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

Andi Stephens[1]
Ian G. Taylor[2]

[1]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2032 S.E. OSU Drive Newport, Oregon 97365

[2]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112

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Contents

References

Executive Summary

executive-summary

Stock

stock

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

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

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

Catches

catches

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

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

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

Catch figures: (Figures a-b)
Catch tables: (Tables a-b)

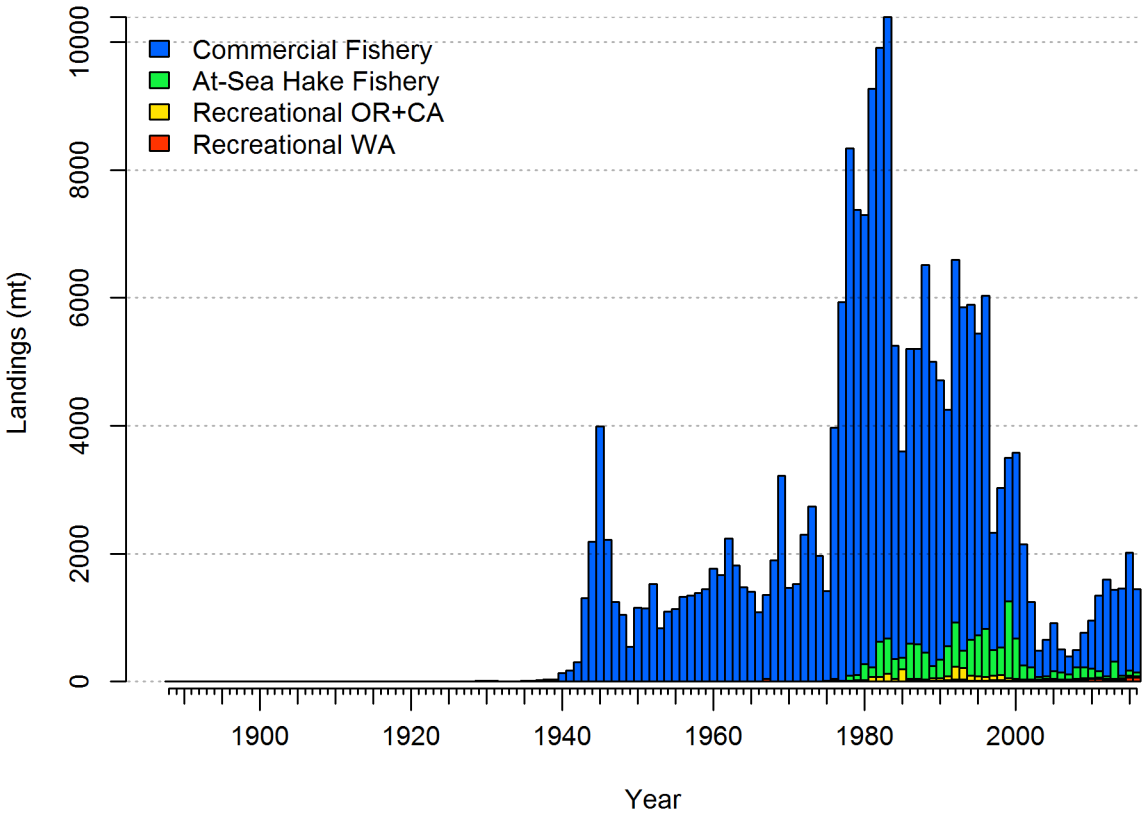

Figure a: Estimated catch history of Yellowtail Rockfish in the Northern model. Recreational catches in Washington are model estimates of total weigth converted from input catch in numbers using model estimates of growth and selectivity. `fig:r4ss_catch_N`

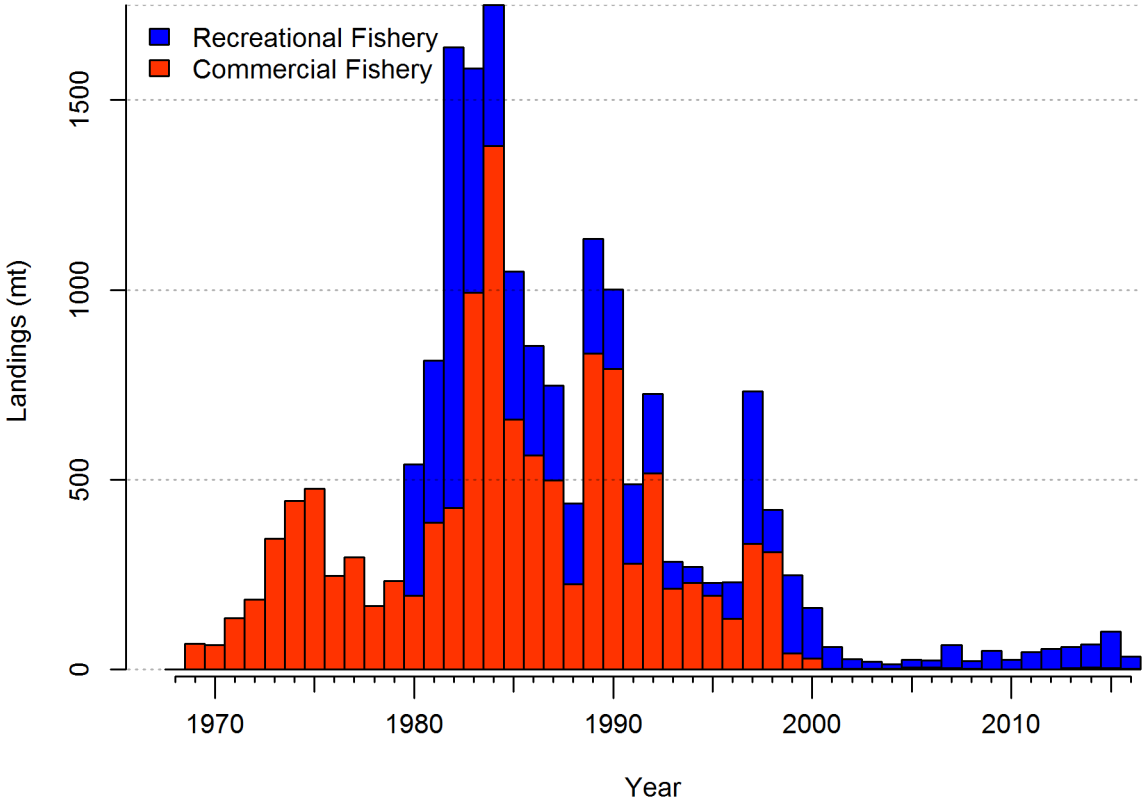

Figure b: Estimated catch history of Yellowtail Rockfish in the Southern model. [fig:r4ss_catch_S

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	-	-

Data and Assessment

data-and-assessment

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

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

Map of assessment region: (Figure 1).

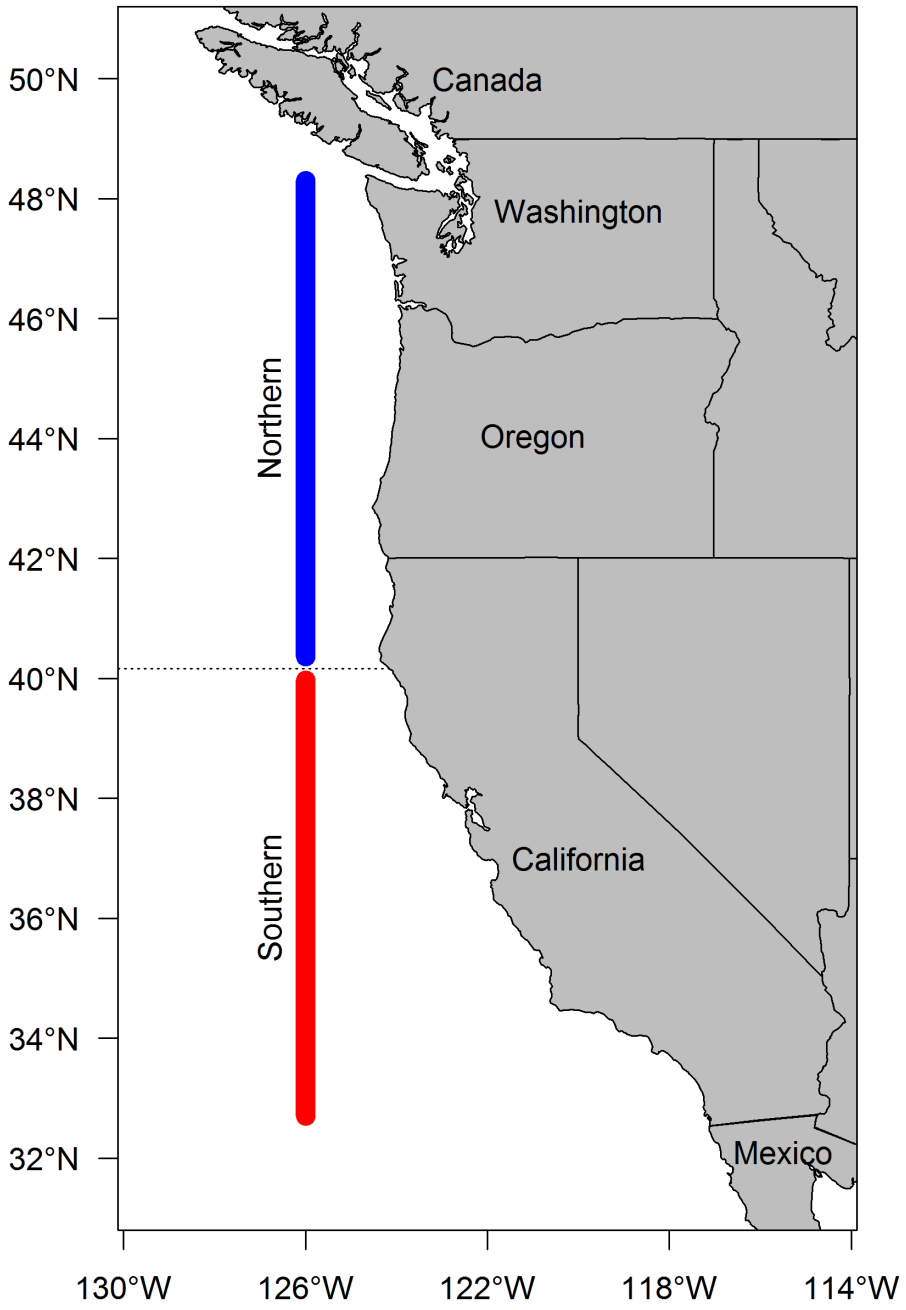

Figure c: Map depicting the boundaries for the base-case model. fig:assess_region_map

Stock Biomass

stock-biomass

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.

Spawning output Figure: Figure d
Spawning output Table(s): Table c
Relative depletion Figure: Figure e

Example text (remove Models 2 and 3 if not needed - if using, remove the # in-line comments!!!)
The estimated relative depletion level (spawning output relative to unfished spawning output) of the the base-case model in 2016 is 53% (˜95% asymptotic interval: ± 41.3%-64.8%) (Figure e).

The estimated relative depletion level of model 2 in 2016 is 92.2% (˜95% asymptotic interval: ± 72.1%-112%) (Figure e).

The estimated relative depletion level of model 3 in 2016 is (˜95% asymptotic interval: ±) (Figure e).

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

tab:SpawningDeplete_mod1

Year	Spawning Output (trillion 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.

tab:SpawningDeplete_mod2

Year	Spawning Output (trillion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2008	1.983	(-0.76-4.72)	0.588	(0.45-0.726)
2009	1.975	(-0.74-4.69)	0.586	(0.453-0.718)
2010	1.989	(-0.73-4.71)	0.590	(0.461-0.719)
2011	2.027	(-0.73-4.78)	0.601	(0.473-0.729)
2012	2.084	(-0.73-4.9)	0.618	(0.489-0.747)
2013	2.177	(-0.75-5.11)	0.646	(0.512-0.779)
2014	2.298	(-0.78-5.38)	0.682	(0.543-0.821)
2015	2.478	(-0.83-5.79)	0.735	(0.584-0.886)
2016	2.743	(-0.91-6.39)	0.814	(0.643-0.984)
2017	3.109	(-1.02-7.23)	0.922	(0.721-1.123)

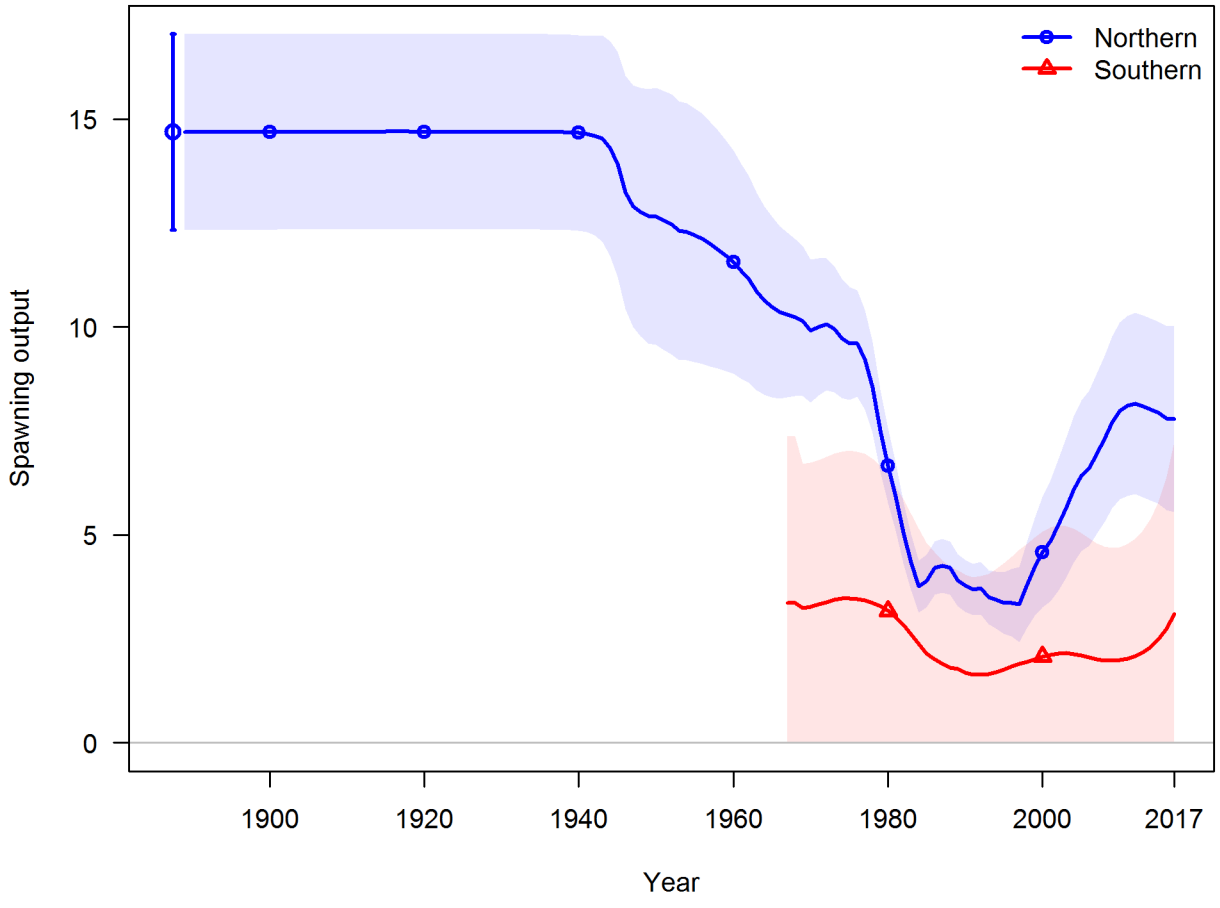

Figure d: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

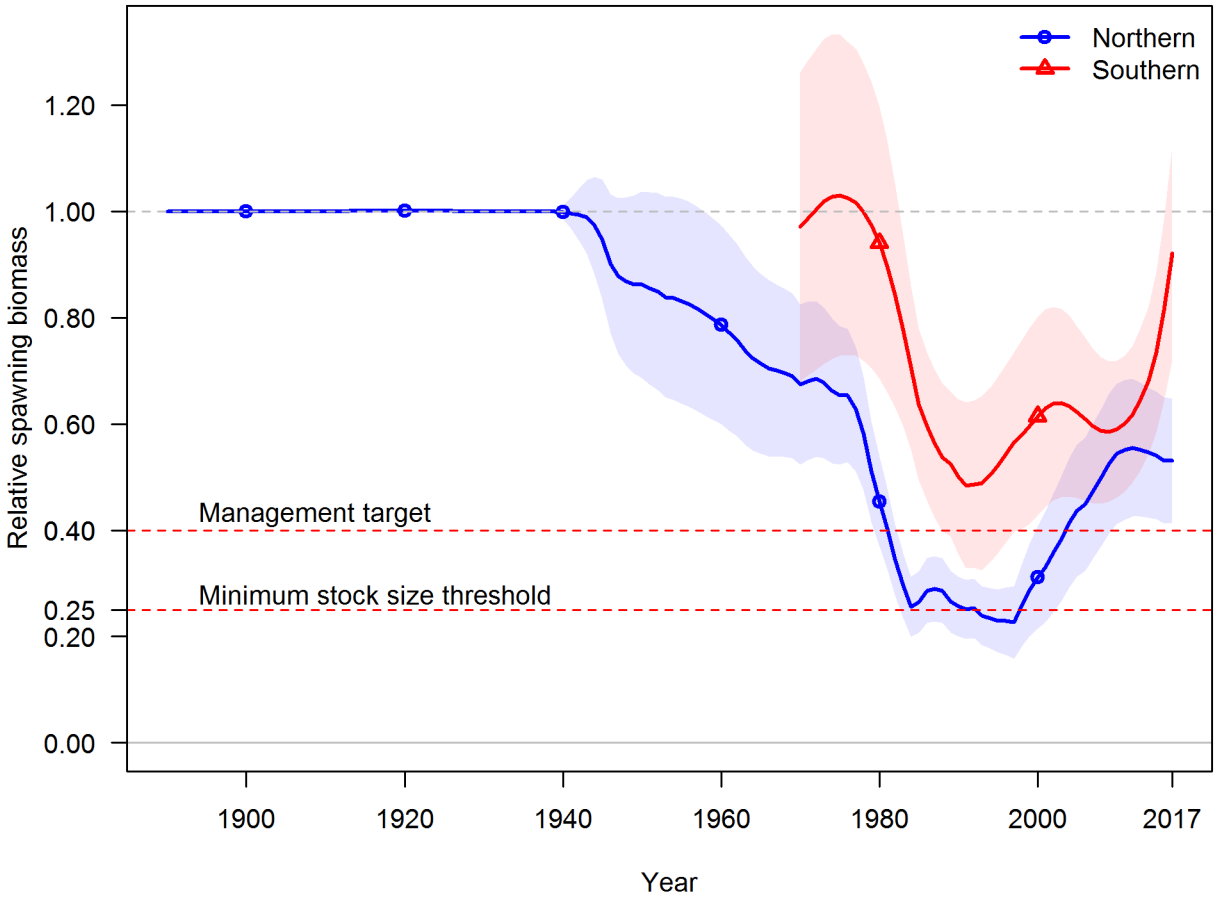

Figure e: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. 「fig:RelDeplete_all

Recruitment

recruitment

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

Recruitment Figure: (Figure f)
Recruitment Tables: (Tables e, f and **??**)

Table e: Recent recruitment for the Northern model.

tab:Recruit_mod1

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.

tab:Recruit_mod2

Year	Estimated Recruitment (millions)	~ 95% confidence interval
2008	123.60	(31.9 - 478.95)
2009	61.44	(9.88 - 382.1)
2010	84.06	(14.63 - 483.13)
2011	68.11	(12.28 - 377.66)
2012	35.52	(6.07 - 207.89)
2013	41.50	(8.35 - 206.26)
2014	32.55	(6.23 - 170.09)
2015	25.26	(4.87 - 131.01)
2016	21.17	(3.94 - 113.89)
2017	21.81	(4.06 - 117.31)

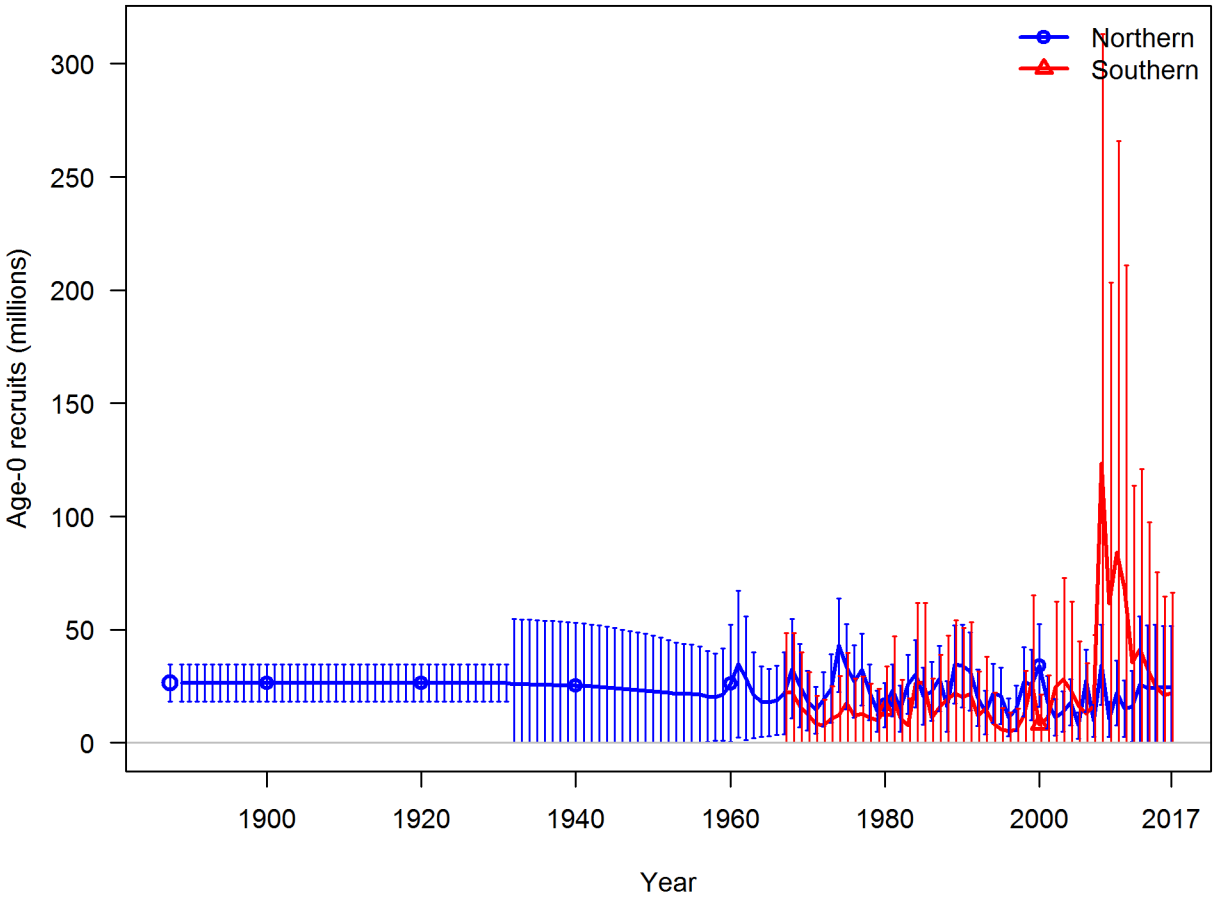

Figure f: Time series of estimated Yellowtail Rockfish recruitments for the base-case model with 95% confidence or credibility intervals. ⌜fig:Recruits_all

Exploitation status

exploitation-status

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

Exploitation Tables: Table g, Table h, Table **??** Exploitation Figure: Figure g).

A summary of Yellowtail Rockfish exploitation histories for base model is provided as Figure 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}.

tab:SPR_Exploit_mod1

Year	Fishing intensity	~ 95% confidence interval	Exploitation rate	~ 95% confidence interval
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}.

tab:SPR_Exploit_mod2

Year	Fishing intensity	~ 95% confidence interval	Exploitation rate	~ 95% confidence interval
2007	0.04	(-0.01-0.1)	0.00	(0-0)
2008	0.02	(0-0.04)	0.00	(0-0)
2009	0.03	(-0.01-0.07)	0.00	(0-0)
2010	0.01	(0-0.03)	0.00	(0-0)
2011	0.02	(-0.01-0.05)	0.00	(0-0)
2012	0.02	(-0.01-0.05)	0.00	(0-0)
2013	0.02	(-0.01-0.05)	0.00	(0-0)
2014	0.02	(-0.01-0.05)	0.00	(0-0)
2015	0.03	(-0.01-0.07)	0.00	(0-0)
2016	0.01	(0-0.02)	0.00	(0-0)

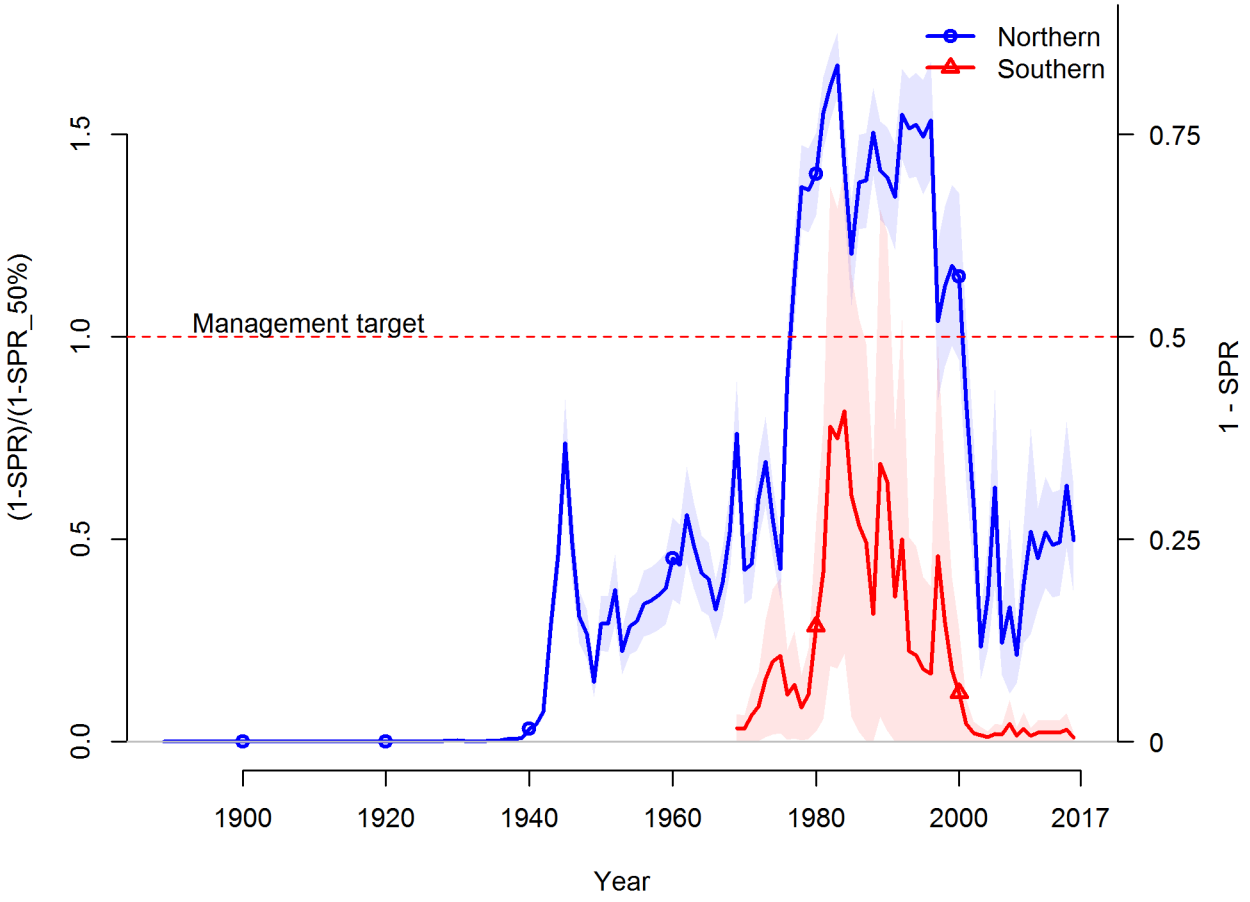

Figure g: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing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

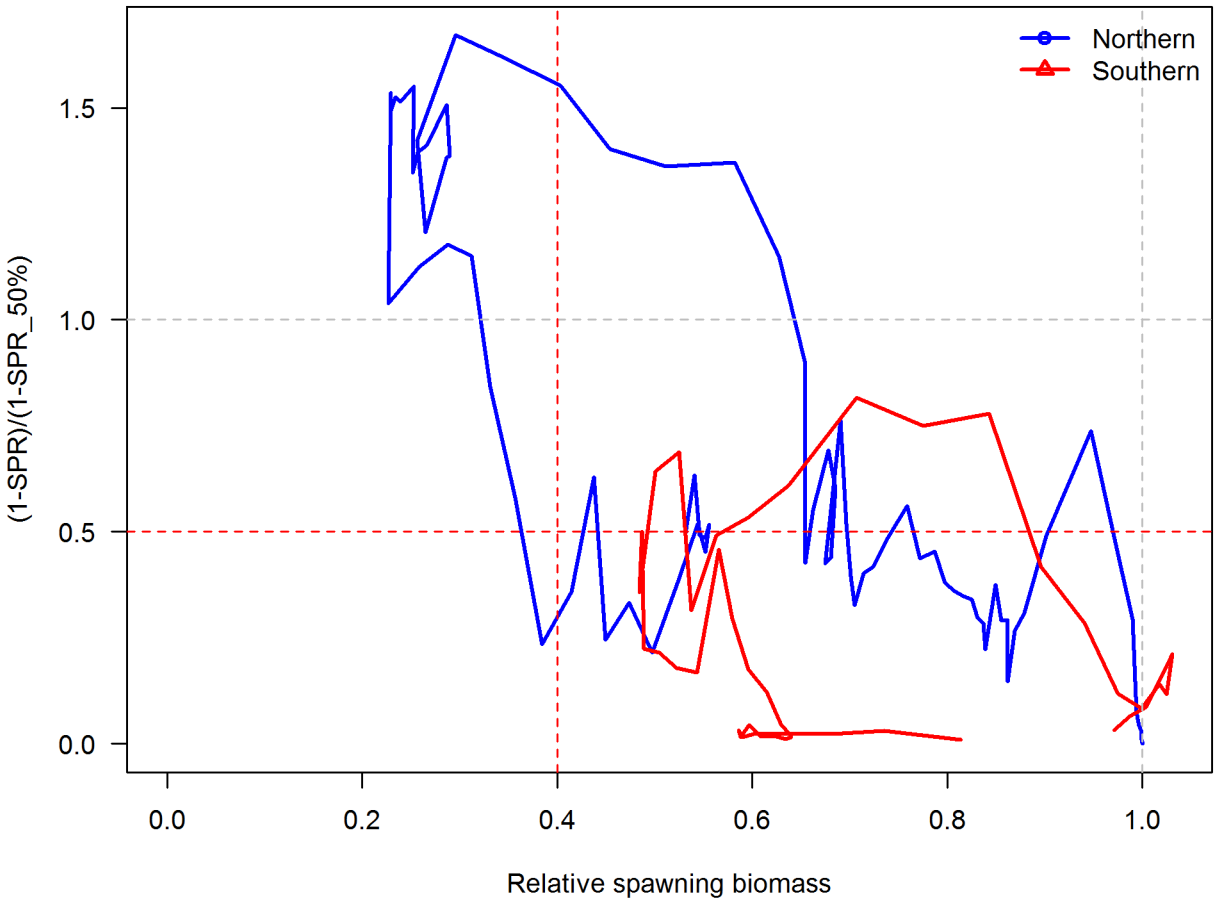

Figure h: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. `fig:Phase_all`

Ecosystem Considerations

ecosystem-considerations

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

Reference Points

reference-points

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

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

This stock assessment estimates that Yellowtail Rockfish in the Northern model are above the biomass target, but above the minimum stock size threshold. Add sentence about spawning output trend. The estimated relative depletion level for Model 1 in 2016 is 53% (˜95% asymptotic interval: ± 41.3%-64.8%, corresponding to an unfished spawning output of 7.79131 trillion eggs (˜95% asymptotic interval: 5.55-10.03 trillion eggs) of spawning output in the base model (Table i). Unfished age 4+ biomass was estimated to be 128999 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 5.9 trillion eggs, which gives a catch of 3910.4 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 3691.6 mt.

This stock assessment estimates that Yellowtail Rockfish in the Southern model are above the biomass target, but above the minimum stock size threshold. Add sentence about spawning output trend. The estimated relative depletion level for Model 2 in 2016 is 92.2% (˜95% asymptotic interval: ± 72.1%-112%), corresponding to an unfished spawning output of 3.10871 trillion eggs (˜95% asymptotic interval:) of spawning output in the base model (Table j). Unfished age 4+ biomass was estimated to be 71633.9 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 1.3 trillion eggs, which gives a catch of mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 1890.2 mt.

This stock assessment estimates that Yellowtail Rockfish in the are

the biomass target, but
the minimum stock size threshold. Add sentence about spawning output trend. The estimated relative depletion level or Model 3 in 2016 is (˜95% asymptotic interval: ±), corresponding to an unfished spawning output of (˜95% asymptotic interval:) of spawning output in the base model (Table **??**). Unfished age 4+ biomass was estimated to be mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is , which gives a catch of mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is mt.

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

tab:Ref_pts_mod1

Quantity	**Estimate**	**95% Confidence Interval**
Unfished spawning output (trillion eggs)	14.7	(12.3-17)
Unfished age 4+ biomass (mt)	128999	(110839.6-147158.4)
Unfished recruitment (R0, thousands)	26398.3	(18222.3-34574.3)
Spawning output(2016 trillion 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.

tab:Ref_pts_mod2

Quantity	**Estimate**	**95% Confidence Interval**
Unfished spawning output (trillion eggs)	3.4	(-0.6265-7.4)
Unfished age 4+ biomass (mt)	71633.9	(-12564.9768-155832.8)
Unfished recruitment (R0, thousands)	22259.8	(-3949.6224-48469.2)
Spawning output(2016 trillion eggs)	2.7	(-0.9069-6.4)
Depletion (2016)	0.8136	(0.643-0.9843)
Reference points based on $SB_{40\%}$		
Proxy spawning output ($B_{40\%}$)	1.3	(-0.2506-2.9)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.4589	(0.4589-0.4589)
Exploitation rate resulting in $B_{40\%}$	0.0576	(0.0559-0.0593)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	1997	(-354.5756-4348.5)
Reference points based on SPR proxy for MSY		
Spawning output	1.5	(-0.2791-3.3)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0508	(0.0493-0.0522)
Yield with SPR_{proxy} at SB_{SPR} (mt)	1890.2	(-335.3679-4115.8)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	0.8199	(-0.1516-1.8)
SPR_{MSY}	0.3175	(0.3141-0.3208)
Exploitation rate at MSY	0.0885	(0.0861-0.0909)
MSY (mt)	2197.8	(-391.3228-4786.9)

Management Performance

management-performance

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

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.

tab:mnmgt_perform

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	-	-	-	-

Unresolved Problems And Major Uncertainties

unresolved-problems-and-major-uncertainties

TBD after STAR panel

Decision Table(s) (groundfish only)

decision-tables-groundfish-only

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

OFL projection table: Table l

Decision table(s) Table m, Table n, Table **??**

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

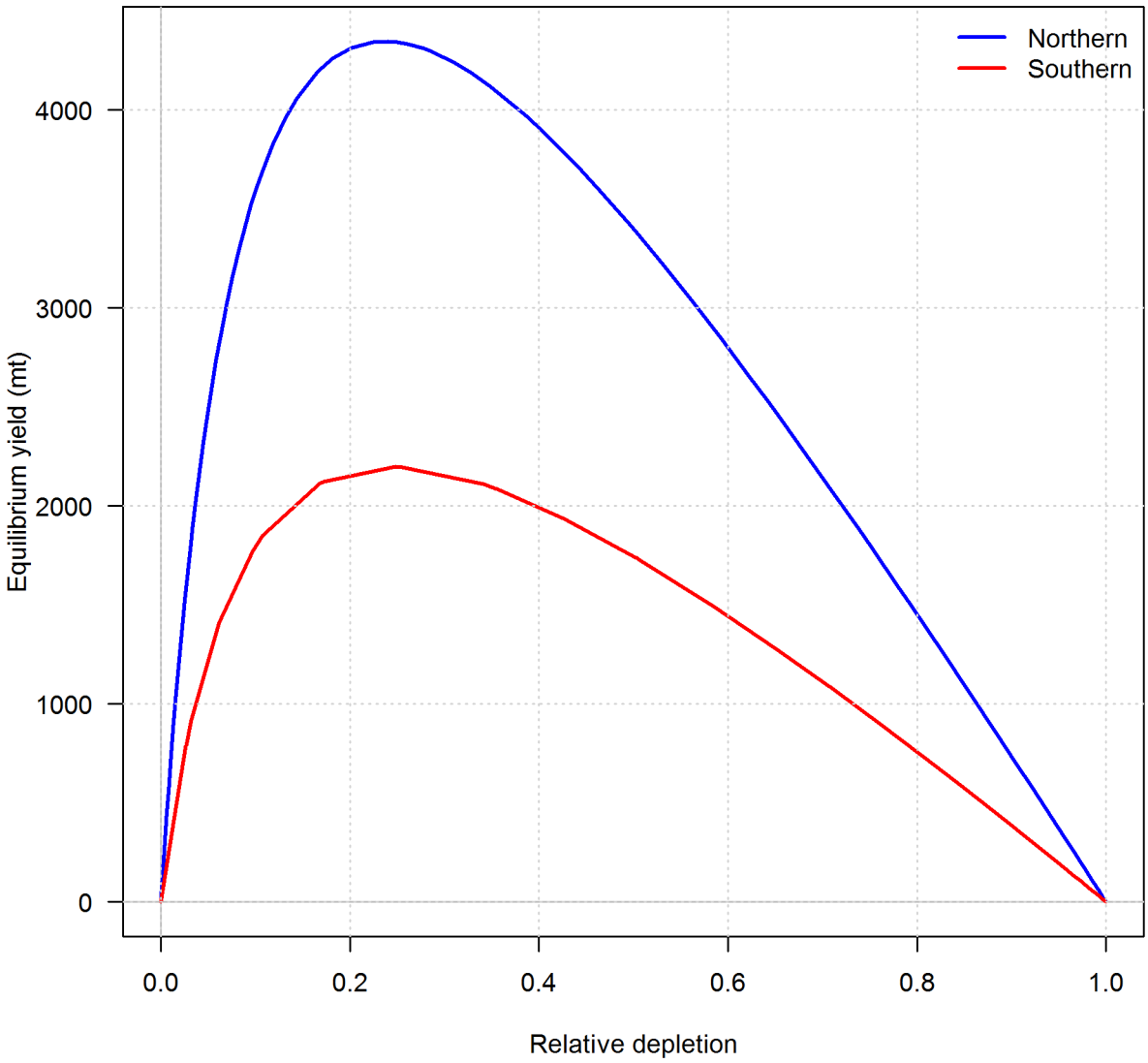

Figure i: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at... `fig:Yield_all`

Table l: 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	5152.74	9141.55
2018	3840.38	5006.04	8846.42
2019	3712.42	4801.18	8513.60
2020	3611.38	4566.83	8178.21
2021	3544.46	4324.17	7868.63
2022	3513.29	4085.35	7598.64
2023	3512.56	3857.50	7370.06
2024	3532.98	3645.03	7178.01
2025	3564.86	3450.44	7015.30
2026	3600.46	3274.82	6875.28
2027	3634.58	3118.20	6752.78
2028	3664.30	2979.81	6644.11

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					
			Low M 0.05		Base M 0.07		High M 0.09	
	Year	Catch	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.

tab:Decision_table_mod2

			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	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 o: Yellowtail Rockfish base case results summary.

tab:base_summary

Model Region	Quantity	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Landings (mt)										
	Total Est. Catch (mt)										
	OFL (mt)										
	ACL (mt)										
Model 1	(1-SPR)(1-$SPR_{50\%}$)	0.21	0.39	0.52	0.45	0.52	0.49	0.49	0.63	0.50	
Base Case	Exploitation rate	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	
	Age 4+ biomass (mt)	76365.3	77111.1	76466.7	77313.9	75707.8	77354.4	76340.3	76683.8	76225.2	75174.0
	Spawning Output	7.3	7.7	8.0	8.1	8.2	8.1	8.0	7.9	7.8	7.8
	95% CI	(5.31-9.3)	(5.65-9.78)	(5.87-10.12)	(5.94-10.27)	(5.98-10.34)	(5.91-10.29)	(5.83-10.21)	(5.75-10.14)	(5.6-10.02)	(5.55-10.03)
	Depletion	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.5
	95% CI	(0.368-0.627)	(0.394-0.656)	(0.412-0.676)	(0.42-0.683)	(0.426-0.685)	(0.425-0.677)	(0.423-0.669)	(0.421-0.661)	(0.413-0.65)	(0.413-0.648)
	Recruits	34.46	10.44	22.11	15.15	15.95	25.87	24.05	24.51	24.35	24.34
	95% CI	(20.8 - 57.08)	(5.04 - 21.65)	(11.8 - 41.43)	(6.89 - 33.31)	(6.29 - 40.42)	(8.87 - 75.43)	(8.24 - 70.21)	(8.62 - 69.71)	(8.57 - 69.16)	(8.57 - 69.13)
Model 2	(1-SPR)(1-$SPR_{50\%}$)	0.02	0.03	0.01	0.02	0.02	0.02	0.02	0.03	0.01	
Base Case	Exploitation rate	0	0	0	0	0	0	0	0	0	
	Age 4+ biomass (mt)	41317.6	43306.9	44211.0	44337.0	44909.1	63175.4	72683.3	85860.8	96433.1	101051.0
	Spawning Output	2	2	2	2	2	2	2	2	3	3
	95% CI	(-0.76-4.72)	(-0.74-4.69)	(-0.73-4.71)	(-0.73-4.78)	(-0.73-4.9)	(-0.75-5.11)	(-0.78-5.38)	(-0.83-5.79)	(-0.91-6.39)	(-1.02-7.23)
	Depletion	0.59	0.59	0.59	0.60	0.62	0.65	0.68	0.74	0.81	0.92
	95% CI	(0.45-0.726)	(0.453-0.718)	(0.461-0.719)	(0.473-0.729)	(0.489-0.747)	(0.512-0.779)	(0.543-0.821)	(0.584-0.886)	(0.643-0.984)	(0.721-1.123)
	Recruits	123.60	61.44	84.06	68.11	35.52	41.50	32.55	25.26	21.17	21.81
	95% CI	(31.9 - 478.95)	(9.88 - 382.1)	(14.63 - 483.13)	(12.28 - 377.66)	(6.07 - 207.89)	(8.35 - 206.26)	(6.23 - 170.09)	(4.87 - 131.01)	(3.94 - 113.89)	(4.06 - 117.31)

Research And Data Needs

research-and-data-needs

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

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

1. List item No. 1 in the list
2. List item No. 2 in the list, etc.

Rebuilding Projections

rebuilding-projections

Include: reference to the principal results from rebuilding analysis if the stock is overfished. This section should be included in the Final/SAFE version assessment document but is not required for draft assessments undergoing review. See Rebuilding Analysis terms of reference for detailed information on rebuilding analysis requirements.

1 Introduction

introduction

1.1 Basic Information

basic-information

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

1.2 Map

map

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

1.3 Life History

life-history

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

1.4 Ecosystem Considerations

ecosystem-considerations-1

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

1.5 Fishery Information

fishery-information

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

Rockfish example: The rockfish fishery off the U.S. Pacific coast first developed off California in the late 19th century as a hook-and-line fishery (Love et al. 2002).
The rockfish trawl fishery was established in the early 1940s, when the United States became involved in World War II and wartime shortage of red meat created an increased demand for other sources of protein (Harry and Morgan 1961, Alverson et al. 1964). Etc. . . .

1.6 Summary of Management History

summary-of-management-history

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

1.7 Management Performance

management-performance-1

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

Management performance table: (Table k)
A summary of these values as well as other base case summary results can be found in Table o.

1.8 Fisheries off Canada, Alaska, and/or Mexico

fisheries-off-canada-alaska-andor-mexico

Include if necessary.

2 Data

data

Data used in the Northern and Southern yellowtail rockfish assessments are summarized in Figures 49 and 49.

Data sources for the two models are largely distinct. Northern fisheries and surveys had very sparse data (if any) for the south and vice-versa. Among the 12 data sources referenced below, only 2 data sources are common to both models. These are the MRFSS/RecFIN recreational dockside survey, which focuses on California and Oregon, and the CalCOM California commercial dataset, which contributed data from the northern-most California counties (Eureka and Del Norte) to the Northern model. The CalCOM data account for less than five percent of the commercial landings in the Northern model, and less than 1% of the biological samples.

Commercial landings are not differentiated in either model. For the Northern model, this is due to the very small portion (1.15 %) of the landings that are attributed to non-trawl gear. For the Southern model, this is due to the paucity of data.

A description of each model's data sources follows.

2.1 Northern Model Data

northern-model-data

Table 1: Summary of the data source in the Northern model.

tab:Data_sources

Source	Landings	Lengths	Ages	Indices	Discard	Type
PacFIN	Y	Y	Y	Y		Commercial
WCGOP		Y			Y	Commercial Discards
Hake Bycatch	Y	Y	Y	Y		Commercial
CalCOM	Y	Y	Y			Commercial
WaSport	Y	Y	Y			Recreational
MRFSS	Y	Y				Recreational
RecFIN	Y	Y				Recreational
Triennial		Y	Y	Y		Survey
NWFSCcombo		Y	Y	Y		Survey
Pikitch		Y			Y	Commercial Study
ODFW	Y					Historical data
WDFW	Y					Historical data

2.1.1 Commercial Fishery Landings

commercial-fishery-landings

Washington and Oregon Landings The bulk of the commercial landings for Washington and Oregon came from the from the Pacific Fisheries Information Network (**PacFIN**) database.

Washington Catch Information
The Washington Department of Fisheries and Wildlife (**WDFW**) provided historical yellowtail catch for 1889–1980. Landings for 1981-2016 came from the PacFIN database. WDFW also provided catches for the period 1981 – 2016 to include the re-distribution of the un-speciated "URCK" landings in PacFIN; this information is currently not available from PacFIN.

Oregon Catch Information
The Oregon Department of Fisheries and Wildlife (**ODFW**) provided historical yellowtail catch from 1892-1985. ODFW also provided estimates of yellowtail rockfish in the in the un-speciated PacFIN "URCK" and "POP1" catch categories for recent years, and those estimates were combined with PacFIN landings for 1986-2016.

Northern California Catch
The California Commercial Fishery Database (**CalCOM**) provided landings for the Northern model for the two counties north of 40.10 (Eureka and Del Norte) for 1969-2016.

Hake Bycatch
The Alaska Fisheries Science Center (**AFSC**) provided data for yellowtail bycatch in the hake fishery from 1976-2016.

2.1.2 Sport Fishery Removals

`sport-fishery-removals`

Washington Sport Catch
WDFW provided recreational catches for 1967 and 1975-2016.

Oregon Sport Catch
ODFW provided recreational catch data for 1979-2016.

MRFSS and RecFIN Data from Northern California came from the Marine Recreational Fisheries Statistical Survey (**MRFSS**) and from the Recreational Fisheries Information Network (**RecFIN**). These are dockside surveys focused on California and Oregon. MRFSS was conducted from 1980-1989 and 1993-2003, RecFIN from 2004 to the present.

2.1.3 Estimated Discards

`estimated-discards`

Commercial Discards
The West Coast Groundfish Observing Program (**WCGOP**) is an onboard observer program that has extensively surveyed fishing practices since 2002, with nearly 100% observer coverage in the trawl sector in recent years. WCGOP provided discard ratios for yellowtail rockfish from 2002 to 2015.

Pikitch Study
The Pikitch study was conducted between 1985 and 1987 (Pikitch et al. 1988). The northern and southern boundaries of the study were 48°42′ N latitude and 42°60′ N. latitude respectively, which is primarily within the Columbia INPFC area (Pikitch et al. 1988 , Rogers and Pikitch 1992).

Participation in the study was voluntary and included vessels using bottom, midwater, and shrimp trawl gears.
Observers of normal fishing operations on commercial vessels collected the data, estimated the total weight of the catch by tow and recorded the weight of species retained and discarded in the sample.

Pikitch study discards were aggregated due to small sample size and included in the data as representing a single year mid-way through the study.

