

¹ Status of Yellowtail Rockfish (*Sebastes*
² *flavidus*) Along the U.S. Pacific Coast in 2017



³ Jean DeMarignac (SIMoN / MBNMS), Public Domain

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101

Executive Summary

executive-summary

102

Stock

stock

103 This assessment reports the status of the Yellowtail Rockfish (*Sebastodes flavidus*) resource in
104 U.S. waters off the coast of California, Oregon, and Washington using data through 2016.

105 The Pacific Fishery Management Council (PFMC) manages the U.S. fishery as two stocks
106 separated at Cape Mendocino, California ($40^{\circ} 10'N$). This assessment analyzes those two
107 areas as independent stocks, with the southern stock extending southward to the U.S./Mexico
108 border and the northern stock extending northward to the U.S./Canada border.

109 The previous assessment (Wallace and Lai 2005), following the pattern of prior assessments,
110 included only the Northern stock which it divided into three assessment areas with divisions
111 at Cape Elizabeth ($47^{\circ} 20'N$) and Cape Falcon ($45^{\circ} 46'N$). However, a more recent genetic
112 analysis (Hess et al. n.d.) found distinct stocks north and south of Cape Mendocino but
113 did not find stock differences within the northern area, with the genetic stock extending
114 northward through British Columbia, Canada to Southeast Alaska. However, Canada and
115 Alaska are not included in this assessment. Since the previous assessment, reconstruction of
116 historical catch by Washington and Oregon makes any border but the state line incompatible
117 with the data. Additionally, much of the groundfish catch landed in northern Oregon is
118 caught in Washington waters.

119

Catches

catches

120 Catches from the Northern stock were divided into four categories: commercial catch, bycatch
121 in the at-sea hake fishery, recreational catch in Oregon and California (north of $40^{\circ} 10'N$),
122 and recreational catch in Washington. The first three of these fleets were entered in metric
123 tons, but the recreational catch from Washington was entered in the model as numbers of
124 fish with the average weight calculated internally in the model.

125 Catches from the Southern stock were divided into two categories: commercial and recreational
126 catch, both of which were entered as metric tons.

127 Include: trends and current levels-include table for last ten years and graph with long term
128 data

129 Catch figures: (Figures a-b)

130 Catch tables: (Tables a-b)

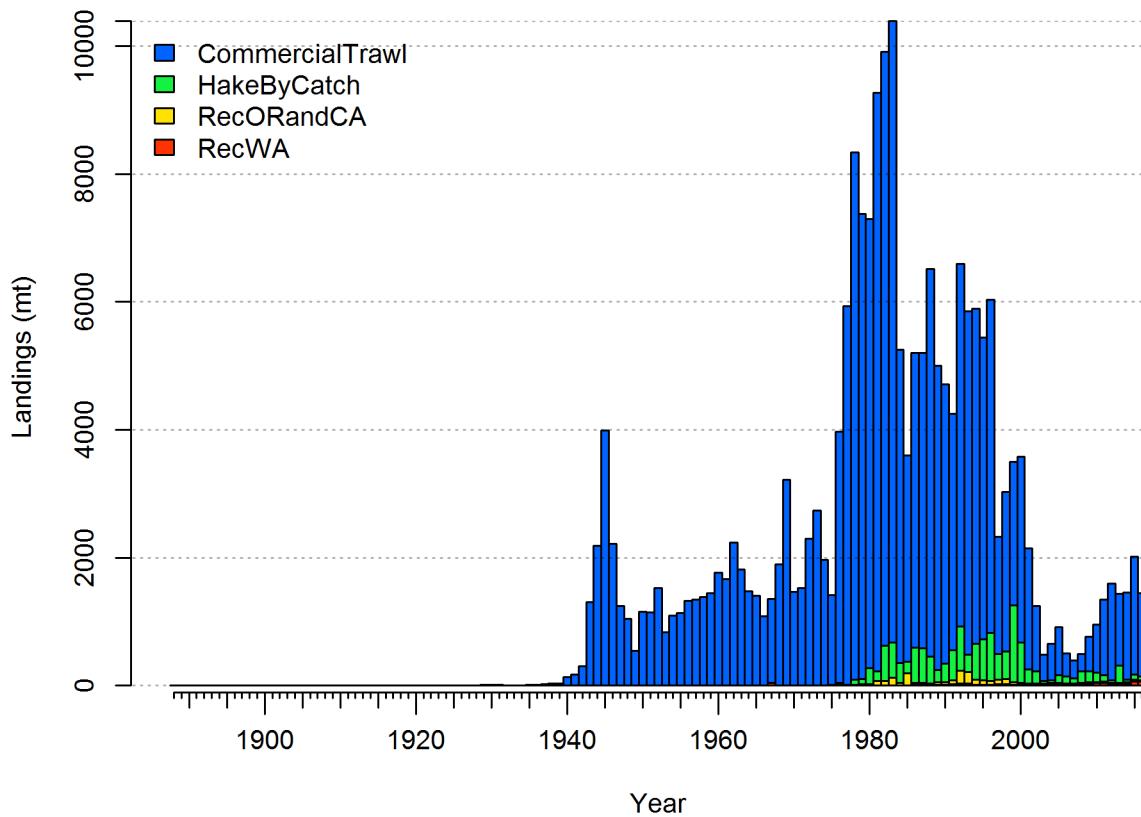


Figure a: Estimated catch history of Yellowtail Rockfish in the Northern model. Recreational catches in Washington are model estimates of total weight converted from input catch in numbers using model estimates of growth and selectivity.
fig:r4ss_catch_N

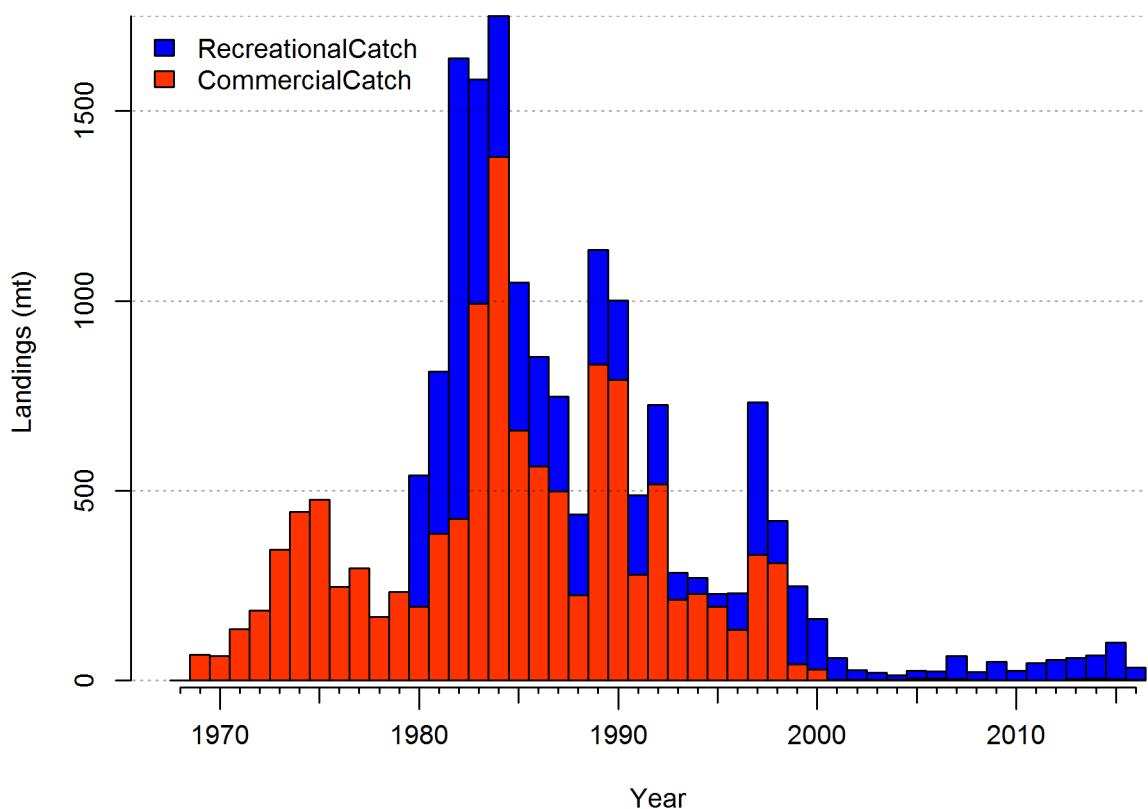


Figure b: Estimated catch history of Yellowtail Rockfish in the Southern model. [fig:r4ss_catch_S](#)

Table a: Recent Yellowtail Rockfish catch by fleet for the Northern stock (north of 40° 10'N).

tab:Exec_catch_N

Year	Commercial (t)	At-sea hake bycatch (t)	Recreational OR+CA (t)	Recreational WA (1000s)
2007	-	-	-	-
2008	-	-	-	-
2009	-	-	-	-
2010	-	-	-	-
2011	-	-	-	-
2012	-	-	-	-
2013	-	-	-	-
2014	-	-	-	-
2015	-	-	-	-
2016	-	-	-	-

Table b: Recent Yellowtail Rockfish catch by fleet for the Southern stock (south of 40° 10'N).

tab:Exec_catch_S

Year	Recreational (t)	Commercial (t)
2007	-	-
2008	-	-
2009	-	-
2010	-	-
2011	-	-
2012	-	-
2013	-	-
2014	-	-
2015	-	-
2016	-	-

131 Data and Assessment

data-and-assessment

132 Include: date of last assessment, type of assessment model, data available, new information,
 133 and information lacking.

134 Yellowtail Rockfish was assessed.... This assessment uses the newest version of Stock
 135 Synthesis (3.xxx). The model begins in 1889, and assumes the stock was at an unfished
 136 equilibrium that year.

137 Map of assessment region: (Figure c).

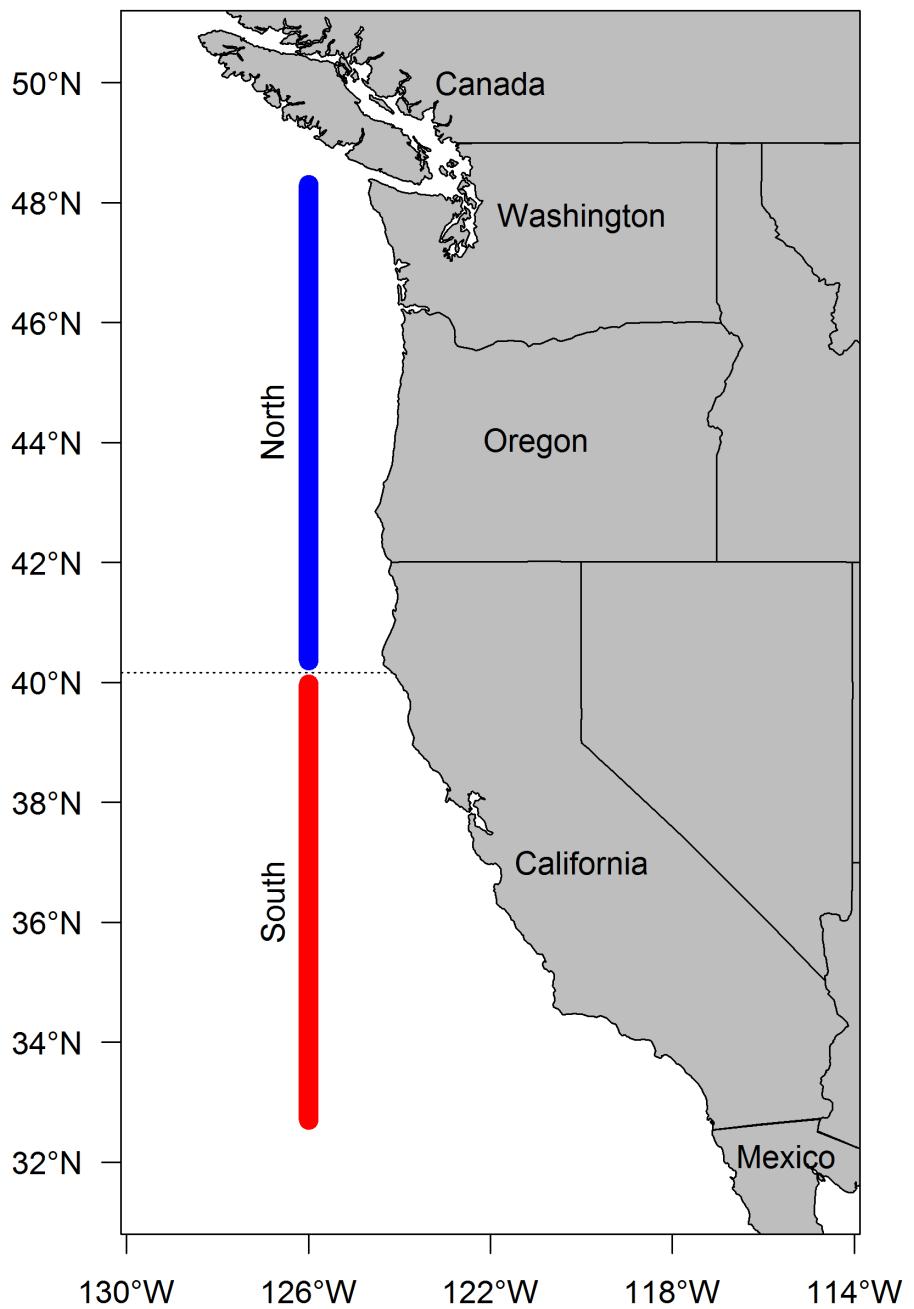


Figure c: Map depicting the boundaries for the base-case model. fig:assess_region_map

¹³⁸ **Stock Biomass**

stock-biomass

¹³⁹ **Include: trends and current levels relative to virgin or historic levels, description of uncertainty-include table for last 10 years and graph with long term estimates.**

¹⁴¹ Spawning output Figure: Figure [d](#)

¹⁴² Spawning output Table(s): Table [c](#)

¹⁴³ Relative depletion Figure: Figure [e](#)

¹⁴⁴ Example text (remove Models 2 and 3 if not needed - if using, remove the # in-line comments!!!)

¹⁴⁵ The estimated relative depletion level (spawning output relative to unfished spawning output)

¹⁴⁶ of the the base-case model in 2016 is 53% (~95% asymptotic interval: ± 41.3%-64.8%) (Figure ¹⁴⁷ [e](#)).

¹⁴⁸ The estimated relative depletion level of model 2 in 2016 is 88.9% (~95% asymptotic interval:

¹⁴⁹ ± 69.1%-109%) (Figure [e](#)).

¹⁵⁰ The estimated relative depletion level of model 3 in 2016 is (~95% asymptotic interval: ±)
¹⁵¹ (Figure [e](#)).

Table c: Recent trend in beginning of the year spawning output and depletion for the Northern model for Yellowtail Rockfish.

Year	Spawning Output (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2008	7.307	(5.31-9.3)	0.497	(0.368-0.627)
2009	7.713	(5.65-9.78)	0.525	(0.394-0.656)
2010	7.991	(5.87-10.12)	0.544	(0.412-0.676)
2011	8.105	(5.94-10.27)	0.552	(0.42-0.683)
2012	8.160	(5.98-10.34)	0.555	(0.426-0.685)
2013	8.101	(5.91-10.29)	0.551	(0.425-0.677)
2014	8.021	(5.83-10.21)	0.546	(0.423-0.669)
2015	7.943	(5.75-10.14)	0.541	(0.421-0.661)
2016	7.806	(5.6-10.02)	0.531	(0.413-0.65)
2017	7.791	(5.55-10.03)	0.530	(0.413-0.648)

Table d: Recent trend in beginning of the year spawning output and depletion for the Southern model for Yellowtail Rockfish.

Year	Spawning Output (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2008	1.310	(-0.06-2.68)	0.549	(0.415-0.683)
2009	1.310	(-0.05-2.67)	0.549	(0.419-0.678)
2010	1.323	(-0.05-2.69)	0.554	(0.428-0.681)
2011	1.353	(-0.04-2.74)	0.567	(0.441-0.692)
2012	1.396	(-0.03-2.82)	0.585	(0.458-0.712)
2013	1.463	(-0.02-2.95)	0.613	(0.481-0.744)
2014	1.551	(-0.02-3.12)	0.649	(0.512-0.787)
2015	1.679	(-0.01-3.37)	0.703	(0.554-0.852)
2016	1.866	(0-3.73)	0.781	(0.613-0.95)
2017	2.123	(0-4.24)	0.889	(0.691-1.087)

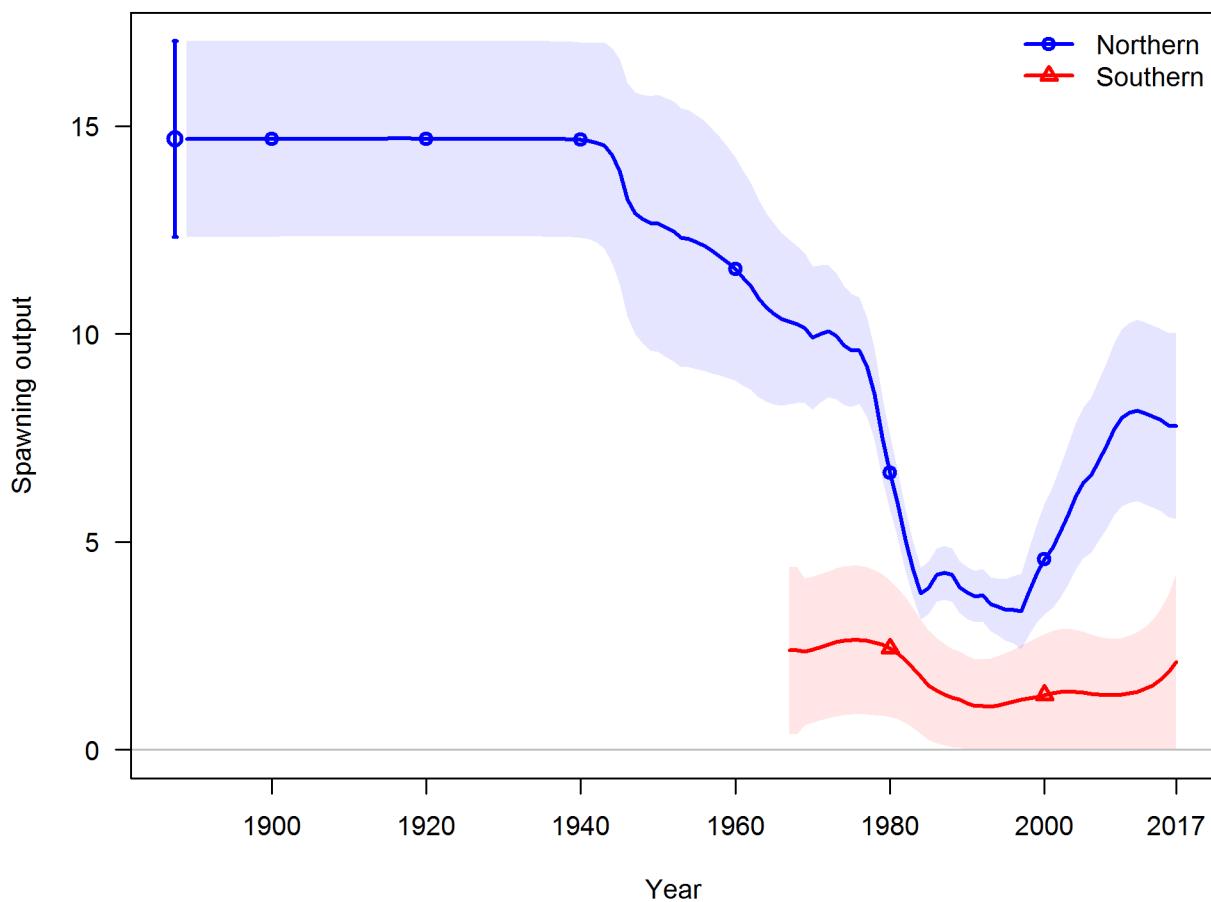


Figure d: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. [fig:Spawnbio_all](#)

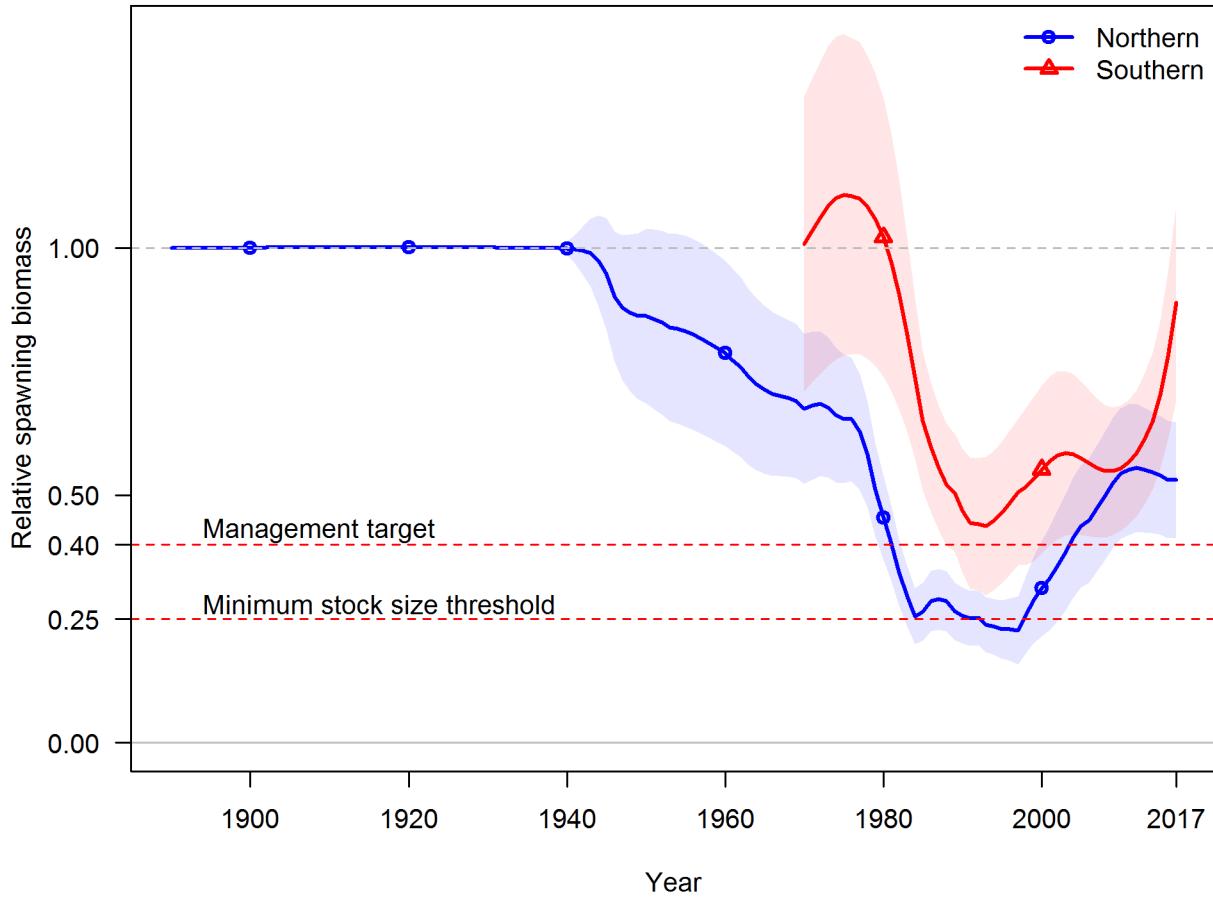


Figure e: Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model. [fig:RelDeplete_all](#)

152 **Recruitment**

recruitment

153 Include: trends and current levels relative to virgin or historic levels-include table for last 10
154 years and graph with long term estimates.

155 Recruitment Figure: (Figure f)

156 Recruitment Tables: (Tables e, f and ??)

Table e: Recent recruitment for the Northern model.

Year	Estimated Recruitment (millions)	~ 95% confidence interval
2008	34.46	(20.8 - 57.08)
2009	10.44	(5.04 - 21.65)
2010	22.11	(11.8 - 41.43)
2011	15.15	(6.89 - 33.31)
2012	15.95	(6.29 - 40.42)
2013	25.87	(8.87 - 75.43)
2014	24.05	(8.24 - 70.21)
2015	24.51	(8.62 - 69.71)
2016	24.35	(8.57 - 69.16)
2017	24.34	(8.57 - 69.13)

Table f: Recent recruitment for the Southern model.

Year	Estimated Recruitment (millions)	~ 95% confidence interval
2008	83.95	(25.9 - 272.16)
2009	48.41	(8.2 - 285.6)
2010	53.68	(8.77 - 328.57)
2011	50.97	(10 - 259.73)
2012	24.44	(4.55 - 131.38)
2013	29.08	(6.62 - 127.77)
2014	23.37	(4.98 - 109.65)
2015	18.37	(3.92 - 86.03)
2016	15.01	(3.1 - 72.6)
2017	15.48	(3.2 - 74.82)

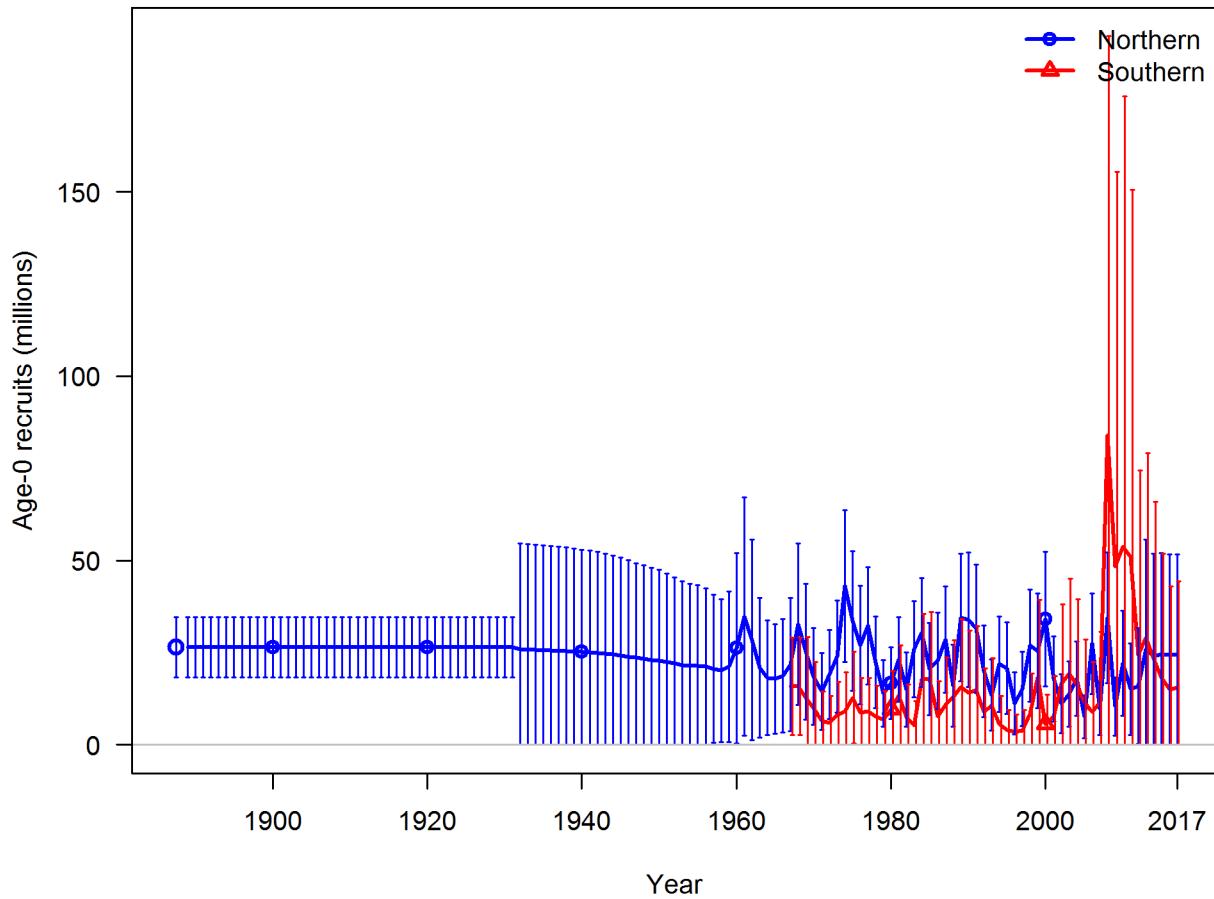


Figure f: Time series of estimated Yellowtail Rockfish recruitments for the base-case model with 95% confidence or credibility intervals. [fig:Recruits_all](#)

157 **Exploitation status**

exploitation-status

158 Include: exploitation rates (i.e., total catch divided by exploitable biomass, or the annual
159 SPR harvest rate) include a table with the last 10 years of data and a graph showing the
160 trend in fishing mortality relative to the target (y-axis) plotted against the trend in biomass
161 relative to the target (x-axis).

162 Exploitation Tables: Table [g](#), Table [h](#), Table ?? Exploitation Figure: Figure [g](#)).

163 A summary of Yellowtail Rockfish exploitation histories for base model is provided as Figure
164 [h](#).

Table g: Recent trend in spawning potential ratio and exploitation for Yellowtail Rockfish in the Northern model. Fishing intensity is (1-SPR) divided by 50% (the SPR target) and exploitation is F divided by F_{SPR} .

Year	Fishing intensity	~ 95% confidence interval	Exploitation rate	~ 95% confidence interval	tab:SPR_Exploit_mod1
2007	0.33	(0.12-0.55)	0.01	(0-0.02)	
2008	0.21	(0.14-0.28)	0.01	(0-0.01)	
2009	0.39	(0.24-0.54)	0.01	(0.01-0.02)	
2010	0.52	(0.27-0.77)	0.02	(0.01-0.03)	
2011	0.45	(0.33-0.58)	0.02	(0.01-0.02)	
2012	0.52	(0.38-0.65)	0.02	(0.01-0.03)	
2013	0.49	(0.36-0.62)	0.02	(0.01-0.02)	
2014	0.49	(0.36-0.62)	0.02	(0.01-0.02)	
2015	0.63	(0.48-0.79)	0.03	(0.02-0.03)	
2016	0.50	(0.36-0.63)	0.02	(0.01-0.02)	

Table h: Recent trend in spawning potential ratio and exploitation for Yellowtail Rockfish in the Southern model. Fishing intensity is $(1-SPR)$ divided by 50% (the SPR target) and exploitation is F divided by F_{SPR} .

