Stock Assessment of Pacific Ocean Perch in Waters off of the U.S. West Coast in 2011

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Stock

This assessment applies to the Pacific ocean perch (*Sebastes alutus*) (POP) species of rockfish off of the U.S. West Coast from Northern California to the Canadian Border. 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, and no significant genetic differences have been found in the range covered by this assessment.

Catches

Measurable harvest of Pacific ocean perch off of the northern half of the U.S. West Coast first occurred in 1940 and ramped up rapidly from under 300 mt in 1948 to over 2,000 in 1952. Estimated landings averaged 2,200 mt from 1952 to 1960, and then increased to between 5,000 and 20,000 mt during the mid-1960s. The largest removals in 1966-1968 were largely the result of harvest by foreign vessels. The fishery proceeded with more moderate removals of between 1,000 and 3,000 metric tons per year from 1969 through 1980, with the foreign fishery ending in 1977, and between 1,000 and 2,000 mt per year from 1981 through 1994. Management measures further reduced landings which fell steadily thereafter until reaching between 60 and 150 metric tons per year from 2002 through 2010, with total yearly catch, including discard, estimated to have been between 75 and 210 metric tons during those years. Discards are assumed to be quite low (size-based only) prior to 1982, increasing to progressively through the 1980s and early 1990s to a management- and size-based discard rate of about 1/6 of catch weight for 1995 through 2007, then increasing to approximately 1/3 to 1/2 of catch weight for 2008 and 2009.

Table a. Landings for the past 10 years, and model estimated catches including discards (all in metric tons). Note that at-sea hake and survey "landings" are catch for those fleets reduced by fishery discard rates. This is done as all landings are subsequently expanded to account for discard within the model via the retention curve to estimate total catch.

Year	WA	OR	CA	AtSeaHake	Survey	Total	ModeledCatch
2001	51	193	1	18	2	264	310
2002	39	107	1	3	0	150	176
2003	30	94	0	5	4	134	157
2004	22	96	2	1	1	122	144
2005	10	51	0	1	2	64	76
2006	16	52	0	3	1	72	86
2007	45	83	0	3	1	132	156
2008	17	58	0	10	1	86	134
2009	33	59	1	1	1	95	202
2010	22	58	0	11	1	91	141

Data and Assessment

This is the first full assessment of Pacific ocean perch since 2003 and the first one conducted in Stock Synthesis (SS, version 3.21d, R. Methot) since those conducted in the original version of Synthesis in the 1990s. The resultant SS model treats the data somewhat differently than the stand-alone forward-projection statistical catch-at-age model (Ianelli et al. 2000; Hamel et al. 2003; Hamel 2005, 2007, 2009).

In addition, nearly all of the sources of data for Pacific ocean perch have been re-evaluated for 2011. Changes of varying degrees have occurred in the data from those used in previous assessments. These current data represent the best available scientific information. The landings history has been updated and extended back to 1940, since records indicate that harvest was negligible before that year. Survey data from the Alaska and Northwest Fisheries Science Centers have been used to construct series of indices using a GLMM model (J. Wallace, pers. comm) as well as length, age and conditional age-at length compositions consistent with the stratifications used for constructing the indices.

The assessment uses landings data and discard-fraction estimates; catch-per-unit-of-effort (CPUE) and survey indices; length or age composition data for each year and fishery or survey (with conditional age at length compositional data and mean-length at age data used in preliminary models); information on weight-at-age, maturity-at-age, and fecundity-at-age; priors on natural mortality (by sex) and the steepness of the Beverton-Holt stock-recruitment relationship (for preliminary models and sensitivities); estimates of ageing error; and (iteratively) sigma-r (representing the variability of the recruitments about the stock-recruitment curve) as inputs to the forward projection age structured model (SS). Recruitment at "equilibrium biomass", length-based selectivity of the fishery and surveys, retention of the fishery, catchability of the surveys, the time series of biomass, age and size structure, and current and projected future stock status are outputs of the model. Growth, natural mortality and steepness were fixed in the final model after being estimated in preliminary models. This was done to simplify the models and due to relatively flat likelihood surfaces, such that fixing parameters and then varying them was deemed the best way to characterize uncertainty.

A number of sources of uncertainty are explicitly included in this assessment. For example, allowance is made for uncertainty in survey catchability coefficients. Furthermore, this assessment, unlike previous assessments, includes gender differences in growth and survival, a non-linear relationship between individual spawner biomass and effective spawning output, and a more complicated relationship between age and maturity, based upon published information. As is always the case, overall uncertainty is greater than that predicted by a single model specification. Among other sources of uncertainty that are not included in the current model are the degree of connectivity between the stocks of Pacific ocean perch off of Vancouver Island, British Columbia and those in PFMC waters, and the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of Pacific ocean perch.

A reference case was selected which adequately captures the central tendency for those sources of uncertainty considered in the model.

Stock Biomass and Reference Points

The point estimate for the depletion of the spawning output at the start of 2011 is 19.1%. The OFL for 2013 based upon the base model would be 844 mt, and the 40-10 rule management limit (without accounting for the scientific uncertainty buffer) would be 554 mt. The ACL for 2013 given the current 0.864 rebuilding SPR would be 150 mt. The OFL and ACL for 2011 in the table below are based on current management and the 2009 assessment. For West Coast rockfish, a stock is considered overfished when it is below 25% of virgin spawning output (which is equivalent to spawning biomass only when there is a linear relationship between biomass and output; here the units of spawning output are 10^8 (100 million) eggs), and recovered when it reaches 40% of virgin spawning output. Overfishing for POP is considered to be occurring when catch exceeds the OFL which is based on $F_{50\%}$ for POP and other rockfish. Based on this assessment, POP on the West Coast are overfished and in the process of rebuilding and overfishing is not occurring. Summary (3+) biomass in 2011 is 25,482 mt, which is only about 5% below what a pure update of the old model would estimate (26,839 mt). However, since the estimated unfished summary biomass is much larger (119,914 mt vs. 83,850 mt), and therefore, so is the unfished spawning output, the estimated depletion level of 19.1% in 2011 is much lower than the value of

28.6% (in 2009) from the 2009 assessment, or 31.5% (in 2011) which a pure update of the old model would produce.

Table b. Retrospective of past 10 years

Year	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Estimated Total Catch (mt)	310	176	157	144	76	86	156	134	202	141	
Estimated Discards (mt)	46	26	23	22	12	14	24	48	107	50	
Landings equivalents(mt)	264	150	134	122	64	72	132	86	95	91	
*ABC/**OFL** (mt)*	1,541	640	689	980	966	934	900	911	1,160	1,173	1,026
*OY/**ACL** (mt)*	303	350	377	444	447	447	150	150	189	200	180
F	0.0215	0.0120	0.0106	0.0094	0.0048	0.0052	0.0089	0.0074	0.0108	0.0074	
SPR	0.69	0.80	0.82	0.84	0.91	0.91	0.85	0.87	0.82	0.87	
Expl. Rate	0.0162	0.0089	0.0076	0.0067	0.0034	0.0037	0.0066	0.0056	0.0083	0.0058	
3+Biomass(mt)	19,090	19,745	20,789	21,628	22,353	22,928	23,578	24,006	24,281	24,361	25,482
Spawning Output(10^8 eggs)	9,405	9,569	9,795	10,072	10,438	10,941	11,509	11,985	12,318	12,450	12,532
Sp Bio. sd	2,147	2,214	2,280	2,356	2,450	2,565	2,697	2,815	2,898	2,941	2,963
Sp Bio. cv	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.24	0.24	0.24
Recruitment(10^3)	3,096	1,985	805	2,921	2,017	1,250	1,193	10,709	2,696	3,589	3,606
Rec. sd	906	635	336	894	736	548	587	3808	1732	2610	2623
Rec. cv	0.29	0.32	0.42	0.31	0.36	0.44	0.49	0.36	0.64	0.73	0.73
Depletion	0.143	0.146	0.149	0.154	0.159	0.167	0.176	0.183	0.188	0.190	0.191
Depl. sd	0.024	0.025	0.026	0.027	0.028	0.029	0.030	0.032	0.033	0.033	0.033
Depl. cv	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

Table c. Major quantities from assessment

	Value	*sd*	*cv*
$Sp.Output_0$	65,560	6,116	0.09
R_0	9,329	870	0.09
$Sp.Output_{40\%y}$	26,224	2,446	0.09
$F_{50\%}$	0.0322	0.0001	0.003
MSY_{proxy}	863	79	0.09

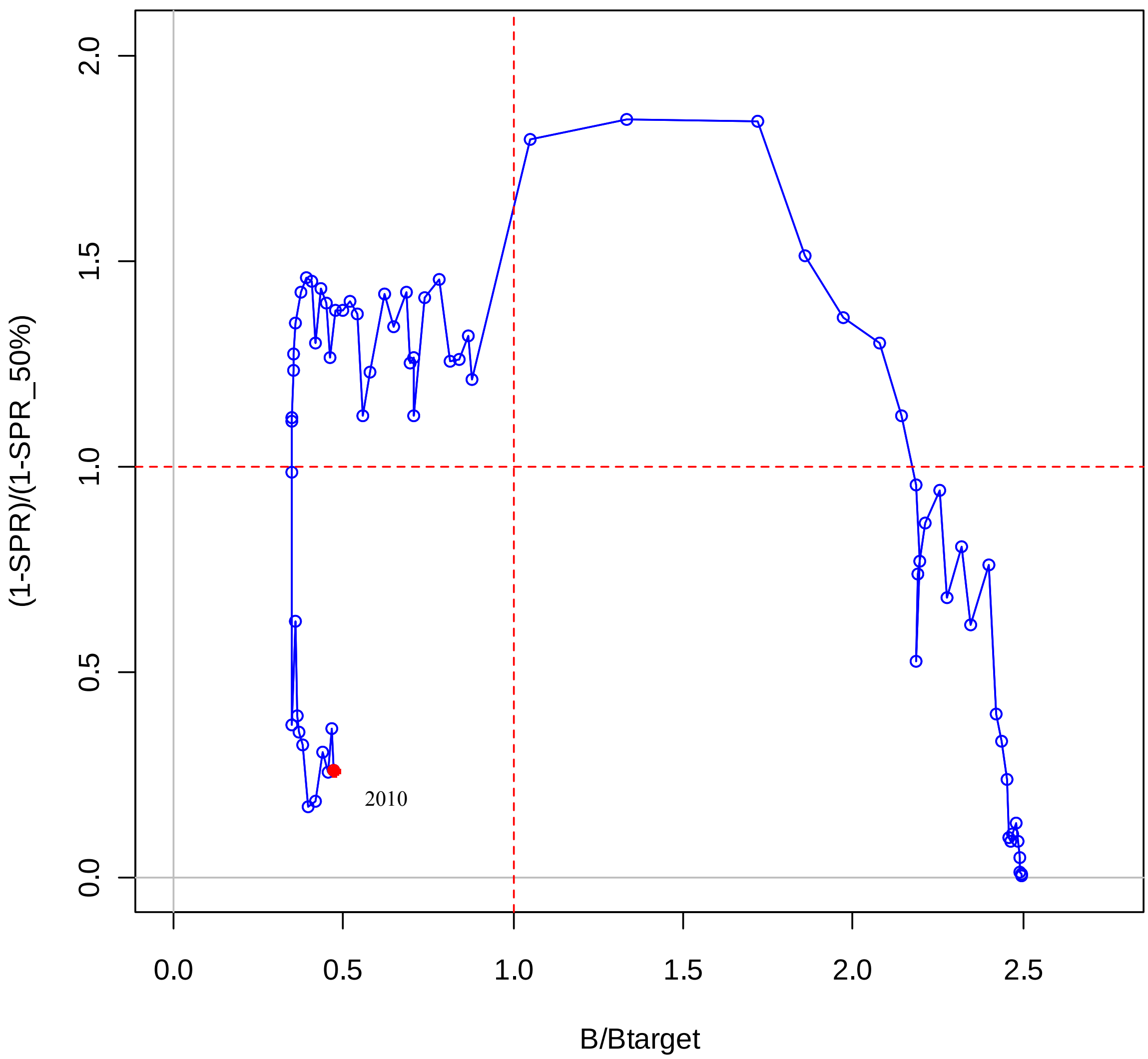

Figure a. F/Fmsy versus B/Bmsy for all years of catch data

According to the base model, the fishing level has been below F50% for the past 12 years, during which period the stock has begun to rebuild (Figure a.). The point estimates of summary (age 3+) biomass also show an upward trend over the past decade, increasing approximately 50% in that time (Figure b.).

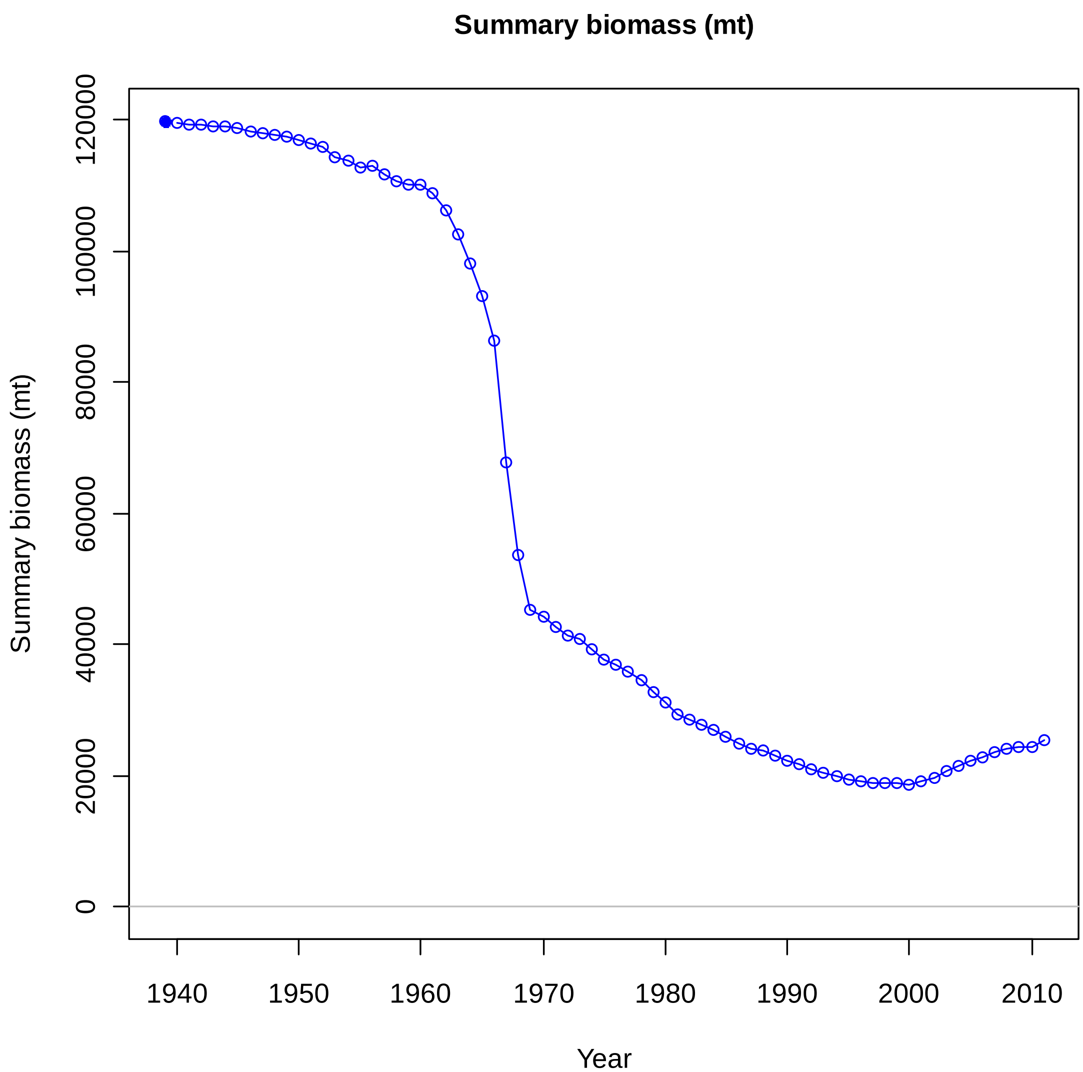

Figure b. Time series of summary (3+) biomass.

The recruitment pattern for POP is similar to that of many rockfish species. Recent decades have provided rather poor year-classes compared with the 1950s and 1960s, although the 1999 and 2000 year classes appear to be above average, and the 2008 year class, while uncertain, appears to be the largest in at least the past 50 years.

There are limited age-composition data to support estimates of recruitment back to the first years of the model. The estimates of recruitment for the years prior to the late 1960s are based on very little actual precise age data. The first few years with recruitment estimates that are informed by data are highly uncertain. The relatively large estimated recruitments in the early 1950s may simply reflect higher average recruitment over the years ~1940-60. Recent estimates of recruitment are highly variable by year, and lower on average than those prior to 1970. There is evidence of strong year classes in 1999 and 2000, as well as in 2008. The estimate of recruitment for 2008 is based on very limited information, mainly the presence of that year class in the 2010 NWFSC survey.

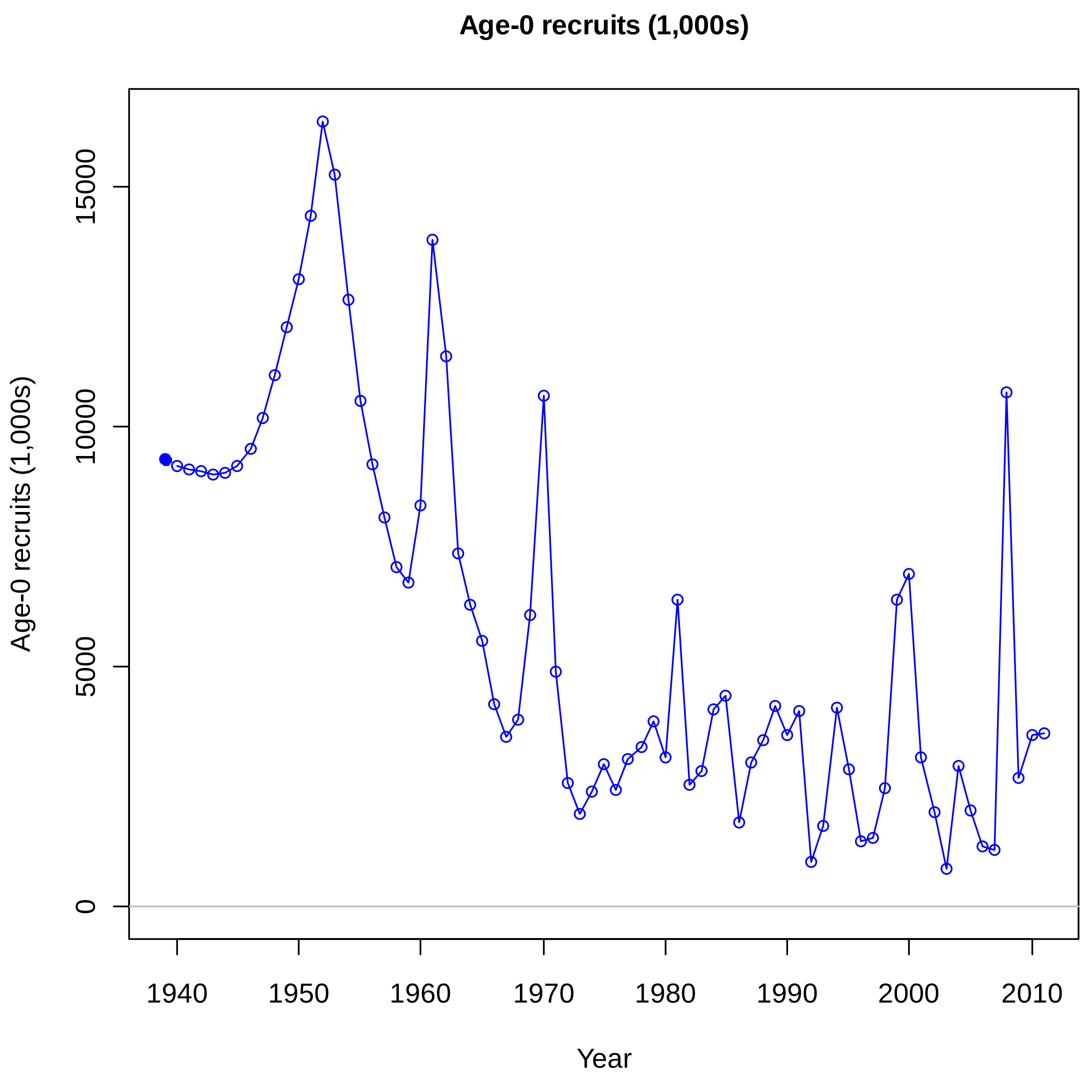

Figure c. Time series of estimated (age 0) recruitments

Exploitation Status

The exploitation rate (percent of biomass taken) on fully-selected animals peaked near 23% in the mid-1960's when foreign fishing was intensive. The exploitation rate dropped by the late 1960's, but increased slowly and steadily from 1975 to the early 1990's, due to decreasing exploitable biomass. Over the past 10 years the exploitation rate has fallen further from around 2% to under 1%.

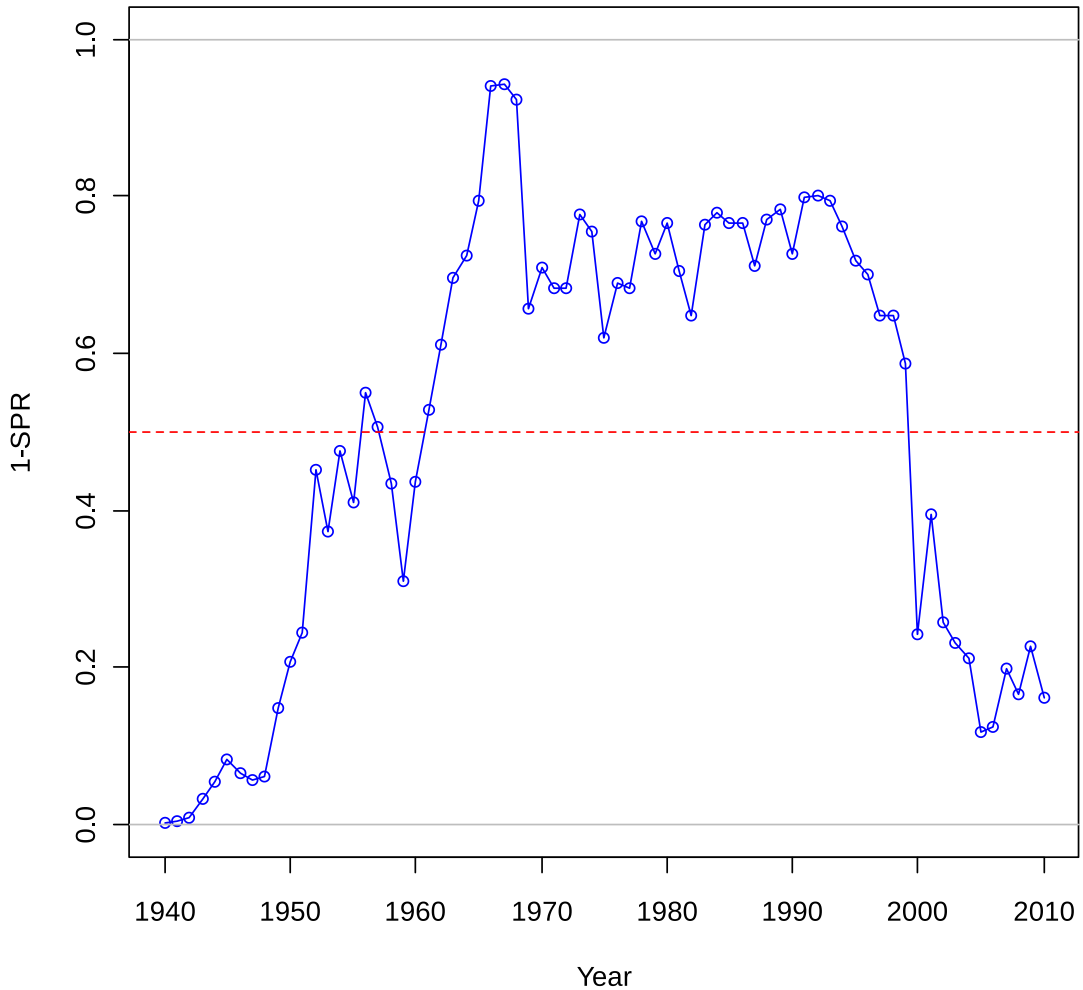

Figure d. Time series of 1-SPR, showing ramp-up, periods of over-exploitation and current management.

Table d. Summary of Pacific ocean perch reference points in the base model (standard deviation in parentheses).

	F_{msy}=F_{spr} (0.5)	F_{msy} = F_{Btarg}(B_{40})	Calculated F_{msy}
SPR	**0.5**	**0.625**	**0.619**
Exploitation Rate	**0.0322**	**0.0206**	**0.0210**
MSY (mt - catch)	**863 (79)**	**1,057 (96)**	**1,058 (96)**
SB_0 (Sp.Output)	**65,560 (6,117)**		
Sp.Out $_{msy}$	**13,112 (1,223)**	**26,224 (2,447)**	**25,601 (2,381)**
Sp.Out/$Sp.Out_0$	**0.200**	**0.400**	**0.390**

Pacific ocean perch are essentially managed on a regional basis, as they occur almost exclusively off of Oregon and Washington for the West Coast. Management and assessment of stock status might be improved through greater cooperation with British Columbia, as the stock extends northward into Canadian waters off of Vancouver Island.

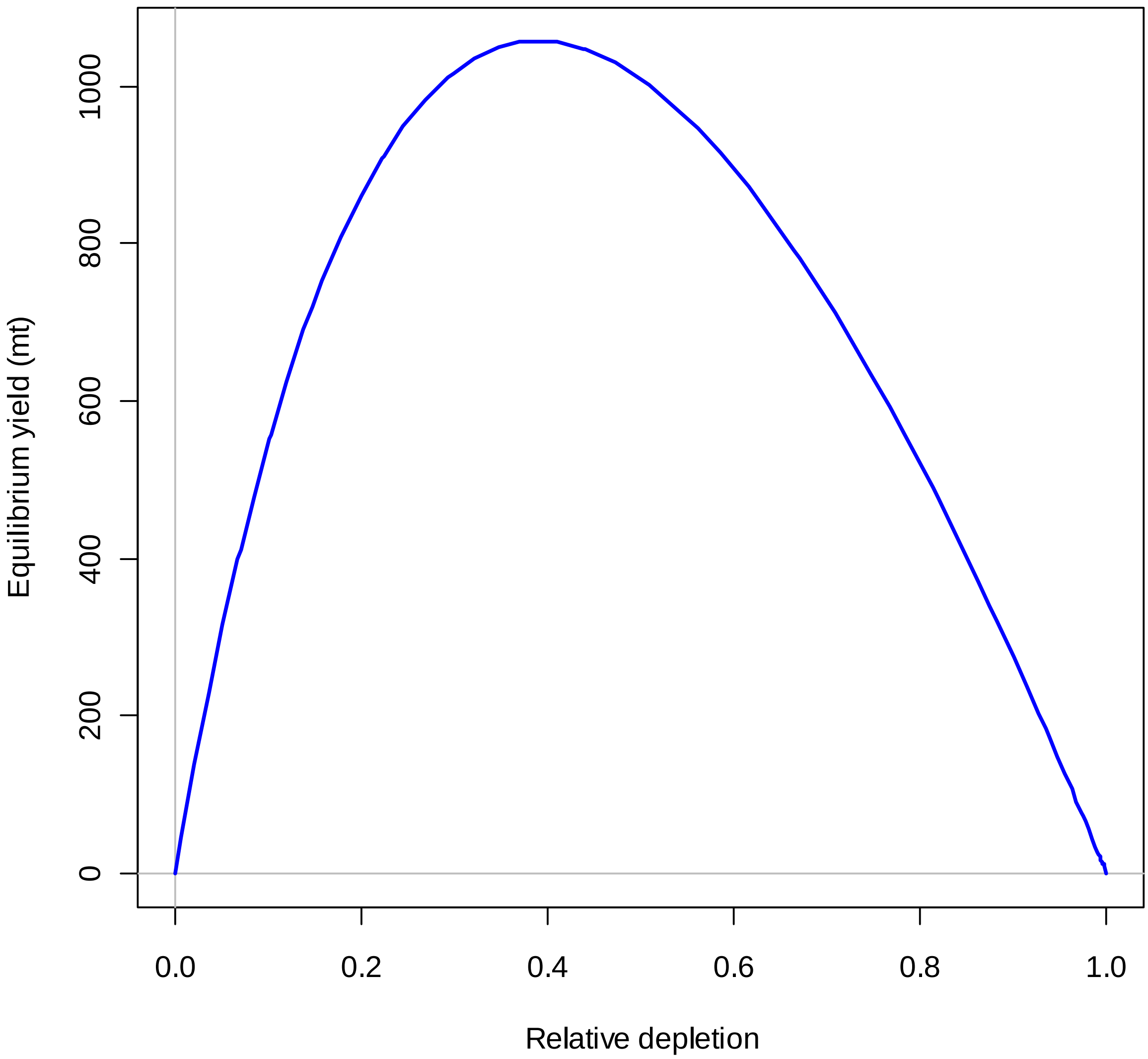

Figure e. Equilibrium yield curve for Pacific ocean perch.

Decision table

The decision table is based upon uncertainty in stock-recruitment steepness, representing uncertainty in productivity. The base model fixes steepness at 0.4, while the low and high states fix steepness at 0.35 and 0.55 respectively (being 25% of the way to the bound in each case).

Table f. Decision Table for Pacific ocean perch. The three catch streams from 2013-2022 are based upon an SPR of 0.864 applied to each of the three states. The 2011 and 2012 catch levels are based upon current management. OFL and Catch in metric tons; Spawning output in 100 million (10^8) eggs.

	Year	Base OFL	Catch	Low h.35		Base h.4		High h.55	
				Sp. Out	Depletion	Sp. Out	Depletion	Sp. Out	Depletion
Low Catch Series	2011	*1,026*	180	7,987	0.118	12,532	0.191	26,089	0.399
	2012	*1,049*	183	7,998	0.119	12,621	0.193	26,388	0.403
	2013	844	94	8,124	0.120	12,906	0.197	27,107	0.414
	2014	864	96	8,366	0.124	13,358	0.204	28,124	0.430
	2015	893	98	8,647	0.128	13,882	0.212	29,283	0.448
	2016	926	101	8,904	0.132	14,369	0.219	30,351	0.464
	2017	958	104	9,129	0.135	14,804	0.226	31,287	0.478
	2018	986	107	9,291	0.138	15,133	0.231	31,977	0.489
	2019	1,011	109	9,423	0.140	15,413	0.235	32,551	0.498
	2020	1,035	111	9,553	0.142	15,693	0.239	33,113	0.506
	2021	1,058	113	9,743	0.144	16,075	0.245	33,881	0.518
	2022	1,080	115	9,966	0.148	16,514	0.252	34,751	0.531
Medium Catch Series	2011	*1,026*	180	7,987	0.118	12,532	0.191	26,089	0.399
	2012	*1,049*	183	7,998	0.119	12,621	0.193	26,388	0.403
	2013	844	150	8,124	0.120	12,906	0.197	27,107	0.414
	2014	862	153	8,336	0.124	13,328	0.203	28,094	0.430
	2015	889	158	8,587	0.127	13,821	0.211	29,223	0.447
	2016	920	164	8,812	0.131	14,277	0.218	30,259	0.463
	2017	950	169	9,004	0.134	14,679	0.224	31,162	0.476
	2018	976	174	9,132	0.135	14,975	0.228	31,819	0.486
	2019	999	178	9,230	0.137	15,221	0.232	32,359	0.495
	2020	1,020	182	9,327	0.138	15,467	0.236	32,887	0.503
	2021	1,041	185	9,481	0.141	15,814	0.241	33,620	0.514
	2022	1,062	189	9,666	0.143	16,215	0.247	34,453	0.527
High Catch Series	2011	*1,026*	180	7,987	0.118	12,532	0.191	26,089	0.399
	2012	*1,049*	183	7,998	0.119	12,621	0.193	26,388	0.403
	2013	844	316	8,124	0.120	12,906	0.197	27,107	0.414
	2014	856	322	8,248	0.122	13,240	0.202	28,006	0.428
	2015	878	333	8,408	0.125	13,643	0.208	29,045	0.444
	2016	903	344	8,540	0.127	14,007	0.214	29,988	0.458
	2017	927	354	8,637	0.128	14,314	0.218	30,796	0.471
	2018	947	363	8,671	0.129	14,515	0.221	31,358	0.479
	2019	964	370	8,675	0.129	14,667	0.224	31,804	0.486
	2020	980	377	8,678	0.129	14,820	0.226	32,240	0.493
	2021	994	383	8,733	0.129	15,068	0.230	32,875	0.503
	2022	1,009	388	8,815	0.131	15,366	0.234	33,607	0.514

Unresolved problems and major uncertainties

Survey data begins after the depletion of the stock, thus there is a lack of fishery independent indices to help pin down the current relative biomass and spawning output levels relative to the unfished status. The current survey index is highly variable from year to year. The large estimated recruitments in the early 1950s are likely mainly due to large catches in late 1960s rather than age or length data. The natural mortality rate (~0.05) is similar to recent assessments but less than that for stock assessments of populations off of British Columbia or Alaska (~0.06). While steepness is also low relative to those stocks, there is reason to believe there is less influence of adjoining stocks on the U.S. West Coast stock since it is at the edge of the species range. Therefore, the dynamics experienced as well as the recruitment input received from other stocks is likely far less than for more connected stocks. Time varying selectivity may occur, but allowing for changes in selectivity likely results in overfitting the data. The 1999/2000 year classes no longer seem as large as previously estimated, but the 2008 year class looks to be larger than those year classes; however this is based on only the 2010 NWFSC survey data.

Research and Data Needs

There are a number of areas of future research, e.g.:

1) Research on the relative density of Pacific ocean perch in trawlable and untrawlable areas and difference in age and/or length compositions between those areas.
2) Estimation of climatic effects on recruitment, growth and survival.
3) Selection of an appropriate prior distribution for the survey catchability coefficients.
4) Further research on the relationship of individual female age and biomass to survival of offspring.
5) Research on the relative status of the British Columbia stock of Pacific ocean perch off of Vancouver Island and its relationship to that off of the U.S. West Coast.
6) Use of simulation models to evaluate how well one can estimate recruitment using size-composition data or biased or unbiased age-composition data, or a mix of the three.
7) Catch reconstruction for Washington State.

Contents

1.1 Introduction

Pacific ocean perch (*Sebastes alutus*) (POP) 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 POP off of British Columbia (Withler et al., 2001) with, notably, a separate stock off of Vancouver Island, no significant genetic differences have been found in the range covered by this assessment. Pacific ocean perch show dimorphic growth, with females reaching a slightly large size than males. Males and females are equally abundant on rearing grounds at age 1.5.

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

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

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

Age estimates for Pacific ocean perch prior to the 1980s were made via surface ageing of otoliths, which misses the very tight annuli at the edge of the otolith once the fish reaches near maximum size. Ages are biased by around age 10-12, and maximum age was estimated to be in the 20s, which lead to an overestimate of the natural mortality rate and the productivity of the stock. Using break and burn methods, Pacific ocean perch have been aged to over 100 years, and we now know that the underlying assumptions of the early models were overly optimistic about productivity.

Research surveys have been used to provide fishery-independent information about the abundance, distribution, and biological characteristics of Pacific ocean perch. A coast–wide survey of the rockfish resource was conducted in 1977 (Gunderson and Sample 1980) and was repeated every three years through 2004. The National Marine Fisheries Service (NMFS) coordinated a cooperative research survey of the Pacific ocean perch stocks off Washington and Oregon with the Washington Department of Fisheries (WDFW) and the Oregon Department of Fish and Wildlife (ODFW) in March-May 1979 (Wilkins and Golden 1983). This survey was repeated in 1985. Two slope surveys have been conducted on the west coast in recent years, one using the research vessel Miller Freeman, which ended in 2001, and another ongoing cooperative survey using commercial fishing vessels which began in 1998 as a DTS (Dover sole, thornyhead and sablefish) survey, was expanded to other groundfish in 1999. In 2003, this survey was expanded spatially to include the shelf. This last survey, conducted by the NWFSC, continues to cover depths from 30-700 fathoms (55-1280 meters) on an annual basis.

1.2. Data

1.2.1. Removals and regulations

Catch history

Landings data from the Pacific ocean perch fishery off the west coast of the continental United States are estimated from 1940 through 2010 (Figure 1; Table 2). While estimated domestic landings were available from some sources back to 1892, total estimated annual landings did not exceed 1 metric ton (mt) until 1940.

California landings were obtained from the CalCom database for the entire period, and these amounts closely matched those available from PacFIN from 1981 through 2010. Reconstructed Oregon landings from 1940 – 1986 were obtained directly from the Oregon Department of Fish and Wildlife (ODFW), with subsequent Oregon landings obtained from PacFIN. Historical records obtained from Washington start in 1952. Based on the estimated ratio between Washington and Oregon landings in 1952 and 1953, landings in Washington were assumed to be one fifth of those in Oregon for the years 1940 through 1951. Washington landings from 1952 through 1969 were assumed to be ¾ of the landings reported in fish tickets where the majority of catch was indicated to be from U.S. waters. Landings from 1970 through 1980 were obtained directly from the Washington Department of Fish and Wildlife (WDFW), and from 1981 through 2010 from PacFIN. In addition to landings data from the three states, catch data were available from the the At-Sea-Hake Observer Program (NorPAC) from 1975 through 2010, and from surveys from 2001-2010, with values estimated back to 1977. To convert these catch values to landings equivalents, since discard is added on to landings within the model, catch numbers were adjusted by an estimated discard rate during each period.

The domestic fishery took large catches during the mid-1960s. In 1965, foreign vessels (mainly trawlers from the Soviet Union and Japan) began intensive harvesting operations for Pacific ocean perch off of Canada, and off of the U.S. one year later. Foreign catch estimates for the years 1966-76 are taken from Rogers (2003). The foreign fleets accounted for the bulk of Pacific ocean perch removals during the periods 1966-68 (taking over 15,000, 12,000 and 6,000 mt in those three years) and again in 1973-74 (with much lower harvest of less than 2,000 mt in each year). The foreign fishery ended in 1977 following the passage of the Magnuson-Stevens Act. Removals since the early 1980s have been restricted by the PFMC to promote the rebuilding of the resource, however more recent assessments reveal that harvest were not reduced sufficiently to promote rebuilding until around 2000.

Discards

A 5% discard rate (discarded weight/catch weight) was estimated based on the work of Pikitch et al. (1988), and applied to the years 1982-1988. A 10% discard rate was assumed for 1989-1994, when somewhat more constrictive management was applied. More recent discard estimates were provided by the West Coast Groundfish Observer Program for the years 2002-2009 (Table 3). The discard rates for the years 2002-2007 are quite consistent (averaging about 1/6th of catch), and were collectively applied to the years 1995-2007. Higher rates were observed in 2008 (1/3rd of catch) and 2009 (1/2 of catch).

Fishery Age and Length compositions

For otoliths collected from POP prior to 1981, all ages were determined using otolith surface ageing which is biased for Pacific ocean perch. Therefore, length composition data were used instead of age data from this period. WDFW re-read a large number of otoliths from 1971 and 1975, so age data were used from these two years. Fishery age-composition data based on the break-and-burn technique are available for 1981-1988, 1994 and 1999-2010 from the PacFIN database. The break-and-burn technique is considered to provide unbiased estimates of age (Chilton and Beamish 1982). Ages 1-34 are fitted as individual age classes, with age 35 being the plus-group.

Fishery length compositions were estimated from PacFIN data and used for the years 1966-1970, 1972-1974, 1976-1980, 1989-1991 and 1995-1998. The model is fit to the size-composition data (1 cm bins from 11 to 47cm, where 11 cm is a minus-group and 47 cm is a plus-group) from the commercial fishery for these years. Neither size nor age data were available for 1992-1993. In all cases, composition data were available from Oregon and Washington, but not California. However, since California accounts for a very small percentage of the total landings, the vast majority of the fishery is represented.

Fishery length compositions were constructed using data retrieved from the PacFIN Biological Data System (BDS) on May 6th, 2011. Length, age and sex data were acquired at the trip level, and then aggregated to the state level. For each trip, the length or age composition of the sampled individuals was scaled up to represent the length or age composition of the trip landings through use of an expansion factor. In this assessment, the expansion factor was calculated as:

$$\text{Expansion Factor} = (WT_{total}/WT_{sampled})^{0.85} ,$$

with total weight divided by sample weight being the equivalent of total estimated number over sampled number. The exponent 0.85 was used rather than capping the expansion factor at a specific value (such as 500), in acknowledgment of the reduced information that occurs with any expansion to the trip level. In practice this reduced the largest expansion factor from 738 to 274, which is less than the cap of 500 that is frequently applied. The initial effective N value (input N) for each state was calculated via Stewart's Method (Ian Stewart, pers. Comm.), which for fisheries is:

$$N_{effective} = N_{trips} + 0.138 N_{fish} \quad \text{if } N_{fish}/N_{trips} < 44$$
$$N_{effective} = 7.06 N_{trips} \quad \text{if } N_{fish}/N_{trips} \geq 44$$

Ideally the relative effective sample size for each state would be equal to the relative landings for each state. In order to account for lack of proportional sampling in each state, the effective N for each state was down-weighted using the geometric mean of the product of the ratio of individual state landings to total (two state) landings and the ratio of individual state effective N to the sum of the effective Ns for the two states as follows:

$$W_s = \sqrt{\left(\left(\frac{Land_s}{Land_T}\right)\left(\frac{EffN_s}{EffN_T}\right)\right)}$$

where *Land* represents landings, *s* indexes the states, *T* represents total or sum of individual states, and *EffN* is initial effective sample size (input N). These W_s were used as weighting factors in summing the normalized length compositions L_s of the states before renormalizing:

$$\vec{L}_T = \frac{\sum_{s=1}^{2} W_s \vec{L}_s}{\sum_{s=1}^{2} W_s}$$

Total input N was calculated by summing the individual state estimated initial effective N values and then multiplying this sum by a down weighting factor equal to the sum of the W_s (which is always ≤ 1). This was done in order to down weight the input N in cases where sampling was unbalanced.

Fishery conditional age-at-length compositions and mean length-at-age

Conditional age-at-length compositions are not used for fishery data due to the difficulty of accounting for growth across a year in an annual model. This difficulty greatly reduces the usefulness of the data in estimating growth, especially in comparison to survey conditional age-at length data, which is taken over a relatively short portion of the year. For those years for which fishery age data was used, mean length-at-age was calculated as well.

Discard length compositions

The length compositions of discards for 2002-2009 were calculated using observer data from fishing vessels that used bottom trawl gear. Individual lengths were scaled up to the total discard for each observed tow. Due to lack of sex data across the full range of length bins, all discard length-, age- and conditional age-at-length compositions were developed as combined-sex length compositions. Input N values for discard length compositions were calculated via Stewart's Method.

Ageing error

It is necessary to account for ageing error when fitting the model to the age-composition data. This involves converting from the model estimate of the age composition to the expected observed age composition given aging error. This is accomplished through the use of an ageing-error matrix (which specifies the probability that a fish of given actual age will be given a particular estimated age). The ageing-error matrix is based on the assumption that ageing error is normally distributed with a mean of 0 (i.e. no bias) and a CV of 0.064. This CV is based on the results of a double-read analysis of 1,161 Pacific ocean perch otoliths by the Cooperative Ageing Project at the Newport Laboratory of the Northwest Fisheries Science Center, NMFS (unpublished data).

CPUE data

Data on catch-per-unit-of-effort (CPUE) in mt/hr from the domestic fishery were combined for the INPFC Vancouver and Columbia areas (Figure 2, Table 4; from Gunderson (1977)). Although these data reflect catch rates for the U.S. fleet, the highest catch rates coincided with the beginning of removals by the foreign fleet. This suggests that, barring unaccounted changes in fishing efficiency during this period, the level of abundance was high at that time. While a CV of 0.2 was assumed in previous use of these data, a CV of 0.4 was used here to match the larger CVs observed in the survey data.

1.2.2. Surveys

NMFS Cruises

The results from four fishery-independent surveys are used as six separate time series in this assessment (Figures 3-8; Table 4).

1. The POP surveys for 1979 and 1985.
2. The NMFS triennial shelf survey that was conducted every third year from 1977-2004 (The 1977 triennial survey biomass value is not used due to bottom tending issues, and the survey series is split into two time periods due to differences in survey timing: 1980-1992 and 1995-2004).
3. The AFSC slope survey for the years 1996, 1997 and 1999-2001. (Previous combined "Super-years" were not used, but 1996 was used despite the limited spatial coverage - from 43 degrees N. lat. to the Canadian border - since very few Pacific ocean perch were observed south of 43 degrees in any of the subsequent AFSC slope surveys).
4. The NWFSC slope survey for the years 1999-2002, and the NWFSC survey (shelf/slope combo) for 2003-2010.

Size- rather than age-composition data are used when fitting the model for the years prior to 1989 due to use of surface ageing or lack of age-composition data. Survey age-composition data are not available for the AFSC slope survey or for the NWFSC slope survey prior to 2001.

Indices

Indices of abundance were derived from each of the above surveys and years using a generalized linear mixed model (GLMM) for each survey. (J. Wallace, pers. Comm.). In the GLMM, the *occurrence* of Pacific ocean perch rockfish in a survey haul is modeled as a binomial process and the *size* of the non-zero catches is modeled using a gamma model. Coefficients of variation (CVs) about the indices were produced from the GLMM as well. This is the first time that the GLMM approach has been used for the POP assessment. In this assessment, the GLMM approach was used for all six survey series, utilizing two or three depth strata, or two depth by two latitudinal strata. Depth ranges were limited to those which were covered in all years of each survey, and stratification was limited by sample size in each stratum and year. Depth breaks occurred at the shallowest depth surveyed (often 55 m (30 fathoms)), 200 m (or 183 m for surveys that started at that depth (100 fathoms)), 300m and 549 m (300 fathoms, or shallower if the survey did not extend to that depth). The smallest Pacific ocean perch tend to occur in depths less than 200 m, and only quite large individuals are seen beyond 300 m.

Length and age compositions

Length and age compositions (Table 5) were derived for each survey. Tow-level length, age, and sex data were aggregated within the same strata as used in the GLMMs. For each trip, the length composition of the sampled individuals was scaled up to represent the length composition of the trip landings through use of an expansion factor. In this assessment, the expansion factor was calculated as:

$$\text{Expansion Factor} = (WT_{total}/WT_{sampled})$$

The initial effective N (input N) was calculated via Stewart's Method (Ian Stewart, pers. Comm.), which for surveys is

$$N_{effective} = N_{tows} + 0.0707 N_{fish} \quad \text{if } N_{fish}/N_{tows} < 55$$
$$N_{effective} = 4.89 N_{tows} \quad \text{if } N_{fish}/N_{tows} \geq 55$$

where N_{fish} is the total number of fish sampled across all trips.

Conditional age-at-length compositions

Conditional age-at-length compositions were constructed from age and length data, assuming each fish sampled was a random sample among fish of that length. These compositions were constructed for all survey years with ages available based on the break and burn technique. These include the 1985 POP survey, the 1989-2004 triennial survey years, all years of the AFSC slope survey, and the 2001-2010 NWFSC survey years. Conditional age-at-length compositions were used in preliminary models, but not in the base model.

A summary of data sources and years included in the base model is given in Table 6 and Figure 9.

1.2.3. Biology and life history

Natural mortality, longevity, and age at recruitment

Pacific ocean perch ages, determined using scales and surface readings from otoliths, gave estimates of natural mortality of about 0.15yr^{-1} and longevity of about 30 years (Gunderson 1977). Based on the now-accepted break-and-burn method of age determination using otoliths, Chilton and Beamish (1982) determined the maximum age of *S. alutus* to be 90 years. Using similar information, Archibald et al. (1981) concluded that natural mortality for Pacific ocean perch should be on the order of 0.05yr^{-1}. Hoenig's (1983) relationship estimates that if Pacific ocean perch longevity is between 70 and 90 years (Beamish 1979, Chilton and Beamish 1982), M would be between 0.046 and 0.059yr^{-1}. In previous assessments a fairly tight prior distribution was imposed on natural mortality (lognormal with median 0.05 yr^{-1} and σ 0.1). Essentially, this specification acknowledged some uncertainty regarding the value for M, while nevertheless constraining the estimate of M to the general range of past estimates. However, for this assessment, priors based upon multiple life-history correlates (including Hoenig's method, Gunderson gonadosomatic index (Gunderson 1997) and McCoy and Gillooly's (2008) theoretical relationship) were developed separately for female and male POP. The median in real space for females is 0.060, and for males is 0.063, while for both with the sigma (in log space, similar to the CV in real space) was 0.31.

The age at recruitment for summary biomass is set at 3 years as in previous assessments.

Sex ratio, maturation and fecundity

Survey data indicate that sex ratios of young fish are within 5% of 1:1, so in this assessment, the sex ratio at birth is assumed to be 1:1. The maturity-at-age in the previous assessment was based on a logistic curve with the 50% female maturity set at age 8 as was recommended by the 2000 Pacific ocean perch STAR panel. In this assessment, we created a new maturity-at-age key based on the work of Hannah and Parker (2007) (Figure 10). This study determined the POP maturation-at-age based on 461 fish samples collected off the US West Coast where the ovaries maturity stage was identified by histological examination and the age estimated using the break-and-burn method (Chilton and Beamish 1982). The maturity-at-age data are asymmetric due to the presence of abortive maturation in individual females that have spawned in previous years, which occurs more often in younger mature females (Hannah and Parker 2007). As part of the sensitivity analysis, we smoothed out the data to create a monotonically increasing curve. This had essentially no effect on the model results.

For the previous assessment, the fecundity at age was considered proportional to the female weight. In this assessment, we used the estimates for the fecundity at weight relationship determined by Dick (2009):

$$\text{Fecundity} = 5.2 * W^{1.44}.$$

Spawning output at length is shown in Figure 11.

Length-weight relationship

The length-weight relationship for Pacific ocean perch was estimated using fishery data from 1966 through 2010.

$$W(L) = 1.065 \cdot 10^{-2} L^{3.08} \text{ for females}$$

$$W(L) = 1.395 \cdot 10^{-2} L^{3.00} \text{ for males}$$

where L is length in cm and W is weight in grams.

Growth (length at age)

Growth for females and males was estimated in preliminary models and fixed in the base model for this assessment (Table 7 and Figure 12).

1.2.4 Changes in data from the 2009 assessment

All of the data in this assessment were revisited, except for the fishery CPUE series.

1.3. Assessment model

1.3.1. Changes between the 2009 assessment model and the current model

The current model represents the first assessment of Pacific ocean perch carried out in the Stock synthesis framework. Major differences include changing to a two-sex model and estimating growth within preliminary models via the use of conditional age-at length data and length at age data. Selectivity in this model is assumed to be length-based and is modeled using double-normal or logistic curves, rather than using second-difference penalties. The current base model does not include time-varying fishery selectivity, but does include a time-varying retention curve instead of simply inflating catch to account for discard. The catch series has been built up from scratch, and extended back in time to 1940 (rather than 1956). Finally, the survey indices have been recalculated via GLMM analysis, rather than using area-swept estimates.

The landings histories used in the current assessment and the previous assessment are compared in Figure 13. The biggest difference between the two is that the current landing history includes data prior to 1956, back to 1940 when the first coastwide landings above 1 mt were recorded. Other smaller changes are due to reconstructed Oregon landings and a new look at Washington landings; however these changes are minimal in magnitude when compared to the foreign removals.

In this assessment, a beta prior developed from a meta-analysis of west coast groundfish species was imposed on steepness (M. Dorn, pers. Comm.) in preliminary models, with steepness fixed in the final base model.

1.3.2. Likelihood contributions

The objective function which is minimized to obtain the point estimates of the model parameters includes contributions by the data (survey biomass estimates, CPUE data, fishery and survey age- size- and conditional age-at-length composition data).

Model convergence was assessed in several ways.

1. The Hessian matrix was inverted to ensure that it was positive definite; a non-positive definite Hessian matrix is an indication of a poorly converged or over-parameterized model.
2. The estimation was always initiated with starting values that were far from the final solution. Starting values for the base model were jittered away from the base starting values to ensure that result was not due to the starting values. Jittered runs that converged to other results had far worse likelihood values, representing local minima.
3. The estimation was conducted in several phases to avoid problems when highly non-linear models (such as that used here) enter biologically unreasonable regions (e.g., stock sizes smaller than the total catch or stock sizes several orders of magnitude too high).

1.3.3. Priors

As reference above, a beta prior developed from a meta-analysis of west coast groundfish species was imposed on steepness (M. Dorn, pers. comm.), and log-normal priors on natural mortality were developed multiple using life history correlates including Hoenig's method (Hoenig, 1981), Gunderson's gonadosomatic index (Gunderson, 1997) and the theoretical relationship using maximum weight and environmental temperature of McCoy and Gillooly (2008).

1.4. Results

1.4.1. Model selection and evaluation

A parsimonious model with adequate flexibility to fit the data was selected as the base model. In developing this model, growth parameters were estimated in preliminary models including conditional age-at-length data and mean-length at age data, and female natural mortality rate was fixed at 0.05 with a male offset estimated, and steepness estimated as well in a second preliminary model. In the final base model, stock-recruitment steepness is fixed at 0.4, with growth and female natural mortality rate fixed as above. Fishery selectivity is modeled as being dome-shaped in length. Selectivity for the triennial shelf survey was allowed to be domed-shaped as well, and the relationship is assumed to be the same in both stanzas. However, the model estimated triennial survey selectivity as being asymptotic. The POP, AFSC slope and NWFSC slope surveys share a single asymptotic selectivity curve, while an asymptotic selectivity curve for the NWFSC shelf/slope survey is estimated separately. Fishery retention is modeled as an asymptotic curve as well, with the asymptote estimated in time blocks to fit the observed discard rates and length compositions.

The base model converged and fits the data well given its highly variable nature. Runs with starting parameter values jittered from the base model inputs (with a jitter factor of 0.15) mostly converged to the base model results, with a few converging to points with much larger likelihood values (300 points or more).

Comparison of key model assumptions include comparisons based on nested models (e.g. asymptotic vs. domed selectivities, constant vs. time varying selectivities).

1.4.2. Reference model results

Figures 14 and 15 show the time-trajectories of the point estimates (i.e. those that correspond to the maximum of the objective function, which are also those corresponding to the maximum of the posterior density function) for total biomass and depletion. Figures 16-18 provide information of recruitment in the base model, while Figures 19-20 give the time trajectories of exploitation rate and relative SPR. The selectivity of the fishery and surveys are shown in Figures 21-24. The fits of the base model to the various indices are seen in Figures 2-8. Total discard and fit to the discard fraction data is seen in Figures 25-26. Fit to the length and age data are seen in Figures 27-80. There is no evidence for model mis-specification in any of these fits.

A comparison of the 2009 model, the 2011 "update" of the 2009 model, and the current (2011; SS) model in terms of summary (3+) biomass and recruitment (age 3 instead of age 0, since the old model started at age 3) are shown in figures 81 and 82. The 2011 update of the 2009 model provides essentially the same values as the 2009 model with two more years of data. The biomass trajectory and recruitment time series are quite similar among all three models from 1970 forward. However, instead of having two large recruitments at the end of the 1950s to provide adequate biomass for the foreign fleet removals a decade later, the SS model estimates a larger virgin biomass and "equilibrium" recruitment level, while still estimating somewhat higher than average recruitment in the 1950s. Given that the high recruitments, especially the extremely high value in 1957, were based upon very little data, and were partially due to the model starting in 1956, this seems a more realistic representation of recruitment history (although clearly, data is lacking to discern individual recruitment events in the early period).

Given the results of the Base SS model, the OFL for 2013 would be 844 mt. The ACL for 2013 given the 0.864 rebuilding SPR for POP would be 150 mt.

Table 8 gives the time series of key values in the assessment, and Table 9 lists the output numbers-at-age matrix for females in the base model. The base model gives and estimate of the spawning stock biomass as depleted to 19.1% of its unfished equilibrium level of eggs in 2011 (Table 8). The spawning output first dropped below the target level of ($SB_{40\%}$) in 1969 and reached its lowest level (14.0% depletion level) in 1999. The estimated MSY based on an SPR of 50% is 863 mt, while the calculated estimate of MSY is 1,058 mt, which is smaller than all estimated annual catches (including discard) from 1951-1994, but larger than all subsequent catches. The fishing mortality throughout the period 2000-2010 has been less than $F_{50\%}$ and also less than F_{MSY}.

Assessments for the Queen Charlotte Islands in British Columbia, Canada (BC) and for Alaska show the same steep decline in stock biomass in the 1960s. In particular, the recent (2010) BC assessment shows a similar increase in the late 1950's, followed by a decline in the late 1960s with a continual decline until the early 1980s, and also a decline from the mid-1990s until the mid 2000s. The assessment also has large recruitment events in the early 1950s and a large age-1 recruitment in 2001 (matching the 2000 age zero recruitment in this assessment). Even though there is little direct mixing between the Queen Charlottes and the U.S. Wet Coast, this indicates that the same factors effect recruitment in these two areas – possibly climatic factors and timing and strength of upwelling.

The catchability parameters are reasonable, if a bit hard to evaluate versus other species since its meaning depends on the scaling of the GLMM and also the particular selectivity curve. For example, the NWFSC shelf/slope survey catchability is 3 times that of the slope survey which preceded it, however, the overall curve is shifted down and to the right except at the smallest sizes. To compare, one should multiply selectivity by catchability and plot the results, which would show the shelf/slope survey having greater catchability at length across the board. This is mainly due to a few large indices, and given the highly variable nature of the survey, it is only by chance that no such indices occurred in the four years of the slope only survey.

1.4.3. Retrospective analysis

Retrospective analysis (Table 10 and Figure 83) going back six years were used for comparison to the 2009 and 2007 assessments:

1) Retro 2009: Retrospective analysis – ignores the assessment data for 2010 (as if assessment were conducted in 2010)
2) Retro 2008: Retrospective analysis – ignores the assessment data for 2009 and 2010 (as if assessment were conducted in 2009)
3) Retro 2007: Retrospective analysis (as if assessment were conducted in 2008)
4) Retro 2006: Retrospective analysis (as if assessment were conducted in 2007)
5) Retro 2005: Retrospective analysis (as if assessment were conducted in 2006)
6) Retro 2004: Retrospective analysis (as if assessment were conducted in 2005)

There is no consistent retrospective pattern across the 6 retrospective runs. The 2004 through 2009 retrospective models have fairly consistent estimates of natural mortality, but steepness varies, first down and then up as more years are removed. Also, the earliest retrospectives have the largest estimates of the 2000 recruitment, which causes a greater increase in biomass at the end of the time series. The more recent data do not seem to support extremely large recruitments during those years.

Ignoring the data for 2010 and 2009 (retro 2008) has a moderate impact on estimated spawning biomass and depletion in 2009. Note that the depletion level of for the Retrospective 2009 model is below the estimated depletion of 0.188 in 2009 in the current base model, and far below the estimate of 0.286 in the 2009 assessment.

1.4.4. Profiles and Sensitivity Analysis

A number of profiles and sensitivity analyses were conducted, including:

1. Profiles over fixed values of female natural mortality : 0.03 to 0.07 (Table 11 and Figure 84)
2. A profile over fixed values of stock-recruitment steepness: 0.3 to 0.9. (Table 12 and Figure 85).
3. Alternative selectivity configurations (Table 13 and Figure 86) including
    a. Fishery selectivity asymptotic
    b. Fishery selectivity asymptotic prior to 1970 (for large foreign catches)
    c. Fishery selectivity asymptotic prior to 1989 (and substantial management restrictions)
    d. Fishery selectivity asymptotic prior to 2002 and rockfish conservation areas (RCAs).
4. Estimation of steepness (h) and/or the natural mortality rate (M) (Table 14 and Figure 87):
    a. Estimate both M and h
    b. Estimate h with female M fixed at 0.05
    c. Estimate M and h while forcing asymptotic fishery selectivity prior to 1989
    d. Estimate M with steepness fixed at 0.4

The profiles over M and h show how different assumptions can result in very different results, but if one is estimated and the other fixed, generally the results are not overall all that different. When both M and h are fixed, the resultant depletion is closely related to those values. Selectivity changes do produce somewhat different results, mainly for asymptotic non-time varying fishery selectivity. However, this last fits the data considerably less well.

The Base model was chosen over any of these sensitivities due to its parsimony and as a basis for producing a Decision Table via varying the value of steepness (*h*). However, since a number of parameters are fixed, the uncertainty in current stock status shown (Figure 19) is underestimated. Figure 88 shows the time series of depletion and the uncertainty around it under sensitivities 4a. and 4c. above.

There are a number of important sources of uncertainty. Survey data begins after the depletion of the stock, thus there is a lack in indices to help pin down the current relative biomass and spawning output levels relative to the unfished status. The current survey index is highly variable from year to year. Time varying selectivity may occur but allowing for changes likely results in overfitting the data. The 1999/2000 year classes no longer seem as large as previously estimated, but the 2008 year class looks to be larger than those year classes; however this is based on only on the 2010 NWFSC survey data.

1.5. Response to STAR panel requests

1) Use discard rates over time from Pikitch data
Rationale: Better data exists than what was assumed in base case as presented
Response: Used updated values provided by Dan Erickson.

2) Check discard sample size used
Rationale: Seems like actual number of fish are used and therefore different than survey and fishery approaches used.
Response: Actually correct values used, but should be reweighted by factor of about 50%.

3) Omit 2004 age data from the survey (perhaps it may be okay for the marginal age compositions) unless it can be corrected.
Response: Found that age data from one of three vessels for 2004 survey was mis-entered, so used data from the other two vessels only.

4) Compare mean weights-at-age from 2009 assessment to this year
Rationale: Need a way to compare growth
Response: Found that mean weights–at-age used for 2000-2009 assessments did not match the data in the assessment, and the current weights-at-age fit much better.

5) Exchange conditional age-length data for marginal age compositions
Rationale: In the bridge analysis and elsewhere, it was apparent that the composition data had a large impact—fix growth if needed
Response: Fixed growth and switched to age data. This eliminated the very large early recruitment in the 1950s.

6) Check old model numbers over time (i.e. age 3) with stock synthesis cross (A). Investigate what may be causing the difference in recent trend and in Bmsy and other reference point estimates.
Rationale: To try to better understand the difference between old and new assessments.
Response: Major difference is changes in B_0.

7) Try a run with R1 specified
Rationale: See if that improves the behavior of the single year class.
Response: Does not improve.

8) Do a run with and without the Oregon catch reconstruction
Rationale: A sensitivity to this has not been completed?
Response: Removing both the Oregon and Washington reconstruction does change B0 and current status, but there are no data prior to 1956 without the reconstruction.

9) Try a run with higher σ_R (i.e. 2.0 or 3.0) and steepness fixed at 1.0
Rationale: See if M estimates change
Response: Yes, M gets larger (0.09), but the entire trajectory is not reasonable.

10) Show pairwise diagnostic plots of MCMC chain
Rationale: May show correlations among parameters and if there are parameters that are poorly determined.
Response: Produced these – nothing obvious came of this.

11) Summarize results from recent Canadian assessment
Response: Showed results from assessment around Queen Charlotte Islands which are similar in terms of timing of large removals and overall trajectory.

12) Show plots of priors on M and h relative to previously used values.
Response: Shown (no prior on h previously, and very tight prior on M)

13) Provide table and summary of the meta-analysis used for steepness prior.
Response: Provided by Martin Dorn.

14) Provide maps showing coverage of the surveys relative to the fishery.
Response: Attempted, but lack of time. STAT felt description indicated adequate coverage.

1.6. Future research

There are a number of areas of future research, e.g.:

1) Research on the relative density of Pacific ocean perch in trawlable and untrawlable areas and difference in age and/or length compositions between those areas.
2) Estimation of climatic effects on recruitment, growth and survival.
3) Selection of an appropriate prior distribution for the survey catchability coefficients.
4) Further research on the relationship of individual female age and biomass to survival of offspring.
5) Research on the relative status of the British Columbia stock of Pacific ocean perch off of Vancouver Island.
6) Use of simulation models to evaluate how well one can estimate recruitment using size-composition data or biased or unbiased age-composition data, or a mix of the three.
7) Catch reconstruction for Washington state.

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Tables

Table 1. Pacific Fishery Management Council groundfish management/regulatory actions regarding Pacific ocean perch (POP) since Fishery Management Plan implementation in 1982.

Date	Regulatory Action
November 10, 1983	Recommended closure of Columbia area to POP fishing until the end of the year as 950 t OY for this species has been reached; retain 5,000 pound trip limit or 10 percent of total trip weight on landings of POP in the Vancouver area.
January 1, 1984	Continuation of 5,000 pound trip limit or 10 percent of total trip weight on POP as specified in FMP. Fishery closes when area OY's are reached (see action effective November 10, 1983 above).
August 1, 1984	Recommended immediate reduction in trip limit for POP in the Vancouver and Columbia areas to 20 percent by weight of all fish on board, not to exceed 5,000 pounds per vessel per trip. When OY is reached in either area, landings of POP will be prohibited in that area (Oregon and Washington implemented POP recommendation in mid-July).
August 16, 1984 (Automatic closure)	Commercial fishing for POP in the Columbia area closed for remainder of the year. (See items regarding this species effective January 1 and August 1, 1984 above.)
January 10, 1985	Recommended Vancouver and Columbia areas POP trip limit of 20 percent by weight of all fish on board (no 5,000 pound limit as specified in last half of 1984).
April 28, 1985	Recommended the Vancouver and Columbia areas POP trip limit be reduced to 5,000 pounds or 20 percent by weight of all fish on board, whichever is less. Landings of POP less than 1,000 pounds will be unrestricted. The fishery for this species will close when the OY in each area is reached.
June 10, 1985	Recommended landings of POP up to 1,000 pounds per trip will be unrestricted regardless of the percentage of these fish on board.
January 1, 1986	Recommended the POP limit in the area north of Cape Blanco (42 degrees, 50 minutes N) should be 20 percent (by weight) of all fish on board or 10,000 pounds whichever is less; landings of POP should be unrestricted if less than 1,000 pounds regardless of percentage on board; Vancouver area OY = 600 t; Columbia area OY = 950 t.
December 1, 1986	OY quota for POP reached in the Vancouver area; fishery closed until January 1, 1987.
January 1, 1987	Recommended the coastwide POP limit should be 20 percent of all legal fish on board or 5,000 pounds whichever is less (in round weight); landings of POP unrestricted if less than 1,000 pounds regardless of percentage on board; Vancouver area OY = 500 t; Columbia area OY = 800 t.
January 1, 1988	Recommended the coastwide POP trip limit should be 20 percent (by weight) of all fish on board or 5,000 pounds, whichever is less; landings of POP be unrestricted if less than 1,000 pounds regardless of percentage on board; Vancouver area OY = 500 t; Columbia area OY = 800 t.
January 1, 1989	Established the coastwide POP trip limit at 20 percent (by weight) of all fish on board or 5,000 pounds whichever is less; landings of POP unrestricted if less than 1,000 pounds regardless of percentage on board (Vancouver area OY = 500 t; Columbia area OY = 800 t).
July 26, 1989	Reduced the coastwide trip limit for POP to 2,000 pounds or 20 percent of all fish on board, whichever is less, with no trip frequency restriction. Increased the Columbia area POP OY from 800 to 1,040 t.
December 13, 1989	Closed the POP fishery in the Columbia area because 1,040 t OY reached.
January 1, 1990	Established the coastwide POP trip limit at 20 percent (by weight) of all fish on board or 3,000 pounds whichever is less; landings of POP be unrestricted if less than 1,000 pounds regardless of percentage on board. (Vancouver area OY = 500 t; Columbia area OY = 1,040 t).
January 1, 1991	Established the coastwide POP trip limit at 20 percent (by weight) of all fish on board or 3,000 pounds whichever is less; landings of POP be unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,000 t).
January 1, 1992	Established the coastwide POP trip limit at 20 percent (by weight) of all groundfish on board or 3,000 pounds whichever is less; landings of POP be unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,550 mt).
January 1, 1993	Continued the coastwide POP trip limit at 20 percent (by weight) of all groundfish on board or 3,000 pounds whichever is less; landings of POP be unrestricted if less than 1,000 pounds regardless of percentage on board (harvest guideline for combined Vancouver and Columbia areas = 1,550 mt).
January 1, 1994	Adopted the following management measure for the limited entry fishery in 1994: POP: Trip limit of 3,000 pounds or 20 percent of all fish on board, whichever is less, in landings of POP above 1,000 pounds. Adopted the following management measure for open access gear except trawls in 1994: Rockfish: Limit of 10,000 pounds per vessel per trip, not to exceed 40,000 pounds cumulative per month, and the limits for any rockfish species or complex in the limited entry longline or pot fishery must not be exceeded.
May 1, 1994	Changed trip limit for rockfish taken with setnet gear off California. The 10,000 pound trip limit for rockfish caught with setnets, which applied to each trip, was removed. The 40,000 pound cumulative limit that applies per calendar month remains in effect.
January 1, 1995	Established cumulative trip limits of 6,000 pounds per month.
January 1, 1996	Established cumulative trip limits of 10,000 pounds every two months.
July 1, 1996	Reduced cumulative 2-month trip limit to 8,000 pounds.
January 1, 1997	Established cumulative trip limits of 10,000 pounds every two months.
January 1998	Harvest guidelines reduced from 750 mt to 650 mt with ABC=0. Limited entry fishery under 8,000 pounds per two-months until September with monthly limits of 4,000 pounds
January 1999	Monthly cumulative trip limit of 4,000 pounds for limited entry fishery. A 100 pound per month limit established for open access fishery.
January 2000	Monthly cumulative trip limit of 2,500 pounds (May-October) and 500 pounds (November-April) for limited entry fishery.
January 2001	Monthly cumulative trip limit of 2,500 pounds (May-October) and 1,500 pounds (November-April) for limited entry fishery
June 2001	Monthly cumulative trip limit increased to 3,500 pounds for limited entry fishery beginning July 1, 2001.
September 2001	POP limited entry and open access fisheries closed starting October 1, 2001 through the end of 2001.
January 2002	Limited entry trip limit of 4,000 pounds/month (May-June), 4,000 pounds/2 months (July-October) or 2,000 pounds/month (November-March)
.January 2003	Two-month cumulative trip limit of 3,000 pounds for limited entry trawl fishery and 1,800 pounds for limited entry fixed gear fishery throughout the year. 100 pounds per month open access limit. In effect in 2007.
2002-2010	Rockfish Conservation Areas Implemented

Table 2. Pacific ocean perch estimated landings (or landings equivalents for AtSeaHake and Survey catches) from the US West Coast (in metric tons).

