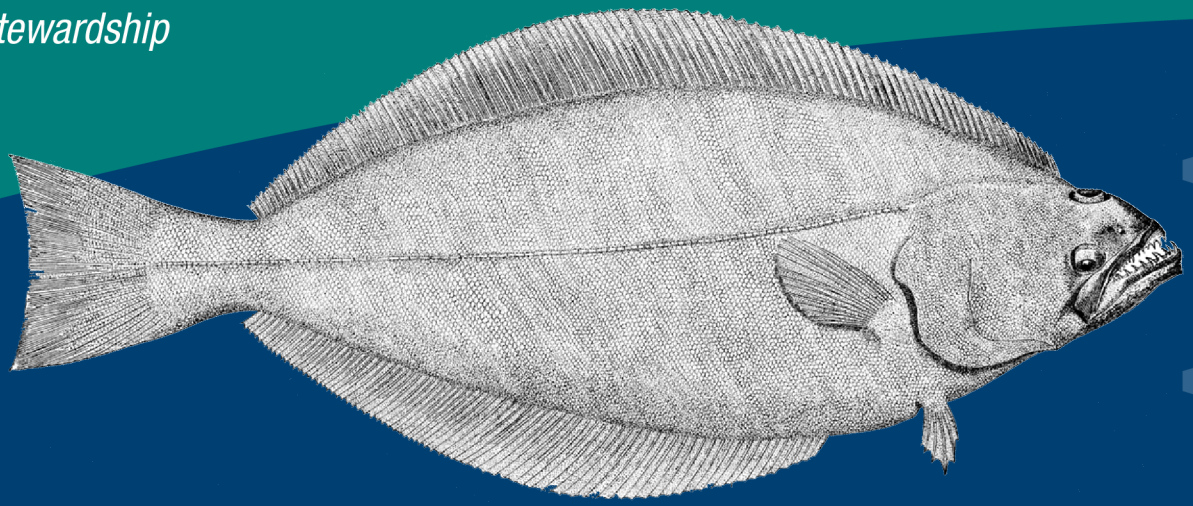
Science, Service, Stewardship



BSAI Greenland turbot assessment 2016

Steve Barbeaux, James Ianelli, Dan Nichol, and Jerry Hoff

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NPFMC Plan Team, Nov. 16, 2016

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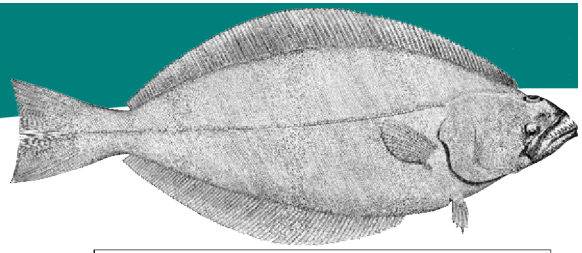
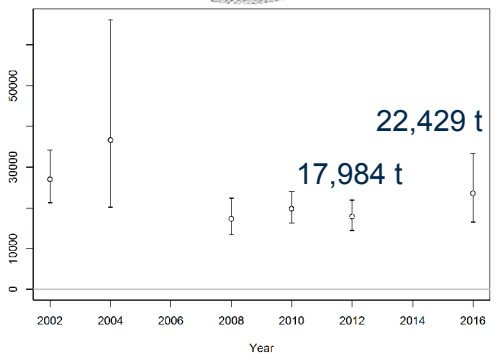
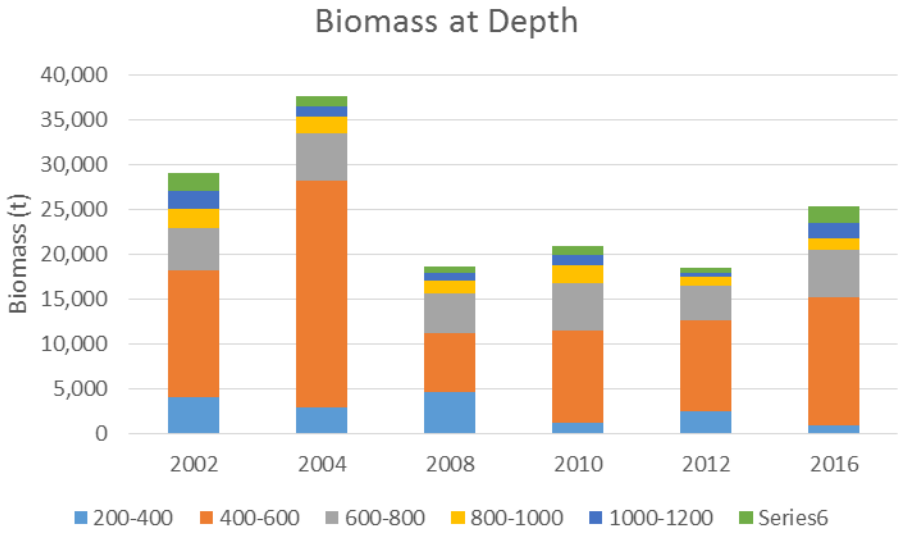
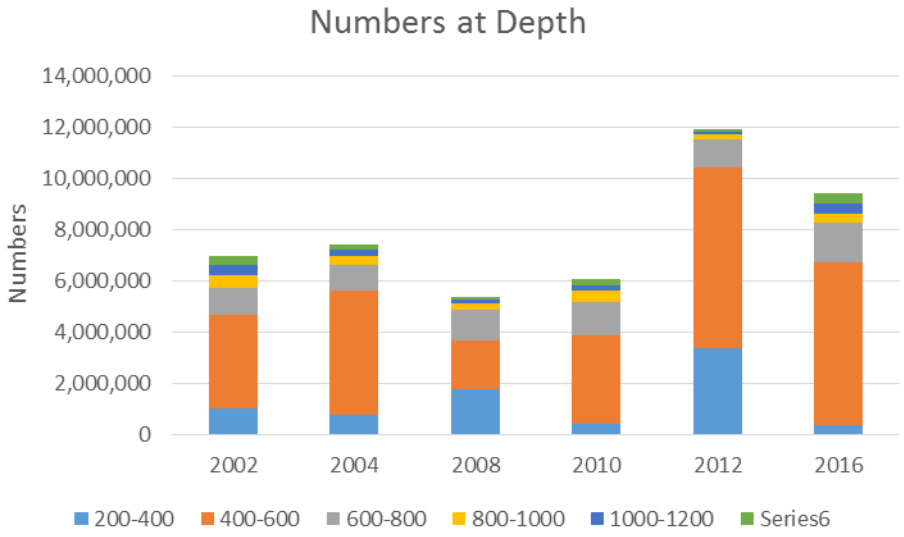


New slope survey!



- Biomass up from 2012
- Abundance down at levels consistent with M
- Distribution consistent with southward and downward migration of strong 2007-2009 year classes





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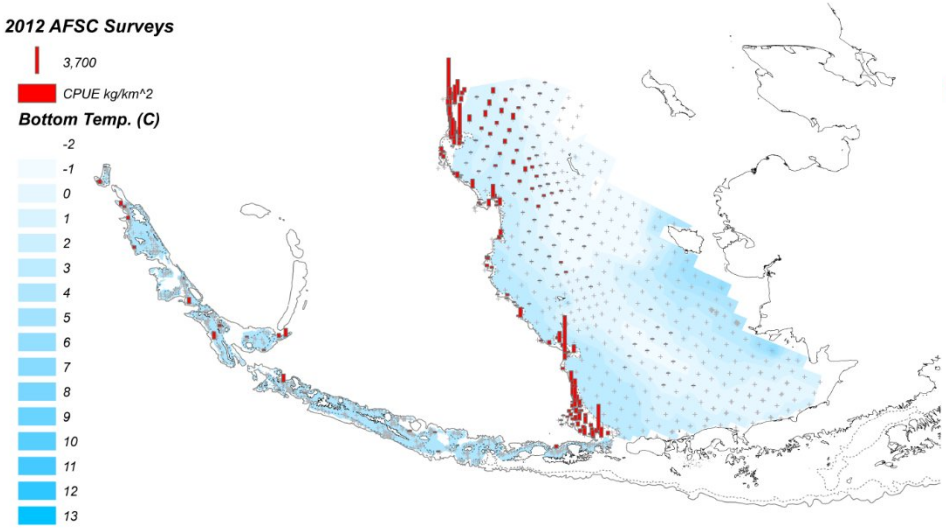
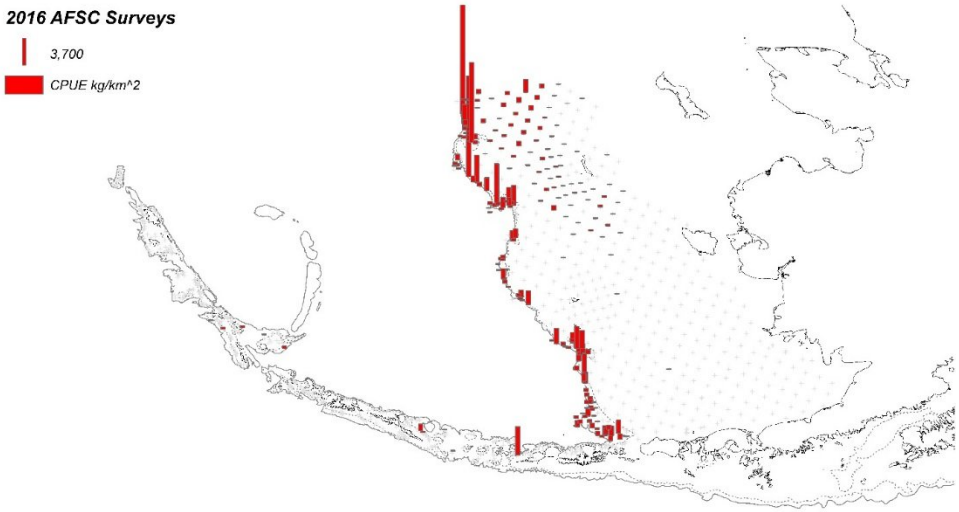
Slope survey

- Southern shift from 2012 as 2007-2009 year classes migrate downward and south.





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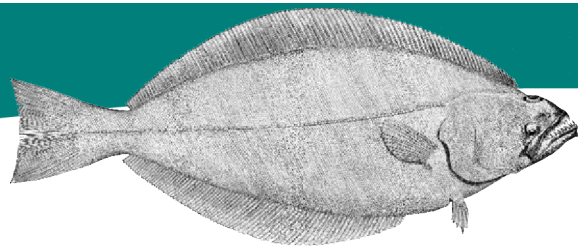
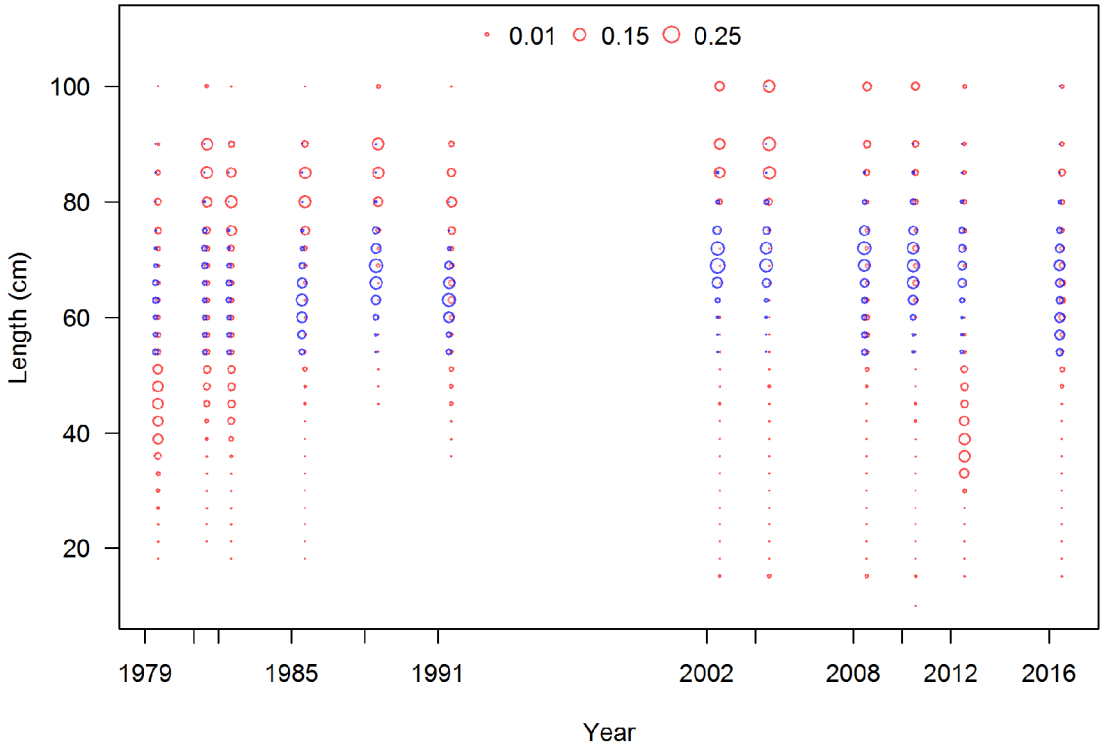


Slope size composition

- Increase in 55-75 cm fish
- Smaller fish less abundant
- Consistent with growth of 2007-2009 year classes
- Low recruitment since 2010