Year	Fishing intensity	~ 95% confidence interval	Exploitation rate	~ 95% confidence interval	tab:SPR_Exploit_mod2
2007	0.07	(0-0.13)	0.00	(0-0)	
2008	0.02	(0-0.05)	0.00	(0-0)	
2009	0.05	(0-0.09)	0.00	(0-0)	
2010	0.02	(0-0.04)	0.00	(0-0)	
2011	0.03	(0-0.07)	0.00	(0-0)	
2012	0.03	(0-0.06)	0.00	(0-0)	
2013	0.03	(0-0.07)	0.00	(0-0)	
2014	0.03	(0-0.06)	0.00	(0-0)	
2015	0.04	(0-0.09)	0.00	(0-0)	
2016	0.01	(0-0.03)	0.00	(0-0)	

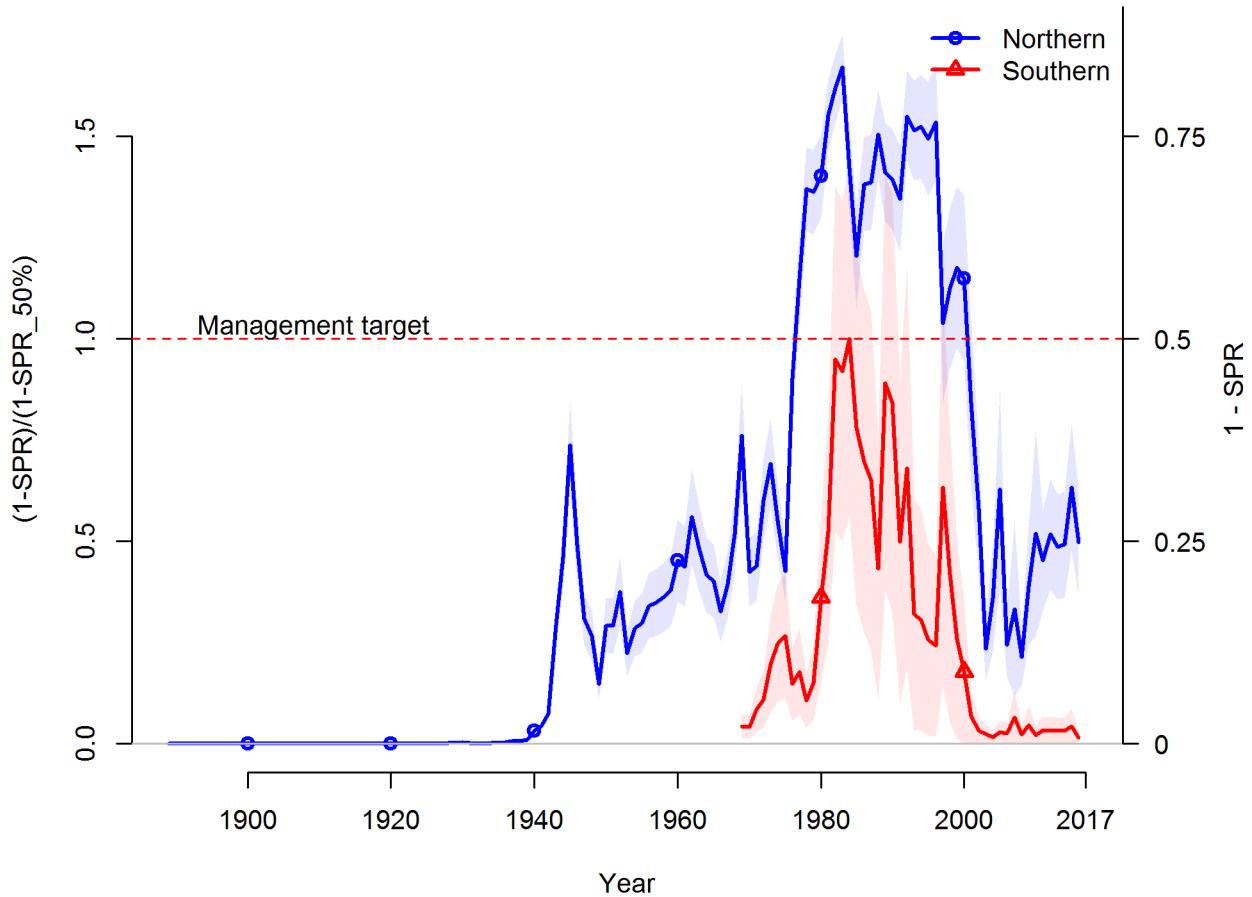


Figure g: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{50\%}$ harvest rate. The last year in the time series is 2016. | [fig:SPR_all](#)

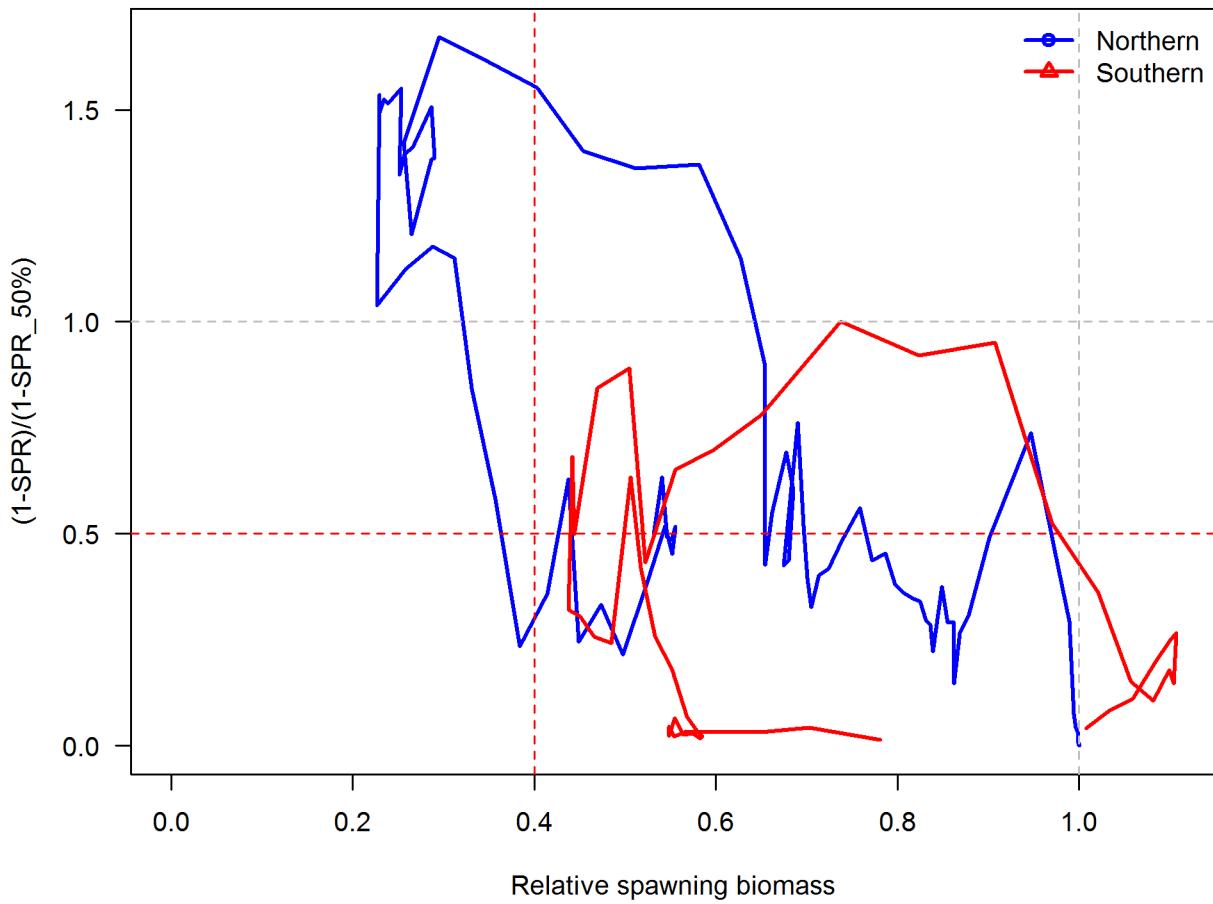


Figure h: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. | [fig:Phase_all](#)

165 **Ecosystem Considerations**

ecosystem-considerations

166 In this assessment, ecosystem considerations were. . . .

167 **Reference Points**

reference-points

168 **Include:** management targets and definition of overfishing, including the harvest rate that
169 brings the stock to equilibrium at $B_{40\%}$ (the B_{MSY} proxy) and the equilibrium stock size
170 that results from fishing at the default harvest rate (the F_{MSY} proxy). Include a summary
171 table that compares estimated reference points for SSB, SPR, Exploitation Rate and Yield
172 based on SSBproxy for MSY, SPRproxy for MSY, and estimated MSY values

173 Write intro paragraph....and remove text for Models 2 and 3 if not needed

174 This stock assessment estimates that Yellowtail Rockfish in the Northern model are above
175 the biomass target, but above the minimum stock size threshold. Add sentence about
176 spawning output trend. The estimated relative depletion level for Model 1 in 2016 is 53%
177 (~95% asymptotic interval: $\pm 41.3\%-64.8\%$, corresponding to an unfished spawning output of
178 7.79131 billion eggs (~95% asymptotic interval: 5.55-10.03 billion eggs) of spawning output
179 in the base model (Table i). Unfished age 1+ biomass was estimated to be 128999 mt in the
180 base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 5.9
181 billion eggs, which gives a catch of 3910.4 mt. Equilibrium yield at the proxy F_{MSY} harvest
182 rate corresponding to $SPR_{50\%}$ is 3691.6 mt.

183 This stock assessment estimates that Yellowtail Rockfish in the Southern model are above the
184 biomass target, but above the minimum stock size threshold. Add sentence about spawning
185 output trend. The estimated relative depletion level for Model 2 in 2016 is 88.9% (~95%
186 asymptotic interval: $\pm 69.1\%-109\%$), corresponding to an unfished spawning output of 2.12257
187 billion eggs (~95% asymptotic interval:) of spawning output in the base model (Table j).
188 Unfished age 1+ biomass was estimated to be 51107.8 mt in the base case model. The target
189 spawning output based on the biomass target ($SB_{40\%}$) is 0.9551 billion eggs, which gives a
190 catch of mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is
191 1347.3 mt.

192 This stock assessment estimates that Yellowtail Rockfish in the are

193 the biomass target, but
194 the minimum stock size threshold. Add sentence about spawning output trend. The estimated
195 relative depletion level or Model 3 in 2016 is (~95% asymptotic interval: \pm), corresponding
196 to an unfished spawning output of (~95% asymptotic interval:) of spawning output in the
197 base model (Table ??). Unfished age 1+ biomass was estimated to be mt in the base case
198 model. The target spawning output based on the biomass target ($SB_{40\%}$) is , which gives a
199 catch of mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is
200 mt.

Table i: Summary of reference points and management quantities for the base case Northern model.

Quantity	Estimate	<small>tab:Ref_pts_mod1</small> 95% Confidence Interval
Unfished spawning output (billion eggs)	14.7	(12.3-17)
Unfished age 1+ biomass (mt)	128999	(110839.6-147158.4)
Unfished recruitment (R0, thousands)	26398.3	(18222.3-34574.3)
Spawning output(2016 billion eggs)	7.8	(5.6-10)
Depletion (2016)	0.5313	(0.413-0.6496)
Reference points based on SB_{40%}		
Proxy spawning output ($B_{40\%}$)	5.9	(4.9-6.8)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.4589	(0.4589-0.4589)
Exploitation rate resulting in $B_{40\%}$	0.0539	(0.0514-0.0564)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	3910.4	(3265-4555.8)
Reference points based on SPR proxy for MSY		
Spawning output	6.5	(5.5-7.6)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0477	(0.0455-0.05)
Yield with SPR_{proxy} at SB_{SPR} (mt)	3691.6	(3085.6-4297.5)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	3.5	(2.9-4.1)
SPR_{MSY}	0.3118	(0.3067-0.3169)
Exploitation rate at MSY	0.0821	(0.0779-0.0863)
MSY (mt)	4347.6	(3612-5083.2)

Table j: Summary of reference points and management quantities for the base case Southern model.

Quantity	Estimate	<small>tab:Ref_pts_mod2</small> 95% Confidence Interval
Unfished spawning output (billion eggs)	2.4	(0.3775-4.4)
Unfished age 1+ biomass (mt)	51107.8	(8536.6-93679)
Unfished recruitment (R0, thousands)	15828	(2605.8-29050.2)
Spawning output(2016 billion eggs)	1.9	(-0.0034-3.7)
Depletion (2016)	0.7814	(0.6131-0.9496)
Reference points based on SB_{40%}		
Proxy spawning output ($B_{40\%}$)	0.9551	(0.151-1.8)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.4589	(0.4589-0.4589)
Exploitation rate resulting in $B_{40\%}$	0.0578	(0.0561-0.0594)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	1423.2	(235.5-2610.8)
Reference points based on SPR proxy for MSY		
Spawning output	1.1	(0.1682-2)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0509	(0.0495-0.0523)
Yield with SPR_{proxy} at SB_{SPR} (mt)	1347.3	(223.1-2471.5)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	0.5812	(0.0926-1.1)
SPR_{MSY}	0.3177	(0.3144-0.321)
Exploitation rate at MSY	0.0887	(0.0863-0.0911)
MSY (mt)	1565.5	(258-2873)

201 **Management Performance**

management-performance

202 Include: catches in comparison to OFL, ABC and OY/ACL values for the most recent 10
203 years (when available), overfishing levels, actual catch and discard. Include OFL(encountered),
204 OFL(retained) and OFL(dead) if different due to discard and discard mortality.

205 Management performance table: Table [k](#)

Table k: Recent trend in total catch and commercial landings (mt) relative to the management guidelines. Estimated total catch reflect the commercial landings plus the model estimated discarded biomass.

Year	OFL (mt; ABC prior to 2011)	ABC (mt)	ACL (mt; OY prior to 2011)	Estimated total catch (mt)
2007	-	-	-	-
2008	-	-	-	-
2009	-	-	-	-
2010	-	-	-	-
2011	-	-	-	-
2012	-	-	-	-
2013	-	-	-	-
2014	-	-	-	-
2015	-	-	-	-
2016	-	-	-	-
2017	-	-	-	-
2018	-	-	-	-

206 **Unresolved Problems And Major Uncertainties**

unresolved-problems-and-major-uncertainties

207 TBD after STAR panel

208 **Decision Table(s) (groundfish only)**

decision-tables-groundfish-only

209 Include: projected yields (OFL, ABC and ACL), spawning biomass, and stock depletion levels
210 for each year. Not required in draft assessments undergoing review.

211 OFL projection table: Table [l](#)

212 Decision table(s) Table [m](#), Table [n](#), Table ??

213 Yield curve: Figure \ref{fig:Yield_all}

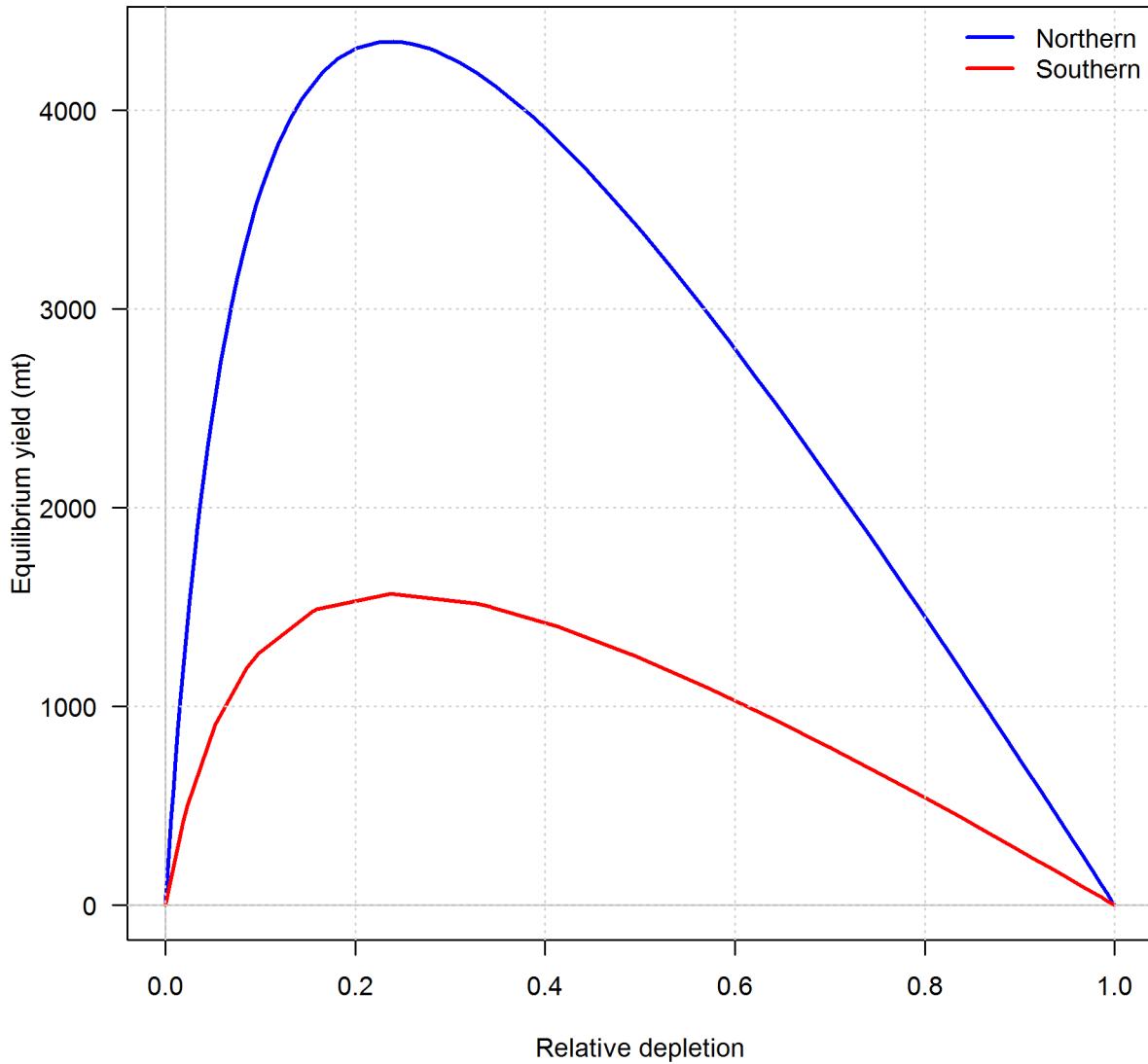


Figure i: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at... Fig:Yield_all

Table 1: Projections of potential OFL (mt) for each model, using the base model forecast.
tab:OFL_projection

Year	Model 1	Model 2	Total
2017	3988.81	3606.24	7595.05
2018	3840.38	3508.37	7348.75
2019	3712.42	3368.32	7080.74
2020	3611.38	3206.21	6817.59
2021	3544.46	3037.51	6581.97
2022	3513.29	2871.28	6384.57
2023	3512.56	2712.78	6225.34
2024	3532.98	2565.19	6098.17
2025	3564.86	2430.26	5995.12
2026	3600.46	2308.71	5909.17
2027	3634.58	2200.50	5835.08
2028	3664.30	2105.02	5769.32

Table m: Summary of 10-year projections beginning in 2018 for alternate states of nature based on an axis of uncertainty for the Northern model. Columns range over low, mid, and high states of nature, and rows range over different assumptions of catch levels. An entry of “–” indicates that the stock is driven to very low abundance under the particular scenario.

tab:Decision_table_mod1
States of nature

	Year	Catch	Low M 0.05		Base M 0.07		High M 0.09	
			Spawning Output	Depletion	Spawning Output	Depletion	Spawning Output	Depletion
40-10 Rule, Low M	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
40-10 Rule	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
40-10 Rule, High M	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
Average Catch	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-

Table n: Summary of 10-year projections beginning in 2018 for alternate states of nature based on an axis of uncertainty for the Southern model. Columns range over low, mid, and high states of nature, and rows range over different assumptions of catch levels. An entry of “–” indicates that the stock is driven to very low abundance under the particular scenario.

		States of nature					
		Low M 0.05		Base M 0.07		High M 0.09	
	Year	Catch	Spawning Output	Depletion	Spawning Output	Depletion	Spawning Output
40-10 Rule, Low M	2019	-	-	-	-	-	-
	2020	-	-	-	-	-	-
	2021	-	-	-	-	-	-
	2022	-	-	-	-	-	-
	2023	-	-	-	-	-	-
	2024	-	-	-	-	-	-
	2025	-	-	-	-	-	-
	2026	-	-	-	-	-	-
	2027	-	-	-	-	-	-
	2028	-	-	-	-	-	-
40-10 Rule	2019	-	-	-	-	-	-
	2020	-	-	-	-	-	-
	2021	-	-	-	-	-	-
	2022	-	-	-	-	-	-
	2023	-	-	-	-	-	-
	2024	-	-	-	-	-	-
	2025	-	-	-	-	-	-
	2026	-	-	-	-	-	-
	2027	-	-	-	-	-	-
	2028	-	-	-	-	-	-
40-10 Rule, High M	2019	-	-	-	-	-	-
	2020	-	-	-	-	-	-
	2021	-	-	-	-	-	-
	2022	-	-	-	-	-	-
	2023	-	-	-	-	-	-
	2024	-	-	-	-	-	-
	2025	-	-	-	-	-	-
	2026	-	-	-	-	-	-
	2027	-	-	-	-	-	-
	2028	-	-	-	-	-	-
Average Catch	2019	-	-	-	-	-	-
	2020	-	-	-	-	-	-
	2021	-	-	-	-	-	-
	2022	-	-	-	-	-	-
	2023	-	-	-	-	-	-
	2024	-	-	-	-	-	-
	2025	-	-	-	-	-	-
	2026	-	-	-	-	-	-
	2027	-	-	-	-	-	-
	2028	-	-	-	-	-	-

Table o: Yellowtail Rockfish base case results summary.

Model Region	Quantity	2016						2017												
		Landings (mt)		2008		2009		2010		2011		2012		2013		2014		2015		2016
Total Est. Catch (mt)																				
Base Case	(1-SPR)(1-SPR _{90%})	0.21	0.39	0.52	0.45	0.52	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	
Age 1+ biomass (mt)	Exploitation rate	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Spawning Output	76305.3	77111.1	76466.7	77313.9	75707.8	77354.4	76340.3	76340.3	76340.3	76683.8	76683.8	76225.2	76225.2	76225.2	76225.2	76225.2	76225.2	76225.2	76225.2	
95% CI	(5.31-9.3)	(5.65-9.78)	(5.31-9.3)	(5.65-9.78)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	
Depletion	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Recruits	(0.368-0.627)	(0.394-0.656)	(0.412-0.676)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	
95% CI	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	(34.46 - 57.08)	
Model 1																				
Base Case	(1-SPR)(1-SPR _{90%})	0.21	0.39	0.52	0.45	0.52	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	
Age 1+ biomass (mt)	Exploitation rate	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Spawning Output	7.3	7.7	8.0	8.1	8.2	8.1	8.2	8.1	8.2	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
95% CI	(5.31-9.3)	(5.65-9.78)	(5.31-9.3)	(5.65-9.78)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	(5.31-9.3)	
Depletion	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Recruits	(0.368-0.627)	(0.394-0.656)	(0.412-0.676)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	(0.426-0.683)	
95% CI	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	(20.8 - 57.08)	
Model 2																				
Base Case	(1-SPR)(1-SPR _{90%})	0.02	0.05	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
Age 1+ biomass (mt)	Exploitation rate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Spawning Output	27894.9	28342.0	30035.0	30175.5	30175.5	30622.8	43077.5	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	50645.0	
95% CI	(-0.06-2.68)	(-0.05-2.67)	(-0.05-2.67)	(-0.05-2.67)	(-0.05-2.67)	(-0.05-2.67)	(-0.04-2.74)	(-0.03-2.82)	(-0.03-2.82)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	(-0.02-2.95)	
Depletion	0.55	0.55	0.55	0.55	0.55	0.57	0.57	0.58	0.58	0.61	0.61	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
95% CI	(0.415-0.683)	(0.419-0.678)	(0.428-0.681)	(0.441-0.692)	(0.441-0.692)	(0.441-0.692)	(0.448-0.712)	(0.458-0.744)	(0.458-0.744)	(0.512-0.744)	(0.512-0.744)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)	(0.554-0.787)
Recruits	83.95	48.41	53.68	50.97	24.44	29.08	23.37	18.37	18.37	15.01	15.01	15.48	15.48	15.48	15.48	15.48	15.48	15.48	15.48	
95% CI	(25.9 - 272.16)	(8.2 - 285.6)	(8.77 - 328.57)	(10 - 259.73)	(4.55 - 131.38)	(6.62 - 127.77)	(4.98 - 109.65)	(3.92 - 86.03)	(3.92 - 86.03)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	(3.1 - 72.6)	

214 **Research And Data Needs**

research-and-data-needs

215 **Include:** identify information gaps that seriously impede the stock assessment.

216 We recommend the following research be conducted before the next assessment:

217 1. List item No. 1 in the list

218 2. List item No. 2 in the list, etc.

219 **Rebuilding Projections**

rebuilding-projections

220 **Include:** reference to the principal results from rebuilding analysis if the stock is overfished.

221 This section should be included in the Final/SAFE version assessment document but is not
222 required for draft assessments undergoing review. See Rebuilding Analysis terms of reference
223 for detailed information on rebuilding analysis requirements.

224 2

section-1

225 3

section-2

226 4 Introduction

introduction

227 4.1 Basic Information

basic-information

228 Include: Scientific name, distribution, the basis of the choice of stock structure, including
229 regional differences in life history or other biological characteristics that should form the
230 basis of management units.

231 4.2 Map

map

232 A map showing the scope of the assessment and depicting boundaries for fisheries or data
233 collection strata is provided in Figure 1.

234 4.3 Life History

life-history

235 Include: Important features of life history that affect management (e.g., migration, sexual
236 dimorphism, bathymetric demography).

237 4.4 Ecosystem Considerations

ecosystem-considerations-1

238 Include: Ecosystem considerations (e.g., ecosystem role and trophic relationships of the
239 species, habitat requirements/preferences, relevant data on ecosystem processes that may
240 affect stock or parameters used in the stock assessment, and/or cross-FMP interactions with
241 other fisheries). This section should note if environmental correlations or food web interactions
242 were incorporated into the assessment model. The length and depth of this section would
243 depend on availability of data and reports from the IEA, expertise of the STAT, and whether
244 ecosystem factors are informational to contribute quantitative information to the assessment.

245 **4.5 Fishery Information**

fishery-information

246 **Include:** Important features of current fishery and relevant history of fishery.

247 Rockfish example: The rockfish fishery off the U.S. Pacific coast first developed off California
248 in the late 19th century as a hook-and-line fishery (Love et al. [2002](#)).

249 The rockfish trawl fishery was established in the early 1940s, when the United States became
250 involved in World War II and wartime shortage of red meat created an increased demand for
251 other sources of protein (Harry and Morgan [1961](#), Alverson et al. [1964](#)). Etc....

252 **4.6 Summary of Management History**

summary-of-management-history

253 **Include:** Summary of management history (e.g., changes in mesh sizes, trip limits, or other
254 management actions that may have significantly altered selection, catch rates, or discards).

255 **4.7 Management Performance**

management-performance-1

256 **Include:** Management performance, including a table or tables comparing Overfishing Limit
257 (OFL), Annual Catch Limit (ACL), Harvest Guideline (HG) [CPS only], landings, and catch
258 (i.e., landings plus discard) for each area and year.

259 Management performance table: (Table [k](#))

260 A summary of these values as well as other base case summary results can be found in Table
261 [O](#).

262 **4.8 Fisheries off Canada, Alaska, and/or Mexico**

fisheries-off-canada-alaska-andor-mexico

263 Include if necessary.

264 **4.9 Data**

data

265 Data used in the Yellowtail Rockfish assessment are summarized in Figure [3](#).

266 A description of each data source is below.

²⁶⁷ **4.9.1 Commercial Fishery Landings**

commercial-fishery-landings

²⁶⁸ **Washington catch information**

²⁶⁹ WDFW provided historical yellowtail catch for 1889 – 1980 period. WDFW also provided
²⁷⁰ catches for 1981 – 2016 period to include the re-distribution of the “URCK” landings in
²⁷¹ PacFIN database. This information is currently not available from PacFIN.

²⁷² **Sub-heading 2**

²⁷³ **Sub-heading 3**

²⁷⁴ **4.9.2 Sport Fishery Removals**

sport-fishery-removals

²⁷⁵ **Sub-heading 1**

²⁷⁶ **Sub-heading 2**

²⁷⁷ **Sub-heading 3**

²⁷⁸ **4.9.3 Estimated Discards**

estimated-discards

²⁷⁹ **Sub-heading 1**

²⁸⁰ **Sub-heading 2**

²⁸¹ **Sub-heading 3**

²⁸² **4.9.4 Abundance Indices**

abundance-indices

²⁸³ **Sub-heading 1**

²⁸⁴ **Sub-heading 2**

²⁸⁵ **4.9.5 Fishery-Independent Data: possible sources**

fishery-independent-data-possible-sources

²⁸⁶ *Northwest Fisheries Science Center (NWFSC) slope survey*

²⁸⁷ The NWFSC slope survey was conducted annually from 1999 to 2002.

²⁸⁸ The depth range of this survey is 100-700 fm.

²⁸⁹ *Northwest Fisheries Science Center (NWFSC) shelf-slope survey*

²⁹⁰ This survey is referred to as the “combo,” conducted annually since 2003.

²⁹¹ The survey consistently covered depths between 30 and 700 fm.

²⁹² *Alaska Fisheries Science Center (AFSC) shelf survey*

²⁹³ The survey, often referred to as the “triennial” survey was conducted every third year between
²⁹⁴ 1977 and (and conducted in 2004 by the NWFSC using the same protocols). The triennial
²⁹⁵ survey trawls in depths of 30 to 275 fm.

²⁹⁶ *Pikitch Study*

²⁹⁷ The Pikitch study was conducted between 1985 and 1987 (Pikitch et al. [1988](#)). The northern
²⁹⁸ and southern boundaries of the study were 48°42' N latitude and 42°60' N. latitude respectively,
²⁹⁹ which is primarily within the Columbia INPFC area (Pikitch et al. [1988](#), Rogers and Pikitch
³⁰⁰ [1992](#)). Participation in the study was voluntary and included vessels using bottom, midwater,
³⁰¹ and shrimp trawl gears.

³⁰² Observers of normal fishing operations on commercial vessels collected the data, estimated
³⁰³ the total weight of the catch by tow and recorded the weight of species retained and discarded
³⁰⁴ in the sample.

³⁰⁵ *Enhanced Data Collection Project (EDCP)*

³⁰⁶ The EDCP was conducted by ODFW to collect information on bycatch and discard groundfish
³⁰⁷ species off the coast of Oregon from late 1995 to early 1999.

³⁰⁸ EDCP had limited spatial coverage in Oregon waters only.

³⁰⁹ *Partnership For Interdisciplinary Studies of Coastal Oceans (PISCO)*

³¹⁰ Blurb on species presence in PISCO surveys

³¹¹ 4.9.6 Biological Parameters and Data

biological-parameters-and-data

³¹² Length And Age Compositions

³¹³ Include: Sample size information for length and age composition data by area, year, gear,
³¹⁴ market category, etc., including both the number of trips and fish sampled.

