Blueline Tilefish: South of Cape Hatteras Age-aggregated Production Model (ASPIC)

Nikolai Klibansky

National Oceanic and Atmospheric Administration

August 29, 2017

Table of contents

Methods

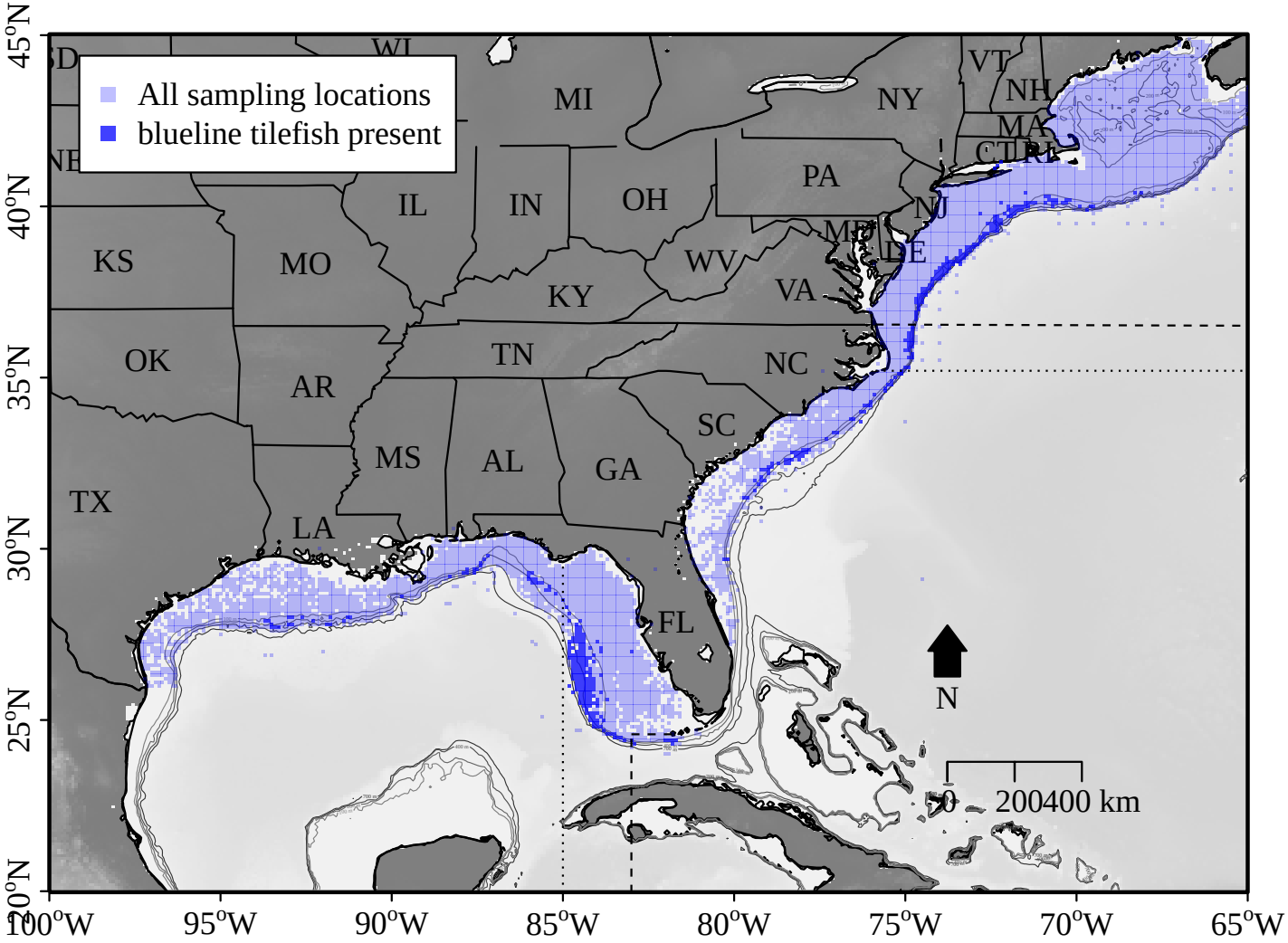
- Models run with ASPIC Suite Version 7
- Age-aggregated annual biomass, no age-structure
- Assumes recruitment + growth - nat. mortality = 'surplus' production
- Graham-Schaefer logistic formulation (continuous time): $\frac{d\mathrm{B}_t}{dt} = r\mathrm{B}_t - \frac{r}{K}\mathrm{B}_t^2 - F_t\mathrm{B}_t$
- Assumes surplus production symmetric about $B_{\mathrm{MSY}} = 0.5K$ (shape parameter=0.5)
- Conditioned on yield
- Fit to CPUE indices of abundance (ASPIC, Prager 1994)
- Model estimates B_1/K, F_{MSY}, MSY, and q_i parameters

Methods

- Inputs
  - Single series of removals
  - Abundance indices and annual CVs
  - Item values of B_1/K, F_{MSY}, MSY, and q_i parameters
  - Range limits or prior distributions on parameters
  - Settings (e.g. fitting method, rules, tolerance)
- Outputs
  - Single estimated biomass series
  - Estimates of B_1/K, F_{MSY}, MSY, and q_i parameters
  - Estimated CPUE series (scaling B by q_i)
  - Status series (F/F_{MSY}, B/B_{MSY})

Methods

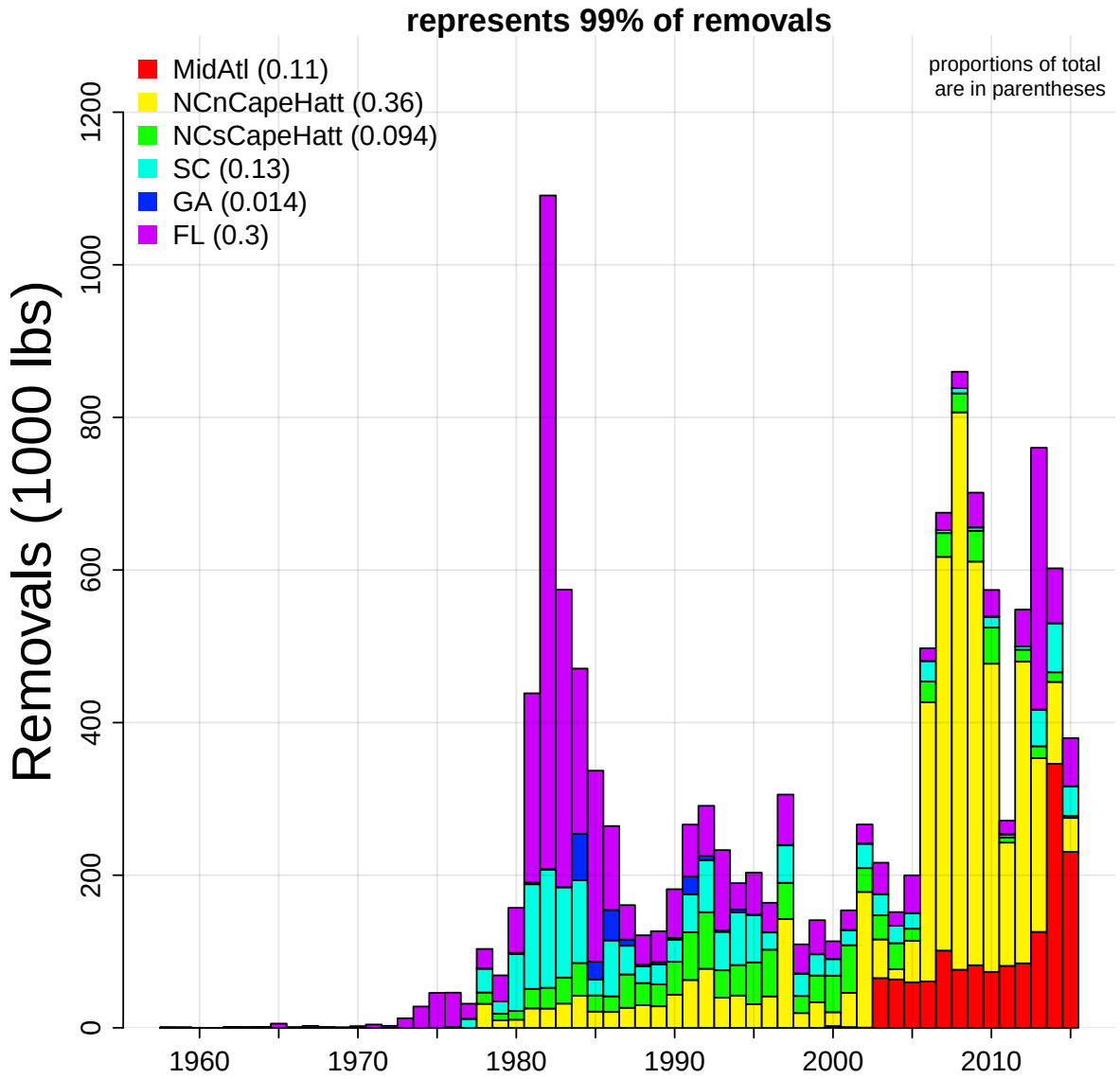
Data series restricted to area between GMFMC/SAFMC boundary at Key West north in the Atlantic to Cape Hatteras



Methods

All Atlantic removals by aggregated area

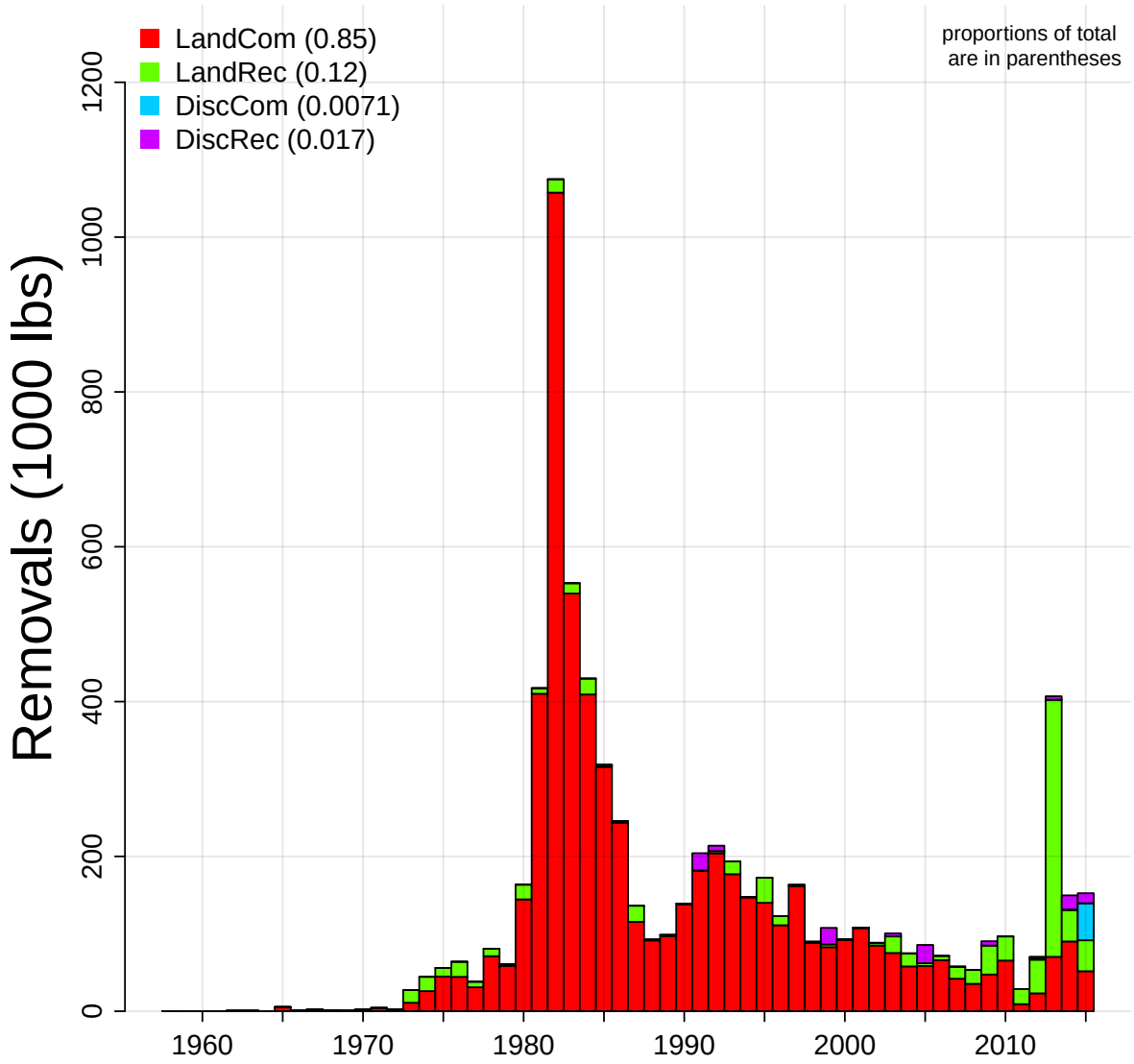
- Landings included in models south of Cape Hatteras included:
  - NCsCapeHatt
  - SC
  - GA
  - FL (east)



