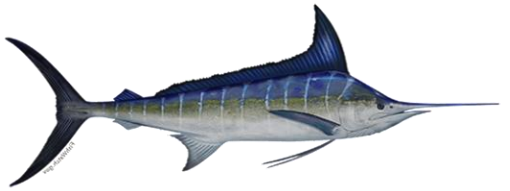


Stock assessment of striped marlin (*Kahikia audax*) in the southwest Pacific Ocean: 2024

WCPFC-SC20-2024 / SA-WP-03
August 2024
Manila, Philippines

C. Castillo Jordan[1], J. Day[1], T. Teears[1], N. Davies[2], J. Hampton[1],

S. McKechnie[1], A. Magnusson[1], T. Peatman[3],

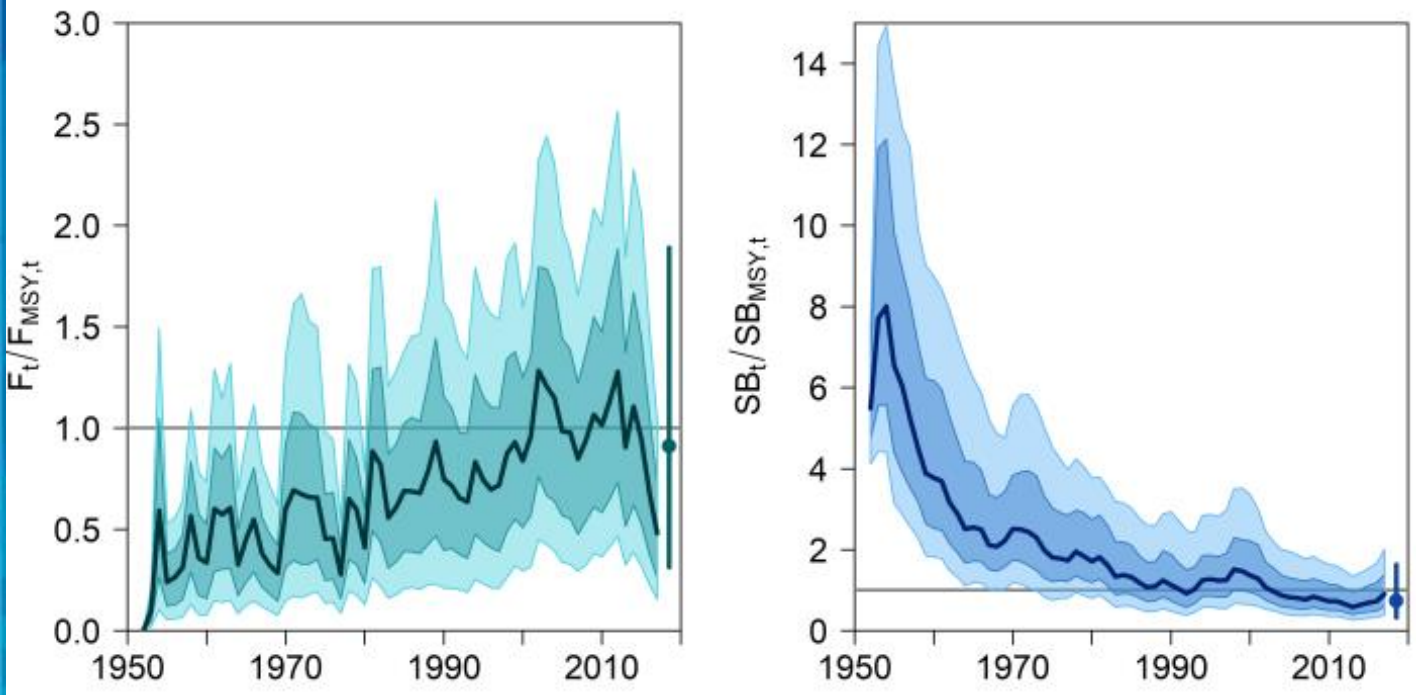
T. Vidal[1], P. Williams, P. Hamer[1]

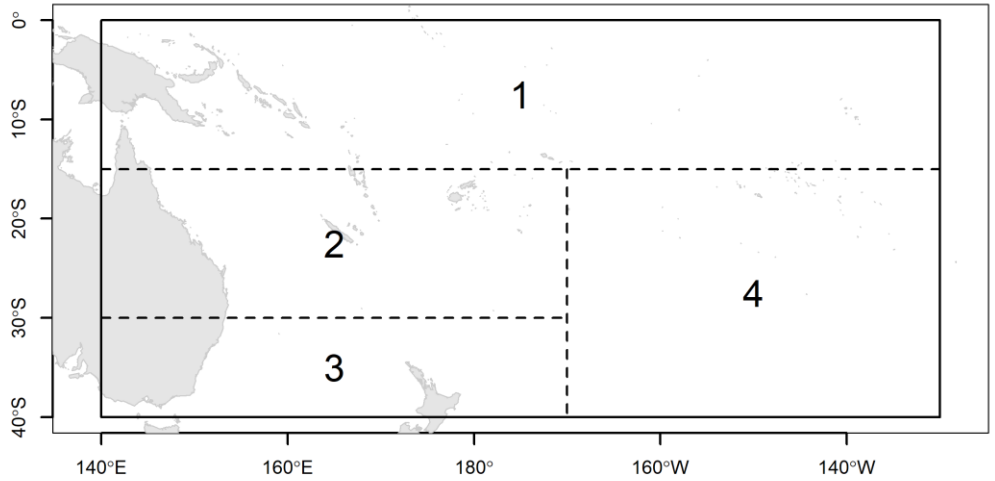
1 Oceanic Fisheries Programme, the Pacific Community

2 TeTakina Ltd

3 Private Consultant

MLS 2019 in a nutshell (Ducharme-Barth et al. 2019)





Natural mortality (M) and **steepness (*h*)** contributed to the overall level of uncertainty in the assessment

	Option 1	Option 2	Option 3
h	0.65	**0.8**	0.95
Growth	**Kopf et.al 2011**	Otolith age	
M	0.3	**0.4**	0.5
CPUE	**JP 2 LL**	TW 5 LL	AU 6 LL
Size freq (W/L)	10/20	**20/40**	50/100
Rec CV	**0.2**	0.5	2.2

Stock likely overfished, and close to be overfishing

	Median	10th %ile	90th %ile
F_{recent}/F_{MSY}	0.911	0.313	1.891
SB_{recent}/SB_{MSY}	0.737	0.334	1.635
$SB_{recent}/SB_{F=0}$	0.198	0.093	0.464

2024 MLS assessment – highlights and key changes

2024 stock assessment

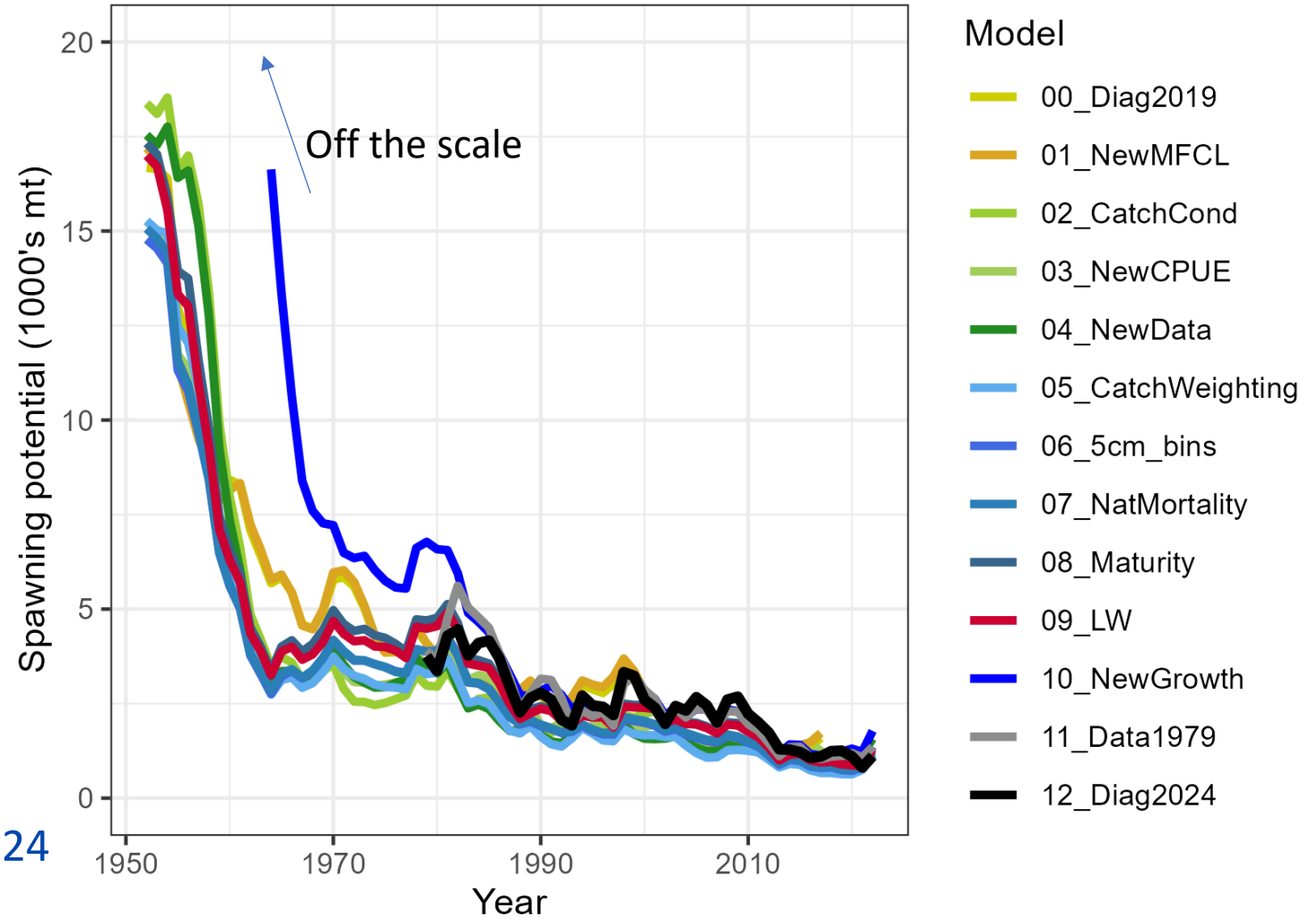
- Team working in different places

Main new changes

- New MFCL 2.2.7.0 version
- Catch conditioning method
- Index fishery, sdmTMB, JPTW, vessel ID random effect
- Input data reweighted by catch and CPUE
- Francis size data weighting
- New growth and revise maturity by Farley et al 2021.
- Lorenzen M
- M and *h* ensemble for uncertainty (priors)
- Model start in 1979
- Reduction in parameters from 2248 to 76
- PDH

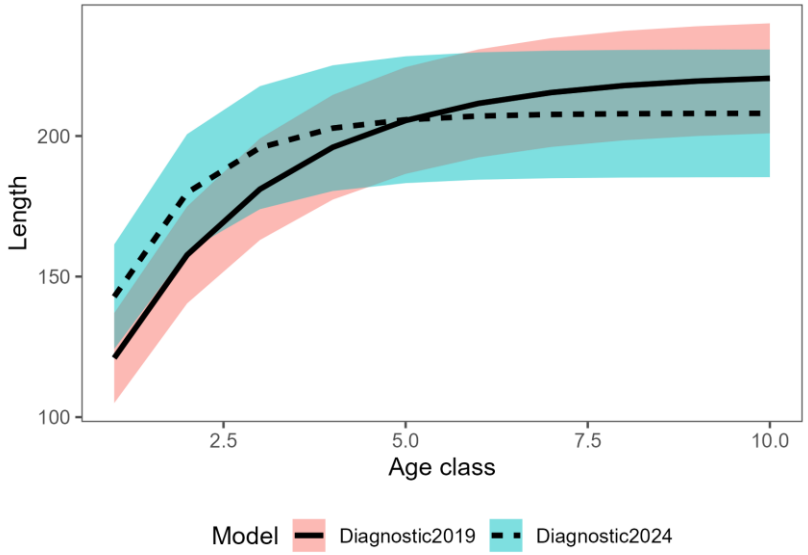
Diagnostic model development

- 00 = Diagnostic case 2019
- 01 = new MFCL
- 02 = Catch conditioning 2019
- 03 = New CPUE
- 04 = New Data until 2022
- 05 = Catch weighting
- 06 = 5 cm bins
- 07 = Lorenzen M
- 08 = New maturity
- 09 = New LW relationship
- 10 = New growth
- 11 = Data start in 1979
- 12 = Francis method, PDH, Diag.case 2024

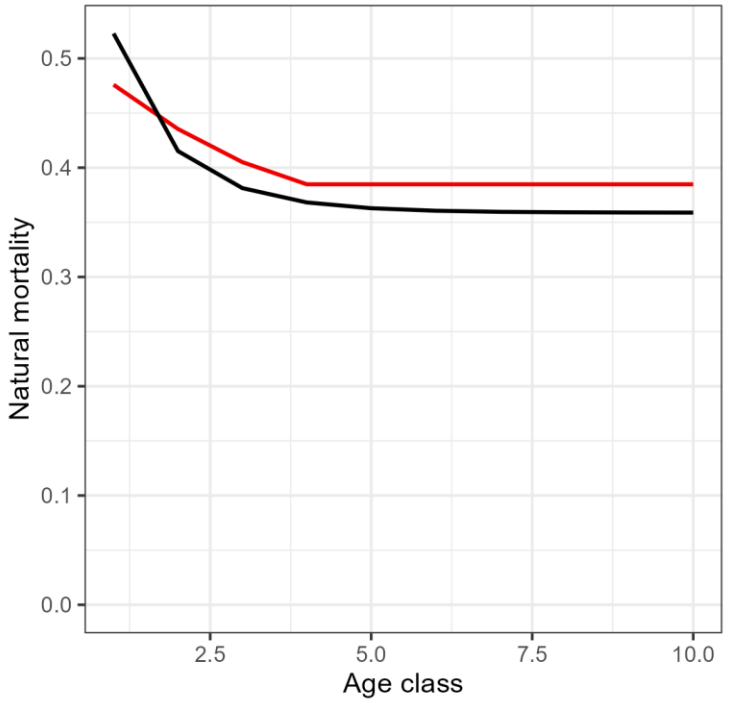


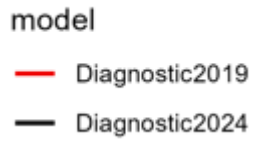
Updated biology (Csiro, Farley et al 2021)

Size-at-age

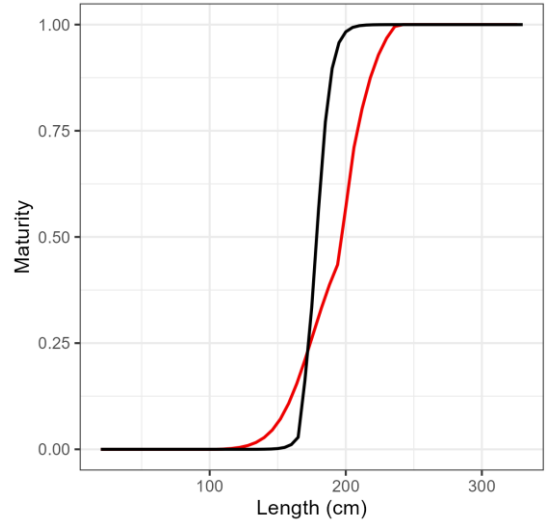


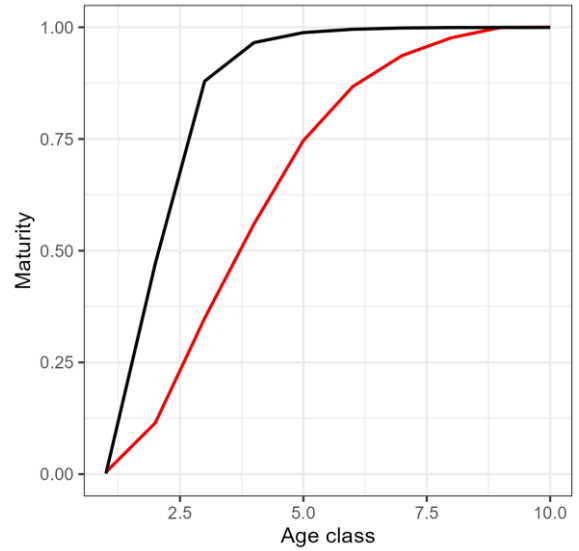
Natural mortality-at-age





Maturity-at-length & age



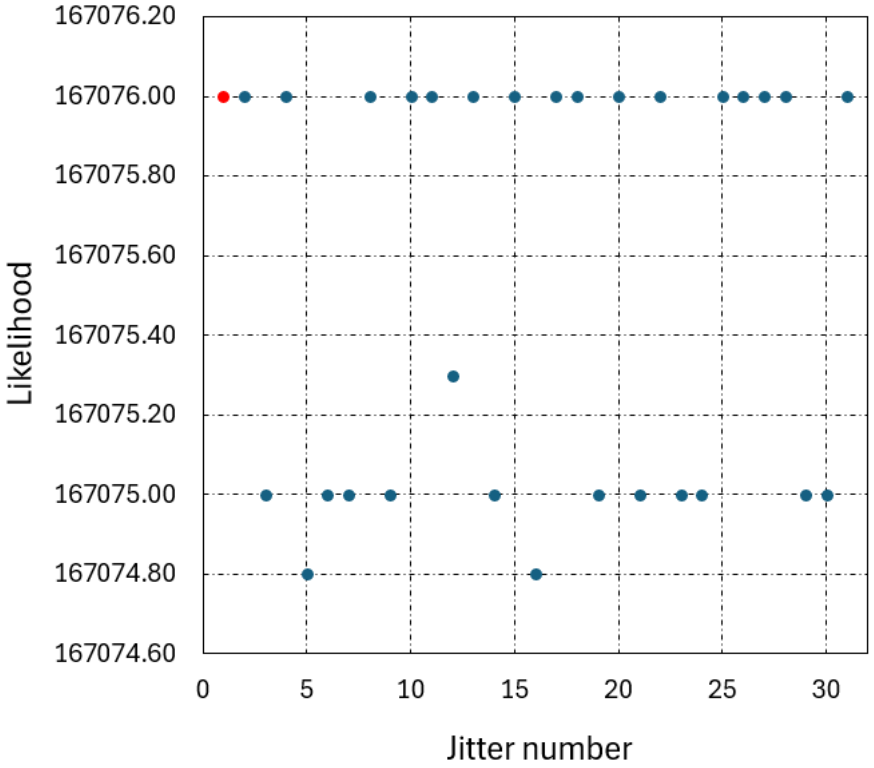


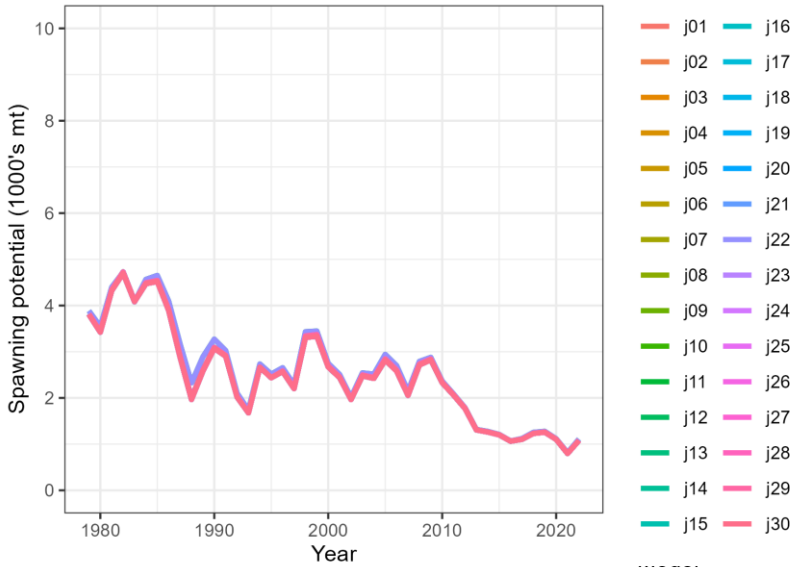
2024 diagnostic:

