Science, Service, Stewardship

2014 GOA Pacific cod stock assessment

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NOAA FISHERIES SERVICE

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Overview

- SSC and Plan Team comments
- Data
- Models
- Results
- More data
- More results

SSC and Plan Team comments

- Plan Team, September 2014: "*The PT concurred with the author to bring forward three models to the November Plan Team meeting: Models P1, S1a, and S1b. These three models give a reasonable portrayal of stock dynamics. The major differences in the S1 models compared to the P1 model (last year's model) is the use of a conditional age at length key for survey data, treating bottom trawl survey data as one source (i.e. sub 27 and 27 plus size groups combined), and the inclusion a recruitment variability multiplier (sigma r multiplier) applied to recent recruitment estimates,. Model P1 omits the sub 27 survey data. Model S1b includes the use of splines to estimate selectivity curves.*"
- Response: The models presented are the 2013 model, S1a, S1b, and the 2013 model with adjustments

SSC and Plan Team comments

- Plan Team, September 2014: "*For all models, the Plan Team recommends that starting values for sample weights for compositional data (i.e. age and length data) be based on the number of hauls or trips rather than the number samples. These starting values should be the upper limit of sample weights.*"
- Response: The fishery length composition sample sizes are based on the number of hauls or trips, and the survey composition sample sizes are based on the number of hauls.

SSC and Plan Team comments

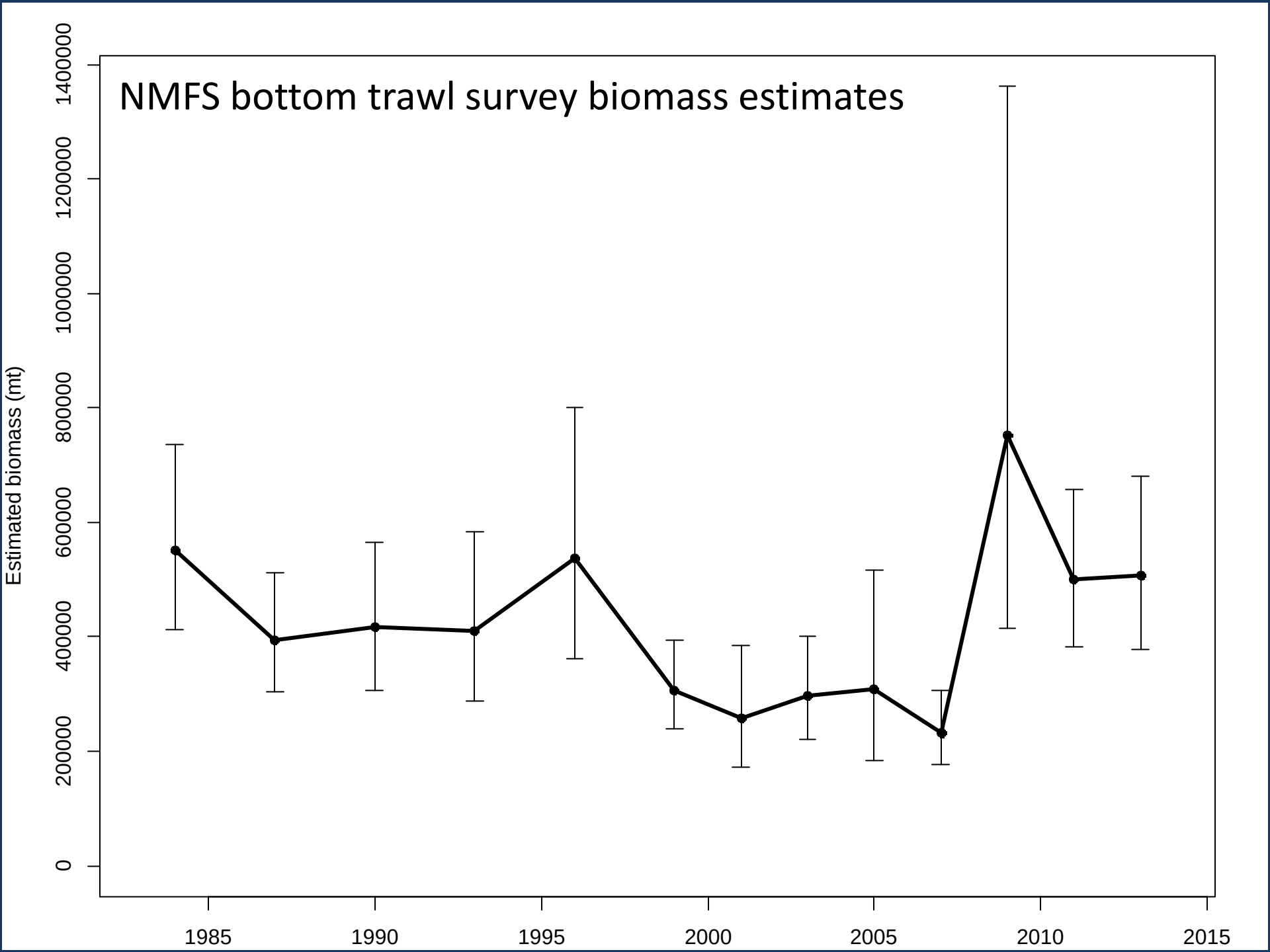
- Plan Team, September 2014: "*The Plan Team recommends that the authors explore the use of the "10% selectivity rule" presented by Grant Thompson as the year class to start applying the sigma r multiplier.*"
- Response: The result of the calculation is age 1. However, this has been changed to age 2, since the survey selectivity-at-age is higher at age-1 than age-2 in most years.

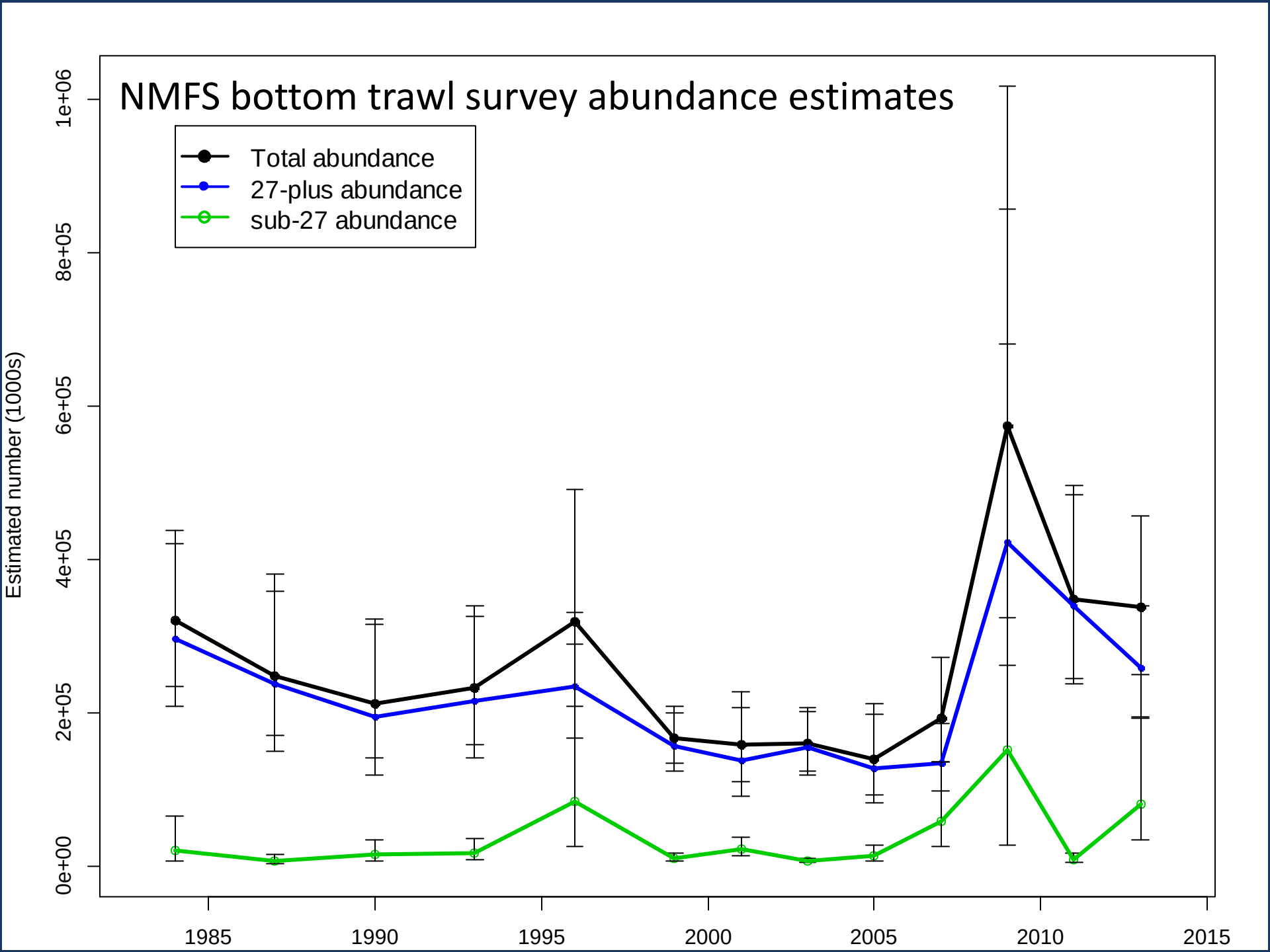
SSC and Plan Team comments

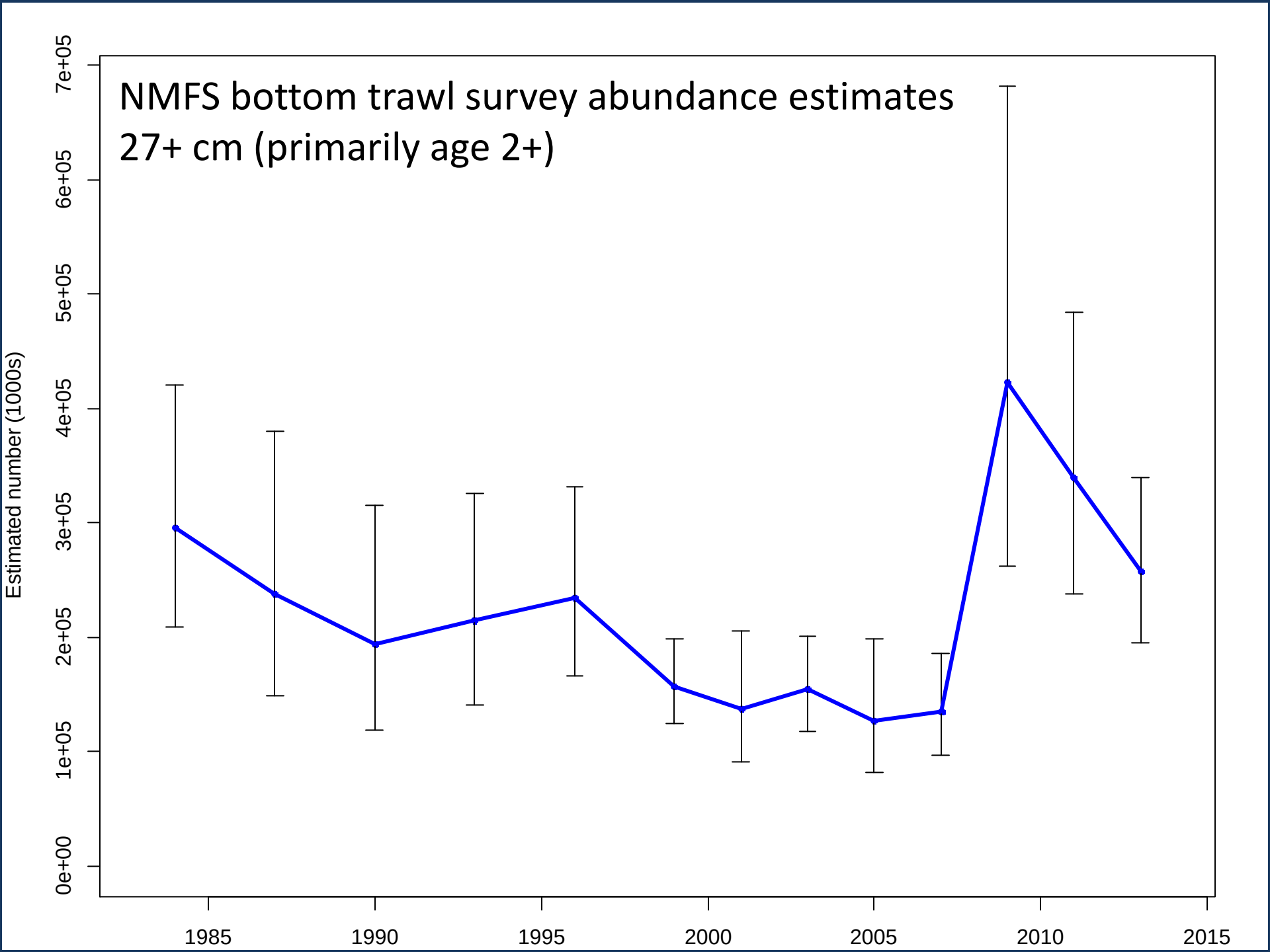
- Plan Team, September 2014: "*The Plan Team also recommends exploration of the use of longline survey data as an additional source of abundance index data for adult Pacific cod.*"
- Response: This exploration is ongoing.

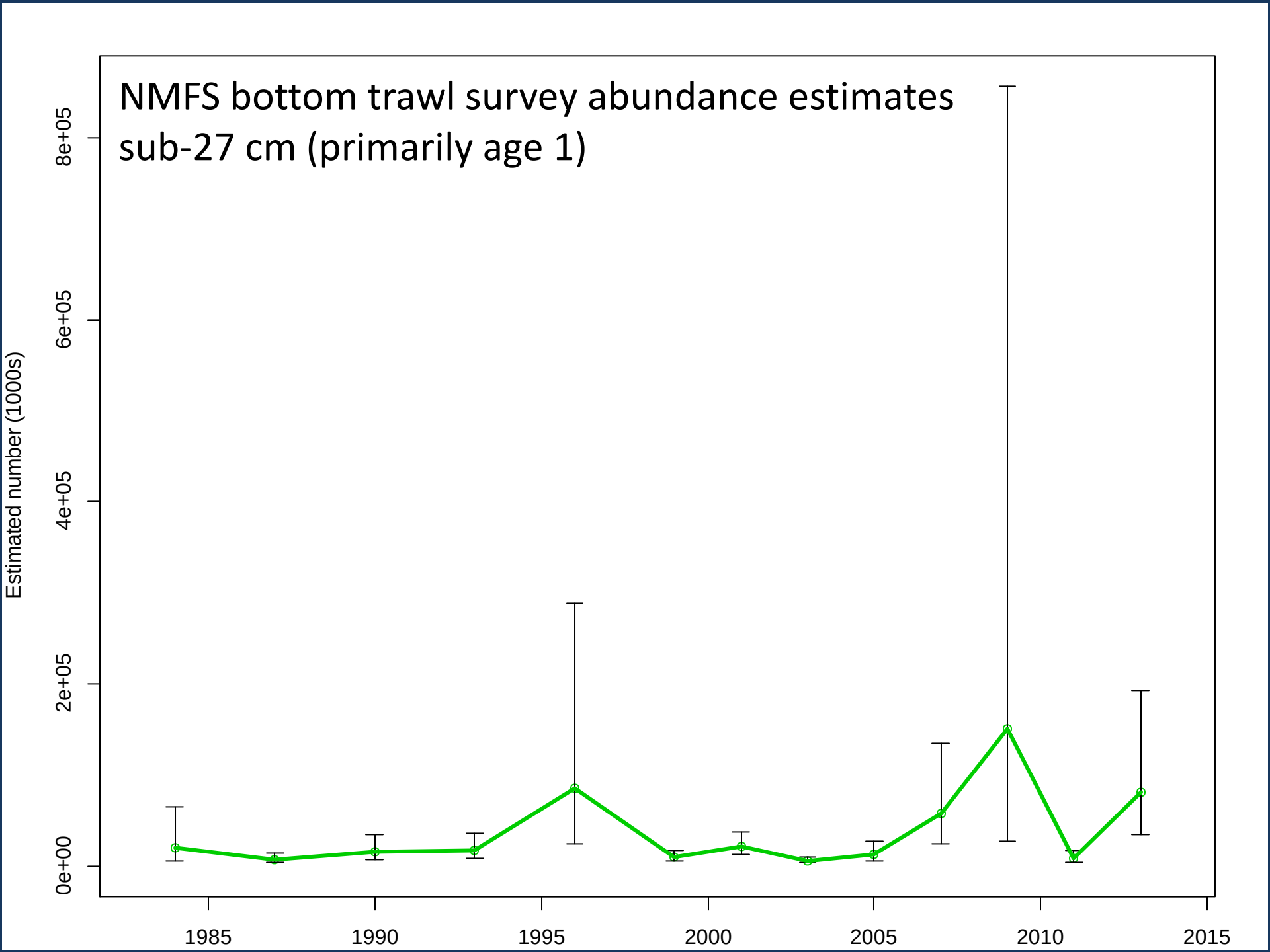
Data

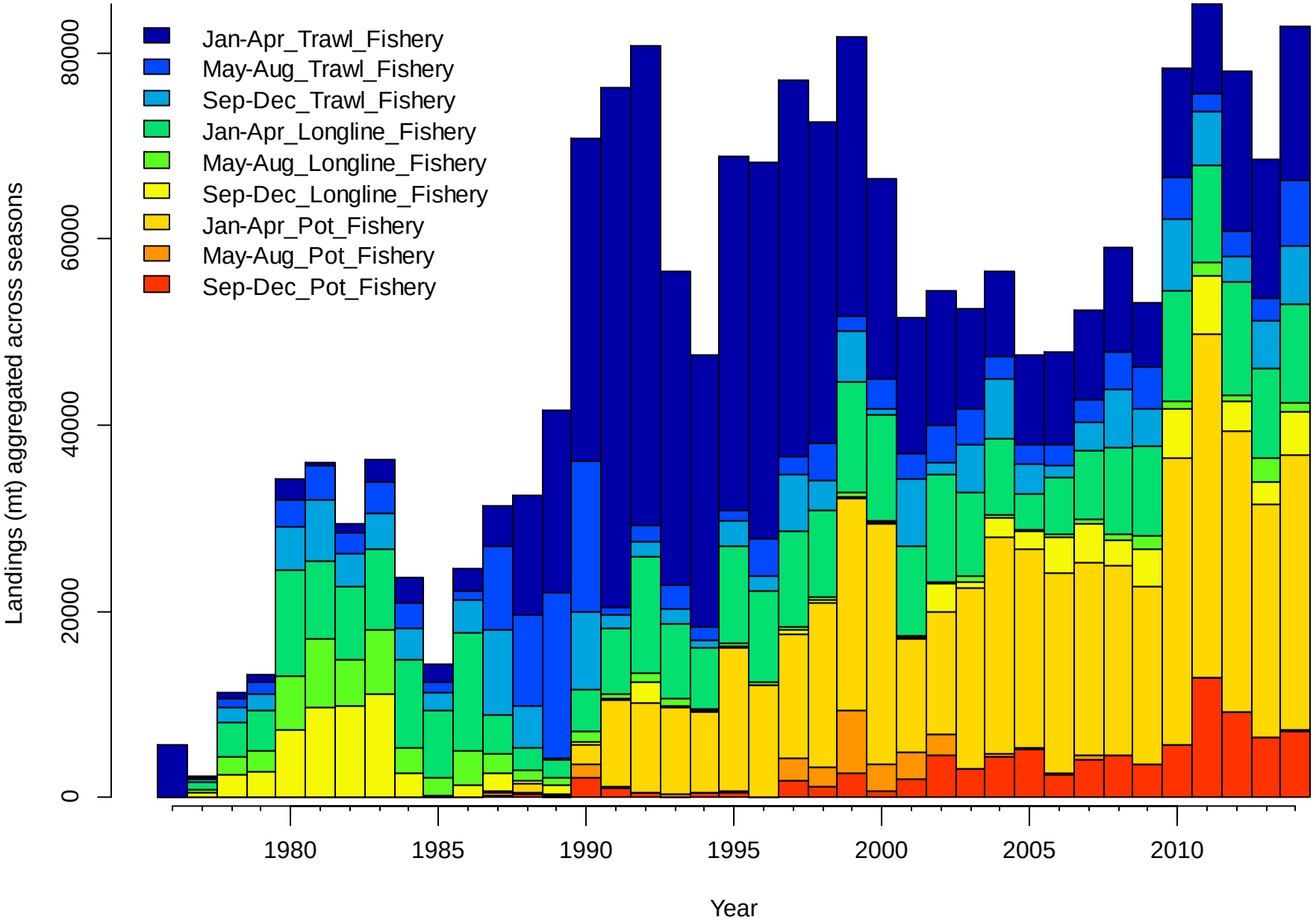
- Federal and state catch data for 1977 – 2013, preliminary data for 2014
- Federal and state fishery size composition data for 1977 – 2013, preliminary data for 2014
- GOA NMFS bottom trawl survey abundance estimates for 1984 – 2013
- Survey population length composition estimates for 1984 – 2013
- Survey population age composition estimates, mean length-at-age, and conditional age-at-length data for 1987 – 2011


