Spring 2021 SA SSC Meeting: SEDAR 66 South Atlantic Tilefish

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Introduction

Assessment history

- SEDAR 04 2004 Benchmark Assessment
- SEDAR 25 2011 Standard Assessment
- SEDAR 25 2016 Update Assessment (used for management)
- SEDAR 25 2017 Update Assessment (model)
- SEDAR 66 2021 Operational Assessment

- The 2016 Update assessment indicated that the South Atlantic Tilefish stock was not overfished ($\text{SSB}_{2014}/\text{MSST} = 1.13$) but was undergoing overfishing ($F_{2012-2014}/F_{\text{MSY}} = 2.42$)

Assessment	M	Steepness	MSY (klb)	F_{MSY}	MSST (mt)	F/F_{MSY}	SSB/MSST
Benchmark (S04), 2004	0.07	0.72	335	0.043	659[a]	1.53	1.27
Standard (S25), 2011	0.1083	0.84	638	0.185	19.0[b]	0.360	2.42
Update (S25), 2016	0.1083	0.84	560	0.236	16.4[c]	2.42	1.13

[a] SSB = mature female biomass and $\text{MSST} = 0.75\text{SSB}_{\text{MSY}}$

[b] SSB = mature female gonad weight and $\text{MSST} = (1-M)\text{SSB}_{\text{MSY}}$

[c] SSB = mature female gonad weight and $\text{MSST} = 0.75\text{SSB}_{\text{MSY}}$

- Detailed management history is provided in SEDAR 66 Assessment Report Section I. 2.6 Management and Regulatory Timeline
- Commercial
  - Seasonal closures (2006 - 2018)
  - Quotas (1994 - 2018)
  - Quotas met (2006 - 2018)
  - Annual Catch Limits (ACL) equal to quota (2012 - 2018)
  - Retention limits
    - ★ 5000 lb GW trip limit; retain $\leq$ 300 lb GW when quota filled (1994 - 2006 Oct)
    - ★ 4000 lb GW trip limit; retain $\leq$ 300 lb GW when quota filled (2006 Oct - 2013)
    - ★ 4000 lb GW trip limit; retain $\leq$ 500 lb GW when quota filled (2014 - 2018)
  - No size limits

Introduction

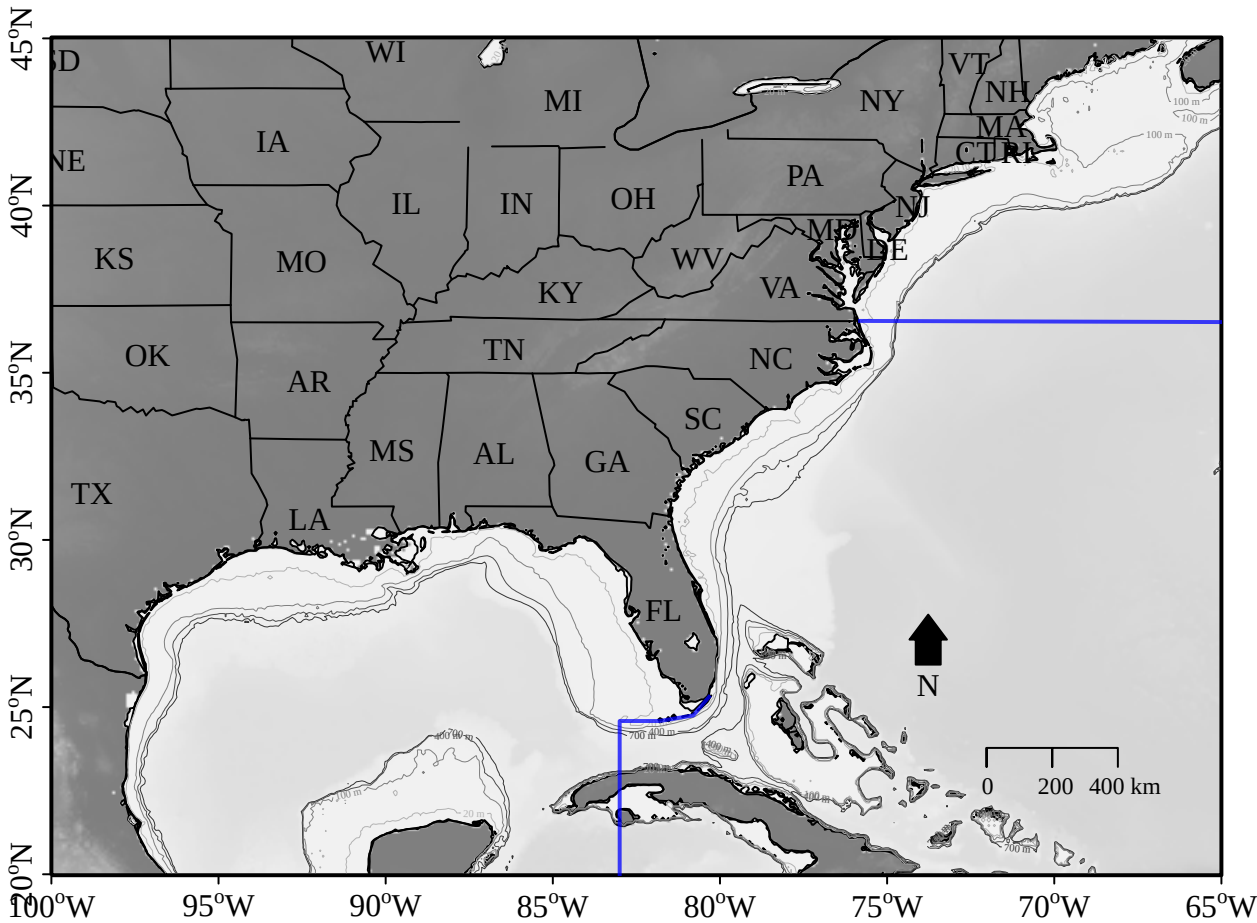
Federal management history

- Recreational
  - Seasonal closures (2011 - 2018)
  - Quotas (2011 - 2018)
  - Quotas met (2011 - 2018)
  - Annual Catch Limits (ACL; 2011 - 2018)
  - Retention limits
    - ★ 5 fish/person/day (1994 - 2006 Oct)
    - ★ 1 fish/person/day (2006 Oct - 2018)
  - Aggregate grouper retention limits
    - ★ 5 fish/person/day (1994 - 2009 Jul)
    - ★ 3 fish/person/day (2009 Jul - 2018)
  - No size limits

Introduction

Stock Unit

- VA/NC line to the Gulf Council Boundary inclusive of Monroe County, FL



Blue lines indicate rough Council boundaries

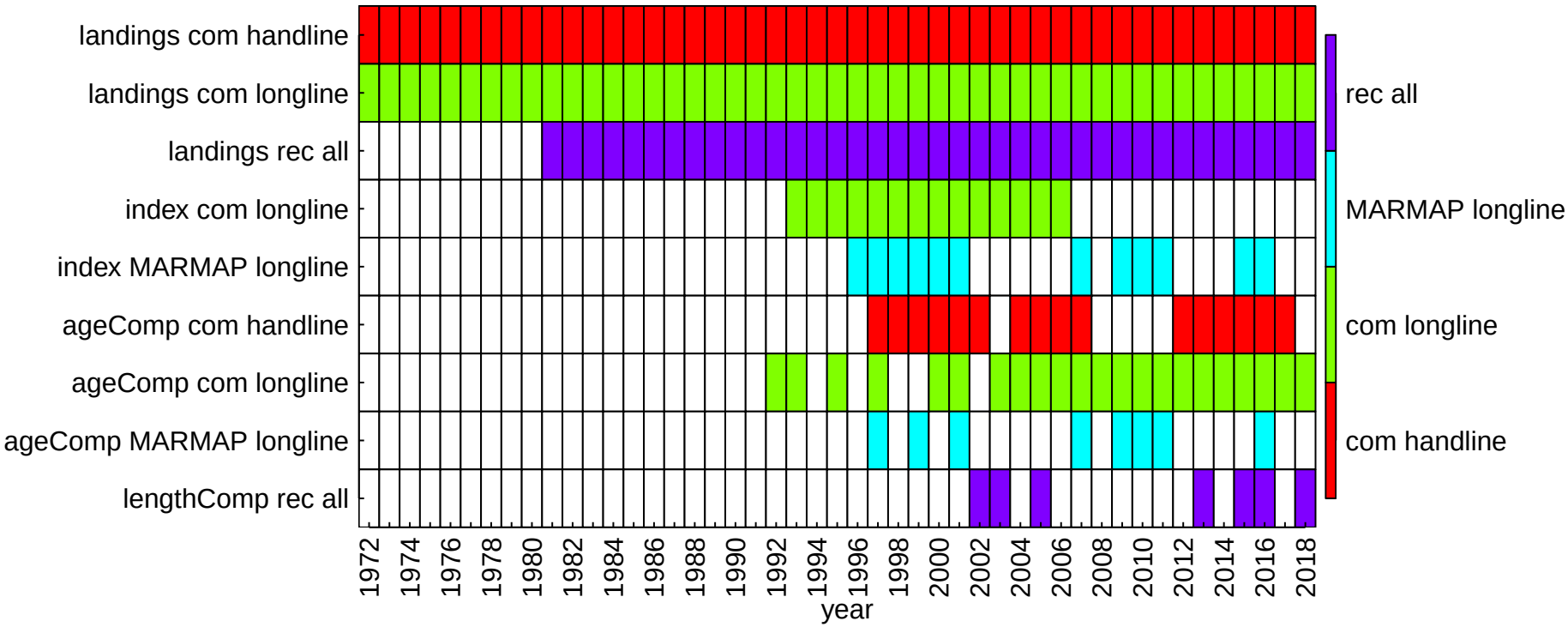
Introduction

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

Data

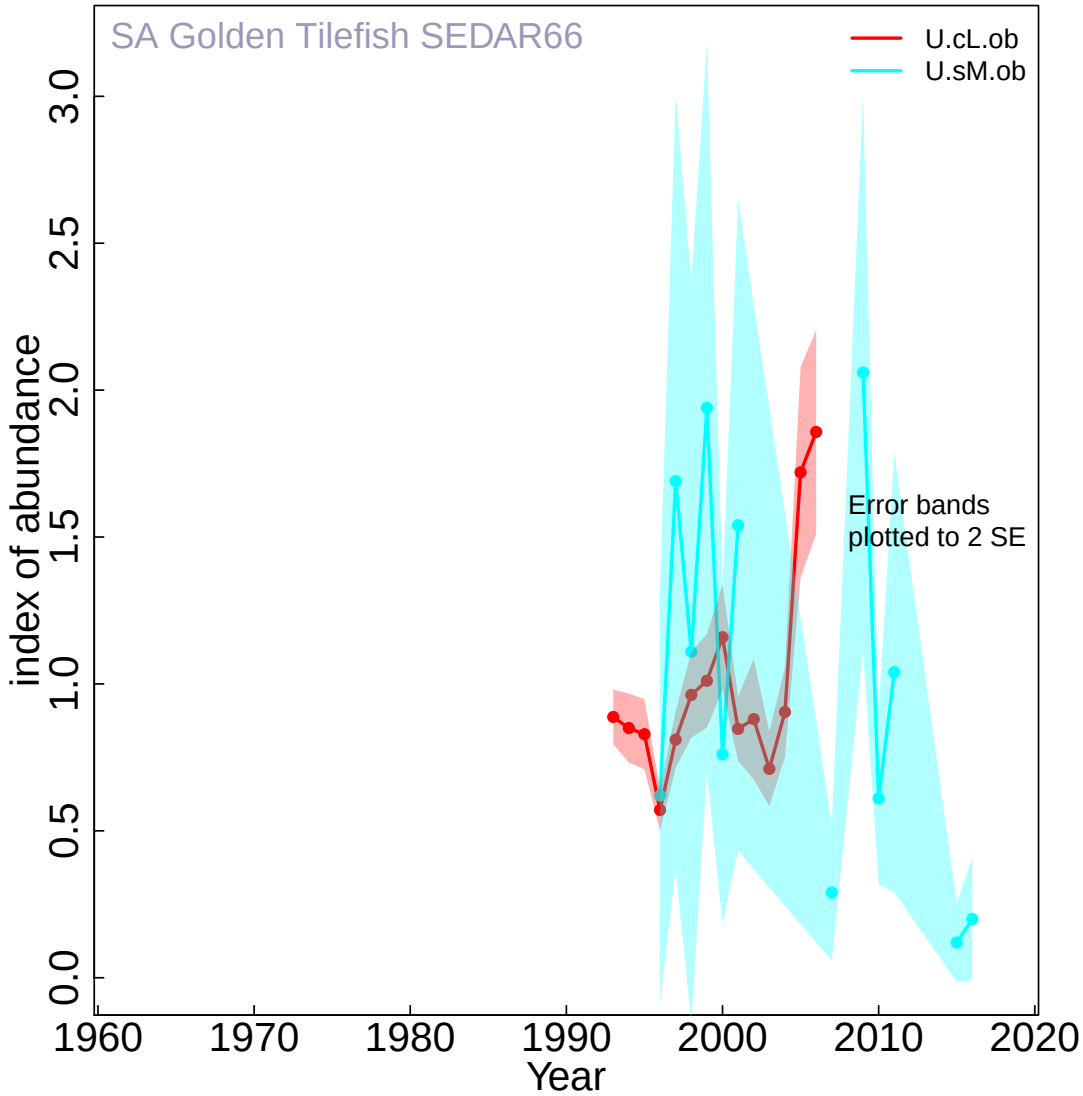
Summary of data fit by the assessment



Data

Indices of abundance

- commercial longline (cL; S66_WP03 Fitzpatrick 2020)
- MARMAP long-bottom (a.k.a. horizontal) longline survey (sM; S66_WP02 Bubley and Smart 2020)

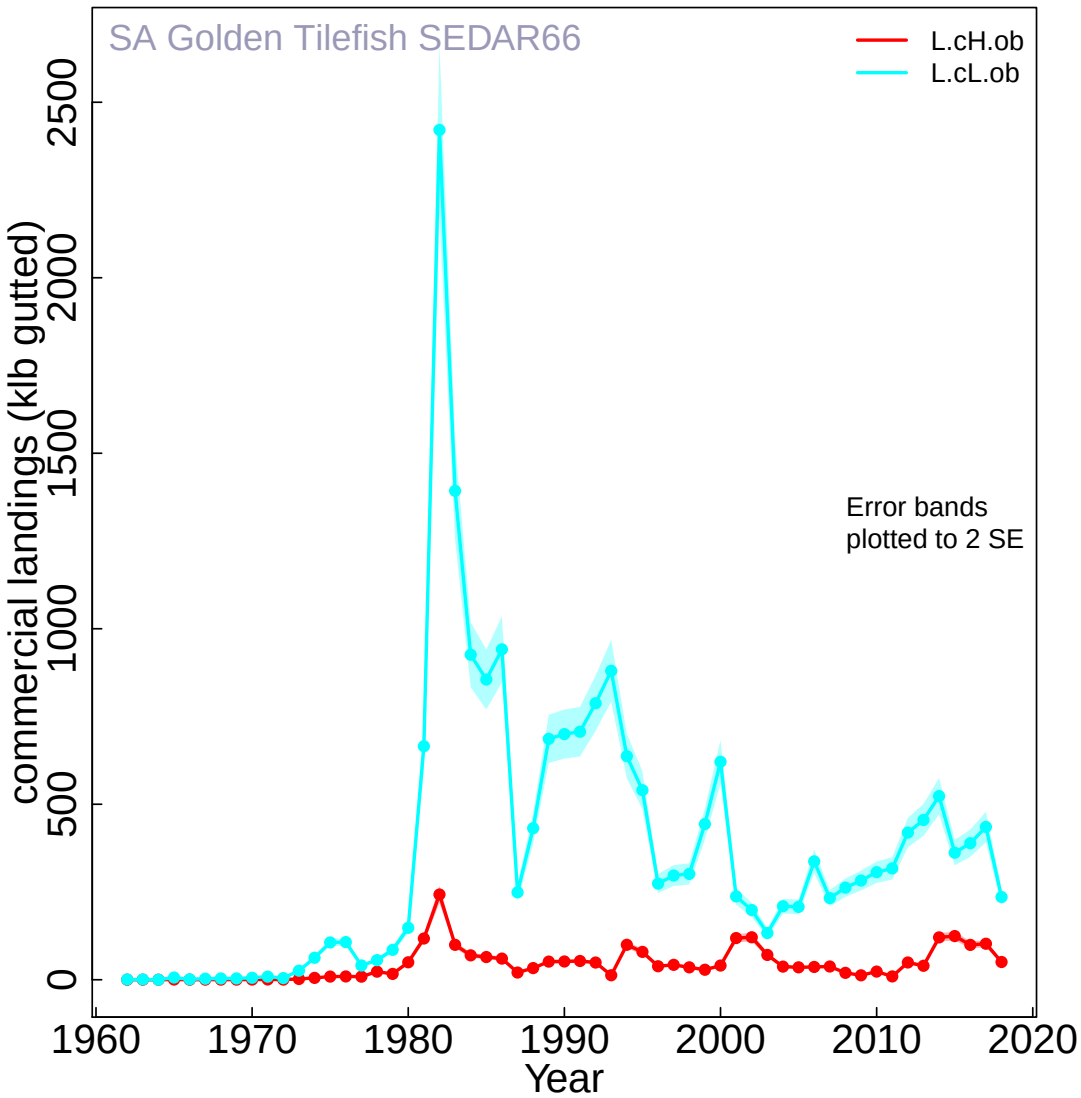


Data

Removals

Commercial landings by fleet

- commercial handline (cH)
- commercial longline (cL)

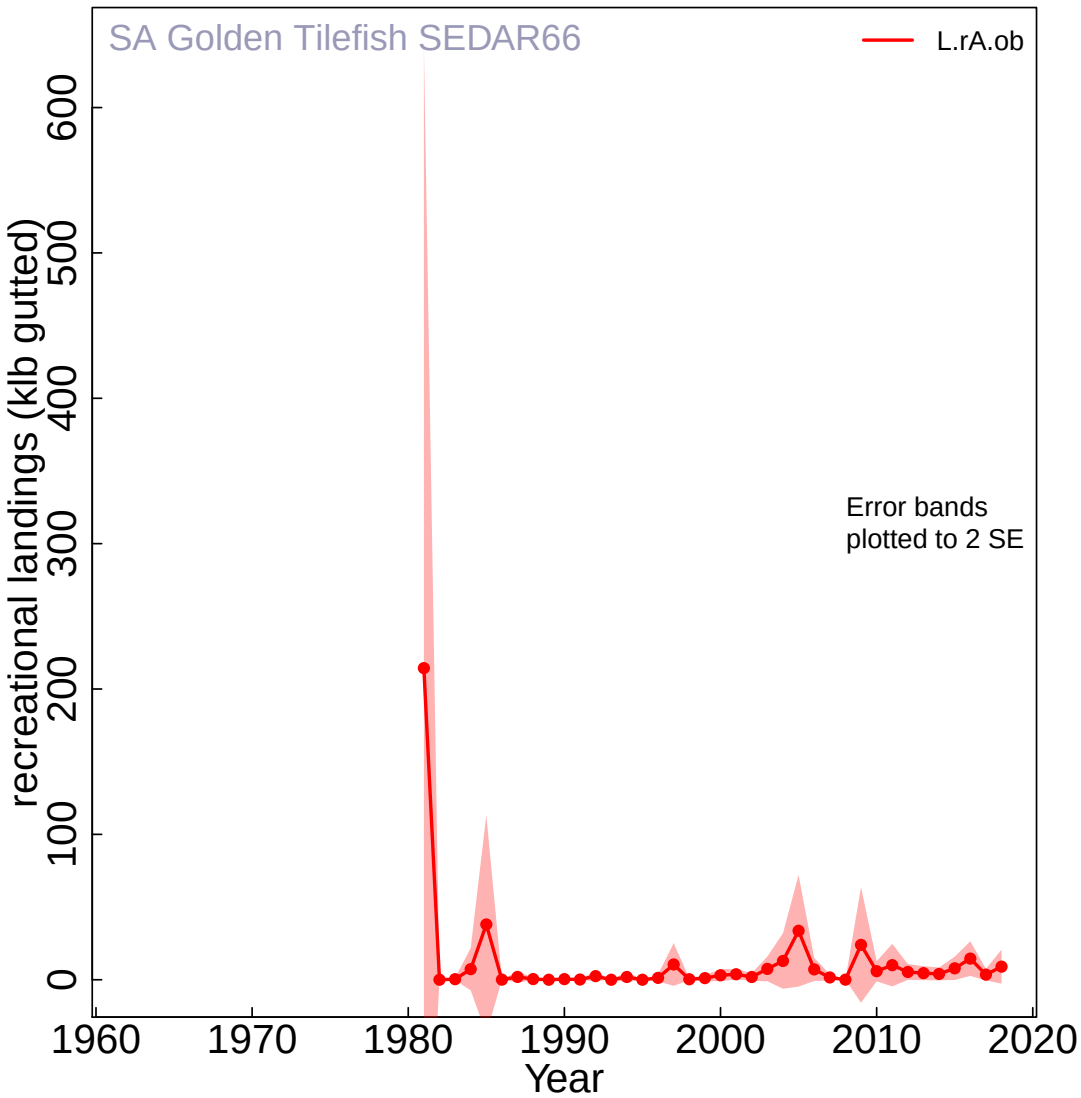


Data

Removals

Recreational landings by fleet

- recreational all (rA; S66_WP01 Nuttall and Matter 2020)
  - Does not include headboat landings which were negligible (Eric Fitzpatrick pers. comm.)



