

Scalloped and Carolina Hammerheads (Mixed Species Complex) Base Model Development

(GOM + ATL) Continuity Analysis Model Configuration and Model Fits

SEDAR 77 (Assessment Webinar VII)

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Tables and Figures

References

SEDAR. 2020. SEDAR 65 Atlantic Blacktip Shark Stock Assessment Report. SEDAR, North Charleston SC. 438 pp. available online at: <http://sedarweb.org/sedar-65>

Tables

Table 1. Time series of commercial landings, recreational catch, relative abundance, and length composition data used in the Stock Synthesis (GOM + ATL) continuity analysis model configuration.

Time series	Symbol	Commercial landings, recreational catch (A+B1+B2PRM) and relative abundance	Name	Definition	Length composition
1	F1	Commercial landings (t)	Com-BLL	Bottom longlines Kept + PRM (1981 – 2019)	UF ¹ + SBLOP ² (1993 – 2019)
2	F2	Commercial landings (t)	Com-GN	Gillnets Kept + PRM (1981 – 2019)	GNOP ³ (2002 – 2019)
3	F3	Commercial landings (t)	Com-PLL	Pelagic longline discard PRM (1981 – 2019)	(1992 – 2019)
4	F4	Recreational catch (1000s)	Rec	Recreational (A+B1) (1981 – 2019)	MRIP ⁴ + SRHS ⁵ (1981 – 2019)
5	F5	Recreational PRM (1000s)	Rec-PRM	Recreational (B2 PRM) (1981 – 2019)	Mirror F4
6	F6	Commercial landings (t)	Com-Other-Kept	Hook and line plus hand line (1981 – 2019)	Mirror F4
7	S1	Relative abundance (numbers)	PLL-Obs	Pelagic longline observer program (1992 – 2019)	Mirror F3
8	S2	Relative abundance (numbers)	Shark-BLL-Obs	Bottom longline fishery observer program (1994 – 2007)	Mirror F1
9	S3	Relative abundance (numbers)	Shark-BLL-Res	Shark bottom longline research fishery (2008 – 2019)	Mirror F1
10	S4	Relative abundance (numbers)	FSU-BLLS	FSU bottom longline survey (2011 – 2019)	2011 – 2019
11	S5	Relative abundance (numbers)	SEFSC-BLLS	NMFS SEFSC bottom longline survey (1995 – 2019)	1995 – 2019
12	R1	Relative abundance (numbers)	TXPWD-GNS	Texas Parks and Wildlife Dep. gillnet survey (age-0, 1982 – 2019)	1982 – 2019
13	R2	Relative abundance (numbers)	GULFSPAN-GNS	GILFSPAN gillnet survey (age-0, 1996 – 2019)	1994 – 2019
14	R3	Relative abundance (numbers)	COASTSPAN-BLLS	(COASTSPAN) bottom longline survey (age-0, 2005 – 2019)	2000 – 2019
15	R4	Relative abundance (numbers)	COASTSPAN-LGNS	COASTSPAN long-gillnet survey (age-0, 2001-2019)	2001 – 2019
16	R5	Relative abundance (numbers)	COASTSPAN-SGNS	COASTSPAN short-gillnet survey (age-0, 2007 – 2019)	Mirror R4 ⁶

¹ University of Florida (UF) Longline 1993 – 2005.

² Southeast Fisheries Science Center (SEFSC) Panama City Lab Shark Bottom Longline Observer Program (SBLOP) 2005 – 2019.

³ Southeast Fisheries Science Center (SEFSC) Panama City Lab Gillnet Observer Program (GNOP).

⁴ Marine Recreational Information Program (MRIP).

⁵ Southeast Region Head Boat Survey (SRHS).

⁶ Total length composition sample size for COASTSPAN-SGNS (n = 34) was too small to fit in Stock Synthesis.

Table 2. Length composition sample size (number of sharks measured) for fleets (F) surveys (S), and age-0 recruitment indices (R) fit in the Stock Synthesis (GOM + ATL) continuity analysis model configuration.

	F1		F2		F3		F4		S4		S5	
	(Com-BLL)		(Com-GN)		(Com-PLL)		(Rec)		(FSU-BLLS)		(SEFSC-BLL)	
	1993 – 2019		2002 – 2019		1992 – 2019		1981-2018		2011 – 2019		1995 – 2019	
	Min. ¹ 30		Min. 30		Min. 20		Min. 20		Min. 20		Min. 20	
Year	(♀)	(♂)	(♀,♂,Unknown) ²		(♀)	(♂)	(♀,♂,Unknown) ³		(♀)	(♂)	(♀)	(♂)
1981							4					
1982							21					
1983							4					
1984							4					
1985							20					
1986							3					
1987							9					
1988							7					
1989							8					
1990							11					
1991							9					
1992					16	17	9					
1993	0	1			11	3	25					
1994	7	17			6	5	7					
1995	10	46			6	8	22				1	10
1996	9	55			4	1	8				2	5
1997	43	17			16	10	9				2	13
1998	55	78			2	3	8				0	0
1999	7	24			1	0	6				12	7
2000	1	2			0	2	8				23	22
2001	67	42			9	0	8				12	14
2002	75	56	12		0	0	14				22	22
2003	68	195	9		1	2	6				14	16
2004	79	97	39		1	1	8				7	7
2005	10	14	15		15	4	13				4	6
2006	39	28	15		14	15	6				8	9
2007	27	9	1		2	0	7				4	8
2008	33	7	3		24	11	0				3	6
2009	239	191	62		40	15	4				17	11
2010	91	121	12		6	2	1				12	13
2011	142	111	6		3	2	3	9	16		70	71
2012	36	46	16		1	2	3	0	0		4	7
2013	19	36	30		3	1	13	8	0		6	3
2014	51	66	5		1	0	1	1	0		5	7
2015	24	76	6		2	3	1	6	2		15	31
2016	15	50	2		1	2	0	0	3		9	18
2017	44	88	1		0	0	0	15	5		42	79
2018	7	55	9		0	0	0	1	2		16	20
2019	8	32	2		0	1	0	3	4		2	17
Total	1206	1560	245		185	110	290	43	32		312	422
Proportion (♀,♂)	99%		95%		99%		NA	99%			94%	

¹ Years with less than minimum sample size were excluded from the fit in the model likelihood.

² Sex-combined length composition data (♀, ♂, Unknown) were input for fleet F2 following SEDAR 65 blacktip

³ Sex specific length composition data were not available for fleets F4.

Table 2. Continued.

	R1	R2	R3	R4
	(TXPWD-GNS)	(GULFSPAN-GNS)	(COASTSPAN-BLLS)	(COASTSPAN-LGNS)
	1982– 2019	1994 – 2019	2000 – 2019	2001 – 2019
	Min. 20	Min. 30	Min. 20	Min. 30
Year	(♀,♂,Unknown) ³	(♀,♂,Unknown) ³	(♀,♂,Unknown) ³	(♀,♂,Unknown) ³
1981				
1982	4			
1983	8			
1984	2			
1985	2			
1986	5			
1987	0			
1988	7			
1989	3			
1990	12			
1991	4			
1992	1			
1993	3			
1994	3	46		
1995	1	0		
1996	23	23		
1997	13	99		
1998	3	35		
1999	6	41		
2000	11	38	18	
2001	31	75	7	34
2002	3	123	0	21
2003	15	68	4	90
2004	7	32	6	3
2005	22	18	14	18
2006	13	29	19	18
2007	3	95	3	36
2008	11	74	5	10
2009	20	87	34	59
2010	20	97	98	14
2011	40	59	65	2
2012	23	65	19	127
2013	96	73	25	152
2014	35	67	5	77
2015	14	39	10	36
2016	17	46	26	50
2017	3	66	24	93
2018	69	62	19	98
2019	16	73	38	79
Total	569	1530	439	1017
Proportion (♀,♂)	NA	NA	NA	NA

³ Sex-combined length composition data (♀, ♂, Unknown) were input for recruitment indices.

Table 3. The von Bertalanffy growth (VBG) relationship implemented separately for females and males in the Stock Synthesis (GOM + ATL) continuity analysis model configuration.

Age (yr.)	Female cm FL predicted from the VBG parameters below	Male cm FL predicted from VBG parameters below
0	42.0	41.6
1	57.4	58.1
2	71.6	73.3
3	84.5	87.0
4	96.5	99.6
5	107.4	111.1
6	117.4	121.5
7	126.7	131.1
8	135.1	139.8
9	142.9	147.7
10	150.0	155.0
11	156.5	161.6
12	162.5	167.6
13	168.0	173.1
14	173.0	178.1
15	177.7	182.7
16	181.9	186.8
17	185.8	190.6
18	189.4	194.1
19	192.7	197.3
20	195.7	200.2
21	198.4	202.8
22	201.0	205.2
23	203.3	207.4
24	205.4	209.4
25	207.4	211.2
26	209.2	212.9
27	210.8	214.4
28	212.4	215.8
29	213.7	217.0
30 ¹	215.0	218.2
31	216.2	219.2
32	217.3	220.2
33	218.2	221.0
34	219.1	221.8
35	220.0	222.6
36	220.7	223.2
37	221.4	223.8
38	222.1	224.4
39	222.7	224.9
40 ¹	223.2	225.3
41	223.7	225.8
42	224.1	226.1
43	224.6	226.5
44	224.9	226.8
45	225.3	227.1
46	225.6	227.4
47	225.9	227.6
48	226.2	227.8
49	226.4	228.0
50 ²	226.7	228.2
VBG parameters	Female	Male
L_{inf}	229.2	230
k	0.086	0.092
t_0	-2.35	-2.166
CV implemented for L_{Amin}	0.093	0.097
CV implemented for L_{inf}	0.090	0.082

¹ Observed Tmax (♀) = 29.5 and Tmax (♂) = 39.5 (Data Workshop Section 2.4 Life History Report, their Table 1).

² Theoretical Tmax (♀) = 51 and Tmax (♂) = 48 (SEDAR77AW04, their Table 6; Pers. Comm. E. Cortés).

Table 4. Annual pup production at age used in the (GOM + ATL) continuity analysis model configuration.

Age (yr.)	Litter size (LS) ¹	Fraction mature ²	Fraction maternal ³	Pup production ⁴	Annual pup production ⁵
0	18.00	0.00	0.00	0.0	0.00
1	18.00	0.00	0.00	0.0	0.00
2	18.00	0.00	0.00	0.0	0.00
3	18.00	0.00	0.00	0.0	0.00
4	18.00	0.00	0.00	0.0	0.00
5	18.00	0.00	0.00	0.0	0.00
6	18.00	0.00	0.00	0.0	0.00
7	18.00	0.00	0.00	0.0	0.00
8	18.00	0.00	0.00	0.0	0.00
9	18.00	0.01	0.00	0.0	0.00
10	18.00	0.01	0.01	0.2	0.18
11	18.00	0.02	0.01	0.2	0.18
12	18.00	0.05	0.02	0.4	0.36
13	18.00	0.09	0.05	0.9	0.90
14	18.00	0.17	0.09	1.6	1.62
15	18.00	0.31	0.17	3.1	3.06
16	18.00	0.48	0.31	5.6	5.58
17	18.00	0.66	0.48	8.6	8.64
18	18.00	0.80	0.66	11.9	11.88
19	18.00	0.90	0.80	14.4	14.40
20	18.00	0.95	0.90	16.2	16.20
21	18.00	0.97	0.95	17.1	17.10
22	18.00	0.99	0.97	17.5	17.46
23	18.00	0.99	0.99	17.8	17.82
24	18.00	1.00	0.99	17.8	17.82
25	18.00	1.00	1.00	18.0	18.00
26	18.00	1.00	1.00	18.0	18.00
27	18.00	1.00	1.00	18.0	18.00
28	18.00	1.00	1.00	18.0	18.00
29	18.00	1.00	1.00	18.0	18.00
30	18.00	1.00	1.00	18.0	18.00
31	18.00	1.00	1.00	18.0	18.00
32	18.00	1.00	1.00	18.0	18.00
33	18.00	1.00	1.00	18.0	18.00
34	18.00	1.00	1.00	18.0	18.00
35	18.00	1.00	1.00	18.0	18.00
36	18.00	1.00	1.00	18.0	18.00
37	18.00	1.00	1.00	18.0	18.00
38	18.00	1.00	1.00	18.0	18.00
39	18.00	1.00	1.00	18.0	18.00
40	18.00	1.00	1.00	18.0	18.00
41	18.00	1.00	1.00	18.0	18.00
42	18.00	1.00	1.00	18.0	18.00
43	18.00	1.00	1.00	18.0	18.00
44	18.00	1.00	1.00	18.0	18.00
45	18.00	1.00	1.00	18.0	18.00
46	18.00	1.00	1.00	18.0	18.00
47	18.00	1.00	1.00	18.0	18.00
48	18.00	1.00	1.00	18.0	18.00
49	18.00	1.00	1.00	18.0	18.00
50	18.00	1.00	1.00	18.0	18.00

¹ Brood size = 18; range 7-30 (Data Workshop Section 2.4 Life History Report, their Table 1).

² Fraction mature at age "tmat = 16.11 years, a = -11.979, b = 0.744" (DW Section 2.4, their Table 1).

³ Fraction maternal assumed an 10-12 month gestation period (DW Section 2.4, their Table 1), approximated here by a one year offset from maturity to maternity, e.g., see outlined boxes above at ages 9 and 23.

⁴ Pup production was obtained as (LS at age)* (Fraction maternal at age).

⁵ Annual pup production was obtained by assuming an annual reproductive cycle (DW Section 2.4, their Table 1) and calculated as [(LS at age)* (Fraction maternal at age)]/1 .

Table 5. Number of estimated parameters (numbers within parentheses) in the (GOM + ATL) continuity analysis model configuration.

Fleet	Fleet name	Proposed selectivity pattern	Implemented selectivity pattern	Sex	Time block(s)	Number of selectivity parameters	Number of catchability parameters	Sub-total of parameters	Sub-total of estimated parameters
1	F1 (Com-BLL)	Logistic	Logistic	Sex specific	Sel. (peak, ascend) ¹	19 (12)	0 (0)	19	12
2	F2 (Com-GN)	Double normal	Double normal	Combined sex	Sel. (peak) ²	7 (4)	0 (0)	7	4
3	F3 (Com-PLL)	Logistic	Logistic	Sex specific		11(3)	0 (0)	11	3
4	F4 (Rec)	Double normal	Double normal	Combined sex	Sel. (end) ³	7 (1)	0 (0)	7	1
5	F5 (Rec-RPM)		Mirror F4	Mirror F4	Mirror F4	0 (0)	0 (0)	0	0
6	F6 (Com-Other-Kept)		Mirror F4	Mirror F4	Mirror F4	0 (0)	0 (0)	0	0
7	S1 (PLL-Obs)		Mirror F3	Mirror F3		0 (0)	1 (0)	0	0
8	S2 (Shark-BLL-Obs)		Mirror F1	Mirror F1	Catchability ⁴	0 (0)	3 (3)	3	3
9	S3 (Shark-BLL-Res)		Mirror F1	Mirror F1	Catchability ⁵	0 (0)	3 (3)	3	3
10	S4 (FSU-BLLS)	Logistic	Logistic	Sex specific		11(2)	0 (0)	11	2
11	S5 (SEFSC-BLLS)	Logistic	Logistic	Sex specific		11(3)	0 (0)	11	3
12	R1 (TXPWD-GNS)	Double normal	Double normal	Combined sex		6 (2)		6	2
13	R2 (GULFSPAN-GNS)	Double normal	Double normal	Combined sex		6 (1)		6	1
14	R3 (COASTSPAN-BLLS)	Double normal	Double normal	Combined sex		6 (1)		6	1
15	R4 (COASTSPAN-LGNS)	Double normal	Double normal	Combined sex		6 (1)		6	1
16	R5 (COASTSPAN-SGNS)	Double normal	Mirror R4	Mirror R4		0 (0)		0	0
Total (selectivity, catchability)								96	36
Other Estimated Parameters									
ln(R ₀)									1
Recruitment deviations						1988 – 2019			32
Grand Total									69

¹Time blocks in selectivity for F1 (1981 – 1996, 1997 – 2004, 2005 – 2008, 2009 – 2017 [main years], 2018 – 2019; adapted from SEDAR 65 blacktip).

²Time blocks in selectivity for F2 (1981 – 2006, 2007 – 2019 [main years]; adapted from SEDAR 65 blacktip).

³Time blocks in selectivity for F4 (1981 – 1999, 2000 – 2019 [main years]; adapted from SEDAR 65 blacktip).

⁴Time blocks in catchability for S2 (1981 – 1996, 1997 – 2004 [main years], 2005 – 2007; adapted from SEDAR 65 blacktip).

⁵Time blocks in catchability for S3 (2008; 2009 – 2017 [main years], 2018 – 2019; adapted from SEDAR 65 blacktip).

Table 6. Two stage data weighting used in the (GOM + ATL) continuity analysis model configuration. The stage-1 CPUE (survey) variance adjustments are provided along with the mean of input CV and the resulting mean of adjusted input CV obtained after adding the variance adjustment (**Panel A**). The stage-2 length composition effective sample size (Effn) adjustments are provided along with the mean input sample size (n) and the resulting mean of the adjusted input sample size, n, obtained after multiplying by the Effn adjustment (**Panel B**).

Panel A

Survey	Mean of input CV	Variance adjustment	Mean of adjusted input CV
S1 (PLL-Obs)	0.6968	0.0000	0.6968
S2 (Shark-BLL-Obs)	0.5390	0.2530	0.7920
S3 (Shark-BLL-Res)	0.3967	0.0000	0.3967
S4 (FSU-BLLS)	0.6352	0.0000	0.6352
S5 (SEFSC-BLLS)	0.3013	0.0097	0.3110
R1 (TXPWD-GNS)	0.6652	0.0318	0.6970
R2 (GULFSPAN-GNS)	0.2552	0.4318	0.6870
R3 (COASTSPAN-BLLS)	0.6178	0.0000	0.6178
R4 (COASTSPAN-LGNS)	0.6626	0.0000	0.6626
R5 (COASTSPAN-SGNS)	0.4597	0.0000	0.4597

Panel B

Length composition data source	Mean of input n	Adjustment method	Sample size adjustment	Mean of adjusted input n
F1 (Com-BLL)	118.0	Francis Effn	0.092	10.8
F2 (Com-GN)	43.7	Harmonic Mean Effn	0.130	5.7
F3 (Com-PLL)	35.6	Francis Effn	0.505	18.0
F4 (Rec)	22.0	Harmonic Mean Effn	0.240	5.3
S4 (FSU-BLLS)	22.5	Harmonic Mean Effn	1.120	25.2
S5 (SEFSC-BLLS)	51.7	Francis Effn	1.384	71.6
R1 (TXPWD-GNS)	37.9	Harmonic Mean Effn	0.186	7.0
R2 (GULFSPAN-GNS)	66.4	Harmonic Mean Effn	0.695	46.1
R3 (COASTSPAN-BLLS)	44.3	Harmonic Mean Effn	0.063	2.8
R4 (COASTSPAN-LGNS)	77.6	Harmonic Mean Effn	0.603	46.8

Table 7. (GOM + ATL) continuity analysis model configuration parameters. Parameters with a negative phase were fixed at their initial value. CV is calculated as the asymptotic standard error (Parm_StDev) divided by the estimated value (Value).