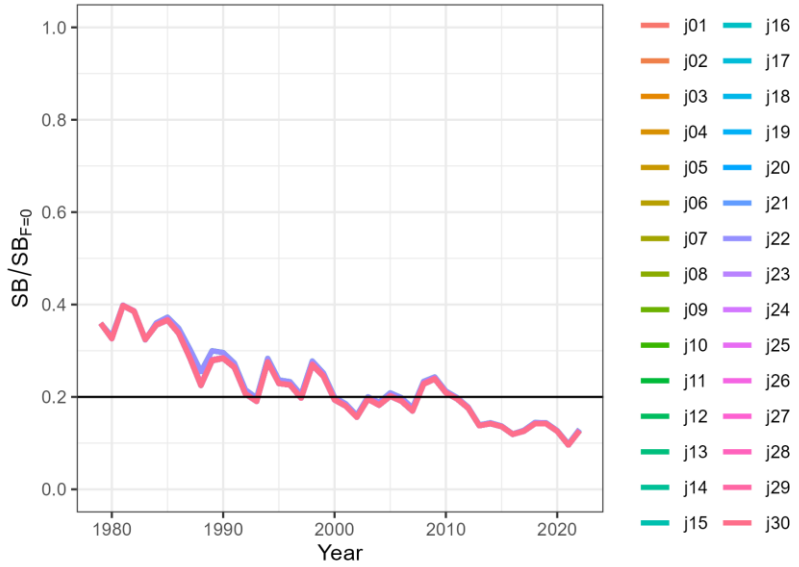
- Diagnostics analysis
  - Hessian
  - Jitter
  - ASPM
  - Catch Curve
  - Likelihood profiles
  - “Piner” plots
  - Retrospectives

- Sensitivities
  - Recruitment CV
  - CPUE
  - Initial conditions F
  - M and *h*
- Others (late model exploration)
  - 2019 subjective fix DW
  - Removing 2022 07.LL.AU.3
  - 06.LL.AU.2 and 07.LL.AU.3
    - Removing LF
    - Similar DW 06 and 07
  - NZ ODF request F12 and the weight frequency data in F6 and F7

Convergence

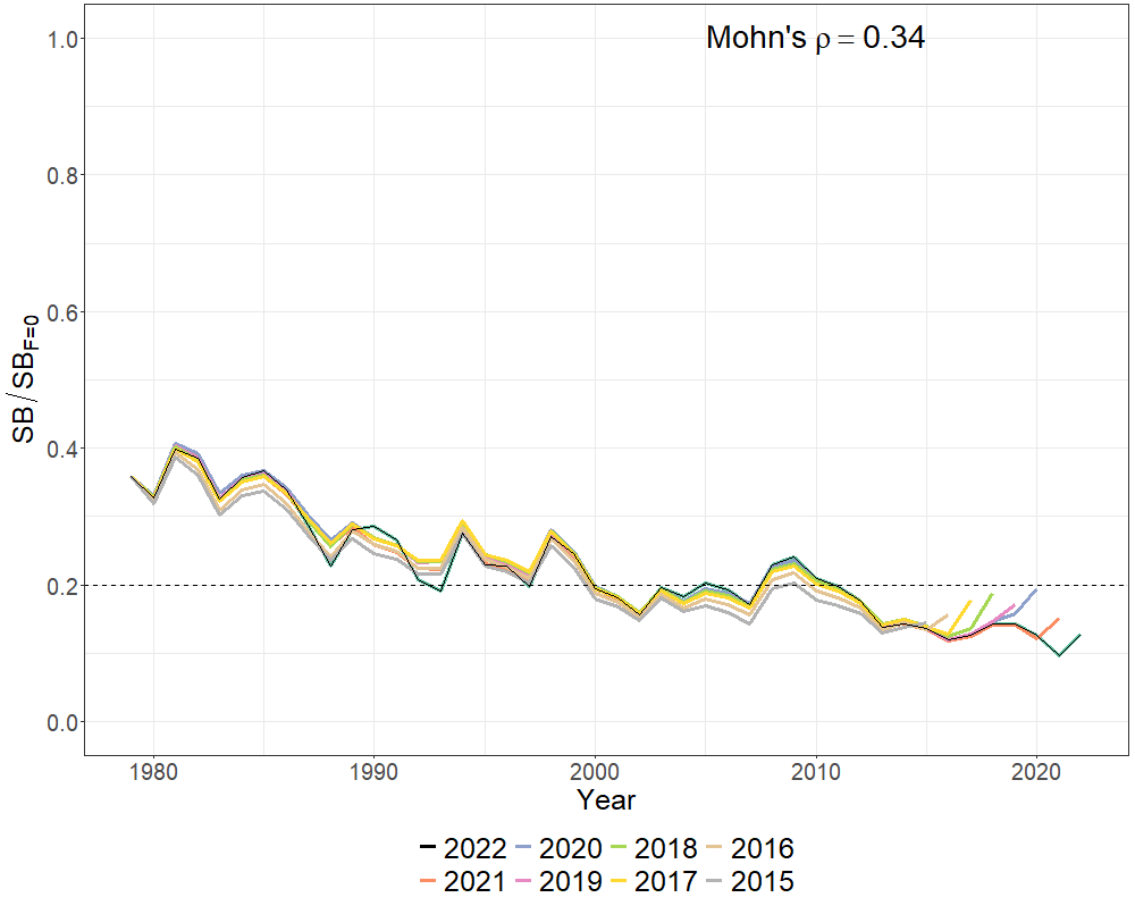


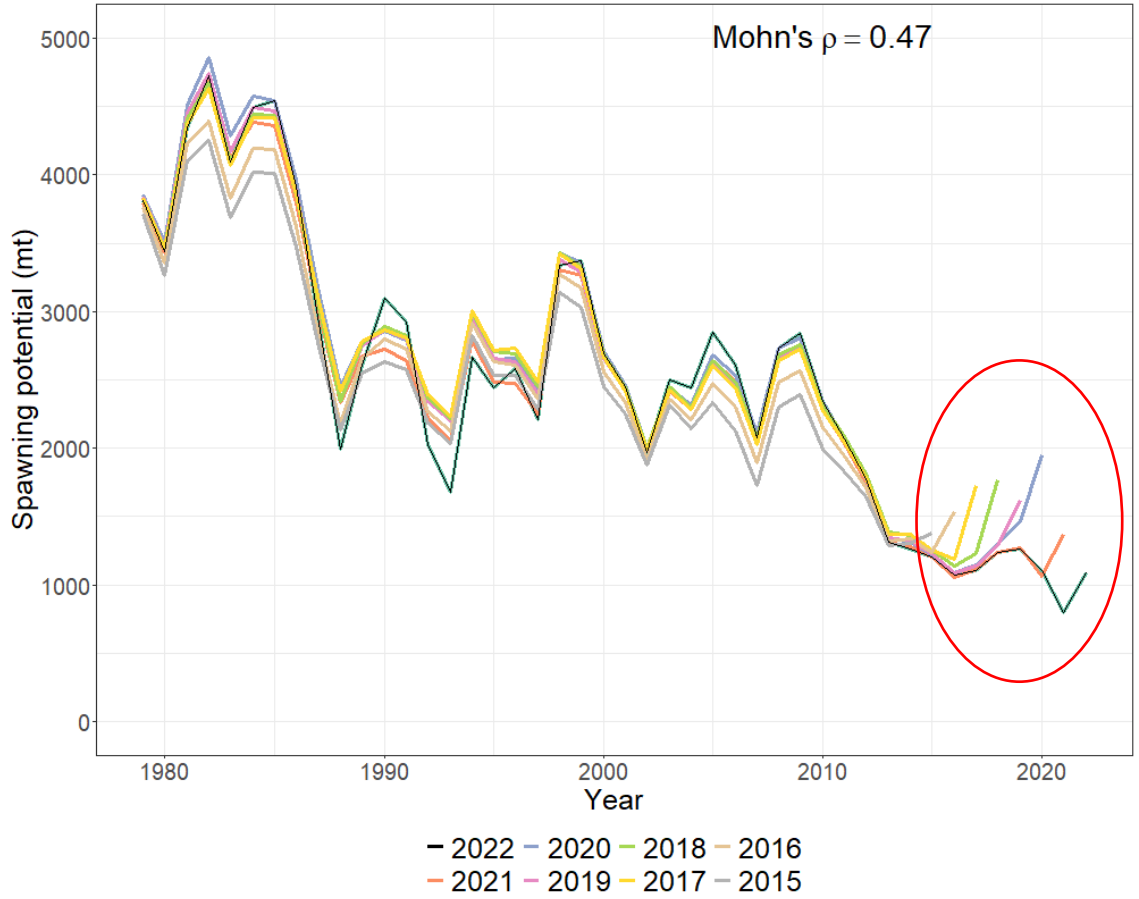




Gradients E-05, PDH and pass jitter test

Retrospective analysis



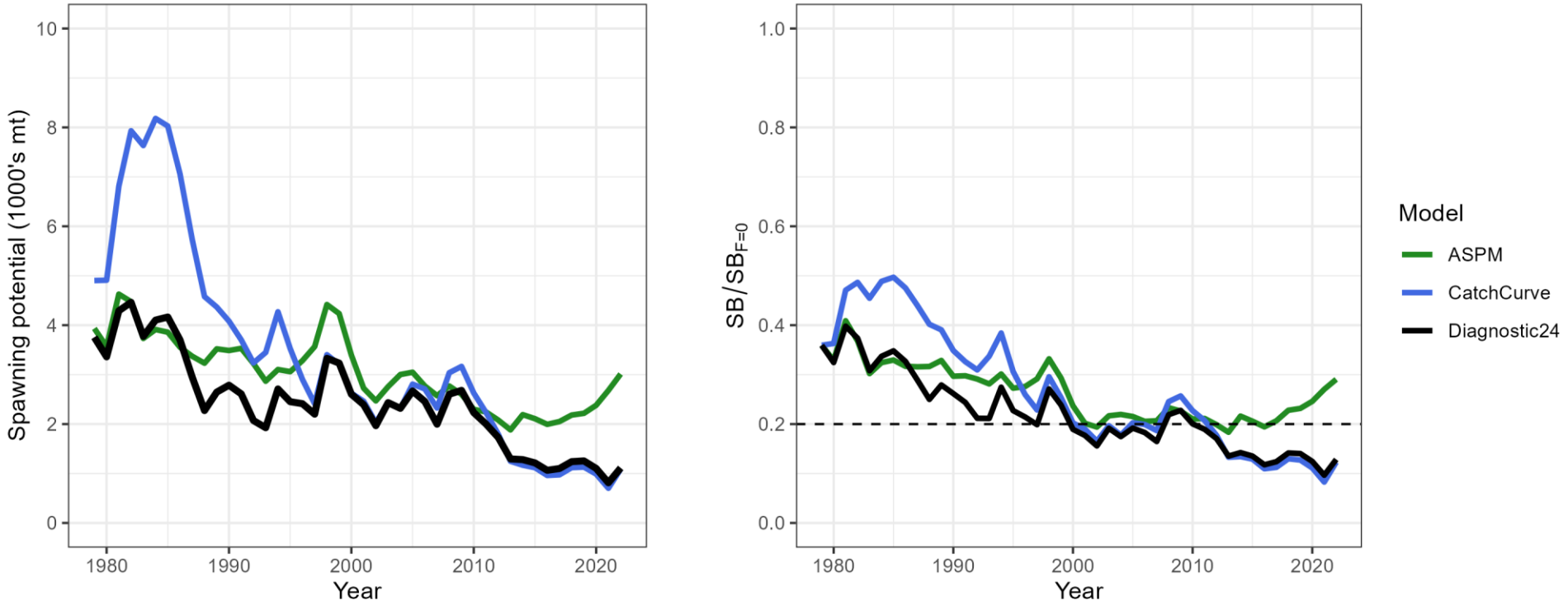


Artificial kick up

Issue for projections

MFCL development work

ASPM and Catch curve (extreme cases)