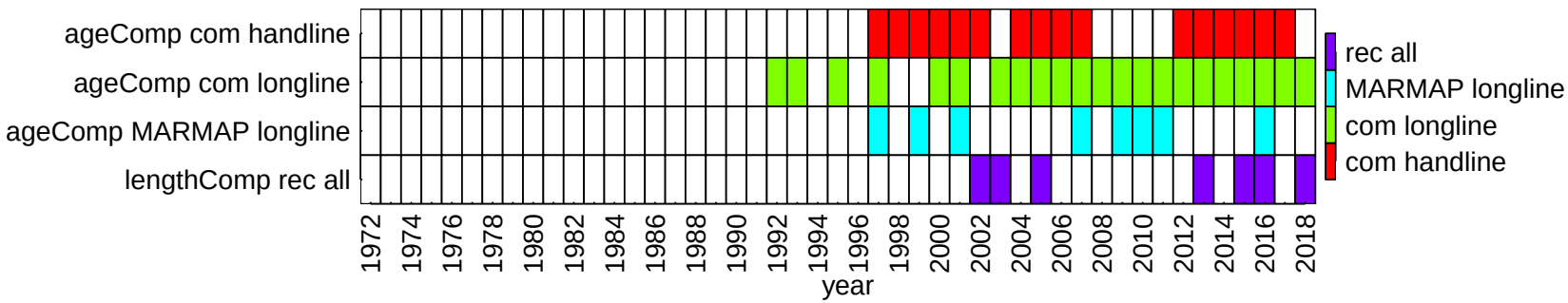
Discards

- Discards were not included in previous assessments, due to negligible rates of discarding
- For SEDAR 66, sources of discards were reexamined
  - Commercial discards were negligible (Kevin McCarthy, unpublished data)
  - Headboat at-sea discards (Dominique Lazarre, pers. comm.)
  - Discards from other recreational modes also negligible (S66_WP01 Nuttall and Matter 2020)
- Discards were not modeled in SEDAR 66

Data

Age and length compositions

- Fit to age composition data
  - Ages 1-20+ for commercial handline and longline
  - Ages 1-16+ for MARMAP longline survey
  - Only include years with at ≥ 5 trips and ≥ 25 fish
  - Exclude 1996, 1997, and 1999 from commercial longline age comps as in 2016 Update
- Fit to length composition data
  - 30 mm TL bins
  - 340 - 1000 mm
  - Only include years with at ≥ 5 trips and ≥ 25 fish
- Commercial length comps excluded
  - Early model runs showed conflict between commercial age and length comps
  - Available age data were sufficient and considered a better source of information than lengths
  - Thus length comps for commercial handline and longline are currently excluded from the model



Data

Life history

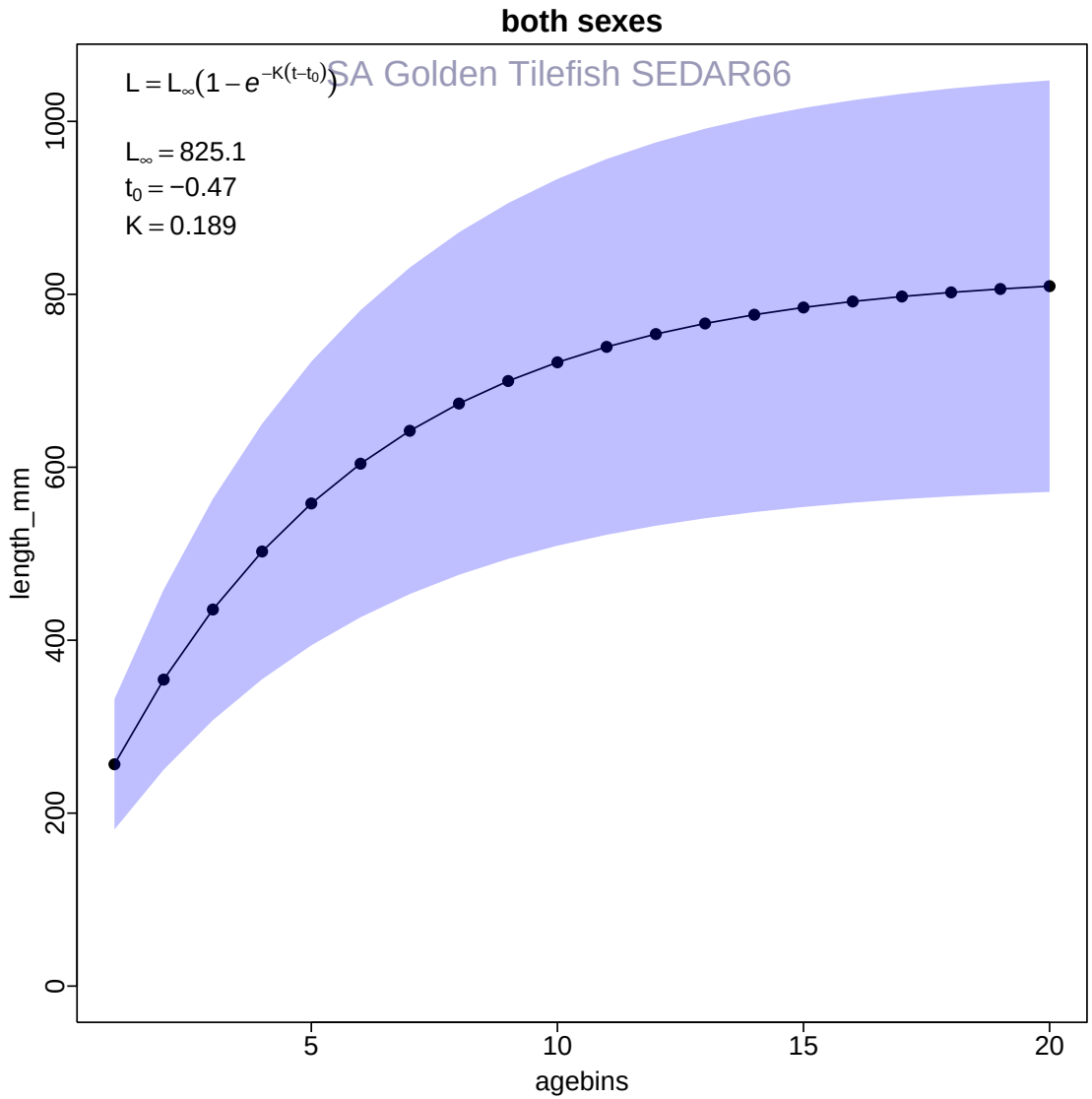
- $W_{\text{fishWhole}} = aL^b$
  $a = 4.04\text{E}-6$, $b = 3.155$
  $W_{\text{fishWhole}}$ = whole fish weight (g)
  L = TL (mm)
- $W_{\text{gonad}} = aW_{\text{fishWhole}}^b$
  $a = -9.16802$, $b = 1.70498$
  W_{gonad} = gonad weight (g)
- $W_{\text{fishWhole}} = aW_{\text{fishGutted}}$
  $a = 1.05893$
  $W_{\text{fishGutted}}$ = gutted fish weight (g)
- Time of (peak) spawning = May 31^{st}
  `spawn_time_frac`$= 5/12 = 0.42$

Data

Life history

Von Bertalanffy growth equation

- both sexes
- Total length (TL) in mm

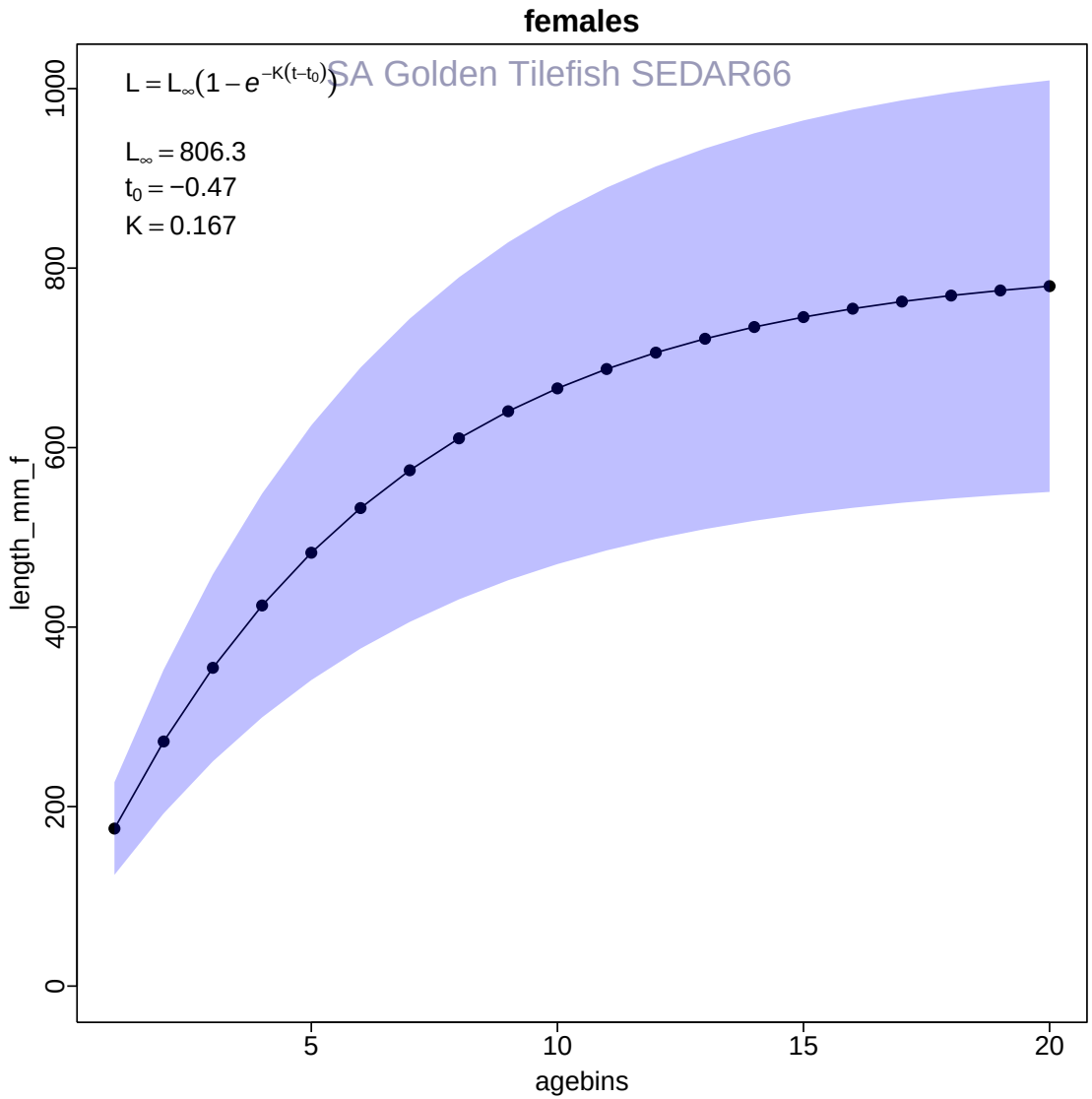


Data

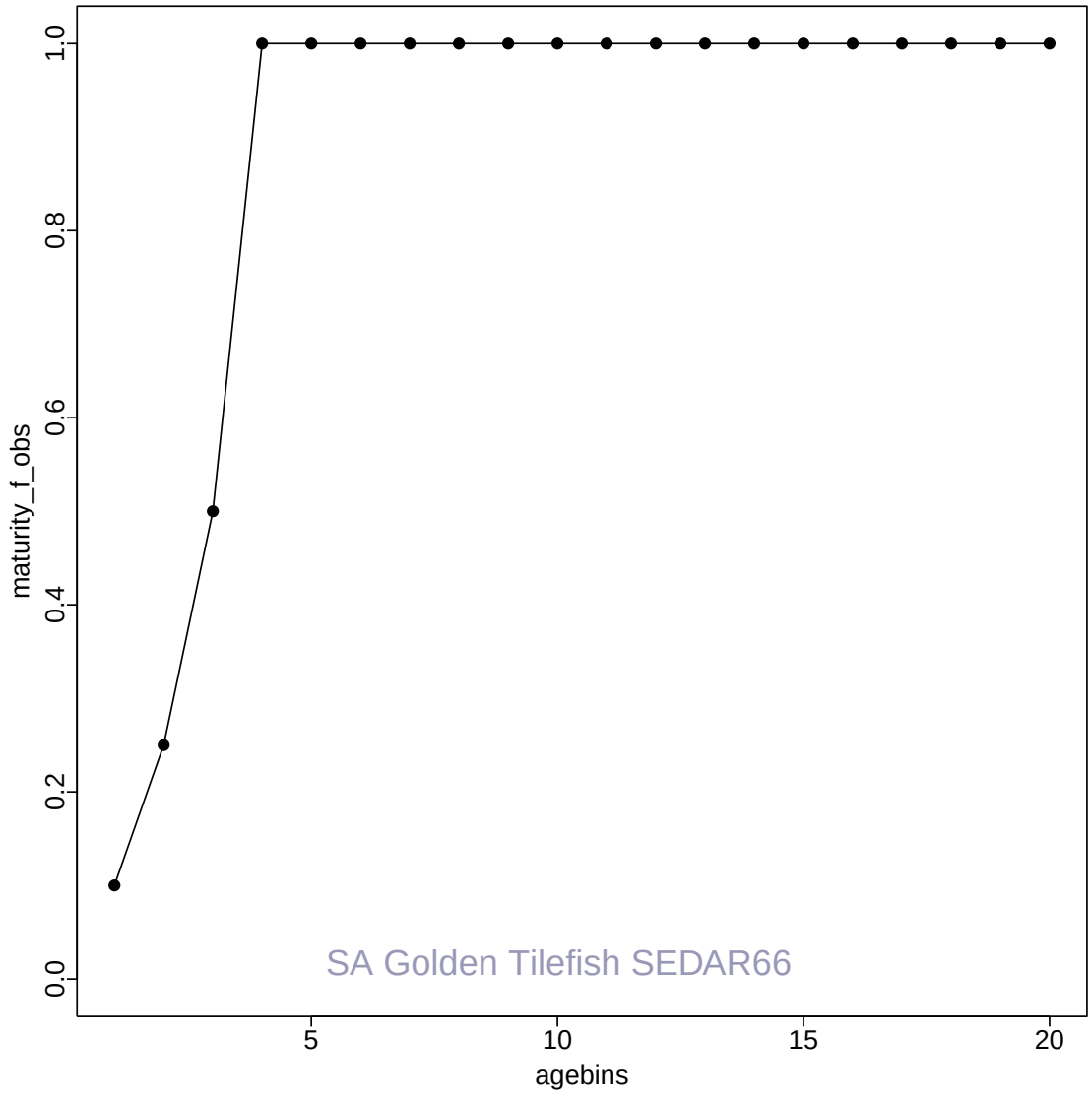
Life history

Von Bertalanffy growth equation

- females
- Total length (TL) in mm

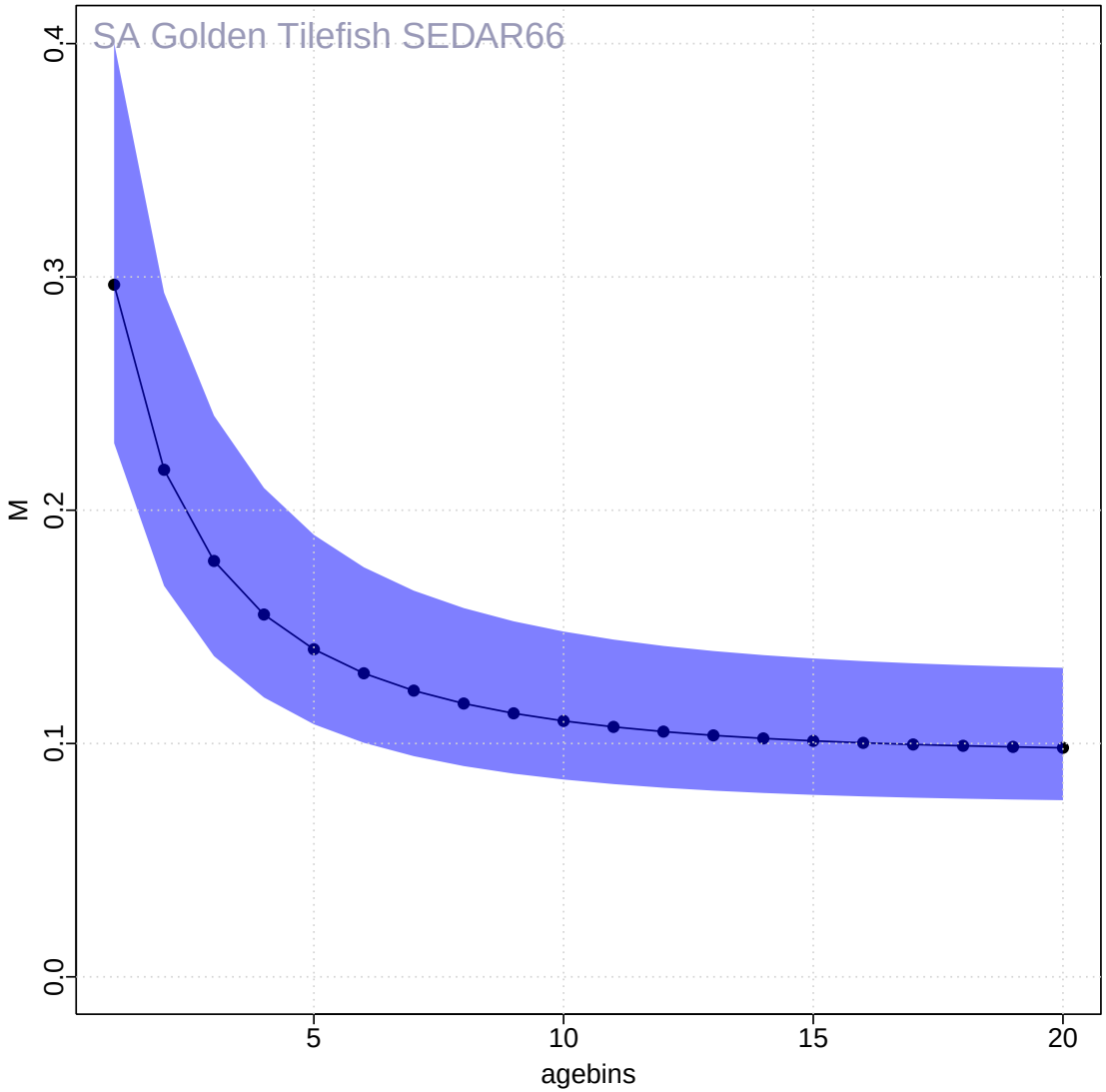


Proportion of females mature



Natural mortality

- Solid line indicates M-at-age vector
- Shaded area indicates range of M-at-age vectors scaled by upper and lower M-constant estimates
- $t_{max} = 40$
- $M = 0.1038$
- $M_{lo} = 0.08$; $M_{up} = 0.14$



Data

Comparison to previous assessment

Life history information

- No difference from 2016 Update

Data

Comparison to previous assessment

Data structure

1. Addition of four recent years of data (2015-2018) to many data sources
2. Later start year of 1972 compared with 2016 Update which started in 1962
3. MARMAP longline index is now estimated for individual years as opposed to five year averages in 2016 Update (S66_WP02 Bubley and Smart 2020)
4. Commercial longline index truncated to end in 2006 due to changes in regulations that affected fishing behavior and catch rates (S66_WP03 Fitzpatrick 2020)
5. Excluded commercial length composition information data, which conflicted with age composition data
6. Use of ages 1-20 for commercial age comps and 1-16 for MARMAP age comps

