

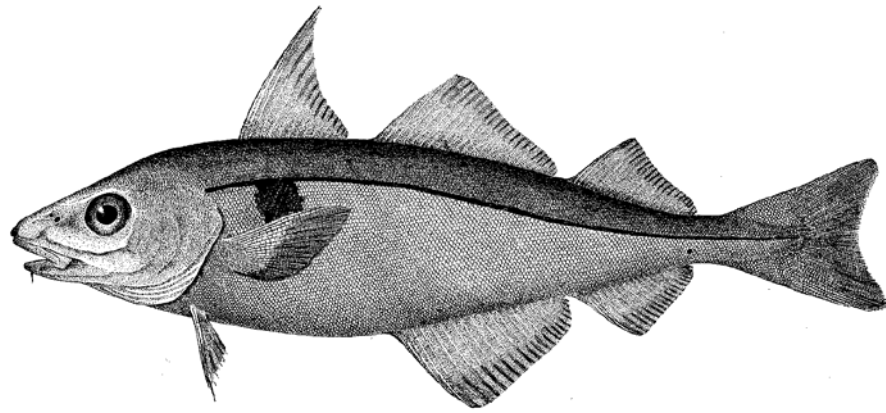


NOAA
FISHERIES
NEFSC

Gulf of Maine haddock

Michael Palmer

NEFSC/Population Dynamics Branch



Groundfish Operational Assessment Meeting
September 14-18, 2015
Woods Hole, MA

2015 Assessment Update: Presentation Overview

- Overview of the previous stock assessment (2014)
- Major signals in the fishery and survey data
 - Model independent evaluation of stock condition
- Data assembly, modelling, reference point and projection approach
- Assessment data inputs and changes from the 2014 assessment
- Model diagnostics and results
- Updated biological reference points and stock status
- Preliminary short-term (2016-2018) catch and biomass projections



2014 Benchmark Assessment (SAW/SARC 59)

- Stock Status:

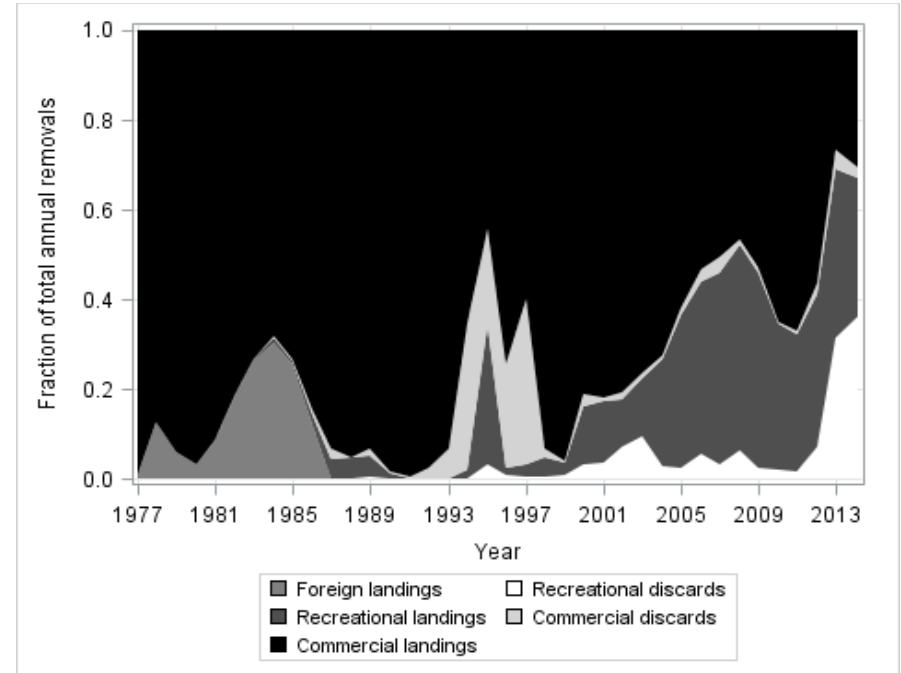
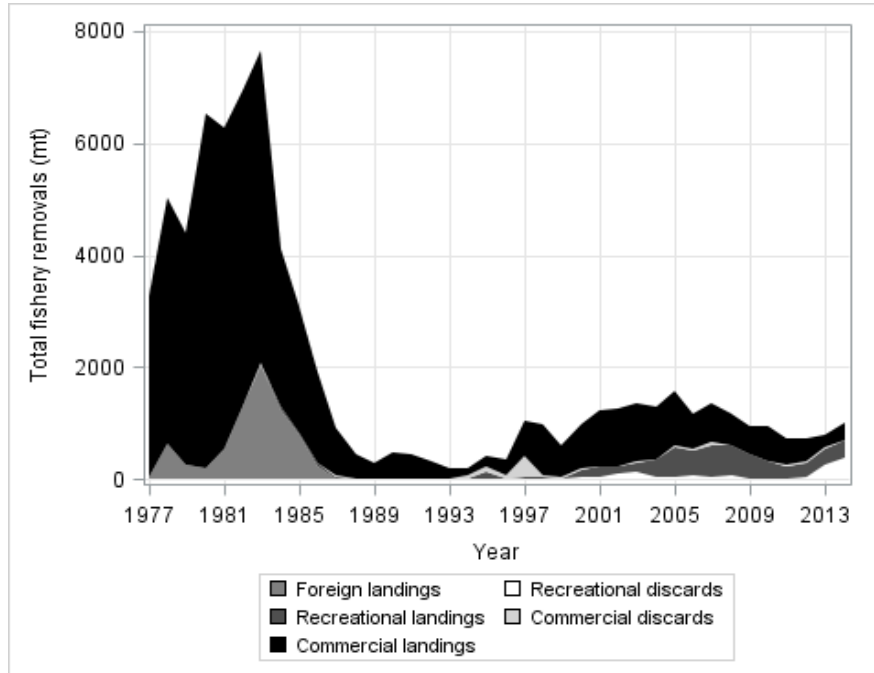
Assessment	Proxy reference points	Base
SAW/SARC 59	$F_{full, 2013}$	0.39 (0.24 - 0.60)
	F_{MSY}	0.46 (0.36 - 0.54)
	$F_{full, 2013}/F_{MSY}$	0.85
	Overfishing	No
	SSB_{2013} (mt)	4,153 (2,960 - 6,043)
	SSB_{MSY} (mt)	4,108 (1,774 - 7,861)
	SSB_{2013}/SSB_{MSY}	1.01
	Overfished	No
	MSY (mt)	955 (421 - 1,807)
	Median age1 recruitment (000s)	1,121 (205 - 6,500)

- Issues and uncertainties:

- Size of the terminal (2012) year class was estimated to be large, but was highly uncertain
 - Estimate based entirely on only two survey index values
- Survey data indicates the presence of another strong year class (2013)

