STOCK ASSESSMENT OF SKIPJACK TUNA IN THE WESTERN AND CENTRAL PACIFIC OCEAN

SA-WP-O4

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Oceanic Fisheries Programme

SPC

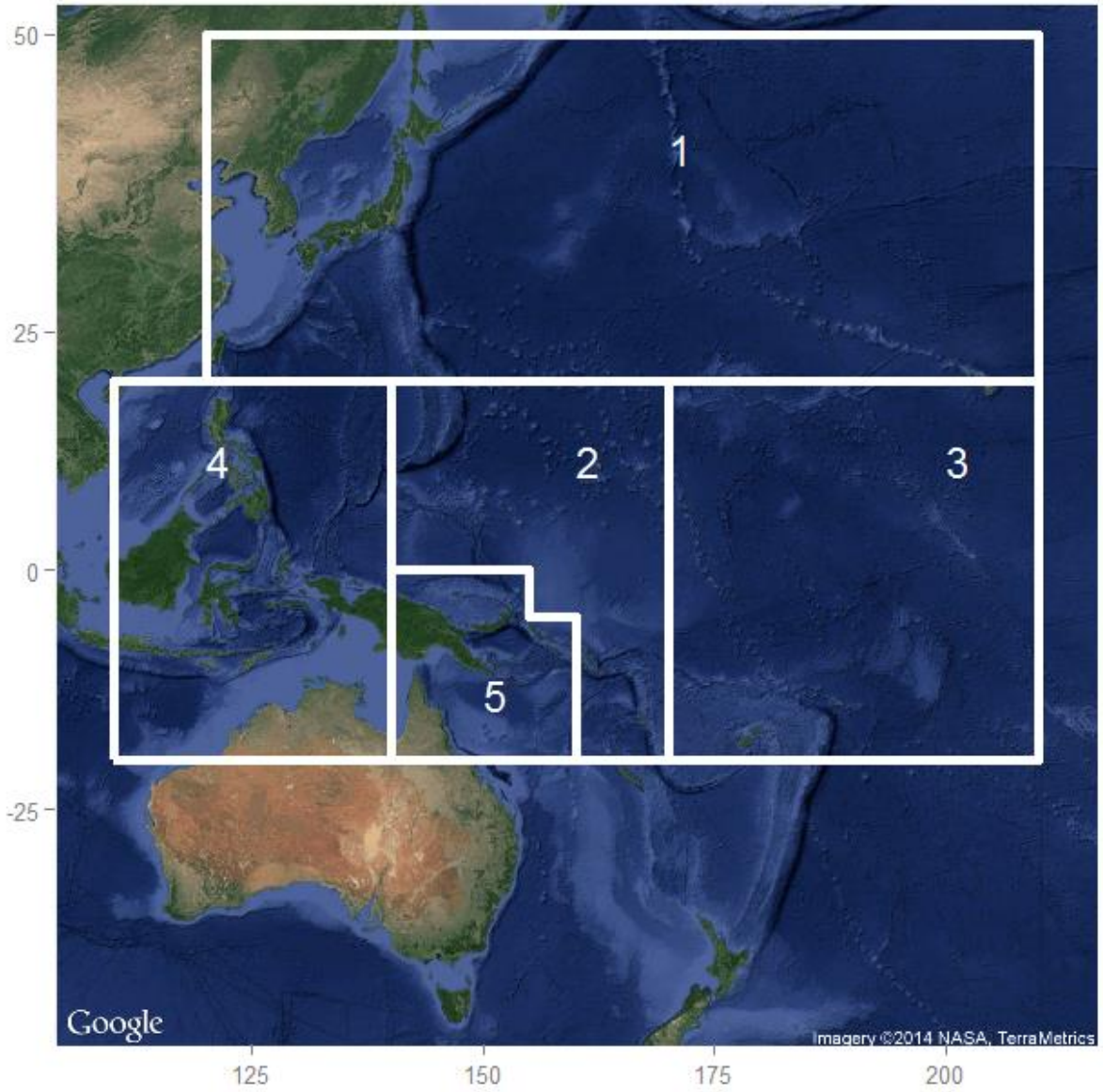
Overview

- What's new in the 2016 assessment
- Reference case settings
- Reference case results
- Sensitivity/uncertainty analyses
- Stock status and conclusions
- Inputs: SA-IP-04 Tremblay-Boyer et al. (CPUE PNG)
  SA-IP-05 McKechnie et al. (Tagging input file)
  SA-IP-06 McKechnie (Fisheries definitions/data summaries)
  SA-IP-12 Bigelow et al. (CPUE PH R4)
  SA-WP-05 Kiyofuji (CPUE JP PL R1-3)
  Also see SA-IP-09 Kiyofuji & Ochi (Alternative spatial structures)

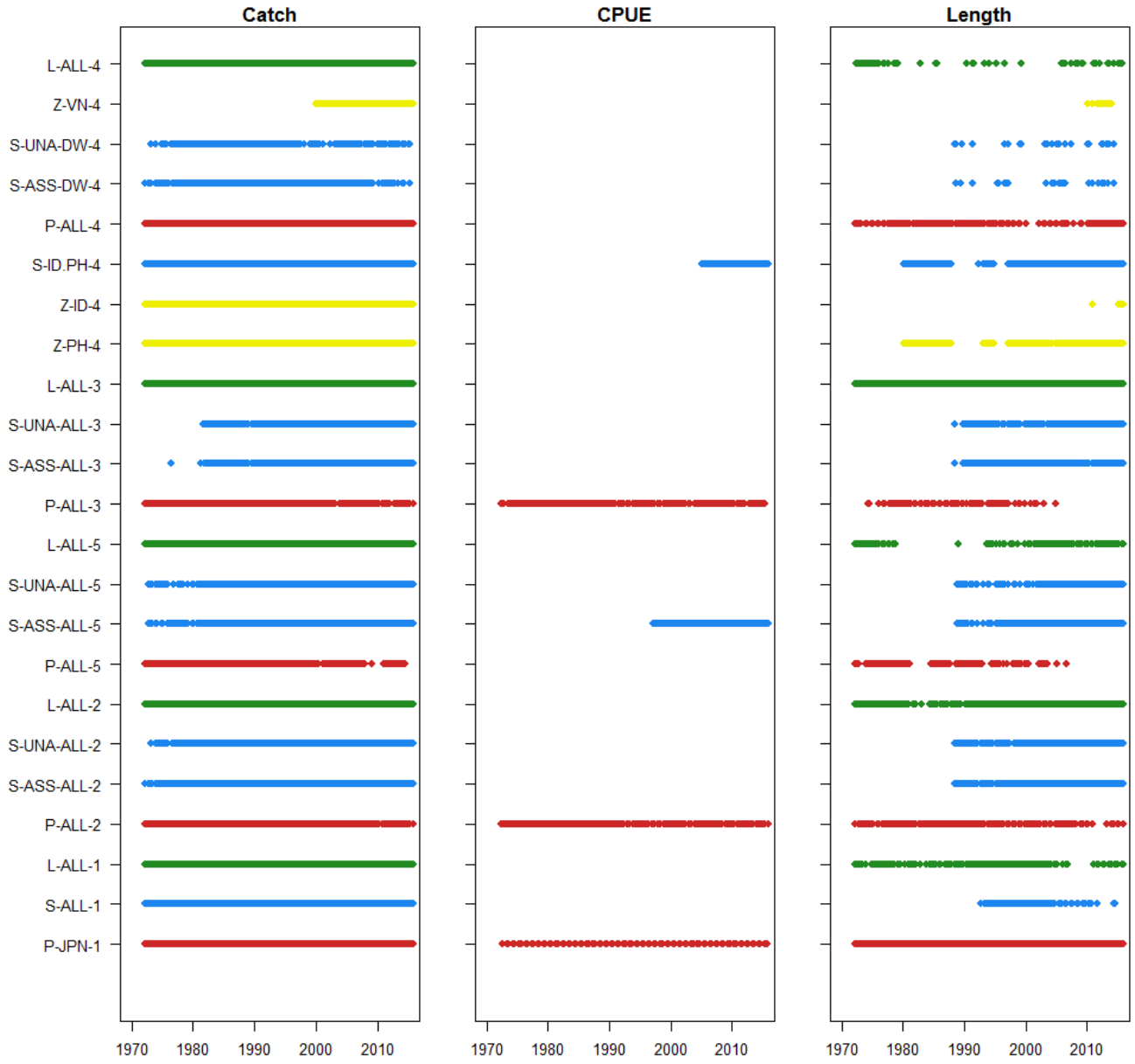
Main changes from 2014

- Data updated to end of 2015
- Minor changes to fishery definitions
- Japanese tag releases pre 1998 unavailable
- Incorporates new features of Multifan-CL
- Tagging likelihood uses reparameterised negative binomial; improves estimation of overdispersion
- More exploration of data weightings
- Several model parameters (e.g. selectivity) modified

2016 Model Regions



Summary of available data



- 23 fisheries
- 1972-2015
- Quarterly time steps
- 5 Standardised indices (1 per region)
- Size data = lengths
- 4 tagging programmes

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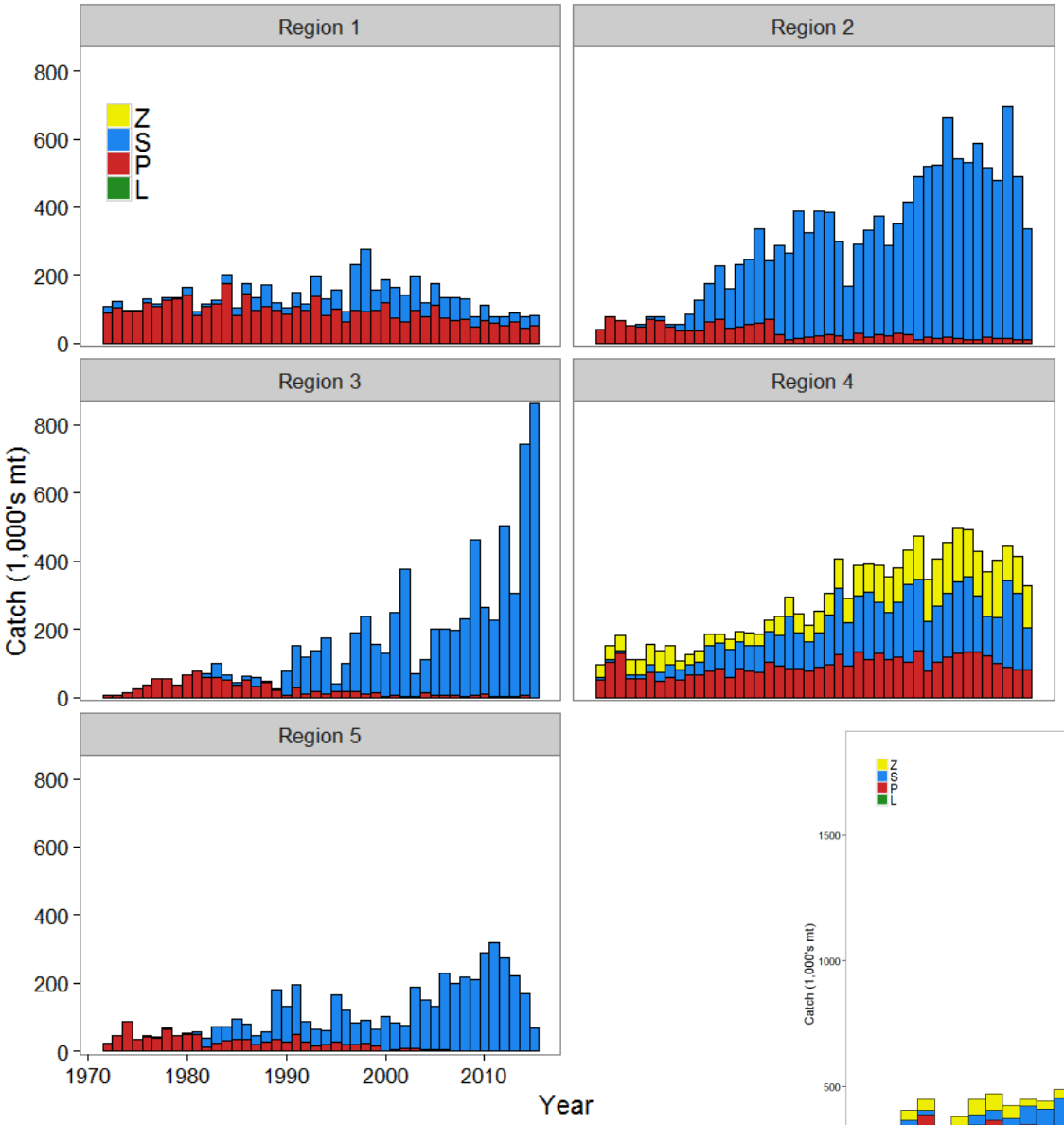
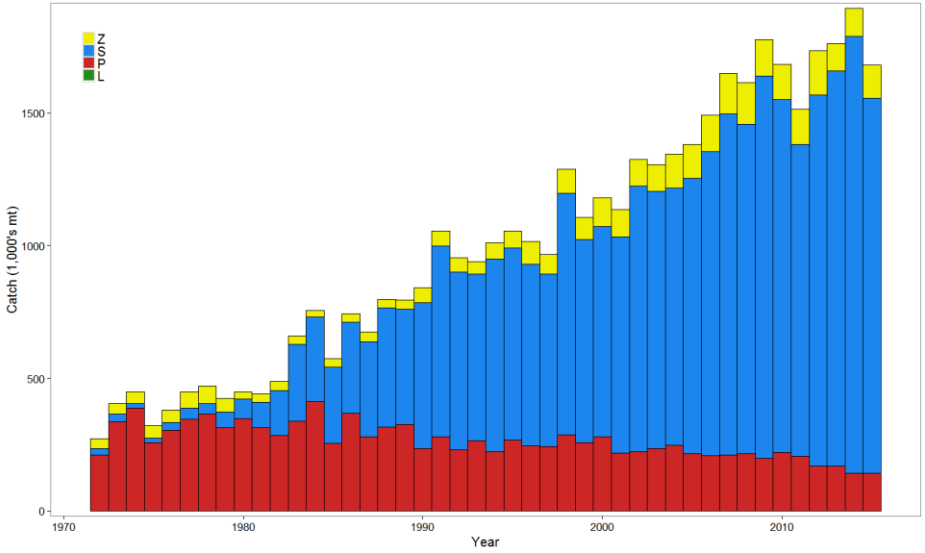
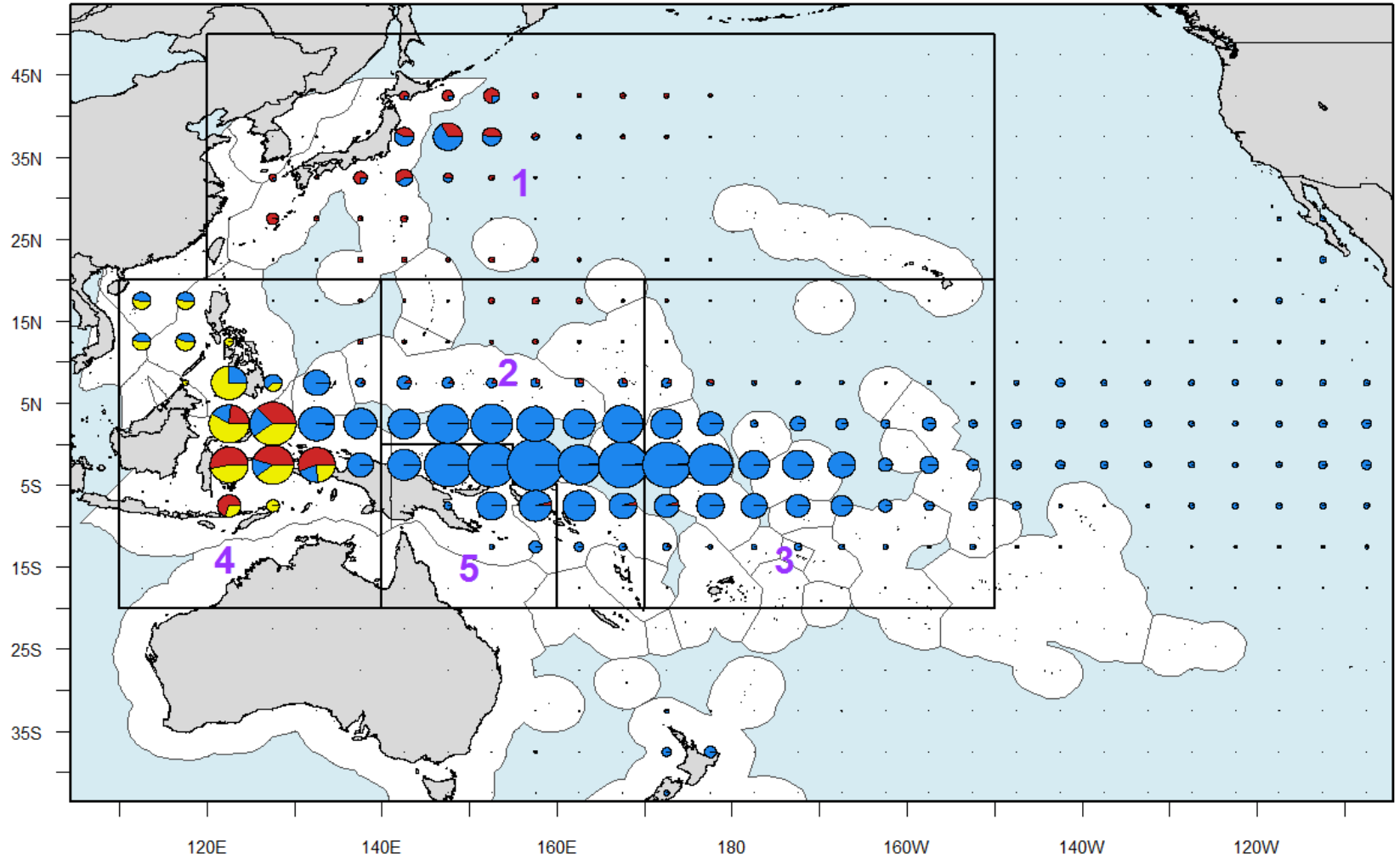
Catch

