Science, Service, Stewardship

SEDAR 25 Stock Assessment of U.S. South Atlantic tilefish

SEDAR 25 Review Workshop

Charleston, SC

October 11, 2011

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Outline

The “D” in SEDAR: Data

— Stock definition and life history data

— Fisheries data

The “A” in SEDAR: Assessment

— Statistical catch-at-age model (BAM)

— Surplus production model (ASPIC)

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Stock Definition - Tilefish

No new data since SEDAR 4

Recommendation:

—Same stock definition as used in previous assessment

- Northern boundary: NC/VA Border
- Separate stock from GOM (e.g. southern boundary at FL Keys)

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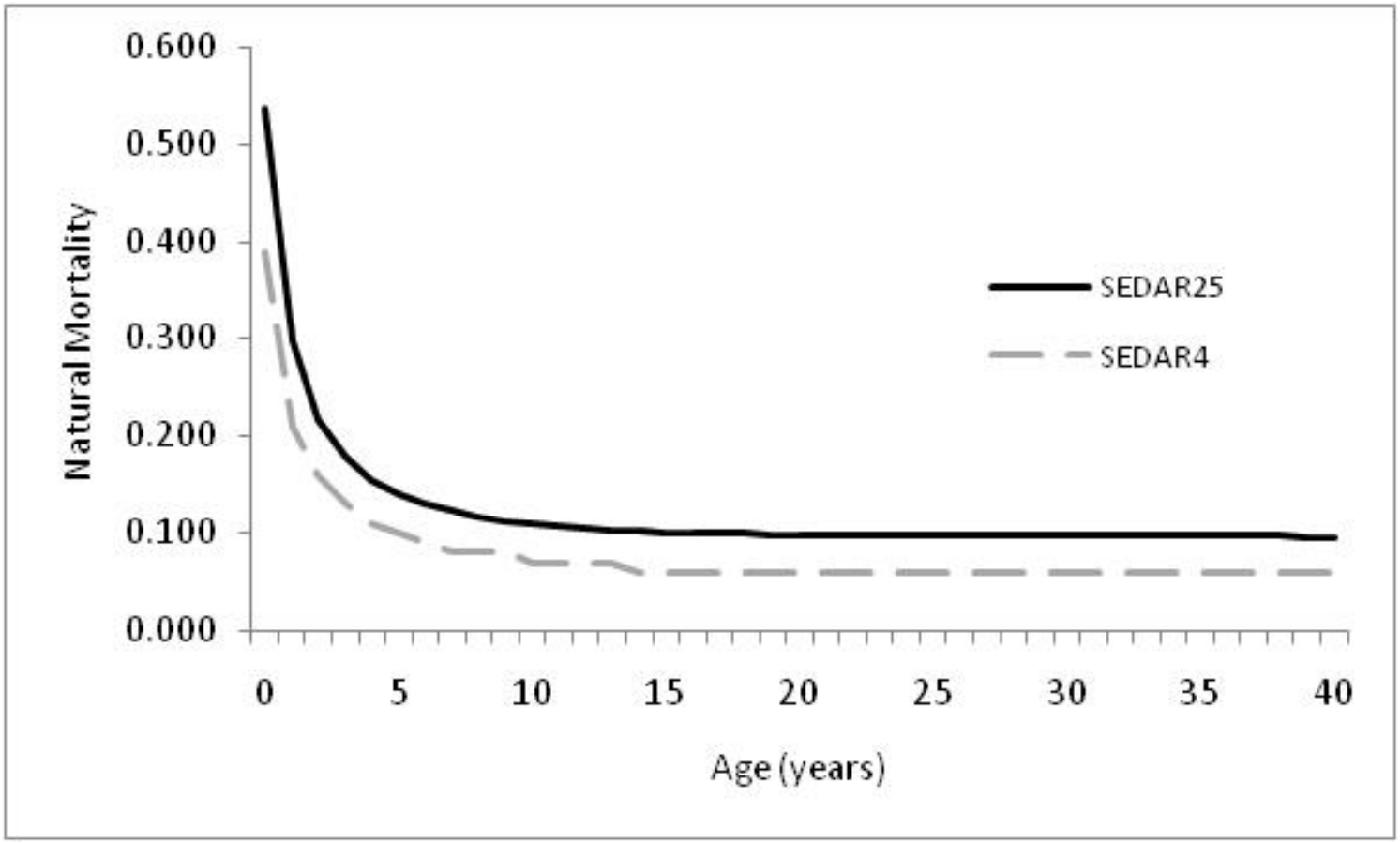
Natural mortality



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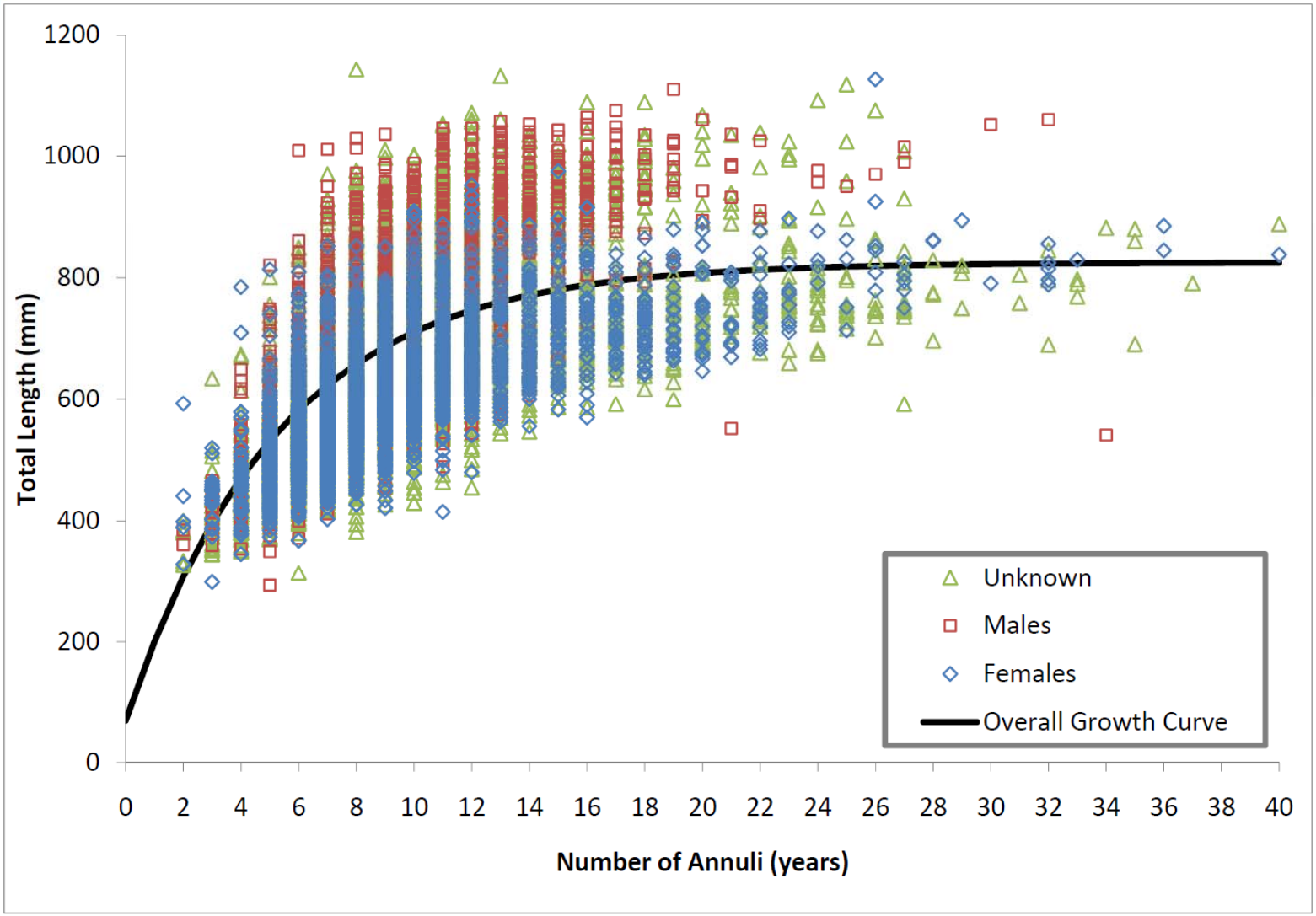
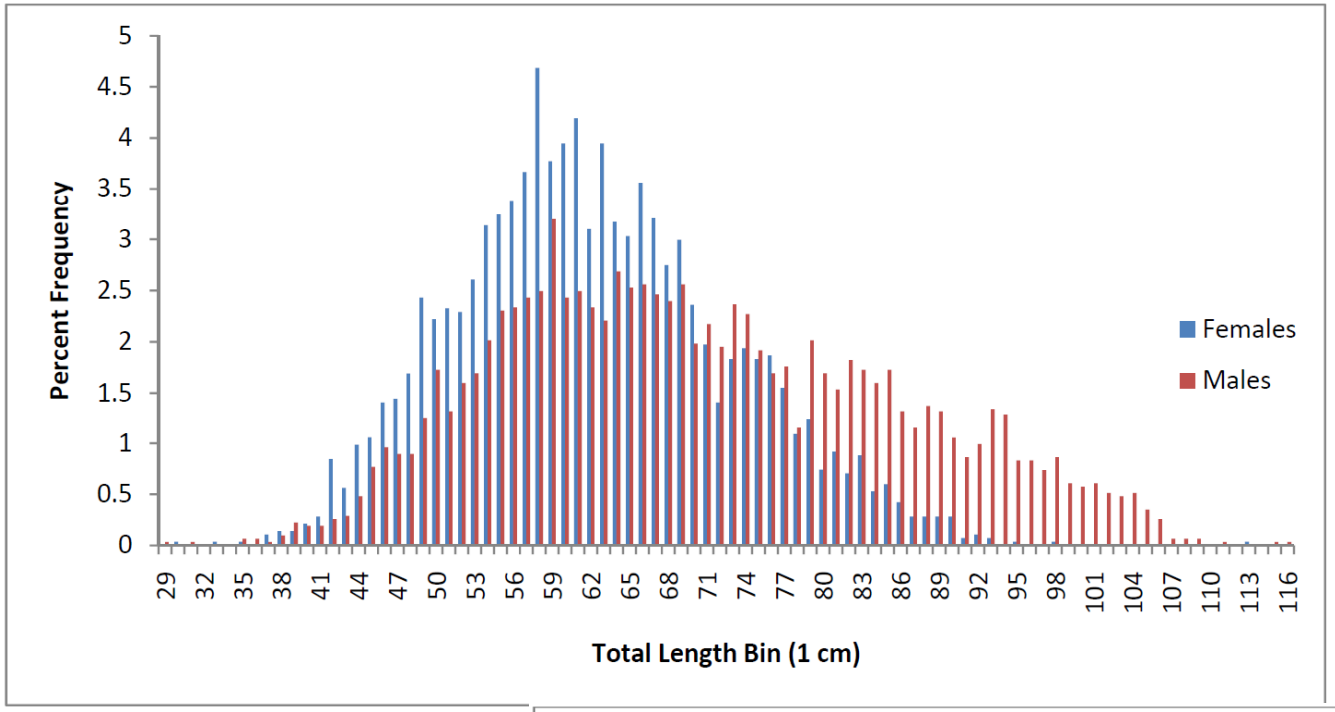
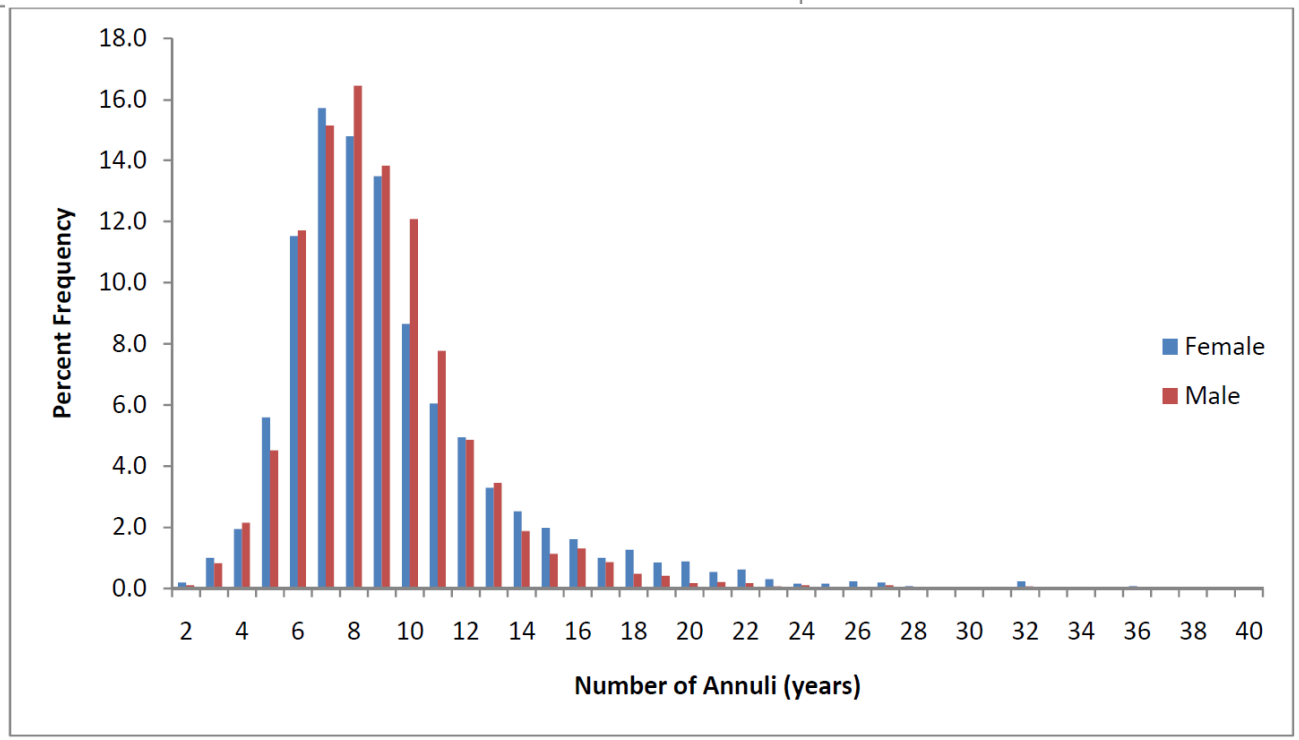
Tilefish Age and Growth



Tilefish Age and Growth





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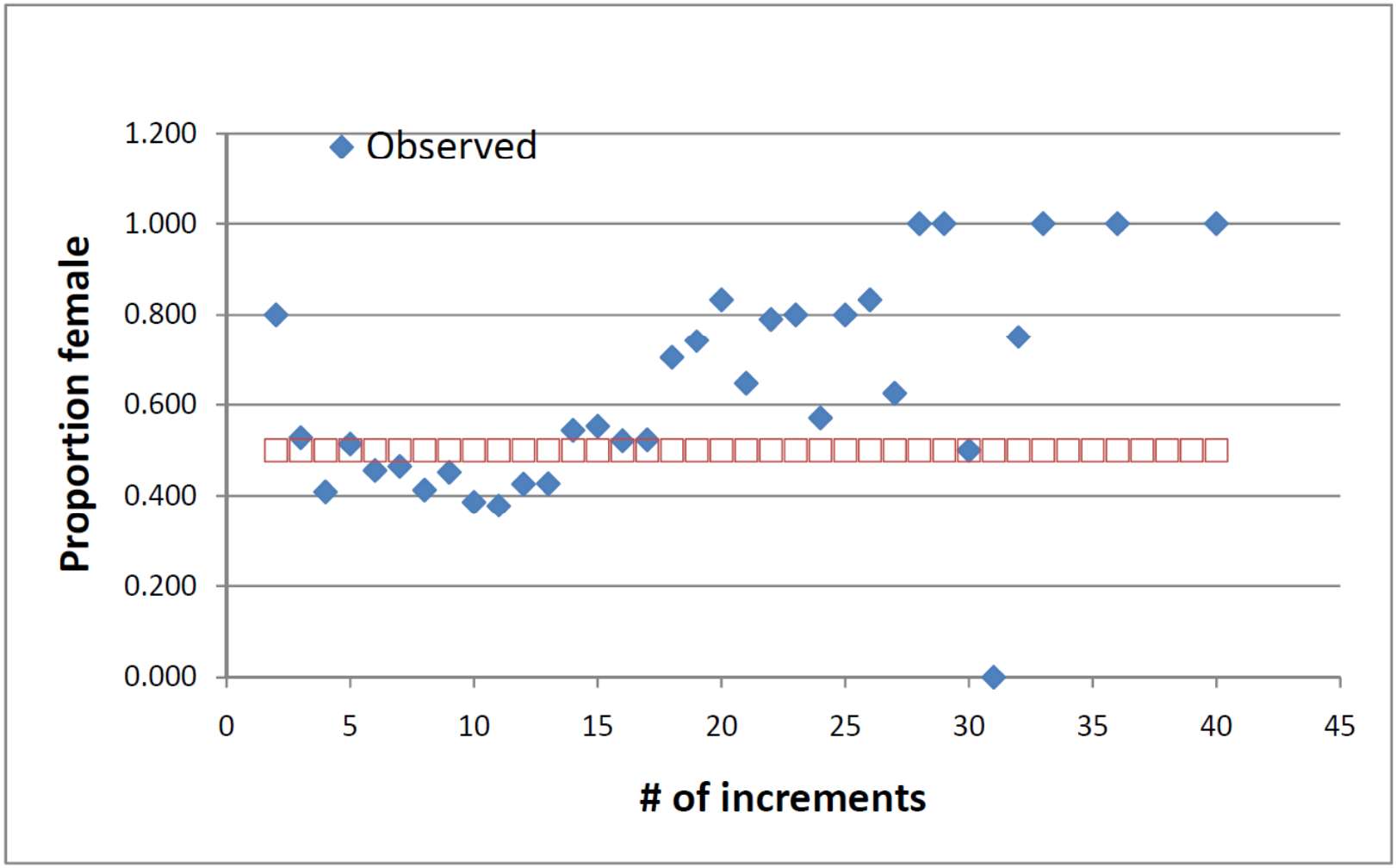
Sex ratio



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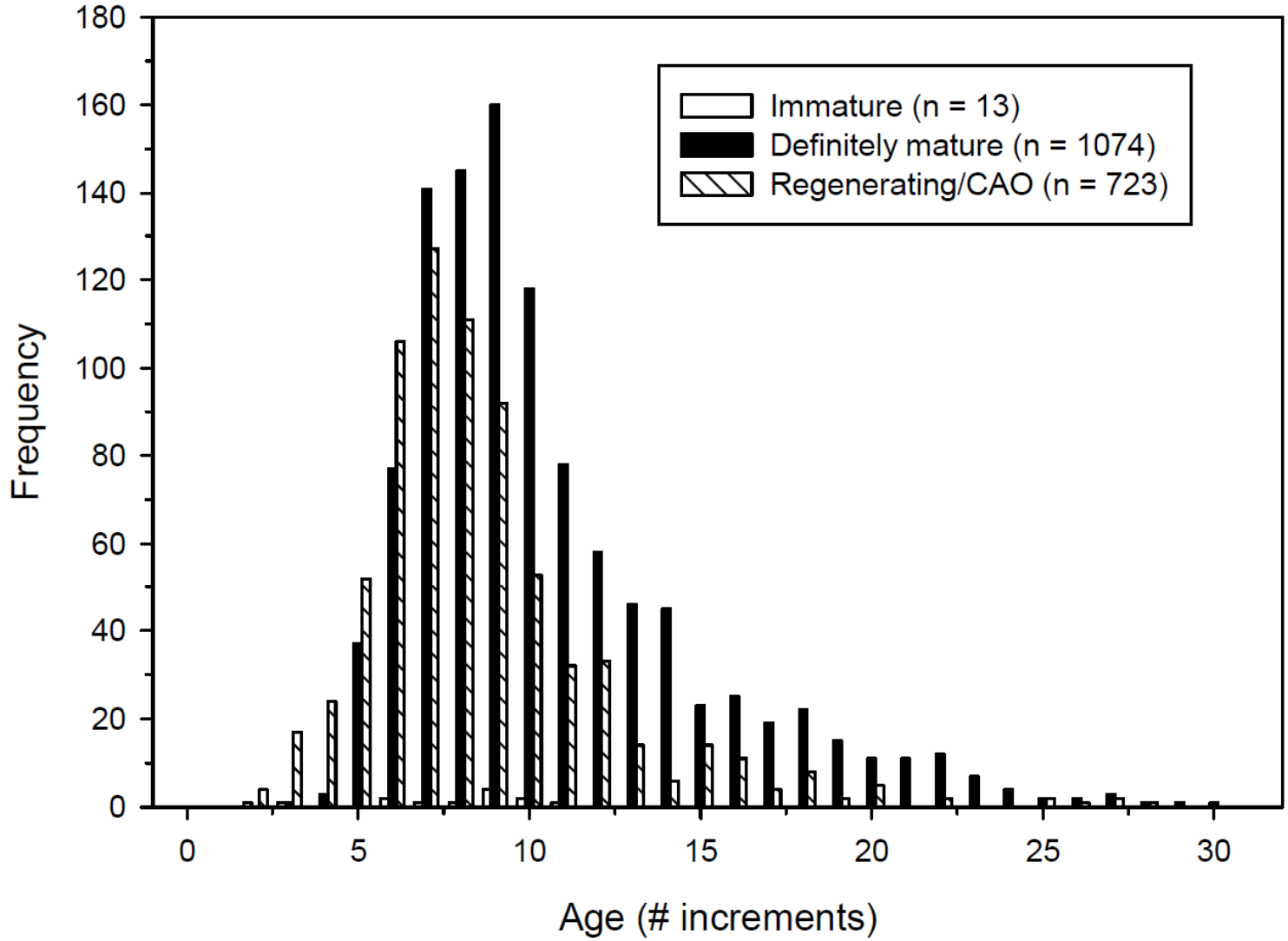
Maturity