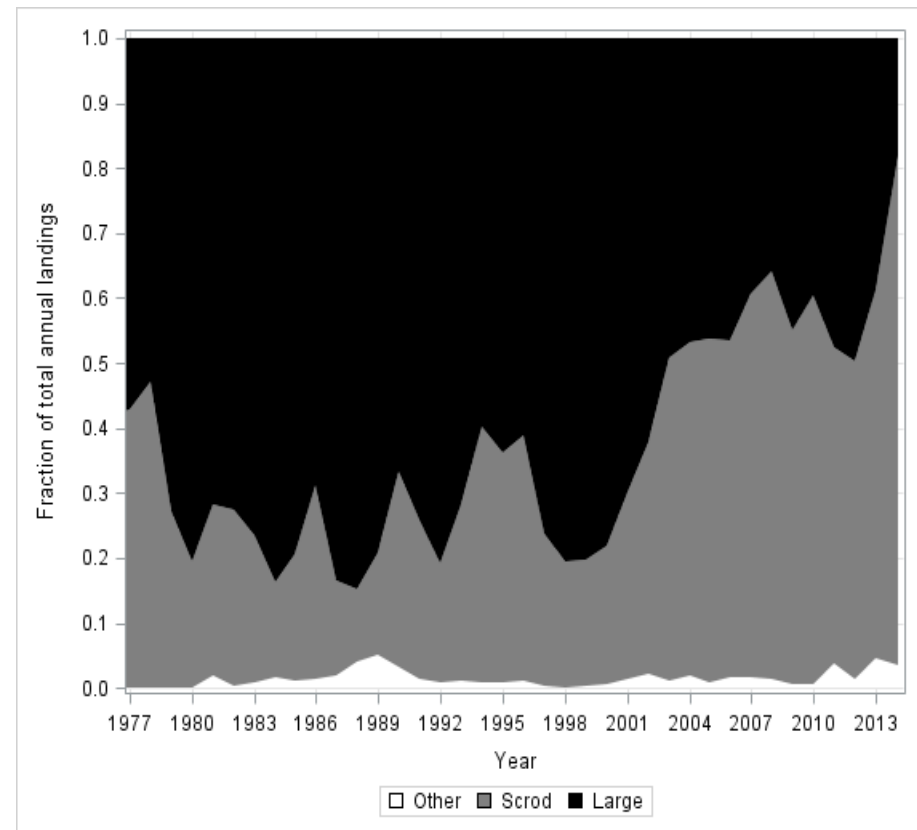
Overview of Fishery and Survey Data

- Fishery: catch source



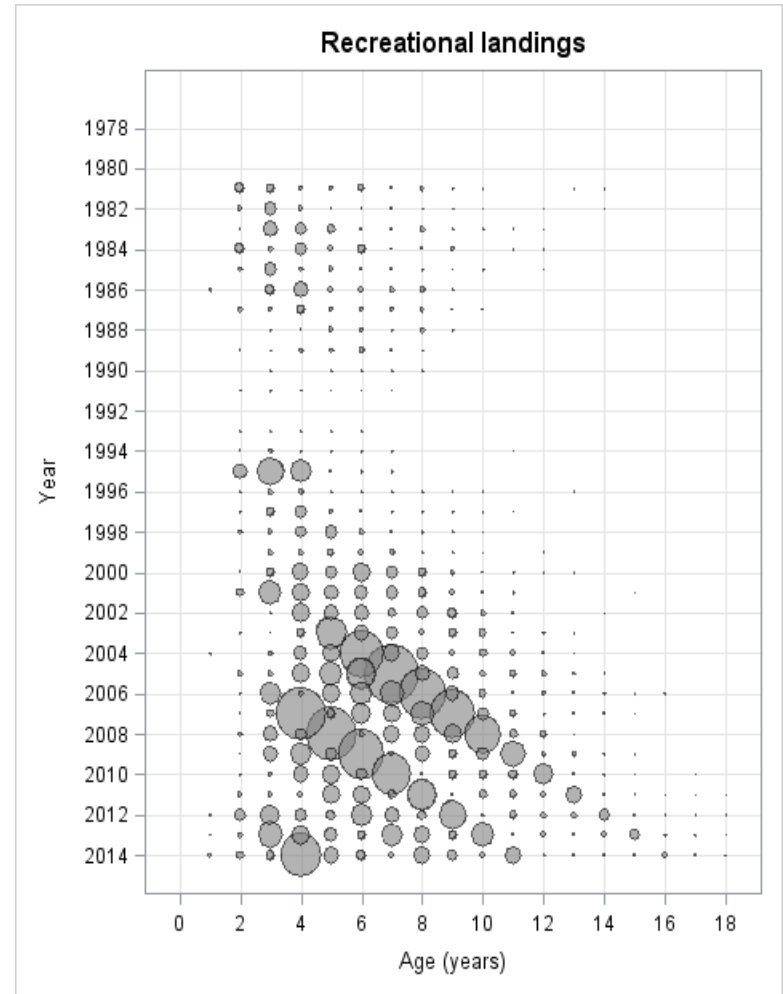
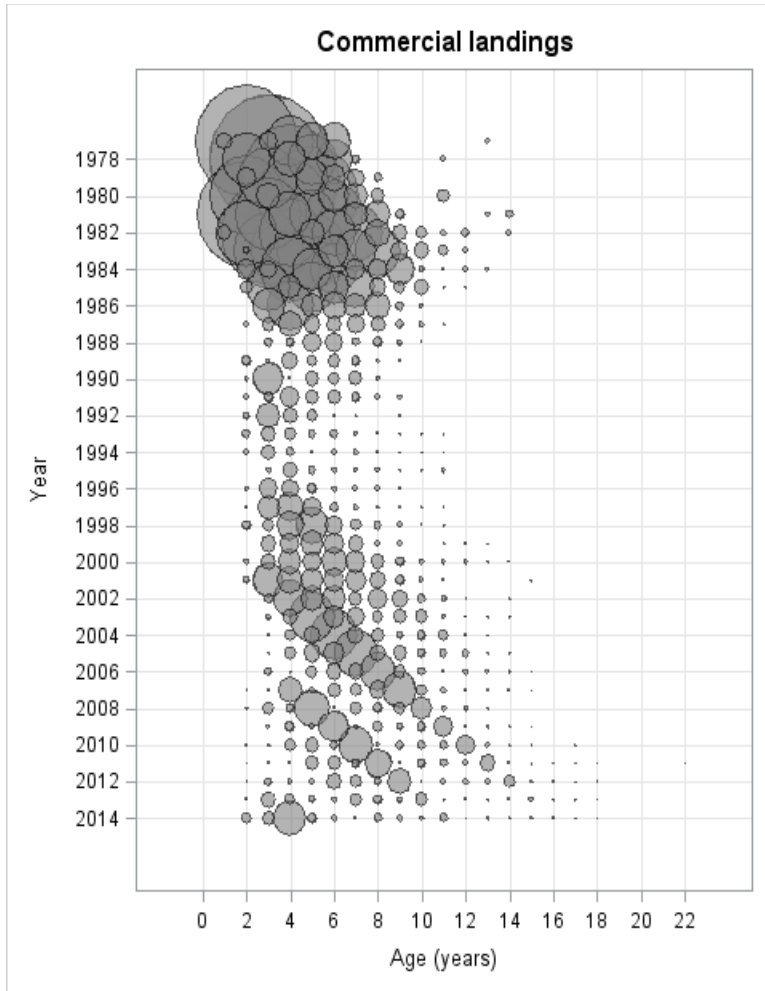
Overview of Fishery and Survey Data

- Fishery: commercial length distributions



Overview of Fishery and Survey Data

- Fishery: commercial and recreational age structure:



Overview of Fishery and Survey Data

- Fishery: catch-curve estimated total mortality (Z)

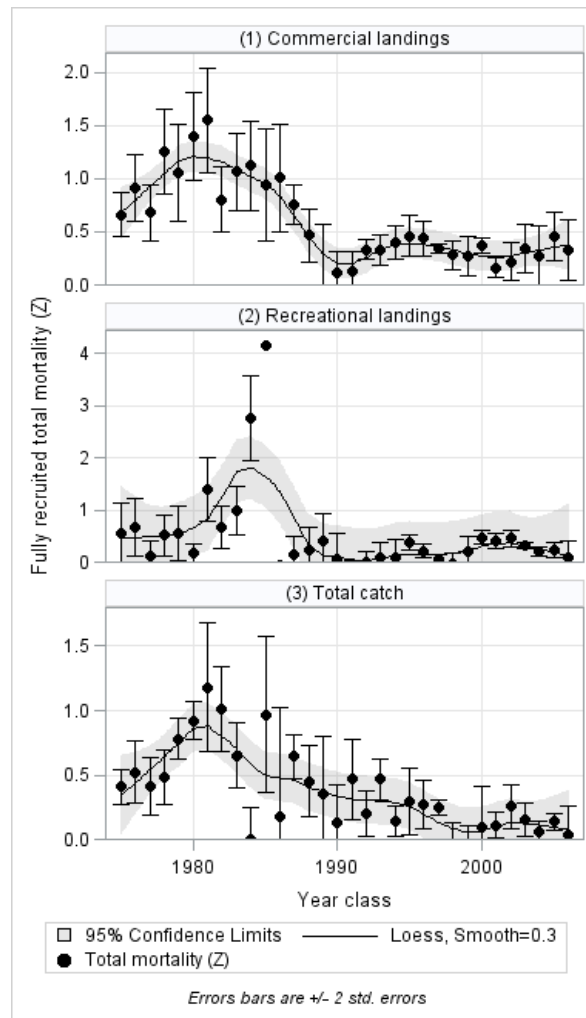
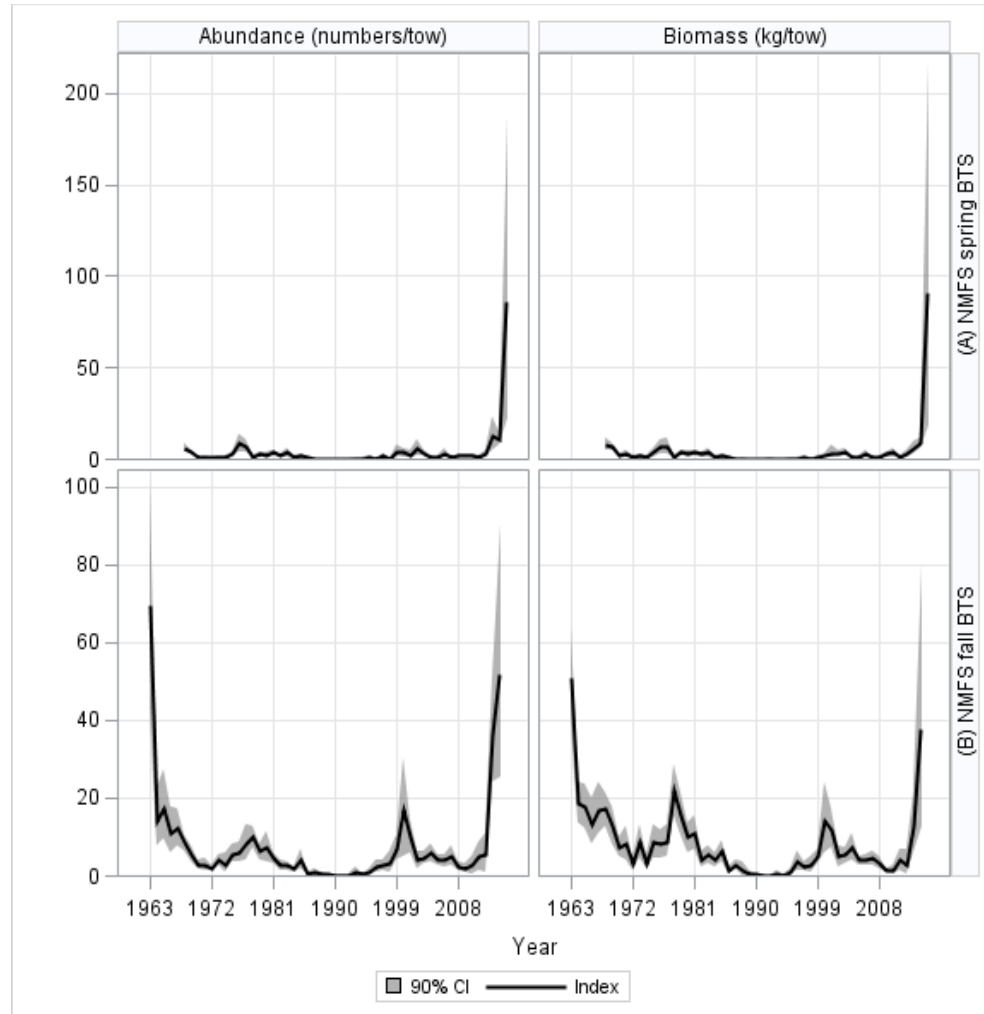


