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

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Contents

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 2014.

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.

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)

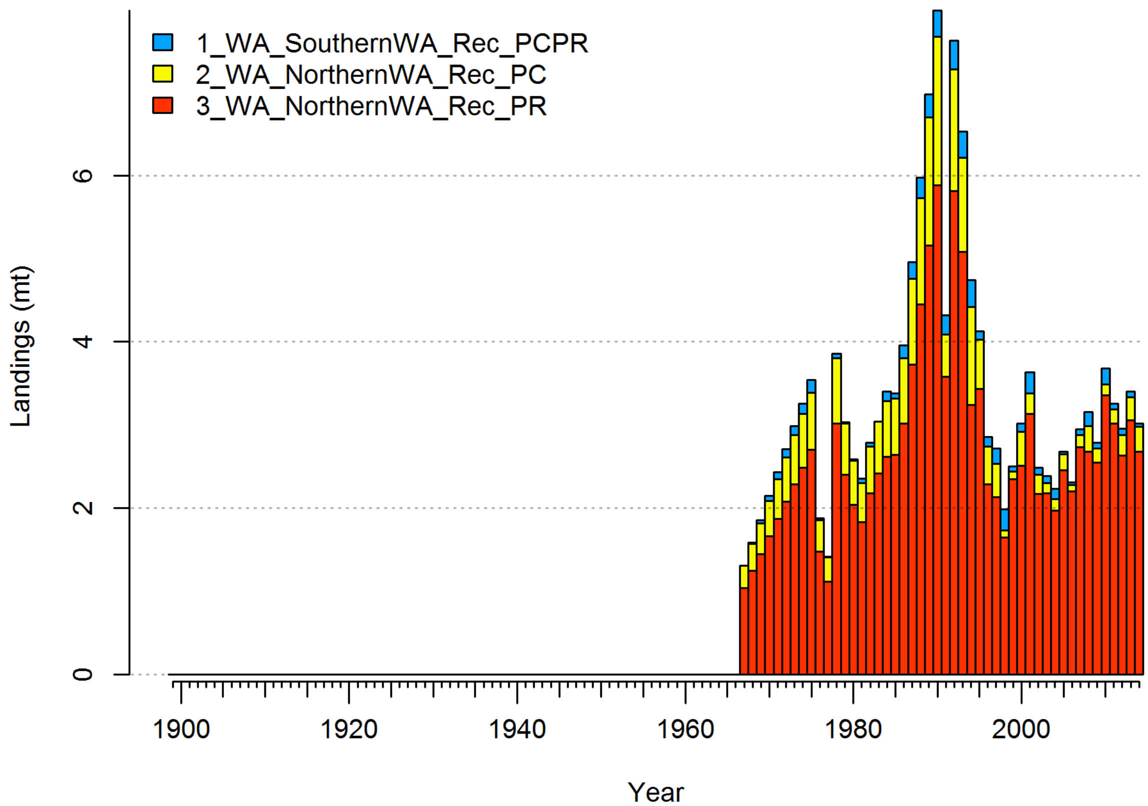

Figure a: Estimated catch history of Yellowtail Rockfish in the Northern model. Recreational catches in Washington are model estimates of total weigth converted from input catch in numbers using model estimates of growth and selectivity. fig:r4ss_catch_N

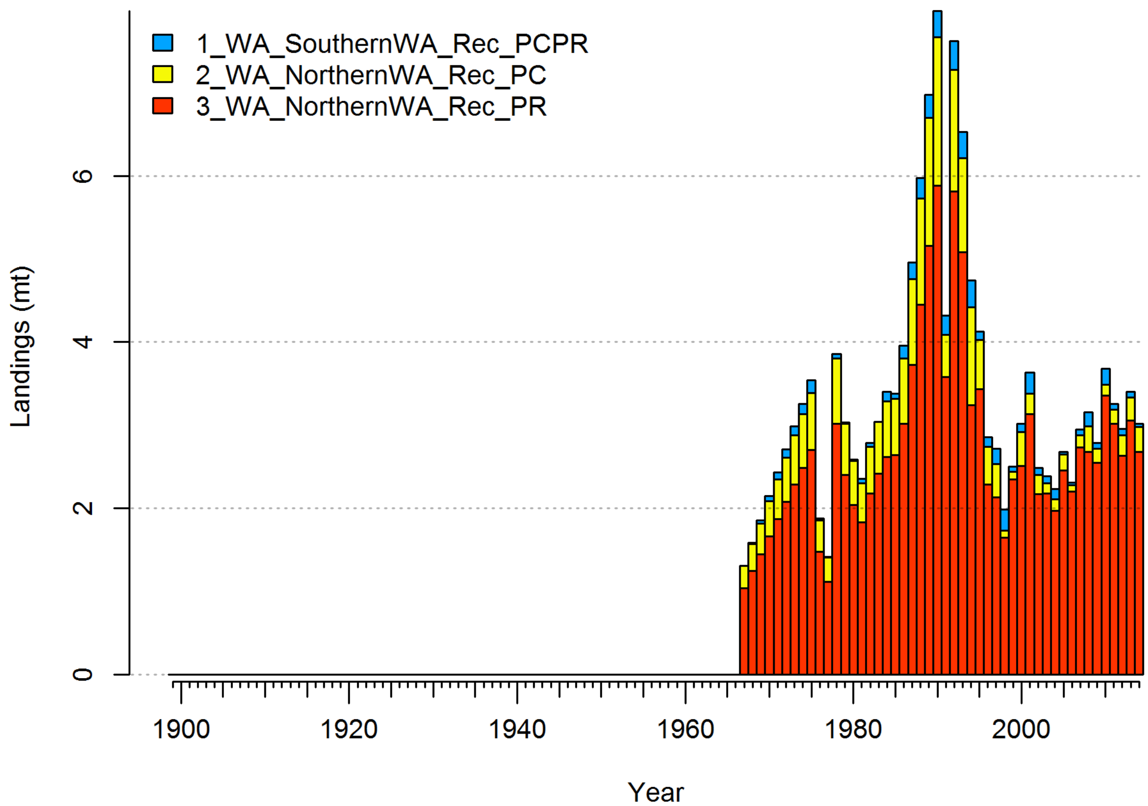

Figure b: Estimated catch history of Yellowtail Rockfish in the Southern model. fig:r4ss_catch_S

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 1900, and assumes the stock was at an unfished equilibrium that year.

Map of assessment region: (Figure c).

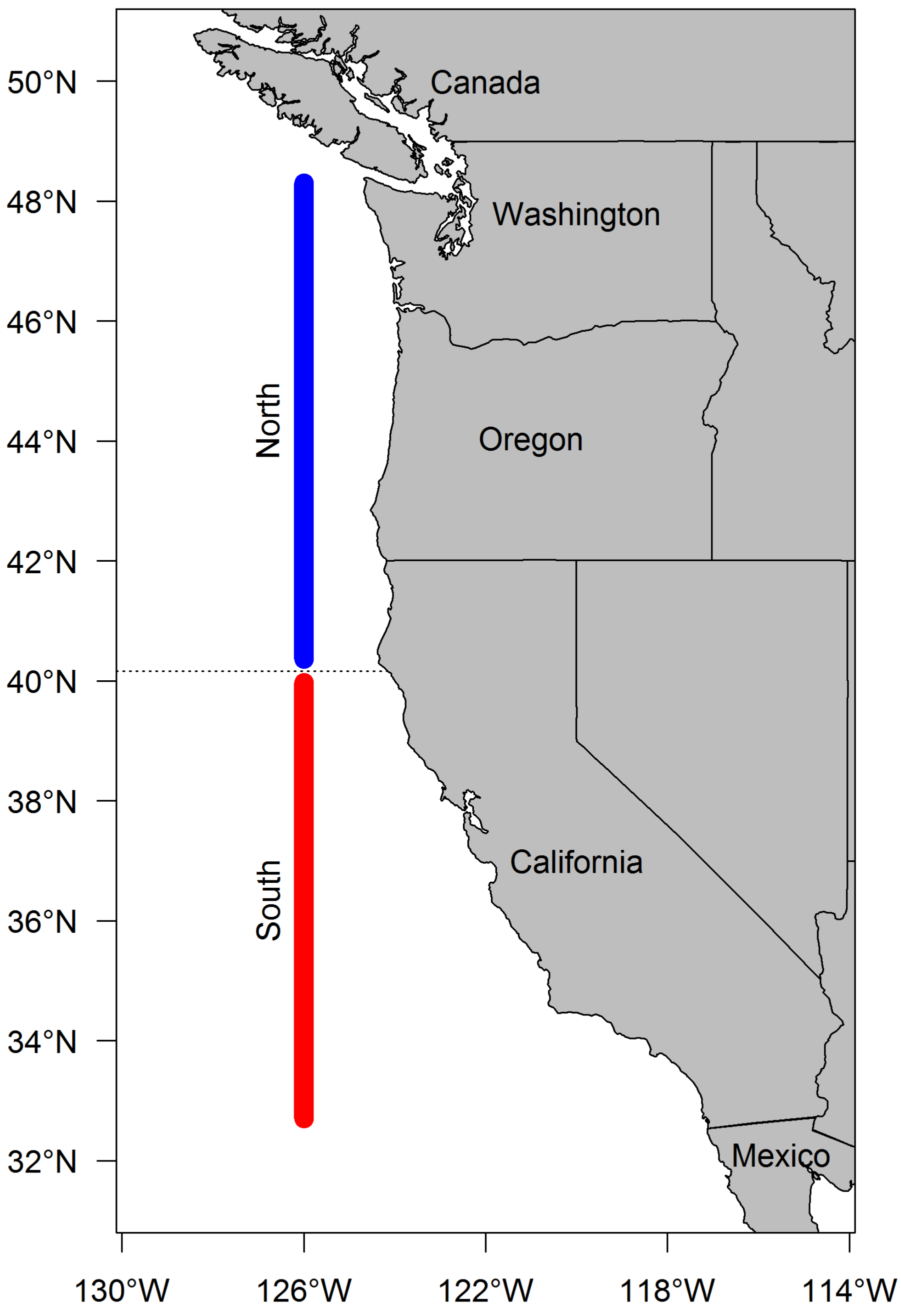

Figure c: Map depicting the boundaries for the base-case model. fig:assess_region_map

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 2014 is 73.4% (~95% asymptotic interval: ± 63.7%-83.2%) (Figure e).

The estimated relative depletion level of model 2 in 2014 is 73.4% (~95% asymptotic interval: ± 63.7%-83.2%) (Figure e).

The estimated relative depletion level of model 3 in 2014 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 (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2006	17.942	(8.86-27.03)	0.734	(0.638-0.83)
2007	18.030	(8.94-27.12)	0.738	(0.642-0.833)
2008	18.044	(8.95-27.14)	0.738	(0.643-0.833)
2009	18.034	(8.93-27.13)	0.738	(0.642-0.833)
2010	18.062	(8.96-27.17)	0.739	(0.644-0.834)
2011	17.993	(8.89-27.1)	0.736	(0.64-0.833)
2012	17.971	(8.86-27.08)	0.735	(0.638-0.832)
2013	17.981	(8.87-27.09)	0.736	(0.639-0.833)
2014	17.944	(8.83-27.06)	0.734	(0.637-0.832)
2015	17.950	(8.83-27.07)	0.734	(0.637-0.832)

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 (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2006	17.942	(8.86-27.03)	0.734	(0.638-0.83)
2007	18.030	(8.94-27.12)	0.738	(0.642-0.833)
2008	18.044	(8.95-27.14)	0.738	(0.643-0.833)
2009	18.034	(8.93-27.13)	0.738	(0.642-0.833)
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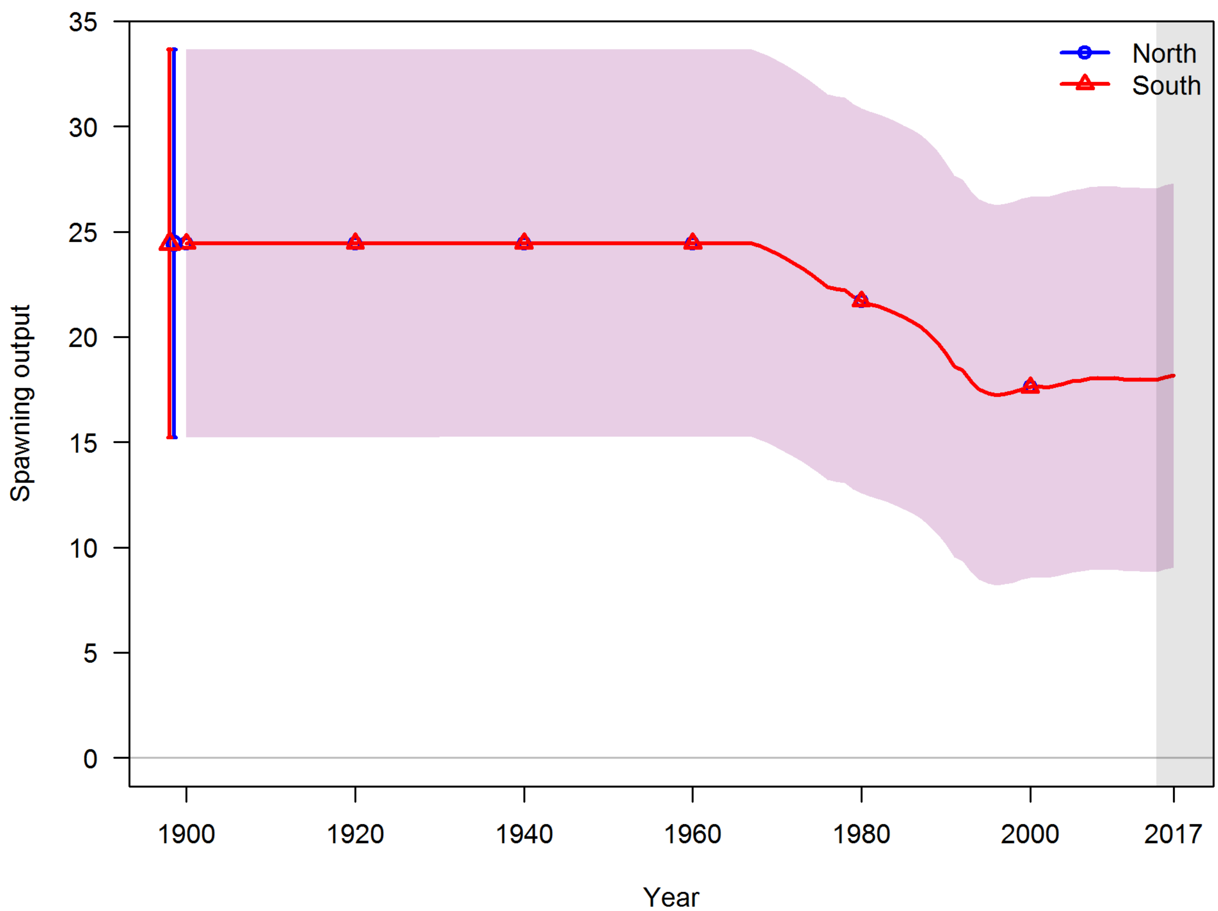

