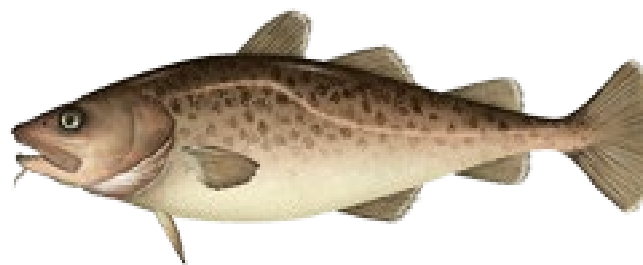


# Bering Sea Pacific Cod September 2024



Authors: Steve Barbeaux, Pete Hulson, Maia Kapur, and Ingrid Spies

# September explorations



- Bin size analysis
  - 1cm, 3cm, and 5cm length bins
- Non-time varying survey selectivity
  - Remove time varying survey selectivity
- Conditional age-at-length (CAAL)
  - Add survey and fishery CAAL data 2000-2023 to model
  - Remove marginal age composition data
- Change in growth model
  - Annually varying parameter changed from  $L_{\min}$  and  $R$  to  $L_{\min}$  and  $K$  based on sensitivity analysis
- Updated ageing error matrix
  - Update aging error matrix using 2000-2023 age data using AgeingError R library
  - Change to splined values at age instead of two parameter linear vector method

# September exploration results

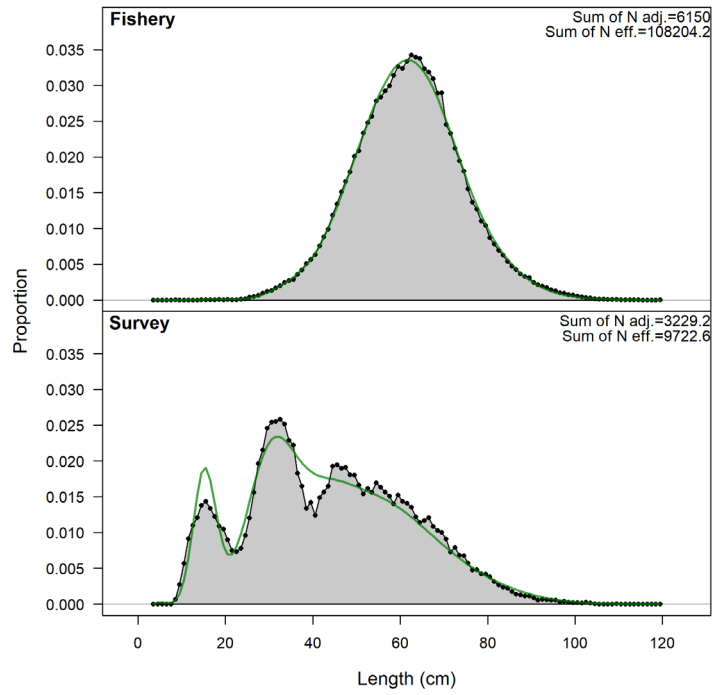


- Bin size analysis
  - Small improvement in model fit
  - Faster model runs
  - Little to no difference in model results
- Non-time varying survey selectivity
  - Poorer fit to survey index, but overall improvement in parsimony with fewer parameters
  - Little to no difference in model performance and results
- Conditional age-at-length
  - Poorer fits to all other data, particularly the survey index
  - Changes growth parameters and Q resulting in lower biomass estimates
  - Changes trajectory of final year's spawning biomass
- Change in growth model
  - Improvement in fit to CAAL data, poorer fits to other data components
  - Little change in model performance and results
- Updated ageing error matrix
  - Larger aging error estimates
  - Mixed results, tuning results in a down-weighting of survey age composition
  - Reverts to results more similar to non-CAAL results for models with survey CAAL only.
  - Highlights potential issues with model misspecification in the CAAL models

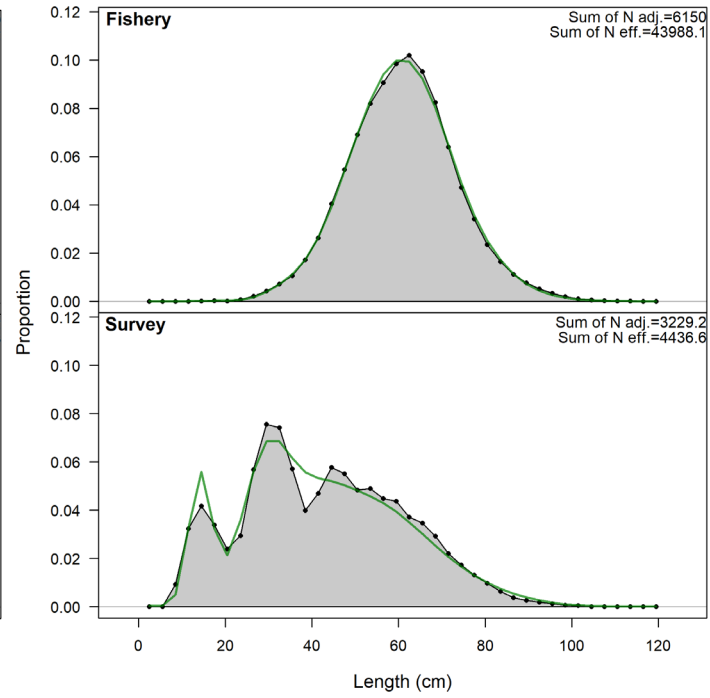
# Bin size analysis



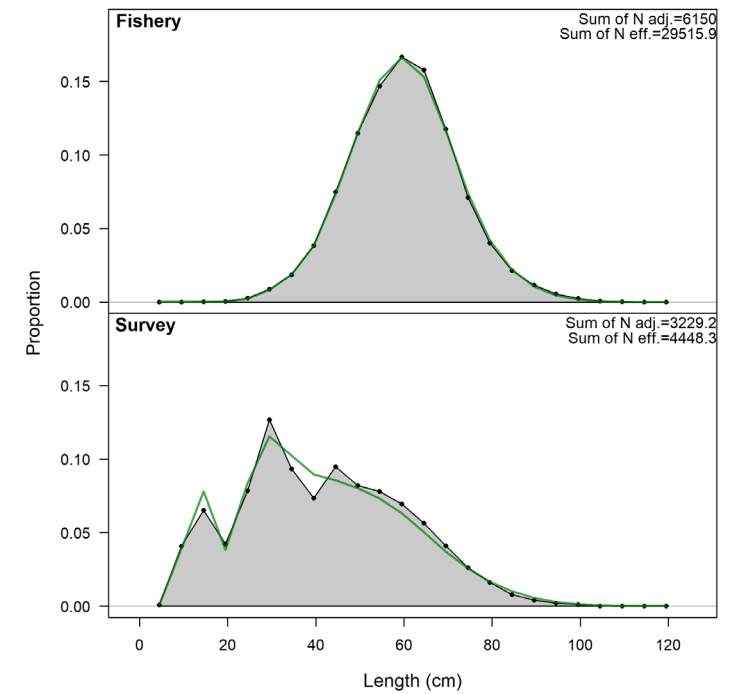
## 1CM



## 3 CM

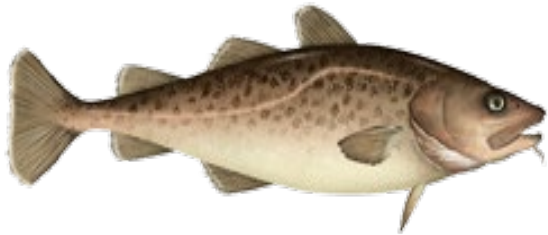


## 5 CM



# Bin size analysis

- Improved fits to non-size components
- Small changes in growth parameters
- Small change in results

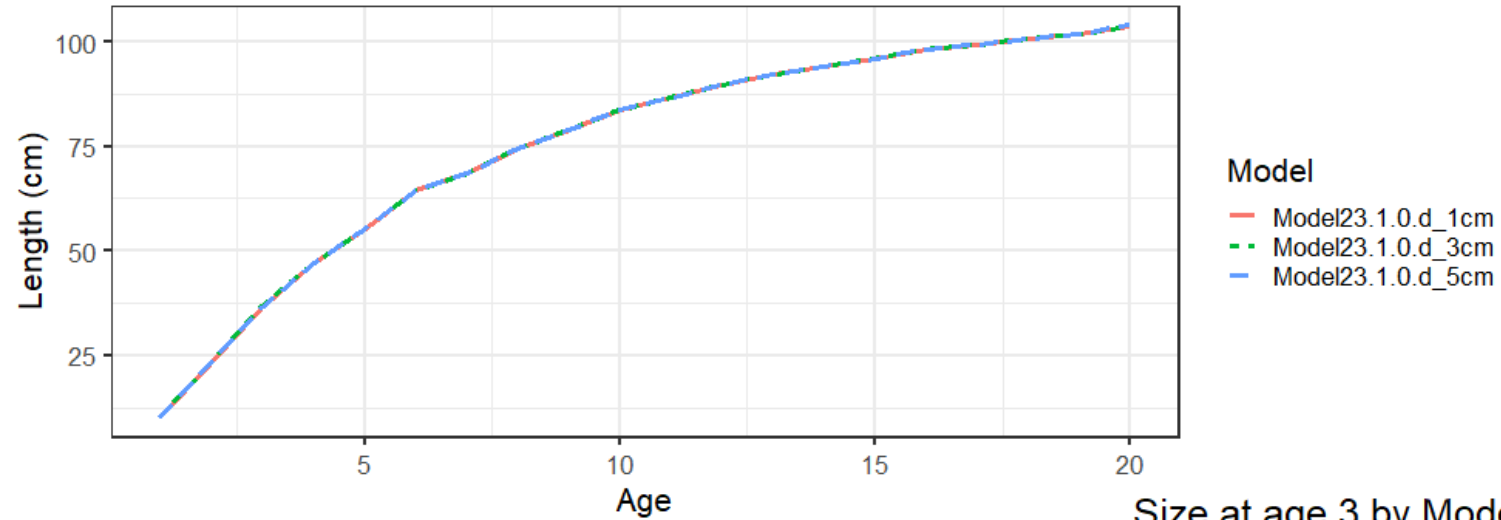


	Model 23.1.0.d 1CM	Model 23.1.0.d 3CM	Model 23.1.0.d 5CM
	Last year's model	M23.1.0.d W/ 3cm length bins	M 23.1.0.d W/ 5cm length bins
<b>Parameters #</b>	201	201	201
<b>Likelihoods</b>			
<b>Total</b>	350.77	292.71	246.93
<b>Index</b>	<b>-79.51</b>	<b>-80.34</b>	<b>-80.57</b>
<b>Agecomp</b>	<b>94.74</b>	<b>93.78</b>	<b>92.04</b>
<b>Sizecomp</b>	297.88	242.47	199.71
<b>AIC</b>	1103.5	987.4	895.9
<b>Retrospective</b>			
<b>Mohn's Rho</b>	-0.03	-0.03	-0.03
<b>Predictive Rho</b>	-0.08	-0.08	-0.08
<b>OSA SDNR</b>			
<b>Survey Age</b>	0.96	0.96	0.96
<b>Survey Length</b>	0.95	0.96	0.96
<b>Fishery Length</b>	1.08	1.08	1.07
<b>Growth Parameters</b>			
<b>Lmin</b>	<b>14.542</b>	<b>14.438</b>	<b>14.202</b>
<b>Lmax</b>	<b>111.967</b>	<b>112.032</b>	<b>112.138</b>
<b>K</b>	<b>0.117</b>	<b>0.117</b>	<b>0.116</b>
<b>Richard's Rho</b>	<b>1.399</b>	<b>1.408</b>	<b>1.414</b>
<b>Survey Catchability</b>			
	0.93	0.93	0.92
<b>Derived Quantities</b>			
<b>Unfished SSB</b>	573,675	574,200	573,695
<b>F<sub>40</sub></b>	0.38	0.38	0.38
<b>Bratio 2023</b>	0.36	0.36	0.36