Year	WA	OR	CA	AtSeaHake	Survey	Foreign	Total
1940	2	9	1				12
1941	3	14	1				18
1942	5	27	0				32
1943	19	94	1				114
1944	33	164	3				200
1945	49	247	7				303
1946	39	193	7				239
1947	33	167	3				203
1948	36	178	4				217
1949	95	473	2				570
1950	138	690	1				830
1951	168	840	4				1,012
1952	305	2,030	3				2,338
1953	338	1,224	146				1,708
1954	504	1,837	123				2,465
1955	530	1,346	23				1,899
1956	517	2,564	4				3,085
1957	508	2,128	1				2,638
1958	496	1,565	3				2,064
1959	420	893	1				1,314
1960	869	1,359	10				2,238
1961	1,104	2,062	1				3,167
1962	1,615	2,585	1				4,200
1963	1,878	3,694	4				5,576
1964	1,657	4,262	8				5,927
1965	1,846	5,628	18				7,491
1966	1,615	1,591	2			15,561	18,769
1967	1,742	355	9			12,357	14,463
1968	2,008	466	11			6,639	9,125
1969	1,048	422	8			469	1,948
1970	1,387	507	9			441	2,344
1971	879	290	12			902	2,084
1972	963	105	11			950	2,030
1973	956	121	12			1,773	2,862
1974	857	137	16			1,457	2,466
1975	652	181	11	59		496	1,400
1976	834	664	17	30		239	1,784
1977	1,232	457	17	4	1		1,711
1978	1,781	499	43	15			2,337
1979	1,004	736	137	14	1		1,892
1980	1,106	949	19	45	1		2,120

Table 2 (continued). Pacific ocean perch estimated landings (or landings equivalents for AtSeaHake and Survey catches) from the US West Coast (in metric tons).

Year	WA	OR	CA	AtSeaHake	Survey	Foreign	Total
1981	439	930	11	15			1,395
1982	328	584	148	27			1,086
1983	482	1,033	105	10	1		1,631
1984	840	750	56	2			1,648
1985	613	789	71	11	1		1,485
1986	684	676	53	19	1		1,433
1987	448	549	119	4			1,120
1988	584	740	81	4			1,409
1989	483	923	29	4	1		1,440
1990	435	566	18	72			1,091
1991	543	836	9	41			1,428
1992	431	611	15	336	1		1,394
1993	461	785	11	1	0		1,258
1994	349	616	7	75	0		1,047
1995	287	509	9	39	1		845
1996	232	523	19	5	1		780
1997	184	434	16	5	0		639
1998	171	423	22	19	2		636
1999	151	323	20	14	1		509
2000	33	83	7	8	1		133
2001	51	193	1	18	2		264
2002	39	107	1	3	0		150
2003	30	94	0	5	4		134
2004	22	96	2	1	1		122
2005	10	51	0	1	2		64
2006	16	52	0	3	1		72
2007	45	83	0	3	1		132
2008	17	58	0	10	1		86
2009	33	59	1	1	1		95
2010	22	58	0	11	1		91

Table 3. Estimated input dicard rates (Discarded POP/Total POP catch) used in the assessment.

Year	Discard Rate	CV
1986	0.05	0.3
1992	0.1	0.3
2002	0.155	0.109
2003	0.157	0.125
2004	0.192	0.109
2005	0.175	0.160
2006	0.135	0.104
2007	0.172	0.140
2008	0.362	0.078
2009	0.518	0.076

Table 4. CPUE and GLMM –based biomass indices used in the assessment model.

CPUE

Year	Index Value	Input CV	Extra CV
1956	0.4	0.4	
1957	0.3	0.4	
1958	0.32	0.4	
1959	0.29	0.4	
1960	0.28	0.4	
1961	0.31	0.4	
1962	0.29	0.4	
1963	0.34	0.4	
1964	0.35	0.4	
1965	0.55	0.4	
1966	0.47	0.4	
1967	0.3	0.4	
1968	0.17	0.4	
1969	0.178	0.4	
1970	0.175	0.4	
1971	0.2034	0.4	
1972	0.1984	0.4	
1973	0.1144	0.4	

POP Survey

Year	Index Value	Input CV	Extra CV
1979	30,872	0.0785	0.11
1985	15,909	0.0835	0.11

Early Triennial Survey

Year	Index Value	Input CV	Extra CV
1980	8,208	0.1735	
1983	6,390	0.1346	
1986	5,303	0.3214	
1989	6,636	0.3075	
1992	3,568	0.2926	

Late Triennial Survey

Year	Index Value	Input CV	Extra CV
1995	1,827	0.1608	0.27
1998	6,477	0.2782	0.27
2001	2,753	0.305	0.27
2004	6,250	0.2301	0.27

AFSC Slope Survey

Year	Index Value	Input CV	Extra CV
1996	4,621	0.2176	0.47
1997	1,768	0.4163	0.47
1999	12,094	0.3758	0.47
2000	2,971	0.2948	0.47
2001	15,631	0.408	0.47

NWFSC Slope Survey

Year	Index Value	Input CV	Extra CV
1999	2,558	0.3326	
2000	3,991	0.3901	
2001	4,495	0.324	
2002	2,213	0.3618	

NWFSC Shelf/Slope Survey

Year	Index Value	Input CV	Extra CV
2003	25,088	0.2685	0.29
2004	5,348	0.2596	0.29
2005	9,351	0.317	0.29
2006	13,090	0.4095	0.29
2007	3,674	0.2635	0.29
2008	6,462	0.3345	0.29
2009	12,014	0.3888	0.29
2010	19,047	0.375	0.29

Table 5: Number of hauls, fish, and total input Ns for Survey length composition data used in the assessment: lengths

Portion of catch	Year	Fish	Trips	Input N	ReWt N
Retained	1966	238	1	5	
	1967	1,020	5	32	
	1968	912	3	19	
	1969	1,213	4	24	
	1970	1,830	13	79	
	1972	4,561	23	147	
	1973	4,134	17	117	
	1974	4,808	20	138	
	1976	3,630	20	140	
	1977	4,847	32	208	
	1978	7,717	52	330	
	1979	3,414	34	239	
	1980	5,433	55	388	
	1989	798	16	92	
	1990	599	12	65	
	1991	216	8	30	
	1995	3,761	49	308	
	1996	3,085	64	439	
	1997	3,570	76	519	
	1998	3,450	56	376	
Discard	2003	34	8	13	7
	2004	400	27	82	41
	2005	543	45	120	60
	2006	241	36	69	35
	2007	537	75	149	75
	2008	391	33	87	44
	2009	1,274	129	305	153

ages

Portion of catch	Year	Fish	Trips	Input N	ReWt N
Retained	1971	1,131	7	50	
	1975	997	9	64	
	1981	1,027	11	67	
	1982	2,777	40	281	
	1983	3,320	33	233	
	1984	2,625	27	187	
	1985	2,097	21	99	
	1986	1,694	17	85	
	1987	1,195	24	108	
	1988	200	4	17	
	1994	238	8	33	

1999	863	18	95
2000	654	13	91
2001	1,350	40	218
2002	1,416	38	223
2003	1,309	40	197
2004	704	27	122
2005	920	35	162
2006	1,259	49	222
2007	1,798	62	310
2008	1,015	34	167
2009	1,549	76	290
2010	1,264	55	226

lengths

Survey	Year	Fish	Hauls	Input N	ReWt N
POP	1979	10347	125	611	
Triennial	1980	4823	28	137	
	1983	4081	44	215	
	1986	1939	17	83	
AFSC slope	1996	1714	48	169	144
	1997	347	21	46	39
	1999	1673	21	103	88
	2000	389	19	47	40
	2001	891	23	86	73

ages

Survey	Year	Fish	Hauls	Input N	ReWt N
POP	1985			142	57
Triennial	1989			98	69
	1992			66	46
	1995			75	63
	1998			75	63
	2001			93	78
	2004			89	75
NWFSC slope	2001			27	
	2002			42	
NWFSC combo	2003			72	
	2004			44	
	2005			53	
	2006			50	
	2007			74	
	2008			60	
	2009			63	
	2010			92	

Table 6. List of the data sources and associated time periods used in present assessment.

Data Source	Years
Landings	1940-2010
Fishery age-composition data	1971, 1975, 1981-1988,1994, 1999-2010
Fishery size-composition data	1966-2010, for those years without age data
Fishery CPUE	1956-73
Biomass indices	
Triennial survey – Early	1980,1983,1986,1989,1992
Triennial survey - Late	1995,1998,2001,2004
POP/Rockfish survey	1979,1985
AFSC slope survey	1996, 1997, 1999-2001
NWFSC slope survey	1999-2002
NWFSC survey (shelf/slope combo)	2003-2010
Survey age composition data	
Triennial survey	1989, 1992, 1995, 1998, 2001, 2004
POP / NWFSC slope surveys	1985, 2001-2010
Survey size-composition data	
Triennial survey	1980,1983,1986,(1989,1992, 1995,1998,2001,2004)
POP / AFSC slope surveys	1979, (1985), 1996, 1998-2001
NWFSC Slope/Combo surveys	(2001-2010)

Table 7: Parameters in the base model

Parameters	Value	Estimation
Mortality and growth		
Female natural mortality	0.05	Fixed
Female length at age 3	21.211	Fixed
Female length at age 25	41.983	Fixed
Female Von-Bertalanfy *K*	0.159	Fixed
Female CV of size at age (young)	0.072	Fixed
Female CV of size at age (old)	0.064	Fixed
Male natural mortality (exponential offset)	0.027	Estimated
Male length at age 3 (exponential offset)	0.000	Fixed
Male length at age 25 (exponential offset)	-0.059	Fixed
Male Von-Bertalanfy *K*(exponential offset)	0.195	Fixed
Male CV of size at age 3 (exponential offset)	0.049	Fixed
Male CV of size at age 25 (exponential offset)	-0.189	Fixed
Biological parameters		
Female scalar for weight at length	1.065E-5	Fixed
Female exponent for weight at length	3.080	Fixed
Maturity at age	vector	Fixed
Scalar for fecundity	5.200	Fixed
Exponent for fecundity	1.440	Fixed
Male scalar for weight at length	1.395E-5	Fixed
Male exponent for weight at length	3.000	Fixed
B-H stock recruitment R_0	9.141	Estimated
B-H stock recruitment steepness (h)	0.4	Fixed
B-H stock recruitment SD	0.700	Fixed
Catchability		
POP/Rockfish survey	0.87	Estimated
Early Triennial Survey	0.35	Estimated
Late Triennial Survey	0.29	Estimated
AFSC Slope Survey	0.34	Estimated
NWFSC Slope Survey	0.21	Estimated
NWFSC Shelf/Slope Survey	0.63	Estimated
Selectivity: Fishery (double normal)		
Peak	36.607	Estimated
Width of peak	-5.000	Fixed
Ascending width	3.257	Estimated
Descending width	0.633	Estimated
Initial	-2.737	Estimated
Final	0.998	Estimated
Retention: Fishery		
Inflection point	30.937	Estimated
Slope	1.879	Estimated
Asymptote in 2008 and 2010	0.681	Estimated
Male offset	0.000	Fixed

Table 7: Continued: Parameters in the base model

Parameters	Value	Estimation
Selectivity: POP, AFSC Slope and NWFSC Slope survey (logistic)		
Inflection point	23.009	Estimated
95% width	9.328	Estimated
Selectivity: Triennial Shelf (logistic)		
Inflection point	20.323	Estimated
95% width	5.419	Estimated
Selectivity: NWFSC Shelf/Slope 2003-2010 (logistic)		
Inflection point	25.854	Estimated
95% width	17291	Estimated
Selectivity block parameters		
Retention asymptote 1940-1981	0.999	Fixed
Retention asymptote 1982-1988	0.980	Fixed
Retention asymptote 1989-1994	0.964	Estimated
Retention asymptote 1995-2007	0.906	Estimated
Retention asymptote 2009	0.497	Estimated
(Retention asymptote 2008, 2010)	0.681	Estimated

Table 8: Time series of population estimates from the base case model

Year	Total biomass (mt)	Spawning output	Depletion	Age-0 recruits (1000s)	Total catch (mt)	SPR	Relative exploitation rate
1940	120,246	65,471	99.9%	9,165	12	99.7%	0.0001
1941	120,103	65,414	99.8%	9,121	18	99.6%	0.0002
1942	119,770	65,353	99.7%	9,054	32	99.3%	0.0003
1943	117,855	65,287	99.6%	9,010	114	97.4%	0.0010
1944	115,898	65,180	99.4%	9,029	200	95.6%	0.0018
1945	113,619	65,025	99.2%	9,189	303	93.4%	0.0027
1946	114,999	64,812	98.9%	9,541	239	94.7%	0.0021
1947	115,790	64,634	98.6%	10,159	203	95.5%	0.0018
1948	115,464	64,476	98.3%	11,056	217	95.2%	0.0019
1949	107,985	64,309	98.1%	12,075	570	88.0%	0.0051
1950	102,947	63,941	97.5%	13,051	830	83.3%	0.0074
1951	99,572	63,439	96.8%	14,391	1,012	80.0%	0.0091
1952	80,393	62,869	95.9%	16,361	2,338	61.9%	0.0211
1953	87,999	61,596	94.0%	15,234	1,708	69.1%	0.0156
1954	77,985	60,799	92.7%	12,630	2,465	59.7%	0.0227
1955	84,595	59,700	91.1%	10,547	1,899	65.9%	0.0177
1956	70,675	59,103	90.2%	9,197	3,085	52.8%	0.0288
1957	74,881	58,028	88.5%	8,105	2,638	56.8%	0.0250
1958	81,644	57,420	87.6%	7,085	2,064	63.1%	0.0197
1959	92,806	57,282	87.4%	6,759	1,314	73.6%	0.0126
1960	79,925	57,598	87.9%	8,366	2,238	61.5%	0.0215
1961	69,861	57,284	87.4%	13,869	3,167	52.1%	0.0307
1962	60,743	56,260	85.8%	11,467	4,200	43.6%	0.0415
1963	51,030	54,465	83.1%	7,358	5,576	34.8%	0.0570
1964	47,627	51,763	79.0%	6,283	5,927	31.8%	0.0633
1965	39,147	48,823	74.5%	5,534	7,491	24.3%	0.0842
1966	18,513	45,083	68.8%	4,229	18,769	7.8%	0.2280
1967	18,422	35,015	53.4%	3,527	14,463	7.7%	0.2256
1968	21,617	27,493	41.9%	3,891	9,125	10.0%	0.1810
1969	56,007	23,076	35.2%	6,062	1,948	39.3%	0.0461
1970	50,244	22,744	34.7%	10,641	2,344	34.1%	0.0567
1971	53,293	22,032	33.6%	4,909	2,084	36.8%	0.0521
1972	53,483	21,317	32.5%	2,584	2,030	37.0%	0.0520
1973	42,418	20,554	31.4%	1,937	2,862	27.1%	0.0741
1974	44,984	19,366	29.5%	2,397	2,466	29.4%	0.0667
1975	60,783	18,567	28.3%	2,960	1,400	43.7%	0.0396
1976	52,978	18,508	28.2%	2,450	1,784	36.6%	0.0515

Table 8: Continued. Time series of population estimates from the base case model

Year	3+ biomass (mt)	Spawning output	Depletion	Age-0 recruits (1000s)	Catch (mt)	SPR	Relative exploitation rate
1977	53,858	18,275	27.9%	3,071	1,711	37.4%	0.0510
1978	44,099	17,968	27.4%	3,340	2,337	28.6%	0.0717
1979	49,002	17,094	26.1%	3,871	1,892	33.0%	0.0613
1980	44,320	16,269	24.8%	3,115	2,120	28.8%	0.0718
1981	54,994	15,227	23.2%	6,407	1,395	38.4%	0.0500
1982	60,842	14,624	22.3%	2,540	1,086	43.7%	0.0409
1983	47,281	14,282	21.8%	2,837	1,631	31.4%	0.0630
1984	45,327	13,691	20.9%	4,098	1,648	29.7%	0.0659
1985	46,788	13,091	20.0%	4,387	1,485	31.0%	0.0622
1986	46,583	12,596	19.2%	1,763	1,433	30.8%	0.0625
1987	53,026	12,124	18.5%	3,006	1,120	36.6%	0.0505
1988	45,703	11,855	18.1%	3,460	1,409	30.0%	0.0644
1989	43,787	11,425	17.4%	4,180	1,440	28.3%	0.0693
1990	51,047	10,973	16.7%	3,586	1,091	34.8%	0.0546
1991	42,640	10,706	16.3%	4,078	1,428	27.3%	0.0728
1992	42,277	10,253	15.6%	942	1,394	27.0%	0.0734
1993	44,064	9,827	15.0%	1,688	1,258	28.6%	0.0685
1994	48,458	9,500	14.5%	4,147	1,047	32.5%	0.0583
1995	52,502	9,303	14.2%	2,870	845	36.1%	0.0515
1996	54,836	9,237	14.1%	1,378	780	38.2%	0.0485
1997	61,118	9,202	14.0%	1,438	639	44.0%	0.0398
1998	61,477	9,209	14.0%	2,478	636	44.3%	0.0395
1999	68,334	9,168	14.0%	6,400	509	50.7%	0.0318
2000	101,035	9,178	14.0%	6,945	133	81.4%	0.0084
2001	87,526	9,405	14.3%	3,096	264	68.6%	0.0162
2002	99,716	9,569	14.6%	1,985	150	80.2%	0.0089
2003	101,897	9,795	14.9%	805	134	82.3%	0.0076
2004	103,613	10,072	15.4%	2,921	122	83.9%	0.0067
2005	111,324	10,438	15.9%	2,017	64	91.2%	0.0034
2006	110,716	10,941	16.7%	1,250	72	90.6%	0.0037
2007	104,416	11,509	17.6%	1,193	132	84.6%	0.0066
2008	106,917	11,985	18.3%	10,709	86	87.0%	0.0056
2009	101,533	12,318	18.8%	2,696	95	81.9%	0.0083
2010	106,847	12,450	19.0%	3,589	91	87.0%	0.0058
2011	24,505	56,721	18.8%				

Table 9: Female numbers at age (1000s) for 1940-2010

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1938	4664	4437	4221	4015	3819	3633	3456	3287	3127	2974	2829	2691	2560	2435	2316	2203	2096	1994	1896	1804	1716
1939	4664	4437	4221	4015	3819	3633	3456	3287	3127	2974	2829	2691	2560	2435	2316	2203	2096	1994	1896	1804	1716
1940	4583	4361	4137	3913	3701	3507	3331	3170	3020	2974	2829	2691	2560	2435	2316	2203	2096	1994	1896	1804	1716
1941	4561	4359	4149	3935	3722	3521	3336	3168	3015	2872	2829	2691	2560	2435	2316	2203	2096	1993	1896	1804	1716
1942	4527	4338	4146	3946	3743	3540	3349	3173	3014	2867	2732	2690	2559	2434	2316	2203	2095	1993	1896	1803	1716
1943	4505	4306	4126	3944	3754	3560	3368	3185	3018	2866	2727	2598	2558	2434	2315	2202	2095	1992	1895	1803	1715
1944	4514	4285	4096	3925	3751	3570	3386	3202	3028	2868	2723	2591	2468	2431	2312	2200	2092	1990	1893	1801	1713
1945	4595	4294	4076	3895	3733	3568	3395	3218	3042	2875	2723	2585	2459	2343	2308	2195	2088	1987	1890	1798	1710
1946	4770	4371	4084	3876	3705	3550	3392	3225	3056	2887	2727	2582	2451	2332	2222	2189	2082	1981	1884	1793	1705
1947	5079	4538	4157	3884	3686	3523	3375	3223	3064	2901	2740	2588	2450	2326	2213	2109	2077	1976	1880	1788	1701
1948	5528	4832	4316	3953	3694	3506	3350	3208	3062	2909	2754	2601	2457	2326	2208	2101	2002	1972	1876	1785	1698
1949	6038	5258	4595	4105	3760	3513	3333	3184	3048	2908	2762	2614	2468	2332	2208	2096	1994	1900	1872	1781	1694
1950	6526	5743	5000	4369	3903	3575	3338	3164	3018	2885	2751	2612	2472	2334	2205	2088	1983	1887	1798	1771	1685
1951	7196	6207	5460	4753	4154	3709	3395	3165	2994	2851	2723	2595	2463	2331	2202	2080	1970	1871	1781	1697	1672
1952	8180	6845	5900	5190	4518	3947	3521	3216	2992	2824	2686	2563	2442	2318	2194	2073	1959	1856	1762	1677	1599
1953	7617	7781	6500	5603	4928	4287	3737	3319	3014	2790	2625	2493	2378	2266	2152	2038	1926	1821	1725	1639	1560
1954	6315	7245	7392	6175	5323	4679	4064	3530	3122	2826	2609	2452	2327	2220	2116	2011	1905	1801	1703	1614	1533
1955	5274	6007	6879	7019	5862	5050	4428	3827	3304	2907	2621	2416	2269	2154	2056	1961	1864	1767	1670	1580	1498
1956	4598	5017	5706	6534	6666	5565	4785	4179	3595	3090	2711	2441	2250	2113	2007	1916	1828	1738	1648	1559	1474
1957	4052	4374	4760	5414	6200	6320	5259	4493	3893	3326	2846	2491	2242	2066	1942	1846	1763	1683	1601	1518	1437
1958	3542	3855	4152	4519	5139	5881	5978	4947	4197	3615	3076	2627	2298	2069	1908	1794	1706	1631	1557	1482	1405
1959	3379	3370	3661	3943	4291	4877	5569	5636	4639	3918	3364	2858	2440	2135	1923	1774	1669	1587	1518	1450	1380
1960	4183	3214	3202	3479	3747	4076	4626	5268	5314	4361	3675	3153	2678	2287	2001	1802	1663	1565	1489	1424	1360
1961	6934	3979	3052	3040	3303	3555	3859	4360	4936	4954	4052	3410	2924	2484	2122	1858	1674	1545	1455	1384	1324
1962	5733	6596	3776	2896	2885	3131	3359	3622	4059	4563	4558	3720	3128	2683	2280	1949	1708	1540	1422	1339	1275
1963	3679	5454	6254	3580	2746	2732	2952	3139	3347	3715	4150	4132	3369	2834	2433	2070	1771	1553	1401	1294	1219
1964	3141	3499	5164	5922	3389	2595	2566	2740	2870	3020	3322	3694	3674	2997	2524	2169	1848	1582	1389	1254	1159
1965	2767	2988	3312	4887	5603	3201	2435	2375	2493	2572	2679	2933	3257	3241	2647	2232	1922	1638	1405	1234	1114
1966	2115	2632	2823	3129	4616	5280	2989	2232	2127	2186	2225	2302	2515	2795	2786	2280	1927	1661	1418	1217	1070
1967	1764	2012	2457	2635	2919	4278	4768	2559	1782	1592	1565	1557	1600	1753	1959	1967	1620	1376	1191	1021	878
1968	1946	1678	1877	2293	2458	2704	3862	4080	2041	1332	1137	1092	1080	1113	1226	1380	1393	1154	984	855	735
1969	3031	1851	1572	1759	2147	2289	2466	3375	3374	1605	1011	849	811	803	832	921	1042	1056	877	750	653
1970	5321	2883	1754	1489	1666	2031	2154	2298	3104	3068	1449	910	762	729	723	749	830	940	954	793	678
1971	2454	5061	2730	1660	1410	1575	1908	1998	2098	2796	2738	1287	807	677	648	643	667	741	839	852	709
1972	1292	2335	4794	2586	1573	1333	1481	1774	1832	1900	2511	2450	1150	722	606	581	577	599	665	754	766
1973	968	1229	2212	4541	2449	1487	1254	1377	1627	1660	1707	2247	2190	1028	646	543	521	518	538	598	679
1974	1198	921	1162	2091	4292	2310	1391	1154	1242	1440	1452	1485	1951	1902	895	563	474	455	453	472	525
1975	1480	1140	871	1099	1977	4052	2164	1284	1045	1106	1269	1272	1299	1708	1668	786	495	417	402	400	416
1976	1225	1408	1081	826	1042	1872	3820	2022	1187	957	1006	1151	1153	1177	1549	1514	714	450	380	365	364
1977	1535	1165	1333	1024	782	985	1761	3551	1853	1074	859	900	1028	1030	1053	1387	1357	641	404	341	329
1978	1670	1460	1104	1263	970	740	927	1638	3258	1680	966	769	805	920	922	944	1245	1219	576	364	307
1979	1936	1589	1381	1044	1194	915	693	855	1481	2897	1477	844	671	703	804	808	828	1094	1073	507	320
1980	1557	1841	1504	1308	988	1129	859	642	779	1331	2578	1308	747	594	623	714	718	737	974	956	452
1981	3204	1481	1741	1422	1236	933	1057	792	581	693	1171	2256	1143	653	520	546	627	631	649	858	842
1982	1270	3047	1404	1650	1348	1170	877	984	728	527	624	1051	2022	1025	586	467	491	564	569	585	774
1983	1418	1208	2889	1331	1564	1276	1103	820	910	666	480	566	952	1833	930	532	425	447	514	518	533
1984	2049	1349	1143	2734	1259	1477	1197	1020	746	815	591	423	499	839	1617	822	471	376	396	456	460
1985	2193	1949	1276	1081	2586	1189	1384	1105	925	665	718	518	371	437	737	1422	723	415	332	350	403
1986	881	2086	1844	1208	1023	2442	1115	1280	1004	827	589	633	456	326	385	650	1257	640	368	294	310
1987	1503	838	1974	1745	1143	966	2290	1031	1163	898	732	518	556	401	287	340	574	1112	567	326	261
1988	1730	1430	794	1870	1653	1081	908	2129	945	1052	806	654	463	497	359	257	305	515	998	509	293
1989	2090	1646	1353	751	1769	1560	1013	839	1931	843	929	708	574	406	437	316	227	269	455	882	450
1990	1793	1988	1556	1279	710	1669	1461	934	759	1716	740	812	617	501	355	382	277	199	236	400	777
1991	2039	1705	1883	1474	1211	672	1568	1356	854	684	1534	659	722	549	446	316	341	247	178	211	359
1992	471	1939	1613	1780	1393	1142	628	1444	1223	756	599	1335	573	627	478	389	276	299	217	156	186
1993	844	448	1834	1525	1683	1314	1069	578	1301	1083	661	521	1158	497	545	416	339	242	261	190	137

Table 9: Continued. Female numbers at age (1000s) for 1940-2010

Year	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40+
1938	1632	1553	1477	1405	1336	1271	1209	1150	1094	1041	990	942	896	852	811	771	733	698	664	12944
1939	1632	1553	1477	1405	1336	1271	1209	1150	1094	1041	990	942	896	852	811	771	733	698	664	12944
1940	1632	1553	1477	1405	1336	1271	1209	1150	1094	1041	990	942	896	852	811	771	733	698	664	12944
1941	1632	1553	1477	1405	1336	1271	1209	1150	1094	1041	990	942	896	852	810	771	733	698	664	12942
1942	1632	1552	1477	1405	1336	1271	1209	1150	1094	1041	990	941	896	852	810	771	733	697	663	12940
1943	1631	1552	1476	1404	1336	1271	1209	1150	1094	1040	989	941	895	852	810	771	733	697	663	12937
1944	1630	1550	1475	1403	1334	1269	1207	1148	1092	1039	988	940	894	851	809	770	732	697	663	12924
1945	1627	1547	1472	1400	1332	1267	1205	1146	1091	1037	987	939	893	849	808	768	731	695	661	12901
1946	1622	1543	1468	1396	1328	1264	1202	1143	1088	1035	984	936	890	847	806	766	729	693	660	12866
1947	1619	1540	1465	1393	1325	1261	1199	1141	1085	1032	982	934	889	845	804	765	727	692	658	12839
1948	1615	1537	1462	1391	1323	1258	1197	1139	1083	1030	980	932	887	844	803	763	726	691	657	12816
1949	1612	1534	1459	1388	1320	1256	1195	1137	1081	1028	978	931	885	842	801	762	725	689	656	12791
1950	1603	1525	1451	1381	1313	1249	1189	1131	1076	1023	973	926	881	838	797	758	721	686	652	12726
1951	1591	1513	1440	1370	1303	1240	1180	1122	1067	1015	966	919	874	831	791	752	716	681	648	12631
1952	1575	1499	1426	1357	1291	1228	1168	1112	1057	1006	957	910	866	824	784	745	709	675	642	12515
1953	1487	1465	1395	1327	1263	1201	1143	1088	1035	984	936	891	847	806	767	729	694	660	628	12247
1954	1460	1391	1371	1305	1242	1182	1124	1070	1018	968	921	876	834	793	755	718	683	650	618	12052
1955	1423	1355	1292	1273	1212	1153	1098	1044	994	946	900	856	814	775	737	701	667	634	603	11771
1956	1398	1329	1265	1206	1189	1132	1077	1025	975	928	883	840	799	760	723	688	655	623	592	11556
1957	1359	1289	1225	1167	1113	1097	1044	994	946	900	856	815	775	737	702	667	635	604	575	11210
1958	1330	1259	1194	1135	1081	1031	1016	967	920	876	834	793	755	718	683	650	618	588	560	10919
1959	1309	1239	1172	1112	1057	1007	960	946	901	858	816	777	739	703	669	637	606	576	548	10696
1960	1295	1228	1163	1100	1044	992	945	901	889	846	805	766	729	694	660	628	598	569	541	10558
1961	1265	1204	1143	1081	1024	971	923	879	839	827	787	749	713	679	646	614	585	556	529	10328
1962	1219	1165	1109	1053	997	943	895	851	811	773	762	726	691	657	626	595	566	539	513	10010
1963	1161	1111	1062	1011	960	908	860	816	776	739	705	695	662	630	599	571	543	517	492	9597
1964	1092	1040	996	952	907	861	815	772	732	696	663	633	624	594	565	538	512	487	464	9055
1965	1031	972	926	886	848	807	767	726	687	652	620	591	564	556	529	504	479	456	434	8483
1966	967	895	844	805	771	737	702	667	631	598	567	540	514	490	484	460	438	417	397	7761
1967	774	701	649	613	585	561	537	511	486	460	436	414	394	375	358	353	336	320	305	5957
1968	634	559	507	471	445	425	407	390	372	353	335	317	301	287	273	261	257	245	233	4562
1969	562	486	429	390	362	342	327	313	300	286	272	258	245	232	221	211	201	198	189	3698
1970	591	509	439	388	352	327	310	296	284	272	259	246	234	221	210	200	191	182	179	3519
1971	607	529	455	393	348	316	293	277	265	254	244	232	221	209	198	188	179	171	163	3315
1972	638	546	476	410	354	313	284	264	250	239	229	219	209	199	189	179	170	162	154	3135
1973	690	574	492	429	369	319	282	256	238	225	215	207	198	189	179	170	161	153	146	2966
1974	595	605	504	432	377	325	281	248	225	209	198	189	182	174	166	158	150	142	135	2736
1975	463	526	535	446	382	333	287	248	220	199	185	175	168	161	154	147	140	132	126	2542
1976	379	422	479	488	406	348	304	262	226	200	182	169	160	153	147	140	134	127	121	2433
1977	328	341	380	432	439	366	314	274	236	204	180	164	152	144	138	132	127	121	115	2301
1978	296	295	308	342	389	396	330	283	247	213	184	163	148	137	130	124	119	114	109	2179
1979	271	261	260	271	302	343	350	291	250	218	188	162	144	131	121	115	110	105	101	2022
1980	286	242	233	232	242	270	307	312	260	223	195	168	145	128	117	108	103	98	94	1897
1981	399	252	213	206	205	214	238	271	276	230	197	172	148	128	113	103	96	91	87	1760
1982	760	360	228	193	186	185	193	215	245	249	208	178	156	134	116	103	93	87	82	1670
1983	705	693	328	208	176	169	169	176	197	223	227	190	163	142	122	106	94	85	79	1598
1984	473	627	616	292	185	156	151	150	157	175	199	202	169	145	126	109	94	83	76	1493
1985	407	419	555	545	258	164	138	133	133	139	155	176	179	150	128	112	97	83	74	1391
1986	358	361	372	493	484	230	145	123	119	119	124	138	157	160	133	114	100	86	74	1303
1987	275	317	321	330	438	430	204	129	109	105	105	110	122	139	142	118	101	89	76	1224
1988	235	248	285	289	297	394	388	184	116	98	95	95	99	110	125	128	107	91	80	1171
1989	259	208	219	253	256	263	349	344	163	103	87	84	84	88	98	111	113	94	81	1110
1990	397	228	183	193	223	226	232	308	303	144	91	77	74	74	78	86	98	100	83	1051
1991	696	356	205	164	173	200	202	209	277	272	129	82	69	67	67	70	78	88	90	1019
1992	315	611	312	180	144	153	176	178	183	243	239	113	72	61	59	59	61	68	78	975
1993	163	276	536	274	158	127	134	155	156	161	214	210	100	63	53	52	52	54	60	926

Table 9: Continued. Female numbers at age (1000s) for 1940-2010

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1994	2074	803	424	1734	1442	1588	1230	985	523	1157	952	578	454	1011	435	478	365	298	212	230	167
1995	1435	1972	760	401	1641	1362	1490	1140	898	469	1029	842	511	402	895	385	424	325	265	189	205
1996	689	1365	1868	720	380	1552	1280	1385	1044	812	421	919	751	456	359	801	345	380	291	238	170
1997	719	656	1293	1770	682	359	1460	1192	1272	948	731	378	823	673	409	322	720	311	342	263	215
1998	1239	684	621	1226	1678	646	339	1365	1102	1165	862	663	342	746	611	371	293	655	283	312	239
1999	3200	1179	648	589	1163	1589	609	317	1262	1009	1060	783	602	311	678	555	338	267	597	258	284
2000	3472	3044	1118	615	559	1102	1501	571	295	1165	927	972	717	551	285	622	510	310	245	548	237
2001	1548	3303	2894	1063	585	531	1046	1422	540	278	1098	873	915	675	519	268	586	480	292	231	517
2002	992	1473	3138	2749	1010	555	504	988	1338	506	260	1025	815	854	630	485	251	548	449	273	216
2003	402	944	1400	2983	2613	960	527	477	934	1262	477	245	965	767	804	593	457	236	516	423	258
2004	1460	383	897	1331	2835	2483	911	500	451	882	1190	449	231	909	723	758	560	431	223	487	399
2005	1009	1389	364	853	1265	2695	2358	864	473	427	833	1123	424	218	858	683	716	528	407	210	459
2006	625	959	1321	346	811	1203	2561	2240	820	448	404	789	1064	401	206	813	647	678	501	385	199
2007	597	594	912	1256	329	771	1143	2432	2125	777	425	383	747	1007	380	195	770	613	642	474	365
2008	5354	567	565	867	1194	313	733	1084	2303	2009	734	401	361	705	951	359	184	727	579	607	448
2009	1348	5093	540	537	825	1135	297	695	1027	2179	1899	694	379	341	666	899	339	174	688	547	574
2010	1794	1282	4842	513	511	784	1078	282	658	970	2055	1790	654	357	322	628	847	320	164	649	516
2011	1426	1355	563	8196	166	322	518	1133	398	737	999	1836	1434	433	314	137	595	814	144	86	574

Year	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40+
1994	121	143	243	473	242	139	112	118	136	138	142	189	186	88	56	47	46	46	48	871
1995	149	107	128	217	422	216	124	100	106	122	123	127	169	166	79	50	42	41	41	820
1996	184	134	97	115	195	380	194	112	90	95	110	111	114	152	149	71	45	38	37	774
1997	153	166	121	87	104	176	343	175	101	81	86	99	100	103	137	135	64	41	34	733
1998	196	140	151	110	80	95	161	313	160	92	74	78	90	91	94	125	123	58	37	700
1999	218	178	127	138	100	73	86	147	285	146	84	68	71	82	83	86	114	112	53	673
2000	261	201	164	117	127	92	67	80	135	263	134	78	62	66	76	77	79	105	103	668
2001	223	246	189	155	110	120	87	63	75	127	248	127	73	59	62	72	72	75	99	728
2002	483	209	231	177	145	103	112	82	59	70	119	232	119	68	55	58	67	68	70	774
2003	204	456	197	217	167	136	97	106	77	56	66	112	219	112	64	52	55	63	64	795
2004	243	192	430	186	205	157	129	92	100	73	52	62	106	206	106	61	49	52	60	811
2005	377	230	181	406	175	194	149	122	87	94	68	50	59	100	195	100	57	46	49	822
2006	435	357	218	172	385	166	183	141	115	82	89	65	47	56	95	185	94	54	44	825
2007	189	412	338	206	163	364	157	174	133	109	78	85	62	44	53	90	175	89	52	824
2008	345	178	390	320	195	154	344	149	164	126	103	74	80	58	42	50	85	165	85	827
2009	424	326	169	369	302	184	146	326	141	155	119	98	70	76	55	40	47	80	156	862
2010	541	400	308	159	348	285	174	137	307	133	147	112	92	66	71	52	37	45	76	961
2011	470	210	445	291	84	356	196	113	102	223	187	198	101	101	48	99	62	35	43	1243

Table 10. Selected likelihoods, parameters and estimated quantities for retrospective analyses.

	Base	Retro-1	Retro-2	Retro-3	Retro-4	Retro-5	Retro-6
Ending year of data	2010	2009	2008	2007	2006	2005	2004
Negative log-likelihood							
Total	1188.0	1134.9	1065.9	1029.3	977.4	931.8	883.0
Survey index	-14.6	-14.7	-14.4	-14.1	-15.3	-14.9	-14.5
Length composition	589.7	584.9	570.0	555.5	533.8	517.4	506.0
Age composition	644.5	598.5	541.9	515.4	482.9	452.0	410.0
Parameter priors	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parameters							
R_0 (billions)	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Steepness (*h*)	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Natural mortality (M; *f*)	0.050	0.050	0.050	0.050	0.05	0.050	0.050
Natural mortality (M; *m*)	0.051	0.052	0.052	0.052	0.053	0.053	0.054
Reference points							
SB_0 (million mt)	0.066	0.066	0.066	0.066	0.066	0.065	0.066
2006 Depletion	0.154	0.158	0.145	0.137	0.175	0.174	0.155
2005 SPR ratio	0.355	0.346	0.374	0.39	0.319	0.331	0.367

Table 11. Selected likelihoods, parameters and estimated quantities for sensitivity analyses to the priors on natural mortality rate while steepness is fixed at 0.4.

	Base	*M*=0.03	*M*=0.04	*M*=0.06	*M*=0.07
Negative log-likelihood					
Total	1188.0	1225.6	1194.1	1191.4	1195.9
Survey index	-14.6	-5.8	-12.7	-13.9	-12.5
Length composition	589.7	584.4	586.1	591.7	593.0
Age composition	644.5	663.5	650.1	645.3	647.2
Parameter priors	0.0	0.0	0.0	0.0	0.0
Parameters					
R_0 (billions)	0.009	0.005	0.007	0.013	0.022
Steepness (*h*)	0.400	0.400	0.400	0.400	0.400
Natural mortality (M; *f*)	0.050	0.030	0.040	0.060	0.070
Natural mortality (M; *m*)	0.051	0.032	0.041	0.062	0.072
Reference points					
SB_0 (million mt)	0.066	0.067	0.068	0.070	0.087
2011 Depletion	0.191	0.017	0.064	0.407	0.636
2010 SPR ratio	0.261	1.543	0.713	0.105	0.048

Table 12. Selected likelihoods, parameters and estimated quantities for sensitivity analyses to the priors on steepness while natural mortality is fixed at 0.05. Bold values are those used in decision table.

	Base	*h*=0.3	***h*=0.35**	*h*=0.45	*h=0.5*	***h=0.55***	*h*=0.6	*h*=0.7	*h*=0.8	*h*=0.9
Negative log-likelihood										
Total	1188.0	1191.9	1188.4	1188.6	1189.4	1190.0	1190.5	1191.4	1192.0	1192.5
Survey index	-14.6	-12.8	-14.3	-14.5	-14.3	-14.0	-13.7	-13.4	-13.1	-12.9
Length composition	589.7	586.9	588.7	590.1	590.3	590.3	590.3	590.2	590.2	590.1
Age composition	644.5	648.2	645.4	644.4	644.6	644.9	645.1	645.4	645.6	645.8
Parameter priors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parameters										
R_0 (billions)	0.009	0.010	0.010	0.009	0.009	0.009	0.009	0.009	0.010	0.010
Steepness (*h*)	0.400	0.300	0.350	0.450	0.500	0.550	0.600	0.700	0.800	0.900
Natural mortality (M; *f*)	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Natural mortality (M; *m*)	0.051	0.051	0.051	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Reference points										
SB_0 (million mt)	0.066	0.070	0.067	0.065	0.065	0.065	0.066	0.067	0.067	0.067
2011 Depletion	0.191	0.062	0.118	0.268	0.339	0.399	0.449	0.526	0.580	0.621
2010 SPR ratio	0.261	0.619	0.385	0.194	0.156	0.133	0.118	0.101	0.091	0.085

Table 13. Selected likelihoods, parameters and estimated quantities for the sensitivity analysis of the forcing fishery selectivity to be asymptotic during some period of time – always or prior to 1970, 1989 or 2002. .

	Base	asymFishsel	earlyasym1970	earlyasym1989	earlyasym2002
Negative log-likelihood					
Total	1188.0	1247.0	1191.9	1213.2	1205.9
Survey index	-14.6	-13.9	-13.6	-14.1	-14.1
Length composition	589.7	633.7	591.0	605.7	596.9
Age composition	644.5	657.5	647.6	655.1	656.9
Parameter priors	0.0	0.0	0.0	0.0	0.0
Parameters					
R_0 (billions)	0.009	0.009	0.009	0.009	0.009
Steepness (*h*)	0.400	0.400	0.400	0.400	0.400
Natural mortality (M; *f*)	0.050	0.050	0.050	0.050	0.050
Natural mortality (M; *m*)	0.051	0.052	0.052	0.052	0.053
Reference points					
SB_0 (million mt)	0.066	0.063	0.067	0.065	0.064
2011 Depletion	0.191	0.119	0.210	0.172	0.200
2010 SPR ratio	0.261	0.416	0.238	0.294	0.251

Table 14. Selected likelihoods, parameters and estimated quantities for the sensitivity analysis of influence of estimating m and/or h, or estimating both and forcing asymptotic fishery selectivity prior to 1989. Likelihoods are not comparable due to prior penalties when M and/or h are estiamted (italics).

	Base	Est.h.M	Est.h.M.05	Est.h.M.earlyasym1989	Est.M.h.4
Negative log-likelihood					
Total	*1188.0*	*1189.9*	*1190.6*	*1215.1*	*1188.9*
Survey index	-14.6	-14.6	-14.6	-14.1	-14.6
Length composition	589.7	589.4	592.4	605.8	592.1
Age composition	644.5	644.6	642.4	655.2	642.5
Parameter priors	*0.0*	*1.8*	*1.8*	*1.8*	*0.2*
Parameters					
R_0 (billions)	0.009	0.008	0.009	0.009	0.009
Steepness (*h*)	0.400	0.447	0.396	0.421	0.400
Natural mortality (M; *f*)	0.050	0.047	0.050	0.051	0.049
Natural mortality (M; *m*)	0.051	0.048	0.050	0.053	0.049
Reference points					
SB_0 (million mt)	0.066	0.065	0.064	0.065	0.064
2011 Depletion	0.191	0.206	0.173	0.222	0.162
2010SPR ratio	0.261	0.259	0.290	0.231	0.310

1.7.Figures

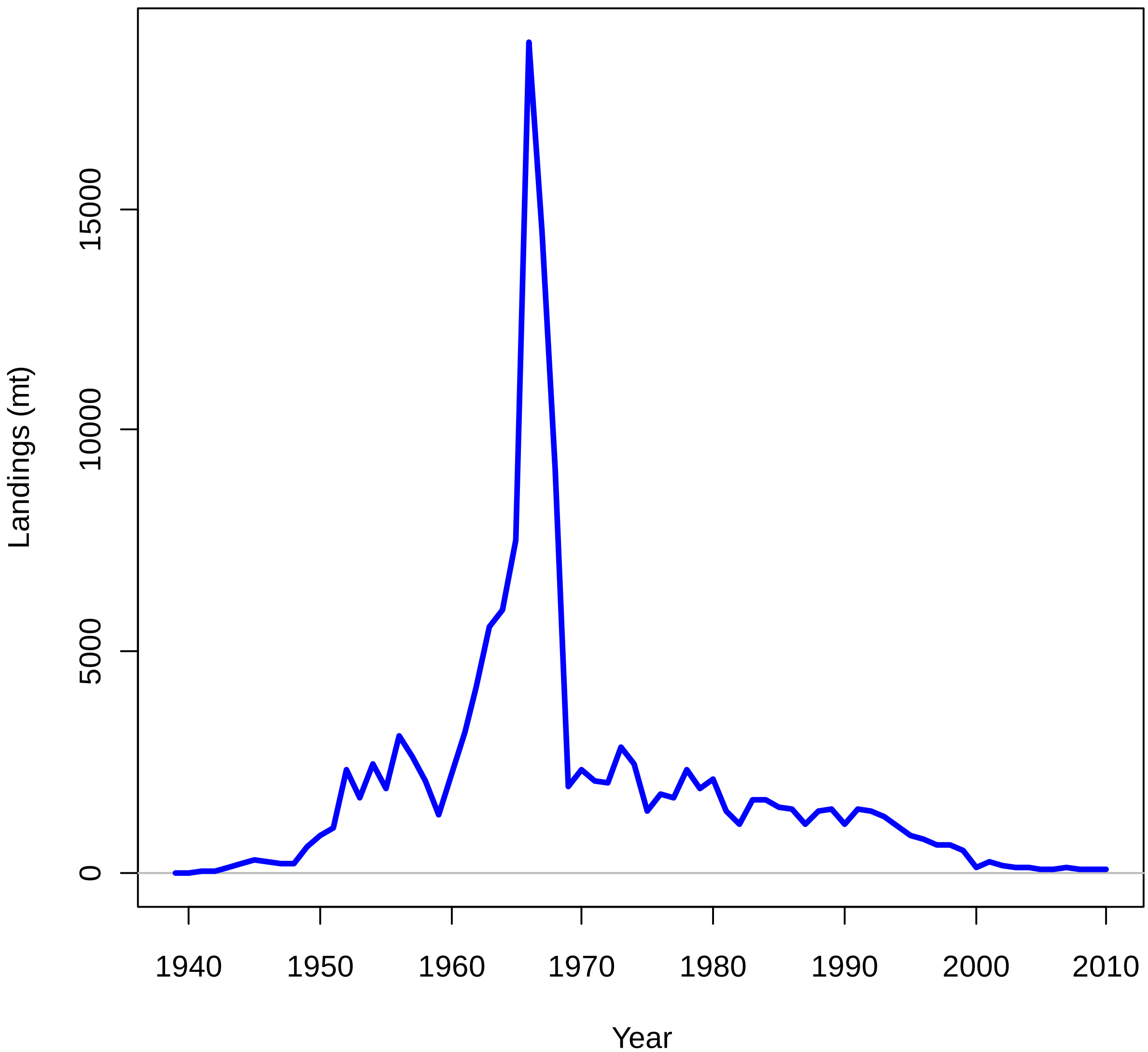

Figure 1. Landings of Pacific ocean perch (domestic and foreign fleets combined).

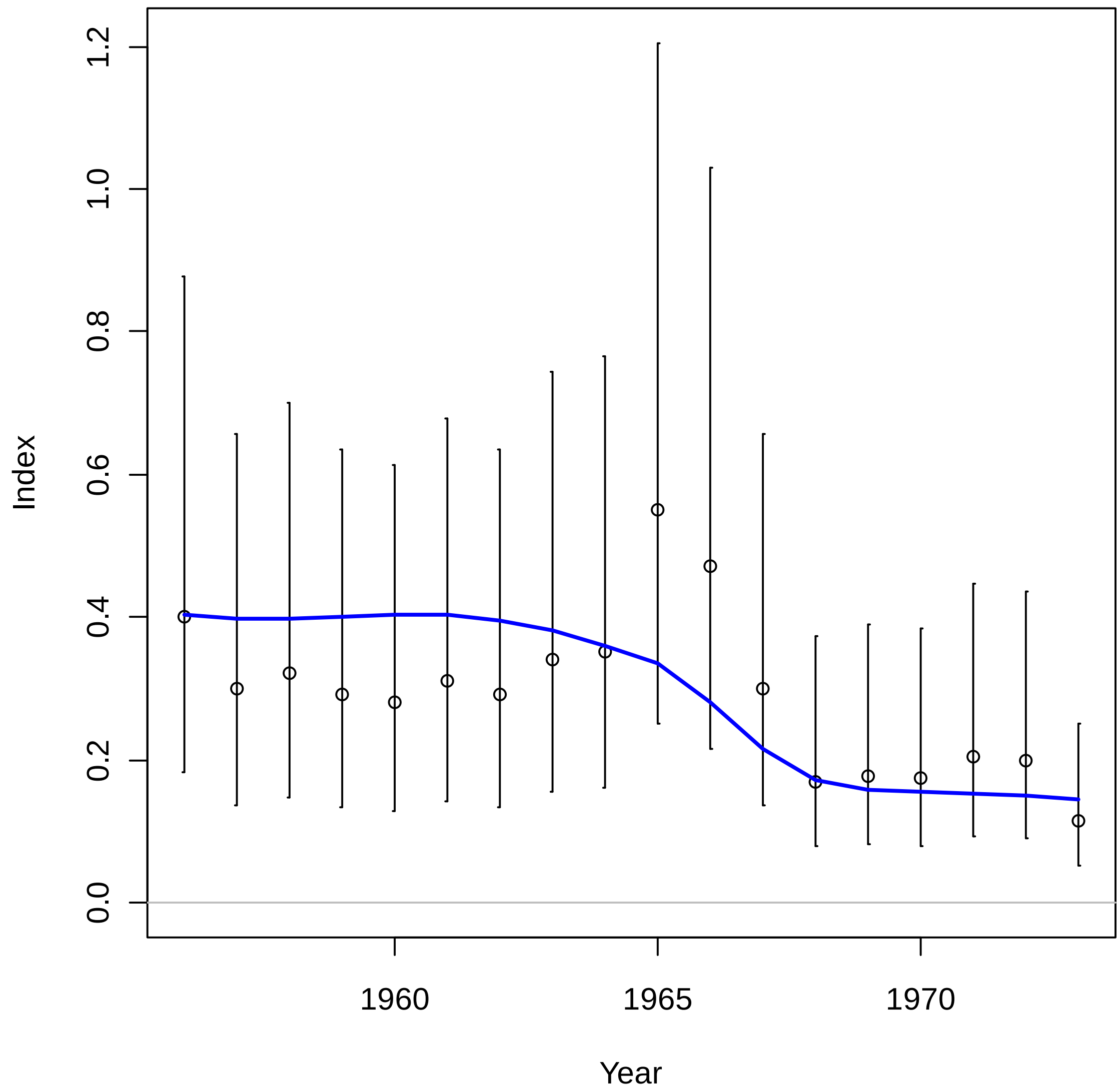

Figure 2. CPUE index and base model fit.

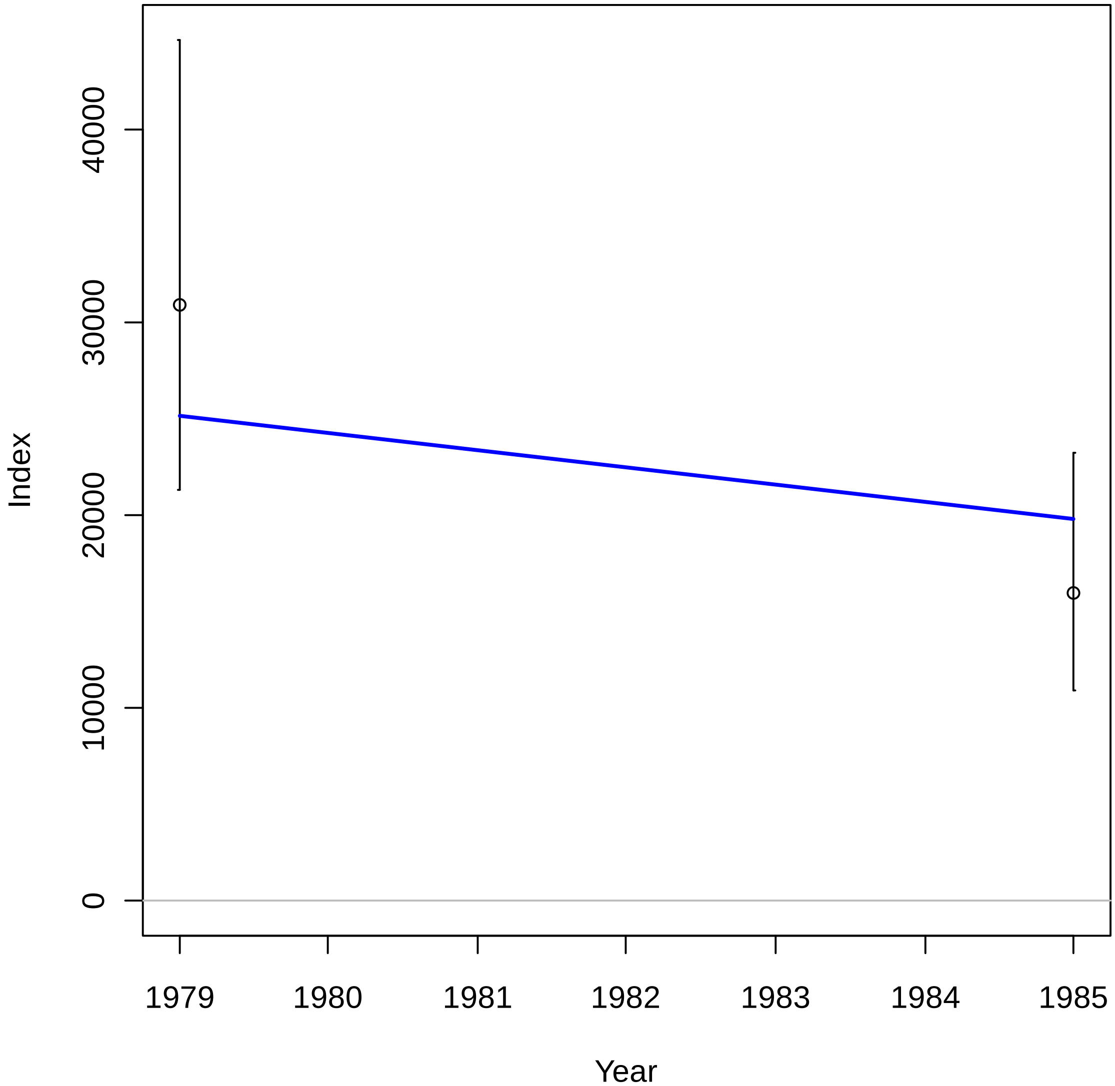

Figure 3. POP/Rockfish survey index and base model fit.

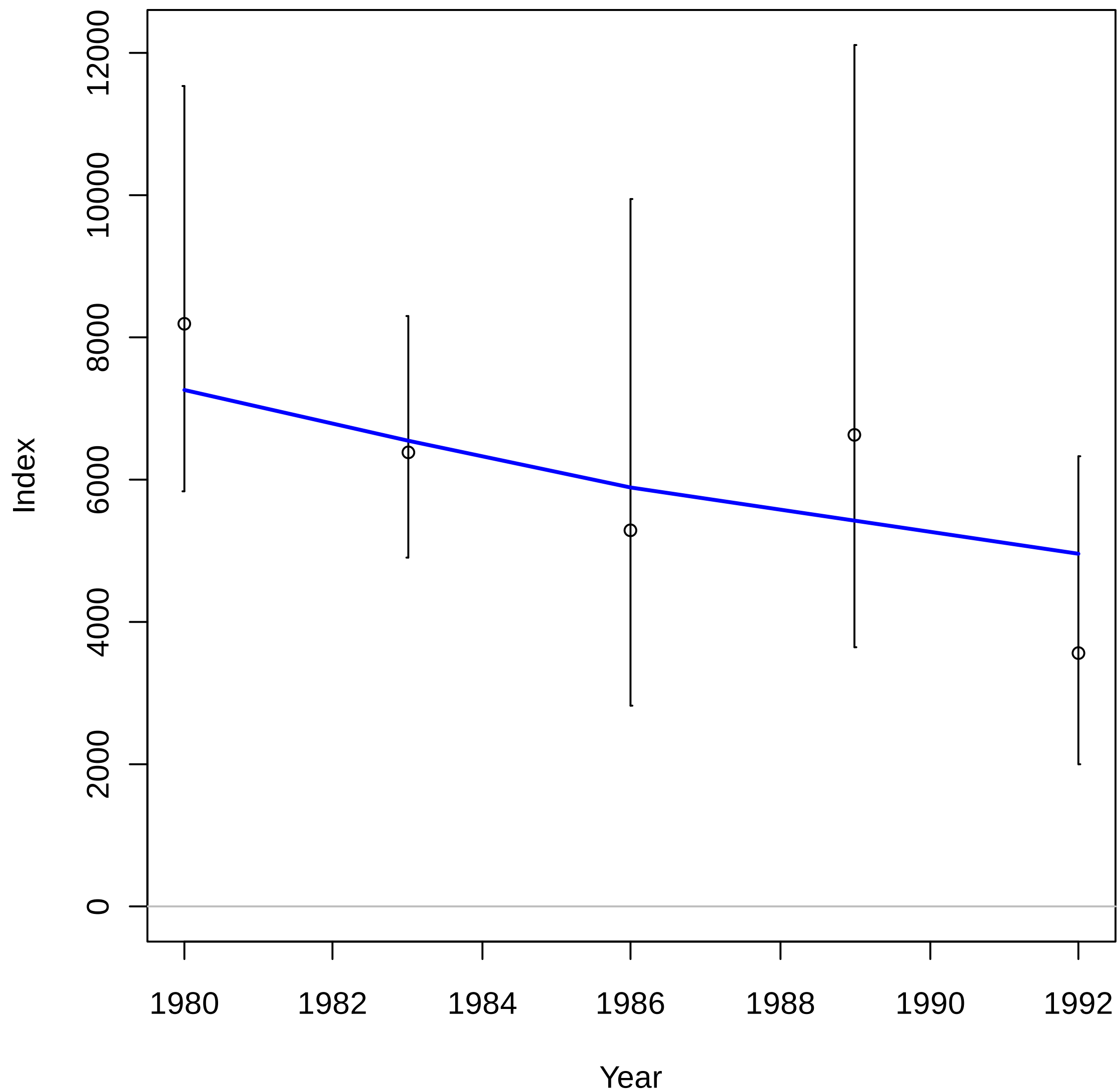

Figure 4. Early NMFS Triennial Shelf Survey index and base model fit.

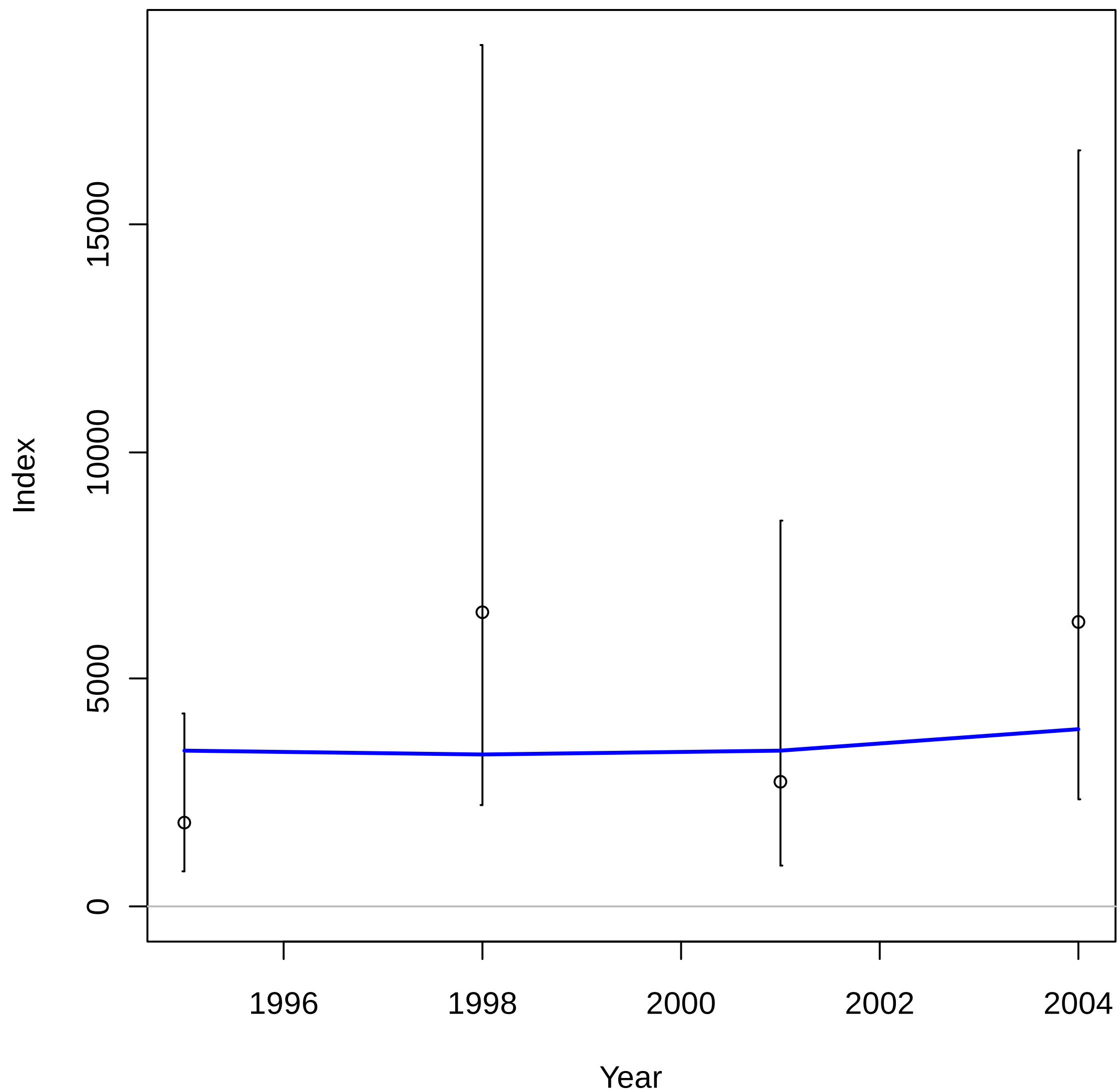

Figure 5. Late NMFS Triennial Shelf Survey index and base model fit.

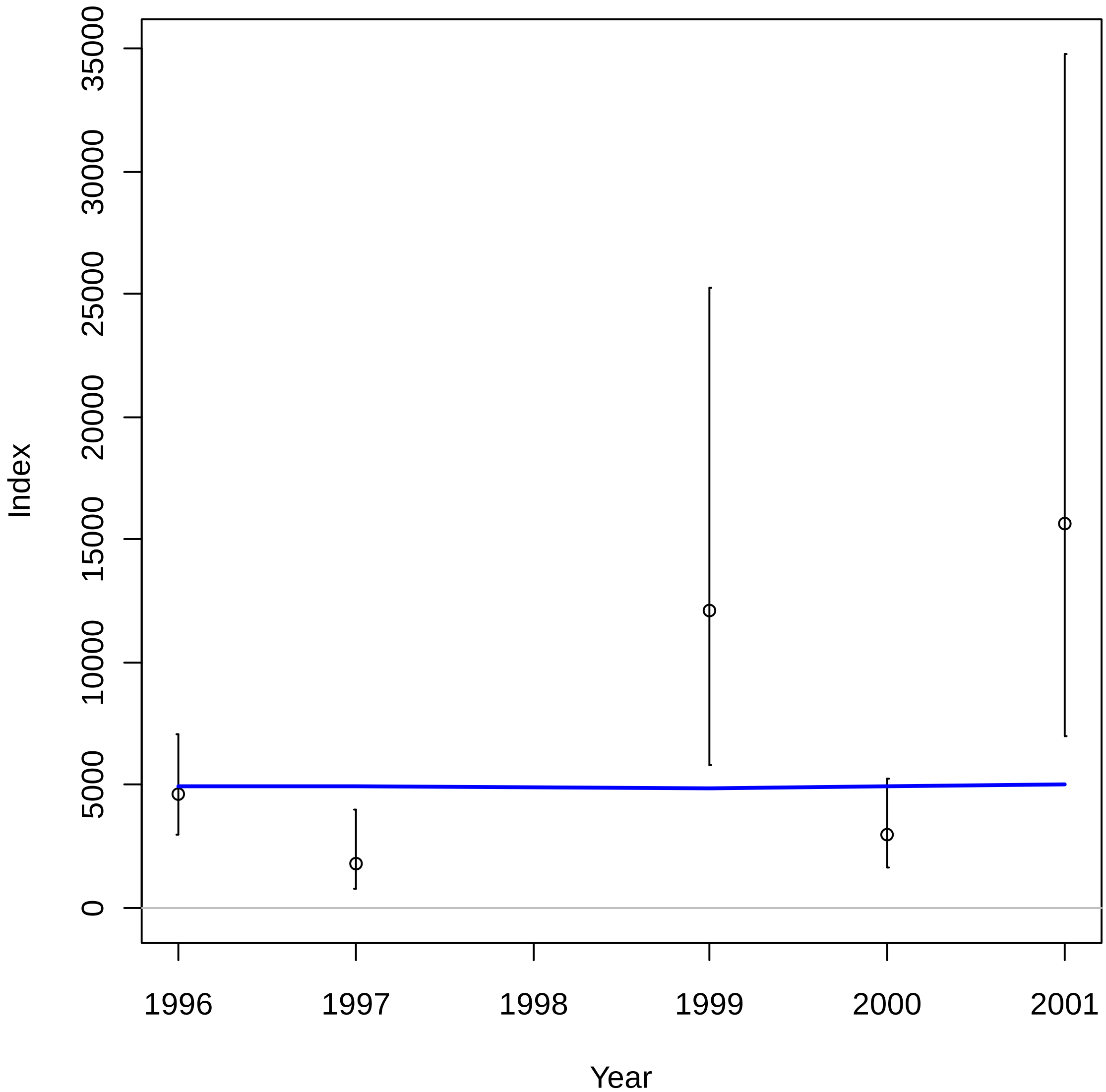

Figure 6. AFSC slope survey index and base model fit.

