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 for Pacific ocean perch by fleet.

tab:Exec_catch

Year	California	Oregon	Washington	At-sea Hake	Research	Total Landings
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	33.92	15.82	3.92	0.56	54.40
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

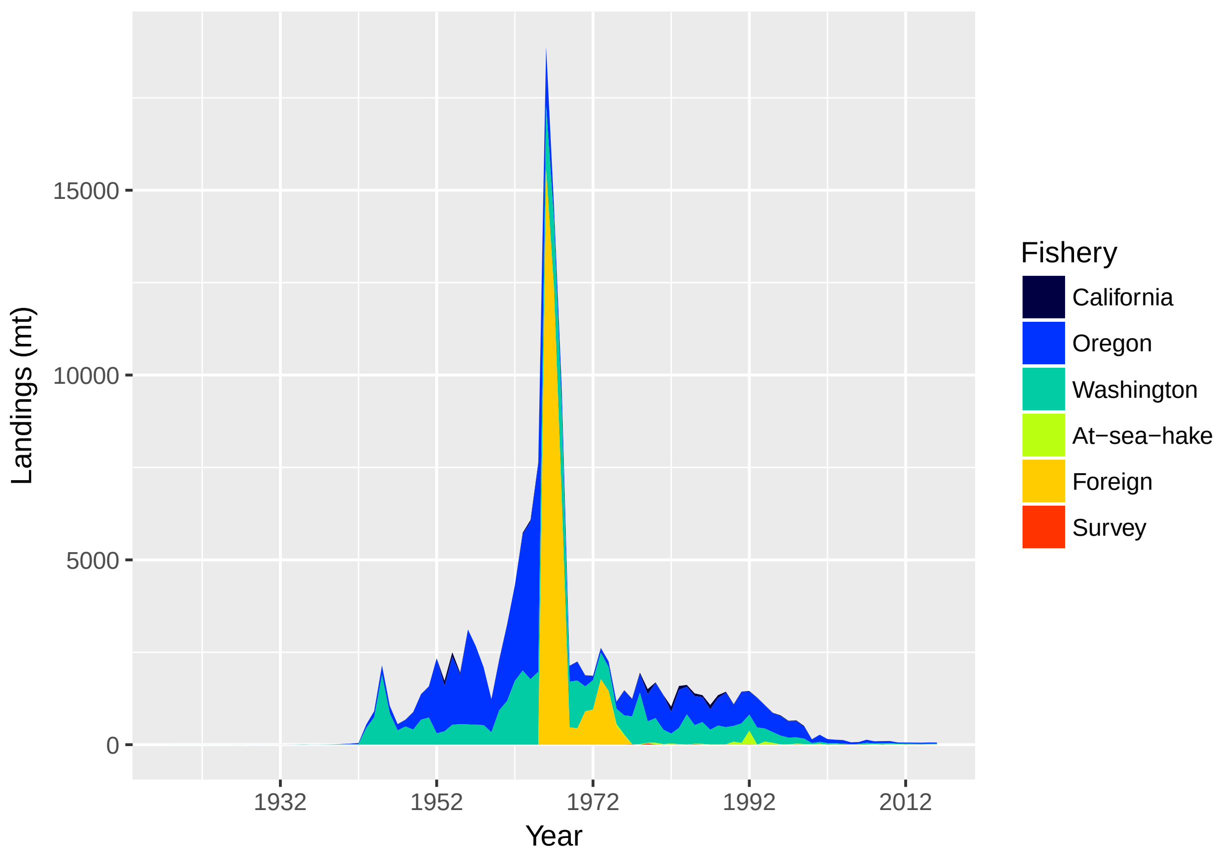

Figure a: Landings of Pacific ocean perch for California, Oregon, Washington, the Foriegn fishery (1966-1976), At-Sea Hake fishery, and fishery independent surveys. fig:Exec_catch1

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 estimated spawning output (million eggs) and relative spawning output.

tab:SpawningDeplete_mod1

Year	Spawning Output (million 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

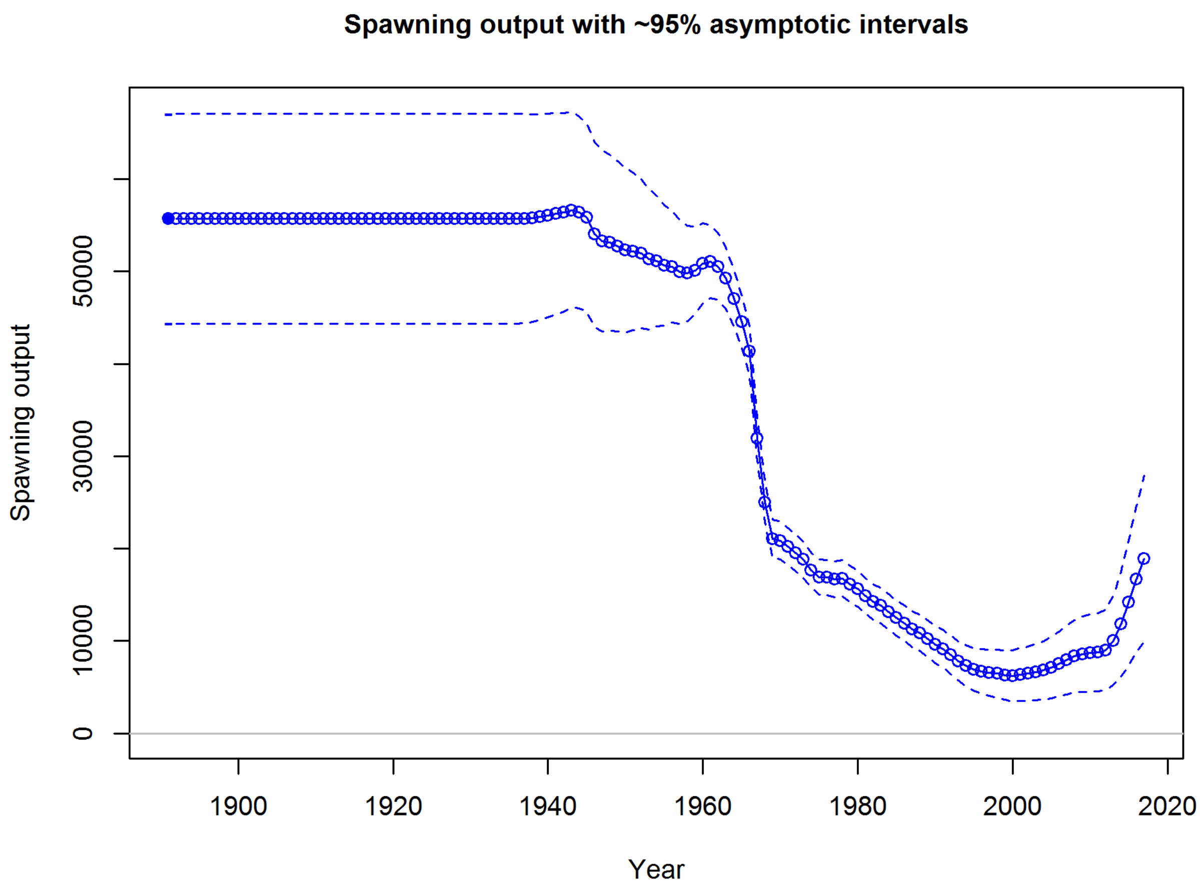

Figure b: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

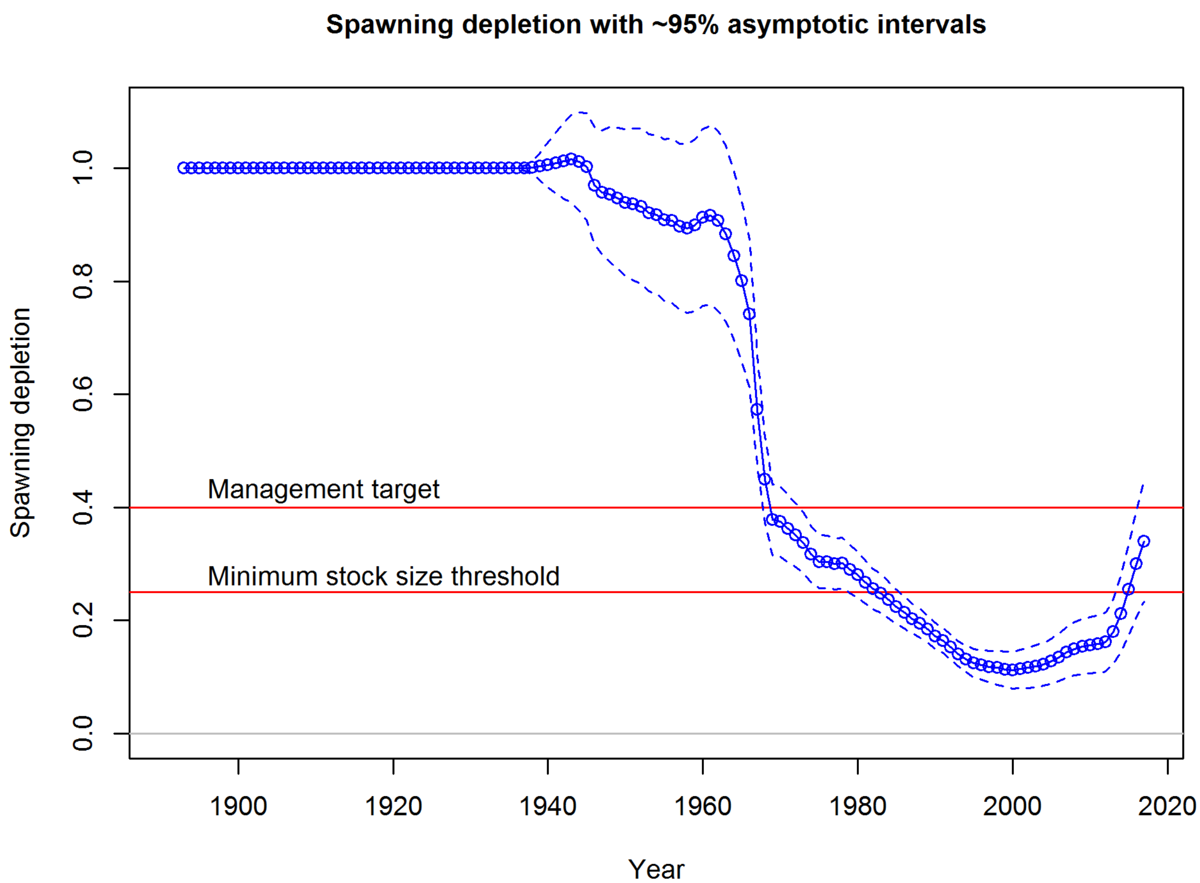

Figure c: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

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)

Table c: Recent estimated trend in recruitment with approximate 95confidence intervals determined from the base model

tab:Recruit_mod1

Year	Estimated Recruitment	~ 95% confidence interval	Estimated Recruitment Devs.	~ 95% confidence interval
2008	48465.00	30145 - 77918	3.16	3.017 - 3.313
2009	9731.00	5203 - 18198	1.54	1.081 - 1.993
2010	3848.00	1697 - 8724	0.60	-0.133 - 1.327
2011	14688.00	8492 - 25404	1.93	1.609 - 2.246
2012	2574.00	965 - 6863	0.10	-0.852 - 1.046
2013	29962.00	16892 - 53146	2.40	2.034 - 2.757
2014	2279.00	748 - 6947	-0.37	-1.509 - 0.762
2015	3756.00	1052 - 13404	-0.00	-1.369 - 1.359
2016	4228.00	1181 - 15135	0.00	-1.372 - 1.372
2017	4583.00	1729 - 12146	0.00	-0.970 - 0.970