Figure 19

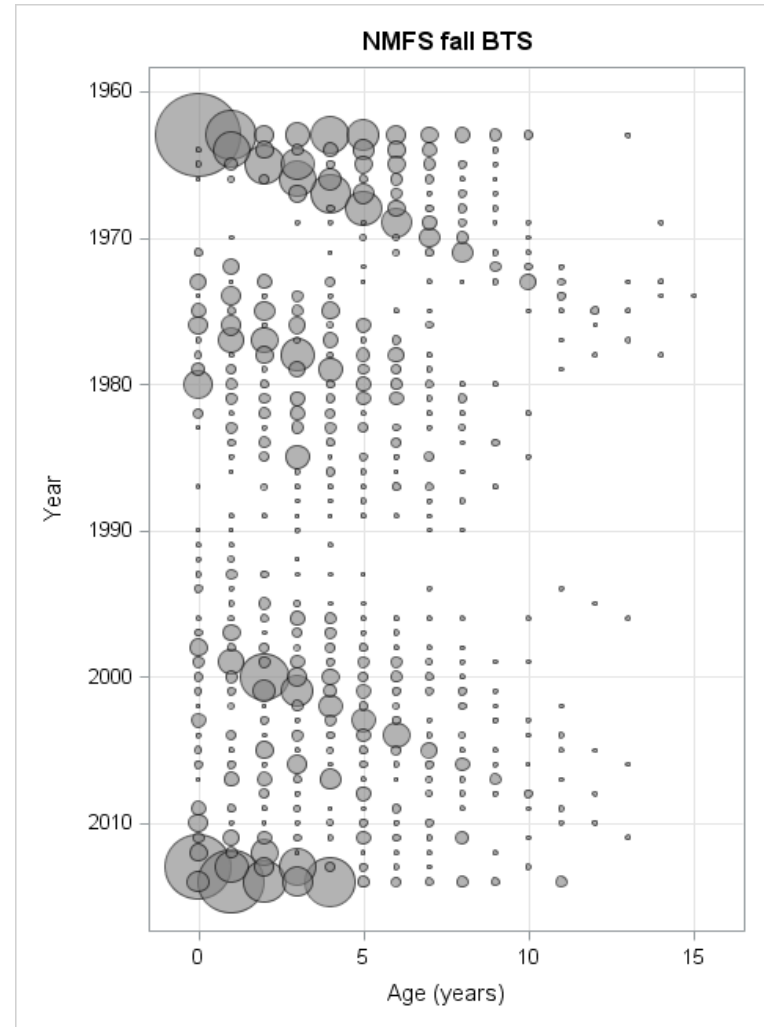
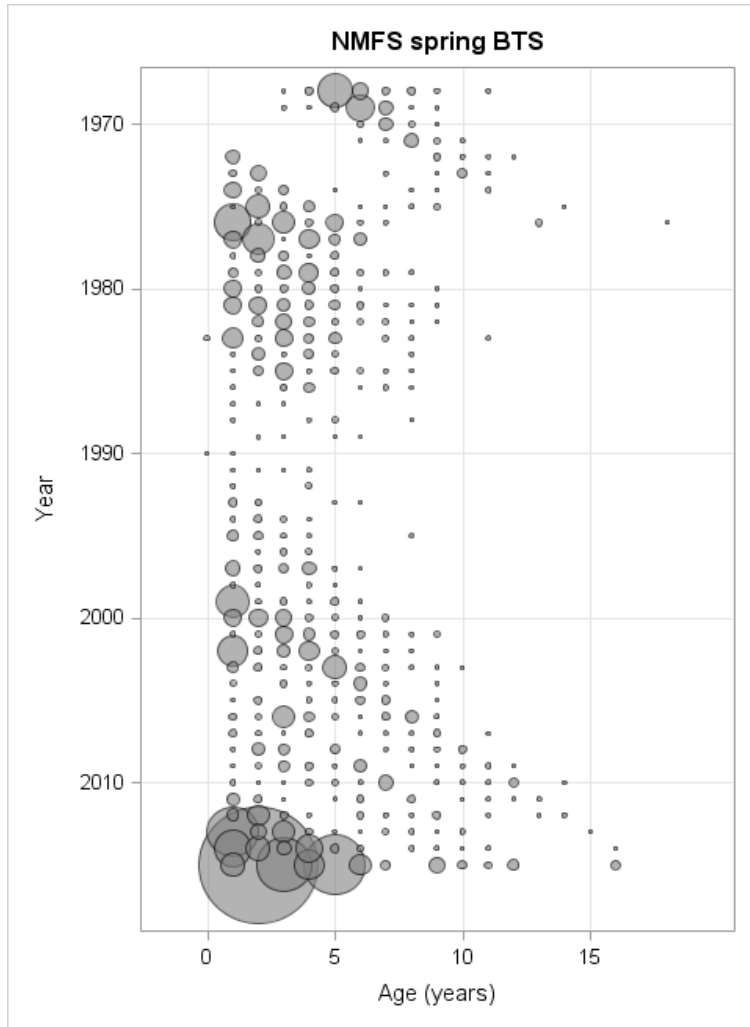
Overview of Fishery and Survey Data

- Survey: aggregate indices



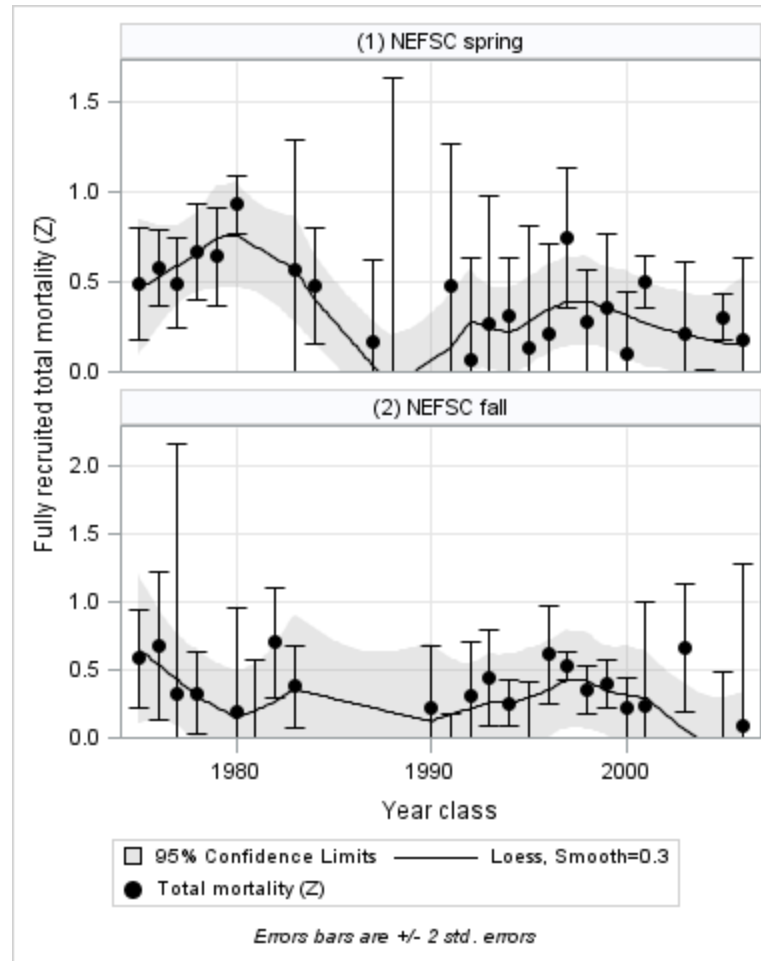
Overview of Fishery and Survey Data

- Survey: indices-at-age



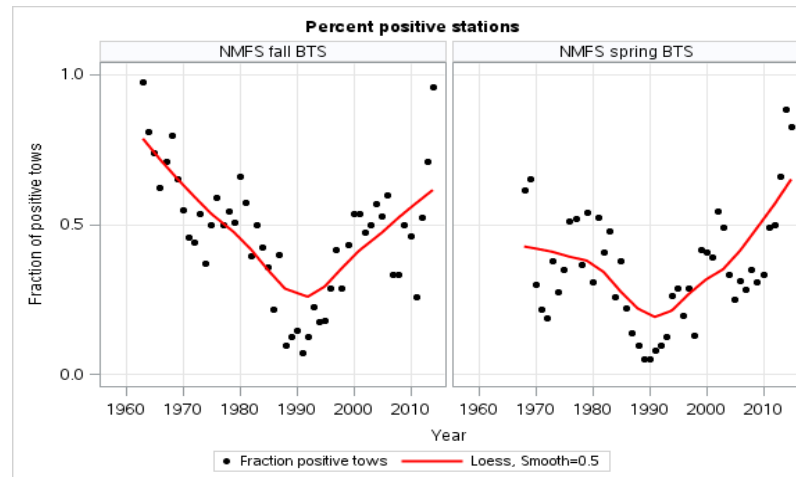
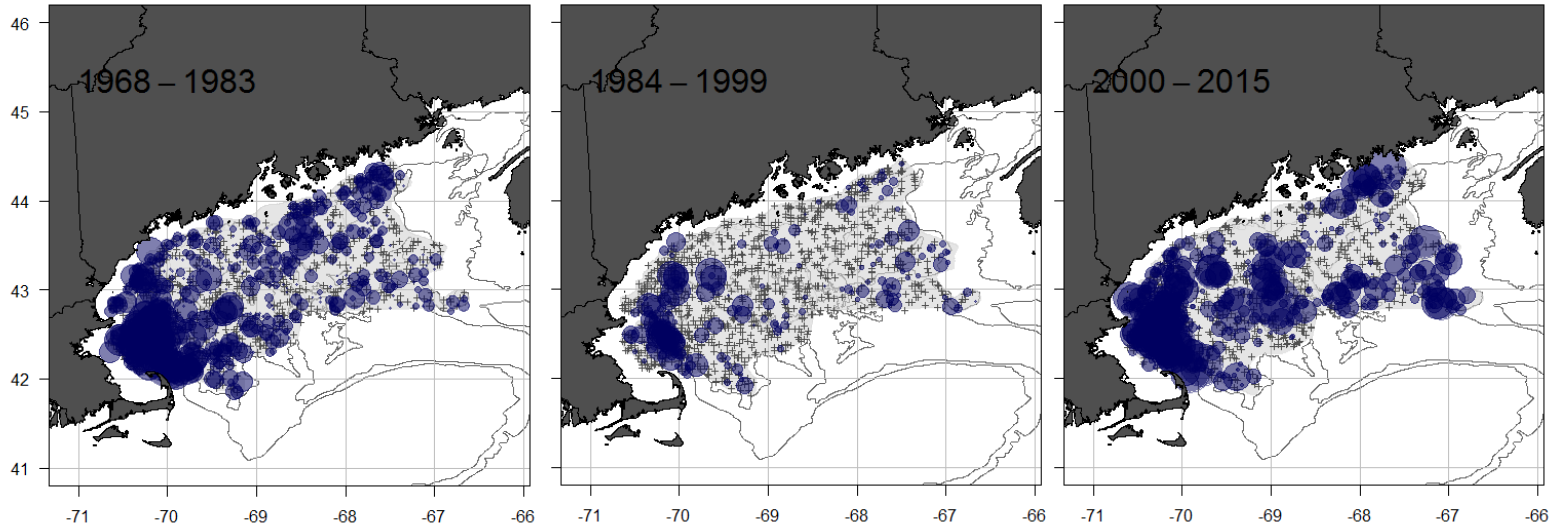
Overview of Fishery and Survey Data

