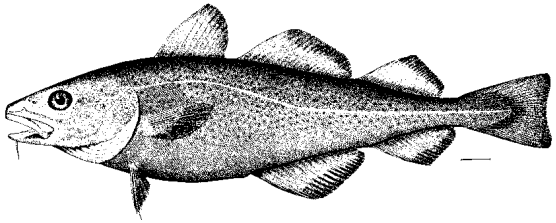
Georges Bank Cod



Gadus morhua

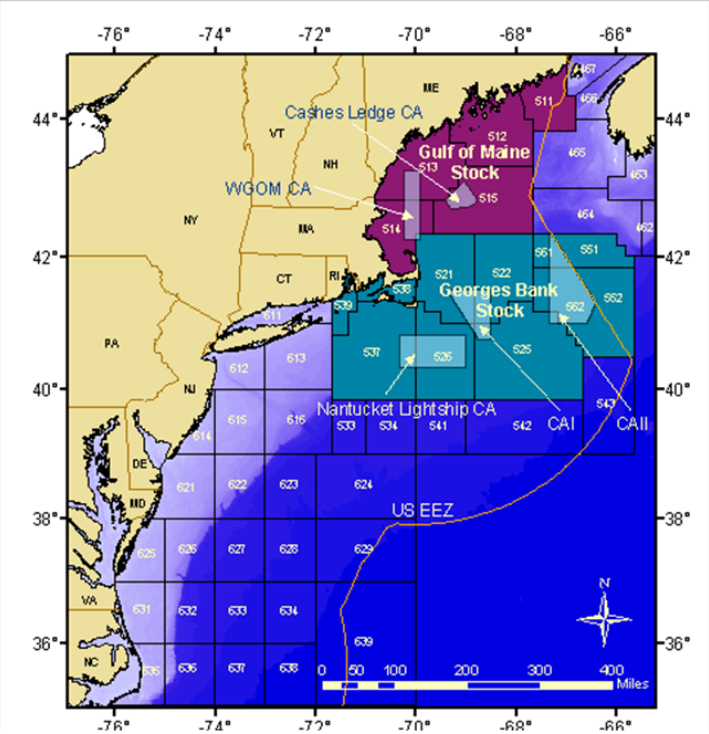
Groundfish Operational Assessment Review Meeting
NEFSC
Woods Hole, Ma
September 14-18, 2015

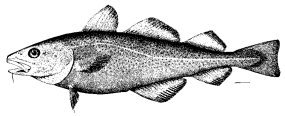
Last assessed:
2012 SARC 55 Benchmark

Statistical CAA model :
ASAP; Terminal year = 2010

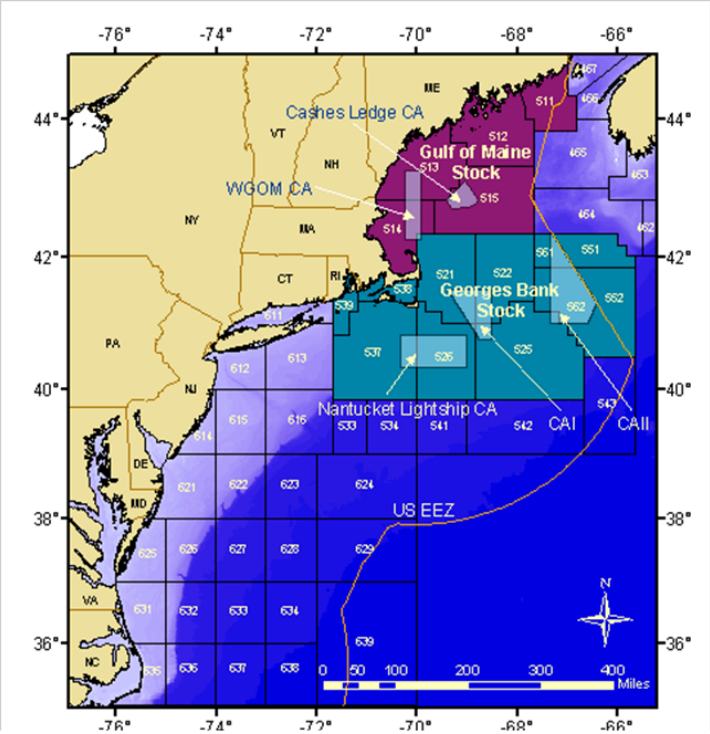
Reference Points:
$F_{40\%} = 0.177$
MSY = 30,622 mt
SSB_{MSY} = 186,535 mt

Status in 2012:
Overfished : 2011 SSB = 13,217 mt (retro adjusted)
Overfishing occurring: 2011 F = 0.42 (retro adjusted)





2015 Operational assessment:



Statistical CAA model :

Accepted Benchmark ASAP; TY = 2014

Reference Points:

$F_{40\%}$ = 0.169

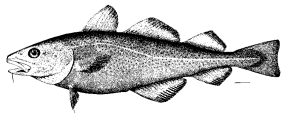
MSY = 30,570 mt

SSB_{MSY} = 201,466 mt

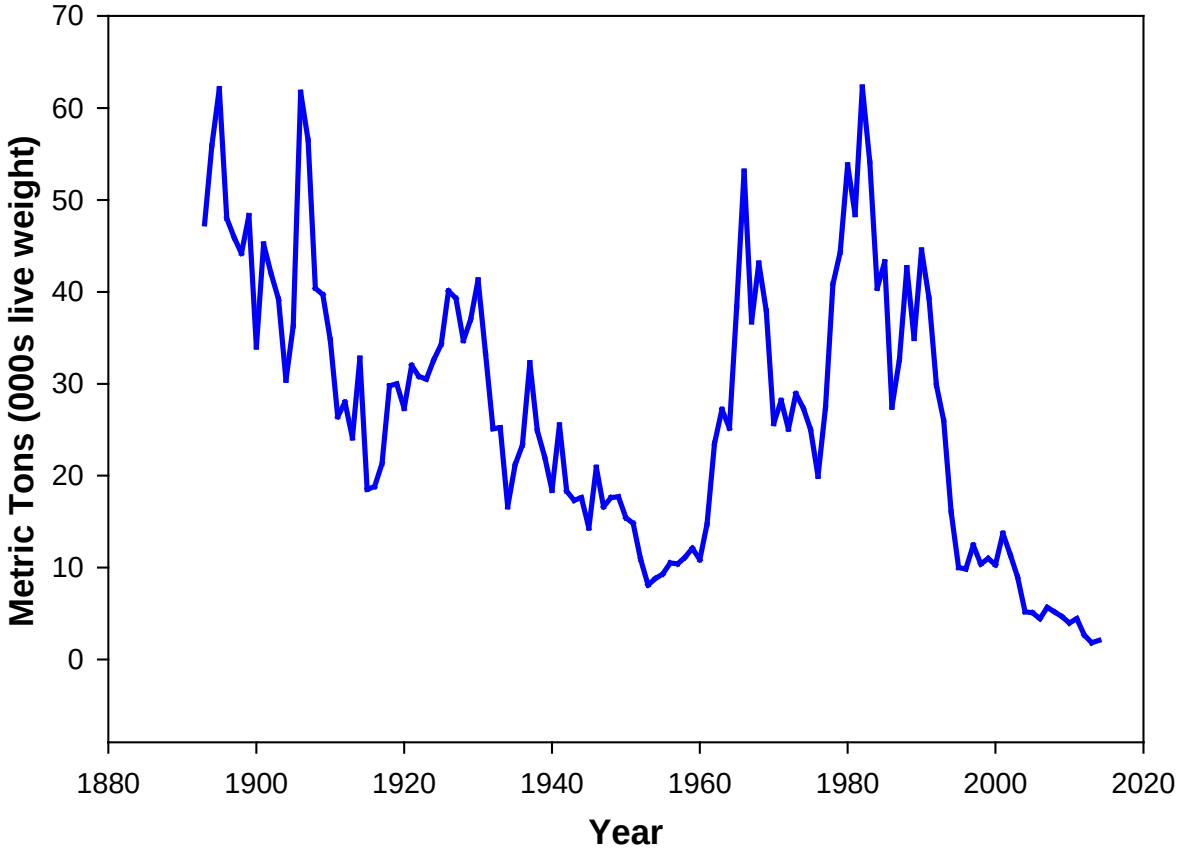
Status in 2015:

Overfished : 2014 SSB = 1,966 mt (retro adjusted)

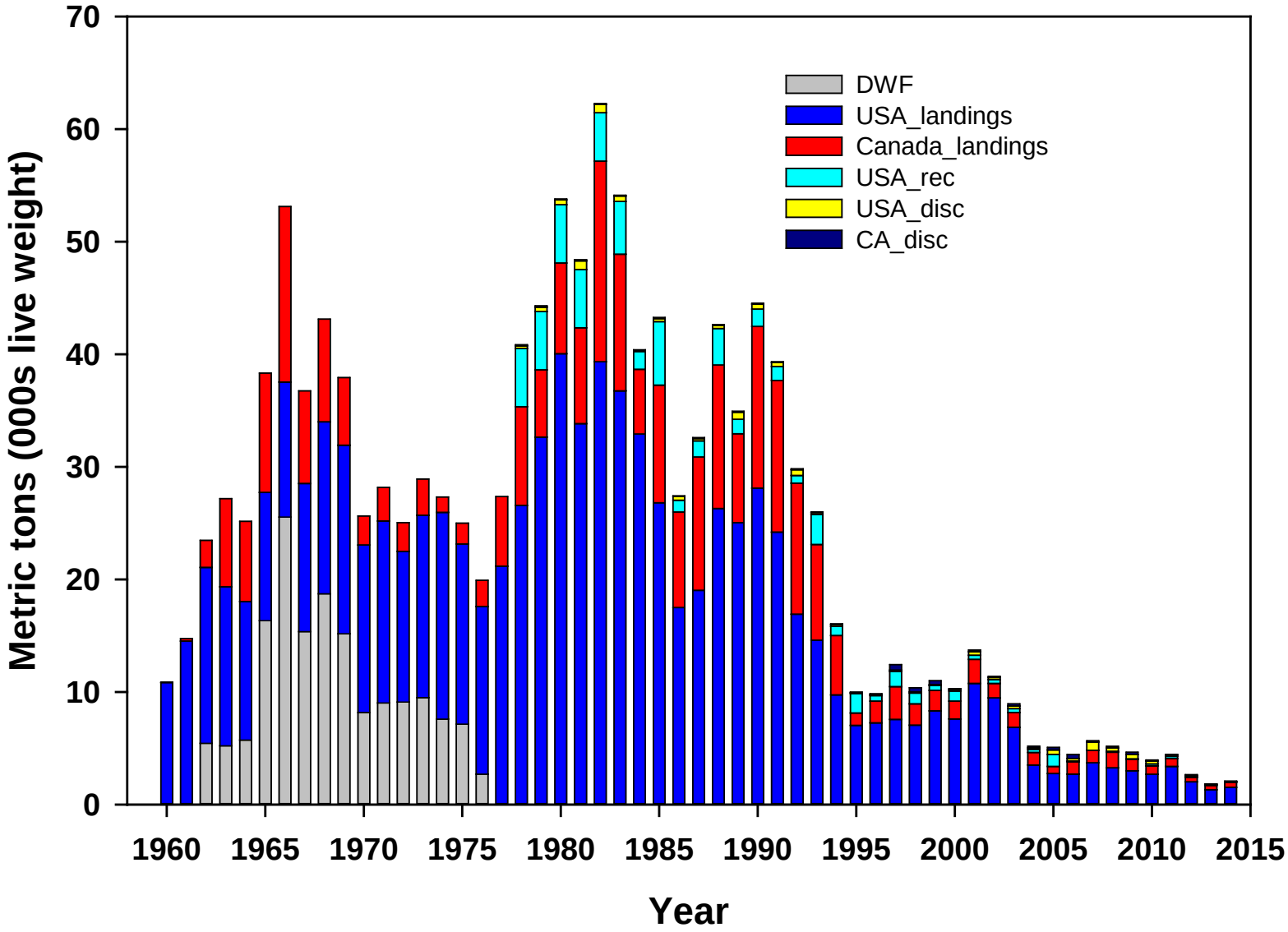
Overfishing occurring: 2014 F = 1.61 (retro adjusted)



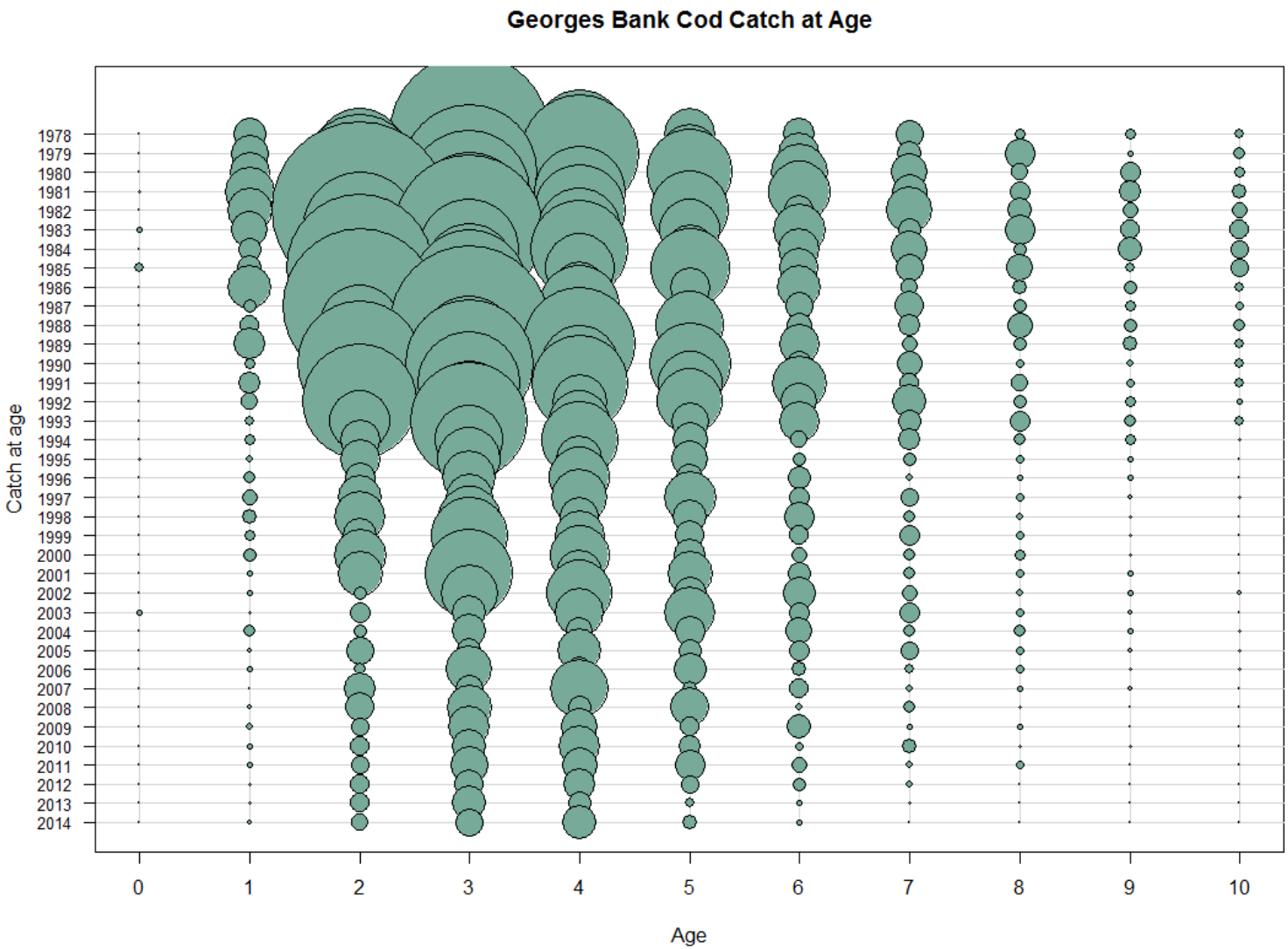
Total Catch of GB cod since 1893



Catch - 1960 -2014 ; DWF, US, CA



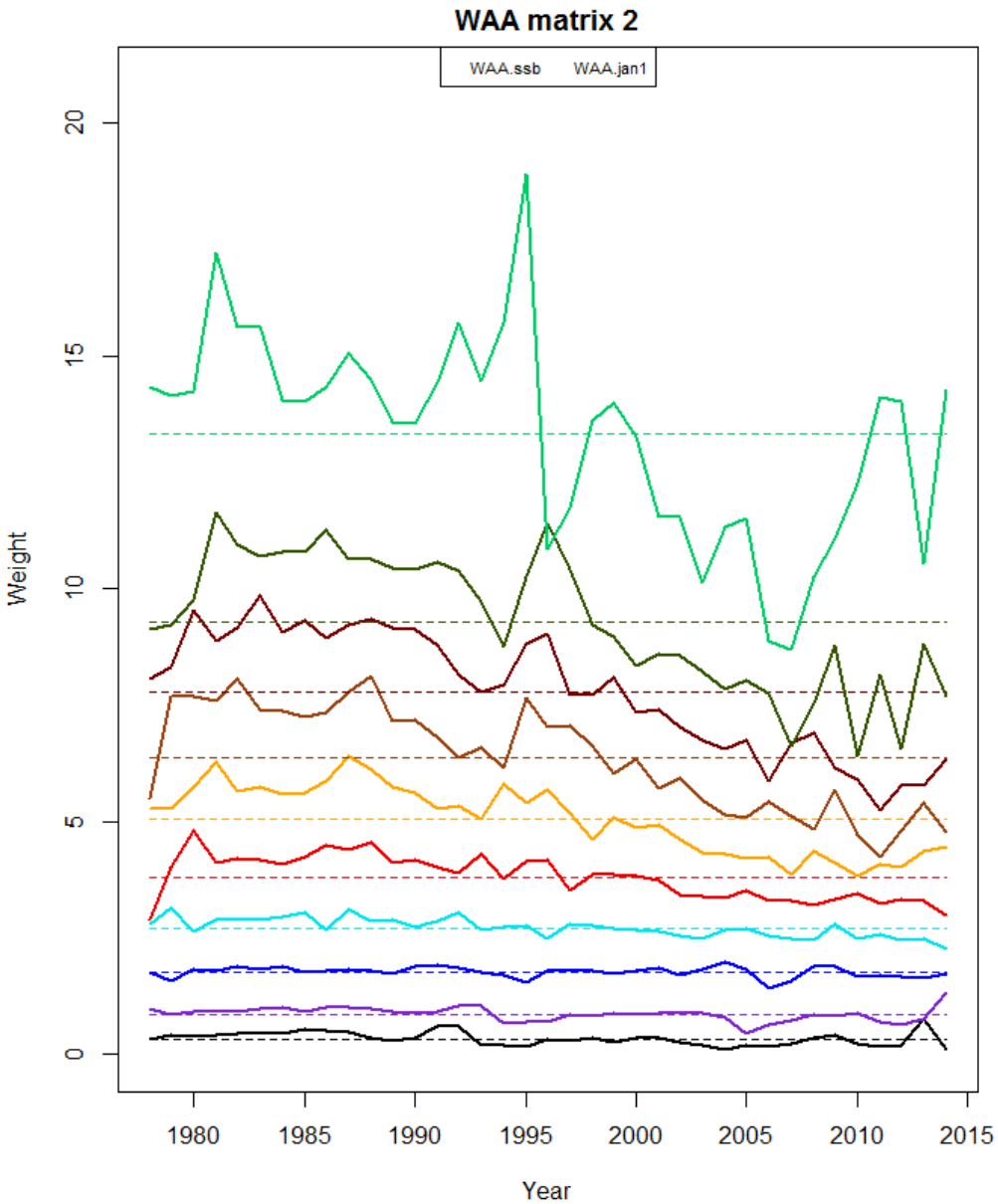
Total Catch: US comm. & rec., CA comm.