2.1.4 Abundance Indices

`abundance-indices`

Commercial Logbook CPUE
The commercial logbook (fish-ticket) data in PacFIN was used to generate an index for the

years 1987-1998, a period in which management of the fishery was stable, i.e., regulations weren"t changing fishery practices.

The data were modeled with a modified Stephens-MacCall approach (Stephens and MacCall 2004). This approach uses the species composition of the catch to evaluate the per-haul probability of encountering a particular species; in this case, yellowtail rockfish. The intent of the analysis is to eliminate all hauls from the index that could not encounter yellowtail.

Usually, the Stephens-MacCall approach is a simple binomial model for presence-absence of the predictive species and the target, however a generalized linear mixed-effects approach – modeling the species as binomial and adding random effects for the interaction of year and vessel, for haul duration, and for month improved the model fit.

The hauls identified with a reasonable probability of encountering yellowtail were then modeled in a delta-lognormal glm to produce an annual index of abundance, bootstrapped 500 times to evaluate uncertainty.

Hake Bycatch Index

The Hake bycatch data provided by the Alaska Fisheries Science Center (AFSC) was used to generate an index of abundance for 1985-1999.

Data on haul-by-haul catch of Yellowtail Rockfish and Pacific Hake for the period 1976-2016 were obtained from the At-Sea Hake Observer Program along associated information including the location of each tow and the duration. Previous Yellowtail assessments used an index of abundance for the years 1978-1999. The most recent assessment (Wallace and Lai, 2005) stated that the index was not updated to include years beyond 1999 "because subsequent changes in fishery regulations and behavior have altered the statistical properties of these abundance indices". The ending year of 1999 was retained for this analysis. However, the years up to 1984 have relatively few tows with adequate information for CPUE analysis, and fishing effort off the coast of Washington where yellowtail are most commonly encountered (Figure X1). Therefore, for this new analysis, 1985 was chosen as the starting year.

The hake fishery was evolving during the chosen 15 year period (1985-1999), which included a transition from foreign to domestic fleets fishing for Pacific Hake (Figure X2). The index from the at-sea hake fishery used in previous assessments standardized for changes in catchability by using a ratio estimator relating yellowtail catch to hake catch and then scaling by an estimate of fishing effort for hake (Equation 1 in Wallace and Lai, 2005). However, that approach does not take into account differences in the spatial distribution of the at-sea hake fishery relative to the distributions of hake and yellowtail.

For this new analysis, changes in catchability were estimated by comparing an index based on a geostatistical analysis of the hake CPUE from VAST (Thorson et al. YYYY) to the estimated available hake biomass from the most recent stock assessment (Berger et al. 2017). The relative catchability was then used to adjust an independent geostatistical index of yellowtail CPUE (Figure X3). In order to capture the general trend in catchability, reducing

the variability among years, linear, exponential, and locally smoothed (LOWESS) models were fit to the time series of individual estimates of hake index to available biomass (Figure X3b). Of these, the LOWESS model best captured the pattern of fastest change in the middle of the time series. The average rate of increase in the resulting estimated catchability time series is 13% per year.

VAST was then used to conduct a geostatistical standardization of the CPUE of yellowtail caught as bycatch in the at-sea hake fishery. The resulting yellowtail index after adjustment by the estimated changes in catchability is qualitatively more similar to the index used in previous assessments (Figure X4) than the index resulting from assuming constant catchability.

Pikitch Study

The Pikitch data referenced above provided an index for years 1981-91. need information about developing the index.

NWFSCcombo Index

Triennial Index

2.1.5 Fishery-Independent Data

`fishery-independent-data`

Northwest Fisheries Science Center (NWFSC) shelf-slope survey

This survey, referred to as the **NWFSCcombo Survey**, has been conducted annually since 2003.

The survey consistently covers depths between 30 and 700 fm.

Data from this survey for yellowtail rockfish was available for 2003-2016, and provided an index in addition to length and age data.

Alaska Fisheries Science Center (AFSC) Triennial shelf survey

The **Triennial Survey** was conducted by the AFSC every third year between 1977 and 2001, (and was conducted in 2004 by the NWFSC using the same protocols). The Triennial Survey trawled in depths of 30 to 275 fm.

The Triennial Survey provided yellowtail rockfish length and age data, as well as an index of abundance from 1997-2004.

2.1.6 Biological Samples

`biological-samples`

Length And Age Compositions

Length composition data were compiled from PacFIN for Oregon and Washington for the

Northern model and combined with raw (unexpanded) length data from CalCOM for the two California counties north of 40.10 (Eureka and Del Norte counties).

Length compositions were provided from the following sources:

Table 2: Summary of the time series of lengths used in the stock assessment. tab:Length_sources

Source	Type	Lengths	Tows	Years
PacFIN	commercial	186161	3830	1968-2016
CalCOM	commercial	2340		1978-2015
MRFSS	recreational	4125		1980-2003
RecFIN	recreational	432		2004-2016
WASport	recreactional	11099		1975-2015
Triennial	survey	16262	465	1977-2004
NWFSCcombo	survey	940	564	2004-2016

Age structure data were available from the following sources:

Table 3: Summary of the time series of age data used in the stock assessment. tab:Age_sources

Source	Type	Ages	Tows	Years
PacFIN	commercial	138854		1972-2016
CalCOM	commercial	3546		1980-2002
WASport	recreational	4027		1997-2016
Triennial	survey	6553	278	1997-2004
NWFSCcombo	survey	2990	544	2003-2016

2.2 Southern Model Data

southern-model-data

Table 4: Summary of the data source in the Northern model.

tab:Data_sources

Source	Landings	Lengths	Ages	Indices	Discard	Type
CalCOM	Y	Y	Y			Commercial
MRFSS	Y	Y				Recreational
RecFIN	Y	Y				Recreational
HookandLine		Y	Y	Y		Survey
Onboard		Y	Y	Y		Survey
SmallResearch		Y	Y			Study

2.2.1 Commercial Fishery Landings

commercial-fishery-landings-1

California Commercial Landings
The California Commercial Fishery Database (**CalCOM**) provided landings in California south of 40.10 for 1969-2016.

2.2.2 Sport Fishery Removals

sport-fishery-removals-1

MRFSS Estimates and RecFIN
The California Department of Fish and Wildlife (**CDFW**) provided estimated yellowtail removals for the Marine Recreational Fisheries Statistical Survey (**MRFSS**) from 1980-1989, 1993-2003. The Recreational FIsheries Information Network, (**RecFIN**) provided landings for 2004-2016.

Small Research Study A small number of fish were collected from the recreational fishery by the Southwest Fisheries Science Center (**SWFSC**) and are included in the data for 1978-1984.

2.2.3 Estimated Discards

estimated-discards-1

No discard data were available for the Southern model.

2.2.4 Abundance Indices

abundance-indices-1

MRFSS Index
An index of abundance was developed from trip-aggregated MRFSS data for the years 1980-1989, 1992-2003.

California Onboard Survey
An Onboard recreational survey conducted by provided data for an index of abundance provided by the SWFSC for 1987-2016.

2.2.5 Fishery-Independent Data

fishery-independent-data-1

Hook and Line Survey
The NWFSC Hook and Line survey provided data for an index in the Southern California Bight from 2004-2016.

2.2.6 Biological Samples

biological-samples-1

Length composition samples were available for the Southern model from 5 sources, and ages from 3.

Length compositions were provided from the following sources:

Table 5: Summary of the time series of lengths used in the stock assessment.

tab:Length_sources

Source	Type	Lengths	Tows	Years
CalCOM	commercial	16160	1543	1978-2015
MRFSS	recreational	39425		1980-2003
RecFIN	recreational	49136		2004-2016
Onboard	recreational	76740		1987-2016
Small Study	recreational	909		1978-1984
Hook and Line	survey	1339	174	2004-2016

Age structure data were available from the following sources:

Table 6: Summary of the time series of age data used in the stock assessment.

tab:Age_sources

Source	Type	Ages	Years
CalCOM	commercial	7875	1980-2004
Small Study	recreational	400	1978-1984
Hook and Line	survey	248	2004

2.3 Biological Parameters Common to Both Models

biological-parameters-common-to-both-models

Aging Precision And Bias

Age error matrices were developed for double-reads at the PFMC aging lab in Newport, OR and for double reads within the WDFW aging lab. The Newport lab has done all of the Survey aging for the NWFSC, along with some commercial ages and the 400 fish from the Small Study. WDFW provided the bulk of recreational and commercial ages. Between-lab differences in aging were minute, as were within-lab differences.

Weight-Length

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

To estimate this relationship, 12,778 samples with both weight and length measurements from the fishery independent surveys were analyzed. These included 6,354 samples from the NWFSC Combo survey, 5,085 from the Triennial survey, and 1,339 from the Hook and Line survey. All Hook and Line survey samples were from the Southern area, along with 910 samples from the other two surveys (Figure 3). A single weight-length relationship was chosen for females and males in both areas after examining various factors that may influence this relationships, including sex, area, year, and season. None of these factors had a strong influence in the overall results. Season was one of the bigger factors, with fish sampled later in the year showing a small increase in weight at a given length (2-6% depending on the other factors considered). However, season was confounded with area because most of the samples from the Southern area were collected from the Hook and Line survey which takes place later in the year (mid-September to mid-November) and the resolution of other data in the model do not support modeling the stock at a scale finer than a annual time step. Males and females did not show strong differences in either area, and the estimated differences were in opposite directions for the two areas, suggesting that this might be a spurious relationship or confounded with differences timing of the sampling relative to spawning.

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

Maturity And Fecundity Maturity was estimated from histological analysis of

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

Natural Mortality

Natural mortality estimates used as priors for the Northern model and as fixed values for the Southern model were provided by Owen Hamel (pers. comm.).

Sex ratios

The largest fish seen in the data are females, however the oldest are males. The sex ratio falls off differently in each model, as can be seen in Figs(x,y).

2.3.1 Environmental Or Ecosystem Data Included In The Assessment

environmental-or-ecosystem-data-included-in-the-assessment

No environmental index is present in either model.

3 Assessment

assessment

3.1 History Of Modeling Approaches Used For This Stock

history-of-modeling-approaches-used-for-this-stock

Yellowtail rockfish was previously modeled as a 3-area stock north of 40.10 using ADMB in 1999 Need citation, with an update assessment in 2004(Wallace and Lai 2005). That assessment divided the stock into 3 INPFC areas which are not coincident with state boundaries; this is a concern in that recent reconstructions of historical catch are state-by-state along the West Coast. Because we cannot produce data that conform to the areas previously assessed, we have made no effort to reproduce the previous model.

3.1.1 Previous Assessment Recommendations

previous-assessment-recommendations

Many of the recommendations of the previous STAR panel are not relevant to this assessment, as they related to data deficiencies at that time that have since been resolved. The 2004 STAR particularly recommended a focus on abundance indices, which they noted might require further survey information.

This assessment provides three indices for the Northern model, and two for the Southern model.

3.2 Model Description

model-description

3.2.1 Transition To The Current Stock Assessment

transition-to-the-current-stock-assessment

These are the main changes from the previous model, and our rationale for them:

1. Transition to Stock Synthesis. *Rationale*: The Pacific Fishery Management Council's preferred modeling platform for stock assessments is Stock Synthesis (Methot 2015), developed since the last full assessment of yellowtail rockfish.

2. Addition of Southern model. *Rationale*: Hess, et al. determined that the West Coast yellowtail stocks show a genetic cline occurring near Cape Mendocino, which is roughly 40.10 north latitude (Hess et al. n.d.). This divides the stock into two genetically distinct substocks which we model independently.

3. Availability of recent data. *Rationale*: Ten years of data collection have occurred since the last update assessment, and the data necessary for an assessment of the Southern stock is now available.

4. Historical catch reconstructions. *Rationale*: Reconstruction of catch timeseries in California, Washington and Oregon clarify stock history as far back as 1898.

3.2.2 Definition of Fleets and Areas

definition-of-fleets-and-areas

Northern Model

Commercial: The commercial fleet consists primarily of bottom and midwater trawl. No attempt was made to analyze the fishery separately by gear, particularly since it seems that in the fishery in the 1980s and 1990s, "bottom trawl"" gear was used in the midwater as well as on the bottom, and "midwater gear"" was sometimes dragged across soft bottoms (Craig Goode, ODFW Port Sampler, pers. comm).

Recreational: The recreational fleet includes data from sport fisheries off Washington, Oregon, and northern California (Eureka and Del Norte counties)

Research: Research derived-data include observations from the West Coast Groundfish Observing Program (WCGOP) which documents discarding in the commercial fishery, the Alaska Fisheries Science Center's Triennial Trawl survey, and the Northwest Fisheries Science Center's NWFSCcombo survey.

Southern Model

Commercial: The commercial fleet consists primarily of hook and line and trawl gear. Hook and line gear account for 78% of the landings by weight in the recent period (1978-2016).

Recreational: The recreational fleet includes data from sport fishery off the California coast south of Cape Mendocino.

Research: Research derived-data include observations from the Northwest Fisheries Science Center's NWFSCcombo survey, and California Onboard recreational survey.

3.2.3 Modeling Software

modeling-software

The STAT team used Stock Synthesis 3 version 3.3 (Methot 2015).

3.2.4 Data Weighting

data-weighting

Commercial and survey length composition and marginal age composition data are weighted according to the method of Ian Stewart (pers.comm):

Sample Size = 0.138 * Nfish + Ntows if Nfish/Ntows < 44, and Ntows * 7.06 otherwise.

Age-at-Length samples are unwieghted; that is, each fish is assumed to represent an independent sample.

Recreational trips (the analogue of tows in the commercial fishery) are difficult to define in most cases. Since much of the recreational data are from the dockside interview MRFSS program, which didn't anticipate the need to delineate samples as belonging to particular trips, we chose to use all recreational data "as-is", with the initial weights entered as number of fish.

Stock Synthesis performs internal re-weighting within fleets to adjust for between-year differences in sample size. Weighting among fleets uses either the Francis method (Francis 2011) or the Ianelli-McAllister harmonic mean method (McAllister and Ianelli 1997). The Francis method was used for all fleets, except for the age data from the Southern model's Hook and Line survey, which is a single year of data to which we applied the Ianelli-McAllister method.

3.2.5 Priors

priors

Natural Mortality (M) priors were provide by Owen Hamel prior on natural mortality (Hamel 2015). We used the Hamel prior as a fixed value in the Southern model, however the Northern model was able to estimate M. In both models, male M was estimated as an offset from female M. The Southern female M is 0.18; the Northern female M prior is 0.12.

The prior for steepness (h, 0.718) was provided by James Thorson and used as a fixed parameter in both models. <TOADS: Citation>

3.2.6 General Model Specifications

general-model-specifications

Citation for posterior predictive fecundity relationship from Dick (2009)
Model data, control, starter, and forecast files can be found at https://DEVORE .

3.2.7 Estimated And Fixed Parameters

estimated-and-fixed-parameters

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

3.3 Model Selection and Evaluation

model-selection-and-evaluation

3.3.1 Key Assumptions and Structural Choices

key-assumptions-and-structural-choices

Selectivity in both models is asymptotic, with the exception of the OR-CA MRFSS recreational fleet in the Northern model, and the Onboard recreational fleet in the Southern model.

3.3.2 Alternate Models Considered

alternate-models-considered

Time-blocked selectivity and retention were investigated in the Northern model, as were domed selectivities.

We also explored time-blocks on selectivity in the Southern model, and domed selectivity for the MRFSS/RecFIN data.

These approaches resulted in model fits to data that were obviously poor, and so they were rejected

3.3.3 Convergence

convergence

Boilerplate, revisit:

Convergence testing through use of dispersed starting values often requires extreme values to actually explore new areas of the multivariate likelihood surface. Jitter is a Stock Synthesis option that generates random starting values from a normal distribution logistically transformed into each parameter's range (Methot 2015). Table 9 shows the results of running 100 jitters for each pre-STAR base model. . . .

3.4 Response To The Current STAR Panel Requests

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

Request No. 1: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 2: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 3: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

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

- **Item No. 1**
- **Item No. 2**
- **Item No. 3, etc.**

Rationale: Add after STAR panel.

STAT Response: Continue requests as needed.

3.5 Model 1

`model-1`

3.5.1 Model 1 Base Case Results

`model-1-base-case-results`

Table **??**

3.5.2 Model 1 Uncertainty and Sensitivity Analyses

`model-1-uncertainty-and-sensitivity-analyses`

Table 10

3.5.3 Model 1 Retrospective Analysis

model-1-retrospective-analysis

3.5.4 Model 1 Likelihood Profiles

model-1-likelihood-profiles

3.5.5 Model 1 Harvest Control Rules (CPS only)

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

3.5.6 Model 1 Reference Points (groundfish only)

model-1-reference-points-groundfish-only

Intro sentence or two. . . .(Table 11).

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

3.6 Model 2

model-2

3.6.1 Model 2 Base Case Results

model-2-base-case-results

3.6.2 Model 2 Uncertainty and Sensitivity Analyses

model-2-uncertainty-and-sensitivity-analyses

3.6.3 Model 2 Retrospective Analysis

model-2-retrospective-analysis

3.6.4 Model 2 Likelihood Profiles

model-2-likelihood-profiles

3.6.5 Model 2 Harvest Control Rules (CPS only)

model-2-harvest-control-rules-cps-only

3.6.6 Model 2 Reference Points (groundfish only)

model-2-reference-points-groundfish-only

4 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

Table k

Model 1 Projections and Decision Table (groundfish only) (Table 12

Table m

Model 2 Projections and Decision Table (groundfish only)

Model 3 Projections and Decision Table (groundfish only)

5 Regional Management Considerations

`regional-management-considerations`

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

6 Research Needs

`research-needs`

1. Research need No. 1
2. Research need No. 2
3. Research need No. 3
4. etc.

7 Acknowledgments

`acknowledgments`

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

8 Tables

tables

Table 7: 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)	OK	0.009	None
2	L_at_Amin_Fem_GP_1	14.879	3	(1, 25)	OK	0.575	None
3	L_at_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
8	Wtlen_2_Fem	3.067	-50	(2, 4)			None
9	Mat50%_Fem	42.490	-50	(30, 56)			None
10	Mat_slope_Fem	-0.401	-50	(-2, 1)			None
11	Eggs_scalar_Fem	0.000	-50	(0, 6)			None
12	Eggs_exp_len_Fem	4.590	-50	(2, 7)			None
13	NatM_p_1_Mal_GP_1	-0.142	2	(-3, 3)	OK	0.017	None
14	L_at_Amin_Mal_GP_1	0.000	-2	(-1, 1)			None
15	L_at_Amax_Mal_GP_1	-0.148	2	(-1, 1)	OK	0.005	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)			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
20	Wtlen_2_Mal	3.067	-50	(2, 4)			None
24	CohortGrowDev	1.000	-50	(0, 2)			None
25	FracFemale_GP_1	0.500	-99	(0.001, 0.999)			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
28	SR_sigmaR	0.546	-6	(0.5, 1.2)			None
29	SR_regime	0.000	-50	(-5, 5)			None

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Table 7: 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_NWFSCcombo(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 7: 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)			None
169	SizeSel_P3_RecWA(4)	-1.407	6	(-5, 20)	OK	2.463	None
170	SizeSel_P4_RecWA(4)	70.000	-4	(-5, 70)			None
171	SizeSel_P5_RecWA(4)	-999.000	-99	(-999, 25)			None
172	SizeSel_P6_RecWA(4)	-999.000	-99	(-999, 25)			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)			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)			None
177	SizeSel_P5_Triennial(5)	-999.000	-99	(-999, 25)			None
178	SizeSel_P6_Triennial(5)	-999.000	-99	(-999, 25)			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)			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)			None
183	SizeSel_P5_NWFSCcombo(6)	-999.000	-99	(-999, 25)			None
184	SizeSel_P6_NWFSCcombo(6)	-999.000	-99	(-999, 25)			None
185	Retain_P3_CommercialTrawl(1)_BLK1repl_2002	2.228	6	(-10, 20)	OK	0.457	None
186	Retain_P3_CommercialTrawl(1)_BLK1repl_2003	3.708	6	(-10, 20)	OK	0.756	None
187	Retain_P3_CommercialTrawl(1)_BLK1repl_2004	1.128	6	(-10, 20)	OK	0.522	None
188	Retain_P3_CommercialTrawl(1)_BLK1repl_2005	-0.115	6	(-10, 20)	OK	0.400	None
189	Retain_P3_CommercialTrawl(1)_BLK1repl_2006	1.760	6	(-10, 20)	OK	0.260	None
190	Retain_P3_CommercialTrawl(1)_BLK1repl_2007	-0.516	6	(-10, 20)	OK	0.625	None
191	Retain_P3_CommercialTrawl(1)_BLK1repl_2008	2.373	6	(-10, 20)	OK	0.820	None
192	Retain_P3_CommercialTrawl(1)_BLK1repl_2009	0.480	6	(-10, 20)	OK	0.495	None

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Table 7: 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)_BLK1repl_2010	0.159	6	(-10, 20)	OK	0.678	None
194	Retain_P3_CommercialTrawl(1)_BLK1repl_2011	7.327	6	(-10, 20)	OK	0.670	None

tab:model_params

Table 8: Summary of the biomass/abundance time series used in the stock assessment.

tab:Index_summary

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 9: Results from 100 jitters from each of the three models.

tab:jitter

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

Table 11: 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 exploitation 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 11: 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 exploitation 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 11: 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 exploitation 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 11: 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 exploitation 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 10: Sensitivity of the base model to dropping or down-weighting data sources and alternative assumptions about growth.

tab:Sensitivity_model1

Label	Base (Francis weights)	Harmonic mean 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_Unfished_thousand_mt	-	-	-	-	-	-	-	-
TotBio_Unfished	-	-	-	-	-	-	-	-
SmryBio_Unfished	-	-	-	-	-	-	-	-
Recr_Unfished_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 12: Projection of potential OFL, spawning biomass, and depletion for the base case model.

tab:Forecast_mod1

Yr	OFL contriubtion (mt)	ACL landings (mt)	Age 5+ biomass (mt)	Spawning Biomass (mt)	Depletion
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

9 Figures

figures

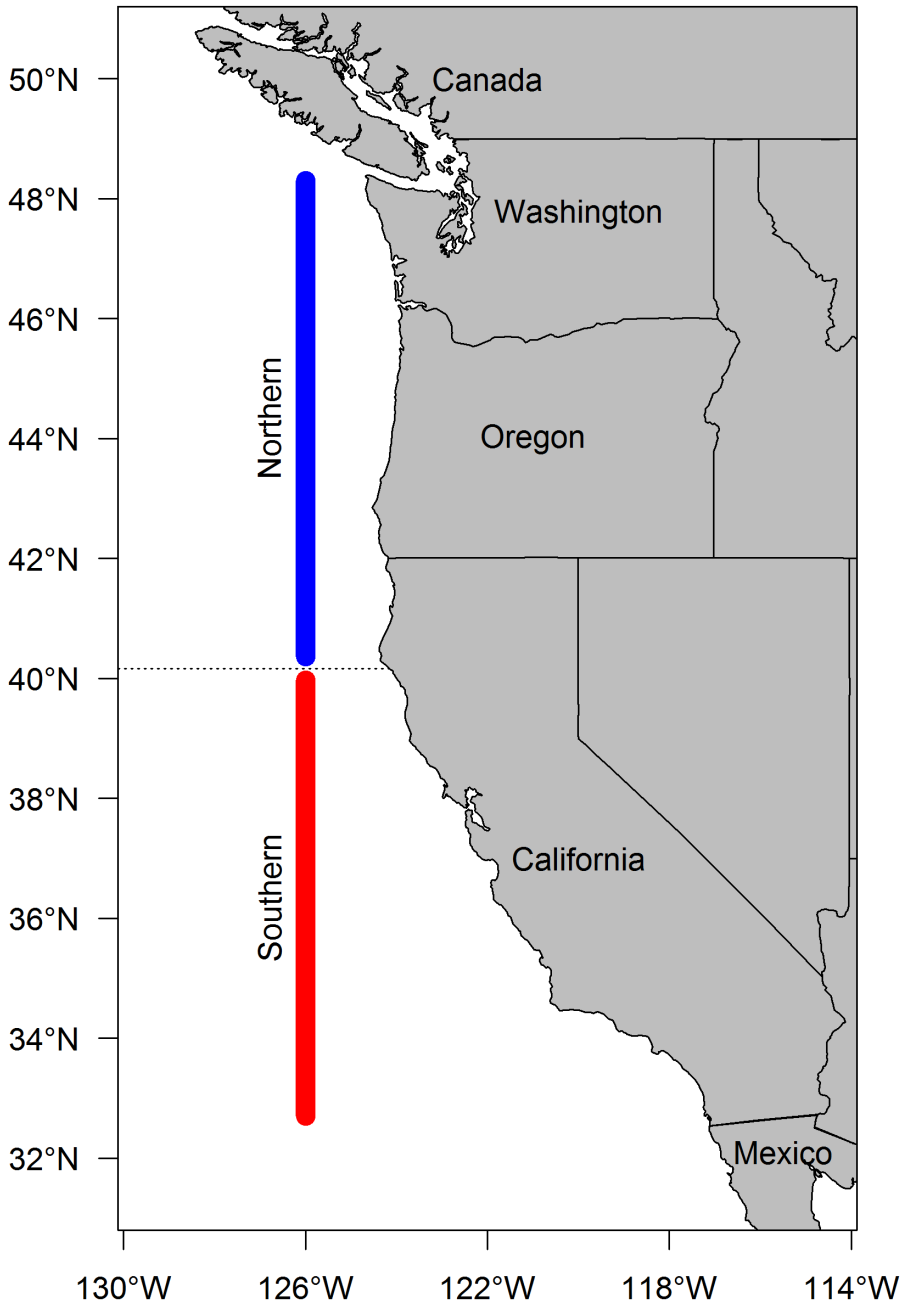


Figure 1: Map depicting the boundaries for the base-case model. fig:assess_region_map

9.1 Life history (maturity, fecundity, and growth) for both models

life-history-maturity-fecundity-and-growth-for-both-models

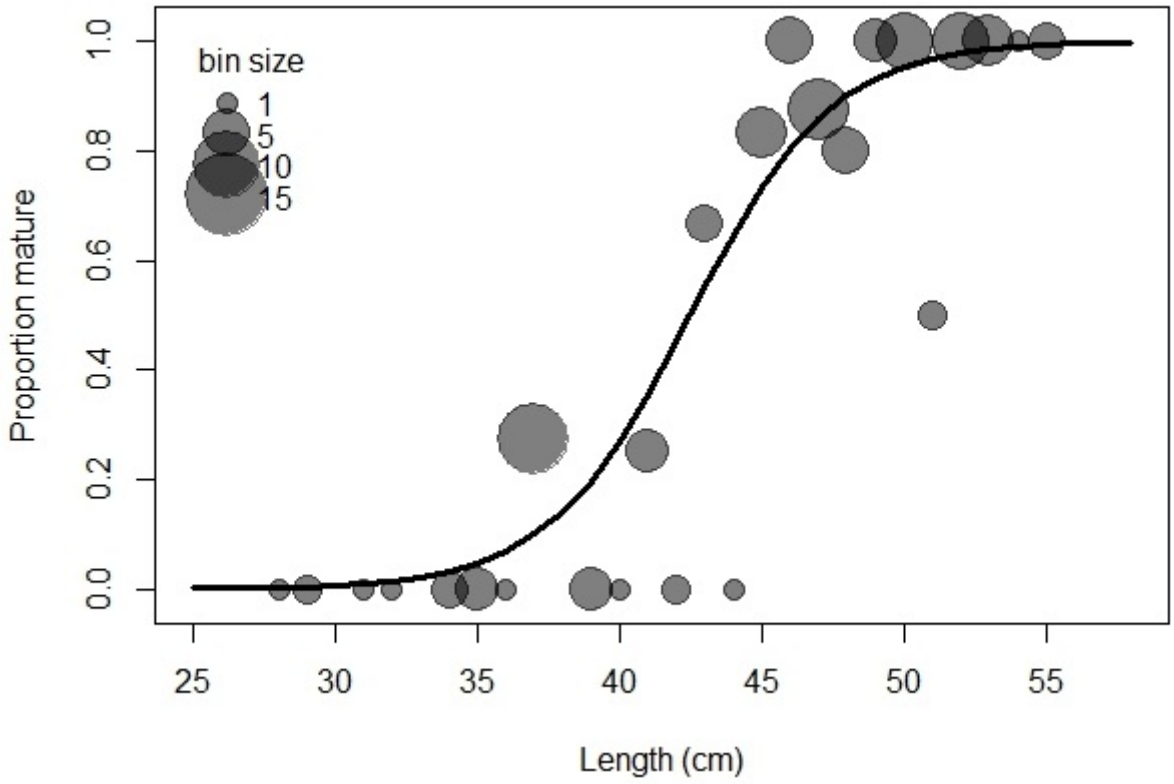


Figure 2: Estimated maturity relationship for Yellowtail Rockfish used in both models. Gray points indicate average observed functional maturity within each length bin with point size proportional to the number of samples.

fig:maturity

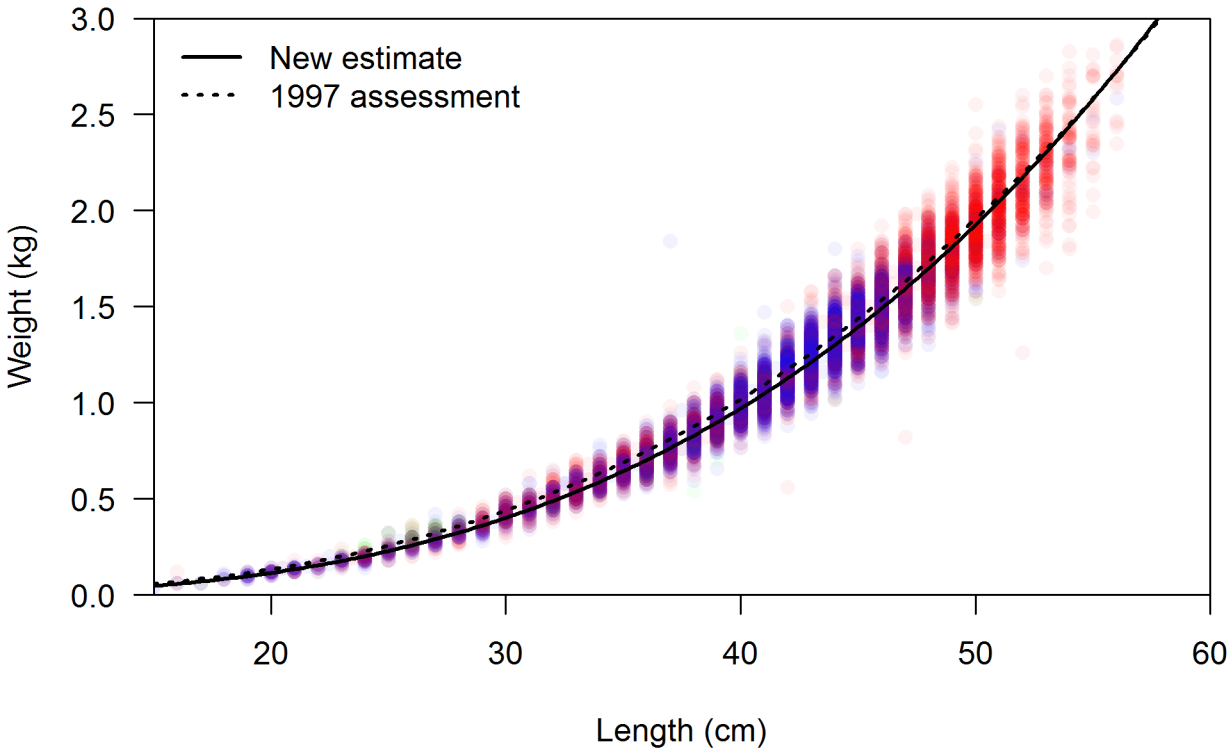


Figure 3: Estimated weight-length relationship for Yellowtail Rockfish used in both models. Colored points show observed values (red for females, blue for males, and green for unsexed). The black line indicates the estimated relationship $W = 0.000011843L^{3.0672}$. `fig:weight-length`

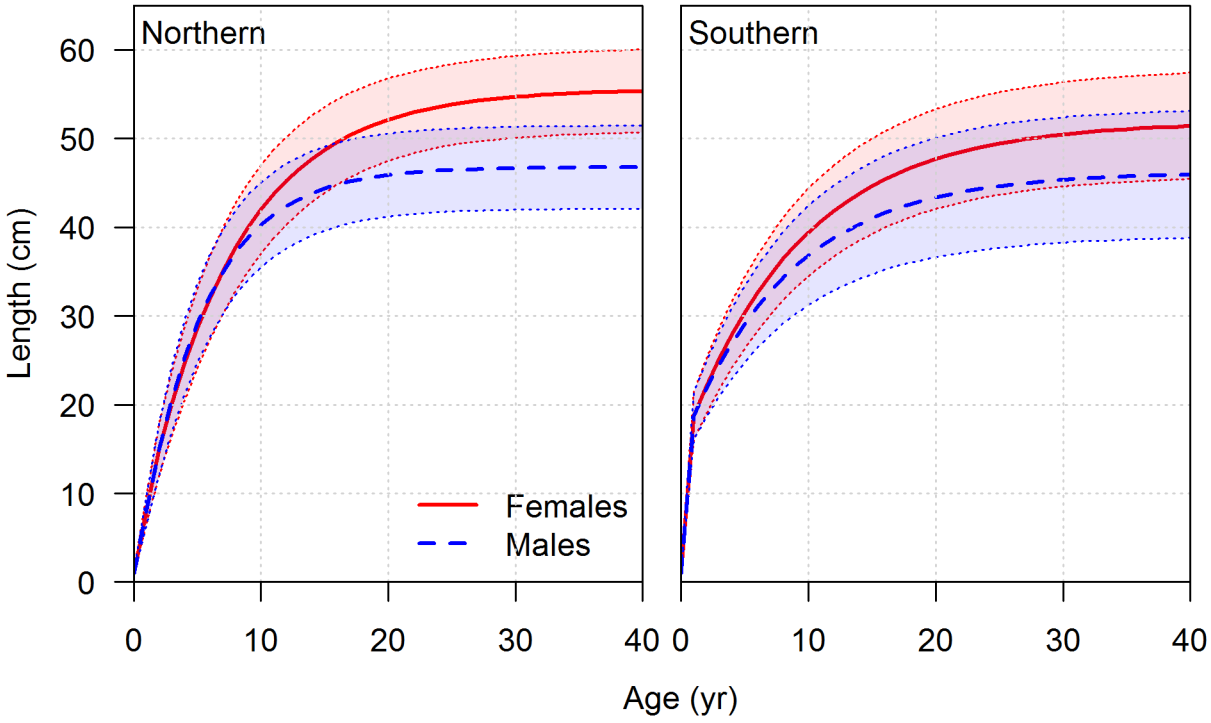


Figure 4: Estimated length-at-age for female and male Yellowtail Rockfish in each model. Shaded areas indicate 95% intervals for distribution of lengths at each age. Values represent beginning-of-year growth. ⌈fig:growth

9.2 Data and model fits for the Northern model

data-and-model-fits-for-the-northern-model

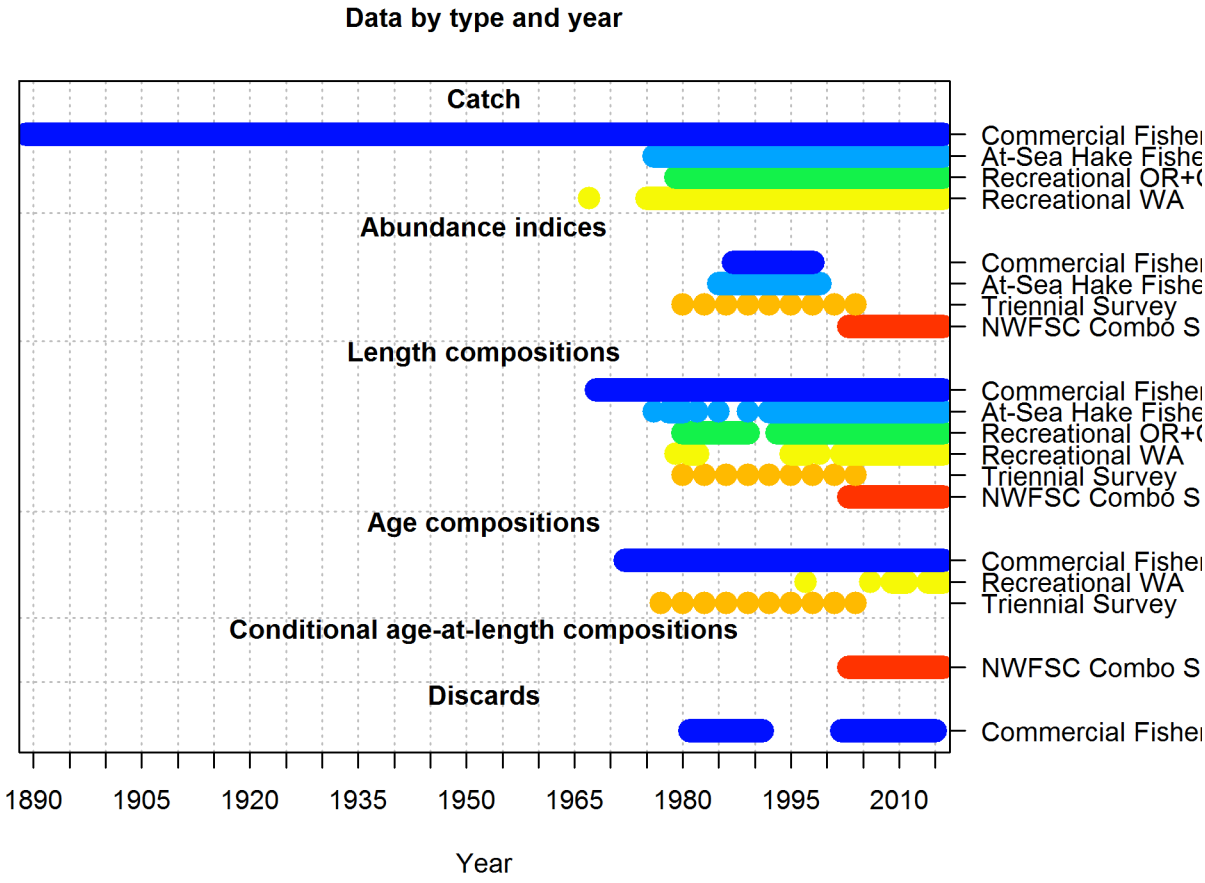


Figure 5: Summary of data sources used in the Northern model. fig:data_plot

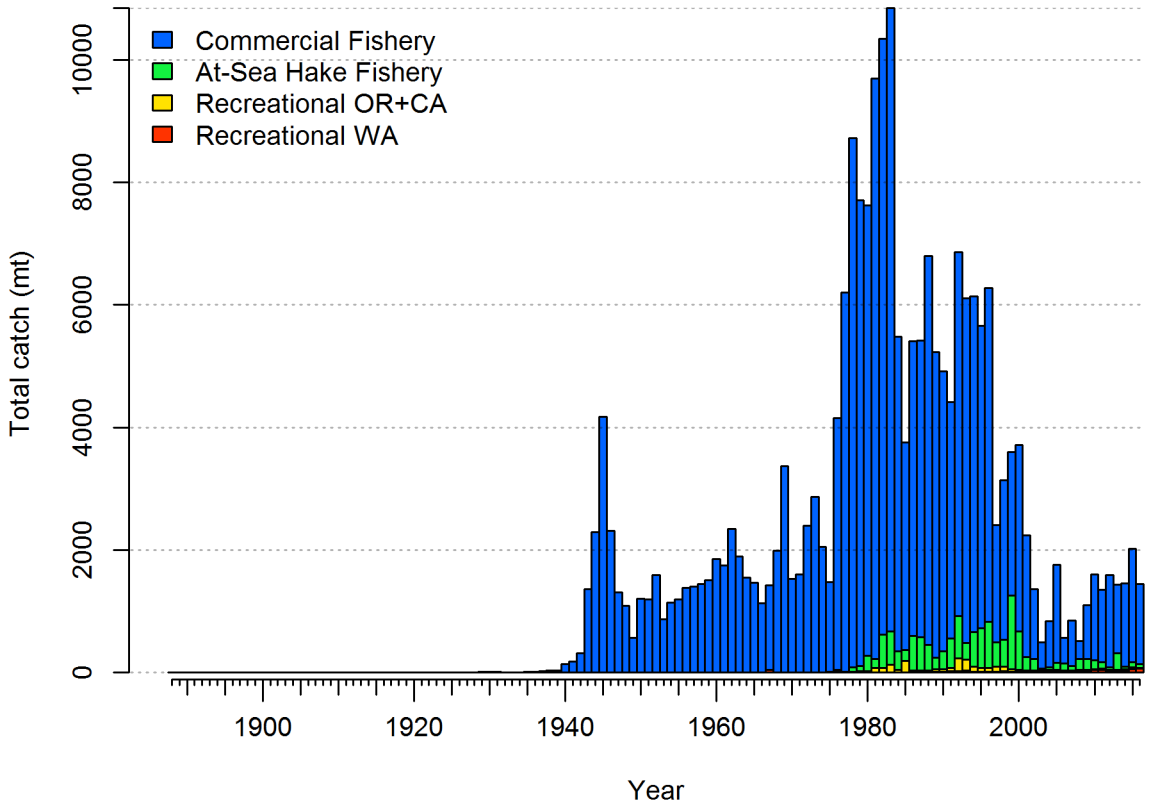


Figure 6: Estimated catch history of Yellowtail Rockfish in the Northern model. Recreational catches in Washington are model estimates of total weigth converted from input catch in numbers using model estimates of growth and selectivity. Catches for the Commercial Fishery include estimated discards.fig:r4ss_total_catch_N

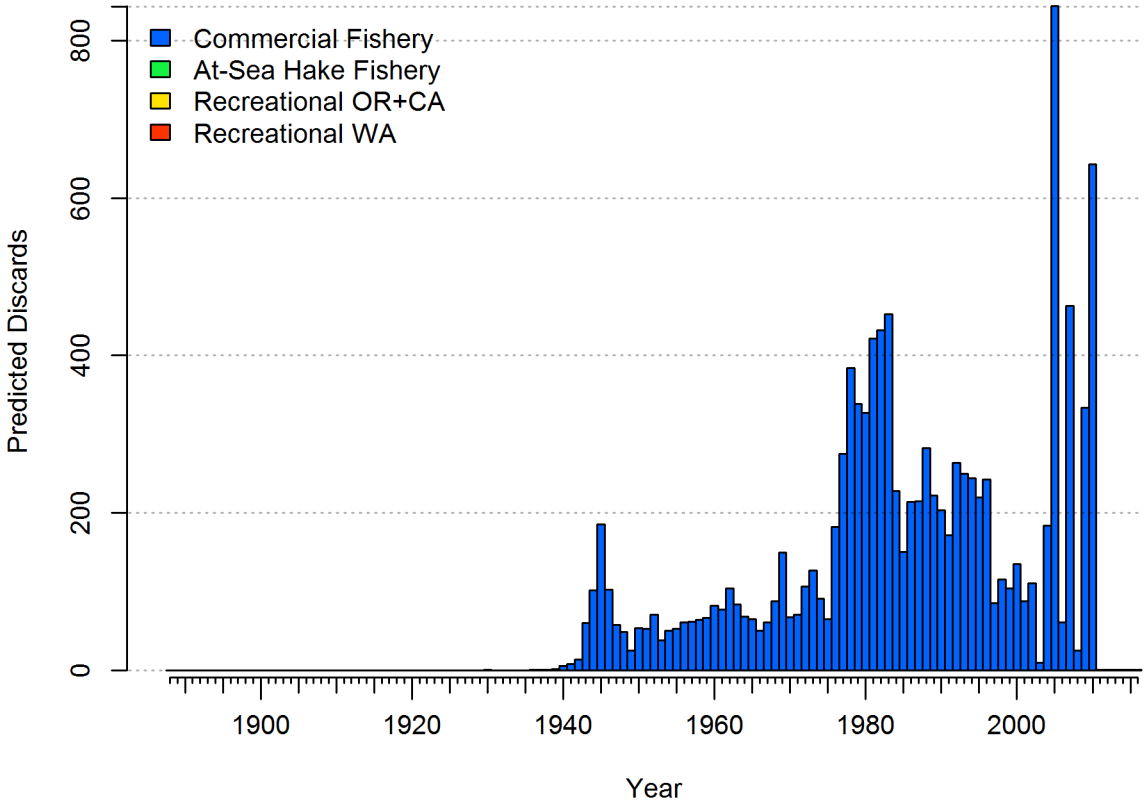


Figure 7: Estimated discards in the Commercial Fishery in the Northern model. Estimates are influenced by the data for landings, discard ratios, and discard length combines and depend on the estimated parameters controlling selectivity and retention.[?fig:r4ss_discard_N]

9.2.1 Selectivity, retention, and discards for Northern model

selectivity-retention-and-discards-for-northern-model

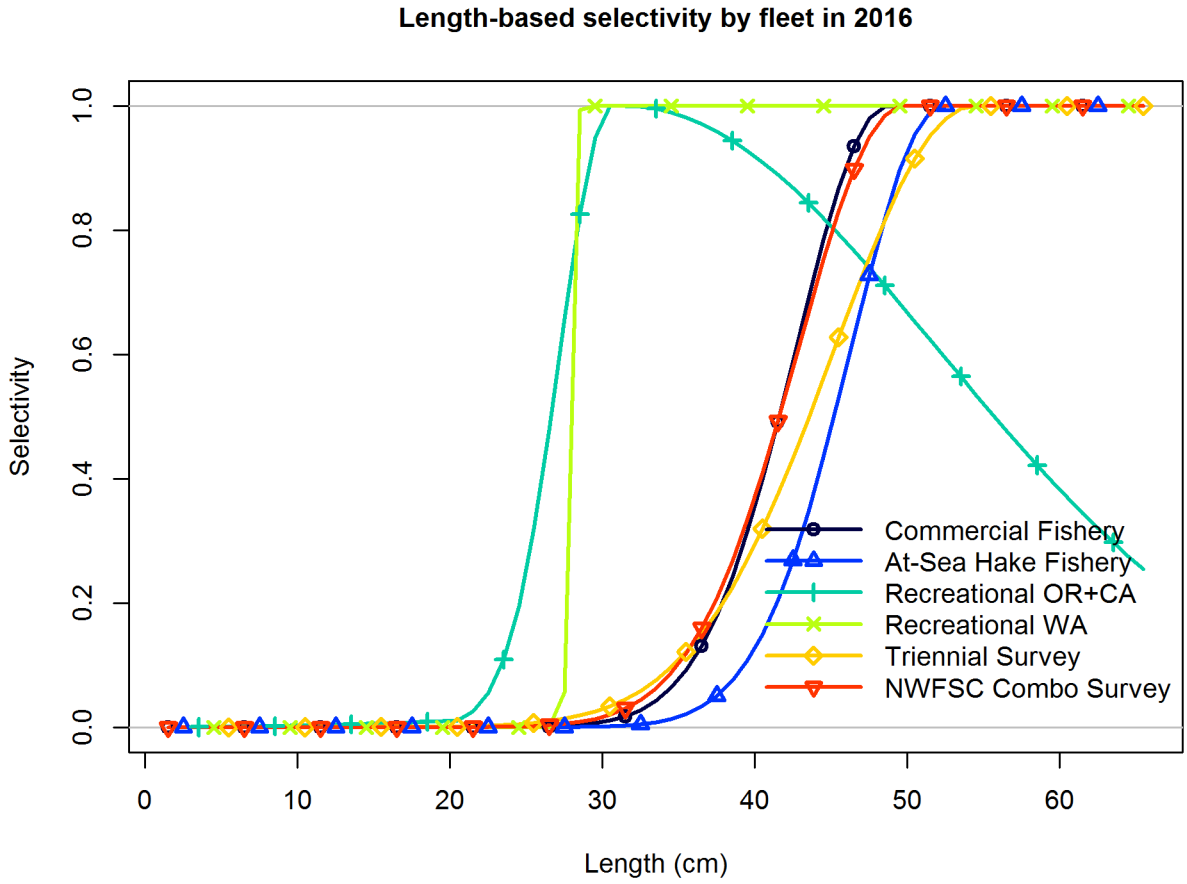


Figure 8: Estimated selectivity by length by each fishery and survey in the Northern model. fig:selex

