Status of the U.S. petrale sole resource in 2012

by

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Executive Summary

Stock

This assessment reports the status of the petrale sole (*Eopsetta jordani*) resource off the coast of California, Oregon, and Washington using data through 2012. While petrale sole are modeled as a single stock, the spatial aspects of the coast-wide population are addressed through geographic separation of data sources/fleets where possible. There is currently no genetic evidence suggesting distinct biological stocks of petrale sole off the U.S. coast. The limited tagging data available to describe adult movement suggests that petrale sole may have some homing ability for deep water spawning sites but also have the ability to move long distances between spawning sites and seasonally.

Catches

While records do not exist, the earliest catches of petrale sole are reported in 1876 in California and 1884 in Oregon. Fishery removals were divided among 4 fleets: 1) winter North trawl, 2) summer North trawl, 3) winter South trawl, and 4) summer South trawl. Landings for the North fleet are defined as fish landed in Washington and Oregon ports. Landings for the South fleet are defined as fish landed in California ports. Recent annual catches during 1981–2012 range between 749-2,903 mt (Table a, Figure a). Petrale sole are almost exclusively caught by trawl fleets; non-trawl gears contribute less than 3% of the catches. Based on the 2005 assessment, annual catch limits (ACLs) were reduced to 2499 mt for 2007-2008. Following the 2009 assessment ACLs were further reduced to a low of 976 mt for 2011 and have subsequently increased to a high value of 2,652 for 2014. From the inception of the fishery through the war years, the vast majority of catches occurred between March and October (the summer fishery), when the stock is dispersed over the continental shelf. The post-World War II period witnessed a steady decline in the amount and proportion of annual catches occurring during the summer months (March-October). Conversely, petrale catch during the winter season (November–February), when the fishery targets spawning aggregations, has exhibited a steadily increasing trend since the 1940s. Since the mid-1980s until recently, catches during the winter months have been roughly equivalent to or exceeded catches throughout the remainder of the year (Figure a).

Table a: Recent Catches based on the November 1 – October 31 fishing year.

Fishing Year	North Catch (mt)	South Catch (mt)	Total Catch (mt)
2003	1,258	436	1,694
2004	1,759	444	2,204
2005	2,032	871	2,903
2006	1,549	579	2,128
2007	1,466	879	2,346
2008	1,196	933	2,130
2009	1,488	720	2,209
2010	550	199	749
2011	645	117	762
2012	884	232	1,116

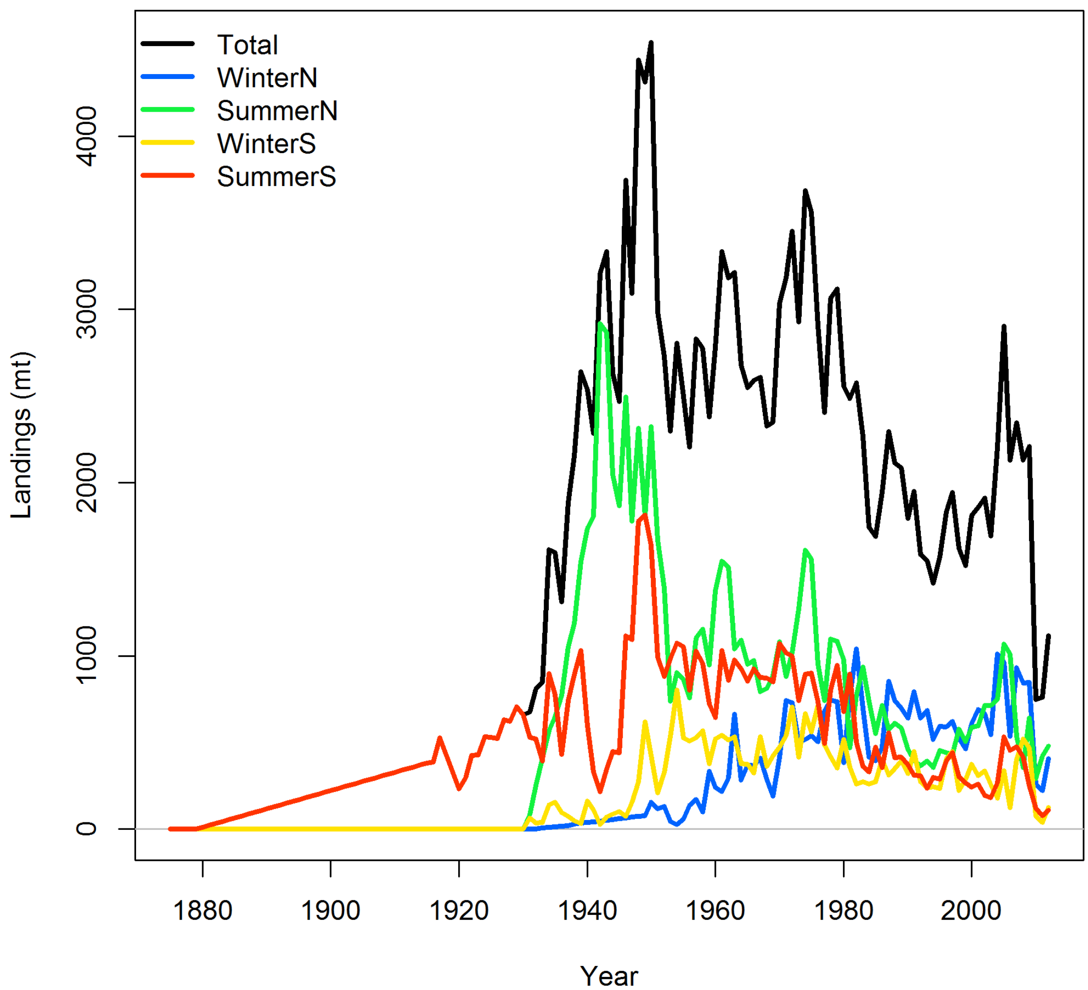

Figure a: Catch History

Data and assessment

The previous stock assessment for petrale sole was developed during 2011 using Stock Synthesis 3, an integrated length-age structured model. The current assessment has been upgraded to a newer version of SS (3.24o, R. Methot) and is structured as an annual model with the start of the fishing year on November 1 and ending on October 31. The fisheries are structured seasonally based on winter (November to February) and summer (March to October) fishing seasons due to the development and growth of the wintertime fishery, beginning in the 1950s. In recent decades the wintertime catches often exceed the summertime catches. The four fisheries are divided into North Winter, North Summer, where the north includes both Washington and Oregon, and South Winter, and South Summer, which encompasses California fisheries. The model includes catch, length- and age-frequency data from the trawl fleets described above as well as standardized winter fishery CPUE indices. While the impact of rapidly changing regulations in the trawl fishery after 2000 can make the fishery-based CPUE indices unreliable, the standardized fishery CPUE indices attempt to account for the impact of some of the management changes. Biological data are derived from both port and on-board observer sampling programs. The National Marine

Fisheries Service (NMFS) early (1980, 1983, 1986, 1989, 1992) and late (1995, 1998, 2001, and 2004) triennial bottom trawl survey and the Northwest Fisheries Science Center (NWFSC) trawl survey (2003–2012) relative biomass indices and biological sampling provide fishery independent information on relative trend and demographics of the petrale sole stock.

