Status of Pacific ocean perch (*Sebastes alutus*) along the U.S. west coast in 2017

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Contents

Executive Summary

executive-summary

Stock

stock

This assessment reports the status of the Pacific ocean perch (*Sebastes alutus*) speciess off rockfish off the U.S. West Coast from Northern California to the Canadian Border using data through 2017. Pacific ocean perch are most abundant in the Gulf of Alaska and have observed off of Japan, in the Bering Sea, and south to Baja California, although they are sparse south of Oregon and rare in southern California. Composition data indicate that good recruitment years coincide in Oregon and Washington. To date, no significant genetic differences have been found in the range covered by this assessment.

Landings

landings

The first year that harvest of Pacific ocean perch exceeded 1 mt off the U.S. West Coast first occured in 1929. Catches ramped up in the 1940s with large removals in Washington waters. During the 1950s the removals primarily occured in Oregon waters with catches from Washington declining following the 1940s. The largest removals in 1966-1968 were largely a result of harvest by foreing vessels. The fishery proceed with more moderate removals ranging between 1,200 to 2,600 metric tons per year between 1969 to 1980. Removals generally decined from 1981 to 1994 to between 1,000 and 1,700 metric tons per year. Pacific ocean perch was declared overfished in 1999 resulting in large reduction in harvest in recent years since the declaration.

Table a: Landings (mt) for the past 10 years forPacific ocean perch by fleet.

tab:Exec_catch

Year	California	Oregon	Washington	At-sea-hake	Survey	Total Catch
2007	0.15	83.65	45.12	4.05	0.58	133.55
2008	0.39	58.64	16.61	15.93	0.80	92.37
2009	0.92	58.75	33.22	1.56	2.70	97.15
2010	0.14	58.00	22.29	16.87	1.62	98.92
2011	0.12	30.26	19.66	9.17	1.19	60.39
2012	0.18	30.41	21.79	4.52	1.59	58.49
2013	0.08	34.86	14.83	5.41	1.71	56.89
2014	0.18	30.64	9.55	3.92	0.56	44.85
2015	0.12	38.12	11.41	8.71	1.51	59.87
2016	0.19	34.15	13.12	10.30	0.00	57.75

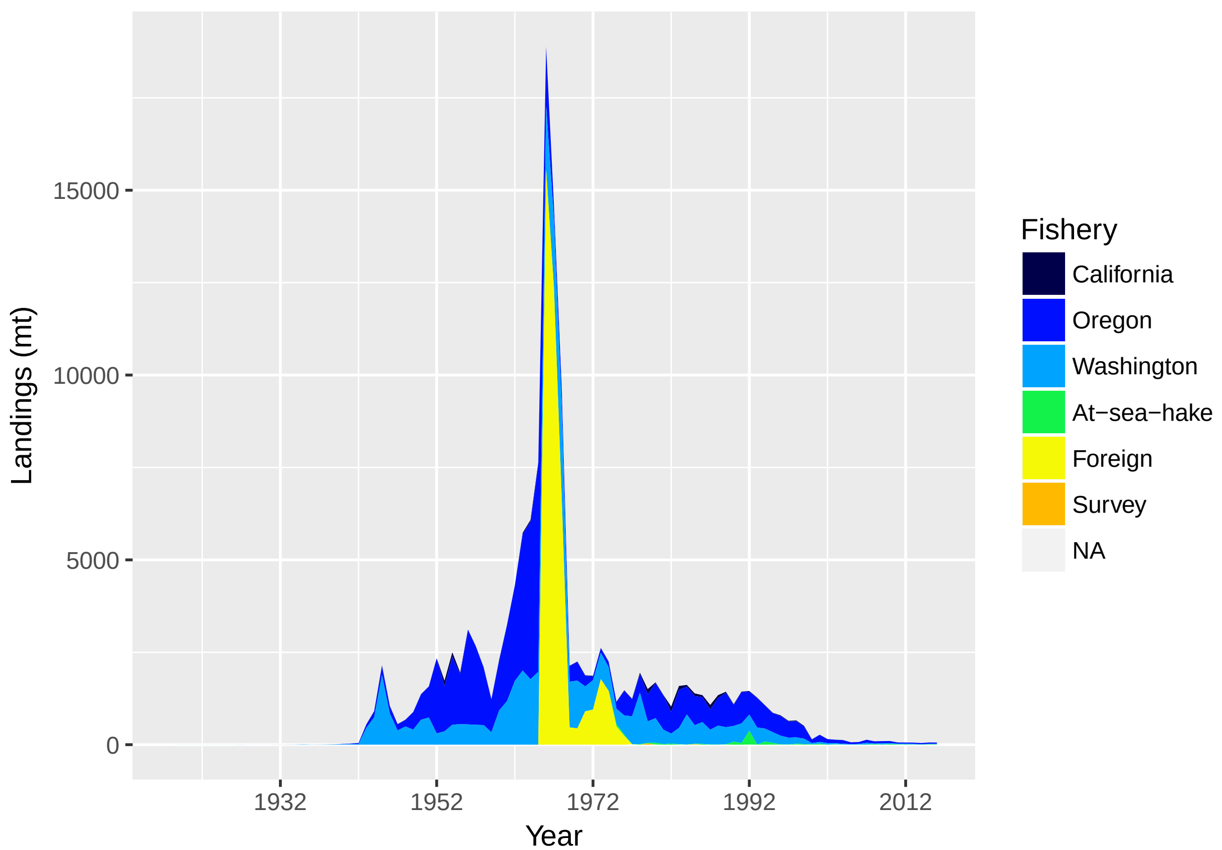

Figure a: Landings of Pacific ocean perch for California, Oregon, Washington, the foriegn fishery (1966-1976), at-sea-hake fishery, and fishery independent surveys. fig:Exec_catch1

Data and Assessment

data-and-assessment

This a new full assessment for Pacific ocean perch which was last assessed in 2011. In this assessment, all aspects of the model including catches, data, and modelling assumptions were re-evaluated as much as possible. The assessment was conducted using the length- and age-structured modeling software Stock Synthesis (version 3.30). The coastwide population was modeled assuming separate growth and mortality parameters for each sex (a two-sex model) from 1892 to 2017, and forecasted beyond 2017.

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 b
Spawning output Table(s): Table b
Relative depletion Figure: Figure c

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 2017 is 33.9% (~95% asymptotic interval: ± 23.3%-44.6%) (Figure c).

Table b: Recent trend in beginning of the year spawning output and depletion for the Base model for Pacific ocean perch.

tab:SpawningDeplete_mod1

Year	Spawning Output (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2008	8344.00	4420 - 12268	0.15	0.103 - 0.197
2009	8589.00	4525 - 12653	0.15	0.105 - 0.203
2010	8719.00	4563 - 12875	0.16	0.107 - 0.206
2011	8817.00	4585 - 13048	0.16	0.107 - 0.209
2012	9021.00	4691 - 13351	0.16	0.110 - 0.214
2013	10051.00	5241 - 14861	0.18	0.123 - 0.238
2014	11807.00	6177 - 17437	0.21	0.145 - 0.279
2015	14162.00	7428 - 20896	0.25	0.174 - 0.334
2016	16712.00	8769 - 24656	0.30	0.206 - 0.394
2017	18909.00	9916 - 27901	0.34	0.233 - 0.446

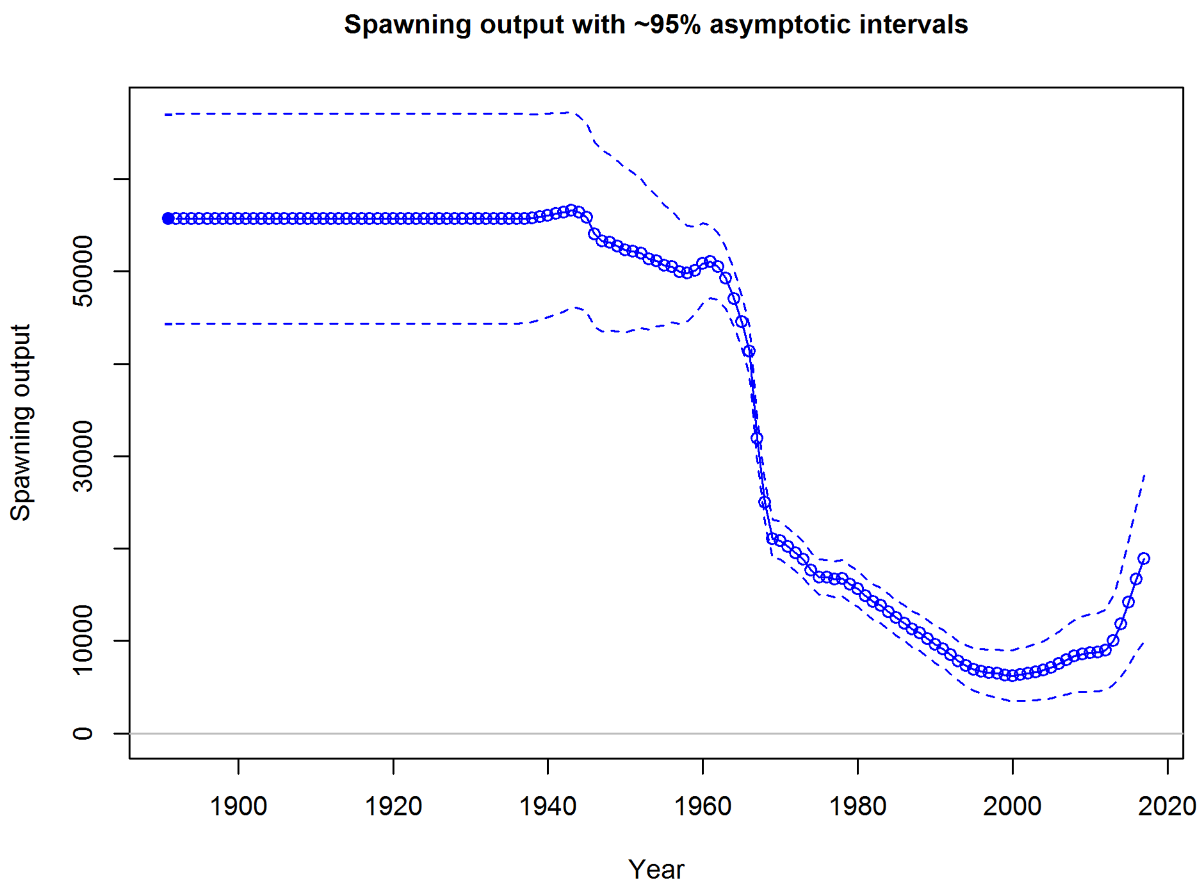

Figure b: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

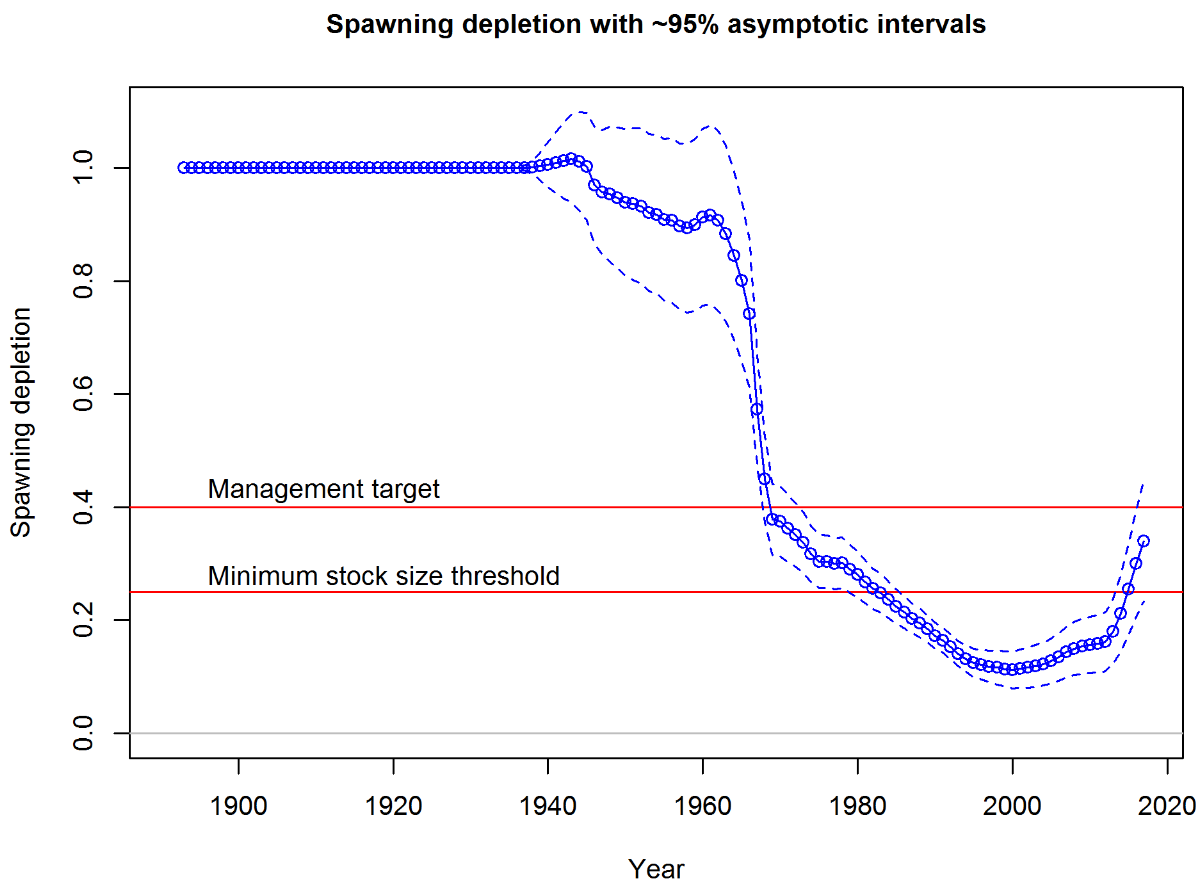

Figure c: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

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 d)
Recruitment Tables: (Tables c, **??** and **??**)

Table c: Recent recruitment for the Base model.

tab:Recruit_mod1

Year	Estimated Recruitment (millions)	~ 95% confidence interval
2008	48.00	30 - 78
2009	10.00	5 - 18
2010	4.00	2 - 9
2011	15.00	8 - 25
2012	3.00	1 - 7
2013	30.00	17 - 53
2014	2.00	1 - 7
2015	4.00	1 - 13
2016	4.00	1 - 15
2017	5.00	2 - 12