Label	Value	Active	Phase	Min	Max	Init	StDev	Pr_type	Prior	Pr_SD	CV
L_at_Amin_Fem_GP_1	41.97	—	-3	5	100	41.97	—	Normal	41.97	1000	NA
L_at_Amax_Fem_GP_1	229.20	—	-4	50	600	229.20	—	Normal	229.20	1000	NA
VonBert_K_Fem_GP_1	0.09	—	-5	0.01	0.65	0.09	—	Normal	0.06	0.2	NA
CV_young_Fem_GP_1	0.09	—	-2	0.01	0.3	0.09	—	Normal	0.09	0.01	NA
CV_old_Fem_GP_1	0.09	—	-3	0.01	0.3	0.09	—	Normal	0.09	0.01	NA
Wtlen_1_Fem_GP_1	0.00	—	-3	-3	3	0.00	—	Normal	0.00	0.8	NA
Wtlen_2_Fem_GP_1	3.13	—	-3	-3	5	3.13	—	Normal	3.00	0.8	NA
Mat50%_Fem_GP_1	199.10	—	-3	1	300	199.10	—	Normal	199.10	0.8	NA
Mat_slope_Fem_GP_1	-0.19	—	-3	-200	3	-0.19	—	Normal	-0.19	0.8	NA
Eggs_scalar_Fem_GP_1	18.00	—	-3	-3	50	18.00	—	Normal	18.00	0.8	NA
Eggs_exp_len_Fem_GP_1	0.00	—	-3	-3	3	0.00	—	Normal	0.00	0.8	NA
L_at_Amin_Mal_GP_1	41.57	—	-3	5	100	41.57	—	Normal	41.57	1000	NA
L_at_Amax_Mal_GP_1	230.10	—	-4	50	600	230.10	—	Normal	230.10	1000	NA
VonBert_K_Mal_GP_1	0.09	—	-5	0.01	0.65	0.09	—	Normal	0.09	0.2	NA
CV_young_Mal_GP_1	0.10	—	-2	0.01	0.3	0.10	—	Normal	0.10	0.01	NA
CV_old_Mal_GP_1	0.08	—	-3	0.01	0.3	0.08	—	Normal	0.08	0.01	NA
Wtlen_1_Mal_GP_1	0.00	—	-3	-3	3	0.00	—	Normal	0.00	0.8	NA
Wtlen_2_Mal_GP_1	2.91	—	-3	-3	5	2.91	—	Normal	3.00	0.8	NA
CohortGrowDev	1.00	—	-1	0.1	10	1.00	—	Normal	1.00	1	NA
FracFemale_GP_1	0.50	—	-99		0.99	0.50	—	No_prior			NA
SR_LN(R0)	4.27	1	1	2.0685	8.742	4.14	0.08	Normal	7.04	1000	2%
SR_BH_steep	0.69	—	-2	0.2	0.99	0.69	—	Normal	0.69	1000	NA
SR_sigmaR	0.28	—	-4	0.2	1.9	0.28	—	Normal	0.28	1000	NA
SR_regime	0.00	—	-4	-5	5	0.00	—	Normal	0.00	1	NA
SR_autocorr	0.00	—	-4	-5	5	0.00	—	Normal	0.00	1	NA

Table 7. Continued.

Label	Value	Active	Phase	Min	Max	Init	StDev	Pr_type	Prior	Pr_SD	CV
Early_RecrDev_1988	-0.21	2	4	-10	10	0.00	0.25	dev			
Early_RecrDev_1989	-0.14	3	4	-10	10	0.00	0.25	dev			
Early_RecrDev_1990	-0.18	4	4	-10	10	0.00	0.25	dev			
Early_RecrDev_1991	-0.21	5	4	-10	10	0.00	0.24	dev			
Early_RecrDev_1992	-0.19	6	4	-10	10	0.00	0.23	dev			
Early_RecrDev_1993	-0.49	7	4	-10	10	0.00	0.22	dev			
Early_RecrDev_1994	-0.11	8	4	-10	10	0.00	0.20	dev			
Early_RecrDev_1995	-0.29	9	4	-10	10	0.00	0.22	dev			
Early_RecrDev_1996	0.08	10	4	-10	10	0.00	0.17	dev			
Early_RecrDev_1997	-0.80	11	4	-10	10	0.00	0.19	dev			
Main_RecrDev_1998	-0.27	12	3	-10	10	0.00	0.20	dev			
Main_RecrDev_1999	0.09	13	3	-10	10	0.00	0.19	dev			
Main_RecrDev_2000	0.10	14	3	-10	10	0.00	0.17	dev			
Main_RecrDev_2001	-0.43	15	3	-10	10	0.00	0.16	dev			
Main_RecrDev_2002	0.05	16	3	-10	10	0.00	0.16	dev			
Main_RecrDev_2003	-0.26	17	3	-10	10	0.00	0.18	dev			
Main_RecrDev_2004	0.05	18	3	-10	10	0.00	0.21	dev			
Main_RecrDev_2005	-0.03	19	3	-10	10	0.00	0.21	dev			
Main_RecrDev_2006	0.10	20	3	-10	10	0.00	0.18	dev			
Main_RecrDev_2007	0.19	21	3	-10	10	0.00	0.14	dev			
Main_RecrDev_2008	-0.09	22	3	-10	10	0.00	0.14	dev			
Main_RecrDev_2009	-0.14	23	3	-10	10	0.00	0.15	dev			
Main_RecrDev_2010	0.30	24	3	-10	10	0.00	0.14	dev			
Main_RecrDev_2011	0.33	25	3	-10	10	0.00	0.13	dev			
Main_RecrDev_2012	0.19	26	3	-10	10	0.00	0.13	dev			
Main_RecrDev_2013	0.08	27	3	-10	10	0.00	0.13	dev			
Main_RecrDev_2014	-0.04	28	3	-10	10	0.00	0.15	dev			
Main_RecrDev_2015	-0.15	29	3	-10	10	0.00	0.17	dev			
Main_RecrDev_2016	-0.15	30	3	-10	10	0.00	0.16	dev			
Main_RecrDev_2017	0.10	31	3	-10	10	0.00	0.16	dev			
Late_RecrDev_2018	-0.07	32	6	-10	10	0.00	0.18	dev			
Late_RecrDev_2019	0.19	33	6	-10	10	0.00	0.19	dev			

Table 7. Continued.

Label	Value	Active	Phase	Min	Max	Init	StDev	Pr_type	Prior	Pr SD	CV
LnQ_base_S1_PLL_Obs(7)	-7.49	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_S2_Shark_BLL_Obs(8)	-1.44	44	1	-25	25	0.00	0.37	Sym_Beta	0.00	0.05	26%
LnQ_base_S3_Shark_BLL_Obs_Res(9)	0.33	45	1	-25	25	0.00	0.27	Sym_Beta	0.00	0.05	80%
LnQ_base_S4_FSU_BLLS(10)	-10.33	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_S5_NMFS_SEFSC_BLLS(11)	-7.54	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_R1_TXPWD_Gillnet(12)	-11.08	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_R2_GULFSPAN(13)	-6.51	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_R3_COASTSPAN_LL(14)	-2.94	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_R4_SCCOASTGN_LONG(15)	-3.07	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_R5_SCCOASTGN_SHORT(16)	-6.37	—	-1	-25	25	0.00	—	No_prior			NA
LnQ_base_S2_Shark_BLL_Obs(8)_BLK3repl_1981	-1.36	46	1	-25	25	0.00	0.46	Sym_Beta	0.00	0.05	34%
LnQ_base_S2_Shark_BLL_Obs(8)_BLK3repl_2005	-1.36	47	1	-25	25	0.00	0.50	Sym_Beta	0.00	0.05	37%
LnQ_base_S3_Shark_BLL_Obs_Res(9)_BLK4repl_2008	-2.65	48	1	-25	25	0.00	0.82	Sym_Beta	0.00	0.05	31%
LnQ_base_S3_Shark_BLL_Obs_Res(9)_BLK4repl_2018	-0.30	49	1	-25	25	0.00	0.49	Sym_Beta	0.00	0.05	164%
Size_DblN_peak_F1_COM_BLL(1)	188.05	50	2	55.6	247.5	116.60	10.71	Sym_Beta	116.60	0.05	6%
Size_DblN_top_logit_F1_COM_BLL(1)	4.00	—	-3	-6	4	4.00	—	Sym_Beta	4.00	0.05	NA
Size_DblN_ascend_se_F1_COM_BLL(1)	7.28	51	3	-1	9	6.40	0.39	Sym_Beta	6.40	0.05	5%
Size_DblN_descend_se_F1_COM_BLL(1)	-1.00	—	-3	-1.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
Size_DblN_start_logit_F1_COM_BLL(1)	-5.50	—	-2	-15.00	9.00	-5.50	—	Sym_Beta	-5.50	0.05	NA
Size_DblN_end_logit_F1_COM_BLL(1)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
SzSel_Fem_Peak_F1_COM_BLL(1)	-37.31	52	4	-50.00	50.00	0.00	6.54	Normal	0.00	1000	18%
SzSel_Fem_Ascend_F1_COM_BLL(1)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Descend_F1_COM_BLL(1)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Final_F1_COM_BLL(1)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Scale_F1_COM_BLL(1)	0.41	53	5	-15.00	15.00	1.00	0.08	Normal	1.00	1000	19%
Size_DblN_peak_F2_Com_GN(2)	67.77	54	2	42.50	247.50	73.10	9.21	Sym_Beta	73.10	0.05	14%
Size_DblN_top_logit_F2_Com_GN(2)	-2.90	—	-3	-6.00	4.00	-2.90	—	Sym_Beta	-2.90	0.05	NA
Size_DblN_ascend_se_F2_Com_GN(2)	4.77	55	3	-1.00	9.00	5.30	1.58	Sym_Beta	5.30	0.05	33%
Size_DblN_descend_se_F2_Com_GN(2)	6.40	56	3	-1.00	9.00	7.80	1.08	Sym_Beta	7.80	0.05	17%
Size_DblN_start_logit_F2_Com_GN(2)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_end_logit_F2_Com_GN(2)	-2.30	—	-2	-15.00	9.00	-2.30	—	Sym_Beta	-2.30	0.05	NA
Size_DblN_peak_F3_COM_PLL_PRM(3)	135.27	57	2	55.60	247.50	143.40	8.90	Sym_Beta	143.40	0.05	7%
Size_DblN_top_logit_F3_COM_PLL_PRM(3)	-6.00	—	-3	-6.00	4.00	-6.00	—	Sym_Beta	-6.00	0.05	NA
Size_DblN_ascend_se_F3_COM_PLL_PRM(3)	6.26	58	3	-1.00	9.00	6.50	0.74	Sym_Beta	6.50	0.05	12%
Size_DblN_descend_se_F3_COM_PLL_PRM(3)	9.00	—	-3	-1.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
Size_DblN_start_logit_F3_COM_PLL_PRM(3)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_end_logit_F3_COM_PLL_PRM(3)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
SzSel_Male_Peak_F3_COM_PLL_PRM(3)	14.25	59	4	-50.00	50.00	0.00	6.79	Normal	0.00	1000	48%
SzSel_Male_Ascend_F3_COM_PLL_PRM(3)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Male_Descend_F3_COM_PLL_PRM(3)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Male_Final_F3_COM_PLL_PRM(3)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Male_Scale_F3_COM_PLL_PRM(3)	1.00	—	-5	-15.00	15.00	1.00	—	Normal	1.00	1000	NA

Table 7. Continued.

Label	Value	Active	Phase	Min	Max	Init	StDev	Pr type	Prior	Pr SD	CV
Size_DblN_peak_F4_Rec(4)	61.80	—	-2	42.50	247.50	61.80	—	Sym_Beta	61.80	0.05	NA
Size_DblN_top_logit_F4_Rec(4)	-6.00	—	-3	-6.00	4.00	-6.00	—	Sym_Beta	-6.00	0.05	NA
Size_DblN_ascend_se_F4_Rec(4)	9.00	—	-3	-1.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
Size_DblN_descend_se_F4_Rec(4)	7.60	—	-3	-1.00	9.00	7.60	—	Sym_Beta	7.60	0.05	NA
Size_DblN_start_logit_F4_Rec(4)	1.00	—	-2	-15.00	9.00	1.00	—	Sym_Beta	1.00	0.05	NA
Size_DblN_end_logit_F4_Rec(4)	-1.00	—	-2	-15.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
SizeSel_P1_F5_Rec_PRM(5)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_F5_Rec_PRM(5)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
SizeSel_P1_F6_Com_HL(6)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_F6_Com_HL(6)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
SizeSel_P1_S1_PLL_Obs(7)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_S1_PLL_Obs(7)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
SizeSel_P1_S2_Shark_BLL_Obs(8)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_S2_Shark_BLL_Obs(8)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
SizeSel_P1_S3_Shark_BLL_Obs_Res(9)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_S3_Shark_BLL_Obs_Res(9)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
Size_DblN_peak_S4_FSU_BLLS(10)	123.90	60	2	55.60	247.50	131.40	8.33	Sym_Beta	131.40	0.05	7%
Size_DblN_top_logit_S4_FSU_BLLS(10)	4.00	—	-3	-6.00	4.00	4.00	—	Sym_Beta	4.00	0.05	NA
Size_DblN_ascend_se_S4_FSU_BLLS(10)	6.17	61	3	-1.00	9.00	5.90	0.64	Sym_Beta	5.90	0.05	10%
Size_DblN_descend_se_S4_FSU_BLLS(10)	-1.00	—	-3	-1.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
Size_DblN_start_logit_S4_FSU_BLLS(10)	-5.50	—	-2	-15.00	9.00	-5.50	—	Sym_Beta	-5.50	0.05	NA
Size_DblN_end_logit_S4_FSU_BLLS(10)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
SzSel_Fem_Peak_S4_FSU_BLLS(10)	0.00	—	-4	-50.00	50.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Ascend_S4_FSU_BLLS(10)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Descend_S4_FSU_BLLS(10)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Final_S4_FSU_BLLS(10)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Scale_S4_FSU_BLLS(10)	1.00	—	-5	-15	15	1.00	—	Normal	1.00	1000	NA
Size_DblN_peak_S5_NMFS_SEFSC_BLLS(11)	102.51	62	2	55.60	247.50	102.00	4.33	Sym_Beta	102.00	0.05	4%
Size_DblN_top_logit_S5_NMFS_SEFSC_BLLS(11)	4.00	—	-3	-6.00	4.00	4.00	—	Sym_Beta	4.00	0.05	NA
Size_DblN_ascend_se_S5_NMFS_SEFSC_BLLS(11)	5.96	63	3	-1.00	9.00	8.50	0.28	Sym_Beta	9.00	0.05	5%
Size_DblN_descend_se_S5_NMFS_SEFSC_BLLS(11)	-1.00	—	-3	-1.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
Size_DblN_start_logit_S5_NMFS_SEFSC_BLLS(11)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_end_logit_S5_NMFS_SEFSC_BLLS(11)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
SzSel_Fem_Peak_S5_NMFS_SEFSC_BLLS(11)	-11.59	64	4	-50.00	50.00	0.00	2.38	Normal	0.00	1000	21%
SzSel_Fem_Ascend_S5_NMFS_SEFSC_BLLS(11)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Descend_S5_NMFS_SEFSC_BLLS(11)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Final_S5_NMFS_SEFSC_BLLS(11)	0.00	—	-4	-15.00	15.00	0.00	—	Normal	0.00	1000	NA
SzSel_Fem_Scale_S5_NMFS_SEFSC_BLLS(11)	1.00	—	-5	-15.00	15.00	1.00	—	Normal	1.00	1000	NA

Table 7. Continued.