- Survey: catch-curve estimated total mortality (Z)



Overview of Fishery and Survey Data

- Survey: spatial distribution



2015 Assessment Update Overview

- Incorporate an additional year of data (2014) into the 2014 assessment time series
 - Minor changes:
 - Update of MRIP catch estimates to reflect data updates
- Update the SAW/SARC 59 ASAP model through 2014
 - Carry forward the sensitivity model ‘Constrain terminal R’
 - Minor changes:
 - Turn ASAP likelihood constants off (this update, moderate impacts)
- Update F_{MSY} proxies ($F_{40\%}$)
 - Use recent 5-year average weights
- Update SSB_{MSY} proxies
- Update short-term projections (2016-2018)



Model Inputs

- Data changes:
 - MRIP updates

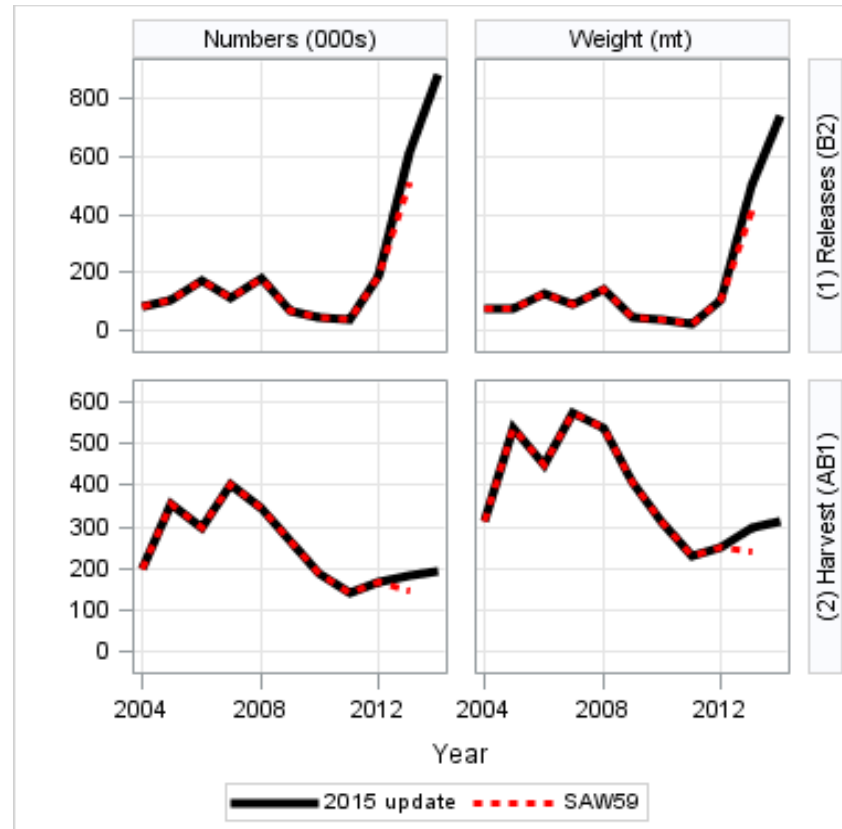


Figure 11

Model Inputs

- Biology
 - Maturity-at-age (1977-2014 time series average)
 - Assumed natural mortality ($M=0.2$)
 - Stock weights-at-age
- Fishery catches
 - Commercial landings and discards (ages 1-9+)
 - Discard mortality assumed 100% (primarily trawl fishery)
 - Recreational landings and discards (ages 1-9+)
 - Discard mortality rate assumed 50% (uncertain)
 - Catch weights-at-age
- Survey
 - NEFSC spring and fall (ages 1-9+)





Model Formulation

- Model formulation:
 - Years: 1977-2014
 - Fishery:
 - Single fleet (combined commercial and recreational)
 - CV = 1977-1988: 0.20, 1989-2000: 0.15, 2001-2014: 0.10
 - Selectivity modelled with three selectivity blocks (at-age)
 - 1982-1988, 1989-2004, 2005-2014
 - Surveys:
 - CVs from surveys with re-weighting
 - NMFS spring:+0.3, NMFS fall:+0.2
 - Selectivity freely estimated at-age; fixed 4⁺ (spring), 6⁺ (fall)
 - Catchability does not vary over time
 - Recruitment modelled as deviations from the mean ('Base' model)
 - Sensitivity model constrains recruitment in the terminal year
 - 'Constrain terminal R' model
 - CV=0.5 on terminal year recruitment estimate



Model Formulation

- Likelihood constants
 - Likelihood constant option was turned on in the SAW/SARC 59 assessment model
- Turning them off results in positive rescaling of recruitment and SSB and negative rescaling of F
- See Legault (2015) background paper for detailed explanation
 - “Should I stay or should I go? The ASAP likelihood constants explained”

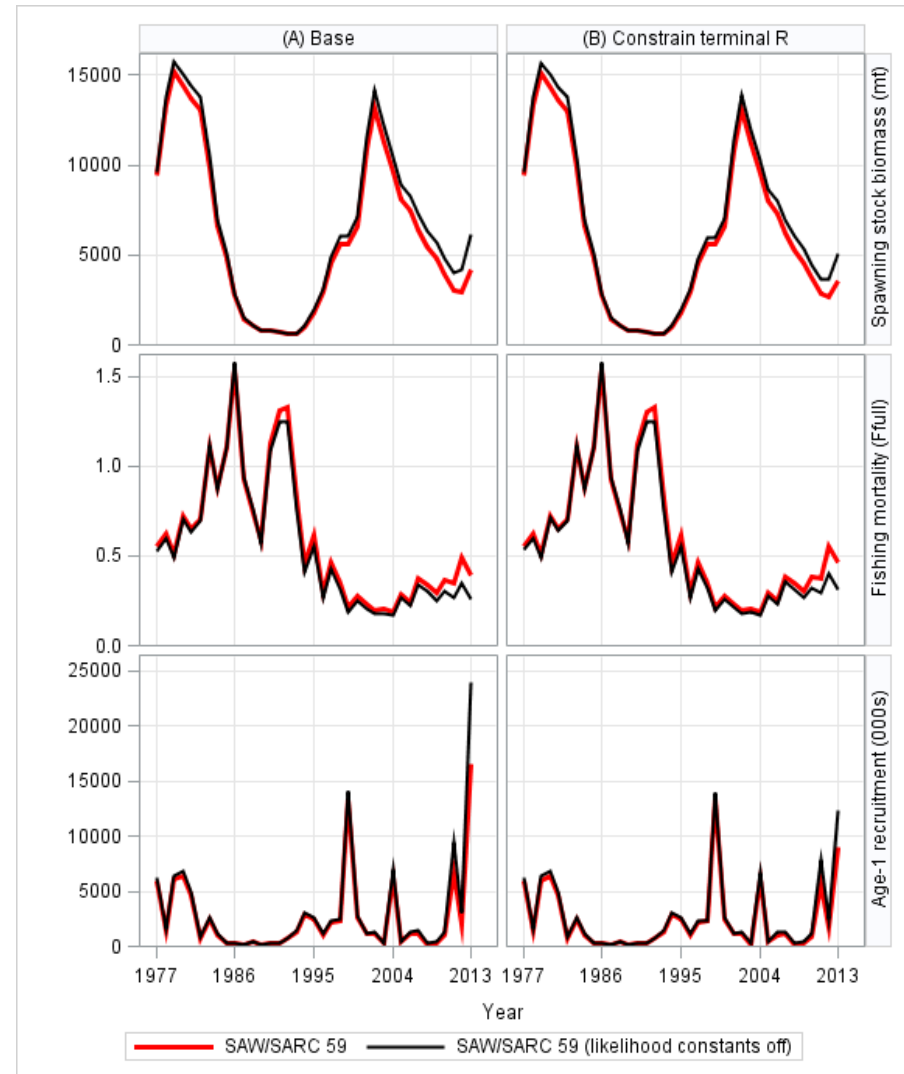


Figure 45

Model Diagnostics

- Selectivity and survey catchability

Block/survey	Parameter	Base		Constrain terminal R	
		Value	CV	Value	CV
Catch block1 (1977-1988)	Age1	0.00	0.72	0.00	0.72
	Age2	0.20	0.18	0.20	0.18
	Age3	0.35	0.16	0.35	0.16
	Age4	0.57	0.16	0.57	0.16
	Age5	0.54	0.17	0.54	0.17
	Age6	0.62	0.18	0.62	0.18
	Age7	0.75	0.21	0.75	0.21
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
Catch block2 (1989-2004)	Age1	0.00	0.36	0.00	0.36
	Age2	0.04	0.23	0.04	0.22
	Age3	0.21	0.20	0.21	0.20
	Age4	0.38	0.19	0.38	0.19
	Age5	0.55	0.19	0.55	0.19
	Age6	0.79	0.19	0.79	0.19
	Age7	0.86	0.21	0.86	0.21
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
Catch block3 (2005-2014)	Age1	0.00	0.30	0.01	0.29
	Age2	0.04	0.17	0.04	0.17
	Age3	0.17	0.14	0.17	0.14
	Age4	0.33	0.13	0.33	0.13
	Age5	0.51	0.13	0.51	0.13
	Age6	0.70	0.13	0.70	0.13
	Age7	0.85	0.12	0.85	0.12
	Age8	1.00		1.00	
	Age9 ⁺	0.82	0.16	0.82	0.16