Figure d: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

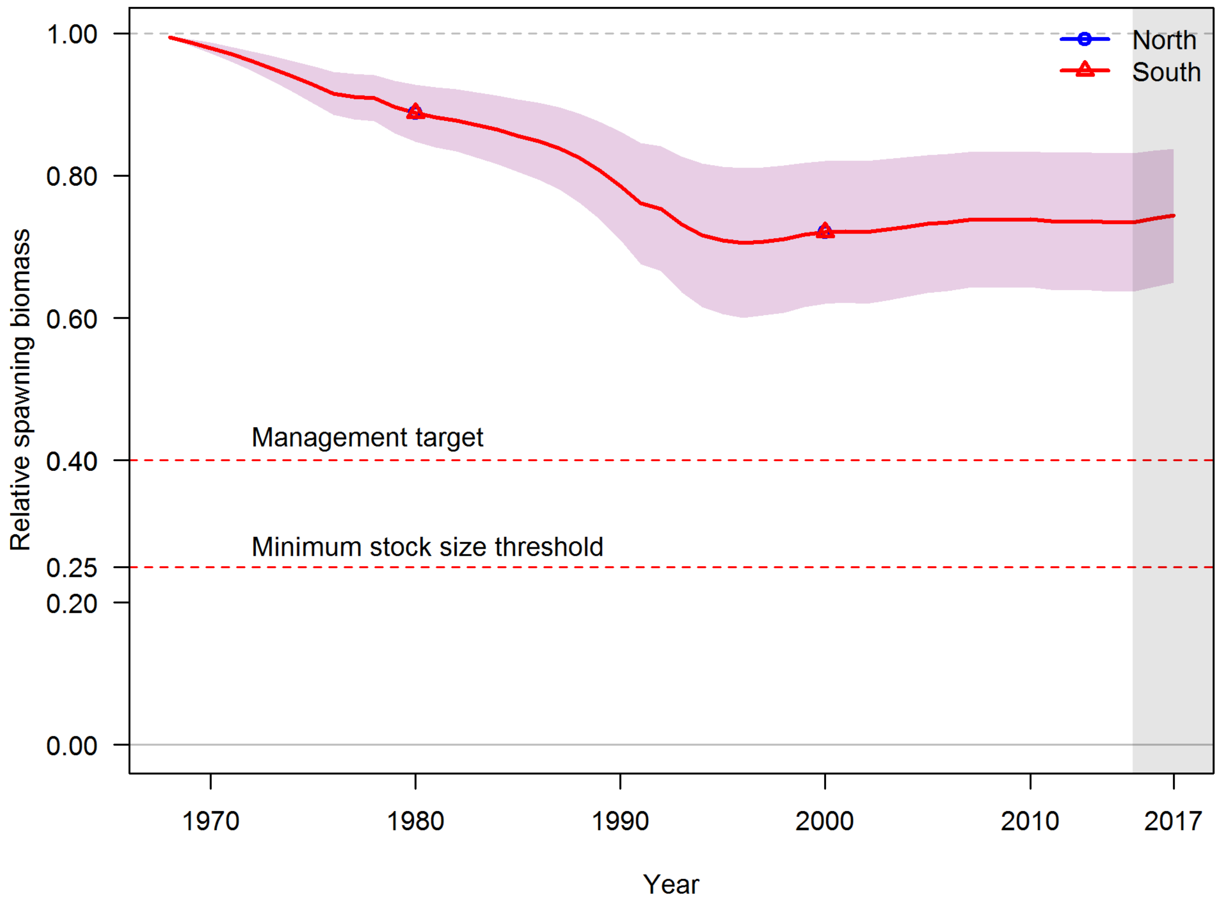

Figure e: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

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 (1,000s)	~ 95% confidence interval
2006	33.29	(23.31 - 47.53)
2007	33.30	(23.33 - 47.54)
2008	33.30	(23.33 - 47.54)
2009	33.30	(23.33 - 47.54)
2010	33.31	(23.33 - 47.55)
2011	33.30	(23.32 - 47.54)
2012	33.29	(23.31 - 47.54)
2013	33.29	(23.32 - 47.54)
2014	33.29	(23.31 - 47.54)
2015	33.29	(23.31 - 47.54)

Table f: Recent recruitment for the Southern model.

tab:Recruit_mod2

Year	Estimated Recruitment (1,000s)	~ 95% confidence interval
2006	33.29	(23.31 - 47.53)
2007	33.30	(23.33 - 47.54)
2008	33.30	(23.33 - 47.54)
2009	33.30	(23.33 - 47.54)
2010	33.31	(23.33 - 47.55)
2011	33.30	(23.32 - 47.54)
2012	33.29	(23.31 - 47.54)
2013	33.29	(23.32 - 47.54)
2014	33.29	(23.31 - 47.54)
2015	33.29	(23.31 - 47.54)

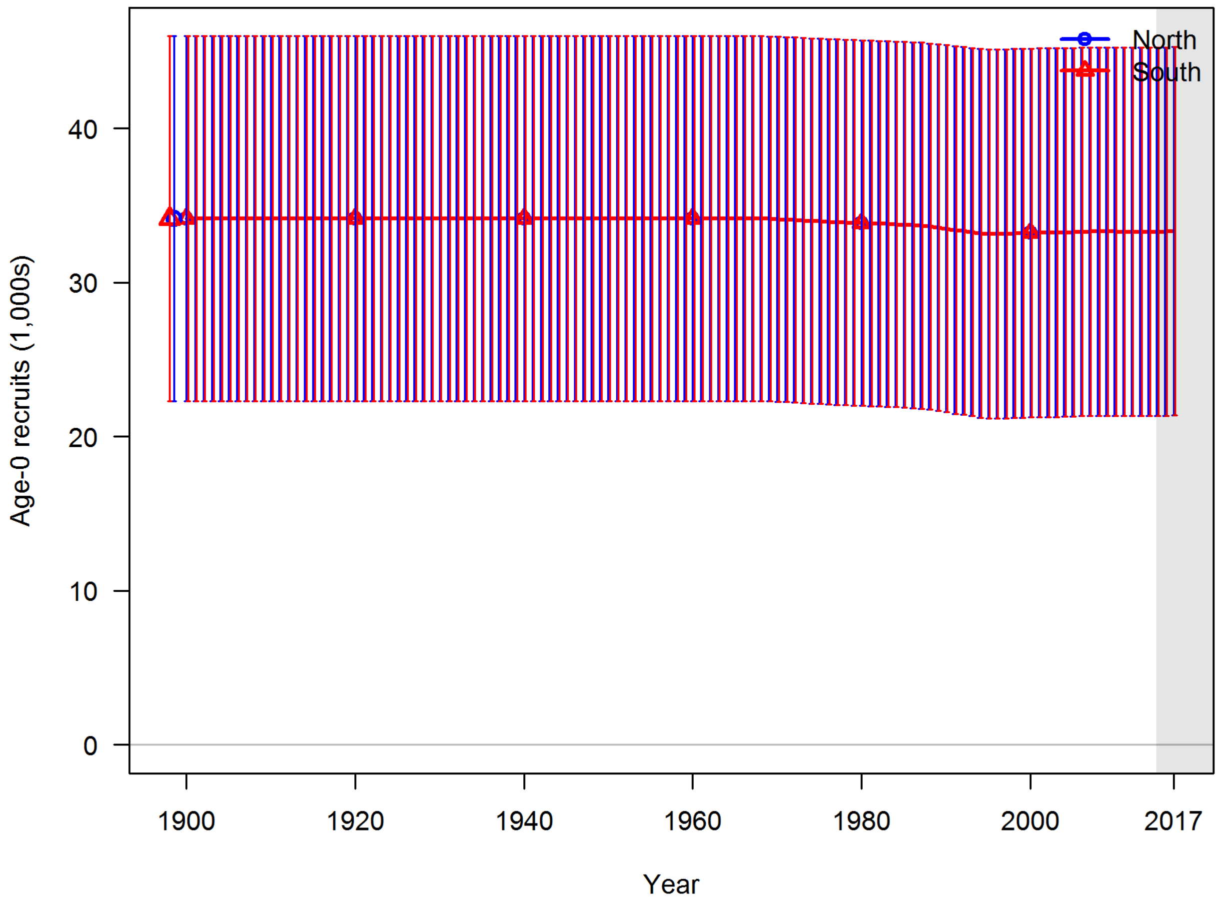

Figure f: Time series of estimated Yellowtail Rockfish recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

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
2005	0.44	(0.27-0.61)	0.32	(0.17-0.47)
2006	0.39	(0.24-0.55)	0.28	(0.15-0.4)
2007	0.47	(0.3-0.65)	0.35	(0.19-0.51)
2008	0.50	(0.32-0.68)	0.38	(0.2-0.55)
2009	0.45	(0.28-0.63)	0.33	(0.18-0.49)
2010	0.56	(0.36-0.76)	0.44	(0.24-0.64)
2011	0.51	(0.32-0.7)	0.39	(0.21-0.57)
2012	0.48	(0.3-0.66)	0.35	(0.19-0.52)
2013	0.53	(0.34-0.72)	0.41	(0.22-0.59)
2014	0.48	(0.3-0.67)	0.36	(0.19-0.53)

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
2005	0.44	(0.27-0.61)	0.32	(0.17-0.47)
2006	0.39	(0.24-0.55)	0.28	(0.15-0.4)
2007	0.47	(0.3-0.65)	0.35	(0.19-0.51)
2008	0.50	(0.32-0.68)	0.38	(0.2-0.55)
2009	0.45	(0.28-0.63)	0.33	(0.18-0.49)
2010	0.56	(0.36-0.76)	0.44	(0.24-0.64)
2011	0.51	(0.32-0.7)	0.39	(0.21-0.57)
2012	0.48	(0.3-0.66)	0.35	(0.19-0.52)
2013	0.53	(0.34-0.72)	0.41	(0.22-0.59)
2014	0.48	(0.3-0.67)	0.36	(0.19-0.53)

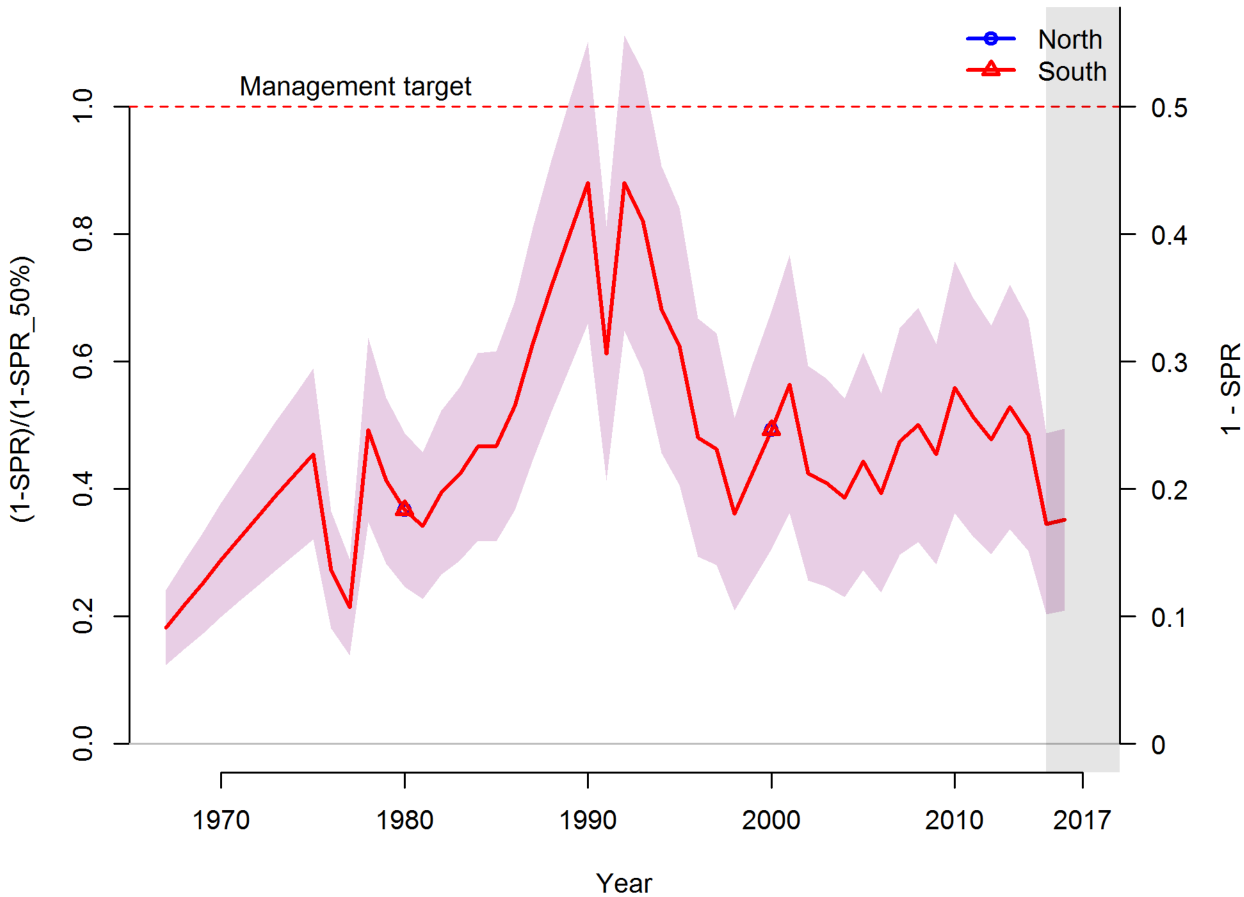

Figure g: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{50\%}$ harvest rate. The last year in the time series is 2014. fig:SPR_all