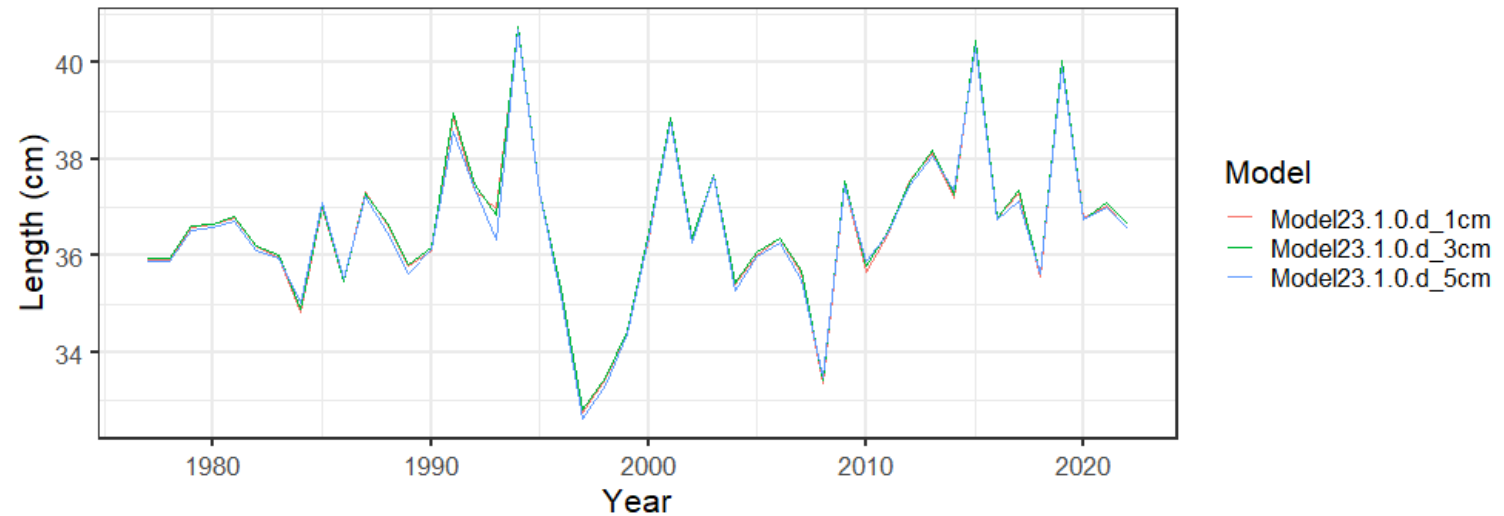
# Bin size analysis



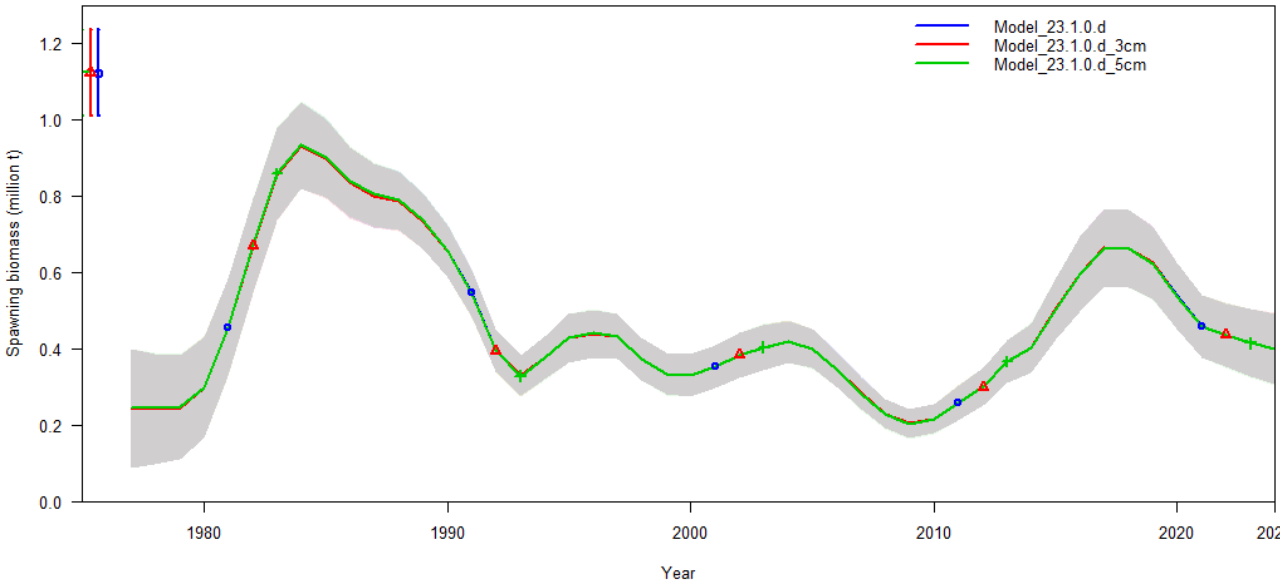
Size at age in 2022 by Model



Size at age 3 by Model

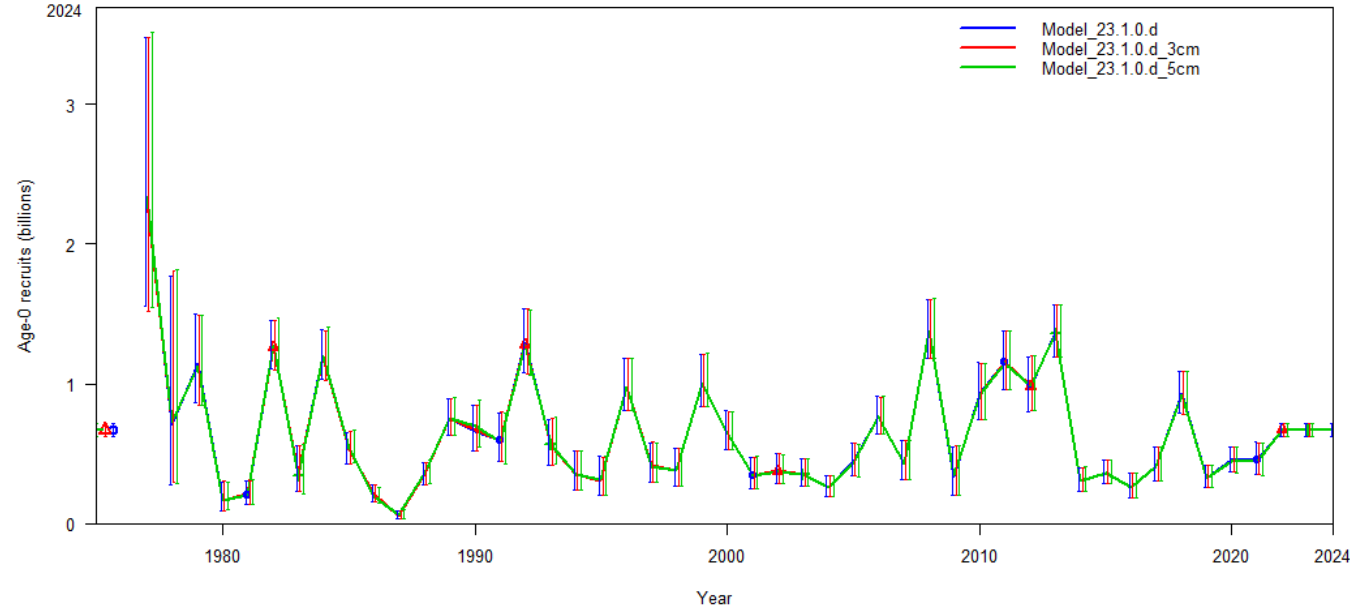


# Bin size analysis



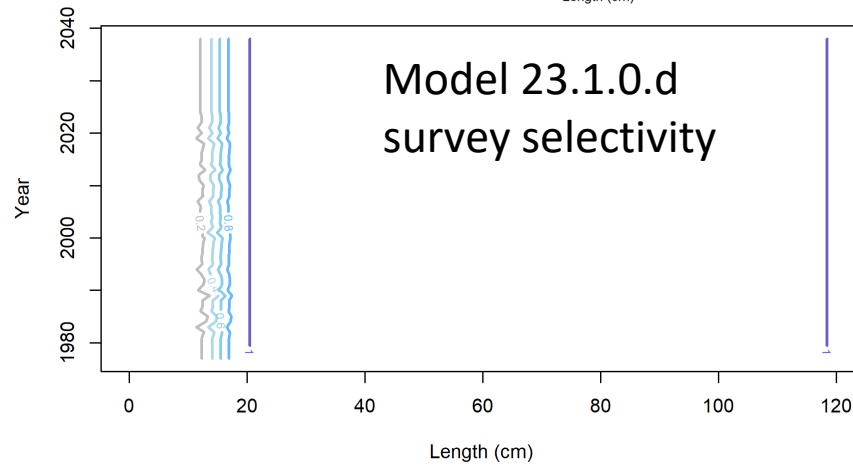
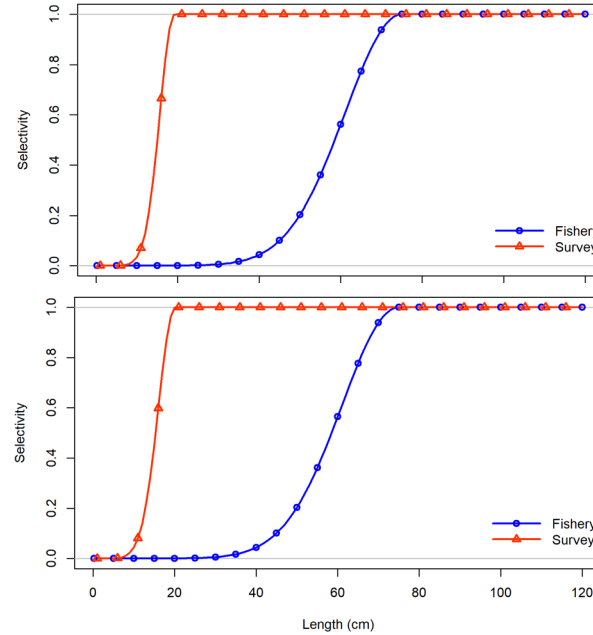
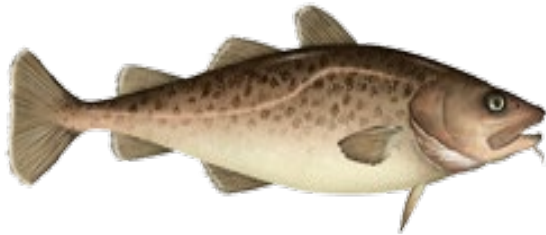
## Spawning biomass

## Age-0 Recruits



# Survey selectivity

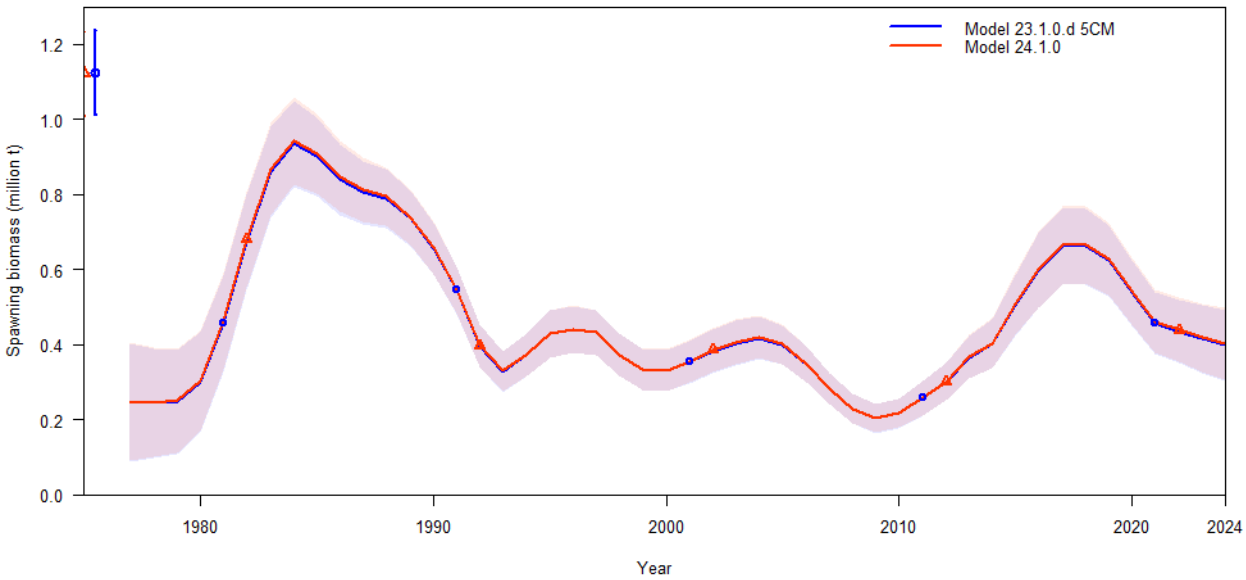
- Degradation in fit for index and size compositions
- Small changes in growth parameters
- Small change in results
- Overall improved parsimony with reduction in parameters (lower AIC)



	Model 23.1.0.d 5CM	Model 24.1.0
	M 23.1.0.d W/ 5cm length bins	M23.1.0.d 5CM W/static survey selectivity
Parameters #	201	160
Likelihoods		
<b>Total</b>	<b>246.93</b>	<b>258.64</b>
<b>Index</b>	<b>-80.57</b>	<b>-76.30</b>
<b>Agecomp</b>	<b>92.04</b>	<b>91.71</b>
<b>Sizecomp</b>	<b>199.71</b>	<b>210.75</b>
<b>AIC</b>	<b>895.9</b>	<b>837.3</b>
Retrospective		
<b>Mohn's Rho</b>	-0.03	-0.03
<b>Predictive Rho</b>	-0.08	-0.08
OSA SDNR		
<b>Survey Age</b>	0.96	0.96
<b>Survey Length</b>	0.96	0.96
<b>Fishery Length</b>	1.07	1.07
Growth Parameters		
<b>Lmin</b>	14.202	14.047
<b>Lmax</b>	112.138	112.614
<b>K</b>	0.116	0.114
<b>Richard's Rho</b>	1.414	1.432
Survey Catchability		
	0.92	0.92
Derived Quantities		
<b>Unfished SSB</b>	573,695	572,660
<b>F<sub>40</sub></b>	0.38	0.38
<b>Bratio 2023</b>	0.36	0.37

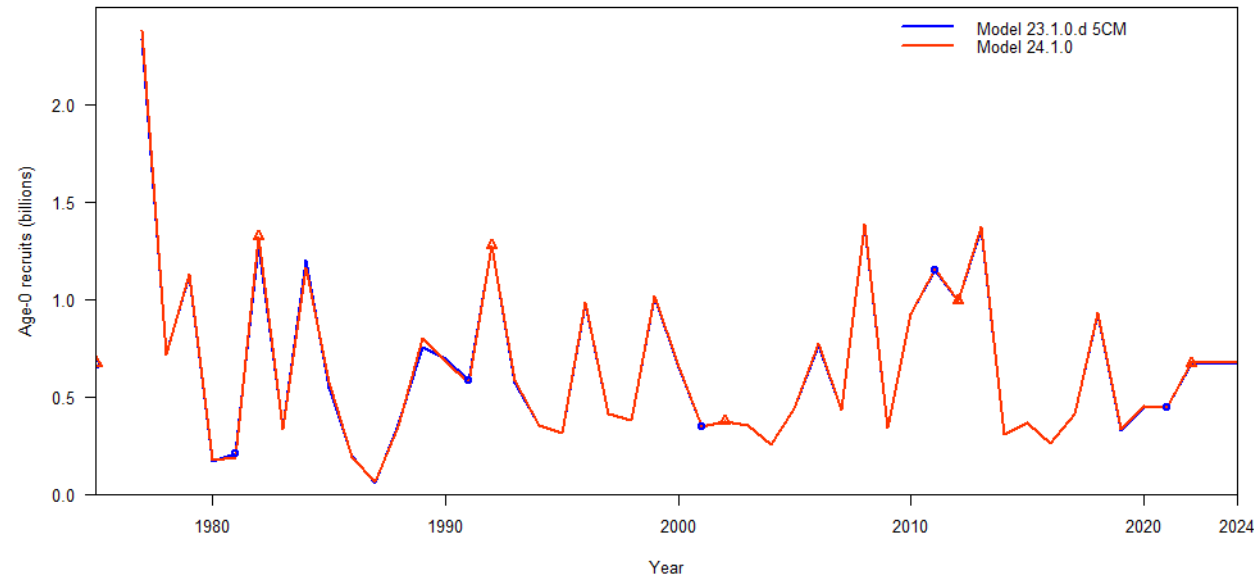


# Survey selectivity



# Spawning biomass

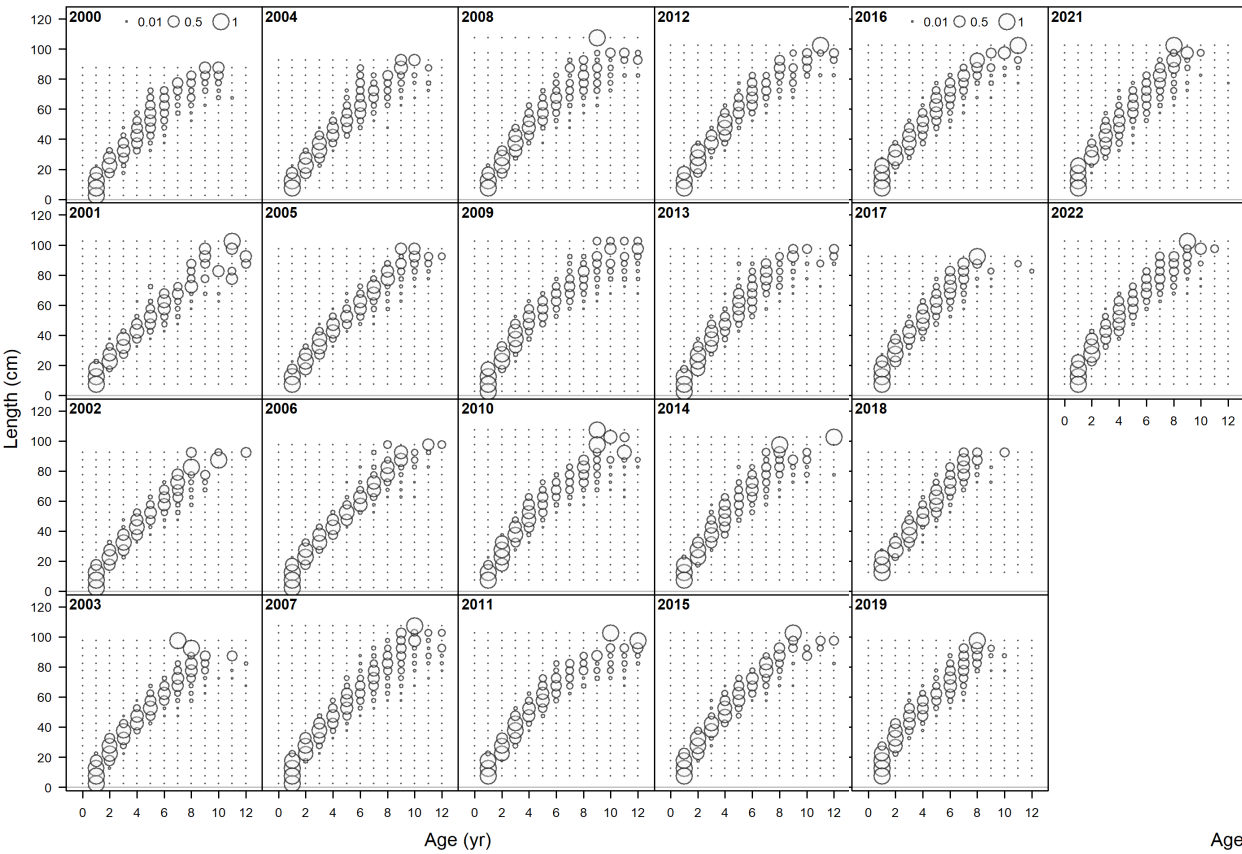
## Age-0 Recruits



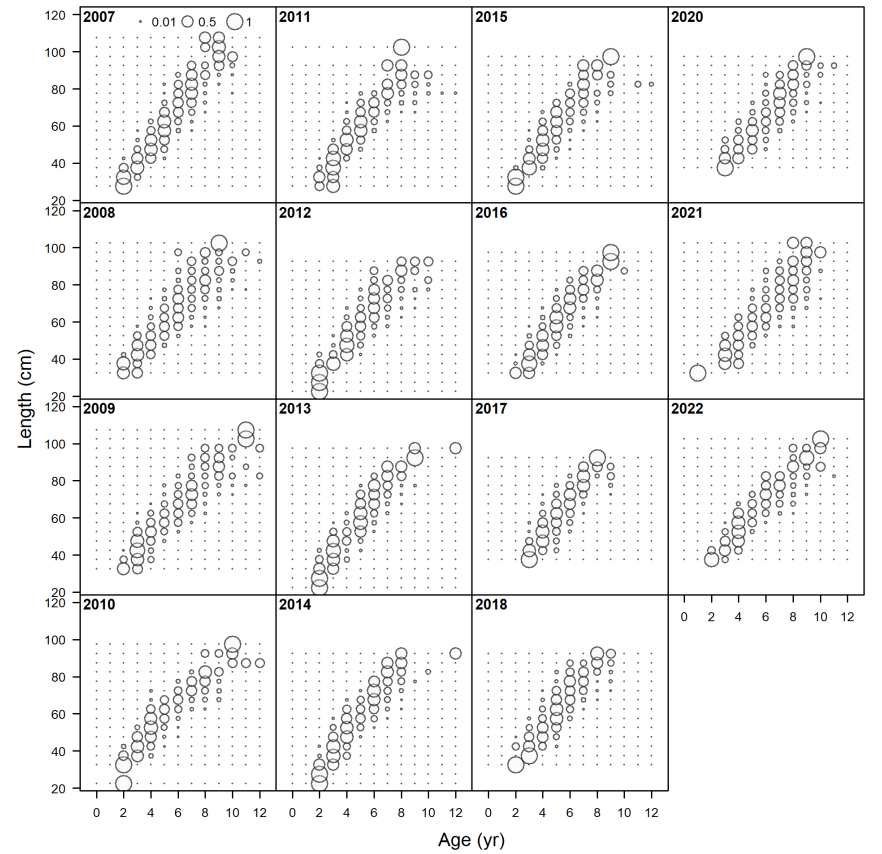
# Conditional age-at-length



## Survey

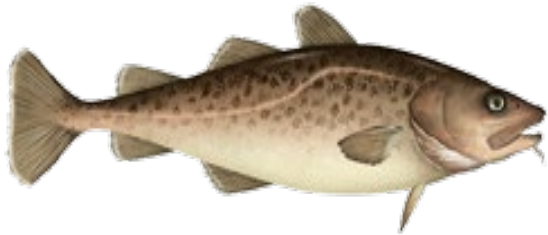


## Fishery



# Conditional age-at-length

- Degradation in fit to index
- Large change in growth
- Increase in survey index catchability