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 (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

Beverton-Holt stock-recruit function

- R_0 (unfished age-1 recruitment) is being estimated
- Steepness (h) is fixed at 0.84 (tended to go to upper bound)
- Rec sigma (σ) is fixed at 0.6 (tended to go to 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

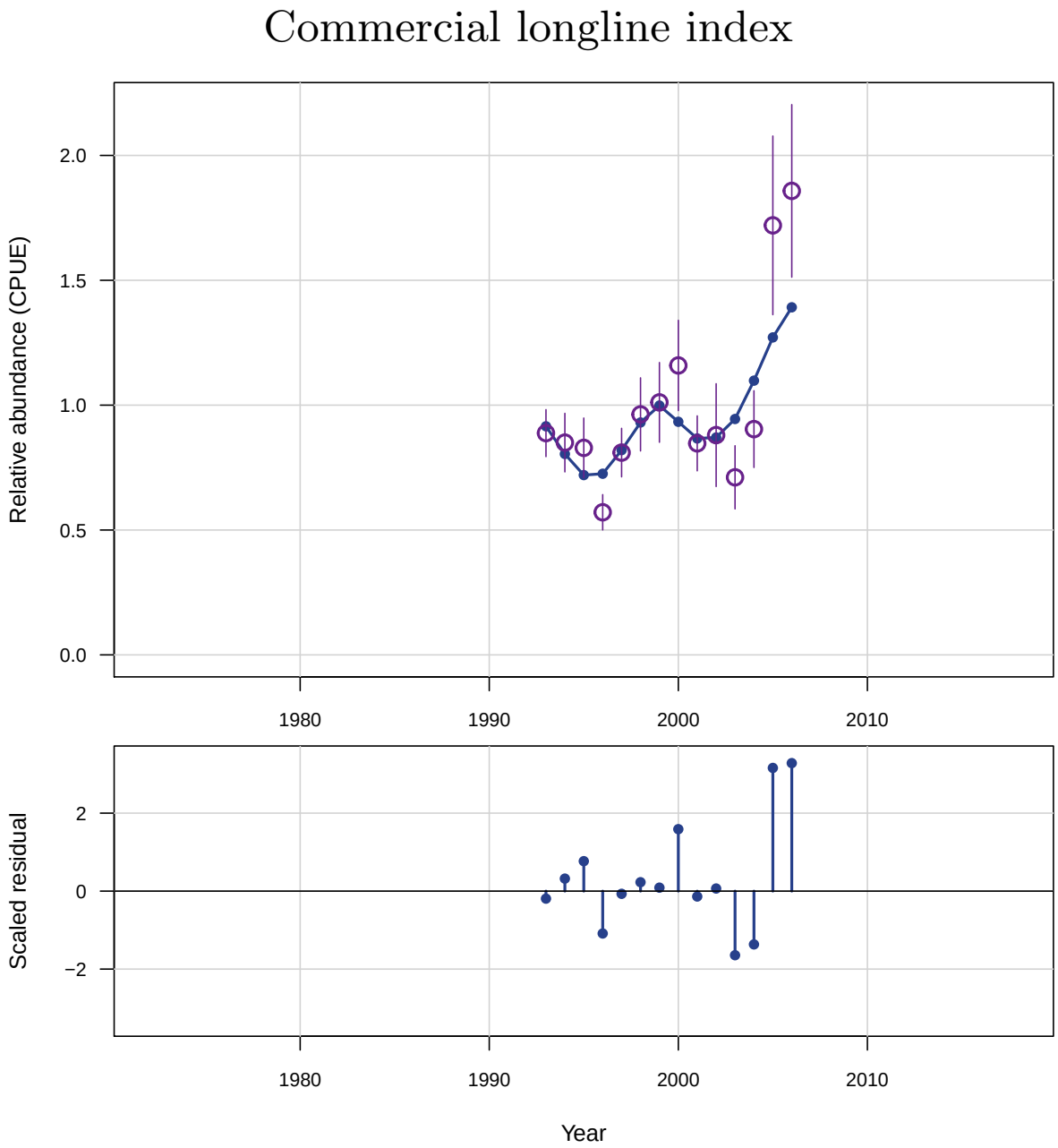
Comparison to previous assessment

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 2016 Update
4. Modeling ages 1-20 in population compared with 1-25 in 2016 Update

Stock assessment model

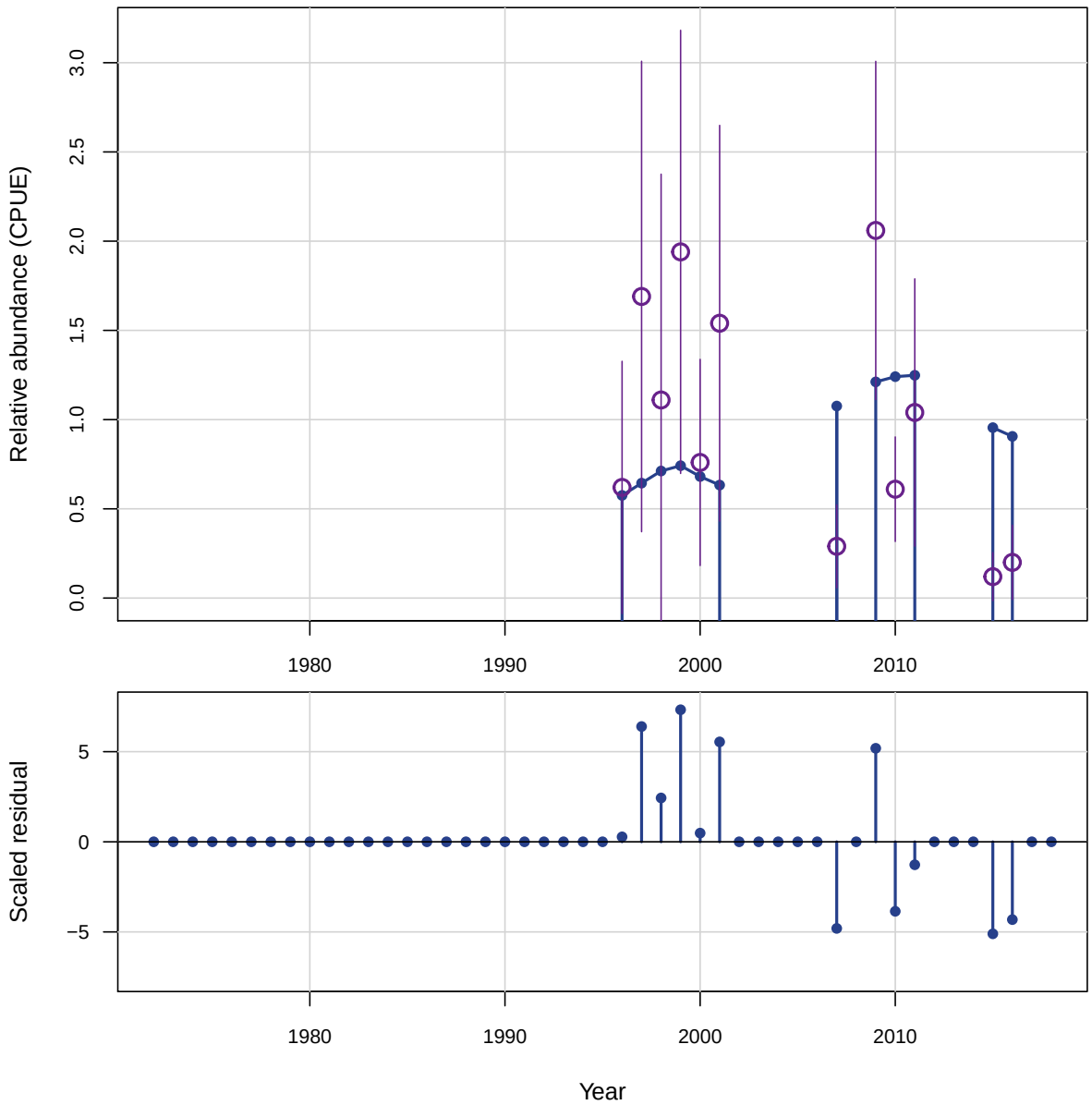
Fit to indices



Stock assessment model

Fit to indices

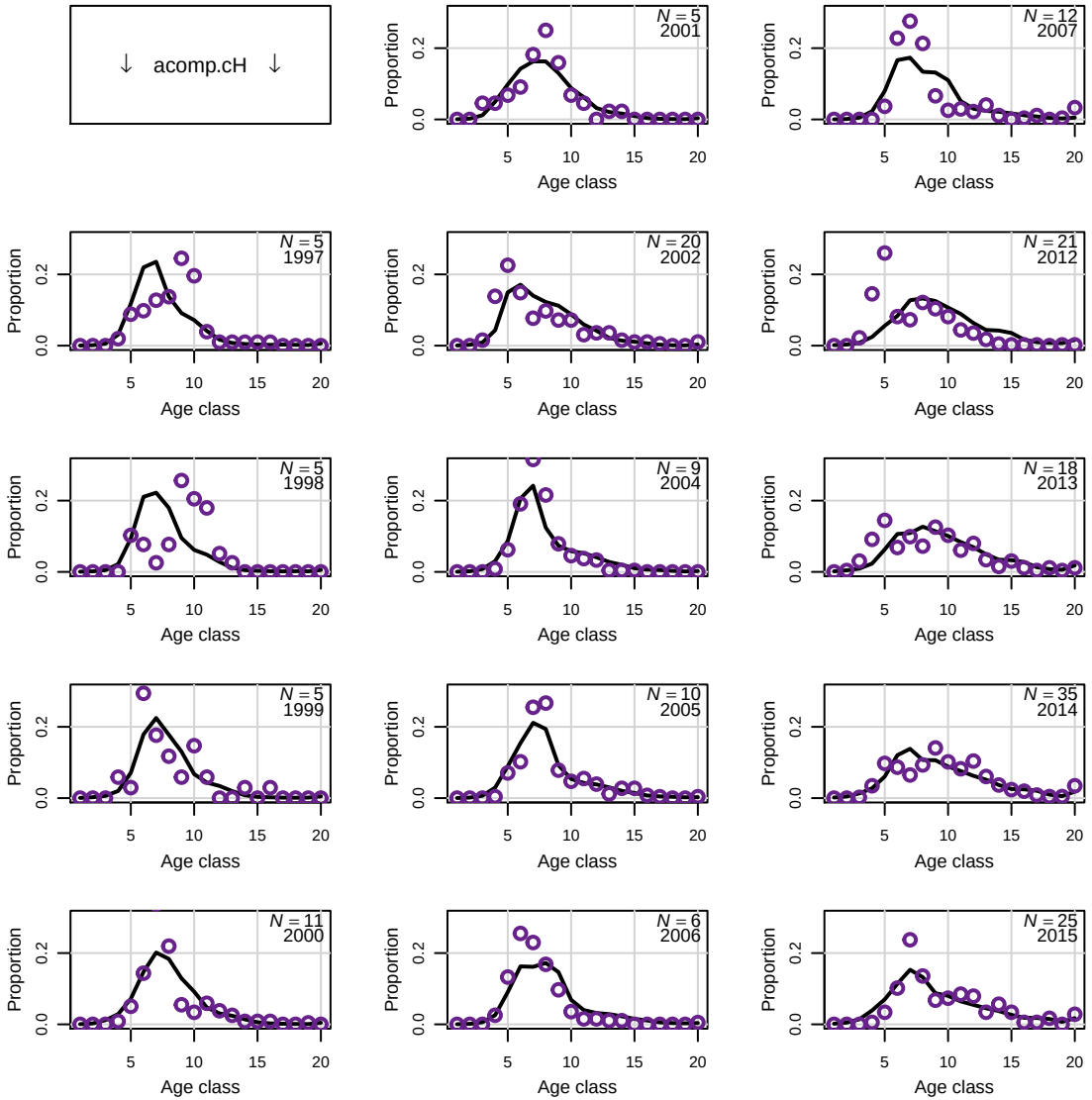
MARMAP horizontal longline survey index



Stock assessment model

Fit to age and length compositions

Commercial handline ages: 1997 – 2015

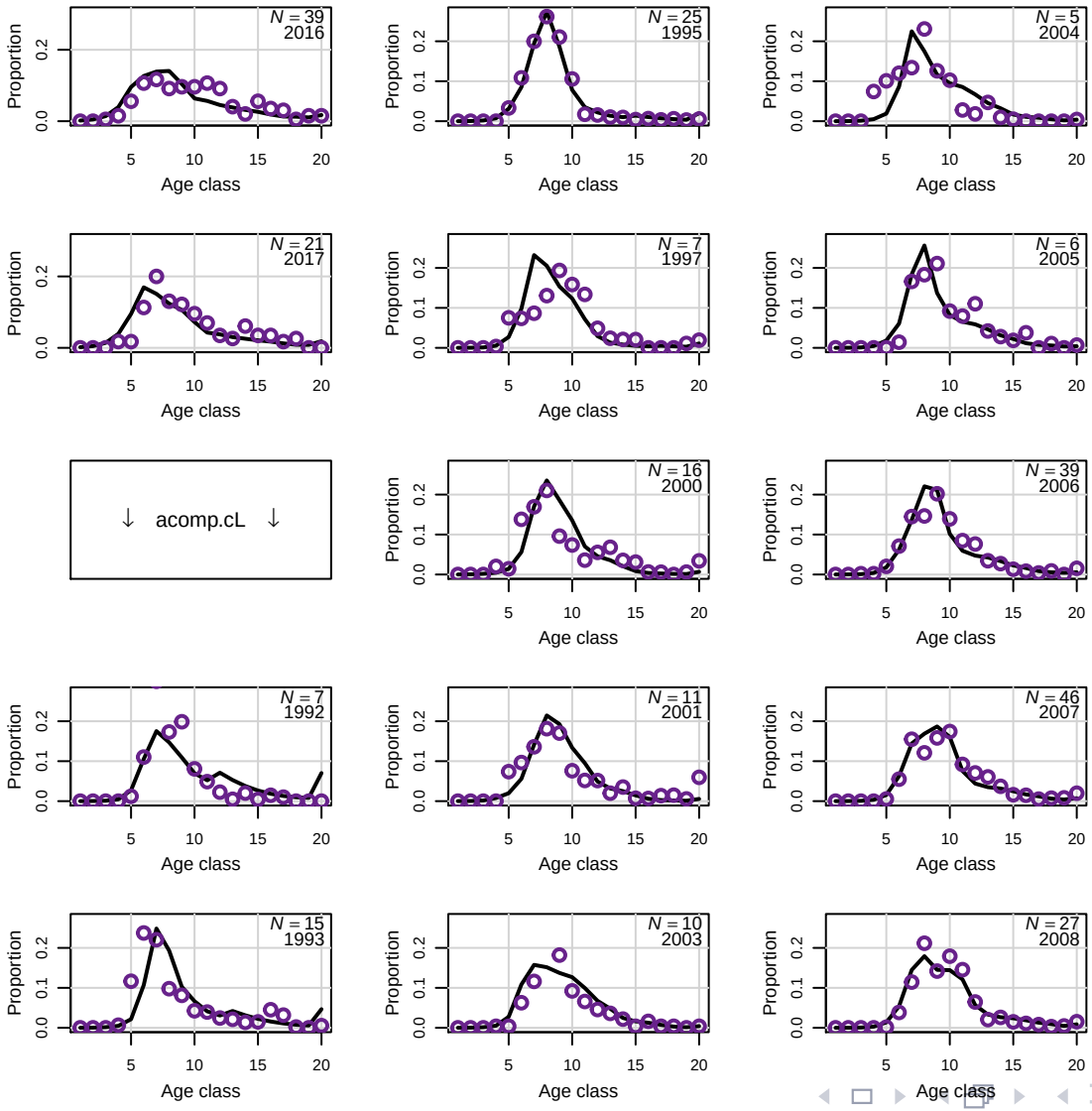


Stock assessment model

Fit to age and length compositions

Commercial handline ages: 2016 – 2017

Commercial longline ages: 1992 – 2008

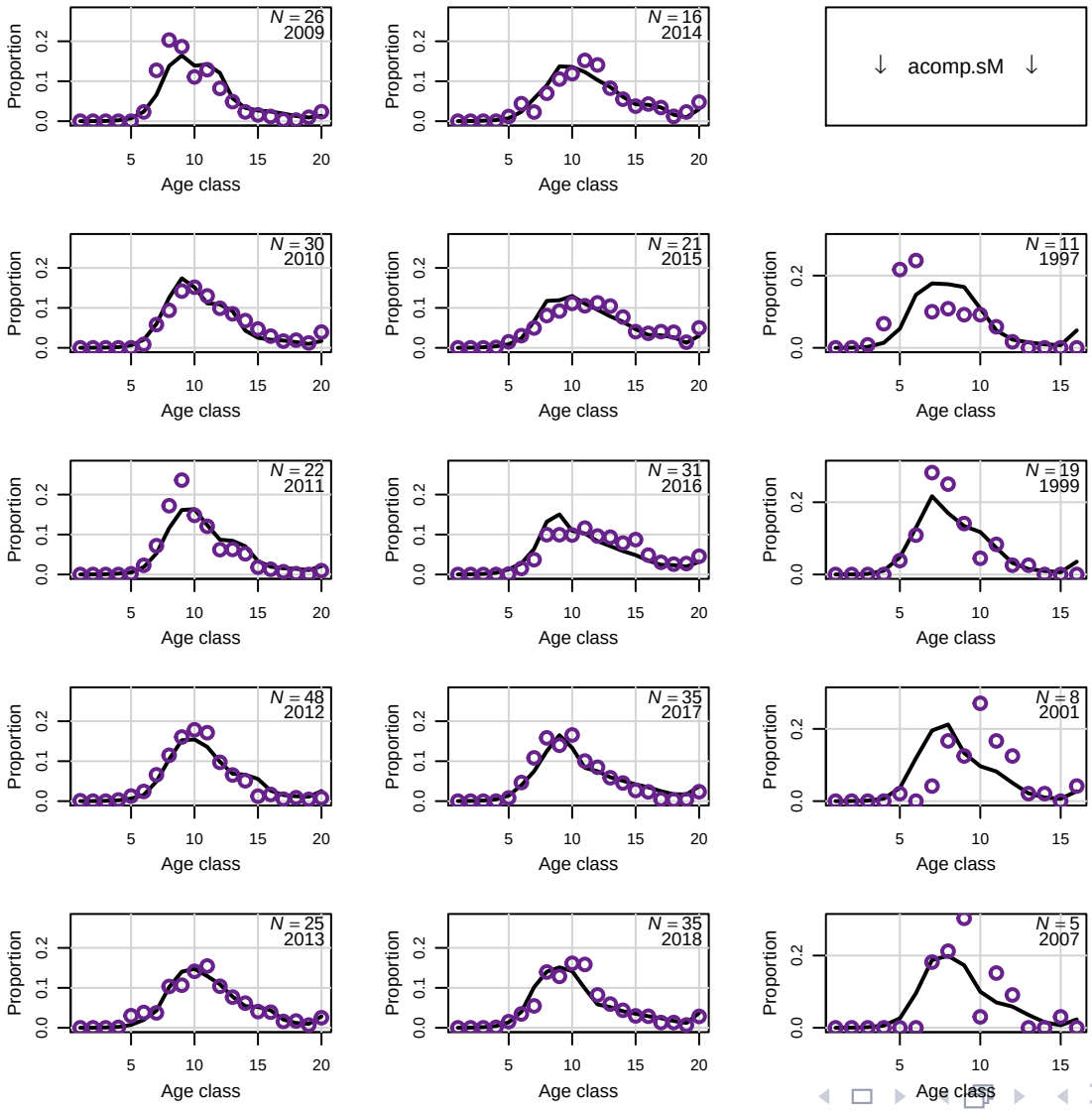


Stock assessment model

Fit to age and length compositions

Commercial longline ages: 2009 – 2018

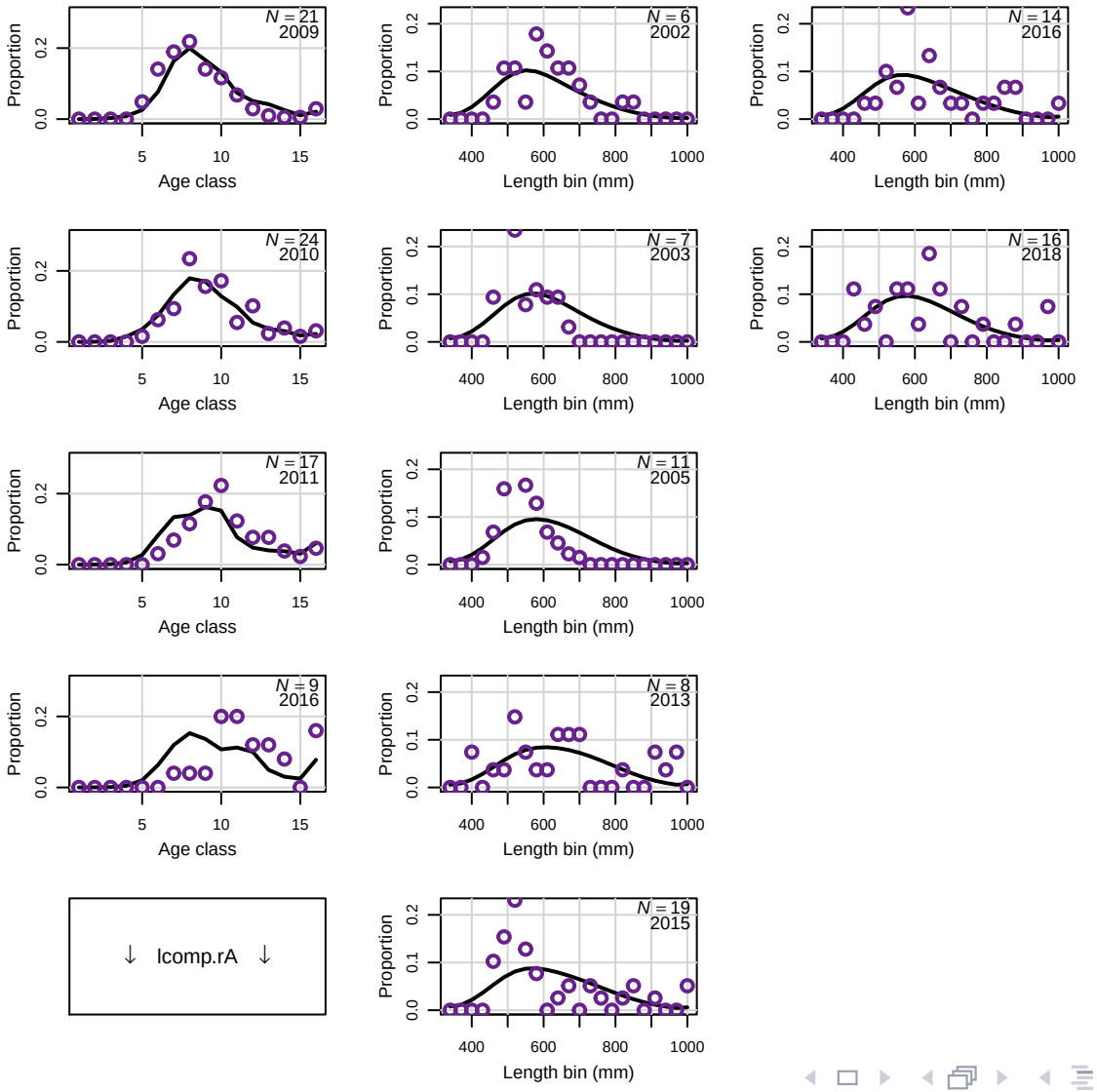
MARMAP longline survey ages: 1997 – 2007