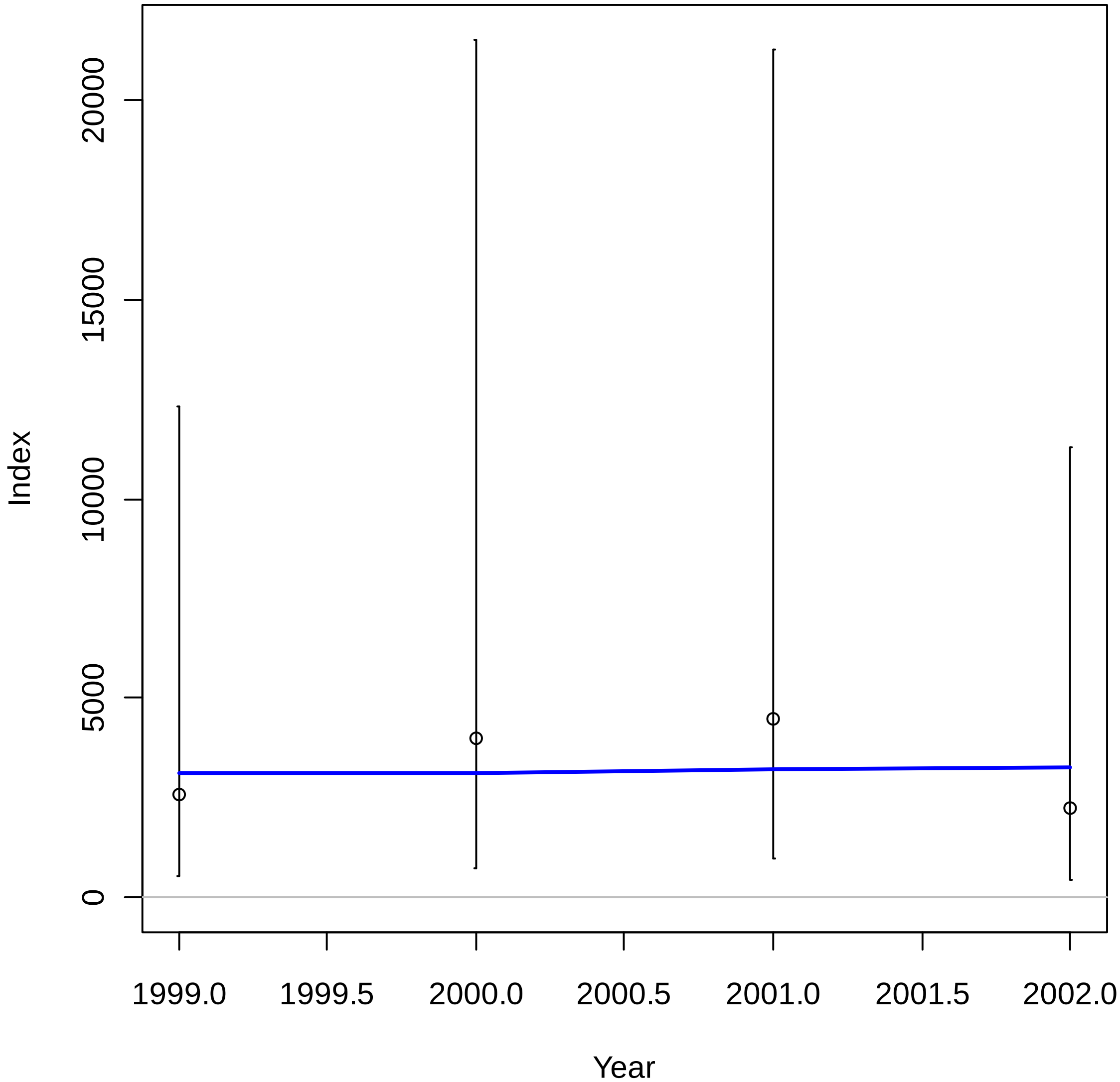

Figure 7. NWFSC slope survey index and base model fit.

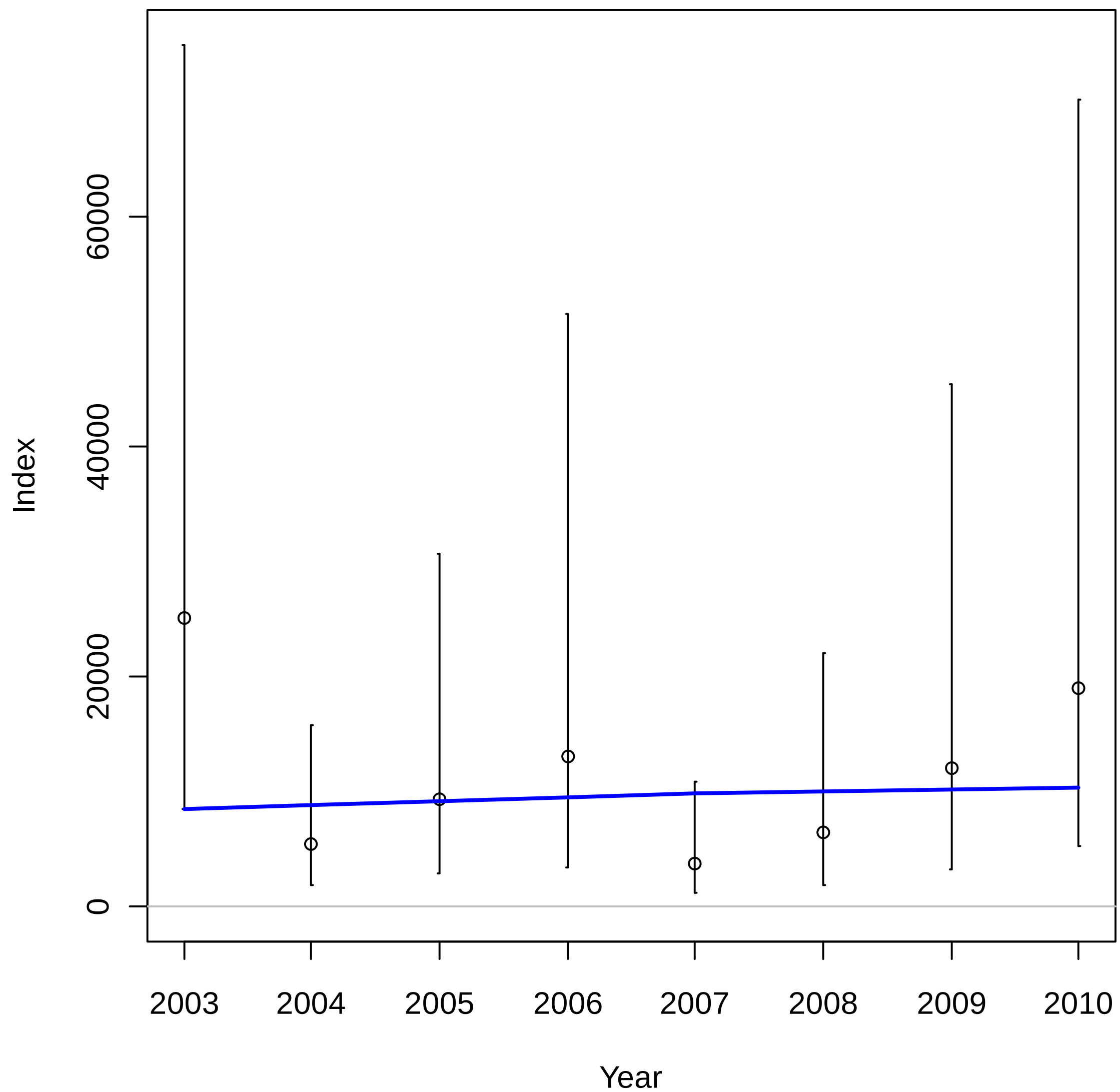

Figure 8. NWFSC shelf/slope survey index and base model fit.

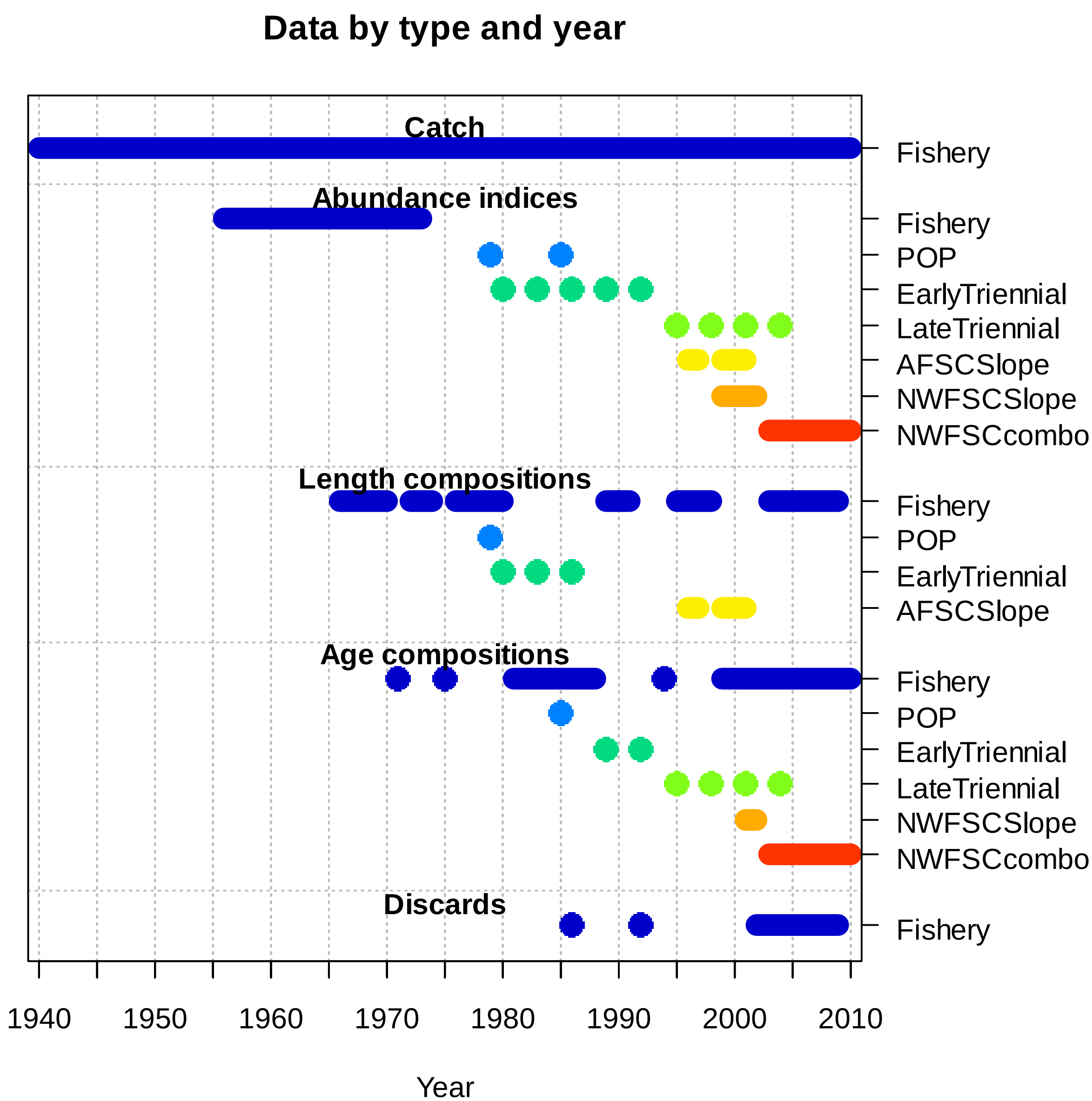

Figure 9. Data used in the base model (including data compared but given no weigh to avoid double use of data).

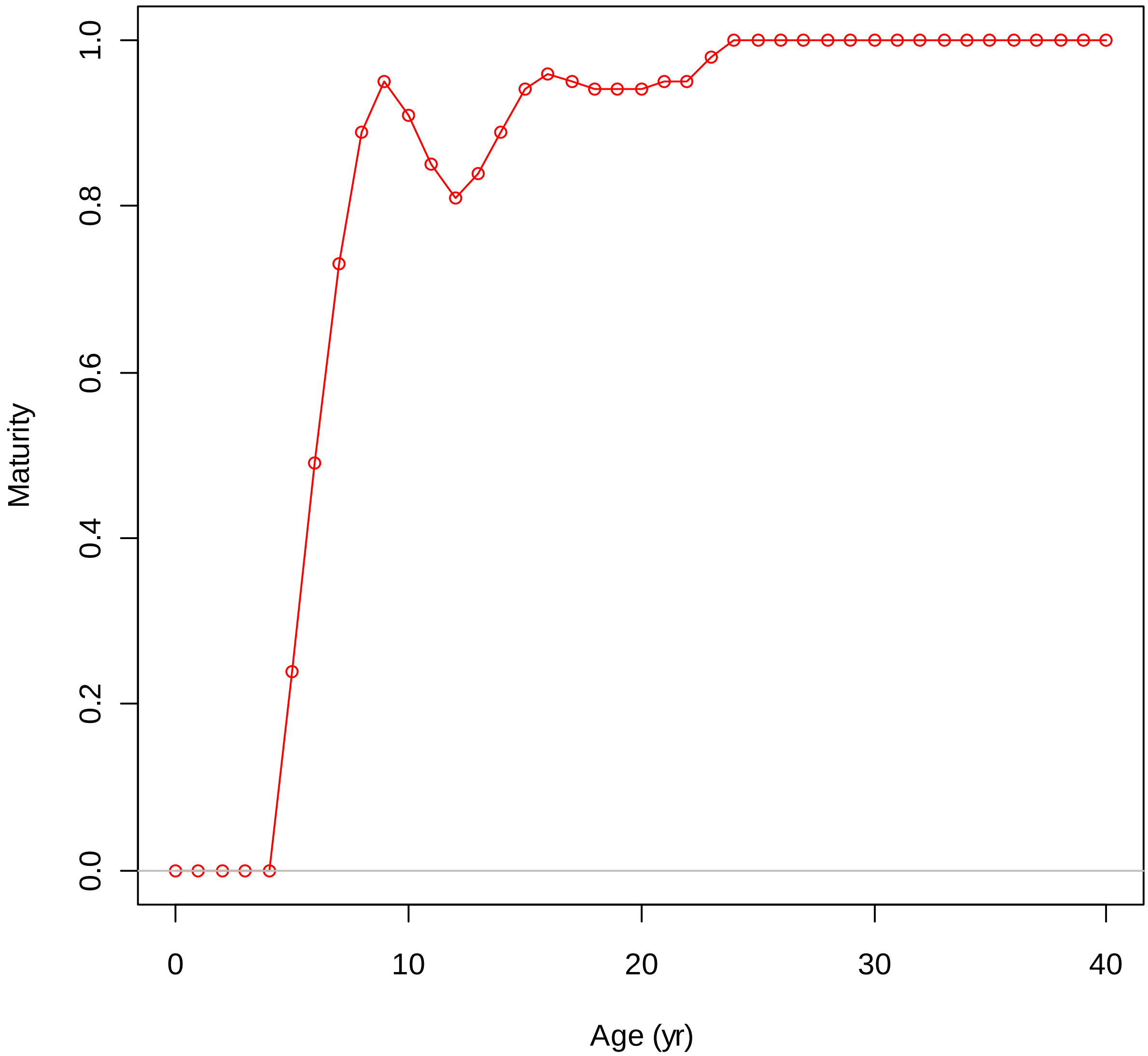

Figure 10: Maturity curve for female Pacific ocean perch

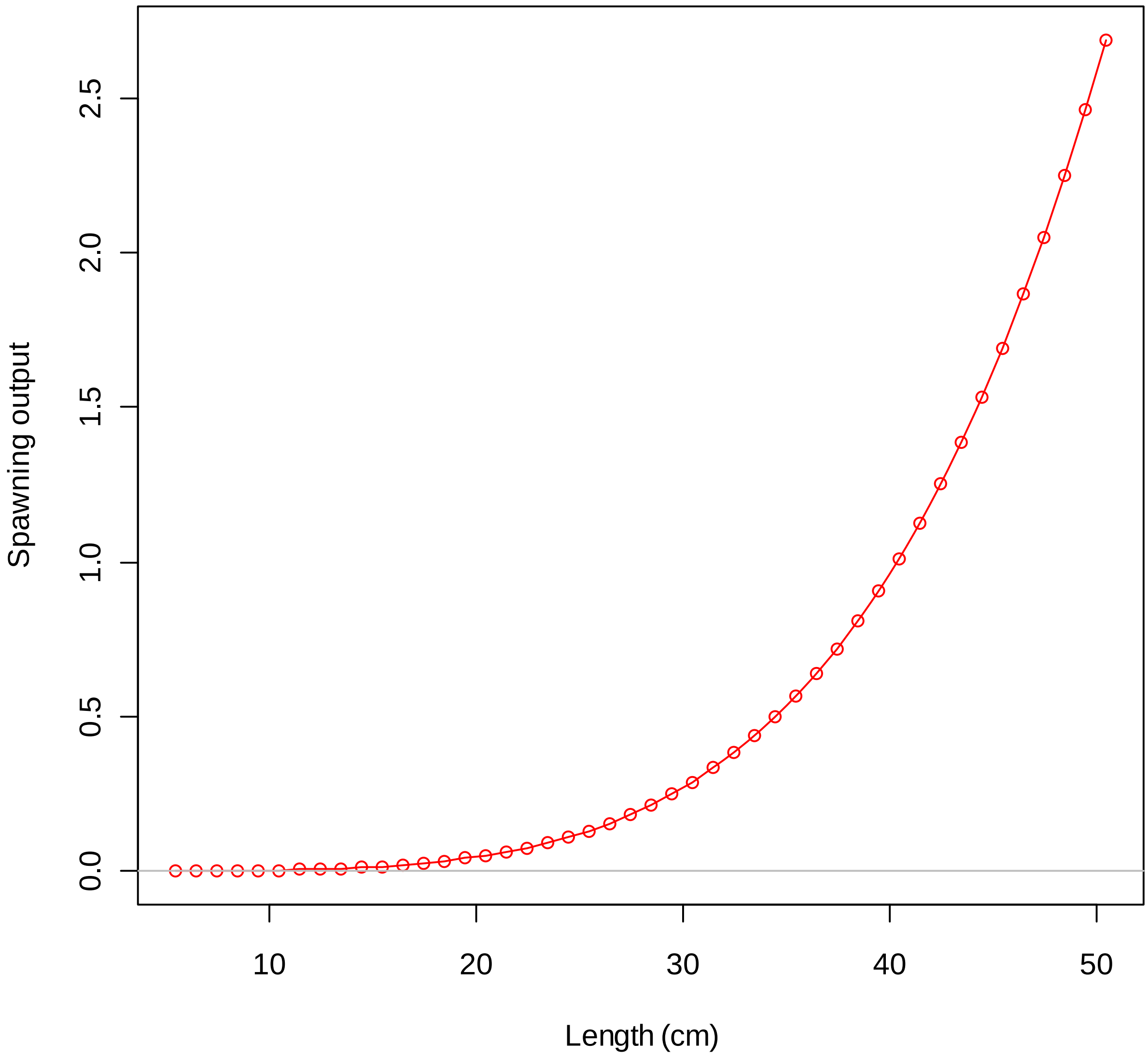

Figure 11: Spawning output by length for female Pacific ocean perch

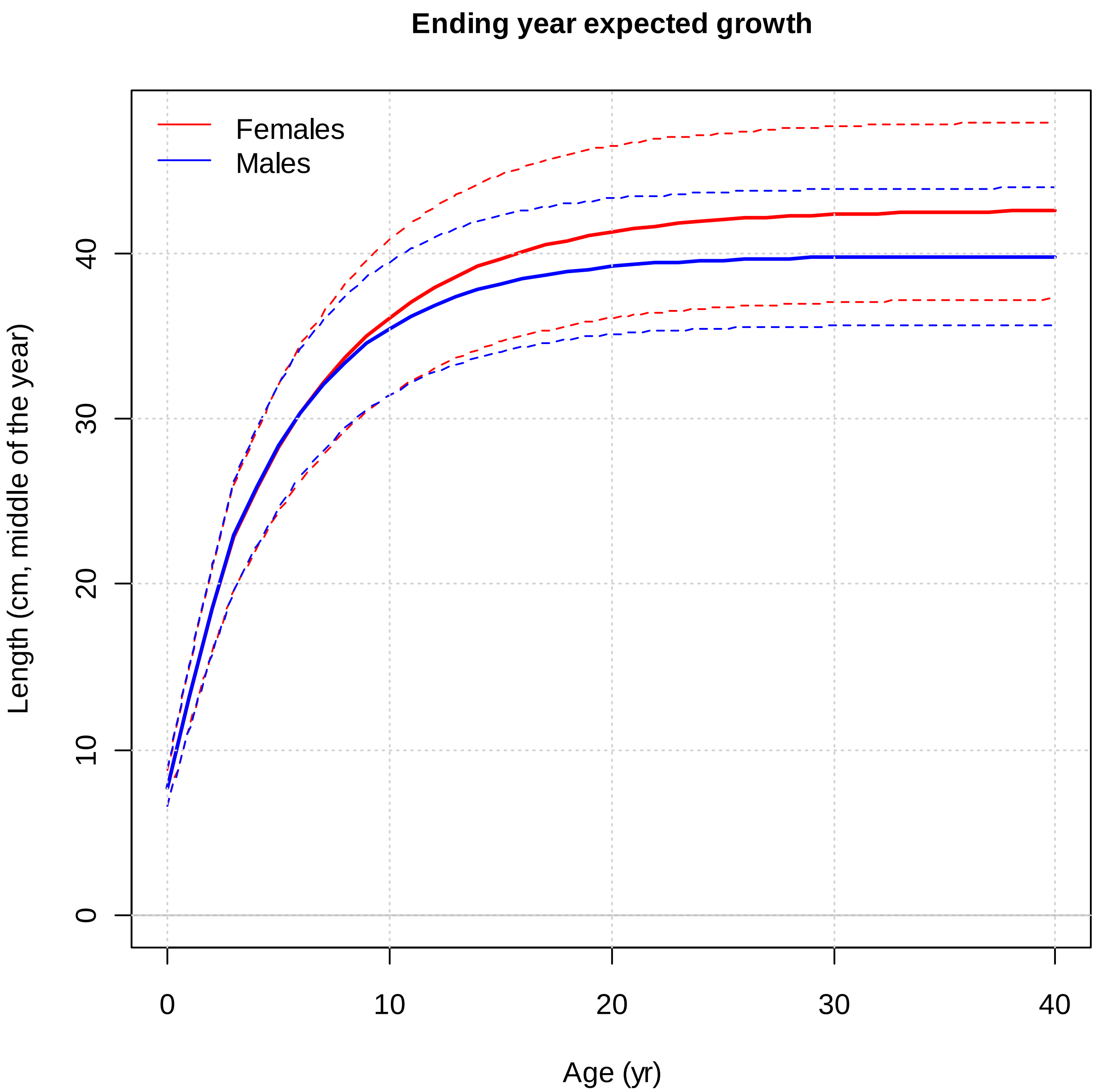

Figure 12: Growth curve for female (red) and male(blue) Pacific ocean perch estimated in the model

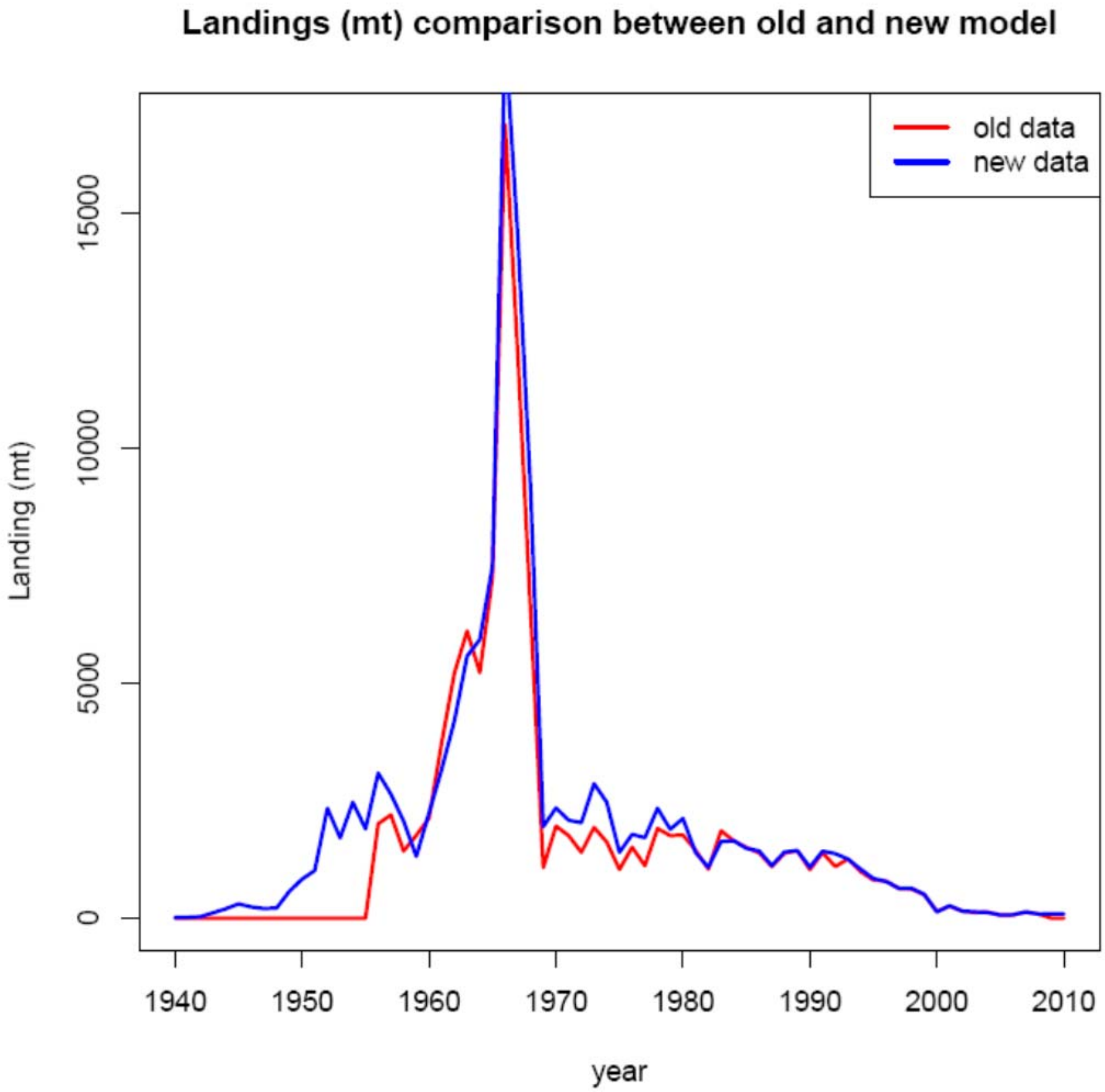

Figure 13. Comparison of landings data from the 2009 and the current assessment.

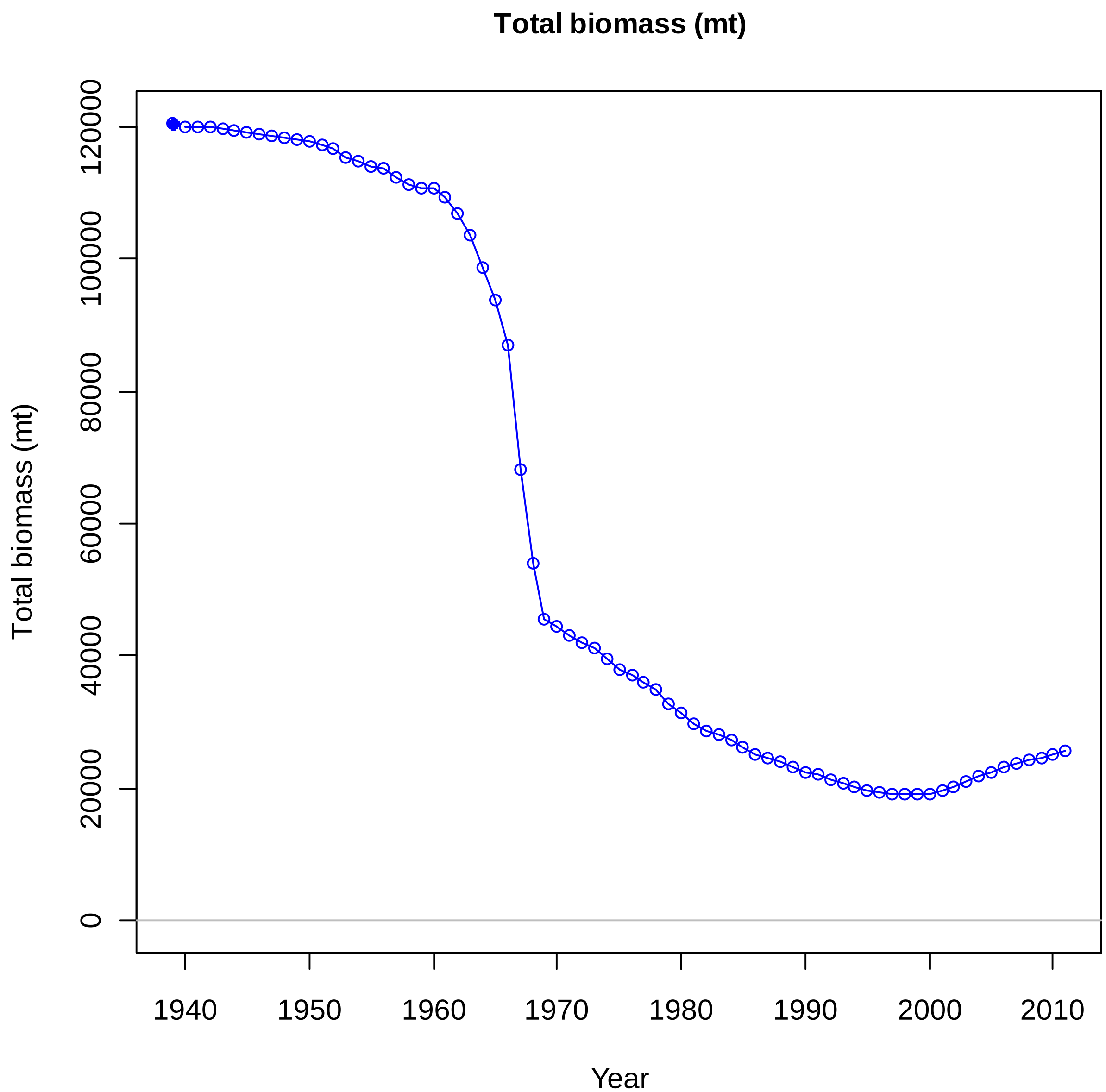

Figure 14: Times series of estimated biomass.

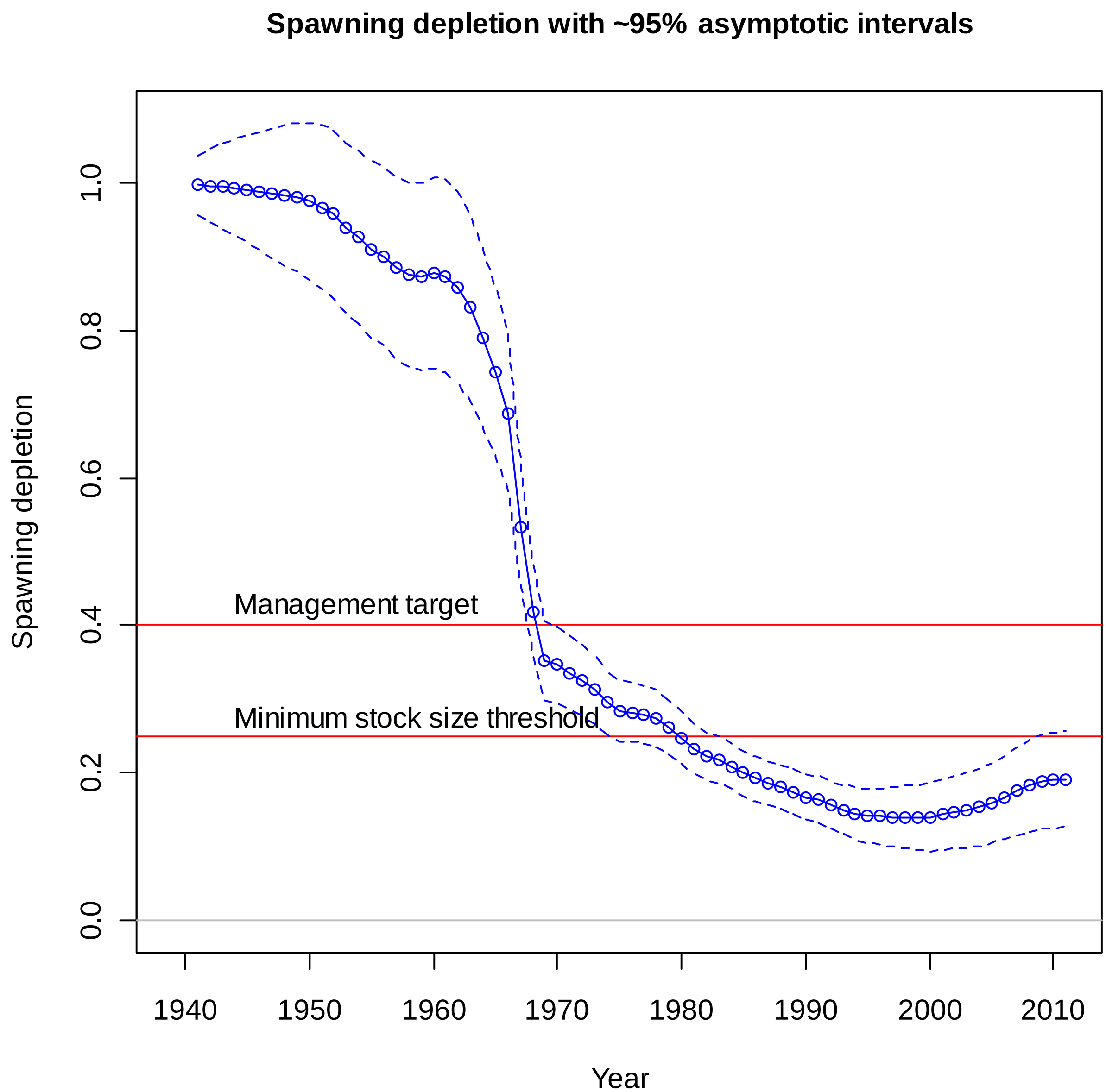

Figure 15: Time series of estimated depletion with 95% asymptotic interval.

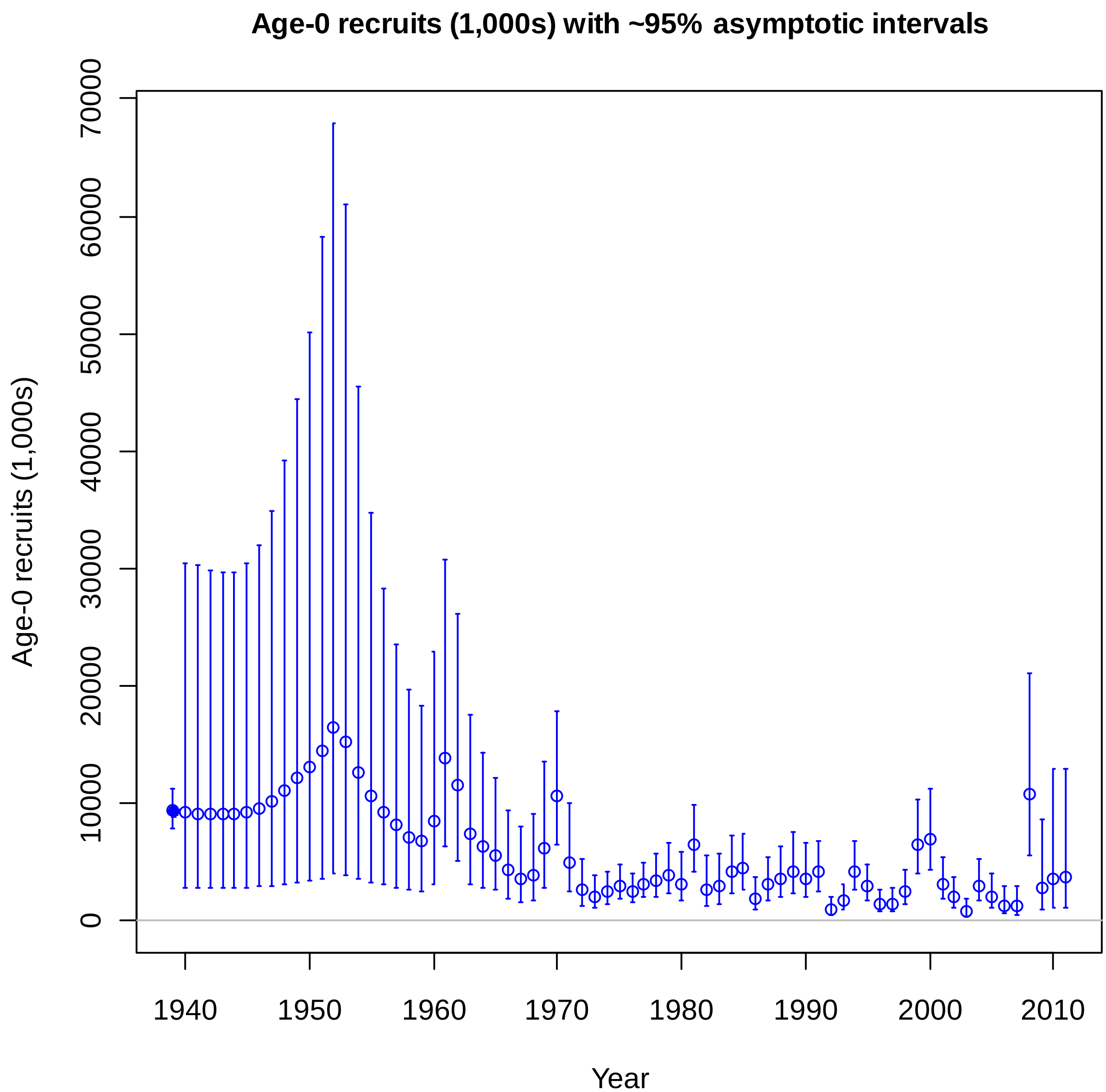

Figure 16: Time series of recruitment

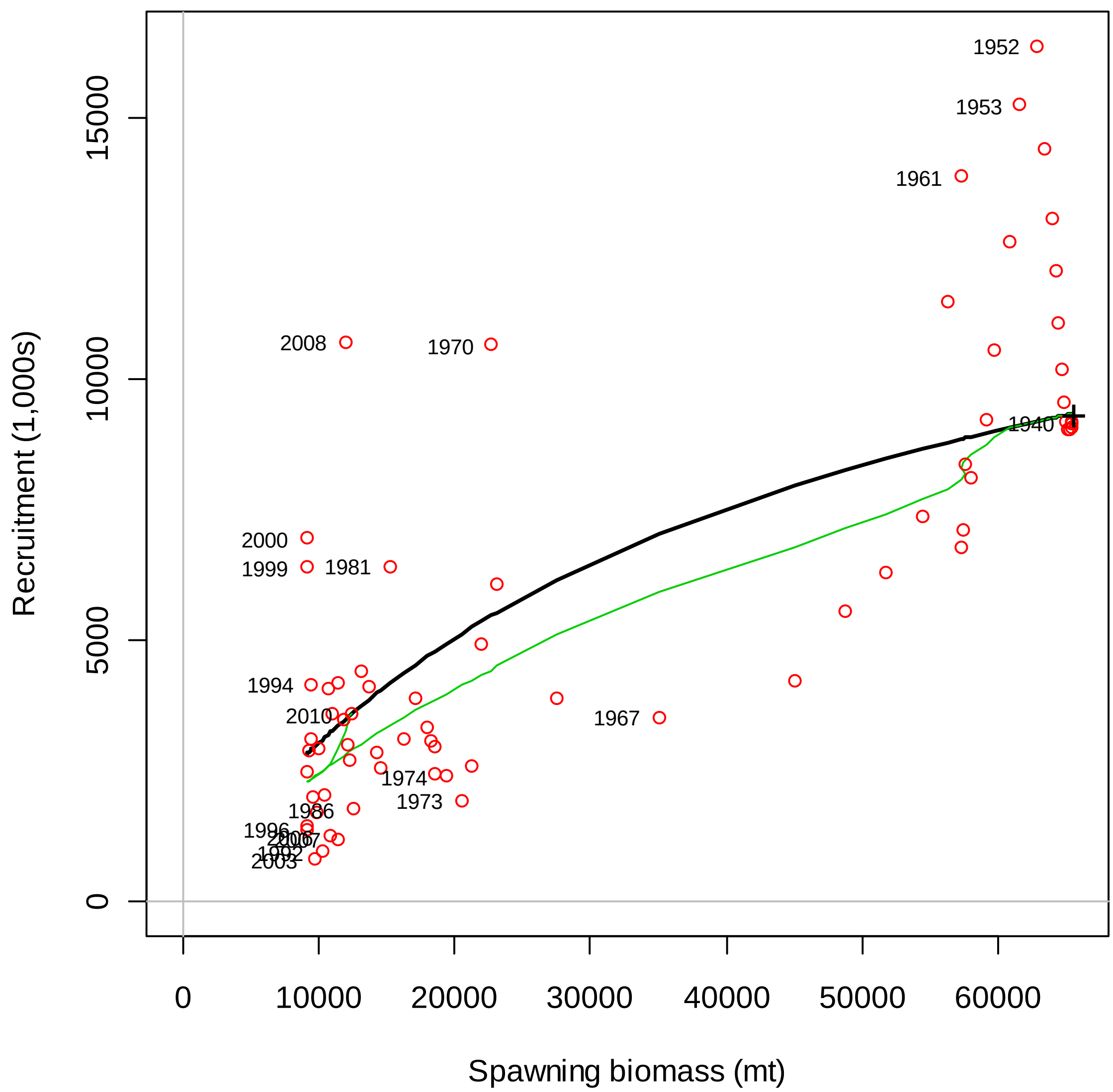

Figure 17. Spawner-recruit curve and recruitments.

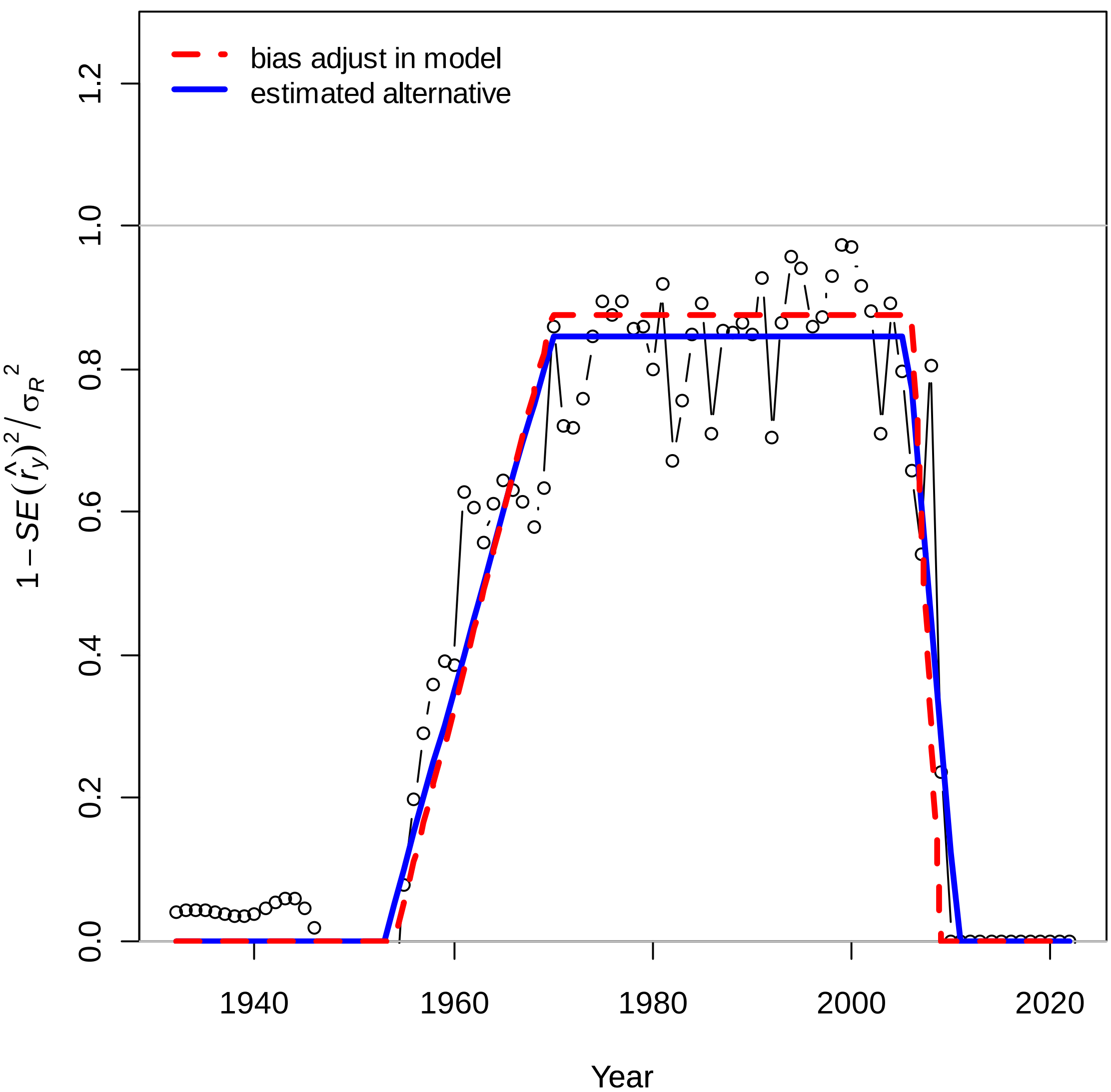

Figure 18. Bias adjustment time series for recruitment estimation.

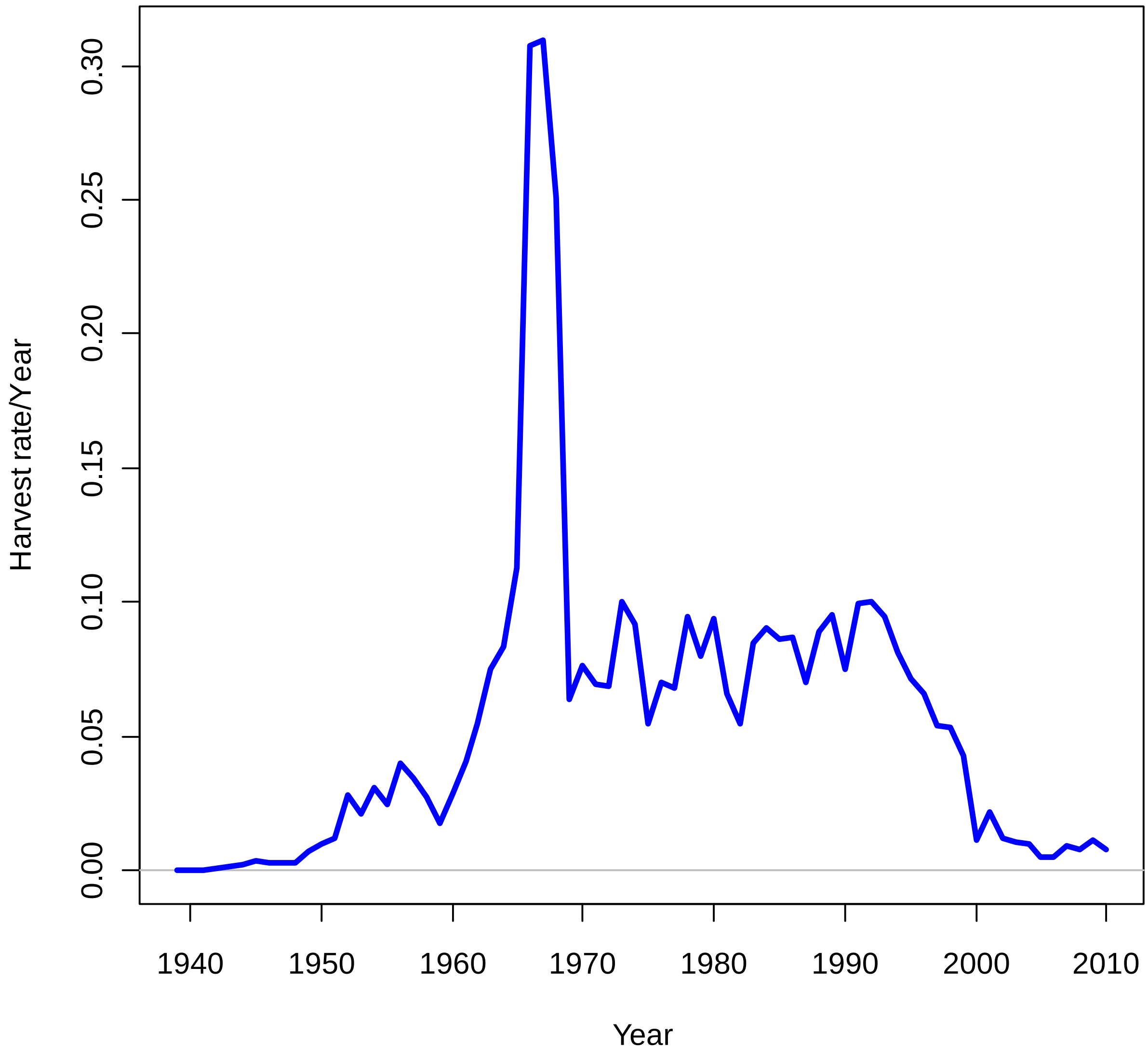

Figure 19: Time series of exploitation rate (catch/summary biomass)

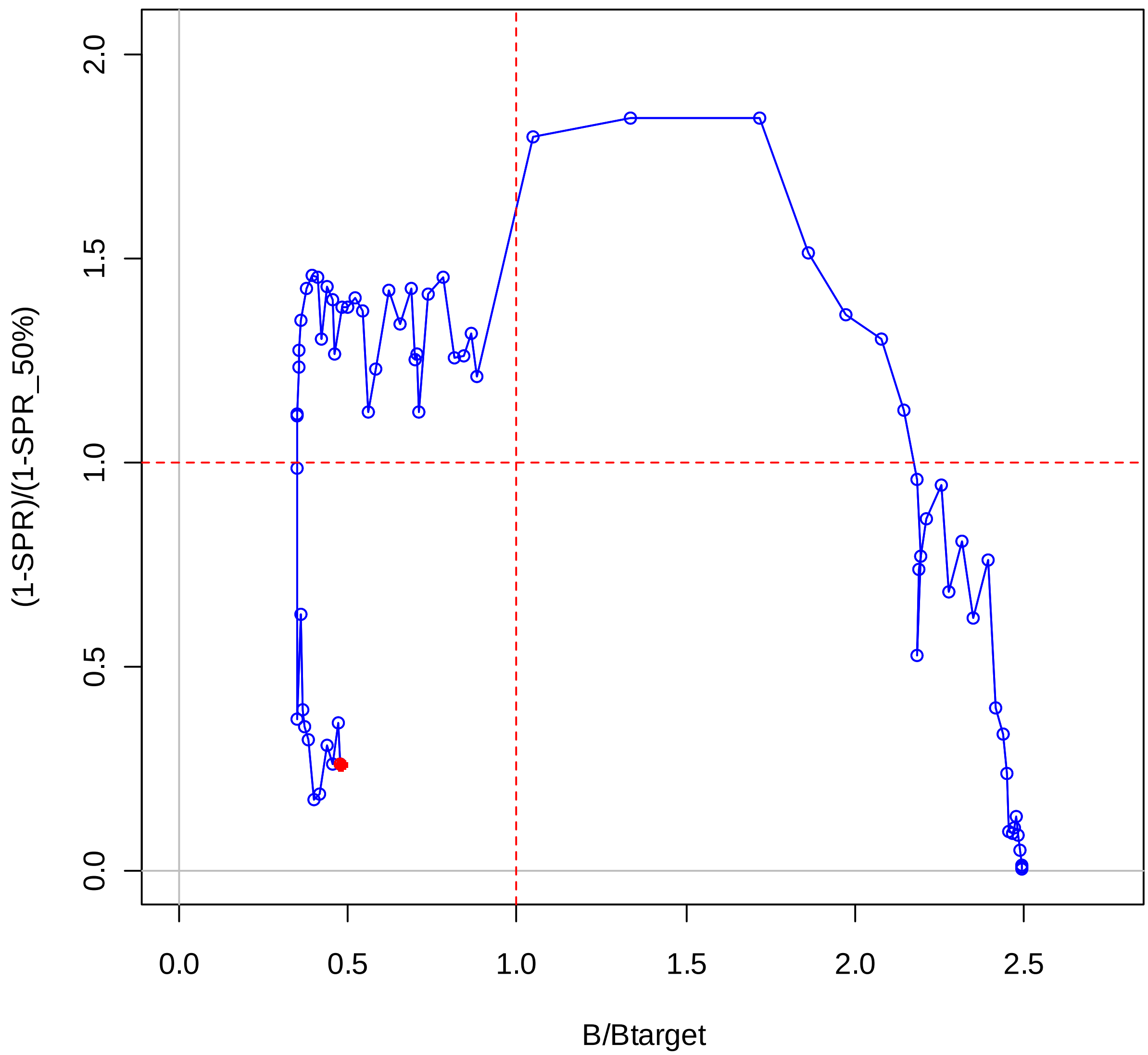

Figure 20: Relative SPR vs. relative biomass time series.

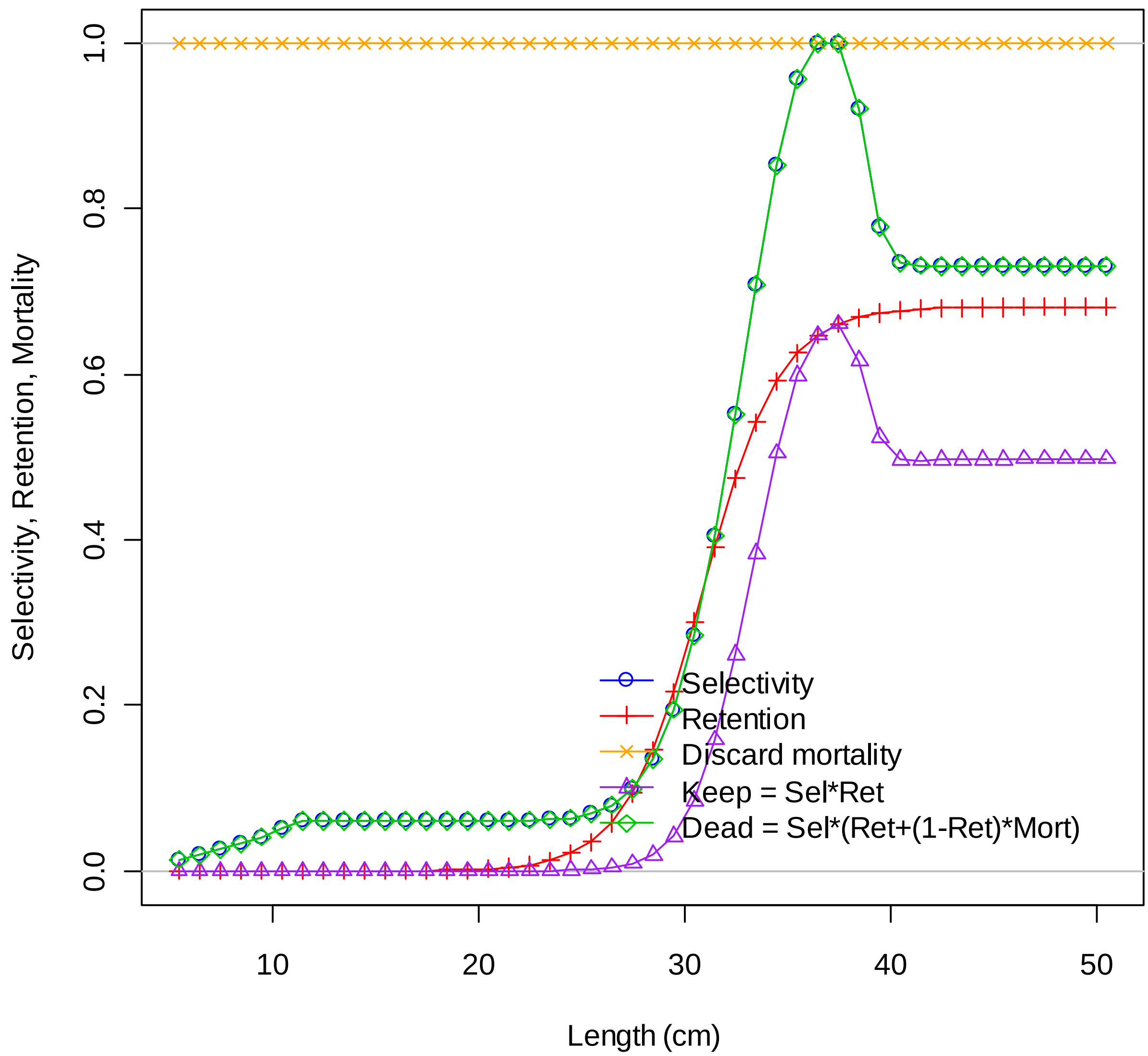

Figure 21: Fishery selectivity (time-invariant) and ending year retention (2008 and 2010)

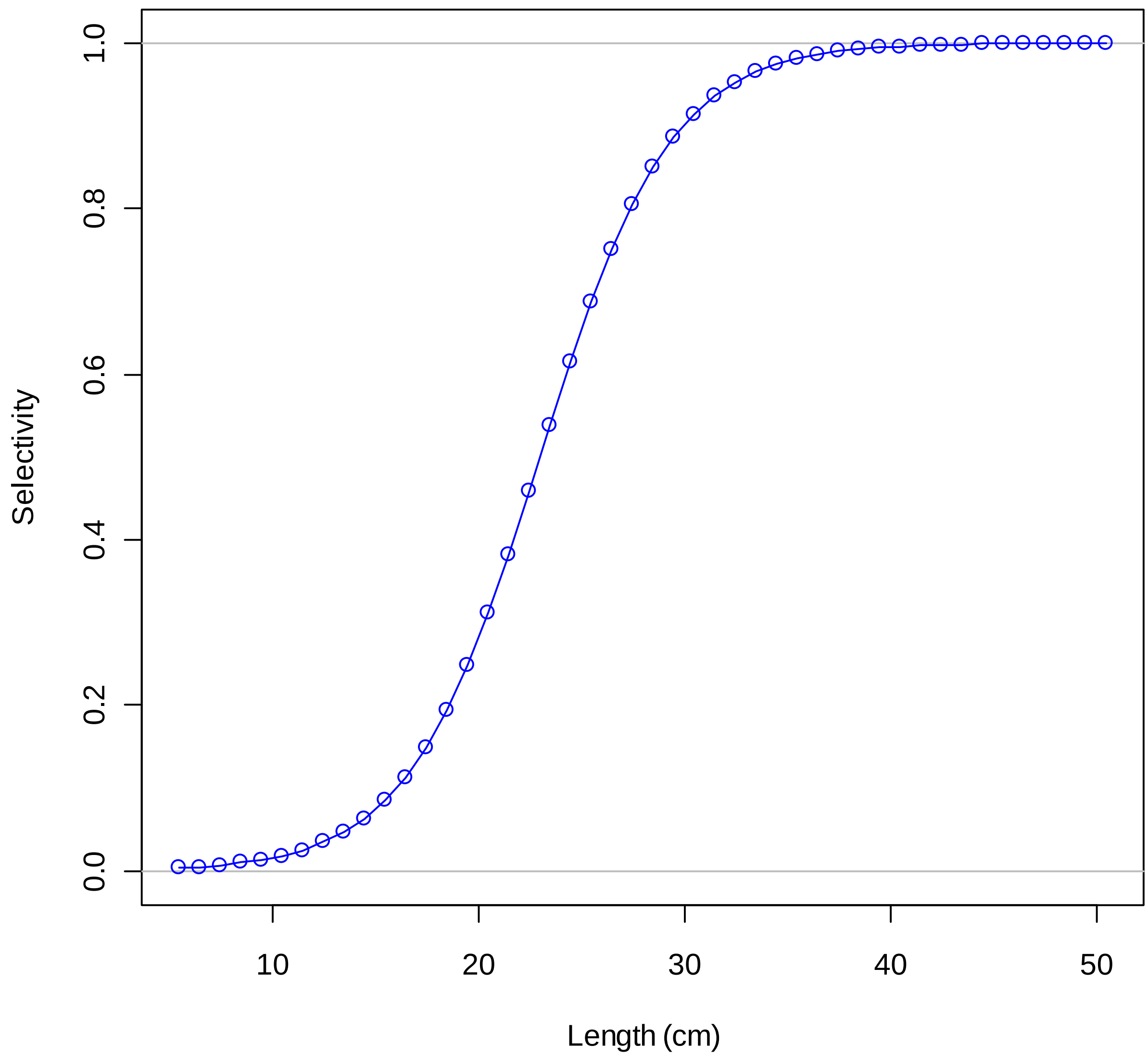

Figure 22: Selectivity for POP/rockfish, AFSC slope and NWFSC slope surveys.

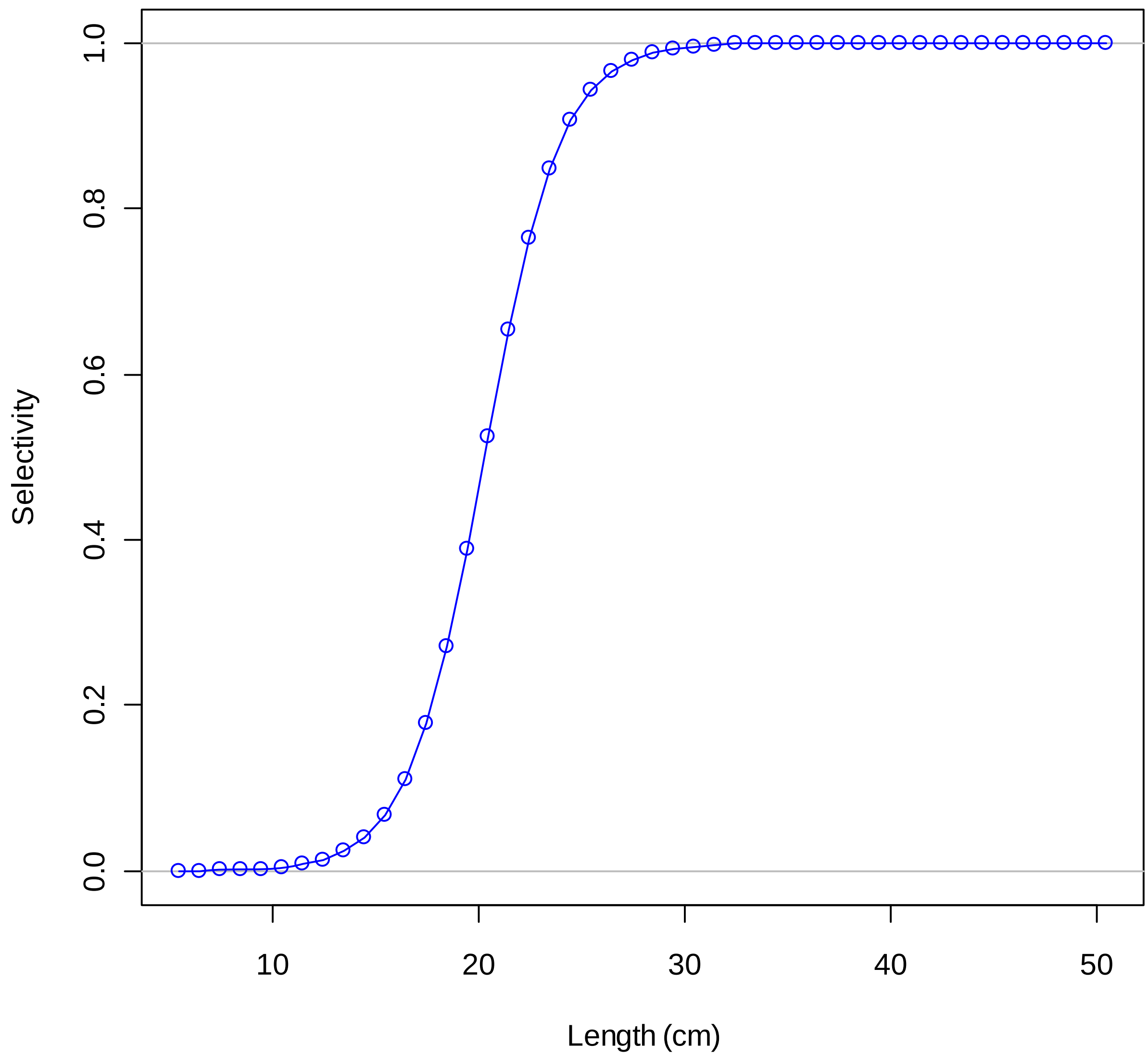

Figure 23: Selectivity for early and late triennial surveys.

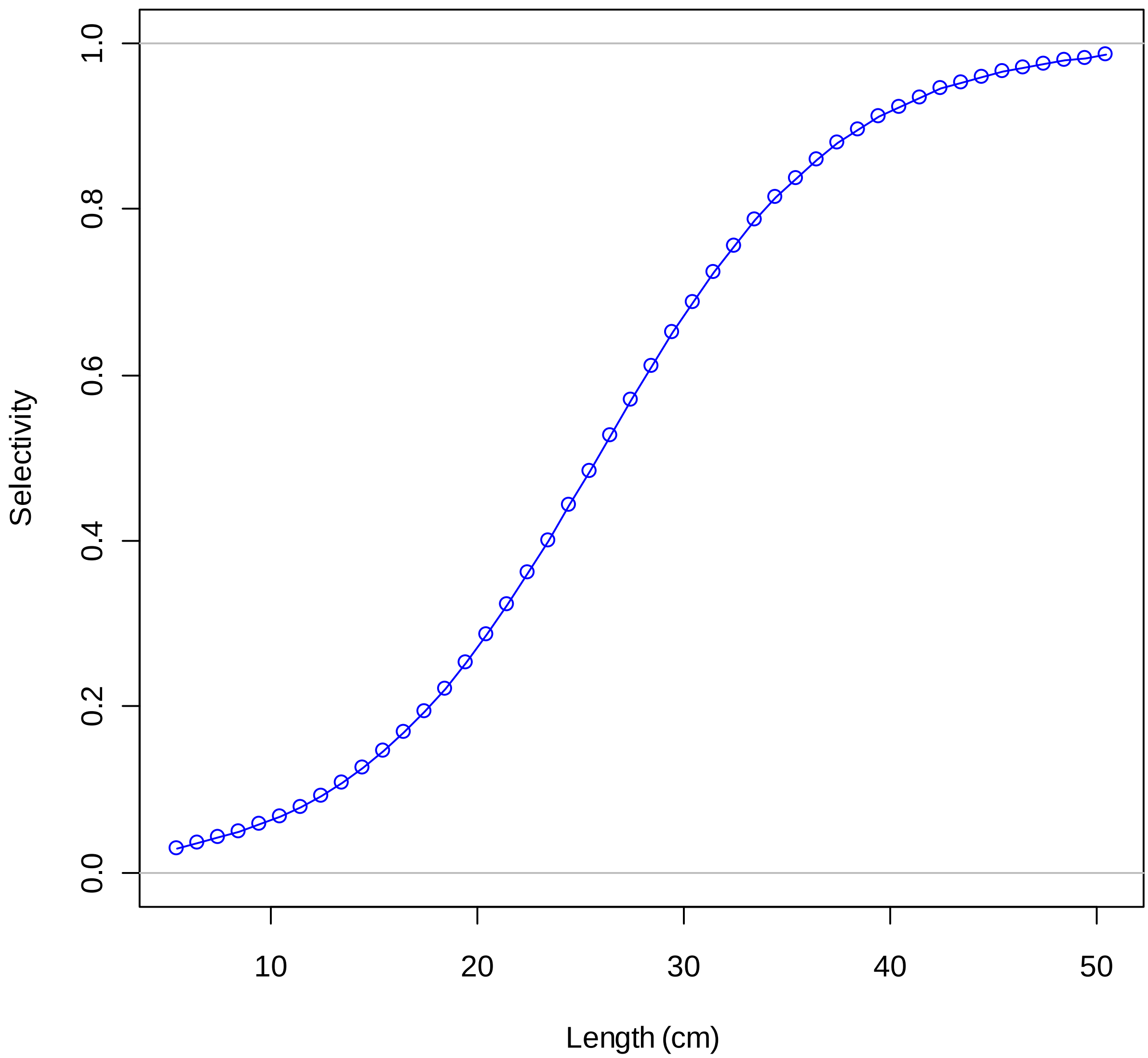

Figure 24: Selectivity for NWFSC shelf/slope combo survey.