Methods

Removals south of Cape Hatteras, by fleet

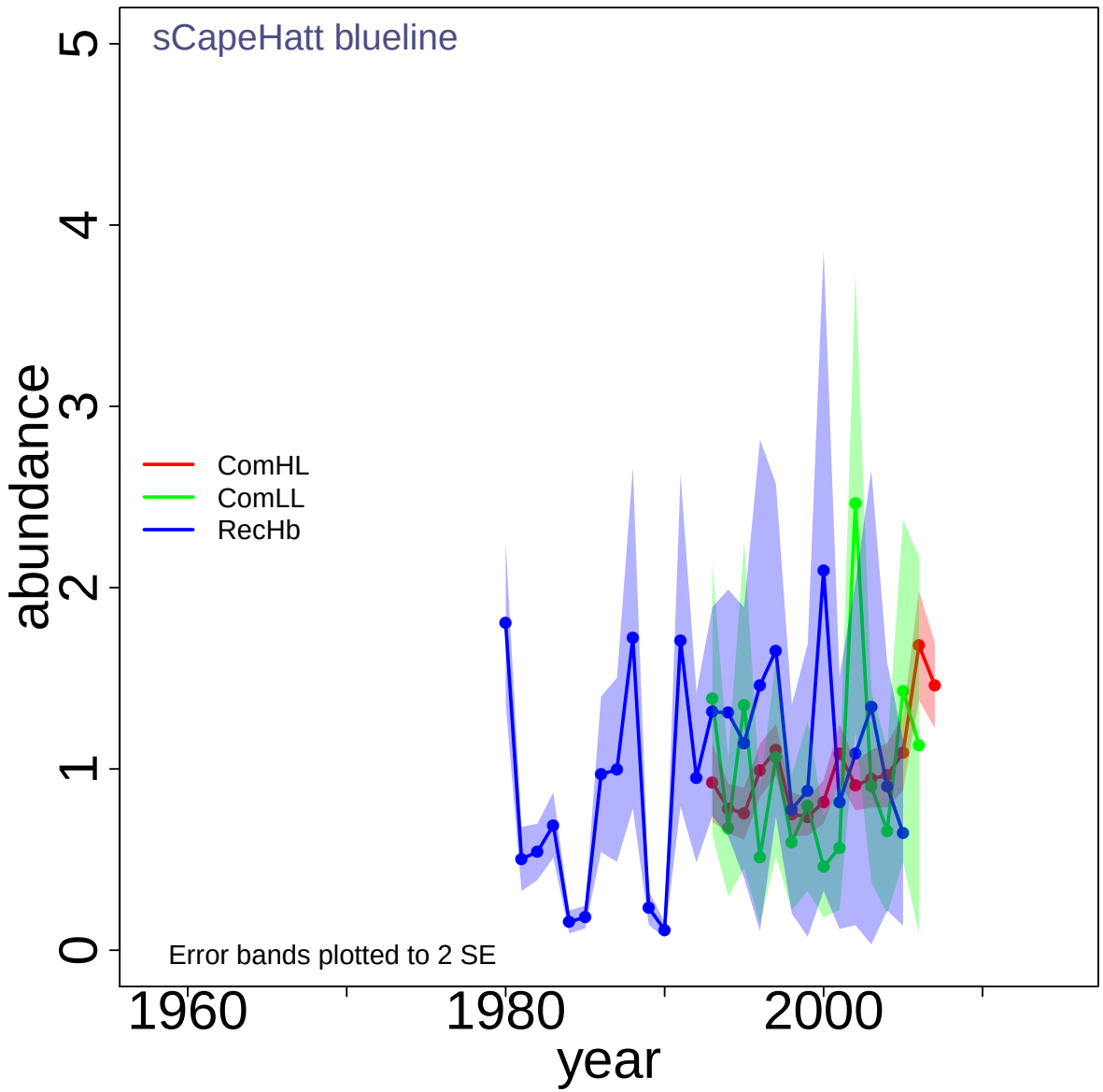
- Commercial landings
- Recreational landings
- Commercial dead discards
- Recreational dead discards



Methods

Indices of abundance

- Commercial handline (ComHL)
- Commercial longline (ComLL)
- Recreational headboat (RecHb)



Methods

- Ran models with all combinations of indices
- Ran models with combined (i.e. averaging; Conn, 2010) versions of indices
- Headboat index excluded from base models
  - Fishery only covers margins of Blueline Tilefish distribution
  - Concern that wide swings in CPUE may be more representative of fleet behavior rather than true abundance
  - Negatively correlated with commercial indices
- Handline and longline indices considered equal quality
- Assessment Panel chose to average the results of the handline and longline models
- Combining indices or running both in one model weights indices based on CVs, placing undue weight on the handline index
- Runs with other combinations of indices were considered as sensitivity runs

Methods

- Models run from 1958-2015
- Removals 1958-2015
  - Commercial handline (1993-2007)
  - Commercial longline (1993-2008)
  - Recreational headboat (1993-2006)
- Status determination
  - F status: $F_{2013-2015}/F_{\text{MSY}}$
  - Overfishing if $F_{2013-2015}/F_{\text{MSY}} > 1$
  - Minimum Stock Size Threshold = MSST = $0.75B_{\text{MSY}}$
  - B status: B_{2015}/MSST
  - Overfished if $B_{2015}/\text{MSST} < 1$

Methods

- Additional sensitivity runs were configured to match ASPIC models from SEDAR 32, and/or included removals north of Cape Hatteras
- ASPIC bootstrap procedures were run to estimate uncertainty in the models
- Results of bootstrapping were combined (i.e. merged) to characterize the uncertainty in the average of the handline and longline models

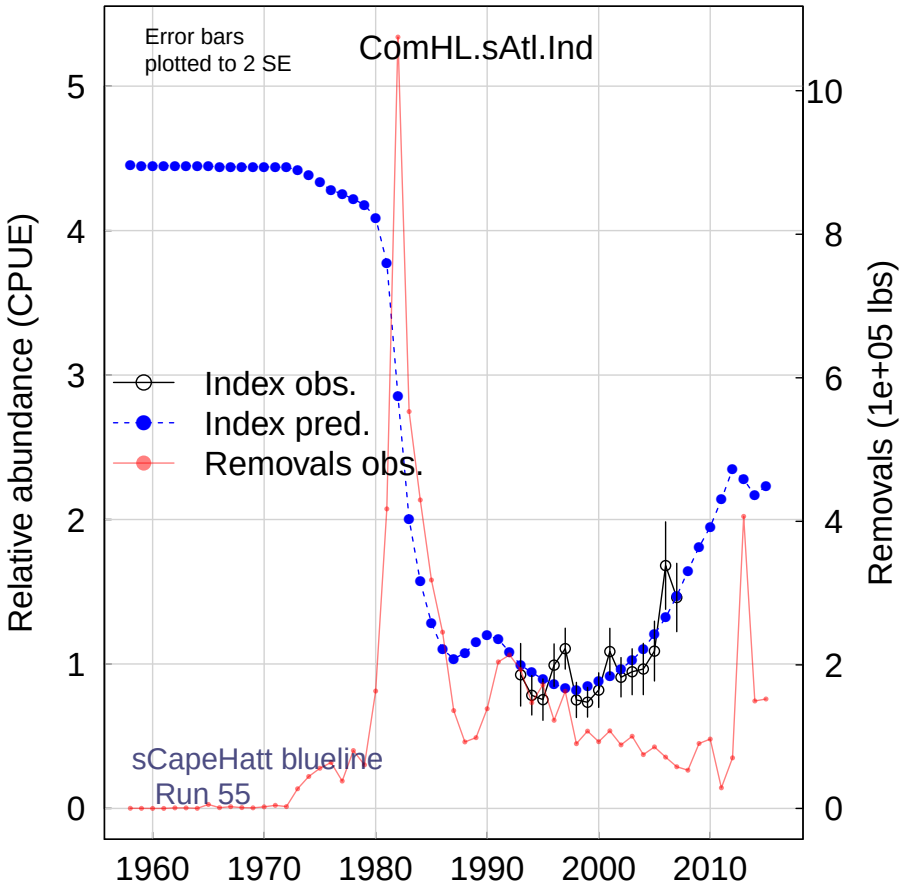
Methods

Projections

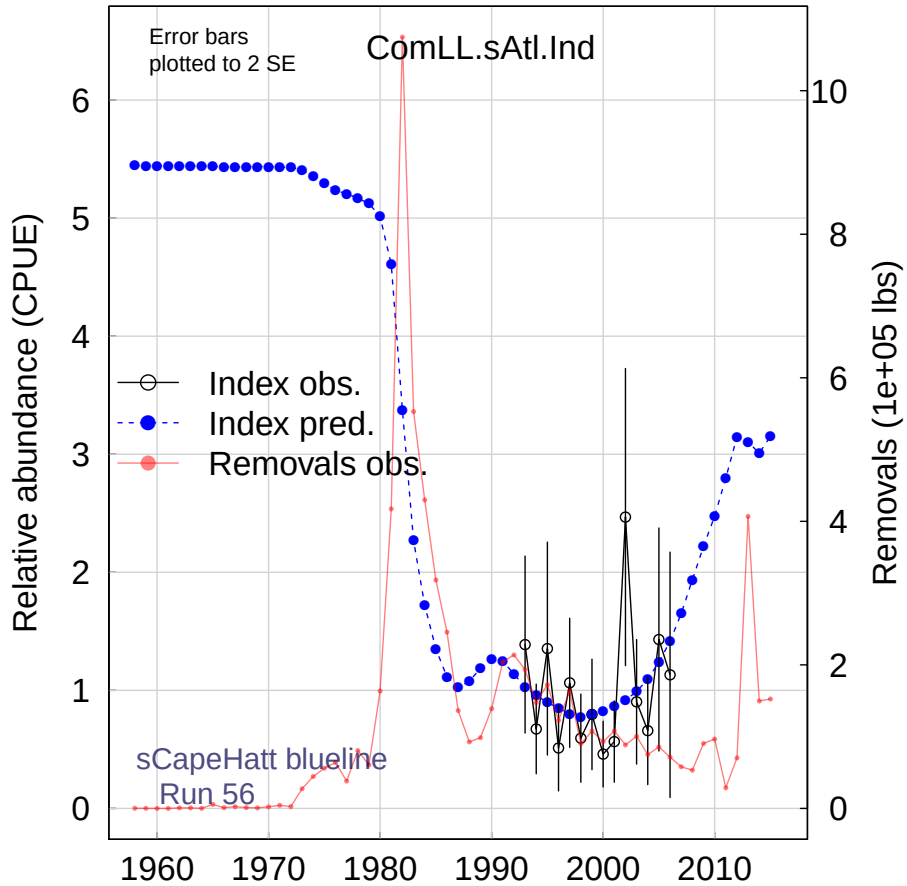
- Five year projections at:
  - $F = F_{\text{MSY}}$
  - $F = F_{\text{current}}$
  - $F = F_{\text{target}} = 0.75 F_{\text{MSY}}$
- $F_{2016} = F_{\text{current}}$
- Projections were made from the combined bootstrap results from the handline and longline models
- Uncertainty in projections based on bootstrap runs

Results

Fit to handline model (Run 55)

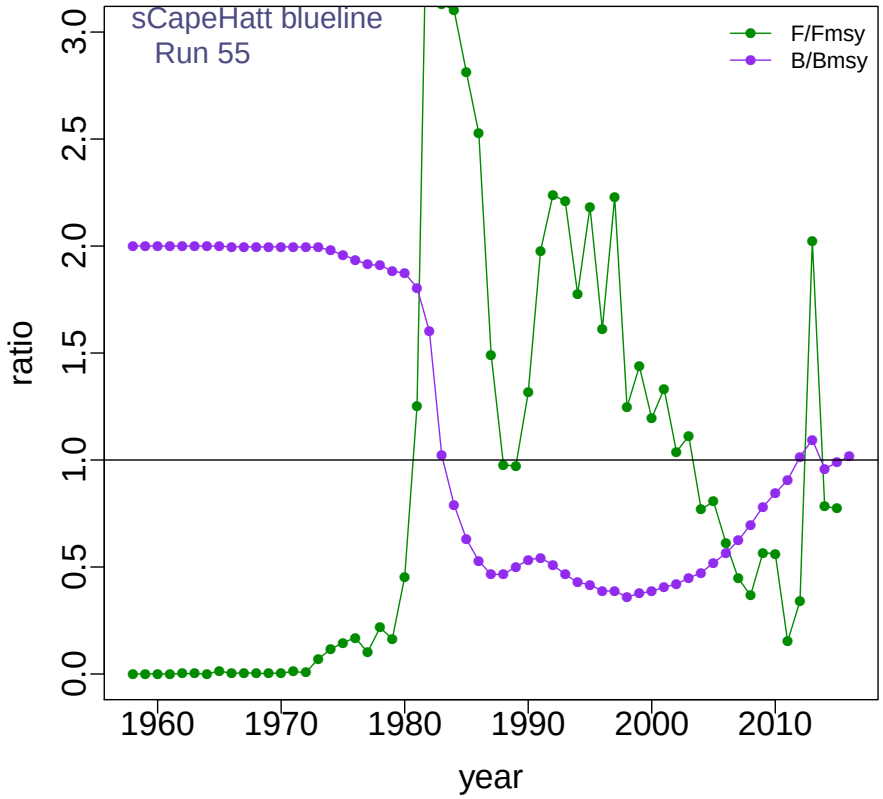


Fit to longline model (Run 56)

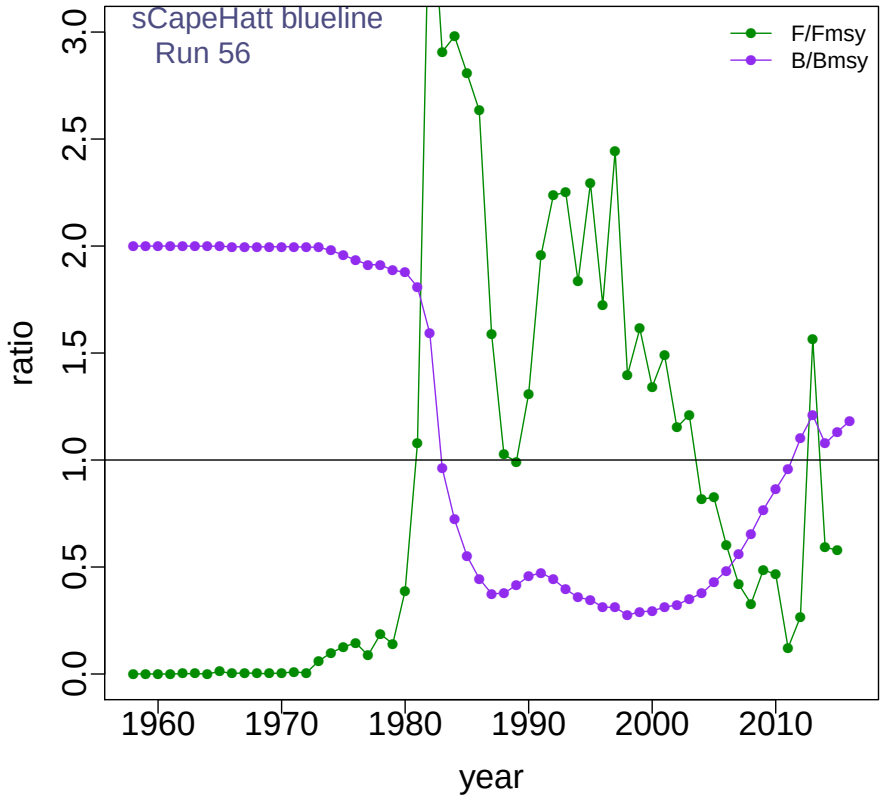


Results

Status trends for handline model (Run 55)