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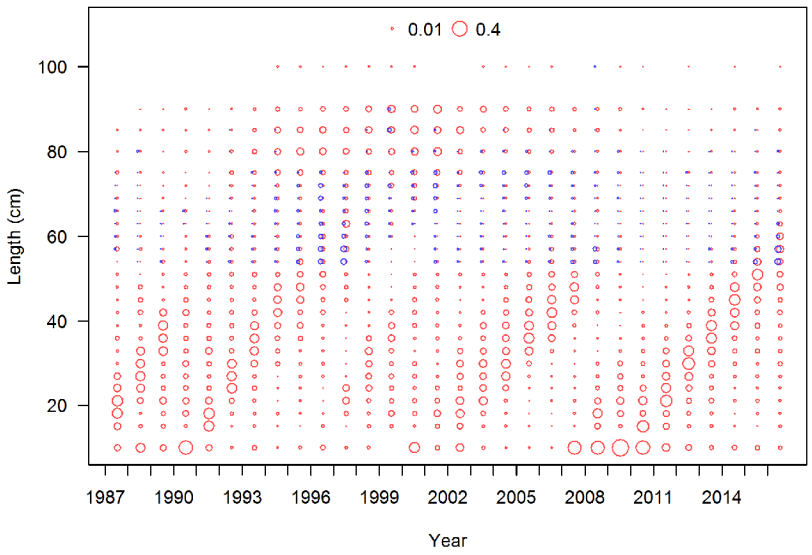
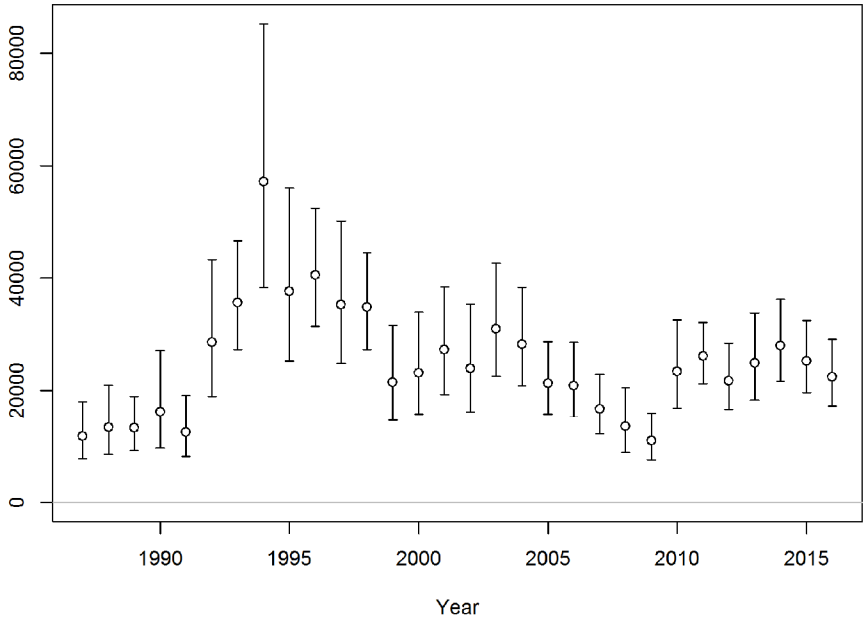
Shelf survey biomass index

- 22,429 t
- Down 11% from 2015, consistent with recent low recruitment and off-shelf migration of large 2007-2009 year classes





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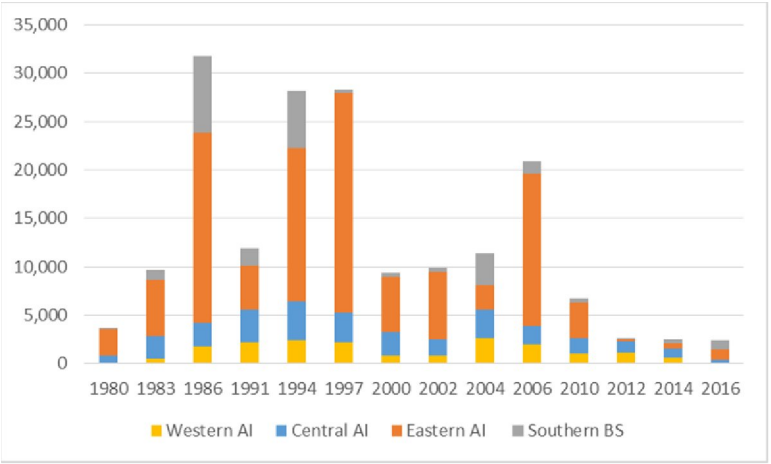
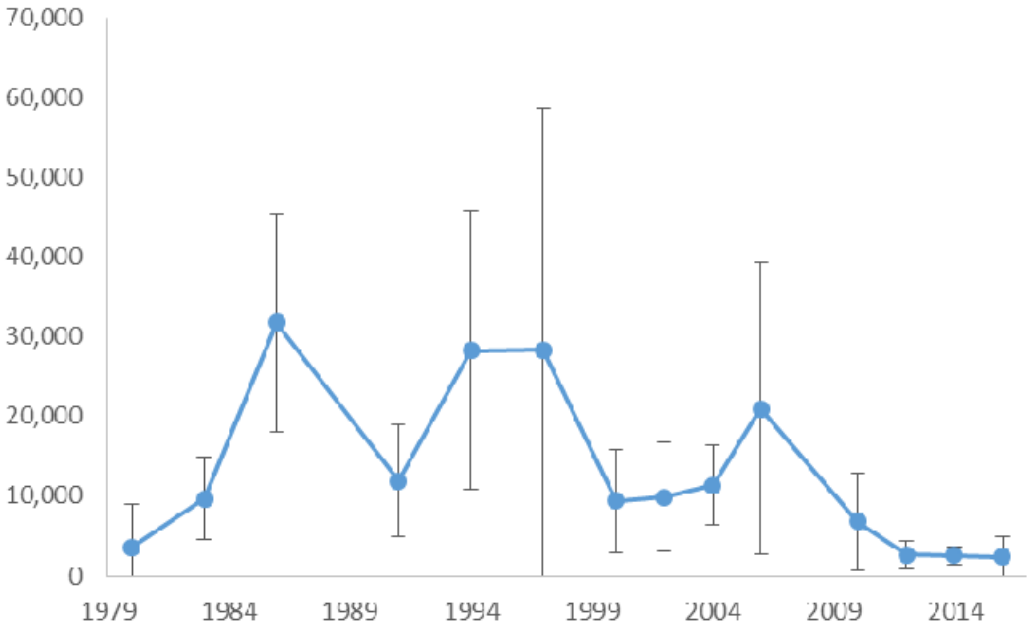
AI survey (not used in assessment)

- 2,378 t, down 6% from 2014
- Slight decline but relatively stable since 2012
- Decrease from historical levels





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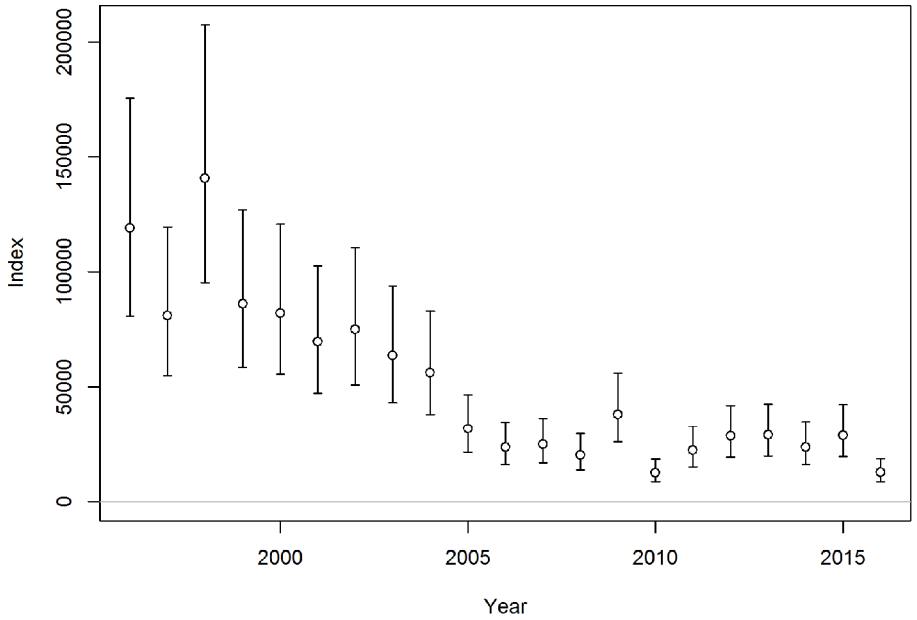
Auke Bay longline survey

- RPN index alternates between Bering Sea (odd years) and Aleutians (even years).
- Apparent decline from 2015 and 2014



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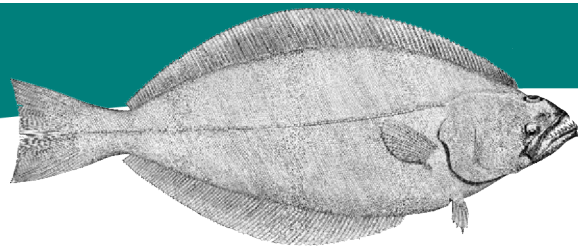
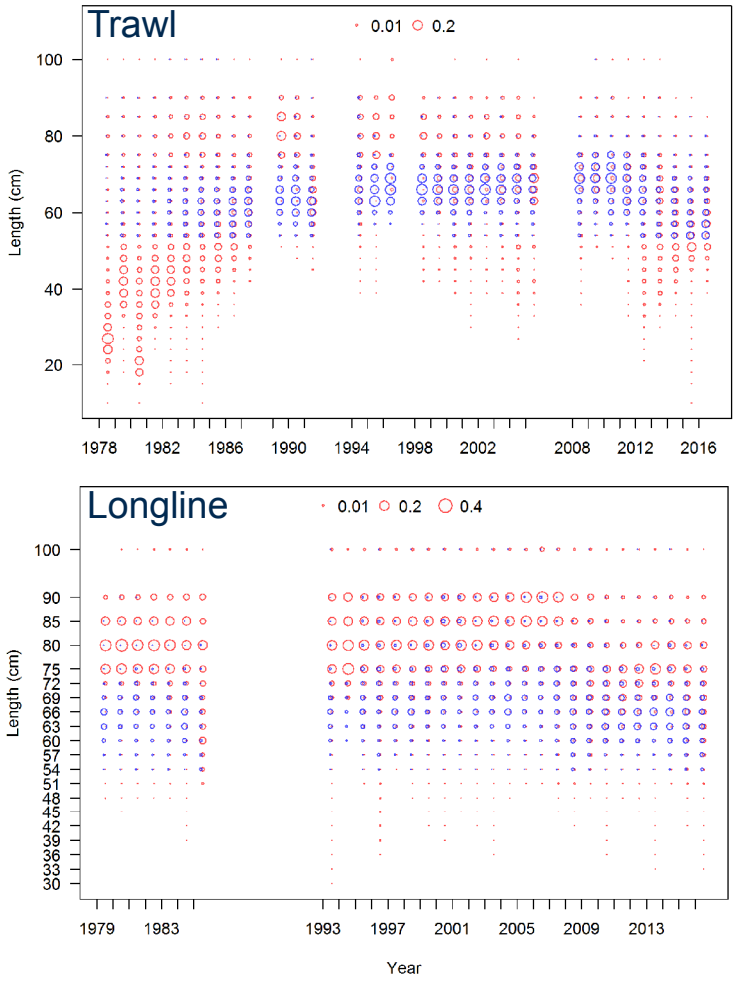
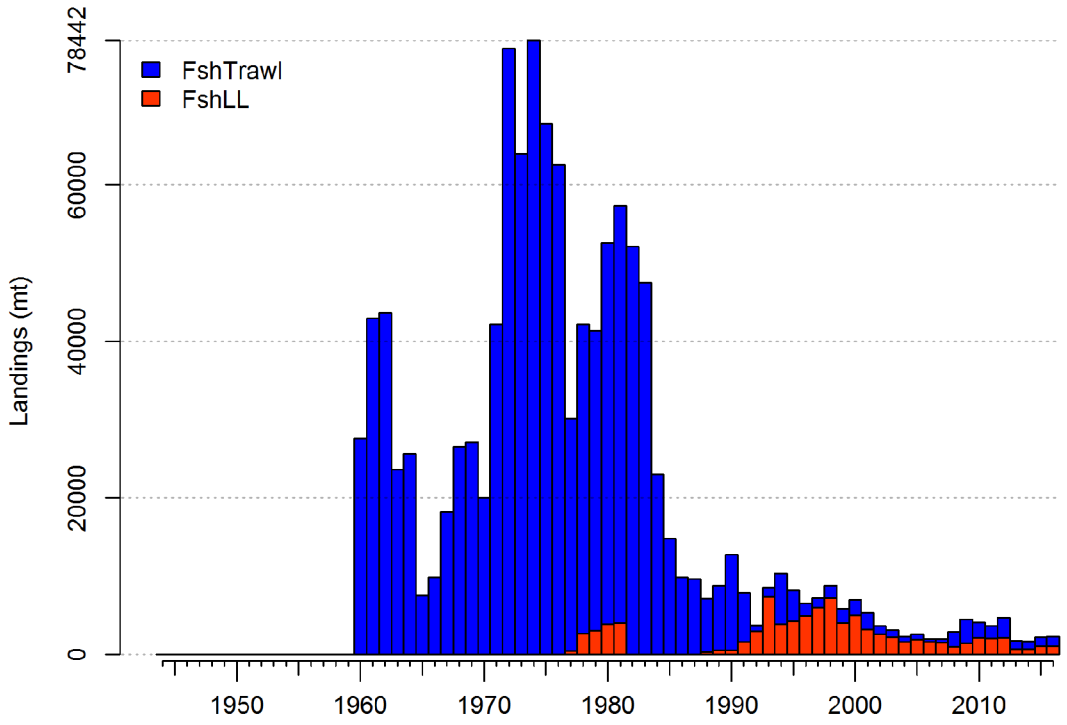


Fisheries data



- 2,002 t in 2016 as of Oct. 28
- 2,176 t in 2015



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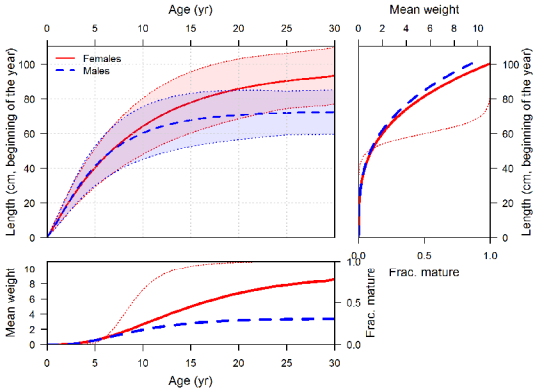
Assessment models

- All SS3 age-based statistical models
  - Split sex
  - Fixed natural mortality for both sexes
    - M = 0.112
  - Von Bertalanffy growth curve
  - Beverton-Holt stock recruitment model
    - Steepness = 0.79
    - Sigma R = 0.8
  - Fixed Q for both surveys (based on previous year's analyses)
    - Slope = 0.57
    - Shelf = 0.62