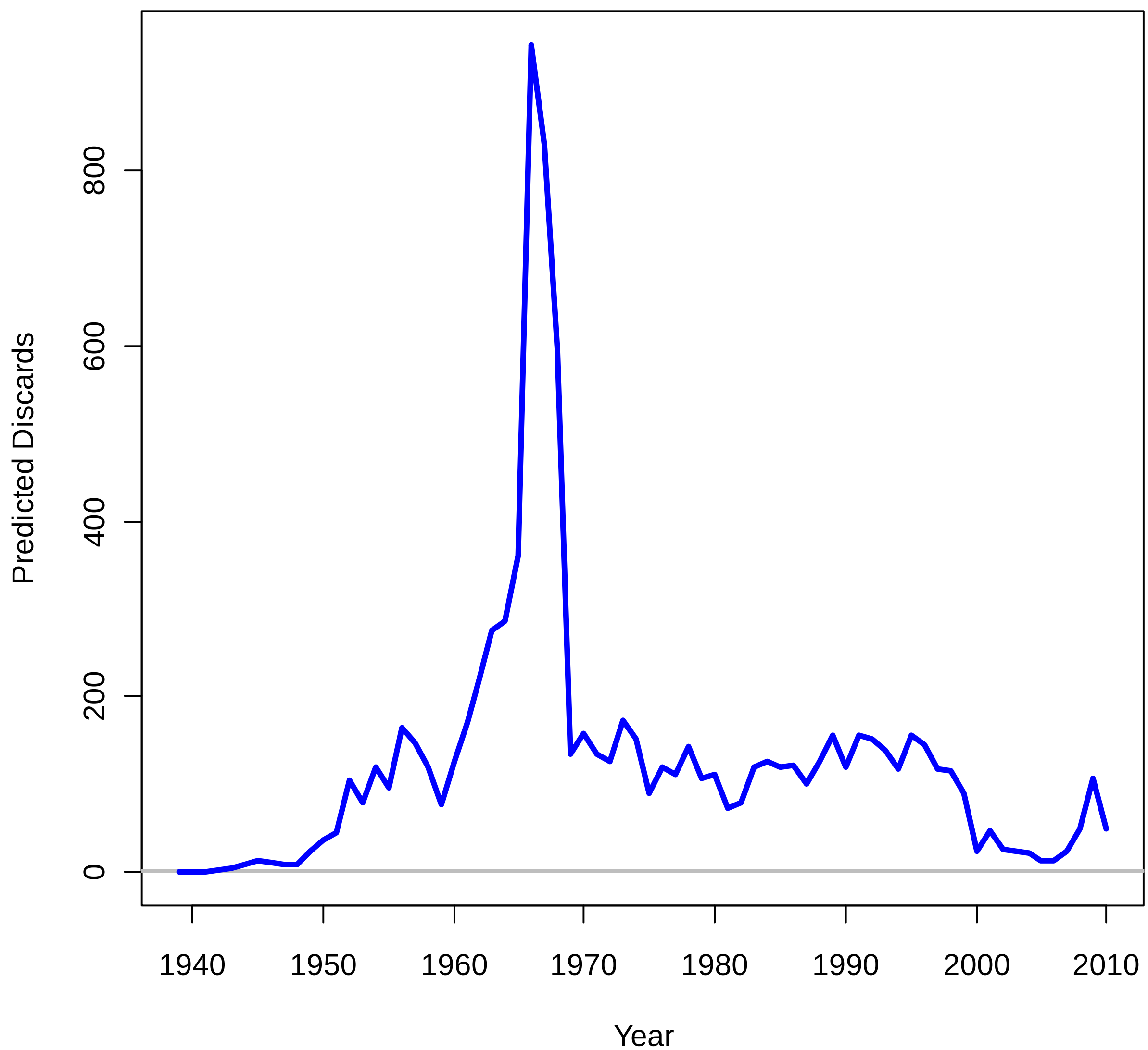

Figure 25: Time series of estimated discard

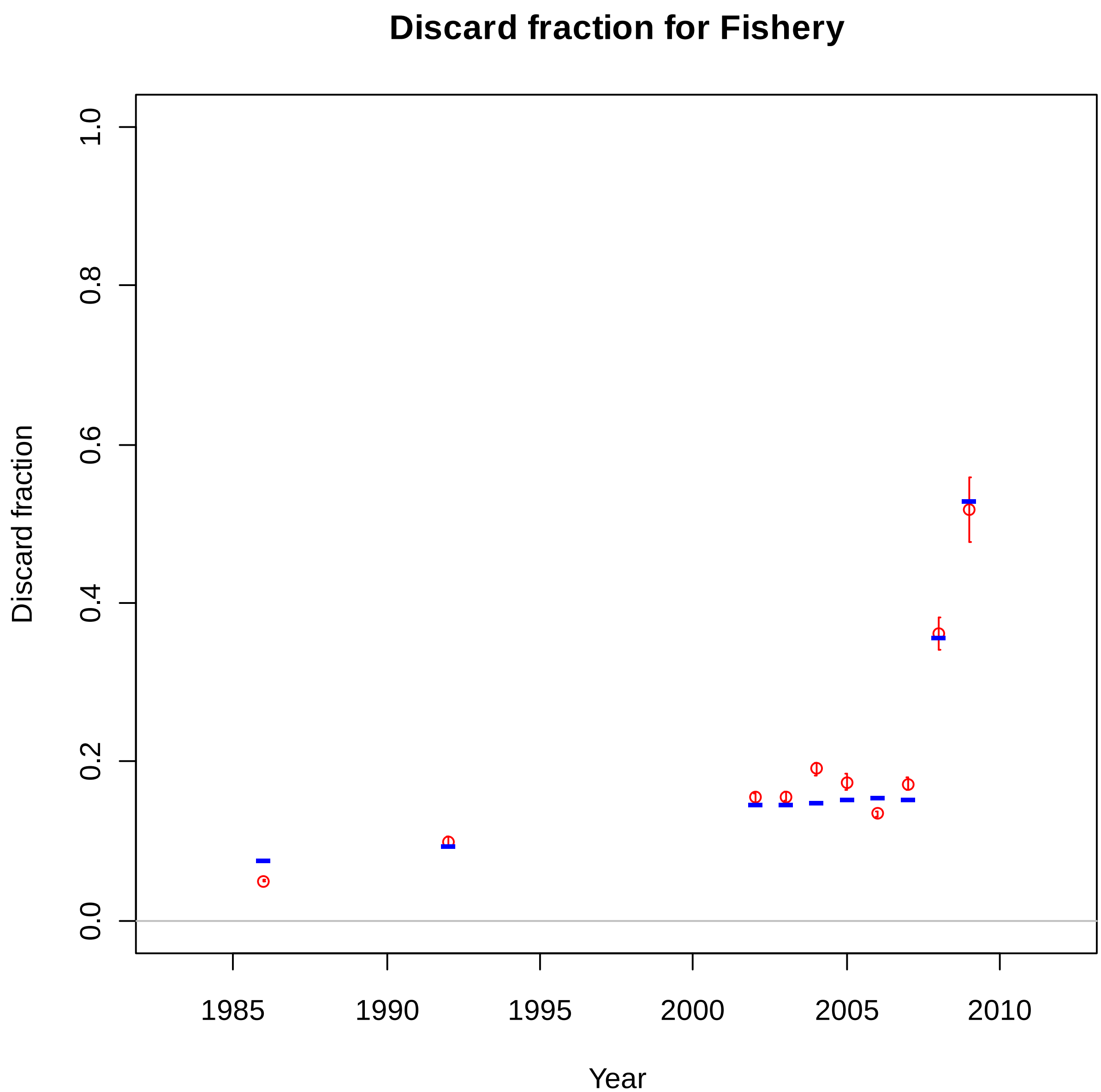

Figure 26: Fishery discard fraction by year (observed values are indicated by red circles, model estimated values by blue dashes)

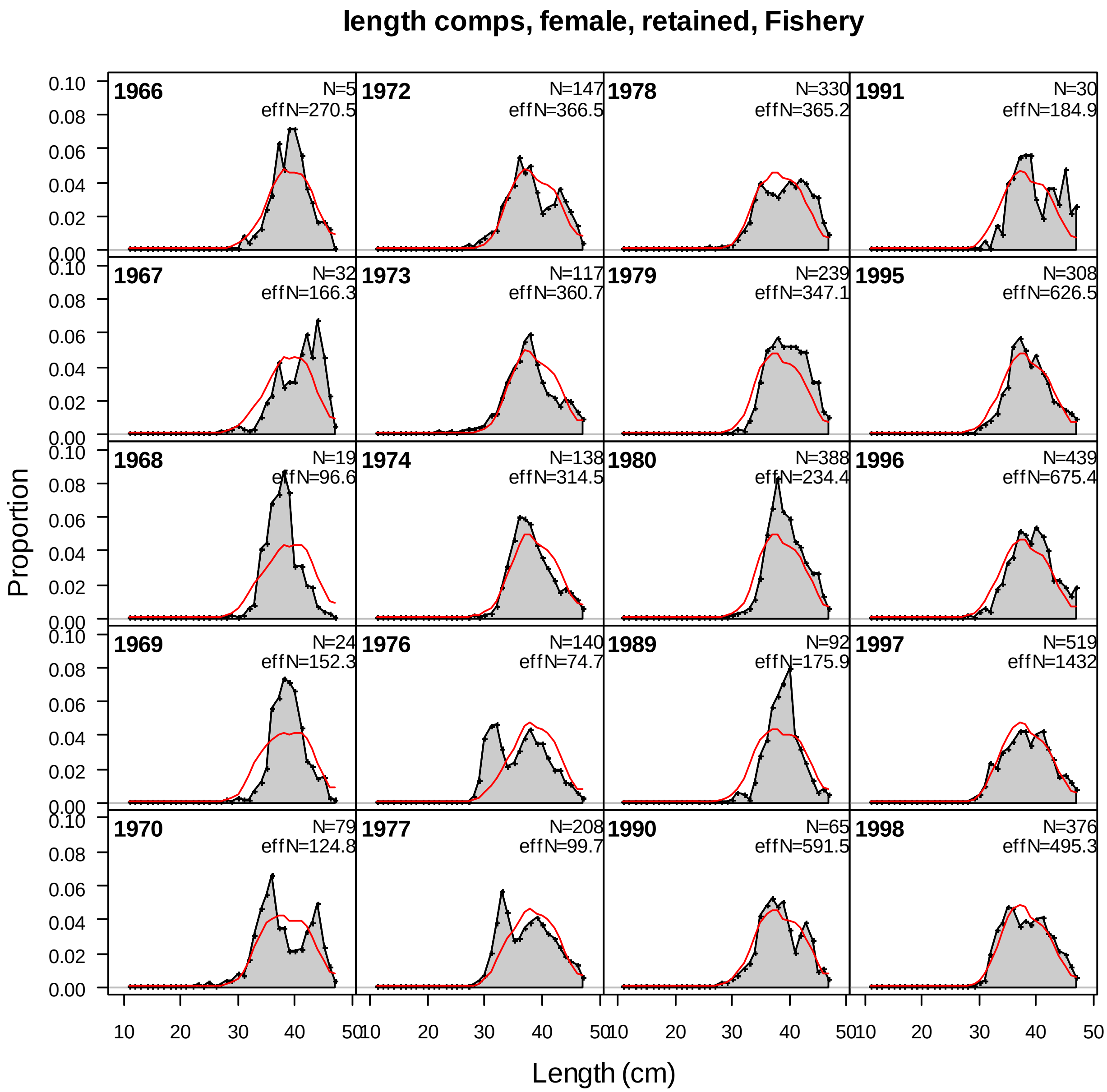

Figure 27: Female fishery length compositions and model fit

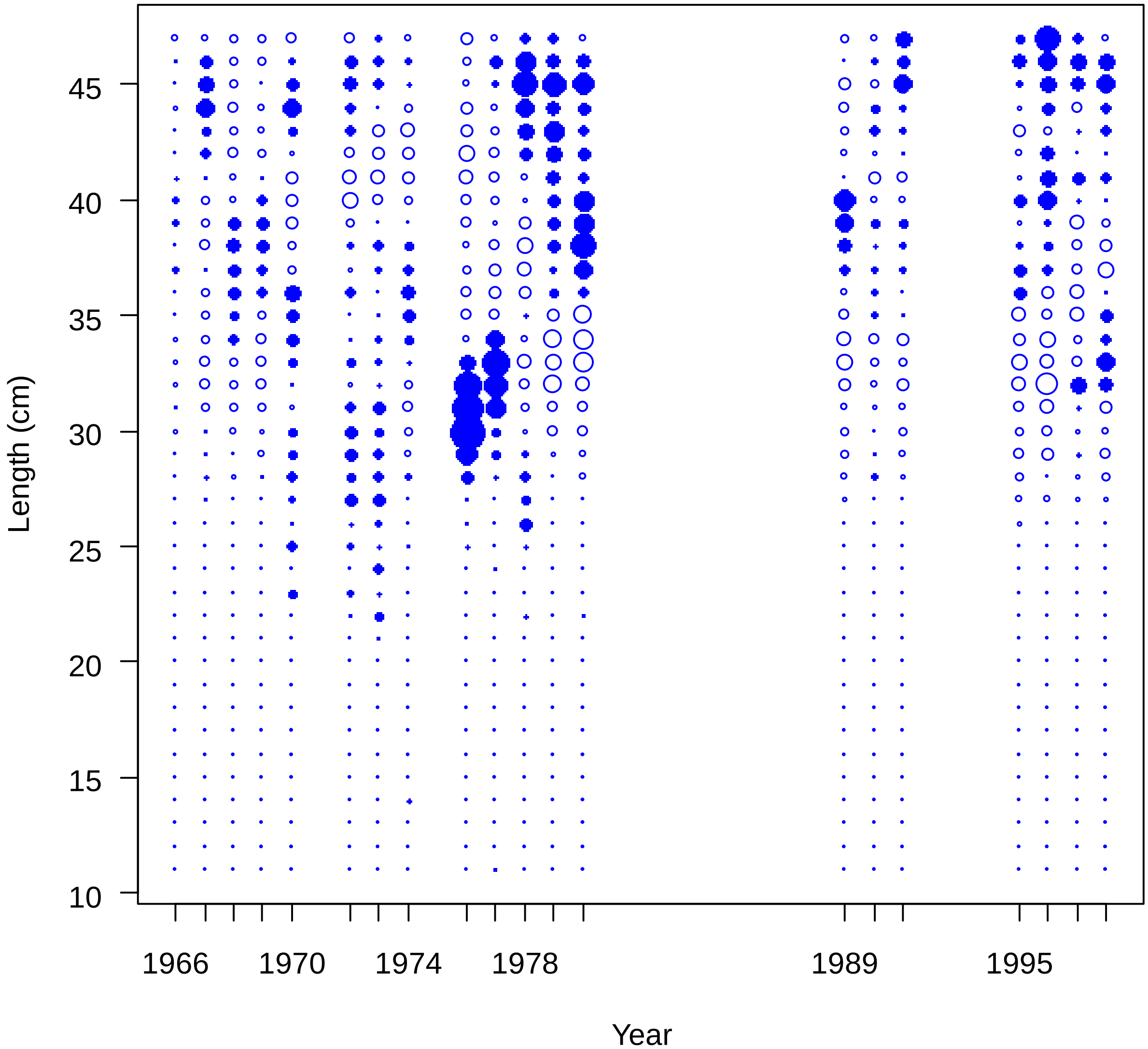

Figure 28: Pearson residuals for female length compositions fits to the fishery data

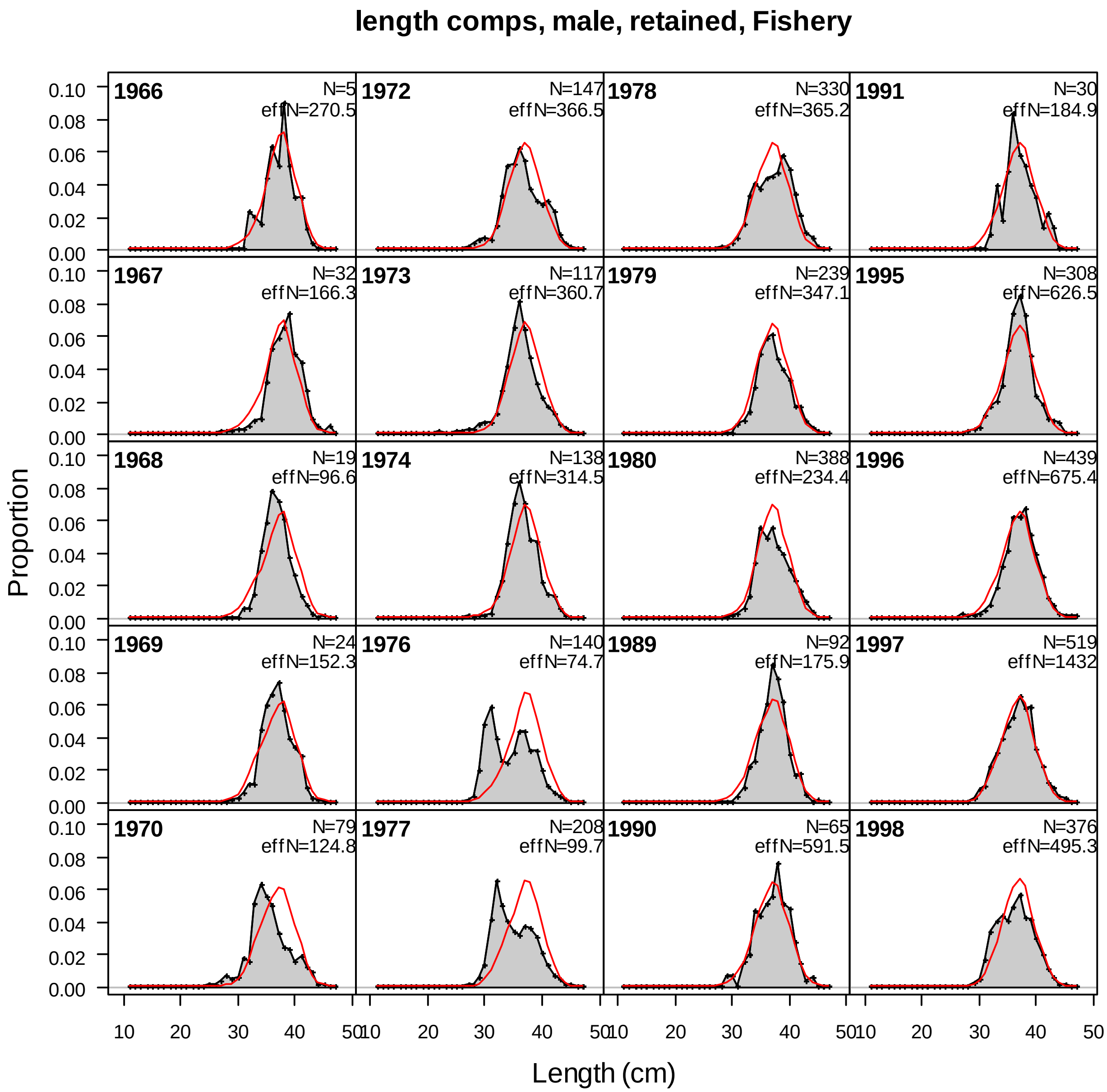

Figure 29: Male fishery length compositions and model fit

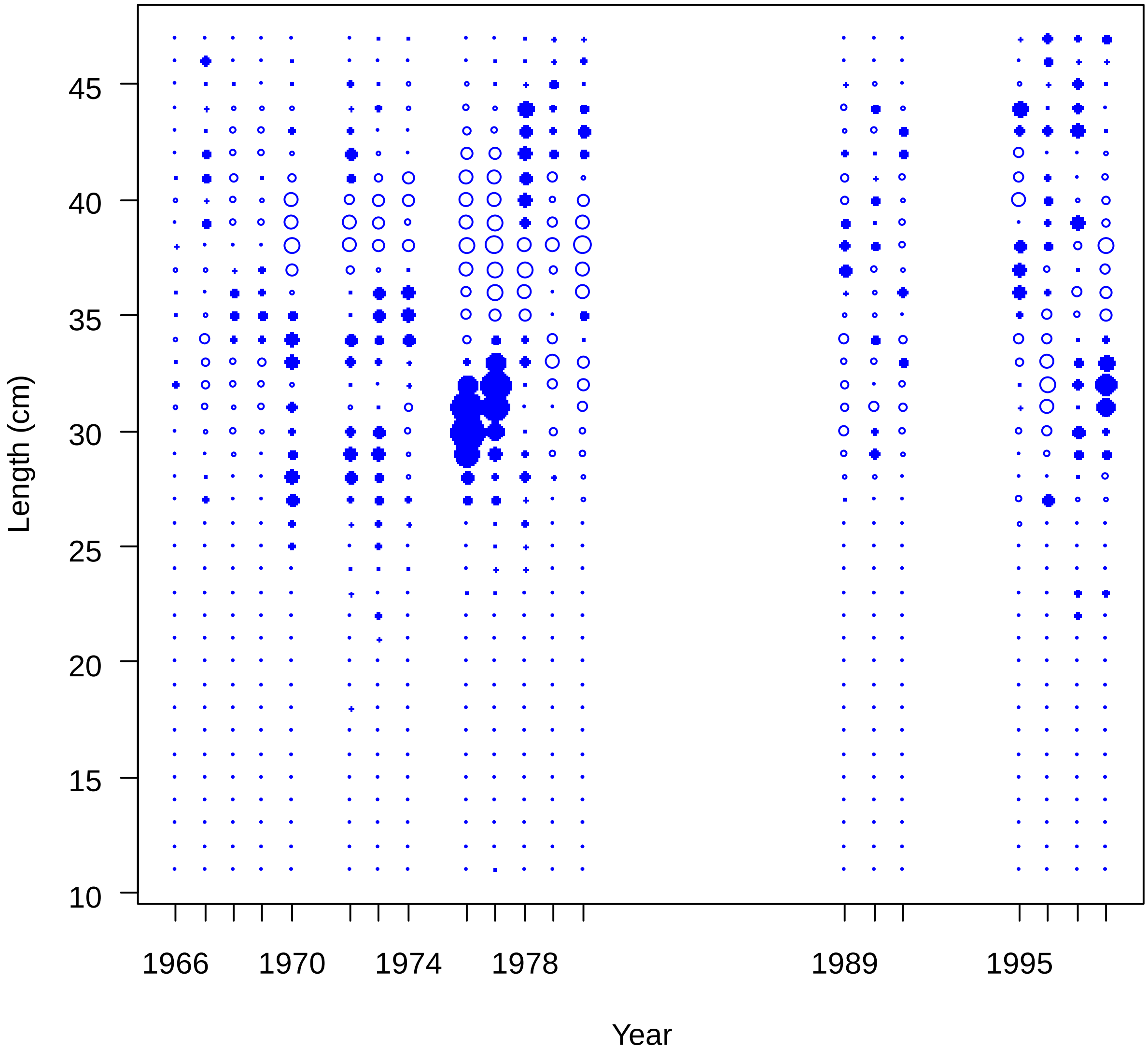

Figure 30: Pearson residuals for male length compositions fits to the fishery data

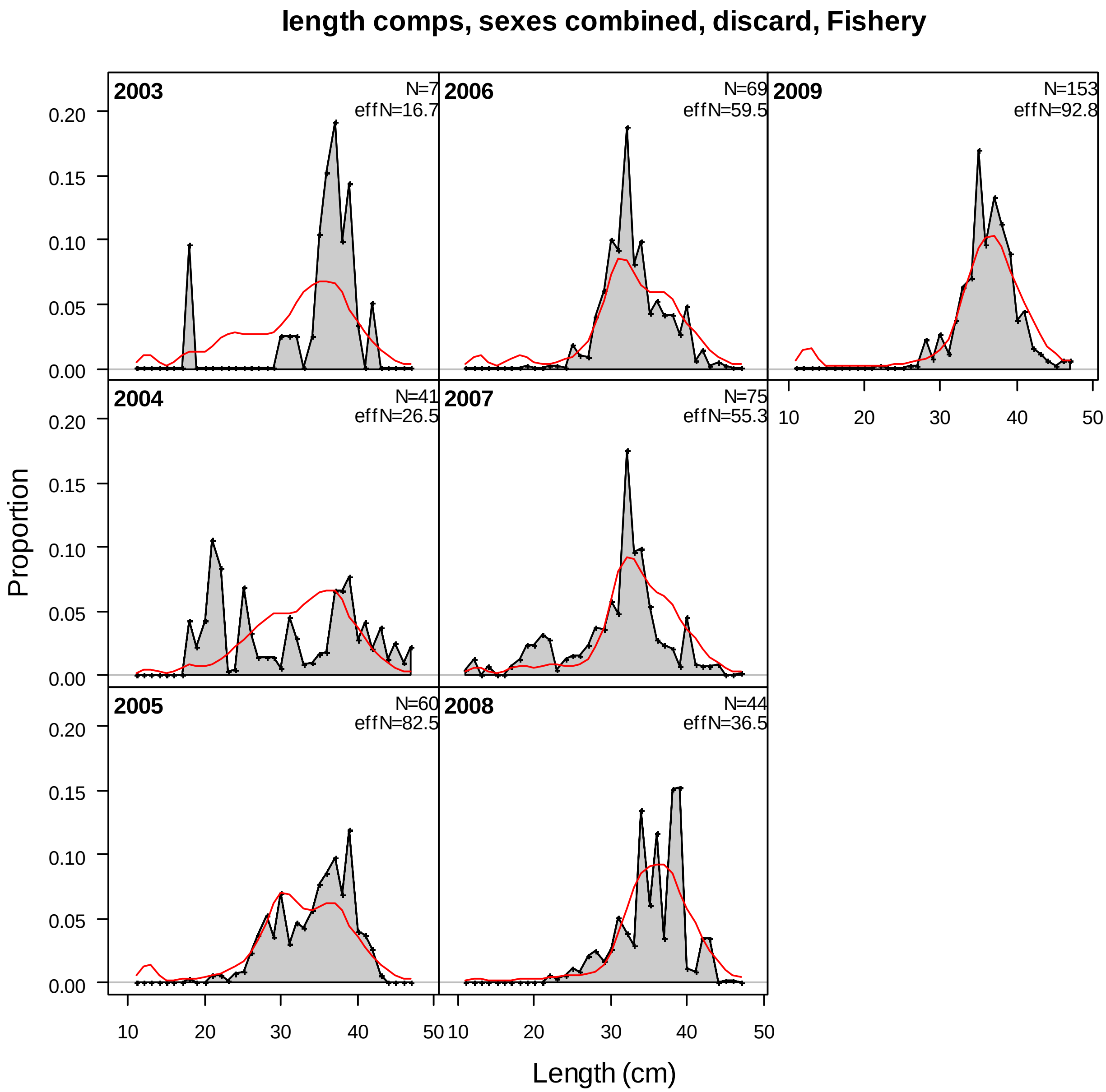

Figure 31: Fishery discard length compositions and model fits

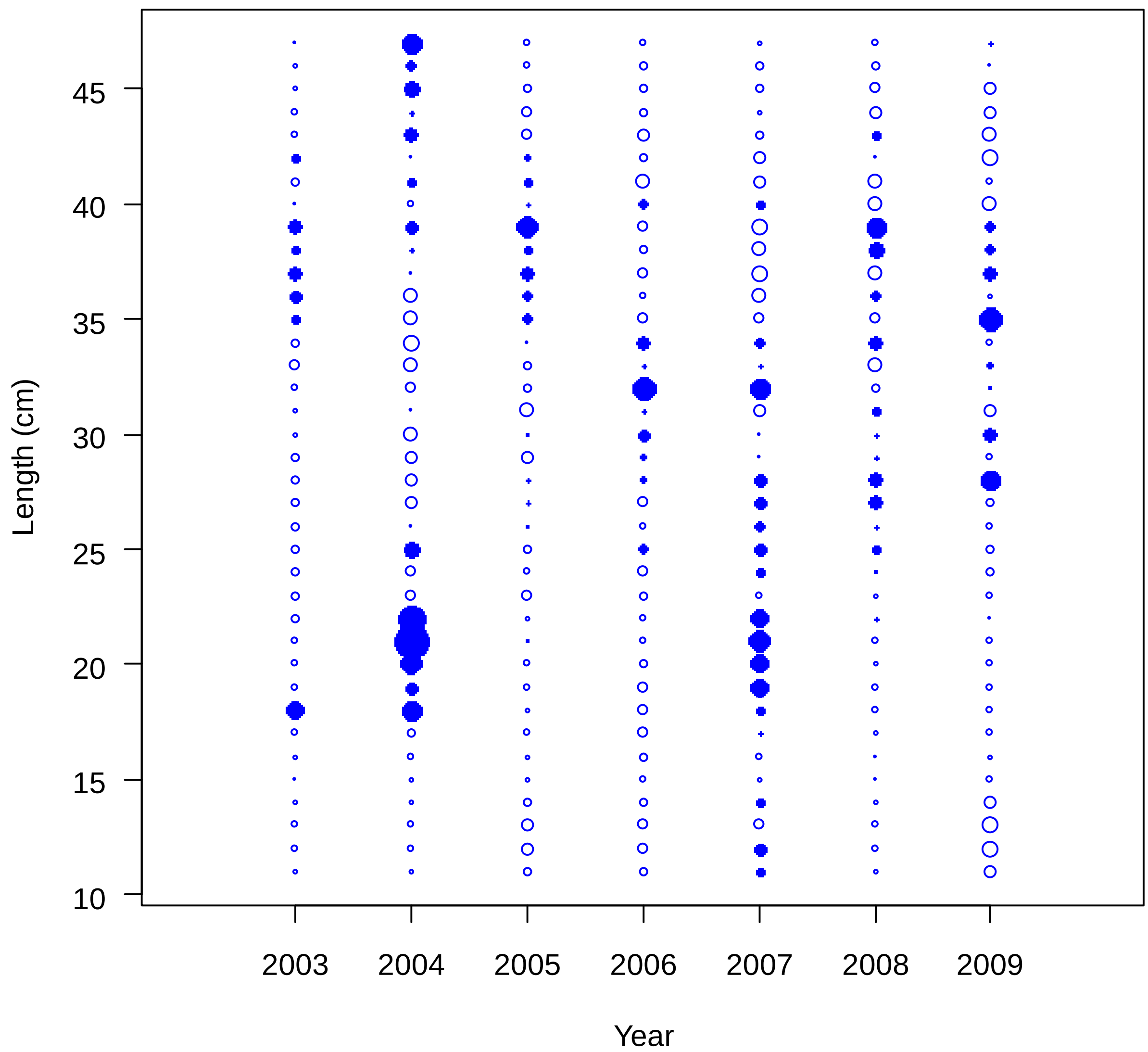

Figure 32: Pearson residuals for female length compositions fits to the fishery data

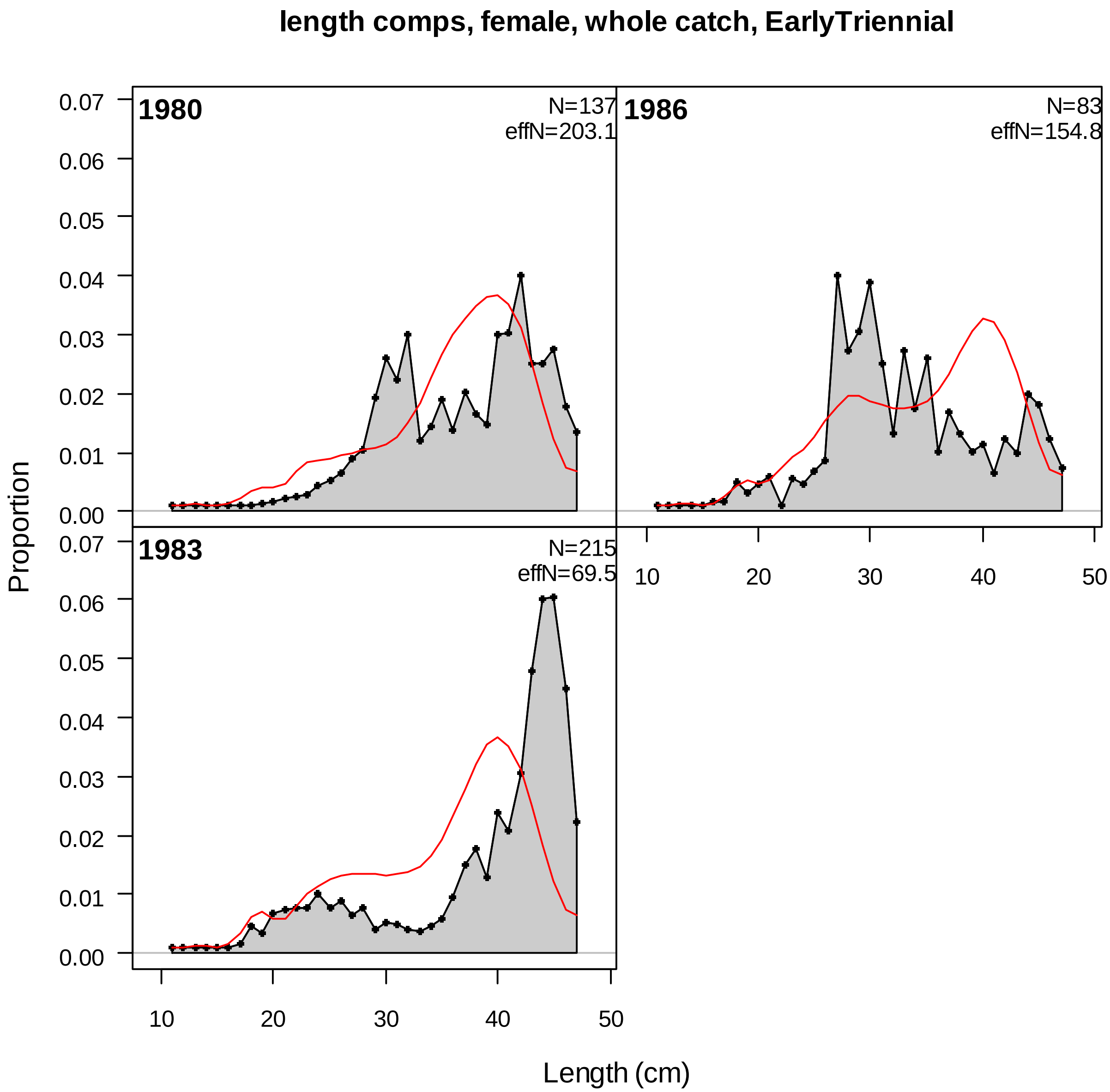

Figure 33: Early triennial survey female length compositions and model fits (1991-1992)

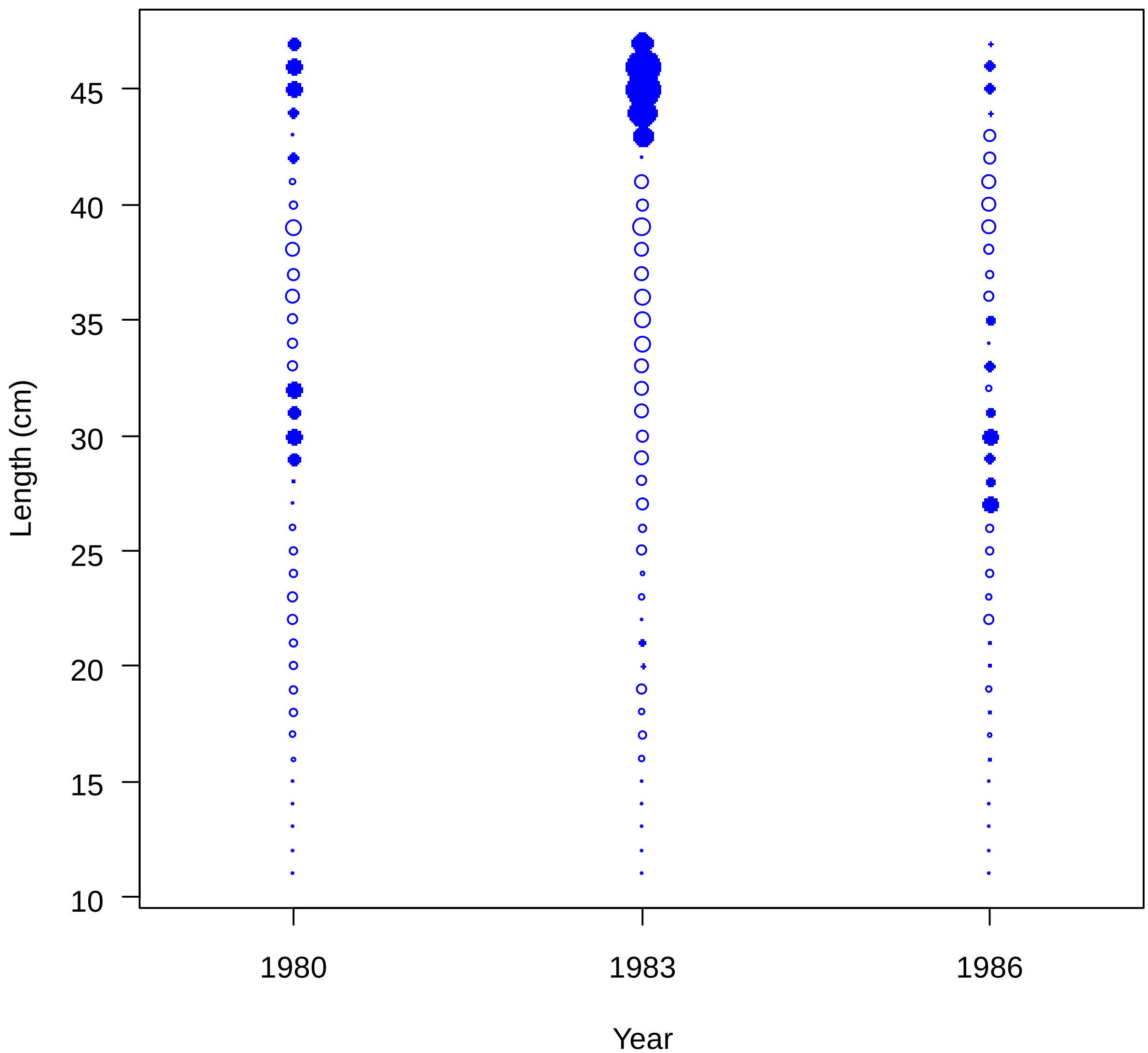

Figure 34: Pearson residuals for female length compositions fits to the Early triennial survey data

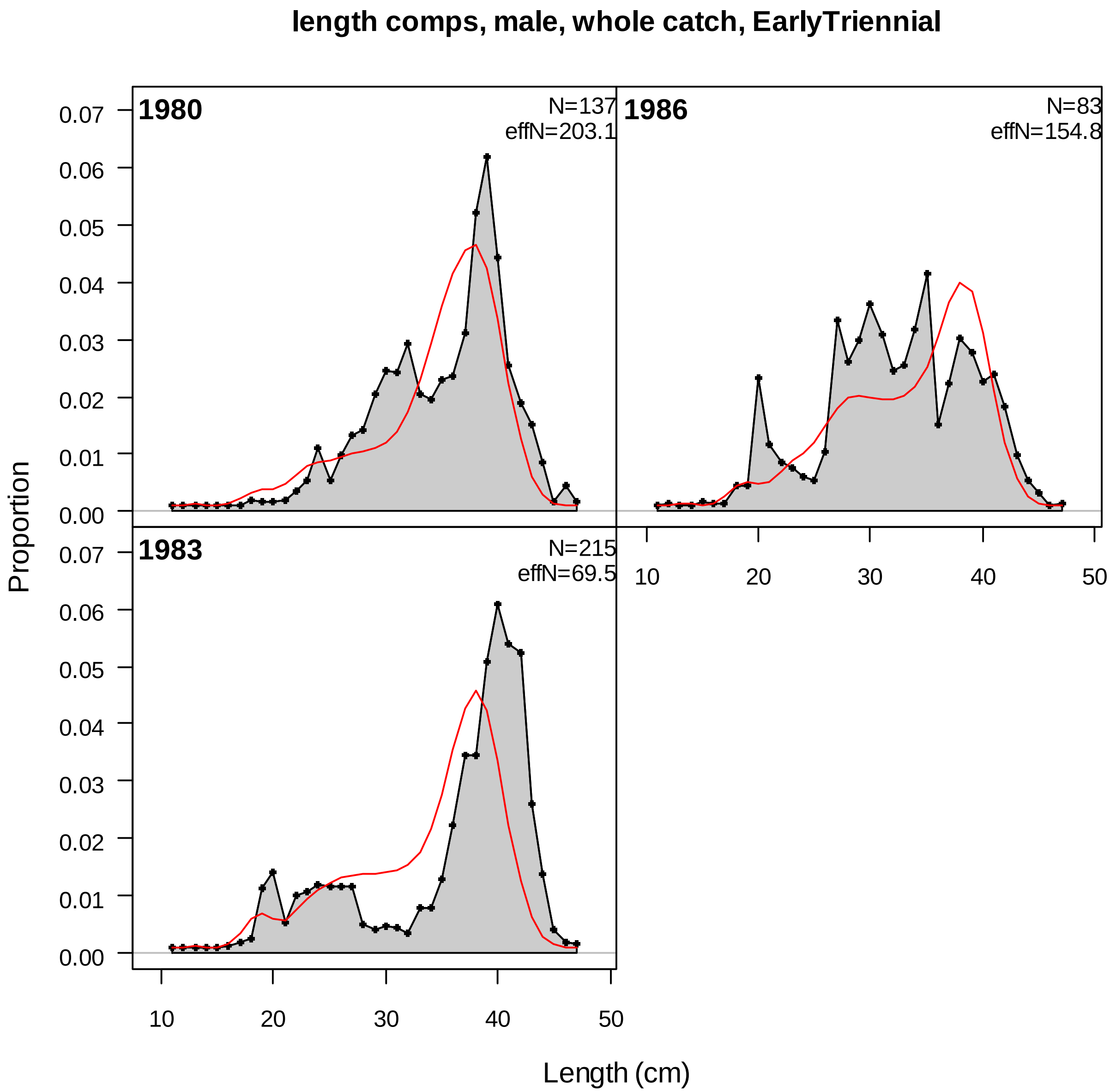

Figure 35: Early triennial survey male length compositions and model fits

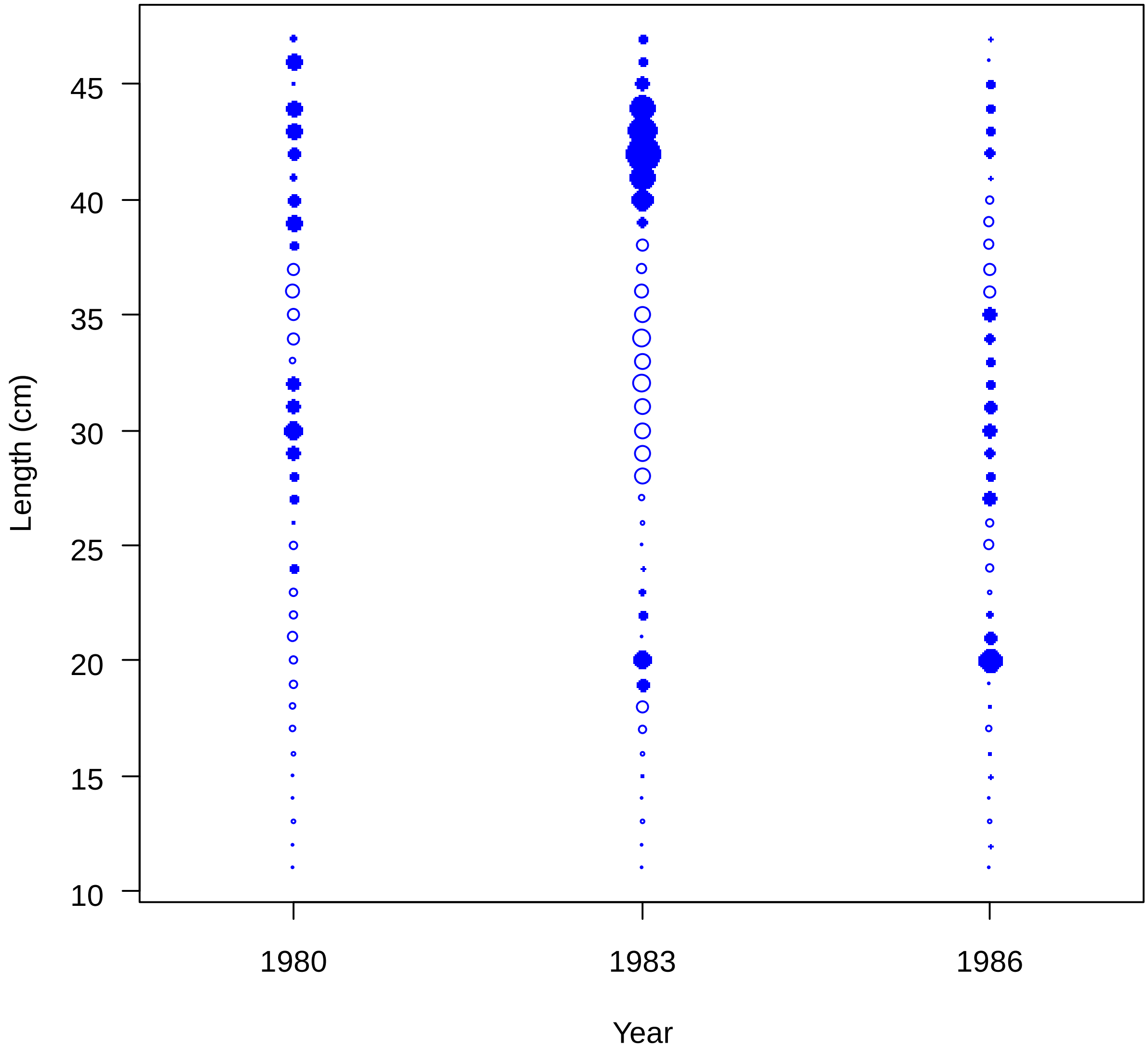

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Figure 36: Pearson residuals for male length compositions fits to the Early triennial survey data

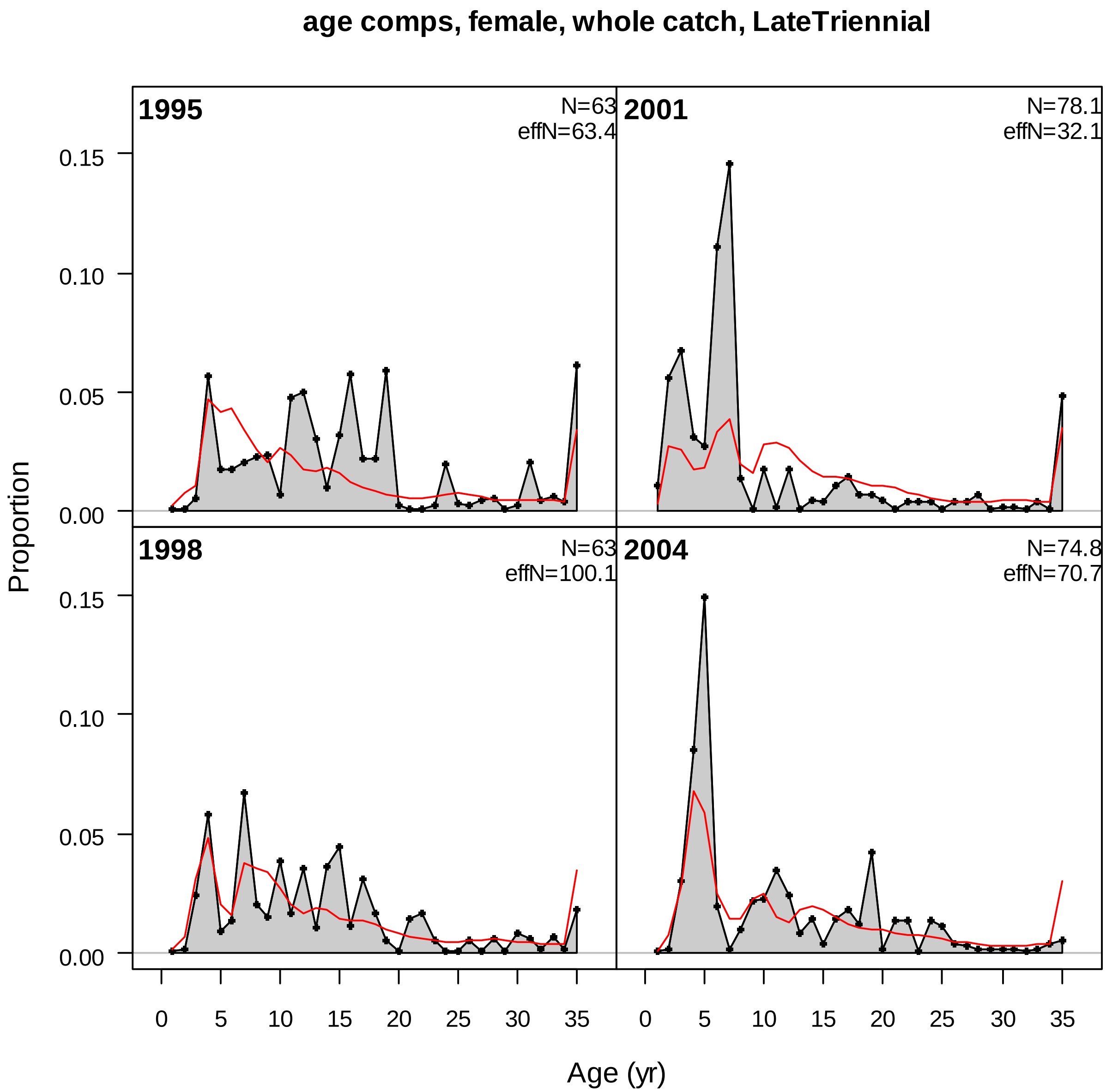

Figure 37: Late triennial survey female length compositions and model fits

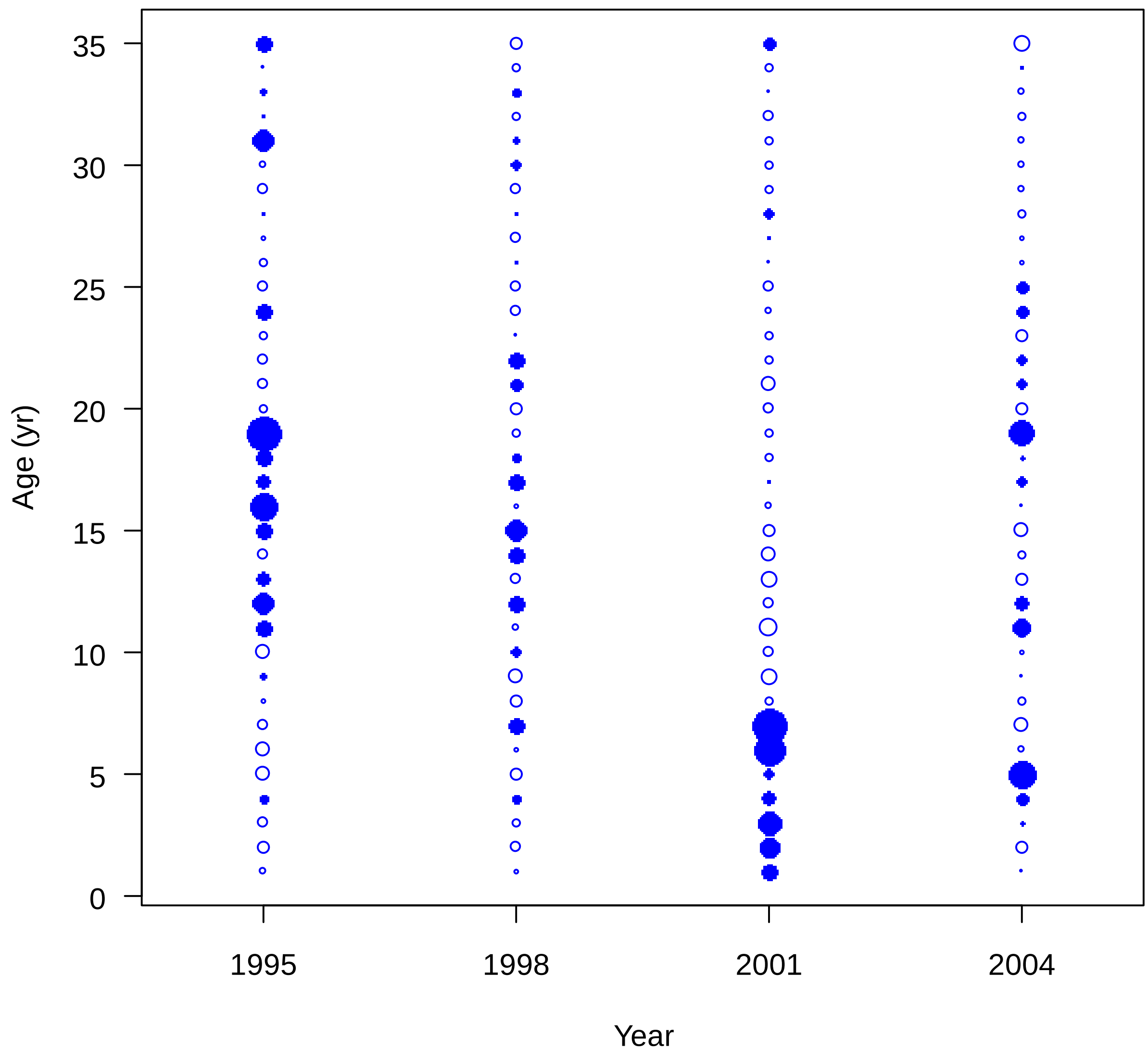

Figure 38: Pearson residuals for female length compositions fits to the Late triennial survey data

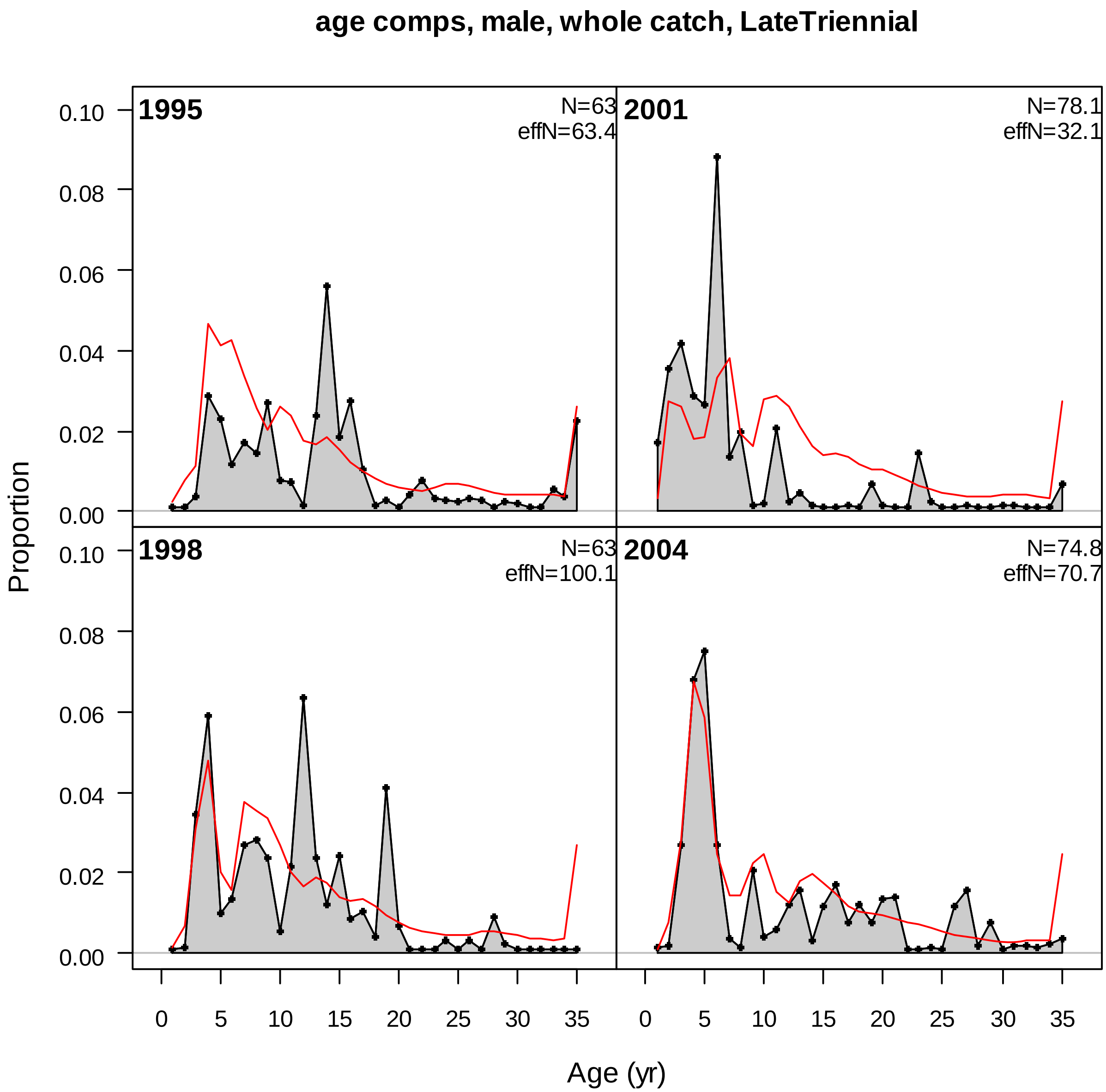

Figure 39: Late triennial survey male length compositions and model fits

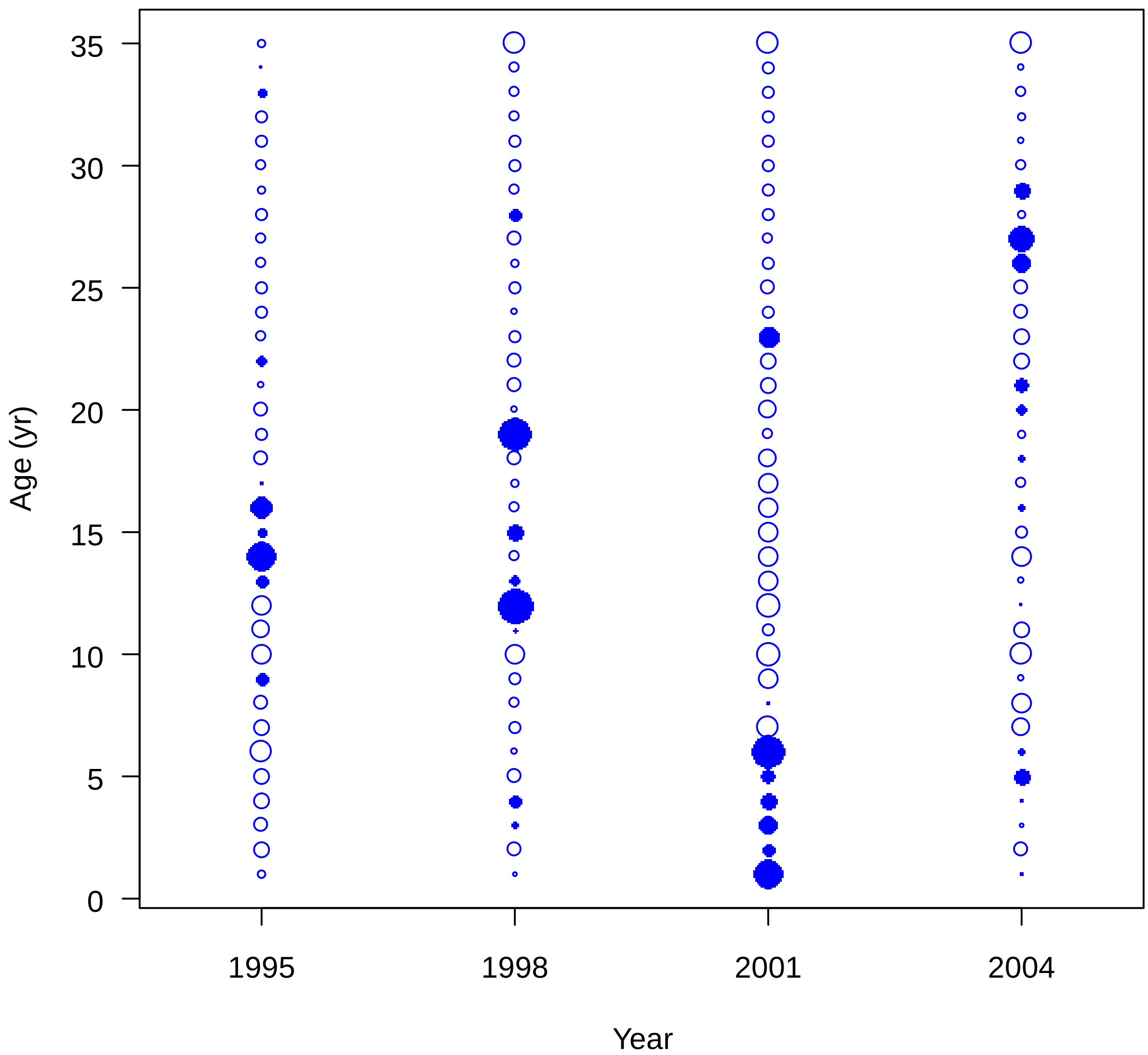

Figure 40: Pearson residuals for male length compositions fits to the Late triennial survey data

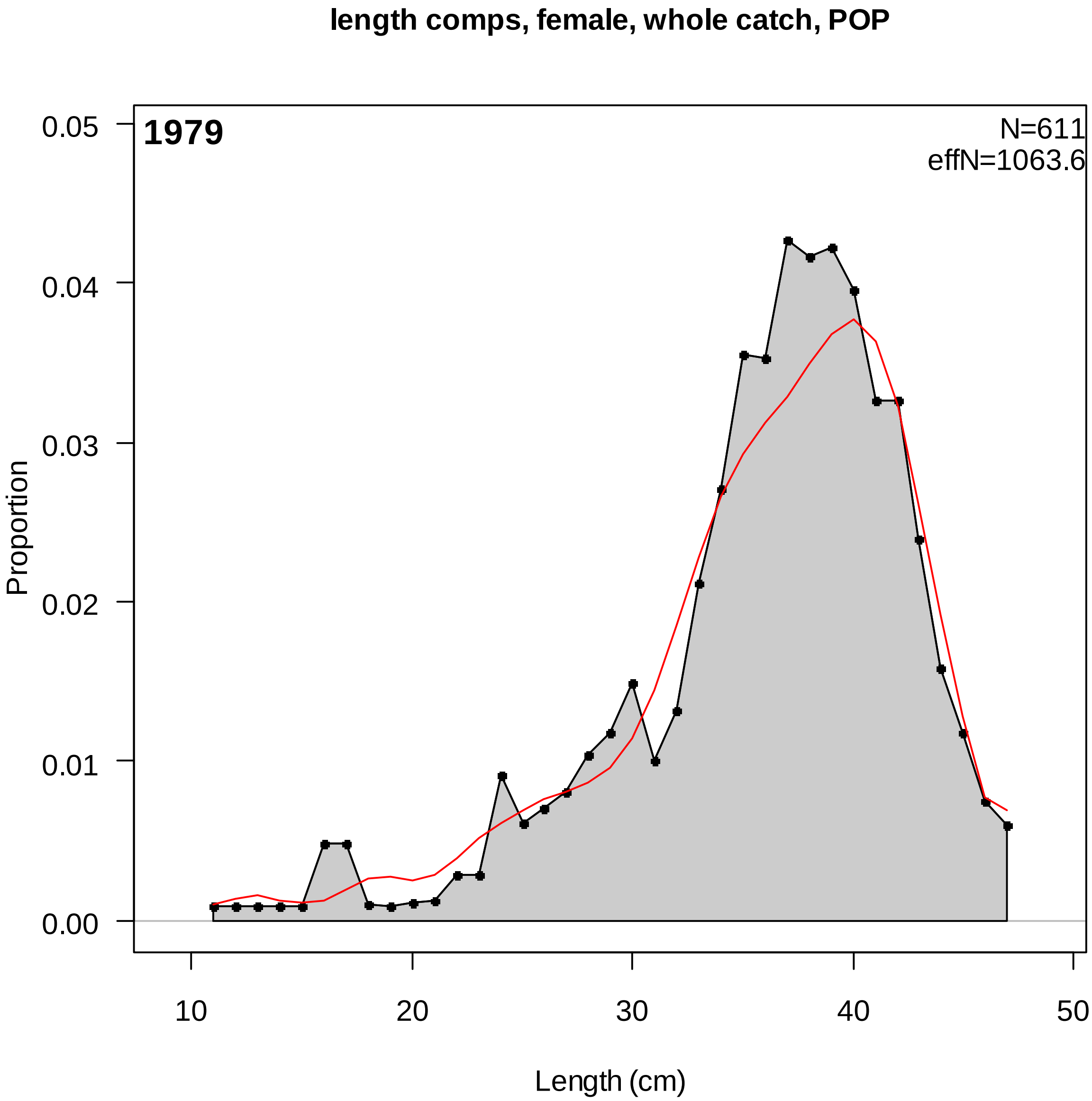

Figure 41: POP/rockfish survey female length compositions and model fits

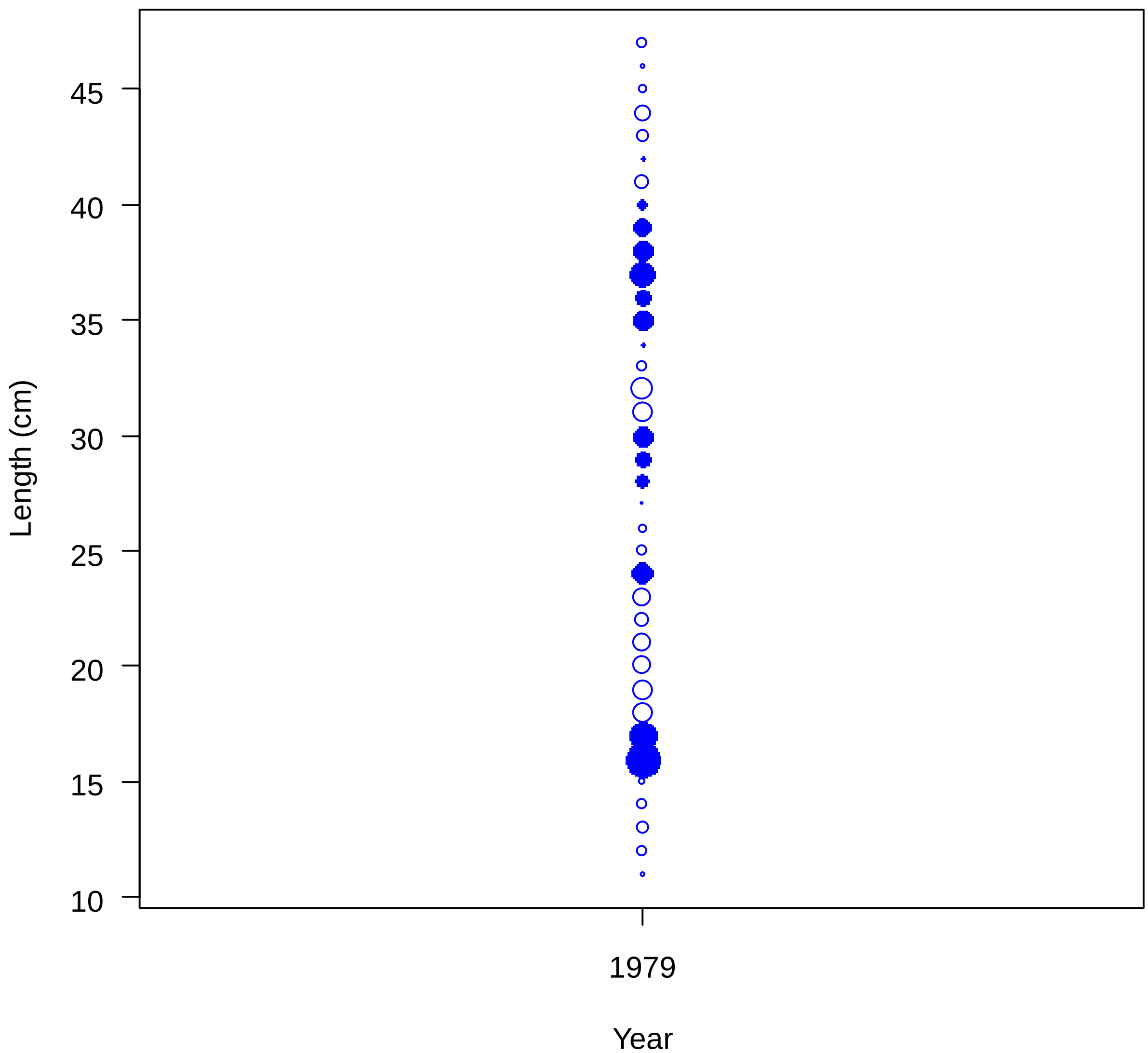

Figure 42: Pearson residuals for female length compositions fits to the POP/rockfish survey data

