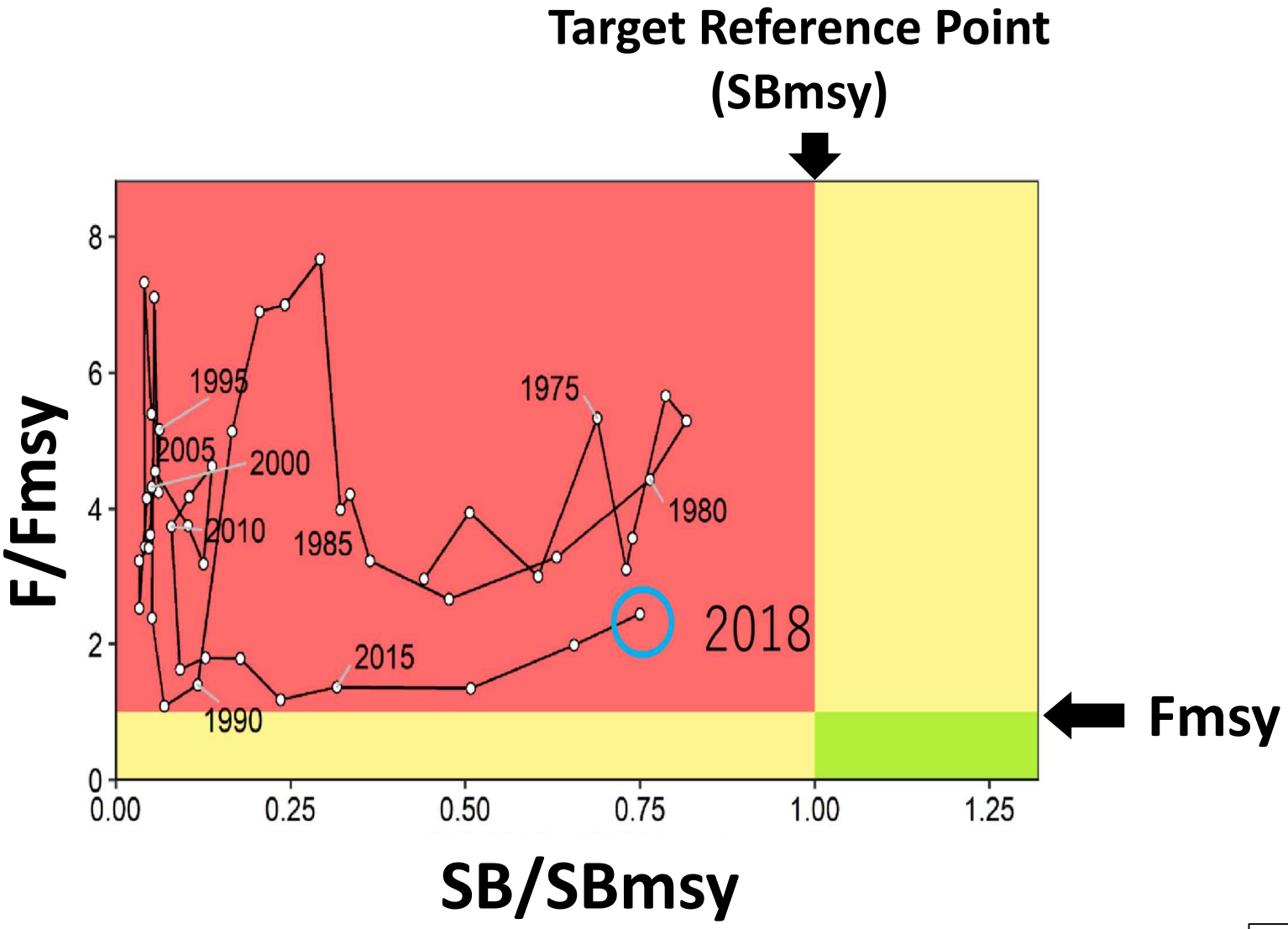

Autumn survey
Recruitment
Dipnet
SSB
Egg abundance
SSB
Early summer
Recruitment
Residual
Year
Autumn survey
dip-net fishery
Egg survey
Spring survey
Residual
Year

Number-at-age and SSB

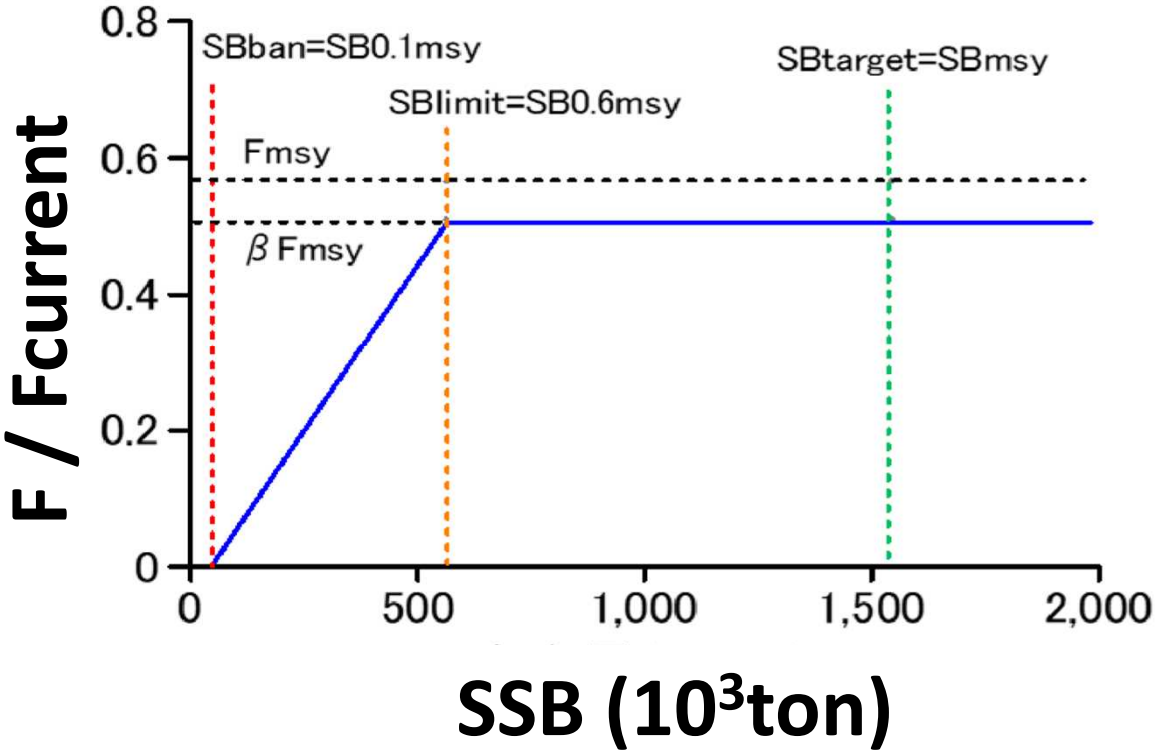




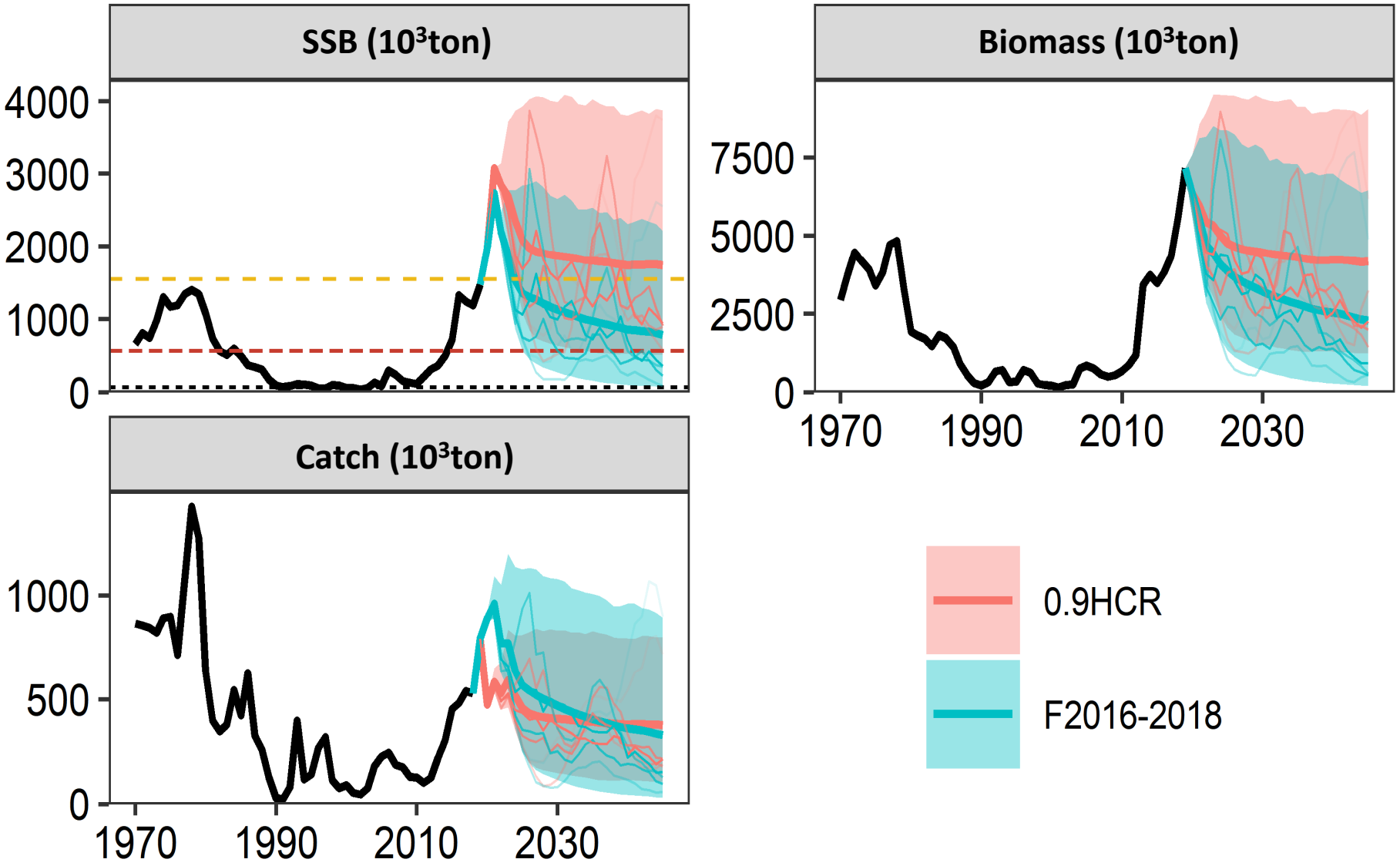
Kobe plot


Target Reference Point
(SBmsy)
F/Fmsy
SB/SBmsy
Fmsy
0
2
4
6
8
0.00
0.25
0.50
0.75
1.00
1.25
1995
2005
2000
2010
1985
1975
1980
2018
2015
1990

Harvest Control Rule



Future Projection 1



Future Projection 2

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

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	0	100	100	100	100	88	61	53	50	49	48	47	42	42
0.9	0	100	100	100	100	95	67	58	54	53	52	52	47	46
0.8	0	100	100	100	100	99	74	63	59	58	56	56	52	51
0.7	0	100	100	100	100	100	81	68	64	62	61	61	57	57
0.6	0	100	100	100	100	100	88	74	69	67	66	65	62	62
0.5	0	100	100	100	100	100	94	81	75	72	71	70	68	68
0.4	0	100	100	100	100	100	98	87	81	78	76	76	74	73
0.3	0	100	100	100	100	100	100	92	87	83	81	81	79	79
0.2	0	100	100	100	100	100	100	97	91	88	86	86	84	84
0.1	0	100	100	100	100	100	100	99	95	93	91	90	89	88
0.0	0	100	100	100	100	100	100	100	99	96	95	94	93	92

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

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	100	100	100	100	100	100	100	100	98	97	97	96	91	90
0.9	100	100	100	100	100	100	100	100	99	98	98	97	94	92
0.8	100	100	100	100	100	100	100	100	100	99	98	98	96	95
0.7	100	100	100	100	100	100	100	100	100	100	99	99	97	96
0.6	100	100	100	100	100	100	100	100	100	100	99	99	98	98
0.5	100	100	100	100	100	100	100	100	100	100	100	100	99	99
0.4	100	100	100	100	100	100	100	100	100	100	100	100	99	99
0.3	100	100	100	100	100	100	100	100	100	100	100	100	99	100
0.2	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
0.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Future Projection 3

