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

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DRAFT SAFE

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???

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 primarly 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	2.72	97.17
2010	0.14	58.00	22.29	16.87	1.68	98.98
2011	0.12	30.26	19.66	9.17	1.94	61.14
2012	0.18	30.41	21.79	4.52	1.62	58.51
2013	0.08	34.86	14.83	5.41	1.71	56.89
2014	0.18	33.92	15.82	3.92	0.57	54.41
2015	0.12	38.12	11.41	8.71	1.59	59.95
2016	0.19	34.15	13.12	10.30	3.10	60.85

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 1918 to 2017, and forecasted beyond 2017.

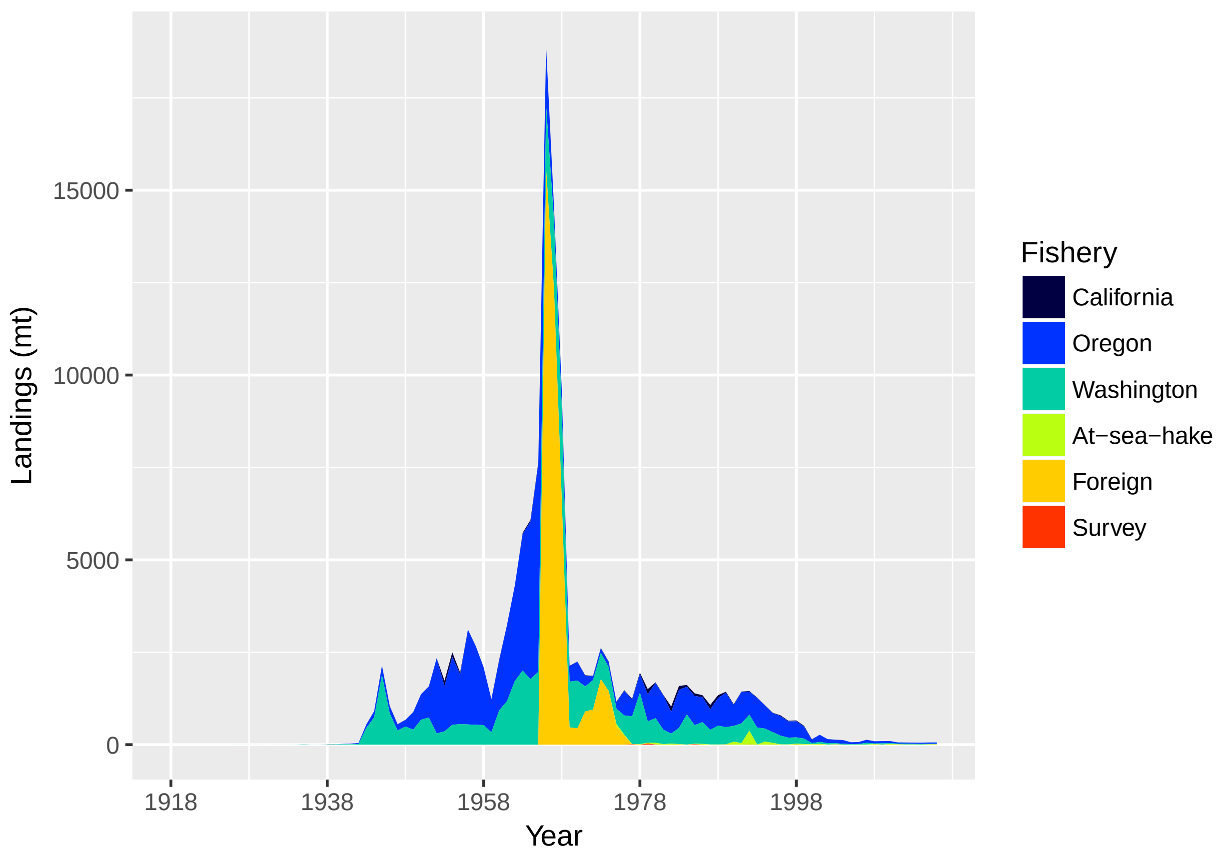

Figure a: Landings of Pacific ocean perch for California, Oregon, Washington, the Foriegn fishery (1966-1976), At-Sea Hake fishery, and fishery independent surveys. fig:Exec_catch1

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 50.2% (~95% asymptotic interval: ± 25.7%-74.7%) (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	1923.00	397 - 3449	0.32	0.149 - 0.481
2009	2006.00	418 - 3595	0.33	0.156 - 0.501
2010	2063.00	431 - 3695	0.34	0.161 - 0.514
2011	2102.00	440 - 3764	0.34	0.164 - 0.524
2012	2133.00	451 - 3815	0.35	0.167 - 0.531
2013	2161.00	462 - 3860	0.35	0.170 - 0.537
2014	2251.00	492 - 4009	0.37	0.179 - 0.557
2015	2492.00	568 - 4416	0.41	0.203 - 0.612
2016	2802.00	662 - 4943	0.46	0.232 - 0.685
2017	3068.00	742 - 5394	0.50	0.257 - 0.747

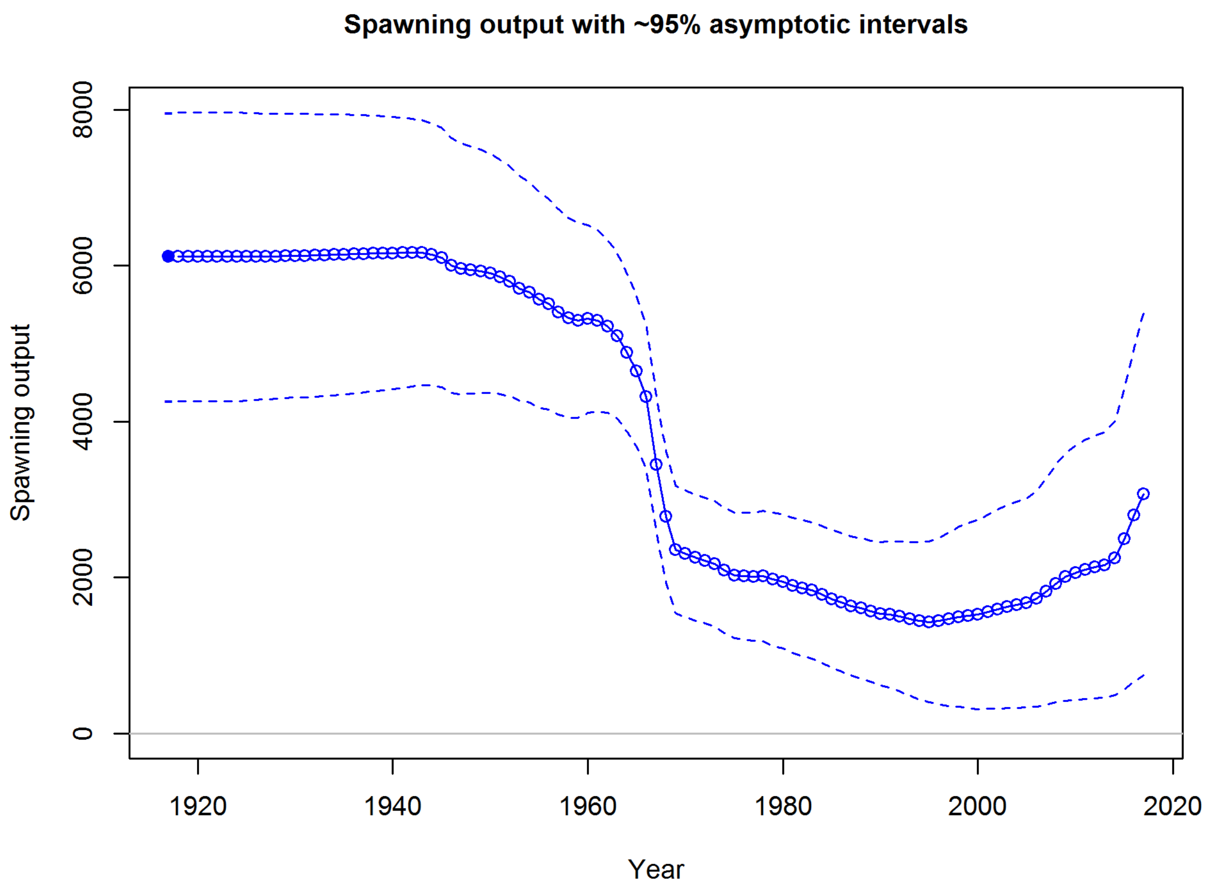

Figure b: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

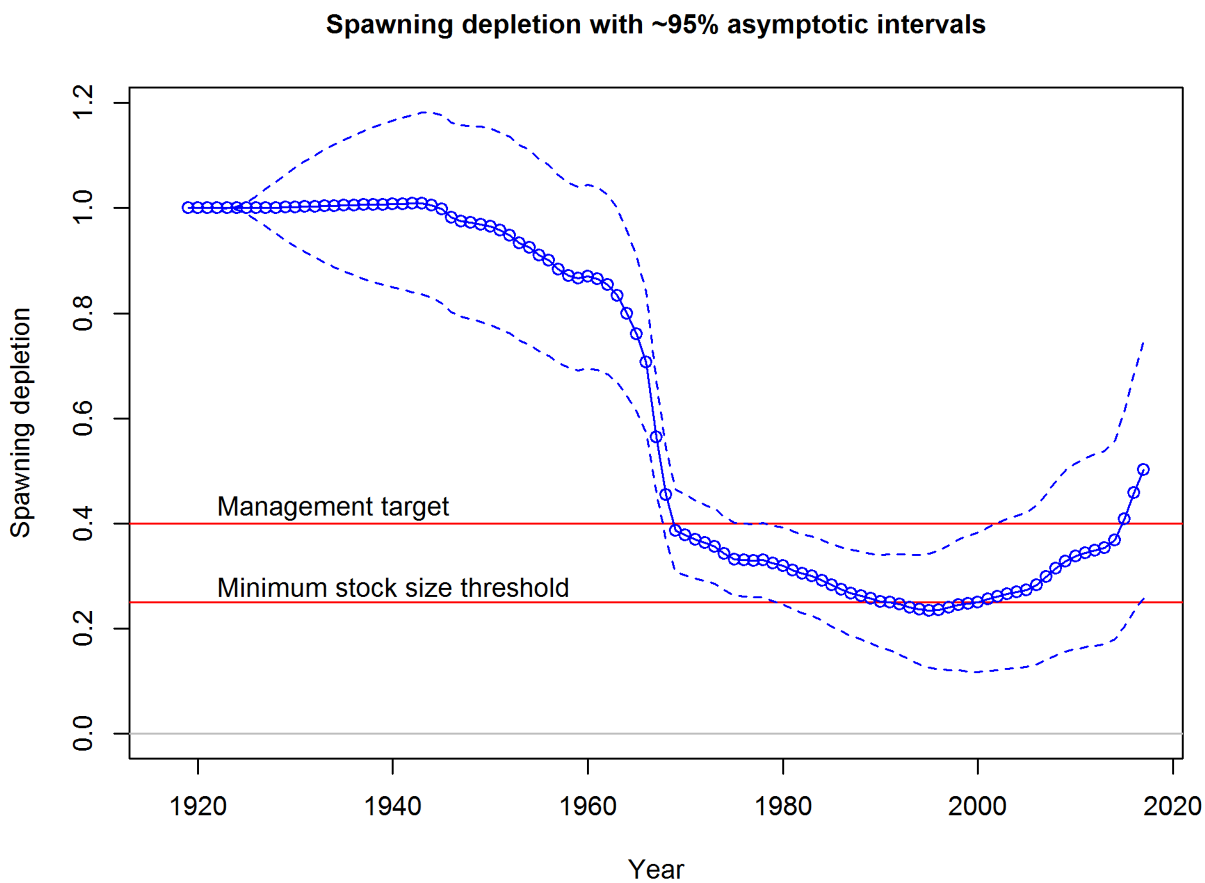

Figure c: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

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	83174.00	40153 - 172291	2.74	2.426 - 3.055
2009	3101.00	1222 - 7869	-0.59	-1.355 - 0.164
2010	4762.00	2060 - 11009	-0.20	-0.807 - 0.401
2011	8909.00	3966 - 20013	0.39	-0.168 - 0.954
2012	1669.00	656 - 4243	-1.31	-2.096 - -0.524
2013	20055.00	8632 - 46595	1.15	0.519 - 1.780
2014	3349.00	1113 - 10074	-0.68	-1.741 - 0.372
2015	7032.00	1880 - 26304	-0.00	-1.373 - 1.365
2016	7562.00	2027 - 28205	0.00	-1.372 - 1.372
2017	7952.00	2827 - 22372	0.00	-0.970 - 0.970

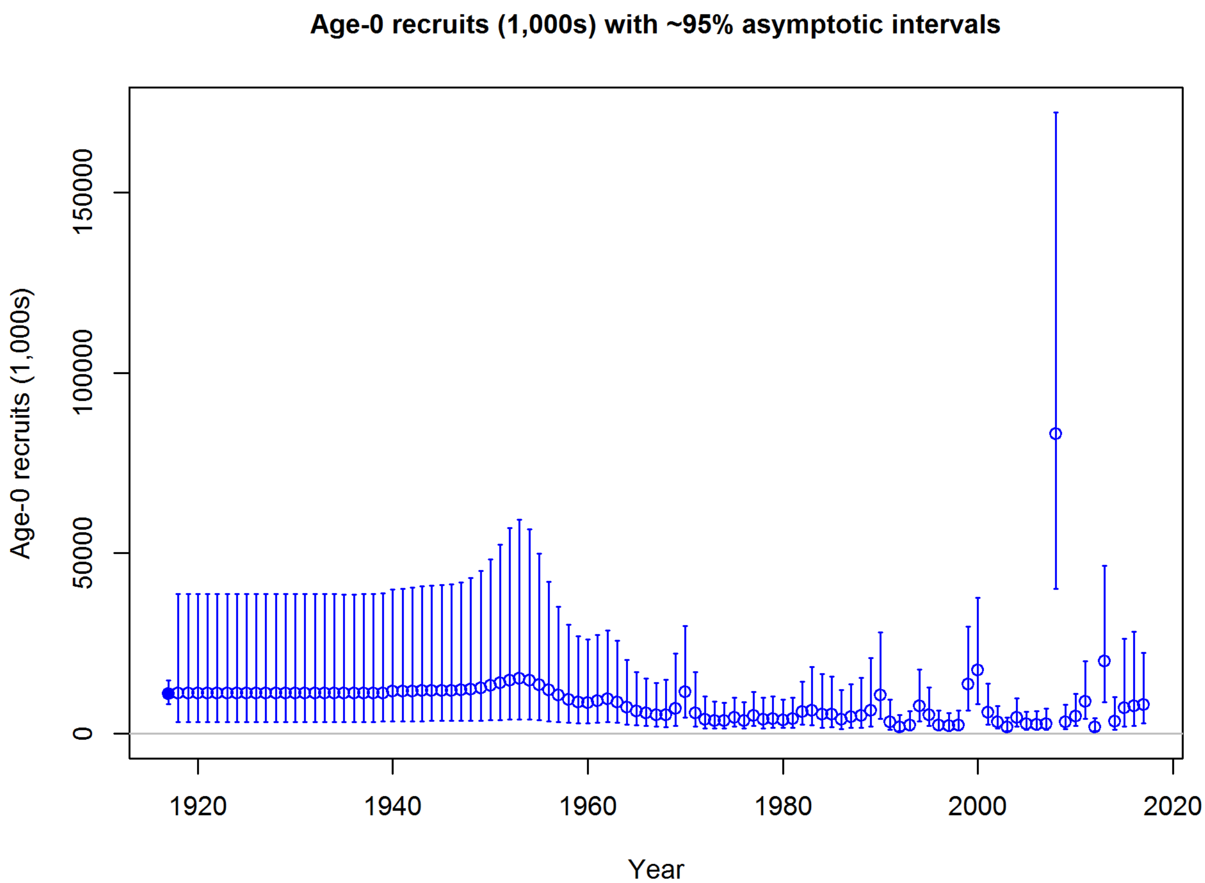

Figure d: Time series of estimated Pacific ocean perch recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

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	0.168	0.046 - 0.291	0.004	0.001 - 0.006
2008	0.139	0.035 - 0.244	0.003	0.001 - 0.005
2009	0.186	0.046 - 0.325	0.004	0.001 - 0.008
2010	0.175	0.044 - 0.305	0.004	0.001 - 0.007
2011	0.061	0.015 - 0.108	0.001	0.000 - 0.002
2012	0.057	0.014 - 0.101	0.001	0.000 - 0.002
2013	0.054	0.013 - 0.095	0.001	0.000 - 0.002
2014	0.048	0.012 - 0.084	0.001	0.000 - 0.001
2015	0.047	0.012 - 0.082	0.001	0.000 - 0.001
2016	0.043	0.011 - 0.075	0.001	0.000 - 0.001

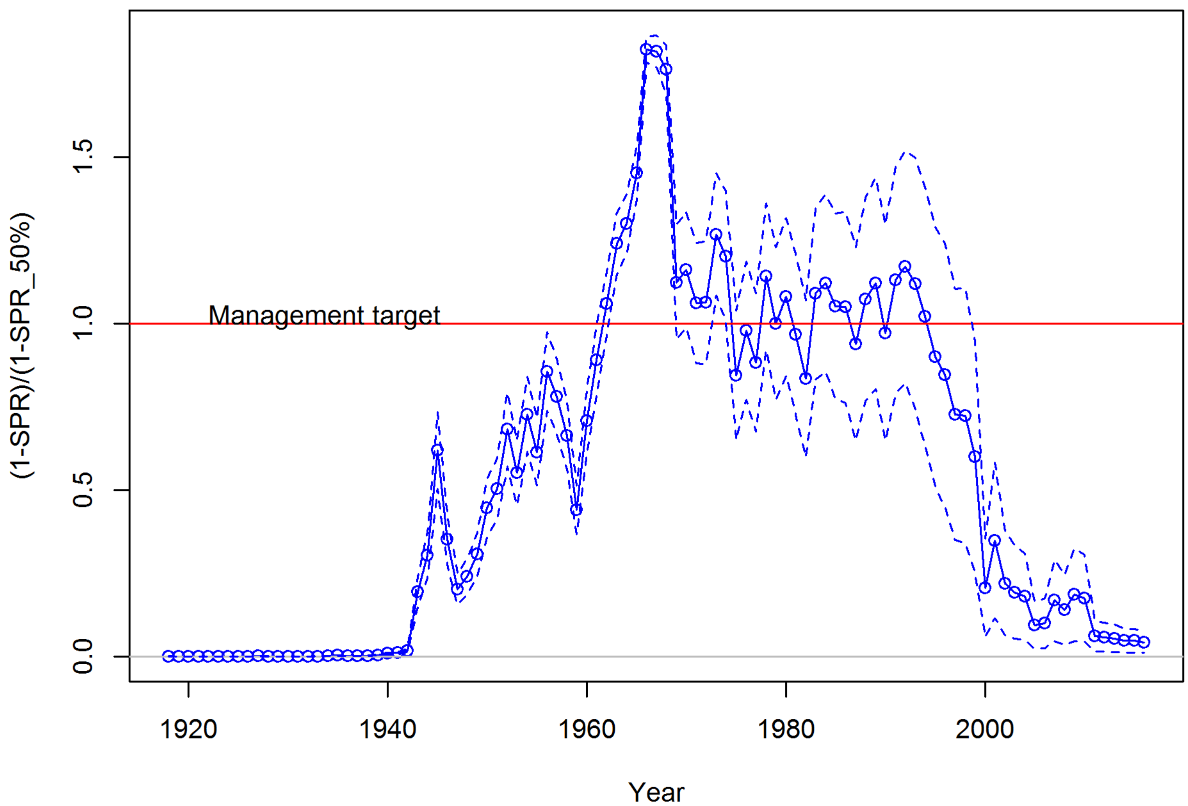

Figure e: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing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

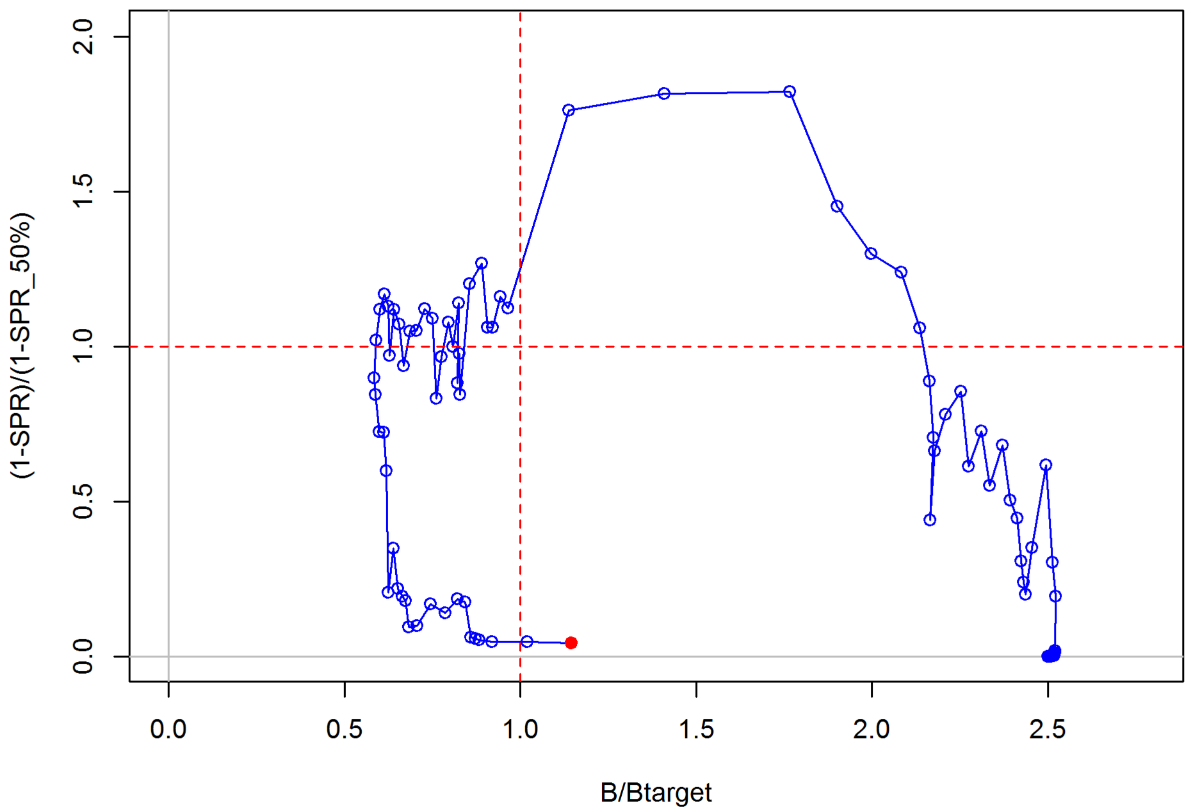

Figure f: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. fig:Phase_all

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 above the biomass target, but above the minimum stock size threshold. Add sentence about spawning output trend. The estimated relative depletion level for Model 1 in 2017 is 50.2% (˜95% asymptotic interval: ± 25.7%-74.7%, corresponding to an unfished spawning output of 3068 million eggs (˜95% asymptotic interval: 742.049538465854-5393.71046153415 million eggs) of spawning output in the base model (Table e). Unfished age 3+ biomass was estimated to be 130420 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 2445.2 million eggs, which gives a catch of 1208.4 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 987.1 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)	6113	4262.3 - 7963.7
Unfished age 3+ biomass (mt)	130420	93173.4 - 167666.6
Unfished recruitment (R0, thousands)	10912	8103 - 14694.8
Spawning output(2017 million eggs)	3067.9	742 - 5393.7
Depletion (2017)	0.502	0.257 - 0.747
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	2445.2	1704.9 - 3185.5
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.625	0.625 - 0.625
Exploitation rate resulting in $B_{40\%}$	0.021	0.021 - 0.022
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	1208.4	861.3 - 1555.4
Reference points based on SPR proxy for MSY		
Spawning output	1222.6	852.5 - 1592.7
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.033	0.033 - 0.034
Yield with SPR_{proxy} at SB_{SPR} (mt)	987.1	703.5 - 1270.8
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	2386.5	1665.2 - 3107.8
SPR_{MSY}	0.619	0.617 - 0.621
Exploitation rate at MSY	0.022	0.022 - 0.022
MSY (mt)	1208.8	861.6 - 1556

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	900	-	150	134	158
2008	911	-	150	92	134
2009	1160	-	189	97	193
2010	1173	-	200	99	183
2011	1026	981	180	61	61
2012	1007	962	183	59	59
2013	844	807	150	57	58
2014	838	801	153	54	55
2015	842	805	158	60	60
2016	850	813	164	61	60

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}`

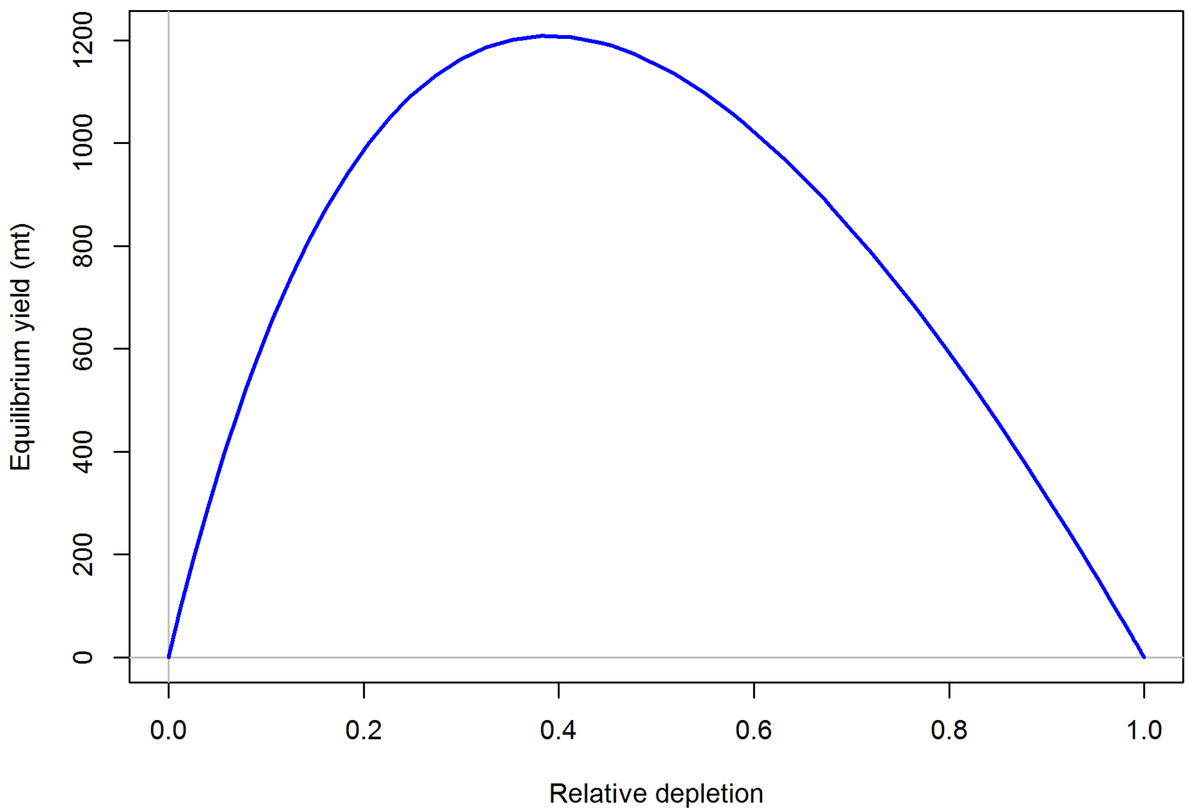

Figure g: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at... fig:Yield_all

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	2605	2491	3068	0.502
2018	2685	2566	3162	0.517
2019	2707	2588	3208	0.525
2020	2693	2575	3238	0.530
2021	2660	2543	3250	0.532
2022	2615	2500	3239	0.530
2023	2564	2452	3211	0.525
2024	2512	2402	3175	0.519
2025	2462	2354	3134	0.513
2026	2416	2310	3091	0.506
2027	2374	2269	3047	0.499
2028	2335	2232	3004	0.491

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)	911	1160	1173	1026	1007	844	838	842	850	964
Total Est. Catch (mt)	150	189	200	180	183	150	153	158	164	281
OFL (mt)	92	97	99	61	59	57	54	60	61	
ACL (mt)	134	193	183	61	59	58	55	60	60	
(1-SPR)(1-$SPR_{50\%}$)	0.14	0.19	0.17	0.06	0.06	0.05	0.05	0.05	0.04	
Exploitation rate	0	0	0	0	0	0	0	0	0	
Age 3+ biomass (mt)	45099.4	45600.5	45811.6	54233.7	58517.9	62792.3	67111.2	70349.9	74728.5	77555.4
Spawning Output	1923	2006	2063	2102	2133	2161	2251	2492	2802	3068
95% CI	397 - 3449	418 - 3595	431 - 3695	440 - 3764	451 - 3815	462 - 3860	492 - 4009	568 - 4416	662 - 4943	742 - 5394
Depletion	0.315	0.328	0.337	0.344	0.349	0.354	0.368	0.408	0.458	0.502
95% CI	0.149 - 0.481	0.156 - 0.501	0.161 - 0.514	0.164 - 0.524	0.167 - 0.531	0.170 - 0.537	0.179 - 0.557	0.203 - 0.612	0.232 - 0.685	0.257 - 0.747
Recruits	83174	3101	4762	8909	1669	20055	3349	7032	7562	7952
95% CI	40153 - 172291	1222 - 7869	2060 - 11009	3966 - 20013	656 - 4243	8632 - 46595	1113 - 10074	1880 - 26304	2027 - 28205	2827 - 22372

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 US 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 fishery-indepenent surveys.

Prior to 1966, the Pacific ocean perch resource off of the northern portion of the US 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 (Table 1 and Figure 1).

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, US 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 2016 (Table 2).

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 off 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 Summary of Management History

summary-of-management-history

The landings of Pacific ocean perch have been historically governed by harvest guidelines and trip limits, while recently management is imposed with total catch harvest limits in the form of overfishing limits (OFLs), acceptable biological catches (ABCs), and annual catch limits (ACLs). A trawl rationalization program, consisting of an individual fishing quota (IFQ) or catch shares system was implemented in 2011 for the limited entry trawl fleet targeting non-whiting groundfish, including Pacific ocean perch, and the trawl fleet targeting and delivering whiting to shore-based processors. The limited entry at-sea trawl sectors (motherships and catch-processors) that target whiting and process at sea are managed in a system of harvest cooperatives.

Limits onPacific ocean perch were first established in 1983 (Table 3). These were implemented as area closures, trip limits, and cumulative landing limits. In 1999, Pacific ocean perch was declared overfished with the assessment estimating the spawning output below the management limit (25% of virgin biomass). In reaction to the overfished decleration, harvest limits were reduced relative to previous years and a rebuilding plan was implemented in 2001.

1.3 Fisheries off Canada and Alaska

fisheries-off-canada-and-alaska

Pacific ocean perch can be found in waters off the US west coast and northward through Alaskan waters. In contrast the Pacific ocean perch stock off the US west coast, each assessed portion of the stock in Canada and Alaskan waters are estimated to be above management targets. The subset of the stock off the US west coast represents the tail of the species distribution with little to no Pacific ocean perch being encountered south of northern California. Pacific ocean perch are harvested both in Canada and Alaska. The most recent updated assessments for the Bering Sea and the Gulf of Alaska stocks determined that neither stock are in an overfished state and recommended and acceptable biological catch of 43,723 mt and 23,918 mt, respectively, for 2017.

In Canadian waters Pacific ocean perch has the largest single-species quota, accounting for approximately 25% of all rockfish landings by weight in the bottom trawl fleet. The Canadian Pacific ocean perch stock is broken into three seperate areas that are individually assessed. The status of the stock within each area are above Canadian management targets.

2 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 Fishery-Independent Data:

fishery-independent-data

2.1.1 Northwest Fisheries Science Center (NWFSC) shelf-slope survey

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 (approximately 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 spatio-temporal delta-generalized linear mixed model (VAST 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 smallest Pacific ocean perch tend to occur in the shallower depths (< 200 m) with only larger individuals occurring at depths deeper than 300 m. Data collected by the NWFSC Shelf-Slope survey between depths of 55 - 549 m and north of 42° and south of 49° were stratified to generate an index of abundance from 2003-2016. The estimated index of abundance is shown in Table 4. The lognormal distribution with random strata-year and vessel effects had the lowest AIC and was chosen as the final model. The Q-Q plot does not show any departures from the assumed distribution (Figure 3). The indices for the NWFSC shelf-slope survey show a tentative decline in the population between 2003 and 2009, with an increasing trend in biomass between the 2009 and 2016 median point estimates.

Length, age, and conditional age-at-length compositions were expanded based upon the stratification. The number of tows with length data ranged from 33 in 2006 to 69 in 2015 (Table 5) where ages were collected for Pacific ocean perch in nearly every tow (Table 6). The expanded length frequencies from this survey show an increase in small fish starting in 2010 (Figure 4). The age frequencies provide clear evidence of large year-classes moving through the population from the 1999, 2000, and 2008 recruitment; with early indications of a large 2013 recruitment (Figure 5).

The effective sample sizes for length and marginal age composition data for all fishery-independet surveys were calculated according to Stewart & Hamel (2014) which determined that the approximate realized sample size for shelf/slope rockfish species was $2.43{*}N_{\text{tow}}$. The effective sample size of conditional-age-at-length data was set at the number of fish at each length by year.

2.1.2 Northwest Fisheries Science Center (NWFSC) slope survey

`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 between 1999 and 2002. Tows conducted between the depths of 183 and 549 m were used to create an index of abundance using the VAST delta-GLMM model. The estimated index of abundance is show in Table 4. The lognormal distribution with random strata-year had the lowest AIC and was chosen as the final model. The Q-Q plot does not show any departures from the assumed distribution (Figure XXXX). } The trend of abundance across the four surveys years was generally flat with high estimated annual variance.

Length and age compositions were available for 2001 and 2002 and were expanded based upon the survey stratification (Tables 7 and 8. The expanded length frequencies from this survey shows that primarily only large fish were captured both years (Figure 6). The majority of fish observed by this survey were aged at greater than 10 years (Figure 7).

2.1.3 Alaska Fisheries Science Center (AFSC) slope survey

`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 (Table 9). 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.

An index of abundance was estimated based on the data using the VAST delta-GLMM model. The estimated index of abundance is shown in Table 4. The lognormal distribution with random strata-year had the lowest AIC and was chosen as the final model. The Q-Q plot does not show any departures from the assumed distribution (Figure 8). The trend in the indices was generally flat over time.

Length compositions were available for each year the survey was conducted. No age data were available from this survey. The expanded length frequencies from this survey were generally of larger fish ($>$ 30 cm), expect for 1997 where the highest frequency of fish were between 20 and 30 cm for both females and males (Figure 9).

2.1.4 Triennial Bottom Trawl Survey

`triennial-bottom-trawl-survey`

The triennial survey was first conducted by the AFSC in 1977 and spanned the time-frame 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. The survey design has changed slightly over the period of time. 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.

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 data was examined for varying distribution of length and/or ages of fish based upon the shift in survey timing and little evidence was found of ontogenetic shifts in Pacific ocean perch during the summer months.Pacific ocean perch are rarely encountered south of 40^{c}irc where the change in southern range of the survey would have no impact on data collected regarding Pacific ocean perch. Given these factors the Triennial survey was analyzed as a single time-series a departure from how the previous assessment which split the time-series into and an early (1980-1992) and a late period (1995-2004).

An index of abundance was estimated based on the data using the VAST delta-GLMM model. The estimated index of abundance is shown in Table 4. The lognormal distribution with random strata-year had the lowest AIC and was chosen as the final model. The Q-Q plot does not show any departures from the assumed distribution (Figure 10). The index shows a decline in abundance in the early years of the time-series and abundance remaining flat for the latter years.

Length and age compositions were expanded based upon the stratification. The number of tows with length data ranged from 17 in 1986 to 81 in 1998 10. Ages were read using surface reading methods until 1989 when the break-and-burn method replaced surface reads as the best method to age Pacific ocean perch. Unfortunately, surface reading of Pacific ocean perch otoliths results in significant underestimates of age. Due to this, these otolith were excluded from analysis. The available ages from the Triennial survey and the number of tows where otoliths were collected are shown in Table 11. The expanded length frequencies from this survey show an increase in small fish starting in 1995 (Figure 11). The age frequencies provide clear evidence of large year-classes moving through the population from the 1999 and 2000 recruitment (Figure 12).

2.1.5 Pacific ocean perch Survey

pacific-ocean-perch-survey

A survey targeted designed to sample Pacific ocean perch was conducted in 1979 and again in 1985 (for a detailed description see (Ianelli et al. 1992). An index of abundance was estimated based on the data using the VAST delta-GLMM model. The estimated index of abundance is shown in Table 4. The lognormal distribution with random strata-year had the lowest AIC and was chosen as the final model. The Q-Q plot does not show any departures from the assumed distribution (Figure 13). The index shows a clear decline in abundance between the two survey years.