The base case assessment model includes parameter uncertainty from a variety of sources, but likely underestimates the uncertainty in recent trends and current stock status. For this reason, in addition to asymptotic confidence intervals (based upon the model's analytical estimate of the variance near the converged solution), results from models that reflect alternate states of nature regarding the rate of female natural mortality are presented as a decision table.

Stock biomass

Petrale sole were lightly exploited during the early 1900s, but by the 1950s the fishery was well developed and showing clear signs of depletion and declines in catches and biomass (Figures a, b). The rate of decline in spawning biomass accelerated through the 1930s–1970s reaching minimums generally around or below 10% of the unexploited levels during the 1980s through the early 2000s (Figure b). The petrale sole spawning stock biomass is estimated to have increased slightly from the late 1990s, peaking in 2005, in response to above average recruitment (Table b, Figure b). However, this increasing trend reversed between 2005 and 2010 and the stock declined, most likely due to strong year classes having passed through the fishery (Table b). Since 2010 the total biomass of the stock has increased as large recruitments during the late 2000s appear to be moving into the population. The estimated relative depletion level in 2013 is 22.3% of unfished biomass (~95% asymptotic interval: 15.1% - 29.5%, ~ 75% interval based on the range of states of nature: 18.2% - 27.6%), corresponding to 7,233 mt (~95% asymptotic interval: 5,668 – 8,796 mt, states of nature interval: 6,800 – 7,846 mt) of female spawning biomass in the base model (Table b). The base model indicates that the spawning biomass was generally below 25% of the unfished level between the 1960s and 2013.

Table b: Recent trend in beginning of the year biomass and depletion

Fishing Year	Spawning Biomass (mt)	~95% confidence interval	Range of states of nature	Estimated depletion	~95% confidence interval	Range of states of nature
2004	4,229	3783 - 4673	3933 - 4645	13%	9.5% - 16.6%	0.105 - 0.163
2005	4,618	4146 - 5089	4305 - 5059	14.20%	10.4% - 18.1%	0.115 - 0.178
2006	4,354	3876 - 4829	4042 - 4793	13.40%	9.7% - 17.1%	0.108 - 0.169
2007	4,230	3749 - 4710	3931 - 4695	13%	9.5% - 16.6%	0.105 - 0.164
2008	3,868	3369 - 4365	3580 - 4274	11.90%	8.5% - 15.3%	0.096 - 0.15
2009	3,612	3063 - 4160	3325 - 4017	11.10%	7.8% - 14.4%	0.089 - 0.141
2010	3,378	2729 - 4025	3072 - 3804	10.40%	7% - 13.8%	0.082 - 0.134
2011	4,146	3324 - 4967	3809 - 4616	12.80%	8.7% - 16.9%	0.102 - 0.162
2012	5,465	4351 - 6577	5081 - 6002	16.90%	11.5% - 22.2%	0.136 - 0.211
2013	7,233	5668 - 8796	6800 - 7846	22.30%	15.1% - 29.5%	0.182 - 0.276

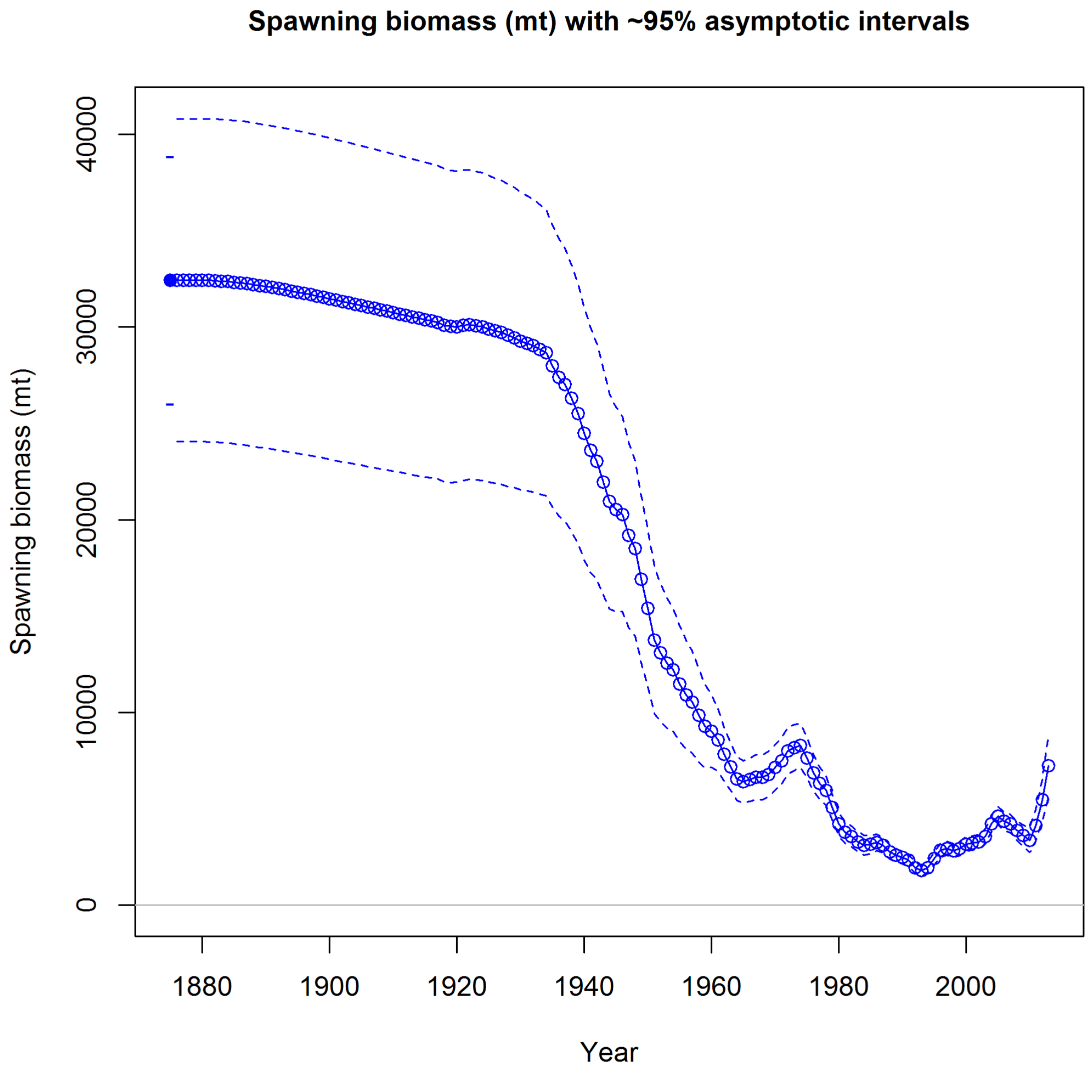

Figure b: Biomass time series.