NMFS bottom trawl survey biomass estimates
Estimated biomass (mt)
0
200000
400000
600000
800000
1000000
1200000
1400000
1985
1990
1995
2000
2005
2010
2015


NMFS bottom trawl survey abundance estimates
Total abundance
27-plus abundance
sub-27 abundance
Estimated number (1000s)
0e+00
2e+05
4e+05
6e+05
8e+05
1e+06
1985
1990
1995
2000
2005
2010
2015


NMFS bottom trawl survey abundance estimates
27+ cm (primarily age 2+)
Estimated number (1000s)
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
7e+05
1985
1990
1995
2000
2005
2010
2015


NMFS bottom trawl survey abundance estimates
sub-27 cm (primarily age 1)
Estimated number (1000s)
0e+00
2e+05
4e+05
6e+05
8e+05
1985
1990
1995
2000
2005
2010
2015

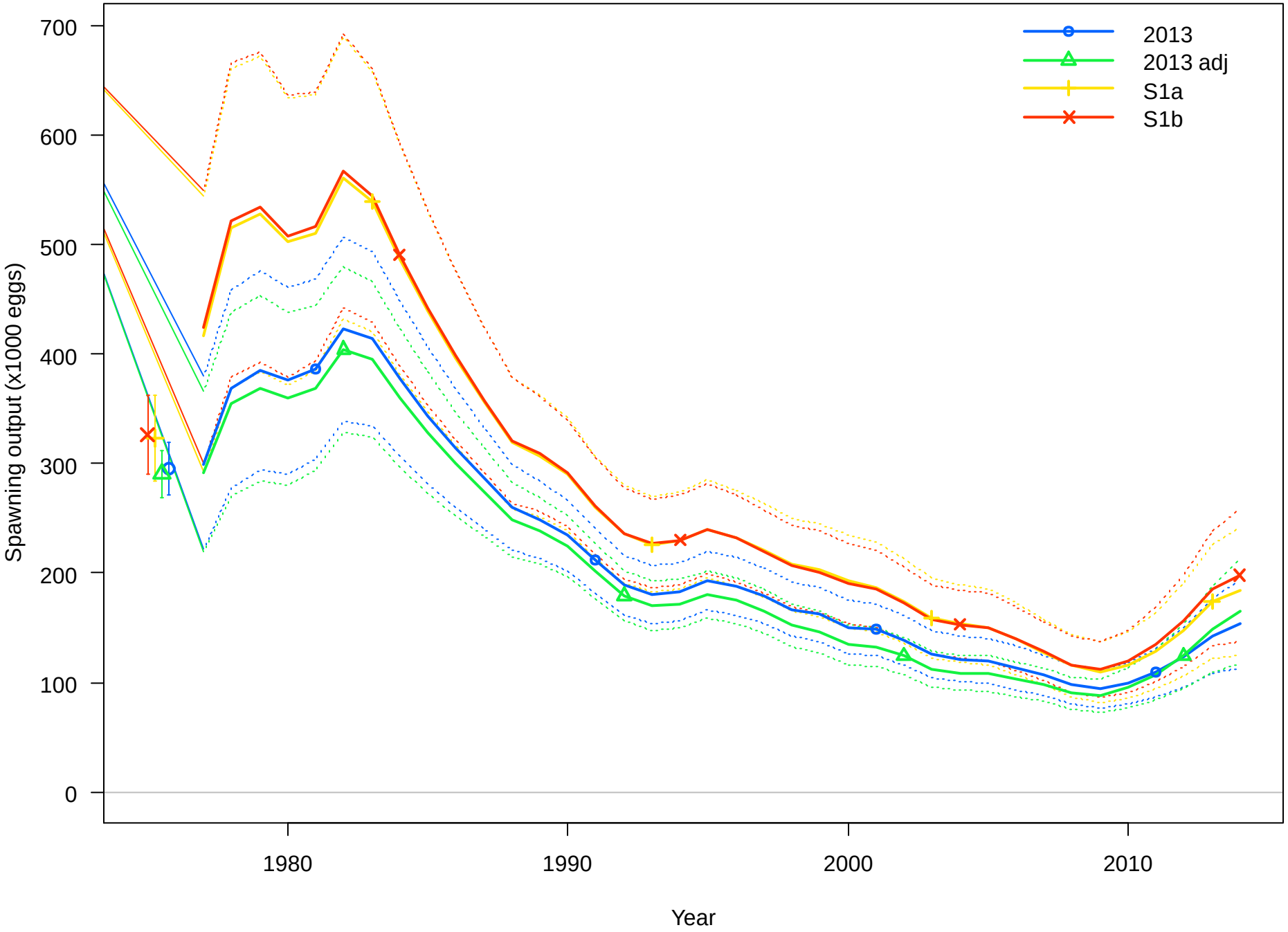

Jan-Apr_Trawl_Fishery
May-Aug_Trawl_Fishery
Sep-Dec_Trawl_Fishery
Jan-Apr_Longline_Fishery
May-Aug_Longline_Fishery
Sep-Dec_Longline_Fishery
Jan-Apr_Pot_Fishery
May-Aug_Pot_Fishery
Sep-Dec_Pot_Fishery
Landings (mt) aggregated across seasons
0
20000
40000
60000
80000
1980
1985
1990
1995
2000
2005
2010
Year

Models

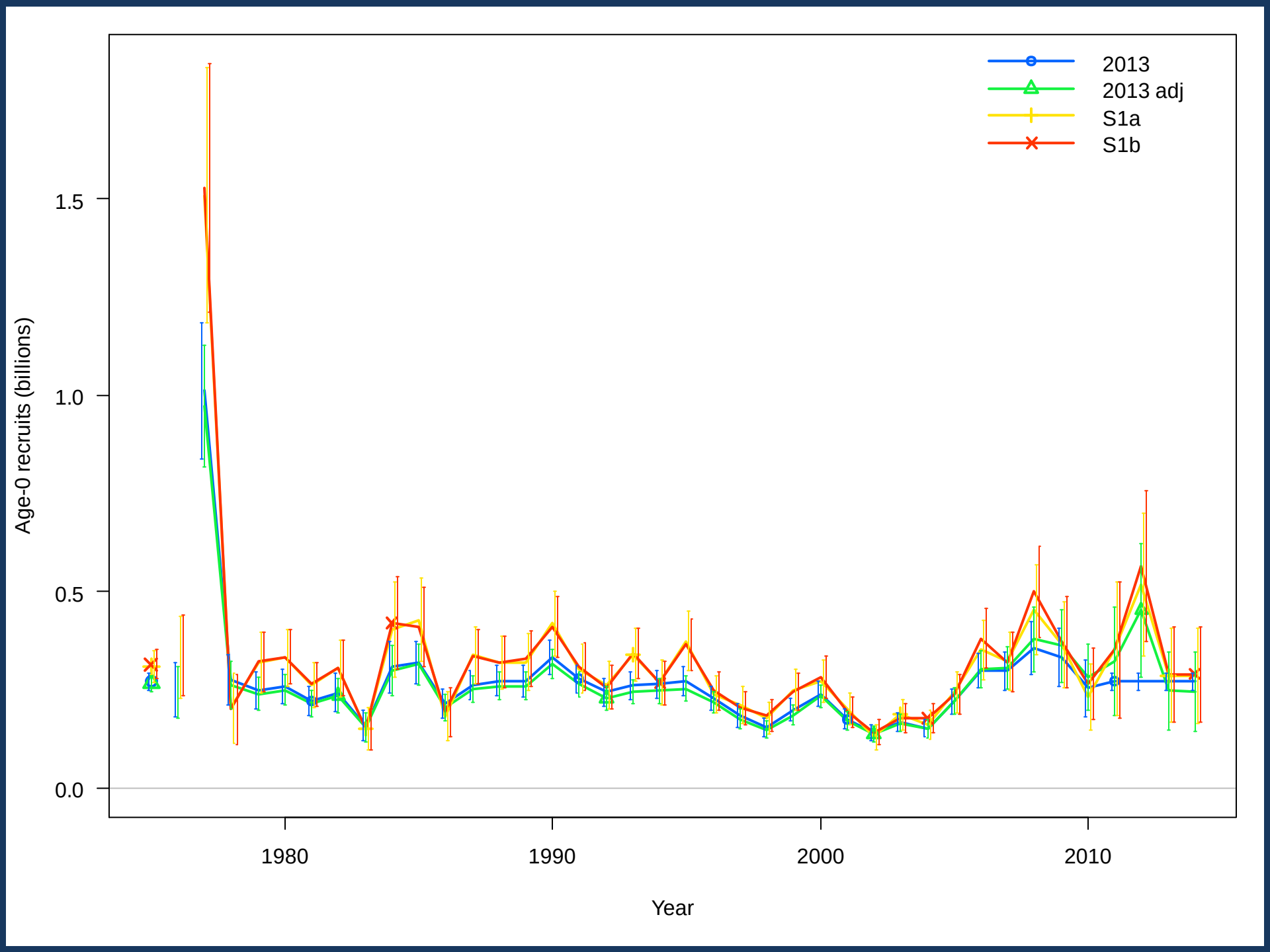
- Model P1 – the 2013 model (the 2012 model)
- The 2013 model with adjustments
  - Includes the sigmaR multiplier for recent recruits
- September 2014 models
  - Bottom trawl survey used as one data source
  - 3 blocks of non-parametric (S1a) or cubic spline-based (S1b) survey selectivity-at-age
  - Includes survey conditional age-at-length data
  - Includes the sigmaR multiplier for recent recruits

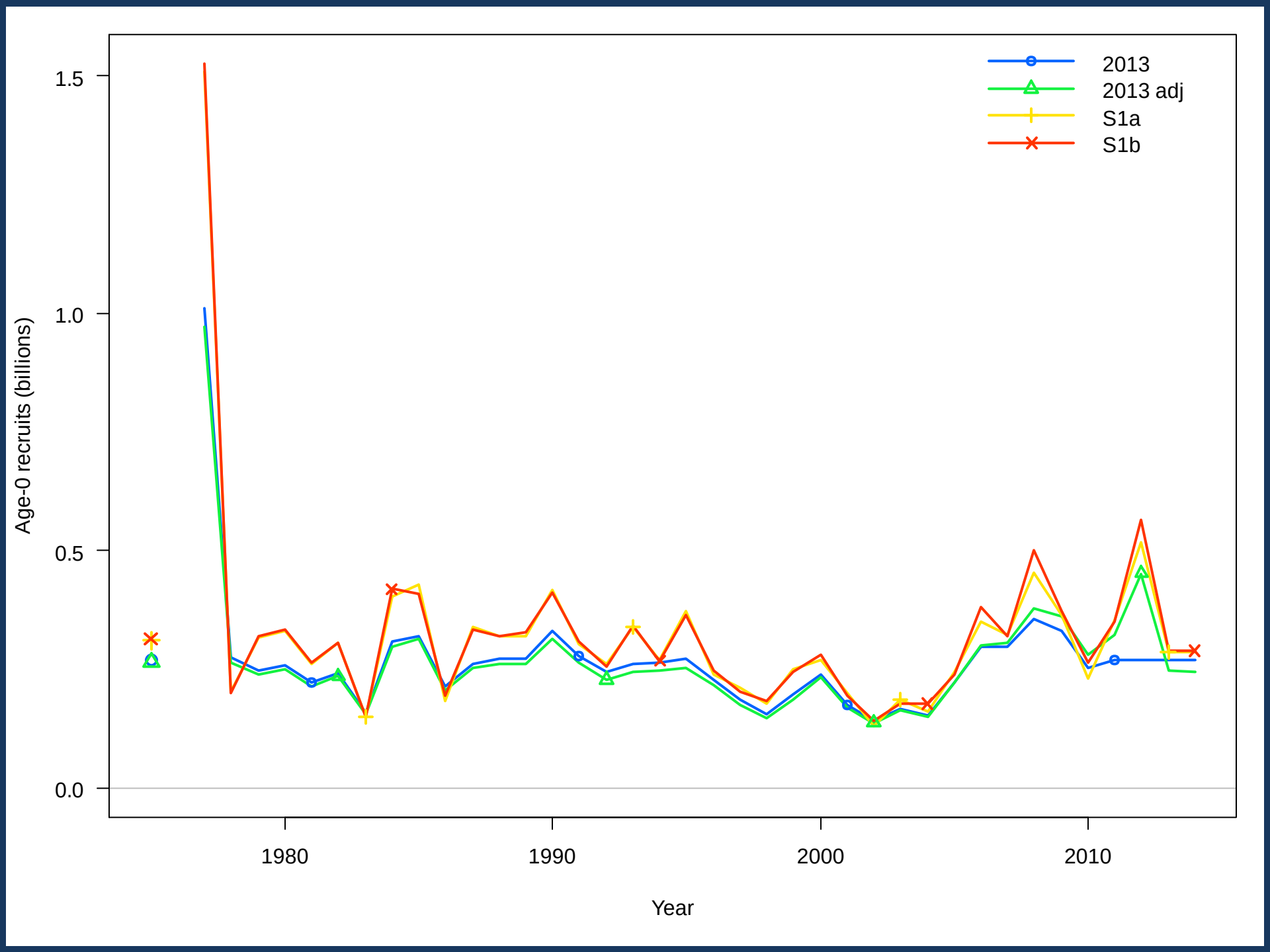
Results

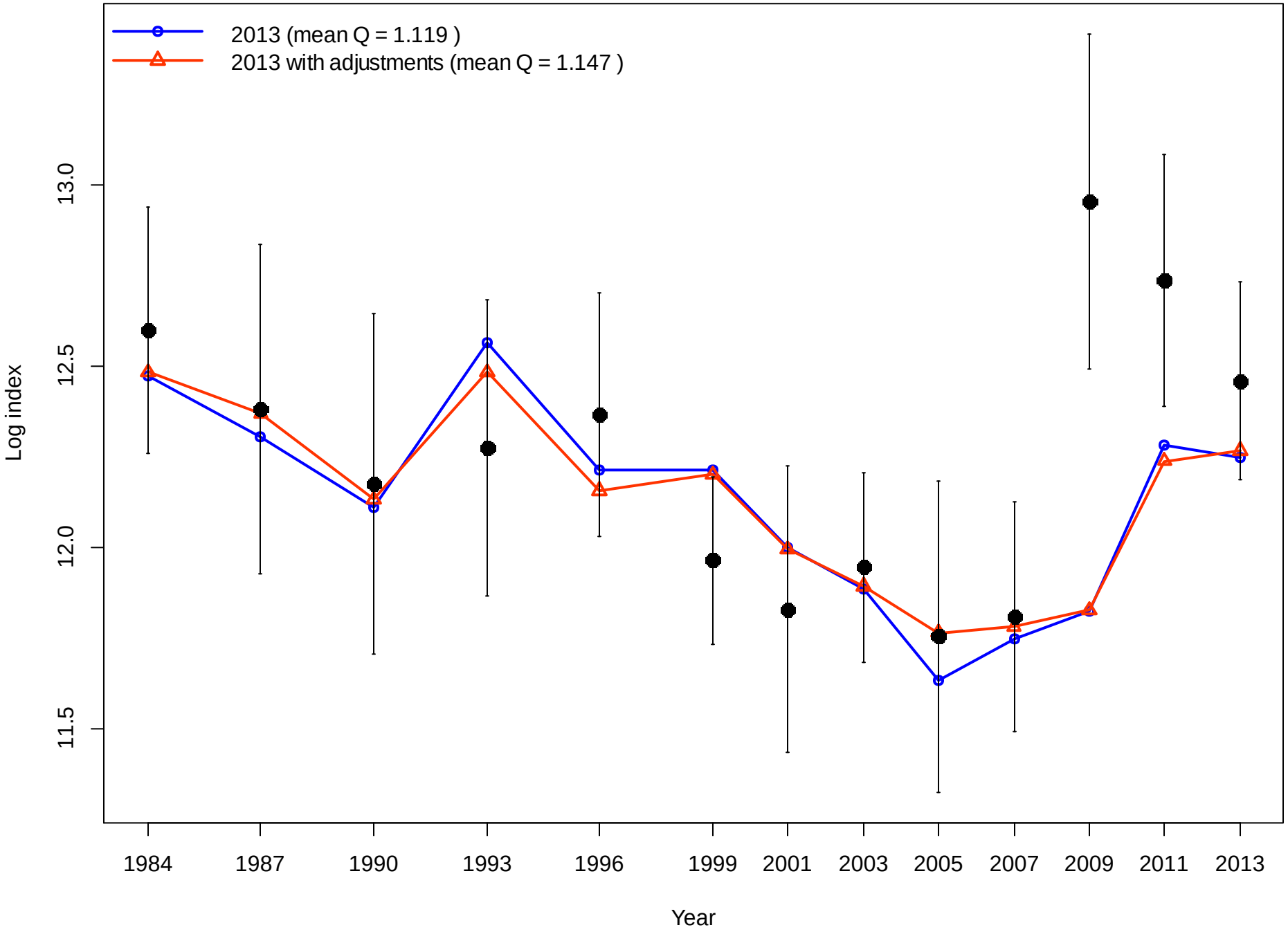
- The 2013 model with adjustments fit to the data better than the 2013 model
- Model S1a (non-parametric) fit to the data better than Model S1b (splines)