Length and age compositions were expanded based on the stratification. The survey had 125 and 126 Pacific ocean perch tows (Table 12) and ages were only available in 1985 due to surface reads for the 1979 data (Table 13). The length frequencies for both years are highest between the 30-45 cm range (Figure 14) with ages in 1985 having a large number of fish age 40 and greater (Figure 15).

2.2 Fishery-Dependent Data

fishery-dependent-data

2.2.1 Commercial Fishery Landings

commercial-fishery-landings

Washington

Historical commercial fishery landings 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 May 2, 2017}, 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 catches 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 directly from John Field at the SWFSC due to database issues for the historical period for 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 May 2, 2017, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org).

At-Sea Hake 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 Catches

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.

2.2.2 Discards

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 14.

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 14 shows the discard ratios (discarded/(discarded + retained)) of Pacific ocean perch from the WCGOP. Since 2011, when the trawl rationalization program 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. Coeffienct of variations were calculated by bootstrapping vessels within ports because the observer program randomly chooses vessels within porats to be observed in the non-catch shares sectors. Discard length composition for the trawl fleet varied by year, with larger fish being discarded prior to 2011 (Figure 16).

2.2.3 Historical Commercial Catch-per-unit effort

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 (Table 15, 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.

2.2.4 Fishery Length And Age Data

fishery-length-and-age-data

Biological data from commercial fisheries that caught Pacific ocean perch were extracted from PacFIN (PFSMFC) on XXXX. Lengths taken during port sampling in Oregon and Washington were used to calculate length and age compositions. There were no biological data for Pacific ocean perch available within PacFIN. The overwhelming majority of these data were collected from the mid-water and bottom trawl gear, but additional biological data were collected from non-trawl gear which was grouped together with trawl gear data. Tables 16 and 17 show the number of trips and fish sampled, along with the calculated sample sizes. Length and age data were acquired at the trip level, and then aggregated to the state level. The sample sizes were calculated via the Stewart Method (Ian Stewart, pers. Comm.) which for commercial fishery data is:

$$\text{Input effN} = N_{\text{trips}} + 0.138 * N_{\text{fish}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is} < 44$$

$$\text{Input effN} = 7.06 * N_{\text{trips}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is} \geq 44$$

2.3 Biological Data

biological-data

2.3.1 Natural mortality

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 mortality 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 development of the prior where median for female natural mortality was 0.054.

2.3.2 Sex ratio, maturation, and fecundity

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 (Figures 19 and 20), 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 (Figure 21). Comparison between the maturity-at-age used in the previous assessment and the updated functional maturity-at-length is shown in Figure 22.

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 estimated equal to $0L^{4.98}$ in millions of eggs. Spawning output at length is shown in Figure 23.

2.3.3 Length-weight relationship

`length-weight-relationship`

The length-weight relationship for Pacific ocean perch was estimated outside the model using all biological data available from fishery and fishery-independent data sources where the female weight-at-length in grams was estimated at $0.0000104L^{3.09}$ and males at $0.0000105L^{3.08}$ where L is length in cm (Figures 24 and 25).

2.3.4 Growth (length-at-age)

`growth-length-at-age`

The length-at-age was estimated for male and female Pacific ocean perch using data collected from both fishery-dependent and -independent data sources that were collected from 1981-2016. Figure 26 shows the lengths and ages for all years and all data as well as predicted von Bertalanffy fits to the data. Females grow larger than males and sex specific growth parameters were estimated at the following values:

$$\text{Females } L_\infty = 42.32;\ k = 0.169;\ t_0 = \text{-}1.466$$

$$\text{Males } L_\infty = 39.03;\ k = 0.212;\ t_0 = \text{-}1.02$$

2.3.5 Ageing Precision And Bias

`ageing-precision-and-bias`

Uncertainty surrounding the ageing-error process for Pacific ocean perch was incorporated by estimating ageing error by age. Age-composition data used in the model were from break-and-burn otolith reads aged by the Cooperative Ageing Project (CAP) in Newport, Oregon. Break-and-burn double reads of more than 1500 otoliths were provided by the CAP lab. An ageing error estimate was made based on these double reads using a computational tool specifically developed for estimating ageing error (Punt et al. 2008), and using release 1.0.0 of the R package nwfscAgeingError (Thorson et al. 2012) for input and output diagnostics, publicly available at: https://github.com/nwfsc-assess/nwfscAgeingError. A non-linear standard error was estimated by age where there is more variability in the estimated age of older fish was estimated (Table 20, Figure 27).

2.4 History Of Modeling Approaches Used For This Stock

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

2.4.1 Previous Assessments

`previous-assessments`

The status of Pacific ocean perch off British Columbia, Washington, and Oregon have been periodically assessed since the intensive exploitation that occured in the 1960s. Concerns regarding Pacific ocean perch status off the coast the US west coast were raised in the late 1970s (Gunderson 1978, Gunderson (1981)) and in 1981 the PFMC adopted a 20-year plan to rebuild the stock.

The 1992 assessment determined that Pacific ocean perch remained at low levels relative to the population size in 1960 (Ianelli et al. 1992) and recommended additional harvest restrictions to allow for stock rebuilding. The 1998 assessment (Ianelli and Zimmermann 1998) estimated that the stock was 13% of the unfished level, leading the National Marine Fishery Service (NMFS) to declare the stock overfished in 1999. The formal rebuilding plan was implemented in 2001. The rebuilding plan reduced the SPR harvest rate used to determine catches to 0.864, relative to the PFMC rockfish default harvest (SPR = 0.50). The last full assessment of Pacific ocean perch was conducted in 2011 (Hamel and Ono 2011) which concluded that the stock was still well below the target biomass of $0.40SB_0$ estimating the relative stock status at 19.1%.

2.4.2 Previous Assessment Recommendations

`previous-assessment-recommendations`

Recommendation: Considering trans-boundary stock effects should be pursued. In particular the consequences of having spawning contributions from external stock components should be evaluated relative to the steepness estimates obtained in the present assessment (see more complete discussion of this recommendation under the Unresolved Problems and Major Uncertainties section, above).

STAT response: The STAT team agrees that this should be an ongoing area of research and collaboration between the US and Canada. This assessment presents a sensitivity where the inclusion of Canadian data are included within the model.

Recommendation:The benefits of adopting the complex model used this year should be evaluated relative to simpler assumptions and models. While the transition from the simpler old model to Stock Synthesis was shown to be similar for the historical period, the depletion estimates in the most recent years were different enough to warrant further investigation.

STAT response: This assessment was performed in Stock Synthesis, an integrated model, which can be modified to either simple or complex structural forms based upon the available data and the processes being modeled. There were not addtional explorations of alternative modeling platforms.

Recommendation:Discard estimates from observer programs should be presented, reviewed (similar to the catch reconstructions), and be made available to the assessment process.

STAT response: This assessment uses discard rates and discard lengths collected by the WCGOP from 2003-2015.

Recommendation:The ability to allow different "plus groups" for specific data types should be evaluated (and implemented in Stock Synthesis). For example, this would provide the ability to use the biased surface-aged data in an appropriate way.

STAT response: Additional research needs to completed which evaluates the amount of bias and imprecision in surface-read ages. Evaluating avaiable surface-read ages within the PacFIN database fish of lengths between 23-44 cm can be aged at 10 years old. This large range of lengths at the same age indicates considerable bias in ages for fish surface-read younger aged fish.

Recommendation:Historical catch reconstruction estimates should be formally reviewed prior to being used in assessments and should be coordinated so that interactions between stocks are appropriately treated. The relative reliability of the catch estimates over time could provide an axis of uncertainty in future assessments.

STAT response: California and Oregon have ungone extensive work to create historical catch reconstructions. This is the first assessment for Pacific ocean perch which includes a Washington historical catch reconstruction. The data used in this assessment represent Washington state's current best estimate for historical catches. Both California and Washington are conducting research to estimate uncertainty surround historical catches which could be used to propegate uncertainty within the assessment.

3 Assessment

`assessment`

3.1 General Model Specifications and Assumptions

`general-model-specifications-and-assumptions`

Stock Synthesis v3.30.01.12 was used to estimate the parameters in the model. R4SS, revision 1.26.0, along with R version 3.3.2 were used to investigate and plot model fits. A summary of the data sources used in the model (details discussed above) is shown in Figure 2.

Stock Synthesis has many options when setting up a model and the assessment model for Pacific ocean perch was set up in the following manner.

3.1.1 Changes between the 2011 assessment model and current model

`changes-between-the-2011-assessment-model-and-current-model`

The current model for Pacific ocean perch has many made many similar assumptions to the 2011 assessment but differs in some key ways. This assessment disaggrated the fleets into a trawl/other gear, at-sea hake, historical foreign fleet, and research fleets. The previous assessment implemented a single fleet where removal from all sources were aggregated together. The seperating of fleets applied in this assessment allowed for differing assumptions regarding current and historical discarding practices. Although there are no compositional data available from the foreign fleet, it is assumed that very little discarding to no discarding of fish occured. Additionally, the at-sea hake fishery removals are represent both discarded and retained fish and hence an additional discard rate would not be appropriate. Similar logic was applied in regard to survey and research removals.

The historical landing used in the model differs from those used in 2011. The assessment includes the first state provided historical reconstruction landings for Washington state. The historical reconstruction provided Pacific ocean perch landing within Washington state starting in 1916 and have significantly larger removals in the 1940s relative to those used in 2011. Given the increase in historical removals prior to 1940, the 2011 model starting year, the starting year for modeling the stock was revised to 1918, the first year Pacific ocean perch landings exceeded 1 mt, for this assessment. Explorations were conducted relative to the model starting year and no differences were found between the 1918 start year compared to starting the model in 1892, the first record of Pacific ocean perch landings between California, Oregon, and Washington catch data.

Selectivity in this model is assumed to be length-based and is modeled using double-normal for all fleets, expect the Pacific ocean perch survey which retained the previous assessment assumption of logistic selectivity. The previous assessment mirrored selectivity amont the Pacific ocean perch and both slope surveys (AFSC and NWFSC). This assessment allow for survey specific estimated double-normal selectivity.

All fishery-independent indices have been reevaluated for this assessment using a spatial-temporal delta generalized linear mixed model (VAST delta-GLMM) which is updated from 2011 which used a bayesian delta-GLMM which did not incorporate spatial effects. An additional update to the treatment of survey data was the decision to use the Triennial survey as a single time series ranging from 1980-2004. The previous assessment opted to split this survey into early and a late index of abundance based upon the change in southern sampling and a shift in survey timing. Northern California is considered to be the southern end of Pacific ocean perch West Coast distribution with rare encounters in central or southern California waters. The biological data from the Triennial survey showed no discernable ontogenetic shifts in Pacific ocean perch during the early or late period of summer samples. Based upon these investigations, the Triennial survey was retained as a single index of abundance.

Maturity and fecundity were updated for this assessment based upon new research. Fecundity for Pacific ocean perch used in this assessment was base on reevaluation of the fecundity of West Coast rockfish by Dick et al. (2017) updating the previous fecundity estimates used in the 2011 assessment (Dick 2009). Maturity in this assessment was based on examination of 537 fish samples which were used to estimate 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 updated maturity curve was based on maturity-at-length where the previous estimates used in 2011 were based on maturity-at-age.

In this assessment, the beta prior developed from a meta-analysis of West Coast groundfish was updated to the 2017 value (J. Thorson personal communication) in preliminary models, with steepness fixed in the final base model. Additionally, the prior for natural mortality was updated base on analysis conducted by Owen Hamel (personal communication), where female natural mortality was fixed at the prior median with males estimated as an offset from the female value.

3.1.2 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...

3.1.3 Summary of Data for Fleets and Areas

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

3.1.4 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.

3.1.5 Data Weighting

data-weighting

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

3.1.6 Priors

priors

Citation for Hamel prior on natural mortality (Hamel 2015)

3.1.7 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.

3.1.8 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 **??**

3.2 Model Selection and Evaluation

model-selection-and-evaluation

3.2.1 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).

3.2.2 Alternate Models Considered

alternate-models-considered

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

3.2.3 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 24 shows the results of running 100 jitters for each pre-STAR base model....

3.3 Response To The Current STAR Panel Requests

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

Request No. 1: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 2: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 3: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

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

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

Rationale: Add after STAR panel.

STAT Response: Continue requests as needed.

3.4 Base Model Results

`base-model-results`

Table **??**

3.4.1 Uncertainty and Sensitivity Analyses

`uncertainty-and-sensitivity-analyses`

Table 25

3.4.2 Retrospective Analysis

`retrospective-analysis`

3.4.3 Likelihood Profiles

`likelihood-profiles`

3.4.4 Reference Points

`reference-points-1`

Intro sentence or two....(Table 26).

Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 987.1 mt. Table e shows the full suite of estimated reference points for the northern area model and Figure g shows the equilibrium yield curve.

4 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

Table f

Model 1 Projections and Decision Table (groundfish only) (Table 27

Table h

Model 2 Projections and Decision Table (groundfish only)

Model 3 Projections and Decision Table (groundfish only)

5 Regional Management Considerations

regional-management-considerations

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

6 Research Needs

research-needs

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

7 Acknowledgments

acknowledgments

Teresa Tsou (WDFW), Philip Wyland (WDFW), Ali Whitman (ODFW), Patrick Mirrick (ODFW), Patrick McDonald (CAPS), Vanessa Tuttle (ASHOP), Beth Horness (NWFSC), Kayleigh Sommers (NWFSC), Jason Jannot (NWFSC)

8 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	0.0	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	0.0	0.0	0.4	0.0	0	0.0
1920	0.0	0.0	0.3	0.0	0	0.0
1921	0.0	0.0	0.3	0.0	0	0.0
1922	0.0	0.0	0.1	0.0	0	0.0
1923	0.0	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	0.1	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	0.3	0.1	0.7	0.0	0	0.0
1930	0.2	0.1	0.9	0.0	0	0.0
1931	0.4	0.1	0.4	0.0	0	0.0

Year	California	Oregon	Washington	At-Sea Hake	Foreign	Research
1932	0.3	0.1	0.4	0.0	0	0.0
1933	0.6	0.1	0.5	0.0	0	0.0
1934	0.4	0.0	2.3	0.0	0	0.0
1935	0.4	0.1	7.7	0.0	0	0.0
1936	0.2	0.2	1.6	0.0	0	0.0
1937	0.5	0.4	2.0	0.0	0	0.0
1938	0.6	0.1	5.1	0.0	0	0.0
1939	0.9	0.4	8.7	0.0	0	0.0
1940	0.9	9.1	12.2	0.0	0	0.0
1941	1.3	14.0	13.6	0.0	0	0.0
1942	0.4	26.6	18.6	0.0	0	0.0
1943	1.0	94.3	453.6	0.0	0	0.0
1944	2.8	164.5	739.3	0.0	0	0.0
1945	6.7	247.1	1887.1	0.0	0	0.0
1946	7.3	193.2	845.9	0.0	0	0.0
1947	2.6	167.2	385.3	0.0	0	0.0
1948	3.9	177.8	491.1	0.0	0	0.0
1949	2.0	472.9	409.5	0.0	0	0.0
1950	1.5	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	1.8
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	1.7
2011	0.1	30.3	19.7	9.2	0	1.9
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	1.6
2016	0.2	34.1	13.1	10.3	0	3.1

Table 2: West Coast history of regulations.

tab:Regs

Date	Area	Regulation
11/10/1983	Columbia	Closed Columbia area to Pacific ocean perch fishing until the end of the year, as 950 mt OY for this species has been reached;
11/10/1983	Vancouver	retained 5,000-pound trip limit or 10% of total trip weight on landings of Pacific ocean perch in the Vancouver area.
1/1/1984	ALL	Continued 5,000-pound trip limit or 10% of total trip weight on Pacific ocean perch as specified in FMP. Fishery to close when area OYs are reached (see action effective November 10, 1983 above).
8/1/1984	Vancouver Columbia	Reduced trip limit for Pacific ocean perch in the Vancouver and Columbia areas to 20% by weight of all fish on board, not to exceed 5,000 pounds per vessel per trip.
8/16/1984	Columbia	Commercial fishing for Pacific ocean perch in the Columbia area closed for remainder of the year.
1/10/1985	Vancouver Columbia	Established Vancouver and Columbia areas Pacific ocean perch trip limit of 20% by weight of all fish on board (no 5,000-pound limit as specified in last half of 1984).
4/28/1985	Vancouver Columbia	Reduced the Vancouver and Columbia areas Pacific ocean perch trip limit to 5,000 pounds or 20% by weight of all fish on board, whichever is less.
4/28/1985	ALL	Landings of Pacific ocean perch less than 1,000 pounds will be unrestricted. The fishery for this species will close when the OY in each area is reached.
6/10/1985	ALL	Landings of Pacific ocean perch up to 1,000 pounds per trip will be unrestricted regardless of the percentage of these fish on board.
1/1/1986	Cape Blanco North	Established the Pacific ocean perch trip limit north of Cape Blanco (4250) at 20% (by weight) of all fish on board or 10,000 pounds whichever is less;
1/1/1986	ALL	landings of Pacific ocean perch unrestricted if less than 1,000 pounds regardless of percentage on board; Vancouver area OY = 600 mt; Columbia area OY =950 mt.
12/1/1986	Vancouver	OY quota for Pacific ocean perch reached in the Vancouver area; fishery closed until January 1, 1987.
1/1/1987	ALL	Established coastwide Pacific ocean perch limit at 20% of all legal fish on board or 5,000 pounds whichever is less (in round weight); landings of Pacific ocean perch unrestricted if less than 1,000 pounds regardless of percentage on board; Vancouver area OY =500 mt; Columbia area OY = 800 mt.
1/1/1988	ALL	Established the coastwide Pacific ocean perch trip limit at 20% (by weight) of all fish on board or 5,000 pounds, whichever is less; landings of Pacific ocean perch unrestricted if less than 1,000 pounds regardless of percentage on board;
1/1/1989	ALL	Established the coastwide Pacific ocean perch trip limit at 20% (by weight) of all fish on board or 5,000 pounds whichever is less;
1/1/1989	ALL	landings of Pacific ocean perch unrestricted if less than 1,000 pounds regardless of percentage on board (Vancouver area OY =500 mt; Columbia area OY =800 mt).
7/26/1989	ALL	Reduced the coastwide trip limit for Pacific ocean perch to 2,000 pounds or 20% of all fish on board, whichever is less, with no trip frequency restriction.
12/13/1989	Columbia	Closed the Pacific ocean perch fishery in the Columbia area because 1,040 mt OY reached.
1/1/1990	ALL	Established the coastwide Pacific ocean perch trip limit at 20% (by weight) of all fish on board or 3,000 pounds whichever is less; landings of Pacific ocean perch be unrestricted if less than 1,000 pounds regardless of percentage on board. (Vancouver area OY = 500 mt; Columbia area OY = 1,040 mt).
1/1/1991	ALL	Established the coastwide Pacific ocean perch trip limit at 20% (by weight) of all groundfish on board or 3,000 pounds whichever is less; landings of Pacific ocean perch be unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,000 mt).
1/1/1992	ALL	For Pacific ocean perch, established the coastwide trip limit at 20% (by weight) of all groundfish on board or 3,000 pounds whichever is less; landings of Pacific ocean perch be unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,550 mt).

Date	Area	Regulation
1/1/1993	Cape Mendocino Coos Bay	For Pacific ocean perch, continued the coastwide trip limit at 20% (by weight) of all groundfish on board or 3,000 pounds whichever is less; landings of Pacific ocean perch unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,550 mt).
1/1/1994	ALL	Pacific Ocean Perch trip limit of 3,000 pounds or 20% of all fish on board, whichever is less, in landings of Pacific ocean perch above 1,000 pounds.
1/1/1995	ALL	For Pacific Ocean Perch, established a cumulative trip limit of 6,000 pounds per month
1/1/1996	ALL	Pacific Ocean Perch cumulative trip limit of 10,000 pounds per two-month period.
7/1/1996	4030 North	Reduced the cumulative 2-month limit for Pacific ocean perch to 8,000 pounds, and established the cumulative 2-month limit for Dover sole north of Cape Mendocino at 38,000 pounds
1/1/1997	ALL	Pacific Ocean Perch limited entry fishery cumulative trip limit of 8,000 pounds per two-month period
1/1/1998	ALL	Pacific Ocean Perch: limited entry fishery Cumulative trip limit of 8,000 pounds per two-month period.
7/1/1998	ALL	Open Access Rockfish: removed overall rockfish monthly limit and replaced it with limits for component rockfish species: for Sebastes complex, monthly cumulative limit is 33,000 pounds, for widow rockfish, monthly cumulative trip limit is 3,000 pounds, for Pacific Ocean Perch, monthly cumulative trip limit is 4,000 pounds.
1/1/1999	ALL	for the limited entry fishery A new three phase cumulative limit period system is introduced for 1999. Phase 1 is a single cumulative limit period that is 3months long, from January 1 - March 31. Phase 2 has 3 separate 2 month cumulative limit periods of April 1 - May 31, June 1 - July 31, and August 1 - September 30. Phase 3 has 3 separate 1 month cumulative limit periods of October 1-31, November 1-30, and December 1-31. For all species except Pacific ocean perch and Bocaccio, there will be no monthly limit within the cumulative landings limit periods. An option to apply cumulative trip limits lagged by 2 weeks (from the 16th to the 15th) was made available to limited entry trawl vessels when their permits were renewed for 1999. Vessels that are authorized to operate in this "B" platoon may take and retain, but may not land, groundfish during January 1-15, 1999.
1/1/1999	ALL	for the limited entry fishery Pacific Ocean Perch: cumulative limit, Phase 1: 4,000 pounds per month; Phase 2: 4,000 pounds per month; Phase 3: 4,000pounds per month.
1/1/1999	ALL	for open access gear: Pacific Ocean Perch: coastwide, 100 pounds per month.
1/1/2000	ALL	Limited entry trawl, Pacific Ocean Perch, 500 lbs per month
1/1/2000	ALL	Pacific Ocean Perch, Open Access gear except exempted trawl, 100 lbs per month
1/1/2000	ALL	Pacific Ocean Perch, limited entry fixed gear, 500 lbs per month
5/1/2000	ALL	Limited entry trawl, Pacific Ocean Perch, 2500 lbs per 2 months
5/1/2000	ALL	Pacific Ocean Perch, limited entry fixed gear, 2500 lbs per month
11/1/2000	ALL	Limited entry trawl, Pacific Ocean Perch, 500 lbs per month
11/1/2000	ALL	Pacific Ocean Perch, limited entry fixed gear, 500 lbs per month
1/1/2001	3600 North	Pacific Ocean Perch, open access, 100 lbs per month
1/1/2001	4010 North	Pacific Ocean Perch, limited entry trawl, 1500 lbs per mont
1/1/2001	ALL	Pacific Ocean Perch, limited entry fixed gear, 1500 lbs per month
5/1/2001	4010 North	Pacific Ocean Perch, limited entry trawl, 2500 lbs per month
5/1/2001	ALL	Pacific Ocean Perch, limited entry fixed gear, 2500 lbs per month
10/1/2001	4010 North	Pacific Ocean Perch, limited entry trawl, 1500 lbs per month
11/1/2001	ALL	Pacific Ocean Perch, limited entry fixed gear, 1500 lbs per month
1/1/2002	4010 North	Pacific Ocean Perch, open access, 100 lbs per month
1/1/2002	4010 North	Pacific Ocean Perch, limited entry fixed gear, 2000 lbs per month
1/1/2002	4010 North	Pacific Ocean Perch, limited entry trawl, 2000 lbs per month
4/1/2002	4010 North	Pacific Ocean Perch, limited entry fixed gear, 4000 lbs per month
5/1/2002	4010 North	Pacific Ocean Perch, limited entry trawl, 4000 lbs per month
11/1/2002	4010 North	Pacific Ocean Perch, limited entry fixed gear, 2000 lbs per month
11/1/2002	4010 North	Pacific Ocean Perch, limited entry trawl, 2000 lbs per month
1/1/2003	3800 South	minor slope rockfish south including pacific ocean perch, open access gear, 10000 lbs per 2 months

Date	Area	Regulation
1/1/2003	3800 South	Minor slope rockfish south including Pacific ocean perch, limited entry fixed gear, 30000 lbs per 2 months
1/1/2003	3800 South	Minor slope rockfish south including Pacific ocean perch , limited entry trawl, 30000 lbs per 2 months
1/1/2003	3800 4010	minor slope rockfish south including pacific ocean perch, open access gear, per trip no more than 25% (by weight) of sablefish landed
1/1/2003	3800 4010	Minor slope rockfish south including Pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2003	3800 4010	Minor slope rockfish south including Pacific ocean perch , limited entry trawl, 1800 lbs per 2 months
1/1/2003	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2003	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2003	4010 North	Pacific Ocean Perch, Limited entry trawl gear, 3000 lbs per 2 months
3/1/2003	3800 4010	Minor slope rockfish south including Pacific ocean perch, limited entry fixed gear, no more than 25% of the weight of sablefish landed per trip
11/1/2003	3800 4010	Minor slope rockfish south including Pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2004	3800 South	Minor slope rockfish south including Pacific ocean perch, open access gear, 10000 lbs per 2 months
1/1/2004	3800 South	minor slope rockfish south inclding pacific ocean perch, limited entry fixed gear, 40000 lbs per 2 months
1/1/2004	3800 South	minor slope rockfish south including pacific ocean perch, limited entry trawl, 40000 lbs per 2 months
1/1/2004	3800 4010	Minor slope rockfish south including Pacific ocean perch, open access gear, per trip no more than 25% of the weight of sablefish landed
1/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry fixed gear, 7000 lbs per 2 months
1/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry trawl, 7000 lbs per 2 months
1/1/2004	4010 North	pacific ocean perch, open access gear, 100 lbs per month
1/1/2004	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2004	4010 North	pacific ocean perch, limited entry trawl, 3000 lbs per 2 months
5/1/2004	3800 South	minor slope rockfish south inclding pacific ocean perch, limited entry fixed gear, 50000 lbs per 2 months
5/1/2004	3800 South	minor slope rockfish south including pacific ocean perch, limited entry trawl, 50000 lbs per 2 months
5/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry fixed gear, 50000 lbs per 2 months
5/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry trawl, 50000 lbs per 2 months
11/1/2004	3800 South	minor slope rockfish south inclding pacific ocean perch, limited entry fixed gear, 50000 lbs per 2 months
11/1/2004	3800 South	minor slope rockfish south including pacific ocean perch, limited entry trawl, 50000 lbs per 2 months
11/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry fixed gear, 10000 lbs per 2 months
11/1/2004	3800 4010	minor slope rockfish south including pacific ocean perch, limited entry trawl, 10000 lbs per 2 months
1/1/2005	3800 South	minor slope rockfish south including darkblotched and pacific ocean perch, open access gear, 10000 lbs per 2 months
1/1/2005	3800 South	minor slope rockfish south including darkblotched rockfish and pacific ocean perch, limited entry trawl, closed
1/1/2005	3800 4010	minor slope rockfish south including darkblotched and pacific ocean perch, open access gear, per trip no more than 25% of weight of sablefish onboard
1/1/2005	3800 4010	minor slope rockfish south including darkblotched rockfish and pacific ocean perch, limited entry trawl, 4000 lbs per 2 months
1/1/2005	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2005	4010 North	pacific ocean perch, limited entry trawl gear, 3000 lbs per 2 months
1/1/2005	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2005	4010 South	minor slope rockfish south including darkblotched and pacific ocean perch, limited entry fixed gear, 40000 lbs per 2 months
5/1/2005	3800 4010	minor slope rockfish south including darkblotched rockfish and pacific ocean perch, limited entry trawl, 8000 lbs per 2 months

Date	Area	Regulation
1/1/2008	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 15000 lbs per 2 months
1/1/2008	4010 North	pacific ocean perch, limited entry trawl, 1500 lbs per 2 months
1/1/2009	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2009	4010 South	minor slope rockfish south including pacific ocean perch and darkblotched, limited entry fixed gear, 40000 lbs per 2 months
1/1/2009	3800 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, 10000 lbs per 2 months
1/1/2009	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, per trip no more than 25% (by weight) of sablefish landed
1/1/2009	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2009	3800 South	minor slope rockfish southincluding pacific ocean perch and darkblotched rockfish, limited entry trawl, 55000 lbs per 2 months
1/1/2009	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 15000 lbs per 2 months
1/1/2009	4010 North	pacific ocean perch, limited entry trawl, 1500 lbs per 2 months
7/1/2009	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 10000 lbs per 2 months
11/1/2009	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 15000 lbs per 2 months
1/1/2010	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2010	4010 South	minor slope rockfish south including pacific ocean perch and darkblotched,limited entry fixed gear, 40000 lbs per 2 months
1/1/2010	3800 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, 10000 lbs per 2 months
1/1/2010	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, per trip no more than 25% (by weight) of sablefish landed
1/1/2010	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2010	3800 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 55000 lbs per 2 months
1/1/2010	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, limited entry trawl, 15000 lbs per 2 months
1/1/2010	4010 North	pacific ocean perch, limited entry trawl, 1500 lbs per 2 months
1/1/2011	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2011	4010 South	minor slope rockfish south including pacific ocean perch and darkblotched, limited entry fixed gear, 40000 lbs per 2 months
1/1/2011	3800 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, 10000 lbs per 2 months
1/1/2011	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, per trip no more than 25% (by weight) of sablefish landed
1/1/2011	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2011	ALL	Pacific Ocean Perch managed in part by IFQ
1/1/2012	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2012	4010 South	minor slope rockfish southincluding pacific ocean perch and darkblotched, limited entry fixed gear, 40000 lbs per 2 months
1/1/2012	3800 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, 10000 lbs per 2 months
1/1/2012	3800 4010	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, per trip no more than 25% (by weight) of sablefish landed
1/1/2012	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2013	4010 North	pacific ocean perch, open access gears, 100 lbs per month
1/1/2013	4010 North	pacific ocean perch, limited entry fixed gear, 1800 lbs per 2 months
1/1/2013	4010 South	minor slope rockfish south including pacific ocean perch and darkblotched, limited entry fixed gear, 40000 lbs per 2 months no more than 1375 lbs may be blackgill
1/1/2013	4010 South	minor slope rockfish south including pacific ocean perch and darkblotched rockfish, open access gear, 10000 lbs per 2 months no more than 475 lbs of which may be blackgill rockfish
1/1/2014	4010 North	non-trawl, limited entry, pacific ocean perch, 1800 lbs per 2 months
1/1/2014	4010 South	non-trawl, limited entry, minor slope rockfish and darkblotched rockfish and pacific ocean perch, 40000 lbs per 2 months of which no more than 1375 lbs may be blackgill rockfish

Date	Area	Regulation
1/1/2014	4010 North	non-trawl, open access, pacific ocean perch, 100 lbs per month
1/1/2014	4010 South	non-trawl, open access, minor slope rockfish including darkblotched rockfishand pacific ocean perch, 10000 lbs per 2 months of which no more than 475 lbs may be blackgill rockfish
1/1/2015	4010 North	non-trawl, limited entry, pacific ocean perch, 1800 lbs per 2 months
1/1/2015	4010 South	non-trawl, limited entry, minor slope rockfish and darkblotched rockfish and pacific ocean perch, 40000 lbs per 2 months of which no more than 1375 lbs may be blackgill rockfish
1/1/2015	4010 North	non-trawl, open access, pacific ocean perch, 100 lbs per month
1/1/2015	4010 South	non-trawl, open access, minor slope rockfish including darkblotched rockfishand pacific ocean perch, 10000 lbs per 2 months of which no more than 475 lbs may be blackgill rockfish
7/1/2015	4010 South	non-trawl, limited entry, minor slope rockfish and darkblotched rockfish and pacific ocean perch, 40000 lbs per 2 months of which no more than 1600 lbs may be blackgill rockfish
7/1/2015	4010 South	non-trawl, open access, minor slope rockfish including darkblotched rockfishand pacific ocean perch, 10000 lbs per 2 months of which no more than 550 lbs may be blackgill rockfish
1/1/2016	4010 North	non-trawl, limited entry, pacific ocean perch, 1800 lbs per 2 months
1/1/2016	4010 North	non-trawl, open access, pacific ocean perch, 100 lbs per month
1/1/2016	4010 South	non-trawl, open access, minor slope rockfish including darkblotched rockfishand pacific ocean perch, 10000 lbs per 2 months of which no more than 475 lbs may be blackgill rockfish
7/1/2016	4010 South	non-trawl, open access, minor slope rockfish including darkblotched rockfishand pacific ocean perch, 10000 lbs per 2 months of which no more than 550 lbs may be blackgill rockfish

Table 3: Recent trend in estimated total catch relative to management guidelines.

tab:mnmgt_perform_tables

Year	OFL (mt; ABC prior to 2011)	ABC (mt)	ACL (mt; OY prior to 2011)	Total landings (mt)	Estimated
2007	900	-	150	134	158
2008	911	-	150	92	134
2009	1160	-	189	97	193
2010	1173	-	200	99	183
2011	1026	981	180	61	61
2012	1007	962	183	59	59
2013	844	807	150	57	58
2014	838	801	153	54	55
2015	842	805	158	60	60
2016	850	813	164	61	60

Table 4: Summary of the fishery-independant biomass/abundance time-series used in the stock assessment. The standard error includes the input annual standard error and model estimated added variance.

tab:Index_Summary

	POP		Triennial		AFSC Slope		NWFSC Slope		NWFSC Shelf-Slope	
Year	Obs	SE	Obs	SE	Obs	SE	Obs	SE	Obs	SE
1979	56461	0.27	-	-	-	-	-	-	-	-
1980	-	-	10384	0.58	-	-	-	-	-	-
1983	-	-	8974	0.53	-	-	-	-	-	-
1985	34645	0.29	-	-	-	-	-	-	-	-
1986	-	-	2977	0.59	-	-	-	-	-	-
1989	-	-	4873	0.59	-	-	-	-	-	-
1992	-	-	3207	0.58	-	-	-	-	-	-
1995	-	-	2724	0.56	-	-	-	-	-	-
1996	-	-	-	-	7621	0.51	-	-	-	-
1997	-	-	-	-	3807	0.51	-	-	-	-
1998	-	-	4163	0.57	-	-	-	-	-	-
1999	-	-	-	-	4694	0.50	2201	0.48	-	-
2000	-	-	-	-	4243	0.53	2010	0.50	-	-
2001	-	-	1494	0.57	4187	0.49	2290	0.57	-	-
2002	-	-	-	-	-	-	1646	0.58	-	-
2003	-	-	-	-	-	-	-	-	9646	0.37
2004	-	-	2922	0.61	-	-	-	-	5284	0.41
2005	-	-	-	-	-	-	-	-	7528	0.40
2006	-	-	-	-	-	-	-	-	6010	0.43
2007	-	-	-	-	-	-	-	-	6268	0.37
2008	-	-	-	-	-	-	-	-	3867	0.40
2009	-	-	-	-	-	-	-	-	2745	0.37
2010	-	-	-	-	-	-	-	-	5404	0.36
2011	-	-	-	-	-	-	-	-	7533	0.36
2012	-	-	-	-	-	-	-	-	9289	0.36
2013	-	-	-	-	-	-	-	-	8093	0.36
2014	-	-	-	-	-	-	-	-	4914	0.35
2015	-	-	-	-	-	-	-	-	5752	0.33
2016	-	-	-	-	-	-	-	-	11770	0.37

Table 5: 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
2016	50	58	121

Table 6: Summary of NWFSC shelf-slope survey age samples used in the stock assessment. tab:NWcombo_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
2012	49	217	119
2013	44	308	106
2014	52	195	126
2015	68	182	165
2016	44	281	106

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 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 9: 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 10: 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 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 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 13: 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 14: Summary of discard rates used in the model by each data source.
tab:Discard

Year	Source	Discard	Standard Error
1985	Pikitch	0.027	0.068
1986	Pikitch	0.024	0.063
1987	Pikitch	0.039	0.083
1992	Management Restrictions	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 15: 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 16: 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 17: 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 18: Summary of At-Sea hake fishery length samples used in the stock assessment.
tab:ASHOP_Lengths

Year	Trips	Fish	Sample Size
2003	153	805	263
2004	128	329	172
2005	221	734	321
2006	210	751	312
2007	319	1119	470
2008	26	2491	162
2009	12	366	63
2010	22	1794	155
2011	36	1748	226
2012	26	881	148
2013	26	834	140
2014	31	532	103
2015	23	925	150
2016	35	1947	240

Table 19: Summary of At-sea hake fishery age samples used in the stock assessment.
tab:ASHOP_Ages

Year	Trips	Fish	Sample Size
2003	142	378	194
2006	198	410	255
2007	297	620	383

Table 20: Estimated ageing error from the CAPS lab used in the assessment model
tab:Age_Error

True Age (yr)	SD of Observed Age (yr)	True Age (yr)	SD of Observed Age (yr)
0.5	0.156	31.5	2.772
1.5	0.156	32.5	2.854
2.5	0.249	33.5	2.935
3.5	0.341	34.5	3.016
4.5	0.433	35.5	3.097
5.5	0.524	36.5	3.177
6.5	0.615	37.5	3.257
7.5	0.706	38.5	3.337
8.5	0.796	39.5	3.416
9.5	0.886	40.5	3.495
10.5	0.976	41.5	3.574
11.5	1.065	42.5	3.652
12.5	1.154	43.5	3.73
13.5	1.242	44.5	3.808
14.5	1.33	45.5	3.885
15.5	1.418	46.5	3.962
16.5	1.505	47.5	4.039
17.5	1.592	48.5	4.115
18.5	1.679	49.5	4.191
19.5	1.765	50.5	4.267
20.5	1.851	51.5	4.342
21.5	1.937	52.5	4.417
22.5	2.022	53.5	4.492
23.5	2.107	54.5	4.566
24.5	2.191	55.5	4.641
25.5	2.275	56.5	4.714
26.5	2.359	57.5	4.788
27.5	2.442	58.5	4.861
28.5	2.525	59.5	4.934
29.5	2.608	60.5	5.007
30.5	2.69		