Different data components

ASPM = CPUE

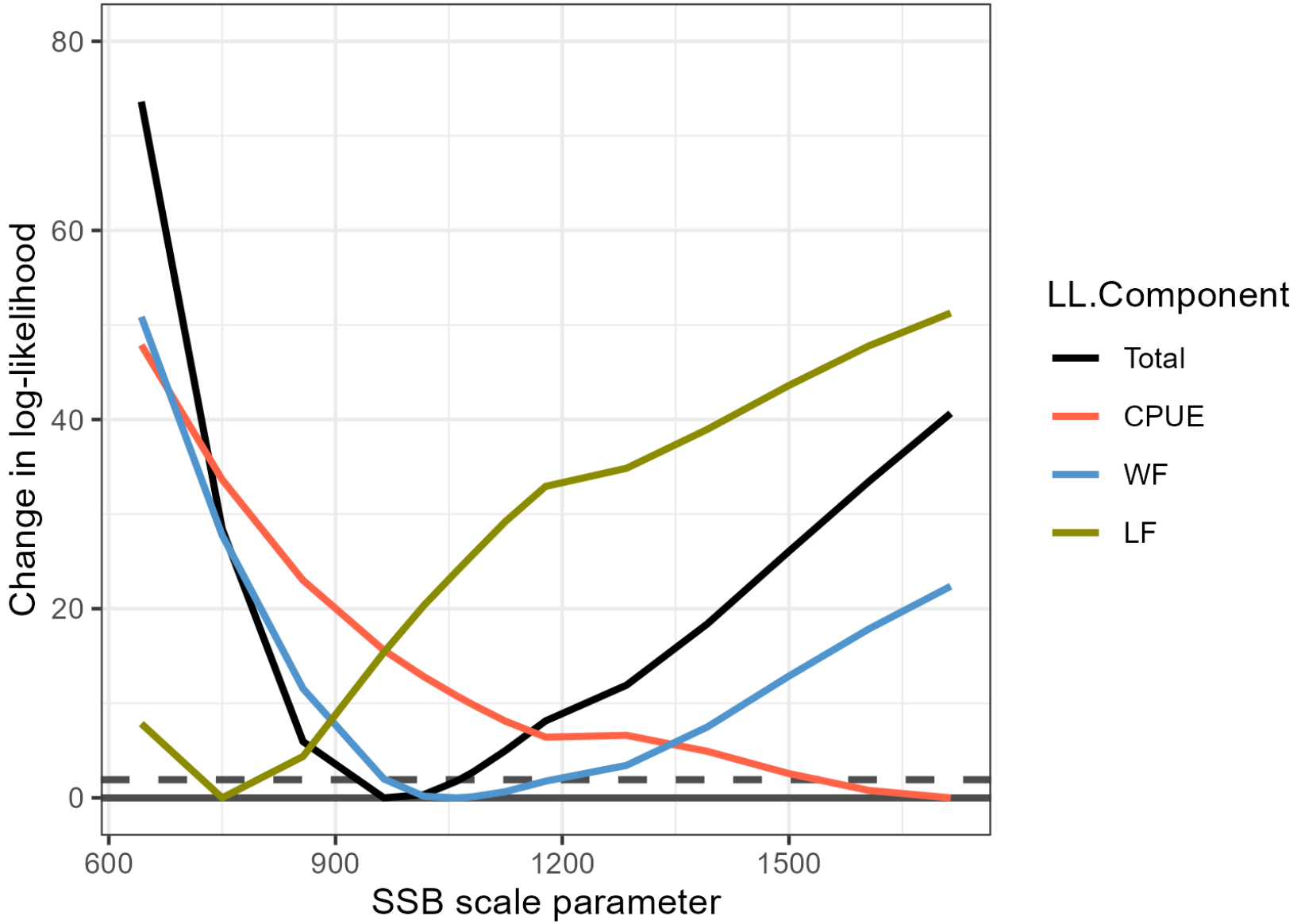
Catch curve = size composition

LL profile total

WF

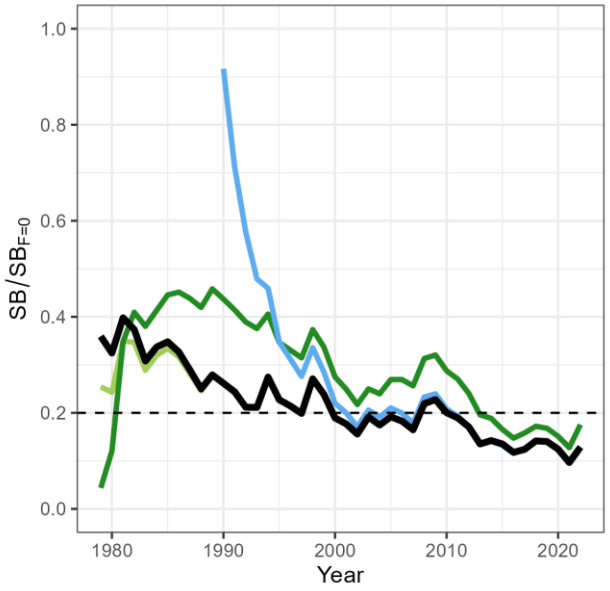
LF

CPUE

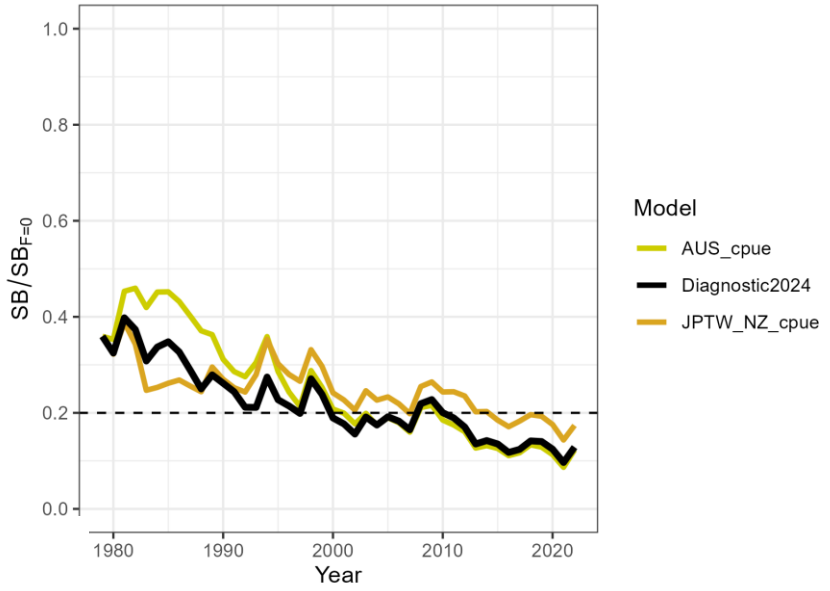


Sensitivities

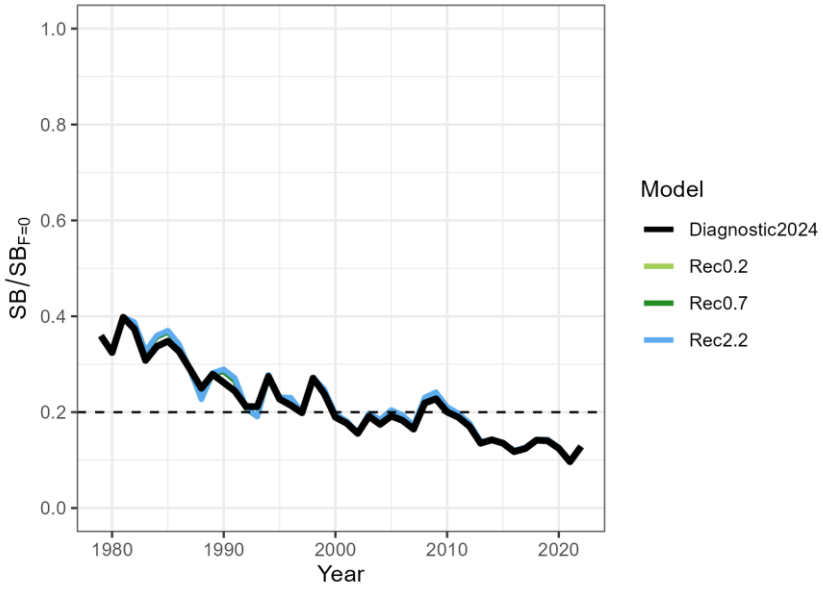
Initial conditions

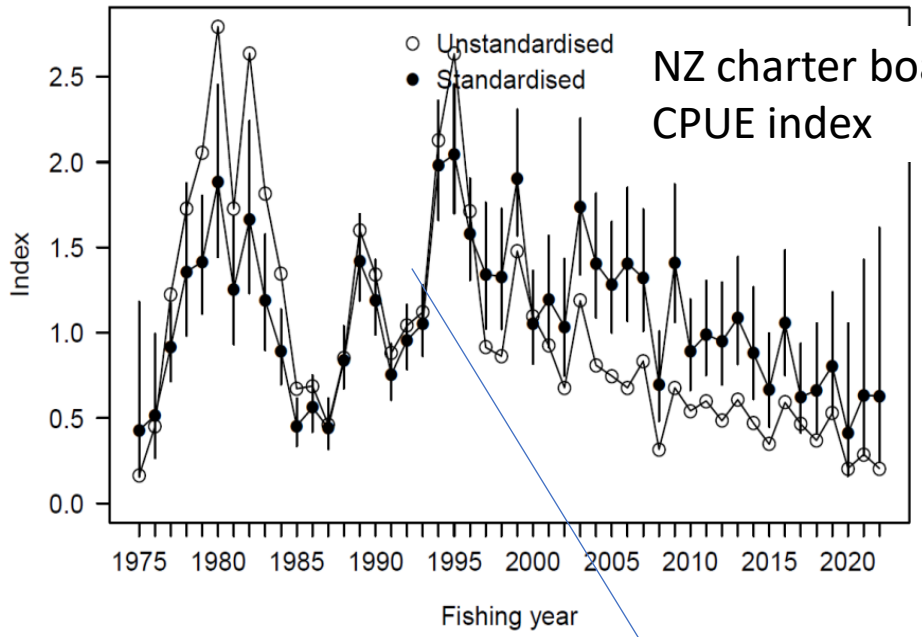


CPUEs



Recruitment penalty





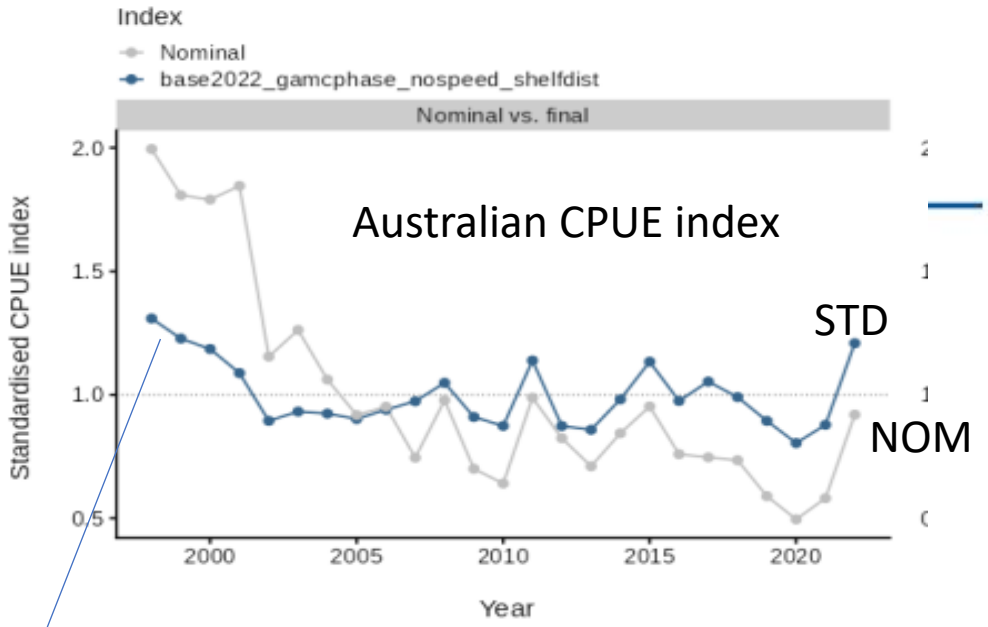
NZ charter boat CPUE index

Figure 15: The effect of standardisation on East Northland charter boat striped marlin catch. The unstandardised index is based on the geometric mean of the catch only and is not adjusted for effort. The standardised index is adjusted for fishing effort and vessel.

Holdsworth, J.C. (2023). Striped marlin catch and CPUE in the New Zealand sport fishery, 2019–20 to 2021–22. *New Zealand Fisheries Assessment Report 2023/05.* 35 p.

WCPFC-SC20-2024/SA-IP-17

Sensitivities

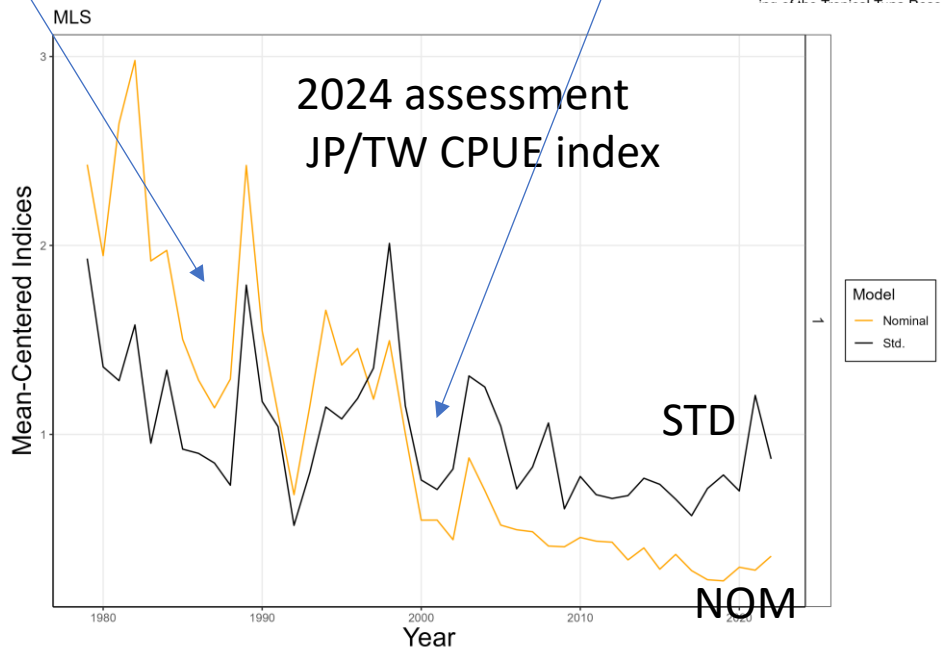


Australian CPUE index

STD

NOM

Tremblay-Boyer, L. and Williams, A. (2023). Standardised CPUE indices for the target species in the Eastern Tuna and Billfish fishery–1998 to 2022. Working Paper presented to the 38th meeting of the Tropical Tuna Resource Assessment Group held 11-13 July 2023, Mooloolaba.



2024 assessment JP/TW CPUE index

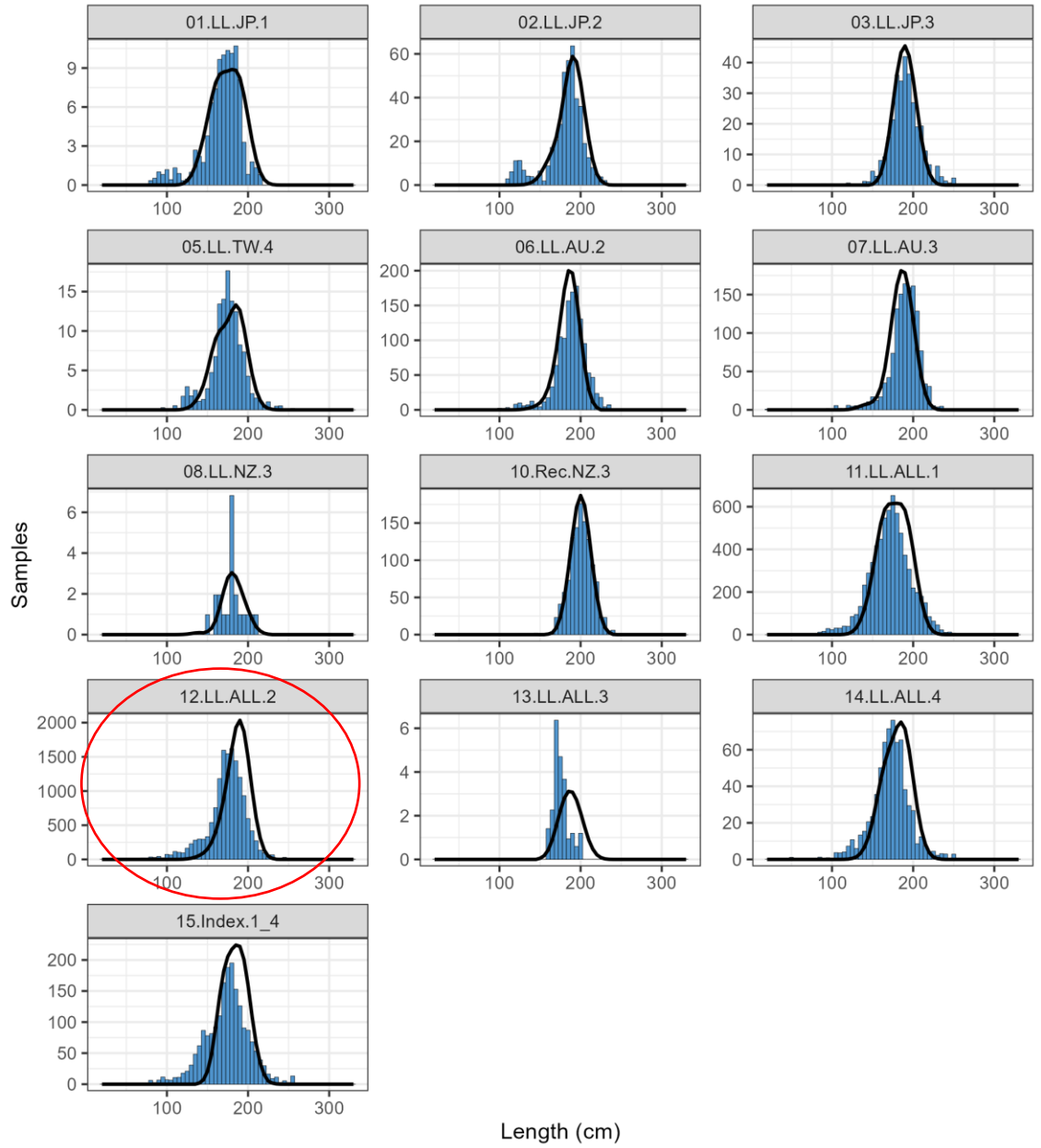
STD

NOM

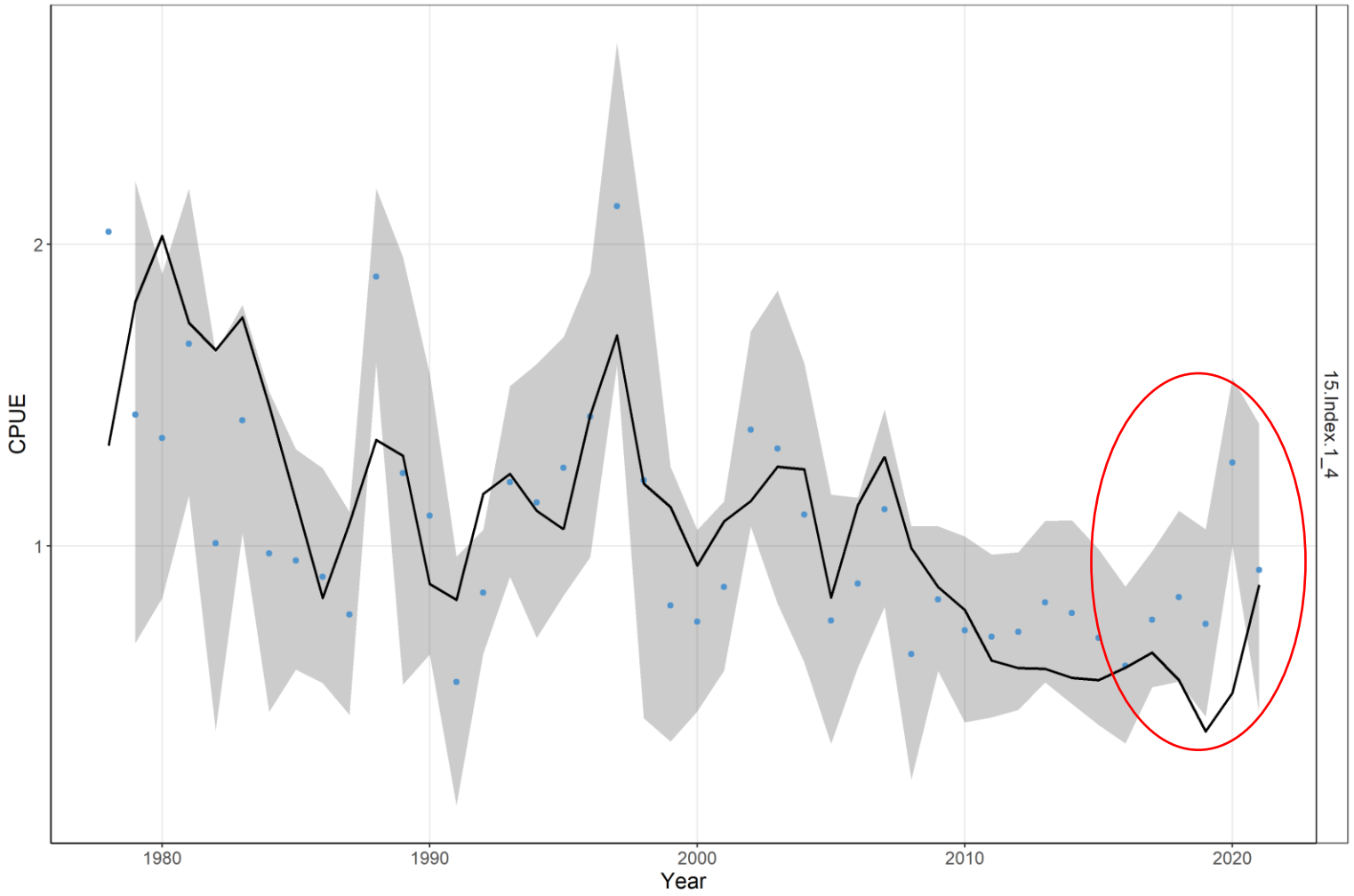
Abundance indices for striped marlin in the southwest Pacific