³¹⁵ Length compositions were provided from the following sources, by region, with brief descriptions below:

³¹⁷ Model 1

- ³¹⁸ • Source No. 1 (*ex. research, commerical dead fish, live fish, etc,*
³¹⁹ date range (*ex. 2010-2011*))
- ³²⁰ • Source No. 2 (*ex. research, commerical dead fish, live fish, etc,*
³²¹ date range (*ex. 2010-2011*))

- 322 ● etc...
- 323 ● Begin sublist if desired
- 324 — Sublist source No. 1
- 325 — Sublist source No. 2
- 326 — etc...
- 327 ● Back to main list, next Source
- 328 ● Last Source
- 329 Can duplicate this list if you have more than one assessment model
- 330 Possible sources of age and length data:
- 331 *Recreational: Washington (WDFW)*
- 332 *Recreational: California MRFSS And CRFS Length Composition Data* Individual fish lengths
- 333 recorded by MRFSS (1980-2003) and CRFS (2004-2011) samplers were downloaded from the
- 334 RecFIN website (www.recfin.org). CRFS data from 2012-2014 were obtained directly from
- 335 CDFW.
- 336 *Recreational: Oregon Recreational Boat Survey (ORBS)* Biological data from the ORBS
- 337 program were provided by ODFW. The ORBS is a dockside sampling program for the
- 338 both the recreational CPFV and private modes. Length composition samples from north of
- 339 Florence for the CPFV and private fleets were provided from 1980-2014. Samples from south
- 340 of Florence spanned 1984-2014
- 341 *Recreational: Miller and Gotshall (1965)*
- 342 The Northern California Marine Sport Fish Survey conducted an assessment survey with
- 343 goals that included estimation of annual fishing effort by all recreational fishing modes, catch
- 344 by weight, CPUE, and collection of data to analyze length compositions
- 345 *Commercial: PacFIN (Oregon and California)*
- 346 *Research: NMFS Groundfish Ecology Survey*
- 347 From 2001-2005, the SWFSC Fisheries Ecology Division conducted longline surveys aboard a
- 348 chartered commercial longline vessel at various stations between Monterey and Davenport,
- 349 CA (36° N. latitude to 37.5° N. latitude) (pers. comm. Don Pearson, SWFSC). Longline gear
- 350 was set in various depths from 10 meters to 700 meters, parallel to the depth contour. Each
- 351 longline set consisted of 3-5 skates, each with about 250 2/0 circle hooks baited with squid.
- 352 In nearshore habitats, the gear soaked for roughly 30 minutes.
- 353 *Research: California Collaborative Fisheries Research Program (CCFRP)*
- 354 *Research: NWFSC shelf-slope survey*
- 355 *Research: NWFSC slope survey*

356 *Research: Abrams Thesis*

357 Age Structures

358 Age structure data were available from the following sources:

359 Model Region 1

- 360 • Source No. 1 (*ex. research, commercia dead fish, live fish, etc,*
361 date range (ex. 2010-2011))
- 362 • Source No. 2 (*ex. research, commercia dead fish, live fish, etc,*
363 date range (ex. 2010-2011))
- 364 • etc...
- 365 • Begin sublist if desired
 - 366 – Sublist source No. 1
 - 367 – Sublist source No. 2
 - 368 – etc...
- 369 • Back to main list, next Source
- 370 • Last Source

371 Can duplicate this list if you have more than one assessment model

372 Length-at-age was initially estimated external to the population dynamics models using the
373 von Bertalanffy growth curve (Bertalanffy 1938), $L_i = L_\infty e^{(-k[t-t_0])}$, where L_i is the length
374 (cm) at age i , t is age in years, k is rate of increase in growth, t_0 is the intercept, and L_∞ is
375 the asymptotic length.

376 Aging Precision And Bias

377 Weight-Length

378 The weight-length relationship is based on the standard power function: $W = \alpha(L^\beta)$ where
379 W is individual weight (kg), L is length (cm), and α and β are coefficients used as constants.

380 To estimate this relationship, 12,778 samples with both weight and length measurements
381 from the fishery independent surveys were analyzed. These included 6,354 samples from
382 the NWFSC Combo survey, 5,085 from the Triennial survey, and 1,339 from the Hook and
383 Line survey. All Hook and Line survey samples were from the Southern area, along with
384 910 samples from the other two surveys (Figure 44). A single weight-length relationship was
385 chosen for females and males in both areas after examining various factors that may influence
386 this relationships, including sex, area, year, and season. None of these factors had a strong
387 influence in the overall results. Season was one of the bigger factors, with fish sampled later

388 in the year showing a small increase in weight at a given length (2-6% depending on the
389 other factors considered). However, season was confounded with area because most of the
390 samples from the Southern area were collected from the Hook and Line survey which takes
391 place later in the year (mid-September to mid-November) and the resolution of other data in
392 the model do not support modeling the stock at a scale finer than a annual time step. Males
393 and females did not show strong differences in either area, and the estimated differences were
394 in opposite directions for the two areas, suggesting that this might be a spurious relationship
395 or confounded with differences timing of the sampling relative to spawning.

396 The estimated coefficients resulting from this analysis were $\alpha = 1.1843e - 05$ and $\beta = 3.0672$.

397 **Maturity And Fecundity** Maturity was estimated from histological analysis of 141 samples
398 collected in 2016. These include 96 from the NWFSC Combo survey, 25 from mid-water
399 catches in the NWFSC acoustic/trawl survey, 13 from the Hook and Line survey, and 7 from
400 Oregon Department of Fish and Wildlife. The sample sizes were not adequate to estimate
401 differences in maturity by area. Length at 50% maturity was estimated at 42.49cm (Figure
402 43) which was consistent with the range 37-45cm cited in the previous assessment (Wallace
403 and Lai 2005).

404 **Natural Mortality**

405 Natural mortality for wild fish populations is extremely difficult to estimate.

406 **Sex ratios**

407 **4.9.7 Environmental Or Ecosystem Data Included In The Assessment** environmental-or-ecosystem-data-included-in-the-assessment

408 **5 Assessment**

assessment

409 **5.1 History Of Modeling Approaches Used For This Stock** history-of-modeling-approaches-used-for-this-stock

410 **5.1.1 Previous Assessments**

previous-assessments

411 **5.1.2 Previous Assessment Recommendations**

previous-assessment-recommendations

412 Include: Response to STAR panel recommendations from the most recent previous assessment.

413 **Recommendation 1:** blah blah blah.

414

415 STAT response: blah blah blah....

416 **Recommendation 2:** blah blah blah.

417

418 STAT response: blah blah blah....

419 **Recommendation 3:** blah blah blah., etc.

420

421 STAT response: Continue recommendations as needed

422 **5.2 Model Description**

model-description

423 **5.2.1 Transition To The Current Stock Assessment**

transition-to-the-current-stock-assessment

424 Include: Complete description of any new modeling approaches

425 Below, we describe the most important changes made since the last full assessment and
426 explain rationale for each change.:

427 1. Change No. 1. *Rationale:* blah blah blah.

428 2. Change No. 2. *Rationale:* blah blah blah.

429 3. Change No. 3. *Rationale:* Continue list as needed.

430 **5.2.2 Definition of Fleets and Areas**

definition-of-fleets-and-areas

431 We generated data sources for each of the models. Fleets by model include:

432 **Model Region 1 or remove this line if only one model**

433 *Commercial:* The commercial fleets include...

434 *Recreational:* The recreational fleets include...

435 *Research:* Research derived-data include...

436 **5.2.3 Summary of Data for Fleets and Areas**
summary-of-data-for-fleets-and-areas

437 **5.2.4 Modeling Software**
modeling-software

438 The STAT team used Stock Synthesis 3 version 3.24u by Dr. Richard Methot at the NWFSC.
439 This most recent version (SS-V3.24u) was used, since it included improvements and corrections
440 to older versions.

441 **5.2.5 Data Weighting**
data-weighting

442 Citation for Francis method (Francis 2011)
443 Citation for Ianelli-McAllister harmonic mean method (McAllister and Ianelli 1997)

444 **5.2.6 Priors**
priors

445 Citation for Hamel prior on natural mortality (Hamel 2015)

446 **5.2.7 General Model Specifications**
general-model-specifications

447 Citation for posterior predictive fecundity relationship from Dick (2009)
448 Model data, control, starter, and forecast files can be found in Appendices A-D.

449 **5.2.8 Estimated And Fixed Parameters**
estimated-and-fixed-parameters

450 A full list of all estimated and fixed parameters is provided in Tables. . . . Estimated and fixed
451 parameters tables currently read in from .csv file, EXAMPLE: Table ??

452 **5.3 Model Selection and Evaluation**
model-selection-and-evaluation

453 **5.3.1 Key Assumptions and Structural Choices**
key-assumptions-and-structural-choices

454 Include: Evidence of search for balance between model realism and parsimony.
455 Comparison of key model assumptions, include comparisons based on nested models (e.g.,
456 asymptotic vs. domed selectivities, constant vs. time-varying selectivities).

457 **5.3.2 Alternate Models Considered**

alternate-models-considered

458 Include: Summary of alternate model configurations that were tried but rejected.

459 **5.3.3 Convergence**

convergence

460 Include: Randomization run results or other evidence of search for global best estimates.

461 Convergence testing through use of dispersed starting values often requires extreme values to
462 actually explore new areas of the multivariate likelihood surface. Jitter is a SS option that
463 generates random starting values from a normal distribution logically transformed into
464 each parameter's range (Methot 2015). Table 3 shows the results of running 100 jitters for
465 each pre-STAR base model....

466 **5.4 Response To The Current STAR Panel Requests**

response-to-the-current-star-panel-requests

467 **Request No. 1: Add after STAR panel.**

468

469 **Rationale:** Add after STAR panel.

470 **STAT Response:** Add after STAR panel.

471 **Request No. 2: Add after STAR panel.**

472

473 **Rationale:** Add after STAR panel.

474 **STAT Response:** Add after STAR panel.

475 **Request No. 3: Add after STAR panel.**

476

477 **Rationale:** Add after STAR panel.

478 **STAT Response:** Add after STAR panel.

479 **Request No. 4: Example of a request that may have a list:**

480

- 481 • **Item No. 1**
- 482 • **Item No. 2**
- 483 • **Item No. 3, etc.**

484 **Rationale:** Add after STAR panel.

485 **STAT Response:** Continue requests as needed.

486 **5.5 Model 1**

model-1

487 **5.5.1 Model 1 Base Case Results**

model-1-base-case-results

488 Table ??

489 **5.5.2 Model 1 Uncertainty and Sensitivity Analyses**

model-1-uncertainty-and-sensitivity-analyses

490 Table 4

491 **5.5.3 Model 1 Retrospective Analysis**

model-1-retrospective-analysis

492 **5.5.4 Model 1 Likelihood Profiles**

model-1-likelihood-profiles

493 **5.5.5 Model 1 Harvest Control Rules (CPS only)**

model-1-harvest-control-rules-cps-only

494 **5.5.6 Model 1 Reference Points (groundfish only)**

model-1-reference-points-groundfish-only

495 Intro sentence or two....(Table 5).

496 Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 3691.6 mt.
497 Table i shows the full suite of estimated reference points for the northern area model and
498 Figure i shows the equilibrium yield curve.

- 499 **5.6 Model 2** model-2
- 500 **5.6.1 Model 2 Base Case Results** model-2-base-case-results
- 501 **5.6.2 Model 2 Uncertainty and Sensitivity Analyses** model-2-uncertainty-and-sensitivity-analyses
- 502 **5.6.3 Model 2 Retrospective Analysis** model-2-retrospective-analysis
- 503 **5.6.4 Model 2 Likelihood Profiles** model-2-likelihood-profiles
- 504 **5.6.5 Model 2 Harvest Control Rules (CPS only)** model-2-harvest-control-rules-cps-only
- 505 **5.6.6 Model 2 Reference Points (groundfish only)** model-2-reference-points-groundfish-only
- 506 **5.7 Model 3** model-3
- 507 **5.7.1 Model 3 Base Case Results** model-3-base-case-results
- 508 **5.7.2 Model 3 Uncertainty and Sensitivity Analyses** model-3-uncertainty-and-sensitivity-analyses
- 509 **5.7.3 Model 3 Retrospective Analysis** model-3-retrospective-analysis
- 510 **5.7.4 Model 3 Likelihood profiles** model-3-likelihood-profiles
- 511 **5.7.5 Model 3 Harvest Control Rules (CPS only)** model-3-harvest-control-rules-cps-only
- 512 **5.7.6 Model 3 Reference Points (groundfish only)** model-3-reference-points-groundfish-only

513 **6 Harvest Projections and Decision Tables** harvest-projections-and-decision-tables

- 514 Table [k](#)
- 515 Model 1 Projections and Decision Table (groundfish only) (Table [6](#))
- 516 Table [m](#)

517 Model 2 Projections and Decision Table (groundfish only)

518 Model 3 Projections and Decision Table (groundfish only)

519 7 Regional Management Considerations

regional-management-considerations

- 520 1. For stocks where current practice is to allocate harvests by management area, a
521 recommended method of allocating harvests based on the distribution of biomass should
522 be provided. The MT advisor should be consulted on the appropriate management
523 areas for each stock.
- 524 2. Discuss whether a regional management approach makes sense for the species from a
525 biological perspective.
- 526 3. If there are insufficient data to analyze a regional management approach, what are the
527 research and data needs to answer this question?

528 8 Research Needs

research-needs

- 529 1. Research need No. 1
- 530 2. Research need No. 2
- 531 3. Research need No. 3
- 532 4. etc.

533 9 Acknowledgments

acknowledgments

534 Include: STAR panel members and affiliations as well as names and affiliations of persons
535 who contributed data, advice or information but were not part of the assessment team. Not
536 required in draft assessment undergoing review.

537 **10 Tables**

tables

Table 1: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD)).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
1	NatM_p_1_Fem_GP_1	0.141	2	(0.02, 0.25) (1, 25)	OK	0.009	None
2	Lat_Amin_Fem_GP_1	14.879	3	(1, 25)	OK	0.575	None
3	Lat_Amax_Fem_GP_1	53.827	2	(35, 70)	OK	0.235	None
4	VonBert_K_Fem_GP_1	0.137	3	(0.1, 0.4)	OK	0.004	None
5	CV_young_Fem_GP_1	0.101	5	(0.03, 0.16)	OK	0.010	None
6	CV_old_Fem_GP_1	0.043	5	(0.03, 0.16)	OK	0.003	None
7	Wtlen_1_Fem	0.000	-50	(0, 3)	None	None	None
8	Wtlen_2_Fem	3.067	-50	(2, 4)	None	None	None
9	Mat50%_Fem	42.490	-50	(30, 56)	None	None	None
10	Mat_slope_Fem	-0.401	-50	(-2, 1)	None	None	None
11	Eggs_scalar_Fem	0.000	-50	(0, 6)	None	None	None
12	Eggs_exp_len_Fem	4.590	-50	(2, 7)	OK	0.017	None
13	NatM_p_1_Mal_GP_1	-0.142	2	(-3, 3)	OK	0.017	None
14	Lat_Amin_Mal_GP_1	0.000	-2	(-1, 1)	OK	0.005	None
15	Lat_Amax_Mal_GP_1	-0.148	2	(-1, 1)	OK	0.027	None
16	VonBert_K_Mal_GP_1	0.369	3	(-1, 1)	OK	0.027	None
17	CV_young_Mal_GP_1	0.000	-5	(-1, 1)	OK	0.070	None
18	CV_old_Mal_GP_1	0.172	5	(-1, 1)	OK	0.070	None
19	Wtlen_1_Mal	0.000	-50	(0, 3)	None	None	None
20	Wtlen_2_Mal	3.067	-50	(2, 4)	None	None	None
24	CohortGrowDev	1.000	-50	(0, 2)	None	None	None
25	FracFemale_GP_1	0.500	-99	(0.001, 0.999)	None	None	None
26	SR_LN(R0)	10.181	1	(5, 20)	OK	0.158	None
27	SR_BH_stEEP	0.718	-6	(0.2, 1)	None	None	None
28	SR_sigmar	0.546	-6	(0.5, 1.2)	None	None	None
29	SR_regime	0.000	-50	(-5, 5)	None	None	None

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Table 1: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD)).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
30	SR.autocorr	0.000	-50	(0, 2)			None
140	LnQ_base_CommercialTrawl(1)	-4.397	-1	(-30, 15)			None
141	LnQ_base_HakeByCatch(2)	-9.820	-1	(-30, 15)			None
142	Q_extraSD_HakeByCatch(2)	0.278	1	(0, 0.5)	OK	0.083	None
143	LnQ_base_Triennial(5)	-1.003	-1	(-30, 15)			None
144	LnQ_base_NWFSCombo(6)	-0.559	-1	(-30, 15)			None
145	SizeSel_P1_CommercialTrawl(1)	48.717	1	(20, 55)	OK	0.724	None
146	SizeSel_P2_CommercialTrawl(1)	70.000	-4	(-20, 70)			None
147	SizeSel_P3_CommercialTrawl(1)	4.296	3	(-5, 20)	OK	0.095	None
148	SizeSel_P4_CommercialTrawl(1)	70.000	-4	(-5, 70)			None
149	SizeSel_P5_CommercialTrawl(1)	-999.000	-99	(-999, 25)			None
150	SizeSel_P6_CommercialTrawl(1)	-999.000	-99	(-999, 25)			None
151	Retain_P1_CommercialTrawl(1)	24.506	3	(20, 55)	OK	3.272	None
152	Retain_P2_CommercialTrawl(1)	1.597	3	(0.1, 40)	OK	0.700	None
153	Retain_P3_CommercialTrawl(1)	3.070	3	(-10, 20)	OK	0.706	None
154	Retain_P4_CommercialTrawl(1)	0.000	-4	(-3, 3)			None
155	SizeSel_P1_HakeByCatch(2)	52.341	1	(20, 55)	OK	0.878	None
156	SizeSel_P2_HakeByCatch(2)	70.000	-4	(-20, 70)			None
157	SizeSel_P3_HakeByCatch(2)	4.301	3	(-5, 20)	OK	0.113	None
158	SizeSel_P4_HakeByCatch(2)	70.000	-4	(-5, 70)			None
159	SizeSel_P5_HakeByCatch(2)	-999.000	-99	(-999, 25)			None
160	SizeSel_P6_HakeByCatch(2)	-999.000	-99	(-999, 25)			None
161	SizeSel_P1_RecORandCA(3)	30.578	1	(20, 55)	OK	0.710	None
162	SizeSel_P2_RecORandCA(3)	-19.161	4	(-20, 7)	OK	3239.790	None
163	SizeSel_P3_RecORandCA(3)	3.117	3	(-5, 20)	OK	0.237	None
164	SizeSel_P4_RecORandCA(3)	6.734	4	(-5, 20)	OK	0.566	None
165	SizeSel_P5_RecORandCA(3)	-999.000	-99	(-999, 25)			None

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Table 1: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD)).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
166	SizeSel_P6_RecORandCA(3)	-999.000	-99	(-999, 25)			None
167	SizeSel_P1_RecWA(4)	28.338	6	(20, 55)	OK	0.950	None
168	SizeSel_P2_RecWA(4)	70.000	-4	(-20, 70)	OK	2.463	None
169	SizeSel_P3_RecWA(4)	-1.407	6	(-5, 20)	OK		None
170	SizeSel_P4_RecWA(4)	70.000	-4	(-5, 70)	OK		None
171	SizeSel_P5_RecWA(4)	-999.000	-99	(-999, 25)	OK		None
172	SizeSel_P6_RecWA(4)	-999.000	-99	(-999, 25)	OK		None
173	SizeSel_P1_Triennial(5)	54.364	1	(20, 55)	OK	3.966	None
174	SizeSel_P2_Triennial(5)	70.000	-4	(-20, 70)	OK		None
175	SizeSel_P3_Triennial(5)	5.128	3	(-5, 20)	OK	0.308	None
176	SizeSel_P4_Triennial(5)	70.000	-4	(-5, 70)	OK		None
177	SizeSel_P5_Triennial(5)	-999.000	-99	(-999, 25)	OK		None
178	SizeSel_P6_Triennial(5)	-999.000	-99	(-999, 25)	OK		None
179	SizeSel_P1_NWFSCCombo(6)	49.696	1	(20, 55)	OK	2.906	None
180	SizeSel_P2_NWFSCCombo(6)	70.000	-4	(-20, 70)	OK		None
181	SizeSel_P3_NWFSCCombo(6)	4.551	3	(-5, 20)	OK	0.433	None
182	SizeSel_P4_NWFSCCombo(6)	70.000	-4	(-5, 70)	OK		None
183	SizeSel_P5_NWFSCCombo(6)	-999.000	-99	(-999, 25)	OK		None
184	SizeSel_P6_NWFSCCombo(6)	-999.000	-99	(-999, 25)	OK		None
185	Retain_P3_CommercialTrawl(1)_BLK1repL2002	2.228	6	(-10, 20)	OK	0.457	None
186	Retain_P3_CommercialTrawl(1)_BLK1repL2003	3.708	6	(-10, 20)	OK	0.756	None
187	Retain_P3_CommercialTrawl(1)_BLK1repL2004	1.128	6	(-10, 20)	OK	0.522	None
188	Retain_P3_CommercialTrawl(1)_BLK1repL2005	-0.115	6	(-10, 20)	OK	0.400	None
189	Retain_P3_CommercialTrawl(1)_BLK1repL2006	1.760	6	(-10, 20)	OK	0.260	None
190	Retain_P3_CommercialTrawl(1)_BLK1repL2007	-0.516	6	(-10, 20)	OK	0.625	None
191	Retain_P3_CommercialTrawl(1)_BLK1repL2008	2.373	6	(-10, 20)	OK	0.820	None
192	Retain_P3_CommercialTrawl(1)_BLK1repL2009	0.480	6	(-10, 20)	OK	0.495	None

Continued on next page

Table 1: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD)).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
193	Retain.P3_CommercialTrawl(1)_BLK1rep1.2010	0.159	6	(-10, 20)	OK	0.678	None
194	Retain.P3_CommercialTrawl(1)_BLK1rep1.2011	7.327	6	(-10, 20)	OK	0.670	None

tab-model-params

Table 2: Summary of the biomass/abundance time series used in the stock assessment.

Region	ID	Fleet	Years	Name	Fishery ind.	Filtering	Method	Endorsed
WA	1	4	1981- 2014	Dockside CPUE	No	trip, area, month, Stephens- MacCall	delta-GLM (bin- gamma)	SSC
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

Table 3: Results from 100 jitters from each of the three models.

Status	Model.1	Model.2	Model.3	tab:jitter
Returned to base case	-	-	-	
Found local minimum	-	-	-	
Found better solution	-	-	-	
Error in likelihood	-	-	-	
Total	100	100	100	

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative ex- ploitation rate	SPR
1889	128998	15	0.00	26416	0	0.00	1.00
1890	128998	15	1.00	26416	0	0.00	1.00
1891	128997	15	1.00	26416	0	0.00	1.00
1892	128977	15	1.00	26416	2	0.00	1.00
1893	128980	15	1.00	26416	2	0.00	1.00
1894	128980	15	1.00	26416	2	0.00	1.00
1895	128994	15	1.00	26416	1	0.00	1.00
1896	128998	15	1.00	26416	0	0.00	1.00
1897	128998	15	1.00	26416	0	0.00	1.00
1898	128998	15	1.00	26416	0	0.00	1.00
1899	128998	15	1.00	26416	0	0.00	1.00
1900	128997	15	1.00	26416	0	0.00	1.00
1901	128997	15	1.00	26416	0	0.00	1.00
1902	128996	15	1.00	26416	0	0.00	1.00
1903	128996	15	1.00	26416	0	0.00	1.00
1904	128993	15	1.00	26416	1	0.00	1.00
1905	128995	15	1.00	26416	0	0.00	1.00
1906	128995	15	1.00	26417	1	0.00	1.00
1907	128994	15	1.00	26417	1	0.00	1.00
1908	128992	15	1.00	26417	1	0.00	1.00
1909	128993	15	1.00	26417	1	0.00	1.00
1910	128993	15	1.00	26417	1	0.00	1.00
1911	128992	15	1.00	26417	1	0.00	1.00
1912	128992	15	1.00	26417	1	0.00	1.00
1913	128991	15	1.00	26417	1	0.00	1.00
1914	128991	15	1.00	26417	1	0.00	1.00
1915	128989	15	1.00	26417	1	0.00	1.00
1916	128989	15	1.00	26417	1	0.00	1.00
1917	128988	15	1.00	26417	1	0.00	1.00
1918	128963	15	1.00	26417	4	0.00	1.00
1919	128979	15	1.00	26417	2	0.00	1.00
1920	128980	15	1.00	26417	2	0.00	1.00
1921	128981	15	1.00	26417	2	0.00	1.00
1922	128983	15	1.00	26417	2	0.00	1.00
1923	128982	15	1.00	26417	2	0.00	1.00
1924	128976	15	1.00	26417	3	0.00	1.00
1925	128972	15	1.00	26417	3	0.00	1.00
1926	128963	15	1.00	26417	4	0.00	1.00
1927	128955	15	1.00	26417	5	0.00	1.00
1928	128948	15	1.00	26417	6	0.00	1.00

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative ex- ploitation rate	SPR
1929	128895	15	1.00	26417	12	0.00	1.00
1930	128855	15	1.00	26417	16	0.00	1.00
1931	128906	15	1.00	26416	11	0.00	1.00
1932	128972	15	1.00	25869	3	0.00	1.00
1933	128961	15	1.00	25816	4	0.00	1.00
1934	128936	15	1.00	25755	7	0.00	1.00
1935	128911	15	1.00	25686	10	0.00	1.00
1936	128873	15	1.00	25606	14	0.00	1.00
1937	128765	15	1.00	25516	27	0.00	1.00
1938	128739	15	1.00	25415	30	0.00	1.00
1939	128664	15	1.00	25306	38	0.00	1.00
1940	127810	15	1.00	25186	137	0.00	0.98
1941	127419	15	1.00	25051	182	0.00	0.98
1942	126278	15	0.99	24902	316	0.00	0.96
1943	118201	15	0.99	24735	1363	0.01	0.85
1944	111879	14	0.97	24527	2291	0.02	0.77
1945	101159	14	0.95	24284	4177	0.03	0.63
1946	110770	13	0.90	23931	2315	0.02	0.75
1947	117634	13	0.88	23608	1304	0.01	0.85
1948	119213	13	0.87	23335	1094	0.01	0.87
1949	123621	13	0.86	23082	570	0.01	0.93
1950	118250	13	0.86	22821	1208	0.01	0.85
1951	118297	13	0.86	22467	1194	0.01	0.85
1952	115125	12	0.85	22053	1594	0.01	0.81
1953	120832	12	0.84	21672	870	0.01	0.89
1954	118529	12	0.84	21493	1141	0.01	0.86
1955	118066	12	0.83	21469	1189	0.01	0.85
1956	116427	12	0.82	21229	1382	0.01	0.83
1957	116142	12	0.82	20596	1403	0.01	0.83
1958	115689	12	0.81	20155	1444	0.01	0.82
1959	115004	12	0.80	21249	1512	0.01	0.81
1960	112205	12	0.79	26215	1850	0.02	0.77
1961	112783	11	0.77	34817	1743	0.02	0.78
1962	108082	11	0.76	28452	2342	0.02	0.72
1963	111006	11	0.74	20940	1897	0.02	0.76
1964	113580	11	0.72	18139	1548	0.02	0.79
1965	114117	10	0.71	17896	1466	0.02	0.80
1966	116975	10	0.70	18720	1135	0.01	0.84
1967	114315	10	0.70	21822	1420	0.01	0.80
1968	109723	10	0.70	32764	1985	0.02	0.74

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative ex- ploitation rate	SPR
1969	100189	10	0.69	25306	3364	0.03	0.62
1970	113265	10	0.67	18555	1530	0.02	0.79
1971	112767	10	0.68	14419	1598	0.02	0.78
1972	106461	10	0.68	19106	2400	0.03	0.70
1973	102941	10	0.68	23959	2865	0.03	0.65
1974	108465	10	0.66	43111	2055	0.02	0.72
1975	113173	10	0.65	33612	1480	0.02	0.79
1976	94517	10	0.65	27068	4151	0.05	0.55
1977	84114	9	0.63	32309	6205	0.07	0.43
1978	73977	9	0.58	22366	8721	0.10	0.31
1979	74340	8	0.51	13972	7712	0.09	0.32
1980	72474	7	0.45	16706	7625	0.09	0.30
1981	64605	6	0.40	23192	9692	0.12	0.22
1982	61042	5	0.34	15076	10338	0.14	0.19
1983	57786	4	0.30	25907	10842	0.16	0.16
1984	71611	4	0.26	30505	5477	0.09	0.29
1985	81228	4	0.26	20605	3751	0.06	0.40
1986	73723	4	0.29	22826	5412	0.09	0.31
1987	73504	4	0.29	28515	5419	0.09	0.31
1988	67338	4	0.29	16021	6800	0.11	0.25
1989	71983	4	0.27	34522	5227	0.09	0.29
1990	72925	4	0.26	33940	4916	0.08	0.30
1991	75372	4	0.25	31514	4418	0.07	0.33
1992	64703	4	0.25	19984	6857	0.11	0.22
1993	66430	4	0.24	13490	6104	0.10	0.24
1994	66346	3	0.23	21921	6140	0.10	0.24
1995	68115	3	0.23	20802	5657	0.09	0.25
1996	65907	3	0.23	11261	6275	0.10	0.23
1997	89311	3	0.23	15130	2412	0.04	0.48
1998	85488	4	0.26	26917	3142	0.05	0.44
1999	84144	4	0.29	25511	3599	0.06	0.41
2000	84704	5	0.31	34151	3716	0.06	0.43
2001	97218	5	0.33	17903	2236	0.04	0.58
2002	107616	5	0.36	11227	1356	0.02	0.71
2003	120377	6	0.38	13806	491	0.01	0.88
2004	115717	6	0.41	17951	839	0.01	0.82
2005	105479	6	0.44	7619	1753	0.02	0.69
2006	120140	7	0.45	27431	565	0.01	0.88
2007	116755	7	0.47	9802	852	0.01	0.83
2008	121368	7	0.50	34459	520	0.01	0.89

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative ex- ploitation rate	SPR
2009	114737	8	0.53	10442	1095	0.01	0.80
2010	109749	8	0.54	22111	1600	0.02	0.74
2011	112174	8	0.55	15149	1348	0.02	0.77
2012	109683	8	0.56	15950	1593	0.02	0.74
2013	111229	8	0.55	25871	1432	0.02	0.76
2014	110627	8	0.55	24047	1460	0.02	0.75
2015	105097	8	0.54	24513	2017	0.03	0.68
2016	110396	8	0.53	24346			

`tab:Timeseries_mod1`

Table 4: Sensitivity of the base model to dropping or down-weighting data sources and alternative assumptions about growth.