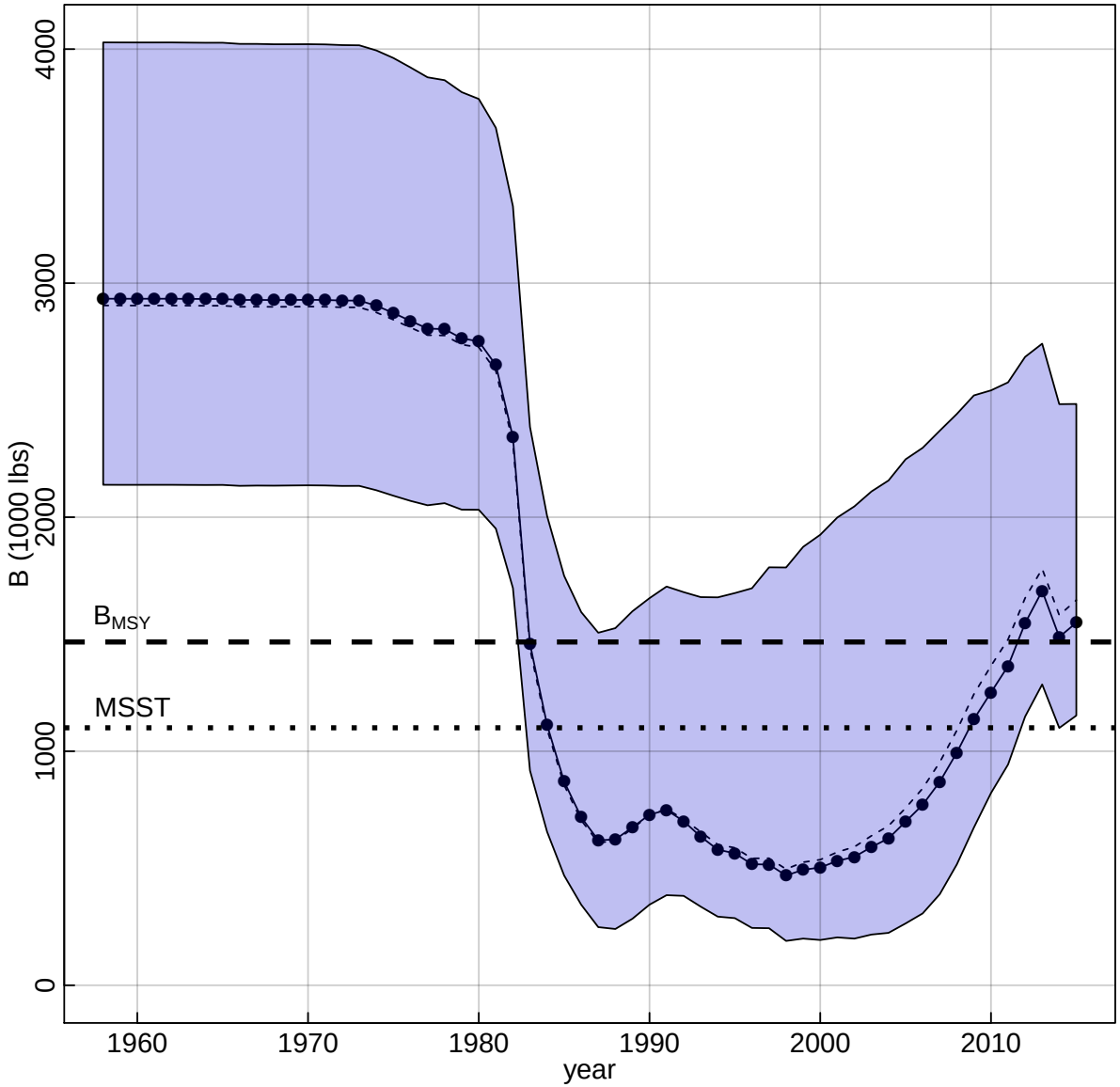


Status trends for longline model (Run 56)



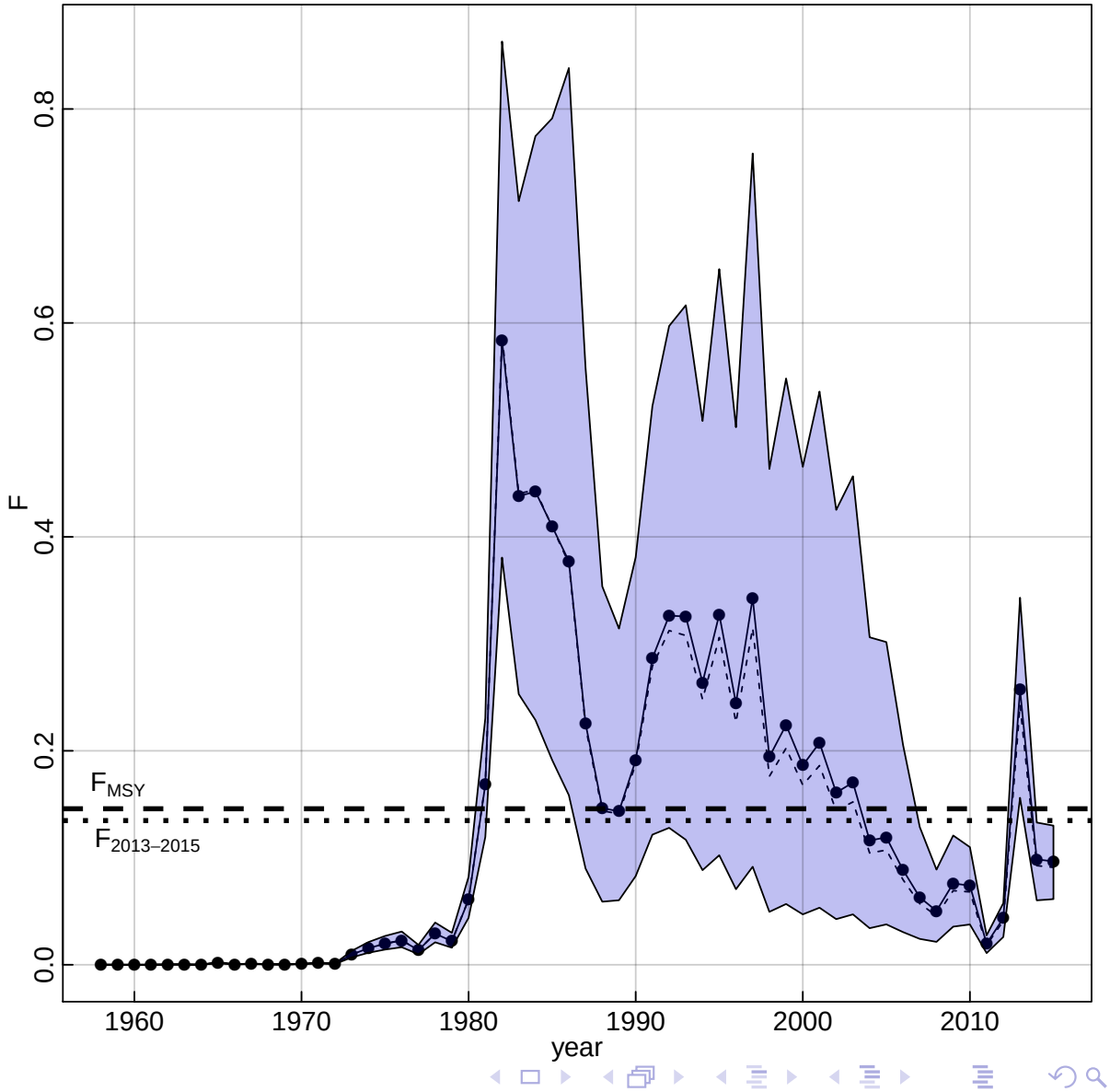
Results

Estimated biomass series (B) combining Runs 55 and 56 from ASPIC



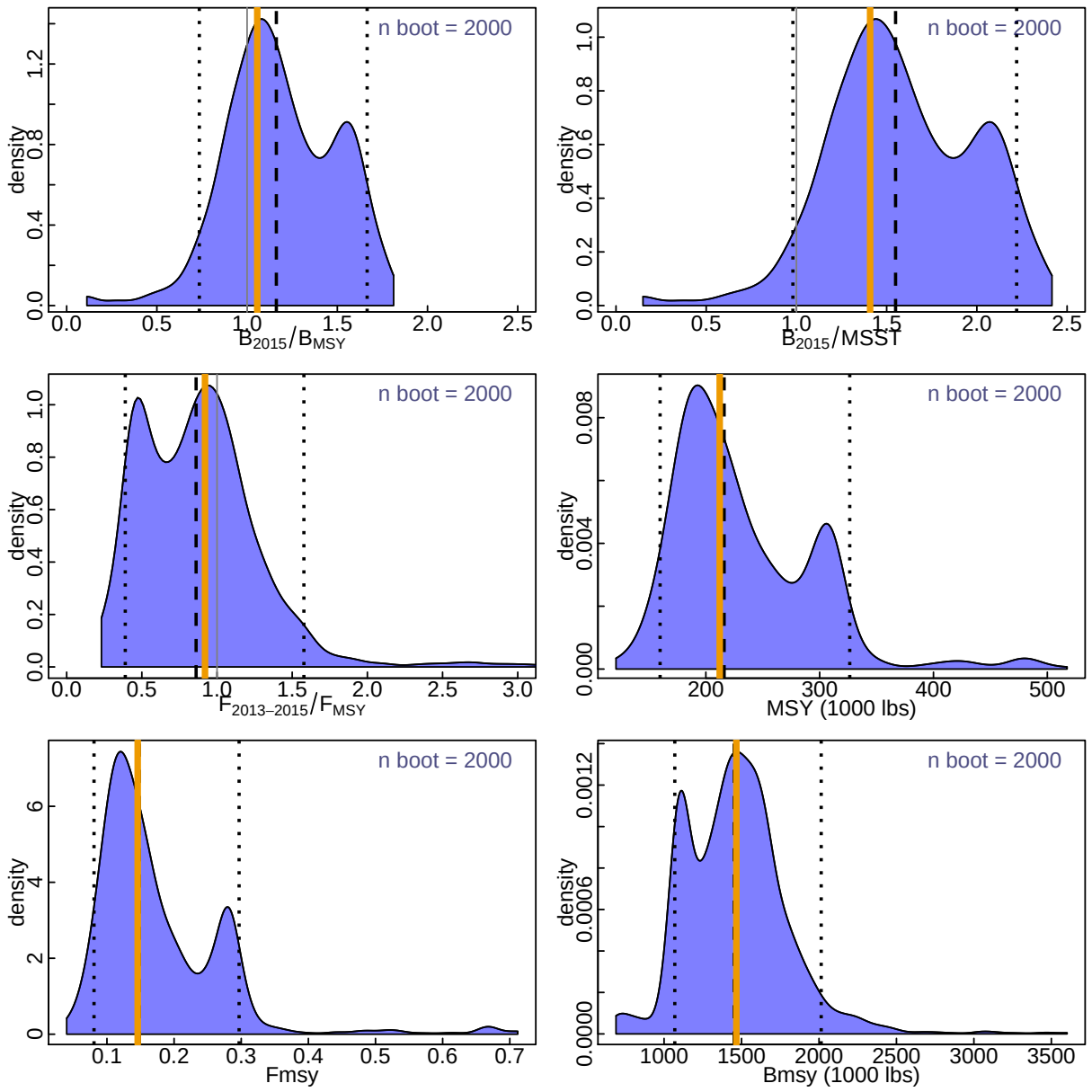
Results

Estimated fishing mortality series (F) combining Runs 55 and 56 from ASPIC



Results

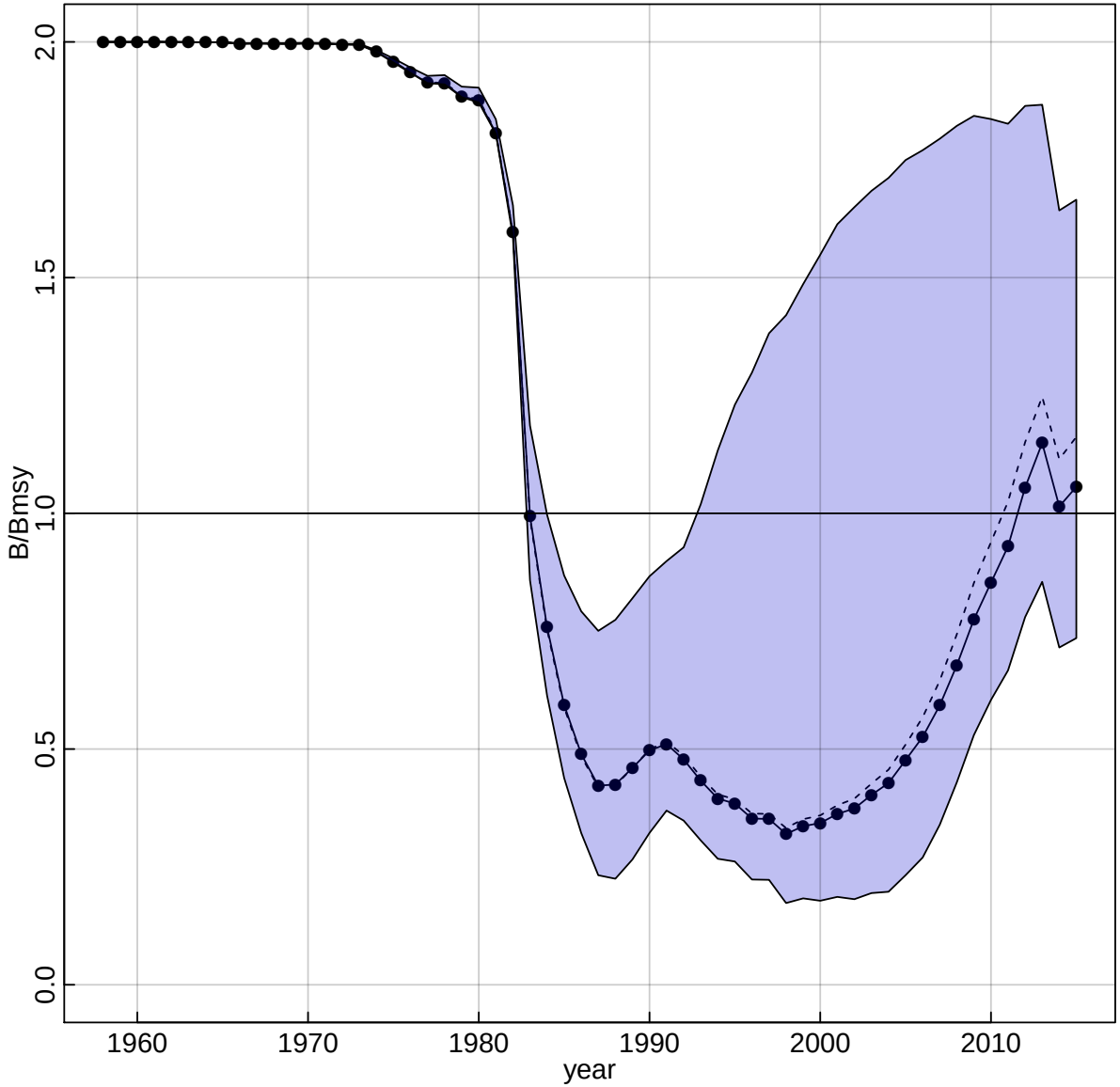
ASPIC bootstrap parameter distributions combining Runs 55 and 56



Results

Estimated biomass series (B) relative to B_{MSY} combining Runs 55 and 56 from ASPIC