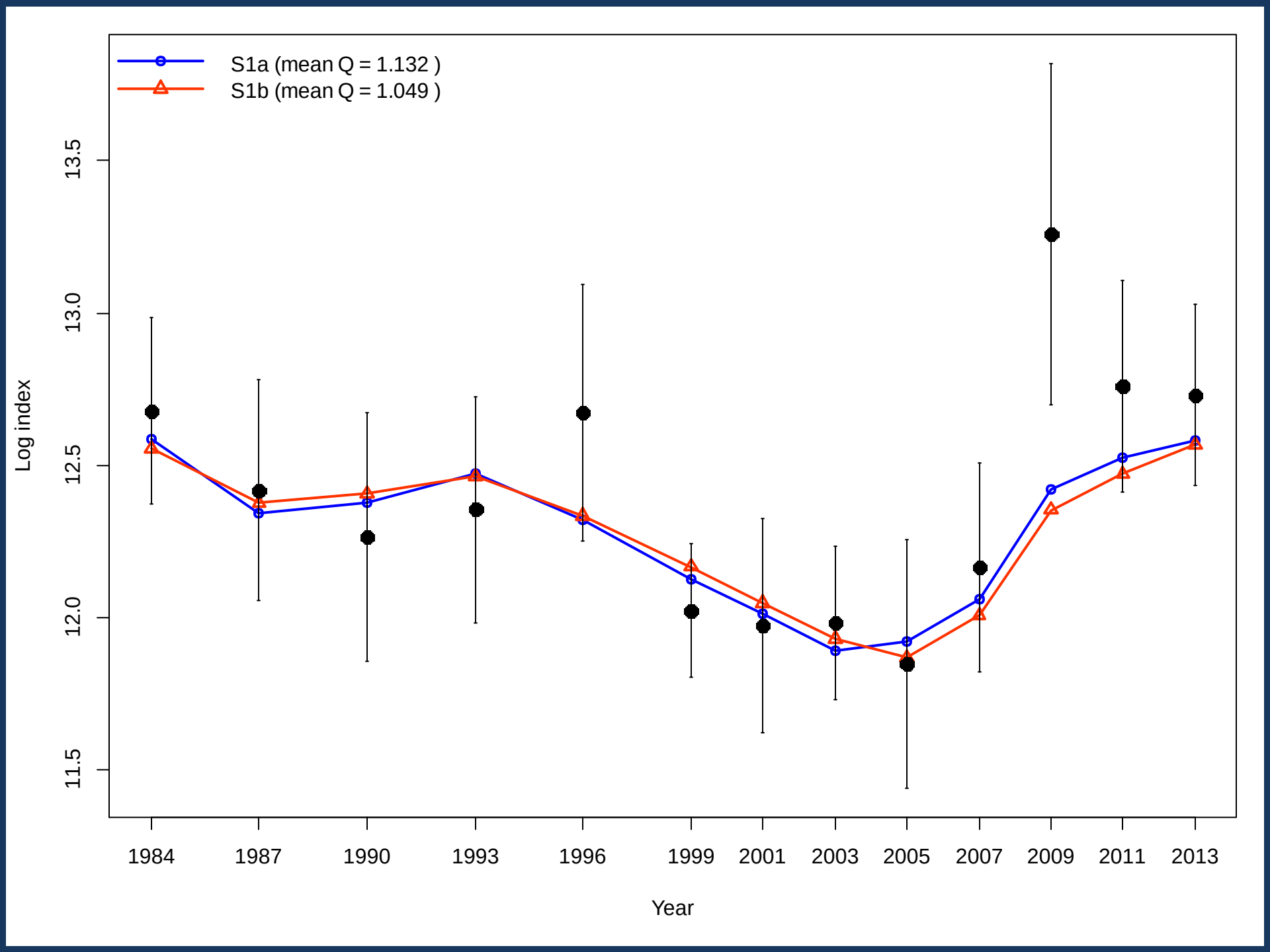

2013
2013 adj
S1a
S1b
Spawning output (x1000 eggs)
700
600
500
400
300
200
100
0
1980
1990
2000
2010
Year

2013
2013 adj
S1a
S1b
Spawning output (x1000 eggs)
0
100
200
300
400
500
1980
1990
2000
2010
Year


2013
2013 adj
S1a
S1b
Age-0 recruits (billions)
0.0
0.5
1.0
1.5
1980
1990
2000
2010
Year


2013
2013 adj
S1a
S1b
1.5
1.0
0.5
0.0
Age-0 recruits (billions)
1980
1990
2000
2010
Year


2013 (mean Q = 1.119)
2013 with adjustments (mean Q = 1.147)
Log index
13.0
12.5
12.0
11.5
1984
1987
1990
1993
1996
1999
2001
2003
2005
2007
2009
2011
2013
Year


S1a (mean Q = 1.132)
S1b (mean Q = 1.049)
Log index
11.5
12.0
12.5
13.0
13.5
1984
1987
1990
1993
1996
1999
2001
2003
2005
2007
2009
2011
2013
Year

	2013 model	2013 with adj	Non-parametric	Splines
Number of parameters	254	249	230	213
Likelihood components (-ln)				
27-plus survey index	-1.61	-1.99	-	-
Full survey index	-	-	-14.01	-12.14
Length compositions	2095.25	2089.93	2202.93	2206.40
Age compositions	56.78	56.48	415.39	418.49
Size-at-age	398.85	396.00	-	-
Recruitment	-21.67	-24.90	-17.52	-17.75
Forecast recruitment	-	4.49	4.22	5.37
Total	2527.66	2520.06	2591.09	2600.41
Length composition likelihoods (-ln)				
Jan-Apr Trawl	298.13	294.52	299.84	298.54
Jan-Apr LL	150.88	147.09	140.98	141.14
Jan-Apr Pot	223.57	222.95	212.43	212.96
May-Aug Trawl	452.74	453.65	438.86	438.33
May-Aug LL	136.67	137.26	133.87	134.10
May-Aug Pot	336.42	337.93	334.27	334.10
Sep-Dec Trawl	267.44	267.20	271.28	271.14
Sep-Dec LL	45.78	46.09	45.35	45.41
Sep-Dec Pot	168.59	169.05	168.04	168.86
27-plus survey	15.04	14.18	-	-
Full survey	-	-	158.02	161.83
Age compositions likelihoods (-ln)				
27-plus survey	56.78	56.48	-	-
Age full survey	-	-	415.39	418.49
Mean size-at-age likelihoods (-ln)				
27-plus survey	398.85	396.00	-	-

Growth parameter estimates

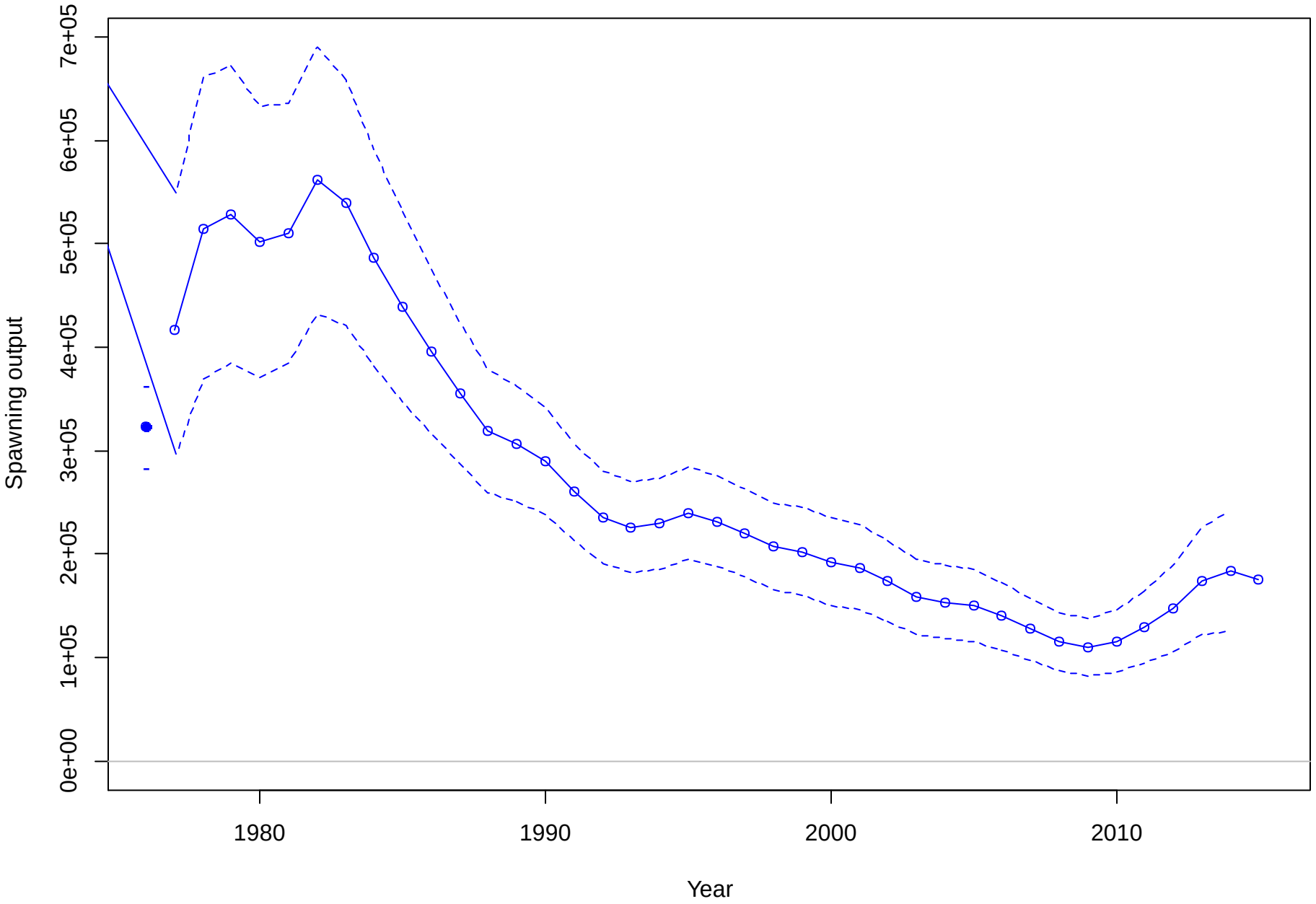
	2013 model	2013 model with adj	Non-parametric	Splines
Length-at-Amin	26.32	26.40	23.34	23.37
Length-at-A∞	98.33	98.68	94.28	94.25
k	0.181	0.180	0.201	0.201
CV for L-at-Amin	[3.13]	[3.13]	4.60	4.59
CV for L-at-A∞	[6.55]	[6.55]	6.78	6.81
ln(R0)	12.50	12.49	12.64	12.66

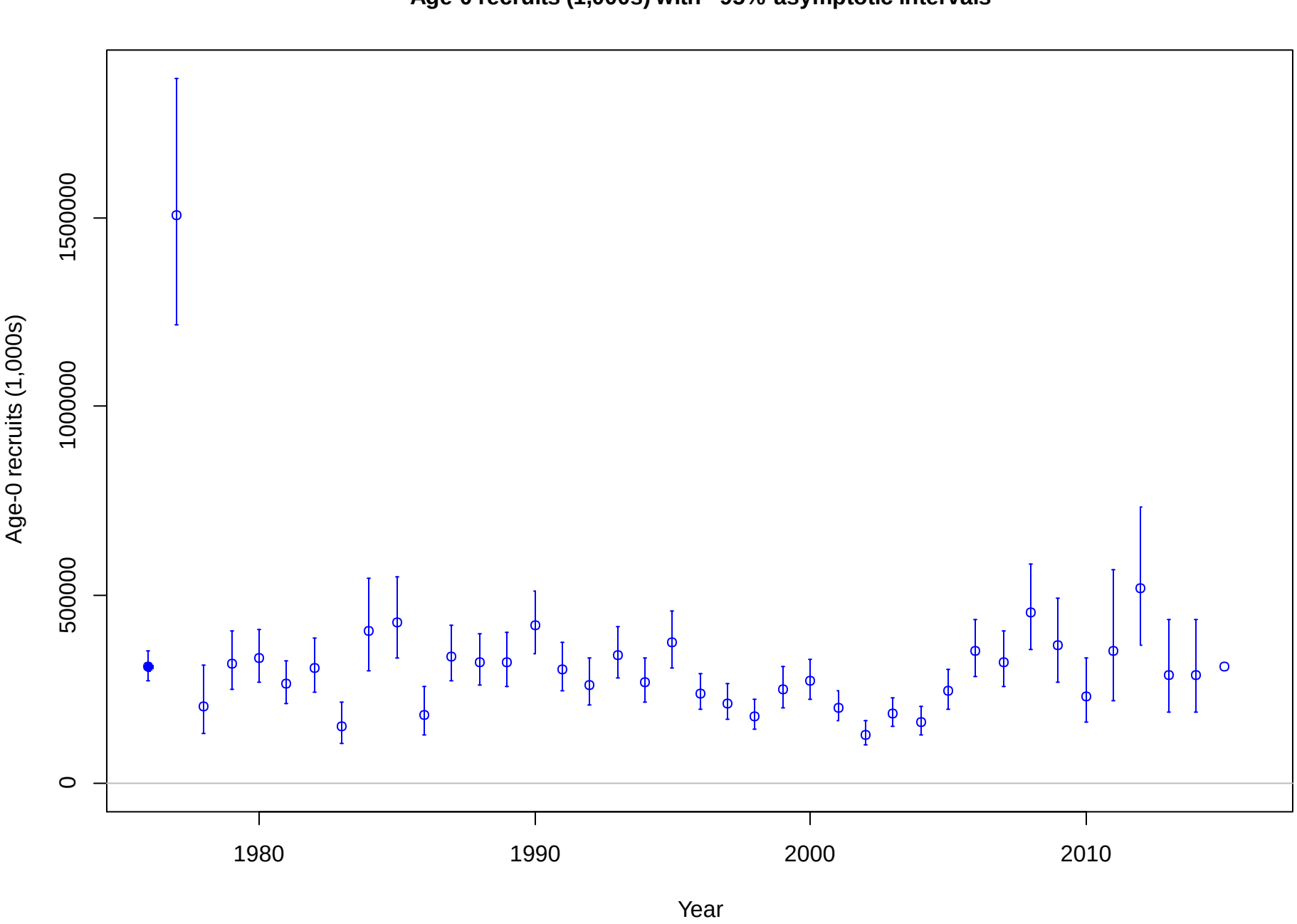
Which model and why?

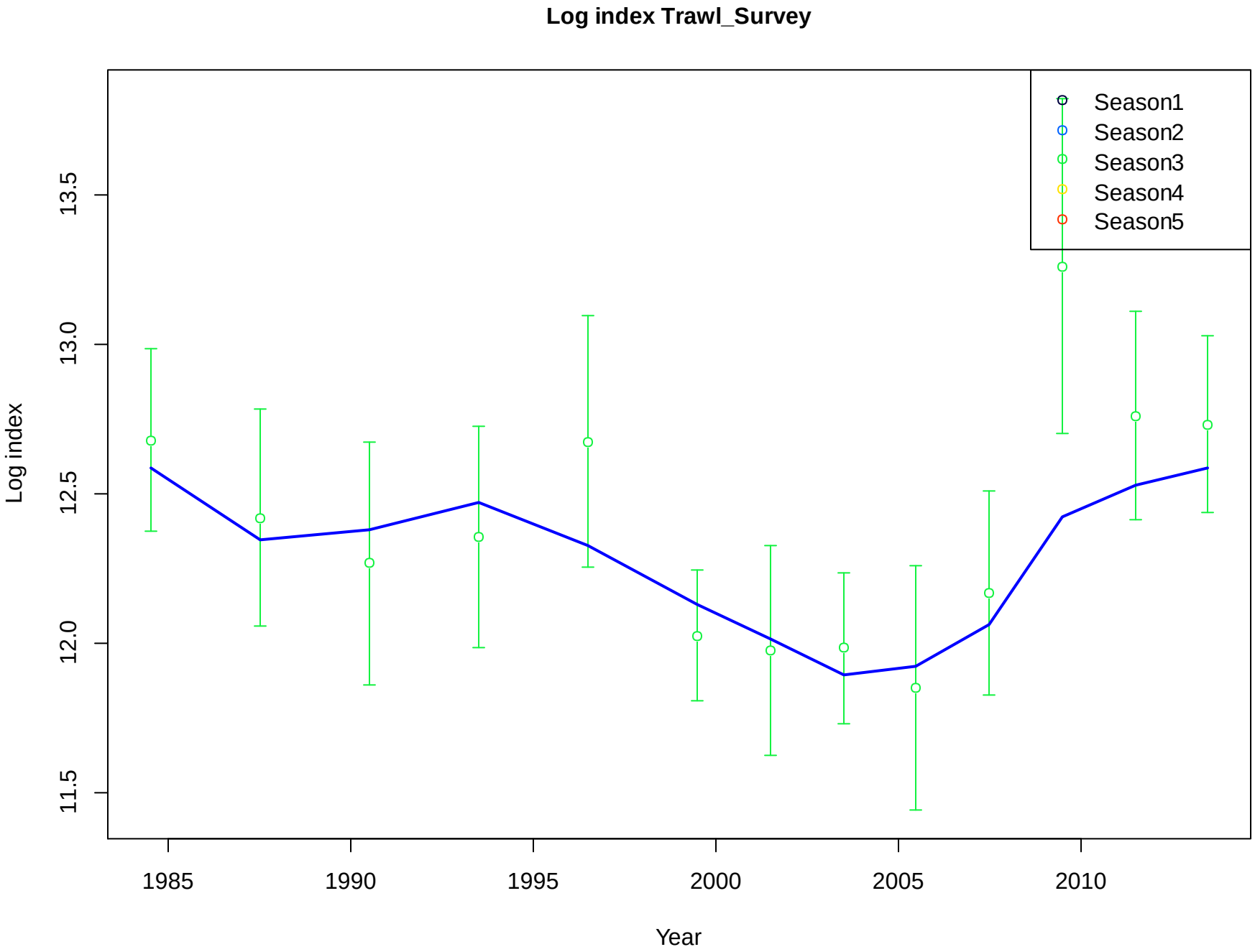
- Model S1a or S1b
  - Use the full survey as one data source
  - More flexible survey selectivity-at-age curves
  - Better fits to fishery length composition data than the 2013 models
- Model S1a
  - Better fits to the survey data than Model S1b