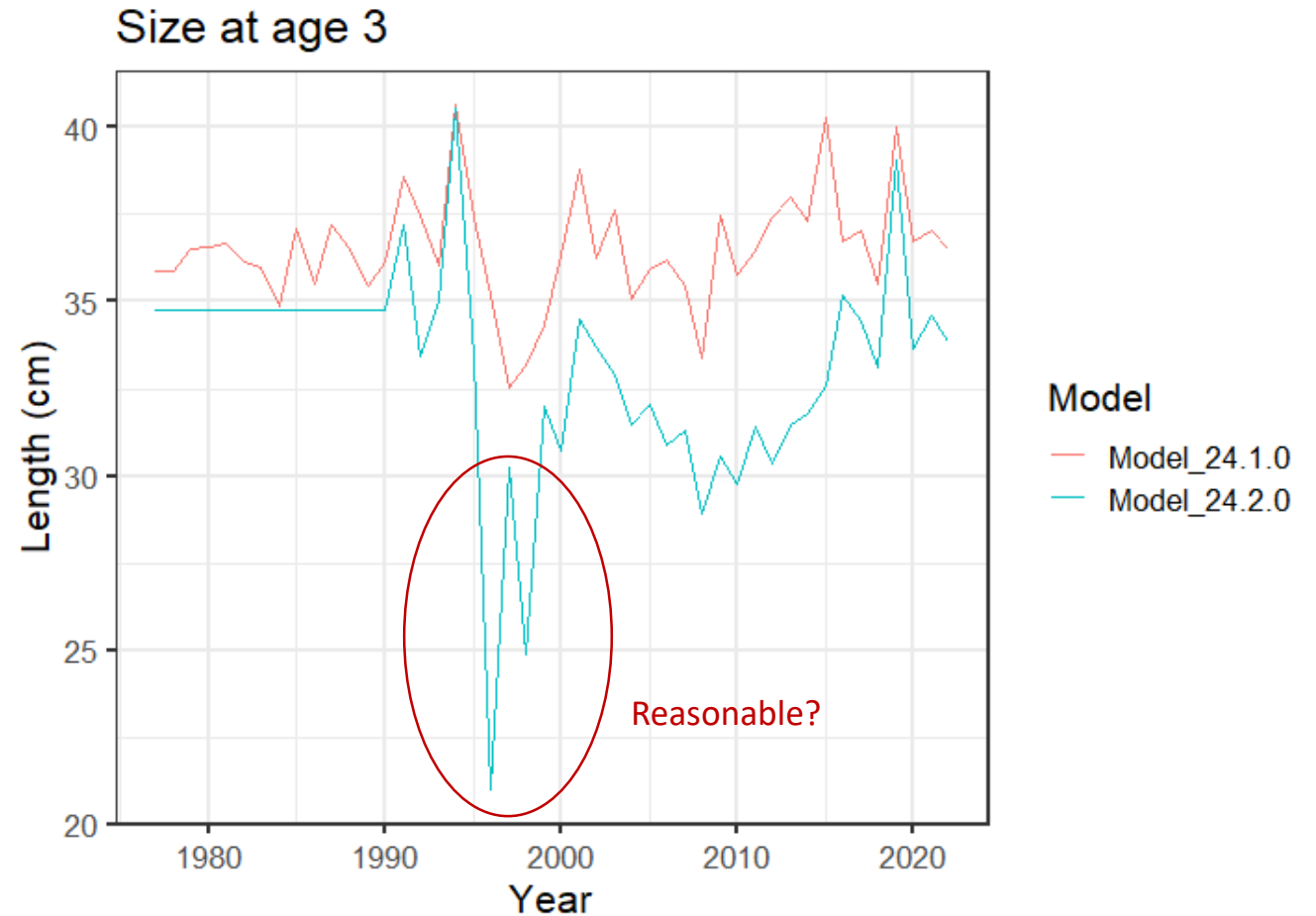
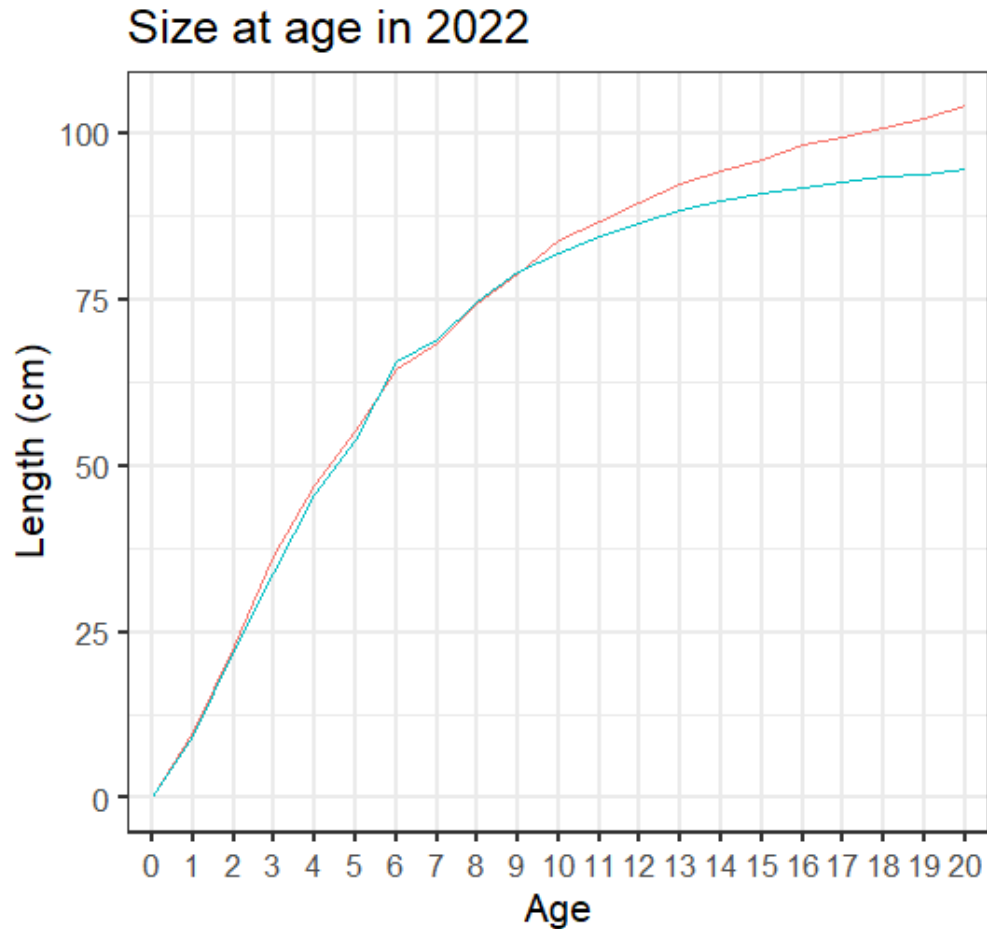


	Model 24.1.0	Model 24.2.0
	M23.1.0.d 5CM W/static survey selectivity	M24.1.0 W/ CAAL
Parameters #	160	147
Likelihoods		
Total	258.64	813.80
Index	<b>-76.30</b>	<b>-42.39</b>
Agecomp	91.71	491.00
Sizecomp	210.75	340.34
AIC	837.3	1921.6
Retrospective		
Mohn's Rho	-0.03	-0.050
Predictive Rho	-0.08	-0.059
OSA SDNR		
Survey Age	0.96	
Survey Length	0.96	0.98
Fishery Length	1.07	1.08
Growth Parameters		
Lmin	<b>14.047</b>	<b>13.61</b>
Lmax	<b>112.614</b>	<b>95.82</b>
K	<b>0.114</b>	<b>0.23</b>
Richard's Rho	<b>1.432</b>	<b>0.85</b>
Survey Catchability		
	<b>0.92</b>	<b>1.14</b>
Derived Quantities		
Unfished SSB	572,660	558,755
F <sub>40</sub>	0.38	0.36
Bratio 2023	0.37	0.38

# Conditional age-at-length



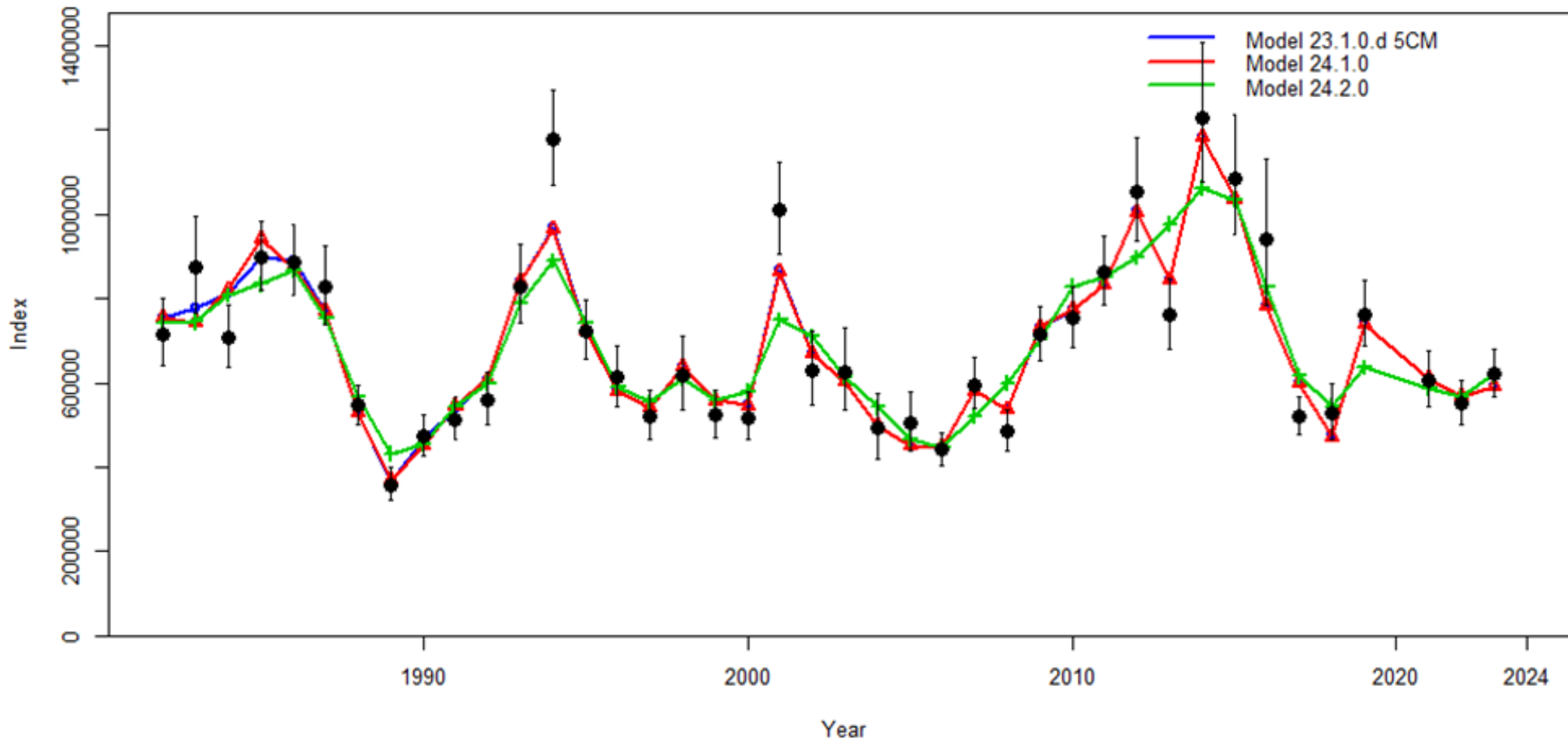
Change in growth estimation with higher annual variability



# Conditional age-at-length



Fit to survey index

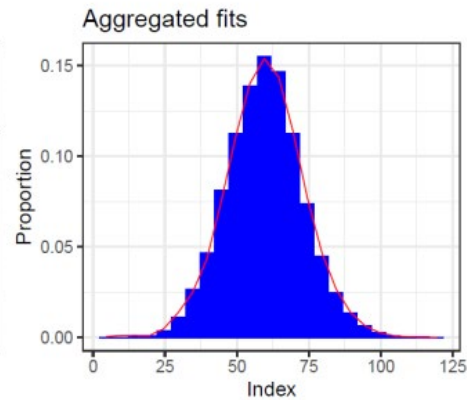
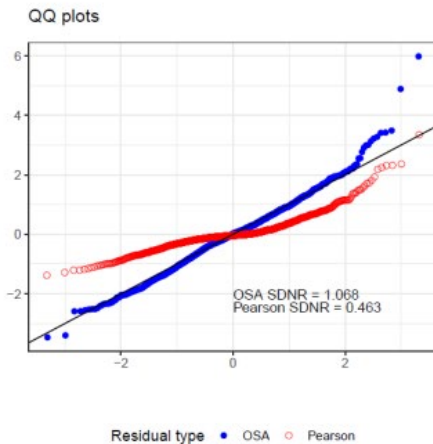
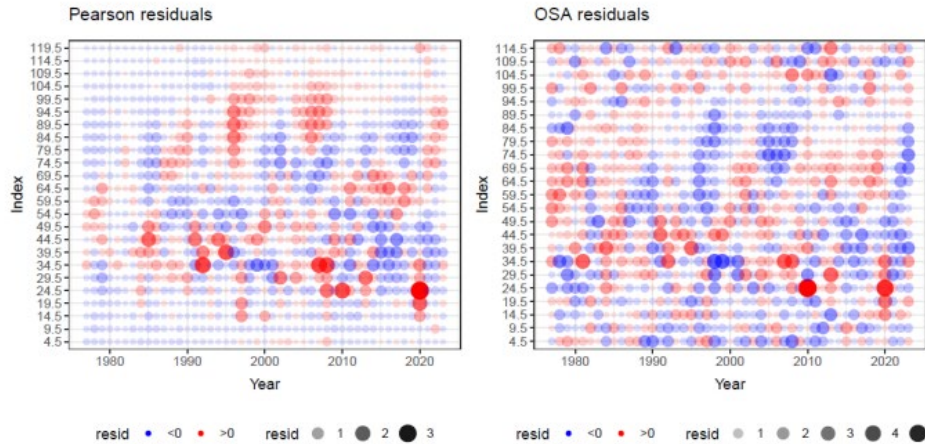


# Conditional age-at-length

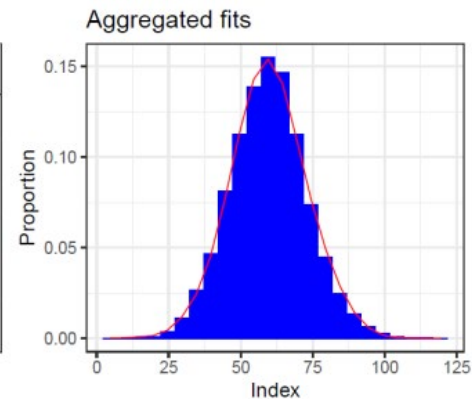
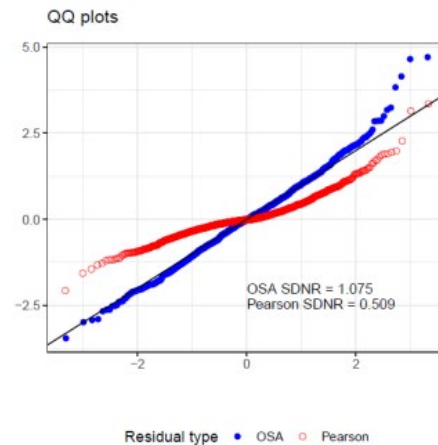
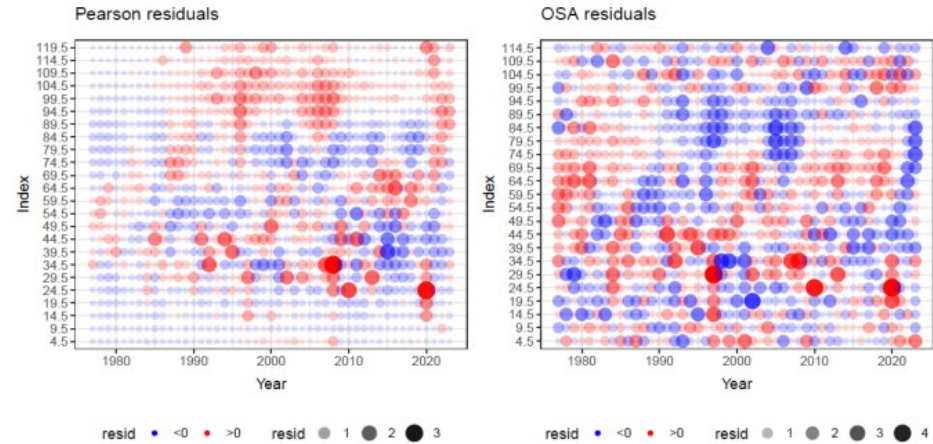
## Fit to fishery length composition