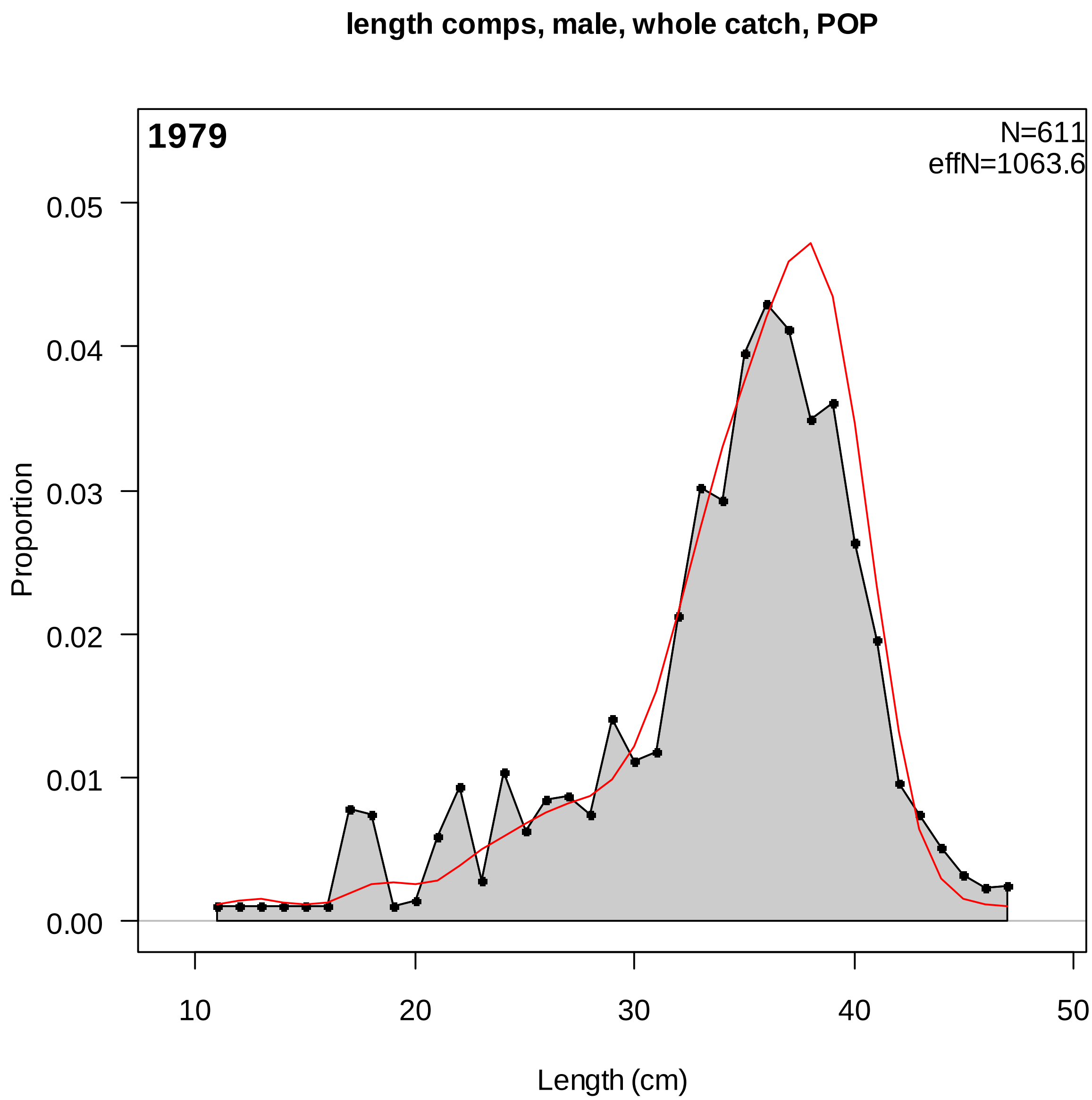

Figure 43: POP/rockfish survey male length compositions and model fits

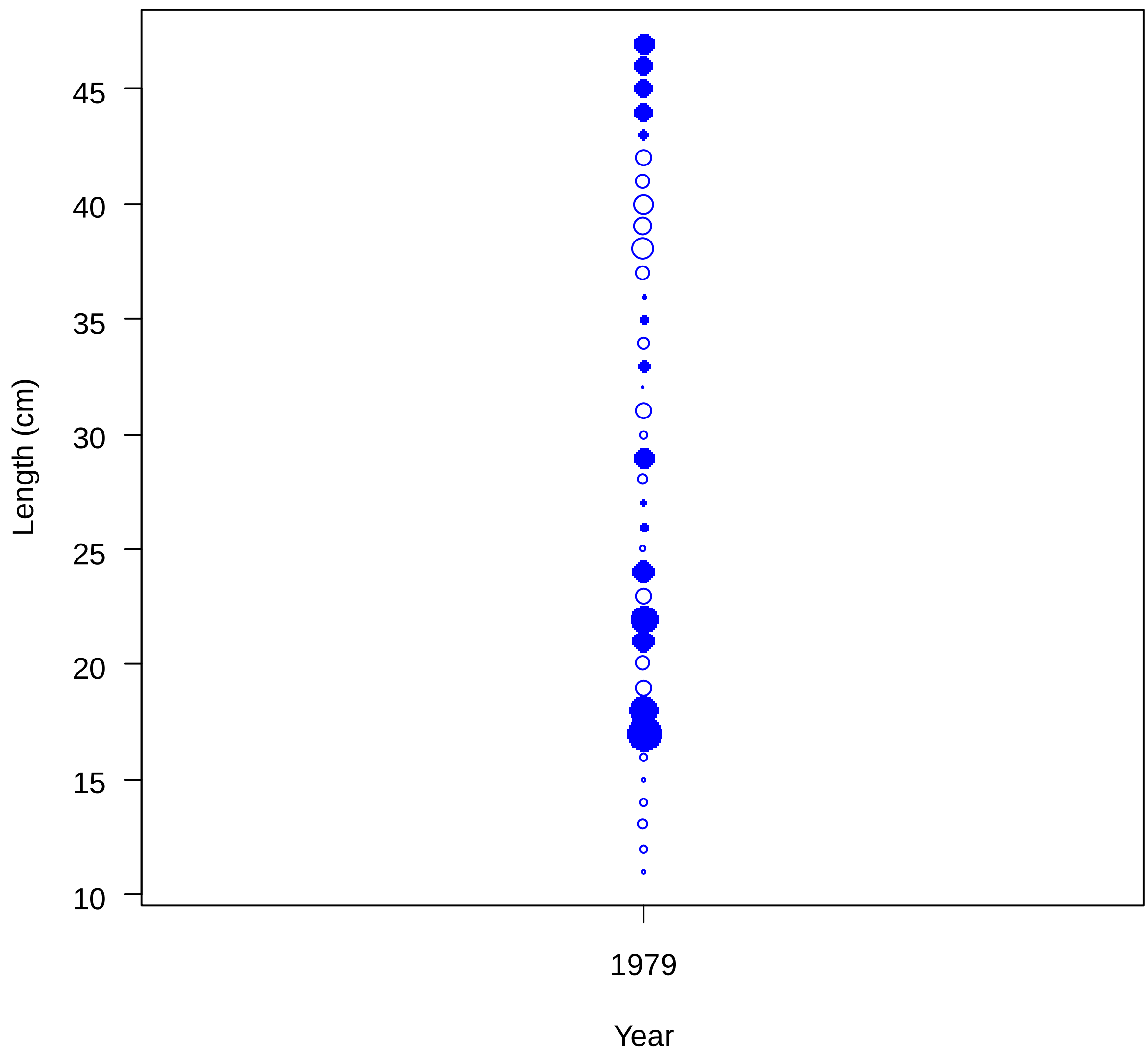

Figure 44: Pearson residuals for male length compositions fits to the POP/rockfish survey data

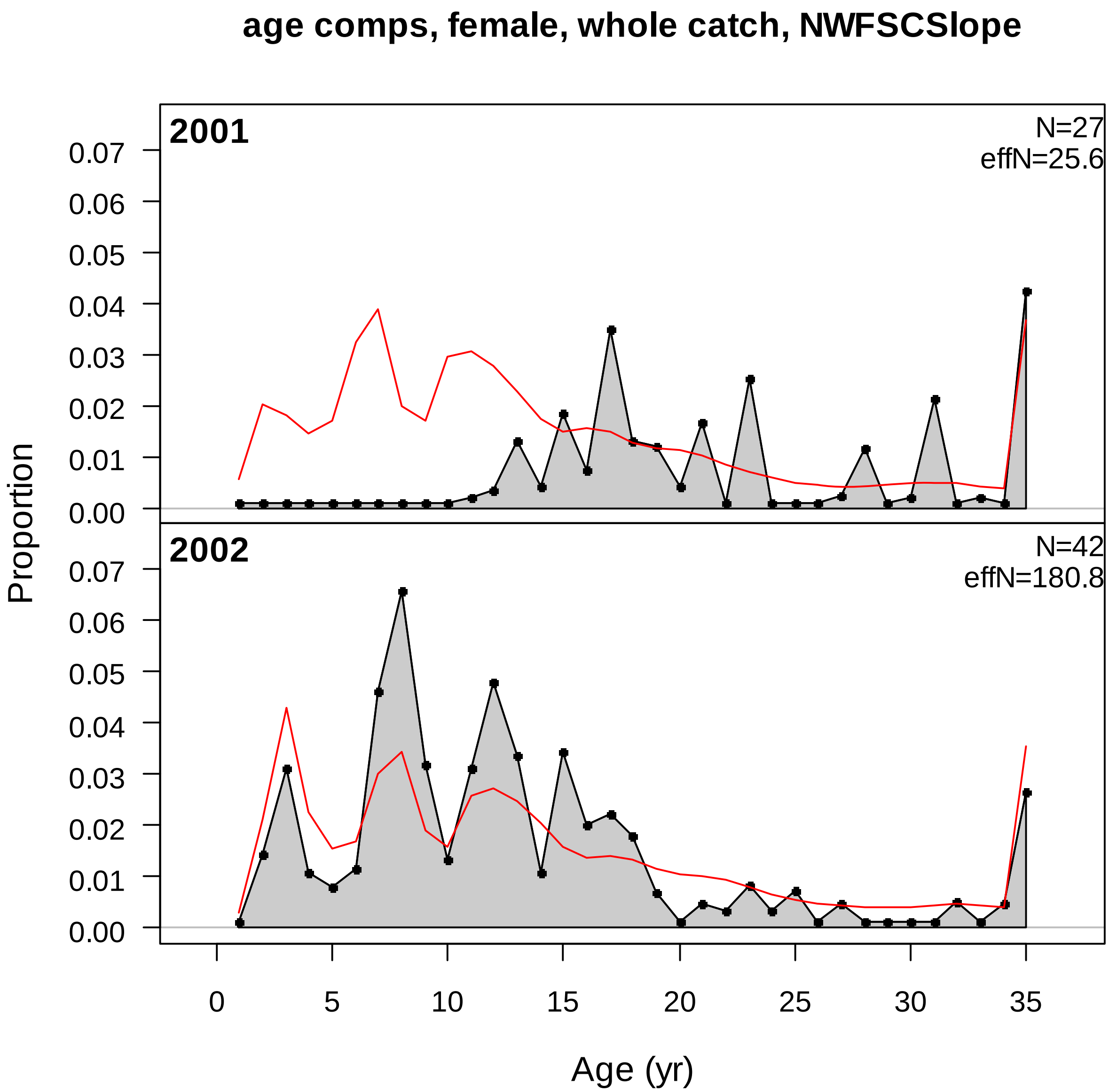

Figure 45: NWFSC slope Survey female length compositions and model fits

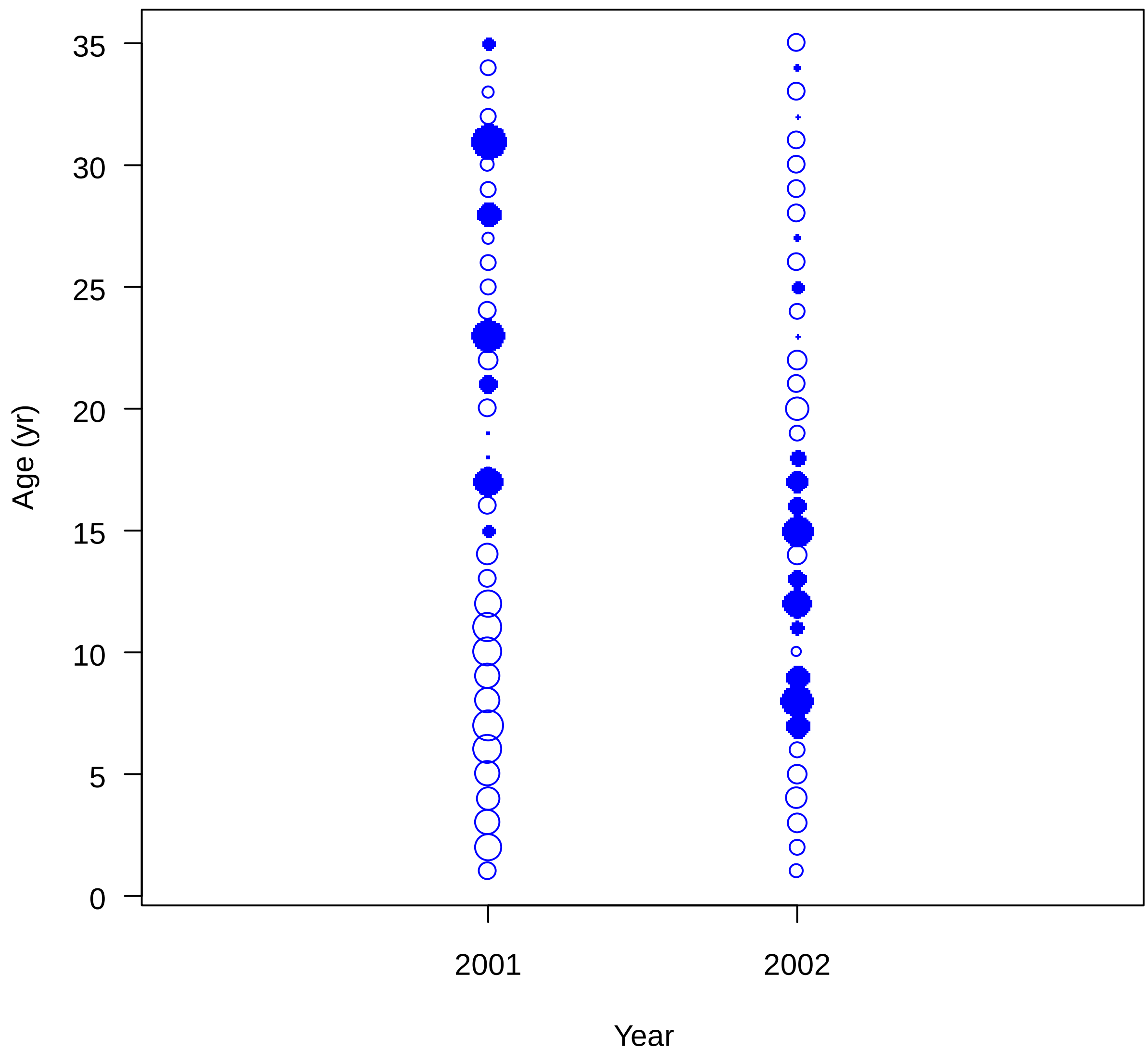

Figure 46: Pearson residuals for female length compositions fits to the NWFSC slope Survey data

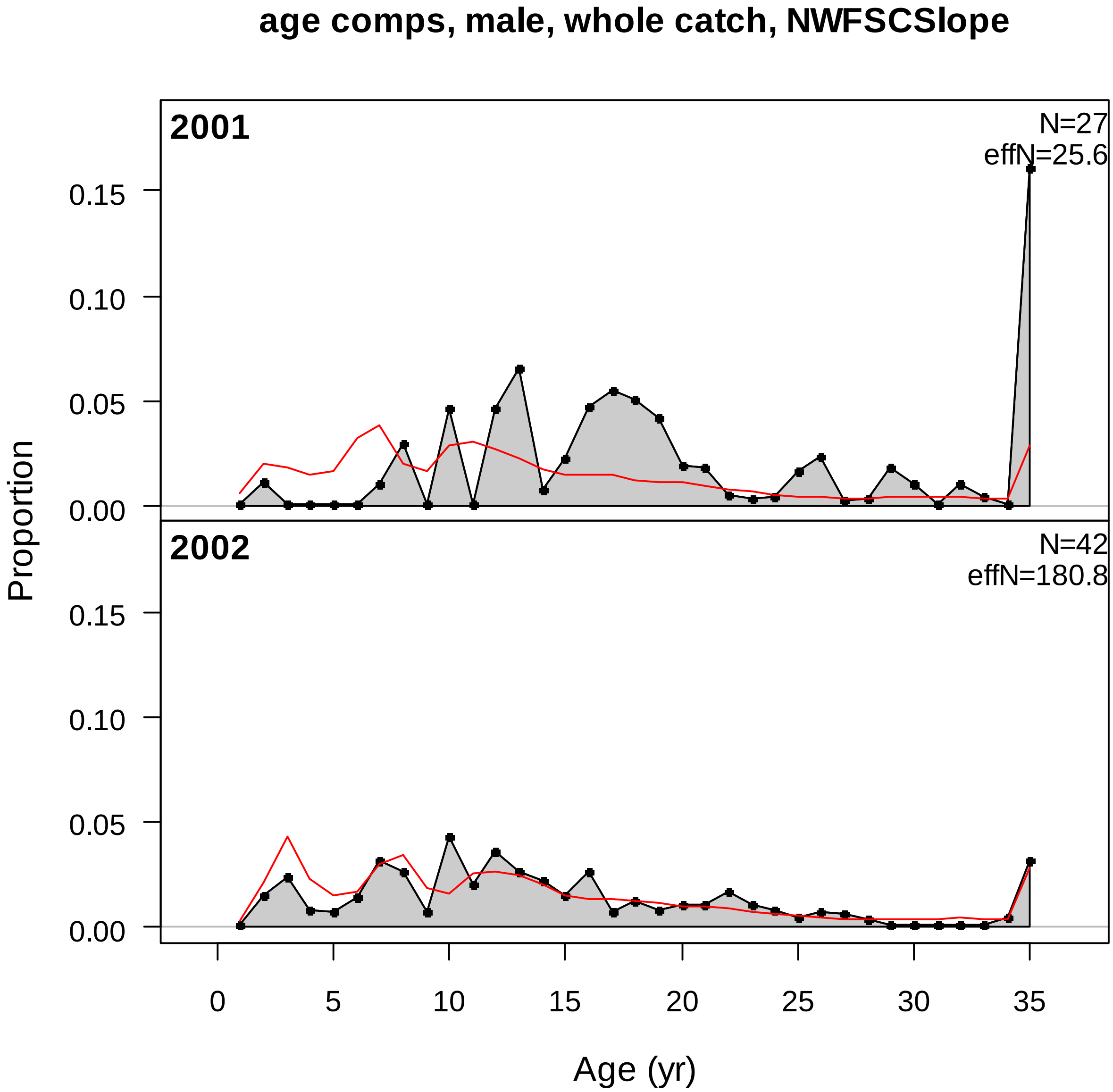

Figure 47: NWFSC slope Survey male length compositions and model fits

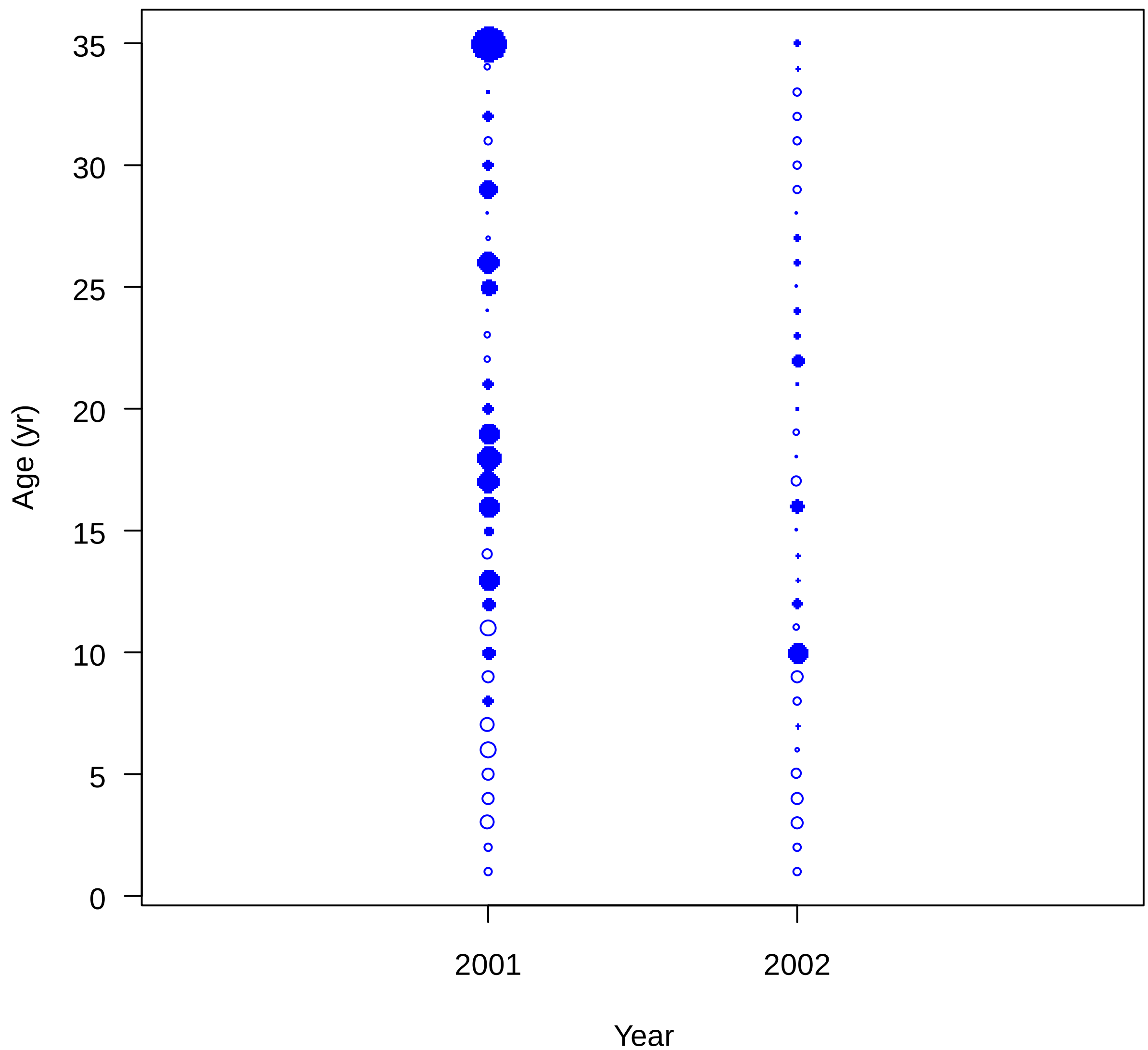

Figure 48: Pearson residuals for male length compositions fits to the NWFSC slope Survey data

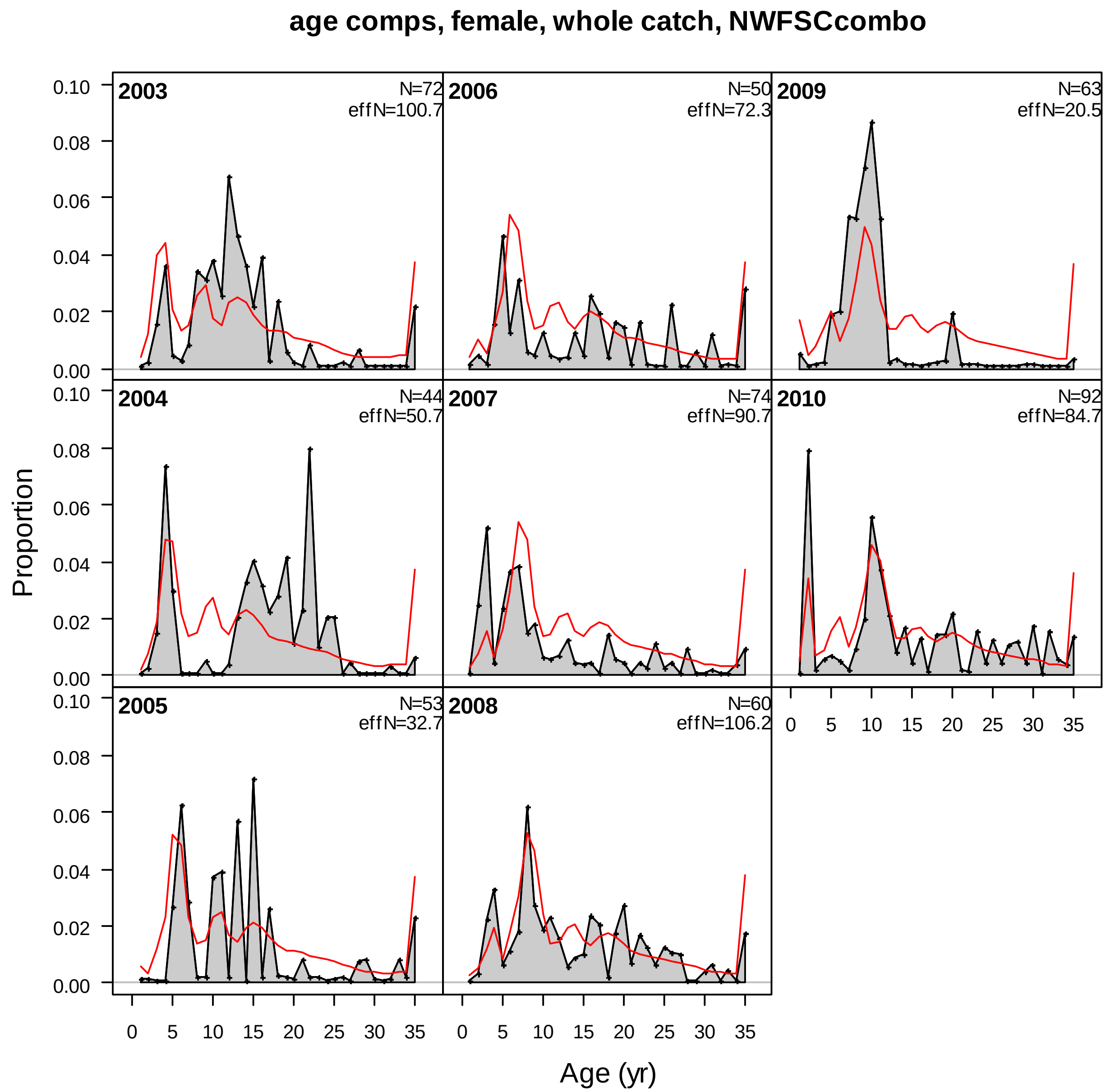

Figure 49: NWFSC Shelf/Slope Combo Survey female length compositions and model fits

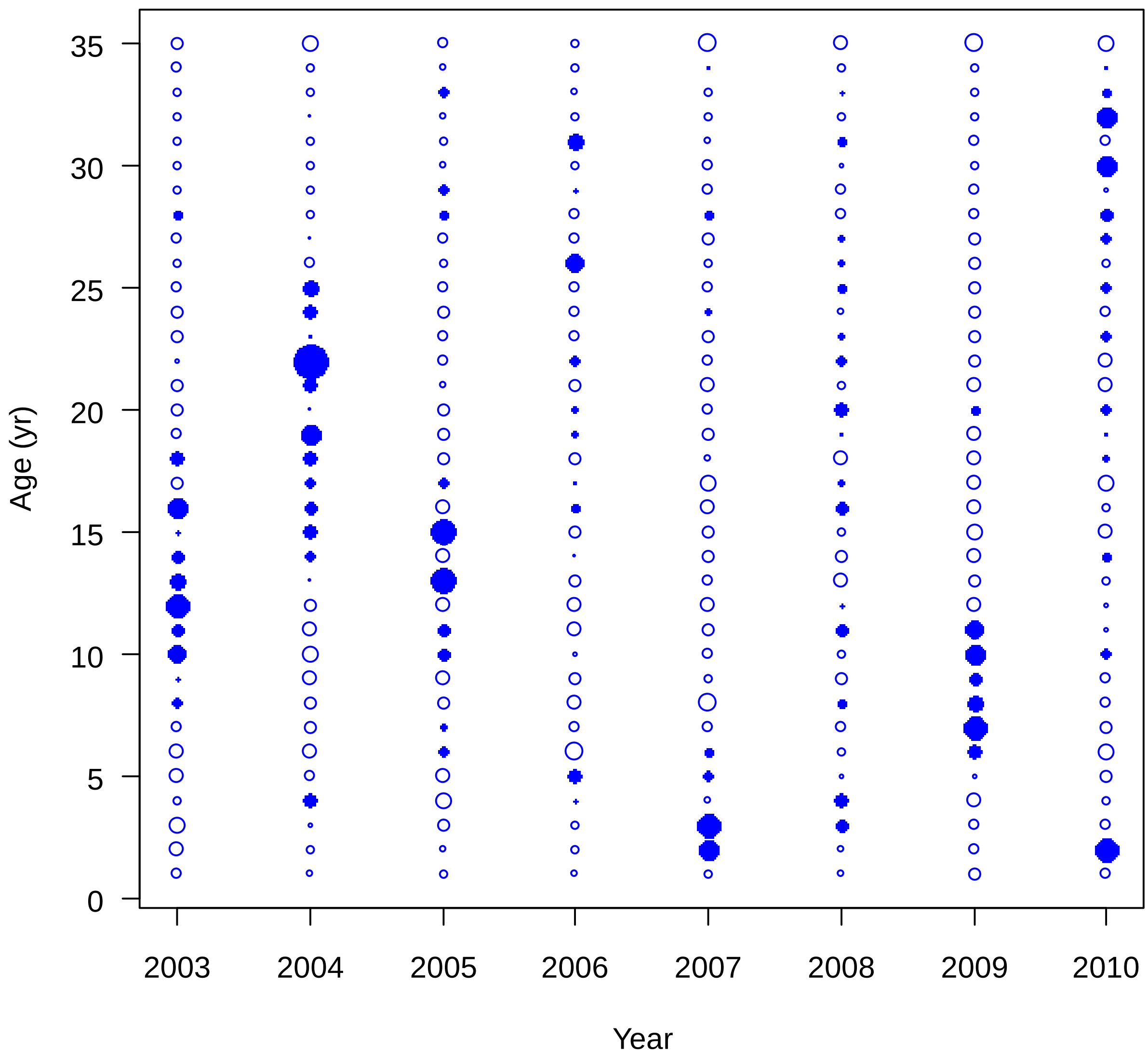

Figure 50: Pearson residuals for female length compositions fits to the NWFSC Shelf/Slope Combo Survey data

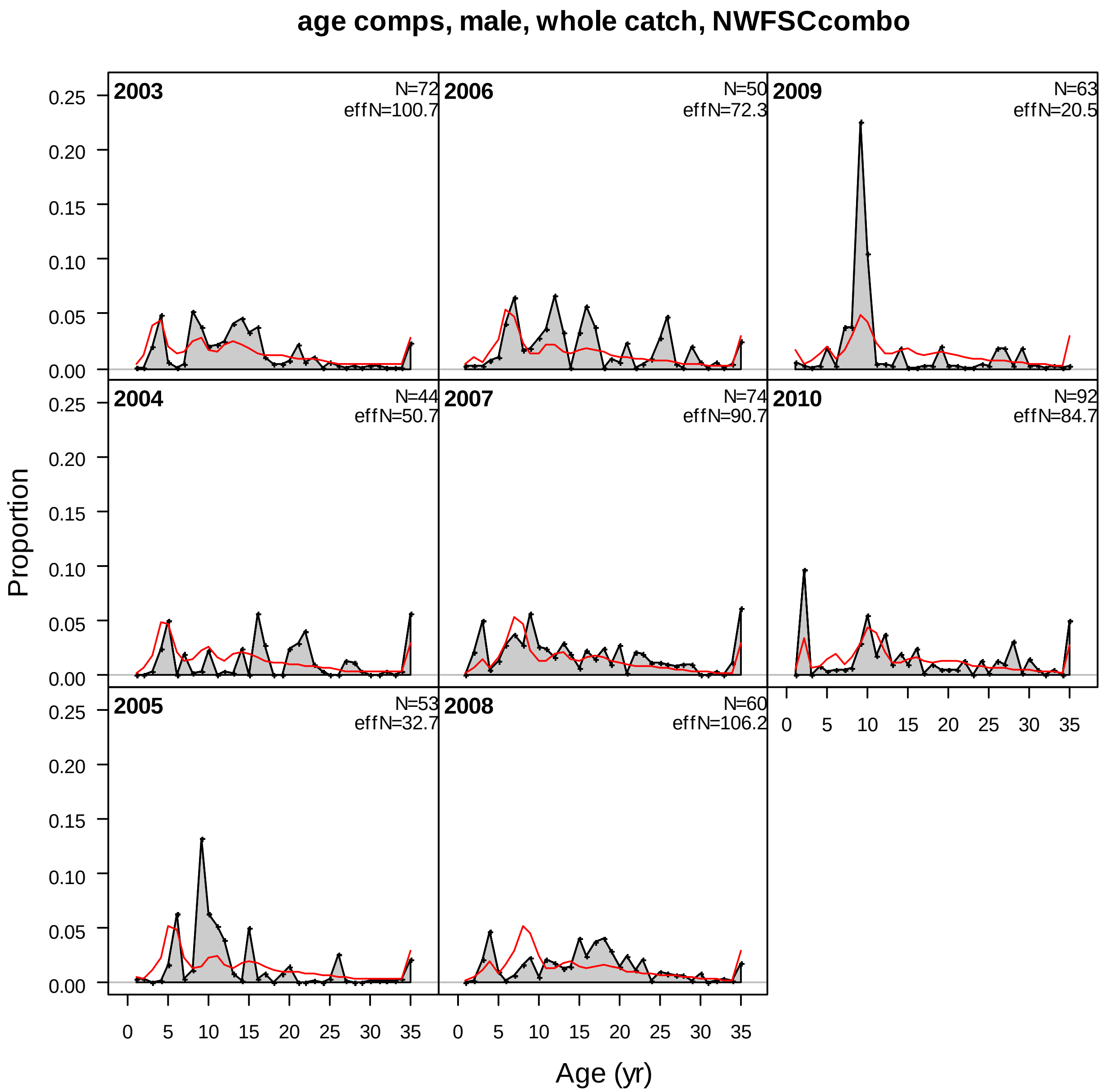

Figure 51: NWFSC Shelf/Slope Combo Survey male length compositions and model fits

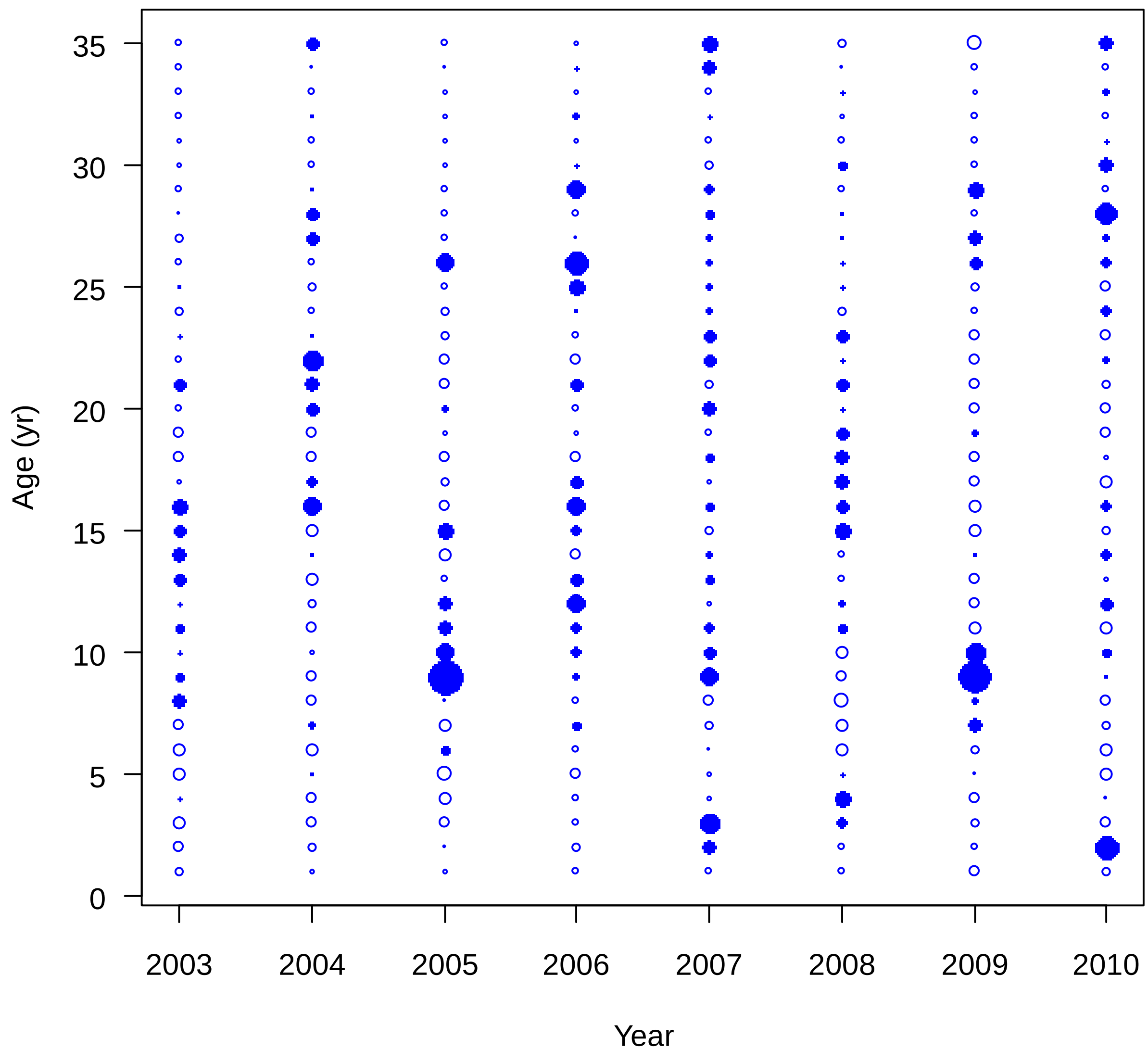

Figure 52: Pearson residuals for male length compositions fits to the NWFSC Shelf/Slope Combo Survey data

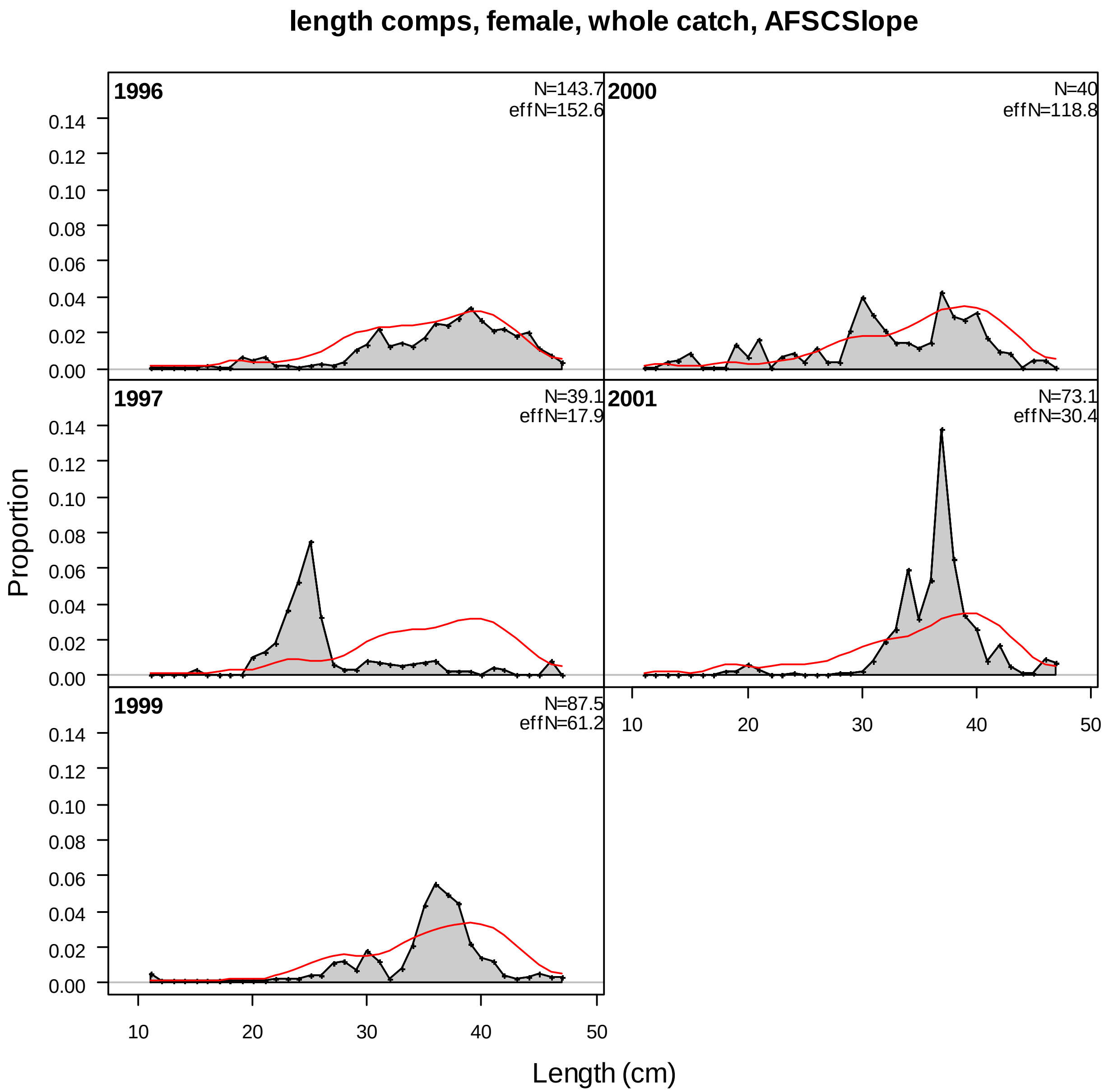

Figure 53: AFSC slope Survey female length compositions and model fits

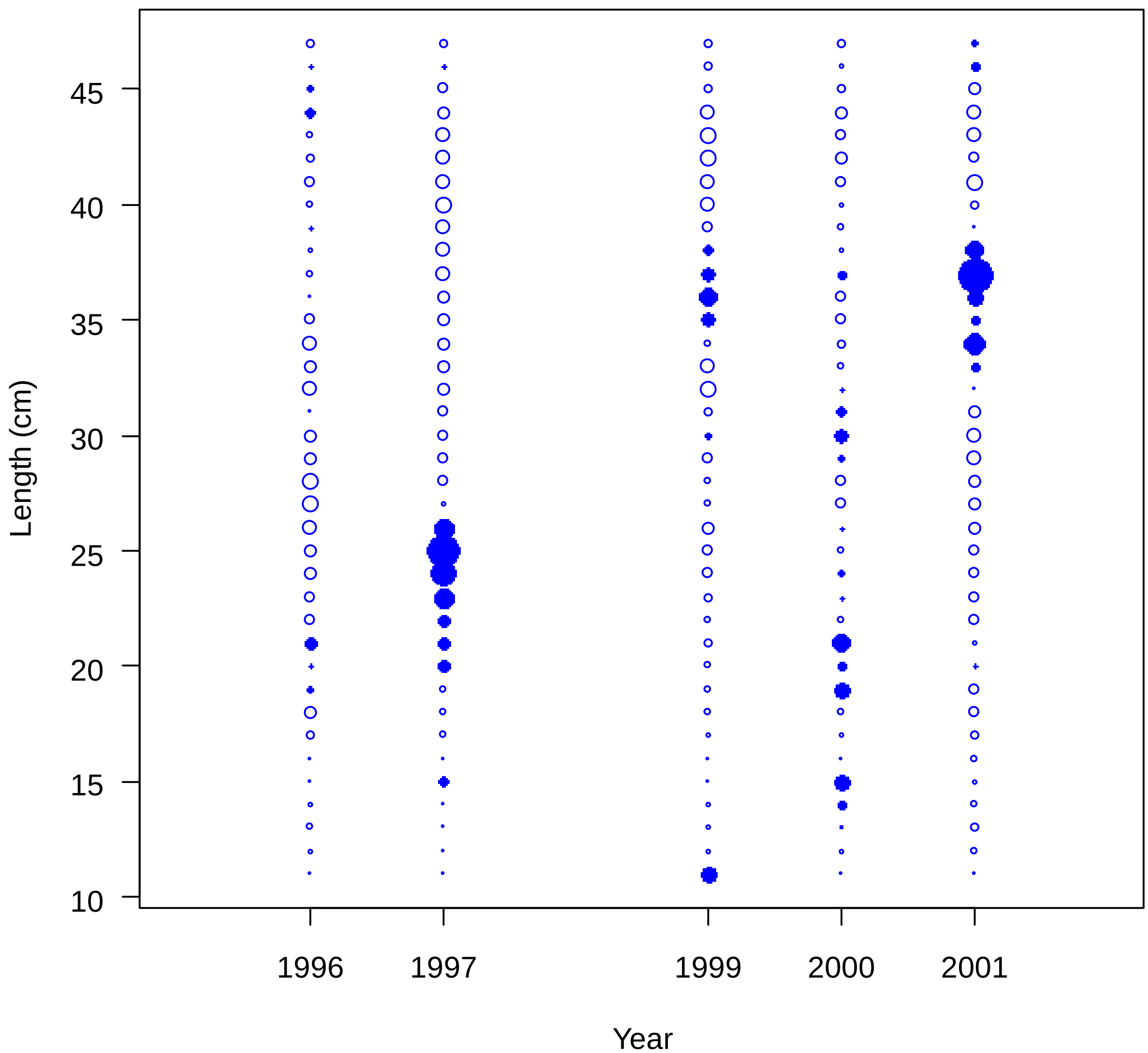

Figure 54: Pearson residuals for female length compositions fits to the AFSC slope Survey data

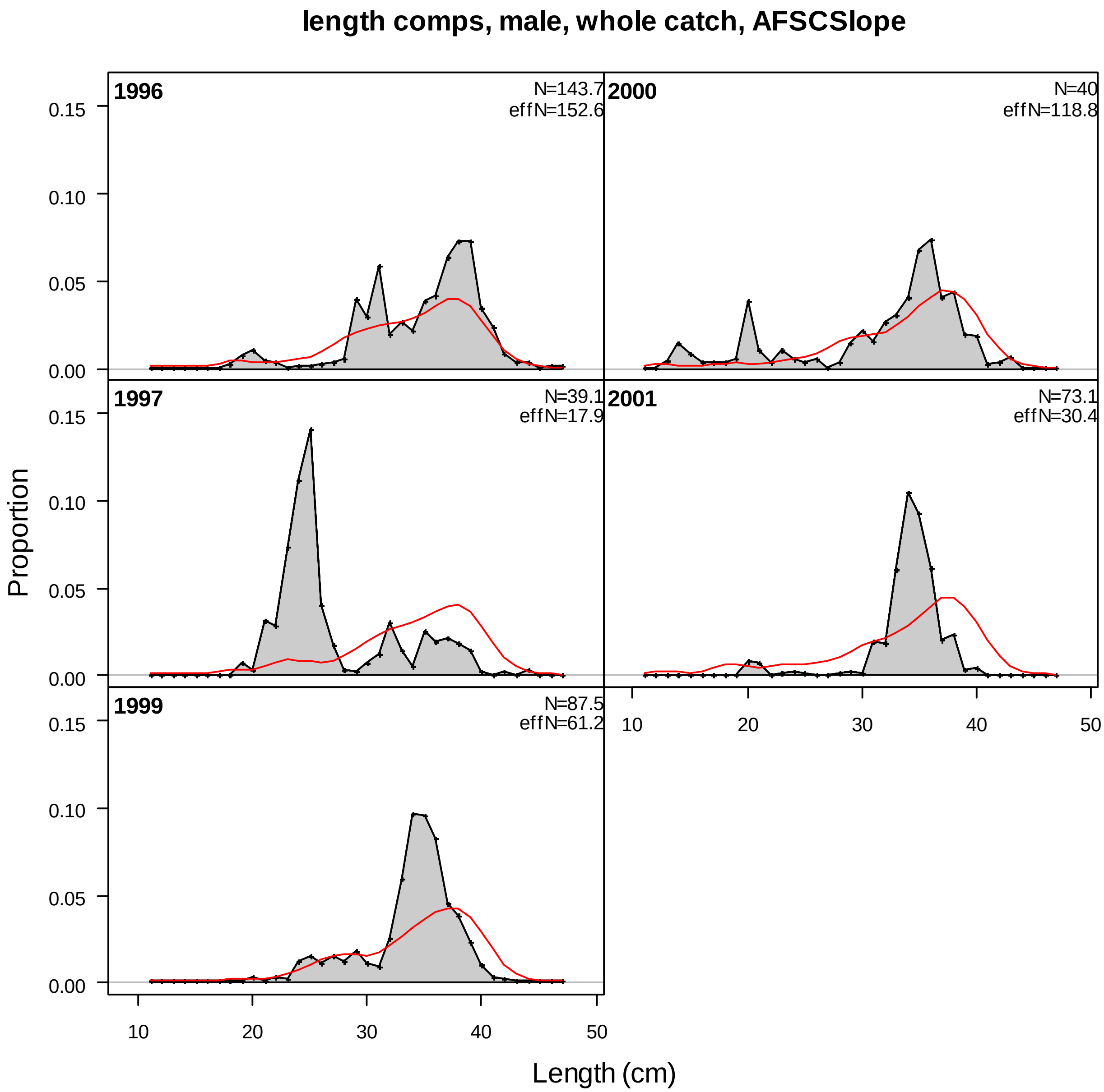

Figure 55: AFSC slope Survey male length compositions and model fits

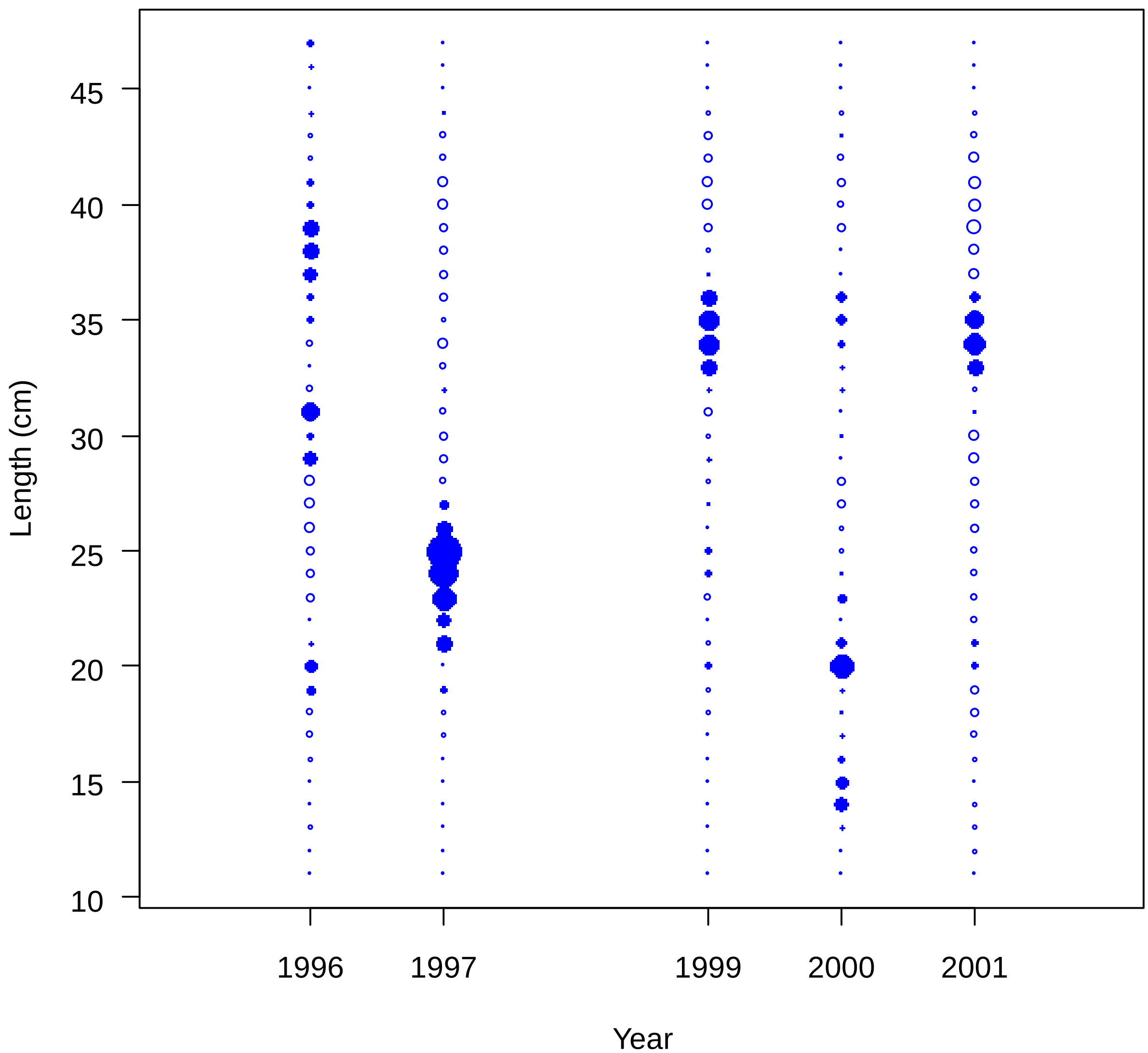

Figure 56: Pearson residuals for male length compositions fits to the AFSC slope Survey data

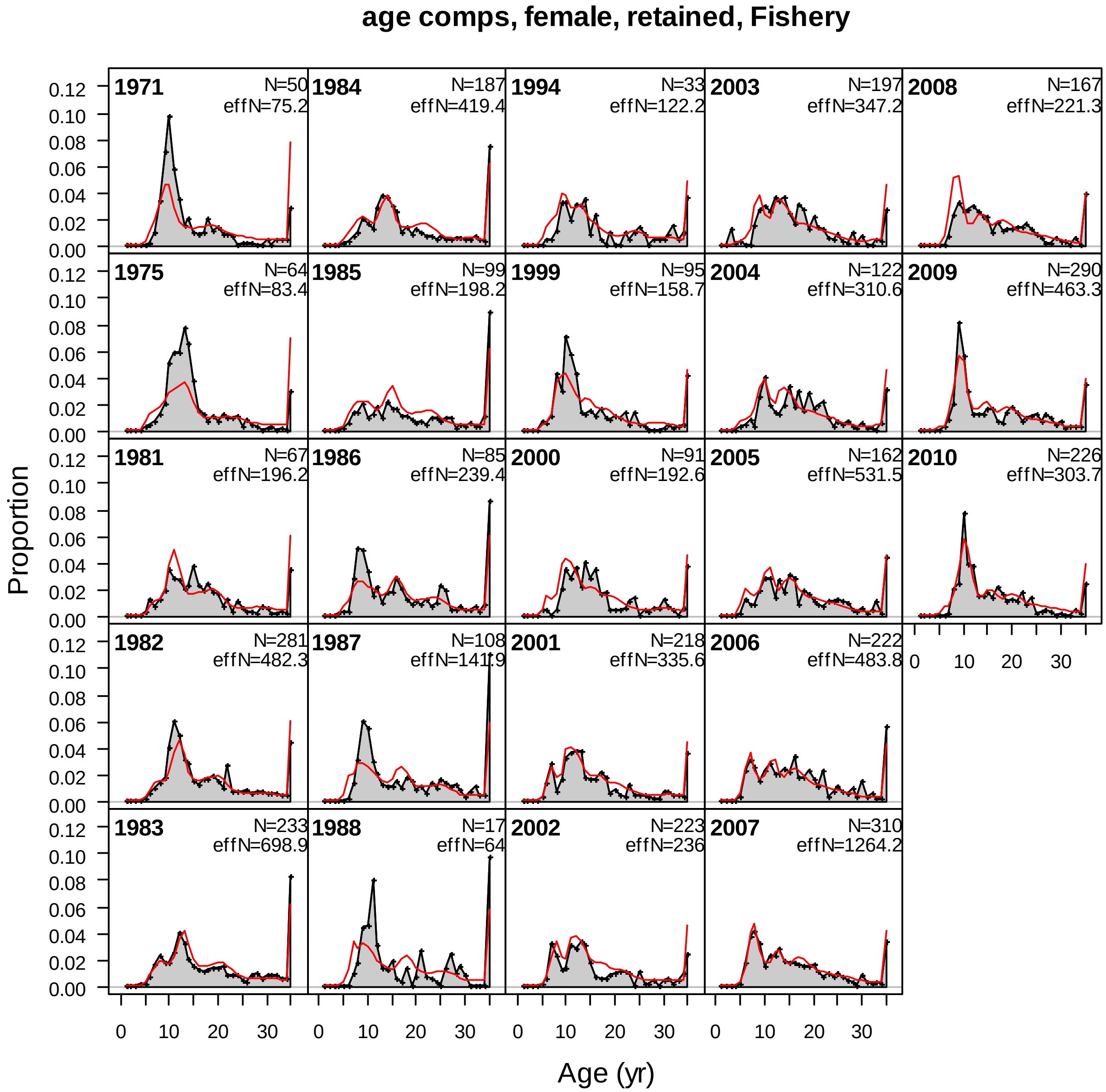

Figure 57: Female fishery age compositions and model fits

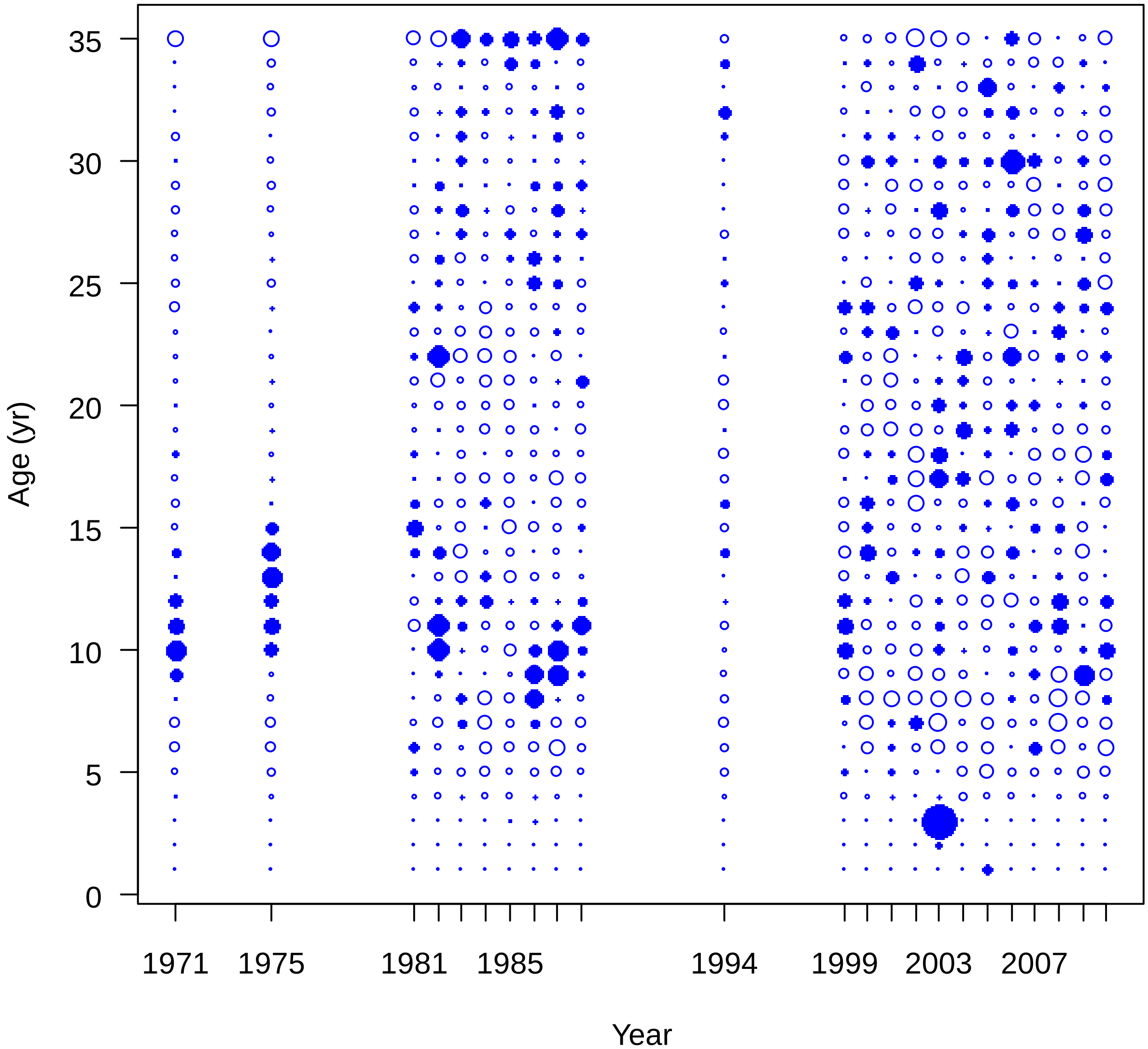

Figure 58: Pearson residuals for female age compositions fits to the fishery data