Based on this:
Age-1: 0.1
Age-2: 0.25
Age-3: 0.5
Age-4+: 1.0



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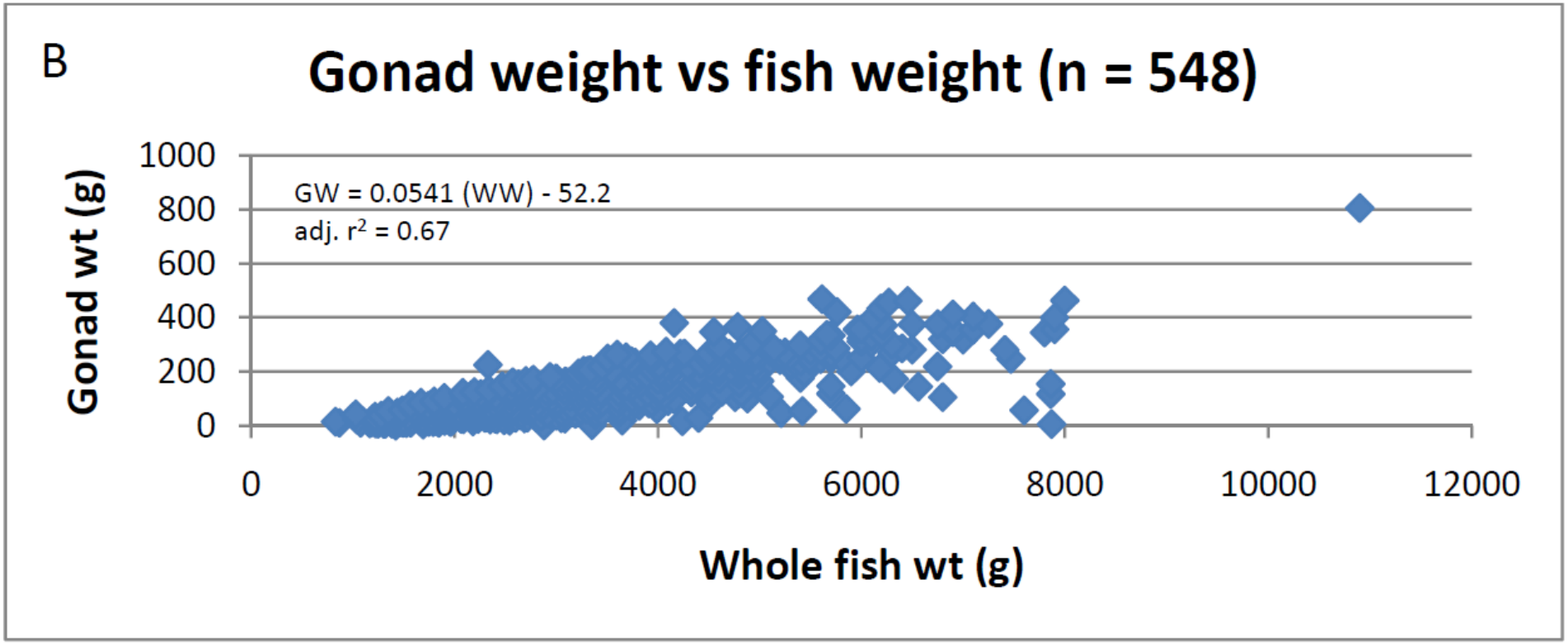
Measure of spawning stock: Female Gonad Weight



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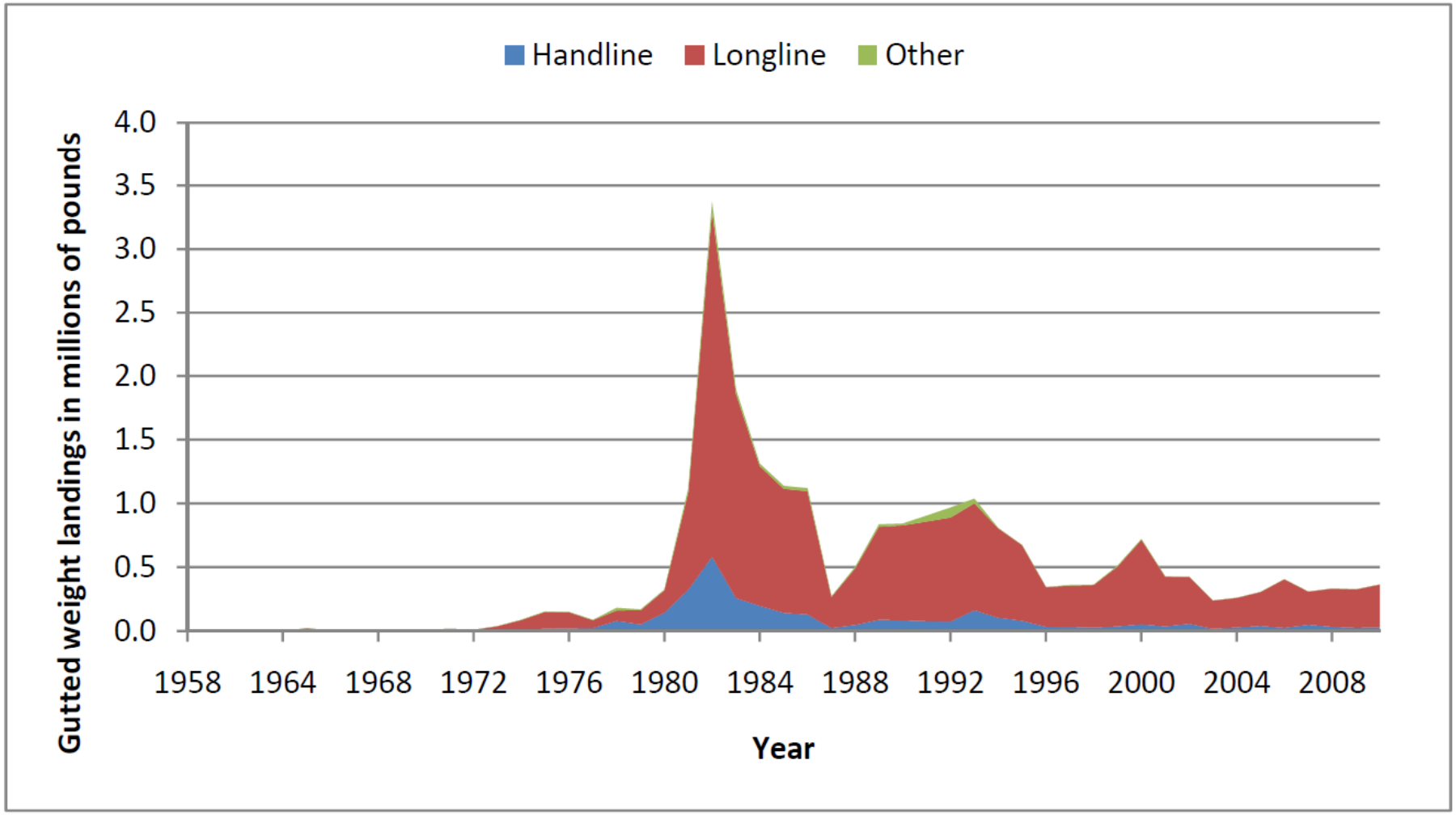
Commercial Landings



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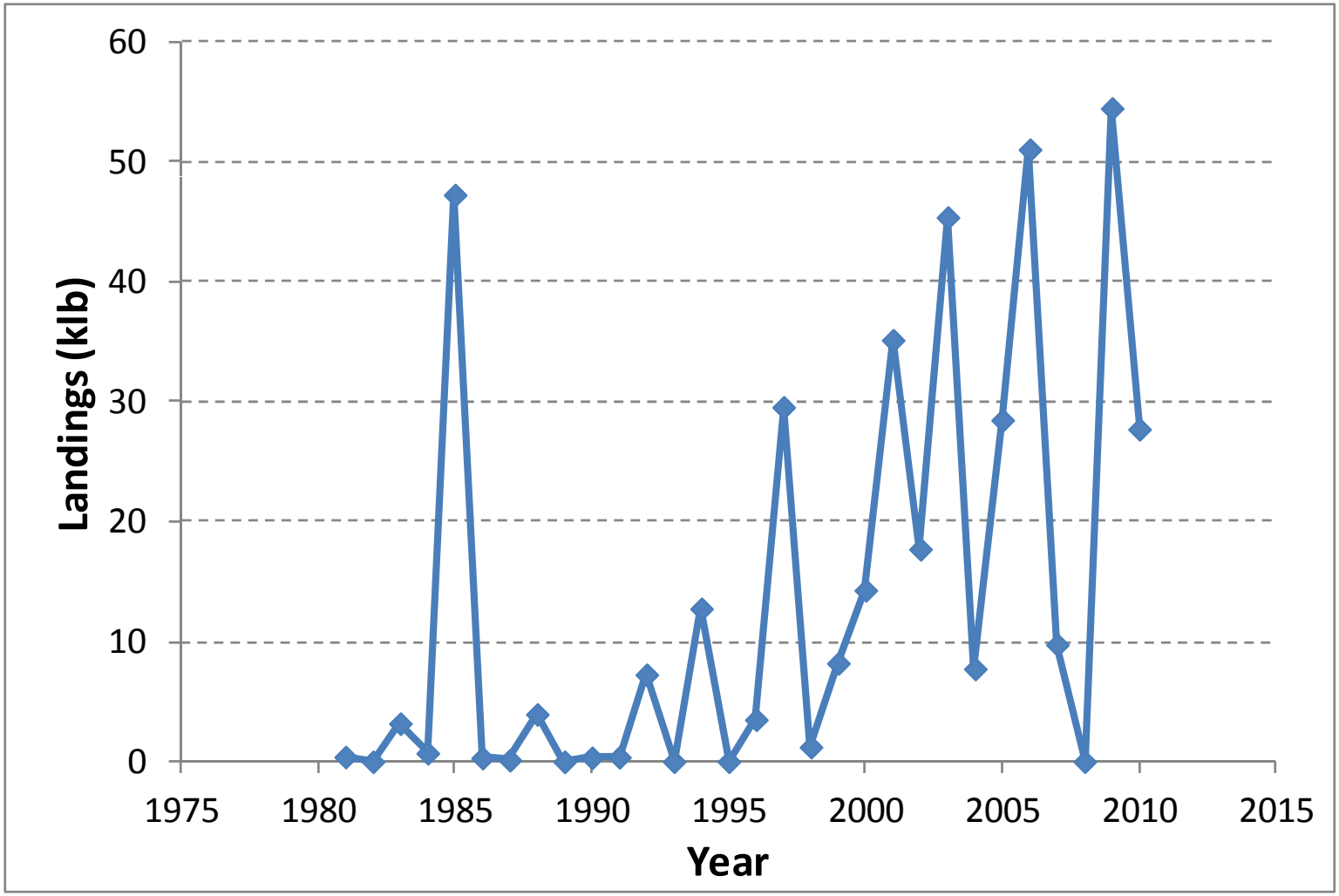
Recreational Landings



Length Composition Data

	Recreational		Commercial Longline		Commercial Handline	
YEAR	samples	trips	samples	trips	samples	trips
1981	1	1				
1982	0	0				
1983	0	0				
1984	10	2			19	2
1985	1	1			52	6
1986	0	0			79	2
1987	1	1	484	7	58	2
1988	1	1	1057	8	3	1
1989	17	10	328	5	5	1
1990	14	6	738	7	3	1
1991	2	1	5291	40	134	7
1992	1	1	12558	100	8	1
1993	0	0	26441	141	54	3
1994	2	2	9943	59	68	2
1995	0	0	7473	64	438	5
1996	53	6	1847	30	13	2
1997	126	9	1388	19	84	5
1998	48	5	881	15	43	2
1999	4	2	2807	26	84	8
2000	5	2	1603	13	322	8
2001	20	7	1488	23	66	7
2002	28	6	987	19	160	13
2003	64	7	254	10	1	1
2004	28	4	356	15	1	1
2005	130	9	404	16	103	5
2006	17	4	821	36	59	2
2007	1	1	945	35	1	1
2008	0	0	554	20	1	1
2009	12	5	880	25	7	1
2010	11	5	703	24	13	2

Age Composition Data

	Commercial Longline		Commercial Handline		MARMAP	
YEAR	samples	trips	samples	trips	samples	trips
1981						
1982						
1983						
1984			16	2		
1985			20	6	269	59
1986			3	2		
1987	28	7	3	2		
1988	0	8	0	1		
1989	0	5	0	1		
1990	0	7	0	1		
1991	0	40	0	7		
1992	124	100	8	1		
1993	209	141	1	3		
1994	8	59	8	2		
1995	373	64	0	5		
1996	782	30	0	2		
1997	908	19	143	5		
1998	269	15	61	2	344	38
1999	350	26	35	8		
2000	338	13	222	8		
2001	296	23	46	7		
2002	57	19	202	13	94	23
2003	177	10	61	1		
2004	264	15	255	1		
2005	410	16	255	5		
2006	842	36	214	2	80	14
2007	1153	35	275	1		
2008	1172	20	50	1		
2009	1542	25	86	1		
2010	989	24	67	2	332	44

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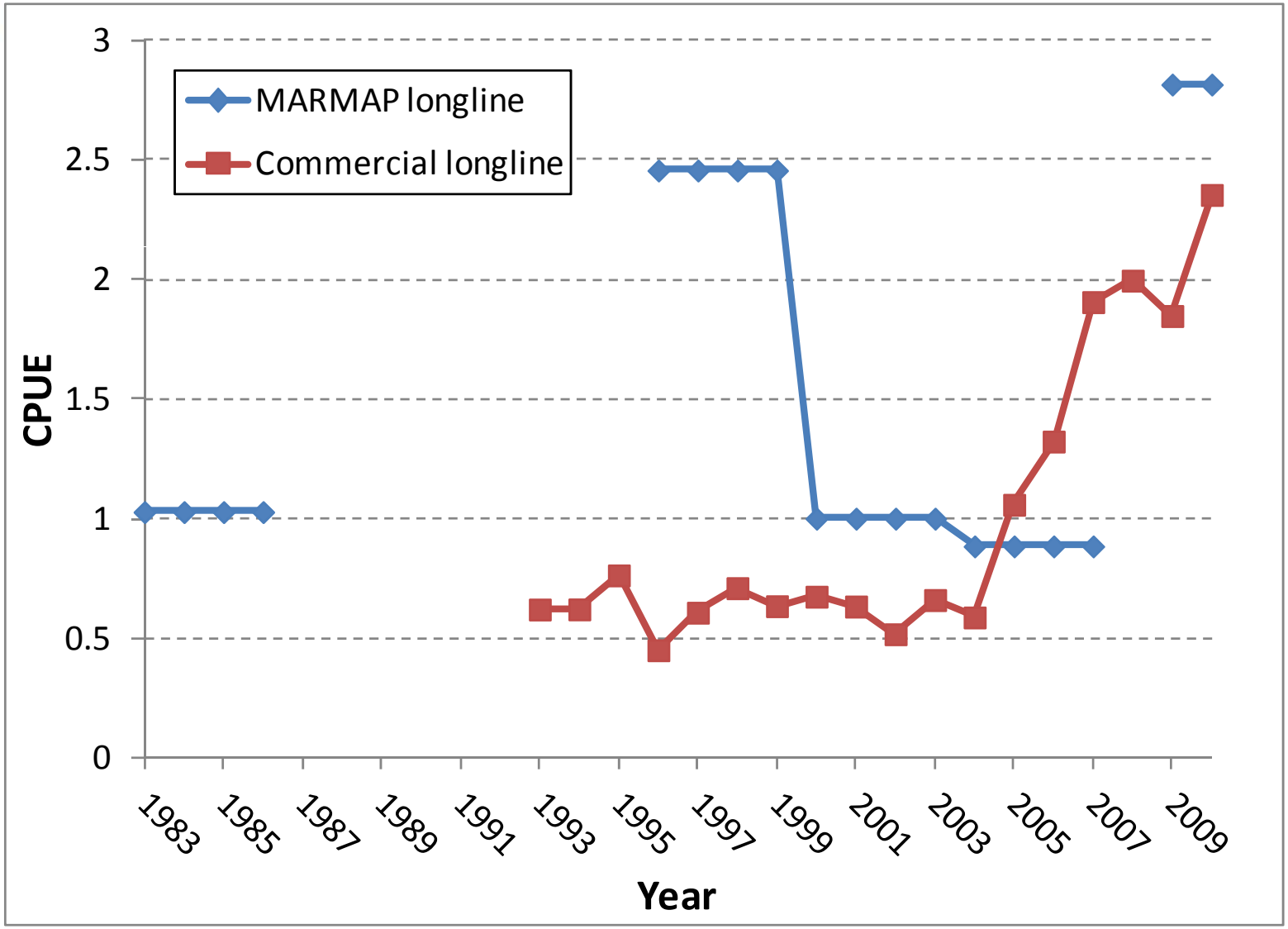
Indices



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Questions about the data?

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SCAA Model - BAM

$$w^L_{(f),a,y} = \theta_1 (\xi^L_{(f),a,y})^{\theta_2}$$

$$Z_{a,y} = M_a + F_{a,y}$$

$$L''_{f,a,}\Lambda_7 = \omega_7 \left[\sum_{y=Y_2}^{Y} \frac{[(R_y - \widehat{\varrho} R_{y-1}) + (\widehat{\sigma}_R^2/2)]^2}{2\widehat{\sigma}_R^2} + n \log(\sigma_R) \right]$$

$$l_a = L_\infty (1 - \exp[-K(a - t_0 + 0.5)])$$

$$\Lambda_3 = \sum_f \sum_y \frac{\left[\log\left((L_{f,y}+x)/(\breve{L}_{f,y}+x)\right)\right]^2}{2(\sigma^L_{f,y})^2}$$

$$F_{a,y} = \sum_f F_{f,a,y}$$

$$\sigma^U_{u,y} = \sqrt{\log(1 + (c^U_{u,y}/\omega^U_u)^2)}$$

$$N_{0,1962} = \frac{\widehat{R}_0 (0.8\varsigma \widehat{h} \phi_{init} - 0.2\phi_0 (1-\widehat{h}))}{(\widehat{h} - 0.2)\phi_{init}}$$

$$L'_{f,a,y} = \frac{F_{f,a,y}}{Z_{a,y}} N_{a,y} [1 - \exp(-Z_{a,y})]$$

$$\psi^u_{a,l} = \frac{1}{\sqrt{2\pi}(\sigma^\lambda_a)} \frac{\exp\left[-(l'_l - l_a)^2\right]}{\left(2(\sigma^\lambda_a)^2\right)}$$

$$s_{(f,u),a} = \frac{1}{1 + \exp\left[-\widehat{\eta}_{(f,u)}\left(a - \widehat{\alpha}_{(f,u)}\right)\right]}$$

$$N_{A,y} = N_{A-1,y-1} \frac{\exp(-Z_{A-1,y-1})}{1 - \exp(-Z_{A,y-1})})$$

$$N_{0,y+1} = \frac{0.8\widehat{R}_0 \widehat{h} S_y}{0.2\phi_0 \widehat{R}_0 (1-\widehat{h}) + (\widehat{h} - 0.2) S_y} \exp(\widehat{R}_{y+1})$$

$$F_{f,a,y} = s_{f,a,y} \widehat{F}_{f,y}$$

$$\Lambda_2 = -\sum_{f,u} \sum_y \left[\omega^\alpha_{(f,u)} n^\alpha_{(f,u),y} \sum_a (p^\alpha_{(f,u),a,y} + x) \log\left(\frac{(\breve{p}^\alpha_{(f,u),a,y} + x)}{(p^\alpha_{(f,u),a,y} + x)} \right) \right]$$

$$B_y = \sum_a N_{a,y} w_a$$

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SCAA Model – BAM Configuration

- Modeled ages: 1-25+
- Fisheries: commercial longline, commercial handline, recreational
- Discards: None
- Abundance Indices: commercial longline (FD), MARMAP longline (FI)
- Selectivity: logistic functions for commercial longline, commercial handline, and MARMAP index; recreational assumed equal to commercial handline
- Fishing mortality: annual estimates (free parameters) for each fishery
- Stock-recruit: Beverton-Holt curve with lognormal recruitment deviations
- Length-age: conversion matrix based on normally distributed lengths at age

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SCAA Model – BAM Estimated Parameters

- S-R parameters (2): R0, sigma-R (steepness=0.84)
- Annual R devs (28): 1976-2003 (1962-1975, 2004-2010 = 0.0)
- Selectivity (6): slopes and A50s for commercial fisheries and MARMAP index
- Catchability (2): q for each abundance index
- Fishing mortality (130): average F + annual deviations for each fishery
- Length-at-age (1): CV of length-at-age conversion matrix

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SCAA Model – BAM Likelihood Components

- Landings: Lognormal with assumed CV=0.05
- Indices: Lognormal with annual CVs provided by data workshop
- Age Compositions: Multinomial with annual n = number of sampled trips
- Length Compositions: Multinomial with annual n = number of sampled trips
- S-R penalty: Lognormal with estimated sigma-R parameter
- Prior penalties:
  - CV of length-at-age: mean and CV from empirical data
  - sigma-R: mean and CV from published meta-analysis
  - selectivity slopes: mean and CV set as loose constraint
- F penalty: added when total F>1.0 (see report for details)

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SCAA Model – BAM Path to Base Run

- Biomass in 1962 fixed to 0.9 of virgin
- R-devs starting in 1976
- Set recreational selectivity = commercial handline selectivity
- Steepness hitting upper bound, set h = 0.84
- Add ageing error matrix based on 0.5 of GOM sd's
- Add F constraint