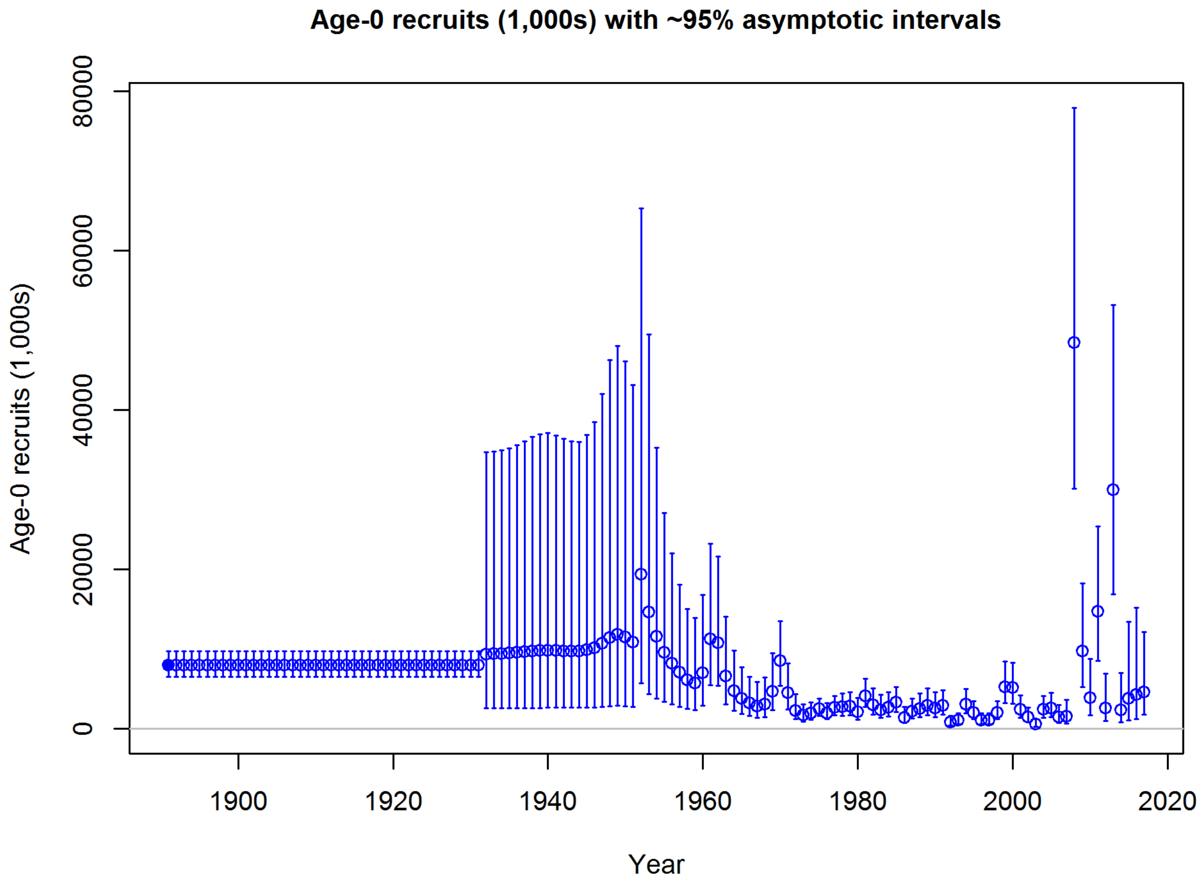

Figure d: Time series of estimated Pacific ocean perch recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

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 (1-SPR) and summary exploitation rate forPacific ocean perch.

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

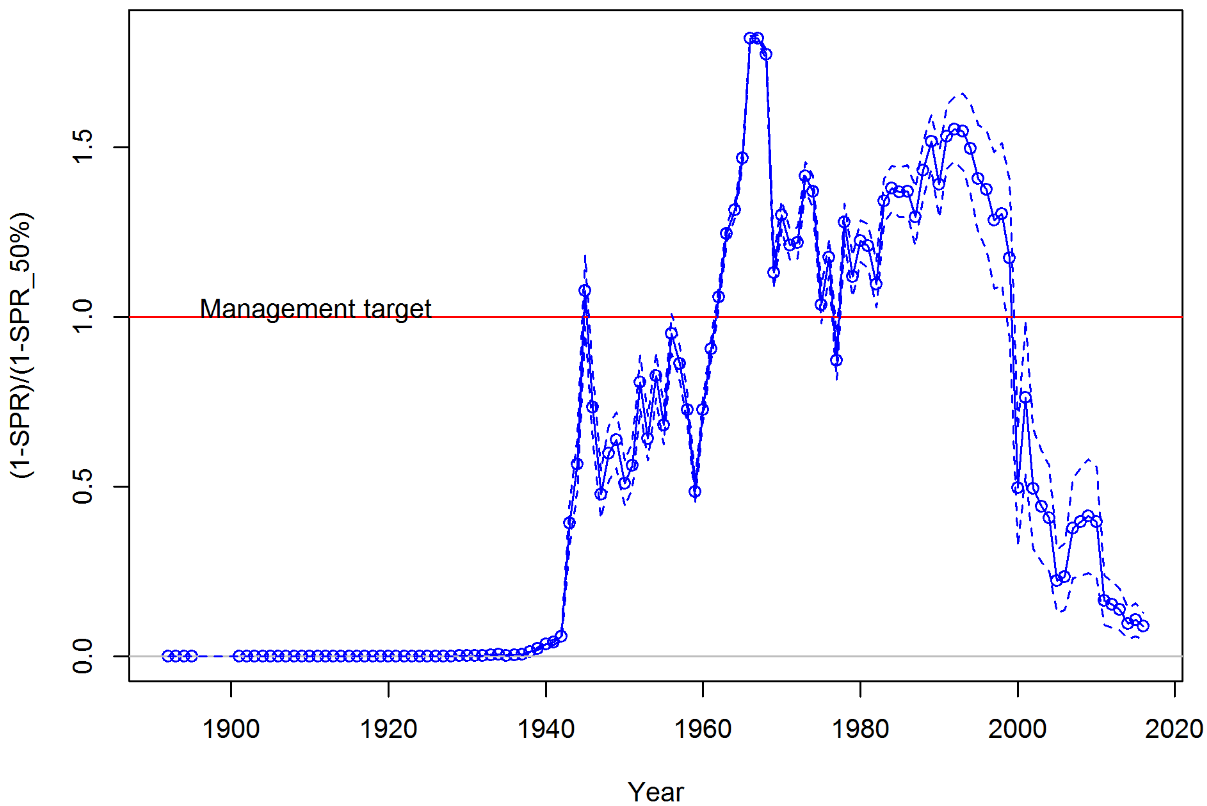

Figure e: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing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

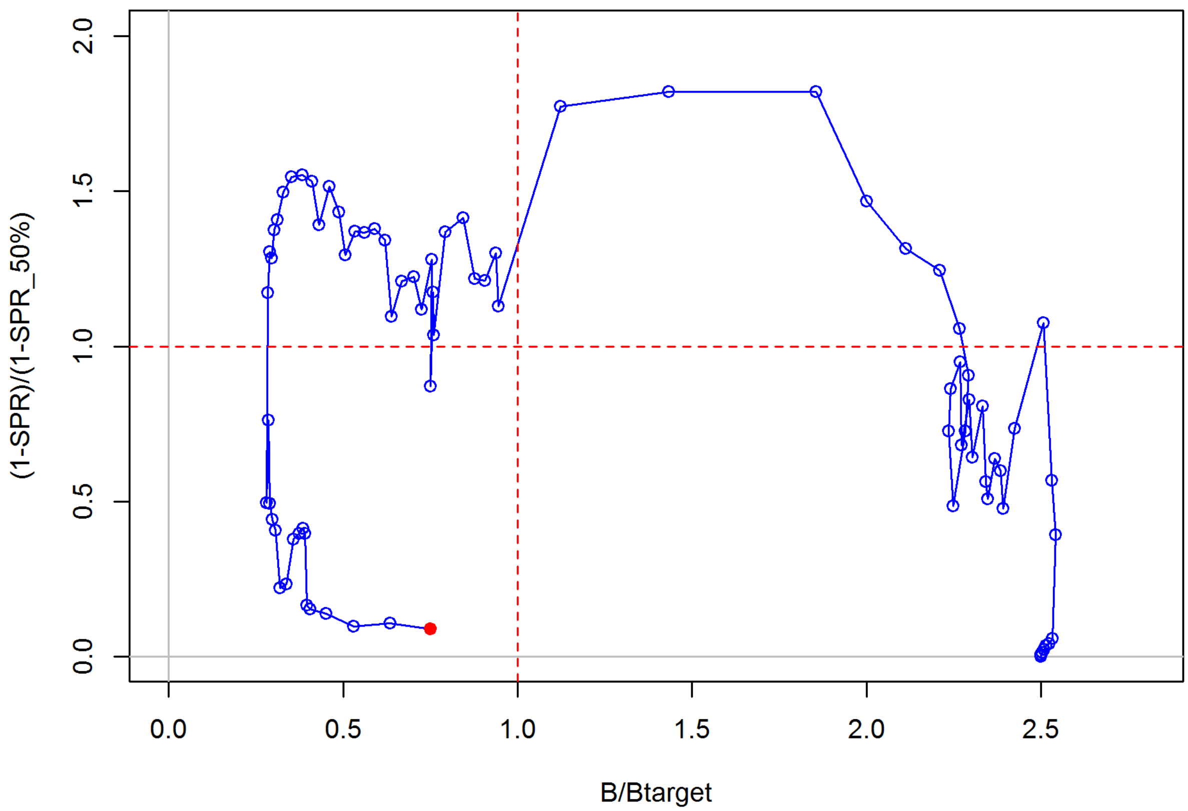

Figure f: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. fig:Phase_all

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 million eggs (~95% asymptotic interval: 9915.73644901456-27901.4635509854 million 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 million 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.

tab:Ref_pts_mod1

Quantity	Estimate	95% Confidence Interval
Unfished spawning output (million 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 million 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)	Total landings (mt)	Estimated total catch (mt)
2007	-	-	150	134	138
2008	-	-	150	92	151
2009	-	-	189	97	168
2010	-	-	200	99	161
2011	-	-	180	60	60
2012	-	-	183	58	59
2013	-	-	150	57	57
2014	-	-	153	45	46
2015	-	-	158	60	60
2016	-	-	164	57	58

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}`

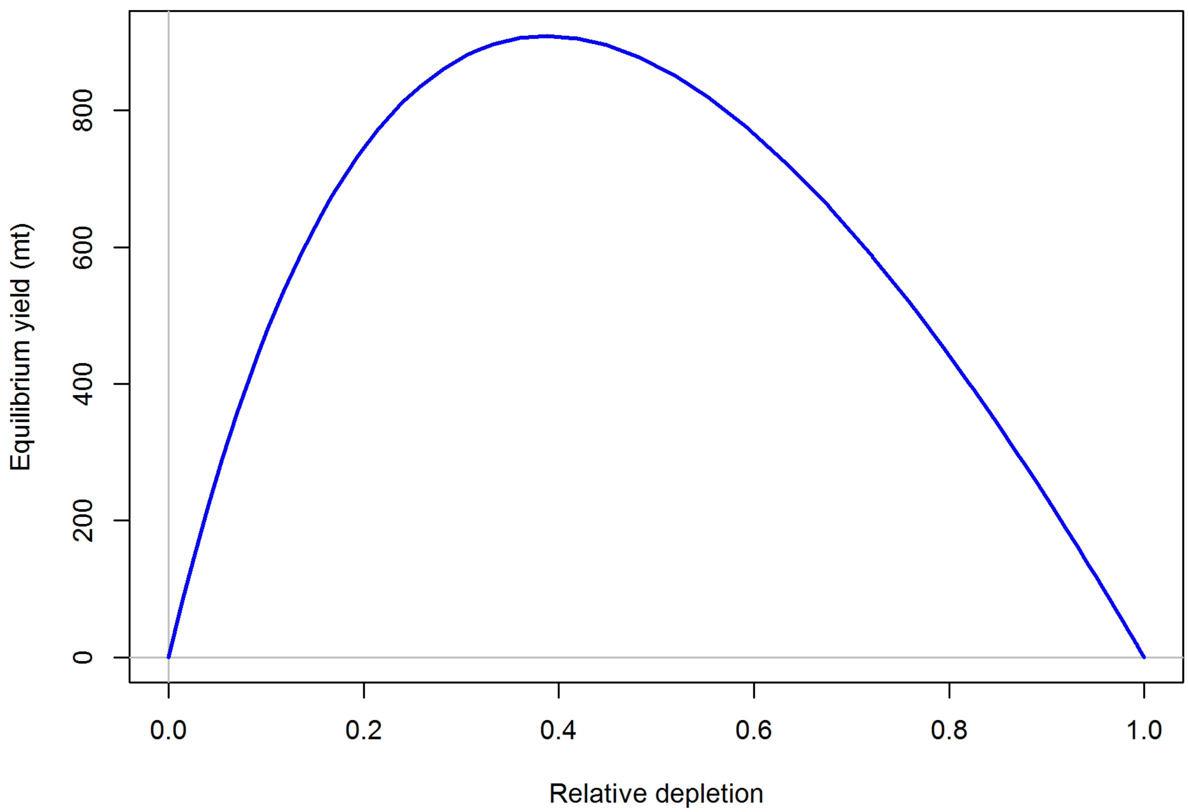

Figure g: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at… fig:Yield_all

Table g: Projections of potential OFL (mt) and ACL (mt) and the estimated spawning output and relative biomass.

