SEDAR 66 South Atlantic Tilefish Assessment Webinar III

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Introduction

Assessment Schedule

- 2020-11-16 to 2020-11-19: Data/Assessment Workshop
- 2020-12-01: Assessment Webinar I
- 2021-01-27: Assessment Webinar II
- 2021-02-18: Assessment Webinar III
- 2021-03-05: Assessment Report draft due
- 2021-03-19: Assessment Report comments due
- 2021-04-02: Assessment Report final due to SEDAR
- 2021-04-02: Assessment Report final due to Council

Introduction

Recap from Assessment Webinar II

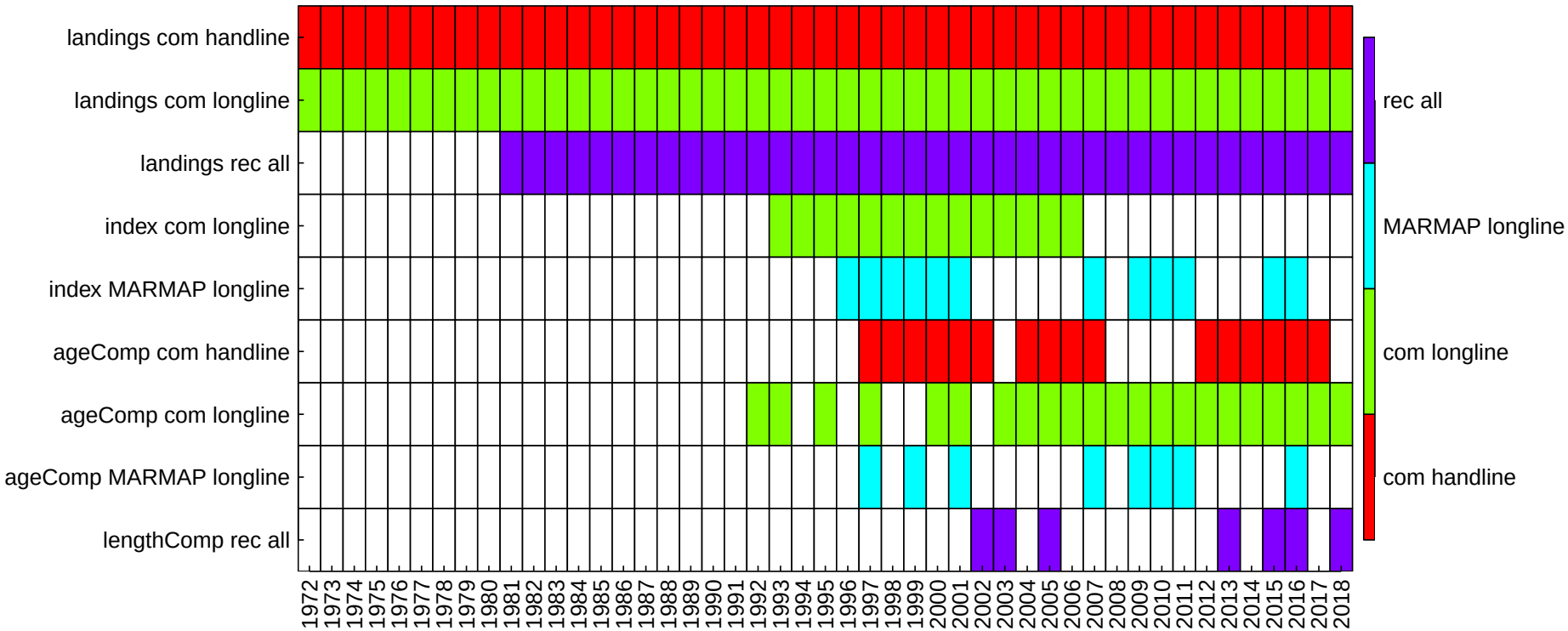
- We agreed on a base model
- We identified sensitivity runs including a new run involving alternative recruitment for the last several years of the assessment
- Meet for Webinar III to look at model diagnostics and projections

Introduction

1. Random restarts
2. Likelihood profiles on steepness, natural mortality, R_0, rec sigma, and F_{init}
3. Sensitivity analysis
4. Uncertainty analysis

Data

Summary of data being fit by the assessment



Stock assessment model

Base model configuration

- Model coded in Automatic Differentiation Model Builder (ADMB)
- Catch-at-age model used in most SEDAR assessments in the US South Atlantic, the Beaufort Assessment Model (BAM)
- Started with most updated version of BAM (SEDAR 25, 2017 Update)
- Timeline for SEDAR 66: 1972-2018

Stock assessment model

Base model configuration

- Age-structured life history
  - $(W_{\text{fishWhole}} = aL^b)$
  - $W_{\text{gonad}} = aW^b_{\text{fishWhole}}$
  - $W_{\text{fishWhole}} = aW_{\text{fishGutted}}$
  - $TL = VB(age)$
  - $TL_{female} = VB(age)$
  - Age-dependent female maturity
  - Age-dependent natural mortality
- Match landings time series
- Fit indices of abundance time series
- Fit age compositions
- Fit length compositions
- Estimate recruitment deviations
- Estimate fleet specific fishing mortality (average and time series of deviations)
- Estimate Beverton-Holt stock-recruit parameters
- Estimate selectivity functions
- Calculate biological reference points and stock status

Stock assessment model

Initialization

- Initial fishing mortality in 1972 (F_{init}) is fixed at 0.01
- Deviations from equilibrium age structure in 1972 are fixed at zero

Stock assessment model

Recruitment

Stock-recruit function

- Beverton-Holt stock-recruit function
- R_0 (unfished age-1 recruitment) is being estimated
- Steepness (h) is fixed at 0.84 (had a tendency to go to upper bound)
- Rec sigma (σ) is fixed at 0.6 (had a tendency to go to a lower bound)

Recruitment deviations

- Age composition data spans 1992-2018
- Most commercial ages are for age 6-15
- Recruitment deviations estimated from 1982-2011
- No additional constraints on recruitment

Stock assessment model

Selectivity

- Commercial handline landings
  - Logistic
  - Two time blocks: $1972 - 2008$, $2009 - 2018$
- Commercial longline landings
  - Logistic
  - Two time blocks: $1972 - 2008$, $2009 - 2018$
- Recreational landings
  - Logistic
  - One time block $1972 - 2018$
- MARMAP horizontal longline survey index
  - Logistic
  - One time block $1996 - 2016$

Stock assessment model

Comparison to previous assessment

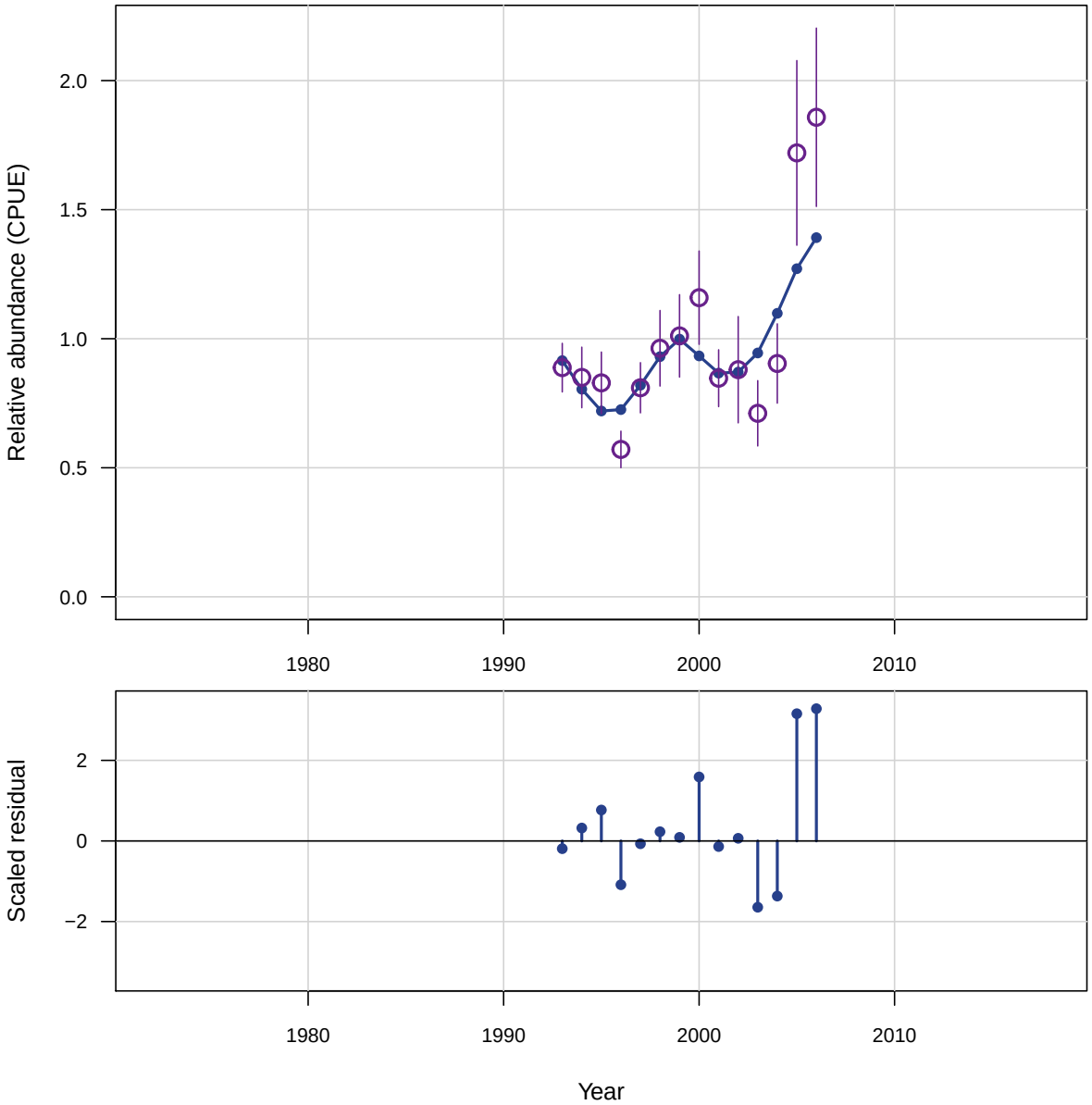
Model configuration

1. Beverton-Holt rec sigma (σ) is fixed
2. Selectivity of commercial handline and longline include two time blocks (1972-2007, 2008-2018)
3. Length and age compositions were fit using Dirichlet multinomial likelihoods, compared with robust multinomial likelihoods used in the SEDAR 25, 2016 Update
4. Modeling ages 1-20 in population compared with 1-25 in SEDAR 25, 2016 Update