Stock assessment model

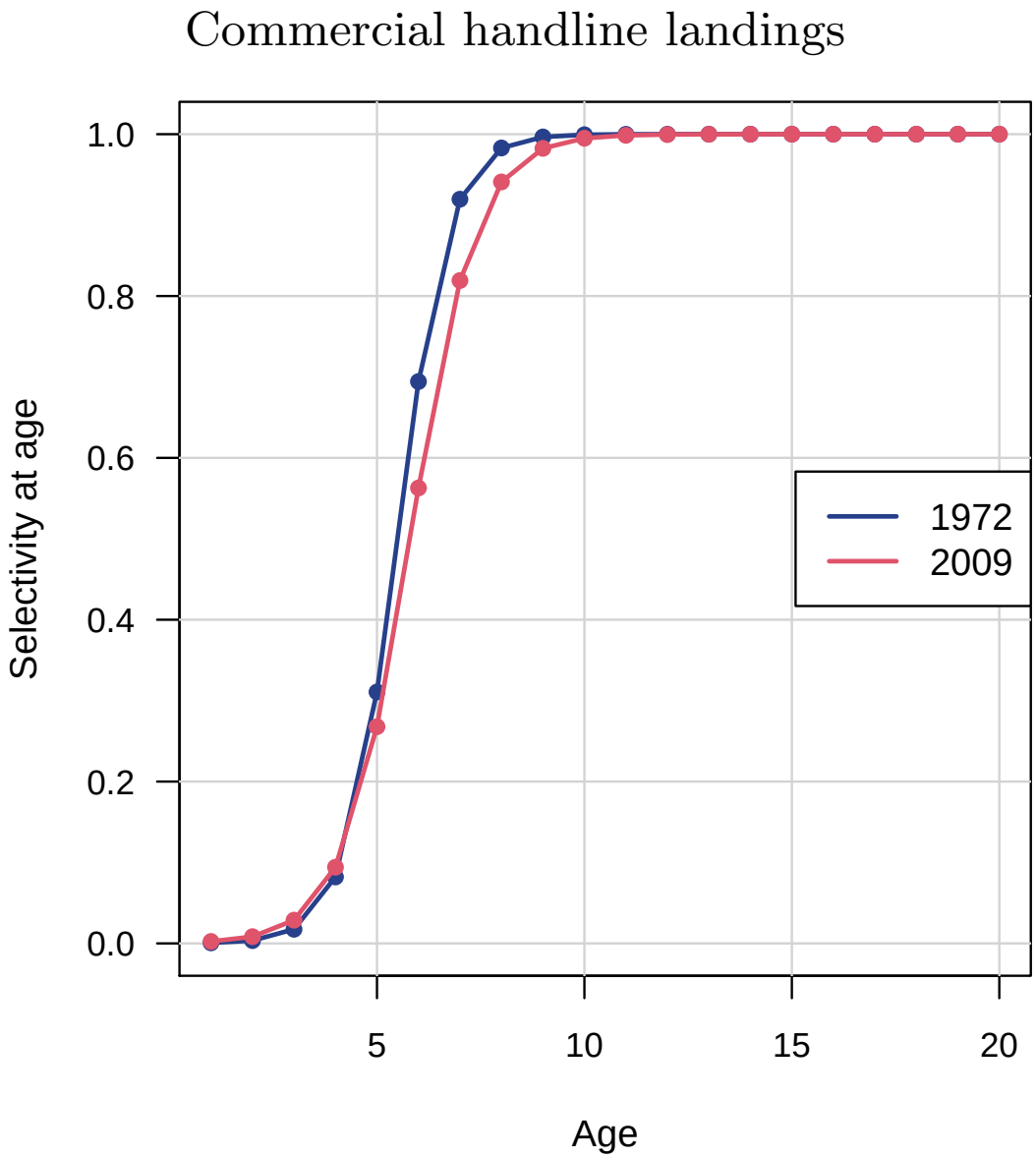
Fit to age and length compositions

MARMAP longline survey ages: 2009 – 2016
Recreational lengths: 2002 – 2018



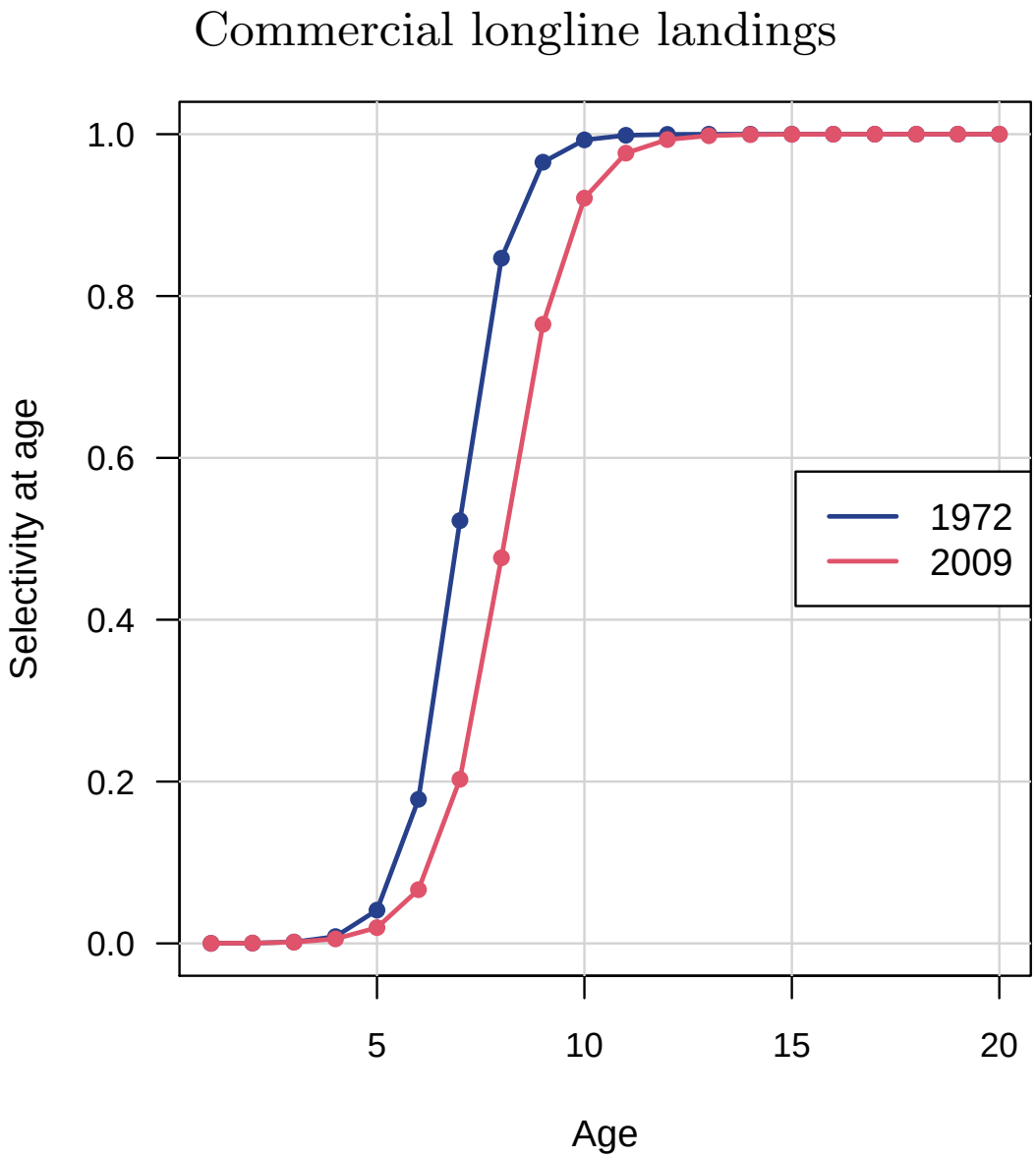
Stock assessment model

Estimated selectivity



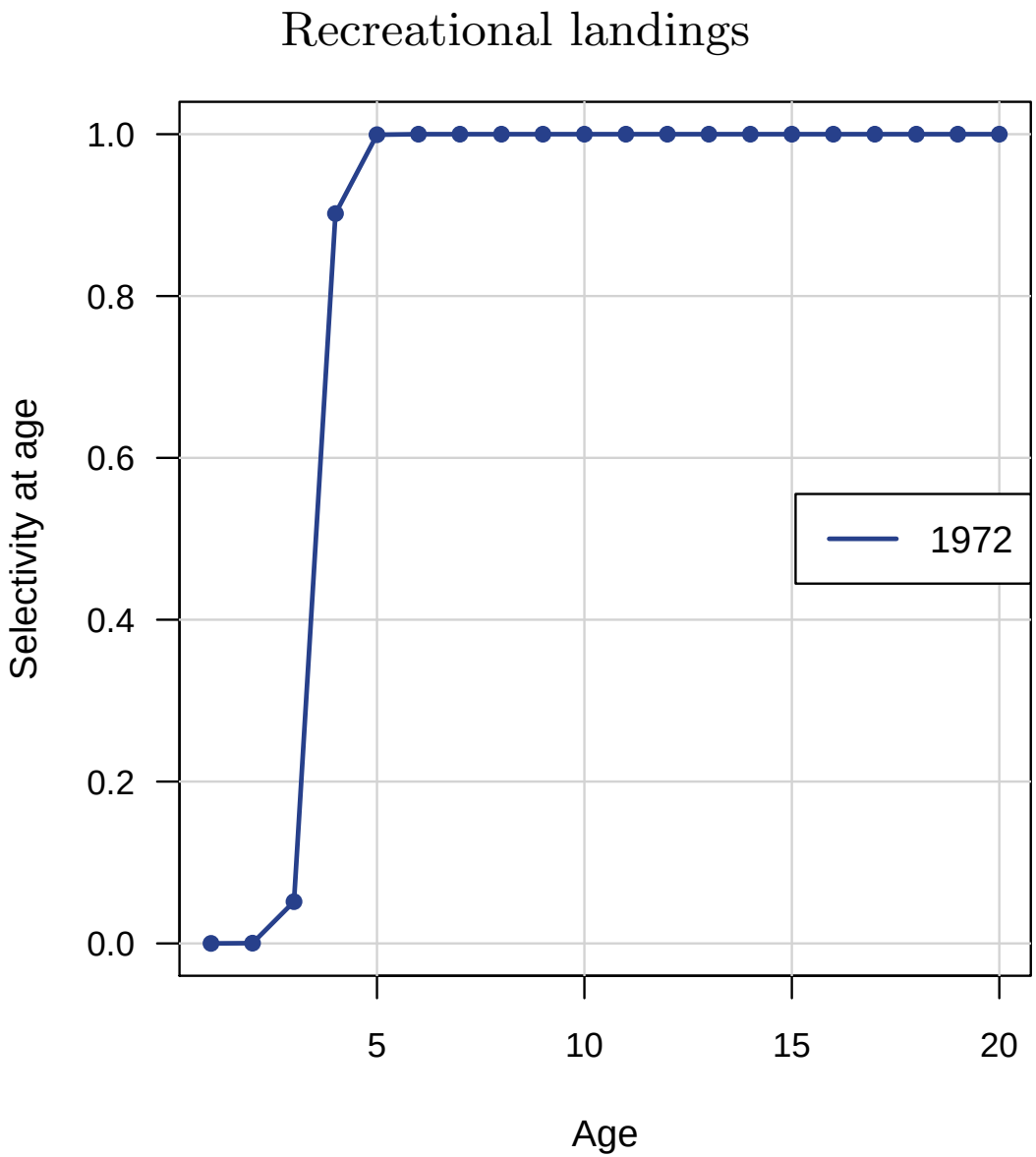
Stock assessment model

Estimated selectivity



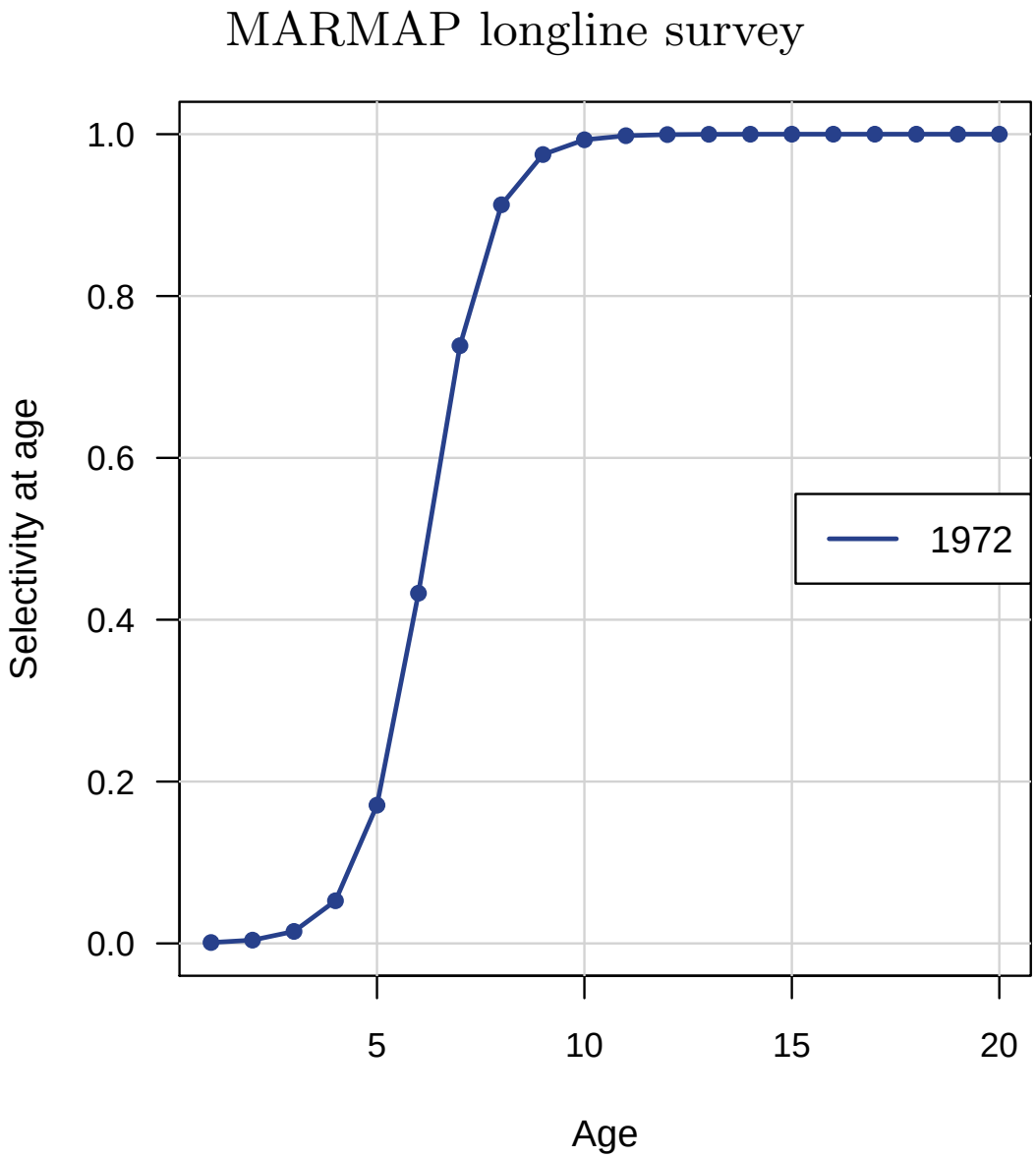
Stock assessment model

Estimated selectivity



Stock assessment model

Estimated selectivity



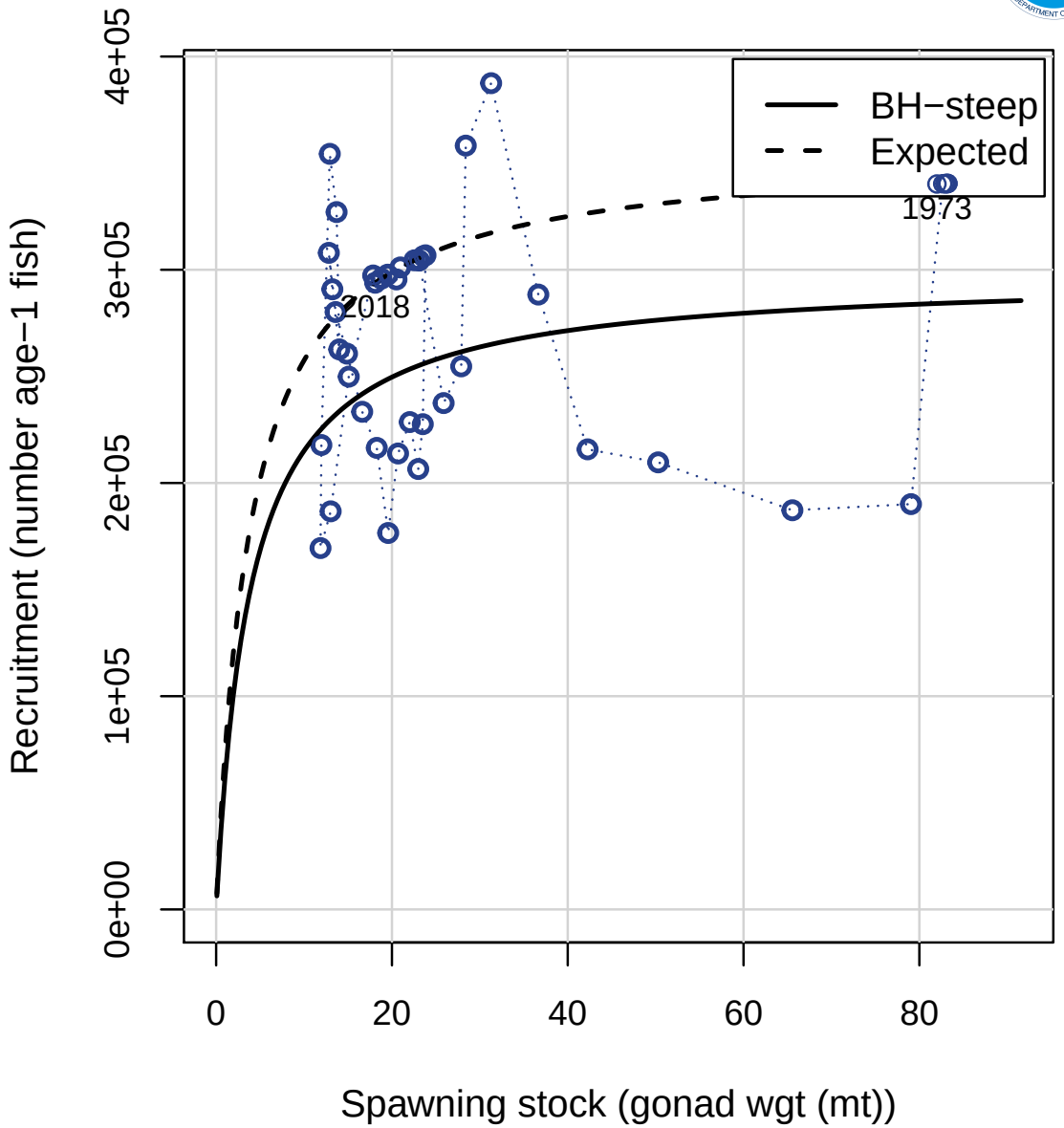