Table 21: Specifications of the base model for ‘r spp‘.

tab:Model_setup

Model Specification	Base Model
Starting year	1918
Population characteristics	
Maximum age	60
Gender	2
Population lengths	5-50 cm by 1 cm bins
Summary biomass (mt)	Age 3+
Data characteristics	
Data lengths	11-47 cm by 1 cm bins
Data ages	1-40
Minimun age for growth calculations	3
Maximum age for growth calculations	20
First mature age	0
Starting year of estimated recruitment	1940
Fishery characteristics	
Fishery timing	mid-year
Fishing mortality method	discrete
Maximum F	0.9
Catchability	Analytical estimate
Fishery selectivity	Double Normal
At-Sea Hake selectivity	Double Normal
POP survey selectivity	Logistic
Triennial survey	Double Normal
AFSC slope survey	Double Normal
NWFSC slope survey	Double Normal
NWFSC shelf/slope survey	Double Normal
Fishery time blocks	
Fishery selectivity	none
Fishery retention	1918-1991, 1992-2001, 2002-2007, 2008, 2009-2010, 2011-2016

Table 22: 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)	NA
1	NatM_p_1_Fem_GP_1	0	-5.000	(0.02, 0.1)			Log_Norm	Log_Norm (-2.92, 0.44)
2	L_at_Amin_Fem_GP_1	21	3.000	(15, 25)	OK	0	No_prior	None
3	L_at_Amax_Fem_GP_1	41	2.000	(35, 45)	OK	0	No_prior	None
4	VonBert_K_Fem_GP_1	0	3.000	(0.1, 0.4)	OK	0	No_prior	None
5	CV_young_Fem_GP_1	1	5.000	(0.03, 5)	OK	0	No_prior	None
6	CV_old_Fem_GP_1	3	5.000	(0.03, 5)	OK	0	No_prior	None
7	Wtlen_1_Fem	0	-50.000	(0, 3)			No_prior	None
8	Wtlen_2_Fem	3	-50.000	(2, 4)			No_prior	None
9	Mat50%_Fem	32	-50.000	(20, 40)			No_prior	None
10	Mat_slope_Fem	-1	-50.000	(-2, 4)			No_prior	None
11	Eggs_scalar_Fem	0	-50.000	(0, 6)			No_prior	None
12	Eggs_exp_len_Fem	5	-50.000	(-3, 5)			No_prior	None
13	NatM_p_1_Mal_GP_1	0	5.000	(0, 0.3)	OK	0	Normal	Normal (0.05, 0.1)
14	L_at_Amin_Mal_GP_1	21	-2.000	(6, 68)			No_prior	None
15	L_at_Amax_Mal_GP_1	39	2.000	(13, 122)	OK	0	No_prior	None
16	VonBert_K_Mal_GP_1	0	3.000	(0.04, 1.09)	OK	0	No_prior	None
17	CV_young_Mal_GP_1	1	5.000	(0, 742.07)	OK	0	No_prior	None
18	CV_old_Mal_GP_1	2	5.000	(0, 742.07)	OK	0	No_prior	None
19	Wtlen_1_Mal	0	-50.000	(0, 3)			No_prior	None
20	Wtlen_2_Mal	3	-50.000	(2, 4)			No_prior	None
24	CohortGrowDev	1	-50.000	(0, 2)			No_prior	None
25	FracFemale_GP_1	0	-99.000	(0.01, 0.99)			No_prior	None
26	SR_LN(R0)	9	1.000	(5, 20)	OK	0	No_prior	None
27	SR_BH_steep	0	-2.000	(0.2, 1)			Full_Beta	Full_Beta (0.7606, 0.146
28	SR_sigmaR	1	-6.000	(0.5, 1.2)			No_prior	None
29	SR_regime	0	-50.000	(-5, 5)			No_prior	None

Continued on next page

Table 22: 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)	NA
30	SR_autocorr	0	-50.000	(0, 2)			No_prior	None
154	LnQ_base_Fishery(1)	-12	-1.000	(-15, 15)			No_prior	None
155	LnQ_base_POP(4)	0	-1.000	(-15, 15)			No_prior	None
156	LnQ_base_Triennial(5)	-1	-1.000	(-15, 15)			No_prior	None
157	Q_extraSD_Triennial(5)	0	2.000	(0, 0.5)	OK	0	No_prior	None
158	LnQ_base_AFSCSlope(6)	-2	-1.000	(-15, 15)			No_prior	None
159	LnQ_base_NWFSCSlope(7)	-3	-1.000	(-15, 15)			No_prior	None
160	LnQ_base_NWFSCcombo(8)	-2	-1.000	(-15, 15)			No_prior	None
161	Q_extraSD_NWFSCcombo(8)	0	2.000	(0, 0.5)	OK	0	No_prior	None
162	SizeSel_P1_Fishery(1)	38	1.000	(20, 45)	OK	1	No_prior	None
163	SizeSel_P2_Fishery(1)	-5	-2.000	(-6, 4)			No_prior	None
164	SizeSel_P3_Fishery(1)	4	3.000	(-1, 9)	OK	0	No_prior	None
165	SizeSel_P4_Fishery(1)	-3	3.000	(-9, 9)	OK	7	No_prior	None
166	SizeSel_P5_Fishery(1)	-4	-4.000	(-5, 9)			No_prior	None
167	SizeSel_P6_Fishery(1)	1	2.000	(-5, 9)	OK	0	No_prior	None
168	Retain_P1_Fishery(1)	29	1.000	(15, 45)	OK	0	No_prior	None
169	Retain_P2_Fishery(1)	1	1.000	(0.1, 10)	OK	0	No_prior	None
170	Retain_P3_Fishery(1)	1	1.000	(-10, 10)	OK	31441	No_prior	None
171	Retain_P4_Fishery(1)	0	-3.000	(0, 0)			No_prior	None
172	SizeSel_P1_ASHOP(2)	50	1.000	(20, 49.5)	HI	0	No_prior	None
173	SizeSel_P2_ASHOP(2)	-5	-2.000	(-6, 4)			No_prior	None
174	SizeSel_P3_ASHOP(2)	5	3.000	(-1, 9)	OK	0	No_prior	None
175	SizeSel_P4_ASHOP(2)	1	3.000	(-1, 9)	OK	6112	No_prior	None
176	SizeSel_P5_ASHOP(2)	-4	-4.000	(-9, 9)			No_prior	None
177	SizeSel_P6_ASHOP(2)	999	-2.000	(-5, 999)			No_prior	None
178	SizeSel_P1_POP(4)	24	1.000	(20, 70)	OK	2	No_prior	None

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Table 22: 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)	NA
179	SizeSel_P2_POP(4)	11	3.000	(0.001, 50)	OK	4	No_prior	None
180	SizeSel_P1_Triennial(5)	29	1.000	(20, 45)	OK	4	No_prior	None
181	SizeSel_P2_Triennial(5)	-5	-2.000	(-6, 4)			No_prior	None
182	SizeSel_P3_Triennial(5)	4	3.000	(-1, 9)	OK	2	No_prior	None
183	SizeSel_P4_Triennial(5)	2	3.000	(-1, 9)	OK	3	No_prior	None
184	SizeSel_P5_Triennial(5)	-1	-4.000	(-5, 9)			No_prior	None
185	SizeSel_P6_Triennial(5)	-1	2.000	(-5, 9)	OK	1	No_prior	None
186	SizeSel_P1_AFSCSlope(6)	22	1.000	(20, 45)	OK	2	No_prior	None
187	SizeSel_P2_AFSCSlope(6)	-5	-2.000	(-6, 4)			No_prior	None
188	SizeSel_P3_AFSCSlope(6)	1	3.000	(-1, 9)	OK	2	No_prior	None
189	SizeSel_P4_AFSCSlope(6)	1	3.000	(-1, 9)	OK	6112	No_prior	None
190	SizeSel_P5_AFSCSlope(6)	-9	-4.000	(-9, 9)			No_prior	None
191	SizeSel_P6_AFSCSlope(6)	999	-2.000	(-5, 999)			No_prior	None
192	SizeSel_P1_NWFSCSlope(7)	36	1.000	(20, 45)	OK	2	No_prior	None
193	SizeSel_P2_NWFSCSlope(7)	-5	-2.000	(-6, 4)			No_prior	None
194	SizeSel_P3_NWFSCSlope(7)	2	3.000	(-1, 9)	OK	2	No_prior	None
195	SizeSel_P4_NWFSCSlope(7)	1	3.000	(-1, 9)	OK	6112	No_prior	None
196	SizeSel_P5_NWFSCSlope(7)	-9	-4.000	(-9, 9)			No_prior	None
197	SizeSel_P6_NWFSCSlope(7)	999	-2.000	(-5, 999)			No_prior	None
198	SizeSel_P1_NWFSCcombo(8)	21	1.000	(20, 49.5)	OK	5	No_prior	None
199	SizeSel_P2_NWFSCcombo(8)	-5	-2.000	(-6, 4)			No_prior	None
200	SizeSel_P3_NWFSCcombo(8)	3	3.000	(-1, 9)	OK	2	No_prior	None
201	SizeSel_P4_NWFSCcombo(8)	1	3.000	(-1, 9)	OK	6309	No_prior	None
202	SizeSel_P5_NWFSCcombo(8)	-9	-4.000	(-9, 9)			No_prior	None
203	SizeSel_P6_NWFSCcombo(8)	999	-2.000	(-5, 999)			No_prior	None
204	Retain_P3_Fishery(1)_BLK1repl_1918	4	4.000	(-10, 10)	OK	0	No_prior	None

Continued on next page

Table 22: 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)	NA
205	Retain_P3_Fishery(1)_BLK1repl_1992	2	4.000	(-10, 10)	OK	0	No_prior	None
206	Retain_P3_Fishery(1)_BLK1repl_2002	2	4.000	(-10, 10)	OK	0	No_prior	None
207	Retain_P3_Fishery(1)_BLK1repl_2008	1	4.000	(-10, 10)	OK	0	No_prior	None
208	Retain_P3_Fishery(1)_BLK1repl_2009	-0	4.000	(-10, 10)	OK	0	No_prior	None
209	Retain_P3_Fishery(1)_BLK1repl_2011	7	4.000	(-10, 10)	OK	1	No_prior	None

tab:model_params

Table 23: Likelihood components from the base model

tab:like

Likelihood Component	Value
Total	1653.29
Survey	-27.39
Discard	-34.34
Length-frequency data	199.06
Age-frequency data	1502.7
Recruitment	10.82
Forecast Recruitment	0
Parameter Priors	2.45

Table 24: Results from 100 jitters from the base model.

tab:jitter

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

Table 26: 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 re-cruits	Estimated total catch (mt)	1-SPR	Exp. rate
1918	130421	6113	129749	1.00	11083	0.0	0.00	0
1919	130422	6113	129748	1.00	11088	1.2	0.00	0
1920	130429	6113	129748	1.00	11092	0.5	0.00	0
1921	130447	6113	129765	1.00	11097	0.4	0.00	0
1922	130475	6113	129792	1.00	11102	0.4	0.00	0
1923	130512	6113	129829	1.00	11106	0.2	0.00	0
1924	130558	6113	129875	1.00	11111	0.3	0.00	0
1925	130612	6114	129928	1.00	11116	0.6	0.00	0
1926	130672	6115	129989	1.00	11121	0.7	0.00	0
1927	130738	6117	130055	1.00	11126	1.2	0.00	0
1928	130809	6119	130124	1.00	11132	1.5	0.00	0
1929	130883	6122	130198	1.00	11136	1.3	0.00	0
1930	130960	6125	130275	1.00	11141	1.1	0.00	0
1931	131039	6128	130354	1.00	11145	1.2	0.00	0
1932	131119	6132	130434	1.00	11148	1.0	0.00	0
1933	131201	6135	130515	1.00	11151	0.8	0.00	0
1934	131282	6139	130596	1.00	11154	1.2	0.00	0
1935	131362	6143	130676	1.00	11159	2.8	0.00	0
1936	131436	6146	130749	1.01	11167	8.4	0.00	0
1937	131515	6150	130829	1.01	11180	2.1	0.00	0
1938	131593	6154	130906	1.01	11200	2.9	0.00	0
1939	131668	6157	130980	1.01	11229	5.9	0.00	0
1940	131741	6161	131050	1.01	11639	10.3	0.01	0
1941	131807	6163	131109	1.01	11691	22.7	0.01	0
1942	131882	6166	131165	1.01	11750	29.7	0.02	0
1943	131969	6167	131249	1.01	11814	46.8	0.19	0
1944	131572	6144	130848	1.01	11861	562.8	0.30	0
1945	130857	6104	130130	1.00	11902	929.5	0.62	0.01
1946	128942	6003	128212	0.98	11916	2195.3	0.35	0.02
1947	128238	5960	127505	0.97	12025	1073.0	0.20	0.01
1948	128100	5944	127364	0.97	12256	569.3	0.24	0
1949	127893	5926	127148	0.97	12639	690.1	0.31	0.01
1950	127531	5900	126769	0.97	13216	907.1	0.45	0.01
1951	126758	5853	125969	0.96	13968	1402.5	0.50	0.01
1952	125887	5798	125061	0.95	14763	1620.3	0.68	0.01
1953	124399	5709	123526	0.93	15177	2399.7	0.55	0.02
1954	123740	5653	122827	0.92	14688	1776.1	0.73	0.01

Table 26: 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 re-cruits	Estimated total catch (mt)	1-SPR	Exp. rate
1955	122501	5564	121579	0.91	13451	2565.6	0.61	0.02
1956	122017	5507	121137	0.90	11976	2003.1	0.86	0.02
1957	120450	5402	119651	0.88	10545	3200.4	0.78	0.03
1958	119381	5329	118671	0.87	9426	2741.4	0.66	0.02
1959	118827	5296	118199	0.87	8730	2156.0	0.44	0.02
1960	118996	5316	118428	0.87	8567	1264.8	0.71	0.01
1961	117832	5292	117297	0.87	8979	2368.4	0.89	0.02
1962	115489	5223	114954	0.85	9494	3328.0	1.06	0.03
1963	111879	5096	111321	0.83	8746	4421.8	1.24	0.04
1964	106709	4887	106142	0.80	7181	5877.9	1.30	0.06
1965	101130	4649	100621	0.76	6147	6231.8	1.45	0.06
1966	93897	4321	93475	0.71	5598	7828.3	1.82	0.08
1967	75535	3449	75170	0.56	5084	18968.2	1.82	0.25
1968	61706	2781	61372	0.45	5171	14650.5	1.76	0.24
1969	52966	2359	52649	0.39	6880	9711.9	1.12	0.18
1970	51823	2307	51466	0.38	11493	2182.9	1.16	0.04
1971	50597	2254	50114	0.37	5701	2300.6	1.06	0.05
1972	49889	2217	49282	0.36	3819	1905.0	1.06	0.04
1973	49309	2176	48990	0.36	3533	1888.2	1.27	0.04
1974	47872	2093	47642	0.34	3498	2642.9	1.20	0.06
1975	46692	2027	46473	0.33	4400	2274.3	0.84	0.05
1976	46479	2019	46252	0.33	3559	1182.8	0.98	0.03
1977	45811	2010	45550	0.33	4930	1507.0	0.88	0.03
1978	45272	2016	45034	0.33	3792	1269.2	1.14	0.03
1979	43908	1978	43623	0.32	4033	1997.9	1.00	0.05
1980	42960	1948	42724	0.32	3731	1531.6	1.08	0.04
1981	41751	1898	41508	0.31	4037	1725.6	0.97	0.04
1982	40856	1860	40616	0.30	5992	1380.6	0.83	0.03
1983	40277	1834	39996	0.30	6359	1057.4	1.09	0.03
1984	39180	1781	38809	0.29	5213	1626.9	1.12	0.04
1985	38174	1724	37802	0.28	5271	1659.3	1.05	0.04
1986	37510	1678	37192	0.27	3894	1421.5	1.05	0.04
1987	36955	1634	36652	0.27	4494	1375.4	0.94	0.04
1988	36710	1604	36460	0.26	4924	1106.5	1.07	0.03
1989	36200	1568	35914	0.26	6328	1379.2	1.12	0.04
1990	35655	1537	35319	0.25	10666	1471.8	0.97	0.04
1991	35565	1527	35125	0.25	3122	1123.6	1.13	0.03

Table 26: 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 re-cruits	Estimated total catch (mt)	1-SPR	Exp. rate
1992	35272	1501	34743	0.25	1781	1477.9	1.17	0.04
1993	35006	1467	34835	0.24	2219	1569.6	1.12	0.05
1994	34735	1443	34605	0.24	7619	1417.3	1.02	0.04
1995	34609	1431	34391	0.23	5153	1180.5	0.90	0.03
1996	34682	1440	34261	0.24	2287	954.2	0.85	0.03
1997	34864	1465	34594	0.24	2063	880.6	0.73	0.03
1998	35093	1496	34956	0.24	2294	716.1	0.72	0.02
1999	35176	1513	35017	0.25	13615	723.6	0.60	0.02
2000	35401	1527	35066	0.25	17527	563.9	0.21	0.02
2001	36252	1562	35380	0.26	5887	160.3	0.35	0
2002	37479	1594	36597	0.26	3191	295.1	0.22	0.01
2003	39123	1625	38809	0.27	1777	179.1	0.19	0
2004	40695	1647	40515	0.27	4438	157.0	0.18	0
2005	42129	1671	41981	0.27	2547	148.2	0.09	0
2006	43430	1727	43188	0.28	2506	77.0	0.10	0
2007	44519	1822	44363	0.30	2581	85.3	0.17	0
2008	45456	1923	45099	0.31	83174	157.5	0.14	0
2009	46870	2006	45601	0.33	3101	133.6	0.19	0
2010	49630	2063	45812	0.34	4762	193.4	0.17	0
2011	54462	2102	54234	0.34	8909	182.7	0.06	0
2012	58860	2133	58518	0.35	1669	61.3	0.06	0
2013	63268	2161	62792	0.35	20055	59.0	0.05	0
2014	67471	2251	67111	0.37	3349	57.7	0.05	0
2015	71321	2492	70350	0.41	7032	55.4	0.05	0
2016	74996	2802	74729	0.46	7562	60.0	0.04	0
2017	77998	3068	77555	0.50	7952	60.1	0.97	0
2018	78185	3162	77714	0.52	8084	-	-	-
2019	77898	3208	77406	0.52	8146	-	-	-
2020	77267	3238	76769	0.53	8186	-	-	-
2021	76402	3250	75901	0.53	8203	-	-	-
2022	75395	3239	74892	0.53	8188	-	-	-
2023	74313	3211	73809	0.53	8151	-	-	-
2024	73203	3175	72701	0.52	8101	-	-	-
2025	72098	3134	71598	0.51	8045	-	-	-
2026	71019	3091	70522	0.51	7985	-	-	-
2027	69975	3047	69481	0.50	7923	-	-	-
2028	68970	3004	68481	0.49	7861	-	-	-

Table 26: 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 re-cruits	Estimated total catch (mt)	1-SPR	Exp. rate

tab:Timeseries_mod1

Table 25: 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 27: Projection of potential OFL, spawning biomass, and depletion for the base case model.

tab:Forecast_mod1

Year	OFL contriubtion (mt)	ACL landings (mt)	Age 3+ biomass (mt)	Spawning Output	Depletion
2017	2605	1842	77555	3068	0.50
2018	2685	1897	77714	3162	0.52
2019	2707	1916	77406	3208	0.52
2020	2693	1910	76769	3238	0.53
2021	2660	1889	75901	3250	0.53
2022	2615	1860	74892	3239	0.53
2023	2564	1826	73809	3211	0.53
2024	2512	1790	72701	3175	0.52
2025	2462	1756	71598	3134	0.51
2026	2416	1724	70522	3091	0.51
2027	2374	1694	69481	3047	0.50
2028	2335	1667	68481	3004	0.49

9 Figures

figures

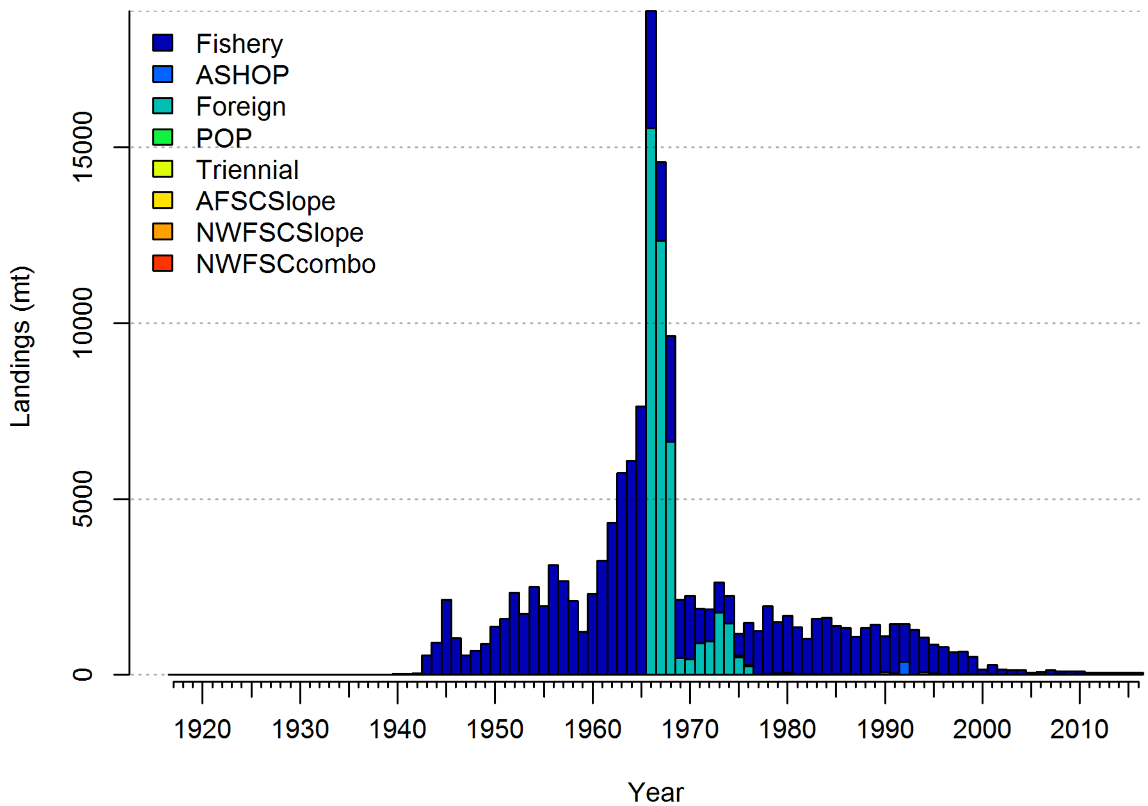

Figure 1: Total catches Pacific ocean perch through 2016. fig:Catch

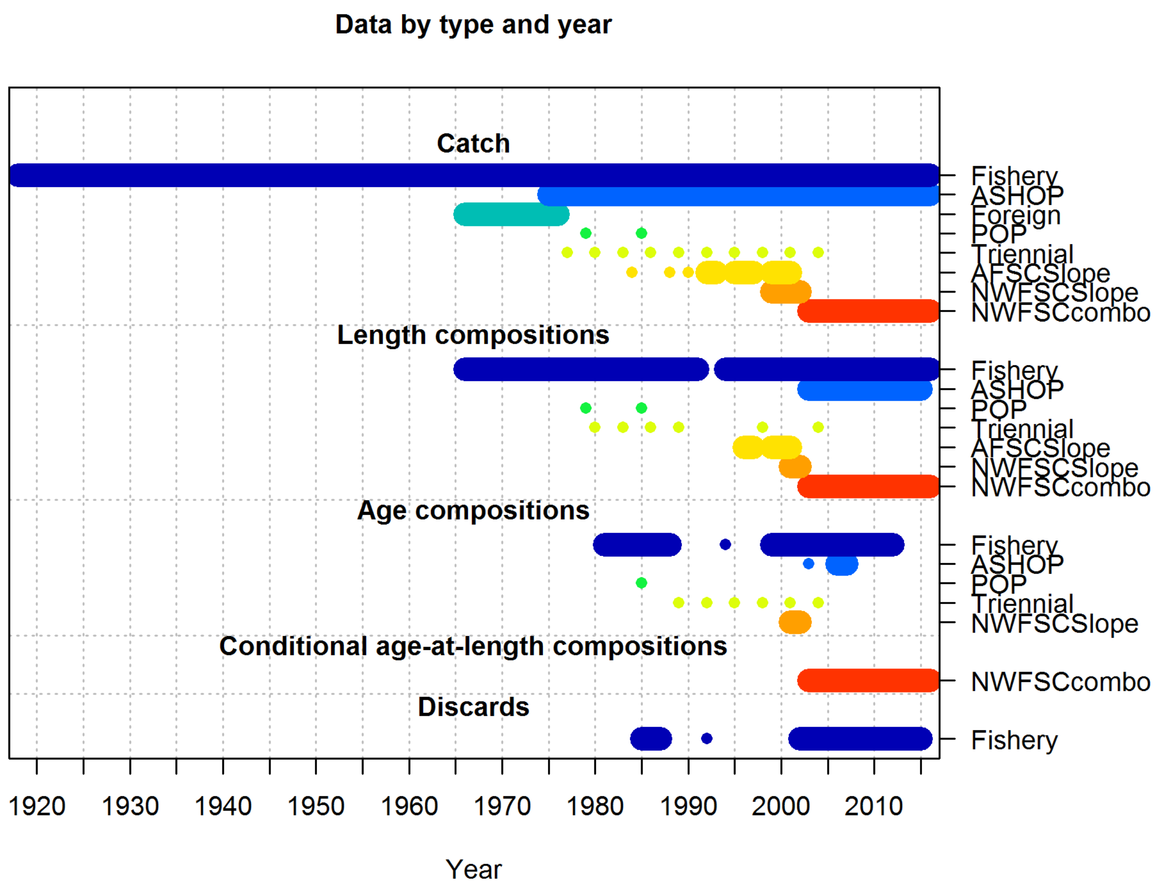

Figure 2: Summary of data sources used in the Base model. fig:data_plot

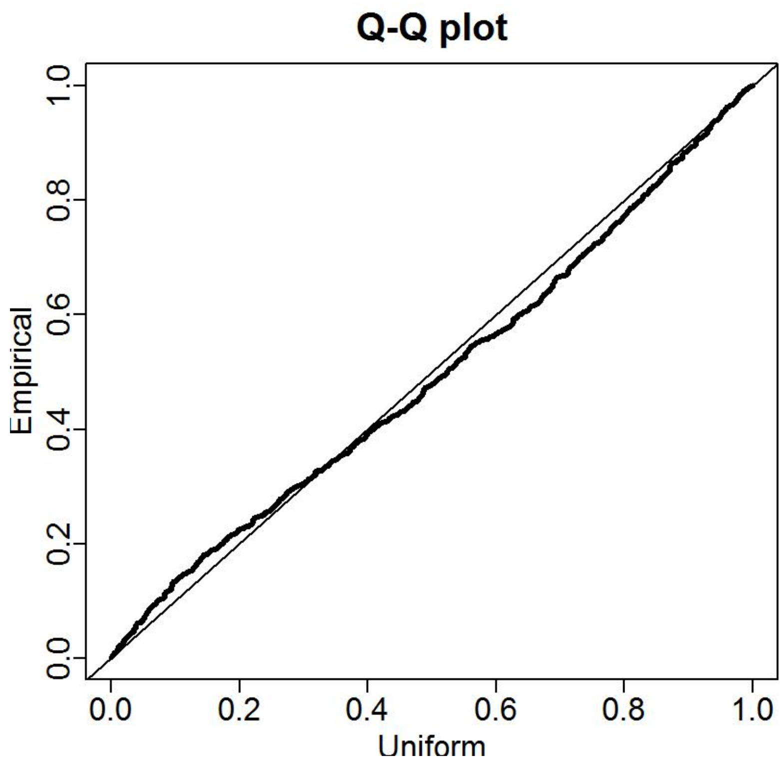

Figure 3: Q-Q plots for the VAST lognormal distribution for the NWFSC shelf-slope survey. fig:nw_qq

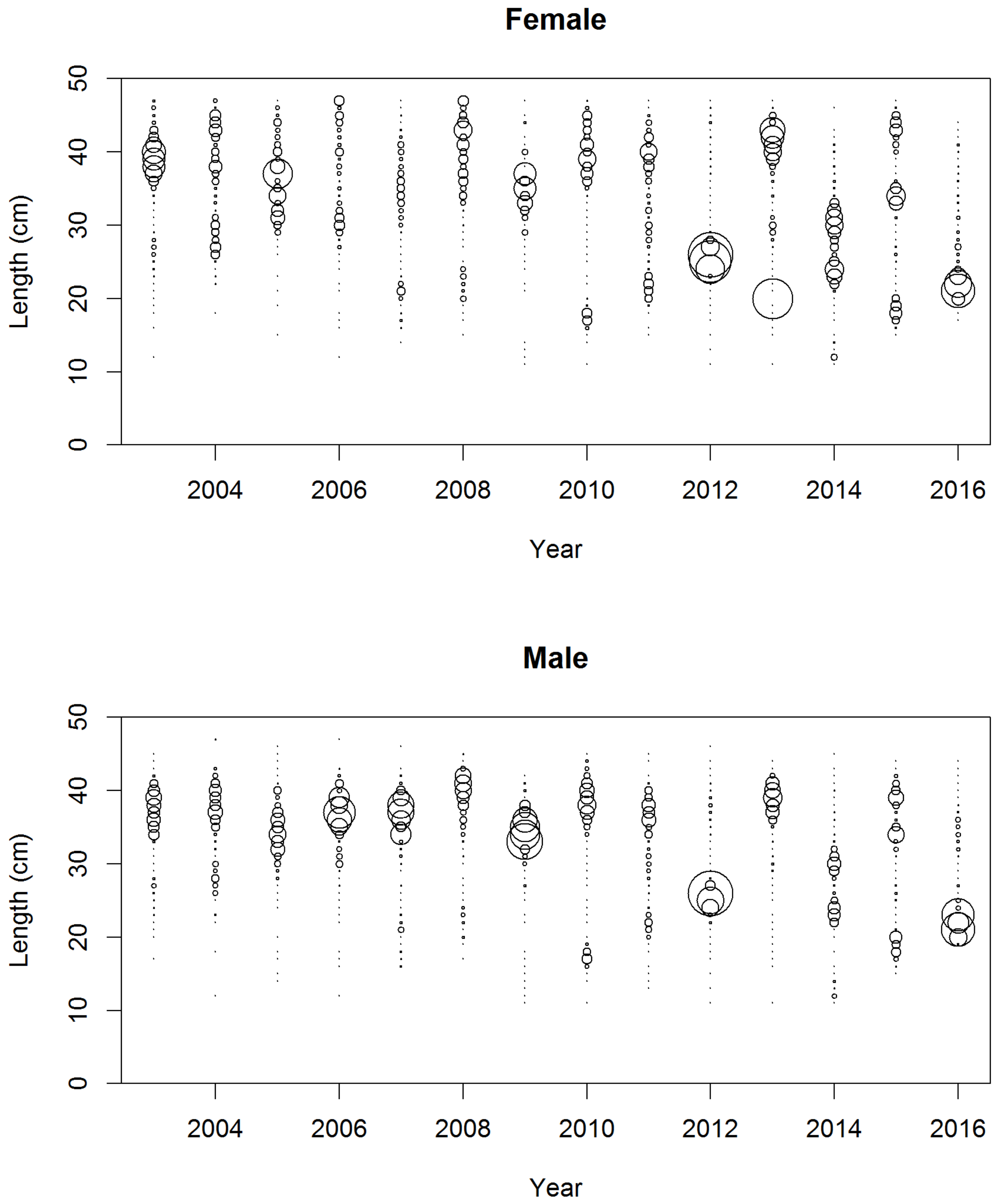

Figure 4: NWFSC shelf-slope survey length frequency distributions for Pacific ocean perch. fig:nw_Length

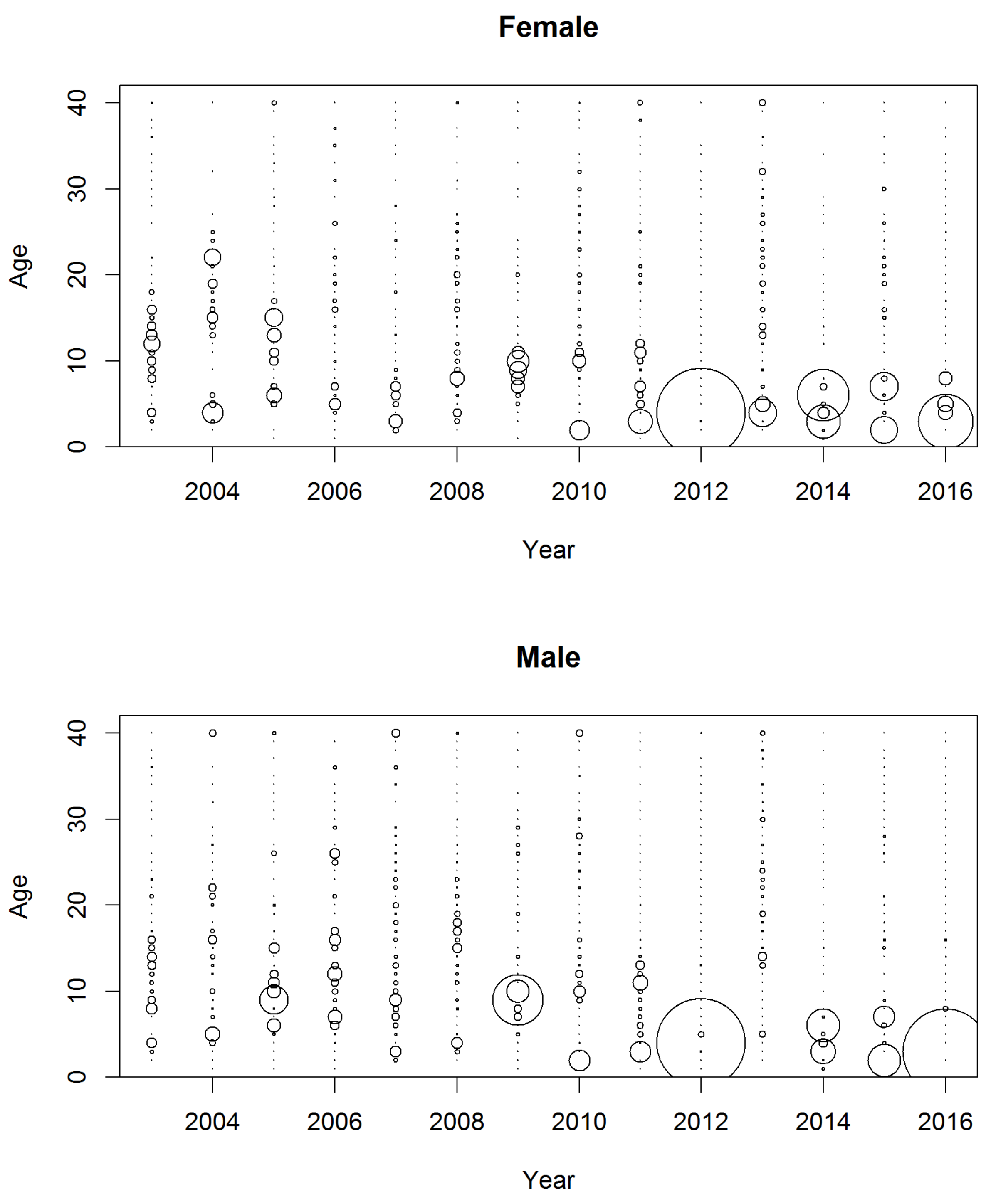

Figure 5: NWFSC shelf-slope survey age frequency distributions for Pacific ocean perch. fig:nw_Age