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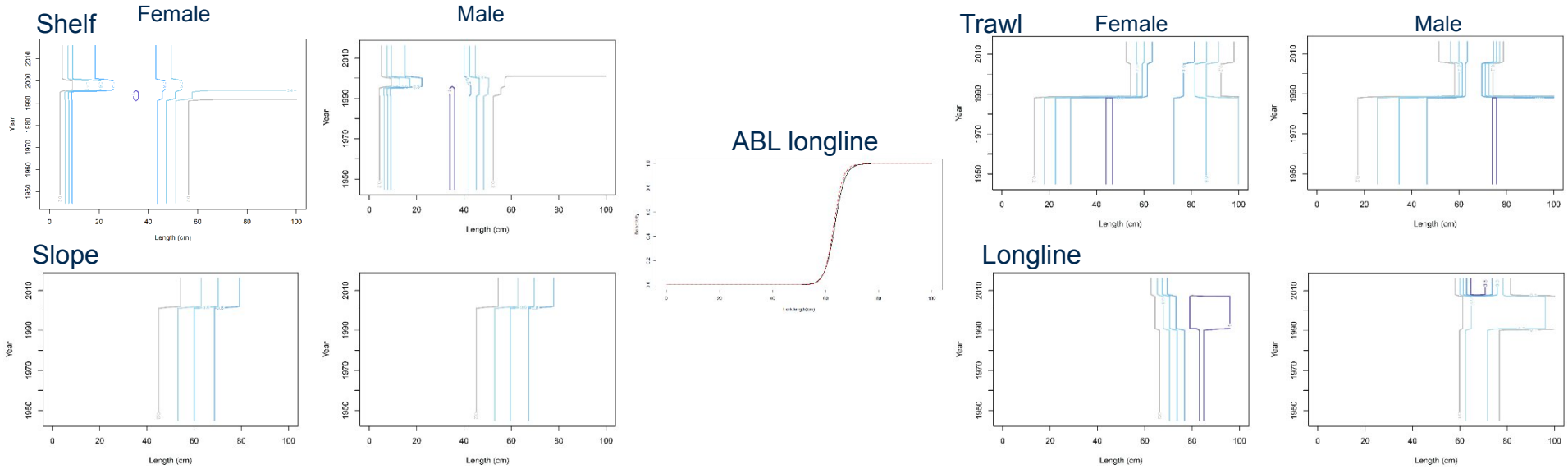
2015 accepted model - selectivity

Component	Type	Time blocks
Trawl Fishery	Double-normal	1945-1988,1989-2005, and 2006-2016
Longline Fishery	Double-normal	1945-1990,1991-2007, and 2008-2016
Shelf Survey	Double-normal	1945-1991,1992-1995,1996-2000, and 2001-2016
Slope Survey	Logistic	1945-2001 and 2002-2016
ABL longline survey	Logistic	none



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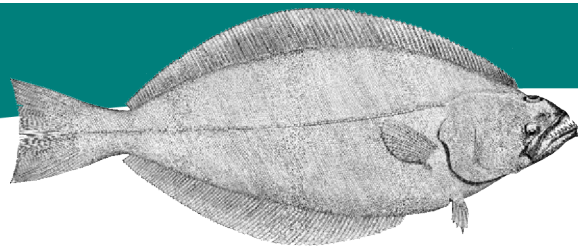

Assessment model alternatives

- **Model 15.1**
  - Same as last year's accepted model with new data.
- **Model 16.1**
  - Combine male and female comp. data at <52 cm
- **Model 16.3**
  - Slope survey to double normal
  - Added time block for Slope survey for 2011-2016
  - Allow dome-shaped selectivity on longline fishery
- **Model 16.4**
  - Same as 16.3 except ABL longline length composition data excluded
- **Model 16.6**
  - Same as 16.4 except R_0 is conditioned on bottom temperatures.

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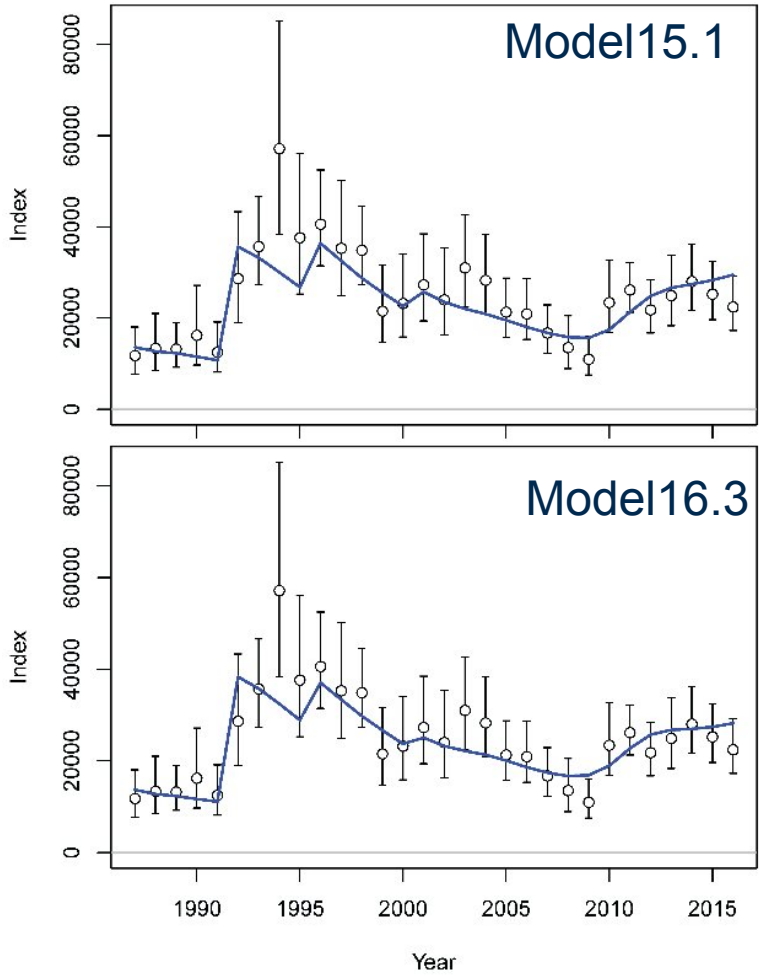
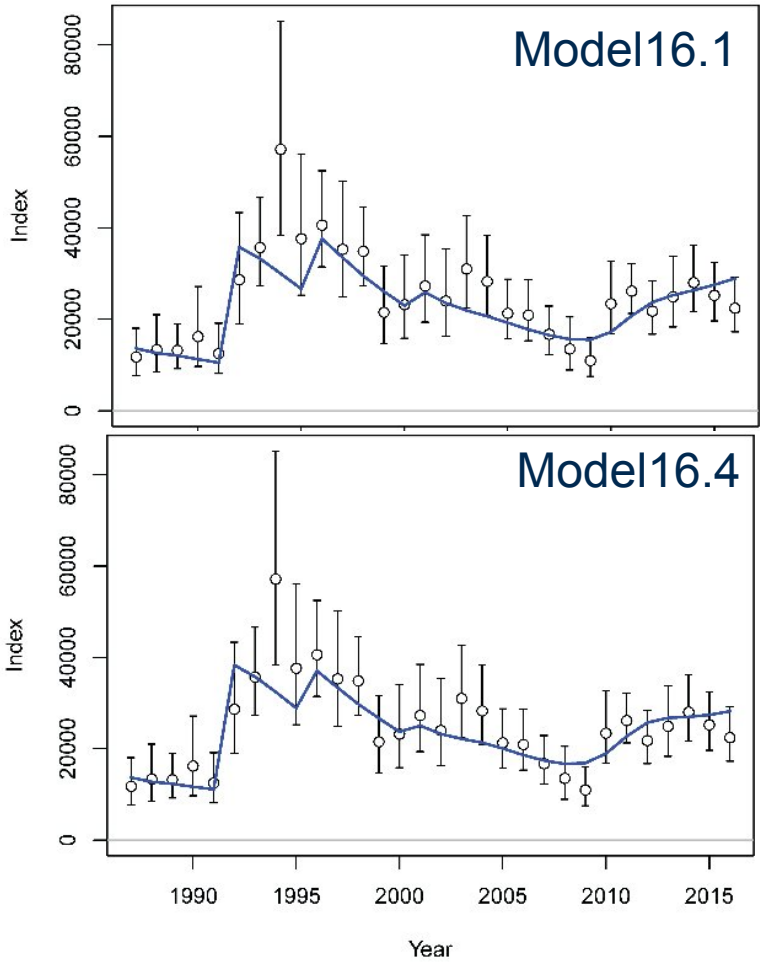
2016 model fits: Slope survey





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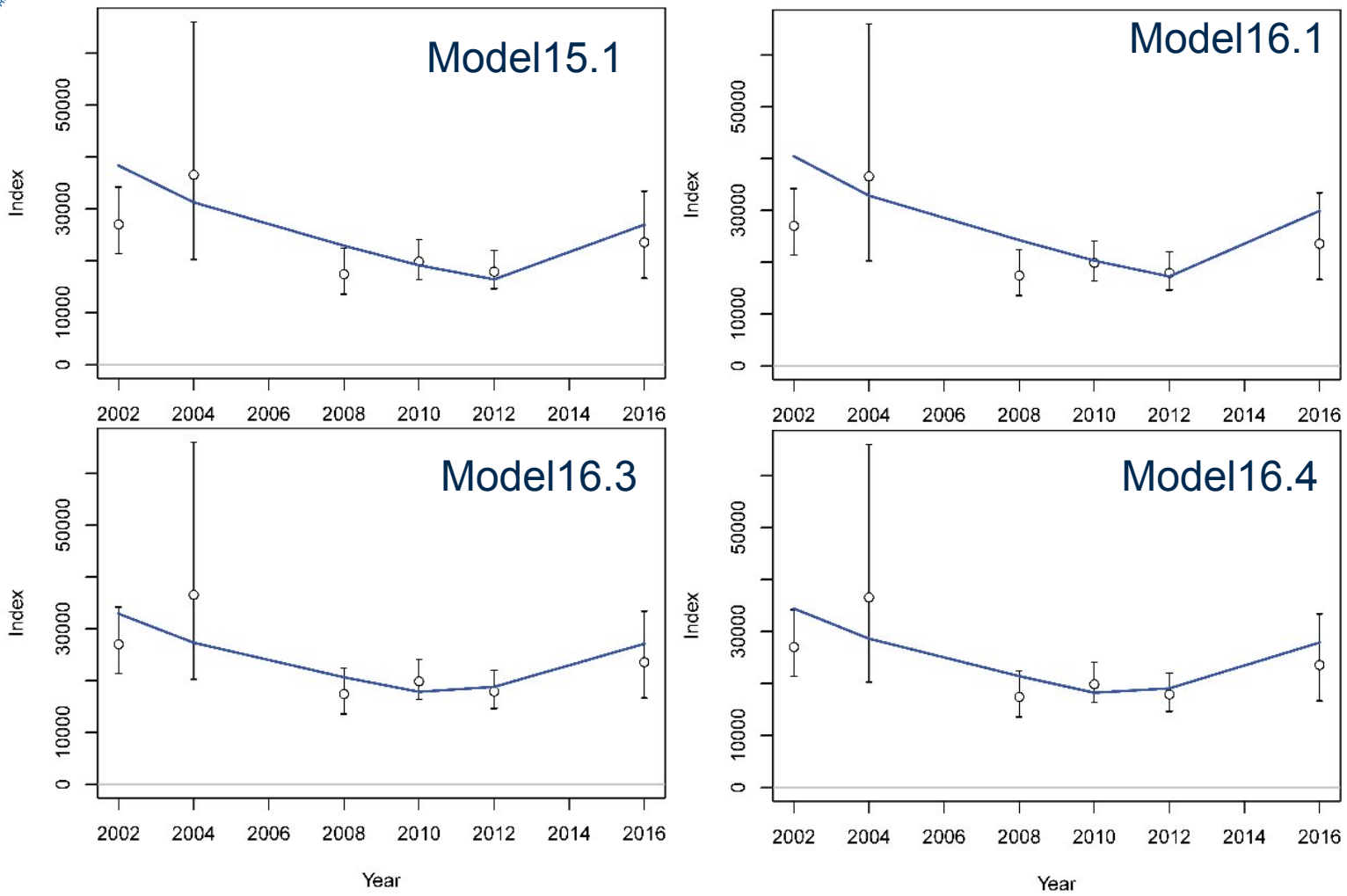
2016 model fits: Slope survey