Stock assessment model

Spawner-recruit curve

$h = 0.84$

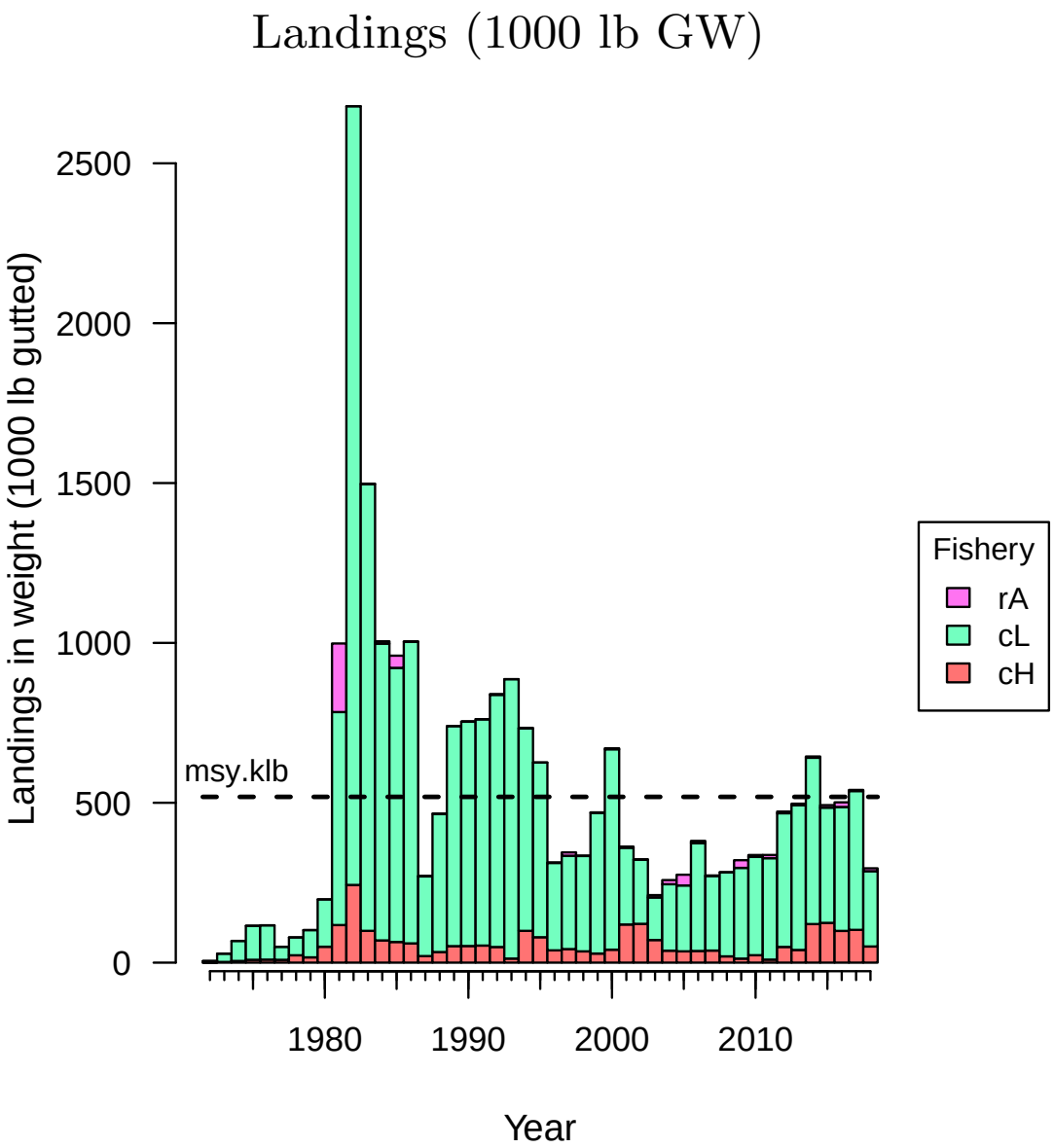
$R_0 = 283,300$

$\sigma_R = 0.6$



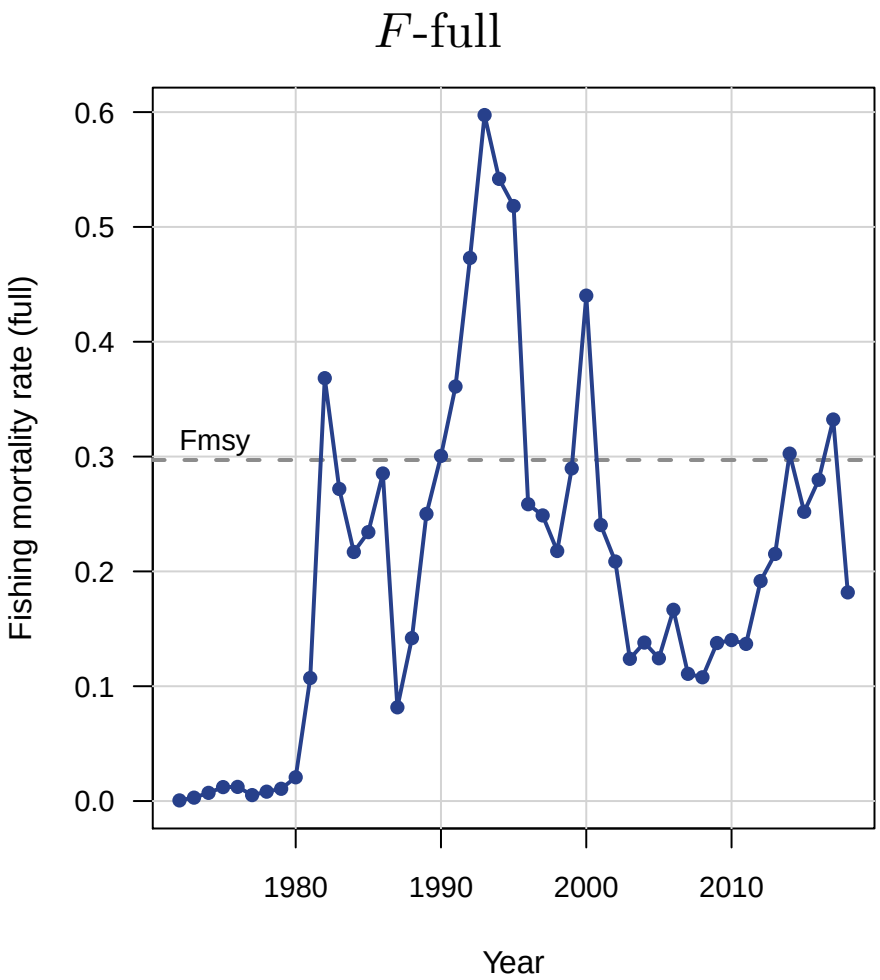
Stock assessment model

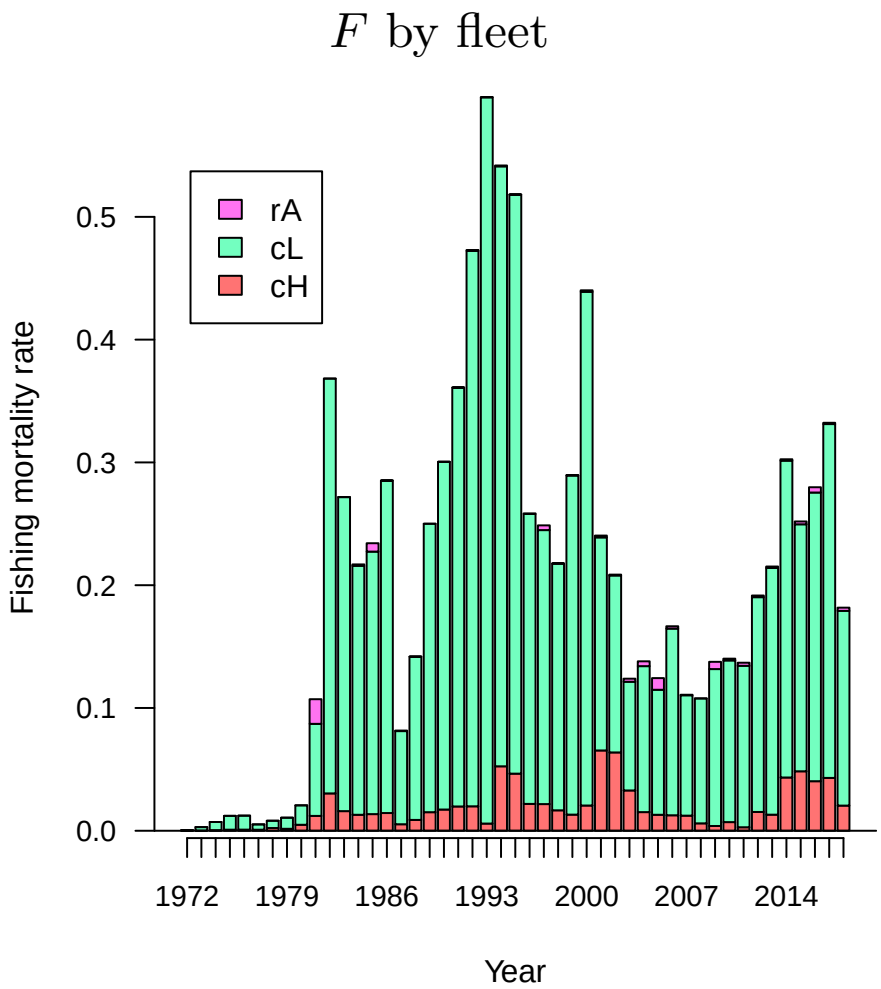
Landings



Stock assessment model

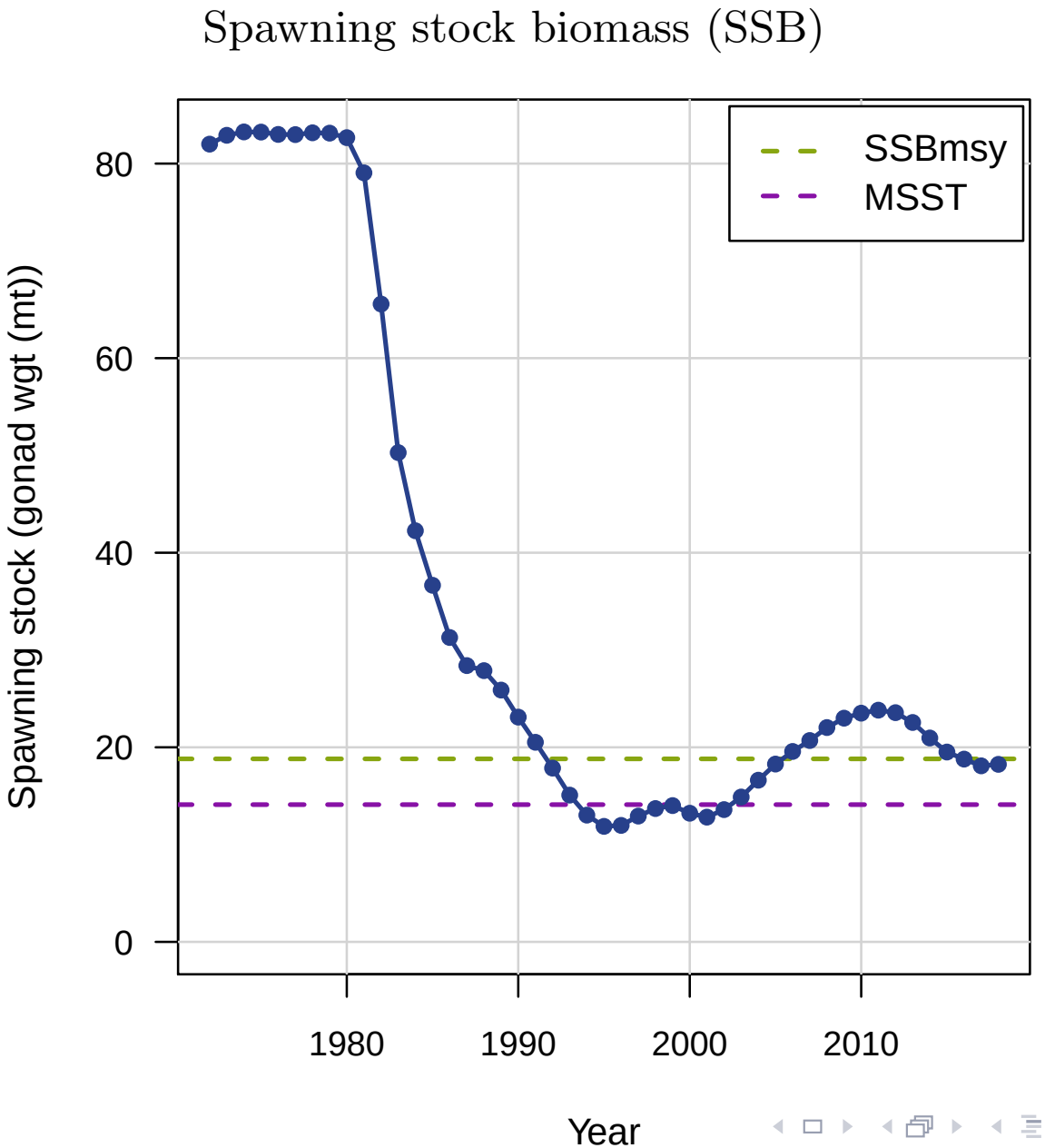
Benchmark time series





Stock assessment model

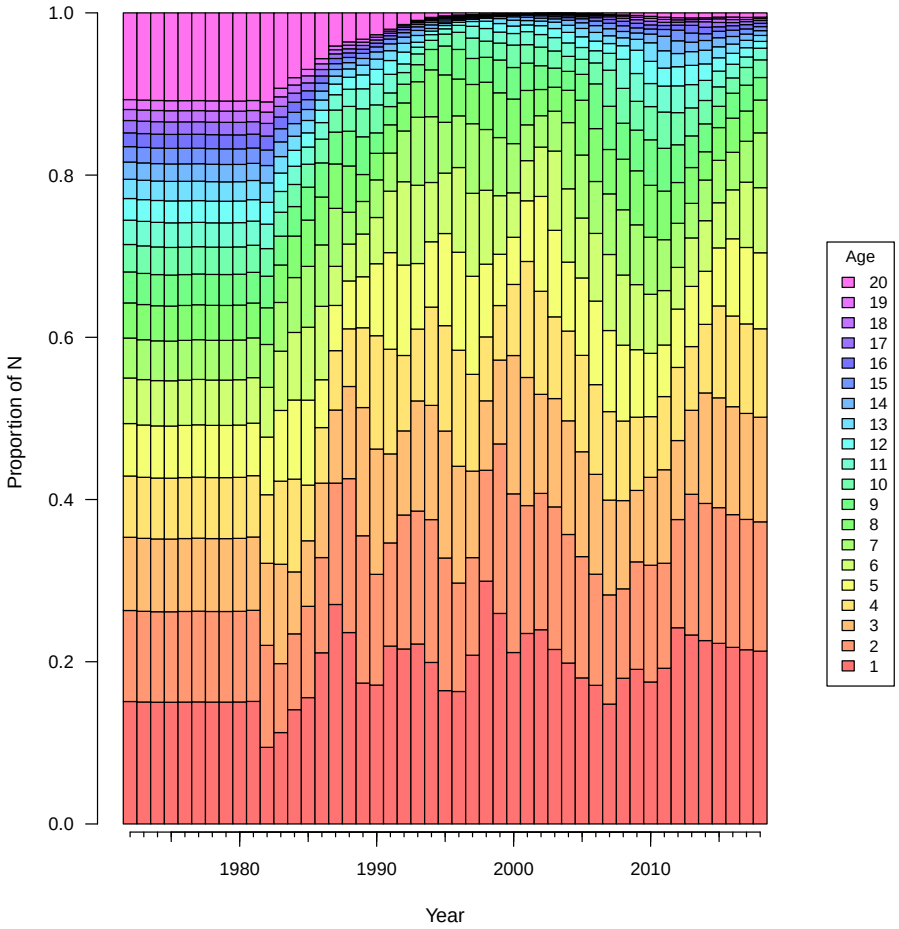
Benchmark time series



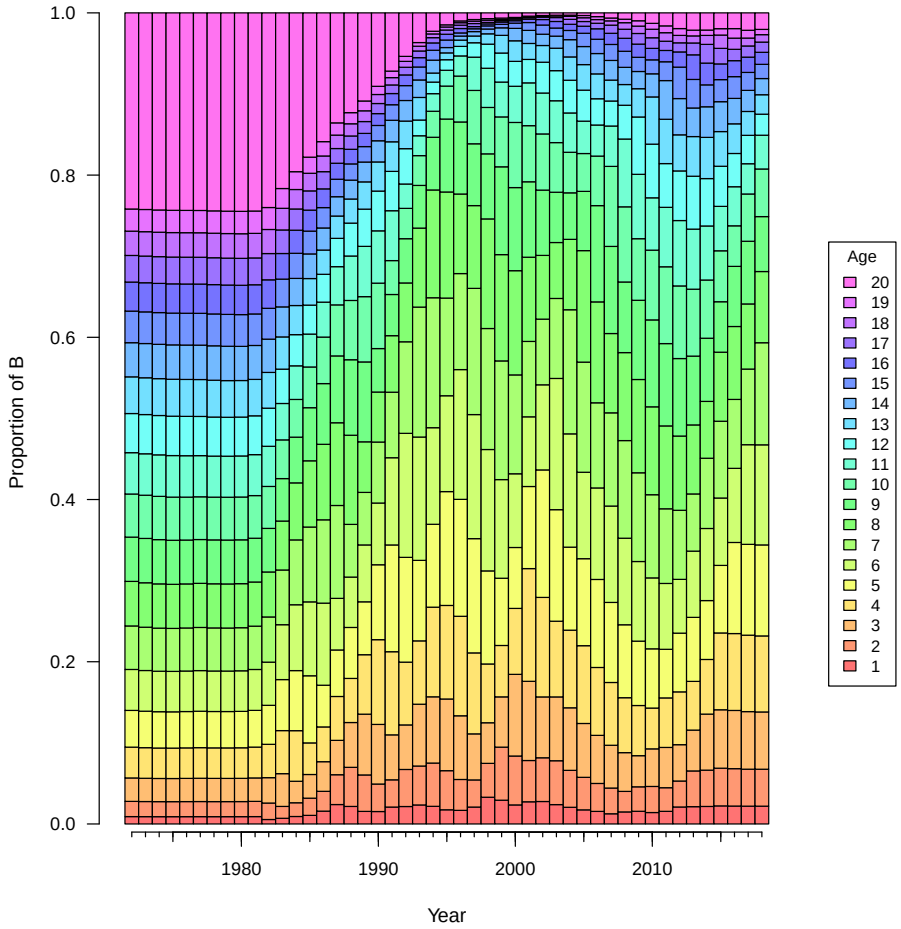
Stock assessment model

Benchmark time series

Numbers-at-age (proportions)