Recruitment

Annual recruitment was treated as stochastic, and estimated as annual deviations from log-mean recruitment where mean recruitment is the fitted Beverton-Holt stock recruitment curve. The time-series of estimated recruitments shows a relationship with the decline in spawning biomass, punctuated by larger recruitments (Figure c). The three strongest recruitments during the last 10 years are estimated to be from 2007, 2008, and 2009, while the four weakest recruitments are estimated to be from 2004, 2005, and 2011 (Table c, Figure c).

Table c: Recent recruitment

Fishing Year	Estimated recruitment (1,000's)	~95% confidence interval	Range of states of nature
2004	9,841	6749 - 14352	7404 - 13925
2005	9,779	6574 - 14548	7322 - 13905
2006	15,448	10413 - 22919	11571 - 21937
2007	22,443	15060 - 33446	16899 - 31673
2008	33,214	22197 - 49699	25240 - 46356
2009	16,584	10269 - 26786	12655 - 23068
2010	11,349	6145 - 20965	8792 - 15597
2011	11,219	5287 - 23812	8582 - 15551
2012	13,824	6102 - 31324	10266 - 19571
2013	14,555	6370 - 33258	10548 - 20987

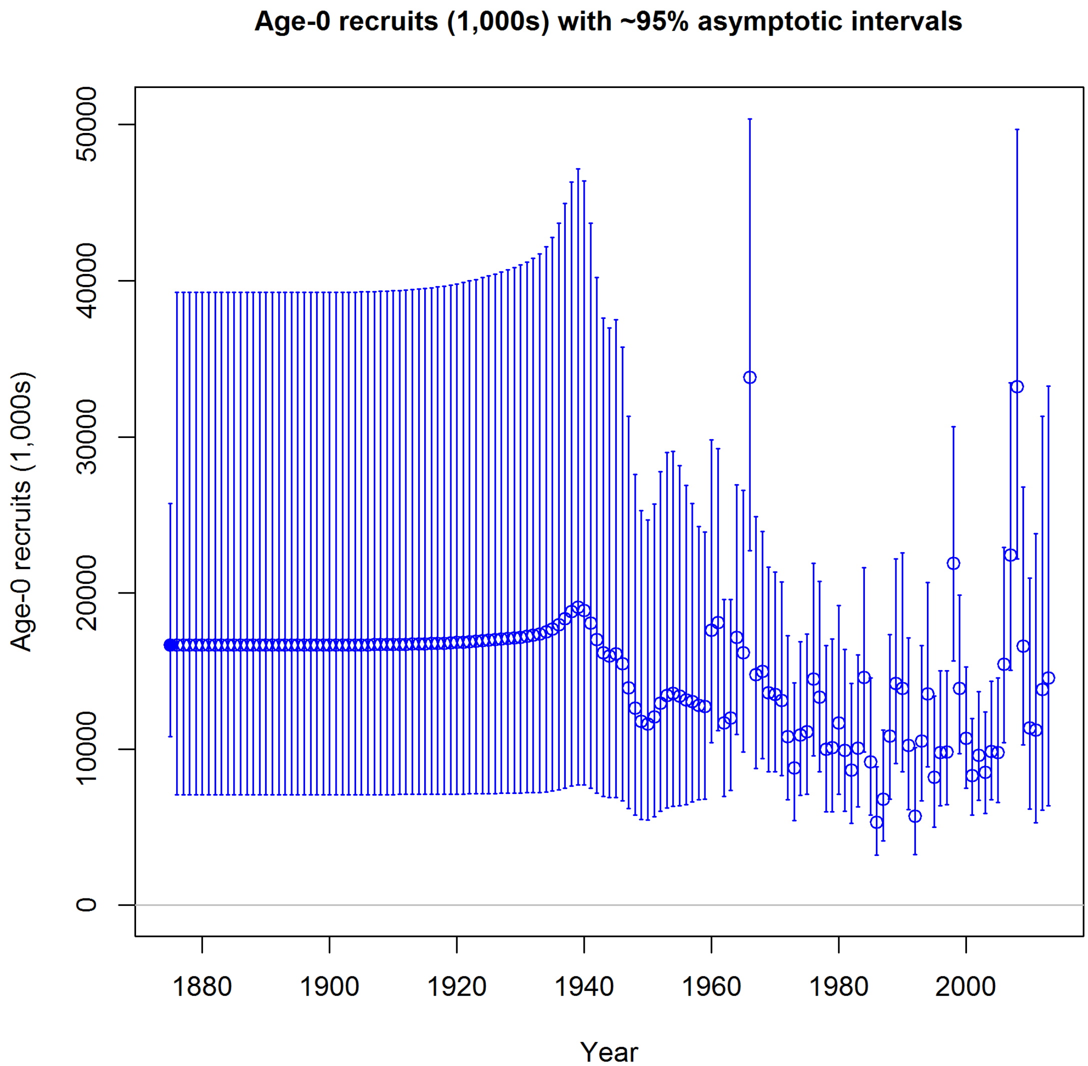

Figure c: Recruitment time series.

Exploitation status

The abundance of petrale sole was estimated to have dropped below the $SB_{25\%}$ management target during the 1960s and generally stayed there through 2013 (Figure d). The stock declined below the $SB_{12.5\%}$ overfished threshold from the early1980s until the early 2000s. In 1984 the stock dropped below 10% of the unfished spawning biomass and did not rise above the 10% level until 2001 (Figure d). Since 2000 the stock has increased, reaching a peak of 14.2% of unfished biomass in 2005, followed by a decreasing trend through 2010 (Table d, Figure d). Fishing mortality rates in excess of the current F-target for flatfish of $SPR_{30\%}$ are estimated to have begun during the 1950s and continued until 2010 (Table d, Figures e, f). Current F (catch/biomass of age-3 and older fish) is estimated to have been 0.08 during 2012, and are projected to meet the targets from 2013 forward (Table d, Figures e,f).

Table d. Recent trend in spawning potential ratio (entered as 1-SPR) and summary exploitation rate (catch divided by biomass of age-3 and older fish).