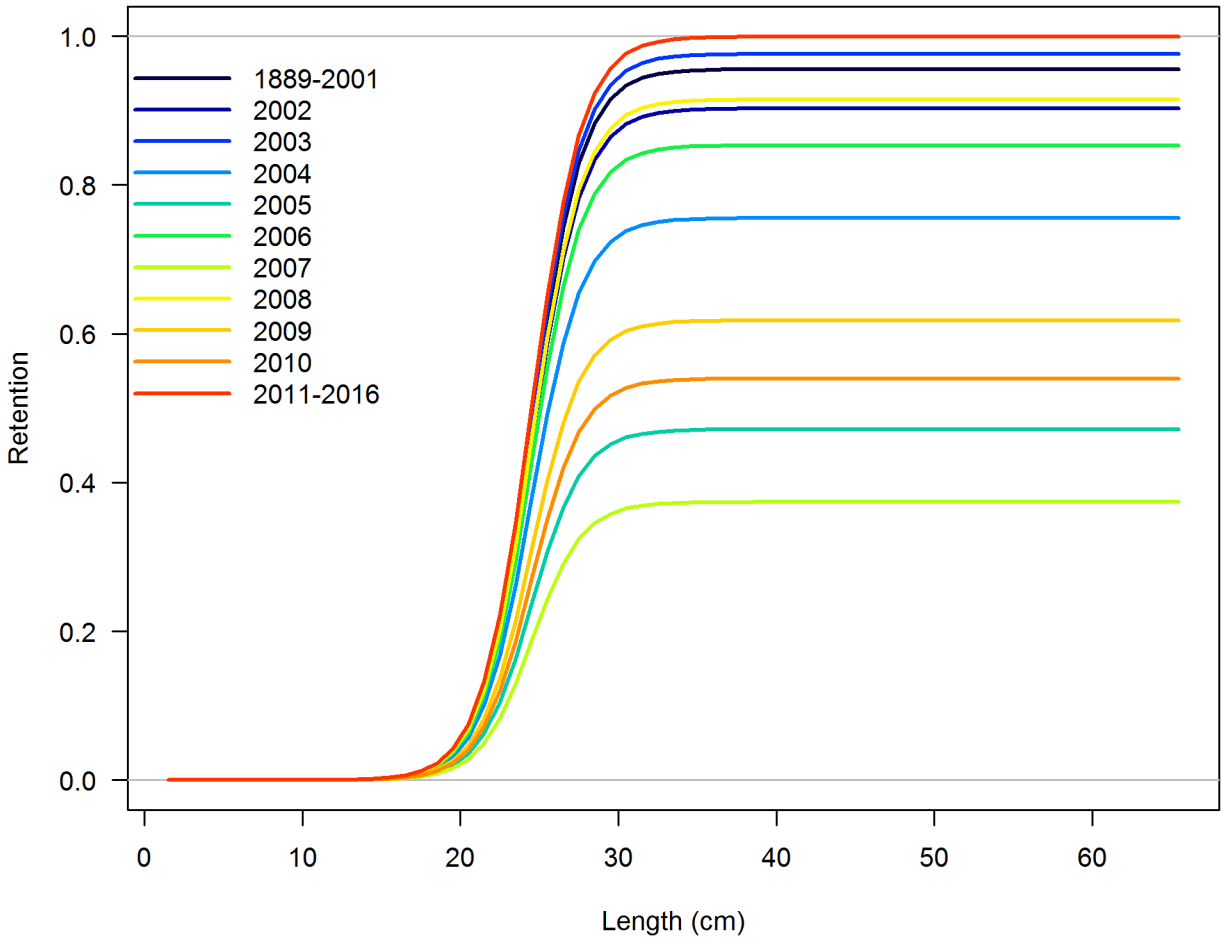


Figure 9: Estimated retention by length by the Commercial Fishery in the Northern model. [fig:retentior

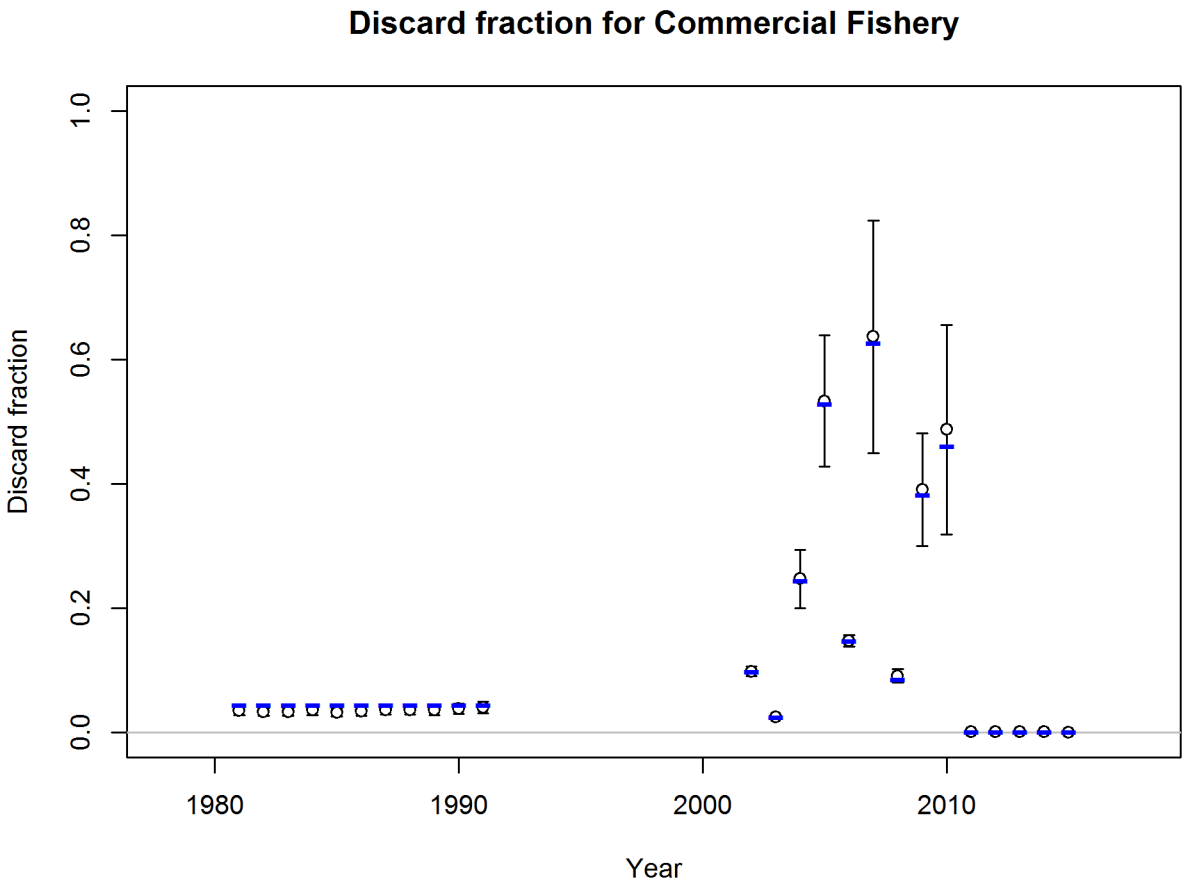


Figure 10: Fit to discard fractions for the commercial fishery in the Northern model. fig:r4ss_discard

9.2.2 Fits to indices of abundance for Northern model

fits-to-indices-of-abundance-for-northern-model

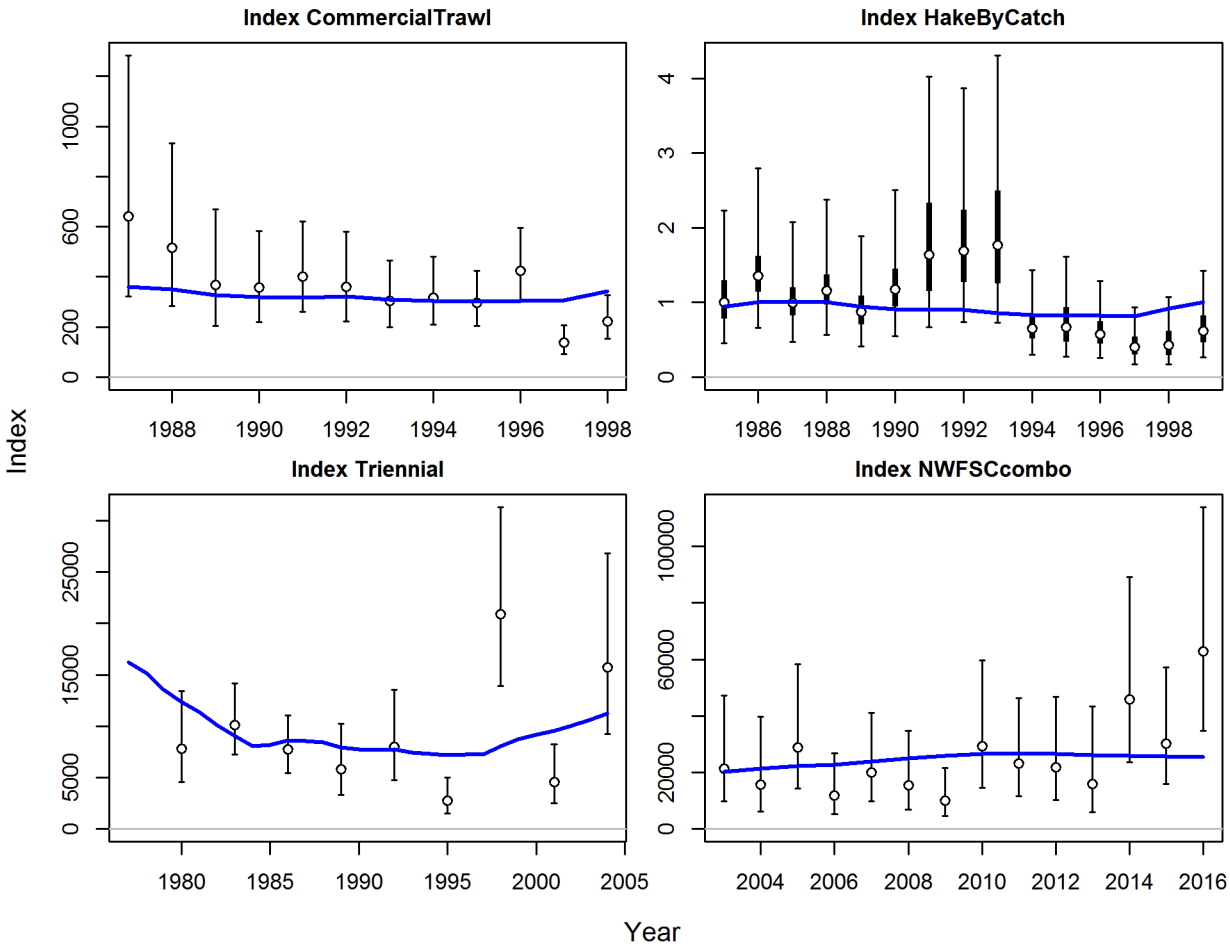


Figure 11: Estimated fits to the CPUE and survey indices for the Northern model. fig:index_fits1

9.2.3 Length compositions for Northern model

length-compositions-for-northern-model

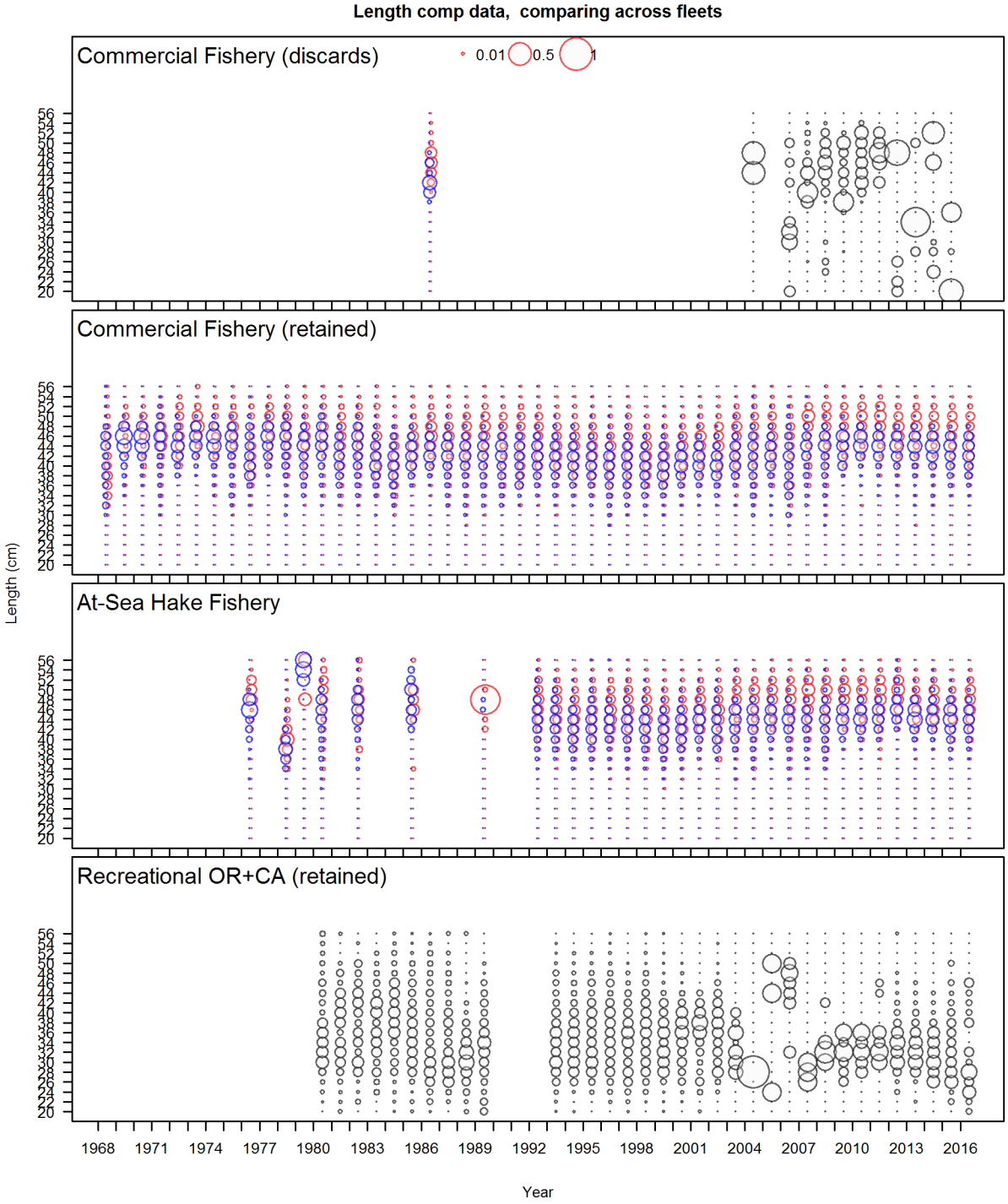


Figure 12: Length compositions for all fleets in the Northern model (figure 1 of 2). Bubble size is proportional to proportions within each year. Bubble colors indicate unsexed fish (gray), females (red), and males (blue).

`fig:comp_length_bubble_mod1_page1`

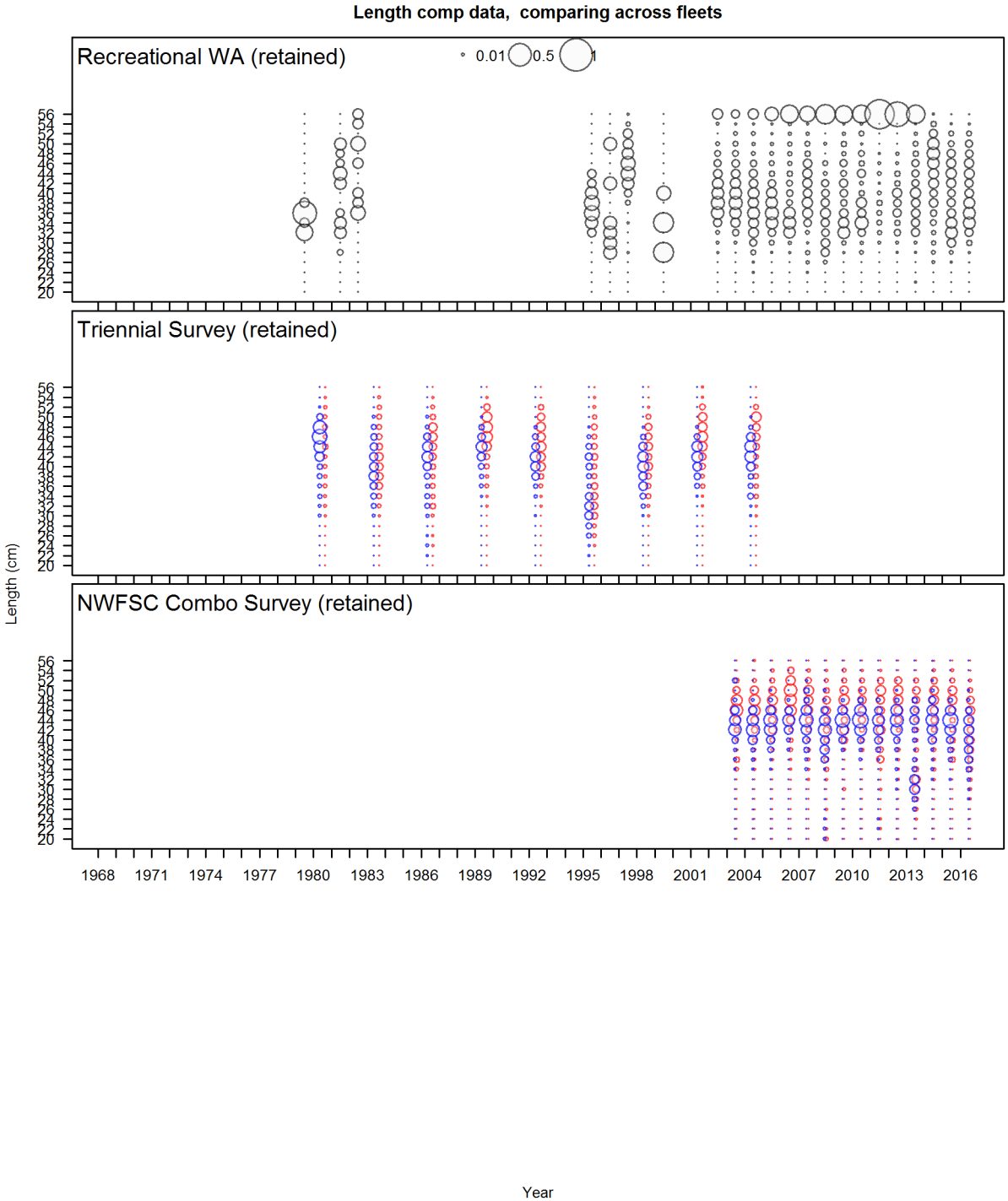


Figure 13: Length compositions for all fleets in the Northern model (figure 2 of 2). `fig:comp_length_`

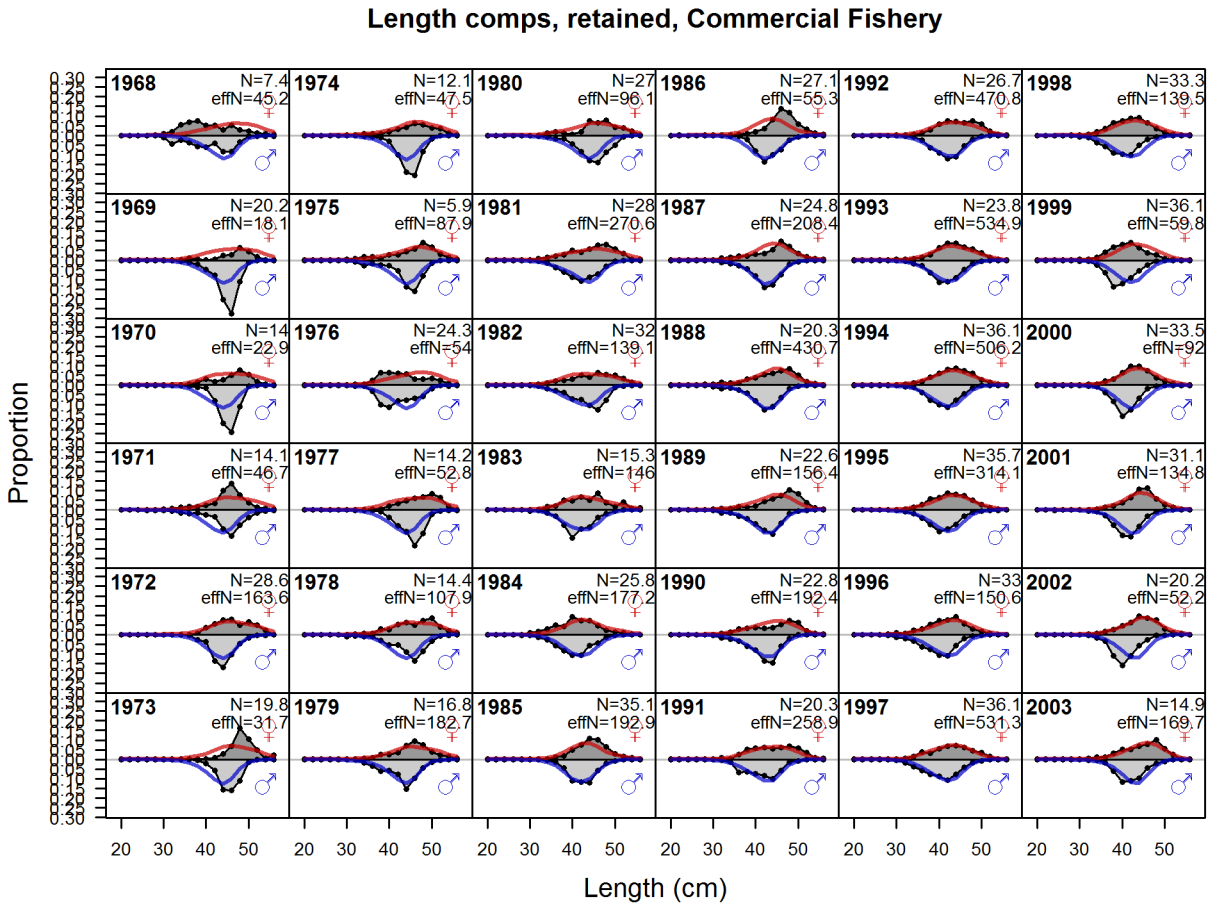
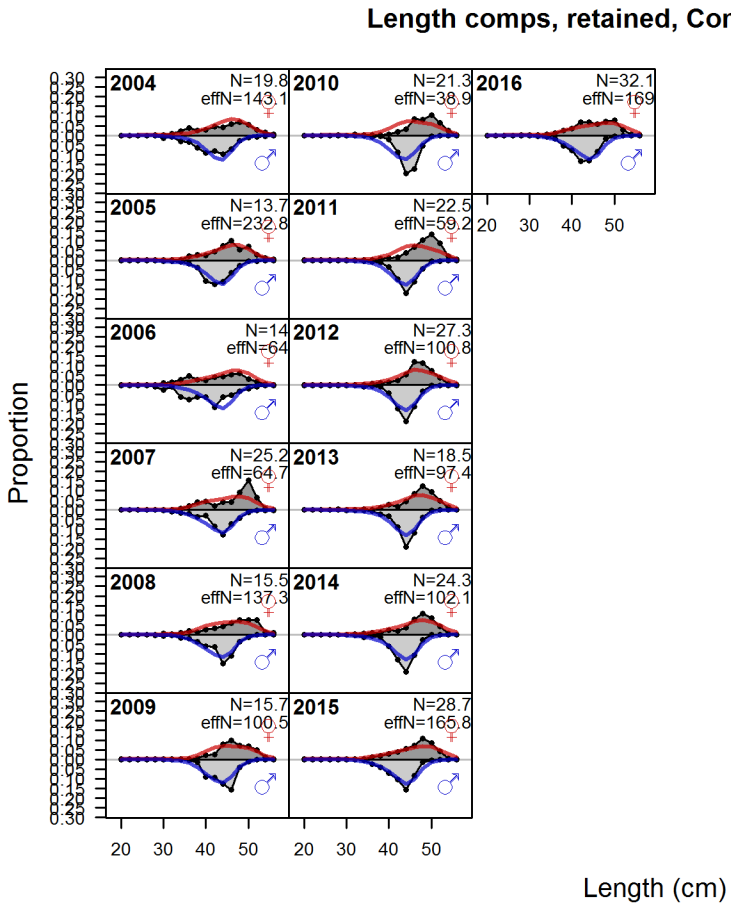


Figure 14: **Northern model** Length comps, retained, Commercial Fishery (plot 1 of 2) [fig:mod1_1_com



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660 Figure continued from previous page

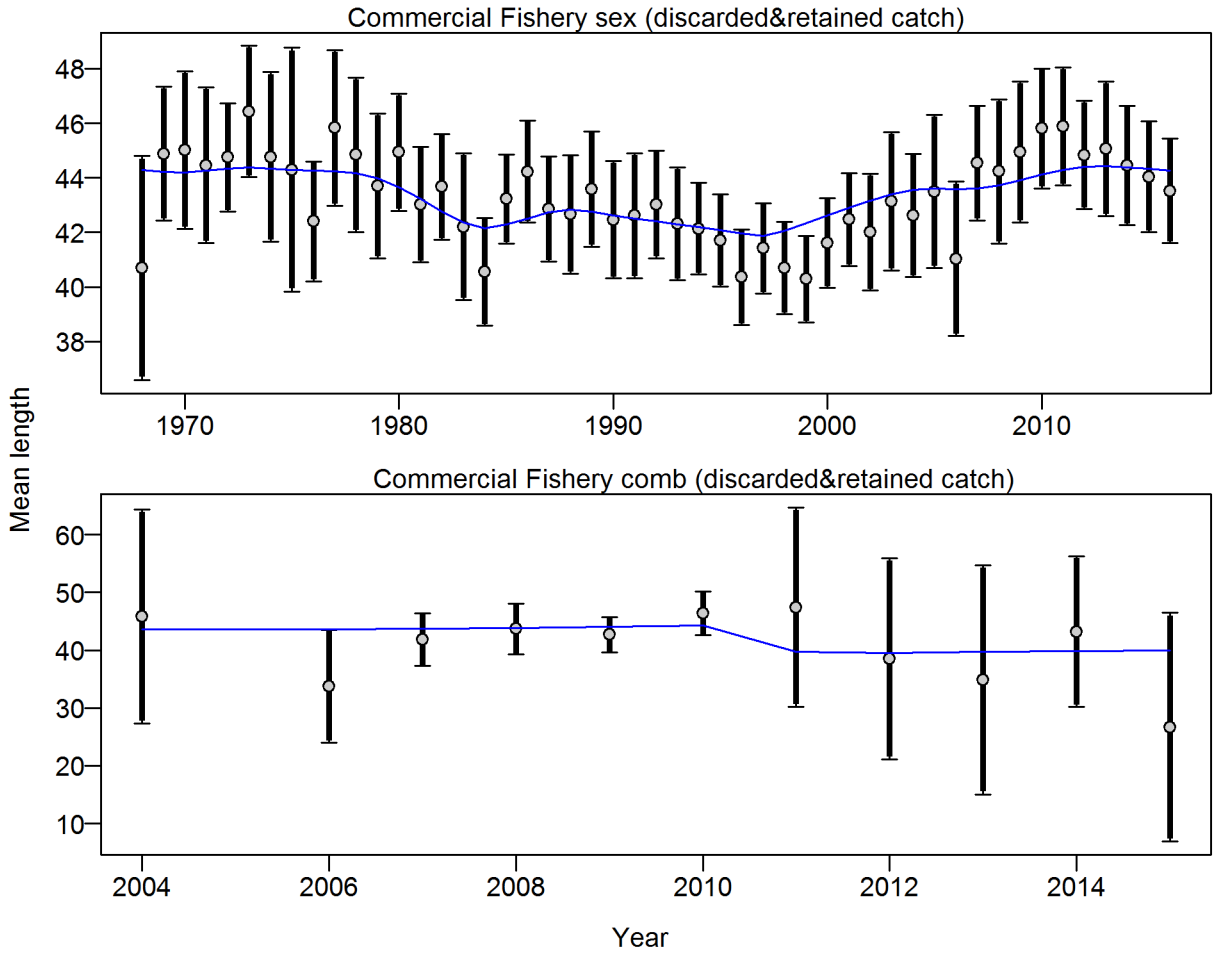


Figure 15: **Northern model** Mean length for Commercial Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Commercial Fishery: 0.9488 (0.7215_1.4041) 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`

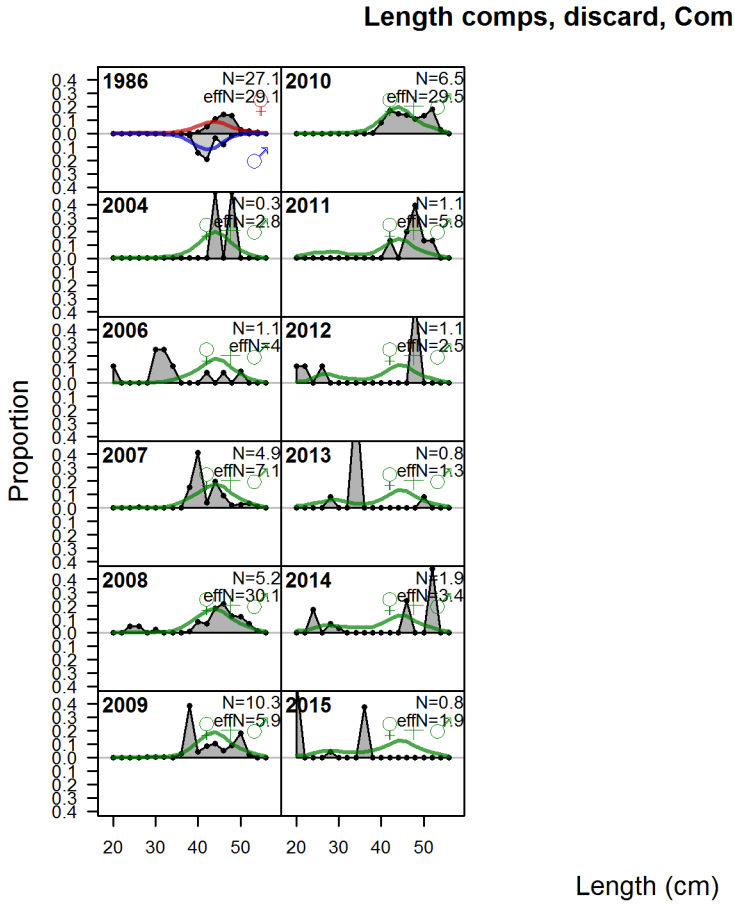


Figure 16: **Northern model** Length comps, discard, Commercial Fishery | `fig:mod1_6_comp_lenf`

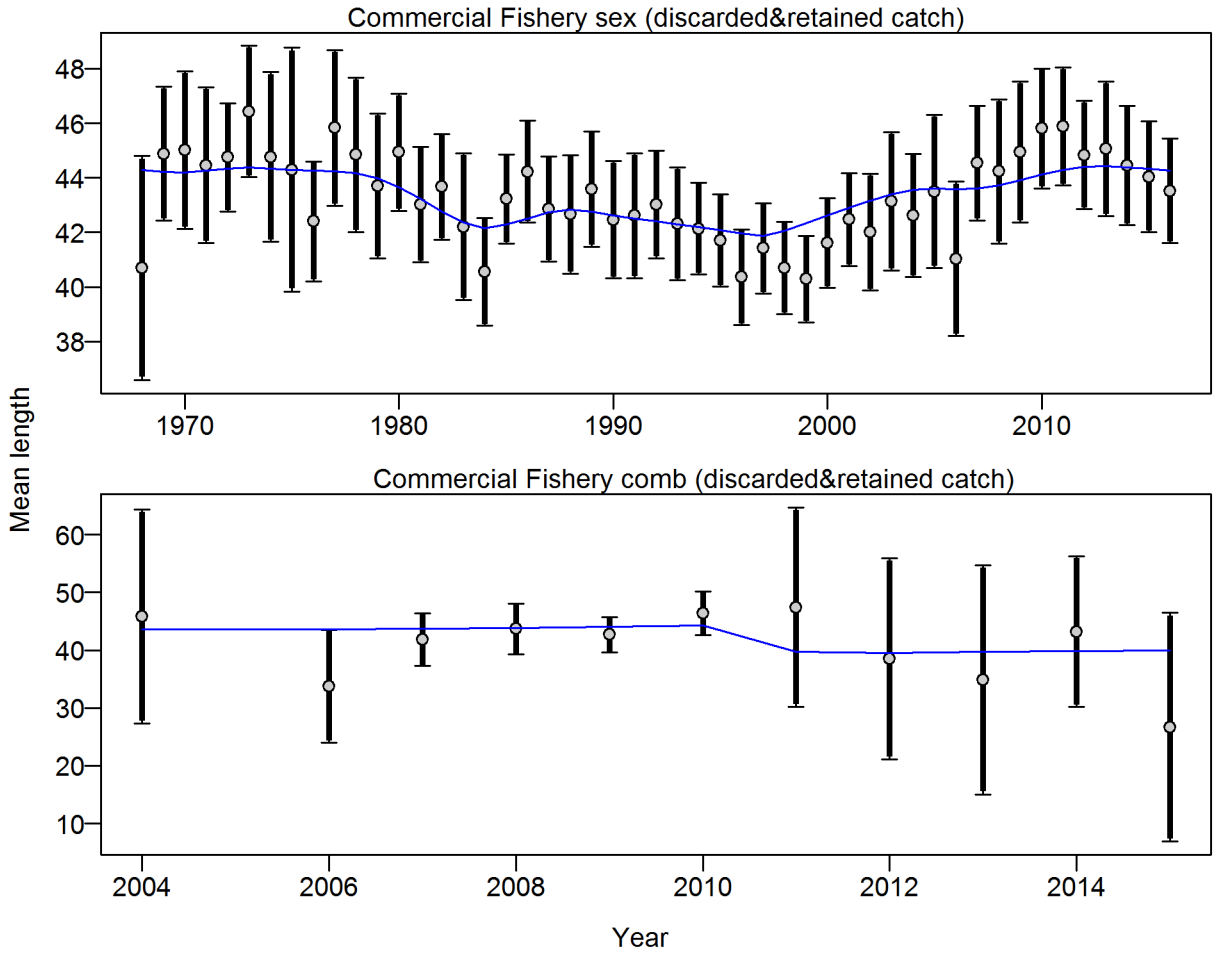


Figure 17: **Northern model** Mean length for Commercial Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Commercial Fishery: 0.9488 (0.7104_1.3849) 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`

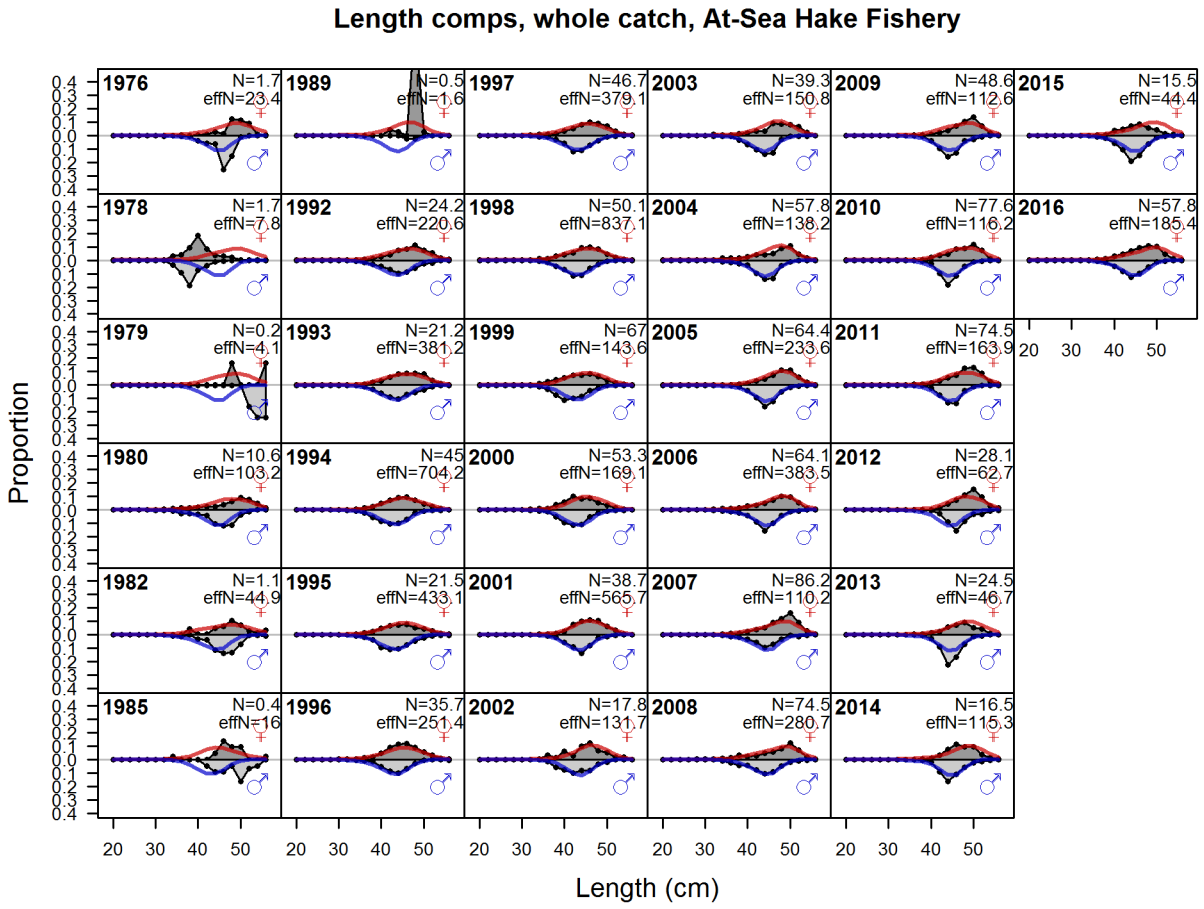


Figure 18: **Northern model** Length comps, whole catch, At_Sea Hake Fishery [fig:mod1_10_comp_1

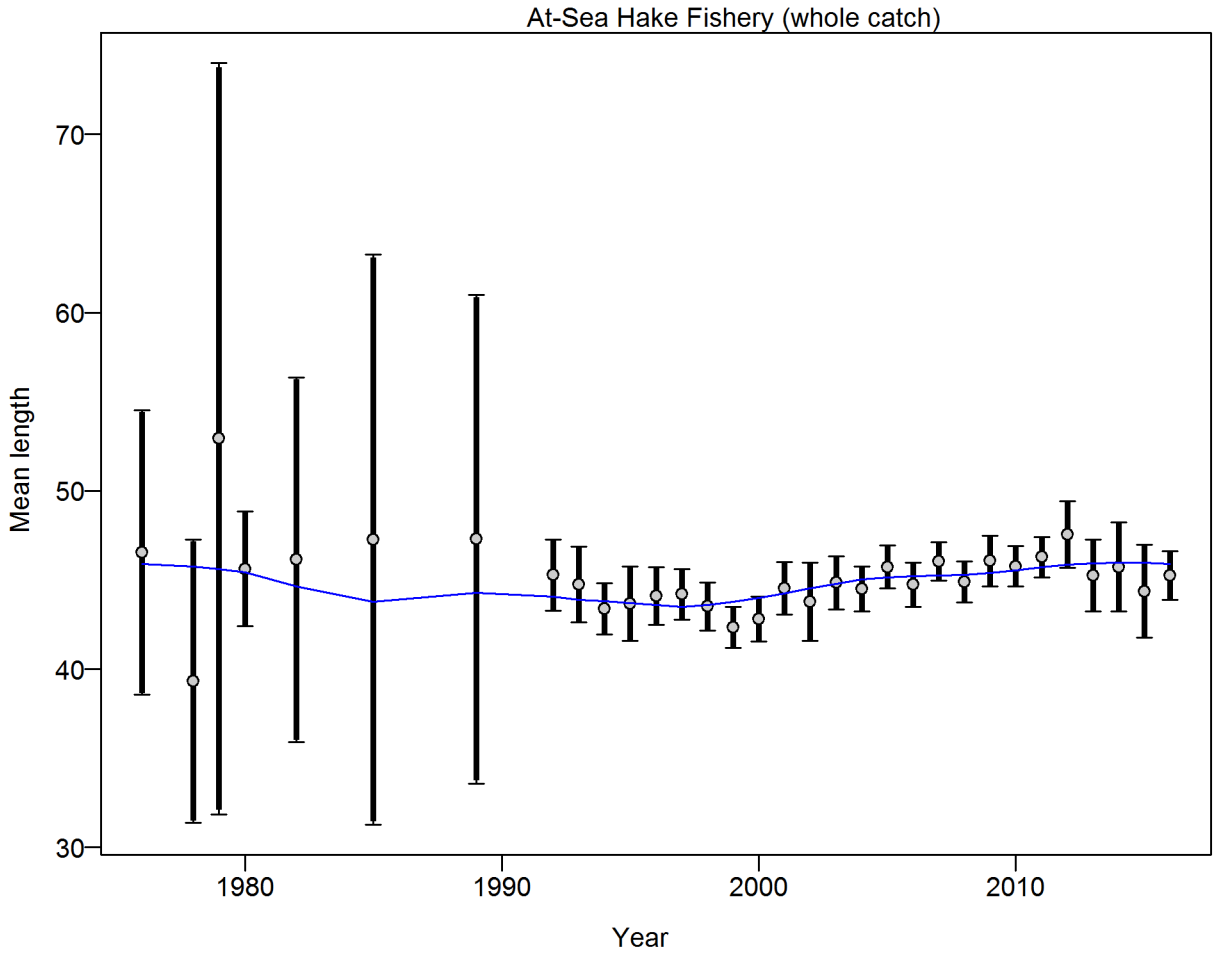


Figure 19: **Northern model** Mean length for At_Sea Hake Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from At_Sea Hake Fishery: 0.9774 (0.6609_1.864) 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_

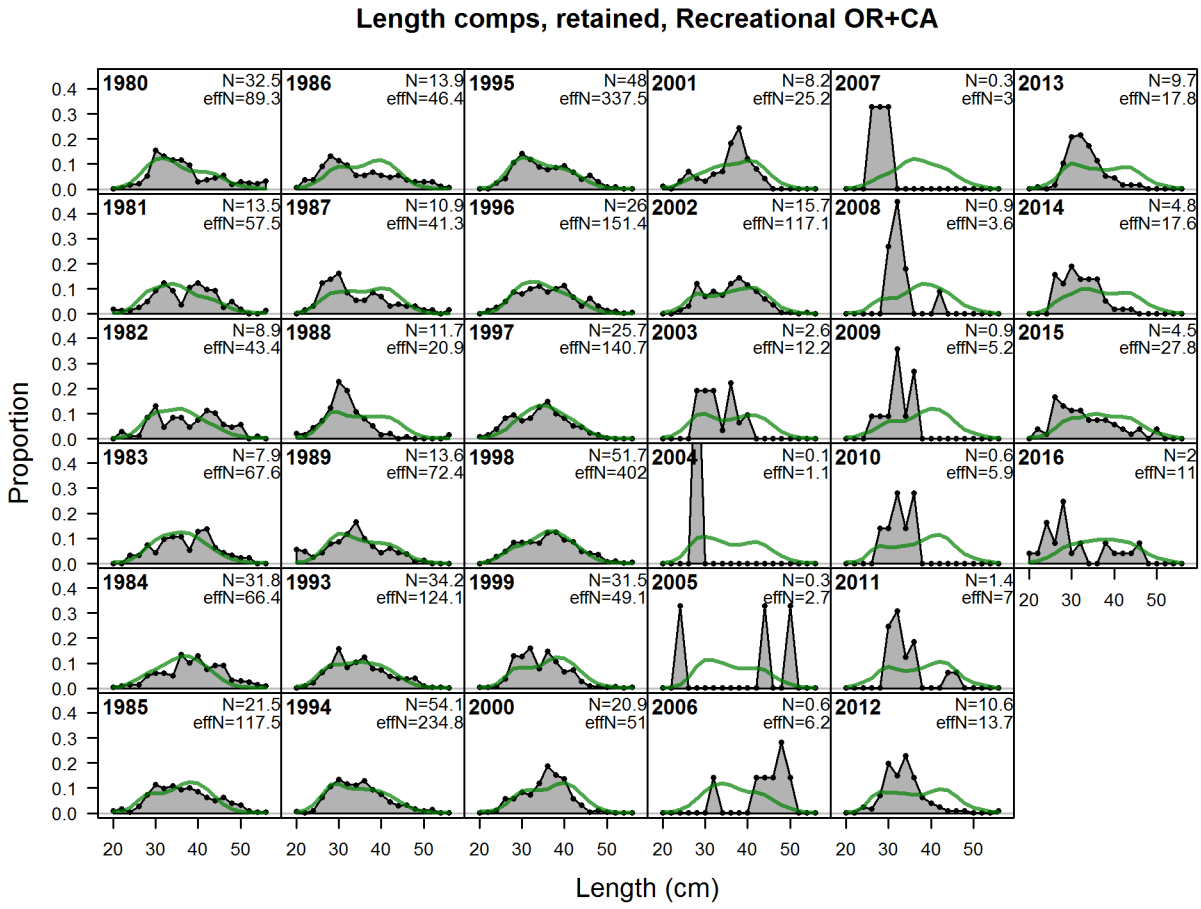


Figure 20: **Northern model** Length comps, retained, Recreational OR+CA [fig:mod1_14_comp_le

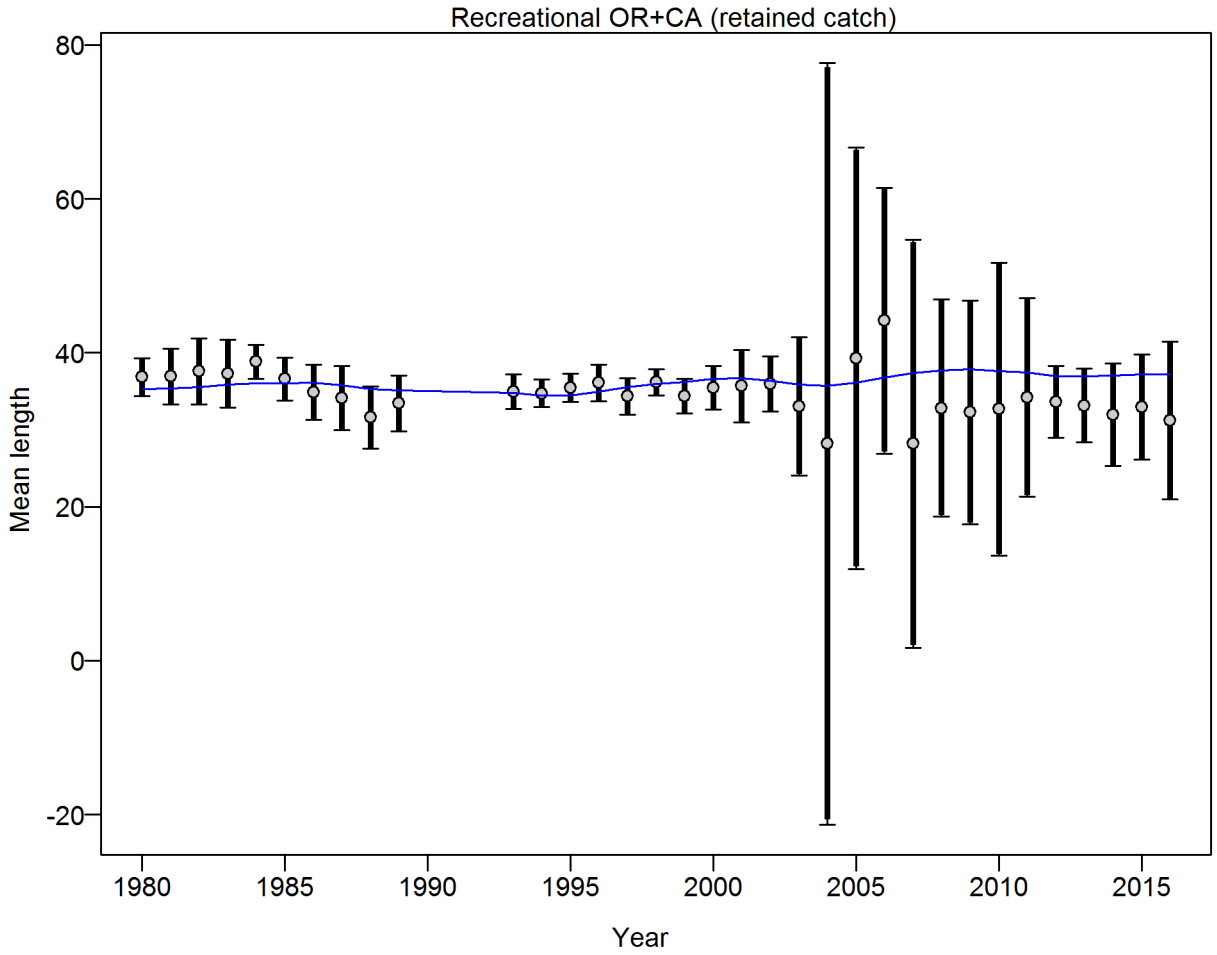


Figure 21: **Northern model** Mean length for Recreational OR+CA with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Recreational OR+CA: 0.9761 (0.648_1.7901) 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_