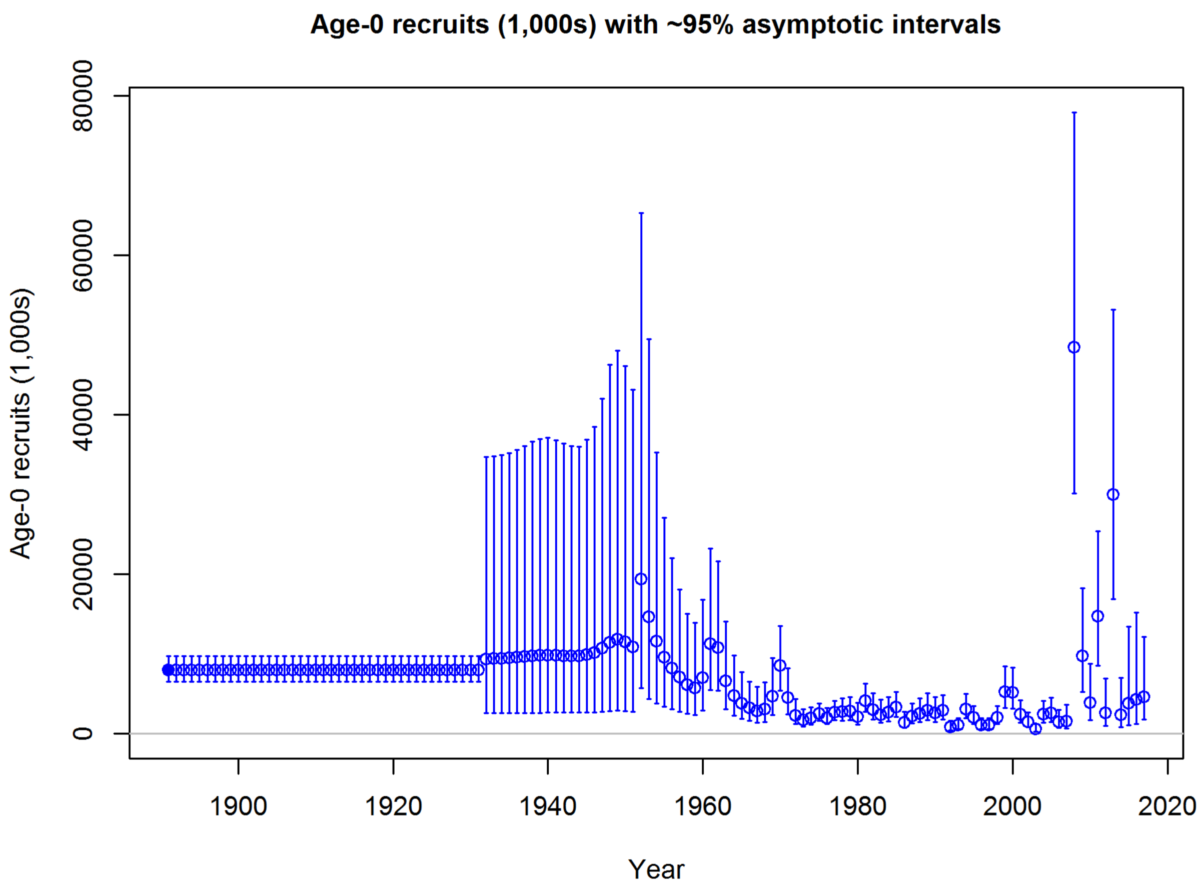

Figure d: Time series of estimated Pacific ocean perch recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

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 d, Table ??, Table ?? Exploitation Figure: Figure e).

A summary of Pacific ocean perch exploitation histories for base model is provided as Figure f.

Table d: Recent trend in spawning potential ratio and exploitation for Pacific ocean perch in the Base 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	0.377	0.229 - 0.524	0.008	0.005 - 0.012
2008	0.396	0.236 - 0.555	0.009	0.005 - 0.013
2009	0.413	0.245 - 0.580	0.010	0.005 - 0.015
2010	0.396	0.234 - 0.557	0.009	0.005 - 0.014
2011	0.165	0.092 - 0.238	0.003	0.001 - 0.004
2012	0.153	0.085 - 0.221	0.002	0.001 - 0.003
2013	0.138	0.076 - 0.200	0.002	0.001 - 0.003
2014	0.096	0.052 - 0.140	0.001	0.001 - 0.002
2015	0.107	0.058 - 0.155	0.002	0.001 - 0.002
2016	0.088	0.047 - 0.128	0.001	0.001 - 0.002

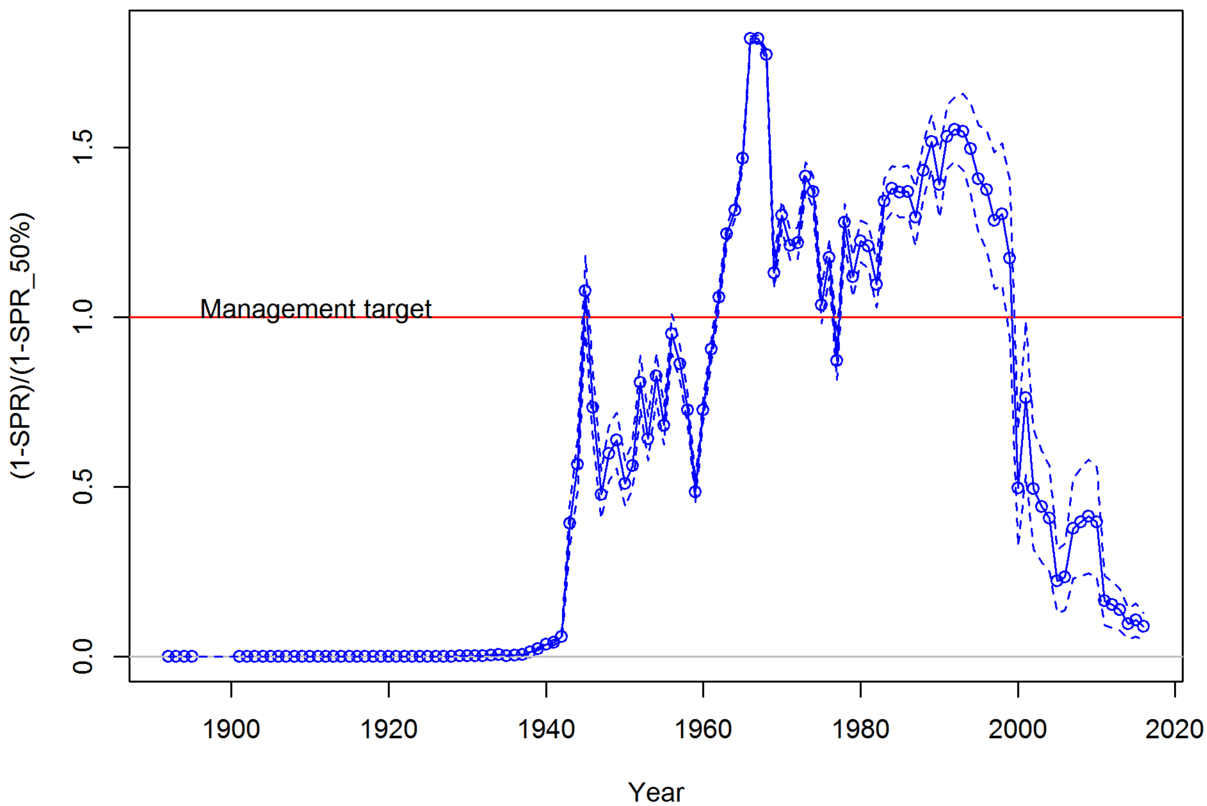

Figure e: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing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

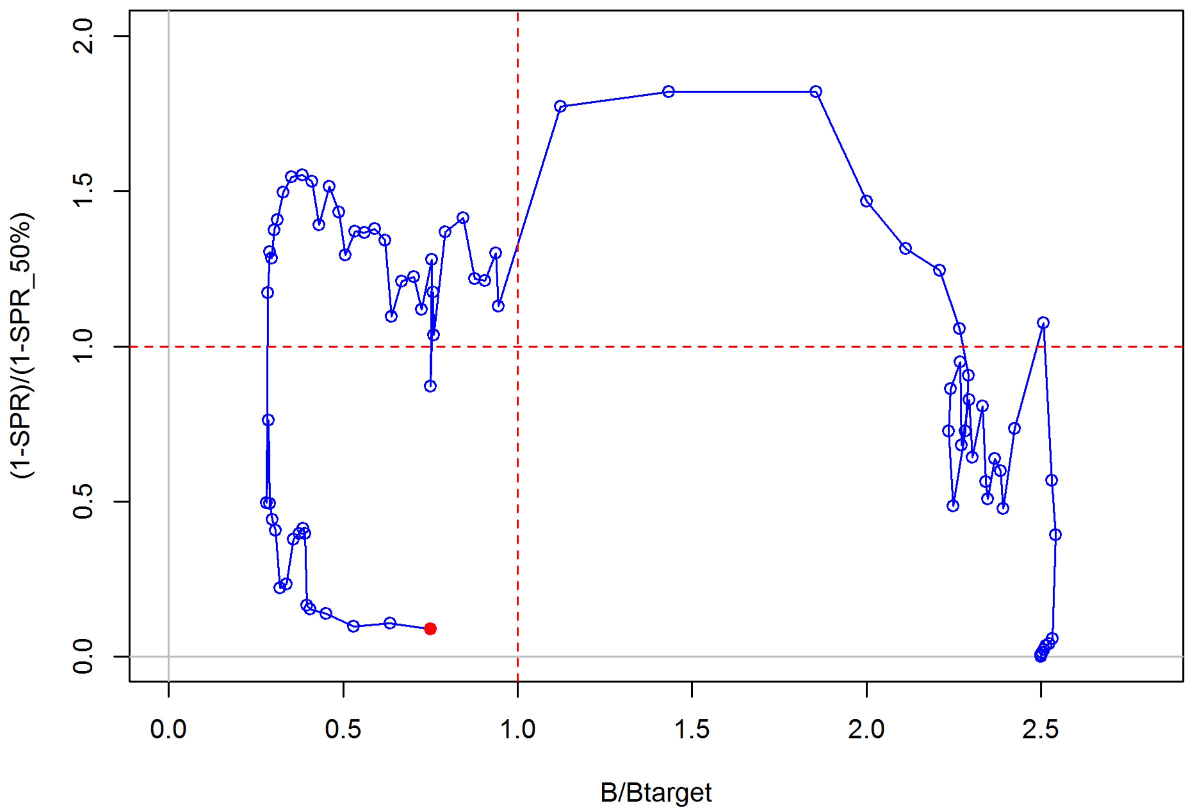

Figure f: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. fig:Phase_all

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

This stock assessment estimates that Pacific ocean perch in the Base model are below 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 2017 is 33.9% (~95% asymptotic interval: ± 23.3%-44.6%, corresponding to an unfished spawning output of 18909 billion eggs (~95% asymptotic interval: 9915.73644901456-27901.4635509854 billion eggs) of spawning output in the base model (Table e). Unfished age 3+ biomass was estimated to be 100784 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 22283.9 billion eggs, which gives a catch of 908.2 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 745.4 mt.

Table e: Summary of reference points and management quantities for the base case Base model.

tab:Ref_pts_mod1

Quantity	Estimate	95% Confidence Interval
Unfished spawning output (billion eggs)	55709.8	44350.8 - 67068.8
Unfished age 3+ biomass (mt)	100784	80592.8 - 120975.2
Unfished recruitment (R0, thousands)	7927.4	6468.7 - 9715
Spawning output(2017 billion eggs)	18908.6	9915.7 - 27901.5
Depletion (2017)	0.339	0.233 - 0.446
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	22283.9	17740.3 - 26827.5
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.625	0.625 - 0.625
Exploitation rate resulting in $B_{40\%}$	0.021	0.021 - 0.021
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	908.2	725.9 - 1090.5
Reference points based on SPR proxy for MSY		
Spawning output	11142	8870.2 - 13413.8
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.033	0.033 - 0.033
Yield with SPR_{proxy} at SB_{SPR} (mt)	745.4	595.7 - 895.1
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	21608.4	17209.1 - 26007.7
SPR_{MSY}	0.617	0.617 - 0.618
Exploitation rate at MSY	0.022	0.022 - 0.022
MSY (mt)	908.8	726.4 - 1091.2

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 f

Unresolved Problems And Major Uncertainties

unresolved-problems-and-major-uncertainties

TBD after STAR panel

Table f: 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	-	-	-	-

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 g

Decision table(s) Table h, Table **??**, Table **??**

Yield curve: Figure \ref{fig:Yield_all}

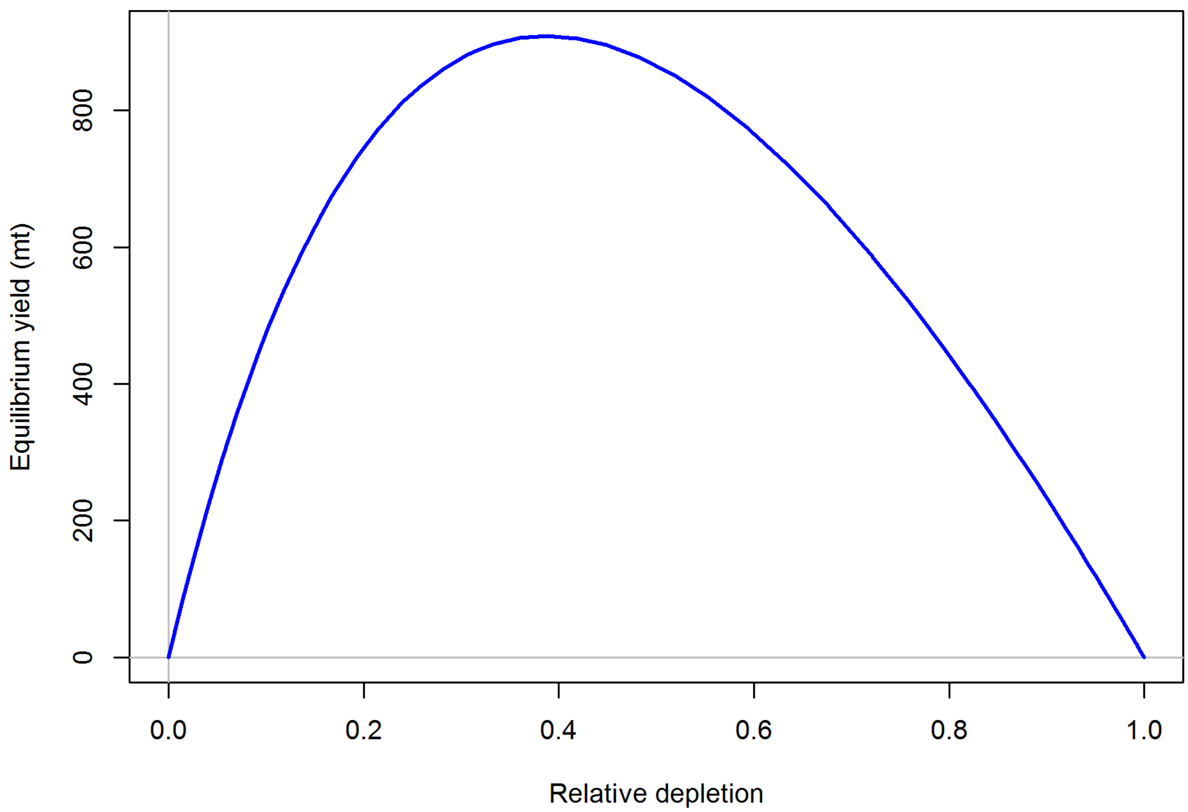

Figure g: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at... fig:Yield_all