Fishing Year	Estimated 1-SPR (%)	~95% confidence interval	Harvest rate (proportion)	~95% confidence interval
2004	0.81	0.74 - 0.87	0.23	0.21 – 0.26
2005	0.84	0.79 - 0.9	0.31	0.27 – 0.34
2006	0.81	0.74 - 0.87	0.25	0.22 – 0.28
2007	0.82	0.76 - 0.89	0.28	0.24 – 0.31
2008	0.82	0.76 - 0.88	0.27	0.23 – 0.31
2009	0.84	0.77 - 0.9	0.28	0.23 – 0.33
2010	0.66	0.56 - 0.76	0.1	0.08 – 0.12
2011	0.58	0.47 - 0.68	0.07	0.05 – 0.08
2012	0.60	0.5 - 0.7	0.08	0.06 – 0.10
2013	0.73	0.64 - 0.81	0.15	0.12 – 0.19

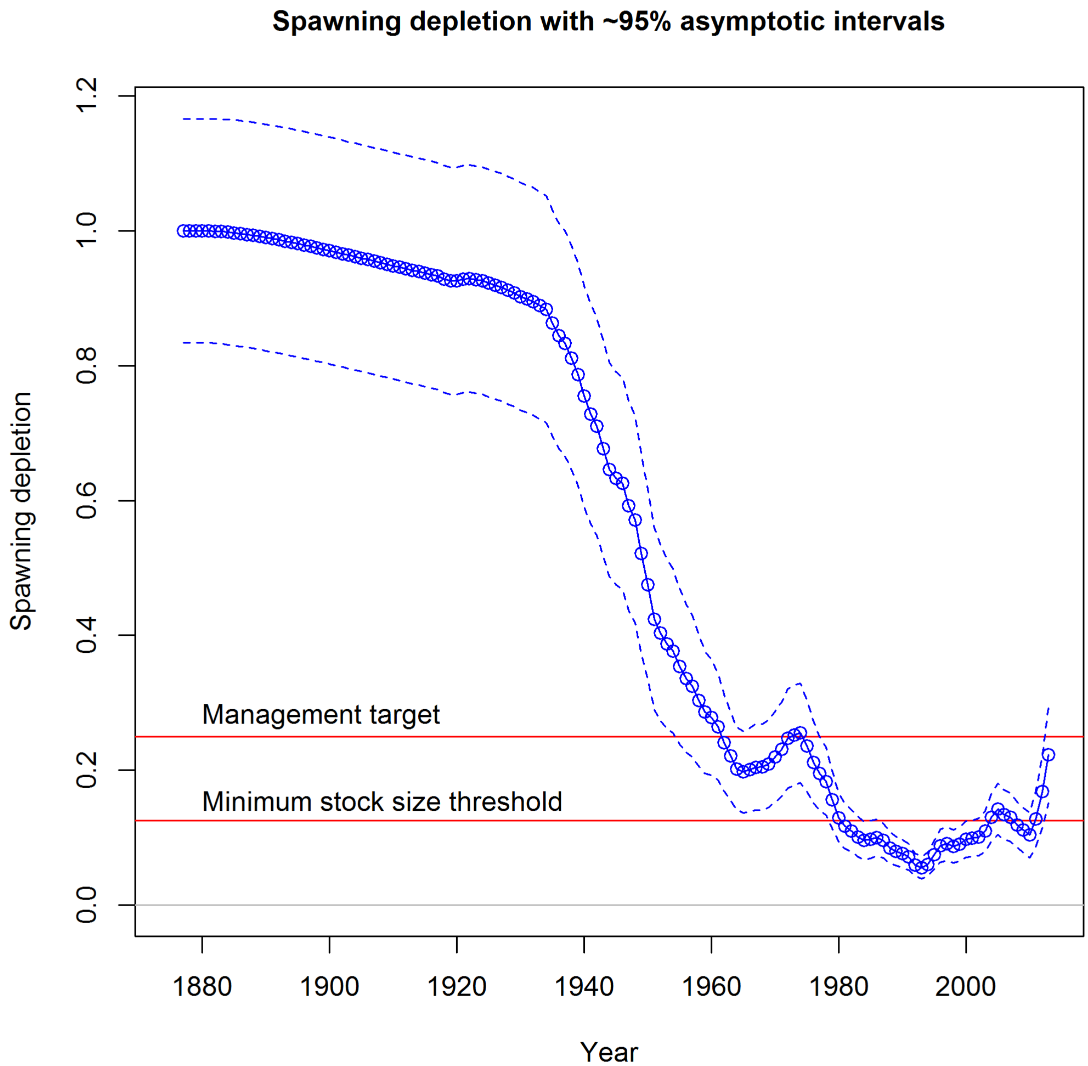

Figure d. Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines).