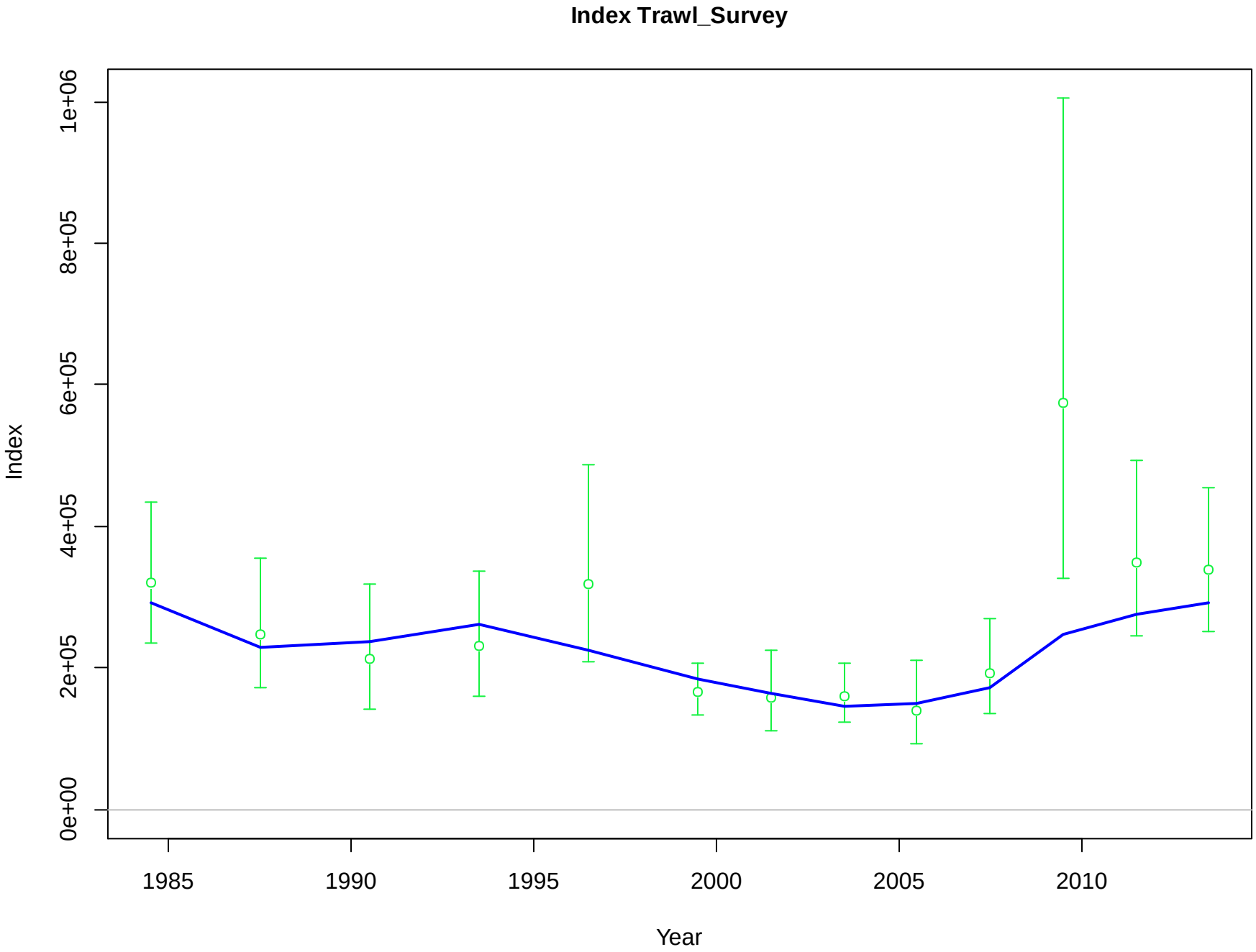
Model S1a

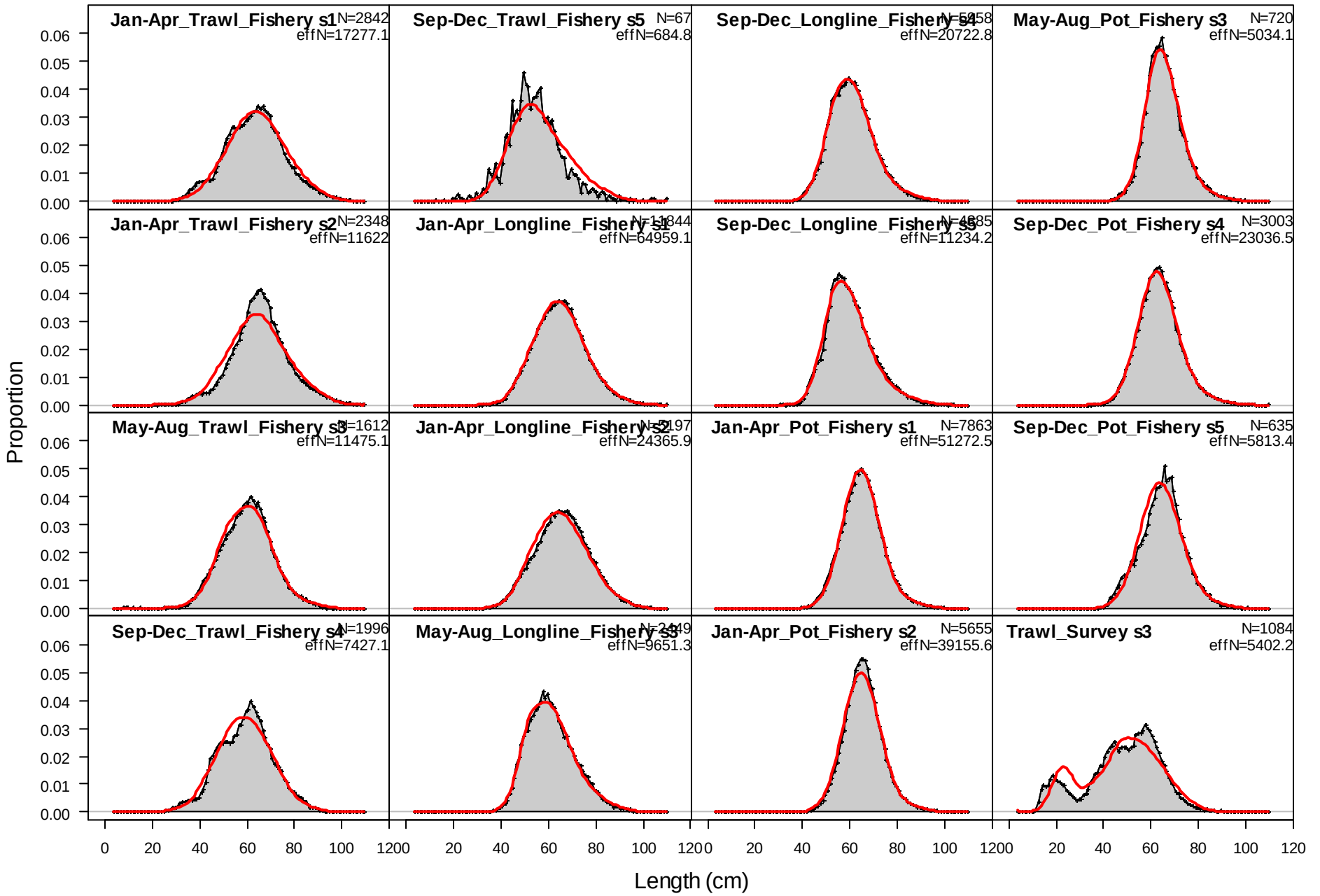
- Uses the bottom trawl survey as one data source for abundance estimates and length and age composition data
- 3 blocks of non-parametric survey selectivity-at-age, 1984 – 1993, 1996 – 2003, 2005 – 2013
- Fits to survey conditional age-at-length data
- Uses the sigmaR multiplier for age-0 recruits for 2012, 2013, and 2014

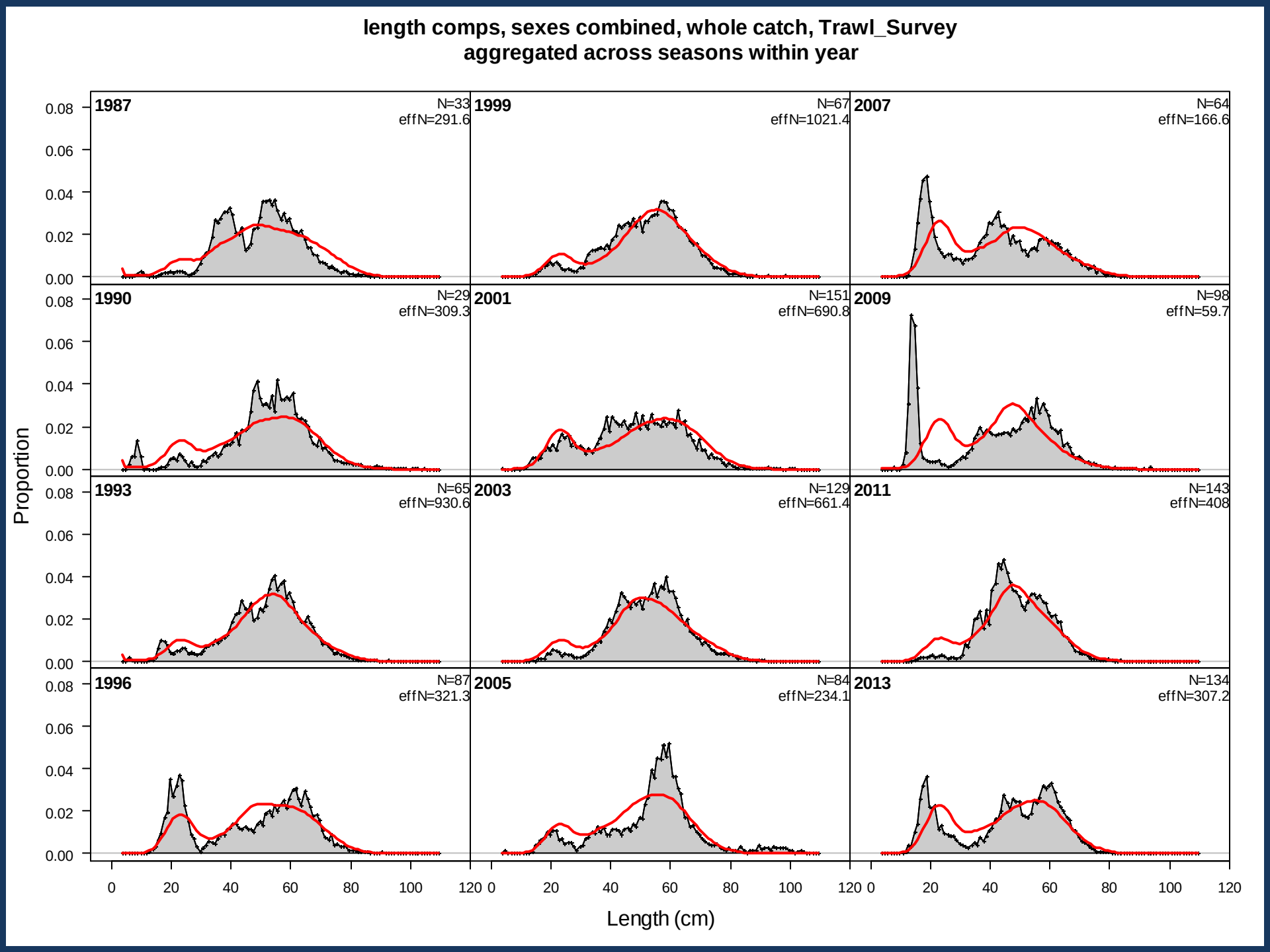

Spawning output with ~95% asymptotic intervals
Spawning output
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
7e+05
1980
1990
2000
2010
Year

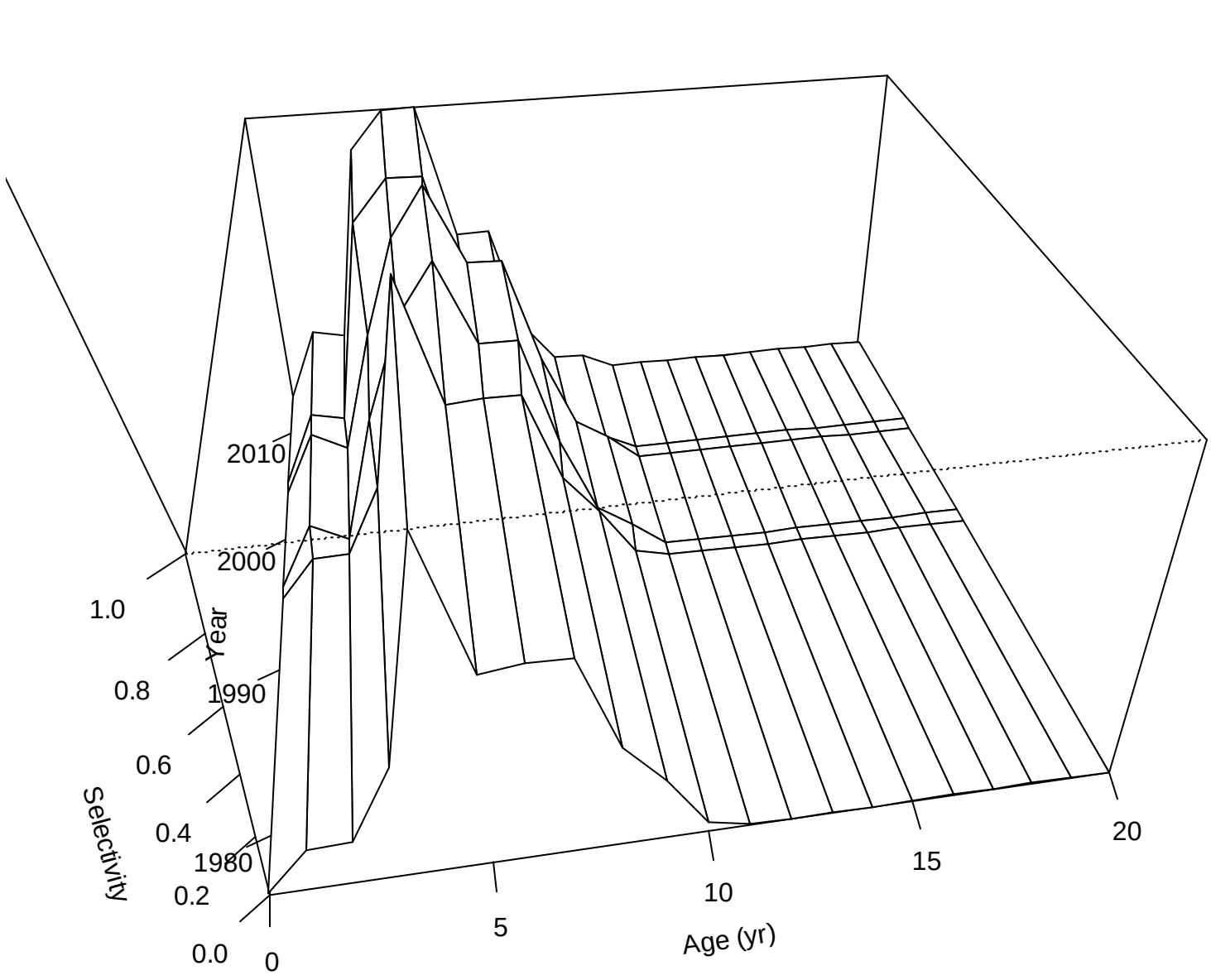

Age-0 recruits (1,000s) with ~95% asymptotic intervals
Age-0 recruits (1,000s)
0
500000
1000000
1500000
1980
1990
2000
2010
Year

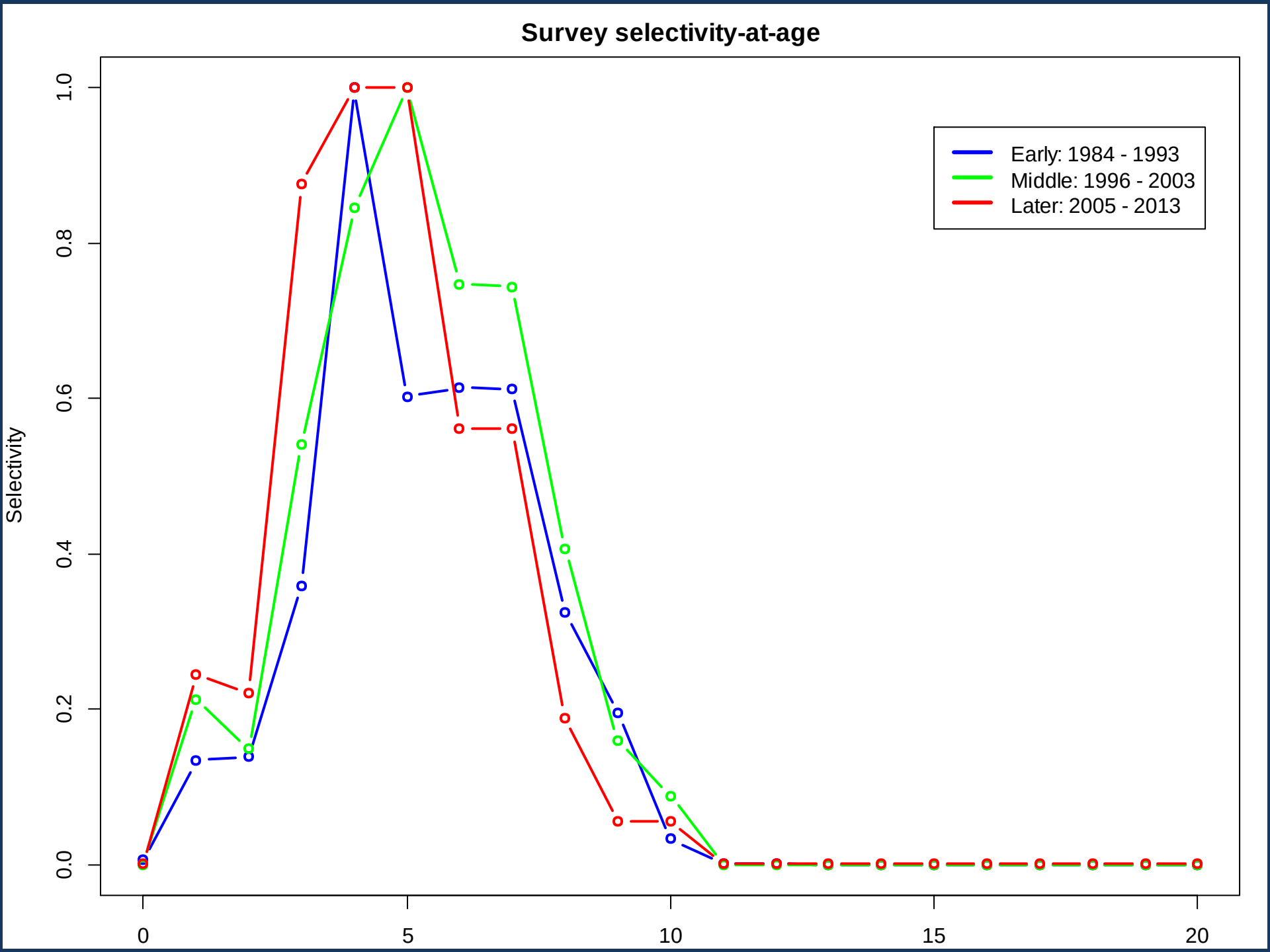

Log index Trawl_Survey
Season1
Season2
Season3
Season4
Season5
Log index
11.5
12.0
12.5
13.0
13.5
1985
1990
1995
2000
2005
2010
Year

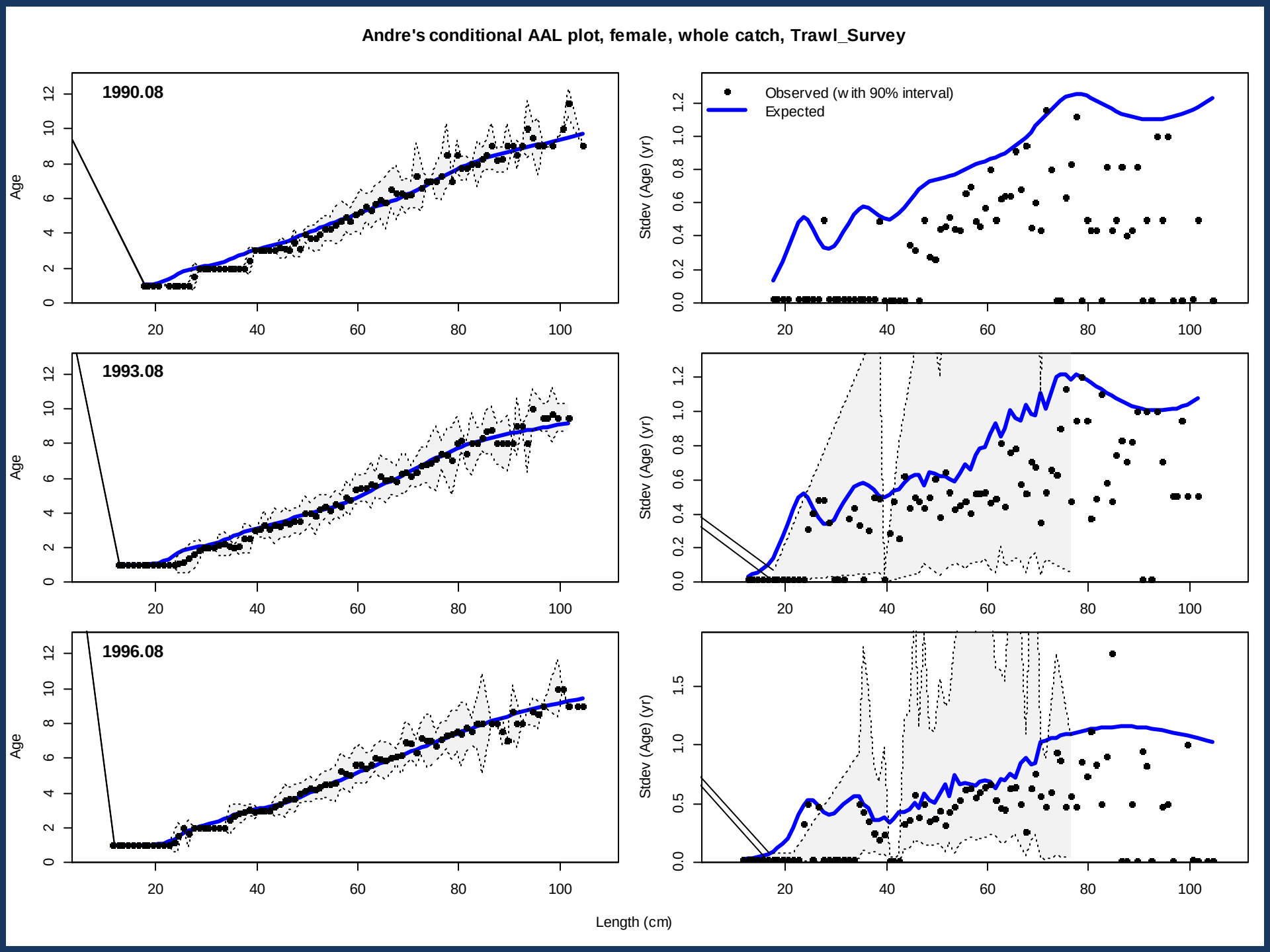

Index Trawl_Survey
Index
0e+00
2e+05
4e+05
6e+05
8e+05
1e+06
1985
1990
1995
2000
2005
2010
Year