Label	Base (Francis weights)	Harmonic weights)	Drop index	Drop ages	Down- weight lengths	Free size Age0	Free CV Amin	External growth
TOTAL_like	-	-	-	-	-	-	-	-
Catch_like	-	-	-	-	-	-	-	-
Equil_catch_like	-	-	-	-	-	-	-	-
Survey_like	-	-	-	-	-	-	-	-
Length_comp_like	-	-	-	-	-	-	-	-
Age_comp_like	-	-	-	-	-	-	-	-
Parm_priors_like	-	-	-	-	-	-	-	-
SSB_Umfished_thousand_mt	-	-	-	-	-	-	-	-
TotBio_Umfished	-	-	-	-	-	-	-	-
SmryBio_Umfished	-	-	-	-	-	-	-	-
Recr_Umfished_billions	-	-	-	-	-	-	-	-
SSB_Btgt_thousand_mt	-	-	-	-	-	-	-	-
SPR_Btgt	-	-	-	-	-	-	-	-
Fstd_Btgt	-	-	-	-	-	-	-	-
TotYield_Btgt_thousand_mt	-	-	-	-	-	-	-	-
SSB_SPRtgt_thousand_mt	-	-	-	-	-	-	-	-
Fstd_SPRtgt	-	-	-	-	-	-	-	-
TotYield_SPRtgt_thousand_mt	-	-	-	-	-	-	-	-
SSB_MSY_thousand_mt	-	-	-	-	-	-	-	-
SPR_MSY	-	-	-	-	-	-	-	-
Fstd_MSY	-	-	-	-	-	-	-	-
TotYield_MSY_thousand_mt	-	-	-	-	-	-	-	-
RetYield_MSY	-	-	-	-	-	-	-	-
Bratio_2015	-	-	-	-	-	-	-	-
F_2015	-	-	-	-	-	-	-	-
SPRratio_2015	-	-	-	-	-	-	-	-
Recr_2015	-	-	-	-	-	-	-	-
Recr_Virgin_billions	-	-	-	-	-	-	-	-
L_at_Amin_Fem_GP_1	-	-	-	-	-	-	-	-
L_at_Amax_Fem_GP_1	-	-	-	-	-	-	-	-
VonBert_K_Fem_GP_1	-	-	-	-	-	-	-	-
CV_young_Fem_GP_1	-	-	-	-	-	-	-	-
CV_old_Fem_GP_1	-	-	-	-	-	-	-	-

Table 6: Projection of potential OFL, spawning biomass, and depletion for the base case model.

Yr	OFL contribution (mt)	ACL landings (mt)	Age 5+ biomass (mt)	Spawning Biomass (mt)	<small>tab:Forecast_mod1</small>
2017	3988.81	3660.21	75949.10	7.79	0.53
2018	3840.38	3524.14	74683.90	7.43	0.51
2019	3712.42	3406.90	74047.40	7.11	0.48
2020	3611.38	3314.36	73875.00	6.83	0.46
2021	3544.46	3253.15	74067.80	6.60	0.45
2022	3513.29	3224.88	74487.30	6.43	0.44
2023	3512.56	3224.60	75022.20	6.34	0.43
2024	3532.98	3243.48	75582.80	6.32	0.43
2025	3564.86	3272.58	76107.30	6.34	0.43
2026	3600.46	3304.98	76561.10	6.38	0.43
2027	3634.58	3336.05	76932.40	6.44	0.44
2028	3664.30	3363.16	77224.20	6.49	0.44

538 **11 Figures**

figures

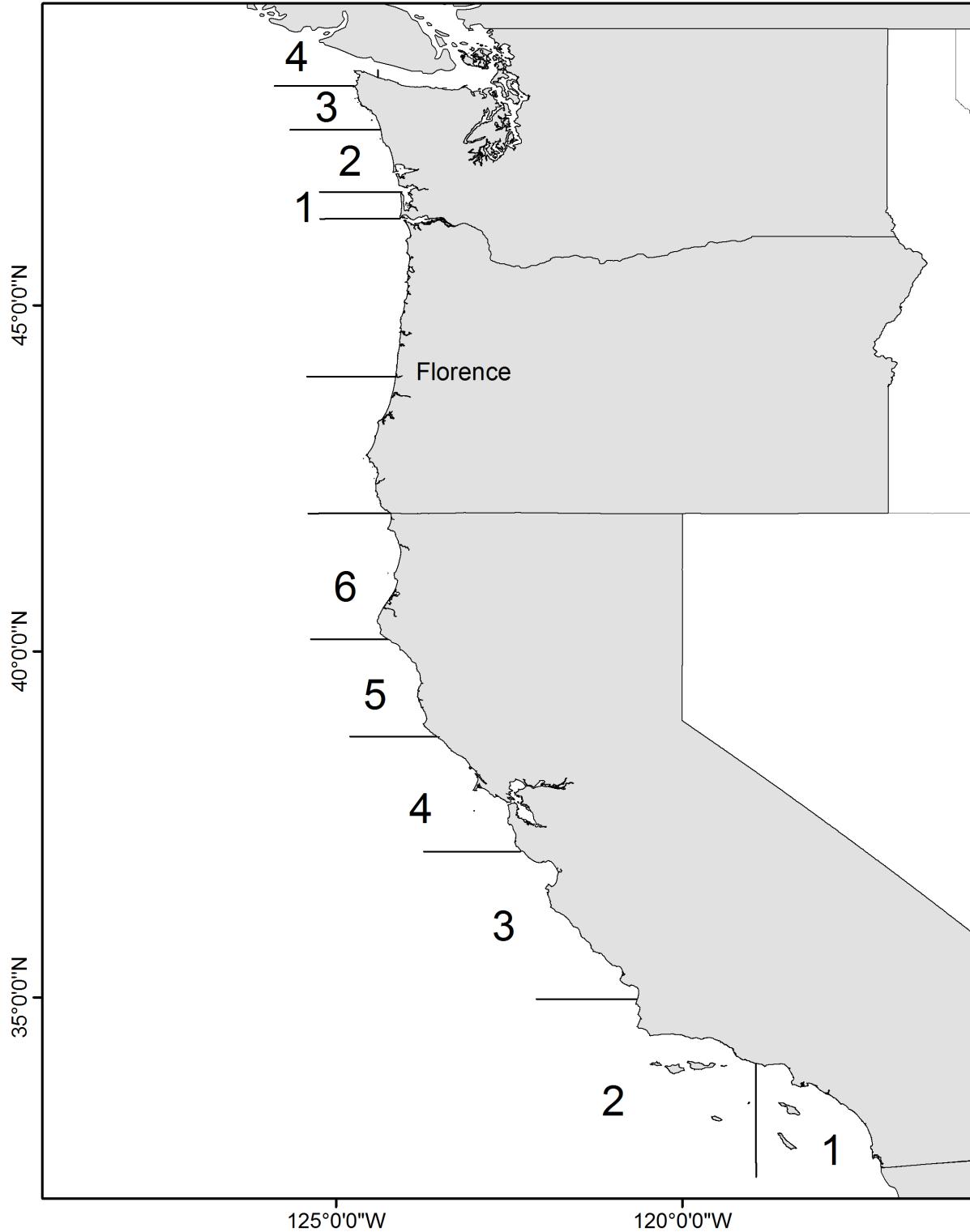


Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. fig:boundary_map

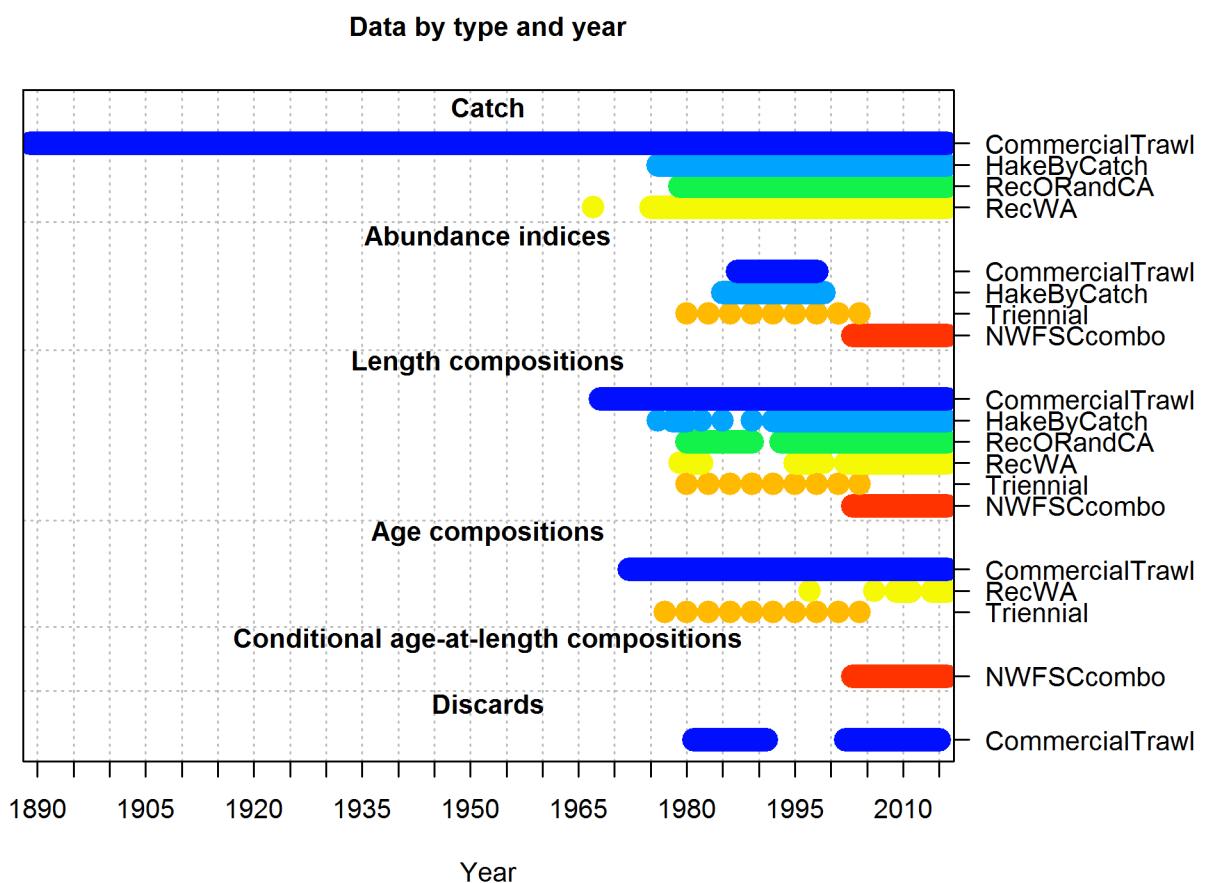


Figure 2: Summary of data sources used in the Northern model. fig:data_plot

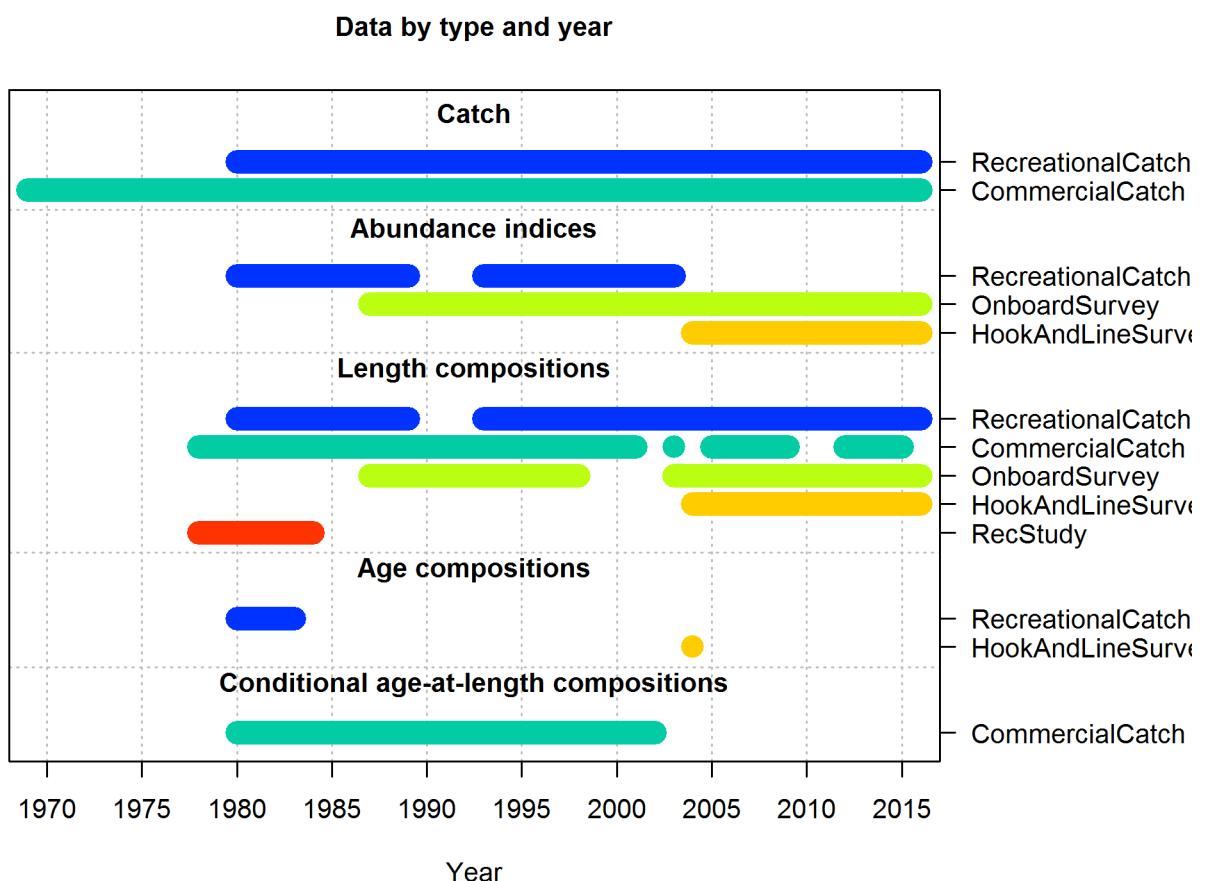


Figure 3: Summary of data sources used in the Southern model. fig:data_plot

Length comps, retained, CommercialTrawl

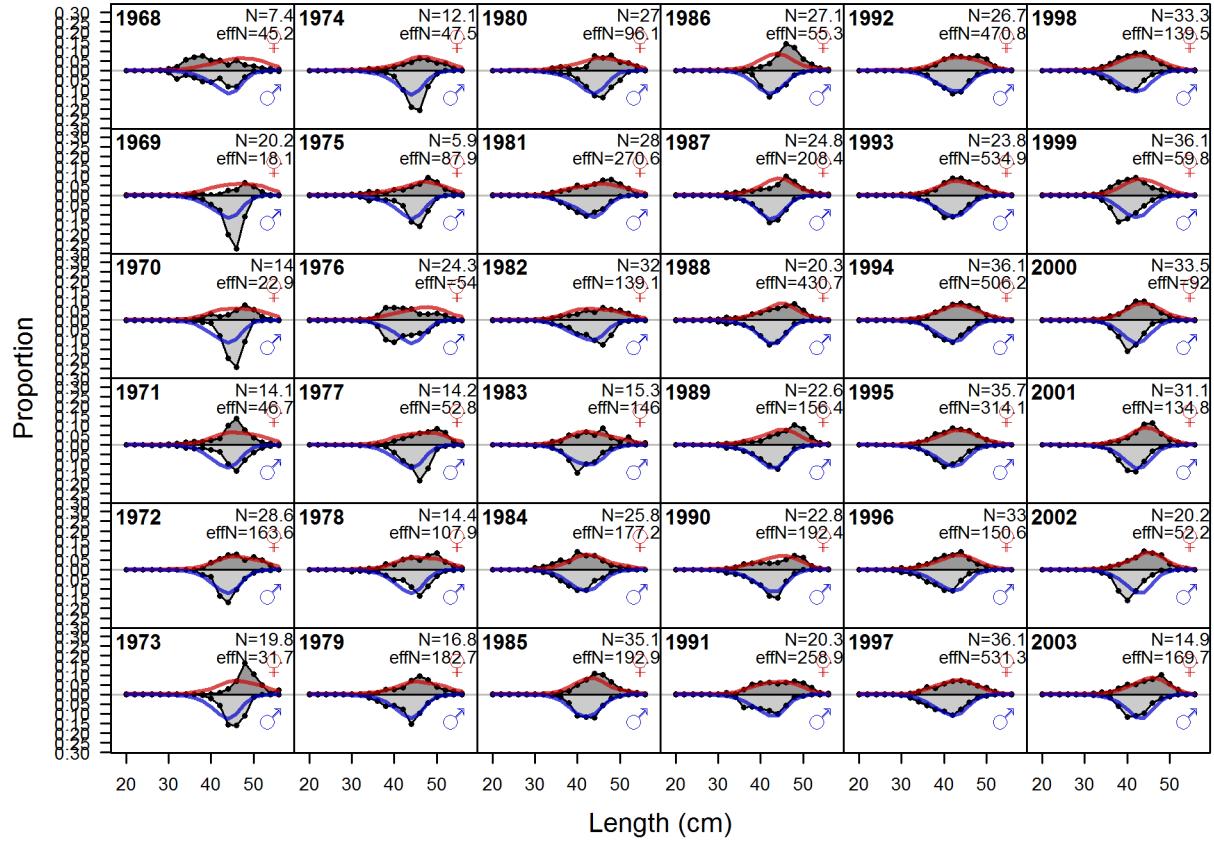
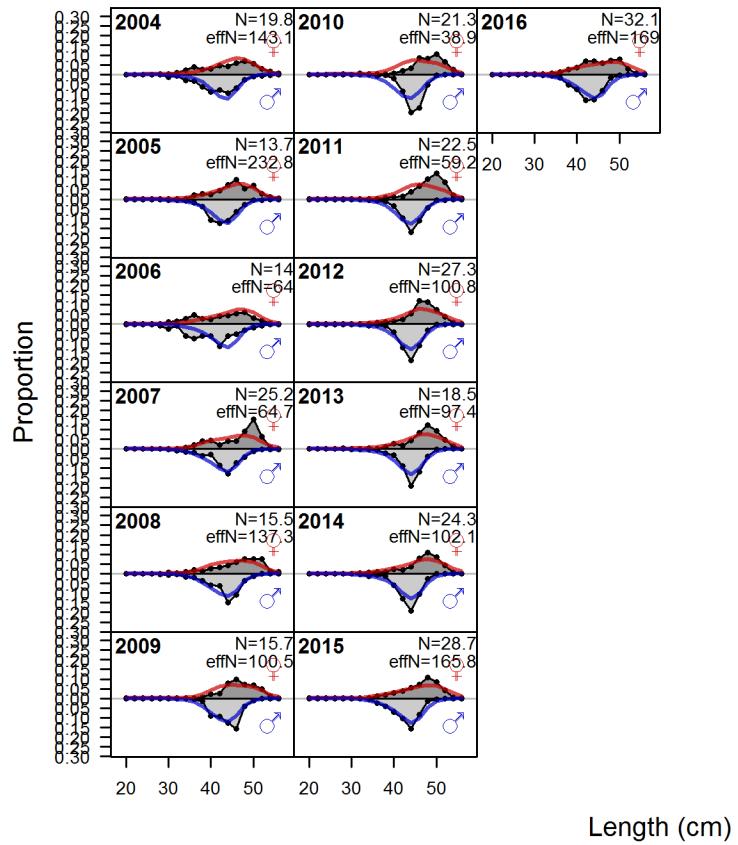


Figure 4: Length comps, retained, CommercialTrawl (plot 1 of 2) [fig:mod1_1_comp_lenfit_f](#)

Length comps, retained, CommercialTrawl

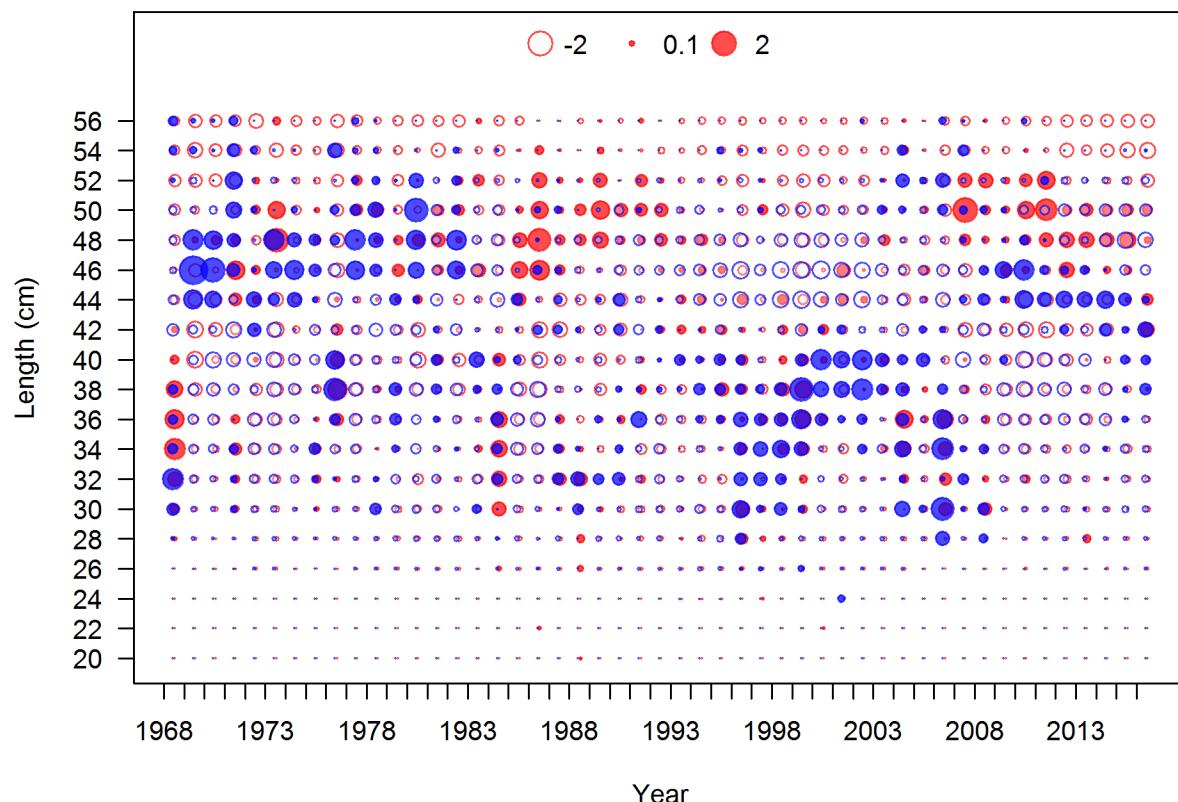


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Figure continued from previous page

Pearson residuals, retained, CommercialTrawl (max=2.68)



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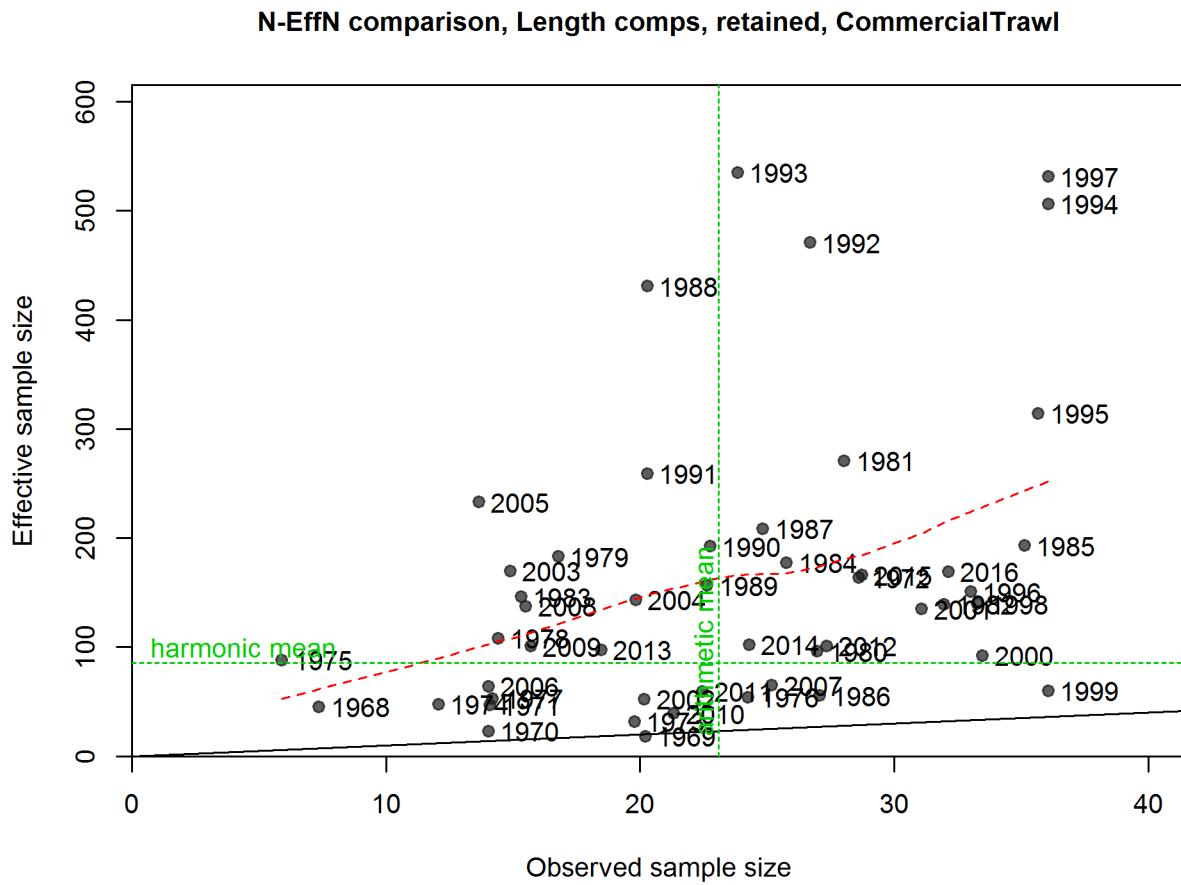


Figure 5: N_EffN comparison, Length comps, retained, CommercialTrawl fig:mod1_4_comp_lenf

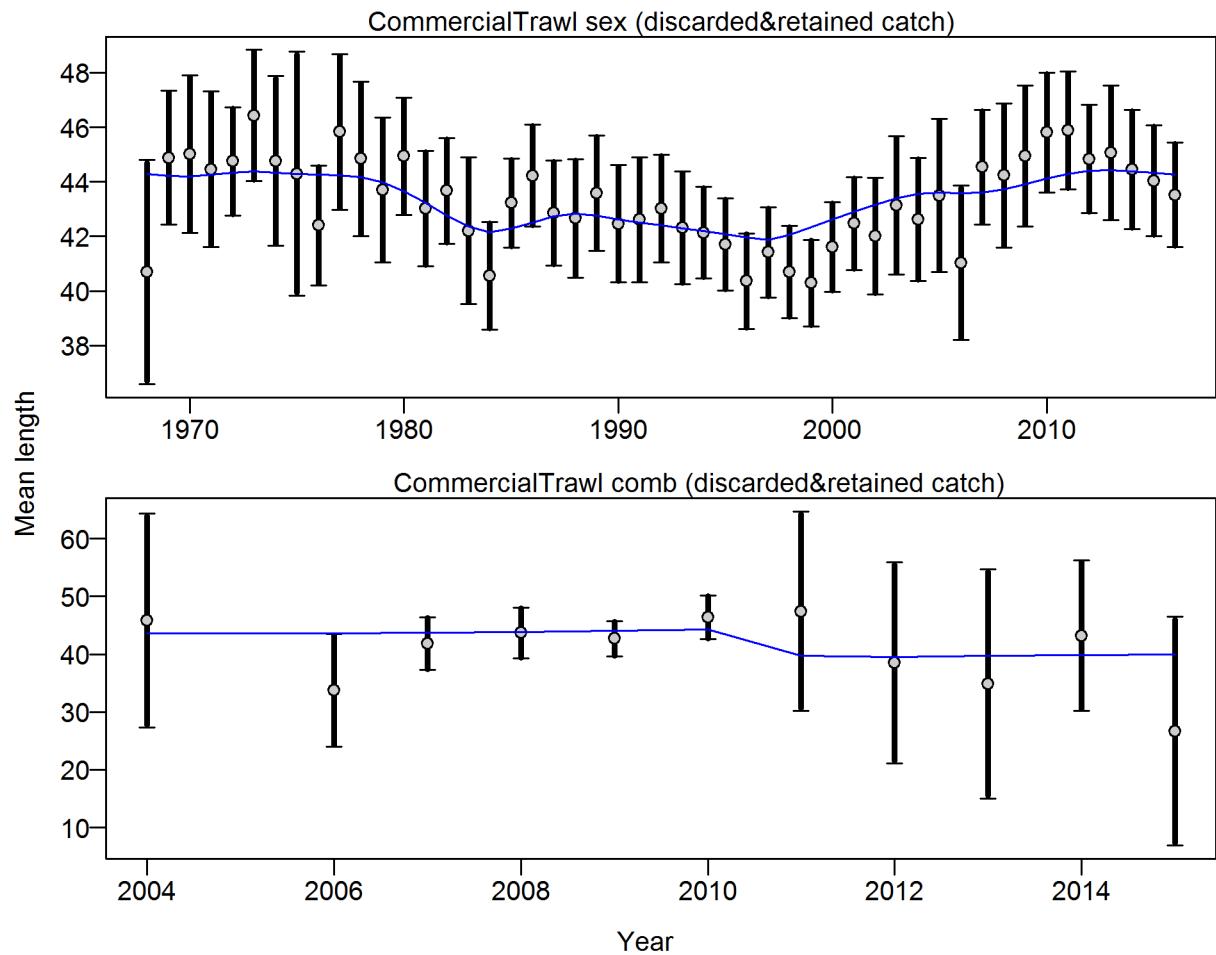


Figure 6: Francis data weighting method TA1.8: CommercialTrawl Suggested sample size adjustment (with 95% interval) for len data from CommercialTrawl: 0.9488 (0.7025_1.4015)
For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_5_comp_lenfit_data_weighting_T](#)

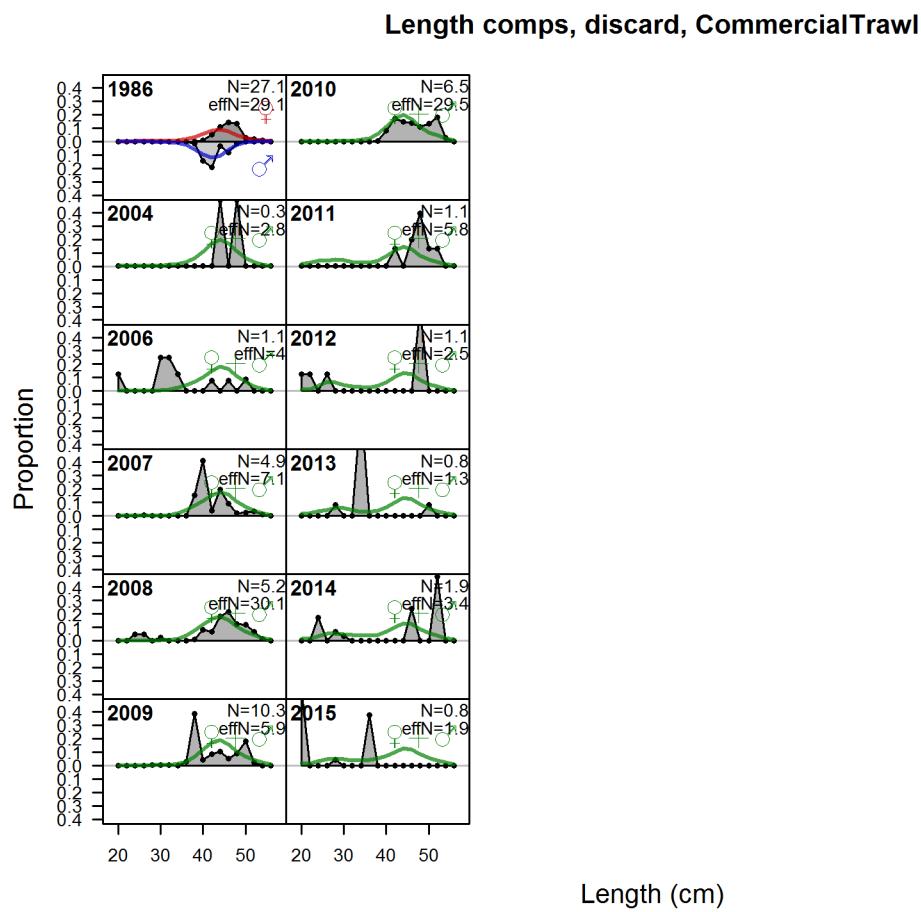


Figure 7: Length comps, discard, CommercialTrawl fig:mod1_6_comp_lenfit_flt1mkt

Pearson residuals, discard, CommercialTrawl (max=4.18)