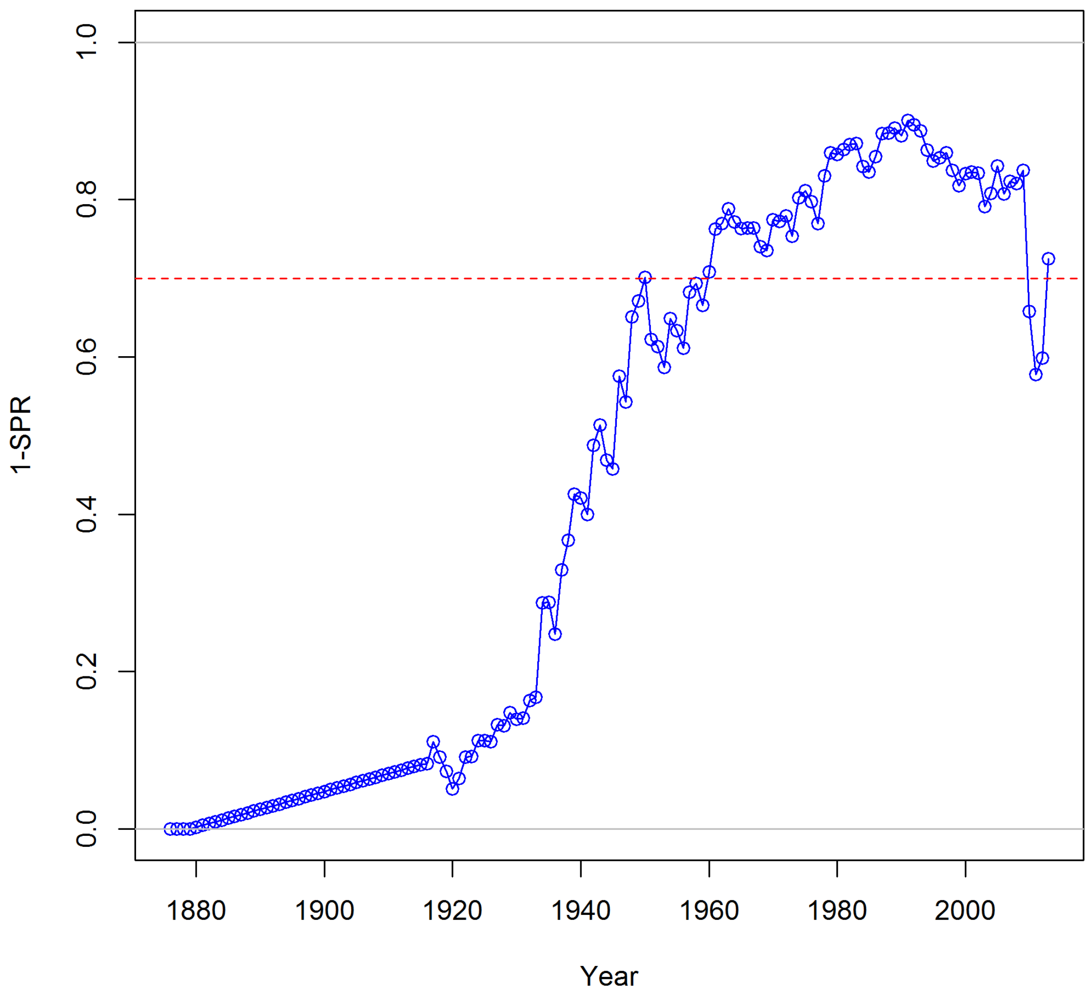

Figure e. Estimated spawning potential ratio (SPR). One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{30\%}$ harvest rate. The last year in the time series is 2013.

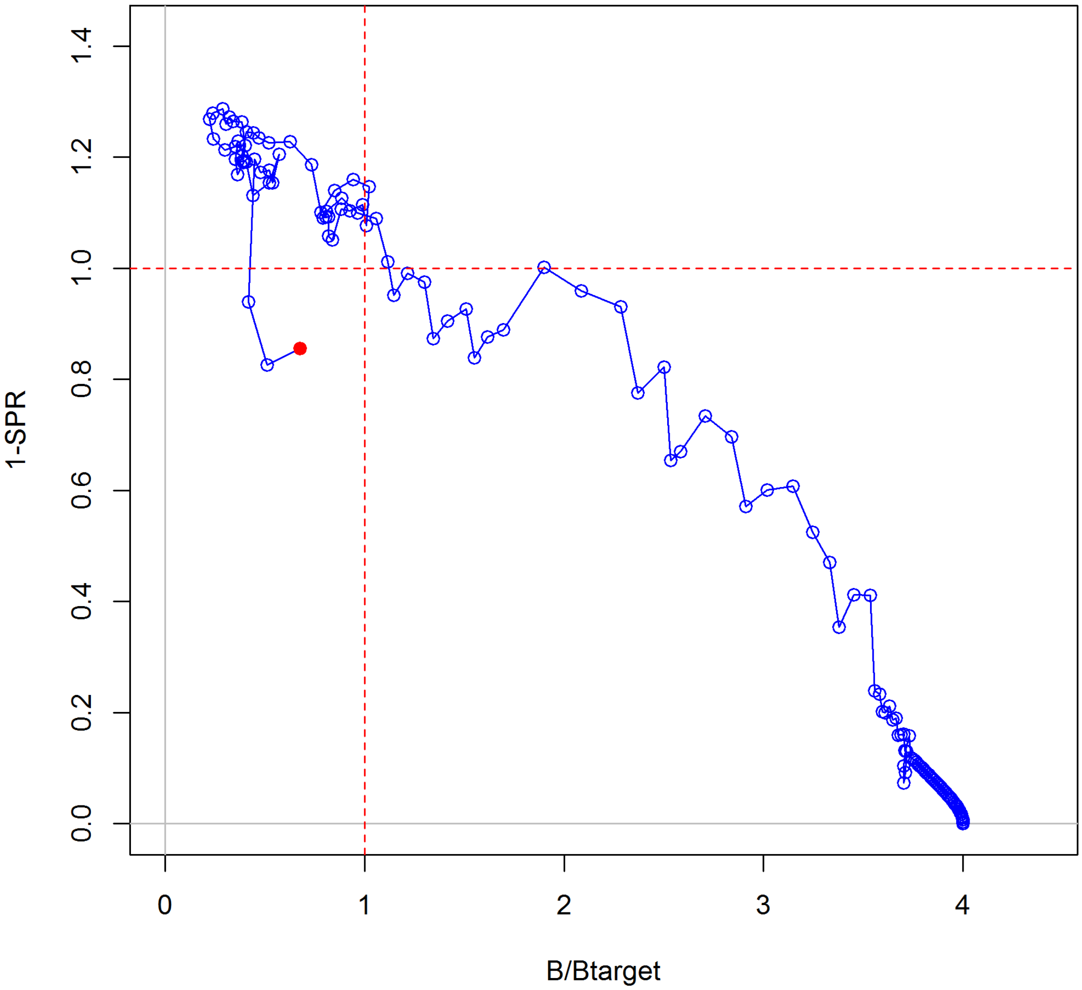

Figure f. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 30% (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 25% of the unfished spawning biomass. The red point indicates 2012.

Ecosystem considerations

Ecosystem factors have not been explicitly modeled in this assessment, but there are several aspects of the California current ecosystem that may impact petrale sole population dynamics and warrant further research. Castillo (1992) and Castillo et al. (1995) suggest that density-independent survival of early life stages is low and show that offshore Ekman transportation of eggs and larvae may be an important source of variation in year-class strength in the Columbia INPFC area. The effects of the Pacific Decadal Oscillation (PDO) on California current temperature and productivity (Mantua et al. 1997) may also contribute to non-stationary recruitment dynamics for petrale sole. The prevalence of a strong late 1990s year-class for many west coast groundfish species suggests that environmentally driven recruitment variation may be correlated among species with relatively diverse life history strategies. Although current research efforts along these lines are limited, a more explicit exploration of ecosystem processes may be possible in future petrale sole stock assessments if resources are available for such investigations.

Reference points

Pacific coast flatfish, including petrale sole, are considered overfished when the stock falls below 12.5% of unfished spawning biomass and rebuilt when it reaches 25% of unfished spawning biomass.

Unfished spawning stock biomass was estimated to be 32,426 mt in the base case model (Figure b). The target stock size ($SB_{25\%}$) is therefore 8,107 mt which gives a catch of 2,750s mt (Table e, Figure b). Model estimates of spawning biomass at MSY are slightly lower than those specified under the current harvest control rule. Maximum sustained yield (MSY) applying recent fishery selectivity and allocations was estimated at 2,761 mt, occurring at a spawning stock biomass of 7,146 mt (SPR = 0.25) (Table e).