SSB （10^3ton）

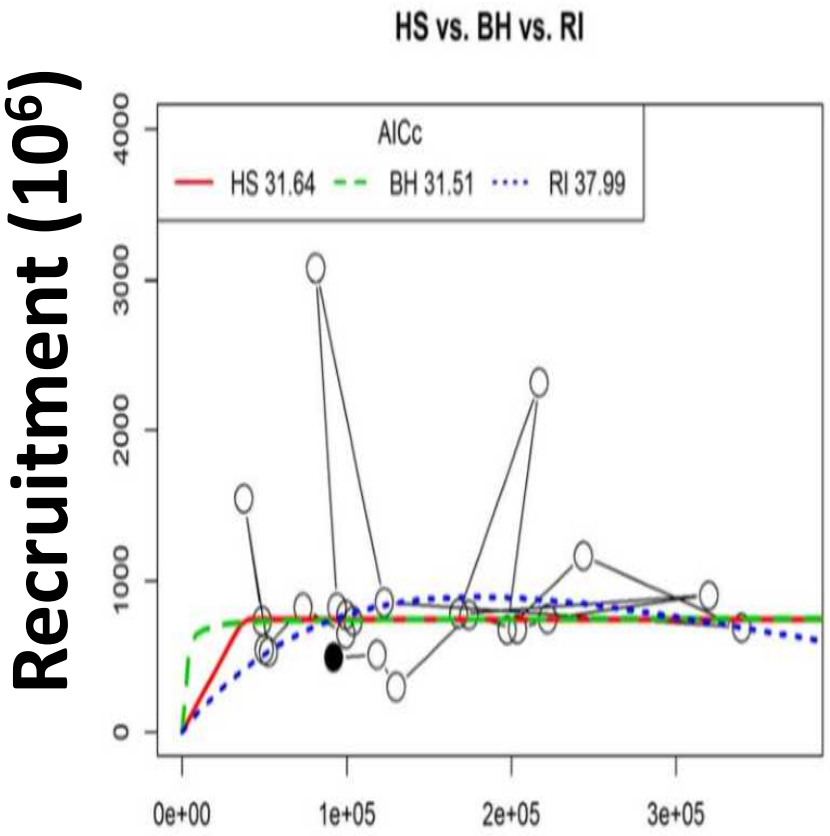
β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	1,472	1,984	3,032	2,761	2,581	2,231	1,977	1,870	1,829	1,807	1,784	1,768	1,623	1,614
0.9	1,472	1,984	3,073	2,844	2,691	2,351	2,087	1,973	1,927	1,904	1,884	1,871	1,737	1,733
0.8	1,472	1,984	3,114	2,929	2,807	2,479	2,208	2,086	2,034	2,010	1,991	1,981	1,860	1,860
0.7	1,472	1,984	3,156	3,017	2,929	2,617	2,341	2,210	2,153	2,126	2,108	2,100	1,991	1,995
0.6	1,472	1,984	3,199	3,109	3,058	2,767	2,486	2,348	2,285	2,255	2,236	2,229	2,132	2,139
0.5	1,472	1,984	3,243	3,204	3,195	2,928	2,645	2,501	2,433	2,398	2,378	2,372	2,284	2,294
0.4	1,472	1,984	3,287	3,302	3,338	3,102	2,820	2,672	2,598	2,559	2,537	2,531	2,450	2,461
0.3	1,472	1,984	3,332	3,404	3,491	3,290	3,013	2,862	2,784	2,742	2,717	2,710	2,633	2,645
0.2	1,472	1,984	3,378	3,510	3,651	3,493	3,226	3,076	2,995	2,949	2,921	2,913	2,838	2,849
0.1	1,472	1,984	3,424	3,619	3,821	3,713	3,461	3,315	3,234	3,186	3,157	3,147	3,071	3,082
0.0	1,472	1,984	3,471	3,733	4,001	3,952	3,721	3,585	3,507	3,460	3,429	3,418	3,340	3,350

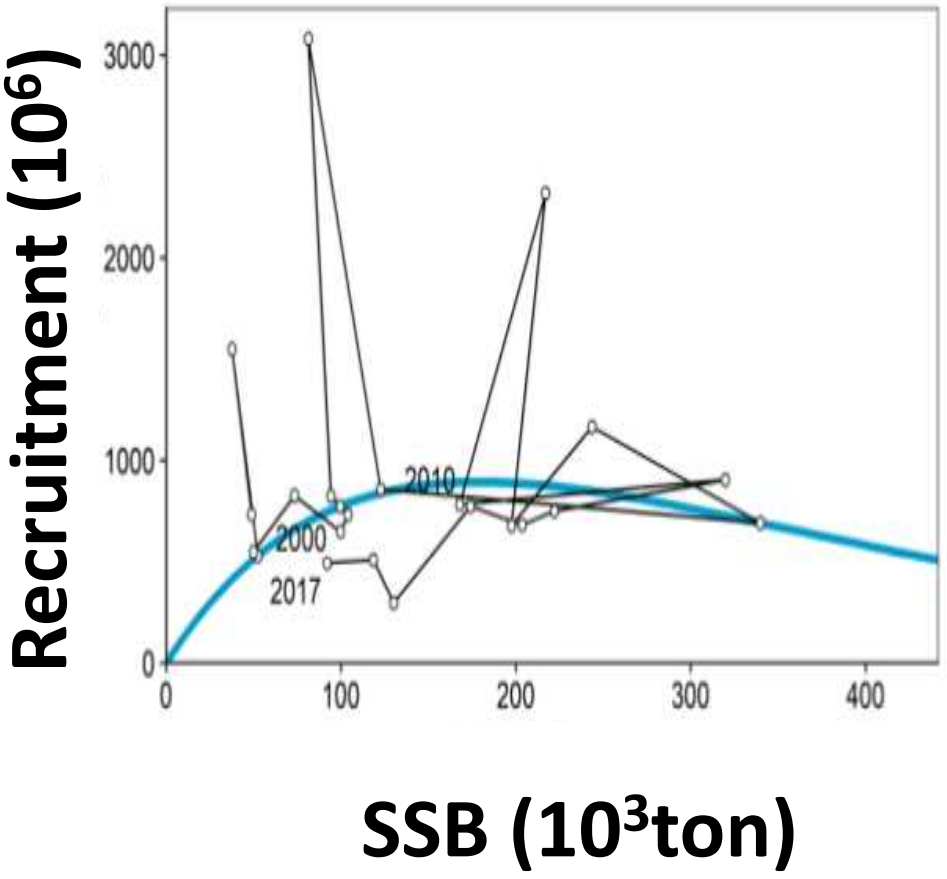
Catch (10^3ton)

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	794	523	633	566	625	540	478	453	440	433	428	425	391	386
0.9	794	474	582	529	592	516	457	433	421	414	410	408	380	376
0.8	794	424	529	488	554	488	434	410	398	392	389	387	365	362
0.7	794	374	473	444	512	456	406	383	372	366	363	362	345	343
0.6	794	323	415	395	463	417	373	352	342	336	334	333	319	318
0.5	794	271	354	343	407	372	334	316	306	301	299	298	288	287
0.4	794	218	290	285	345	319	288	273	264	260	258	257	250	249
0.3	794	165	222	223	274	257	234	222	215	211	210	209	204	203
0.2	794	111	152	155	193	184	169	161	156	153	152	152	148	148
0.1	794	56	78	81	102	99	92	88	85	84	83	83	81	81
0.0	794	0	0	0	0	0	0	0	0	0	0	0	0	0