Table g: Projections of potential OFL (mt) and the ACL (mt) using the base model forecast.
tab:OFL_projection

Year	OFL	ACL
2017	1389.78	1328.63
2018	1529.80	1462.48
2019	1651.26	1578.61
2020	1752.90	1675.78
2021	1823.43	1743.20
2022	1855.87	1774.21
2023	1854.36	1772.77
2024	1829.96	1749.45
2025	1793.89	1714.96
2026	1754.08	1676.90
2027	1715.09	1639.62
2028	1679.03	1605.15

Table h: Summary of 10-year projections beginning in 2019 for alternate states of nature based on an axis of uncertainty for the Base 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 i: Base case results summary.

tab:base_summary

Quantity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Landings (mt)										
Total Est. Catch (mt)										
OFL (mt)										
ACL (mt)										
(1-SPR)(1-$SPR_{50\%}$)	0.40	0.41	0.40	0.16	0.15	0.14	0.10	0.11	0.09	
Exploitation rate	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	
Age 3+ biomass (mt)	16925.8	17248.1	17491.6	23065.1	26699.3	29969.8	34321.0	37585.2	43560.0	47331.8
Spawning Output	8344	8589	8719	8817	9021	10051	11807	14162	16712	18909
95% CI	4420 - 12268	4525 - 12653	4563 - 12875	4585 - 13048	4691 - 13351	5241 - 14861	6177 - 17437	7428 - 20896	8769 - 24656	9916 - 27901
Depletion	0.150	0.154	0.157	0.158	0.162	0.180	0.212	0.254	0.300	0.339
95% CI	0.103 - 0.197	0.105 - 0.203	0.107 - 0.206	0.107 - 0.209	0.110 - 0.214	0.123 - 0.238	0.145 - 0.279	0.174 - 0.334	0.206 - 0.394	0.233 - 0.446
Recruits	48	10	4	15	3	30	2	4	4	5
95% CI	30 - 78	5 - 18	2 - 9	8 - 25	1 - 7	17 - 53	1 - 7	1 - 13	1 - 15	2 - 12

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

Pacific ocean perch (*Sebastes alutus*) are most abundant in the Gulf of Alaska, and have been observed off of Japan, in the Bering Sea, and south to Baja California, although they are sparse south of Oregon and rare in southern California. While genetic studies have found three populations of Pacific ocean perch off of British Columbia (Seeb and Gunderson 1988, Withler et al. 2001) with, notably, a separate stock off of Vancouver Island, no significant genetic differences have been found in the range covered by this assessment. Pacific ocean perch show dimorphic growth, with females reaching a slightly large size than males. Males and females are equally abundant on rearing grounds at age 1.5.

The Pacific ocean perch population has been modeled as a single stock off of the U.S. West Coast (essentially northern California to the Canadian border, since Pacific ocean perch are seen extremely rarely in central and southern California). Good recruitments show up in size-composition data throughout all portions of this area, which supports the single stock hypothesis. This assessment includes landings and catch data for Pacific ocean perch from the states of Washington, Oregon and California, along with records from foreign fisheries, the at-sea hake fleet, and surveys.

Prior to 1966, the Pacific ocean perch resource off of the northern portion of the U.S. West Coast was harvested almost entirely by Canadian and United States vessels. Harvest was negligible prior to 1940, reached 1,000 mt in 1951, 3,000 mt in 1961 and exceeded 7,000 mt in 1965. Catches increased dramatically after 1965, with the introduction of large distant-water fishing fleets from the Soviet Union and Japan. Both nations employed large factory stern trawlers as their primary method for harvesting Pacific ocean perch. Peak removals by all foreign nations combined are estimated at over 15,000 mt in 1966 and remained over 12,000 mt in 1967. These numbers are based upon a re-analysis of the foreign catch data (Rogers 2003), which focused on deriving a more realistic species composition for catches previously identified only as Pacific ocean perch. Catches declined rapidly following these peak years, and Pacific ocean perch stocks were considered to be severely depleted throughout the Oregon-Vancouver Island region by 1969 (Gunderson 1977, Gunderson et al. 1977). Landed harvest averaged 1,500 mt over the period 1977-94. Landings have continued to decline since 1994, primarily due to more restrictive management.

Prior to 1977, Pacific ocean perch in the northeast Pacific were managed by the Canadian Government in its waters and by the individual states in waters off of the United States. With implementation of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1977, U.S. territorial waters were extended to 200 miles from shore, and primary responsibility for management of the groundfish stocks off Washington, Oregon and California shifted from the states to the Pacific Fishery Management Council (PFMC) and the National Marine Fisheries Service (NMFS). At that time, however, a Fishery Management Plan (FMP) for the west coast groundfish stocks had not yet been approved. In the interim, the state agencies worked with the PFMC to address conservation issues. In 1981, the PFMC adopted a management strategy to rebuild the depleted Pacific ocean perch stocks to levels that would produce Maximum Sustainable Yield (MSY) within 20 years. On the basis of cohort analysis (Gunderson 1978), the PFMC set Acceptable Biological Catch (ABC) levels at 600 mt for the US portion of the Vancouver INPFC area and 950 mt for the Columbia INPFC area. To implement this strategy, the states of Oregon and Washington each established landing limits for Pacific ocean perch. Trawl trip limits of various forms remained in effect through 2010 (Table 1).

Age estimates for Pacific ocean perch prior to the 1980s were made via surface ageing of otoliths, which misses the very tight annuli at the edge of the otolith once the fish reaches near maximum size. Ages are biased by around age 10-12, and maximum age was estimated to be in the 20s, which lead to an overestimate of the natural mortality rate and the productivity of the stock. Using break and burn methods, Pacific ocean perch have been aged to over 100 years, and we now know that the underlying assumptions of the early models were overly optimistic about productivity. Research surveys have been used to provide fishery-independent information about the abundance, distribution, and biological characteristics of Pacific ocean perch. A coast-wide survey of the rockfish resource was conducted in 1977 (Gunderson and Sample 1980) and was repeated every three years through 2004. The National Marine Fisheries Service (NMFS) coordinated a cooperative research survey of the Pacific ocean perch stocks off Washington and Oregon with the Washington Department of Fisheries (WDFW) and the Oregon Department of Fish and Wildlife (ODFW) in March-May 1979 (Wilkins and Golden 1983). This survey was repeated in 1985. Two slope surveys have been conducted on the west coast in recent years, one using the research vessel Miller Freeman, which ended in 2001, and another ongoing cooperative survey using commercial fishing vessels which began in 1998 as a DTS (Dover sole, thornyhead and sablefish) survey, was expanded to other groundfish in 1999. In 2003, this survey was expanded spatially to include the shelf. This last survey, conducted by the NWFSC, continues to cover depths from 30-700 fathoms (55-1280 meters) on an annual basis.

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.

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 f)
A summary of these values as well as other base case summary results can be found in Table i.

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 Pacific ocean perch assessment are summarized in Figure 2. A description of each data source is below.

2.1.1 Commercial Fishery Landings

commercial-fishery-landings

Washington

Historical commercial fishery landigns of Pacific ocean perch from Washington for the years 1918-1980 were obtained from Theresa Tsou (WDFW) and Phillip Weyland (WDFW). This assessment is the first Pacific ocean perch assessment to include a state provide historical catch reconstruction and hence, the historical catches for Washington vary markedly from those used in the 2011 assessment. Recent landings (1981-2016) were obtained from PacFIN (Pacific Fisheries Information Network (PacFIN) retrieval dated March 3, 2015, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org).

Oregon

Historical commercial fishery landings of Pacific ocean perch from Oregon for the years 1892-1986 were obtained from Alison Dauble (ODFW). A description of the methods can be found in (Karnowski et al. 2014). Recent landings (1987-2016) were obtained from PacFIN (Pacific Fisheries Information Network (PacFIN) retrieval dated March 3, 2015, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org).

California

Historical commercial fishery landings of Pacific ocean perch were obtained from the online database of the California Cooperative Groundfish Survey, also known as CALCOM (128.114.3.187) for the years 1916-1980. A description of the methods can be found in (Ralston et al. 2010). Recent landings (1981-2016) were obtained from PacFIN (Pacific Fisheries Information Network (PacFIN) retrieval dated March 3, 2015, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org).

At-sea fishery

Catches of Pacific ocean perch are monitored aboard the vessel by observers in the At-Sea hake Observer program (ASHOP) and were available for the years of 1975-2016. Observers use a spatial sample design, based on weight, to randomly choose a portion of the haul to sample for species composition. For the last decade, this is typically 30-50% of the total weight. The total weight of the sample is determined by all catch passing over a flow scale. All species other than hake are removed and weighed, by species, on a motion compensated flatbed scale. Observers record the weights of all non-hake species. Non-hake species total weights are expanded in the database by using the proportion of the haul sampled to the total weight of the haul. The catches of non-hake species in unsampled hauls is determined using bycatch rates determined from sampled hauls. Since 2001, more than 97% of the hauls have been observed and sampled.

Foreign

From the 1960s through the early 1970s, foreign trawling enterprises harvested considerable amounts of rockfish off Washington and Oregon, and along with the domestic trawling fleet, landed large quantities of 'r spp'. Foreign catches of individual species were estimated by Rogers (2003) and attributed to INPFC areas for the years of 1966-1976 for 'r spp'. The foreign catches were combined across areas for a coastwide removal total.

Discards

2.1.2 Abundance Indices

`abundance-indices`

Sub-heading 1

Sub-heading 2

2.1.3 Fishery-Independent Data: possible sources

`fishery-independent-data-possible-sources`

Northwest Fisheries Science Center (NWFSC) shelf-slope survey

The NWFSC shelf-slope survey is based on a random-grid design; covering the coastal waters from a depth of 55 m to 1,280 m (Bradburn et al. 2011). This design uses four chartered industry vessels in most years, assigned to a roughly equal number of randomly selected grid cells. The survey, which has been conducted from late-May to early-October each year, is divided into two 2-vessel passes of the coast, which are executed from north to south. This design therefore incorporates both vessel-to-vessel differences in catchability as well as variance associated with selecting a relatively small number (~700) of cells from a very large population of possible cells (greater than 11,000) distributed from the Mexican to the Canadian border.

Northwest Fisheries Science Center (NWFSC) slope survey

The NWFSC slope survey covered waters throughout the summer from 183 m to 1280 m north of 34°30′ S, which is near Point Conception. The survey strata used to expand the biomass data for this assessment are shown in Table 5.

Alaska Fisheries Science Center (AFSC) slope survey

The AFSC slope survey operated during autumn (October-November) aboard the R/V Miller Freeman. Partial survey coverage of the U.S. west coast occurred during 1988-96 and complete coverage (north of 34°30′ S) during 1997, 1999, 2000, and 2001. Only the four years of consistent and complete surveys plus 1996, which surveyed north of 43° N latitude to the U.S.-Canada border, were used in this assessment. The number of tows ranged from 8 in 2001 to 26 in 1996 (Table 7). The numbers of tows with length data for 'r spp' are also shown in Table 7. Because a large number of positive tows occurred in 1996, it was decided to include that year, which surveyed from 43° N latitude to the U.S.-Canada border. Therefore, only tows from 43° N latitude to the U.S.-Canada border were used.

Triennial Bottom Trawl Survey

The triennial survey was first conducted by the AFSC in 1977 and spanned the timeframe from 1977-2004. The survey's design and sampling methods are most recently described in (Weinberg et al. 2002). Its basic design was a series of equally-spaced transects from which searches for tows in a specific depth range were initiated (Figure 5). The survey design has changed slightly over the period of time (Table 4, Figure 3). In general, all of the surveys were conducted in the mid-summer through early fall: the 1977 survey was conducted from early July through late September; the surveys from 1980 through 1989 ran from mid-July to late September; the 1992 survey spanned from mid-July through early October; the 1995 survey was conducted from early June to late August; the 1998 survey ran from early June through early August; and the 2001 and 2004 surveys were conducted in May-July (Figure 4).

Haul depths ranged from 91-457 m during the 1977 survey with no hauls shallower than 91 m. The surveys in 1980, 1983, and 1986 covered the West Coast south to 36.8° N latitude and a depth range of 55-366 meters. The surveys in 1989 and 1992 covered the same depth range but extended the southern range to 34.5° N (near Point Conception). From 1995 through 2004, the surveys covered the depth range 55-500 meters and surveyed south to 34.5° N. In the final year of the triennial series (2004), the NWFSC's Fishery Resource and Monitoring division (FRAM) conducted the survey and followed very similar protocols as the AFSC.

Given the different depths surveyed during 1977, the data from that year were not included in this assessment. Water hauls (Zimmermann et al. 2003) and tows located in Canadian waters were also excluded from the analysis of this survey. The survey was analyzed as an early series (1980-1992) and a late series (1995-2004), as has been done in other West Coast rockfish assessments.

Pacific ocean perch Survey

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.

2.1.4 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:

- Commercial fishery - landed: 1966-2016
- Commerical fishery - discard: 2004-2015
- At-sea hake fishery: 2003-2016
- Pacific ocean perch Survey: 1979 and 1985
- Trienial Survey: 1980, 1983, 1986, 1989, 1992, 1995, 1998, 2001, 2004
- AFSC Slope Survey: 1996-2001
- NWFS Slope Survey: 2001-2002
- NWFSC Shelf/Slope Survey: 2003-2016

Commercial: PacFIN

Research: NWFSC shelf-slope survey

Research: NWFSC slope survey

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

Length-at-age was initially estimated external to the population dynamics models using the von Bertalanffy growth curve, $L_i = L_\infty e^{(-k[t-t_0])}$, 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.