Model 24.1.0



Model 24.2.0



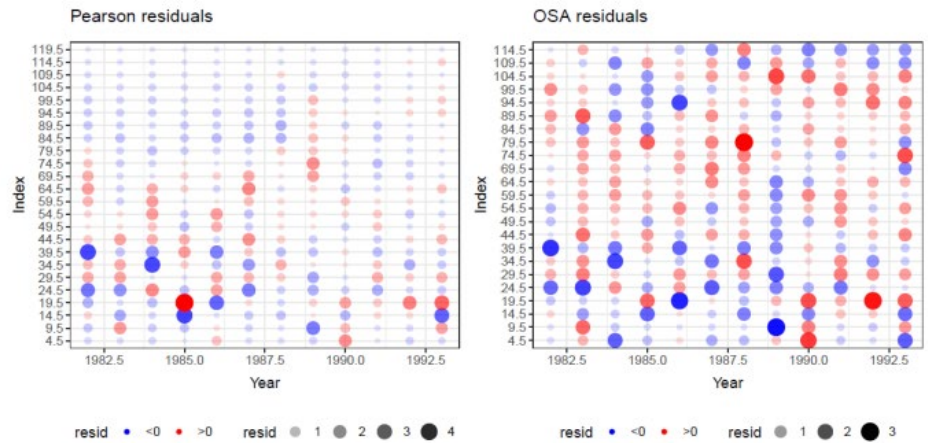


# Conditional age-at-length

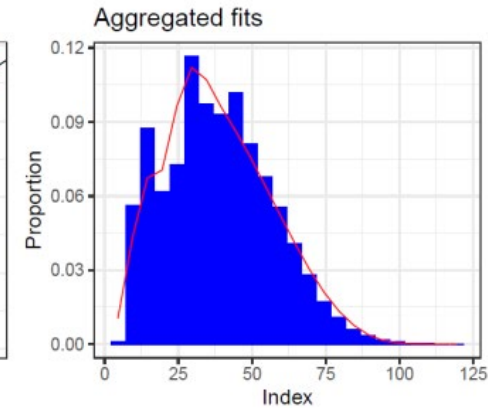
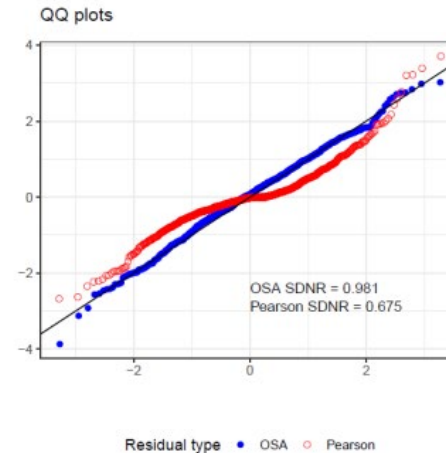
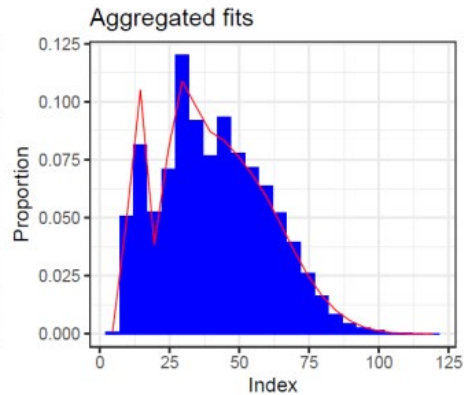
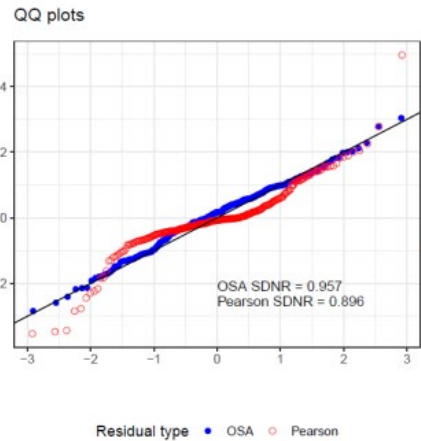
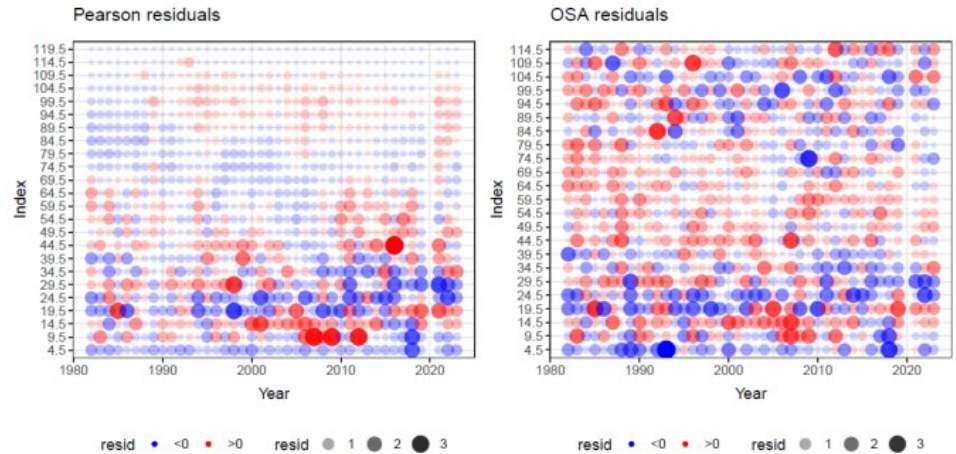
Fit to survey length composition



Model 24.1.0



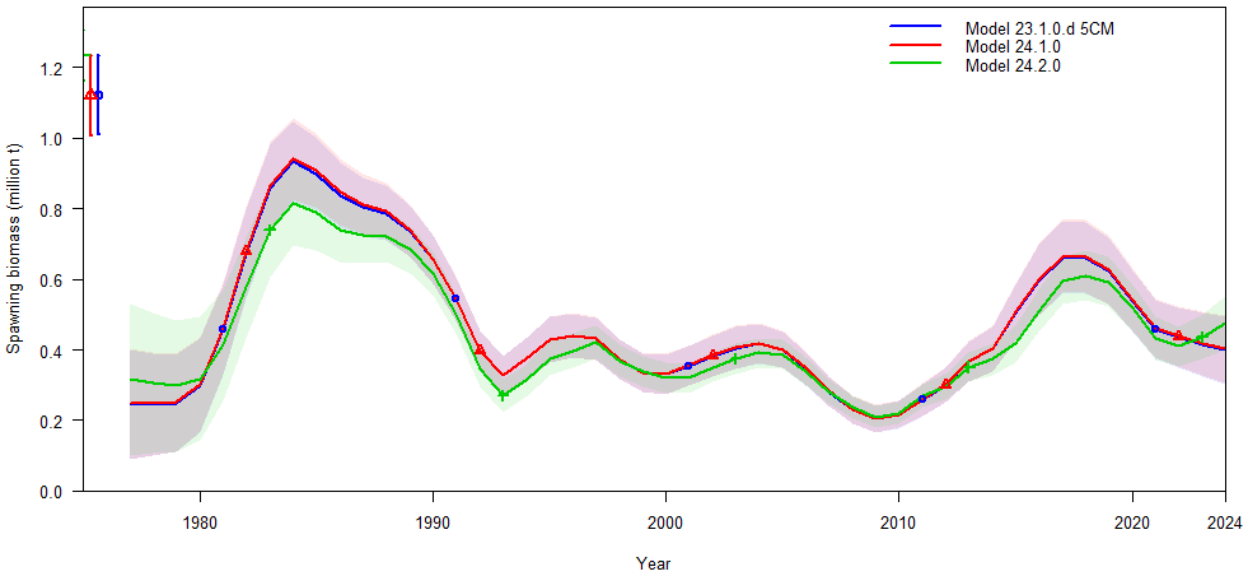
Model 24.2.0



Residual type ● OSA ○ Pearson

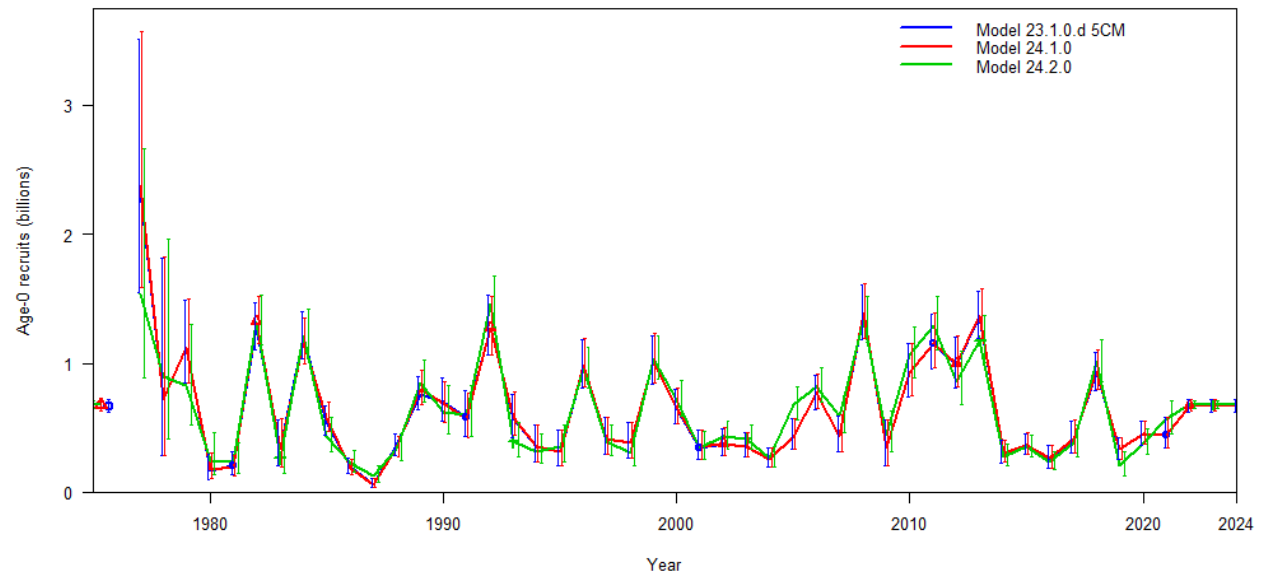
Residual type ● OSA ○ Pearson

# Conditional age-at-length



## Spawning biomass

## Age-0 Recruits

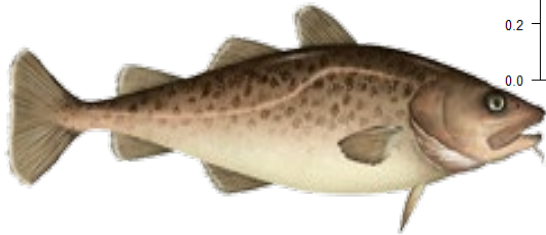
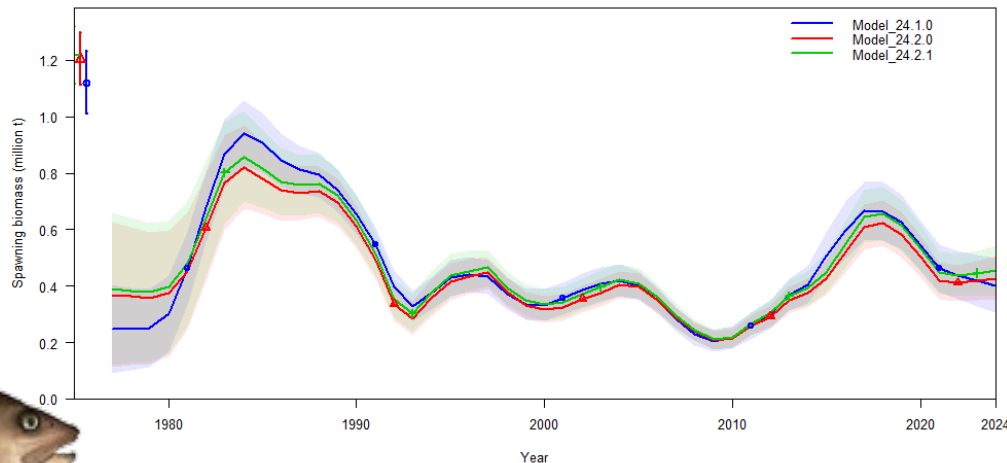




# Removal of fishery

## Conditional age-at-length

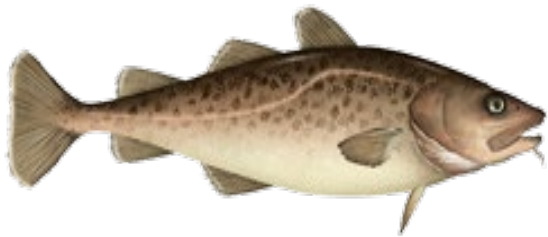
- Slight improved fit to index
- Small change in growth
- Small change in survey index catchability



	Model 24.2.0	Model 24.2.1
	M24.1.0 W/ CAAL	M24.2.0 W/O Fishery CAAL
Parameters #	147	147
Likelihoods		
Total	813.80	700.44
Index	-42.39	-46.33
Agecomp	491.00	386.56
Sizecomp	340.34	336.46
AIC	1921.6	1694.88
Retrospective		
Mohn's Rho	-0.050	-0.050
Predictive Rho	-0.059	-0.059
OSA SDNR		
Survey Age		
Survey Length	0.98	0.98
Fishery Length	1.08	1.07
Growth Parameters		
Lmin	13.61	13.52
Lmax	95.82	96.2
K	0.23	0.21
Richard's Rho	0.85	0.92
Survey Catchability		
	1.14	1.09
Derived Quantities		
Unfished SSB	558,755	564,805
F <sub>40</sub>	0.36	0.36
Bratio 2023	0.38	0.39

# Alternate growth

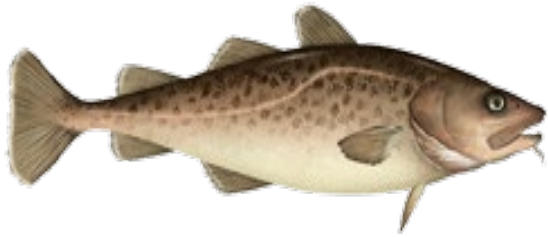
- Richards vs. von Bertalanffy
- All combinations of annual variability in growth with random walk on parameters



Growth Curve	$L_{\min}$	$L_{\max}$	K	R	log Likelihood	Delta LL	#Par	AIC
Richards	N	N	N	N	849.2	278.2	137	1972.3
Richards	Y	N	N	N	652.7	81.7	184	1673.3
Richards	N	Y	N	N	717.9	147.0	184	1803.7
Richards	N	N	Y	N	640.6	69.7	184	1649.3
Richards	N	N	N	Y	651.4	80.5	184	1670.8
Richards	Y	Y	N	N	627.8	56.9	231	1717.7
Richards	Y	N	Y	N	590.3	19.4	231	1642.6
Richards	Y	N	N	Y	599.5	28.5	231	1660.9
Richards	N	Y	Y	N	634.5	63.6	231	1731.0
Richards	N	Y	N	Y	617.6	46.7	231	1697.3
Richards	N	N	Y	Y	596.9	25.9	231	1655.7
Richards	Y	N	Y	Y	581.5	10.6	278	1719.1
Richards	Y	Y	N	Y	598.9	28.0	278	1753.8
Richards	Y	Y	Y	N	585.2	14.3	278	1726.4
Richards	Y	Y	Y	Y	570.9	0.0	325	1791.8
von Bert	N	N	N		854.0	283.1	136	1980.1
von Bert	Y	N	N		697.3	126.4	183	1760.6
von Bert	N	Y	N		719.6	148.7	183	1805.2
von Bert	N	N	Y		644.0	73.1	183	1654.0
von Bert	Y	Y	N		664.1	93.2	230	1788.2
von Bert	Y	N	Y		622.9	52.0	230	1705.9
von Bert	N	Y	Y		638.1	67.2	230	1736.3
von Bert	Y	Y	Y		619.8	48.9	277	1793.7