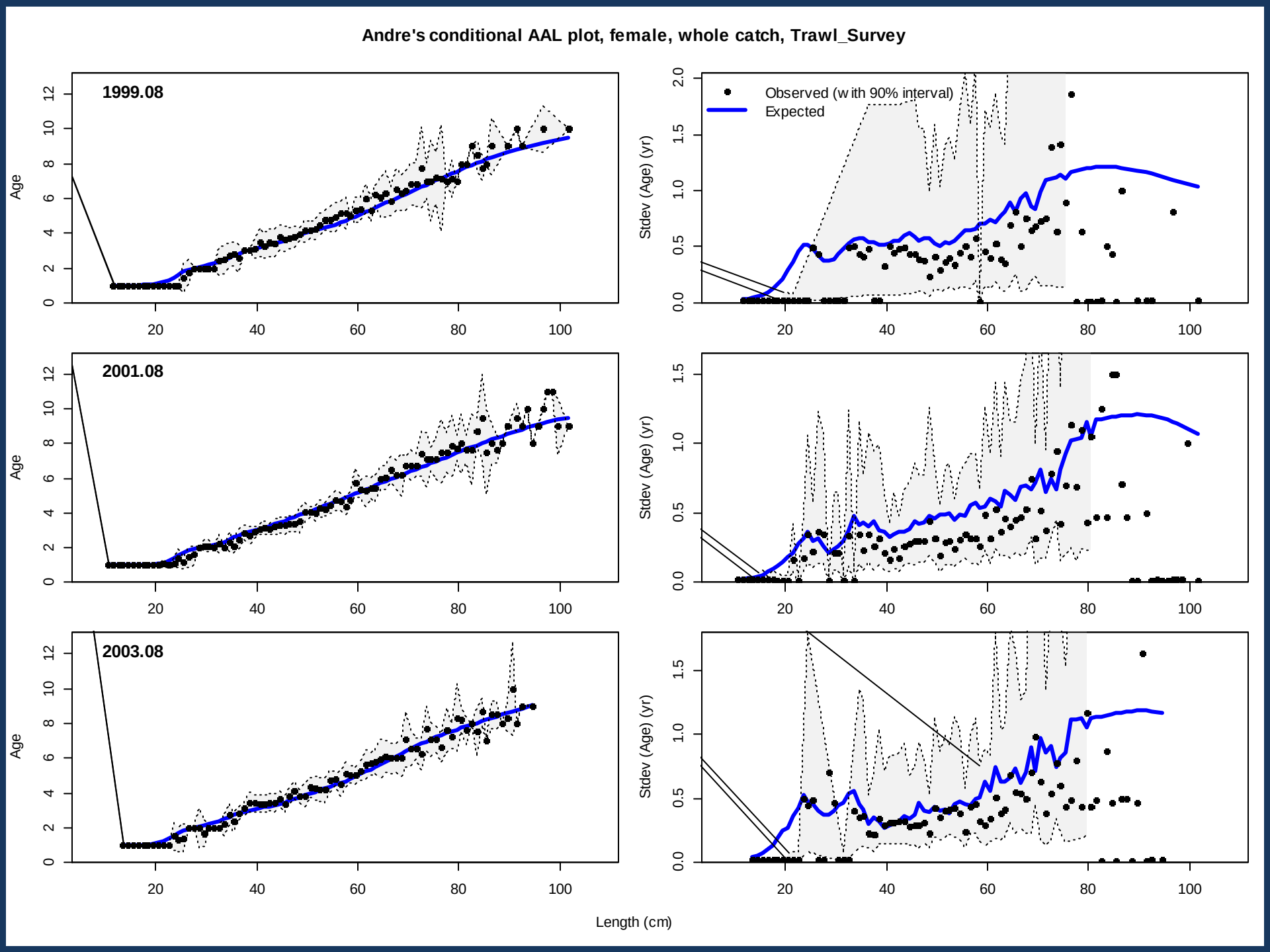

length comps, sexes combined, whole catch,
aggregated within season by fleet
Jan-Apr_Trawl_Fishery s1 N=2842 effN=17277.1
Sep-Dec_Trawl_Fishery s5 N=67 effN=684.8
Sep-Dec_Longline_Fishery s4 N=5458 effN=20722.8
May-Aug_Pot_Fishery s3 N=720 effN=5034.1
Jan-Apr_Trawl_Fishery s2 N=2348 effN=11622
Jan-Apr_Longline_Fishery s1 N=11844 effN=64959.1
Sep-Dec_Longline_Fishery s5 N=4685 effN=11234.2
Sep-Dec_Pot_Fishery s4 N=3003 effN=23036.5
May-Aug_Trawl_Fishery s3 N=1612 effN=11475.1
Jan-Apr_Longline_Fishery s2 N=5197 effN=24365.9
Jan-Apr_Pot_Fishery s1 N=7863 effN=51272.5
Sep-Dec_Pot_Fishery s5 N=635 effN=5813.4
Sep-Dec_Trawl_Fishery s4 N=1996 effN=7427.1
May-Aug_Longline_Fishery s3 N=2449 effN=9651.3
Jan-Apr_Pot_Fishery s2 N=5655 effN=39155.6
Trawl_Survey s3 N=1084 effN=5402.2
Proportion
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0
20
40
60
80
100
120
Length (cm)

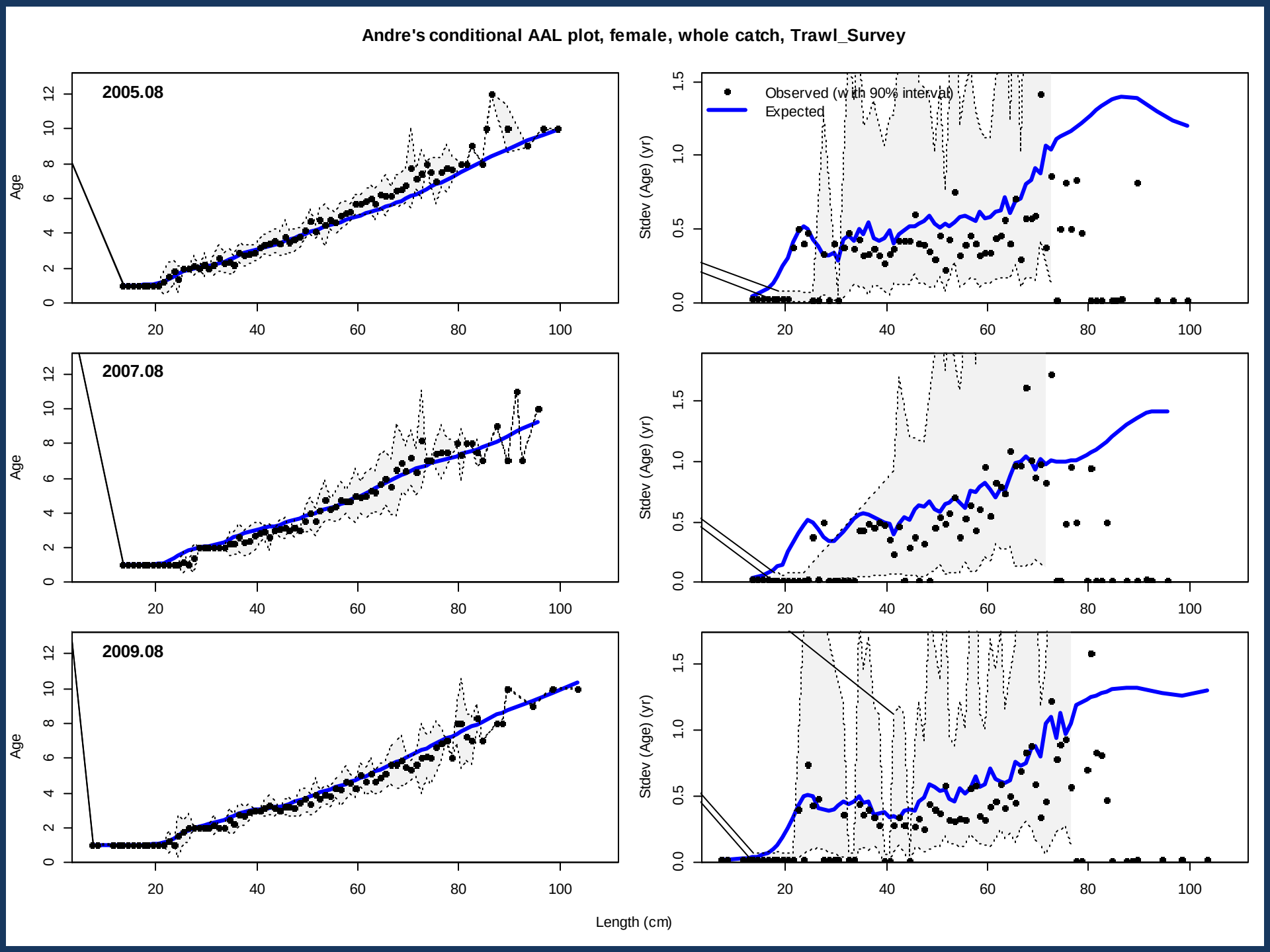

length comps, sexes combined, whole catch, Trawl_Survey
aggregated across seasons within year
1987
N=33
effN=291.6
1999
N=67
effN=1021.4
2007
N=64
effN=166.6
1990
N=29
effN=309.3
2001
N=151
effN=690.8
2009
N=98
effN=59.7
1993
N=65
effN=930.6
2003
N=129
effN=661.4
2011
N=143
effN=408
1996
N=87
effN=321.3
2005
N=84
effN=234.1
2013
N=134
effN=307.2
Proportion
0.00
0.02
0.04
0.06
0.08
0
20
40
60
80
100
120
Length (cm)


Time-varying selectivity for Trawl_Survey
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
Year
1980
1990
2000
2010
Age (yr)
0
5
10
15
20

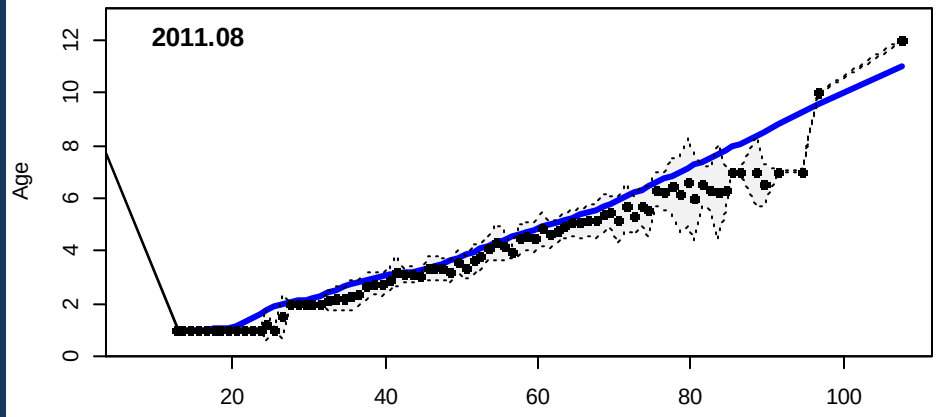

Survey selectivity-at-age
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
Early: 1984 - 1993
Middle: 1996 - 2003
Later: 2005 - 2013

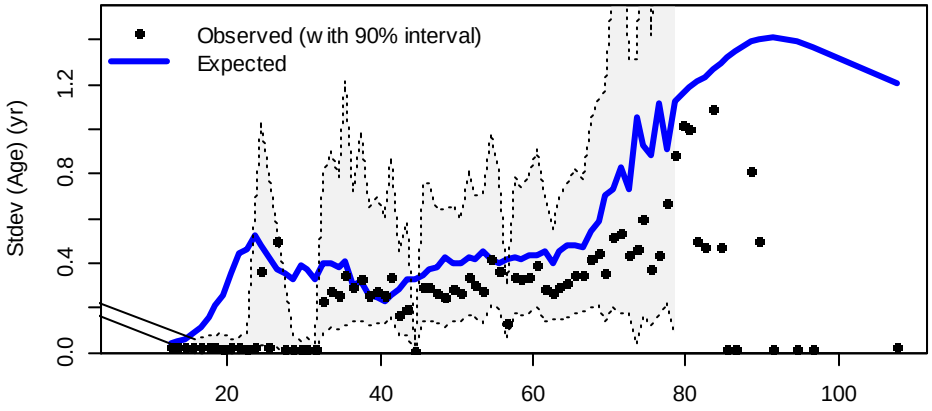

Andre's conditional AAL plot, female, whole catch, Trawl_Survey
1990.08
1993.08
1996.08
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)


Andre's conditional AAL plot, female, whole catch, Trawl_Survey
1999.08
2001.08
2003.08
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)

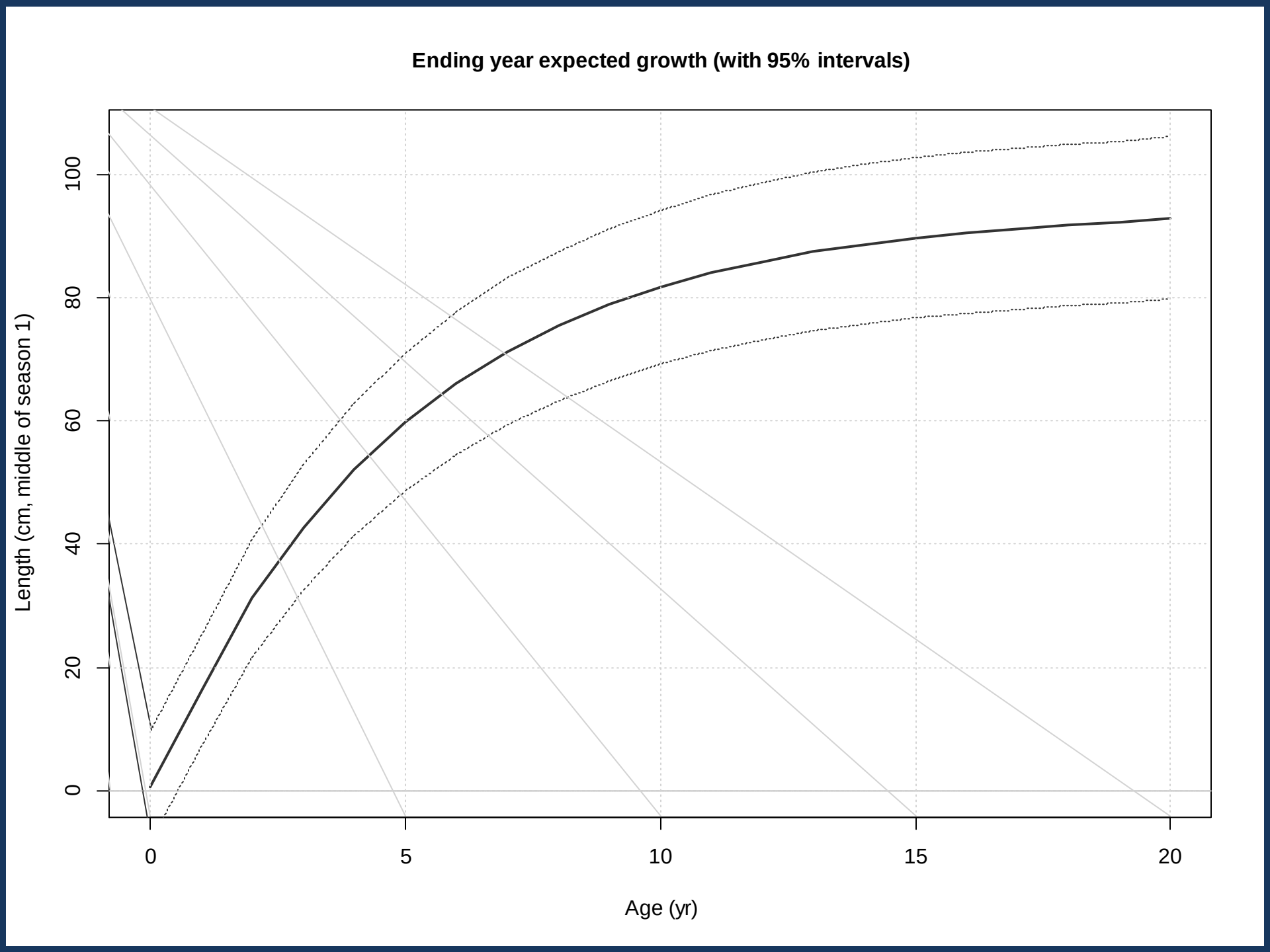

Andre's conditional AAL plot, female, whole catch, Trawl_Survey
2005.08
2007.08
2009.08
Age
Stdev (Age) (yr)
Observed (with 90% interval)
Expected
Length (cm)