Label	Value	Active	Phase	Min	Max	Init	StDev	Pr_type	Prior	Pr_SD	CV
Size_DblN_peak_R1_TXPWD_Gillnet(12)	54.07	65	2	42.50	77.50	55.30	1.02	Sym_Beta	55.30	0.05	2%
Size_DblN_top_logit_R1_TXPWD_Gillnet(12)	-5.90	—	-3	-6.00	4.00	-5.90	—	Sym_Beta	-5.90	0.05	NA
Size_DblN_ascend_se_R1_TXPWD_Gillnet(12)	4.80	—	-3	-1.00	9.00	4.80	—	Sym_Beta	4.80	0.05	NA
Size_DblN_descend_se_R1_TXPWD_Gillnet(12)	2.90	—	-3	-1.00	9.00	2.90	—	Sym_Beta	2.90	0.05	NA
Size_DblN_start_logit_R1_TXPWD_Gillnet(12)	-0.03	66	2	-15.00	9.00	-1.10	0.62	Sym_Beta	-1.10	0.05	2391%
Size_DblN_end_logit_R1_TXPWD_Gillnet(12)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_peak_R2_GULFSPAN(13)	42.50	—	-2	42.50	77.50	42.50	—	Sym_Beta	43.00	0.05	NA
Size_DblN_top_logit_R2_GULFSPAN(13)	-6.00	—	-3	-6.00	4.00	-6.00	—	Sym_Beta	-6.00	0.05	NA
Size_DblN_ascend_se_R2_GULFSPAN(13)	9.00	—	-3	-1.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
Size_DblN_descend_se_R2_GULFSPAN(13)	3.96	67	3	-1.00	9.00	3.90	0.08	Sym_Beta	3.90	0.05	2%
Size_DblN_start_logit_R2_GULFSPAN(13)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	0.60	0.05	NA
Size_DblN_end_logit_R2_GULFSPAN(13)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_peak_R3_COASTSPAN_LL(14)	37.90	—	-2	37.90	250.00	37.90	—	Sym_Beta	37.90	0.05	NA
Size_DblN_top_logit_R3_COASTSPAN_LL(14)	-6.00	—	-3	-6.00	4.00	-6.00	—	Sym_Beta	-6.00	0.05	NA
Size_DblN_ascend_se_R3_COASTSPAN_LL(14)	-1.00	—	-3	-1.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
Size_DblN_descend_se_R3_COASTSPAN_LL(14)	3.39	68	3	-1.00	9.00	4.30	0.67	Sym_Beta	4.30	0.05	20%
Size_DblN_start_logit_R3_COASTSPAN_LL(14)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
Size_DblN_end_logit_R3_COASTSPAN_LL(14)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
Size_DblN_peak_R4_SCCOASTGN_LONG(15)	37.90	—	-2	37.90	250.00	37.90	—	Sym_Beta	37.90	0.05	NA
Size_DblN_top_logit_R4_SCCOASTGN_LONG(15)	-6.00	—	-3	-6.00	4.00	-6.00	—	Sym_Beta	-6.00	0.05	NA
Size_DblN_ascend_se_R4_SCCOASTGN_LONG(15)	-1.00	—	-3	-1.00	9.00	-1.00	—	Sym_Beta	-1.00	0.05	NA
Size_DblN_descend_se_R4_SCCOASTGN_LONG(15)	3.07	69	3	-1.00	9.00	3.60	0.13	Sym_Beta	3.60	0.05	4%
Size_DblN_start_logit_R4_SCCOASTGN_LONG(15)	9.00	—	-2	-15.00	9.00	9.00	—	Sym_Beta	9.00	0.05	NA
Size_DblN_end_logit_R4_SCCOASTGN_LONG(15)	-15.00	—	-2	-15.00	9.00	-15.00	—	Sym_Beta	-15.00	0.05	NA
SizeSel_P1_R5_SCCOASTGN_SHORT(16)	1.00	—	-99	0.00	10.00	1.00	—	Normal	1.00	25	NA
SizeSel_P2_R5_SCCOASTGN_SHORT(16)	44.00	—	-99	10.00	100.00	44.00	—	Normal	44.00	25	NA
Size_DblN_peak_F1_COM_BLL(1)_BLK2repl_1981	188.29	70	2	55.60	247.50	116.59	11.95	Sym_Beta	116.60	0.05	6%
Size_DblN_peak_F1_COM_BLL(1)_BLK2repl_1997	190.71	71	2	55.60	247.50	116.59	16.94	Sym_Beta	116.60	0.05	9%
Size_DblN_peak_F1_COM_BLL(1)_BLK2repl_2005	164.86	72	2	55.60	247.50	116.59	15.32	Sym_Beta	116.60	0.05	9%
Size_DblN_peak_F1_COM_BLL(1)_BLK2repl_2018	203.50	73	2	55.60	247.50	116.59	31.53	Sym_Beta	116.60	0.05	15%
Size_DblN_ascend_se_F1_COM_BLL(1)_BLK2repl_1981	5.21	74	3	-1.00	9.00	6.39	1.42	Sym_Beta	6.40	0.05	27%
Size_DblN_ascend_se_F1_COM_BLL(1)_BLK2repl_1997	7.76	75	3	-1.00	9.00	6.39	0.47	Sym_Beta	6.40	0.05	6%
Size_DblN_ascend_se_F1_COM_BLL(1)_BLK2repl_2005	6.85	76	3	-1.00	9.00	6.39	0.82	Sym_Beta	6.40	0.05	12%
Size_DblN_ascend_se_F1_COM_BLL(1)_BLK2repl_2018	7.98	77	3	-1	9	6.40	0.86	Sym_Beta	6.40	0.05	11%
Size_DblN_peak_F2_Com_GN(2)_BLK5repl_1981	85.80	78	2	42.5	247.5	83.10	14.25	Sym_Beta	73.10	0.05	17%
Size_DblN_end_logit_F4_Rec(4)_BLK6repl_1981	-0.33	79	2	-15	9	-1.00	0.82	Sym_Beta	-1.00	0.05	249%

Table 8. Catchability, q , estimated for indices with time blocks (S2 and S3), along with the median unbiased analytical solution for q calculated in Stock Synthesis for the remaining indices in the (GOM + ATL) continuity analysis model configuration.

Index name and years	$\ln(q)$	q
Main years		
S1 (PLL-Obs; 1992 – 2019)	-7.493	5.57E-04
S2 (Shark-BLL-Obs; 1997 - 2004)	-1.441	2.37E-01
S3 (Shark-BLL-Res; 2009 - 2017)	0.335	1.40E+00
S4 (FSU-BLLS; 2011 - 2019)	-10.325	3.28E-05
S5 (SEFSC-BLLS; 1995 - 2019)	-7.538	5.32E-04
R1 (TXPWD-GNS; 1983 - 2019)	-11.078	1.55E-05
R2 (GULFSPAN-GNS; 1996 - 2019)	-6.508	1.49E-03
R3 (COASTSPAN-BLLS; 2005 - 2019)	-2.938	5.30E-02
R4 (COASTSPAN-LGNS; 2001 - 2019)	-3.067	4.66E-02
R5 (COASTSPAN-SGNS; 2007 - 2019)	-6.366	1.72E-03
Time block years		
S2 (Shark-BLL-Obs; block years 1981 – 1996)	-1.362	2.56E-01
S2 (Shark-BLL-Obs; block years 2005 – 2007)	-1.362	2.56E-01
S3 (Shark-BLL-Res; block year 2008)	-2.647	7.08E-02
S3 (Shark-BLL-Res; block years 2018 – 2019)	-0.295	7.45E-01

Figures

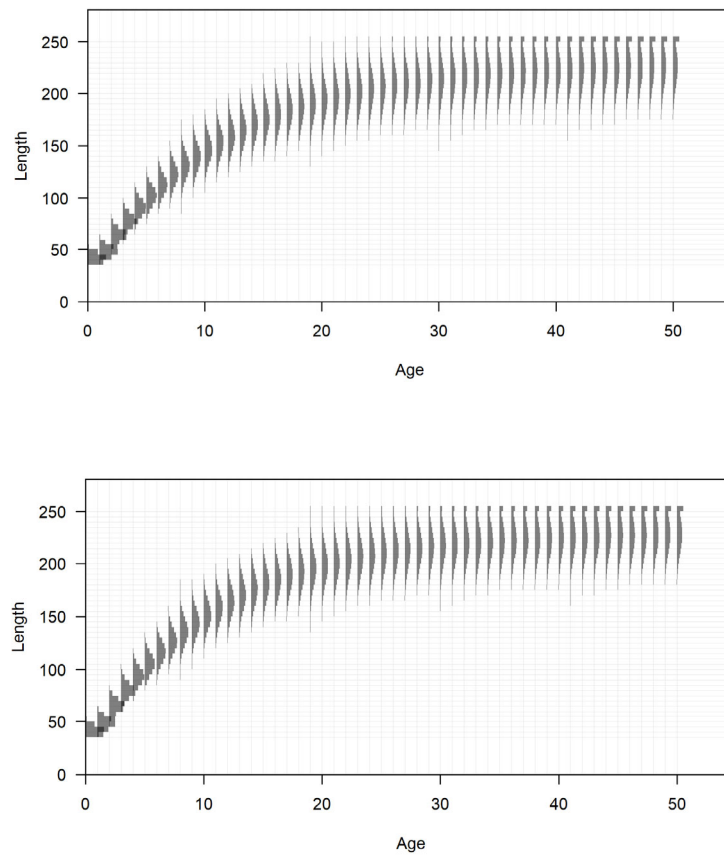


Figure 1. Distribution of mean length (cm FL straight) at each age implemented separately for females (upper panel) and males (lower panel) in the (GOM + ATL) continuity analysis model configuration.

A. S1 (PLL-Obs)

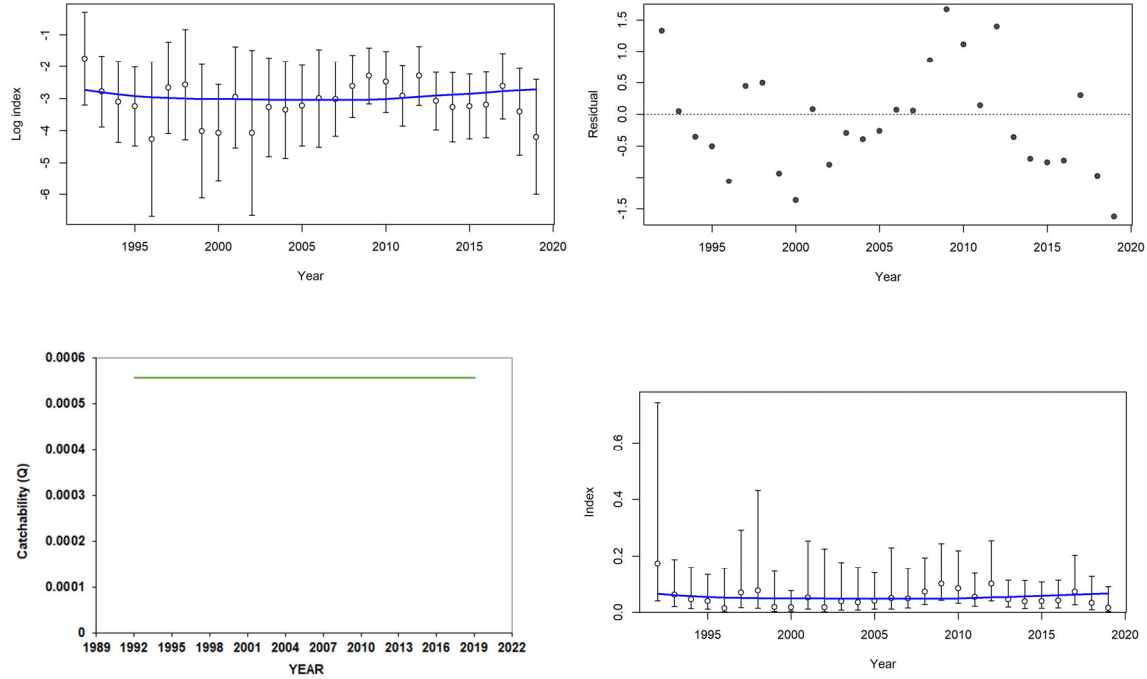


Figure 2. Fits to abundance indices in the (GOM + ATL) continuity analysis model configuration: Upper left panel is predicted (blue line) and observed (open circles with approximate 95% confidence intervals based on the input standard error, SE) on the natural log scale; Upper right panel is residuals on the natural log scale ($\ln(\text{Obs}) - \ln(\text{Exp})$)/(observed SE); Lower left panel is estimated catchability; Lower right panel is observed and predicted on the nominal scale.

B. S2 (Shark-BLL-Obs)

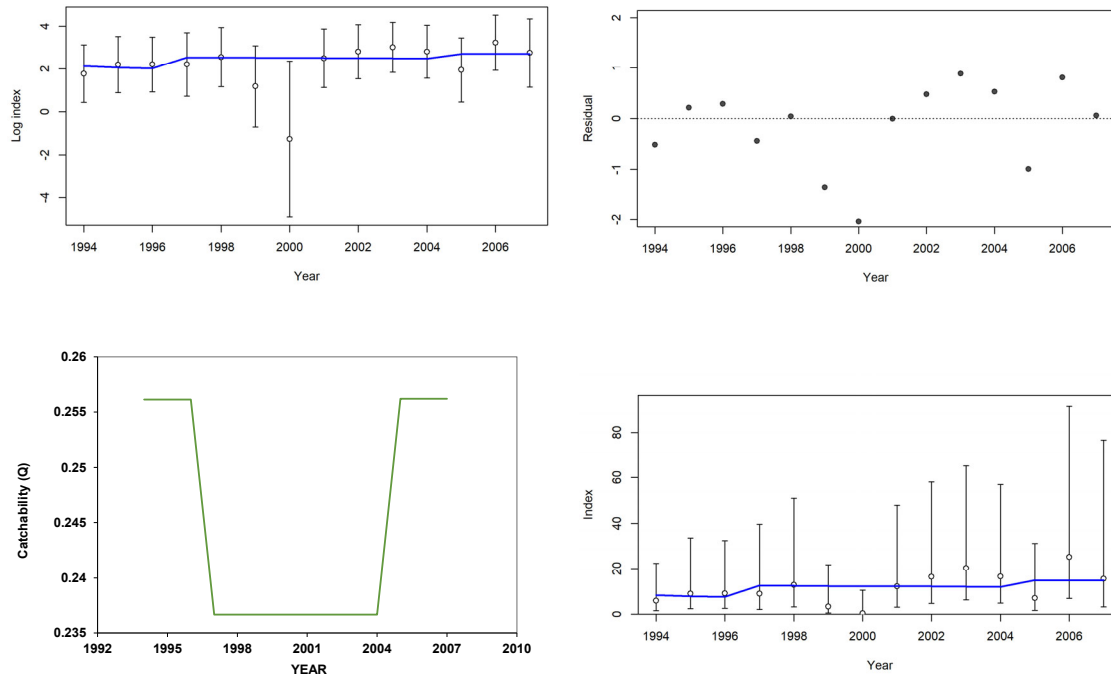


Figure 2. Continued.

C. S3 (Shark-BLL-Res)

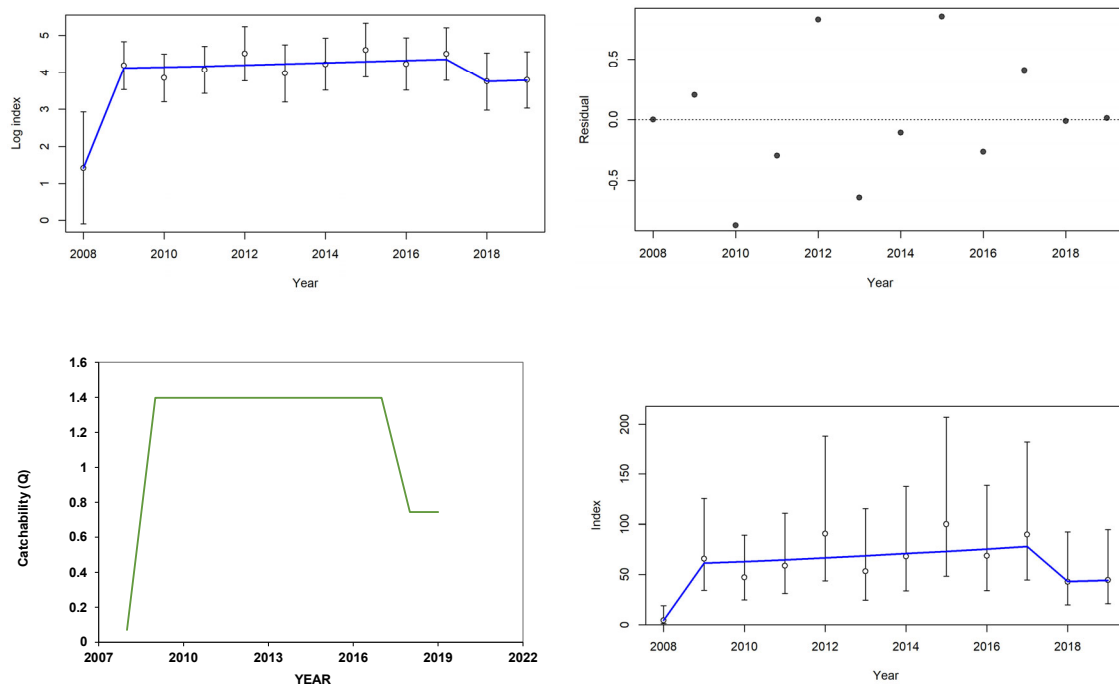


Figure 2. Continued.

D. S4 (FSU-BLLS)

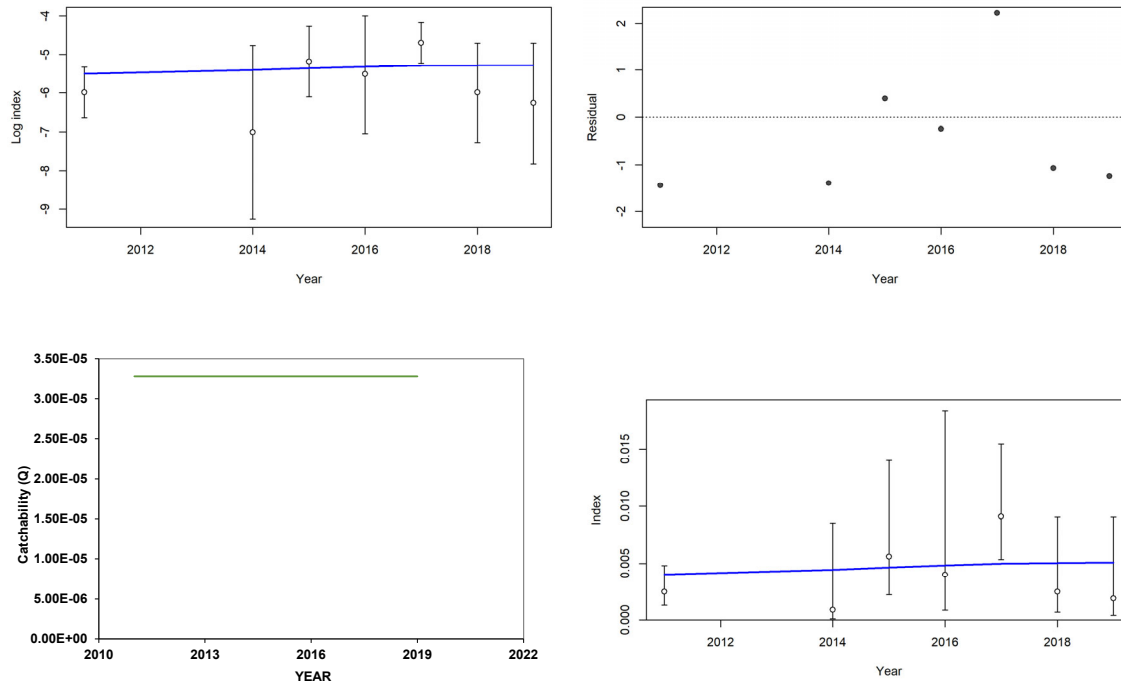


Figure 2. Continued.