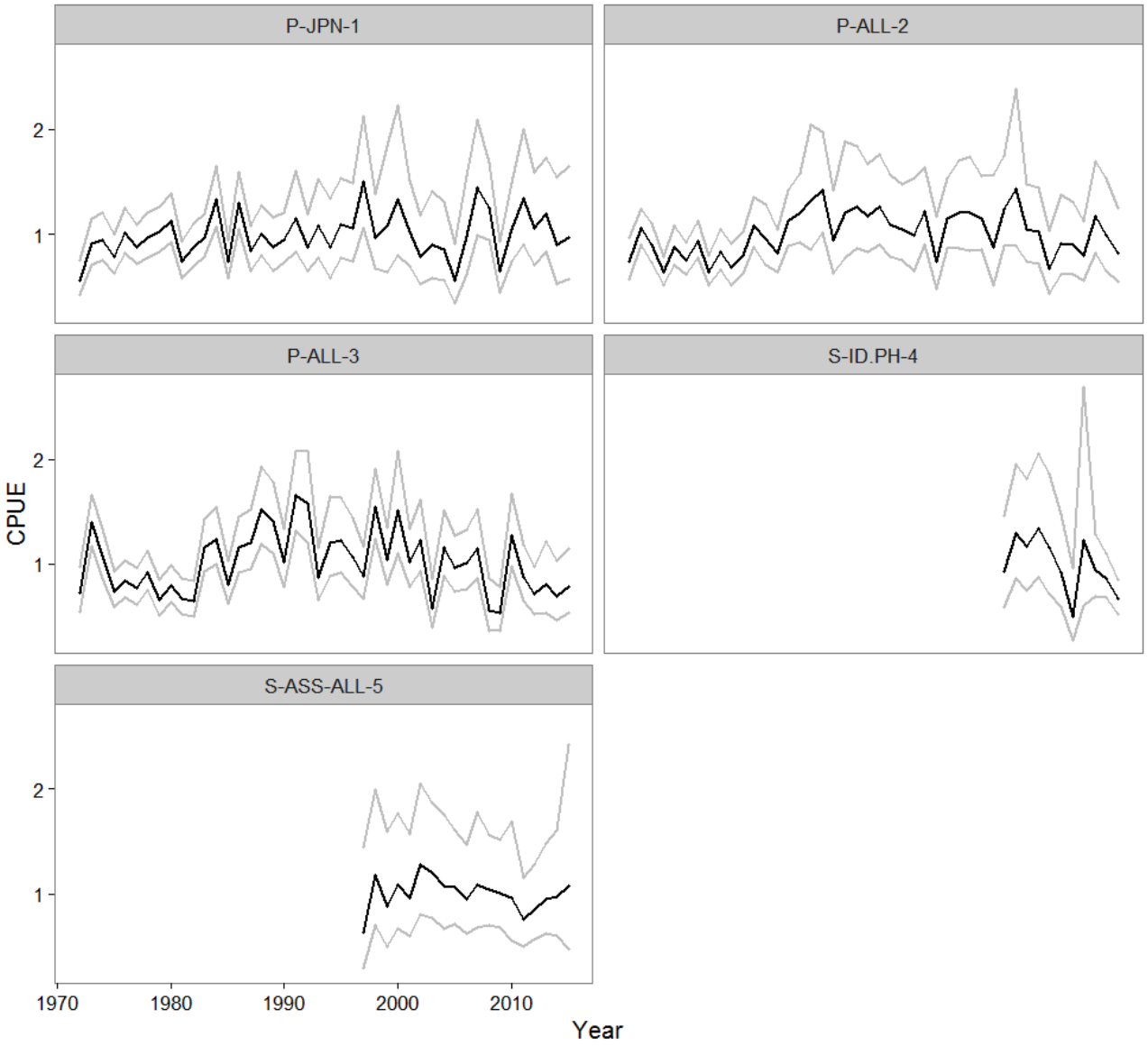




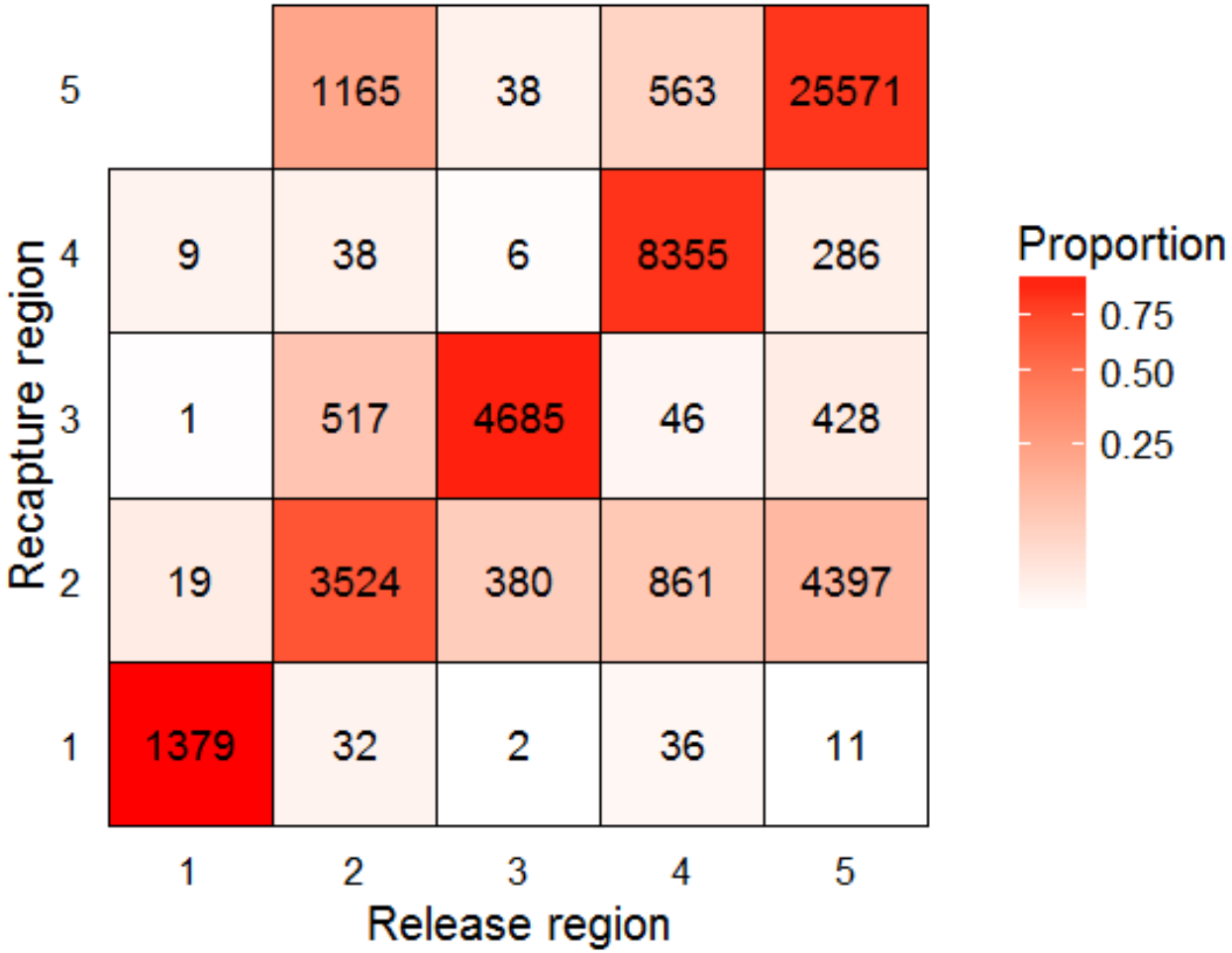
Catch distribution



Standardized CPUE indices



Observed movement of tagged fish

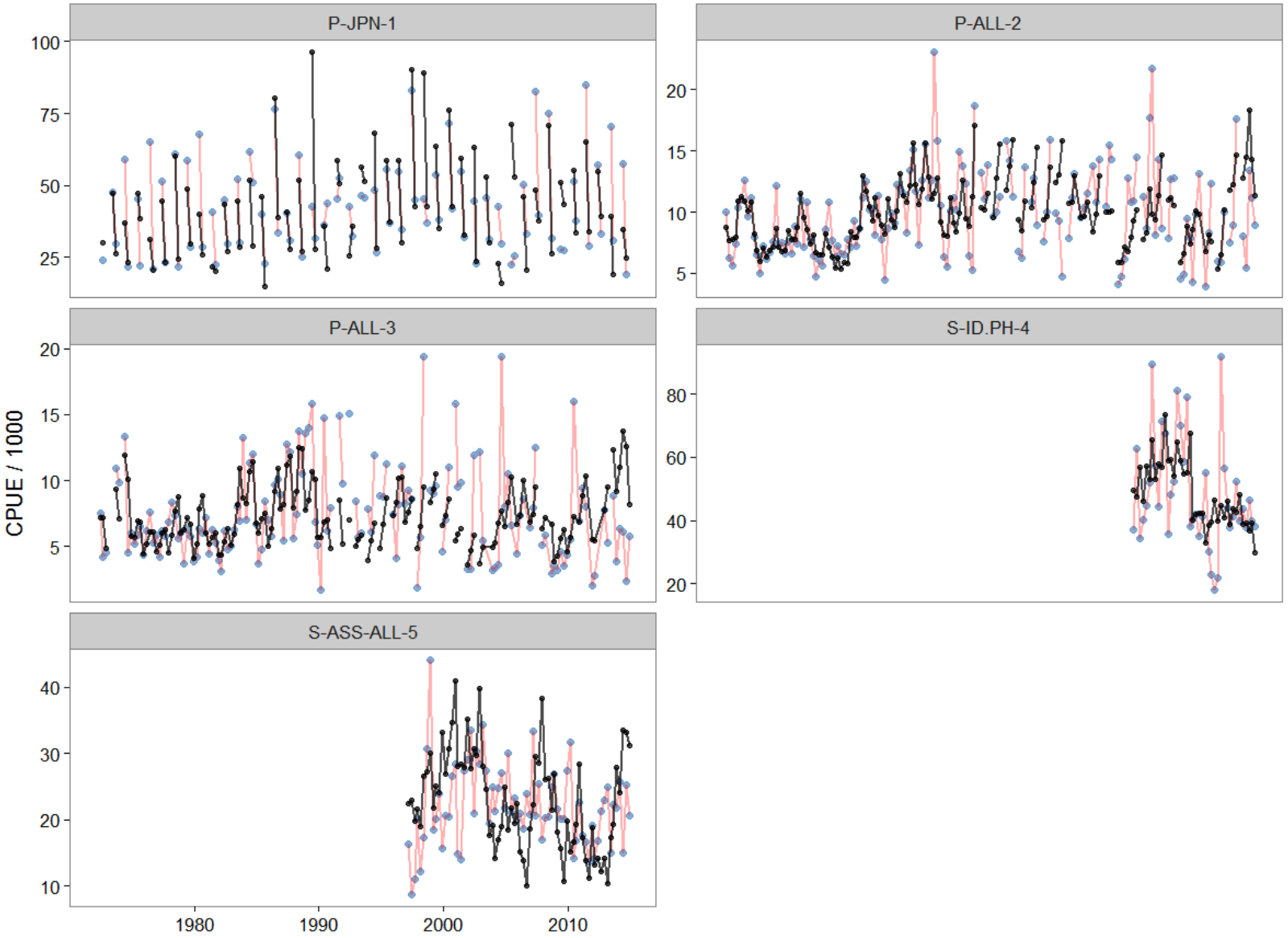


- 277,562 effective releases
- (462,842 raw releases)
- 52,929 recaptures

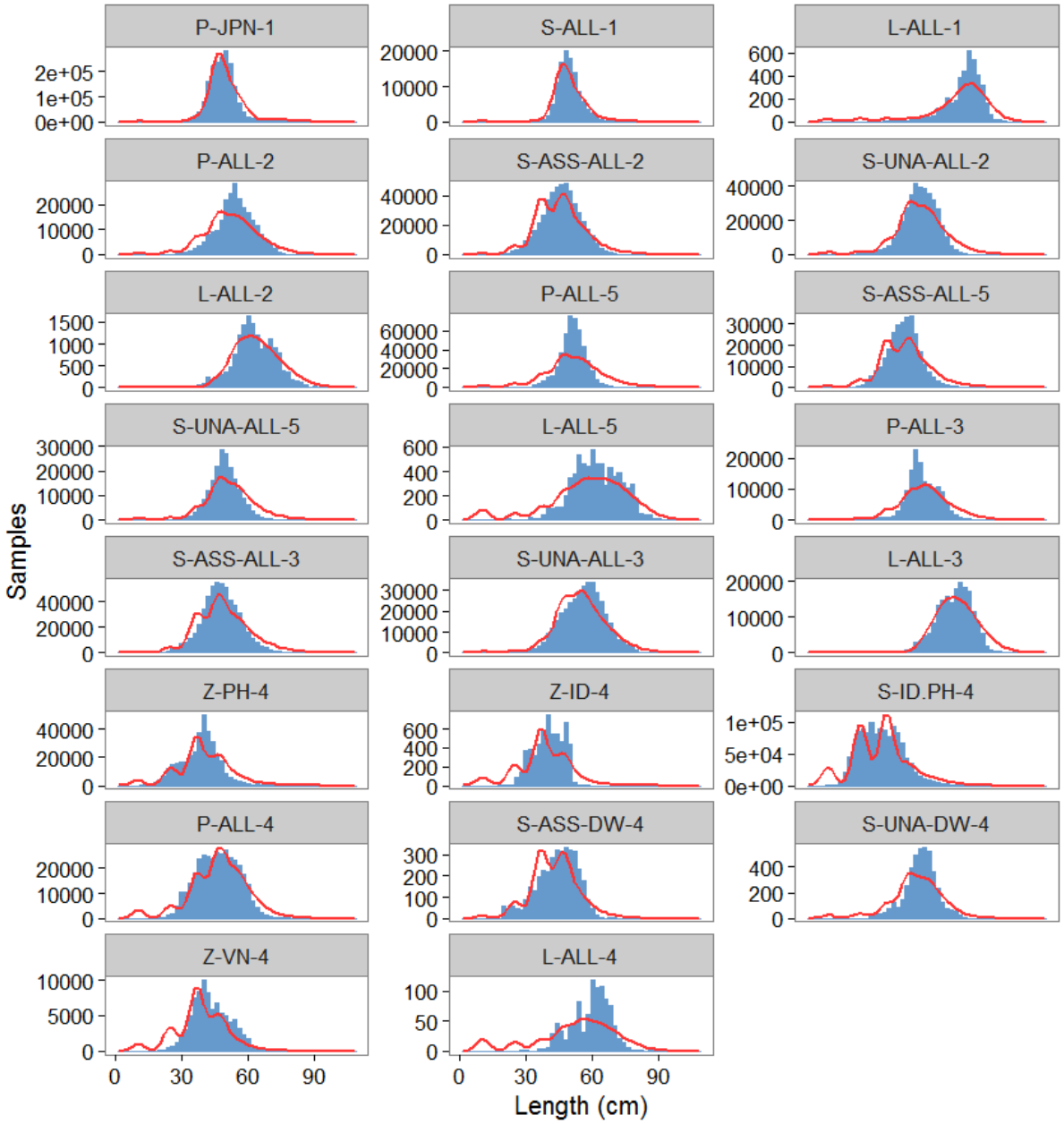
Settings of reference case MFCL runs

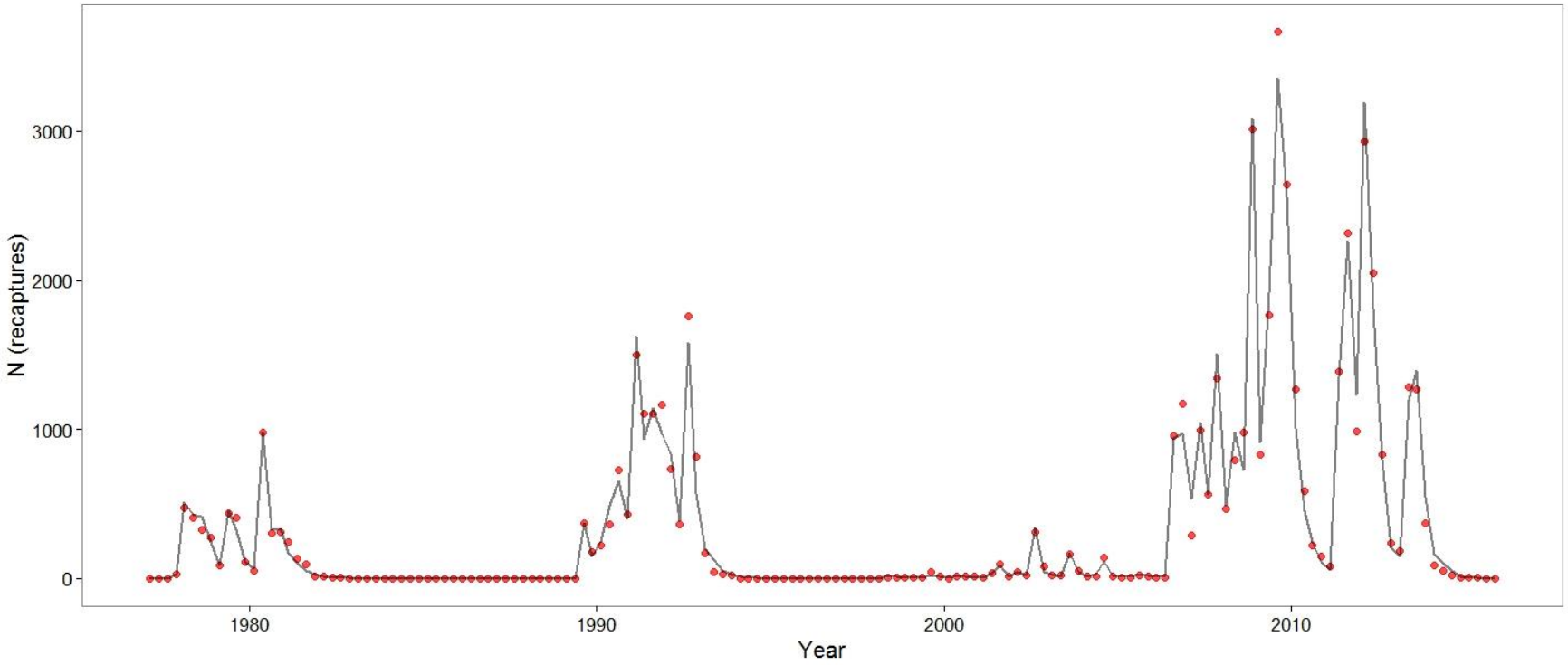
- SRR steepness set to 0.8
- Growth function same as 2014 reference case
- Tag mixing set to 1 quarter time period
- Age-specific natural mortality estimated, but invariant over time/region
- Tagging likelihood overdispersion set at 2014 reference model value
- Length composition data scalar 20
- Movement allowed to be age-dependent
- Maturity knife-edge after 2 quarters
- Last 2 quarterly recruitments = mean of long-term recs