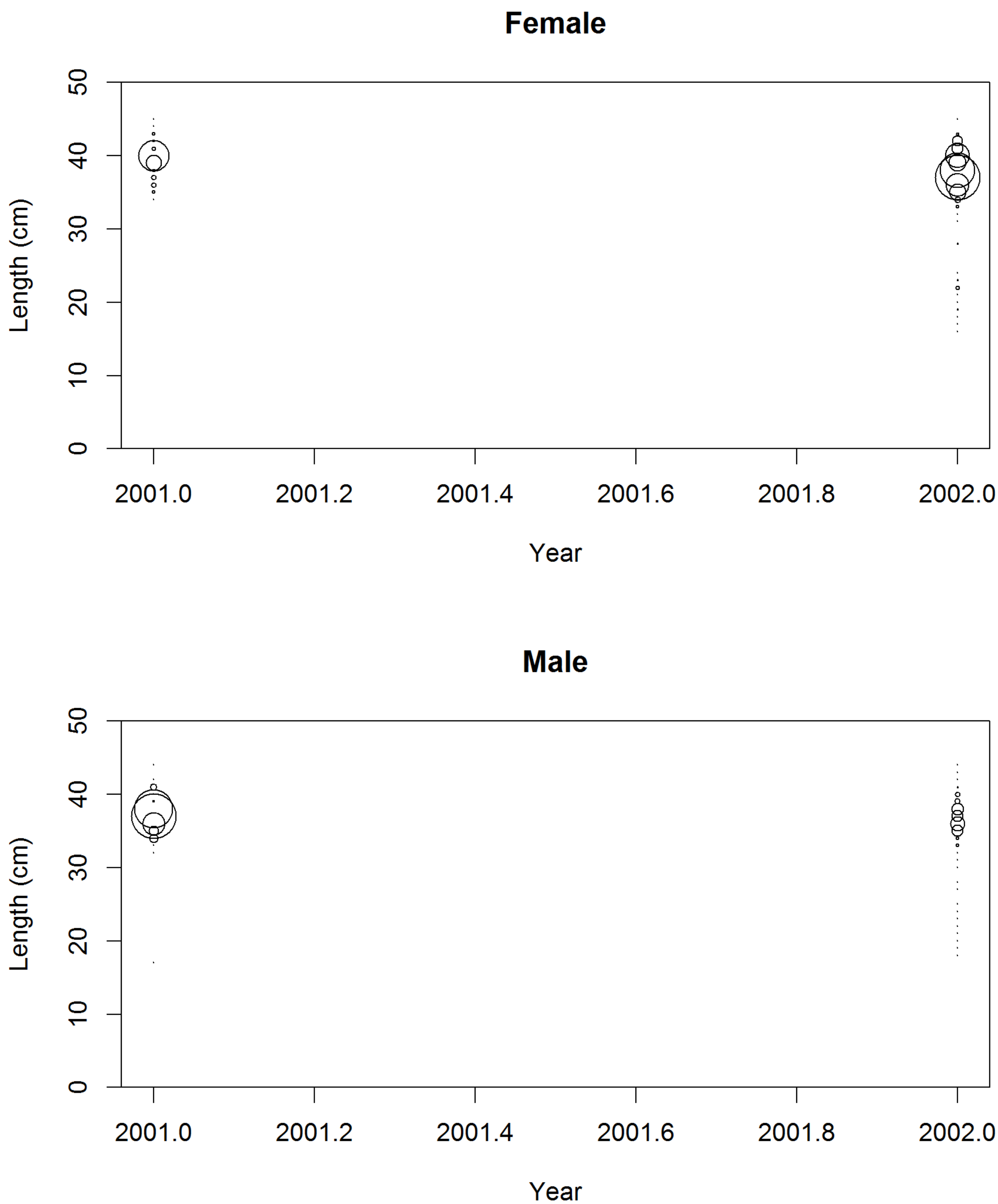

Figure 6: NWFSC slope survey length frequency distributions for Pacific ocean perch. fig:nw_slope_Le

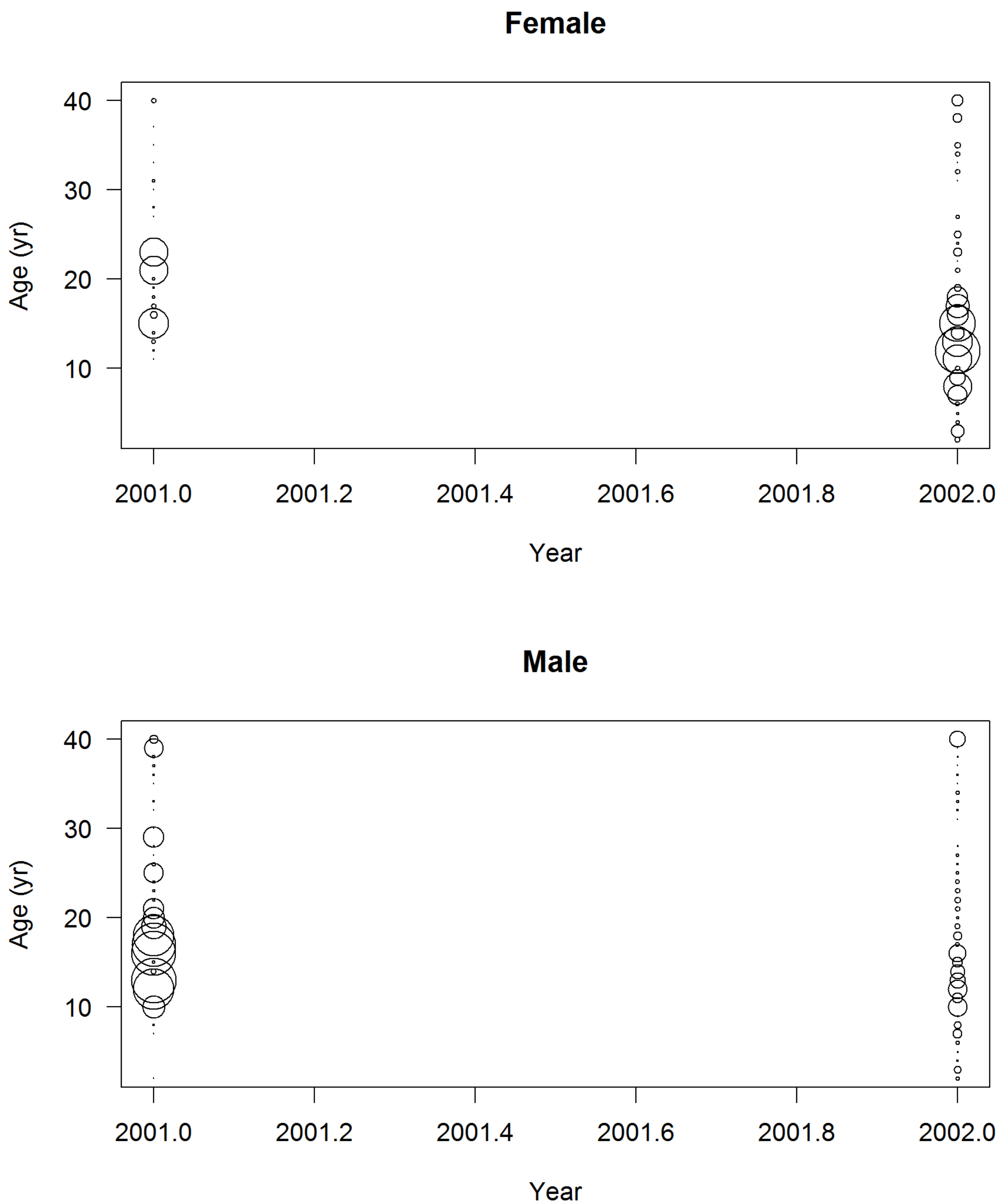

Figure 7: NWFSC slope survey age frequency distributions for Pacific ocean perch. fig:nw_slope_Age

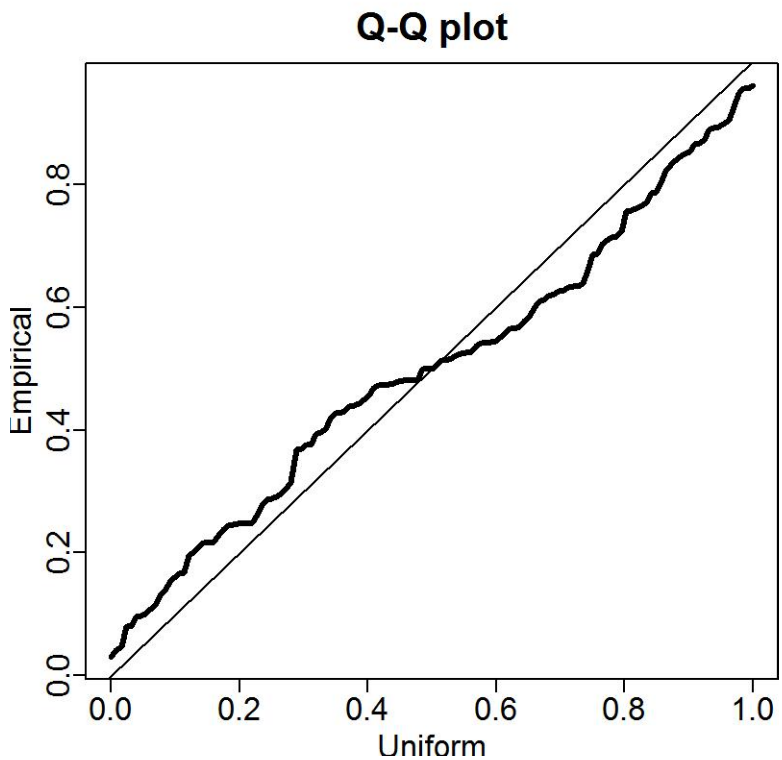

Figure 8: Q-Q plots for the VAST lognormal distribution for the AFSC slope survey. fig:afsc_qq

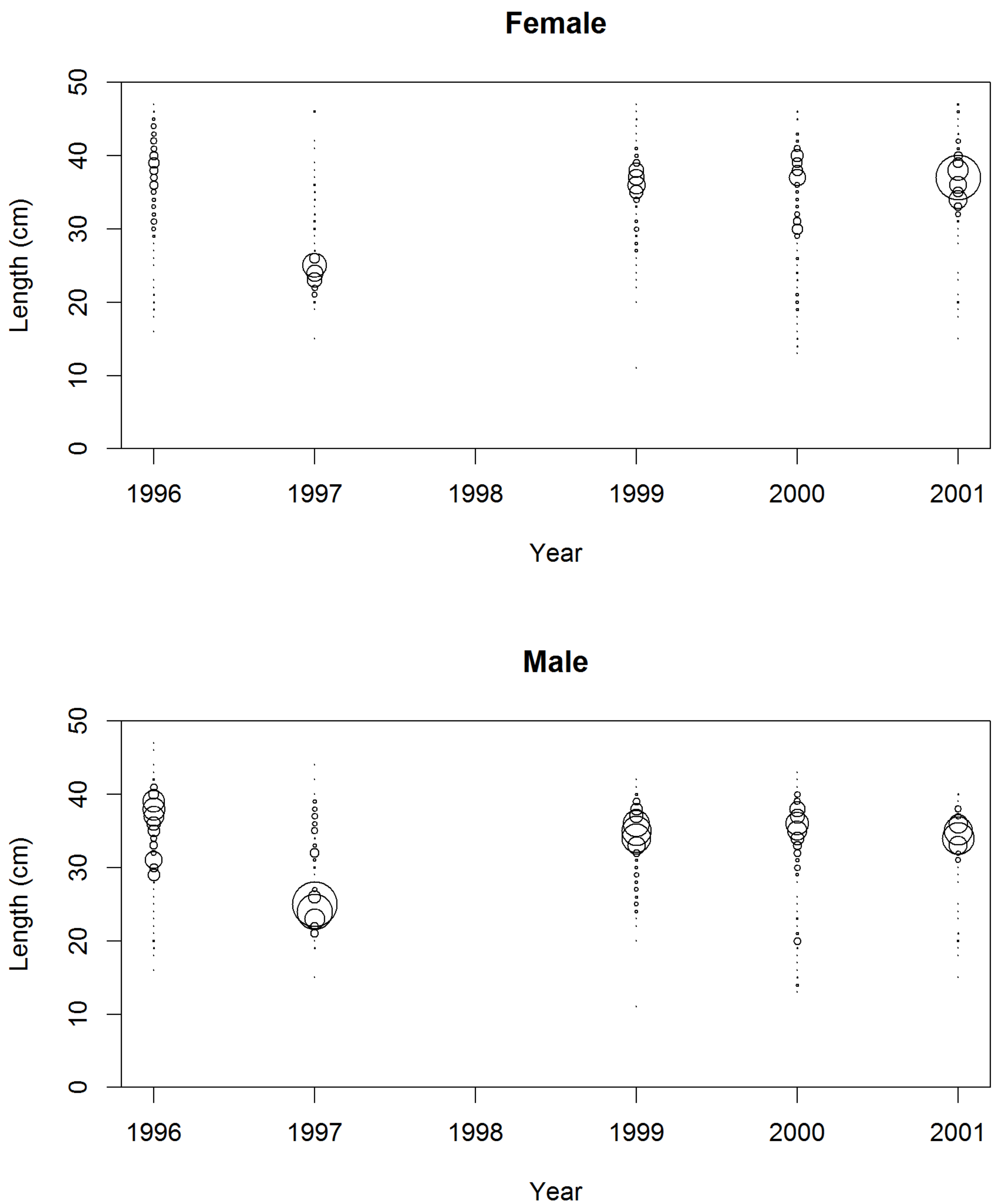

Figure 9: AFSC slope survey length frequency distributions for Pacific ocean perch. fig:afsc_Length

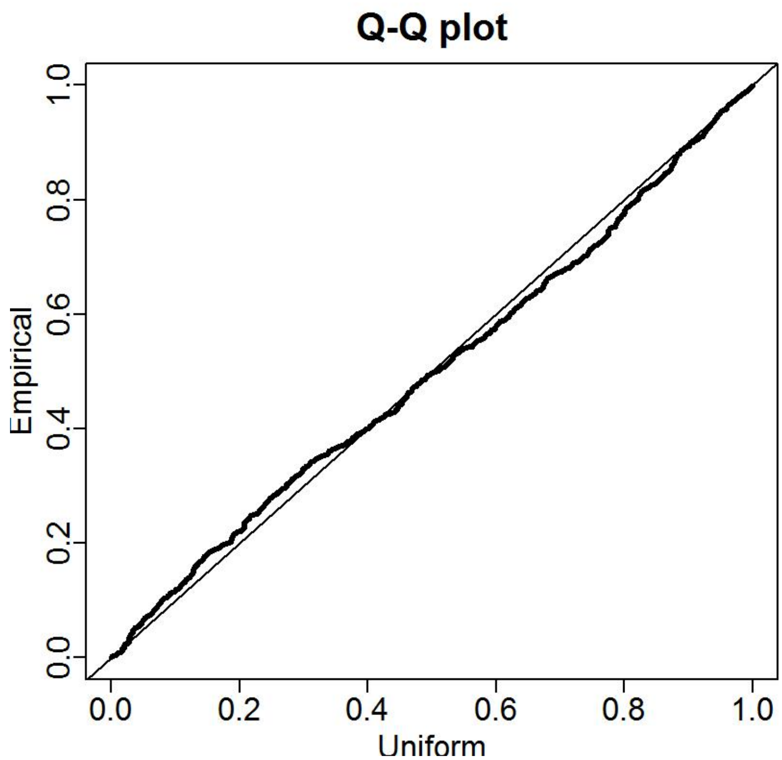

Figure 10: Q-Q plots for the VAST lognormal distribution for the Triennial survey. fig:tri_qq

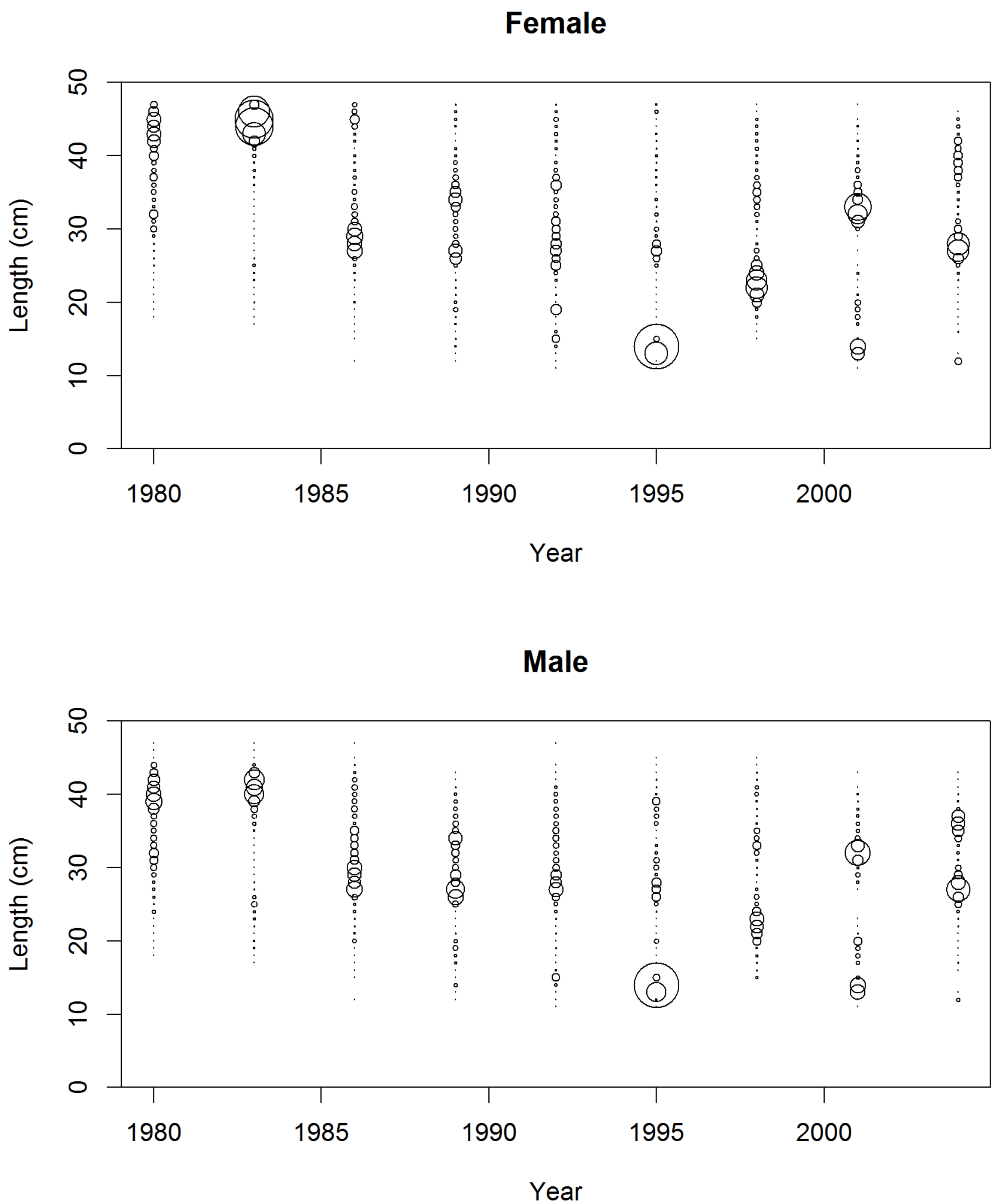

Figure 11: Triennial survey length frequency distributions for Pacific ocean perch. fig:Tri_Length

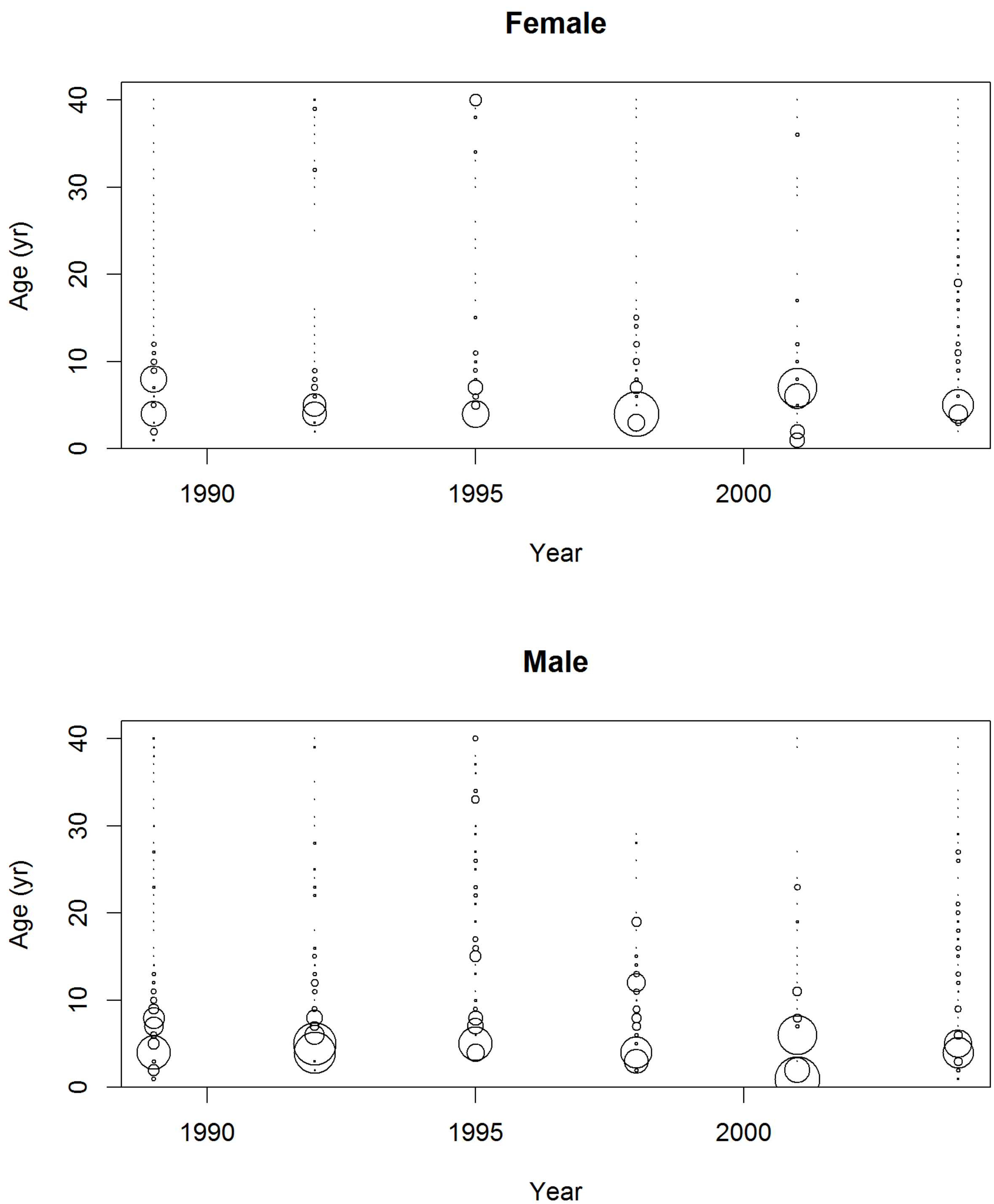

Figure 12: Triennial survey age frequency distributions for Pacific ocean perch. fig:Tri_Age

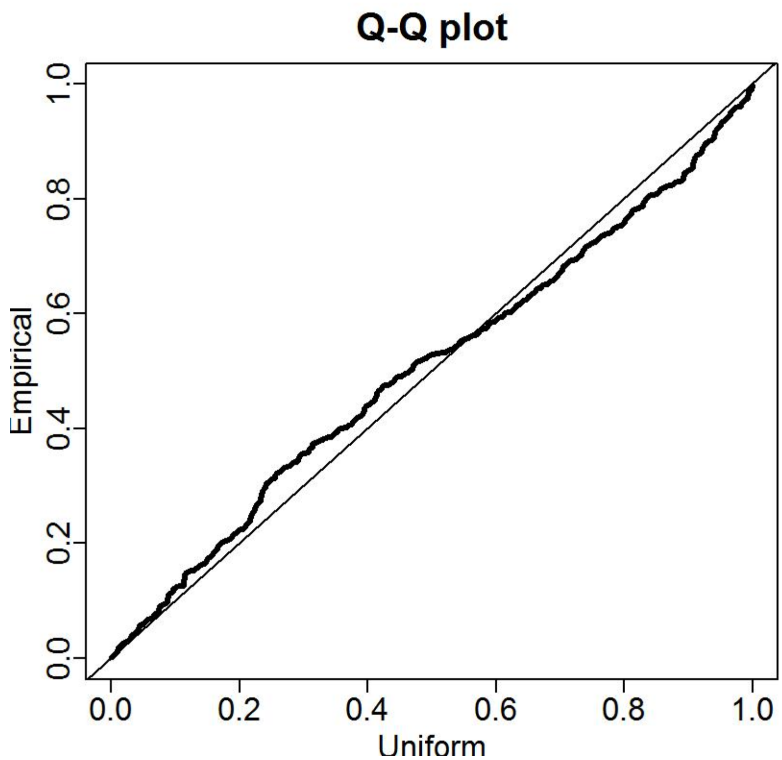

Figure 13: Q-Q plots for the VAST lognormal distribution for the Pacific ocean perch survey.
fig:pop_qq

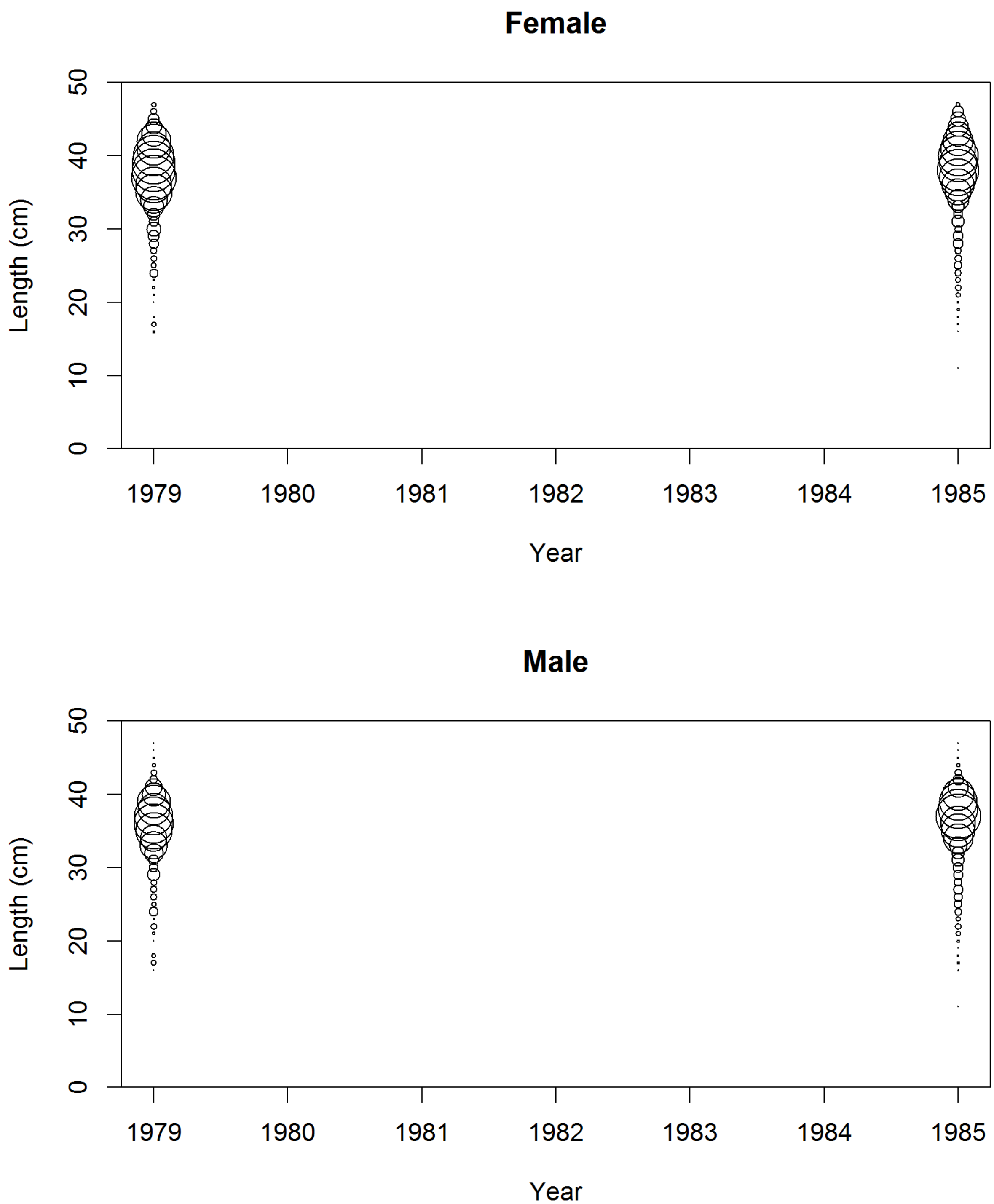

Figure 14: Pacific ocean perch survey length frequency distributions for Pacific ocean perch. fig:POP_Lengt

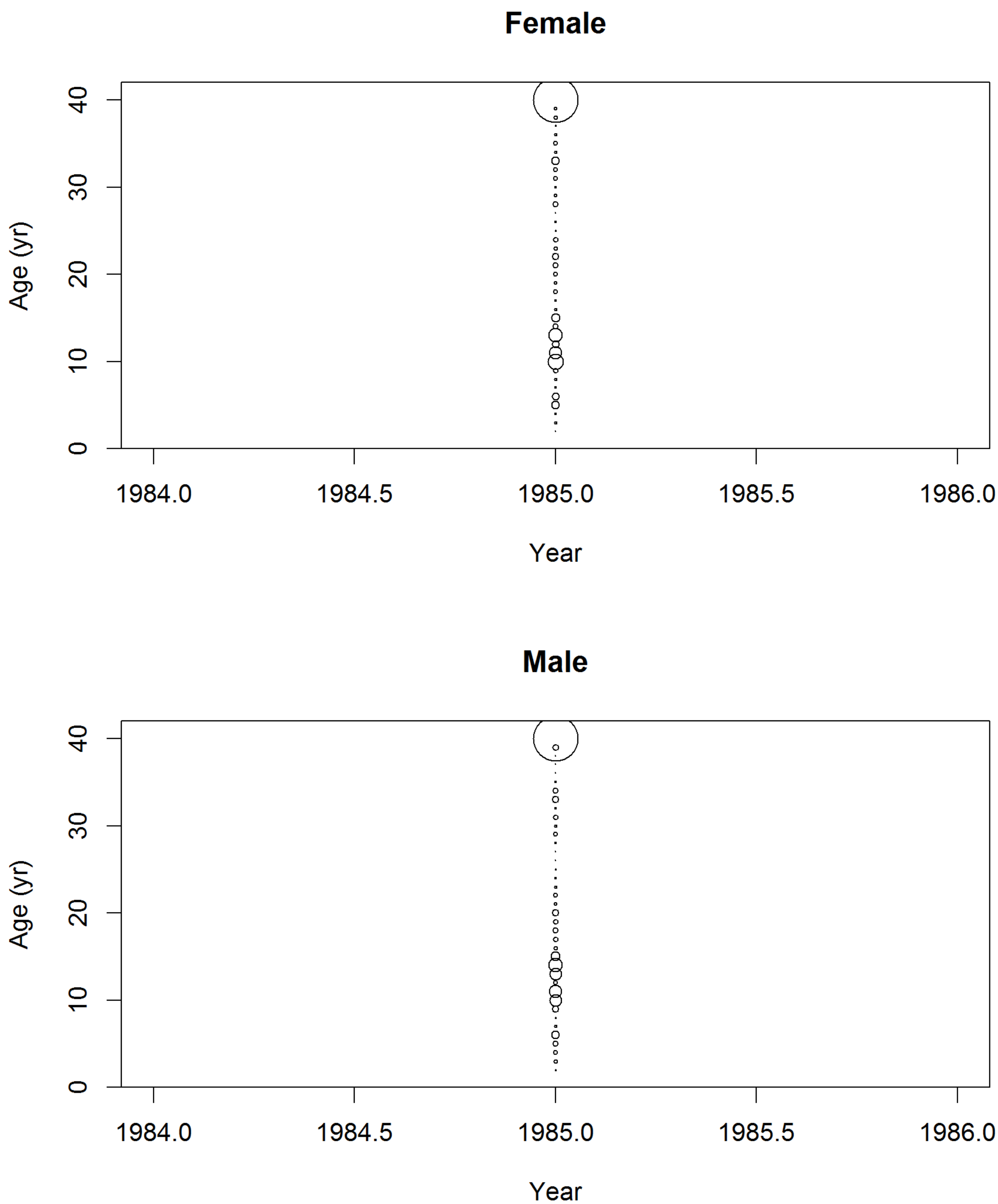

Figure 15: Pacific ocean perch survey age frequency distributions for Pacific ocean perch. fig:POP_Age

Figure 16: Discard length frequency distributions from WCGOP for Pacific ocean perch. fig:WCGOP_dis

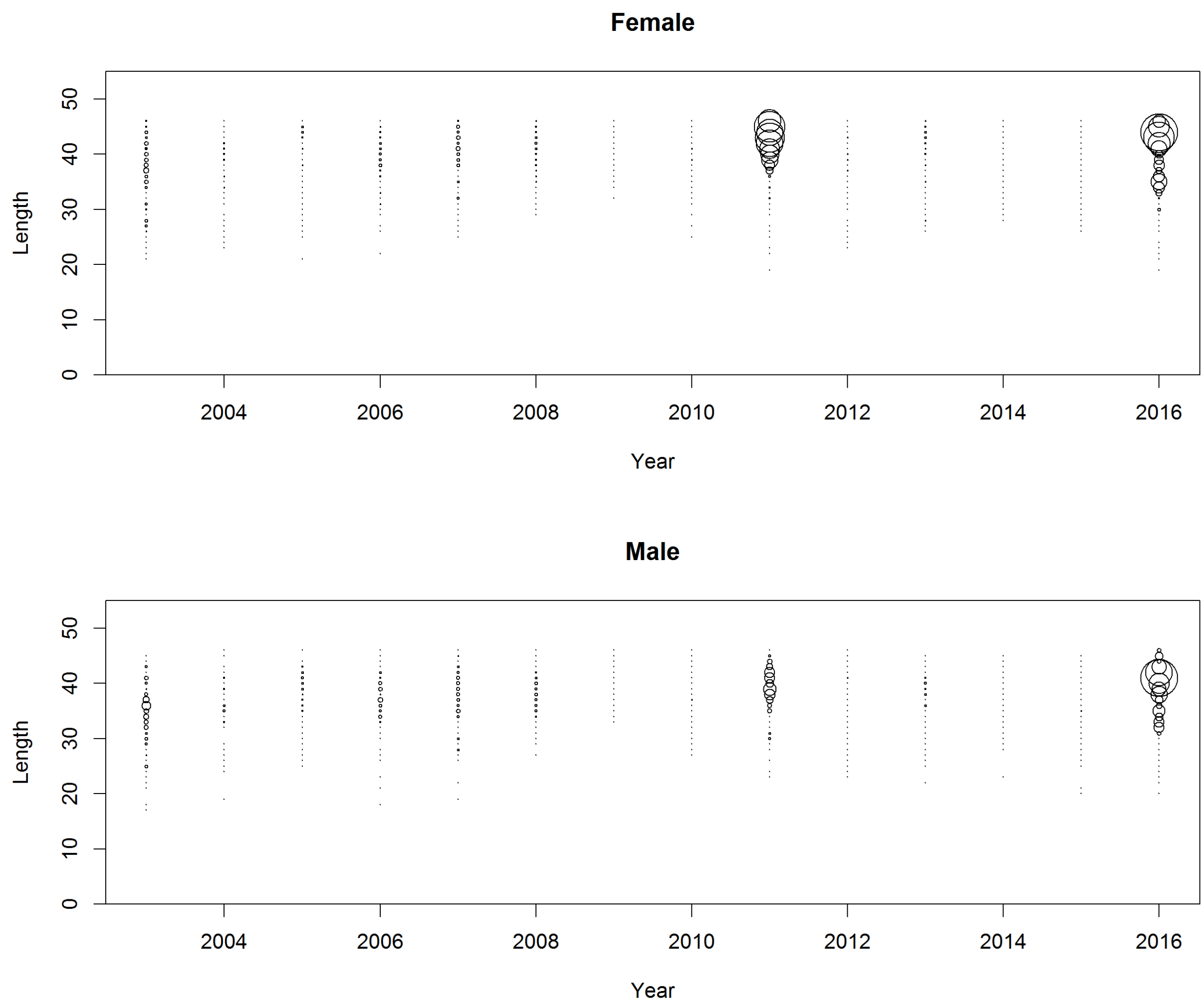

Figure 17: At-Sea hake fishery length frequency distributions for Pacific ocean perch. fig:ASHOP_Lengt