E. S5 (SEFSC-BLLS)

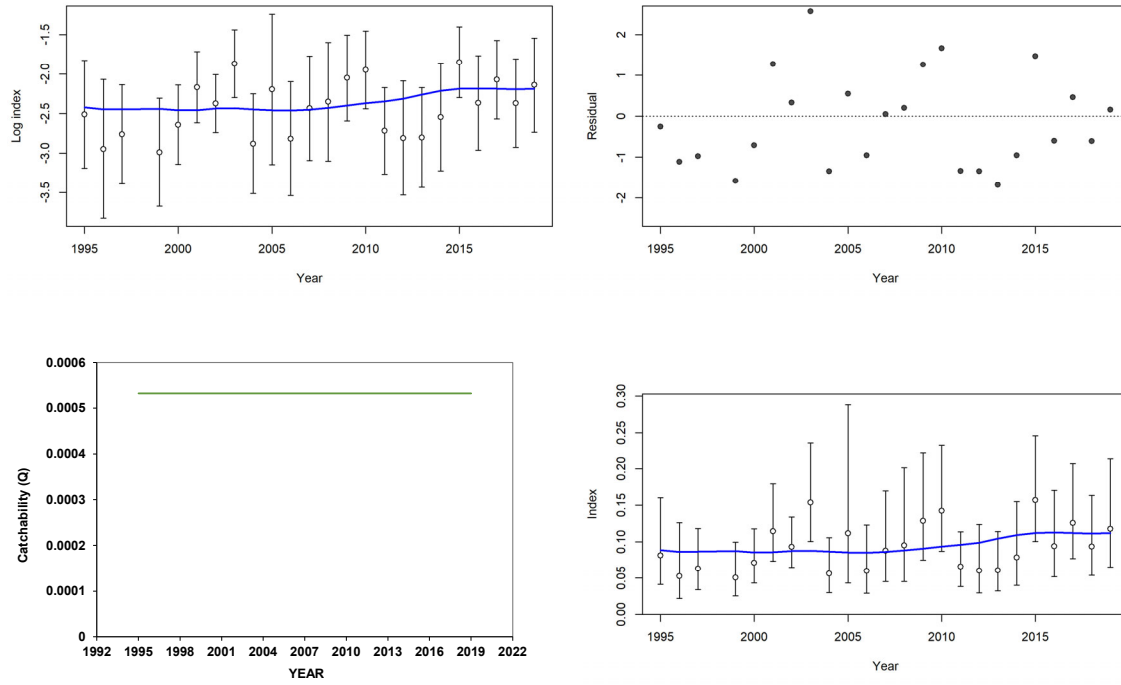


Figure 2. Continued.

F. R1 (TXPWD-GNS)

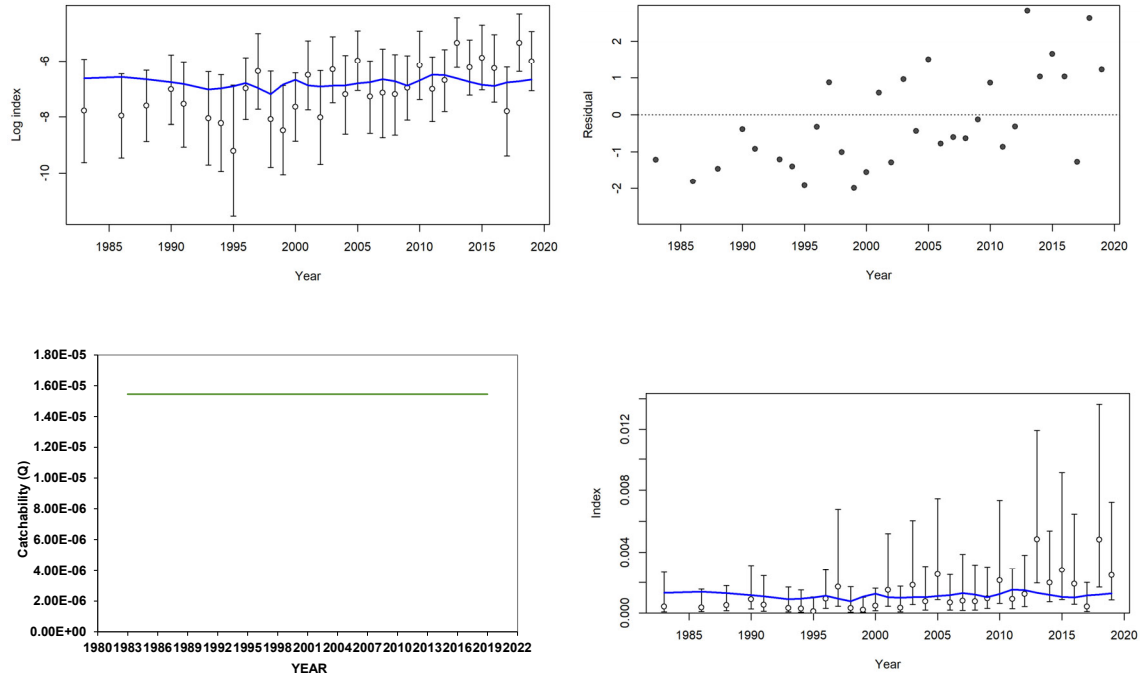


Figure 2. Continued.

G. R2 (GULFSPAN-GNS)

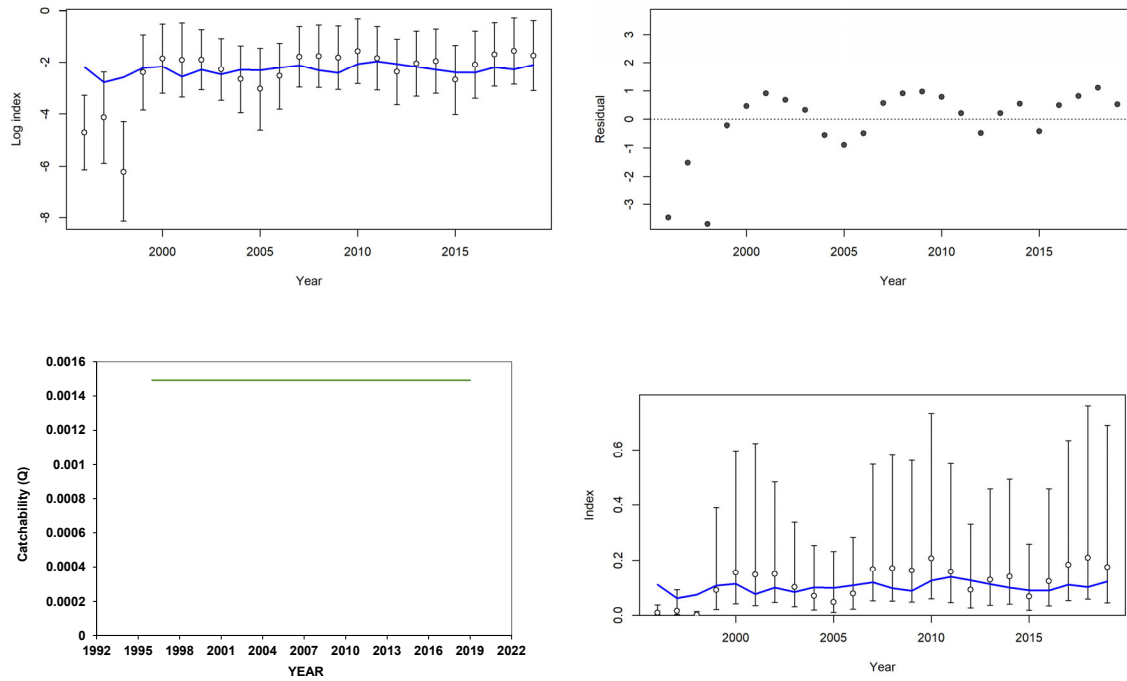


Figure 2. Continued.

H. R3 (COASTSPAN-BLLS)

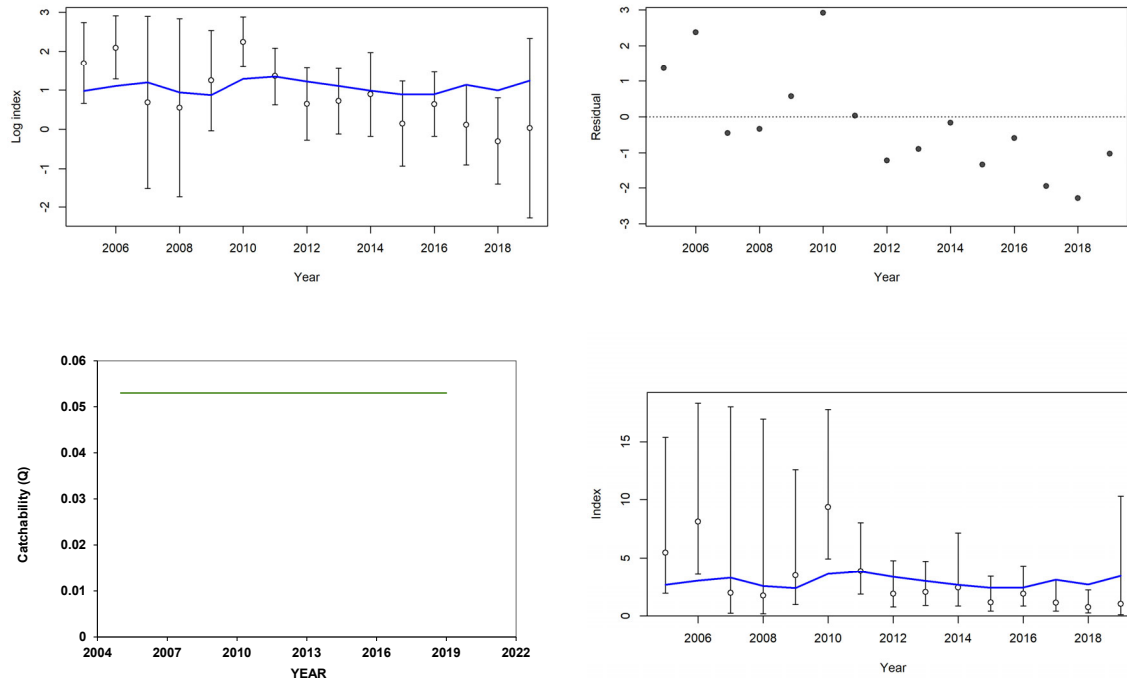


Figure 2. Continued.

I. R4 (COASTSPAN-LGNS)

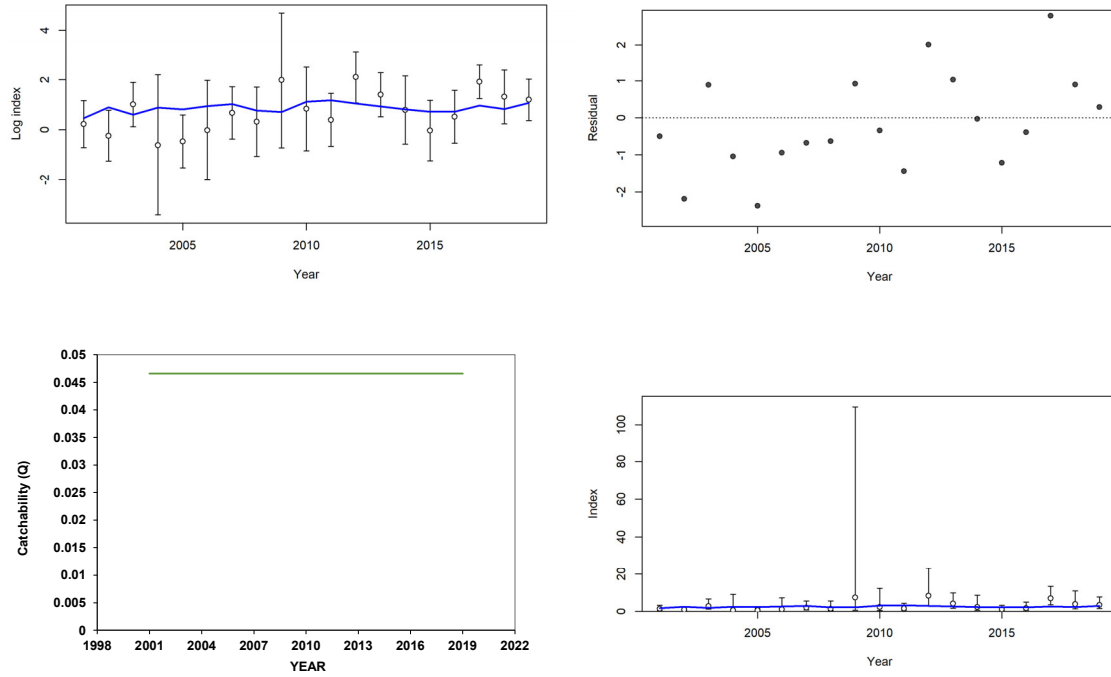


Figure 2. Continued.

J. R5 (COASTSPAN-SGNS)

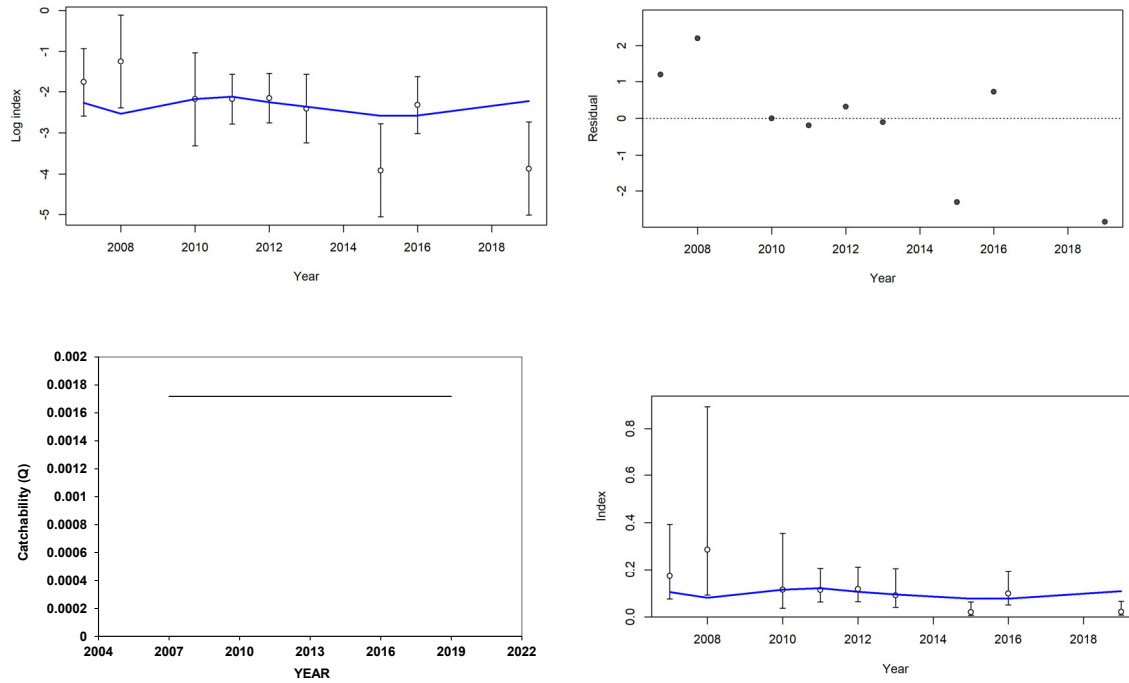


Figure 2. Continued.

Figure 3. Observed and predicted annual length compositions (Upper panels) and Pearson residuals (Lower panel) in the (GOM + ATL) continuity analysis model configuration. Years with annual length composition sample size less than the minimum input sample size (Min; **Table 2**) were excluded from the model fit, and are not plotted. The value “N adj” is the input effective sample size obtained using either the Francis method or the McAllister and Ianelli harmonic mean, as described above. The value “N eff” is an alternative effective sample size estimate (McAllister and Ianelli 1997; Punt 2017, his McAllister-Ianelli-1 in his equation 1.A:) that is not implemented in this assessment. The diameter of Pearson residuals indicates relative error; predicted < observed (solid), predicted > observed (transparent) within the length composition data set. The maximum diameter of Pearson residuals indicates relative error among length composition data sets.

A. F1 (Com-BLL)

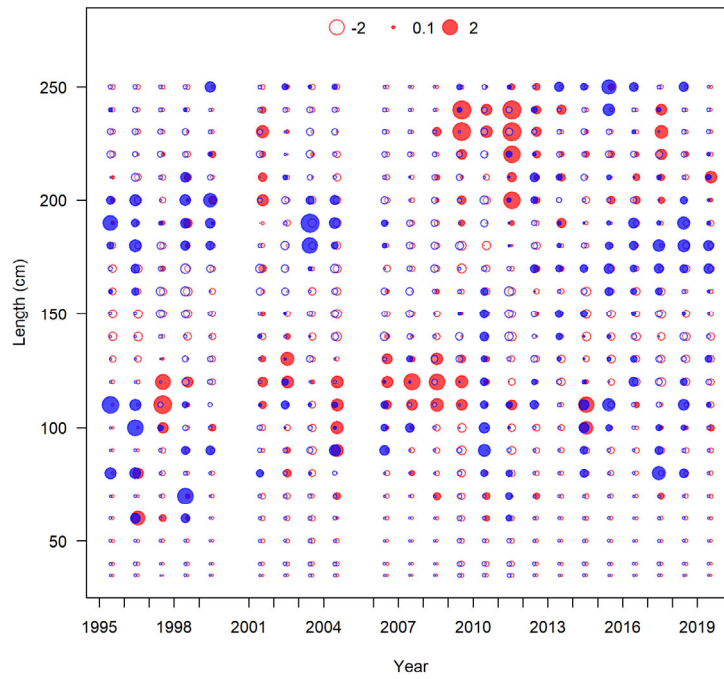
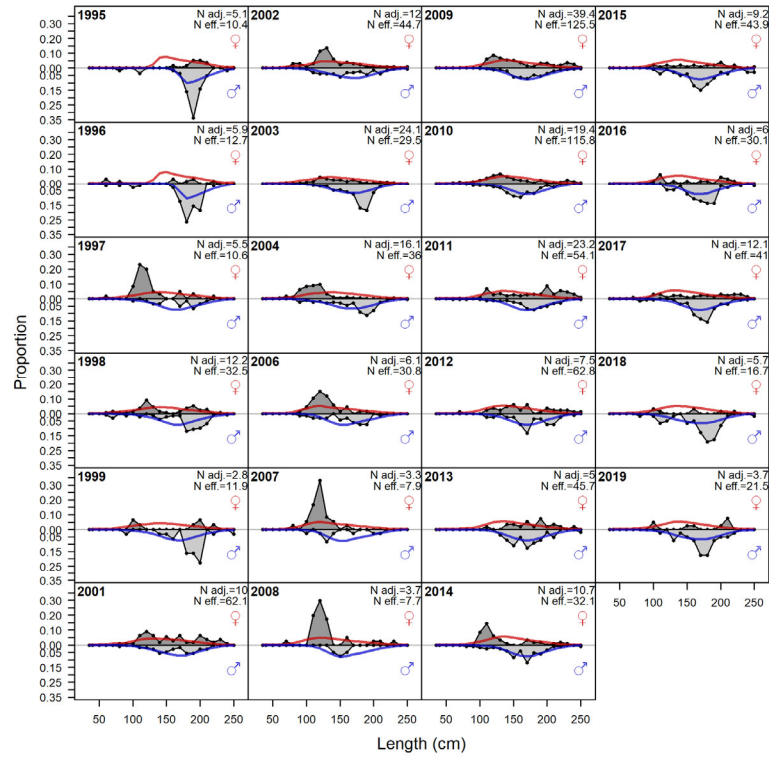


Figure 3. Continued.