tab:OFL_projection

Year	OFL	ACL	Spawning Output (million eggs)	Relative Biomass
2017	1390	1329	18909	0.339
2018	1530	1462	20169	0.362
2019	1651	1579	21186	0.380
2020	1753	1676	22238	0.399
2021	1823	1743	23473	0.421
2022	1856	1774	24463	0.439
2023	1854	1773	24949	0.448
2024	1830	1749	25060	0.450
2025	1794	1715	24883	0.447
2026	1754	1677	24888	0.447
2027	1715	1640	24916	0.447
2028	1679	1605	24850	0.446

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 model results summary.

tab:base_summary

Quantity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Landings (mt)	-	-	-	-	-	-	-	-	-	-
Total Est. Catch (mt)	150	189	200	180	183	150	153	158	164	281
OFL (mt)	92	97	99	60	58	57	45	60	57	
ACL (mt)	151	168	161	60	59	57	46	60	58	
(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	48465	9731	3848	14688	2574	29962	2279	3756	4228	4583
95% CI	30145 - 77918	5203 - 18198	1697 - 8724	8492 - 25404	965 - 6863	16892 - 53146	748 - 6947	1052 - 13404	1181 - 15135	1729 - 12146

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 1,300 mt in 1950, 3,200 mt in 1961 and exceeded 7,600 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 1,350 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 (referred to as the 'Triennial Survey'). 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 (referred to as the Pacific ocean perch Survey). Two slope surveys have been conducted on the West Coast in recent years, one using the research vessel Miller Freeman, which ended in 2001 (referred to as the 'AFSC Slope Survey'), 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 (referred to as the 'NWFSC Slope Survey'). 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 (referred to as the 'NWFSC shelf-slope Survey').

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 and Ecosystem Considerations

life-history-and-ecosystem-considerations

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.

1.4 Fishery Information

fishery-information

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

1.5 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).

1.6 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.

1.7 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 provided below.

2.1.1 Commercial Fishery Landings

commercial-fishery-landings

Washington

Historical commercial fishery landigns of Pacific ocean perch from Washington for the years 1918-2016 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. Due to Recent landings (1981-2016) were obtained directly from Washington state rather than from PacFIN (Pacific Fisheries Information Network (PacFIN) due to identified missing catches not available within PacFIN for Pacific ocean perch.

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 retrieval dated March 3, 2015, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org). The catch data in from the POP and POP2 categories contained within PacFIN for Pacific ocean perch were used for this assessment. Additional cathes from 1987-1999 for Pacific ocean perch under the UROCK category not yet available in PacFIN were received directly from the state and combined with the catch data available for that period within PacFIN.

California

Historical commercial fishery landings of Pacific ocean perch were obtained from the on-line 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 Pacific ocean perch. Foreign catches of individual species were estimated by Rogers (2003) and attributed to INPFC areas for the years of 1966-1976 for Pacific ocean perch. The foreign catches were combined across areas for a coastwide removal total.

Discards

Data on discards of Pacific ocean perch are available from two different data sources. The earliest source is called the Pikitch data and comes from a study organized by Ellen Pikitch that collected trawl discards from 1985-1987 (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. Results of the Pikitch data were obtained from John Wallace (NWFSC, personal communication) in the form of ratios of discard weight to retained weight of Pacific ocean perch and sex-specific length frequencies. Discard estimates are shown in Table 2. Length compositions for discards show a wide range of sizes being discarded, with a peak are XX cm (Cite figure).

The second source is from the West Coast Groundfish Observer Program (WCGOP). This program is part of the NWFSC and has been recording discard observations since 2003. Table **??**{tab:Discard} shows the discard ratios of Pacific ocean perch from the WCGOP. Since 2011, when the trawl rationalization proram was implemented, observer coverage rates increased to nearly 100% for all the limited entry trawl vessels in the program and discard rates declined compared to pre-2011 rates. Discard rates were obtained for both the catch-share and the non-catch share sector for Pacific ocean perch. A single discard rate was calculated by weighting discard rates based on the commercial landings by each sector. Discard length composition for the trawl fleet varied by year, with larger fish being discarded prior to 2011 (Figure 3).

2.1.2 Abundance Indices

abundance-indices

2.1.3 Fishery-Dependent Data:

fishery-dependent-data

Historical Commercial Catch-per-unit effort

Data on catch-per-unit-effort (CPUE) in mt/hr from the domestic fishery were combined for the INPFC Vancouver and Columbia areas (14 from Gunderson (1977)). Although these data reflect catch rates for the US fleet, the highest catch rates coincided with the beginning of removals by the foreign fleet. This suggest that, barring unaccounted changes in fishing efficiency during this period, the level of abundance was high at that time. A CV of 0.40 was used in this assessment to be consistent with the CV observed in the survey data.

2.1.4 Fishery-Independent Data:

fishery-independent-data

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.

The data from the NWFSC shelf-slope survey was analyzed using a spatial delta-generalized linear mixed model (delta-GLMM) (Thorson and Barnett 2017). Predicted fish biomass density is derived as the product of a "delta" portion for the probability of a non-zero catch and a second portion for the magnitude of the non-zero catches. Further, the geostatistical GLMM framework can accommodate spatial autocorrelation. Additional information about the approach and the software package it is implemented in are available from www.fishstats.org. describe VAST

The estimated index of abundance is shown in Table 15.

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.

The estimated index of abundance is shown in Table 15.

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 with length data ranged from 19 in 2000 to 48 in 1996 6. 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.

The estimated index of abundance is shown in Table 15.

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.

Describe whether the time-series was split or retained as one index

The estimated index of abundance is shown in Table 15.

Pacific ocean perch Survey

A survey targeted designed to sample Pacific ocean perch was conducted in 1979 and again in 1985. The estimated index of abundance is shown in Table 15.

2.1.5 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

Natural mortality

Historic Pacific ocean perch ages determined using scales and surface reading methods of otoliths, resulted in estimates of natural mortality of between 0.10 and 0.20yr^{-1} with a longevity less than 30 years(Gunderson 1977). Based on break-and-burn method of age determination using otoliths, the maximum age of Pacific ocean perch was revised to be 90 years (Chilton and Beamish 1982). The updated understanding concerning Pacific ocean perch longevity reduced the estimate of natural morality based on Hoenig's (1983) relationship to 0.059yr^{-1}. The previous assessment applied a prior distribution on natural mortality based upon multiple life history correlates (including Hoenig's method, Gunderson gonadosomatic index (1997), and McCoy and Gillooly's (2008) theoretical relationship) developed separately for female and male Pacific ocean perch. This assessment also applied a prior on natural mortality. However, the prior and standard deviation were generated as a non-linear function of maximum age as developed by Then et al. (2015) and modified by Owen Hamel which greatly improved the fit to the underlying age data to create the 'Hamel-Then' prior. A maximum age of 100 was used in the developement of the prior where female natural moratility was set equal to 0.05 and male natural mortality estimated as an offset from females at 0.054.

Sex ratio, maturation, and fecundity

Examining all biological data sources, the sex ratio of young fish are within 5% of 1:1 by either length or age (Figure 12 and 13), and hence this assessment the sex ratio at birth was assumed to be 1:1. This assessment assumed a logistic maturity-at-length curve based on analysis of 537 fish maturity samples collected from the NWFSC shelf-slope survey. This is revised from the previous assessment which assumed maturity-at-age based on the work of Hannah and Parker (Hannah and Parker 2007). Additionally, the new maturity-at-length curve is based on the estimate of functional maturity an approach that classifies rockfish maturity with developing oocytes as mature or immature based on the proportion of vitellogenin in the cytoplasm and the measured frequency of atretic cells (M. Head, personal communication). The 50% size-at-maturity was estimated at 32.1 cm with maturity asymptoting to one for larger fish.

The fecundity-at-age has also been updated from the previous assessment based on new research. Dick (2017) estimated new fecundity relationships for select West Coast stocks where fecundity for Pacific ocean perch was esimtated equal to $1.08643L^{1.44}$ in millions of eggs. Spawning output at length is shown in Figure 14.

Length-weight relationship

The length-weight relationship for Pacific ocean perch was esimated outside the model using all biological data available from fishery and fishery-independant data sources where the female weight-at-length in grams was estimated at $0.0000106L^{3.08}$ and males at $0.000014L^{3}$ where L is length in cm.

Growth (length-at-age)

Write if estiamted or fixed in the final model

Aging Precision And Bias

2.1.6 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 17 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 18

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 19).

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 20

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	33.9	15.8	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:POP_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:TriennialLengths`

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:AFSC_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:NWslope_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:NWcombo_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_Ages

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:POP_Ages

Year	Tows	Fish	Sample Size
1985	29	1635	70

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

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:NWslope_Ages

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:NWFcombo_Ages

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: Summary of the commercial catch-per-unit effort time-series used in the stock assessment.

tab:CPUE_Summary

Year	Obs	SE
1956	0.40	0.40
1957	0.30	0.40
1958	0.32	0.40
1959	0.29	0.40
1960	0.28	0.40
1961	0.31	0.40
1962	0.29	0.40
1963	0.34	0.40
1964	0.35	0.40
1965	0.55	0.40
1966	0.47	0.40
1967	0.30	0.40
1968	0.17	0.40
1969	0.18	0.40
1970	0.17	0.40
1971	0.20	0.40
1972	0.20	0.40
1973	0.11	0.40

Table 15: Summary of the fishery-independant biomass/abundance time-series used in the stock assessment.

tab:Index_Summary

	POP		Triennial		AFSC Slope		NWFSC Slope		NWFSC Shelf-Slope	
Year	Obs	SE	Obs	SE	Obs	SE	Obs	SE	Obs	SE
1979	36977	0.47	-	-	-	-	-	-	-	-
1980	-	-	7624	0.52	-	-	-	-	-	-
1983	-	-	6561	0.48	-	-	-	-	-	-
1985	24522	0.65	-	-	-	-	-	-	-	-
1986	-	-	2922	0.54	-	-	-	-	-	-
1989	-	-	3690	0.55	-	-	-	-	-	-
1992	-	-	2836	0.53	-	-	-	-	-	-
1995	-	-	1994	0.54	-	-	-	-	-	-
1996	-	-	-	-	6346	0.51	-	-	-	-
1997	-	-	-	-	3156	0.51	-	-	-	-
1998	-	-	2690	0.52	-	-	-	-	-	-
1999	-	-	-	-	3935	0.50	1425	0.97	-	-
2000	-	-	-	-	3557	0.53	1151	0.90	-	-
2001	-	-	1047	0.54	3492	0.48	1959	0.91	-	-
2002	-	-	-	-	-	-	1615	1.08	-	-
2003	-	-	-	-	-	-	-	-	8575	0.65
2004	-	-	1989	0.55	-	-	-	-	4226	0.68
2005	-	-	-	-	-	-	-	-	6835	0.67
2006	-	-	-	-	-	-	-	-	4987	0.70
2007	-	-	-	-	-	-	-	-	5143	0.64
2008	-	-	-	-	-	-	-	-	3334	0.67
2009	-	-	-	-	-	-	-	-	2501	0.64
2010	-	-	-	-	-	-	-	-	4563	0.63
2011	-	-	-	-	-	-	-	-	6642	0.63
2012	-	-	-	-	-	-	-	-	6985	0.64
2013	-	-	-	-	-	-	-	-	6537	0.63
2014	-	-	-	-	-	-	-	-	3997	0.63
2015	-	-	-	-	-	-	-	-	4523	0.60