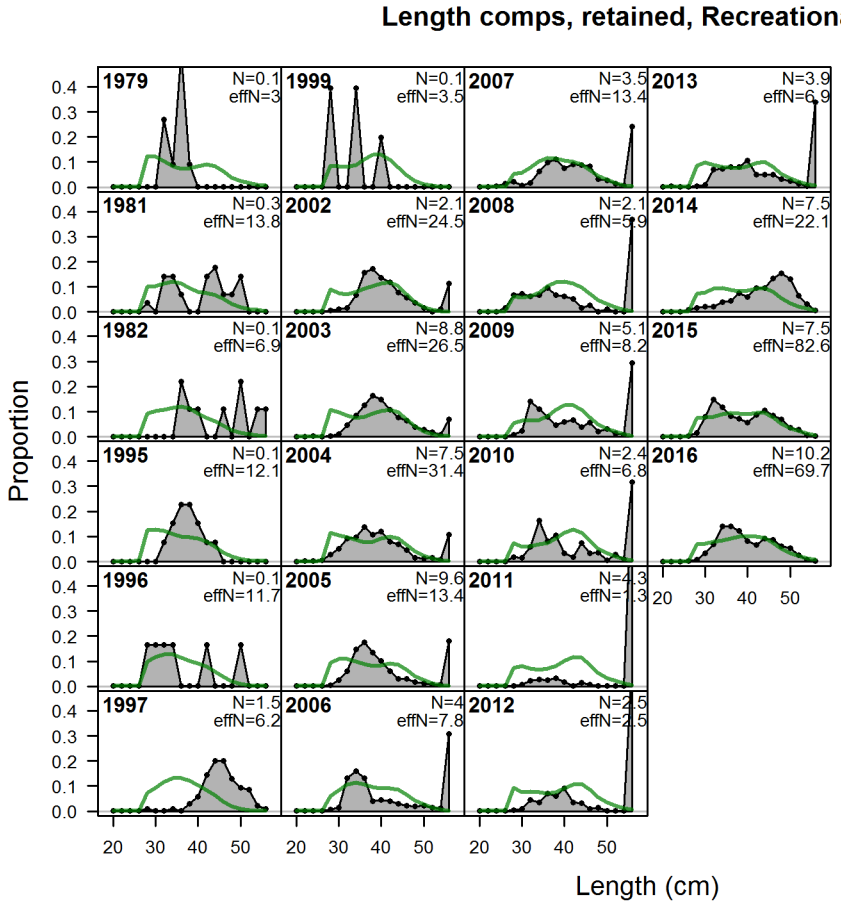


Figure 22: **Northern model** Length comps, retained, Recreational WA | `fig:mod1_18_comp_lenf`

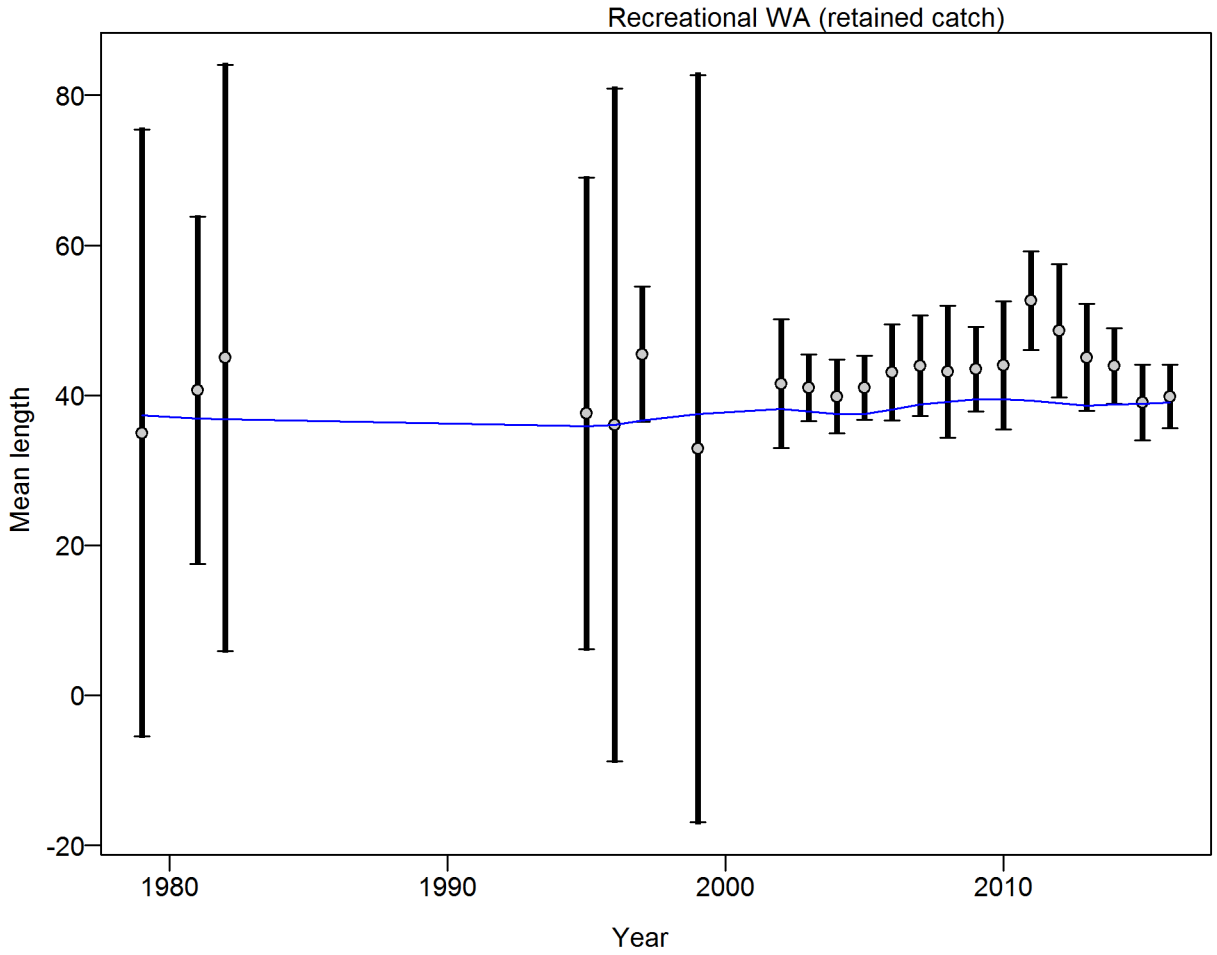


Figure 23: **Northern model** Mean length for Recreational WA with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Recreational WA: 1.0134 (0.5562_2.3747) 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_Recreational

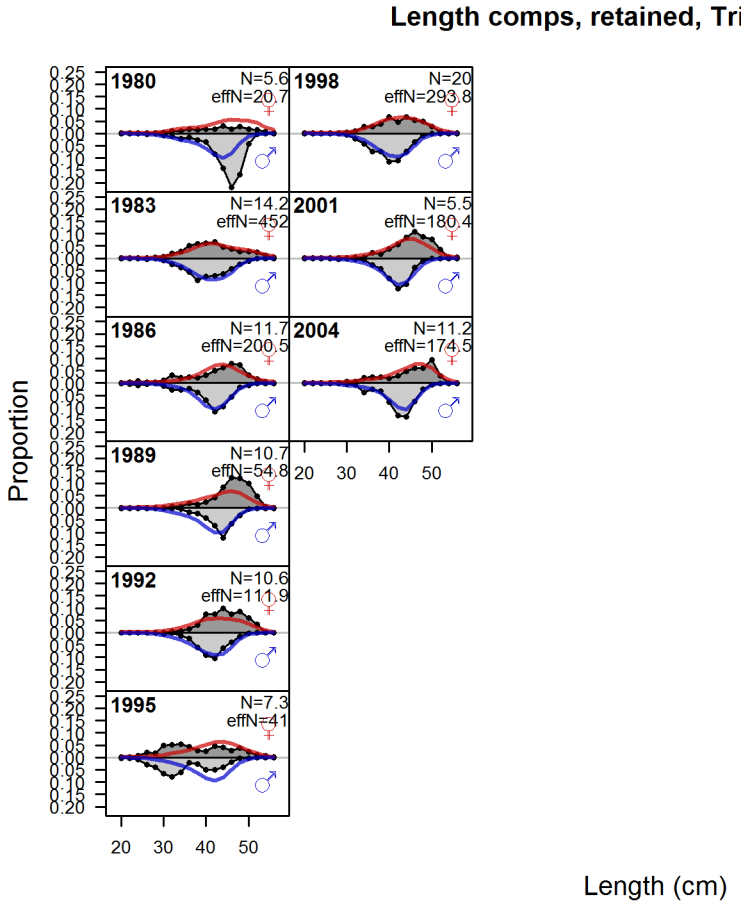


Figure 24: **Northern model** Length comps, retained, Triennial Survey (`fig:mod1_22_comp_lenf`

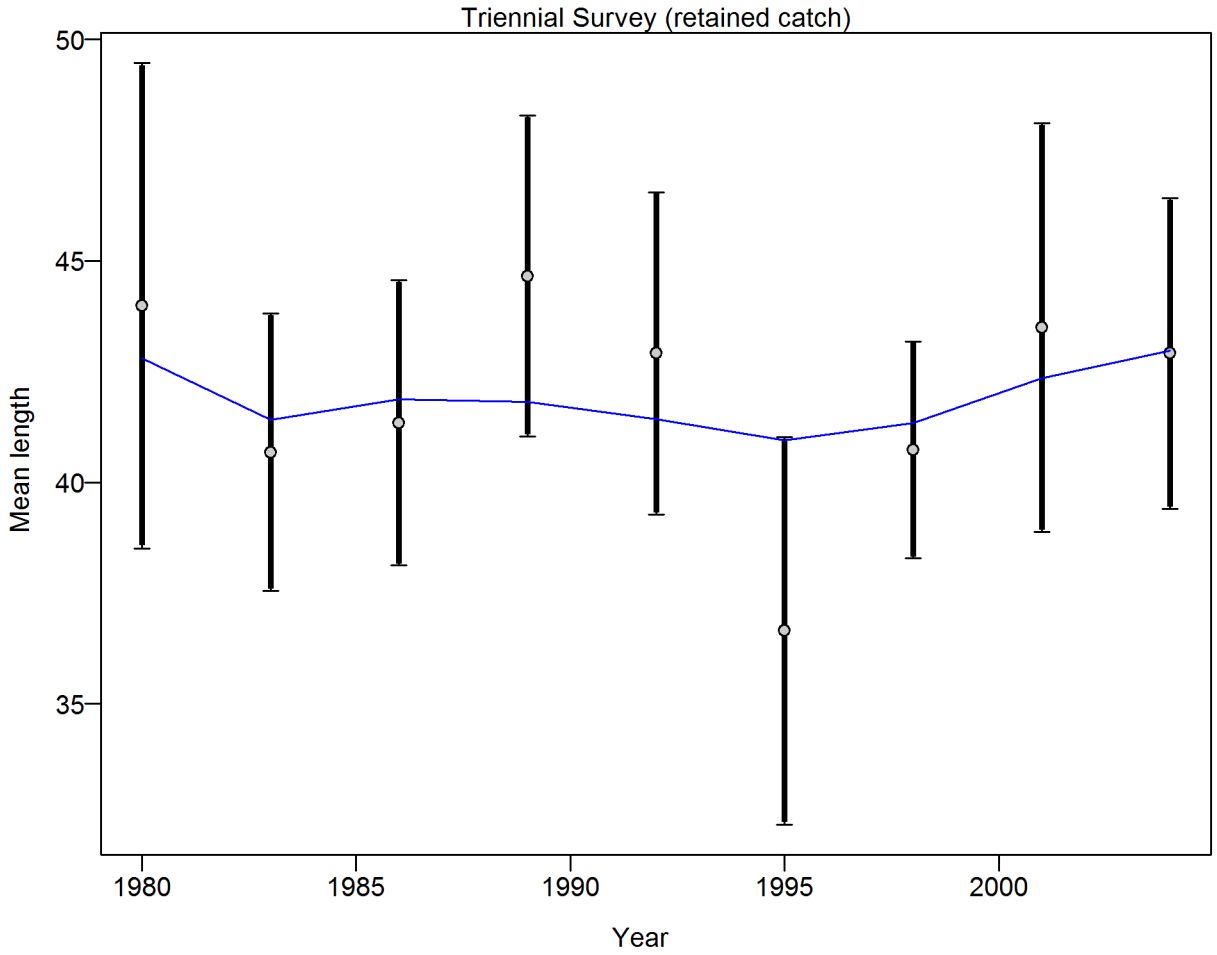


Figure 25: **Northern model** Mean length for Triennial Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Triennial Survey: 0.9781 (0.528_5.4951) 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 Su`

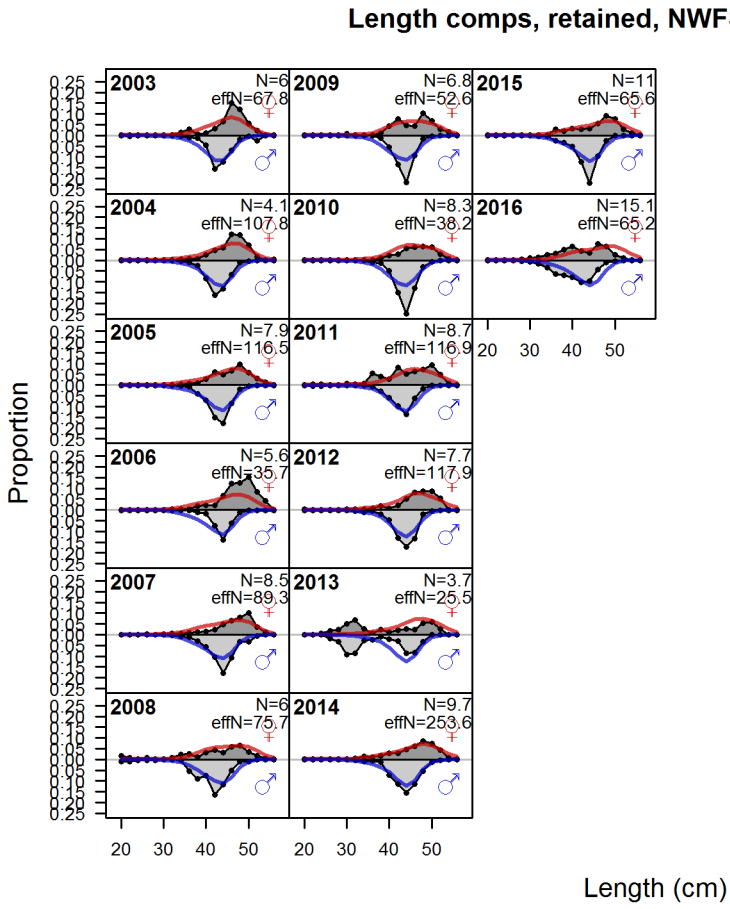


Figure 26: **Northern model** Length comps, retained, NWFSC Combo Survey [fig:mod1_26_comp_l

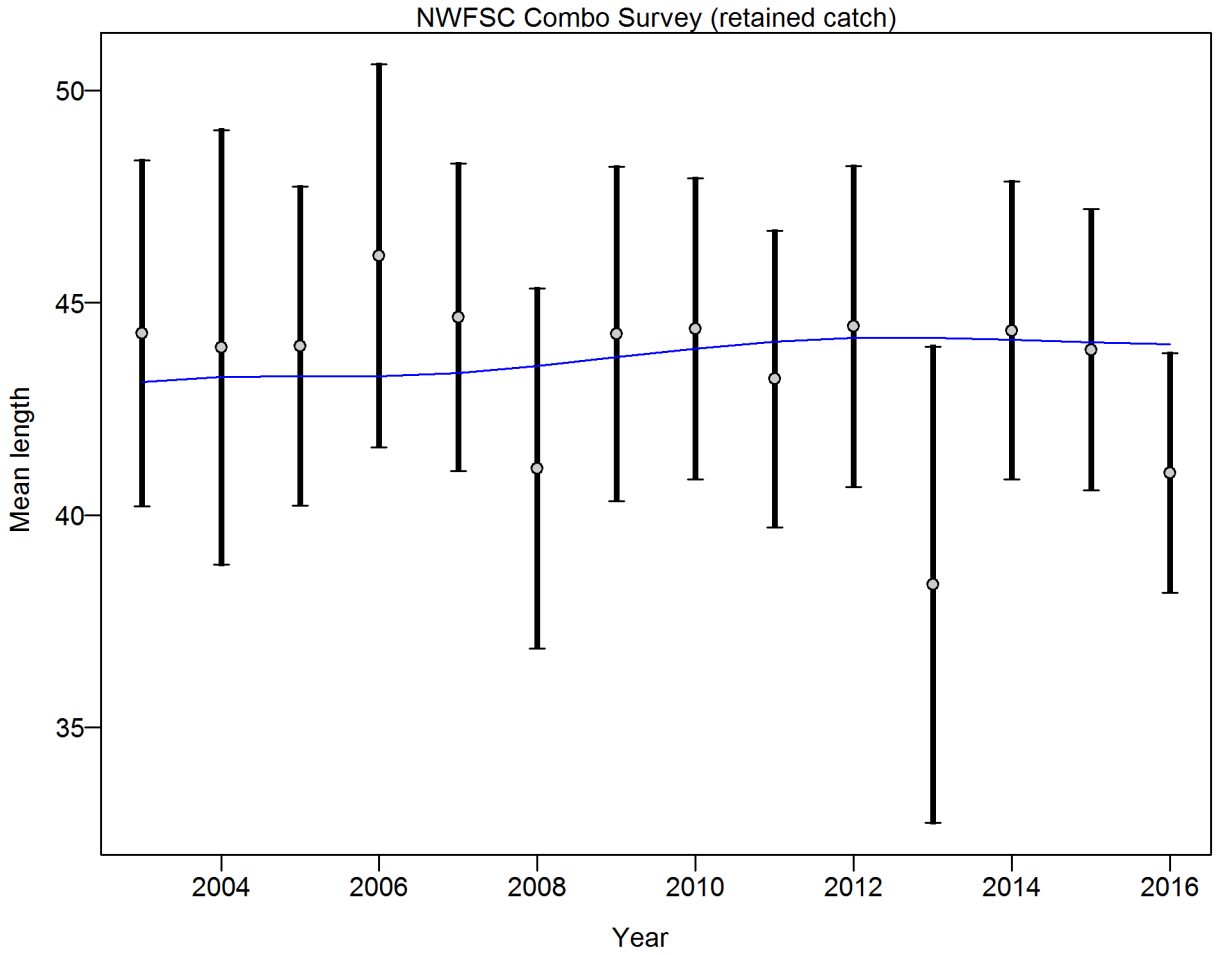


Figure 27: **Northern model** Mean length for NWFSC Combo Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from NWFSC Combo Survey: 1.0144 (0.6361_4.9173) 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_da

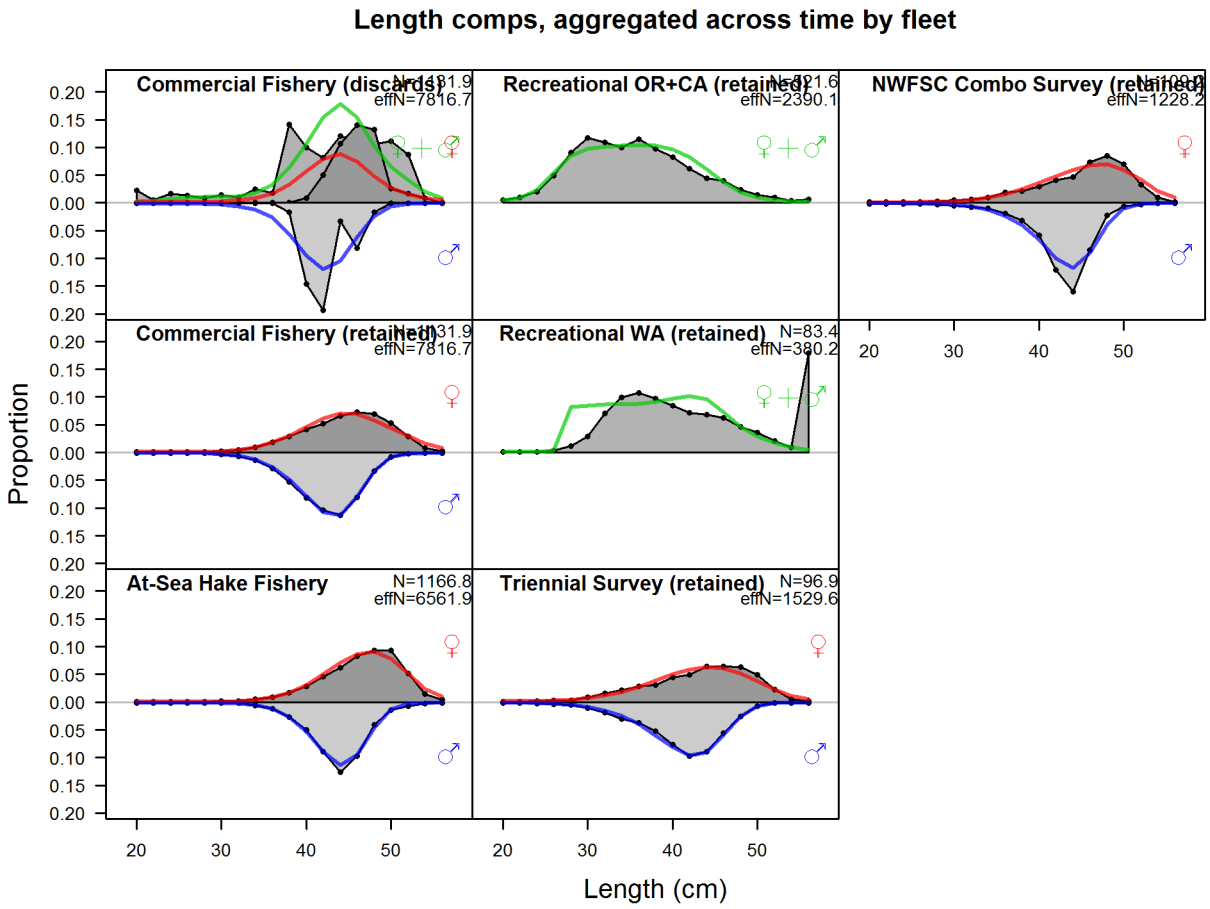


Figure 28: **Northern model** Length comps, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. `fig:mod1_30_comp_lenfit__aggregated_across_time`

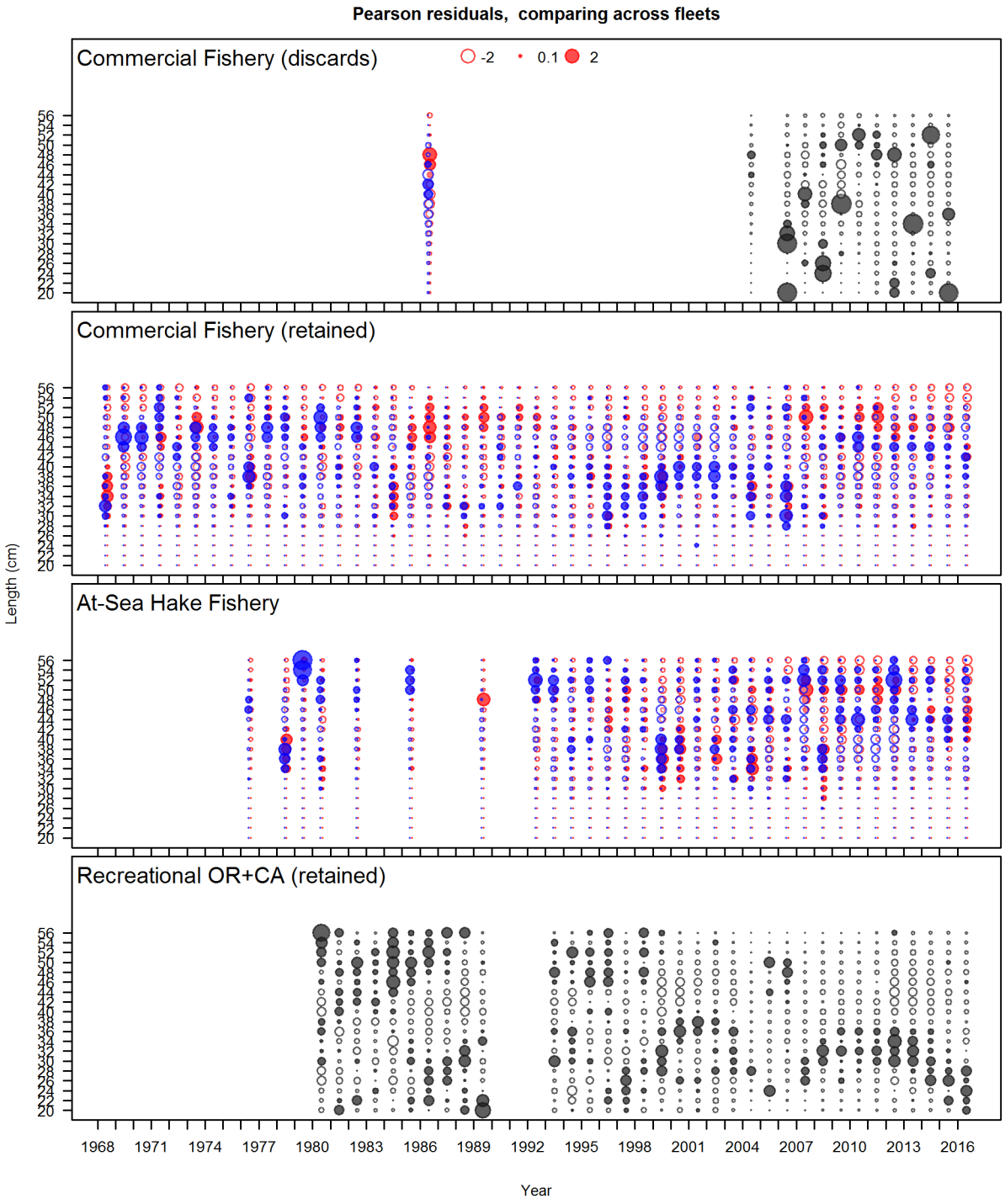


Figure 29: Length composition Pearson residuals for all fleets in the Northern model (Figure 1 of 2). Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Bubble colors indicate unsexed fish (gray), females (red), and males (blue). [fig:comp_Pearson_length_mod1_page1]

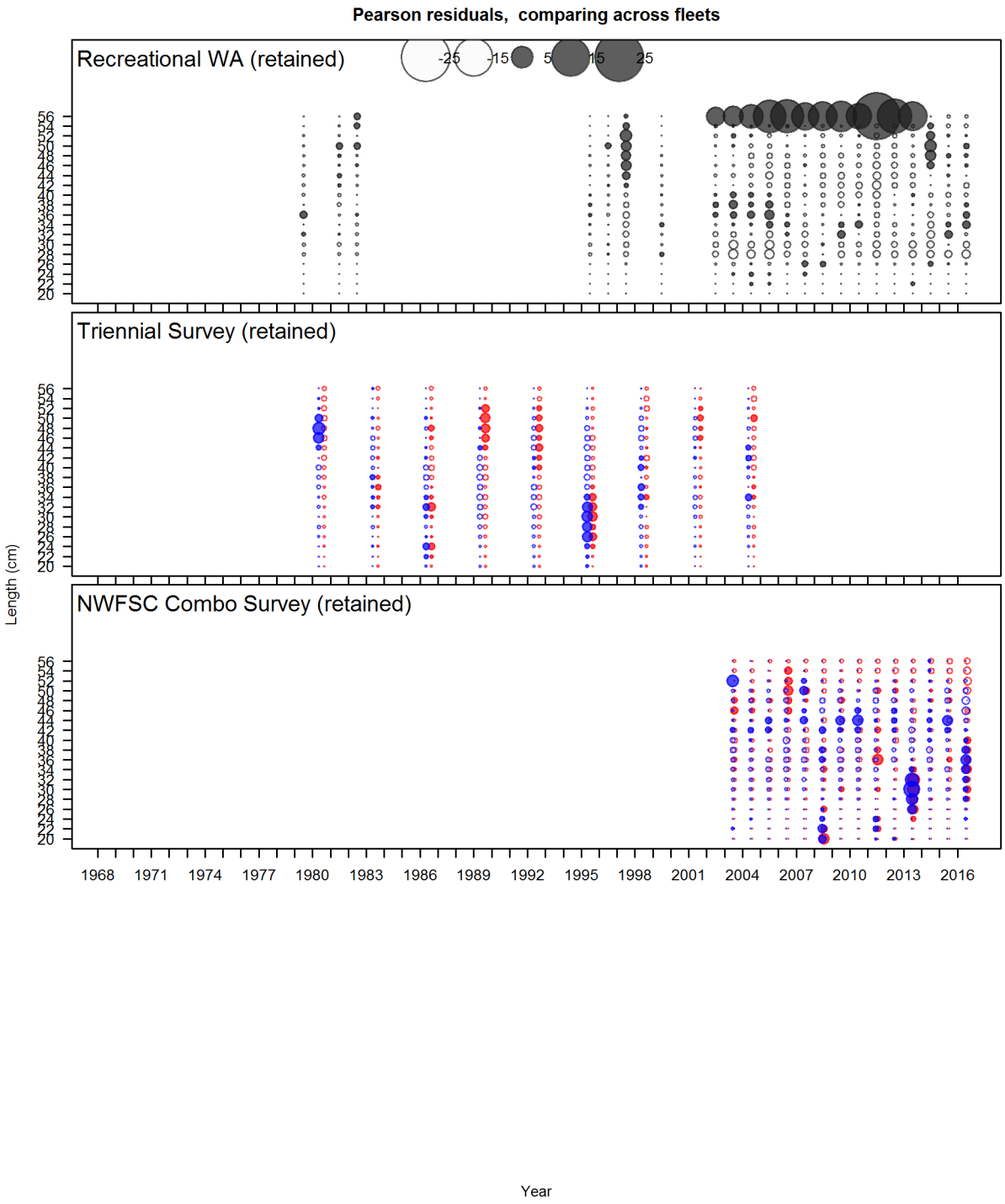


Figure 30: Length composition Pearson residuals for all fleets in the Northern model (Figure 2 of 2). `fig:comp_Pearson_length_mod1_page2`

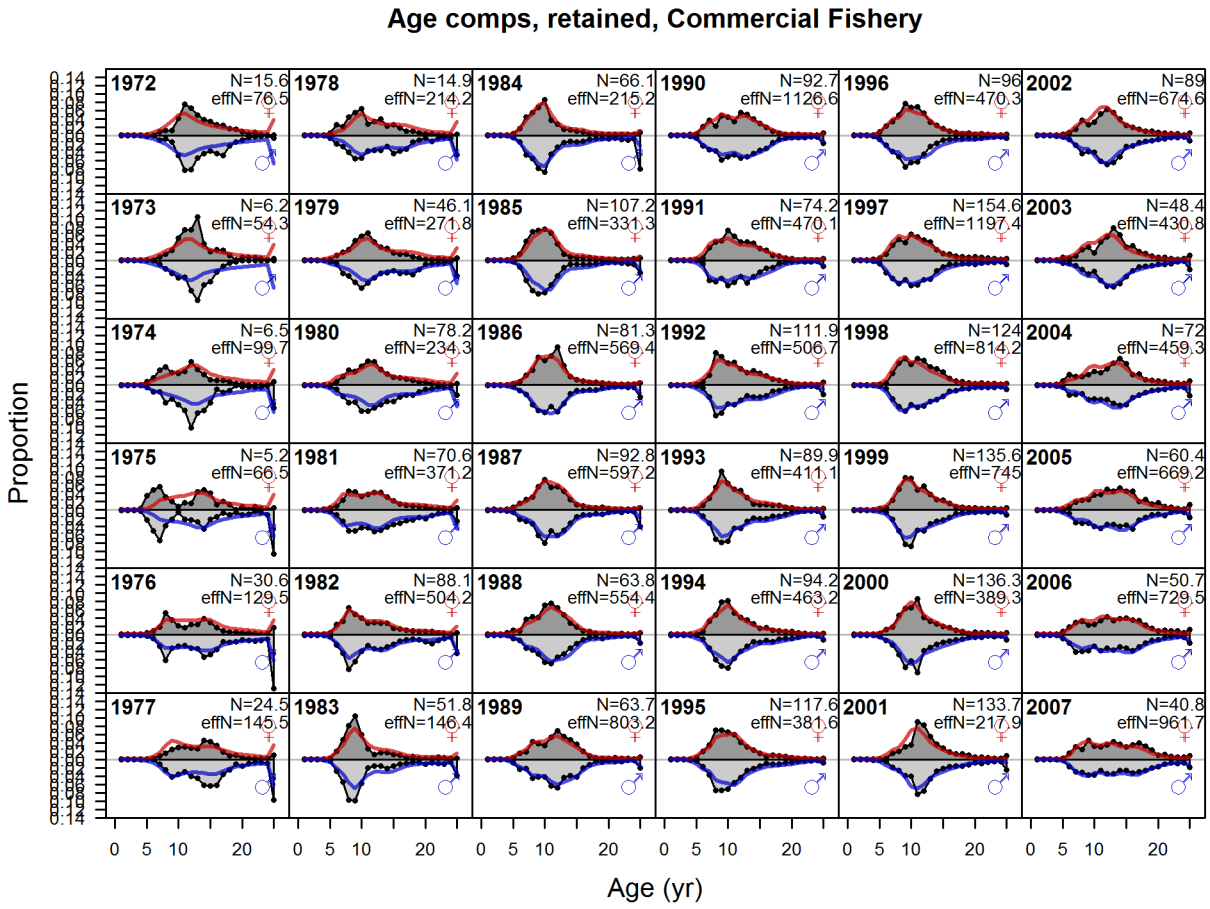


Figure 31: **Northern model** Age comps, retained, Commercial Fishery (plot 1 of 2) [fig:mod1_1_comp

9.2.4 Fits to age compositions for Northern model

fits-to-age-compositions-for-northern-model

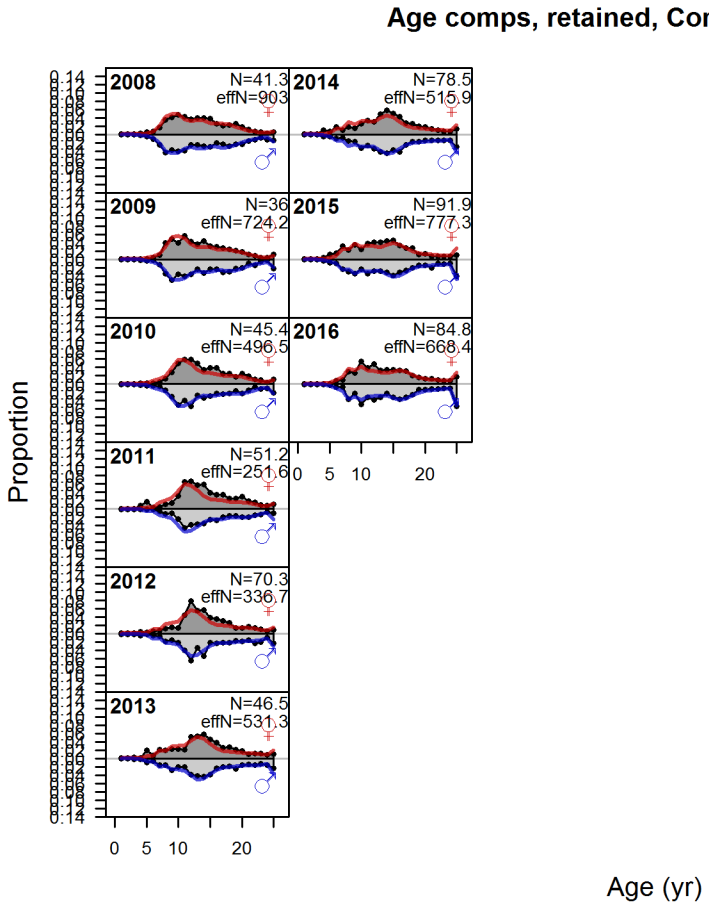


Figure continued from previous page

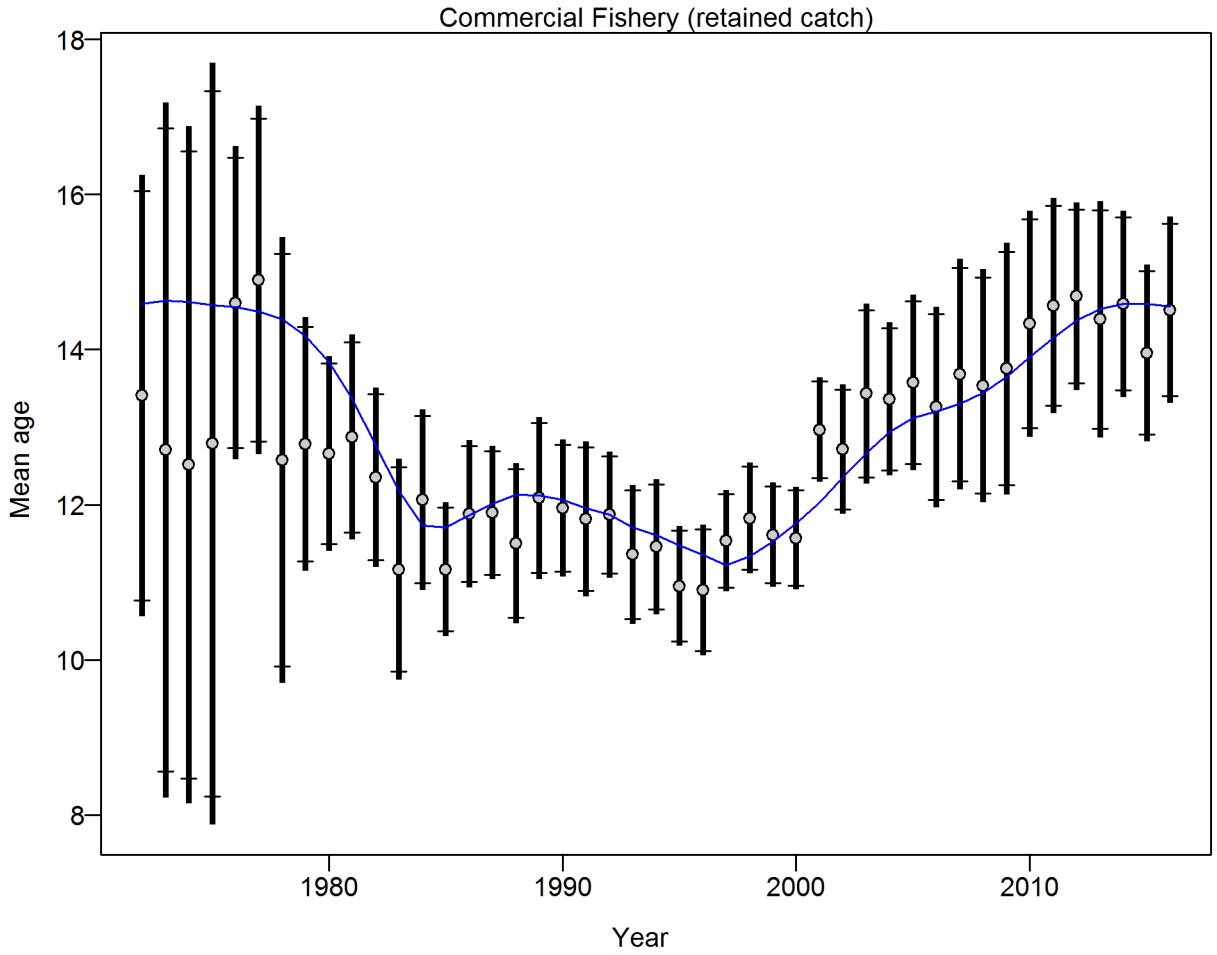


Figure 32: **Northern model** Mean age for Commercial Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for age data from Commercial Fishery: 1.1663 (0.7815_1.9908) 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_agefit_data_weighting_TA1.8_Comme

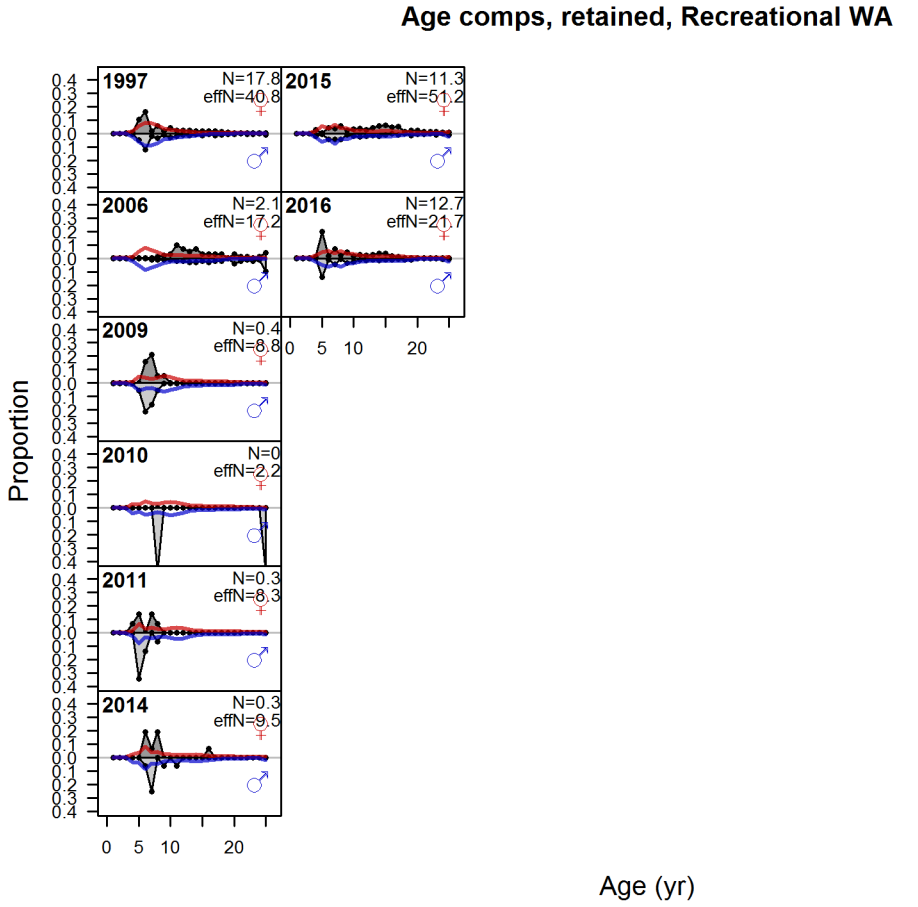


Figure 33: **Northern model** Age comps, retained, Recreational WA [`fig:mod1_6_comp_agefit`

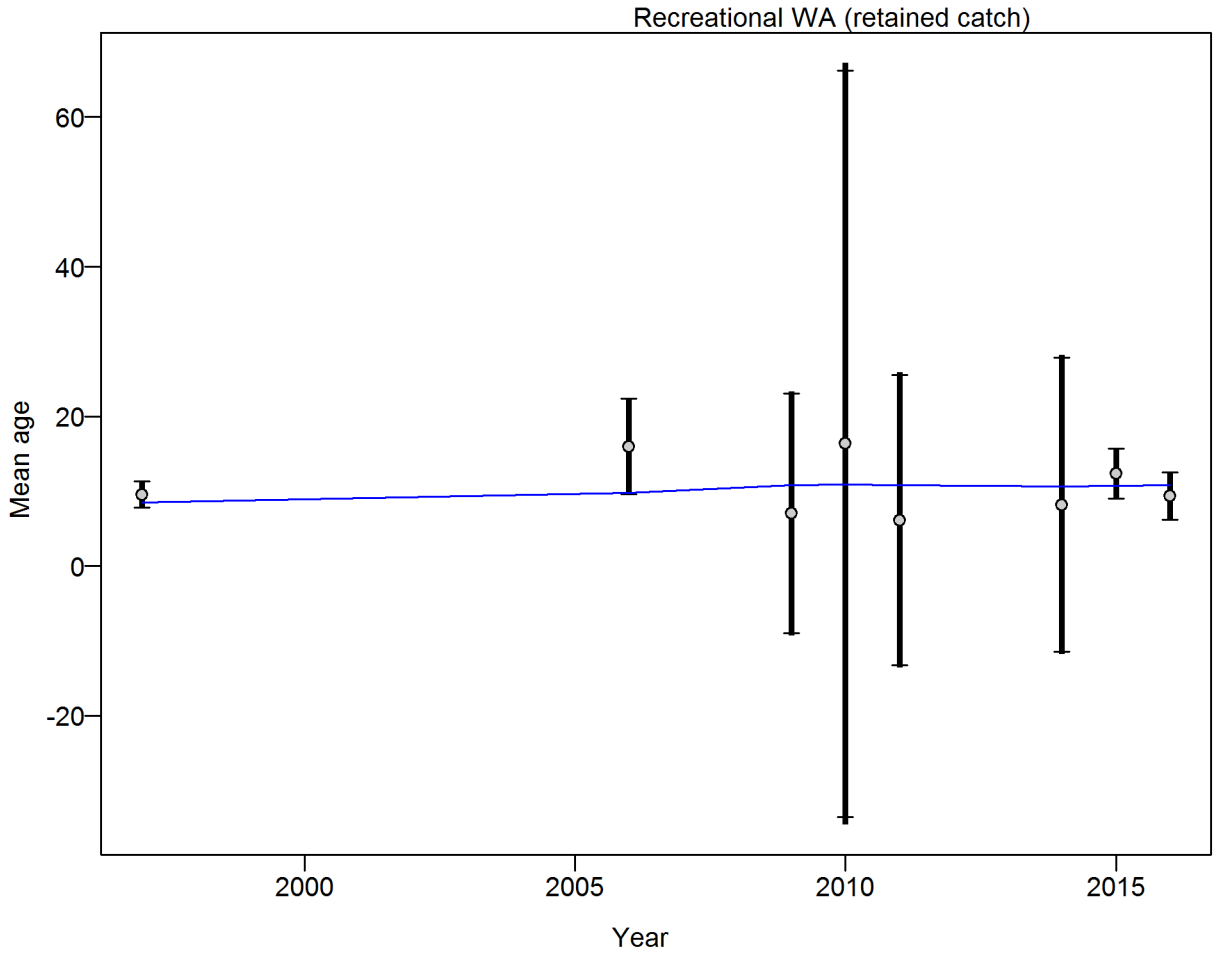


Figure 34: **Northern model** Mean age for Recreational WA with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for age data from Recreational WA: 1.0396 (0.6808_3.6904) 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_agefit_data_weighting_TA1.8_Recreational`

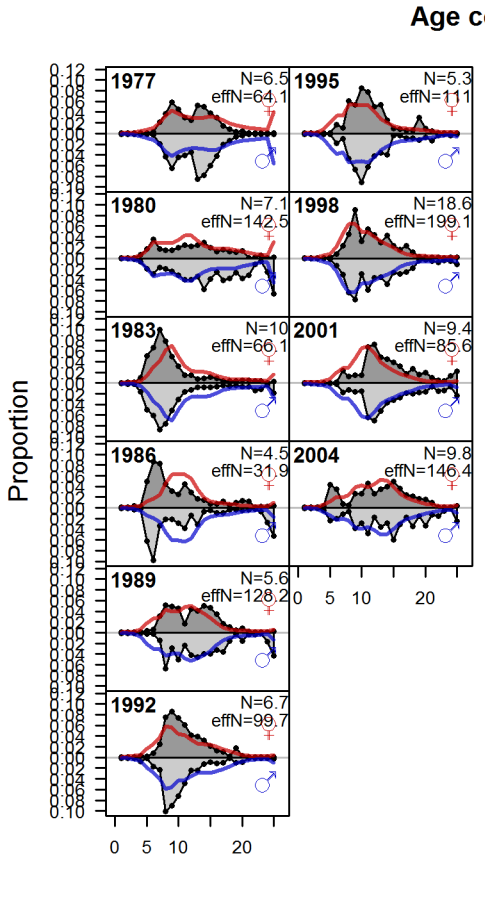


Figure 35: **Northern model** Age comps, retained, Triennial Survey [fig:mod1_10_comp_agefit