B. F2 (Com-GN)

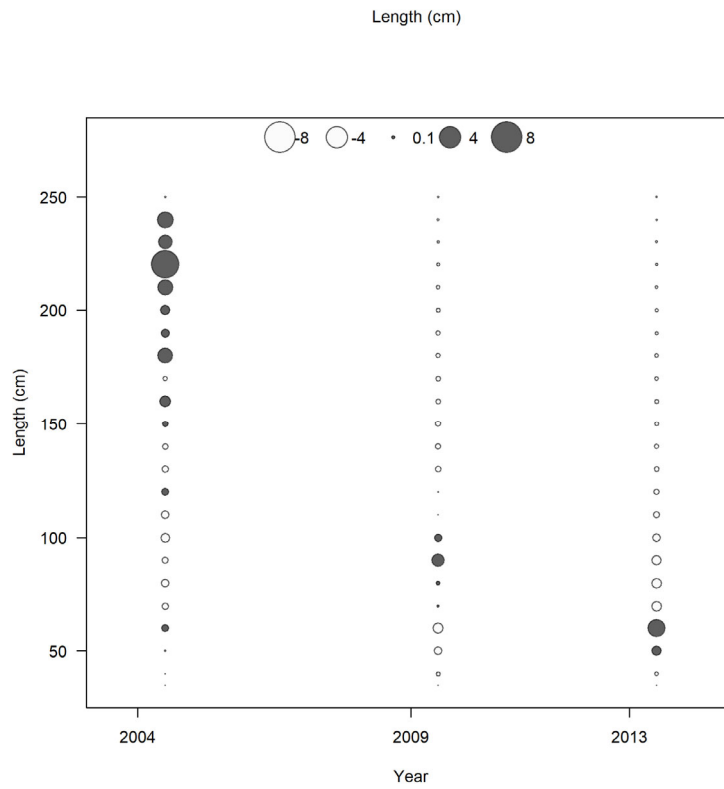
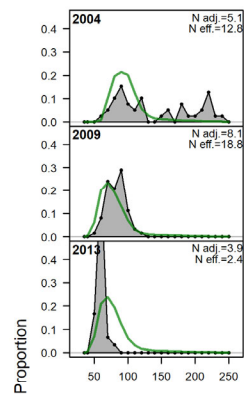
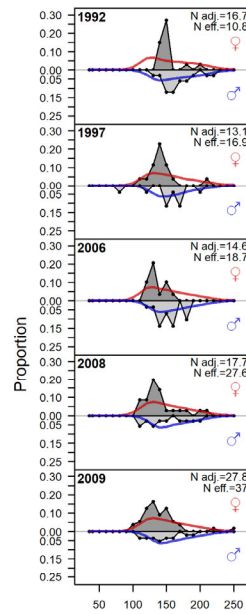


Figure 3. Continued.

C. F3 (Com-PLL)



Length (cm)

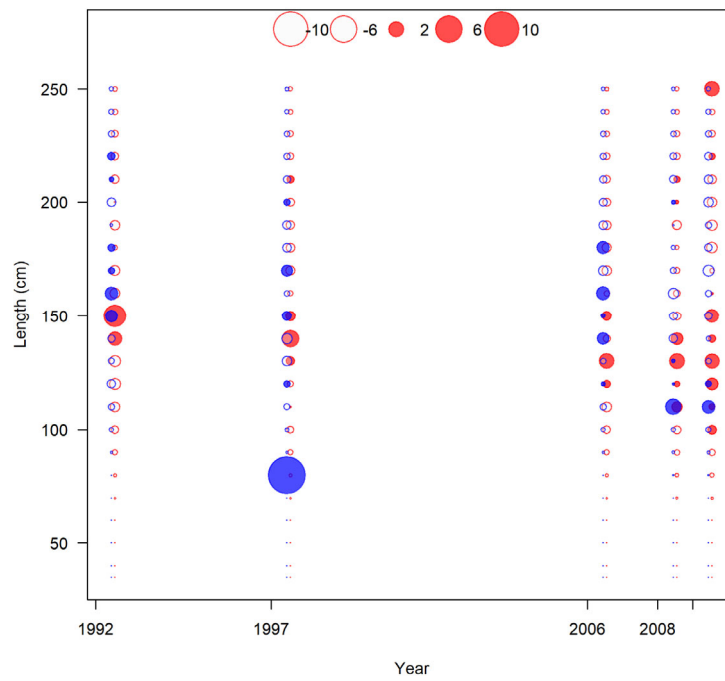


Figure 3. Continued.

D. F4 (Rec)

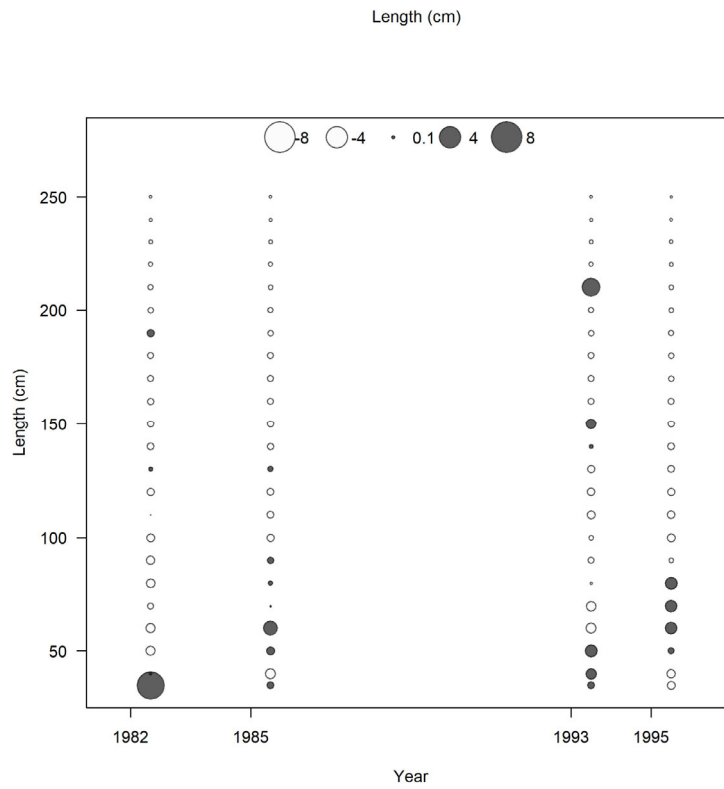
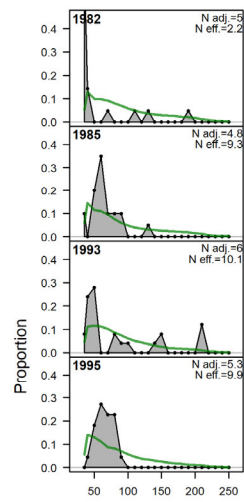
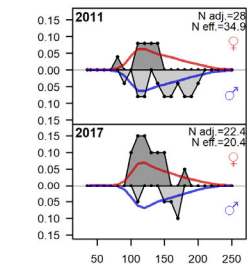


Figure 3. Continued.

E. S4 (FSU-BLLS)



Proportion

Length (cm)

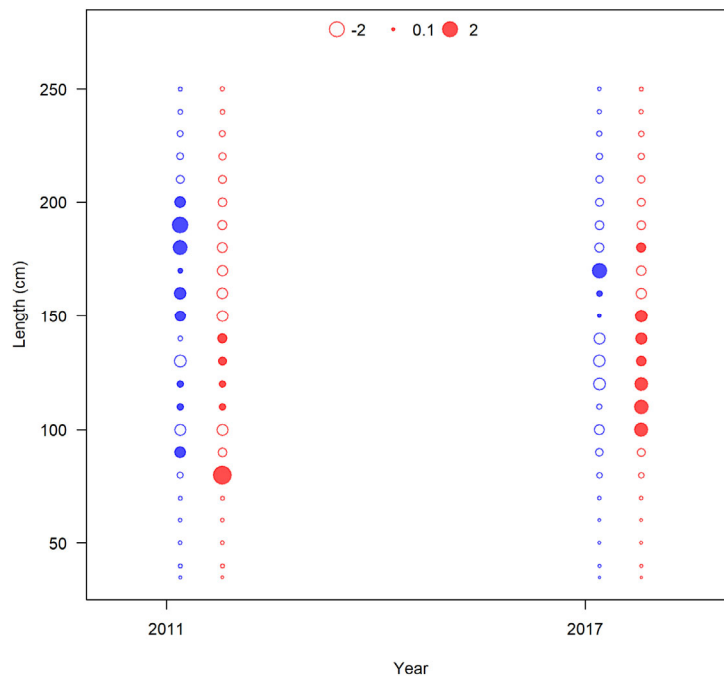


Figure 3. Continued.

F. S5 (SEFSC-BLLS)

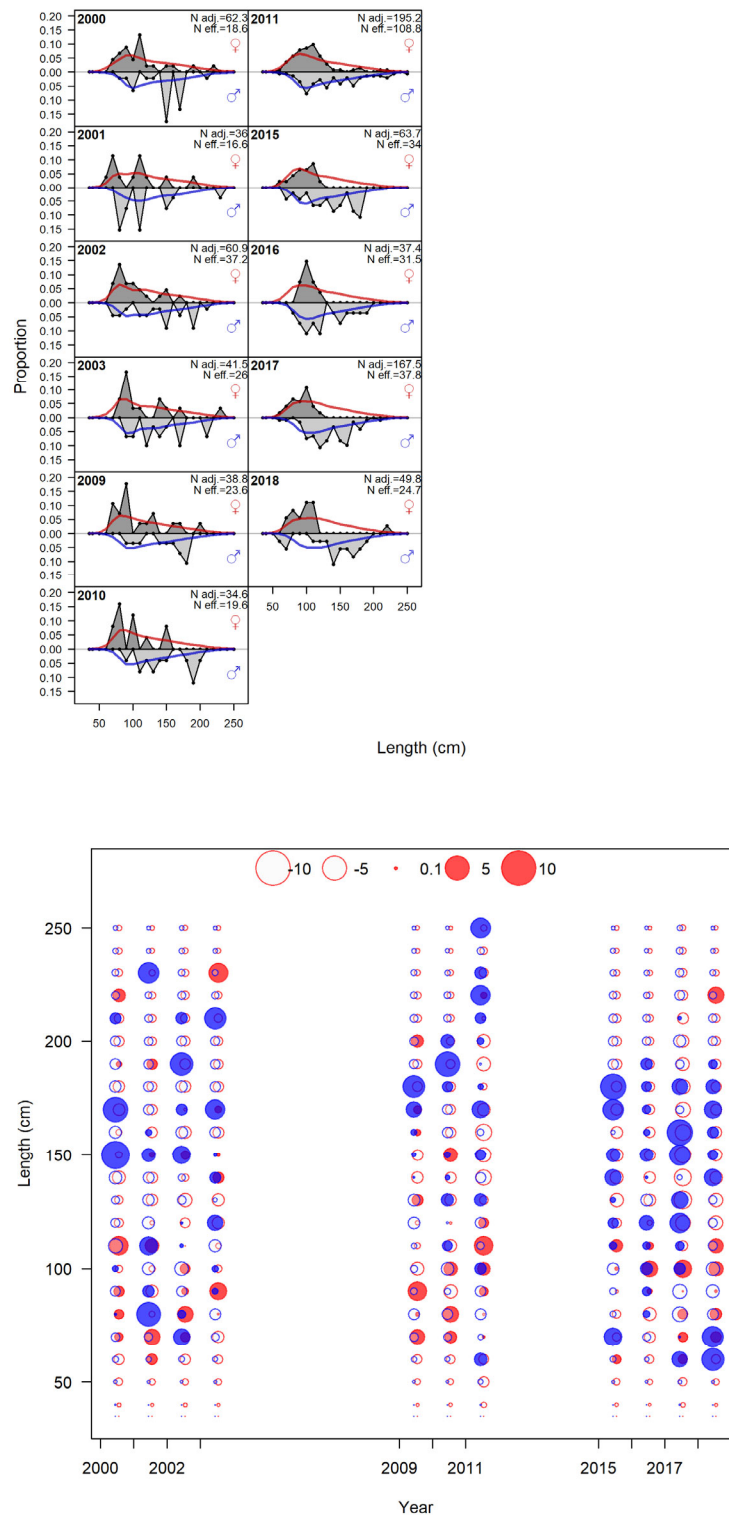


Figure 3. Continued.

G. R1 (TXPWD-GNS)

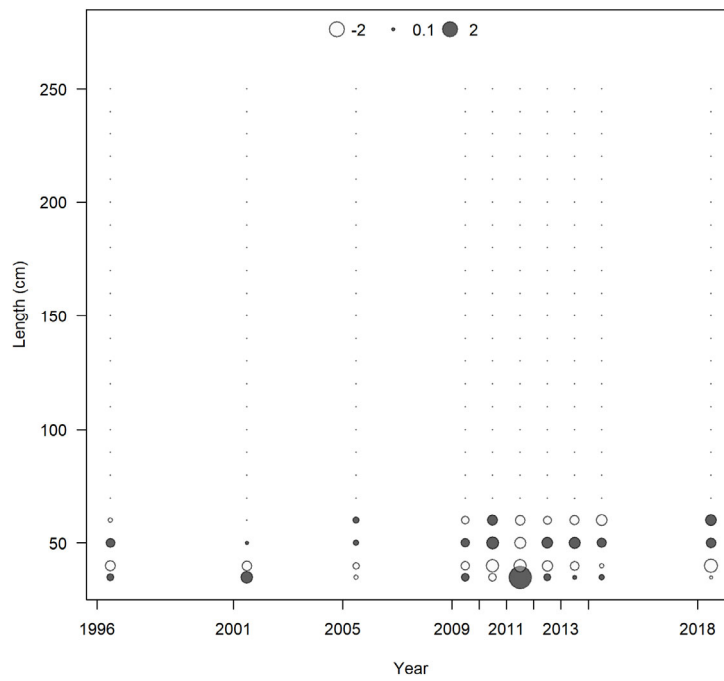
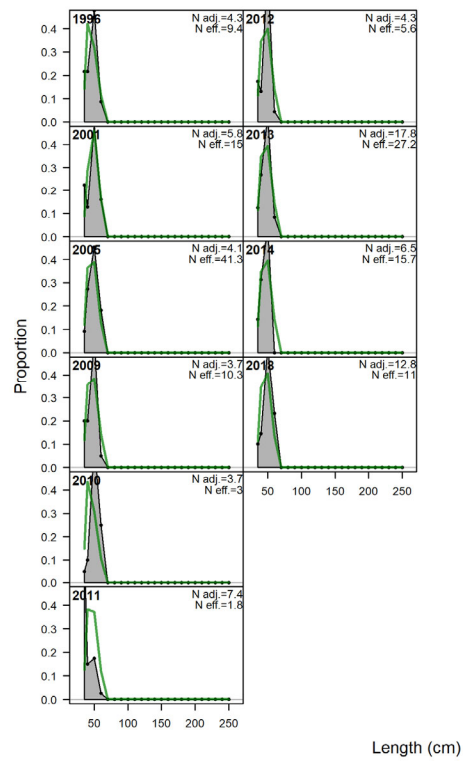


Figure 3. Continued.

H. R2 (GULFSPAN-GNS)

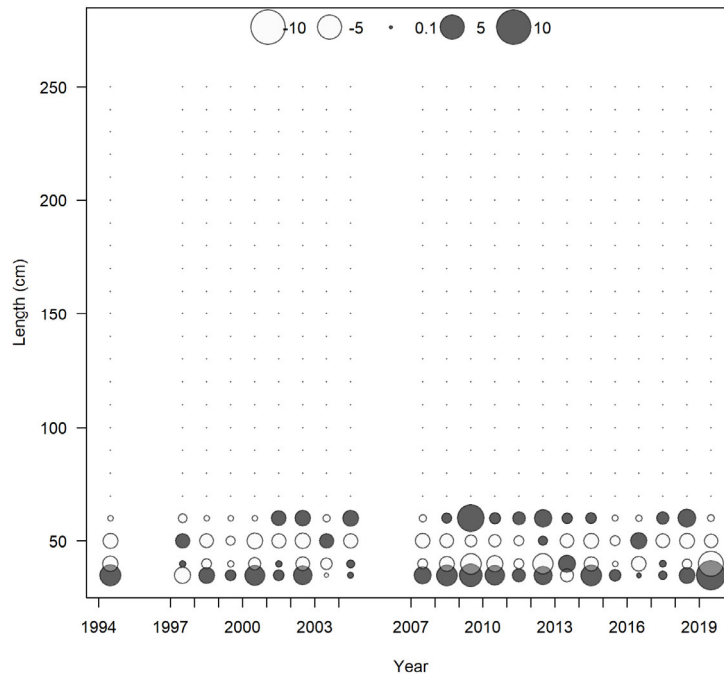
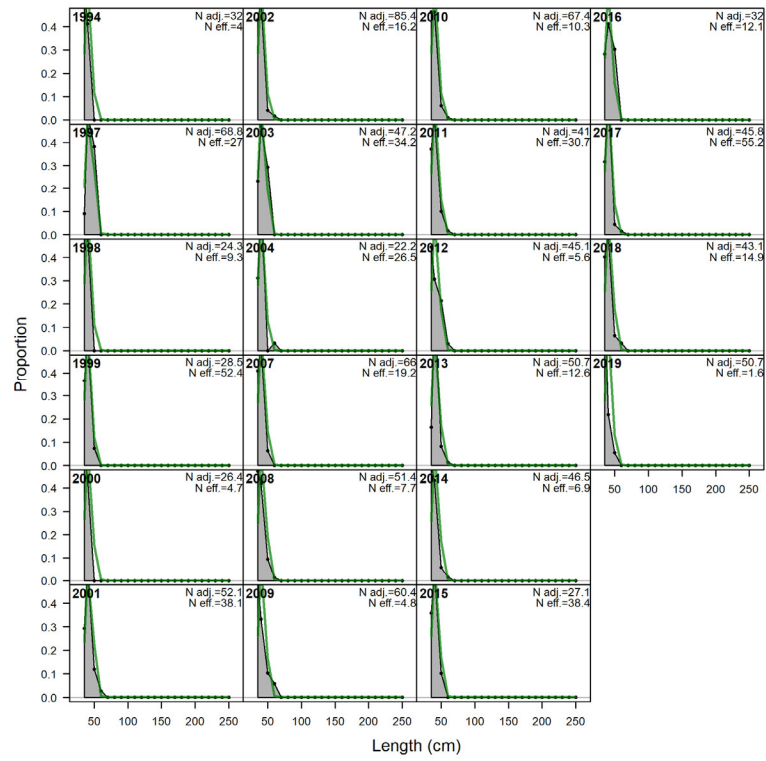


Figure 3. Continued.