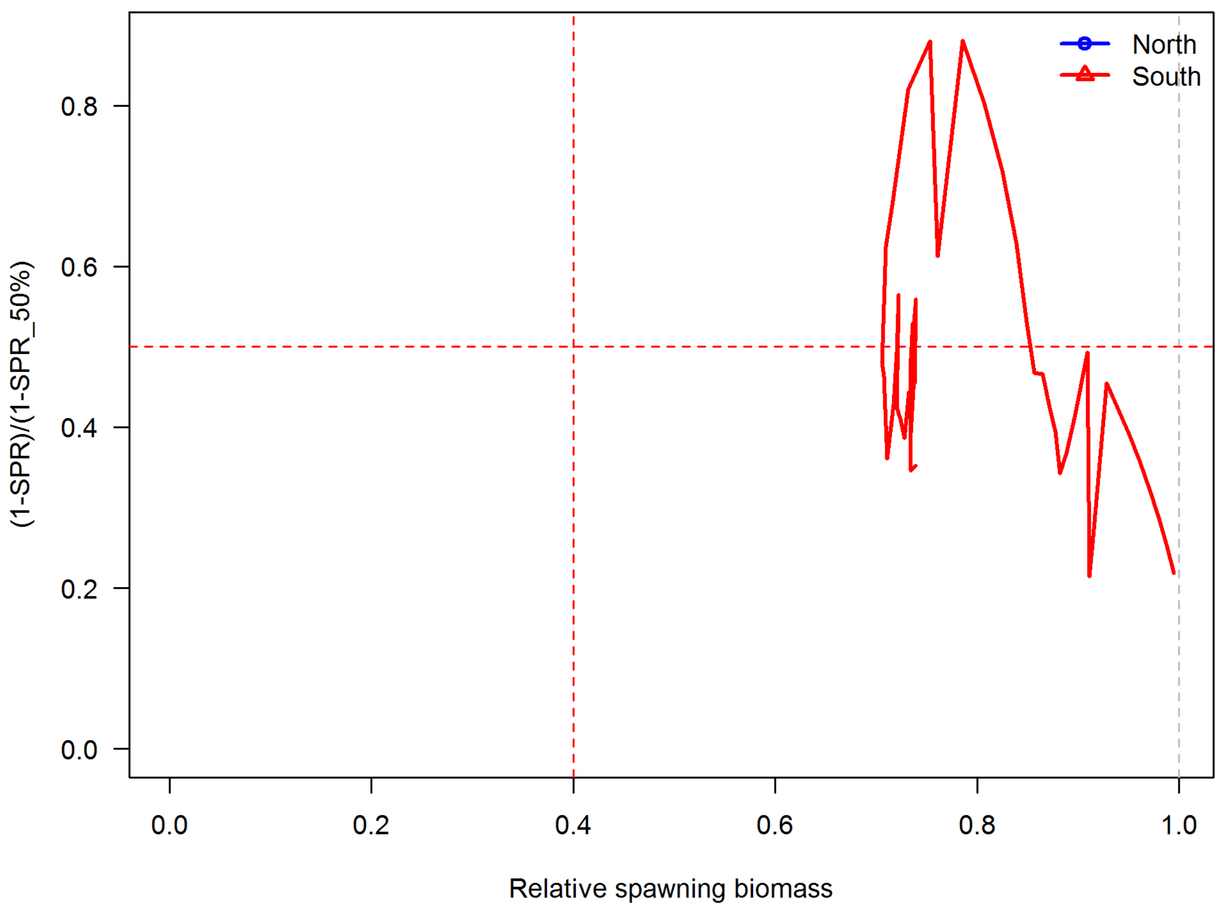

Figure h: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. fig:Phase_all

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 2014 is 73.4% (~95% asymptotic interval: ± 63.7%-83.2%, corresponding to an unfished spawning output of 17.9497 billion eggs (~95% asymptotic interval: 8.83-27.07 billion eggs) of spawning output in the base model (Table i). Unfished age 1+ biomass was estimated to be 240.8 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 9.8 billion eggs, which gives a catch of 6.3 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 5.8 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 2014 is 73.4% (~95% asymptotic interval: ± 63.7%-83.2%), corresponding to an unfished spawning output of 17.9497 billion eggs (~95% asymptotic interval:) of spawning output in the base model (Table j). Unfished age 1+ biomass was estimated to be 240.8 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 9.8 billion eggs, which gives a catch of mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 5.8 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 2014 is (~95% asymptotic interval: ±), corresponding to an unfished spawning output of (~95% asymptotic interval:) of spawning output in the base model (Table **??**). Unfished age 1+ 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 (billion eggs)	24.4	(15.2-33.7)
Unfished age 1+ biomass (mt)	240.8	(153-328.7)
Unfished recruitment (R0, thousands)	34.2	(22.3-46)
Spawning output(2014 billion eggs)	17.9	(8.8-27.1)
Depletion (2014)	0.7342	(0.6367-0.8317)
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	9.8	(6.1-13.5)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.444	(0.444-0.444)
Exploitation rate resulting in $B_{40\%}$	0.0551	(0.0522-0.058)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	6.3	(4-8.5)
Reference points based on SPR proxy for MSY		
Spawning output	11.3	(7-15.5)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0458	(0.0435-0.0482)
Yield with SPR_{proxy} at SB_{SPR} (mt)	5.8	(3.7-7.9)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	5.6	(3.5-7.8)
SPR_{MSY}	0.2875	(0.2823-0.2927)
Exploitation rate at MSY	0.0924	(0.0863-0.0985)
MSY (mt)	7	(4.5-9.4)

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 (billion eggs)	24.4	(15.2-33.7)
Unfished age 1+ biomass (mt)	240.8	(153-328.7)
Unfished recruitment (R0, thousands)	34.2	(22.3-46)
Spawning output(2014 billion eggs)	17.9	(8.8-27.1)
Depletion (2014)	0.7342	(0.6367-0.8317)
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	9.8	(6.1-13.5)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.444	(0.444-0.444)
Exploitation rate resulting in $B_{40\%}$	0.0551	(0.0522-0.058)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	6.3	(4-8.5)
Reference points based on SPR proxy for MSY		
Spawning output	11.3	(7-15.5)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0458	(0.0435-0.0482)
Yield with SPR_{proxy} at SB_{SPR} (mt)	5.8	(3.7-7.9)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	5.6	(3.5-7.8)
SPR_{MSY}	0.2875	(0.2823-0.2927)
Exploitation rate at MSY	0.0924	(0.0863-0.0985)
MSY (mt)	7	(4.5-9.4)

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}`

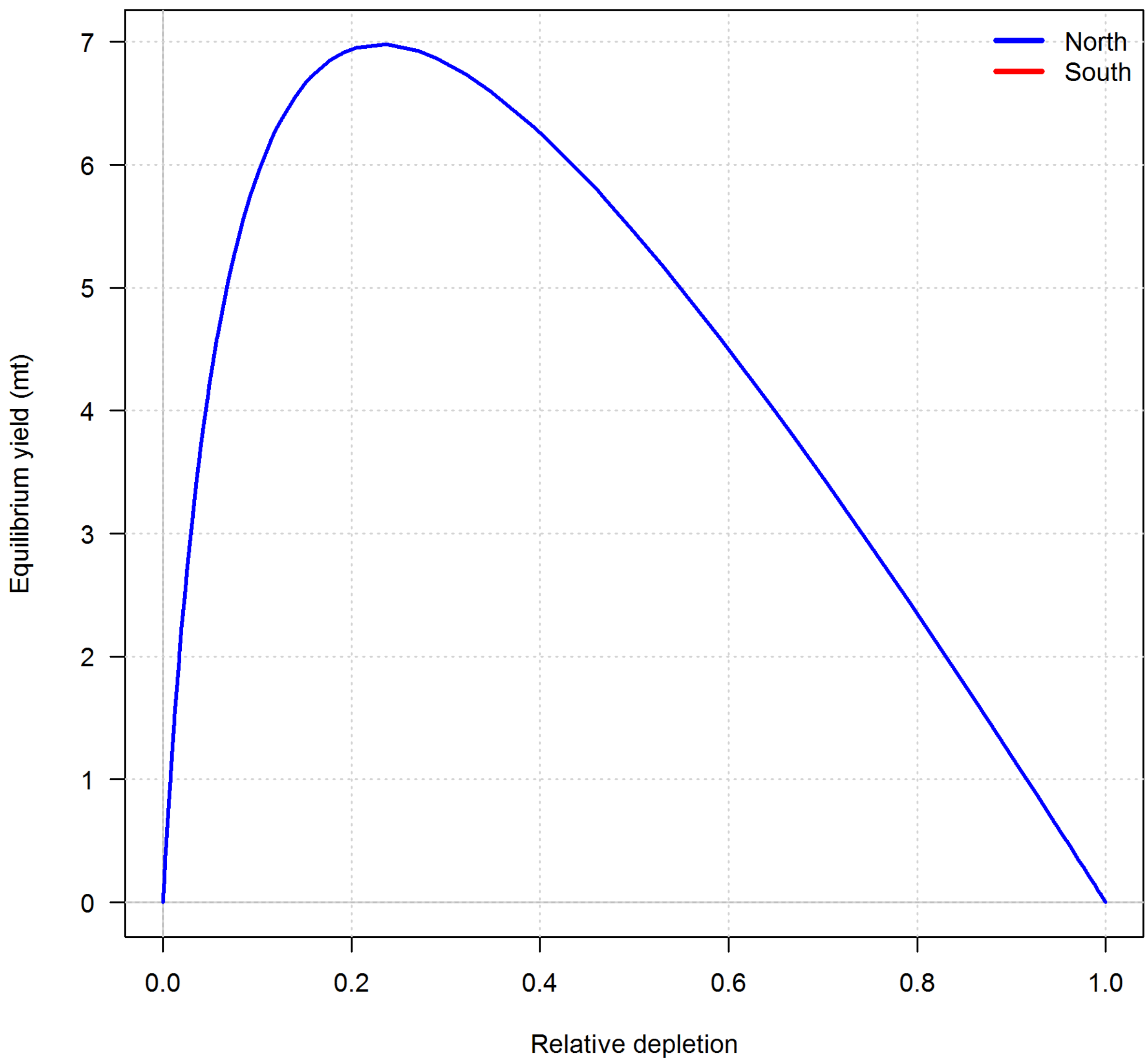

Figure i: Equilibrium yield curve for the base case model. Values are based on the 2014 fishery selectivity and with steepness fixed at... fig:Yield_all

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

tab:OFL_projection

Year	Model 1	Model 2	Total
2015	9.51	9.51	19.01
2016	9.57	9.57	19.14
2017	9.63	9.63	19.26
2018	9.29	9.29	18.58
2019	8.98	8.98	17.95
2020	8.69	8.69	17.38
2021	8.43	8.43	16.87
2022	8.20	8.20	16.40
2023	7.99	7.99	15.98
2024	7.80	7.80	15.61
2025	7.64	7.64	15.27
2026	7.49	7.49	14.98

Table m: Summary of 10-year projections beginning in 2016 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 2016 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	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Landings (mt)										
	Total Est. Catch (mt)										
	OFL (mt)										
	ACL (mt)										
Model 1	(1-SPR)(1-$SPR_{50\%}$)	0.39	0.47	0.50	0.45	0.56	0.51	0.48	0.53	0.48	
Base Case	Exploitation rate	0.28	0.35	0.38	0.33	0.44	0.39	0.35	0.41	0.36	
	Age 1+ biomass (mt)	182.15	182.55	183.26	183.36	183.25	183.49	182.90	182.72	182.82	182.52
	Spawning Output	17.9	18.0	18.0	18.0	18.1	18.0	18.0	18.0	17.9	17.9
	95% CI	(8.86-27.03)	(8.94-27.12)	(8.95-27.14)	(8.93-27.13)	(8.96-27.17)	(8.89-27.1)	(8.86-27.08)	(8.87-27.09)	(8.83-27.06)	(8.83-27.07)
	Depletion	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	95% CI	(0.638-0.83)	(0.642-0.833)	(0.643-0.833)	(0.642-0.833)	(0.644-0.834)	(0.64-0.833)	(0.638-0.832)	(0.639-0.833)	(0.637-0.832)	(0.637-0.832)
	Recruits	33.29	33.30	33.30	33.30	33.31	33.30	33.29	33.29	33.29	33.29
	95% CI	(23.31 - 47.53)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.55)	(23.32 - 47.54)	(23.31 - 47.54)	(23.32 - 47.54)	(23.31 - 47.54)	(23.31 - 47.54)
Model 2	(1-SPR)(1-$SPR_{50\%}$)	0.39	0.47	0.50	0.45	0.56	0.51	0.48	0.53	0.48	
Base Case	Exploitation rate	0.28	0.35	0.38	0.33	0.44	0.39	0.35	0.41	0.36	
	Age 1+ biomass (mt)	182.15	182.55	183.26	183.36	183.25	183.49	182.90	182.72	182.82	182.52
	Spawning Output	18	18	18	18	18	18	18	18	18	18
	95% CI	(8.86-27.03)	(8.94-27.12)	(8.95-27.14)	(8.93-27.13)	(8.96-27.17)	(8.89-27.1)	(8.86-27.08)	(8.87-27.09)	(8.83-27.06)	(8.83-27.07)
	Depletion	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.73	0.73
	95% CI	(0.638-0.83)	(0.642-0.833)	(0.643-0.833)	(0.642-0.833)	(0.644-0.834)	(0.64-0.833)	(0.638-0.832)	(0.639-0.833)	(0.637-0.832)	(0.637-0.832)
	Recruits	33.29	33.30	33.30	33.30	33.31	33.30	33.29	33.29	33.29	33.29
	95% CI	(23.31 - 47.53)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.55)	(23.32 - 47.54)	(23.31 - 47.54)	(23.32 - 47.54)	(23.31 - 47.54)	(23.31 - 47.54)

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.

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 Assessment

assessment

2.1 Data

data

Data used in the Yellowtail Rockfish assessment are summarized in Figure 3.
A description of each data source is below.

2.1.1 Commercial Fishery Landings

commercial-fishery-landings

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.2 Sport Fishery Removals

sport-fishery-removals

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.3 Estimated Discards

estimated-discards

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.4 Abundance Indices

abundance-indices

Sub-heading 1

Sub-heading 2

2.1.5 Fishery-Independent Data: possible sources

fishery-independent-data-possible-sources

Northwest Fisheries Science Center (NWFSC) slope survey
The NWFSC slope survey was conducted annually from 1999 to 2002.
The depth range of this survey is 100-700 fm.