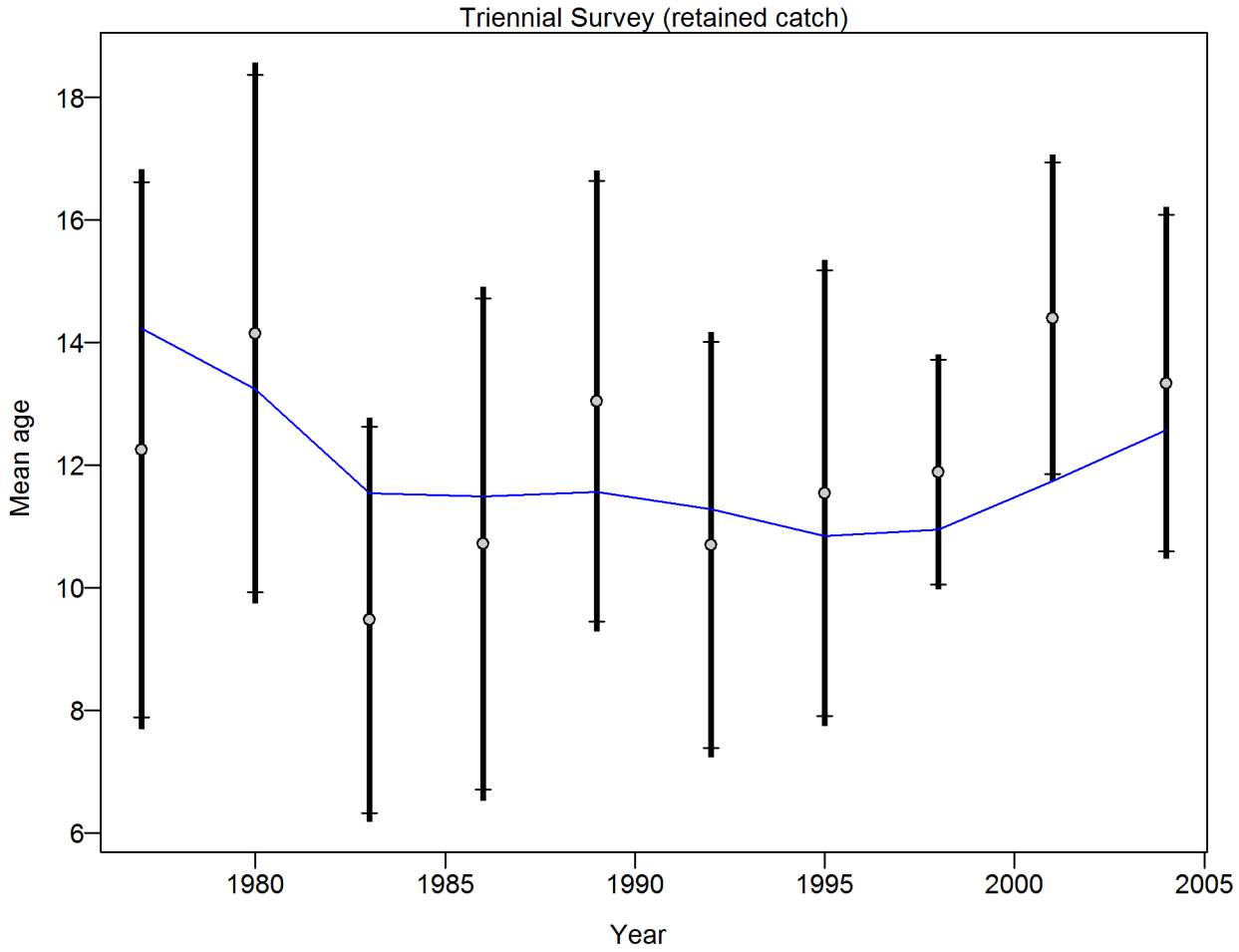


Figure 36: **Northern model** Mean age for Triennial Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for age data from Triennial Survey: 1.0944 (0.6479_3.5223) 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_agefit_data_weighting_TA1.8_Triennial Su

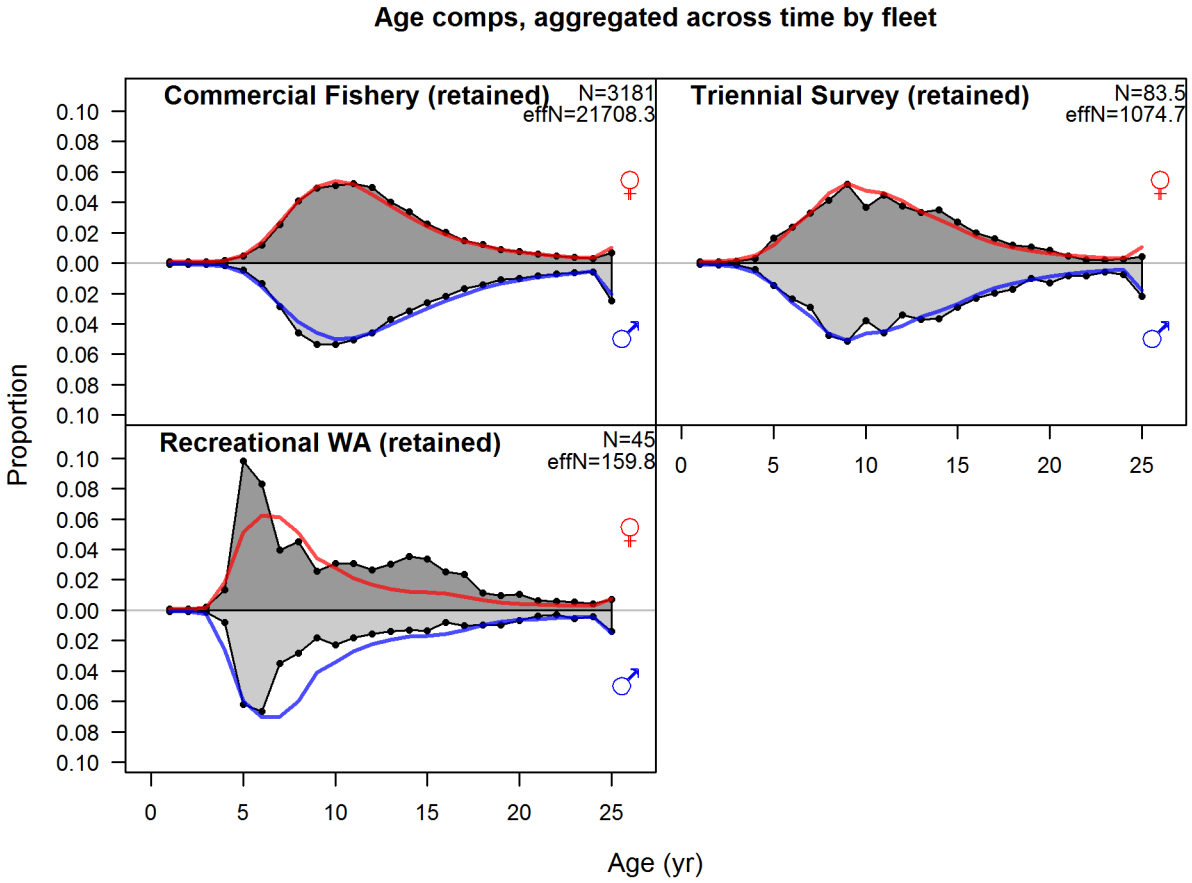


Figure 37: **Northern model** Age comps, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. `fig:mod1_14_comp_agefit__aggregated_across_time`

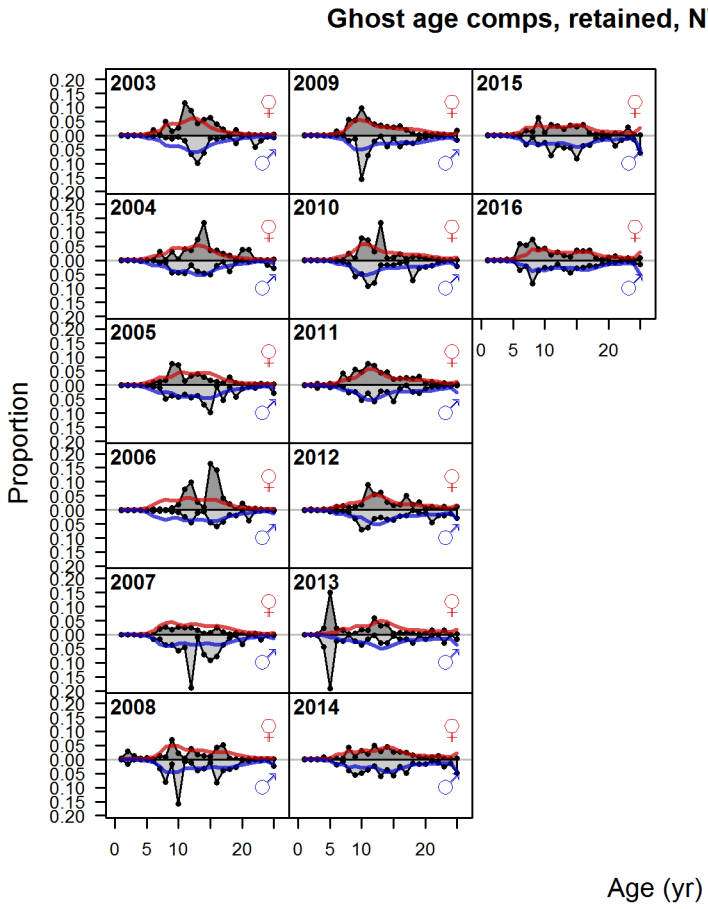


Figure 38: **Northern model** Ghost age comps, retained, NWFSC Combo Survey (fig:mod1_16_comp

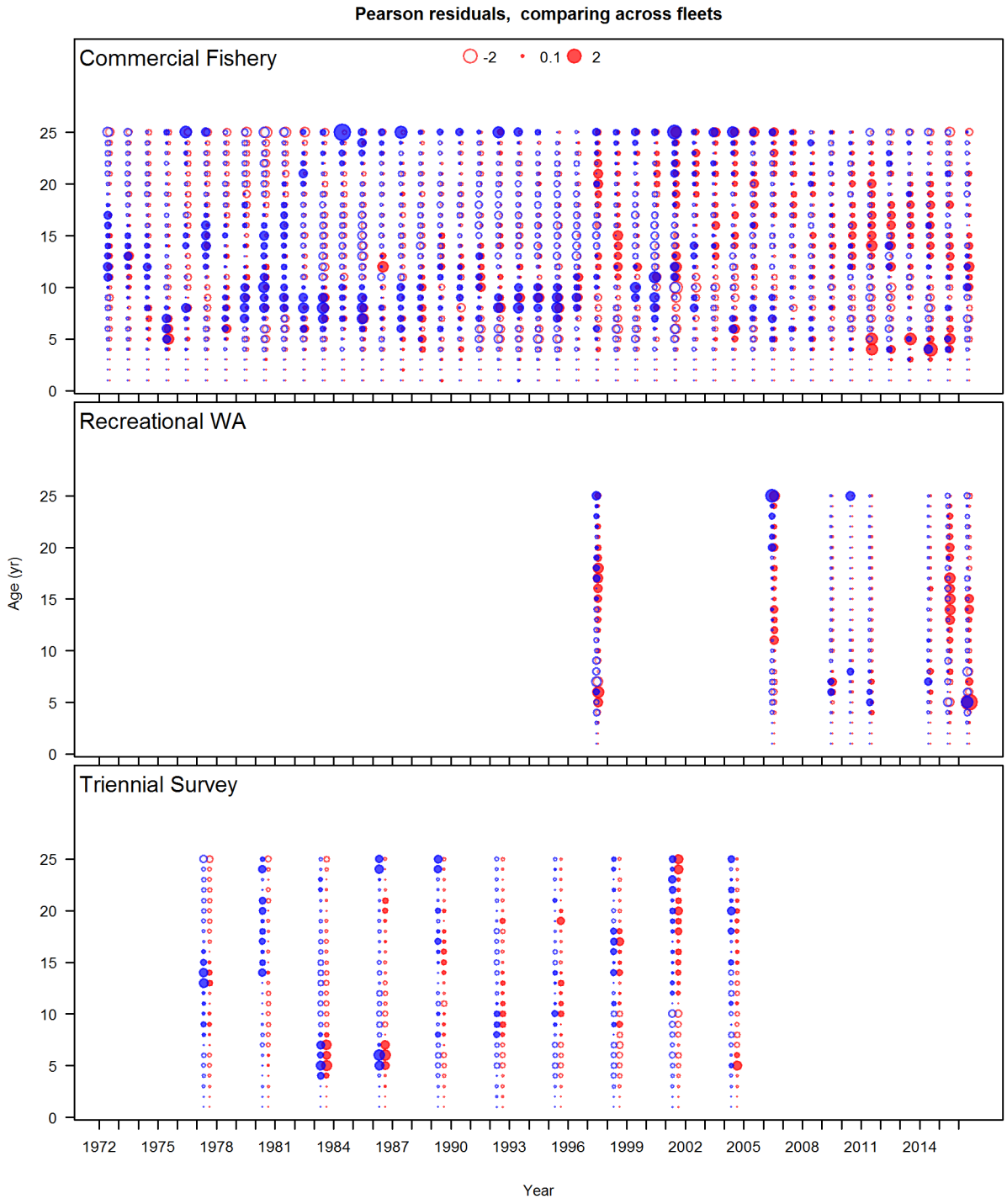


Figure 39: Age composition Pearson residuals for all fleets in the Northern model. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). Bubble colors indicate unsexed fish (gray), females (red), and males (blue).[fig:comp_Pearson_age_mod1]

9.2.5 Fits to conditional-age-at-length compositions for Northern model

fits-to-conditional-age-at-length-compositions-for-northern-model

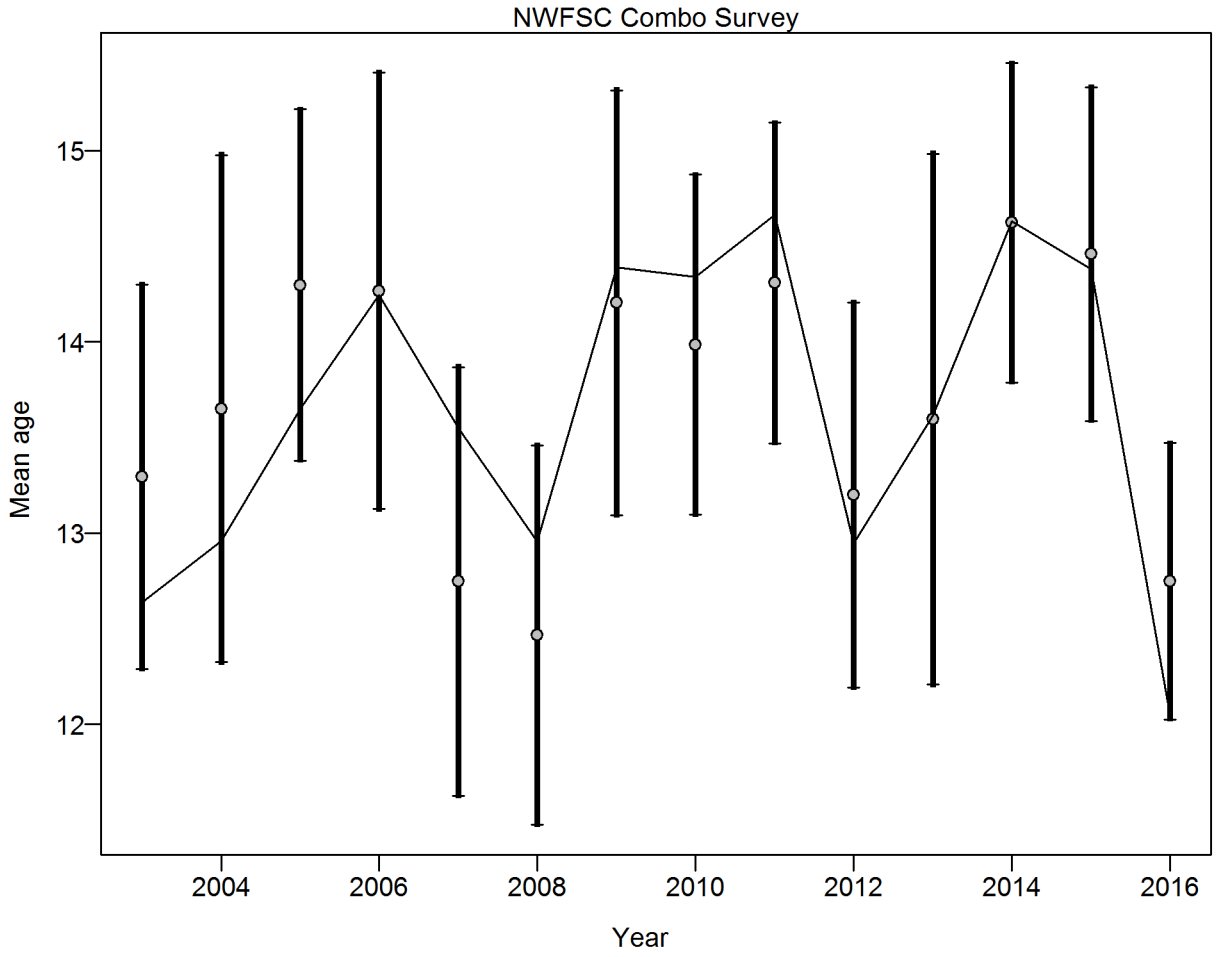


Figure 40: **Northern model** Mean age from conditional data (aggregated across length bins) for NWFSC Combo Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for conditional age_at_length data from NWFSC Combo Survey: 1.0265 (0.6813_2.4963) 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_3_comp_condAALfit_data_weighting_TA1.8_c

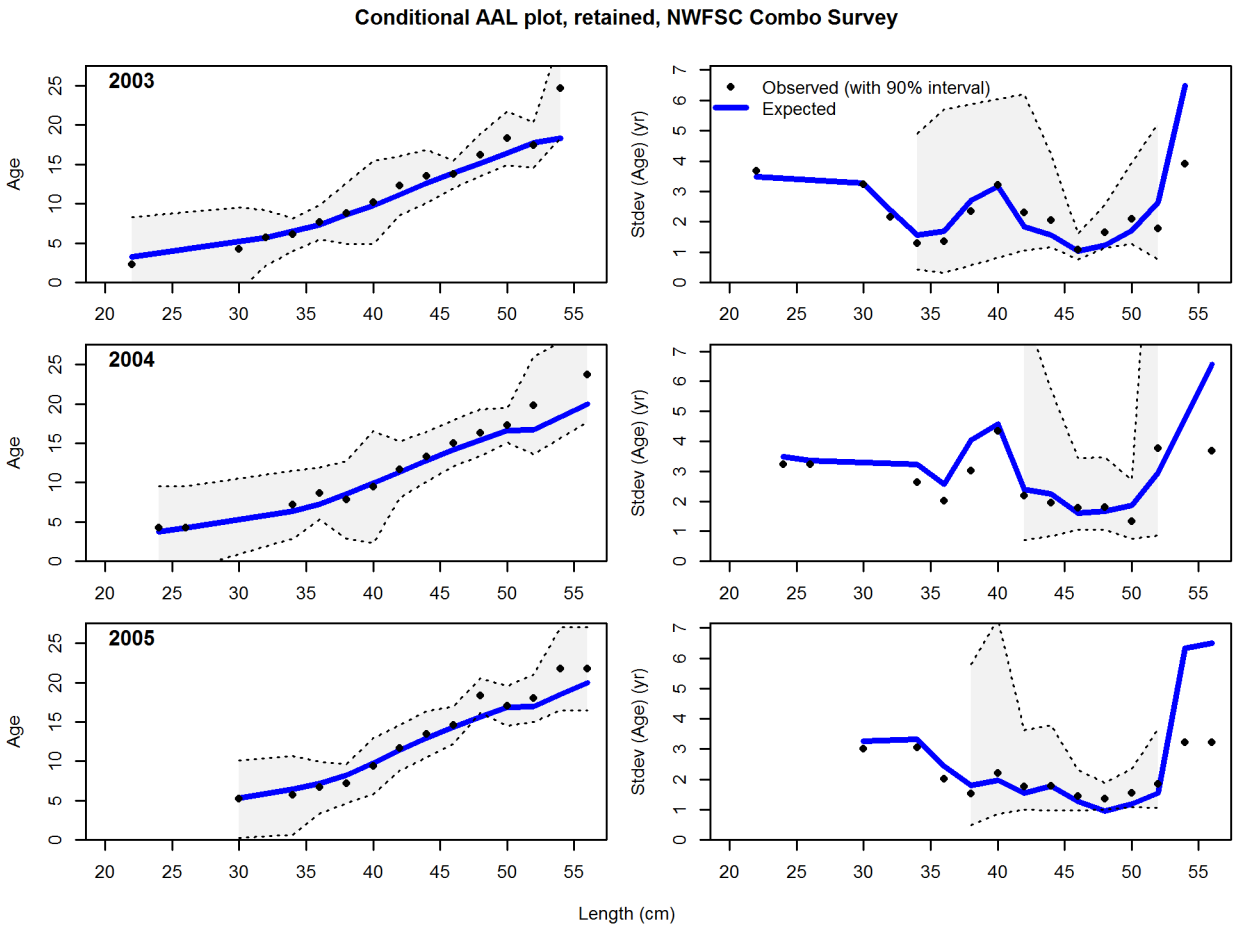
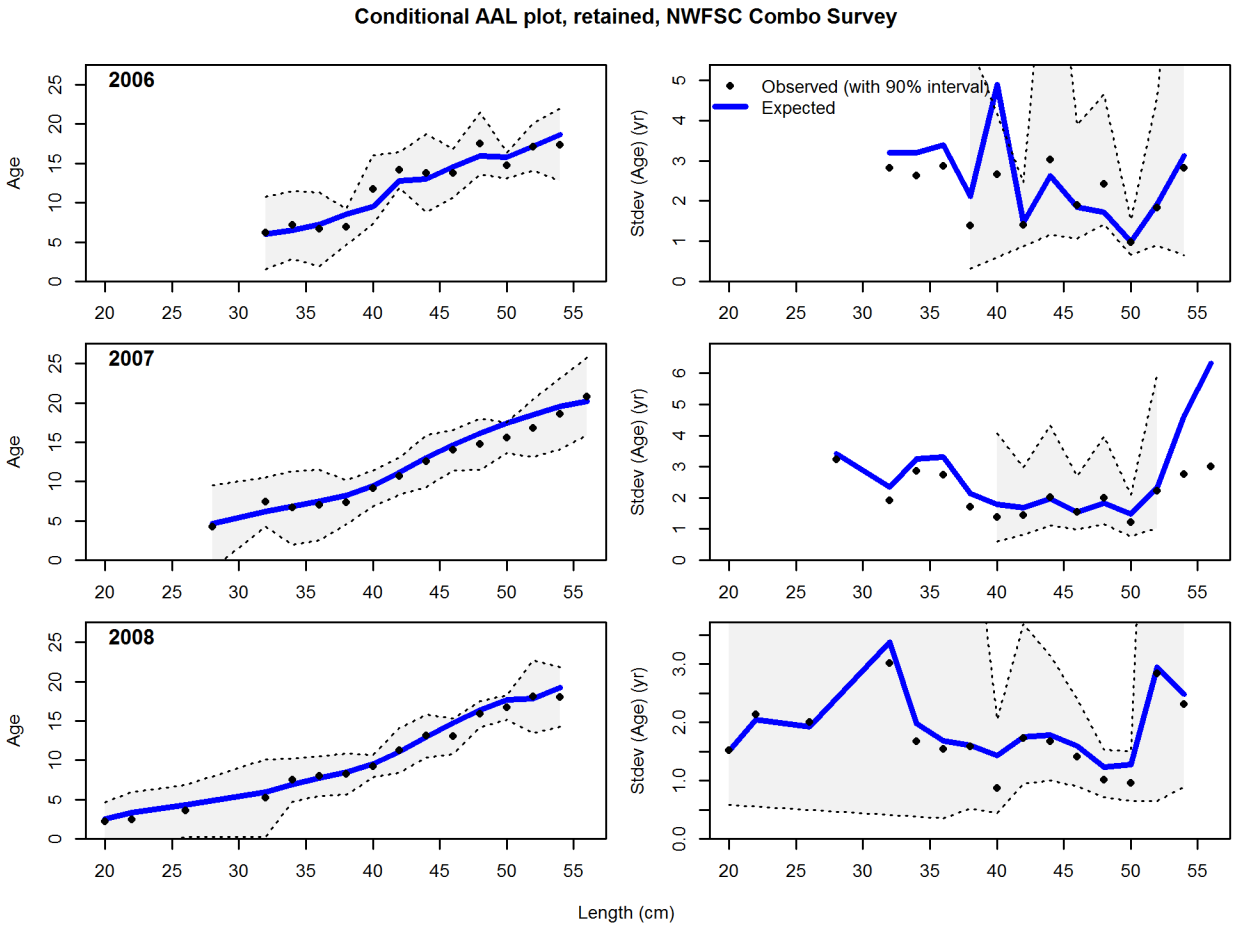
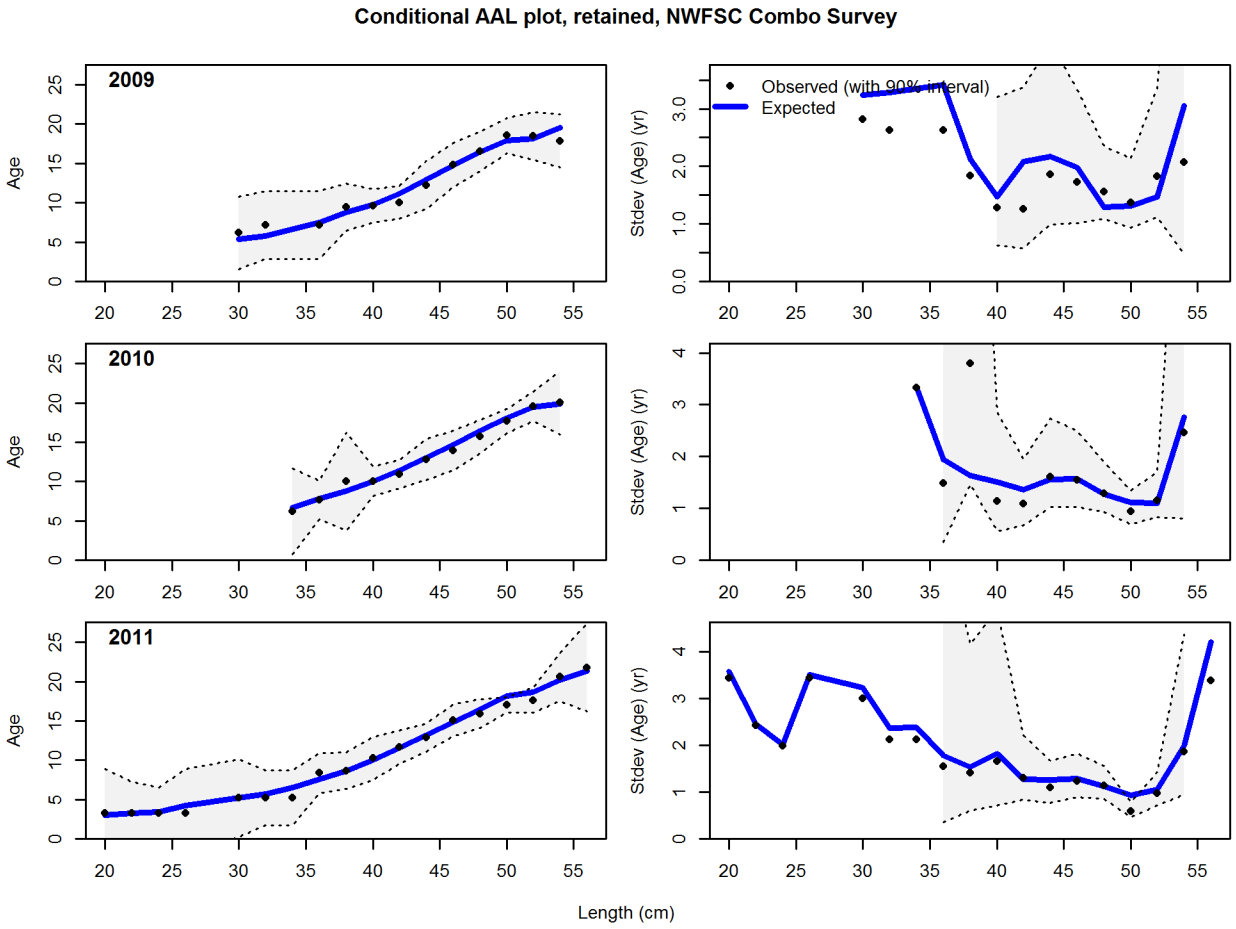


Figure 41: **Northern model** Conditional AAL plot, retained, NWFSC Combo Survey (plot 1 of 5) These plots show mean age and std. dev. in conditional AAL. Left plots are mean AAL by size_class (obs. and pred.) with 90% CIs based on adding 1.64 SE of mean to the data. Right plots in each pair are SE of mean AAL (obs. and pred.) with 90% CIs based on the chi_square distribution. [fig:mod1_4_comp_condAALfit_Andre_plotsflt6mkt2_page1]



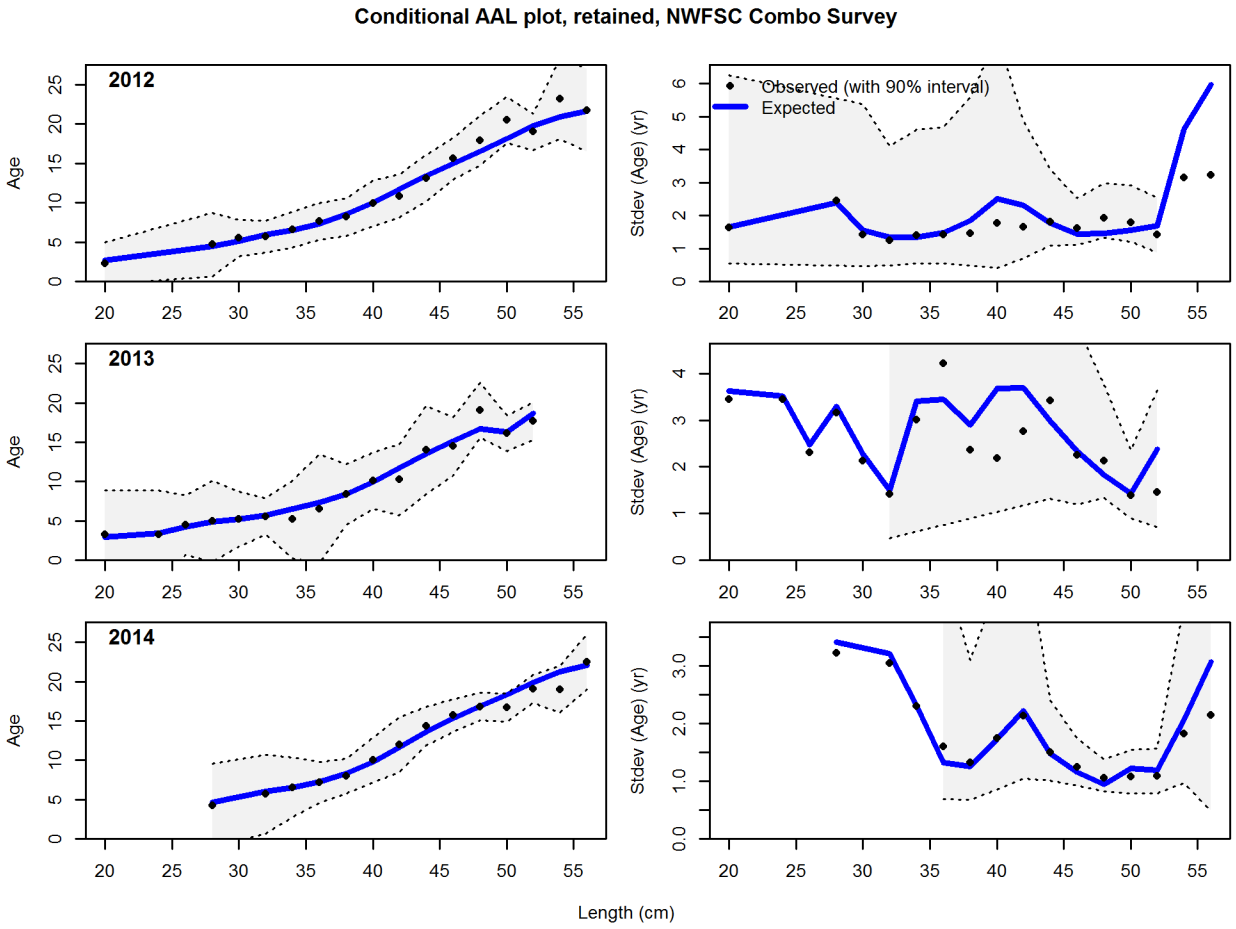
665

666 Figure continued from previous page



667

668 Figure continued from previous page



669

670 Figure continued from previous page

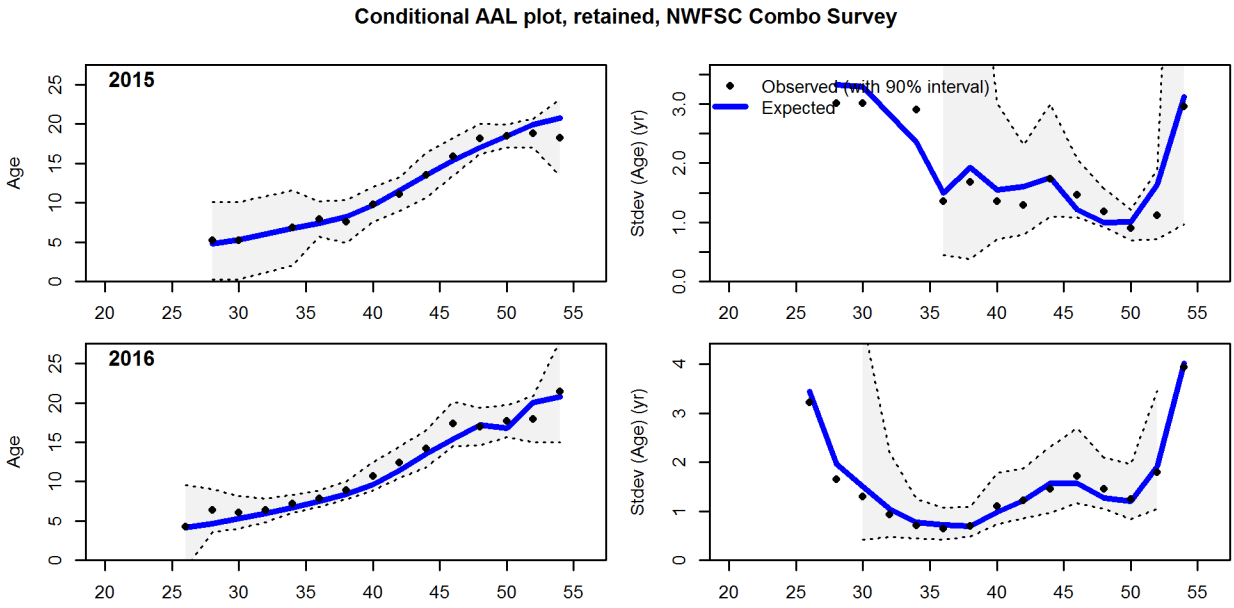


Figure continued from previous page

9.3 Model results for Northern model model-results-for-northern-model

9.3.1 Base model results for Northern model base-model-results-for-northern-model

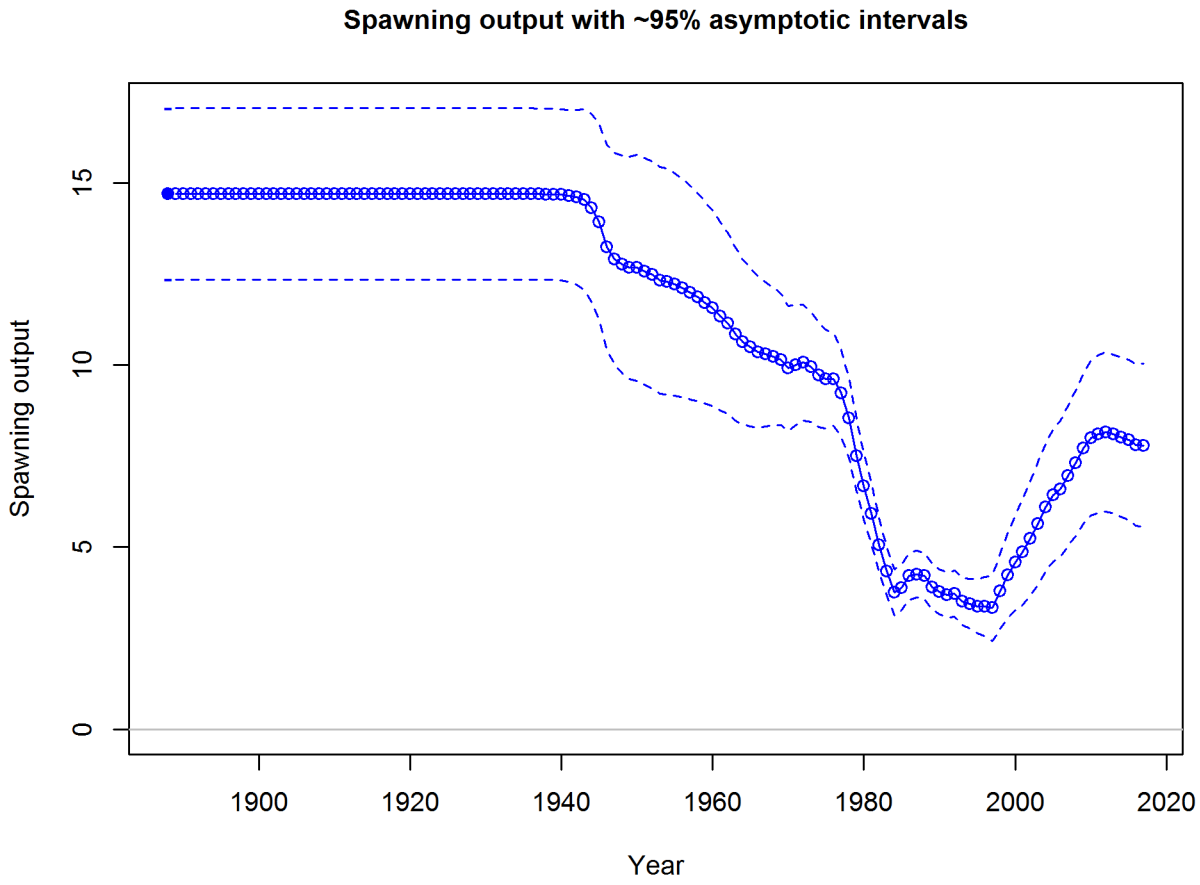


Figure 42: Estimated time-series of spawning output for Northern model. fig:ssb

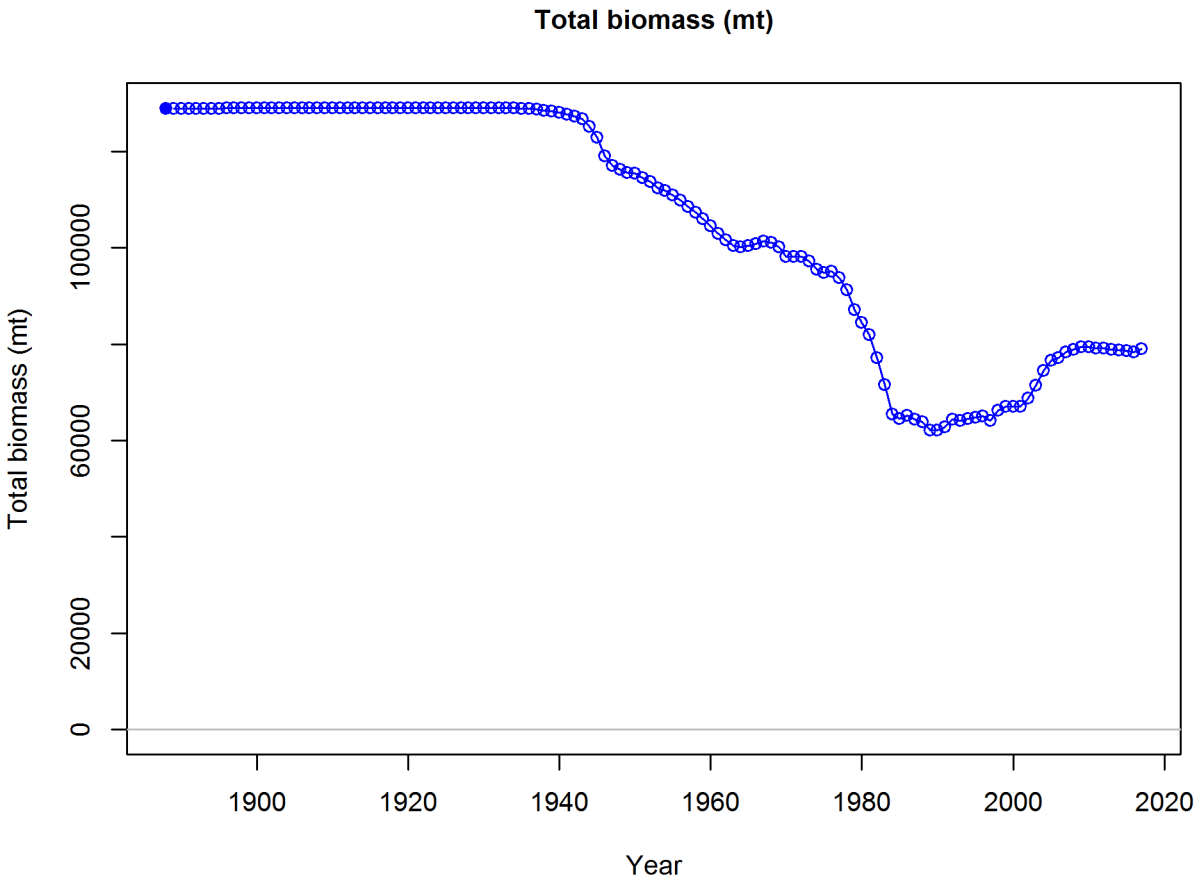


Figure 43: Estimated time-series of total biomass for Northern model. fig:total_bio

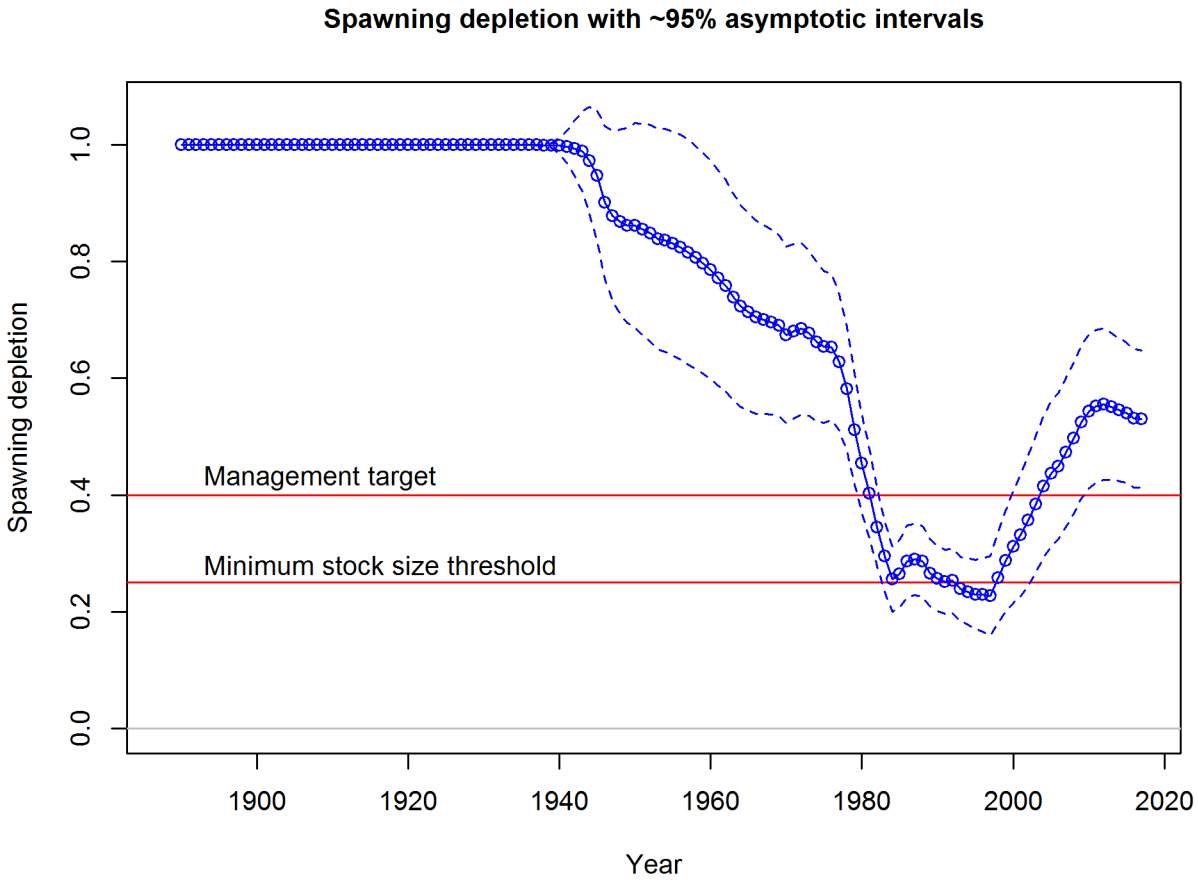


Figure 44: Estimated time-series of relative biomass for Northern model. [fig:depl

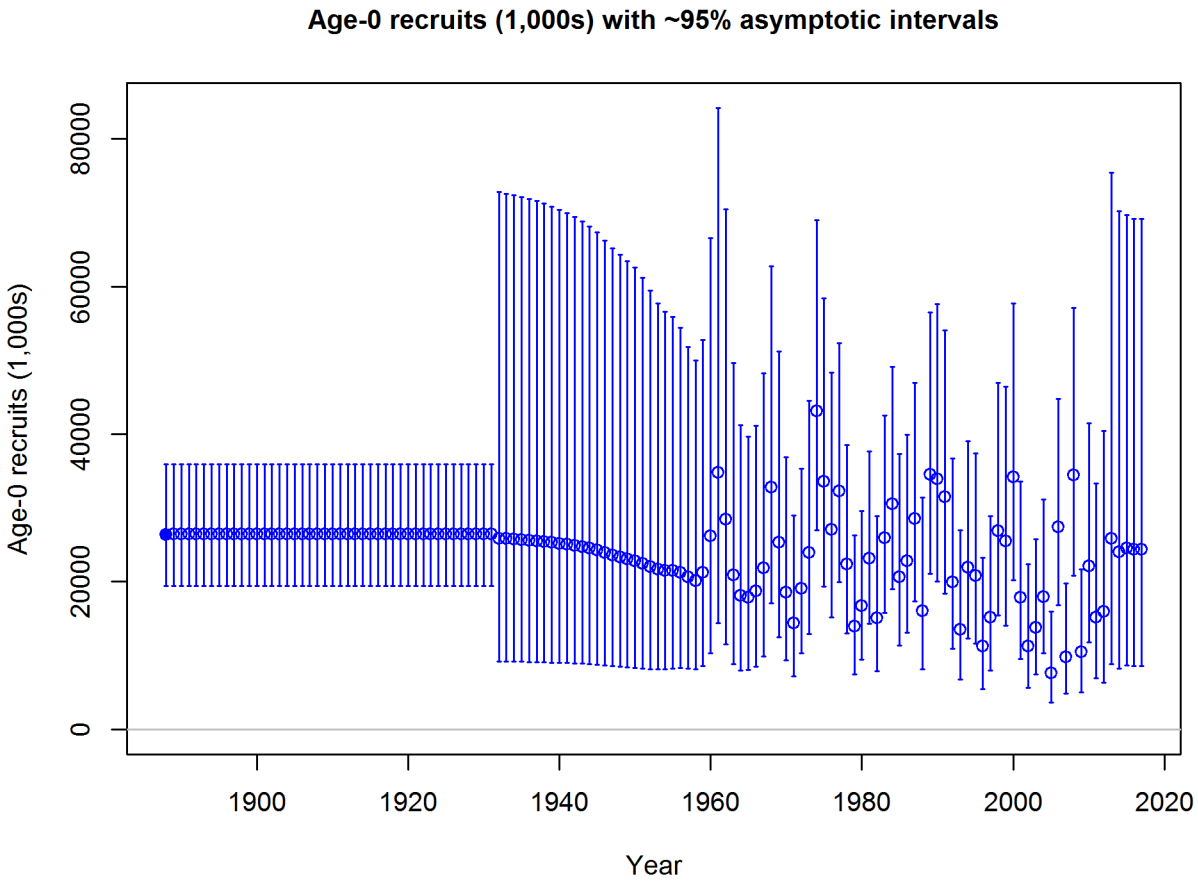


Figure 45: Estimated time-series of recruitment for the Northern model. [fig:recruits1