I. R3 (COASTSPAN-BLLS)

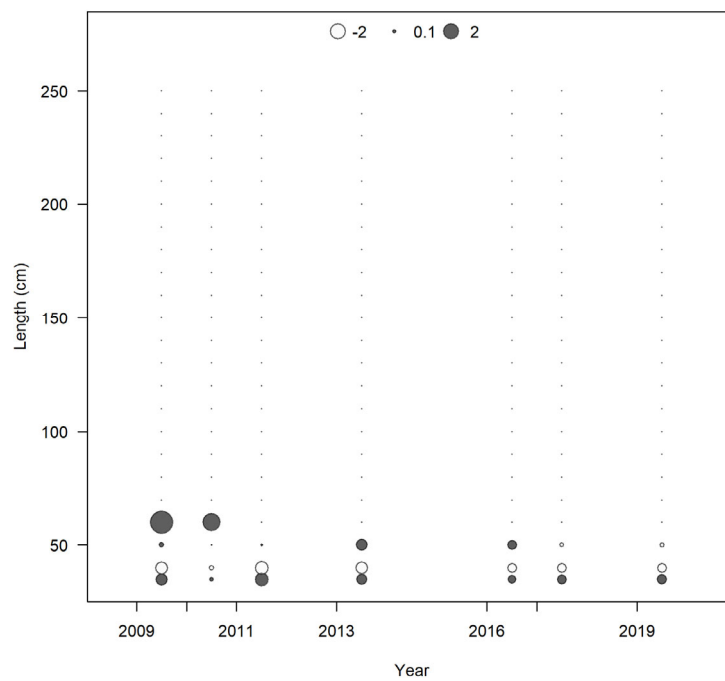
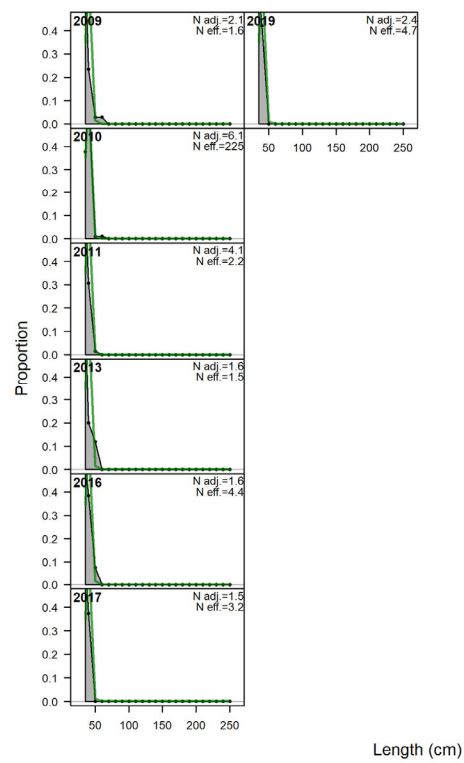


Figure 3. Continued.

J. R4 (COASTSPAN-LGNS)

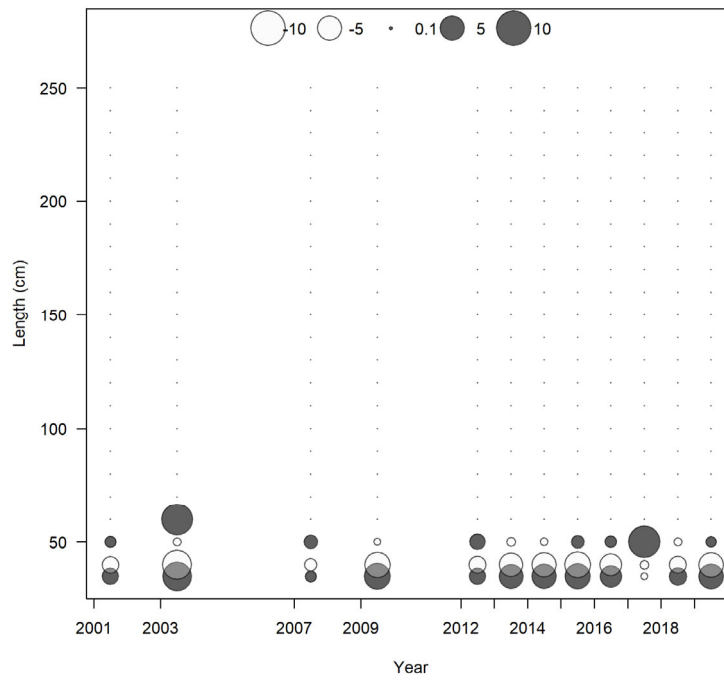
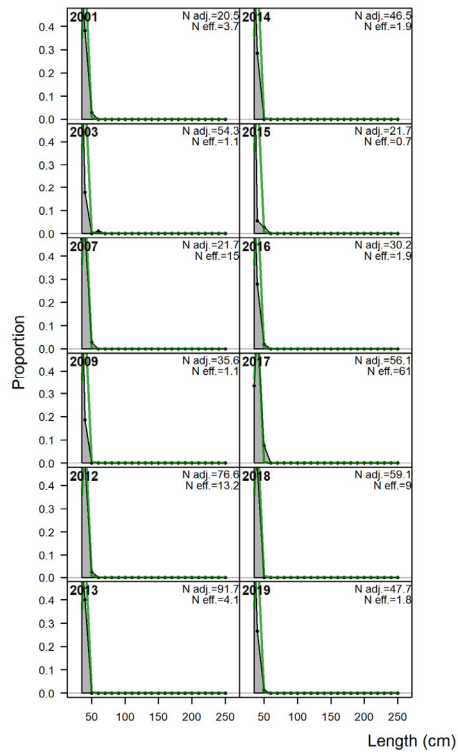


Figure 3. Continued.

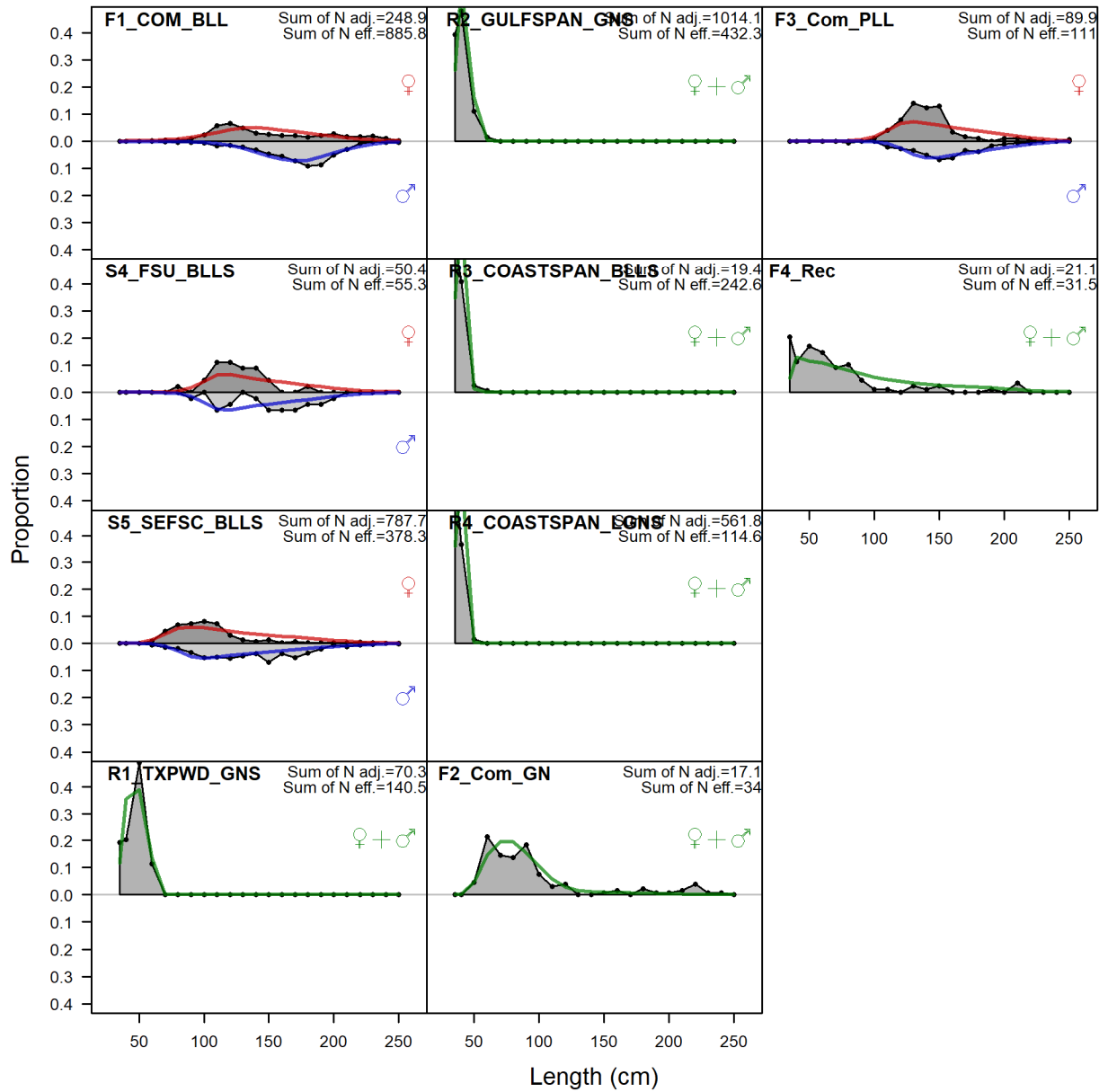


Figure 4. Predicted (line) and observed (shaded) aggregated length compositions in the (GOM + ATL) continuity analysis model configuration. Years with annual length composition sample size less than the minimum input sample size (Min; **Table 2**) were excluded from the model fit, and are not plotted. The value “N adj” is the input effective sample size obtained using either the Francis method or the McAllister and Ianelli harmonic mean, as described above. The value “N eff” is an alternative effective sample size estimate (McAllister and Ianelli 1997; Punt 2017, his McAllister-Ianelli-1 in his equation 1.A:) that is not implemented in this assessment.

A. F1 (Com-BLL)

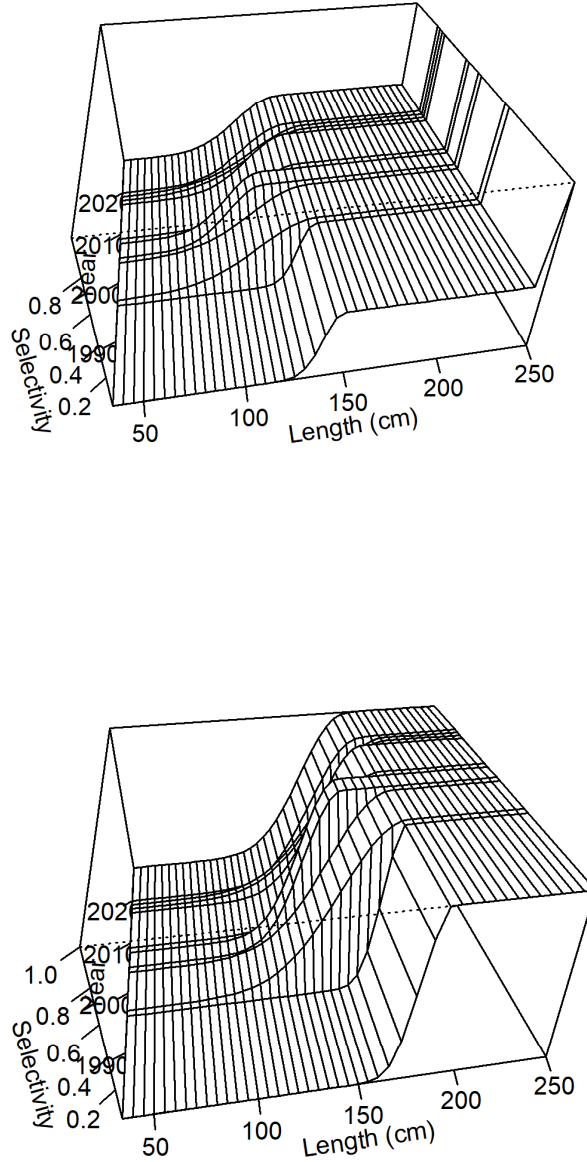


Figure 5. Estimated selectivity at length (cm FL straight) obtained in the (GOM + ATL) continuity analysis model configuration (**Table 5**): Upper panel is female selectivity; Lower panel is male selectivity, if different from female selectivity; Otherwise female and male selectivity are the same.

B. F2 (Com-GN)

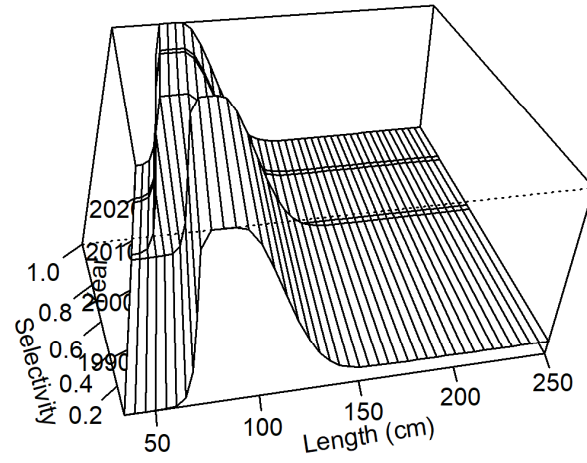


Figure 5. Continued.

C. F3 (Com-PLL)

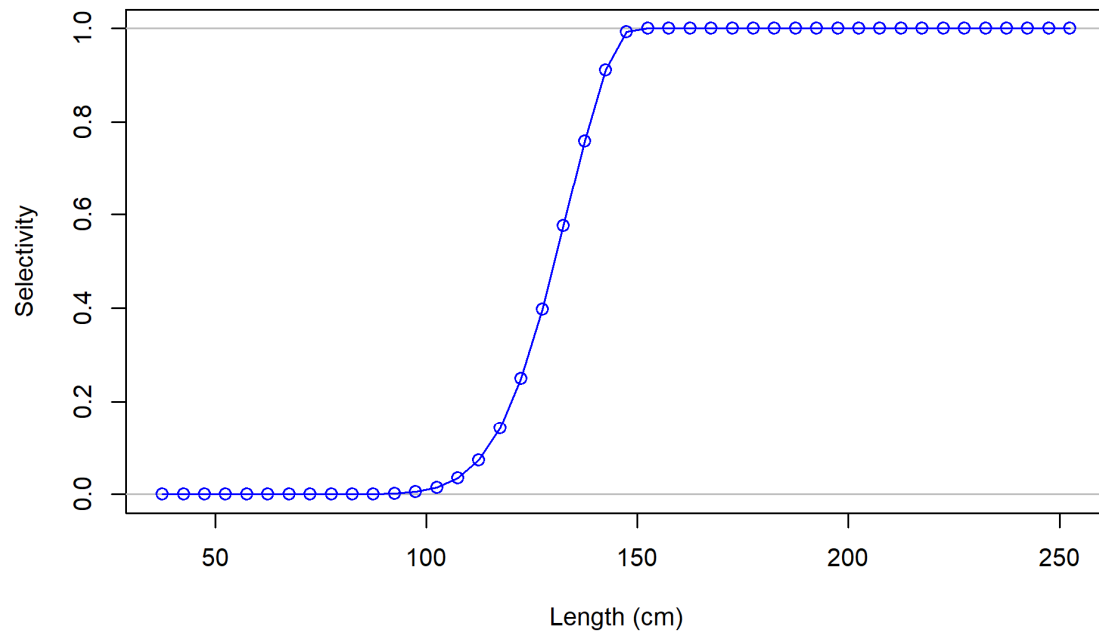
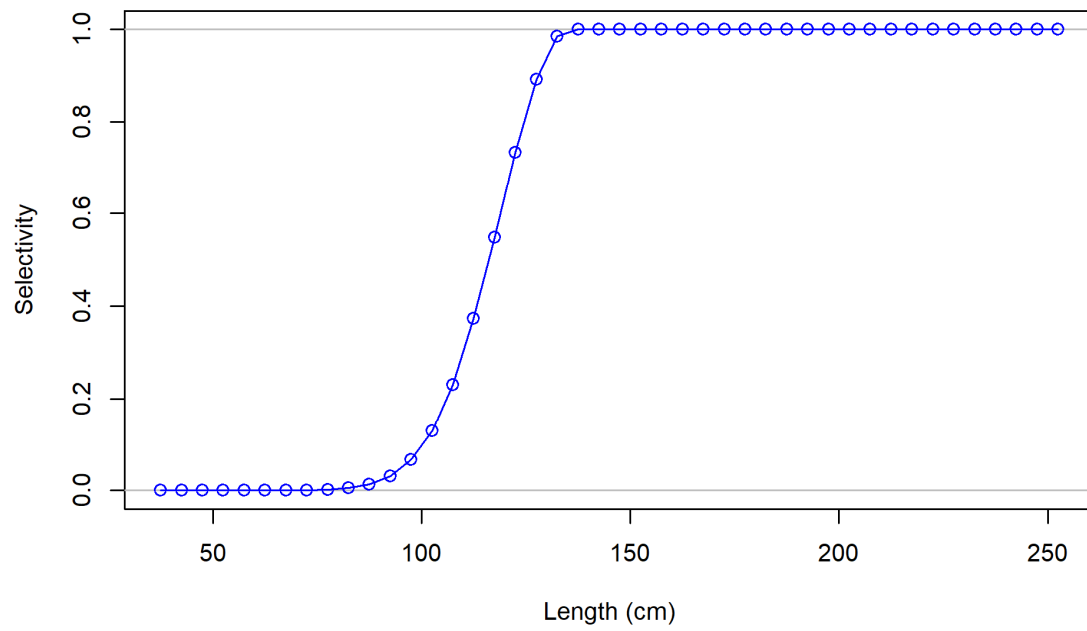


Figure 5. Continued.