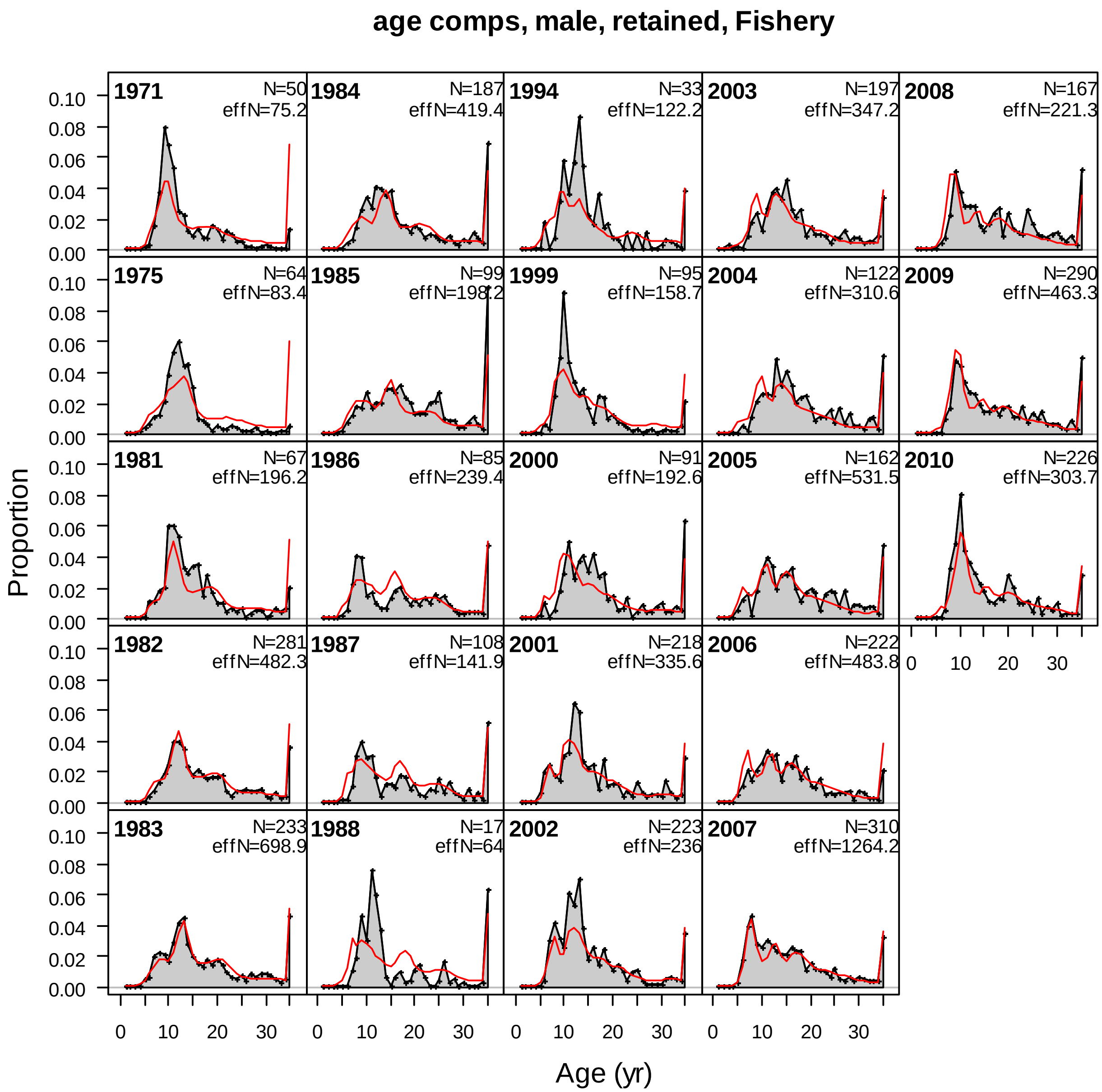

Figure 59: Male fishery age compositions and model fits

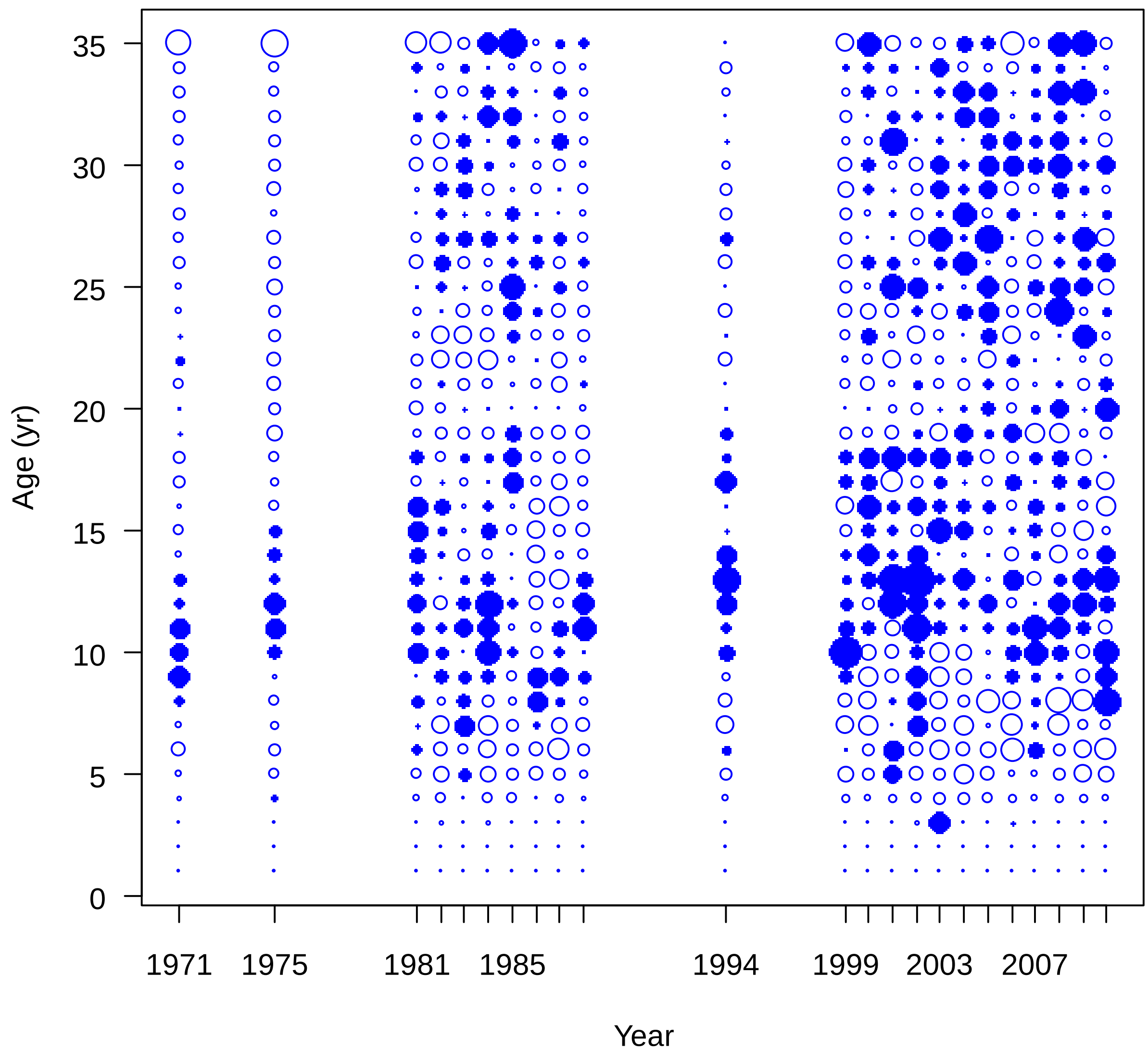

Figure 60: Pearson residuals for male age compositions fits to the fishery data

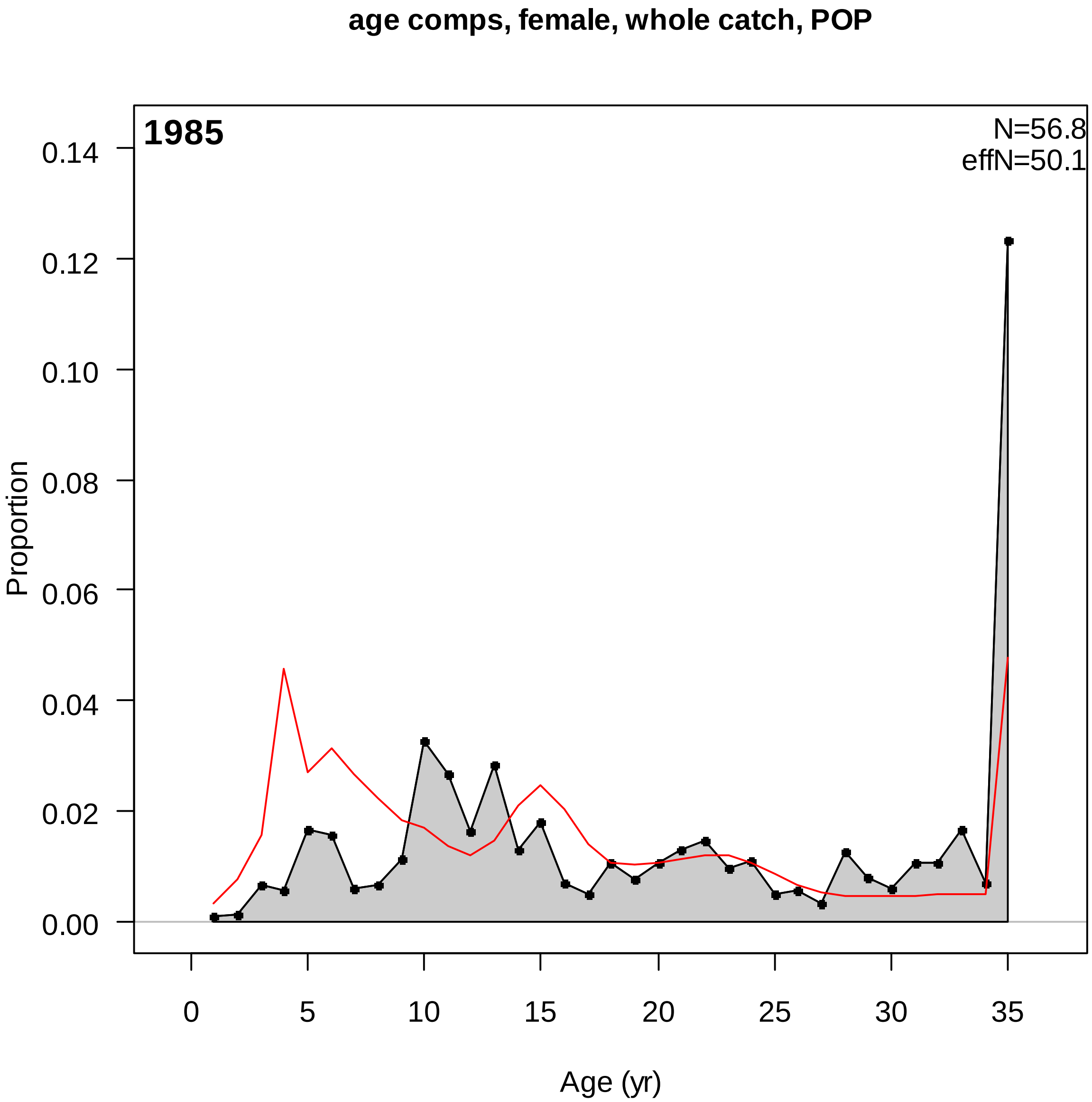

Figure 61 Female POP survey age compositions and model fits

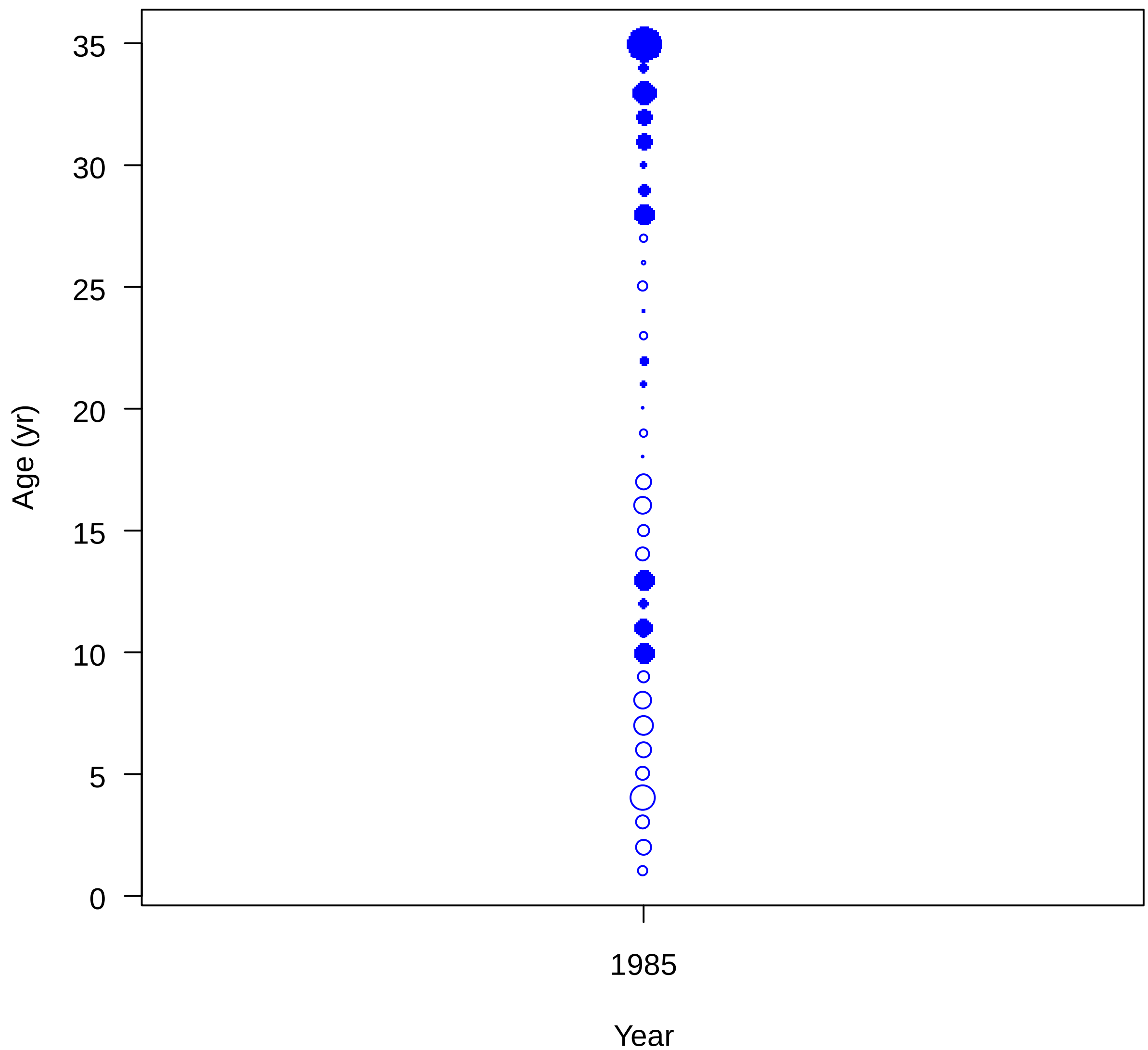

Figure 62: Pearson residuals for female age compositions fits to the POP survey data

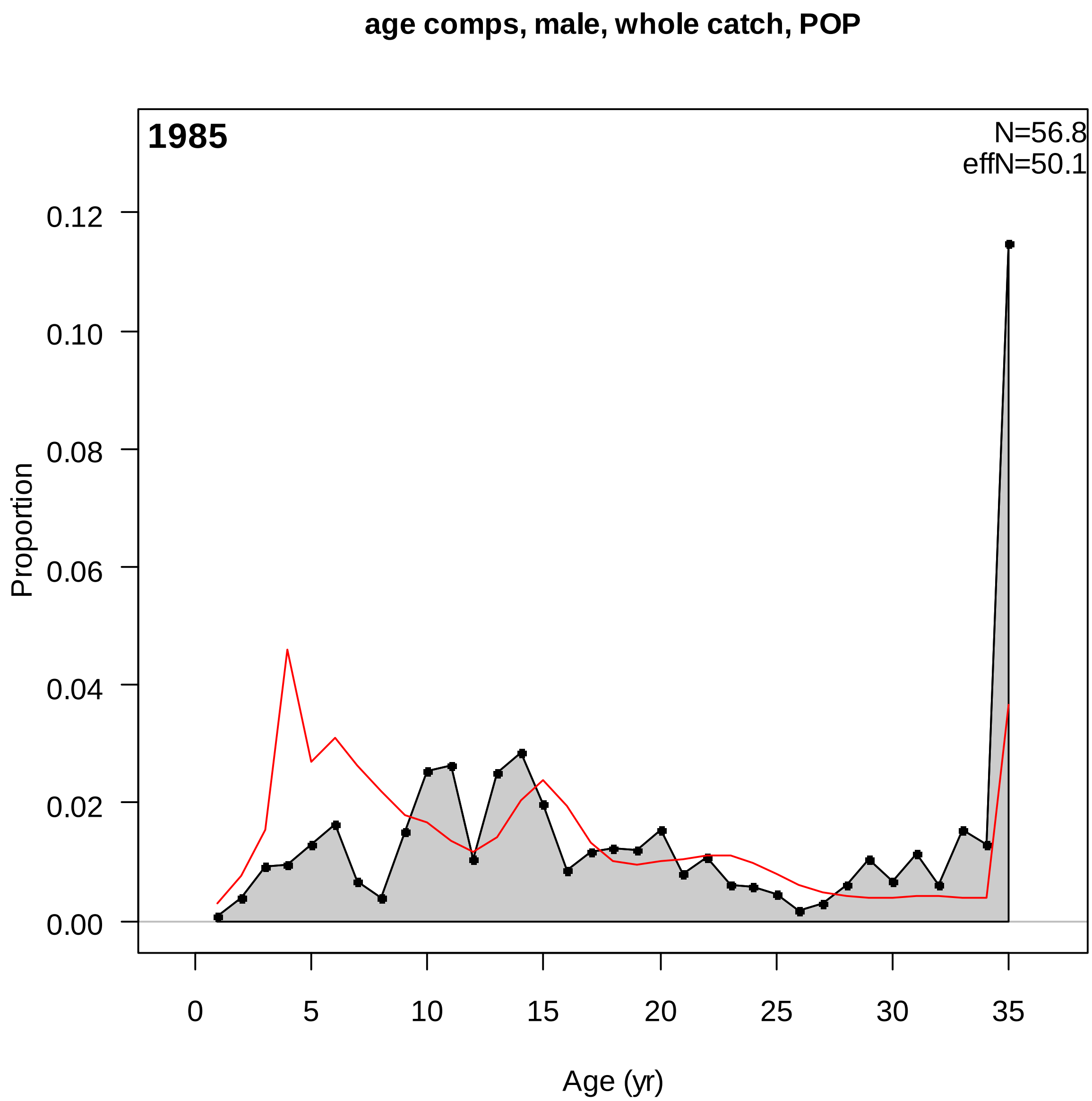

Figure 63: Male POP survey age compositions and model fits

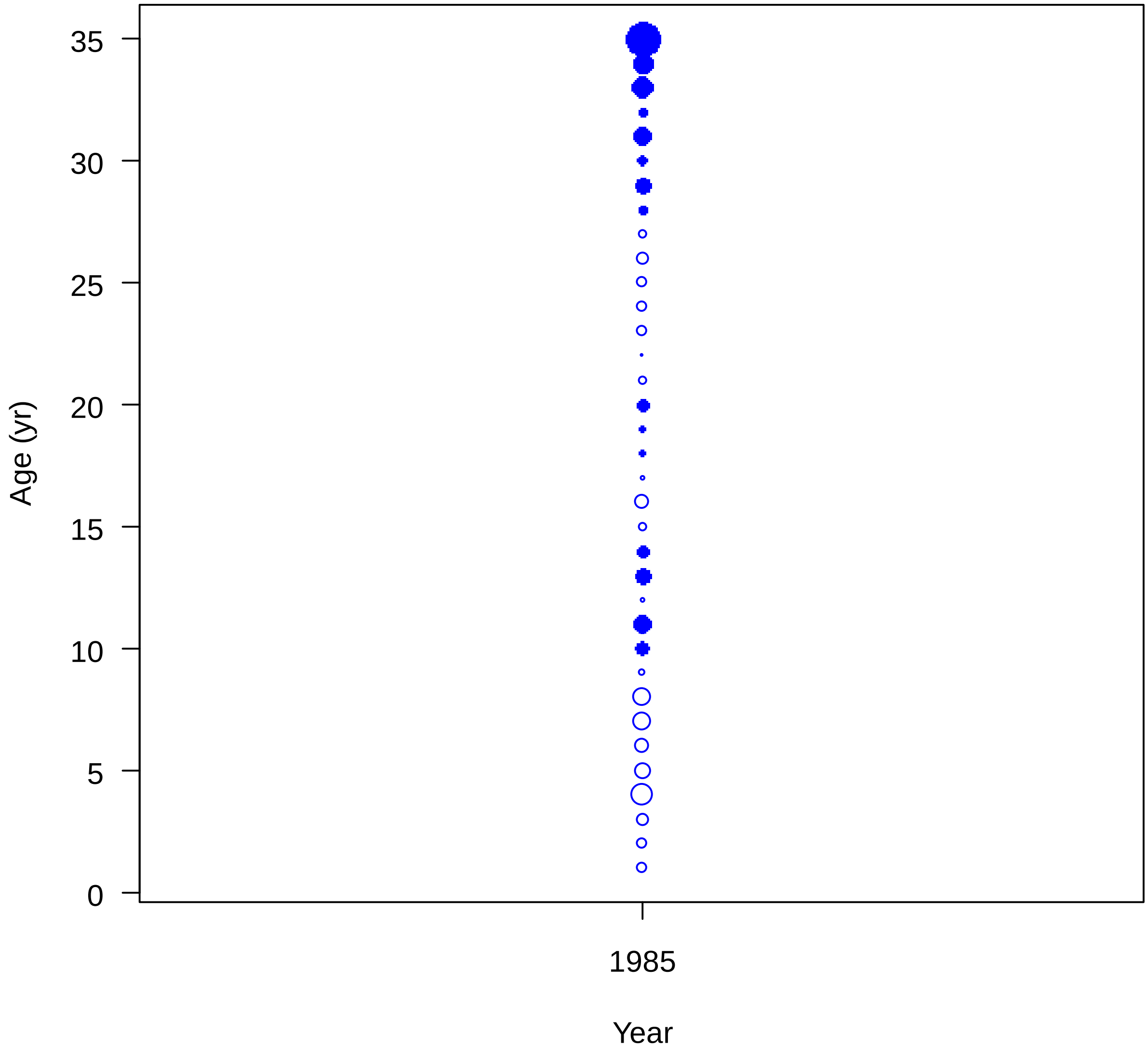

Figure 64: Pearson residuals for male age compositions fits to the POP survey data

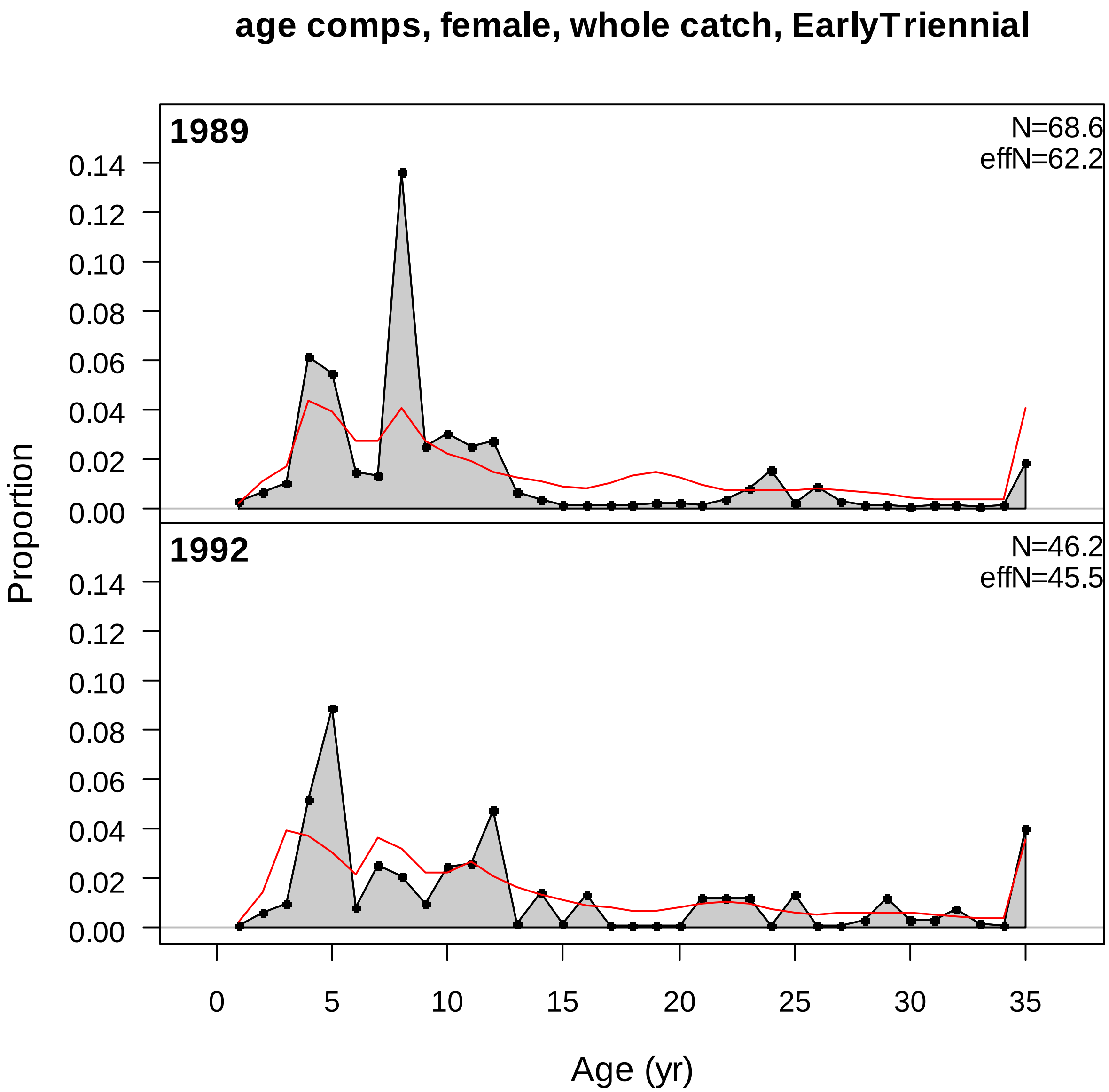

Figure 65: Female early triennial survey age compositions and model fits

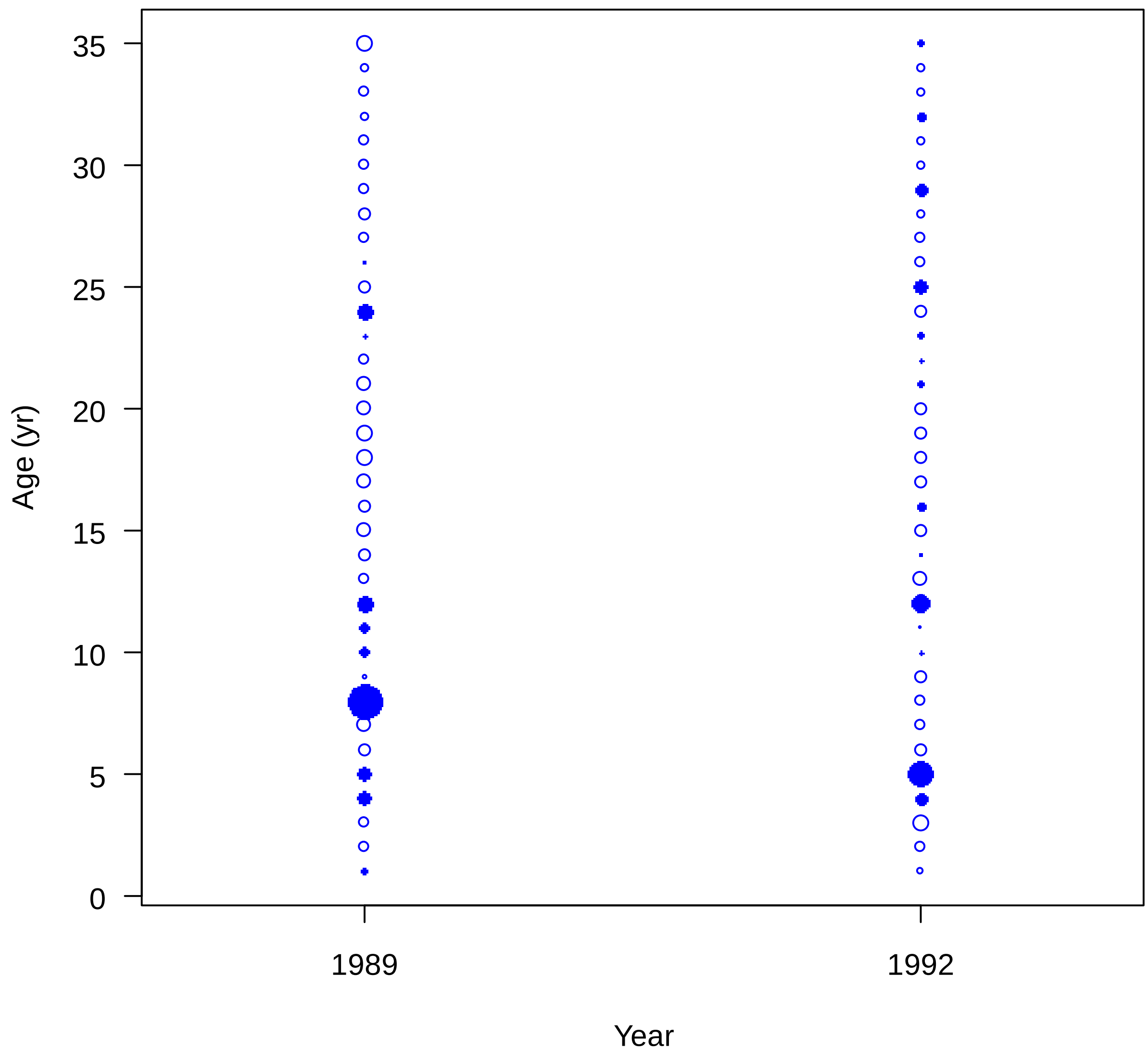

Figure 66: Pearson residuals for female age compositions fits to the early triennial survey data

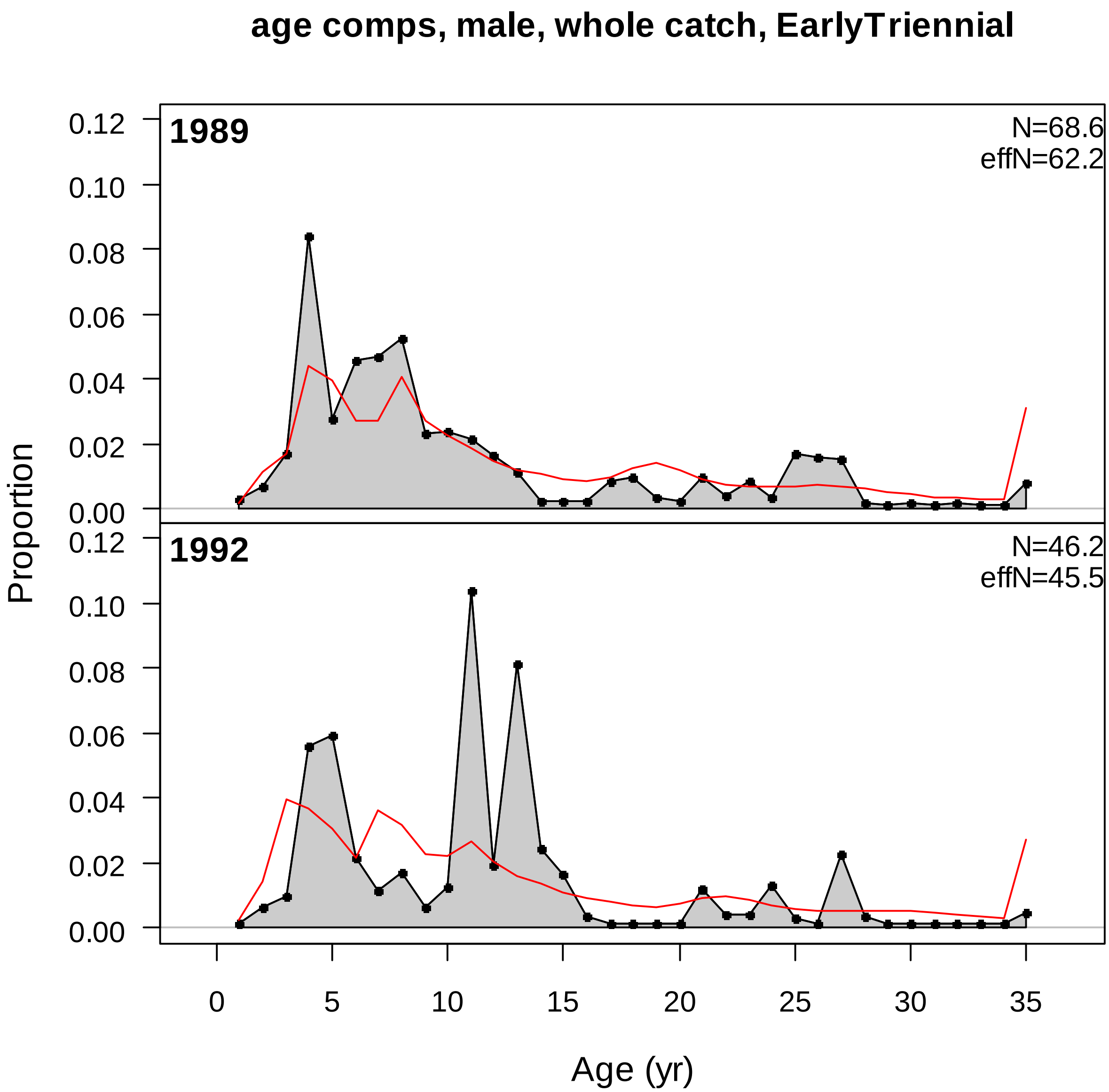

Figure 67: Male early triennial survey age compositions and model fits

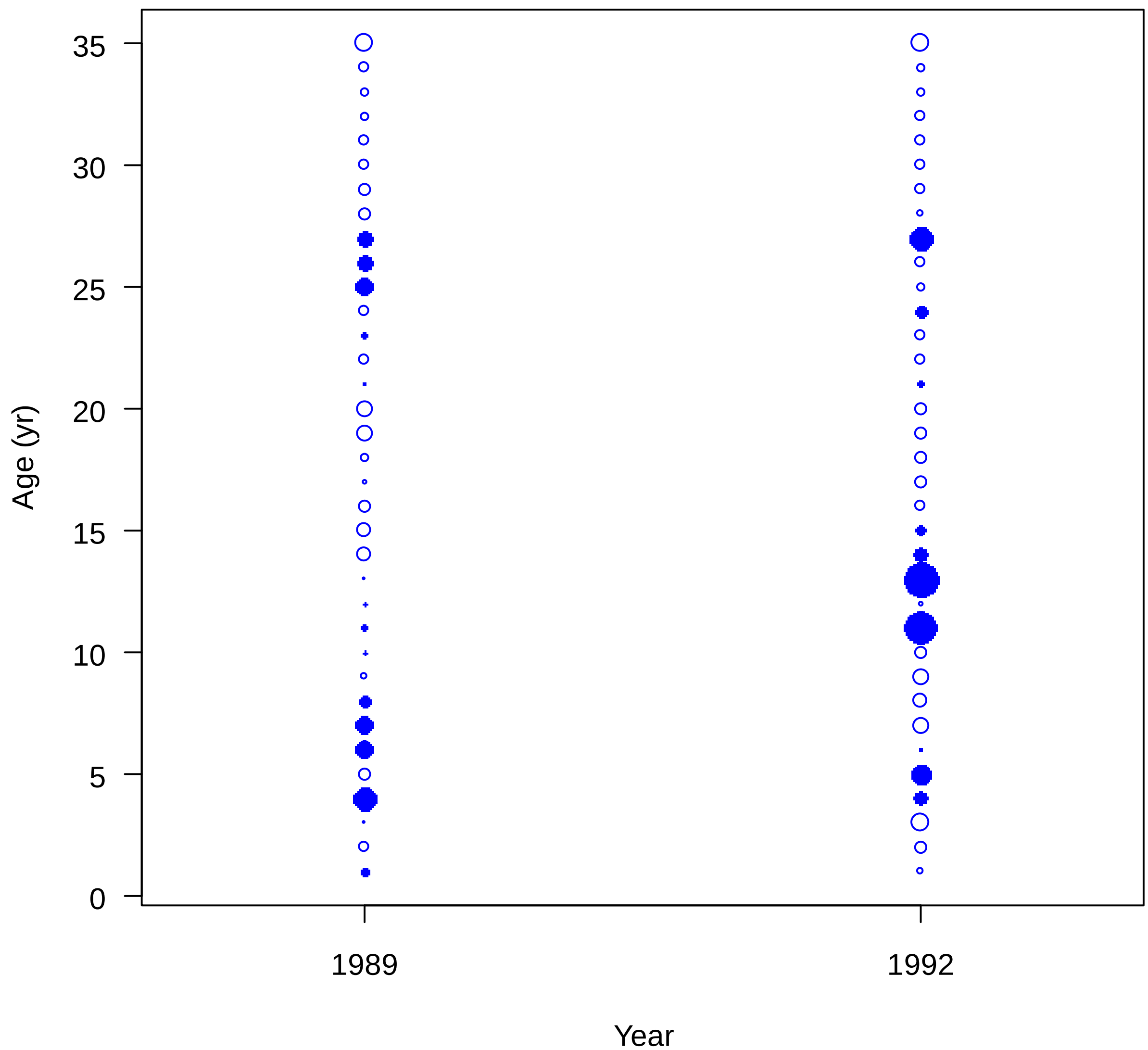

Figure 68: Pearson residuals for male age compositions fits to the early triennial survey data

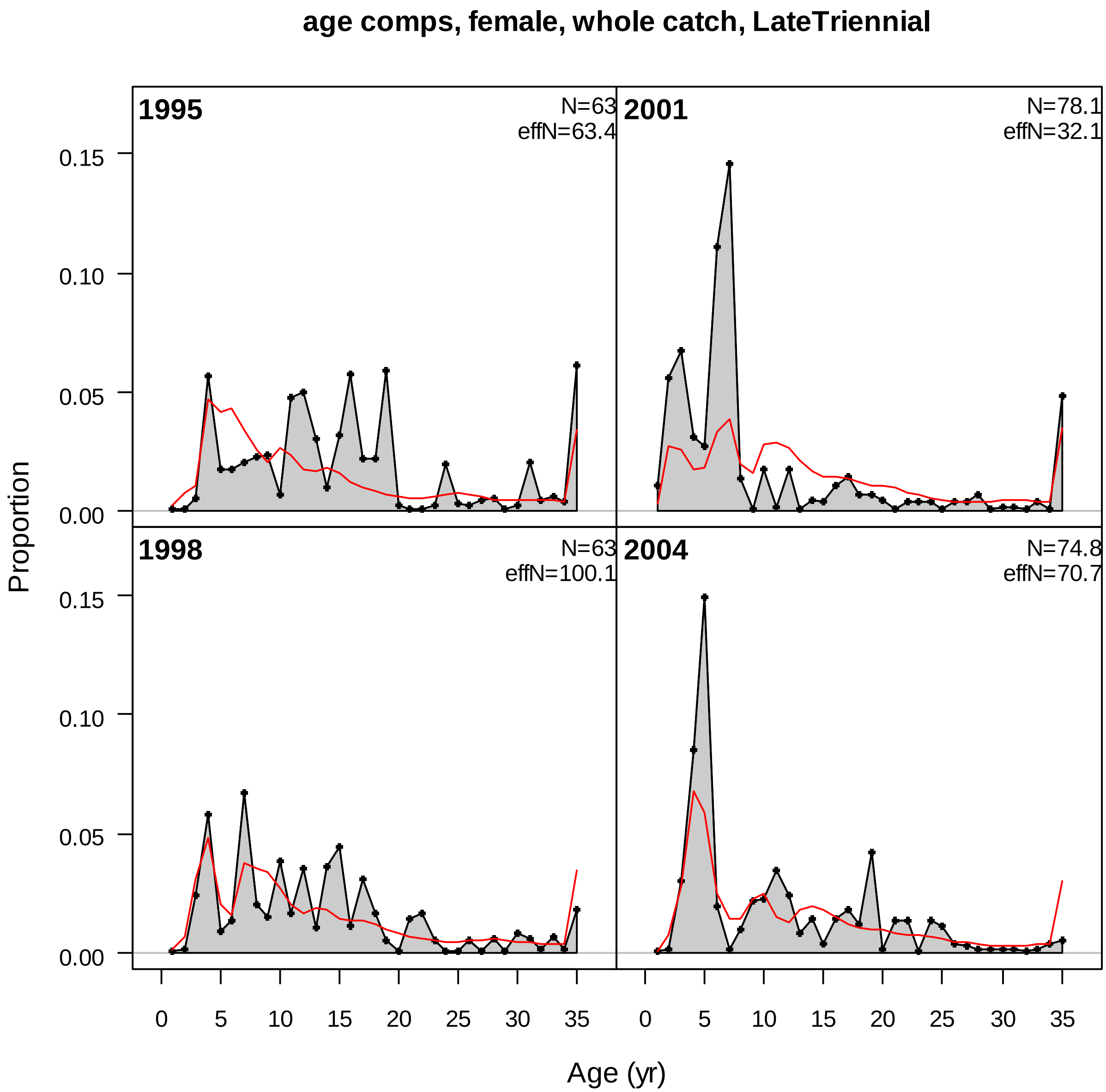

Figure 69: Female late triennial survey age compositions and model fits

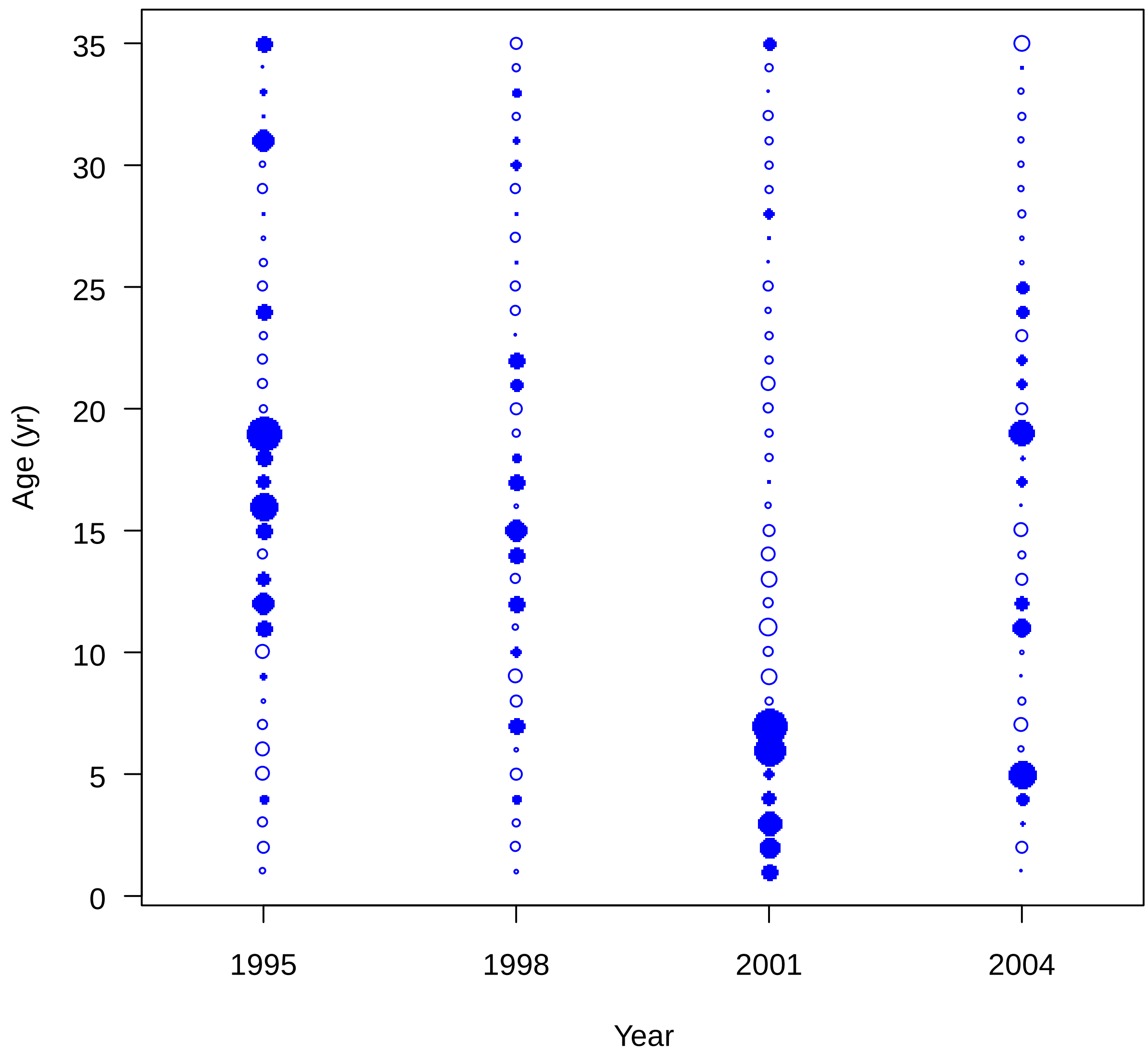

Figure 70: Pearson residuals for female age compositions fits to the late triennial survey data

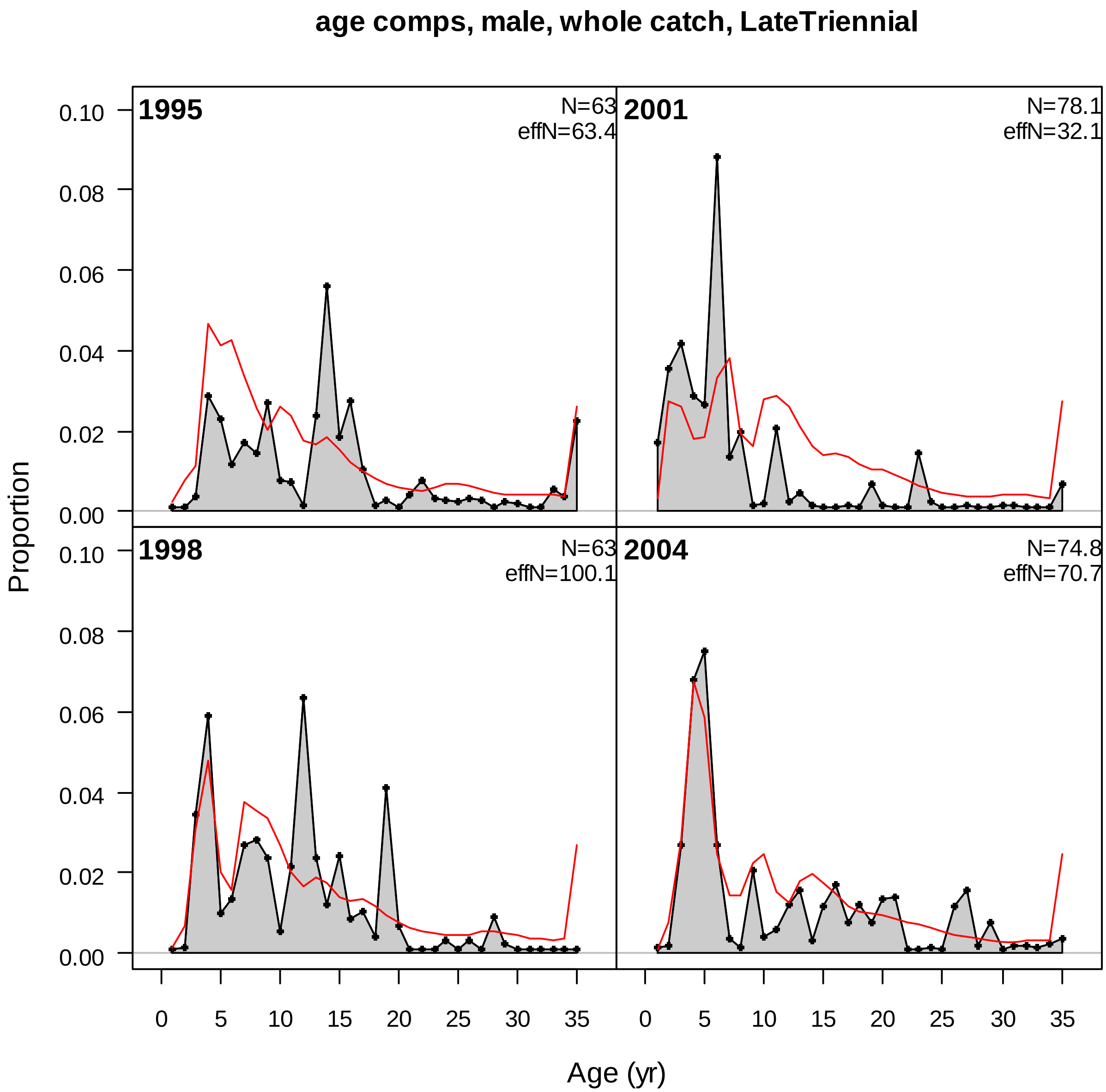

Figure 71: Male late triennial survey age compositions and model fits

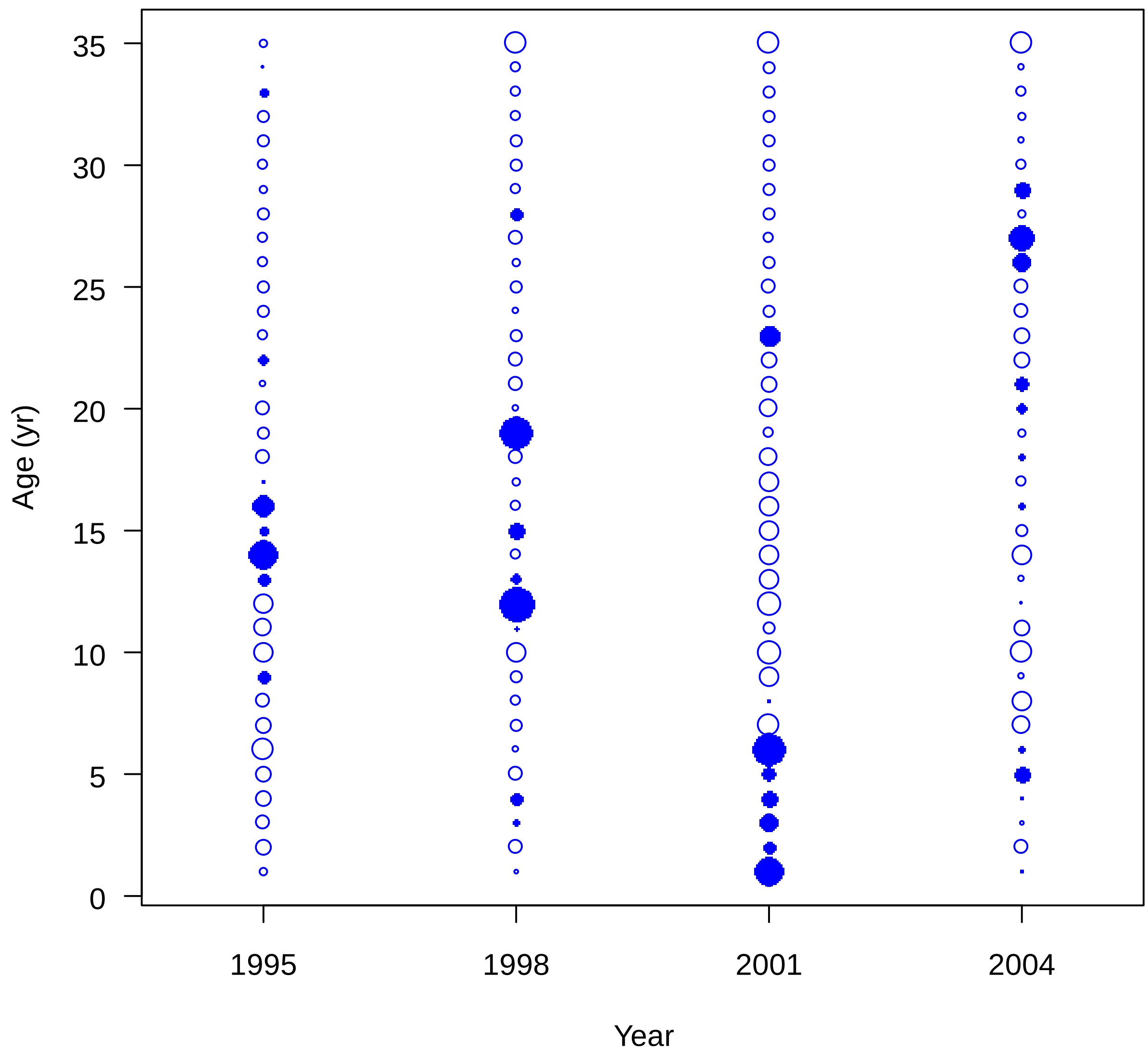

Figure 72: Pearson residuals for male age compositions fits to the late triennial survey data

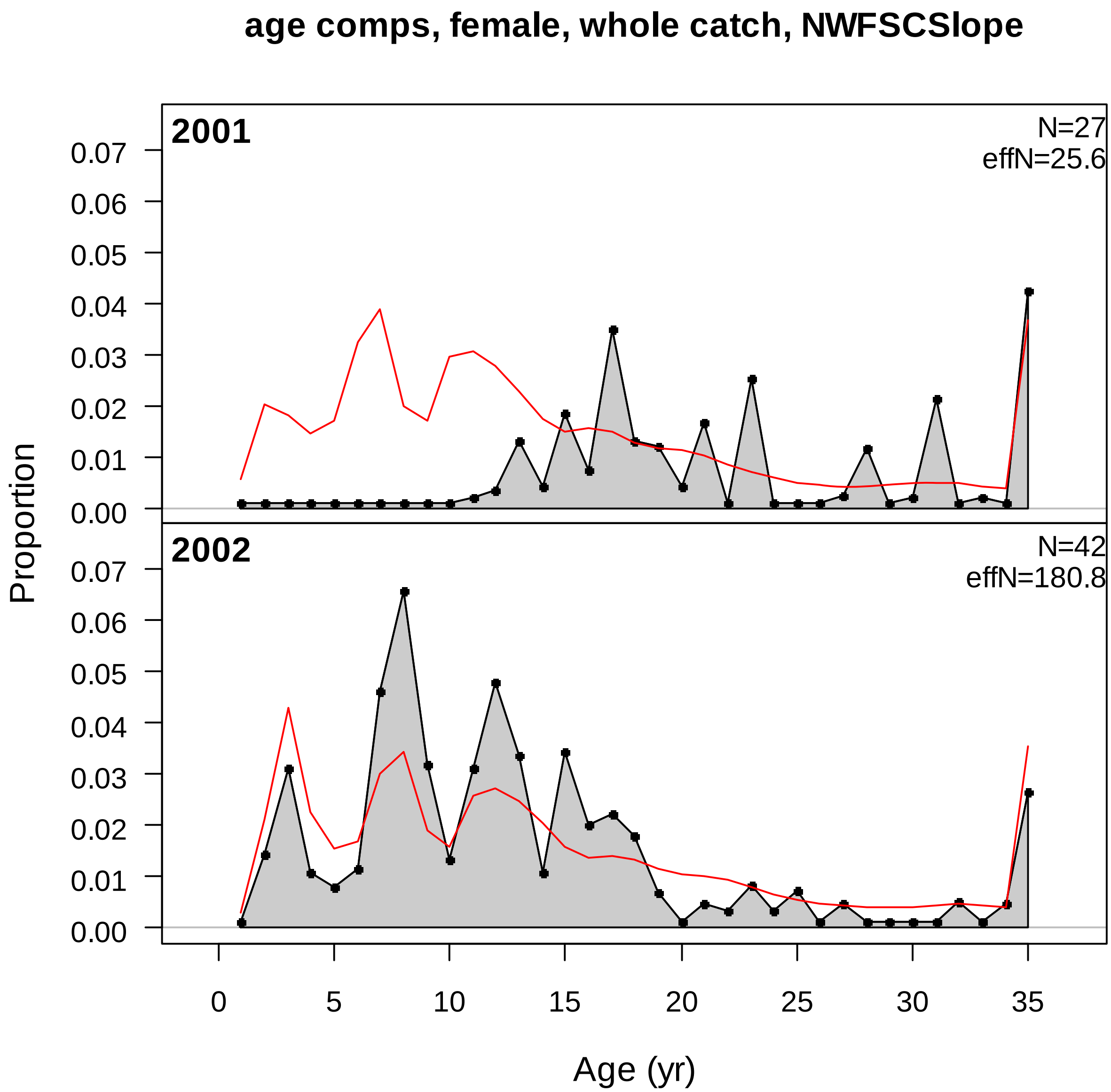

Figure 73: Female NWFSC slope survey age compositions and model fits

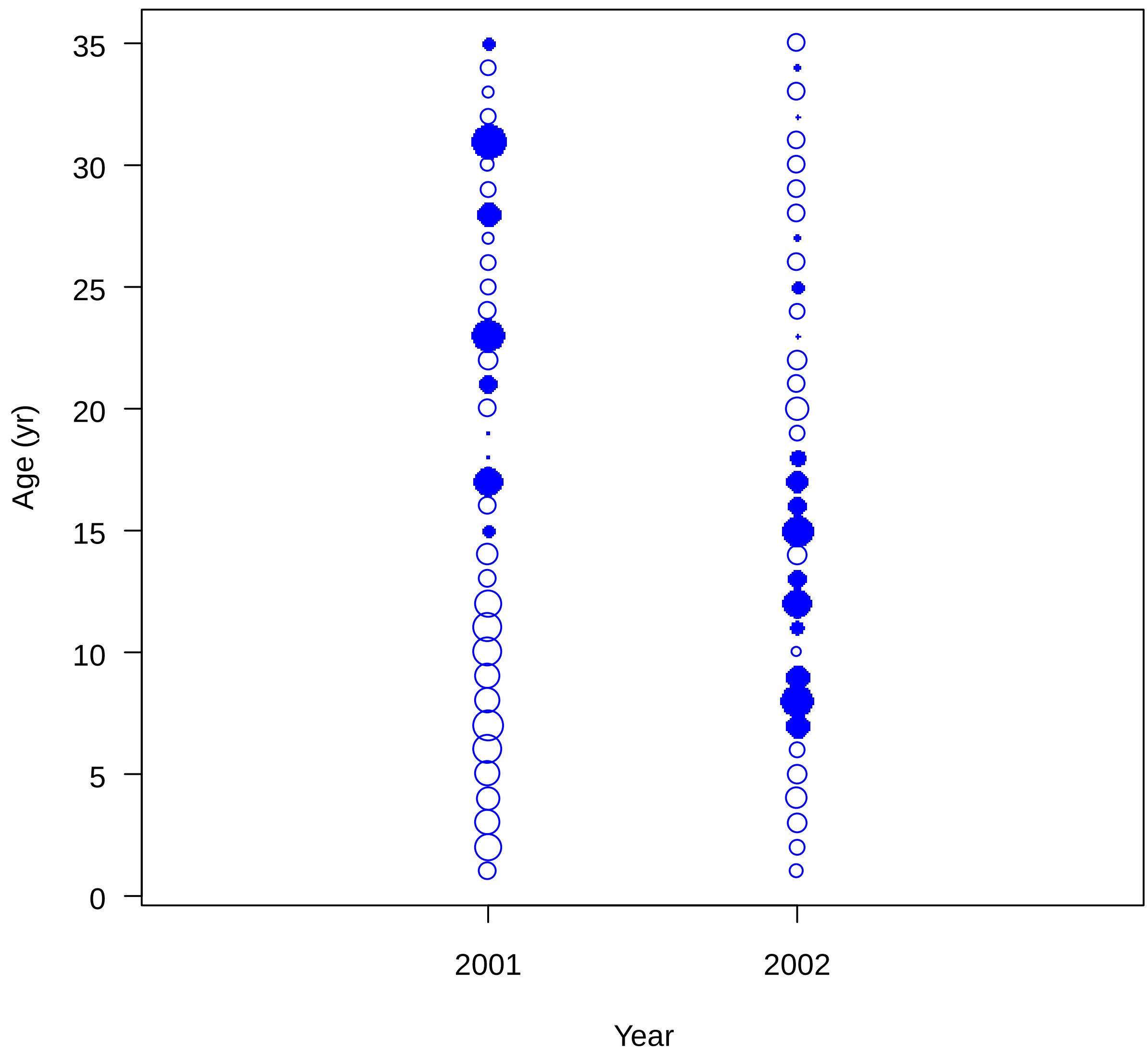

Figure 74: Pearson residuals for female age compositions fits to the NWFSC slope survey data

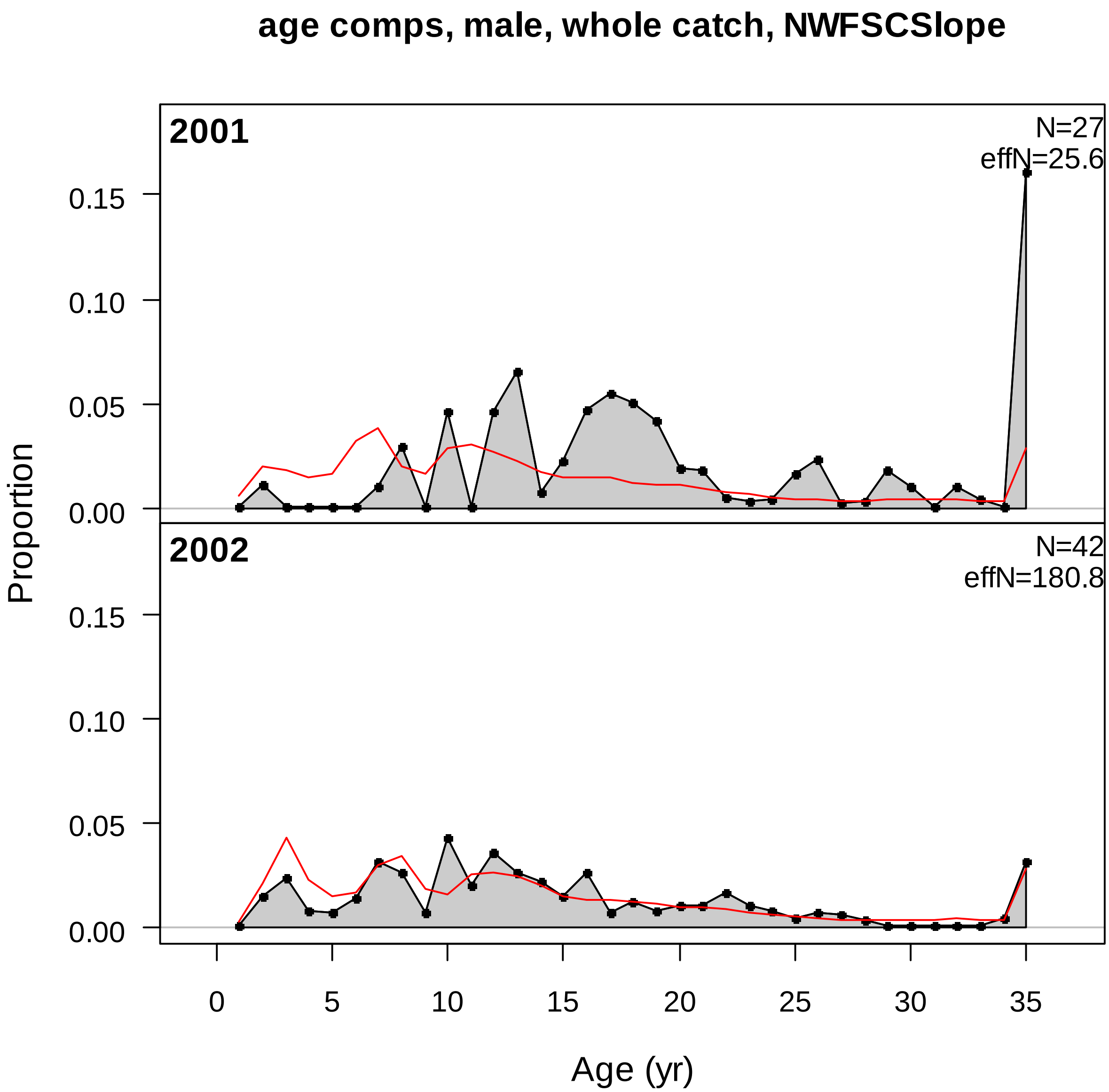

Figure 75: Male NWFSC slope survey age compositions and model fits

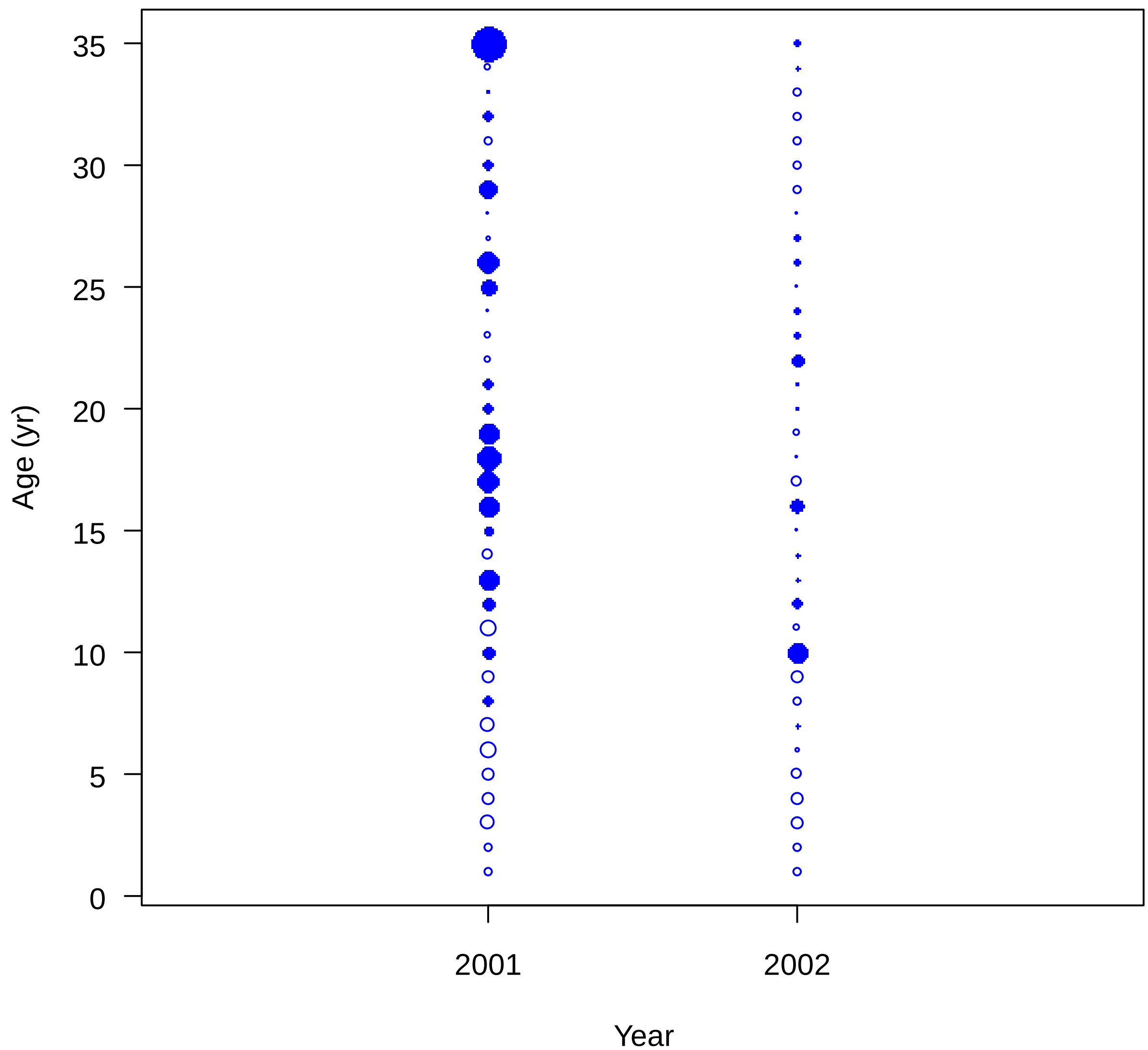

Figure 76: Pearson residuals for male age compositions fits to the NWFSC slope survey data