Table 16: 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 16: 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 16: 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 16: 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 17: 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 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1892	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1893	100784	55710	100260.00	1.00	7927	0.1	0.00	0.00
1894	100784	55710	100260.00	1.00	7927	0.1	0.00	0.00
1895	100784	55710	100260.00	1.00	7927	0.1	0.00	0.00
1896	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1897	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1898	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1899	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1900	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1901	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1902	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1903	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1904	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1905	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1906	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1907	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1908	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1909	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1910	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1911	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1912	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1913	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1914	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1915	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1916	100784	55710	100260.00	1.00	7927	0.0	0.00	0.00
1917	100784	55710	100259.00	1.00	7927	0.1	0.00	0.00
1918	100784	55710	100259.00	1.00	7927	0.2	0.00	0.00
1919	100784	55709	100259.00	1.00	7927	0.2	0.00	0.00
1920	100784	55709	100259.00	1.00	7927	0.1	0.00	0.00
1921	100783	55709	100259.00	1.00	7927	0.1	0.00	0.00
1922	100783	55709	100259.00	1.00	7927	0.1	0.00	0.00
1923	100783	55709	100259.00	1.00	7927	0.1	0.00	0.00
1924	100783	55709	100259.00	1.00	7927	0.1	0.00	0.00
1925	100783	55709	100258.00	1.00	7927	0.2	0.00	0.00
1926	100783	55709	100258.00	1.00	7927	0.2	0.00	0.00
1927	100783	55709	100258.00	1.00	7927	0.3	0.00	0.00

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1928	100782	55709	100258.00	1.00	7927	0.3	0.00	0.00
1929	100782	55709	100258.00	1.00	7927	0.3	0.01	0.00
1930	100781	55708	100256.00	1.00	7927	1.4	0.00	0.00
1931	100780	55707	100255.00	1.00	7927	1.4	0.00	0.00
1932	100781	55706	100254.00	1.00	9343	1.4	0.00	0.00
1933	100801	55706	100253.00	1.00	9366	1.1	0.01	0.00
1934	100864	55701	100245.00	1.00	9396	7.6	0.02	0.00
1935	101019	55696	100398.00	1.00	9444	10.0	0.03	0.00
1936	101256	55694	100634.00	1.00	9515	4.5	0.04	0.00
1937	101570	55714	100944.00	1.00	9611	6.1	0.06	0.00
1938	101956	55774	101324.00	1.00	9713	9.4	0.39	0.00
1939	102396	55884	101759.00	1.00	9786	24.4	0.57	0.00
1940	102882	56041	102238.00	1.01	9822	44.2	1.08	0.00
1941	103400	56229	102752.00	1.01	9801	70.0	0.73	0.00
1942	103955	56431	103306.00	1.01	9745	81.3	0.48	0.00
1943	104512	56627	103865.00	1.02	9707	117.5	0.60	0.00
1944	104281	56379	103637.00	1.01	9701	938.7	0.64	0.01
1945	103543	55863	102900.00	1.00	9856	1487.0	0.51	0.01

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1946	100396	54010	99751.30	0.97	10094	3962.7	0.56	0.04
1947	99267	53290	98609.70	0.96	10671	2043.1	0.81	0.02
1948	99127	53116	98447.70	0.95	11430	1129.5	0.64	0.01
1949	98688	52744	97968.50	0.95	11792	1514.7	0.83	0.02
1950	98246	52320	97484.40	0.94	11437	1640.7	0.68	0.02
1951	98368	52164	97594.70	0.94	10865	1212.2	0.95	0.01
1952	98452	51958	97686.70	0.93	19335	1379.5	0.86	0.01
1953	97805	51314	96954.10	0.92	14609	2290.4	0.73	0.02
1954	98119	51127	96925.50	0.92	11544	1624.3	0.48	0.02
1955	98110	50630	97199.30	0.91	9520	2349.1	0.73	0.02
1956	98748	50530	98020.80	0.91	8156	1749.6	0.91	0.02
1957	98141	49947	97536.00	0.90	7033	2927.8	1.06	0.03
1958	97826	49791	97307.60	0.89	6051	2470.3	1.24	0.03
1959	97815	50099	97366.80	0.90	5707	1906.5	1.31	0.02
1960	98257	50870	97859.10	0.91	6975	1120.6	1.47	0.01
1961	97517	51055	97108.80	0.92	11246	1969.7	1.82	0.02
1962	95725	50517	95193.30	0.91	10739	2794.1	1.82	0.03
1963	93027	49243	92300.30	0.88	6541	3646.3	1.77	0.04

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1964	89078	47051	88442.20	0.84	4695	4964.2	1.13	0.06
1965	84664	44581	84264.20	0.80	3786	5386.5	1.30	0.06
1966	78617	41350	78322.80	0.74	3211	6868.4	1.21	0.09
1967	61184	31953	60944.70	0.57	2821	18204.4	1.22	0.30
1968	48240	25027	48034.20	0.45	3048	13853.2	1.41	0.29
1969	40559	21045	40365.40	0.38	4659	8638.5	1.37	0.21
1970	39794	20878	39557.30	0.37	8530	1650.9	1.04	0.04
1971	38402	20200	38037.20	0.36	4462	2258.5	1.17	0.06
1972	37460	19544	36968.70	0.35	2259	1882.1	0.87	0.05
1973	36612	18804	36355.40	0.34	1641	1866.5	1.28	0.05
1974	34887	17681	34746.80	0.32	1927	2622.5	1.12	0.08
1975	33397	16921	33282.60	0.30	2448	2253.9	1.22	0.07
1976	32876	16880	32740.30	0.30	1938	1167.5	1.21	0.04
1977	31935	16706	31780.20	0.30	2613	1478.8	1.10	0.05
1978	31533	16784	31392.90	0.30	2678	844.8	1.34	0.03
1979	30123	16168	29948.70	0.29	2780	1770.4	1.38	0.06
1980	29170	15641	28992.80	0.28	2076	1277.5	1.37	0.04
1981	27968	14899	27791.30	0.27	4098	1504.8	1.37	0.05

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
1982	26870	14237	26701.20	0.26	2945	1399.4	1.29	0.05
1983	26106	13829	25855.40	0.25	2352	1089.6	1.43	0.04
1984	24866	13174	24680.80	0.24	2598	1636.2	1.52	0.07
1985	23634	12506	23472.50	0.22	3272	1647.0	1.39	0.07
1986	22565	11889	22386.30	0.21	1379	1511.5	1.53	0.07
1987	21605	11293	21418.30	0.20	2154	1440.7	1.55	0.07
1988	20911	10860	20805.80	0.19	2496	1187.5	1.55	0.06
1989	19873	10276	19723.80	0.18	2899	1499.6	1.50	0.08
1990	18655	9600	18484.30	0.17	2561	1709.4	1.41	0.09
1991	17939	9162	17751.80	0.16	2890	1246.5	1.37	0.07
1992	16895	8524	16724.40	0.15	778	1608.6	1.28	0.10
1993	15854	7844	15697.80	0.14	994	1639.2	1.30	0.10
1994	14972	7326	14912.90	0.13	3068	1447.3	1.17	0.10
1995	14260	6937	14161.80	0.12	2024	1223.1	0.50	0.09
1996	13809	6735	13625.70	0.12	1006	962.6	0.76	0.07
1997	13467	6581	13349.80	0.12	1029	877.9	0.49	0.07
1998	13225	6475	13156.10	0.12	1988	726.7	0.44	0.06
1999	12918	6320	12827.00	0.11	5212	747.2	0.41	0.06

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
2000	12802	6239	12616.40	0.11	5099	577.6	0.22	0.05
2001	13226	6382	12889.40	0.11	2402	149.5	0.23	0.01
2002	13697	6470	13406.90	0.12	1448	276.2	0.38	0.02
2003	14344	6623	14202.60	0.12	544	156.1	0.40	0.01
2004	14955	6828	14870.00	0.12	2382	137.7	0.41	0.01
2005	15509	7115	15441.50	0.13	2514	128.8	0.40	0.01
2006	16065	7521	15907.60	0.14	1451	66.5	0.16	0.00
2007	16603	7974	16453.90	0.14	1505	74.5	0.15	0.00
2008	17125	8344	16925.80	0.15	48465	137.5	0.14	0.01
2009	18052	8589	17248.10	0.15	9731	150.8	0.10	0.01
2010	20036	8719	17491.60	0.16	3848	168.4	0.11	0.01
2011	23634	8817	23065.10	0.16	14688	160.9	0.09	0.01
2012	27110	9021	26699.30	0.16	2574	60.4	0.97	0.00
2013	30798	10051	29969.80	0.18	29963	58.8	0.97	0.00
2014	34891	11807	34321.00	0.21	2279	57.2	0.97	0.00
2015	39107	14162	37585.20	0.25	3756	45.6	0.97	0.00
2016	43737	16713	43560.00	0.30	4228	60.2	0.97	0.00
2017	47589	18909	47331.80	0.34	4583	57.6	0.97	0.00

Table 19: Time-series of population estimates from the base model.

Year	Total biomass (mt)	Spawning output (million eggs) (mt)	Summary biomass 3+	Relative biomass	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation r
2018	49797	20169	49511.20	0.36	4773	-	-	-
2019	51393	21186	51086.60	0.38	4921	-	-	-
2020	52413	22238	52094.30	0.40	5067	-	-	-
2021	52921	23473	52592.50	0.42	5233	-	-	-
2022	53010	24463	52671.40	0.44	5360	-	-	-
2023	52785	24949	52436.90	0.45	5421	-	-	-
2024	52349	25060	51993.00	0.45	5435	-	-	-
2025	51781	24883	51422.00	0.45	5413	-	-	-
2026	51140	24888	50781.00	0.45	5413	-	-	-
2027	50467	24916	50108.50	0.45	5417	-	-	-
2028	49786	24850	49427.90	0.45	5409	-	-	-

tab:Timeseries_mod1

Table 18: 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 20: 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