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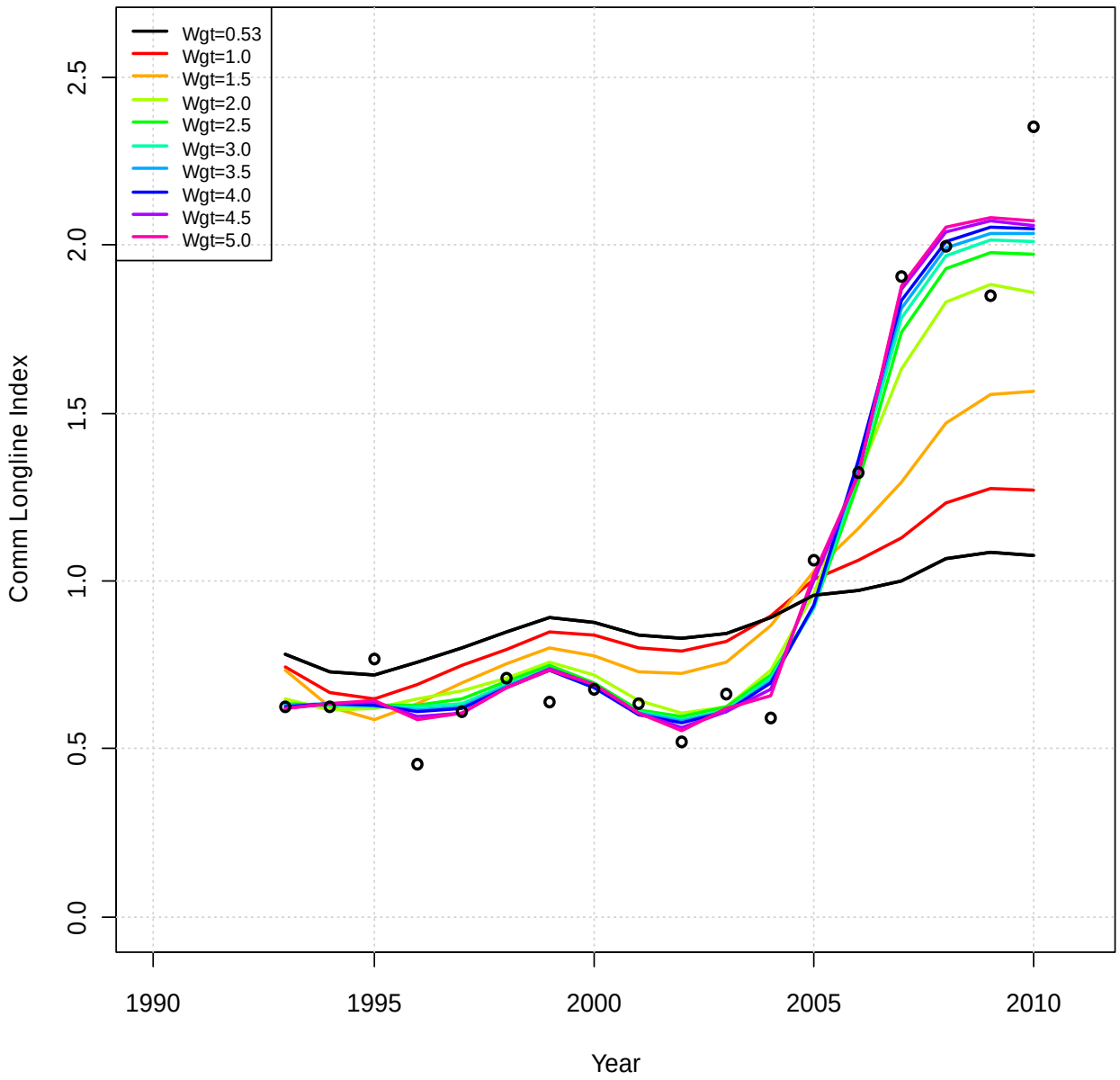
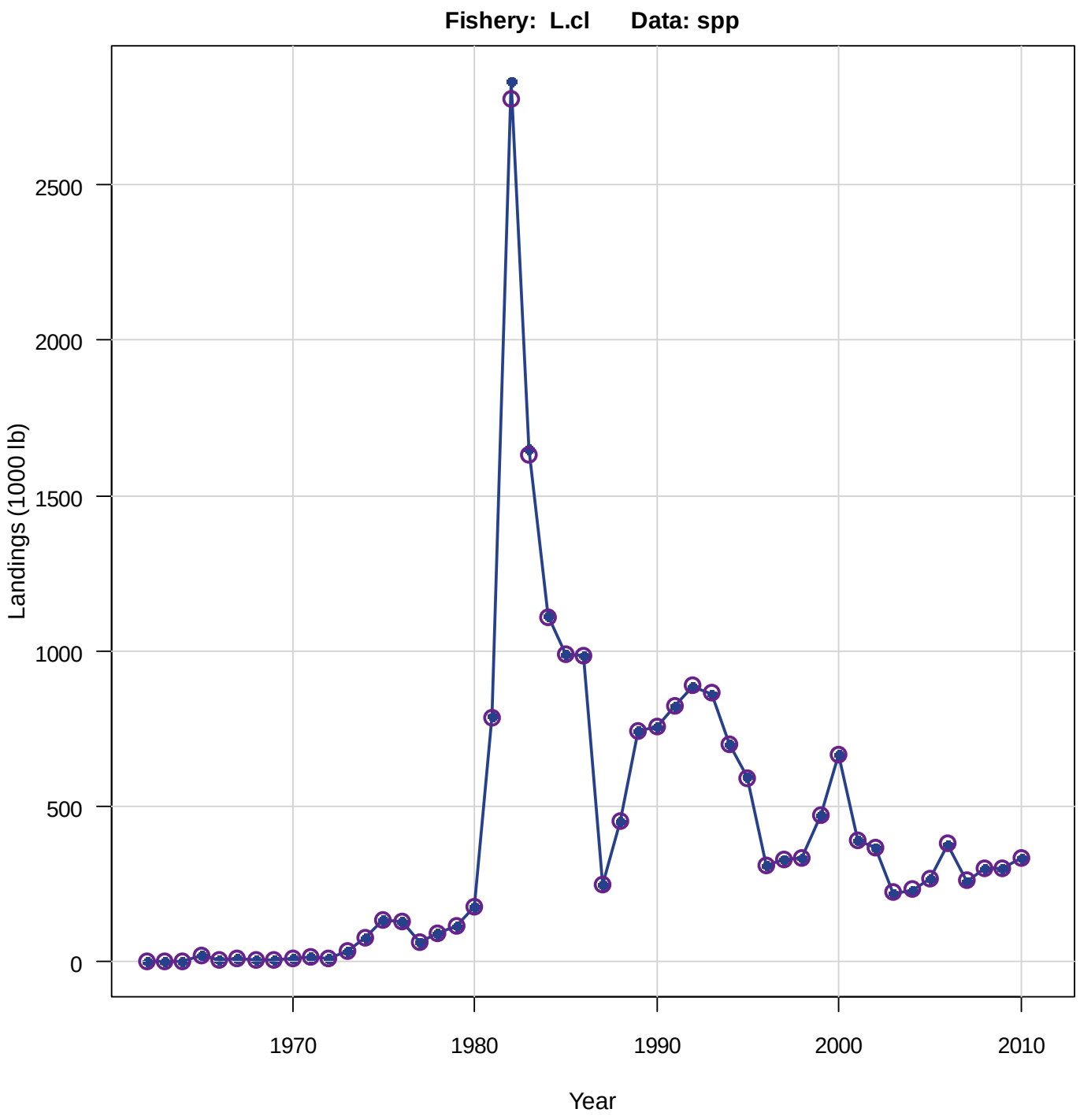
SCAA Model – BAM Iterative Re-weighting

		SDNR			Weights			Cumulative weights (for next iteration)		
		MARMAP	Commercial		MARMAP	Commercial		MARMAP	Commercial	
Run	Source		longline	handline		longline	handline		longline	handline
1	CPUE	0.21	2.98		4.77	0.34		4.77	0.34	
	Length comp		2.17	0.76		0.21	1.75		0.21	1.75
	Age comp	5.98	4.78	0.72	0.03	0.04	1.95	0.03	0.04	1.95
2	CPUE	0.63	1.25		1.60	0.80		7.63	0.27	
	Length comp		1.12	1.00		0.80	1.00		0.17	1.75
	Age comp	0.87	1.02	0.98	1.33	0.97	1.03	0.04	0.04	2.01
3	CPUE	0.92	1.64		1.09	0.61		8.33	0.16	
	Length comp		1.20	1.02		0.69	0.97		0.12	1.69
	Age comp	0.84	1.06	1.06	1.43	0.88	0.89	0.05	0.04	1.78
4	CPUE	0.96	1.37		1.04	0.73		8.64	0.12	
	Length comp		1.03	1.02		0.94	0.96		0.11	1.63
	Age comp	0.91	0.97	1.04	1.20	1.06	0.93	0.06	0.04	1.65
5	CPUE	0.99	1.13		1.01	0.89		8.72	0.11	
	Length comp		0.99	1.01		1.01	0.98		0.11	1.60
	Age comp	0.97	0.98	1.05	1.07	1.05	0.91	0.07	0.04	1.50
6	CPUE	1.00	1.04		1.00	0.96				
	Length comp		1.00	1.01		1.01	0.99			
	Age comp	0.99	0.99	1.03	1.01	1.01	0.95			

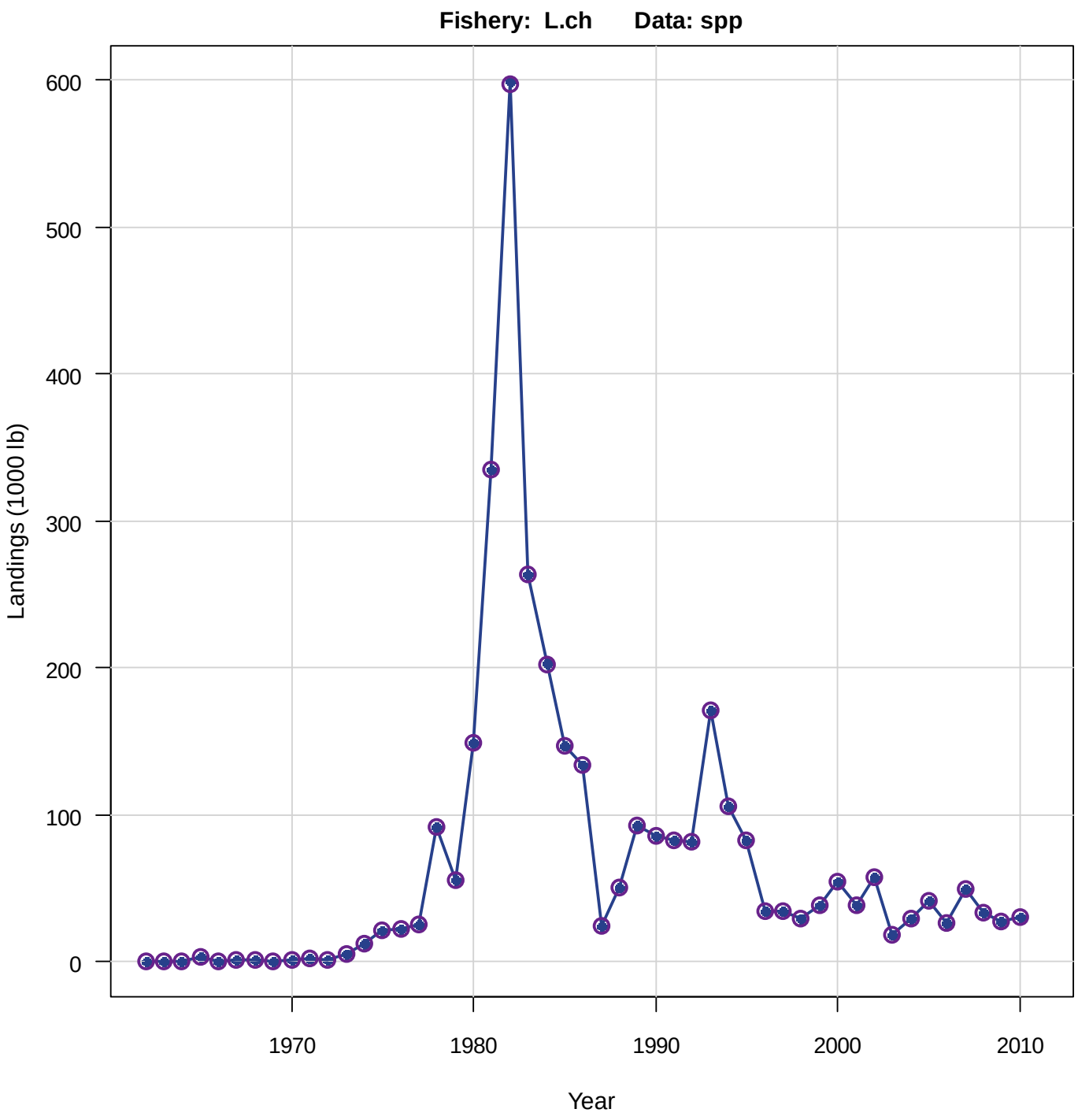
After the iterative re-weighting an examination of the model fit revealed that the fit to the commercial logbook index was unsatisfactory. A series of weights for this index were examined.



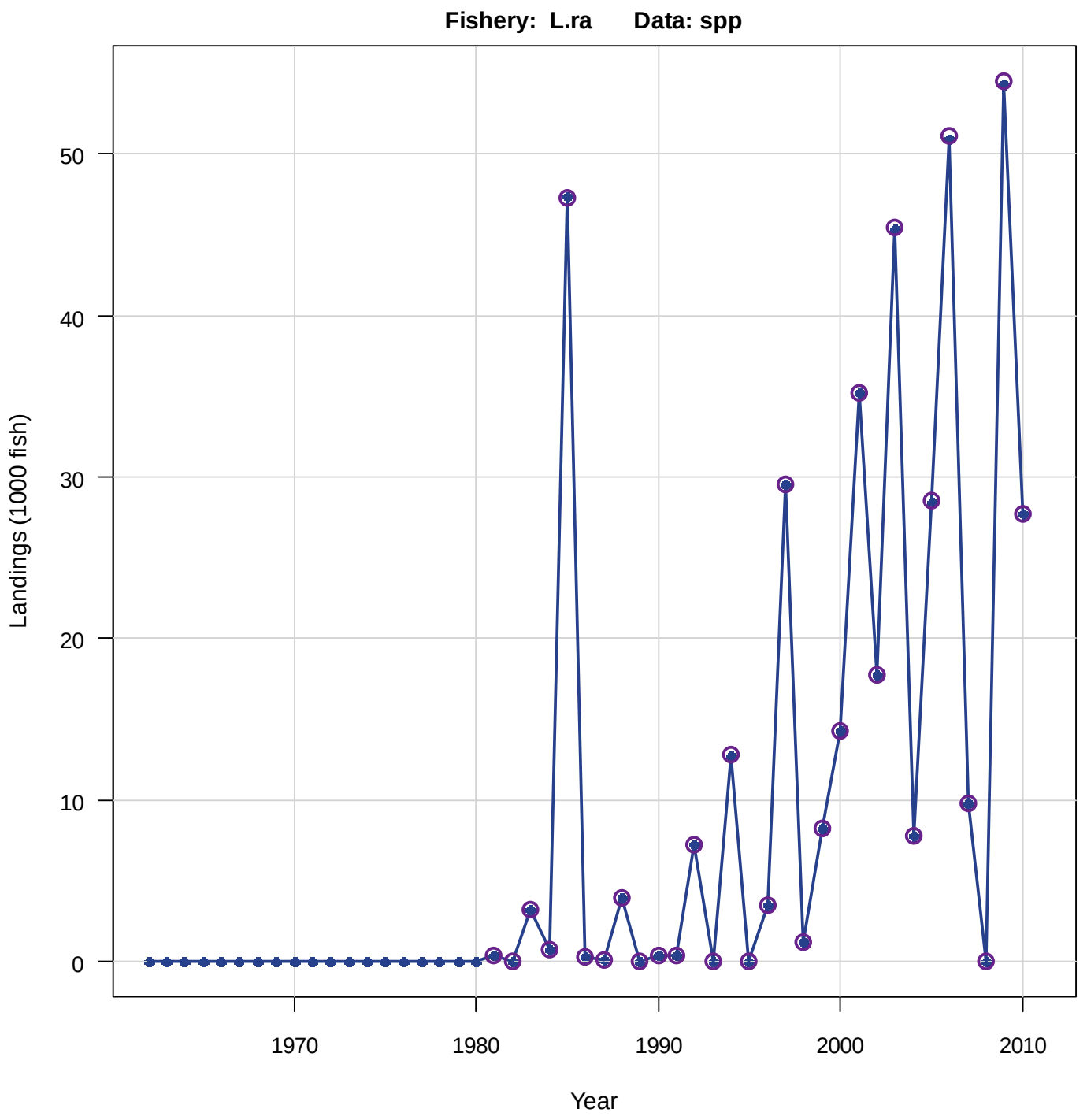
Base run uses a likelihood component weight of 3.0



SCAA Model – BAM AW Base Run Fit



SCAA Model – BAM
AW Base Run Fit



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AW Base Run Fit

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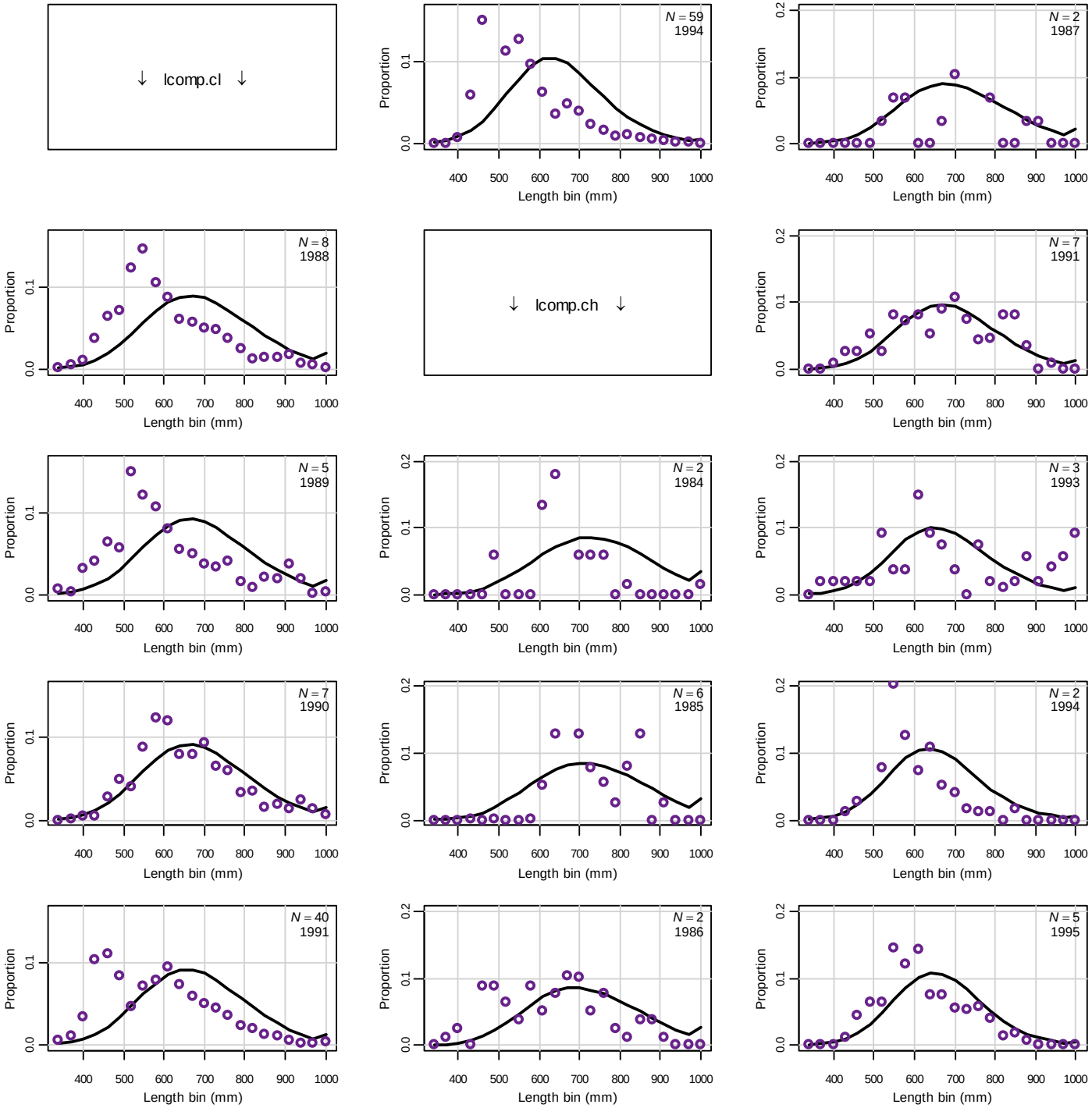

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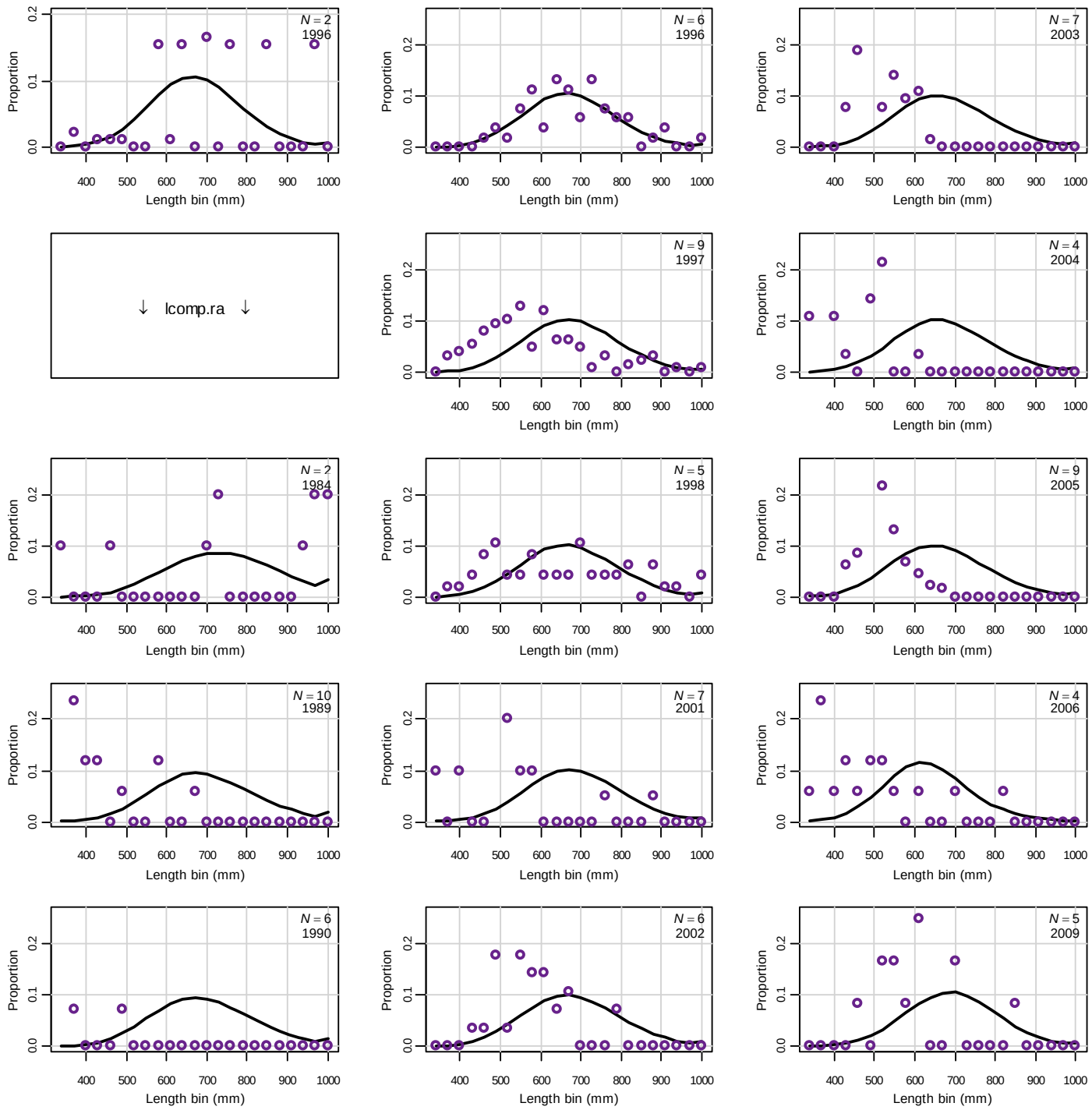