Stock assessment model

Fit to indices

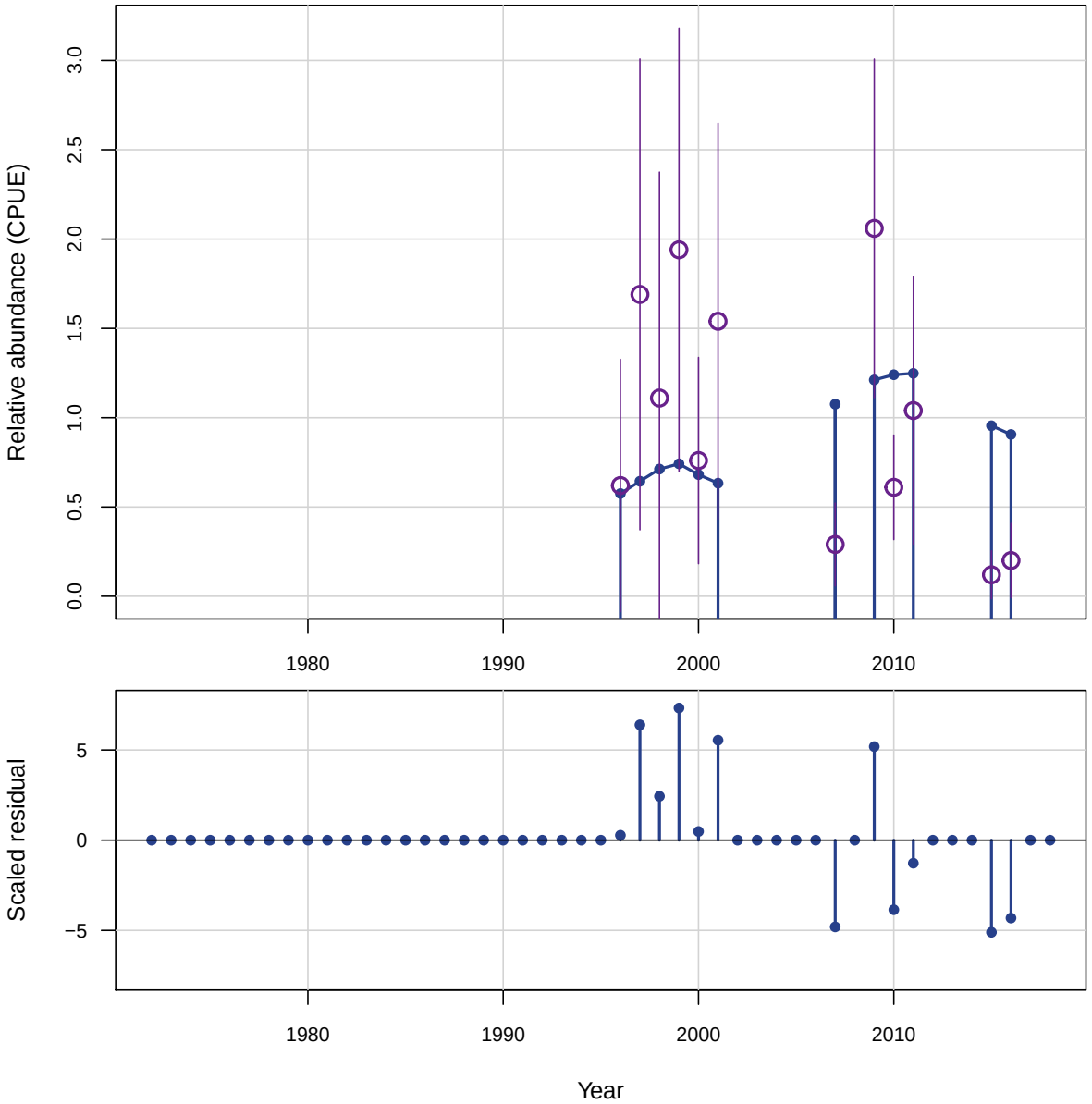
Commercial longline index



Stock assessment model

Fit to indices

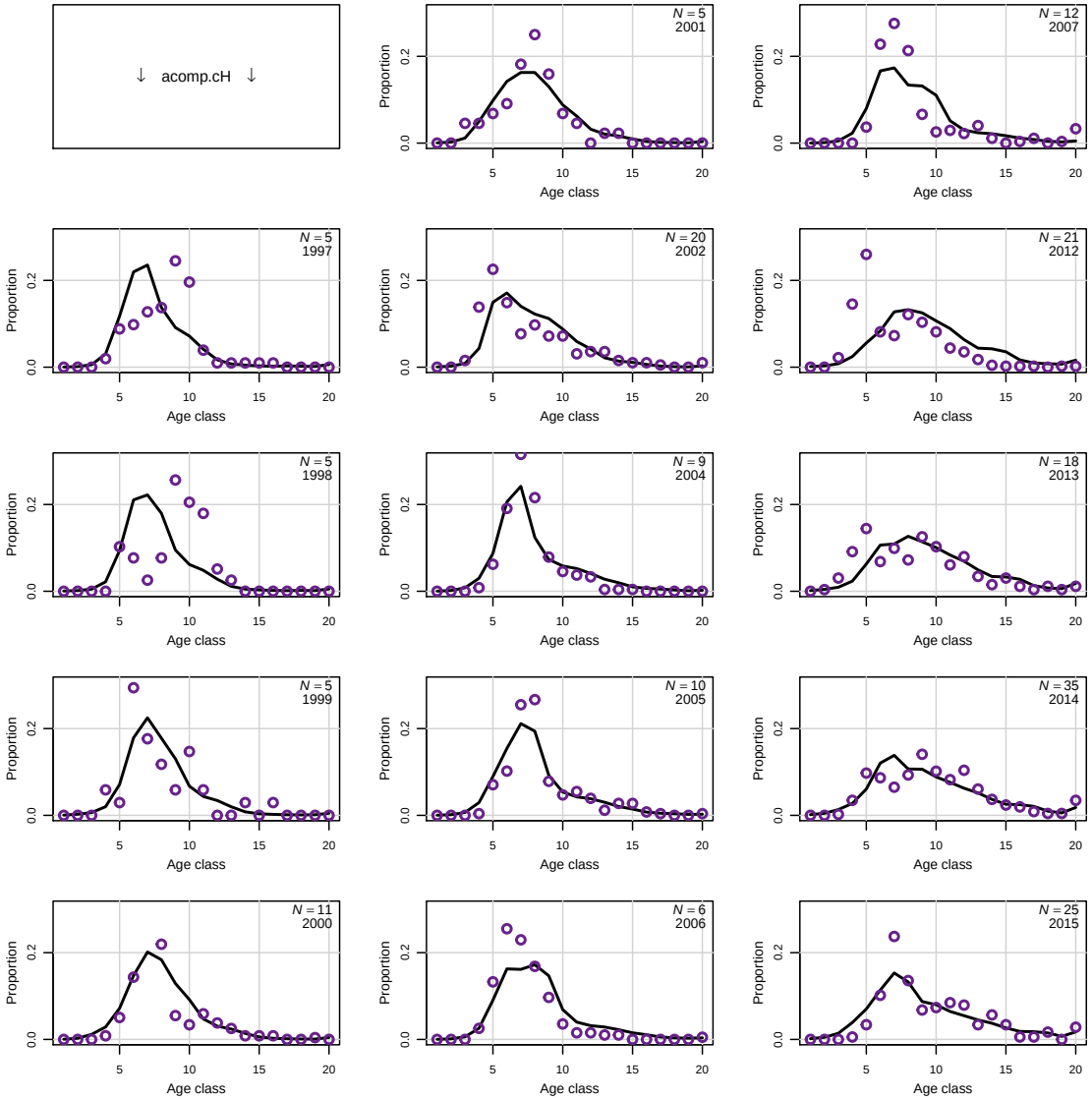
MARMAP horizontal longline survey index



Stock assessment model

Fit to age and length compositions

Commercial handline ages: 1997 – 2015

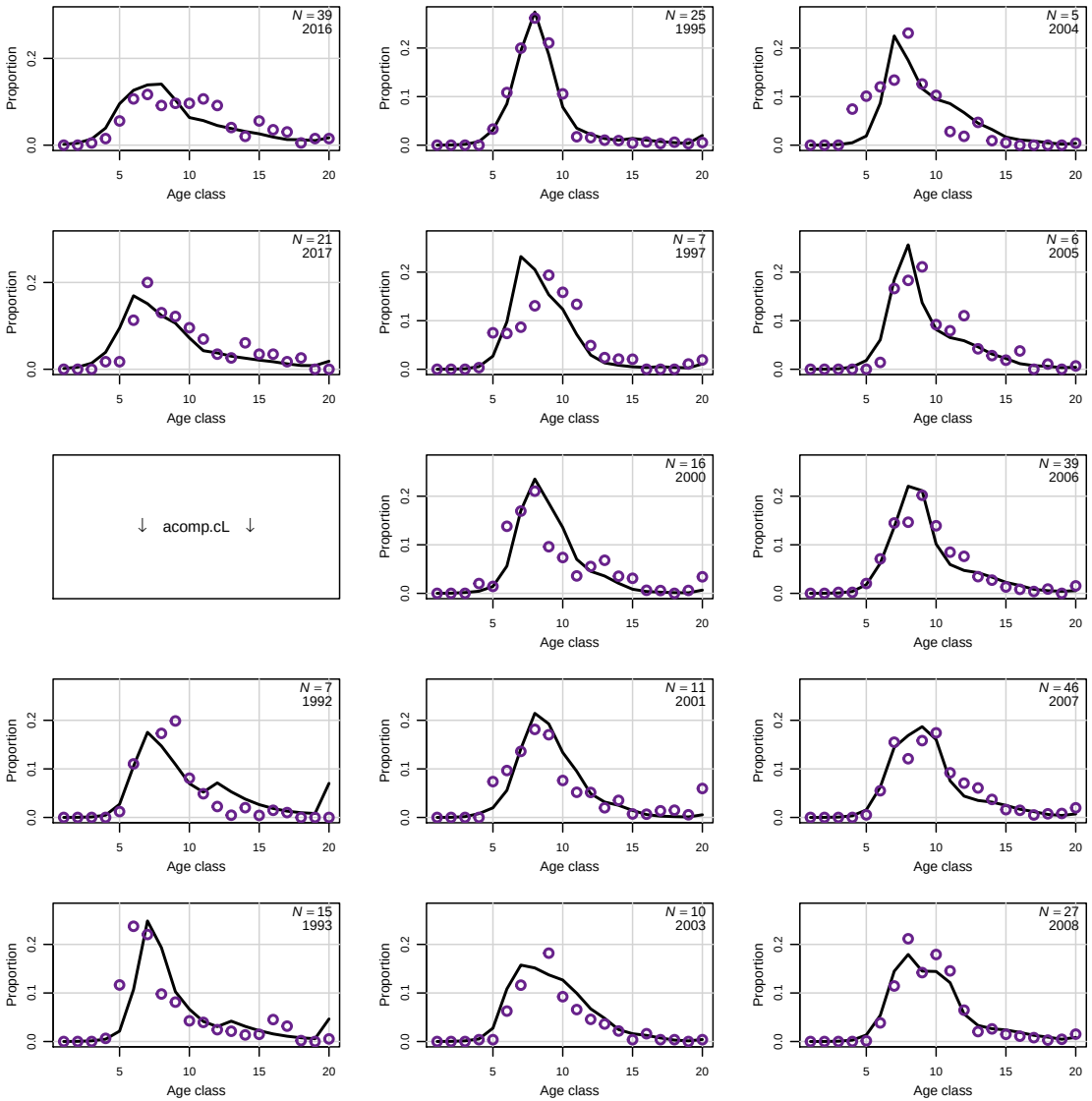


Stock assessment model

Fit to age and length compositions

Commercial handline ages: 2016 – 2017

Commercial longline ages: 1992 – 2008

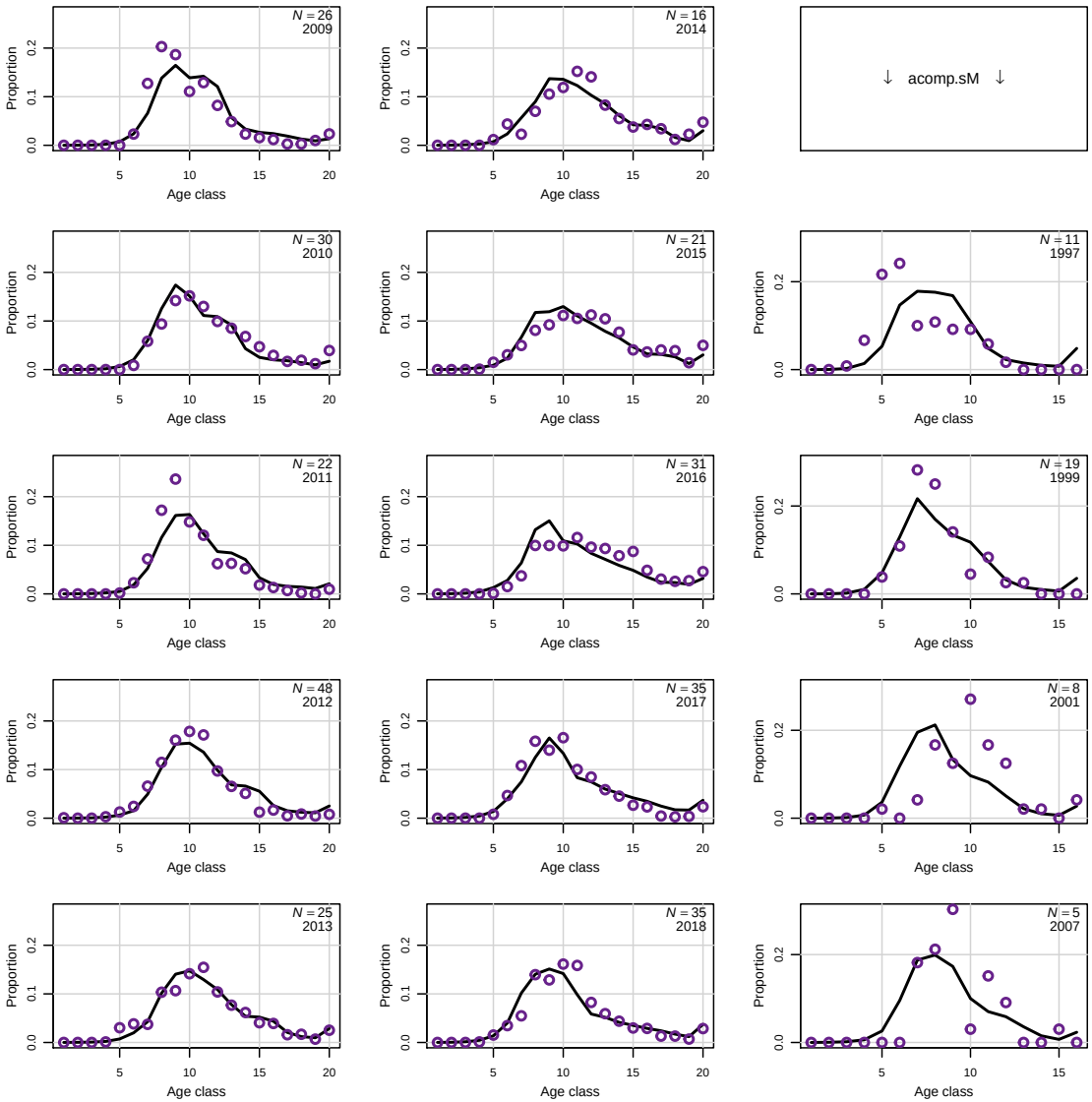


Stock assessment model

Fit to age and length compositions

Commercial longline ages: 2009 – 2018

MARMAP longline survey ages: 1997 – 2007

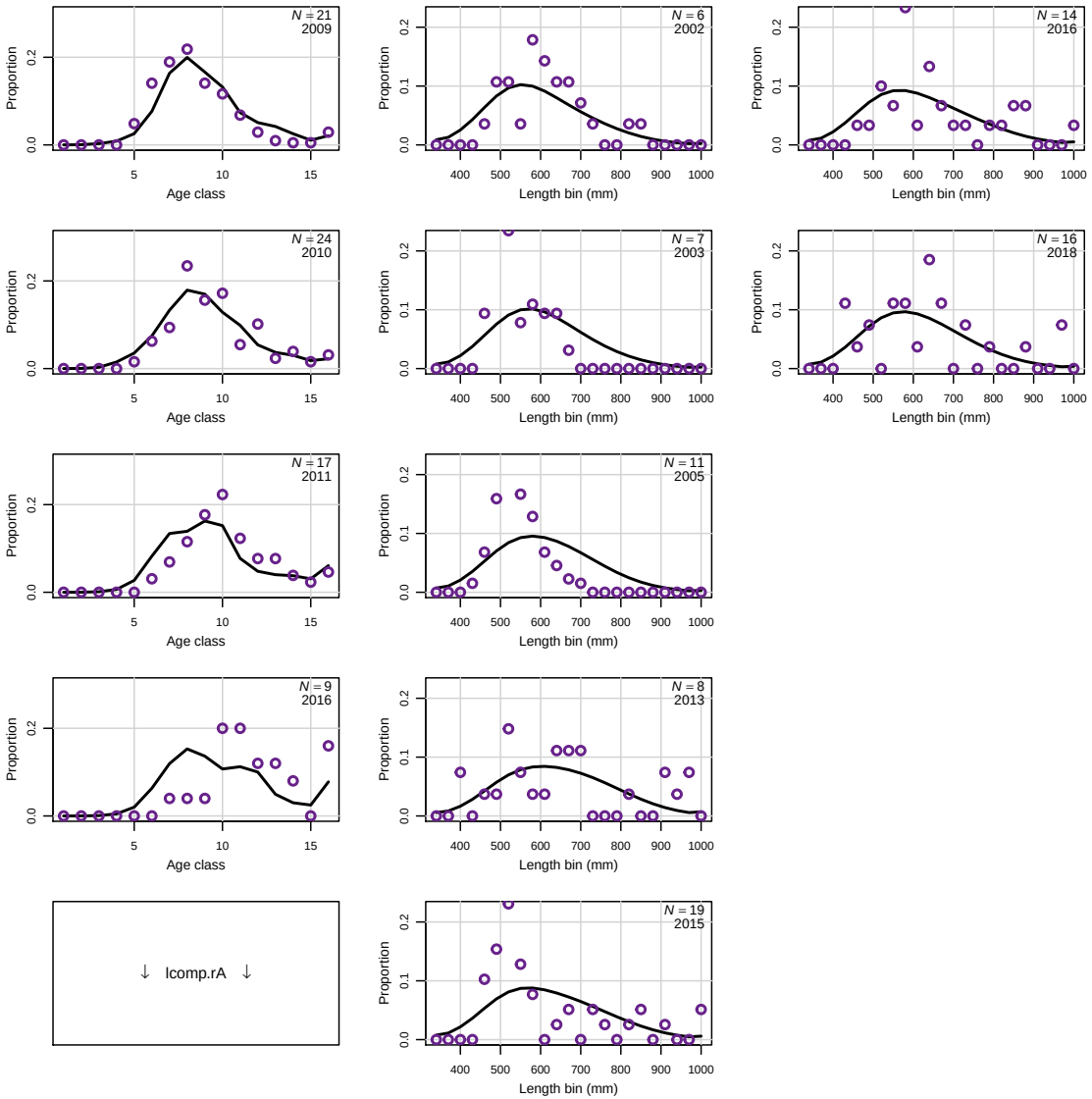


Stock assessment model

Fit to age and length compositions

MARMAP longline survey ages: 2009 – 2016

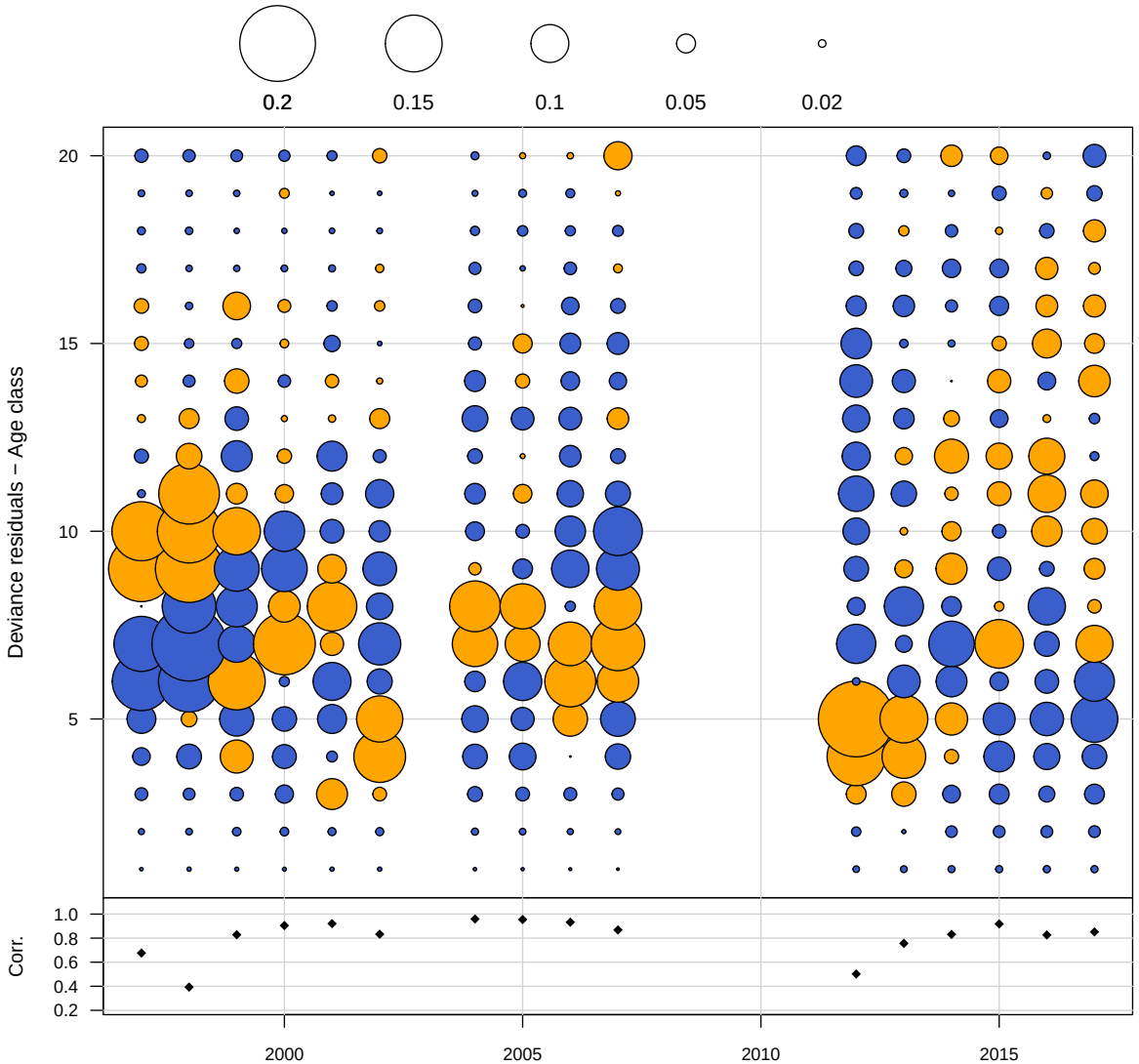
Recreational lengths: 2002 – 2018



Stock assessment model