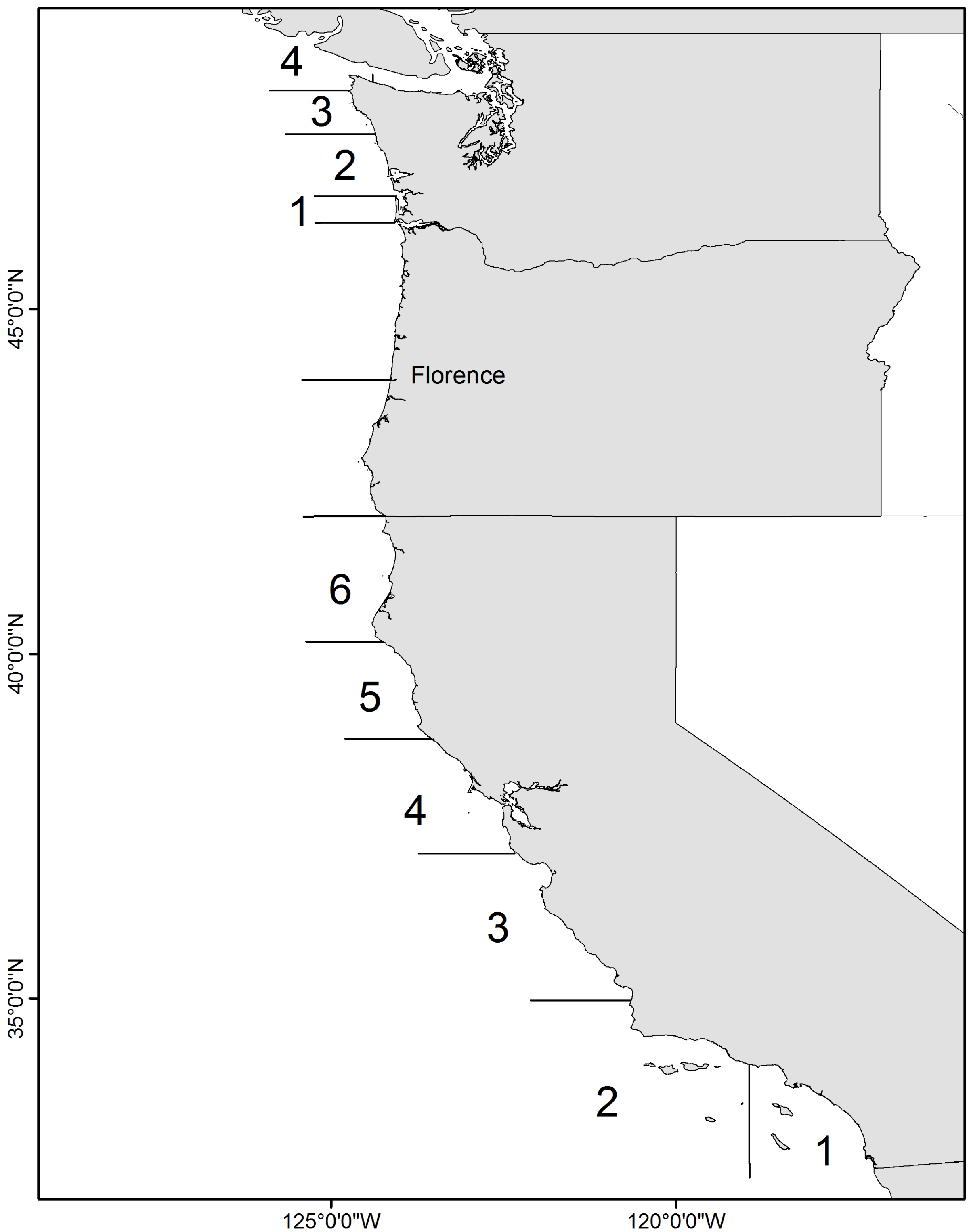


Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. fig:boundary_map

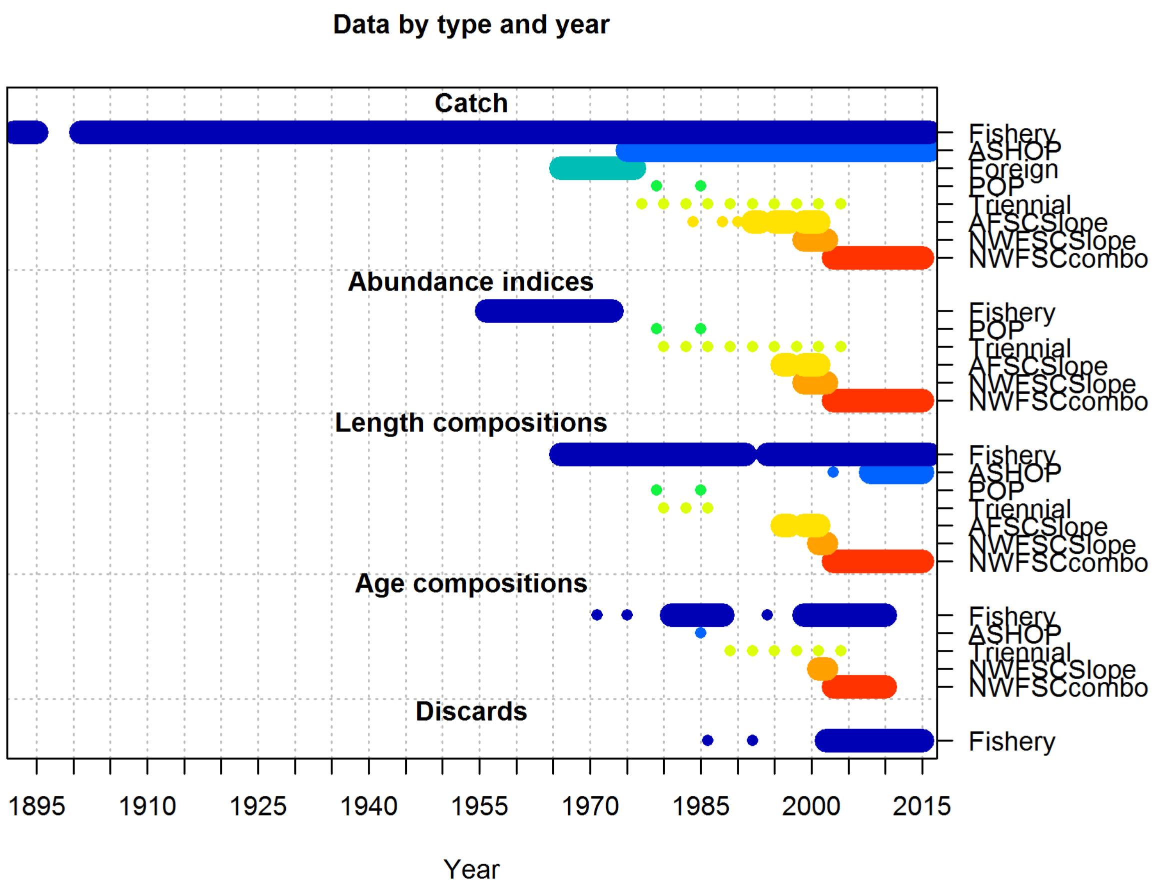


Figure 2: Summary of data sources used in the Base model. fig:data_plot

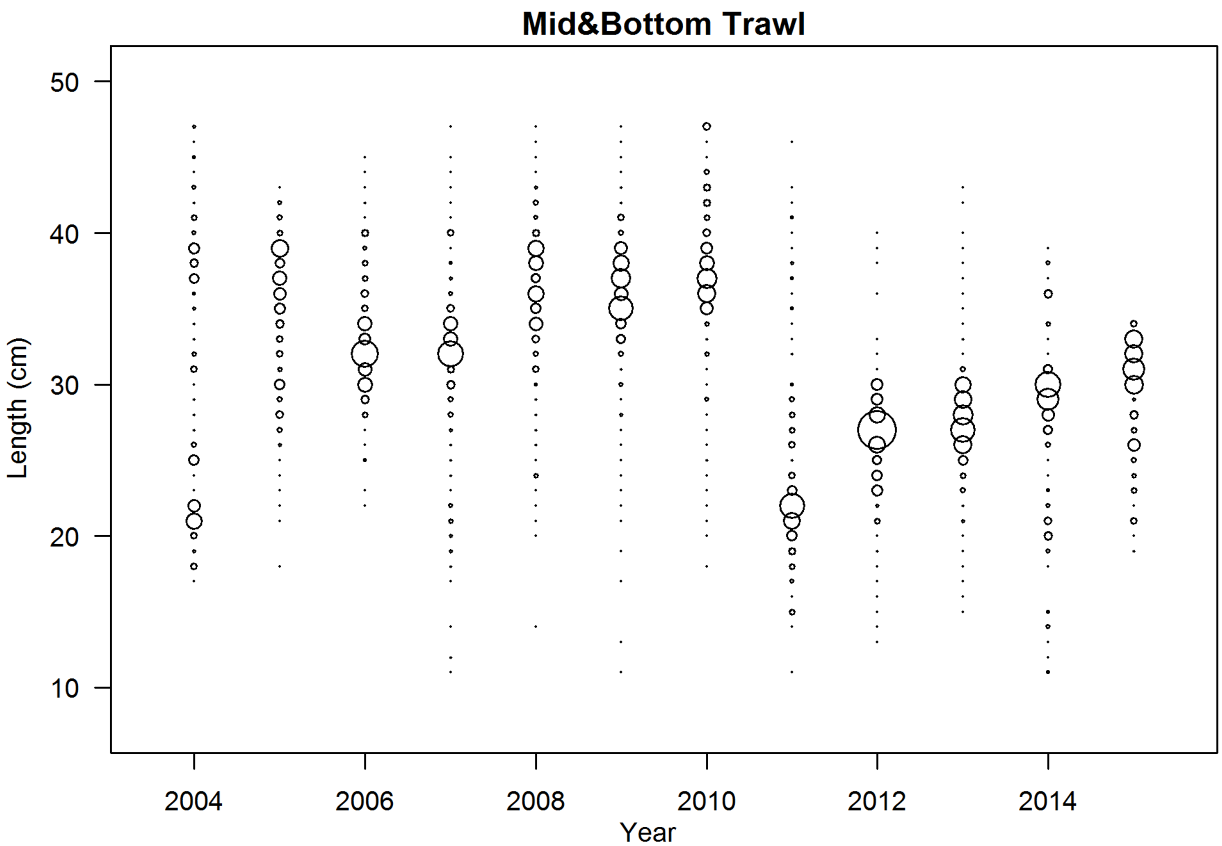
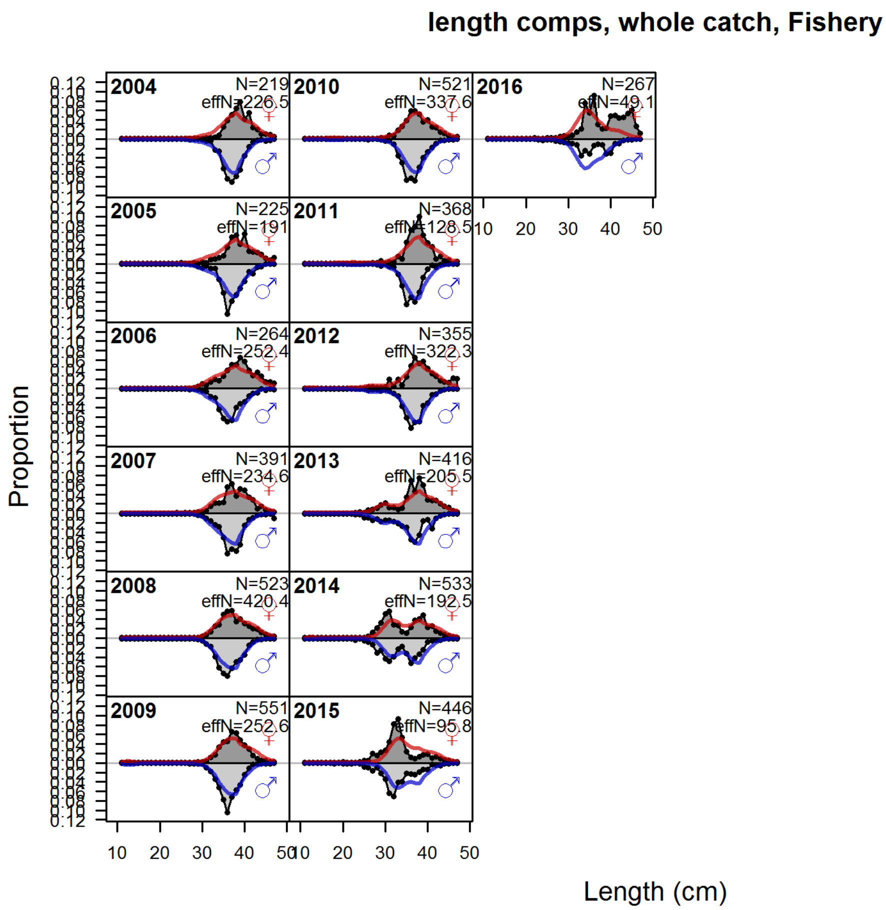


Figure 3: Discard length frequency distributions from the WCGOP for Pacific ocean perch. fig:WCGOP_dis



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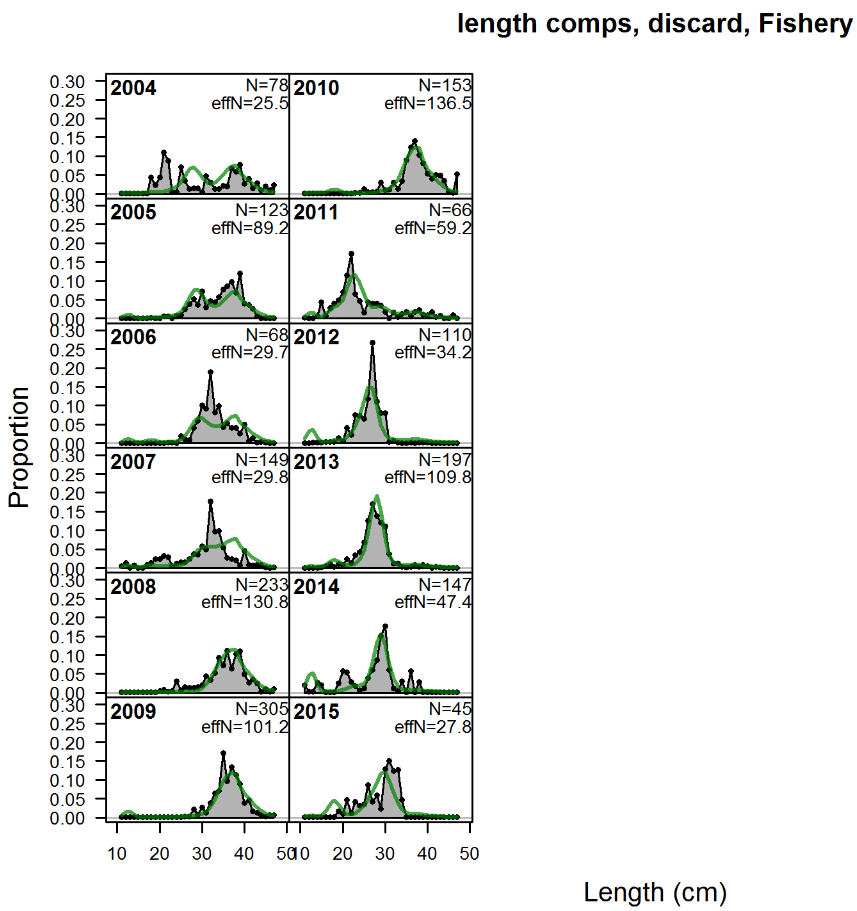