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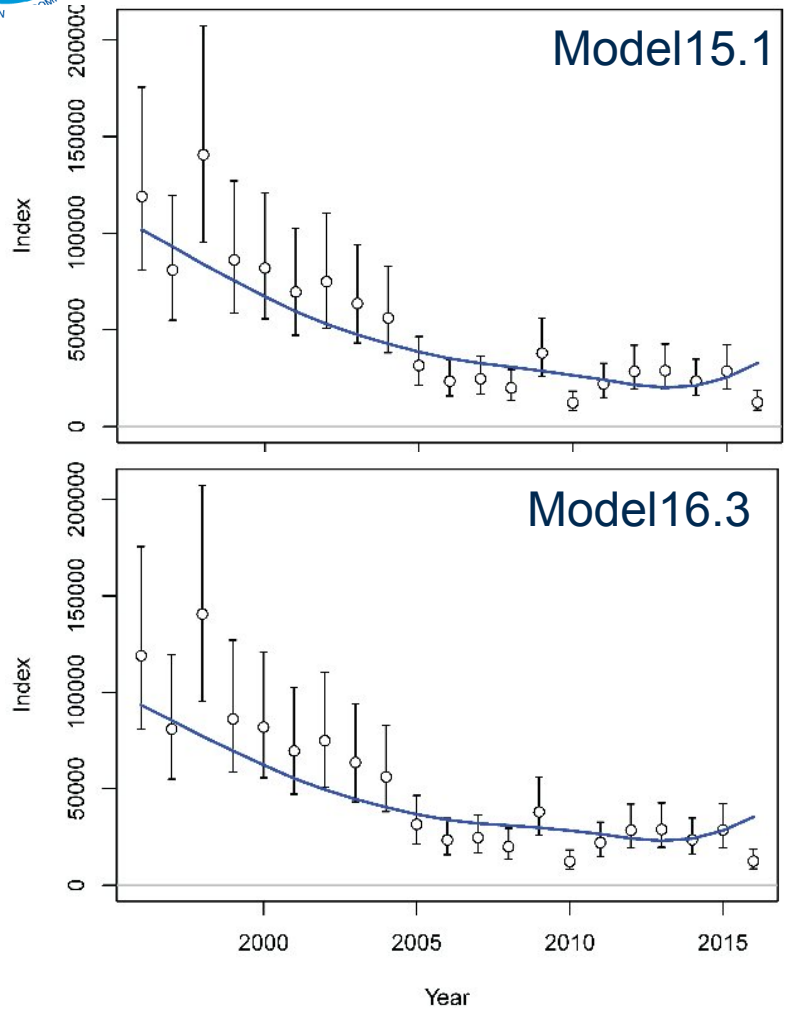
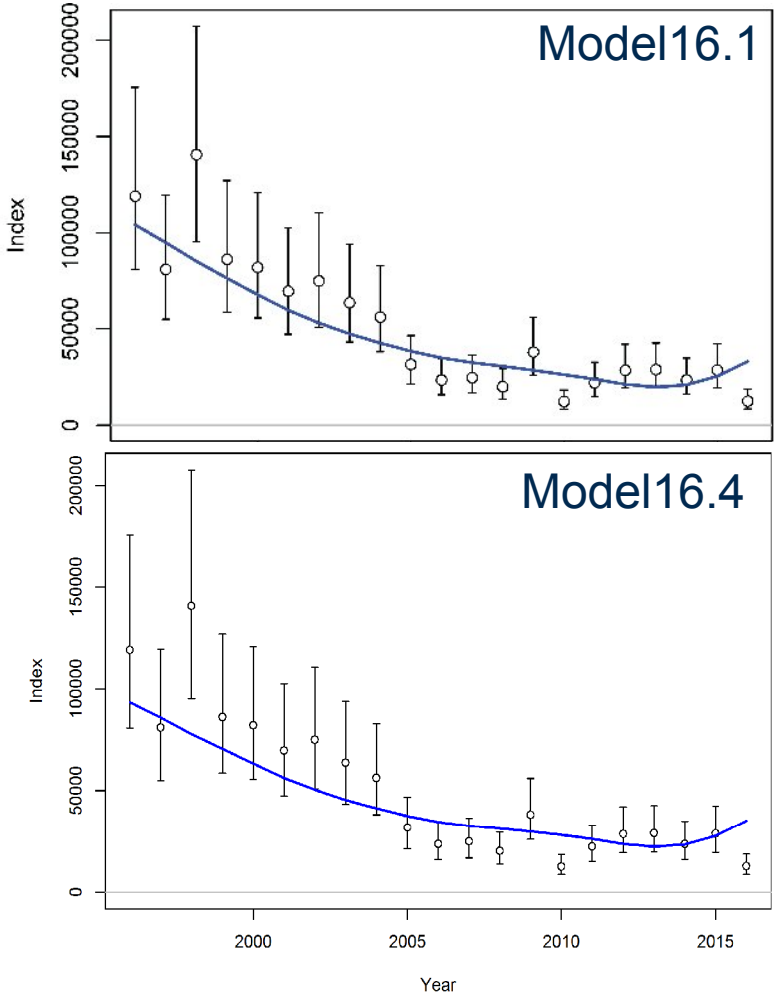
2016 model fits: ABL longline survey





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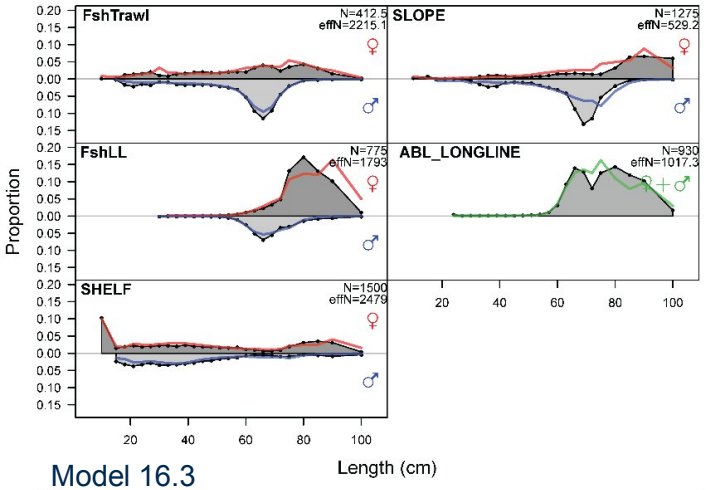
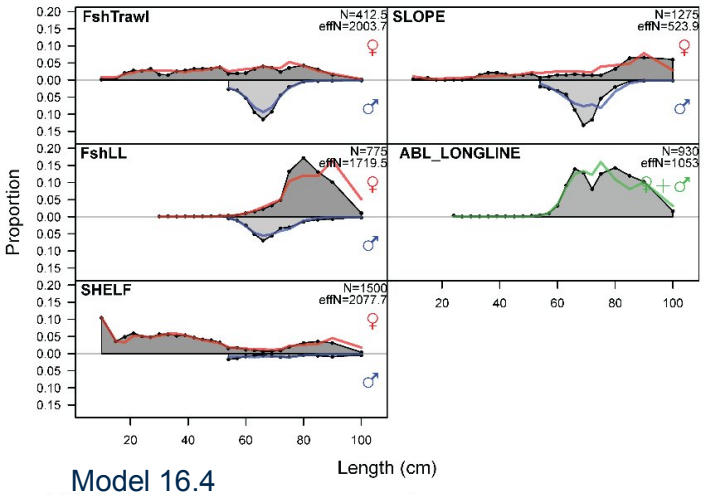
2016 model fits: Length Composition

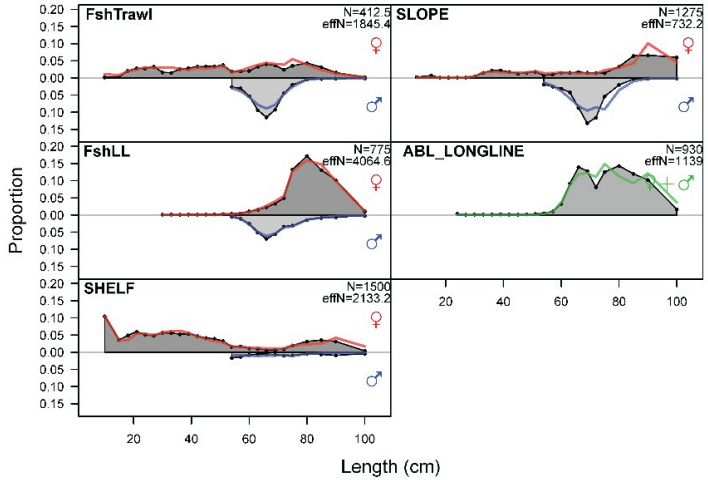
Model 15.1



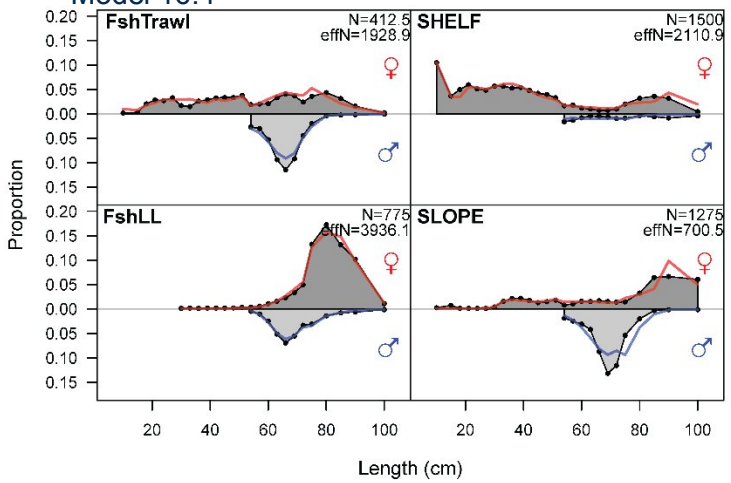
Model 16.1



Model 16.3



Model 16.4



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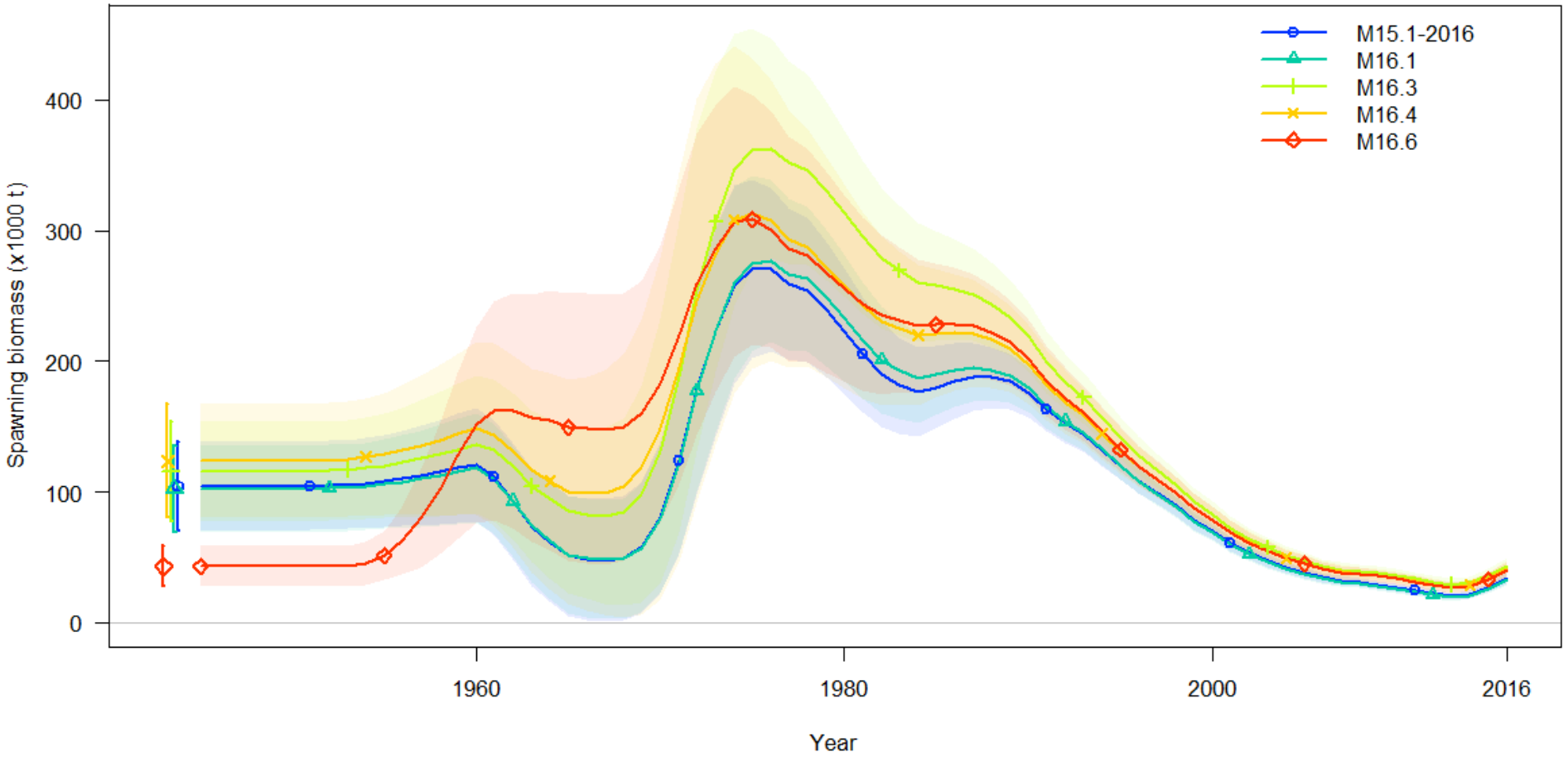