Maturity And Fecundity

Natural Mortality

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

Sex ratios

2.1.5 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:

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 version 3.30.01.13 by Dr. Richard Methot at the NWFSC (Methot and Wetzel 2013). This most recent version was used, since it included improvements and corrections to older versions.

2.3.5 Data Weighting

data-weighting

Citation for Francis method (Francis and Hilborn 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) and (2017)
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 and Wetzel 2013). Table 16 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 17

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 18).

Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 745.4 mt. Table e shows the full suite of estimated reference points for the northern area model and Figure g shows the equilibrium yield curve.

3 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

Table f

Model 1 Projections and Decision Table (groundfish only) (Table 19

Table h

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: Landings for each state (all gears combined), the At-Sea Hake fishery, the Foreign fleet, and research.

tab:Comm_Catch

Year	California	Oregon	Washington	At-Sea Hake	Foreign	Research
1892	0.0	0.1	0.0	0.0	0	0.0
1893	0.0	0.1	0.0	0.0	0	0.0
1894	0.0	0.1	0.0	0.0	0	0.0
1895	0.0	0.0	0.0	0.0	0	0.0
1896	0.0	0.0	0.0	0.0	0	0.0
1897	0.0	0.0	0.0	0.0	0	0.0
1898	0.0	0.0	0.0	0.0	0	0.0
1899	0.0	0.0	0.0	0.0	0	0.0
1900	0.0	0.0	0.0	0.0	0	0.0
1901	0.0	0.0	0.0	0.0	0	0.0
1902	0.0	0.0	0.0	0.0	0	0.0
1903	0.0	0.0	0.0	0.0	0	0.0
1904	0.0	0.0	0.0	0.0	0	0.0
1905	0.0	0.0	0.0	0.0	0	0.0
1906	0.0	0.0	0.0	0.0	0	0.0
1907	0.0	0.0	0.0	0.0	0	0.0
1908	0.0	0.0	0.1	0.0	0	0.0
1909	0.0	0.0	0.1	0.0	0	0.0
1910	0.0	0.0	0.1	0.0	0	0.0
1911	0.0	0.0	0.1	0.0	0	0.0
1912	0.0	0.0	0.0	0.0	0	0.0
1913	0.0	0.0	0.0	0.0	0	0.0
1914	0.0	0.0	0.0	0.0	0	0.0
1915	0.0	0.0	0.0	0.0	0	0.0
1916	0.1	0.0	0.4	0.0	0	0.0
1917	0.1	0.0	0.8	0.0	0	0.0
1918	0.1	0.0	1.1	0.0	0	0.0
1919	0.1	0.0	0.4	0.0	0	0.0
1920	0.1	0.0	0.3	0.0	0	0.0
1921	0.1	0.0	0.3	0.0	0	0.0
1922	0.1	0.0	0.1	0.0	0	0.0
1923	0.1	0.0	0.2	0.0	0	0.0
1924	0.1	0.0	0.5	0.0	0	0.0
1925	0.1	0.0	0.6	0.0	0	0.0
1926	0.2	0.0	1.0	0.0	0	0.0
1927	0.1	0.0	1.4	0.0	0	0.0
1928	0.1	0.1	1.2	0.0	0	0.0
1929	0.5	0.1	0.7	0.0	0	0.0
1930	0.4	0.1	0.9	0.0	0	0.0
1931	0.9	0.1	0.4	0.0	0	0.0

Year	California	Oregon	Washington	At-Sea Hake	Foreign	Research
1932	0.6	0.1	0.4	0.0	0	0.0
1933	1.1	0.1	0.5	0.0	0	0.0
1934	0.8	0.0	2.3	0.0	0	0.0
1935	0.7	0.1	7.7	0.0	0	0.0
1936	0.4	0.2	1.6	0.0	0	0.0
1937	0.9	0.4	2.0	0.0	0	0.0
1938	1.2	0.1	5.1	0.0	0	0.0
1939	1.9	0.4	8.7	0.0	0	0.0
1940	1.7	9.1	12.2	0.0	0	0.0
1941	2.6	14.0	13.6	0.0	0	0.0
1942	0.9	26.6	18.6	0.0	0	0.0
1943	2.0	94.3	453.6	0.0	0	0.0
1944	5.6	164.5	739.3	0.0	0	0.0
1945	13.4	247.1	1887.1	0.0	0	0.0
1946	14.6	193.2	845.9	0.0	0	0.0
1947	5.1	167.2	385.3	0.0	0	0.0
1948	7.9	177.8	491.1	0.0	0	0.0
1949	4.0	472.9	409.5	0.0	0	0.0
1950	3.0	690.1	675.7	0.0	0	0.0
1951	4.3	840.1	735.1	0.0	0	0.0
1952	2.9	2030.5	305.6	0.0	0	0.0
1953	145.6	1223.5	361.6	0.0	0	0.0
1954	123.2	1837.5	538.8	0.0	0	0.0
1955	48.8	1346.4	555.6	0.0	0	0.0
1956	3.8	2563.8	548.2	0.0	0	0.0
1957	1.6	2128.1	538.5	0.0	0	0.0
1958	2.9	1564.9	530.4	0.0	0	0.0
1959	1.5	892.6	337.0	0.0	0	0.0
1960	19.6	1358.8	928.1	0.0	0	0.0
1961	1.1	2061.9	1179.8	0.0	0	0.0
1962	0.6	2584.9	1725.2	0.0	0	0.0
1963	32.5	3693.9	2006.0	0.0	0	0.0
1964	46.1	4261.6	1770.7	0.0	0	0.0
1965	34.9	5627.8	1972.1	0.0	0	0.0
1966	5.2	1591.2	1725.5	0.0	15561	0.0
1967	17.8	354.7	1861.0	0.0	12357	0.0
1968	21.9	466.4	2501.2	0.0	6639	0.0
1969	8.4	422.3	1236.0	0.0	469	0.0
1970	8.7	507.4	1293.3	0.0	441	0.0
1971	12.2	290.4	673.6	0.0	902	0.0
1972	11.4	105.3	796.5	0.0	950	0.0
1973	11.9	121.2	713.1	0.0	1773	0.0
1974	15.7	136.7	641.8	0.0	1457	0.0
1975	11.4	181.3	413.9	62.3	496	0.0
1976	17.1	663.7	521.1	31.9	239	0.0

Year	California	Oregon	Washington	At-Sea Hake	Foreign	Research
1977	16.7	457.1	752.0	3.8	0	11.9
1978	42.5	498.7	1391.5	15.4	0	0.0
1979	136.7	735.9	581.4	15.1	0	34.5
1980	19.2	948.6	666.2	47.0	0	4.6
1981	10.8	929.7	390.3	15.4	0	0.0
1982	145.9	584.0	273.0	28.3	0	0.0
1983	102.0	1032.7	437.7	10.9	0	4.4
1984	47.6	750.4	815.7	2.3	0	0.9
1985	70.9	789.5	503.2	11.4	0	13.6
1986	52.8	676.5	588.9	19.8	0	1.4
1987	120.9	550.0	399.4	5.4	0	0.0
1988	75.4	749.8	509.8	4.5	0	0.5
1989	29.5	927.8	466.2	4.3	0	4.2
1990	18.3	567.8	427.2	80.9	0	0.0
1991	8.4	853.2	530.1	46.1	0	0.0
1992	15.3	623.8	435.2	373.3	0	4.9
1993	11.0	797.8	464.7	0.9	0	0.2
1994	6.7	626.4	352.0	83.8	0	0.0
1995	9.2	515.0	289.8	46.6	0	2.8
1996	18.4	531.1	236.7	6.3	0	1.2
1997	15.8	439.1	184.9	6.4	0	0.1
1998	21.6	436.6	172.4	22.3	0	3.8
1999	19.8	326.8	145.8	16.5	0	1.4
2000	6.8	95.1	33.0	10.1	0	0.6
2001	0.5	193.4	51.8	21.0	0	2.8
2002	0.8	107.1	39.5	3.9	0	0.3
2003	0.2	94.6	30.2	6.3	0	3.6
2004	2.1	97.7	22.3	1.1	0	2.5
2005	0.1	51.2	10.4	1.7	0	1.3
2006	0.2	52.2	15.8	3.1	0	1.2
2007	0.2	83.6	45.1	4.0	0	0.6
2008	0.4	58.6	16.6	15.9	0	0.8
2009	0.9	58.7	33.2	1.6	0	2.7
2010	0.1	58.0	22.3	16.9	0	1.6
2011	0.1	30.3	19.7	9.2	0	1.2
2012	0.2	30.4	21.8	4.5	0	1.6
2013	0.1	34.9	14.8	5.4	0	1.7
2014	0.2	30.6	9.6	3.9	0	0.6
2015	0.1	38.1	11.4	8.7	0	1.5
2016	0.2	34.1	13.1	10.3	0	0.0

Table 2: Summary of discard rates used in the model by each data source.

tab:Discard

Year	Source	Discard	Standard Error
1986	Pikitch	0.050	0.300
1992	Pikitch	0.100	0.300
2002	WCGOP	0.150	0.164
2003	WCGOP	0.183	0.268
2004	WCGOP	0.203	0.206
2005	WCGOP	0.175	0.346
2006	WCGOP	0.148	0.243
2007	WCGOP	0.171	0.261
2008	WCGOP	0.362	0.172
2009	WCGOP	0.504	0.153
2010	WCGOP	0.487	0.195
2011	WCGOP	0.015	0.053
2012	WCGOP	0.028	0.054
2013	WCGOP	0.027	0.054
2014	WCGOP	0.035	0.050
2015	WCGOP	0.010	0.053

Table 3: Summary of commercial fishery length samples used in the stock assessment. tab:Comm_Lengths

Year	Trips	Fish	Sample Size
1966	1	238	7
1967	5	1020	35
1968	3	912	21
1969	4	1213	28
1970	13	1830	92
1971	22	4698	155
1972	23	4561	162
1973	17	4134	120
1974	20	4806	141
1975	19	3637	134
1976	21	3677	148
1977	32	4846	226
1978	52	7715	367
1979	34	3414	240
1980	55	5426	388
1981	40	3921	282
1982	48	4824	339
1983	39	3944	275
1984	31	3103	219
1985	45	4509	318
1986	40	4005	282
1987	43	3056	304
1988	9	602	64
1989	16	798	113
1990	12	599	85
1991	8	216	38
1994	43	2608	304
1995	49	3161	346
1996	64	3085	452
1997	76	3570	537
1998	56	3450	395
1999	58	2812	409
2000	49	2004	326
2001	59	1696	293
2002	50	1666	280

Year	Trips	Fish	Sample Size
2003	68	1685	301
2004	53	1202	219
2005	50	1270	225
2006	59	1486	264
2007	81	2248	391
2008	101	3058	523
2009	108	3208	551
2010	131	2829	521
2011	100	1944	368
2012	97	1873	355
2013	117	2168	416
2014	140	2850	533
2015	107	2459	446
2016	92	1271	267

Table 4: Summary of Pacific ocean perch survey length samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
1979	125	2375	303
1985	126	2558	306

Table 5: Summary of Triennial survey length samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
1980	18	1315	43
1983	40	2820	97
1986	17	877	41
1989	42	1851	102
1992	33	1182	80
1995	71	1136	172
1998	81	1482	196
2001	74	669	179
2004	63	1240	153

Table 6: Summary of AFSC slope survey length samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
1996	48	1396	116
1997	21	347	51
1999	21	562	51
2000	19	353	46
2001	23	390	55

Table 7: Summary of NWFSC slope survey length samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
2001	18	27	43
2002	24	54	58

Table 8: Summary of NWFSC shelf/slope survey length samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
2003	46	80	111
2004	34	56	82
2005	38	81	92
2006	33	73	80
2007	50	74	121
2008	39	75	94
2009	46	61	111
2010	53	73	128
2011	53	72	128
2012	50	79	121
2013	45	76	109
2014	52	77	126
2015	69	67	167

Table 9: Summary of commercial fishery age samples used in the stock assessment. tab:Comm_Lengths

Year	Trips	Fish	Sample Size
1981	11	1027	78
1982	40	2776	282
1983	33	3320	233
1984	27	2625	191
1985	21	2097	148
1986	17	1696	120
1987	24	1196	169
1988	4	200	28
1994	8	238	41
1999	18	863	127
2000	14	677	99
2001	40	1349	226
2002	38	1414	233
2003	41	1333	225
2004	30	854	148
2005	37	1018	177
2006	49	1259	223
2007	63	1825	315
2008	44	1129	200
2009	76	1549	290
2010	53	1258	227
2011	86	1251	259
2012	7	331	49

Table 10: Summary of Pacific ocean perch survey age samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
1985	29	1635	70

Table 11: Summary of Triennial survey age samples used in the stock assessment. tab:Comm_Lengths

Year	Tows	Fish	Sample Size
1989	15	577	36
1992	10	373	24
1995	12	275	29
1998	28	352	68
2001	43	342	104
2004	57	416	138

Table 12: Summary of NWFSC slope survey age samples used in the stock assessment. `tab:Comm_Lengths`

Year	Tows	Fish	Sample Size
2001	17	125	41
2002	24	216	58

Table 13: Summary of NWFSC shelf/slope survey age samples used in the stock assessment. `tab:Comm_Lengths`

Year	Tows	Fish	Sample Size
2003	45	265	109
2004	34	149	82
2005	38	192	92
2006	33	170	80
2007	50	228	121
2008	39	218	94
2009	45	190	109
2010	53	292	128
2011	53	258	128

Table 14: 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	0.050	-2	(0.02, 0.1)			None
2	L_at_Amin_Fem_GP_1	21.211	-3	(15, 25)			None
3	L_at_Amax_Fem_GP_1	41.983	-2	(35, 45)			None
4	VonBert_K_Fem_GP_1	0.159	-3	(0.1, 0.4)			None
5	CV_young_Fem_GP_1	0.072	-5	(0.03, 0.16)			None
6	CV_old_Fem_GP_1	0.064	-5	(0.03, 0.16)			None
7	Wtlen_1_Fem	0.000	-50	(0, 3)			None
8	Wtlen_2_Fem	3.080	-50	(2, 4)			None
9	Mat50%_Fem	8.000	-50	(2, 12)			None
10	Mat_slope_Fem	-2.000	-50	(-2, 4)			None
11	Eggs_scalar_Fem	1.086	-50	(0, 6)			None
12	Eggs_exp_wt_Fem	1.440	-50	(-3, 3)			None
13	NatM_p_1_Mal_GP_1	0.054	2	(-1, 1)	OK	0.014	Normal (0.05, 0.1)
14	L_at_Amin_Mal_GP_1	0.000	-2	(-1, 1)			None
15	L_at_Amax_Mal_GP_1	-0.059	-2	(-1, 1)			None
16	VonBert_K_Mal_GP_1	0.195	-2	(-1, 1)			None
17	CV_young_Mal_GP_1	0.049	-2	(-1, 1)			None
18	CV_old_Mal_GP_1	-0.189	-2	(-1, 1)			None
19	Wtlen_1_Mal	0.000	-50	(0, 3)			None
20	Wtlen_2_Mal	3.000	-50	(2, 4)			None
24	CohortGrowDev	1.000	-50	(0, 2)			None
25	FracFemale_GP_1	0.500	-99	(0.000001, 0.999999)			None
26	SR_LN(R0)	8.978	1	(5, 20)	OK	0.104	None
27	SR_BH_steep	0.400	-3	(0.2, 1)			None
28	SR_sigmaR	0.700	-6	(0.5, 1.2)			None
29	SR_regime	0.000	-50	(-5, 5)			None