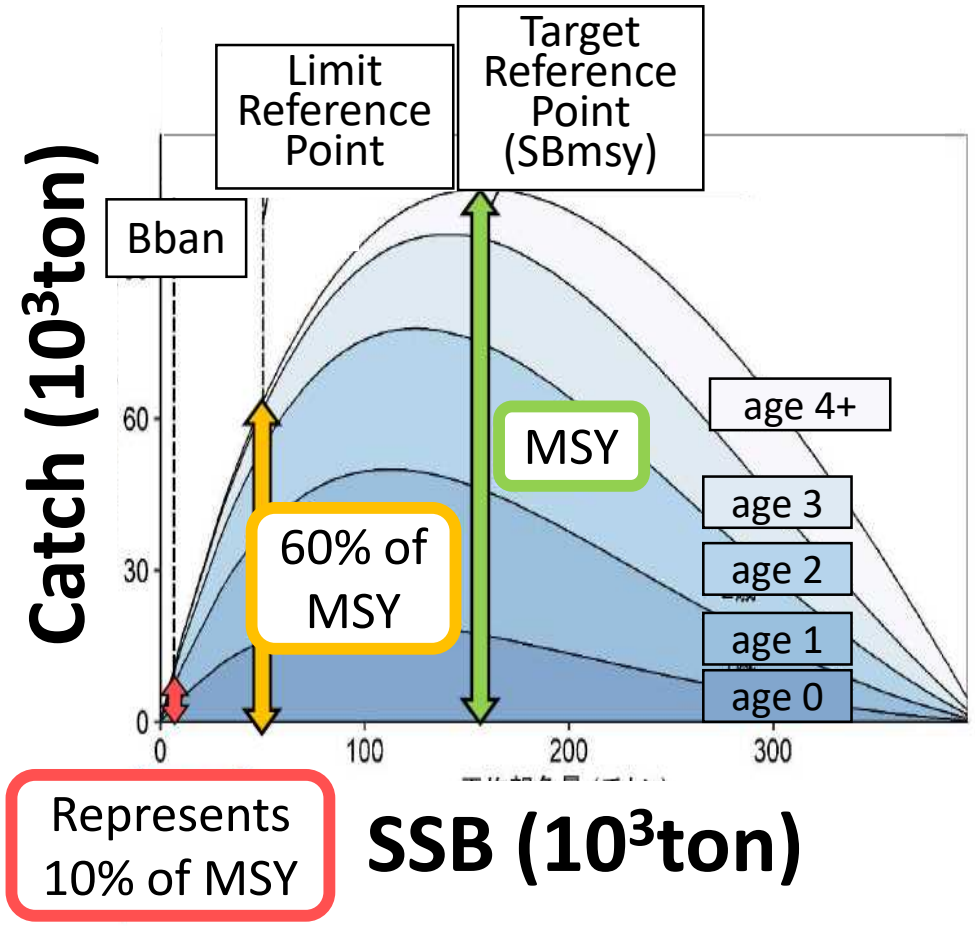
Pacific stock of Blue mackerel

Stock-Recruitment Relationship



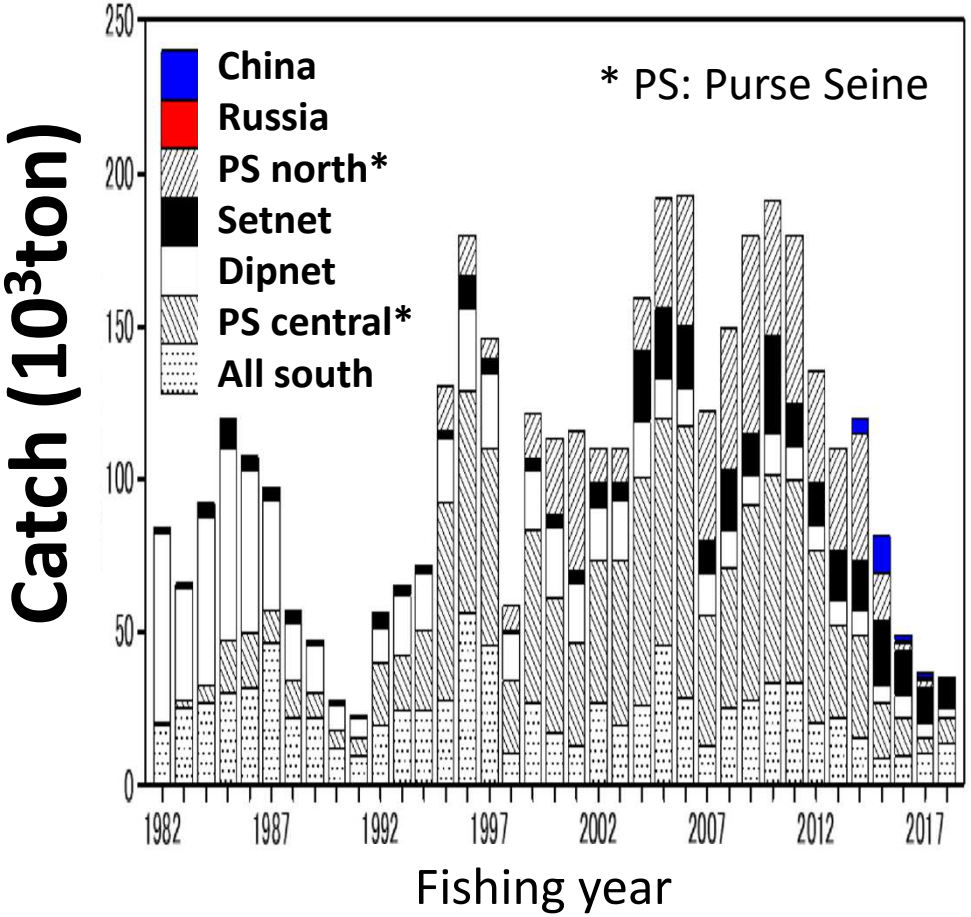


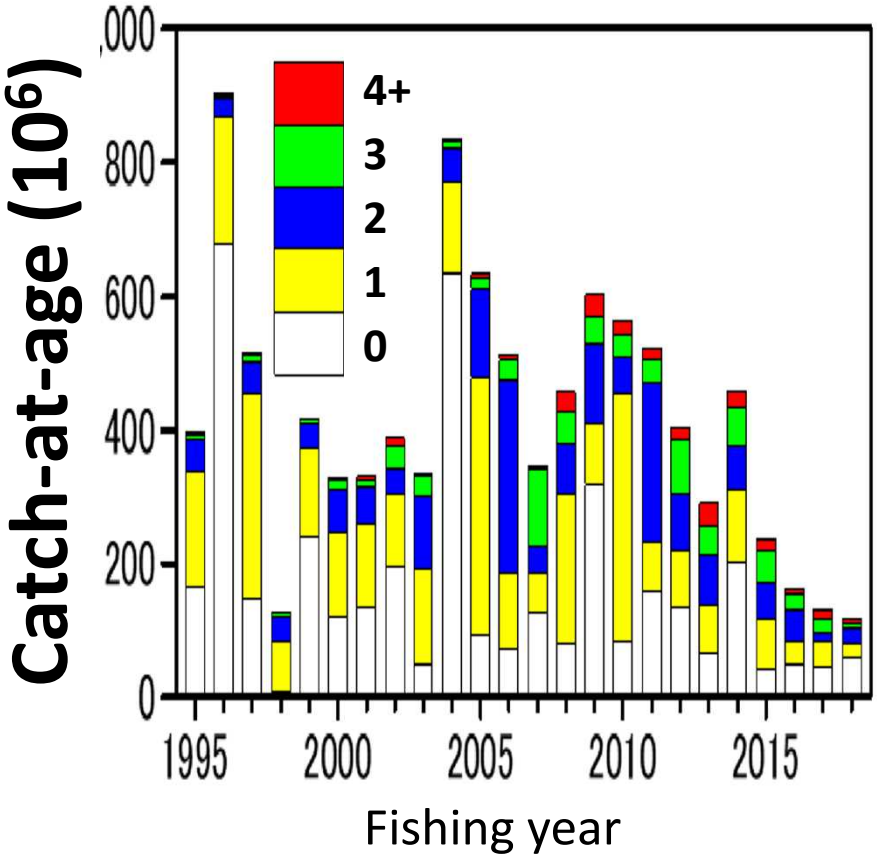
Reference Points



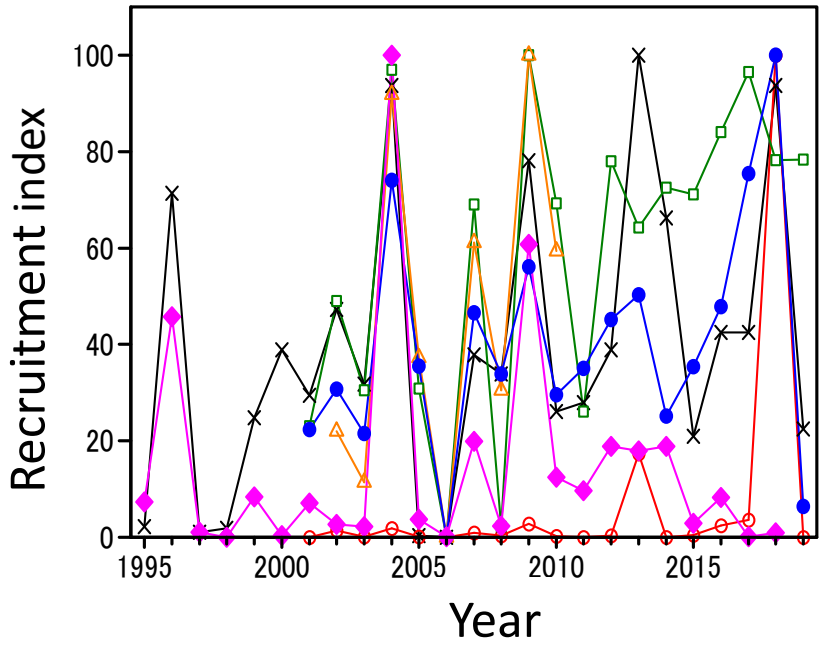
Reference Points	Catch (10^3ton)	SSB (10^3ton)
Target (Sbmsy)	105	158
Limit	63	50
Bban	11	6

Catch and Catch-at-age





Stock indices



occurrence index from the autumn survey

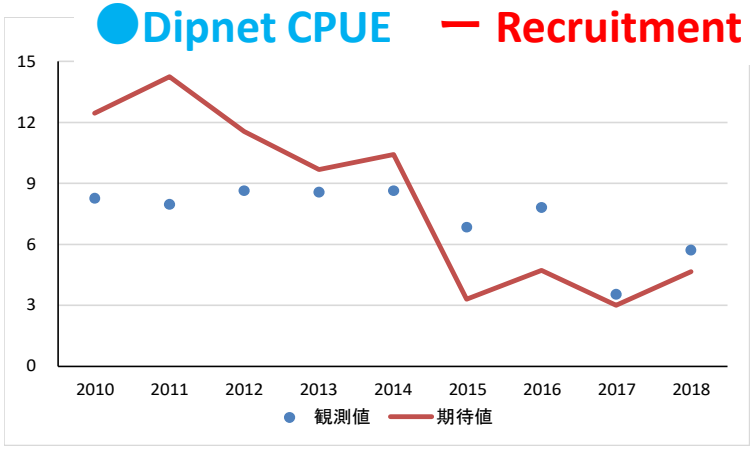
number index from the early summer survey

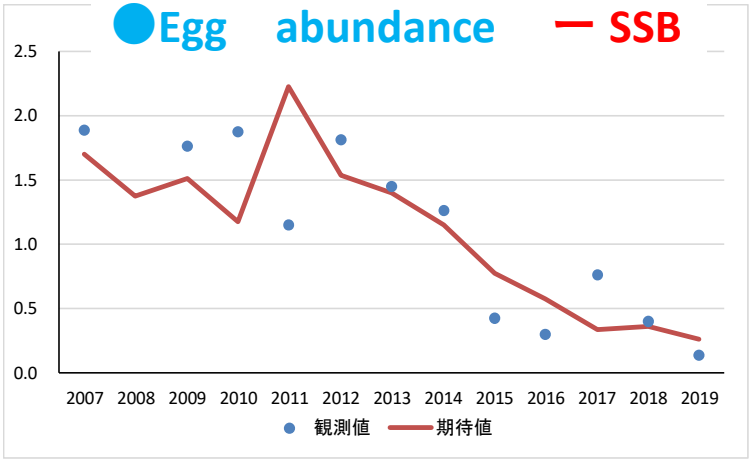
average length index from the early summer survey,