Reference case – CPUE fit

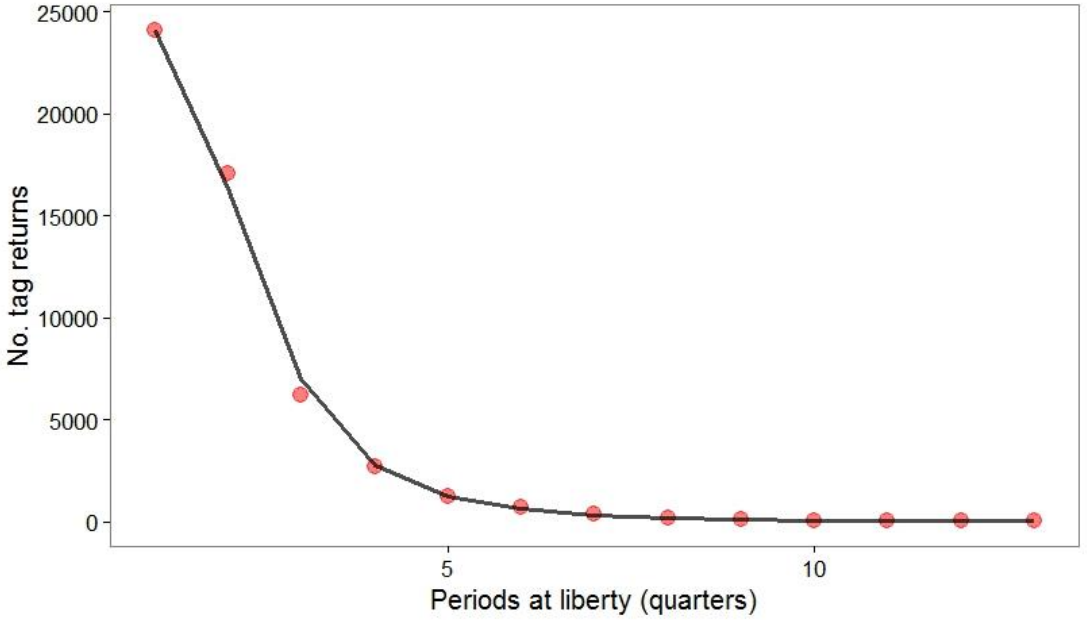


Reference case – length fits





Reference case – tagging fit



Recruitment and spawning biomass

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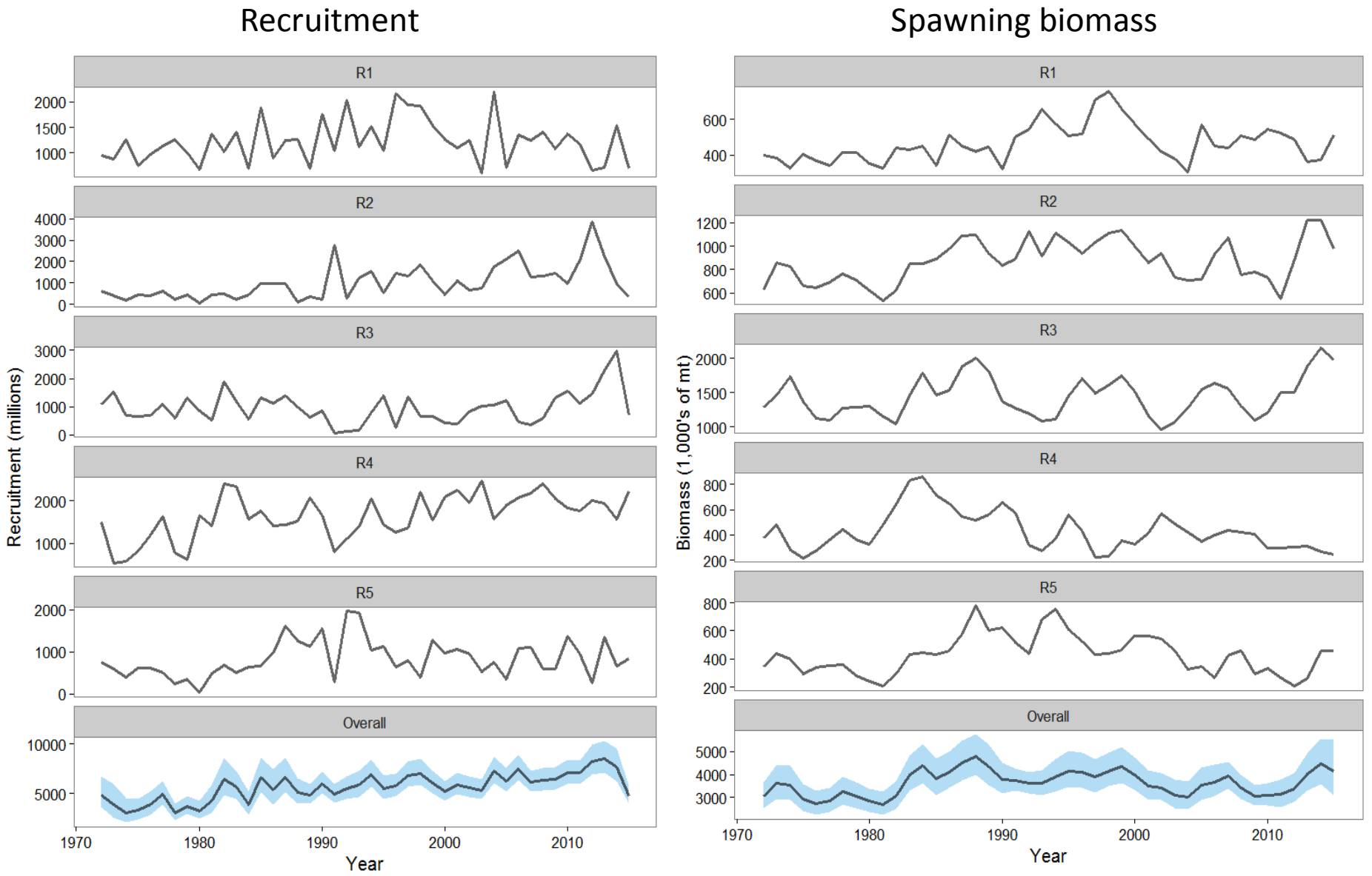
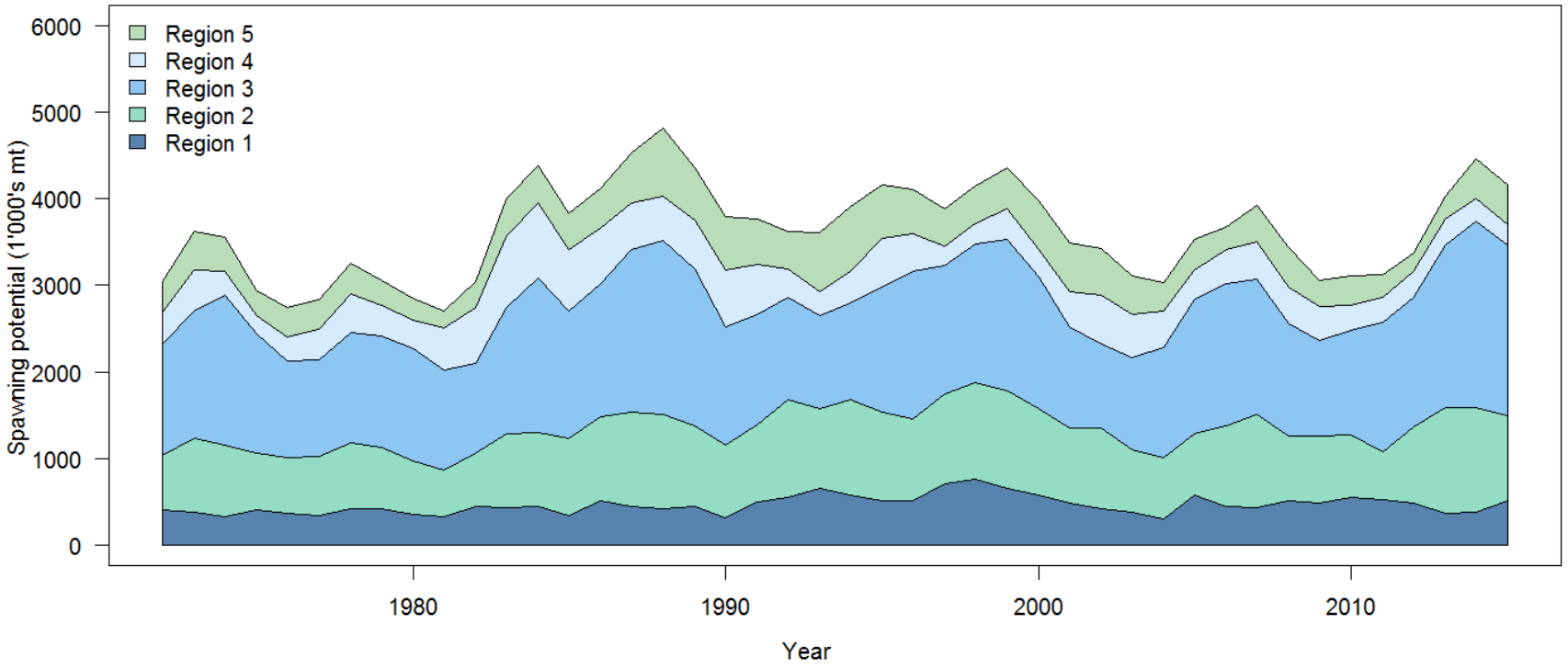
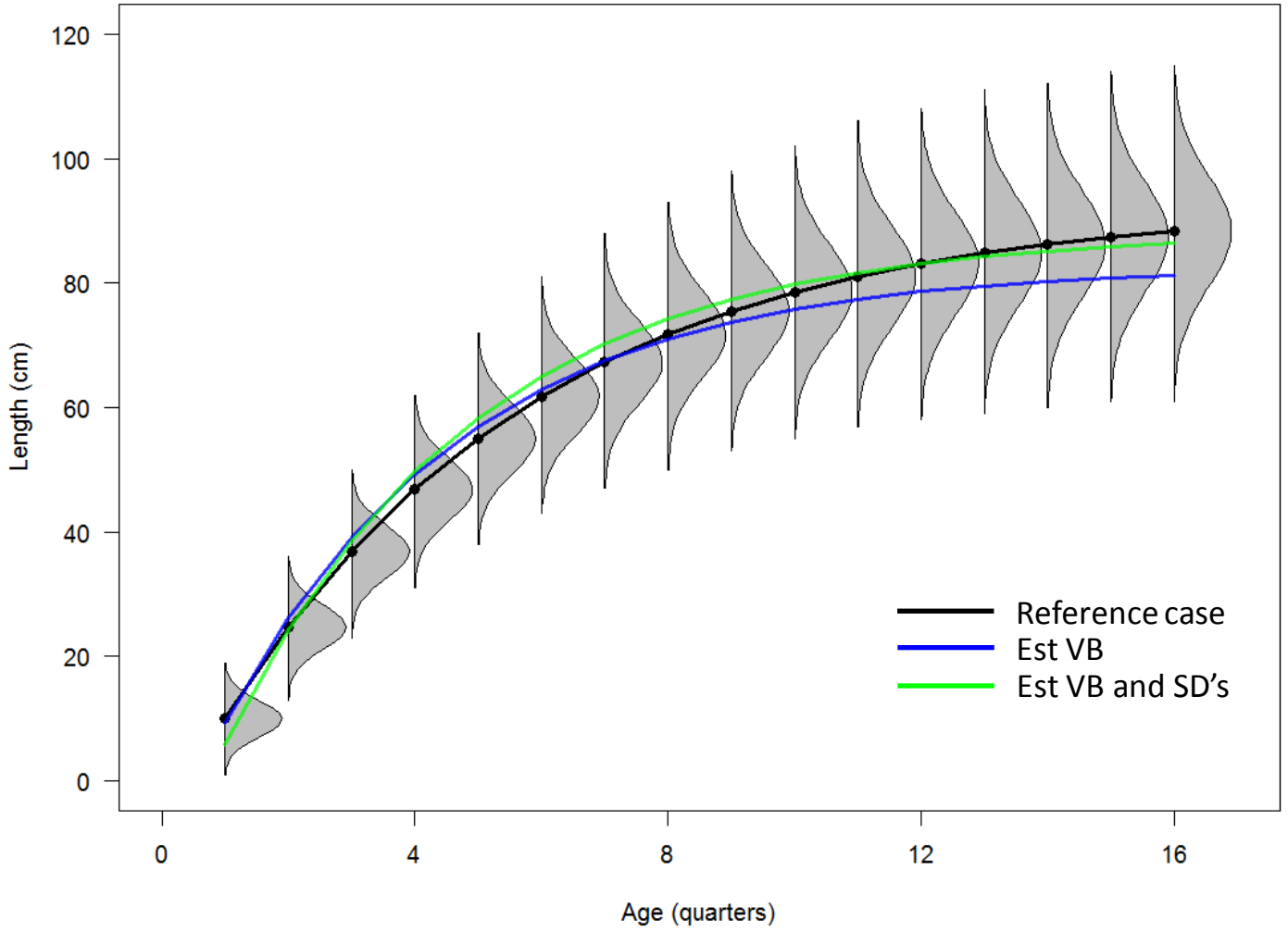


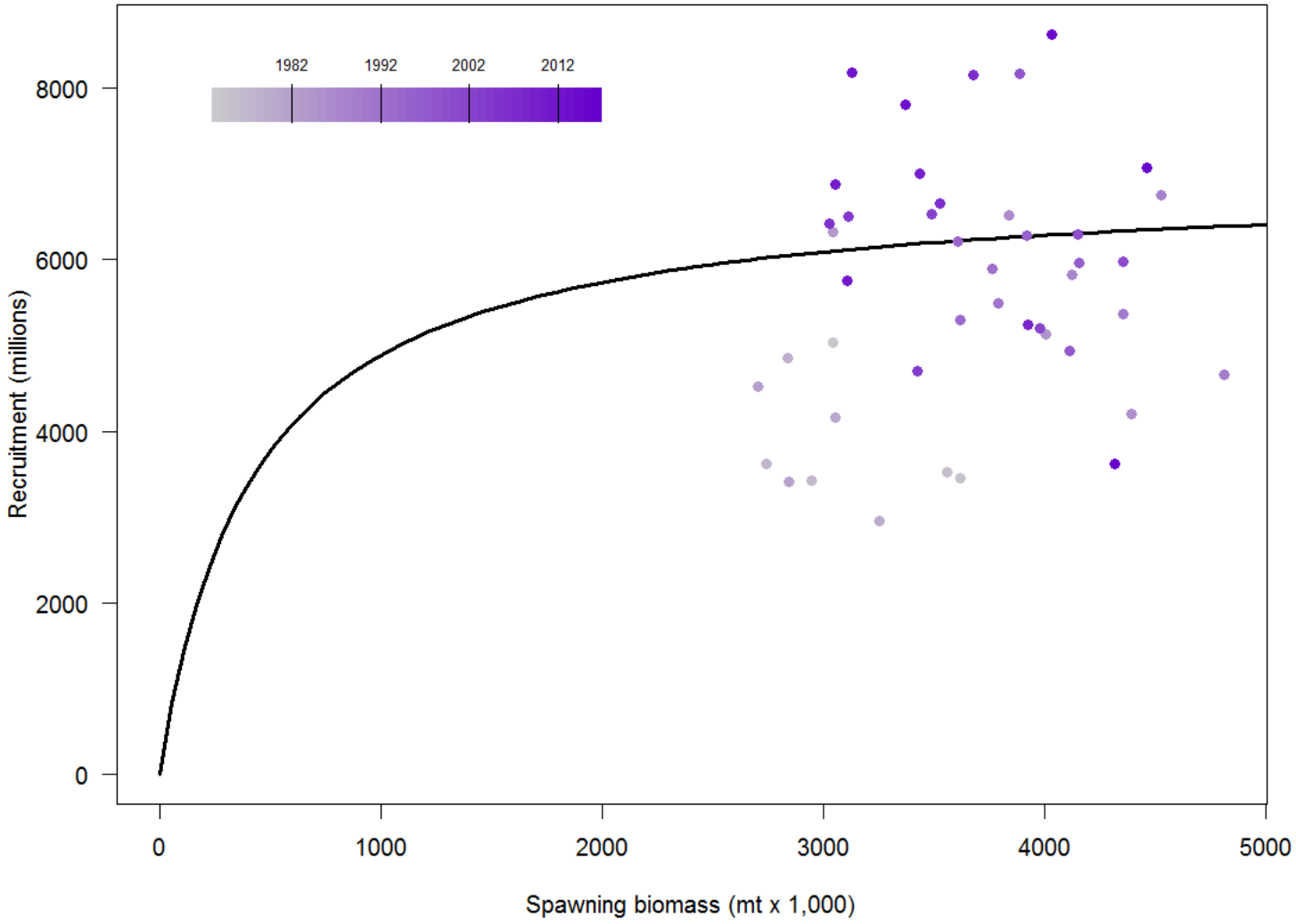
Relative regional spawning biomass



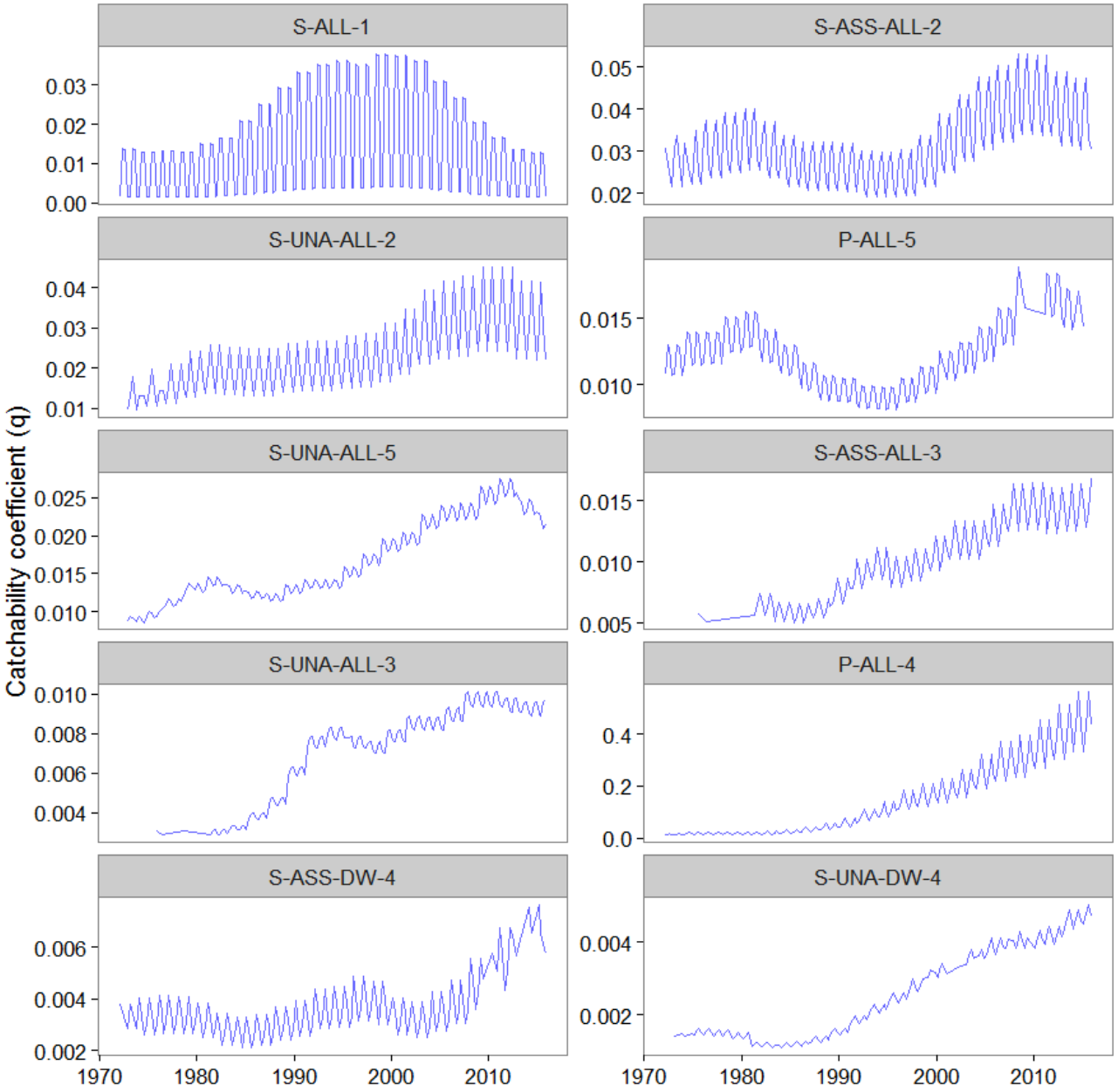
Growth functions



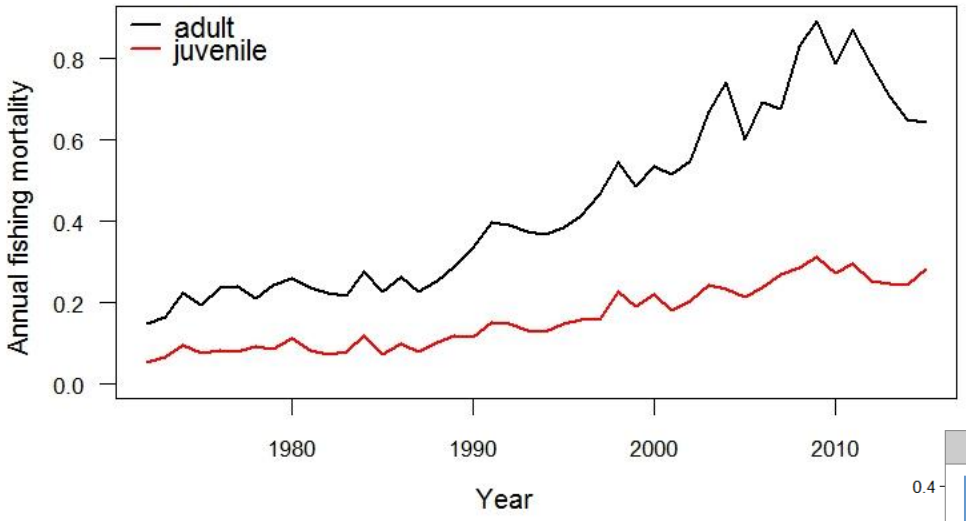
Stock-recruitment relationship



Annual SRR = higher MSY than predicted By Quarterly SRR (2014)