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Table 14: 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_Fishery(1)	-12.034	-1	(-15, 15)			None
141	LnQ_base_POP(4)	0.198	-1	(-15, 15)			None
142	LnQ_base_Triennial(5)	-1.753	-1	(-15, 15)			None
143	LnQ_base_AFSCSlope(6)	-1.183	-1	(-15, 15)			None
144	LnQ_base_NWFSCSlope(7)	-1.865	-1	(-15, 15)			None
145	LnQ_base_NWFSCcombo(8)	-0.994	-1	(-15, 15)			None
146	LnQ_base_Triennial(5)_BLK3add_1995	0.000	3	(0.0001, 2)	LO	0.000	Normal (0.5, 0.5)
147	LnQ_base_Triennial(5)_dev_se	99.000	-5	(0.0001, 2)			Normal (99, 0.5)
148	LnQ_base_Triennial(5)_dev_autocorr	0.000	-6	(-0.99, 0.99)			Normal (0, 0.5)
149	SizeSel_P1_Fishery(1)	37.542	2	(20, 45)	OK	0.152	None
150	SizeSel_P2_Fishery(1)	-4.887	-2	(-6, 4)			None
151	SizeSel_P3_Fishery(1)	3.361	3	(-1, 9)	OK	0.046	None
152	SizeSel_P4_Fishery(1)	-0.367	3	(-1, 9)	OK	0.446	None
153	SizeSel_P5_Fishery(1)	-4.951	4	(-5, 9)	LO	0.126	None
154	SizeSel_P6_Fishery(1)	0.740	2	(-5, 9)	OK	0.092	None
155	Retain_P1_Fishery(1)	28.233	1	(15, 45)	OK	0.189	None
156	Retain_P2_Fishery(1)	1.110	1	(0.1, 10)	OK	0.070	None
157	Retain_P3_Fishery(1)	9.855	1	(-10, 10)	HI	581.149	None
158	Retain_P4_Fishery(1)	0.000	-3	(0, 0)			None
159	SizeSel_P1_ASHOP(2)	52.134	2	(20, 55)	OK	1.266	None
160	SizeSel_P2_ASHOP(2)	-5.000	-2	(-6, 4)			None
161	SizeSel_P3_ASHOP(2)	5.028	3	(-1, 9)	OK	0.098	None
162	SizeSel_P4_ASHOP(2)	7.584	3	(-1, 9)	OK	5434.810	None
163	SizeSel_P5_ASHOP(2)	-5.000	4	(-5, 9)	LO	0.000	None
164	SizeSel_P6_ASHOP(2)	7.674	2	(-5, 9)	OK	6352.230	None

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Table 14: 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)
165	SizeSel_P1_POP(4)	22.242	2	(20, 70)	OK	1.523	None
166	SizeSel_P2_POP(4)	11.010	3	(0.001, 50)	OK	2.763	None
167	SizeSel_P1_Triennial(5)	20.326	2	(18, 70)	OK	0.811	None
168	SizeSel_P2_Triennial(5)	5.516	3	(0.001, 50)	OK	1.493	None
169	SizeSel_P1_AFSCSlope(6)	20.663	2	(18, 70)	OK	0.759	None
170	SizeSel_P2_AFSCSlope(6)	3.608	3	(0.001, 50)	OK	2.781	None
171	SizeSel_P1_NWFSCSlope(7)	32.804	2	(18, 70)	OK	1.318	None
172	SizeSel_P2_NWFSCSlope(7)	9.326	3	(0.001, 50)	OK	2.095	None
173	SizeSel_P1_NWFSCcombo(8)	31.863	2	(20, 70)	OK	1.790	None
174	SizeSel_P2_NWFSCcombo(8)	18.772	3	(0.001, 50)	OK	1.669	None
175	Retain_P3_Fishery(1)_BLK1repl_1940	10.000	-1	(-10, 10)			None
176	Retain_P3_Fishery(1)_BLK1repl_1982	10.000	-1	(-10, 10)			None
177	Retain_P3_Fishery(1)_BLK1repl_1989	2.275	1	(-10, 10)	OK	0.356	None
178	Retain_P3_Fishery(1)_BLK1repl_1995	3.638	1	(-10, 10)	OK	0.192	None
179	Retain_P3_Fishery(1)_BLK1repl_2008	0.264	1	(-10, 10)	OK	0.168	None
180	Retain_P3_Fishery(1)_BLK1repl_2011	5.464	1	(-10, 10)	OK	0.163	None
181	LnQ_base_Triennial(5)_DEVmult_1980	0.000		(NA, NA)			(NA, NA)
182	LnQ_base_Triennial(5)_DEVmult_1981	0.000		(NA, NA)			(NA, NA)
183	LnQ_base_Triennial(5)_DEVmult_1982	0.000		(NA, NA)			(NA, NA)
184	LnQ_base_Triennial(5)_DEVmult_1983	0.000		(NA, NA)			(NA, NA)
185	LnQ_base_Triennial(5)_DEVmult_1984	0.000		(NA, NA)			(NA, NA)
186	LnQ_base_Triennial(5)_DEVmult_1985	0.000		(NA, NA)			(NA, NA)
187	LnQ_base_Triennial(5)_DEVmult_1986	0.000		(NA, NA)			(NA, NA)
188	LnQ_base_Triennial(5)_DEVmult_1987	0.000		(NA, NA)			(NA, NA)
189	LnQ_base_Triennial(5)_DEVmult_1988	0.000		(NA, NA)			(NA, NA)
190	LnQ_base_Triennial(5)_DEVmult_1989	0.000		(NA, NA)			(NA, NA)

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Table 14: 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)
191	LnQ_base_Triennial(5)_DEVmult_1990	0.000		(NA, NA)			(NA, NA)
192	LnQ_base_Triennial(5)_DEVmult_1991	0.000		(NA, NA)			(NA, NA)
193	LnQ_base_Triennial(5)_DEVmult_1992	0.000		(NA, NA)			(NA, NA)
194	LnQ_base_Triennial(5)_DEVmult_1993	0.000		(NA, NA)			(NA, NA)
195	LnQ_base_Triennial(5)_DEVmult_1994	0.000		(NA, NA)			(NA, NA)
196	LnQ_base_Triennial(5)_DEVmult_1995	0.000		(NA, NA)			(NA, NA)
197	LnQ_base_Triennial(5)_DEVmult_1996	0.000		(NA, NA)			(NA, NA)
198	LnQ_base_Triennial(5)_DEVmult_1997	0.000		(NA, NA)			(NA, NA)
199	LnQ_base_Triennial(5)_DEVmult_1998	0.000		(NA, NA)			(NA, NA)
200	LnQ_base_Triennial(5)_DEVmult_1999	0.000		(NA, NA)			(NA, NA)
201	LnQ_base_Triennial(5)_DEVmult_2000	0.000		(NA, NA)			(NA, NA)
202	LnQ_base_Triennial(5)_DEVmult_2001	0.000		(NA, NA)			(NA, NA)
203	LnQ_base_Triennial(5)_DEVmult_2002	0.000		(NA, NA)			(NA, NA)
204	LnQ_base_Triennial(5)_DEVmult_2003	0.000		(NA, NA)			(NA, NA)
205	LnQ_base_Triennial(5)_DEVmult_2004	0.000		(NA, NA)			(NA, NA)

tab:model_params

Table 15: 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 16: 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 18: Time-series of population estimates from the base-case model.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1892	100783	55710	0.00	7927	0	0.00	1.00
1893	100783	55710	1.00	7927	0	0.00	1.00
1894	100783	55710	1.00	7927	0	0.00	1.00
1895	100784	55710	1.00	7927	0	0.00	1.00
1896	100784	55710	1.00	7927	0	0.00	1.00
1897	100784	55710	1.00	7927	0	0.00	1.00
1898	100784	55710	1.00	7927	0	0.00	1.00
1899	100784	55710	1.00	7927	0	0.00	1.00
1900	100784	55710	1.00	7927	0	0.00	1.00
1901	100784	55710	1.00	7927	0	0.00	1.00
1902	100784	55710	1.00	7927	0	0.00	1.00
1903	100784	55710	1.00	7927	0	0.00	1.00
1904	100784	55710	1.00	7927	0	0.00	1.00
1905	100784	55710	1.00	7927	0	0.00	1.00
1906	100784	55710	1.00	7927	0	0.00	1.00
1907	100784	55710	1.00	7927	0	0.00	1.00
1908	100784	55710	1.00	7927	0	0.00	1.00
1909	100784	55710	1.00	7927	0	0.00	1.00
1910	100784	55710	1.00	7927	0	0.00	1.00
1911	100784	55710	1.00	7927	0	0.00	1.00
1912	100784	55710	1.00	7927	0	0.00	1.00
1913	100784	55710	1.00	7927	0	0.00	1.00
1914	100784	55710	1.00	7927	0	0.00	1.00
1915	100784	55710	1.00	7927	0	0.00	1.00
1916	100782	55710	1.00	7927	0	0.00	1.00
1917	100781	55710	1.00	7927	0	0.00	1.00
1918	100779	55710	1.00	7927	0	0.00	1.00
1919	100781	55709	1.00	7927	0	0.00	1.00
1920	100781	55709	1.00	7927	0	0.00	1.00
1921	100782	55709	1.00	7927	0	0.00	1.00
1922	100782	55709	1.00	7927	0	0.00	1.00
1923	100781	55709	1.00	7927	0	0.00	1.00
1924	100780	55709	1.00	7927	0	0.00	1.00
1925	100779	55709	1.00	7927	0	0.00	1.00
1926	100778	55709	1.00	7927	0	0.00	1.00
1927	100779	55709	1.00	7927	0	0.00	1.00
1928	100779	55709	1.00	7927	0	0.00	1.00
1929	100753	55709	1.00	7927	1	0.00	1.00
1930	100753	55708	1.00	7927	1	0.00	1.00

Table 18: Time-series of population estimates from the base-case model.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1931	100752	55707	1.00	7927	1	0.00	1.00
1932	100759	55706	1.00	9343	1	0.00	1.00
1933	100615	55706	1.00	9366	8	0.00	1.00
1934	100563	55701	1.00	9396	10	0.00	1.00
1935	100685	55696	1.00	9444	4	0.00	1.00
1936	100650	55694	1.00	9515	6	0.00	1.00
1937	100575	55714	1.00	9611	9	0.00	1.00
1938	100246	55774	1.00	9713	24	0.00	0.99
1939	99816	55884	1.00	9786	44	0.00	0.99
1940	99263	56041	1.01	9822	70	0.00	0.98
1941	99029	56229	1.01	9801	81	0.00	0.98
1942	98281	56431	1.01	9745	118	0.00	0.97
1943	83720	56627	1.02	9707	939	0.01	0.80
1944	76066	56379	1.01	9701	1487	0.01	0.72
1945	53519	55863	1.00	9856	3963	0.04	0.46
1946	68711	54010	0.97	10094	2043	0.02	0.63
1947	80026	53290	0.96	10671	1130	0.01	0.76
1948	74689	53116	0.95	11430	1515	0.02	0.70
1949	72991	52744	0.95	11792	1641	0.02	0.68
1950	78608	52320	0.94	11437	1212	0.01	0.75
1951	76247	52164	0.94	10865	1380	0.01	0.72
1952	65495	51958	0.93	19335	2290	0.02	0.60
1953	72784	51314	0.92	14609	1624	0.02	0.68
1954	64609	51127	0.92	11544	2349	0.02	0.59
1955	71043	50630	0.91	9520	1750	0.02	0.66
1956	59137	50530	0.91	8156	2928	0.03	0.52
1957	63066	49947	0.90	7033	2470	0.03	0.57
1958	69061	49791	0.89	6051	1907	0.02	0.64
1959	79665	50099	0.90	5707	1121	0.01	0.76
1960	69083	50870	0.91	6975	1970	0.02	0.64
1961	61147	51055	0.92	11246	2794	0.03	0.55
1962	54345	50517	0.91	10739	3646	0.04	0.47
1963	45920	49243	0.88	6541	4964	0.05	0.38
1964	42711	47051	0.84	4695	5386	0.06	0.34
1965	35553	44581	0.80	3786	6868	0.08	0.27
1966	17624	41350	0.74	3211	18204	0.23	0.09
1967	17589	31953	0.57	2821	13853	0.23	0.09
1968	20276	25027	0.45	3048	8639	0.18	0.11
1969	51122	21045	0.38	4659	1651	0.04	0.44