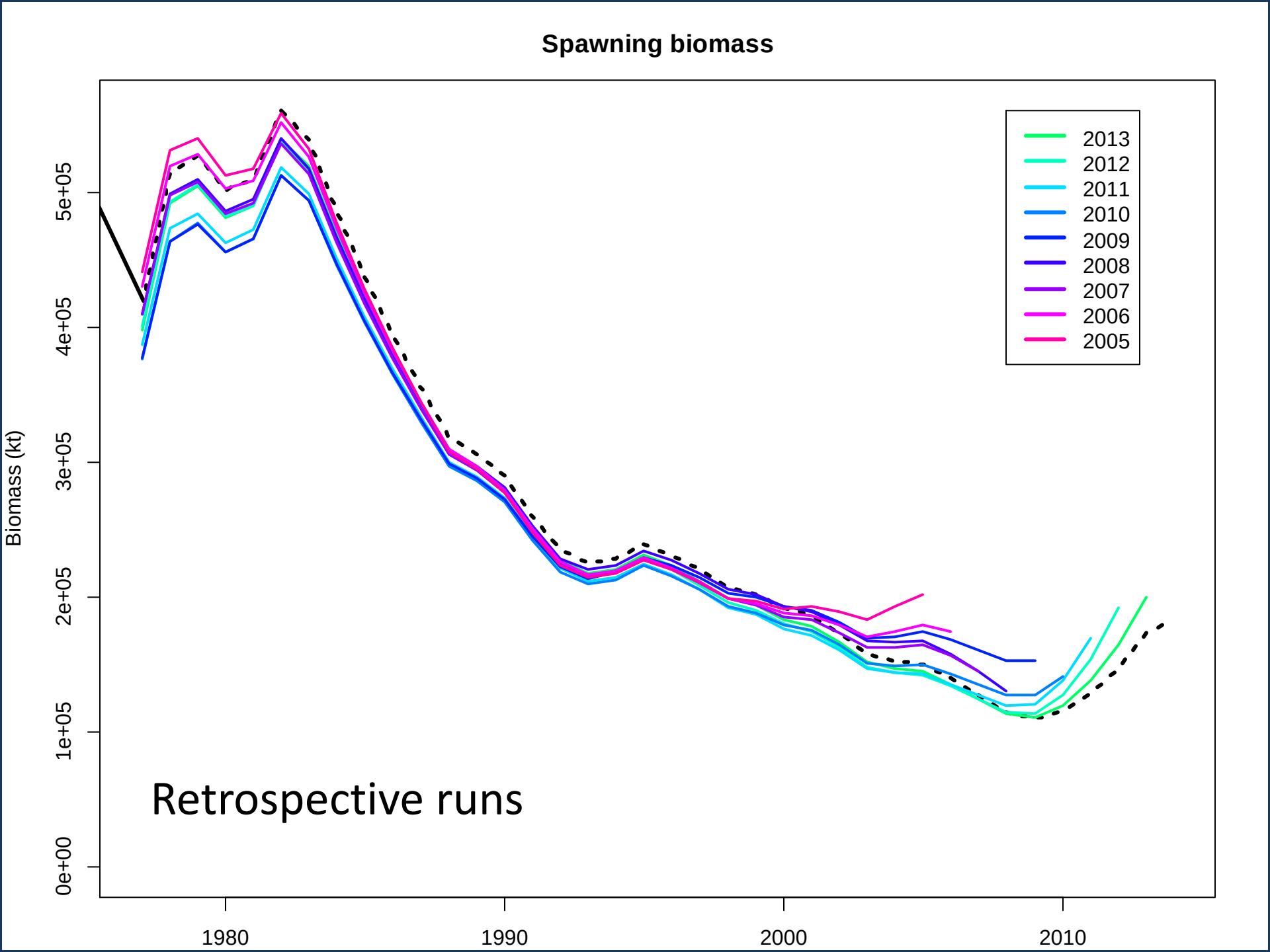
Andre's conditional AAL plot, female, whole catch, Trawl_Survey

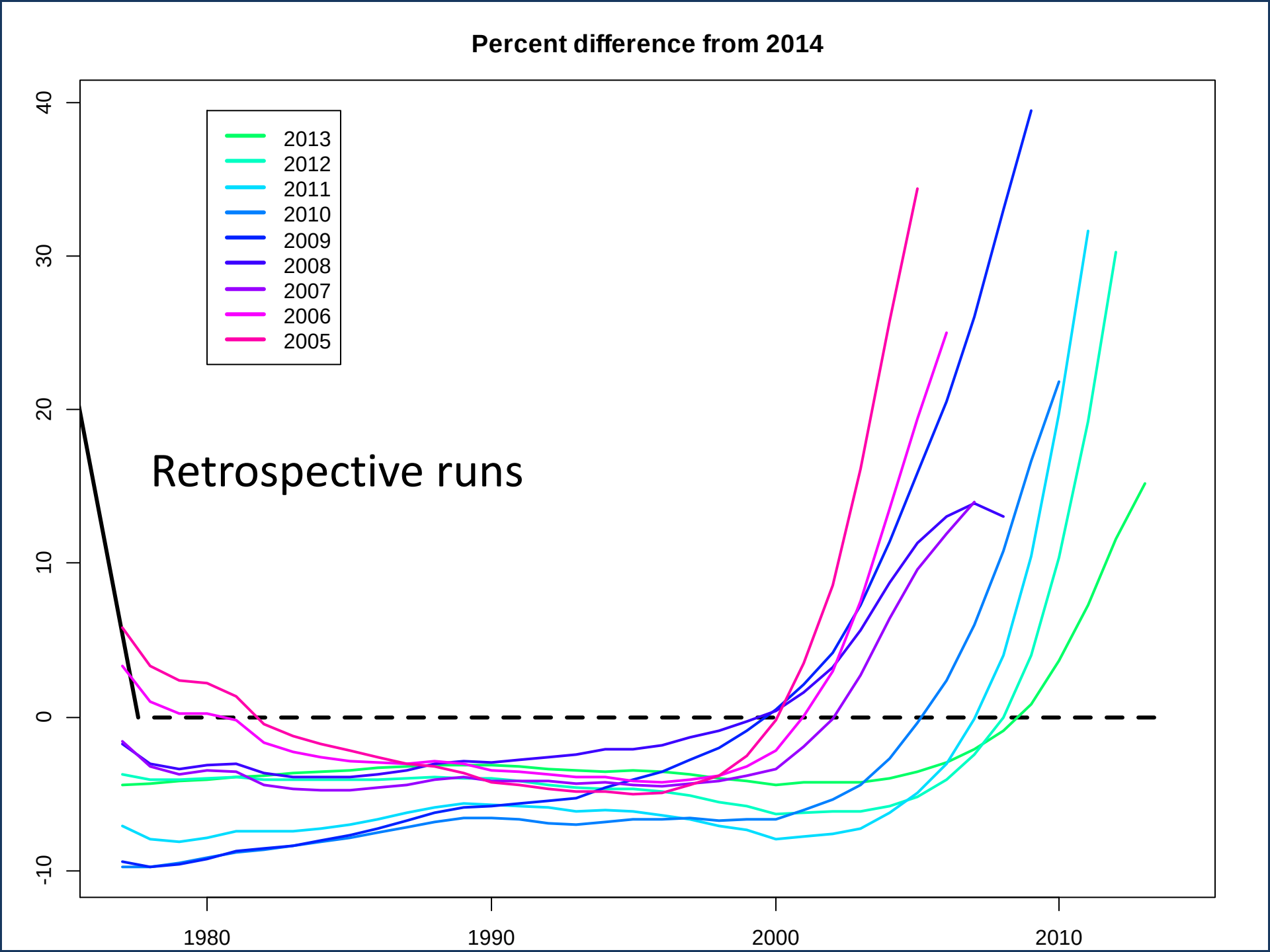


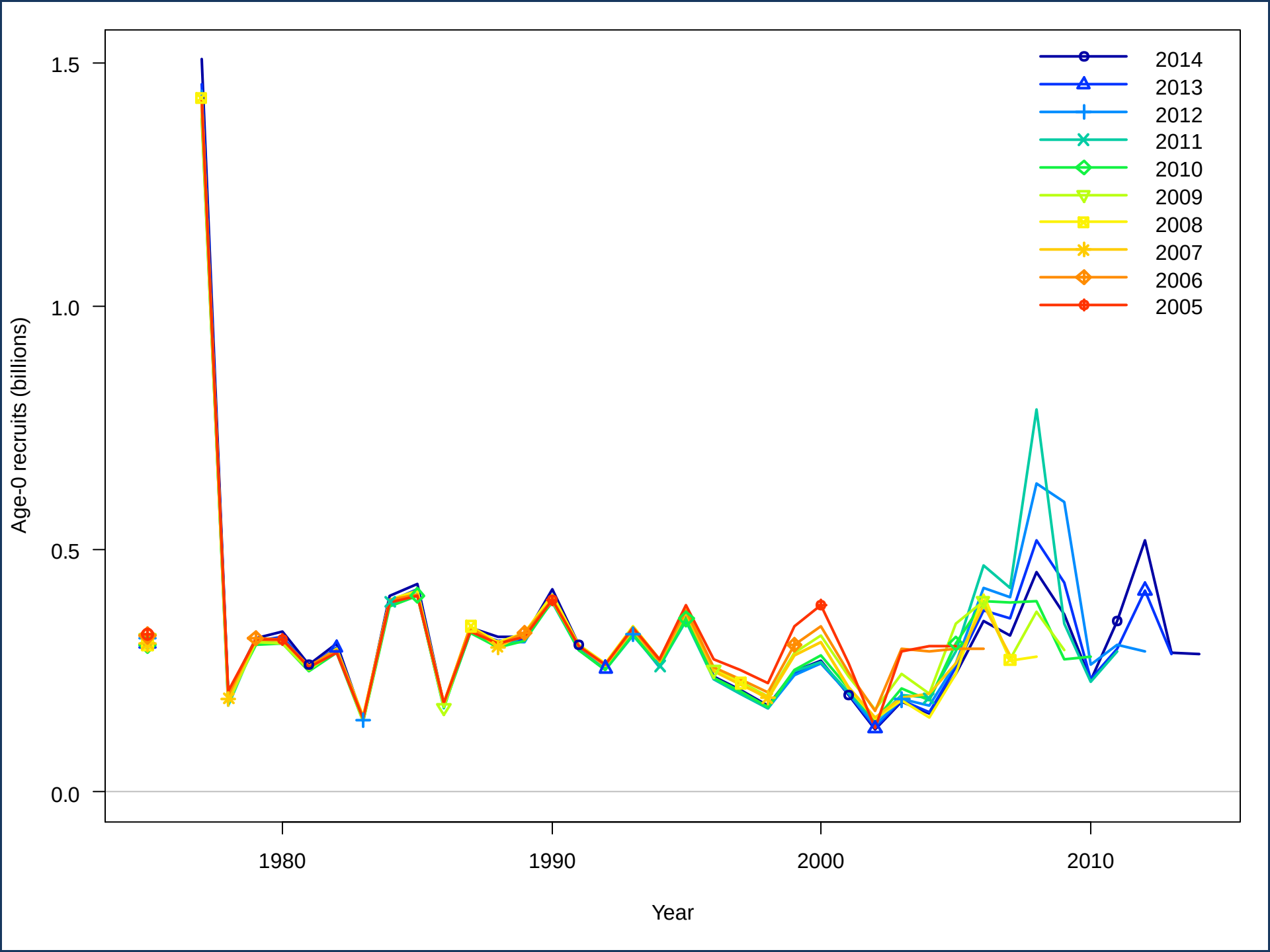


Length (cm)


Ending year expected growth (with 95% intervals)
Length (cm, middle of season 1)
0
20
40
60
80
100
0
5
10
15
20
Age (yr)


Spawning biomass
Biomass (kt)
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
1980
1990
2000
2010
2013
2012
2011
2010
2009
2008
2007
2006
2005
Retrospective runs


Percent difference from 2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
Retrospective runs
40
30
20
10
0
-10
1980
1990
2000
2010

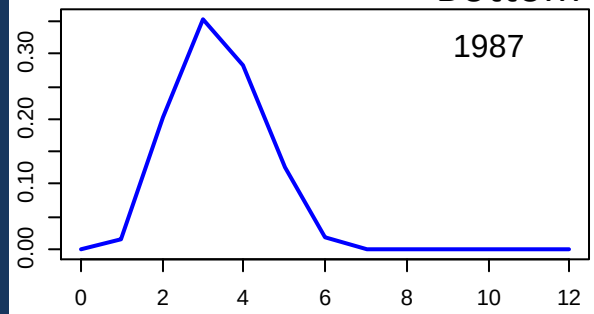

1.5
1.0
0.5
0.0
Age-0 recruits (billions)
1980
1990
2000
2010
Year
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005

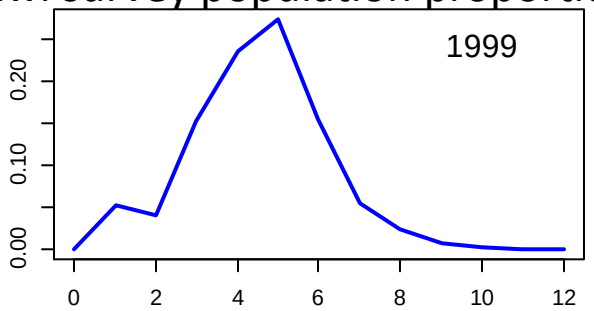
Summary table

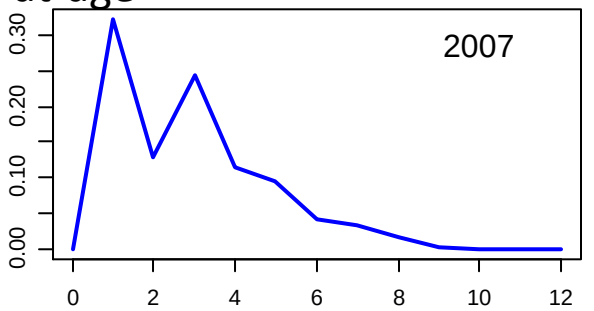
Quantity	As estimated or *specified last* year for:		As estimated or *specified this* year for:	
	2014	2015	2015	2016
M (natural mortality rate)	0.38	0.38	0.38	0.38
Tier	3a	3a	3a	3a
Projected total (age 0+) biomass (t)	422,000	397,000	583,800	558,200
Female spawning biomass (t)				
Projected	120,100	111,500	155,400	150,400
Upper 95% confidence interval	142,800	132,500	215,400	210,400
Lower 95% confidence interval	97,500	90,500	95,400	90,400
$B_{100\%}$	227,800	227,800	316,500	316,500
$B_{40\%}$	91,100	91,100	126,600	126,600
$B_{35\%}$	79,700	79,700	110,700	110,700
F_{OFL}	0.69	0.69	0.626	0.626
$maxF_{ABC}$	0.54	0.54	0.502	0.502
F_{ABC}	0.54	0.54	0.502	0.502
OFL (t)	107,300	101,800	140,300	133,100
maxABC (t)	88,500	84,100	117,200	110,700
ABC (t)	88,500	84,100	117,200	110,700
Status	As determined *last* year for:		As determined *this* year for:	
	2012	2013	2013	2014
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

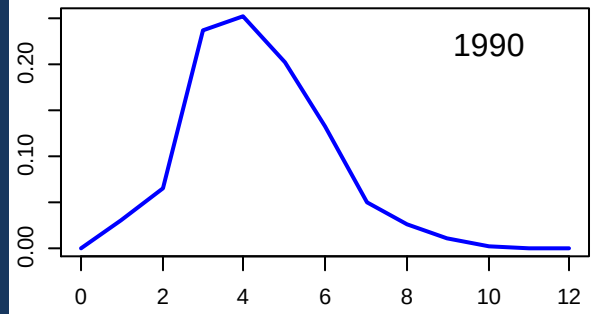
More data

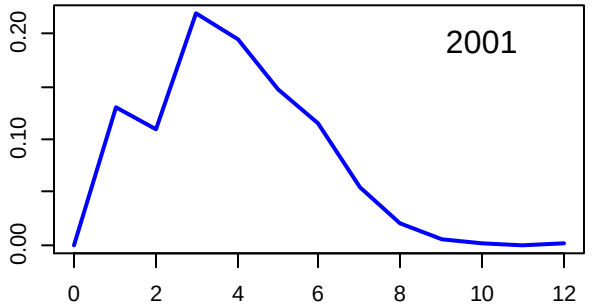
Bottom trawl survey population proportion-at-age

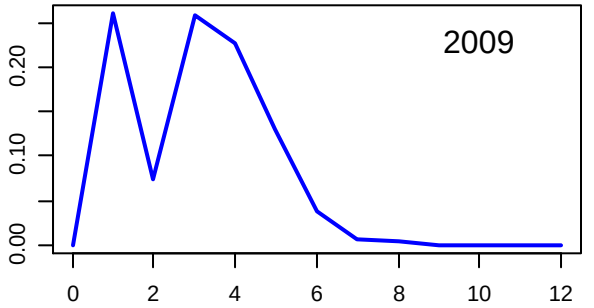


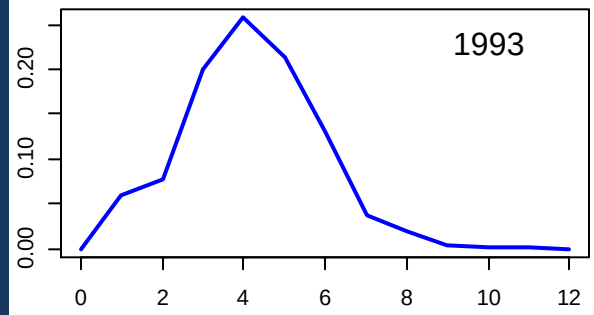


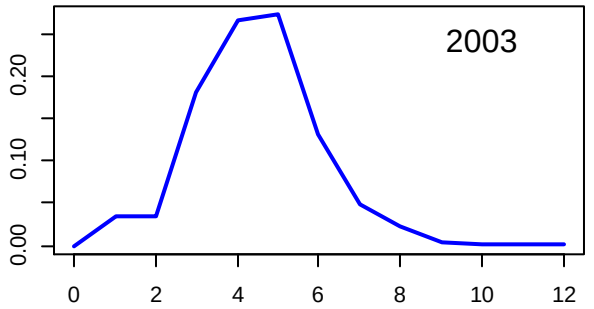


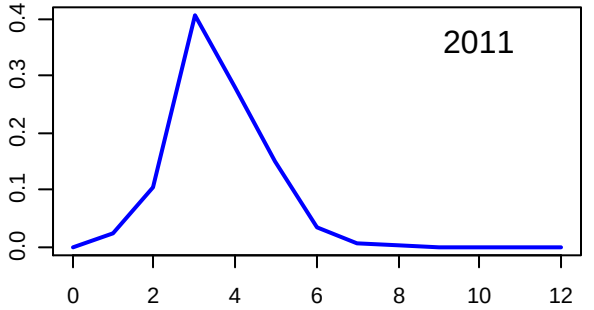


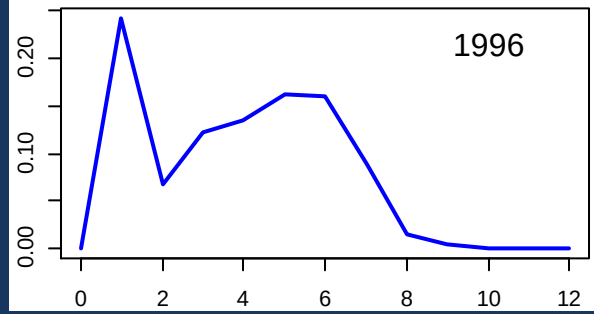


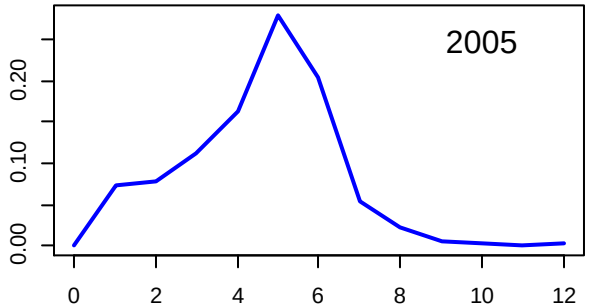


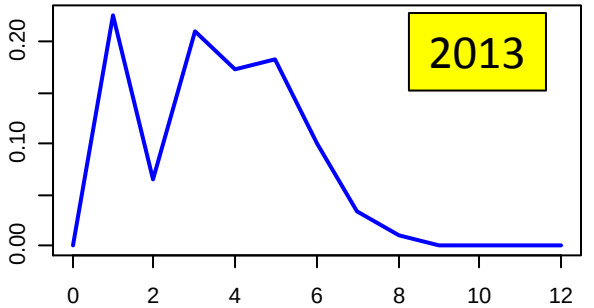




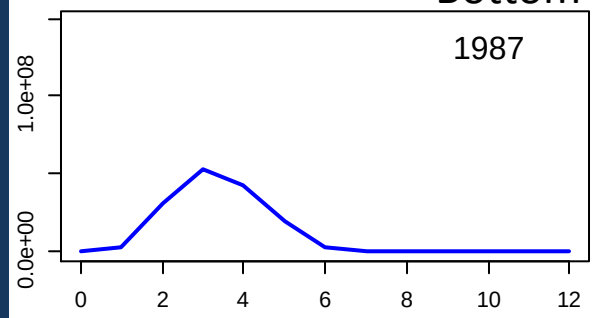


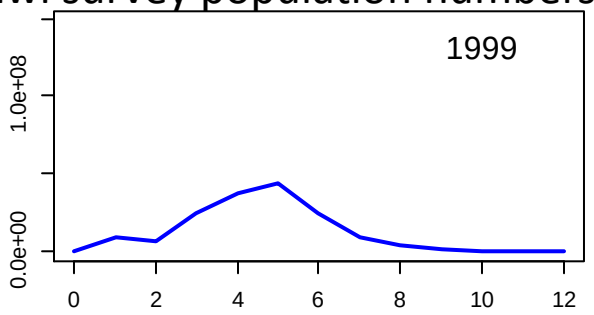


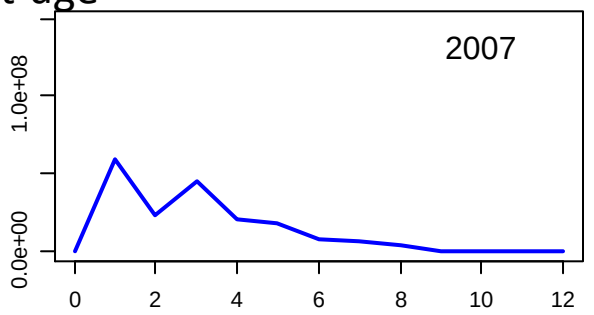


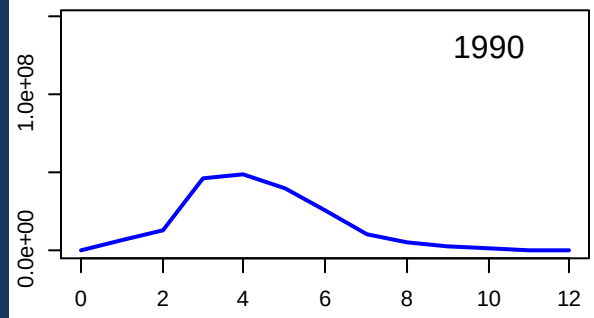


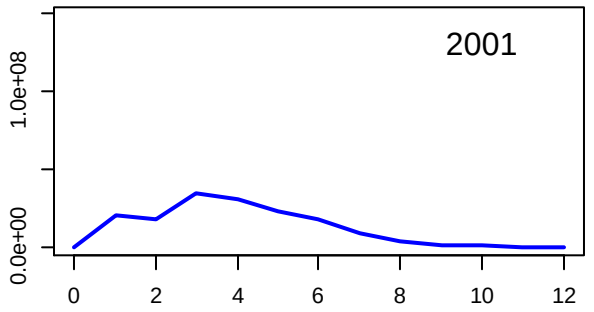
Bottom trawl survey population numbers-at-age