Figure 4: length comps, discard, Fishery fig:mod1_1_comp_lenfit_flt1mkt1

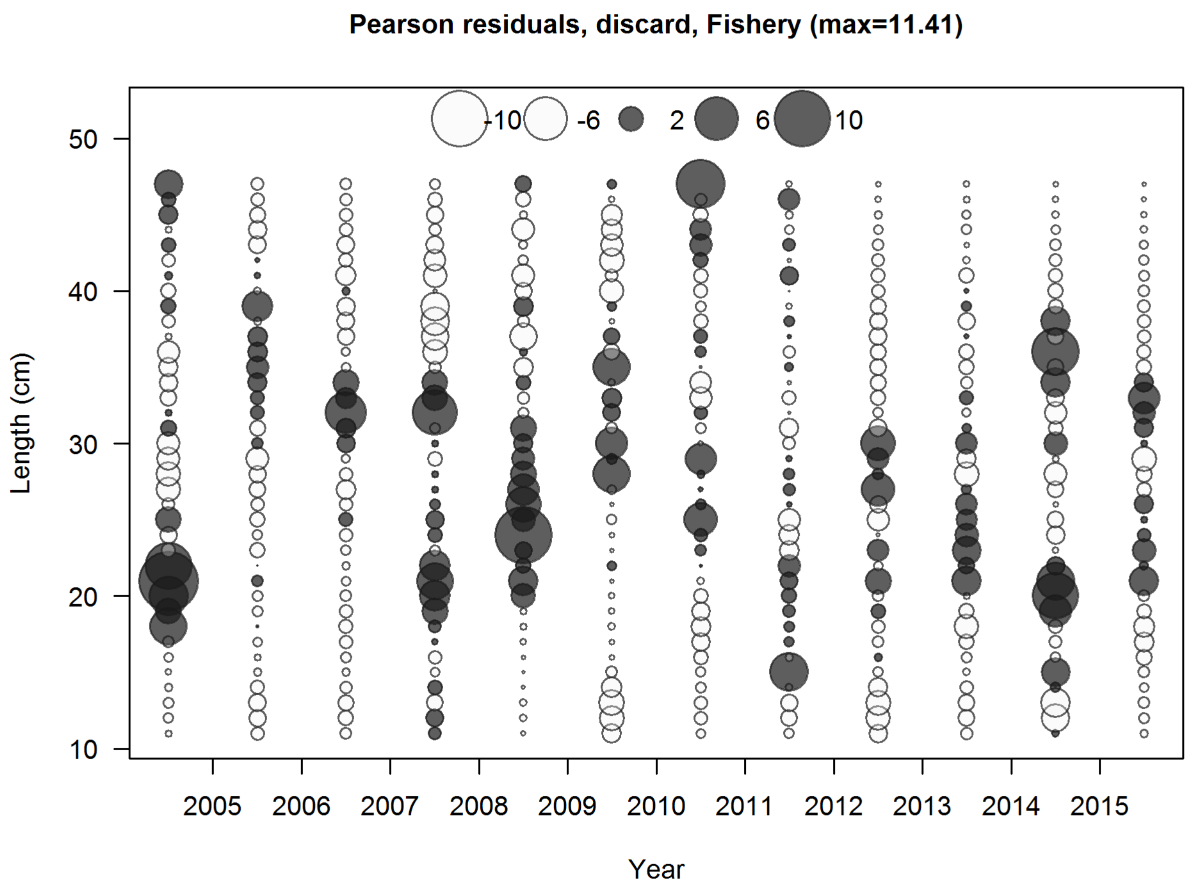


Figure 5: Pearson residuals, discard, Fishery (max=11.41)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_2_comp_lenfit_residsflt1mkt1

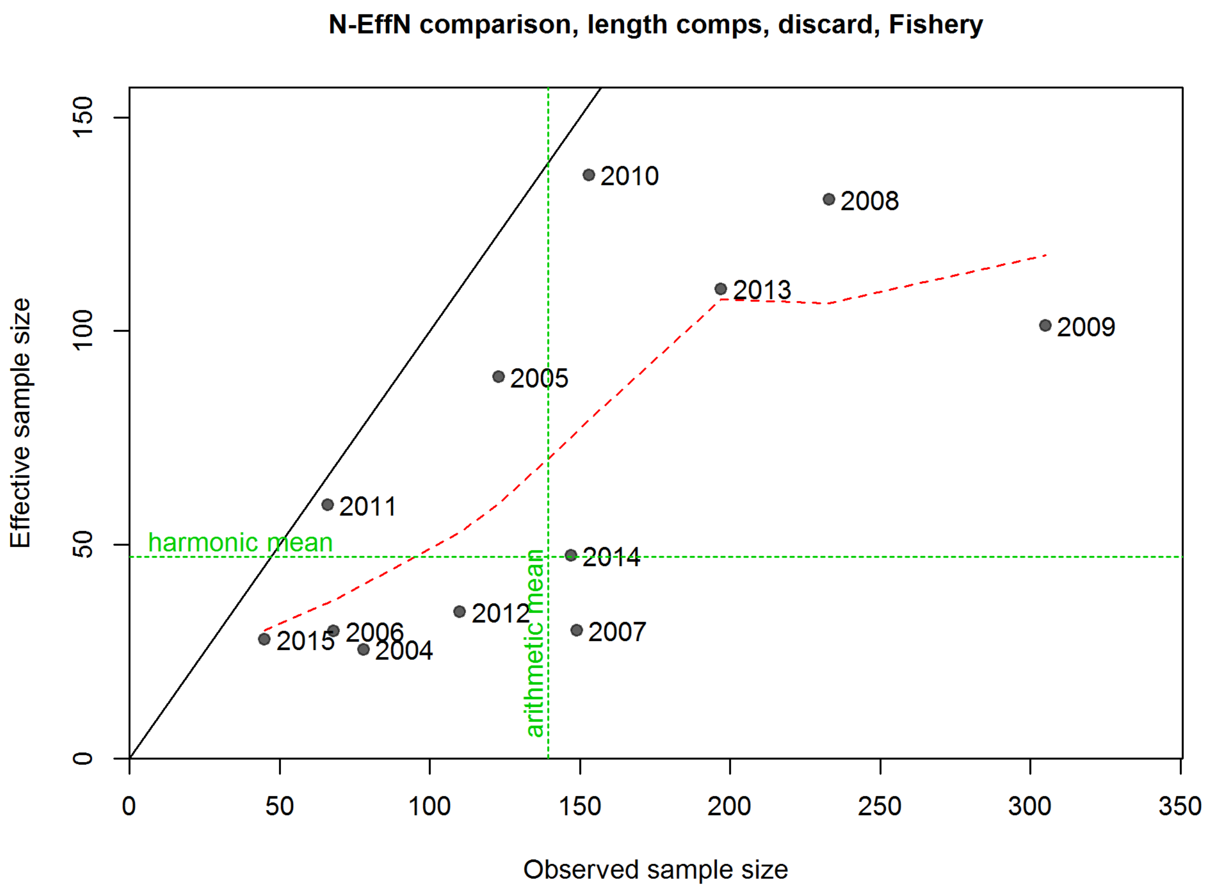


Figure 6: N_EffN comparison, length comps, discard, Fishery fig:mod1_3_comp_lenfit_sam

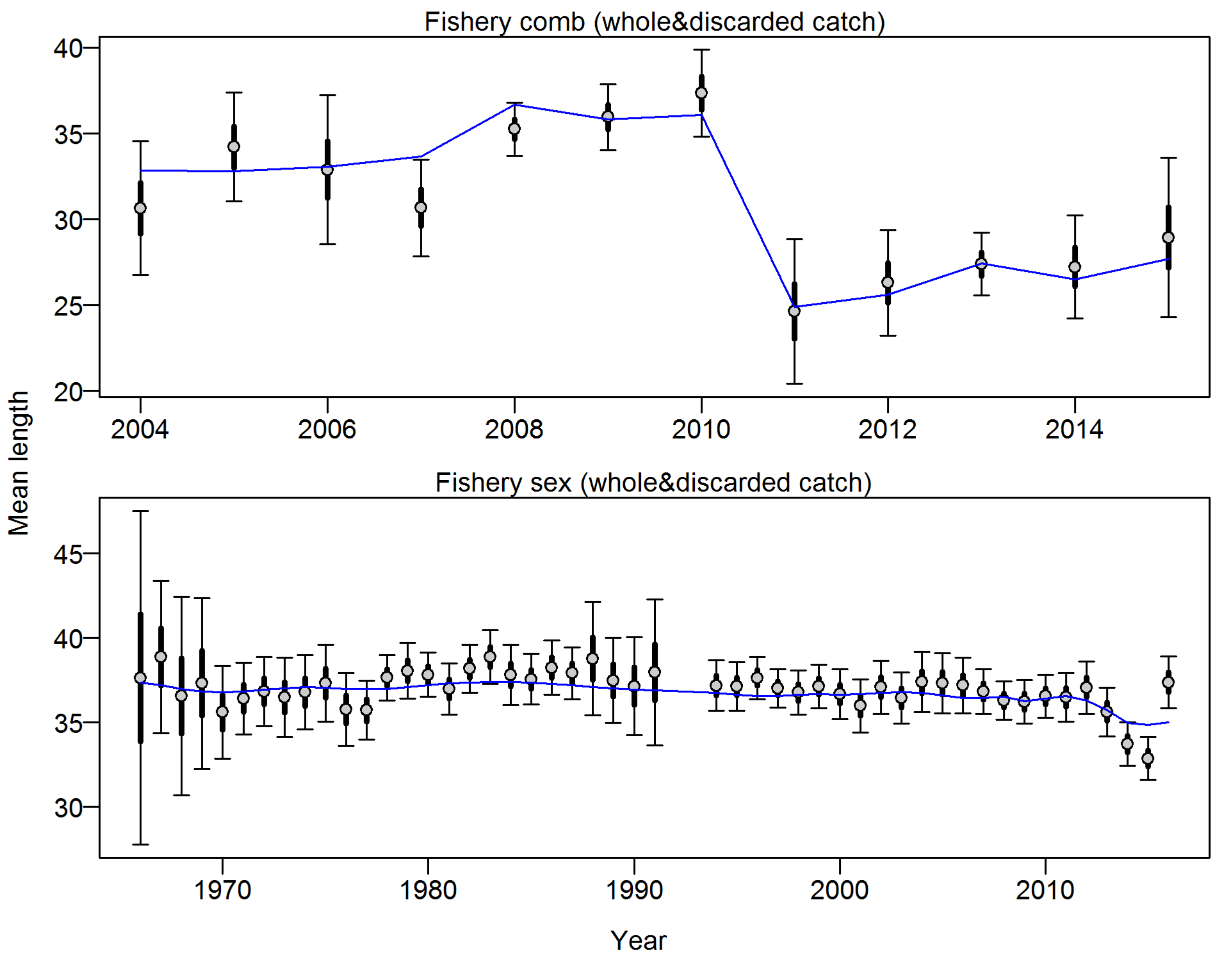


Figure 7: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.146 (0.0961_0.2603) fig:mod1_4_comp_lenfit_data_weigh