2014, 1st yr
No age 9, 10+
In CA fishery

See Table 8b.

Total Catch – Jan. 1 avg wt at age (1 – 10+)



Age 10

Age 1

Survey wt/tow - standardized to mean

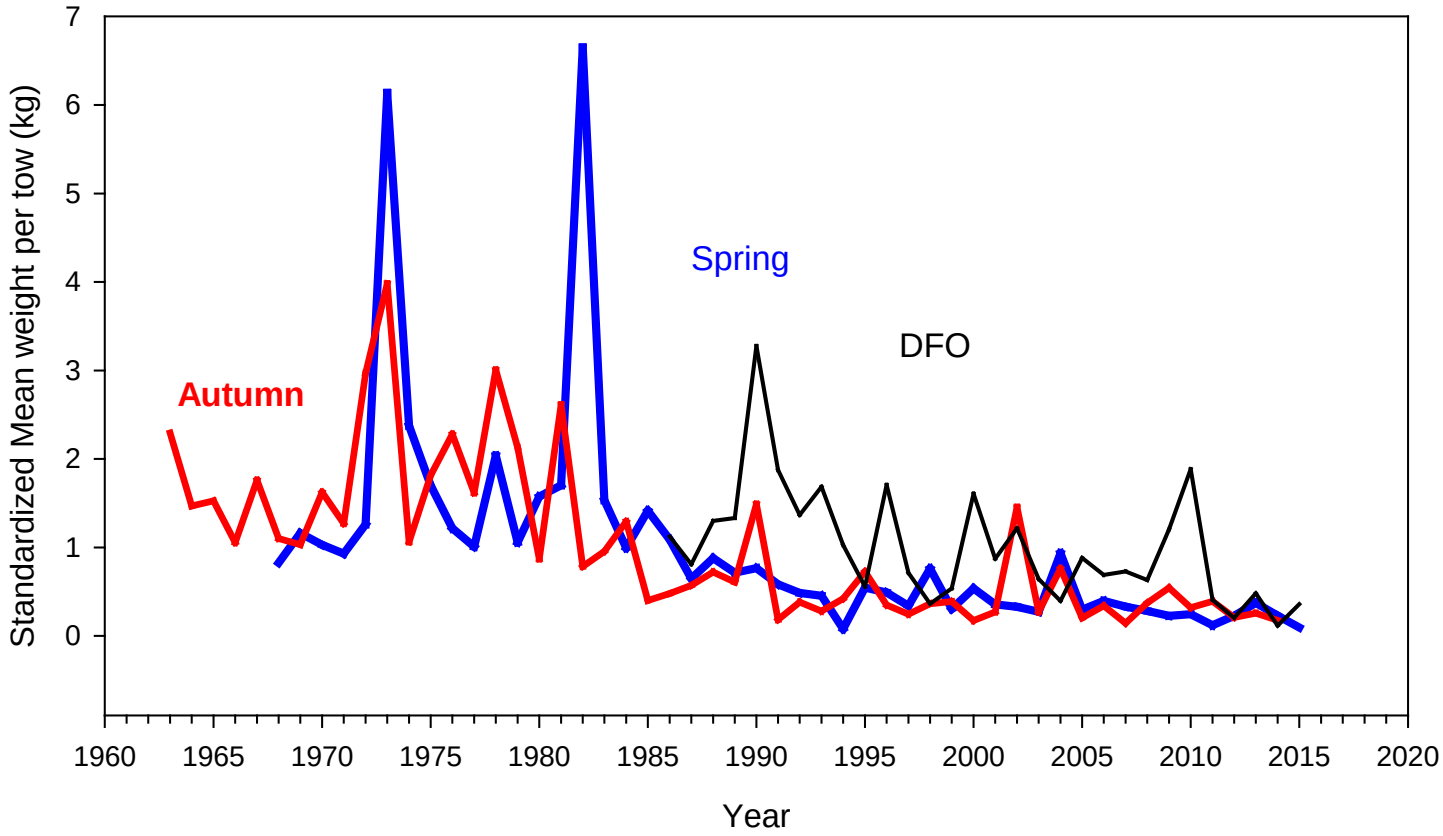
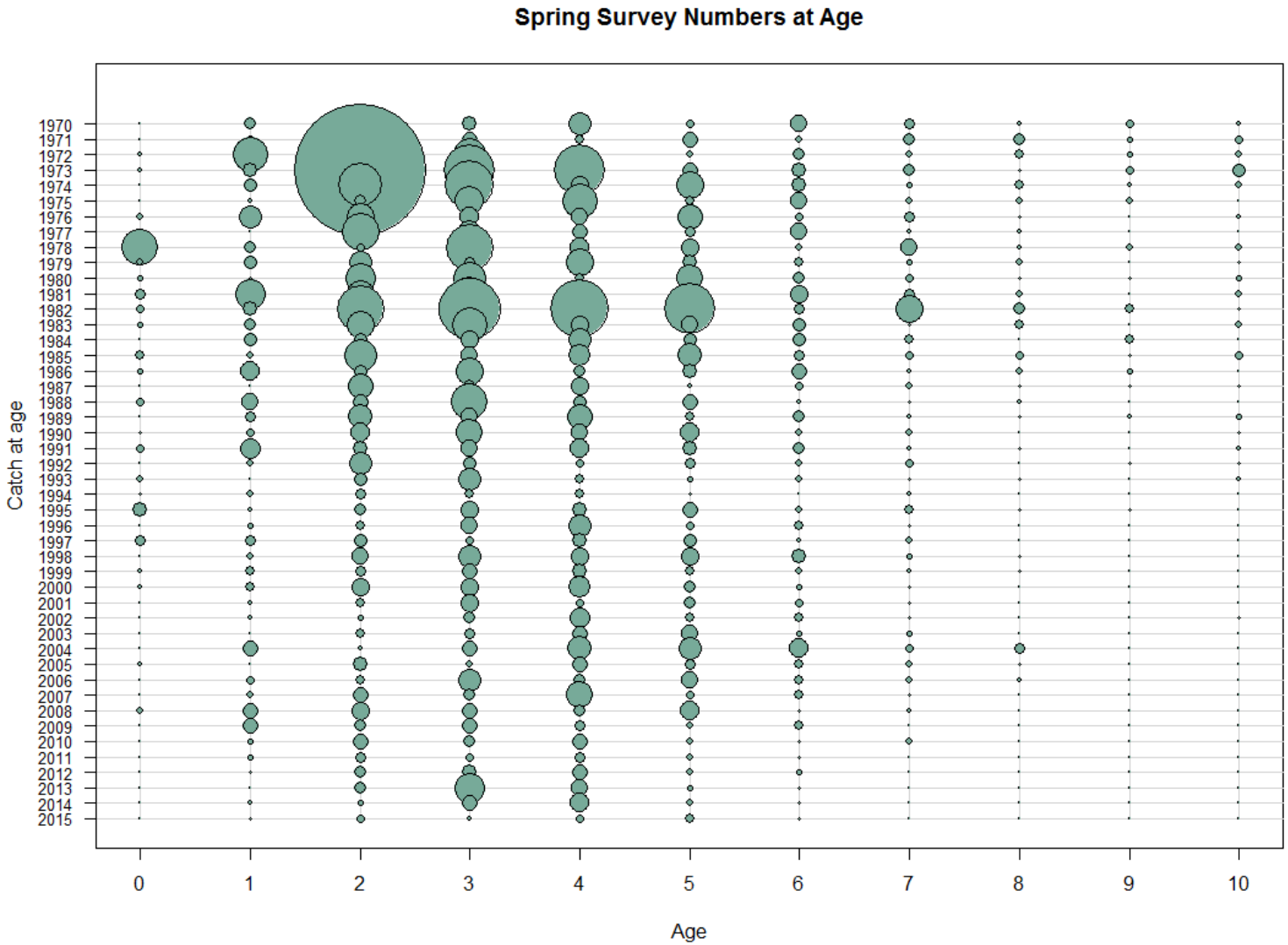
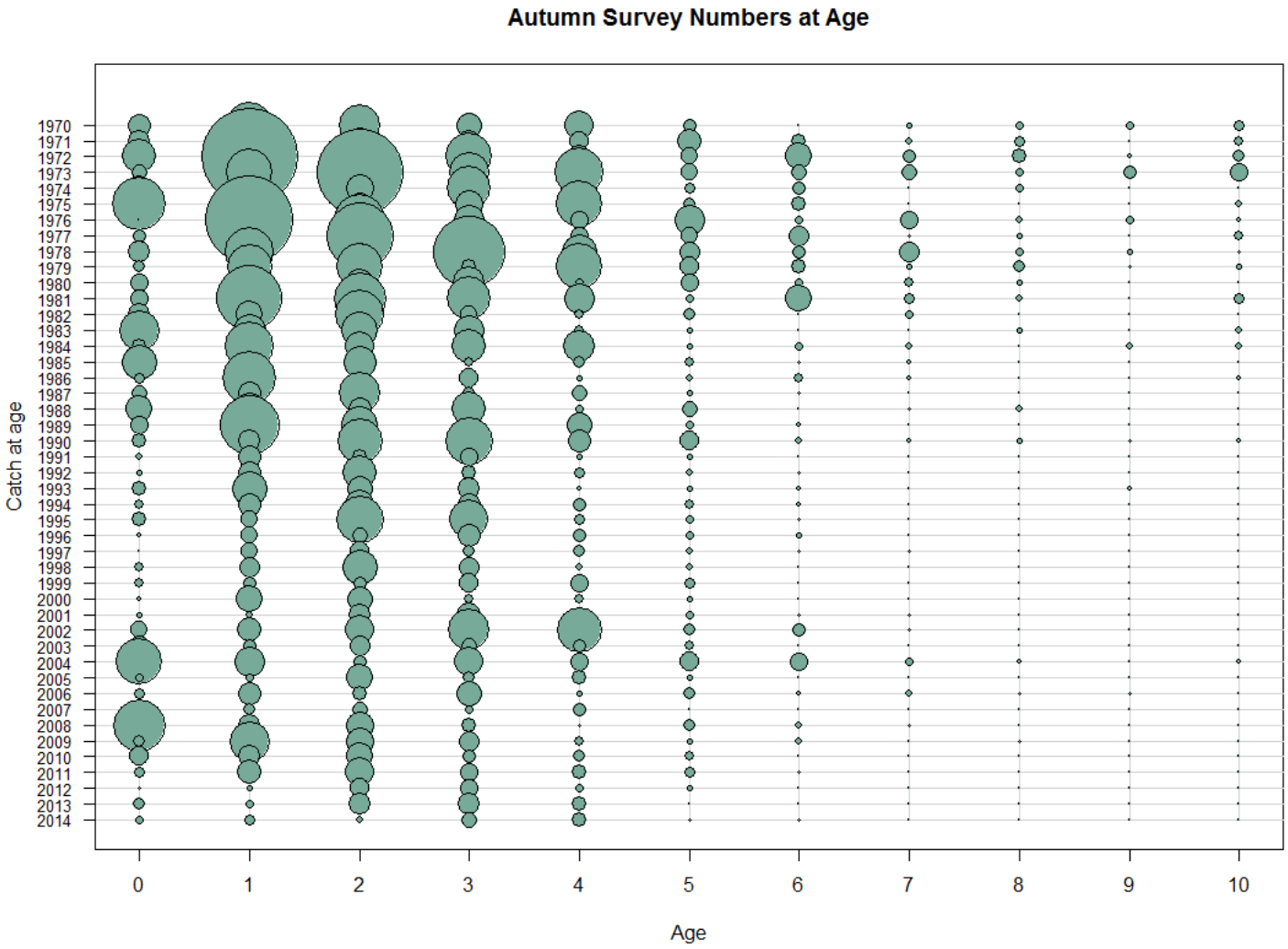