Northwest Fisheries Science Center (NWFSC) shelf-slope survey
This survey is referred to as the "combo," conducted annually since 2003.
The survey consistently covered depths between 30 and 700 fm.

Alaska Fisheries Science Center (AFSC) shelf survey
The survey, often referred to as the "triennial" survey was conducted every third year between 1977 and (and conducted in 2004 by the NWFSC using the same protocols). The triennial survey trawls in depths of 30 to 275 fm.

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.

Enhanced Data Collection Project (EDCP)
The EDCP was conducted by ODFW to collect information on bycatch and discard groundfish species off the coast of Oregon from late 1995 to early 1999.
EDCP had limited spatial coverage in Oregon waters only.

Partnership For Interdisciplinary Studies of Coastal Oceans (PISCO)
Blurb on species presence in PISCO surveys

2.1.6 Biological Parameters and Data

`biological-parameters-and-data`

Length And Age Compositions

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

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

Model 1

- Source No. 1 (*ex. research, commerical dead fish, live fish, etc*, date range (ex. 2010-2011)
- Source No. 2 (*ex. research, commerical dead fish, live fish, etc*, date range (ex. 2010-2011)
- etc...
- Begin sublist if desired
  - Sublist source No. 1
  - Sublist source No. 2
  - etc...
- Back to main list, next Source
- Last Source

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

Possible sources of age and length data:

Recreational: Washington (WDFW)

Recreational: California MRFSS And CRFS Length Composition Data Individual fish lengths recorded by MRFSS (1980-2003) and CRFS (2004-2011) samplers were downloaded from the RecFIN website (www.recfin.org). CRFS data from 2012-2014 were obtained directly from CDFW.

Recreational: Oregon Recreational Boat Survey (ORBS) Biological data from the ORBS program were provided by ODFW. The ORBS is a dockside sampling program for the both the recreational CPFV and private modes. Length composition samples from north of Florence for the CPFV and private fleets were provided from 1980-2014. Samples from south of Florence spanned 1984-2014

Recreational: Miller and Gotshall (1965)
The Northern California Marine Sport Fish Survey conducted an assessment survey with goals that included estimation of annual fishing effort by all recreational fishing modes, catch by weight, CPUE, and collection of data to analyze length compositions

Commercial: PacFIN (Oregon and California)

Research: NMFS Groundfish Ecology Survey

From 2001-2005, the SWFSC Fisheries Ecology Division conducted longline surveys aboard a chartered commercial longline vessel at various stations between Monterey and Davenport, CA (36° N. latitude to 37.5° N. latitude) (pers. comm. Don Pearson, SWFSC). Longline gear was set in various depths from 10 meters to 700 meters, parallel to the depth contour. Each longline set consisted of 3-5 skates, each with about 250 2/0 circle hooks baited with squid. In nearshore habitats, the gear soaked for roughly 30 minutes.

Research: California Collaborative Fisheries Research Program (CCFRP)

Research: NWFSC shelf-slope survey

Research: NWFSC slope survey

Research: Abrams Thesis

Age Structures

Age structure data were available from the following sources:

Model Region 1

- Source No. 1 (*ex. research, commericla dead fish, live fish, etc*, date range (ex. 2010-2011)

- Source No. 2 (*ex. research, commericla dead fish, live fish, etc*, date range (ex. 2010-2011)
- etc...
- Begin sublist if desired
  - Sublist source No. 1
  - Sublist source No. 2
  - etc...
- Back to main list, next Source
- Last Source

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

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

Aging Precision And Bias

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 14). 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 for wild fish populations is extremely difficult to estimate.

Sex ratios

2.1.7 Environmental Or Ecosystem Data Included In The Assessment

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

2.2 History Of Modeling Approaches Used For This Stock

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

2.2.1 Previous Assessments

`previous-assessments`

2.2.2 Previous Assessment Recommendations

`previous-assessment-recommendations`

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

Recommendation 1: blah blah blah.

STAT response: blah blah blah....

Recommendation 2: blah blah blah.

STAT response: blah blah blah....

Recommendation 3: blah blah blah., etc.

STAT response: Continue recommendations as needed

2.3 Model Description

model-description

2.3.1 Transition To The Current Stock Assessment

transition-to-the-current-stock-assessment

Include: Complete description of any new modeling approaches

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

1. Change No. 1. *Rationale*: blah blah blah.
2. Change No. 2. *Rationale*: blah blah blah.
3. Change No. 3. *Rationale*: Continue list as needed.

2.3.2 Definition of Fleets and Areas

definition-of-fleets-and-areas

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

Model Region 1 or remove this line if only one model

Commercial: The commercial fleets include…

Recreational: The recreational fleets include…

Research: Research derived-data include…

2.3.3 Summary of Data for Fleets and Areas

summary-of-data-for-fleets-and-areas

2.3.4 Modeling Software

modeling-software

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

2.3.5 Data Weighting

data-weighting

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

2.3.6 Priors

`priors`

Citation for Hamel prior on natural mortality (Hamel 2015)

2.3.7 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 in Appendices A-D.

2.3.8 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 **??**

2.4 Model Selection and Evaluation

`model-selection-and-evaluation`

2.4.1 Key Assumptions and Structural Choices

`key-assumptions-and-structural-choices`

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

2.4.2 Alternate Models Considered

`alternate-models-considered`

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

2.4.3 Convergence

`convergence`

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

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 SS option that generates random starting values from a normal distribution logistically transformed into each parameter's range (Methot 2015). Table 3 shows the results of running 100 jitters for each pre-STAR base model....

2.5 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.

2.6 Model 1

model-1

2.6.1 Model 1 Base Case Results

model-1-base-case-results

Table **??**

2.6.2 Model 1 Uncertainty and Sensitivity Analyses

model-1-uncertainty-and-sensitivity-analyses

Table 4

2.6.3 Model 1 Retrospective Analysis

`model-1-retrospective-analysis`

2.6.4 Model 1 Likelihood Profiles

`model-1-likelihood-profiles`

2.6.5 Model 1 Harvest Control Rules (CPS only)

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

2.6.6 Model 1 Reference Points (groundfish only)

`model-1-reference-points-groundfish-only`

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

Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 5.8 mt. Table i shows the full suite of estimated reference points for the northern area model and Figure i shows the equilibrium yield curve.

2.7 Model 2

model-2

2.7.1 Model 2 Base Case Results

model-2-base-case-results

2.7.2 Model 2 Uncertainty and Sensitivity Analyses

model-2-uncertainty-and-sensitivity-analyses

2.7.3 Model 2 Retrospective Analysis

model-2-retrospective-analysis

2.7.4 Model 2 Likelihood Profiles

model-2-likelihood-profiles

2.7.5 Model 2 Harvest Control Rules (CPS only)

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

2.7.6 Model 2 Reference Points (groundfish only)

model-2-reference-points-groundfish-only

2.8 Model 3

model-3

2.8.1 Model 3 Base Case Results

model-3-base-case-results

2.8.2 Model 3 Uncertainty and Sensitivity Analyses

model-3-uncertainty-and-sensitivity-analyses

2.8.3 Model 3 Retrospective Analysis

model-3-retrospective-analysis

2.8.4 Model 3 Likelihood profiles

model-3-likelihood-profiles

2.8.5 Model 3 Harvest Control Rules (CPS only)

model-3-harvest-control-rules-cps-only

2.8.6 Model 3 Reference Points (groundfish only)

model-3-reference-points-groundfish-only

3 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

Table k

Model 1 Projections and Decision Table (groundfish only) (Table 6

Table m

Model 2 Projections and Decision Table (groundfish only)

Model 3 Projections and Decision Table (groundfish only)

4 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?

5 Research Needs

research-needs

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

6 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.

7 Tables

tables

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

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
1	NatM_p_1_Fem_GP_1	0.070	-3	(0.01, 0.15)			Log_Norm (-2.94, 0.53)
2	L_at_Amin_Fem_GP_1	2.000	-2	(-10, 45)			Normal (2, 10)
3	L_at_Amax_Fem_GP_1	35.411	6	(20, 50)	OK	0.364	Normal (34, 10)
4	VonBert_K_Fem_GP_1	0.147	6	(0.01, 0.3)	OK	0.006	Normal (0.1, 0.8)
5	CV_young_Fem_GP_1	0.100	-6	(0.01, 0.25)			None
6	CV_old_Fem_GP_1	0.080	6	(0.01, 0.25)	OK	0.007	None
7	NatM_p_1_Mal_GP_1	0.000	-3	(-1, 0.15)			None
8	L_at_Amin_Mal_GP_1	0.000	-2	(-1, 45)			Normal (2, 10)
9	L_at_Amax_Mal_GP_1	0.000	-4	(-1, 50)			Normal (33.13, 10)
10	VonBert_K_Mal_GP_1	0.000	-4	(-1, 0.3)			Normal (0.2461, 0.8)
11	CV_young_Mal_GP_1	0.000	-3	(-1, 0.25)			None
12	CV_old_Mal_GP_1	0.000	-3	(-1, 0.25)			None
13	Wtlen_1_Fem	0.000	-3	(0, 1)			None
14	Wtlen_2_Fem	3.177	-3	(2, 4)			None
15	Mat50%_Fem	28.500	-3	(1, 100)			None
16	Mat_slope_Fem	-1.000	-3	(-9, 9)			None
17	Eggs/kg_inter_Fem	0.196	-3	(-3, 3)			None
18	Eggs/kg_slope_wt_Fem	0.057	-3	(-3, 3)			None
19	Wtlen_1_Mal	0.000	-3	(0, 1)			None
20	Wtlen_2_Mal	3.177	-3	(2, 4)			None
24	CohortGrowDev	0.000	-4	(0, 0)			None
25	SR_LN(R0)	3.531	1	(2, 12)	OK	0.177	None
26	SR_BH_steep	0.773	-3	(0.2, 1)			Full_Beta (0.773, 0.147)
27	SR_sigmaR	0.500	-3	(0, 2)			None
28	SR_envlink	0.100	-3	(-5, 5)			None
29	SR_R1_offset	0.000	-4	(-5, 5)			None

Continued on next page

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

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
30	SR_autocorr	0.000	-99	(0, 0)			None
68	InitF_11_WA_SouthernWA_Rec_PCPR	0.000	-1	(0, 1)			None
69	InitF_22_WA_NorthernWA_Rec_PC	0.000	-1	(0, 1)			None
70	InitF_33_WA_NorthernWA_Rec_PR	0.000	-1	(0, 1)			None
71	Q_extraSD_3_3_WA_NorthernWA_Rec_PR	0.126	2	(0, 2)	OK	0.024	None
72	SizeSel_1P_1_1_WA_SouthernWA_Rec_PCPR	34.890	-4	(19, 36)			None
73	SizeSel_1P_2_1_WA_SouthernWA_Rec_PCPR	-4.000	-9	(-9, 5)			None
74	SizeSel_1P_3_1_WA_SouthernWA_Rec_PCPR	3.970	5	(0, 9)	OK	0.364	None
75	SizeSel_1P_4_1_WA_SouthernWA_Rec_PCPR	8.000	-9	(0, 9)			None
76	SizeSel_1P_5_1_WA_SouthernWA_Rec_PCPR	-8.000	-9	(-9, 9)			None
77	SizeSel_1P_6_1_WA_SouthernWA_Rec_PCPR	8.000	-9	(-9, 9)			None
78	SizeSel_2P_1_2_WA_NorthernWA_Rec_PC	34.862	4	(19, 36)	OK	1.001	None
79	SizeSel_2P_2_2_WA_NorthernWA_Rec_PC	-4.000	-9	(-9, 5)			None
80	SizeSel_2P_3_2_WA_NorthernWA_Rec_PC	2.925	5	(0, 9)	OK	0.347	None
81	SizeSel_2P_4_2_WA_NorthernWA_Rec_PC	8.000	-9	(0, 9)			None
82	SizeSel_2P_5_2_WA_NorthernWA_Rec_PC	-8.000	-9	(-9, 9)			None
83	SizeSel_2P_6_2_WA_NorthernWA_Rec_PC	8.000	-9	(-9, 9)			None

tab:model_params

Table 2: 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 3: 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 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1900	241	24	0.00	34	0	0.00	1.00
1901	241	24	0.00	34	0	0.00	1.00
1902	241	24	0.00	34	0	0.00	1.00
1903	241	24	0.00	34	0	0.00	1.00
1904	241	24	0.00	34	0	0.00	1.00
1905	241	24	0.00	34	0	0.00	1.00
1906	241	24	0.00	34	0	0.00	1.00
1907	241	24	0.00	34	0	0.00	1.00
1908	241	24	0.00	34	0	0.00	1.00
1909	241	24	0.00	34	0	0.00	1.00
1910	241	24	0.00	34	0	0.00	1.00
1911	241	24	0.00	34	0	0.00	1.00
1912	241	24	0.00	34	0	0.00	1.00
1913	241	24	0.00	34	0	0.00	1.00
1914	241	24	0.00	34	0	0.00	1.00
1915	241	24	0.00	34	0	0.00	1.00
1916	241	24	0.00	34	0	0.00	1.00
1917	241	24	0.00	34	0	0.00	1.00
1918	241	24	0.00	34	0	0.00	1.00
1919	241	24	0.00	34	0	0.00	1.00
1920	241	24	0.00	34	0	0.00	1.00
1921	241	24	0.00	34	0	0.00	1.00
1922	241	24	0.00	34	0	0.00	1.00
1923	241	24	0.00	34	0	0.00	1.00
1924	241	24	0.00	34	0	0.00	1.00
1925	241	24	0.00	34	0	0.00	1.00
1926	241	24	0.00	34	0	0.00	1.00
1927	241	24	0.00	34	0	0.00	1.00
1928	241	24	0.00	34	0	0.00	1.00
1929	241	24	0.00	34	0	0.00	1.00
1930	241	24	0.00	34	0	0.00	1.00
1931	241	24	0.00	34	0	0.00	1.00
1932	241	24	0.00	34	0	0.00	1.00
1933	241	24	0.00	34	0	0.00	1.00
1934	241	24	0.00	34	0	0.00	1.00
1935	241	24	0.00	34	0	0.00	1.00
1936	241	24	0.00	34	0	0.00	1.00
1937	241	24	0.00	34	0	0.00	1.00
1938	241	24	0.00	34	0	0.00	1.00
1939	241	24	0.00	34	0	0.00	1.00