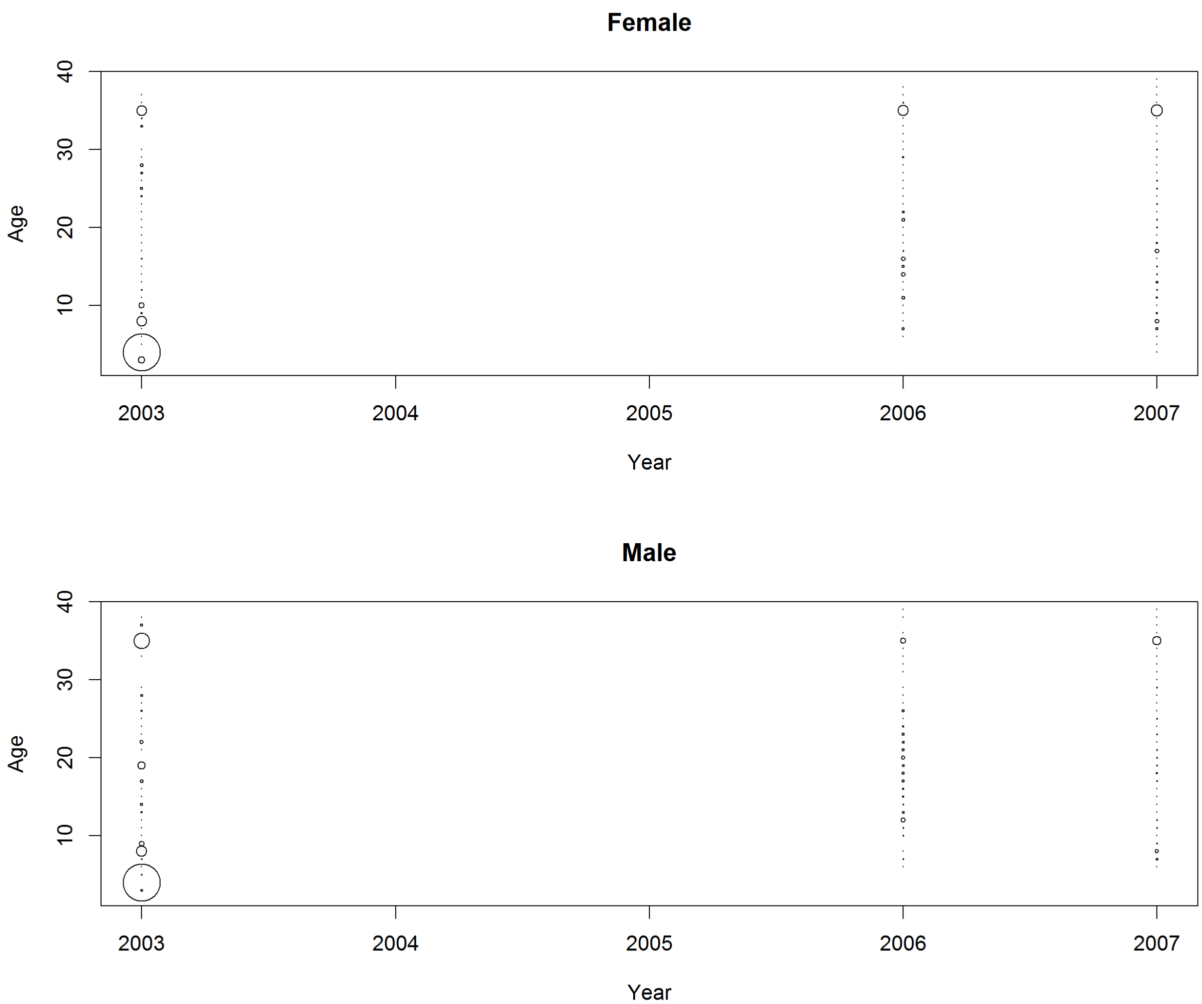

Figure 18: At-Sea hake fishery age frequency distributions for Pacific ocean perch. fig:ASHOP_Age

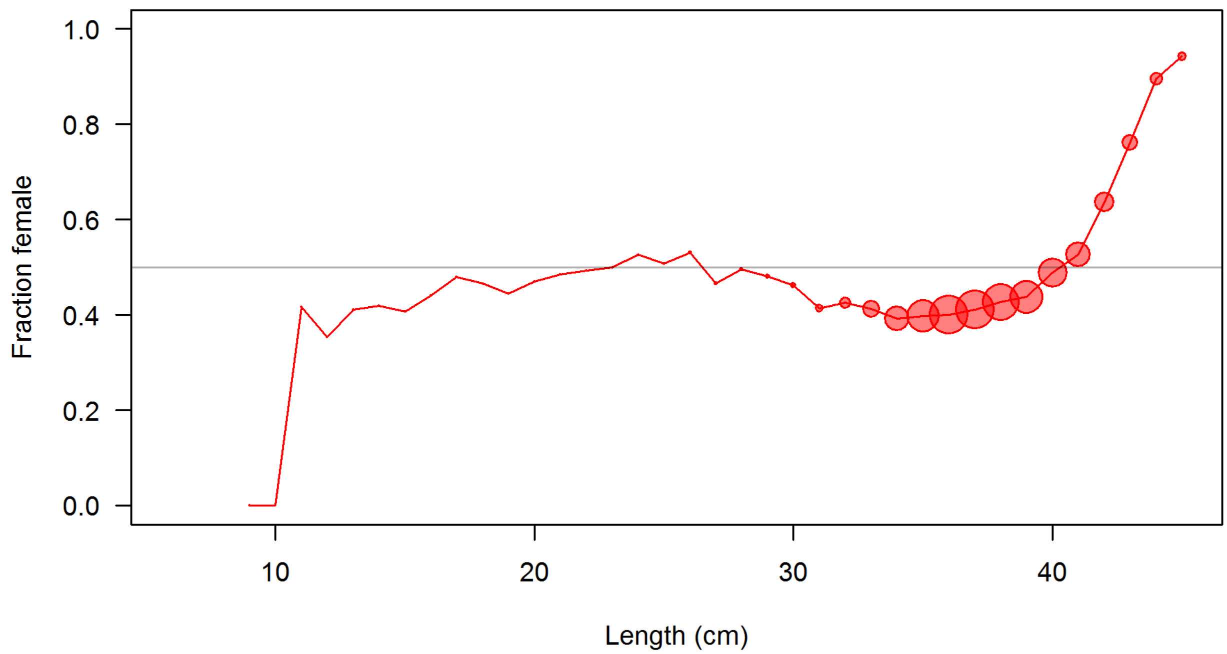

Figure 19: The estimated sex ratio of Pacific ocean perch at length from all biological data sources. fig:sexratio

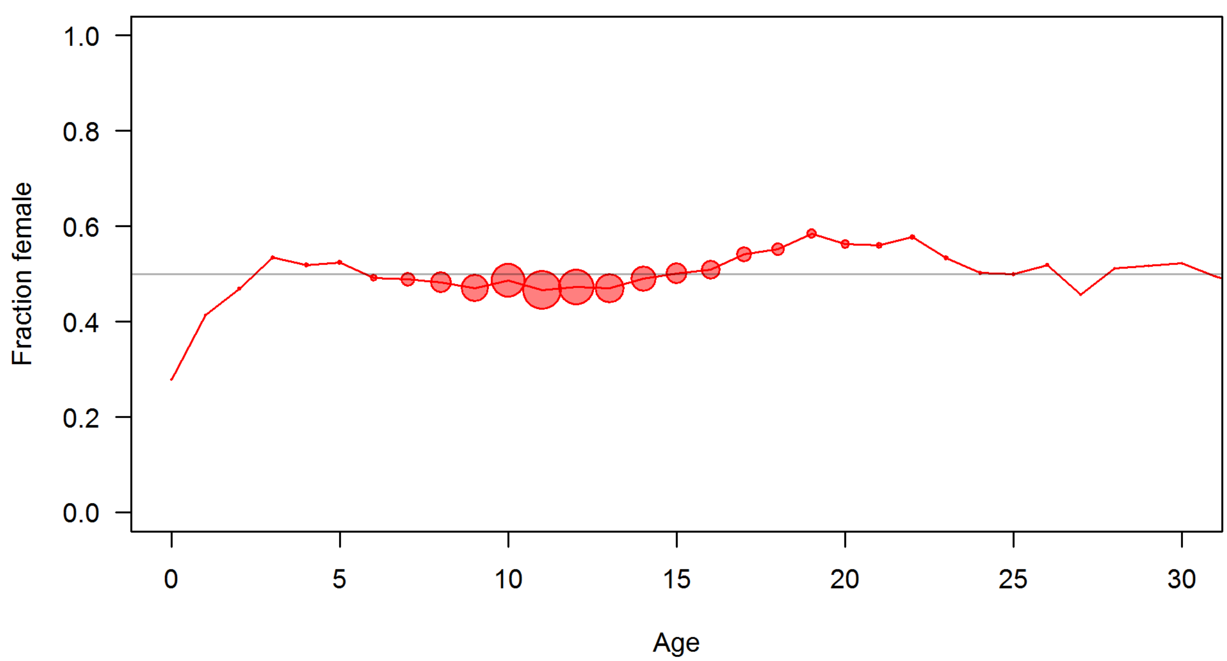

Figure 20: The estimated sex ratio of Pacific ocean perch at age from all biological data sources. fig:sexratio_Age

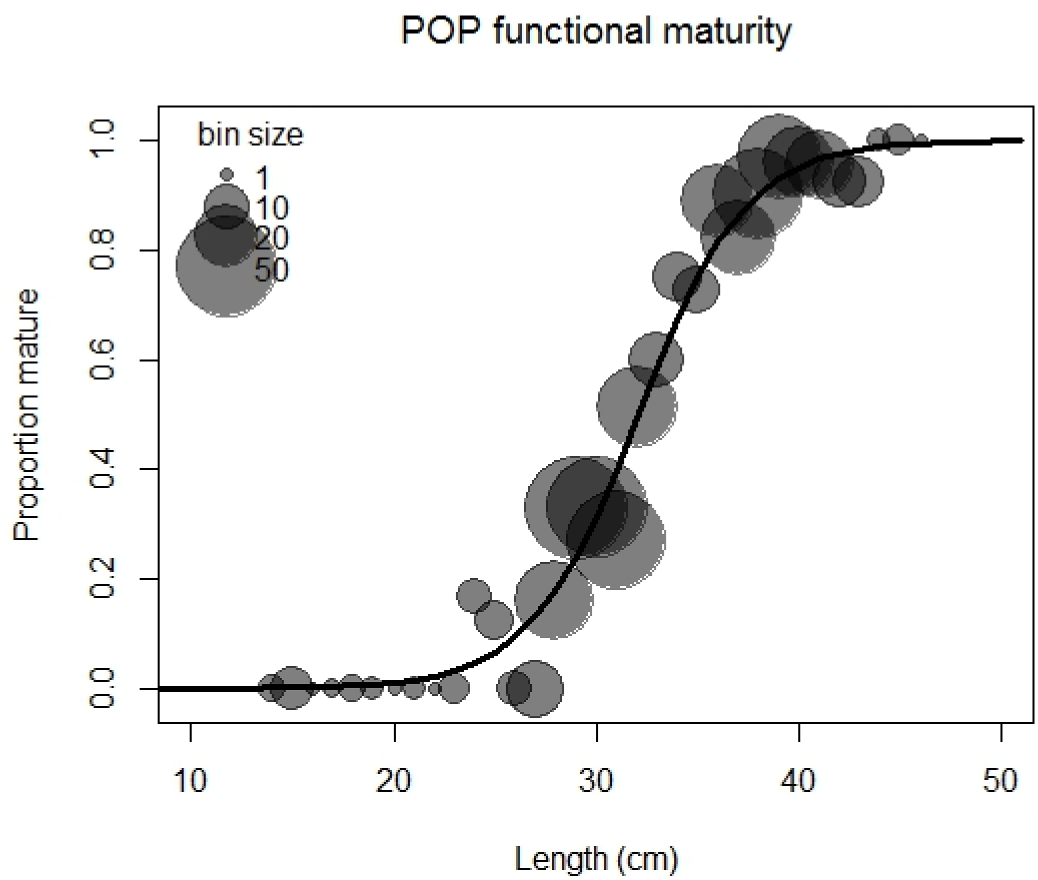

Figure 21: The estimated functional maturity Pacific ocean perch at length. fig:mat

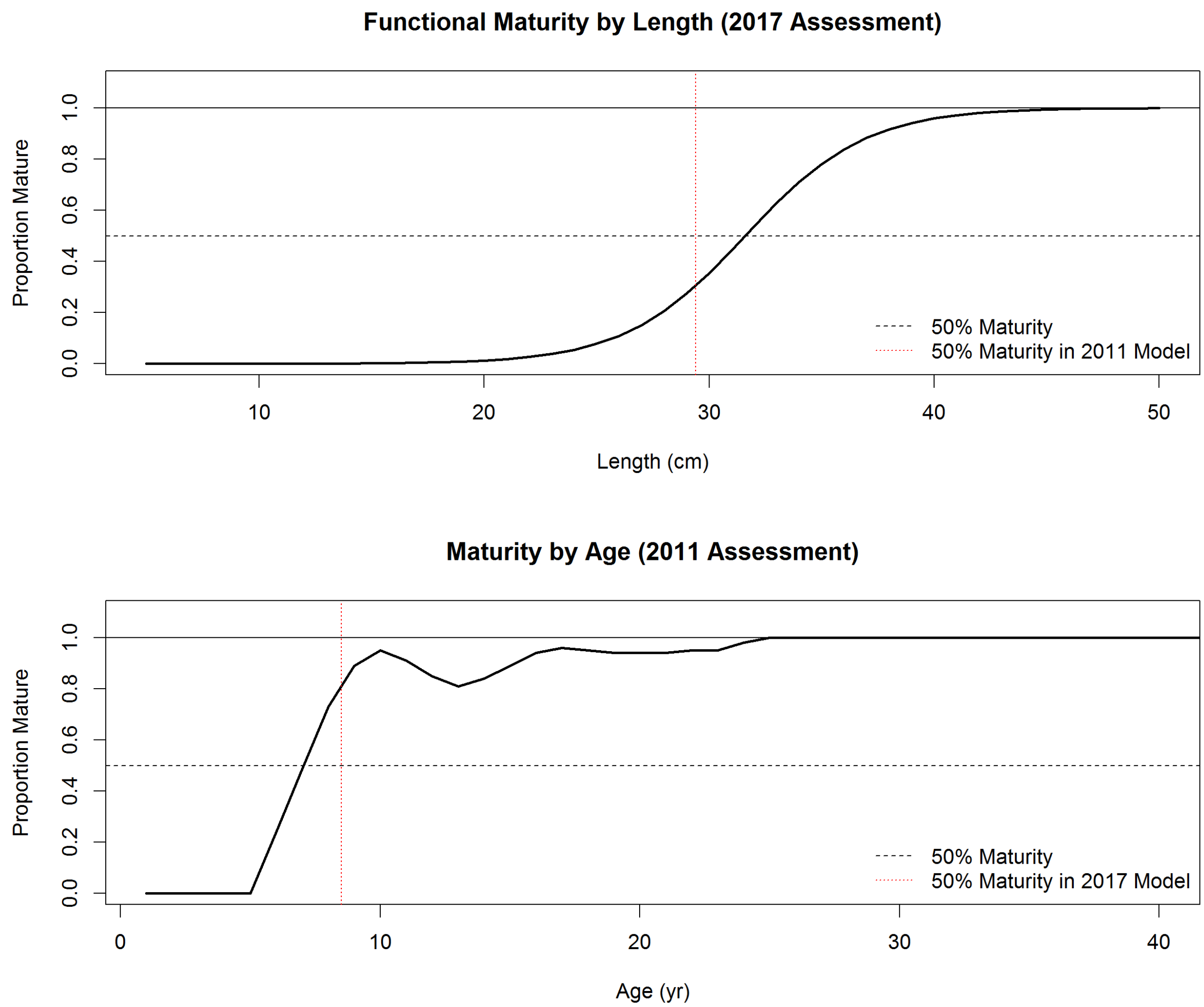

Figure 22: Comparison between estimated maturity-at-length used in this assessment and maturity-at-age applied in the 2011 assessment of Pacific ocean perch. fig:mat_compare

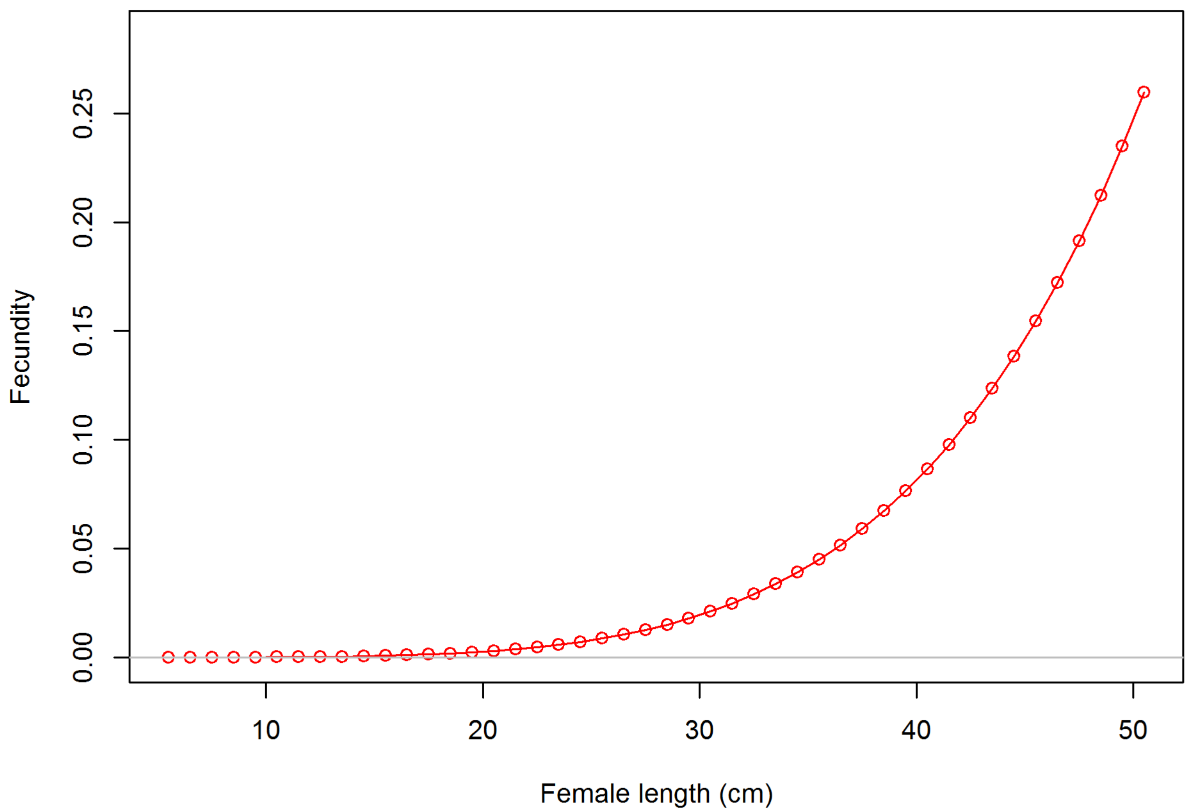

Figure 23: Fecundity at length of Pacific ocean perch in the Base model. fig:fecundity

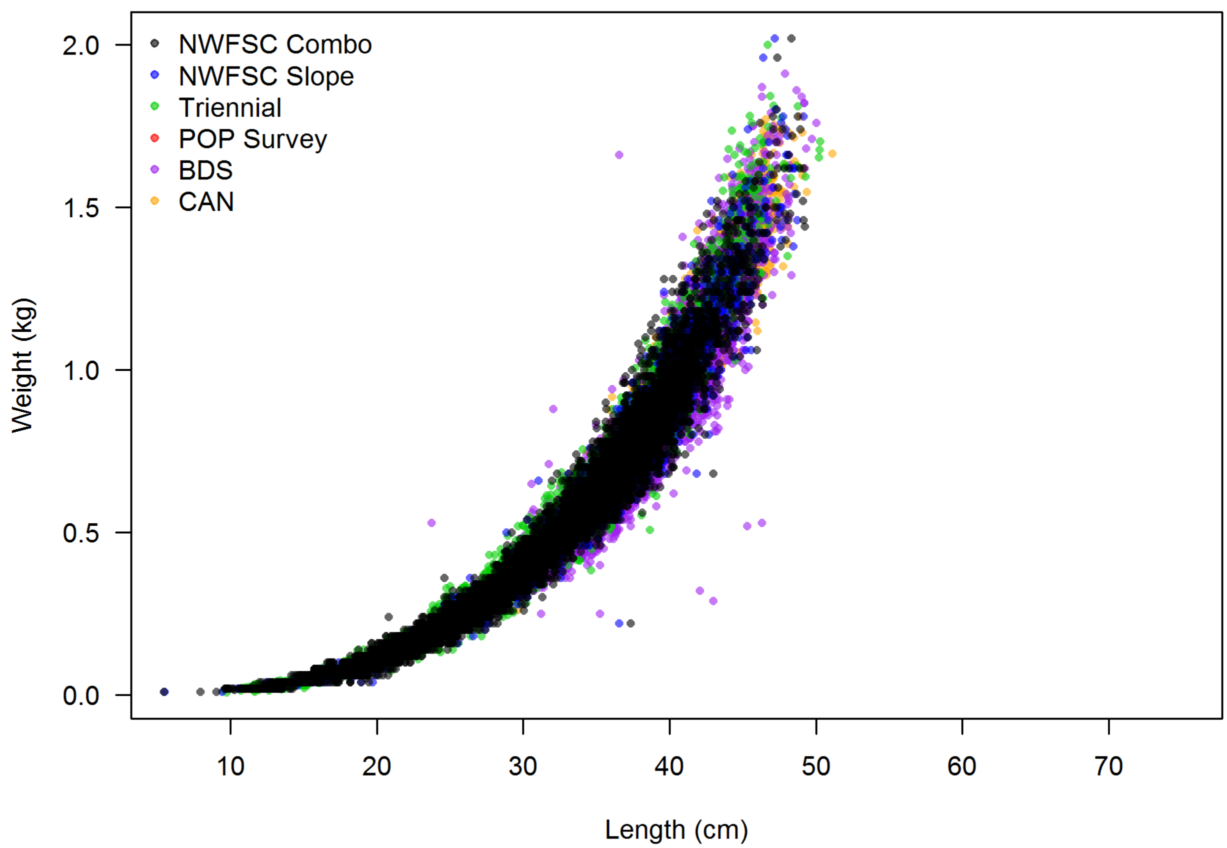

Figure 24: Weight-at-length for Pacific ocean perch from all data sources. fig:Wt_len

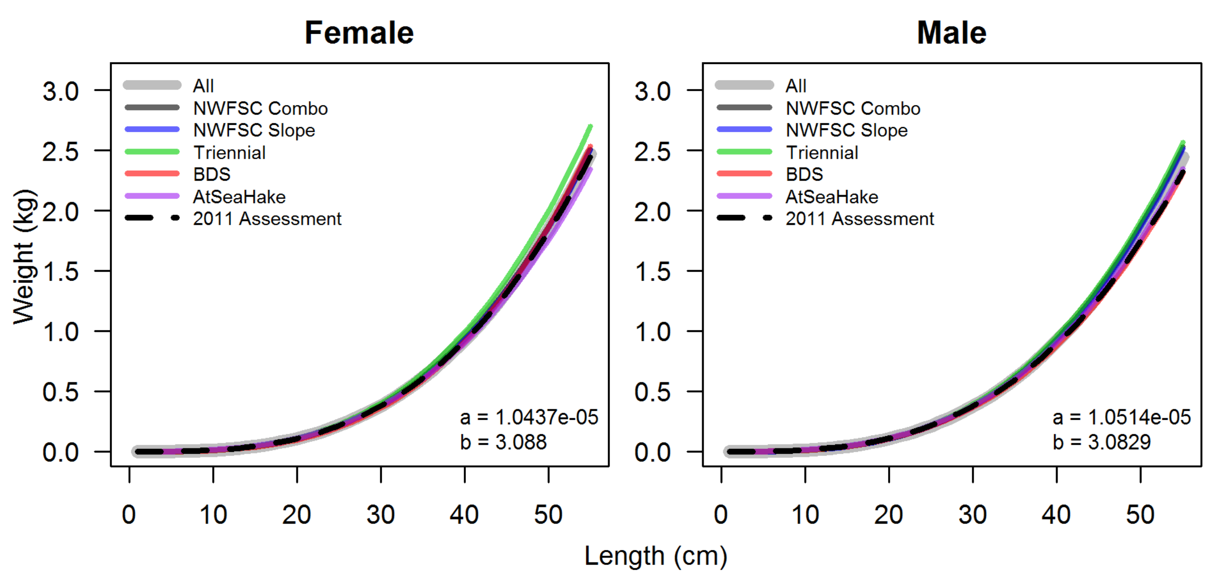

Figure 25: Estimated weight-at-length for Pacific ocean perch from all data sources. fig:Wt_len_pred

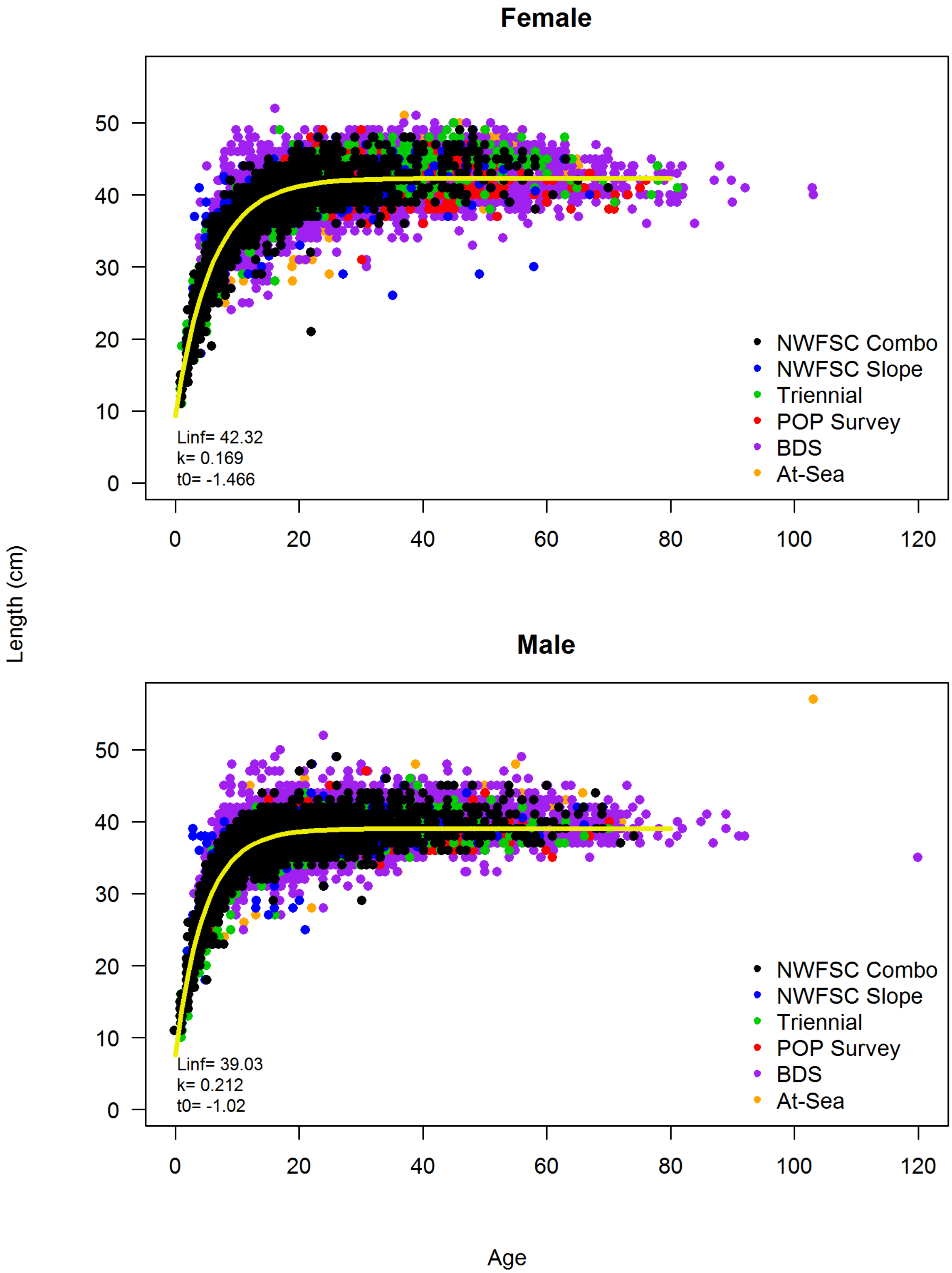

Figure 26: Estimated length-at-age for Pacific ocean perch from all data sources. fig:Len_Age

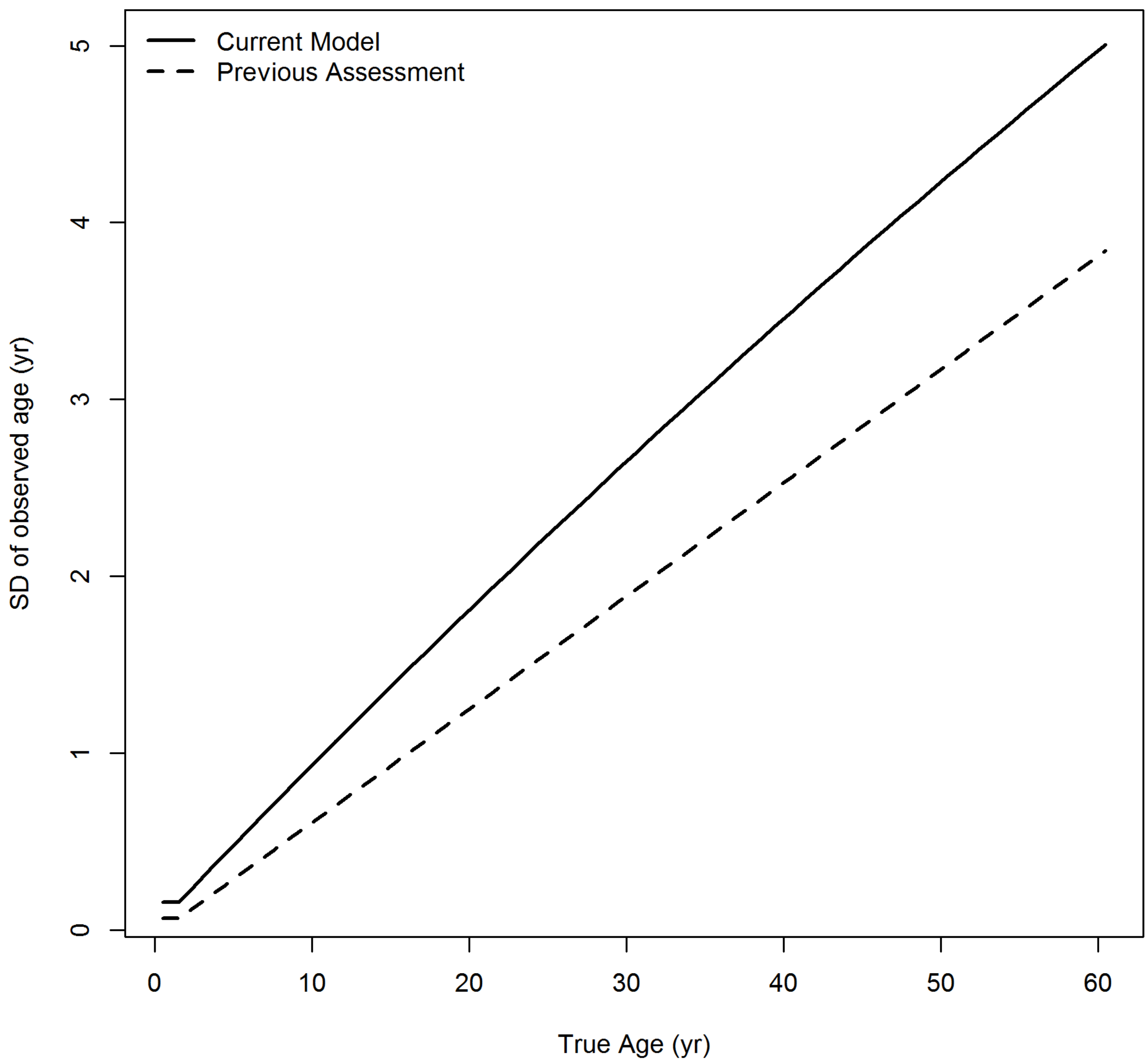

Figure 27: The estimated ageing error used in this assessment compared to the ageing error assumed in the previous assessment for Pacific ocean perch. fig:Age_Error

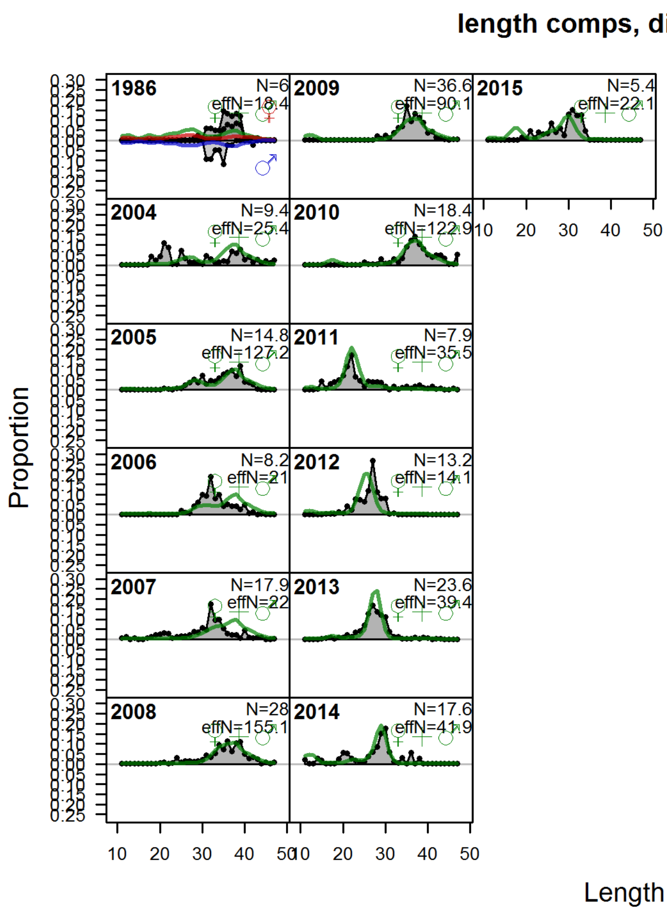

Figure 28: length comps, discard, Fishery fig:mod1_1_comp_lenfit_flt1mkt1

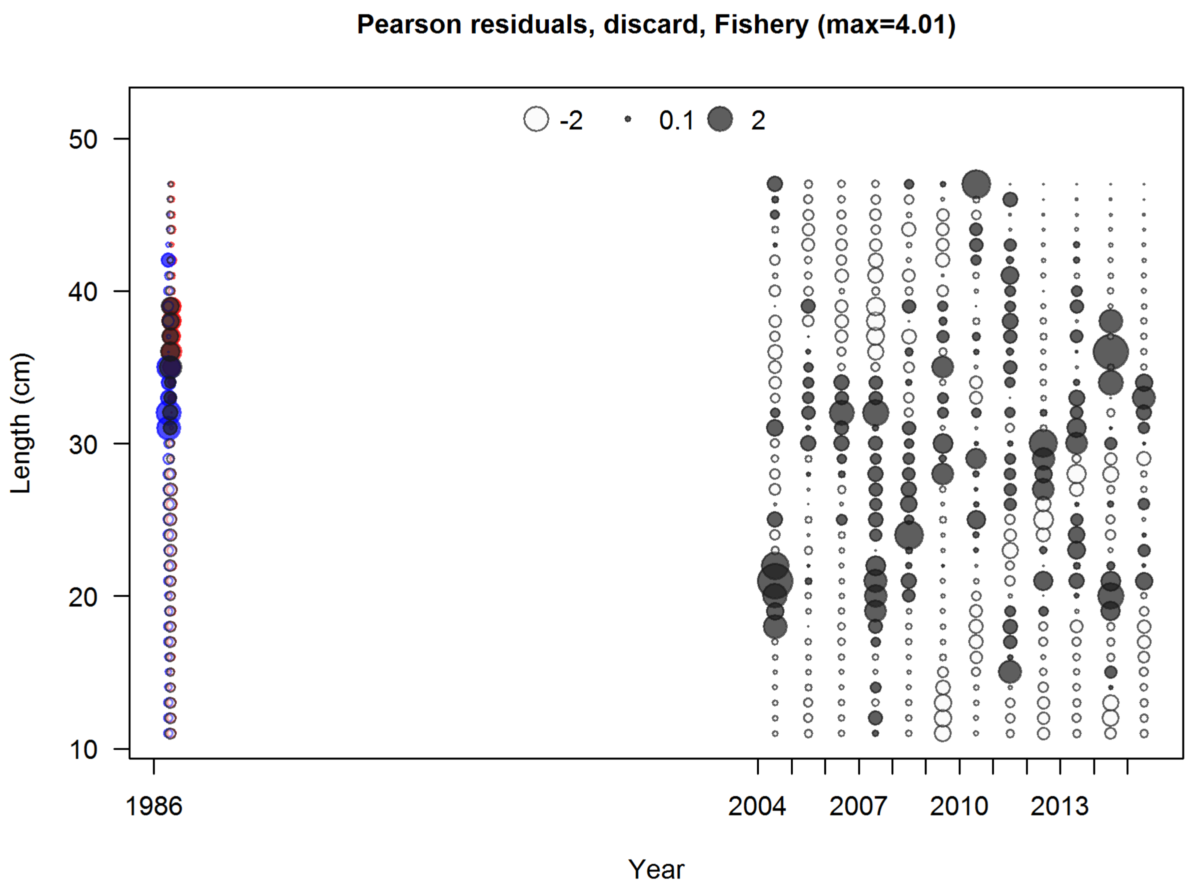

Figure 29: Pearson residuals, discard, Fishery (max=4.01)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_2_comp_lenfit_residsflt1mkt1