Table 11, Figure 5 - Report

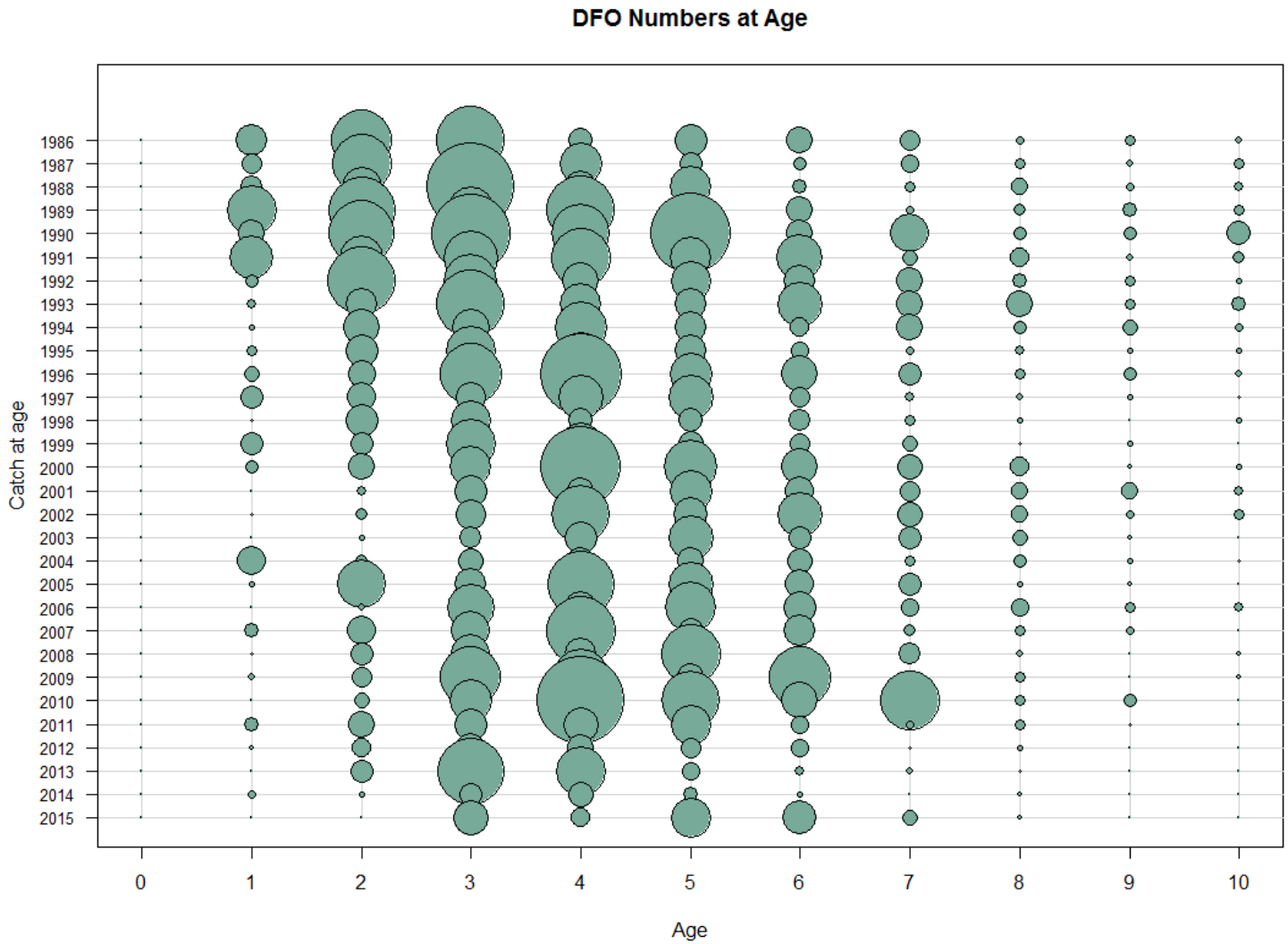
NEFSC Spring survey



NEFSC Autumn survey

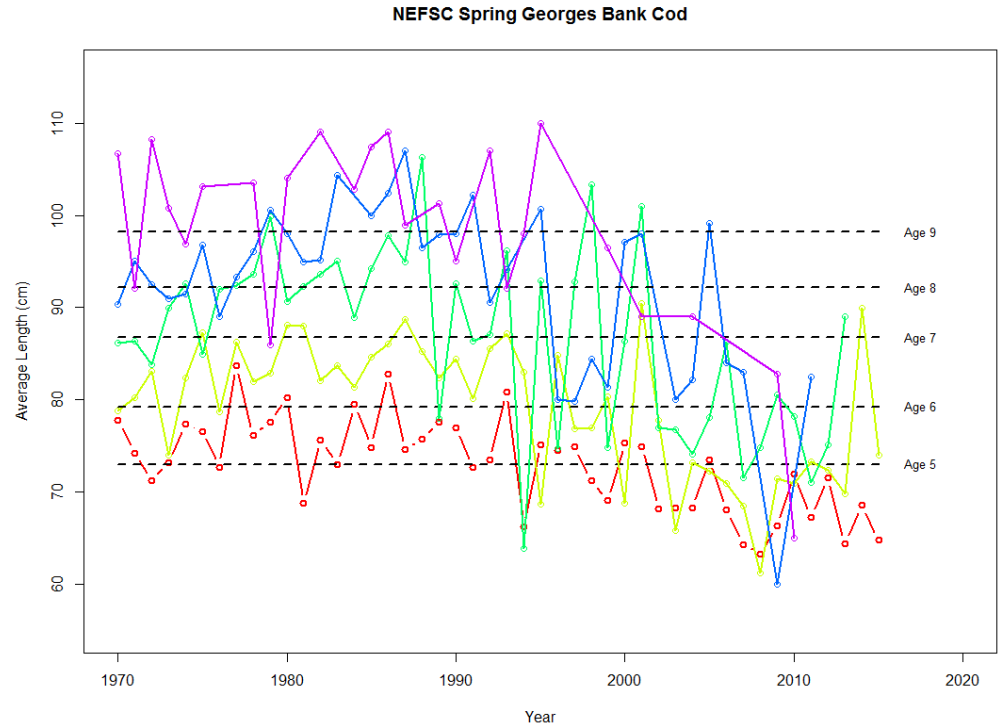


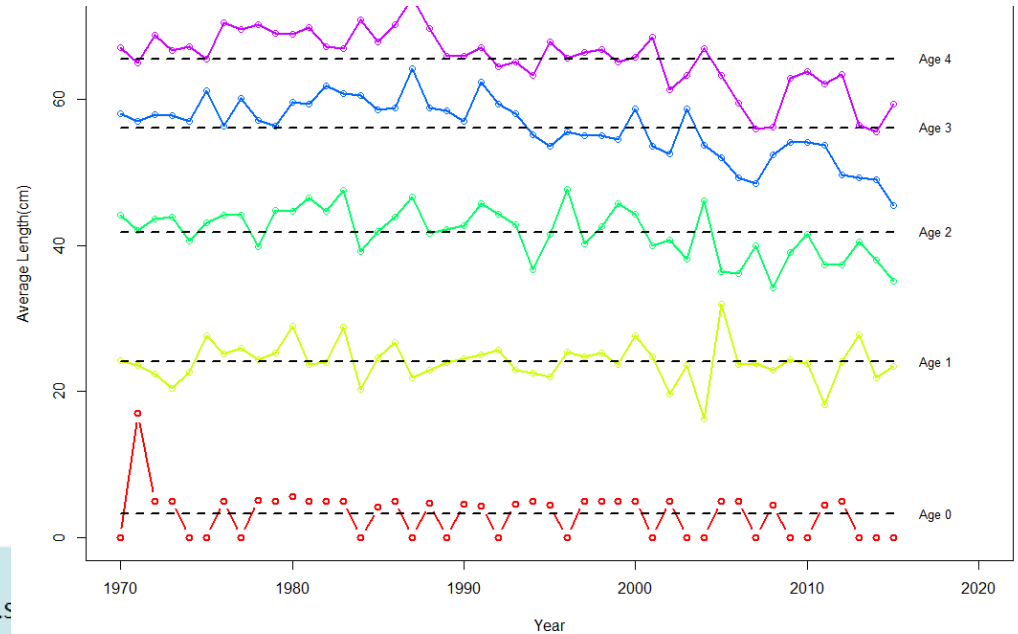
DFO Feb/Mar survey



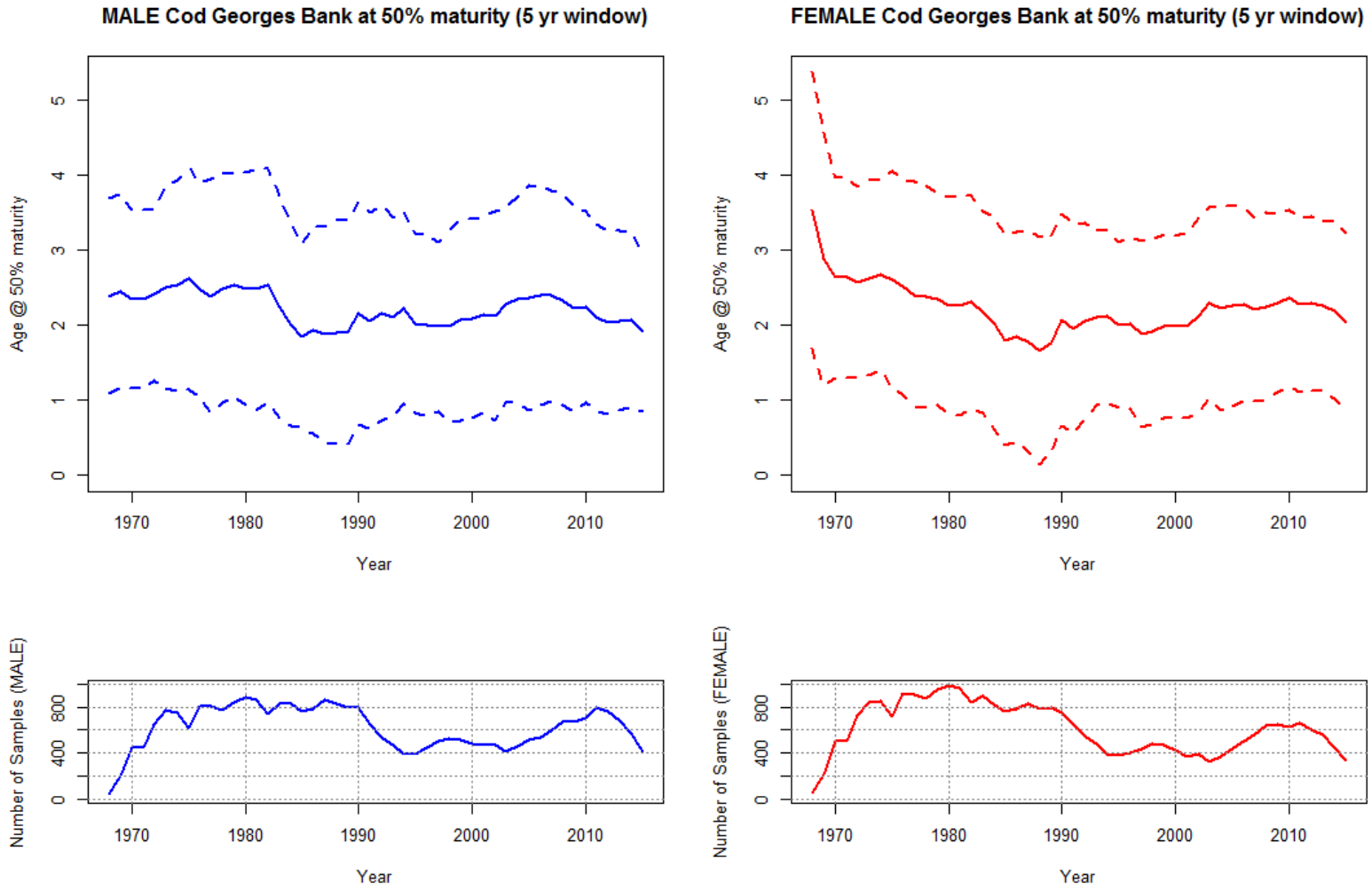
Spring survey

Mean Length at age





Median maturity at age (A50) : 5-yr moving avg (of data)



ASAP Benchmark Model

Ages 1 – 10 +
1978-2014 CAA
Delphi Mortality rate applied to USA discards only

1 Fleet ; 2 Selectivity Blocks
- 1978-1993 ; logistic selectivity (flat)
- 1994-2014 ; logistic selectivity

3 surveys
- Spring NMFS: 1978-2014 ; Ages 1-10, logistic selectivity
- Autumn NMFS: 1978-2014; Ages 1-6 , selectivity at age, fixed age 3 =1
- DFO: 1986-2014; Ages 1-10, logistic selectivity

Split NEFSC Spring Sv: Yankee #41 vs. Yankee #36: 1978-1981 ; 1982-2014

M = 0.2 all ages all years

Fitting

Multinomial distribution : fishery catch at age composition
survey times series and survey age composition

Catch CV = 0.05

Lambda Rec. Dev = 0
Recruitment CV = 0.5

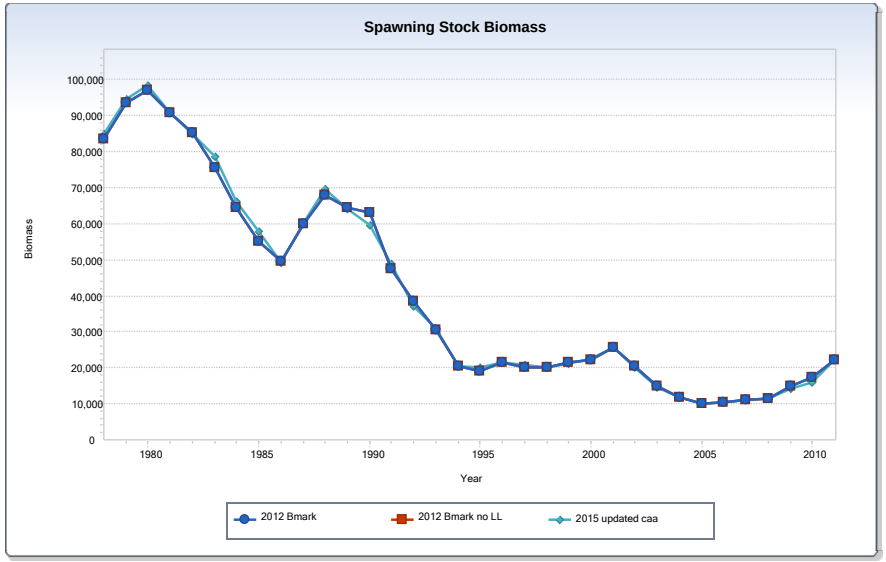
Stock/ Recruit not estimated

Survey CVs
- spring + 0.4, fall + 0.25, DFO + 0.2 added to observed CV estimates

Selectivity:
Fleet : flat-topped
Surveys: flat-topped

Changes in databases and estimation since 2012 Benchmark

have minor effect



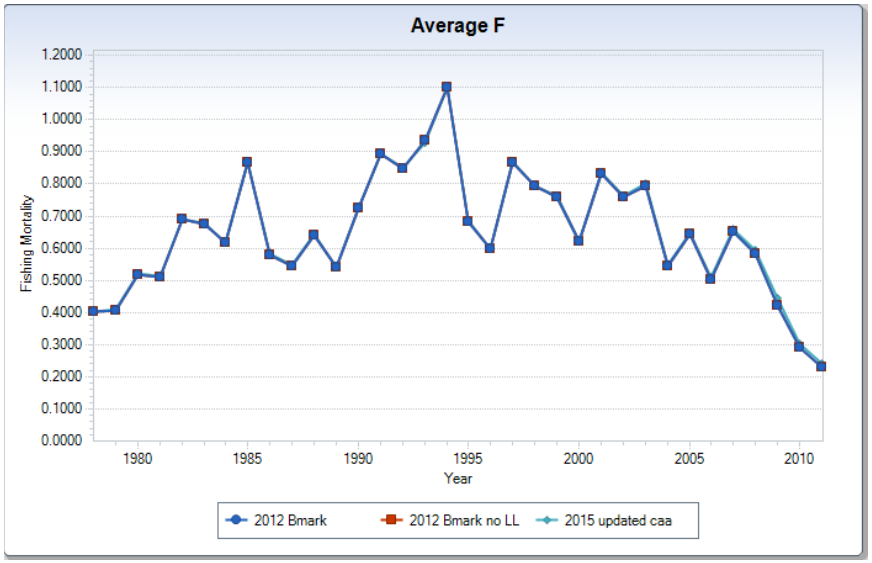
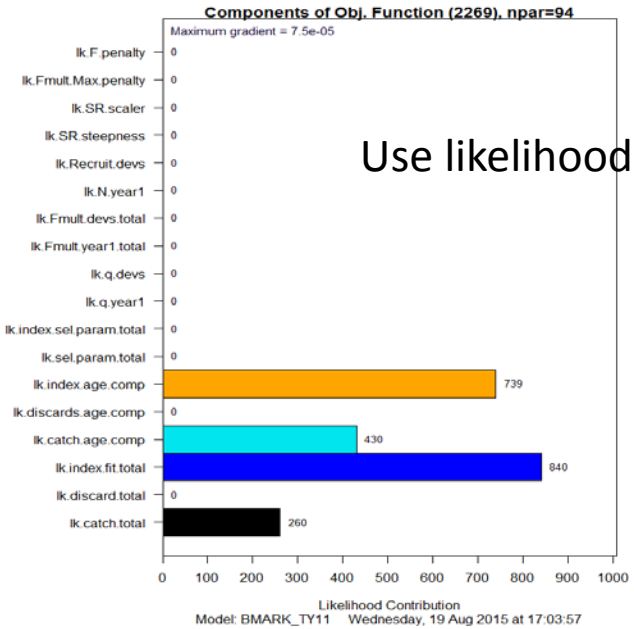