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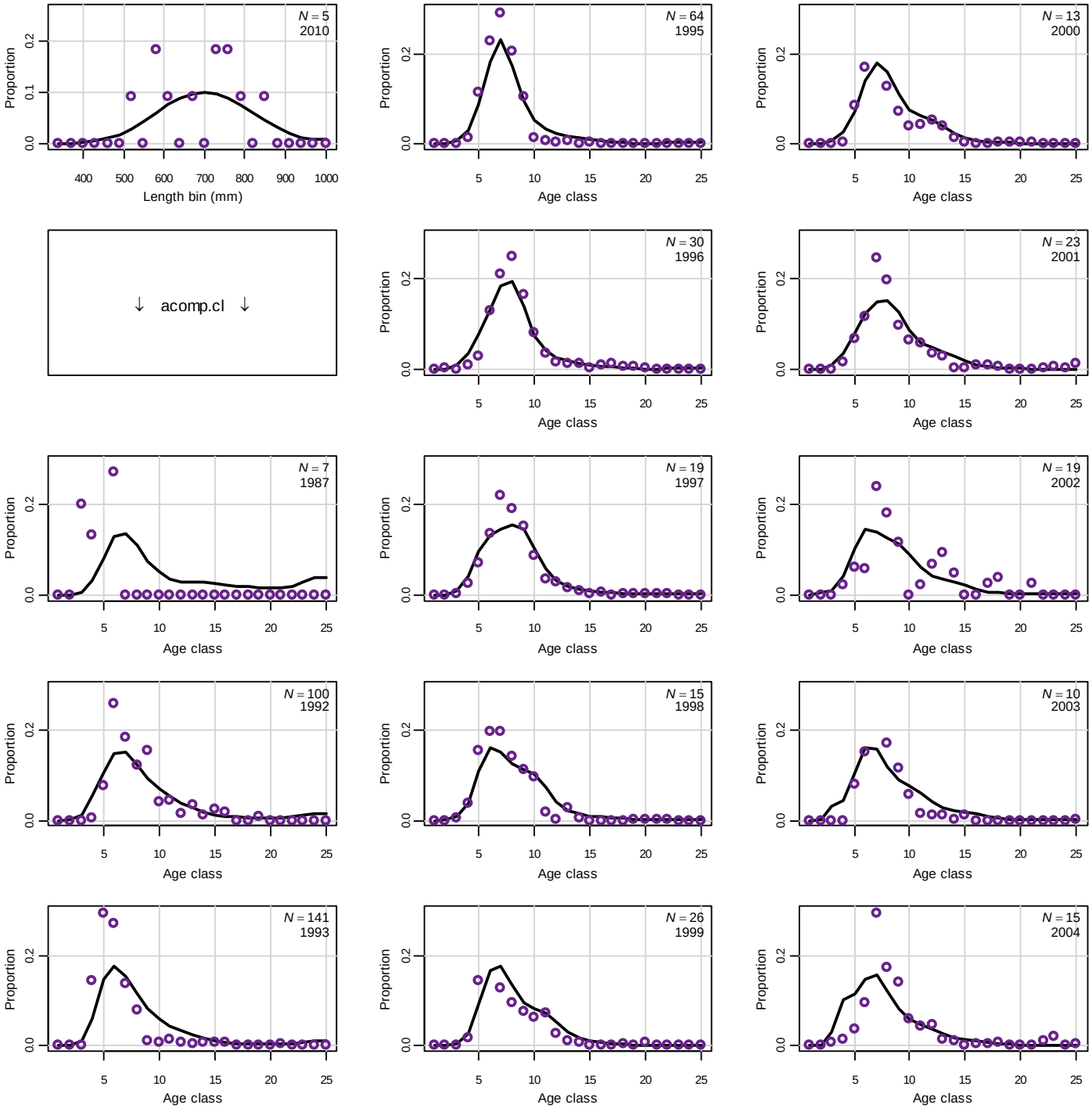
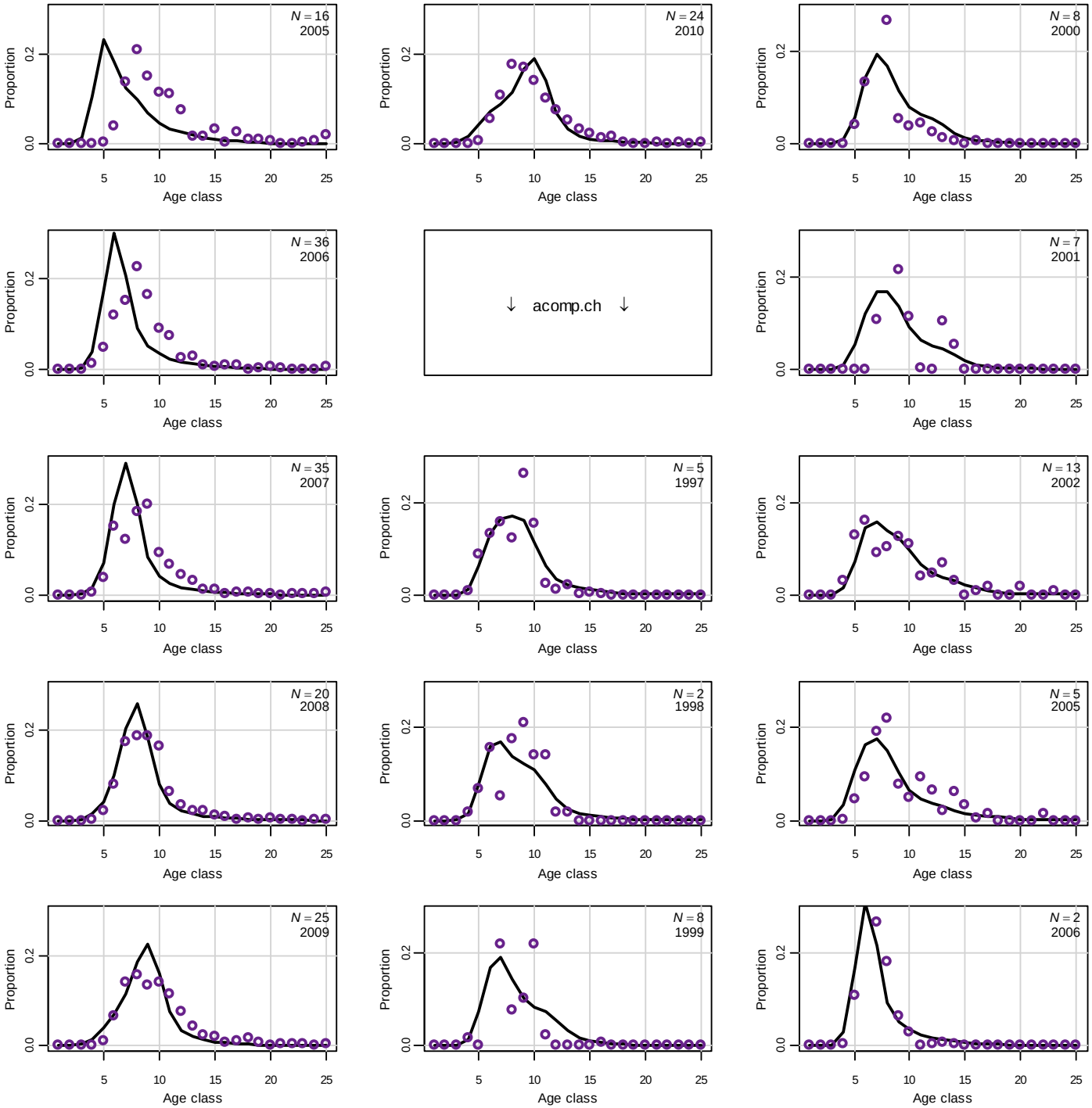
AW Base Run Fit



SCAA Model – BAM AW Base Run Fit



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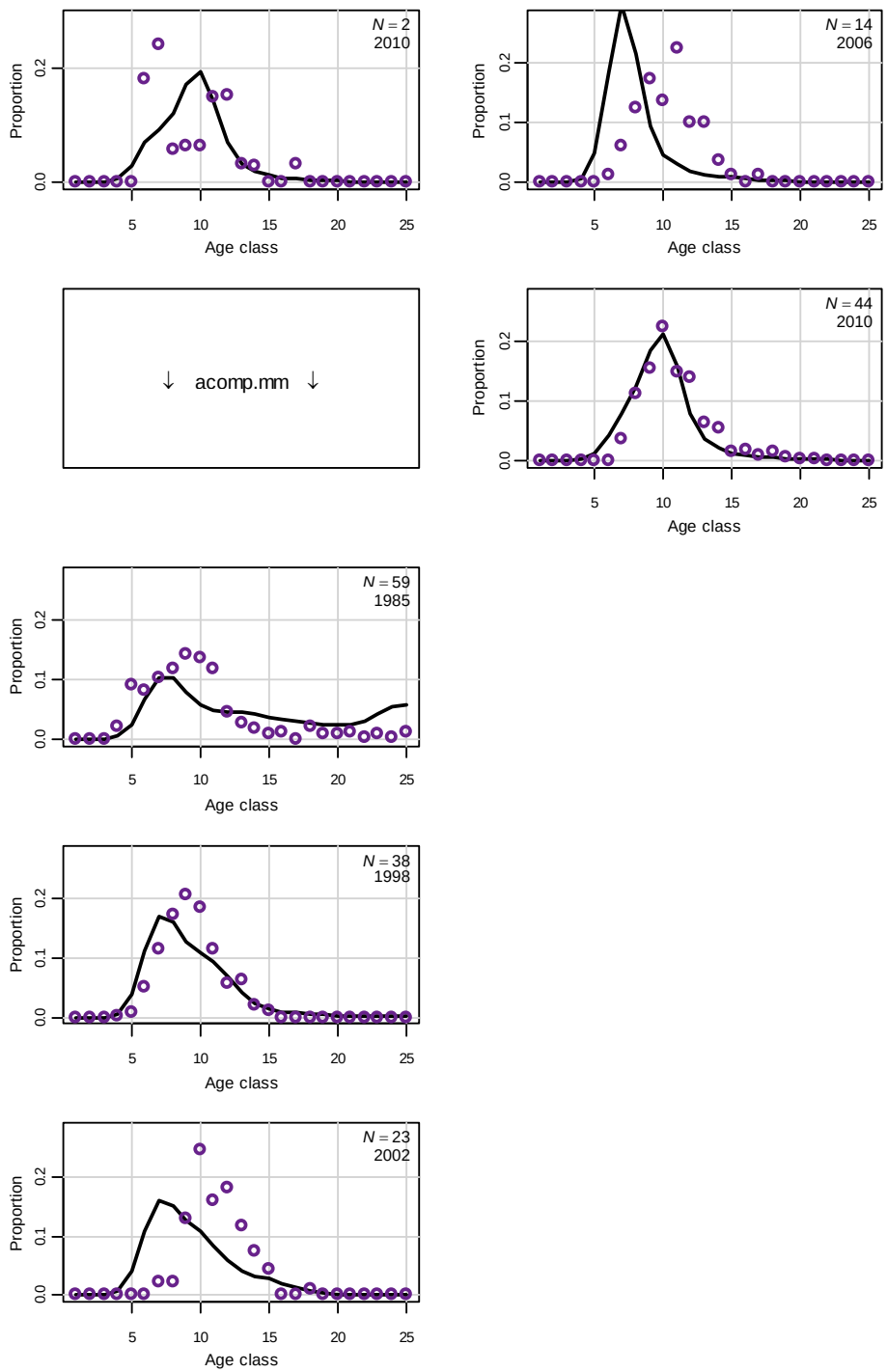

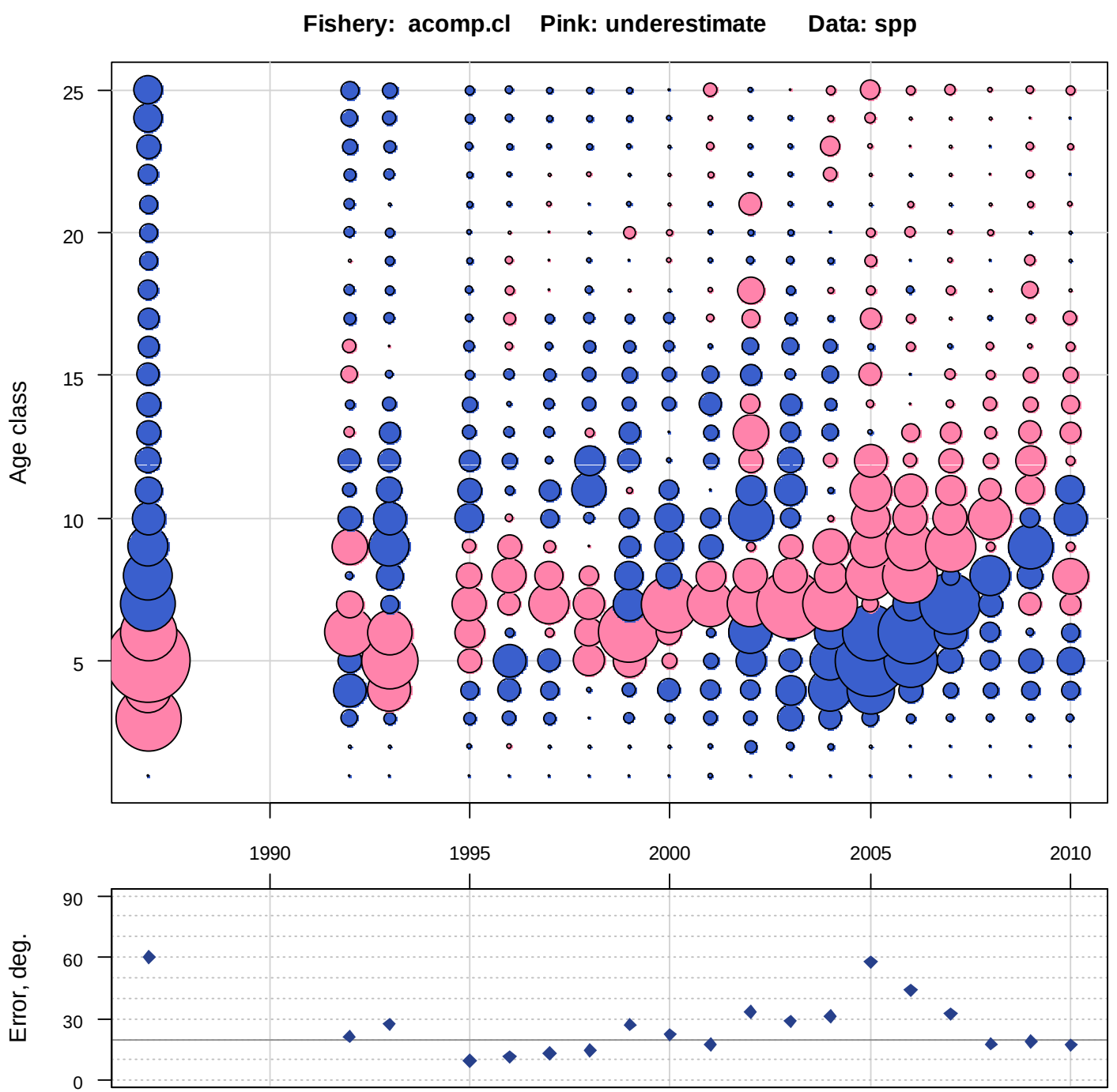

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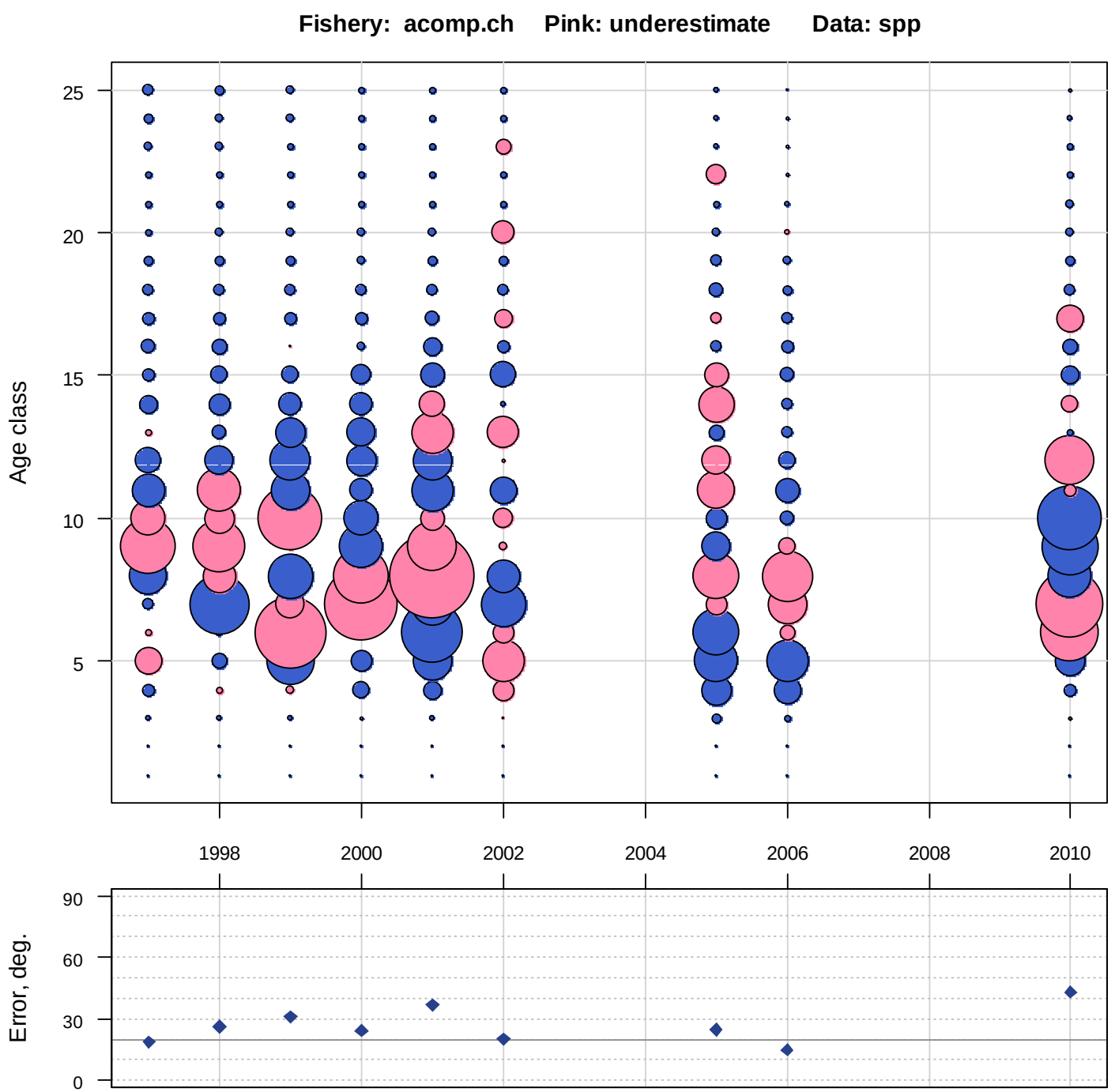

SCAA Model – BAM
AW Base Run Fit

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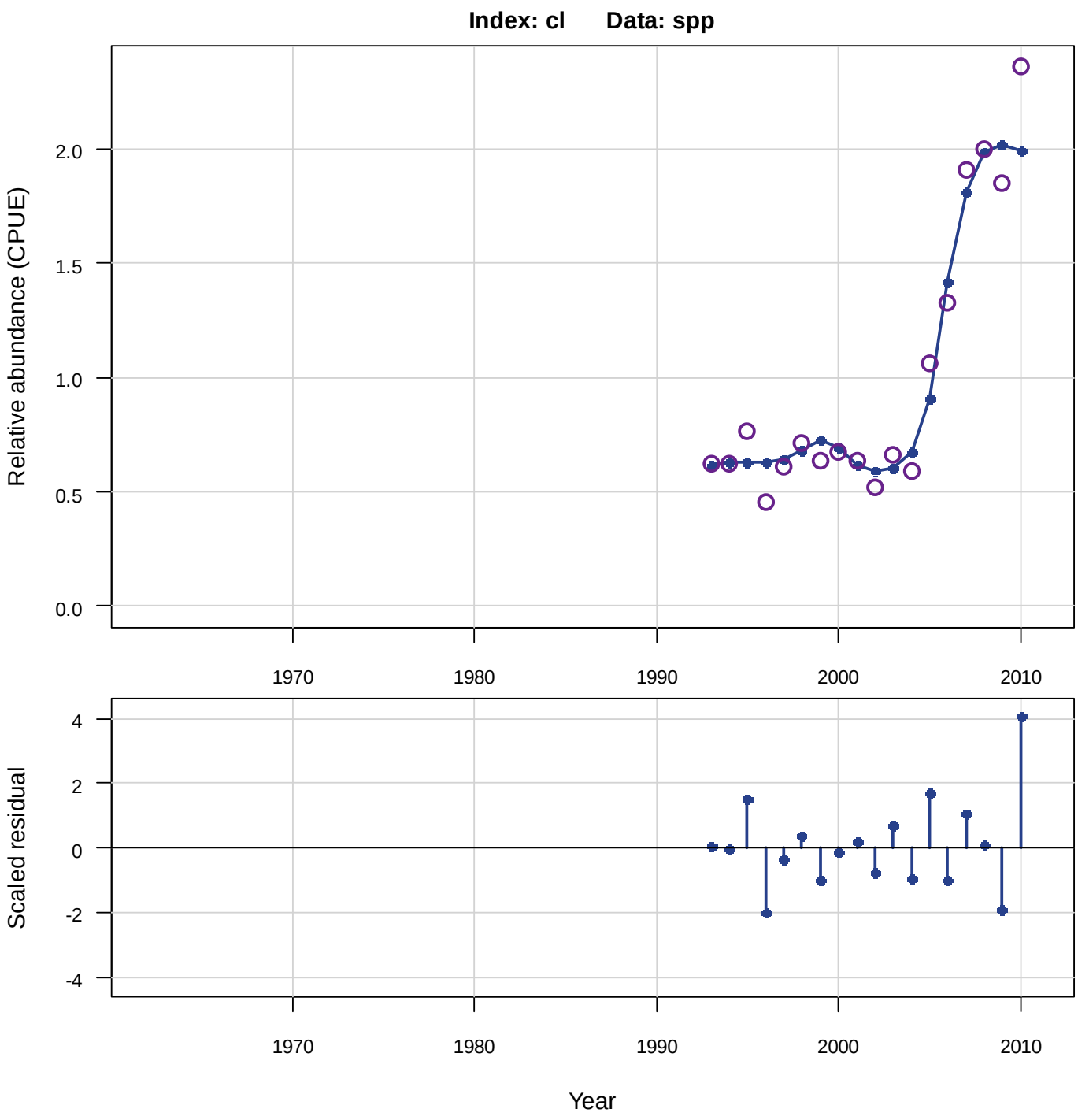