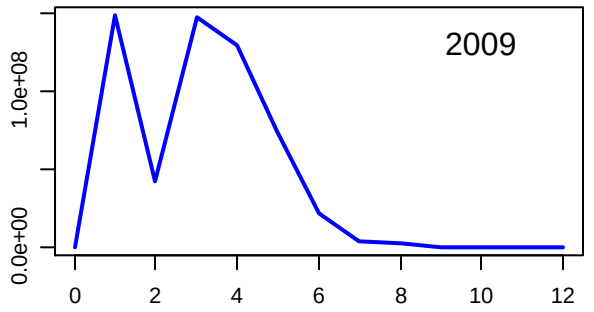


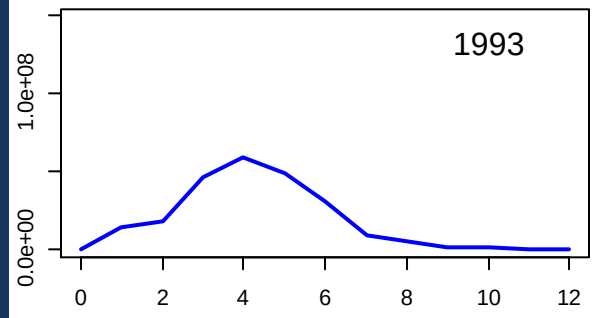


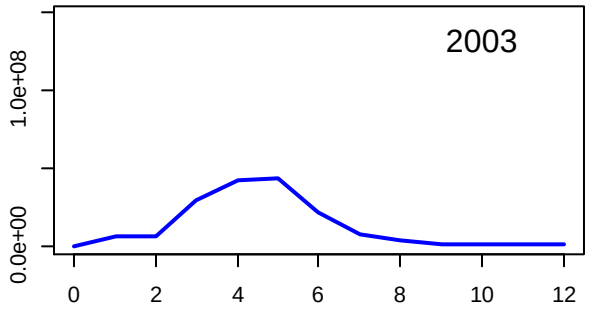


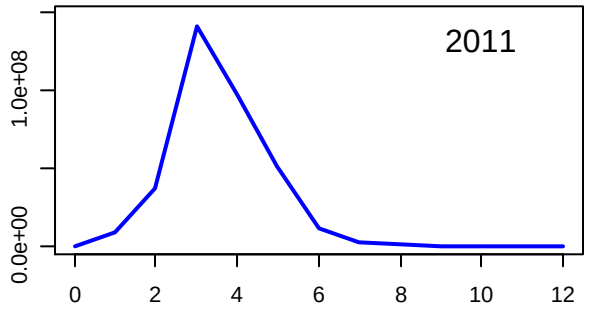


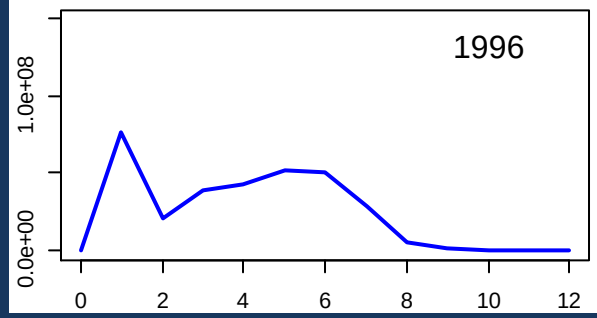


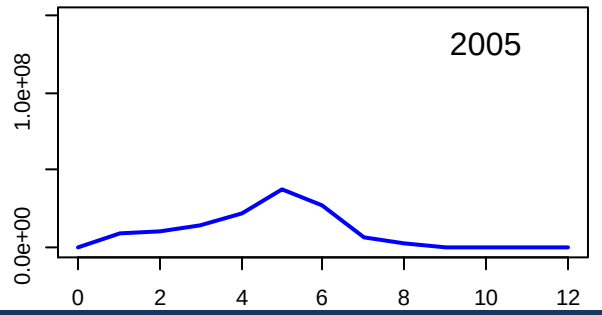


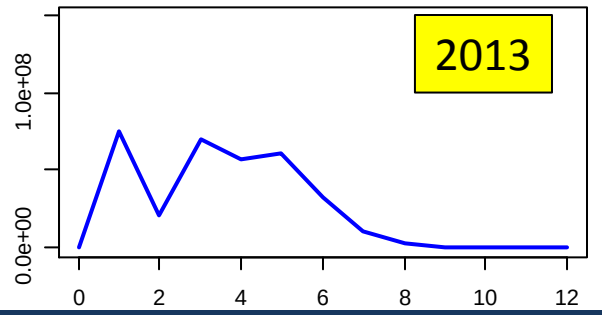




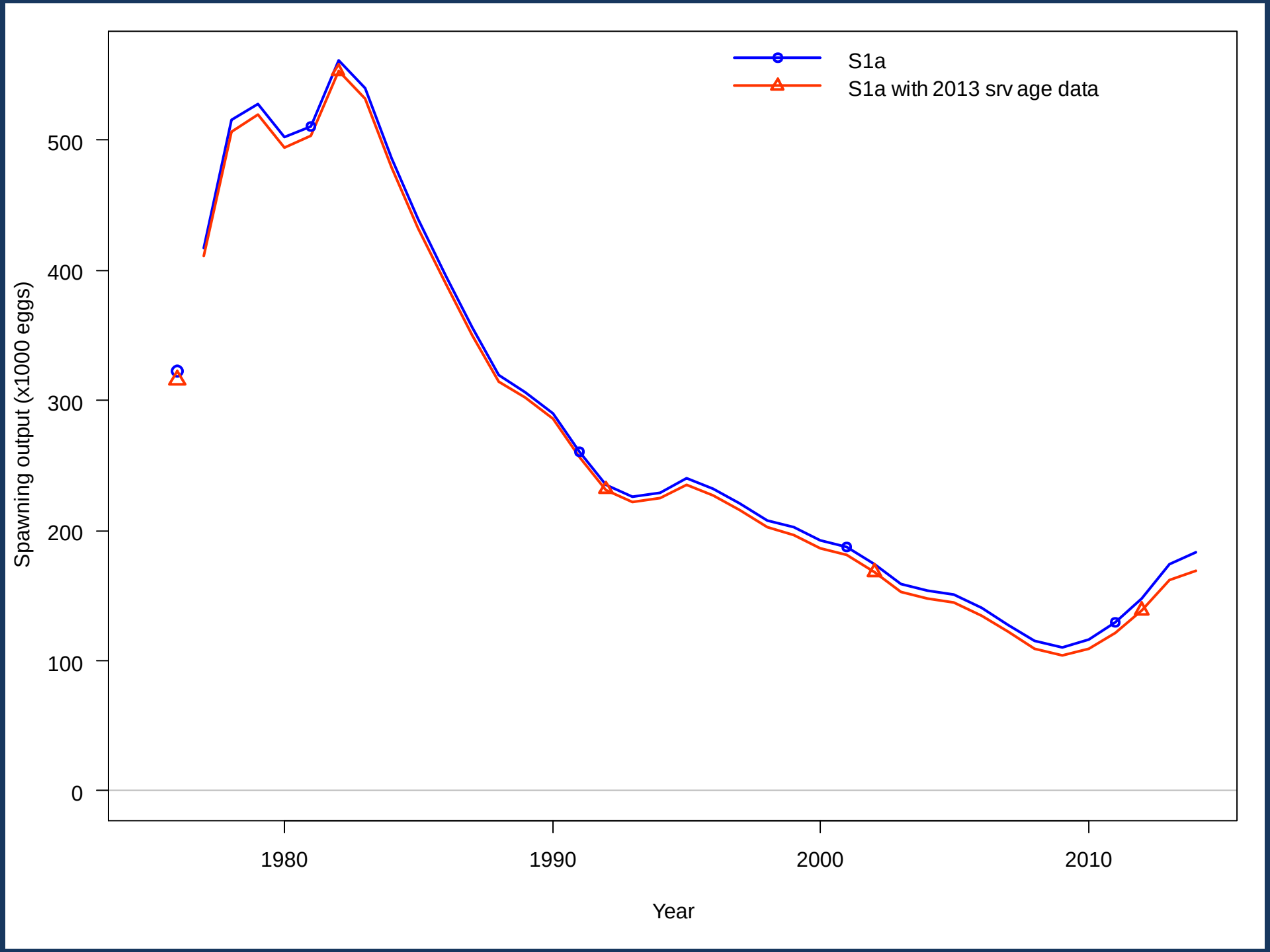


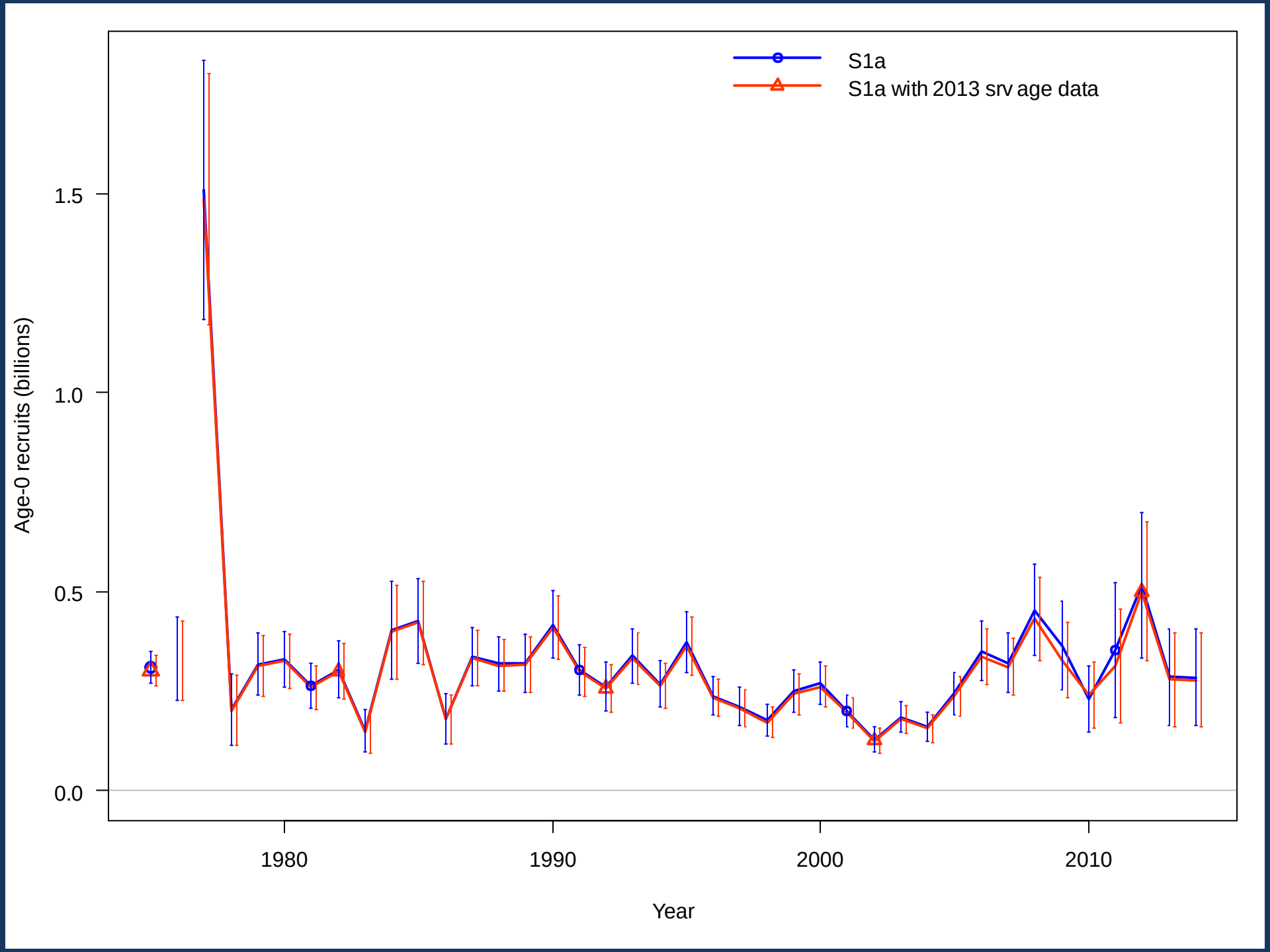


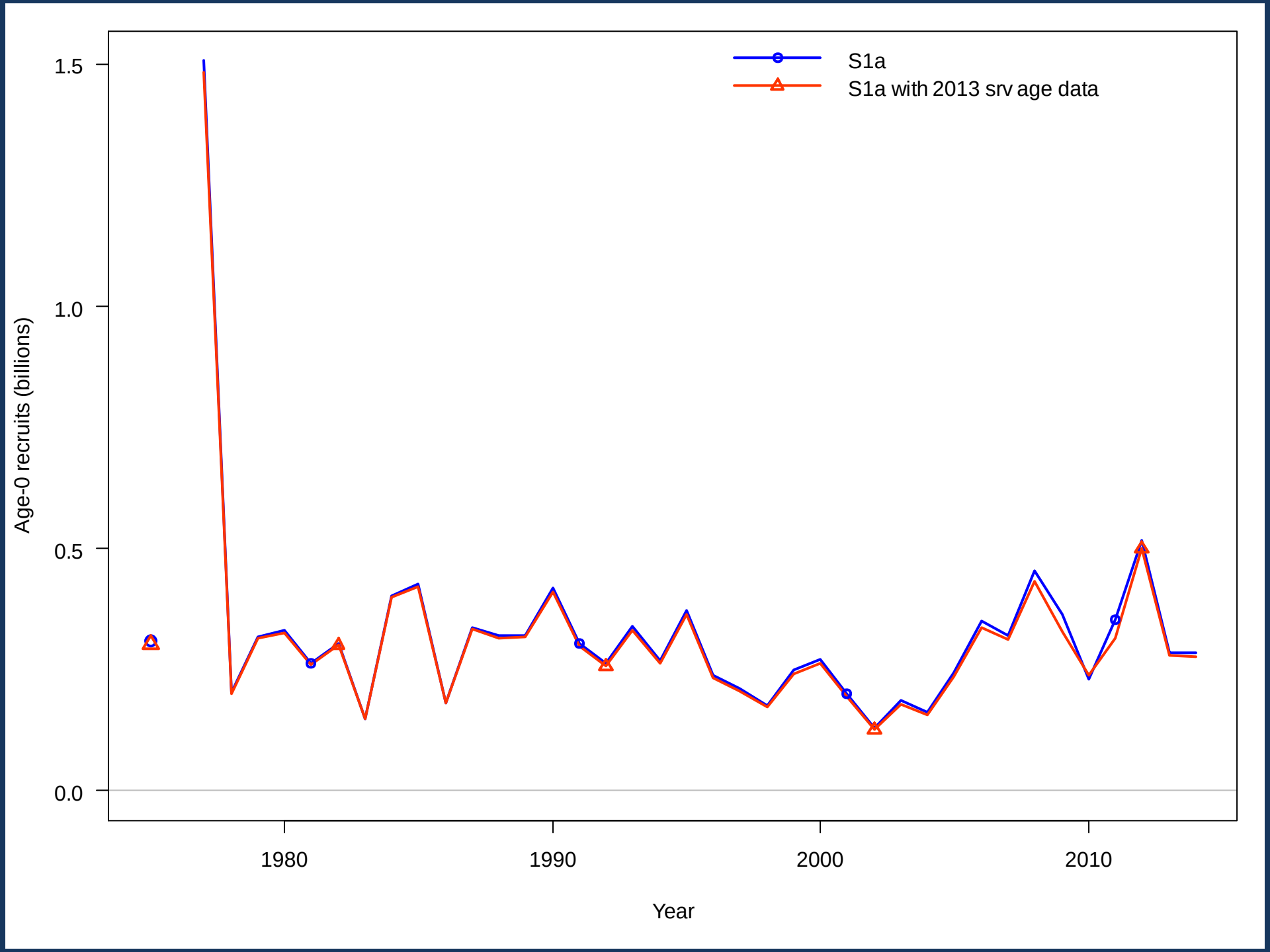


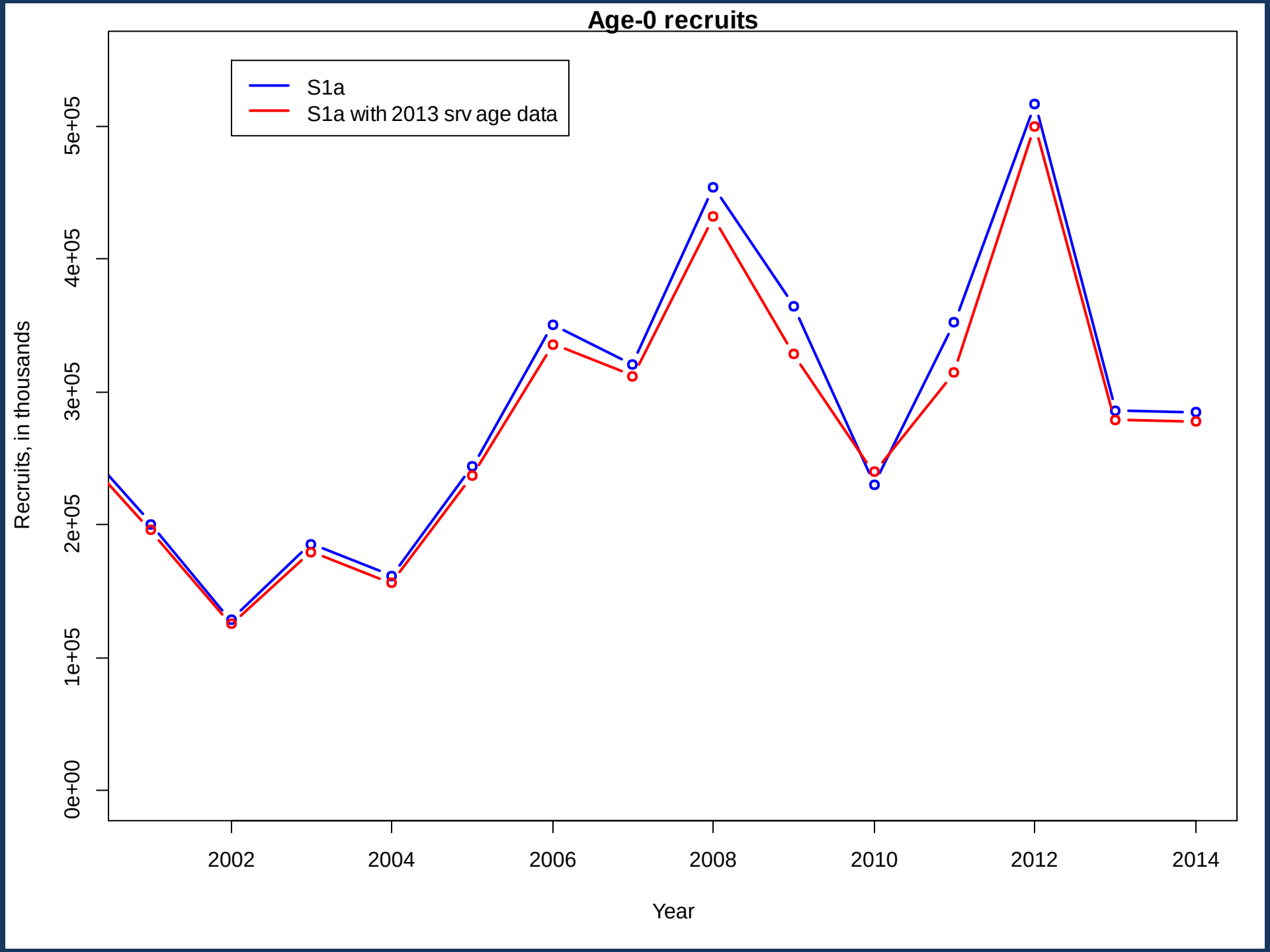


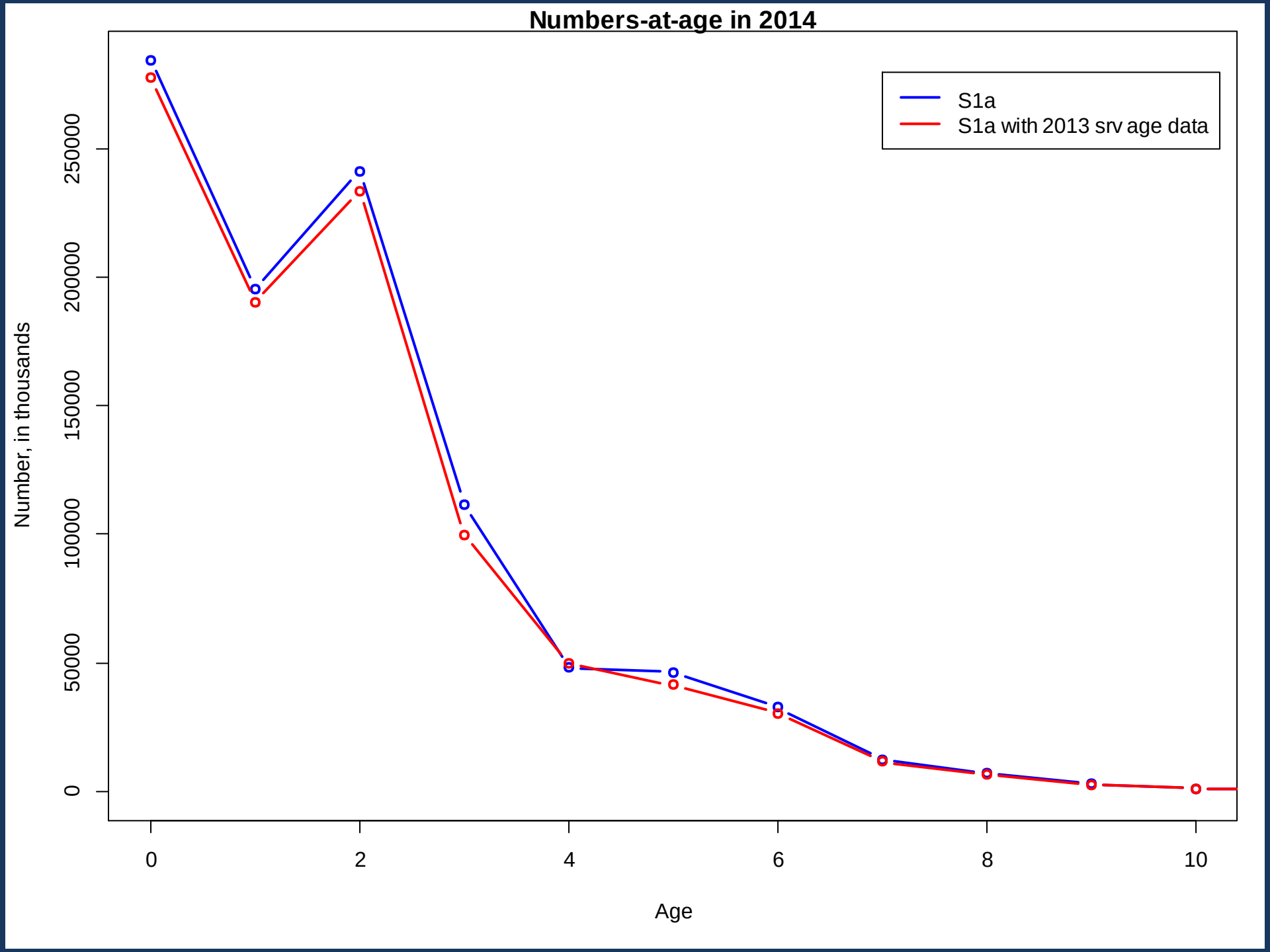
More results

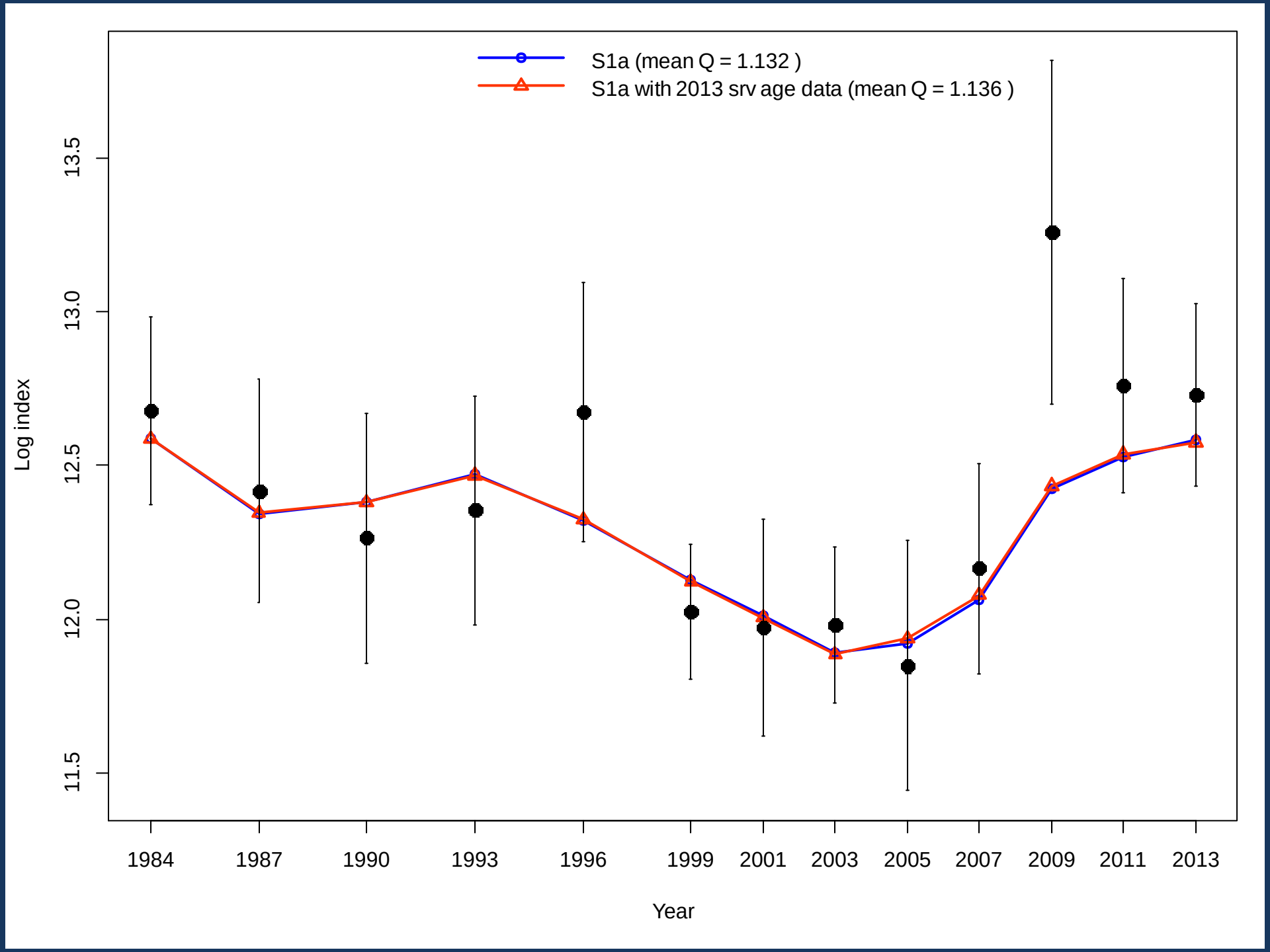

S1a
S1a with 2013 srv age data
Spawning output (x1000 eggs)
0
100
200
300
400
500
1980
1990
2000
2010
Year


S1a
S1a with 2013 srv age data
Age-0 recruits (billions)
0.0
0.5
1.0
1.5
1980
1990
2000
2010
Year

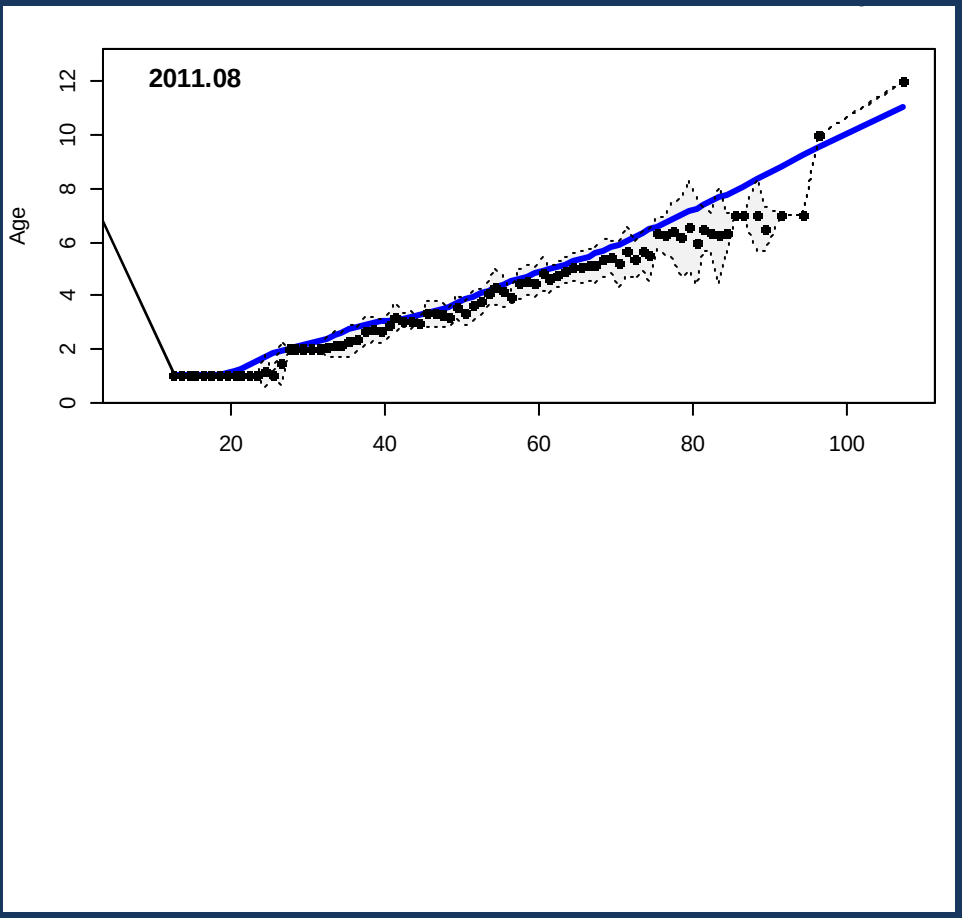

S1a
S1a with 2013 srv age data
Age-0 recruits (billions)
1.5
1.0
0.5
0.0
1980
1990
2000
2010
Year


Age-0 recruits
S1a
S1a with 2013 srv age data
Recruits, in thousands
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
2002
2004
2006
2008
2010
2012
2014
Year

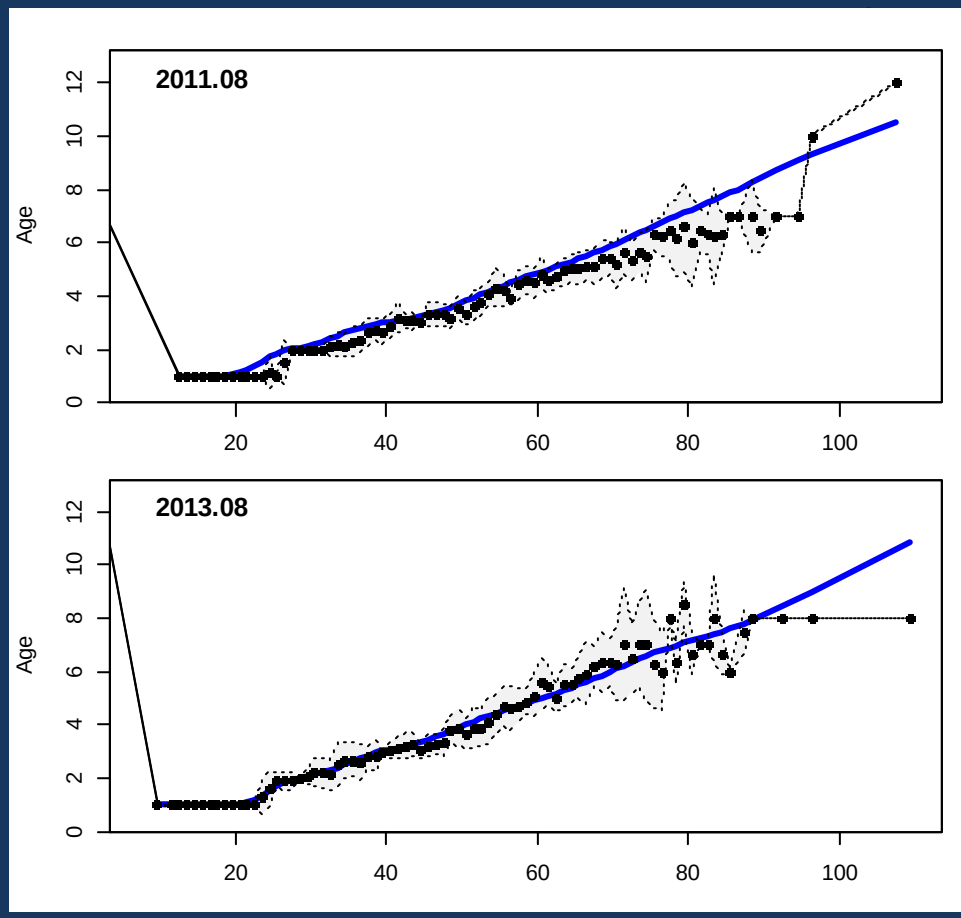

Numbers-at-age in 2014
S1a
S1a with 2013 srv age data
Number, in thousands
0
50000
100000
150000
200000
250000
0
2
4
6
8
10
Age


S1a (mean Q = 1.132)
S1a with 2013 srv age data (mean Q = 1.136)
Log index
11.5
12.0
12.5
13.0
13.5
1984
1987
1990
1993
1996
1999
2001
2003
2005
2007
2009
2011
2013
Year

S1a



S1a with 2013 srv age data



	S1a	S1a with 2013 srv age data
Number of parameters	230	230
Likelihood components (-ln)		
Full survey index	-14.01	-14.16
Length compositions	2202.93	2204.23
Age compositions	415.39	451.46
Recruitment	-17.52	-17.75
Forecast recruitment	4.22	4.10
Total	2591.09	2627.96
Length composition likelihoods (-ln)		
Jan-Apr Trawl	299.84	299.23