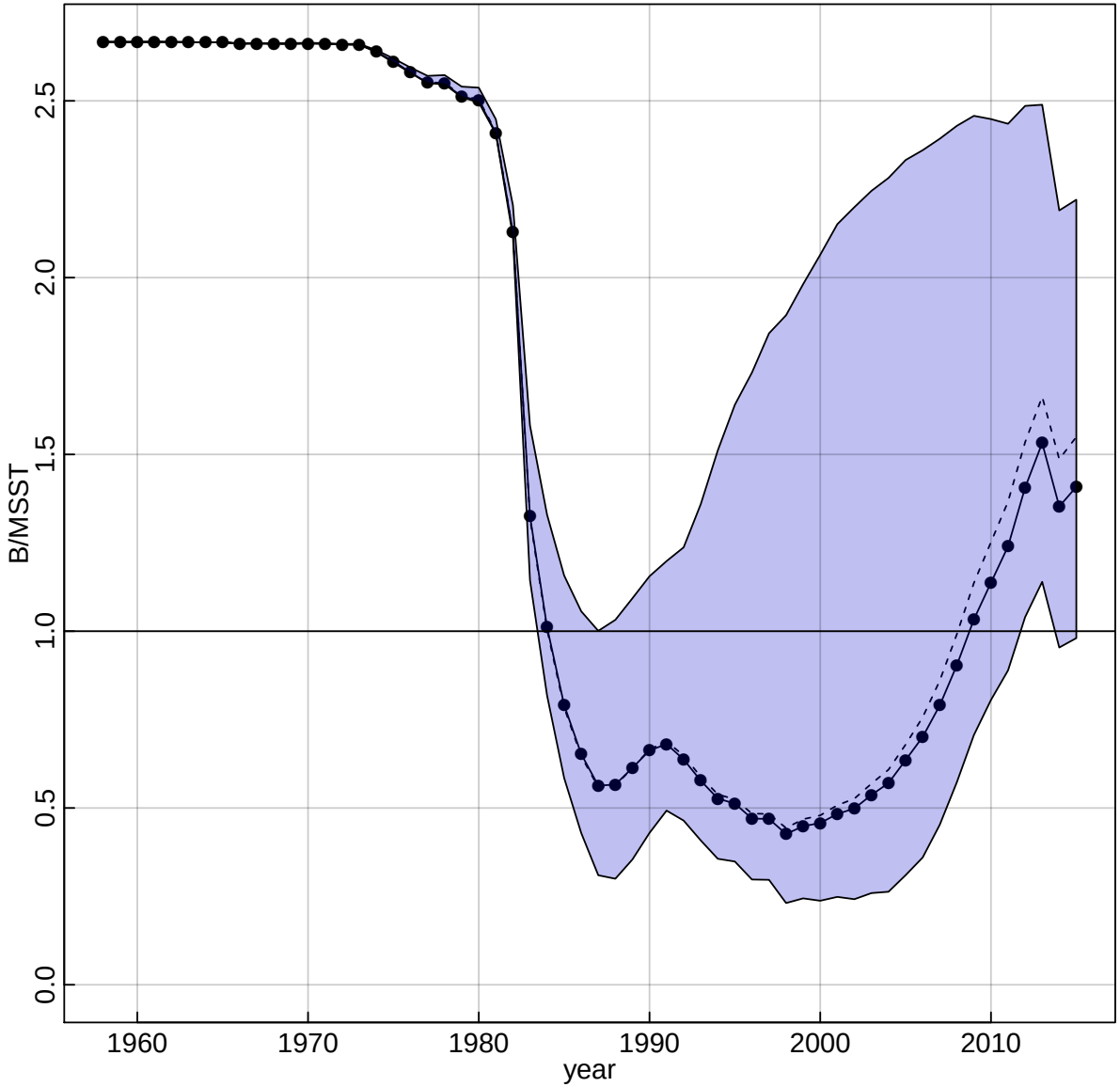
- Solid line indicates average B series relative to average B_{MSY}.
- Dashed line represents the median B/B_{MSY}
- Blue error bands indicate 5^{th} and 95^{th} percentiles of the combined bootstrap trials



Results

Estimated biomass series (B) relative to MSST combining Runs 55 and 56 from ASPIC

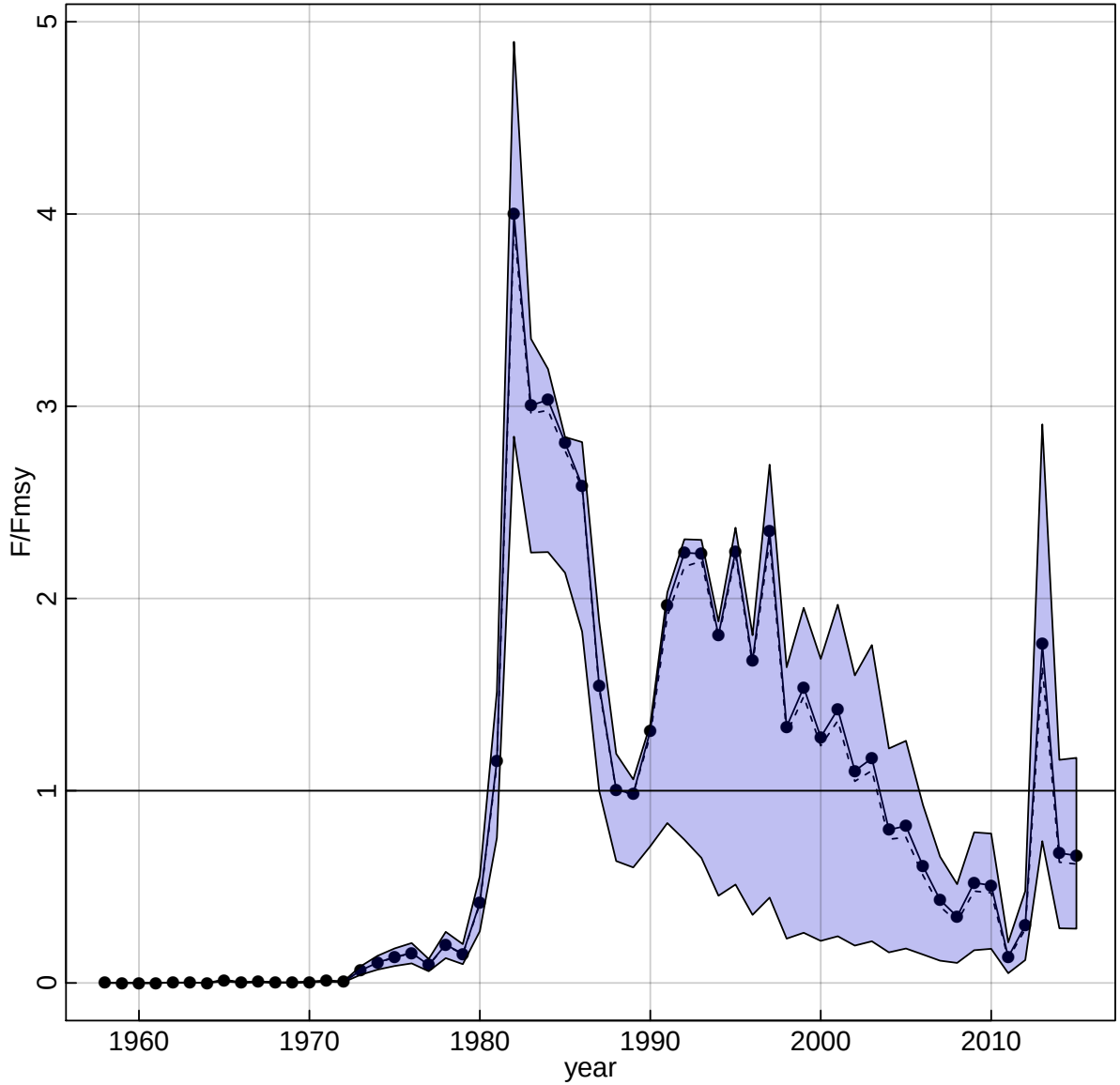
- Solid line indicates average B series relative to average MSST.
- Dashed line represents the median B/MSST
- Blue error bands indicate 5^{th} and 95^{th} percentiles of the combined bootstrap trials



Results

Estimated F series relative to F_{MSY} combining Runs 55 and 56 from ASPIC

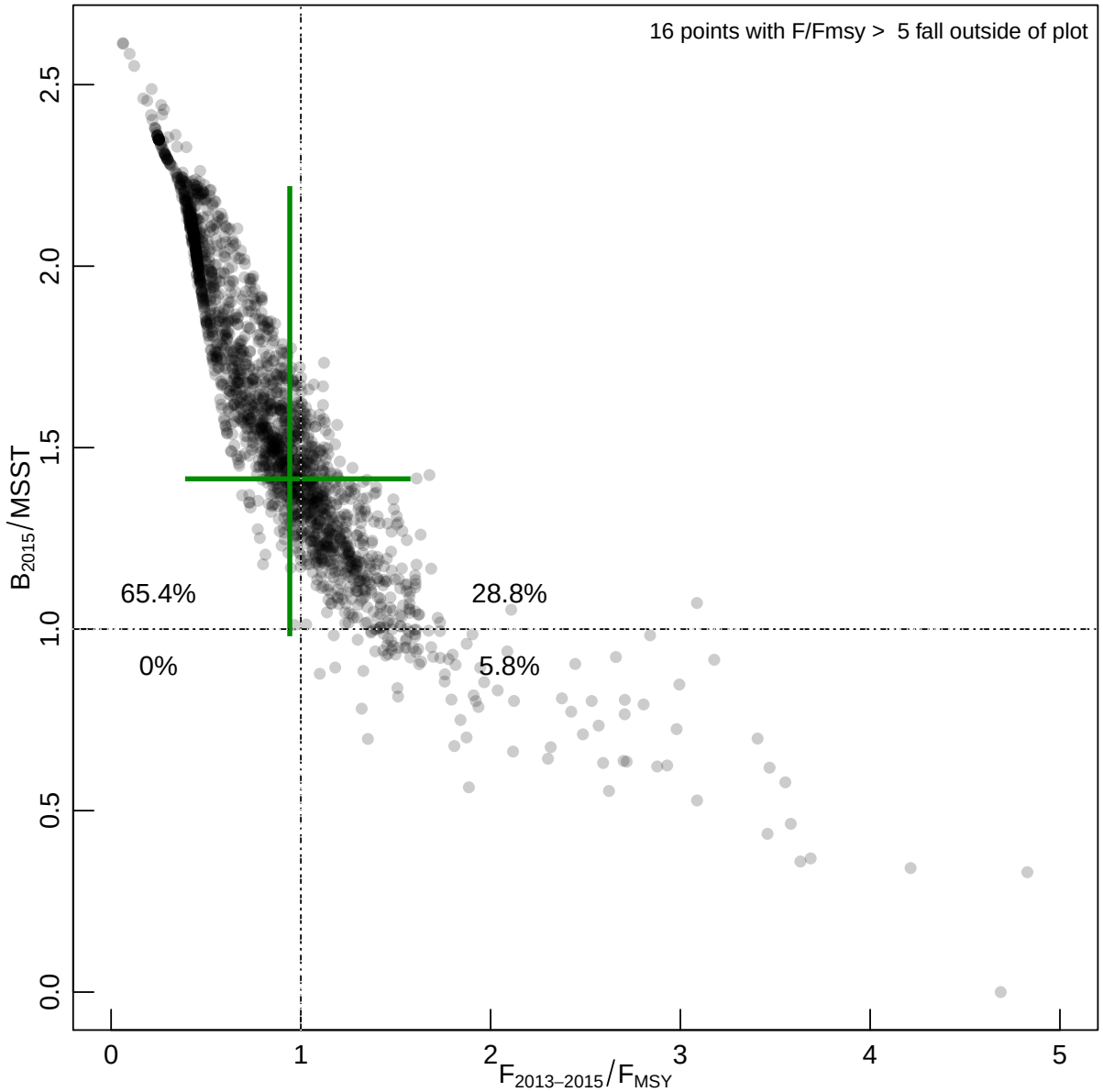
- Solid line indicates average F series relative to average F_{MSY}.
- Dashed line represents the median F/F_{MSY}
- Blue error bands indicate 5^{th} and 95^{th} percentiles of the combined bootstrap trials



Results

Bootstrap status phase plots combining Runs 55 and 56 from ASPIC

- Bootstrapping was conducted for each model separately, results were combined
- The intersection of crosshairs indicates average estimate from the base runs
- Lengths of crosshairs defined by 5^{th} and 95^{th} percentiles
- Percent of runs falling into each quadrant indicated



Results

Base run estimates

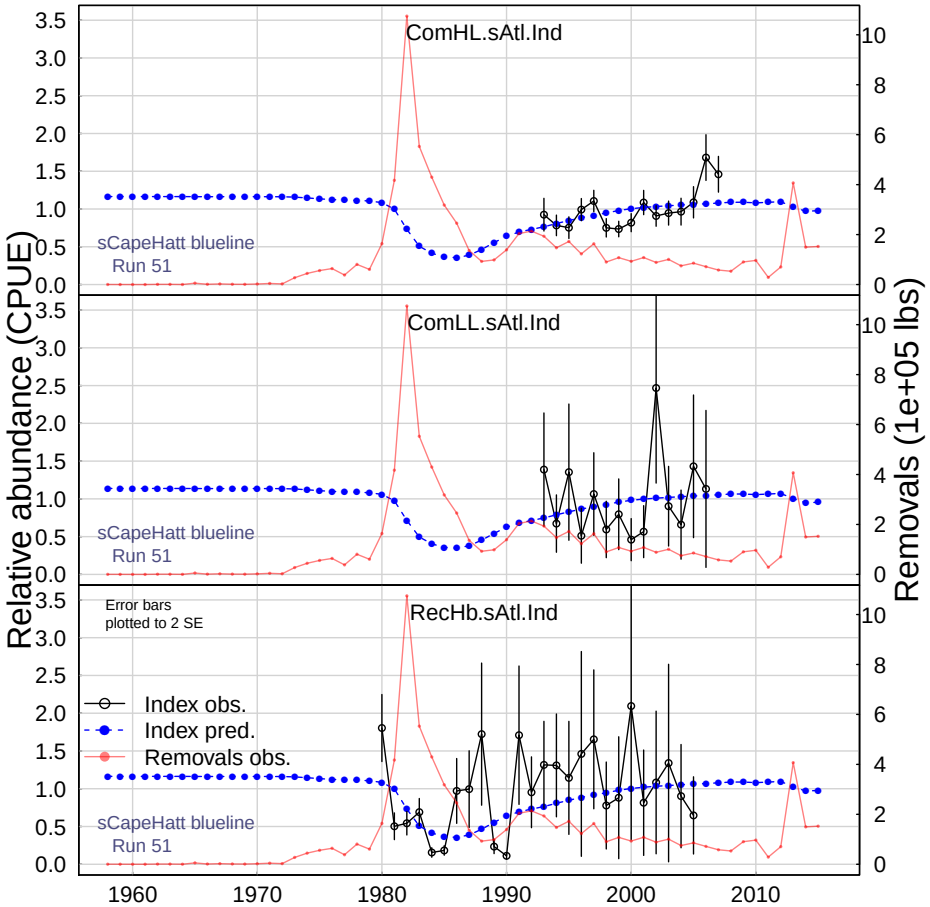
Table: Estimated status indicators, benchmarks, and related quantities from ASPIC, averaged between the handline and longline models for the Atlantic south of Cape Hatteras. Also presented are median values and measures of precision (standard errors, SE) from the bootstrap analysis. Rate estimates (F) are in units of y^{-1}; status indicators are dimensionless; and biomass estimates are in units of 1000 pounds, as indicated.