Block/survey	Parameter	Base		Constrain terminal R	
		Value	CV	Value	CV
NEFSC spring	Age1	0.69	0.13	0.74	0.13
	Age2	0.68	0.13	0.69	0.13
	Age3	0.90	0.14	0.91	0.14
	Age4	1.00		1.00	
	Age5	1.00		1.00	
	Age6	1.00		1.00	
	Age7	1.00		1.00	
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
NEFSC fall	Age1	0.29	0.15	0.29	0.15
	Age2	0.44	0.15	0.44	0.15
	Age3	0.63	0.14	0.63	0.14
	Age4	0.72	0.15	0.72	0.15
	Age5	0.95	0.15	0.95	0.15
	Age6	1.00		1.00	
	Age7	1.00		1.00	
	Age8	1.00		1.00	
	Age9 ⁺	1.00		1.00	
Survey catchability (q)	NEFSC spring	0.24 (0.13)		0.25 (0.13)	
	NEFSC fall	0.86 (0.14)		0.88 (0.14)	



Model Diagnostics

- Model fits to total catch and aggregate survey indices

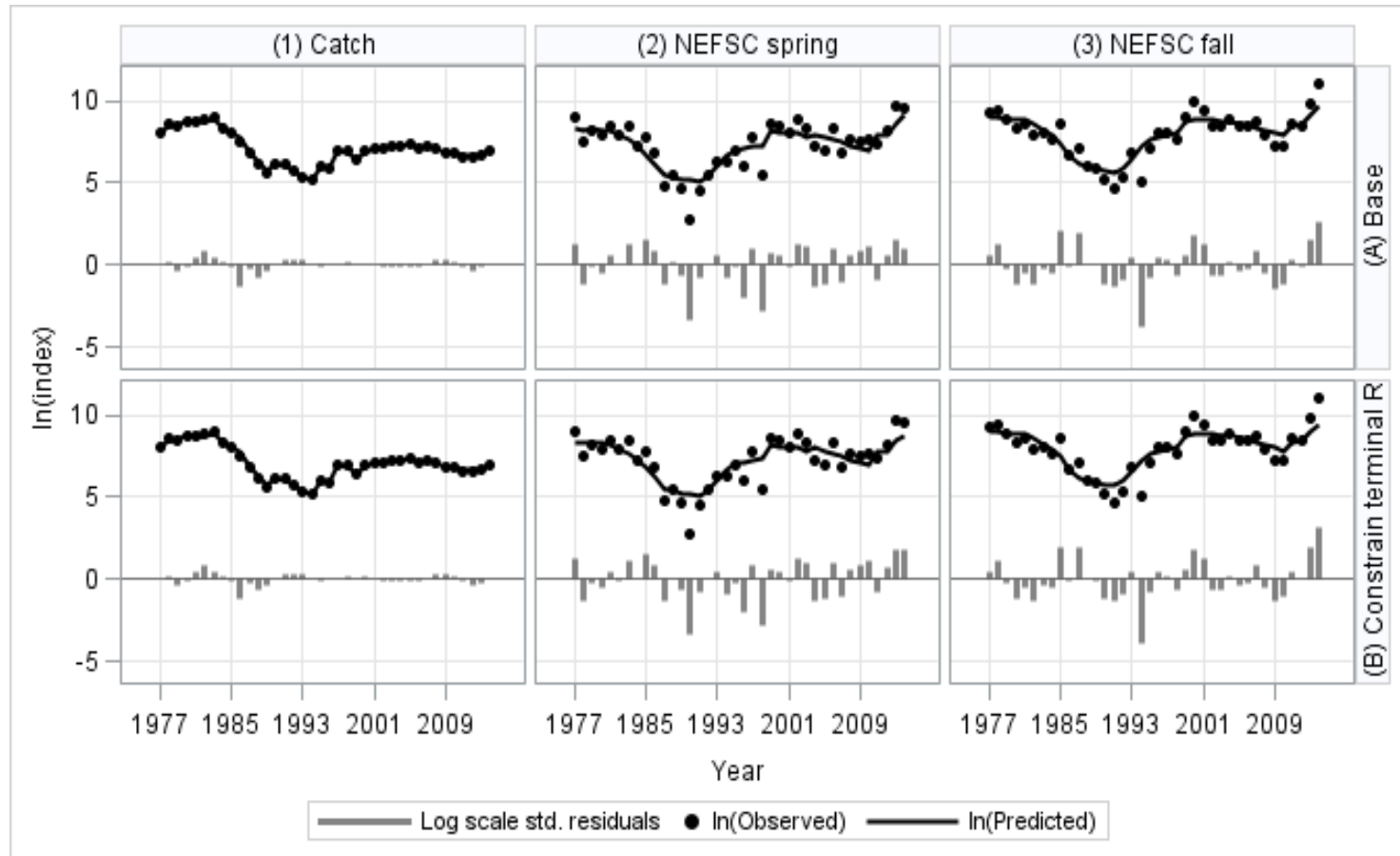
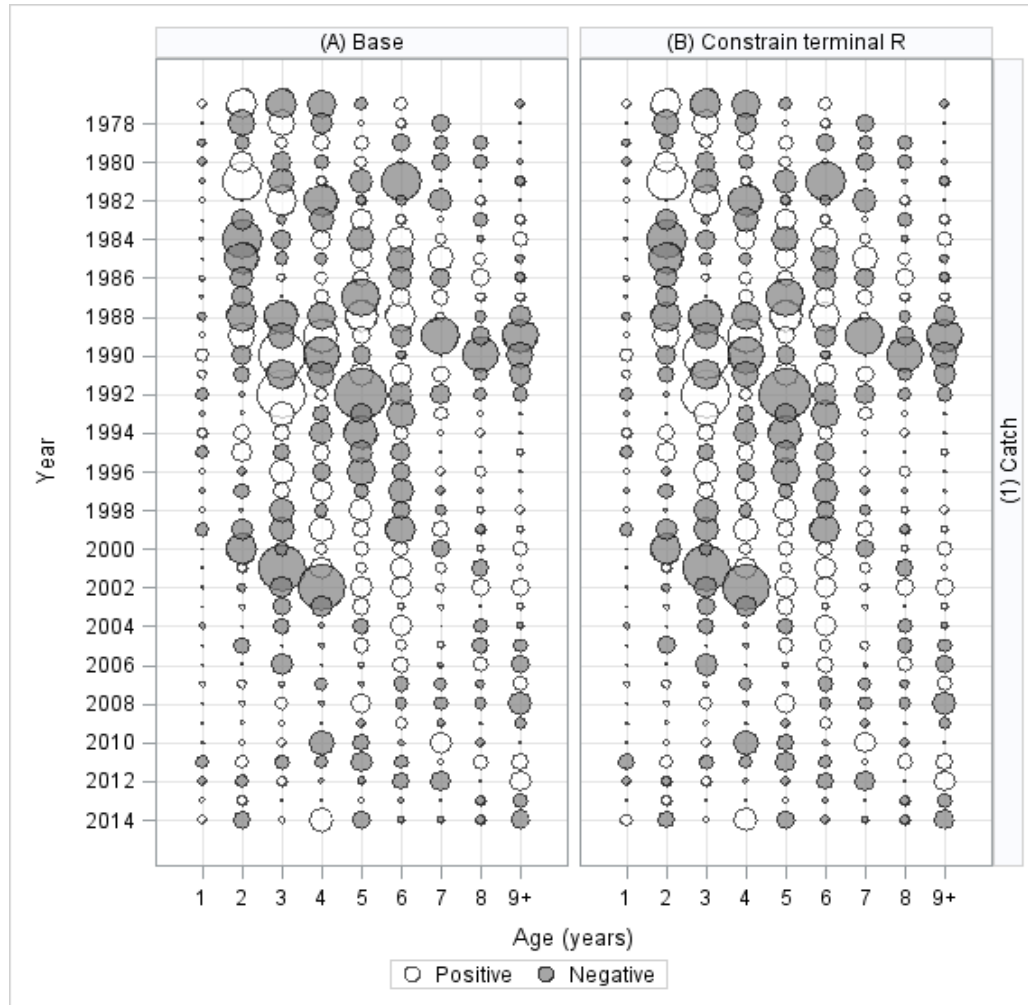