# Alternate growth

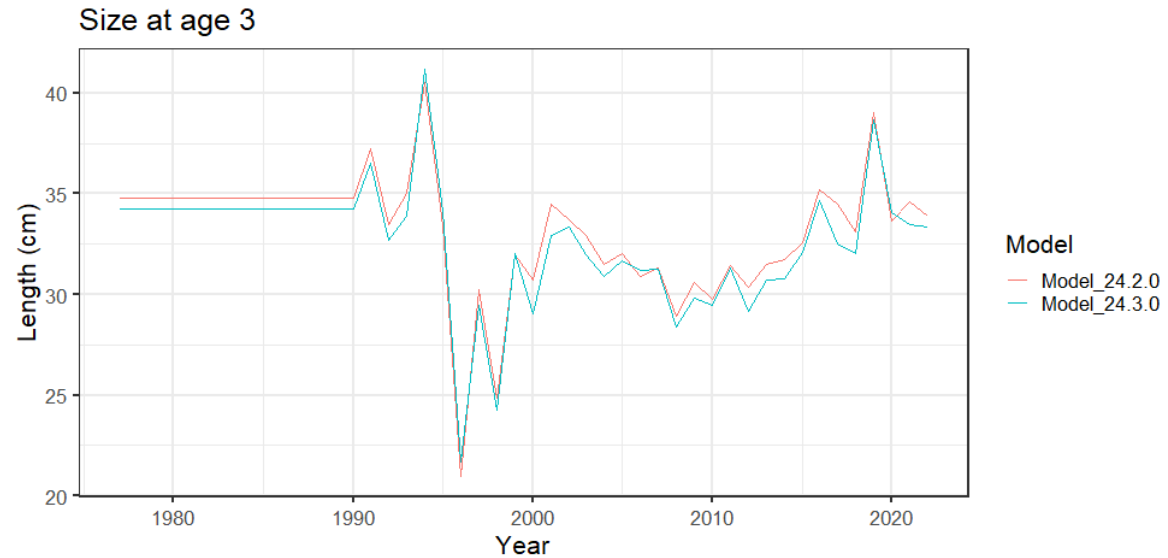
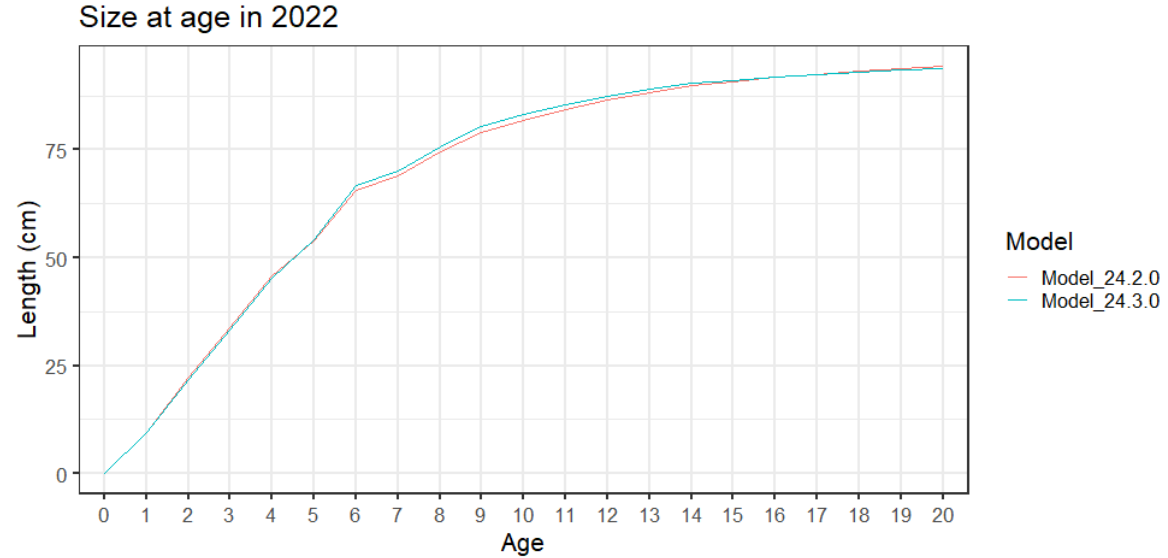
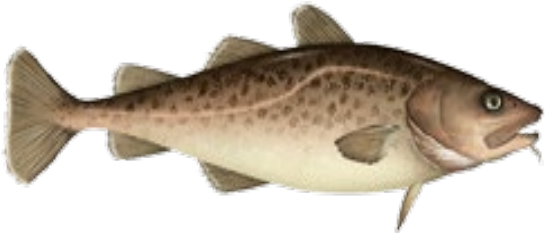
- Improved fit to age composition
- Poorer fit to survey index
- Poorer fit to size composition



	Model 24.2.0	Model 24.3.0	Model 24.2.1	Model 24.3.1
	M24.1.0 W/ CAAL	Model 24.2.0 with alt. growth model	M24.2.0 W/O Fishery CAAL	Model 24.2.1 with alt. growth model
Parameters #	147	147	147	147
Likelihoods				
Total	<b>813.80</b>	<b>800.88</b>	<b>700.44</b>	<b>690.99</b>
Index	<b>-42.39</b>	<b>-38.61</b>	<b>-46.33</b>	<b>-42.5</b>
Agecomp	<b>491.00</b>	<b>472.56</b>	<b>386.56</b>	<b>373.26</b>
Sizecomp	<b>340.34</b>	<b>347.35</b>	<b>336.46</b>	<b>341.45</b>
AIC	<b>1921.6</b>	<b>1895.8</b>	<b>1694.88</b>	<b>1675.98</b>
Retrospective				
Mohn's Rho	-0.050	-0.050	-0.050	-0.042
Predictive Rho	-0.059	-0.027	-0.059	-0.018
OSA SDNR				
Survey Age				
Survey Length	0.98	0.99	0.98	0.99
Fishery Length	1.08	1.08	1.07	1.07
Growth Parameters				
Lmin	<b>13.61</b>	<b>13.95</b>	<b>13.52</b>	<b>13.81</b>
Lmax	<b>95.82</b>	<b>94.69</b>	<b>96.2</b>	<b>95.14</b>
K	<b>0.23</b>	<b>0.28</b>	<b>0.21</b>	<b>0.26</b>
Richard's Rho	<b>0.85</b>	<b>0.54</b>	<b>0.92</b>	<b>0.62</b>
Survey Catchability				
	1.14	1.23	1.09	1.18
Derived Quantities				
Unfished SSB	558,755	573,115	564,805	573,825
F <sub>40</sub>	0.36	0.34	0.36	0.34
Bratio 2023	0.38	0.37	0.39	0.39

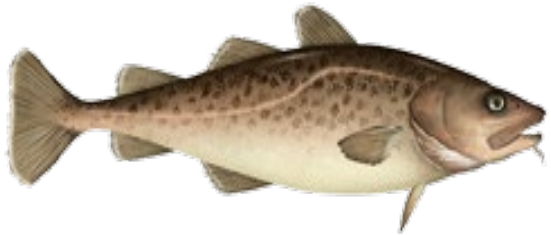
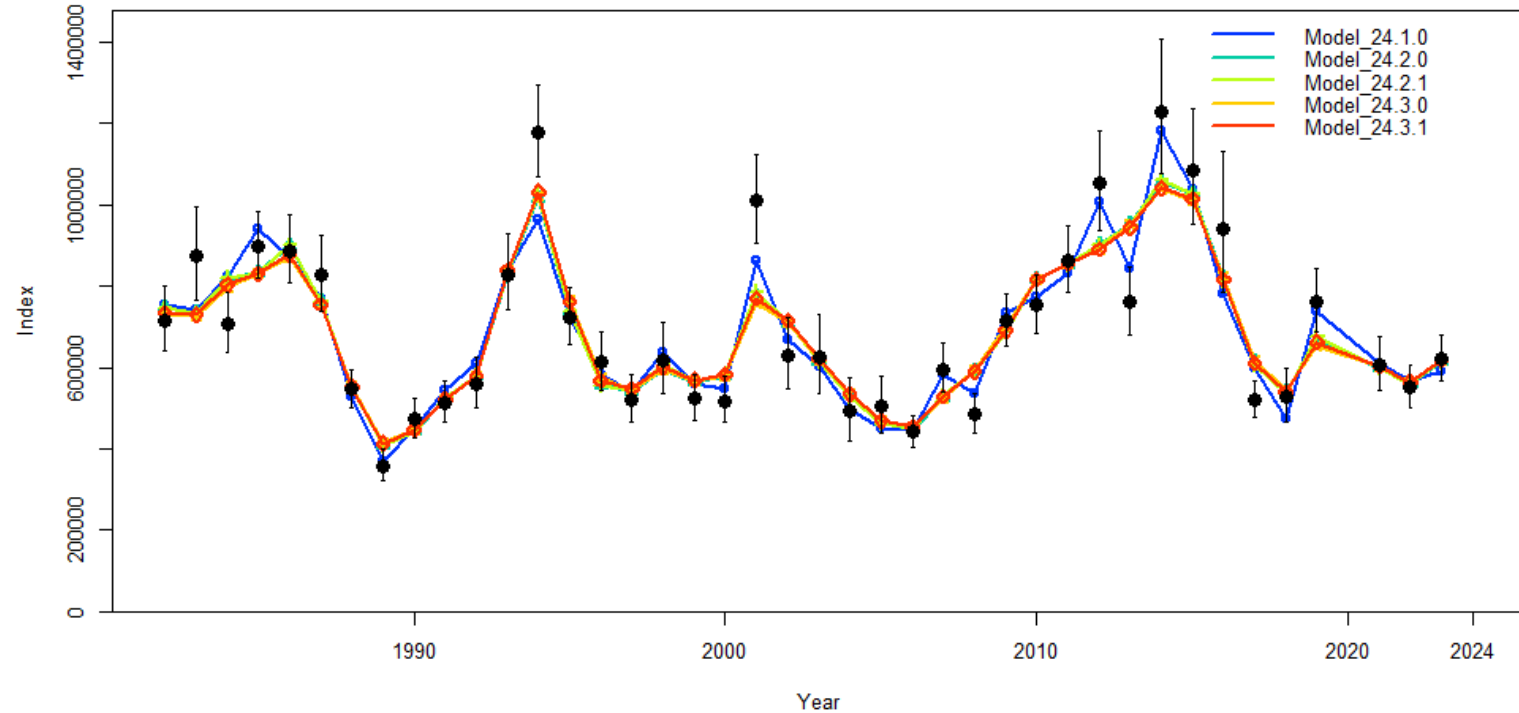
# Alternate Growth

- Small change in growth curve and increased annual variability



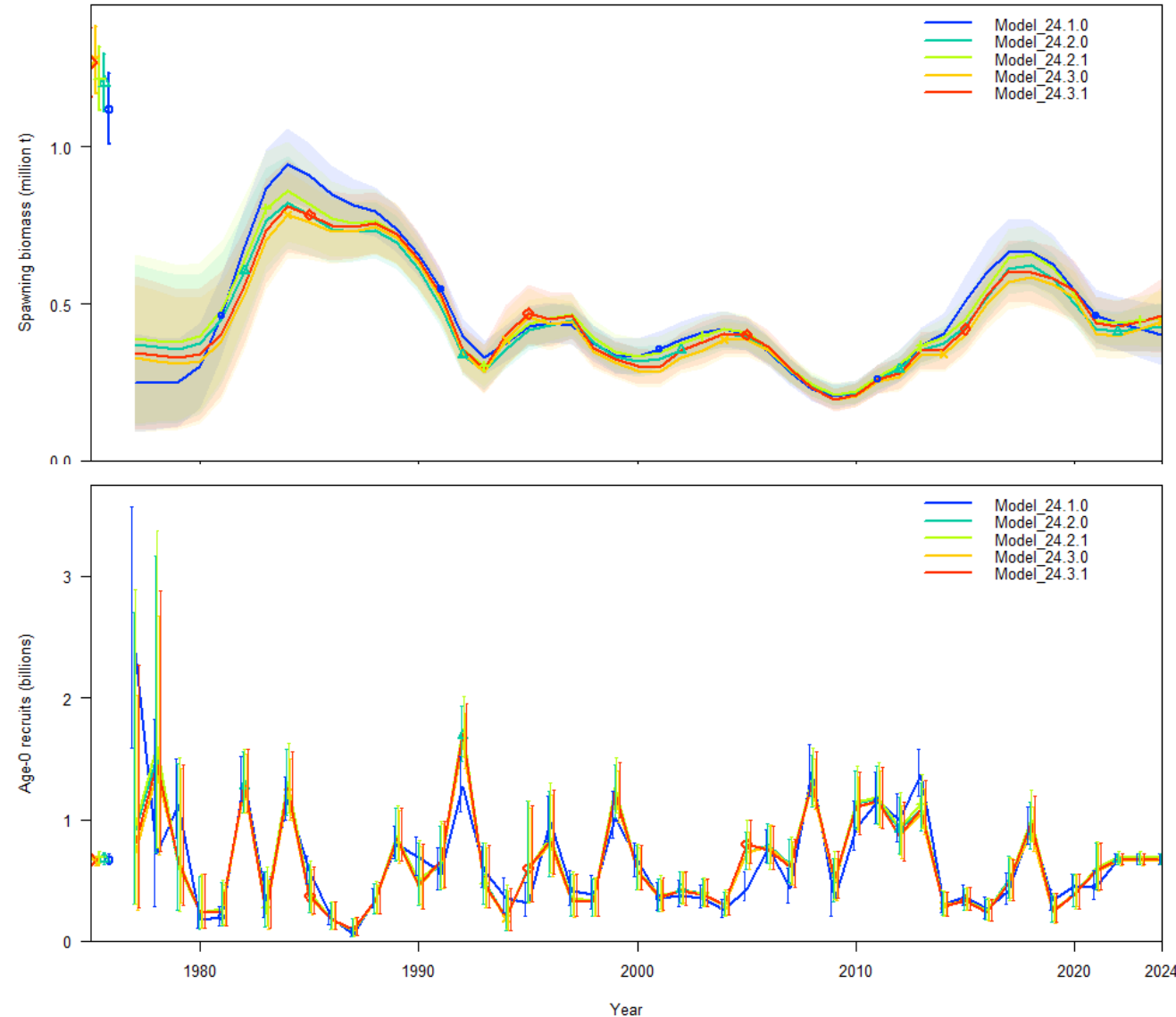
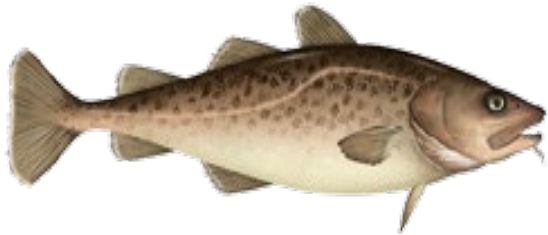
# Alternate Growth Fits

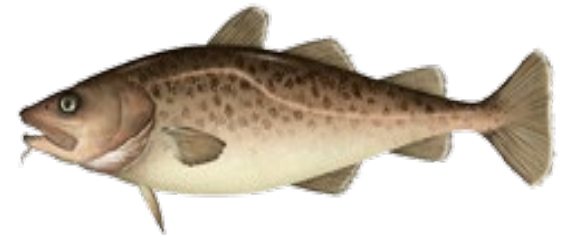
- Small degradation in fit to index from M24.2.0 and M24.2.1
- Continued degraded fit to index compared to 24.1.0
- Improvement in fit to CAAL over M24.2.0 and M24.2.1



# Alternate Growth Results

- Similar recruitment to 24.2 models
- High index catchability similar to 24.2 models resulting in lower biomass compared to Model 24.1.0





# Francis weights and $\sigma$ tuning

- Model 24.4.x - Tuning input variance adjustment factors (IVAF)
  - Francis (2011) TA1.8 method
  - tune\_comps function in r4ss
  - Iterative adjustment
- Model 24.5.x - Tuning  $\sigma$ s and IVAFs
  - Thompson and Thorson (2019)
  - Iterative [R function](#)

$$x_{\sigma_R} = (\text{var}(\text{devs}_{\sigma_R}) + \text{mean}(\text{param\_stdev}_{\sigma_R})^2) / \sigma_R^2 - 1$$

$$x_i = (\text{var}(\text{devs}_{\sigma_i}) + \text{mean}(\text{param\_stdev}_{\sigma_i})^2) - 1$$