Pacific saury fisheries bycatch index

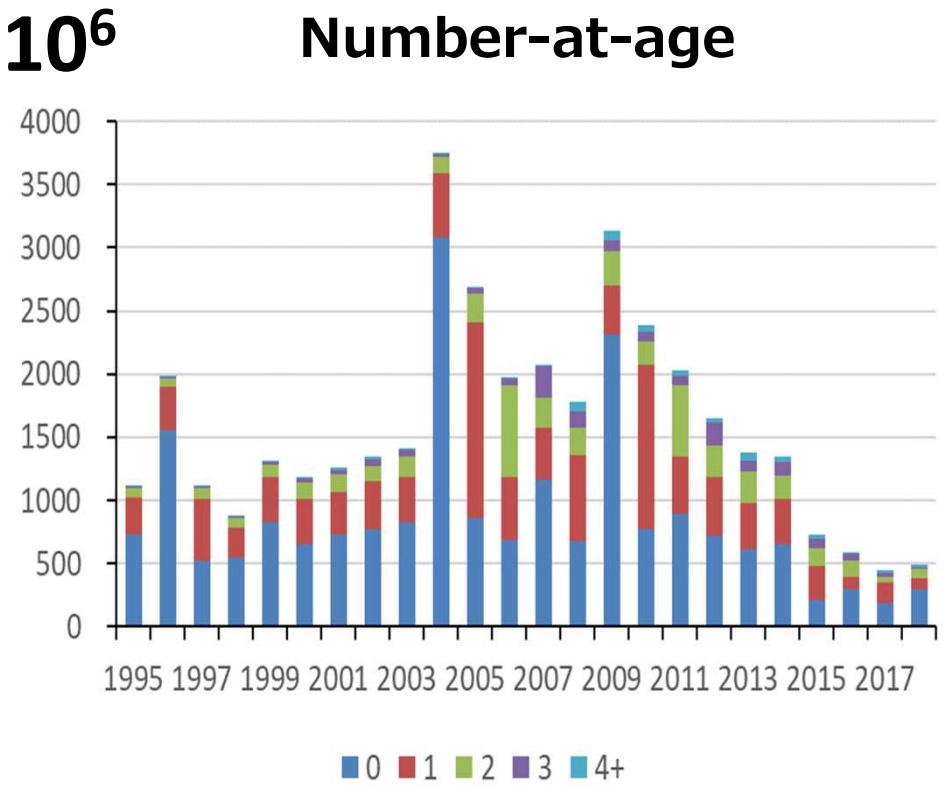
index from the early summer survey

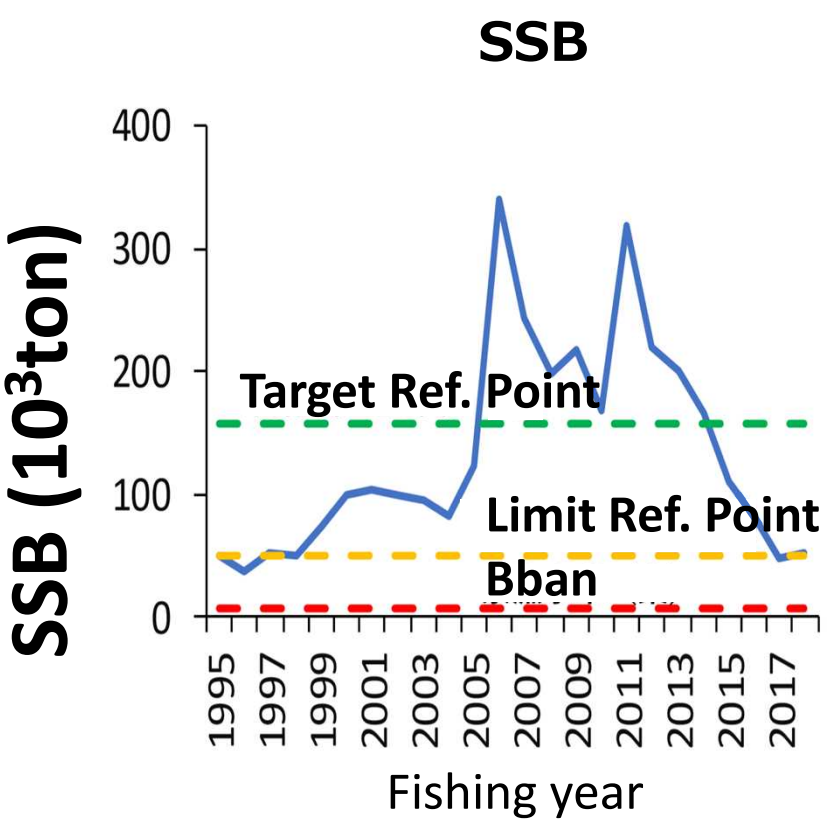
Dipnet index



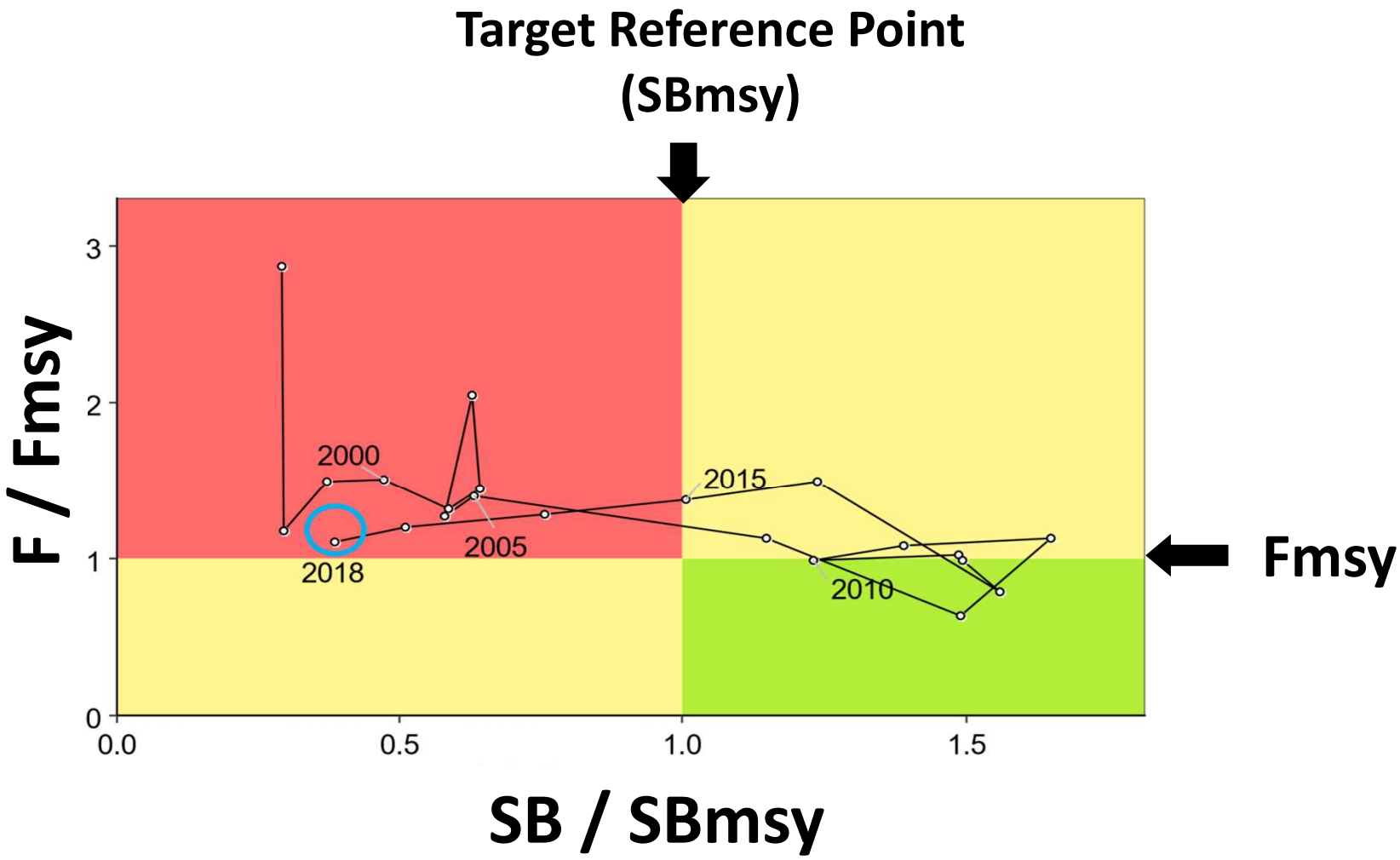


Number-at-age and SSB

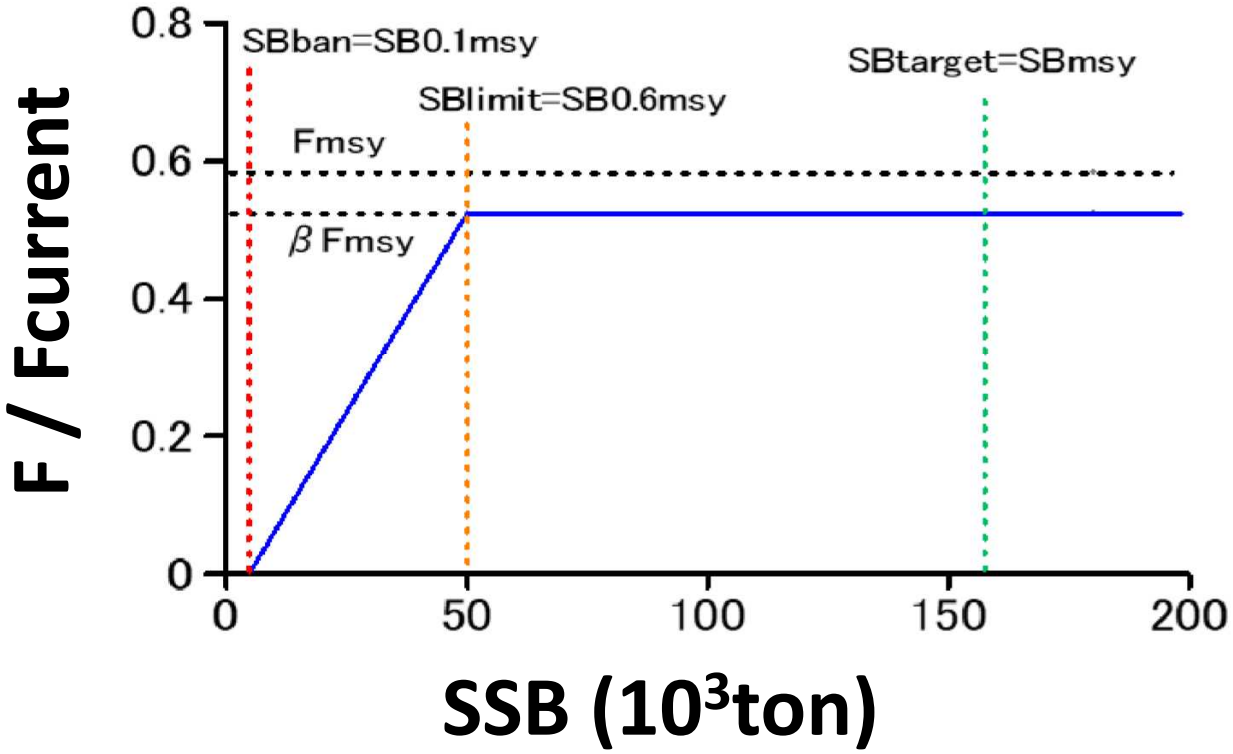




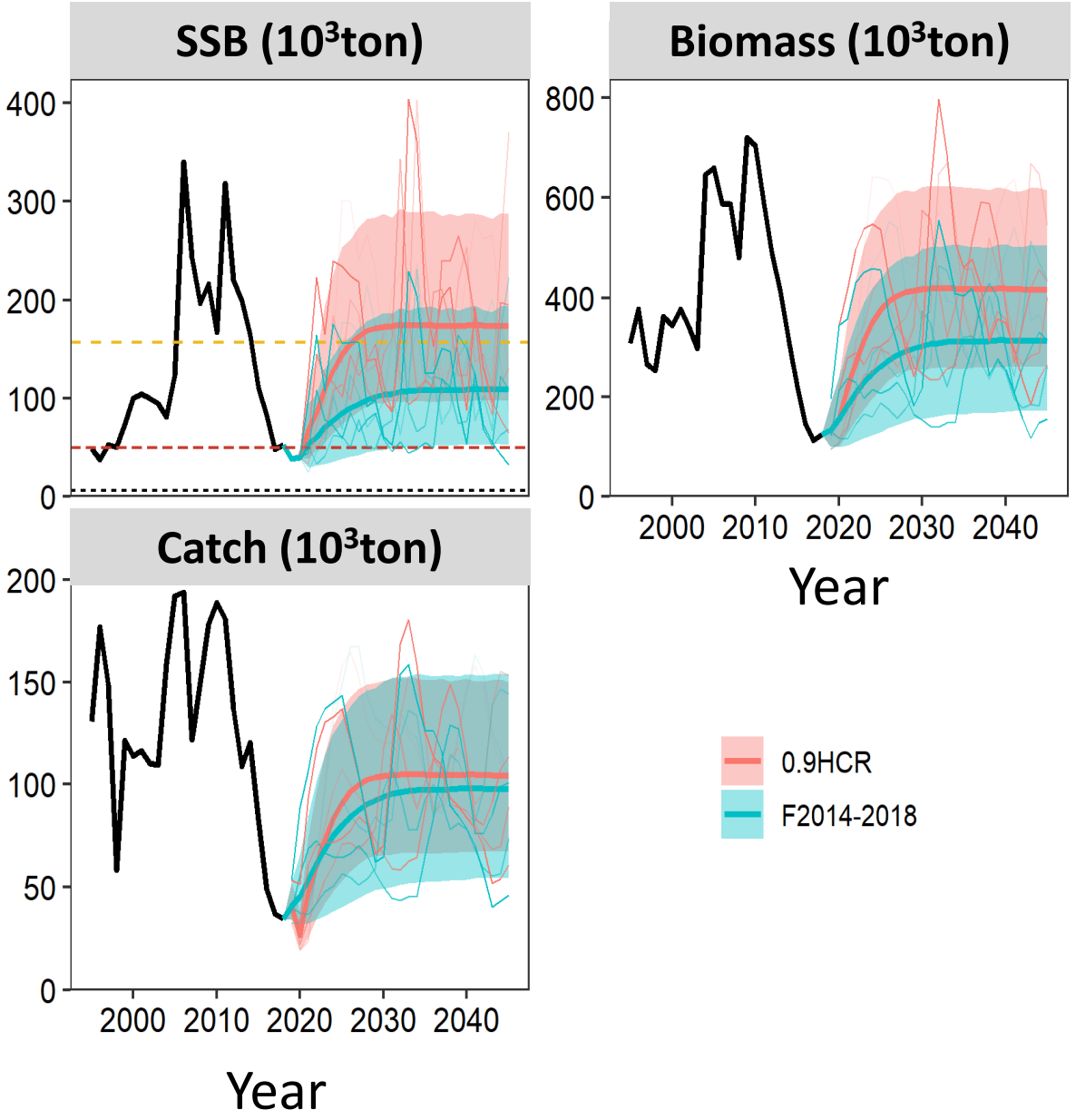
Kobe plot


Target Reference Point
(SBmsy)
F / Fmsy
SB / SBmsy
Fmsy
2000
2005
2010
2015
2018
0
1
2
3
0.0
0.5
1.0
1.5

Harvest Control Rule



Future Projection 1



Future Projection 2

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

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	0	0	1	2	9	16	24	30	34	38	39	41	42	42
0.9	0	0	1	3	13	23	34	42	47	51	52	54	55	55
0.8	0	0	1	4	17	32	46	56	61	65	66	67	67	68
0.7	0	0	1	5	23	42	58	69	75	77	78	79	79	79
0.6	0	0	2	7	30	54	71	81	86	88	88	88	88	89
0.5	0	0	2	10	39	66	83	91	94	95	95	95	95	95
0.4	0	0	2	13	49	78	91	96	98	98	99	98	98	98
0.3	0	0	3	17	60	87	96	99	100	100	100	100	100	100
0.2	0	0	3	21	70	94	99	100	100	100	100	100	100	100
0.1	0	0	3	28	80	97	100	100	100	100	100	100	100	100
0.0	0	0	4	35	88	99	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	2040	2050
1.0	0	0	72	89	96	98	99	99	100	100	100	100	100	100
0.9	0	0	75	92	98	99	100	100	100	100	100	100	100	100
0.8	0	0	79	95	99	100	100	100	100	100	100	100	100	100
0.7	0	0	82	97	99	100	100	100	100	100	100	100	100	100
0.6	0	0	85	98	100	100	100	100	100	100	100	100	100	100
0.5	0	0	87	99	100	100	100	100	100	100	100	100	100	100
0.4	0	0	90	100	100	100	100	100	100	100	100	100	100	100
0.3	0	0	92	100	100	100	100	100	100	100	100	100	100	100
0.2	0	0	94	100	100	100	100	100	100	100	100	100	100	100
0.1	0	0	96	100	100	100	100	100	100	100	100	100	100	100
0.0	0	0	97	100	100	100	100	100	100	100	100	100	100	100

Future Projection 3

SSB（10^3ton）

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	38	40	66	80	100	116	130	139	145	151	154	155	157	158
0.9	38	40	68	84	109	128	145	156	163	169	172	173	174	175
0.8	38	40	70	89	119	142	162	175	183	189	190	192	192	192
0.7	38	40	72	95	129	158	182	196	204	209	210	211	211	211
0.6	38	40	74	101	141	176	204	220	227	231	231	232	231	231
0.5	38	40	76	107	154	196	228	246	251	254	253	253	253	253
0.4	38	40	79	114	169	218	256	274	278	279	277	276	276	276
0.3	38	40	81	122	185	244	287	307	308	306	302	301	302	302
0.2	38	40	84	130	204	273	323	343	342	336	330	329	331	331
0.1	38	40	86	139	224	306	364	385	380	370	361	359	363	363
0.0	38	40	89	149	247	343	412	435	427	411	399	395	401	402

Catch (10^3ton)