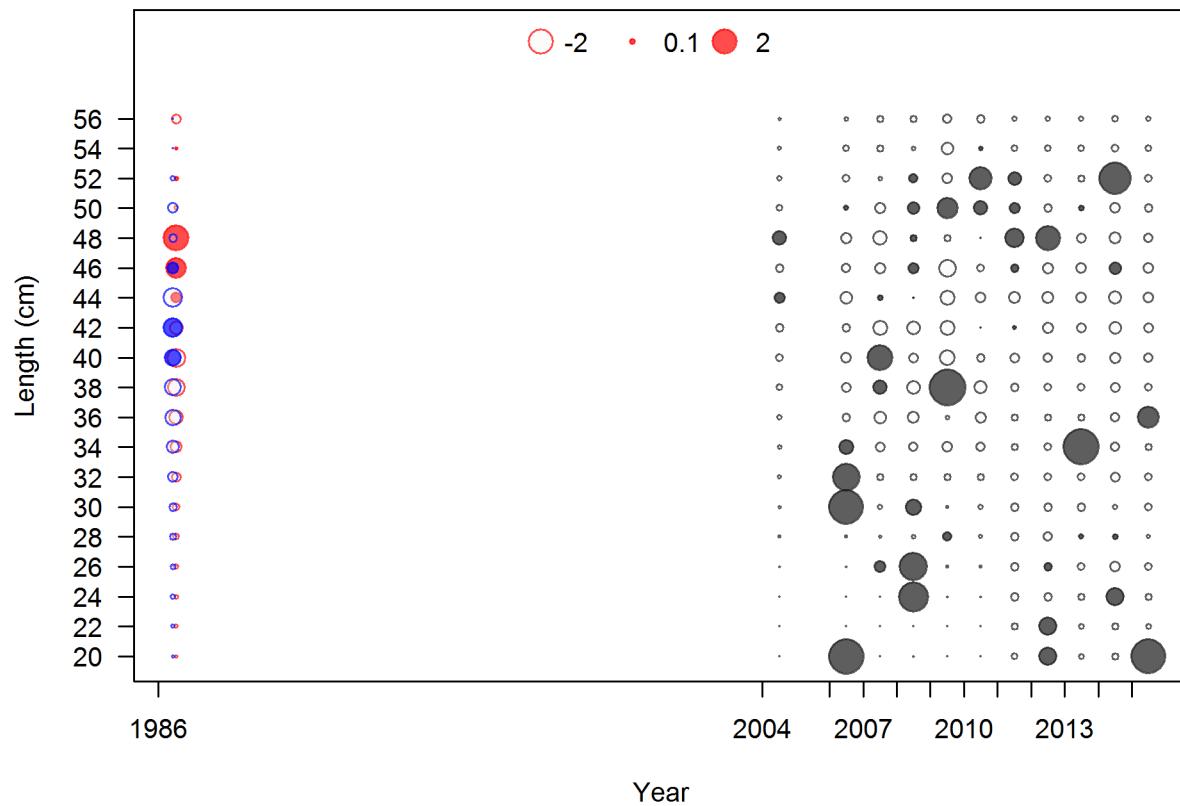


Figure 8: Pearson residuals, discard, CommercialTrawl (max=4.18)

Closed bubbles are positive residuals (observed $>$ expected) and open bubbles are negative residuals (observed $<$ expected). [fig:mod1_7_comp_lenfit_residsfitlmkt1](#)

N-EffN comparison, Length comps, discard, CommercialTrawl

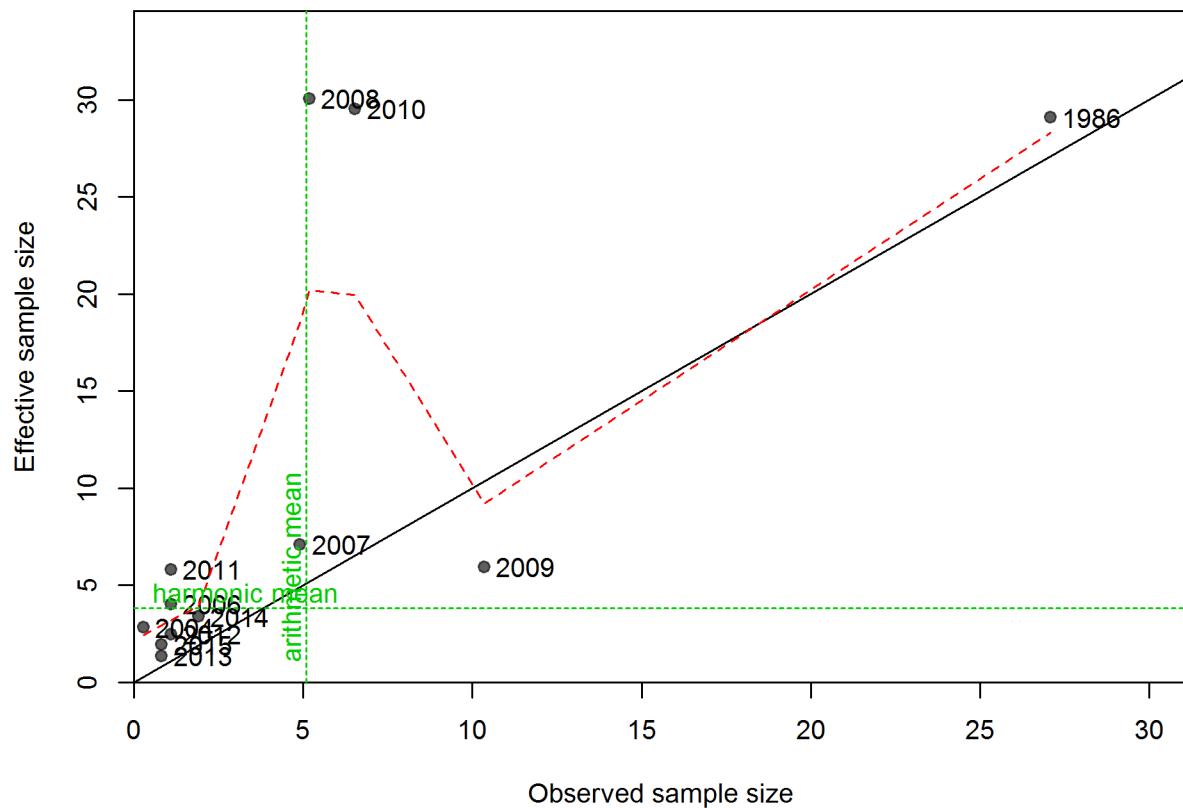


Figure 9: N_EffN comparison, Length comps, discard, CommercialTrawl fig:mod1_8_comp_lenfi

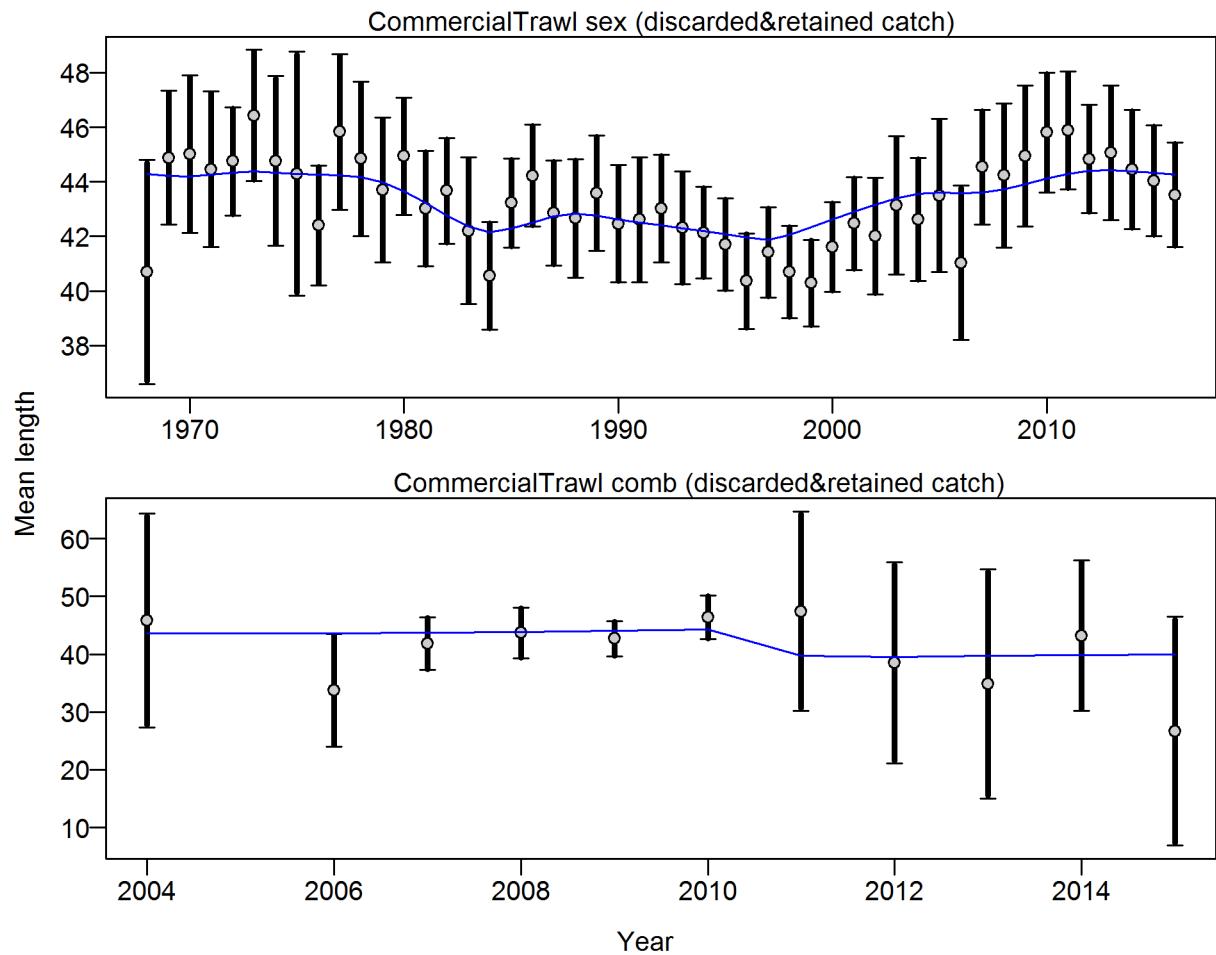


Figure 10: Francis data weighting method TA1.8: CommercialTrawl Suggested sample size adjustment (with 95% interval) for len data from CommercialTrawl: 0.9488 (0.7196_1.3763)
For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_9_comp_lenfit_data_weighting_T](#)

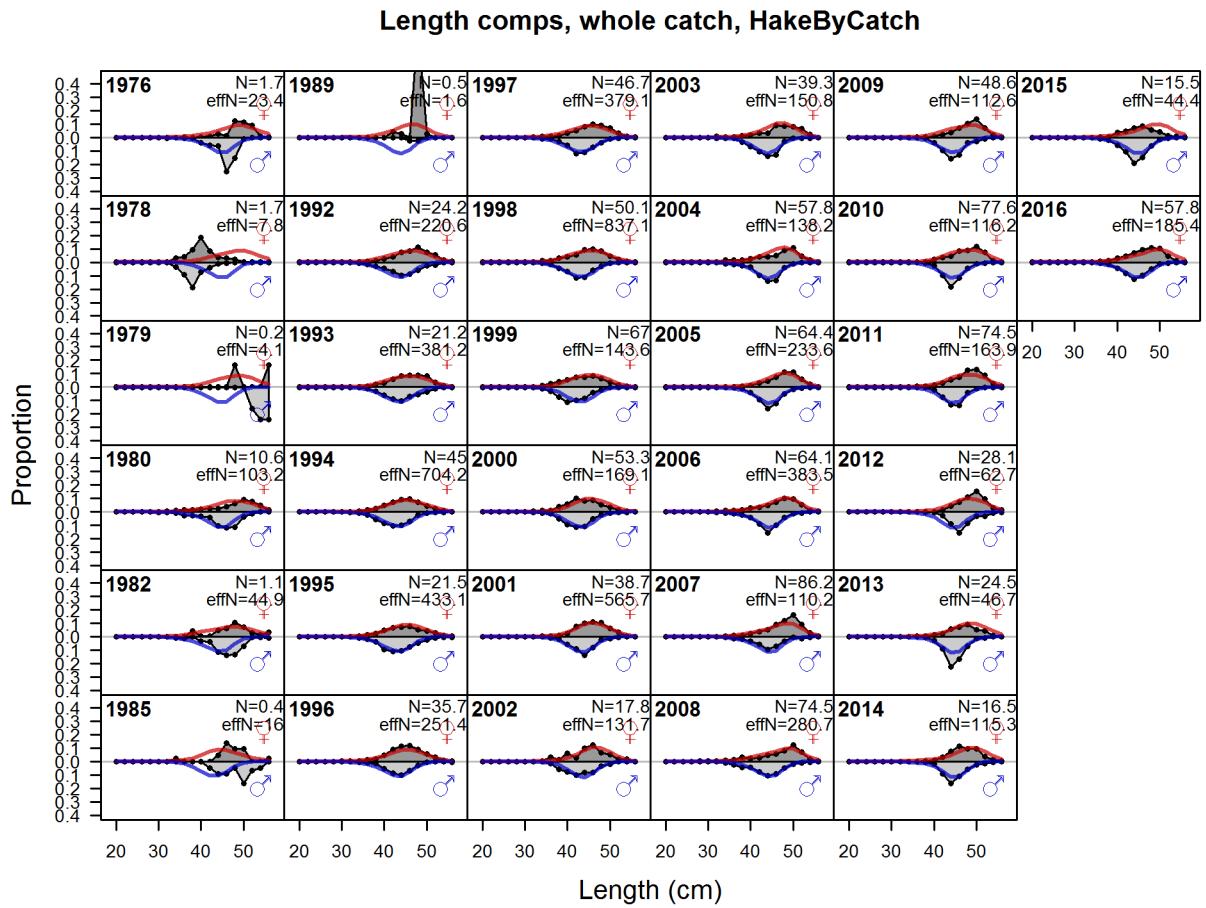


Figure 11: Length comps, whole catch, HakeByCatch

fig:mod1_10_comp_lenfit_flt2mi

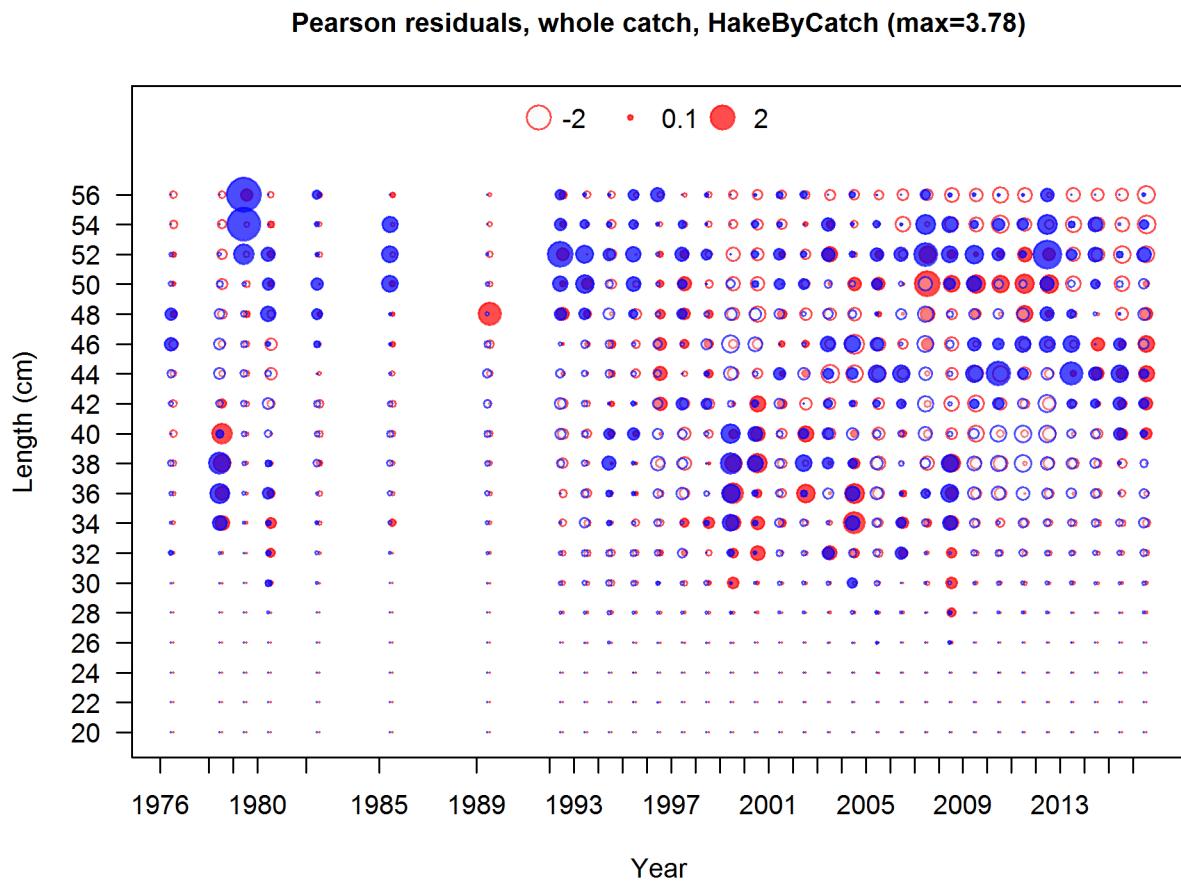


Figure 12: Pearson residuals, whole catch, HakeByCatch (max=3.78)
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_11_comp_lenfit_residsfit2mkt0](#)

N-EffN comparison, Length comps, whole catch, HakeByCatch

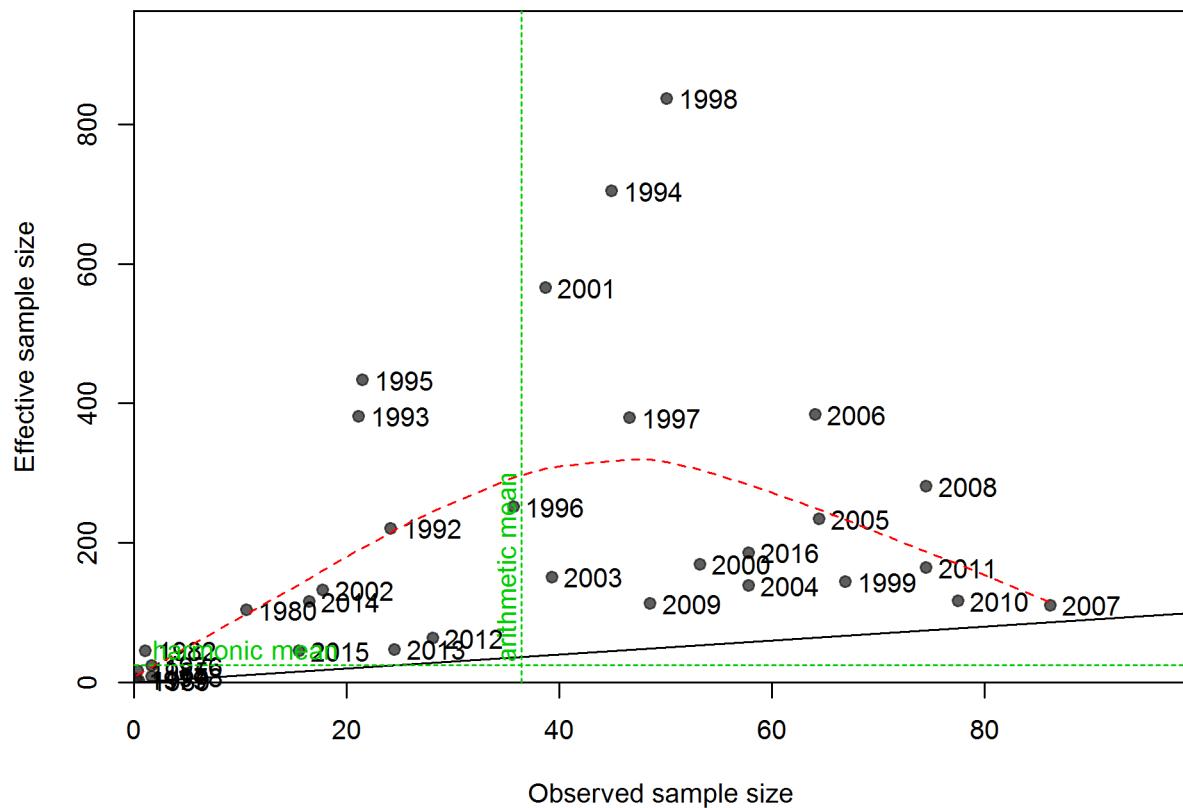


Figure 13: N_EffN comparison, Length comps, whole catch, HakeByCatch fig:mod1_12_comp_len

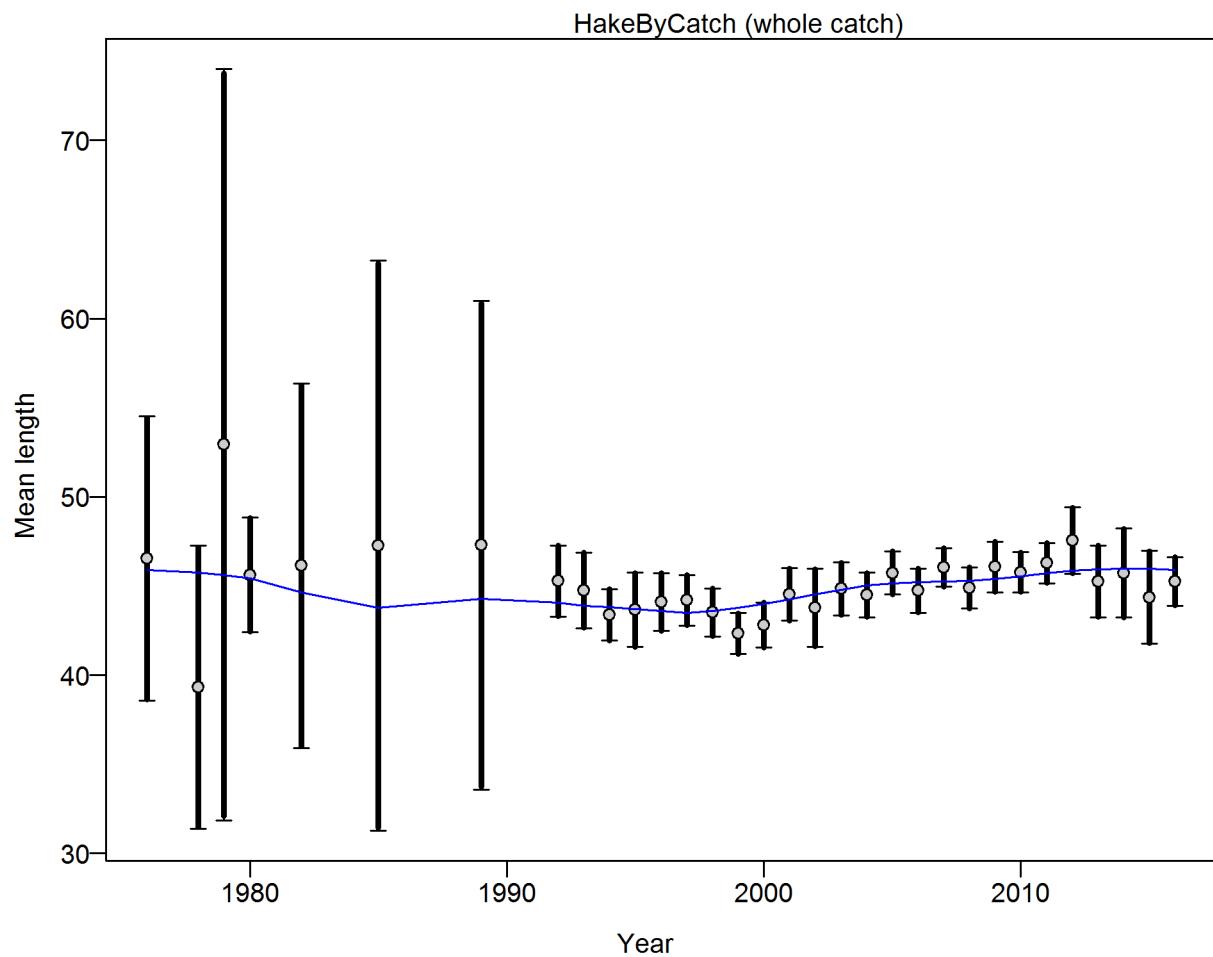


Figure 14: Francis data weighting method TA1.8: HakeByCatch Suggested sample size adjustment (with 95% interval) for len data from HakeByCatch: 0.9774 (0.6495_1.9288) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_13_comp_lenfit_data_weighting_TA1.8_Hake](#)

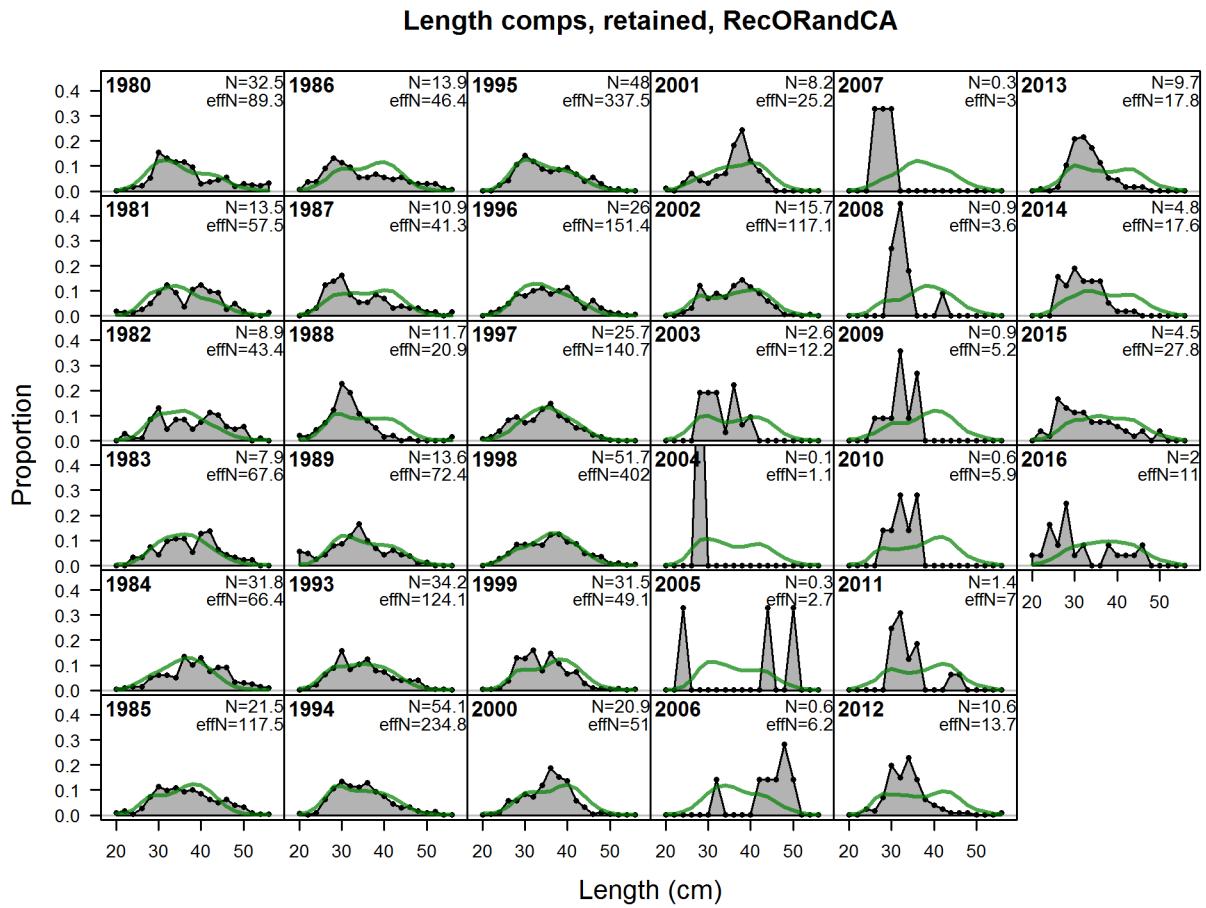


Figure 15: Length comps, retained, RecORandCA fig:mod1_14_comp_lenfit_flt3mkt

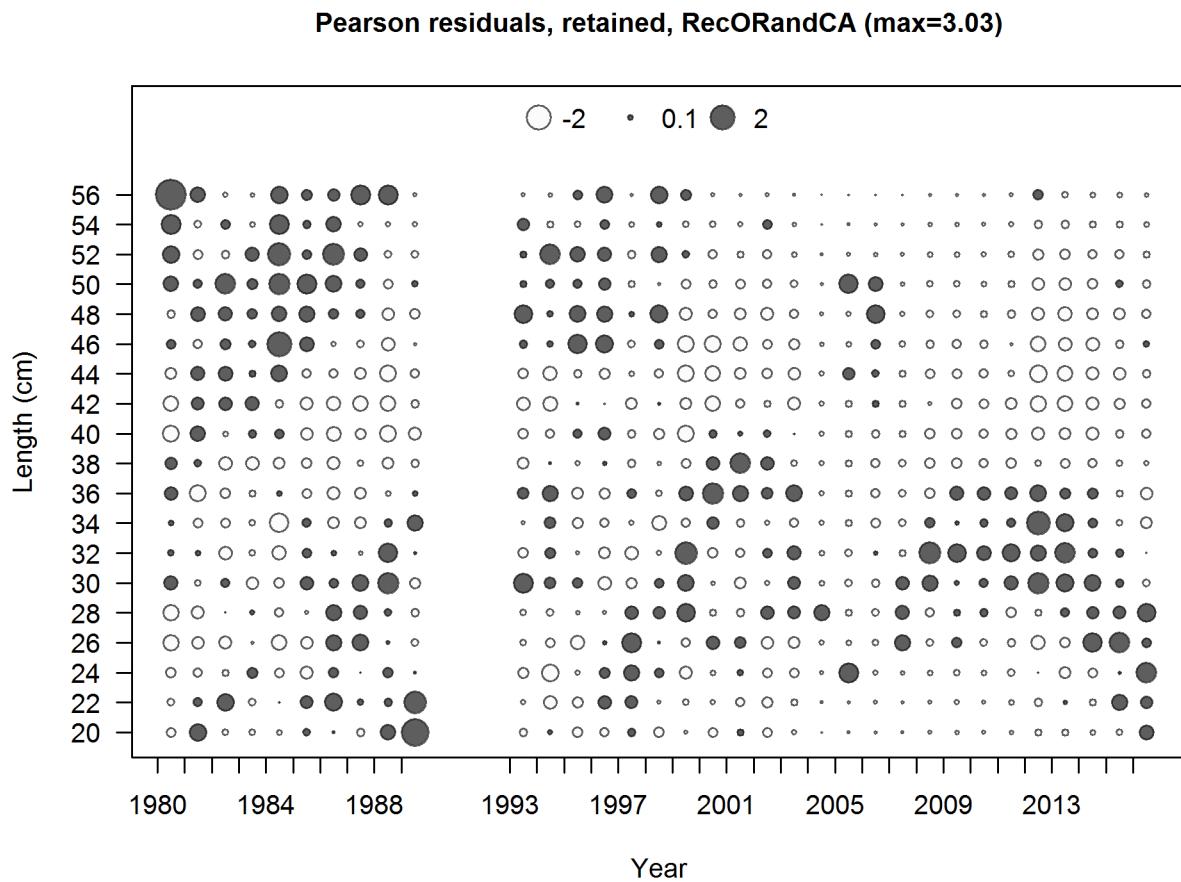


Figure 16: Pearson residuals, retained, RecORandCA (max=3.03)
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_15_comp_lenfit_residsf1t3mkt2](#)