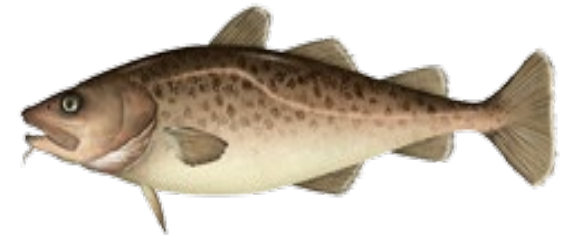
$$\text{New } \sigma_R = 1.5 x_{\sigma_R} \sigma_R$$

$$\text{New } \sigma_i = 1.5 x_i \sigma_i$$

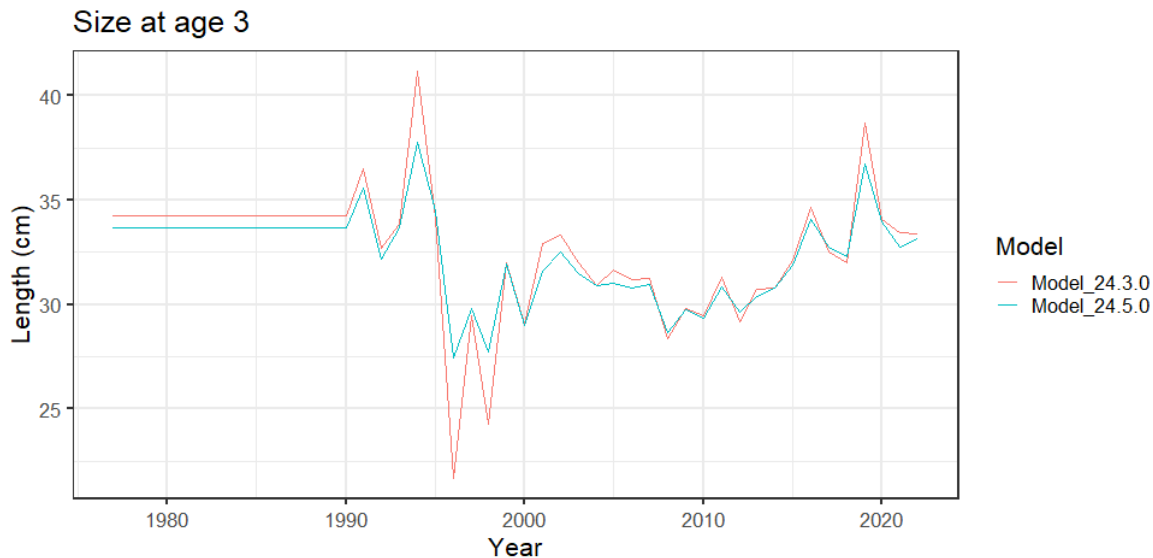
$$\text{Obj\_fun} = \text{sqrt}(\text{crossprod}([x_{\sigma_R}, x_i]) / n)$$

Model	Input variance adjustments factors*				$\sigma_R$	$\sigma$	
	LFish	LSurv	A Fish	ASurv		$L_{\min}$	K
M24.3.x	0.075	0.027	0.012	0.037	0.7381	2.000	0.200
M24.4.0	0.074	0.035	0.010	0.061	0.7381	2.000	0.200
M24.4.1	0.077	0.035	NA	0.063	0.7381	2.000	0.200
M24.5.0	0.073	0.034	0.010	0.064	0.6404	0.370	0.149
M24.5.1	0.081	0.038	NA	0.055	0.6642	0.367	0.149
M24.6.0	0.081	0.043	0.059	0.005	0.5917	0.391	0.165
M24.6.1	0.094	0.068	NA	0.007	0.8043	0.528	0.213

# Francis weights and $\sigma$ tuning



- $\sigma$  tuning resulted in lower annual variability in  $L_{\min}$  and K and subsequent lower annual variability in growth

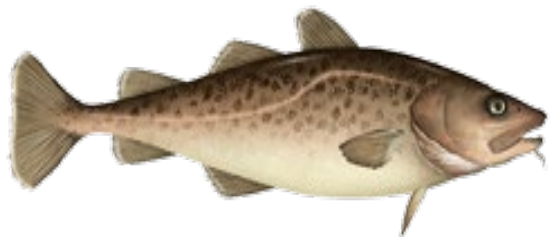


Model	Input variance adjustments factors*				$\sigma_R$	$\sigma$	
	LFish	LSurv	A Fish	ASurv		$L_{\min}$	K
<b>M24.3.x</b>	0.075	0.027	0.012	0.037	0.7381	2.000	0.200
<b>M24.4.0</b>	0.074	0.035	0.010	0.061	0.7381	2.000	0.200
<b>M24.4.1</b>	0.077	0.035	NA	0.063	0.7381	2.000	0.200
<b>M24.5.0</b>	0.073	0.034	0.010	0.064	0.6404	0.370	0.149
<b>M24.5.1</b>	0.081	0.038	NA	0.055	0.6642	0.367	0.149
<b>M24.6.0</b>	0.081	0.043	0.059	0.005	0.5917	0.391	0.165
<b>M24.6.1</b>	0.094	0.068	NA	0.007	0.8043	0.528	0.213



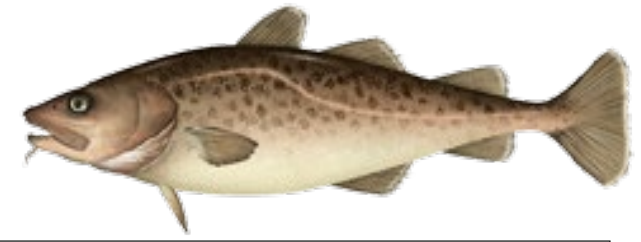
# Francis weights and $\sigma$ tuning

- Tuned models show small changes to fitted parameters and model results
- Standard model diagnostic indices such as likelihood and AIC do not work with changes to data weighting

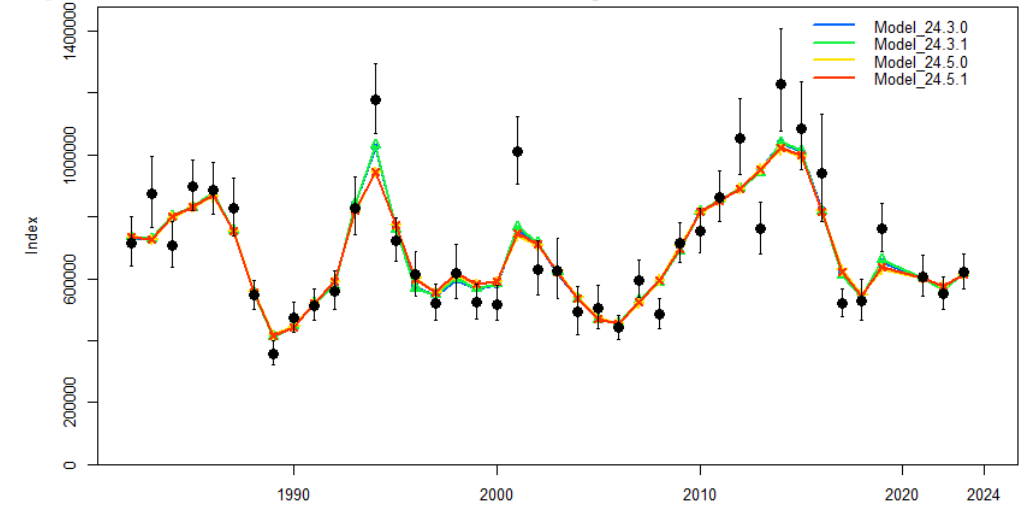


	Model 24.3.0	Model 24.5.0	Model 24.3.1	Model 24.5.1
	Model 24.2.0 with alt. growth model	Model 24.3.0 w/ tuning	Model 24.2.1 with alt. growth model	Model 24.3.1 w/ tuning
Parameters #	147	147	147	147
Likelihoods				
Total	800.88	980.81	690.99	858.53
Index	<b>-38.61</b>	<b>-20.88</b>	<b>-42.50</b>	<b>-24.17</b>
Agecomp	472.56	624.67	373.26	480.32
Sizecomp	347.35	344.15	341.45	370.86
AIC	1895.8	2255.6	1675.98	2011.06
Retrospective				
Mohn's Rho	-0.050	-0.029	-0.042	-0.024
Predictive Rho	-0.027	-0.024	-0.018	-0.021
OSA SDNR				
Survey Age				
Survey Length	0.99	0.98	0.99	0.99
Fishery Length	1.08	1.09	1.07	1.07
Growth Parameters				
Lmin	13.95	13.57	13.81	13.48
Lmax	94.69	93.15	95.14	94.23
K	0.28	0.31	0.26	0.28
Richard's Rho	0.54	0.43	0.62	0.54
Survey Catchability				
	1.23	1.24	1.18	1.21
Derived Quantities				
Unfished SSB	573,115	552,245	573,825	551,085
F <sub>40</sub>	0.34	0.33	0.34	0.34
Bratio 2023	0.37	0.39	0.39	0.40

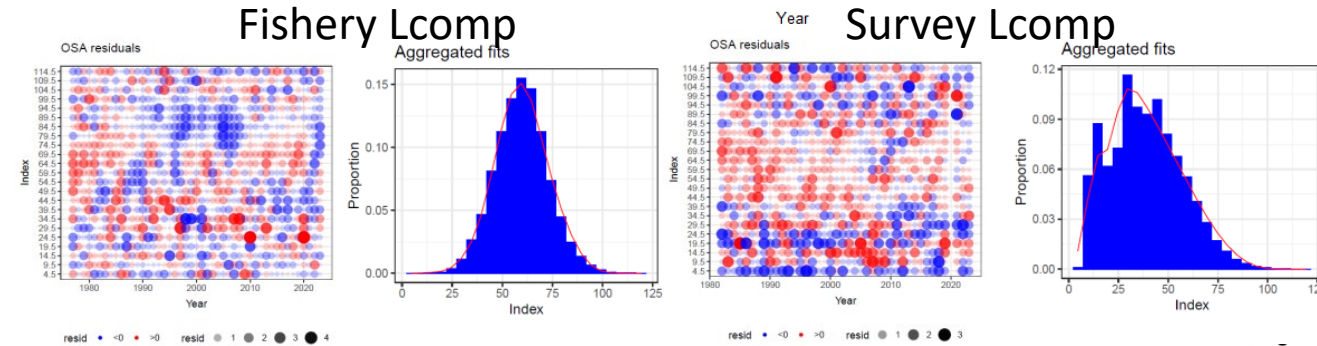
# Francis weights and $\sigma$ tuning



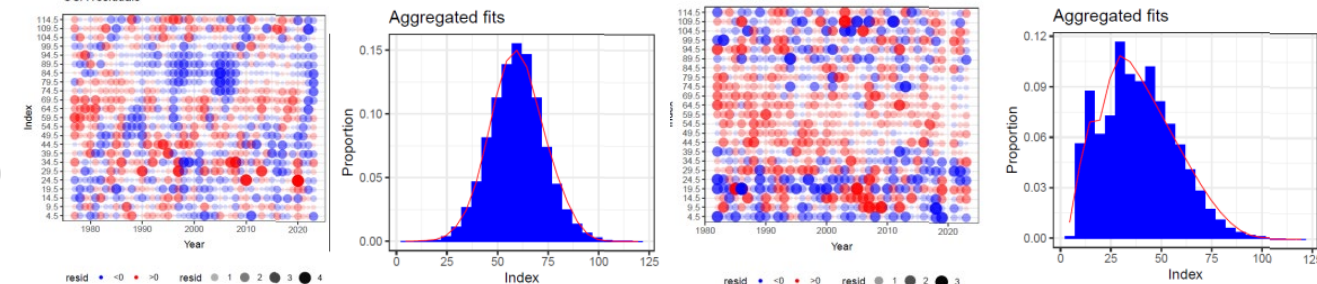
- Poorer fits to the survey index
- Changes to residuals were visually nearly imperceptible
- However the models perform, tuning for both IVAF and  $\sigma$ s should be considered best practices.



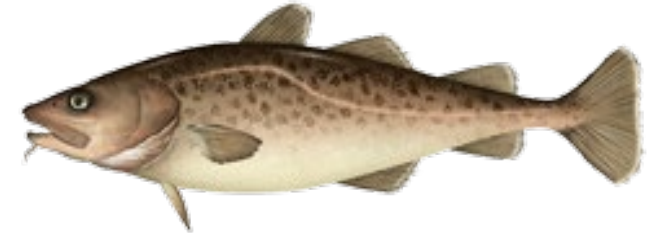
M24.3.0



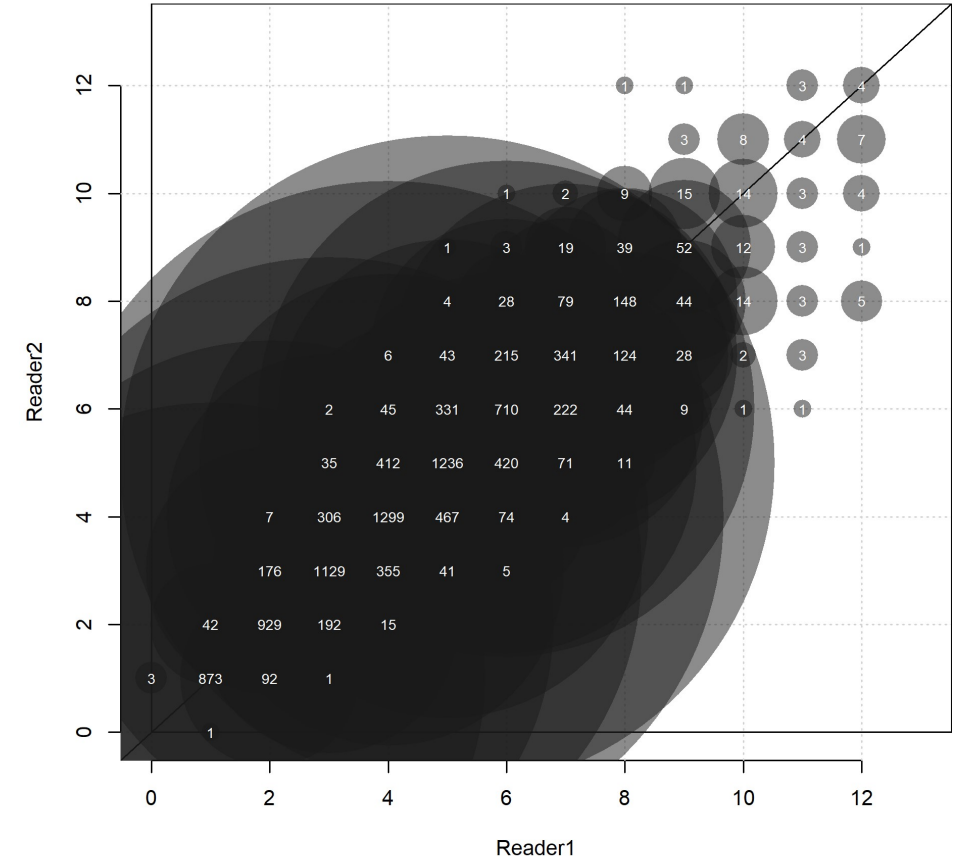
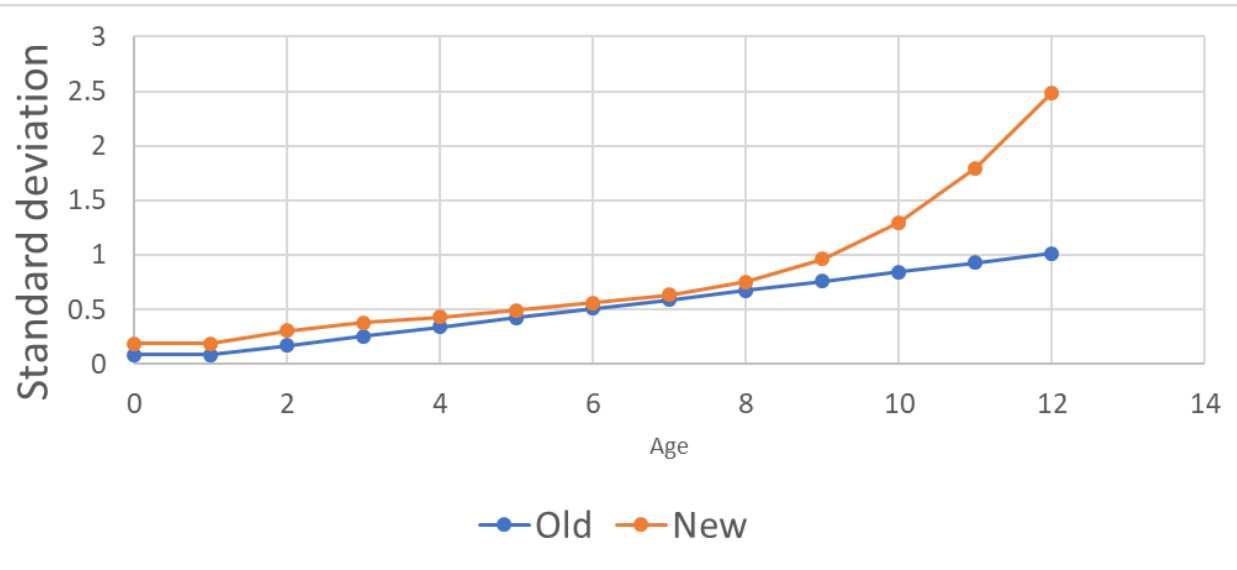
M24.5.0