β	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040	2050
1.0	41	29	50	63	74	84	91	96	99	102	103	104	105	105
0.9	41	27	47	61	73	83	91	96	100	102	103	104	105	105
0.8	41	24	44	58	71	82	90	95	99	101	102	102	102	102
0.7	41	21	40	55	68	79	88	93	96	97	98	98	98	98
0.6	41	19	36	50	64	75	84	89	91	92	93	93	93	93
0.5	41	16	32	45	58	70	78	83	85	85	85	85	85	85
0.4	41	13	27	39	51	62	70	74	75	75	75	75	75	75
0.3	41	10	21	32	42	52	59	62	63	63	62	62	62	62
0.2	41	7	15	23	31	39	45	47	47	47	46	46	46	46
0.1	41	3	8	12	17	22	25	27	27	26	26	26	26	26
0.0	41	0	0	0	0	0	0	0	0	0	0	0	0	0

Catch data for chub mackerel caught by the large-medium purse seine fisheries

Total catch (kg) = Mass of a box * No. of boxes

Total number of fish = No. of fish in a box * No. of boxes

Fish body mass (g) = Mass of a box (16 kg) / No. of fish in the box / 1000

Fish length (cm) = $0.1*(\text{Fish body mass (g)}/8.84E\text{-}6)^{0.325}$

The length–Age conversion table for mackerels caught by the large-medium purse seine fisheries

Age 0

Age 1

Age 2

Age 3+

Chub

Fork length (cm)	Month 1	2	3	4	5	6	7	8	9	10	11	12
0	1	1	1	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0	0
2	1	1	1	0	0	0	0	0	0	0	0	0
3	1	1	1	0	0	0	0	0	0	0	0	0
4	1	1	1	0	0	0	0	0	0	0	0	0
5	1	1	1	0	0	0	0	0	0	0	0	0
6	1	1	1	0	0	0	0	0	0	0	0	0
7	1	1	1	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	0	0	0	0	0
9	1	1	1	0	0	0	0	0	0	0	0	0
10	1	1	1	0	0	0	0	0	0	0	0	0
11	1	1	1	0	0	0	0	0	0	0	0	0
12	1	1	1	0	0	0	0	0	0	0	0	0
13	1	1	1	0	0	0	0	0	0	0	0	0
14	1	1	1	0	0	0	0	0	0	0	0	0
15	1	1	1	0	0	0	0	0	0	0	0	0
16	1	1	1	0	0	0	0	0	0	0	0	0
17	1	1	1	0	0	0	0	0	0	0	0	0
18	1	1	1	0	0	0	0	0	0	0	0	0
19	1	1	1	0	0	0	0	0	0	0	0	0
20	1	1	1	1	0	0	0	0	0	0	0	0
21	1	1	1	1	1	0	0	0	0	0	0	0
22	1	1	1	1	1	1	0	0	0	0	0	0
23	1	1	1	1	1	1	1	0	0	0	0	0
24	1	1	1	1	1	1	1	1	0	0	0	0
25	1	1	1	1	1	1	1	1	1	0	0	0
26	1	1	1	1	1	1	1	1	1	1	1	1
27	1	1	1	1	1	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1	1	1	1	1
29	2	2	2	2	1	1	1	1	1	1	1	1
30	2	2	2	2	2	2	1	1	1	1	1	1
31	2	2	2	2	2	2	2	2	2	2	2	2
32	3	3	3	2	2	2	2	2	2	2	2	2
33	3	3	3	3	3	3	2	2	2	2	2	2
34	3	3	3	3	3	3	3	3	2	2	2	2
35	4	4	4	4	4	4	3	3	3	3	3	3
36	4	4	4	4	4	4	4	4	3	3	3	3
37	4	4	4	4	4	4	4	4	4	4	4	4
38	4	4	4	4	4	4	4	4	4	4	4	4
39	4	4	4	4	4	4	4	4	4	4	4	4
40	4	4	4	4	4	4	4	4	4	4	4	4
41	4	4	4	4	4	4	4	4	4	4	4	4
42	4	4	4	4	4	4	4	4	4	4	4	4
43	4	4	4	4	4	4	4	4	4	4	4	4
44	4	4	4	4	4	4	4	4	4	4	4	4
45	4	4	4	4	4	4	4	4	4	4	4	4
46	4	4	4	4	4	4	4	4	4	4	4	4
47	4	4	4	4	4	4	4	4	4	4	4	4
48	4	4	4	4	4	4	4	4	4	4	4	4
49	4	4	4	4	4	4	4	4	4	4	4	4

Blue (Spotted)

Fork length (cm)	Month 1	2	3	4	5	6	7	8	9	10	11	12
0	1	1	1	1	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0	0
2	1	1	1	1	0	0	0	0	0	0	0	0
3	1	1	1	1	0	0	0	0	0	0	0	0
4	1	1	1	1	0	0	0	0	0	0	0	0
5	1	1	1	1	0	0	0	0	0	0	0	0
6	1	1	1	1	0	0	0	0	0	0	0	0
7	1	1	1	1	0	0	0	0	0	0	0	0
8	1	1	1	1	0	0	0	0	0	0	0	0
9	1	1	1	1	0	0	0	0	0	0	0	0
10	1	1	1	1	0	0	0	0	0	0	0	0
11	1	1	1	1	0	0	0	0	0	0	0	0
12	1	1	1	1	0	0	0	0	0	0	0	0
13	1	1	1	1	0	0	0	0	0	0	0	0
14	1	1	1	1	0	0	0	0	0	0	0	0
15	1	1	1	1	0	0	0	0	0	0	0	0
16	1	1	1	1	0	0	0	0	0	0	0	0
17	1	1	1	1	0	0	0	0	0	0	0	0
18	1	1	1	1	0	0	0	0	0	0	0	0
19	1	1	1	1	1	0	0	0	0	0	0	0
20	1	1	1	1	1	0	0	0	0	0	0	0
21	1	1	1	1	1	0	0	0	0	0	0	0
22	1	1	1	1	1	1	0	0	0	0	0	0
23	1	1	1	1	1	1	0	0	0	0	0	0
24	1	1	1	1	1	1	1	0	0	0	0	0
25	1	1	1	1	1	1	1	0	0	0	0	0
26	1	1	1	1	1	1	1	1	0	0	0	0
27	1	1	1	1	1	1	1	1	1	0	0	0
28	1	1	1	1	1	1	1	1	1	0	0	0
29	1	1	1	1	1	1	1	1	1	1	0	0
30	1	1	1	1	1	1	1	1	1	1	1	1
31	2	2	2	2	2	2	2	1	1	1	1	1
32	2	2	2	2	2	2	2	2	1	1	1	1
33	2	2	2	2	2	2	2	2	2	2	2	2
34	3	3	3	2	2	2	2	2	2	2	2	2
35	3	3	3	3	3	3	3	2	2	2	2	2
36	3	3	3	3	3	3	3	3	3	3	3	3
37	4	4	4	4	4	4	4	3	3	3	3	3
38	4	4	4	4	4	4	4	4	4	4	4	4
39	4	4	4	4	4	4	4	4	4	4	4	4
40	4	4	4	4	4	4	4	4	4	4	4	4
41	4	4	4	4	4	4	4	4	4	4	4	4
42	4	4	4	4	4	4	4	4	4	4	4	4
43	4	4	4	4	4	4	4	4	4	4	4	4
44	4	4	4	4	4	4	4	4	4	4	4	4
45	4	4	4	4	4	4	4	4	4	4	4	4
46	4	4	4	4	4	4	4	4	4	4	4	4
47	4	4	4	4	4	4	4	4	4	4	4	4
48	4	4	4	4	4	4	4	4	4	4	4	4
49	4	4	4	4	4	4	4	4	4	4	4	4

Monthly distributions of fork length in chub mackerel caught by the coastal fisheries in 2018

Age 0

Age 1

Age 2

Age 3+

	Month											
Fork length (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
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	1	0	0	0	0	0	0	0	0
4	0	0	0	4	0	0	0	0	0	0	0	0
5	0	0	0	3	0	0	0	0	0	0	0	0
6	0	0	0	1	0	1	0	0	0	0	0	0
7	0	0	0	1	0	17	1	0	0	0	0	0
8	0	0	0	0	5	100	6	0	0	0	0	0
9	0	0	0	0	8	109	45	3	0	0	0	0
10	0	0	0	2	23	210	120	11	0	0	0	0
11	0	0	0	0	18	200	252	44	7	0	0	0
12	0	0	0	0	1	42	204	154	23	0	0	0
13	0	0	0	0	0	5	57	186	26	0	0	0
14	0	0	0	0	0	8	29	41	24	0	0	0
15	0	0	0	0	0	3	54	18	21	0	0	0
16	0	0	0	0	0	2	59	40	11	1	0	0
17	0	0	0	0	0	0	52	95	31	3	1	0
18	0	0	0	2	0	0	21	107	52	14	1	0
19	0	4	5	0	0	0	12	89	27	57	4	0
20	25	19	23	6	0	0	28	51	49	119	35	2
21	107	119	63	36	0	0	97	60	209	158	107	4
22	184	196	99	121	0	1	75	47	265	150	142	17
23	107	111	141	266	2	1	10	23	125	119	154	45
24	24	49	108	324	18	4	2	25	83	65	245	177
25	16	62	62	309	57	52	6	37	53	29	233	159
26	31	64	39	167	142	170	27	64	25	30	168	99
27	38	76	21	82	259	200	88	140	30	33	123	97
28	22	70	22	65	173	231	135	228	112	37	69	105
29	15	39	39	82	111	194	148	323	298	115	44	69
30	10	24	120	73	81	89	104	377	342	174	60	73
31	2	23	231	95	43	29	110	260	161	165	74	155
32	9	37	197	200	43	23	89	106	43	63	124	235
33	19	75	115	133	147	40	85	88	18	15	70	153
34	12	72	50	57	137	36	78	55	11	6	25	100
35	7	52	25	30	80	18	57	59	6	20	13	50
36	10	25	9	25	66	35	39	25	3	12	15	23
37	9	9	7	21	66	34	36	12	3	3	8	9
38	5	6	3	24	39	29	18	8	1	2	2	8
39	15	8	5	64	72	23	33	6	2	23	3	11
Total inds. measured	667	1140	1384	2194	1591	1906	2177	2782	2061	1413	1720	1591

Monthly distributions of fork length in bule mackerel caught by the coastal fisheries in 2018