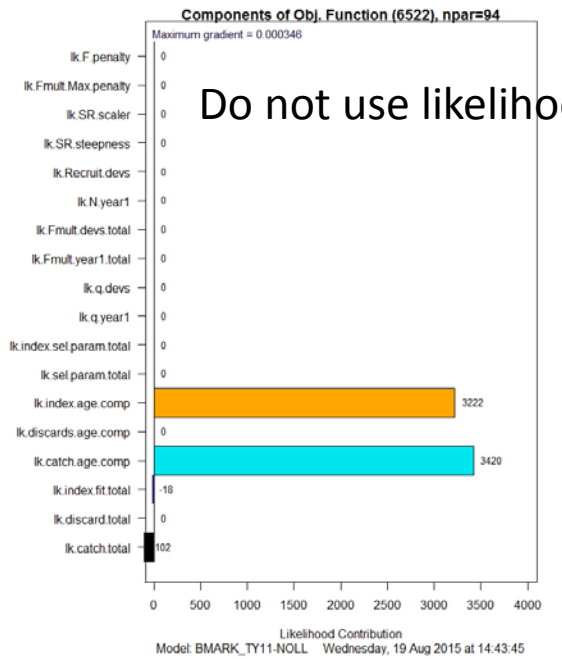
Table 15

Model Diagnostics and Results

For final run with DFO 2012 corrected



Use likelihood constants



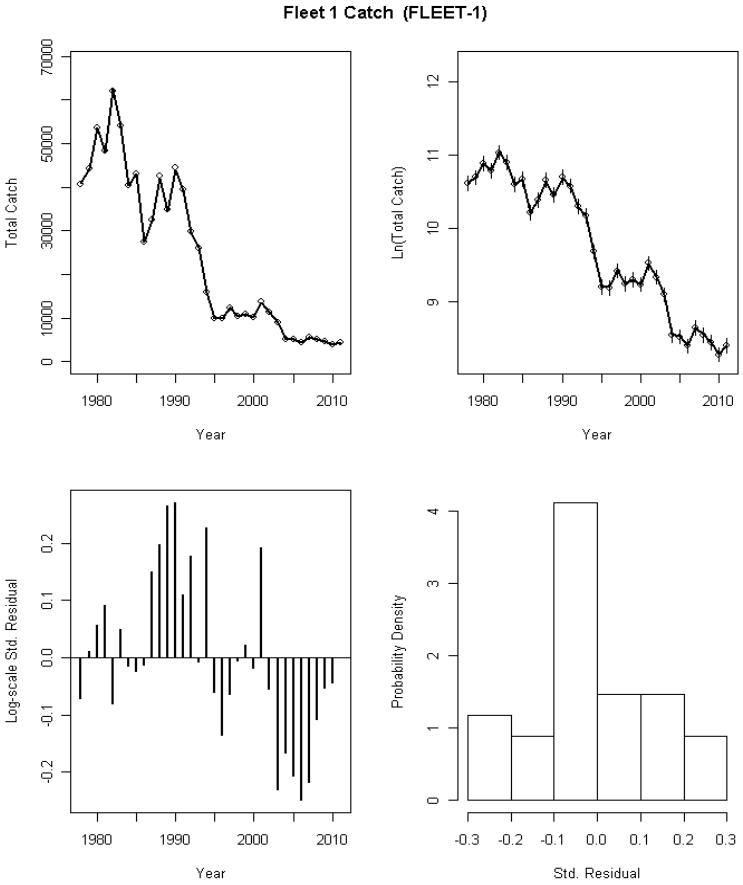
Do not use likelihood constants

Table 15

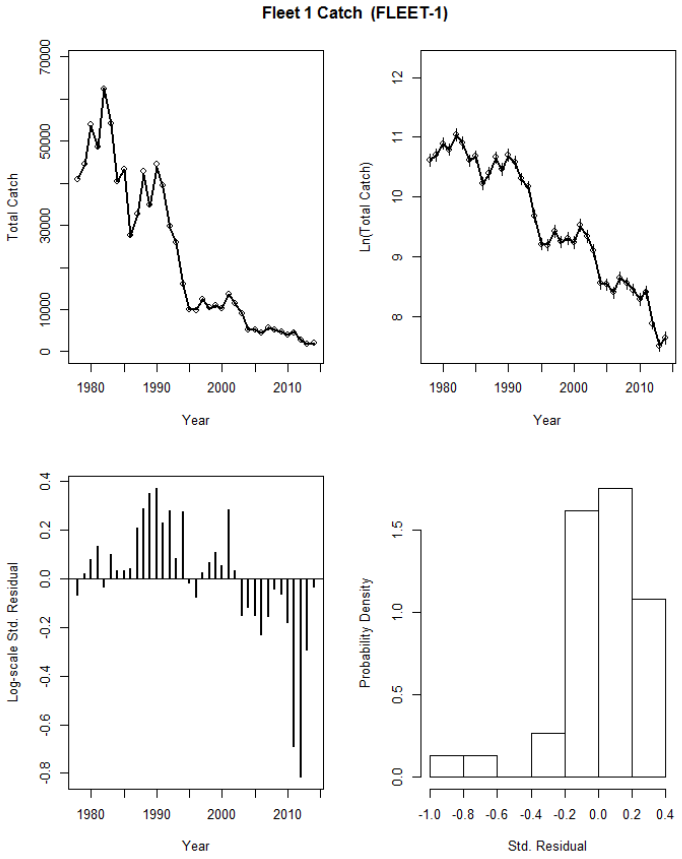
		TY=2011	TY=2011
Model		base_repeat	repeatNO LL
objective function		2269.33	6522.45
components of obj. function			
	catch total	260.398	-101.553
	index fit total	839.96	-17.64
	catch age composition	429.71	3419.89
	Index age composition	739.26	3221.74
	Recruit deviations	0	0
RMSE	Catch fleet	0.14	0.14
	total catch	0.14	0.14
	discards	0.00	0.00
	total discards	0.00	0.00
	DFO	0.92	0.92
	Autumn	1.01	1.01
	Spring 41	1.11	1.11
	Spring 36	0.92	0.92
	Index total	0.96	0.96
CV	catch	0.05	0.05
	dfo	0.2+	0.2+
	fall	0.25+	0.25+
	spring #41	0.1+	0.1+
	spring #36	0.4+	0.4+
ESS	catch	65	65
	dfo	9	9
	fall	14	14
	41	40	40
	36	37	37
Jan 1 biomass		29077	29077
SSB TY mt		22217	22217
SSB TY retro bias adj		13216	
F TY (age 5+)		0.23	0.23
F TY retro bias adj.		0.43	
TY age 1 (millions)		7.334	7.334
TY age 1 retro bias adj.		5.132	
rho F		-0.46	
rho SSB		0.68	
rho rct		0.43	