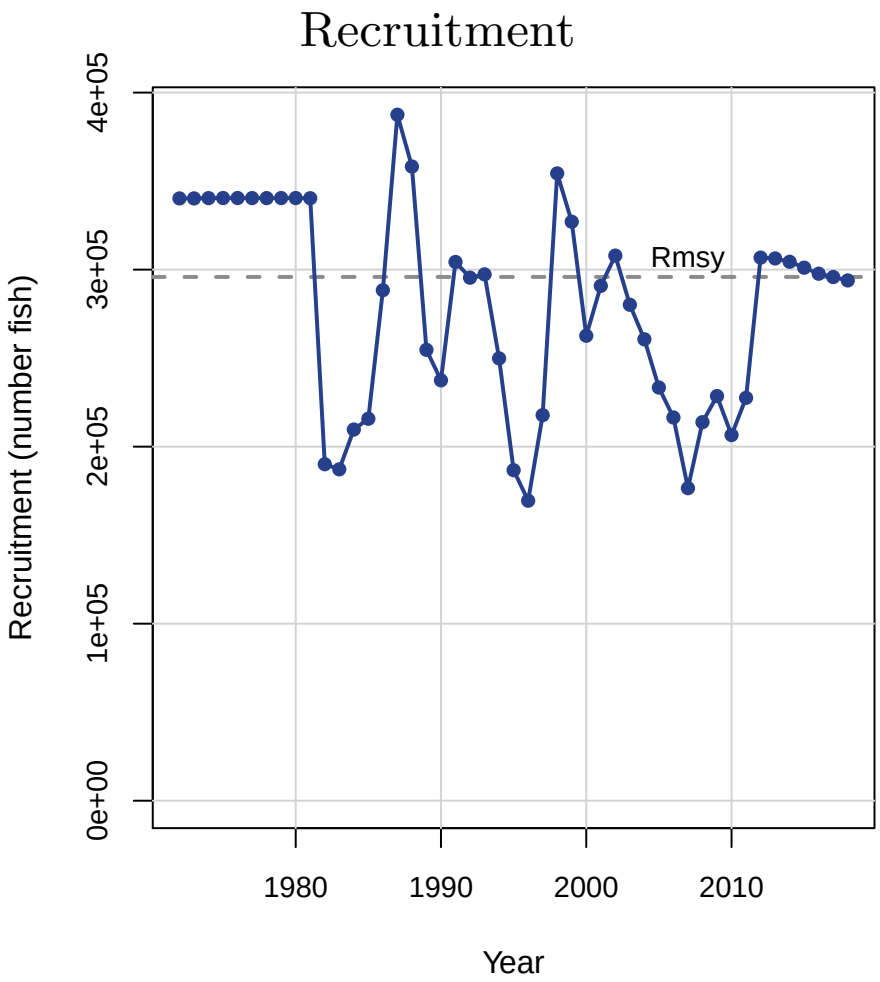


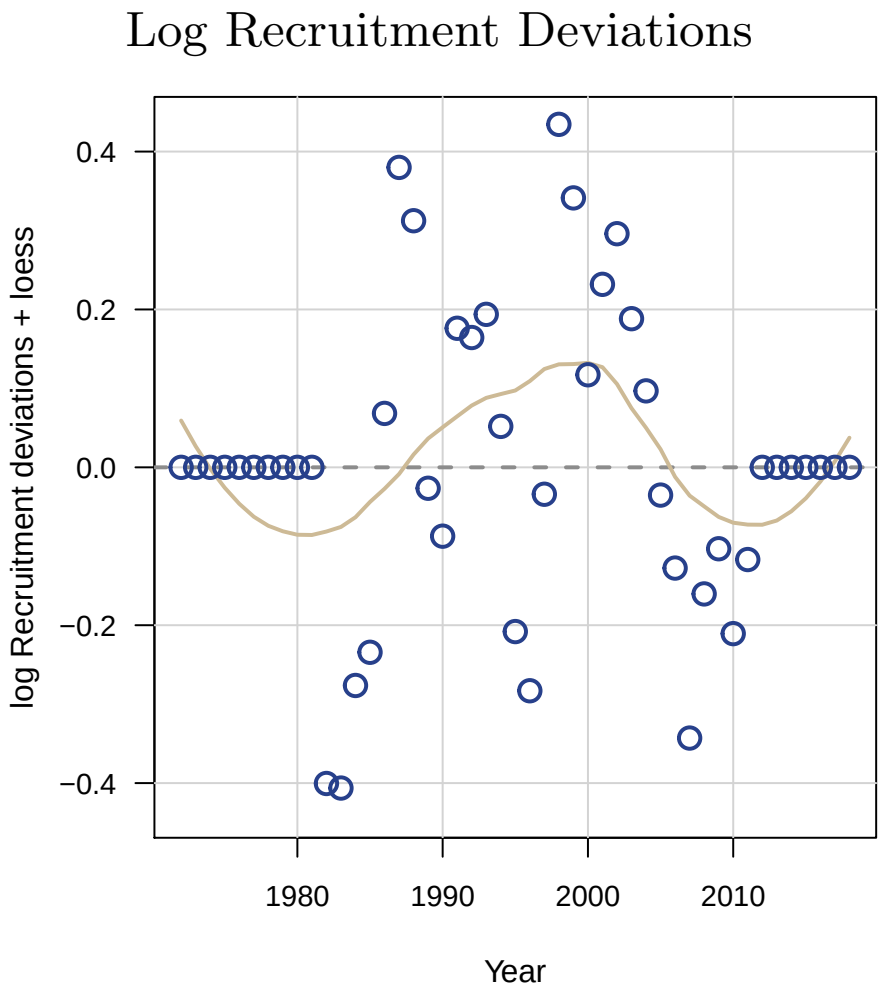
Biomass-at-age (proportions)



Stock assessment model

Benchmark time series





SEDAR 66 Report Table 18

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

Monte Carlo Bootstrap Ensemble (MCBE)

Methods

- The Monte Carlo Bootstrap Ensemble (MCBE) analysis is a process of randomizing data inputs and fixed parameters that go into the assessment model and rerunning the model to estimate uncertainty in the model
- 4200 sets of randomized inputs were drawn and the assessment model is run each time
- Outputs from all runs are combined summarized to characterize uncertainty in the base model and projections

Monte Carlo Bootstrap Ensemble (MCBE)

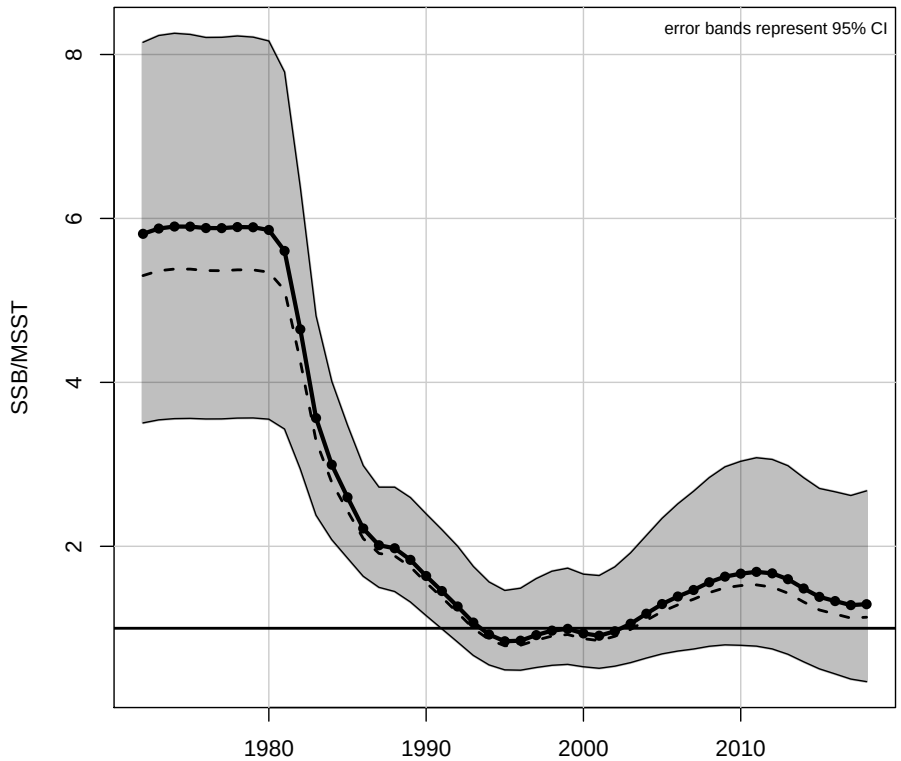
Methods

- Landings resampled from log-normal distributions defined by values provided by data providers
- 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
- Steepness estimates were sampled from a beta distribution based on Shertzer and Conn (2012)
- Rec sigma values were sampled from a truncated normal distribution $(mean = 0.6,\ sd = 0.15,\ lower = 0.3,\ upper = 1.0)$

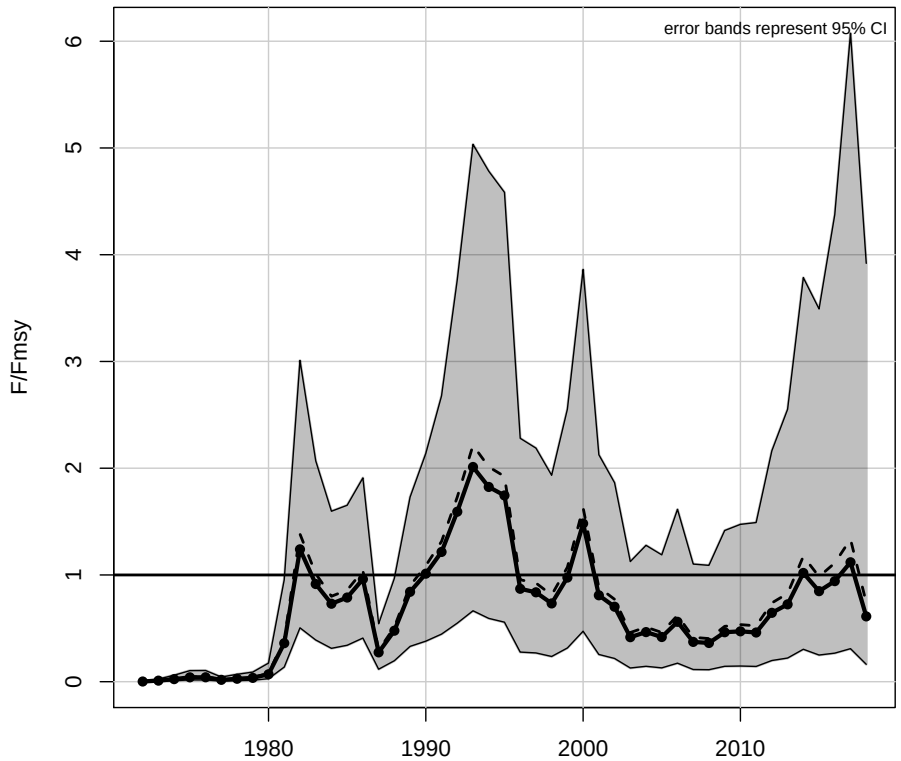
Monte Carlo Bootstrap Ensemble (MCBE)

Results

$SSB/MSST$

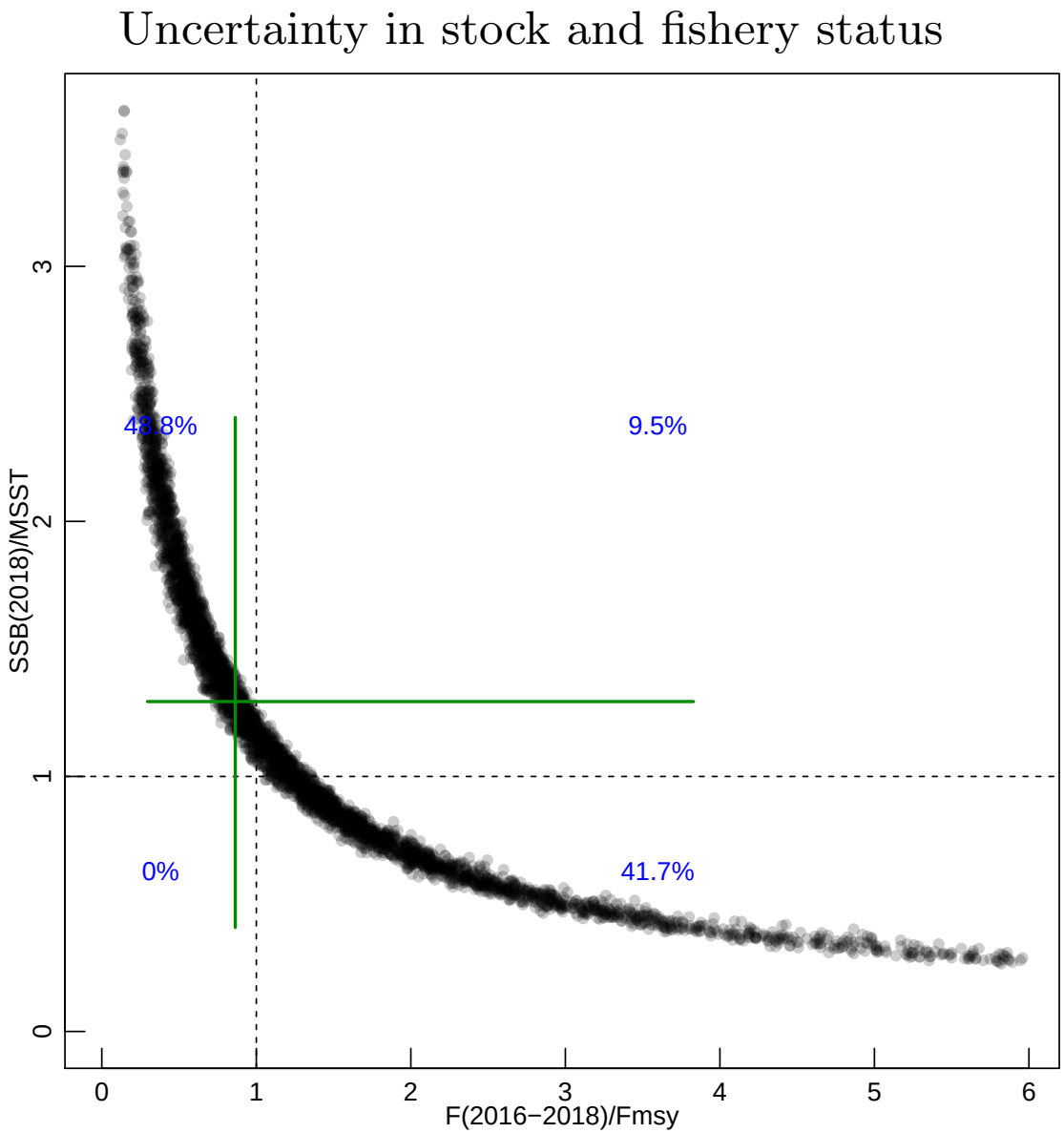


F/F_{msy}

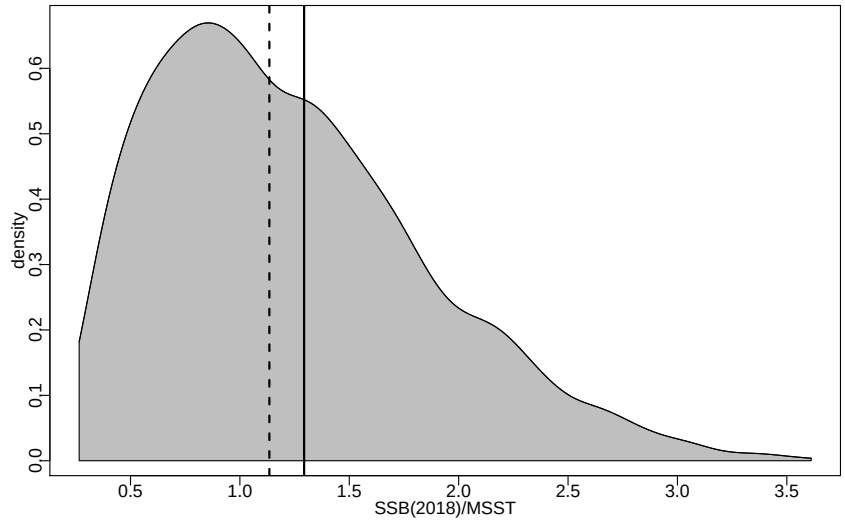


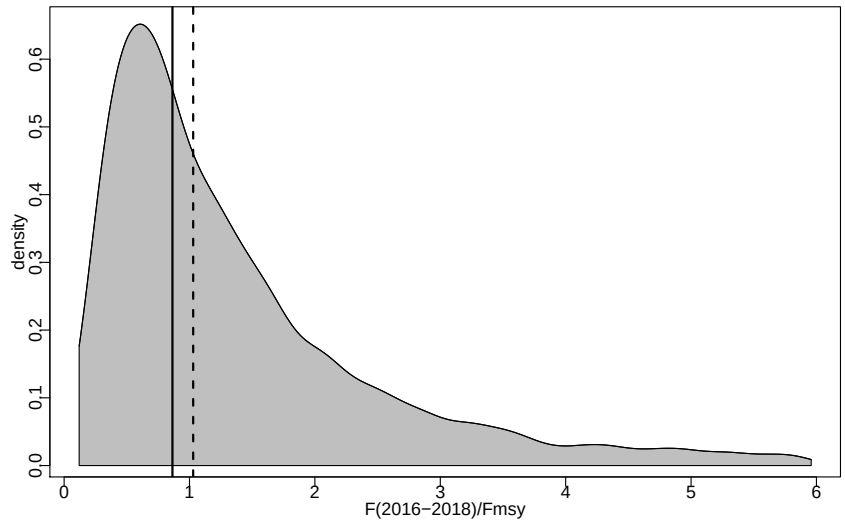
Monte Carlo Bootstrap Ensemble (MCBE)

Results



Uncertainty in stock and fishery status



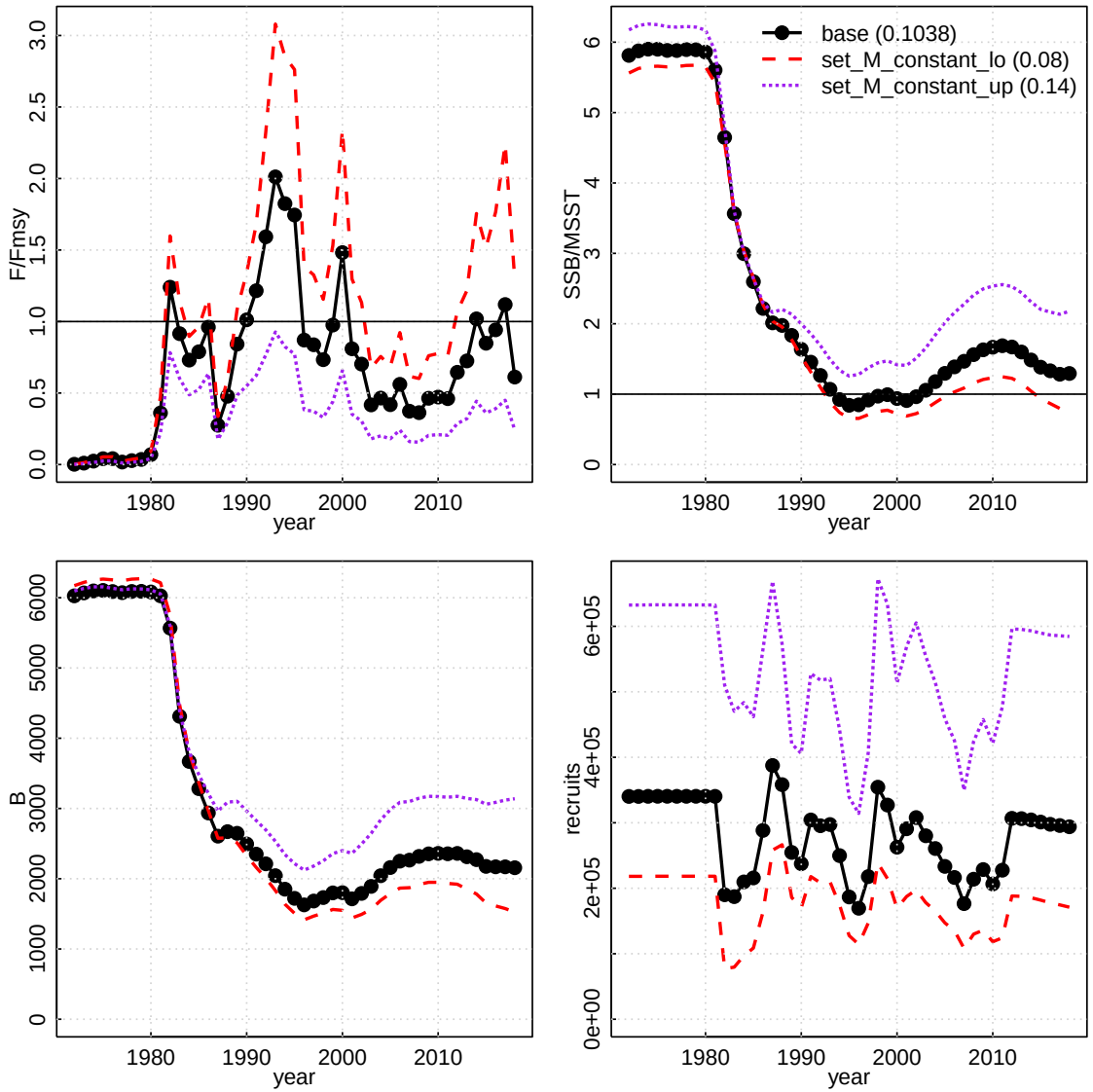


- S1-S2: Low/high values of natural mortality ($M = 0.08, 0.14$)
- S3-S4: Low/high values of steepness ($h = 0.74, 0.94$)
- S5-S6: Higher values of initial F ($F_{init} = 0.053, 0.106$). Values associated with minimum of likelihood profile (lkmin) and half that value (0.5lkmin).
- S7-S8: Down/upweight 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