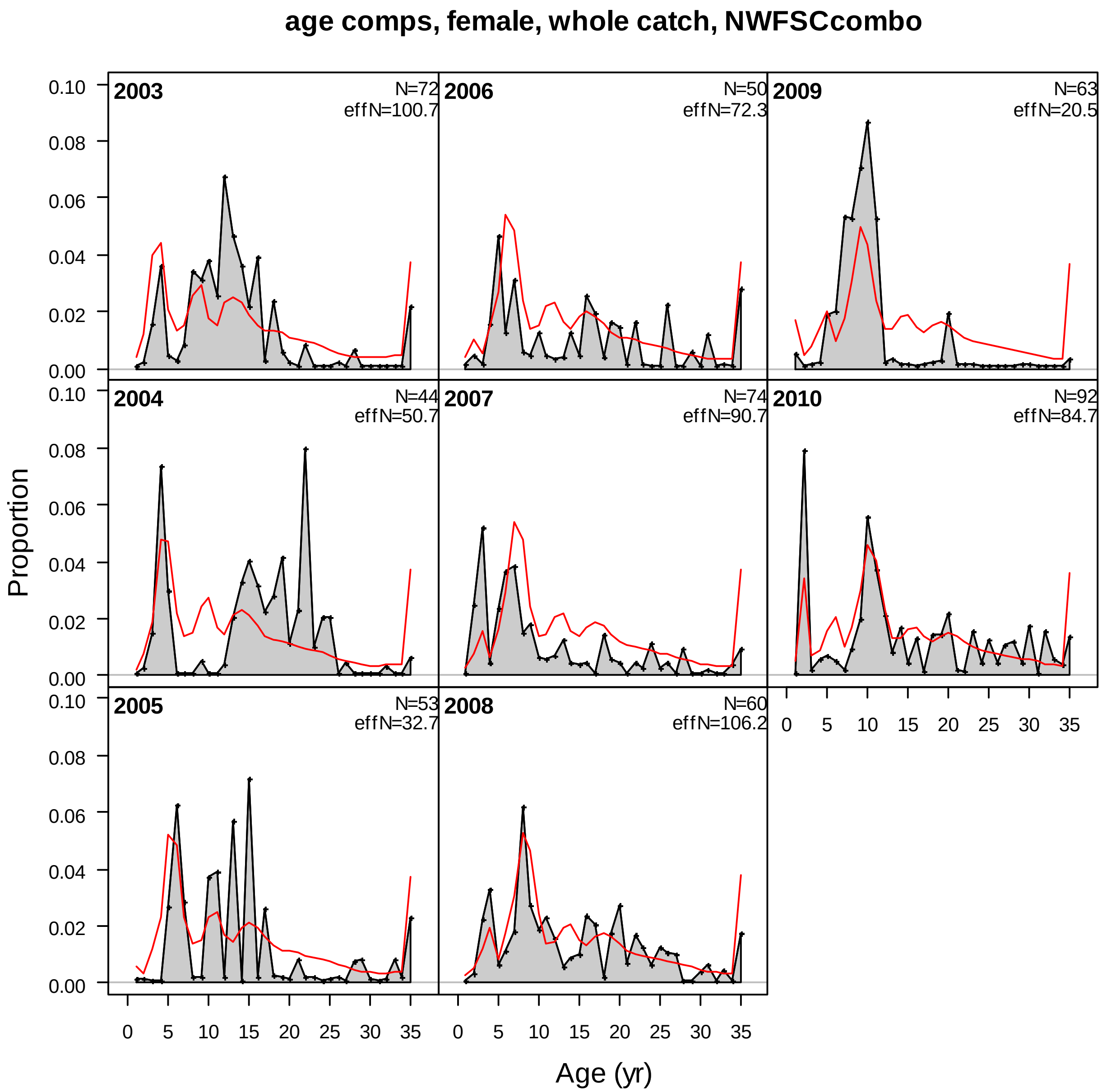

Figure 77: Female NWFSC shelf/slope survey age compositions and model fits

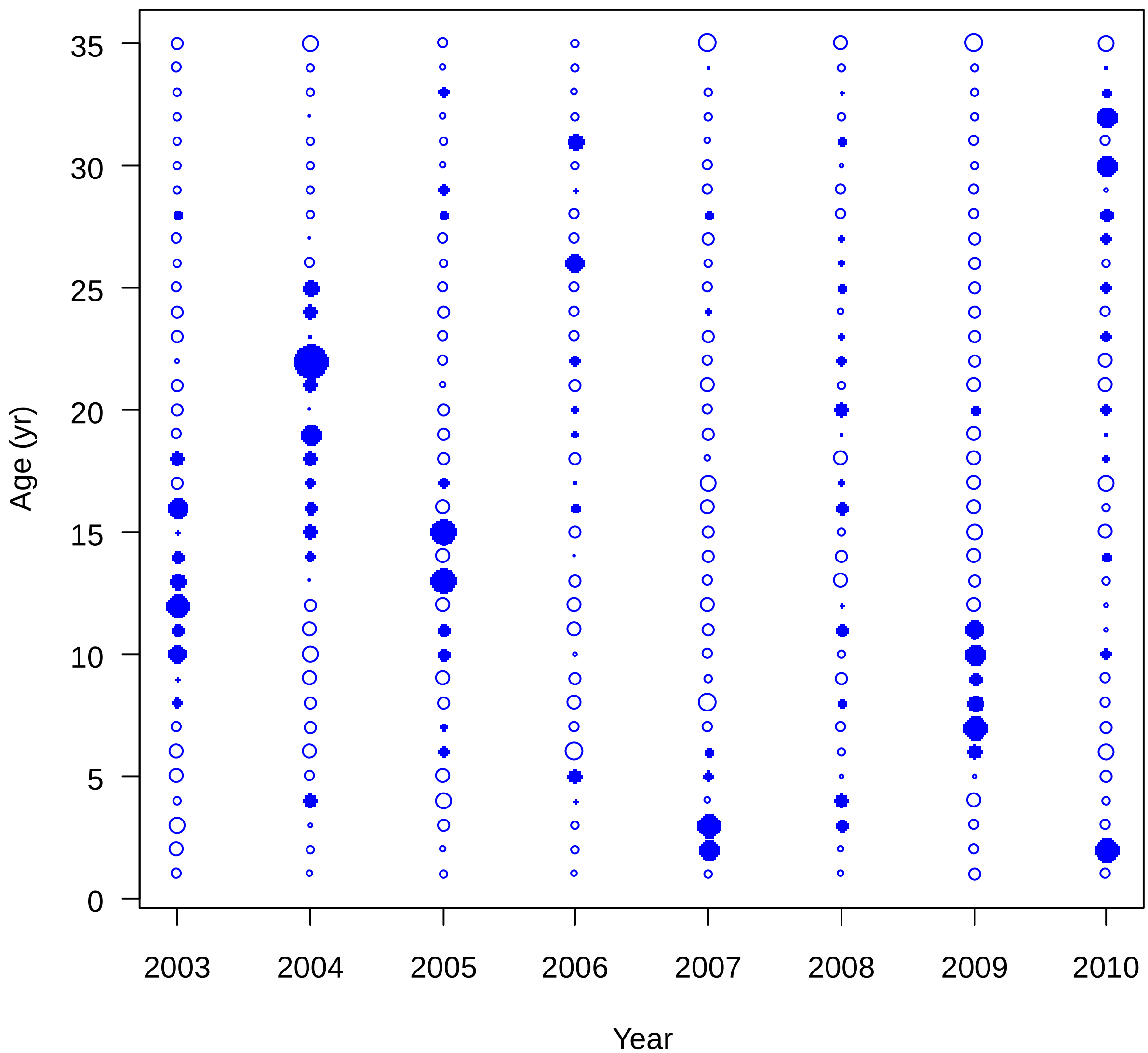

Figure 78: Pearson residuals for female age compositions fits to the NWFSC shelf/slope survey data

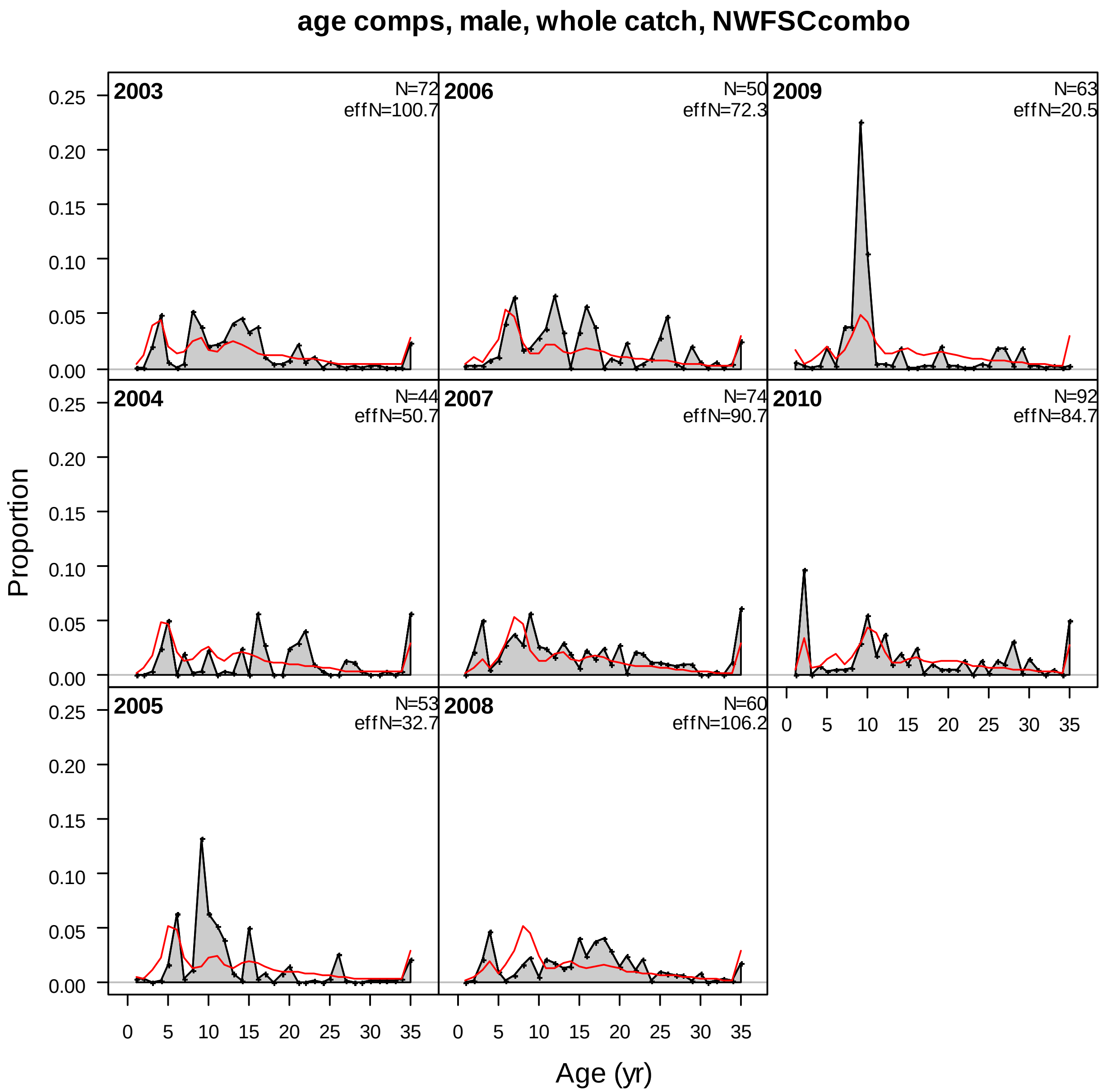

Figure 79: Male NWFSC shelf/slope survey age compositions and model fits

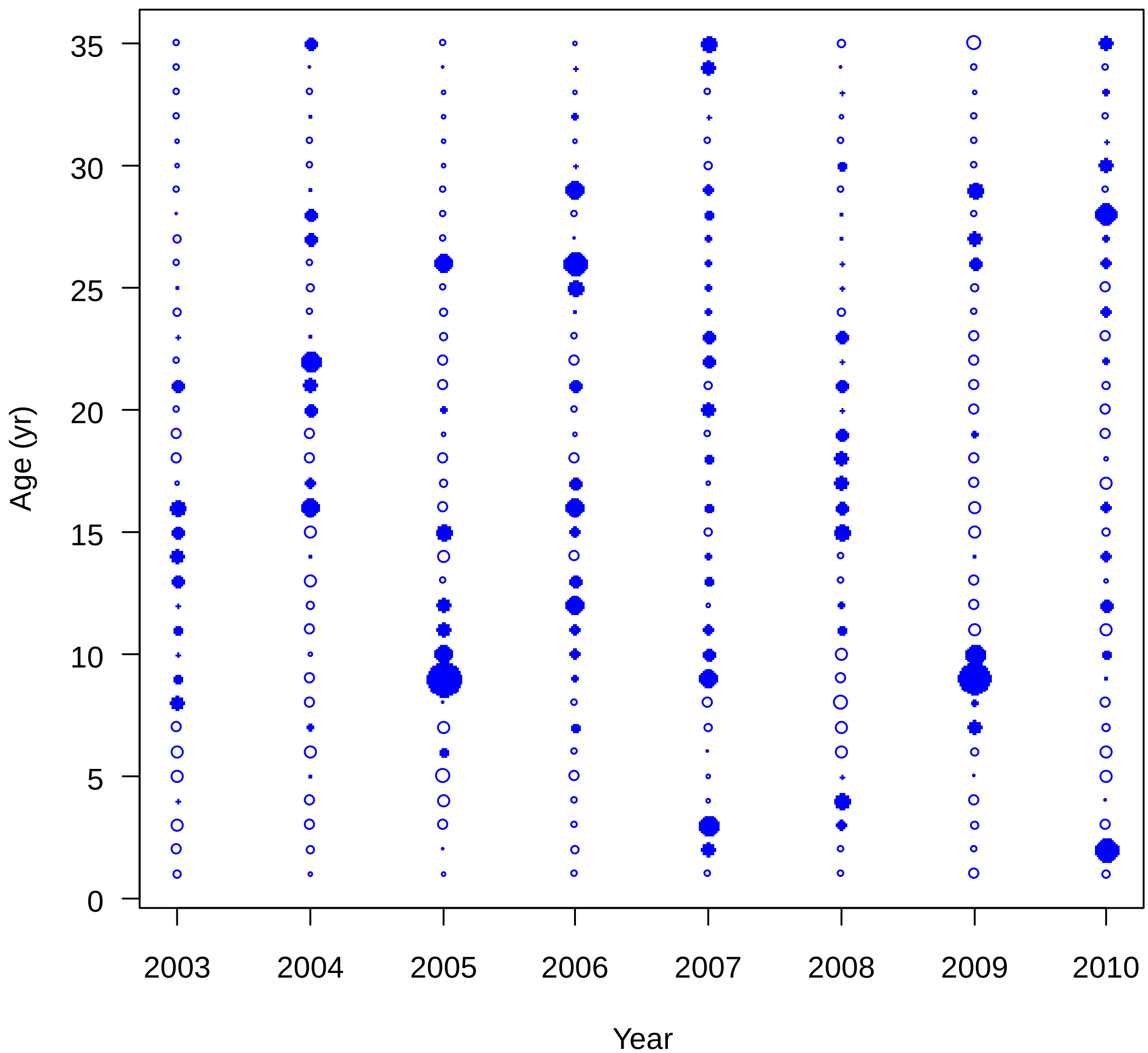

Figure 80: Pearson residuals for male age compositions fits to the NWFSC shelf/slope survey data

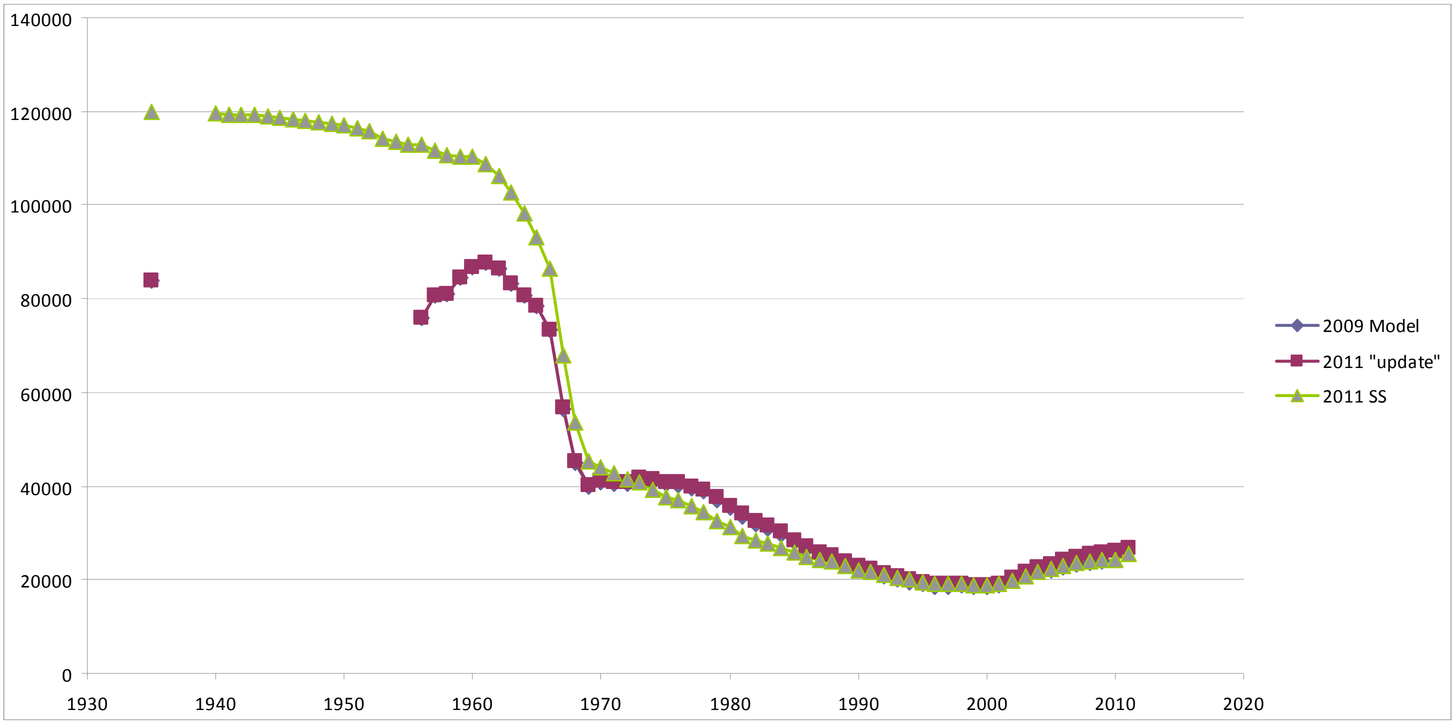

Figure 81. Comparison of Summary (3+) Biomass (mt) trajectories for the 2009 assessment, the 2011 “update” model, and the Base 2011 SS model (this assessment).

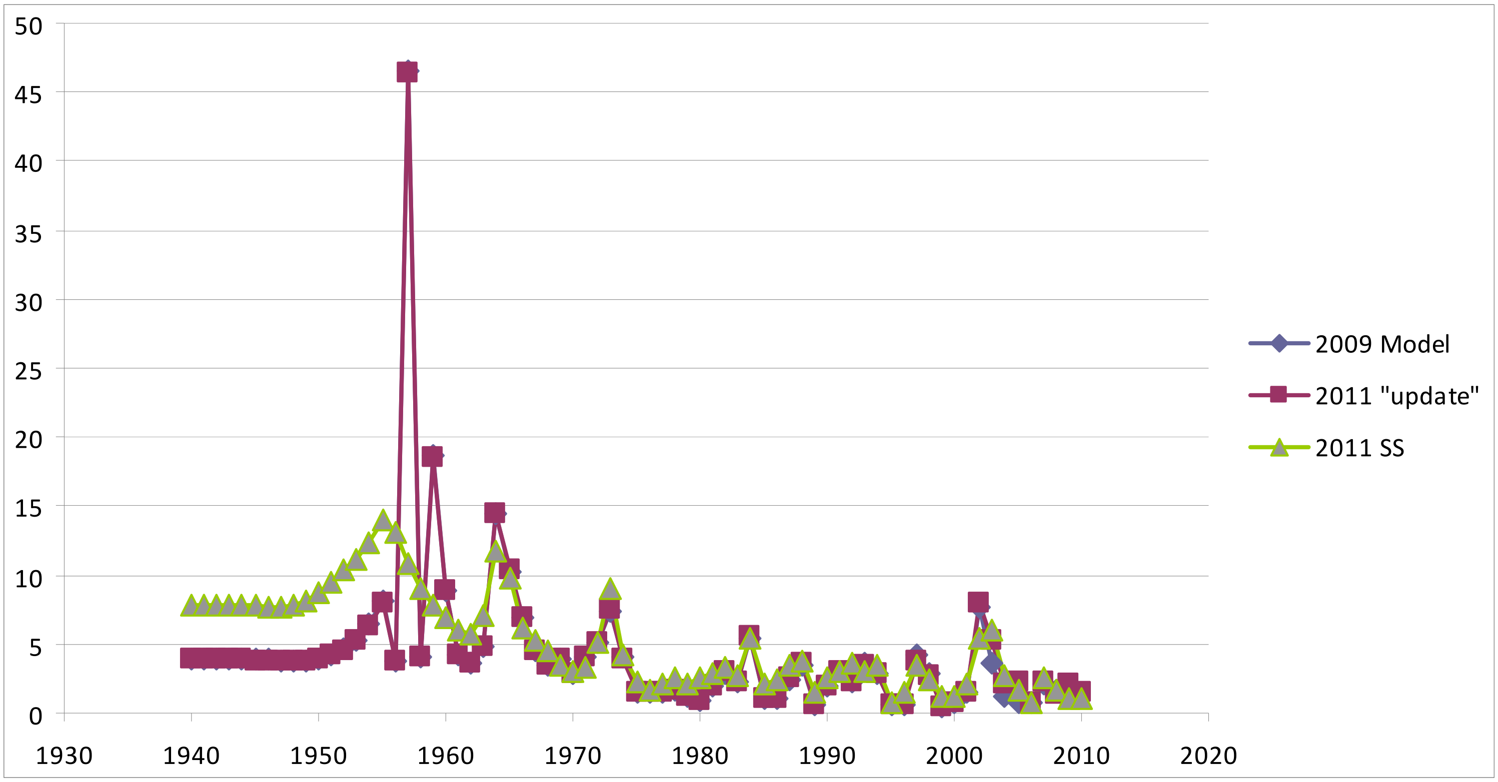

Figure 82. Comparison of recruitment at age 3 (millions) time series for the 2009 assessment, the 2011 “update” model, and the Base 2011 SS model (this assessment).

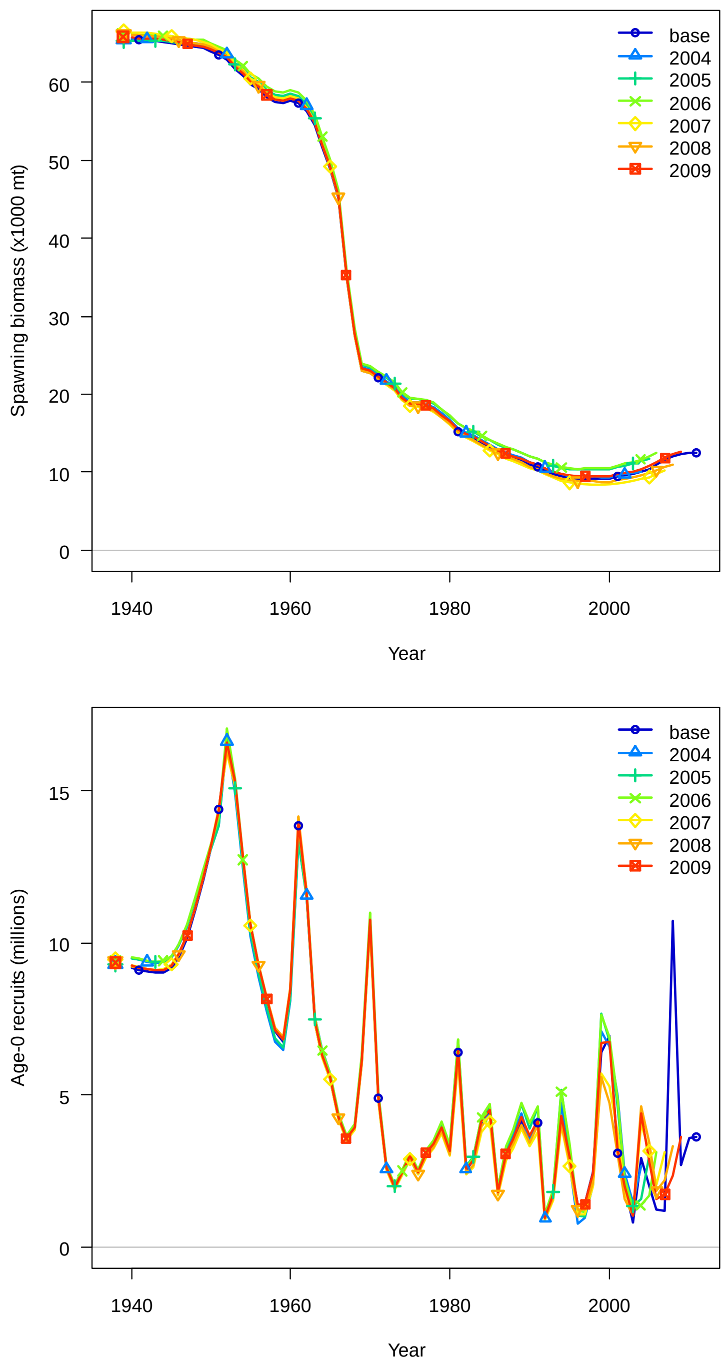

Figure 83: Results of the retrospective analysis

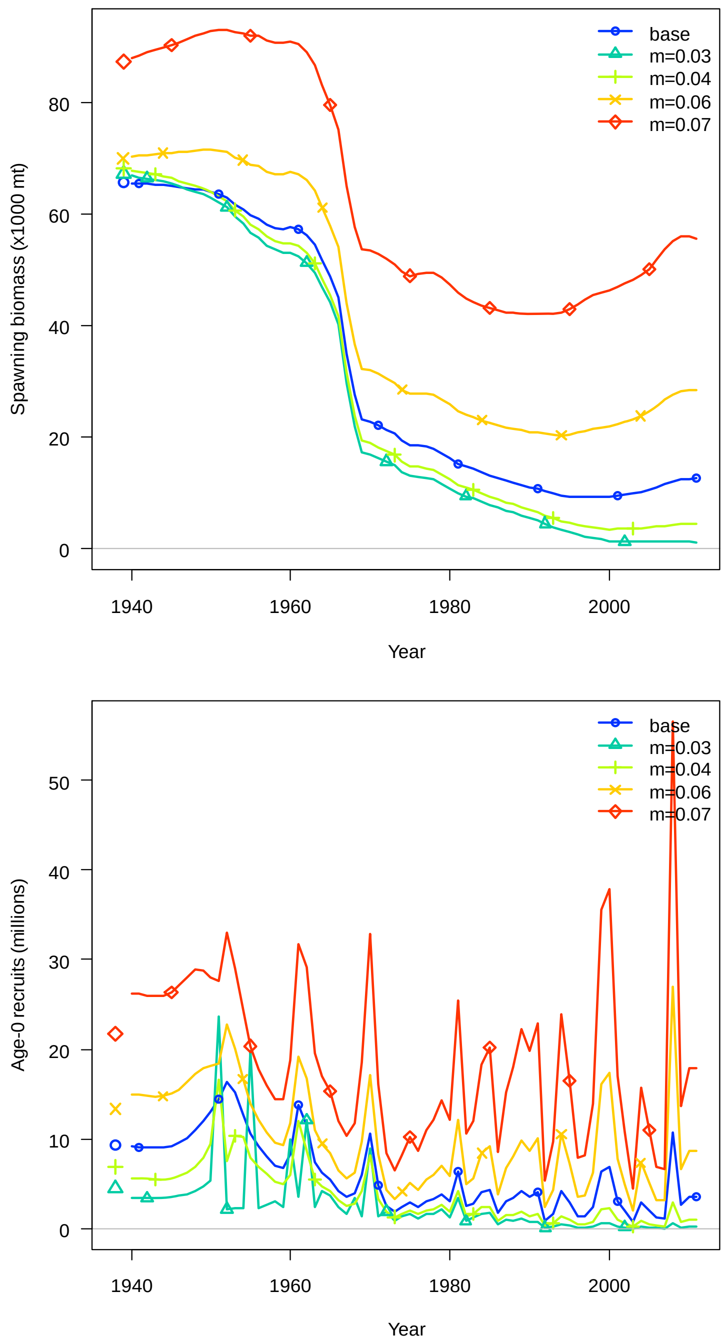

Figure 84: Results of the sensitivity analysis to the treatment of natural mortality when keeping the steepness value fixed at 0.4

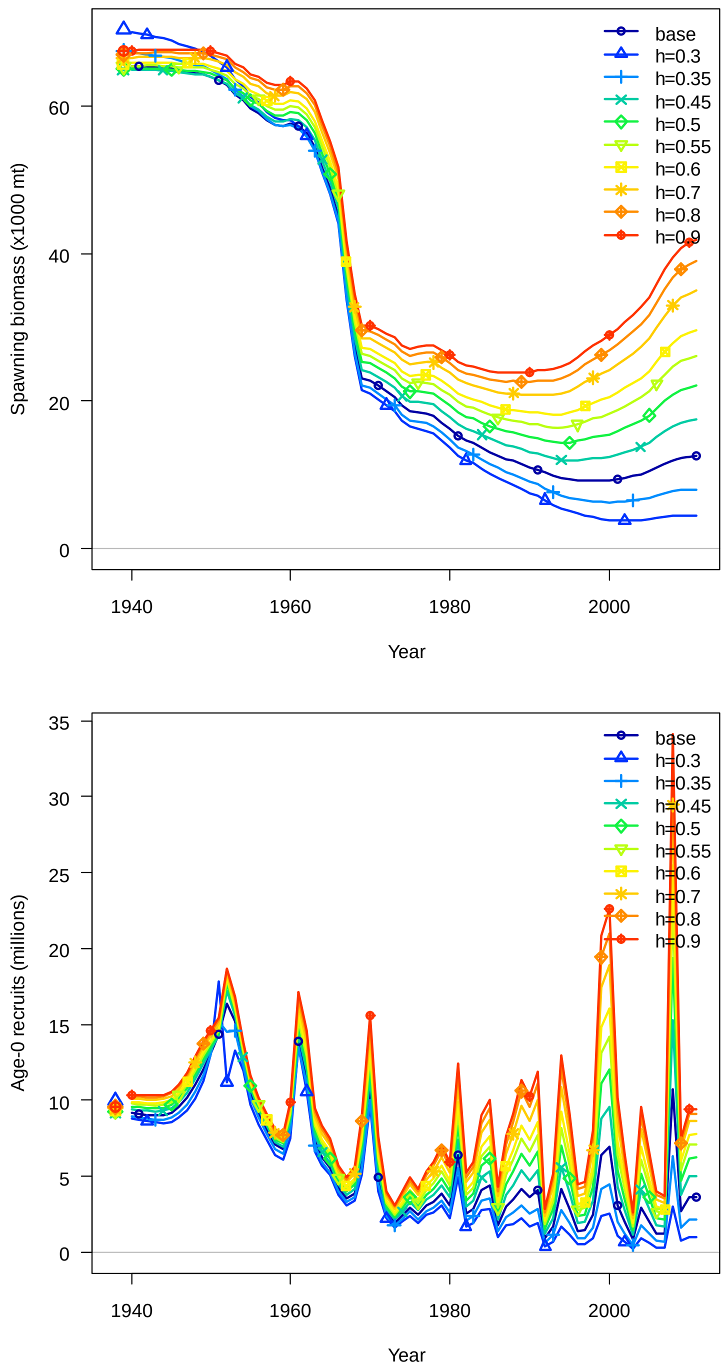

Figure 85: Results of the sensitivity analysis to the treatment of steepness when keeping the natural mortality value fixed at 0.05

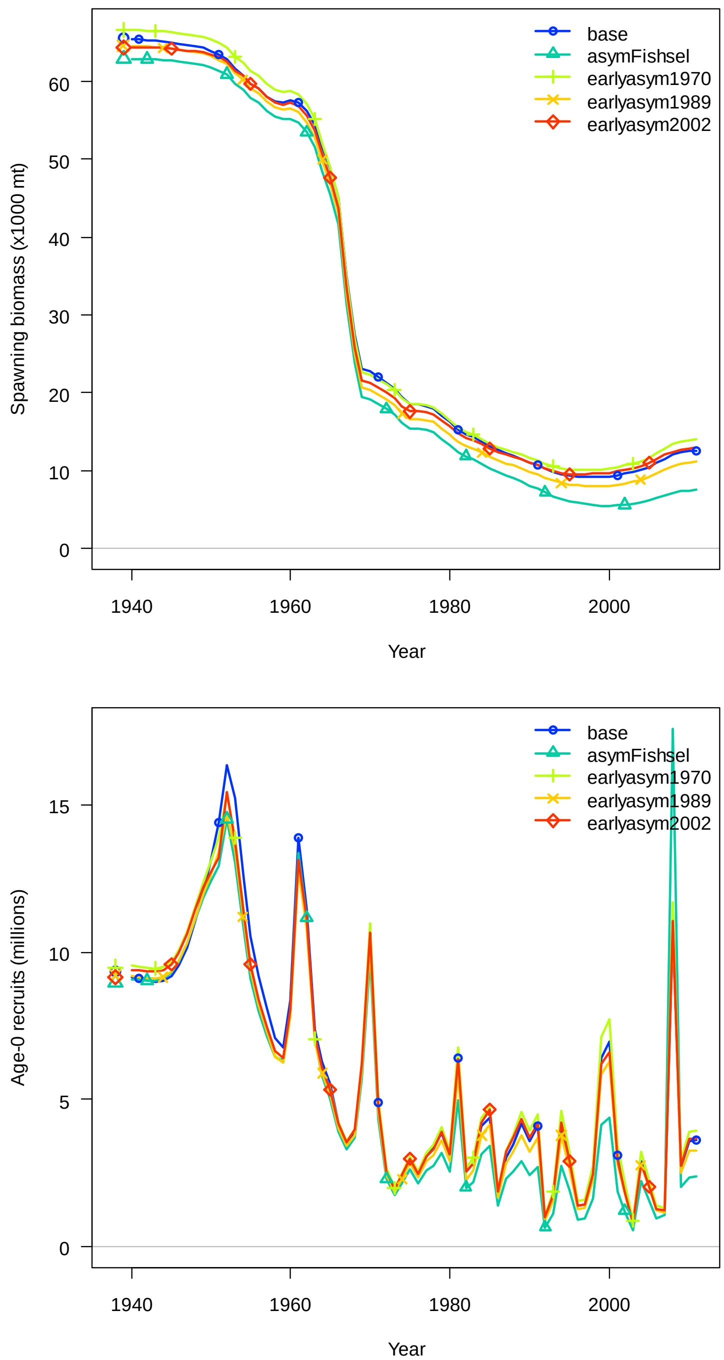

Figure 86: Results of the sensitivity analysis of the timing of the fishery asymptotic selectivity.

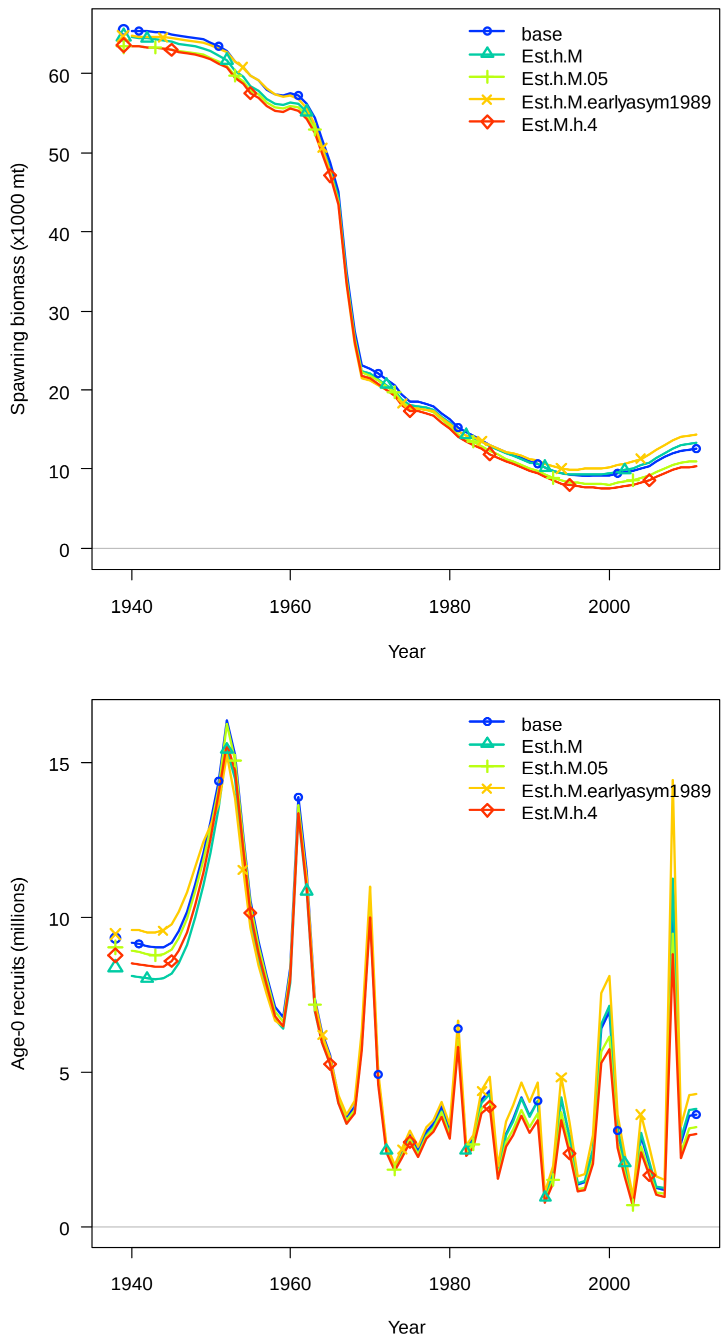

Figure 87: Results of the sensitivity analysis of estimating M and/or h, along with model with estimated M and h with asymptotic selectivity prior to 1989.

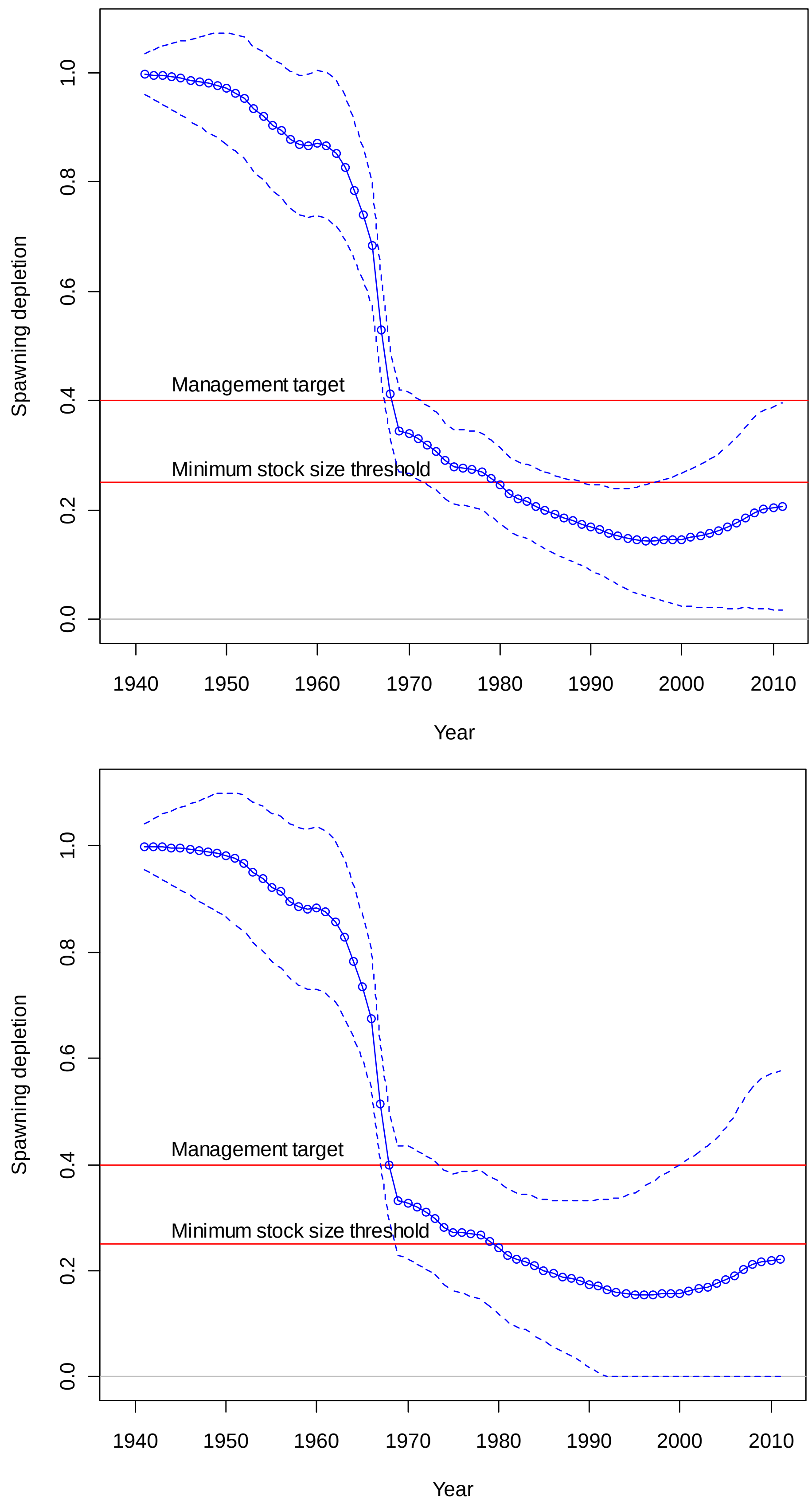

Figure 88: Time series of depletion and uncertainty about depletion for models with estimated h and M. bottom panel includes asymptotic fishery selectivity prior to 1989.

Appendix A: Data File

```
# 2011 data for POP 6/23/2011
########################################

### Global model specifications ###
1940  # Start year
2010  # End year
1     # Number of seasons/year
12    # Number of months/season
1     # Spawning occurs at beginning of season
1     # Number of fishing fleets
6     # Number of surveys
1     # Number of areas
Fishery%POP%EarlyTriennial%LateTriennial%AFSCSlope%NWFSCSlope%NWFSCcomb
o
0.5 0.5 0.5 0.5 0.5 0.5 0.5 # fleet timing_in_season
1 1 1 1 1 1 1     # Area of each fleet
1     # Units for catch by fishing fleet:
1=Biomass(mt),2=Numbers(1000s)
0.05  # SE of log(catch) by fleet for equilibrium and continuous
options
2     # Number of genders (CHANGE - lets try two genders here -
5.11.11)
40    # Number of ages in population dynamics

### Catch section ###
0  # Initial equilibrium catch (landings + discard) by fishing fleet

71 # Number of lines of catch
# Catch Year Season
12    1940  1
18    1941  1
32    1942  1
114   1943  1
200   1944  1
303   1945  1
239   1946  1
203   1947  1
217   1948  1
570   1949  1
830   1950  1
1012  1951  1
2338  1952  1
1708  1953  1
2465  1954  1
1899  1955  1
3085  1956  1
2638  1957  1
2064  1958  1
1314  1959  1
2238  1960  1
3167  1961  1
4200  1962  1
5576  1963  1
5927  1964  1
7491  1965  1
18769 1966  1
14463 1967  1
9125  1968  1
```

```
1948  1969  1
2344  1970  1
2084  1971  1
2030  1972  1
2862  1973  1
2466  1974  1
1400  1975  1
1784  1976  1
1711  1977  1
2337  1978  1
1892  1979  1
2120  1980  1
1395  1981  1
1086  1982  1
1631  1983  1
1648  1984  1
1485  1985  1
1433  1986  1
1120  1987  1
1409  1988  1
1440  1989  1
1091  1990  1
1428  1991  1
1394  1992  1
1258  1993  1
1047  1994  1
845   1995  1
780   1996  1
639   1997  1
636   1998  1
509   1999  1
133   2000  1
264   2001  1
150   2002  1
134   2003  1
122   2004  1
64    2005  1
72    2006  1
132   2007  1
86    2008  1
95    2009  1
91    2010  1

46 # Number of index observations
# Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
# Fleet Units Errortype
1 1 0 # Fishery (CPUE 18 years)
2 1 0 # POP survey (2 years)
3 1 0 # Early Triennial Survey (5 years)
4 1 0 # Late Triennial Survey (4 years)
5 1 0 # AFSC Slope Survey (5 years)
6 1 0 # NWFSC Slope Survey (4 years)
7 1 0 # NWFSC Combo Survey (8 years)

# Year seas index obs se(log)
#CPUE - 18
1956  1     1     0.4         .4 # CPUE - 18 - downweight se log - 0.2
to 2
1957  1     1     0.3         .4
1958  1     1     0.32        .4
1959  1     1     0.29        .4
```

```
1960  1     1     0.28        .4
1961  1     1     0.31        .4
1962  1     1     0.29        .4
1963  1     1     0.34        .4
1964  1     1     0.35        .4
1965  1     1     0.55        .4
1966  1     1     0.47        .4
1967  1     1     0.3         .4
1968  1     1     0.17        .4
1969  1     1     0.178       .4
1970  1     1     0.175       .4
1971  1     1     0.2034      .4
1972  1     1     0.1984      .4
1973  1     1     0.1144      .4
# POP survey - 2
1979  1     2     30872 0.0785
1985  1     2     15909 0.0835
# Early Triennial - 5
1980  1     3     8208  0.1735
1983  1     3     6390  0.1346
1986  1     3     5303  0.3214
1989  1     3     6636  0.3075
1992  1     3     3568  0.2926
# Late Triennial - 4
1995  1     4     1827  0.1608
1998  1     4     6477  0.2782
2001  1     4     2753  0.3050
2004  1     4     6250  0.2301
# AFSC Slope - 5
1996  1     5     4621  0.2176
1997  1     5     1768  0.4163
1999  1     5     12094 0.3758
2000  1     5     2971  0.2948
2001  1     5     15631 0.4080
# NW Slope - 4
1999  1     6     2558  0.3326
2000  1     6     3991  0.3901
2001  1     6     4495  0.3240
2002  1     6     2213  0.3618
# NW Combo - 8
2003  1     7     25088 0.2685
2004  1     7     5348  0.2596
2005  1     7     9351  0.3170
2006  1     7     13090 0.4095
2007  1     7     3674  0.2635
2008  1     7     6462  0.3345
2009  1     7     12014 0.3888
2010  1     7     19047 0.3750

1 #_N_fleets_with_discard
# Fleet Units Error
1     2     0 # this means fishery, discard fraction (of total POP),
and normal distribution with cv.
10 #_N_discard_obs

1986  1     1     0.05  0.3 # Pikitch data, just set asymptote to 1 for
retention prior to 1982
1992  1     1     0.10  0.3 # -assume 89-94 gets higher with tighter
trip limits
2002  1     1     0.155 0.109 #Use average of two ways of calculating
ratio (from raw data or from estimated total)
```

```
2003  1     1     0.157 0.125 #increase cv by 0.01 as well
2004  1     1     0.192 0.109
2005  1     1     0.175 0.160
2006  1     1     0.135 0.104
2007  1     1     0.172 0.140
2008  1     1     0.362 0.078
2009  1     1     0.518 0.076

0 #_N_meanbodywt_obs
30 #_DF_for_meanbodywt_T-distribution_like

## Population size structure
2 # Length bin method: 1=use databins; 2=generate from binwidth,min,max
below;
1 # Population length bin width
5 # Minimum size bin
50 # Maximum size bin

-1    # Minimum proportion for compressing tails of observed
compositional data
0.001       # Constant added to expected frequencies
0     # Combine males and females at and below this bin number

37 # Number of Data Length Bins
# Lower edge of bins
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47

76 #_N_Length_obs
# Year Season Fleet Gender Partition SampleSize Data -
#Fishery discards - half sample for rewt
2003  1     1     0     1     7     0     0     0     0     0     0
      0     0.099268    0     0     0     0     0     0     0     0
      0     0     0     0.024858    0.024858    0.024858    0
      0.024858    0.108242    0.157959    0.198867    0.101564
      0.149151    0.033667    0     0.051848    0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0
2004  1     1     0     1     41    0     0     0     0     0     0
      0.000332    0.042976    0.02182     0.042976    0.109098
      0.085952    0.003027    0.003599    0.070067    0.033751
      0.013286    0.014446    0.013981    0.004962    0.045846
      0.029158    0.008677    0.008941    0.016387    0.018691
      0.06715     0.067534    0.079175    0.028361    0.041902
      0.020814    0.037757    0.012599    0.025199    0.009285
      0.02225     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0
2005  1     1     0     1     60    0     0     0     0     0     0
      0     0.001933    0     0     0.005491    0.004859    0.000722
      0.007069    0.008452    0.024192    0.037272    0.053717
      0.036612    0.07207     0.030571    0.04715     0.044088
      0.057648    0.078843    0.087327    0.099866    0.069904
      0.123314    0.040208    0.037169    0.026946    0.004577    0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0
```

```
2006  1     1     0     1     69    0     0     0     0     0     0
      0     0     0.000669    0     0     0.001338    0.000669    0
      0.01825     0.009364    0.007692    0.041068    0.061535
      0.103198    0.0949      0.194756    0.083322    0.102283
      0.043621    0.0537      0.041737    0.041837    0.026086
      0.049897    0.005351    0.013511    0.000669    0.003879
      0.000669    0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0
2007  1     1     0     1     75    0.004496    0.012367    0
      0.006183    0     0     0.007089    0.012412    0.023278
      0.02429     0.032642    0.028324    0.004395    0.012289
      0.015798    0.014982    0.023285    0.038411    0.036515
      0.059363    0.049491    0.181454    0.09929     0.102014
      0.054853    0.027922    0.023406    0.020556    0.006959
      0.045833    0.008416    0.006712    0.007441    0.007884
      0.00032     0     0.001332    0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0
2008  1     1     0     1     44    0     0     0     0     0     0
      0     0     0     0.000225    0     0.005123    0.002112
      0.004584    0.010291    0.008089    0.020806    0.02512
      0.017256    0.026951    0.051565    0.038826    0.02894
      0.139081    0.062273    0.120497    0.035087    0.155124
      0.15764     0.011369    0.008403    0.035186    0.034467    0
      0.000315    0.000449    0.000225    0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0
2009  1     1     0     1     153   0.00004     0     0.00004     0
      0     0     0.000085    0     0.00004     0     0.000122
      0.001058    0.000389    0.000472    0.000217    0.001653
      0.001774    0.022142    0.007227    0.026314    0.011785
      0.038548    0.064999    0.071751    0.175772    0.098597
      0.137575    0.11683     0.091672    0.038283    0.045563
      0.016017    0.011706    0.006116    0.001804    0.005246
      0.006165    0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0
#Fishery - note numbers are proportions*one million,
1966  1     1     3     2     5     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     8403  4202  8403  12605 25210 33613 67227 50420
      75630 75630 58824 37815 29412 16807 16807 12605 0     0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     0     0     0     0     0     25210 21008 16807
      46218 67227 54622 96639 54622 33613 33613 12605 4202  0     0
      0     0
1967  1     1     3     2     32    0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     1051
      1780  2745  4847  2745  1780  2900  10295 19426 23672 44411 29608
      32451 32296 49949 62842 48187 71090 48385 23219 5036  0     0
      0     0     0     0     0     0     0     0     0     0     0
      0     0     0     2021  1051  1694  2750  2102  4530  8473  9596
      34058 56064 62544 69866 79007 51809 46997 27783 9979  4635  1291
      5036  0
1968  1     1     3     2     19    0     0     0     0     0     0
      0     0     0     0     0     0     0     0     0     0     240
```

	0	1727	240	1102	5809	7802	43696	47020	72067	78176	93037
	79043	32628	32431	19925	19029	6577	3250	2642	721	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	240	6284	6363	14711	44491
	62168	83245	76735	65010	39590	27686	14631	7907	2208	240	1329
	0	0									
1969	1	1	3	2	24	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	1109	0	2218	1109	1109	6636	12178	21116	59186	65386	78137
	75676	70148	46403	25931	22686	15051	15548	2842	1733	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1109	2218	5417	11810	12116	47617
	63599	71105	78625	60690	41755	35835	30446	9991	2599	866	0
	0	0									
1970	1	1	3	2	79	0	0	0	0	0	0
	0	0	0	0	0	0	1199	0	1799	140	1199
	3598	3738	7595	7231	16302	32306	49574	58117	70183	36695	36345
	22458	22909	23028	34259	40226	52146	24815	12133	2998	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	1199	1199	3598	6596	4197	6396	18322	16130	53876	66868
	59231	53168	35269	25619	24825	16187	19521	13332	9875	1799	1199
	600	0									
1971	1	1	3	2	-152	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	142
	693	1273	2167	5456	12968	22501	48484	57997	67648	50353	39964
	25744	23400	31459	31013	34482	26569	17806	6227	1600	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	896	0	0	971	3258	12433	19051	37834	63450
	75094	63691	47555	38630	36888	35028	28992	17823	6851	2429	832
	0	346									
1972	1	1	3	2	147	0	0	0	0	0	0
	0	0	0	0	0	100	561	0	660	561	2243
	1752	4267	7064	9921	10909	26663	32661	40323	58145	47971	52859
	36057	22112	25450	28077	38236	30197	23568	14407	3970	0	0
	0	0	0	0	0	318	0	0	0	0	561
	100	0	561	1266	3898	5647	6730	6244	15101	34696	54622
	55678	65905	58218	39894	31464	28989	31861	24861	9146	3491	1917
	100	0									
1973	1	1	3	2	117	0	0	0	0	0	0
	0	0	0	0	171	1325	593	1866	484	1095	2655
	2786	3888	5248	11155	12170	22240	32441	41074	46014	58587	62671
	44209	32159	24939	22438	17205	21344	20667	13102	9580	0	0
	0	0	0	0	0	0	0	0	470	970	0
	199	1105	1352	2138	2450	6120	7641	7118	12468	28473	44161
	70088	87187	67938	49520	33006	23438	17788	12833	6059	4295	939
	0	138									
1974	1	1	3	2	138	0	0	0	356	0	0
	0	0	0	0	0	0	0	0	224	196	468
	1617	538	1014	2328	7037	18668	32830	49333	63970	62141	59473
	46228	37783	31231	23929	15355	18173	16266	10861	5437	0	0
	0	0	0	0	0	0	0	0	0	0	0
	110	0	765	1559	112	1016	1556	2568	13721	24052	48712
	75471	89068	74895	50758	49631	23585	15026	13720	6259	1449	158
	0	356									
1975	1	1	3	2	-129	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	899	2103
	3901	11493	14629	7363	4720	8055	16447	24095	39345	54076	64664
	64058	65394	50076	37969	28636	26821	19851	17827	10195	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	388	262	3155	7551	11313	4540	8741	9272	9715	23065

	36445	60017	61081	63645	38981	39001	20152	17121	8082	2554	2303
	0	0									
1976	1	1	3	2	140	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	396	225	396
	3458	12957	40510	47586	49318	33845	22845	25139	32353	40484	46151
	36839	36590	28250	20002	20139	12507	11323	5674	2503	0	0
	0	0	0	0	0	0	0	0	0	0	225
	0	0	0	1864	3983	21494	50659	63016	41876	27043	26138
	32460	46614	46866	33983	33430	20486	10579	5538	3284	918	52
	0	0									
1977	1	1	3	2	208	3	0	0	0	0	0
	0	0	0	0	0	0	0	160	0	0	0
	894	2993	6385	21464	40710	60098	47331	28898	29603	36525	39723
	43119	39240	33825	30100	24715	19202	15850	13090	5402	3	0
	0	0	0	0	0	0	0	0	0	0	82
	365	97	130	1491	1520	5871	13749	43587	69750	52759	42592
	35413	33985	39657	38317	32039	22125	13953	6574	4202	1461	735
	216	0									
1978	1	1	3	2	330	0	0	0	0	0	0
	0	0	0	0	0	269	0	0	313	1464	879
	1426	1803	2493	5656	11095	16573	30969	41418	35605	34816	32079
	36677	42091	38870	43927	41208	33340	32995	16963	9727	0	0
	0	0	0	0	0	0	0	0	0	0	0
	269	269	667	467	1802	1818	3466	7718	17045	34636	43587
	40105	46365	47948	49484	61589	52547	35698	22664	10734	7034	1140
	206	86									
1979	1	1	3	2	239	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	7
	309	570	409	2683	1197	7857	15690	32524	52417	54911	60259
	54575	54491	54573	51094	51919	32074	32575	13410	10101	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	832	0	329	5630	8384	13978	30890
	51882	62565	64648	48975	42172	35358	18193	18178	7930	3619	1858
	542	389									
1980	1	1	3	2	388	0	0	0	0	0	0
	0	0	0	0	0	62	0	0	0	0	215
	0	570	795	2440	3799	5244	10852	24618	52953	68792	88112
	66519	62771	48382	44336	34800	28474	27612	13354	6096	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	109	438	1420	2453	6546	13964	36527
	58672	52643	58707	45935	41588	31217	25015	17304	10810	3985	827
	654	390									
1981	1	1	3	2	-278	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	783	205	914	3407	8632	5227	13432	20459	45439	65855	72118
	56242	50605	41846	42678	34257	34917	28311	18790	11417	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	205	1059	4202	7277	18529	46759
	67635	77793	54565	43200	43184	28742	21631	14994	10263	2240	1052
	0	1134									
1982	1	1	3	2	-339	8	0	0	0	0	0
	0	0	0	0	0	0	0	0	440	0	0
	16	547	975	1628	2037	5718	11145	18958	32669	40135	58432
	65733	58706	37370	37120	35795	40550	31097	18711	10235	8	0
	0	0	0	0	0	0	0	0	0	0	0
	0	440	0	421	173	473	849	3859	6153	21426	32739
	53372	67080	55243	57582	55770	46411	39978	24856	18338	4965	1460
	188	192									
1983	1	1	3	2	-274	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	156	582	1501	2708	3181	8921	11273	17548	35276	40187	48780

	47771	34319	37511	35628	37196	44671	37473	23494	16612	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	257	991	1034	2741	6557	17777	37830
	52190	53319	54731	53788	58438	54846	47843	31384	18488	10373	3596
	4269	4758									
1984	1	1	3	2	-218	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	647	1312	4534	6285	8625	12029	16220	25637	46212	61378
	56128	64753	41884	42331	33376	23906	15683	5247	1135	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	231	0	365	1060	1257	1382	4199	11175	21211	48485
	65501	72376	78870	83313	56030	43202	16852	14007	7635	3378	1611
	221	318									
1985	1	1	3	2	-318	0	0	0	0	0	0
	0	113	0	0	0	0	0	0	880	0	0
	696	907	1997	3954	5731	13496	14604	26125	34912	41766	56982
	59010	53808	41080	33166	34393	33327	20730	13060	9649	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	875	2764	1172	5833	6795	9678	18608	42871
	57203	68536	58600	50425	47443	48931	40603	22719	9838	3868	1117
	727	1009									
1986	1	1	3	2	-282	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	378	693
	378	967	1049	3302	6724	6912	19751	24124	37219	45422	60823
	60230	64106	59363	50263	36862	33822	27241	22103	12200	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	378	0	1071	1095	3041	4524	8816	26464
	41593	53424	50310	52680	57137	42177	34384	28255	13556	4937	1304
	920	0									
1987	1	1	3	2	-300	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	700
	0	13	3302	6165	8034	9072	17086	27374	37714	52037	58020
	48460	61770	49730	38835	34993	30552	33072	14682	22735	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	29	612	2579	2861	11540	19902	27681
	48246	57536	64766	66553	44106	42345	26080	16336	6927	4866	88
	0	2604									
1988	1	1	3	2	-63	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	2961
	1516	0	4621	3682	8201	4131	3338	9153	24152	43382	47938
	50037	67893	30580	34181	34578	54994	57915	31661	33407	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1516	5702	6643	11016	7510	15621
	23902	62495	87019	33958	58811	46538	32490	34537	10860	839	9260
	2961	0									
1989	1	1	3	2	92	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	1474	5722	4695	1702	12722	28847	38887	59881	66760
	75158	85136	40910	33082	24286	13167	6143	8400	4366	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	740	0	0	0	4034	9139	23334	26272
	47000	64817	89962	81271	66228	31326	17814	19251	5181	740	1549
	0	0									
1990	1	1	3	2	65	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	2281	2694	4337	6611	11223	14154	21498	44770	51126	55685	50238
	53506	35184	21506	32318	40314	28984	8524	11357	4454	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	7038	7263	0	16140	20454	49252
	45840	54631	58568	80667	54335	50474	29601	15704	3832	5437	0
	0	0									

1991	1	1	3	2	30	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	4651	0	14370	9513	41098	45224	58736	59253
	59325	31865	18761	38278	37683	27852	50773	22029	26497	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	9092	42328	18926
	51620	88799	61531	54262	41568	33569	14651	23277	14469	0	0
	0	0									
1994	1	1	3	2	-275	336	0	0	0	0	0
	0	0	0	0	0	0	0	332	105	0	0
	737	2415	3424	8533	17478	21756	28501	38404	45398	50458	43972
	40666	40563	31813	32419	27403	24747	20860	15907	13160	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	336	0	320	57	970	7747	13641	18187	19540	34417
	39579	66673	71996	84609	50383	32459	19903	12572	9748	4127	2221
	762	368									
1995	1	1	3	2	308	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	444	3200	6357	8562	12092	24399	29167	54982	59997	53071
	42701	49535	38218	31620	19905	18439	14323	12789	8769	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1075	2349	3908	11569	17430	21545	31636
	55137	78820	90486	78184	50974	24446	18404	9295	8749	6701	302
	0	419									
1996	1	1	3	2	439	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	14
	934	434	3522	5309	3695	17705	21700	34633	37790	55034	52923
	46754	56533	51107	42149	24091	23880	18789	13301	18844	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	2152	934	1659	2825	4890	8717	19364	33376
	43952	66359	65939	71694	54128	41612	26464	12843	8214	2407	1046
	1068	1216									
1997	1	1	3	2	519	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	390	2250	4207	10187	24542	21462	31315	33342	37586	44812	44497
	35358	42462	45008	33218	27358	15815	17264	12193	8486	0	0
	0	0	0	0	0	0	0	0	0	466	466
	0	0	0	0	684	3002	8134	10700	23821	32857	42316
	49877	55633	69955	61004	62125	34705	23106	12593	9898	4015	1977
	369	543									
1998	1	1	3	2	376	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	150	0
	0	149	2624	3861	20491	36025	40360	50467	48871	38031	40777
	38900	41937	43392	33433	31035	22370	20479	12168	5272	0	0
	0	0	0	0	0	0	0	0	0	0	631
	0	0	0	0	0	2859	4526	17422	35742	43234	46274
	42909	51739	60437	45715	44457	31100	20920	11579	5927	1756	832
	481	670									
1999	1	1	3	2	-389	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	78	0
	212	1369	818	898	7090	13285	40847	43239	61403	54786	39902
	33725	35884	44701	33349	27097	20044	12839	12300	11330	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	587	0	0	1619	1720	460	3194	17935	36117	45066
	57359	73467	65733	62866	46793	43594	20993	12760	7013	4265	2700
	338	222									
2000	1	1	3	2	-319	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	796
	861	804	1716	1986	4924	14926	18991	30839	38639	52580	71421
	44725	41457	21035	26392	14872	16276	15804	7250	9729	0	0
	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	350	403	1016	8665	12054	14807	26246	54976
	66648	97854	78408	70414	39974	41012	16781	15342	11968	3529	2984
	154	391									
2001	1	1	3	2	-288	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	269
	947	754	7412	8736	16261	16119	17732	33296	52747	74054	58808
	43499	49816	30500	18258	20282	14744	9439	2686	4843	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	155	2114	9529	22507	9634	30243	48504
	65596	65145	81767	70138	57192	27804	8583	11270	4033	3912	672
	0	0									
2002	1	1	3	2	-271	0	0	0	0	0	0
	0	0	0	0	0	28	28	0	56	0	0
	0	72	283	2663	6567	15027	17209	17657	46602	44695	46398
	44301	41886	24696	27229	32554	11972	7025	10279	9945	0	0
	0	0	0	0	0	56	0	0	112	141	197
	0	56	56	1115	0	1030	1970	2701	12287	26694	47744
	69748	67888	91716	79857	76867	49402	33941	17328	9044	1819	882
	0	175									
2003	1	1	3	2	-286	0	0	0	0	0	0
	0	0	487	0	487	1462	7308	2923	487	1992	0
	0	148	1054	2685	9567	7320	21135	29665	41245	49232	60203
	65419	59873	33441	21581	13218	6415	2276	1721	3234	0	0
	0	0	0	0	0	0	0	0	487	487	974
	487	0	1318	943	74	68	890	136	6468	33454	72052
	108469		96747	87205	63575	40407	19699	12856	3556	3151	516
	862	467	74								
2004	1	1	3	2	-217	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	782	71	297	1036	948	3330	9137	27757	38466	52605	65402
	78572	46719	58788	23538	19331	10159	9600	7775	3588	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	782	0	0	913	3792	3828	22374	30812
	68413	90816	102380		81761	66445	37541	18232	6812	2519	143
	2804	1731	0								
2005	1	1	3	2	-226	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	984	0	0
	1423	447	2503	647	7191	9173	11550	18127	35783	57066	62360
	41612	61478	29969	27735	29374	22089	15898	8273	15873	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	75	0	759	4489	9747	4819	8481	8737	30598
	61992	102338		84274	69058	56441	41689	19032	25098	7419	5398
	0	0	0								
2006	1	1	3	2	-254	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	363	4070	9513	7535	13380	18748	15965	25044	39201	50141	49498
	63624	57189	39350	31254	41619	30283	14583	18007	14113	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	72	726	463	1500	4799	6612	16041	19087	41450
	62182	70233	67380	45324	37514	35998	21873	11182	10190	1603	2292
	0	0									
2007	1	1	3	2	-394	480	0	0	0	0	0
	0	0	0	0	0	0	0	46	0	94	48
	260	1956	2654	7916	22252	31354	30876	35162	39037	48020	53711
	48477	45252	39170	28841	15216	21354	11087	5875	2642	480	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	48	301	3995	5382	15625	21742	35453	42679
	60747	85915	74741	50827	42848	24889	19210	12394	4916	2472	1755
	1077	727									
2008	1	1	3	2	-517	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	77	171

```
     0     706   2864  5695  13723 27032 30141 51826 58295 61423 39452
     41661 32209 27036 21281 18844 11475 7972  3623  3404  0     0
     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     634   741   2263  4563  11770 18059 40134 64783
     78002 84287 67345 56392 47595 36617 14482 7662  1981  2161  634
     727   258
2009 1     1     3     2     -520  0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     246   0
     87    1084  2163  2749  11544 18273 35194 47325 51882 70133 65693
     50913 39137 29146 15555 9002  4428  5569  1671  2055  0     0
     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     118   404   716   1508  10518 18613 34256 56480
     80290 106566      76148 58948 47313 26205 11974 3463  1177  984
     276   194   0
2010 1     1     3     2     -508  0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0
     348   1610  121   5190  5659  15918 26633 48456 64263 64845 60054
     44328 46304 24087 23159 15110 10722 5490  1547  3273  0     0
     0     0     0     0     0     0     0     0     0     0     0
     0     0     460   0     0     85    2423  2961  10461 36498 51411
     80293 86565 91900 69675 42108 28847 16208 7851  1493  2329  439
     875   0

# POP survey
1979 1     2     3     0     611   0     0     0     0     0
     0.421107365 0.421107365 0.003016775 0     0.022952845 0.026832708
     0.203023213 0.211599674 0.872347043 0.558926783 0.657958682
     0.764535699 1.012667748 1.161843031 1.502039858 0.97109105
     1.311424268 2.171433631 2.810592591 3.708258732 3.685651608
     4.487668502 4.373363548 4.437374974 4.151099563 3.399681974
     3.407915806 2.475687733 1.593318403 1.168795968 0.702245758
     0.546107962 0     0     0     0     0     0.005925142 0.729552236
     0.689087154 0     0.04920132  0.527251182 0.893945003 0.201115372
     1.012832825 0.57483913  0.808092295 0.824117442 0.690304322
     1.411057471 1.08811026  1.166182888 2.186143359 3.146539296
     3.046645155 4.146866658 4.514169355 4.322230945 3.646315792
     3.772203471 2.723422207 2.003761887 0.921236103 0.68801962
     0.43984328  0.236849269 0.138005604 0.154463099
1985 1     2     3     0     -616  0.01584012  0     0     0     0
     0     0.152916084 0.152916084 0.216312488 0     0.141952818
     0.253172357 0.253172357 0.737852664 0.286073997 0.801545061
     0.757835377 1.089990614 0.584316818 0.817127817 1.352461247
     1.018882471 1.34762623  2.331570608 2.862547823 3.529763333
     3.990011249 4.540049802 4.083488513 4.343144445 3.763212187
     3.267090358 2.71272897  2.162907553 1.600499148 1.274985451
     0.523831059 0     0     0     0     0     0.216312488 0.232713391
     0.152916084 0     0.193888649 0.294868902 0.398874646 0.174285408
     0.926624797 0.296193846 1.067111186 1.168588451 0.997418227
     0.406009732 1.223859597 1.560616206 1.544761525 2.154940599
     3.582805329 4.089648099 4.229496998 5.391598504 4.748483895
     4.533605452 3.892137706 2.423983561 1.309184852 0.894440854
     0.50636527  0.262519594 0.093014168 0.066906883
# Triennial Survey (Early)
1980 1     3     3     0     137   0     0     0     0     0     0
     0.016080868 0.016080868 0.048242605 0.074113532 0.156218932
     0.167052441 0.208876974 0.362581476 0.471165967 0.59544885
     0.877329811 1.022869682 1.968217778 2.696383694 2.289133429
     3.139709199 1.189351581 1.44985965  1.929874272 1.376930631
     2.076799909 1.696999495 1.480440806 3.112594839 3.163192719
     4.195605131 2.587002933 2.589930352 2.869863563 1.823508206
     1.369897596 0     0     0     0     0     0     0.020866661
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     0.110950608 0.073541626 0.067054776 0.117536613 0.26990566
     0.473277283 1.078956558 0.501812672 0.954232215 1.340994011
     1.417061441 2.112366772 2.554675715 2.515282808 3.041109837
     2.087873343 2.015218189 2.385763727 2.427980834 3.230575789
     5.494123719 6.55853279  4.668045451 2.626737142 1.947105245
     1.535786642 0.818012849 0.075136915 0.391958176 0.066166143
1983 1     3     3     0     215   0     0     0     0     0     0
     0.070767235 0.395422174 0.273986526 0.633532091 0.69826762
     0.717978204 0.735120464 0.982693321 0.727297589 0.86037756
     0.603219453 0.711333486 0.326526407 0.466462088 0.430775523
     0.330975262 0.305542311 0.396544532 0.527959092 0.915001355
     1.522674563 1.795365495 1.264876821 2.451377809 2.125646678
     3.17231133  5.052706754 6.365619178 6.382277757 4.725216779
     2.294625552 0     0     0     0     0.020162144 0.0468923
     0.104315737 0.168664089 1.106183794 1.417736597 0.473344155
     0.975319014 1.055849224 1.182358191 1.15394491  1.161529826
     1.15700923  0.442814991 0.334121565 0.409533022 0.365658503
     0.264185633 0.73354251  0.754022127 1.290423047 2.290069419
     3.602547401 3.605844662 5.344315463 6.444482589 5.702928719
     5.538334529 2.683466506 1.371300972 0.352701168 0.104310328
     0.079606624
1986 1     3     3     0     83    0     0     0     0     0
     0.061807246 0.062691462 0.436187587 0.248997416 0.418084728
     0.531491338 0.012331655 0.498736586 0.397335366 0.633511157
     0.830110785 4.197619137 2.8245888   3.18786464  4.07588815
     2.60169201  1.319677191 2.844110896 1.784984714 2.708587529
     0.996586397 1.717129627 1.337813494 0.998411968 1.12959985
     0.604617995 1.214575838 0.953155807 2.044889715 1.855381238
     1.220820603 0.707551611 0     0.062691462 0     0     0.074667777
     0.062691462 0.061807246 0.38812509  0.38812509  2.394829768
     1.158952646 0.833483529 0.719779572 0.549382675 0.475816932
     1.014054267 3.483563592 2.70958077  3.103687118 3.783214827
     3.200115488 2.530439157 2.623049471 3.320025585 4.353255866
     1.538508186 2.296476776 3.151135306 2.883975134 2.330103722
     2.479906298 1.851950572 0.944602268 0.473799727 0.243395912 0
     0.057974175
1989 1     3     3     0     -259  0     0     0     0     0     0
     0     0.017944784 0.352765739 0.068293456 0.034276512 0.089483808
     0.281226716 0     0.948876213 1.968649988 2.725795566 4.357771176
     2.832791123 2.036852455 1.708890865 2.157225308 3.972887715
     4.855863246 4.058820857 2.594439405 2.355331233 1.728695604
     1.530287219 1.059770561 1.375412535 0.586615425 0.374994455
     1.381916149 1.372817058 0.8351069   0.622277188 0     0.013069242
     0     0.034276512 0     0     0     0.032644002 0.107428592
     0.238004599 0.032644002 0.053834353 0     0.264424118 1.569233272
     0.775037973 3.530019459 3.854609366 2.899657675 1.866803804
     2.597749818 2.897981026 3.226374227 5.354756315 2.524195737
     3.128374099 2.551118238 3.120426547 2.664423731 3.020284052
     2.623390138 1.704535002 0.561313427 0.239919054 0     0
     0.227392362
1992 1     3     3     0     -259  0     0     0     0.186182361 0
     0     0.016542231 0.079247264 0.223038478 0     0.196416029
     0.303900467 0.508479528 0.924942589 1.751862194 1.795656429
     2.669217999 1.98989973  3.303389172 2.287122296 1.899154784
     1.479183409 1.282846009 0.787897239 2.193701617 2.949059576
     2.956507296 4.065653214 4.699745717 4.373603985 1.661325534
     2.384163238 1.056414162 1.245689489 1.161467171 1.227484647
     0.781715587 0     0     0     0     0     0     0.033476747
     0.162278536 0.085181118 0.1194996   0.196416029 0.347074053
     0.565909637 0.808999582 1.332660224 2.527450734 3.737167028
     2.486376075 2.903590658 2.307344472 1.557866195 0.880413214
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      1.71978796  1.242969345 1.974210086 4.000668961 5.476909236
      4.354349072 3.164520253 2.600647312 1.327996786 0.990093098
      0.415963491 0.223445744 0     0     0.015225313
# Triennial Survey (Late)
1995  1     4     3     0     -369  0     0.405324095 0     0     0
      0     0     0.071244914 0.205269877 0.257446197 0.195885829
      0.067012482 1.319601482 0.743230971 1.498019335 2.57807562
      3.18976415  2.228080308 0.555781776 1.075668156 0.826756634
      0.606819183 0.24365316  1.539870073 1.652435361 1.441936604
      2.438985827 3.056453383 2.312959227 5.677426381 4.977440984
      5.654228608 2.638811481 3.374752822 1.025103525 1.480625608
      1.735764677 0     0.342240985 0.065330125 0.065312001 0     0
      0.040075757 0.080151515 0.199817763 0.156059241 0.454551709
      0.107088239 0.562456706 0.923701386 2.004855074 3.287951865
      2.654951371 2.075866717 0.655694171 1.138652492 1.920046844
      1.06156483  1.245530898 2.224155368 1.785858914 3.472139746
      4.669943282 4.536540037 3.997610694 2.390253898 1.703423709
      0.900292705 0.120128408 0.042790688 0.040534134 0     0
1998  1     4     3     0     -479  0     0     0     0.01589508  0
      0     0     0.094579178 0.087279388 0.434536229 0.940740714
      1.208612449 1.164366559 1.084259377 1.614343822 2.226799894
      1.584027661 1.184676044 0.554032141 0.839120063 1.268860573
      2.54227457  2.685967384 3.016067685 3.935599224 4.194462289
      3.545642878 2.534661905 3.182290558 2.639527531 3.554545123
      2.75669377  3.182301488 3.511275847 2.41591005  0.466256842
      0.771104043 0     0     0     0     0.056909406 0.024110728
      0.055207432 0.056391853 0.096645897 0.583273365 1.296446311
      1.098595735 1.216543453 1.660184782 2.583096968 2.029849902
      1.539563205 1.0163737   0.682182664 0.840915265 1.680626972
      2.115830838 3.454866204 2.044244922 3.126417557 1.680864149
      1.560236126 1.276231631 1.607467671 2.775138956 2.430622862
      0.977614812 0.62478319  0.531546971 0.040506118 0     0
2001  1     4     3     0     -230  0     0.038581949 0     0
      0.040970128 0     0.533386874 1.642360225 2.041852533 0.785440802
      0.855502636 0.939594667 2.747539788 2.095343103 0.849286188
      0.600574843 0.926279563 0.574781207 0.272172112 1.445886971
      3.695970262 5.215817257 7.110746609 2.650580216 2.478415249
      2.214418583 1.015256907 1.648854162 1.556425255 0.978959345
      0.941534166 1.388529627 2.564963983 1.828135708 1.90302378
      0.67795575  3.81115276  0.040308374 0.372696512 0     0
      0.209400769 0     0.611124803 2.233104225 2.834814973 1.032985561
      0.29178468  1.505251341 2.378915884 2.063321497 0.862171811
      0.143695302 1.152307948 1.114384974 2.02499546  0.893889285
      3.221440681 6.598937905 3.62858939  1.494573501 1.226640214
      1.397906321 1.035664797 1.028471118 0.834641399 0.769729453
      0.439546476 0     0.318923204 0     0.169488937 0     0
2004  1     4     3     0     -303  0     0.15943509  0     0     0
      0.034709545 0.028278236 0.054988137 0.09241409  0.111664802
      0.028278236 0     0.539138789 0.911504447 1.504618162 3.716643548
      6.251895518 7.083302601 2.877024666 2.88369483  1.96303106
      0.872591689 0.781223387 0.943686811 0.997101286 1.678262947
      2.843064639 2.864195509 3.122698975 3.06845696  2.417772321
      2.839287733 0.914262872 1.37502151  1.169375176 0.413441463 0
      0     0.031898581 0.029678239 0     0     0.033678079 0.035850498
      0.061956315 0.064135854 0.030231481 0.128271708 0.727455417
      0.626748286 1.181181318 1.882743617 3.586494739 5.907612677
      4.097406483 2.822173997 2.247666728 0.861993723 1.096823558
      0.969276431 2.462378817 3.901414993 4.52596808  4.267817368
      1.337784603 0.764407503 0.655255777 0.396449525 0.407457247
      0.316723324 0     0     0     0
# AFSC Slope Survey
```