Fit to age and length compositions: residuals

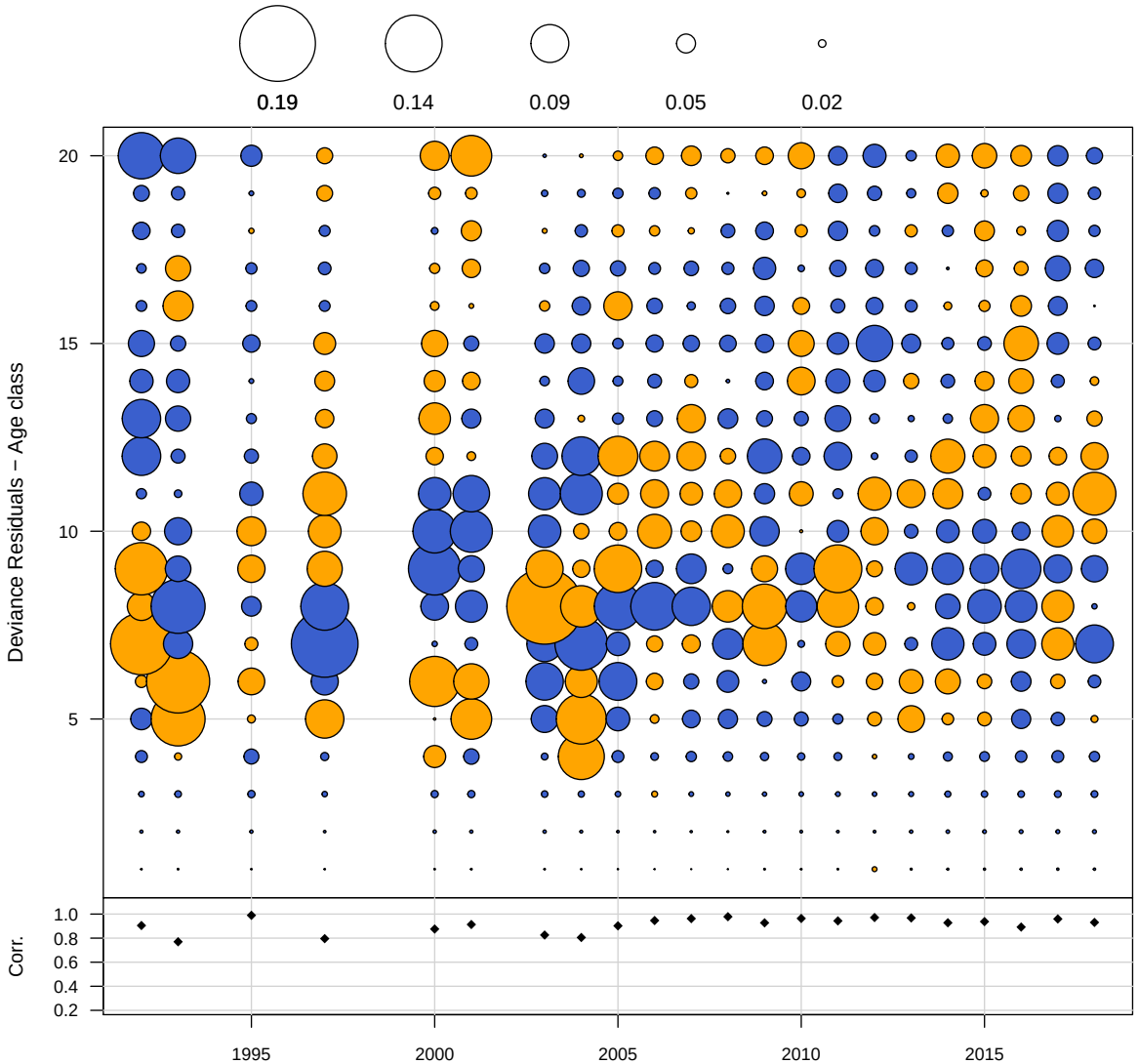
Commercial handline ages



Stock assessment model

Fit to age and length compositions: residuals

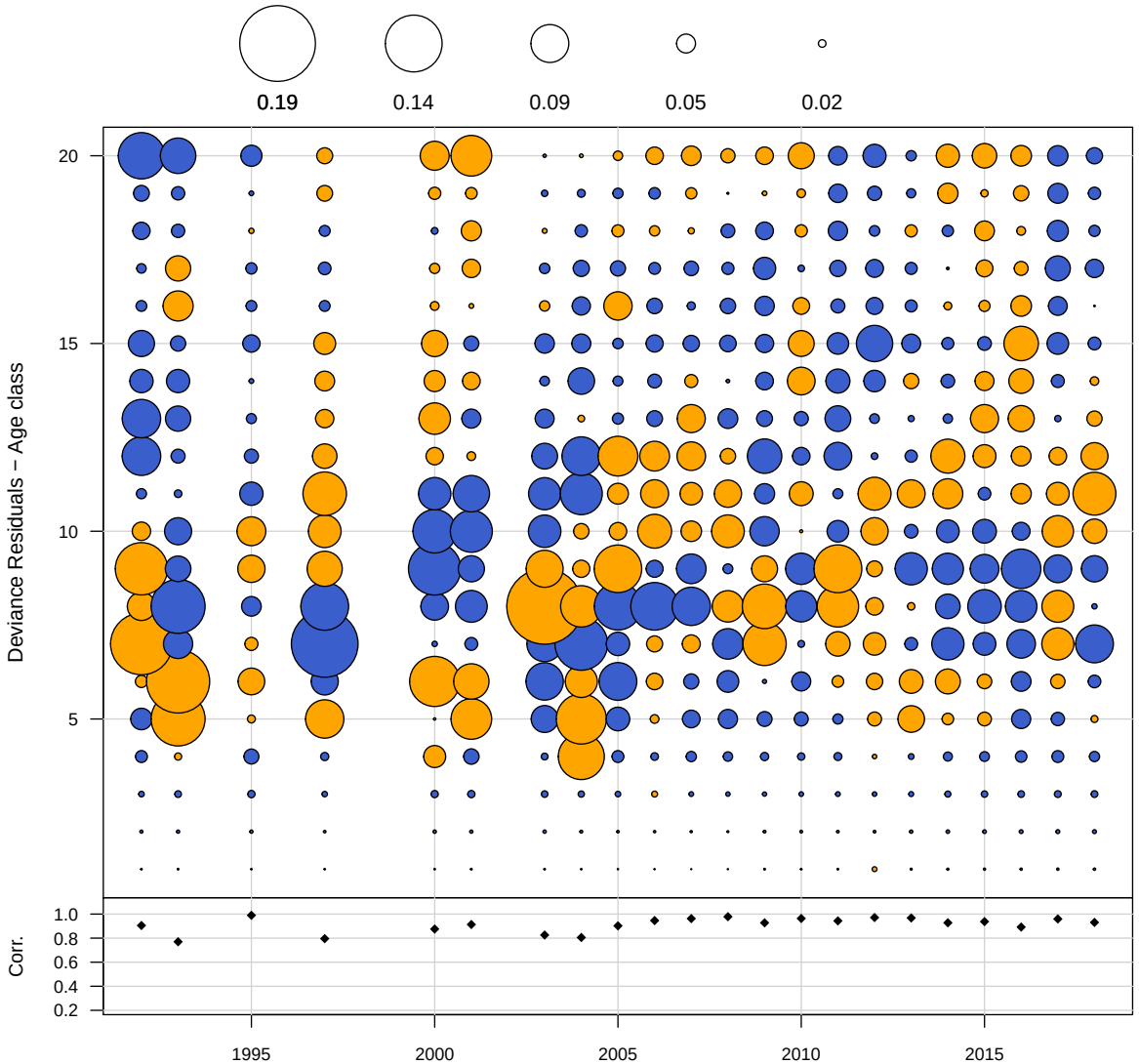
Commercial longline ages



Stock assessment model

Fit to age and length compositions: residuals

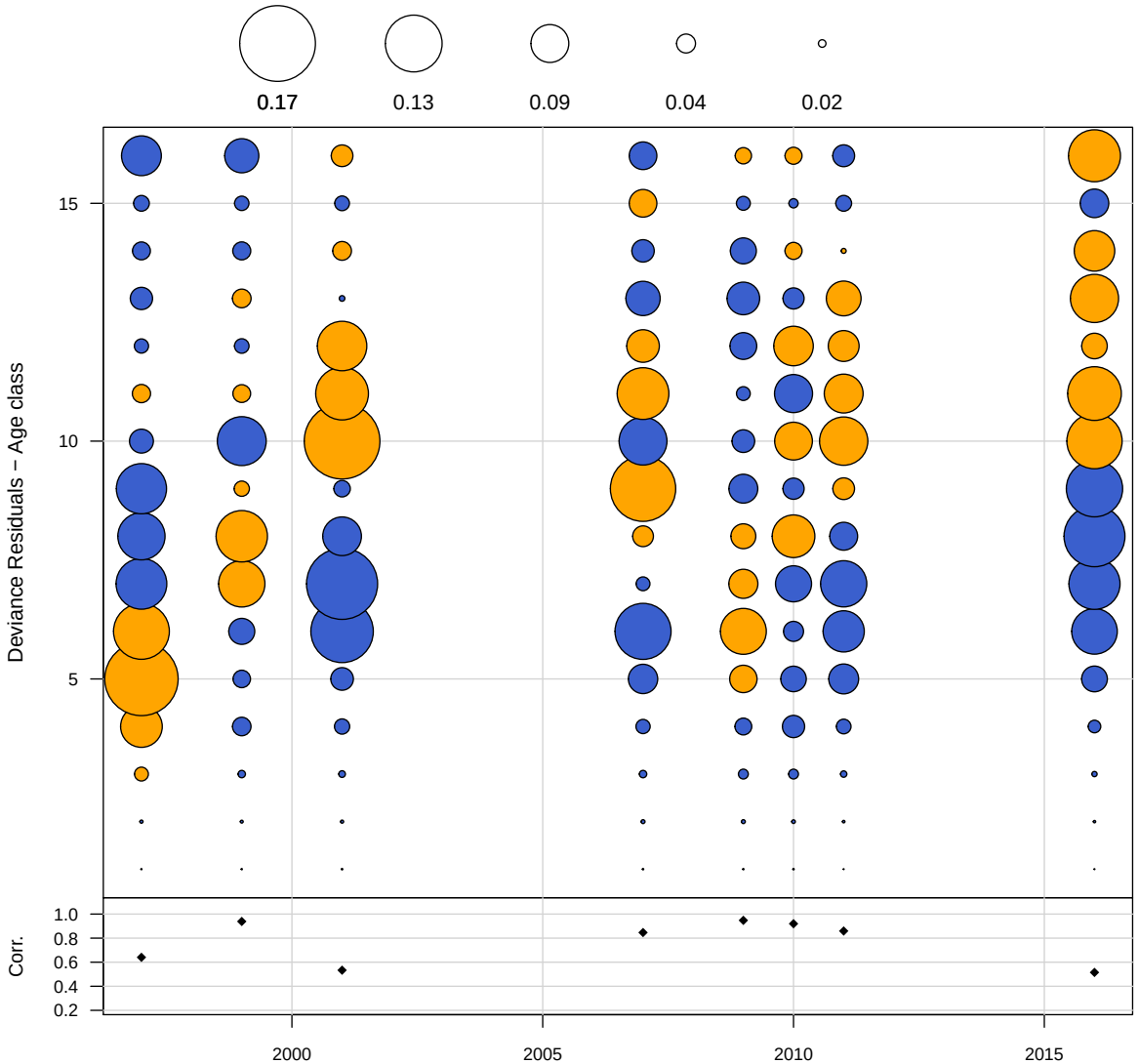
Commercial longline ages



Stock assessment model

Fit to age and length compositions: residuals

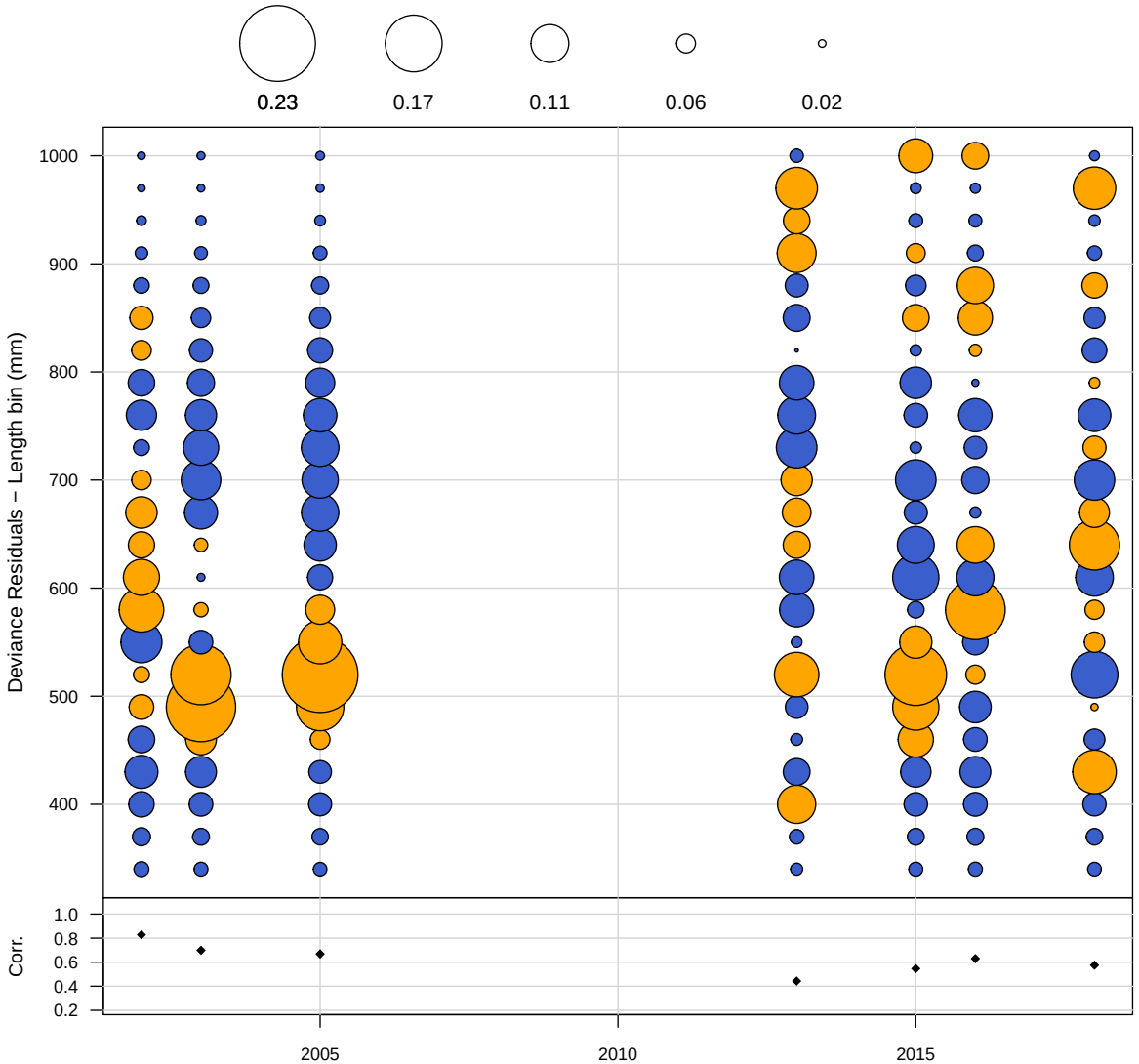
MARMAP longline survey ages



Stock assessment model

Fit to age and length compositions: residuals

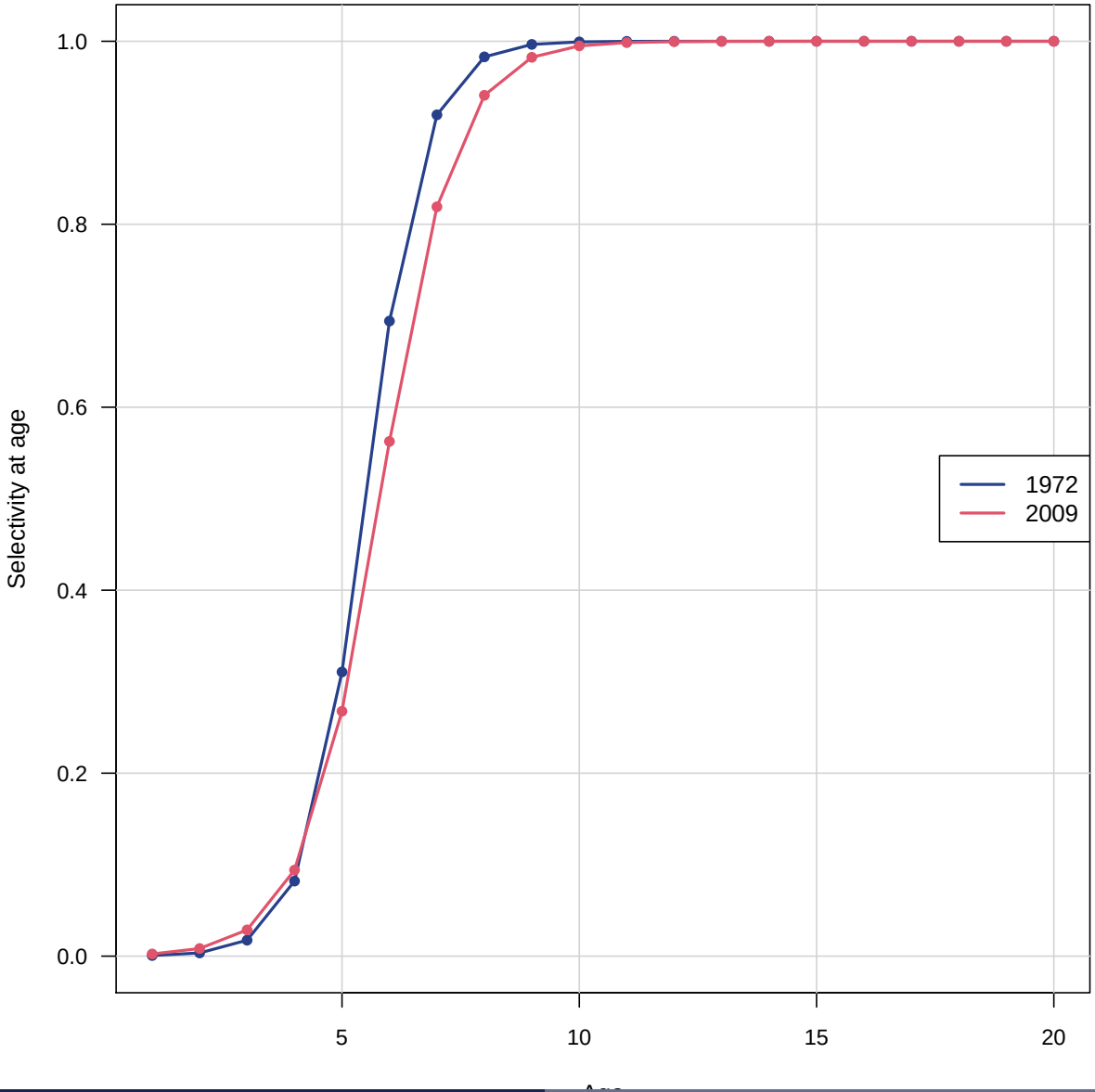
Recreational lengths



Stock assessment model

Estimated selectivity

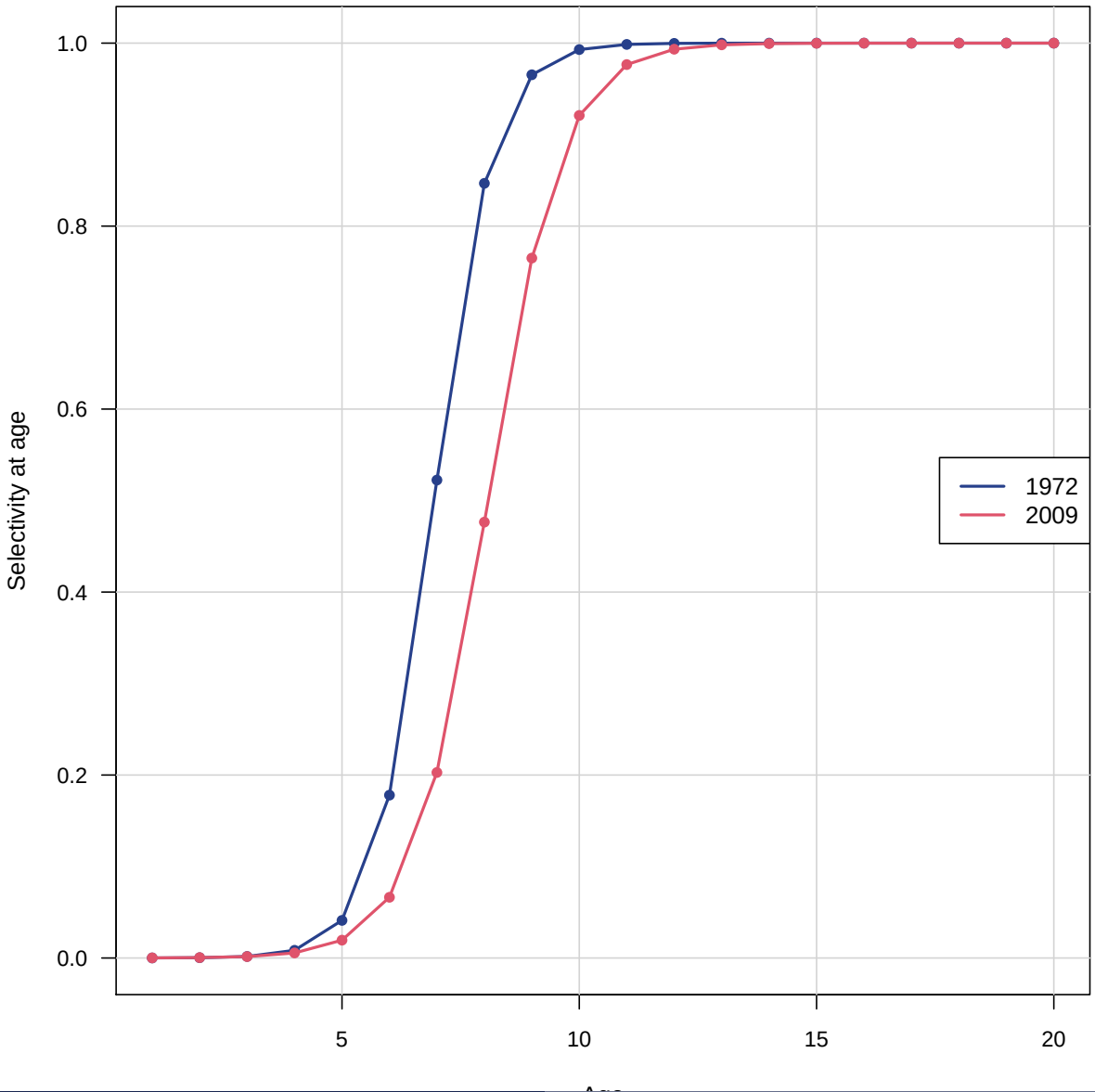
Commercial handline landings



Stock assessment model

Estimated selectivity

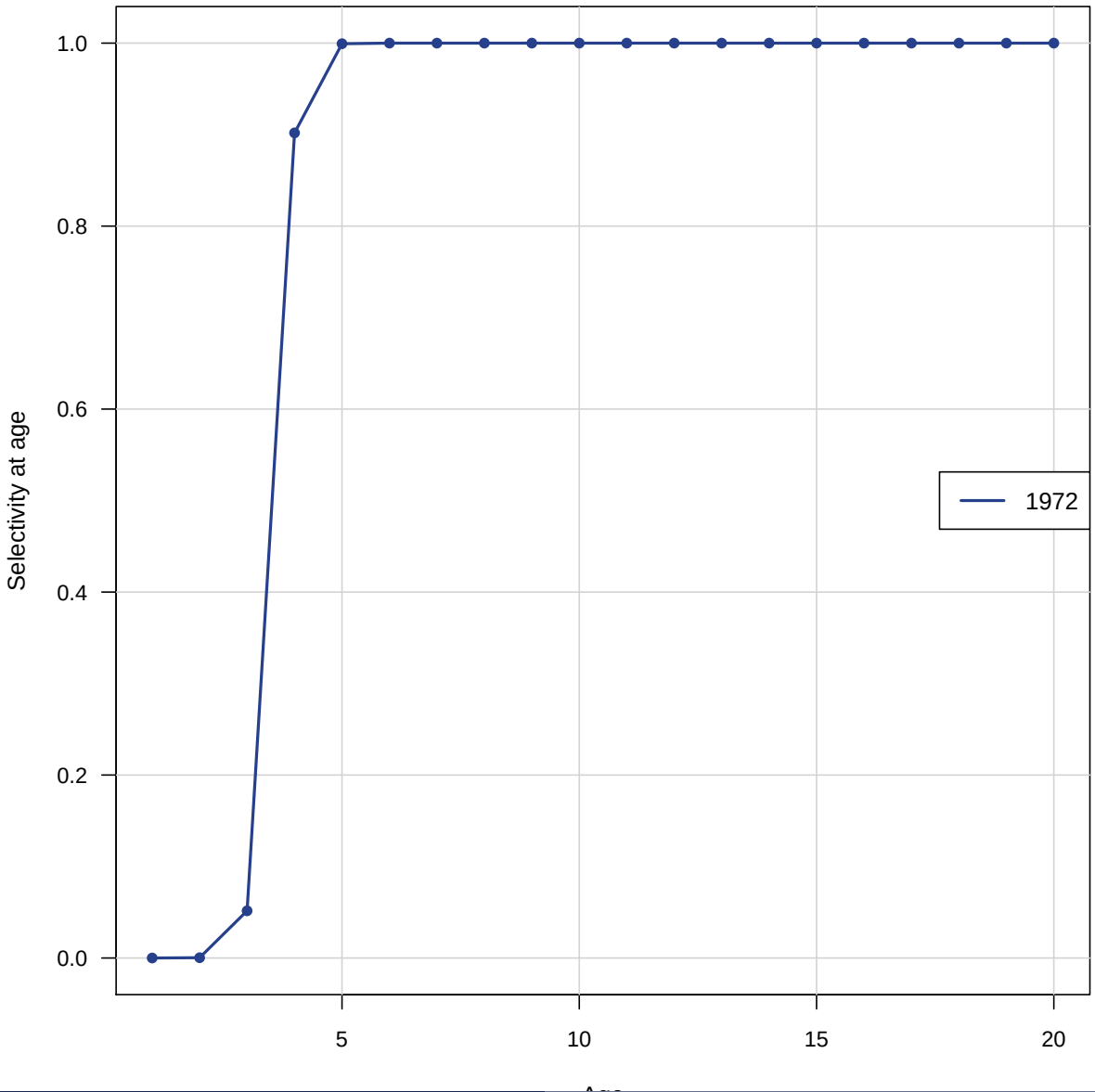
Commercial longline landings



Stock assessment model