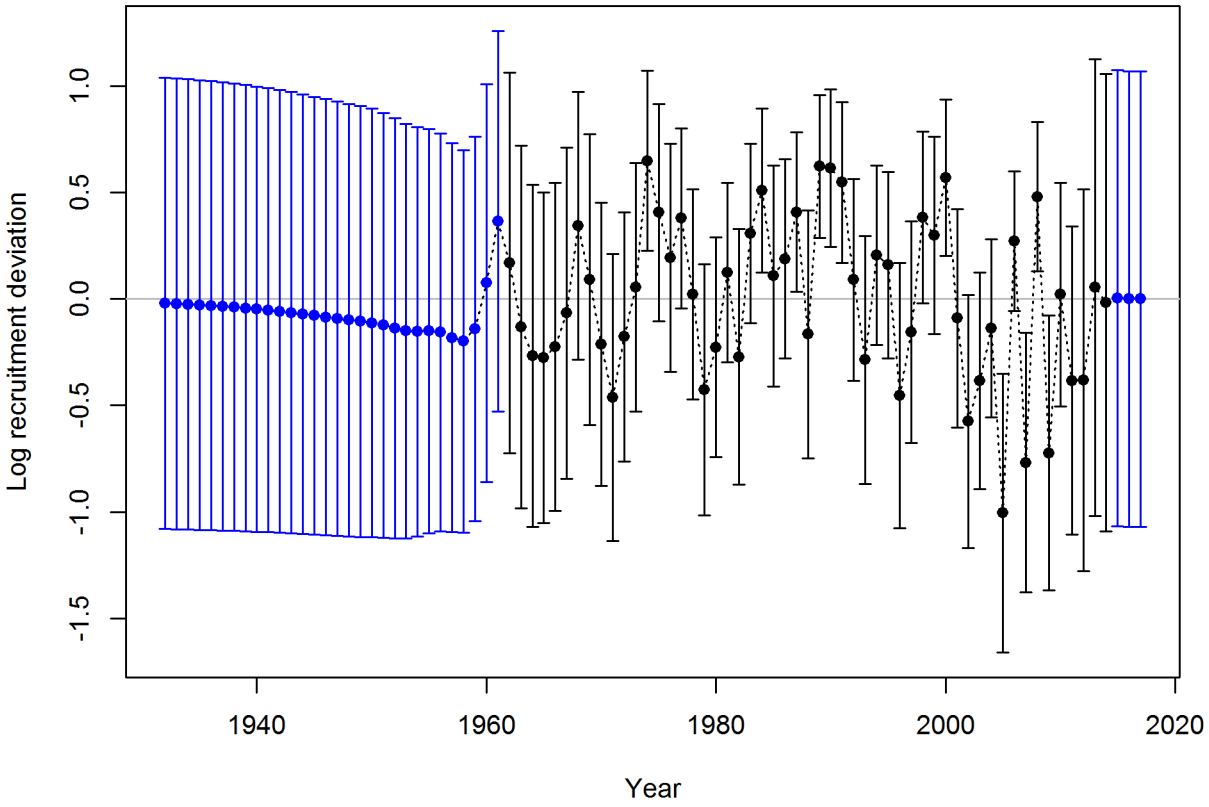


Figure 46: Estimated time-series of recruitment deviations for the Northern model. [fig:recdevs1]

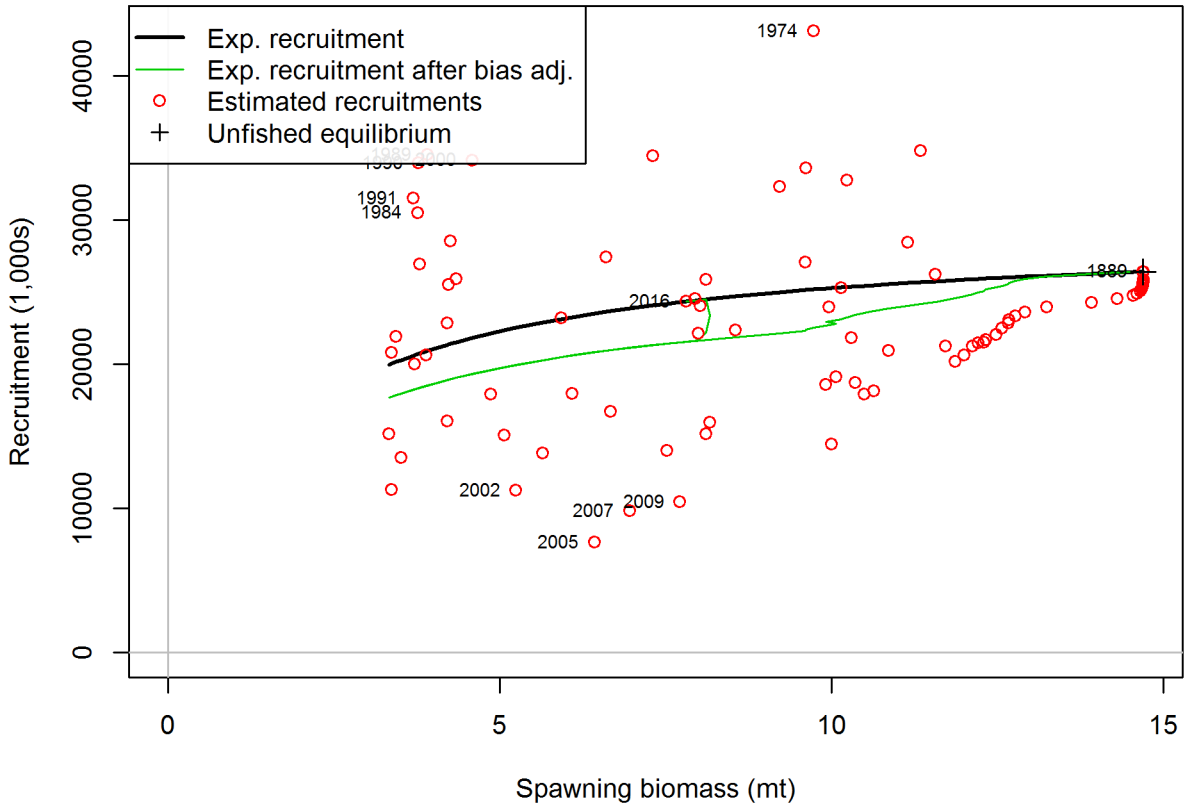


Figure 47: Estimated recruitment (red circles) for the Northern model relative to the stock-recruit relationship (black line). The green line shows the effect of the bias correction for the lognormal distribution [fig:stock_recruit_curve]

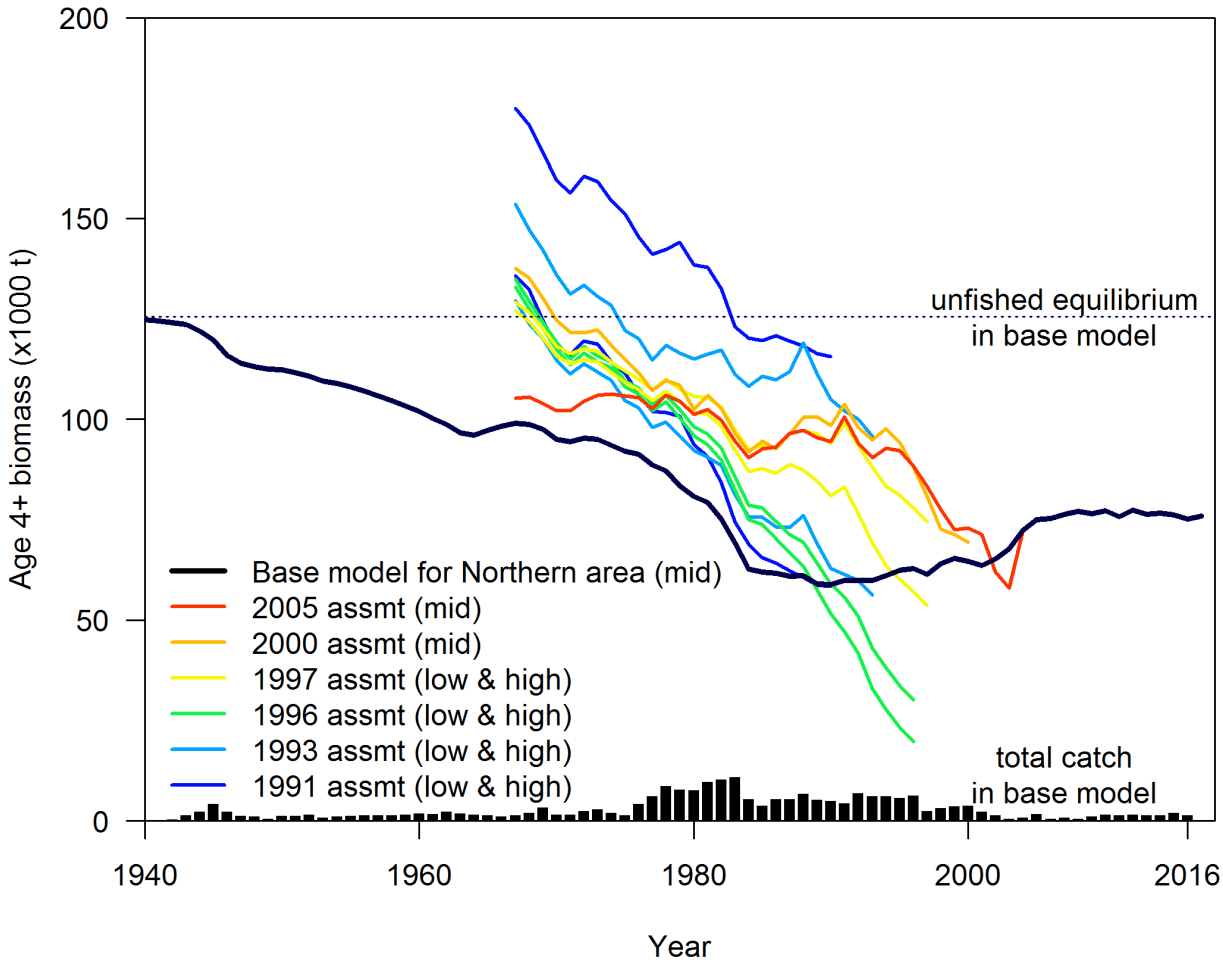


Figure 48: Comparison of time series of age 4+ biomass for Yellowtail Rockfish across past assessments. ⌜fig:assessment_history

9.4 Data and model fits for Southern model

data-and-model-fits-for-southern-model

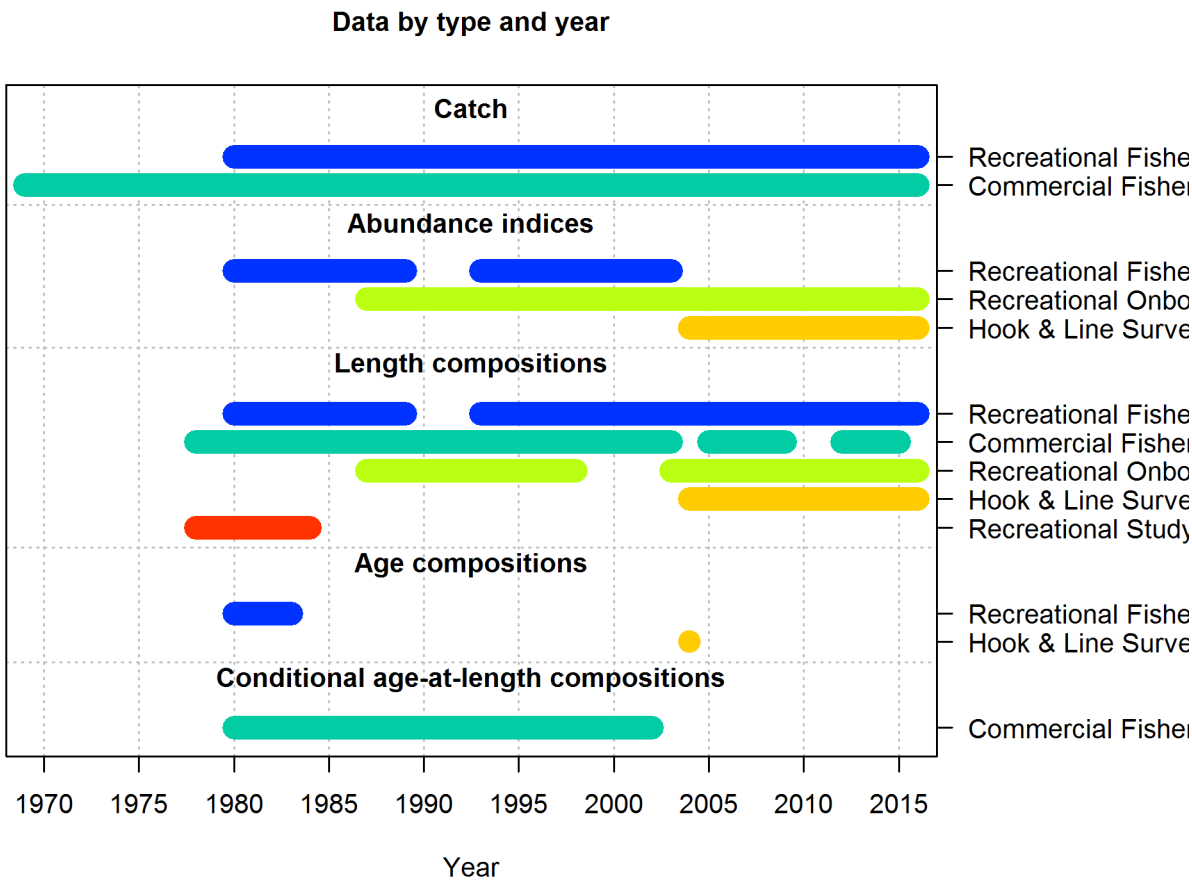


Figure 49: Summary of data sources used in the Southern model. fig:data_plot

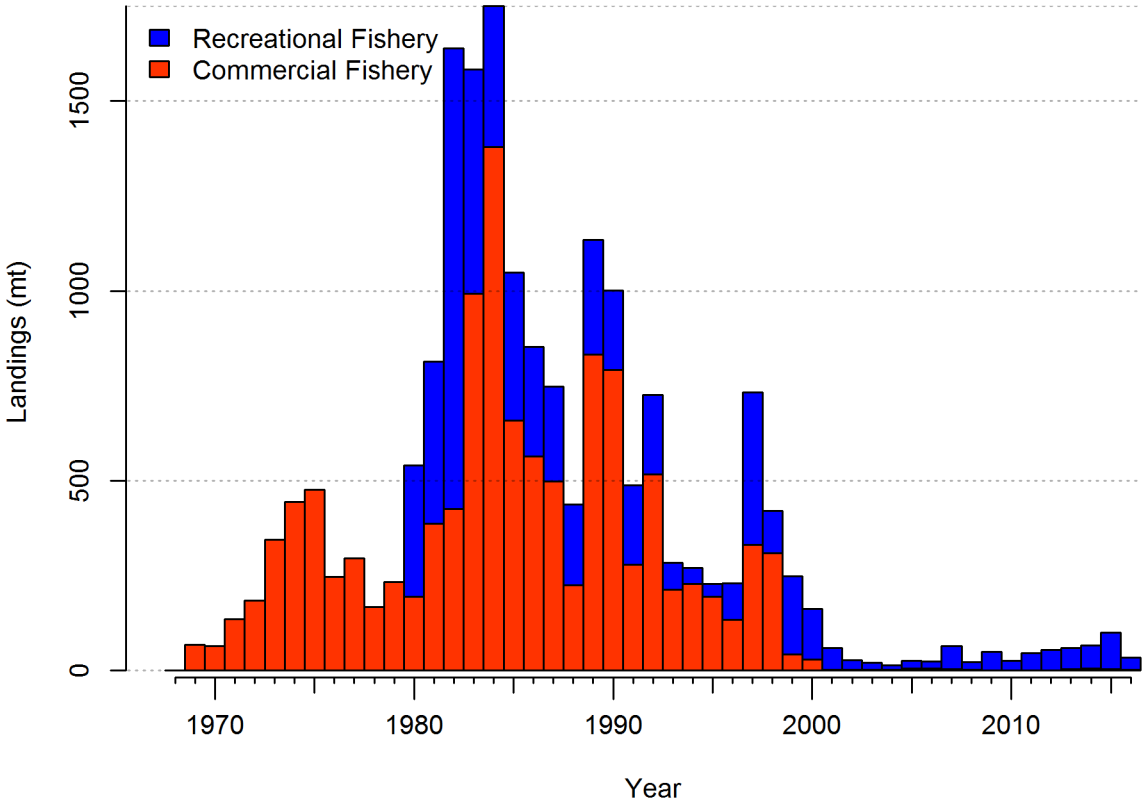


Figure 50: Estimated catch history of Yellowtail Rockfish in the Southern model. [fig:r4ss_catch2_S

9.4.1 Selectivity, retention, and discards for Southern model

selectivity-retention-and-discards-for-southern-model

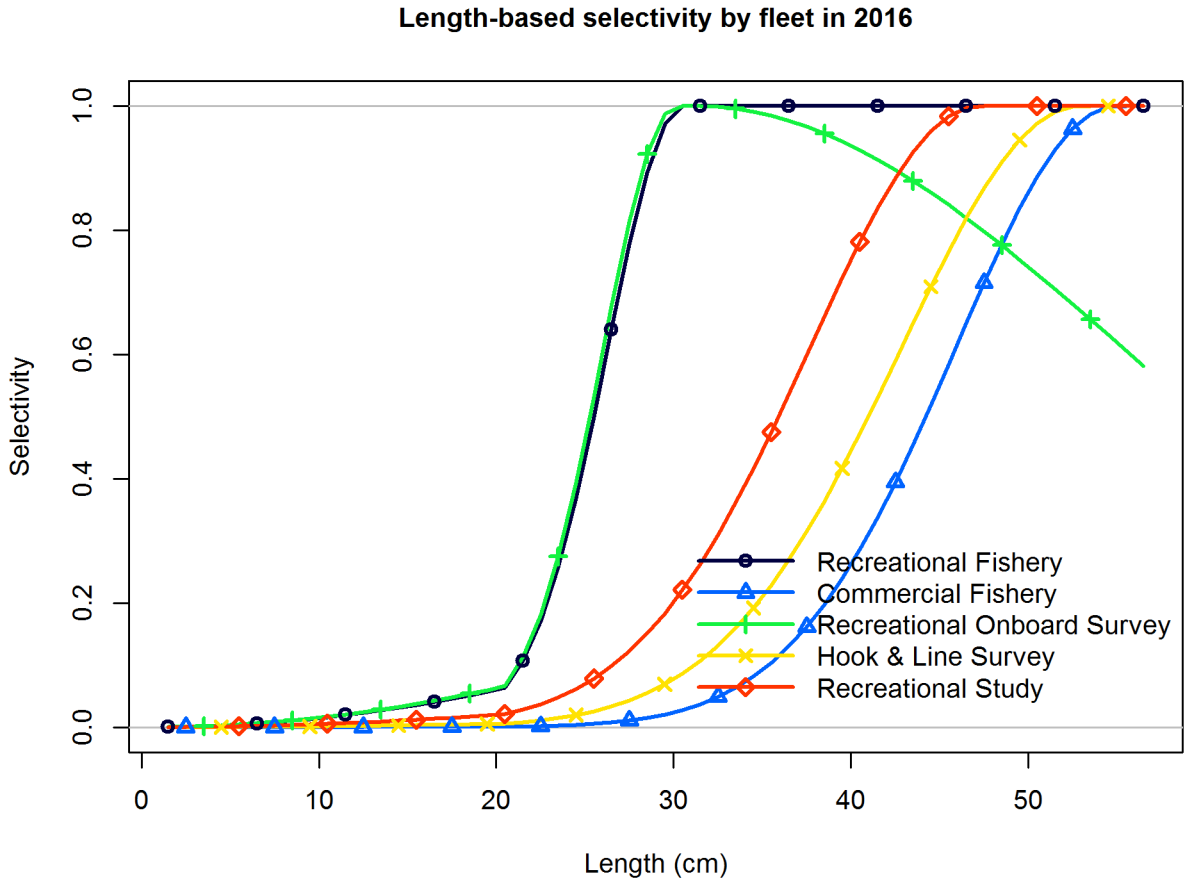


Figure 51: Estimated selectivity by length by each fishery and survey in the Southern model.

fig:selex

9.4.2 Fits to indices of abundance for Southern model

fits-to-indices-of-abundance-for-southern-model

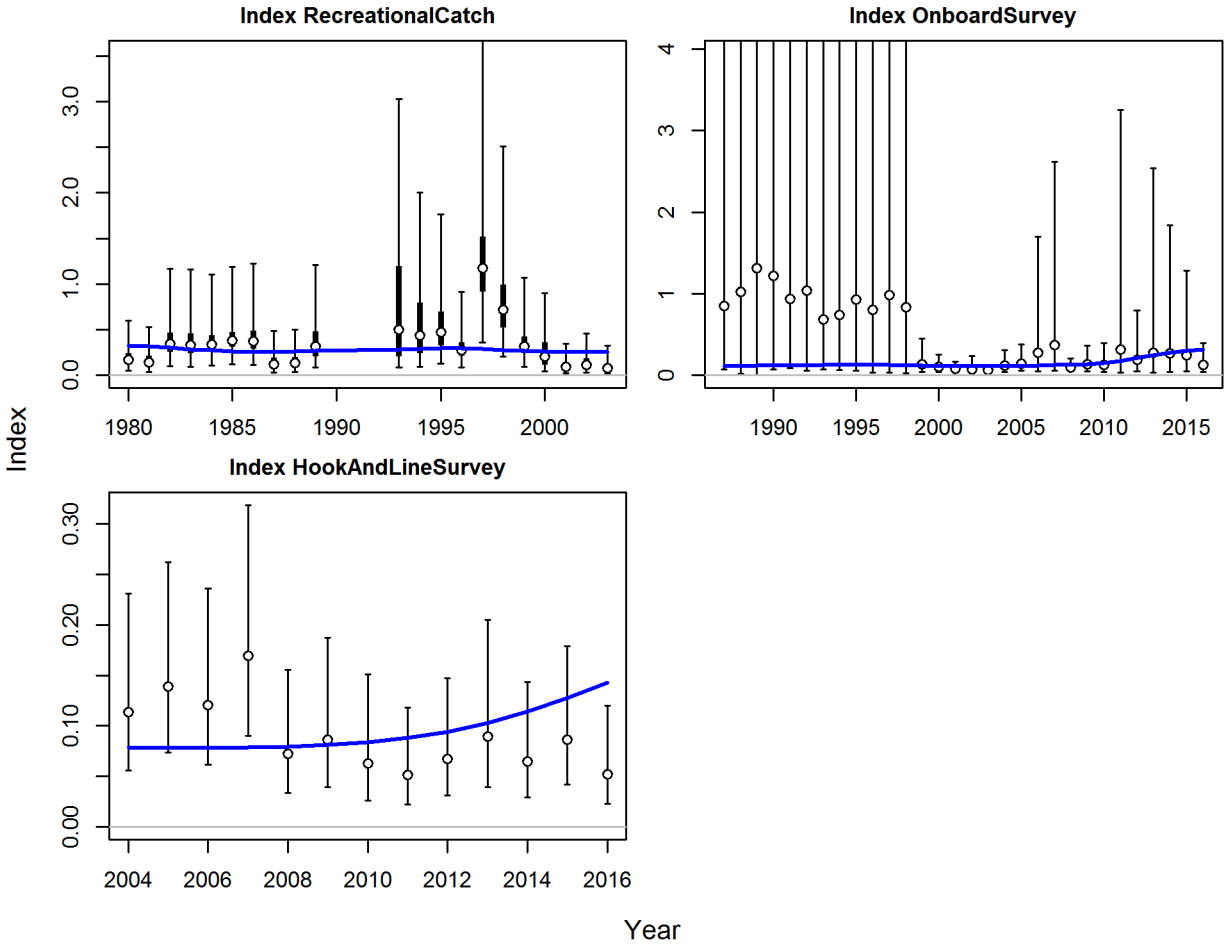


Figure 52: Estimated fits to the CPUE and survey indices for the Southern model. fig:index_fits2

9.4.3 Length compositions for Southern model

length-compositions-for-southern-model

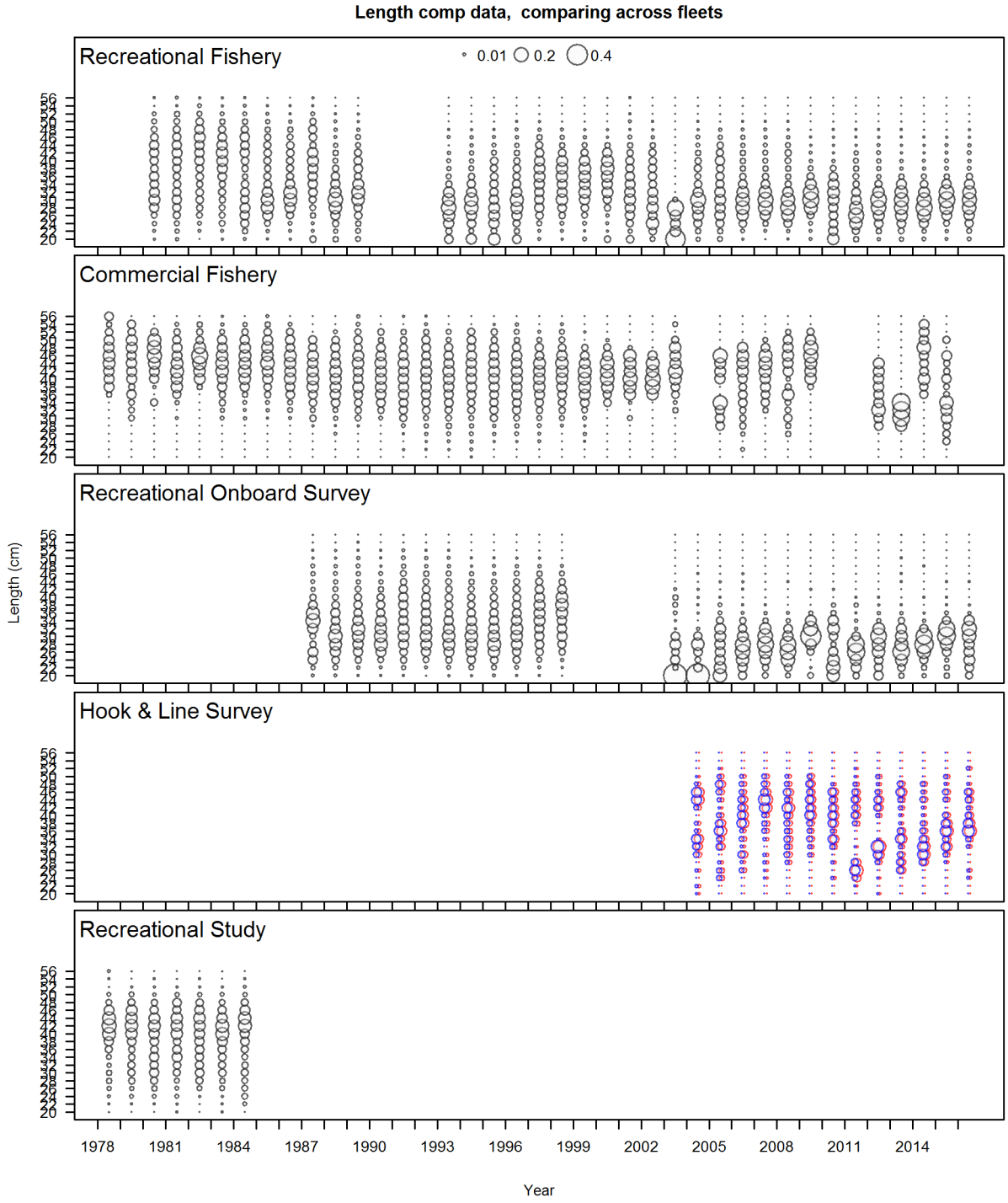


Figure 53: Length compositions for all fleets in the Southern model. Bubble size is proportional to proportions within each year. `fig:comp_length_bubble_mod2`

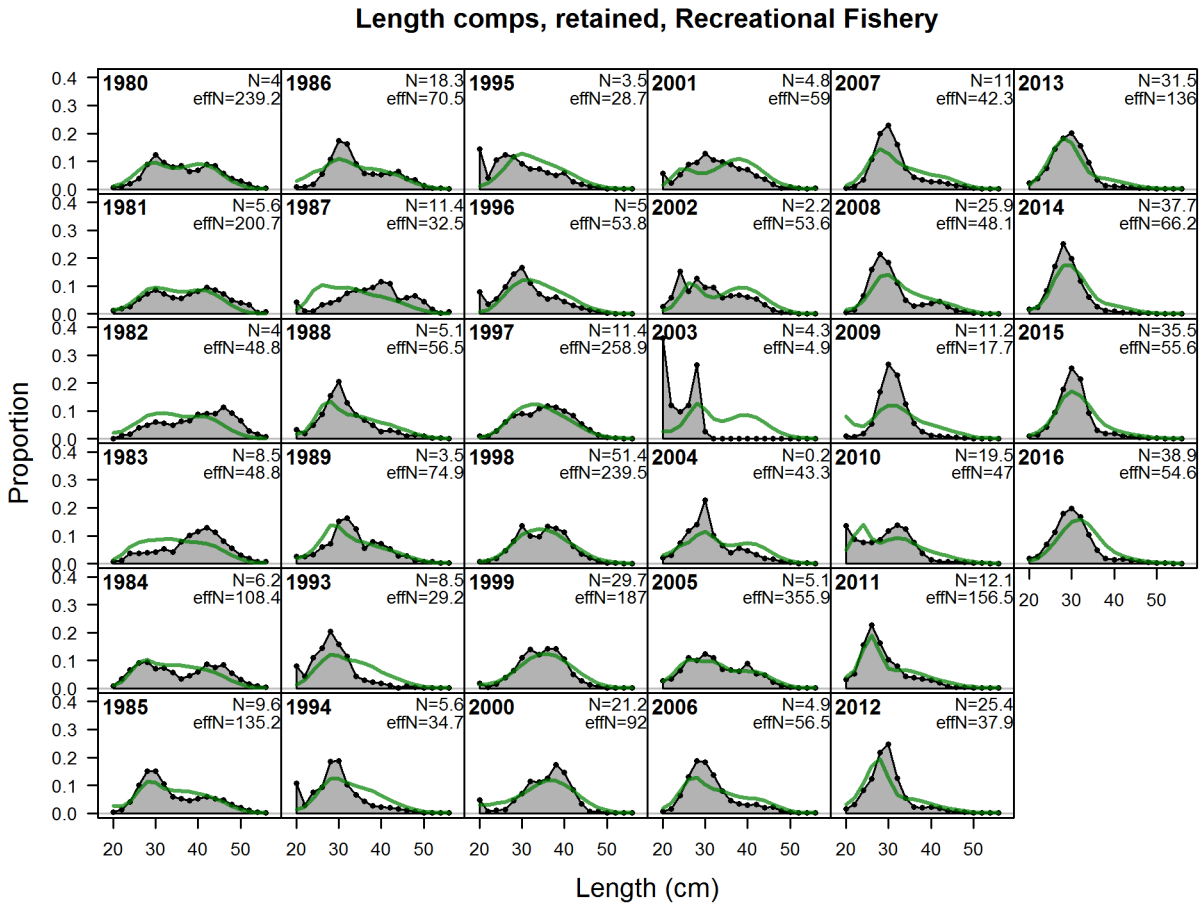


Figure 54: **Southern model** Length comps, retained, Recreational Fishery [fig:mod2_1_comp_len

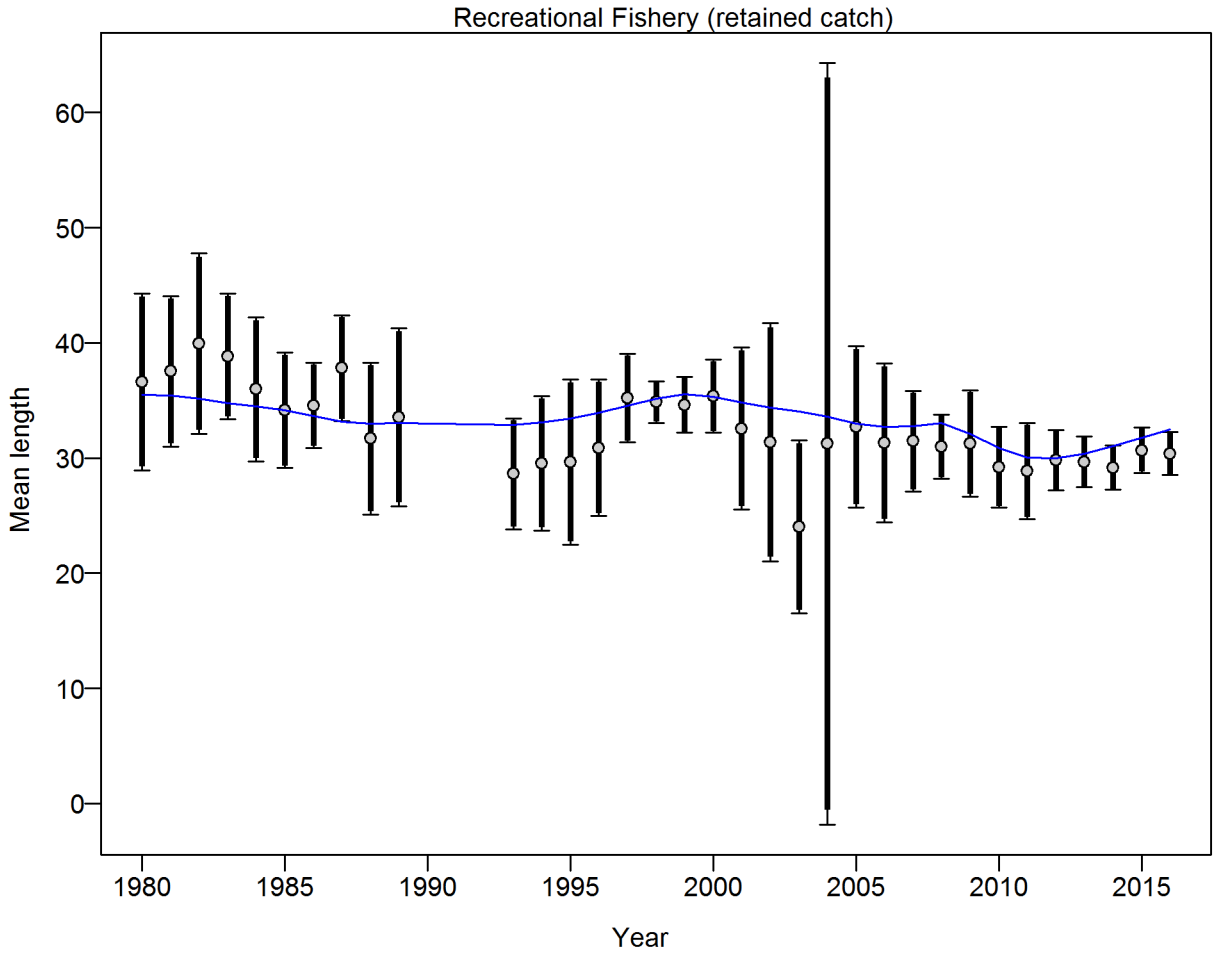


Figure 55: **Southern model** Mean length for Recreational Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Recreational Fishery: 0.9238 (0.6119_1.7256) 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:mod2_4_comp_lenfit_data_weighting_T

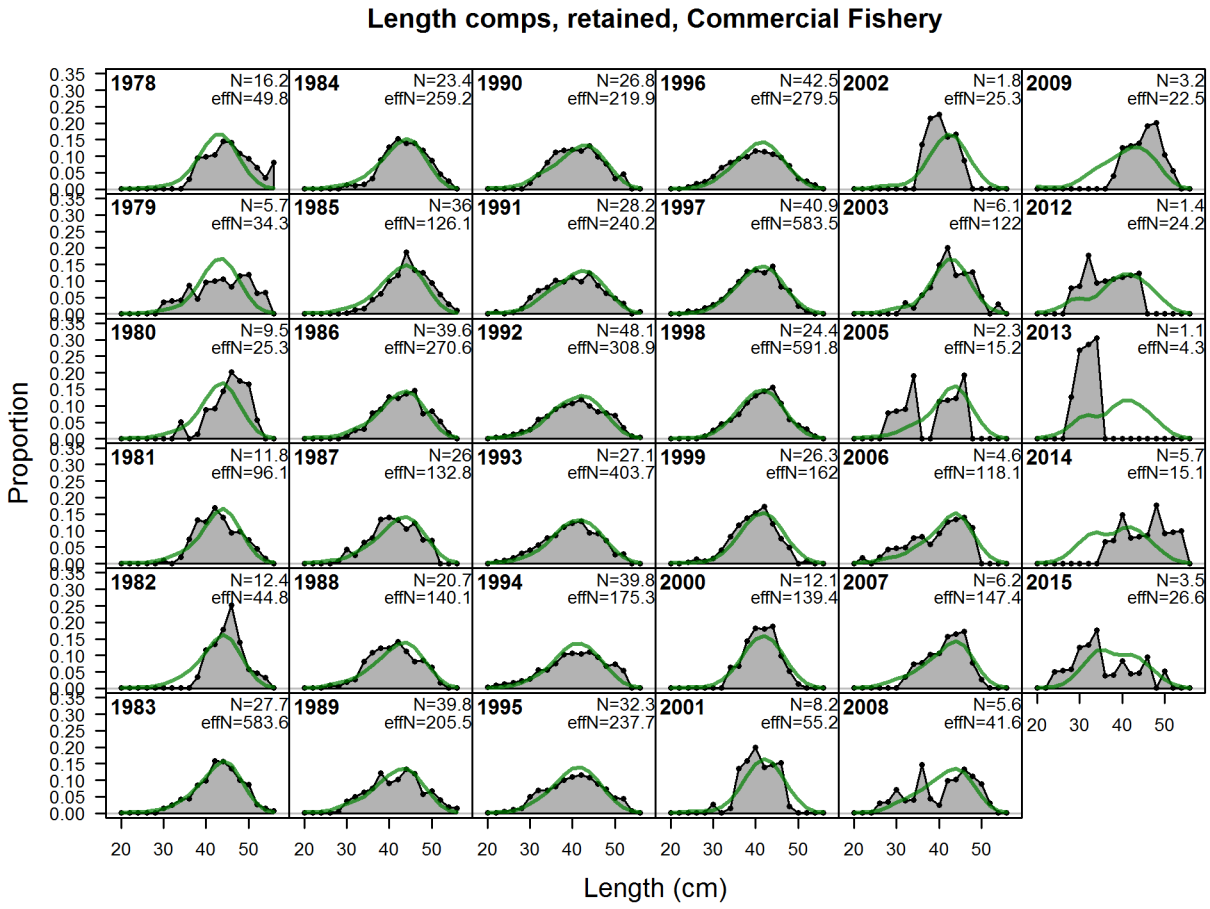


Figure 56: **Southern model** Length comps, retained, Commercial Fishery [fig:mod2_5_comp_len

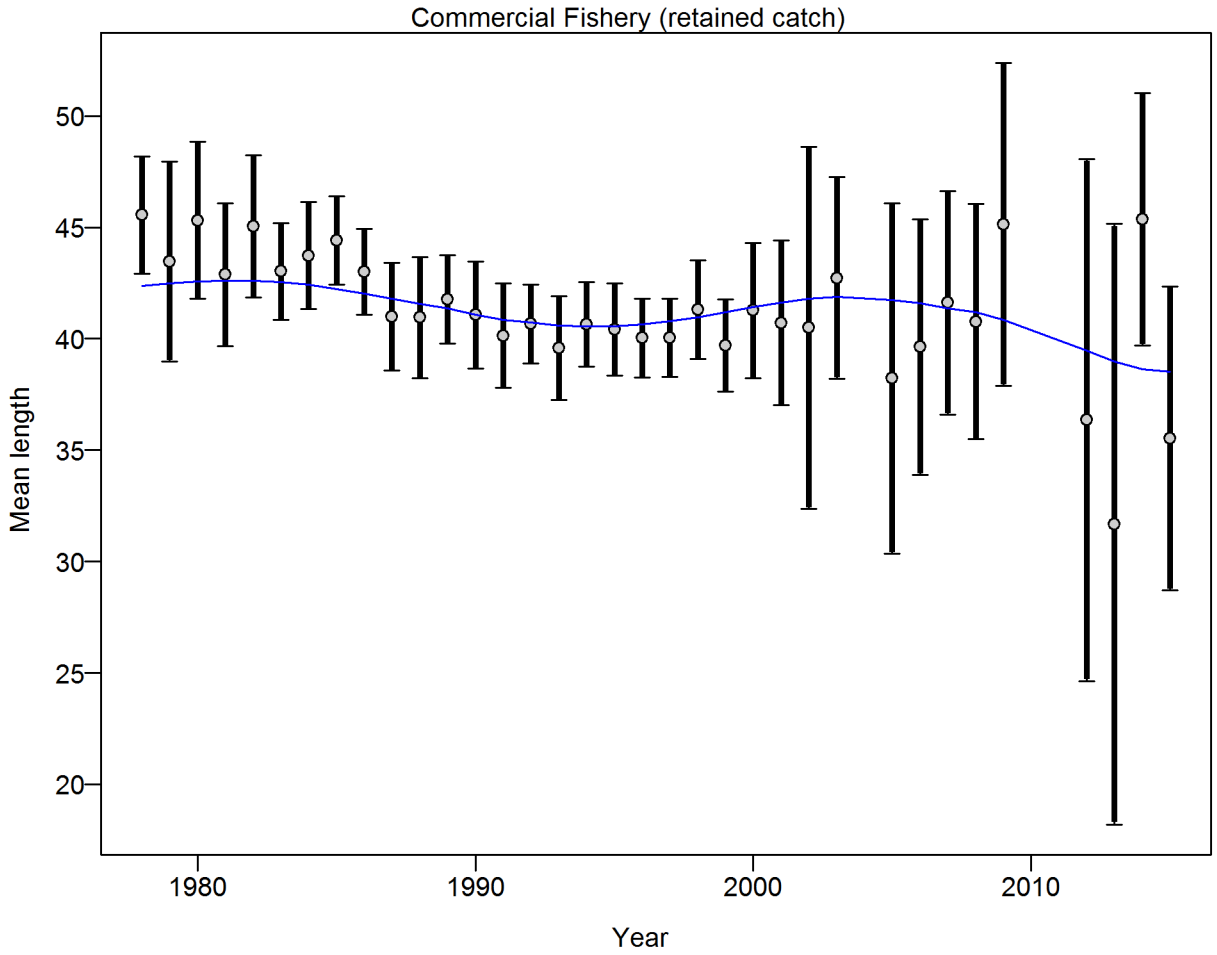


Figure 57: **Southern model** Mean length for Commercial Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Commercial Fishery: 0.9835 (0.6883_1.939) 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:mod2_8_comp_lenfit_data_weighting_T

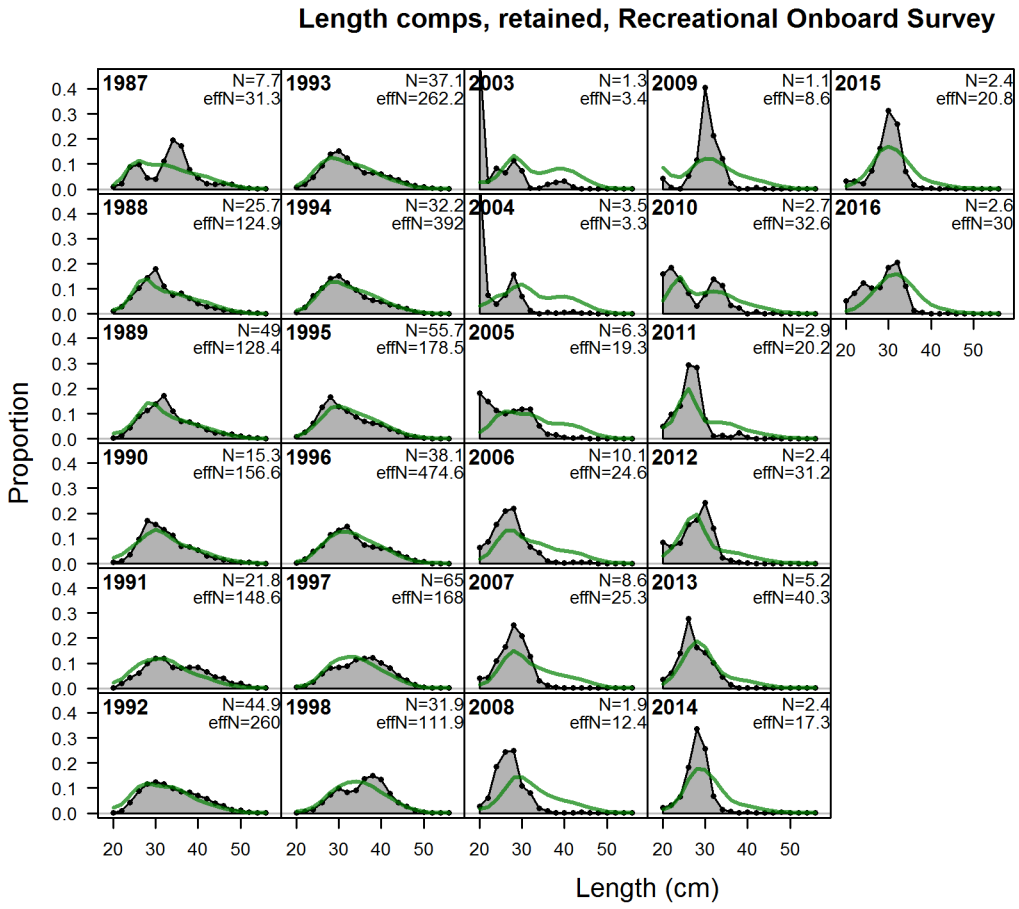


Figure 58: **Southern model** Length comps, retained, Recreational Onboard Survey [fig:mod2_9_comp

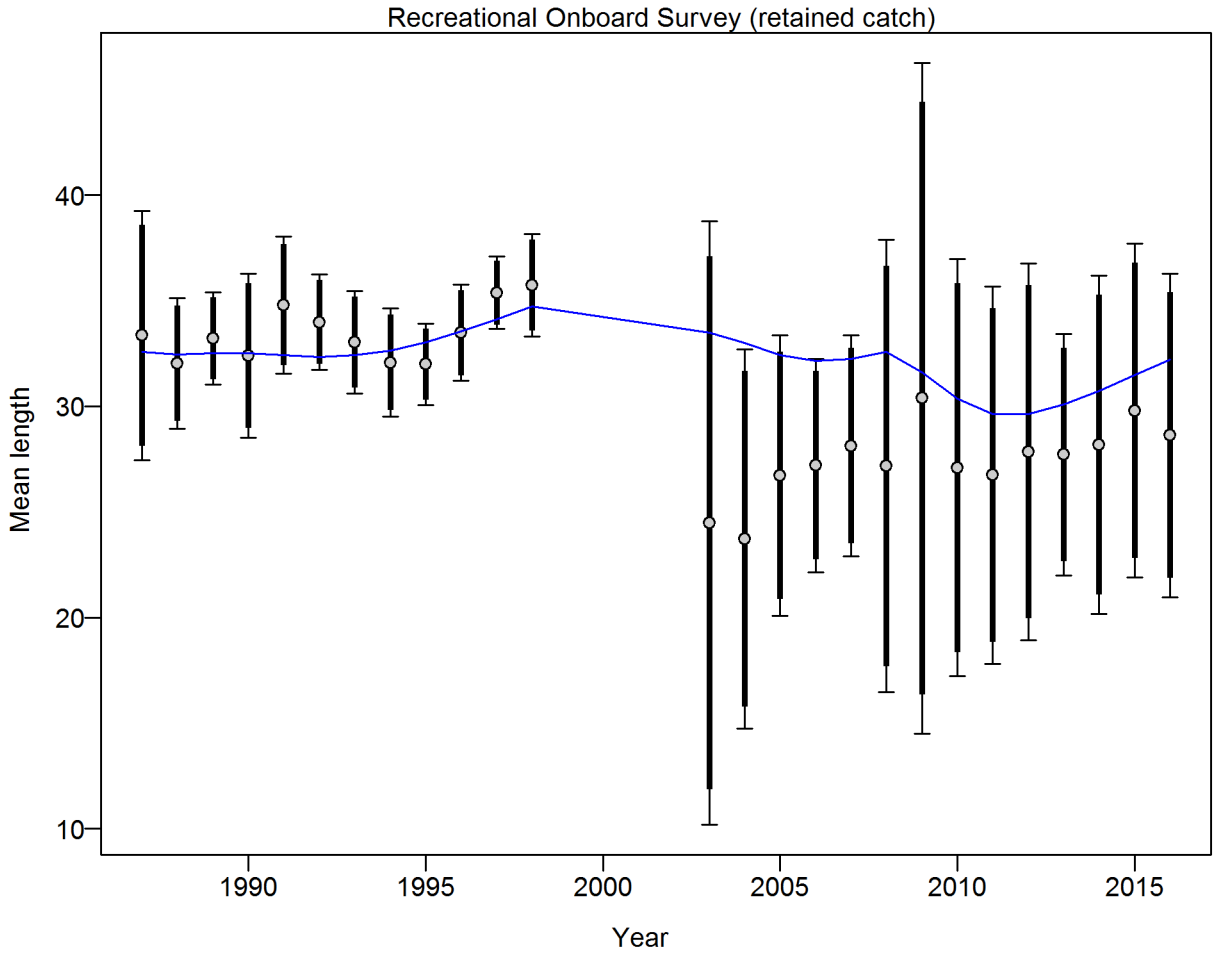


Figure 59: **Southern model** Mean length for Recreational Onboard Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Recreational Onboard Survey: 0.7823 (0.5555_1.5327) 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:mod2_12_comp