Issues arising

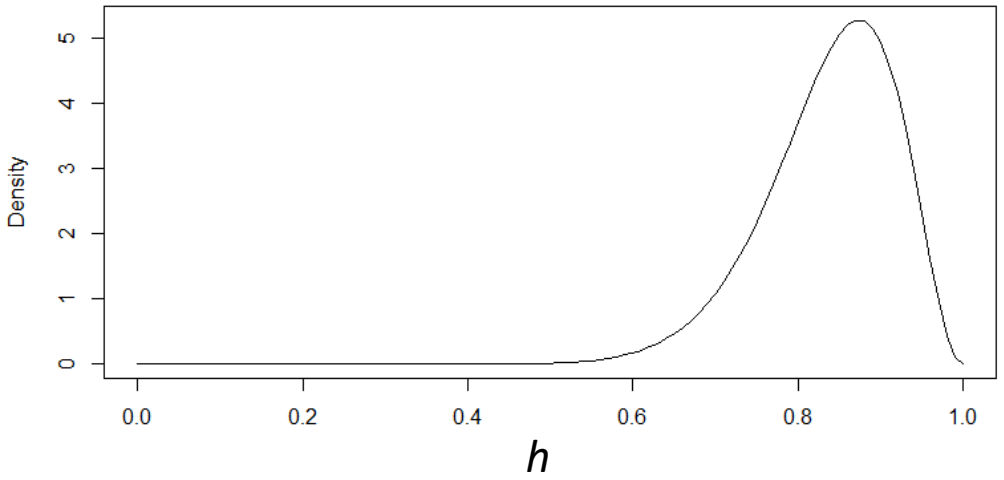
- LF fits
- CPUE

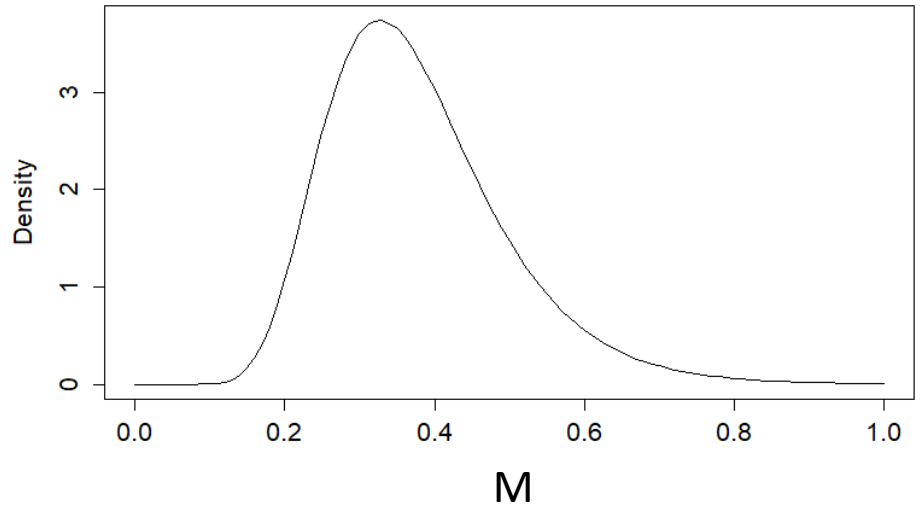


CPUE fit



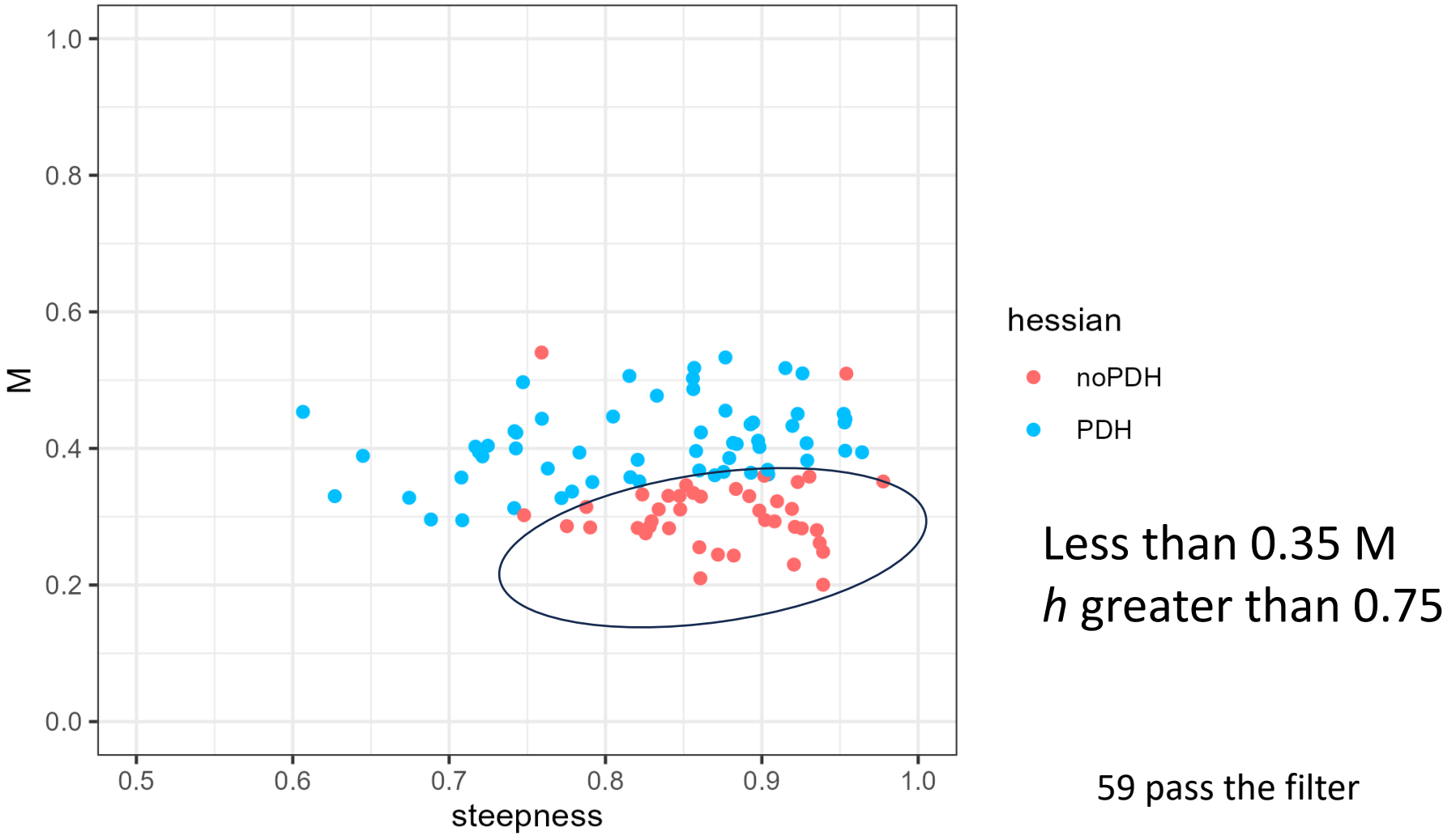
Ensemble models (priors)