1996 1 5 3 0 169 0 0 0 0 0
0.057992912 0 0 0.556340946 0.357580093 0.613234522
0.066328294 0.098772393 0 0.060170775 0.12649907 0.114818785
0.309691872 0.985767642 1.356435322 2.303396239 1.264310181
1.43790238 1.262012429 1.803911732 2.628260805 2.493324675
2.916731853 3.499437997 2.842039721 2.183306045 2.256618424
1.879658741 2.039660952 1.163664954 0.674945533 0.282988509 0
0 0 0 0 0 0 0.168684736 0.726391905
1.018494774 0.365915475 0.280199547 0 0.066328294 0.052197968
0.136304994 0.263339105 0.497723742 4.219725714 3.071926667
6.165644862 1.965816832 2.788259168 2.278952243 4.010905226
4.43373076 6.748030604 7.717541141 7.679617138 3.678626625
2.489633507 0.789727421 0.33687276 0.247904301 0 0.0669283
0.098772393
1997 1 5 3 0 46 0 0 0 0 0.299954077
0 0 0 0 1.021574112 1.311982827 1.79972446
3.899402997 5.520885263 7.920517876 3.421206726 0.599908153
0.299954077 0.299954077 0.820033307 0.721620035 0.573477808
0.460084398 0.616269974 0.727498095 0.812438458 0.149090997
0.157681813 0.149090997 0 0.421665959 0.280699261 0 0
0 0.788830734 0 0 0 0 0 0 0 0
0 0.721620035 0.299954077 3.299494844 2.999540767 7.776853106
11.94163276 15.09611711 4.321068956 1.79972446 0.299954077
0.195386249 0.75619746 1.292859023 3.232748708 1.500085808
0.539863496 2.653160736 2.002863972 2.269401361 1.891547609
1.418612701 0.157681813 0 0.160130321 0 0.299954077 0
0 0
1999 1 5 3 0 103 0.419993577 0 0 0 0
0 0 0 0 0 0 0.127027474 0.190541212
0.127027474 0.363408881 0.33123067 1.146811339 1.164484881
0.727347967 1.83188318 1.179682189 0.109353932 0.785814784
2.121214928 4.610245679 5.847752994 5.257338434 4.713959999
2.296722817 1.399461641 1.176702255 0.340766623 0.109353932
0.259159536 0.501206331 0.248849663 0.237193478 0 0 0
0 0 0 0 0 0 0.317568686 0 0.299895144
0.127027474 1.245672161 1.557320426 1.09768589 1.549636529
1.245950975 1.89957091 1.154977889 0.949341085 2.668206466
6.288623162 10.25663611 10.16277529 8.838577851 4.780405102
4.028996443 2.477677184 0.986258039 0.269793639 0.172867669 0
0 0 0 0
2000 1 5 3 0 47 0 0 0.27026788 0.390520057
0.781040115 0 0 0 1.351339402 0.540535761 1.621607283
0 0.540535761 0.810803641 0.27026788 1.081071522 0.27026788
0.27026788 2.22089267 4.162219902 3.17095733 2.142404305
1.479279836 1.479279836 1.099430576 1.470340002 4.549017225
3.064426623 2.8468101 3.279851915 1.764929973 0.958980436
0.802018459 0 0.367268501 0.367268501 0 0 0
0.390520057 1.441828053 0.781040115 0.282335525 0.27026788
0.27026788 0.540535761 4.054018207 1.081071522 0.27026788
1.081071522 0.540535761 0.27026788 0.540535761 0 0.295855967
1.428103663 2.266717118 1.62576951 2.774947242 3.174995273
4.266319577 7.198030276 7.890477085 4.240981129 4.600090598
2.052551957 1.94468611 0.145023066 0.295855967 0.561130403 0
0 0 0
2001 1 5 3 0 86 0 0 0 0 0 0
0 0.126708396 0.126708396 0.567432997 0.2203623 0 0
0.057188892 0 0 0 0.06601952 0.06601952 0.132039041
0.792002378 1.984327003 2.713912982 6.292613605 3.354494023
5.623842402 14.76150913 6.90201006 3.533633402 2.734812982
0.778586252 1.770440485 0.528515978 0.057188892 0.057188892
0.894272175 0.734813486 0 0 0 0 0 0 0

```
     0     0     0.808429714 0.661086901 0     0.06601952  0.132039041
     0.06601952  0     0     0.057188892 0.132039041 0.057188892
     2.041827973 1.901081869 6.411627513 11.15033107 9.892142963
     6.553937604 2.142226364 2.381116018 0.25959556  0.409458352 0
     0     0     0     0     0     0
# NWFSC Slope survey
2001  1     6     3     0     -28   0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0.121898583 0.573312971
     2.298225114 0.76742624  1.469789081 1.826530596 5.329789877
     4.461168694 0.414326919 4.338289986 2.058275848 0.129328177 0
     0     0     0     0     0     0     0     1.074495958 0     0
     0     0     0     0     0     0     0     0     0     0     0
     0     2.058275848 2.058275848 5.64395038  5.874255694 8.475823629
     18.81093341 16.486015   7.579057112 3.21028643  3.755478267
     0.155658465 0     1.029131874 0     0     0
2002  1     6     3     0     -41   0     0     0     0     0
     0.268997921 0.268997921 0.36913427  0.668778685 0.36913427
     0.32466321  1.75391538  0.73826854  0.36913427  0     0     0
     0.668778685 0     0     0.657706798 0.59928883  1.695650339
     2.675145326 5.325118931 5.67431157  9.422481803 7.244256229
     3.94734186  4.405907616 2.780787034 2.347484755 0.395529404 0
     0.299644415 0     0     0     0     0     0     0     0     0
     0.36913427  0.36913427  0.36913427  0.862628466 1.231823907
     0.36913427  0.274931474 0.36913427  0     0.299644415 0.36913427
     0     0.299644415 0.299644415 1.037912955 2.562530165 1.989728225
     5.962027709 7.318609151 5.065204851 6.625729231 4.019920833
     3.977682501 1.210536522 0.36913427  0.73826854  0.36913427  0
     0     0
# NWFSC Survey (Slope and Shelf)
2003  1     7     3     0     -142  0     0.038564571 0     0     0
     0.032668915 0     0.077129142 0.071294188 0.104376633 0.038564571
     0.109798057 0.43170315  0.631574994 0.71400795  1.239404228
     1.418569192 1.22911149  0.500311286 0.299881745 0.177226303
     0.349930326 0.417897299 0.616691687 1.538895206 2.914745552
     4.95628906  6.463805263 6.406787364 6.846256543 4.628260679
     2.916020288 2.519702455 1.143749675 0.794339108 1.244131375
     0.762470697 0     0     0     0     0     0     0.077565436 0
     0     0.071707718 0.105655163 0.249560007 0.587729372 0.590586147
     0.634306572 0.885448618 1.916107167 1.010668709 0.269379124
     0.098560648 0.228758282 0.386503121 1.086709014 4.220553683
     4.394247904 5.182661005 4.58176315  5.403797425 6.25866375
     4.541540663 3.378616828 1.171122364 0.505391263 0.34225535
     0.185982528 0     0
2004  1     7     3     0     -74   0     0     0     0     0     0
     0     0.217166894 0     0     0     0.396610553 0.394317424
     0.282319483 0.626213264 2.409725992 2.807571308 2.033199219
     2.023270725 2.449515564 1.824511863 0.495744292 1.013890693
     0.837269347 0.786581112 2.362729444 2.479805029 4.379649965
     2.773955546 2.727929167 1.449938029 2.332880965 3.489298457
     3.014066332 3.024977595 0.587255267 1.249553816 0     0.121183058
     0     0     0     0     0     0.086345134 0     0     0
     0.104841363 0.846252869 0     0.406778439 2.003413739 1.909004854
     2.857276773 1.624543437 2.24624604  0.316892815 0.779915918
     0.733410754 1.361778551 3.325528714 4.654825468 6.236857818
     5.241362557 4.919618892 4.702817386 3.189541113 2.011187699
     1.249553816 0     0     0     0.600875446
2005  1     7     3     0     -71   0     0     0     0     0.048379793
     0     0     0     0.048379793 0     0.177251603 0     0.177251603
     0     0     0.280939966 0.223180832 0.221216906 1.885178201
     2.291600901 4.028708317 3.707771454 1.785029539 4.96766792
```

```
      2.312839114 1.743416313 8.55523433  4.397625236 1.579663084
      2.674665042 2.01705673  1.614446017 1.42388722  2.277077114
      0.957967398 1.392991587 0.226564115 0     0     0     0.145133584
      0.096759585 0     0.095450301 0.096110736 0     0.096104943 0
      0     0     0.04772515  0.047557145 0.057272498 0.446923614
      1.424234817 1.226301158 2.429614528 2.664584712 5.367167634
      4.865010762 6.477342227 4.612927189 5.650413331 4.06792312
      2.324060723 1.797600986 3.09441811  0.650268209 0.354508998
      0.177251603 0.177251603 0.261538227 0.232554381 0
2006  1     7     3     0     -79   0     0.095238323 0     0     0
      0.051561427 0.264910145 0.106671208 0     0     0.053338755
      0.048989973 0     0.330570449 0.204644852 0.196590152 1.077735296
      0.626817035 2.122174048 3.017556726 2.660773836 2.098659113
      1.465117223 0.734547076 1.204202915 0.606068933 1.37886008
      1.607007262 1.031701233 2.519734646 1.180045116 1.061493541
      1.282380148 1.992284126 2.320188583 1.109588547 2.824477113 0
      0.095238323 0     0     0     0.053338755 0.106671208 0.104080847
      0     0     0     0.043569752 0.15043634  0.294677242 0.200775066
      0.154180074 0.551431846 0.44876908  0.592486868 2.782949397
      2.2967997   2.066610481 0.760948594 3.350244843 6.837652787
      9.527122281 12.36939789 6.739263173 7.78693515  2.108182315
      3.125557779 1.346559345 0.554797425 0     0     0     0.277395561
2007  1     7     3     0     -87   0     0     0     0.079932056 0
      0.439338974 0.870071319 0.4388044   0.23924823  1.305748466
      2.334454378 1.542577752 0.503527849 0.30712566  0.35089384
      0.266925756 0.153556148 0.356814238 0.469168157 1.225468938
      1.292277222 1.298317899 2.157149816 2.045985322 2.34128355
      2.564534677 2.520272018 1.69801827  1.282521261 2.019630864
      1.991378671 1.018455471 0.636997409 0.336968208 0.52483059
      0.224654382 0.099644442 0     0     0     0     0     0.750981777
      0.717758054 0.837916742 0.4388044   0.478509824 2.247024933
      1.064121386 0.774957384 0.153556148 0.076778074 0.465987447
      0.590810286 0     0.483280889 0.586279778 1.269557861 0.858003329
      1.548297685 7.644744043 4.289335064 7.377604457 10.09712527
      10.26598357 6.07966076  3.418809359 1.304639227 0.89356581
      0.124675831 0     0     0.224654382 0
2008  1     7     3     0     -75   0     0     0     0     0.1287296
      0     0.1287296   0.241956205 0.098492354 1.724594598 1.00325691
      1.163318633 1.766246521 1.654417631 0.258519134 0     0.232579864
      0.246335714 0.224461466 0.527649259 0.296385578 0.498402062
      1.970080036 2.218069713 1.923605994 2.55917054  3.068591259
      1.792966183 3.054206437 2.462961121 3.659533736 2.257555177
      5.133308283 3.323010428 2.293872485 1.730010746 3.040625301 0
      0     0     0     0     0     0.1287296   0     0.387772878
      1.03406489  0.517026621 1.03406489  1.680356902 1.292584024
      0.361845255 0.214141666 0.332458286 0.238799698 0     0.402751729
      0.63396882  0.185570031 1.061821191 1.73416895  2.45721884
      2.462774759 2.50404231  4.019037817 5.024566015 6.385847758
      6.398205892 5.884405665 2.197290342 0.156416015 0.588426589 0
      0
2009  1     7     3     0     -74   0     0.024971158 0.049939499 0
      0     0     0     0     0     0     0.018969966 0.023410285 0
      0.04682057  0.100994713 0.157205881 0.110914994 0.027087072
      1.835914048 0.099036578 1.872504416 2.705441732 4.500302553
      2.870767536 6.456640526 3.027702941 6.551760833 0.300059615
      0.391908849 1.909353991 0.171670727 0.081140064 0     0.883755863
      0.027087072 0     0.027087072 0     0.024971158 0.049939499
      0.049939499 0.025548738 0.018969966 0.023410285 0.023410285 0
      0     0     0.042377433 0.023410285 0     0.047110768 0.100994713
      0.986328354 0.102868325 0.167258582 1.812472771 1.965928611
      3.788465353 13.48886301 11.27410468 11.11519987 9.387896136
```

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      4.609724293 4.225817033 0.274361551 1.106076089 0.910842935
      0.081261215 0     0     0     0     0
2010  1     7     3     0     -115  0.084115681 0     0     0.048113017
      0.164014056 1.149786464 2.71748383  2.965434965 0.625757293
      0.462532542 0     0.194284178 0.079927181 0     0.166912014
      0.119893652 0.243589795 0.338012527 0.268945487 0.087929694
      0.3700341   0.118695292 0.094036722 0.598650151 1.495415494
      2.88976542  3.820021479 2.697912531 5.111289367 2.4738249
      3.953851833 2.012784546 2.50494194  2.506411084 2.79227765
      1.120190419 0.531179004 0     0     0     0.132228699 0.526610255
      1.655362038 3.913032682 2.969848158 1.390662664 0.168231362 0
      0.084115681 0.119513403 0.178152404 0.240916529 0     0.17471864
      0.209136933 0.385785625 0.457762146 0.12445664  0.281205636
      0.204775593 1.761560966 2.917581209 3.715666183 5.436765201
      6.895382965 5.109318986 5.654584486 4.329278554 2.692635136
      1.778810442 1.246473407 0.437413065 0     0


35 #_N_age_bins
# Age bins
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35

1 # N_ageerror_definitions
#assume unbiased age data
0.5   1.5   2.5   3.5   4.5   5.5   6.5   7.5   8.5   9.5   10.5  11.5
      12.5  13.5  14.5  15.5  16.5  17.5  18.5  19.5  20.5  21.5  22.5
      23.5  24.5  25.5  26.5  27.5  28.5  29.5  30.5  31.5  32.5  33.5
      34.5  35.5  36.5  37.5  38.5  39.5  40.5
0.064 0.064 0.128 0.192 0.256 0.32  0.384 0.448 0.512 0.576 0.64  0.704
      0.768 0.832 0.896 0.96  1.024 1.088 1.152 1.216 1.28  1.344 1.408
      1.472 1.536 1.6   1.664 1.728 1.792 1.856 1.92  1.984 2.048 2.112
      2.176 2.24  2.304 2.368 2.432 2.496 2.56

40    # Number of age comp observations
3     # Length bin refers to: 1=population length bin indices; 2=data
length bin indices; 3 = actual length
0     #_combine males into females at or below this bin number
# Year Season Fleet Gender Partition AgeingErrorMat LowerLengthBin
UpperLengthBin SampleSize Data
# Fishery
# New Break and Burn Reads from WA, No data to weight
1971  1     1     3     2     1     -1    -1    50    0     0     0
      1     1     3     12    41    85    118   69    42    19    24
      12    10    12    24    14    17    11    10    8     1     3
      3     3     1     1     6     1     5     5     5     34    0
      0     0     0     2     3     19    44    95    82    64    29
      27    14    10    15    9     9     19    16    8     14    11
      6     6     2     2     1     2     3     2     0     0     0
      16
1975  1     1     3     2     1     -1    -1    64    0     0     0
      0     4     5     8     14    22    54    62    62    82    69
      40    16    13    8     12    8     13    10    10    12    4
      9     5     4     1     2     4     1     2     1     32    0
      0     0     2     4     7     11    13    22    40    56    64
      47    48    32    10    9     6     1     5     3     3     5
      4     1     2     1     4     0     1     0     0     1     1
      5
# Standard
1981  1     1     3     2     1     -1    -1    67    0     0     0
      0     0.00404714  0.01358184  0.008114936 0.01377539  0.0210003
```

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      0.03776729  0.02959072  0.02935805  0.02203359  0.02437436
      0.04024499  0.02495191  0.01985085  0.02573113  0.01890257
      0.01696848  0.007428414 0.01290102  0.003379497 0.01182559
      0.006078263 0.002677124 0.002692868 0.002020621 0.007793796
      0.006441146 0.001390669 0.001384771 0.003090481 0.002019328
      0.03670401  0     0     0     0     0.000679438 0.01089618
      0.01186138  0.01901932  0.02060692  0.0632808   0.06333151
      0.0567635   0.03479275  0.03064706  0.03583724  0.03685141
      0.01465747  0.03013563  0.01743006  0.01060114  0.009881379
      0.00400695  0.006111787 0.004029885 0.006522207 0.000662073
      0.002763755 0.00578793  0.005143223 0.000711231 0.002038314
      0.006180962 0.003764021 0.006180962 0.0207024
1982  1     1     3     2     1     -1    -1    281   0     0     0
      0     0.002132998 0.006337307 0.01018064  0.0139678   0.01875367
      0.04286516  0.06353335  0.0525654   0.0326669   0.02981953
      0.01590161  0.01299883  0.01777515  0.01766112  0.02017463
      0.01609971  0.009923161 0.02874213  0.007705214 0.008165469
      0.007780207 0.008398097 0.00619635  0.007522144 0.008187127
      0.005970706 0.005882244 0.005928687 0.004014203 0.005297769
      0.04695709  0     0     0     0     0.00045301  0.004143073
      0.007809615 0.01372225  0.01935754  0.02606475  0.04215992
      0.04192434  0.0371274   0.02451951  0.01888043  0.02232481
      0.01836699  0.01619652  0.0167241   0.01695384  0.01875878
      0.007162709 0.004013987 0.007067014 0.007677086 0.00872869
      0.007751788 0.007249846 0.008652963 0.003429018 0.002320637
      0.006204256 0.002699466 0.003437117 0.03801413
1983  1     1     3     2     1     -1    -1    233   0     0     0
      0.00115817  0.00186341  0.007814247 0.01724333  0.02476121
      0.01831732  0.01874232  0.02727805  0.04274692  0.03366258
      0.02215793  0.01649924  0.01275526  0.01111045  0.01269436
      0.01520831  0.0144933   0.01607708  0.00862412  0.008360729
      0.008237626 0.005207593 0.003038729 0.009064333 0.0103445
      0.006118069 0.00876701  0.008707983 0.008492463 0.005504288
      0.006250766 0.0885274   0     0     0     0.000794267 0.005384593
      0.006843176 0.02080241  0.02366012  0.02207312  0.01717487
      0.03048257  0.04372703  0.04821186  0.02950706  0.02124069
      0.01575655  0.01384122  0.01801436  0.01422965  0.01904892
      0.0142496   0.01004755  0.006196706 0.005309113 0.007216889
      0.003650226 0.008993751 0.005924503 0.009008974 0.00881555
      0.00783183  0.005457802 0.002968296 0.005123704 0.04858395
1984  1     1     3     2     1     -1    -1    187   0     0     0
      0     0.001572381 0.003792427 0.007333663 0.01062311  0.02232494
      0.01767298  0.01312045  0.03029606  0.04092024  0.0388159
      0.03162818  0.02689064  0.01082901  0.01413702  0.009593329
      0.01295894  0.01034565  0.007436184 0.00709311  0.005591874
      0.008097626 0.005180614 0.004897211 0.006235287 0.005759824
      0.004892832 0.004561946 0.007540143 0.004592413 0.003871902
      0.07952894  0     0     0     0     0.000586729 0.00401475
      0.00695512  0.01489961  0.02779774  0.03558234  0.02815333
      0.04274905  0.0414476   0.03643004  0.04058625  0.02428133
      0.01574172  0.01683637  0.01103561  0.01642903  0.01371435
      0.00716519  0.01046271  0.009570409 0.006557388 0.005204251
      0.009279673 0.004610506 0.002632689 0.006231736 0.005420765
      0.01164494  0.007635027 0.004604425 0.07360452
1985  1     1     3     2     1     -1    -1    99    0     0
      0.000247835 0     0.001990665 0.006105235 0.0143149   0.01424923
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      0.02379929  0.01749925  0.01804744  0.01202197  0.01128798
      0.009264441 0.006880044 0.008148587 0.005185531 0.01053233
      0.01103478  0.007565928 0.009944727 0.01070018  0.001953641
      0.004583315 0.003818808 0.006111777 0.003504214 0.002959293
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     0.01792563  0.02147251  0.02075436  0.03105062  0.03042817
     0.02827209  0.0335502   0.02434064  0.02144205  0.01399645
     0.0139976   0.01364586  0.02112404  0.02282918  0.02838301
     0.01065421  0.00844723  0.008872035 0.004273349 0.004190842
     0.008130574 0.01148255  0.00703564  0.003385141 0.1019032
1986 1      1      3      2      1      -1     -1     85     0      0
     0.000678286 0.001356572 0.003855942 0.003911724 0.03001688
     0.05377225  0.05339607  0.03558444  0.01546342  0.02267736
     0.01045805  0.01867242  0.01837716  0.0301819   0.02140402
     0.01323438  0.008845214 0.01239804  0.009632303 0.01330991
     0.008099126 0.01067901  0.02409306  0.02055235  0.004742028
     0.004327823 0.008213029 0.005274122 0.00536829  0.007195995
     0.0038113   0.008696521 0.09259044  0      0      0      0.000734067
     0.001632132 0.004715412 0.02377281  0.04248157  0.0418597
     0.01536903  0.01767289  0.01003415  0.005953268 0.00591755
     0.01365465  0.01859665  0.02113391  0.01375971  0.008869372
     0.01229253  0.008534795 0.0141186   0.009780276 0.01605867
     0.01206298  0.01551781  0.009088951 0.00579189  0.002645531
     0.002733232 0.003823989 0.004116505 0.004042082 0.002294778
     0.05007107
1987 1      1      3      2      1      -1     -1     108    0      0      0
     0      0      0.001311879 0.01454487  0.03350314  0.06366604
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     0.01158396  0.01571516  0.009998989 0.0189748   0.01537561
     0.00876061  0.01234467  0.005614253 0.01501108  0.01050351
     0.01770615  0.01404578  0.01130768  0.0136457   0.008509312
     0.003659335 0.007523881 0.01190759  0.004920188 0.004831561
     0.1185029   0      0      0      0      0.00198961  0.001859871
     0.01098497  0.03161433  0.04187318  0.03128193  0.032389
     0.01678706  0.003308413 0.01228103  0.01204724  0.009653423
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     0.004110075 0.009065152 0.007404257 0.016315    0.006534699
     0.01305335  0.006264358 0.005332582 0.001514426 0.008845803
     0.001567735 0.006574006 0.001387076 0.05560472
1988 1      1      3      2      1      -1     -1     17     0      0      0
     0      0      0      0.01025222  0.01931725  0.04660088  0.0491093
     0.08561147  0.03265219  0.01383981  0.01320134  0.02063848
     0.00541326  0.00270663  0.01383981  0      0.00811989  0.02906503
     0.00811989  0.00541326  0.00270663  0      0.01383981  0.0263584
     0.01082652  0.01654644  0.008184067 0      0      0      0
     0.1033455   0      0      0      0      0      0      0.01113318
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     0.03865887  0.006160188 0      0.006160188 0.009505294 0.002068154
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     0.004092033 0.01773364  0.002068154 0.004774785 0      0.002068154
     0      0      0      0.002068154 0.06762924
1994 1      1      3      2      1      -1     -1     33     0      0      0
     0      0      0.00537117  0.004273342 0.01205057  0.03466085
     0.03529713  0.02038685  0.03383296  0.03141281  0.0367554
     0.009644512 0.02437989  0.00537117  0      0.01031064  0      0
     0.01030788  0.005231017 0.01015372  0.01538474  0.00950436  0
     0.005231017 0.005076861 0.005231017 0.00950436  0.01590622
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     0.01853856  0.000960432 0.007863358 0.03301106  0.06166524
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     0.01780218  0.03870898  0.01494854  0.0170068   0.008157667
     0.007059839 0.000960432 0.01163563  0.000960432 0.009644512 0
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      0.01617662  0.01122965  0.01782971  0.01104027  0.009657991
      0.01158957  0.0104016   0.01541147  0.004483019 0.01443759
      0.004592586 0.003992047 0.000751616 0.000966322 0.001085881
      0.001385368 0.004886082 0.002639037 0.003747727 0.004749832
      0.04387171  0     0     0     0     0     0.006612424 0.003369334
      0.02615079  0.05224884  0.0976392   0.0496136   0.03577096
      0.02730106  0.03101843  0.01753117  0.007892438 0.0256161
      0.02507092  0.01021999  0.01231647  0.007223641 0.006628415
      0.003909043 0.001060593 0.002235975 0.000596942 0.001840069
      0.00261606  0     0.001227603 0.003364334 0.001431668 0.002204717
      0.004690719 0.0221072
2000  1     1     3     2     1     -1    -1    91    0     0     0
      0     0.004621328 0.005086484 0     0.005430228 0.02245155
      0.03686627  0.03074159  0.03902784  0.02353698  0.04326512
      0.03072616  0.03669003  0.0172341   0.01922109  0.004978302
      0.005487152 0.004694528 0.00582511  0.01230993  0.015007    0
      0.004193096 0.003301265 0.00660253  0.005543024 0.01341854
      0.007977512 0.004977177 0     0.005675063 0.04064394  0     0
      0     0     0.001338652 0.009617093 0.000650737 0.004995765
      0.01801313  0.03068987  0.05269213  0.02679849  0.03915777
      0.04272627  0.03204374  0.04449757  0.02834576  0.03086191
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      0.000741264 0.004042529 0.008577834 0.004326439 0.003873266
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      0.005798077 0.06747071
2001  1     1     3     2     1     -1    -1    218   0     0     0
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      0.006039879 0.009628604 0.0051298   0.002803036 0.01384351
      0.004877326 0.005339418 0.004735034 0.003386827 0.001290735
      0.001338215 0.007899435 0.007068219 0.004823739 0.00404889
      0.003354445 0.03882198  0     0     0     0     0.005801647
      0.02134438  0.02547453  0.01905919  0.01514889  0.03187978
      0.03449174  0.06869971  0.06243677  0.02798946  0.02354967
      0.02597715  0.00887882  0.02995403  0.01116192  0.01271184
      0.01215423  0.004235024 0.007433074 0.0039227   0.01400689
      0.006770342 0.00451679  0.00497903  0.004890659 0.003861665
      0.01507282  0.006654353 0.00272246  0.004834161 0.03098474
2002  1     1     3     2     1     -1    -1    223   0     0     0
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      0.03254949  0.01840434  0.007078608 0.00670111  0.00603008
      0.009563374 0.01058422  0.01189104  0.01128415  0.009912704
      0.000777828 0.01150116  0.002287093 0.001944472 0.004270447 0
      0.004680706 0.005842453 0.002218441 0.004200367 0.01034027
      0.02650638  0     0     0     0     0     0.004212138 0.03225399
      0.04367055  0.03329988  0.02745793  0.06503924  0.05588012
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      0.02621428  0.01711076  0.01063062  0.01518581  0.00978734
      0.003509577 0.009937594 0.01162869  0.004317734 0.001106146
      0.001996885 0.00197276  0.001376646 0.004464055 0.00614531
      0.004621527 0.004320732 0.03635477
2003  1     1     3     2     1     -1    -1    197   0     0.000538995
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      0.03605636  0.0391462   0.02584509  0.0176712   0.03250619
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     0.000103549 0.001254423 0     0.008544496 0.01893534  0.02442018
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     0.007353616 0.004499747 0.004983998 0.005754364 0.008936527
     0.03572862
2004 1     1     3     2     1     -1    -1    122   0     0     0
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     0.01102922  0.002499212 0.05415265
2005 1     1     3     2     1     -1    -1    162   0.00120203  0
     0     0     0.001780144 0.01328789  0.0090509   0.008445236
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     0.001823567 0.04707034  0     0     0     0     0.005559969
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     0.007034333 0.01898903  0.003425562 0.009030088 0.008565533
     0.006954127 0.008141721 0.008017906 0.002584171 0.049963
2006 1     1     3     2     1     -1    -1    222   0     0     0
     0     0.003730371 0.02484128  0.03276966  0.02695146  0.01614483
     0.02482166  0.02980699  0.02158256  0.02131868  0.02603138
     0.02338654  0.03559508  0.019156    0.01945668  0.02469356
     0.01725182  0.0112422   0.02423725  0.003774594 0.008053395
     0.01116033  0.007767003 0.005712081 0.009691572 0.003422438
     0.01534417  0.002626529 0.006761384 0.002233337 0.002251371
     0.06037284  0     0     0.000163878 0.000163878 0.004580535
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     0.03589548  0.02982671  0.0335825   0.0146305   0.02674823
     0.02423284  0.03222515  0.01651638  0.02315864  0.0110577
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     0.006169445 0.006915638 0.007398812 0.002031766 0.007898677
     0.006590063 0.002578945 0.00320599  0.001379748 0.0224066
2007 1     1     3     2     1     -1    -1    310   0     0     0
     7.47E-05    0.001445888 0.01945815  0.04014678  0.04372912
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     0.0161865   0.01746629  0.01159431  0.00749504  0.01082568
     0.007314405 0.009879301 0.00751534  0.00429162  0.002840411
     0.00106328  0.008538699 0.003058225 0.001941654 0.002526443
     0.001161351 0.03614545  0     0     0     5.33E-05    0.002393189
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     0.004835433 0.003553413 0.006007558 0.003537807 0.006544867
     0.004603013 0.003456729 0.00349228  0.00336892  0.03476528
2008 1     1     3     2     1     -1    -1    167   0     0     0
     0     0.00040494  0     0.007048643 0.02477568  0.03506571
     0.02707369  0.02958714  0.03232892  0.02743032  0.02277304
     0.02320081  0.00995862  0.01977301  0.01189943  0.01284122
     0.01400156  0.01418314  0.01415658  0.01726836  0.01376029
     0.009178992 0.005706875 0.002064222 0.002748253 0.005919255
     0.003105831 0.003350357 0.001087993 0.005867794 0     0.04100107
     0     0     0     0     0     0.004500543 0.00775082  0.02373933
     0.05452205  0.03899259  0.02937401  0.02982245  0.03019542
     0.01661048  0.01312547  0.01797767  0.02472568  0.02899959
     0.008937977 0.02465512  0.01418933  0.01100362  0.01073914
     0.02694652  0.01690694  0.009736445 0.009497912 0.007643058
     0.009623281 0.01201221  0.007533447 0.004940447 0.008725563
     0.00347486  0.05553628
2009 1     1     3     2     1     -1    -1    290   0     0     0
     0     0     0.002798747 0.009748058 0.0220168   0.08669066
     0.05964693  0.03106067  0.01388183  0.01341605  0.01397929
     0.01693504  0.017103    0.007960862 0.00696166  0.01457443
     0.01875314  0.01463343  0.007355005 0.009836587 0.01124994
     0.01346397  0.008254407 0.01346481  0.01009797  0.004238319
     0.007665899 0.001698192 0.004144206 0.00282726  0.003531545
     0.03797768  0     0     0     0     0     0.000453922 0.01029903
     0.01754433  0.05086052  0.04652983  0.03589172  0.02796411
     0.02678295  0.02019101  0.0150259   0.01495755  0.01839572
     0.0122906   0.01758235  0.018156    0.01171845  0.01109428
     0.01883779  0.00819866  0.01393227  0.01023696  0.01462439
     0.006994145 0.00688891  0.006223873 0.004503348 0.003341769
     0.008574637 0.002659959 0.05327862
2010 1     1     3     2     1     -1    -1    226   0     0     0
     0     0     0     0.0023072   0.02154089  0.02637859  0.0830457
     0.04209196  0.04033958  0.01639578  0.01551658  0.01926217
     0.01498277  0.02359709  0.01685403  0.01249852  0.01331489
     0.01181121  0.01849437  0.009479911 0.01426854  0.002045071
     0.00401775  0.004602061 0.002782031 0.000905591 0.002234039
     0.000506361 0.000853701 0.004258243 0.002651692 0.02624385  0
     0     0     0     0     0     0.004907797 0.03409966  0.05129289
     0.08516908  0.04604929  0.03755729  0.03087702  0.02399827
     0.0190039   0.01172082  0.009500673 0.01407809  0.01276239
     0.03014084  0.02053393  0.01064694  0.0100559   0.0111855
     0.004563596 0.01316844  0.002953421 0.007827624 0.005128081
     0.009609942 0.001823201 0.002408696 0.002931305 0.00261828
     0.03010697

# POP Survey
1985 1     2     3     0     1     -1    -1    142   0     0.018862275
     0.616846045 0.484426864 1.661506007 1.55460796  0.535235446
     0.591936995 1.110894569 3.392361618 2.738409056 1.633720286
     2.915001351 1.272234338 1.827902161 0.655073754 0.435160008
     1.027269969 0.702799913 1.035482455 1.291368413 1.446797964
     0.914557011 1.050163241 0.429209646 0.504555777 0.244200879
     1.235404376 0.759142344 0.542019319 1.031847215 1.035538227
     1.682610809 0.649933096 13.1083298  0     0.334836717 0.899185338
     0.927749249 1.271221473 1.669324387 0.614410172 0.330146401
     1.520564909 2.617849558 2.720312611 1.022479717 2.571879299
     2.945675308 2.016077598 0.810749979 1.169737164 1.23107343
     1.175793718 1.547487906 0.756586267 1.038264472 0.56995368
```

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      0.512357689 0.388007036 0.085765905 0.236315739 0.557694413
      1.007545516 0.613096757 1.124751793 0.546092192 1.548294879
      1.285162616 12.19814692
# Triennial Survey Early
1989  1     3     3     0     1     -1    -1    98    0.223110617
      0.630217913 1.022636201 6.479018077 5.772909844 1.494955638
      1.314588007 14.48930467 2.62535389  3.172173491 2.591219012
      2.830273794 0.647360895 0.278088666 0.039346787 0.059069981
      0.067581474 0.091097313 0.12448208  0.113465671 0.033958507
      0.309826552 0.796628037 1.595250042 0.113465671 0.819570135
      0.205833291 0.033958507 0.078597883 0     0.033958507 0.033958507
      0     0.075263965 1.888770651 0.230593773 0.654440306 1.698173966
      8.868184339 2.881031064 4.783493614 4.920638403 5.494028592
      2.389715641 2.417873538 2.202354181 1.639282091 1.121027014
      0.166872225 0.136645969 0.133249258 0.785611628 0.90642425
      0.234278292 0.120812622 0.900735727 0.309826552 0.794600482
      0.292263585 1.684688926 1.595250042 1.534663454 0.069575442 0
      0.088839545 0     0.075263965 0.030854252 0     0.753412979
1992  1     3     3     0     1     -1    -1    66    0     0.54397823
      0.942174728 5.466072608 9.380863061 0.75779917  2.616383589
      2.117636447 0.901492992 2.488528247 2.691491464 4.930681353
      0.040227999 1.395042358 0.038452774 1.361795169 0     0     0
      0     1.164718092 1.164718092 1.164718092 0     1.361795169 0
      0     0.197077078 1.164718092 0.197077078 0.197077078 0.662931195
      0.040056287 0     4.170613273 0     0.55841929  0.92837059
      5.887914265 6.22244801  2.223137648 1.120104648 1.717995502
      0.541836792 1.246259098 11.02001691 1.953338799 8.580427988
      2.506238662 1.625366625 0.26877704  0     0.039129391 0     0
      1.164718092 0.330221196 0.330221196 1.264615022 0.230324266 0
      2.329436184 0.269453657 0     0.035926387 0.040056287 0
      0.038452774 0     0.36867397
# Triennial Survey Late
1995  1     4     3     0     1     -1    -1    75    0     0
      0.485716286 6.009393287 1.749393656 1.767478499 2.121665667
      2.311492278 2.428457768 0.675480877 5.01532674  5.235983684
      3.173950829 0.973072716 3.33017605  6.077605999 2.305683532
      2.24446421  6.200508473 0.14285215  0.045491982 0     0.14285215
      2.004140292 0.215418912 0.204535302 0.450787501 0.522285216 0
      0.14285215  2.09026462  0.450787501 0.579013038 0.338193148
      6.497063537 0     0     0.323810857 2.999029241 2.378742577
      1.174536633 1.74228813  1.458671779 2.768794394 0.728097964
      0.67825228  0.045491982 2.432808342 5.898965232 1.884827601
      2.818663246 1.024349237 0.061683152 0.204535302 0     0.358271062
      0.723238328 0.242903409 0.215418912 0.14285215  0.242903409
      0.211231505 0     0.14285215  0.100051259 0     0     0.487741502
      0.2857043   2.29089602
1998  1     4     3     0     1     -1    -1    75    0     0.052853726
      2.49341441  6.127094053 0.895167778 1.371047191 7.088983567
      2.086937896 1.528660947 4.046764261 1.71036109  3.721370783
      1.003425201 3.785143314 4.640220961 1.144402263 3.188143774
      1.673410705 0.461891763 0     1.427956538 1.698251223 0.435076485
      0     0     0.49369278  0     0.585386856 0     0.828098253
      0.515410594 0.043435628 0.616419863 0.080334109 1.847774722 0
      0.047989126 3.605332315 6.198514548 0.951268578 1.341269624
      2.787898451 2.937936041 2.457845307 0.467601674 2.20256469
      6.685275727 2.463644646 1.179642029 2.501943779 0.803692556
      0.992880053 0.318991893 4.327871559 0.601297695 0     0     0
      0.245888988 0     0.245888988 0     0.855691975 0.16622121  0
      0     0     0     0     0.021717814
2001  1     4     3     0     1     -1    -1    93    1.063171807
      5.923960133 7.104500275 3.257359738 2.802332776 11.79064068
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      0     0.424131508 0.336313467 1.084434677 1.488816887 0.672626934
      0.672626934 0.391977218 0     0.336313467 0.336313467 0.336313467
      0.038396932 0.336313467 0.336313467 0.672626934 0.04397534
      0.055663751 0.082252036 0     0.336313467 0     5.105679608
      1.75070479  3.722448583 4.364494653 2.962550875 2.762258978
      9.365690242 1.342541316 2.02567102  0.077667183 0.116937434
      2.103338203 0.166879364 0.376274589 0.039961122 0.038396932
      0.038396932 0.039865935 0.038396932 0.630914816 0.07770628
      0.038396932 0     1.470993482 0.158102549 0     0     0.078262867
      0     0     0.039865935 0.039865935 0     0     0     0.657530701
2004  1     4     3     0     1     -1    -1    89    0     0.063137392
      3.155274354 9.017004331 15.85362155 2.003129683 0.095856593
      0.989258961 2.247745753 2.291103014 3.606564764 2.459898229
      0.779380924 1.439568412 0.295557635 1.444136694 1.85980001
      1.199395034 4.451373756 0.056398524 1.387405287 1.390897364
      0.027705279 1.383469449 1.112843439 0.284348286 0.27062601
      0.050136935 0.10027387  0.050136935 0.086551595 0     0.086551595
      0.320762946 0.508259453 0.031974348 0.09598767  2.775656691
      7.177352197 7.924329486 2.756060655 0.273033898 0.059348332
      2.120410468 0.320950416 0.53174978  1.208100615 1.581266141
      0.26191663  1.162347243 1.706363065 0.741739371 1.178964613
      0.717511662 1.320809953 1.380404935 0.024203482 0     0.072829319
      0     1.128827678 1.588694055 0.101444137 0.696819636 0
      0.101413928 0.106840051 0.03641466  0.13668853  0.311372304
# NW Slope Survey
2001  1     6     3     0     1     -1    -1    27    0     0     0
      0     0     0     0     0     0     0     0.135366382 0.278440674
      1.308553795 0.372109322 1.891547654 0.683608096 3.632155802
      1.308553795 1.185287742 0.376271835 1.708977888 0     2.608371153
      0     0     0     0.156154748 1.158872724 0     0.129739729
      2.181544142 0     0.129739729 0     4.43164875  0     1.074497128
      0     0     0     0     1.029132994 3.087411084 0     4.826555092
      0     4.822743488 6.881626594 0.751164233 2.344160466 4.962417588
      5.808472602 5.372909154 4.352488396 1.988398688 1.832243941
      0.435563448 0.29115812  0.40916053  1.702504212 2.467426519
      0.156154748 0.279420801 1.851144655 1.029132994 0     1.029132994
      0.382745511 0     17.15529006
2002  1     6     3     0     1     -1    -1    42    0     1.422612545
      3.220292224 1.053478952 0.738267186 1.107400778 4.836020147
      6.942978051 3.286356402 1.314768892 3.208241629 5.006043649
      3.480603435 1.033170334 3.554191589 2.059367228 2.289582536
      1.824227691 0.637641656 0     0.395528679 0.250034561 0.791057357
      0.242112977 0.664128497 0     0.395528679 0     0     0     0
      0.42201552  0     0.395528679 2.728205856 0     1.476534371
      2.469546249 0.718692614 0.684345359 1.422612545 3.313883142
      2.737381436 0.630423533 4.491263013 2.09457087  3.757216594
      2.689515493 2.292946915 1.528284644 2.722884019 0.64556324
      1.212614098 0.791057357 0.999557125 1.014696833 1.684483604
      1.014696833 0.791149113 0.395528679 0.619168154 0.521631736
      0.250034561 0     0     0     0     0     0.42201552  3.308316624
# NW Survey
2003  1     7     3     0     1     -1    -1    72    0     0.102923647
      1.568662595 3.76893677  0.417966984 0.207864226 0.81473552
      3.5736887   3.2638661   3.971031893 2.636573835 7.105487555
      4.895688351 3.796771939 2.224060456 4.121441715 0.20135145
      2.429783804 0.550419723 0.147979738 0.021044455 0.806070598 0
      0     0     0.106243886 0     0.571167459 0.026667076 0.029360075
      0.026869896 0.026667076 0.034479403 0.022866079 2.221900798 0
      0.065154053 1.999298318 5.095297051 0.470959347 0     0.319809608
      5.47498739  3.900334093 2.047389197 2.253033671 2.558367939
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0 0.12783295 0.12576719 0.080031276 0 0.080031276
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1.537968023 7.788986226 3.094029045 0 0 0 0.470745597
0 0 0.332691973 2.116780237 3.412962274 4.233560474
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0 0.04788526 0.757348175 0.139138736 2.365691402 0.239650143
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0.37836415 1.2320855 13.96921454 6.686321644 5.449908505
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2006 1 7 3 0 1 -1 -1 50 0.095125892
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3.858865433 0 0.853262442 0.457751256 2.403126419 0
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2.12863934 0.445595336 0.05915545 0.457172103 0.043360939
0.396090339 2.614976835
2007 1 7 3 0 1 -1 -1 74 0 2.546123656
5.448880759 0.406599835 2.415670514 3.858433489 4.054515307
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      1.232929488 2.237556854 0.104881733 0.940471856 0.848388548
      0.69186653  0.590949585 0.17399323  0.848388548 0     0.113290571
      0.366764744 0.187913559 1.915581151
2009  1     7     3     0     1     -1    -1    63    0.472382783 0
      0.042849758 0.165691497 1.912922248 2.057776366 5.608983863
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      0.229627031
2010  1     7     3     0     1     -1    -1    92    0.021342092
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      1.07357853  1.164713633 0.419637738 1.759388724 0     1.612983811
      0.554721912 0.32497245  1.354952627 0.021342092 10.34120382
      0.039498969 0.821193341 0.344923166 0.566577352 0.525485776
      0.615304246 3.015507686 5.82800102  1.915447023 3.865948663
      1.02727217  2.074656041 0.926610168 2.51296236  0.106210256
      0.963038912 0.433603239 0.434885375 0.552008155 1.42662572
      0.055269809 1.42662572  0.106210256 1.365646671 0.927173618
      3.201325326 0.165815177 1.592440898 0.518856618 0.055269809
      0.463586809 0     5.254225312

0     # mean size at age adata
0     # Total number of environmental variables
0     # Total number of environmental observations
0     # No Weight frequency data
0     # No tagging data
0     # No morph composition data

999 # End data file
```

Appendix B: Control File

```
# 2011 POP control 6/23/2011
####################################################
## Prior type -1 = none, 0=normal, 1=symmetric beta, 2=full beta,
3=lognormal
####################################################

1      # N growth patterns
1      # N sub morphs within patterns
1      # Number of block designs for time varying parameters
5        # number of blocks

1940 1981 1982 1988 1989 1994 1995 2007 2009 2009

# Mortality and growth specifications
0.5    # Fraction female (birth)
0      # M setup: 0=single parameter,1=breakpoints,2=Lorenzen,3=age-
specific;4=age-specific,seasonal interpolation
1      # Growth model: 1=VB with L1 and L2, 2=VB with A0 and Linf,
3=Richards, 4=Read vector of L@A
3      # Age for growth Lmin
25     # Age for growth Lmax
0.0    # Constant added to SD of LAA (0.1 mimics SS2v1 for compatibility
only)
0      # Variability of growth: 0=CV~f(LAA), 1=CV~f(A), 2=SD~f(LAA),
3=SD~f(A)
3      #_maturity_option:  1=length logistic; 2=age logistic; 3=read
age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec
and wt from wtatage.ss
#maturity ages 0 to 40 from Hannah and Parker 2007 book bhaper (from
"Biology, Assessment, and Management of North Pacific Rockfishes")
0 0 0 0 0 0.24 0.49 0.73 0.89 0.95 0.91 0.85 0.81 0.84 0.89 0.94 0.96
0.95 0.94 0.94 0.94 0.95 0.95 0.98 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
5      # First age allowed to mature (ignored from above)
3      # Fecundity
option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0      # Hermaphroditism option:  0=none; 1=age-specific fxn
2      # MG parm offset option: 1=none, 2= M,G,CV_G as offset from GP1,
3=like SS2v1
1      # MG parm env/block/dev_adjust_method: 1=standard; 2=logistic
transform keeps in base parm bounds; 3=standard w/ no bound check

# Lo  Hi    Init  Prior Prior Prior Param Env   Use   Dev   Dev   Dev
      Block block
# bnd bnd   value mean  type  SD    phase var   dev   minyr maxyr SD
      design      switch
0.02  0.1   0.05  -2.81 -1    0.31  -2    0     0     0     0     0
      0     0     # M female
### Growth parameters
# Females
15    25    21.211      22.2214     -1    99    -3    0     0     0
      0     0     0     0     # A0
35    45    41.983      39.986      -1    99    -2    0     0     0
      0     0     0     0     # Linf
0.1   0.4   0.159  0.193718  -1     99    -3    0     0     0     0
      0     0     0     # VBK
0.03  0.16  0.072 0.1   -1    99    -5    0     0     0     0     0
      0     0     # CV of length at age 0
0.03  0.16  0.064 0.1   -1    99    -5    0     0     0     0     0
      0     0     # CV of length at age inf
```

```
-1    1     0.00  0.05 0      0.1   2     0     0     0     0     0
      0     0     # M male
# Males
-1    1     0.00  0.00 -1     99    -2    0     0     0     0     0
      0     0           # A0
-1    1     -0.059      0.00 -1     99    -2    0     0     0     0
      0     0     0     # Linf
-1    1     0.195       0.00 -1     99    -2    0     0     0     0
      0     0     0     # VBK
-1    1     0.049       0.00 -1     99    -2    0     0     0     0
      0     0     0     # CV of length at age 0
-1    1     -0.189      0.00 -1     99    -2    0     0     0     0
      0     0     0     # CV of length at age inf
# W-L, maturity and fecundity parameters
# Female Weight Length
# Estimated from BDS data 5.23.11 10:14pm
0     3     1.065E-05   1.0E-05     -1    99    -50   0     0     0
      0     0     0     0     # F W-L slope
2     4     3.08  3.05  -1    99    -50   0     0     0     0     0
      0     0     # F W-L exponent
# Maturity ok from  assessment
2     12    8     8     -1    99    -50   0     0     0     0     0
      0     0     # Age at 50% maturity
-2    4     -2.0  -2.0  -1    99    -50   0     0     0     0     0
      0     0     # Age Logistic maturity slope
#  fecundity relationship from E.J.
0     6     1.08643     1.0   -1    99    -50   0     0     0     0
      0     0     0     # mult for fec since opt 3
-3    3     1.44  1.0   -1    99    -50   0     0     0     0     0
      0     0     # exponent on weight for fecundity since option 3
# Male Weight Length
# Estimated from BDS data 5.23.11 10:14pm
0     3     1.395E-05   1.0E-05     -1    99    -50   0     0     0
      0     0     0     0     # M W-L slope
2     4     3.0   3.05  -1    99    -50   0     0     0     0     0
      0     0     # M W-L exponent
# Unused recruitment interactionM
0     2     1     1     -1    99    -50   0     0     0     0     0
      0     0     # placeholder only
0     2     1     1     -1    99    -50   0     0     0     0     0
      0     0     # placeholder only
0     2     1     1     -1    99    -50   0     0     0     0     0
      0     0     # placeholder only
0     2     1     1     -1    99    -50   0     0     0     0     0
      0     0     # placeholder only
0 0 0 0 0 0 0 0 0 0 # Unused MGparm_seas_effects

# Spawner-recruit parameters
3 # S-R function: 1=B-H w/flat top, 2=Ricker, 3=standard B-H, 4=no
steepness or bias adjustment
# Lo  Hi    Init  Prior Prior Prior Param
# bnd bnd   value mean  type  SD    phase
5     20    10.2  10    -1    5     1     # Ln(R0)
0.2   1     0.4   0.78  -1    .165  -3    # Steepness
0.5   1.2   0.7   0.76  -1    99    -6    # Sigma-R
-5    5     0     0     -1    99    -50   # Env link coefficient
-5    5     0     0     -1    99    -50   # Initial equilibrium
recruitment offset
 0    2     0     1     -1    99    -50     # Autocorrelation in rec
devs
```

```
0 # index of environmental variable to be used
0 # SR environmental target: 0=none;1=devs;_2=R0;_3=steepness
1 # Recruitment deviation type: 0=none; 1=devvector; 2=simple
deviations

# Recruitment deviations
1952  # Start year standard recruitment devs
2008  # End year standard recruitment devs
1     # Rec Dev phase

1 # Read 11 advanced recruitment options: 0=no, 1=yes
1932  # Start year for early rec devs
3     # Phase for early rec devs
5     # Phase for forecast recruit deviations
1     # Lambda for forecast recr devs before endyr+1
1954  # Last recruit dev with no bias_adjustment
1970  # First year of full bias correction (linear ramp from year
above)
2006  # Last year for full bias correction in_MPD
2009  # First_recent_yr_nobias_adj_in_MPD
0.875 # Maximum bias adjustment in MPD
0     # Period of cycles in recruitment (N parms read below)
-6    # Lower bound rec devs
6     # Upper bound rec devs
0     # Read init values for rec devs

# Fishing mortality setup
0.03  # F ballpark for tuning early phases
1999  # F ballpark year
1     # F method:  1=Pope's; 2=Instan. F; 3=Hybrid
0.95  # Max F or harvest rate (depends on F_Method)

# Init F parameters by fleet
#LO   HI    INIT  PRIOR PR_type     SD    PHASE
0     1     0     0.01  -1    99     -2

# Catchability setup
# A=do power: 0=skip, survey is prop. to abundance, 1= add par for non-
linearity
# B=env. link: 0=skip, 1= add par for env. effect on Q
# C=extra SD: 0=skip, 1= add par. for additive constant to input SE (in
ln space)
# D=type: <0=mirror lower abs(#) fleet, 0=no par Q is median unbiased,
1=no par Q is mean unbiased, 2=estimate par for ln(Q)
#        3=ln(Q) + set of devs about ln(Q) for all years. 4=ln(Q) + set
of devs about Q for indexyr-1
# A B C D
# Create one par for each entry > 0 by row in cols A-D
0     0     0     0      # Landings
0     0     0     0      # POP
0     0     0     0      # Early Triennial
0     0     0     0      # Late Triennial
0     0     0     0      # AFSC Slope
0     0     0     0      # NWFSC slope
0     0     0     0      # NWFSC Combo

#_SELEX_&_RETENTION_PARAMETERS
# Size-based setup
# A=Selex option: 1-24
# B=Do_retention: 0=no, 1=yes
# C=Male offset to female: 0=no, 1=yes
```

```
# D=Extra input (#)
# A B C D
# Size selectivity
24    1     0     0      # Landings
1     0     0     0      # POP
1     0     0     0      # Early Triennial
15    0     0     3      # Late Triennial
15    0     0     2      # AFSC Slope
15    0     0     2      # NWFSC slope
1     0     0     0      # NWFSC Combo
# Age selectivity
10    0     0     0  # Fishery
10    0     0     0  # POP
10    0     0     0  # Early Triennial
10    0     0     0   # Late Triennial
10    0     0     0   # AFSC Slope
10    0     0     0   # NWFSC Slope
10    0     0     0   # NWFSC Combo

# Selectivity parameters
# Lo  Hi    Init  Prior Prior Prior Param Env   Use   Dev   Dev   Dev
      Block block
# bnd bnd   value mean  type  SD    phase var   dev   minyr maxyr SD
      design      switch
# Fishery age-based
  # Selectivity parameters
# Lo  Hi    Init  Prior Prior Prior Param Env   Use   Dev   Dev   Dev
      Block block
# bnd bnd   value mean  type  SD    phase var   dev   minyr maxyr SD
      design      switch
# Block design 1 means that parm’ = baseparm + blockparm, 2 means that
parm’ = blockparm
# Fishery length-based
20    45    31    28    -1    50    2     0     0     0     0     0
      0     0 # Peak
-6    4     -5    -1    -1    50    -2    0     0     0     0     0
      0     0 # Top
-1    9     2     4     -1    50    3     0     0     0     0     0
      0     0 # Asc width
-1    9     0     4     -1    50    3     0     0     0     0     0
      0     0 # Desc width
-5    9     -4.99 -4    -1    50    4     0     0     0     0     0
      0     0 # Init
-5    9     1     -2    -1    50    2     0     0     0     0     0
      0     0 # Final
# Retention
15    45    27    35    -1    99    1     0     0     0     0     0.5
      0     0 # Inflection
0.1   10    2     1     -1    99    1     0     0     0     0     0.5
      0     0 # Slope
0.001 1     0.7   0.6   -1    99    1     0     0     0     0     0.5
      1     2 # Asymptote
0     0     0     0     -1    99    -3    0     0     0     0     0.5
      0     0 # Male offset
# POP and slope surveys

20    70    25    30    -1    99    2     0     0     0     0     0
      0     0     #infl_for_logistic
0.001 50    11    15    -1    99    3     0     0     0     0     0
      0     0     #95%width_for_logistic
```

```
# Triennial

18    70    25    30    -1    99    2     0     0     0     0     0
      0     0     #infl_for_logistic
0.001 50    11    15    -1    99    3     0     0     0     0     0
      0     0     #95%width_for_logistic
# NWFSC Combo

20    70    25    30    -1    99    2     0     0     0     0     0
      0     0     #infl_for_logistic
0.001 50    11    15    -1    99    3     0     0     0     0     0
      0     0     #95%width_for_logistic
1     # Selex block setup: 0=Read one line apply all, 1=read one line
each parameter
# Lo  Hi    Init  Prior P_type      SD    Phase
0.001 1     .999  .9    0     99    -1
0.001 1     .98   .9    0     99    -1
0.001 1     .9    .88   0     99    1
0.001 1     .8    .82   0     99    1
0.001 1     .6    .65   0     99    1

# -6  4     0     0     0     50    3
# 31  100   40    55    0     99    3

#Sel Parameter Adjustment Method 1 = direct, 2 = logistic and compare
to bounds
1

0 # Tagging flag: 0=no tagging parameters,1=read tagging parameters

### Likelihood related quantities ###
1 # Do variance/sample size adjustments by fleet (1)
# # Component
 0    0.11  0     0.27  0     0.47  0.29  # Constant added to index CV
 0    0     0     0     0     0     0     # Constant added to discard
SD
 0    0     0     0     0     0     0     # Constant added to body
weight SD
 1    1     1     1     .85   1     1     # multiplicative scalar for
length comps
 1    .4    .7    .84   1     1     1     # multiplicative scalar for
agecomps
 1    1     1     1     1     1     1     # multiplicative scalar for
length at age obs


1     # Lambda phasing: 1=none, 2+=change beginning in phase 1
1     # Growth offset likelihood constant for Log(s): 1=include, 2=not
0 # N changes to default Lambdas = 1.0
# Component codes:
#  1=Survey, 2=discard, 3=mean body weight
#  4=length frequency, 5=age frequency, 6=Weight frequency
#  7=size at age, 8=catch, 9=initial equilibrium catch
#  10=rec devs, 11=parameter priors, 12=parameter devs
#  13=Crash penalty
# Component fleet/survey  phase  value  wtfreq_method

0     # Extra SD reporting switch

999 # End control file
```

Appendix C: Starter File

```
#  starter file

POP_data.SS       # Data file
POP_control.SS # Control file

0     # Read initial values from .par file: 0=no,1=yes
1     # DOS display detail: 0,1,2
2     # Report file detail: 0,1,2
0     # Detailed checkup.sso file (0,1)
0     # Write parameter iteration trace file during minimization
0     # Write cumulative report: 0=skip,1=short,2=full
0     # Include prior likelihood for non-estimated parameters
0     # Use Soft Boundaries to aid convergence (0,1) (recommended)
1     # N bootstrap datafiles to create
25    # Last phase for estimation
1     # MCMC burn-in
1     # MCMC thinning interval
0     # Jitter initial parameter values by this fraction
-1    # Min year for spbio sd_report (neg val = styr-2, virgin state)
-2    # Max year for spbio sd_report (neg val = endyr+1)
0     # N individual SD years
0.00001 # Ending convergence criteria
0     # Retrospective year relative to end year
3     # Min age for summary biomass
1     # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy;
3=rel X*B_styr
1.0   # Fraction (X) for Depletion denominator (e.g. 0.4)
1     # (1-SPR)_reporting:  0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY);
3=rel(1-SPR_Btarget); 4=notrel
1     # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num);
3=sum(frates)
0     # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt

999 # end of file marker
```

Appendix D: Forecast File

```
 # 2011 POP forecast file
1     # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2     # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set
to F(endyr)
0.5   # SPR target (e.g. 0.40)
0.4   # Biomass target (e.g. 0.40)
# Enter either: actual year, -999 for styr, 0 for endyr, neg number for
rel. endyr
2005 2008 2005 2008 2005 2008 # Bmark_years: beg_bio end_bio beg_selex
end_selex beg_alloc end_alloc
2     # Bmark_relF_Basis: 1 = use year range; 2 = set relF same as
forecast below
1     # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (use
first-last alloc yrs); 5=input annual F
12    # N forecast years
1.0   # F scalar (only used for Do_Forecast==5)
# Enter either: actual year, -999 for styr, 0 for endyr, neg number for
rel. endyr
2005 2008 2005 2008 # Fcast_years:  beg_selex end_selex beg_alloc
end_alloc
1     # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.4   # Control rule Biomass level for constant F (as frac of Bzero,
e.g. 0.40)
0.1   # Control rule Biomass level for no F (as frac of Bzero, e.g.
0.10)
1.0   # Control rule target as fraction of Flimit (e.g. 0.75)
3     # N forecast loops (1-3) (fixed at 3 for now)
3     # First forecast loop with stochastic recruitment (fixed at 3 for
now)
-1    # Forecast loop control #3 (reserved)
0     #_Forecast loop control #4 (reserved for future bells&whistles)
0     #_Forecast loop control #5 (reserved for future bells&whistles)
2013  # FirstYear for caps and allocations (should be after any fixed
inputs)
0.0   # stddev of log(realized catch/target catch) in forecast
0     # Do West Coast gfish rebuilder output (0/1)
2001  # Rebuilder:  first year catch could have been set to zero
(Ydecl)(-1 to set to 1999)
2011  # Rebuilder:  year for current age structure (Yinit) (-1 to set
to endyear+1)
1     # fleet relative F:  1=use first-last alloc year; 2=read
seas(row) x fleet(col) below
2     # basis for fcast catch tuning and for fcast catch caps and
allocation  (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
-1    # max totalcatch by fleet (-1 to have no max)
-1    # max totalcatch by area (-1 to have no max)
1     # fleet assignment to allocation group (enter group ID# for each
fleet, 0 for not included in an alloc group)
# assign fleets to groups
1.0
# allocation fraction for each of: 2 allocation groups
2 # Number of forecast catch levels to input (else calc catch from
forecast F)
2 # basis for input Fcast catch:  2=dead catch; 3=retained catch;
99=input Hrate(F) (units are from fleetunits; note new codes in
SSV3.20)
2011 1 1 180
2012 1 1 183
999 # verify end of input
```