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

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1940	241	24	0.00	34	0	0.00	1.00
1941	241	24	0.00	34	0	0.00	1.00
1942	241	24	0.00	34	0	0.00	1.00
1943	241	24	0.00	34	0	0.00	1.00
1944	241	24	0.00	34	0	0.00	1.00
1945	241	24	0.00	34	0	0.00	1.00
1946	241	24	0.00	34	0	0.00	1.00
1947	241	24	0.00	34	0	0.00	1.00
1948	241	24	0.00	34	0	0.00	1.00
1949	241	24	0.00	34	0	0.00	1.00
1950	241	24	0.00	34	0	0.00	1.00
1951	241	24	0.00	34	0	0.00	1.00
1952	241	24	0.00	34	0	0.00	1.00
1953	241	24	0.00	34	0	0.00	1.00
1954	241	24	0.00	34	0	0.00	1.00
1955	241	24	0.00	34	0	0.00	1.00
1956	241	24	0.00	34	0	0.00	1.00
1957	241	24	0.00	34	0	0.00	1.00
1958	241	24	0.00	34	0	0.00	1.00
1959	241	24	0.00	34	0	0.00	1.00
1960	241	24	0.00	34	0	0.00	1.00
1961	241	24	0.00	34	0	0.00	1.00
1962	241	24	0.00	34	0	0.00	1.00
1963	241	24	0.00	34	0	0.00	1.00
1964	241	24	0.00	34	0	0.00	1.00
1965	241	24	0.00	34	0	0.00	1.00
1966	241	24	0.00	34	0	0.00	1.00
1967	223	24	0.00	34	1	0.00	0.91
1968	220	24	0.99	34	2	0.00	0.89
1969	216	24	0.99	34	2	0.17	0.87
1970	213	24	0.98	34	2	0.20	0.86
1971	209	24	0.97	34	2	0.23	0.84
1972	206	23	0.96	34	3	0.26	0.82
1973	203	23	0.95	34	3	0.29	0.80
1974	200	23	0.94	34	3	0.32	0.79
1975	197	23	0.93	34	4	0.35	0.77
1976	214	22	0.92	34	2	0.19	0.86
1977	220	22	0.91	34	1	0.14	0.89
1978	193	22	0.91	34	4	0.39	0.75
1979	201	22	0.90	34	3	0.31	0.79

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

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1980	205	22	0.89	34	3	0.27	0.82
1981	208	22	0.88	34	2	0.24	0.83
1982	203	21	0.88	34	3	0.29	0.80
1983	200	21	0.87	34	3	0.32	0.79
1984	195	21	0.86	34	3	0.36	0.77
1985	195	21	0.86	34	3	0.36	0.77
1986	189	21	0.85	34	4	0.42	0.73
1987	180	20	0.84	34	5	0.53	0.69
1988	171	20	0.82	34	6	0.65	0.64
1989	162	20	0.81	34	7	0.77	0.60
1990	155	19	0.79	33	8	0.90	0.56
1991	181	19	0.76	33	4	0.50	0.69
1992	155	18	0.75	33	8	0.89	0.56
1993	161	18	0.73	33	7	0.78	0.59
1994	174	18	0.72	33	5	0.58	0.66
1995	180	17	0.71	33	4	0.51	0.69
1996	194	17	0.71	33	3	0.35	0.76
1997	196	17	0.71	33	3	0.33	0.77
1998	206	17	0.71	33	2	0.24	0.82
1999	199	18	0.72	33	2	0.30	0.79
2000	193	18	0.72	33	3	0.37	0.75
2001	186	18	0.72	33	4	0.44	0.72
2002	199	18	0.72	33	2	0.30	0.79
2003	201	18	0.72	33	2	0.29	0.80
2004	203	18	0.73	33	2	0.27	0.81
2005	198	18	0.73	33	3	0.32	0.78
2006	203	18	0.73	33	2	0.28	0.80
2007	195	18	0.74	33	3	0.35	0.76
2008	192	18	0.74	33	3	0.38	0.75
2009	197	18	0.74	33	3	0.33	0.77
2010	186	18	0.74	33	4	0.44	0.72
2011	191	18	0.74	33	3	0.39	0.74
2012	194	18	0.74	33	3	0.35	0.76
2013	189	18	0.74	33	3	0.41	0.74
2014	194	18	0.73	33			

tab:Timeseries_mod1

Table 4: 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 6: 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
2015	9.51	1.97	182.58	17.95	0.73
2016	9.57	2.03	183.59	18.07	0.74
2017	9.63	8.81	184.50	18.18	0.74
2018	9.29	8.50	179.23	17.55	0.72
2019	8.98	8.22	174.48	16.98	0.69
2020	8.69	7.96	170.21	16.47	0.67
2021	8.43	7.72	166.38	16.00	0.65
2022	8.20	7.51	162.98	15.58	0.64
2023	7.99	7.31	159.93	15.20	0.62
2024	7.80	7.14	157.22	14.86	0.61
2025	7.64	6.99	154.80	14.57	0.60
2026	7.49	6.85	152.64	14.30	0.59