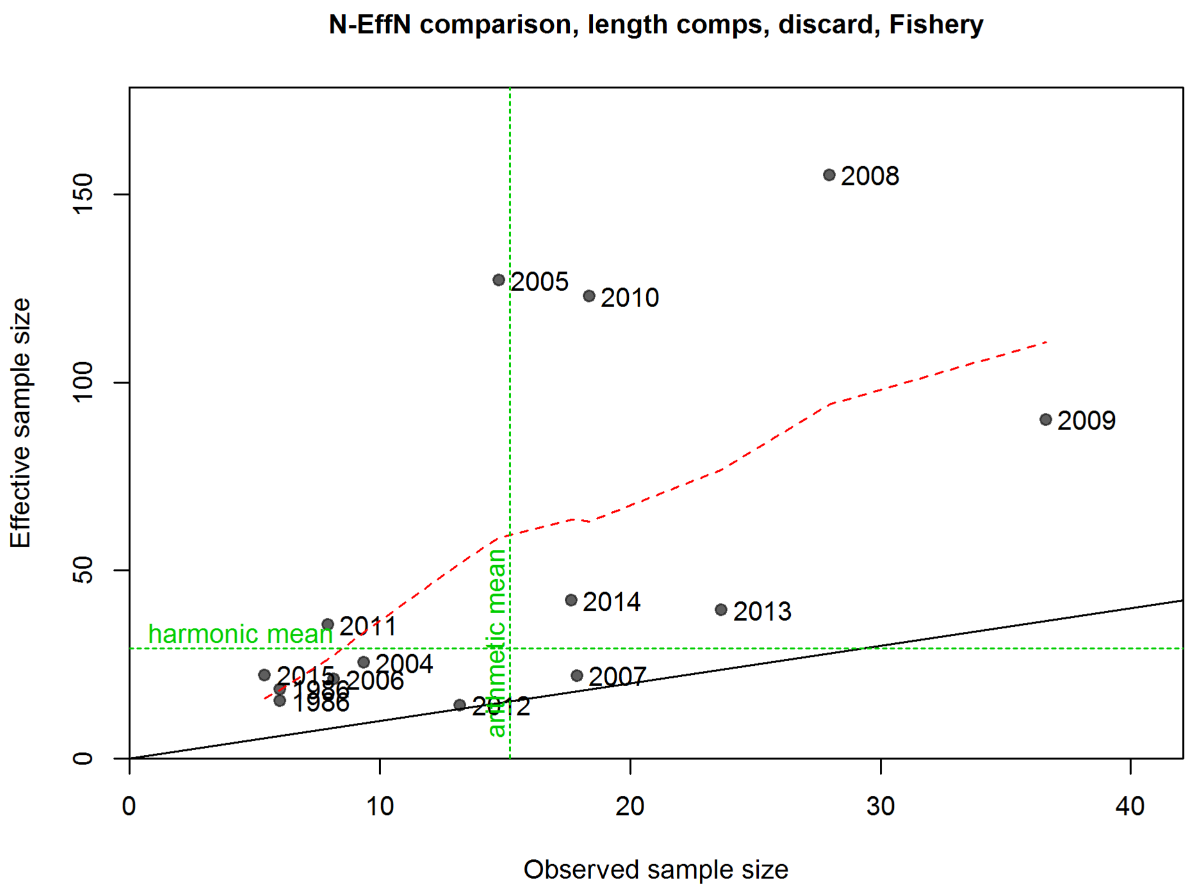

Figure 30: N_EffN comparison, length comps, discard, Fishery fig:mod1_3_comp_lenfit_sa

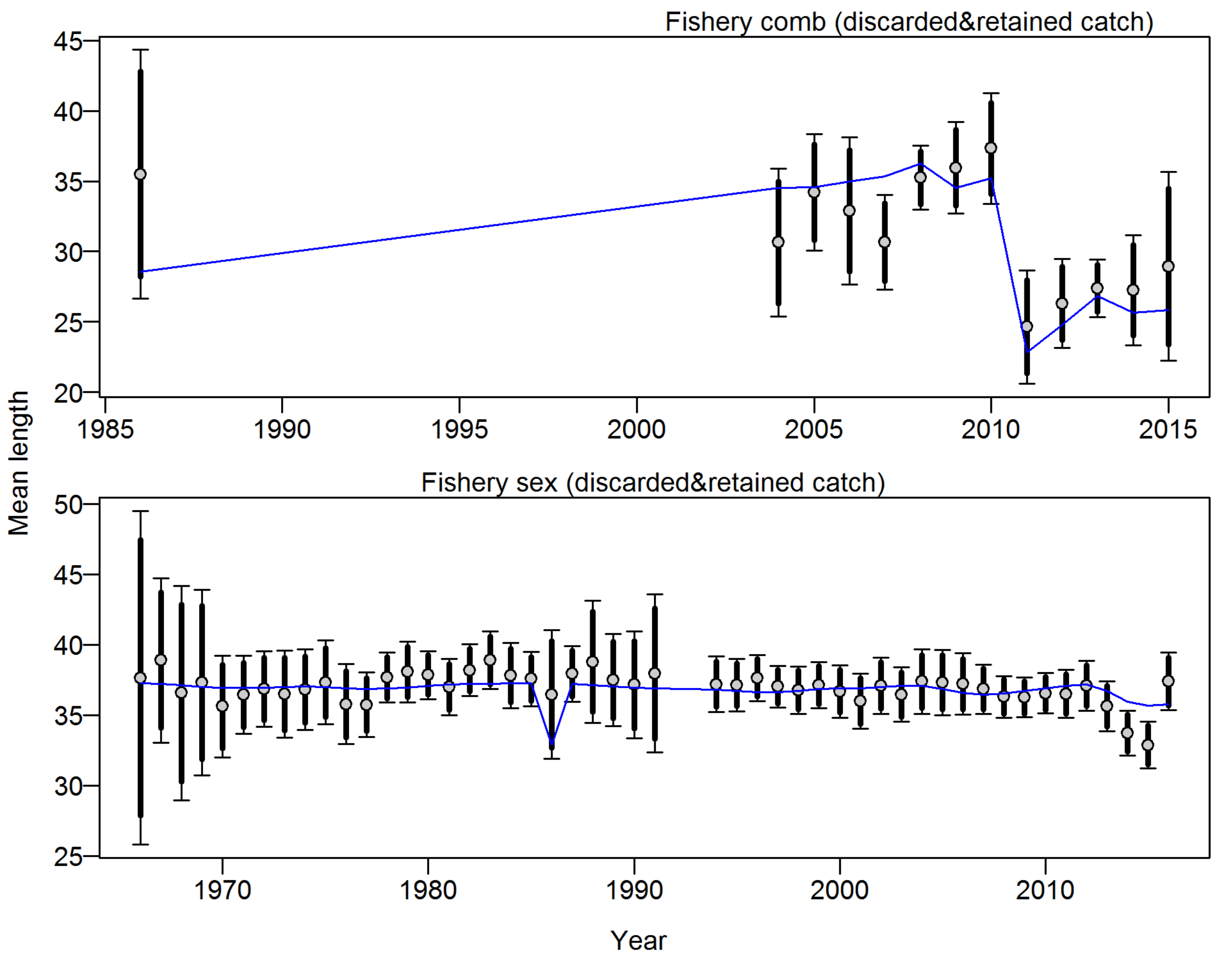

Figure 31: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.6812 (0.4372_1.2922) fig:mod1_4_comp_lenfit_data_weig

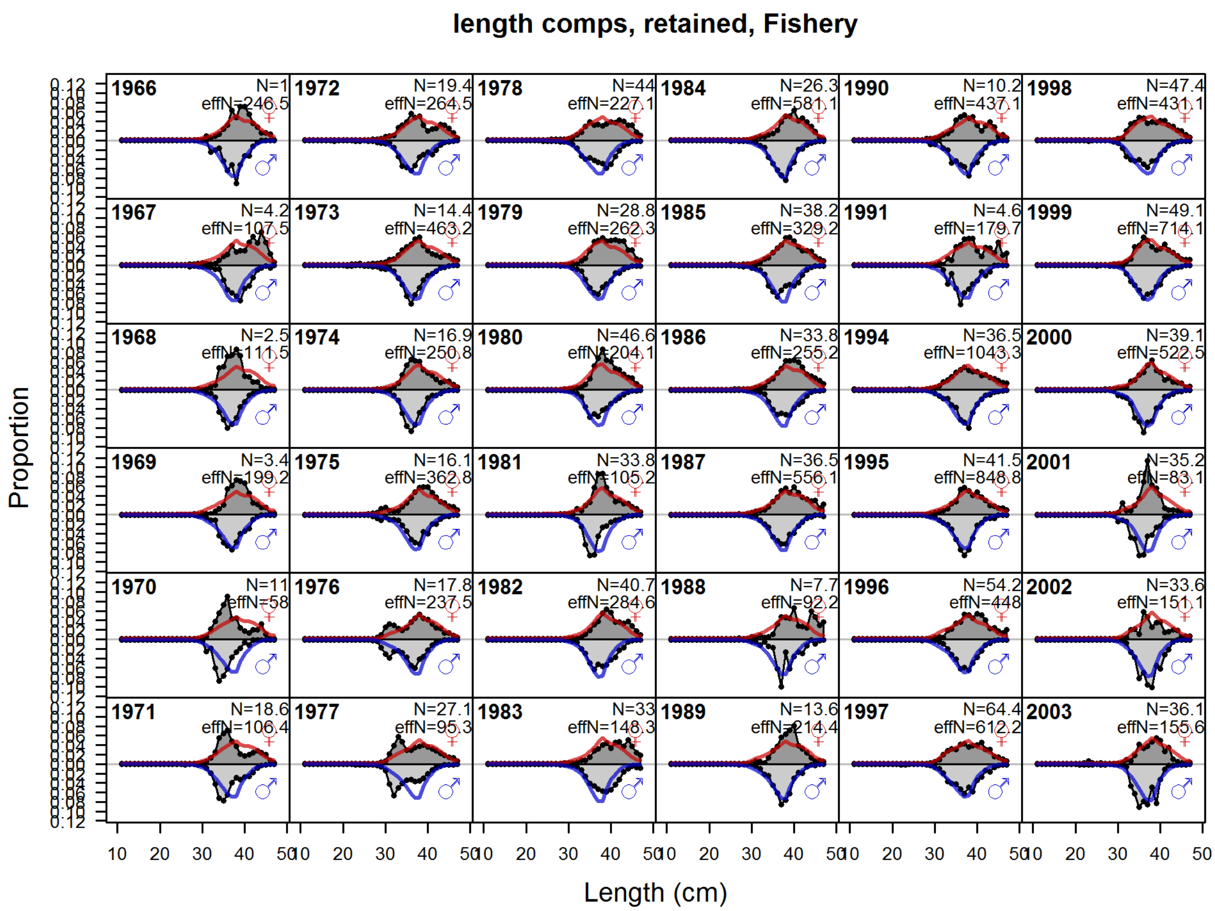

Figure 32: length comps, retained, Fishery (plot 1 of 2) fig:mod1_5_comp_lenfit_flt1ml

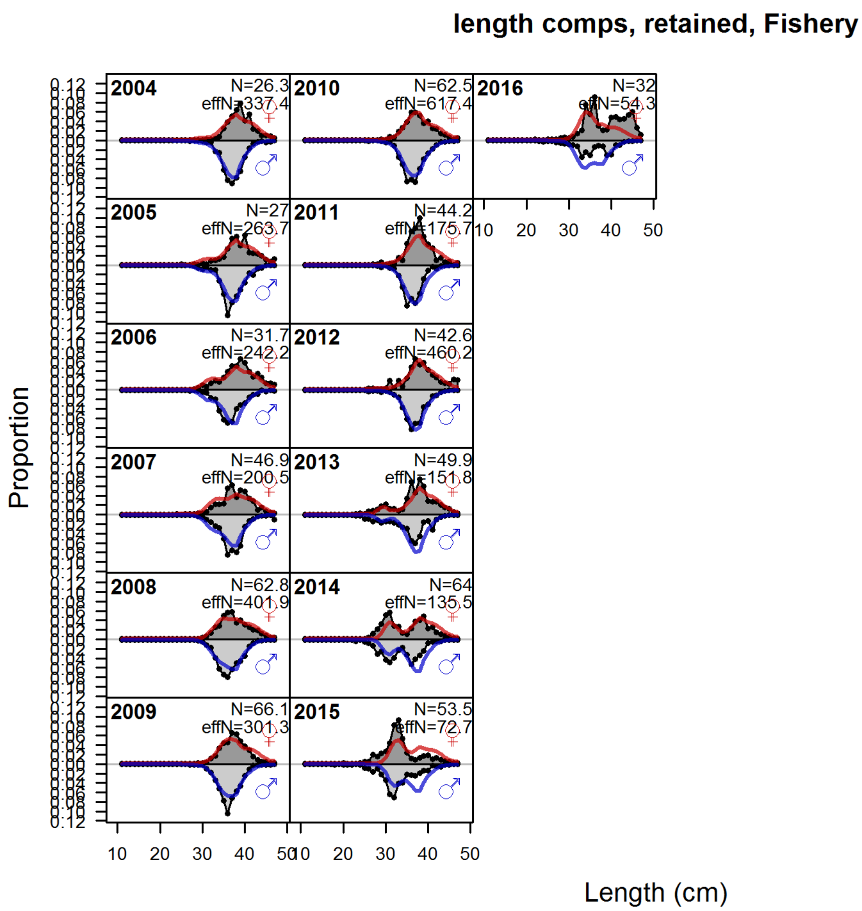

Figure 33: length comps, retained, Fishery (plot 2 of 2) fig:mod1_6_comp_lenfit_flt1ml

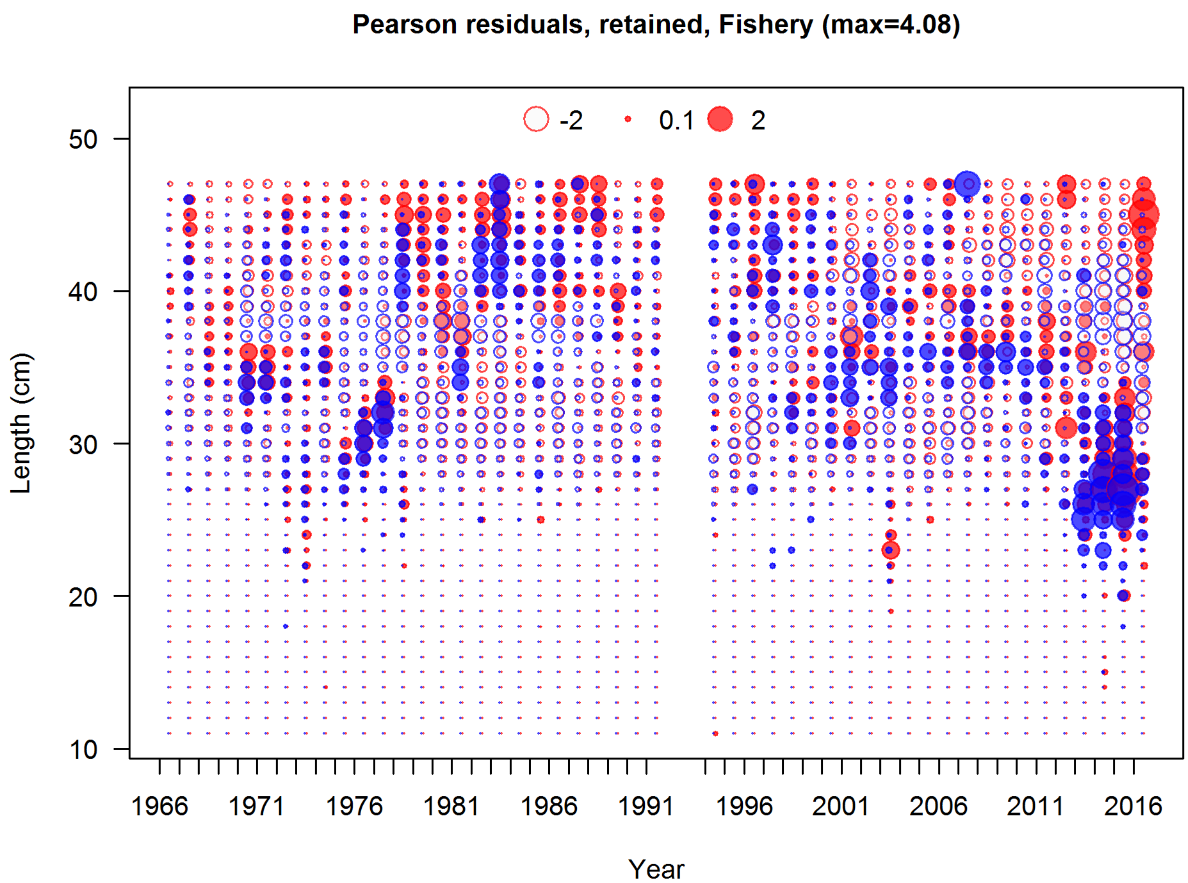

Figure 34: Pearson residuals, retained, Fishery (max=4.08) (plot 2 of 2)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_7_comp_lenfit_residsflt1mkt2_page2

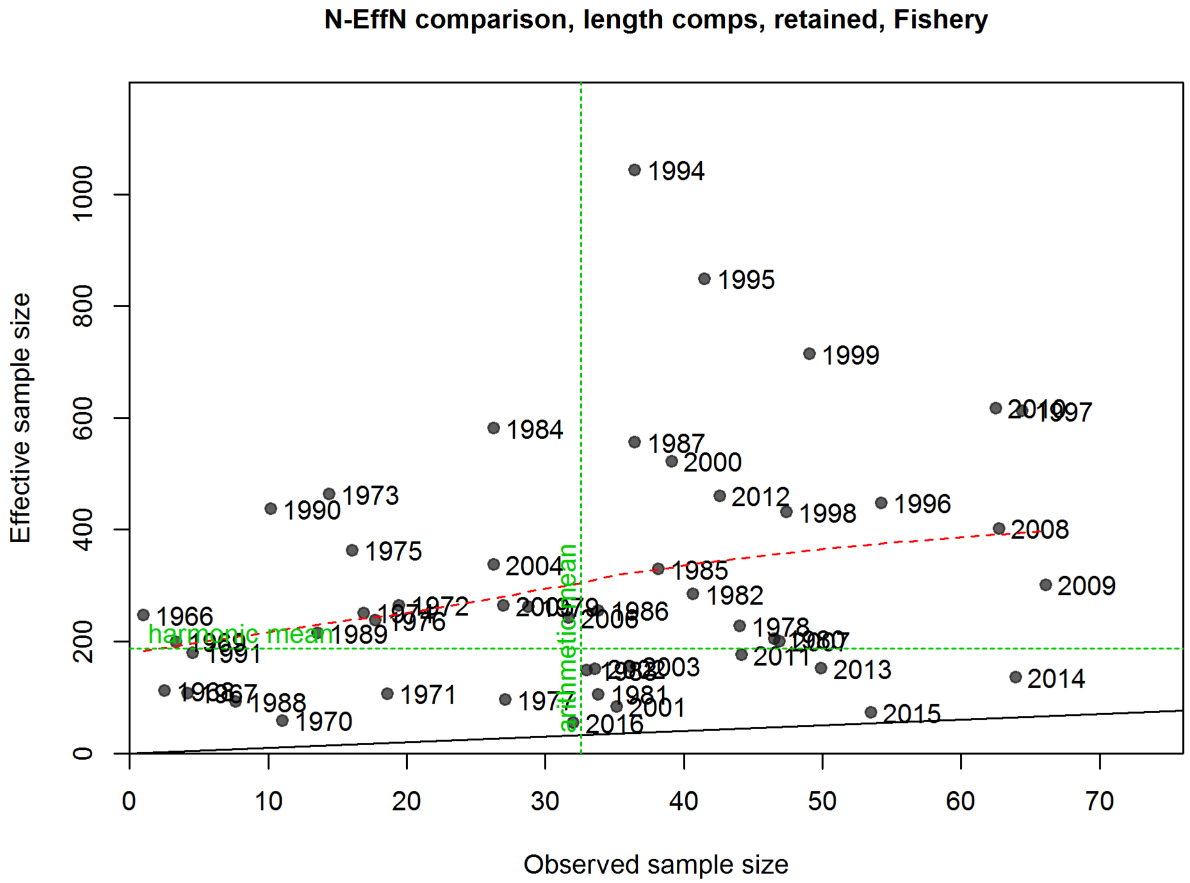

Figure 35: N_EffN comparison, length comps, retained, Fishery fig:mod1_8_comp_lenfit_sa

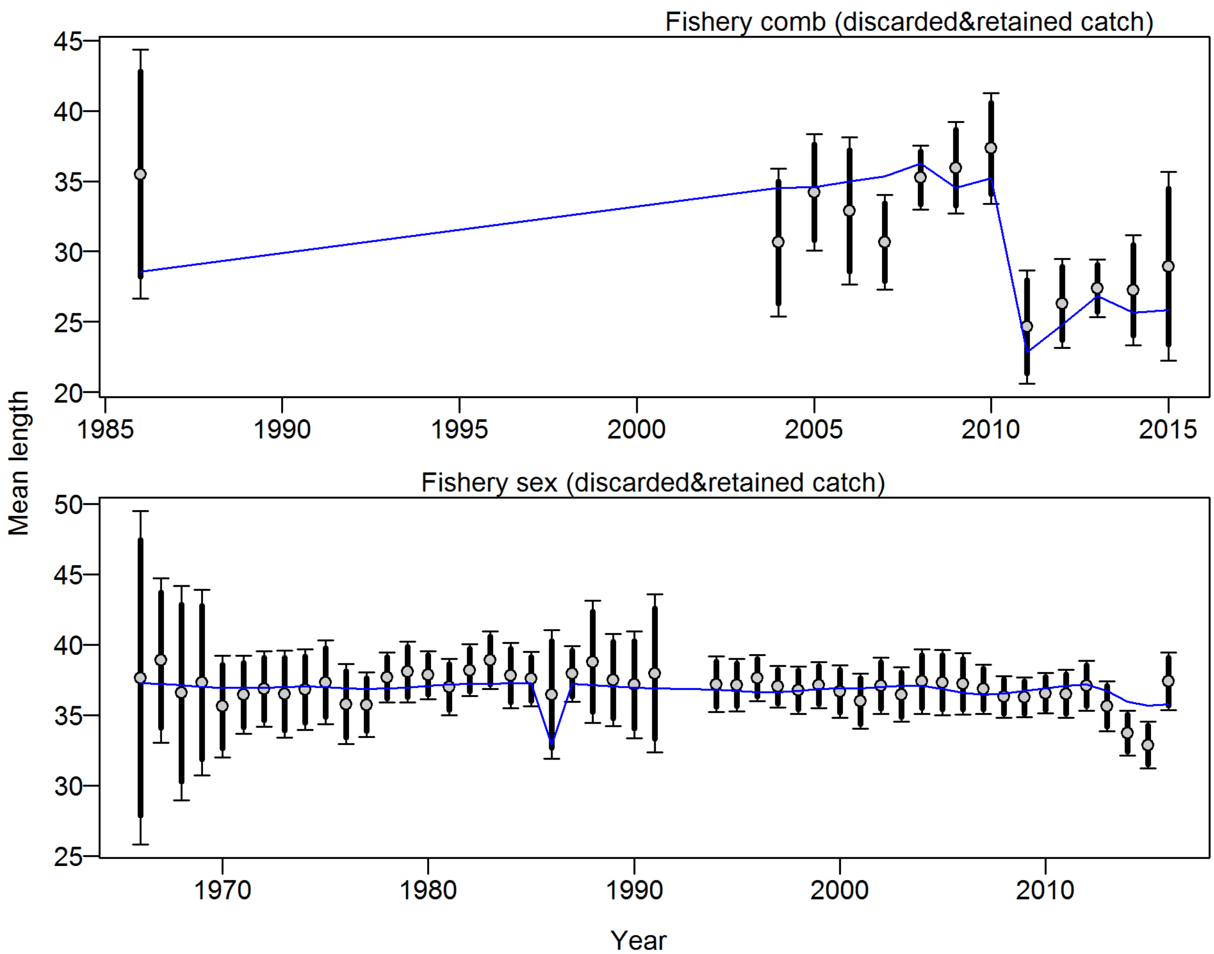

Figure 36: Francis data weighting method TA1.8 Fishery Suggested sample size adjustment (with 95% interval) for len data from Fishery: 0.6812 (0.4608_1.2851) fig:mod1_9_comp_lenfit_data_weig

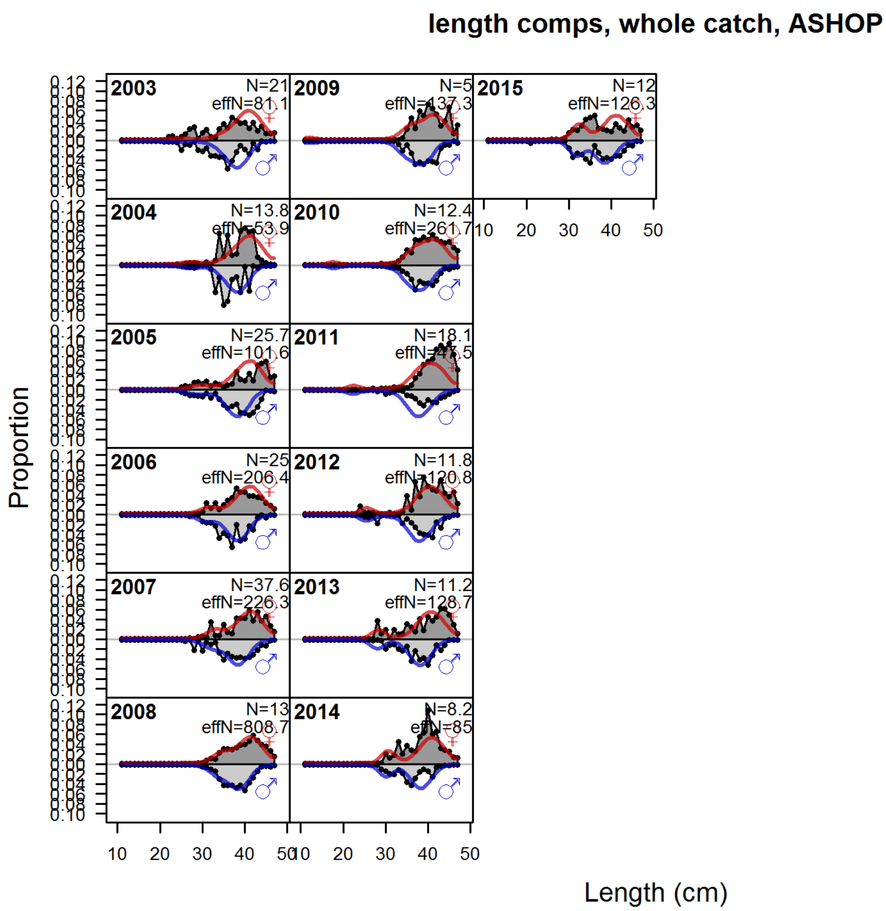

Figure 37: length comps, whole catch, ASHOP fig:mod1_10_comp_lenfit_flt2mkt0

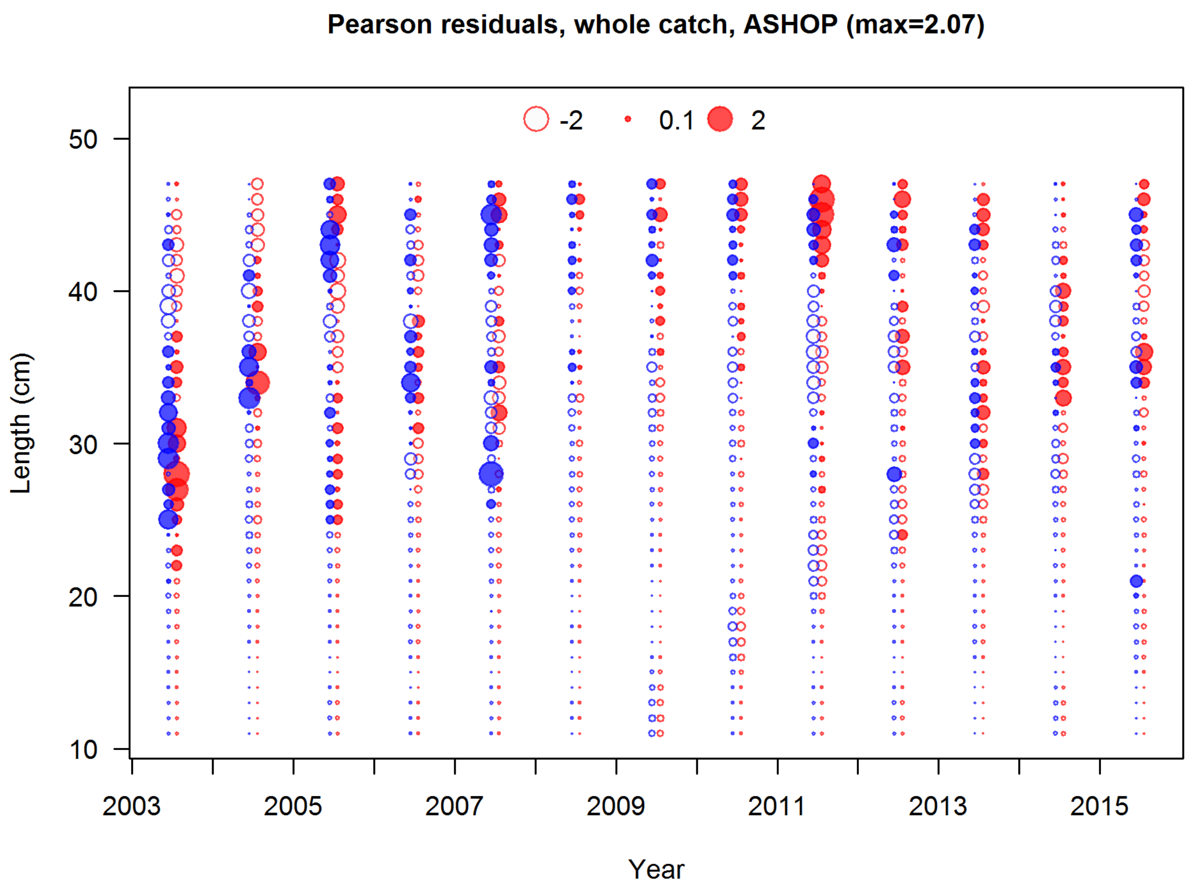

Figure 38: Pearson residuals, whole catch, ASHOP (max=2.07)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_11_comp_lenfit_residsflt2mkt0

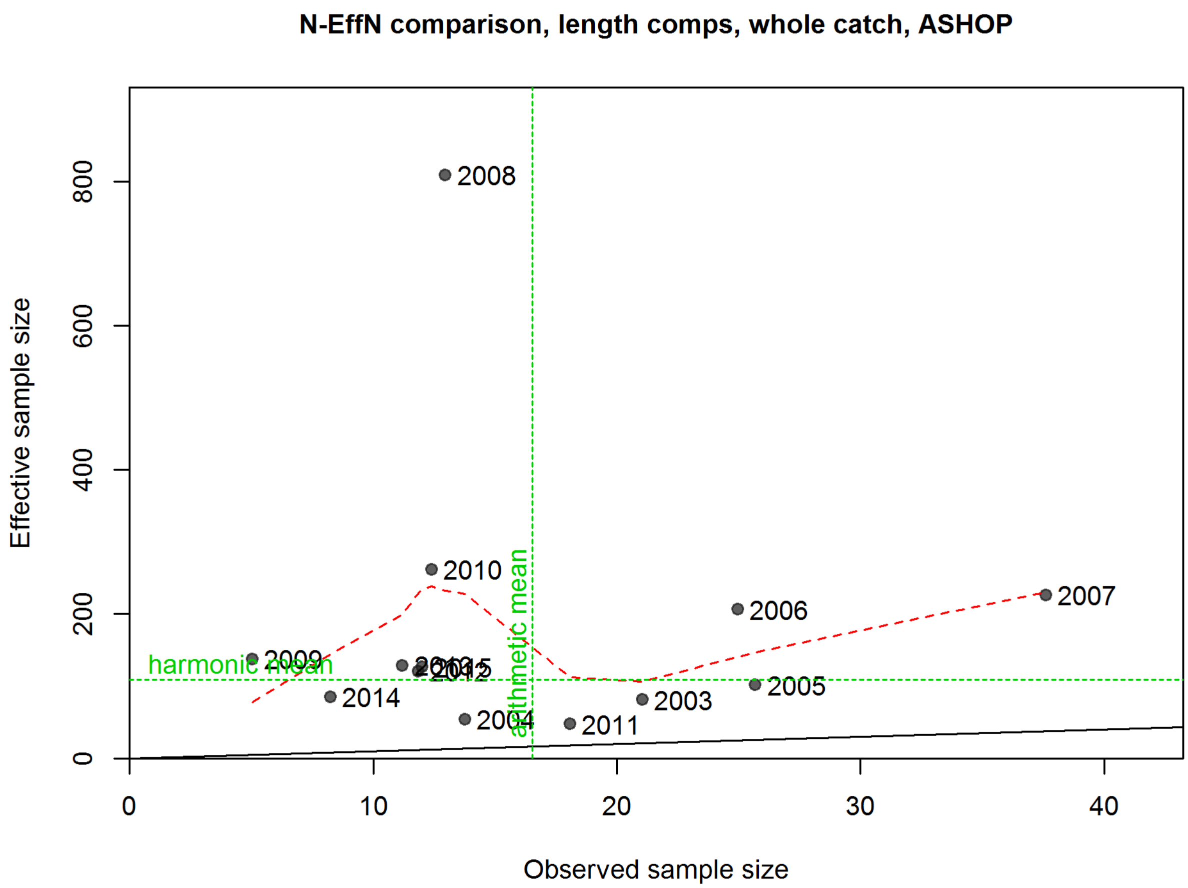

Figure 39: N_EffN comparison, length comps, whole catch, ASHOP fig:mod1_12_comp_lenfit