Filtered by PDH

PDH filter

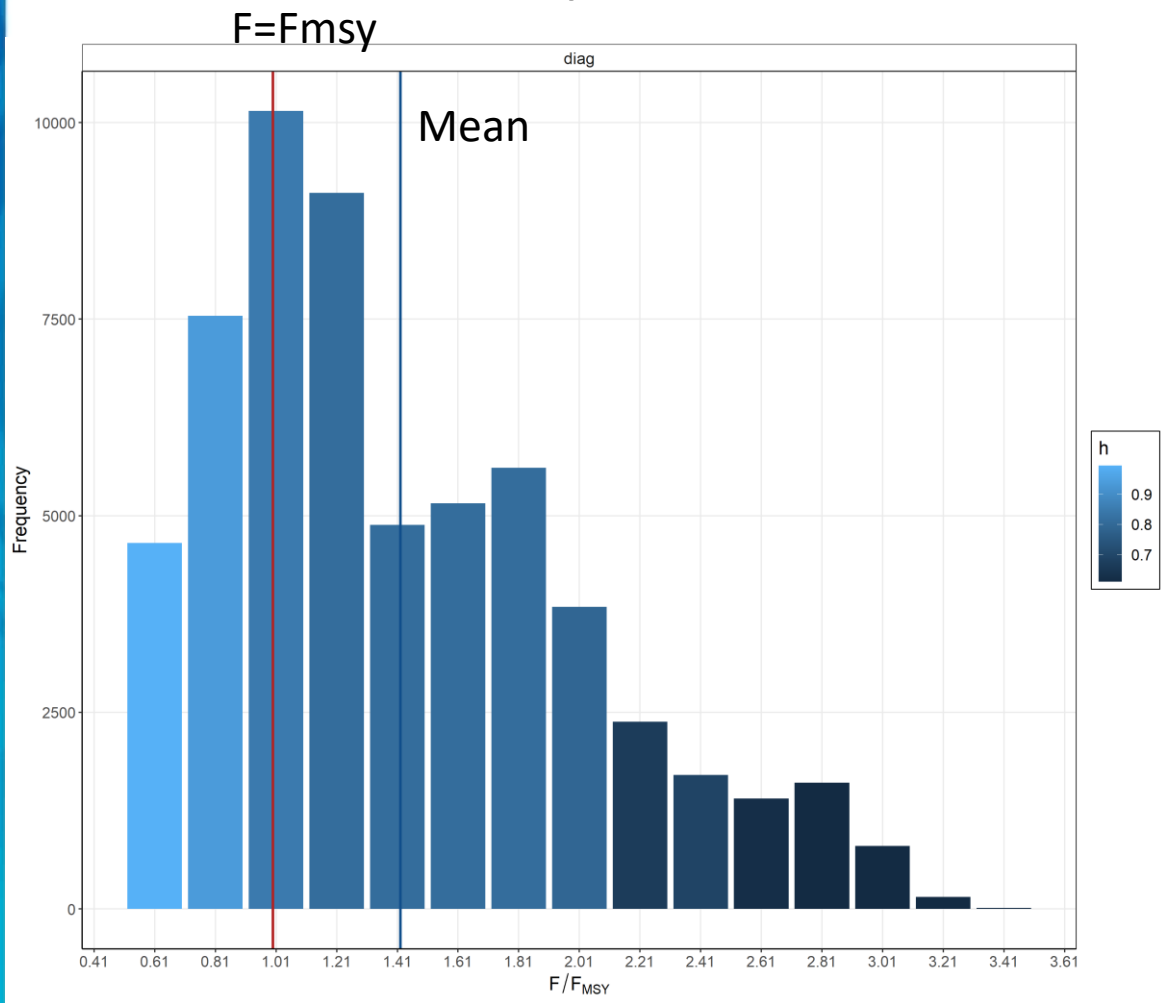


Less than 0.35 M
h greater than 0.75

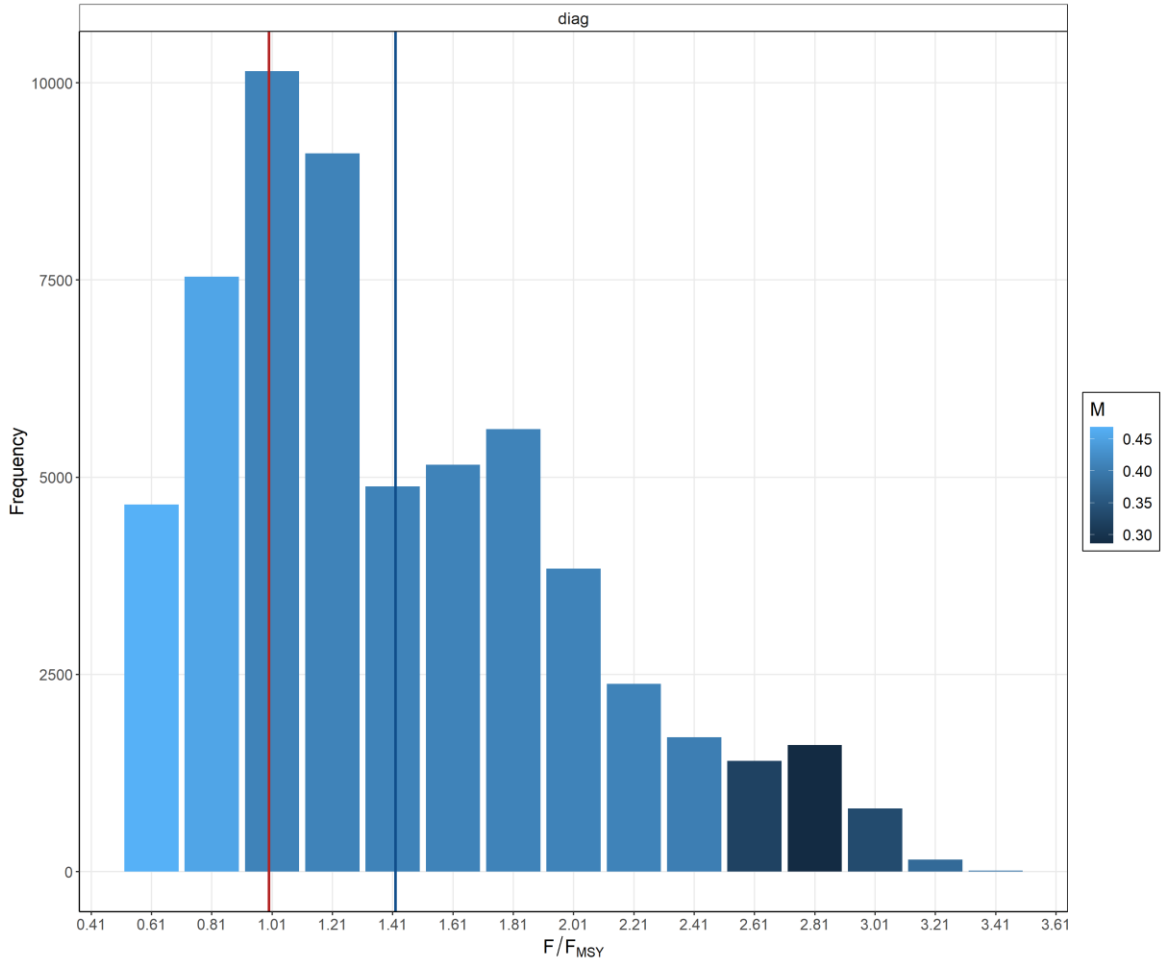
59 pass the filter

Model output – F/F_{MSY} across the range of *h*/M values

steepness

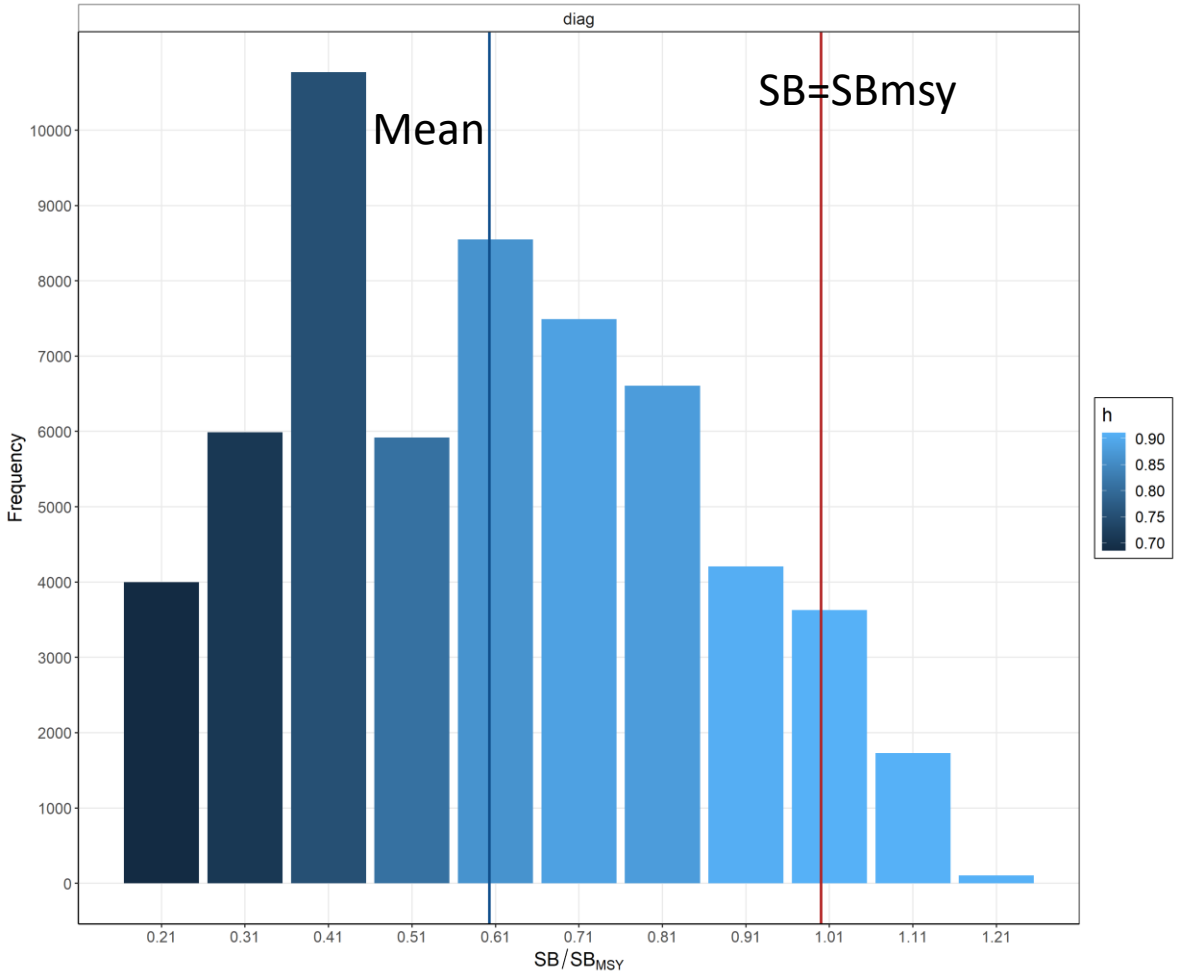


natural mortality

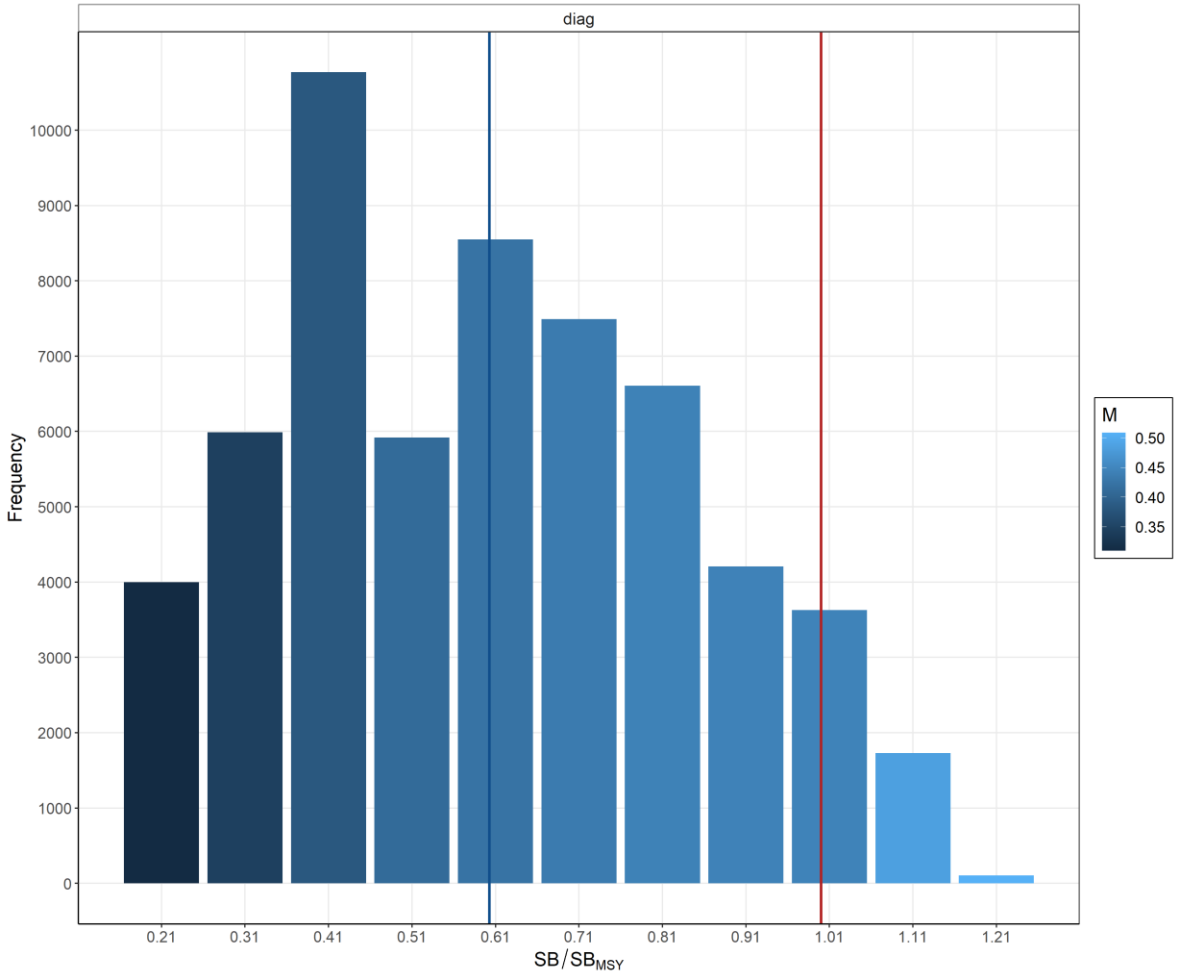


Model output – SBrecent/SBMSY across the range of *h*/M values

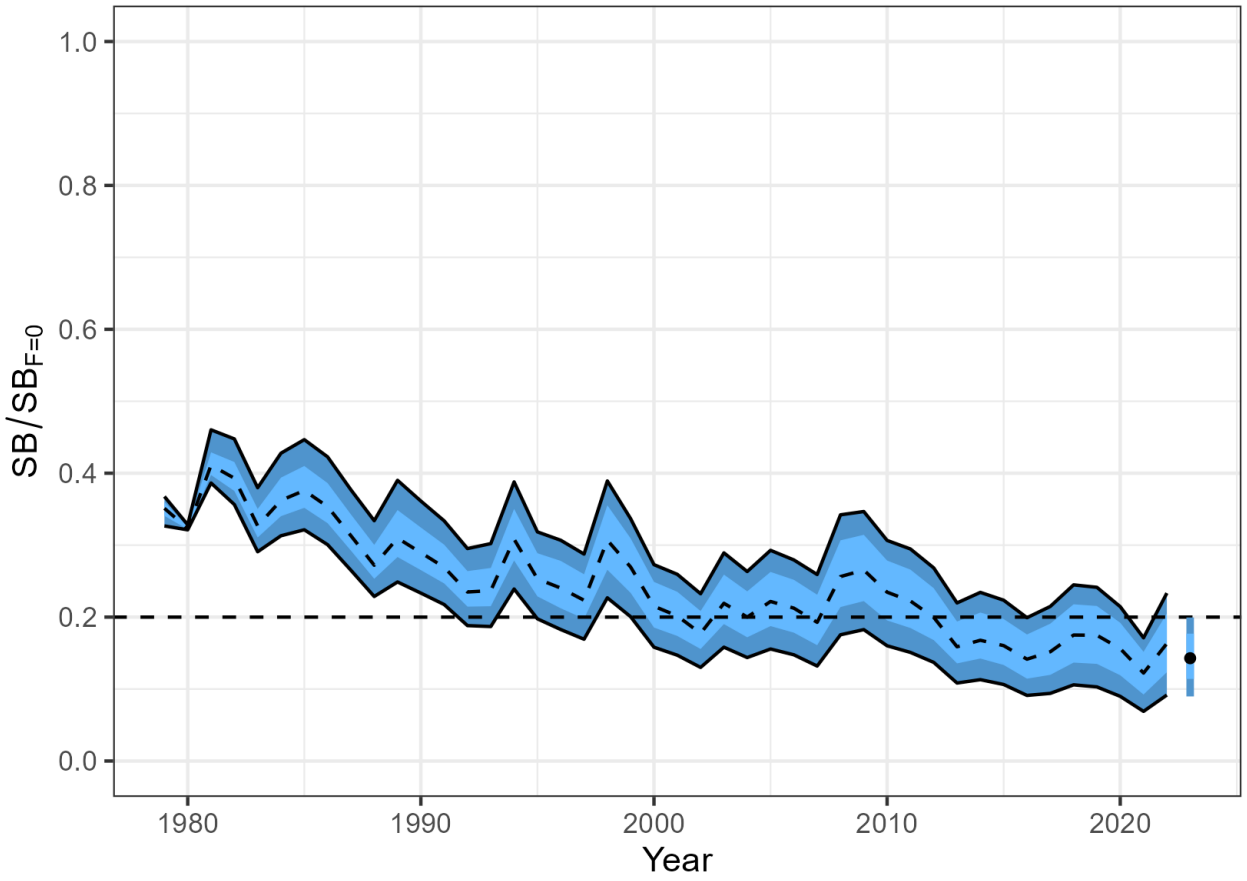
steepness



natural mortality



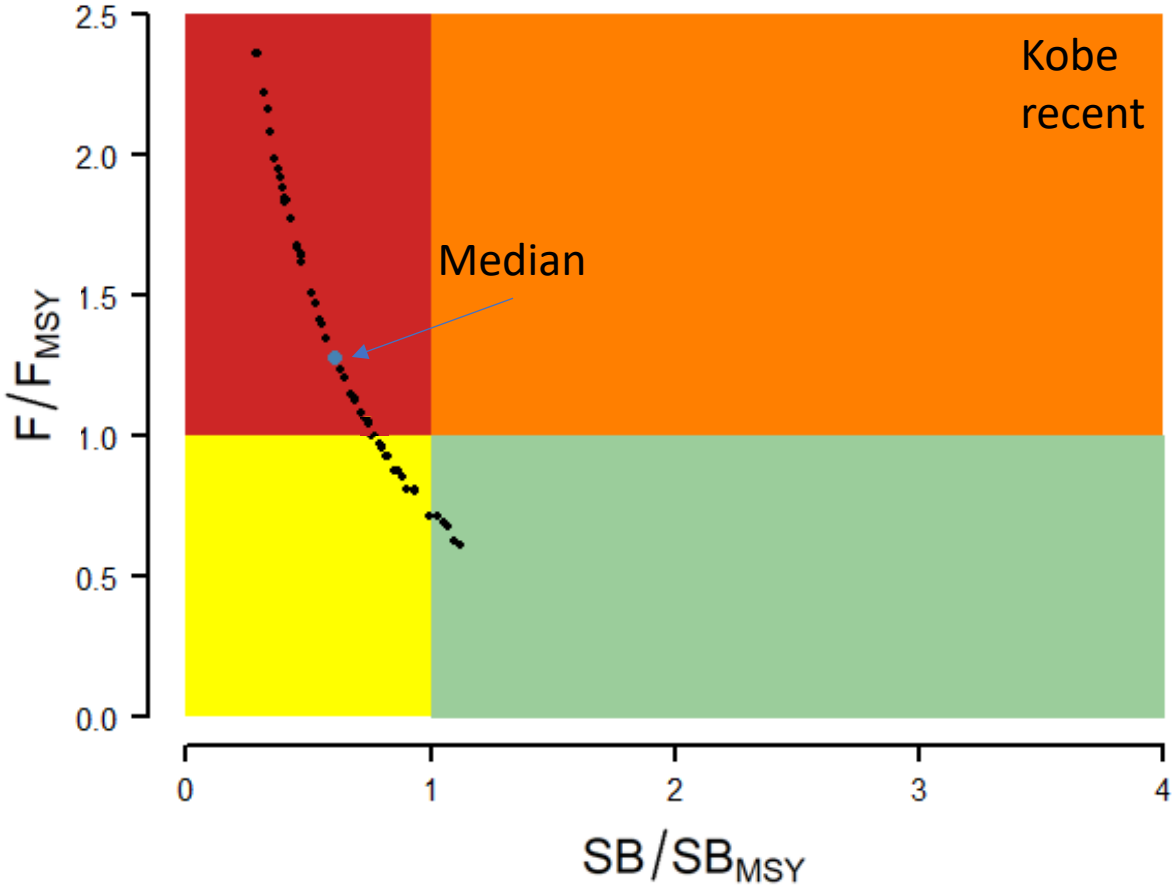
Depletion – all models



Just for interest
No depletion ref.points for Billfishes

SB/SBF=0

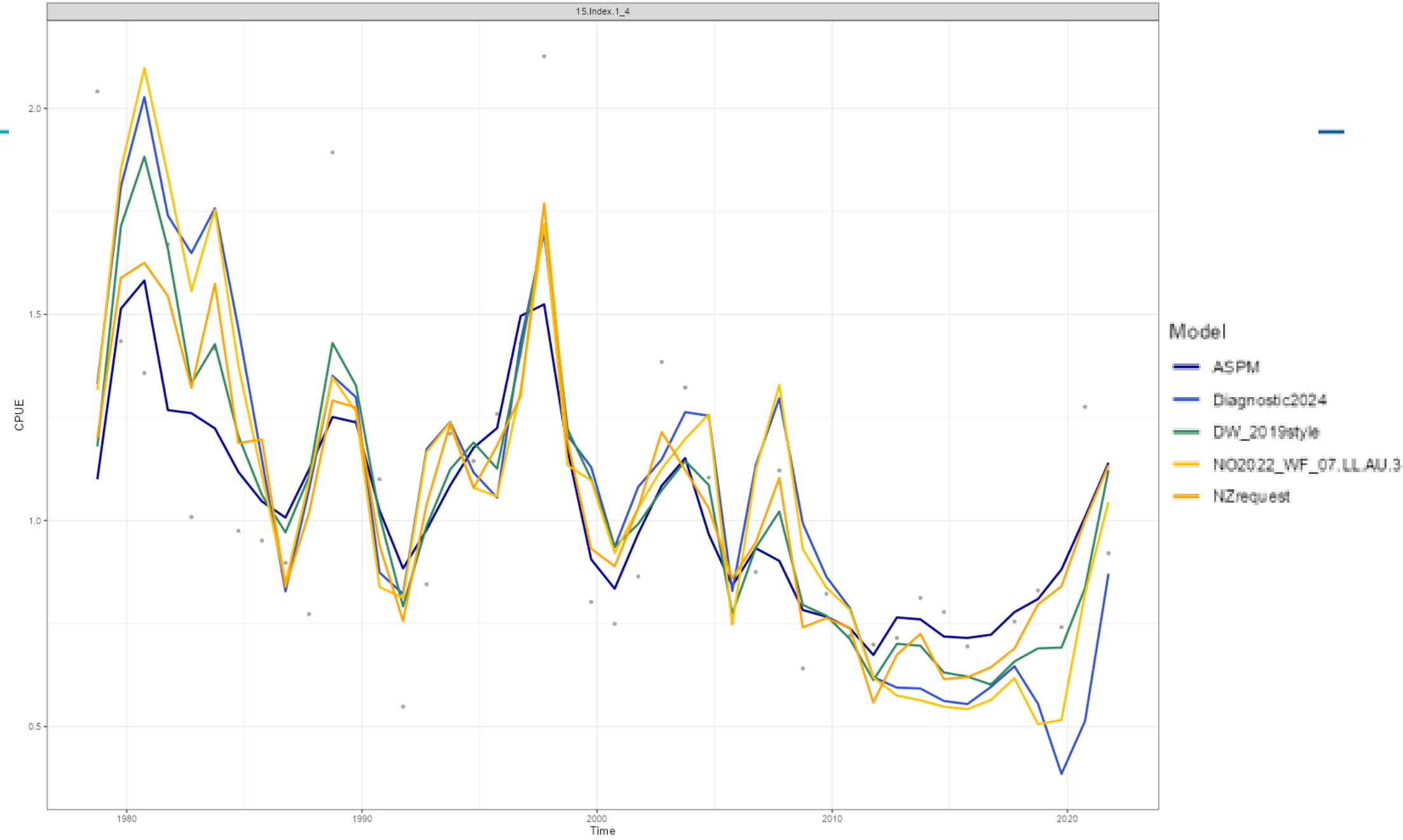
Kobe and Majuro plots



- Overall median change by SB/SBMSY 0.60 (80th percentile 0.29 – 0.95)
- Median F/FMSY= 1.21 (80th percentile 0.79-2.30)

Exploring some of the critical issues

- Data conflict (LF and WF)
- Poor CPUE fit
- Different selectivity groups
- Data weighting
- Influential data from last two years (fleet 6 and 7)


15.Index.1_4
CPUE
2.0
1.5
1.0
0.5
1980
1990
2000
2010
2020
Time
Model
ASPM
Diagnostic2024
DW_2019style
NO2022_WF_07.LLAU.3
NZrequest

Recent exploration model issues

Best CPUE fit

Model	Final SB/SBF0instant	Final SB/SBF0recent	SBrecent/SBmsy	Frecent/Fmsy	MSY	BMSY	FMSY
ASPM	0.290	0.257	0.987	0.959	1752	2607	0.303
NZrequest	0.262	0.234	0.832	1.083	1669	2659	0.290
DW_2019style	0.200	0.173	0.643	1.264	1688	2543	0.300
NO2022_WF_07.LL.AU.3	0.179	0.147	0.540	1.381	1707	2471	0.307
Diagnostic2024	0.129	0.118	0.439	1.537	1700	2438	0.309

Worst CPUE fit

The management values from the current model are biased towards pessimistic

Just diagnostic model

No full exploration (diagnostics)

NZ ODF request : Full down-weight 12.LL.ALL.2 LF, and 06.LL.AU.2 and 07.LL.AU.3 WF. Remove 52%LF and 67%WF

Concerns with the assessment in relation to management quantities (Rev2)

- We have recognised some critical model issues late in the assessment process that would benefit from further work to improve the confidence in the management advice.
- These concerns include poor fits to some of the size data and the under fit to CPUE in the recent time period, data conflicts and data weighting impacts, and the results of the ASPM and Catch Curve models.
- Preliminary work to understand the implications of some of these issues suggest the current model estimates of stock status are likely biased towards more pessimistic management advice, the degree to which we cannot be certain without additional work.
- We also very recently identified some concerns around some data inputs that need further understanding.
- SC20 should consider the issues raised when evaluating whether the assessment results provide the best available science for management advice.