Estimated selectivity

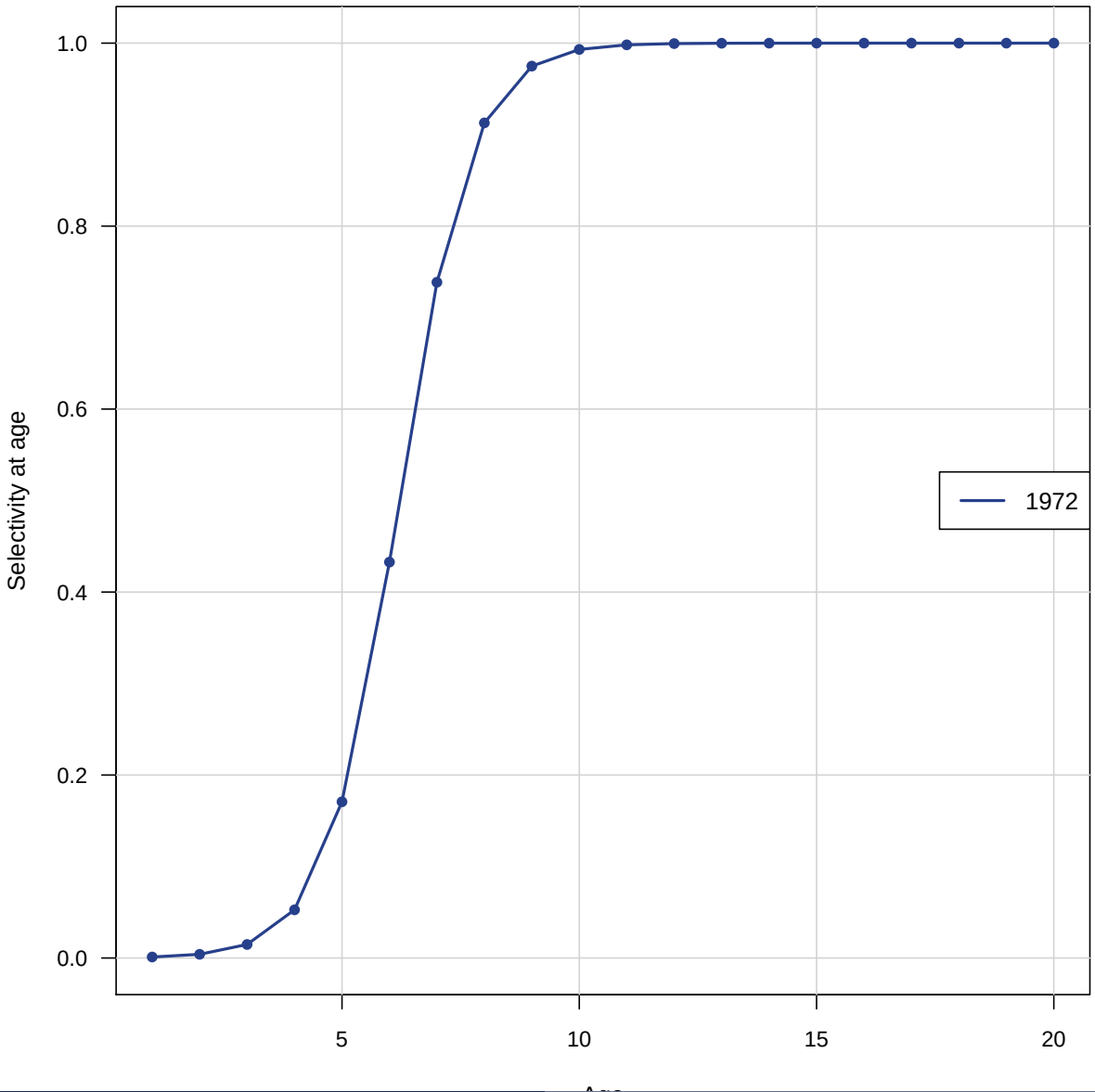
Recreational landings



Stock assessment model

Estimated selectivity

MARMAP longline survey



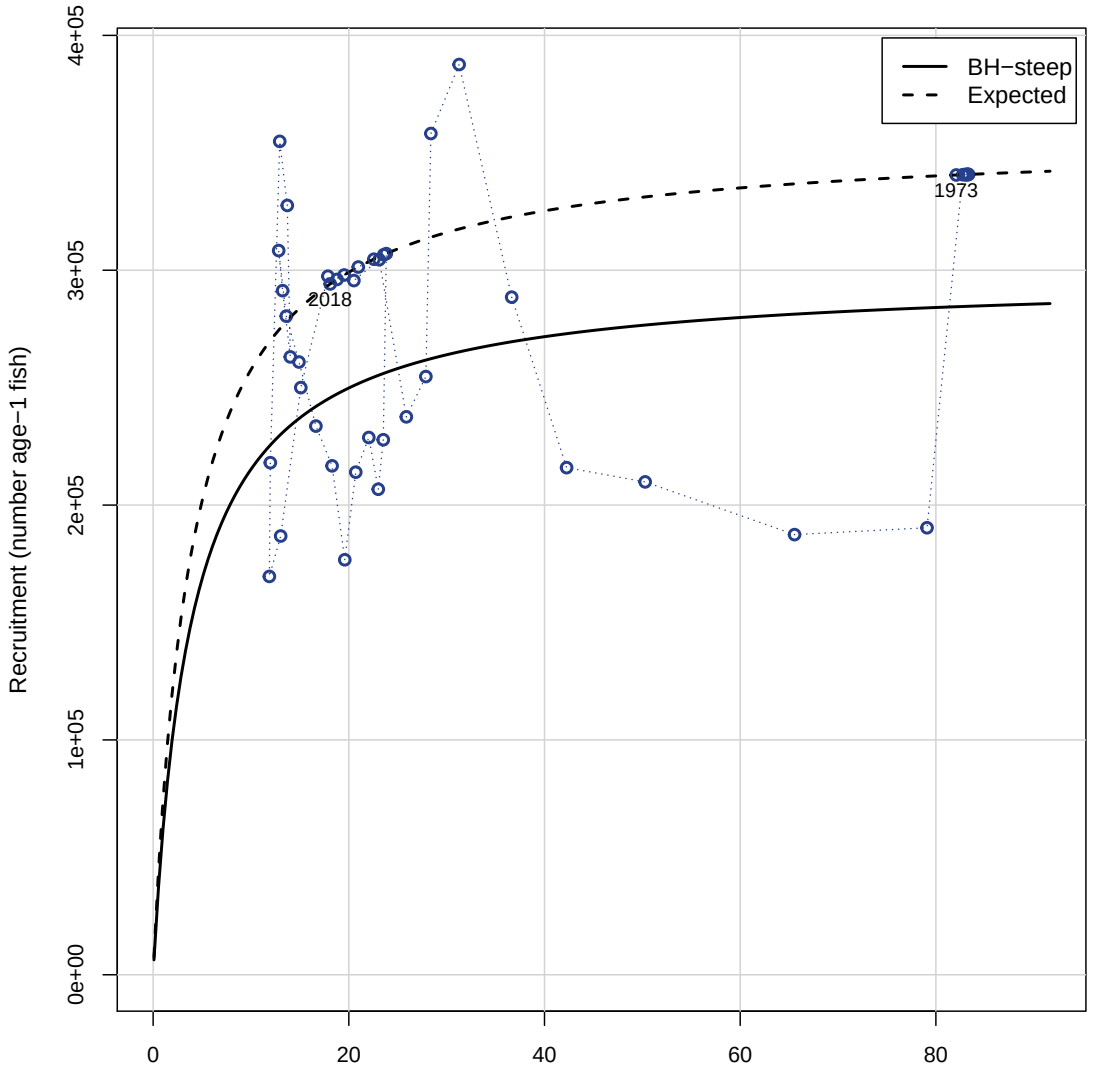
Stock assessment model

Spawner-recruit curve

$h = 0.84$

$R_0 = 283,600$

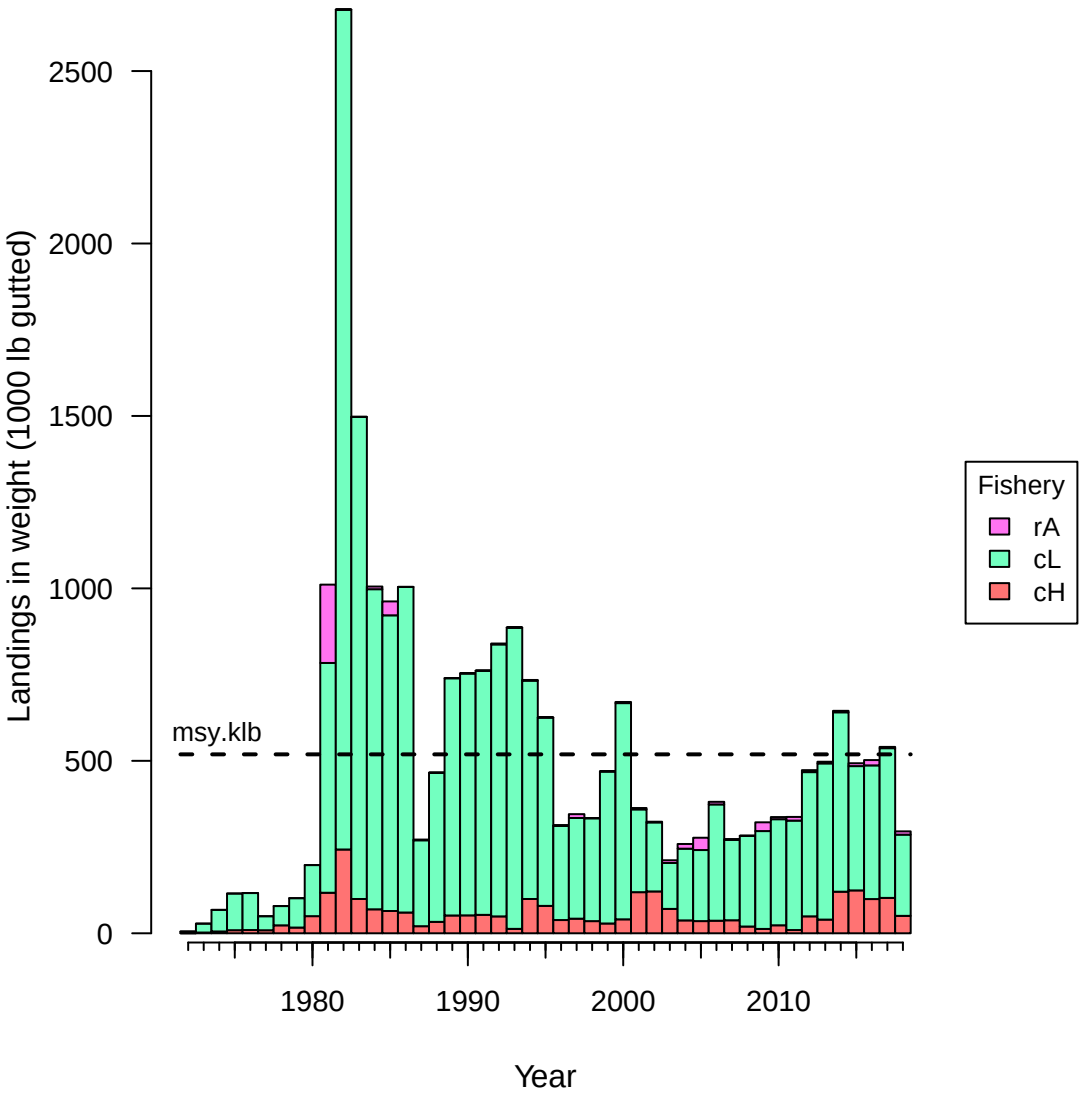
$\sigma_R = 0.6$



Stock assessment model

Landings

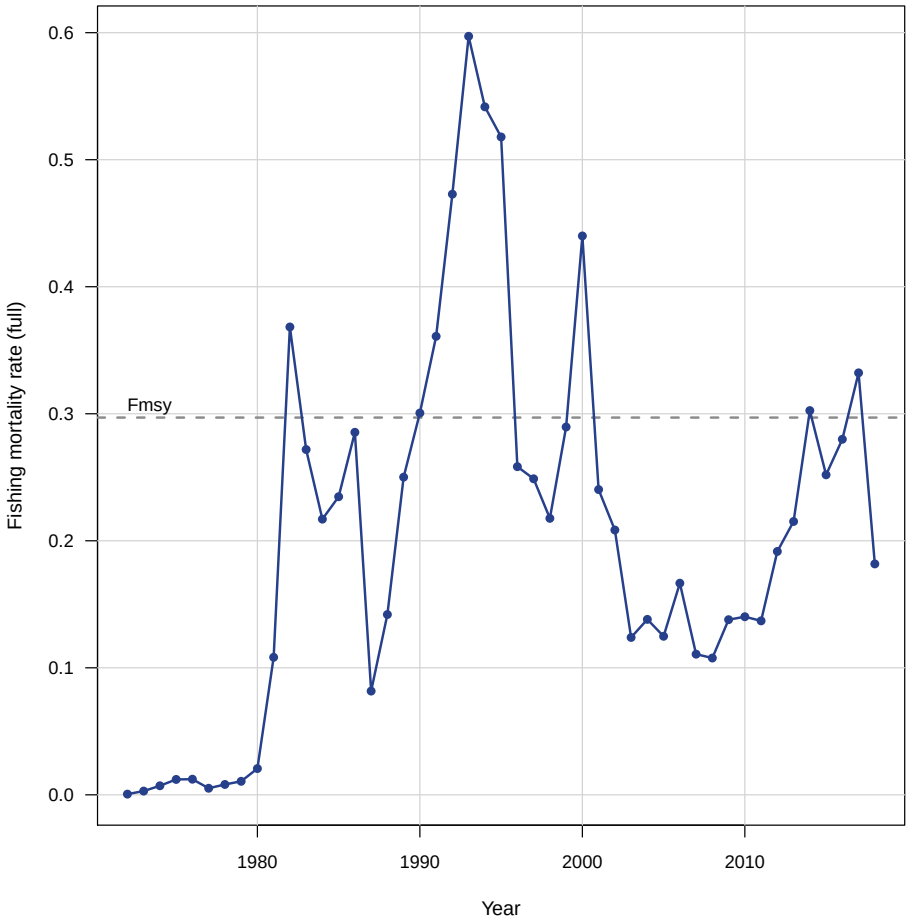
Landings (1000 lb)



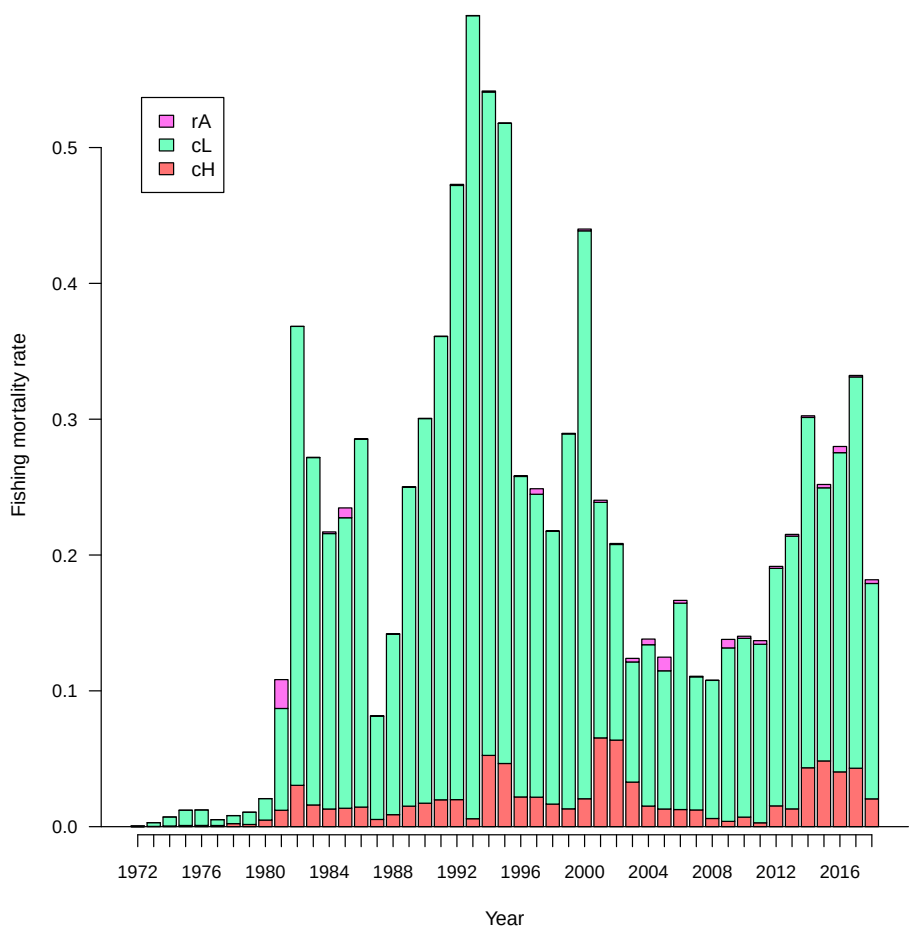
Stock assessment model

Benchmark time series

F-full



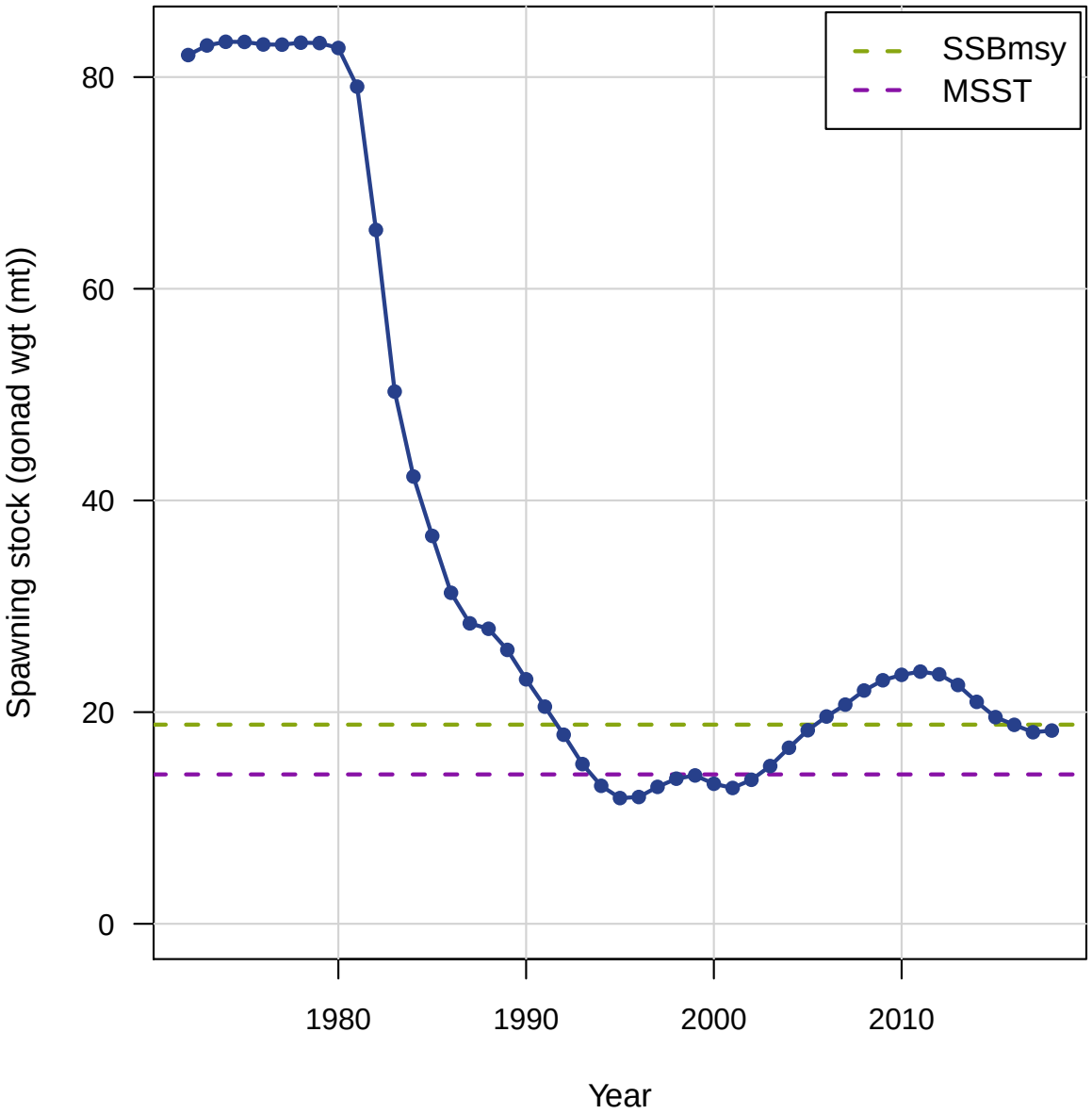
F by fleet



Stock assessment model

Benchmark time series

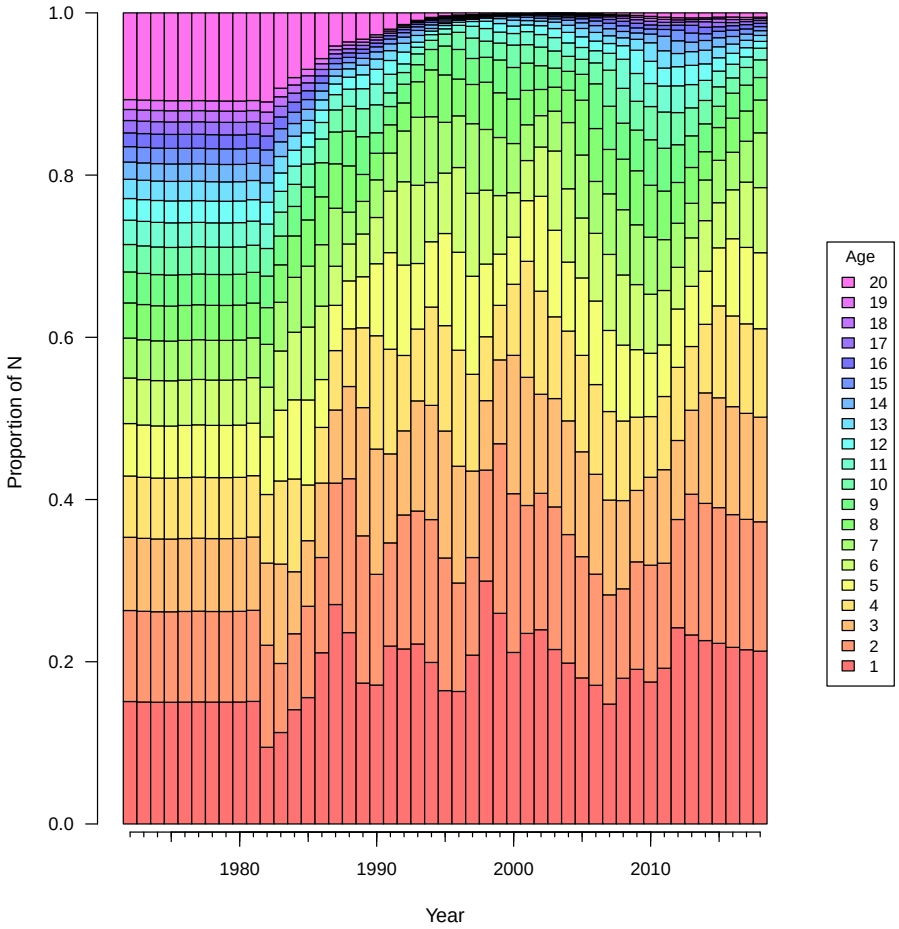
Spawning stock biomass (SSB)



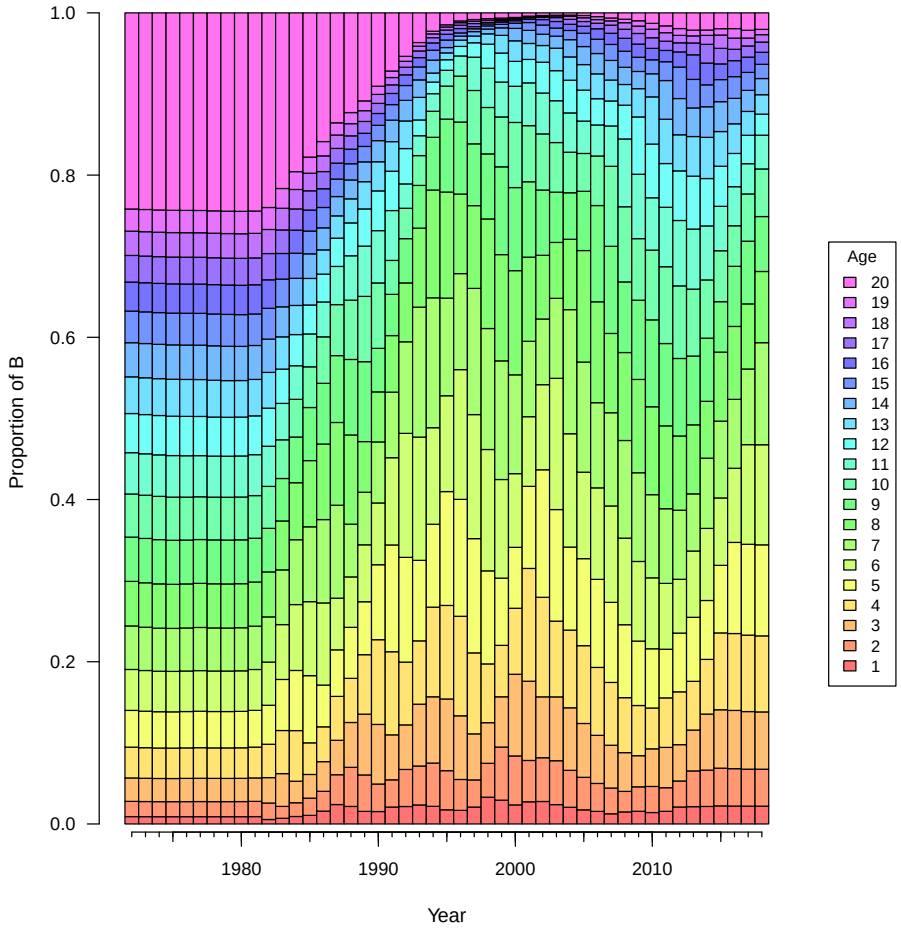
Stock assessment model

Benchmark time series

Numbers-at-age (proportions)

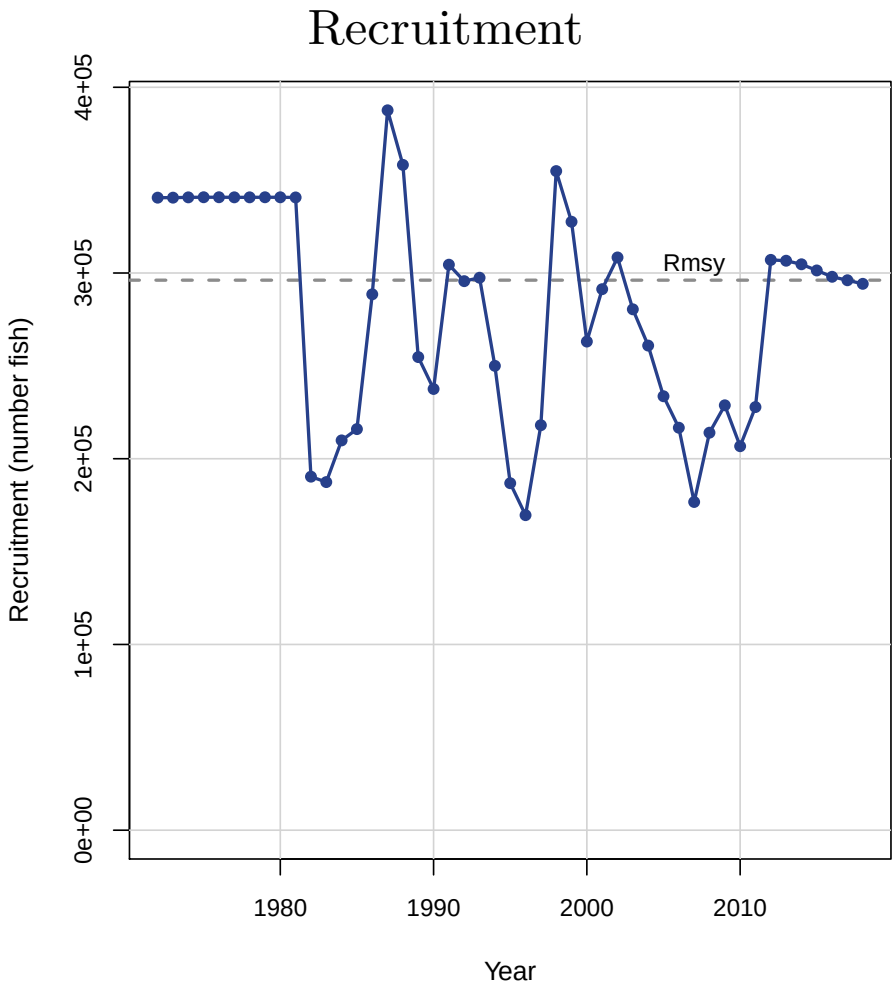


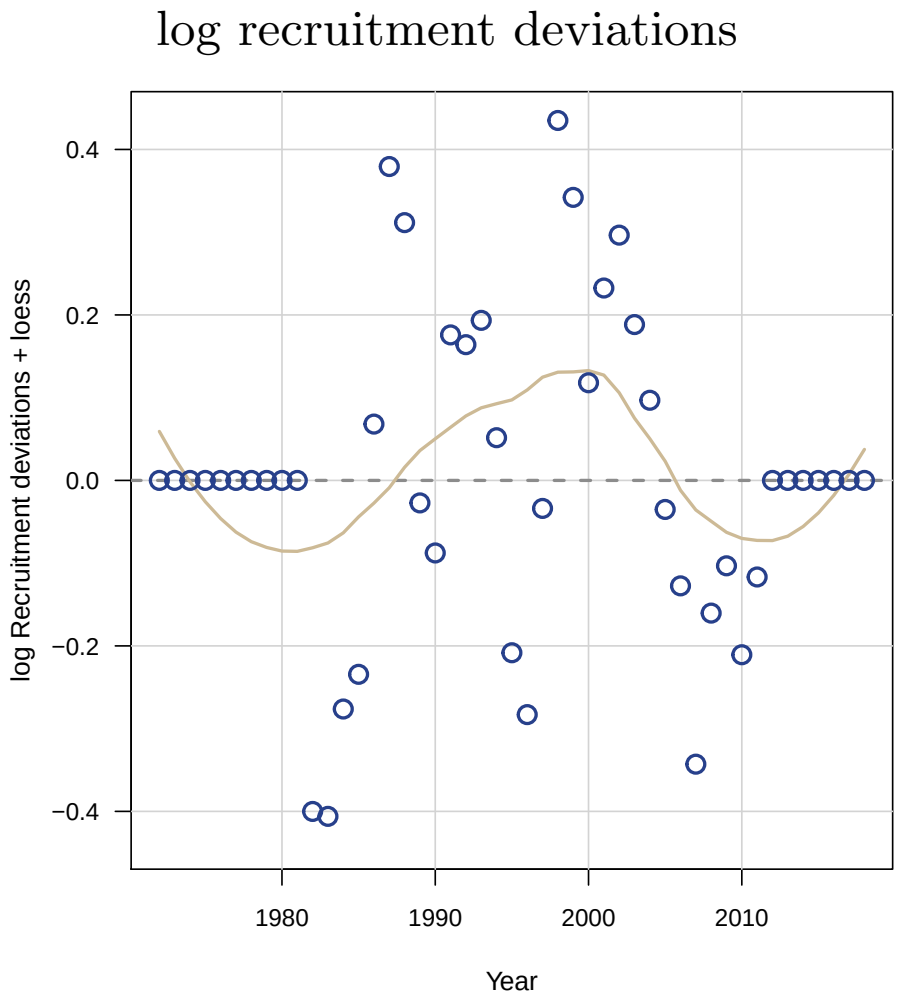
Biomass-at-age (proportions)