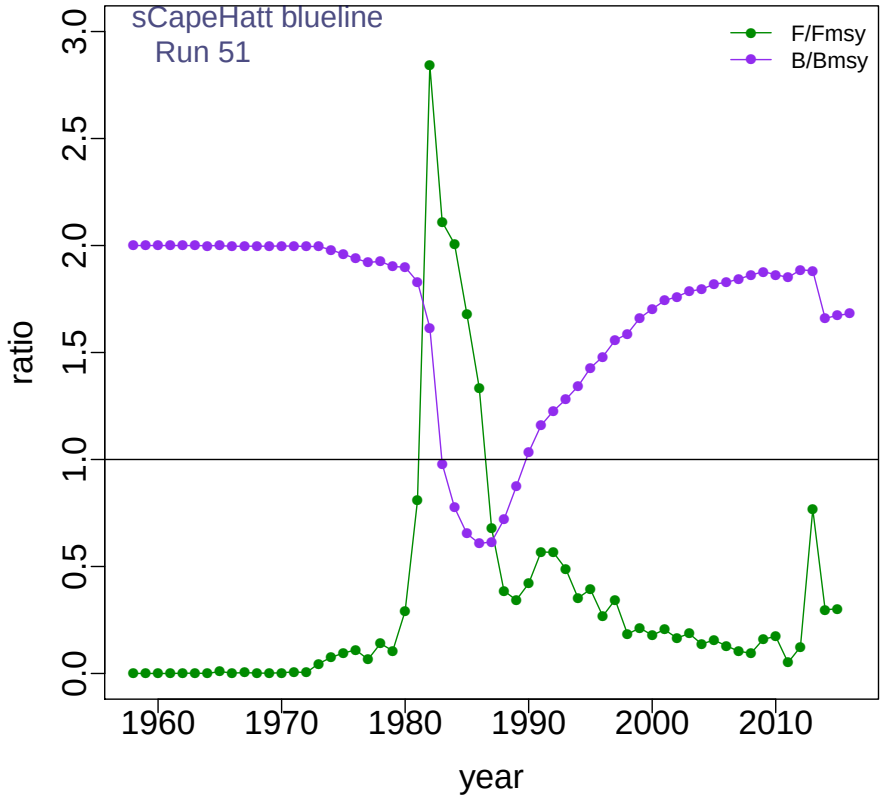
Quantity	Units	Estimate	Median	SE
F_{MSY}	y^{-1}	0.146	0.148	0.106
$85\%F_{MSY}$	y^{-1}	0.124	0.126	0.090
$75\%F_{MSY}$	y^{-1}	0.109	0.111	0.080
$65\%F_{MSY}$	y^{-1}	0.095	0.096	0.069
B_{MSY}	1000 lb	1467	1452	1225
MSST	1000 lb	1100	1089	918
MSY	1000 lb	212	216	85
$F_{2013-2015}/F_{MSY}$	—	0.92	0.86	0.96
$B_{2015}/MSST$	—	1.41	1.55	0.41
B_{2015}/B_{MSY}	—	1.06	1.16	0.31

Results

Sensitivity

Include handline, longline, and headboat indices (Run 51)

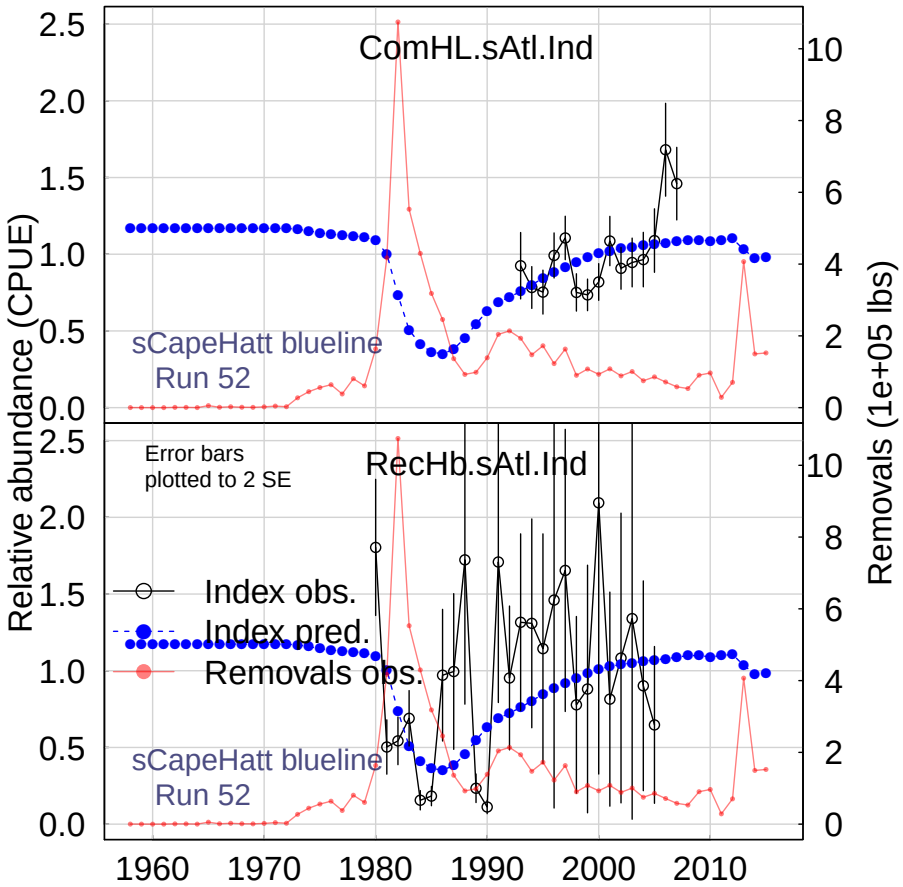


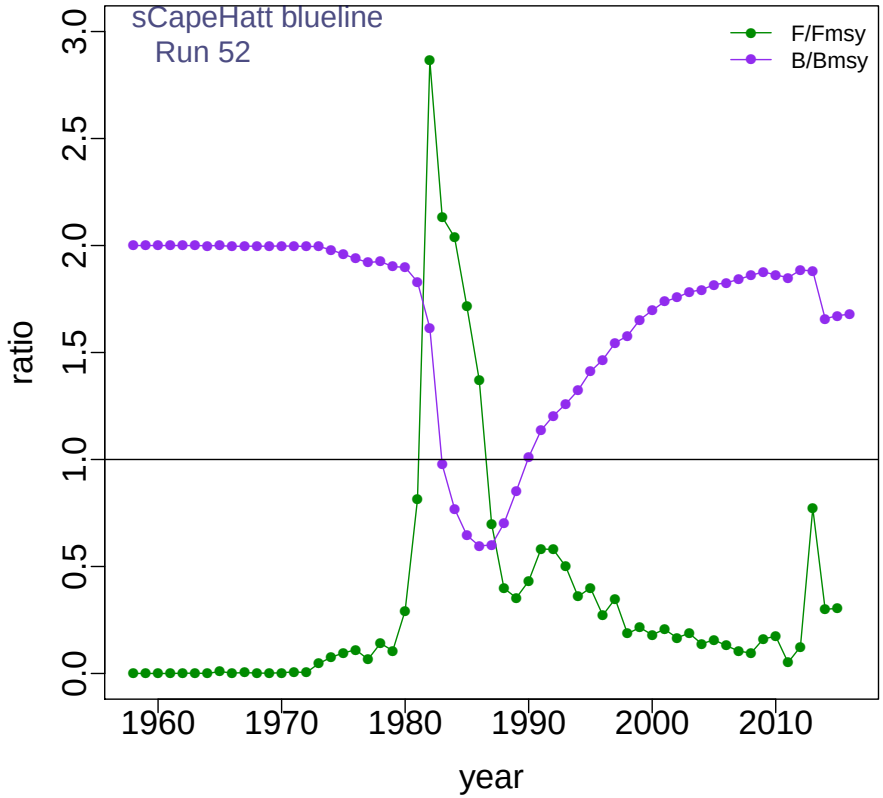


Results

Sensitivity

Include handline and headboat indices (Run 52)

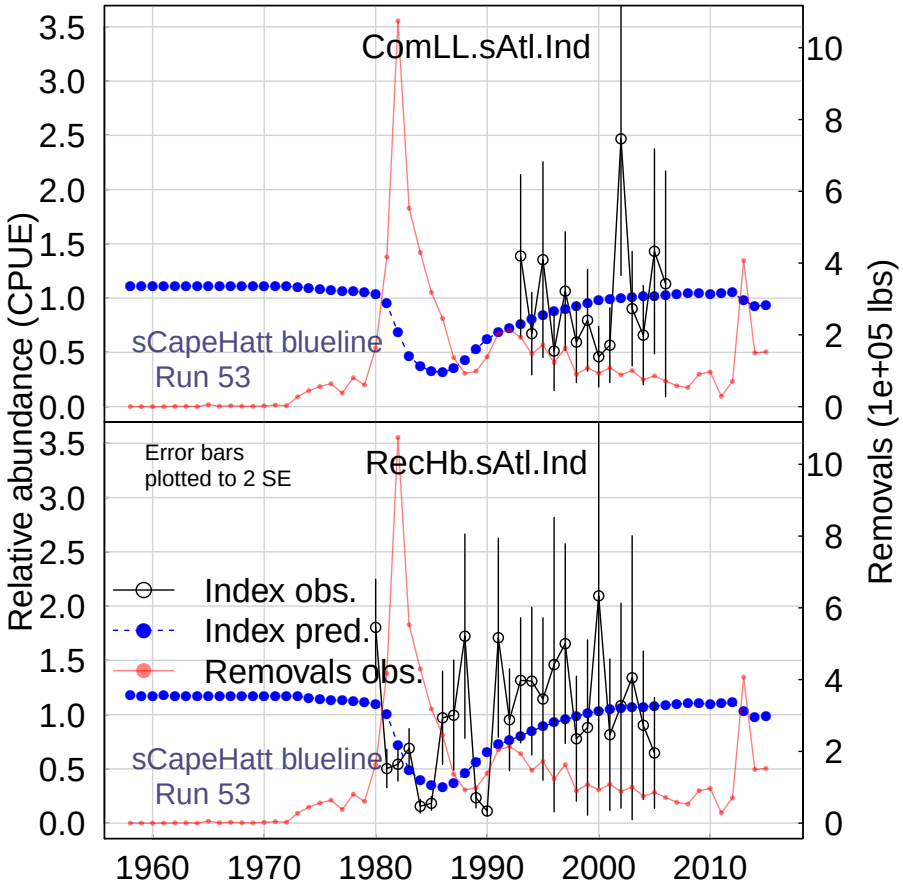


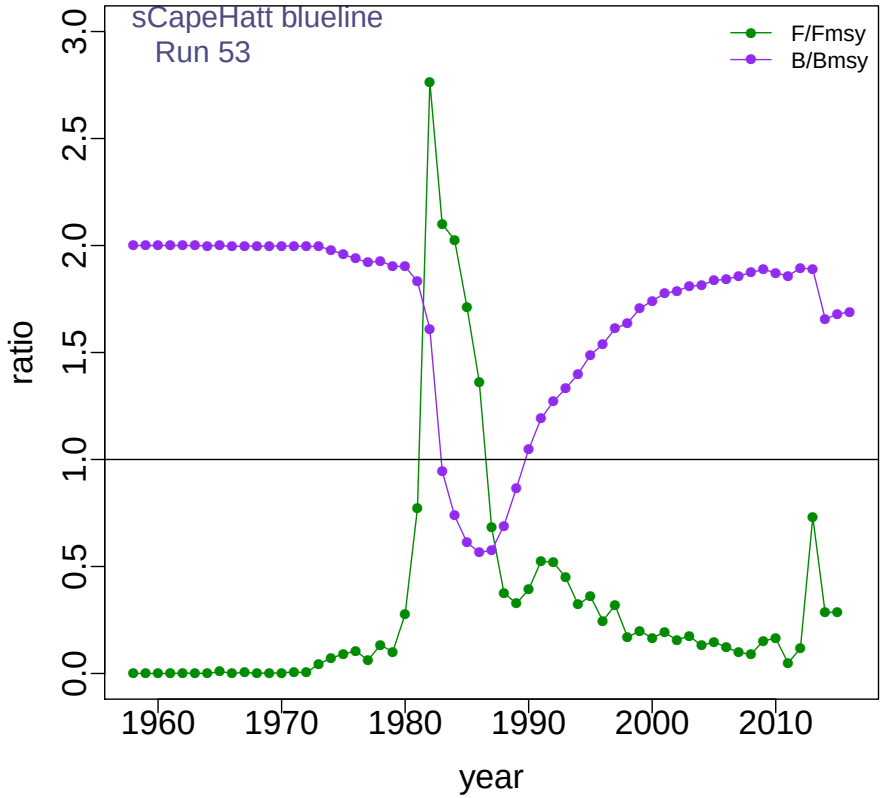


Results

Sensitivity

Include longline and headboat indices (Run 53)