Table e. Summary of reference points for the base case model.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning biomass (mt)	32,426	6,416
Unfished age 3+ biomass (mt)	50,132	8,241
Unfished recruitment (R0)	16,672	7,336
Depletion (2013)	0.223	0.07
Reference points based on $SB_{25\%}$		
Proxy spawning biomass ($B_{25\%}$)	8,107	1,604
SPR resulting in $B25_{\%}$ ($SPR_{30\%}$)	0.28	0.03
Exploitation rate resulting in $B_{25\%}$	0.17	0.02
Yield with *SPR* at $B_{25\%}$ (mt)	2,750	218
Reference points based on SPR proxy for MSY		
Spawning biomass	8,739	2,189
SPR_{proxy}	0.3	
Exploitation rate corresponding to SPR_{proxy}	0.16	0.03
Yield with SPR_{proxy} at SB_{SPR} (mt)	2,732	249
Reference points based on estimated MSY values		
Spawning biomass at *MSY* (SB_{MSY})	7,146	1,810
SPR_{MSY}	0.25	0.07
Exploitation rate corresponding to SPR_{MSY}	0.19	0.03
MSY (mt)	2,761	200

Management performance

The 2009 stock assessment estimated petrale sole to be at 11.6% of unfished spawning stock biomass in 2010. Based on the 2009 stock assessment, the 2010 coast-wide ACL was reduced to 1,200 mt to reflect the overfished status of the stock and the 2011 coast-wide overfishing limit (OFL) and ACL were set at 1,021 mt and 976 mt, respectively (Table f). Recent coast-wide annual landings have not exceeded the ACL. The 2005, 2009, and 2011 stock assessments estimated that petrale sole have been below 25 percent of unfished biomass from the 1960s until recently, with estimated harvest rates in excess of a fishing mortality rate of $F_{30\%}$. The length of time that the petrale sole stock had been below the 25 percent of unfished level while sustaining relatively stable annual landings lead the 2009 STAR panel and SSC to investigate new reference points for all flatfish managed by the PFMC. The end result is that new reference points were specified for flatfish. The new reference points are as follows: the target reference point is 25 percent of the unfished biomass, the overfished reference point is 12.5 percent of the unfished level, the limit reference point is 5% of the unfished level, and the F target is $F_{30\%}$. The 2011 assessment continued to estimate that petrale sole have been below the $SB_{25\%}$ management target since the 1960s and below the new overfished threshold between the early 1980s and the early 2000s with fishing mortality rates in excess of the current F-target for flatfish of $SPR_{30\%}$ since the mid-1930s. This 2013 assessment is consistent with the previous two assessments for petrale sole.

Table f. Recent trend in total catch and commercial landings (mt) based on the calendar year relative to the management guidelines. Estimated total catch reflect the commercial landings plus the model estimated discarded biomass for the calendar year.

Calendar Year	OFL (mt)	ACL (mt)	Commercial Landings (mt)	Estimated Total Catch (mt)
2004	2,762	2,762	1,953	2,248
2005	2,762	2,762	2,734	2,956
2006	2,762	2,762	2,609	2,171
2007	3,025	2,499	2,253	2,374
2008	2,919	2,499	2,220	2,153
2009	2,811	2,433	1,767	2,265
2010	2,751	1,200	797	870
2011	1,021	976	928	787
2012	1,279	1,160	1,092	1,144
2013	2,711	2,592		
2014	2774	2652		

Unresolved problems and major uncertainties

Parameter uncertainty is explicitly captured in the asymptotic confidence intervals reported throughout this assessment for key parameters and management quantities. These intervals reflect the uncertainty in the model fit to the data sources included in the assessment, but do not include uncertainty associated with alternative model configurations, weighting of data sources (a combination of input sample sizes and relative weighting of likelihood components), or fixed parameters.

There are a number of major uncertainties regarding model parameters that have been explored via sensitivity analysis. The most notable explorations involved the sensitivity of model estimates to 1) fleet/model structure, 2) use of early pre-1990s surface age error, 3) inclusion of the OR landings reconstruction and summary of landings by port, 3) use and treatment of revised winter commercial CPUE indices, and 4) exploration of selectivity and retention options including time varying (time blocks, random walk), non-time varying, and dome shaped.

Some problems remain with the Oregon commercial age data from 1981–1997 for years that have not been re-aged using break and burn reads. Ages from this period were aged using a combination of methods and in a non-random manner (i.e. one individual aged all males and another individual aged all females). While age reader information exists it is not currently in the Pacific Fishery Information Network (PacFIN) database, making it impossible to closely examine the impact of varying ageing methods and non-random reader design. This results in higher uncertainty regarding the ages from this period of the Oregon fishery. While some of these historical samples that have been aged using a combination of aging methods have been re-aged using the break and burn method, all of these years have not been re-aged. Age reader information and the aging method for each age read also need to be routinely included in PacFIN.

To date a comprehensive reconstruction of Washington landings has not been completed for west coast groundfish. This is an issue as early Washington landings for petrale sole may have been larger than the current data indicate (T.Tsou , pers. comm.). This assessment would benefit from the completion of a comprehensive groundfish catch reconstruction for the state of Washington.

Decision table

The forecast of stock abundance and yield was developed using the base model. The total catches in 2013 and 2014 are set to the PFMC adopted ACLs. The exploitation rate for 2015 and beyond is based upon an SPR of 30%(Table g). The 25:5 control rule reduces forecasted yields below those corresponding to $F_{30\%}$ if the stocks are estimated to be lower than the management target of $SB_{25\%}$. The average 2011-2012 exploitation rate was used to distribute catches among the fisheries. Uncertainty in the forecasts is based upon the three states of nature agreed upon at the STAR panel. The states of nature were based on the likelihood profile of female M, chosen using a change of 1.2 NLL units (75% interval) from the minimum value to correspond to the midpoints of the lower 25% probability and upper 25% probability regions, from the base model and are low (0.12, rounded to the second decimal place) and high (0.19, rounded to the second decimal place) values for female natural mortality. Each forecast scenario includes random variability in future recruitment deviations. Current base model medium-term forecasts project that the stock, under the current control rule, will increase through 2016 as large recruitments move into the population, reaching a stock depletion of 30% during 2016-2017 (Tables f and g). In and absence of strong recruitments into the future the stock is then expected to decline and stabilized around a stock depletion of 28% (Tables g and h). Catches during the projection period under the current control rule between 2700 mt - 2900 mt, under a control rule that stabilizes the spawning biomass at ~30% of the unfished level catches range between 2300 mt - 2500 mt, and under a control rule that stabilizes the spawning biomass at ~40% of the unfished level catches range between 1400 mt - 2200 mt (Tables g and h).

Table g. Projection of potential OFL, ACL, landings, and catch, summary biomass (age-3 and older), spawning biomass, and depletion projected with status quo catches in 2013 and 2014, and catches at the ACL from 2015 forward. The 2013 and 2014 ACL's are values specified by the PFMC and not predicted by this assessment. The ACL from 2015 forward is the calculated total catch determined by F_{SPR}.