Age 0

Age 1

Age 2

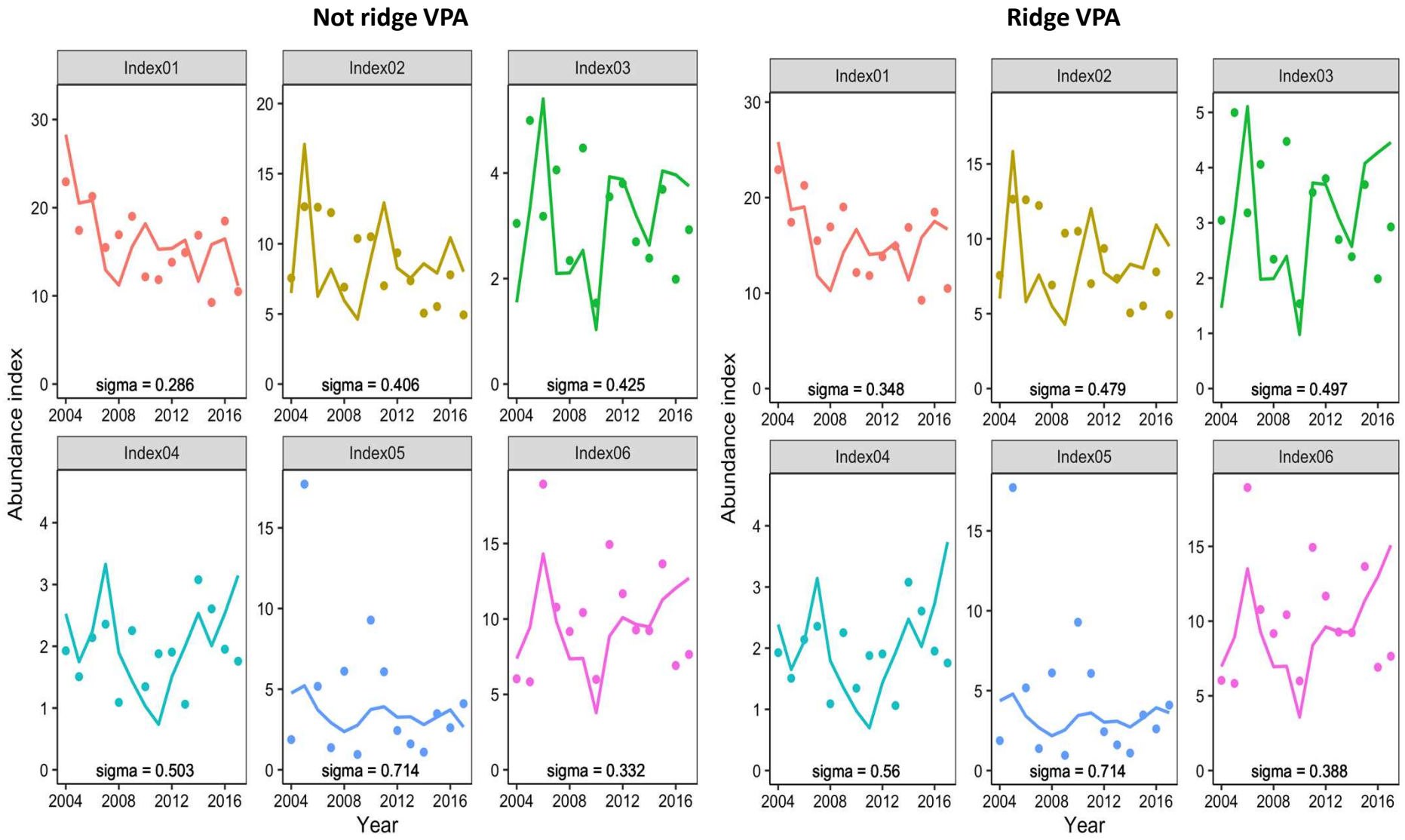
Age 3+

	Month											
Fork length (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
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	1	0	0	0
12	0	0	0	0	0	0	0	0	1	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	2	0	0	0	0	0	0	0
16	0	0	0	0	2	0	0	0	0	0	0	0
17	0	0	0	0	3	0	0	0	0	0	0	0
18	0	0	0	0	11	0	0	0	0	0	0	0
19	0	0	0	0	29	0	0	1	0	0	0	0
20	0	0	0	0	18	0	0	11	8	1	0	0
21	0	0	0	0	4	0	0	22	33	6	0	0
22	0	0	0	0	0	4	0	18	156	12	0	0
23	0	1	0	0	0	41	0	12	134	58	14	0
24	0	2	1	6	0	140	0	51	100	66	45	1
25	0	13	7	16	0	34	0	256	83	72	38	3
26	0	11	24	20	0	0	0	220	116	90	27	3
27	0	5	9	10	1	0	0	78	57	86	31	8
28	0	7	6	17	1	0	0	10	10	55	39	40
29	0	21	7	15	2	1	0	3	1	58	41	85
30	0	56	14	11	4	1	1	1	0	17	29	146
31	0	52	7	2	4	11	3	2	0	11	10	177
32	0	22	3	1	11	52	22	16	0	5	5	147
33	0	7	1	0	30	190	58	47	0	18	6	60
34	0	16	0	0	82	235	93	165	0	31	13	28
35	1	33	0	0	77	133	69	247	0	61	19	27
36	6	17	0	3	55	90	21	204	0	62	7	26
37	21	12	0	2	27	64	7	104	1	59	15	30
38	15	14	0	7	13	45	2	29	0	52	8	17
39	31	24	0	27	8	30	0	7	0	90	4	8
Total inds. measured	74	313	79	137	384	1071	276	1504	701	910	351	806

Data fit

Blue mackerel ECS

Data fit in recent years is worse when using a ridge VPA.