N_EffN comparison, Length comps, retained, RecORandCA

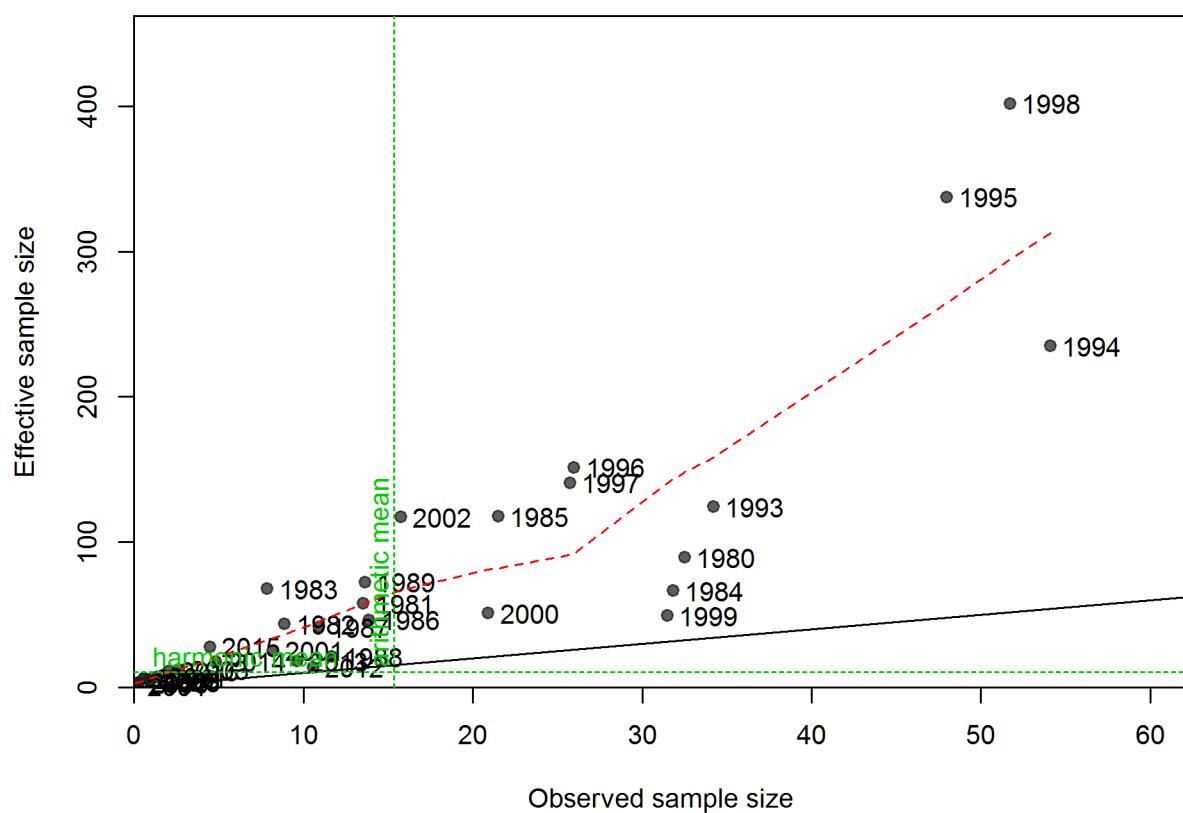


Figure 17: N_EffN comparison, Length comps, retained, RecORandCA `fig:mod1_16_comp_lenf`

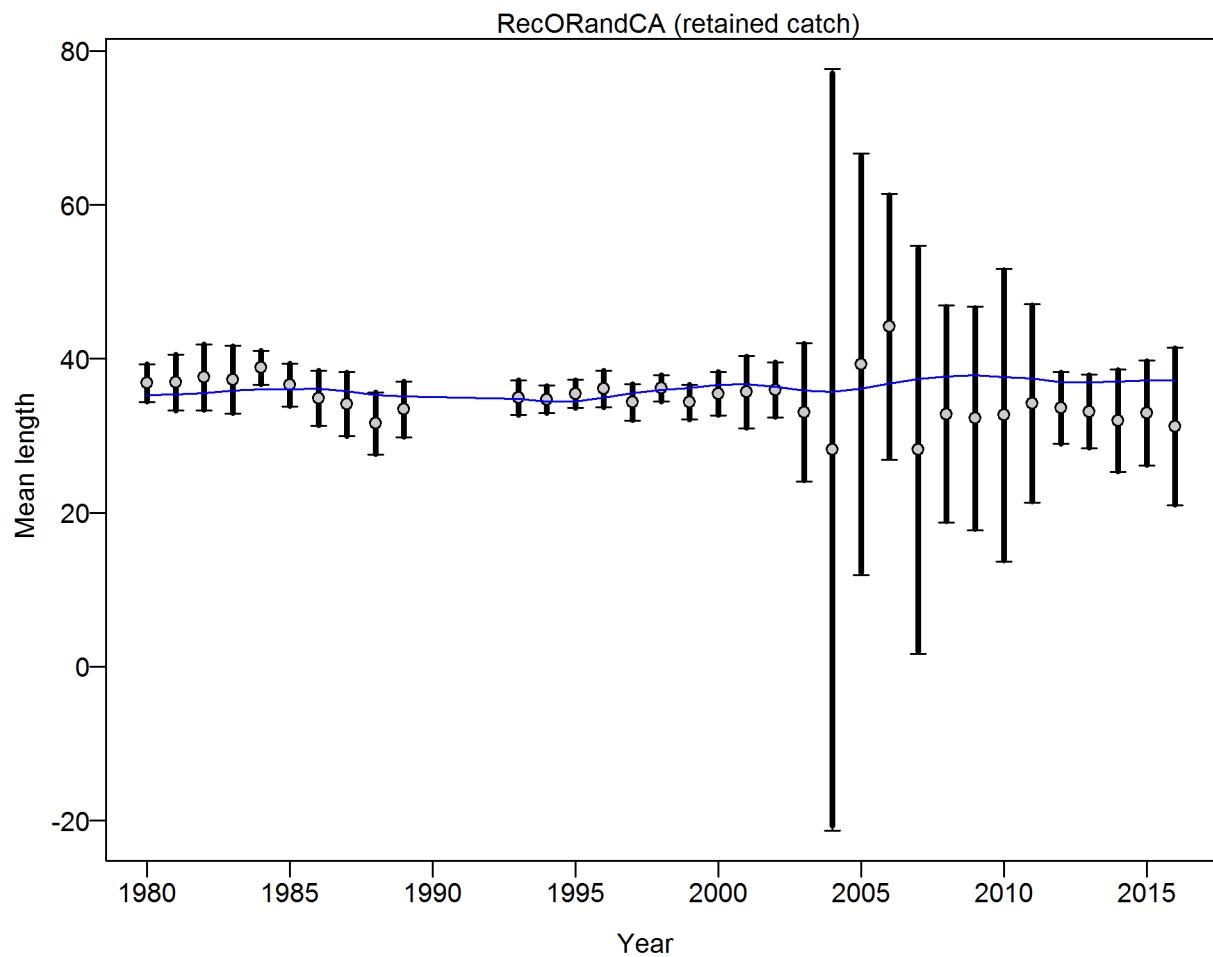


Figure 18: Francis data weighting method TA1.8: RecORandCA Suggested sample size adjustment (with 95% interval) for len data from RecORandCA: 0.9761 (0.6583_1.8129) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_17_comp_lenfit_data_weighting_TA1.8_RecO](#)

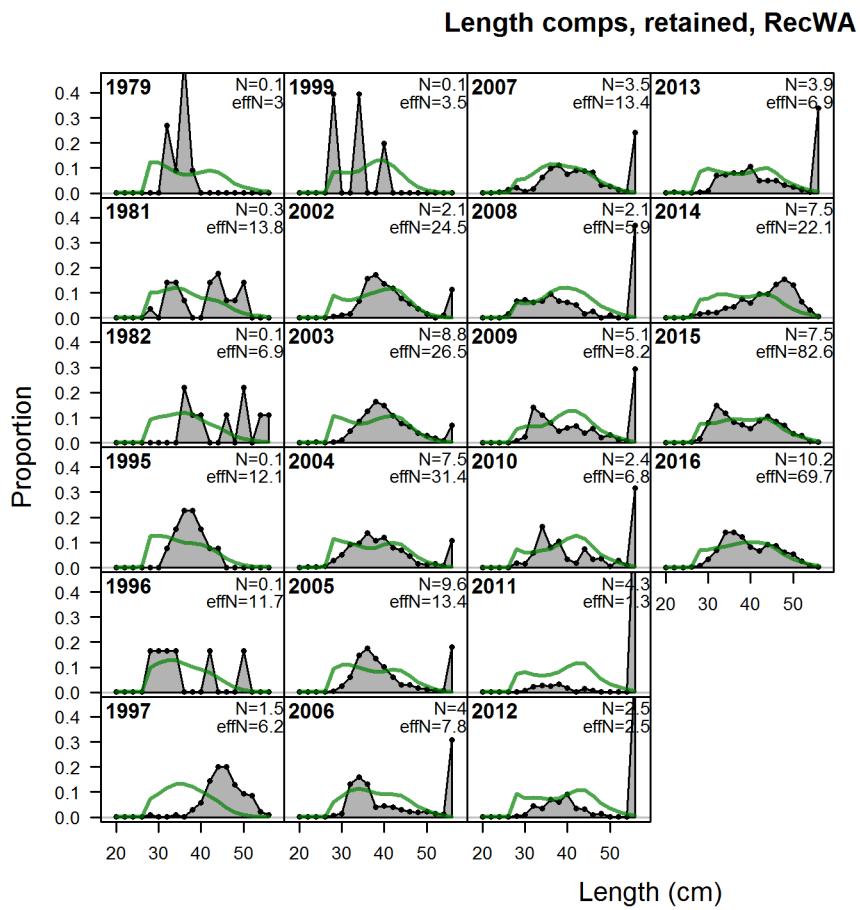


Figure 19: Length comps, retained, RecWA fig:mod1_18_comp_lenfit_flt4mkt2

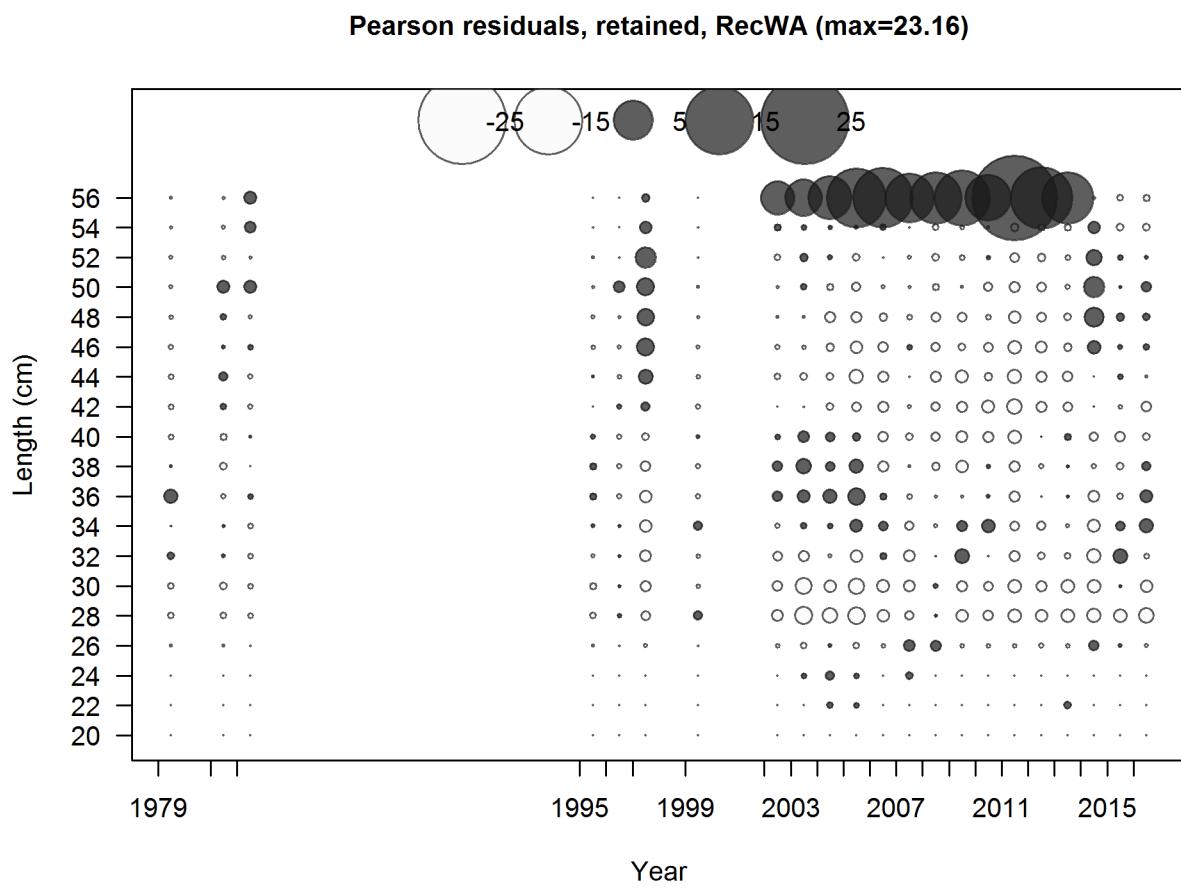


Figure 20: Pearson residuals, retained, RecWA (max=23.16)
 Closed bubbles are positive residuals (observed $>$ expected) and open bubbles are negative residuals (observed $<$ expected). [fig:mod1_19_comp_lenfit_residsfit4mkt2](#)

N-EffN comparison, Length comps, retained, RecWA

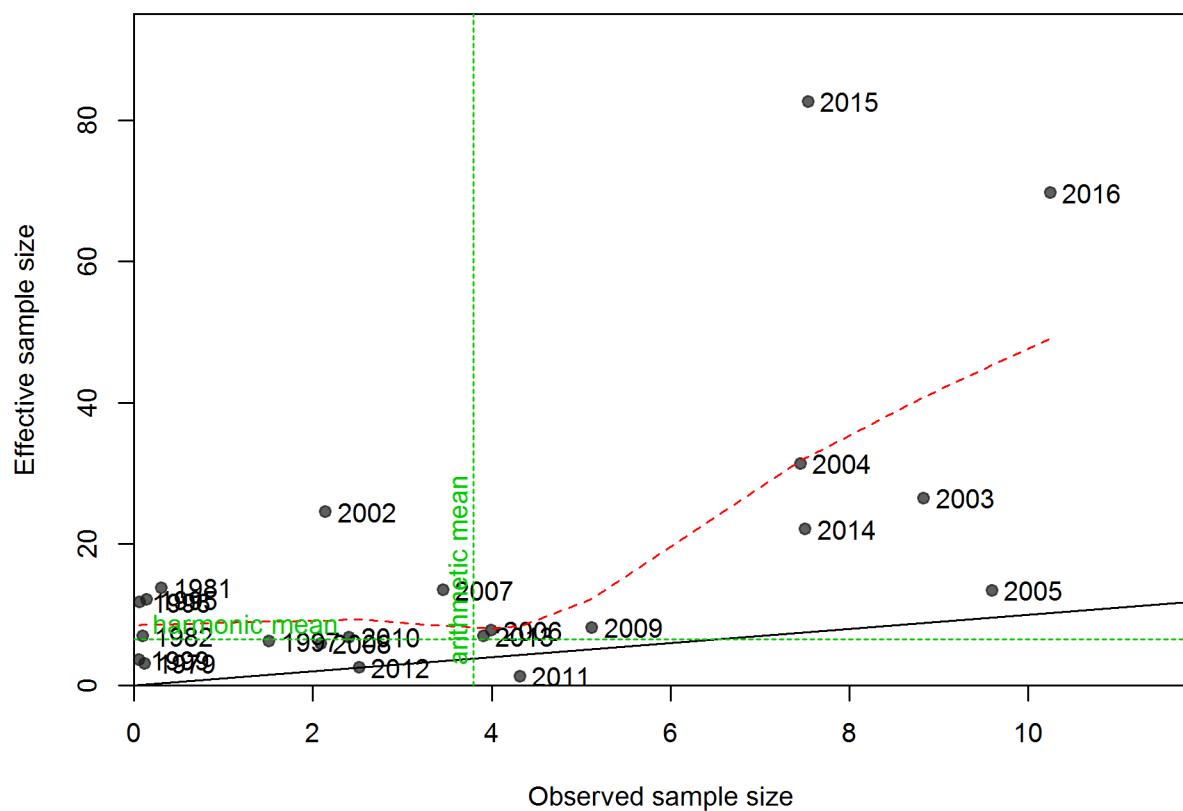


Figure 21: N_EffN comparison, Length comps, retained, RecWA `fig:mod1_20_comp_lenfit_s`

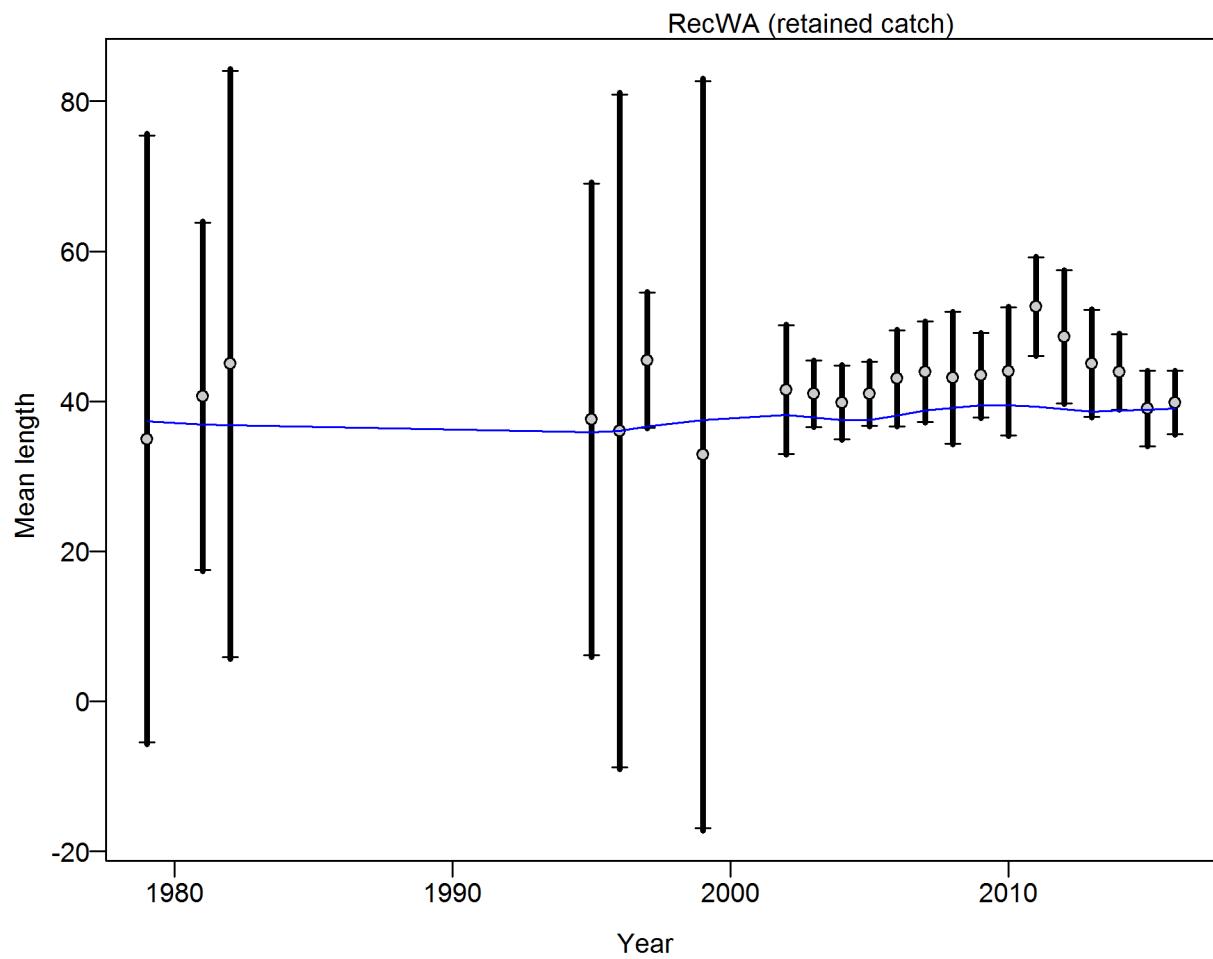


Figure 22: Francis data weighting method TA1.8: RecWA Suggested sample size adjustment (with 95% interval) for len data from RecWA: 1.0134 (0.564_2.3704) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. *Can. J. Fish. Aquat. Sci.* 68: 1124_1138. | [fig:mod1_21_comp_lenfit_data_weighting_TA1.8_RecWA](#)

Length comps, retained, Triennial

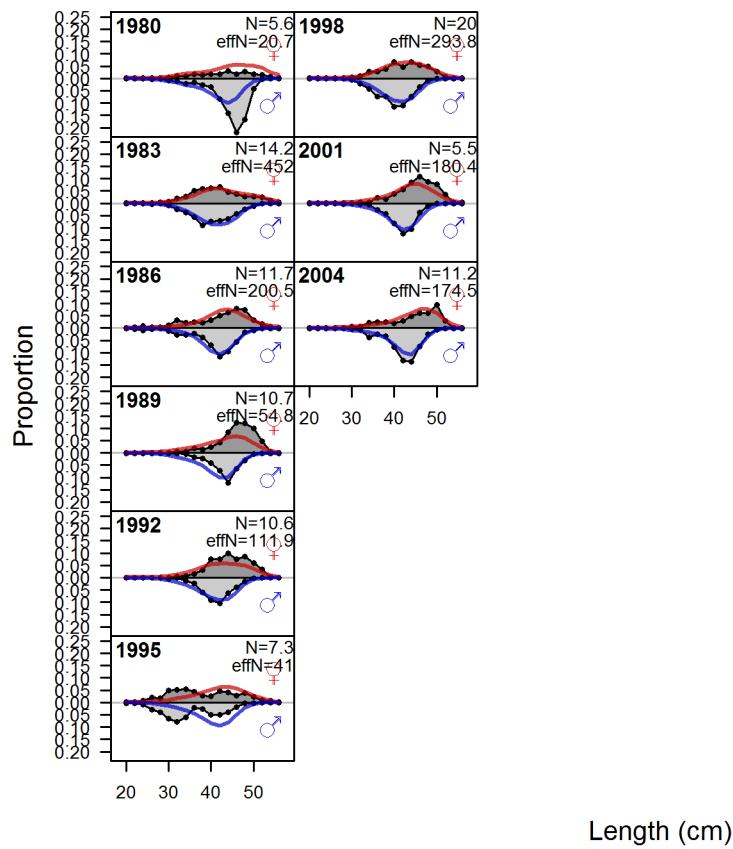


Figure 23: Length comps, retained, Triennial

`fig:mod1_22_comp_lenfit_flt5mkt2`

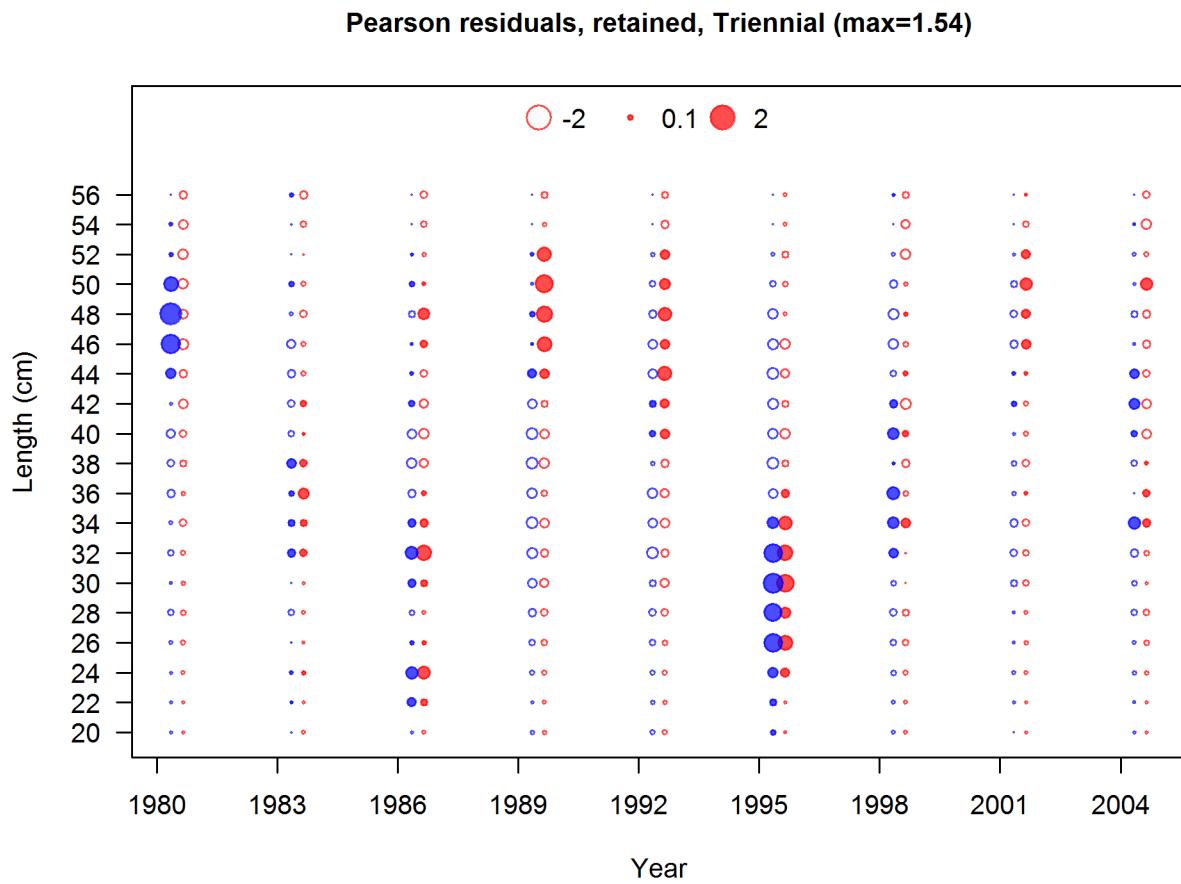


Figure 24: Pearson residuals, retained, Triennial (max=1.54)
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_23_comp_lenfit_residsf1t5mkt2](#)

N-EffN comparison, Length comps, retained, Triennial

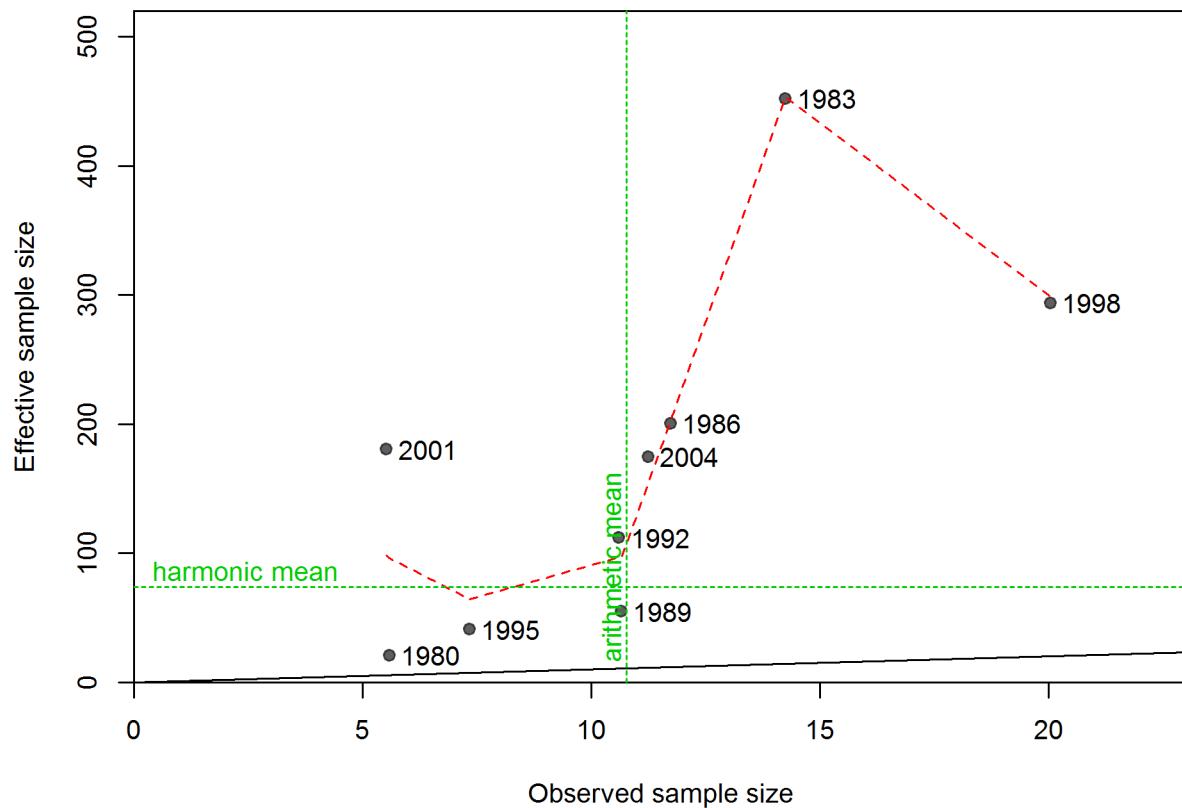


Figure 25: N_EffN comparison, Length comps, retained, Triennial [fig:mod1_24_comp_lenfit](#)