Reference case



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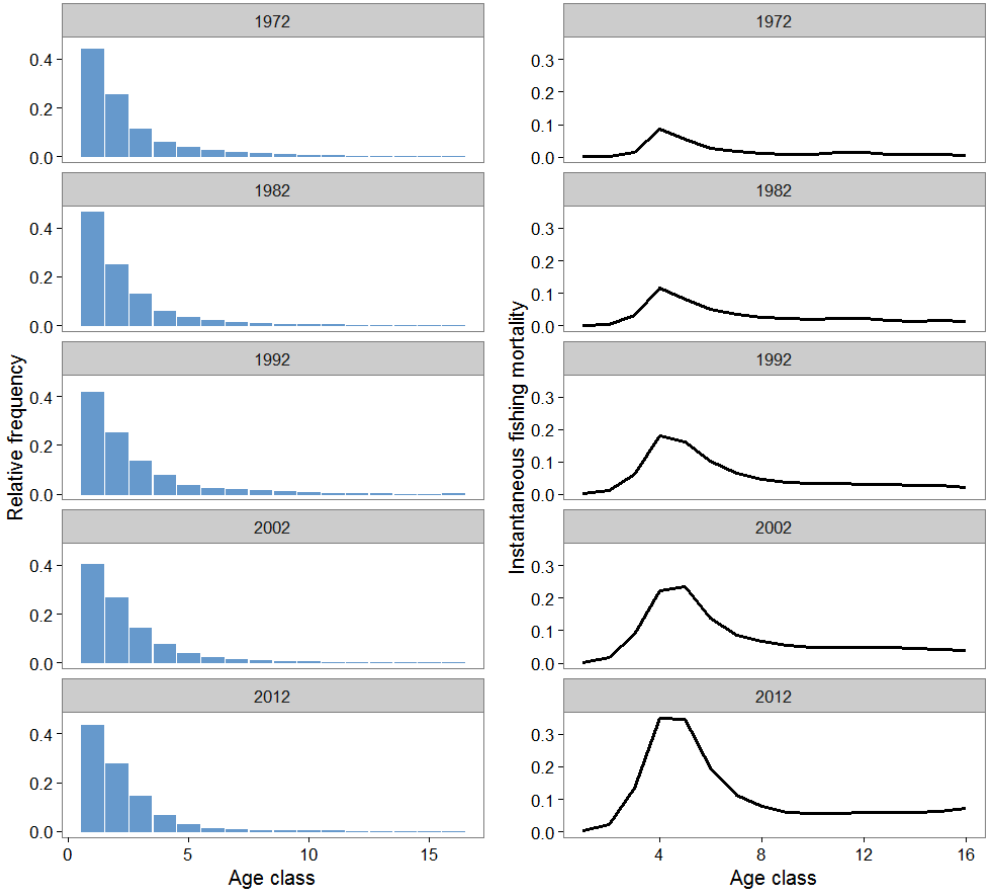
Trends in fishing mortality

Results from reference case



Results from reference case

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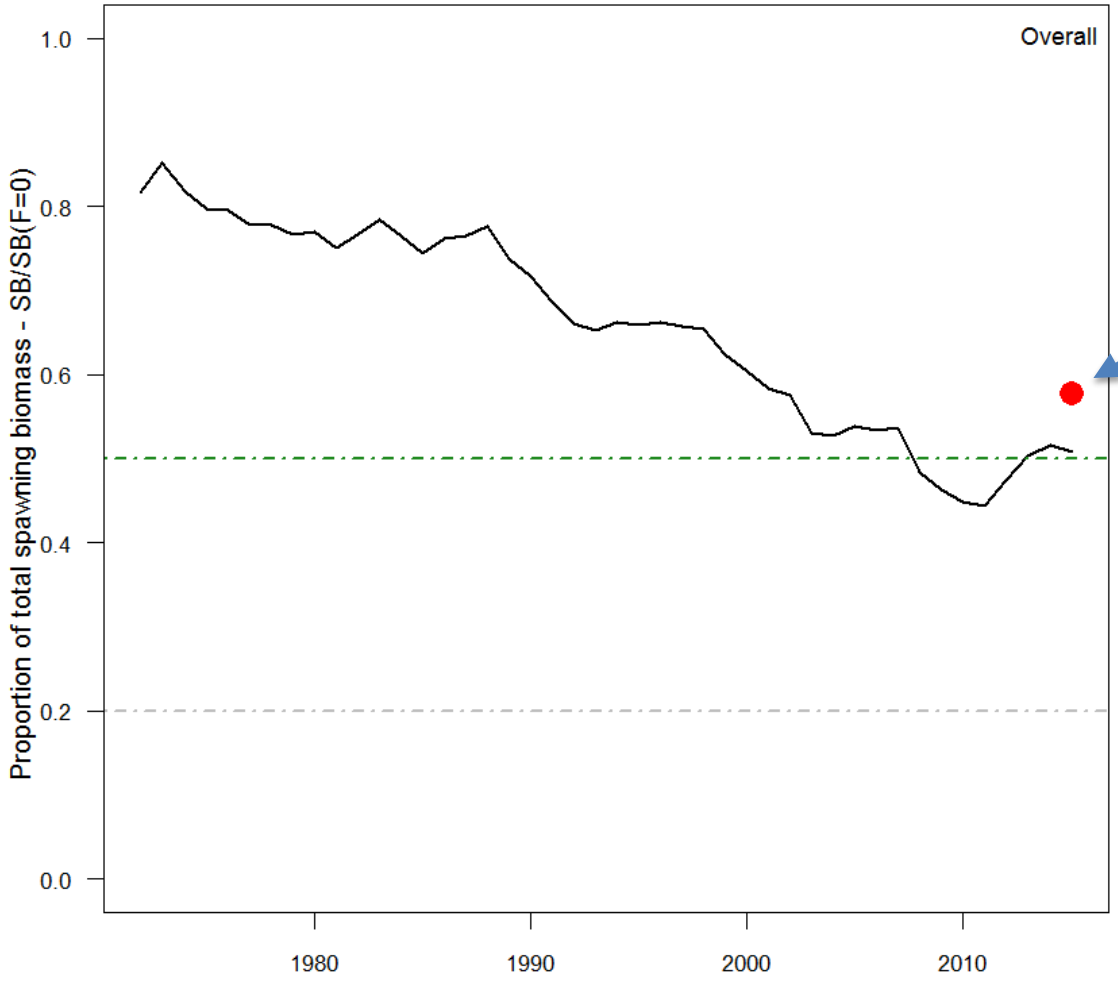
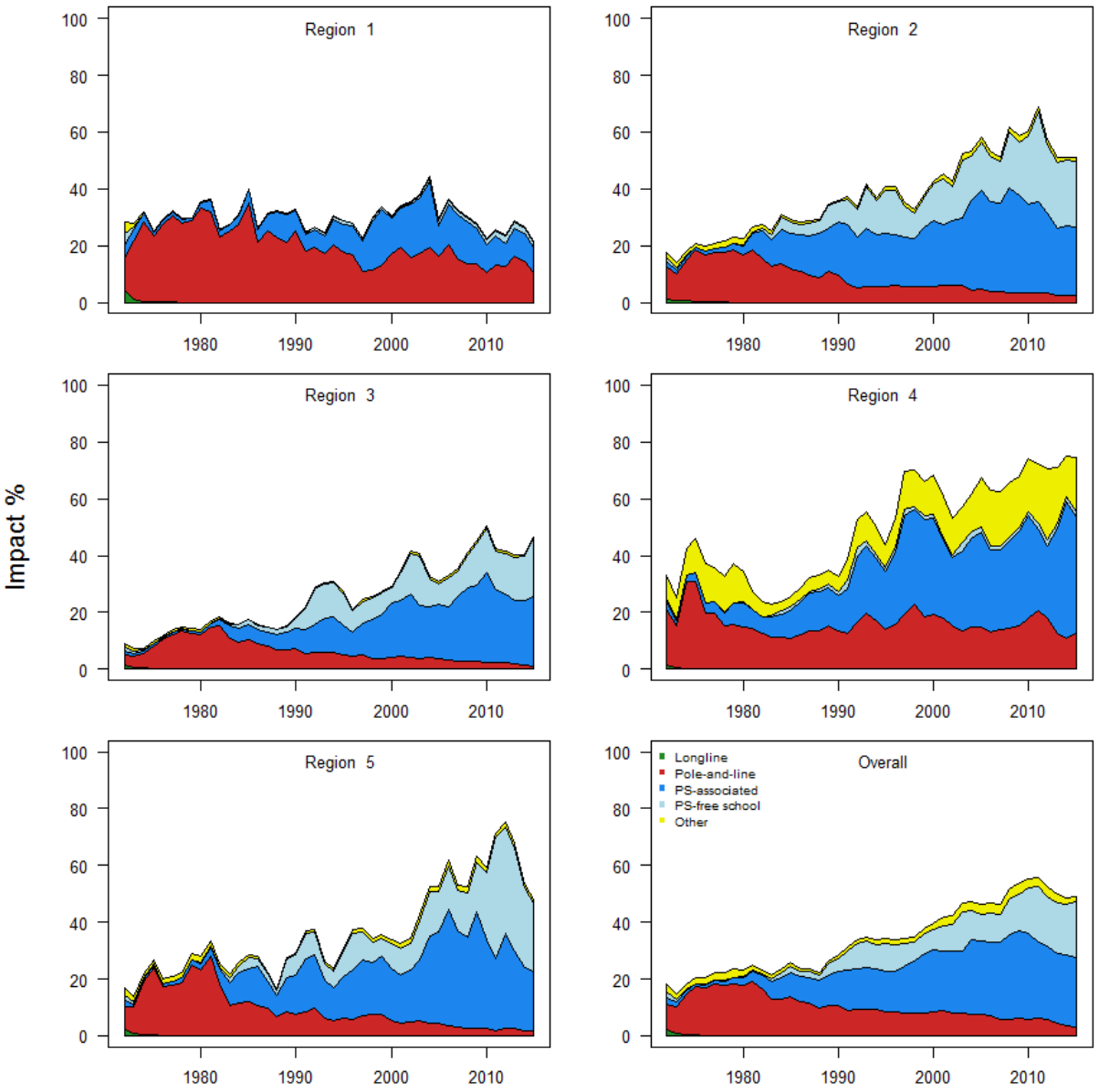
Trend in fisheries depletion