Stock assessment model

Benchmark time series





Stock assessment model

Management quantities

Quantity	Units	Estimate	Median	SE
F_{MSY}	y^{-1}	0.297	0.255	0.183
$85\%F_{\text{MSY}}$	y^{-1}	0.252	0.217	0.156
$75\%F_{\text{MSY}}$	y^{-1}	0.223	0.191	0.138
$65\%F_{\text{MSY}}$	y^{-1}	0.193	0.166	0.119
$F_{20\%}$	y^{-1}	0.381	0.423	0.132
$F_{30\%}$	y^{-1}	0.204	0.225	0.054
$F_{40\%}$	y^{-1}	0.129	0.141	0.029
B_{MSY}	metric tons	2283.3	2515.7	463.2
SSB_{MSY}	gonad wgt (mt)	18.8	21.2	7.6
MSST	gonad wgt (mt)	14.1	15.9	5.7
MSY	1000 lb gutted	518.8	507.2	79.1
R_{MSY}	1000 fish	296.1	331.1	103.1
$L_{85\%\text{MSY}}$	1000 lb gutted	516.6	504.7	79.8
$L_{75\%\text{MSY}}$	1000 lb gutted	511.9	499.2	81.2
$L_{65\%\text{MSY}}$	1000 lb gutted	503.3	489.3	83.3
$F_{2016-2018}/F_{\text{MSY}}$	—	0.864	1.049	1.755
$\text{SSB}_{2018}/\text{MSST}$	—	1.294	1.116	0.63
$\text{SSB}_{2018}/\text{SSB}_{\text{MSY}}$	—	0.97	0.837	0.473

Random restarts

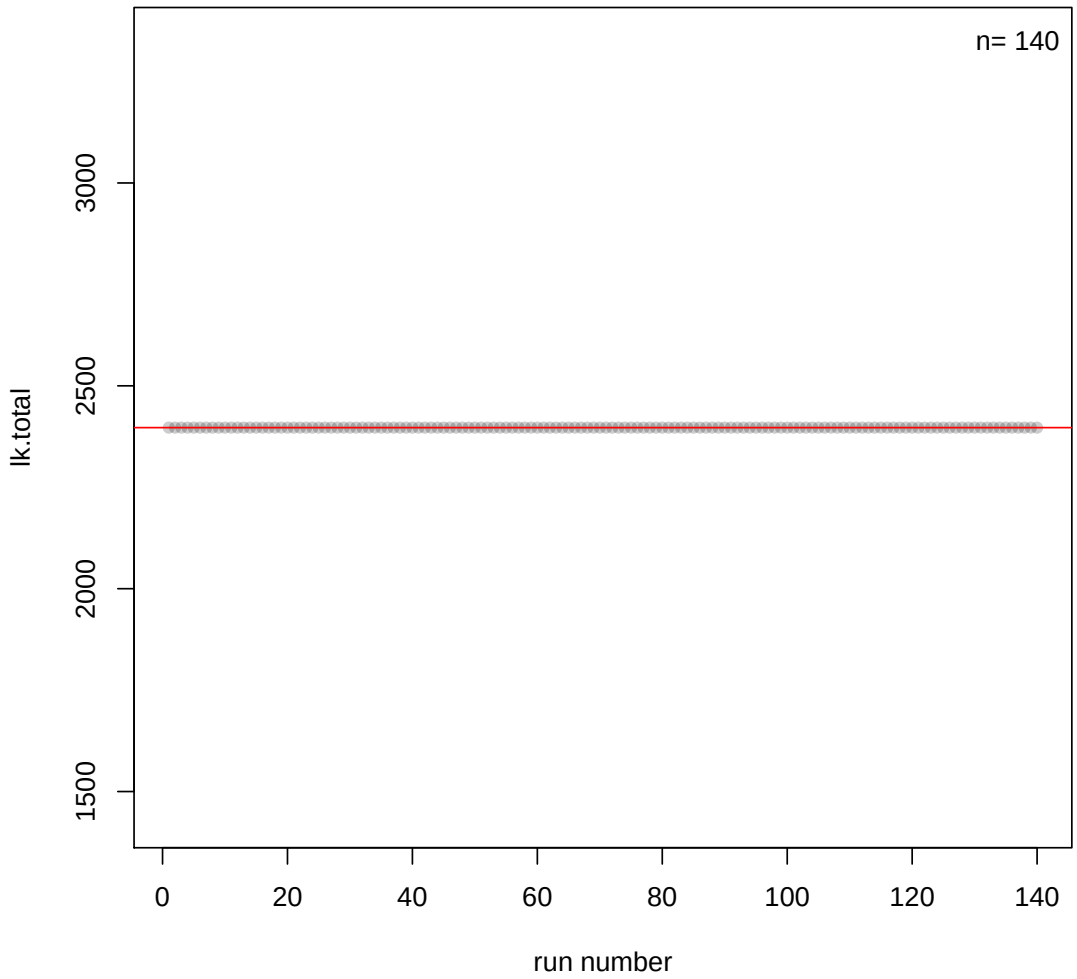
Methods

- This procedure is repeated many times and the results are aggregated to see if the model is sensitive to the starting parameter values, over a reasonable range
- The model should find the same solution despite randomly changing the starting values
- Starting values for estimated point parameters are randomly sampled from uniform distributions $\pm$ 50% of the starting values from the base model
- Parameter vectors like the F and recruitment deviations, and dirichlet multinomial parameters, which usually start at zero, were not randomized
- The model was rerun with these new starting values

Random restarts

Results

- Likelihood values from random restart runs



Likelihood profiles

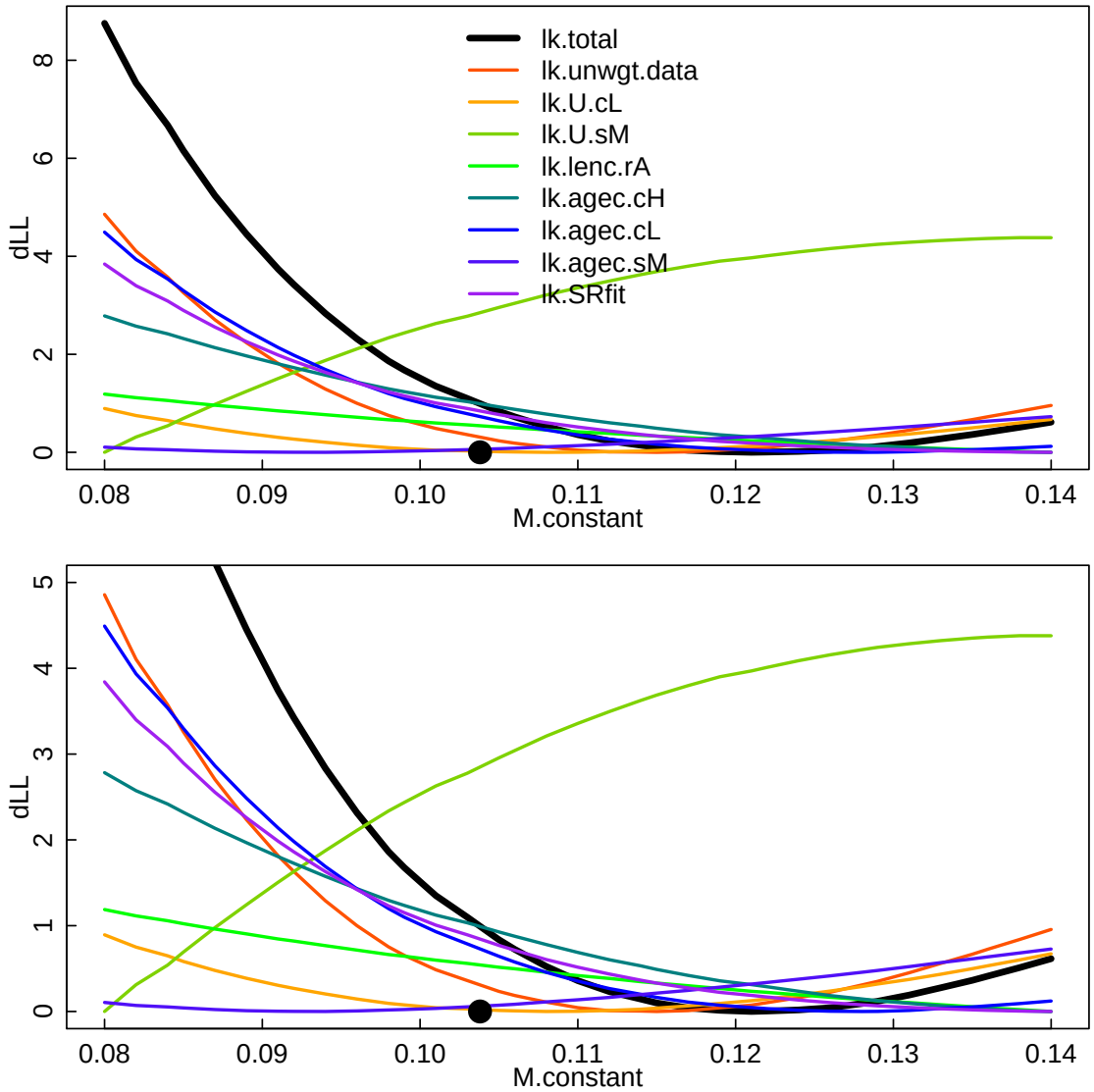
Methods

- Likelihood profiles on steepness, natural mortality, R_0, rec sigma, and F_{init}
- This procedure is repeated multiple times for each parameter of interest over a range of fixed values above and below the base model value
- The model was rerun with these fixed values
- Plotting likelihood versus the fixed parameter values allows us to investigate sources of information informing each parameter

Likelihood profiles

Results

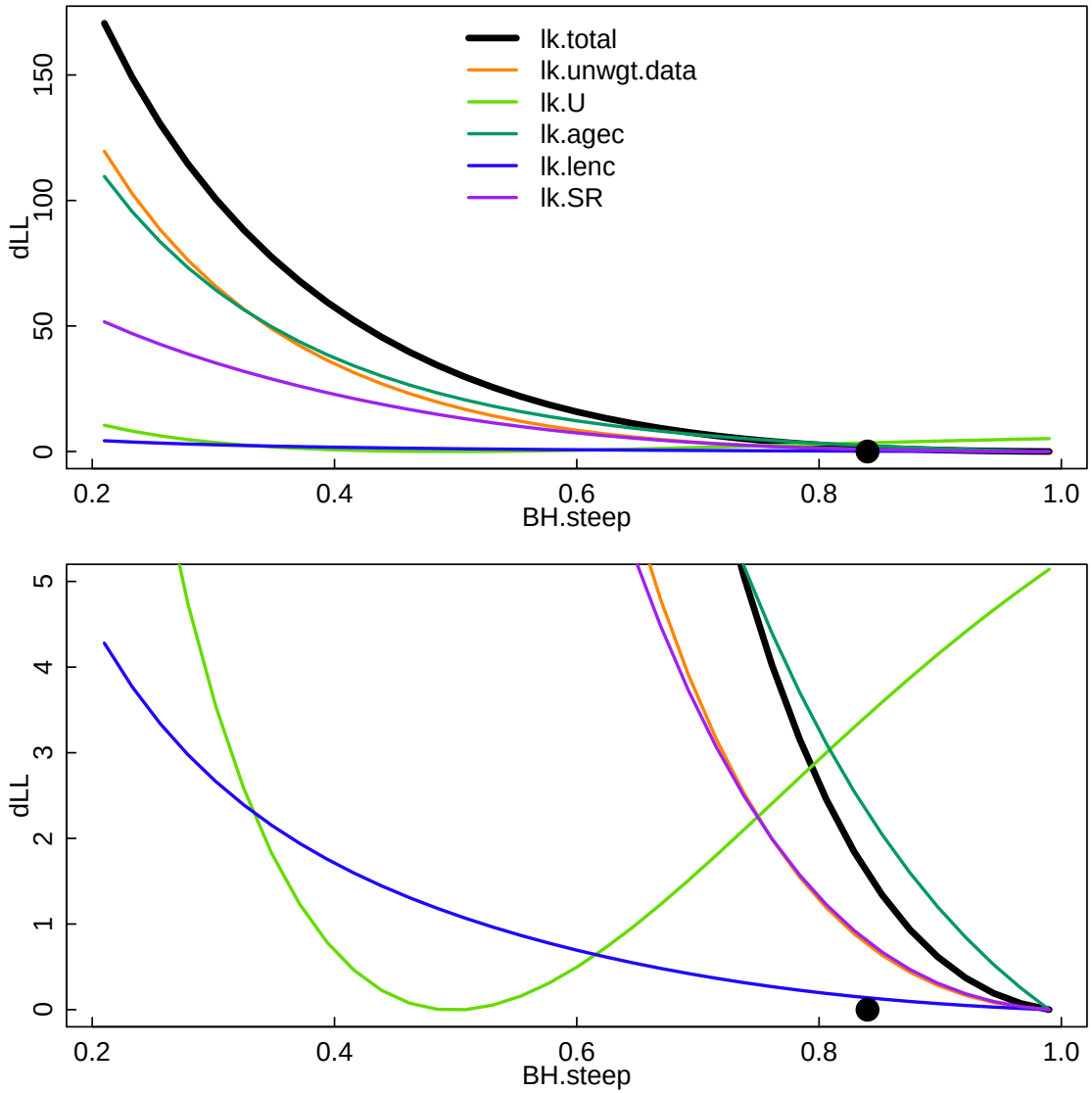
- M



Likelihood profiles

Results

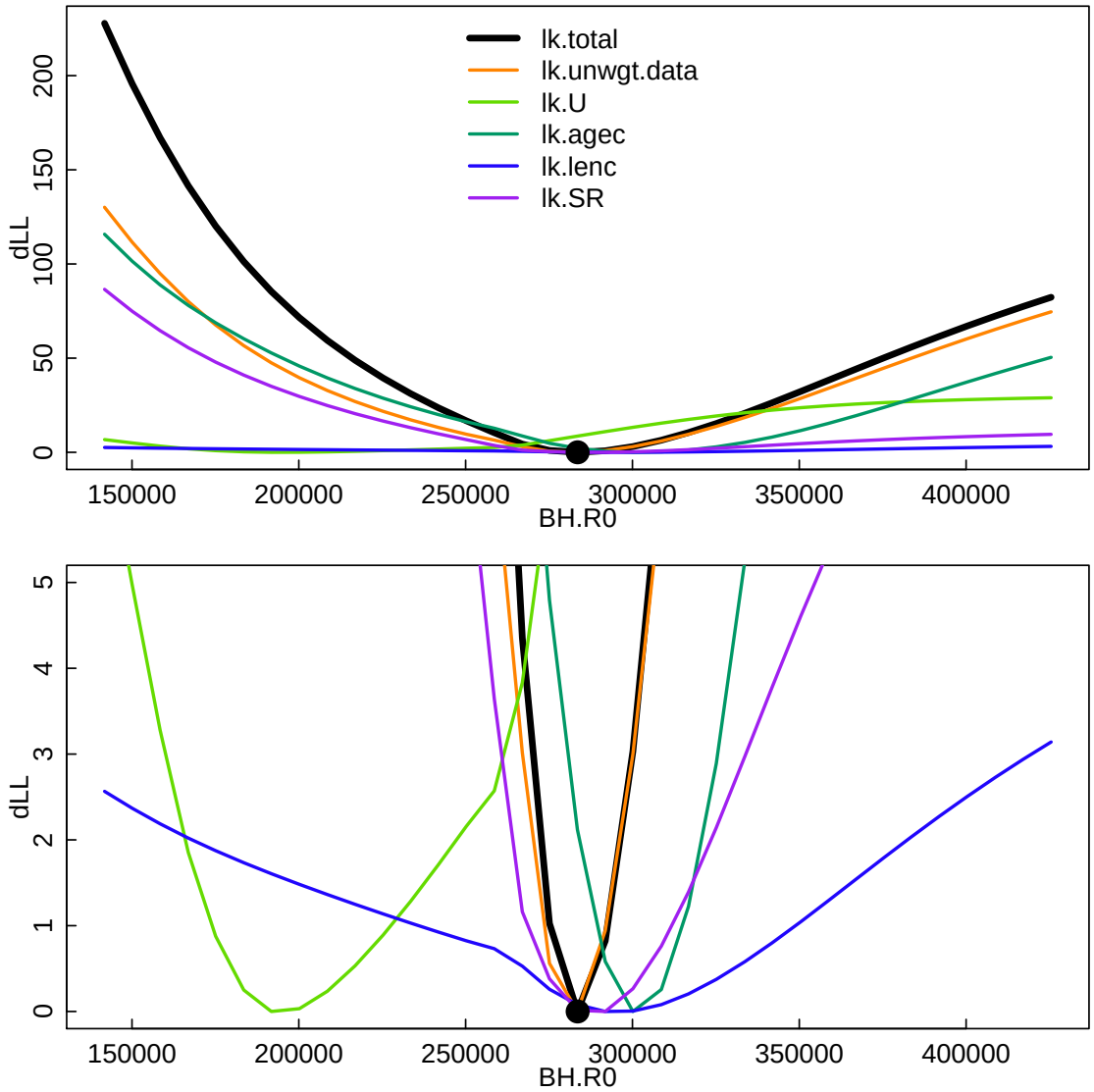
- steepness



Likelihood profiles

Results

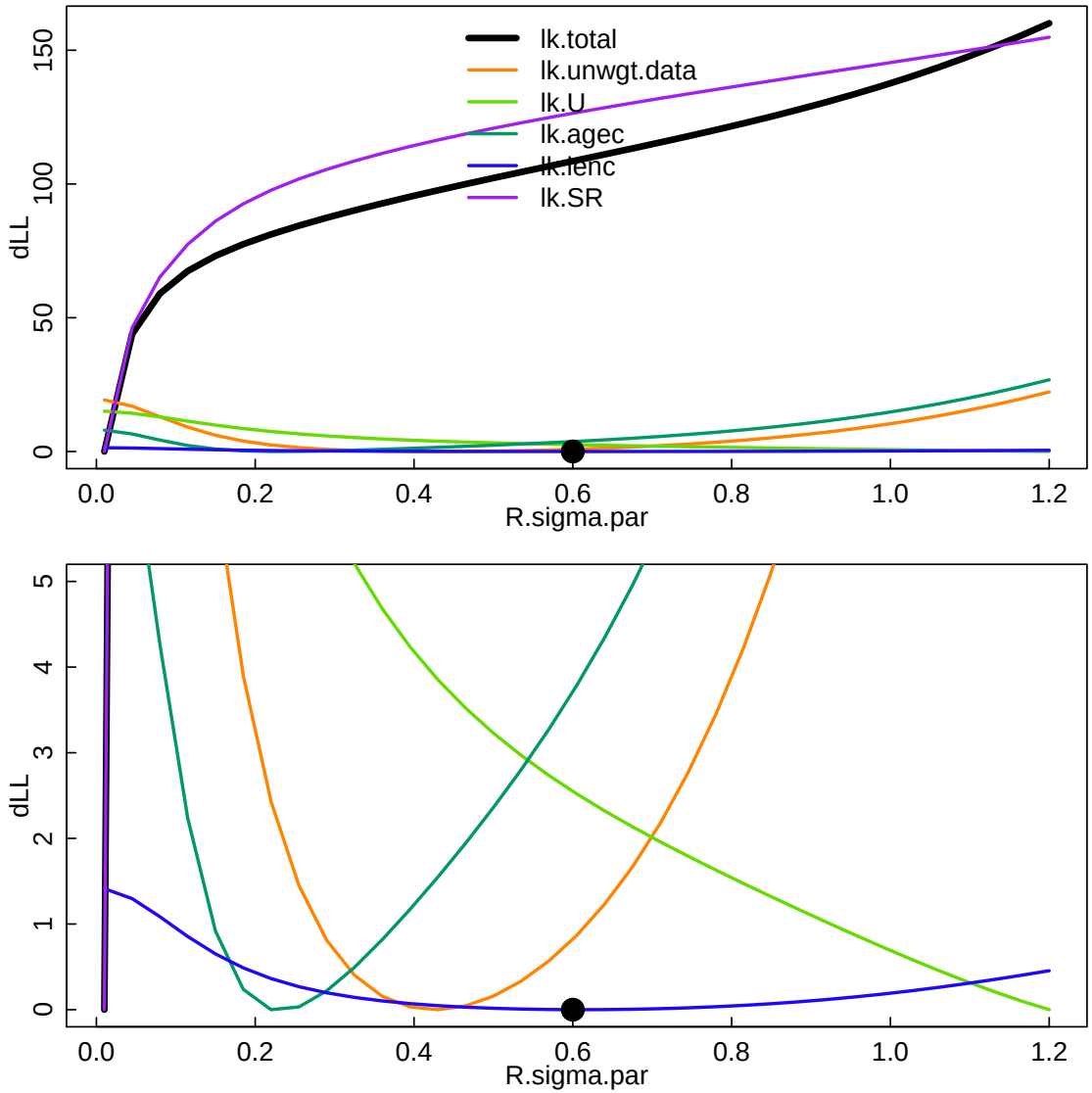
- R_0



Likelihood profiles

Results

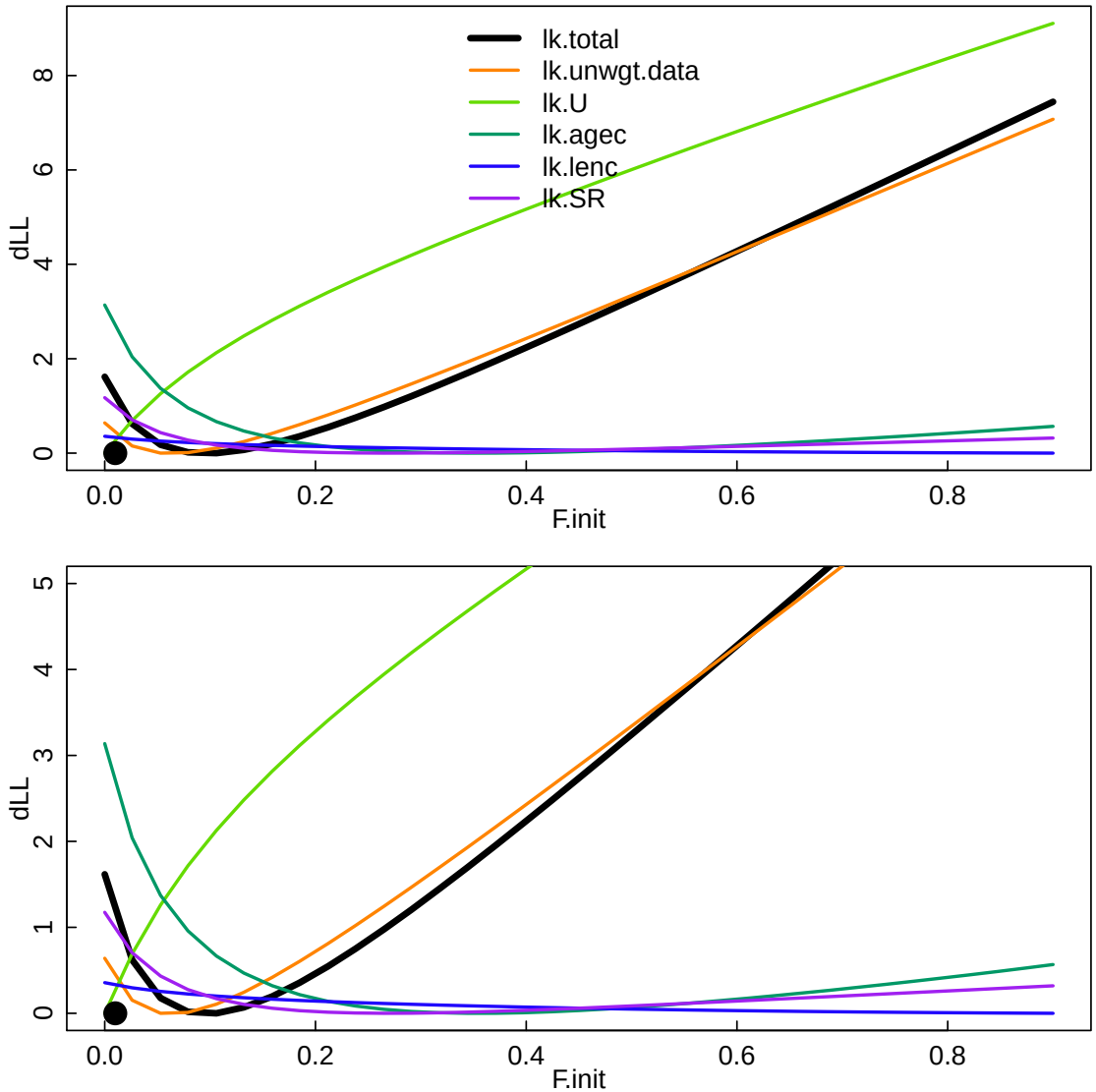
- R_0



Likelihood profiles

Results

- R_0



Monte Carlo Bootstrap (MCB) uncertainty ensemble

Methods

- The Monte-Carlo Bootstrap (MCB) analysis is a process of randomizing data inputs and fixed parameters that go into the assessment model
- 4200 sets of randomized inputs were drawn and the assessment model is run each time
- Outputs from each run are summarized.