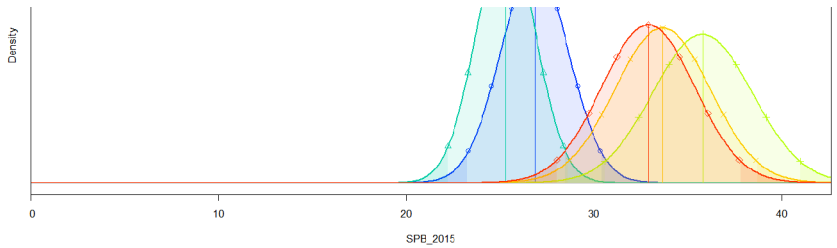

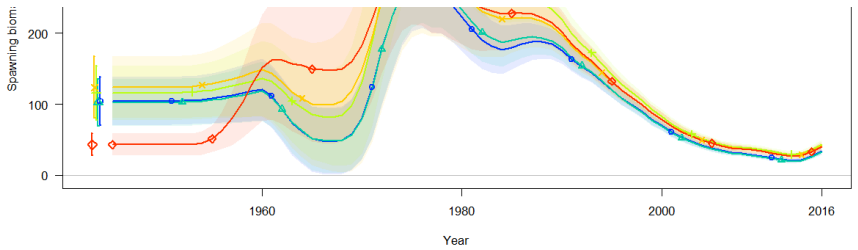

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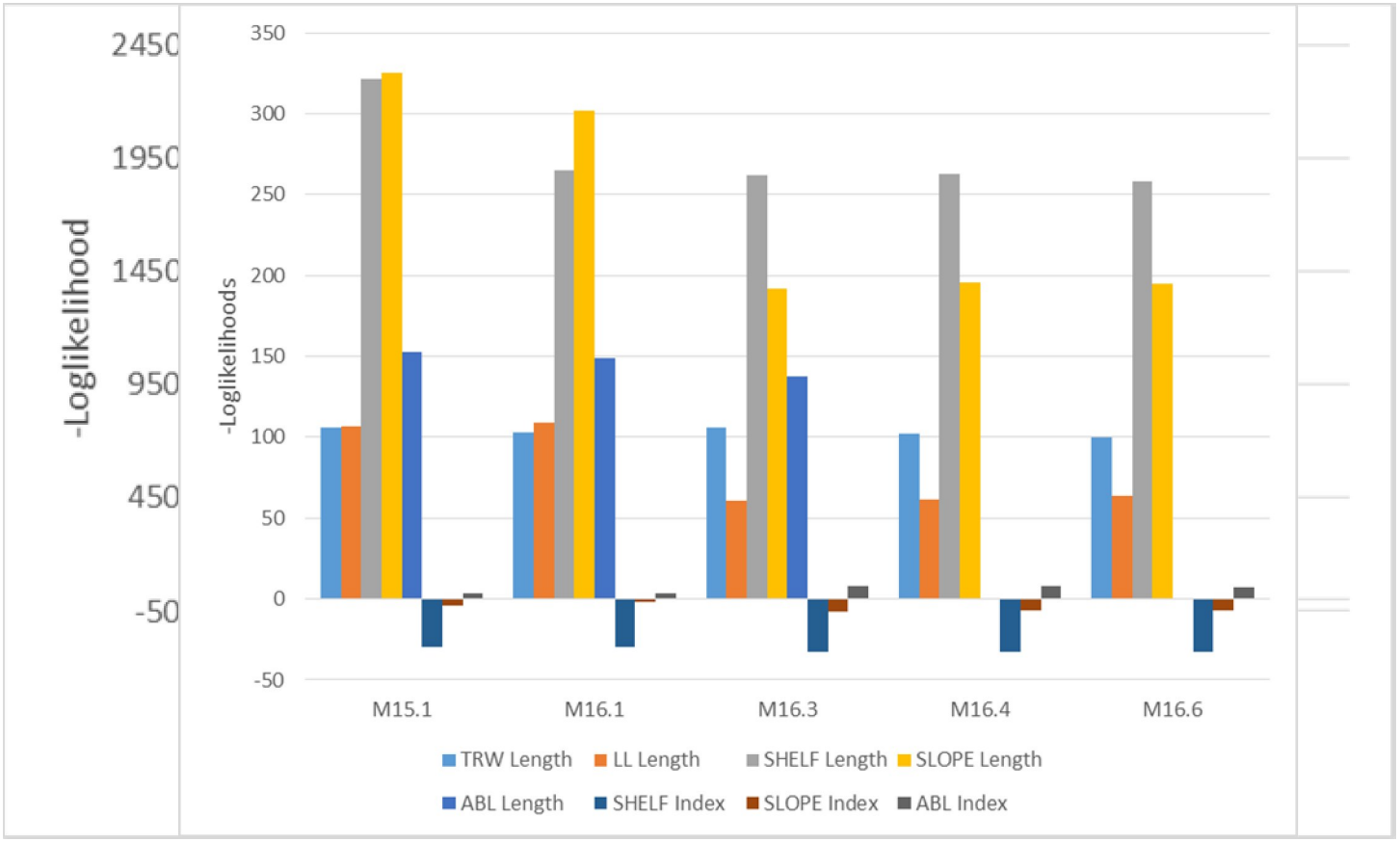
2016 model selection

- Models 15.1, 16.1, and 16.3 likelihoods are not fully comparable to 16.4 and 16.6 due to differences in data



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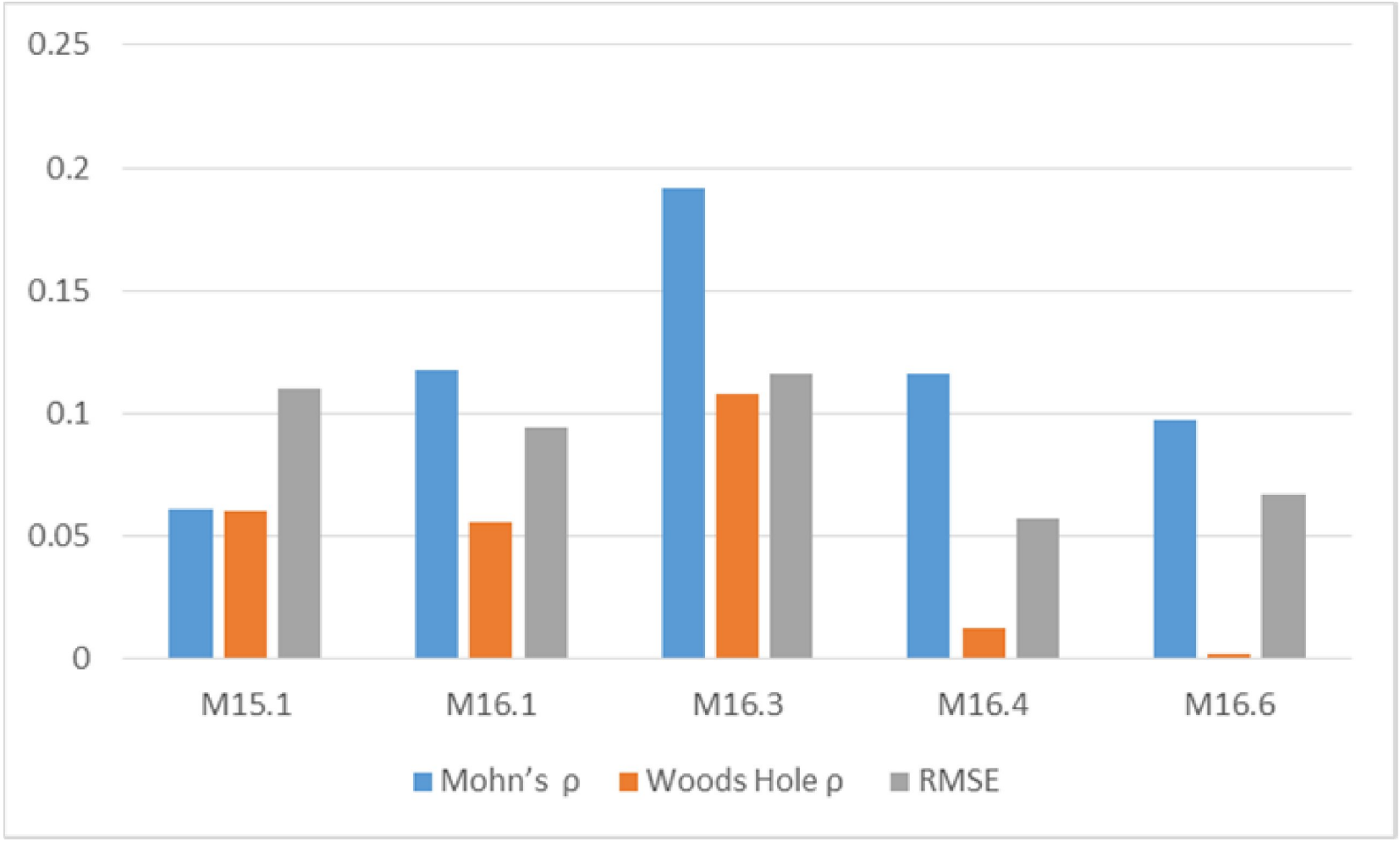
2016 model selection: Retrospectives



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Model	M15.1	M16.1	M16.3	M16.4	M16.6
Likelihoods					
Total	2242.32	2160.85	1979.64	1836.72	1806.26
Survey	-30.15	-27.54	-32.54	-32.15	-32.99
Length Composition	1012.02	927.16	757.58	622.41	616.89
Age Composition	0.000	0.000	0.000	0.000	0.00
Size at Age	1156.58	1155.46	1150.60	1144.47	1144.58
Recruitment	97.33	98.96	96.17	94.12	73.10
Parameter priors	3.98	3.99	4.00	4.00	3.84
Parameters					
LN(R_0)	0.012	0.012	0.014	0.014	0.005
Steepness	0.79	0.79	0.79	0.79	0.79
Natural Mortality	0.112	0.112	0.112	0.112	0.112
q_{Shelf}	0.616	0.616	0.616	0.616	0.616
q_{Slope}	0.573	0.573	0.573	0.573	0.573
Autocor (ρ)	0.601	0.603	0.595	0.607	0.35
L_{max} Female	89.9	89.8	89.5	90.4	90.3
L_{max} Male	71.9	71.8	71.7	72.0	72.0
Von Bert K Female	0.112	0.110	0.115	0.111	0.111
Von Bert K Male	0.186	0.190	0.188	0.187	0.185

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	M15.1	M16.1	M16.3	M16.4	M16.6
Retrospective					
Mohn's ρ	0.06	0.12	0.19	0.12	0.10
Woods Hole ρ	0.06	0.06	0.11	0.01	0.00
RMSE	0.11	0.09	0.12	0.06	0.07
Index RMSE					
Shelf	0.22	0.22	0.21	0.21	0.21
Slope	0.20	0.24	0.18	0.18	0.18
ABL Longline	0.37	0.37	0.40	0.39	0.39
Size Comp					
Har. Mean EffN					
Trawl	41.2	37.3	35.1	36.6	36.8
Longline	47.8	45.8	92.48	91.3	88.7
Shelf	64.9	48.6	48.6	48.7	51.3
Slope	38.6	38.3	48.9	47.9	48.1
ABL Longline	26.7	27.7	31.3	NA	NA
Mean input N					
Trawl	12.5	12.5	12.5	12.5	12.5
Longline	25	25	25	25	25
Shelf	50	50	50	50	50
Slope	106.25	106.25	106.25	106.25	106.25
ABL Longline	30	30	30	NA	NA
Rec. Var. (1975-2015)					
Std.dev(ln(No. Age 1))	1.58	1.60	1.55	1.56	1.51

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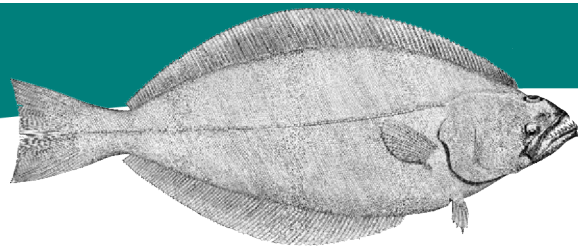

Model	M15.1	M16.1	M16.3	M16.4	M16.6
SSB_{1978} (t)	254,579	262,880	346,327	287,129	280,595
Projection					
$SSB_{100\%}$ (t)	105,877	102,330	105,035	103,097	98,621
SSB_{2016} (t)	34,468	32,507	43,477	41,404	40,964
$SSB_{2016\%}$	32.5	31.8	41.4	40.2	41.5
SSB_{2017}(t)	43,545	41,050	52,360	50,461	50,005
$SSB_{2017\%}$	41.0	40.1	49.9	48.9	50.7
$F_{35\%}$	0.165	0.165	0.216	0.218	0.218
$F_{40\%}$	0.136	0.136	0.181	0.183	0.183
2017					
ABC (t)	8,172	7,749	10,079	9,824	9,743
F_{ABC}	0.136	0.136	0.181	0.183	0.183
OFL (t)	9,836	9,285	11,948	11,615	11,520
F_{OFL}	0.165	0.165	0.216	0.218	0.218
2018					
ABC (t)	8,997	8,540	10,827	10,635	10,564
F_{ABC}	0.136	0.136	0.181	0.183	0.183
OFL (t)	10,820	10,225	12,822	12,561	12,478
F_{OFL}	0.165	0.165	0.216	0.218	0.218

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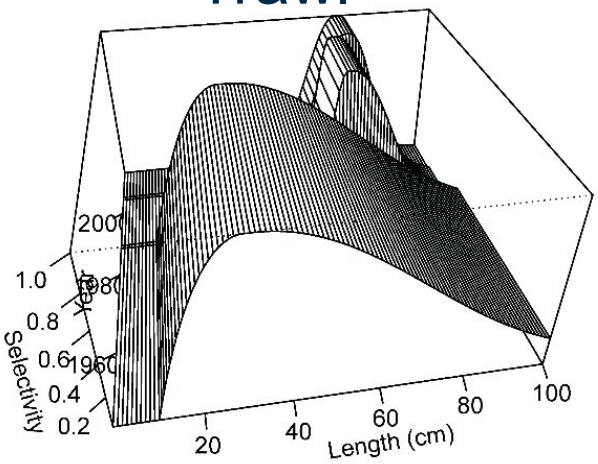
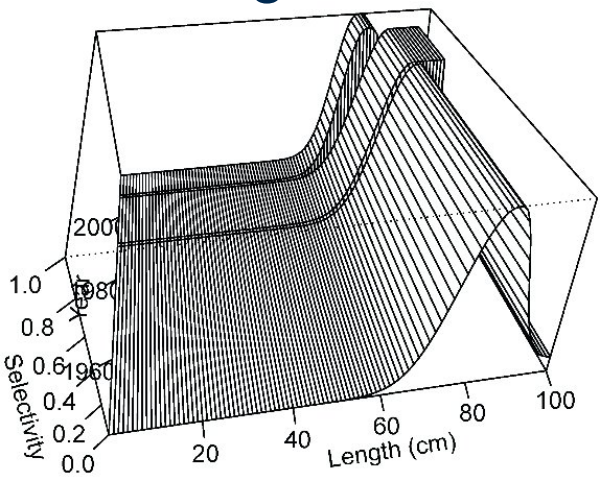
Model 16.4: Fishery selectivity

Trawl

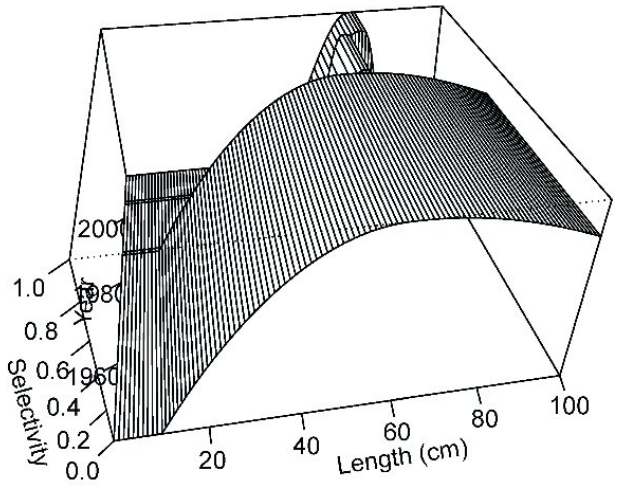
Longline

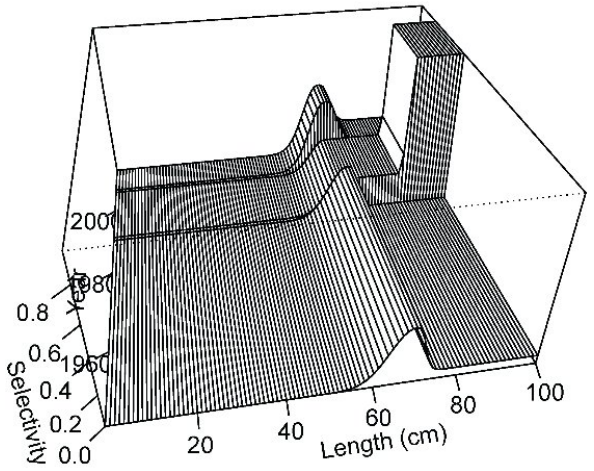
Female





Male





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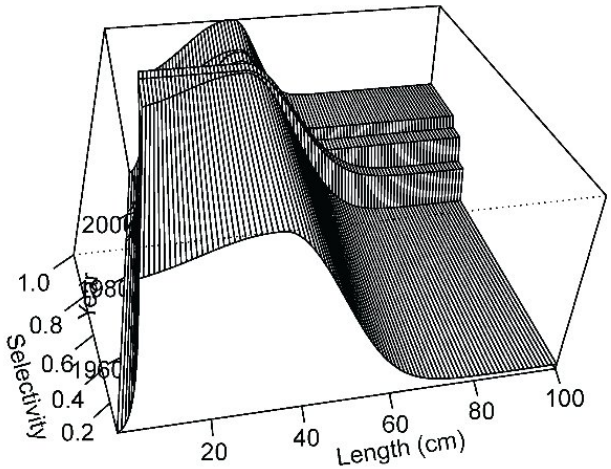
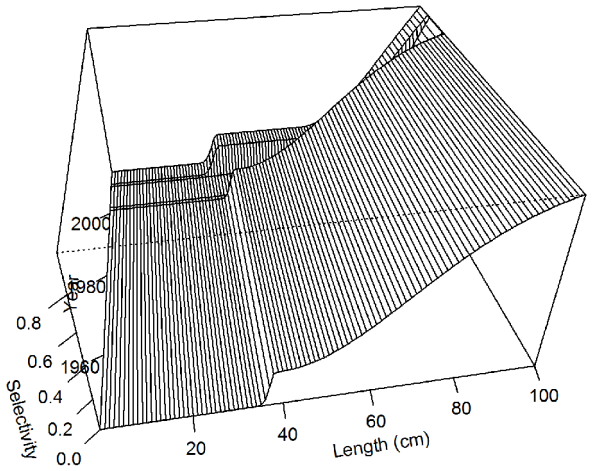
Model 16.4: Survey selectivity