$$SB_{latest} / SB_{F=0}$$

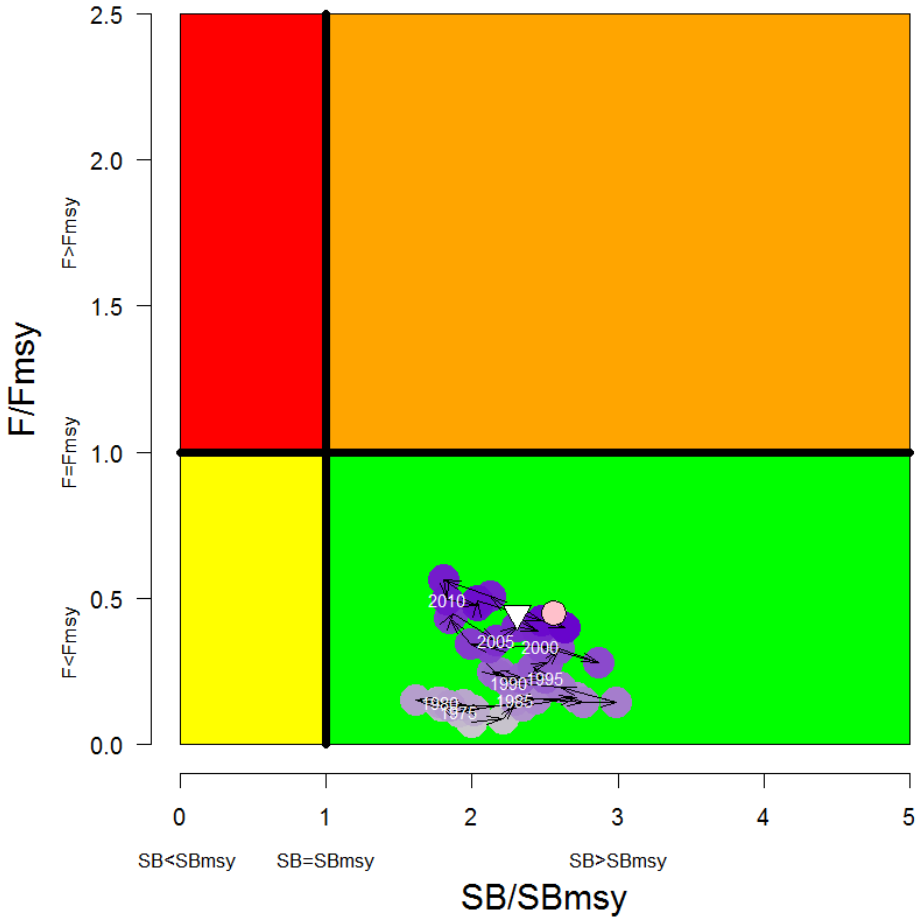
Fishing impact plots



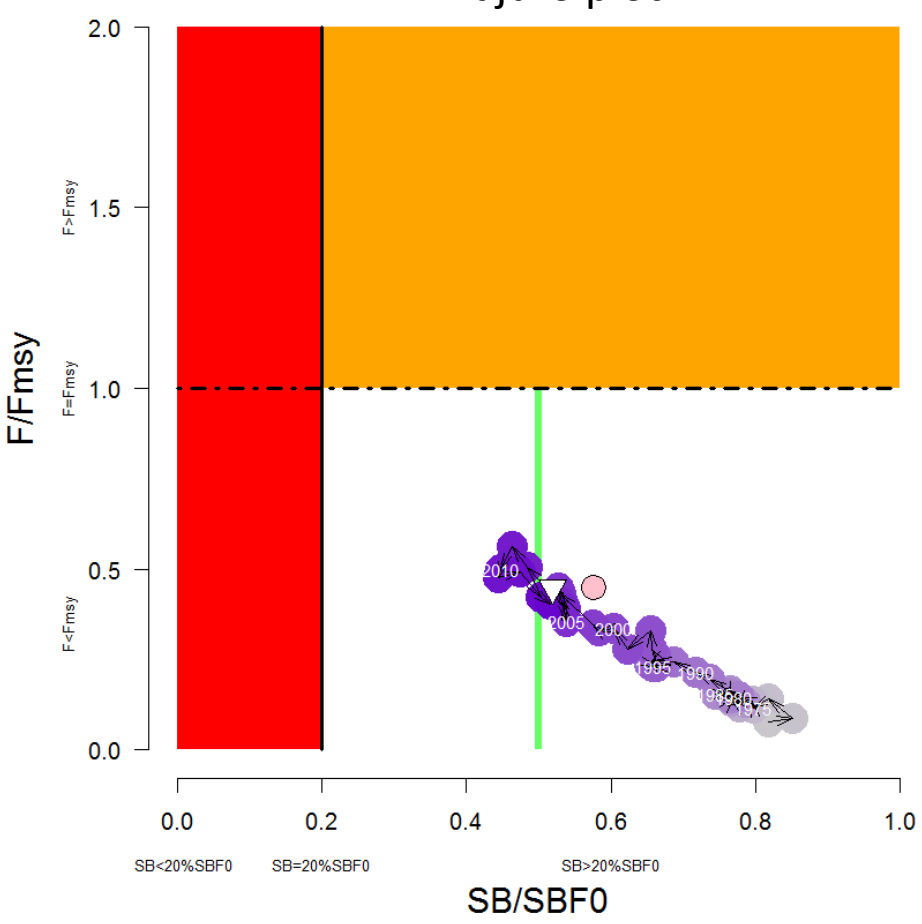
Results from reference case

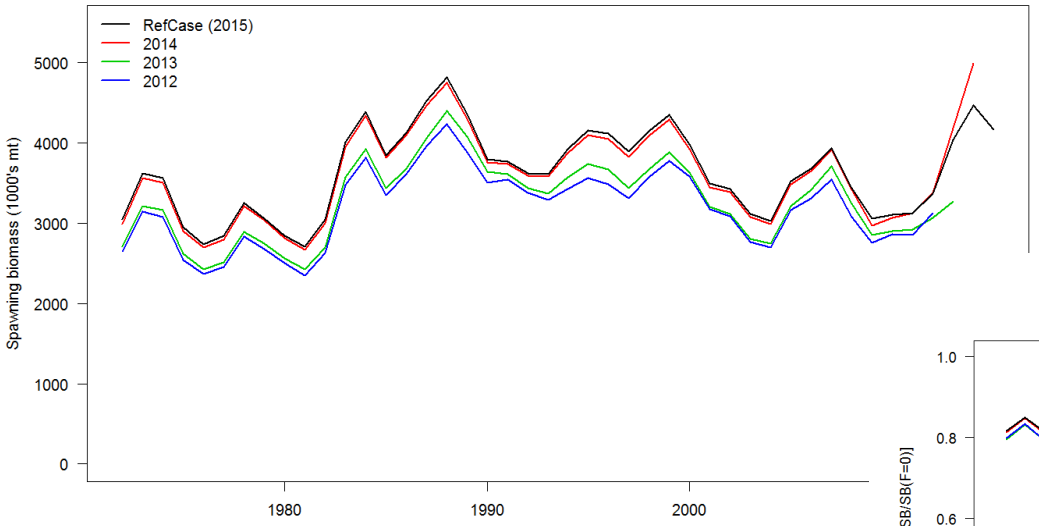
Stock status

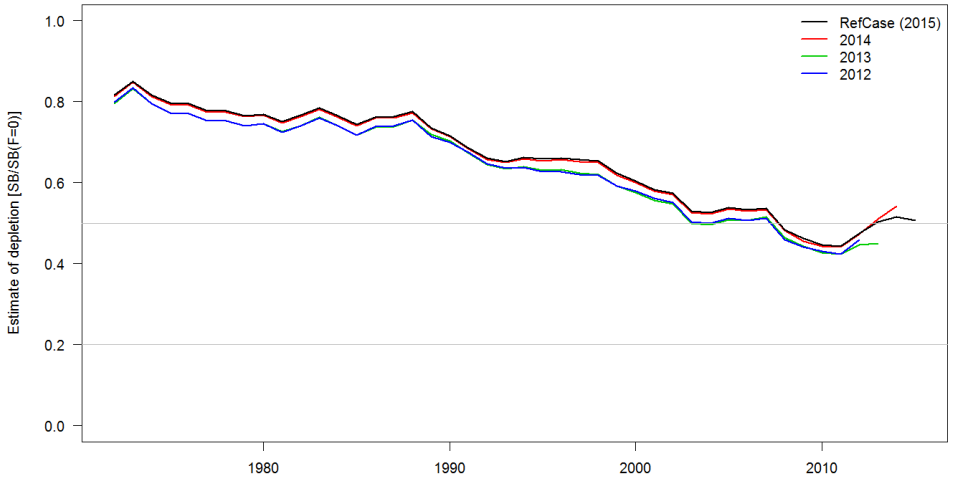
Kobe plot

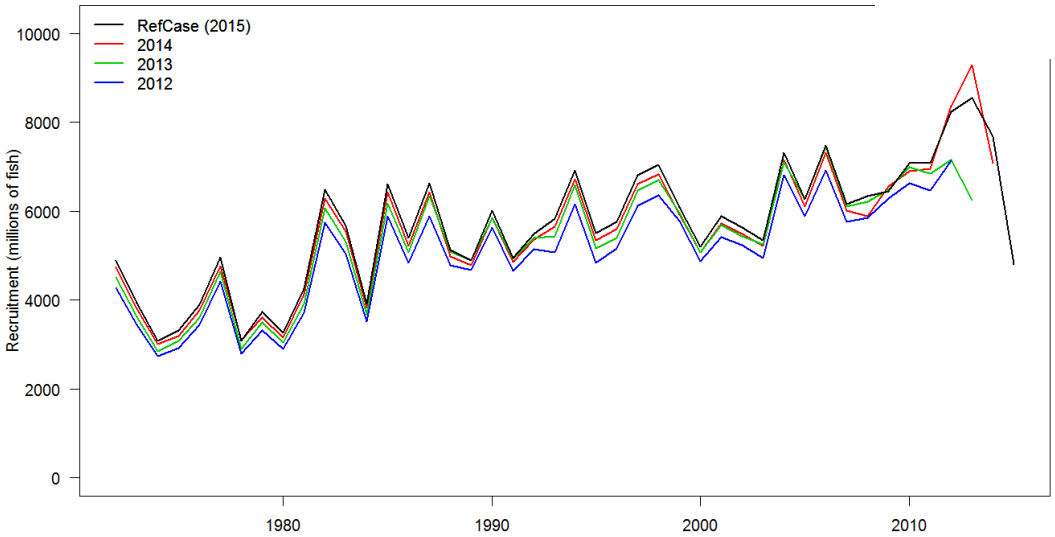


Majuro plot

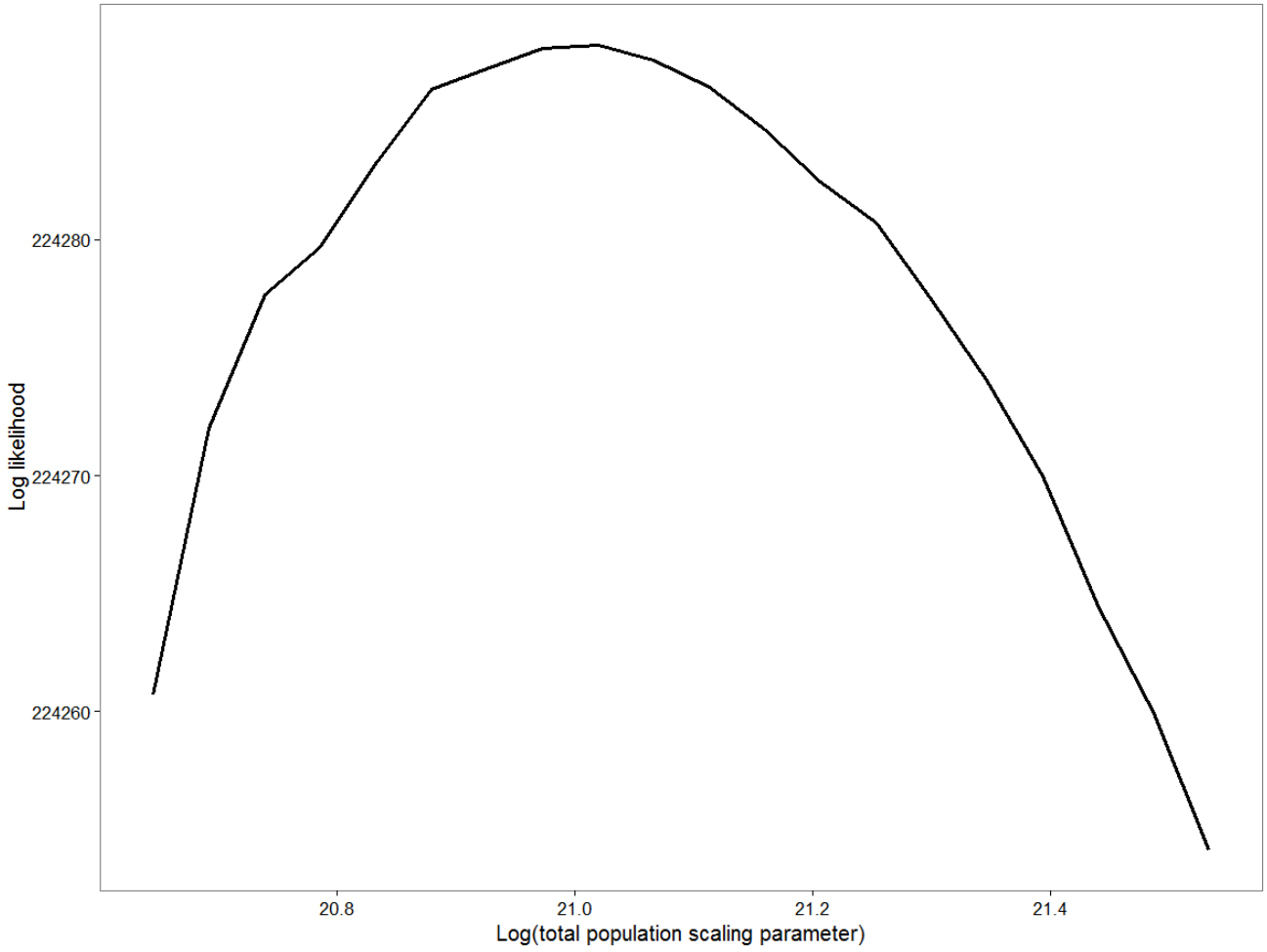








Retrospective model runs
(sequential removal of data)

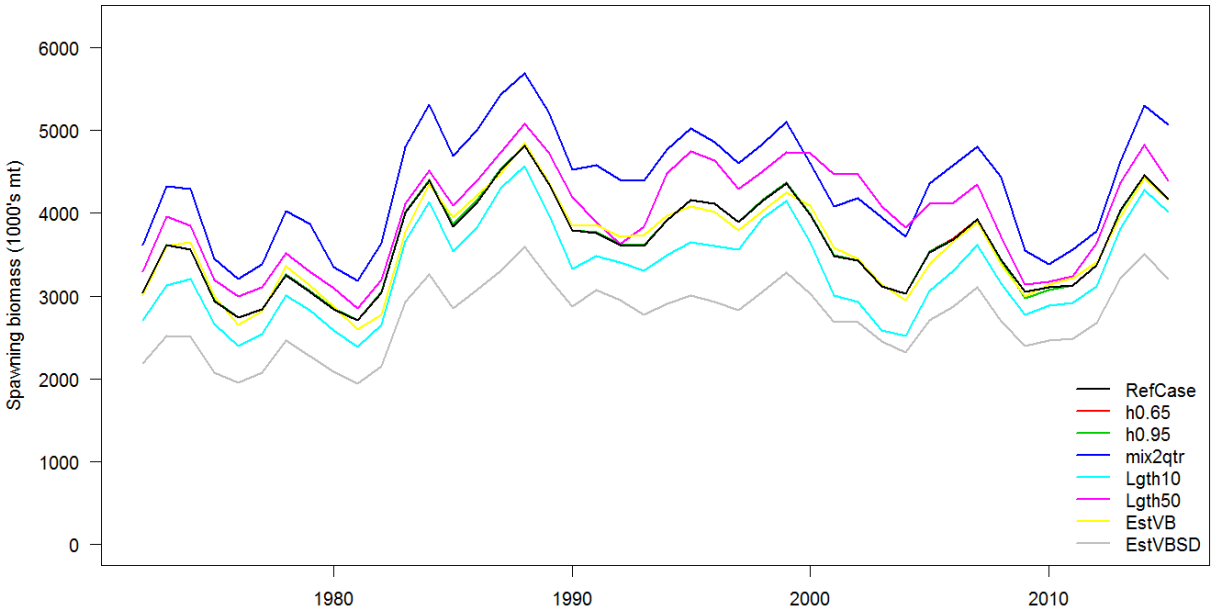

Log likelihood
224280
224270
224260
20.8
21.0
21.2
21.4
Log(total population scaling parameter)

Sensitivities and structural uncertainty

- Steepness (0.8, 0.65, 0.95)
- Tag mixing (1 quarter, 2 quarters)
- Length composition weighting (20, 10, 50)
- Tagging overdispersion (fixed low, fixed middle, estimated)
- Growth function (2014, estimate Von B/2014 SD's, estimate all params)
- Age-invariant movement/ quarterly SRR/ terminal recruitments

Grid – 54 models:

Axis	Levels	Option
Steepness	3	0.65, **0.80**, 0.95
Mixing period	2	1 qtr mixing, **2 qtrs mixing**
Size weighting	3	Scalar of 10, **20**, 50
Tag overdispersion	3	**Default**, Estimated, Fixed (moderate)



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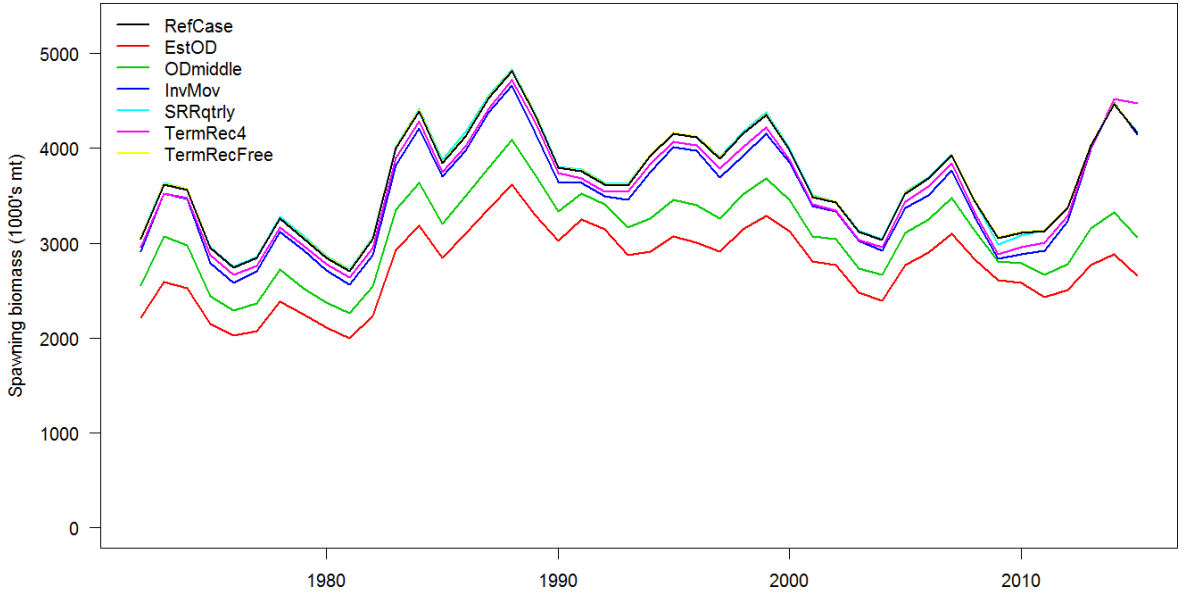
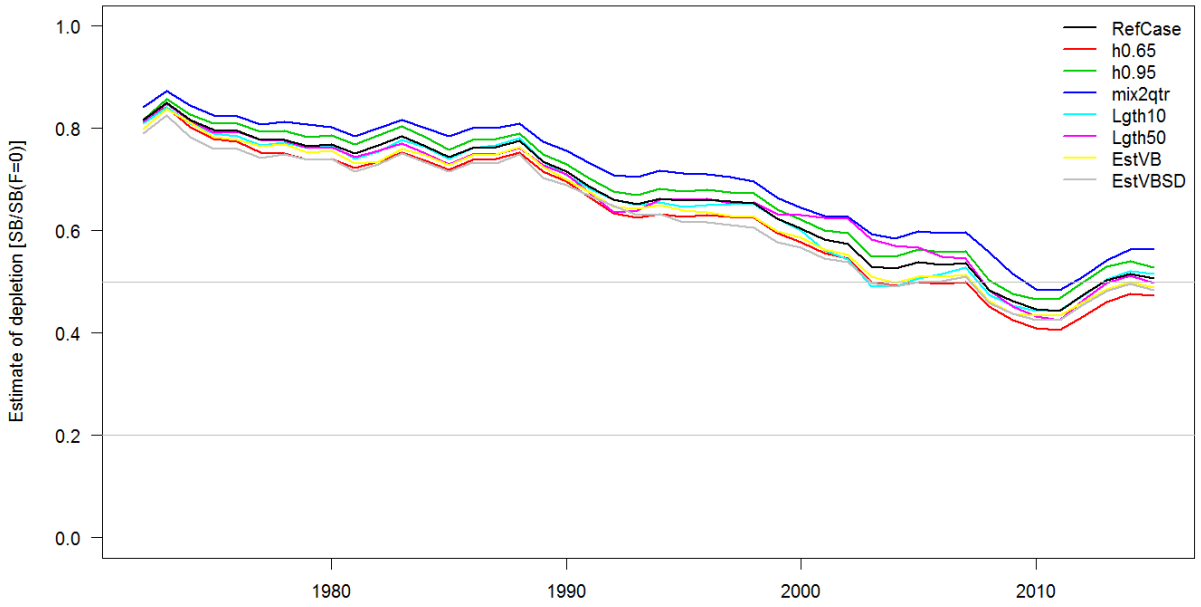
Sensitivity analysis



Spawning biomass



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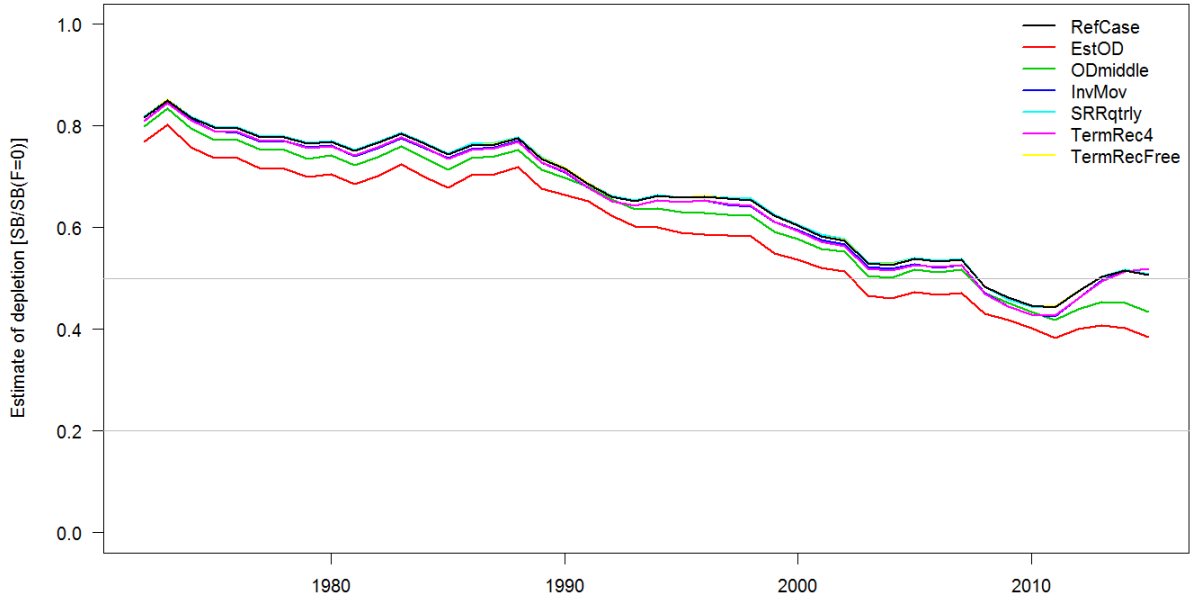
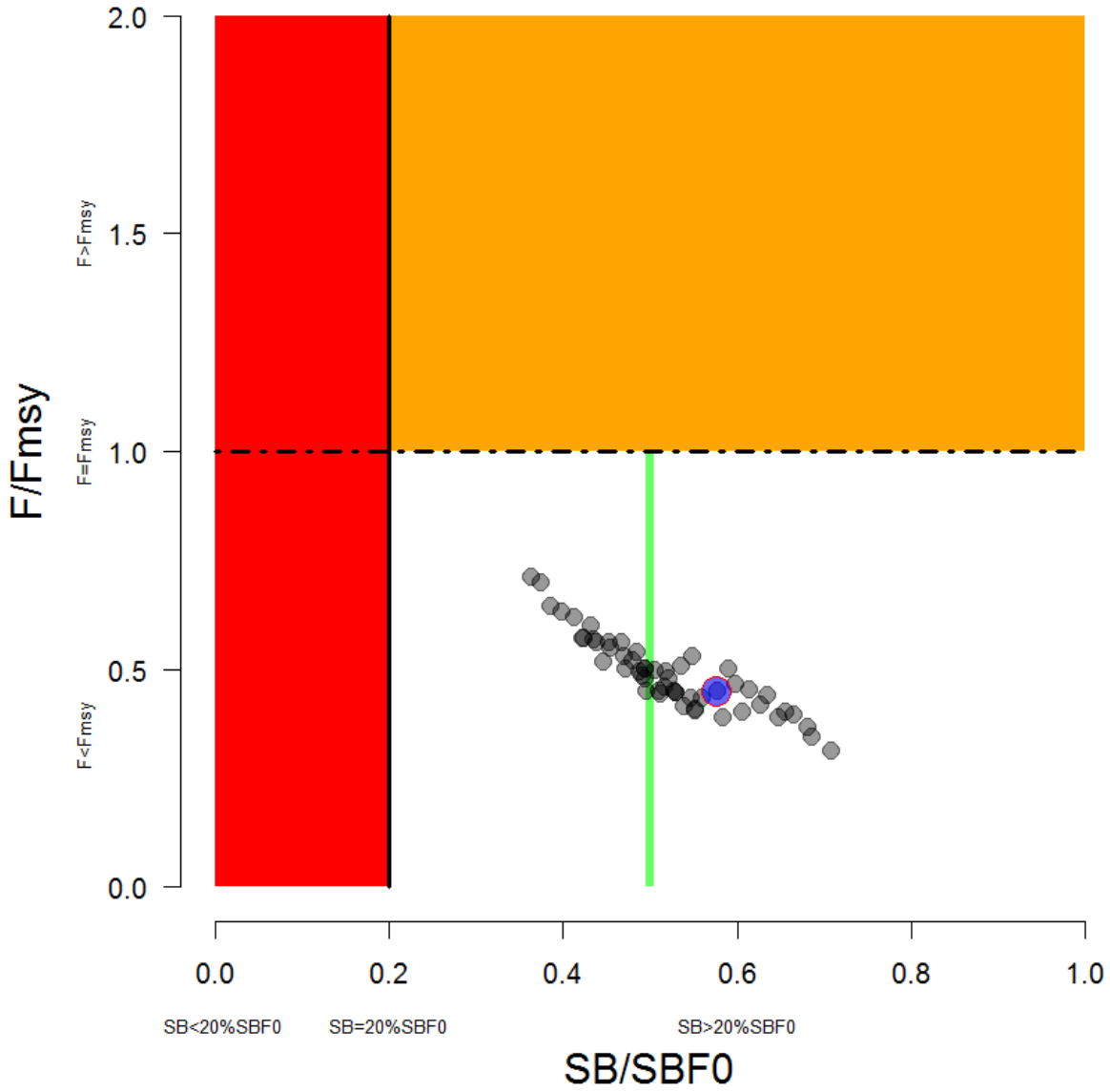
Sensitivity analysis