Monte Carlo Bootstrap (MCB) uncertainty ensemble

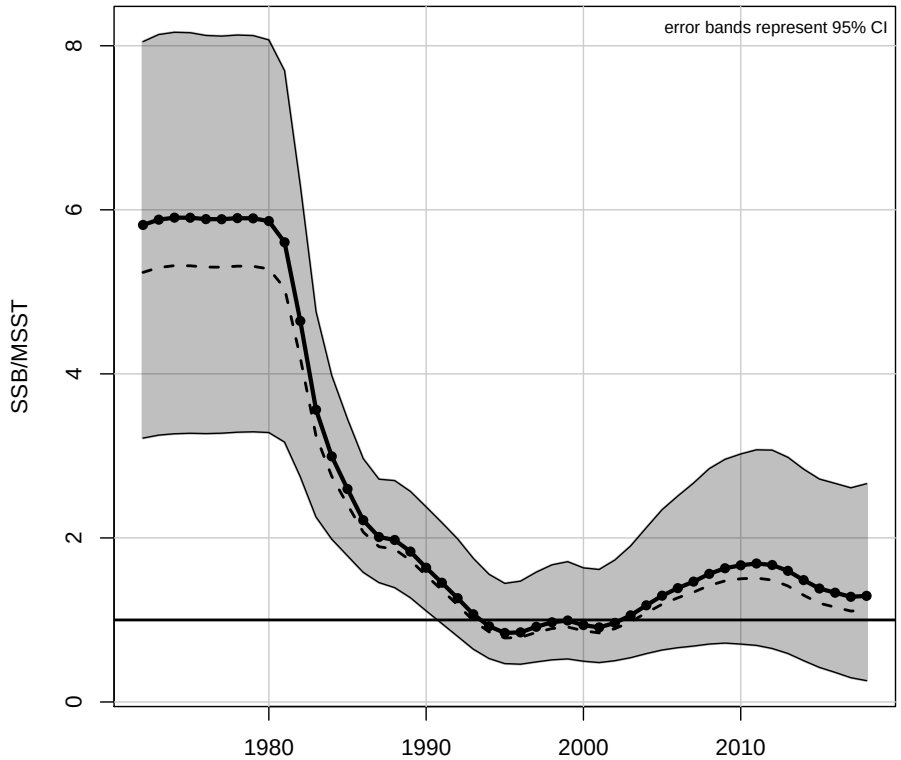
Methods

- Landings resampled from log-normal distributions defined by values provided by data providers
  - Recreational (MRIP) landings CVs based on a new method developed by NMFS staff in Miami
- Indices resampled from log-normal distributions defined by values provided by data providers
- Length and age composition data resampled, with replacement
- Natural mortality estimates were sampled from uniform distribution $(0.08 - 0.14)$ and then used to rescale age-varying M

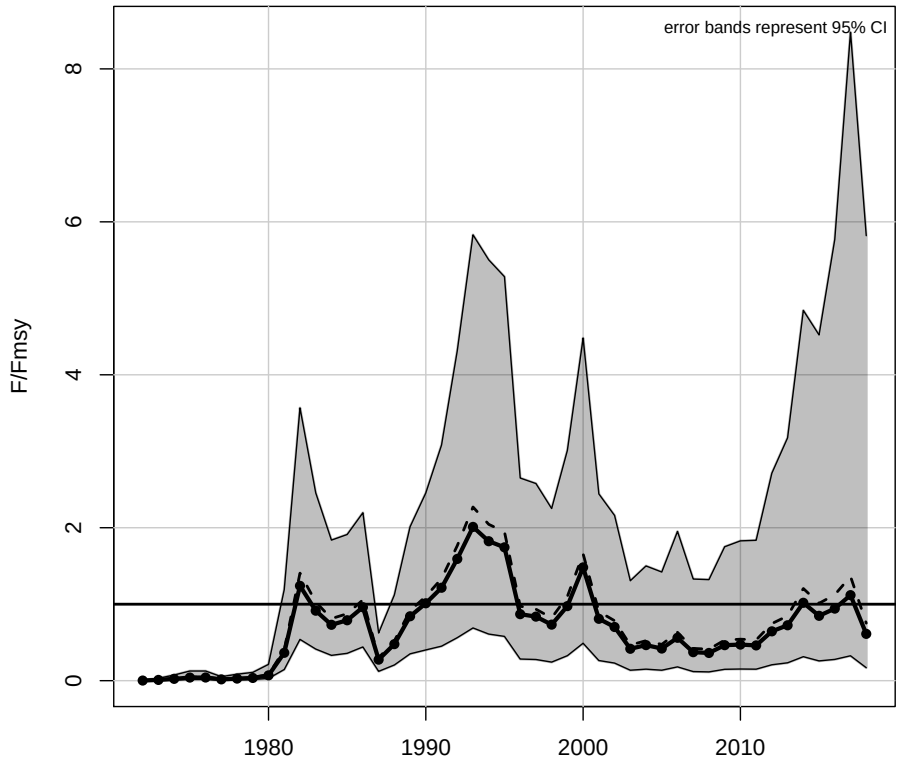
Monte Carlo Bootstrap (MCB) uncertainty ensemble

Results

$SSB/MSST$

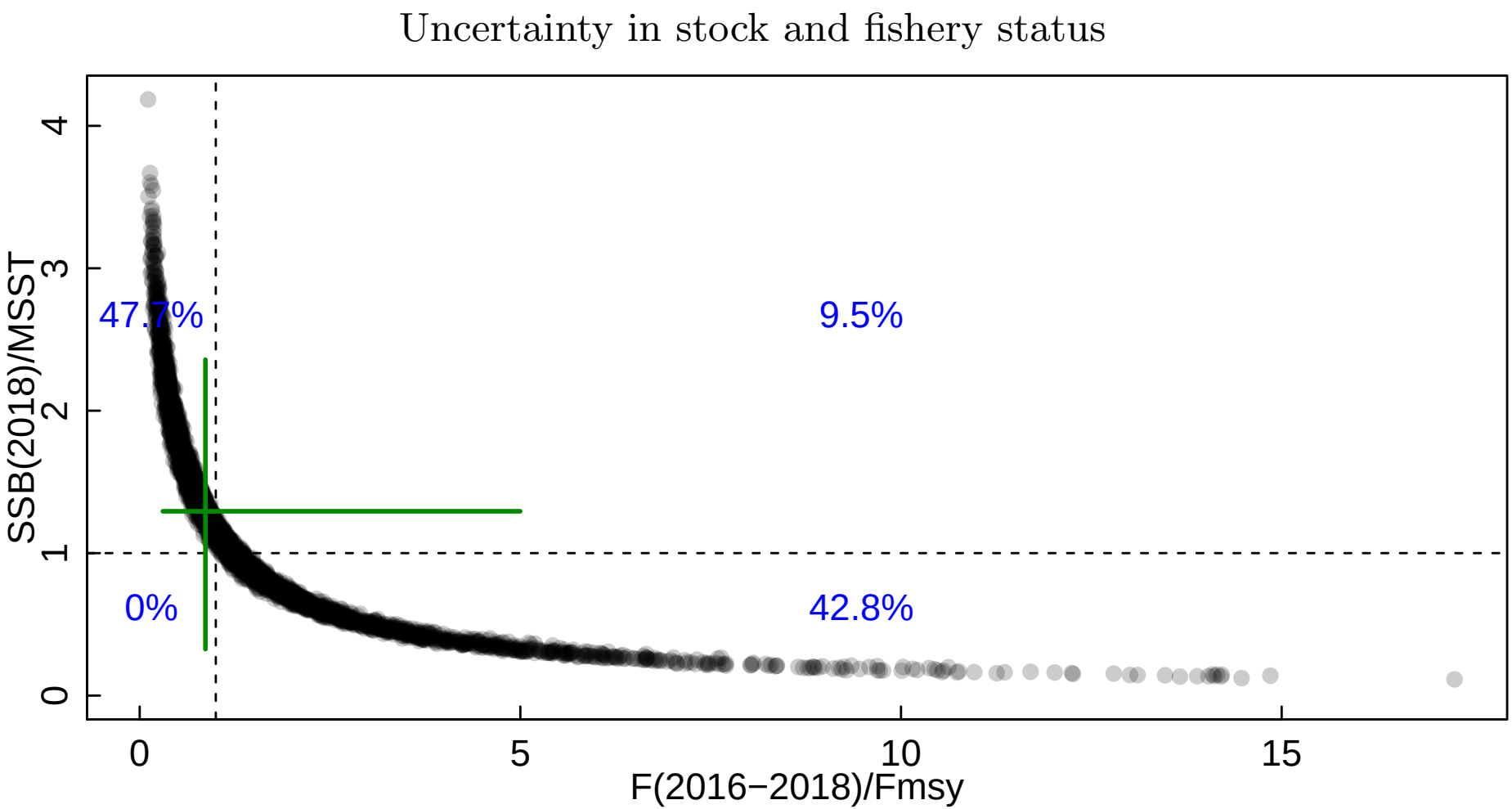


F/F_{msy}



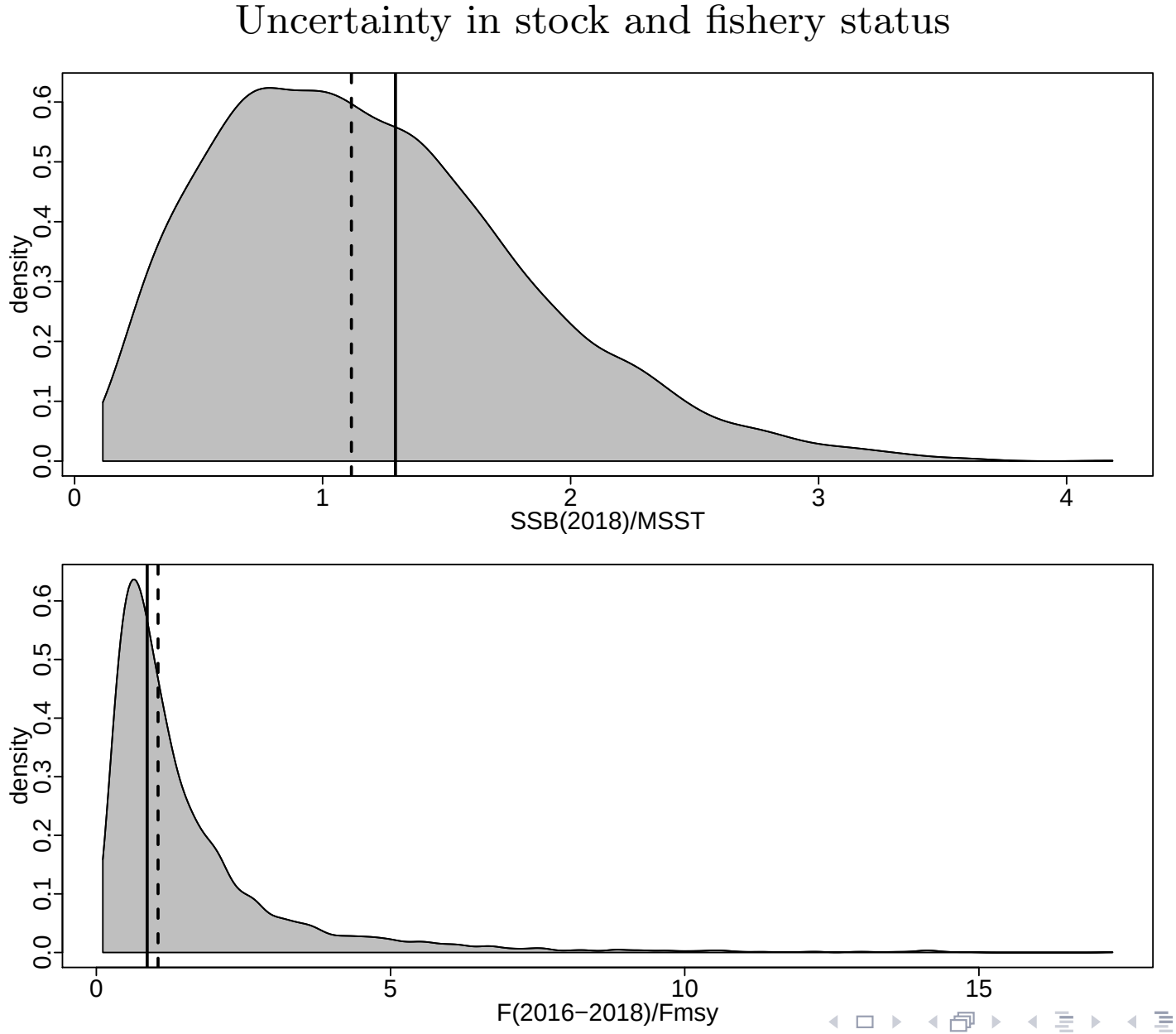
Monte Carlo Bootstrap (MCB) uncertainty ensemble

Results



Monte Carlo Bootstrap (MCB) uncertainty ensemble

Results

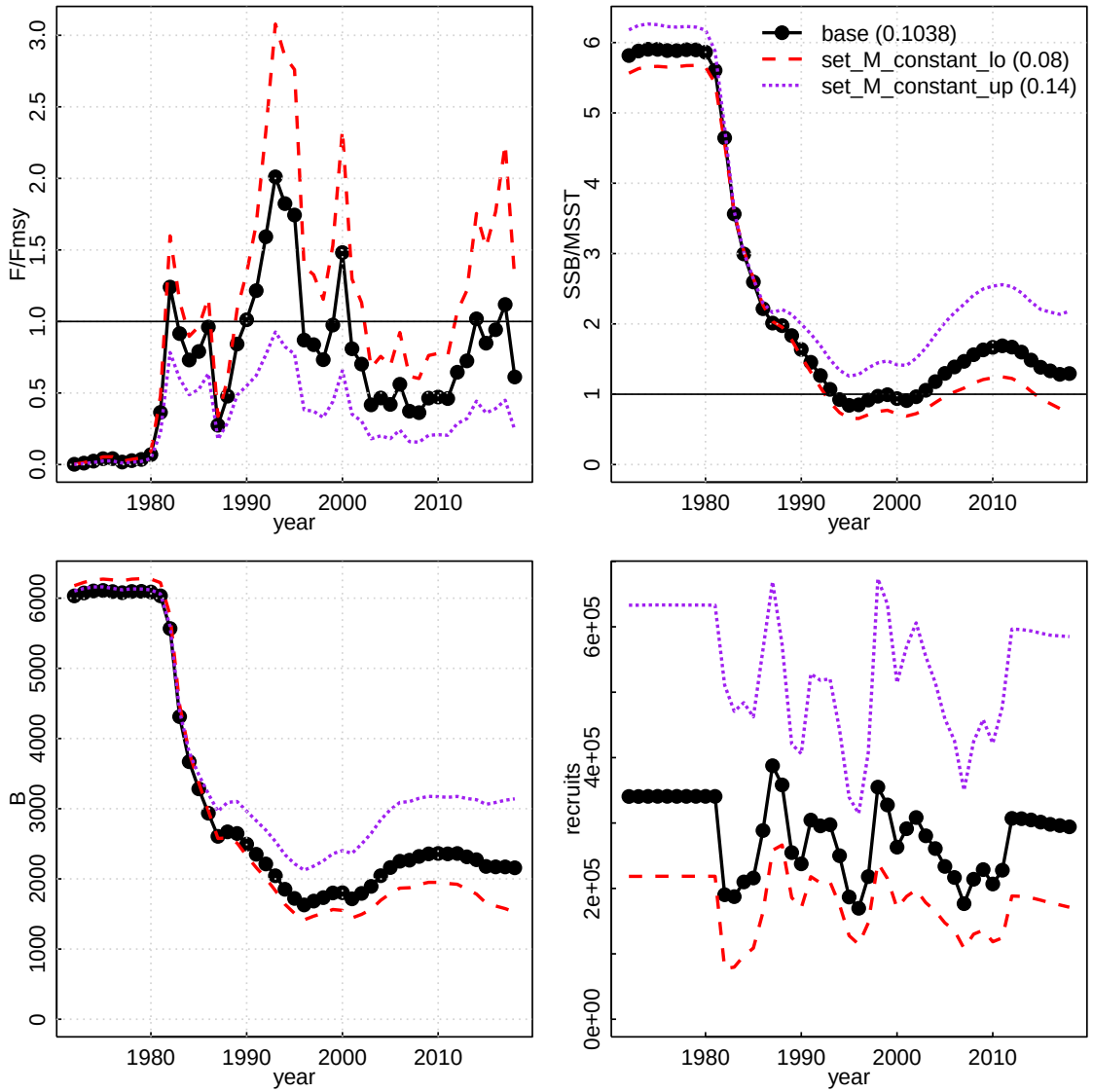


- S1-S2: Low/high values of natural mortality ($M = 0.08, 0.14$)
- S3-S4: Low/high values of steepness ($h = 0.74, 0.94$)
- S5-S6: Higher values of initial F ($F_{init} = 0.053, 0.106$). Values associated with minimum of likelihood profile (lkmin) and half that value (0.5lkmin).
- S7-S8: Down/upweight MARMAP longline index: $1/10\times$, $10\times$
- S9: Use alternate recruitment estimates for years at the end of the assessment (2012-2018) where recruitment deviations were not estimated, based on geometric mean recruitment deviation from the last six years where recruitment deviations were estimated (2006-2011)

Sensitivity analysis

Results

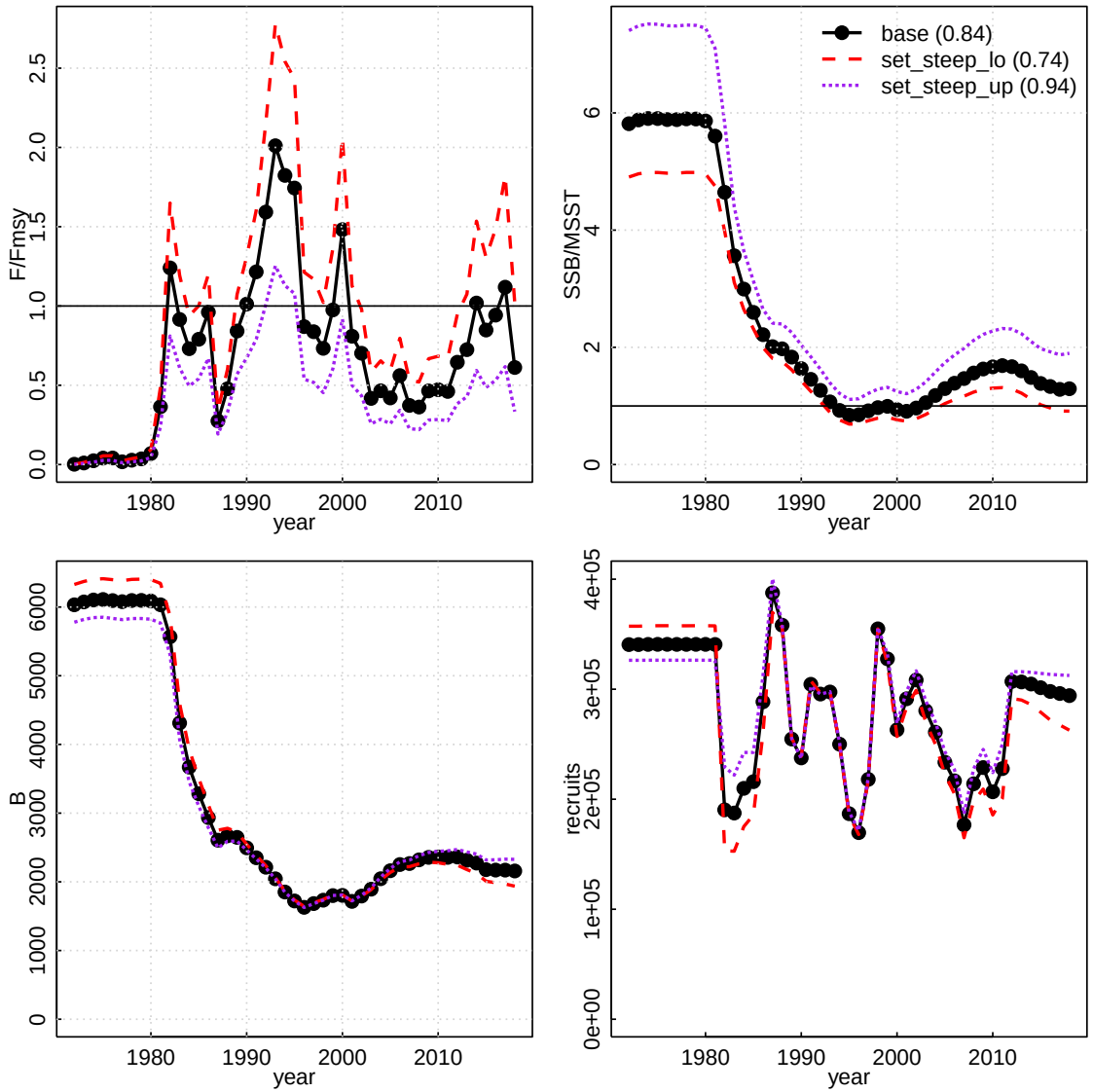
S1-S2: Low/high values of natural mortality ($M = 0.08, 0.14$)