Shelf

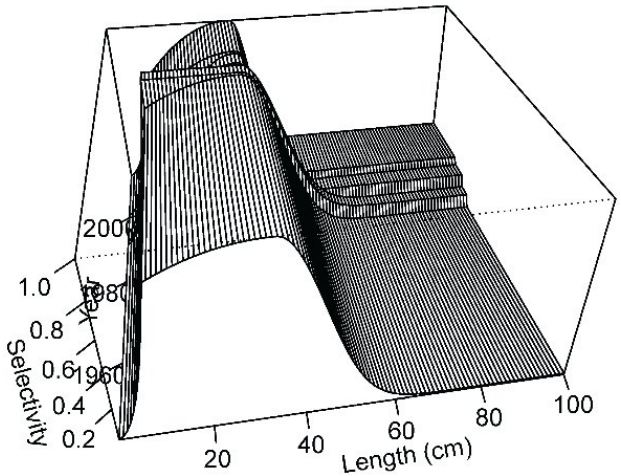
Slope

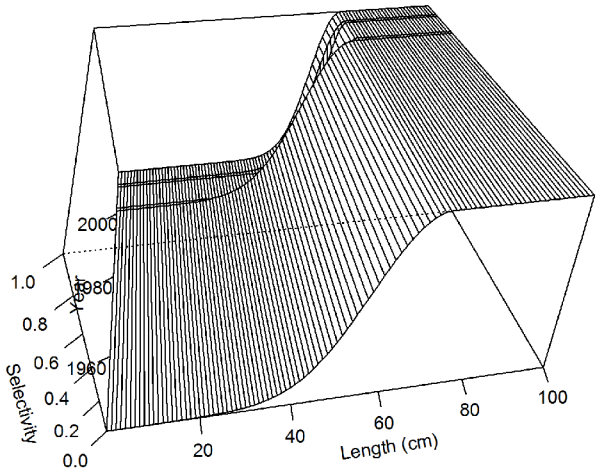
Female





Male





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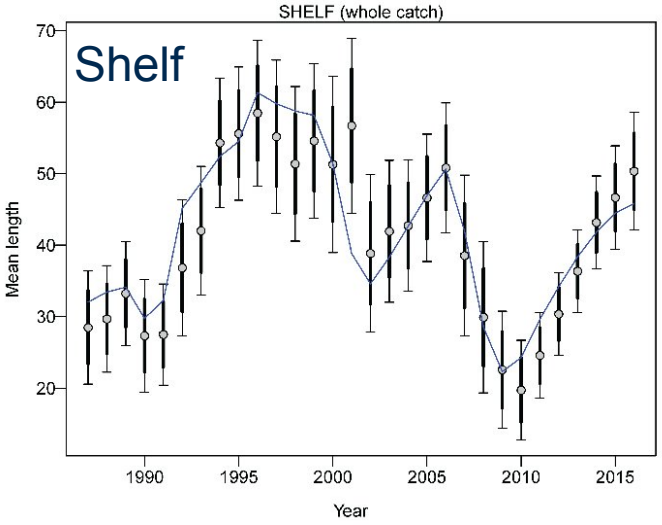
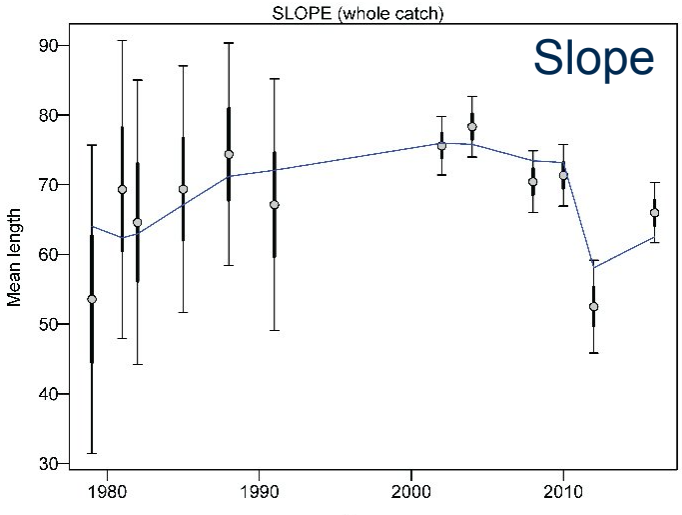
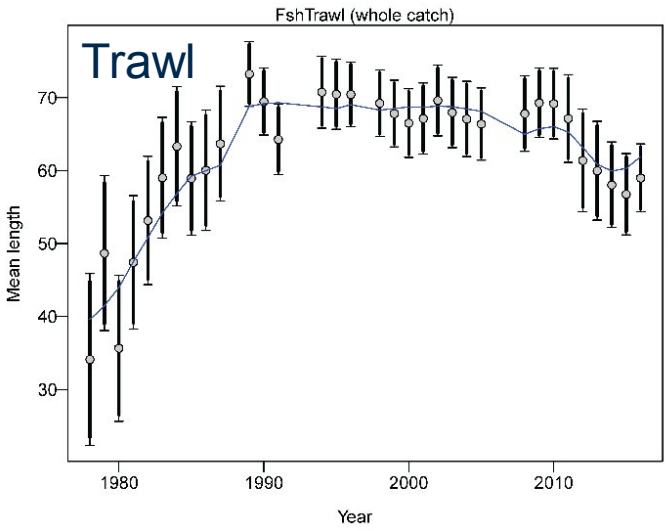
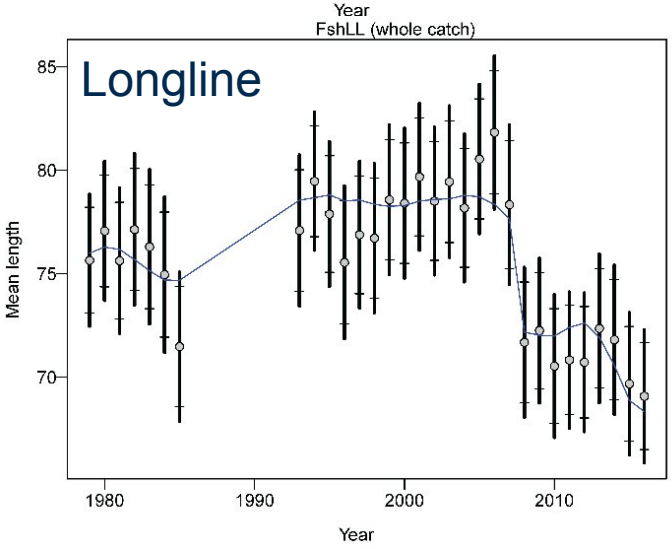
Model 16.4: Mean lengths









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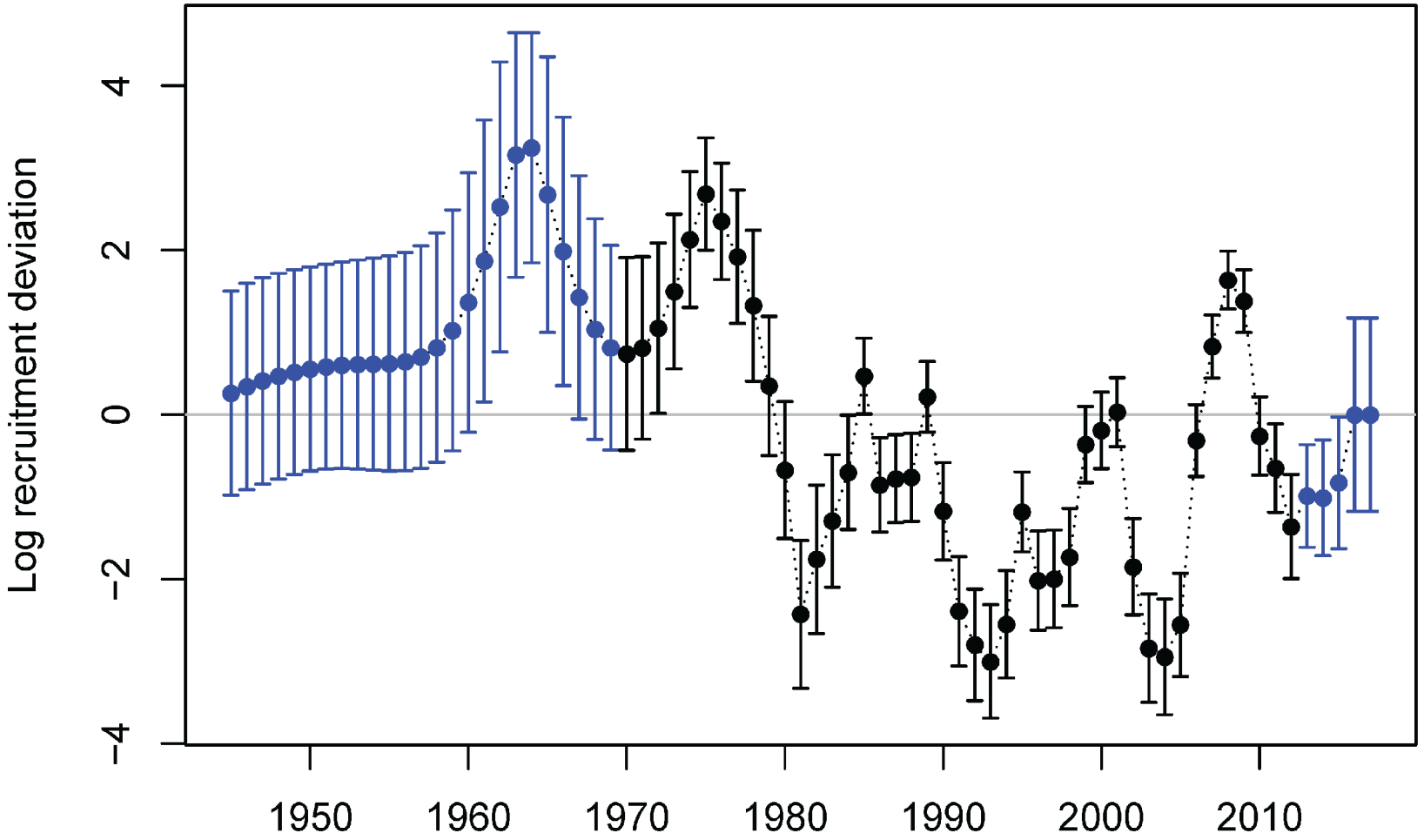
Model 16.4: Recruitment



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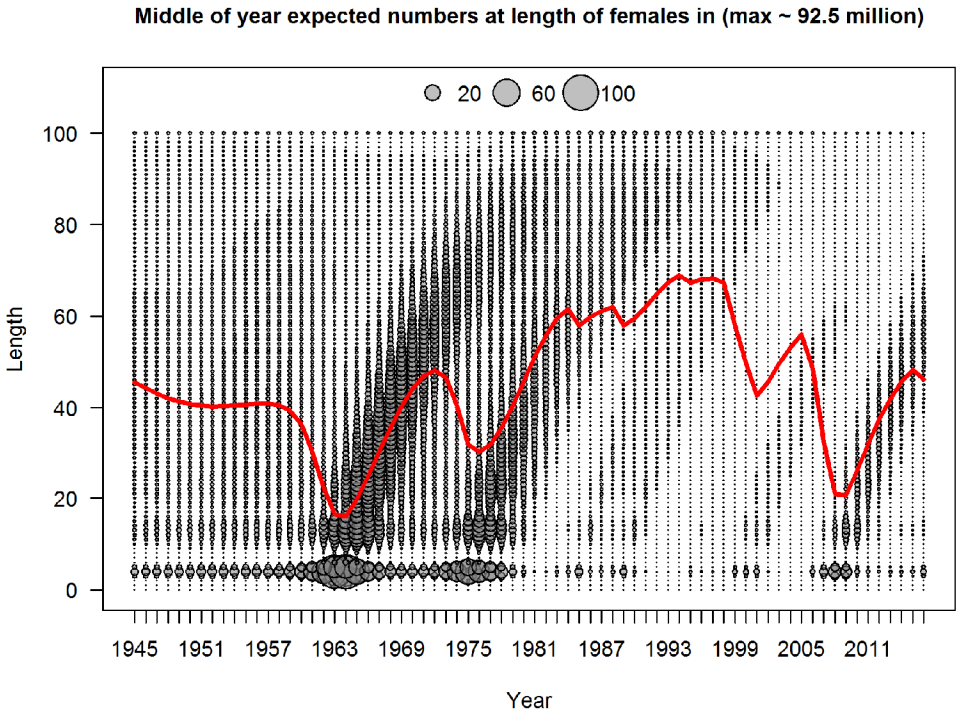
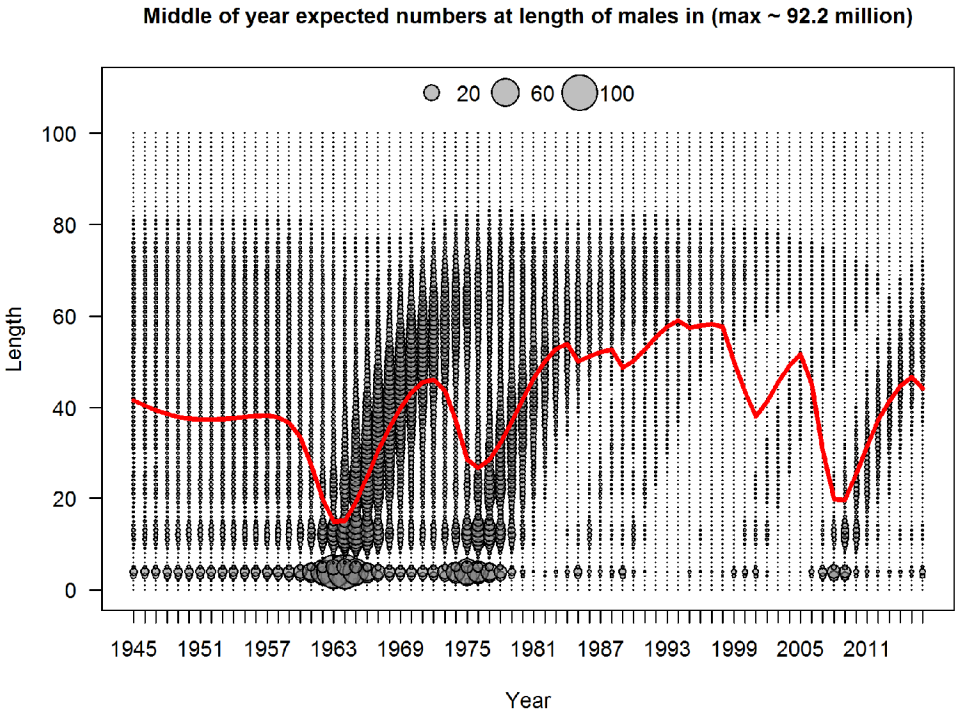
Model 16.4: Numbers at age