Table 18: Time-series of population estimates from the base-case model.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1970	43362	20878	0.37	8530	2258	0.06	0.35
1971	47437	20200	0.36	4462	1882	0.05	0.39
1972	47138	19544	0.35	2259	1867	0.05	0.39
1973	38082	18804	0.34	1641	2622	0.07	0.29
1974	40190	17681	0.32	1927	2254	0.06	0.32
1975	55510	16921	0.30	2448	1167	0.04	0.48
1976	49162	16880	0.30	1938	1479	0.05	0.41
1977	62681	16706	0.30	2613	845	0.03	0.56
1978	44368	16784	0.30	2678	1770	0.06	0.36
1979	51644	16168	0.29	2780	1277	0.04	0.44
1980	46969	15641	0.28	2076	1505	0.05	0.39
1981	47564	14899	0.27	4098	1399	0.05	0.40
1982	52723	14237	0.26	2945	1090	0.04	0.45
1983	41457	13829	0.25	2352	1636	0.06	0.33
1984	39768	13174	0.24	2598	1647	0.07	0.31
1985	40304	12506	0.22	3272	1512	0.06	0.32
1986	40186	11889	0.21	1379	1441	0.06	0.31
1987	43639	11293	0.20	2154	1188	0.06	0.35
1988	37261	10860	0.19	2496	1500	0.07	0.28
1989	33263	10276	0.18	2899	1709	0.09	0.24
1990	39356	9600	0.17	2561	1247	0.07	0.30
1991	32621	9162	0.16	2890	1609	0.09	0.23
1992	32032	8524	0.15	778	1639	0.10	0.22
1993	31822	7844	0.14	994	1447	0.09	0.23
1994	34361	7326	0.13	3068	1223	0.08	0.25
1995	38546	6937	0.12	2024	963	0.07	0.30
1996	39957	6735	0.12	1006	878	0.06	0.31
1997	44156	6581	0.12	1029	727	0.05	0.36
1998	43293	6475	0.12	1988	747	0.06	0.35
1999	49274	6320	0.11	5212	578	0.05	0.41
2000	79382	6239	0.11	5099	150	0.01	0.75
2001	67772	6382	0.11	2402	276	0.02	0.62
2002	79349	6470	0.12	1448	156	0.01	0.75
2003	81702	6623	0.12	544	138	0.01	0.78
2004	83095	6828	0.12	2382	129	0.01	0.80
2005	91186	7115	0.13	2514	66	0.00	0.89
2006	90676	7521	0.13	1451	75	0.00	0.88
2007	84445	7974	0.14	1505	138	0.01	0.81
2008	83818	8344	0.15	48465	151	0.01	0.80

Table 18: Time-series of population estimates from the base-case model.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
2009	82838	8589	0.15	9731	168	0.01	0.79
2010	83802	8719	0.16	3848	161	0.01	0.80
2011	93801	8817	0.16	14688	60	0.00	0.92
2012	94217	9021	0.16	2574	59	0.00	0.92
2013	94864	10051	0.18	29963	57	0.00	0.93
2014	96663	11807	0.21	2279	46	0.00	0.95
2015	96270	14162	0.25	3756	60	0.00	0.95
2016	97103	16713	0.30	4228	58	0.00	0.96
2017	58280	18909	0.34	4583			

tab:Timeseries_mod1

Table 17: 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 19: Projection of potential OFL, spawning biomass, and depletion for the base case model.

tab:Forecast_mod1

Year	OFL contriubtion (mt)	ACL landings (mt)	Age 5+ biomass (mt)	Spawning Biomass (mt)	Depletion
2017	1389.78	1316.13	47331.80	18908.60	0.34
2018	1529.80	1449.72	49511.20	20168.70	0.36
2019	1651.26	1567.57	51086.60	21186.10	0.38
2020	1752.90	1667.07	52094.30	22238.00	0.40
2021	1823.43	1736.15	52592.50	23472.90	0.42
2022	1855.87	1768.07	52671.40	24463.10	0.44
2023	1854.36	1767.05	52436.90	24948.90	0.45
2024	1829.96	1743.89	51993.00	25060.00	0.45
2025	1793.89	1709.43	51422.00	24883.20	0.45
2026	1754.08	1671.35	50781.00	24888.30	0.45
2027	1715.09	1634.02	50108.50	24915.90	0.45
2028	1679.03	1599.48	49427.90	24849.70	0.45

8 Figures

figures

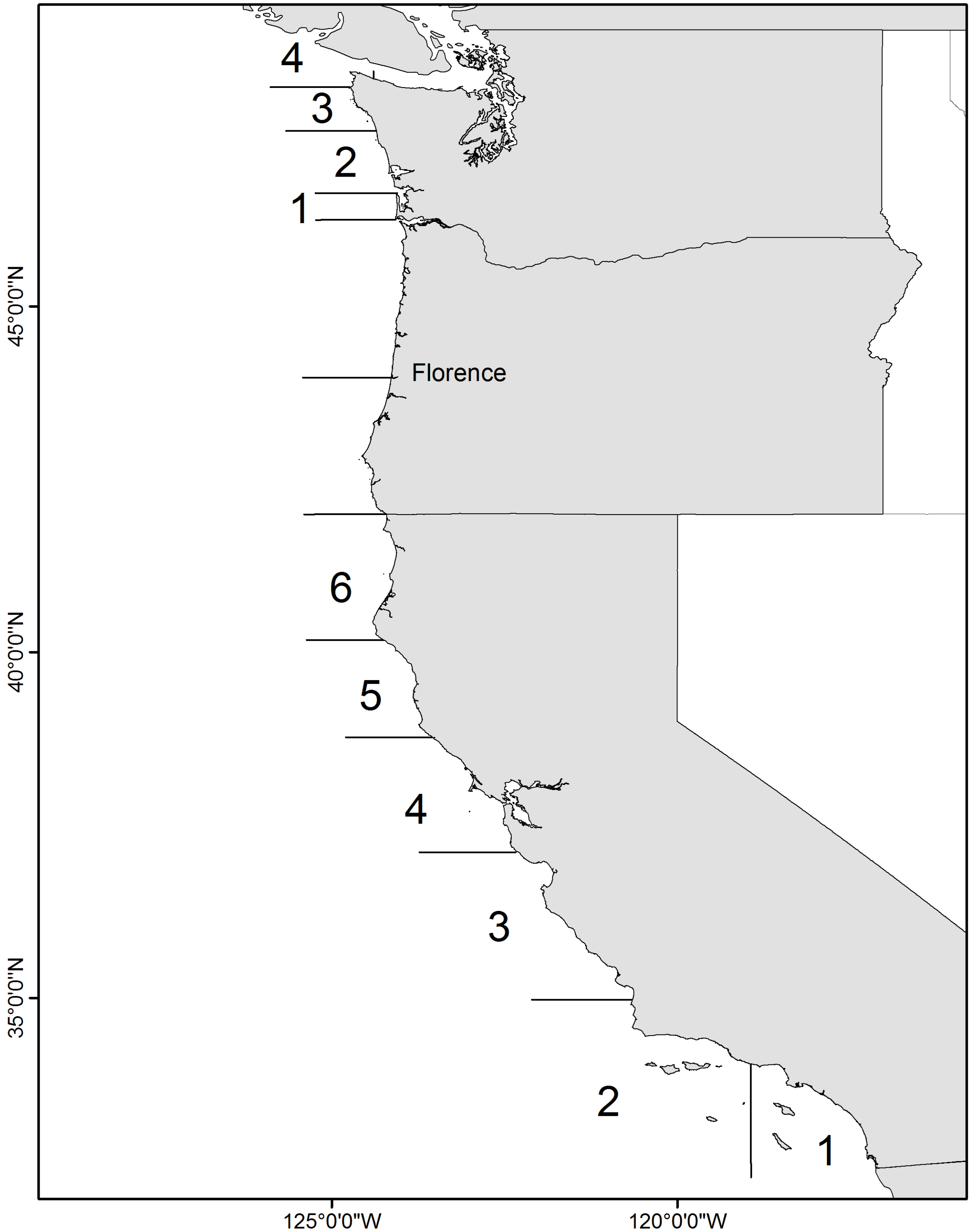


Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. fig:boundary_map

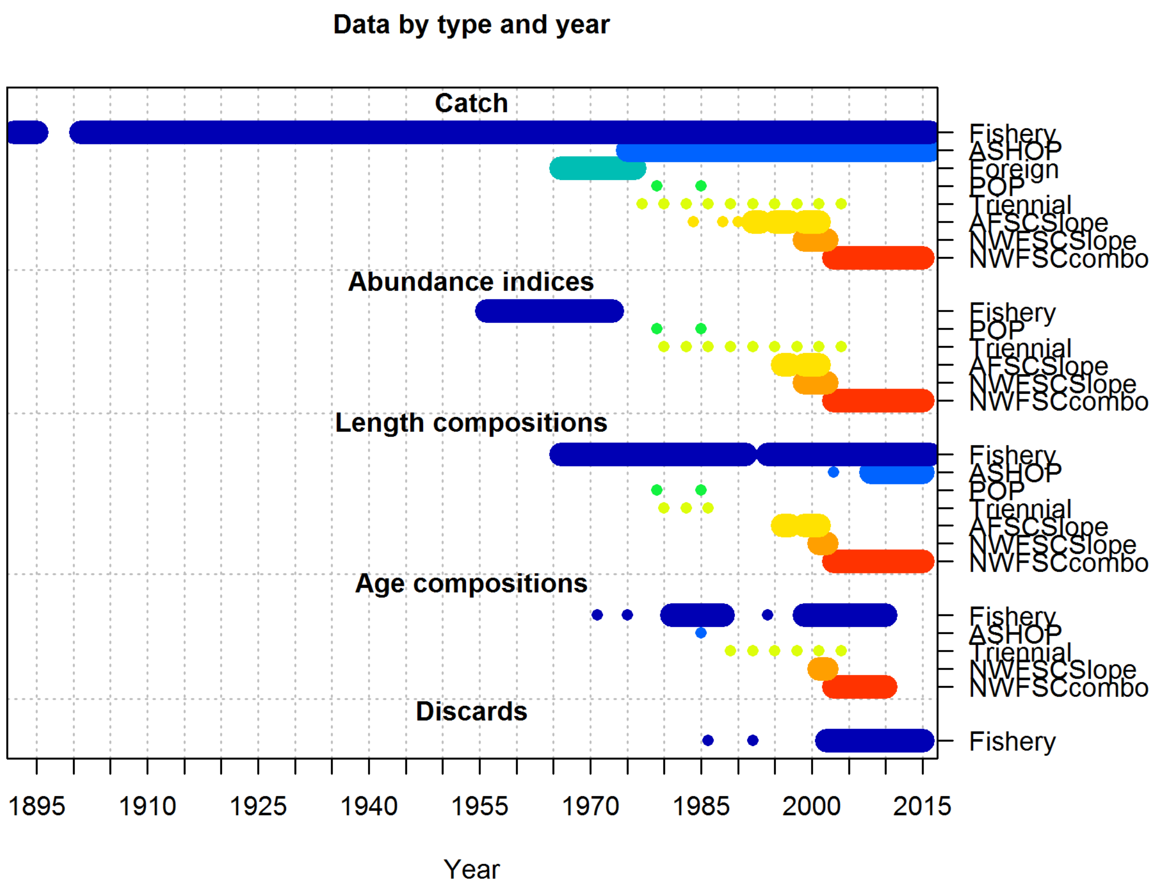
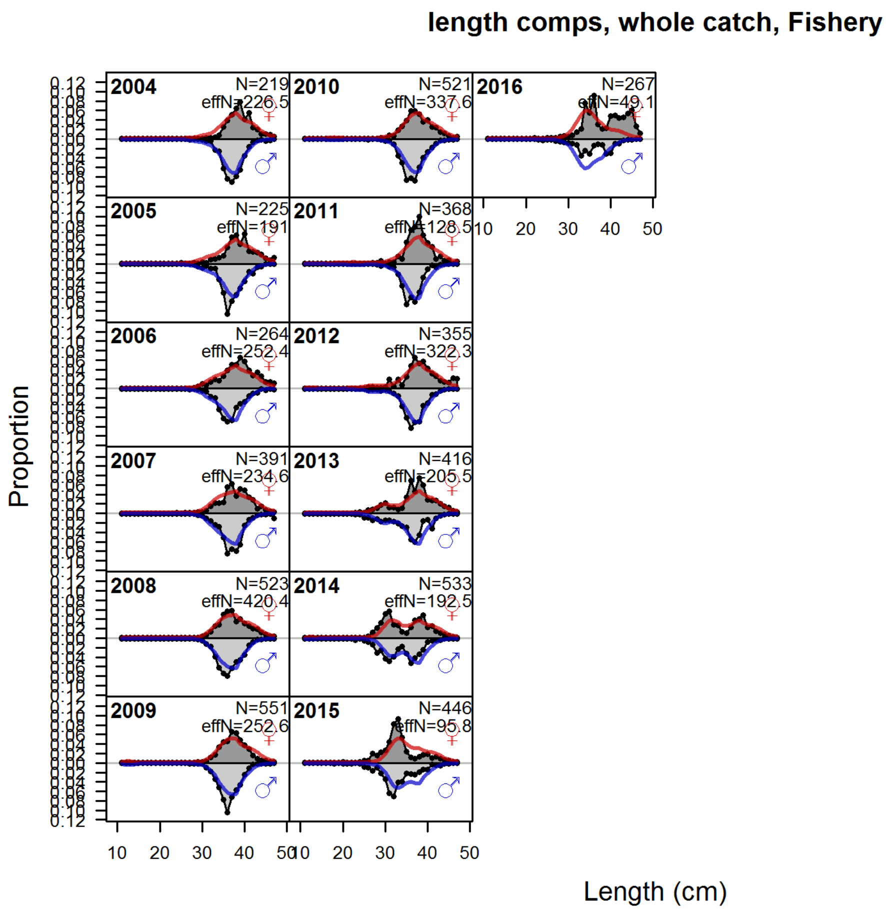


Figure 2: Summary of data sources used in the Base model. fig:data_plot



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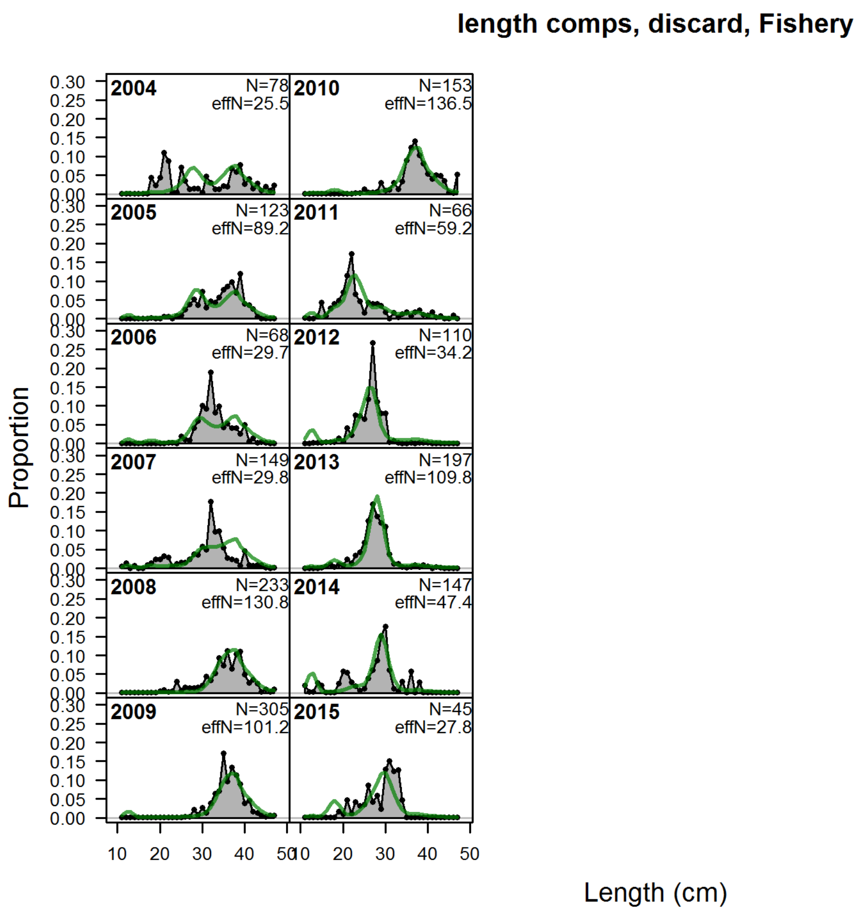