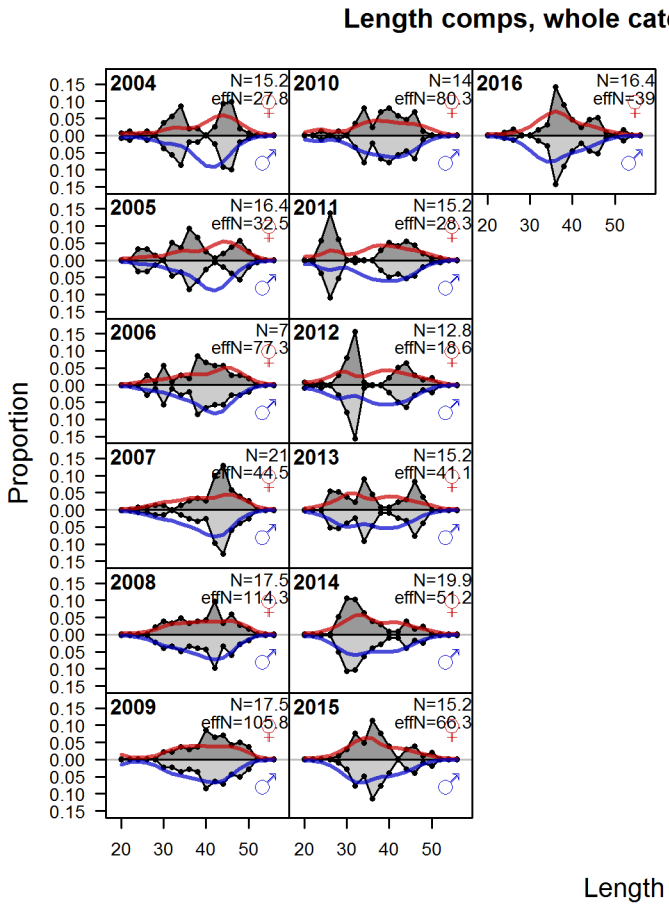


Figure 60: **Southern model** Length comps, whole catch, Hook & Line Survey [fig:mod2_13_comp_l

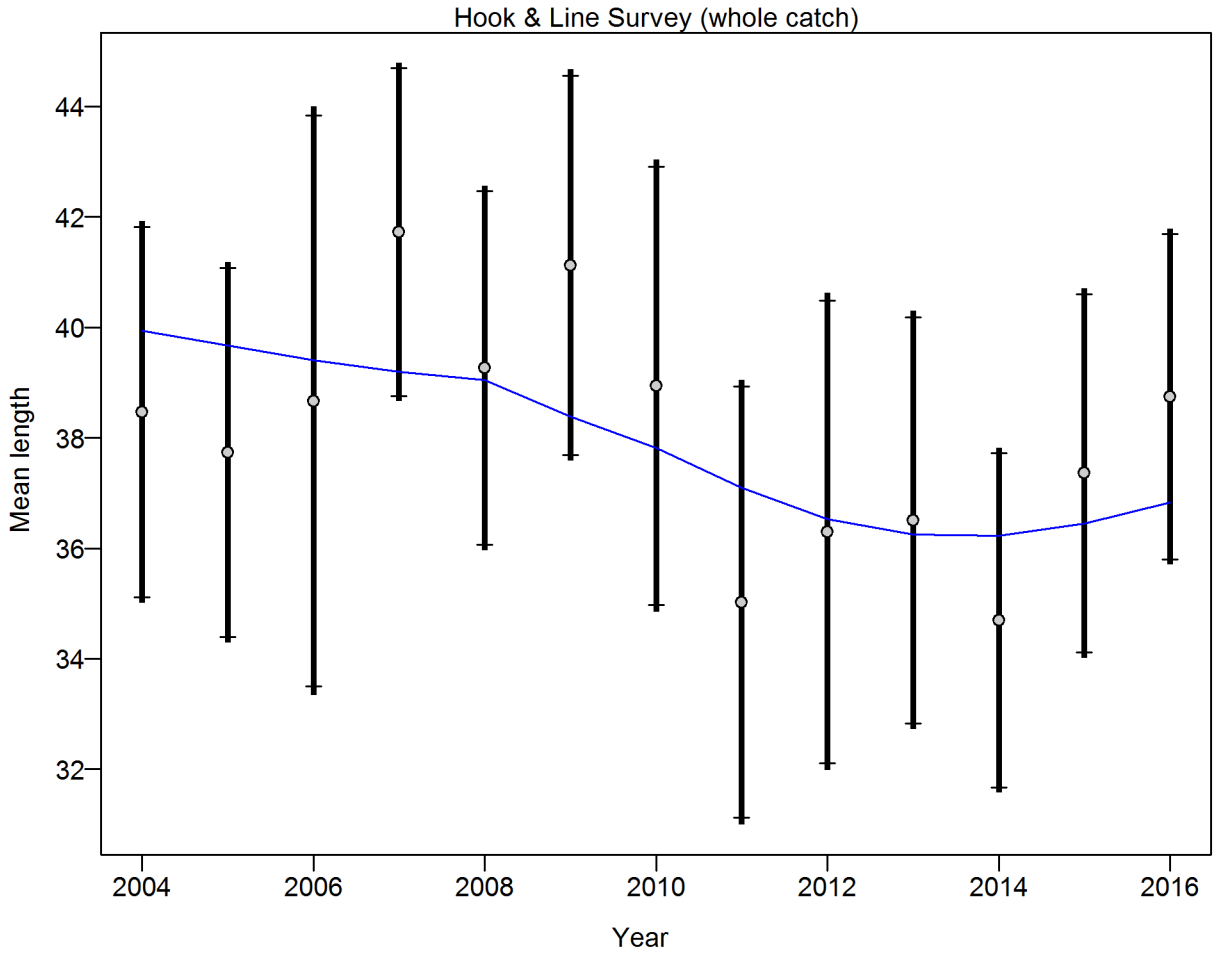


Figure 61: **Southern model** Mean length for Hook & Line Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Hook & Line Survey: 1.0633 (0.7447_2.5263) 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:mod2_16_comp_lenfit_data_weighting_

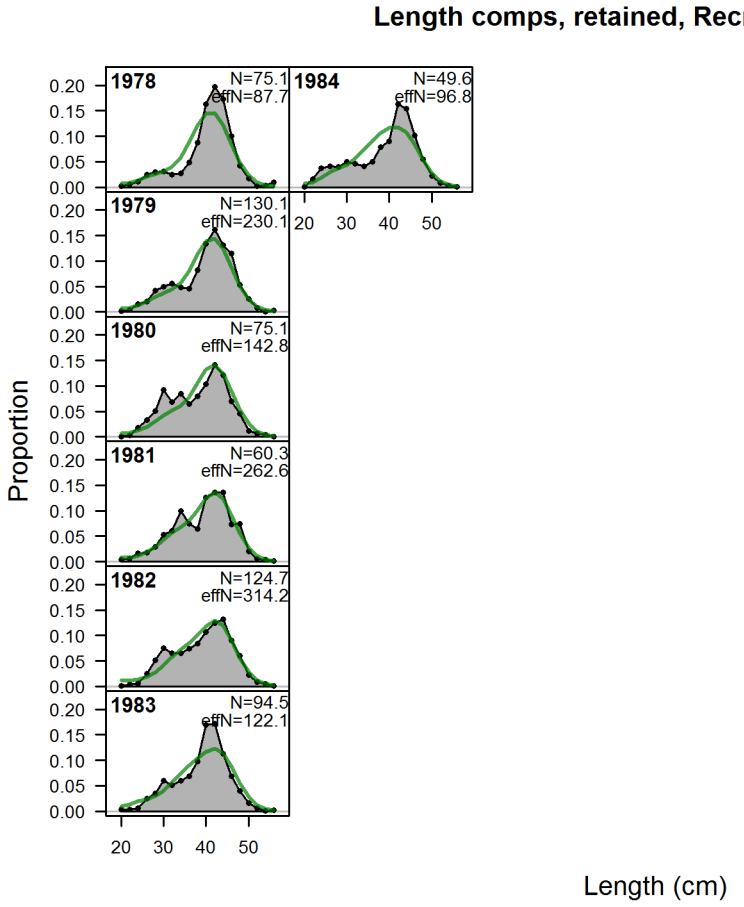


Figure 62: **Southern model** Length comps, retained, Recreational Study [fig:mod2_17_comp_len

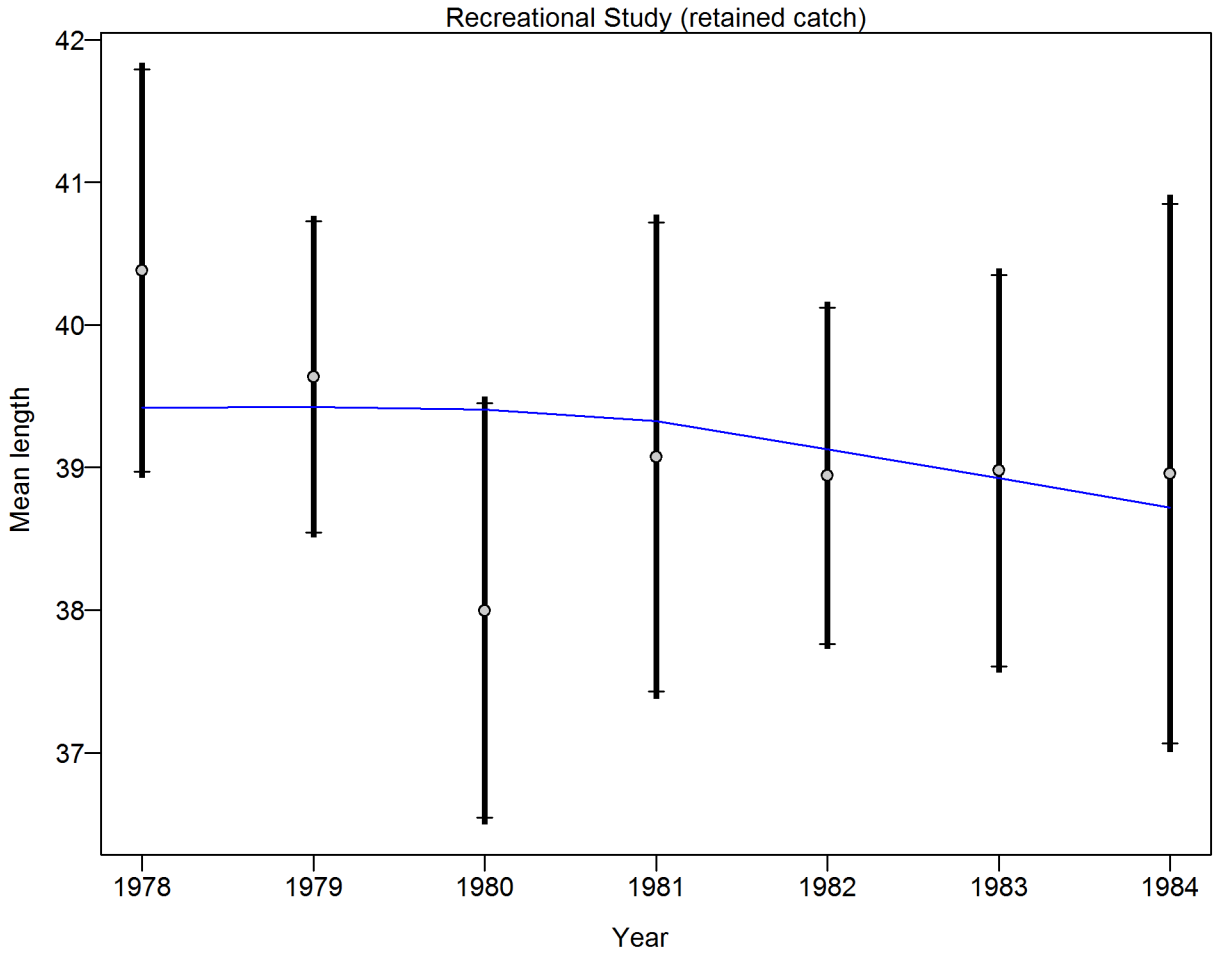


Figure 63: **Southern model** Mean length for Recreational Study with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for len data from Recreational Study: 1.0664 (0.566_16.055) 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:mod2_20_comp_lenfit_data_weighting_`

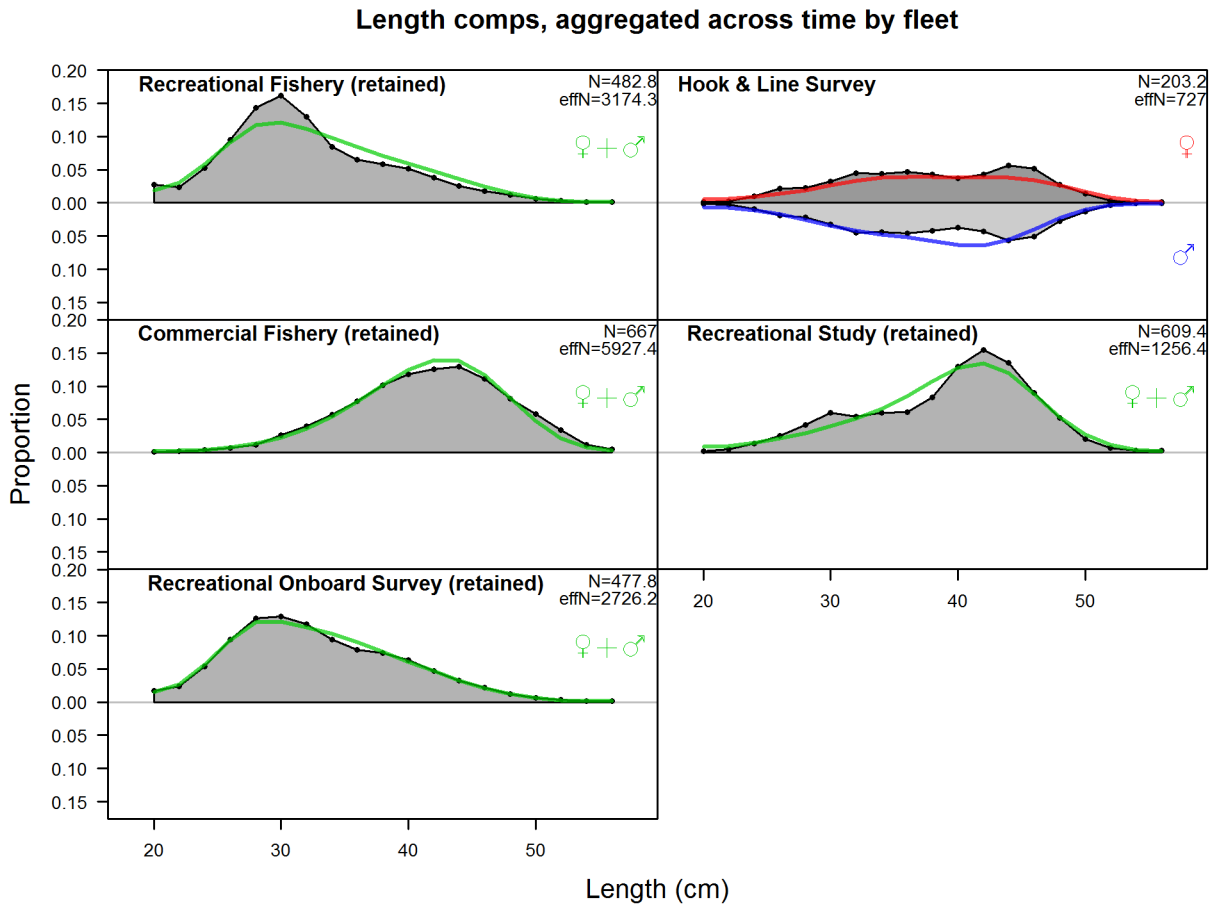


Figure 64: **Southern model** Length comps, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. `fig:mod2_21_comp_lenfit__aggregated_across_time`

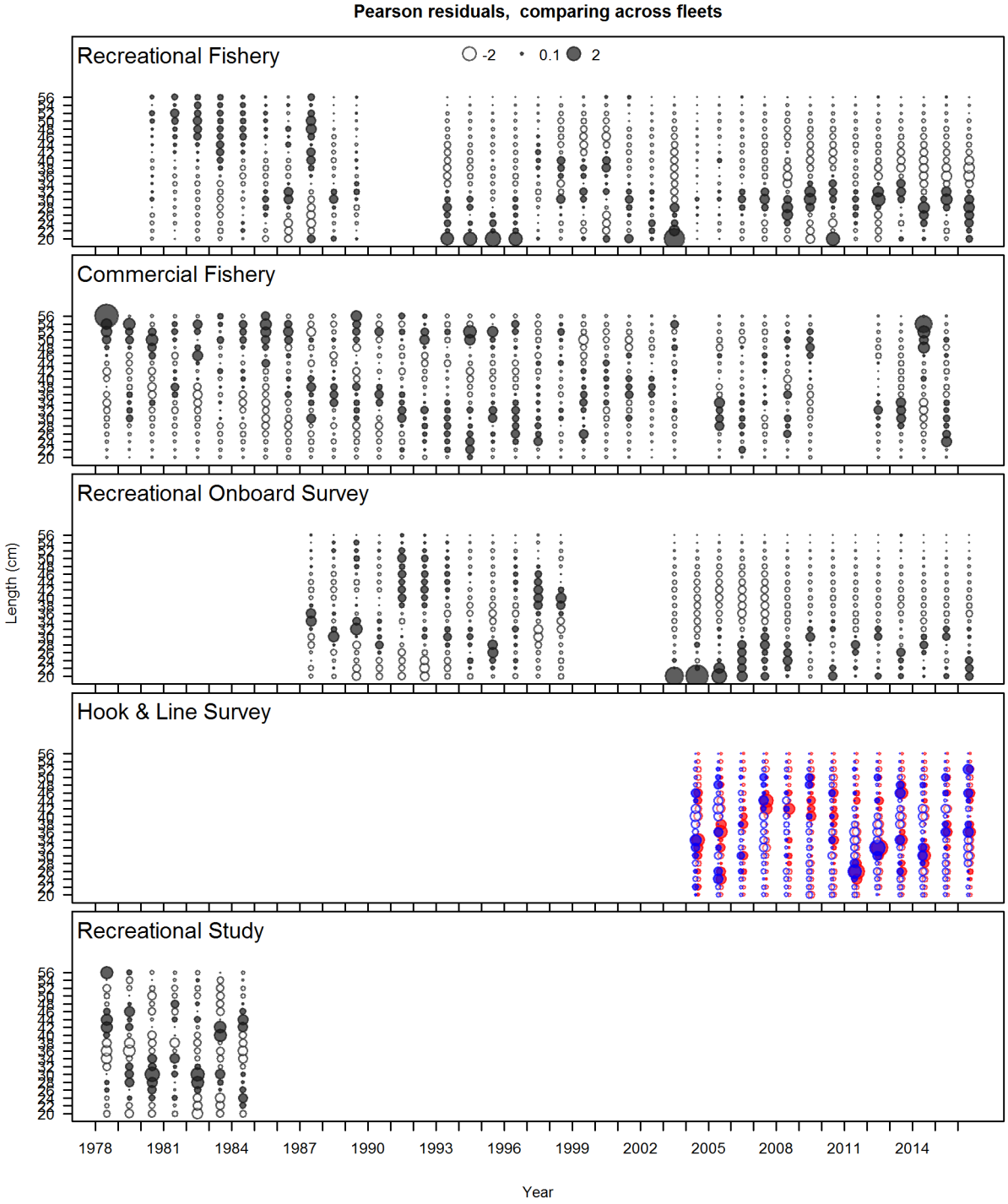


Figure 65: Length composition Pearson residuals for all fleets in the Southern model. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). `fig:comp_Pearson_length_mod2`

9.4.4 Age compositions for Southern model

age-compositions-for-southern-model

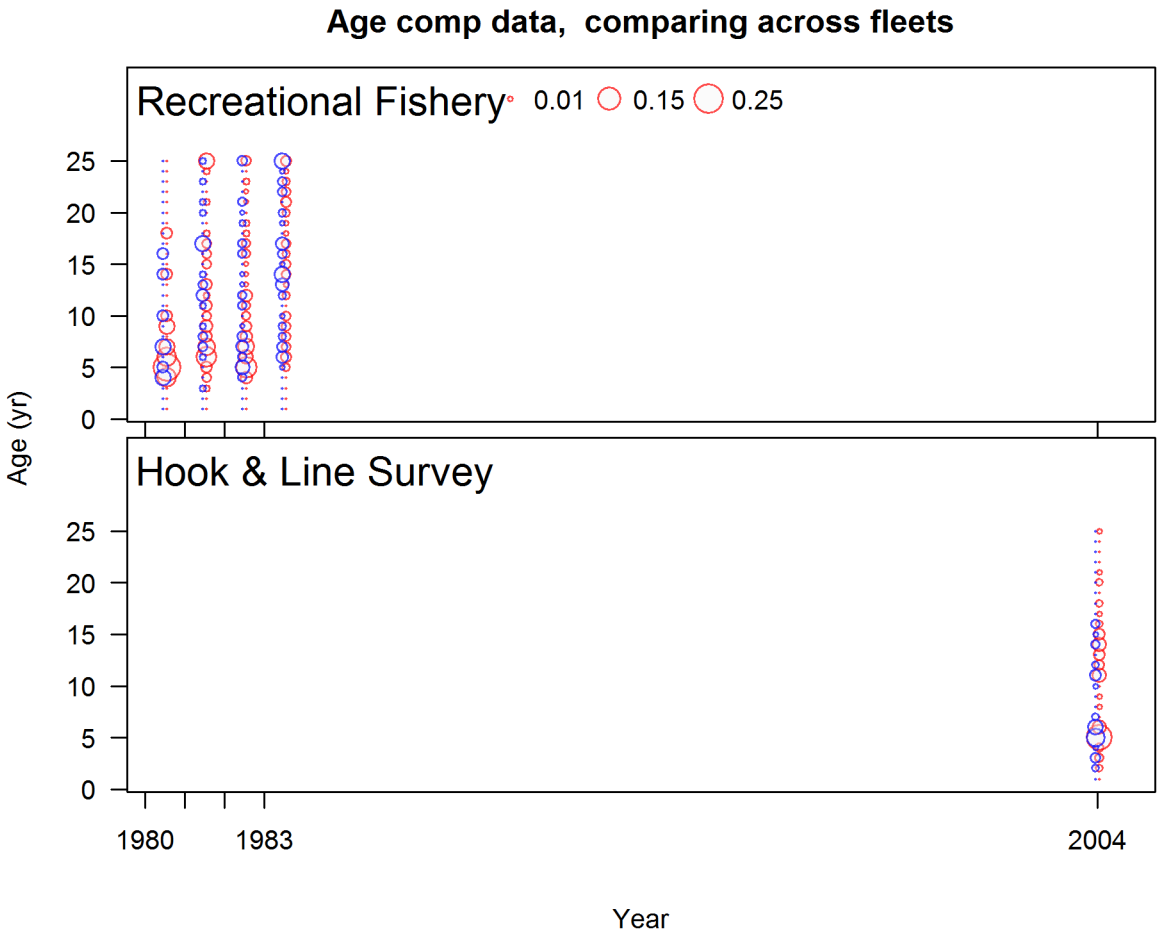


Figure 66: Age compositions for all fleets in the Southern model. Bubble size is proportional to proportions within each year. fig:comp_age_bubble_mod2

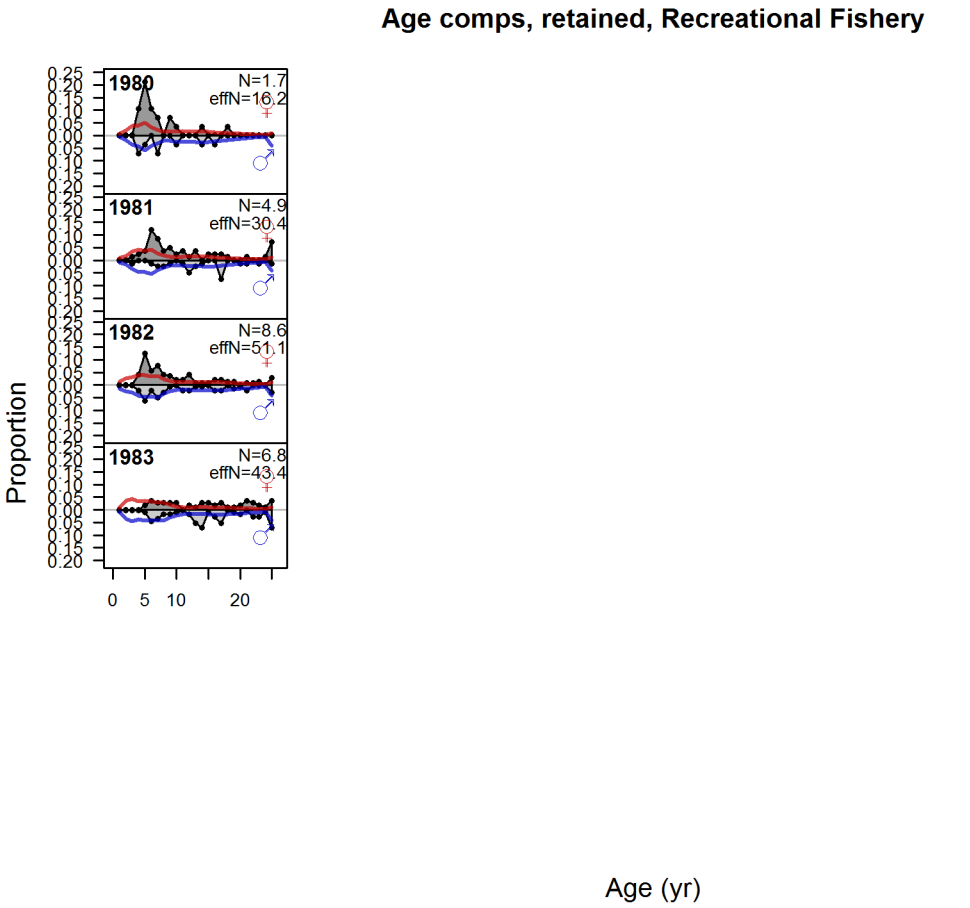


Figure 67: **Southern model** Age comps, retained, Recreational Fishery [fig:mod2_1_comp_agefi

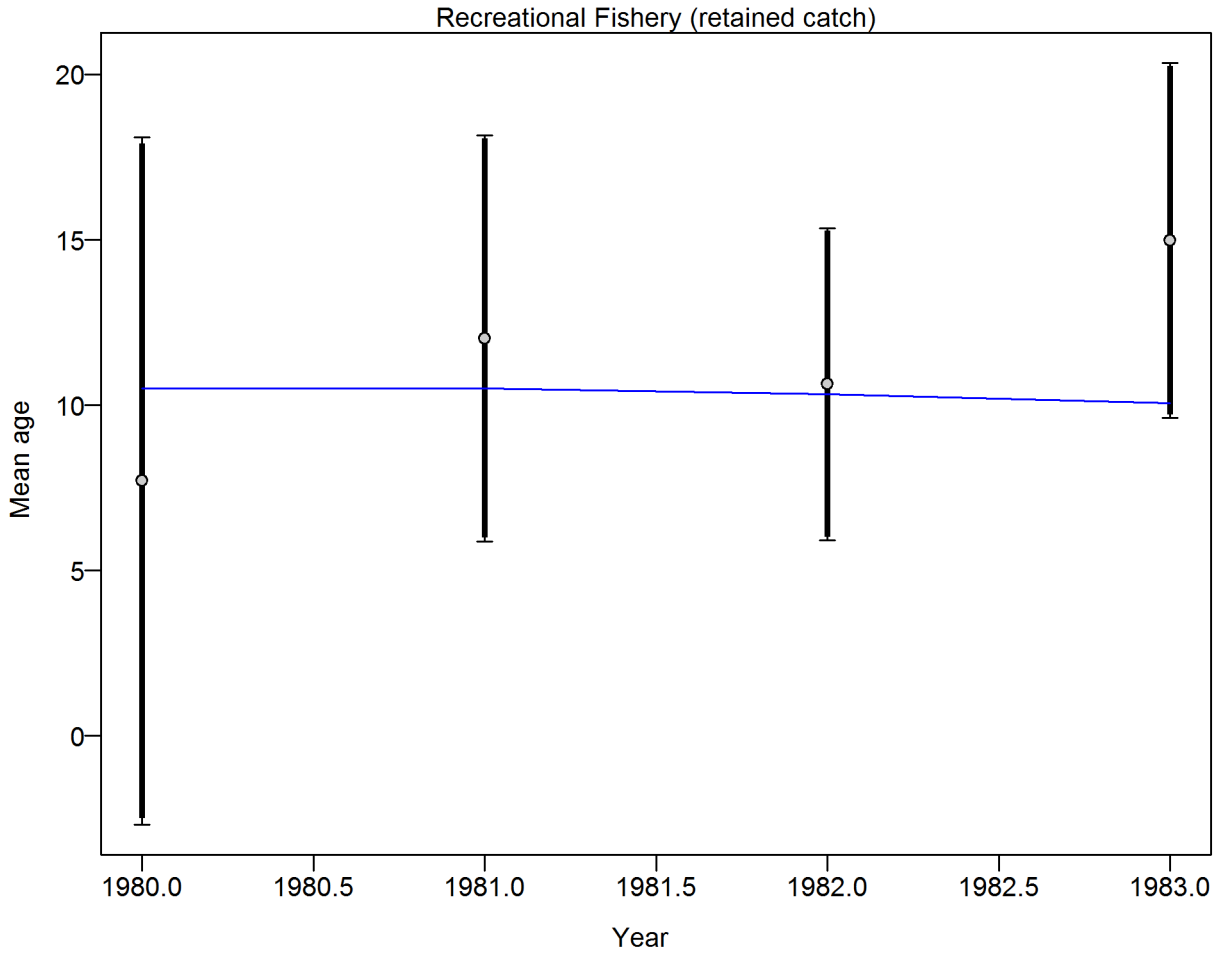


Figure 68: **Southern model** Mean age for Recreational Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for age data from Recreational Fishery: 0.9648 (0.6595_28.2193) 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:mod2_4_comp_agefit_data_weighting_TA1.8_Recre

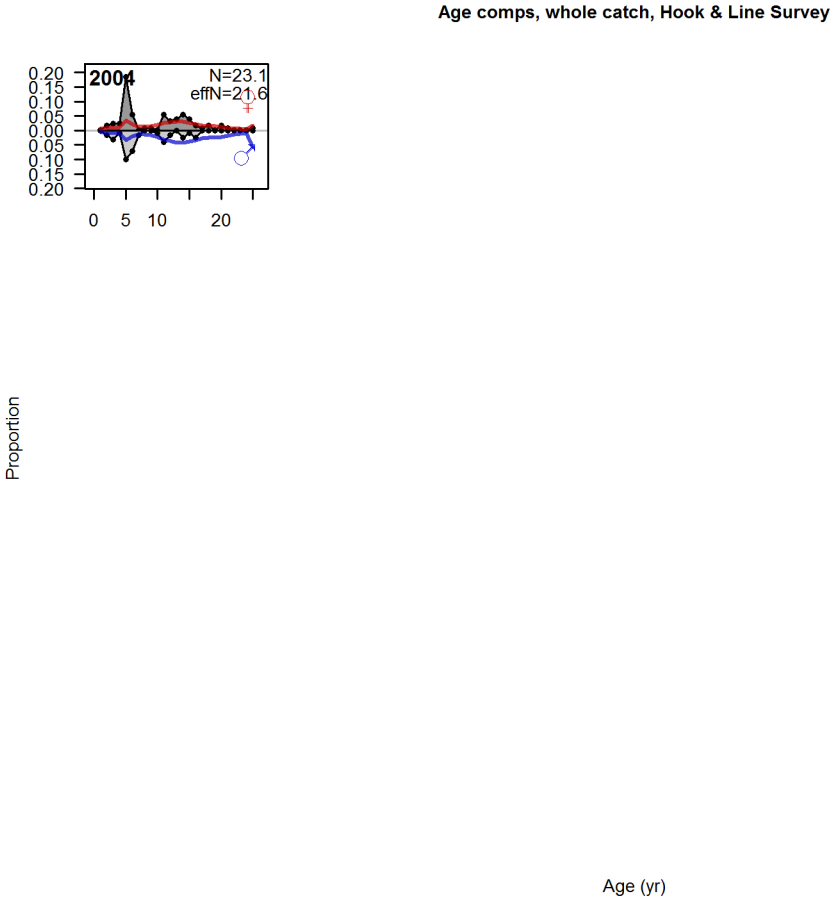


Figure 69: **Southern model** Age comps, whole catch, Hook & Line Survey (`fig:mod2_5_comp_age`

Figure 70: **Southern model** Mean age for Hook & Line Survey with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: too few points to calculate adjustments. 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:mod2_8_comp_

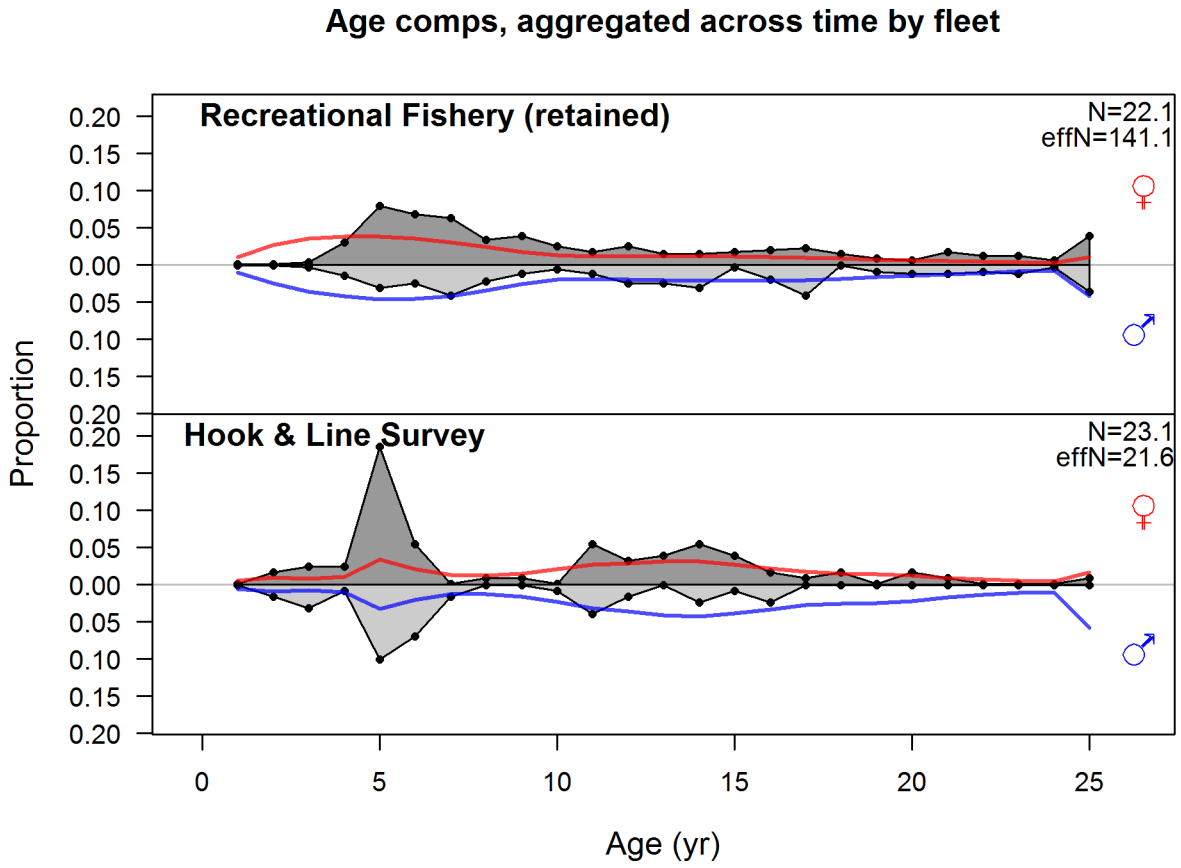


Figure 71: **Southern model** Age comps, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. `fig:mod2_9_comp_agefit__aggregated_across_time`

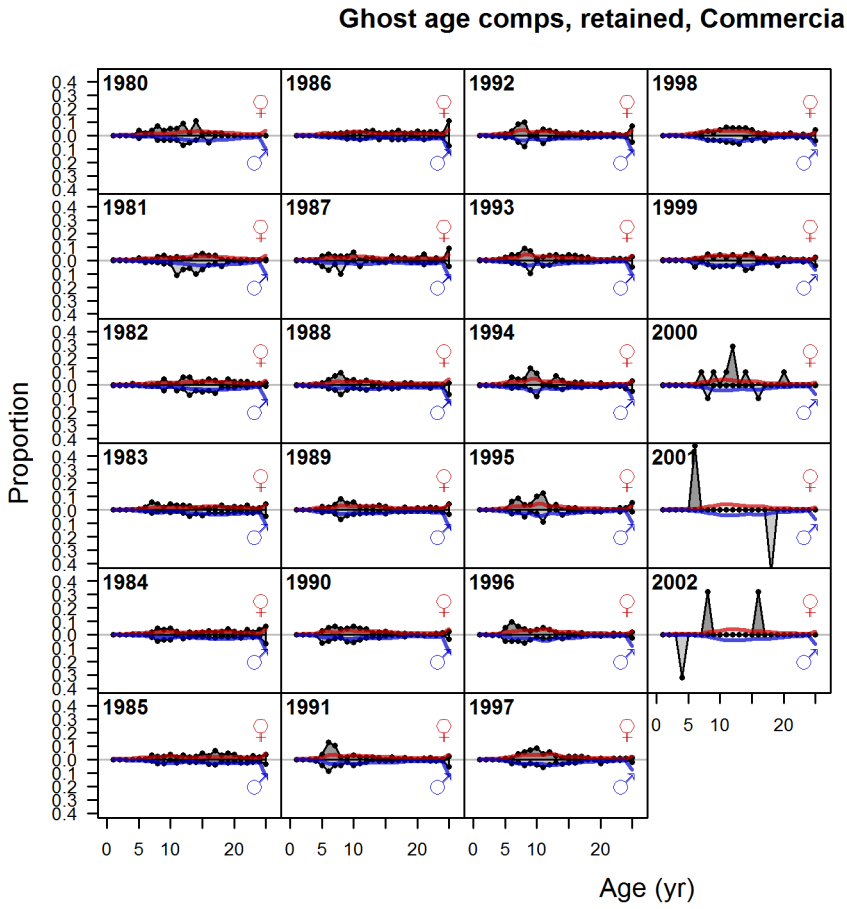


Figure 72: **Southern model** Ghost age comps, retained, Commercial Fishery [fig:mod2_11_comp_g

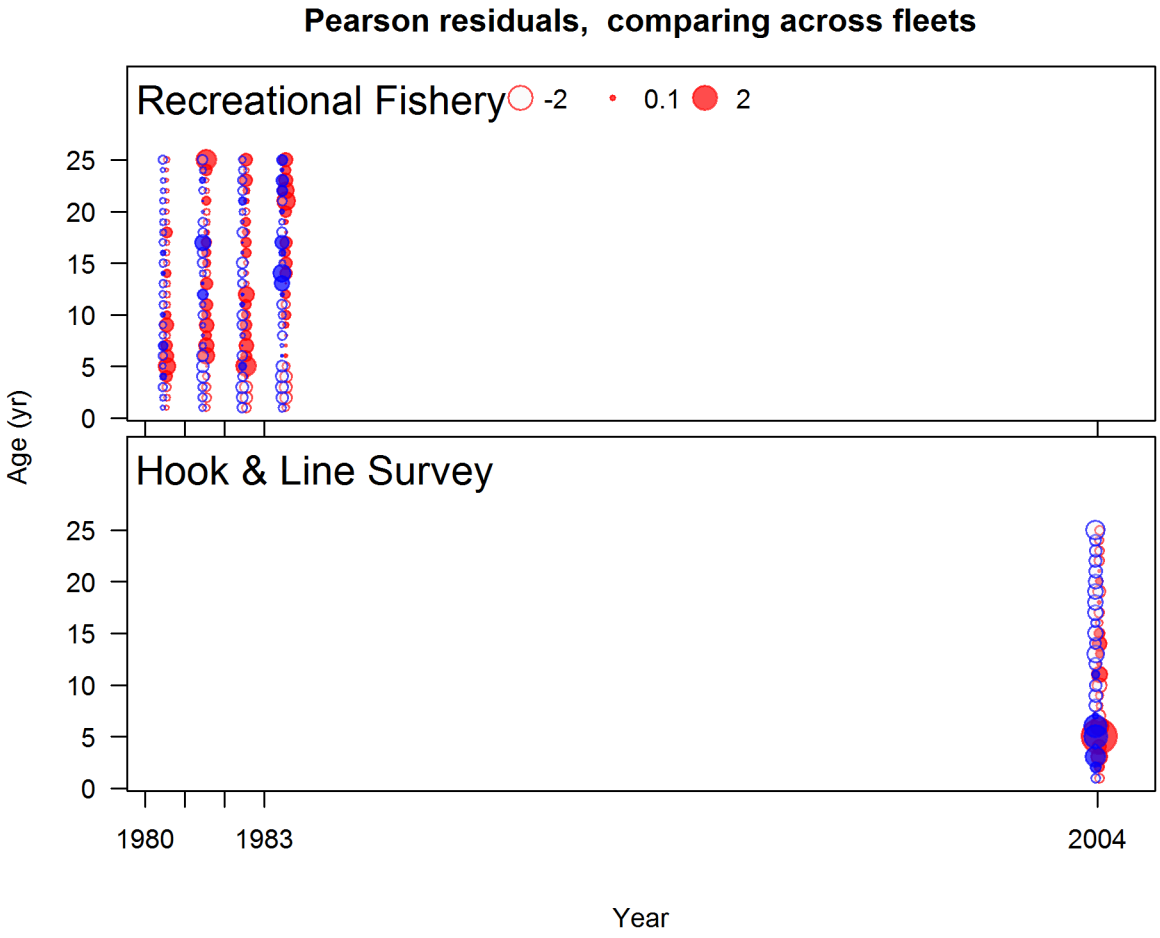


Figure 73: Age composition Pearson residuals for all fleets in the Southern model. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:comp_Pearson_age_mod2

9.4.5 Fits to conditional-age-at-length compositions for Southern model

fits-to-conditional-age-at-length-compositions-for-southern-model

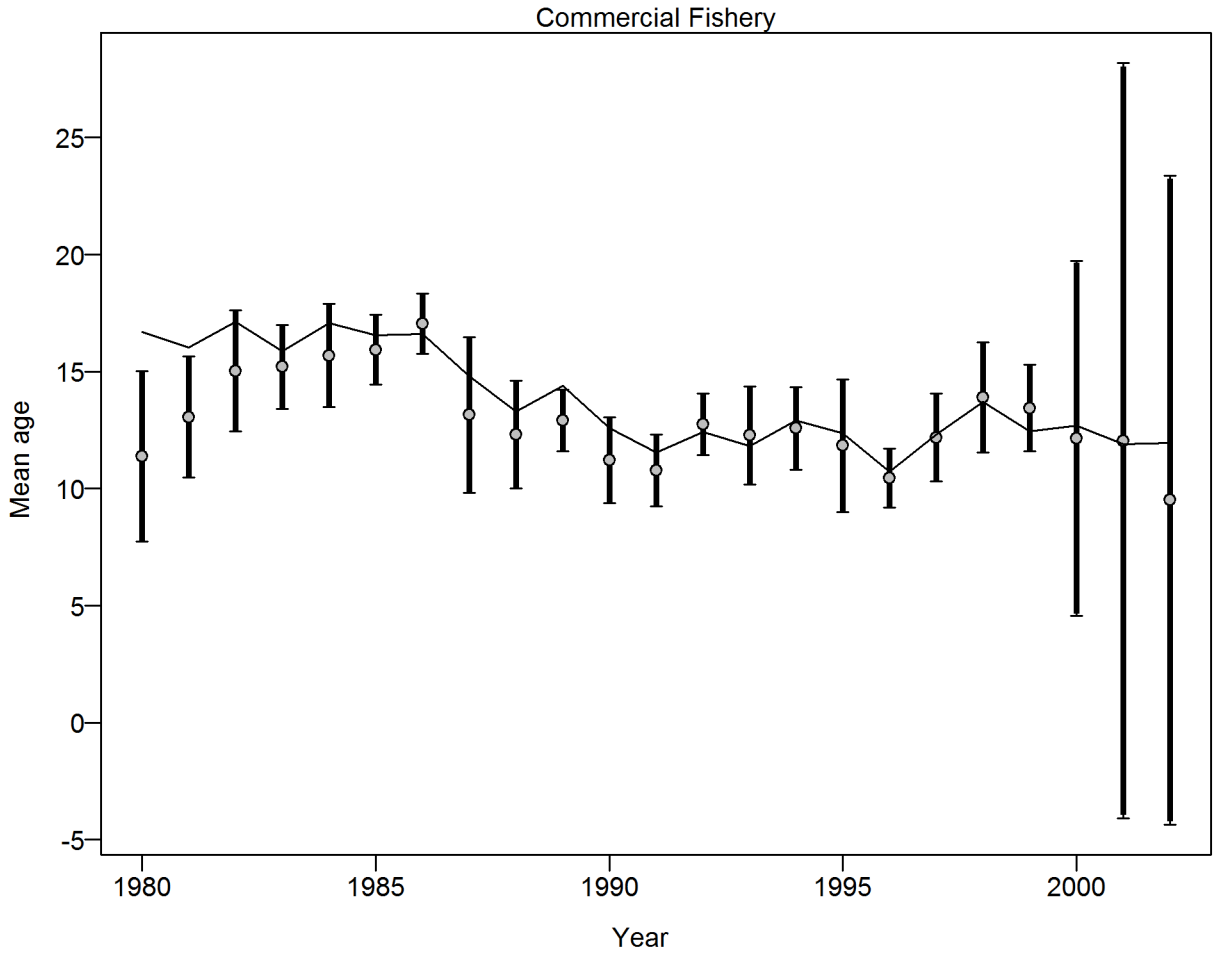


Figure 74: **Southern model** Mean age from conditional data (aggregated across length bins) for Commercial Fishery with 95% confidence intervals based on current samples sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for conditional age_at_length data from Commercial Fishery: 0.9816 (0.6742_2.1384) 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:mod2_4_comp_condAALfit_data_weighting_TA1.8_condAgeCommerc