# Update aging error



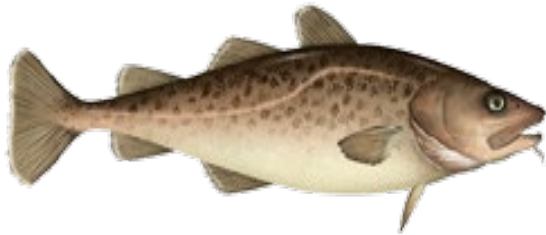
- New age data incorporated 2000-2023 (n=10,857)
- Otoliths read by multiple readers
- AgingError R library
  - Spline with 5 knots (2, 4, 6, 8, 10)



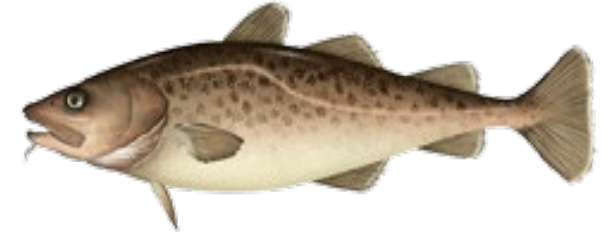
	0	1	2	3	4	5	6	7	8	9	10	11	12
Old	0.0850	0.0850	0.1696	0.2542	0.3388	0.4234	0.5080	0.5926	0.6772	0.7618	0.8464	0.931	1.0156
New	0.1885	0.1885	0.3067	0.3787	0.4331	0.4939	0.5607	0.6356	0.7556	0.9643	1.2988	1.7941	2.4854

# Update Aging Error

- Increase in aging error results in improvement to fit to survey index
- Decrease in fit to length and age composition
- Improvement in fit to CAAL

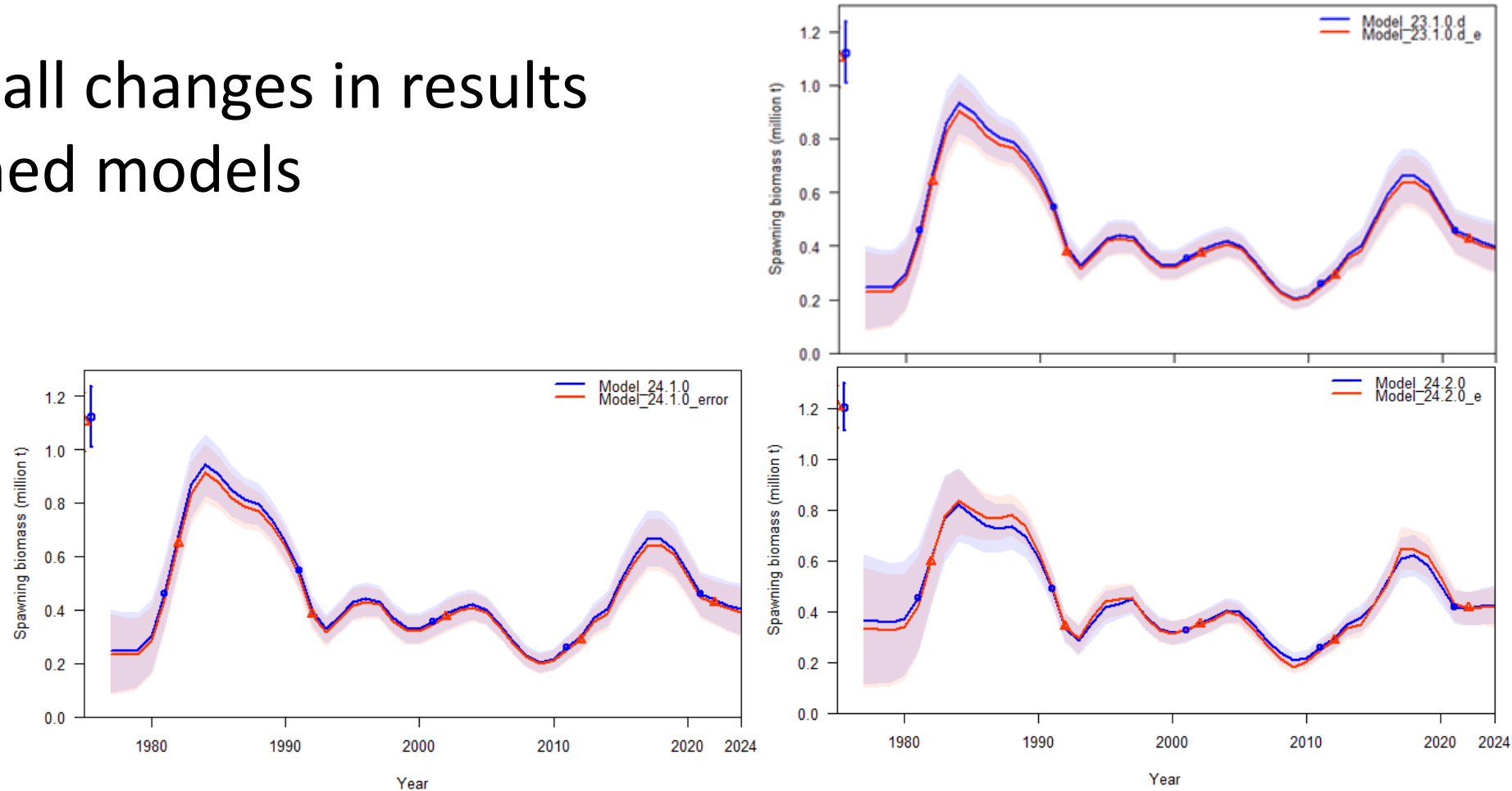


	Model 23.1.0.d	Model 23.1.0.d.e	Model 24.1.0	Model 24.1.0.e	Model 24.2.0	Model 24.2.0.e
	M 23.1.0.d W/ 5cm length bins	M23.1.0.d W/ error matrix update	M23.1.0.d W/static survey selectivity	M24.1.0 W/error matrix update	M24.1.0 W/ CAAL	M24.2.0 W/ error matrix update
<b>Parameters #</b>	201	201	160	160	147	147
<b>Likelihoods</b>						
<b>Total</b>	246.93	281.18	258.64	283.70	813.80	769.18
<b>Index</b>	<b>-80.57</b>	<b>-81.64</b>	<b>-76.30</b>	<b>-77.95</b>	<b>-42.39</b>	<b>-84.15</b>
<b>Agecomp</b>	92.04	124.57	91.71	118.35	491.00	460.55
<b>Sizecomp</b>	199.71	201.52	210.75	209.97	340.34	371.35
<b>AIC</b>	895.9	964.36	837.3	887.39	1921.6	1832.36
<b>Retrospective</b>						
<b>Mohn's Rho</b>	-0.03	-0.03	-0.03	-0.03	-0.05	-0.06
<b>Predictive Rho</b>	-0.08	-0.08	-0.08	-0.08	-0.06	-0.07
<b>OSA SDNR</b>						
<b>Survey Age</b>	0.96	0.95	0.96	0.94		
<b>Survey Length</b>	0.96	0.97	0.96	0.97	0.98	0.95
<b>Fishery Length</b>	1.07	1.07	1.07	1.07	1.08	1.07
<b>Growth Parameters</b>						
<b>Lmin</b>	14.202	13.962	14.047	13.777	13.61	11.62
<b>Lmax</b>	112.138	112.594	112.614	112.865	95.820	97.915
<b>K</b>	0.116	0.117	0.114	0.115	0.230	0.183
<b>Richard's Rho</b>	1.414	1.405	1.432	1.422	0.850	1.363
<b>Survey Catchability</b>						
	0.92	0.959	0.92	0.949	1.140	1.137
<b>Derived Quantities</b>						
<b>Unfished SSB</b>	573,695	563,885	572,660	563,200	558,755	557,240
<b>F<sub>40</sub></b>	0.38	0.38	0.38	0.38	0.36	0.36
<b>B<sub>ratio</sub> 2023</b>	0.36	0.36	0.37	0.36	0.38	0.37



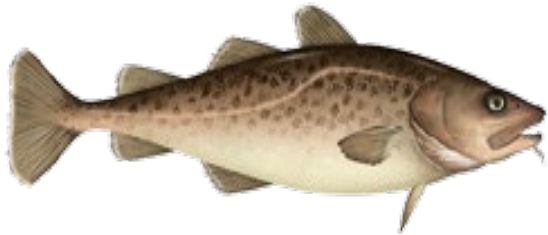
# Update aging error results

- Relatively small changes in results for the untuned models



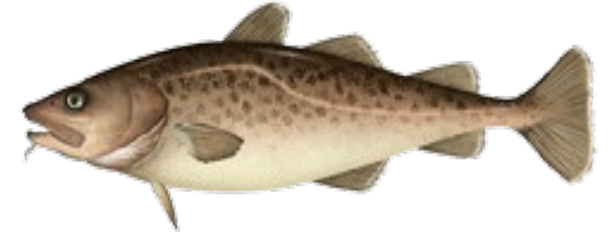
# Update aging error

- Much larger differences in the tuned models



	Model 24.5.0	Model 24.6.0	Model 24.5.1	Model 24.6.1
	Model 24.3.0 w/ tuning	24.5.0 W/ error matrix update	Model 24.3.1 w/ tuning	24.5.1 W/ error matrix update
<b>Parameters #</b>	147	147	147	147
<b>Likelihoods</b>				
<b>Total</b>	980.81	827.17	858.53	668.65
<b>Index</b>	-20.88	-76.06	-24.17	-78.03
<b>Agecomp</b>	624.67	478.92	480.32	253.71
<b>Sizecomp</b>	344.15	394.60	370.86	454.22
<b>AIC</b>	2255.6	1948.34	2011.06	1631.30
<b>Retrospective</b>				
<b>Mohn's Rho</b>	-0.029	-0.111	-0.024	-0.004
<b>Predictive Rho</b>	-0.024	-0.126	-0.021	-0.006
<b>OSA SDNR</b>				
<b>Survey Age</b>				
<b>Survey Length</b>	0.98	0.97	0.99	0.94
<b>Fishery Length</b>	1.09	1.07	1.07	1.05
<b>Growth Parameters</b>				
<b>Lmin</b>	13.57	11.60	13.48	12.31
<b>Lmax</b>	93.15	96.32	94.23	101.51
<b>K</b>	0.31	0.225	0.28	0.14
<b>Richard's Rho</b>	0.43	1.092	0.54	1.53
<b>Survey Catchability</b>				
	1.24	1.198	1.21	0.96
<b>Derived Quantities</b>				
<b>Unfished SSB</b>	552,245	524,005	551,085	563,665
<b>F<sub>40</sub></b>	0.33	0.341	0.34	0.490
<b>B<sub>ratio</sub> 2023</b>	0.39	0.400	0.40	0.480

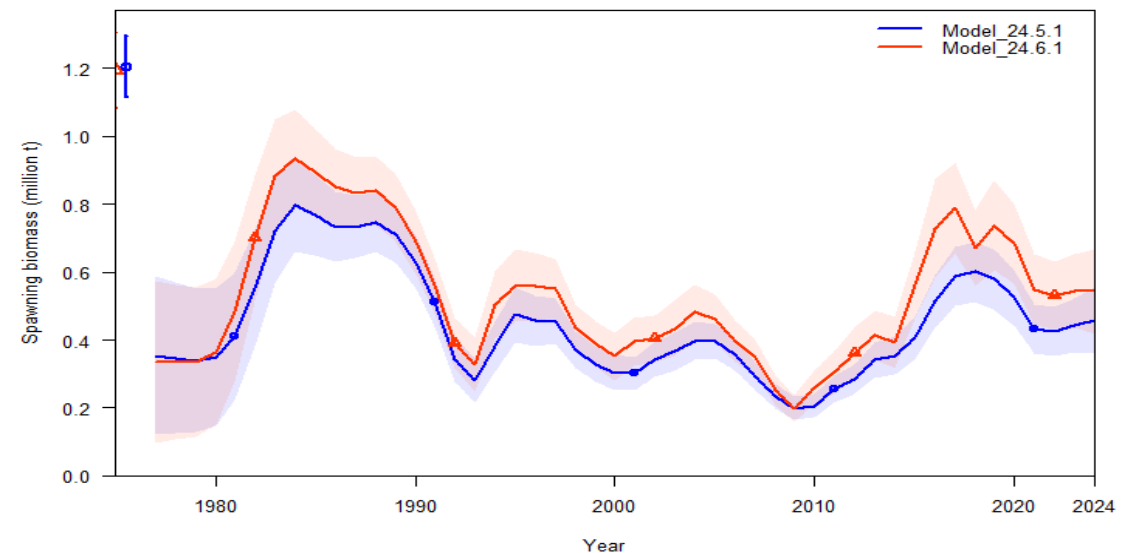


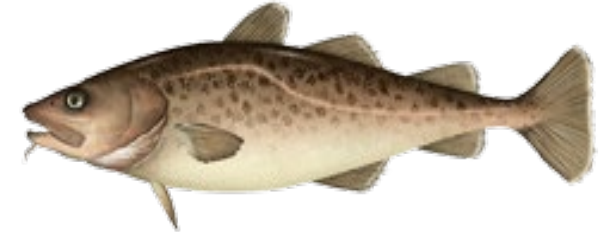


# Update aging error results

- Retuning in models with new aging error greatly down-weight the survey CAAL data.
  - This shows a disagreement between Survey CAAL and other data, potentially due to misspecification of aging bias.
  - **Subsequent analyses show aging bias from 2000-2007 may have been estimated too low**

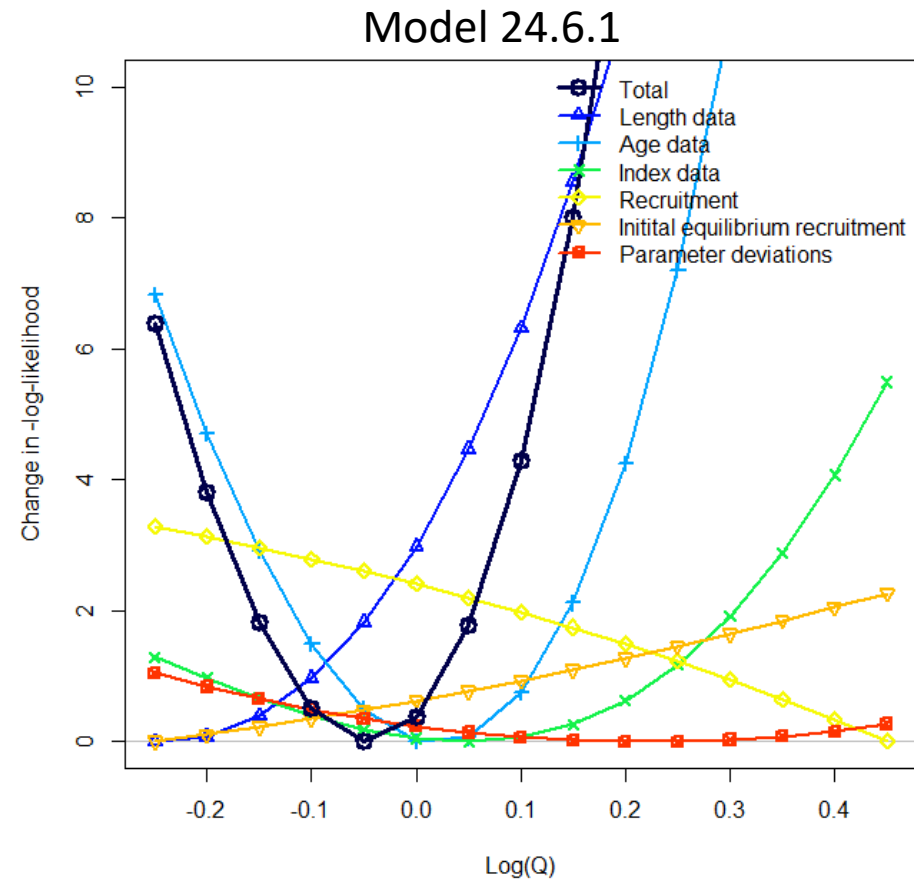
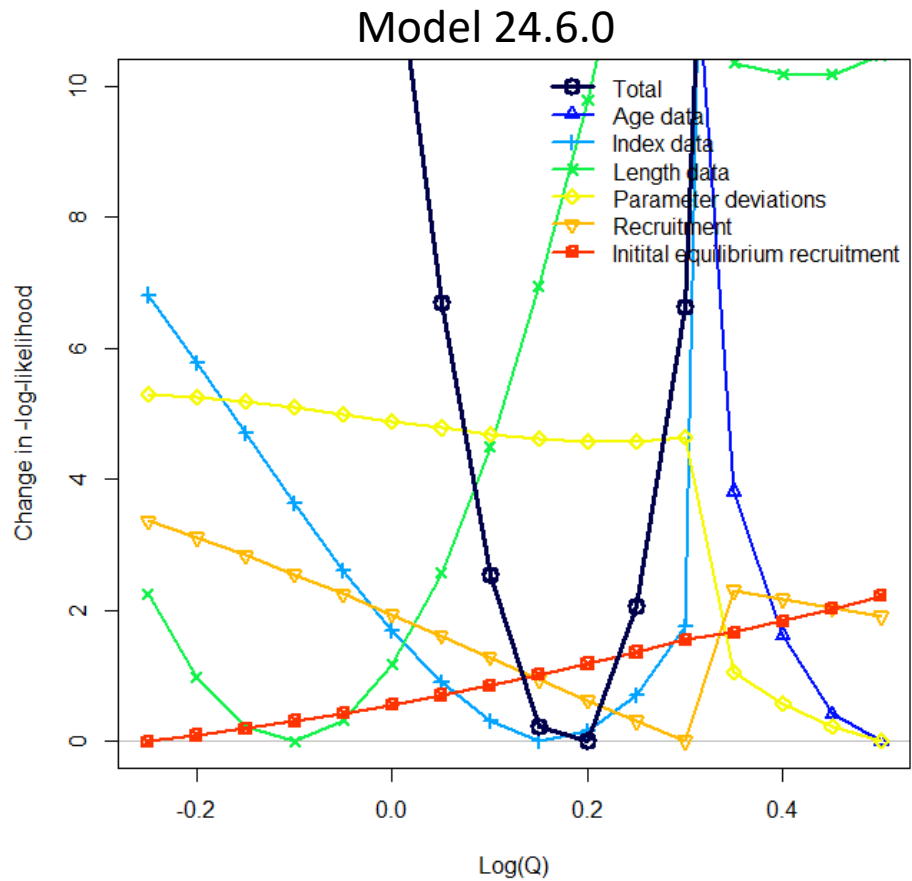
Model	Input variance adjustments factors*				$\sigma_R$	$\sigma$	
	LFish	LSurv	A Fish	ASurv		$L_{\min}$	K
M24.5.0	0.073	0.034	0.010	0.064	0.6404	0.370	0.149
M24.5.1	0.081	0.038	NA	0.055	0.6642	0.367	0.149
M24.6.0	0.081	0.043	0.059	<b>0.005</b>	0.5917	0.391	0.165
M24.6.1	0.094	0.068	NA	<b>0.007</b>	0.8043	0.528	0.213