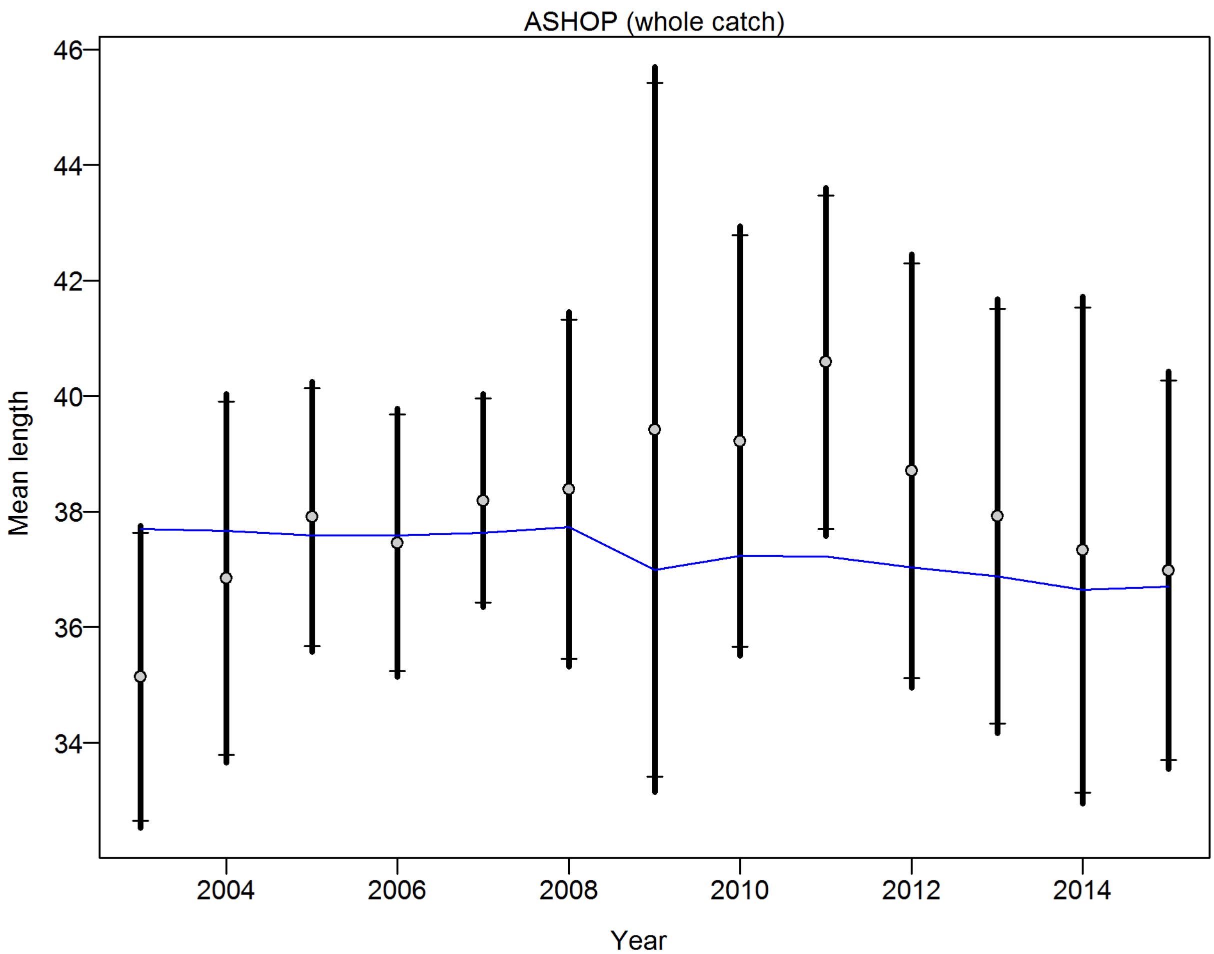

Figure 40: Francis data weighting method TA1.8 ASHOP Suggested sample size adjustment (with 95% interval) for len data from ASHOP: 1.0925 (0.5201_6.8777) fig:mod1_13_comp_lenfit_data_wei

length comps, whole catch, POP

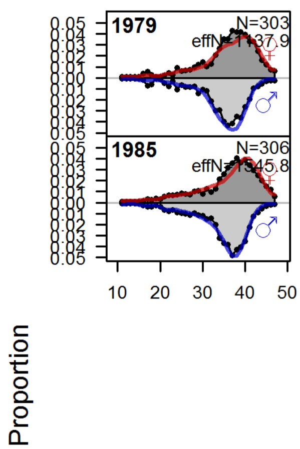

Figure 41: length comps, whole catch, POP fig:mod1_14_comp_lenfit_flt4mkt0

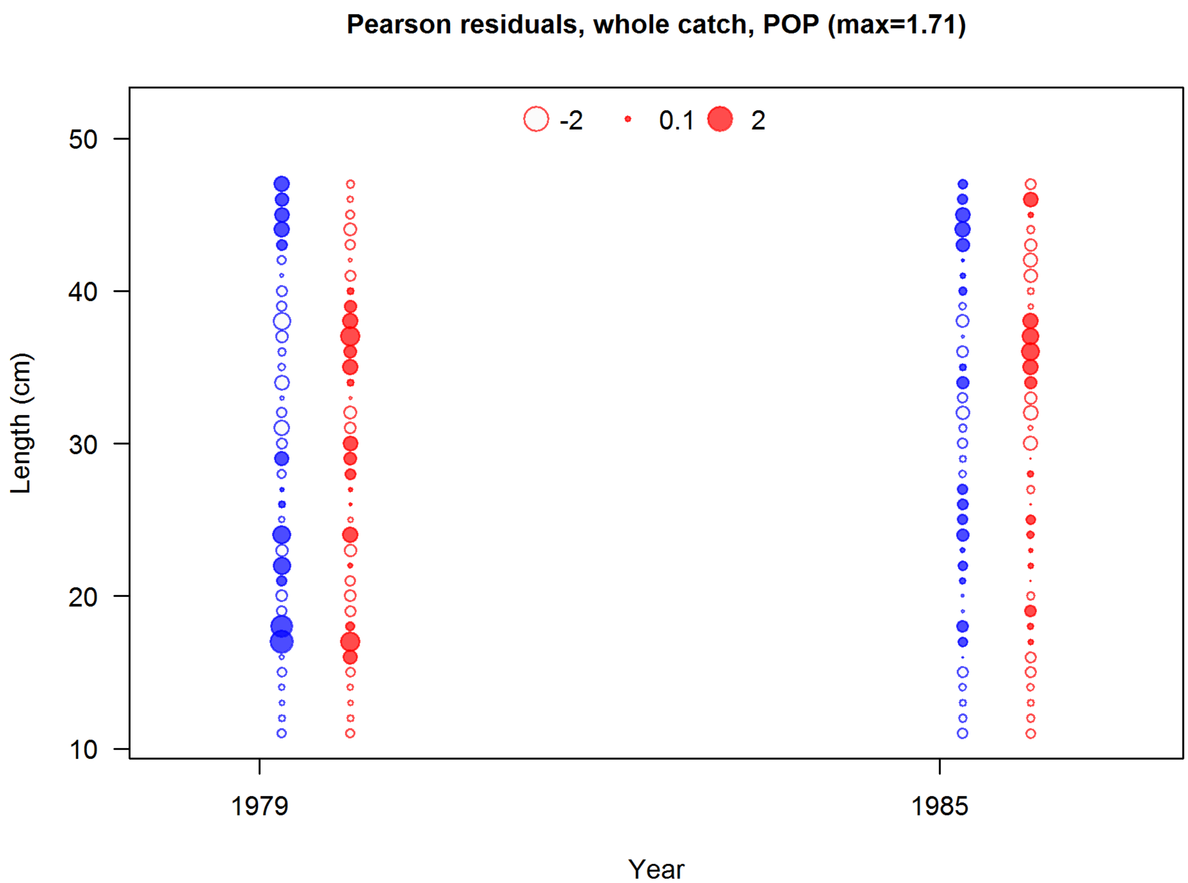

Figure 42: Pearson residuals, whole catch, POP (max=1.71)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_15_comp_lenfit_residsflt4mkt0

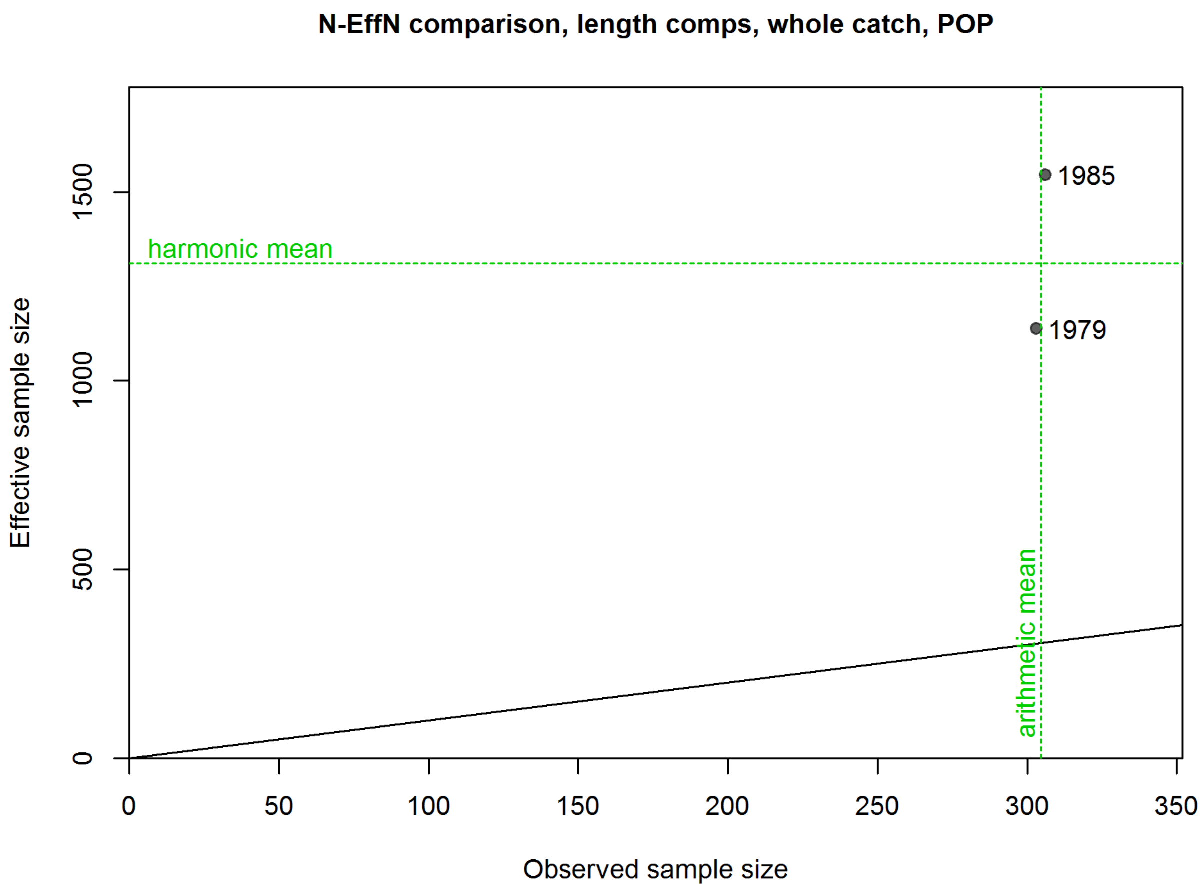

Figure 43: N_EffN comparison, length comps, whole catch, POP fig:mod1_16_comp_lenfit_s

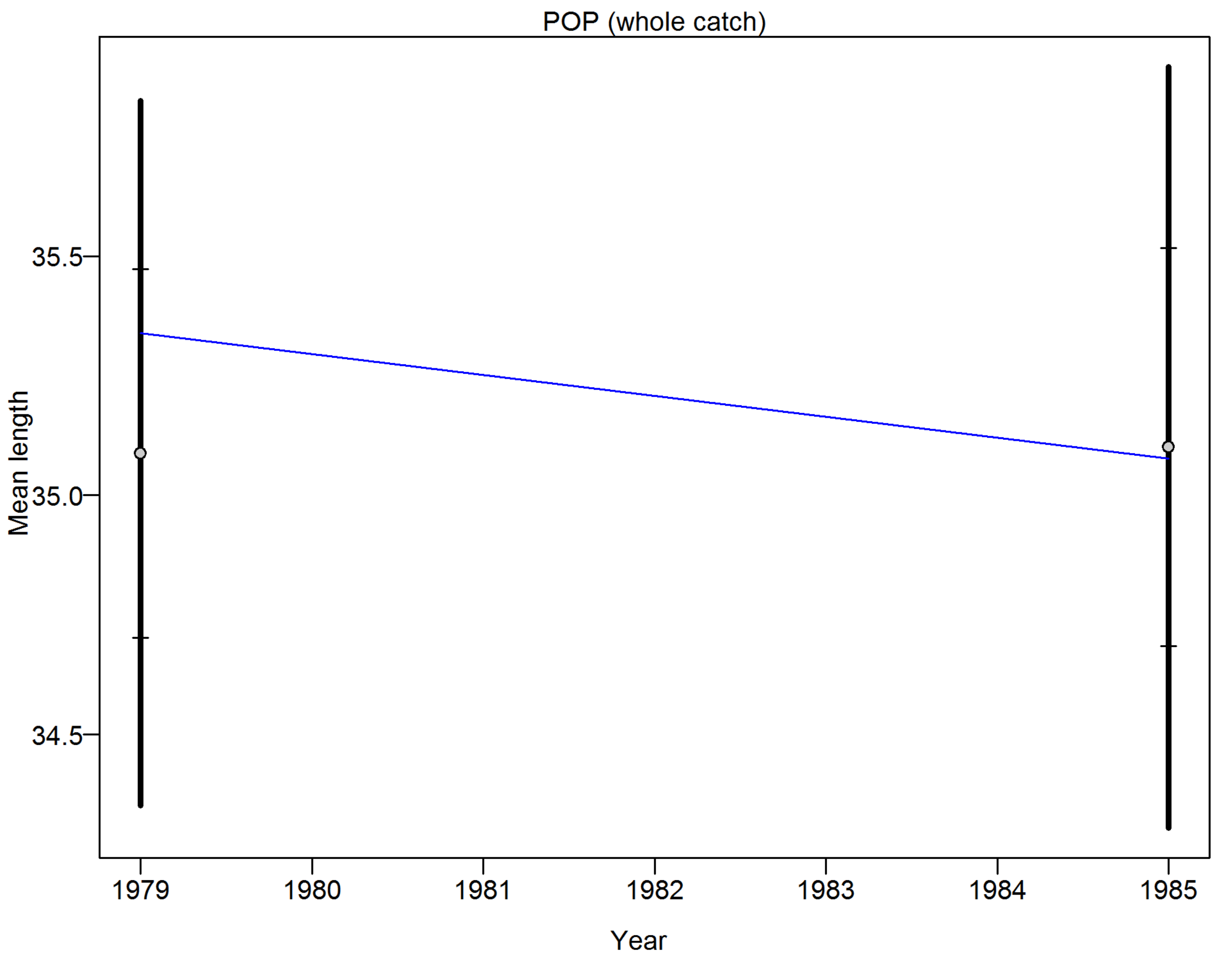

Figure 44: Francis data weighting method TA1.8 POP Suggested sample size adjustment (with 95% interval) for len data from POP: 3.6493 (3.6493_Inf) fig:mod1_17_comp_lenfit_data_weighting

length comps, whole catch, Triennial

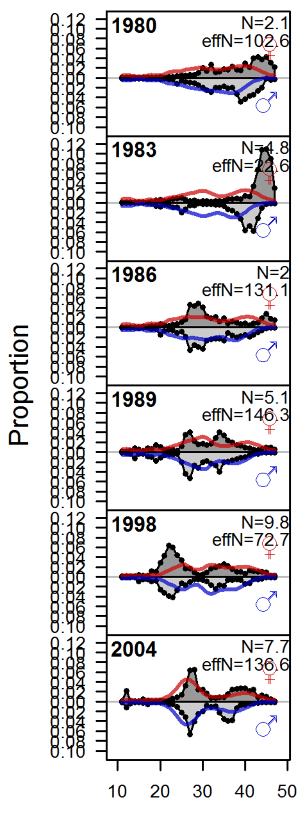

Figure 45: length comps, whole catch, Triennial fig:mod1_18_comp_lenfit_flt5mkt0

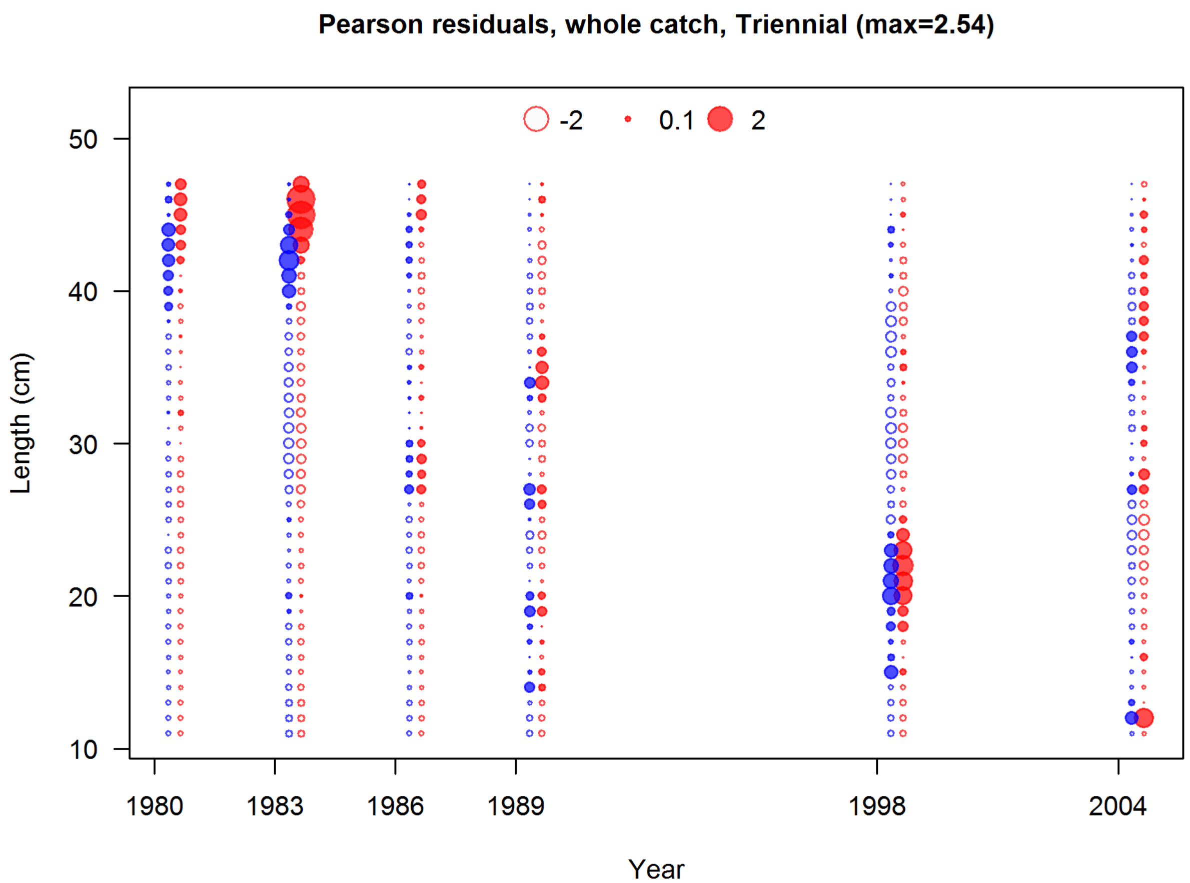

Figure 46: Pearson residuals, whole catch, Triennial (max=2.54)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_19_comp_lenfit_residsflt5mkt0

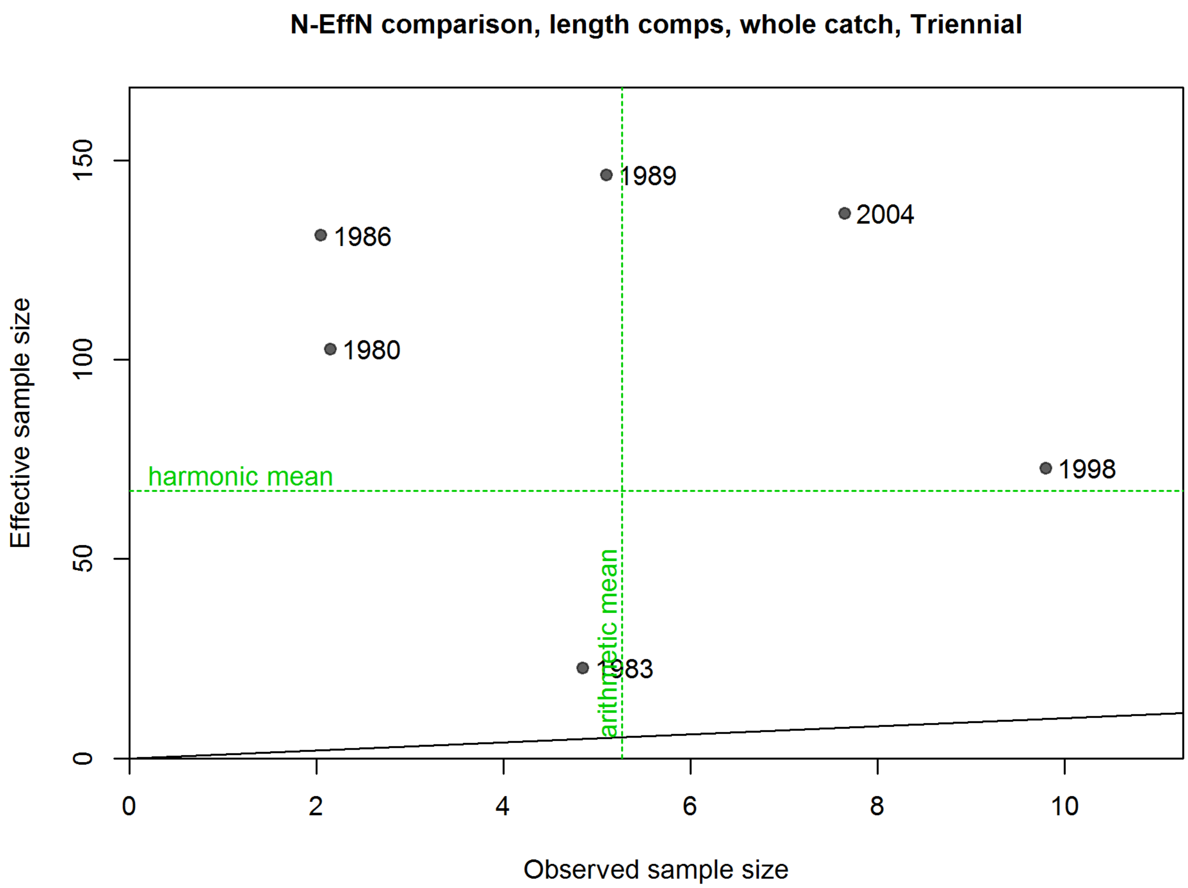

Figure 47: N_EffN comparison, length comps, whole catch, Triennial fig:mod1_20_comp_lenfit

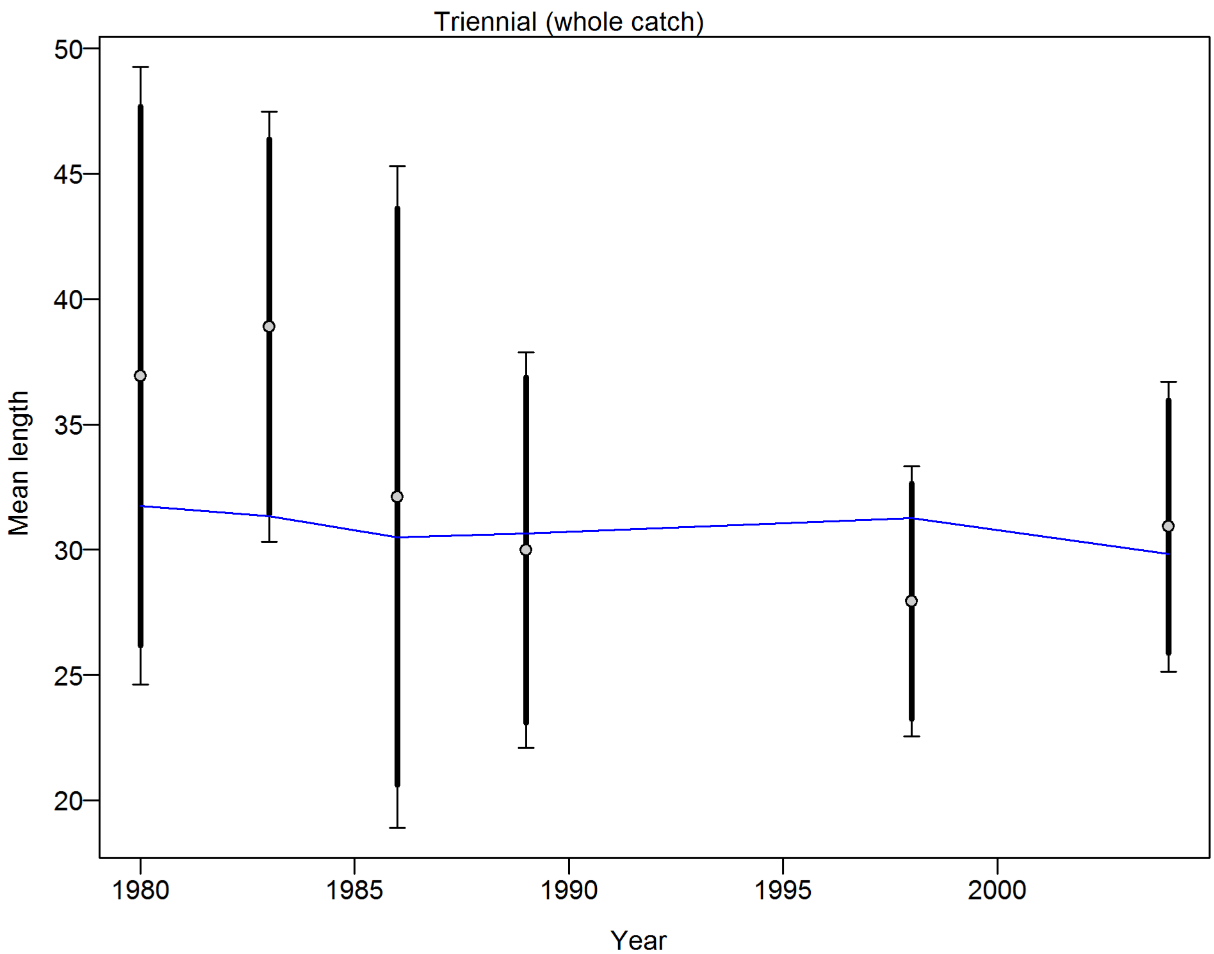

Figure 48: Francis data weighting method TA1.8 Triennial Suggested sample size adjustment (with 95% interval) for len data from Triennial: 0.7605 (0.4163_9.5191) fig:mod1_21_comp_lenfit_data_we

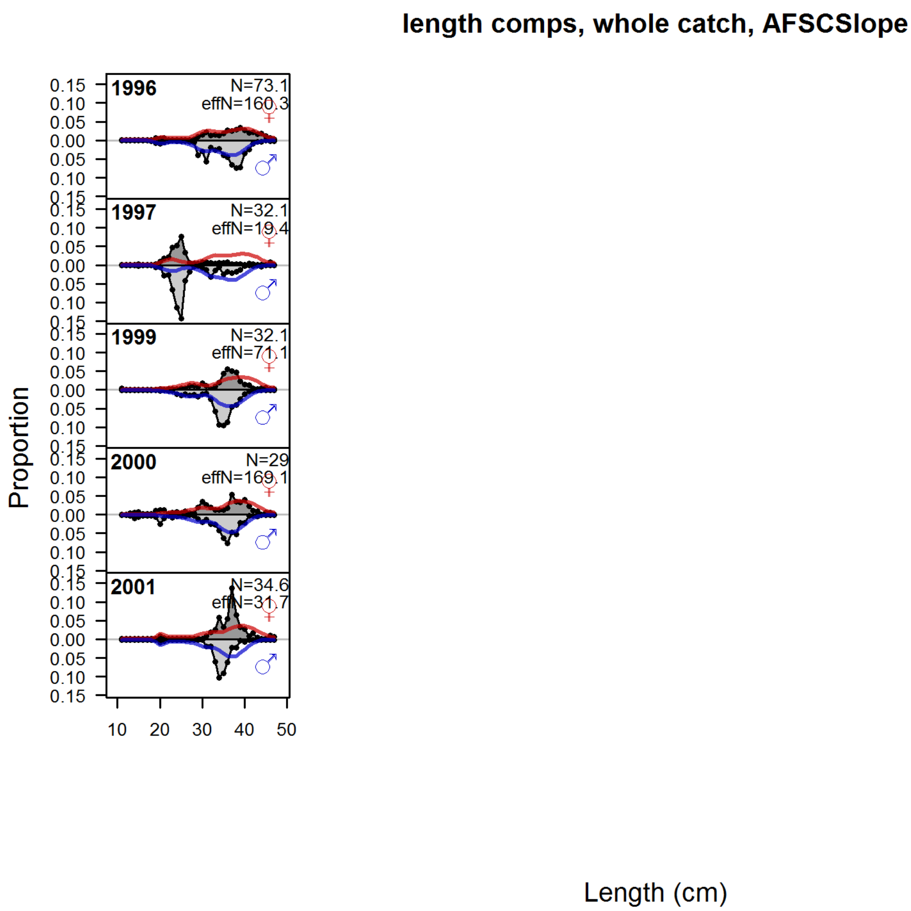

Figure 49: length comps, whole catch, AFSCSlope fig:mod1_22_comp_lenfit_flt6mkt

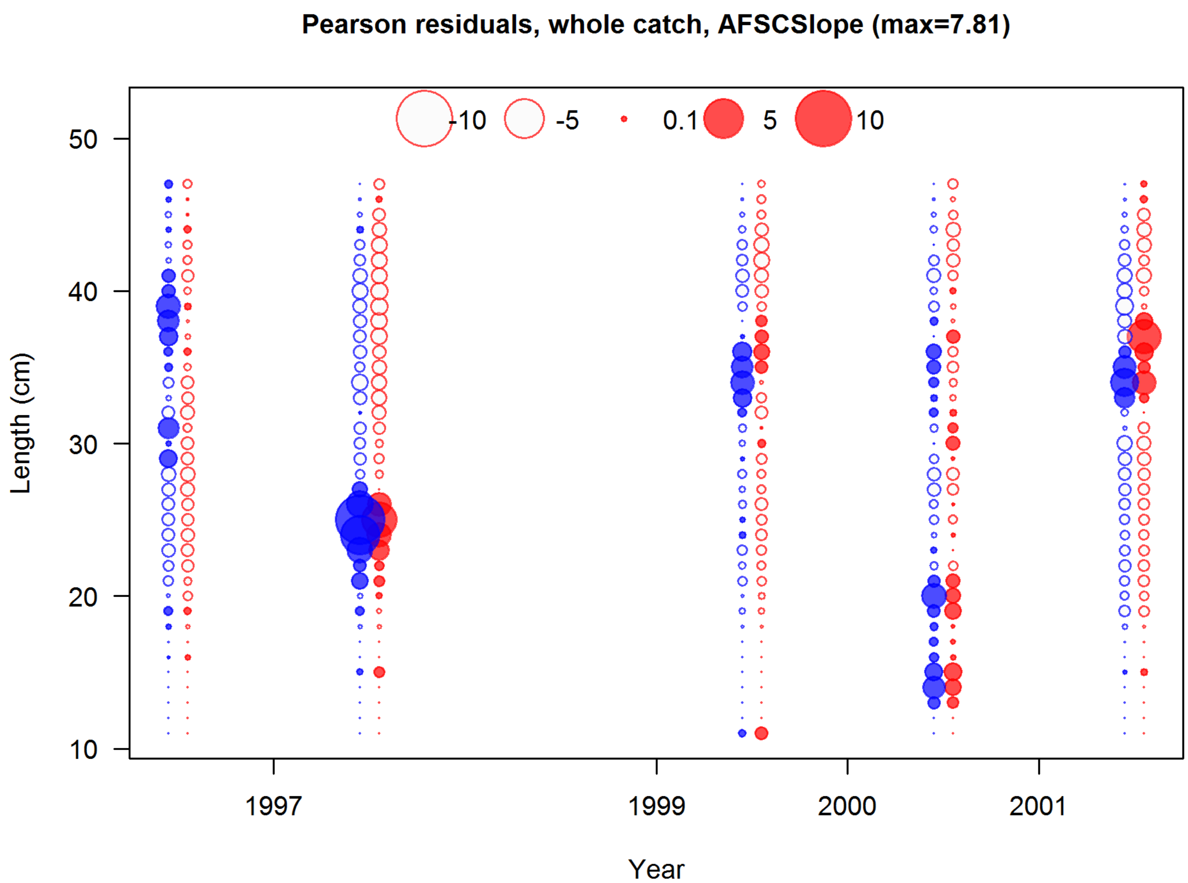

Figure 50: Pearson residuals, whole catch, AFSCSlope (max=7.81)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_23_comp_lenfit_residsflt6mkt0

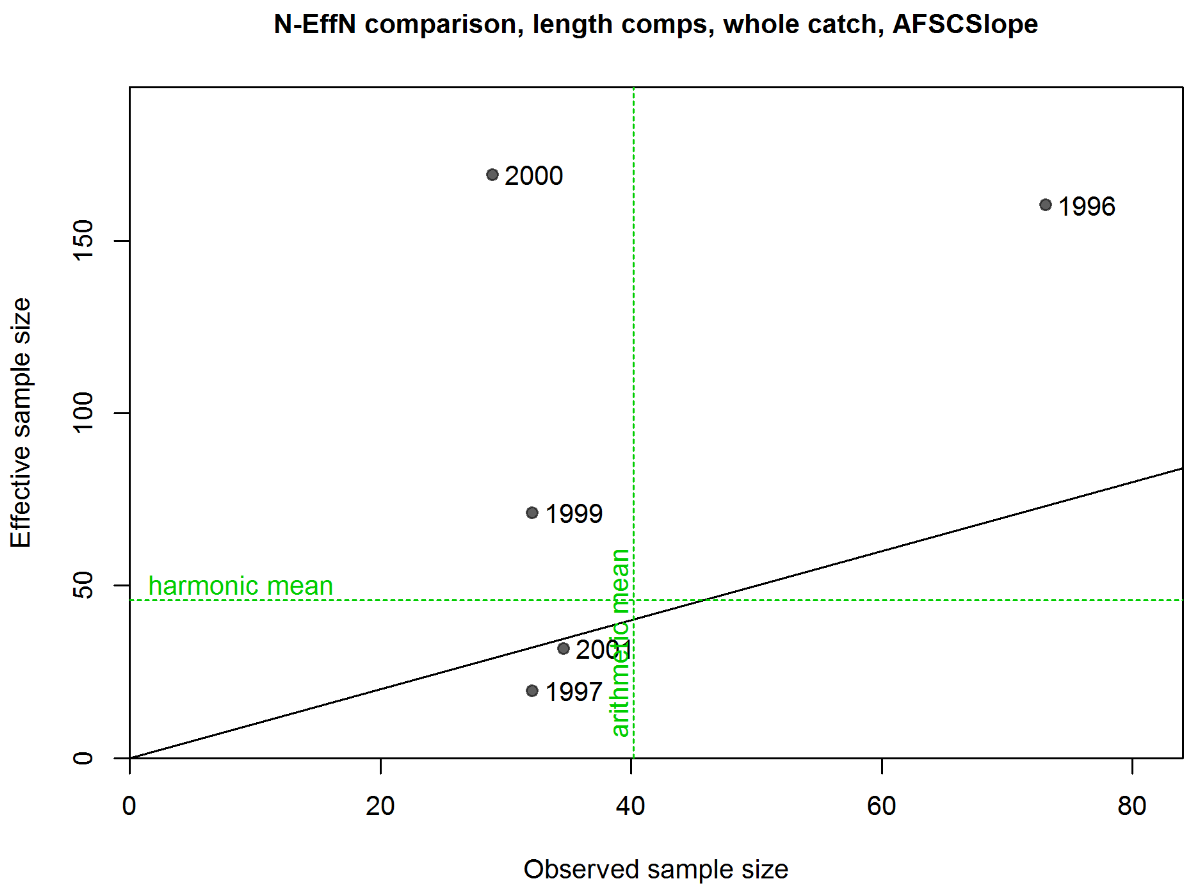

Figure 51: N_EffN comparison, length comps, whole catch, AFSCSlope fig:mod1_24_comp_lenf

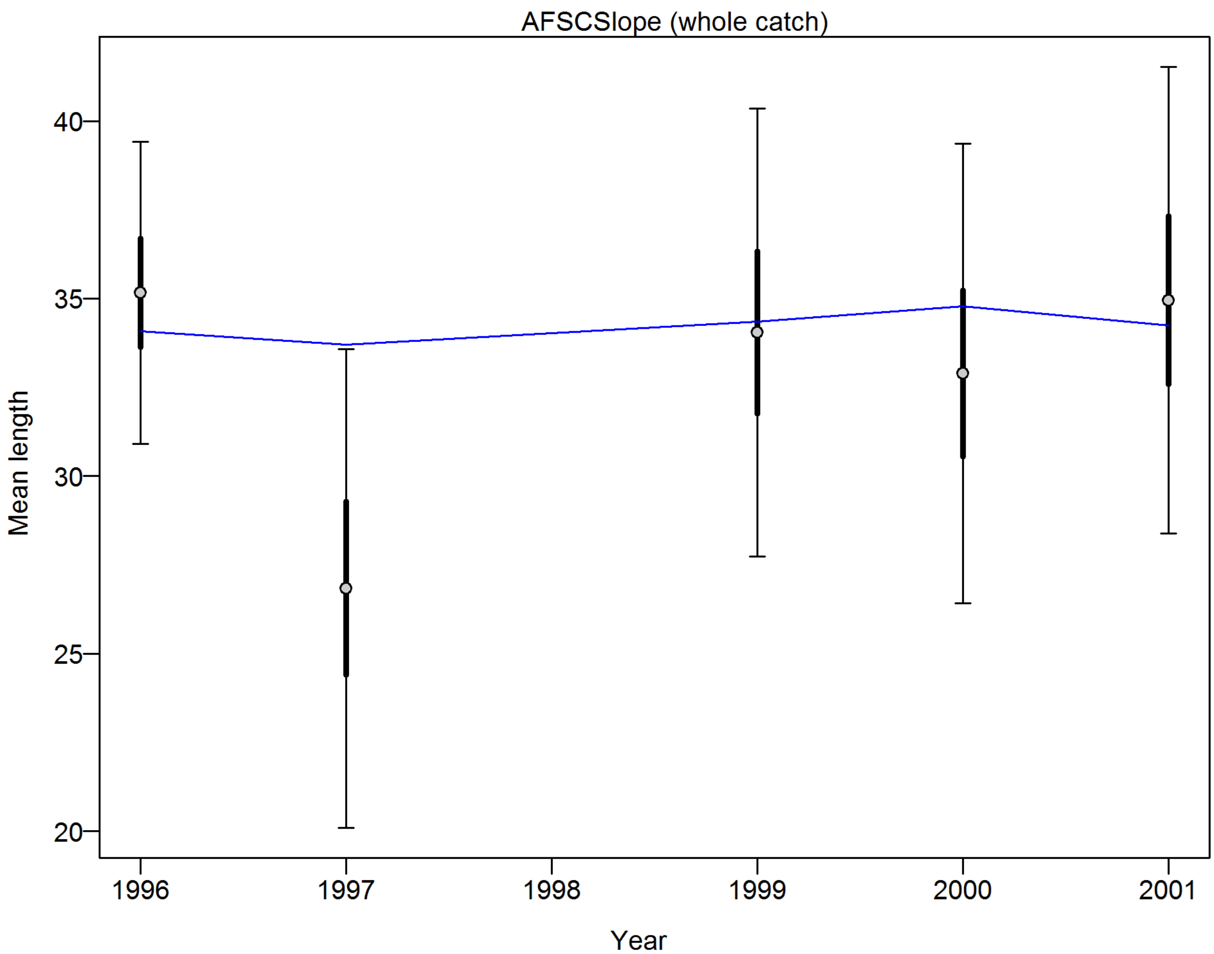

Figure 52: Francis data weighting method TA1.8 AFSCSlope Suggested sample size adjustment (with 95% interval) for len data from AFSCSlope: 0.1309 (0.0769_4.3093) fig:mod1_25_comp_lenfit_data