Figure 38

Model Diagnostics

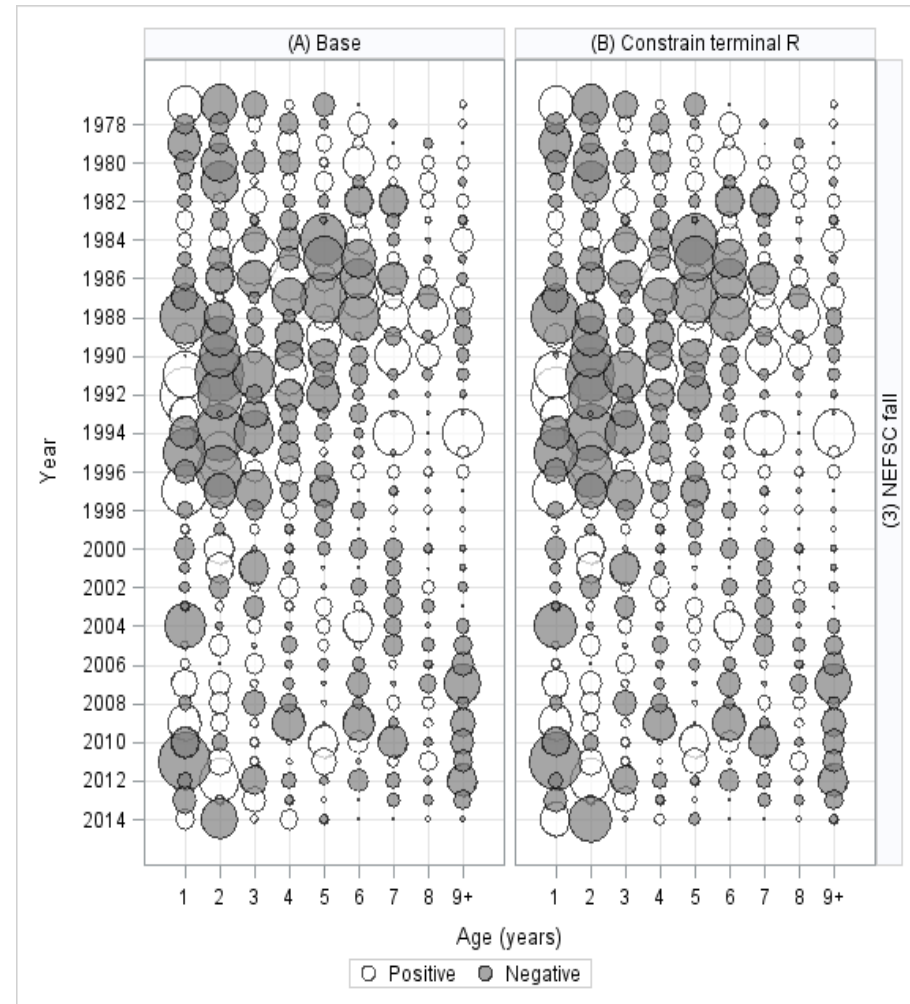
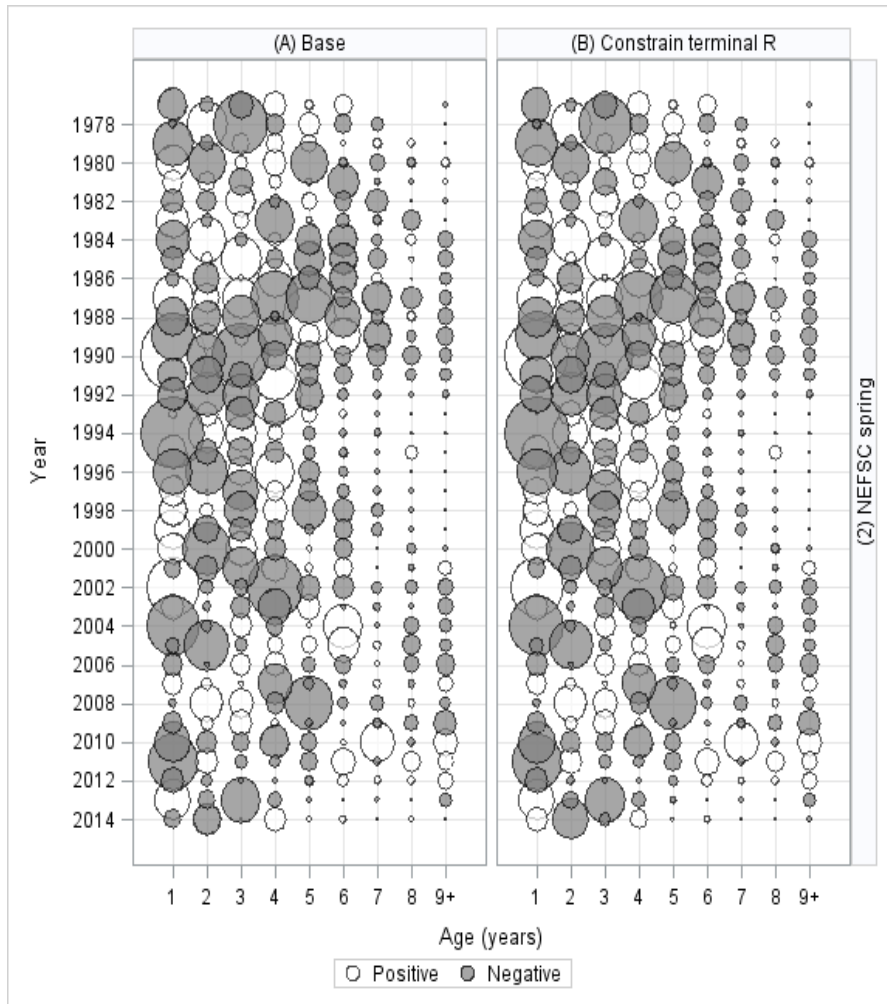
- Model fits to catch-at-age



(1) Catch

Model Diagnostics

- Model fits to survey indices-at-age



Figures 41, 42

Model Results

- Model results
 - 2015 update results are consistent with the 2014 update results (likelihoods off)
- SSB_{2015}
 - Base: 10,325 mt
 - Constrain: 8,759 mt
- F_{2015}
 - Base: 0.257
 - Constrain: 0.301
- Recruitment
 - Strong recent recruitment