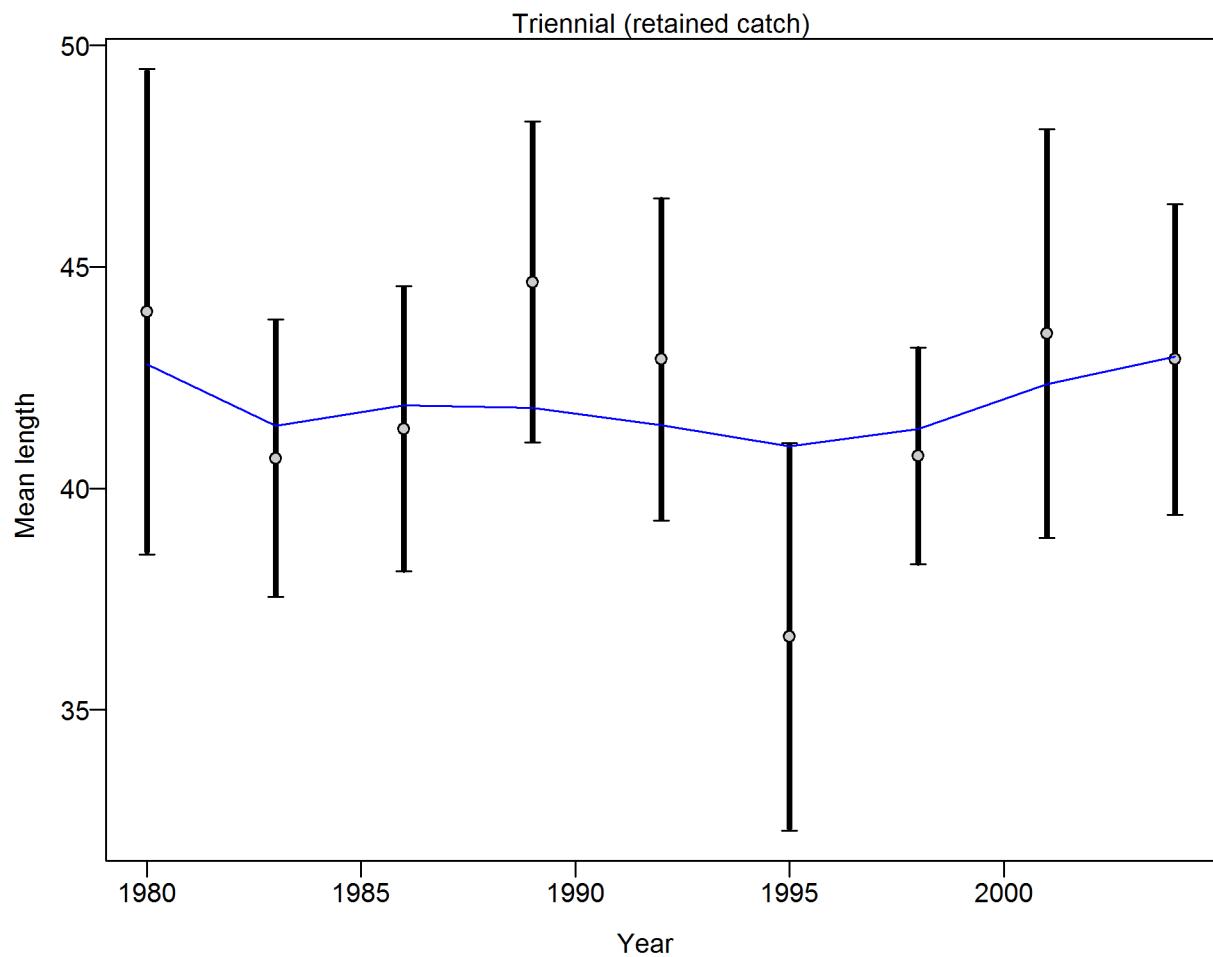


Figure 26: Francis data weighting method TA1.8: Triennial Suggested sample size adjustment (with 95% interval) for len data from Triennial: 0.9781 (0.5215_5.1199) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_25_comp_lenfit_data_weighting_TA1.8_Triennial](#)

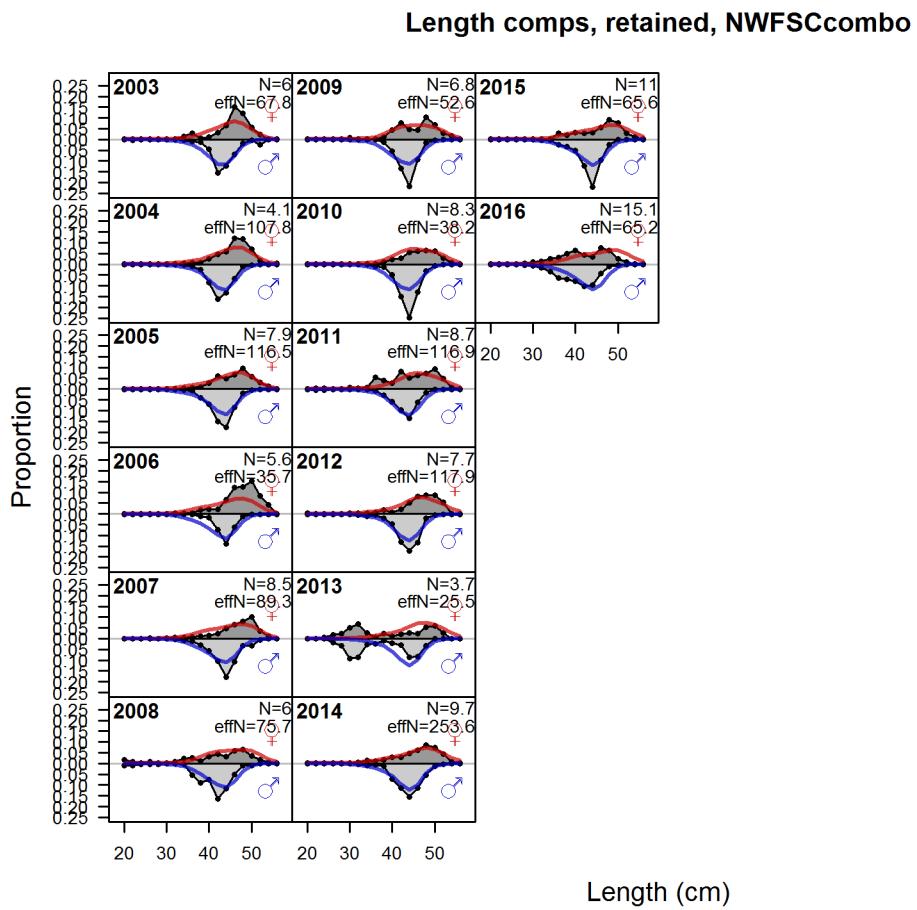


Figure 27: Length comps, retained, NWFSCcombo

`fig:mod1_26_comp_lenfit_flt6mk`

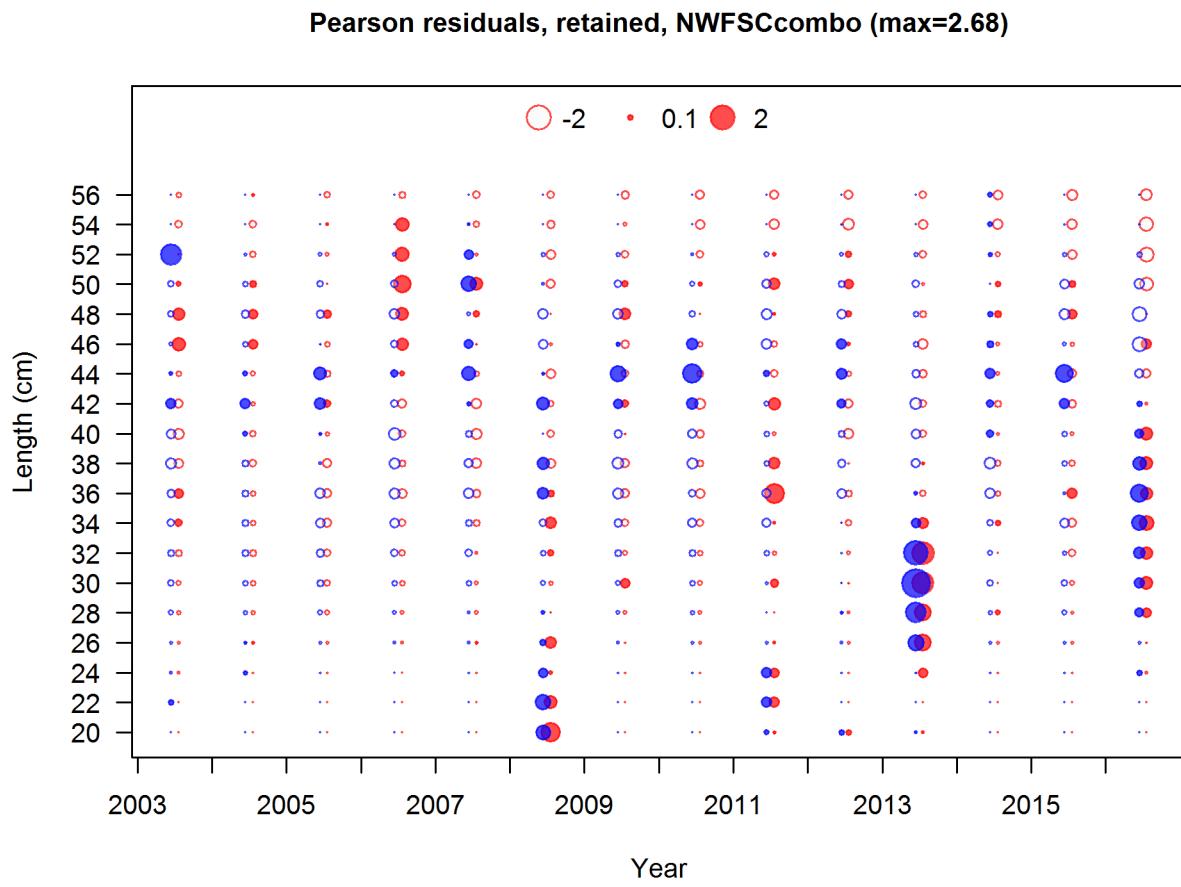


Figure 28: Pearson residuals, retained, NWFSCcombo (max=2.68)
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_27_comp_lenfit_residsflt6mkt2](#)

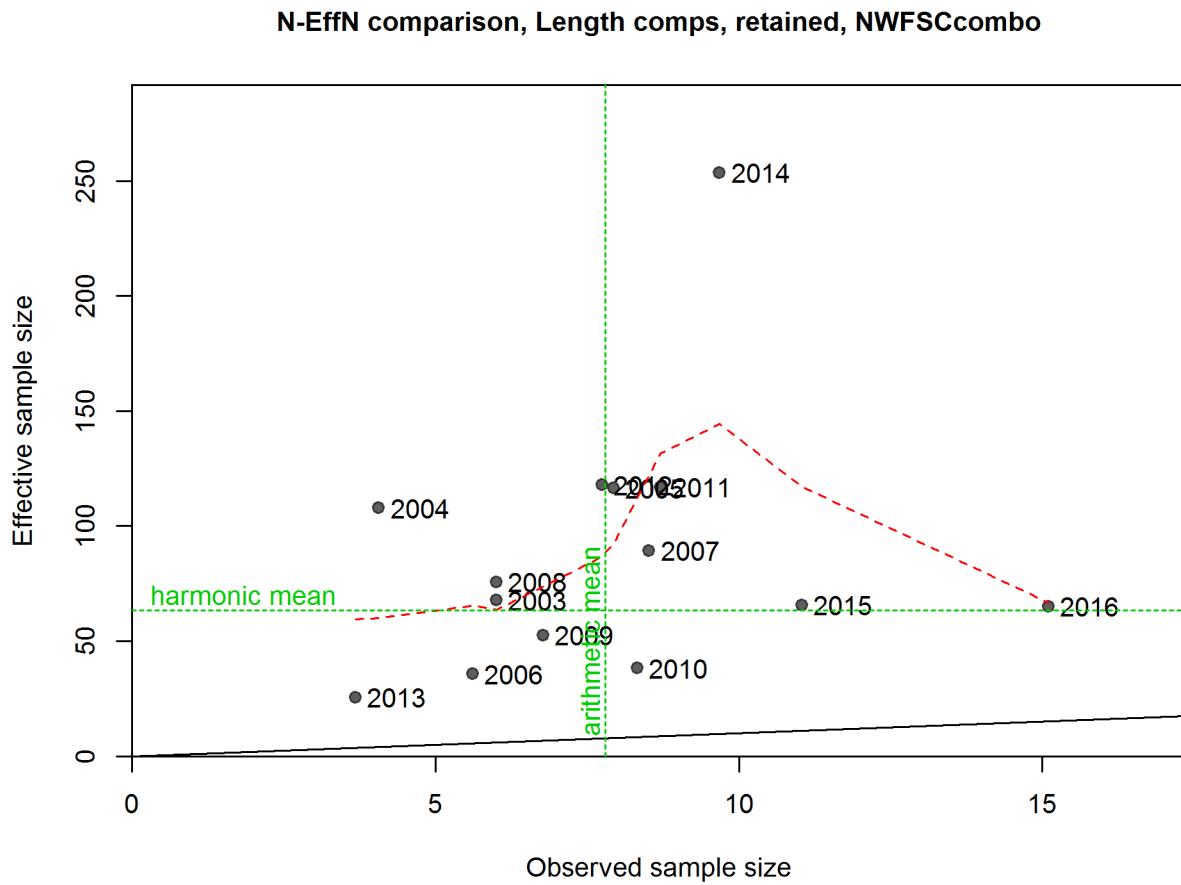


Figure 29: N_EffN comparison, Length comps, retained, NWFSCcombo fig:mod1_28_comp_lenf

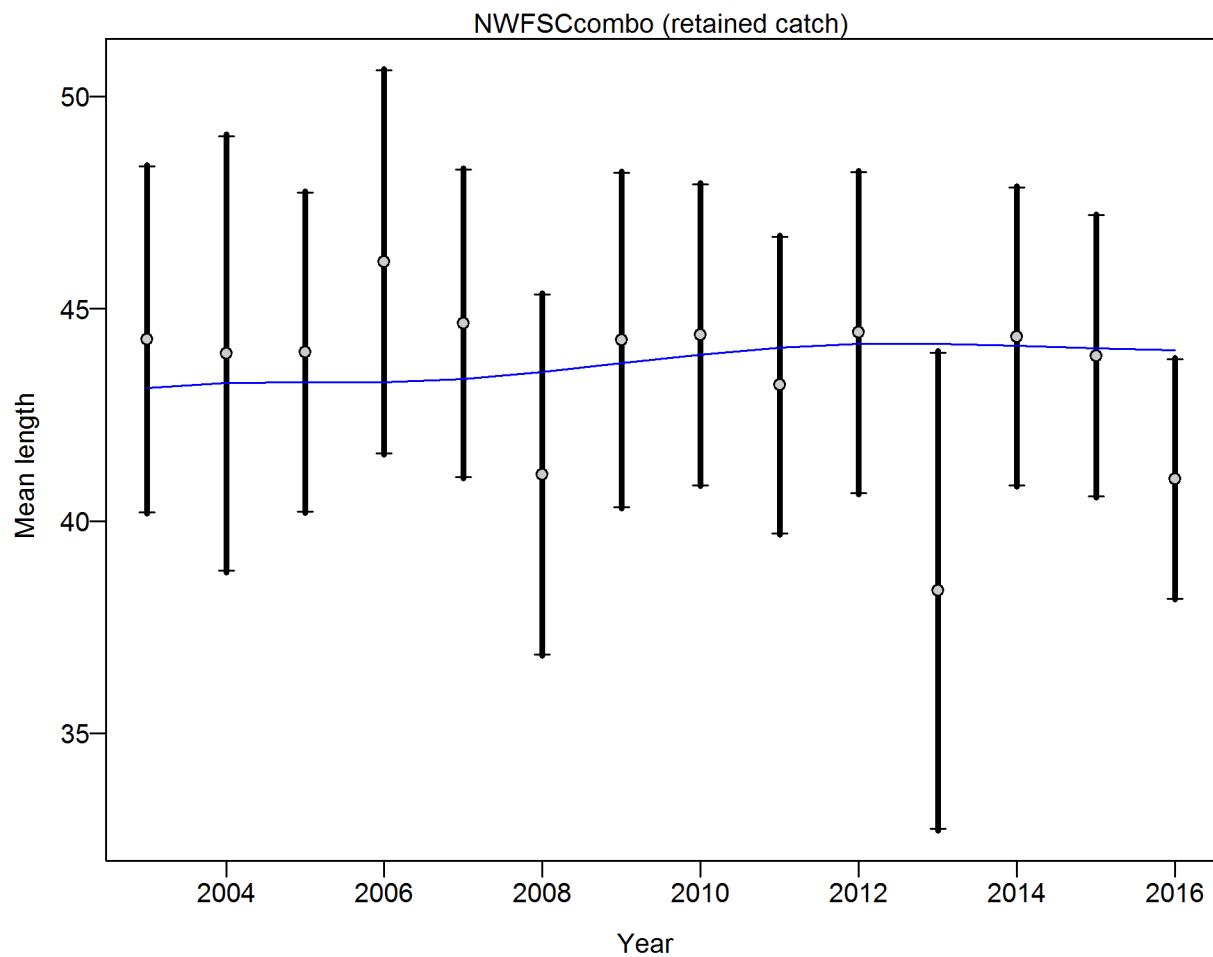


Figure 30: Francis data weighting method TA1.8: NWFSCcombo Suggested sample size adjustment (with 95% interval) for len data from NWFSCcombo: 1.0144 (0.6387_4.7987)
For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. [fig:mod1_29_comp_lenfit_data_weighting](#)

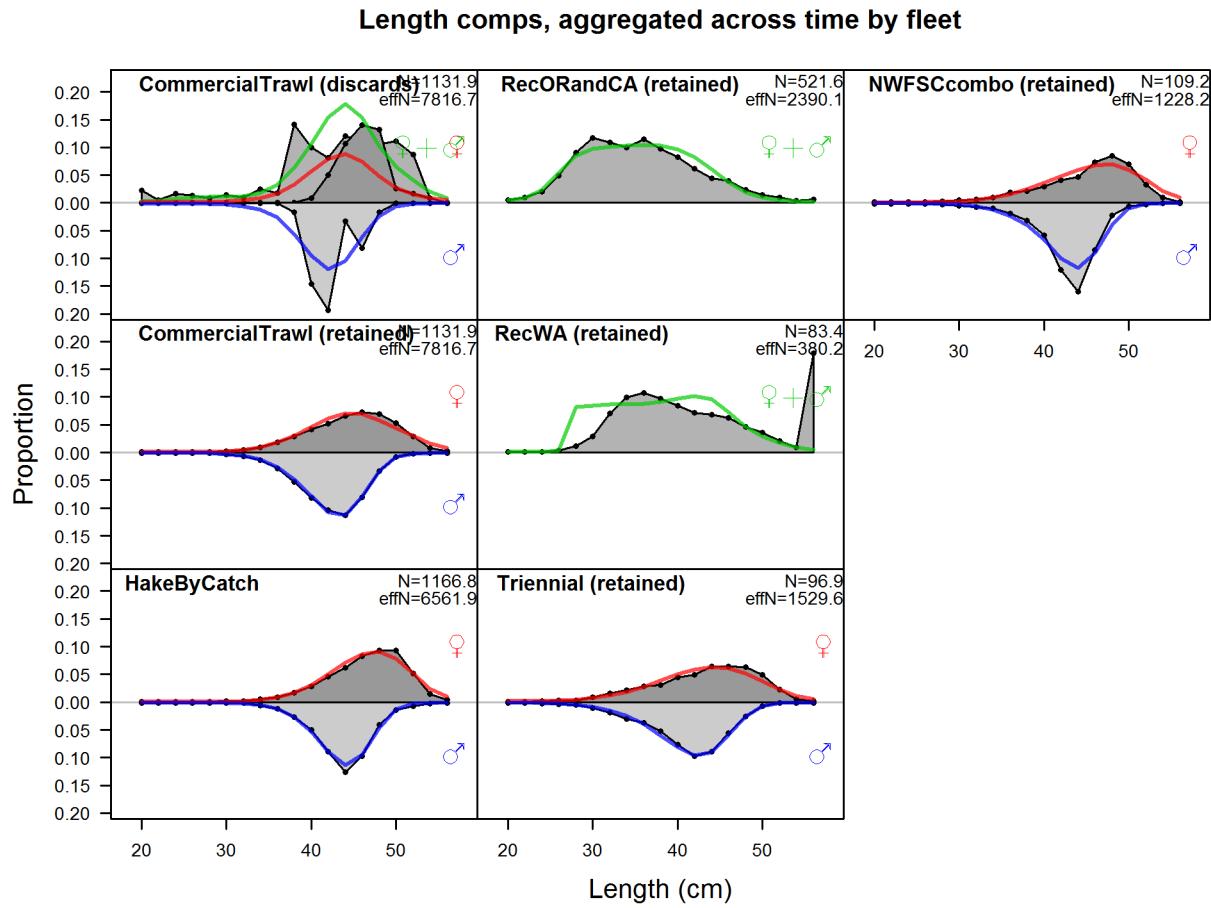


Figure 31: Length comps, aggregated across time by fleet. Labels ‘retained’ and ‘discard’ indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. [fig:mod1_30_comp_lenfit_aggregated_across_time](#)

Pearson residuals, sexes combined, discard, comparing across fleets

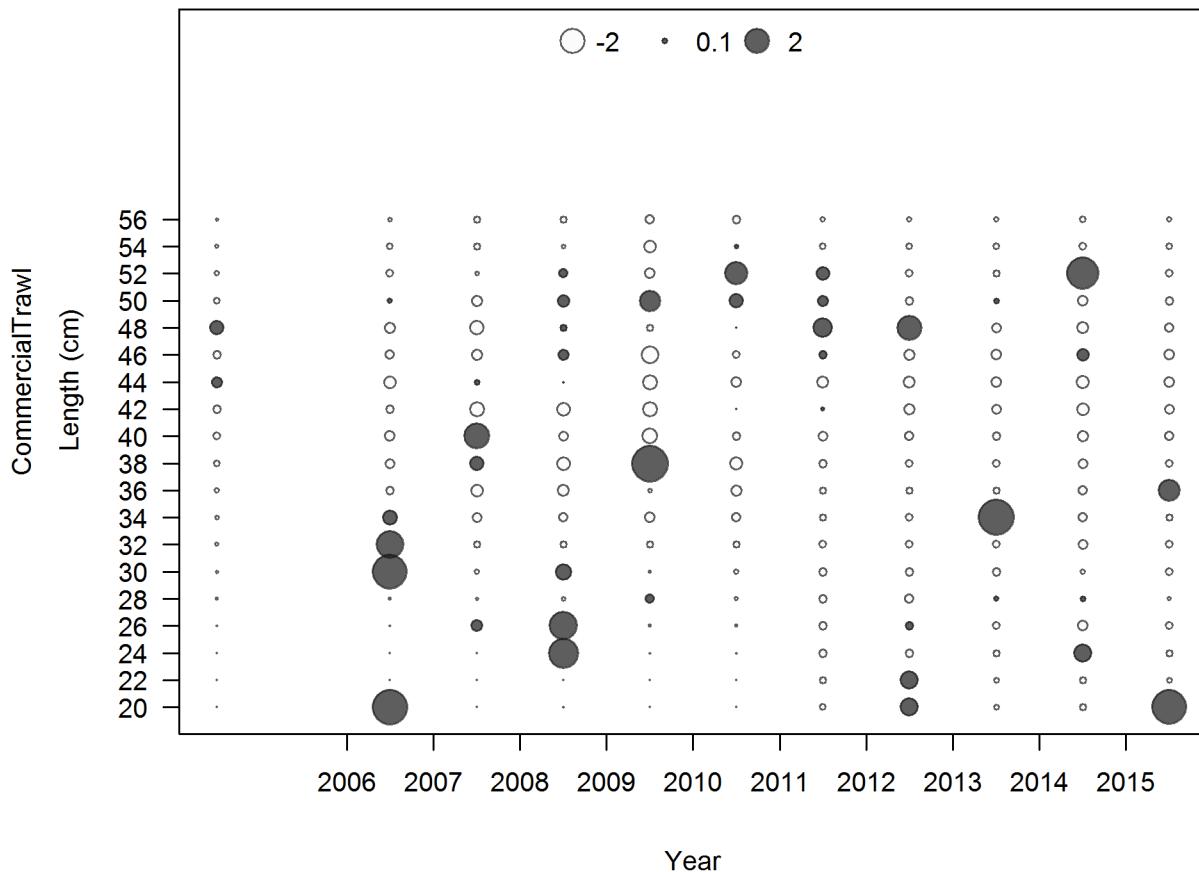


Figure 32: Note: this plot doesn't seem to be working right for some models. Pearson residuals, sexes combined, discard, comparing across fleets
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_31_comp_lenfit_seximkt1_multi-fleet_comparison](#)

Pearson residuals, sexes combined, retained, comparing across fleets

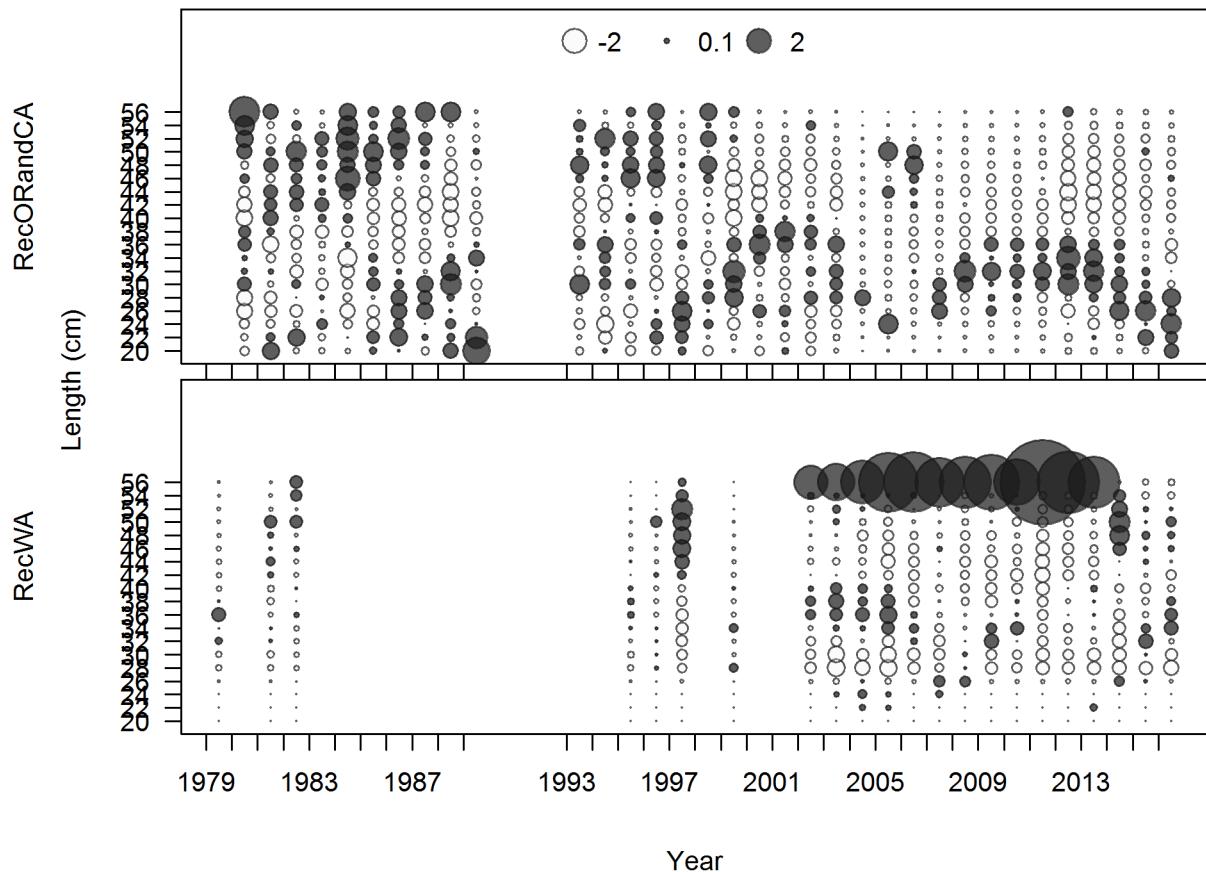


Figure 33: Note: this plot doesn't seem to be working right for some models. Pearson residuals, sexes combined, retained, comparing across fleets
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_32_comp_lenfit_seximkt2_multi-fleet_comparison](#)

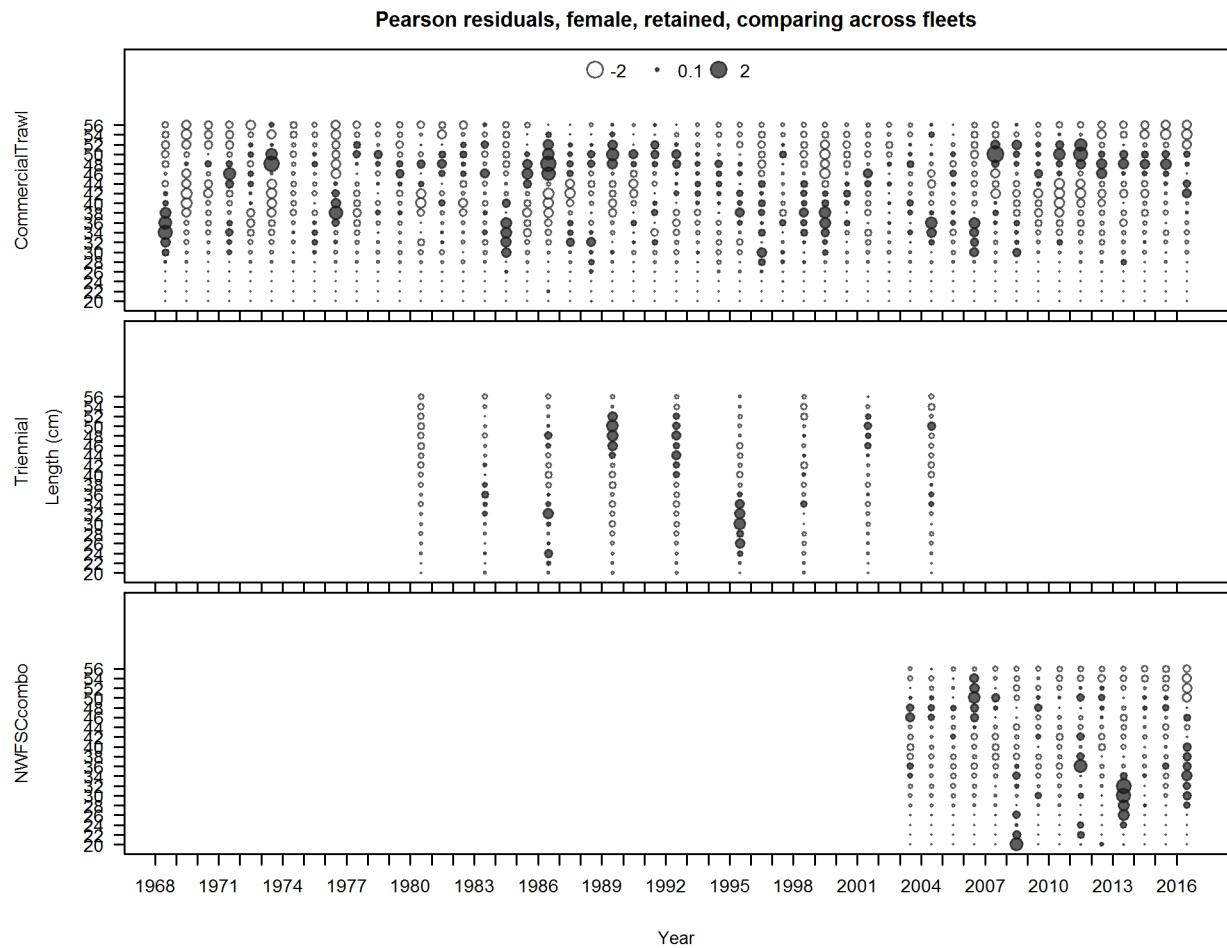


Figure 34: Note: this plot doesn't seem to be working right for some models. Pearson residuals, female, retained, comparing across fleets
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_33_comp_lenfit_sex2mkt2_multi-fleet_comparison](#)