Jan-Apr LL	140.98	140.75
Jan-Apr Pot	212.43	212.17
May-Aug Trawl	438.86	438.21
May-Aug LL	133.87	133.97
May-Aug Pot	334.27	334.26
Sep-Dec Trawl	271.28	271.18
Sep-Dec LL	45.35	45.42
Sep-Dec Pot	168.04	168.17
Full survey	158.02	160.88
Age compositions likelihoods (-ln)		
Age full survey	415.39	451.46

Growth parameters

	S1a	S1a with 2013 srv age data
Length-at-Amin	23.34	23.32
Length-at-A∞	94.28	94.29
k	0.201	0.202
CV for L-at-Amin	4.601	4.561
CV for L-at-A∞	6.775	6.774
ln(R0)	12.64	12.62

Differences due to 2013 srv age data

- The 2013 survey population age composition has peaks at ages 1, 3, and 5
  - Year classes 2012, 2010, and 2008
- Age-0 recruits for 2006 – 2014 changed compared to the model without the 2013 srv age data; all except 2010 decreased
- Numbers-at-age in 2014 are lower compared to the model without the 2013 srv age data, except for age 4

New summary table

Quantity	As estimated or *specified last* year for:		As estimated or *specified this* year for:	
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Tier	3a	3a	3a	3a
Projected total (age 0+) biomass (t)	422,000	397,000	542,300	525,020
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Projected	120,100	111,500	142,500	139,500
Upper 95% confidence interval	142,800	132,500	198,300	195,300
Lower 95% confidence interval	97,500	90,500	86,600	83,700
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$B_{35\%}$	79,700	79,700	108,100	108,100
F_{OFL}	0.69	0.69	0.629	0.629
$maxF_{ABC}$	0.54	0.54	0.505	0.505
F_{ABC}	0.54	0.54	0.505	0.505
OFL (t)	107,300	101,800	128,700	123,700
maxABC (t)	88,500	84,100	107,400	102,900
ABC (t)	88,500	84,100	107,400	102,900
Status	As determined *last* year for:		As determined *this* year for:	
	2012	2013	2013	2014
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no