Added 9/14/2015

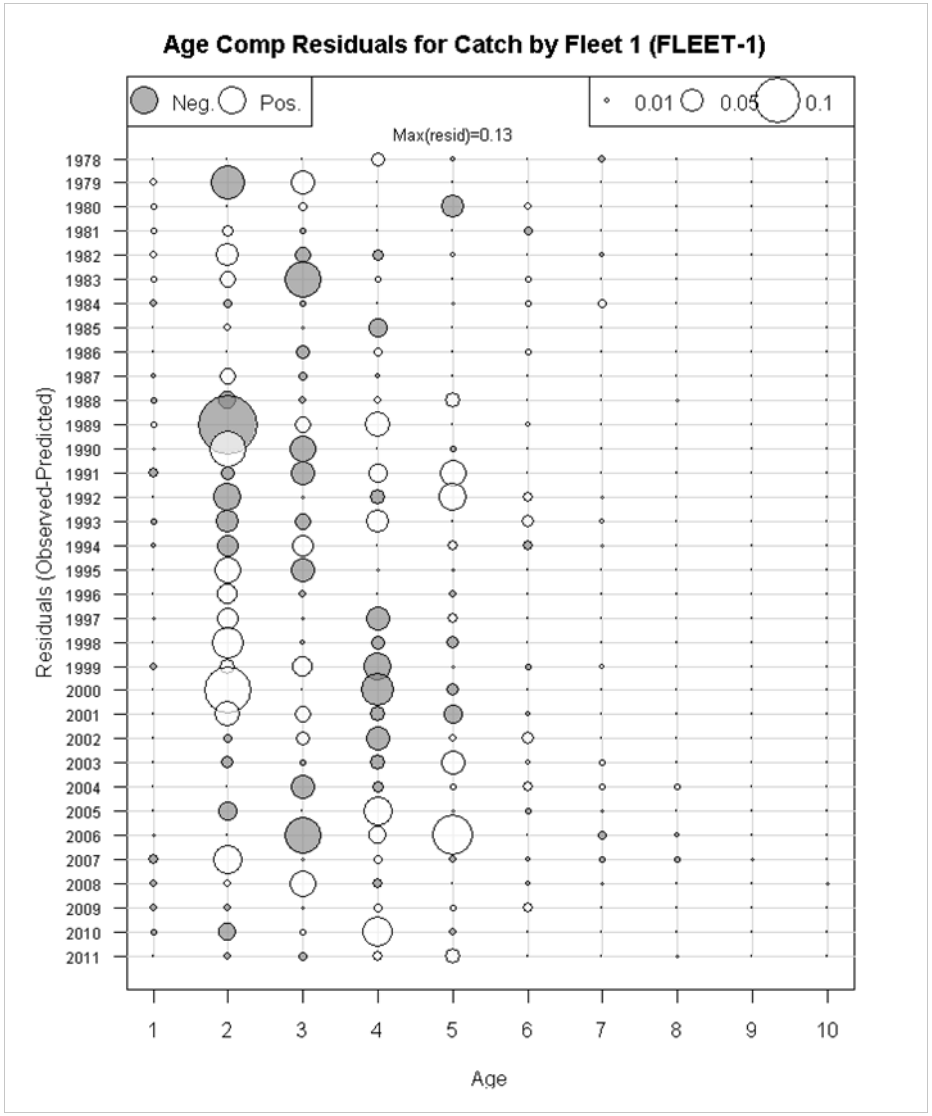
2012 ASAP



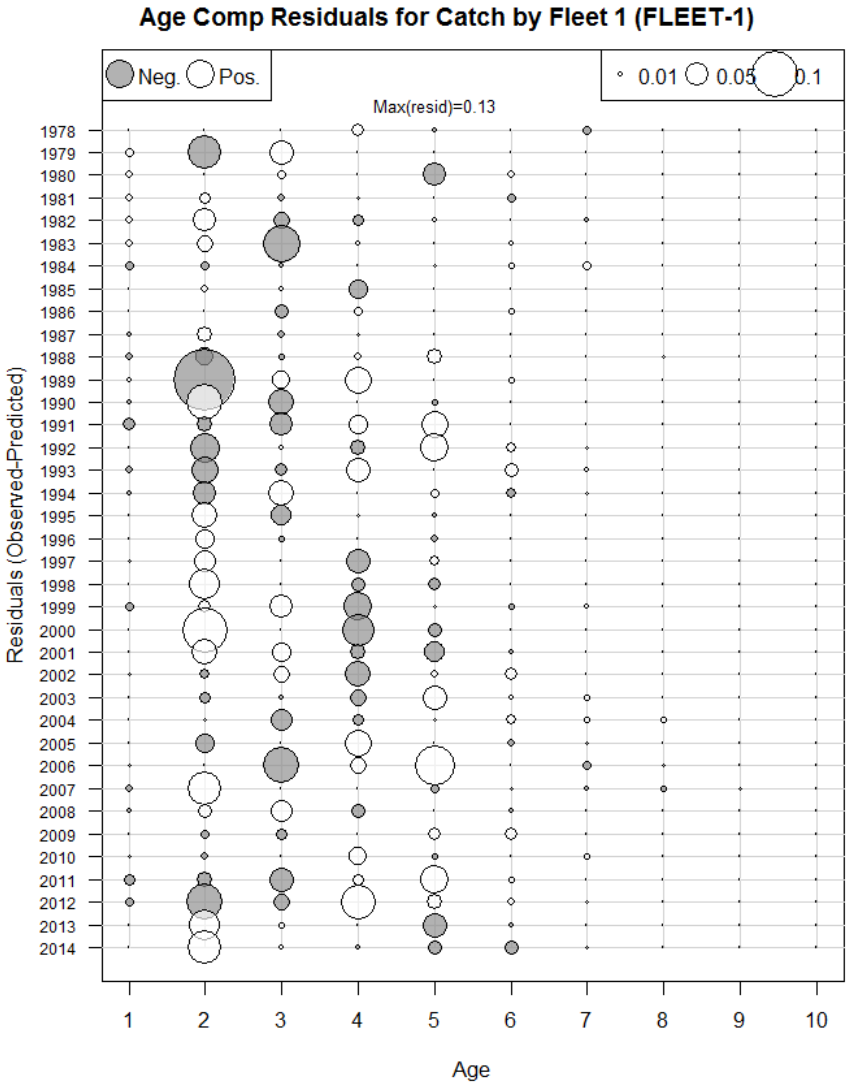
2015 ASAP



2012 ASAP



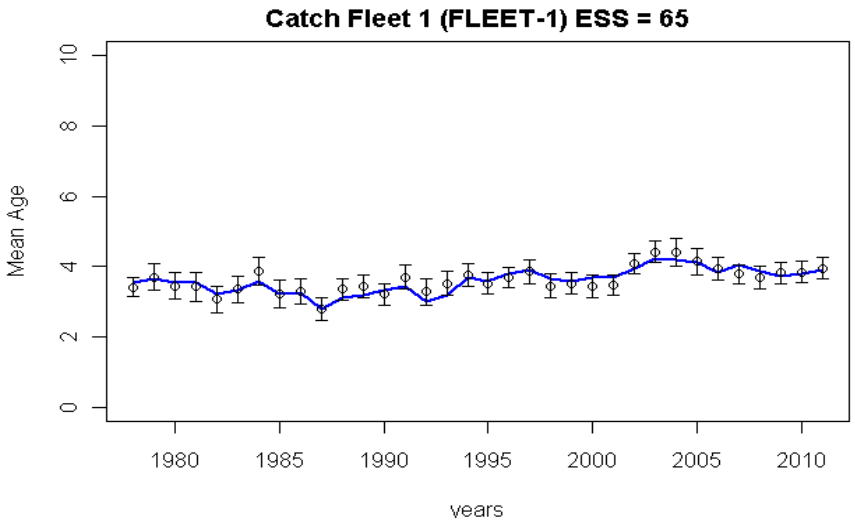
2015 ASAP

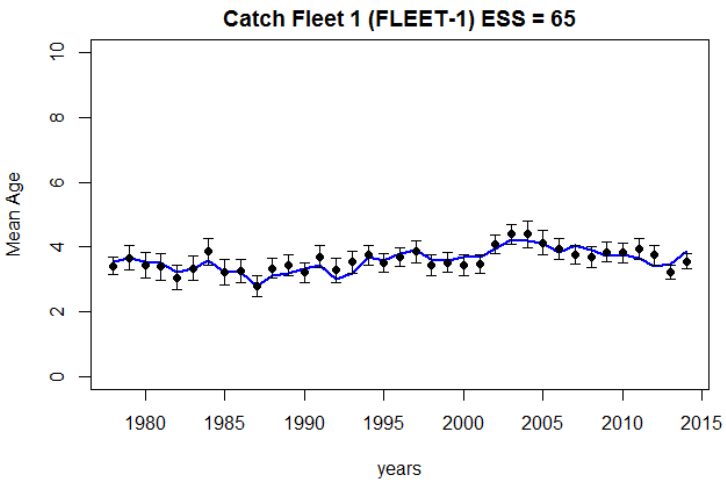


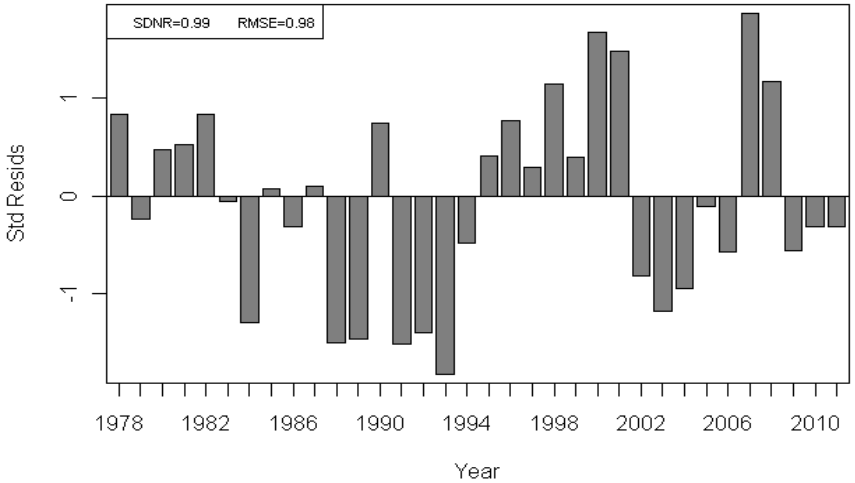
2012 ASAP

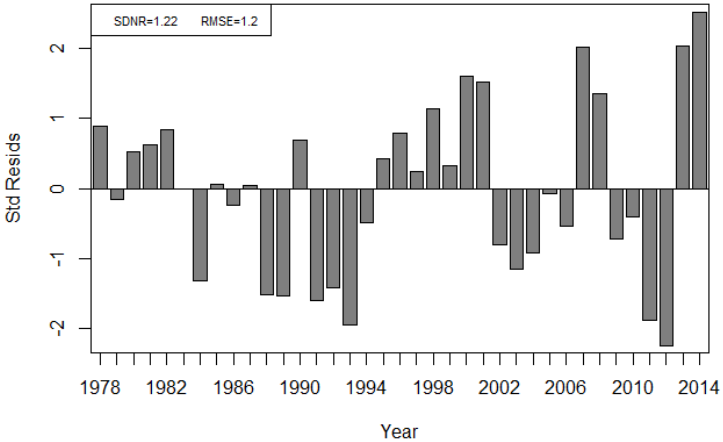
2015 ASAP

Model predicted mean age (blue line) and obs. mean



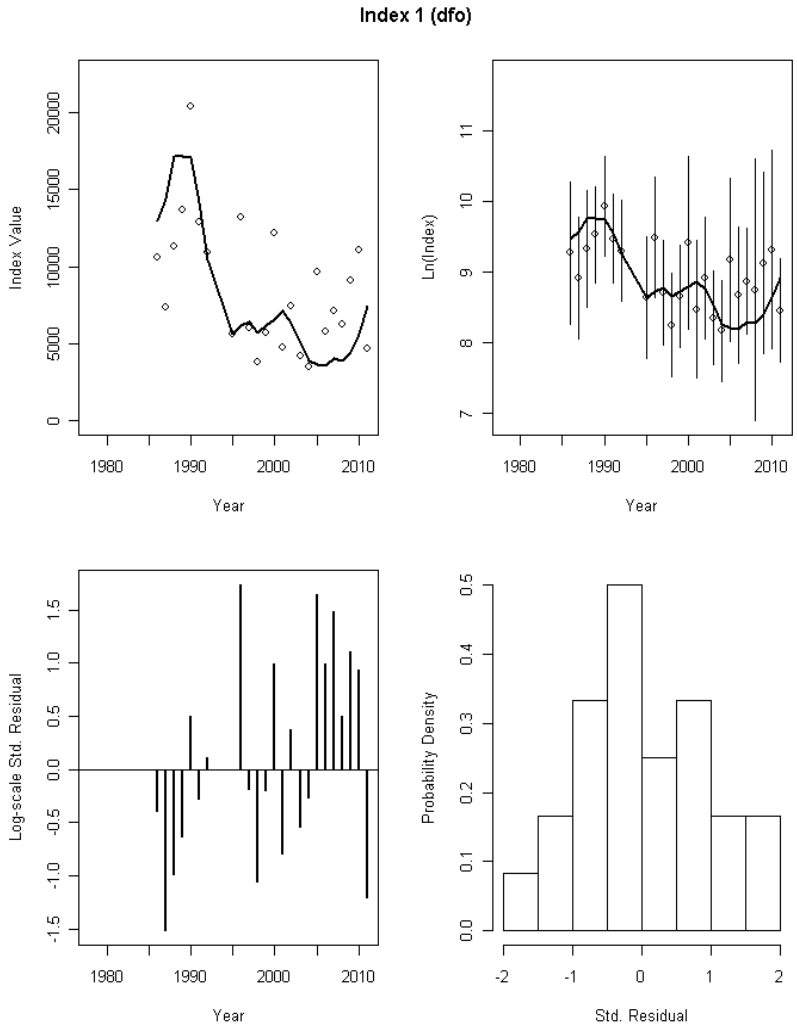




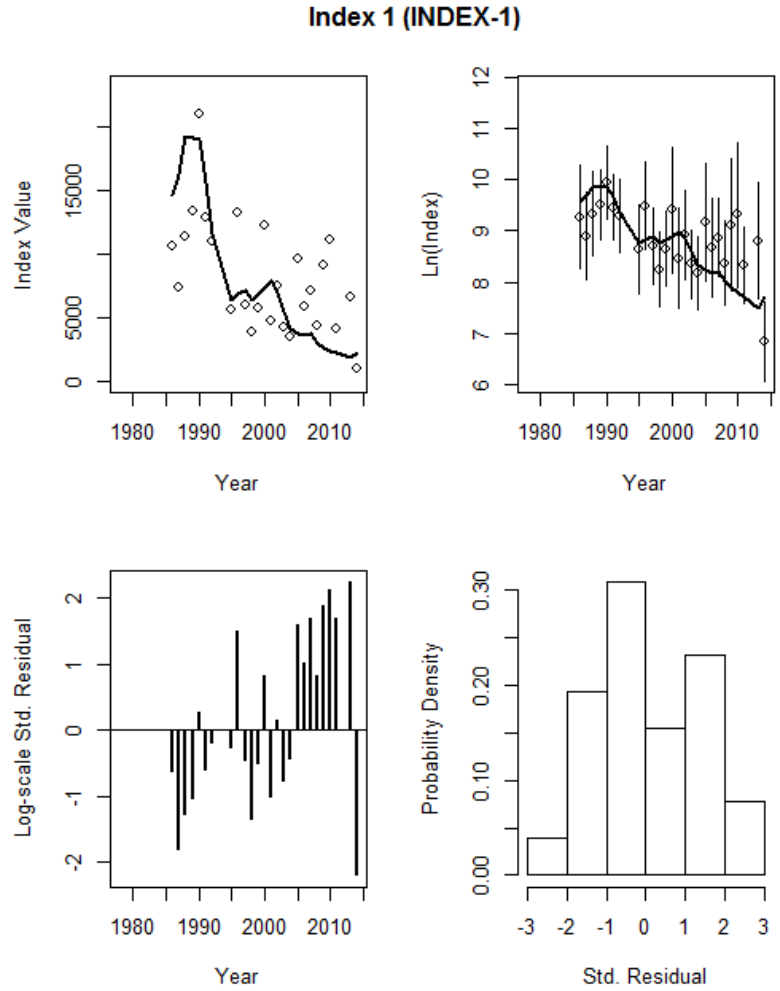


Residuals about the mean

2012 ASAP



2015 ASAP



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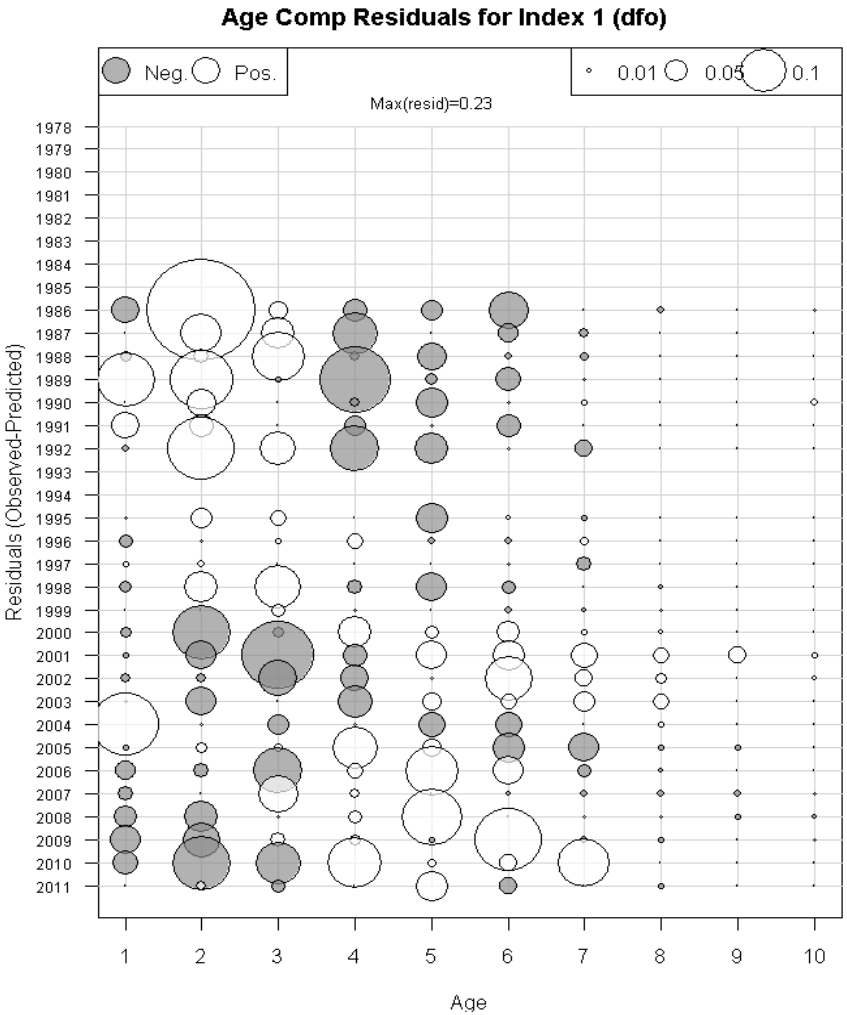

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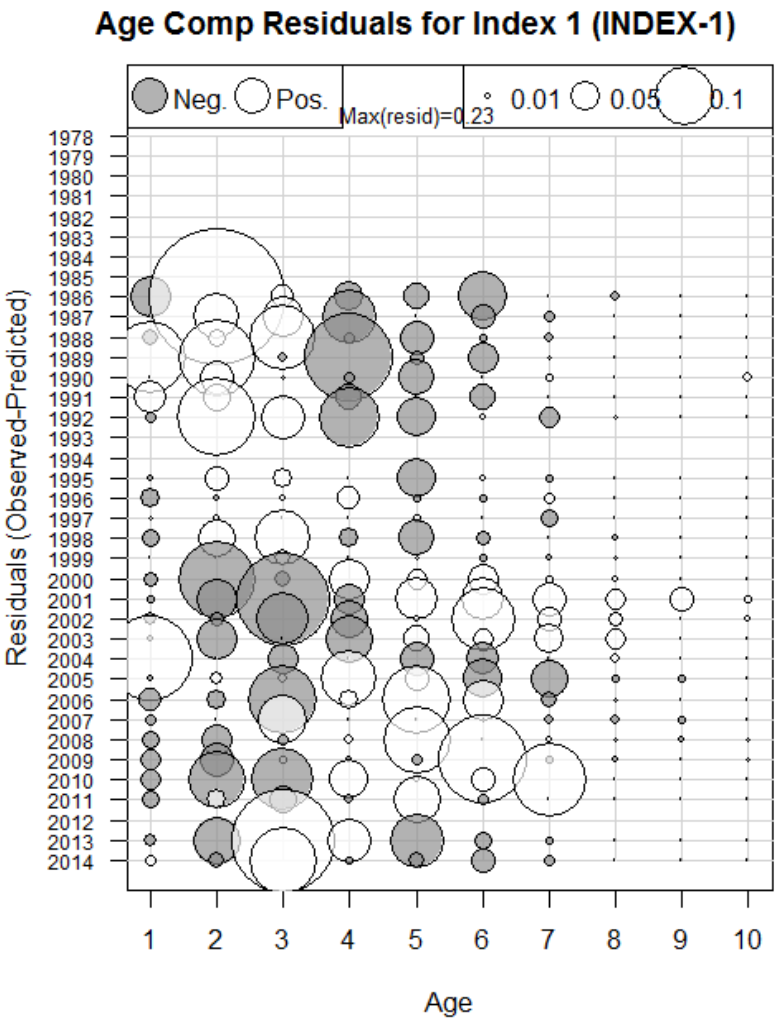

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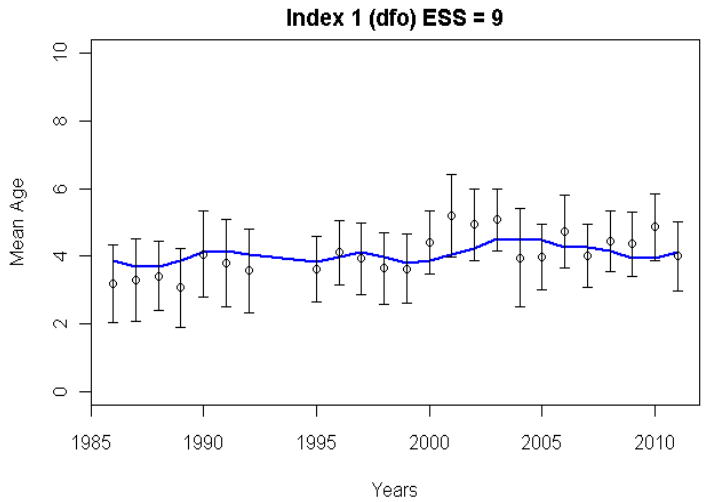

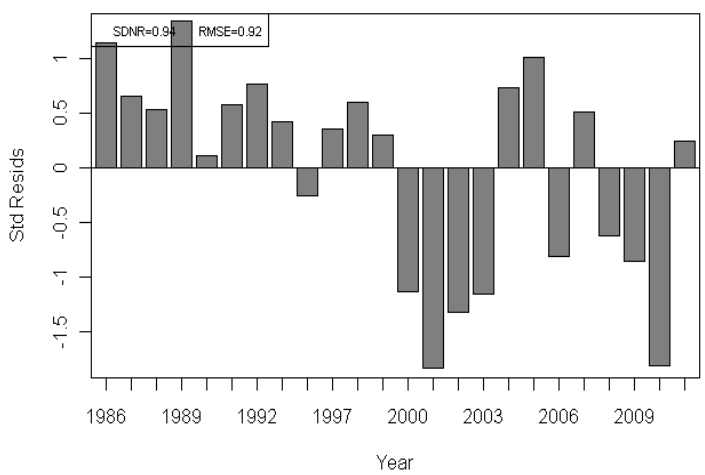

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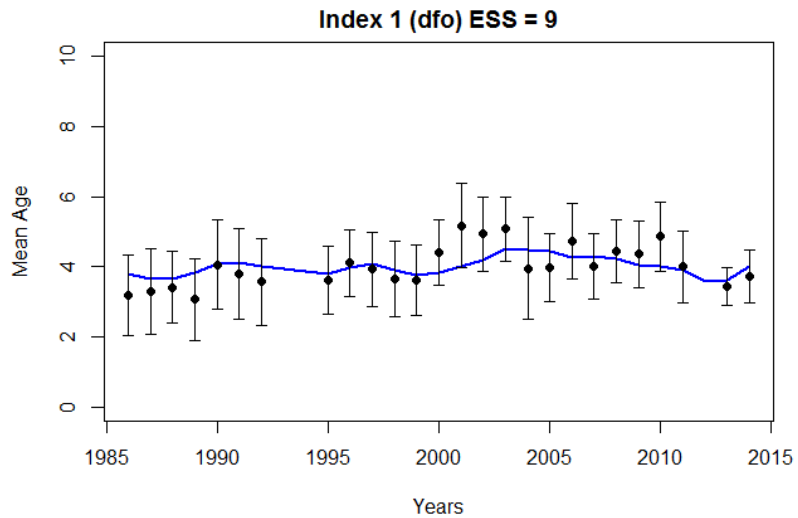
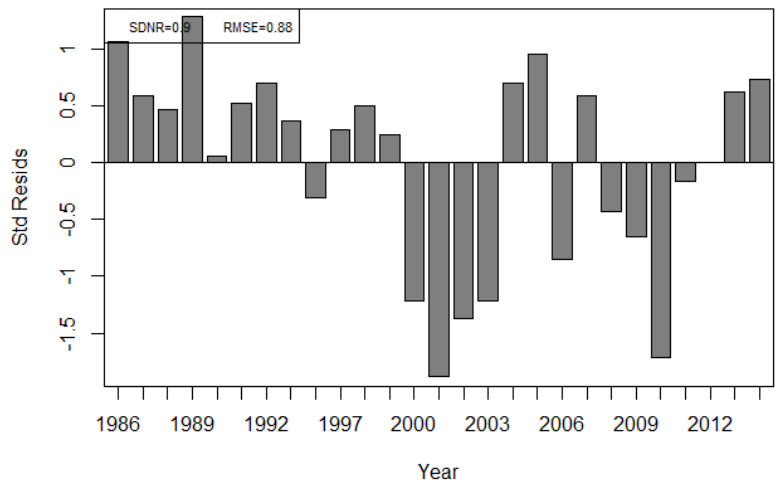
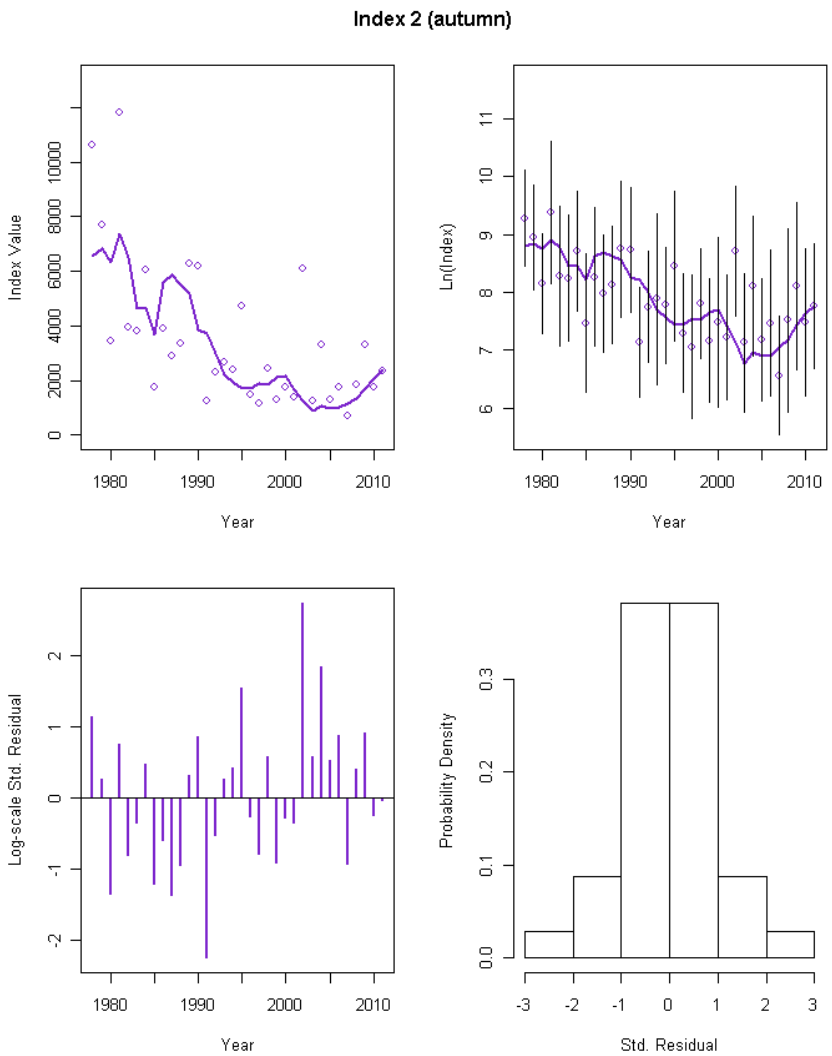
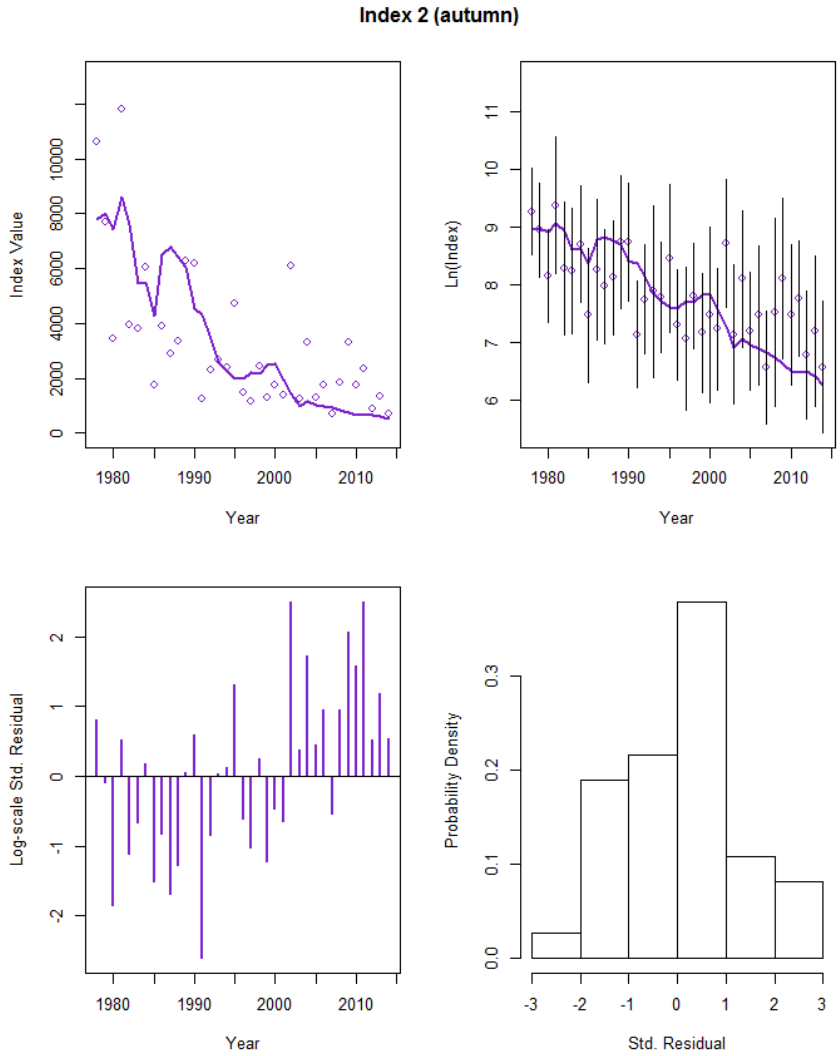