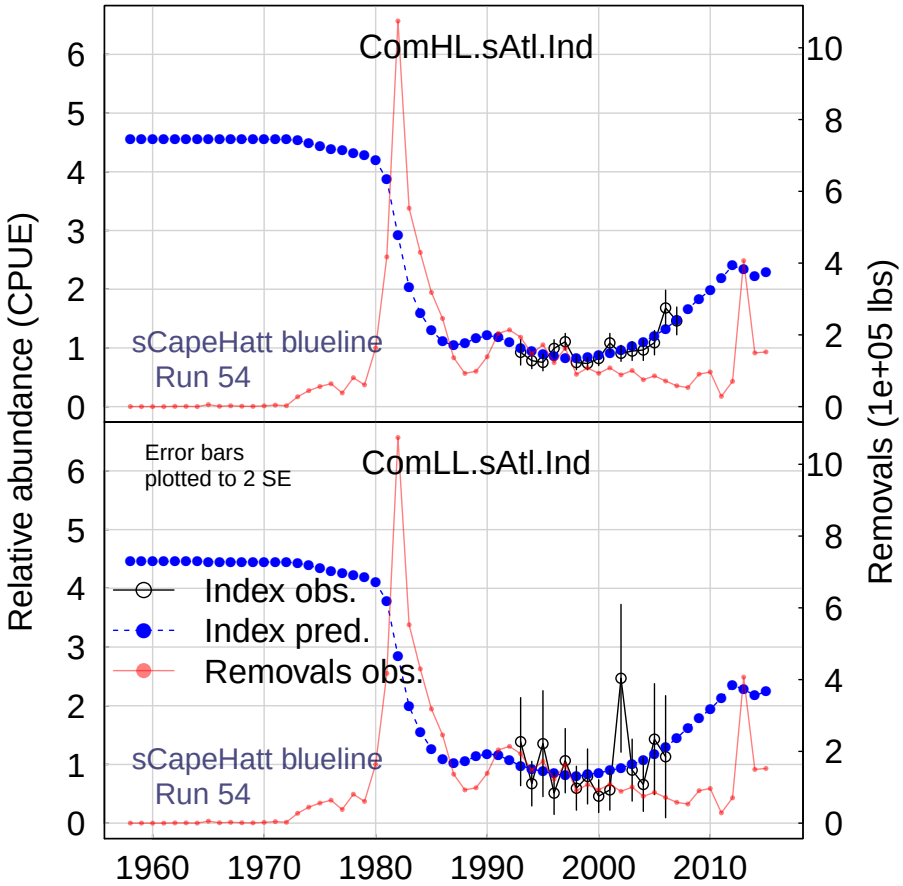


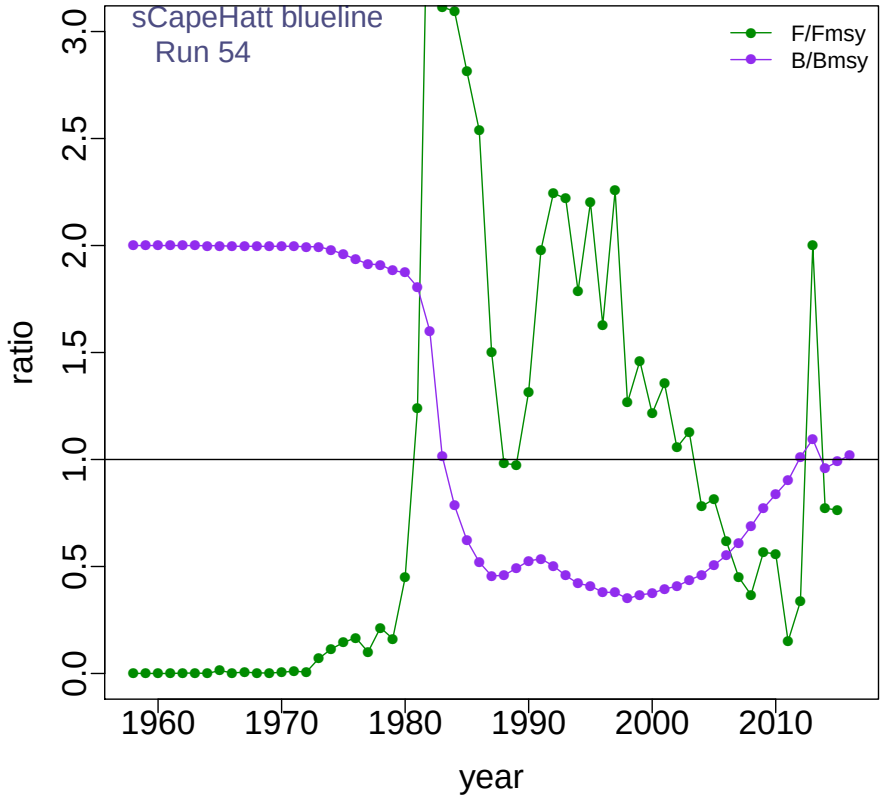


Results

Sensitivity

Include handline and longline indices (Run 54)

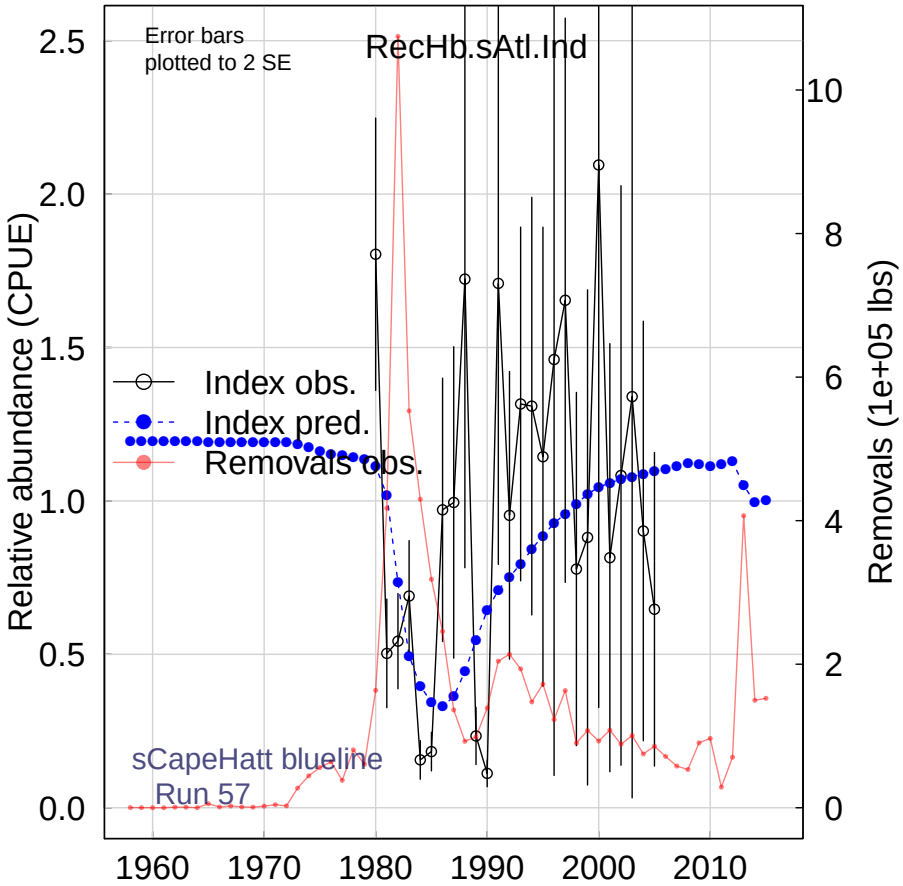


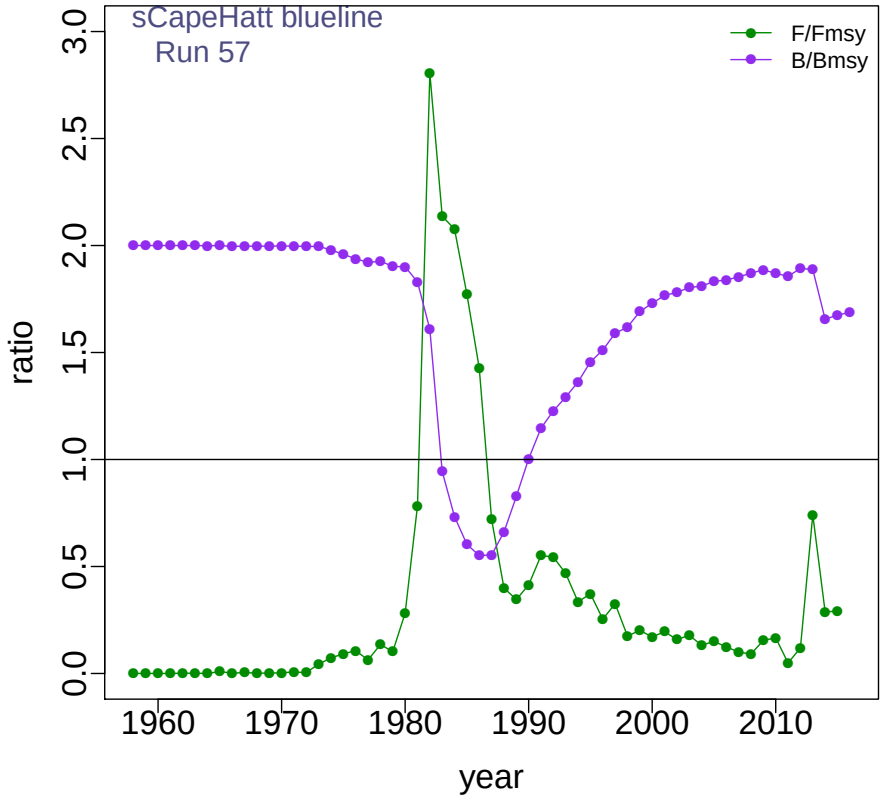


Results

Sensitivity

Include headboat index (Run 57)



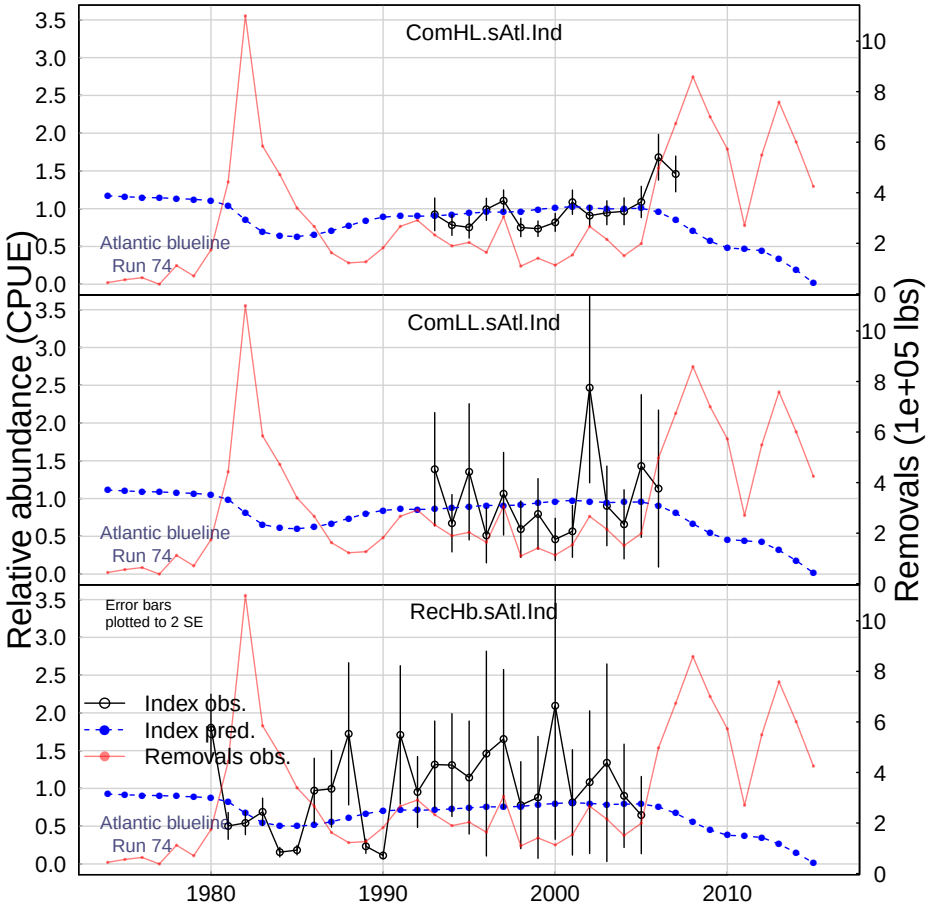


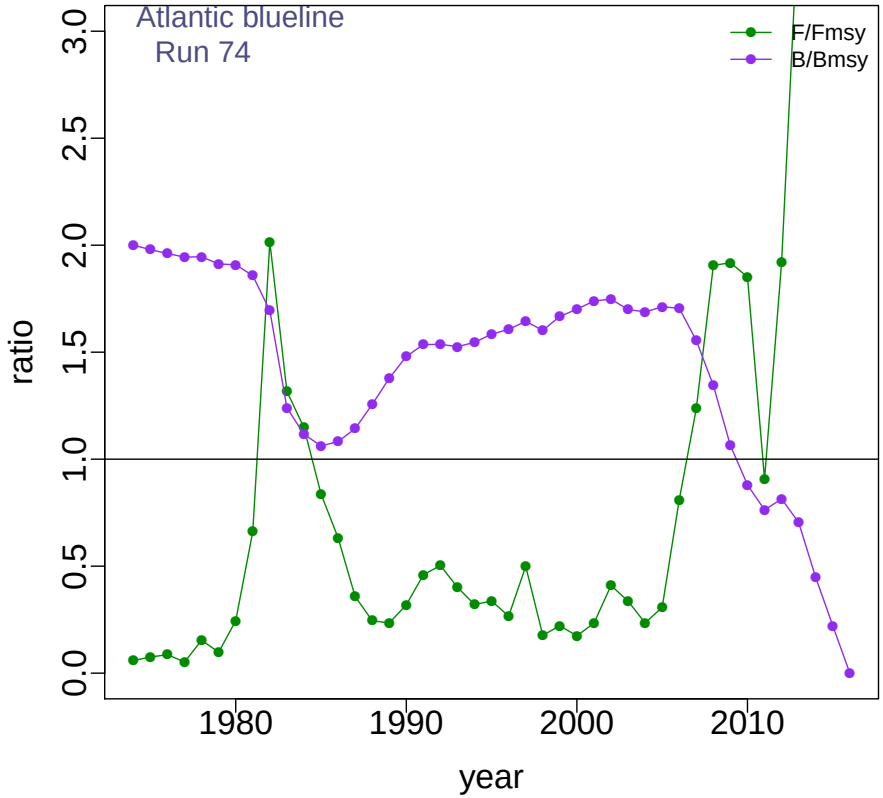
Results

Sensitivity

Continuity with SEDAR 32 (Run 74)

- Include handline, longline, and headboat indices
- Include all Atlantic removals
- Start model in 1974