D. F4 (Rec)

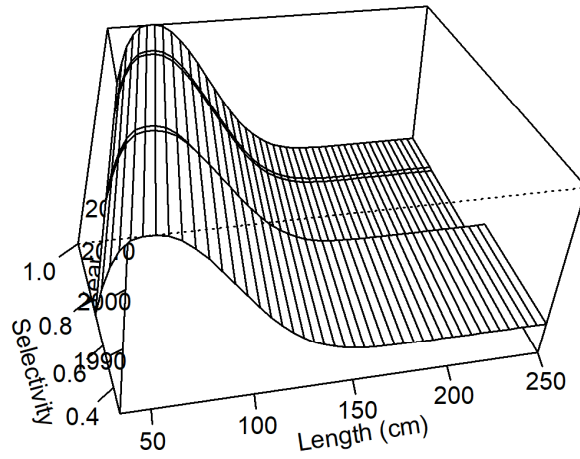


Figure 5. Continued.

E. S4 (FSU-BLLS)

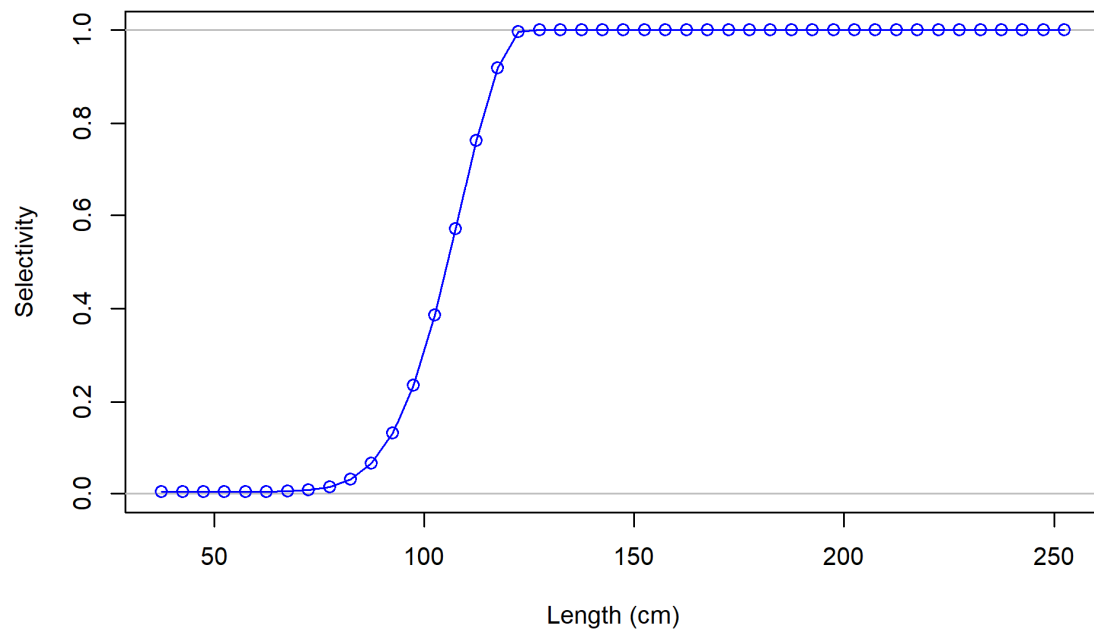
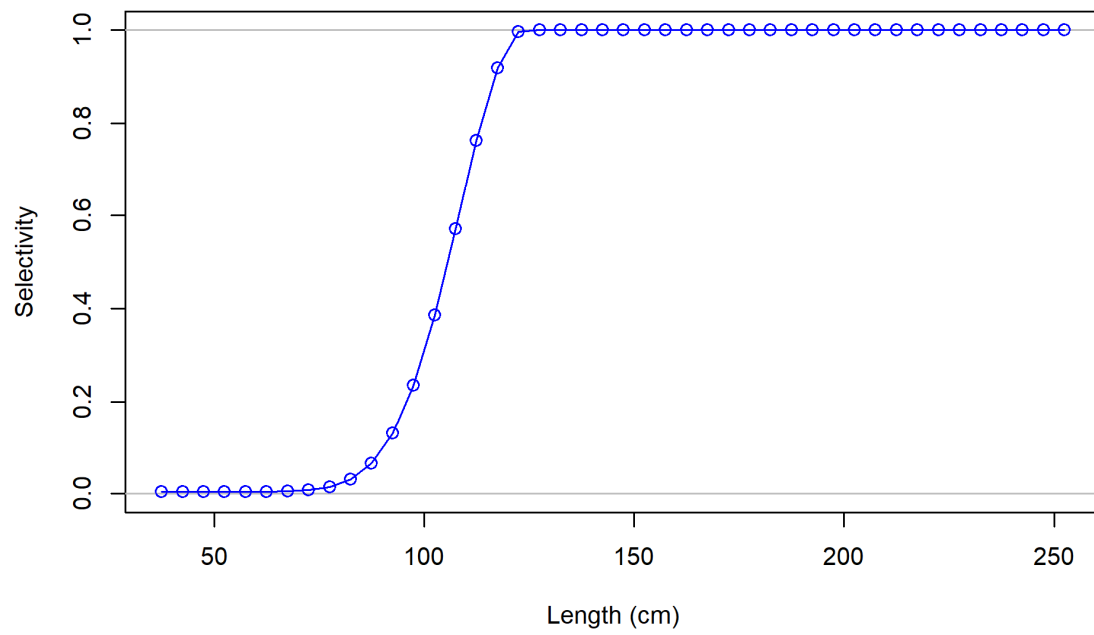


Figure 5. Continued.

F. S5 (SEFSC-BLLS)

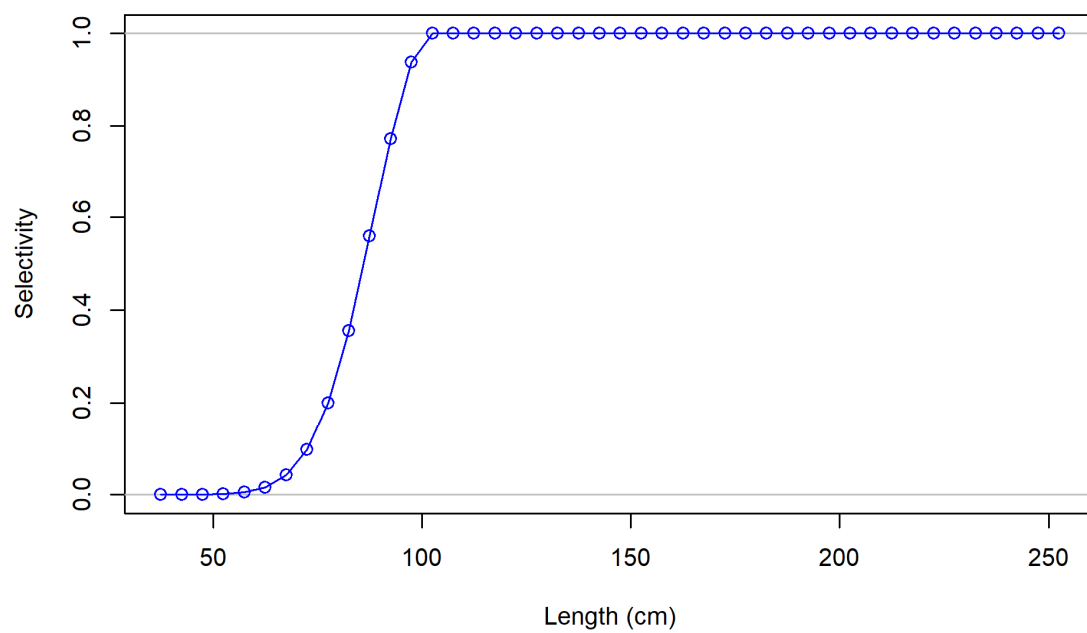
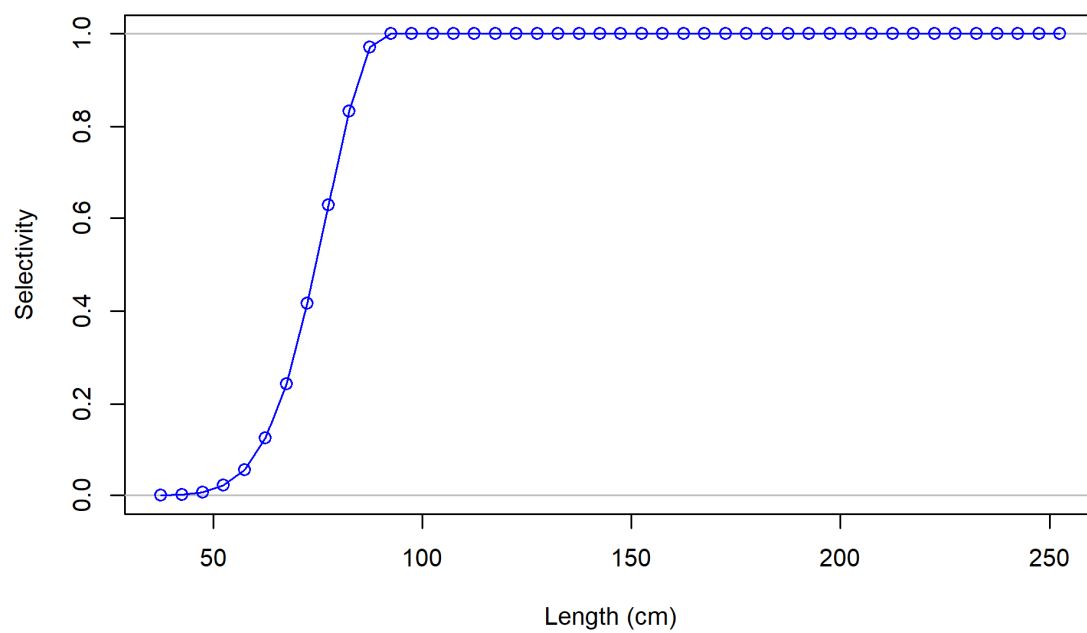


Figure 5. Continued.

G. R1 (TXPWD-GNS)

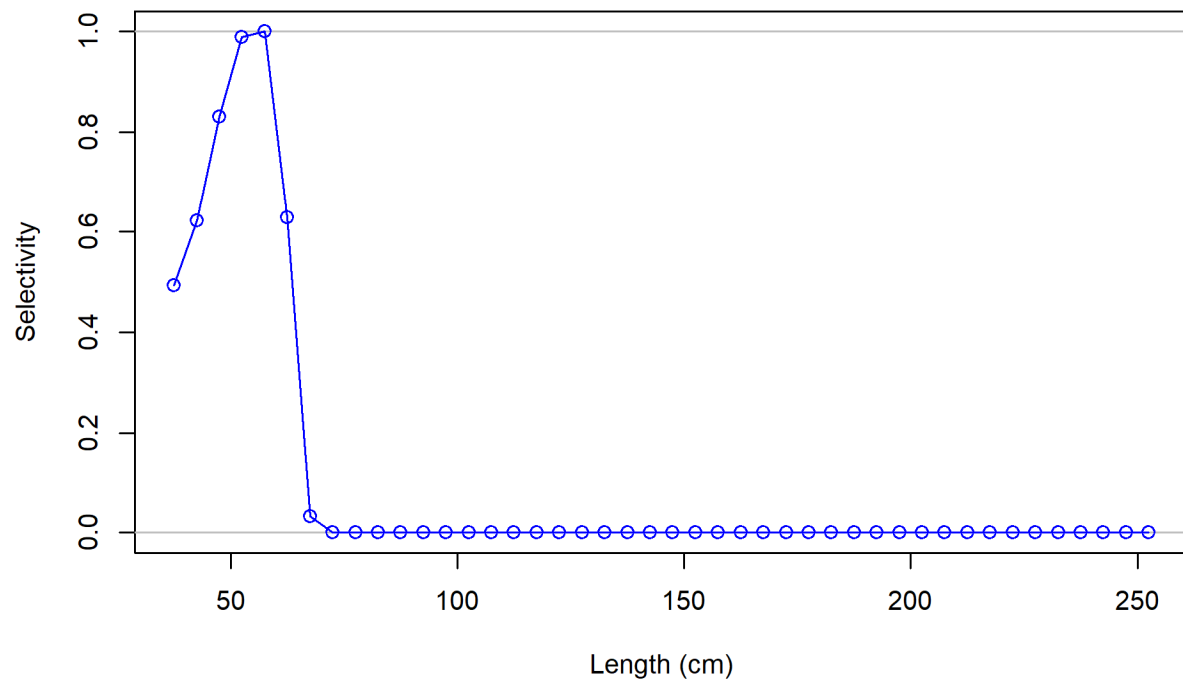


Figure 5. Continued.

H. R2 (GULFSPAN-GNS)

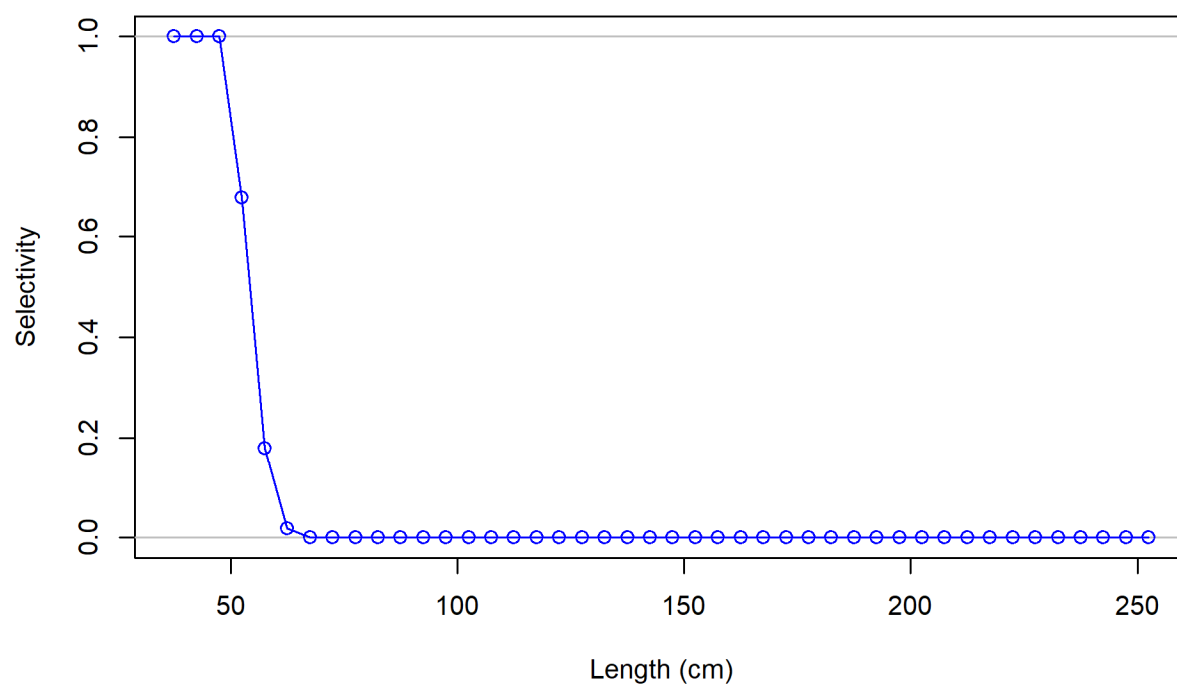


Figure 5. Continued.

I. R3 (COASTSPAN-BLLS)

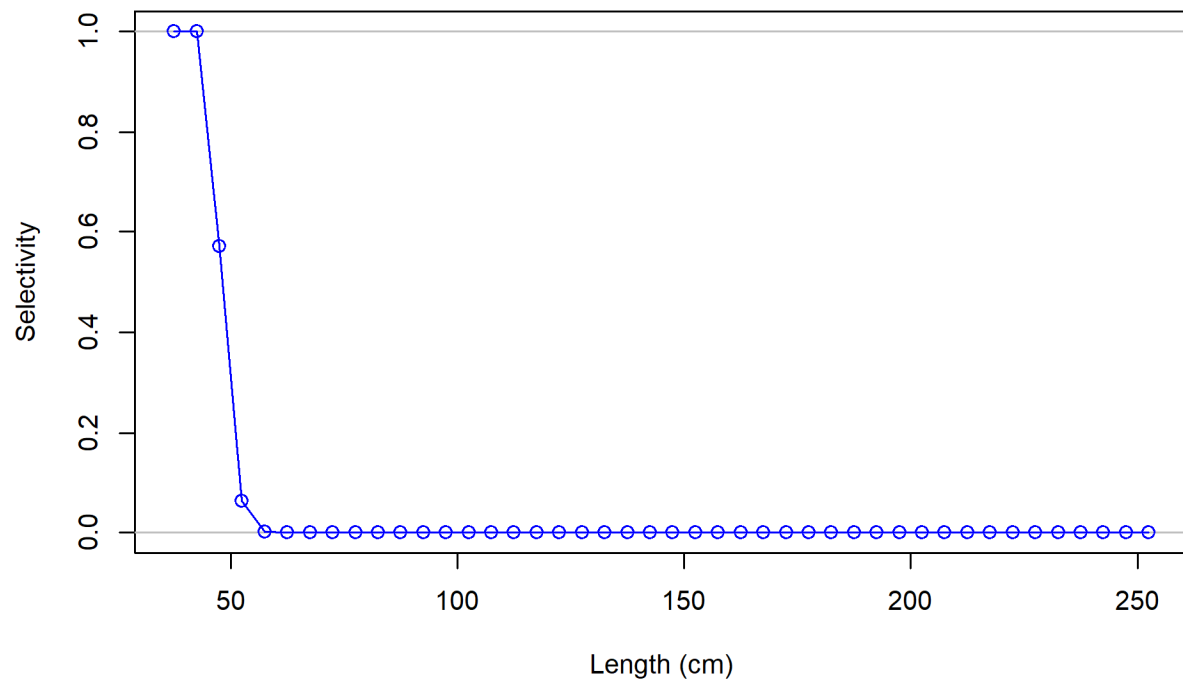


Figure 5. Continued.