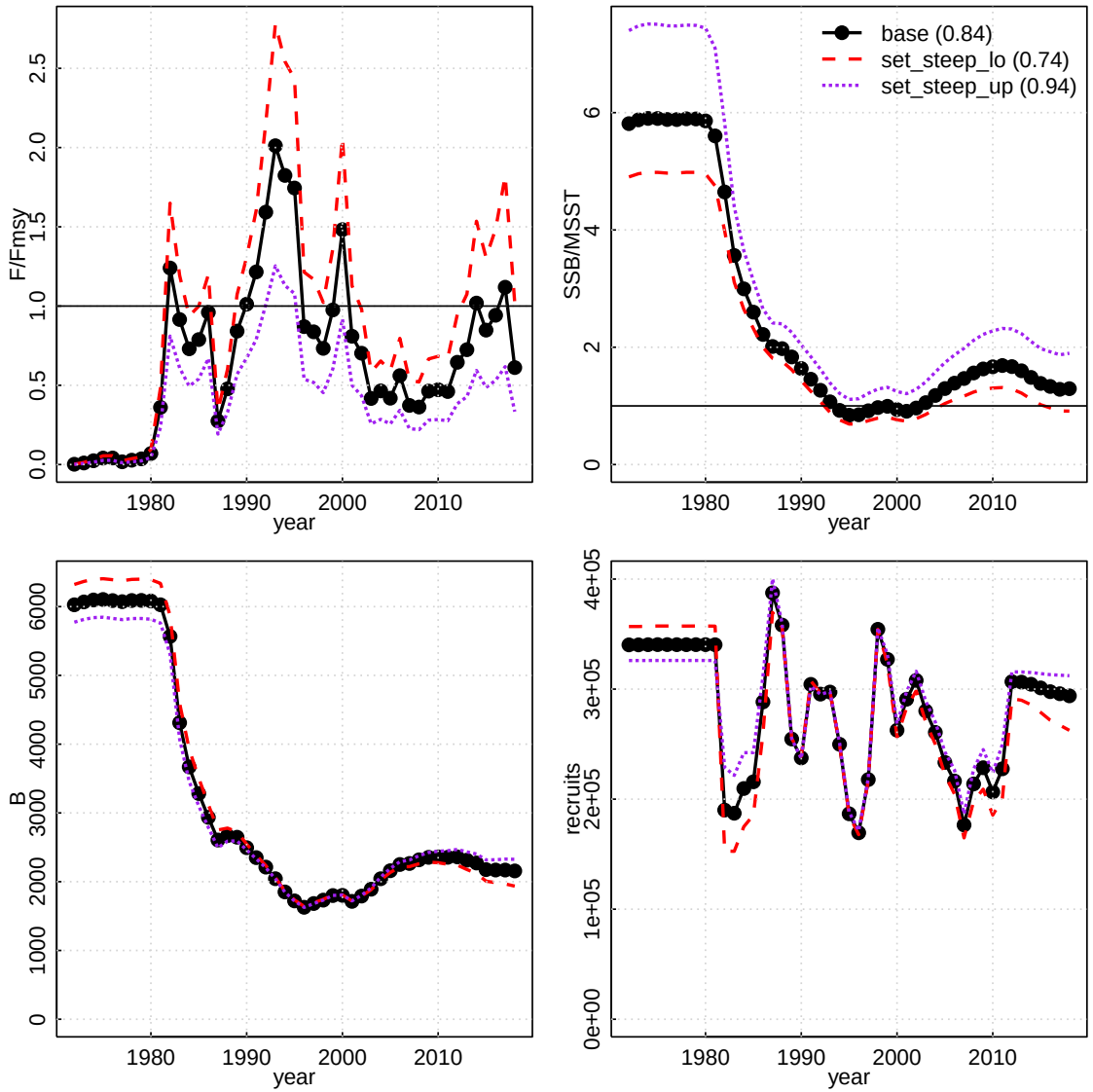
S1-S2: Low/high values of natural mortality ($M = 0.08, 0.14$)



Sensitivity analysis

Results

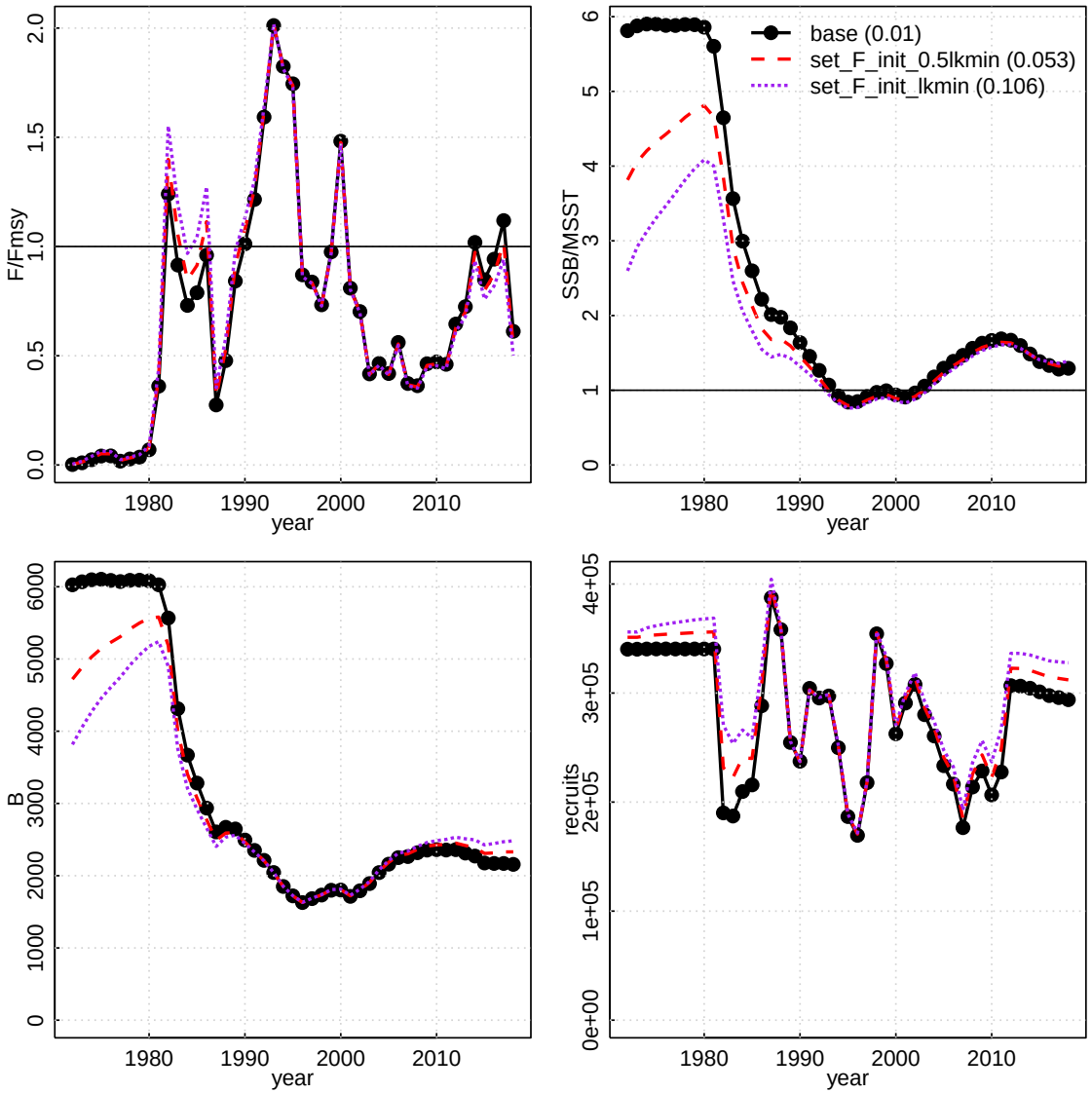
S3-S4: Low/high values of steepness ($h = 0.74, 0.94$)



Sensitivity analysis

Results

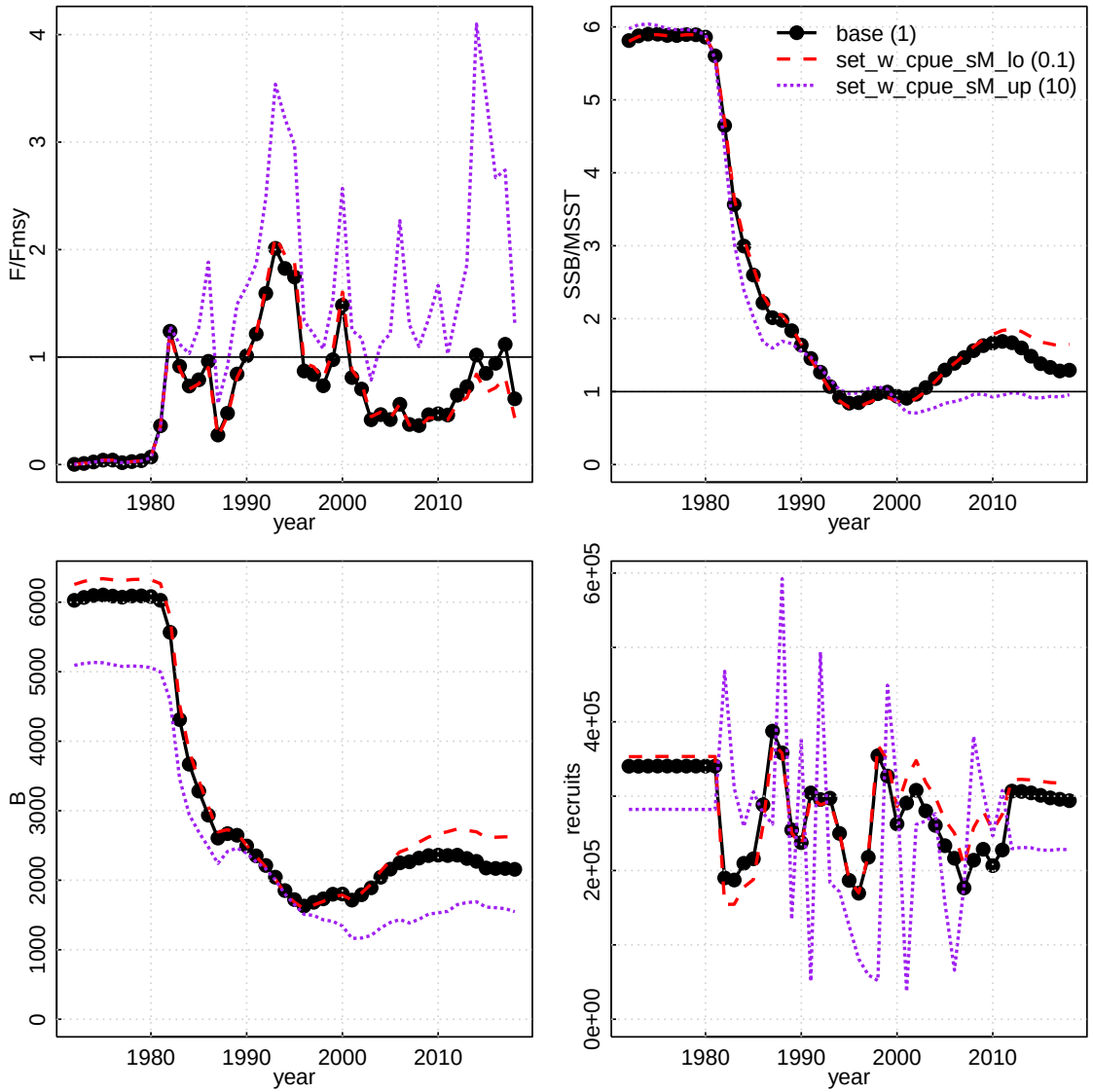
S5-S6: Higher values of initial F ($F_{init} = 0.053, 0.106$).



Sensitivity analysis

Results

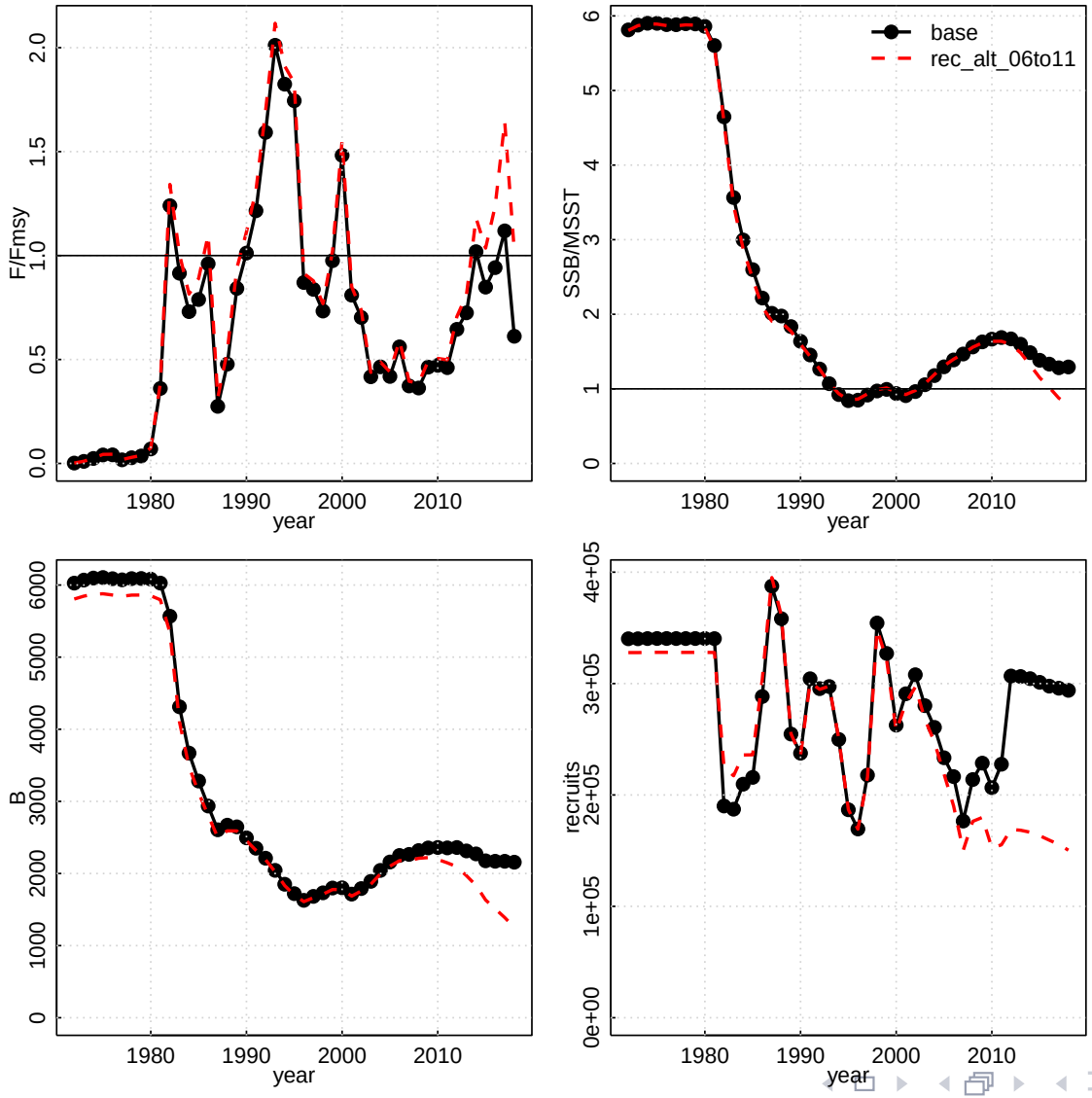
S7-S8: Down/upweight MARMAP longline index: 1/10×, 10×



Sensitivity analysis

Results

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



Retrospective analysis

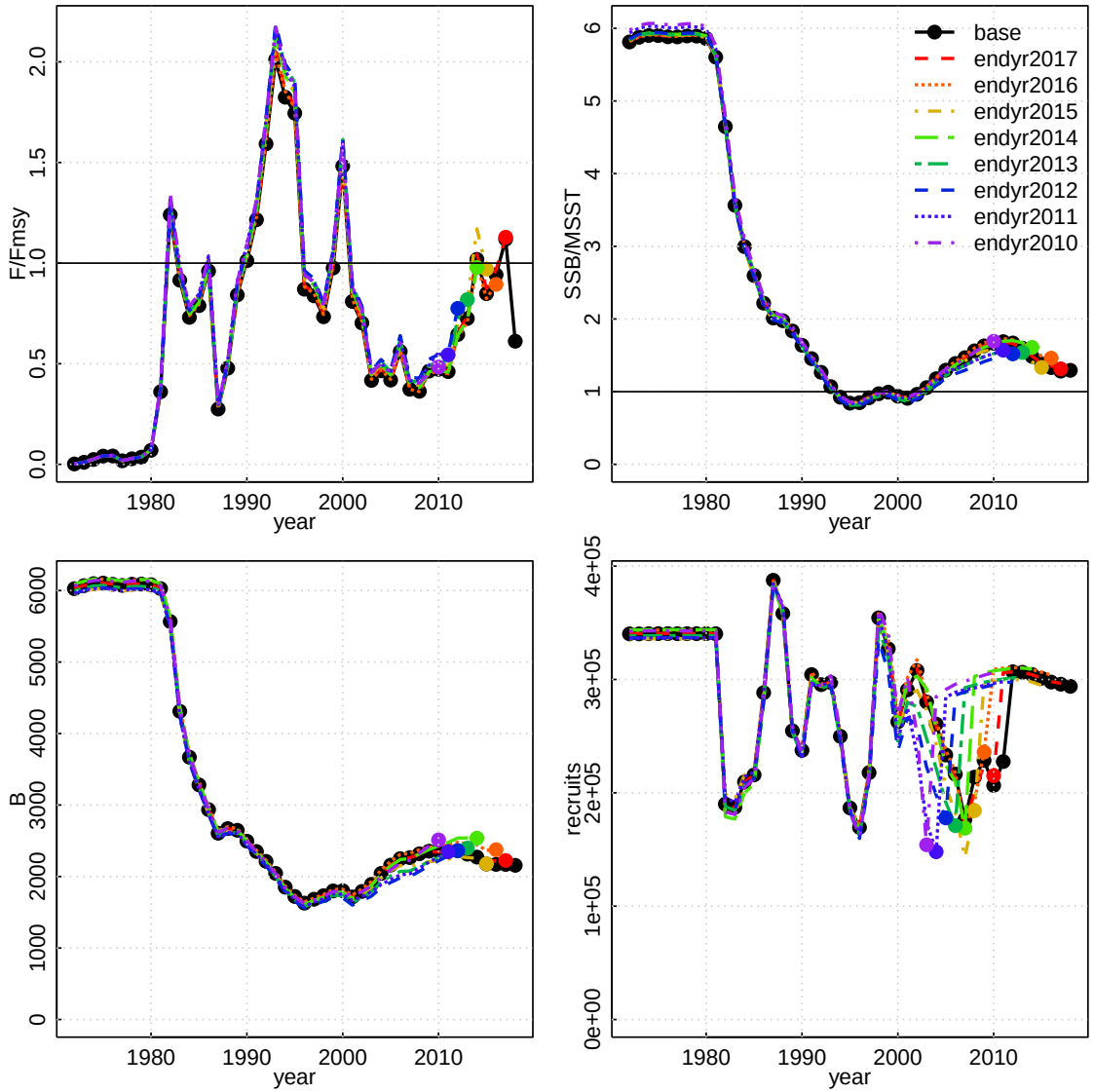
Methods

- 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 for F/F_{MSY}, SSB/MSST, and B, and in the last year recruitment deviations were estimated for the *recruits* series.