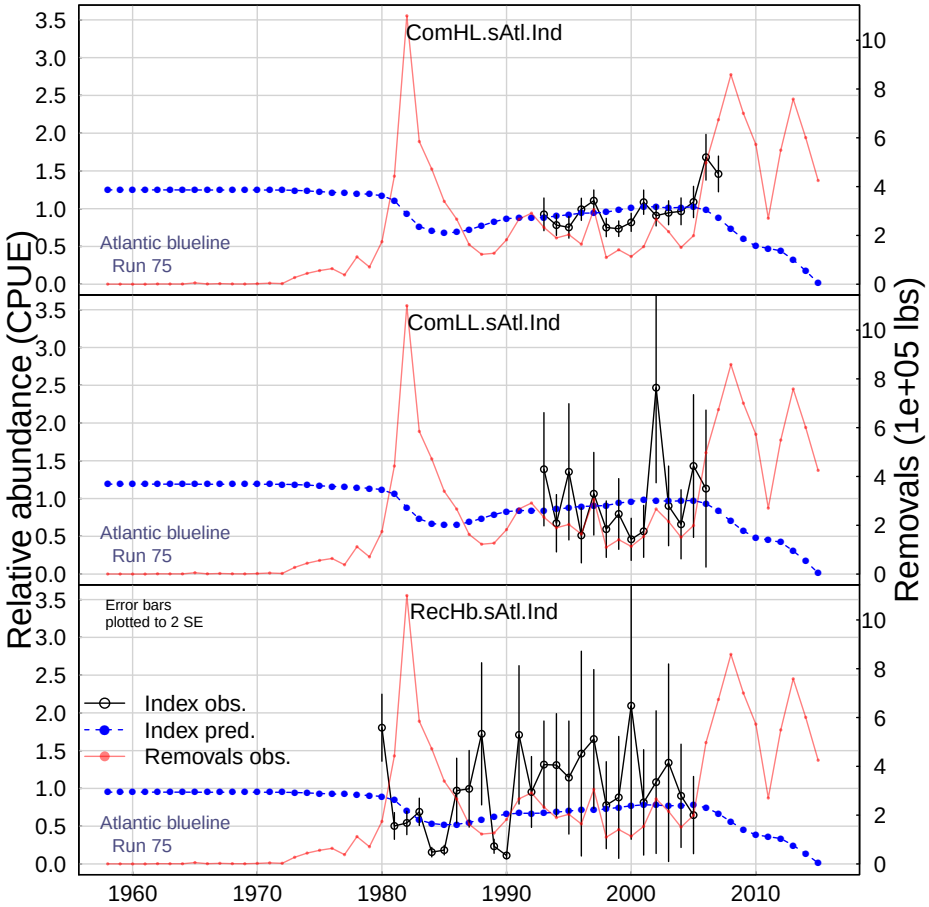


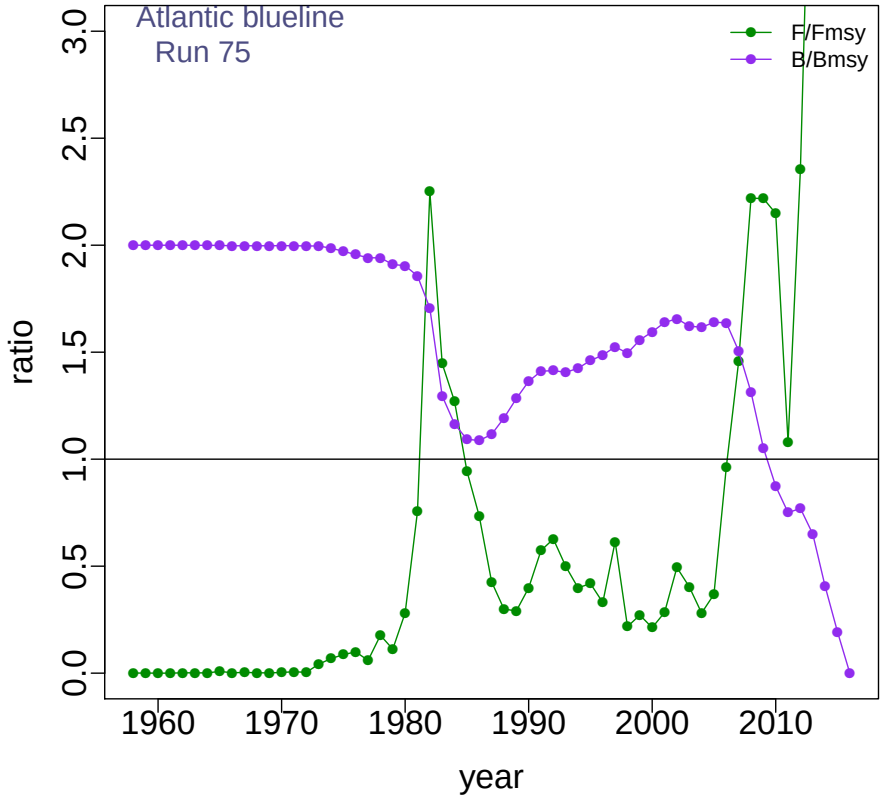
Results

Sensitivity

Continuity with SEDAR 32 (Run 75)

- Include handline, longline, and headboat indices
- Include all Atlantic removals
- Start model in 1958





Results

Summary of sensitivity runs

Table: Parameter estimates from selected ASPIC surplus production model runs for the Atlantic south of Cape Hatteras. B_{MSY} and MSY are in units of 1000 pounds. Likelihood components (Lik) are presented for each index and as a total (Lik_{total}). The numerator in F/F_{MSY} is the geometric mean F from the last three years of the assessment (2013-2015) and the numerator in B/B_{MSY} and B/MSST is biomass in the terminal year of the assessment (2015). Abbreviations in Run Name are as follows: HL = handline index, LL = longline index, Hb = headboat index, Atl. = all Atlantic removals are included, 1974 or 1958 indicates the model start year.

Run	RunName	F/F_{MSY}	B/B_{MSY}	B/MSST	B_{MSY}	MSST	MSY	F_{MSY}	Lik_{total}	Lik_{HL}	Lik_{LL}	Lik_{Hb}
51	HLLLHb	0.41	1.67	2.23	1263	947	301	0.238	167.2	23.2	15.7	128.2
52	HLHb	0.41	1.67	2.23	1260	945	299	0.238	151.4	23.2		128.2
53	LLHb	0.39	1.68	2.24	1186	889	316	0.266	143.5		15.7	127.8
54	HLLL	1.06	0.99	1.32	1538	1153	199	0.129	16.9	4.1	12.8	
55	HL	1.07	0.99	1.32	1554	1165	196	0.126	4.1	4.1		
56	LL	0.81	1.13	1.51	1380	1035	228	0.165	12.7		12.7	
57	Hb	0.40	1.68	2.23	1190	892	312	0.262	127.8			127.8
74	Atl.HLLLHb.1974	8.71	0.22	0.30	1769	1327	378	0.214	205.2	46.0	15.1	144.1
75	Atl.HLLLHb.1958	11.27	0.19	0.26	2076	1557	330	0.159	202.3	40.9	15.0	146.5

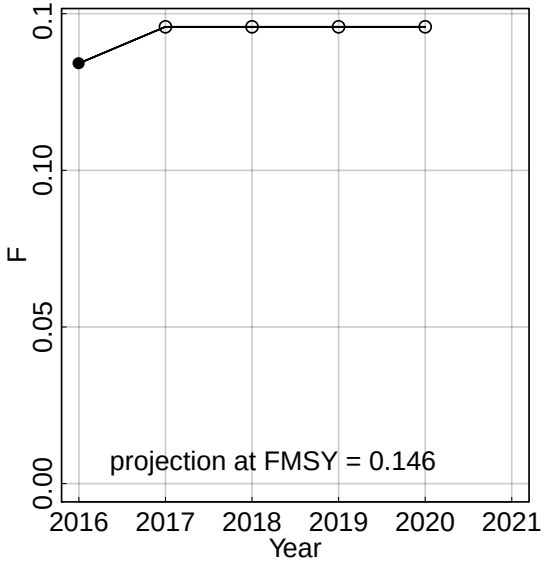
Results

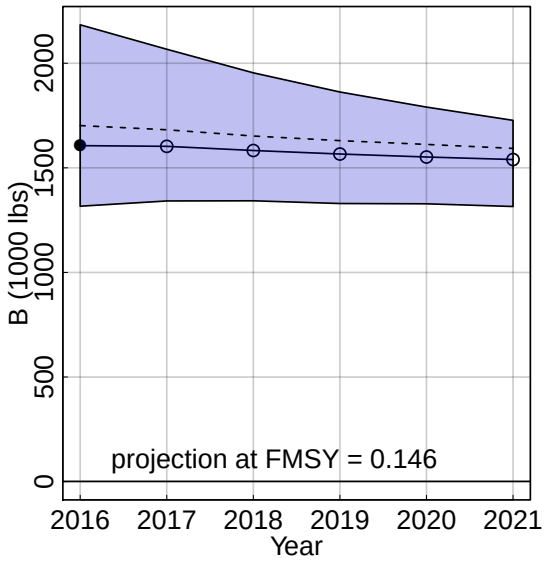
Projections

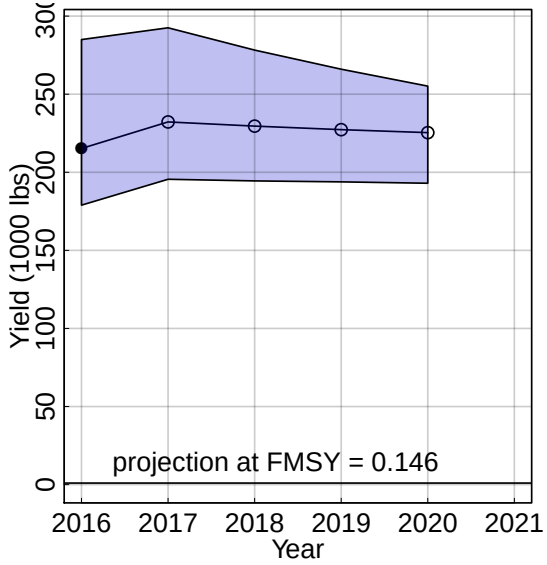
- Projections at:
  - $F = F_{\text{MSY}}$
  - $F = F_{\text{current}}$
  - $F = F_{\text{target}} = 0.75 F_{\text{MSY}}$
- $F_{2016} = F_{\text{current}}$
- Solid circles (2016) represent values projected by the assessment model
- Open circles (2017-2021) represent values produced by the projection code
- Solid lines are deterministic estimates
- Dashed lines are medians of the bootstrap projections, respectively
- Blue error bands indicate 10^{th} and 90^{th} percentiles of the combined bootstrap trials

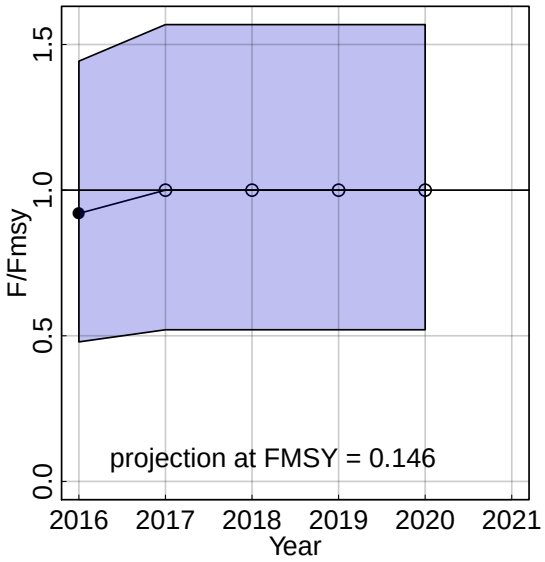
Results

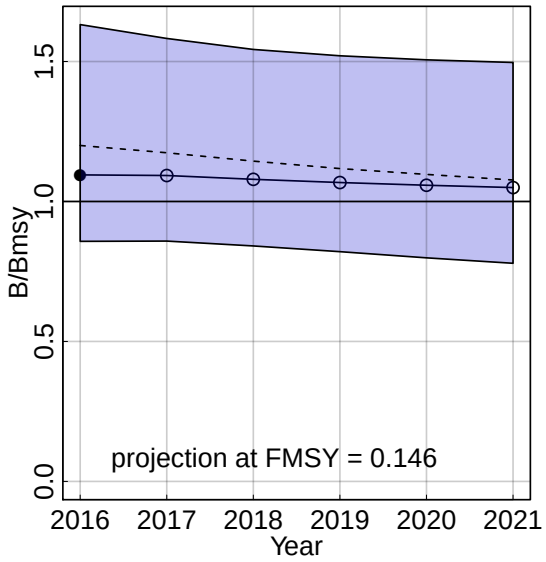
Projections: $F = F_{\mathrm{MSY}}$

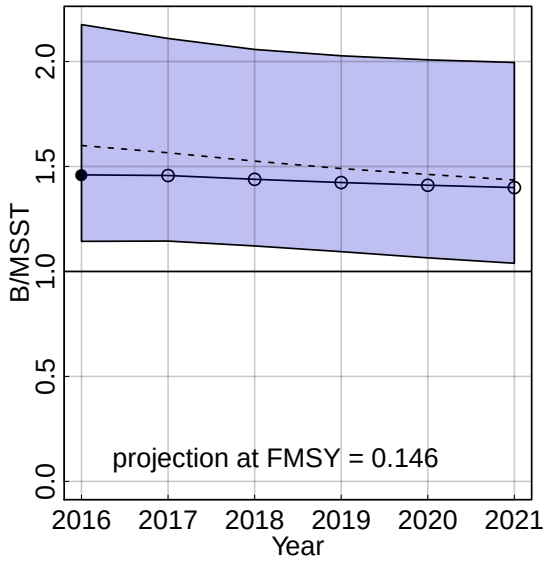












Results

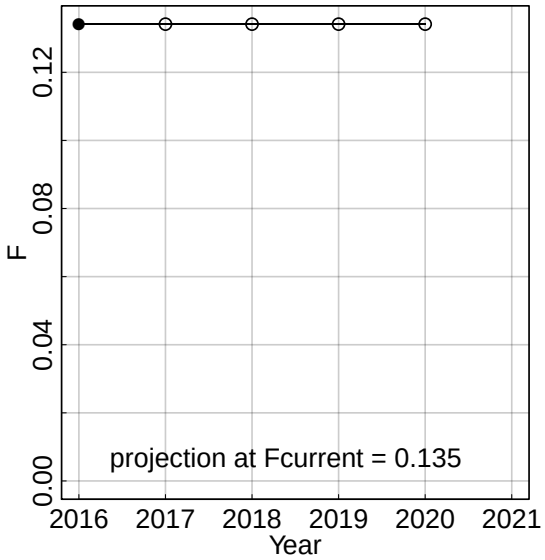
Projections: $F = F_{\text{MSY}}$

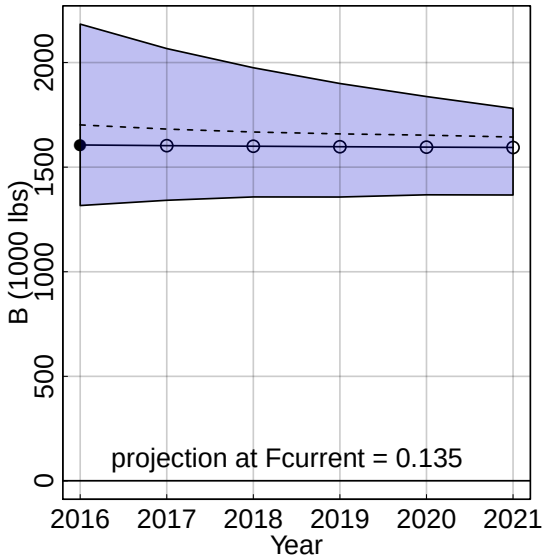
Table: Projection results with fishing mortality fixed at $F = F_{\text{MSY}}$ starting in 2017 . For 2016 , $F = F_{\text{current}}$. F = fishing mortality rate (per year), $P(B > B_{\text{MSY}})$ = proportion of stochastic projection replicates exceeding B_{MSY}, $P(B > \text{MSST})$ = proportion of stochastic projection replicates exceeding MSST, B_{median} = median biomass (1000 lbs) estimate among projections, B = deterministic biomass (1000 lbs) estimate, Y = deterministic yield (1000 lbs) estimate, Sum Y = cumulative sum of deterministic yield (1000 lbs). Yield includes landings and dead discards. Note that observed dead discards were 1, 3 and 18% of total removals from 2013 to 2015 respectively.