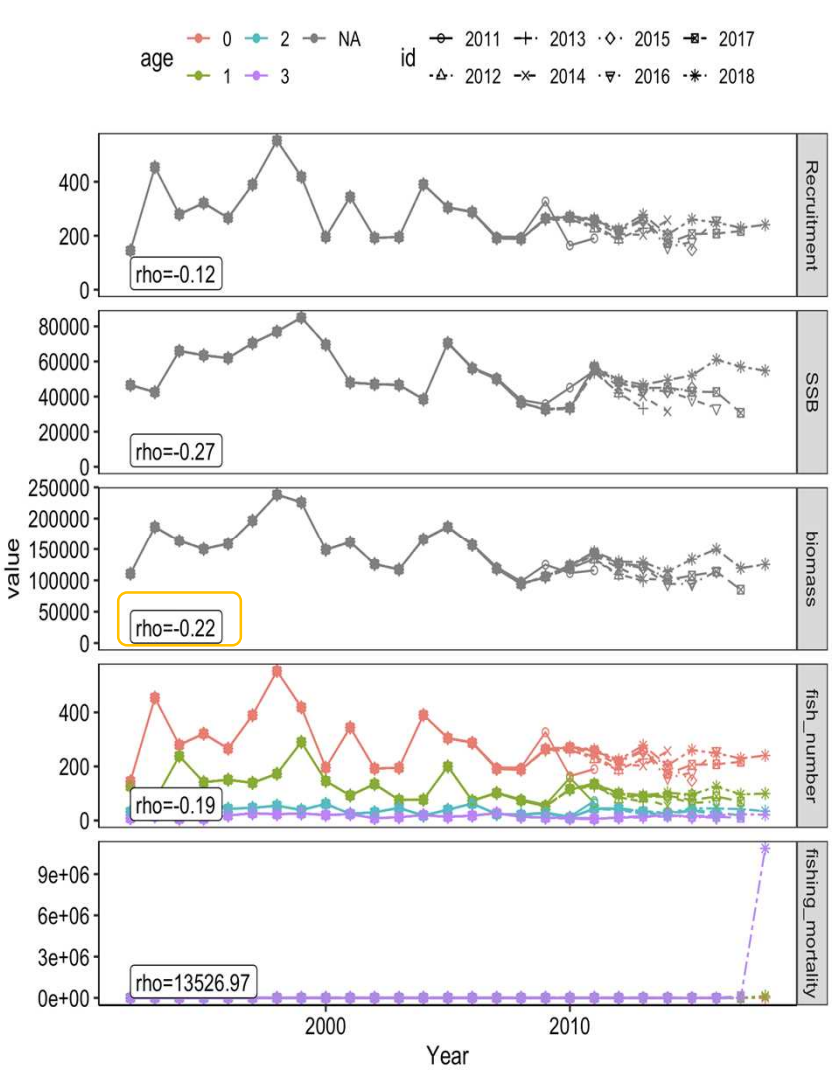


Retrospective bias

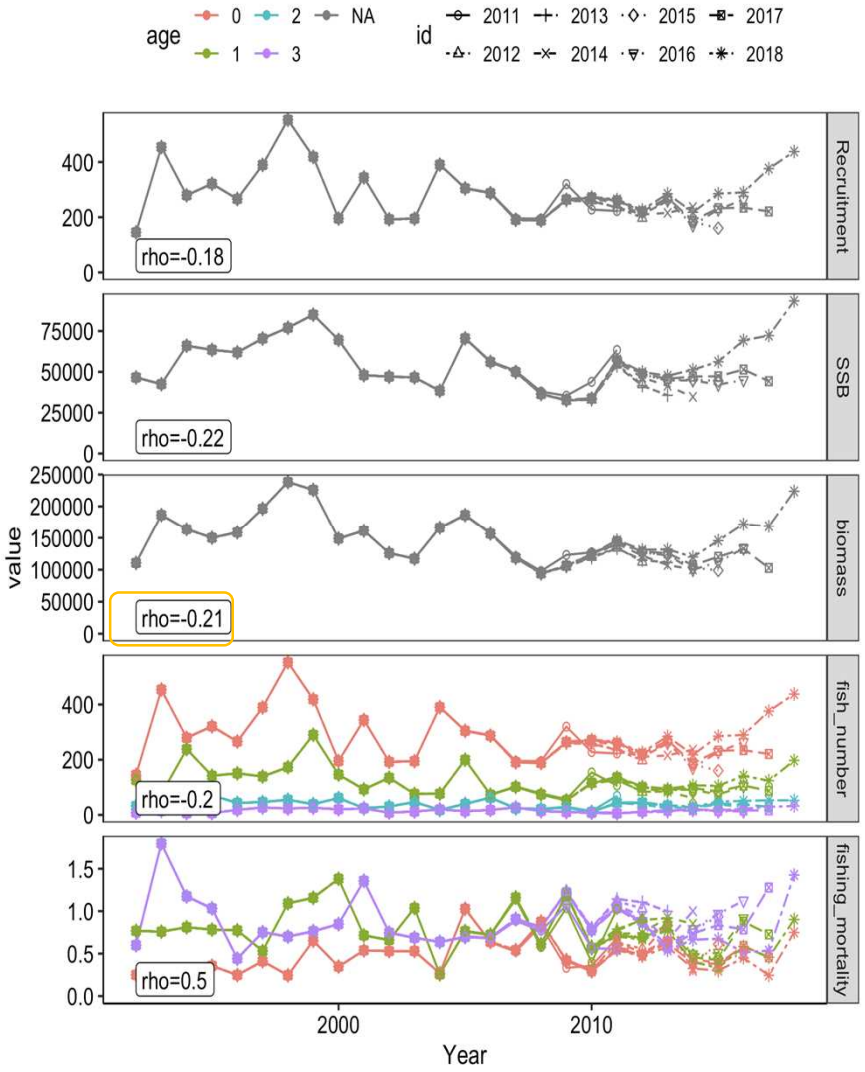
Blue mackerel ECS

To minimize bias of biomass

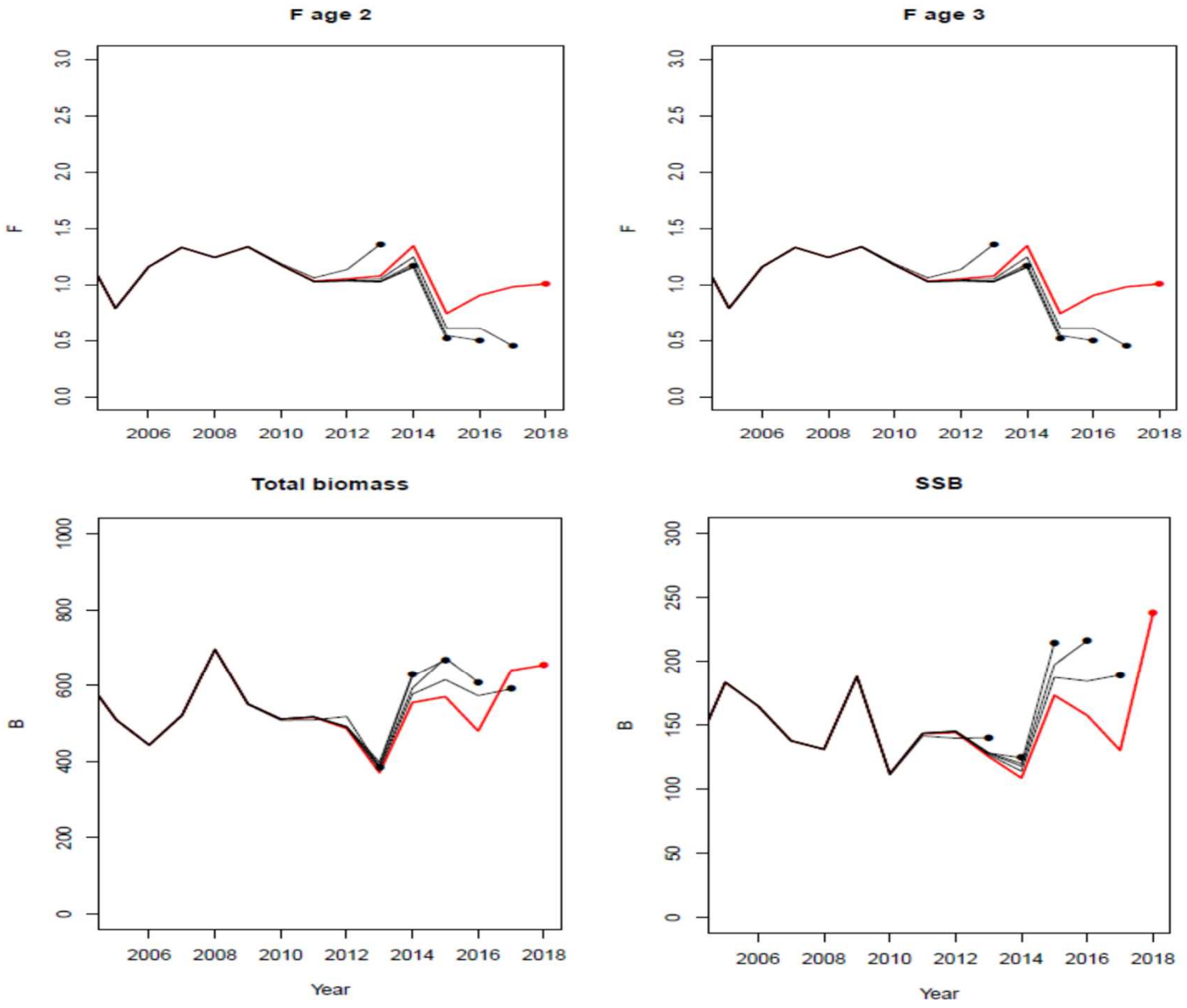
Not ridge VPA



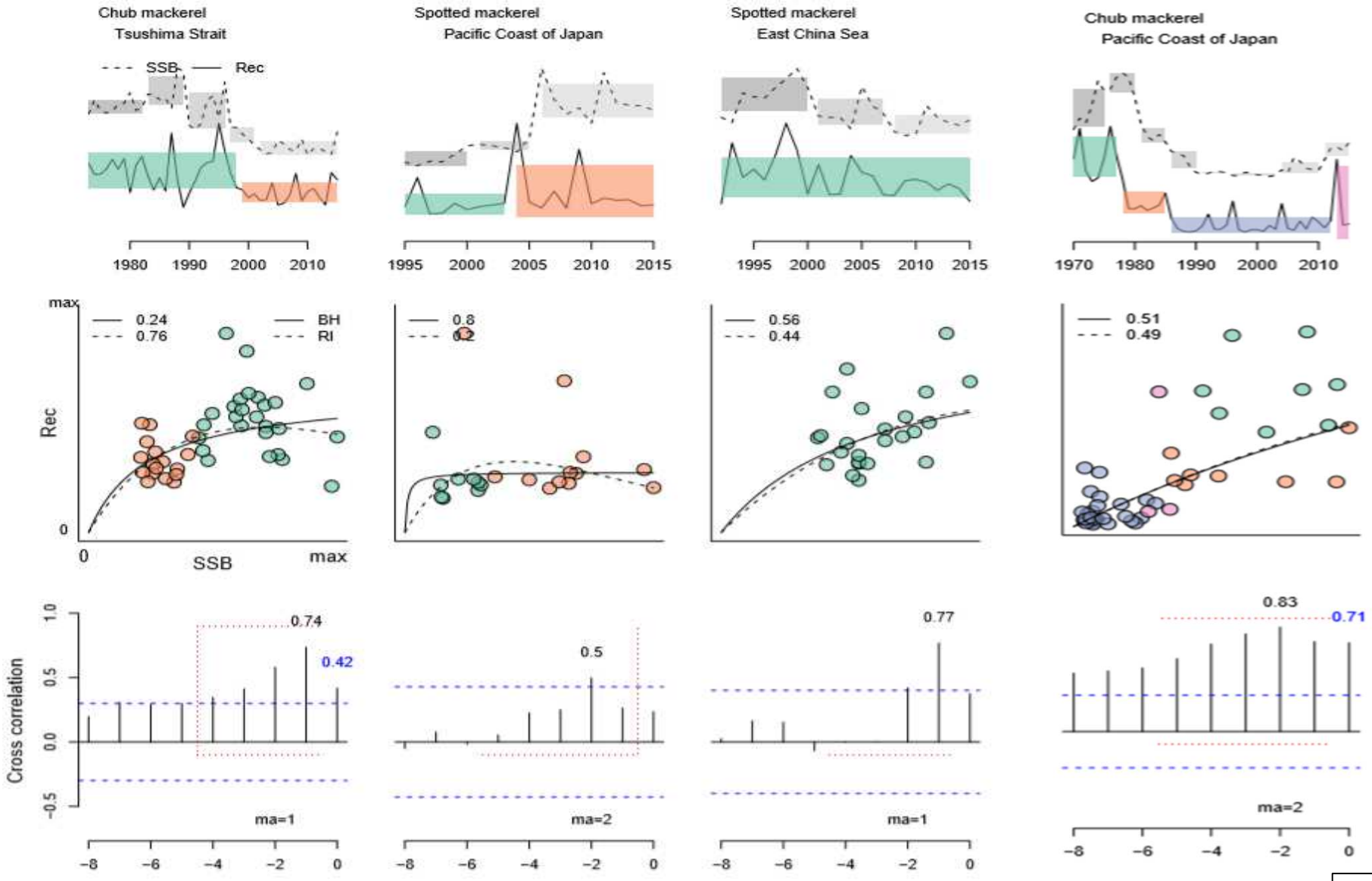
Ridge VPA



Retrospective bias　　Chub mackerel　Tsushima warm current



Stock Recruitment.　Cross relation -1 ～-2 lag



Hiroyuki Kurota, CodyS.Szuwalski, Momoko Ichinokawa (2020) Fisheries Research

Meeting Report on (Biological) Reference Points（Apr. 2019）

Data from 2018 assessment report

- SRR
- Reference Points
- Kobe plot
- Harvest Control Rule
- Future projection

submitted to SH meeting（Jul, 2019）

2019 Stock assessment report（Nov. 2019）

- assessment data updated
- Kobe plot revised
- Future projection revised

submitted to SH meeting（Feb, 2020）

Natural mortality

Table 1. Estimators selected to calculate the natural mortality rate (M) for Chub mackerel in the North Pacific Ocean.

Estimator identifier	Equation	Reference
"Pauly"	$M = 0.9849 L_{\infty}^{-0.279} K^{\ 0.6543} T^{0.4634}$	Pauly 1980
"Pauly update"	$M = 4.118 L_{\infty}^{-0.33} K^{0.73}$	Then et al. 2015
"Jensen"	$M = 1.5K$	Jensen 1996
"Hoenig"	$M = 4.3/A_{max}$	Hoenig 1983
"Hoenig update"	$M = 4.899 A_{max}^{-0.916}$	Then et al. 2015
"Gislason1"	$M = 1.73 L^{-1.61} L_{\infty}^{1.44} K$	Gislason et al. 2010
"Gislason2"	$M = K(L/L_{\infty})^{-1.5}$	Charnov et al. 2013

L_{∞}: asymptotic fish length (cm)
K: Brody growth rate parameter of von Bertalanffy growth curve
T: mean environmental temperature (degree C)
A_{max}: maximum observed age (longevity)
L: individual fish length (cm)

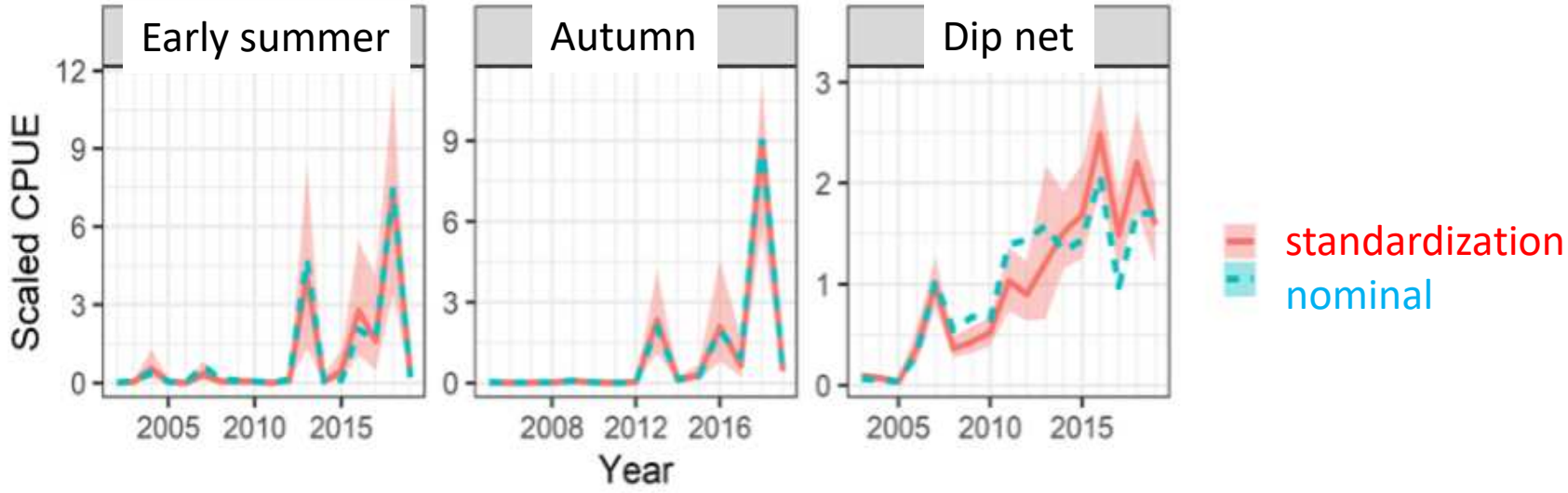
Estimator	M value	L_∞	K	T	A_{max}	L	Input data source
"Pauly"	0.44	44.6	0.20	16.7	-	-	Kamimura in preparation
"Pauly update"	0.36	44.6	0.20	-	-	-	Kamimura in preparation
"Jensen"	0.30	-	0.20	-	-	-	Kamimura in preparation
"Hoenig"	0.43	-	-	-	10	-	Kamimura in preparation
"Hoenig"	0.39	-	-	-	11	-	Iizuka 2002
"Hoenig update"	0.59	-	-	-	10	-	Kamimura in preparation
"Hoenig update"	0.54	-	-	-	11	-	Iizuka 2002
"Gislason1"	0.36	44.6	0.20	-	-	29	Kamimura in preparation
"Gislason2"	0.38	44.6	0.20	-	-	29	Kamimura in preparation
"FishLife"	0.44-0.52 (0.48±SD)	-	-	-	-	-	FishBase (Froese 1990)

Standardization　　Pacific

Chub mackerel

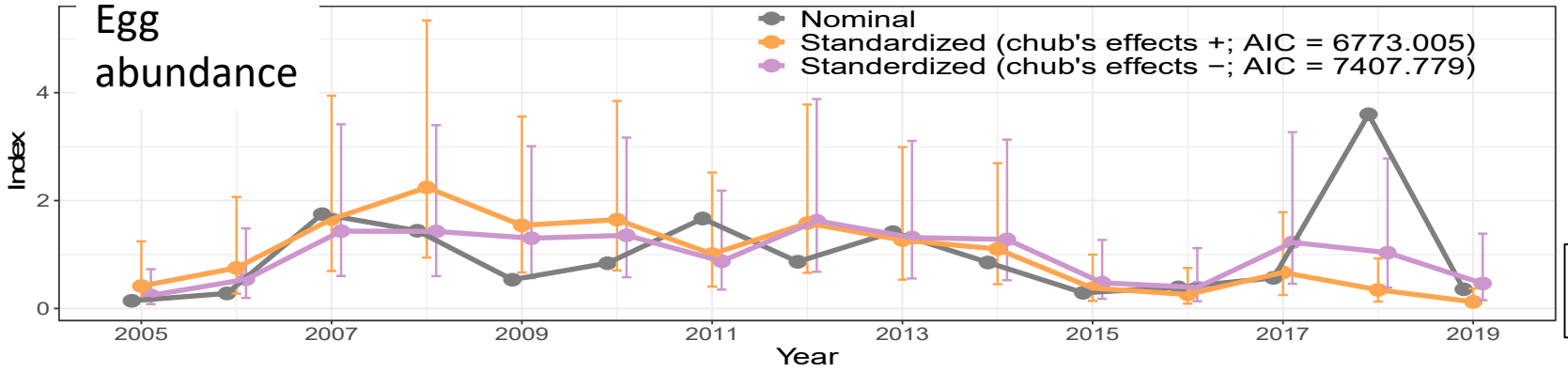
Delta-GLM+GLM-tree (Hashimoto et al. 2019, Fish.Res.)