Figure 3: length comps, discard, Fishery fig:mod1_1_comp_lenfit_flt1mkt1

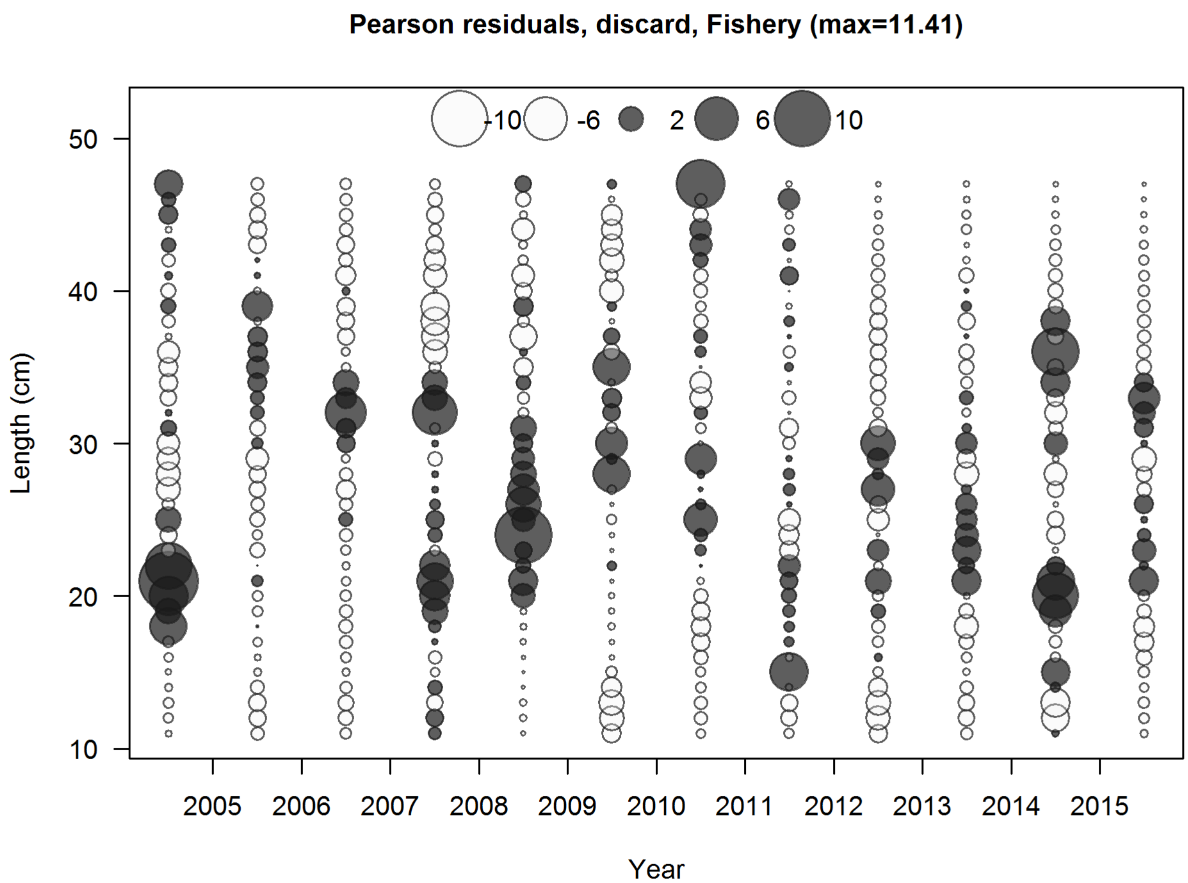


Figure 4: Pearson residuals, discard, Fishery (max=11.41)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_2_comp_lenfit_residsflt1mkt1

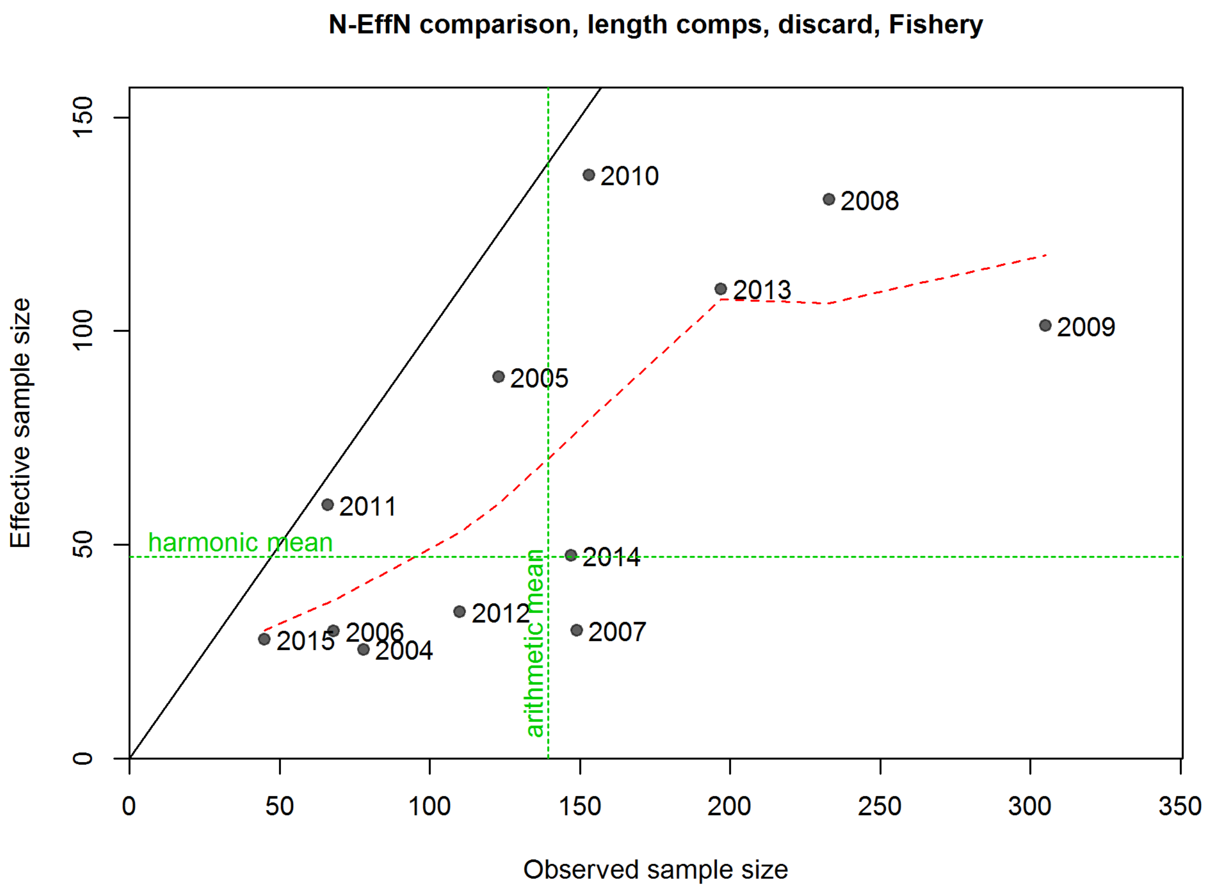


Figure 5: N_EffN comparison, length comps, discard, Fishery fig:mod1_3_comp_lenfit_sam

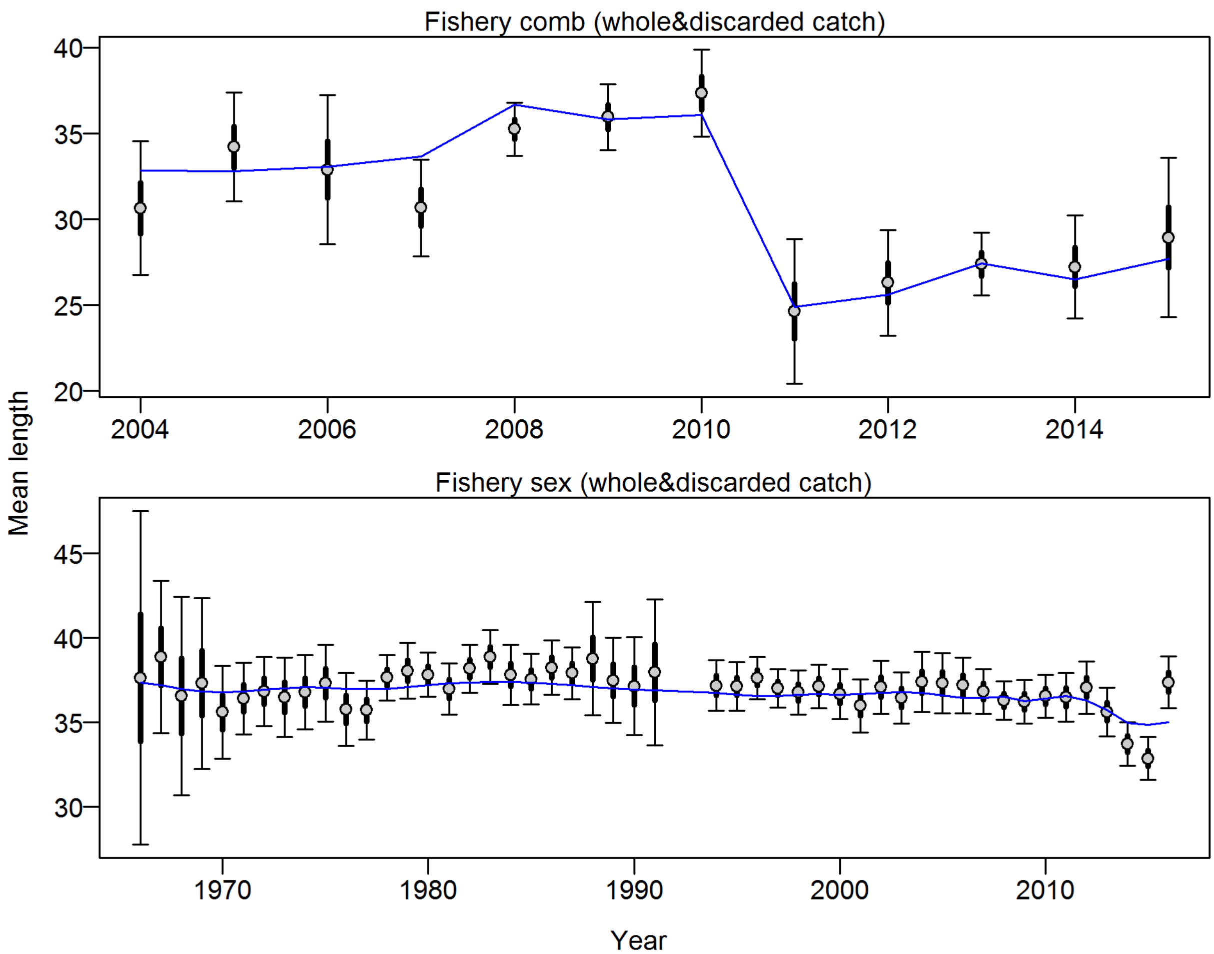


Figure 6: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.146 (0.0976_0.2693) fig:mod1_4_comp_lenfit_data_weigh