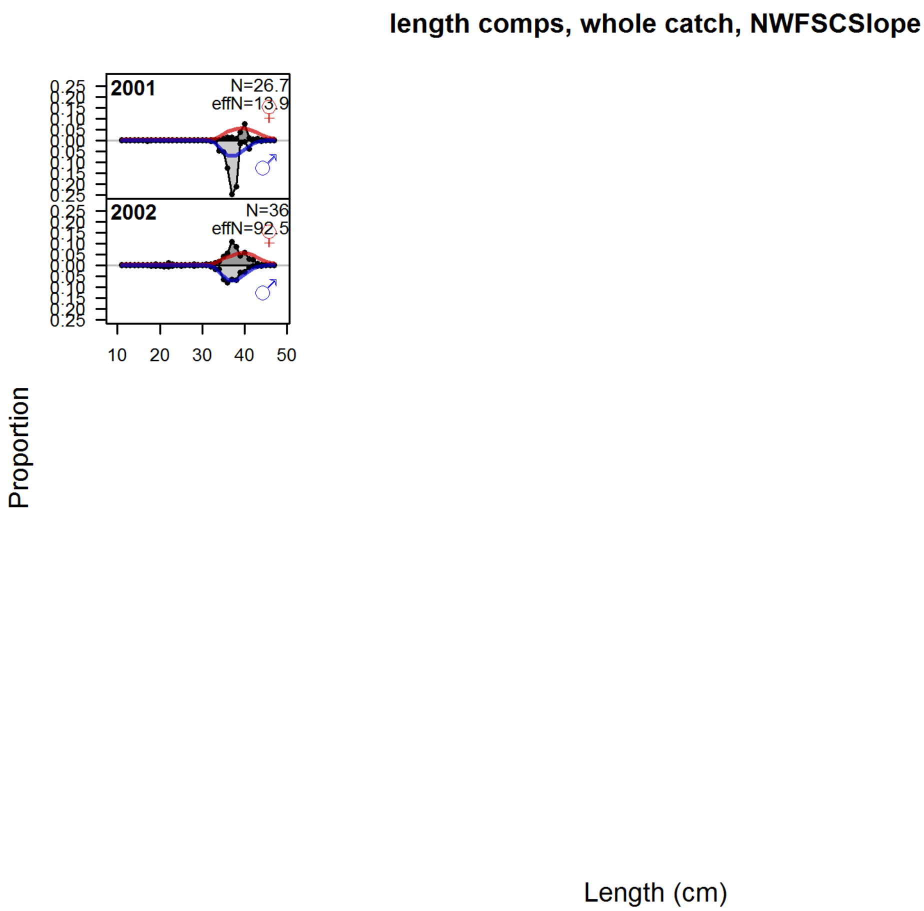

Figure 53: length comps, whole catch, NWFSCSlope fig:mod1_26_comp_lenfit_flt7mk

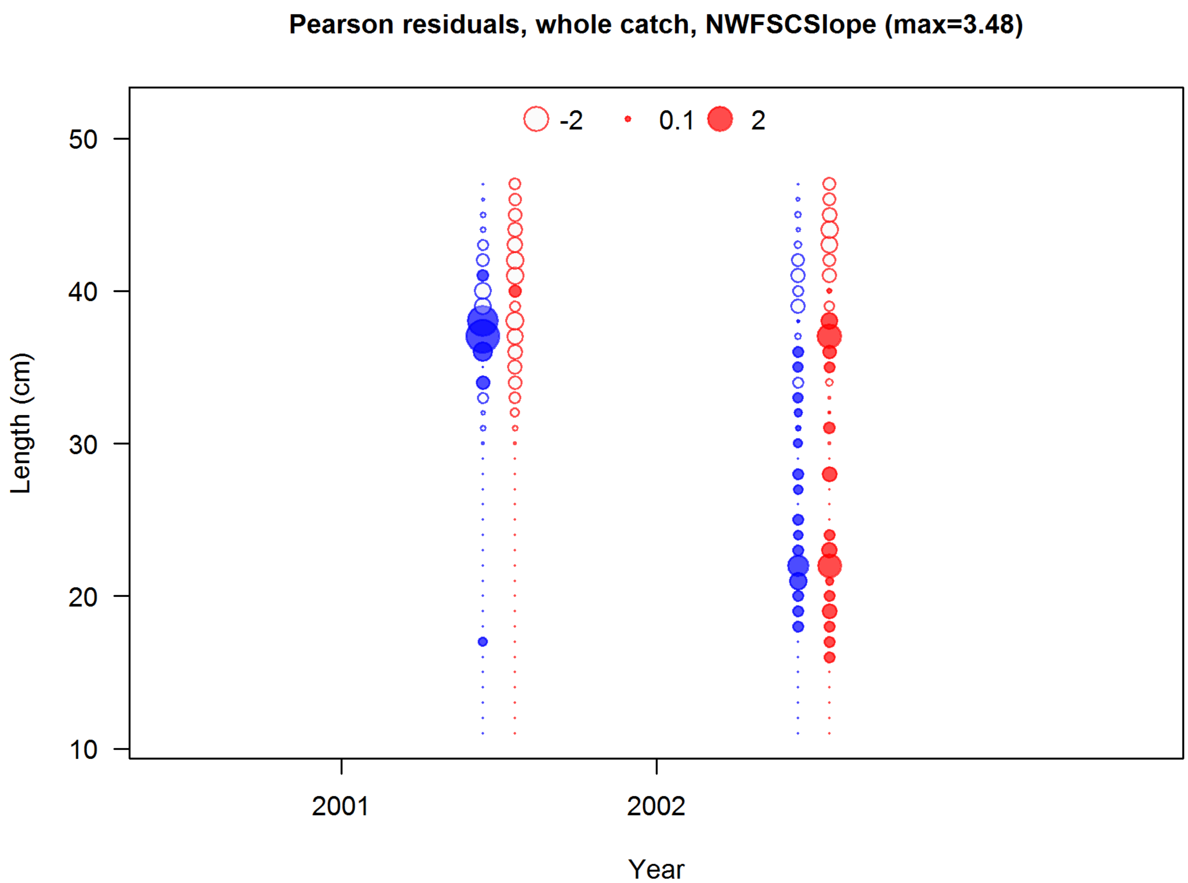

Figure 54: Pearson residuals, whole catch, NWFSCSlope (max=3.48)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_27_comp_lenfit_residsflt7mkt0

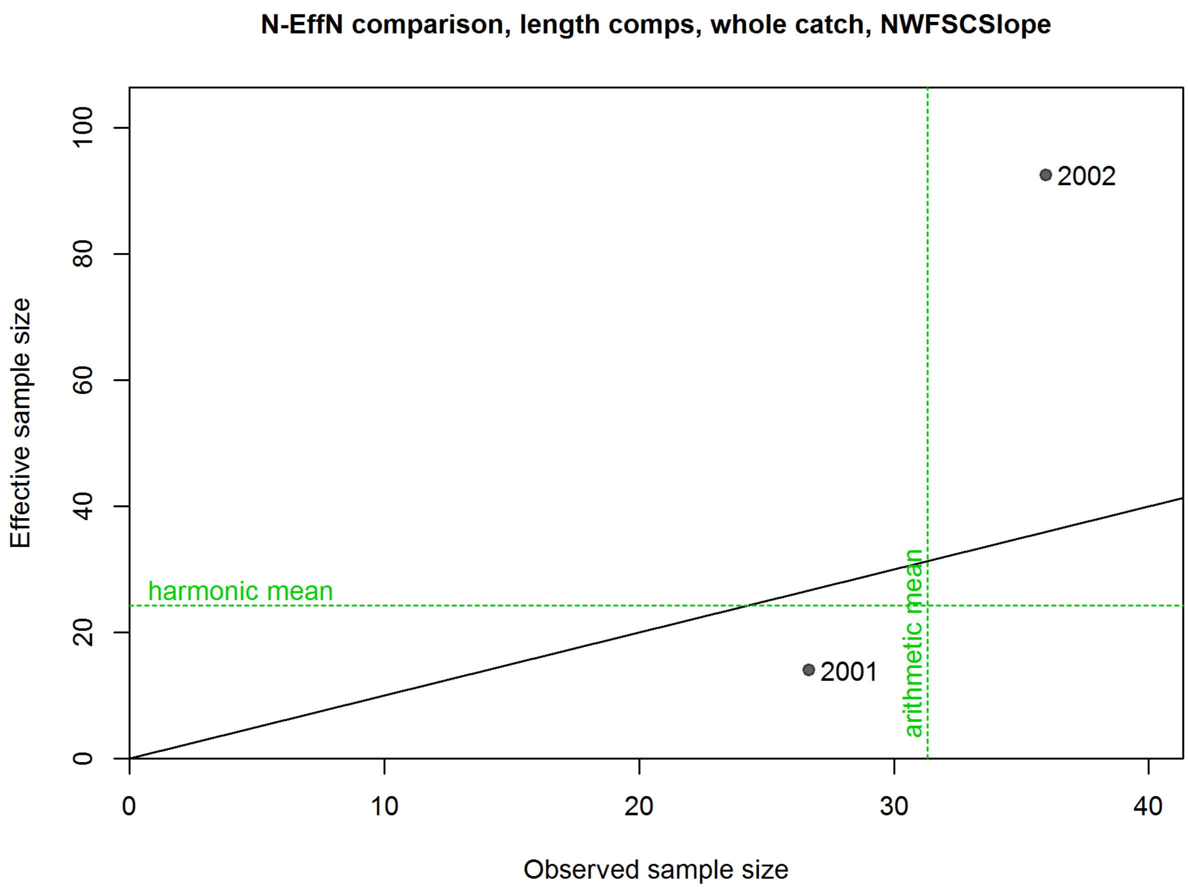

Figure 55: N_EffN comparison, length comps, whole catch, NWFSCSlope fig:mod1_28_comp_len

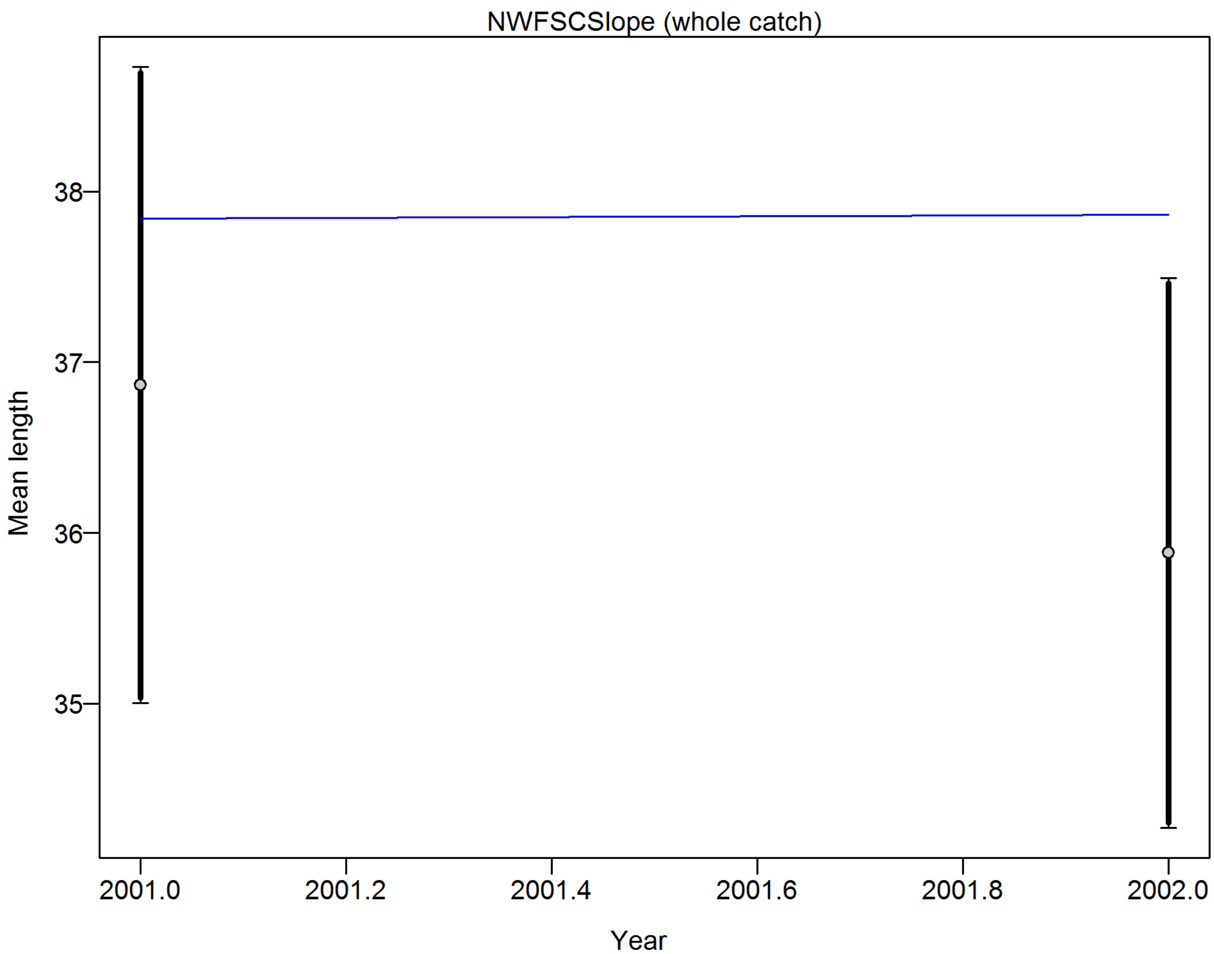

Figure 56: Francis data weighting method TA1.8 NWFSCSlope Suggested sample size adjustment (with 95% interval) for len data from NWFSCSlope: 0.9658 (0.9658_Inf) fig:mod1_29_comp_l

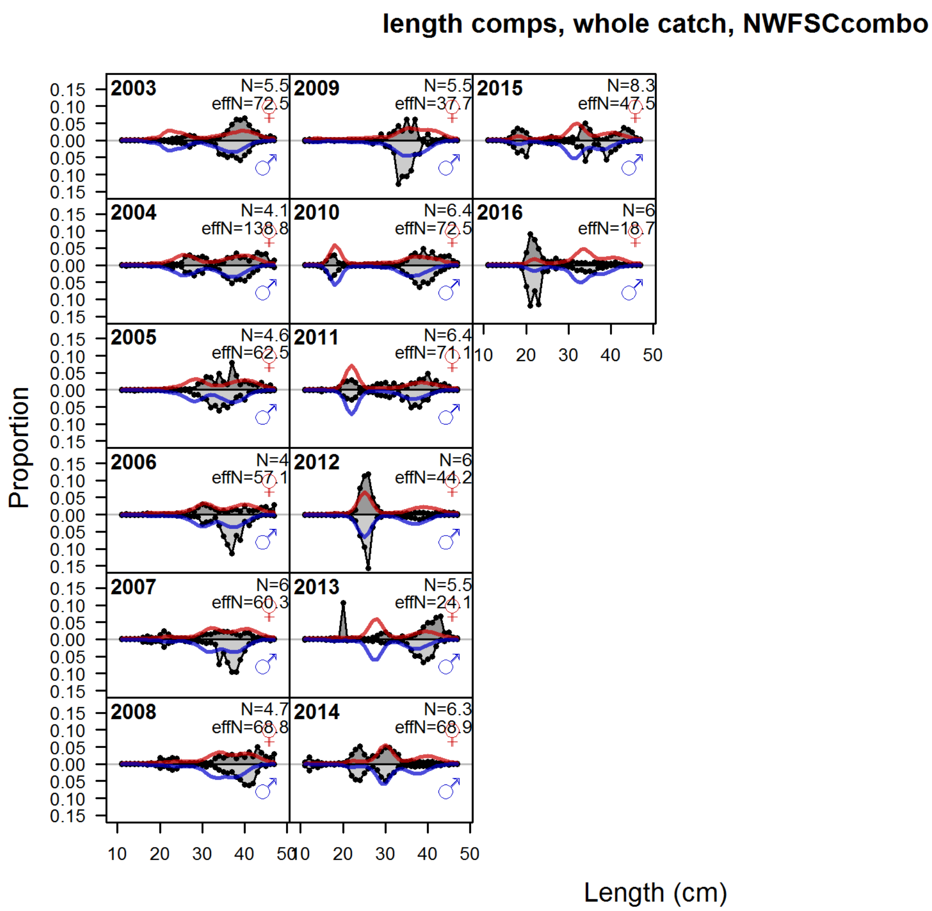

Figure 57: length comps, whole catch, NWFSCcombo fig:mod1_30_comp_lenfit_flt8m

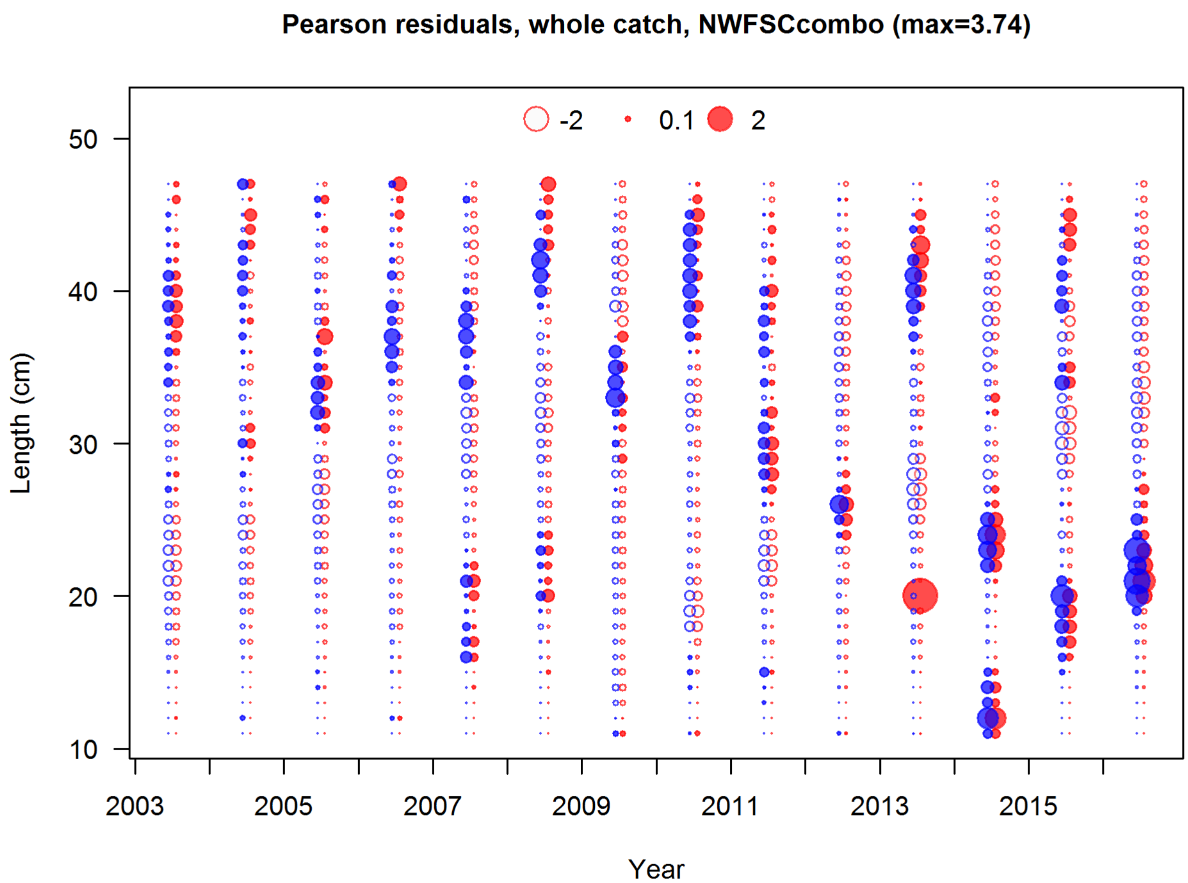

Figure 58: Pearson residuals, whole catch, NWFSCcombo (max=3.74)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_31_comp_lenfit_residsflt8mkt0

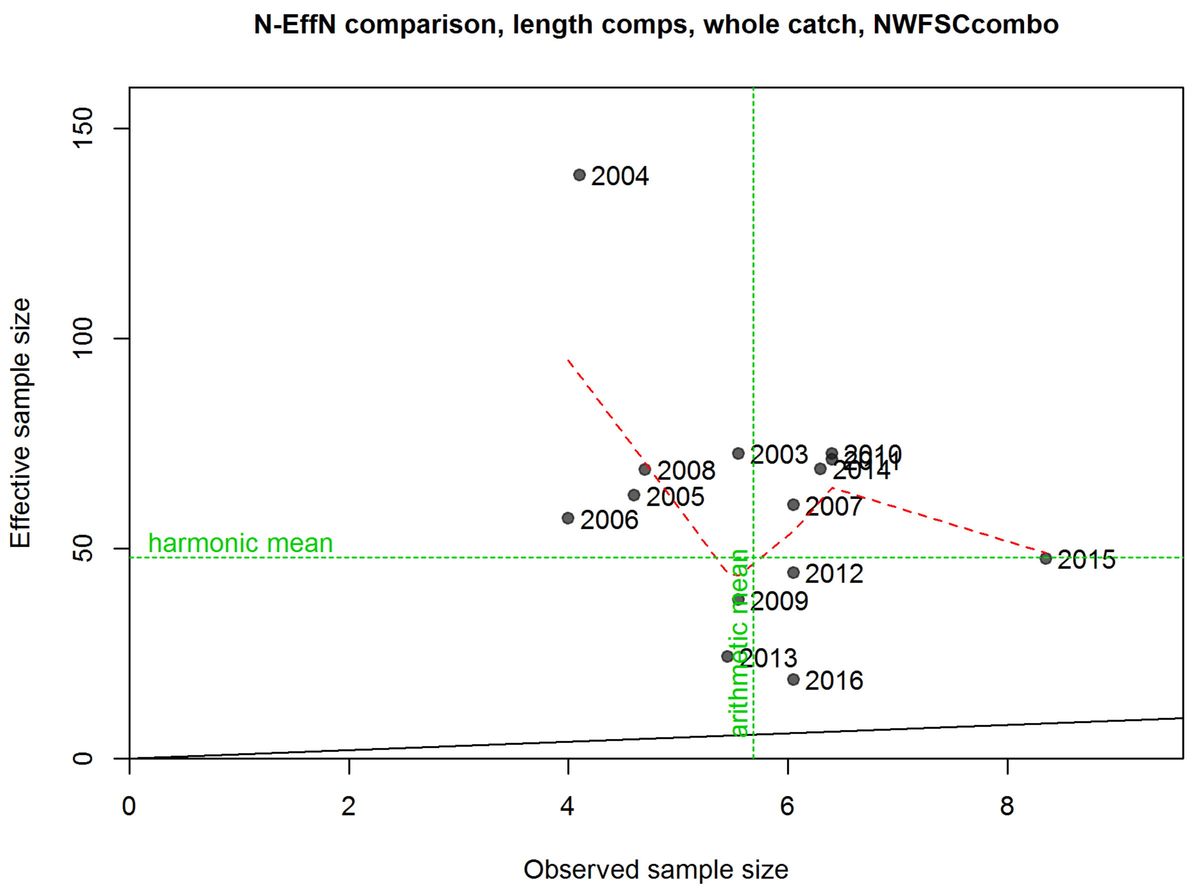

Figure 59: N_EffN comparison, length comps, whole catch, NWFSCcombo fig:mod1_32_comp_len

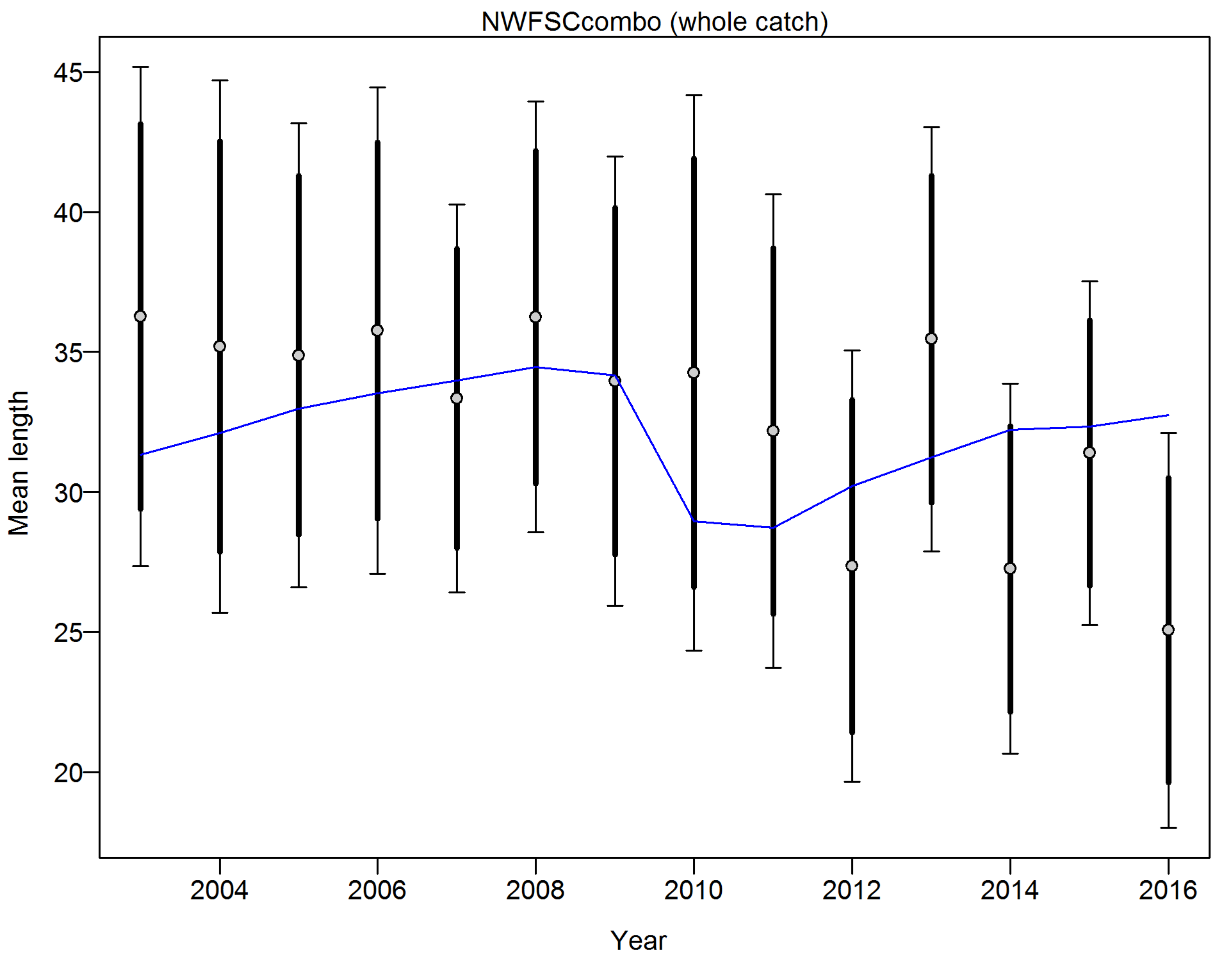

Figure 60: Francis data weighting method TA1.8 NWFSCcombo Suggested sample size adjustment (with 95% interval) for len data from NWFSCcombo: 0.5962 (0.3592_2.224) fig:mod1_33_com

length comps, discard, aggregated across time by fleet

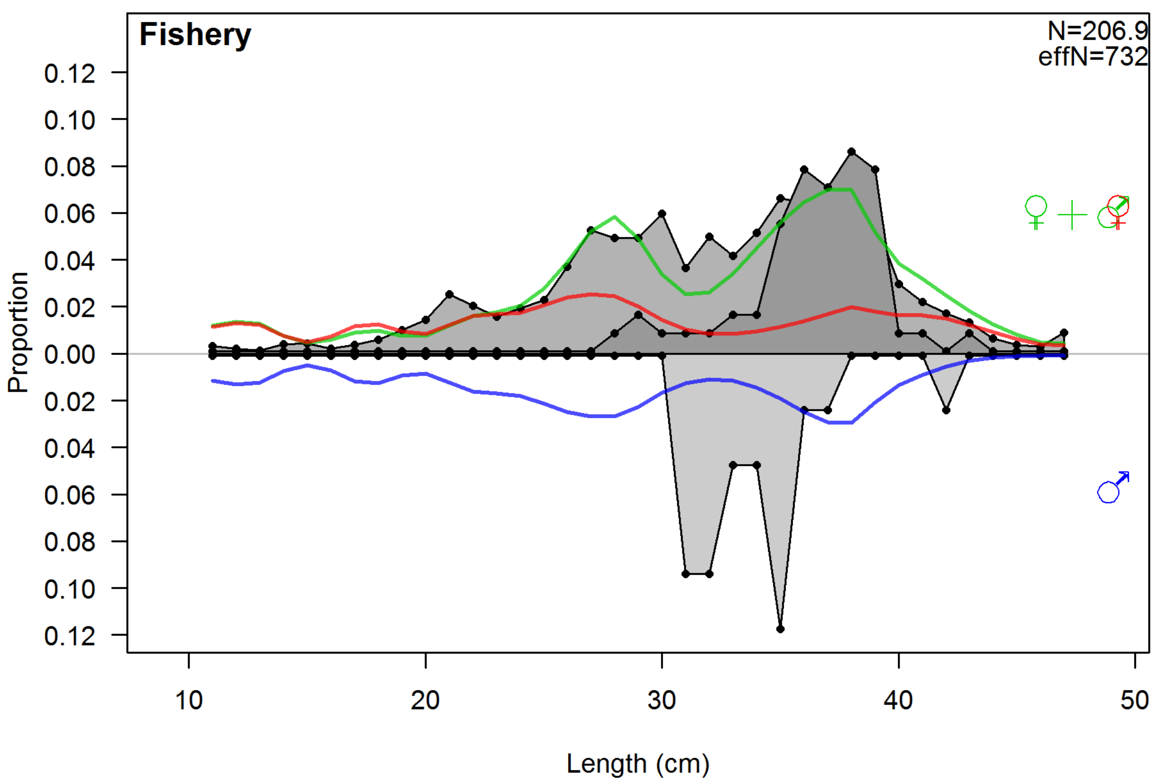

Figure 61: length comps, discard, aggregated across time by fleet fig:mod1_34_comp_lenfit_

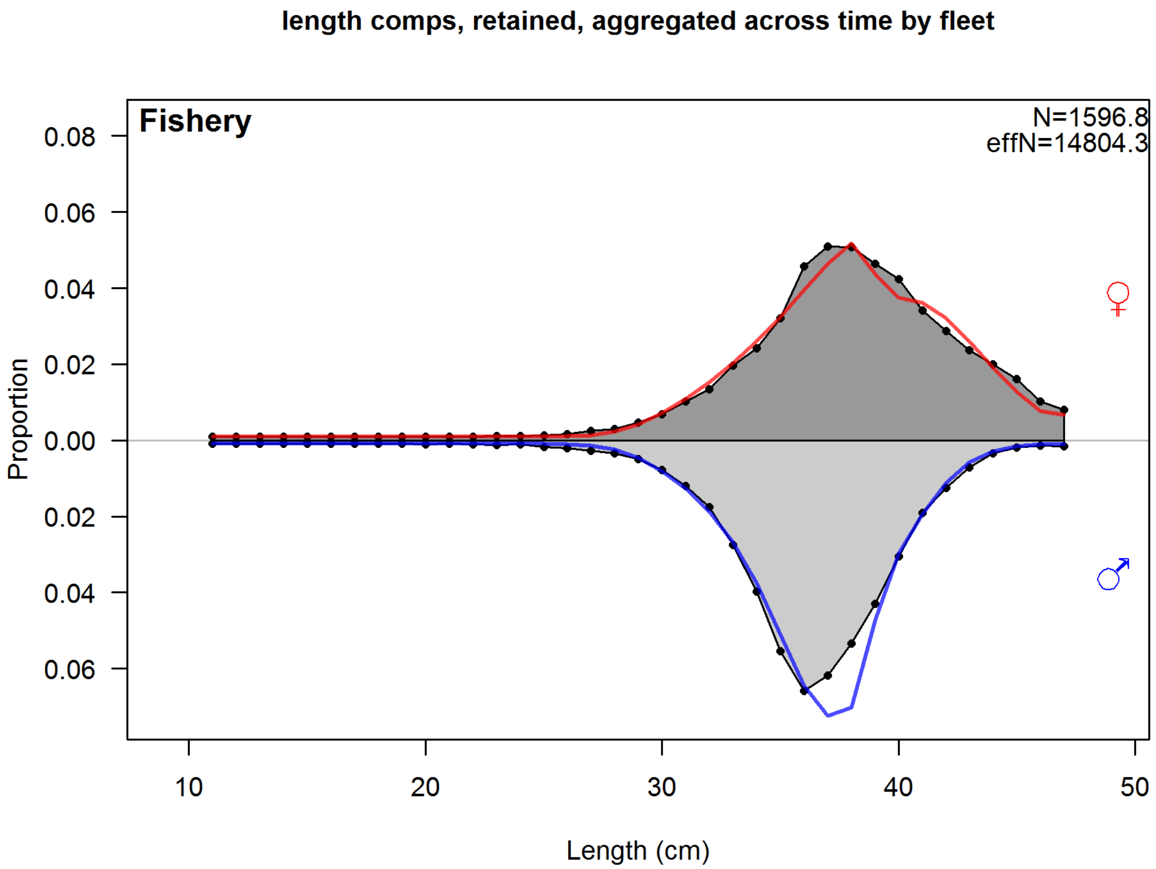

Figure 62: length comps, retained, aggregated across time by fleet fig:mod1_35_comp_lenfit_

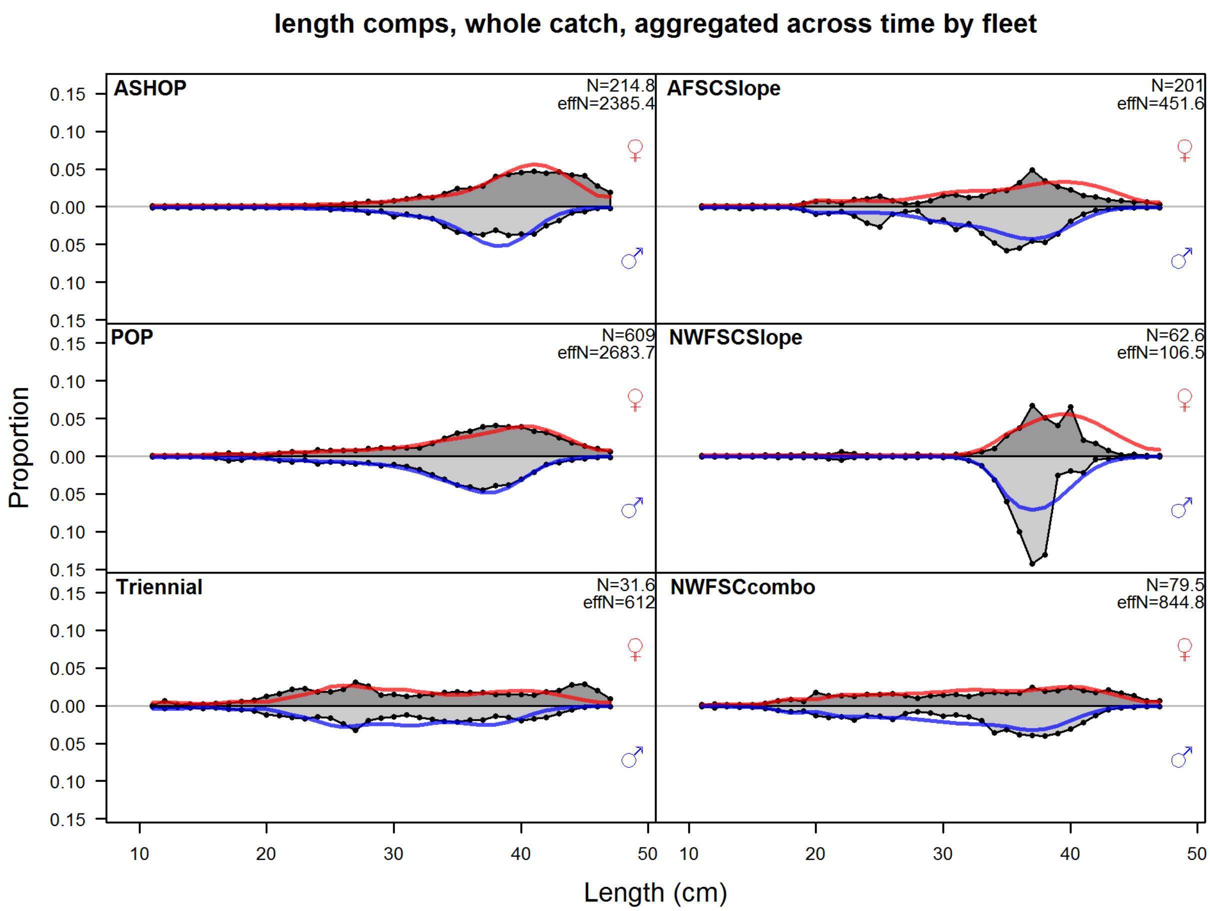

Figure 63: length comps, whole catch, aggregated across time by fleet fig:mod1_36_comp_lenfi

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