Recommendations for further work

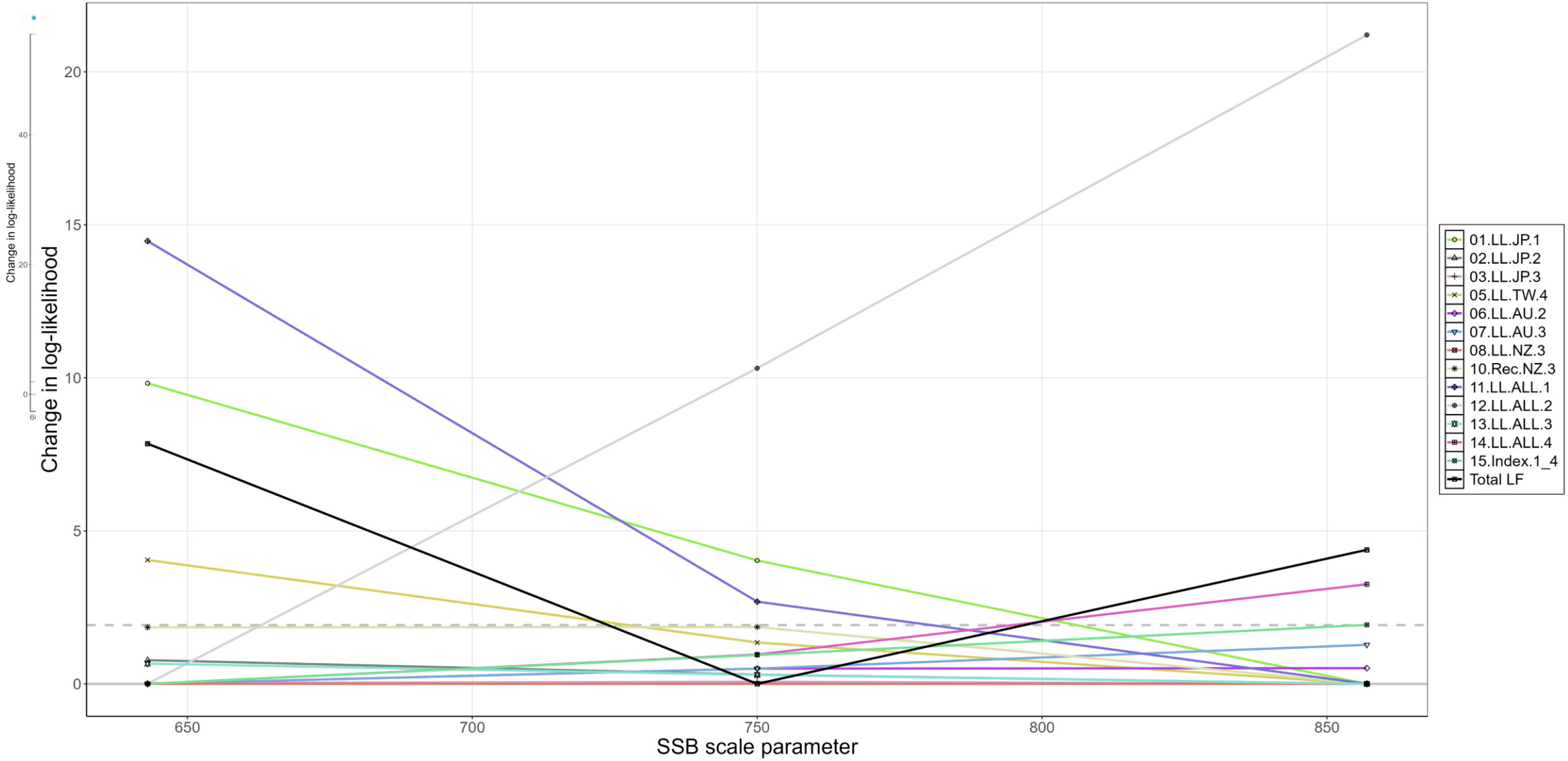
- Increase biology sampling (otoliths, tissues)
- Age validation
- Growth parameters across the Pacific
- Increase collection of representative size comp.data
- Environmental factor on recruitment
- Review of the comp.data (length and weight)
- Consider the issue of effective hook effort changes (reductions)
- Priors investigation for ensemble models
- Quarterly time step model to improve resolution
- Use of alternative model platforms

To be continued? ...

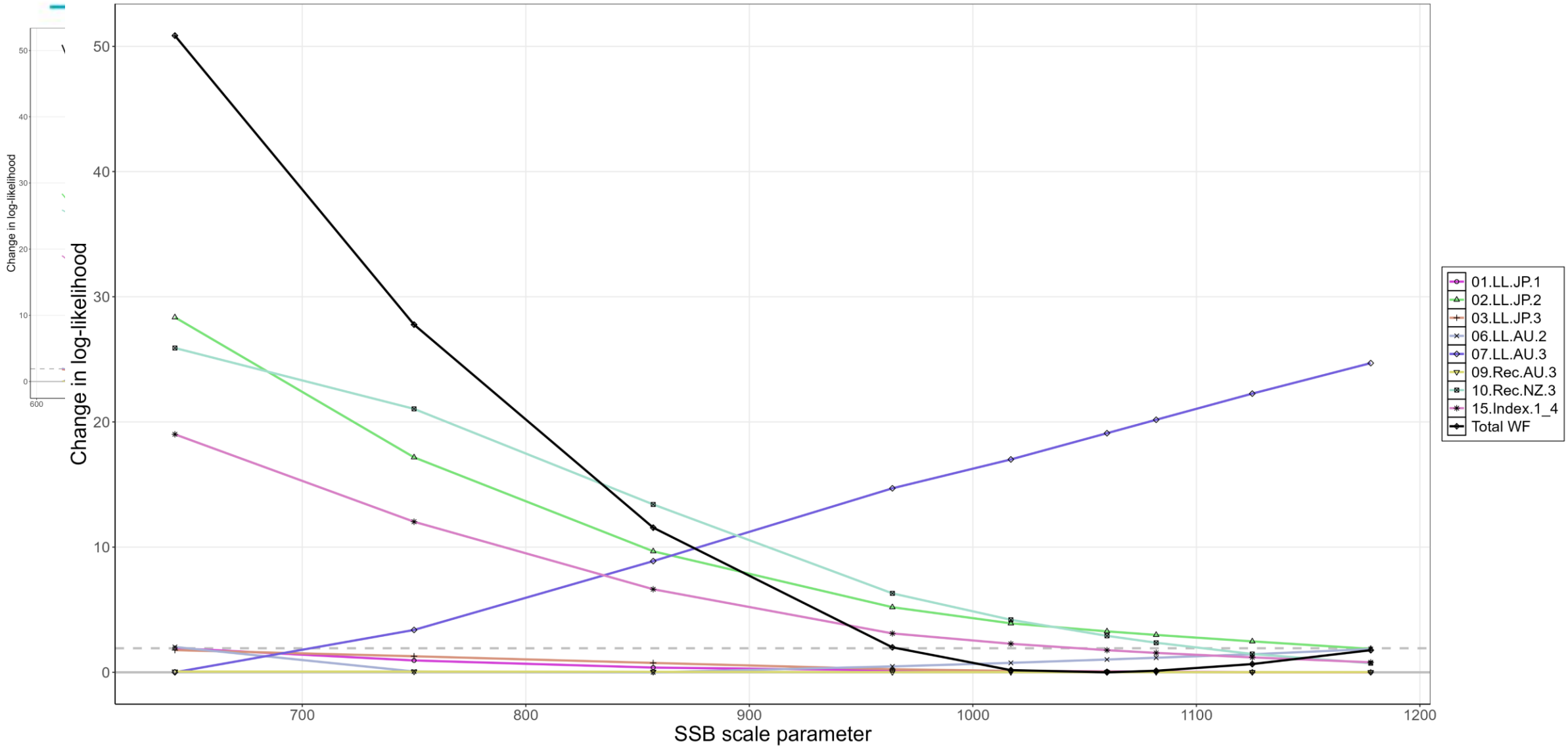
Summary of ref points

Metric	Mean	Median	Min	10%ile	90%ile	Max
C_{latest}	1241	1241	1234	1237	1241	1248
F_{MSY}	0.34	0.35	0.21	0.25	0.43	0.45
f_{mult}	0.82	0.78	0.34	0.45	1.26	1.63
$F_{\text{recent}}/F_{\text{MSY}}$	1.43	1.28	0.61	0.79	2.24	2.95
MSY	1789	1760	1698	1708	1907	2067
SB_0	10145	9457	7250	7850	13153	18950
$SB_{F=0}$	8527	7725	5517	6121	11743	18384
SB_{latest}/SB_0	0.12	0.12	0.06	0.08	0.17	0.19
$SB_{\text{latest}}/SB_{F=0}$	0.15	0.15	0.06	0.09	0.21	0.25
$SB_{\text{latest}}/SB_{\text{MSY}}$	0.63	0.62	0.19	0.31	0.98	1.19
SB_{MSY}	2224	1897	1138	1283	3574	5599
SB_{MSY}/SB_0	0.21	0.20	0.14	0.16	0.26	0.30
$SB_{\text{MSY}}/SB_{F=0}$	0.25	0.25	0.18	0.21	0.30	0.34
$SB_{\text{recent}}/SB_{F=0}$	0.14	0.14	0.06	0.09	0.20	0.23
$SB_{\text{recent}}/SB_{\text{MSY}}$	0.60	0.59	0.18	0.30	0.91	1.10
$Y_{Frecent}$	1563	1704	137	1079	1861	1931
Including estimation uncertainty						
	Mean	Median	Min	10%ile	90%ile	Max
$SB_{\text{recent}}/SB_{F=0}$	0.14	0.14	0.05	0.09	0.20	0.26
$F_{\text{recent}}/F_{\text{MSY}}$	1.42	1.27	0.58	0.74	2.30	3.02
$SB_{\text{recent}}/SB_{\text{MSY}}$	0.60	0.60	0.18	0.29	0.95	1.24

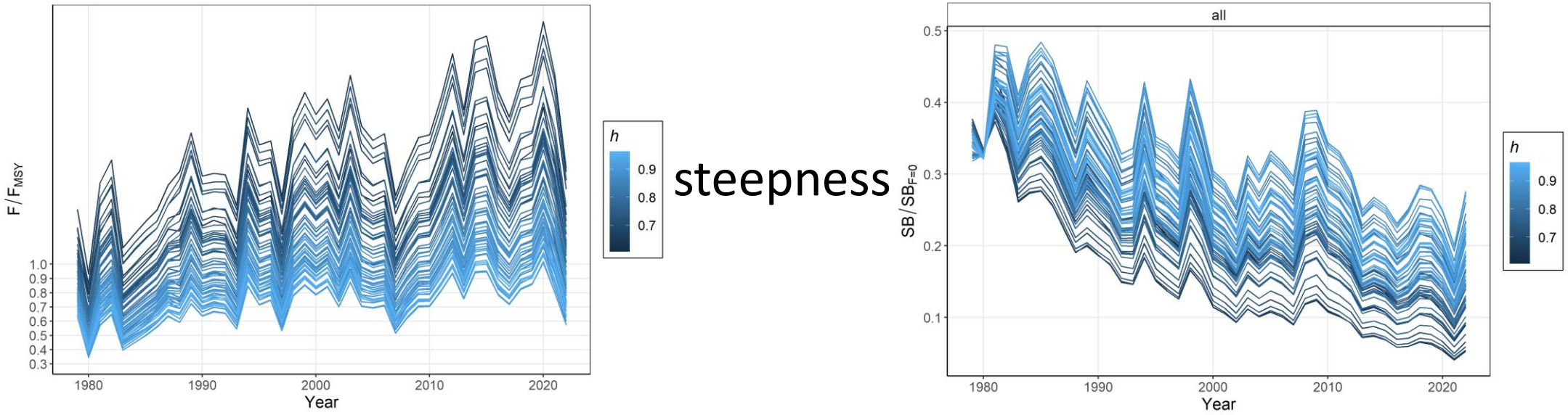
LF by fleet

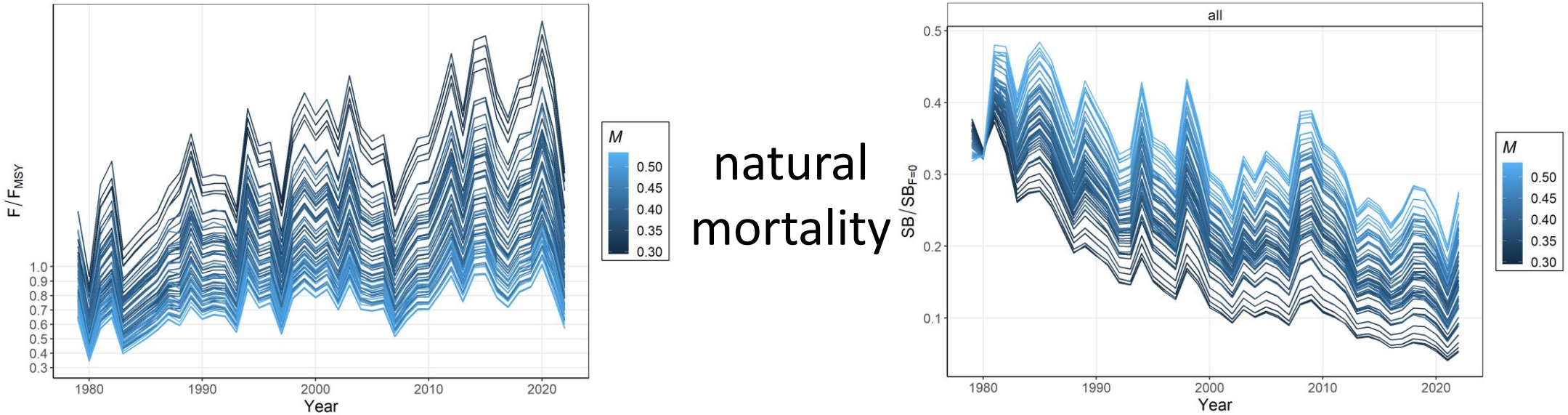

Change in log-likelihood
20
15
10
5
0
650
700
750
800
850
SSB scale parameter
01.LL.JP.1
02.LL.JP.2
03.LL.JP.3
05.LL.TW.4
06.LL.AU.2
07.LL.AU.3
08.LL.NZ.3
10.Rec.NZ.3
11.LL.ALL.1
12.LL.ALL.2
13.LL.ALL.3
14.LL.ALL.4
15.Index.1_4
Total LF

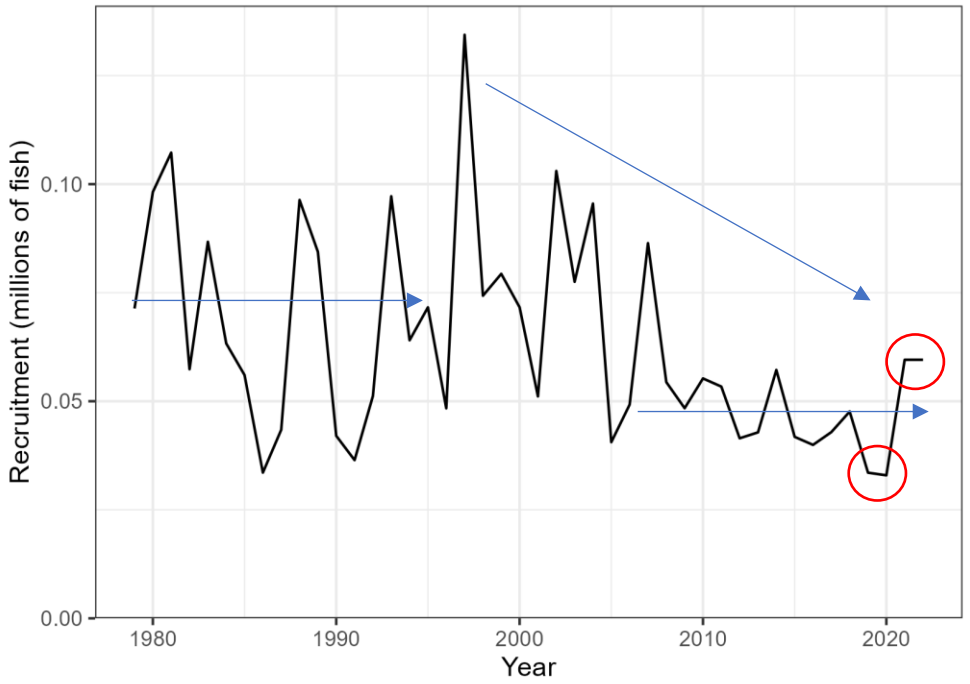
WF by fleet


Change in log-likelihood
SSB scale parameter
0
10
20
30
40
50
700
800
900
1000
1100
1200
01.LL.JP.1
02.LL.JP.2
03.LL.JP.3
06.LL.AU.2
07.LL.AU.3
09.Rec.AU.3
10.Rec.NZ.3
15.Index.1_4
Total WF