Fisheries depletion

Sensitivity analysis

Structural uncertainty grid

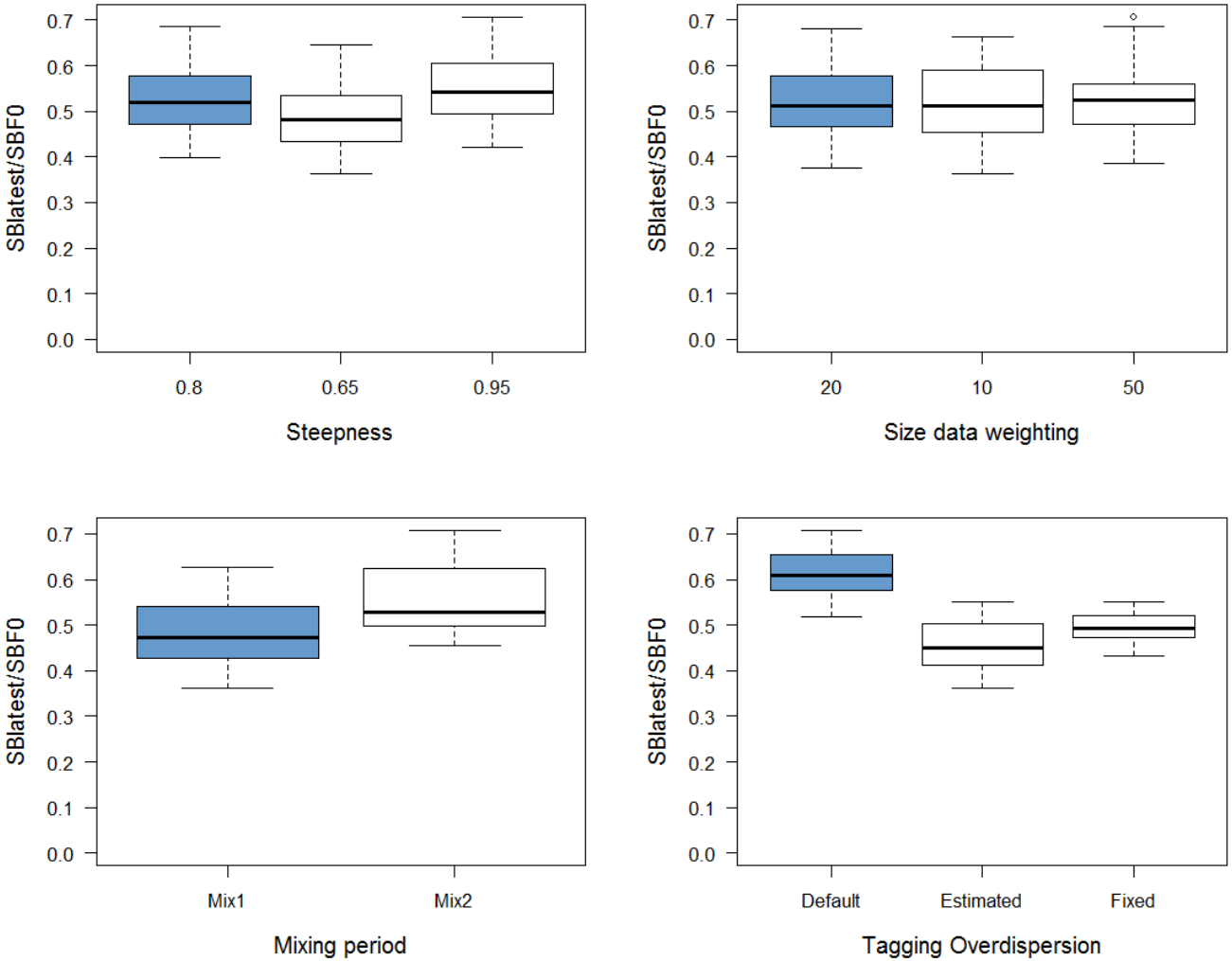


$$SB_{latest}/SB_{F=0}$$

Sensitivity analysis

Influence of uncertainty axes (grid)

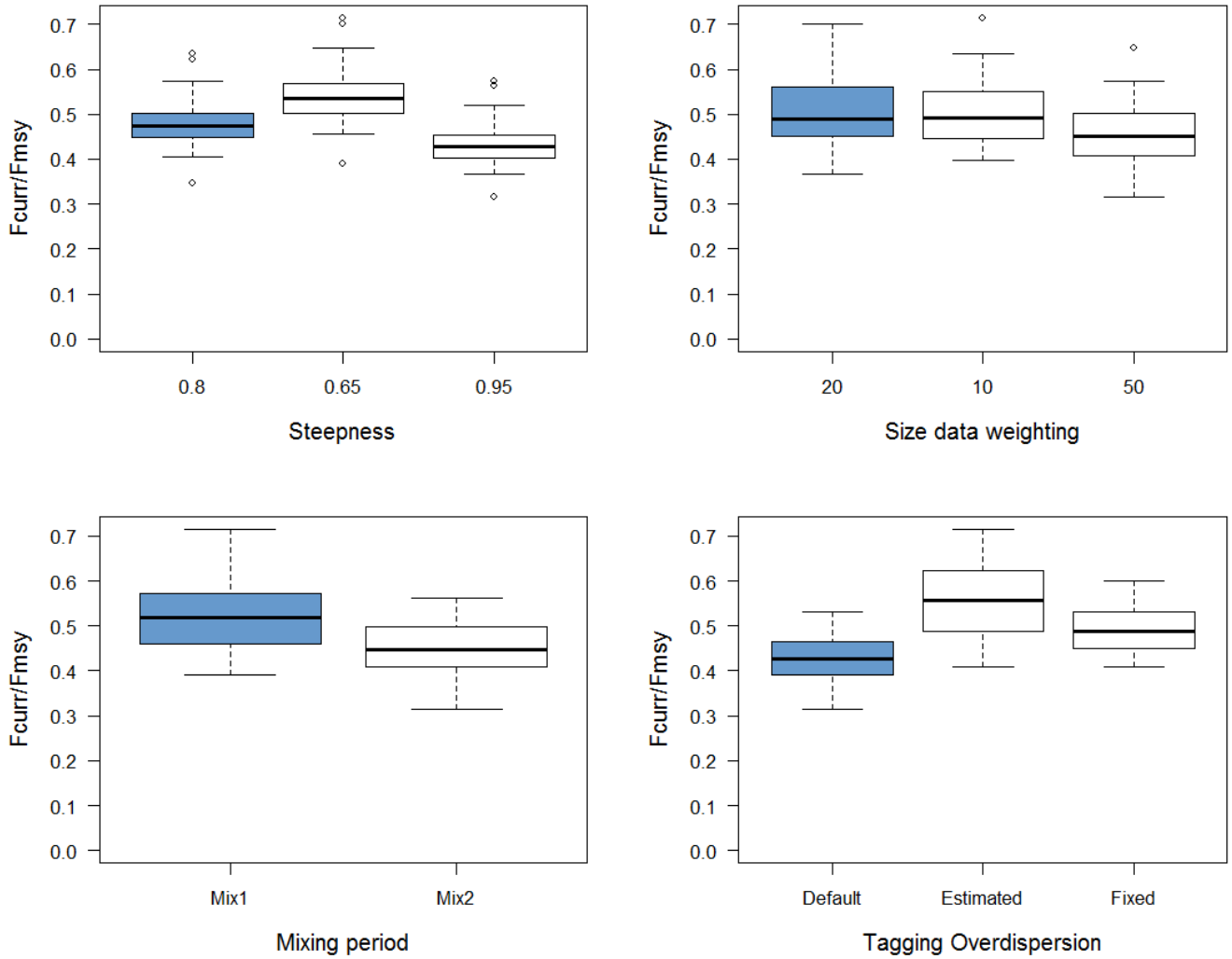
$$SB_{latest}/SB_{F=0}$$



Sensitivity analysis

Influence of uncertainty axes (grid)

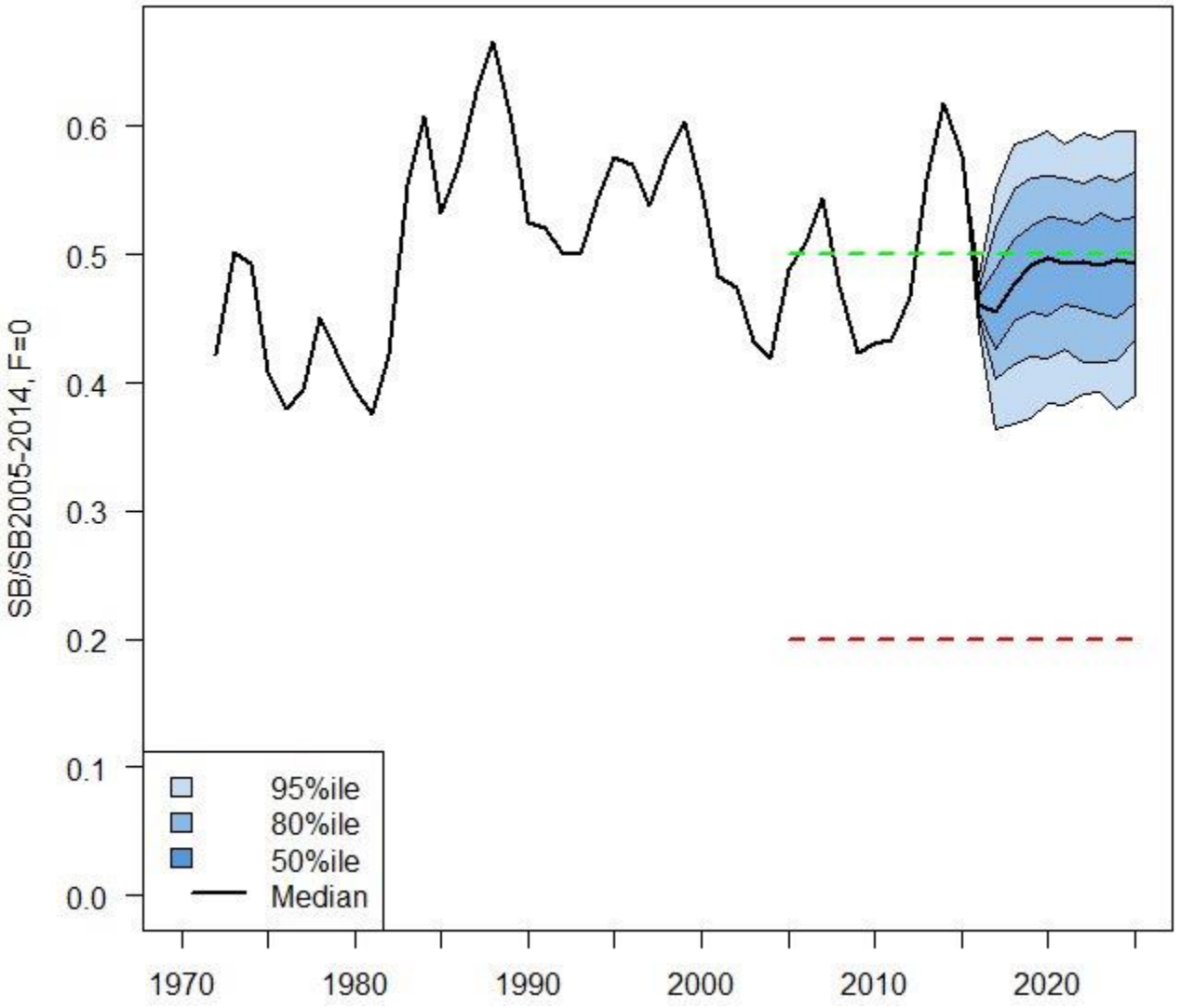
F_{recent}/F_{MSY}



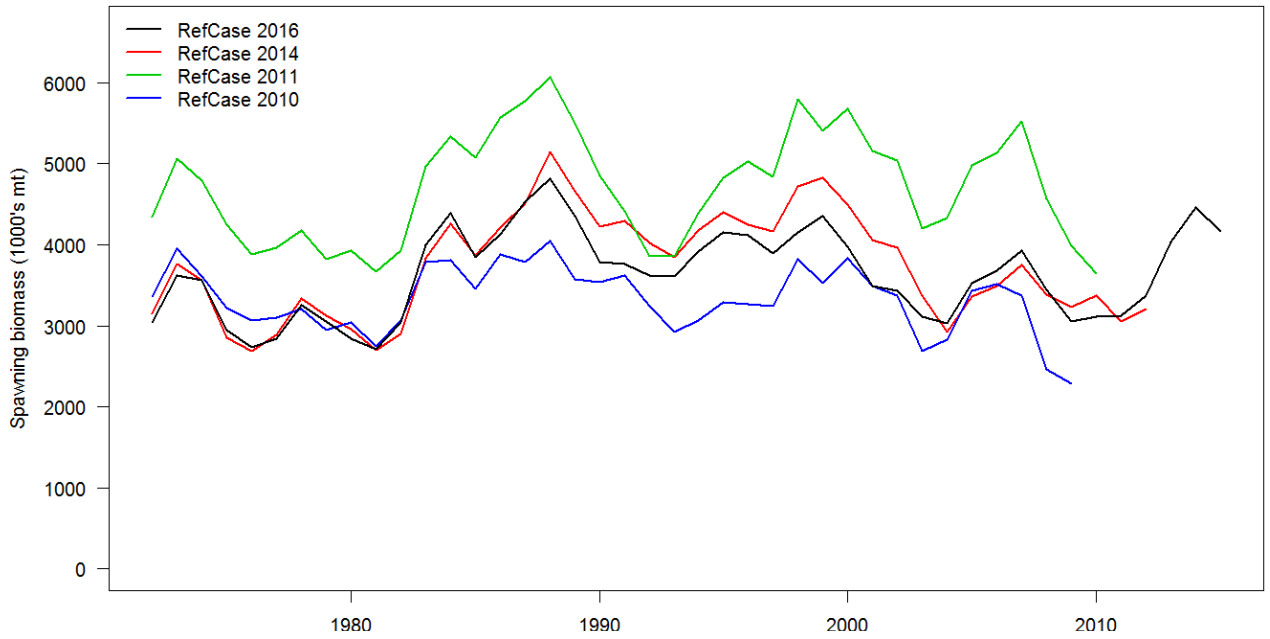
Structural uncertainty grid

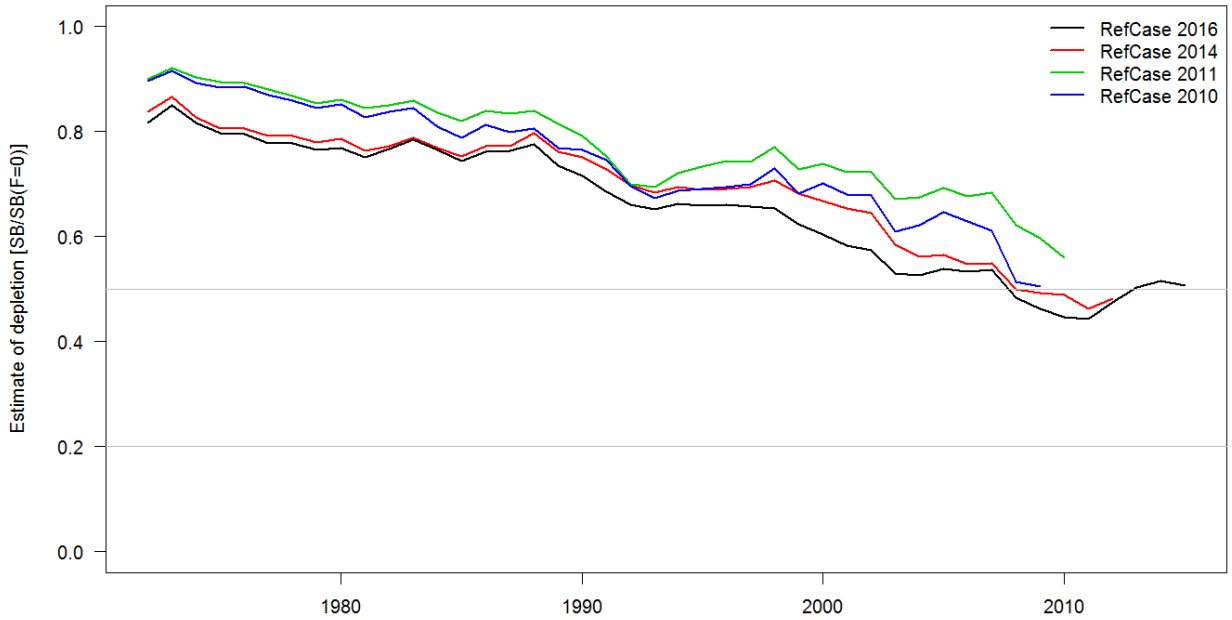
Quantity	Median	5%	95%
C_{latest}	1,679,444	1,678,646	1,679,592
MSY	1,875,600	1,618,060	2,199,880
f_{mult}	2.07	1.57	2.62
F_{recent}/F_{MSY}	0.48	0.38	0.64
$SB_{latest}/SB_{F=0}$	0.51	0.39	0.67
$SB_{recent}/SB_{F=0}$	0.49	0.40	0.57
SB_{latest}/SB_{MSY}	2.15	1.60	3.08

Stochastic projections reference case



- 10 year projections
- 200 simulations
- Catch (LL, ID and PH fisheries) or Effort (PS, PL) assumed to remain at 2015 levels
- Recruitment sampled from 1982-2015 SRR deviates
- Catchability constant at 2015 values


RefCase 2016
RefCase 2014
RefCase 2011
RefCase 2010
Spawning biomass (1000's mt)
0
1000
2000
3000
4000
5000
6000
1980
1990
2000
2010