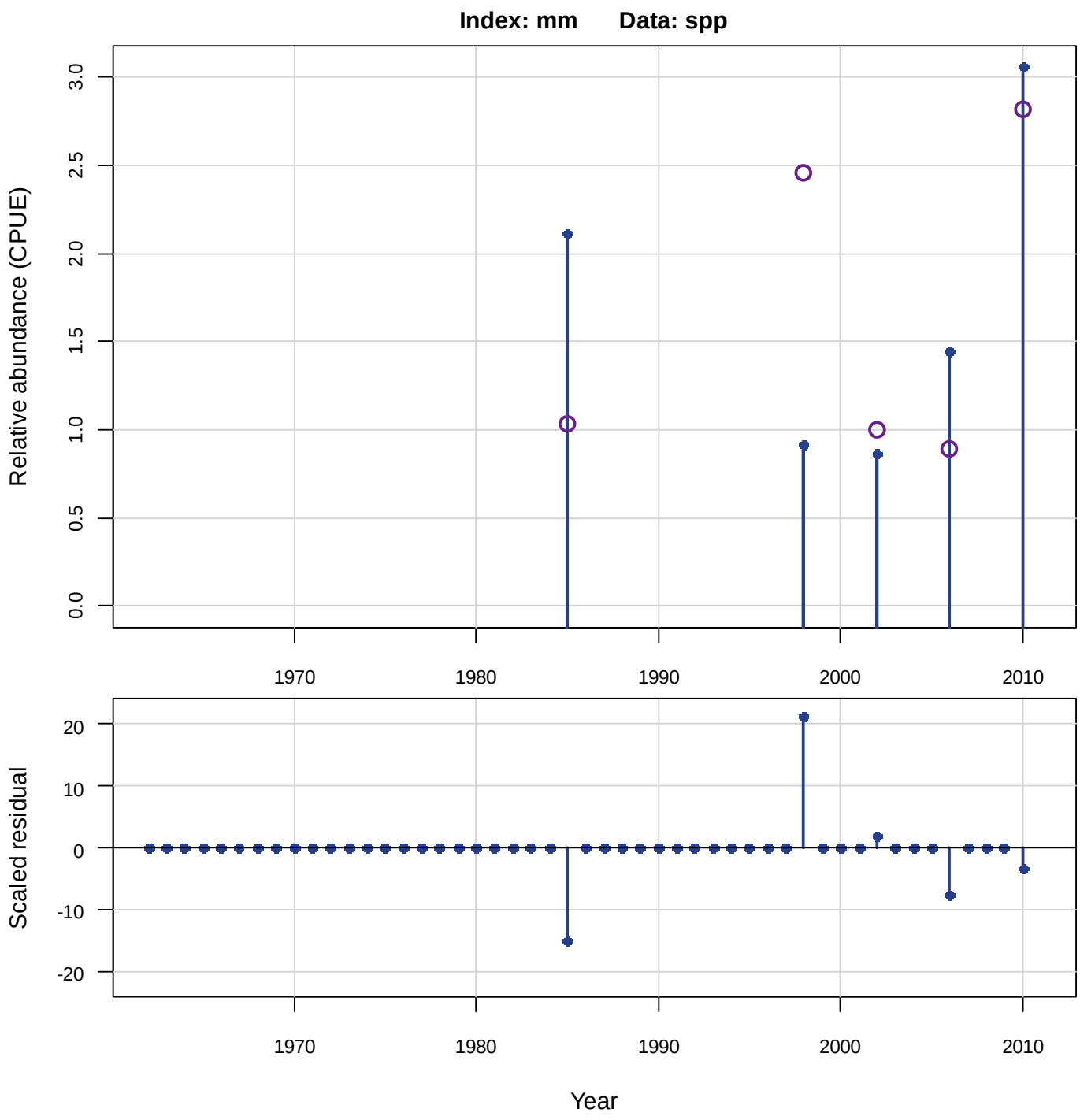

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AW Base Run Fit

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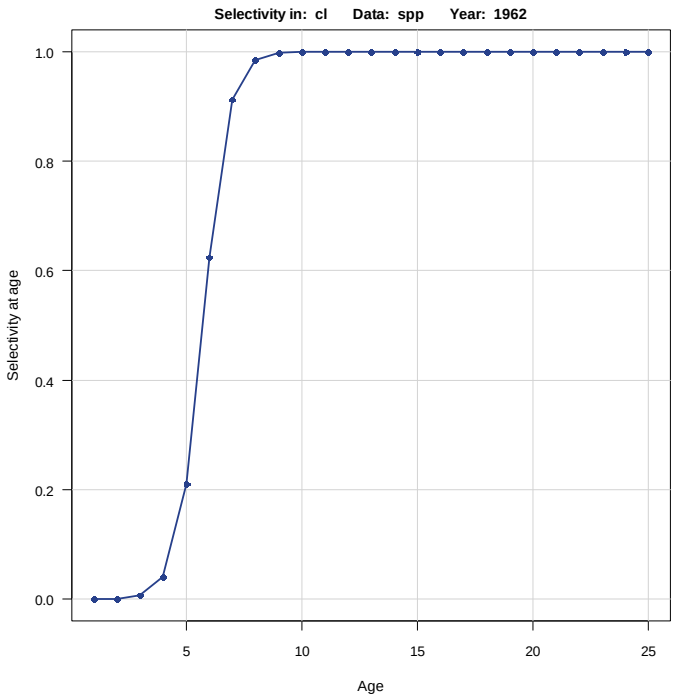
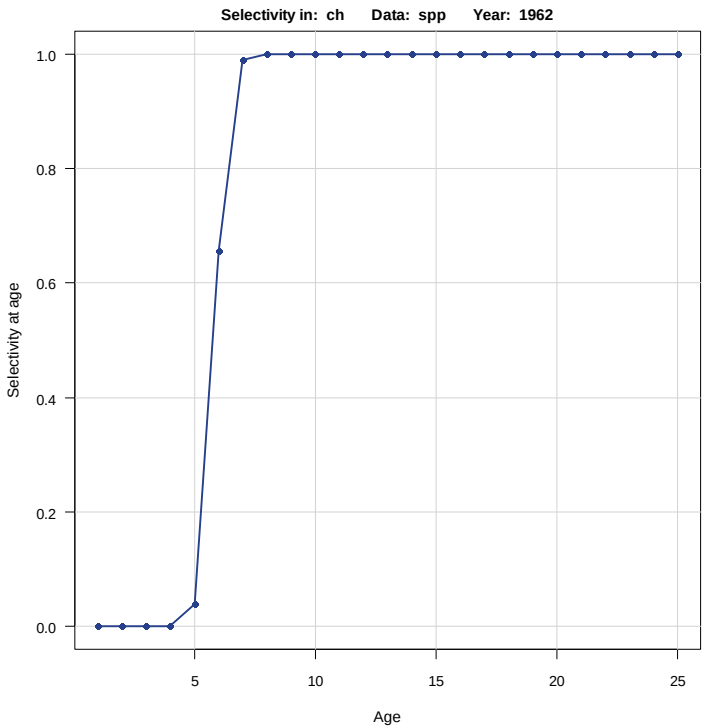
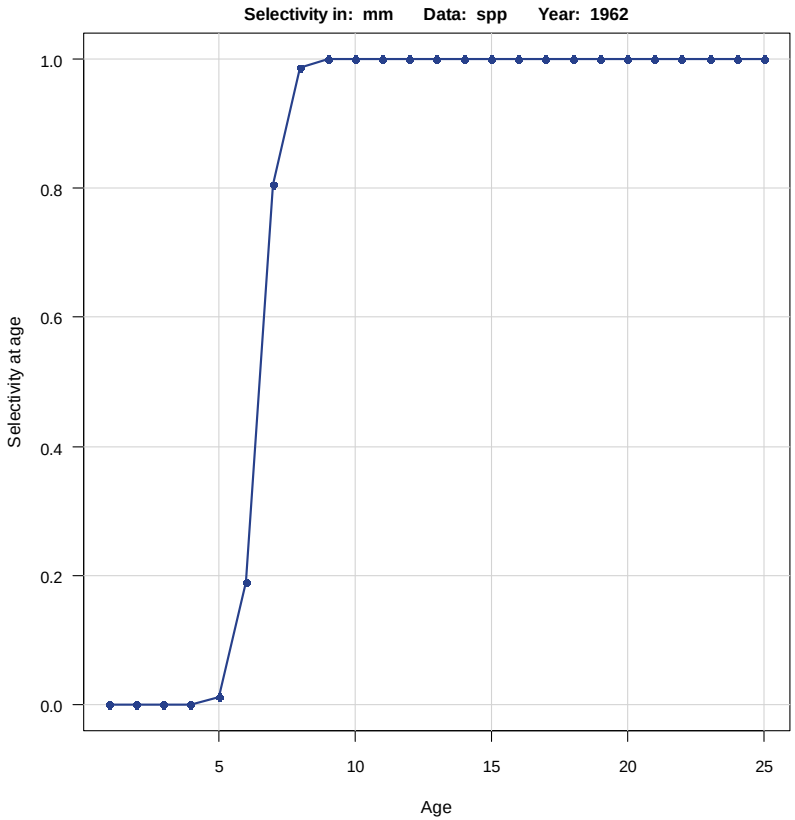
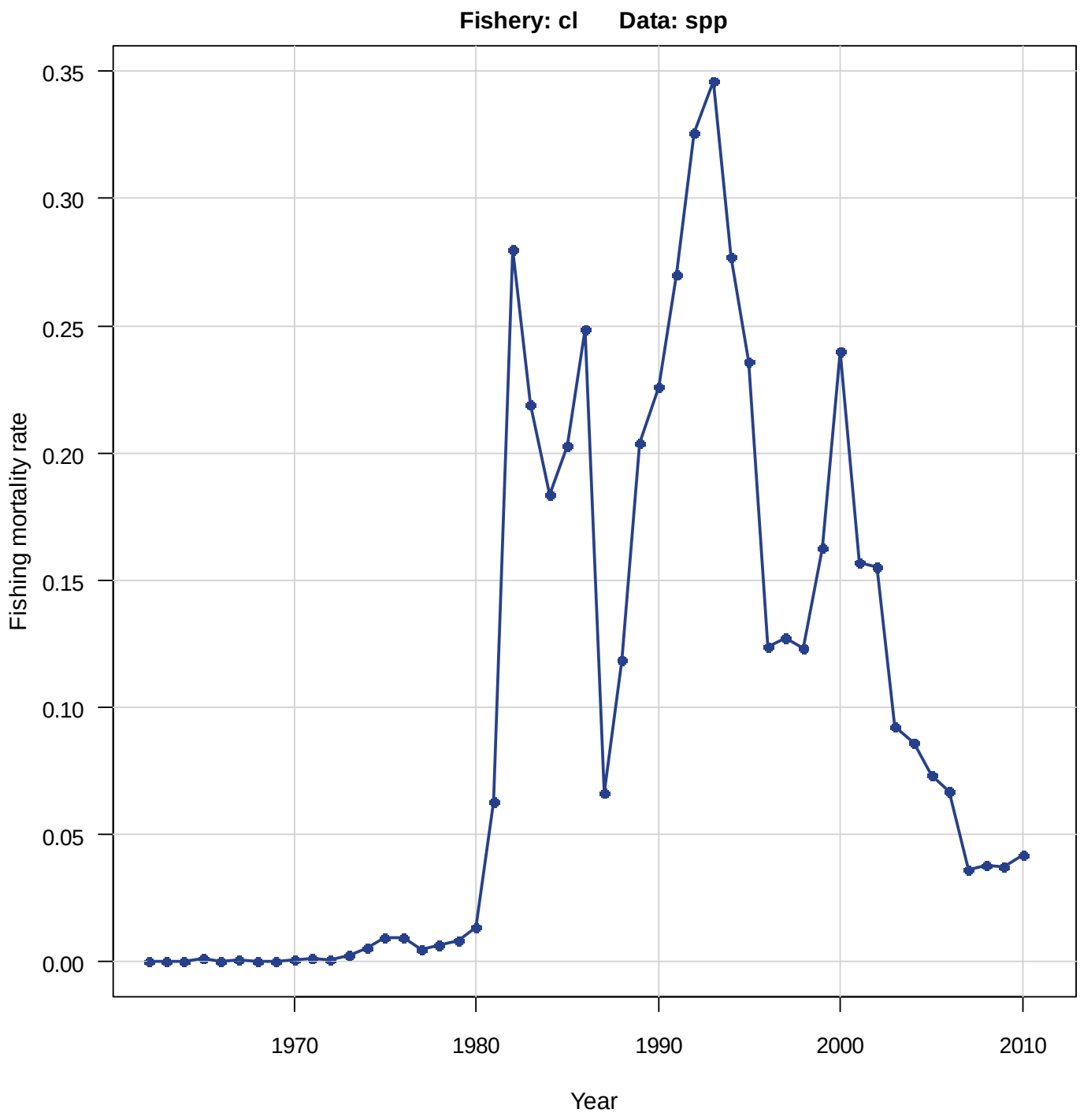