J. R4 (COASTSPAN-LGNS)

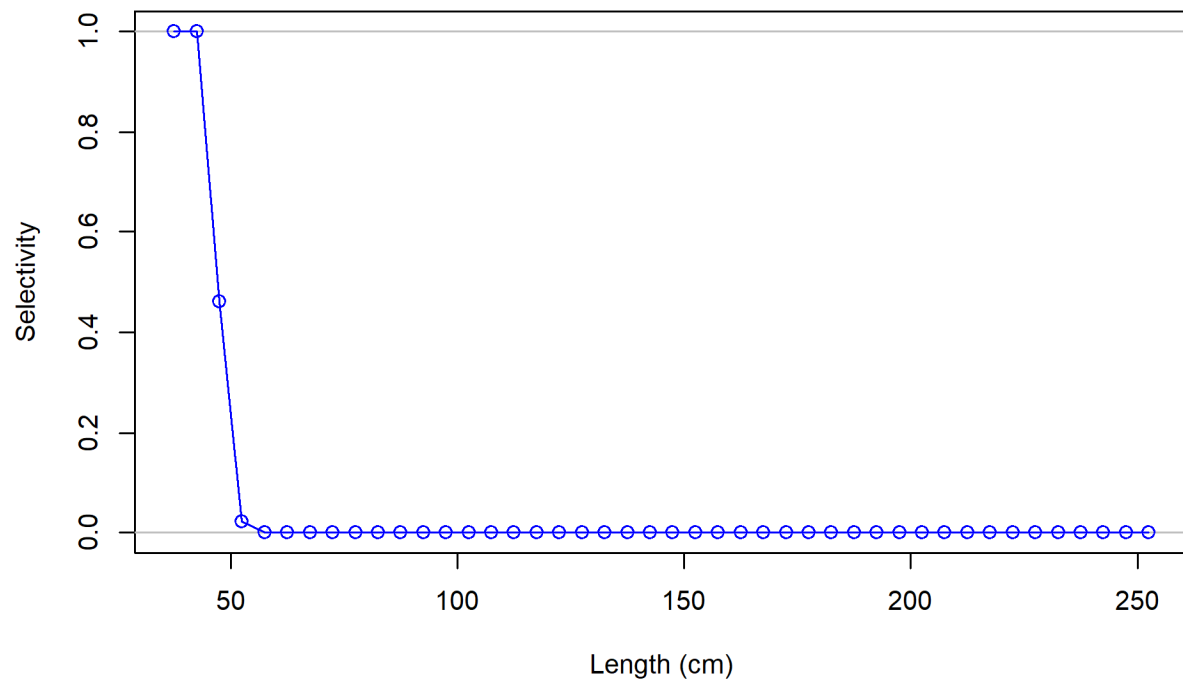


Figure 5. Continued.

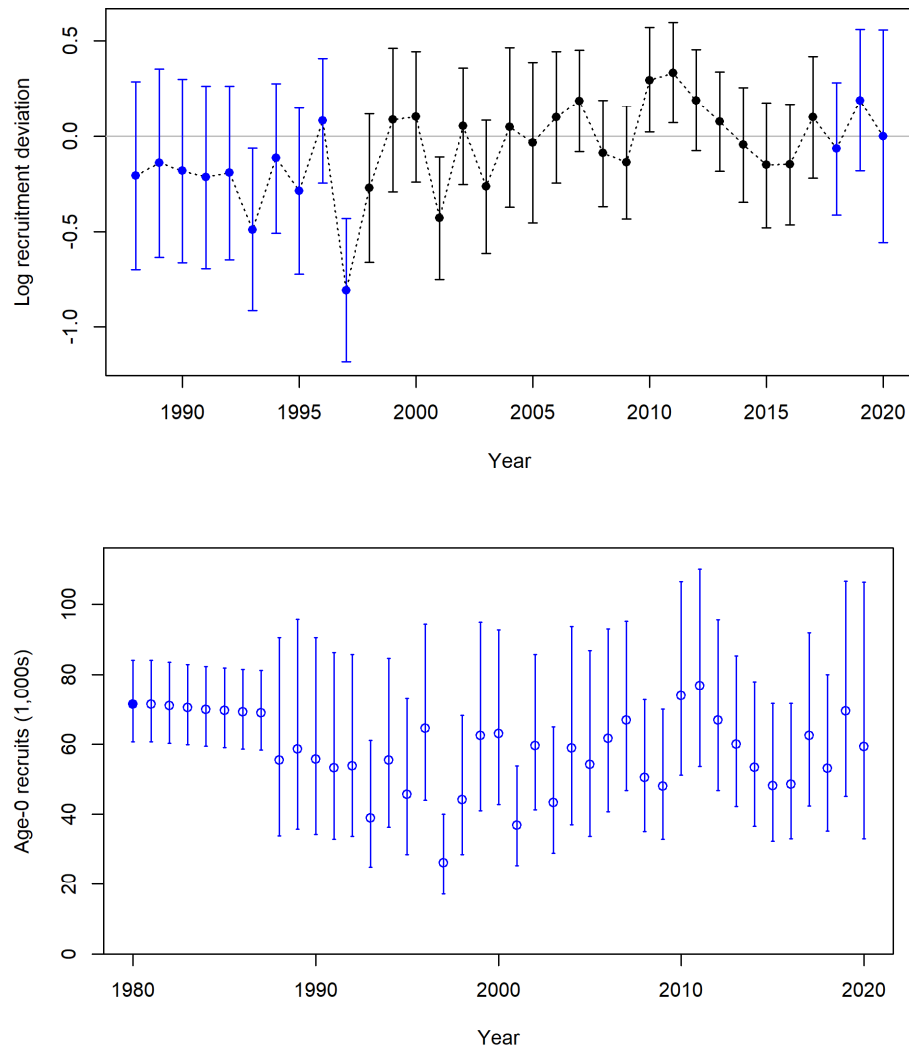


Figure 6. Upper panel is the estimated log recruitment deviations for the early (1988 – 1997, blue), main (1998 – 2017, black), late (2018 – 2019, blue), and forecast (2020, blue) recruitment periods with associated 95% asymptotic confidence intervals in the (GOM + ATL) continuity analysis model configuration. Lower panel is the estimated annual age-0 recruits (circles) with 95% asymptotic confidence intervals. Age-0 recruits follow the assumed stock recruitment relationship exactly in years prior to 1988 and after 2019.

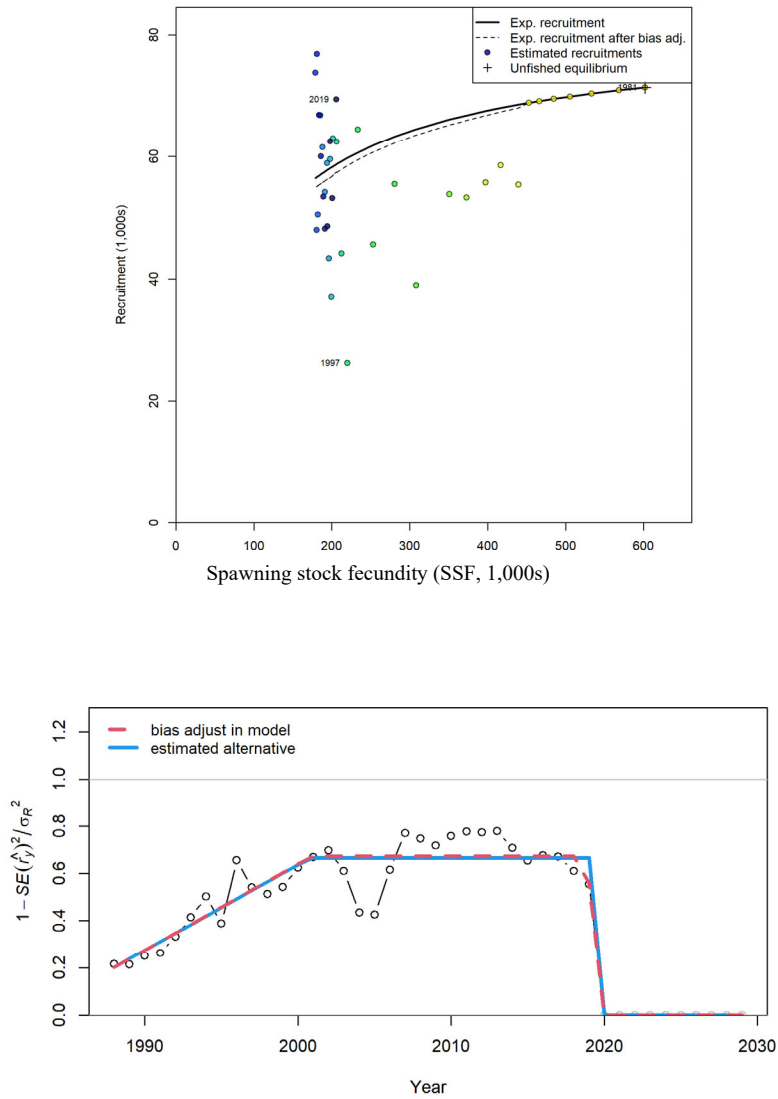


Figure 7. Expected recruitment (Upper panel) from the stock-recruitment relationship (solid line), expected recruitment after implementing the bias adjustment correction (dashed line), estimated annual recruitments (circles), unfished equilibrium (plus), and first (1981) and last (2019) years along with years with log deviations > 0.5 (1997) in the (GOM + ATL) continuity analysis model configuration. Bias adjustment ramp (Lower panel) applied to the stock-recruitment relationship (red stippled line) and the estimated alternative (blue line). The y-axis of the lower panel is the bias adjustment fraction (Methot and Taylor 2011) in the base model configuration.

Figure 8. Total landings (Panel A), continuous fishing mortality by fleet (Continuous F by fleet; Panel B upper plot), and the summary fishing mortality of all fleets combined (Panel B lower plot) in the (GOM + ATL) continuity analysis model configuration. The summary fishing mortality is plotted as a ratio calculated as the total fishing mortality rate experienced by the population ($F=Z-M$) relative to F_{MSY} . Error bars are the 95% asymptotic standard errors, $\pm 1.96*SE$, obtained from Stock Synthesis output. Total landings include commercial landings (mt) along with recreational catch plus recreational discards assumed to die from post release mortality ($A + B1 + B2$ dead). Recreational data was entered in numbers (1,000s) and converted internally within Stock Synthesis to weight (mt) based on the weight at length of recreational fishery removals obtained in the Stock Synthesis base model configuration.

A.

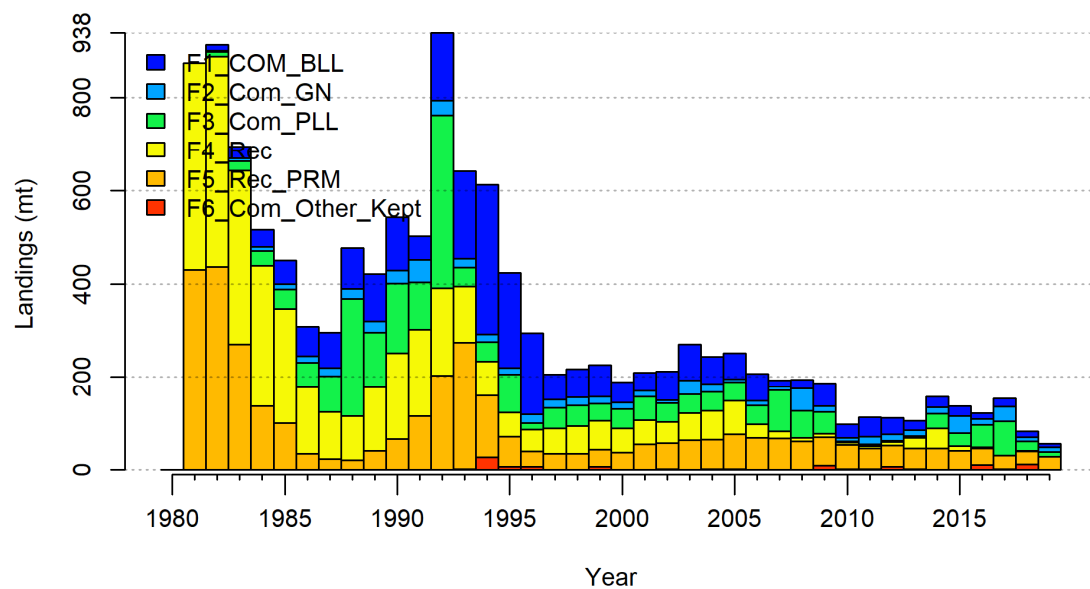
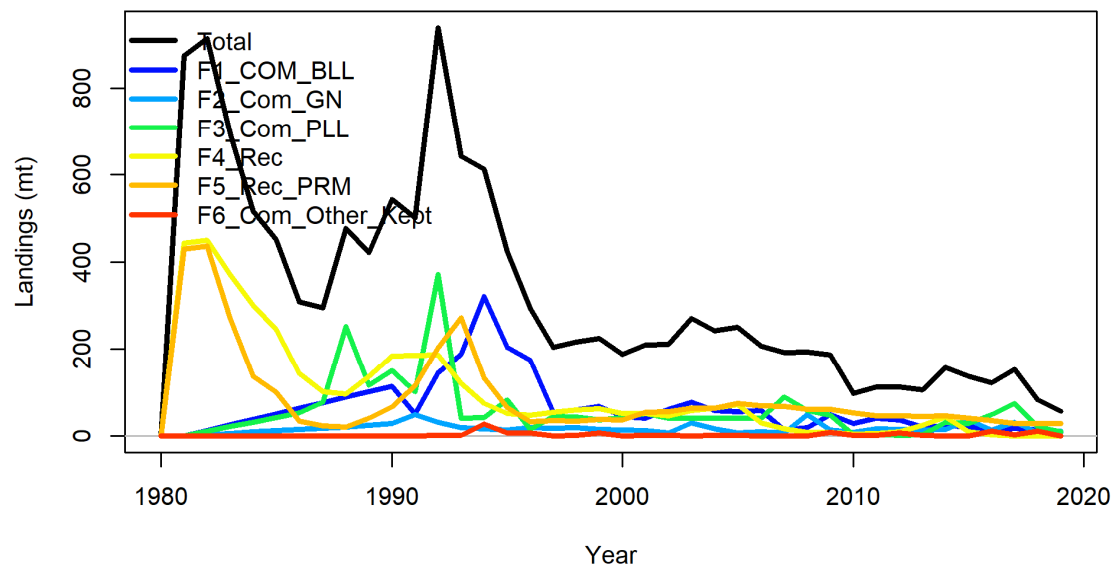


Figure 8. Continued.

B.

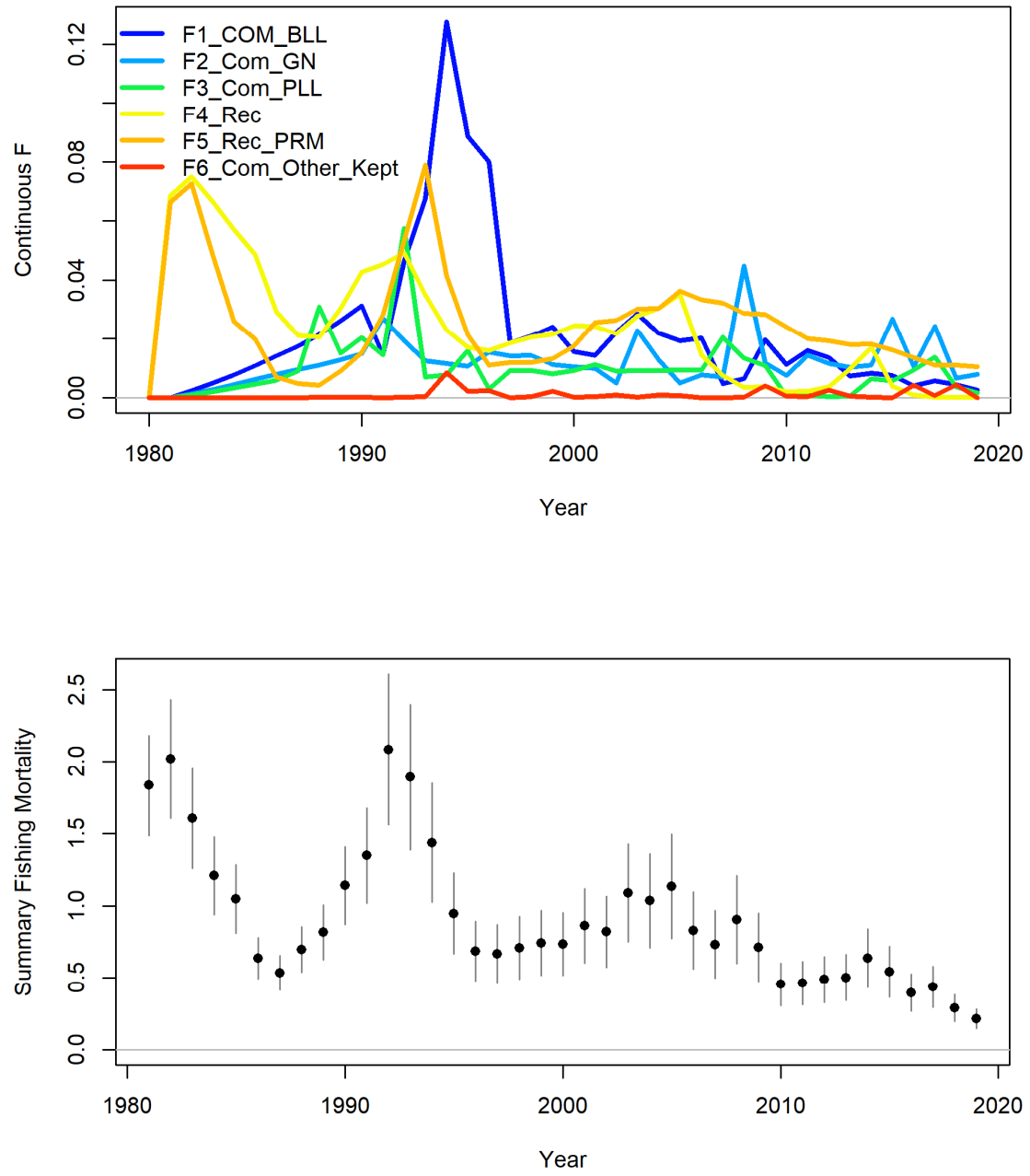


Figure 8. Continued.