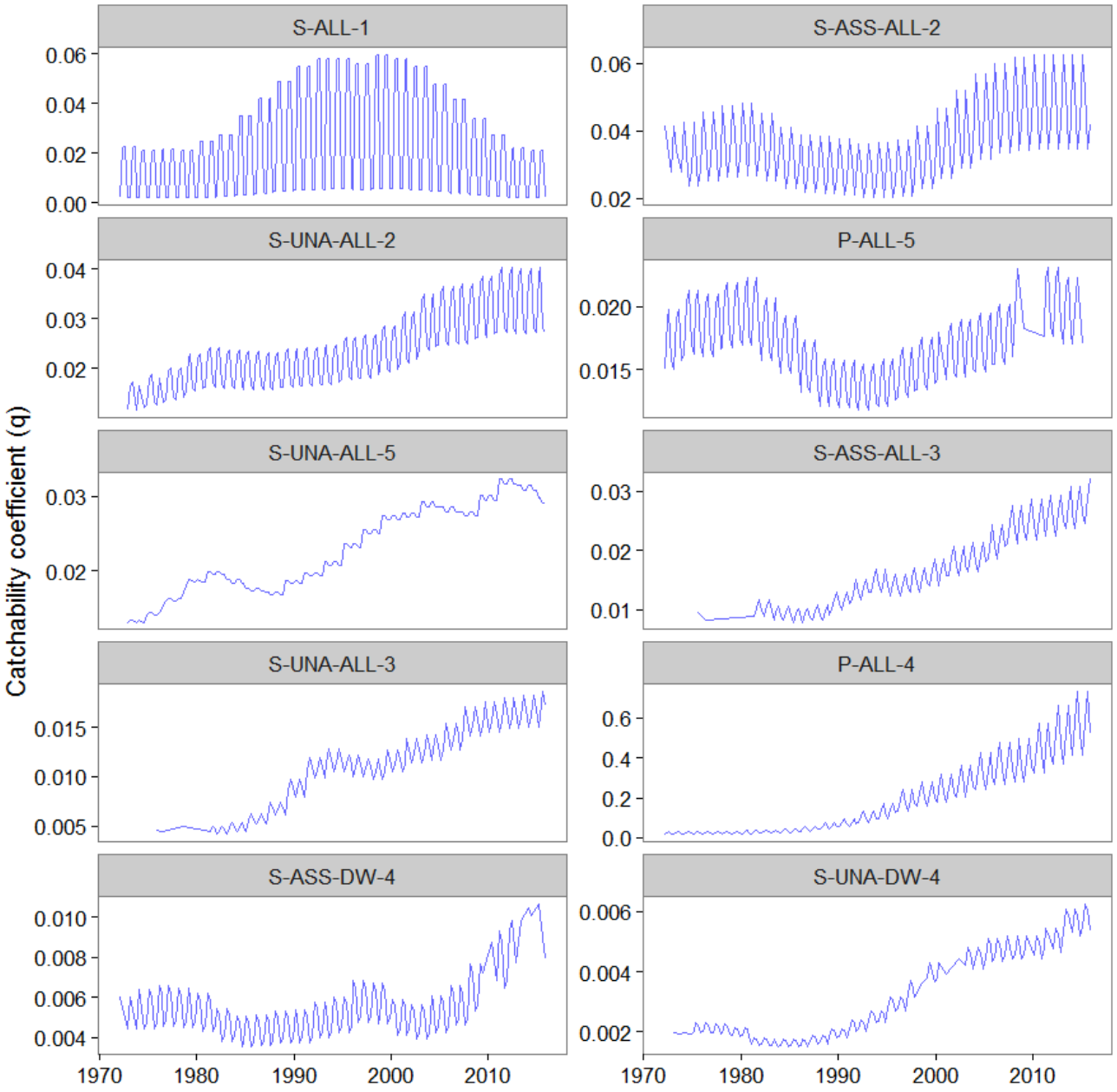

RefCase 2016
RefCase 2014
RefCase 2011
RefCase 2010
Estimate of depletion [SB/SB(F=0)]
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

Conclusions

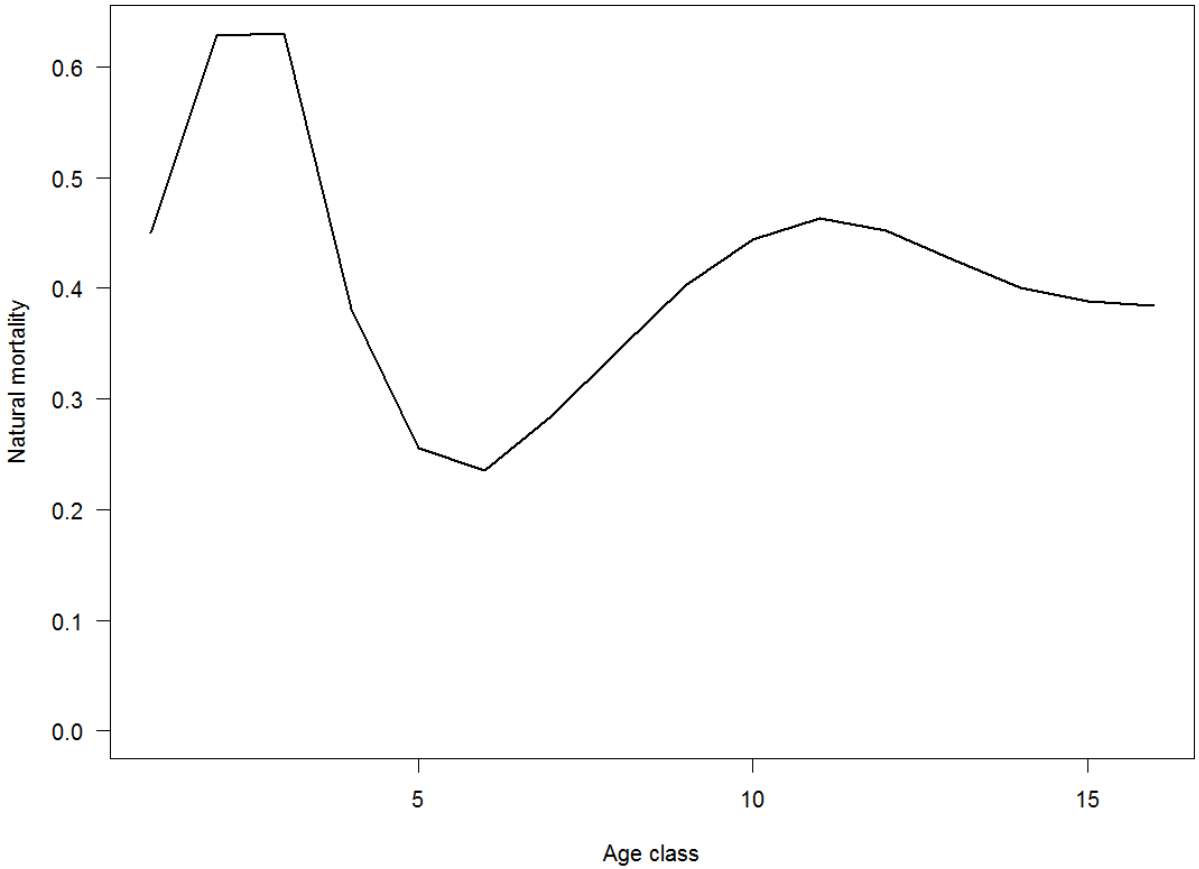
- Results broadly similar to 2014 results; SB increase between assessments
- Current catches less than, but approaching, MSY
- Fishing mortality of juveniles and adults greatly increased over time but remains less than F_{MSY}
- $SB_{latest} > SB_{MSY}$ and $>> 0.2SB_{F=0}$
- All depletion-based reference points for ref. case, sensitivity and uncertainty grid suggest stock is likely relatively close to TRP of 0.5 $SB_{F=0}$
- The assessment suggests that overfishing of the stock is not occurring and the stock is not in an overfished state

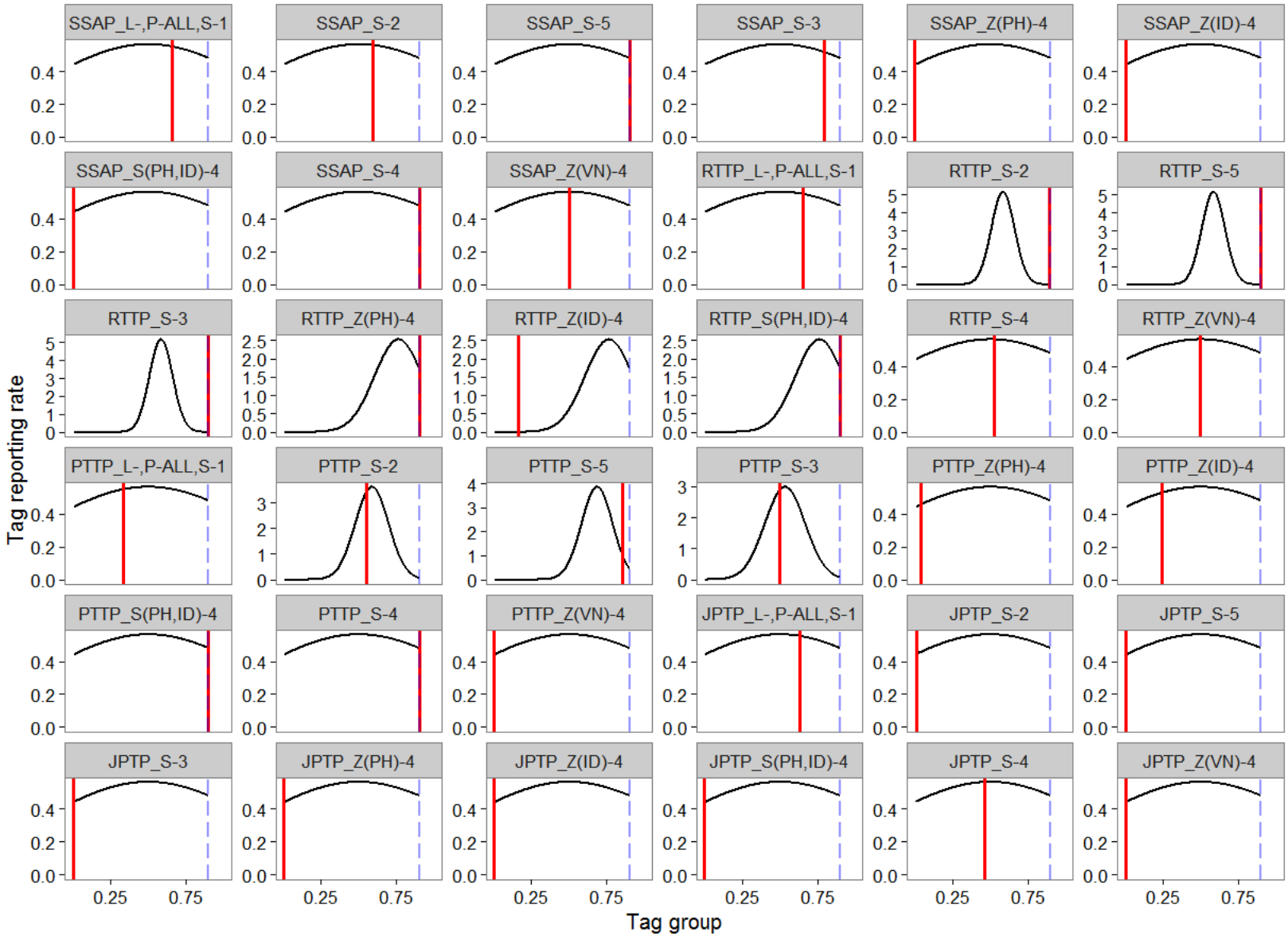
Conclusions

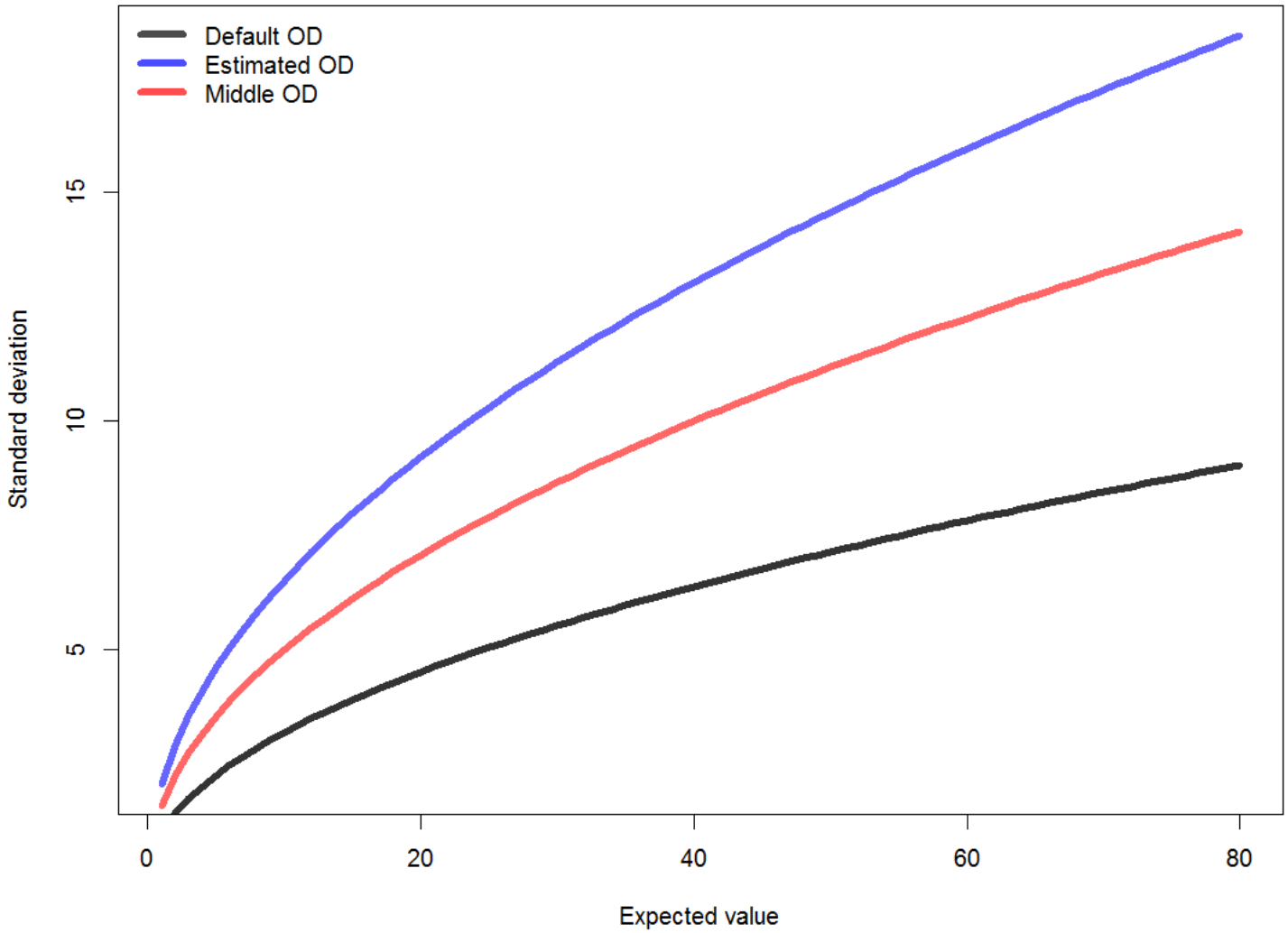
- Model fits sensitive to data weighting, tag mixing and SR steepness with some implications for stock status
- Data weighting – model is sensitive to tagging overdispersion parameter and no clear theoretical guidance on best practices
- $SB_{latest}/SB_{F=0}$ sensitive to temporary rapid changes in status
- SKJ assessment is highly reliant upon and would not be robust without continued access to new tagging data
- Increasing paucity of CPUE indices: PL accounts for less than 10% of total catch and PL fishing area has contracted substantially
- Reliable PS CPUE indices need to be developed to supplement or replace PL CPUE indices

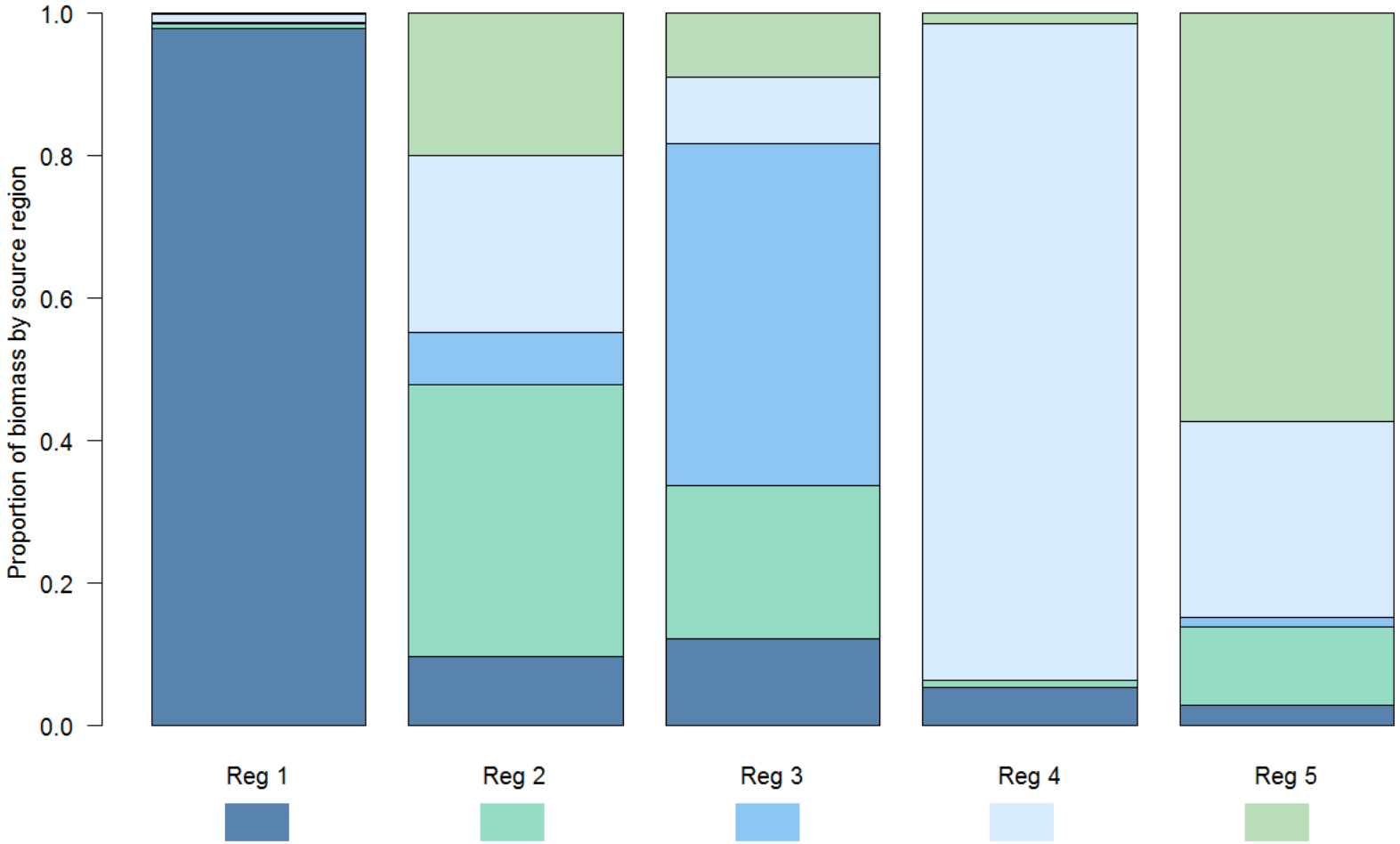


Sensitivity:
Estimate overdispersion


Natural mortality
0.0
0.1
0.2
0.3
0.4
0.5
0.6
5
10
15
Age class


SSAP_L-,P-ALL,S-1
SSAP_S-2
SSAP_S-5
SSAP_S-3
SSAP_Z(PH)-4
SSAP_Z(ID)-4
SSAP_S(PH,ID)-4
SSAP_S-4
SSAP_Z(VN)-4
RTTP_L-,P-ALL,S-1
RTTP_S-2
RTTP_S-5
RTTP_S-3
RTTP_Z(PH)-4
RTTP_Z(ID)-4
RTTP_S(PH,ID)-4
RTTP_S-4
RTTP_Z(VN)-4
PTTP_L-,P-ALL,S-1
PTTP_S-2
PTTP_S-5
PTTP_S-3
PTTP_Z(PH)-4
PTTP_Z(ID)-4
PTTP_S(PH,ID)-4
PTTP_S-4
PTTP_Z(VN)-4
JPTP_L-,P-ALL,S-1
JPTP_S-2
JPTP_S-5
JPTP_S-3
JPTP_Z(PH)-4
JPTP_Z(ID)-4
JPTP_S(PH,ID)-4
JPTP_S-4
JPTP_Z(VN)-4
Tag reporting rate
Tag group
0.25
0.75