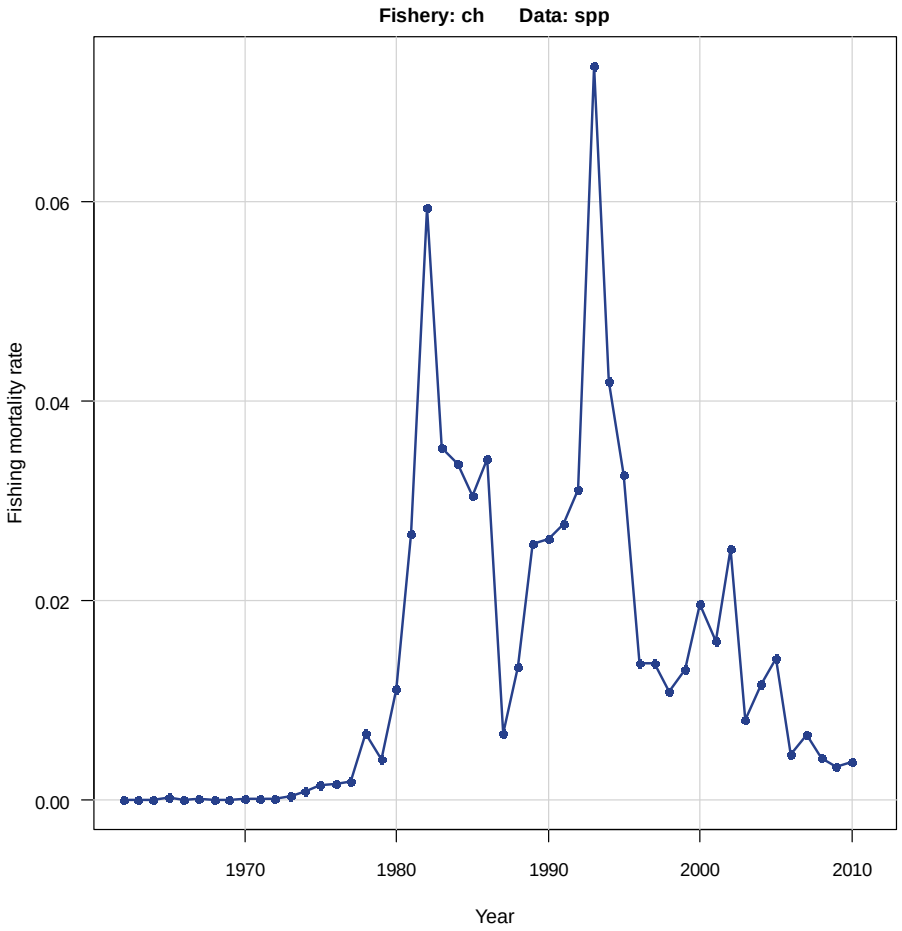


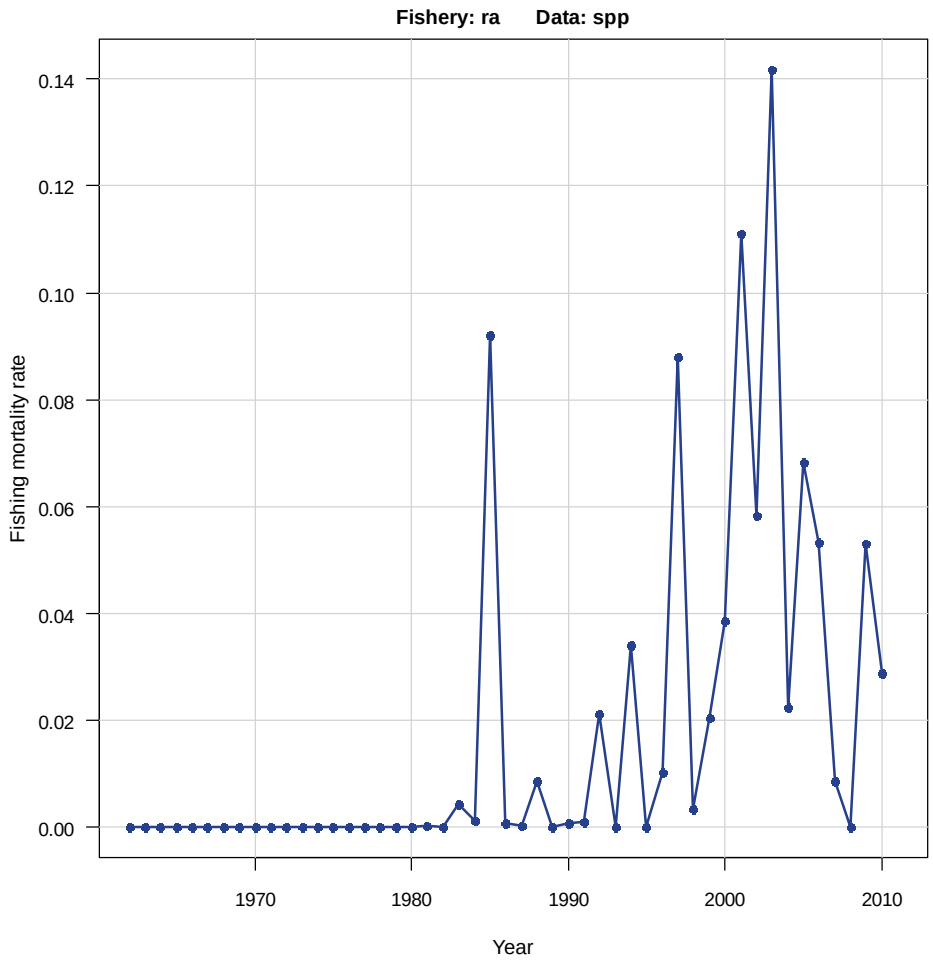


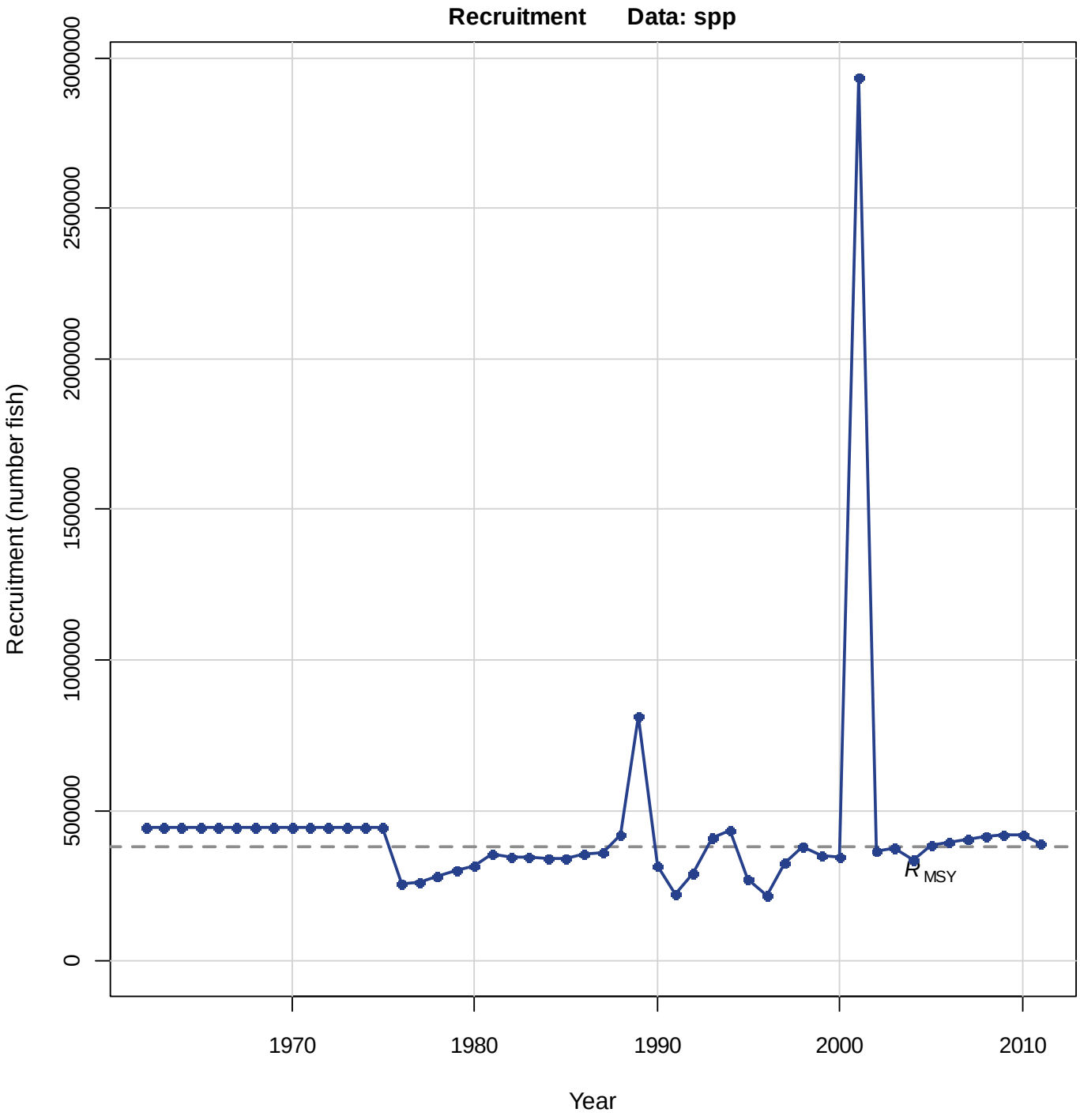


SCAA Model – BAM
AW Base Run Fit

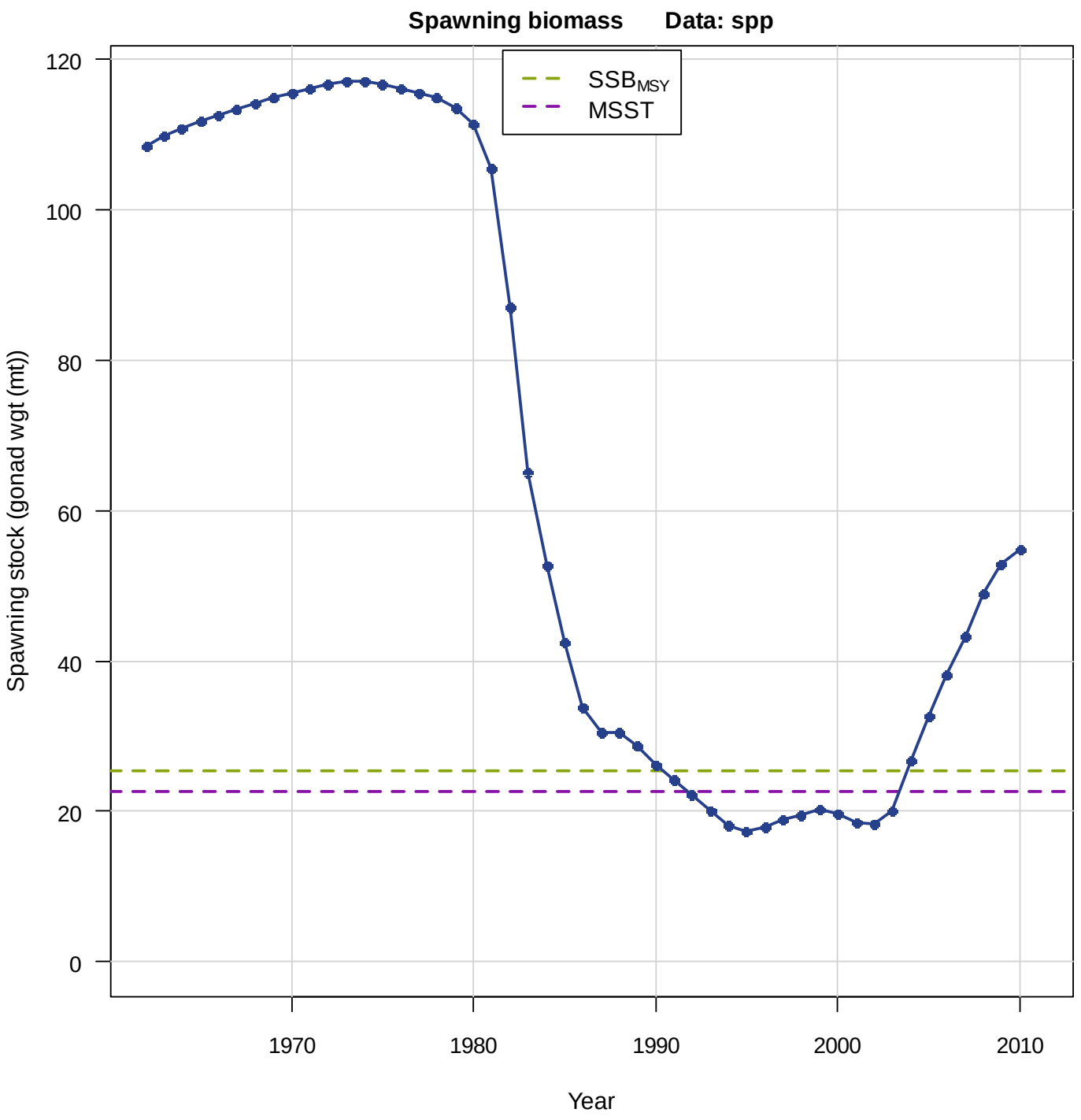
SCAA Model – BAM AW Base Run Fit







SCAA Model – BAM
AW Base Run Fit



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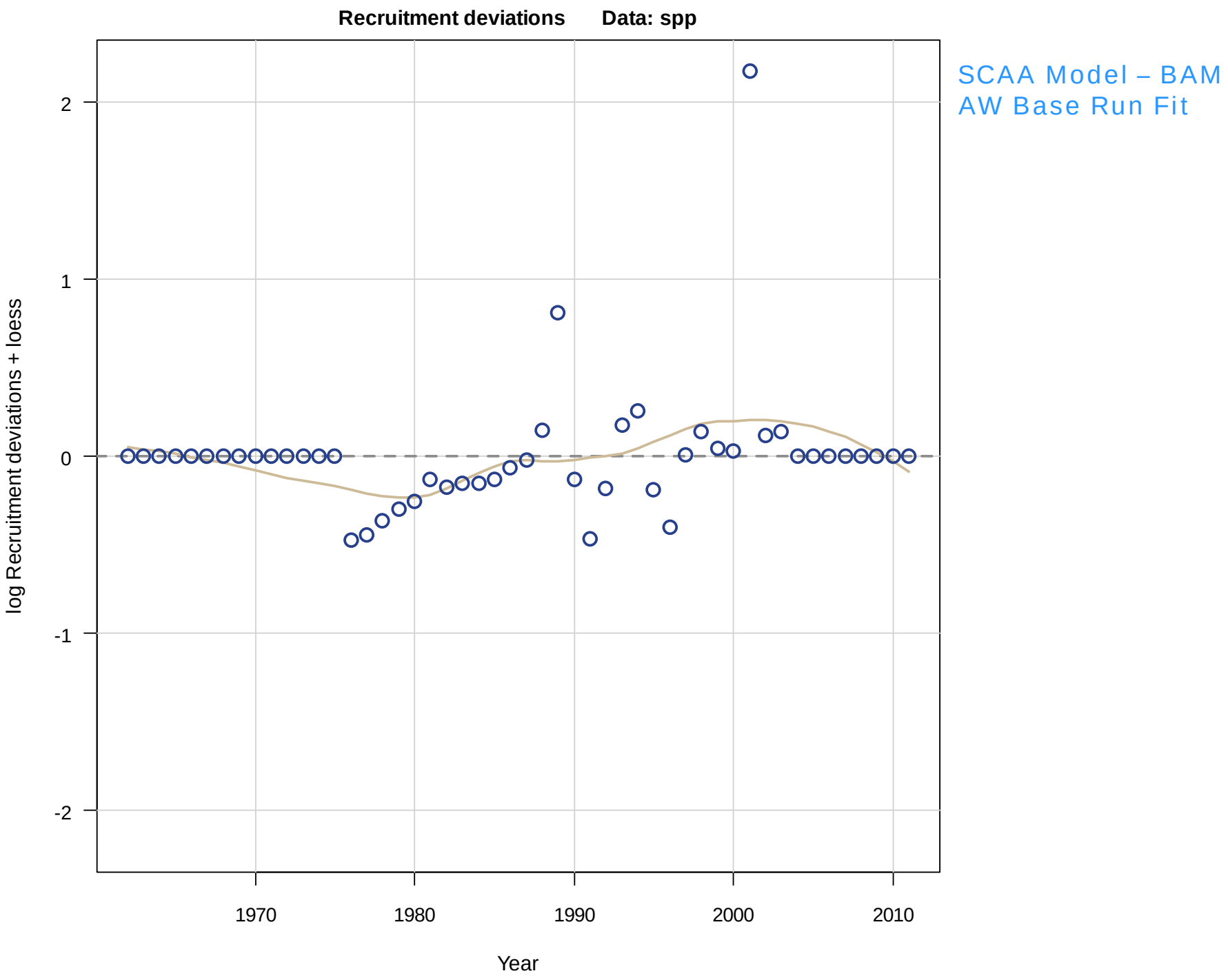
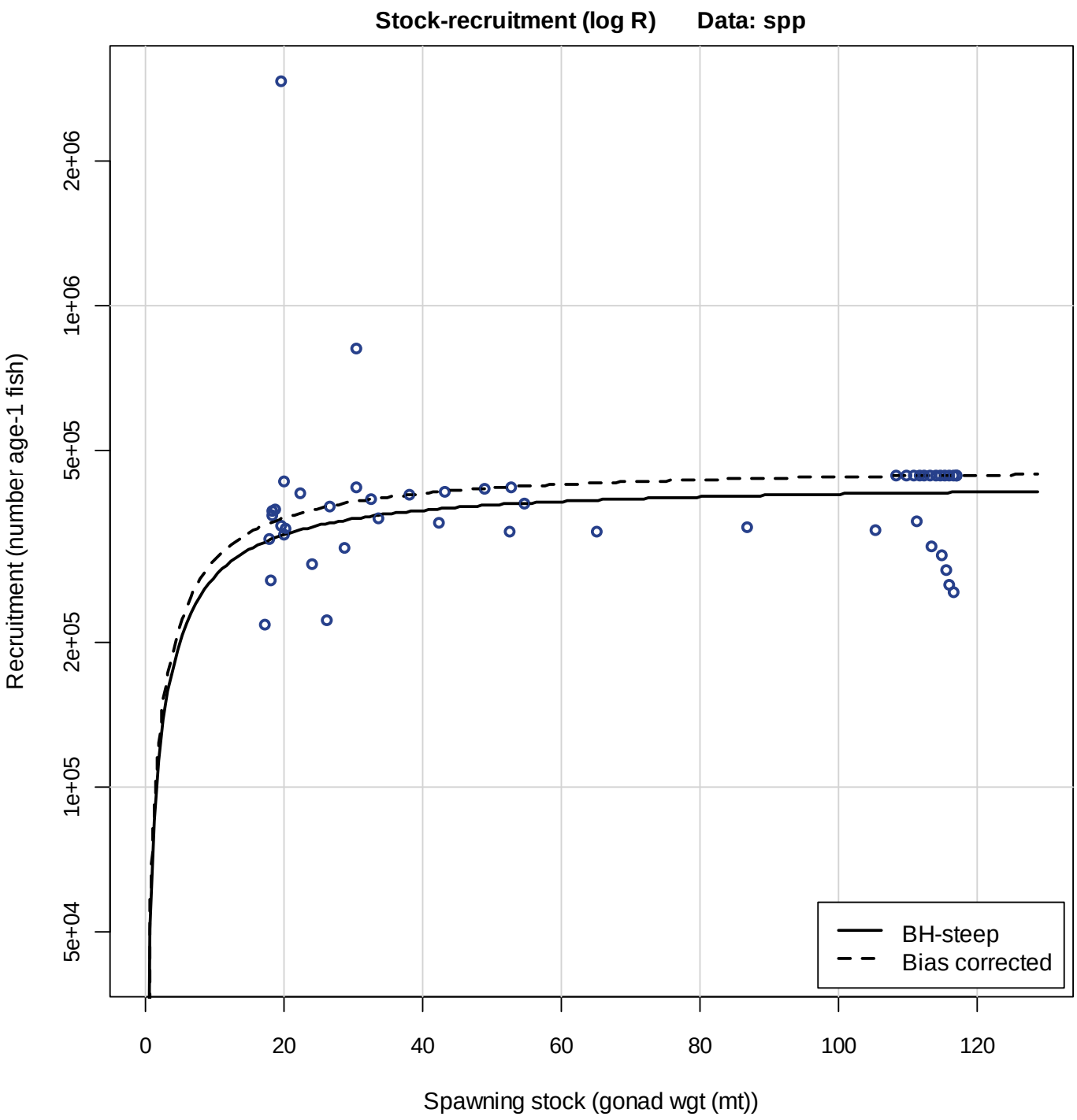

Recruitment deviations
Data: spp
SCAA Model – BAM
AW Base Run Fit
log Recruitment deviations + loess
2
1
0
-1
-2
1970
1980
1990
2000
2010
Year

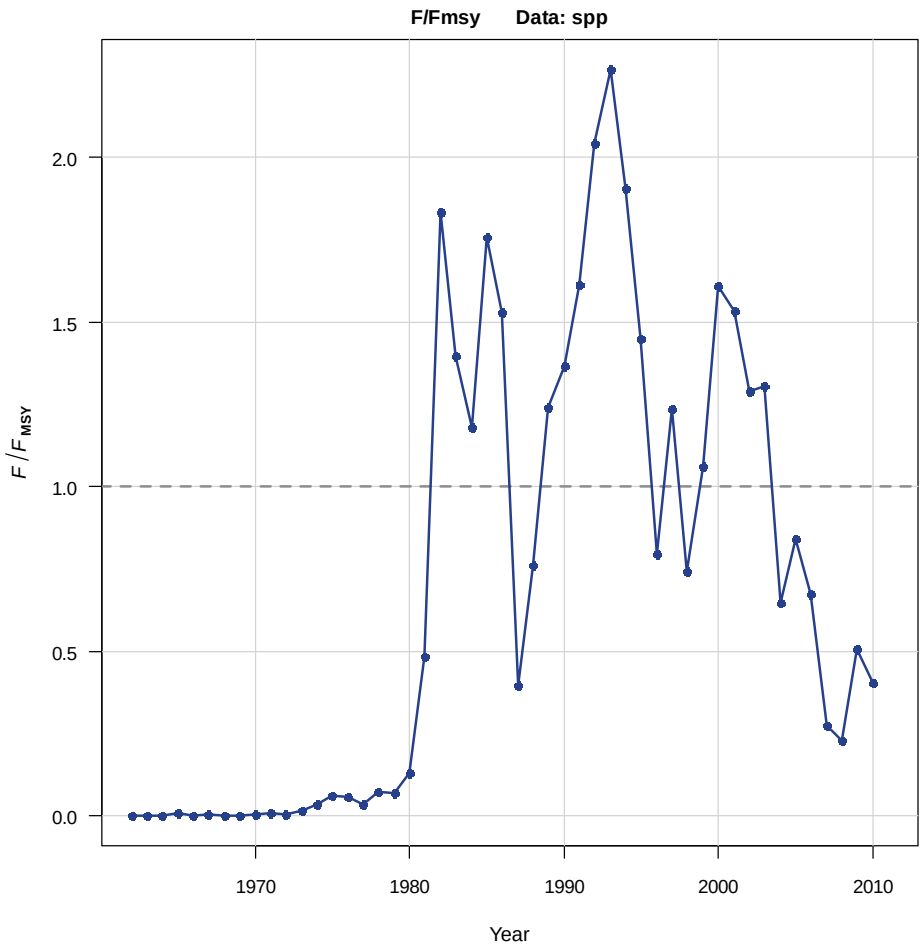


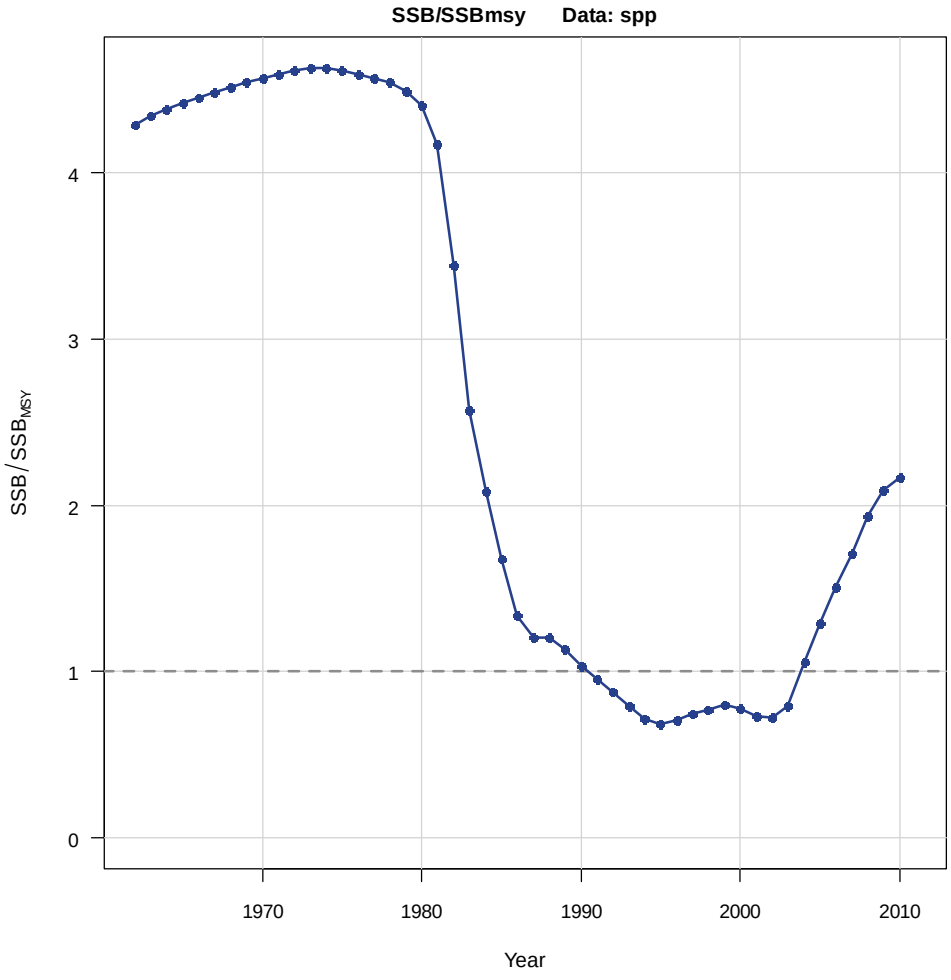
SCAA Model – BAM
AW Base Run Fit

SCAA Model – BAM
AW Base Run Results

Quantity	Units	Estimate
F_{MSY}	y^{-1}	0.185
$85\% F_{\mathrm{MSY}}$	y^{-1}	0.157
$75\% F_{\mathrm{MSY}}$	y^{-1}	0.139
$65\% F_{\mathrm{MSY}}$	y^{-1}	0.120
$F_{30\%}$	y^{-1}	0.140
$F_{40\%}$	y^{-1}	0.094
$F_{50\%}$	y^{-1}	0.065
B_{MSY}	mt	2918
$\mathrm{SSB}_{\mathrm{MSY}}$	mt	25.3
MSST	mt	22.6
MSY	1000 lb	638
D_{MSY}	1000 fish	67
R_{MSY}	1000 age-1 fish	381
Y at $85\% F_{\mathrm{MSY}}$	1000 lb	634
Y at $75\% F_{\mathrm{MSY}}$	1000 lb	625
Y at $65\% F_{\mathrm{MSY}}$	1000 lb	610
$F_{2008-2010}/F_{\mathrm{MSY}}$	—	0.360
$F_{2010}/F_{\mathrm{MSY}}$	—	0.404
$\mathrm{SSB}_{2010}/\mathrm{MSST}$	—	2.43