Model output – Ref pts across the range of *h*/M values






Recruitment (millions of fish)
0.10
0.05
0.00
1980
1990
2000
2010
2020
Year

Model output – SBio and Depletion across the range of *h*/M values

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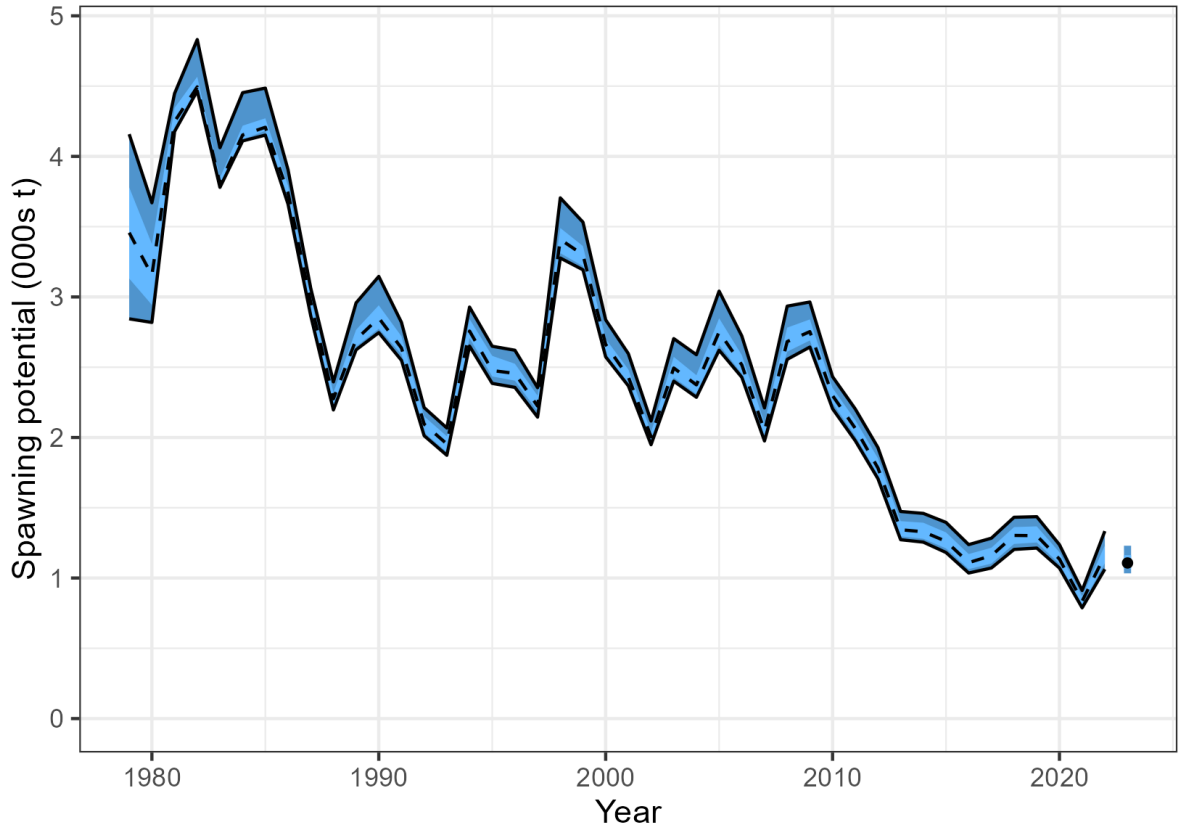
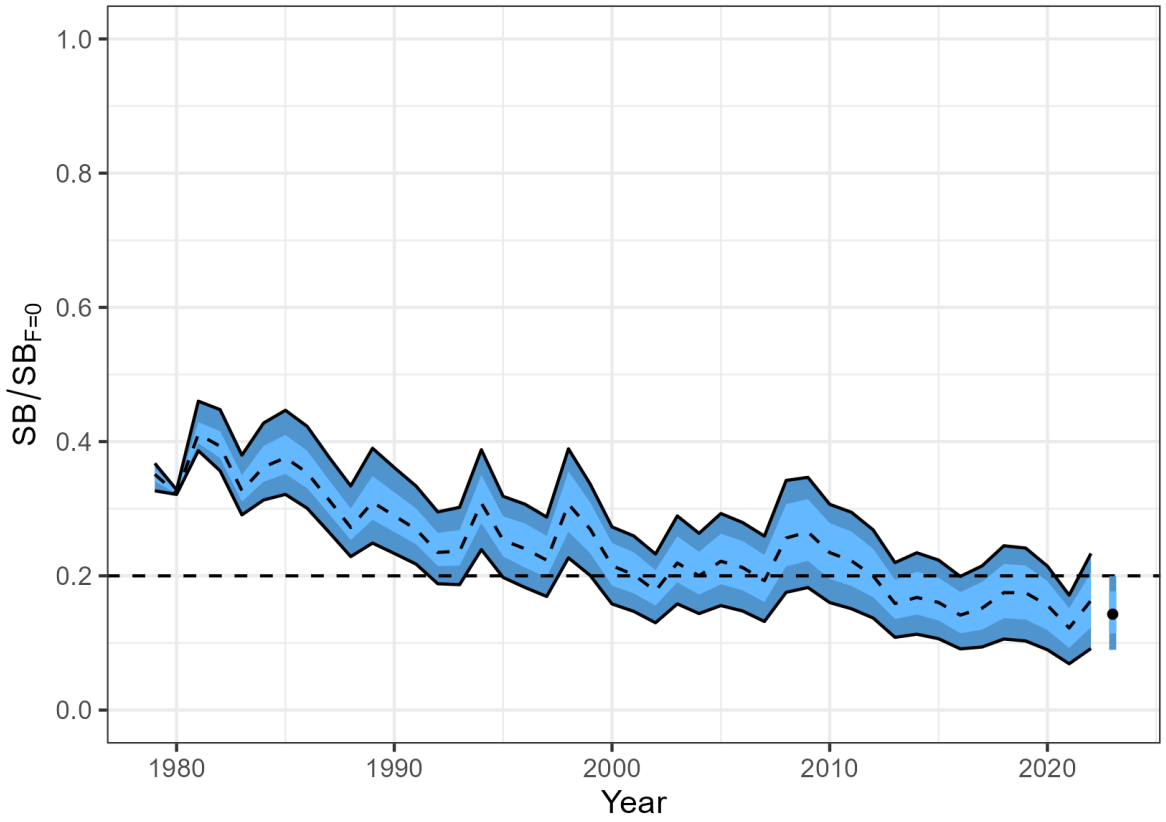
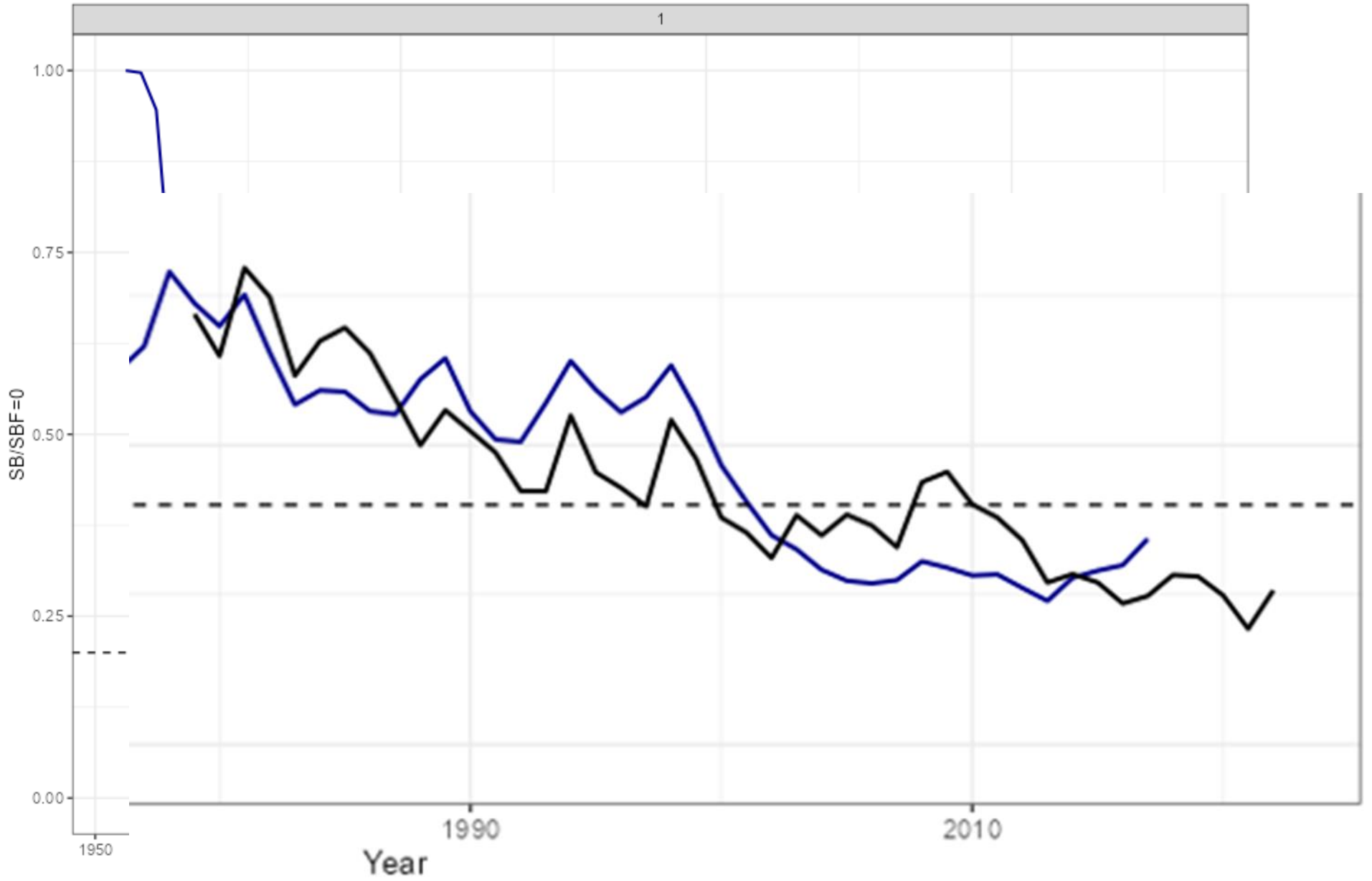
Spawning potential

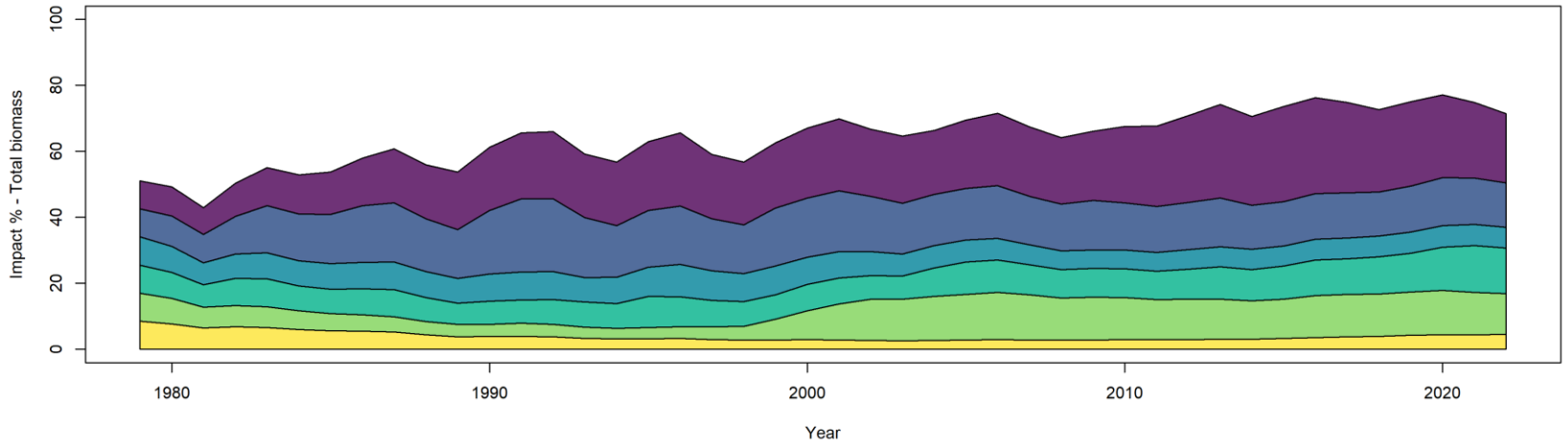


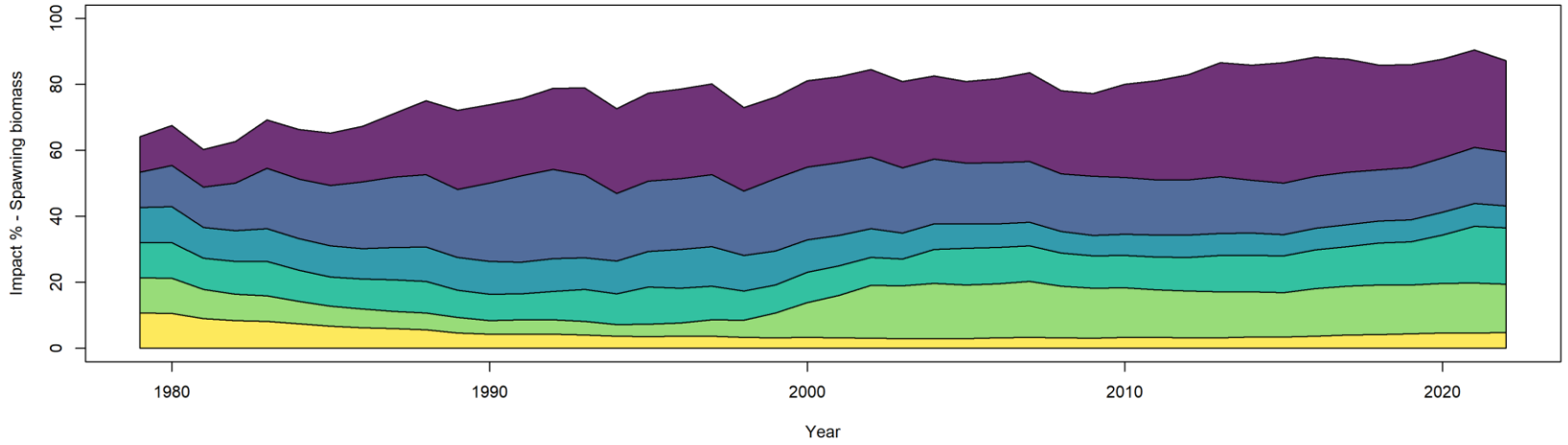
Depletion




1
1.00
0.75
0.50
0.25
0.00
SB/SBF=0
1950
1990
2010
Year

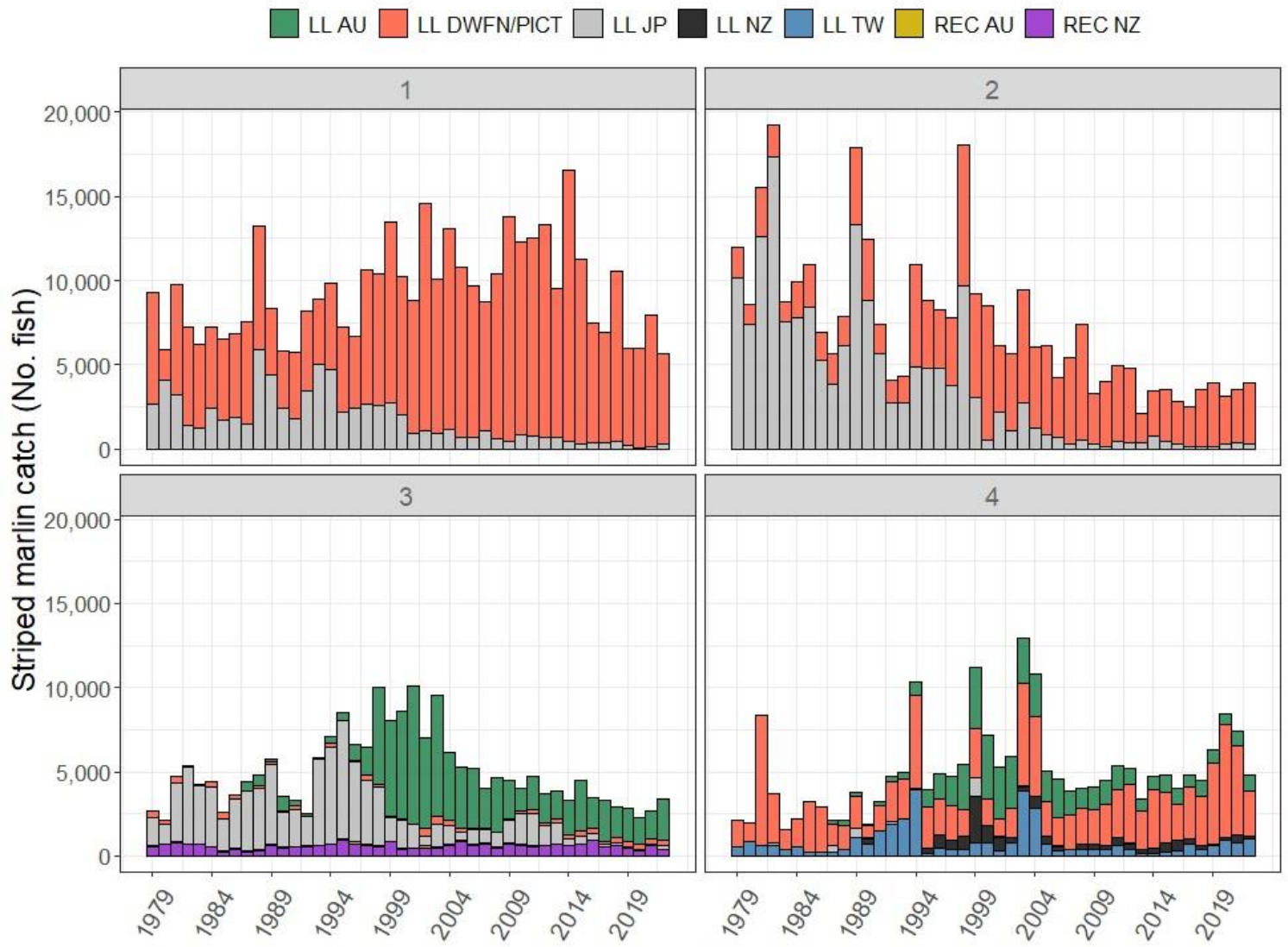
Fisheries impact



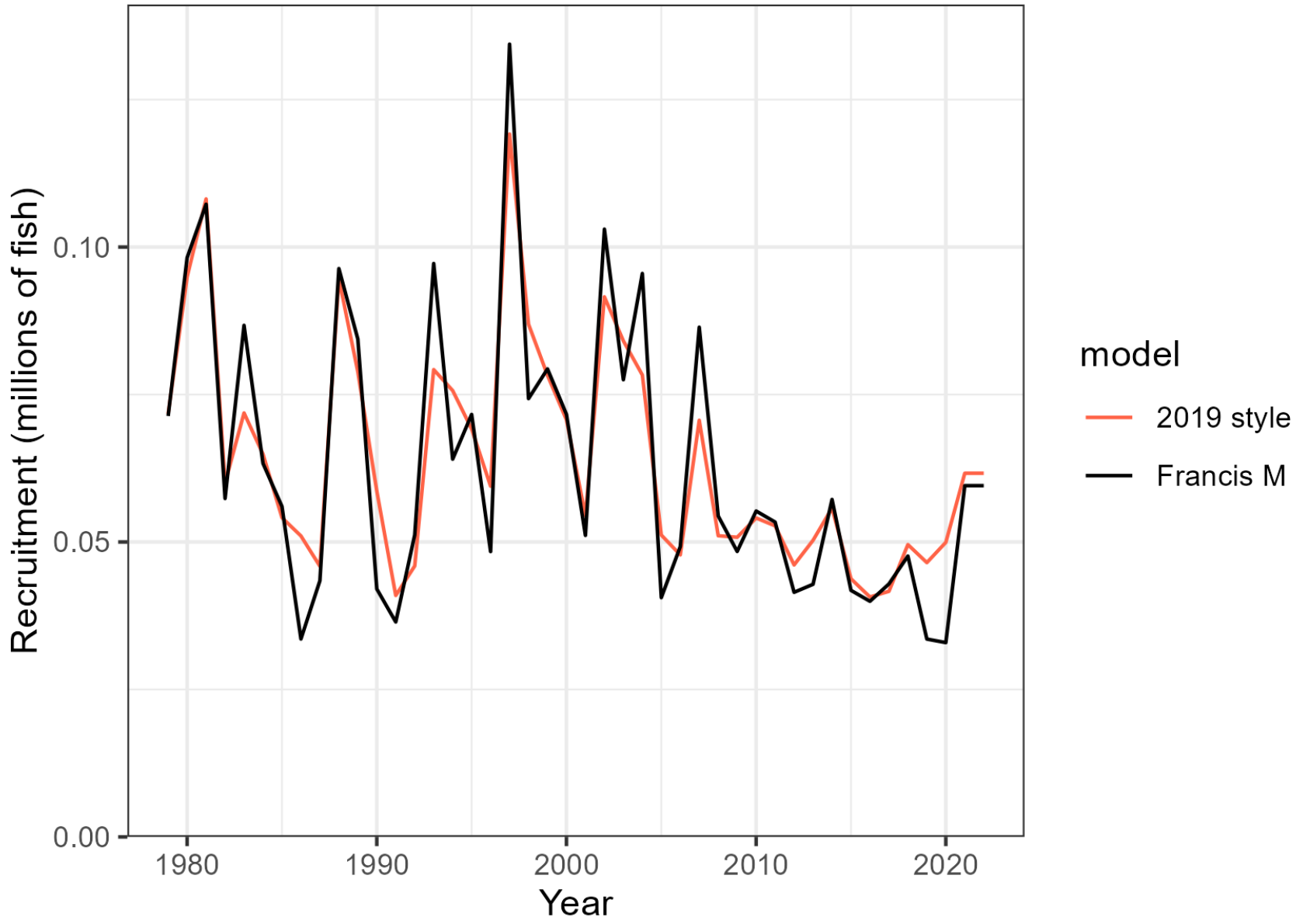


Fishery groups

- LL 1
- LL 2
- LL 3
- LL 4
- AU-NZ LL
- AU-NZ REC


LL AU
LL DWFN/PICT
LL JP
LL NZ
LL TW
REC AU
REC NZ
1
2
3
4
Striped marlin catch (No. fish)
20,000
15,000
10,000
5,000
0
1979
1984
1989
1994
1999
2004
2009
2014
2019