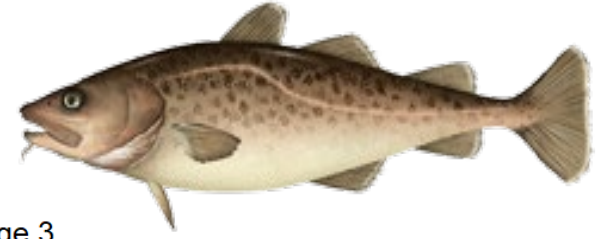


# Update aging error results

- Conflict between length and CAAL data

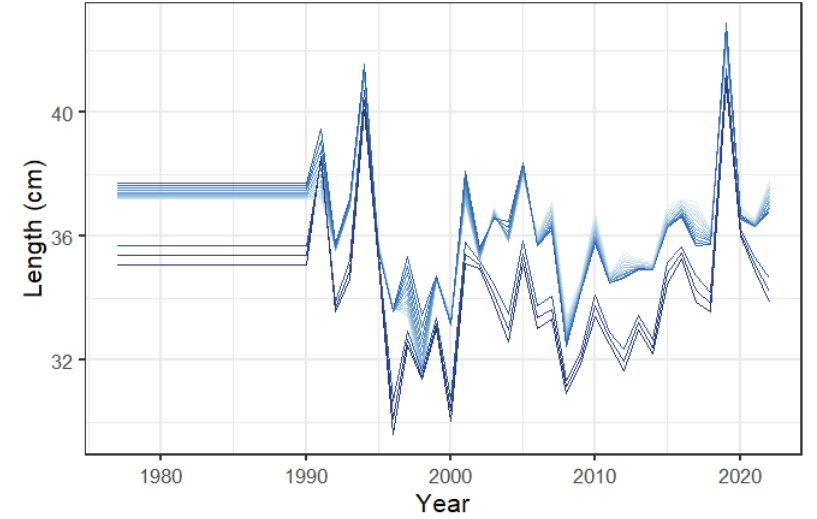




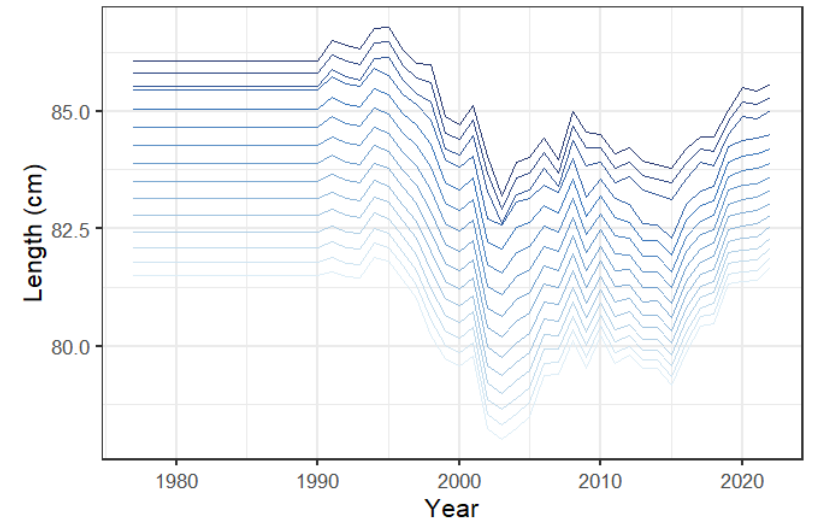


# Growth and catchability interact

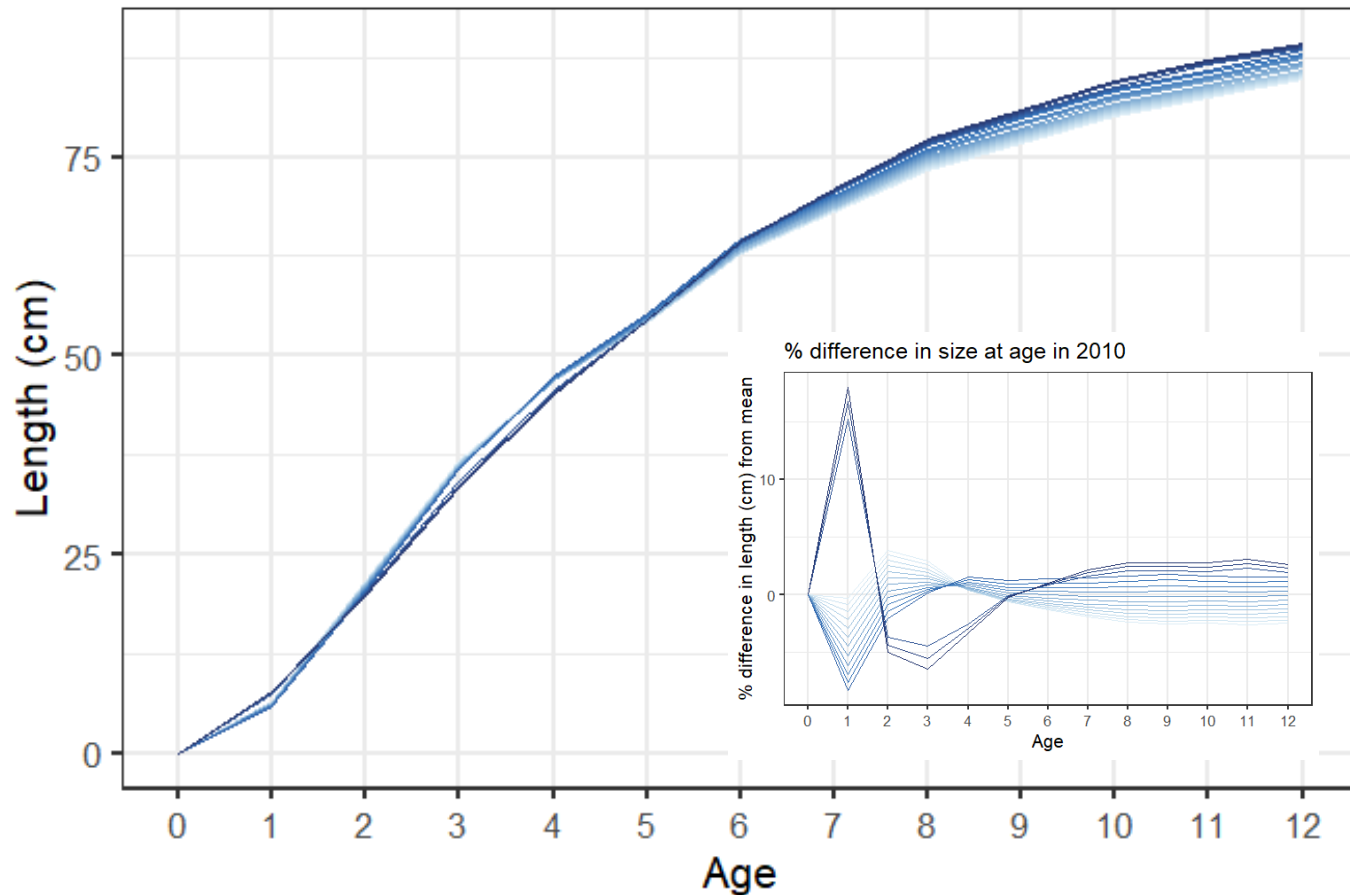
Size at age 3

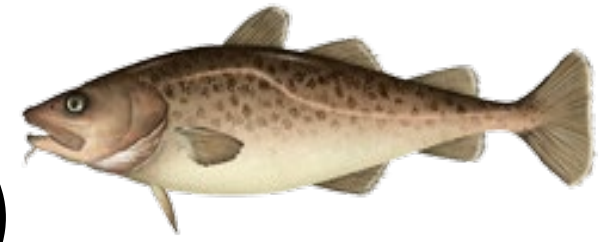


Size at age 10



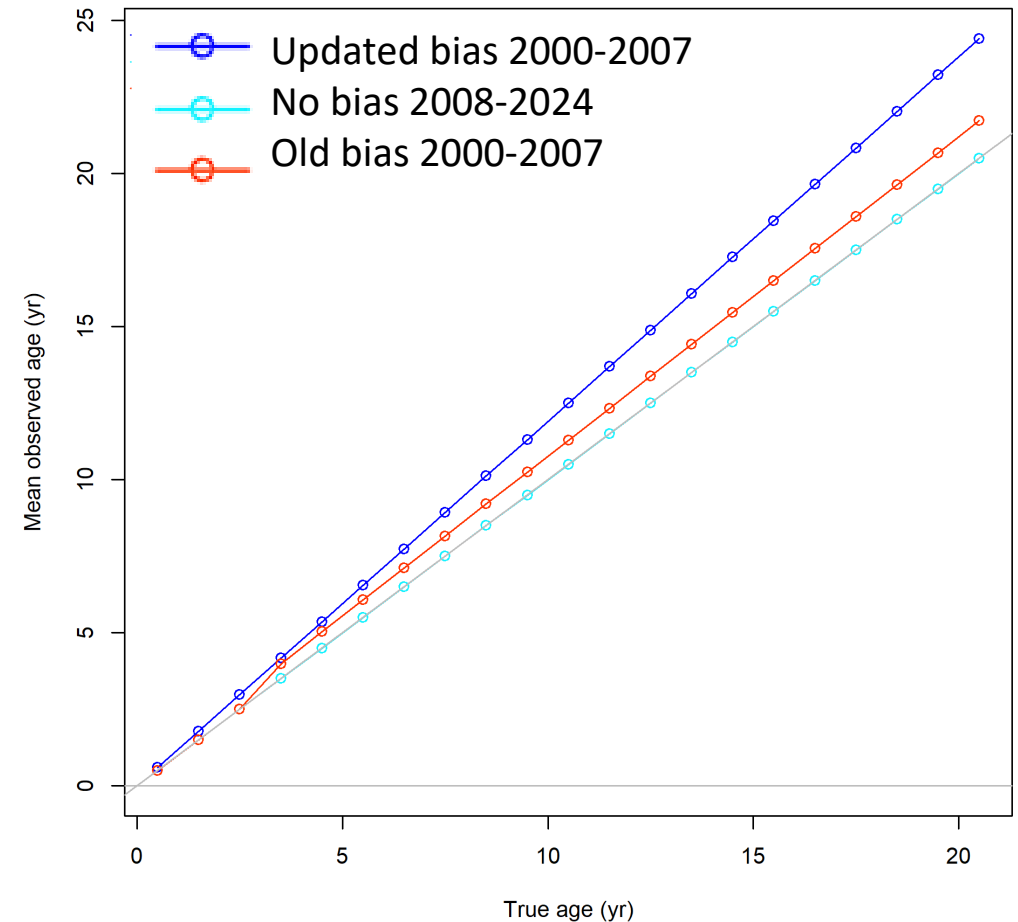
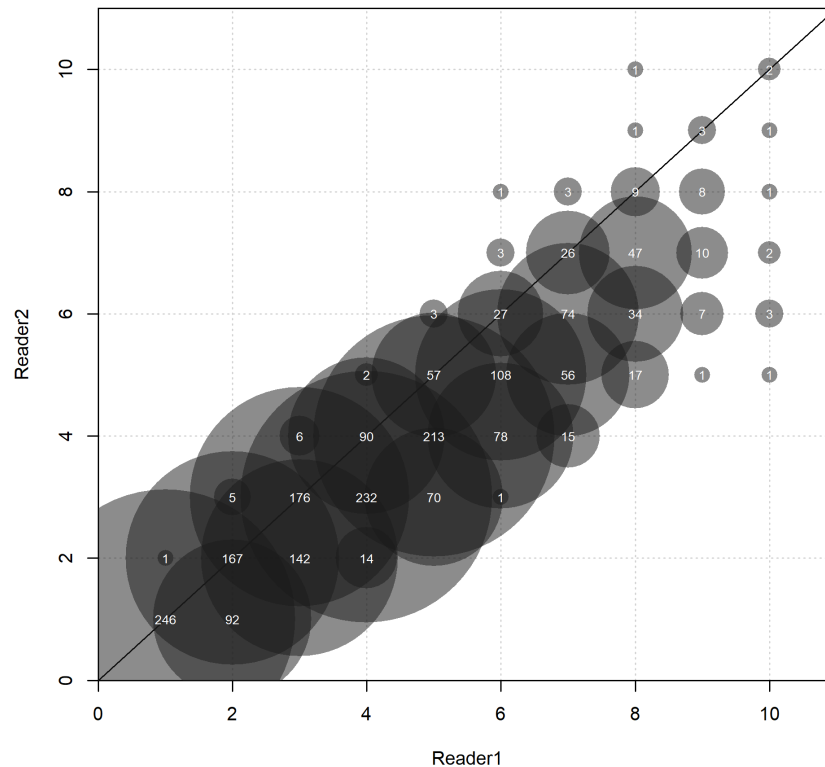
Size at age in 2010





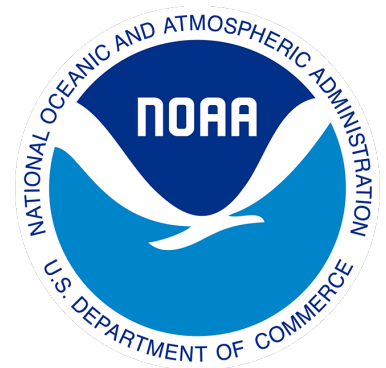
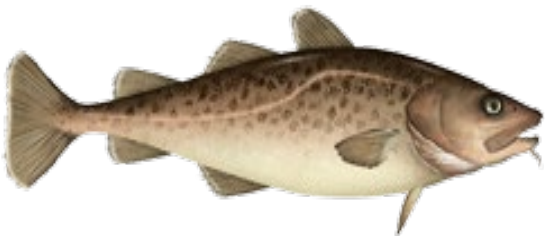
# Update aging bias (not in document)

- Otoliths from 2004 reread in 2018 (n=2,056)
- Analyzed with AgingError library with bias estimated assuming 2018 read was unbiased



# Recommendations for November

- Proposed three models for review in November
  - Model 23.1.0.d – with updated data and updated linear aging error/bias
  - Model 24.1 (24.1.0.e)
    - 5cm length bins, static survey selectivity, updated spline aging error/bias
  - Model 24.2 (24.6.0)
    - Model 24.1 with survey and fishery CAAL



# Data updates for November

- VAST Abundance Index
- VAST Age composition
- CAAL survey and fishery through 2024
- Survey and Fishery length composition
- Catch for 2023 and 2024
- Updated aging error/bias matrix