Year	Predicted OFL (mt)	ACL Catch (mt)	Age 3+ biomass (mt)	Spawning Biomass (mt)	Depletion (%)
2013	2,711	2,592	16,954	7,233	0.22
2014	2,774	2,652	17,656	8,540	0.26
2015	2,946	2,828	18,043	9,462	0.29
2016	3,044	2,922	18,037	9,740	0.3
2017	3,015	2,895	17,803	9,592	0.3
2018	2,936	2,820	17,546	9,331	0.29
2019	2,864	2,751	17,368	9,122	0.28
2020	2,821	2,708	17,284	9,007	0.28
2021	2,804	2,692	17,269	8,966	0.28
2022	2,804	2,692	17,289	8,969	0.28
2023	2,811	2,698	17,318	8,990	0.28
2024	2,818	2,706	17,343	9,012	0.28

Table h. Summary table of 12-year projections beginning in 2015 for alternate states of nature based on an axis uncertainty. Columns range over low, mid, and high state of nature, and rows range over different assumptions of catch levels.

			State of nature					
			Low Female M = 0.12		Base case Female M = 0.15		High Female M = 0.19	
Relative probability			0.25		0.5		0.25	
Manage-ment decision	Year	Catch (mt)	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion
ABC 25:5 Rule	2015	2828	9095	0.244	9461	0.292	10017	0.352
	2016	2922	9519	0.255	9739	0.300	10137	0.357
	2017	2895	9531	0.256	9592	0.296	9819	0.346
	2018	2820	9393	0.252	9330	0.288	9427	0.332
	2019	2751	9255	0.248	9122	0.281	9145	0.322
	2020	2708	9159	0.246	9006	0.278	9005	0.317
	2021	2692	9103	0.244	8966	0.276	8971	0.316
	2022	2692	9072	0.243	8969	0.277	8993	0.316
	2023	2698	9052	0.243	8989	0.277	9033	0.318
	2024	2706	9033	0.242	9011	0.278	9066	0.319
Catch that stabilizes the stock at $\sim SB_{30\%}$	2015	2367	9095	0.244	9461	0.292	10017	0.352
	2016	2533	9784	0.262	9999	0.308	10389	0.366
	2017	2576	10049	0.270	10092	0.311	10297	0.362
	2018	2566	10130	0.272	10028	0.309	10081	0.355
	2019	2544	10164	0.273	9966	0.307	9918	0.349
	2020	2533	10199	0.274	9951	0.307	9850	0.347
	2021	2536	10243	0.275	9979	0.308	9859	0.347
	2022	2549	10290	0.276	10034	0.309	9911	0.349
	2023	2565	10334	0.277	10097	0.311	9975	0.351
	2024	2581	10370	0.278	10157	0.313	10034	0.353
Catch that stabilizes the stock at $\sim SB_{40\%}$	2015	1460	9095	0.244	9461	0.292	10017	0.352
	2016	1678	10304	0.276	10509	0.324	10886	0.383
	2017	1815	11120	0.298	11128	0.343	11288	0.397
	2018	1900	11717	0.314	11537	0.356	11498	0.405
	2019	1960	12199	0.327	11863	0.366	11666	0.411
	2020	2009	12607	0.338	12154	0.375	11838	0.417
	2021	2055	12958	0.348	12419	0.383	12018	0.423
	2022	2098	13260	0.356	12661	0.390	12198	0.429
	2023	2138	13518	0.363	12878	0.397	12368	0.435
	2024	2172	13736	0.368	13069	0.403	12519	0.441

Research and data needs

Progress on a number of research topics and data issues would substantially improve the ability of this assessment to reliably and precisely model petrale sole population dynamics in the future:

1. In the past many assessments have derived historical catches independently. The states of California and Oregon have completed comprehensive historical catch reconstructions. At the time of this assessment, a comprehensive historical catch reconstruction is not available for Washington. Completion of a Washington catch reconstruction would provide the best possible estimated catch series that accounts for all the catch and better resolves historical catch uncertainty for flatfish as a group.
2. Due to limited data, new studies on both the maturity and fecundity relationships for petrale sole would be beneficial.
3. Increased collection of commercial fishery age data as well as re-aging any available historical samples from California would help reduce uncertainty. While some recent age data were made available from California, sample sizes could be increased and this data collection needs to continue into the future. Without good age data, the ability to estimate year-class strength and the extent of variation in recruitment is compromised.
4. Where possible, historical otolith samples aged using a combination of surface and break-and-burn methods should be re-aged using the break-and-burn method. Early surface read otoliths should also be re-aged using the break and burn method. Historical otoliths aged with a standard method will allow the further evaluation of the potential impacts of consistent under aging using surface methods, changes in selectivity during early periods of time without any composition information, and potential changes in growth.
5. The effect of the implementation of the IFQ (catch shares) program that began during 2011 on fleet behavior, including impacts on discards, fishery selectivity, and fishing locations would benefit from further study.
6. Studies on stock structure and movement of petrale sole, particularly with regard to the winter-summer spawning migration of petrale sole and the likely trans-boundary movement of petrale sole between U.S. and Canadian waters seasonally.
7. The extent of spatial variability on productivity processes such as growth, recruitment, and maturity is currently unknown and would benefit from further research.

Rebuilding projections

This assessment indicates that petrale sole continue to be below the overfished threshold of 25% of unfished biomass at the start of 2013. However, the stock is estimated to be at 22.3% of unfished spawning biomass at the beginning of 2013 and is projected to rebuild to 26.3% of unfished spawning biomass at the beginning of 2014. Under the current rebuilding plan the petrale stock is managed under the flatfish control rule.

Table i. Summary table of the results.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Comm. landings (mt)	1,194	1,939	1,590	1,415	1,287	1,362	491	540	710	
Total Est. catch (mt)	2,248	2,956	2,171	2,374	2,153	2,265	870	787	1,144	
OFL (mt)	2,762	2,762	2,762	3,025	2,919	2,811	2,751	1,021	1,279	2,711
ACL (mt)	2,762	2,762	2,762	3,025	2,919	2,811	2,751	1,021	1,279	2,711
1-SPR	0.81	0.84	0.81	0.82	0.82	0.84	0.66	0.58	0.6	0.73
Exploitation rate	0.23	0.31	0.25	0.28	0.27	0.28	0.1	0.07	0.08	0.15
Age 3+ biomass (mt)	9,650	9,662	8,788	8,525	8,038	8,092	8,707	11,717	14,628	16,953
Spawning Biomass	4,229	4,618	4,354	4,230	3,868	3,612	3,378	4,146	5,465	7,233
~95% CI	3783 - 4673	4146 - 5089	3876 - 4829	3749 - 4710	3369 - 4365	3063 - 4160	2729 - 4025	3324 - 4967	4351 - 6577	5668 - 8796
Recruits (mt)	9,841	9,779	15,448	22,443	33,214	16,584	11,349	11,219	13,824	14,555
~95% CI	6749 - 14352	6574 - 14548	10413 - 22919	15060 - 33446	22197 - 49699	10269 - 26786	6145 - 20965	5287 - 23812	6102 - 31324	6370 - 33258
Depletion (%)	13%	14.20%	13.40%	13%	11.90%	11.10%	10.40%	12.80%	16.90%	22.30%
~95% CI	9.5% - 16.6%	10.4% - 18.1%	9.7% - 17.1%	9.5% - 16.6%	8.5% - 15.3%	7.8% - 14.4%	7% - 13.8%	8.7% - 16.9%	11.5% - 22.2%	15.1% - 29.5%