Diagnostic case using different data weighting



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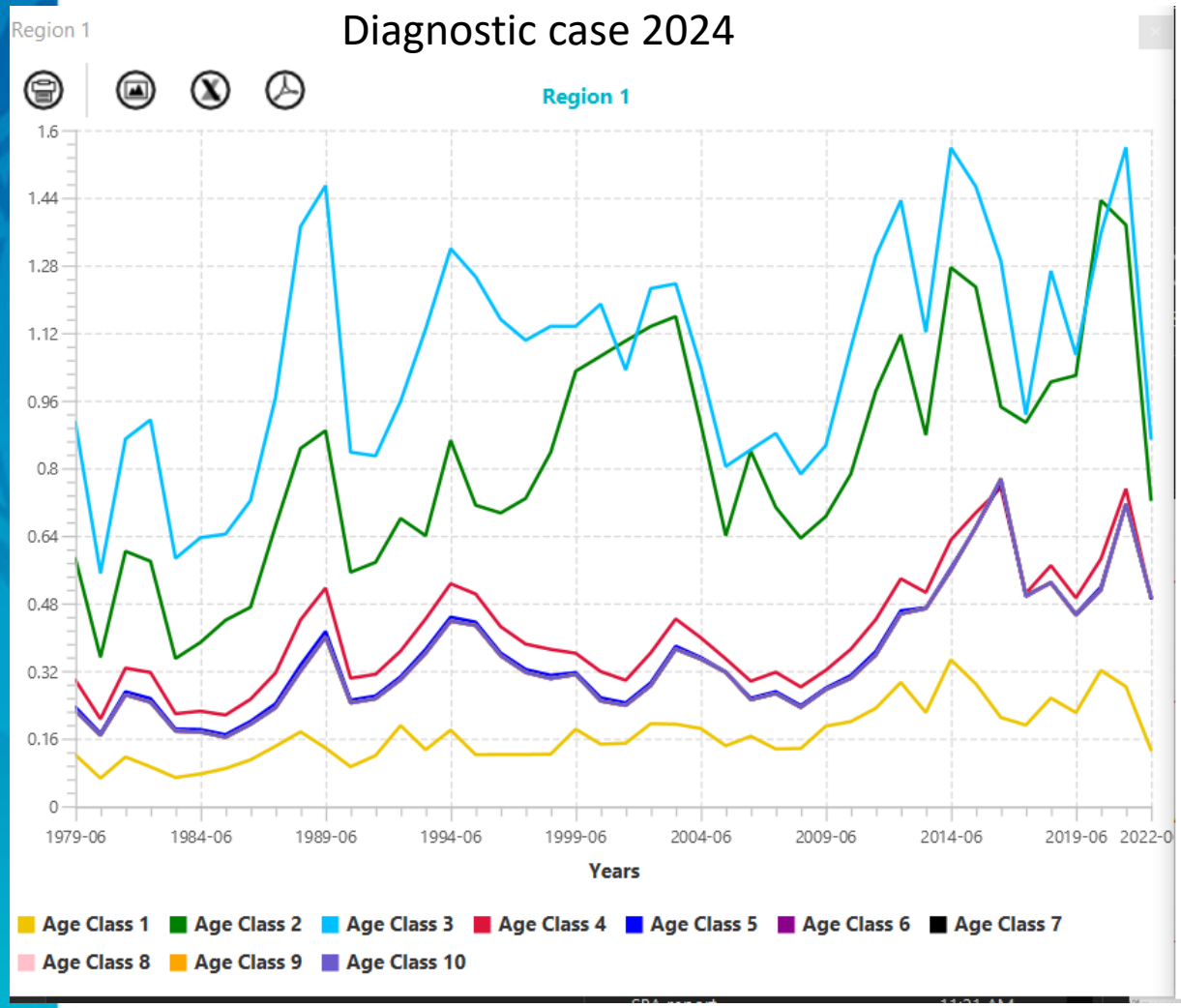
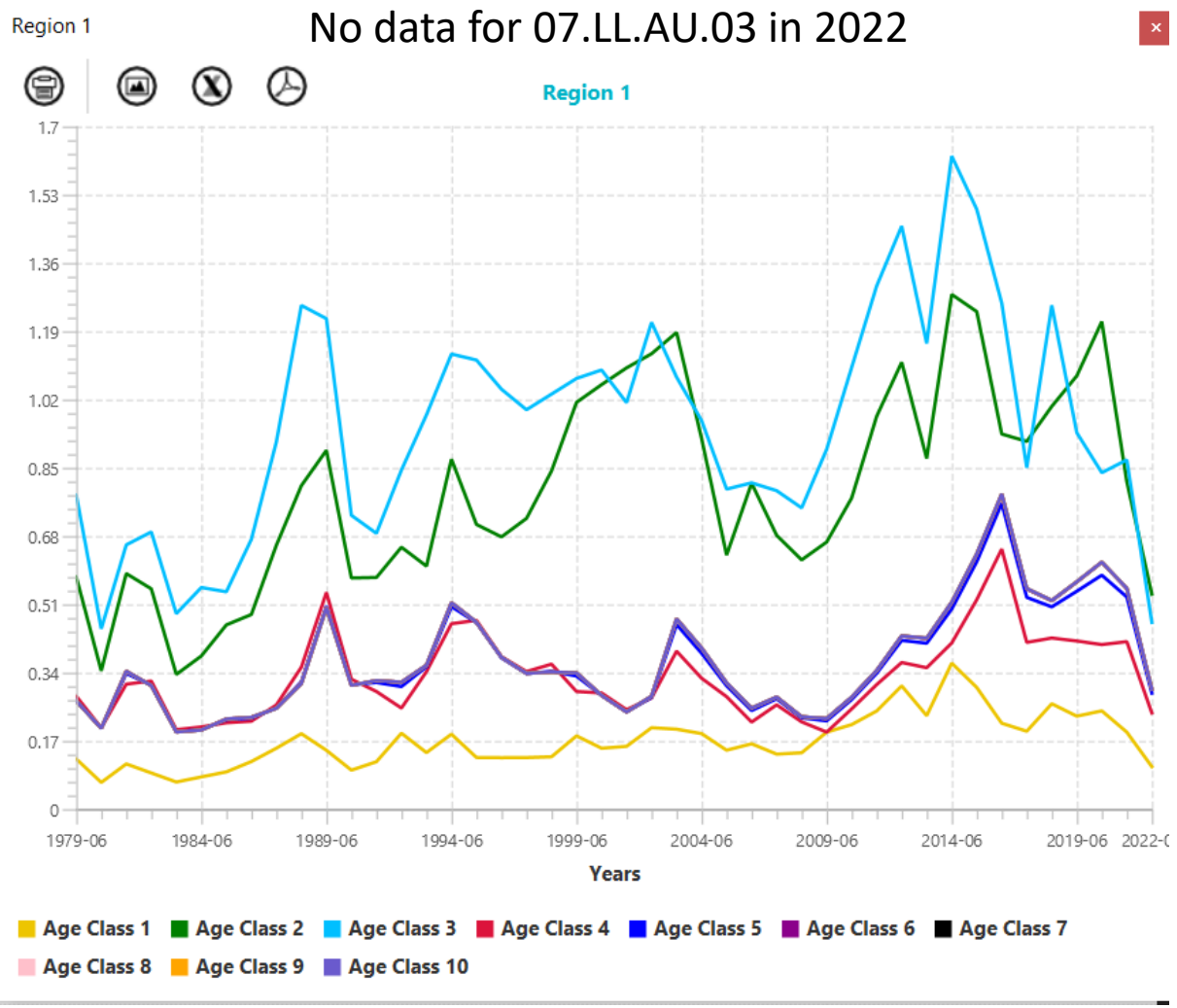
Diagnostic case 2024



No data for 07.LL.AU.03 in 2022



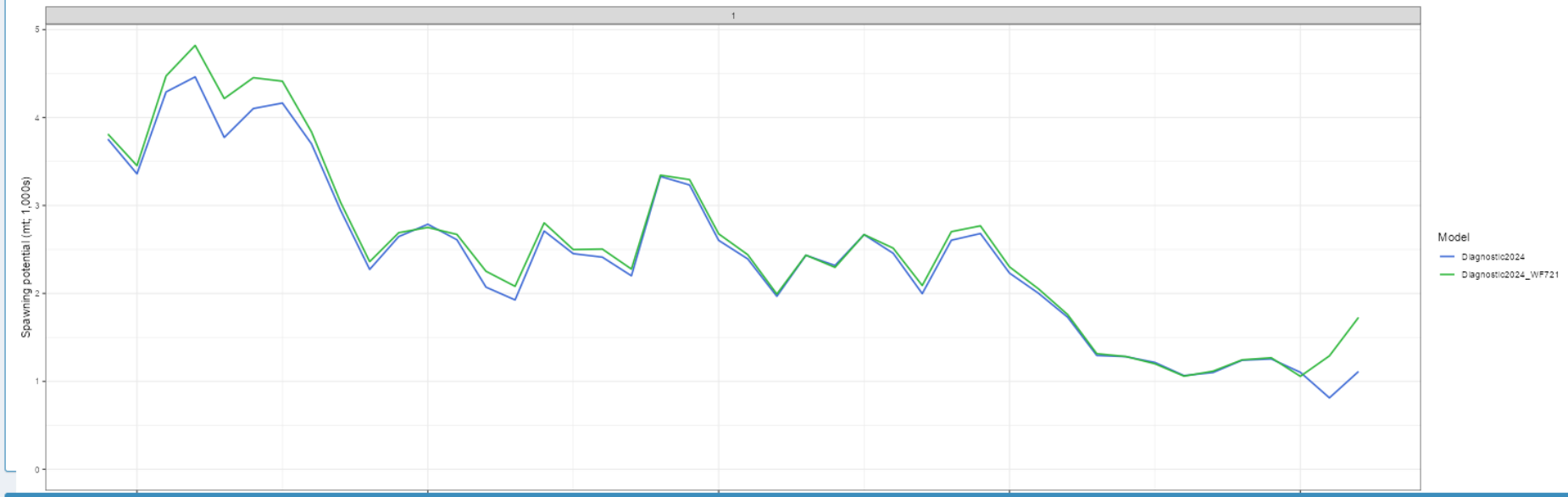
Spawning potential

Region selector

(•) Separate ( ) Combined

Scales

( ) Different (•) Same



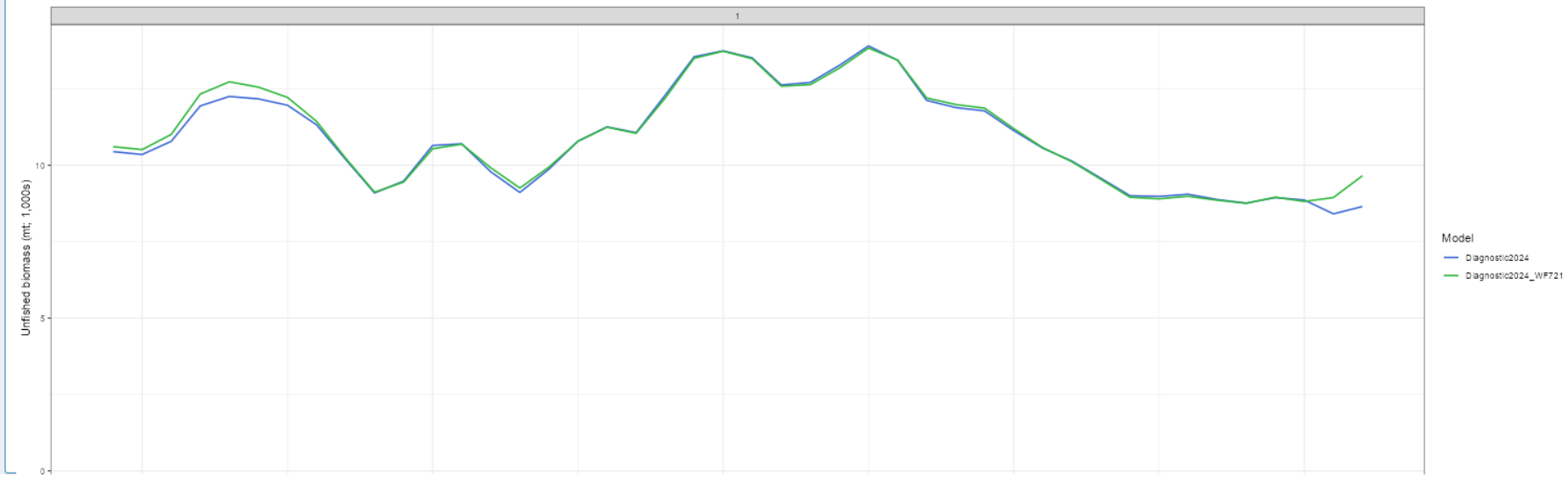
Unfished biomass

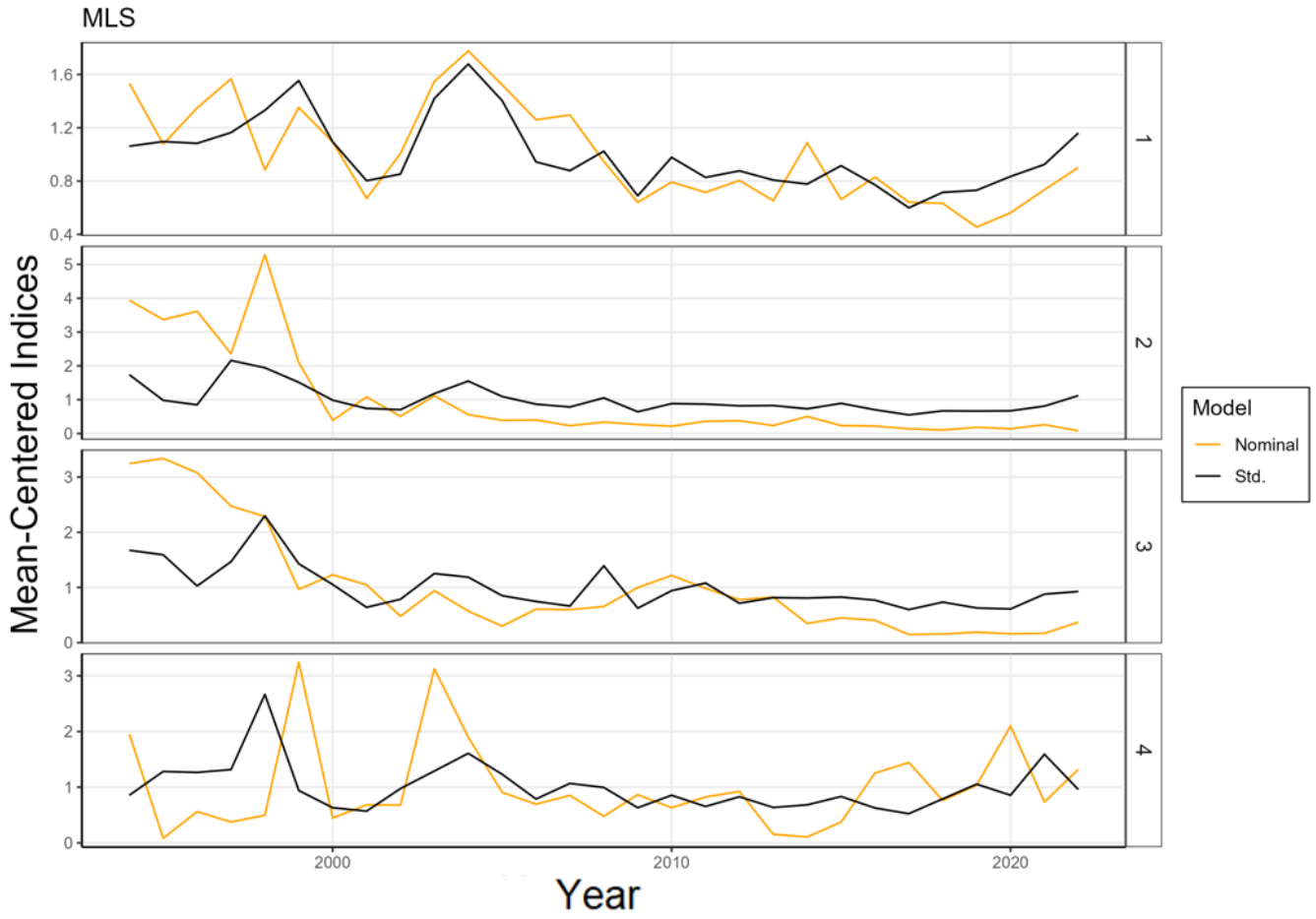
Region selector

(•) Separate ( ) Combined

Scales

( ) Different (•) Same




MLS
Mean-Centered Indices
Year
Model
Nominal
Std.
1
2
3
4
2000
2010
2020