Retrospective analysis

Results

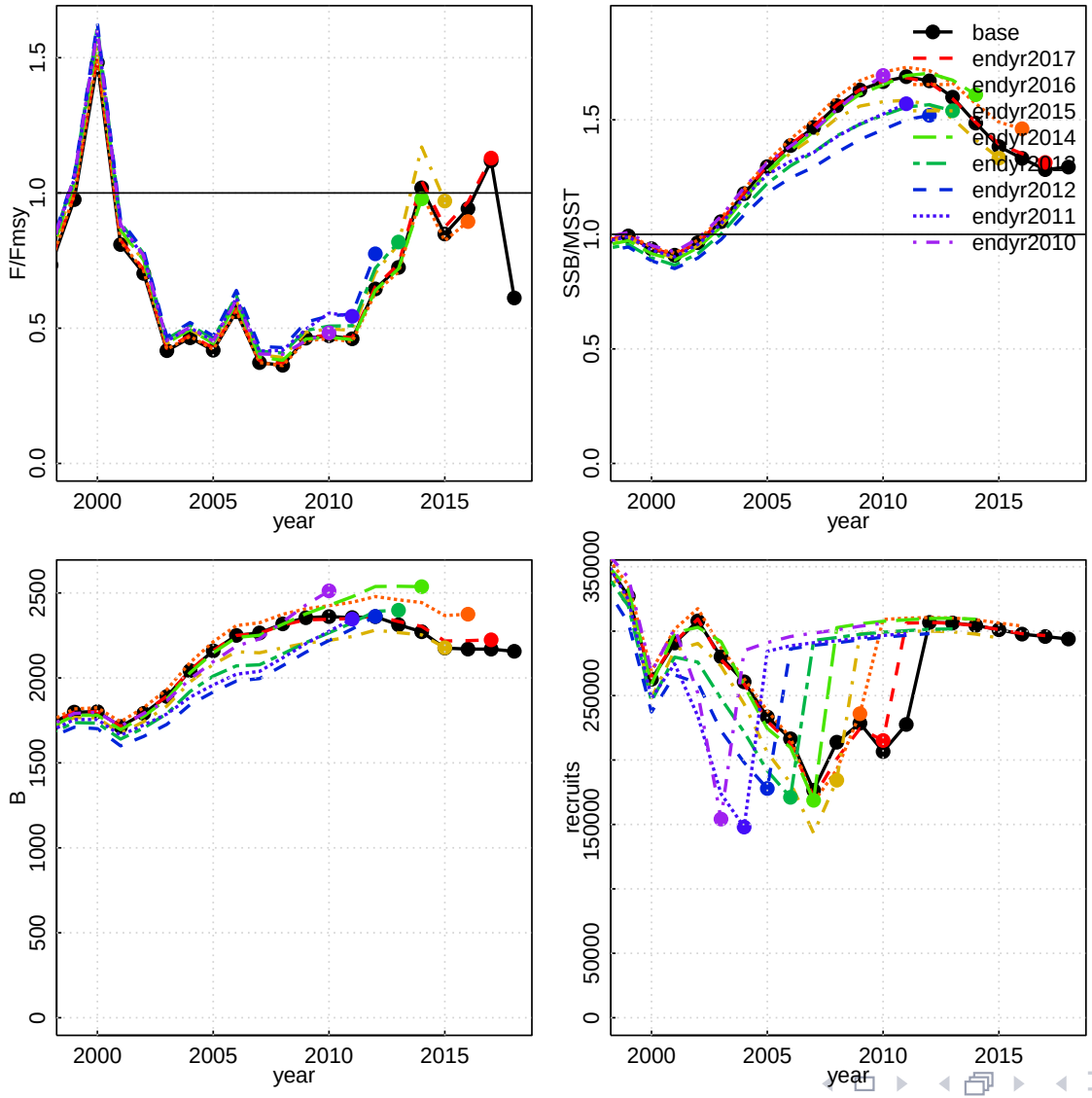
Terminal years of retrospective runs: 2010 – 2017



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

Projections

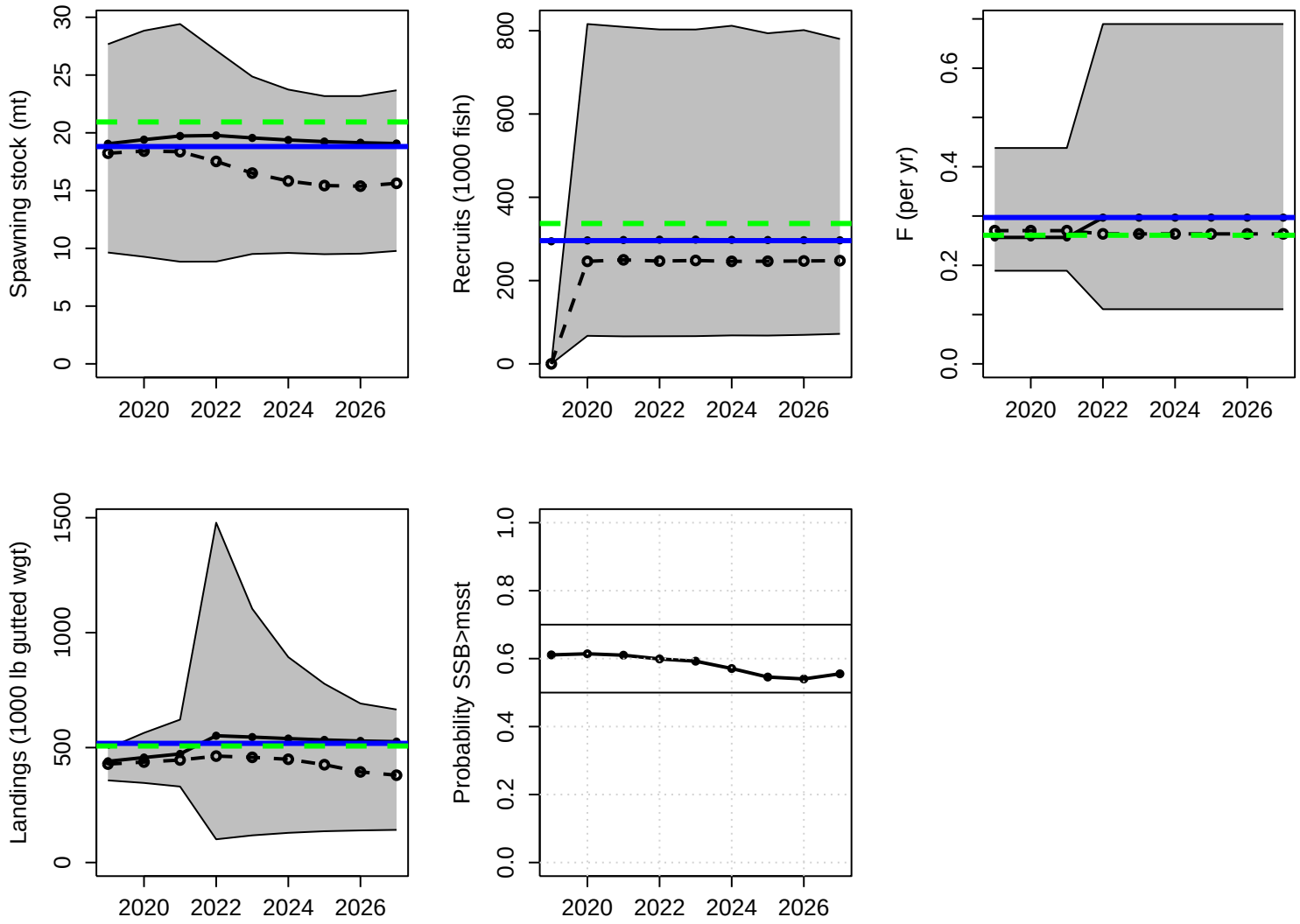
Results

- 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

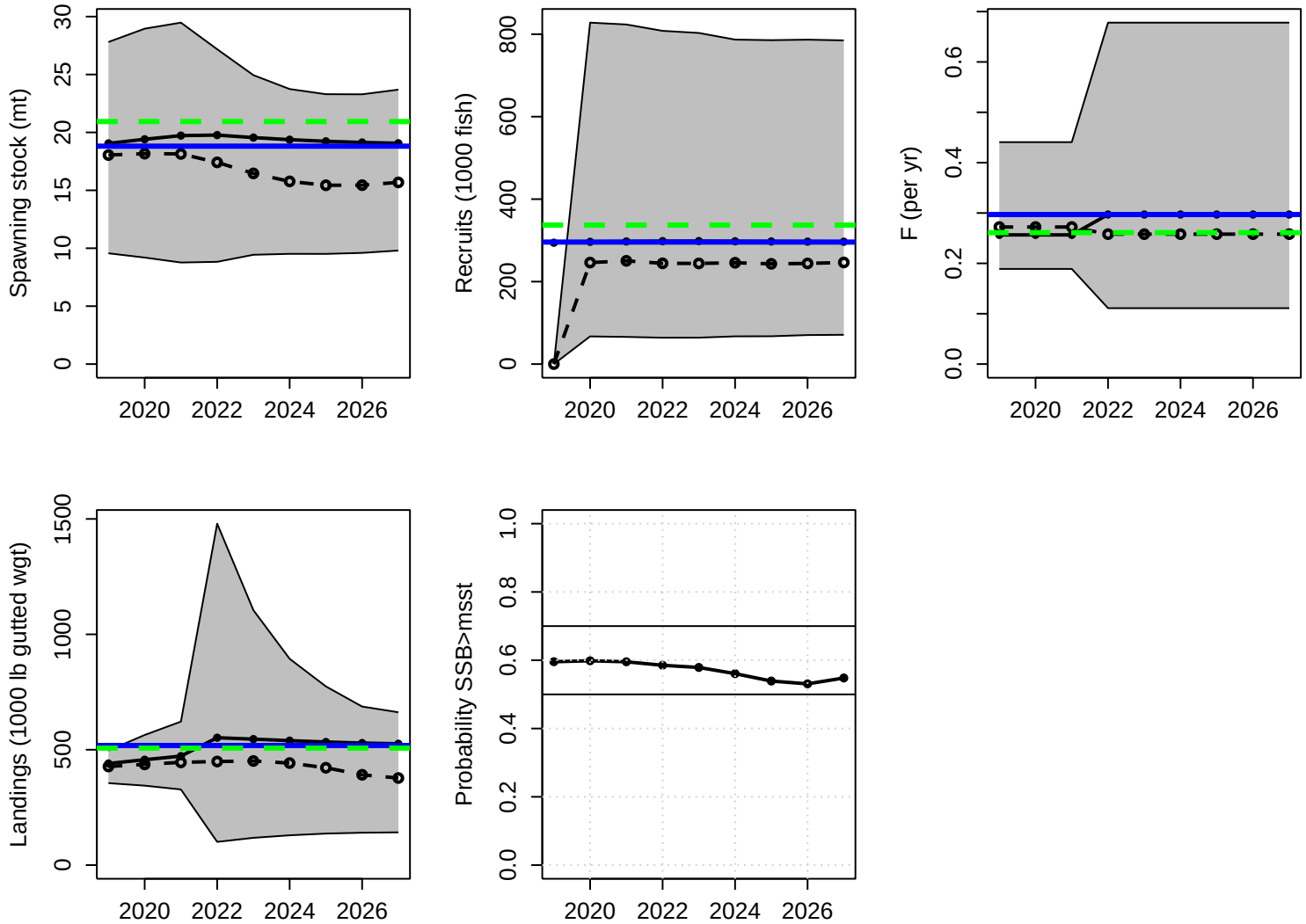
Scenario 1: $F = F_{\mathrm{P}^*_{50\%}}$ from 2022 to 2027



Projections

Results

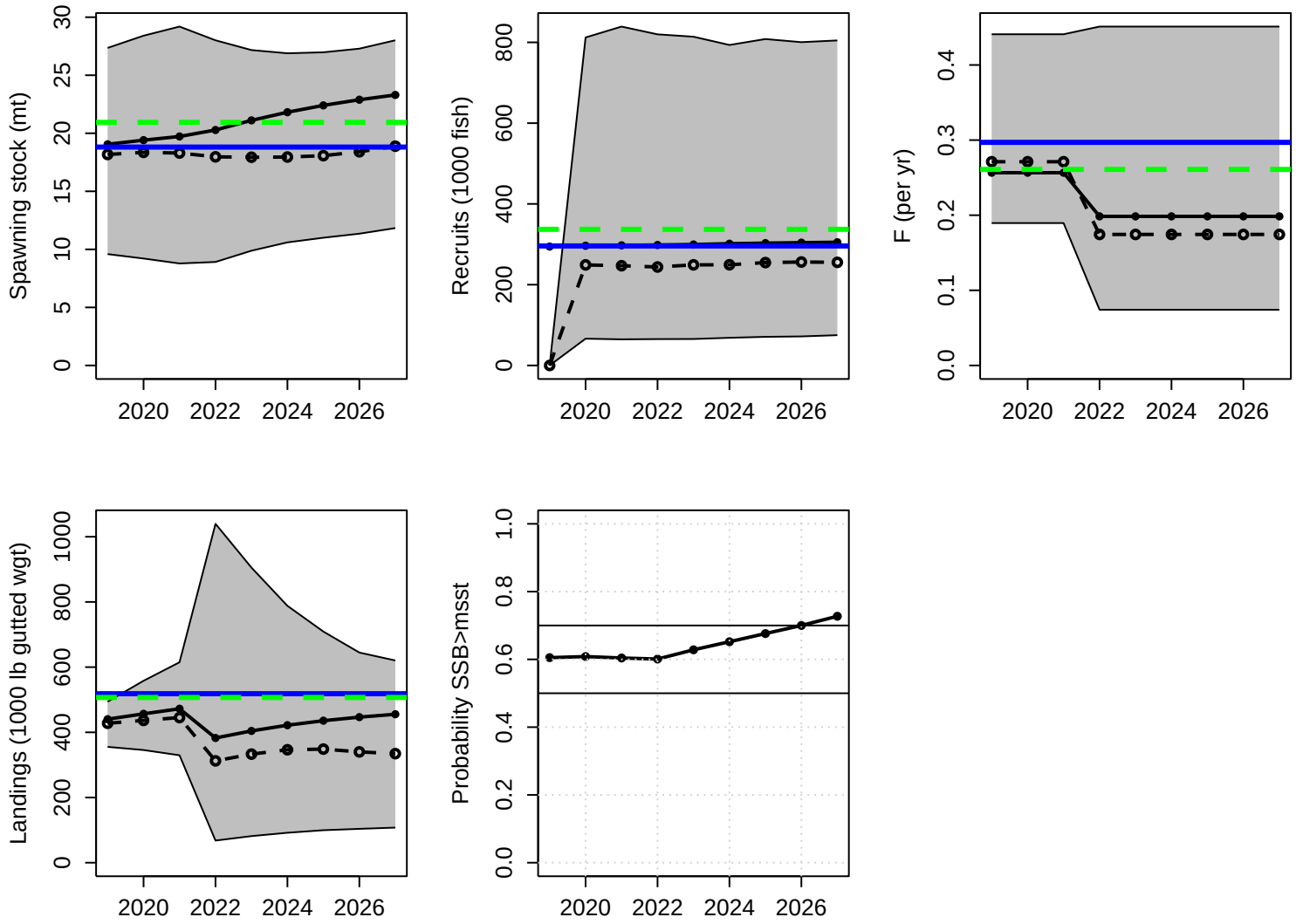
Scenario 2: $F = F_{\text{MSY}}$ from 2022 to 2027



Projections

Results

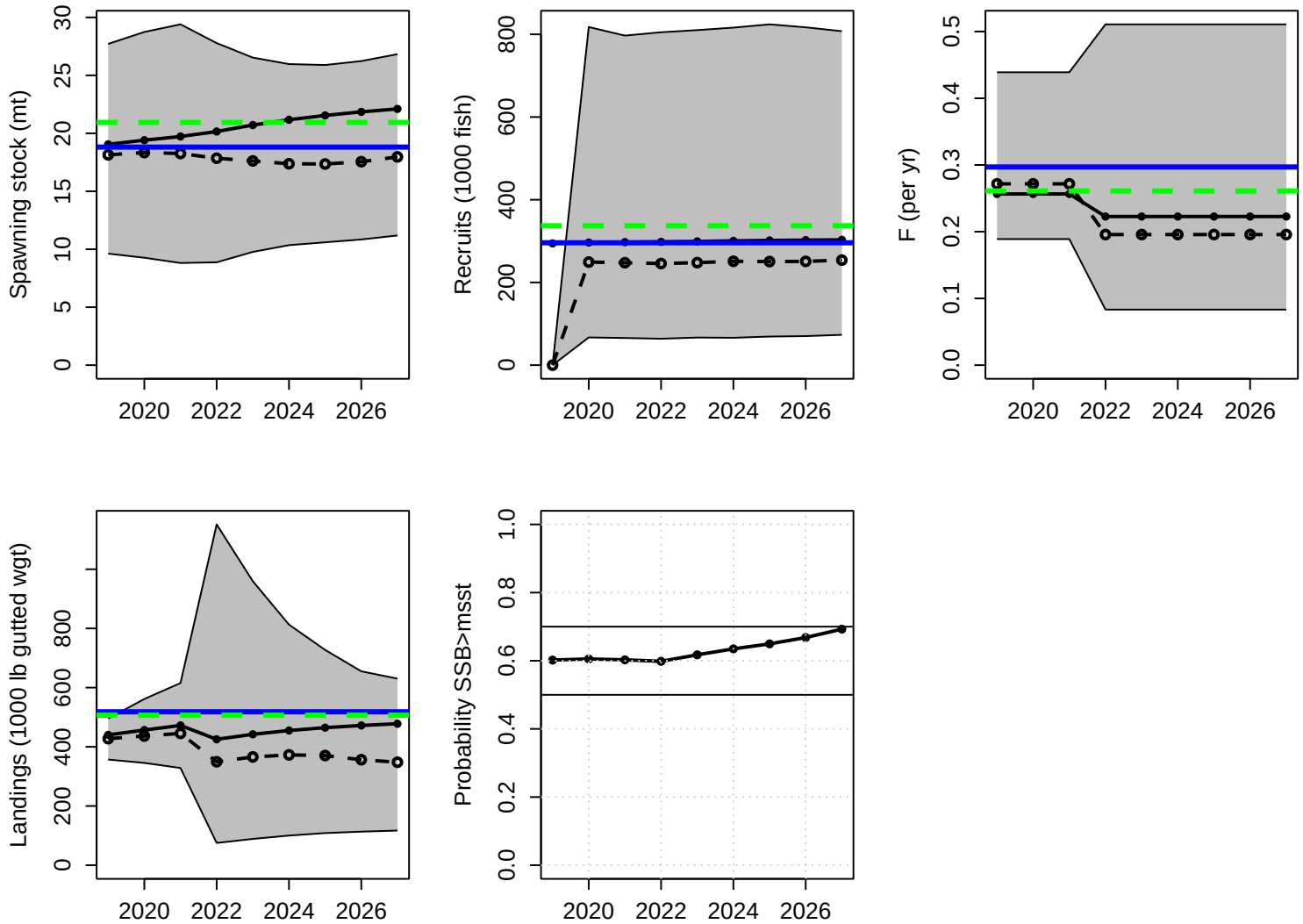
Scenario 3: $F = F_{\mathrm{P}^*_{30\%}}$ from 2022 to 2027



Projections

Results

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



Projections

Results

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

SEDAR 66 Report Table 20

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

SEDAR 66 Report Table 21

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	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

SEDAR 66 Report Table 22

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

SEDAR 66 Report Table 23

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

Conclusions

- The SEDAR 66 assessment indicates that South Atlantic Tilefish stock is not overfished and is not experiencing overfishing.
- The probability that $SSB > MSST$ exceeds 50% in all years of all projections
- However MCB analysis suggests substantial uncertainty in stock and fishing status
- Recruitment is low toward the end of the assessment which could be problematic for the stock if the trend continues. In addition, age composition data for young fish is limited, so recruitment deviations cannot be estimated near the terminal year of the assessment
- A notable challenge for the next assessment is the limited abundance index information beyond 2006