SCAA Model – BAM
AW Base Run Results



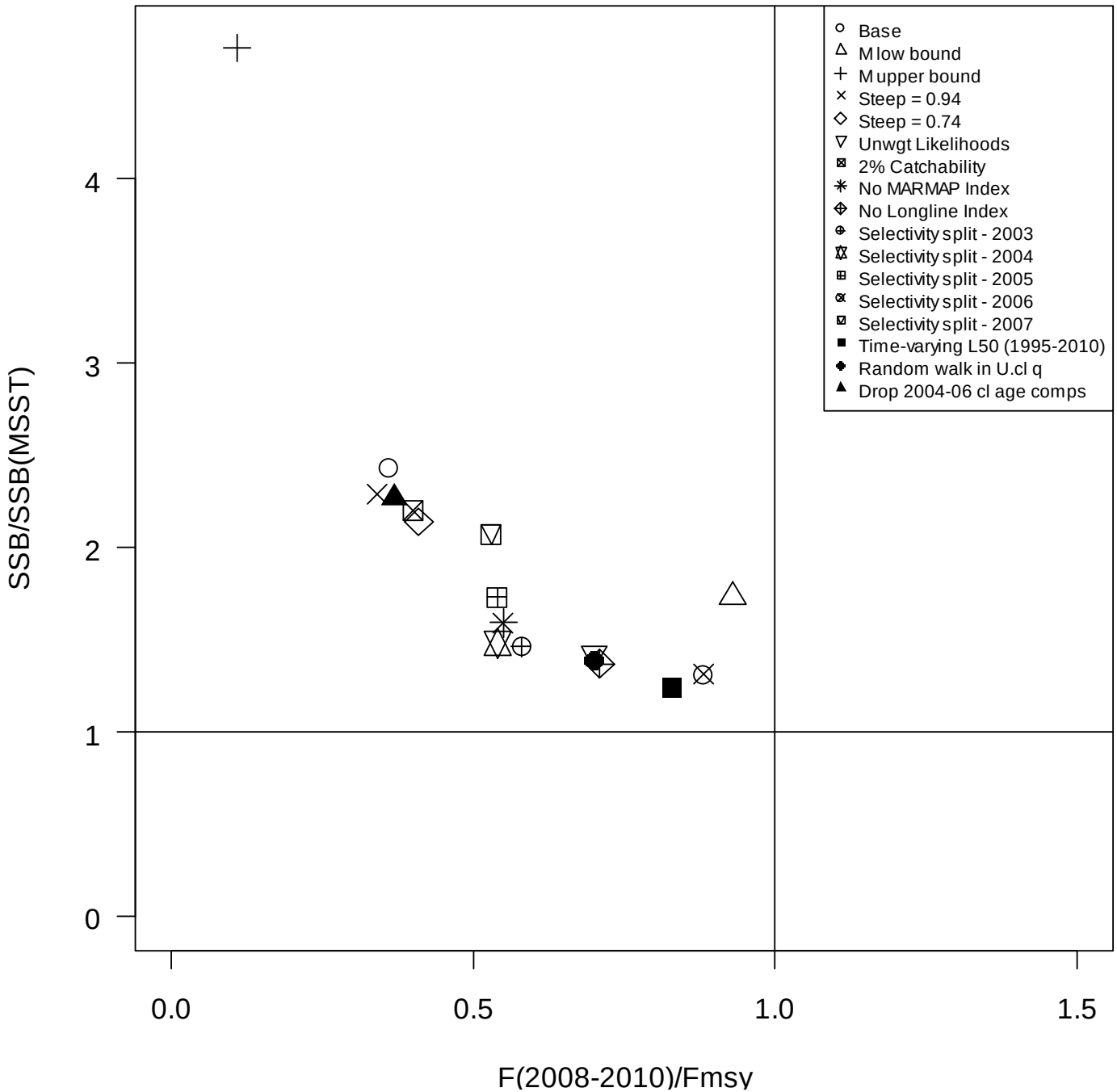


SCAA Model – BAM
Sensitivity Analysis

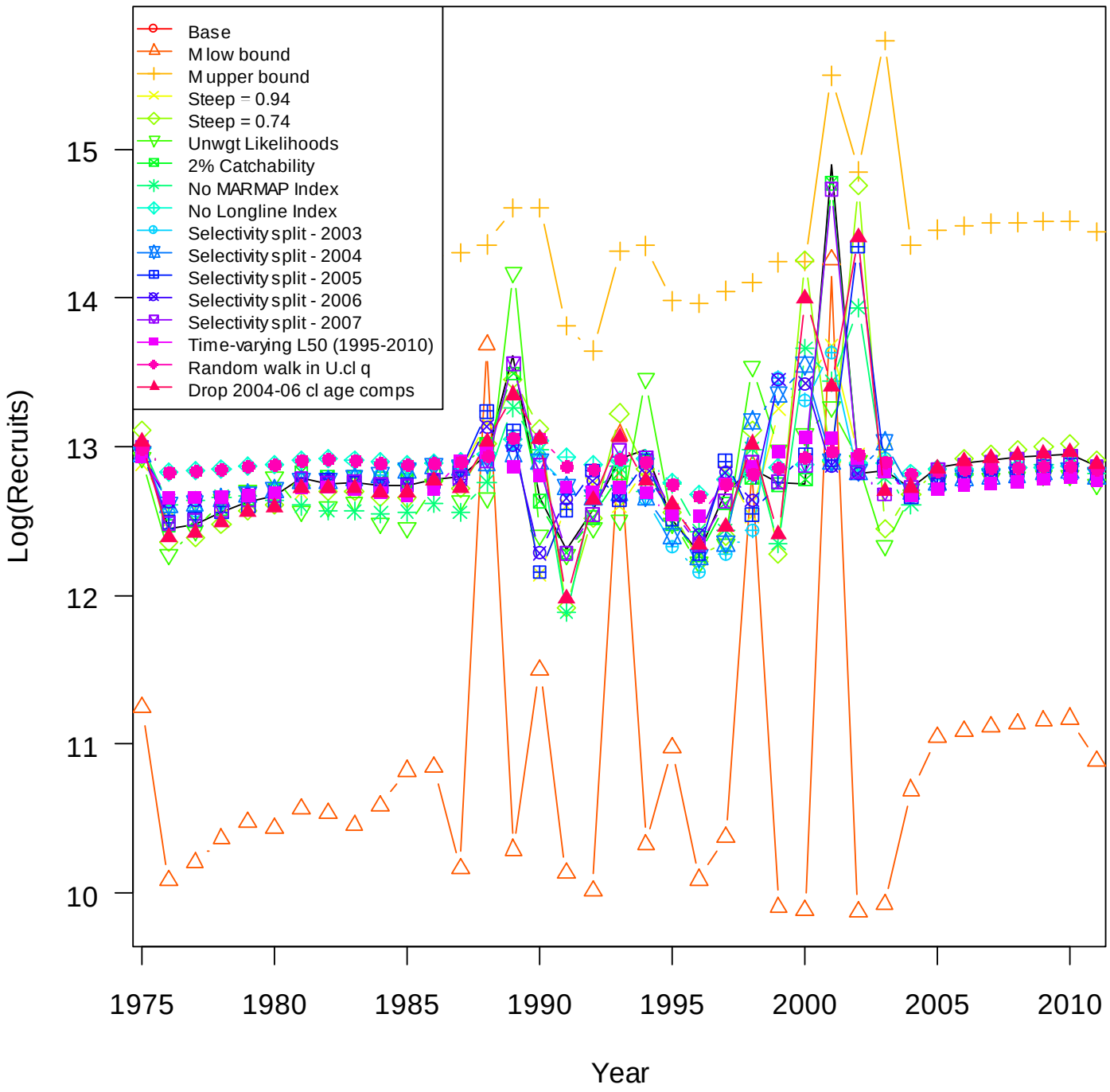
SCAA Model – BAM Sensitivity Analysis

Run	Description	F_{MSY}	SSB_{MSY} (mt)	MSY(1000 lb)	$F_{2008-2010}/F_{MSY}$	SSB_{2010}/MSST	steep	R0(1000)	R sigma
Base	Base Run	0.19	25.30	638	0.36	2.43	0.84	409	0.40
Run1	M low bound	0.07	37.84	317	0.93	1.73	0.84	57	0.76
Run2	M upper bound	0.54	13.04	943	0.11	4.71	0.84	1899	0.38
Run3	Steep $\bar{0}.94$	0.36	16.31	669	0.34	2.29	0.94	380	0.28
Run4	Steep $\bar{0}.74$	0.13	33.34	622	0.41	2.14	0.74	435	0.48
Run5	Unwgt Likelihoods	0.18	23.37	588	0.70	1.42	0.84	384	0.36
Run6	2% Catchability	0.18	25.06	630	0.40	2.20	0.84	408	0.38
Run7	No MARMAP Index	0.18	24.96	637	0.55	1.59	0.84	409	0.40
Run8	No Longline Index	0.17	25.50	615	0.71	1.37	0.84	431	0.20
Run9	Selectivity split – 2003	0.22	23.70	619	0.58	1.46	0.84	403	0.29
Run10	Selectivity split – 2004	0.27	23.79	631	0.54	1.48	0.84	409	0.26
Run11	Selectivity split – 2005	0.17	24.63	605	0.54	1.73	0.84	404	0.35
Run12	Selectivity split – 2006	0.12	25.77	537	0.88	1.31	0.84	407	0.25
Run13	Selectivity split – 2007	0.12	26.95	569	0.53	2.07	0.84	411	0.38
Run14	Time–varying L50 (1995–2010)	0.18	23.92	586	0.83	1.24	0.84	405	0.20
Run15	Random walk in Com.Longline catchability	0.17	25.58	617	0.70	1.39	0.84	432	0.20
Run16	Drop 2004–06 Com.Longline age comps	0.18	25.66	655	0.37	2.27	0.84	416	0.42
Run17	Retrospective 2009	0.19	25.30	638	0.40	2.43	0.84	410	0.40
Run18	Retrospective 2008	0.18	25.14	631	0.53	2.36	0.84	403	0.43
Run19	Retrospective 2007	0.18	25.14	631	0.23	2.20	0.84	401	0.44
Run20	Retrospective 2006	0.20	24.21	635	0.33	1.75	0.84	399	0.38
Run21	Retrospective 2005	0.21	23.07	599	1.22	1.08	0.84	395	0.24
Run22	Retrospective 2004	0.17	24.85	615	0.82	1.18	0.84	421	0.20
Run23	Retrospective 2003	0.16	25.09	608	0.54	1.10	0.84	423	0.20
Run24	Retrospective 2002	0.16	25.17	615	1.04	1.09	0.84	424	0.20

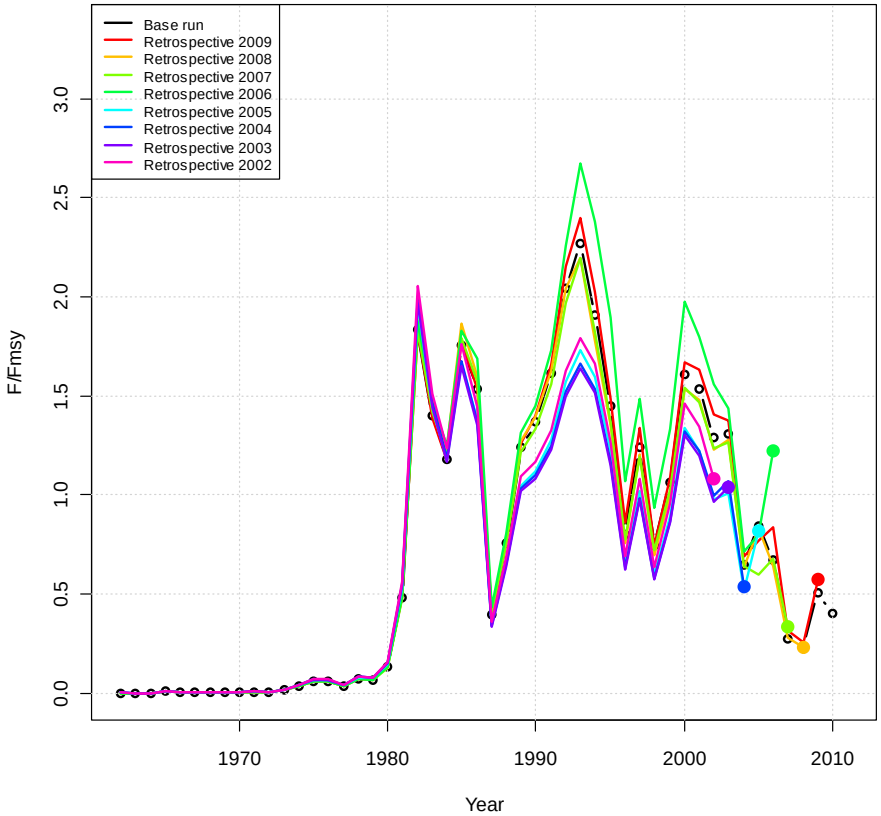
SCAA Model – BAM Sensitivity Analysis

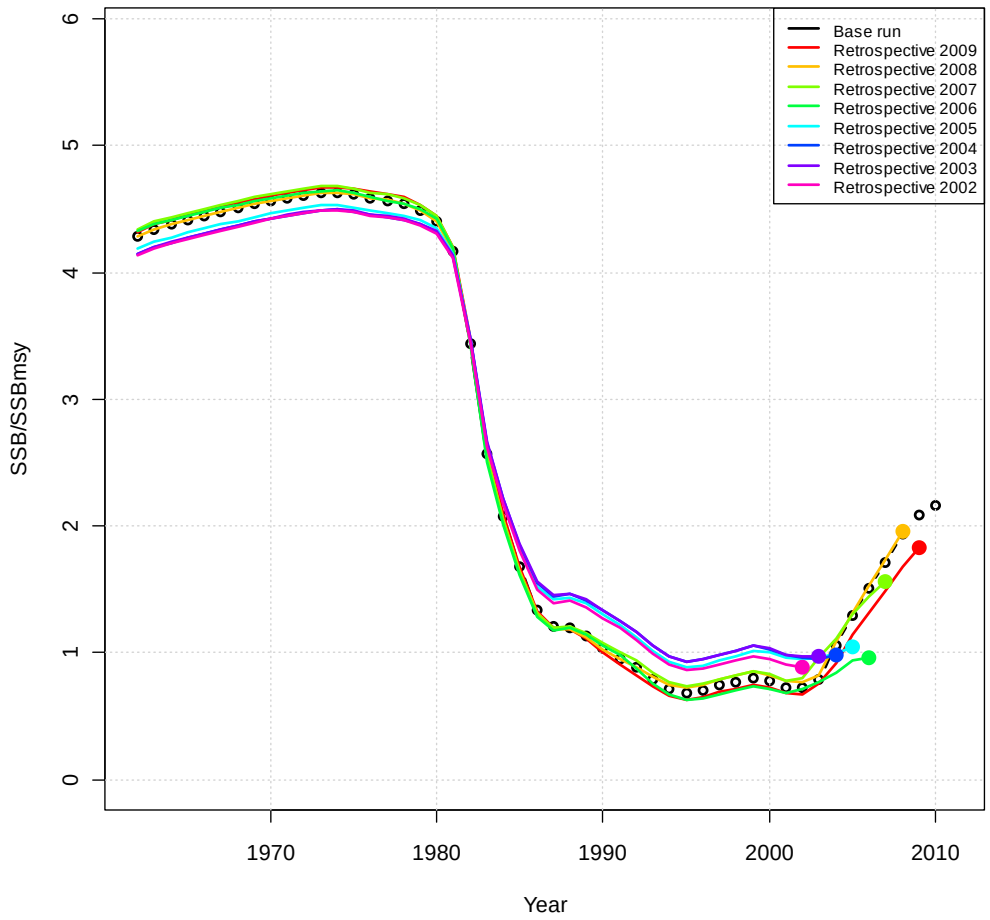


SCAA Model – BAM Sensitivity Analysis



SCAA Model – BAM Sensitivity Analysis





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Uncertainty Analysis
Monte-Carlo Bootstrap

Bootstrap Parts:

- Lognormal likelihood components (landings, indices): a parametric bootstrap to original data, with CVs as applied in the fitting procedure

- Multinomial likelihood components (length, age comps): resample Nfish and assign them to bins with probabilities equal to those from original data

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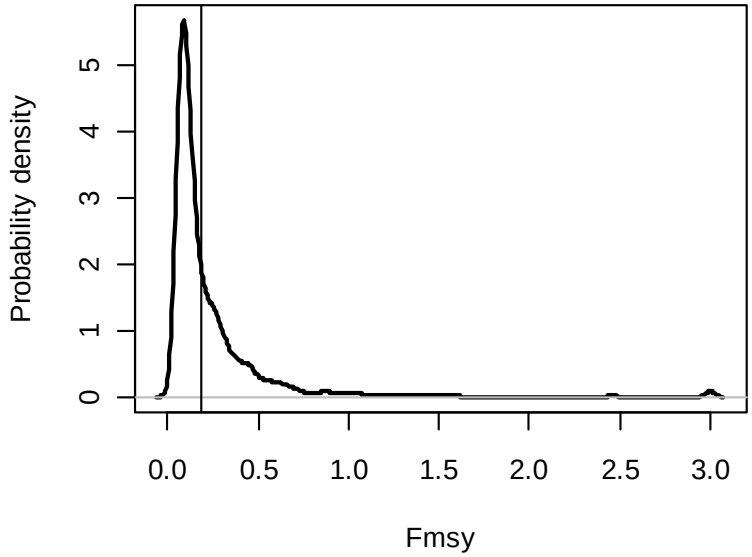
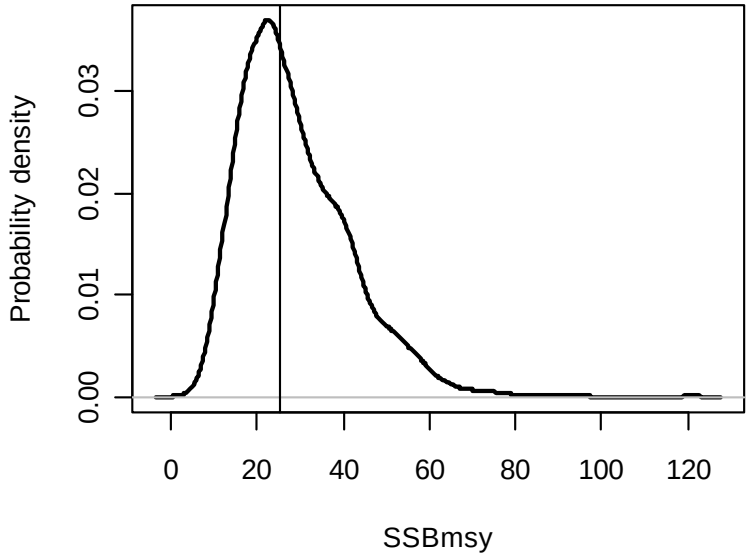
Uncertainty Analysis

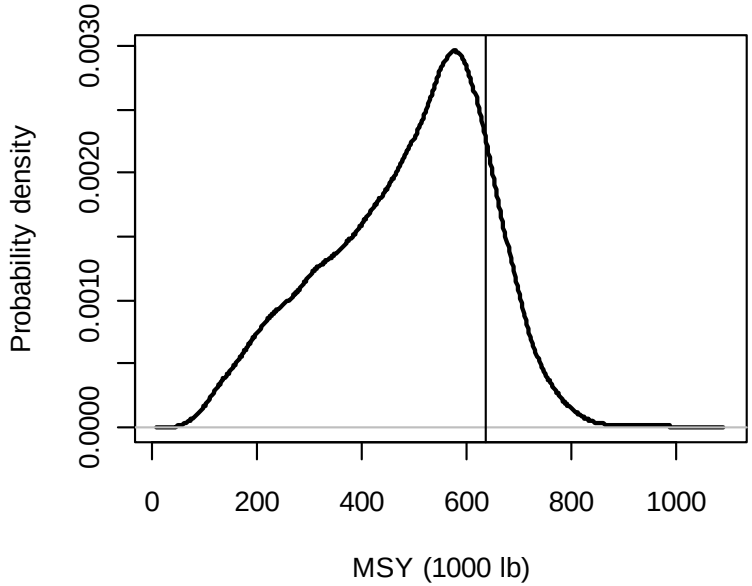
Monte Carlo Parts:

- M: drawn from a truncated normal distribution, with mean equal to base value, and SD computed such that the nearest bound is at the 95% confidence limit
- Steepness: drawn from a truncated beta distribution with parameters from a meta-analysis (α = 5.94, β = 1.97)
- Weights on indices: uniform distribution ±25% of base value (2.5)