Default OD
Estimated OD
Middle OD
Standard deviation
5
10
15
0
20
40
60
80
Expected value


Proportion of biomass by source region
1.0
0.8
0.6
0.4
0.2
0.0
Reg 1
Reg 2
Reg 3
Reg 4
Reg 5


1
2
3
4
5
Total
Instantaneous fishing mortality
Year
Age class
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

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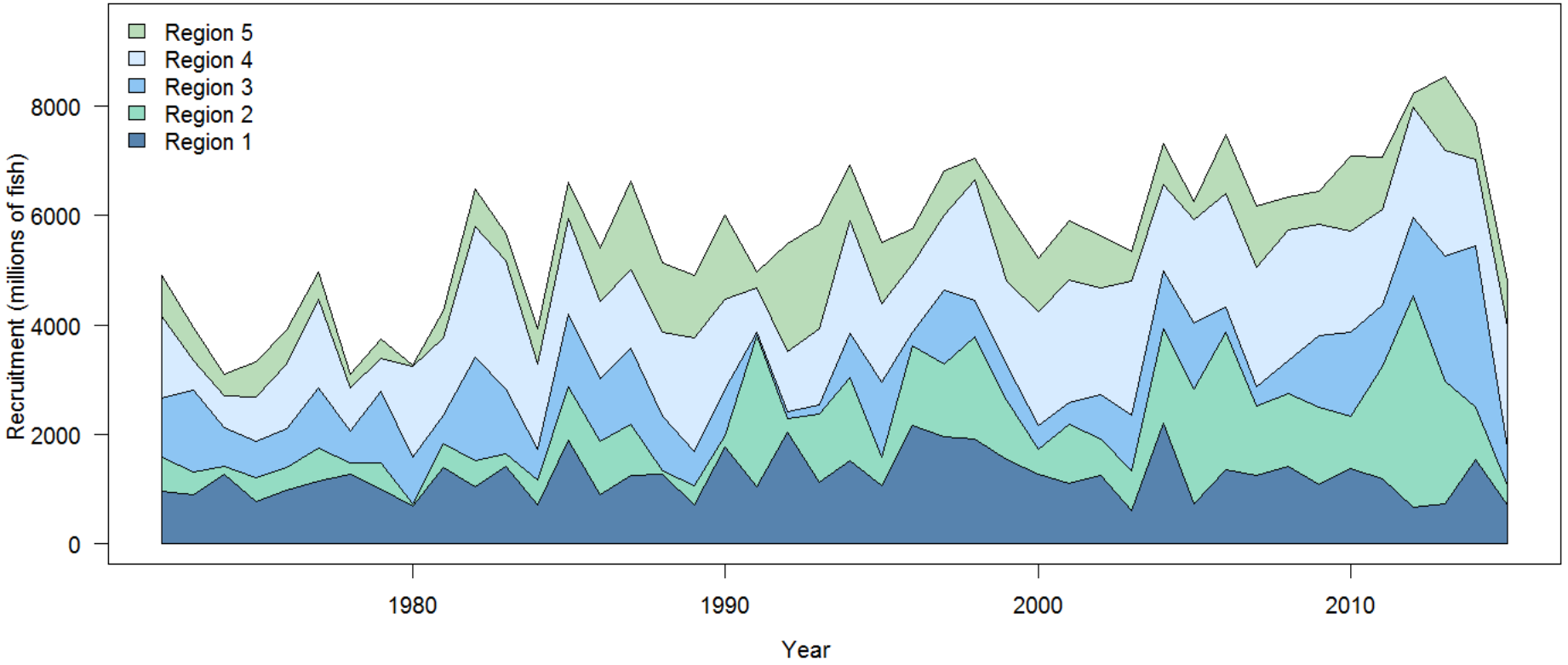

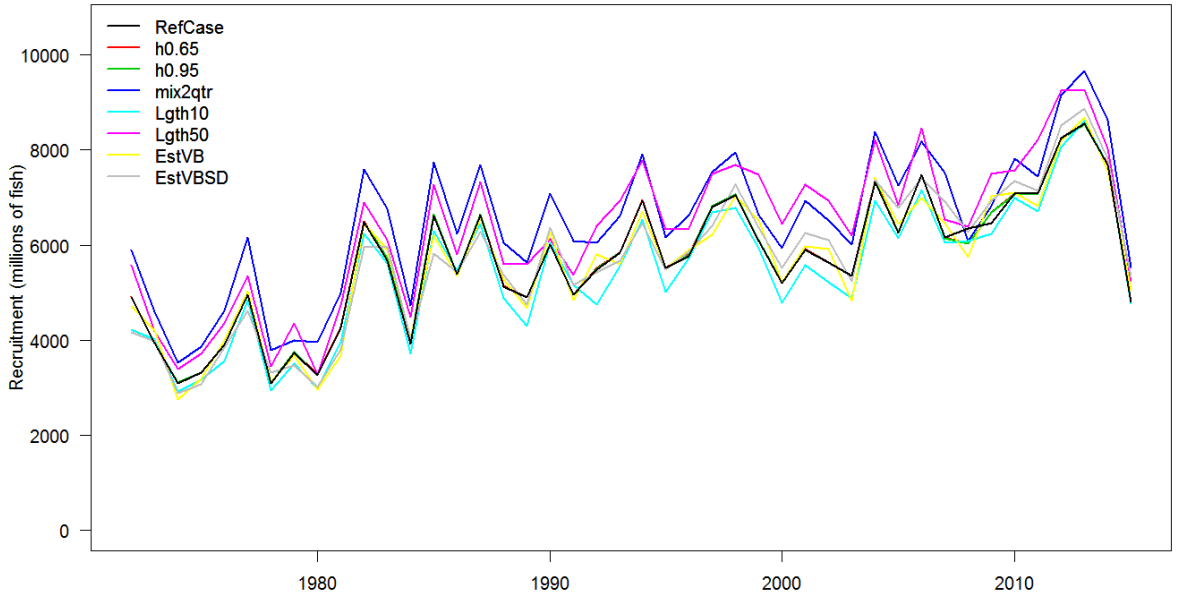

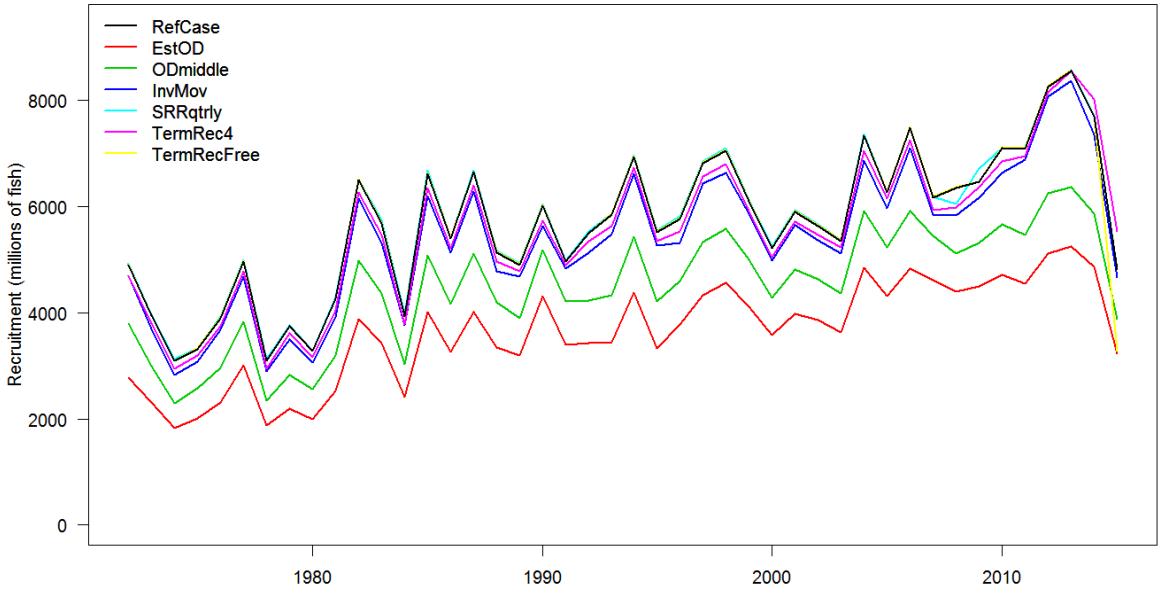

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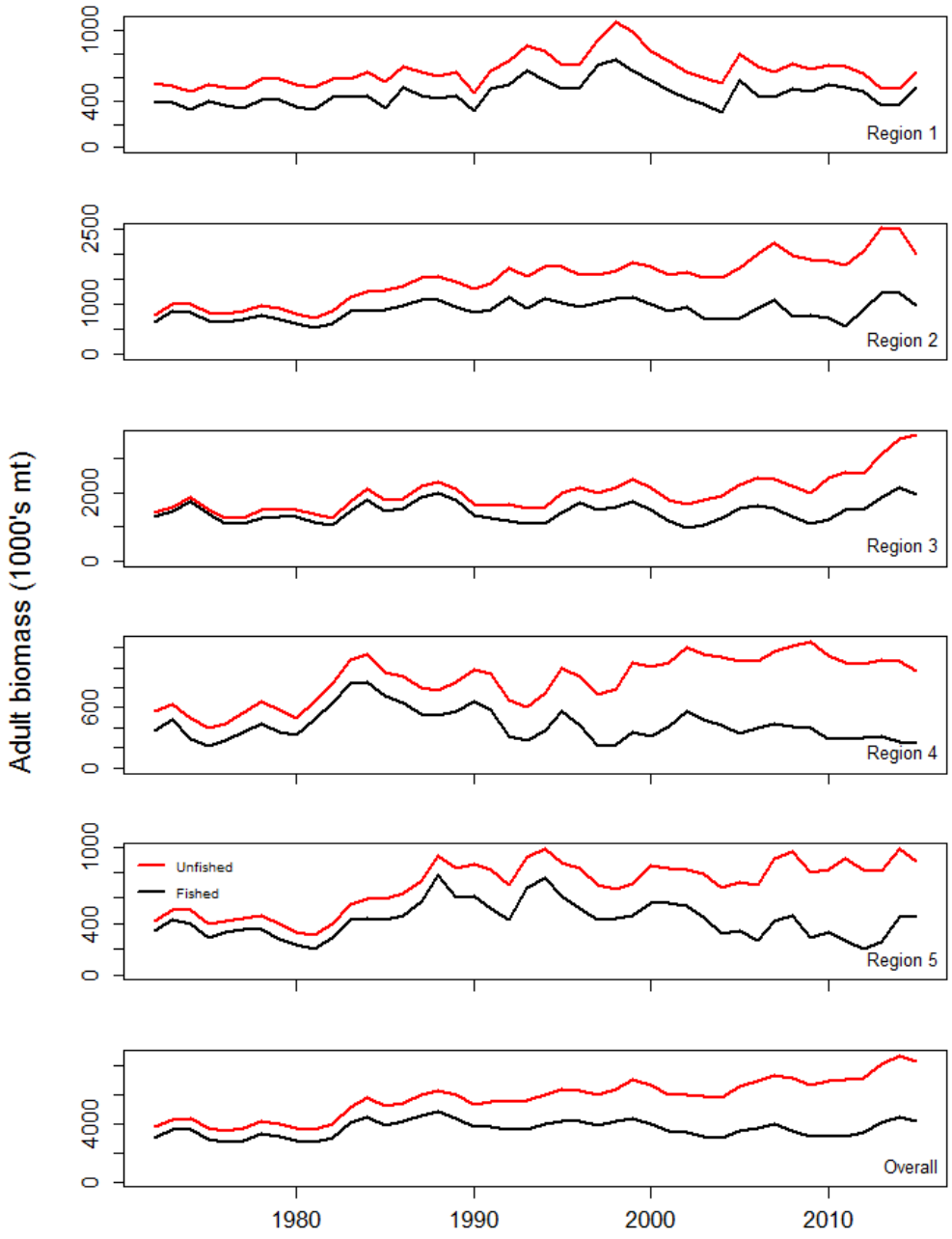

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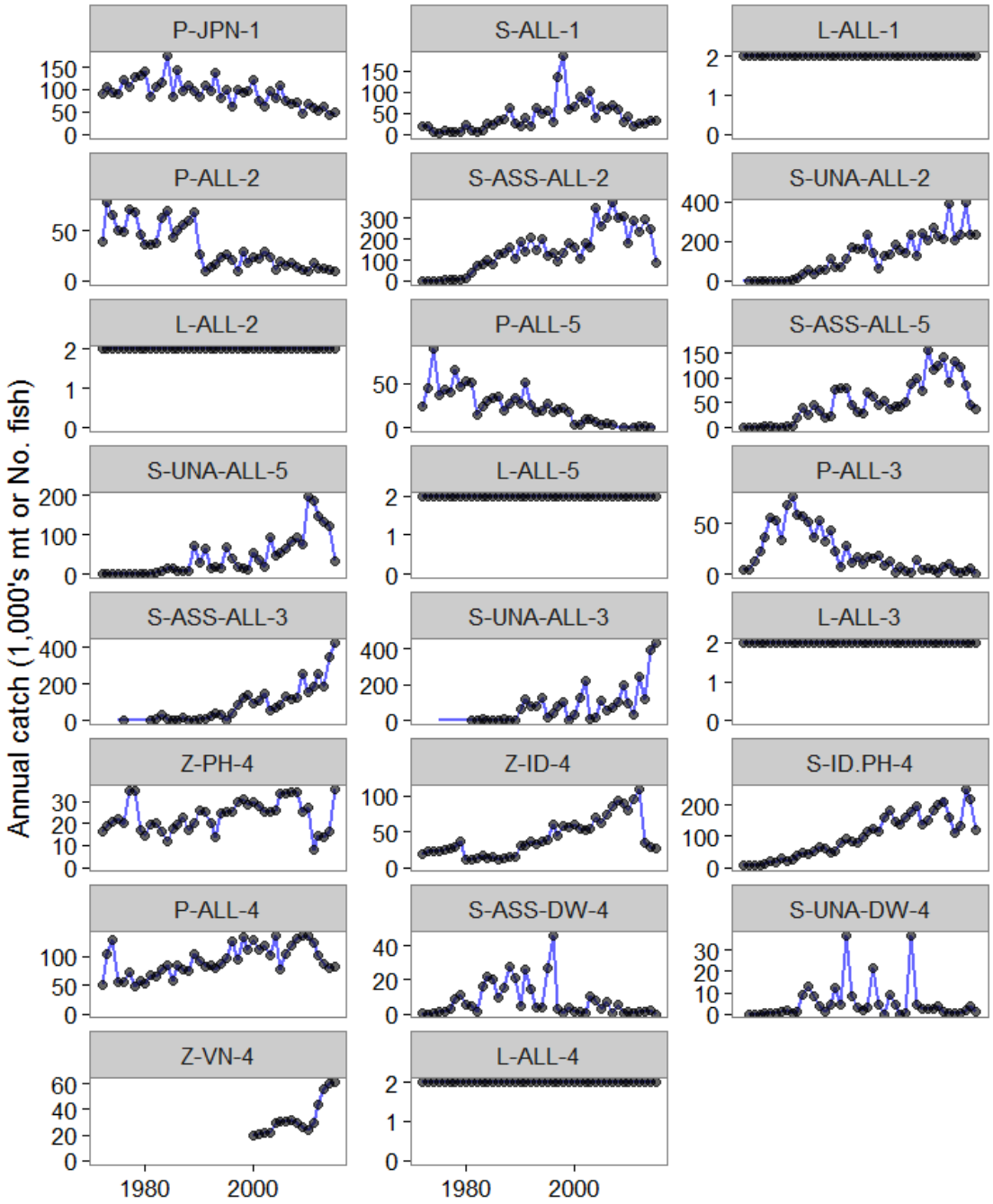

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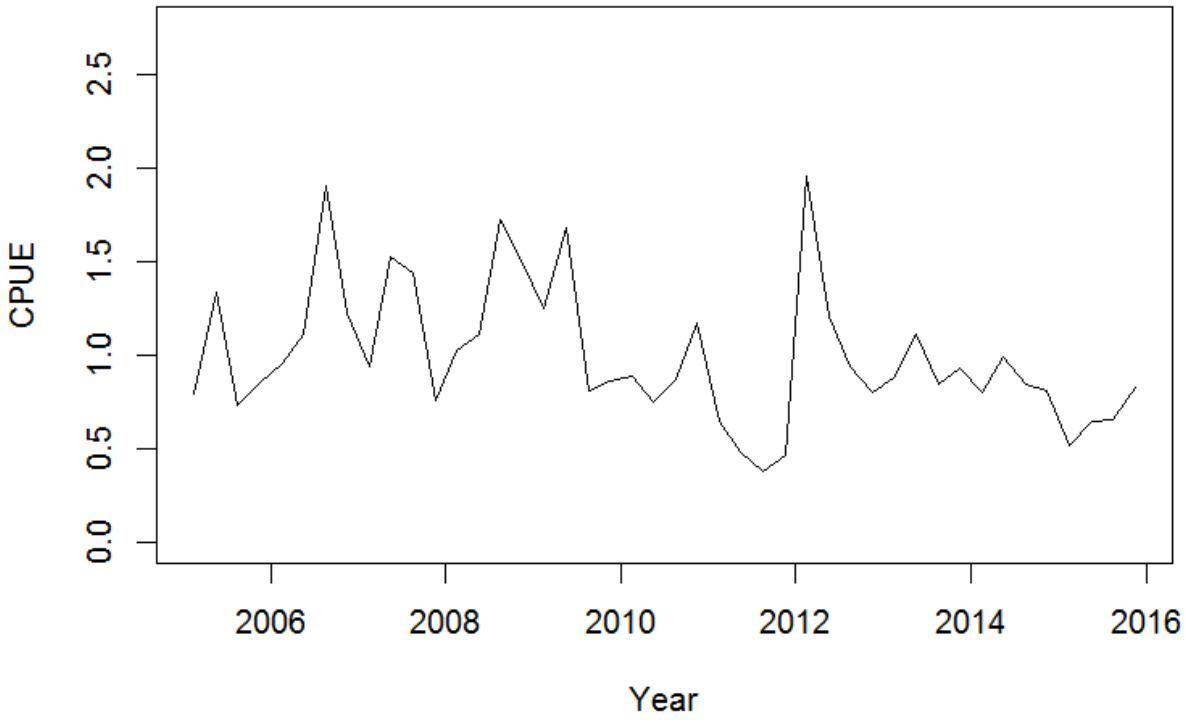
CPUE
0.0
0.5
1.0
1.5
2.0
2.5
2006
2008
2010
2012
2014
2016
Year

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