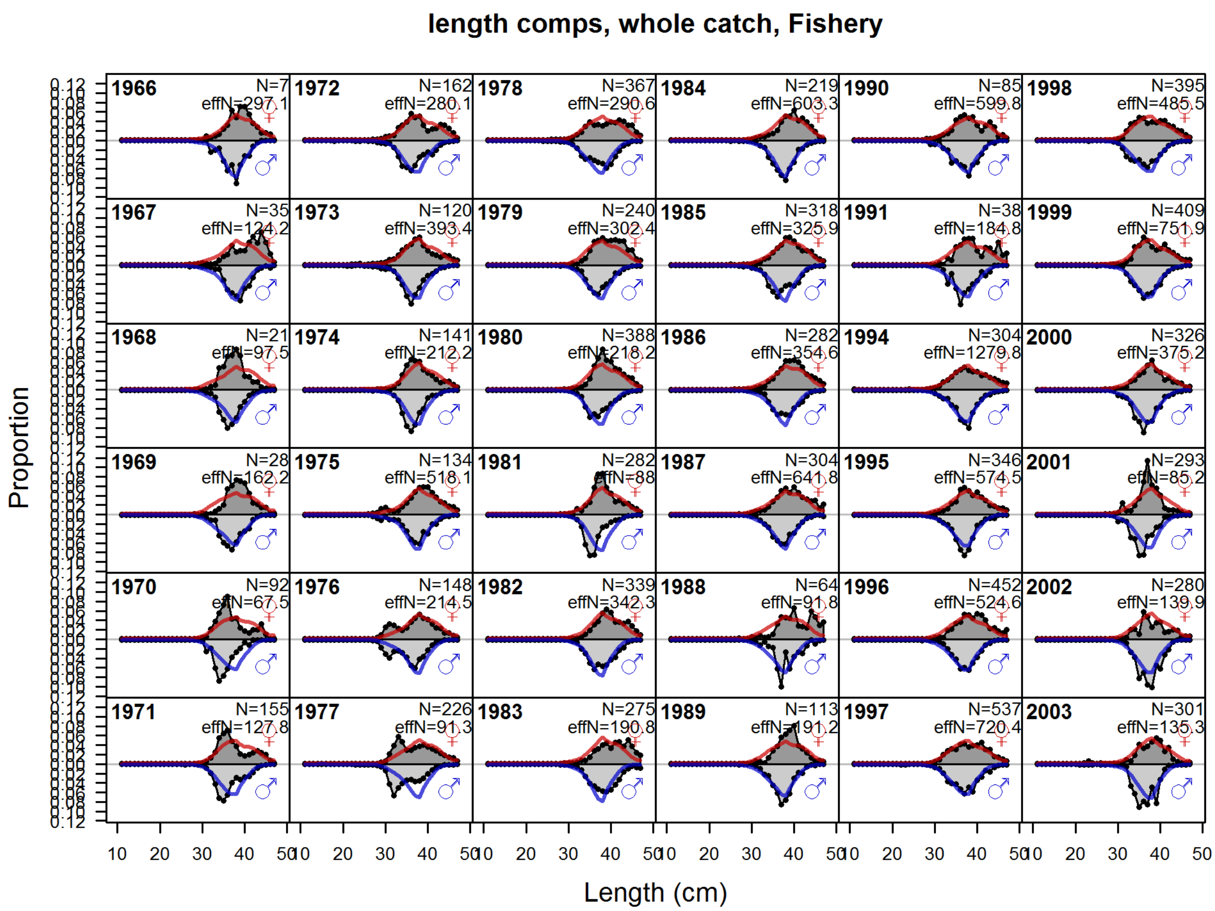
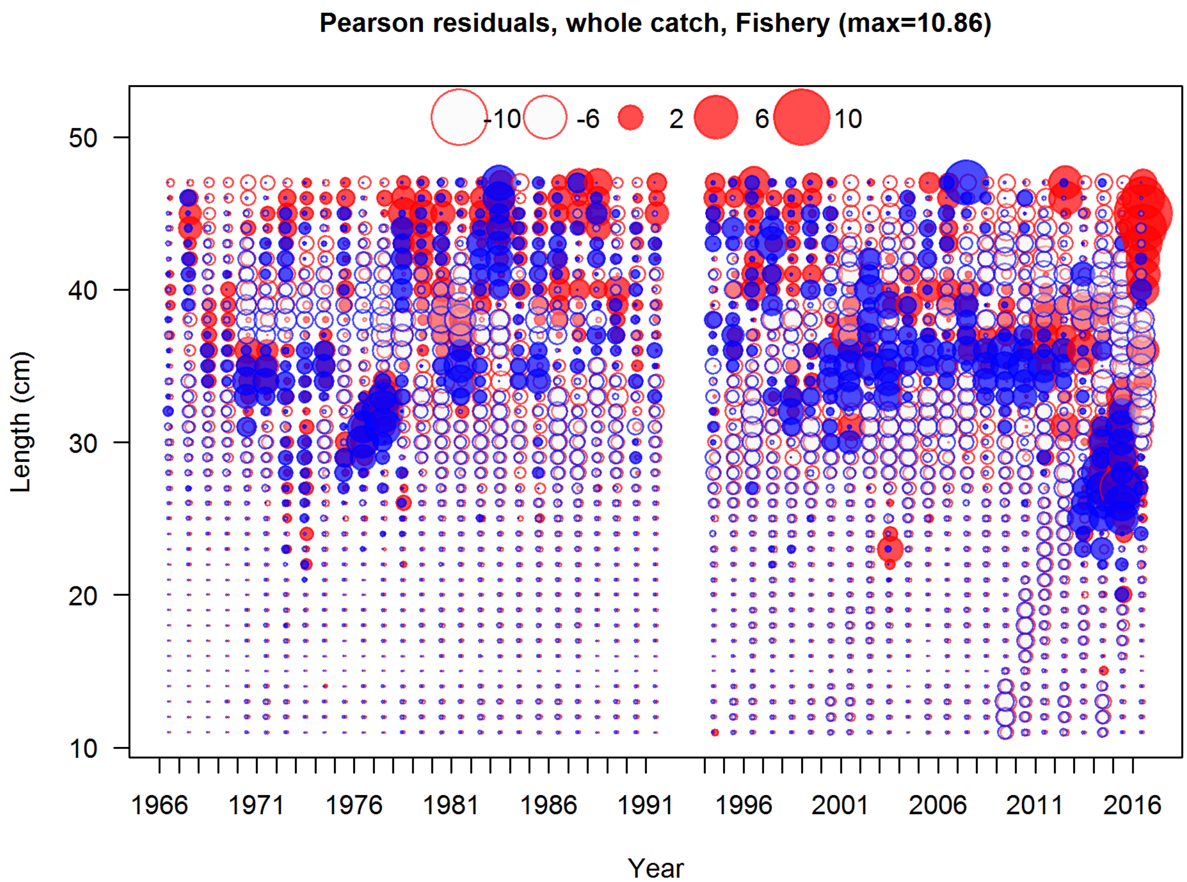


Figure 8: length comps, whole catch, Fishery (plot 1 of 2) fig:mod1_5_comp_lenfit_flt1m



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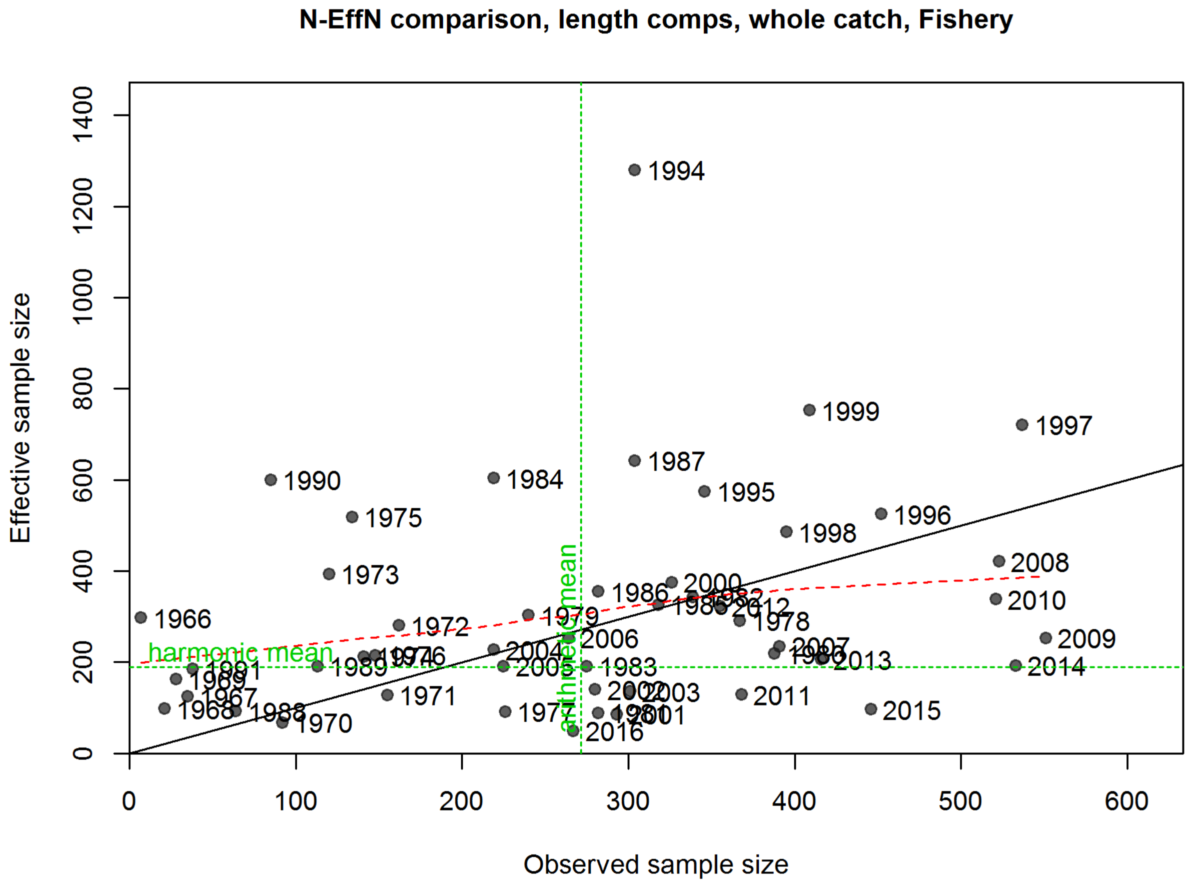

Figure 9: N_EffN comparison, length comps, whole catch, Fishery fig:mod1_8_comp_lenfit_s

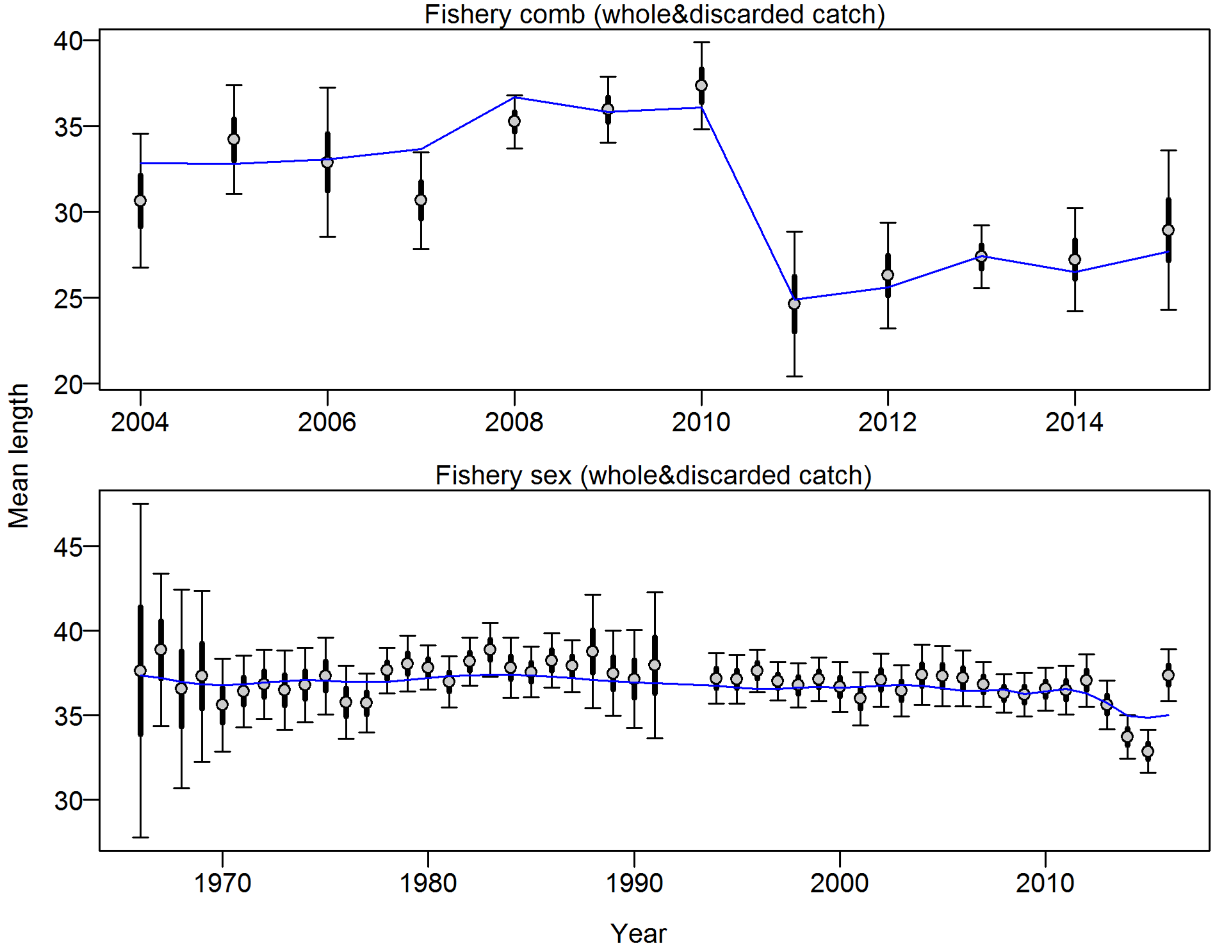

Figure 10: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.146 (0.0944_0.2631) fig:mod1_9_comp_lenfit_data_weigh