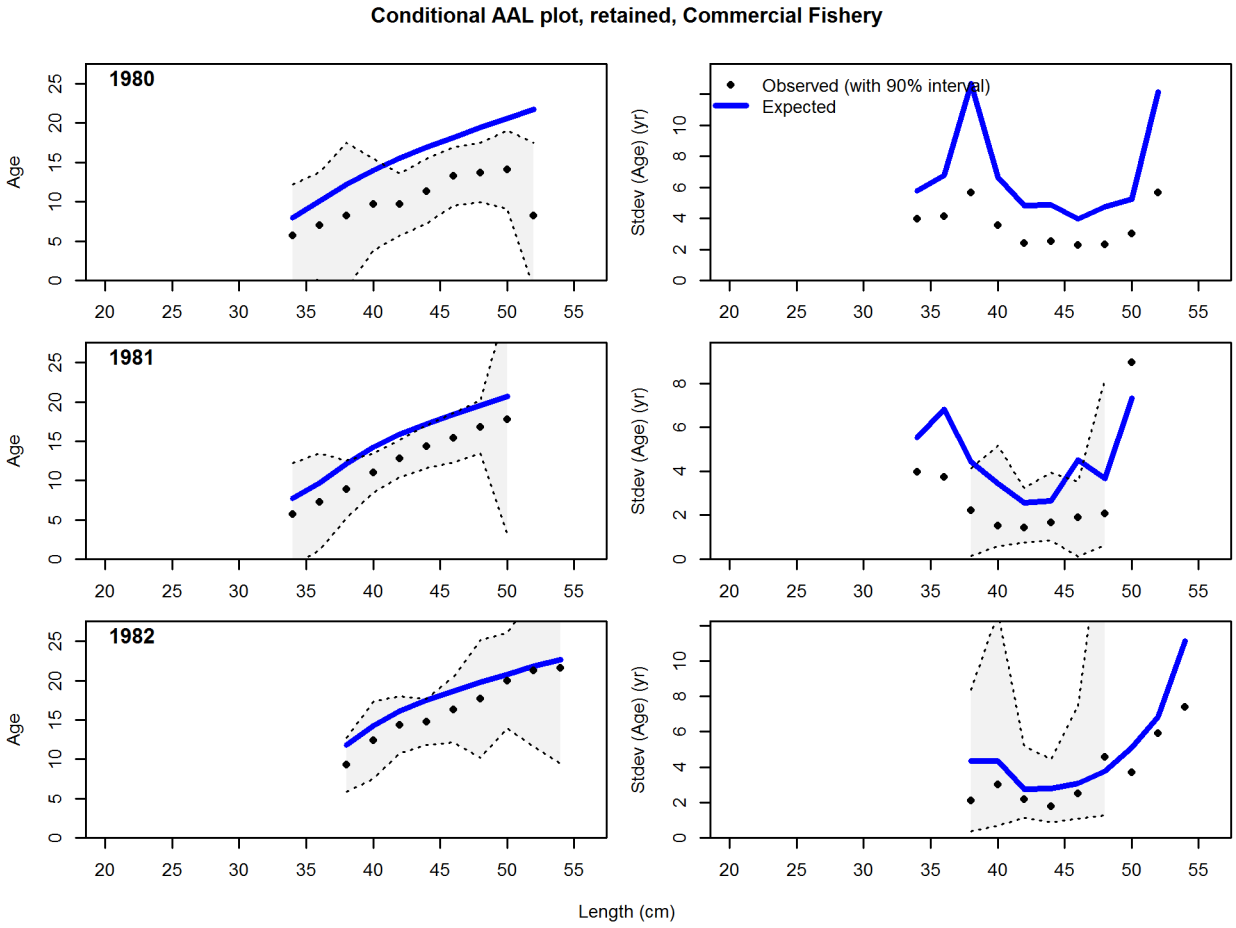
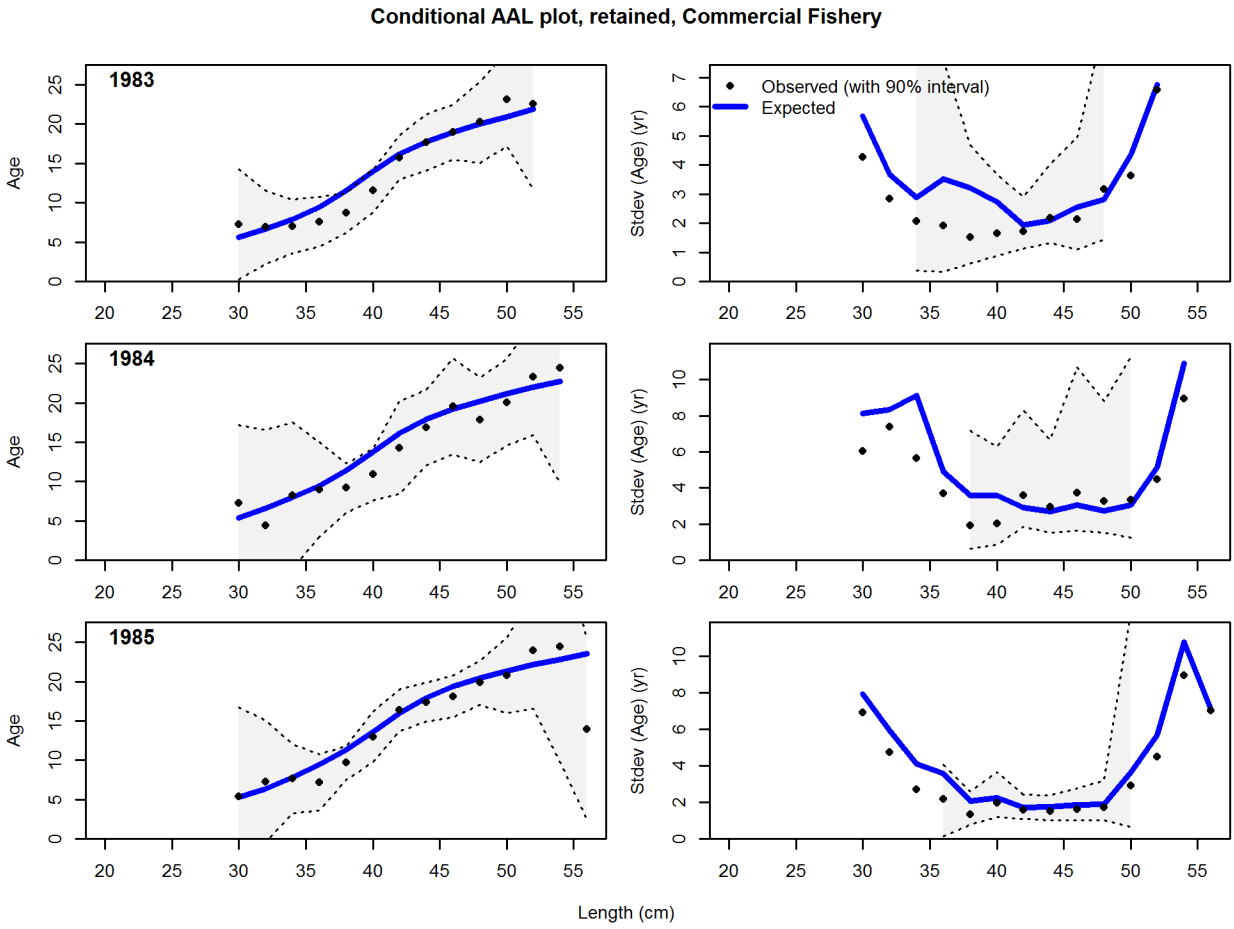


Figure 75: **Southern model** Conditional AAL plot, retained, Commercial Fishery (plot 1 of 8) These plots show mean age and std. dev. in conditional AAL. Left plots are mean AAL by size_class (obs. and pred.) with 90% CIs based on adding 1.64 SE of mean to the data. Right plots in each pair are SE of mean AAL (obs. and pred.) with 90% CIs based on the chi_square distribution. `fig:mod2_5_comp_condAALfit_Andre_plotsflt2mkt2_page1`



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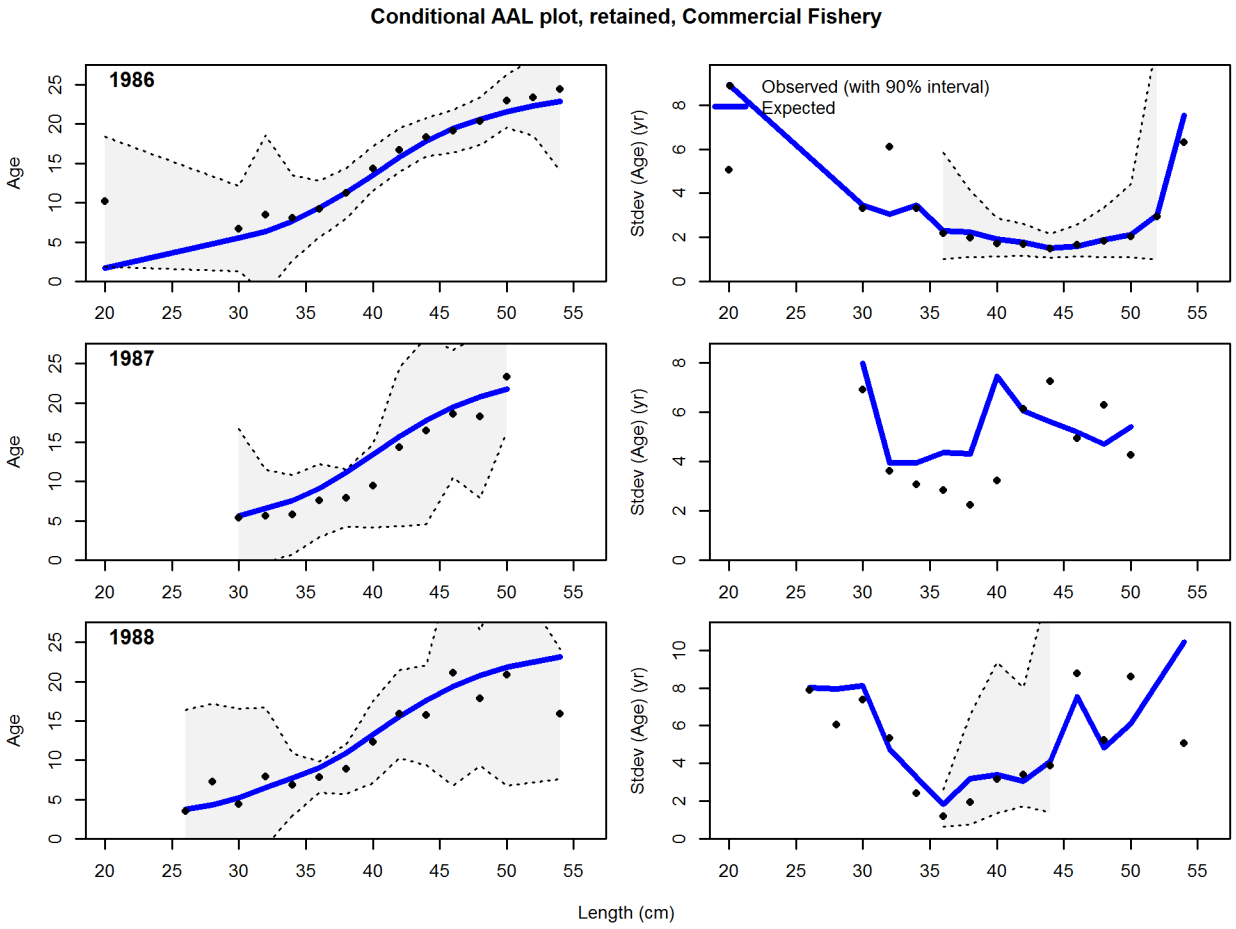
682 Figure continued from previous page



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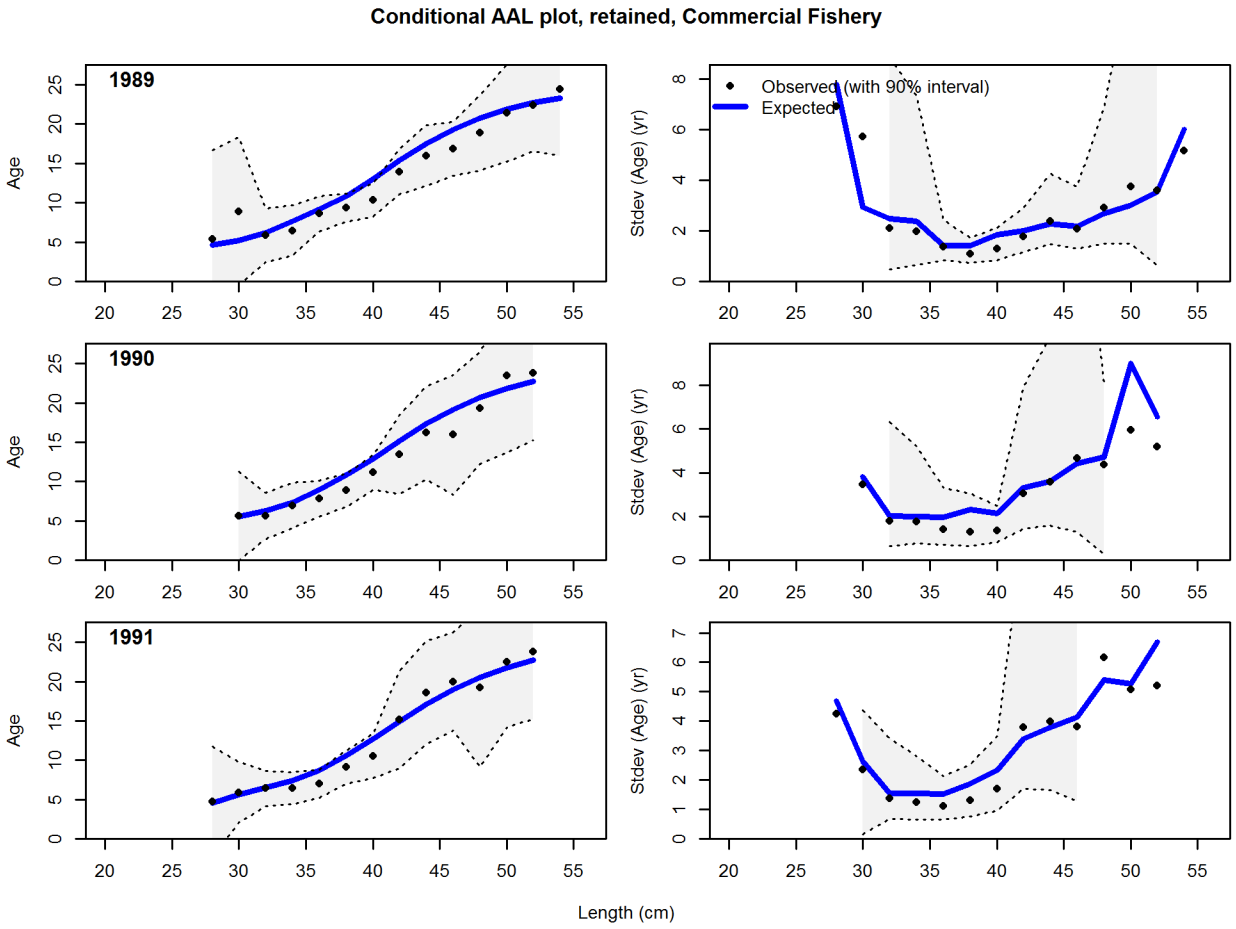

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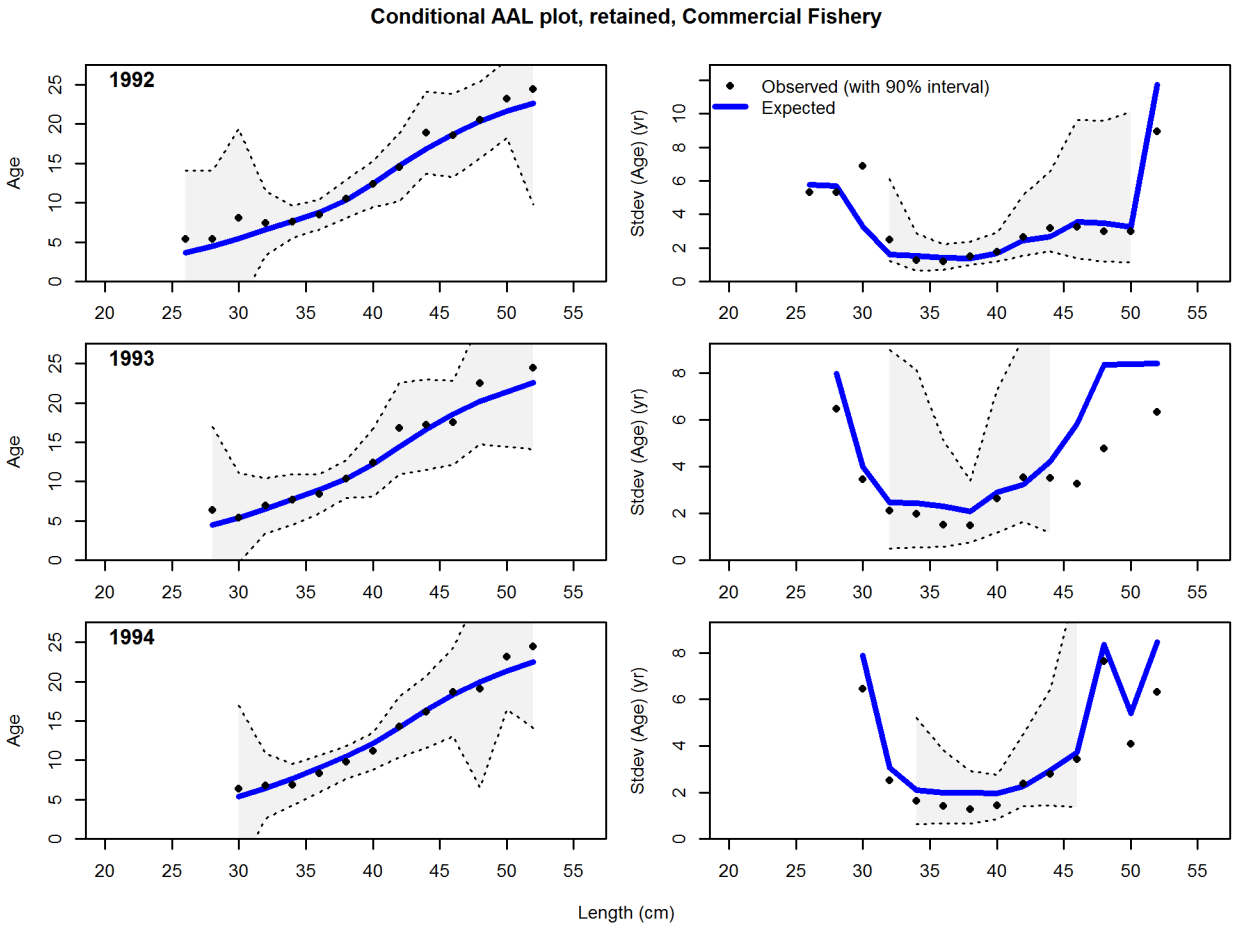
686 Figure continued from previous page



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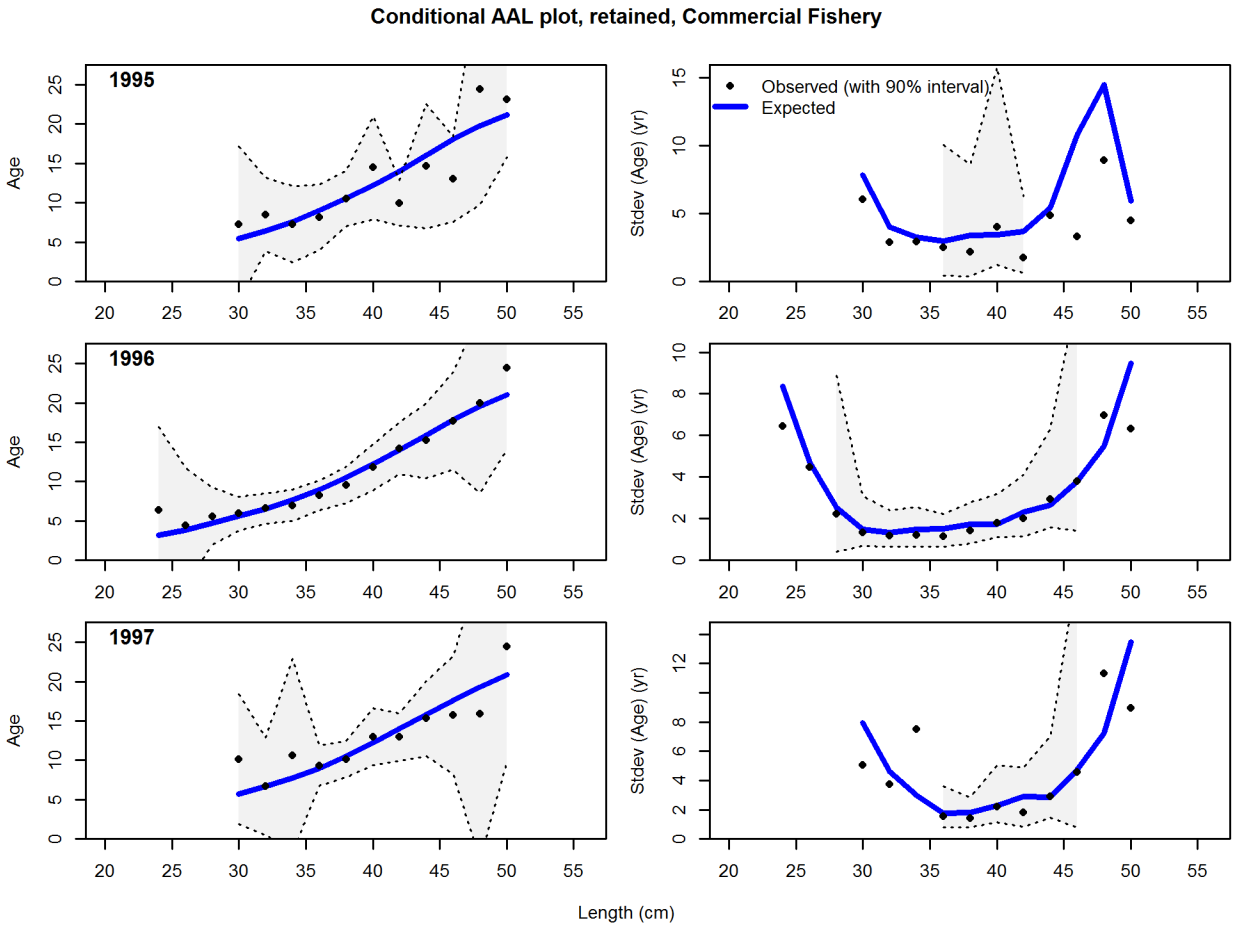
688 Figure continued from previous page



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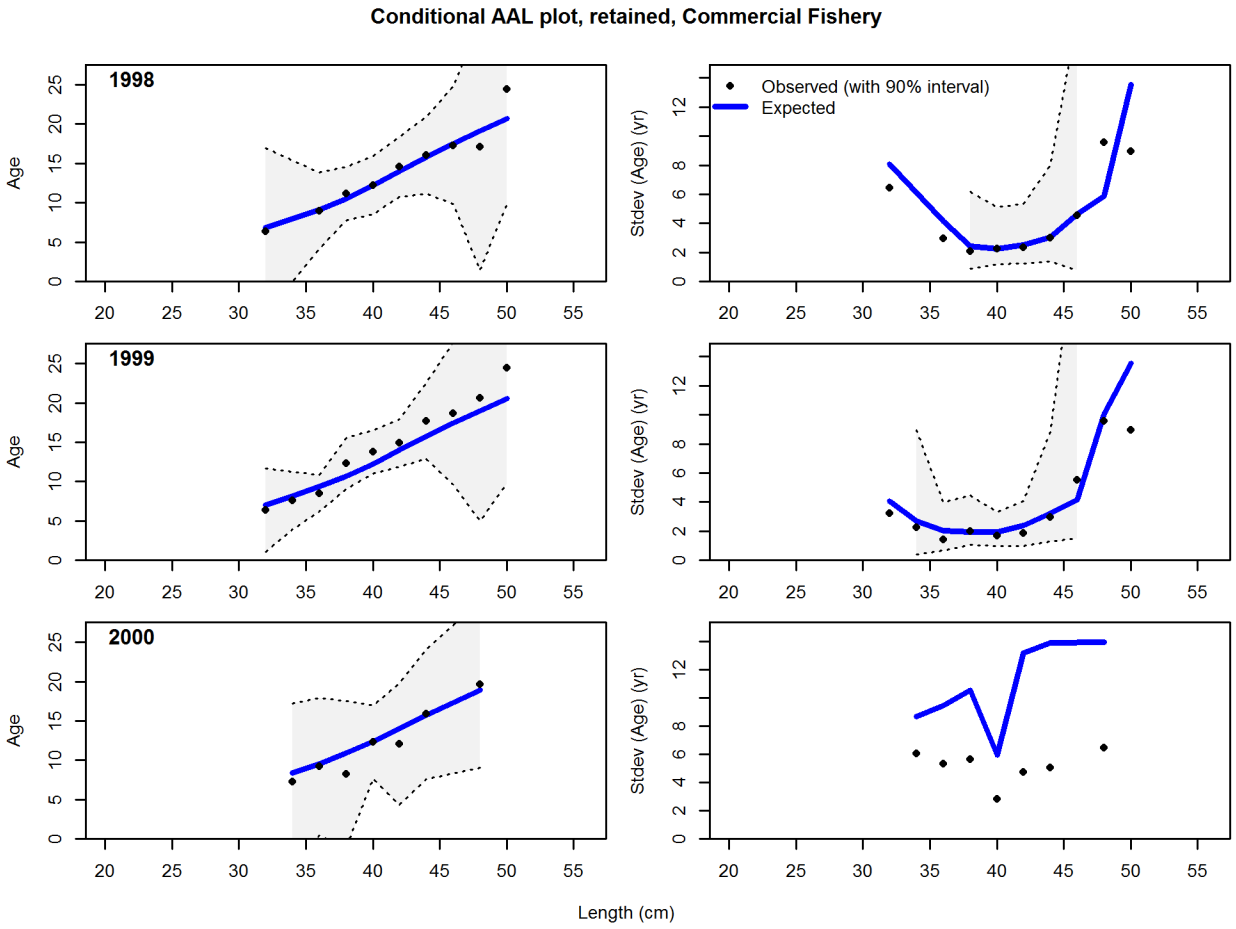

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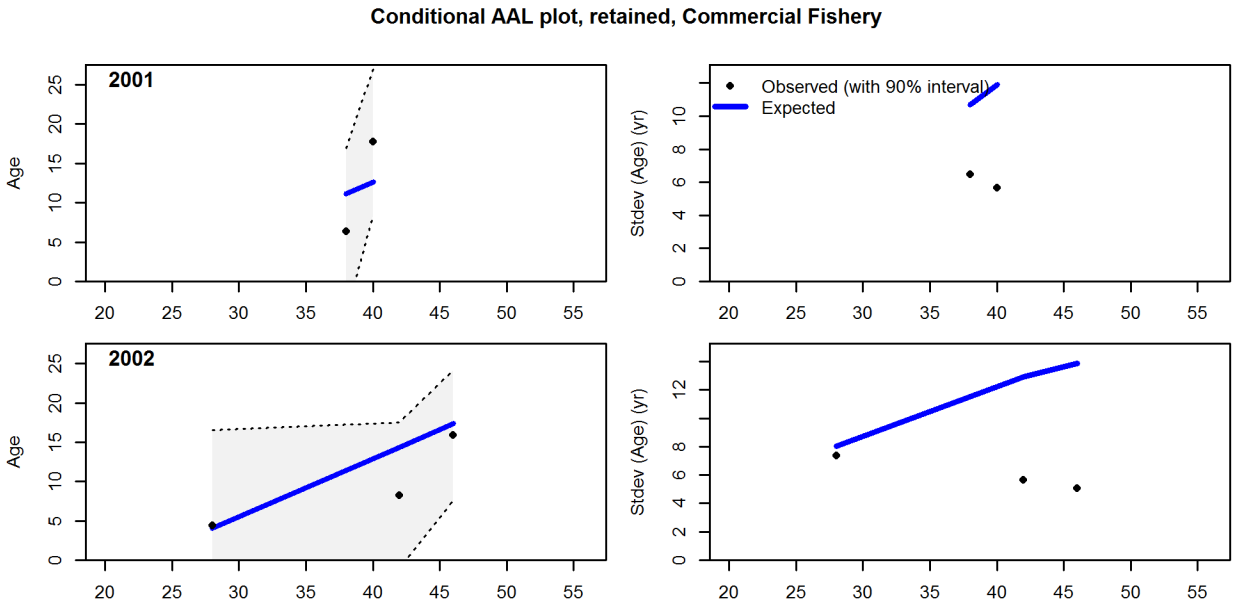
692 Figure continued from previous page



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694 Figure continued from previous page

9.5 Model results for Southern model

model-results-for-southern-model

9.5.1 Base model results for Southern model

base-model-results-for-southern-model

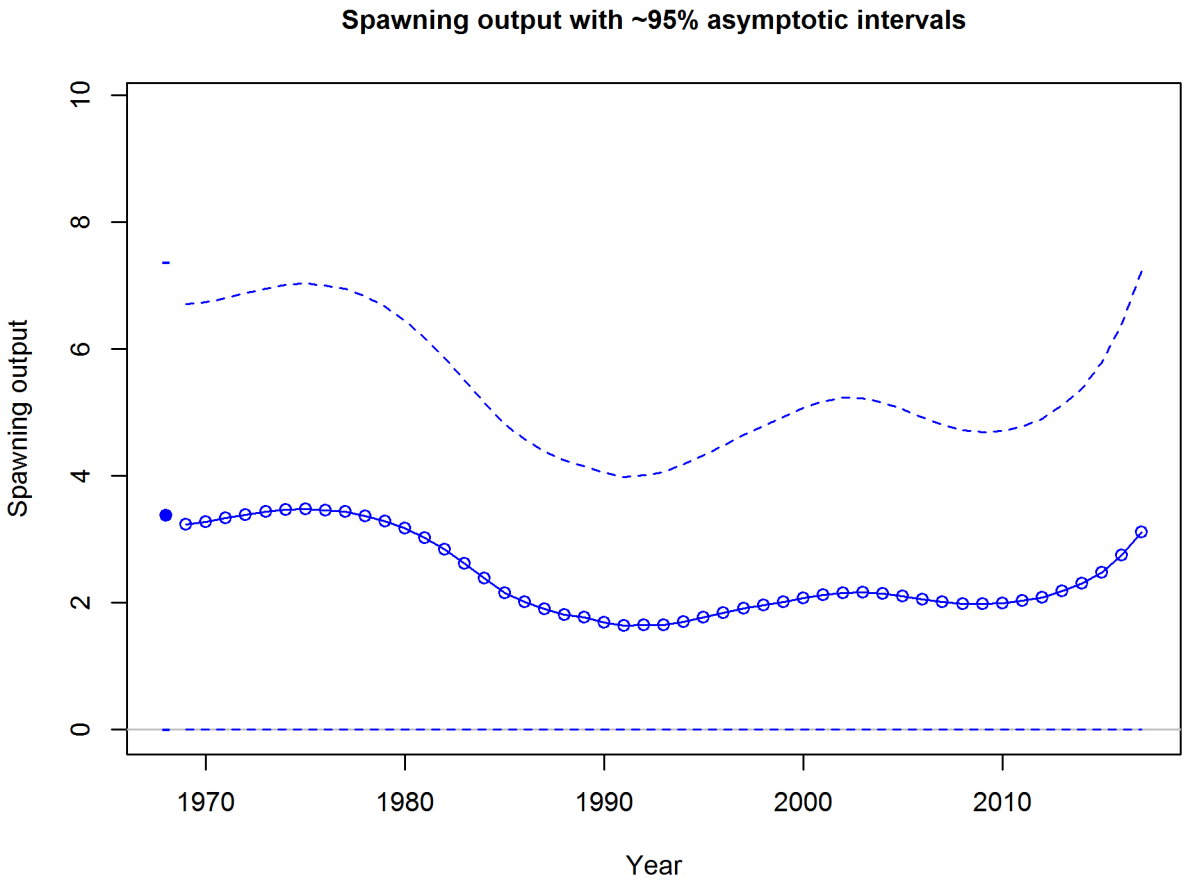

Figure 76: Estimated time-series of spawning output for Southern model. fig:ssb

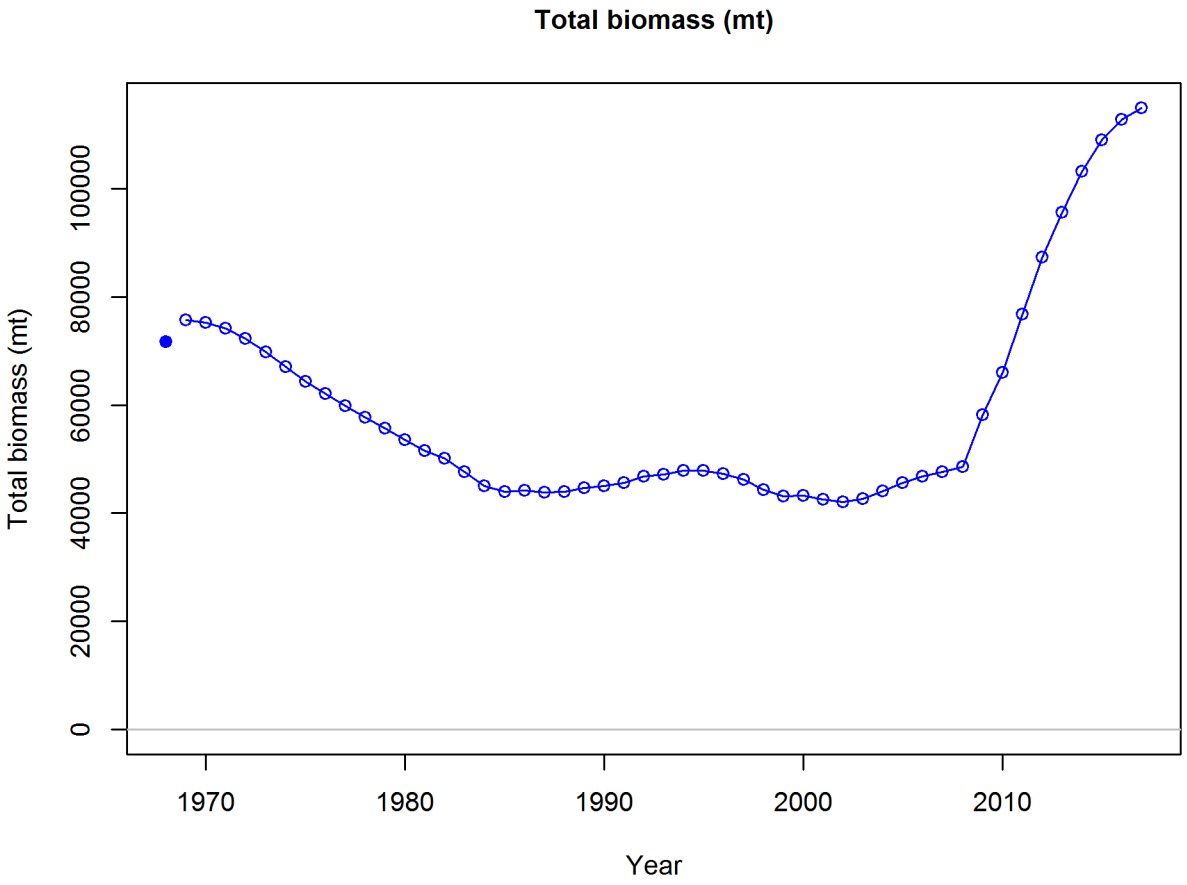

Figure 77: Estimated time-series of total biomass for Southern model. [fig:total_bio

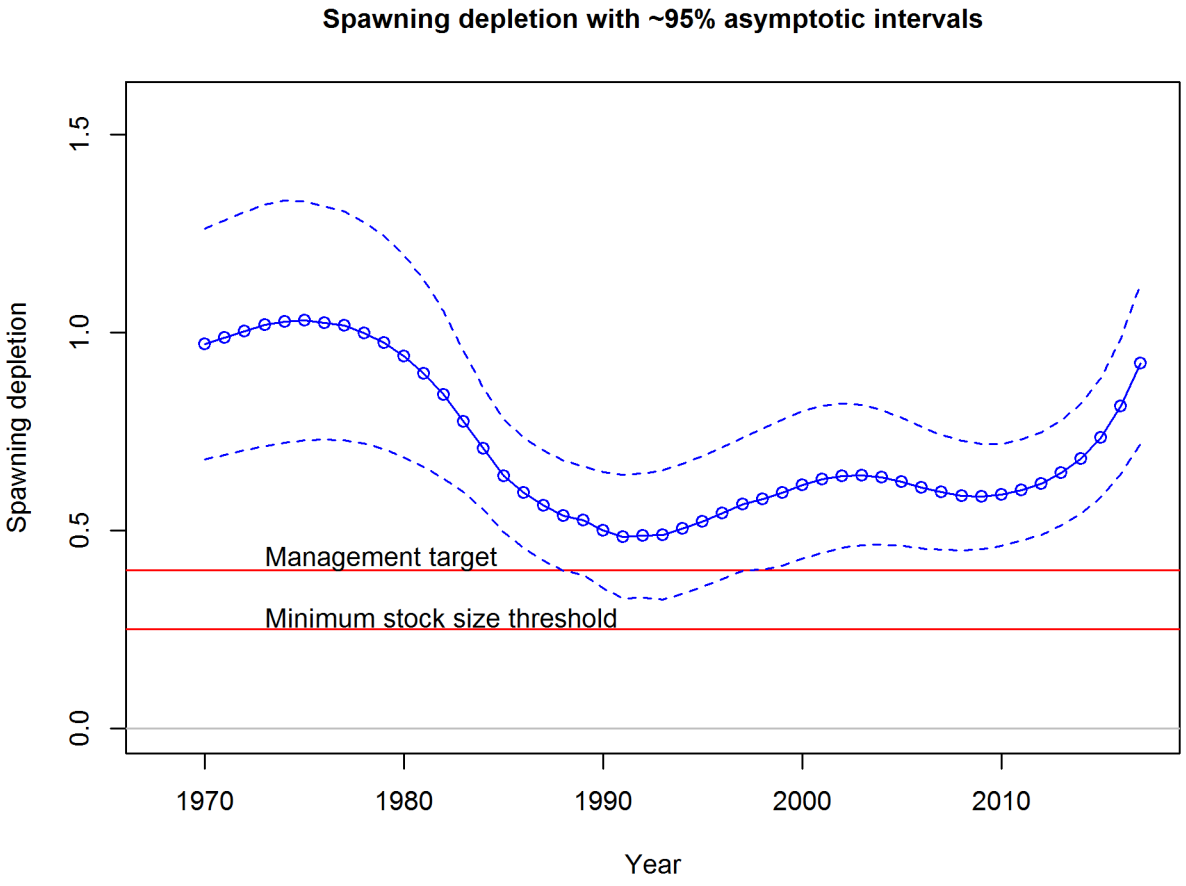

Figure 78: Estimated time-series of relative biomass for Southern model. [fig:depl

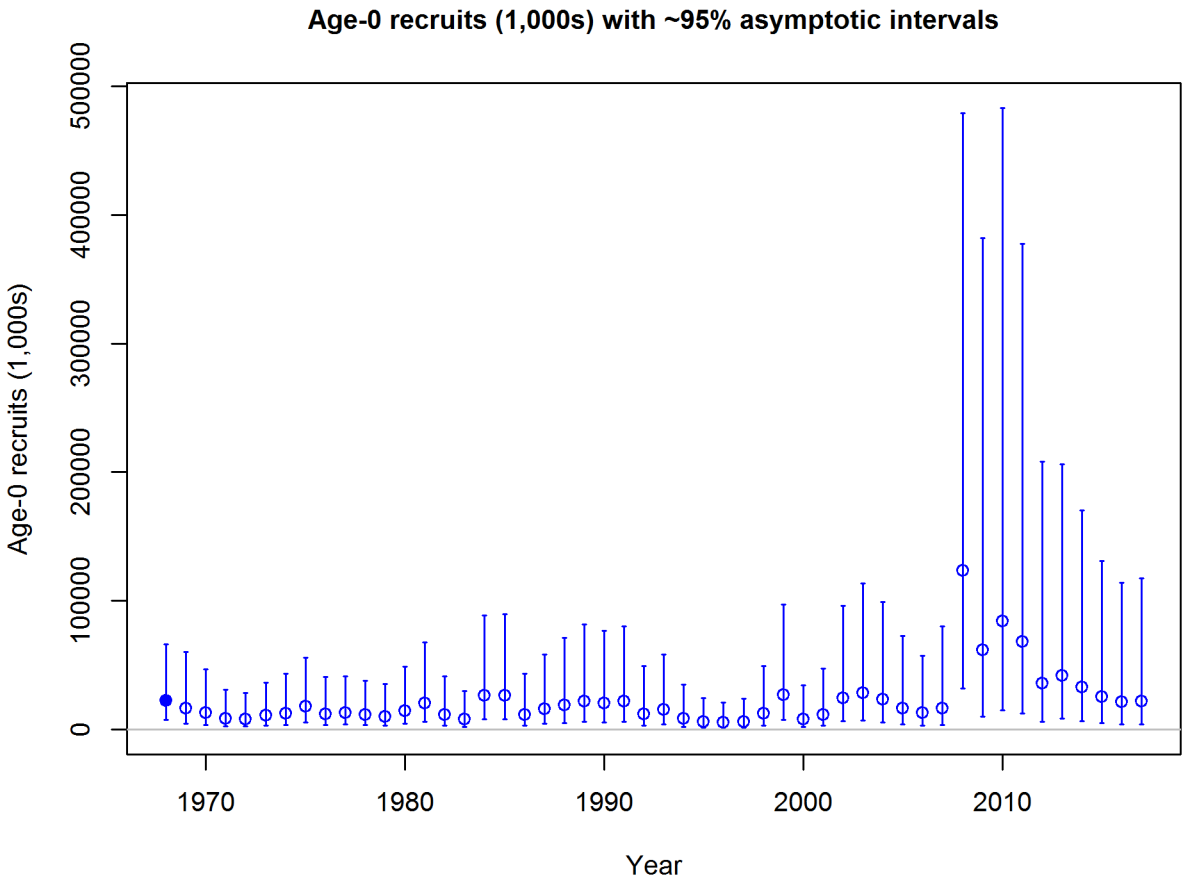

Figure 79: Estimated time-series of recruitment for the Southern model. [fig:recruits1

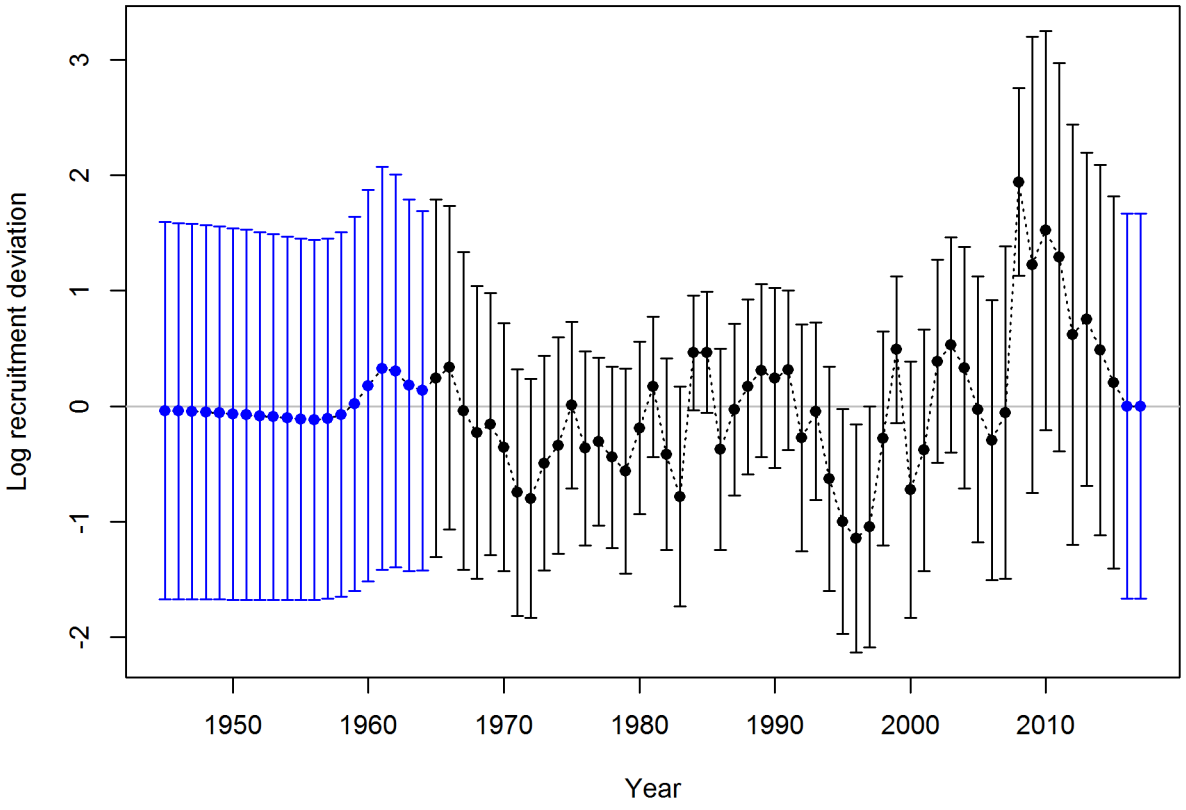

Figure 80: Estimated time-series of recruitment deviations for the Southern model. [fig:recdevs1

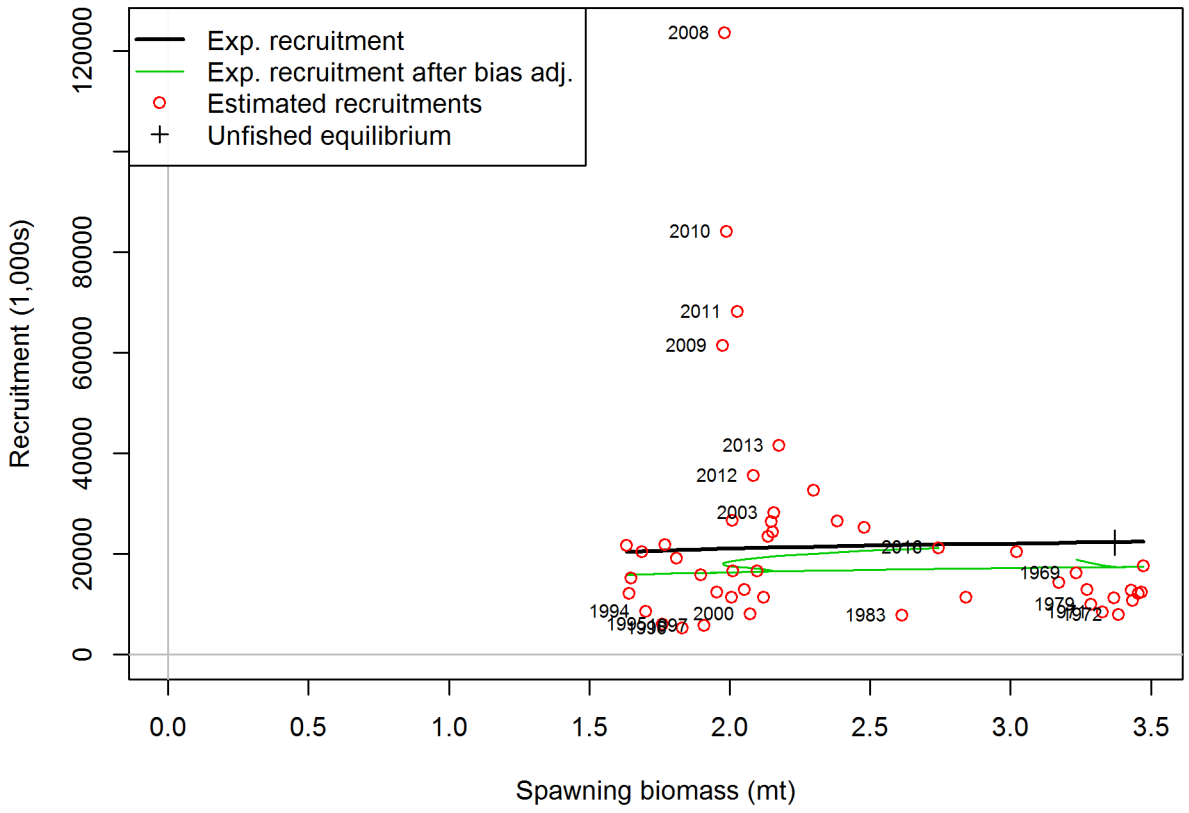

Figure 81: Estimated recruitment (red circles) for the Southern model relative to the stock-recruit relationship (black line). The green line shows the effect of the bias correction for the lognormal distribution [fig:stock_recruit_curve]

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