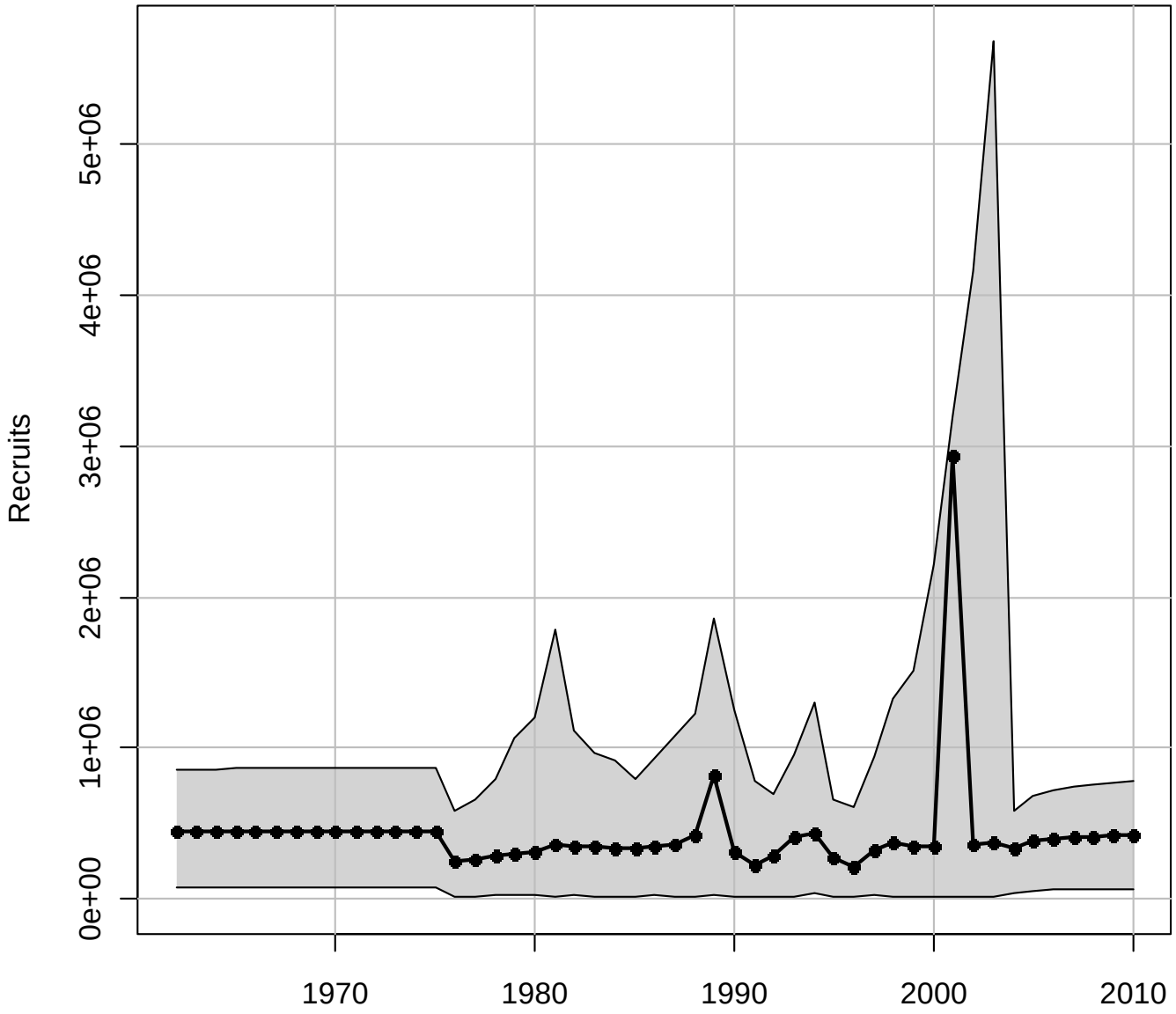
SCAA Model – BAM
Uncertainty Analysis



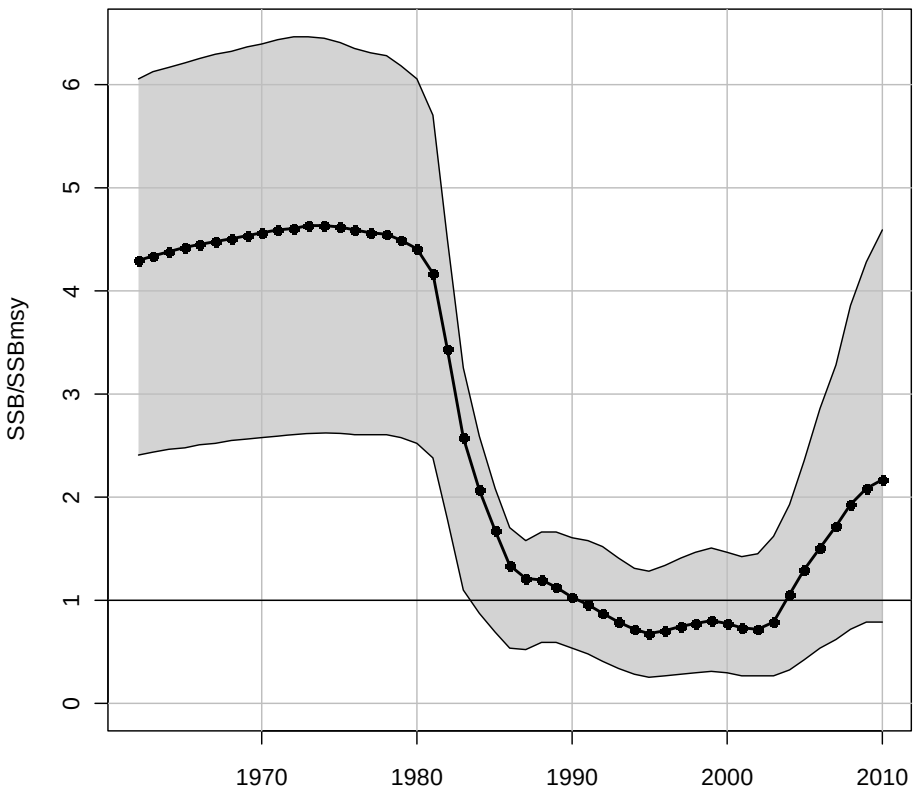


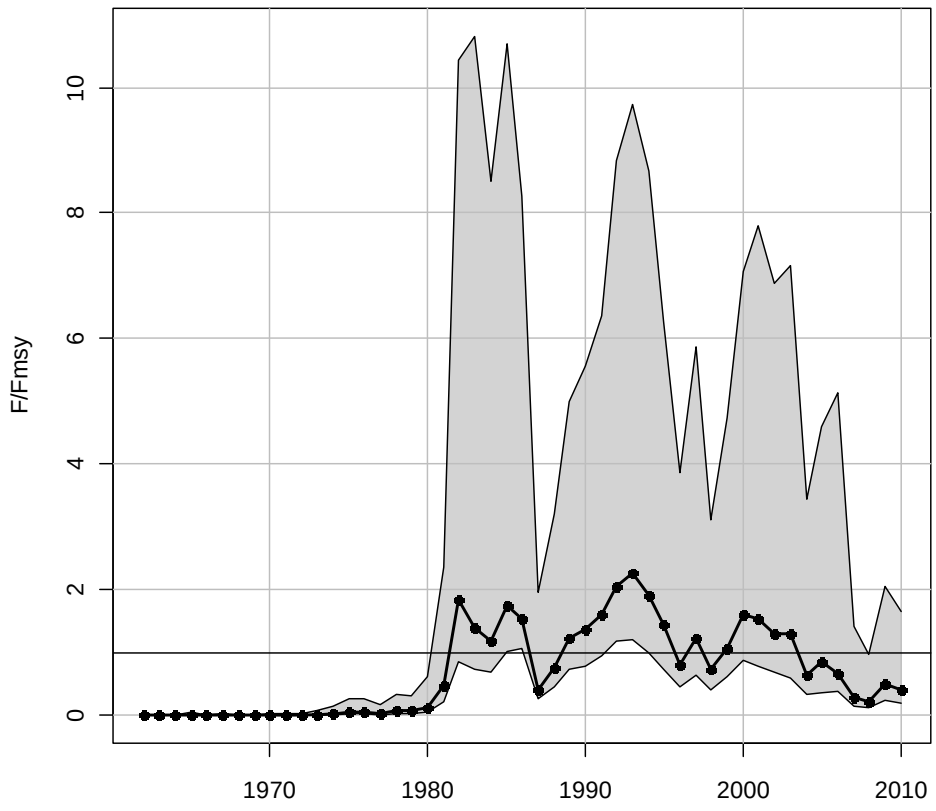


SCAA Model – BAM
Uncertainty Analysis

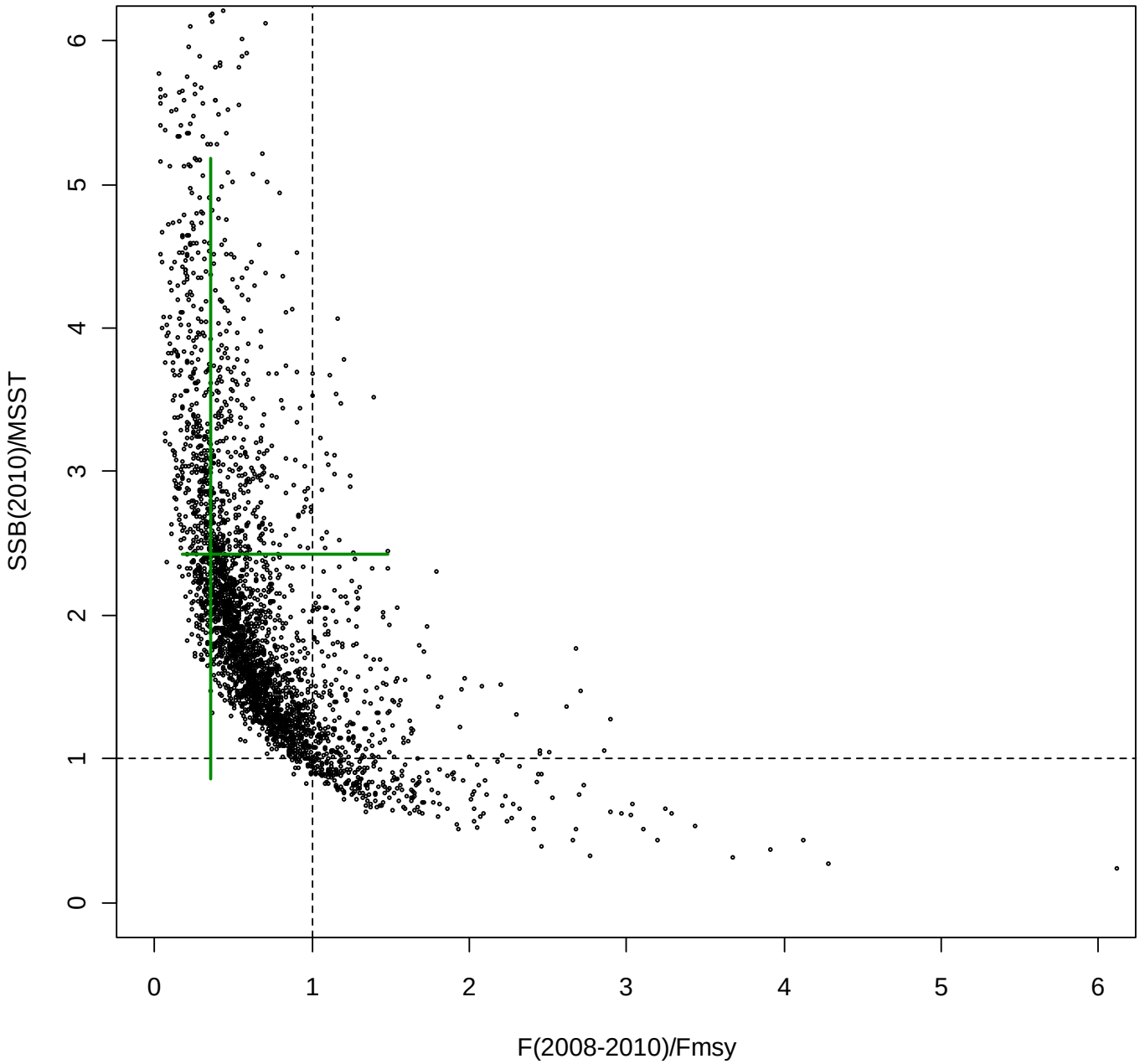


SCAA Model – BAM
Uncertainty Analysis





SCAA Model – BAM
Uncertainty Analysis



SCAA Model – BAM Projections

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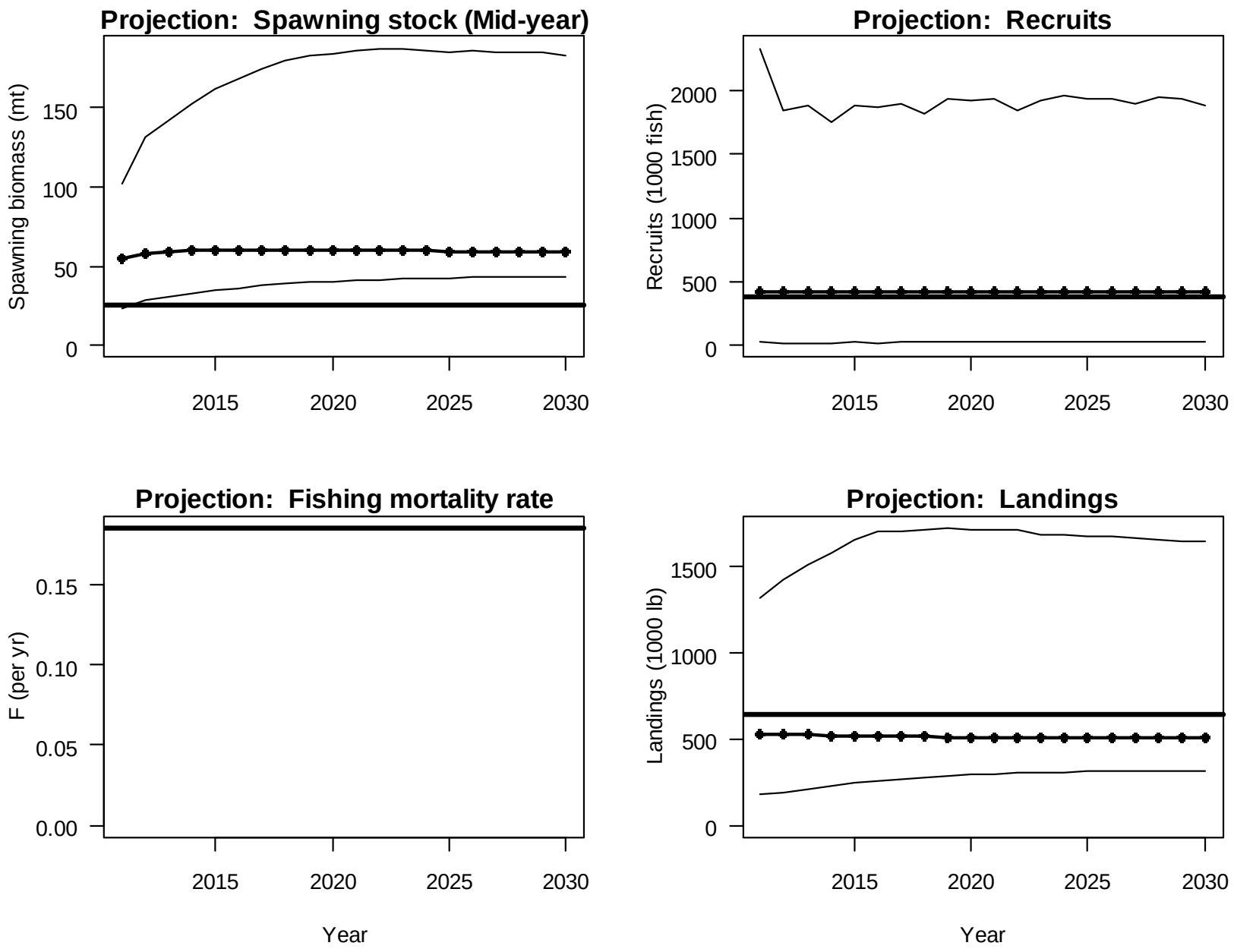
Projection Analysis

- Recruitment pattern from base run does not follow any parametric distribution.
  - Used an empirical bootstrap. Also used R devs specific to the random MCB run chosen for that projection.
- N-at-age in 2010 of base run does not include R variability in ages 1-7.
  - Added sampled R devs for ages 1-7 in N-at-age 2010 for projection analysis.
- Assumed Fcurrent for 2011 and management starting in 2012.

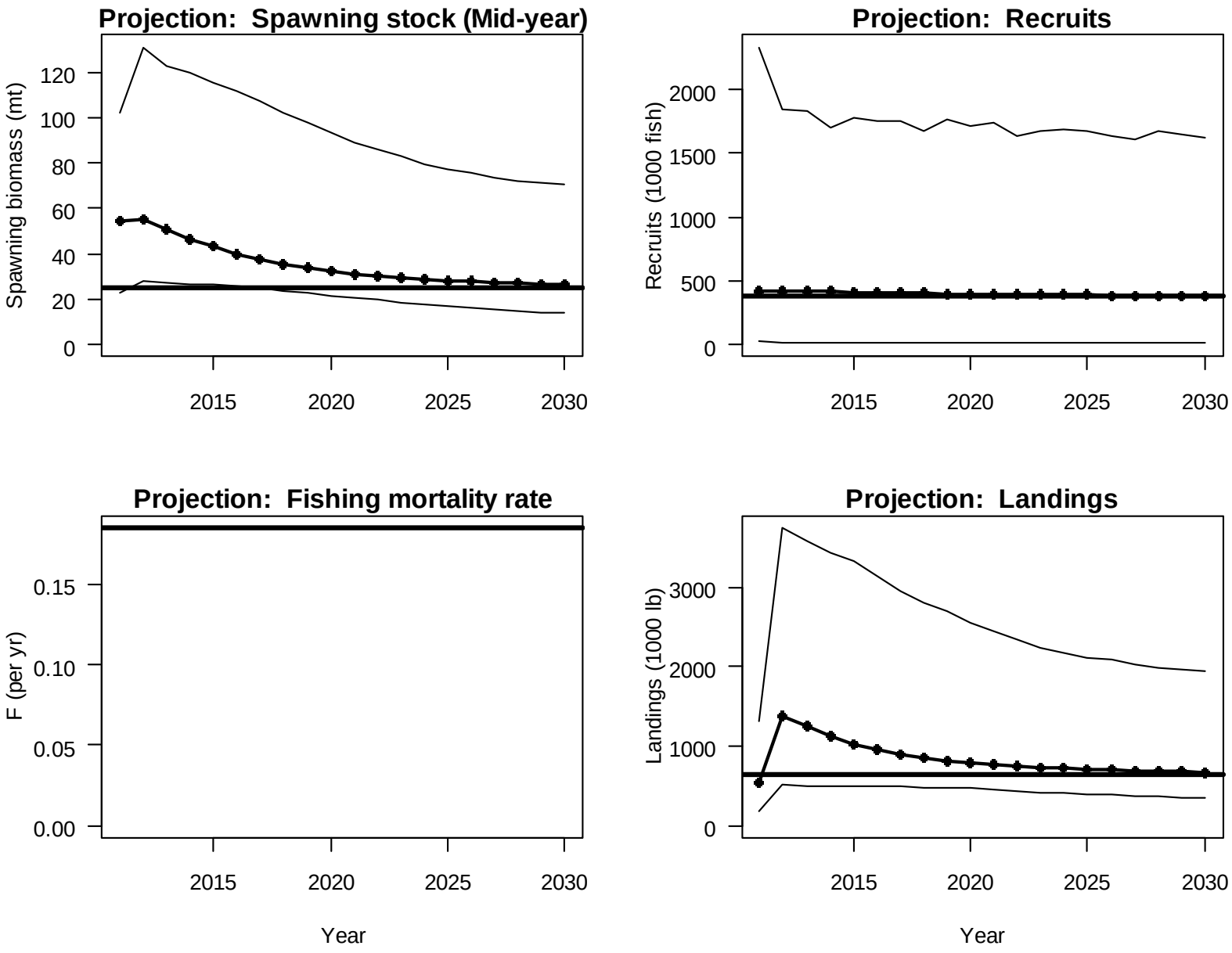
F = Fcurrent

SCAA Model – BAM Projections



F = Fmsy

SCAA Model – BAM Projections



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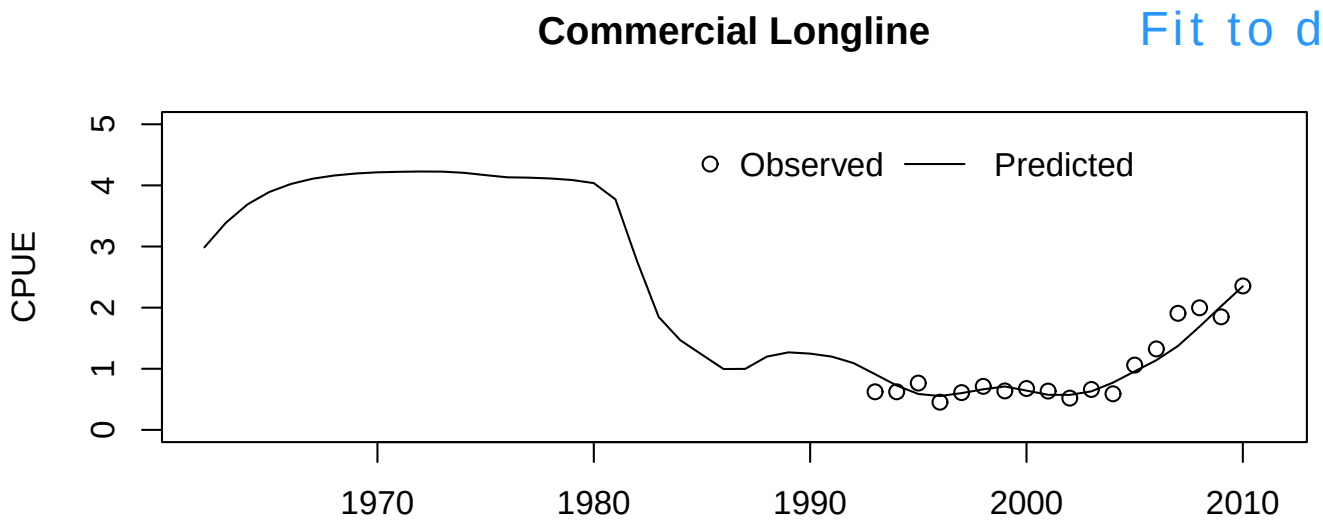
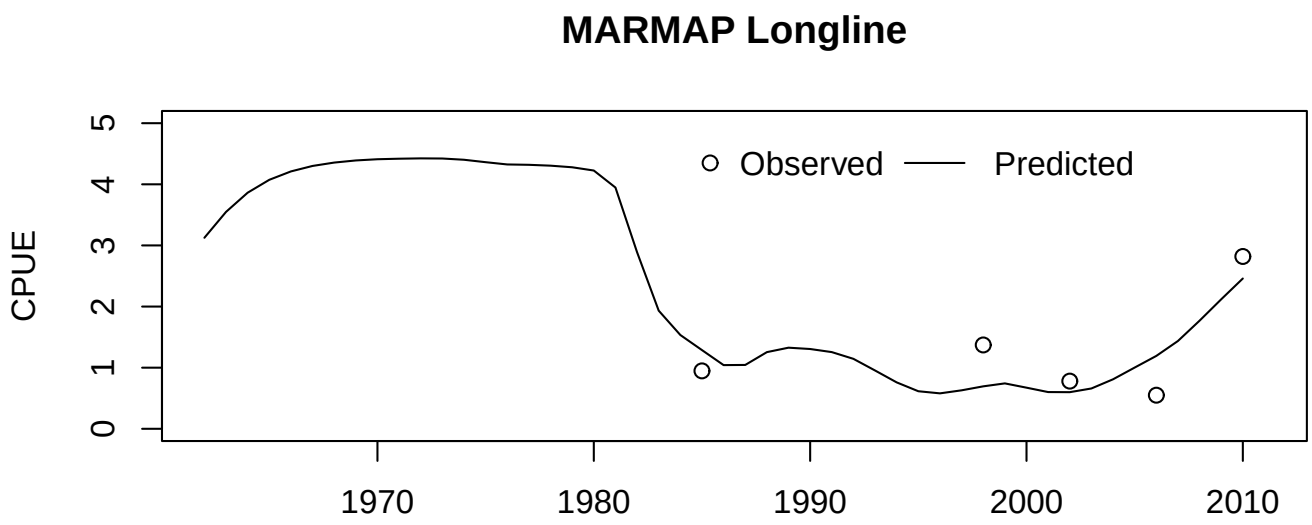
Surplus production model – ASPIC

- logistic form of production model
- data inputs:
  - Landings (lbs)
  - Abundance indices – commercial longline and MARMAP

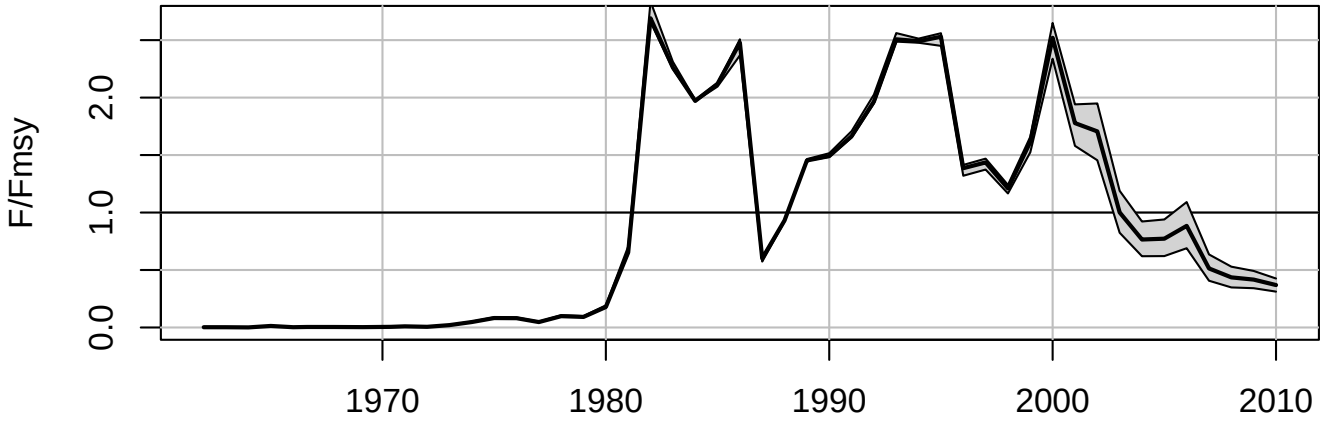
Production Model – ASPIC
Fit to data

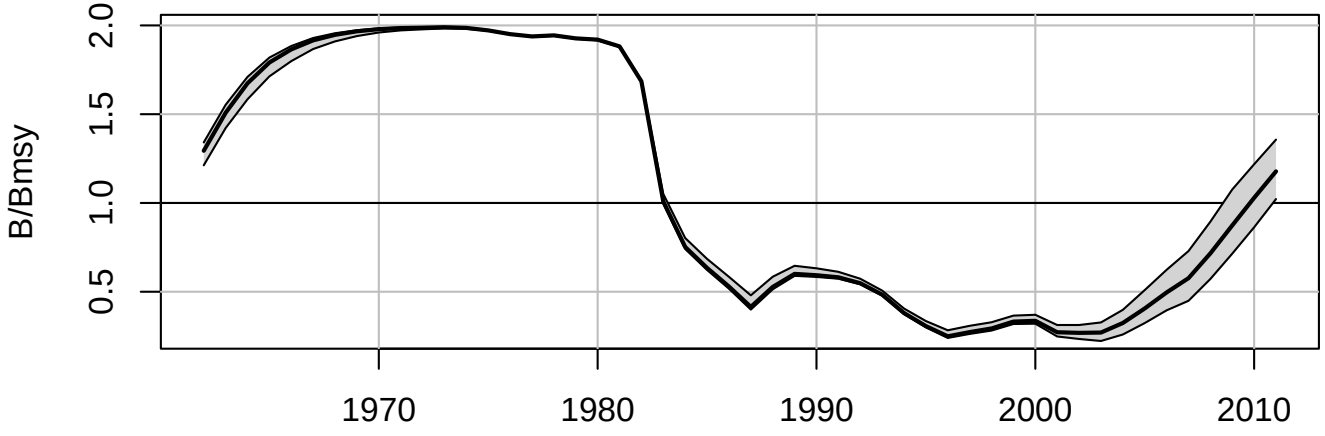




80% confidence intervals shown

Production Model – ASPIC Results and Uncertainty





Questions?