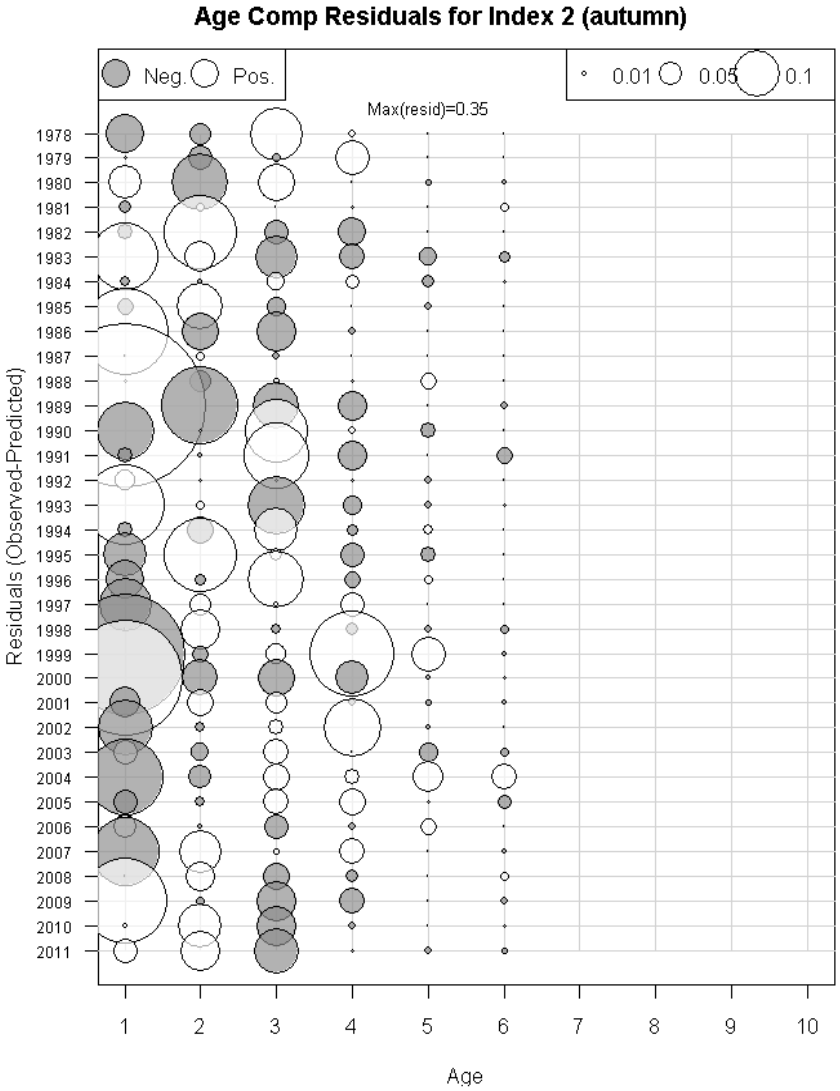
2012 ASAP



2015 ASAP



2012 ASAP



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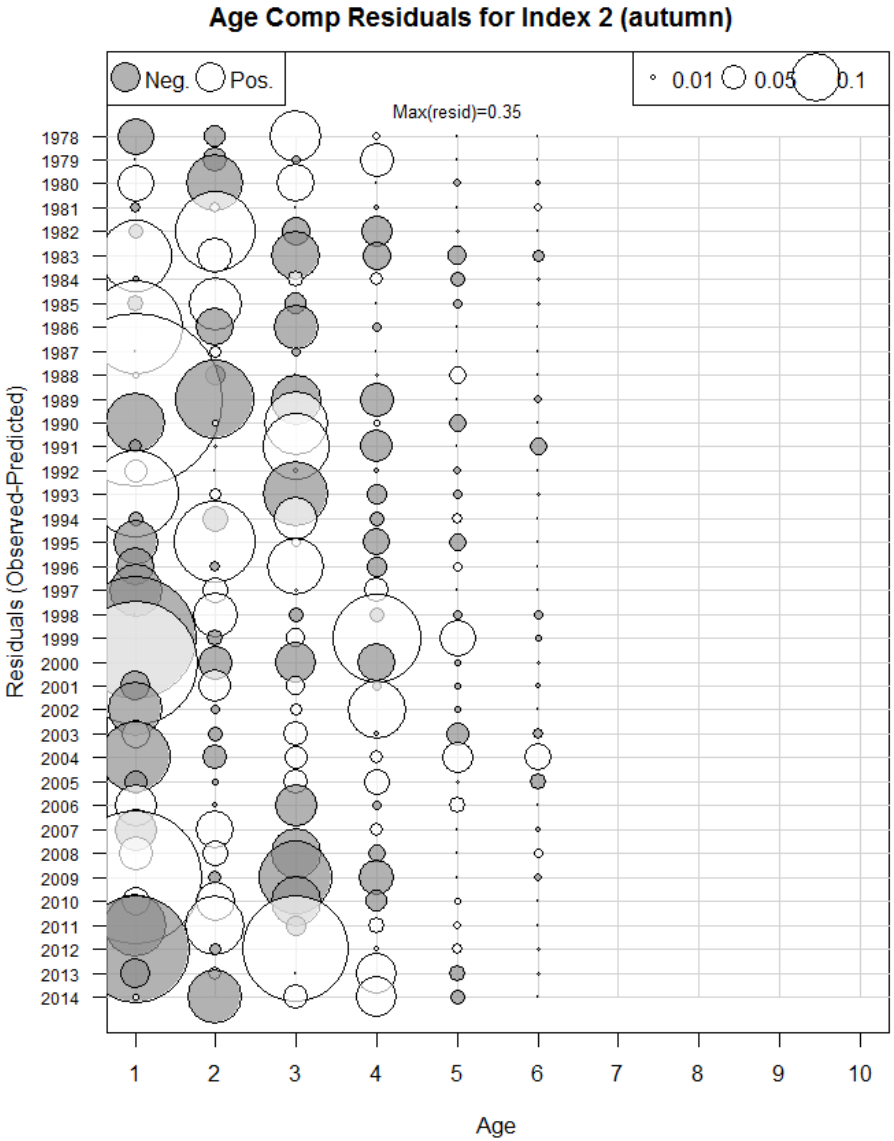

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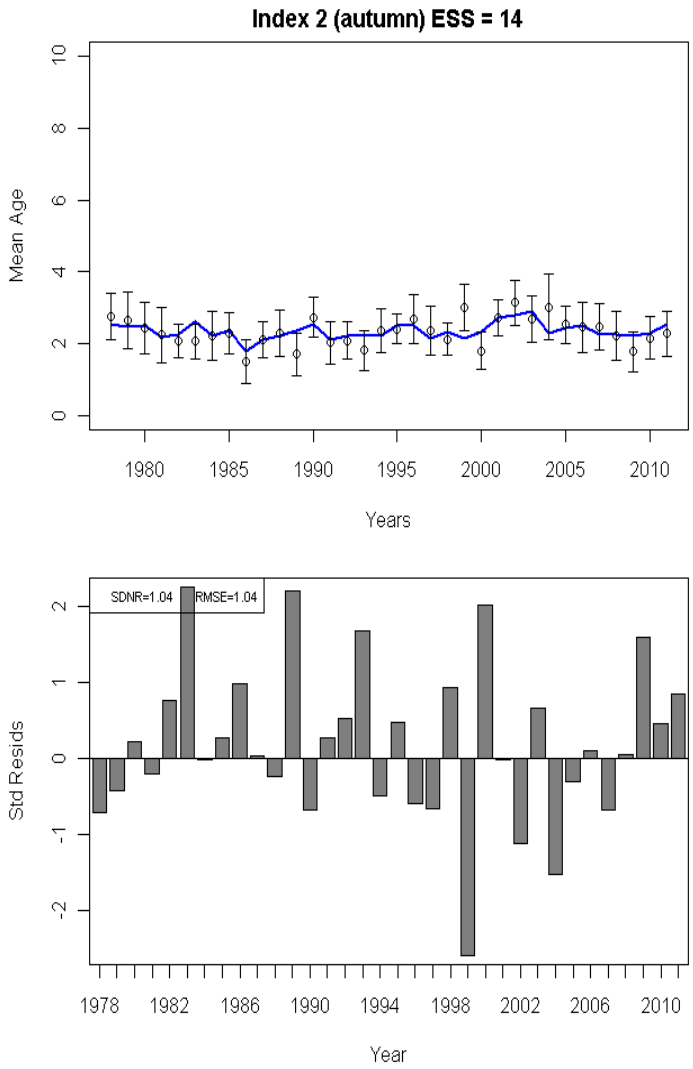

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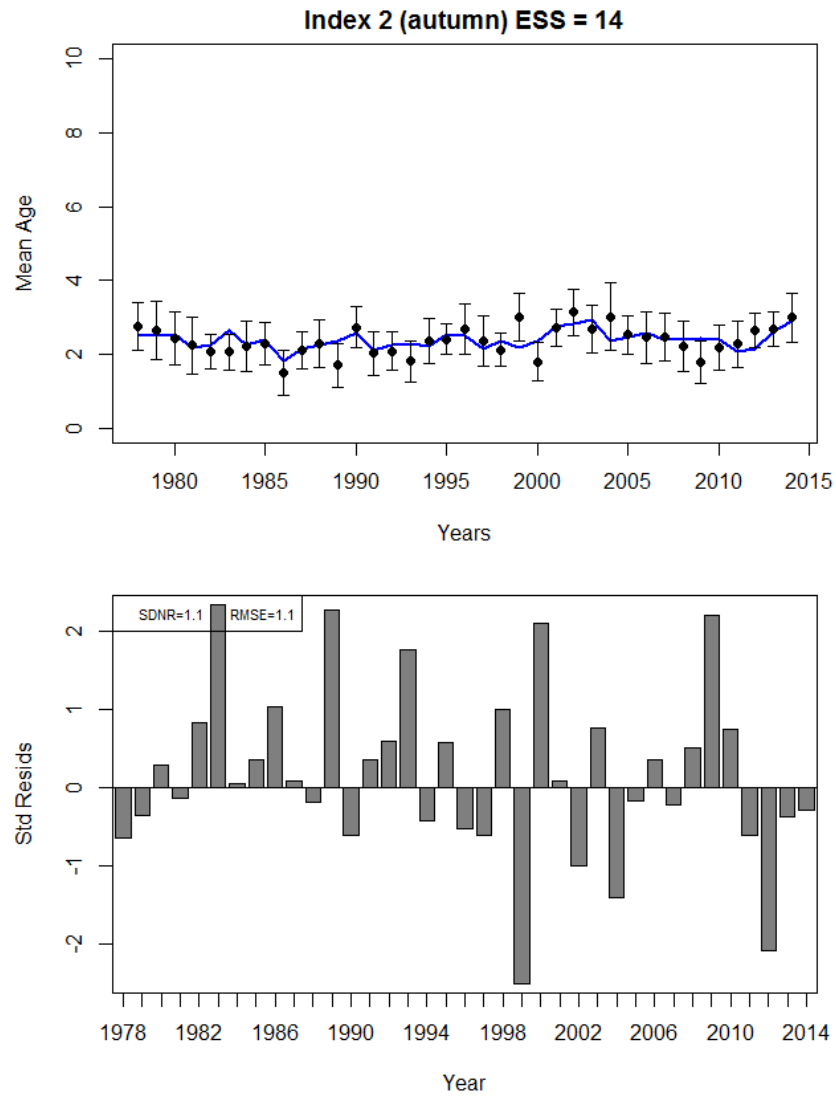

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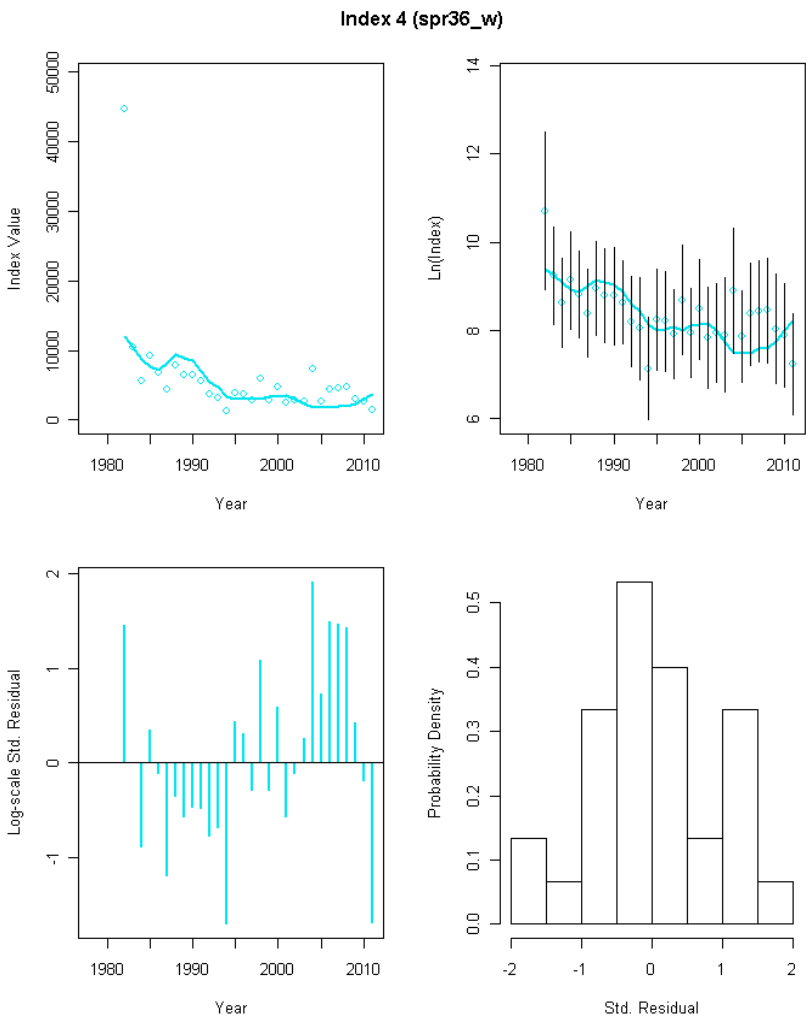
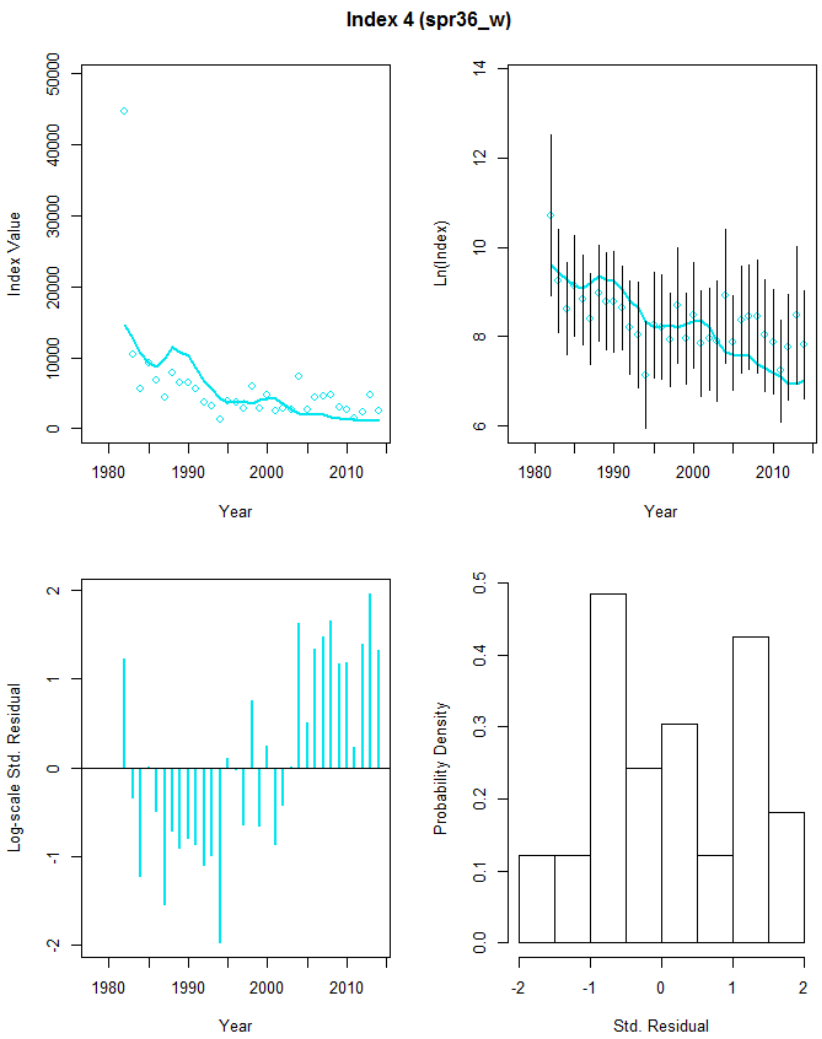
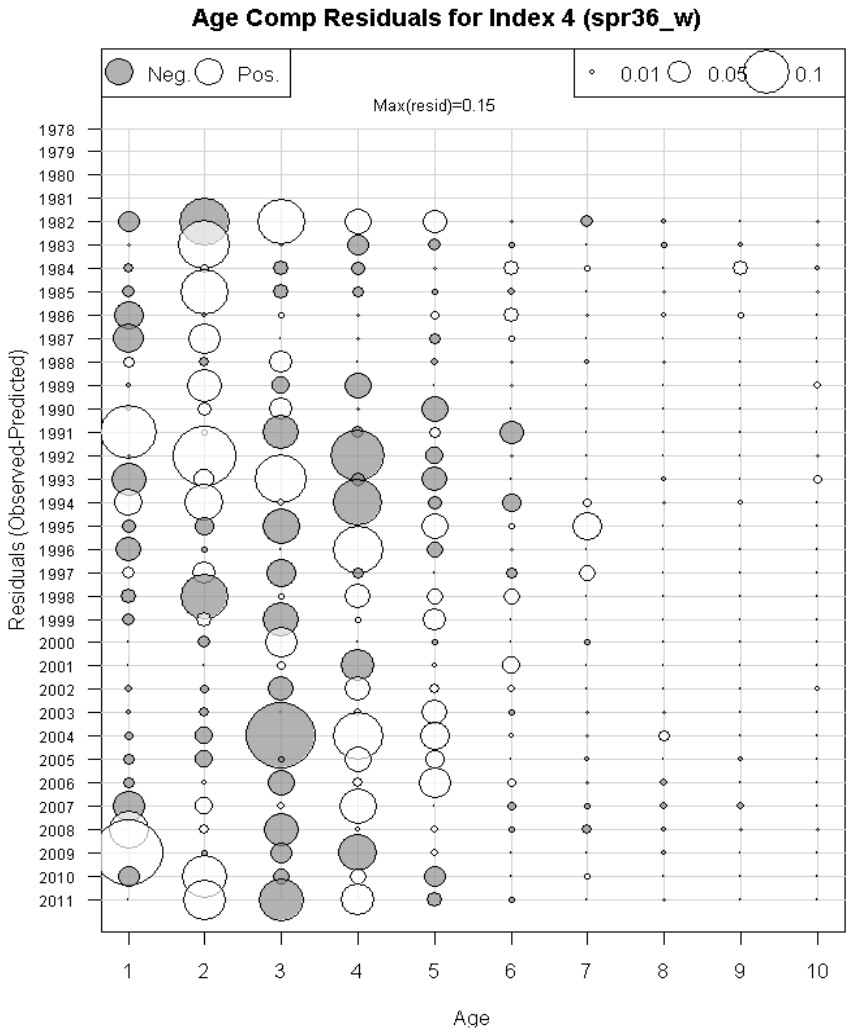