8 Figures

figures

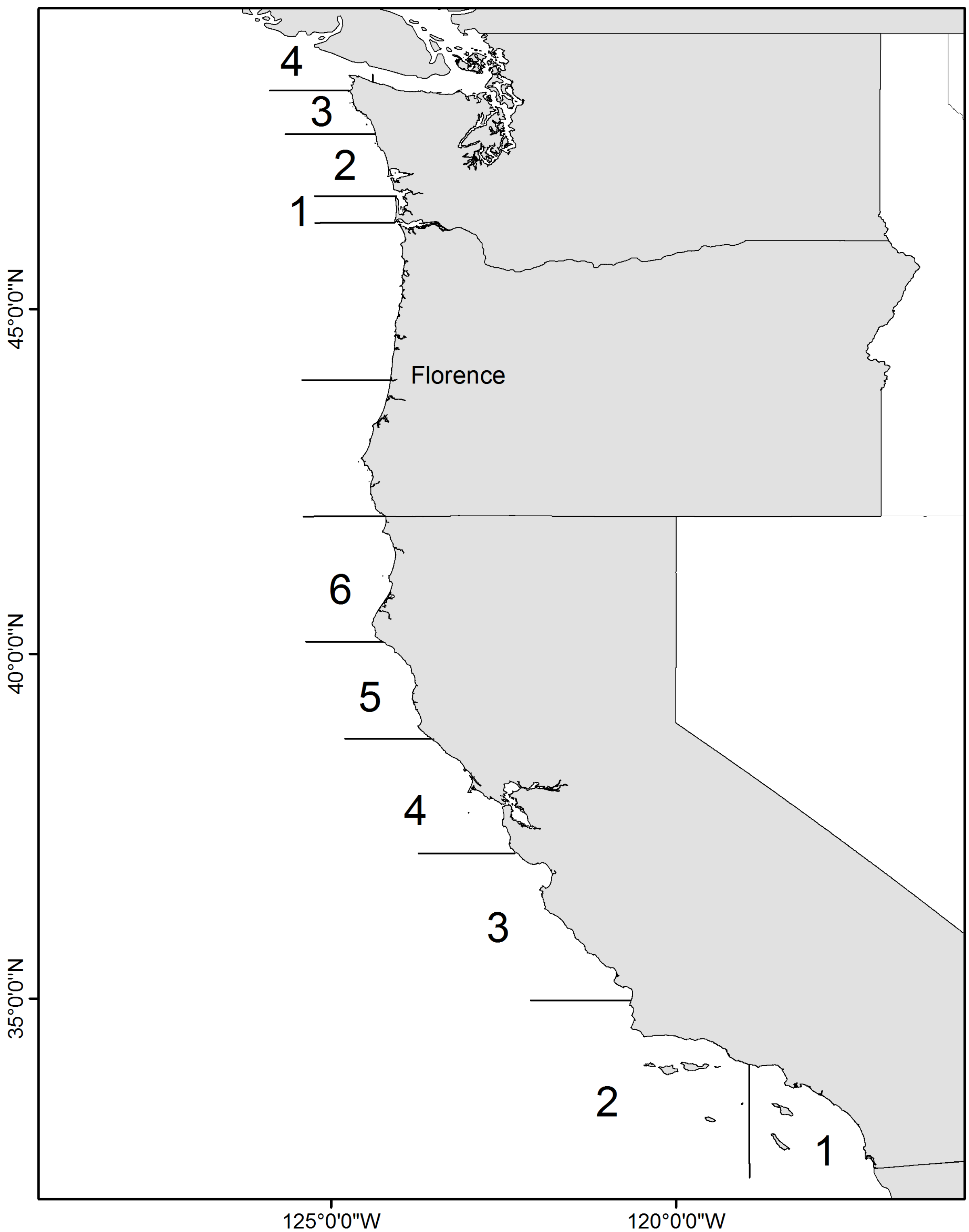

Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. fig:boundary_map

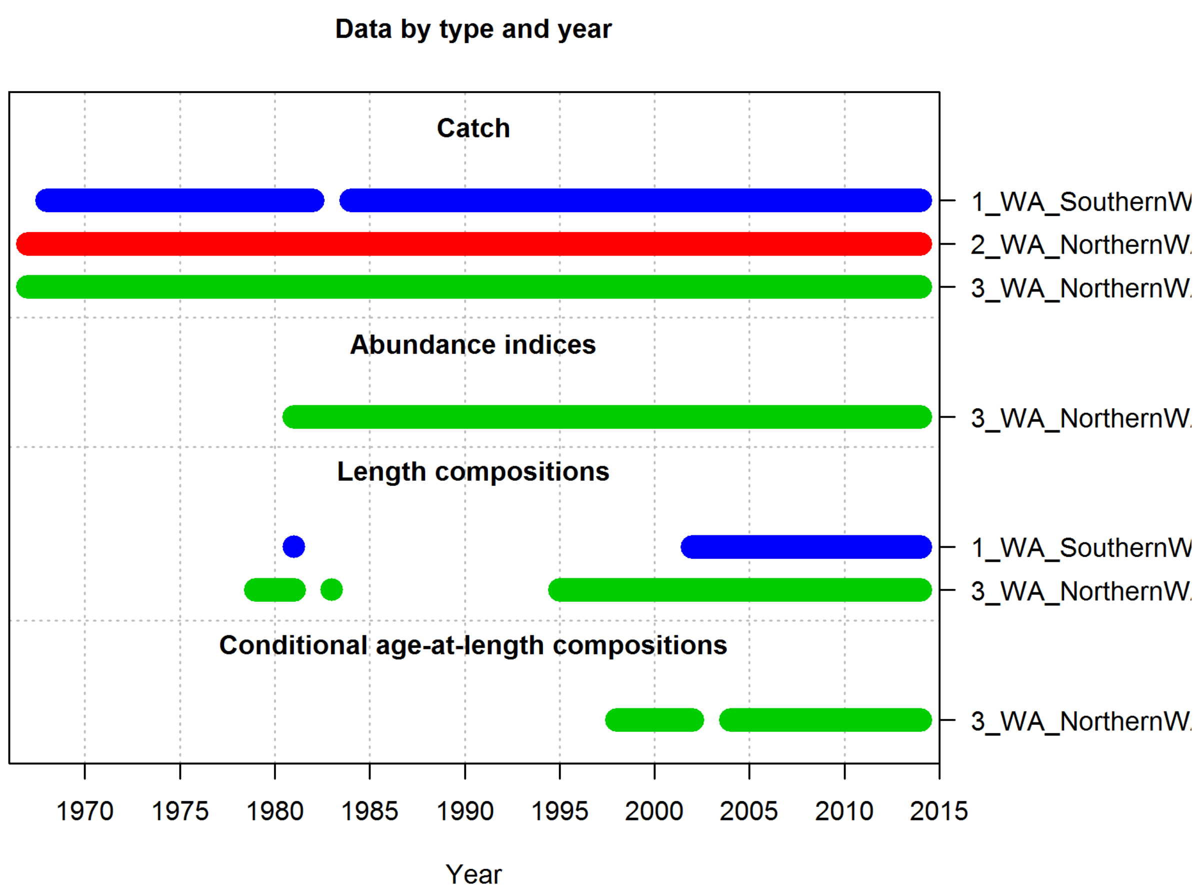

Figure 2: Summary of data sources used in the Northern model. fig:data_plot

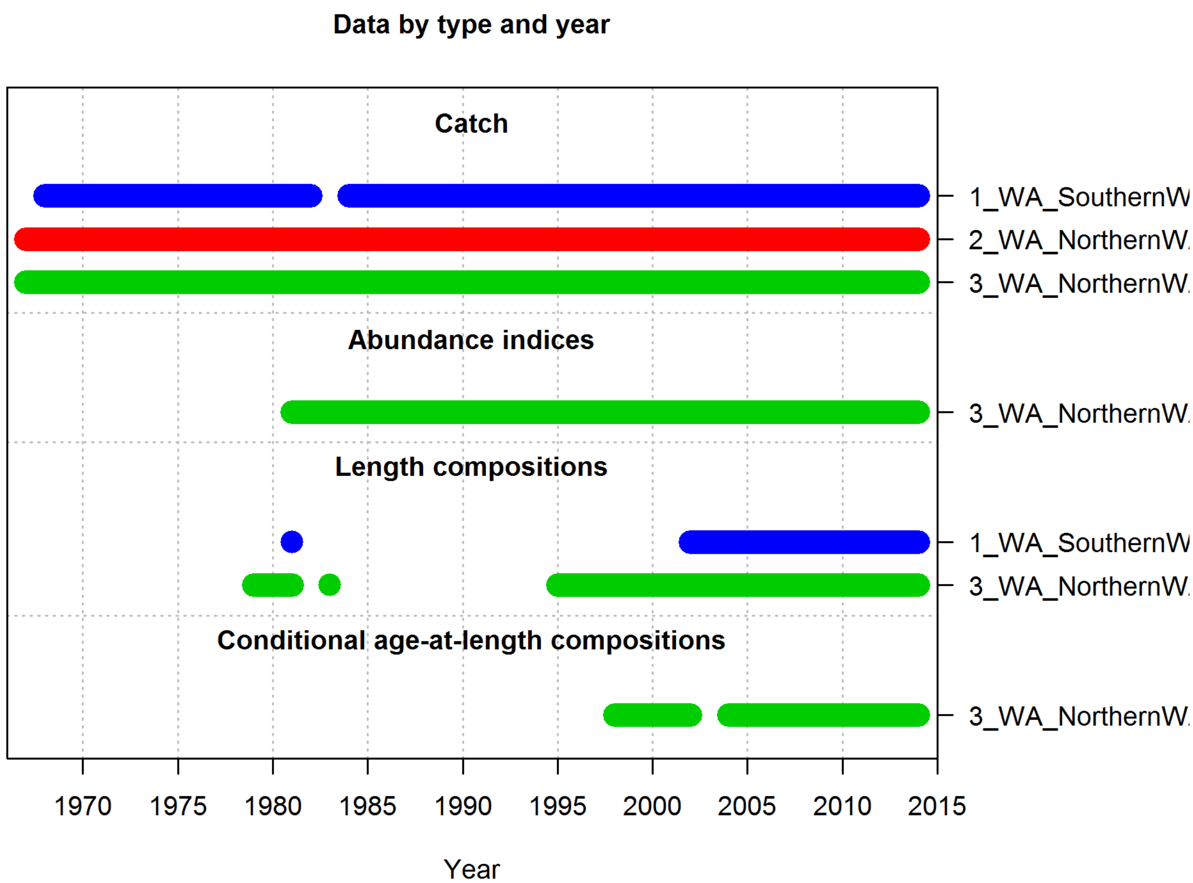

Figure 3: Summary of data sources used in the Southern model. fig:data_plot

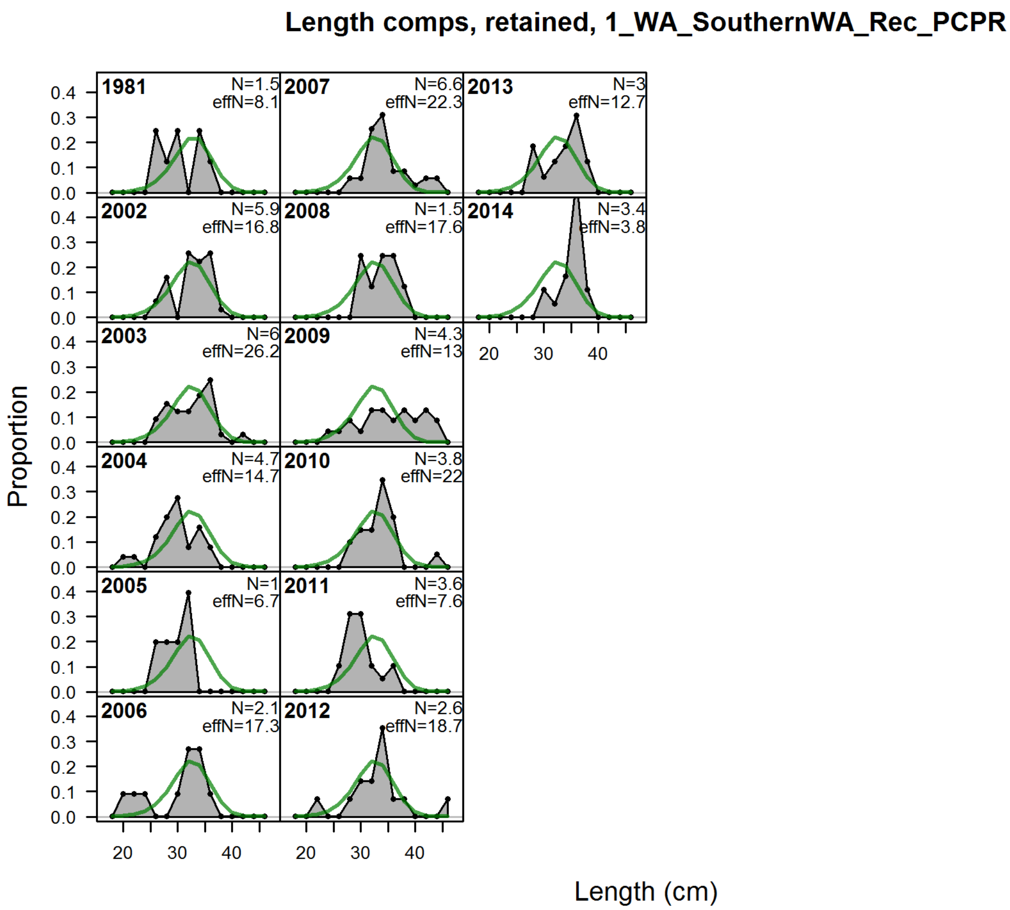

Figure 4: Length comps, retained, 1_WA_SouthernWA_Rec_PCPR fig:mod1_1_comp_lenfit_f

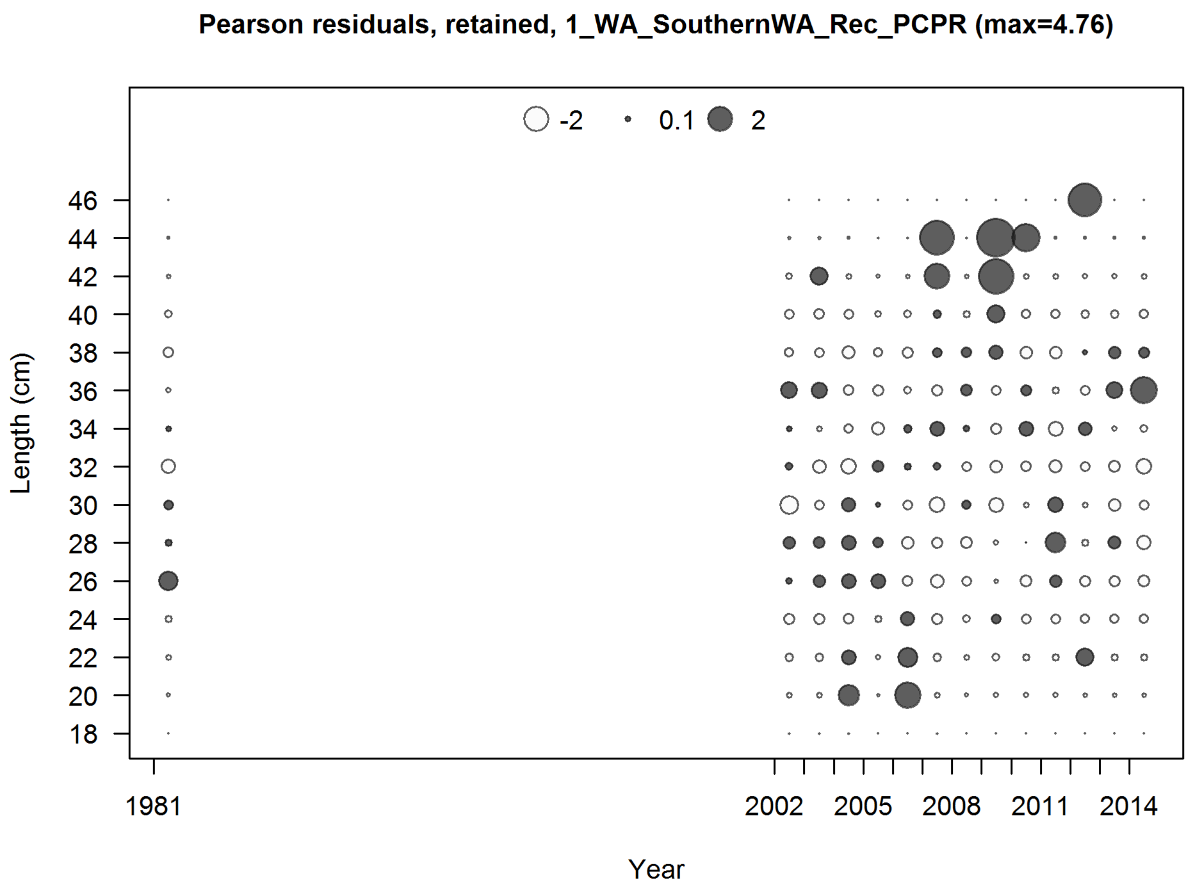

Figure 5: Pearson residuals, retained, 1_WA_SouthernWA_Rec_PCPR (max=4.76)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_2_comp_lenfit_residsflt1mkt2

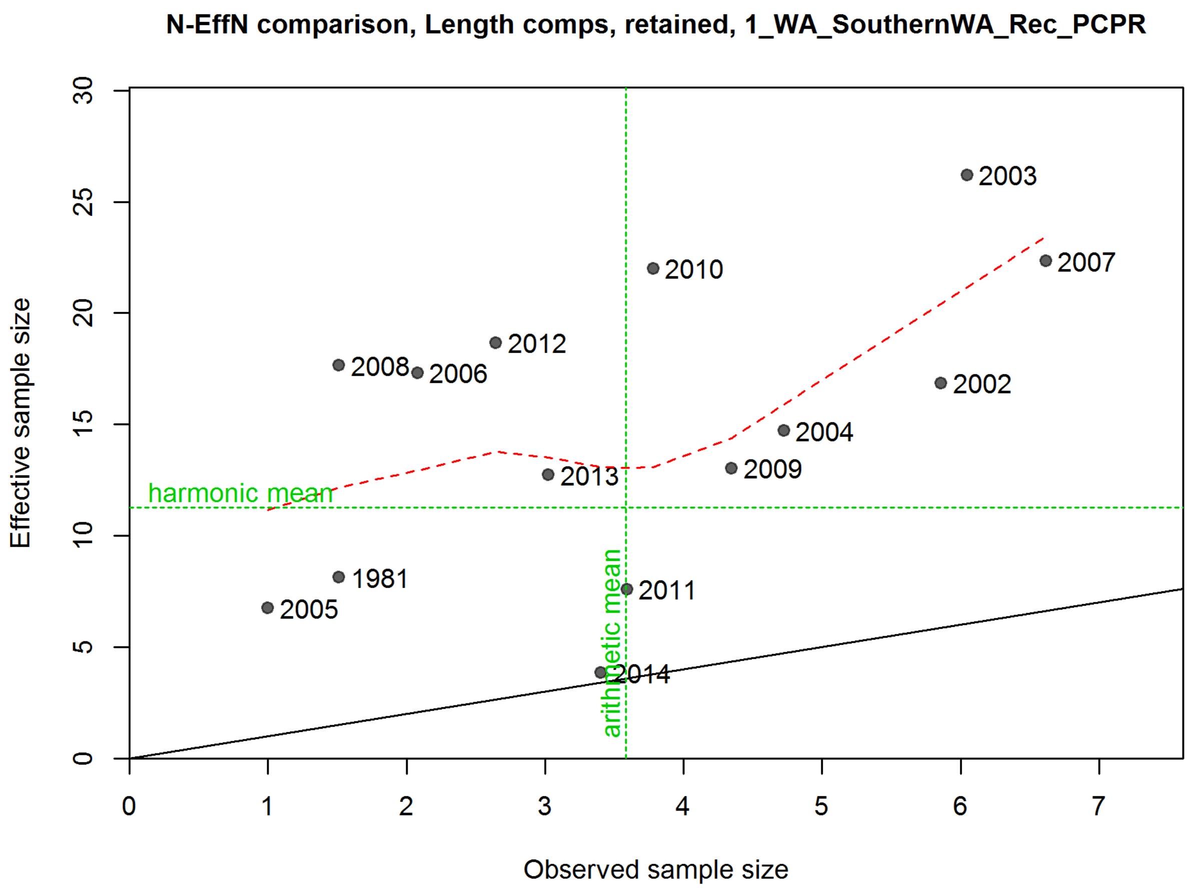

Figure 6: N_EffN comparison, Length comps, retained, 1_WA_SouthernWA_Rec_PCPR fig:mod1_3_com

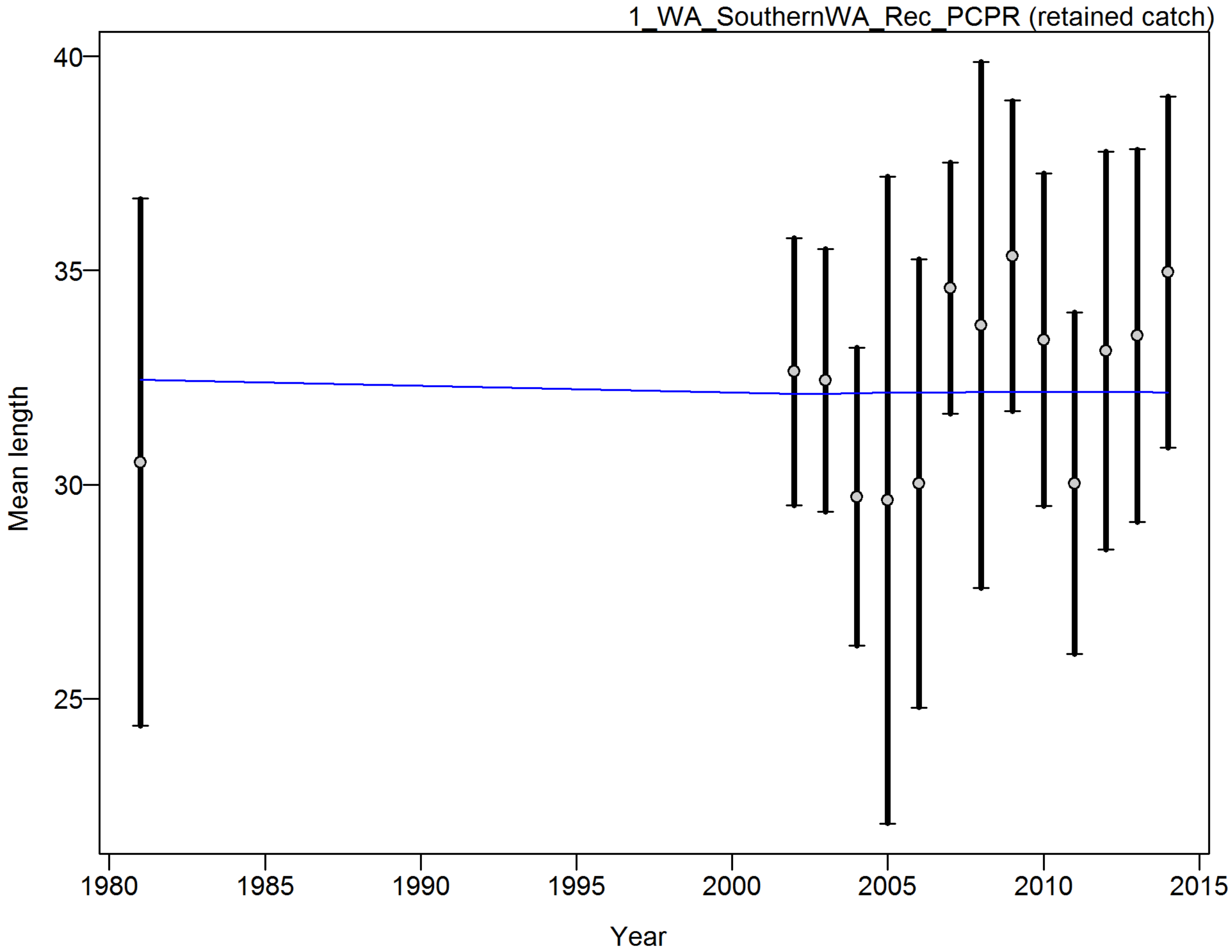

Figure 7: Francis data weighting method TA1.8: 1_WA_SouthernWA_Rec_PCPR Suggested sample size adjustment (with 95% interval) for len data from 1_WA_SouthernWA_Rec_PCPR: 0.9991 (0.6863_2.1806) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. fig:mod1_4_comp_