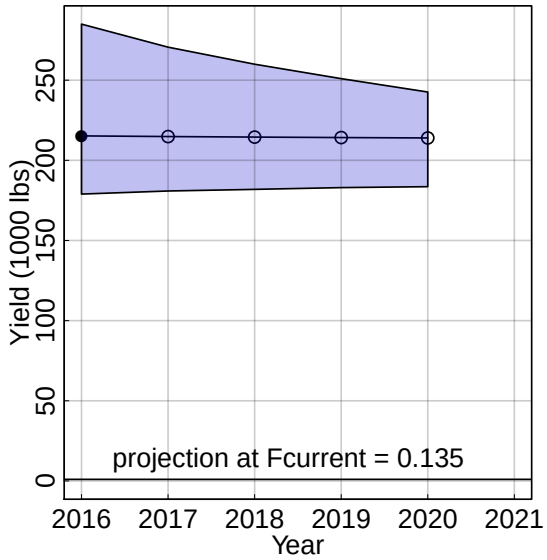
Year	F(per yr)	$P(B > B_{\text{MSY}})$	$P(B > \text{MSST})$	B_{median}	B	Y	Sum Y
2016	0.134	0.77	0.95	1702	1606	215	215
2017	0.146	0.76	0.95	1682	1603	232	447
2018	0.146	0.72	0.95	1652	1583	230	677
2019	0.146	0.69	0.94	1630	1566	227	904
2020	0.146	0.65	0.93	1612	1552	225	1130
2021		0.61	0.92	1593	1540		

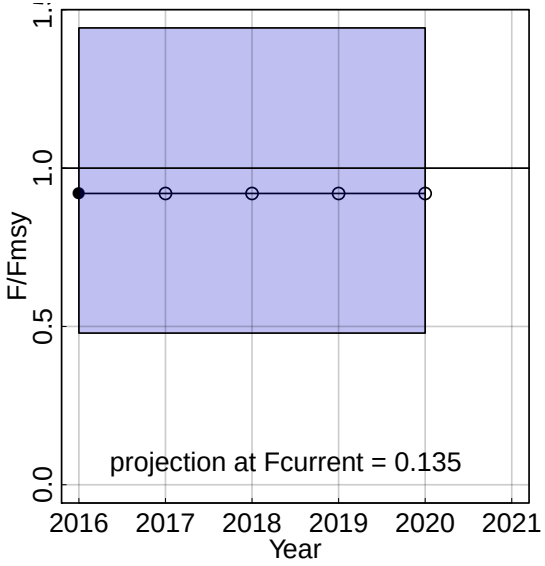
Results

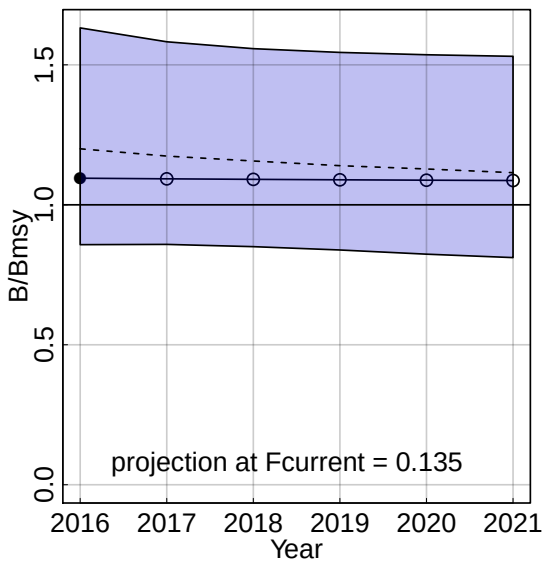
Projections: $F = F_{\text{current}}$

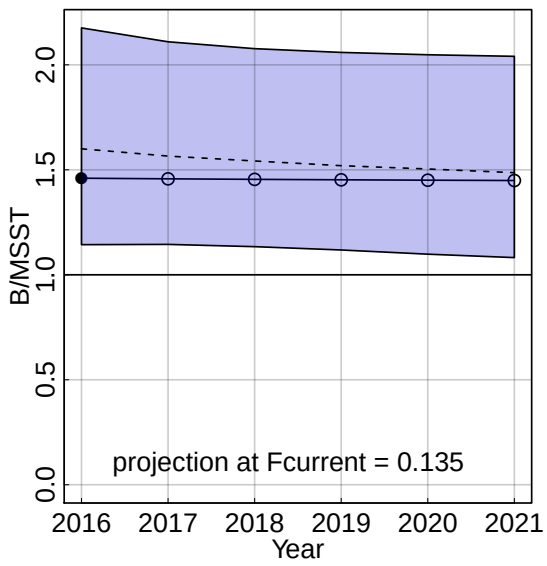












Results

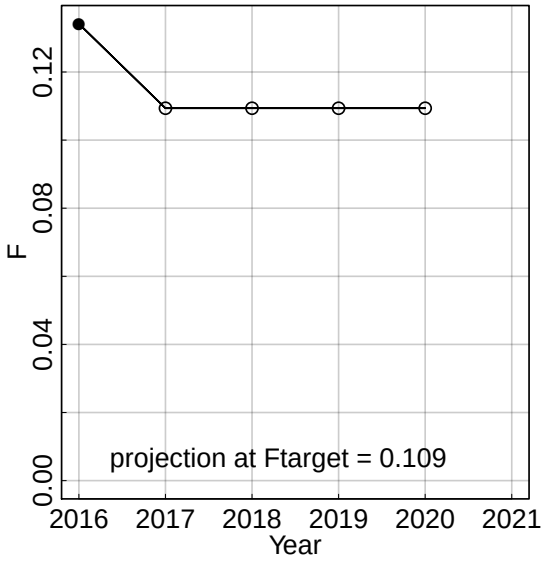
Projections: $F = F_{\text{current}}$

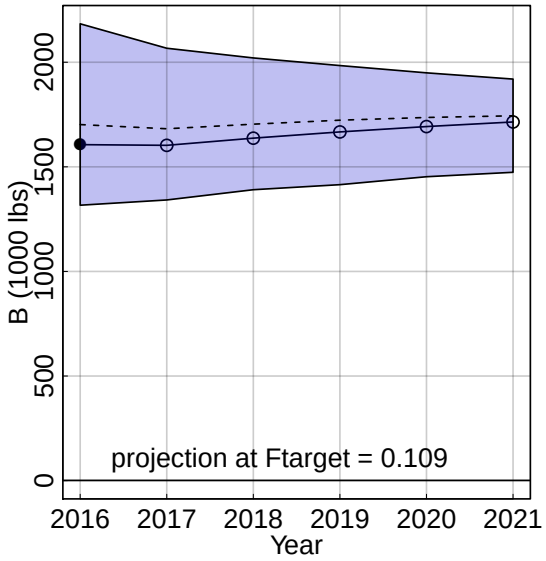
Table: Projection results with fishing mortality fixed at $F = F_{\text{current}}$ starting in 2017 . For 2016 , $F = F_{\text{current}}$. F = fishing mortality rate (per year), $P(B > B_{\text{MSY}})$ = proportion of stochastic projection replicates exceeding B_{MSY}, $P(B > \text{MSST})$ = proportion of stochastic projection replicates exceeding MSST, B_{median} = median biomass (1000 lbs) estimate among projections, B = deterministic biomass (1000 lbs) estimate, Y = deterministic yield (1000 lbs) estimate, Sum Y = cumulative sum of deterministic yield (1000 lbs). Yield includes landings and dead discards. Note that observed dead discards were 1, 3 and 18% of total removals from 2013 to 2015 respectively.

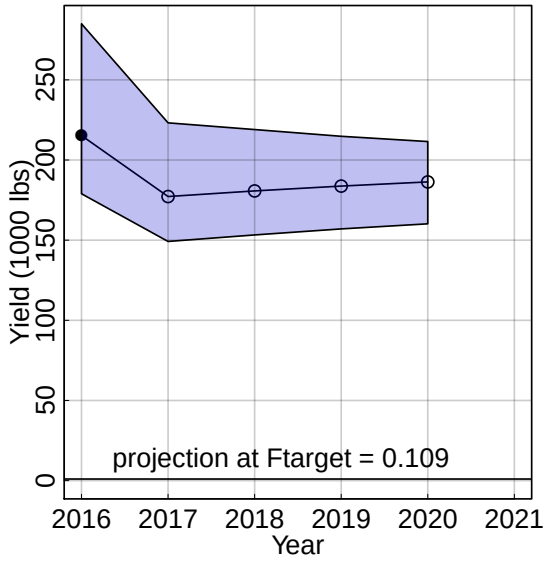
Year	F(per yr)	$P(B > B_{\text{MSY}})$	$P(B > \text{MSST})$	B_{median}	B	Y	Sum Y
2016	0.134	0.77	0.95	1702	1606	215	215
2017	0.134	0.76	0.95	1682	1603	215	430
2018	0.134	0.74	0.95	1668	1600	214	645
2019	0.134	0.72	0.94	1659	1598	214	859
2020	0.134	0.70	0.94	1653	1596	214	1073
2021		0.67	0.93	1644	1594		

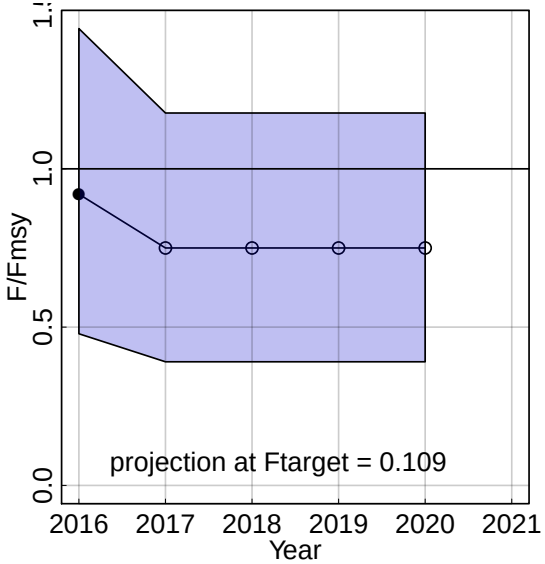
Results

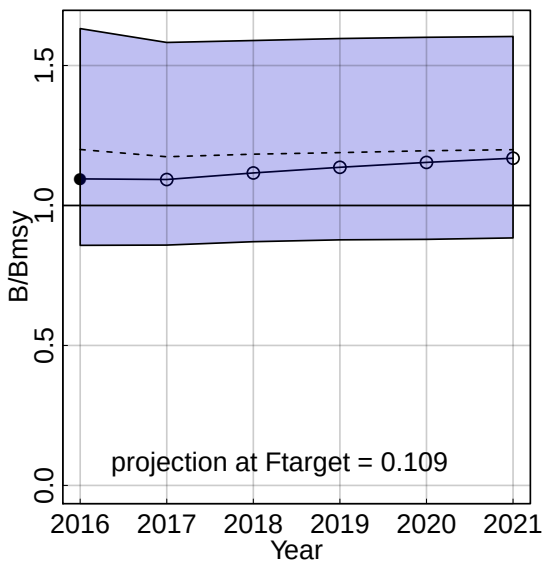
Projections: $F = F_{\text{target}} = 0.75F_{\text{MSY}}$

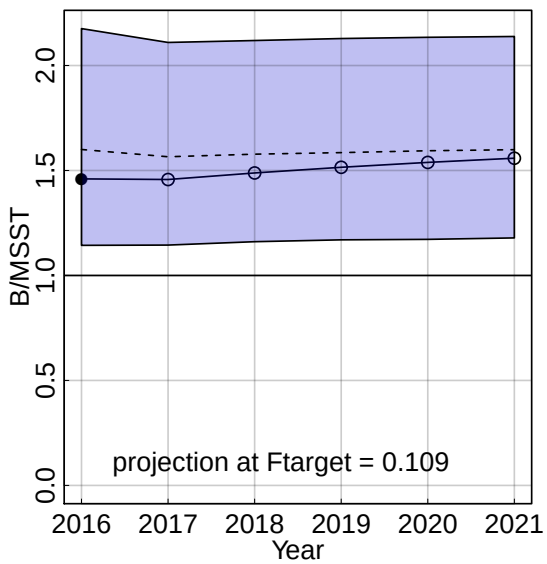












Results

Projections: $F = F_{\text{target}} = 0.75 F_{\text{MSY}}$

Table: Projection results with fishing mortality fixed at $F = F_{\text{target}}$ starting in 2017 . For 2016 , $F = F_{\text{current}}$. F = fishing mortality rate (per year), $P(B > B_{\text{MSY}})$ = proportion of stochastic projection replicates exceeding B_{MSY}, $P(B > \text{MSST})$ = proportion of stochastic projection replicates exceeding MSST, B_{median} = median biomass (1000 lbs) estimate among projections, B = deterministic biomass (1000 lbs) estimate, Y = deterministic yield (1000 lbs) estimate, Sum Y = cumulative sum of deterministic yield (1000 lbs). Yield includes landings and dead discards. Note that observed dead discards were 1, 3 and 18% of total removals from 2013 to 2015 respectively.

Year	F(per yr)	$P(B > B_{\text{MSY}})$	$P(B > \text{MSST})$	B_{median}	B	Y	Sum Y
2016	0.134	0.77	0.95	1702	1606	215	215
2017	0.109	0.76	0.95	1682	1603	177	392
2018	0.109	0.77	0.96	1704	1637	181	573
2019	0.109	0.79	0.96	1723	1667	184	757
2020	0.109	0.79	0.96	1736	1693	186	943
2021		0.80	0.96	1744	1714		

Conclusions

- Blueline Tilefish south of Cape Hatteras are not overfished (B_{2015}/MSST=1.41) and overfishing is not occurring ($F_{2013-2015}/F_{\mathrm{MSY}}$=0.92)
- Bootstrap analysis suggests that stock status (B) is fairly certain, as only 5.5% of runs found the stock to be overfished
- Bootstrap analysis suggests that fishery status (F) is much less certain, as 34.6% of runs found the stock to be undergoing overfishing