Sensitivity analysis

Results

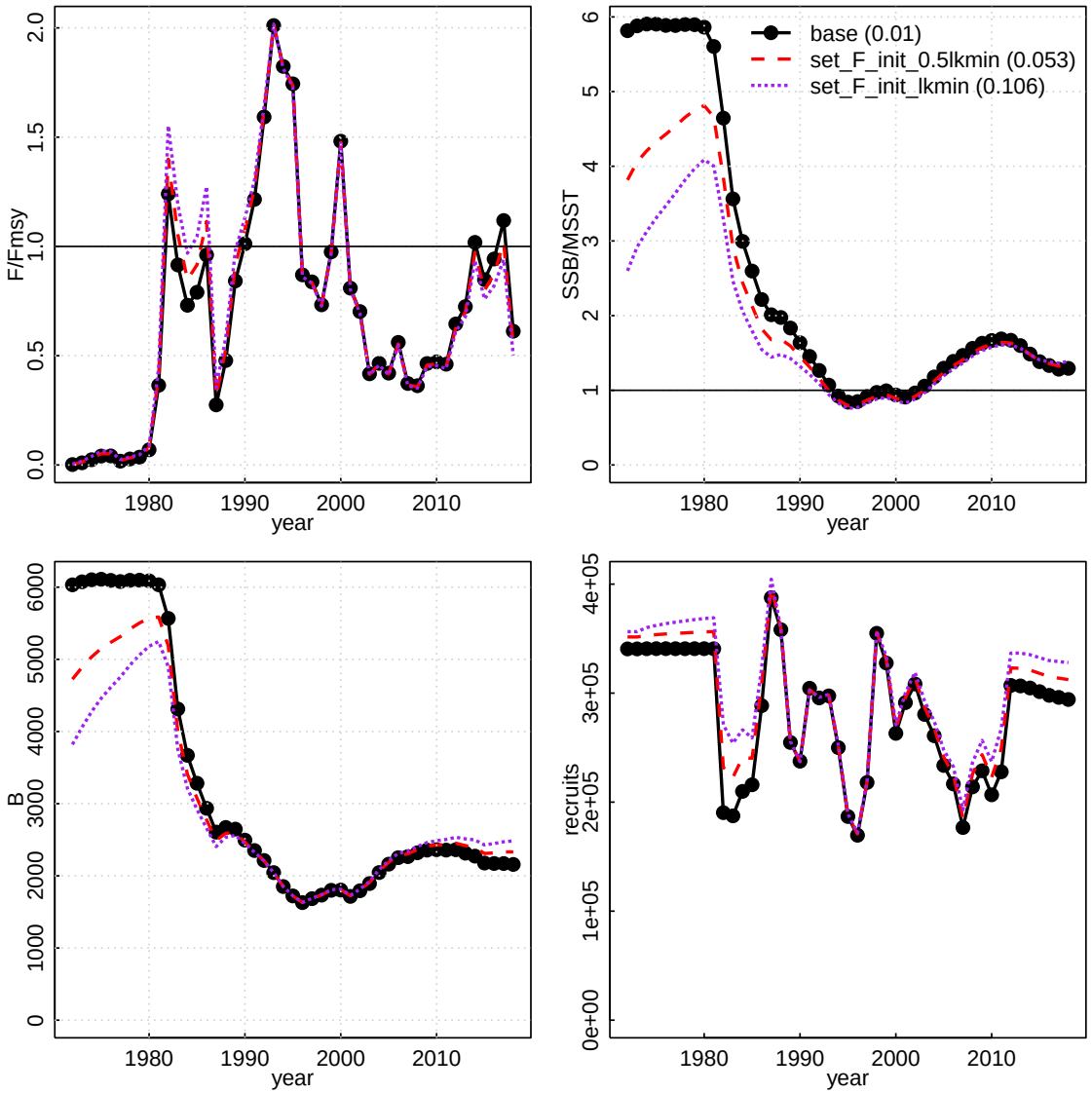
S3-S4: Low/high values of steepness ($h = 0.74, 0.94$)



Sensitivity analysis

Results

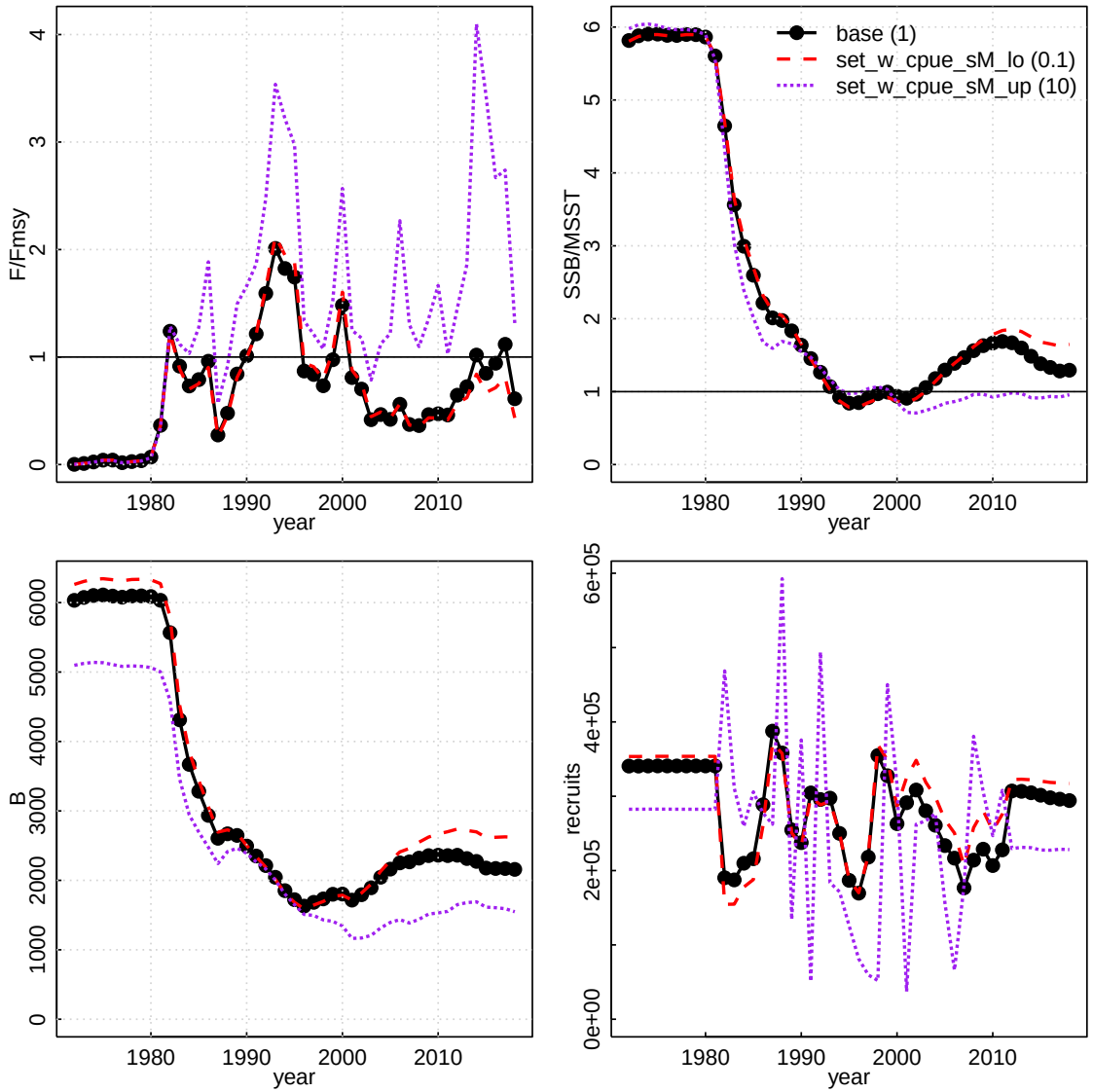
S5-S6: Higher values of initial F ($F_{init} = 0.053, 0.106$).



Sensitivity analysis

Results

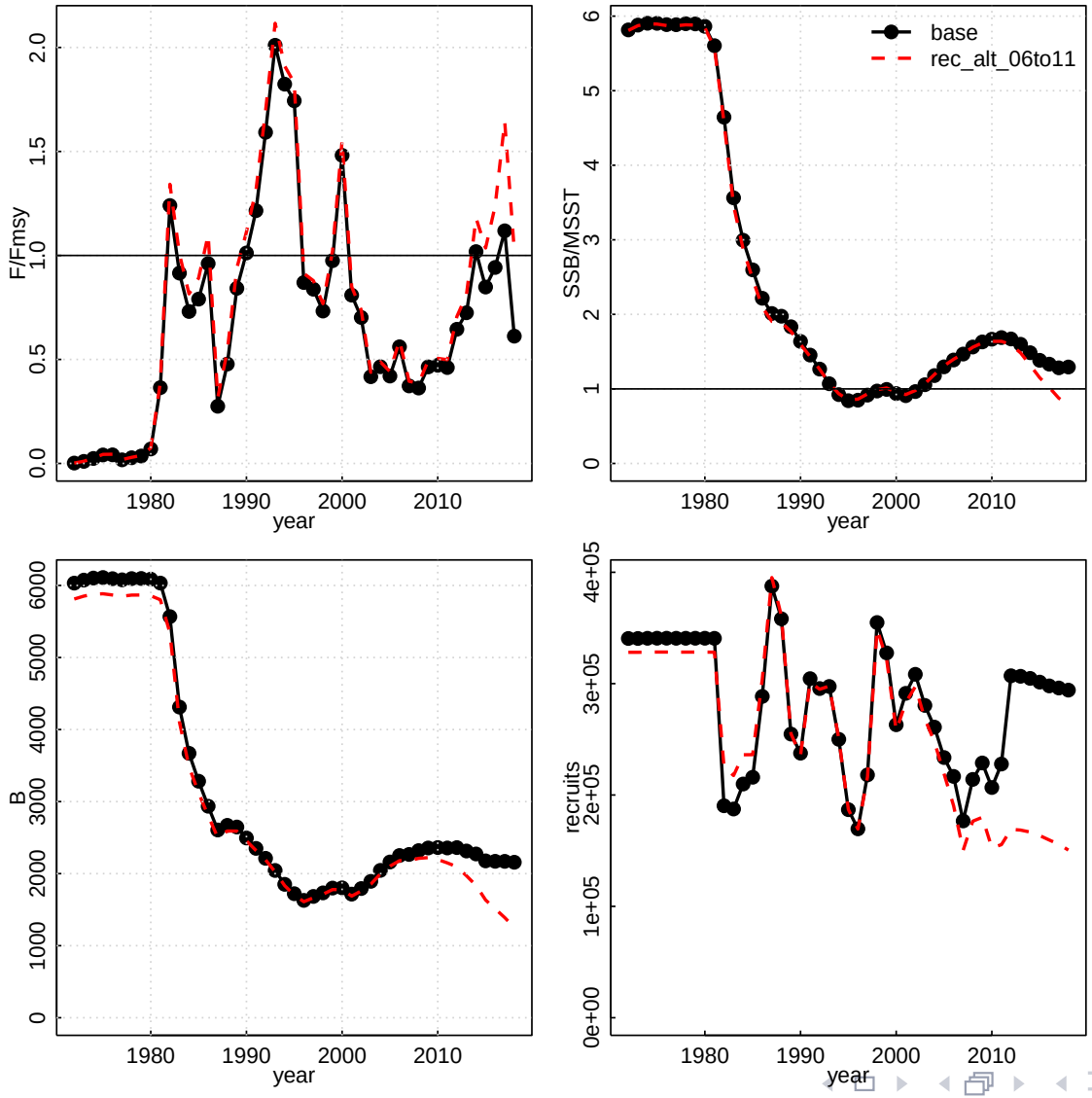
S7-S8: Down/upweight MARMAP longline index: 1/10×, 10×



Sensitivity analysis

Results

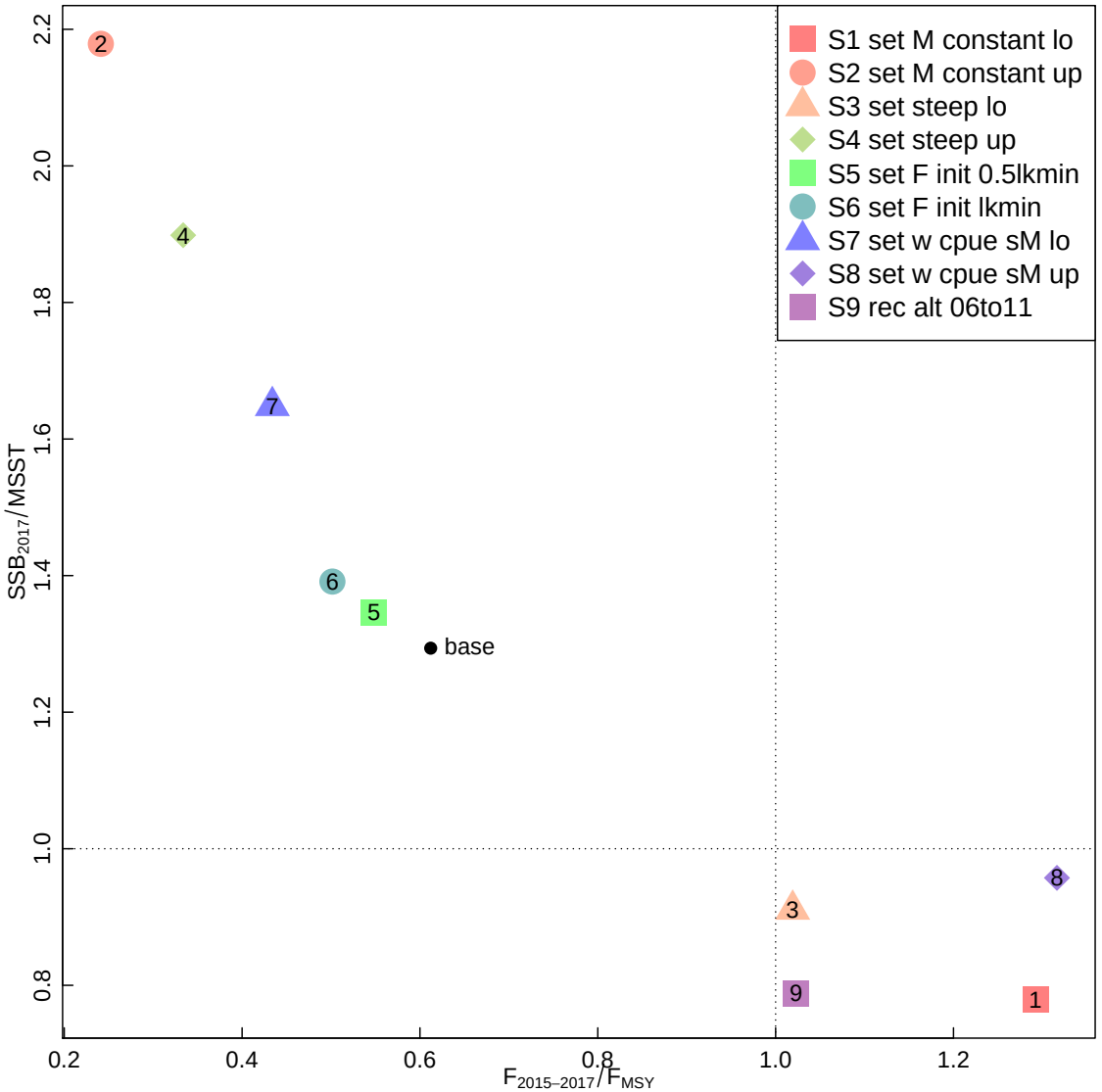
S9: Use alternate recruitment estimates for years at the end of the assessment (2012-2018)



Sensitivity analysis

Results

Stock and fishery status of sensitivity runs



Retrospective analysis

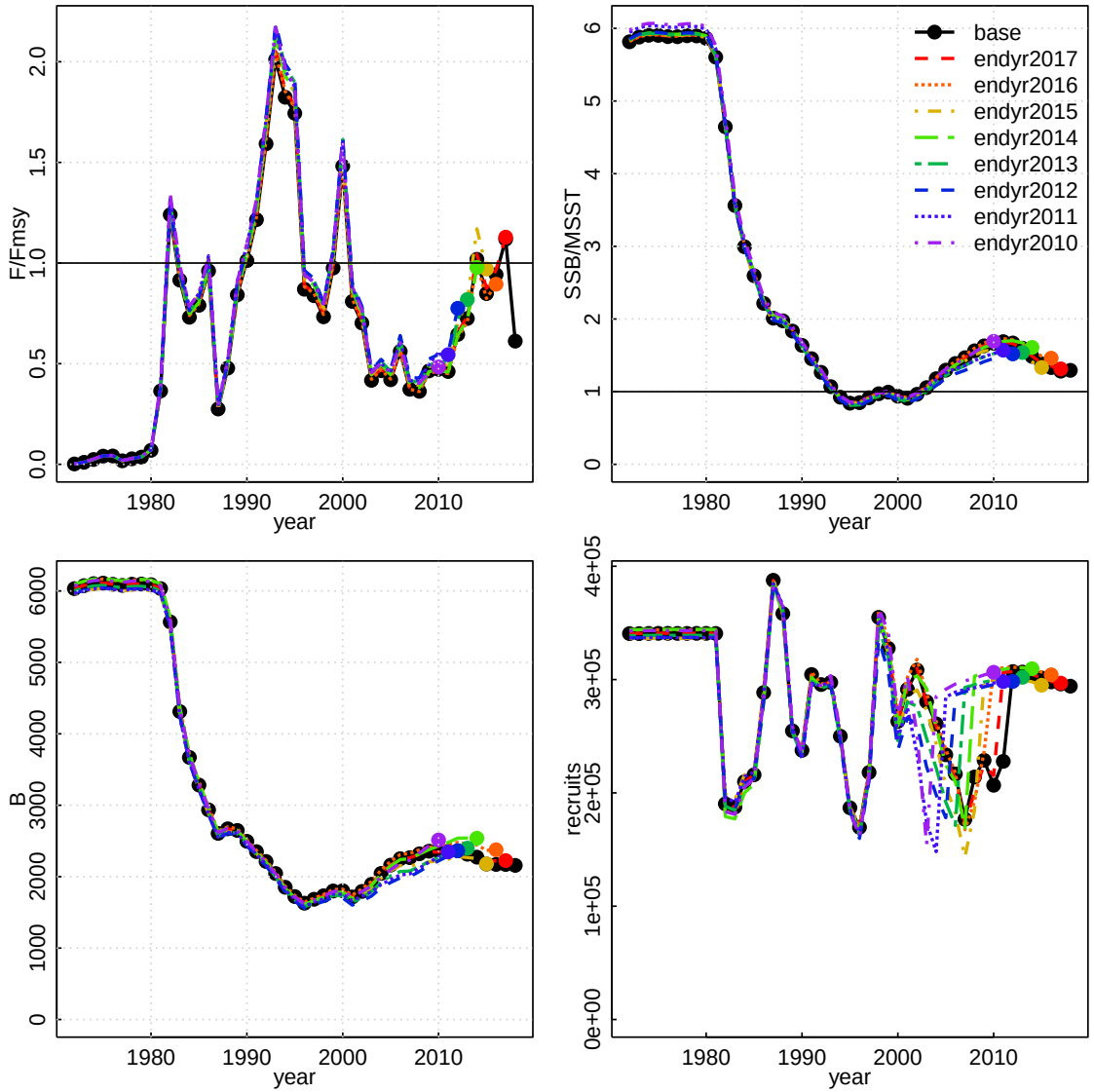
Methods

- Methods similar to sensitivity analysis
- Data in assessment model were truncated to new terminal years of 2010 – 2017
- The base model was rerun with truncated data
- Results of retrospective runs were plotted together to look for patterns in terminal year values

Retrospective analysis

Results

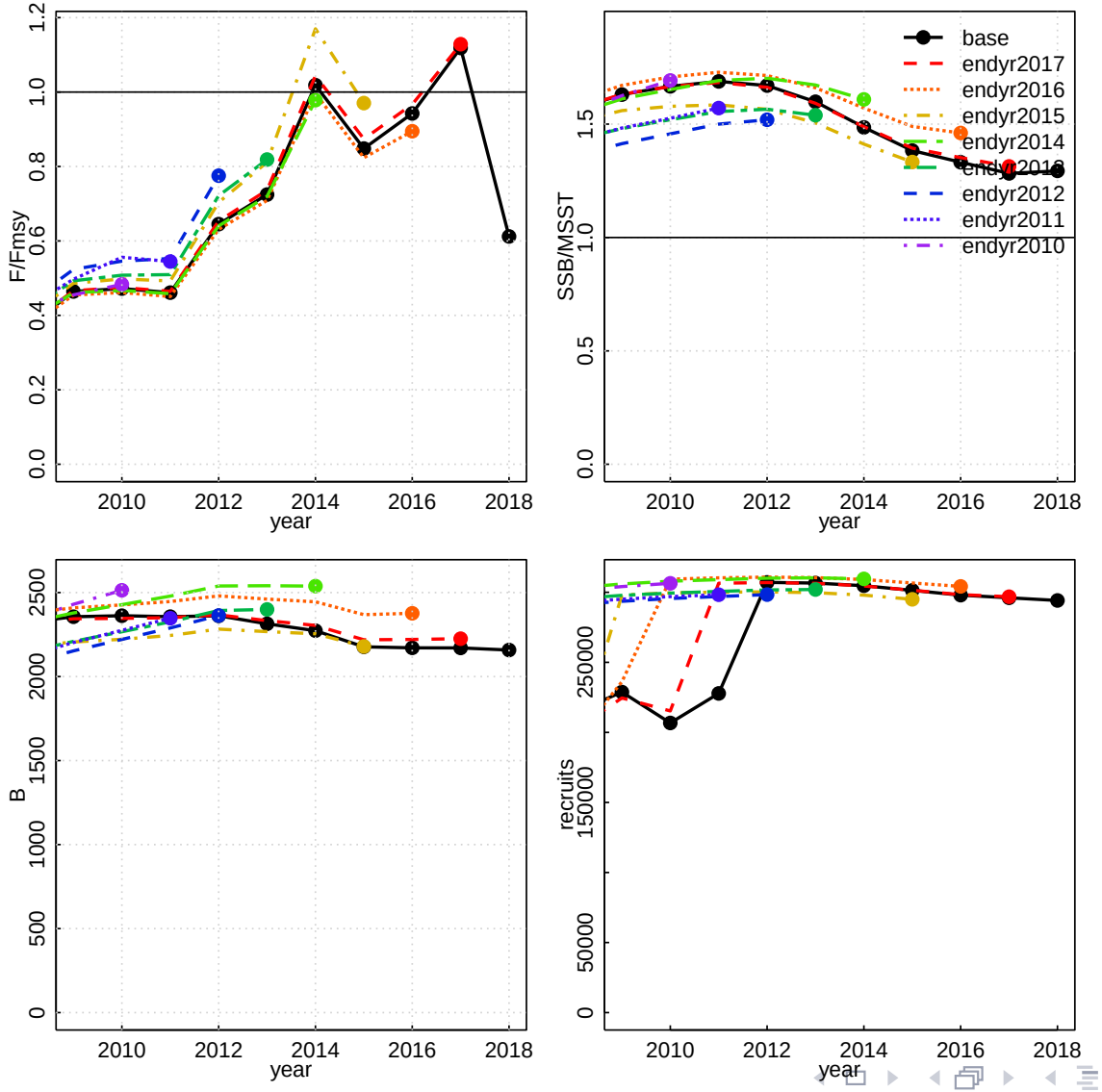
Terminal years of retrospective runs: 2010 – 2017