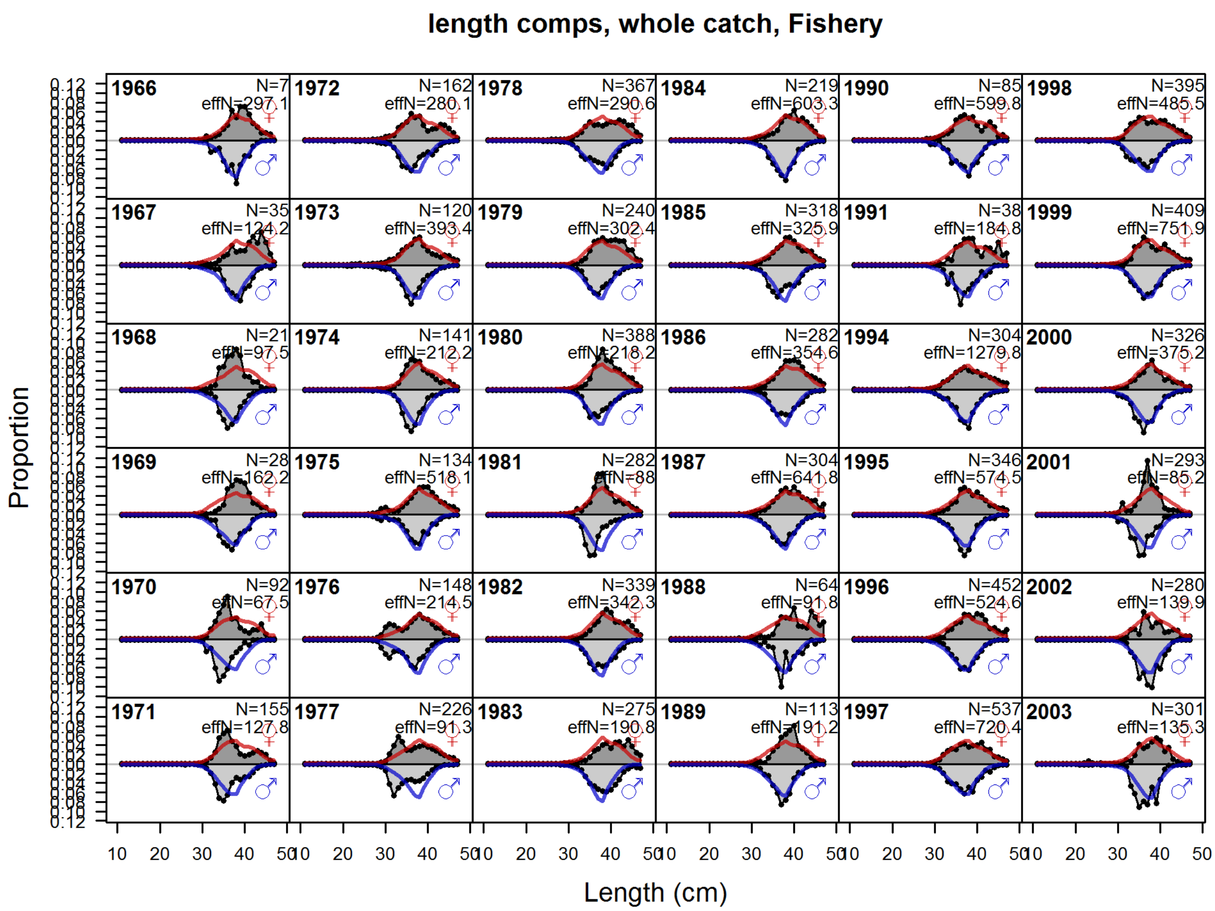
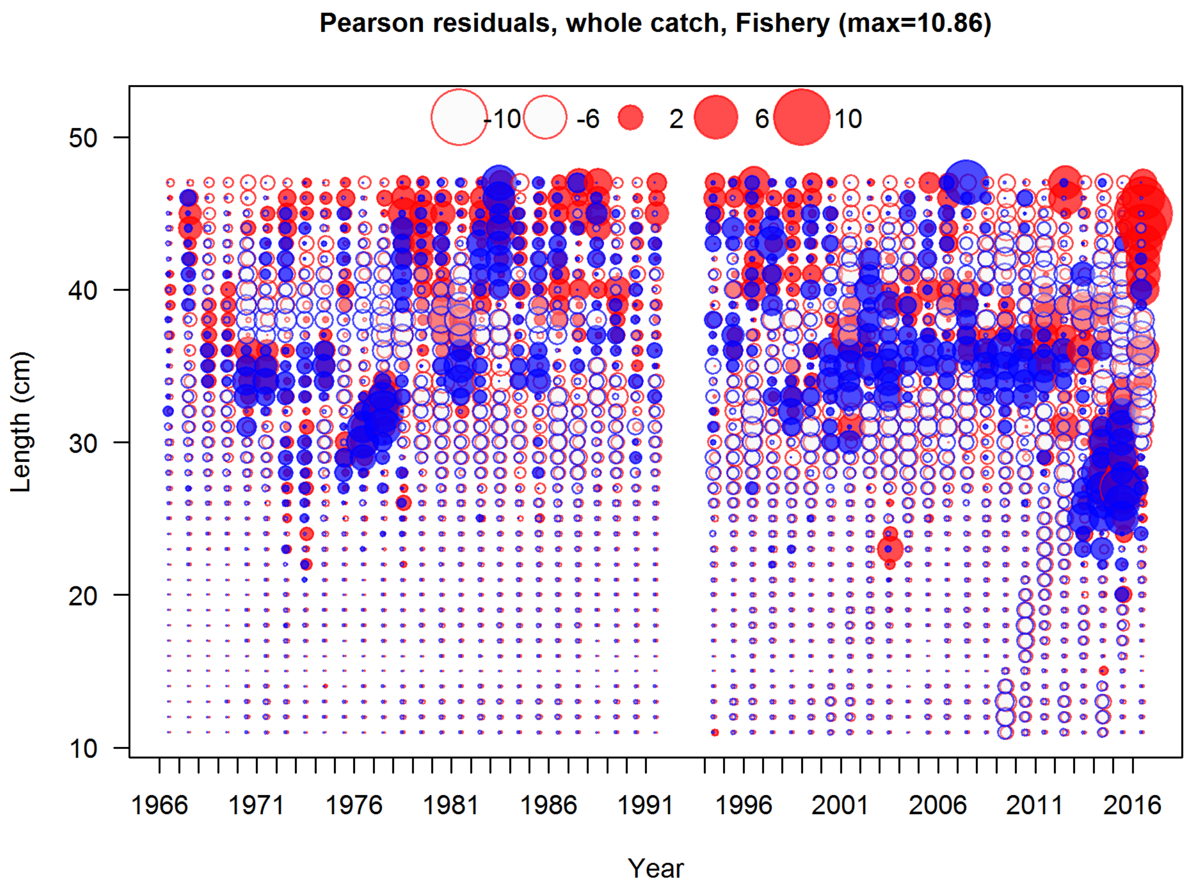


Figure 7: length comps, whole catch, Fishery (plot 1 of 2) `fig:mod1_5_comp_lenfit_flt1m`



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533 Figure continued from previous page

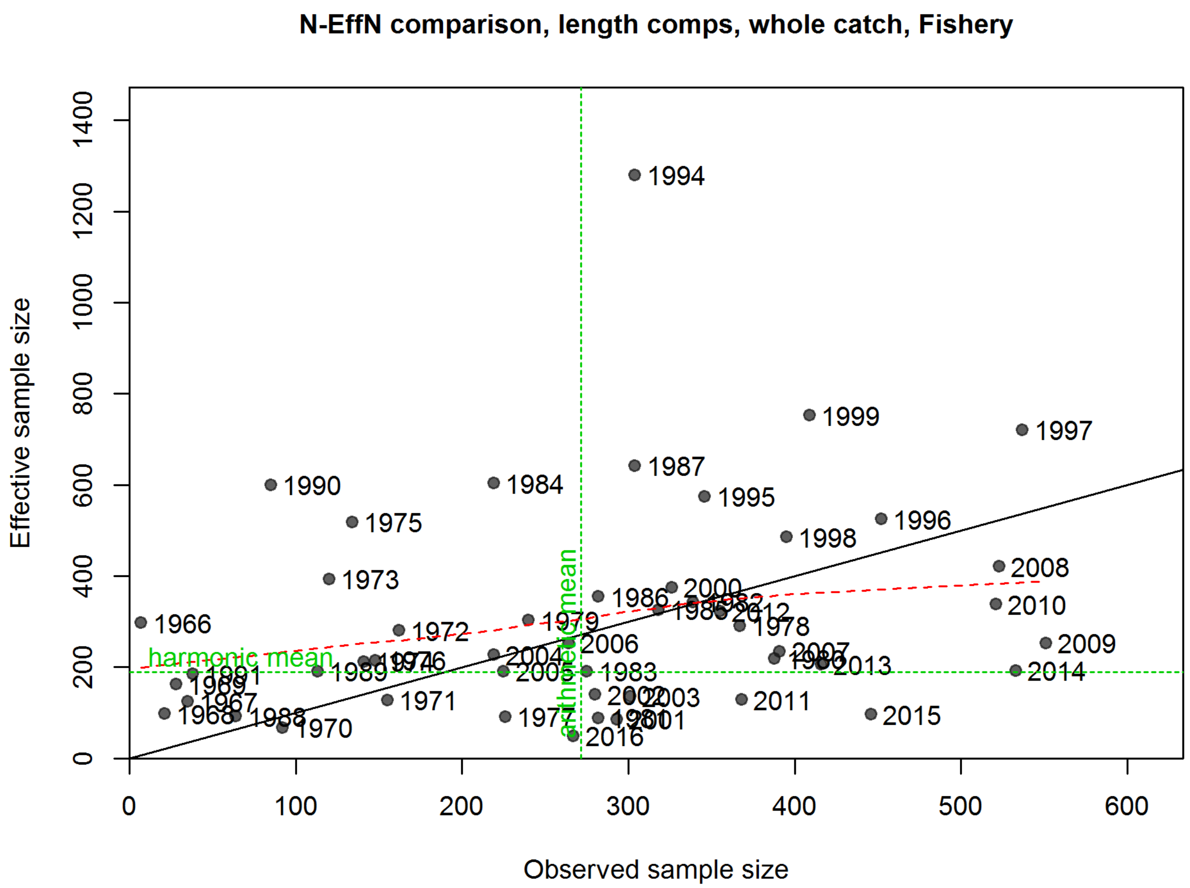

Figure 8: N_EffN comparison, length comps, whole catch, Fishery fig:mod1_8_comp_lenfit_s

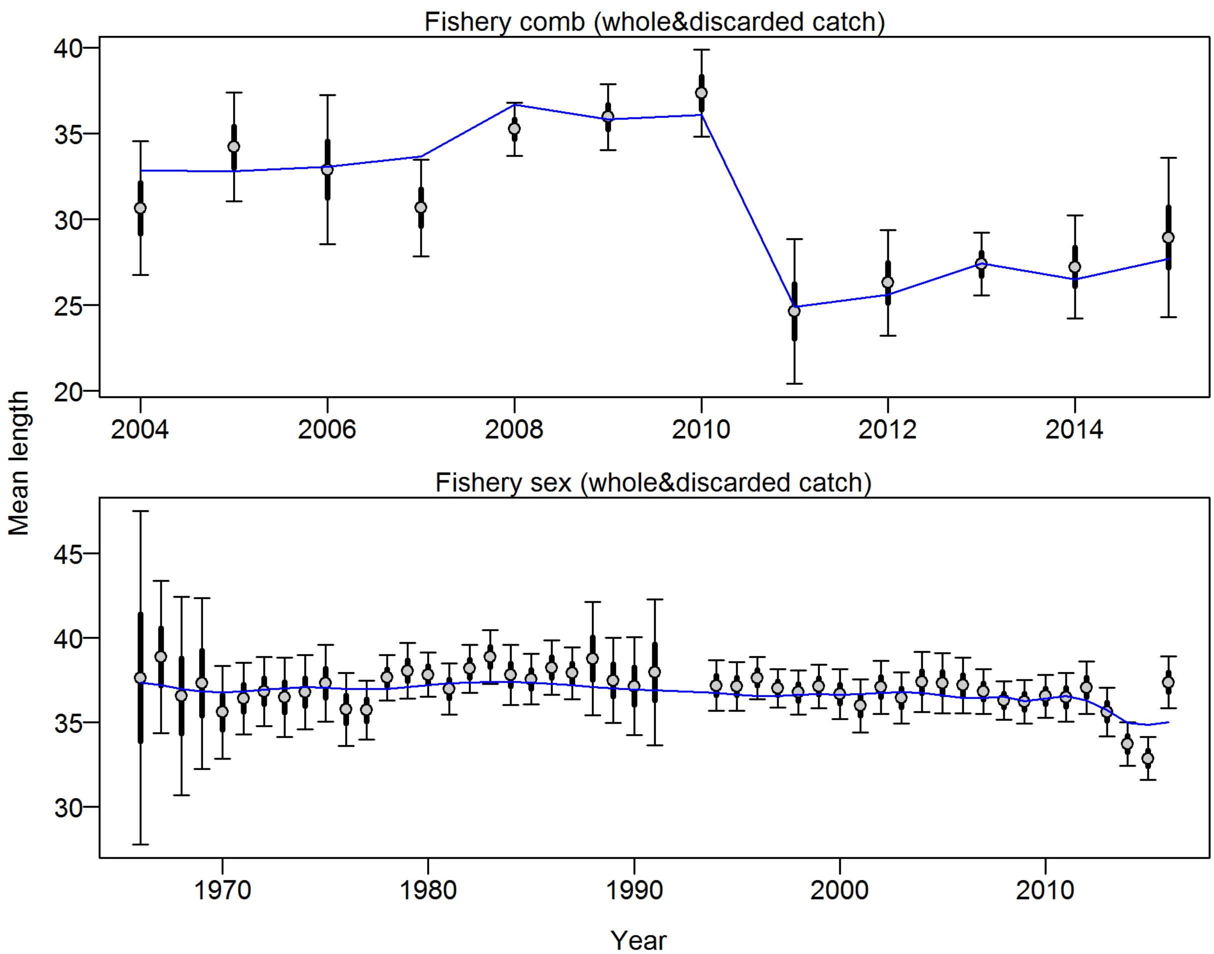

Figure 9: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.146 (0.0933_0.2688) fig:mod1_9_comp_lenfit_data_weigh

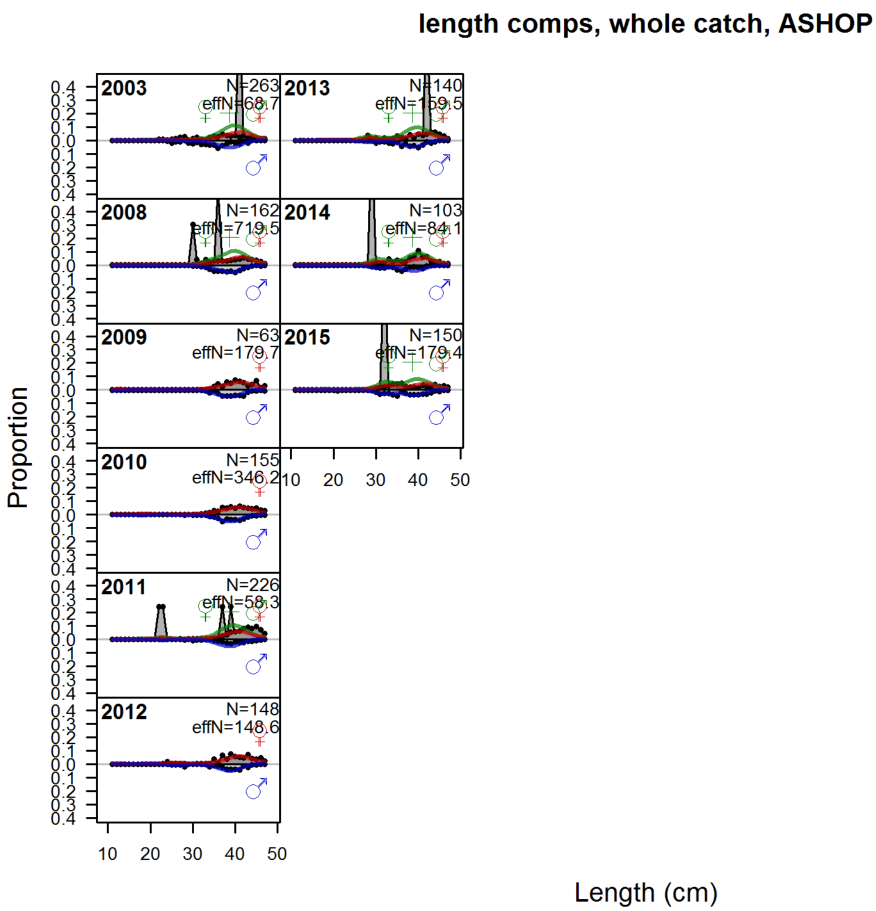

Figure 10: length comps, whole catch, ASHOP [fig:mod1_10_comp_lenfit_flt2mkt0]

¡!– ***********MODEL 2 REFERENCE POINTS FIGURES – IF NEEDED ************ −¿

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