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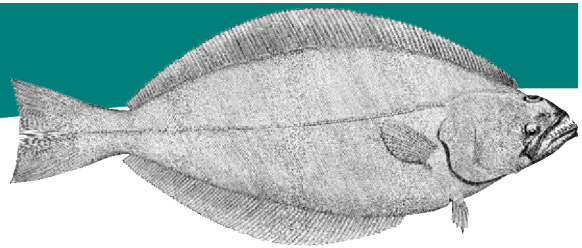
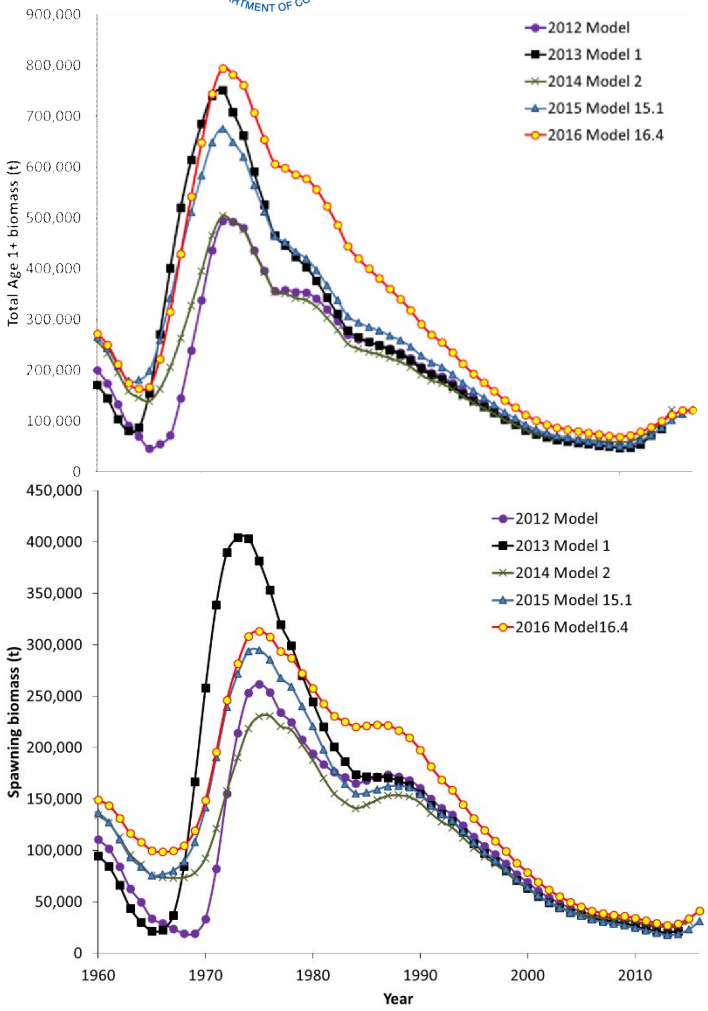
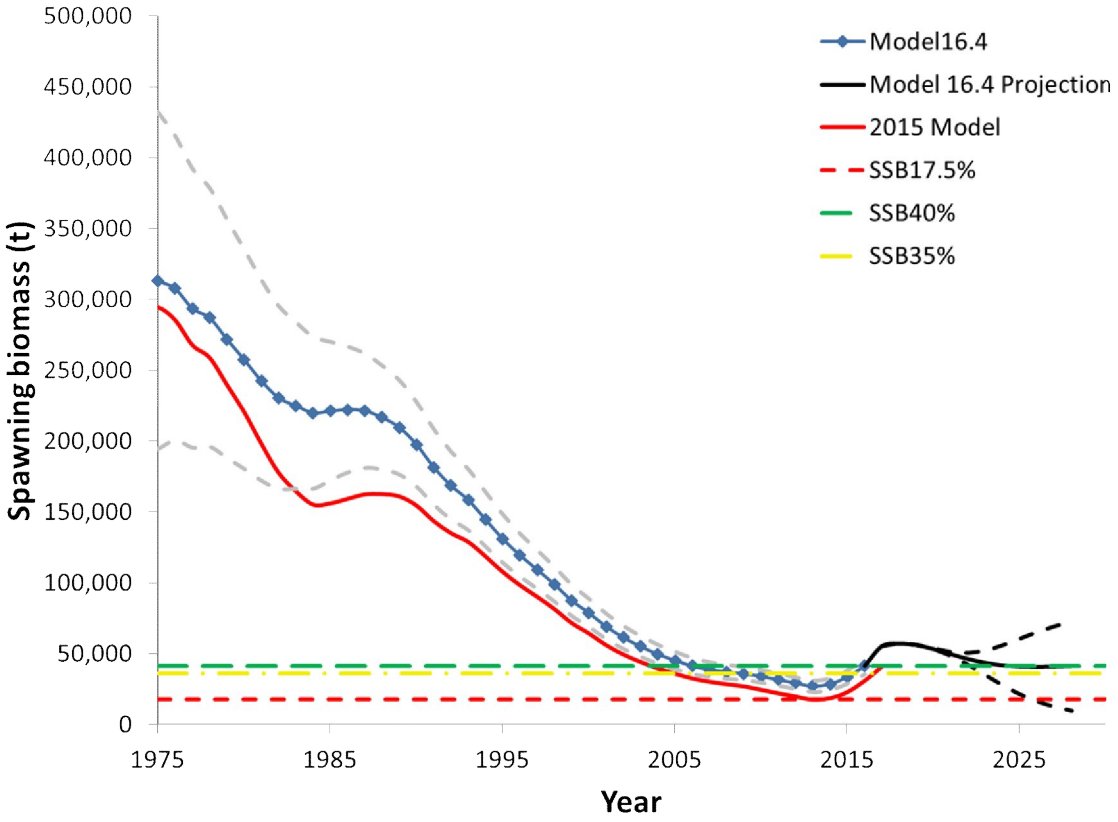


Model 16.4: Biomass trends





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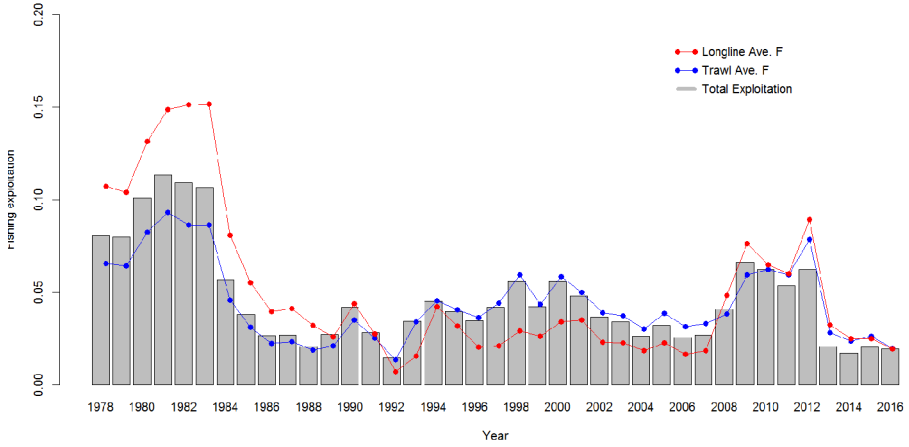
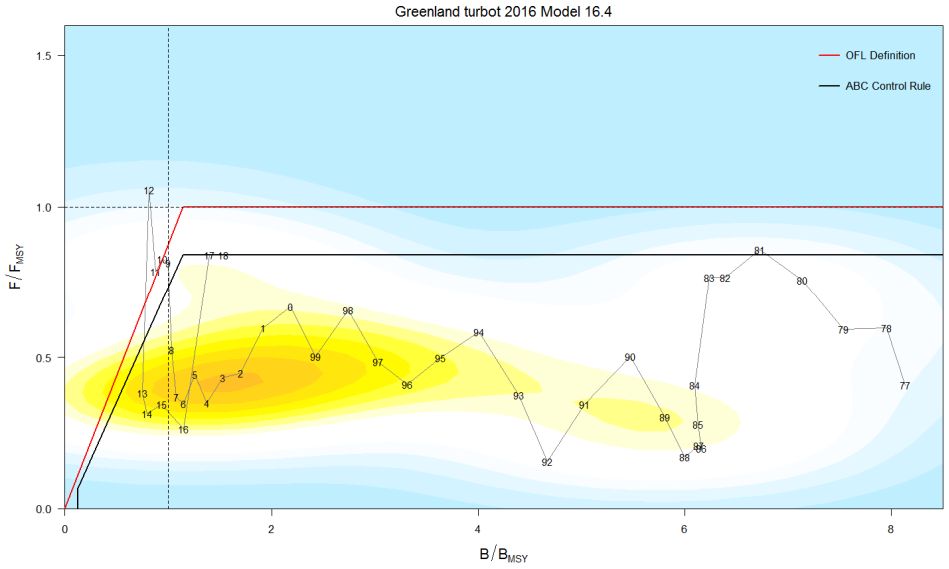
Model 16.4: Fishing mortality and status

- Low F since 2013
- Conservative harvests for 2013-2016





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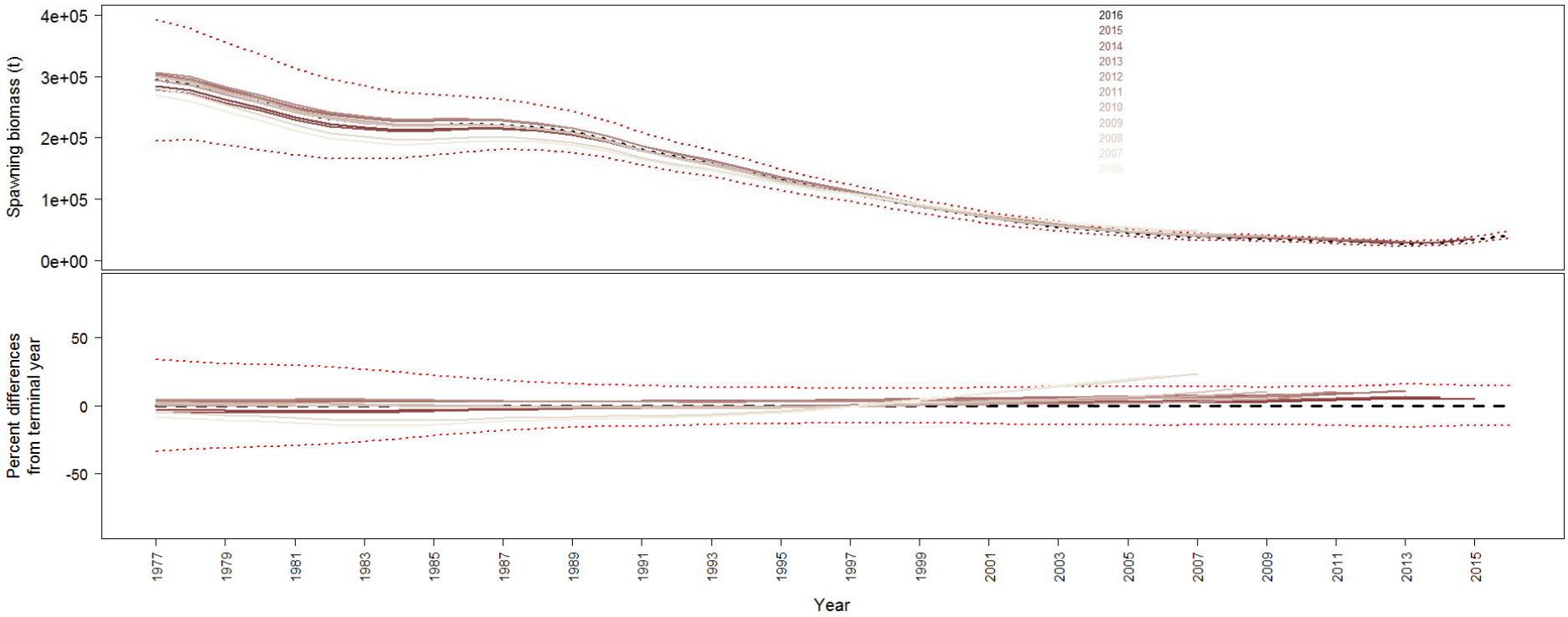
Model 16.4: Retrospective