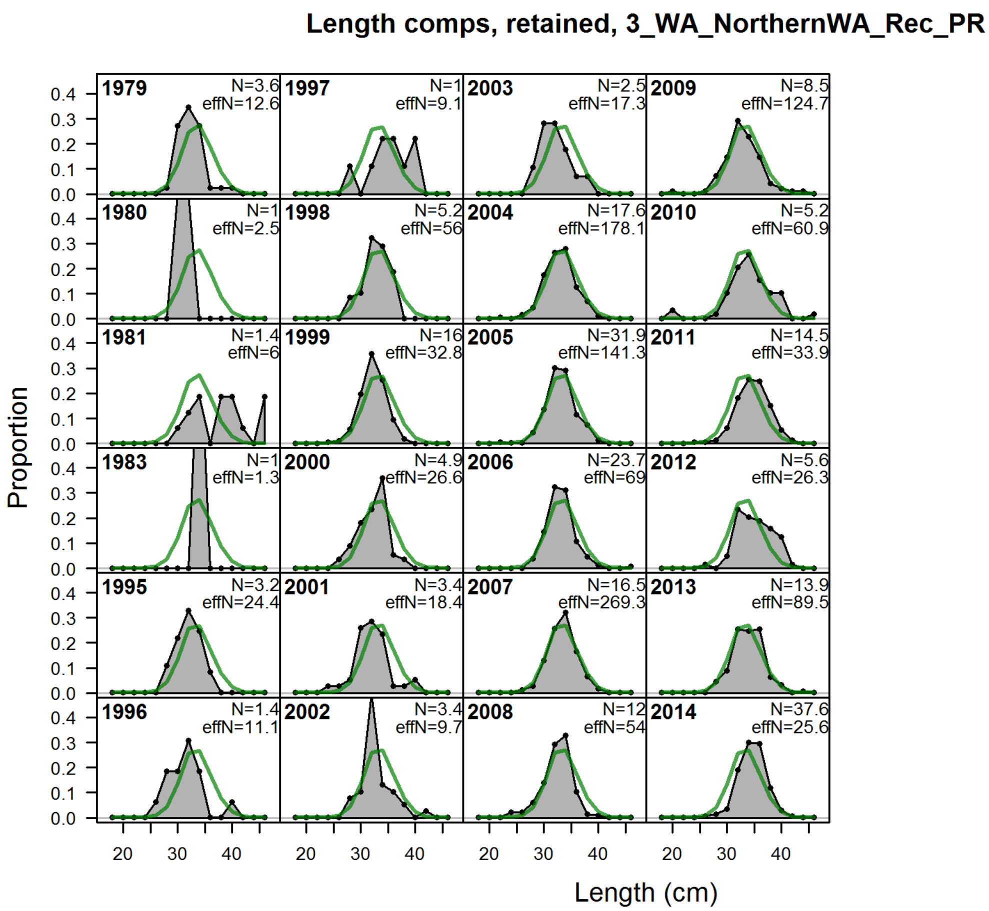

Figure 8: Length comps, retained, 3_WA_NorthernWA_Rec_PR fig:mod1_5_comp_lenfit_fl

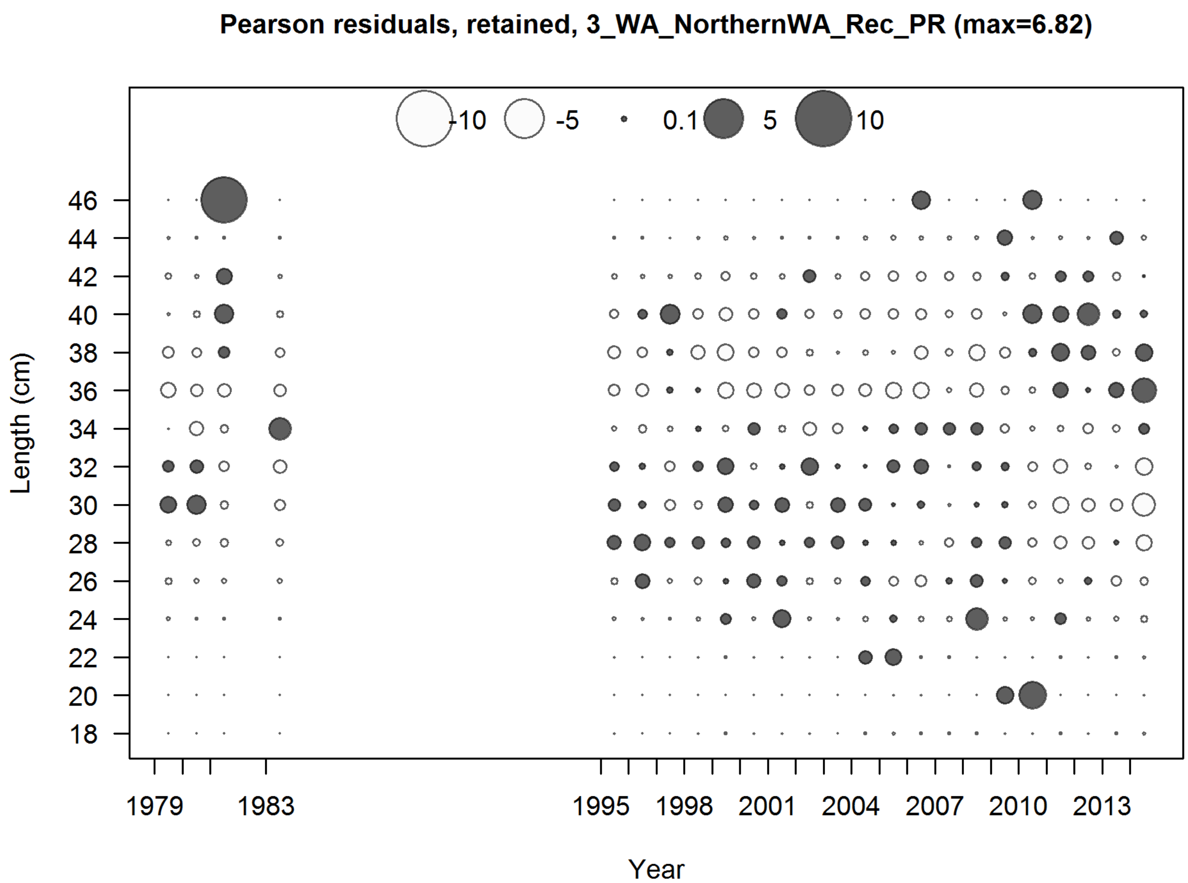

Figure 9: Pearson residuals, retained, 3_WA_NorthernWA_Rec_PR (max=6.82)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_6_comp_lenfit_residsflt3mkt2

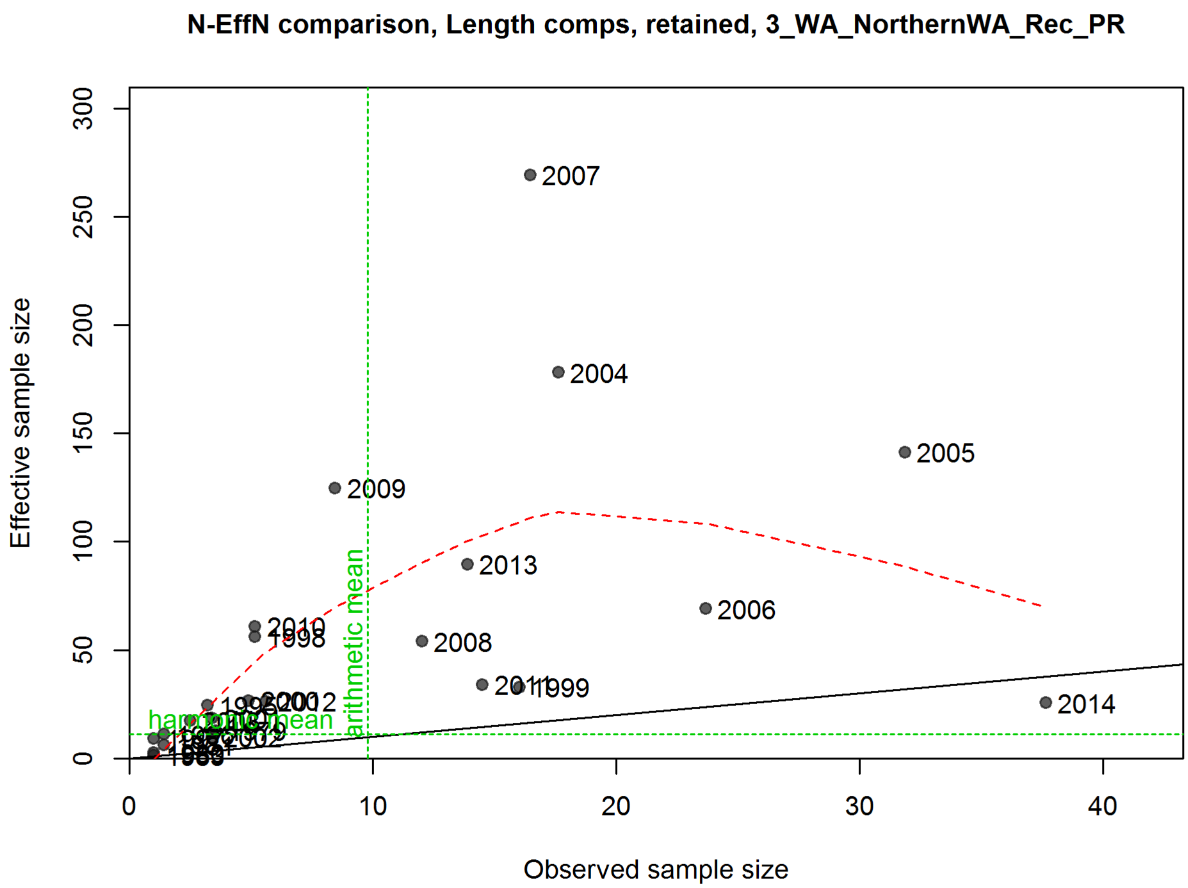

Figure 10: N_EffN comparison, Length comps, retained, 3_WA_NorthernWA_Rec_PR fig:mod1_7_comp_

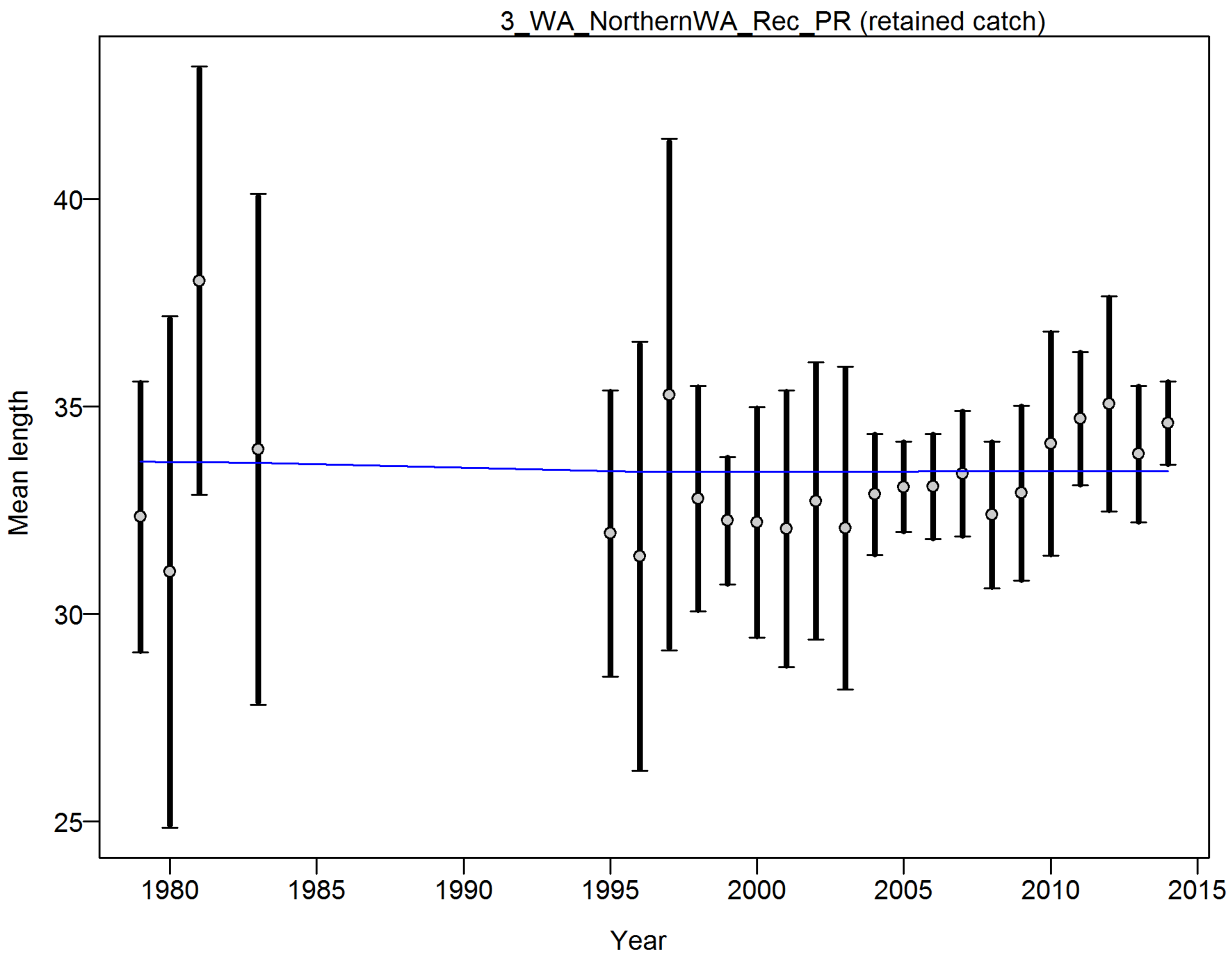

Figure 11: Francis data weighting method TA1.8: 3_WA_NorthernWA_Rec_PR Suggested sample size adjustment (with 95% interval) for len data from 3_WA_NorthernWA_Rec_PR: 0.9797 (0.6498_2.4392) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. fig:mod1_8_comp_