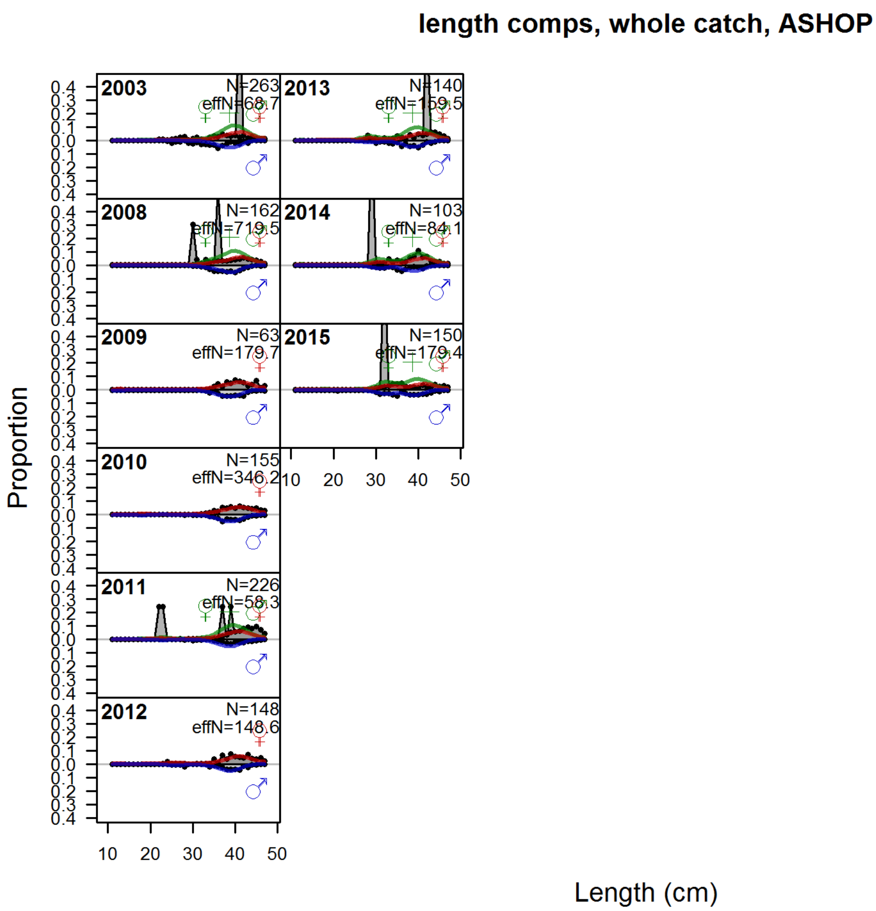

Figure 11: length comps, whole catch, ASHOP fig:mod1_10_comp_lenfit_flt2mkt0

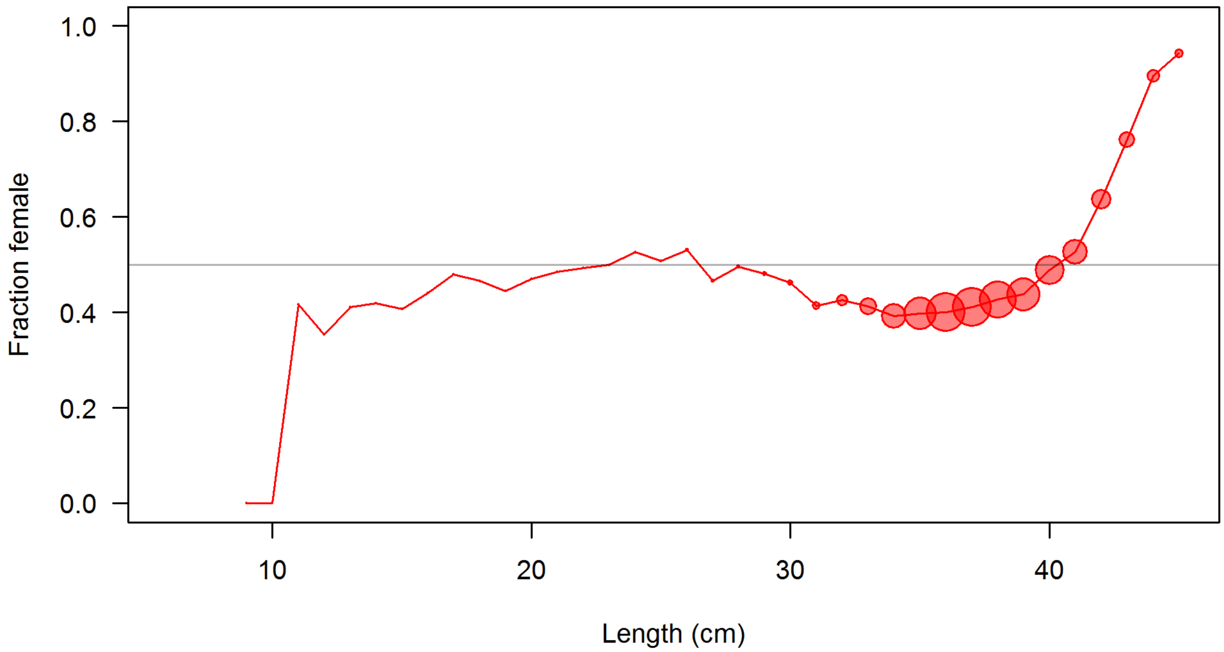

Figure 12: The estimated sex ratio of Pacific ocean perch at length from all biological data sources. fig:sexratio

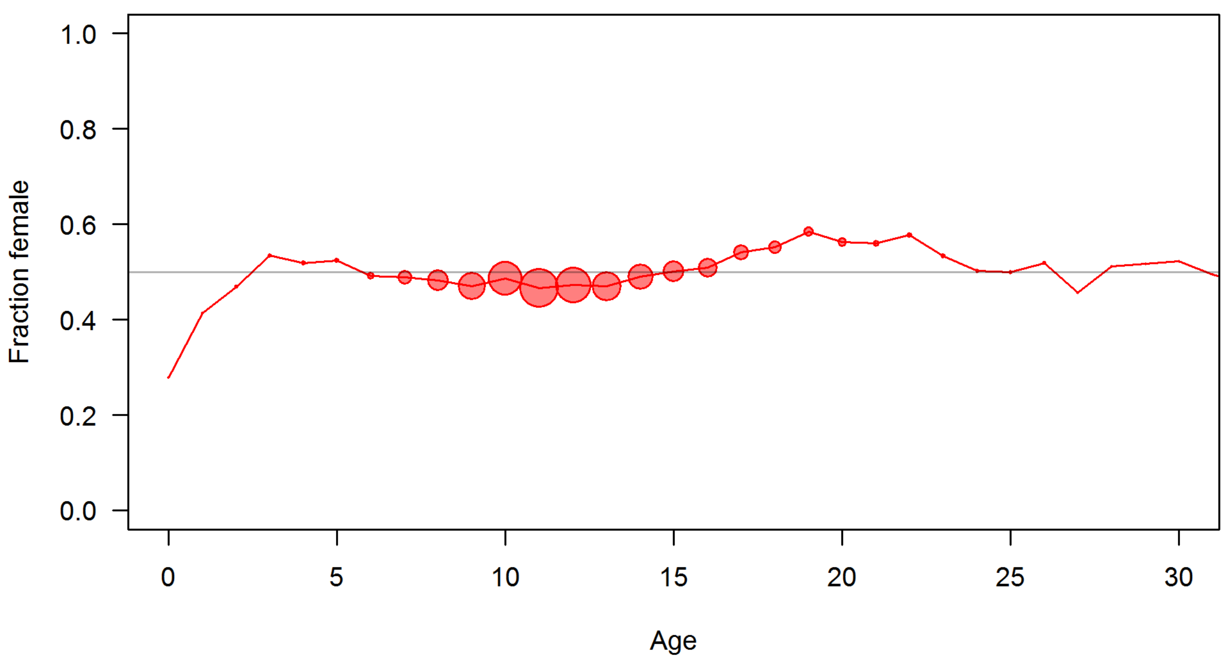

Figure 13: The estimated sex ratio of Pacific ocean perch at age from all biological data sources. fig:sexratio_Age

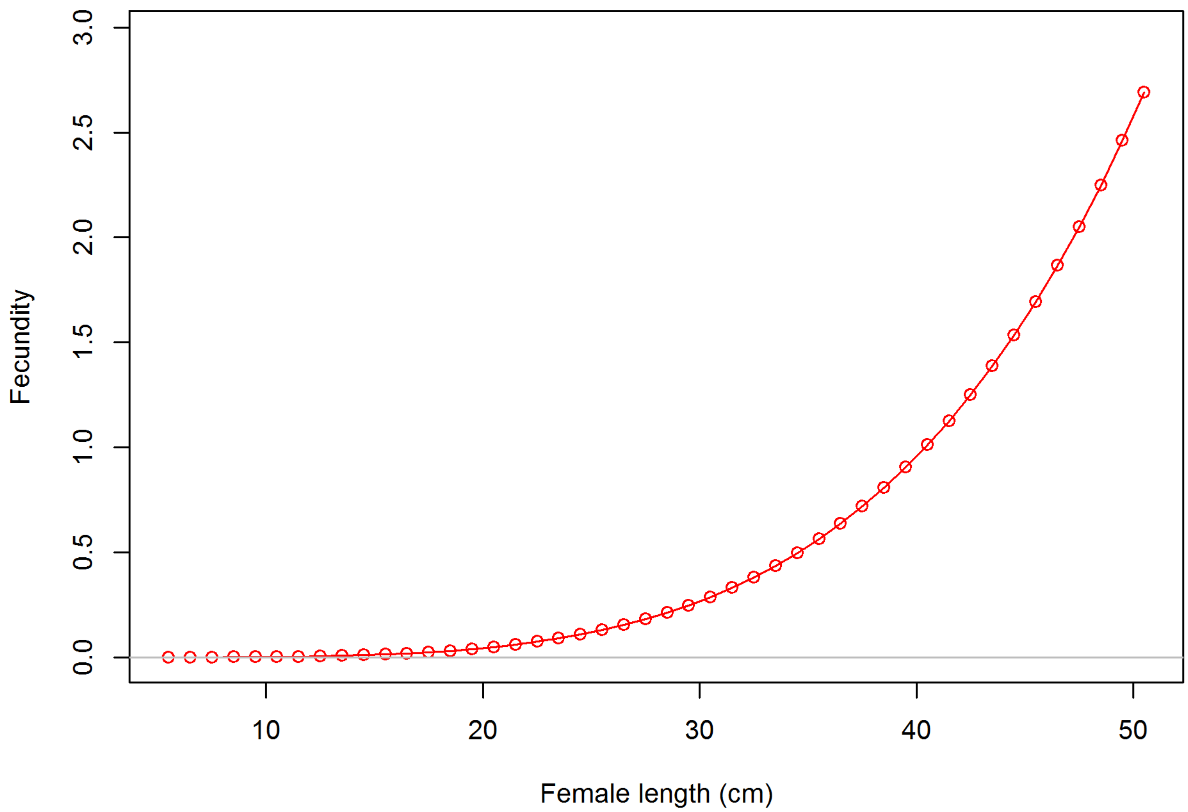

Figure 14: Fecundity at length of Pacific ocean perch in the Base model. fig:fecundity

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

References

references

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