Pearson residuals, female, discard, comparing across fleets

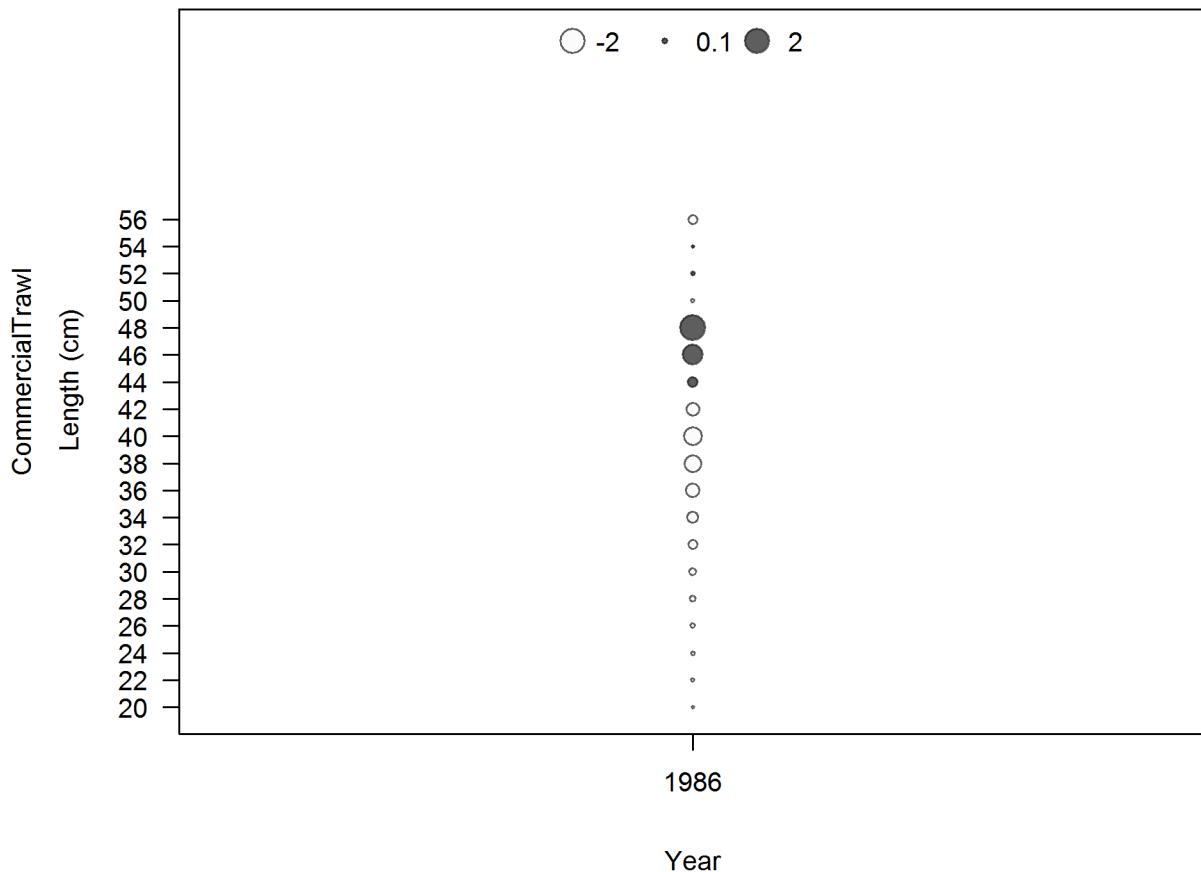


Figure 35: Note: this plot doesn't seem to be working right for some models. Pearson residuals, female, discard, comparing across fleets

Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_34_comp_lenfit_sex2mkt1_multi-fleet_comparison](#)

Pearson residuals, female, whole catch, comparing across fleets

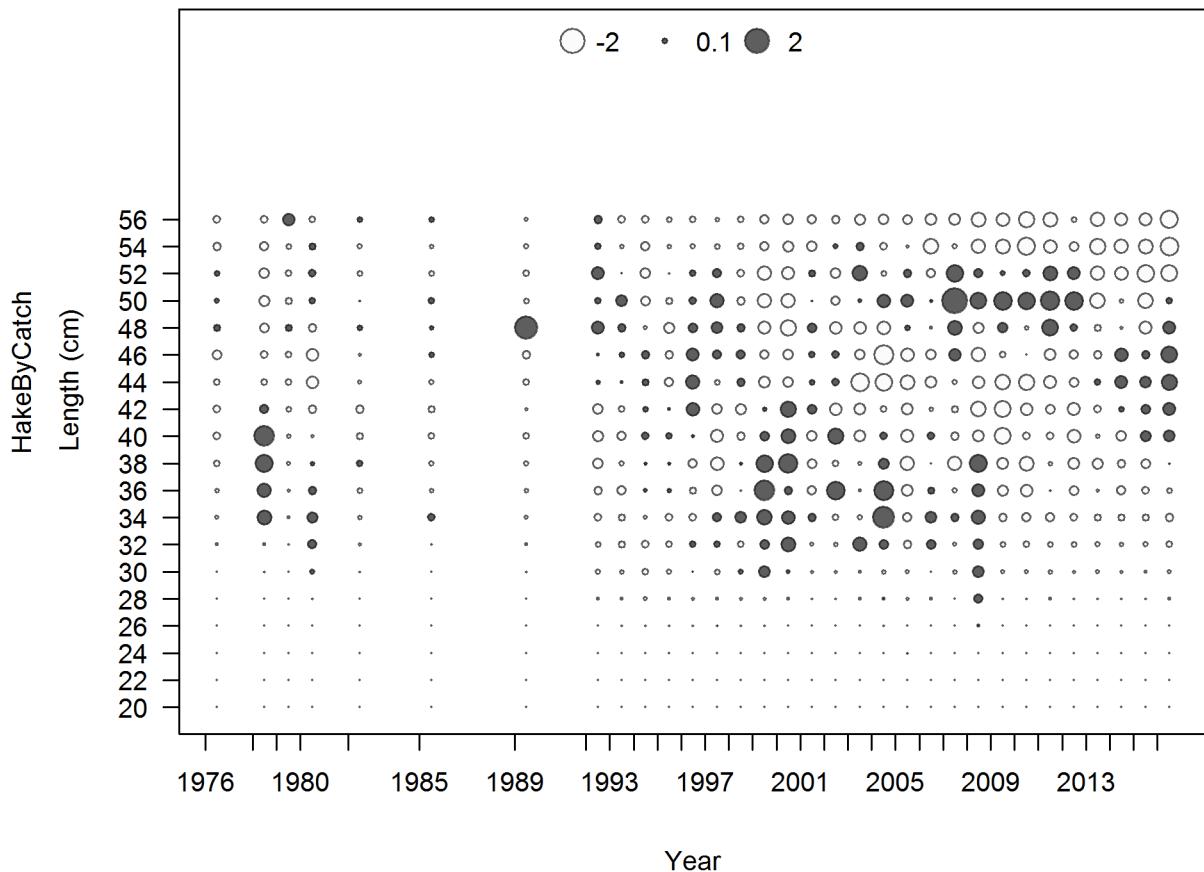


Figure 36: Note: this plot doesn't seem to be working right for some models. Pearson residuals, female, whole catch, comparing across fleets
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_35_comp_lenfit_sex2mkt0_multi-fleet_comparison](#)

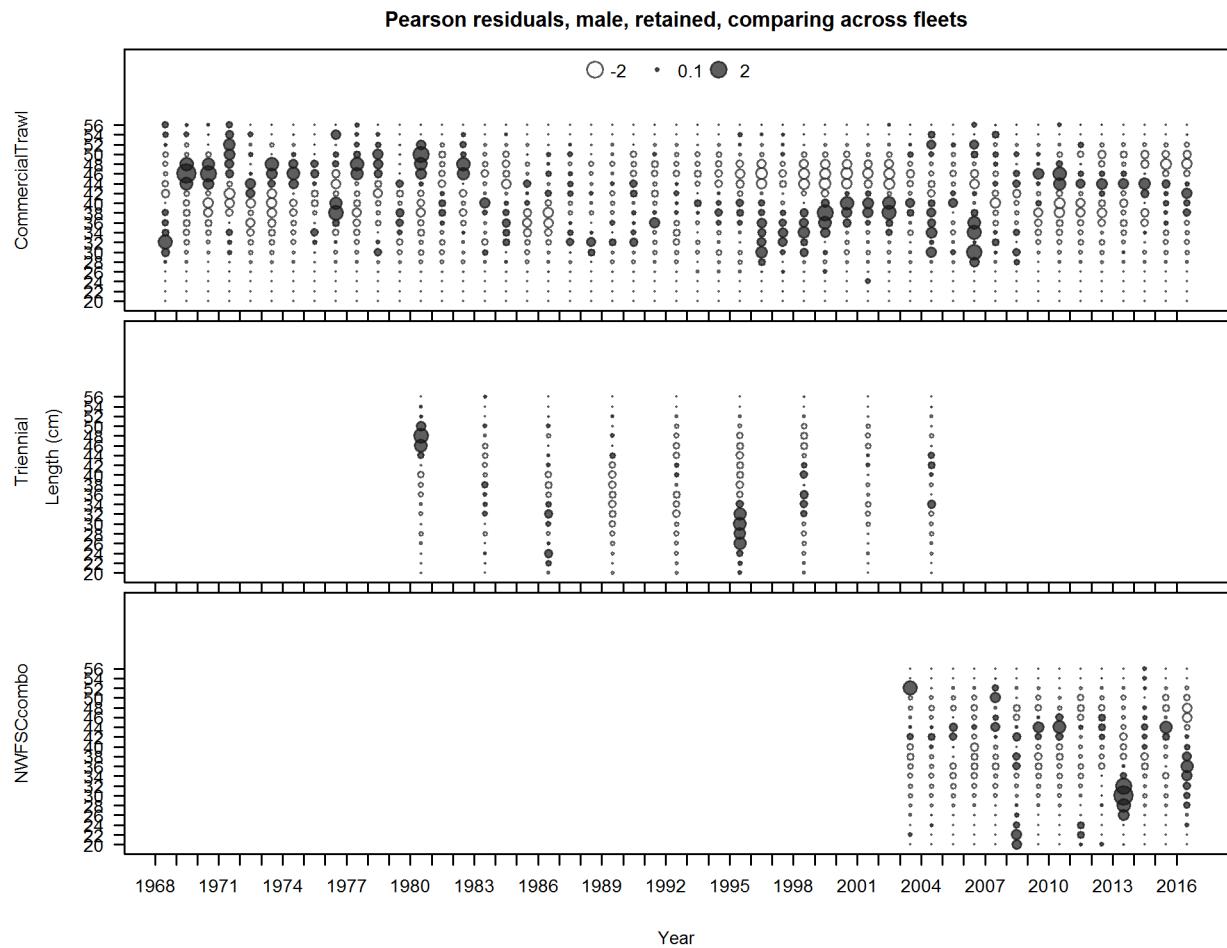


Figure 37: Note: this plot doesn't seem to be working right for some models. Pearson residuals, male, retained, comparing across fleets

Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_36_comp_lenfit_sex3mkt2_multi-fleet_comparison](#)

Pearson residuals, male, discard, comparing across fleets

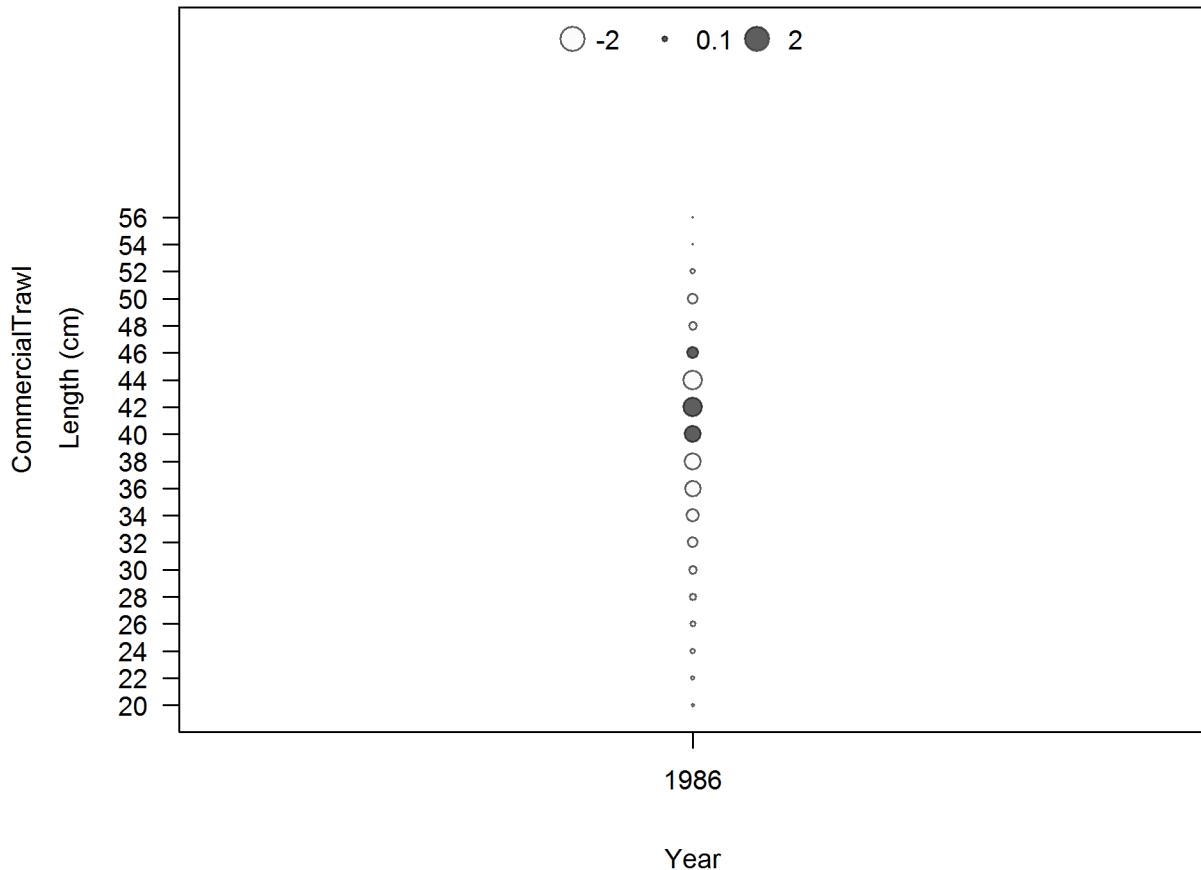


Figure 38: Note: this plot doesn't seem to be working right for some models. Pearson residuals, male, discard, comparing across fleets
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_37_comp_lenfit_sex3mkt1_multi-fleet_comparison](#)

Pearson residuals, male, whole catch, comparing across fleets

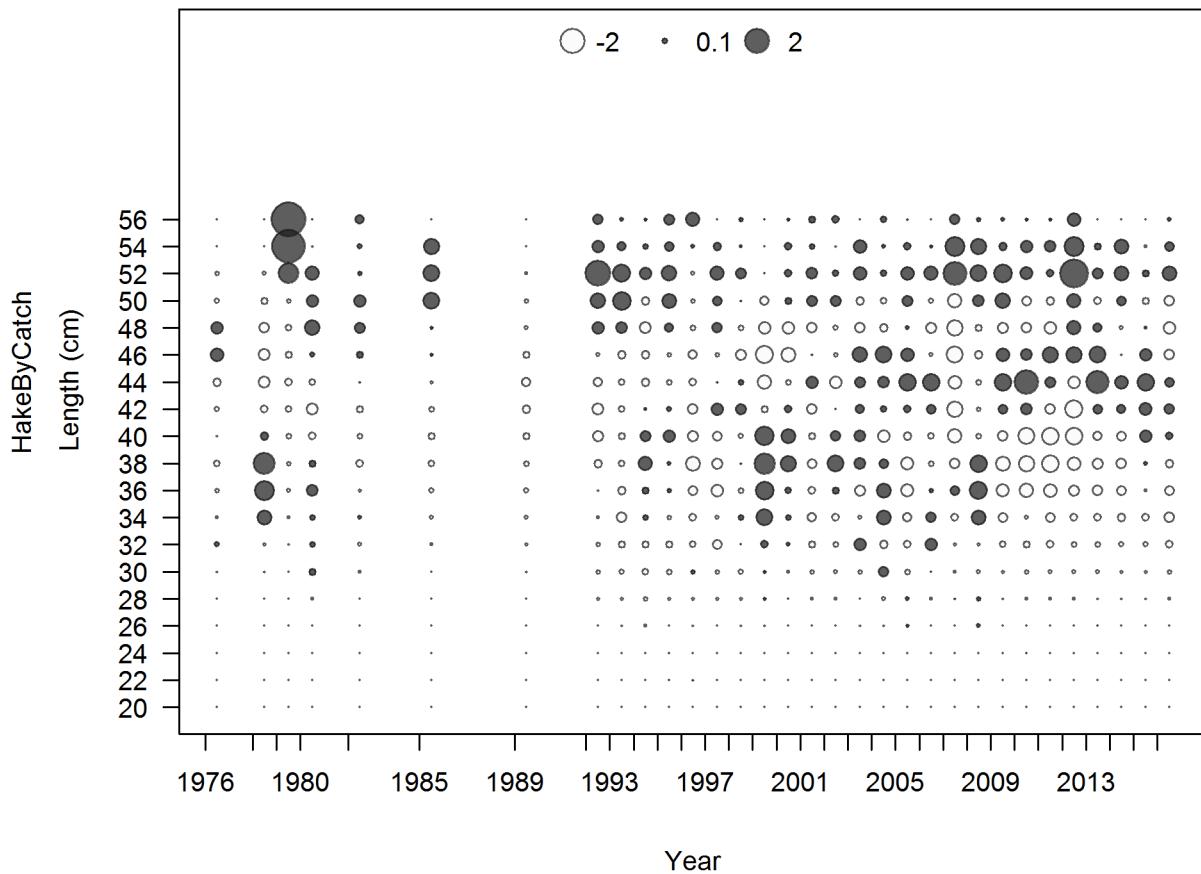


Figure 39: Note: this plot doesn't seem to be working right for some models. Pearson residuals, male, whole catch, comparing across fleets
 Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_38_comp_lenfit_sex3mkt0_multi-fleet_comparison](#)

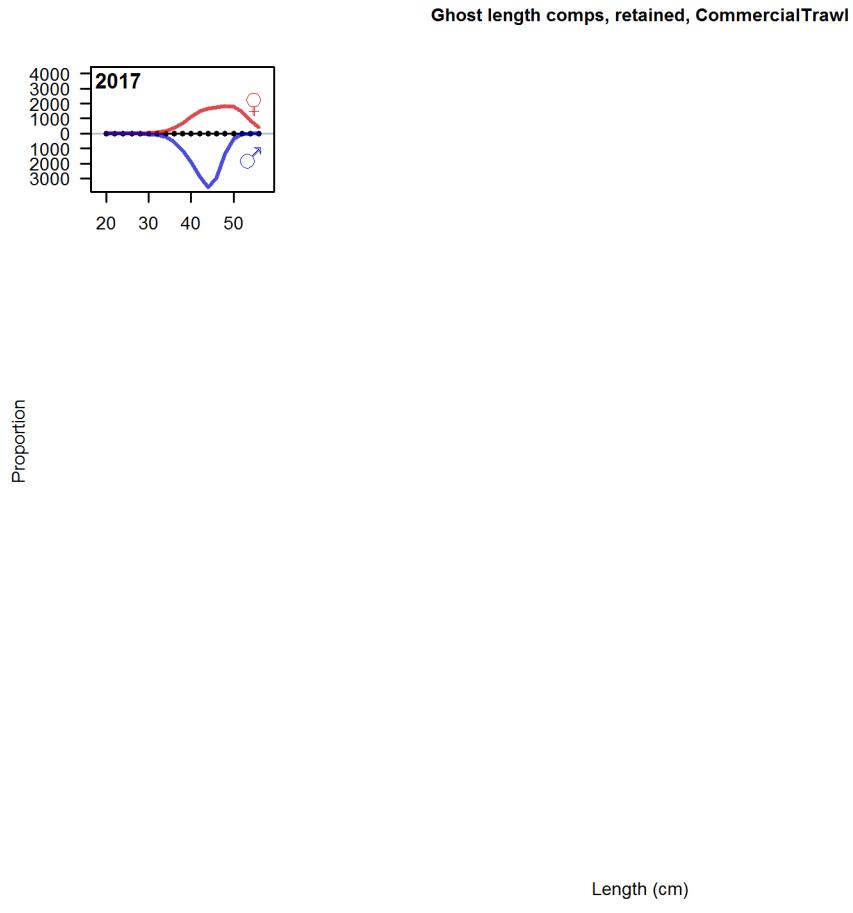


Figure 40: Ghost length comps, retained, CommercialTrawl `fig:mod1_39_comp_gstlenfit`

Figure 41: Pearson residuals, retained, CommercialTrawl (max=NA)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative
residuals (observed < expected). [fig:mod1_40_comp_gstlenfit_residsfltimkt2](#)

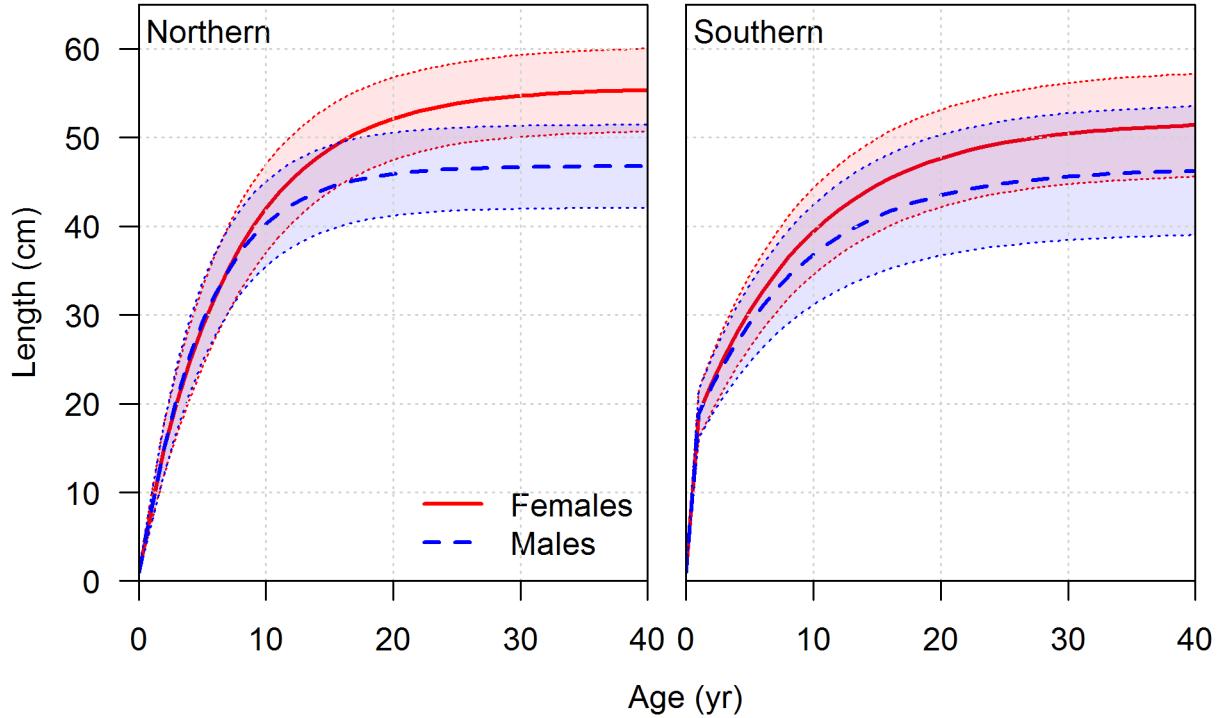


Figure 42: Estimated growth for female and male Yellowtail Rockfish in each model. Shaded areas indicate 95% intervals for distribution of lengths at each age. Values represent beginning-of-year growth. fig:growth

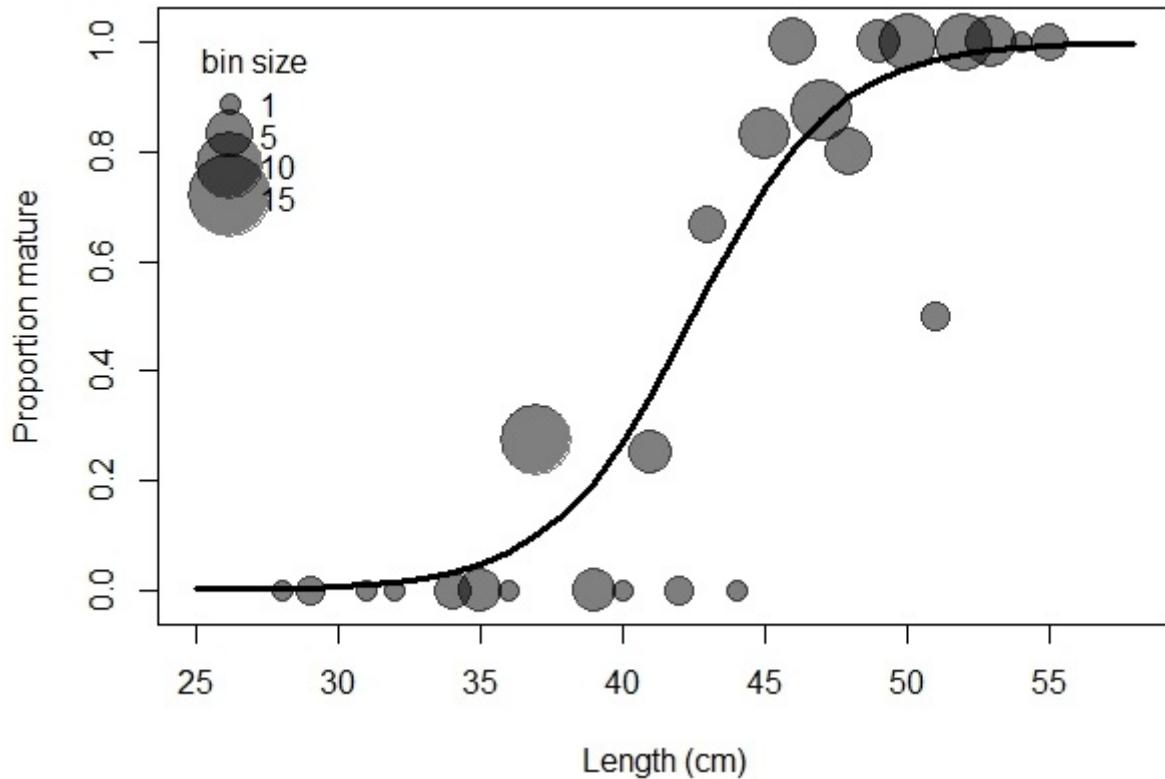


Figure 43: Estimated maturity relationship for Yellowtail Rockfish used in both models. Gray points indicate average observed functional maturity within each length bin with point size proportional to the number of samples.
fig:maturity

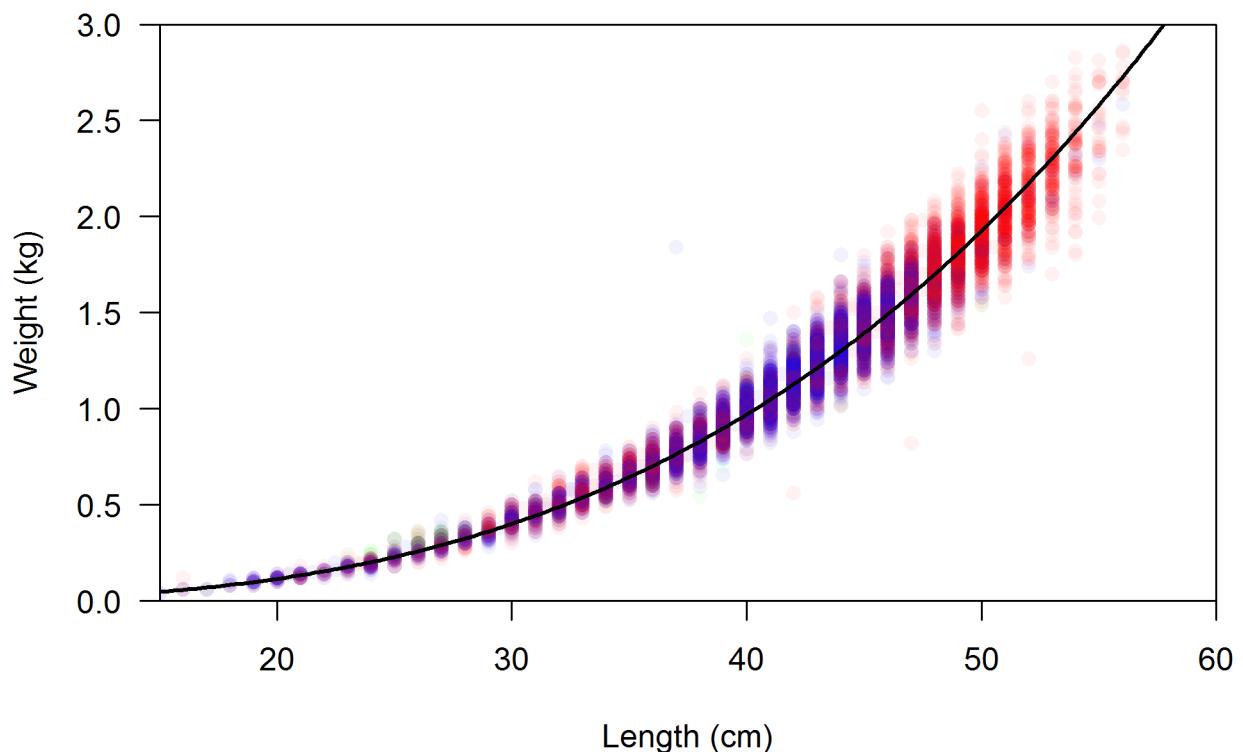


Figure 44: Estimated weight-length relationship for Yellowtail Rockfish used in both models. Colored points show observed values (red for females, blue for males, and green for unsexed). The black line indicates the estimated relationship $W = 0.000011843L^{3.0672}$.
fig:weight-length

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