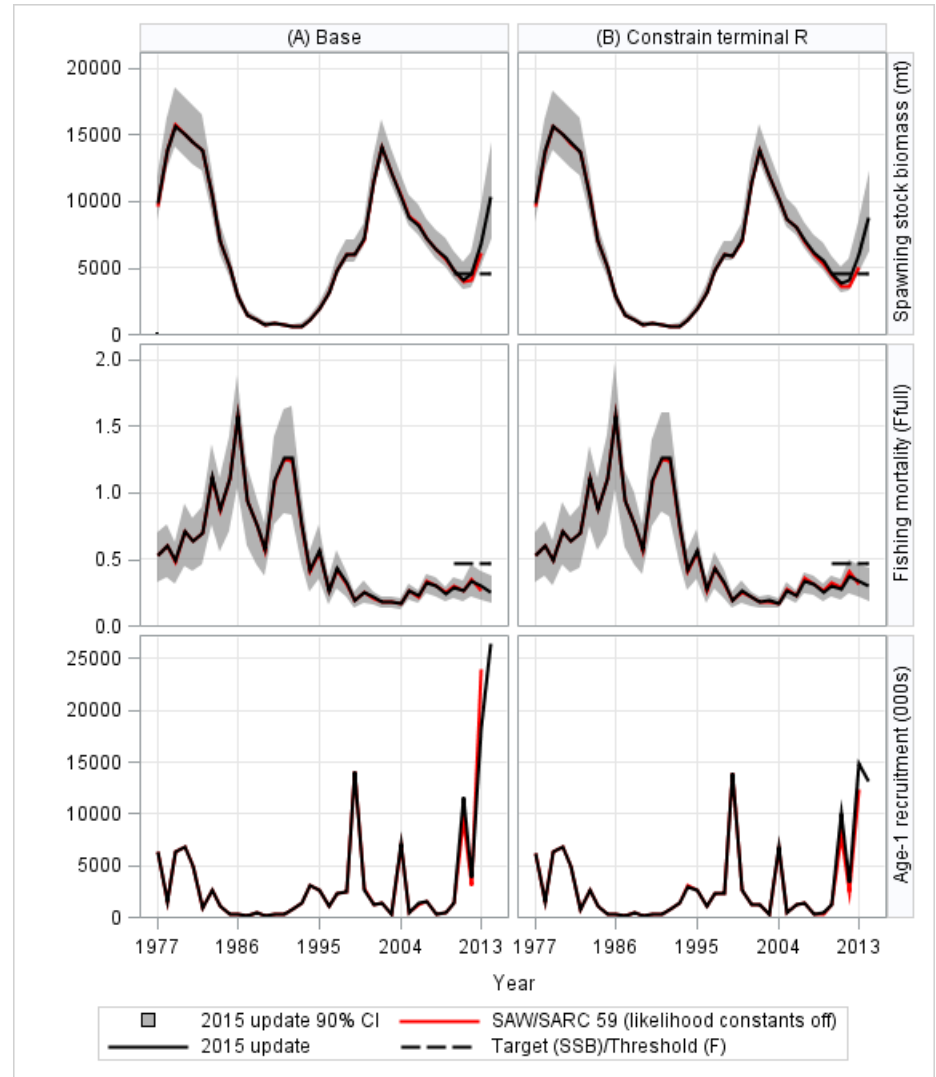
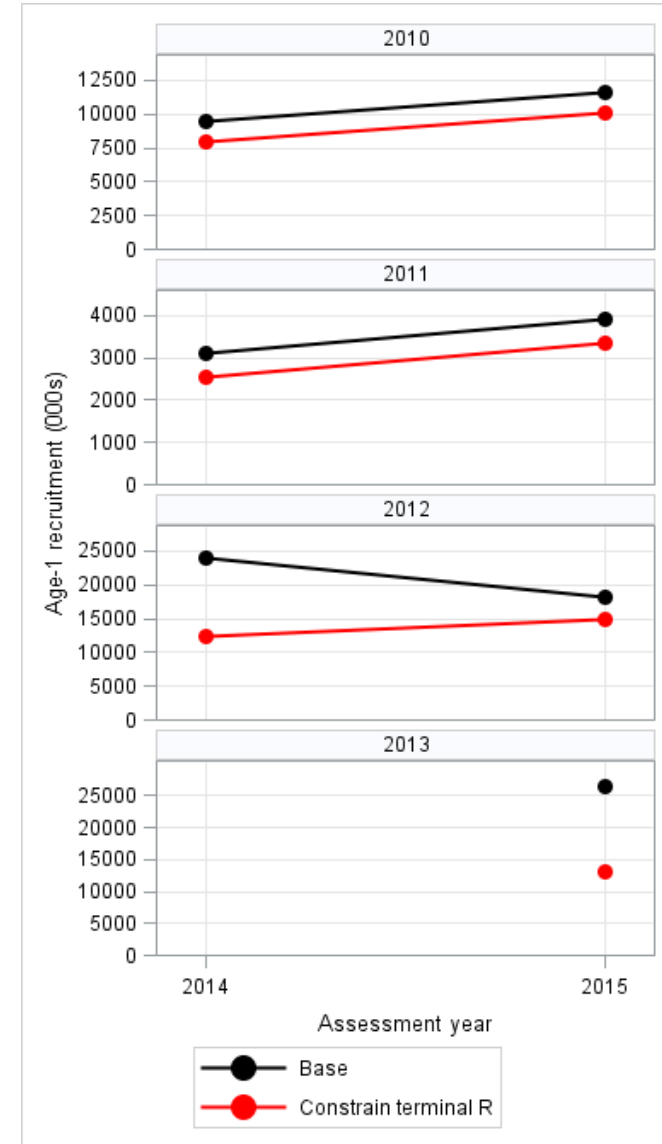
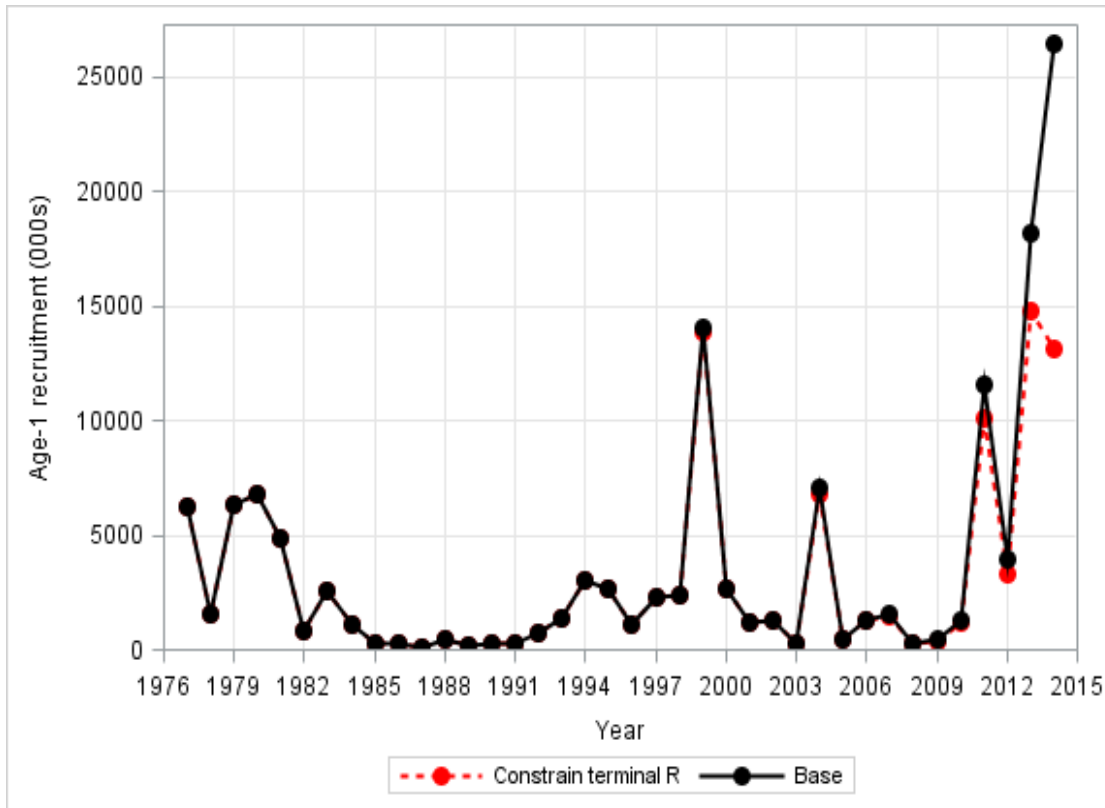


Figure 46

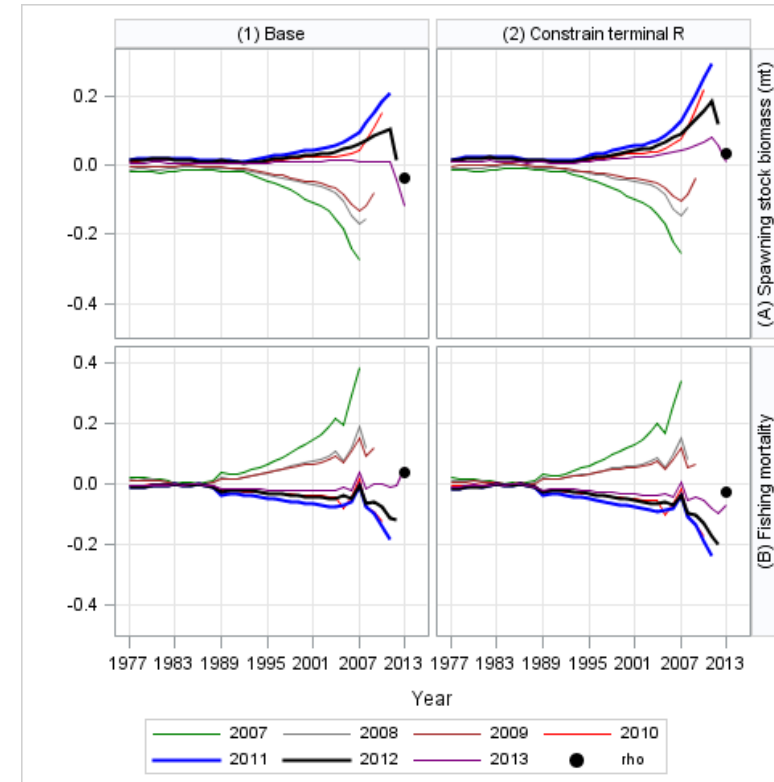
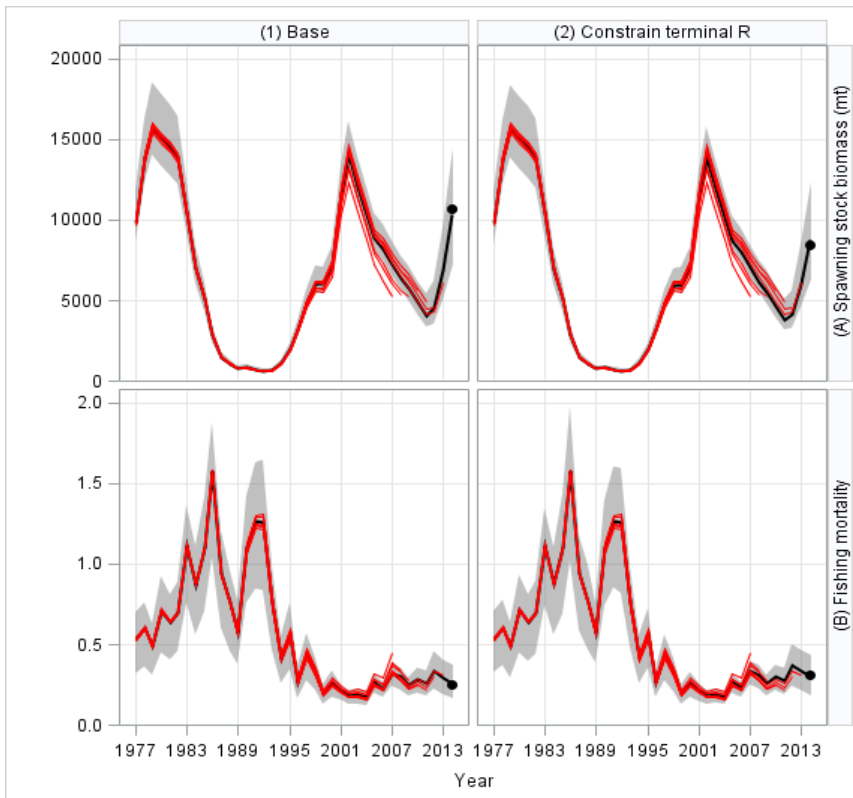
Model Results

- Recruitment (000s fish)
 - 24% downward adjustment of the 2012 year class in the base model
 - 47% increase in the 'Constrain' model



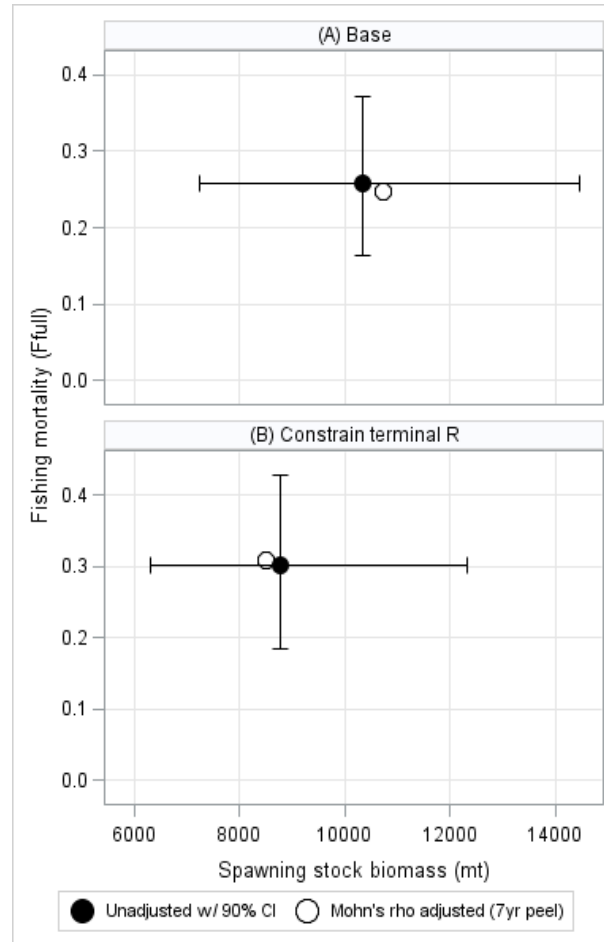
Model Results

- Retrospective error
 - Mohn's rho:
 - SSB: 'Base' (-0.04), 'Constrain' (0.03)
 - F: 'Base' (0.04), 'Constrain' (-0.03)