GLM-tree (Ichinokawa and Brodziak 2010)



Blue mackerel

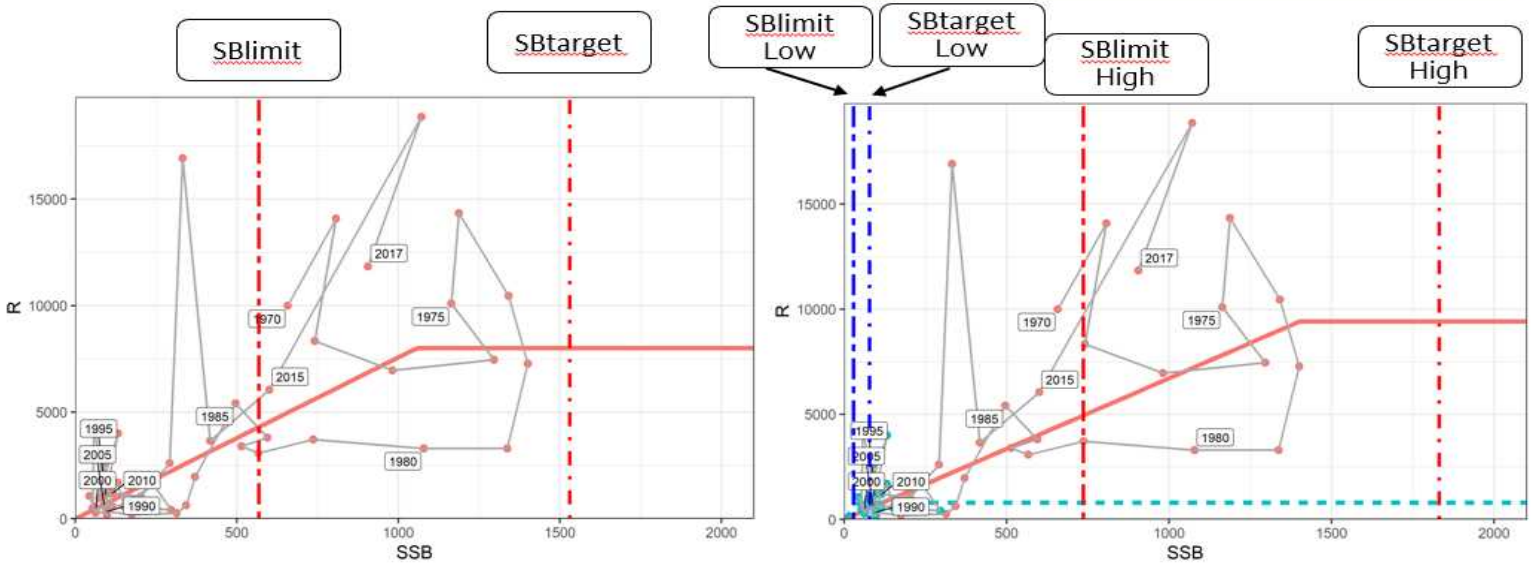
Vector Autoregressive Spatio-Temporal (VAST)　(Kanamori et al. 2019)



Regime shift. Pacific CM

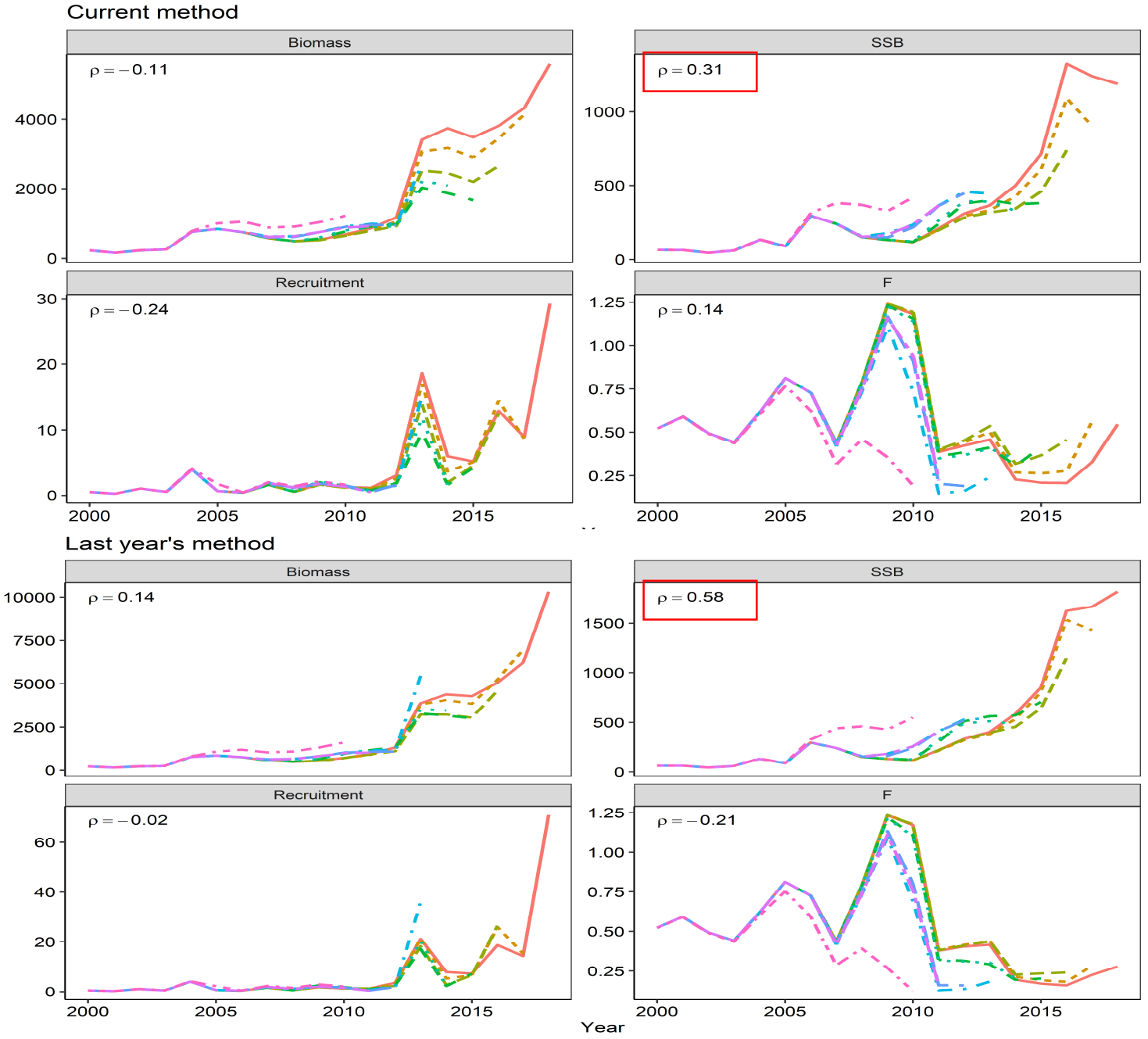
1970-2017 (all)

1970-89, 2011-17(High)
1990-2010(Low)

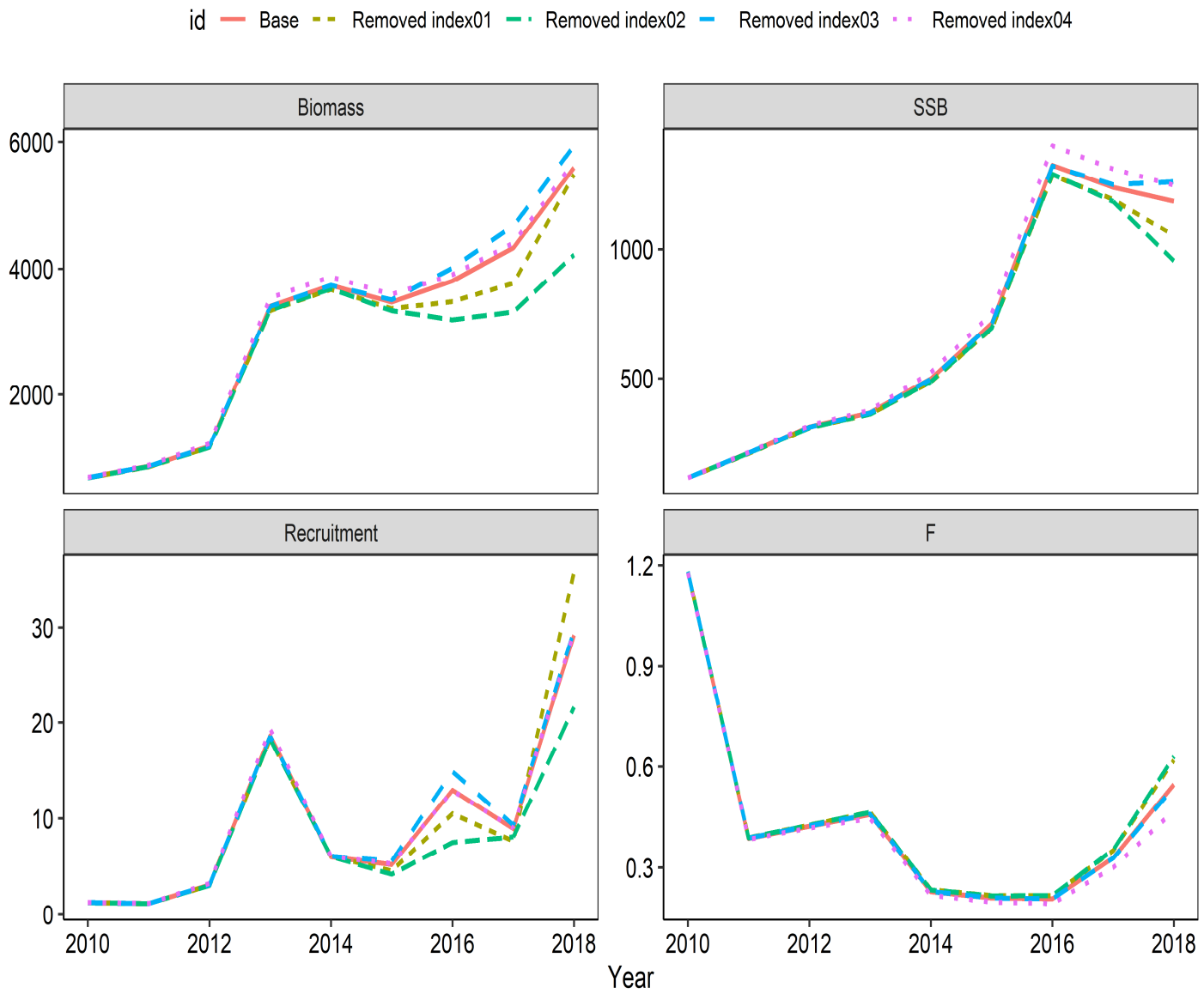


		ALL	High	Low
AICc		130.91	133.02	
TRP	SSB ton	1540*10³	1830*10³	78*10³
	Fmsy/Fcurrent	0.43	0.47	1.45
	Catch ton	372*10³	480*10³	62*10³
LRP	SSB ton	560*10³	740*103	29*103
	Fmsy60%/Fcurrent	0.74	0.72	2.22
	Catch ton	223*10³	288*10³	37*10³

Retrospective pattern using the current method vs last year's method Pacific CM

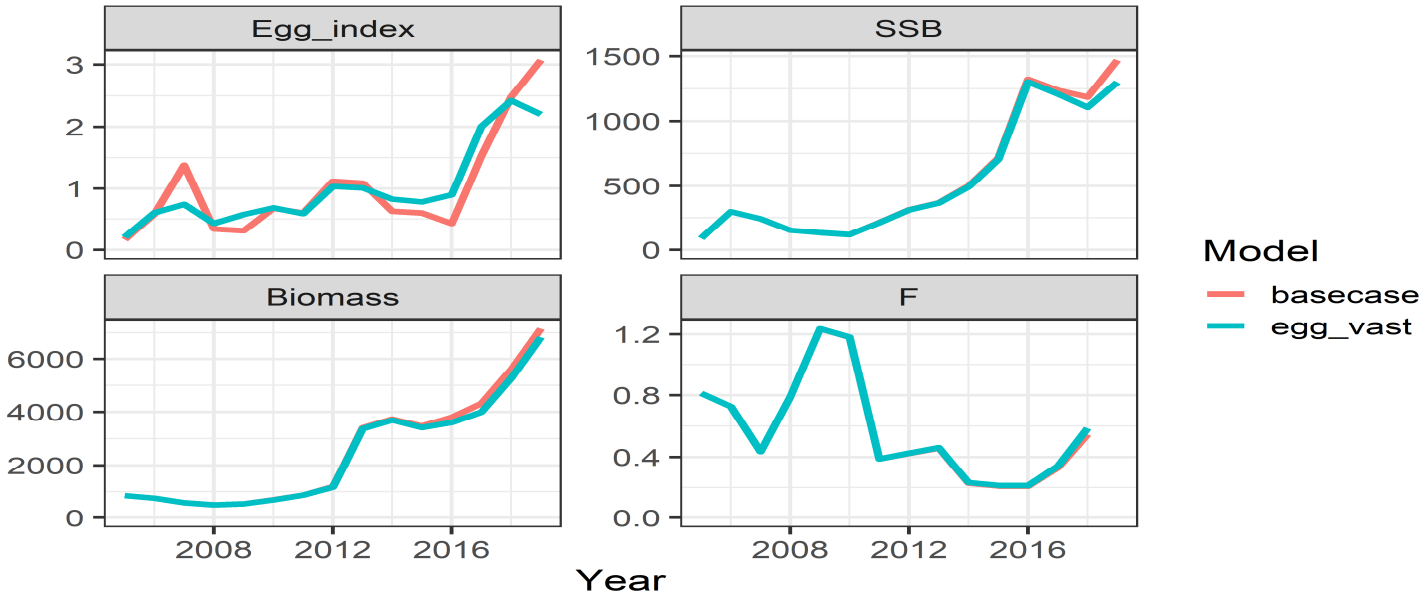


Effect by removing each index (Jackknife analysis) Pacific CM



If egg abundance of Pacific CM were standardized

Pacific CM



Retrospective bias