Retrospective analysis

Results

Terminal years of retrospective runs: 2010 – 2017
(zoomed in on recent years)



Projections

Methods

- Projections were constructed as specified in the ToRs
- Projections were made to 2027, with projected fishing level changes beginning in 2022.
- Fishing mortality for 2019-2021 was set at $F_{\text{current}} = 0.2566$ (geometric mean F from 2016-2018)
- Projections at fixed F from $2022 - 2027$
- To determine OFL:
  - F based on $P* = 50\%$
  - $F = F_{\text{MSY}}$
- To determine ABC:
  - F based on $P* = 30\%$
  - $F = 75\% F_{\text{MSY}}$

Projections

Methods

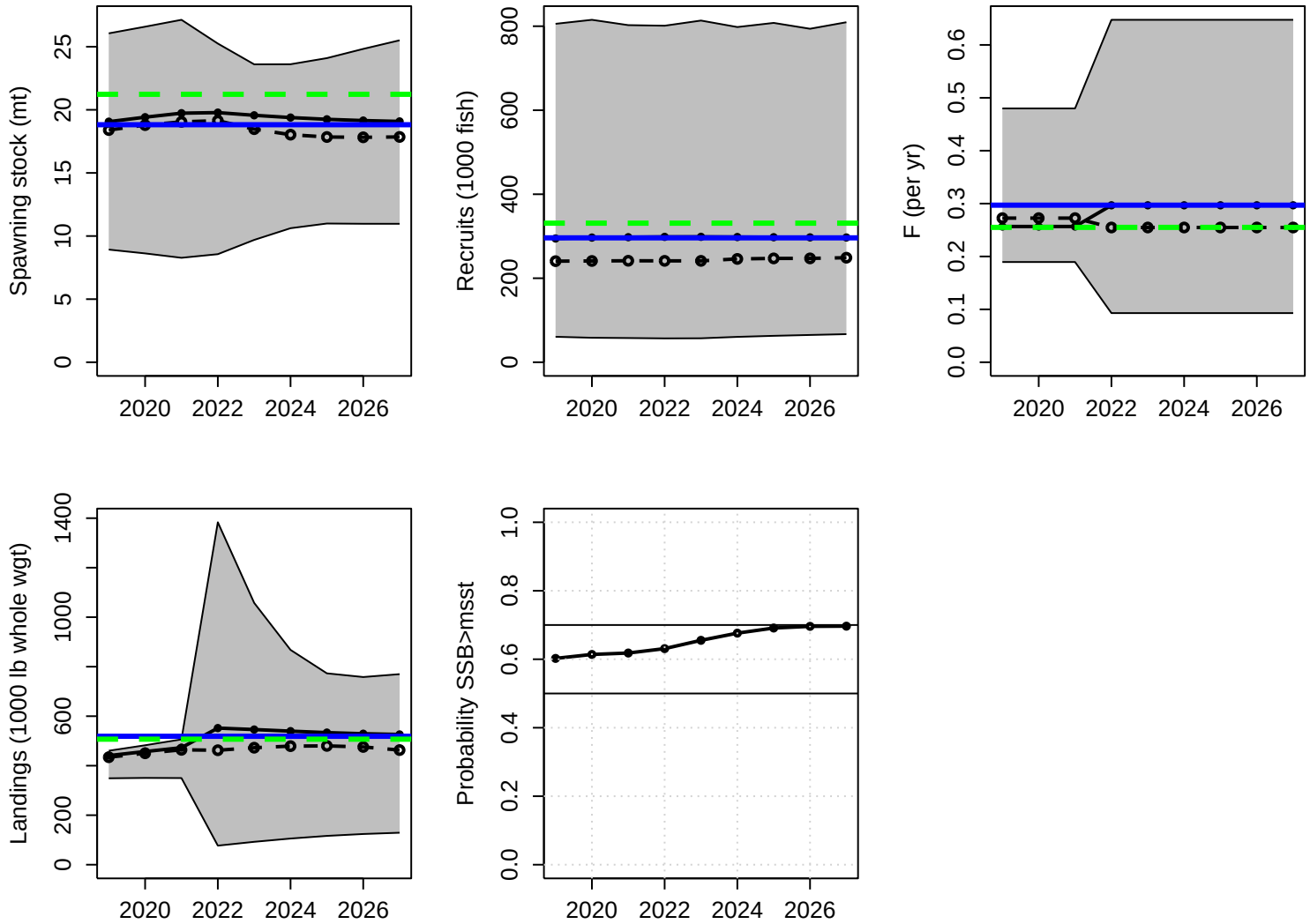
- Scenario 1-4: $F = F_{\text{current}}$ from 2019 to 2021
- Scenario 1: $F = F_{\text{P}^*_{50\%}}$ from 2022 to 2027
- Scenario 2: $F = F_{\text{MSY}}$ from 2022 to 2027
- Scenario 3: $F = F_{\text{P}^*_{30\%}}$ from 2022 to 2027
- Scenario 4: $F = 75\% F_{\text{MSY}}$ from 2022 to 2027

- The following slides show plots of SSB, landings, recruits, dead discards, F and the probability that SSB $>$ MSST for projections
  - In all panels except the bottom right:
    - ★ solid lines with solid circles = base model values
    - ★ dashed lines with open circles = median values from projections
    - ★ thin solid lines = 5^{th} and 95^{th} percentiles of projections
    - ★ Solid horizontal blue lines = MSY-related quantities from the base model
    - ★ dashed horizontal green lines medians = MSY-related quantities median from projections
  - In the bottom right panel, the curve represents the proportion of projection replicates for which SSB has reached the replicate-specific MSST.

Projections

Results

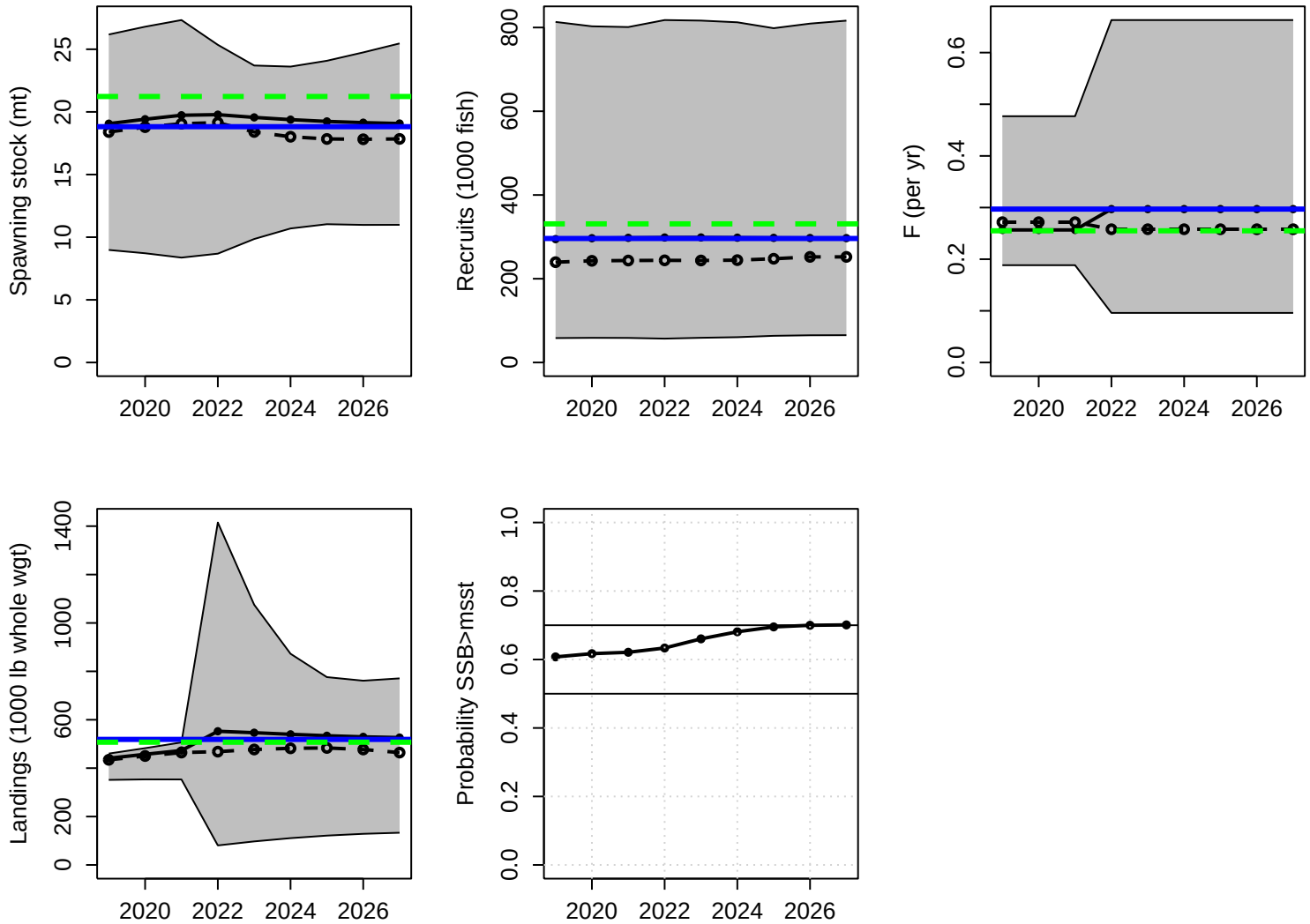
Scenario 1: $F = F_{\mathrm{P}^*_{50\%}}$ from 2022 to 2027



Projections

Results

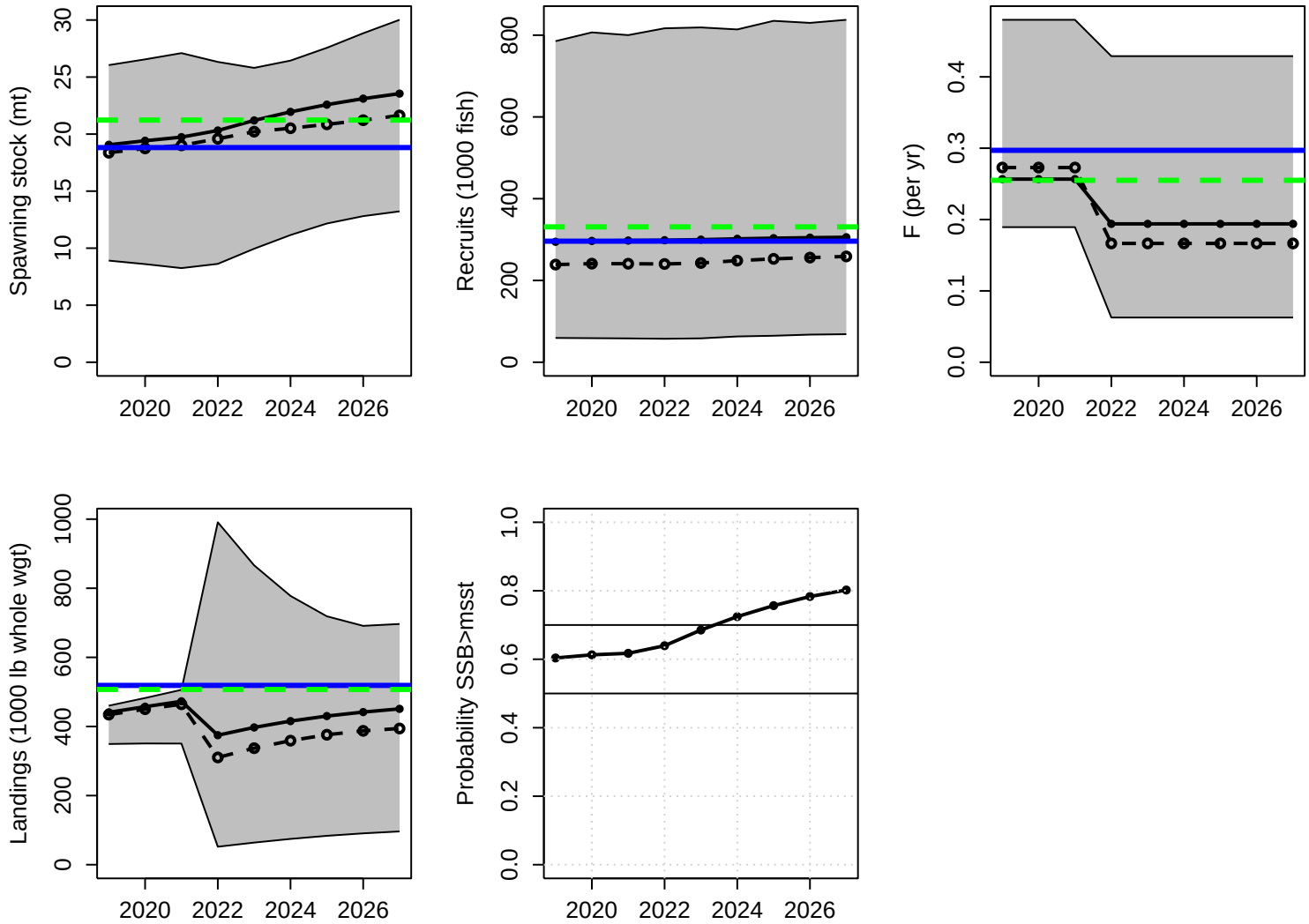
Scenario 2: $F = F_{\text{MSY}}$ from 2022 to 2027



Projections

Results

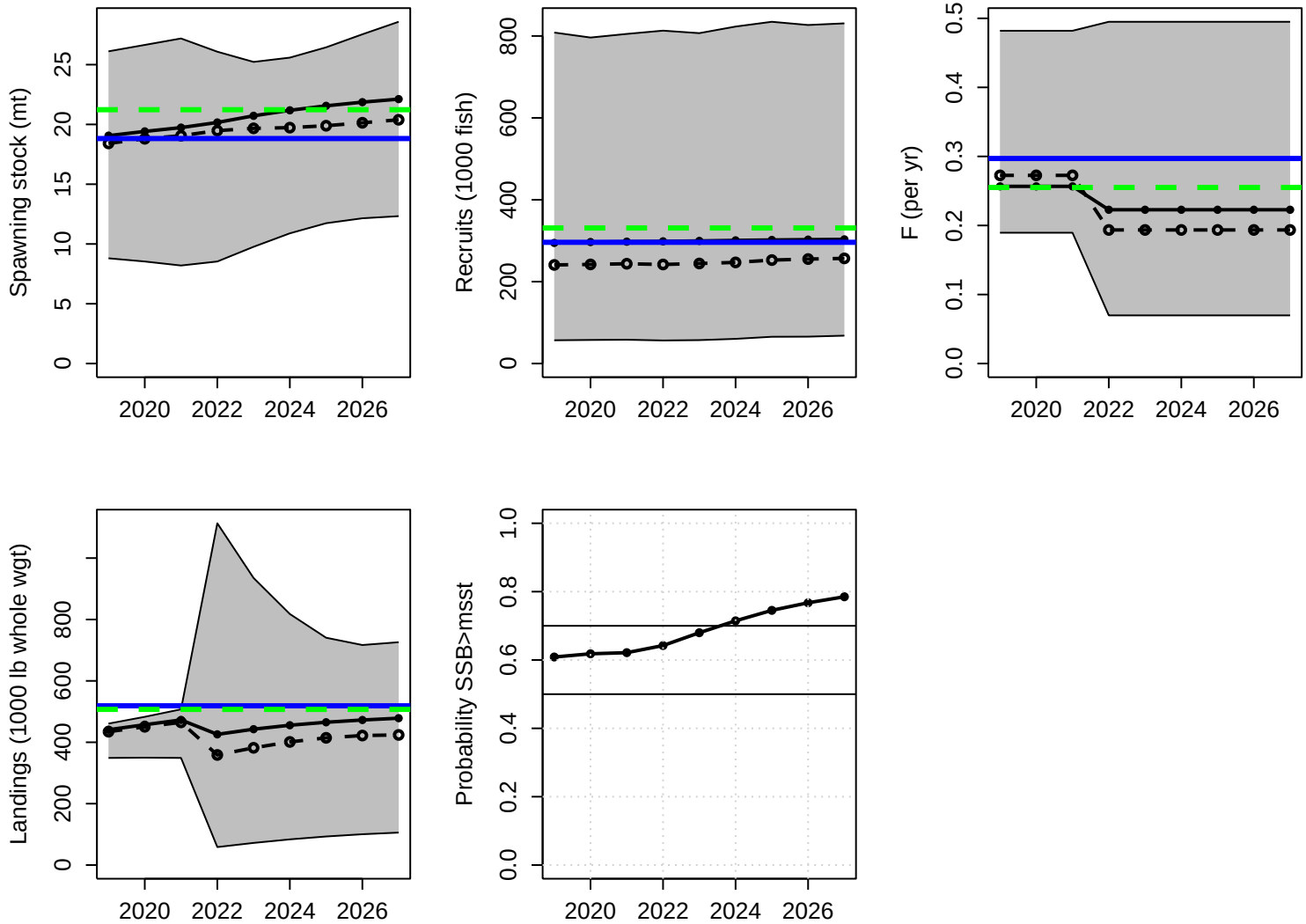
Scenario 3: $F = F_{\mathrm{P}^*_{30\%}}$ from 2022 to 2027



Projections

Results

Scenario 4: $F = 75\%F_{\text{MSY}}$ from 2022 to 2027



Projections

Results

Scenario 1: $F = F_{\mathrm{P}^*_{50\%}}$ from 2022 to 2027

Year	R_b	R_{med}	F_b	F_{med}	S_b (mt)	S_{med} (mt)	L_b (n)	L_{med} (n)	L_b (w)	L_{med} (w)	$P(>$ MSST)
2019	295	241	0.26	0.27	19	18	54	54	441	434	0.602
2020	297	241	0.26	0.27	19	19	57	56	457	450	0.614
2021	298	242	0.26	0.27	20	19	59	57	473	464	0.618
2022	298	241	0.30	0.25	20	19	68	57	552	462	0.631
2023	299	241	0.30	0.25	20	18	67	58	546	473	0.655
2024	298	246	0.30	0.25	19	18	67	59	540	479	0.676
2025	298	247	0.30	0.25	19	18	66	59	534	480	0.691
2026	297	247	0.30	0.25	19	18	66	58	529	476	0.696
2027	297	249	0.30	0.25	19	18	65	57	526	463	0.697

Projections

Results

Scenario 2: $F = F_{\text{MSY}}$ from 2022 to 2027

Year	R_b	R_{med}	F_b	F_{med}	S_b (mt)	S_{med} (mt)	L_b (n)	L_{med} (n)	L_b (w)	L_{med} (w)	$P(>\text{MSST})$
2019	295	240	0.26	0.27	19	18	54	54	441	434	0.608
2020	297	243	0.26	0.27	19	19	57	56	457	450	0.617
2021	298	243	0.26	0.27	20	19	59	57	473	464	0.621
2022	298	244	0.30	0.26	20	19	68	58	552	468	0.633
2023	299	244	0.30	0.26	20	18	67	59	546	477	0.660
2024	298	244	0.30	0.26	19	18	67	59	540	482	0.681
2025	298	248	0.30	0.26	19	18	66	59	534	483	0.695
2026	297	252	0.30	0.26	19	18	66	58	529	477	0.700
2027	297	252	0.30	0.26	19	18	65	57	526	464	0.701

Projections

Results

Scenario 3: $F = F_{\mathrm{P}^*_{30\%}}$ from 2022 to 2027

Year	R_b	R_{med}	F_b	F_{med}	S_b (mt)	S_{med} (mt)	L_b (n)	L_{med} (n)	L_b (w)	L_{med} (w)	$P(>$ MSST)
2019	295	239	0.26	0.27	19	18	54	54	441	434	0.604
2020	297	241	0.26	0.27	19	19	57	56	457	450	0.613
2021	298	241	0.26	0.27	20	19	59	57	473	464	0.617
2022	298	240	0.19	0.17	20	20	46	38	375	310	0.639
2023	300	243	0.19	0.17	21	20	48	41	397	337	0.685
2024	302	249	0.19	0.17	22	21	50	43	416	359	0.724
2025	303	253	0.19	0.17	23	21	52	45	430	376	0.757
2026	305	256	0.19	0.17	23	21	53	46	442	387	0.783
2027	306	259	0.19	0.17	24	22	54	46	451	394	0.802

Projections

Results

Scenario 4: $F = 75\% F_{\text{MSY}}$ from 2022 to 2027

Year	R_b	R_{med}	F_b	F_{med}	S_b (mt)	S_{med} (mt)	L_b (n)	L_{med} (n)	L_b (w)	L_{med} (w)	$P(>$ MSST)
2019	295	241	0.26	0.27	19	18	54	54	441	434	0.609
2020	297	242	0.26	0.27	19	19	57	56	457	450	0.618
2021	298	244	0.26	0.27	20	19	59	57	473	465	0.621
2022	298	242	0.22	0.19	20	19	52	44	426	359	0.642
2023	300	244	0.22	0.19	21	20	54	47	443	382	0.680
2024	301	247	0.22	0.19	21	20	55	49	455	401	0.715
2025	302	253	0.22	0.19	22	20	56	50	465	414	0.745
2026	303	255	0.22	0.19	22	20	57	50	473	422	0.767
2027	303	257	0.22	0.19	22	20	58	50	478	424	0.785

Summary and conclusions

- This assessment indicates that Tilefish are currently not overfished or experiencing overfishing
- However MCB analysis suggests substantial uncertainty in status of the stock or fishery
- Recruitment is low toward the end of the time series which could be problematic for the stock if that trend continues
- The probability of being above $MSST$ only exceeds 50% in all years of all projections