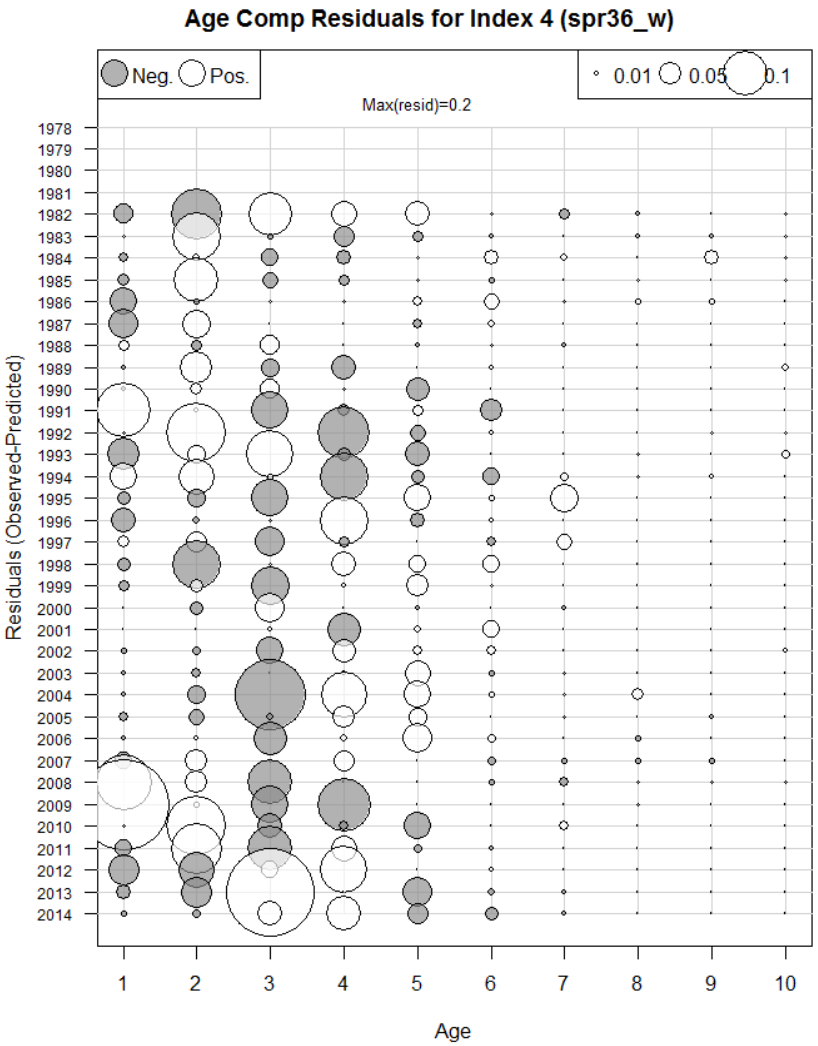
2015 ASAP



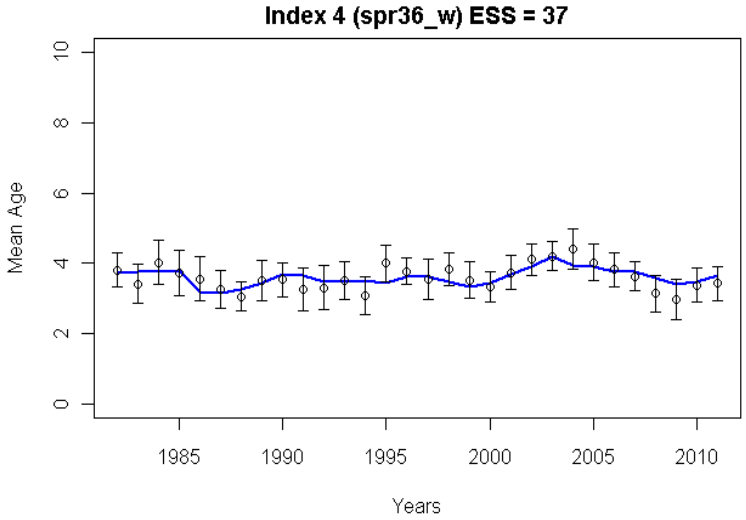
2012 ASAP

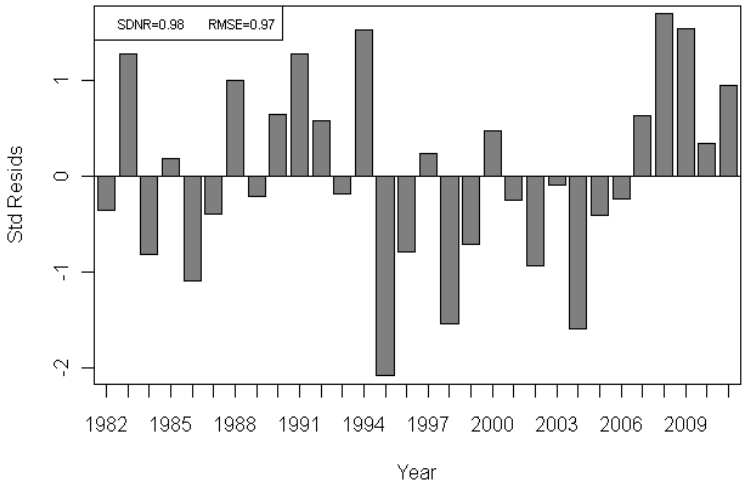


2015 ASAP

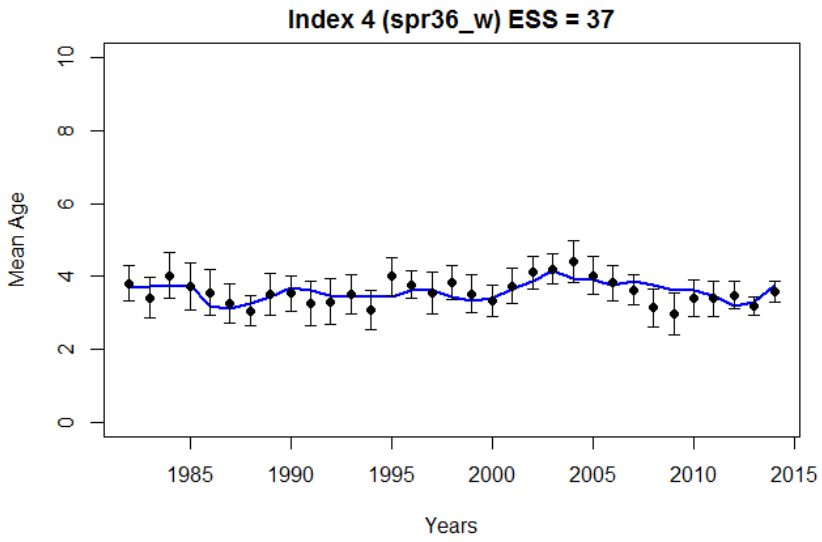


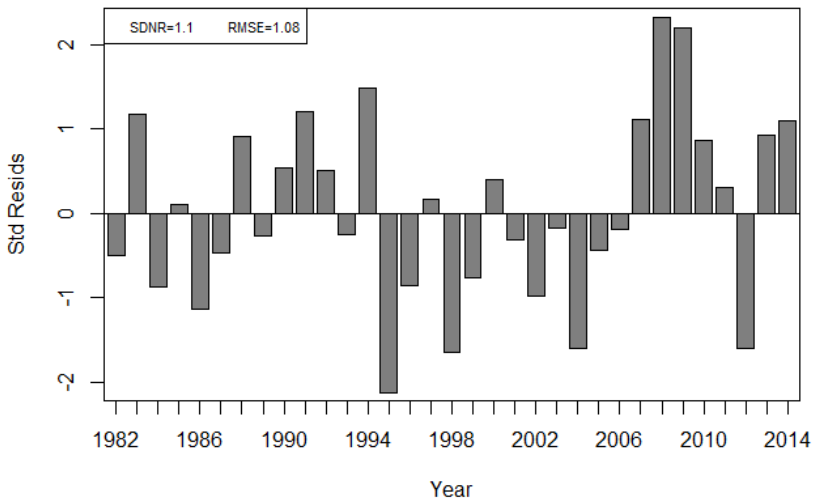
2012 ASAP



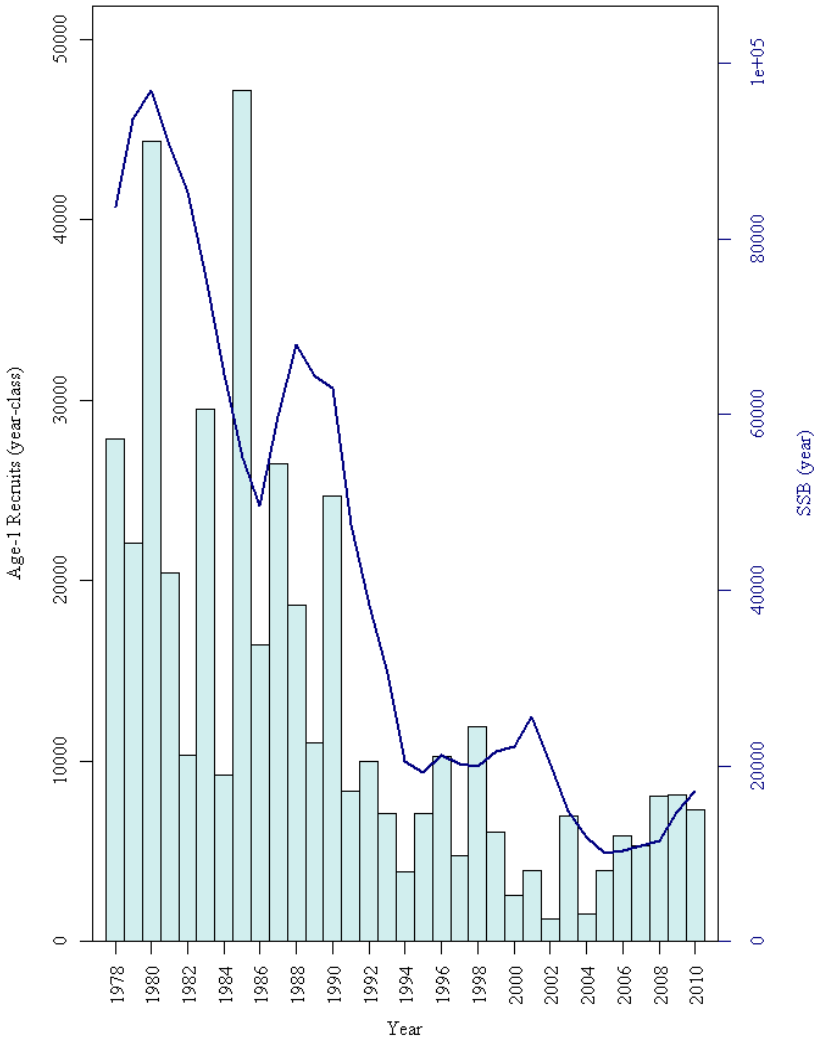


2015 ASAP

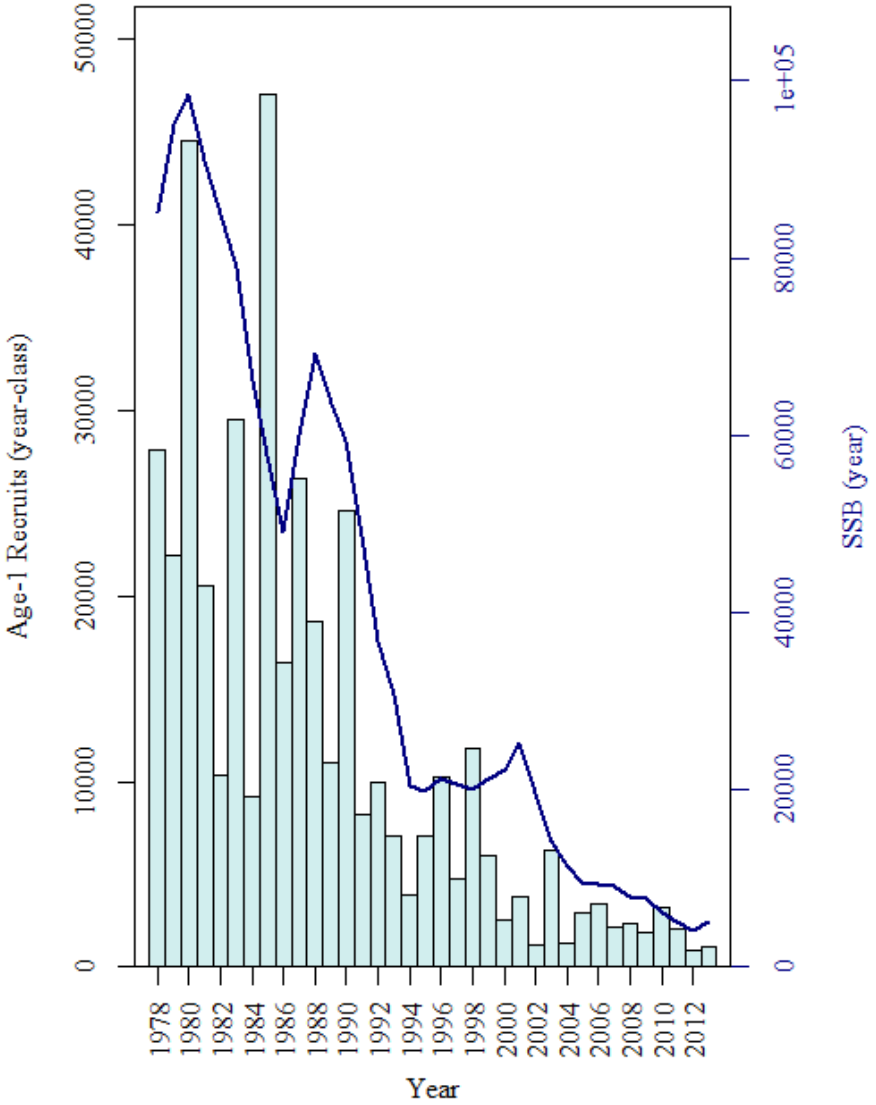




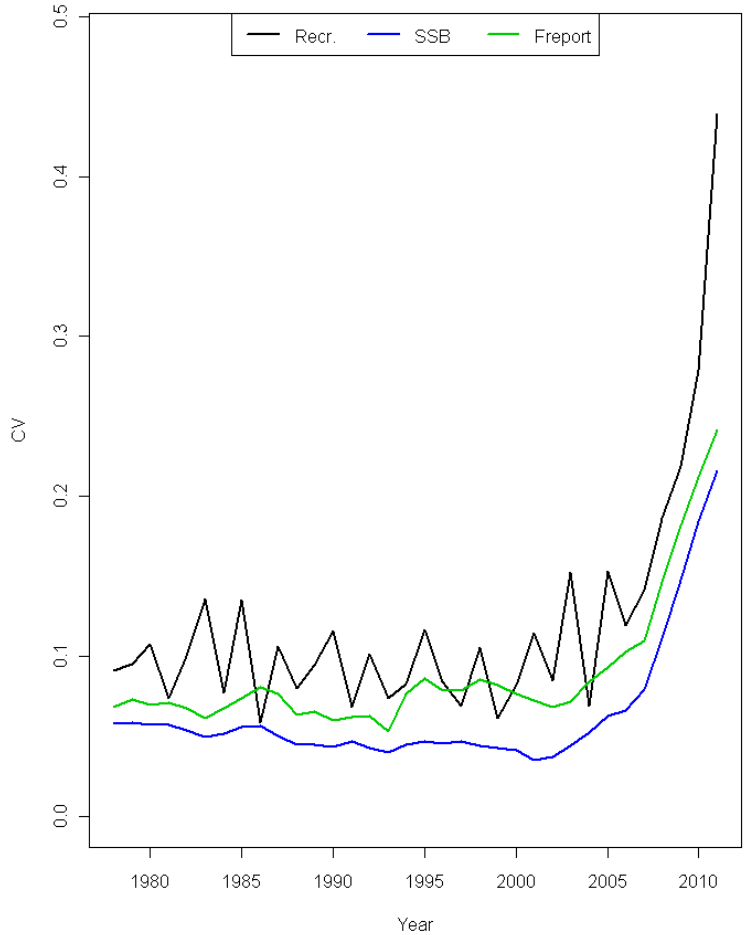
2012 ASAP



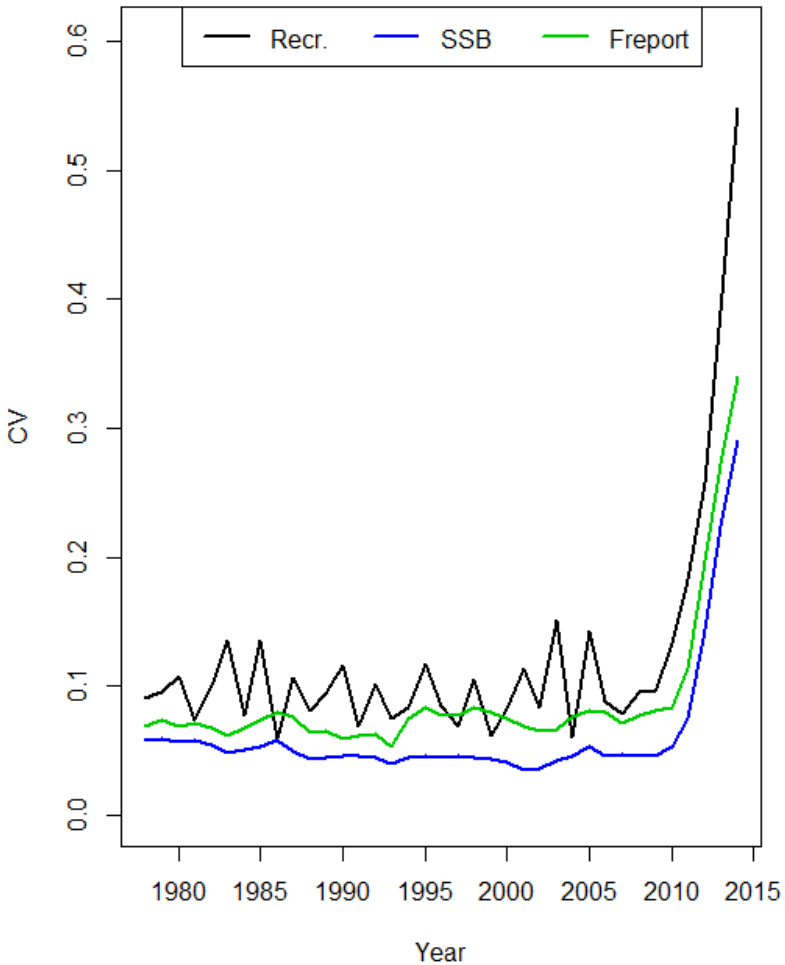
2015 ASAP



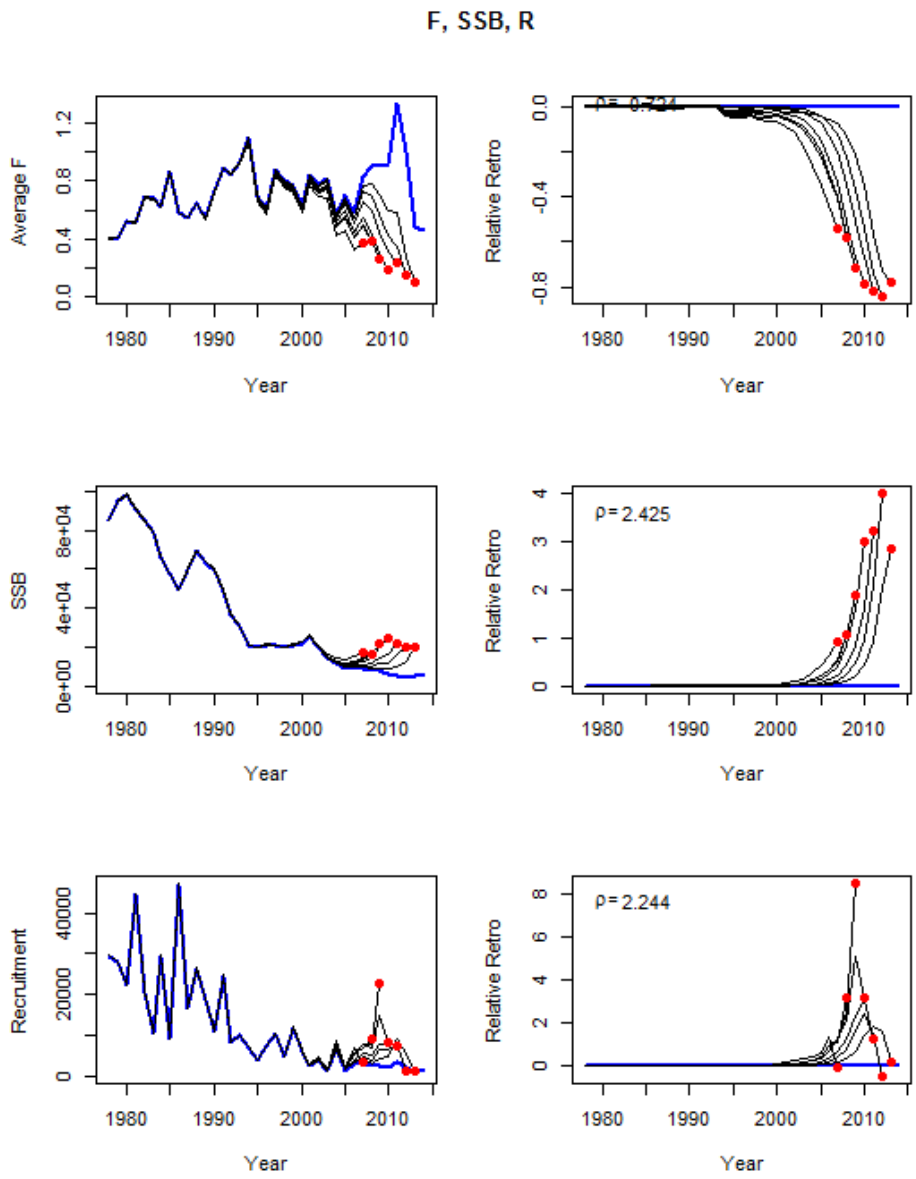
2012 ASAP



2015 ASAP



Retrospective Analysis



Removing DFO 2012
Increased retro slightly

YPR/Projection inputs

M = 0.2 ; 5-yr mean (2010-2014), maturity(2011-2015)

Age	ASAP selectivity	Stock weight	Catch weight	Spawning stock weight	Proportion mature
1	0.01	0.285	0.489	0.285	0.02
2	0.11	0.849	1.390	0.849	0.32
3	0.50	1.679	2.180	1.679	0.90
4	0.89	2.446	2.748	2.446	0.99
5	0.98	3.257	3.660	3.257	1.00
6	1.00	4.151	4.535	4.151	1.00
7	1.00	4.777	5.116	4.777	1.00
8	1.00	5.809	6.276	5.809	1.00
9	1.00	7.519	9.005	7.519	1.00
10	1.00	13.045	13.045	13.045	1.00

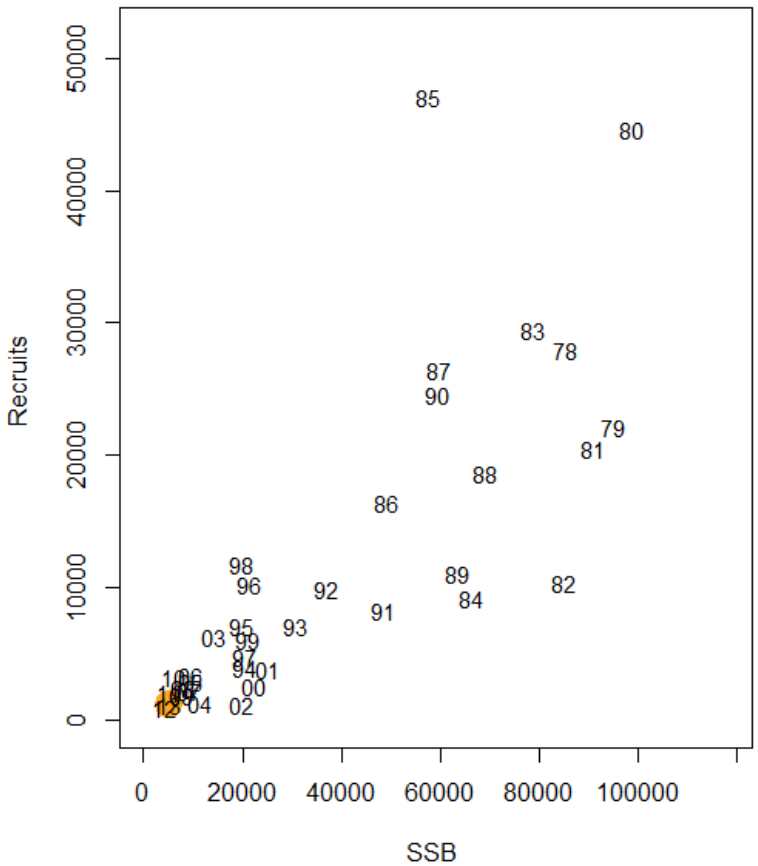
Base ASAP: Biological Reference Points (M=0.2)

Long term projection at F40% to derive MSY BRPs

2-stage empirical CDF of recruitment; 50,000 mt SSB cut point

1st stage – low recruitment: 5.399 million

2nd stage –high recruitment: 24.337 million



Biological Reference Points (M=0.2)

YPR and
MSY BRPs from long-term projection at F40%

Model	F40%	Y/R	SSB / R	Recruitment	SSBmsy	MSY
YPR	0.169	1.28	8.45	12,573	106,285	16,138
100 yr Projection				12,083	201,152	30,569

Since 2012:
Decrease in F40% , increase in SSBmsy

Short term projections

Two stage Empirical model

Year	5%	SSB	95%
2015	539	1,522	3,192
2016	152	932	2,508
2017	787	2,134	6,250
2018	3,054	7,001	24,931
	5%	**F**	**95%**
2015	0.00	1.51	5.00
2016	0.169	0.169	0.169
2017	0.169	0.169	0.169
2018	0.169	0.169	0.169
	5%	**Catch**	**95%**
2015	1	1,784	1,784
2016	19	135	377
2017	87	263	679
2018	351	799	2,794