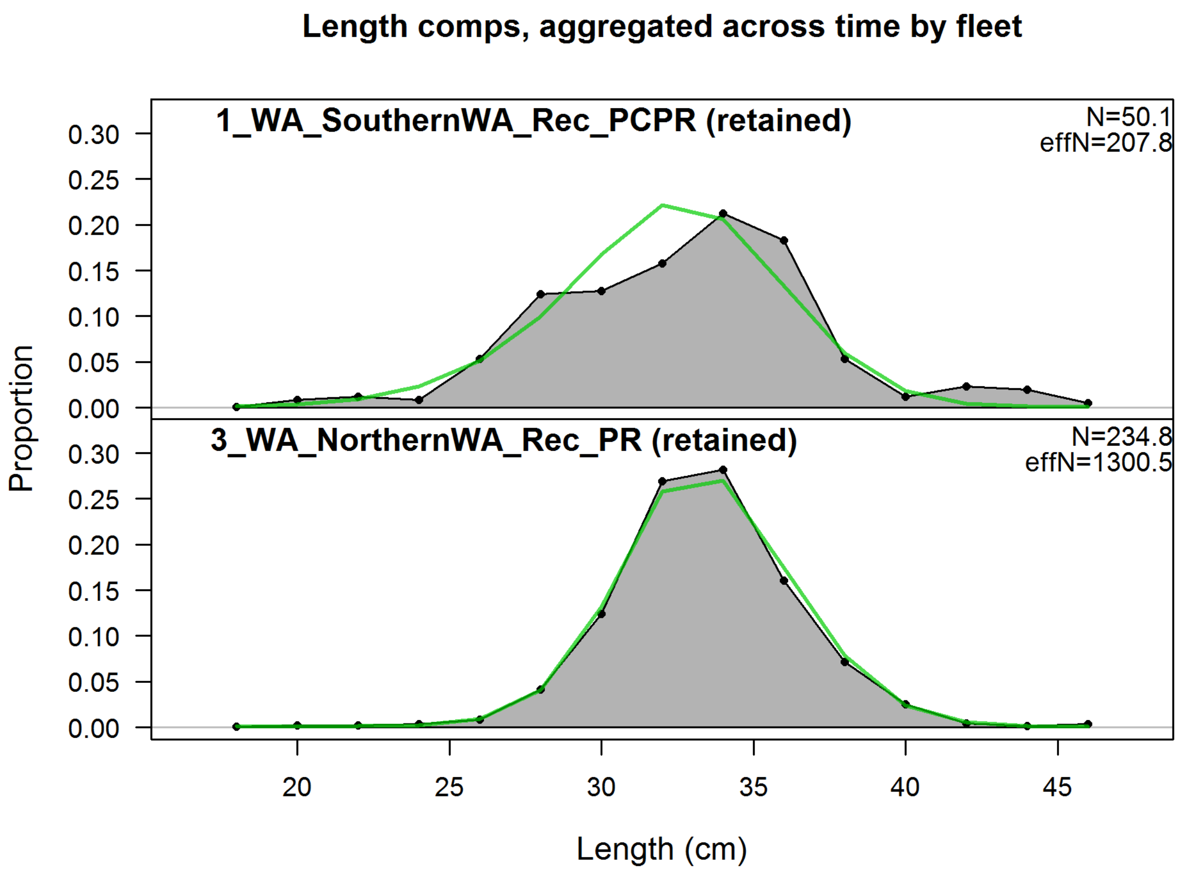

Figure 12: Length comps, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. fig:mod1_9_comp_lenfit__aggregated_across_time

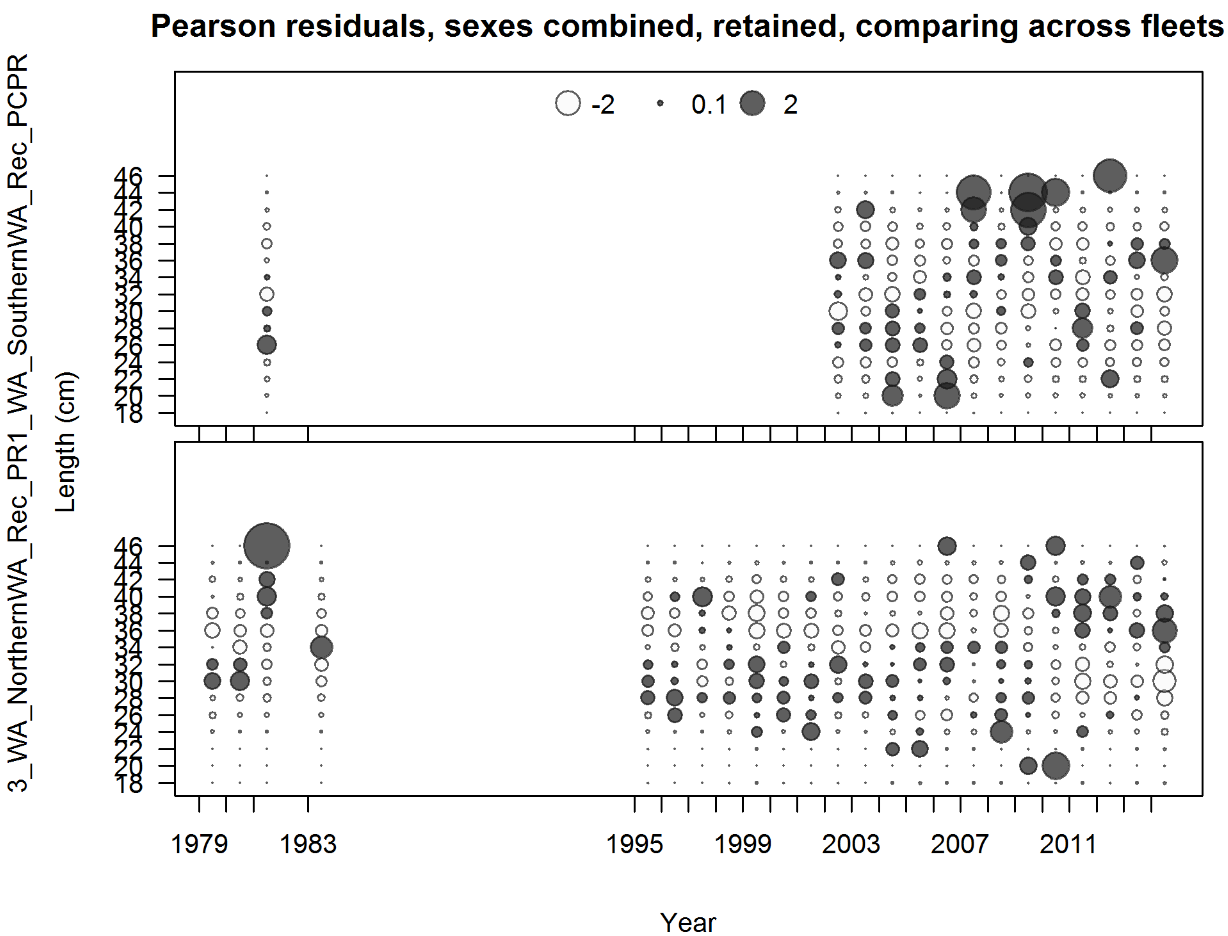

Figure 13: Note: this plot doesn't seem to be working right for some models. Pearson residuals, sexes combined, retained, comparing across fleets
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_10_comp_lenfit_sex1mkt2_multi-fleet_comparison

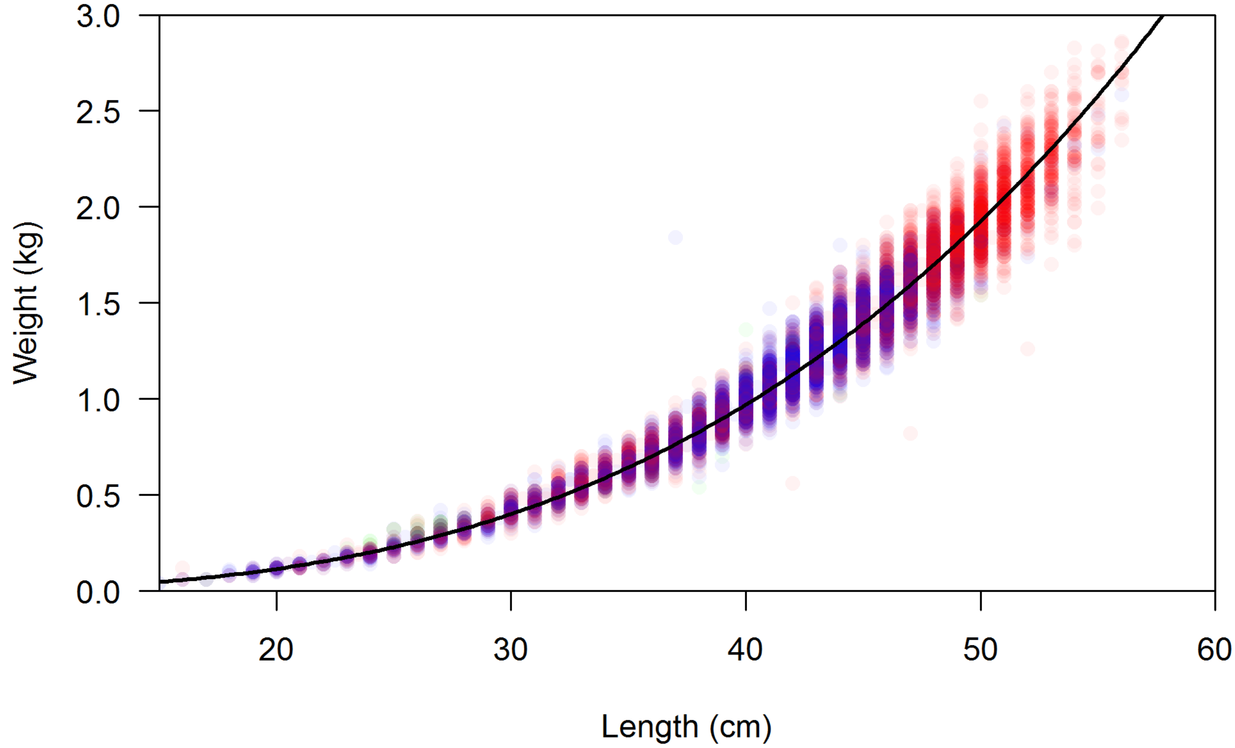

Figure 14: Estimated weight-length relationship for Yellowtail Rockfish used in both models. Colored points show observed values (red for females, blue for males, and green for unsexed). The black line indicates the estimated relationship $W = 0.000011843L^{3.0672}$. fig:weight-length

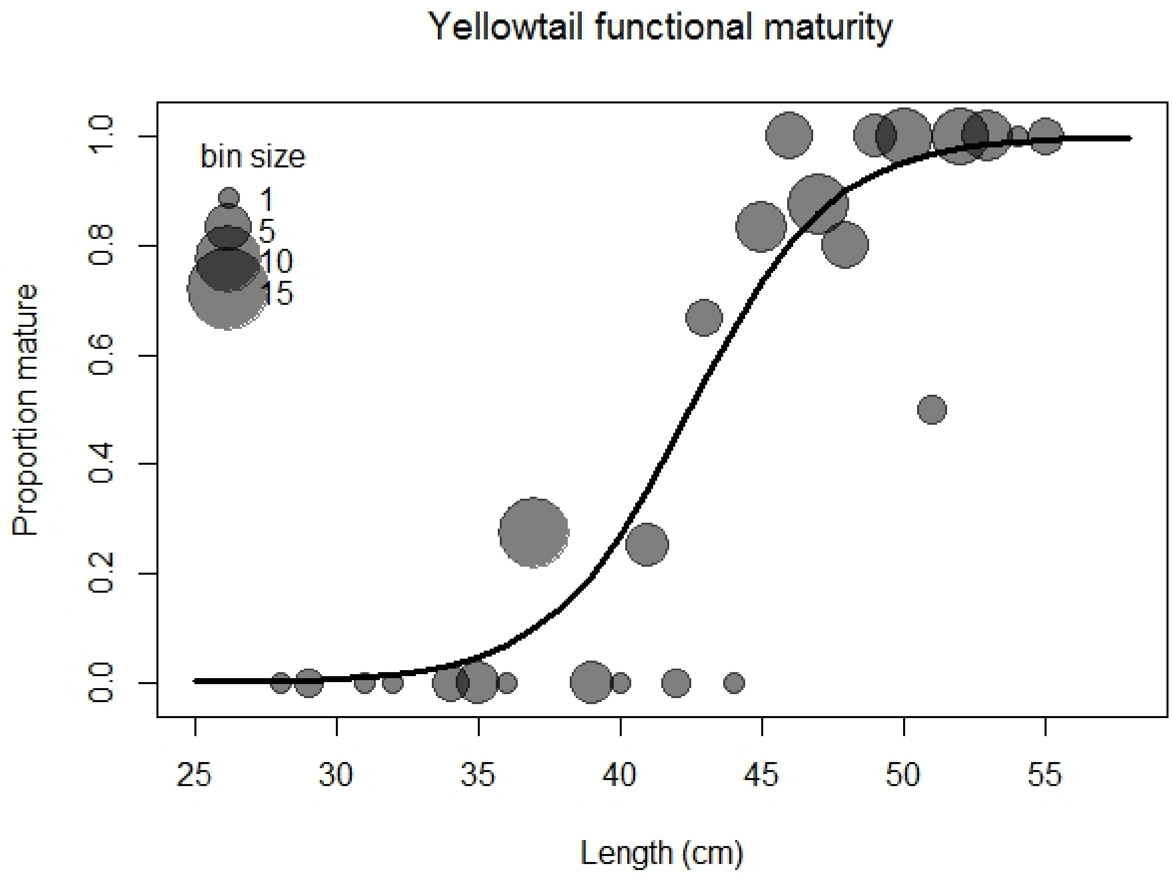

Figure 15: Estimated maturity relationship for Yellowtail Rockfish used in both models. Gray points indicate average observed functional maturity within each length bin with point size proportional to the number of samples. fig:maturity

References

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