Mohn's ρ = 0.12 Woods Hole ρ = 0.01

RMSE = 0.06



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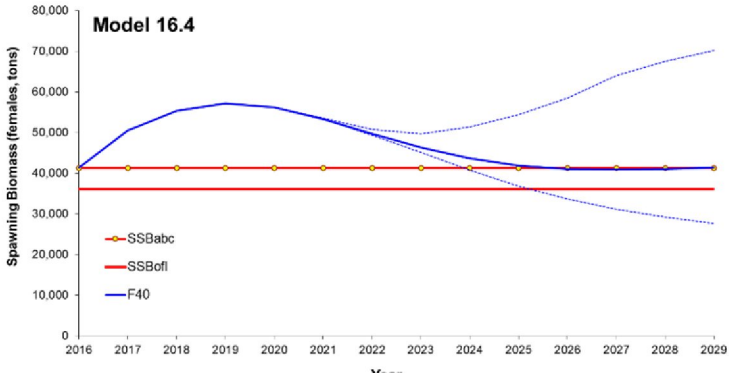
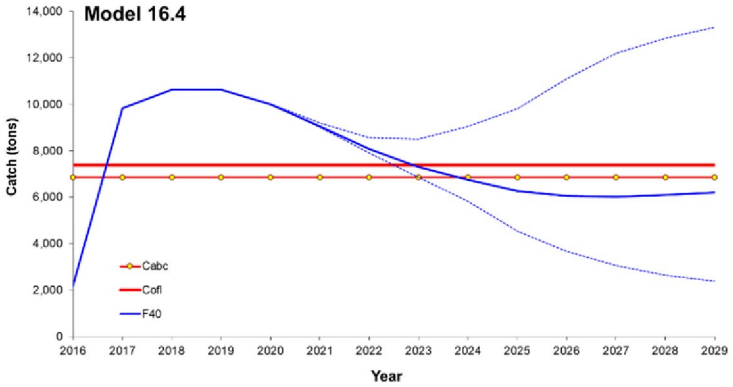
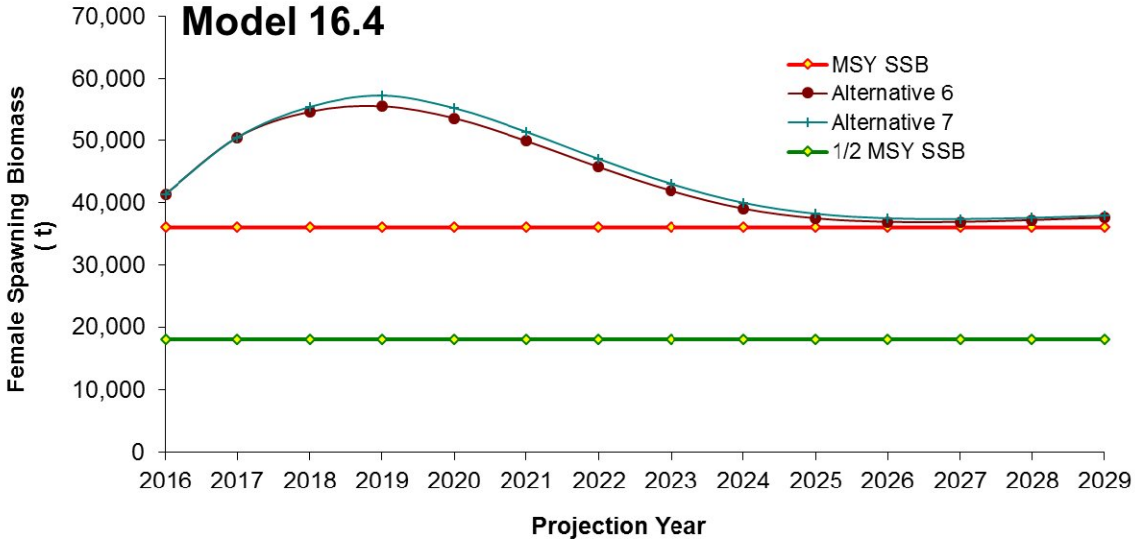
Author's choice Model 16.4







- Not overfished or approaching an overfished condition

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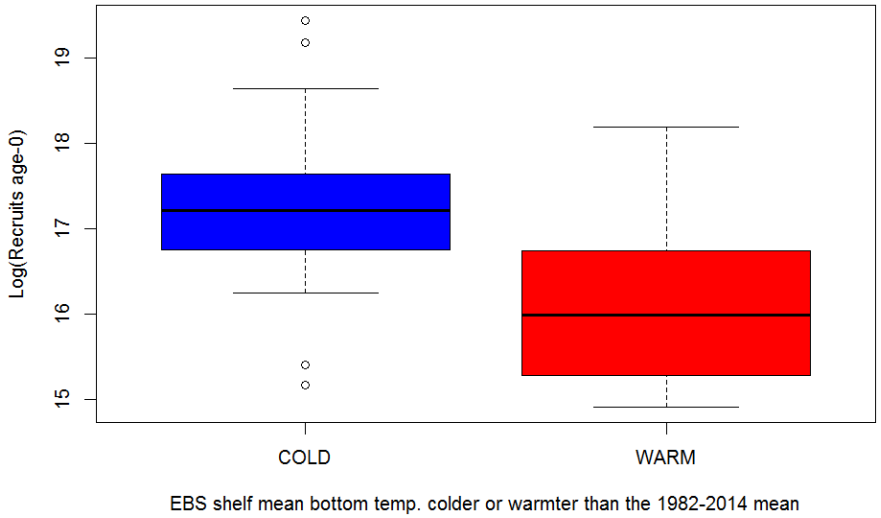
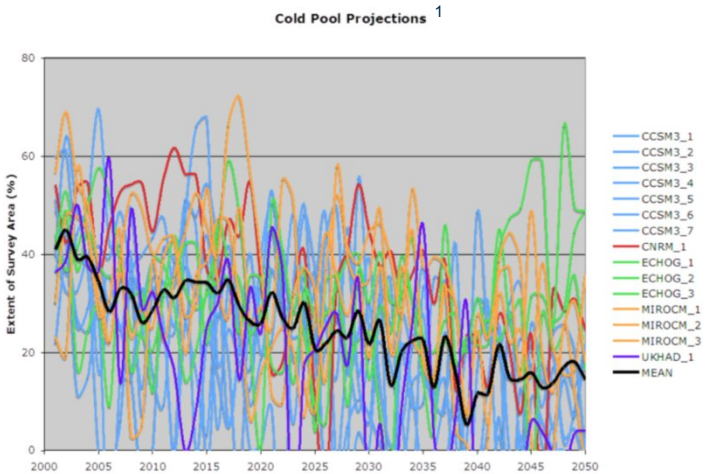
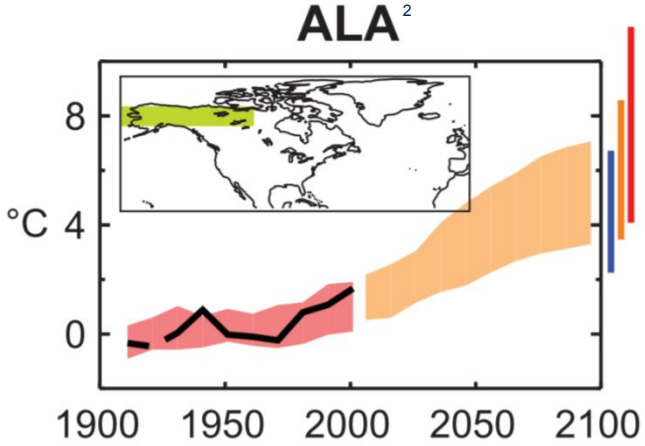
Alternative harvest specifications for Model 16.4

- Lower recruitment in warm years
- Projections suggest warmer climate in near future



EBS shelf mean bottom temp. colder or warmter than the 1982-2014 mean





1 Walsh, J. and N. Bond. 2016. Climate scenarios and vulnerabilities in the Aleutian and Bering Sea islands, ABSI Stakeholder workshop.

2 Christensen, J.H. and associates 2007: Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

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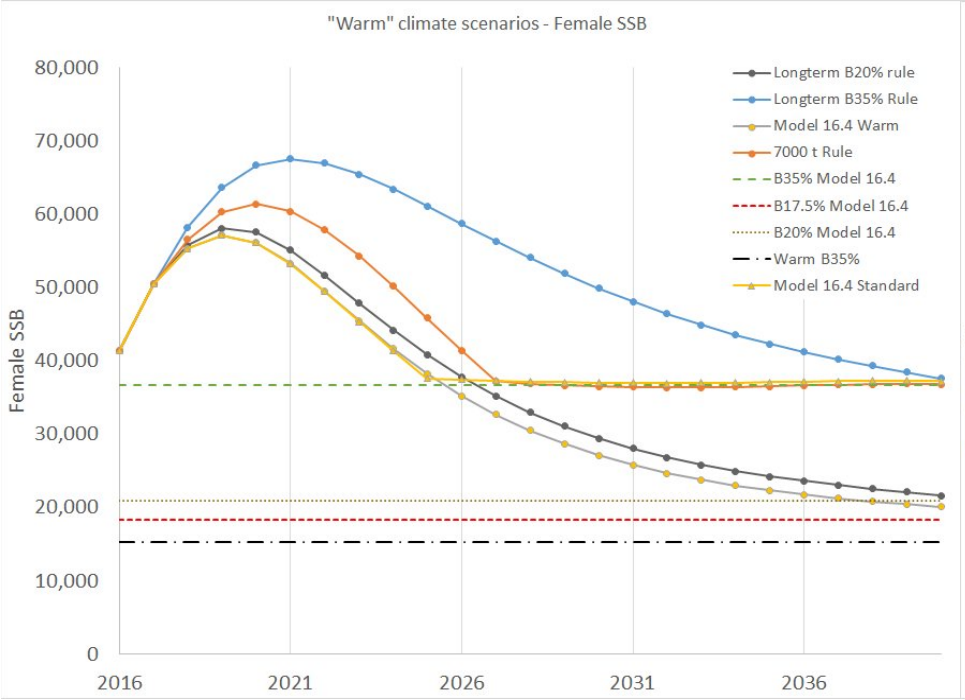
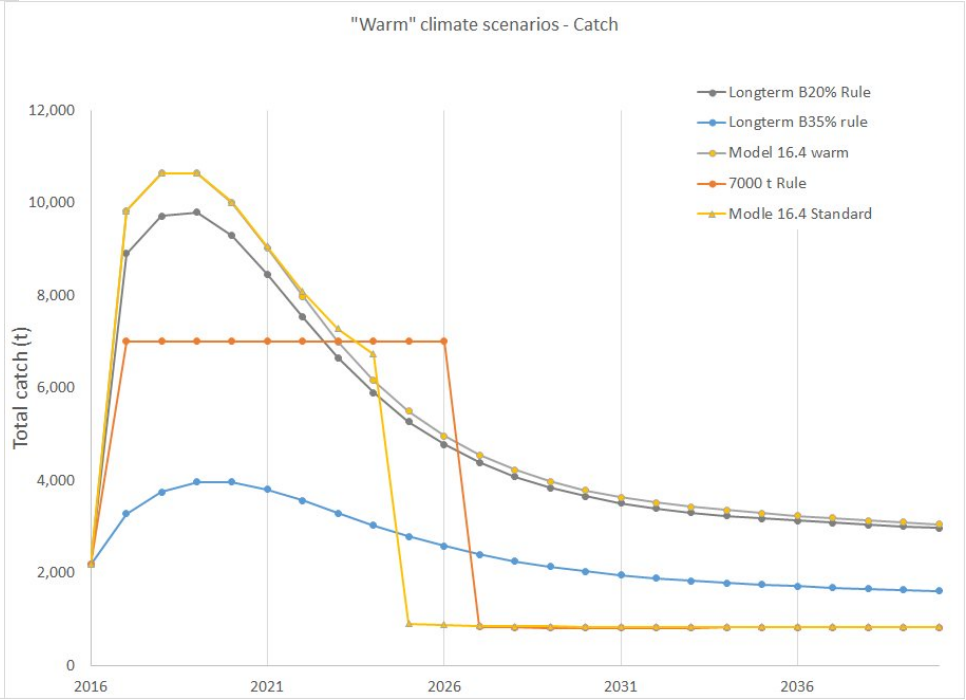
Alternative harvest specifications for Model 16.4

- Project 25 years ahead with recruitment from warm years only
- 7,000 t rule used from 1990-1996





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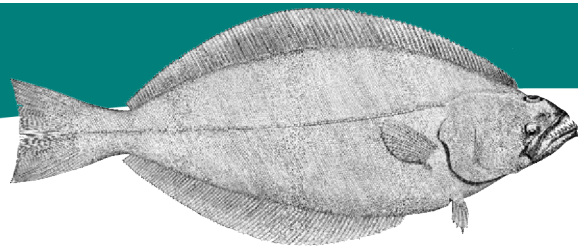

Author's choice Model 16.4

- ABC recommendation based on the least of 7,000 t or max(ABC) alternative rule

	As estimated or specified last year for:		As estimated or recommended this year* for:	
Quantity	2016	2017	2017	2018
M (natural mortality rate)	0.112	0.112	0.112	0.112
Tier	3b	3b	3a	3a
Projected total (age 1+) biomass (t)	114,438	123,494	121,804	122,032
Female spawning biomass (t)	31,028	41,015	50,461	55,347
Projected				
$B_{100\%}$	126,441	126,441	103,097*	103,097
$B_{40\%}$	50,577	50,577	41,239	41,239
$B_{35\%}$	44,255	44,255	36,084	36,084
F_{OFL}	0.10	0.14	0.29	0.29
maxF_{ABC}	0.08	0.11	0.18	0.18
F_{ABC}	0.08	0.11	0.13	0.12
OFL (t)	4,194	7,416	11,615	12,831
maxABC (t)	3,462	6,132	9,825	10,864
ABC (t)	3,462	6,132	7,000	7,000
EBS (ABC, t)	2,673	4,734	6,111	6,111
Aleutian Islands (ABC, t)	789	1,398	889	889
	As determined last year for:		As determined this year for:	
Status	2014	2015	2015	2016
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

* Note that the reference points changed in the projections in part due to a change in the years included. Previously 1975-2014, now 1977-2014.

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Future work

1. Further explore relationships among temperature, recruitment, selectivity, and catchability (Model 16.6).
2. Assess climate change impacts on viability of Greenland turbot fisheries in the BSAI
3. Evaluate alternative management strategies for Greenland turbot in the BSAI
4. Obtain estimates of Greenland turbot catch outside of the US EEZ in the Bering Sea.
5. Stock structure evaluation through genetics and tagging.