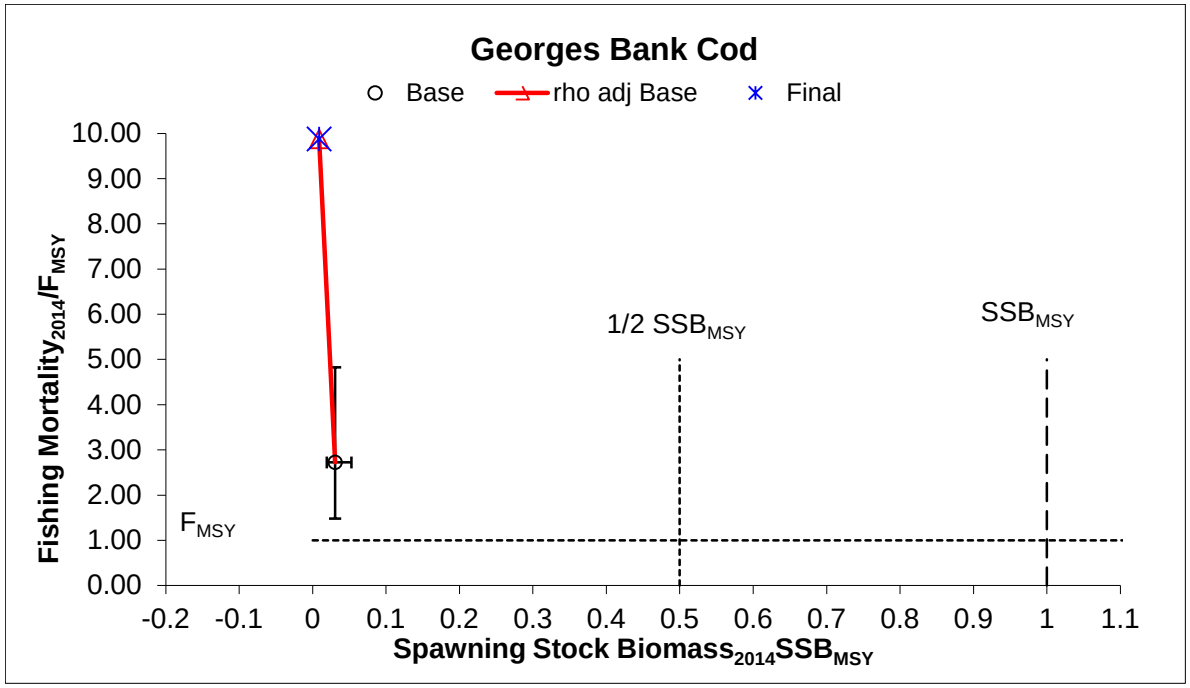
Empirical model 10 years recent rct.

Year	5%	SSB	95%
2015	539	1,522	3,192
2016	136	908	2,469
2017	600	1,473	2,924
2018	2,233	3,746	6,262
	5%	**F**	**95%**
2015	0.00	1.51	5.00
2016	0.169	0.169	0.169
2017	0.169	0.169	0.169
2018	0.169	0.169	0.169
	5%	**Catch**	**95%**
2015	1	1,784	1,784
2016	17	132	375
2017	65	192	425
2018	258	448	757

SSB	Avg. Rct
SSB < 50K	5.399
SSB > 50 K	24.337
34 yr	12.083
10 yr, recent	2.697

Applying 2-stage rct. model provides overly optimistic catch advice, given recent SSB

Georges Bank Cod Stock Status



Stock status : overfished, SSB < ½ B_{MSY}

overfishing is occurring, F > F_{MSY}

Uncertainties and research needs

- **Estimates of catch and natural mortality**
  - **Historically and currently**
- **DFO survey: not all strata sampled every year**
- **Changes in growth**
  - **Affects fecundity , egg viability, larval/juvenile survival to age 1**

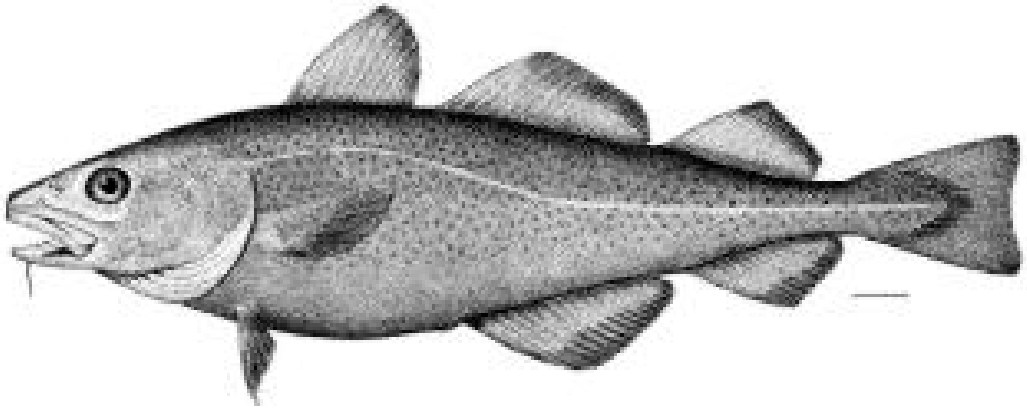
Summary - Re- cap

- Recent survey indices continue to be among the lowest in time series
- Mean length at age declining on 3 + fish since 1985 (affects rct)
- Continued truncated age structure in surveys and fishery (2014 1st year CA did not land any age 9 or 10+ fish)

- ASAP update diagnostics similar to 2012 benchmark within fleet and surveys, however, model fit to surveys more uncertain
- Other model formulations could be explored (e.g. set rec. dev. = 1 and change recruitment CV, increase CV on catch)
- Above is outside the ToR for this operational update.

- Stock has been overfished for entire time series: 37 years
- 34 yr avg. rct = 12.1 M age 1 fish; 1990 yc last above avg YC ~ 25 yrs ago
- Last estimate of SSB > 50K was 1990

- 2-stage empirical rct. model in projections too optimistic, particularly in recent years, could be ~ 50% too high
- eGB model formulations since 2005 have overest. popn# relative to GB model

- 2015 status : GB cod stock is overfished and overfishing is occurring.

Questions ?