Model Results

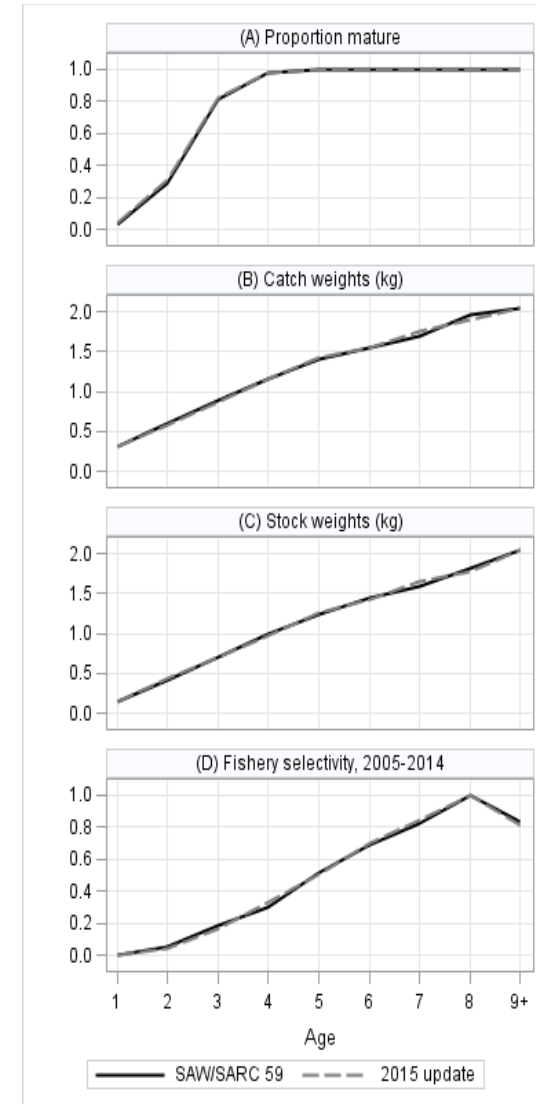
- Retrospective error
 - Neither model exhibits retrospective error



Biological Reference Points

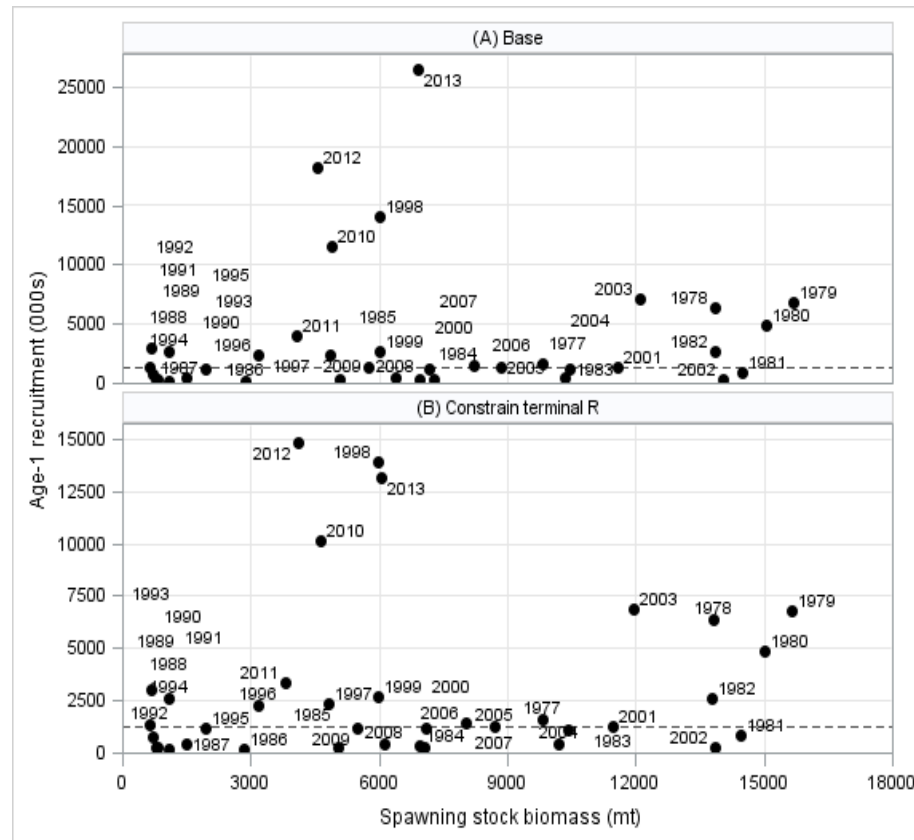
- Reference points only generated for the ‘Base’ model
- Update *stochastic* $F_{40\%}$ F_{MSY} proxies
 - Natural mortality assumed equal to 0.2
 - Time series average maturity ogive
 - 3-year average of weights (2012-2014)
 - Last selectivity block (2004-2014)

Age	Jan1/SSB weights (kg)	Mid-year weights (kg)	Catch weights (kg)	Fishery selectivity	Maturity	Natural mortality						
1	0.152	0.118	0.317	0.155	0.302	0.140	0.005	0.297	0.042	0.099	0.200	0.100
2	0.425	0.072	0.573	0.042	0.578	0.048	0.043	0.172	0.311	0.040	0.200	0.100
3	0.712	0.070	0.858	0.129	0.877	0.128	0.166	0.140	0.823	0.018	0.200	0.100
4	0.979	0.053	1.119	0.055	1.153	0.047	0.335	0.133	0.980	0.005	0.200	0.100
5	1.251	0.048	1.388	0.051	1.426	0.049	0.510	0.132	0.998	0.001	0.200	0.100
6	1.433	0.029	1.528	0.039	1.561	0.041	0.702	0.129	1.000	0.001	0.200	0.100
7	1.643	0.042	1.748	0.056	1.762	0.046	0.849	0.121	1.000	0.001	0.200	0.100
8	1.776	0.036	1.875	0.084	1.898	0.072	1.000	0.001	1.000	0.001	0.200	0.100
9+	2.043	0.025	2.043	0.025	2.049	0.024	0.816	0.157	1.000	0.001	0.200	0.100



Biological Reference Points

- Update *stochastic* SSB_{MSY} proxies
 - Based on 100 year projections run at the F_{MSY} proxy
 - Projection model samples from CDF of recruitment from 1977-2012
 - The t+1 (2014) year class estimated from 1977-2014 geomean



Stock Status

- Updated reference points and stock status
 - **Not** overfished and overfishing is **not** occurring

Assessment	Proxy reference points	Base
2015 update	$F_{full, 2014}$	0.257 (0.164 - 0.373)
	F_{MSY}	0.468 (0.391 - 0.547)
	$F_{full, 2014}/F_{MSY}$	0.55
	Overfishing	No
	SSB_{2014} (mt)	10,325 (7,229 - 14,453)
	SSB_{MSY} (mt)	4,623 (2,036 - 9,283)
	SSB_{2014}/SSB_{MSY}	2.23
	Overfished	No
	MSY (mt)	1,083 (489 - 2,148)
	Median age1 recruitment (000s)	1,335 (253 - 8,198)



Short-term Projections

- Updated short-term projections (2016-2018)
 - ‘Base’ and ‘Constrain terminal R’
 - No retrospective adjustment on either projection
- All projections run at both F_{MSY} or 75% F_{MSY}
 - Assumed catch of 885 mt in 2015 (*GARFO*)

Harvest strategy	Year	Input	Base			Constrain terminal R		
			Catch (mt)	Spawning stock biomass (mt)	F_{full}	Catch (mt)	Spawning stock biomass (mt)	F_{full}
F_{MSY}	2014	Model result	1,021	10,325	0.257	1,021	8,759	0.301
	2015	Assumed catch	885	18,026	0.131	885	14,002	0.162
	2016	Projection	4,717	25,352	0.468	3,544	17,709	0.468
	2017	Projection	5,614	24,623	0.468	3,965	16,522	0.468
	2018	Projection	5,642	20,371	0.468	3,825	13,580	0.468
75% F_{MSY}	2014	Model result	1,021	10,325	0.257	1,021	8,759	0.301
	2015	Assumed catch	885	18,026	0.154	885	14,002	0.162
	2016	Projection	3,630	25,635	0.351	2,731	17,921	0.351
	2017	Projection	4,534	25,915	0.351	3,217	17,467	0.351
	2018	Projection	4,815	22,532	0.351	3,293	15,092	0.351



Summary

- Fishery and survey data indicate that several large year classes have been spawned over the last five years (2010, 2012, 2013)
 - Total mortality is low (e.g., the 1998 year class is still present in the catch data)
- Overall survey indices and percent occurrence is high
- Model results are consistent with the 2014 benchmark (indicative of an growing population)
 - SSB: 10,325 mt
 - F: 0.257
 - Recruitment continues to be strong, but uncertainty should be considered
- Biological reference points are higher than 2014 benchmark
 - Reflect increases in median recruitment
- Stock is **not** overfished and overfishing **not** is occurring

Questions?