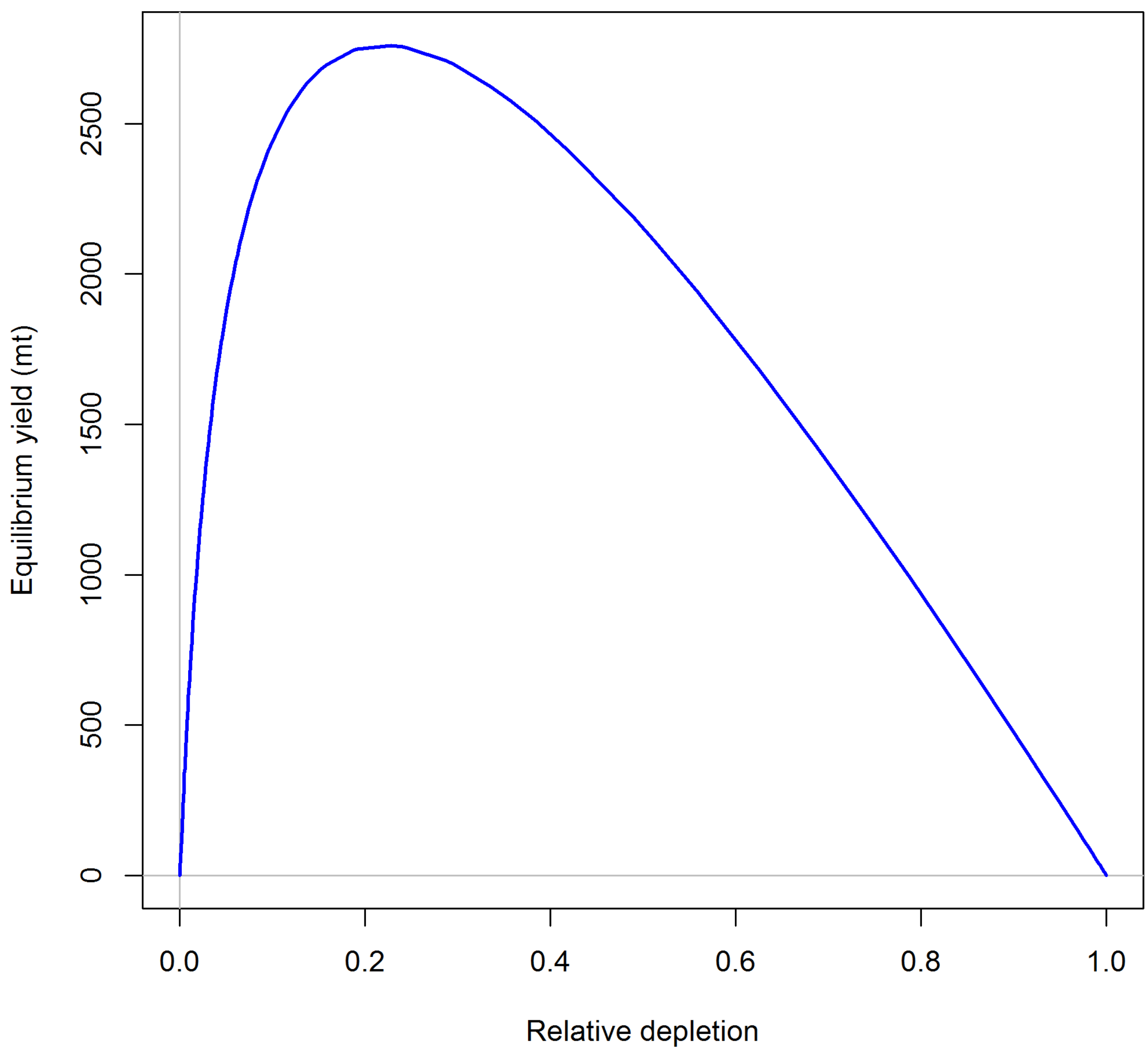

Figure g. Equilibrium yield curve. Values are based on 2012 fishery selectivity and distribution.

1 Introduction

1.1 Basic Information

Petrale sole (*Eopsetta jordani*) is a right-eyed flounder in the family Pleuronectidae ranging from the western Gulf of Alaska to the Coronado Islands, northern Baja California, (Hart 1973; Kramer et al. 1995; Love et al. 2005) with a preference for soft substrates at depths ranging from 0-550 m (Love et al. 2005). Common names include brill, California sole, Jordan's flounder, cape sole, round nose sole, English sole, soglia, petorau, nameta, and tsubame garei (Smith 1937; Hart 1973; Gates and Frey 1974; Love 1996; Eschmeyer and Herald 1983). In northern and central California petrale sole are dominant on the middle and outer continental shelf (Allen et al. 2006). PacFIN fishery logbook data show that adults are caught in depths from 18 to 1,280 m off the U.S. west coast with a majority of the catches of petrale sole being taken between 70–220 m during March through October, and between 290–440 m during November through February.

There is little information regarding the stock structure of petrale sole off the U.S. Pacific coast. No genetic research has been undertaken for petrale sole and there is no other published research indicating separate stocks of petrale sole within U.S. waters. Tagging studies show adult petrale sole can move up to 350 - 390 miles, having the ability to be highly migratory with the possibility for homing ability (Alverson 1957; MBC Appl. Environ. Sci. 1987). Juveniles show little coast-wide or bathymetric movement while studies suggest that adults generally move inshore and northward onto the continental shelf during the spring and summer to feeding grounds and offshore and southward during the fall and winter to deep water spawning grounds (Hart 1973; MBC Appl. Environ. Sci. 1987; Horton 1989; Love 1996). Adult petrale sole can tolerate a wide range of bottom temperatures (Perry et al., 1994).

Tagging studies indicate some mixing of adults between different spawning groups. DiDonato and Pasquale (1970) reported that five fish tagged on the Willapa Deep grounds during the spawning season were recaptured during subsequent spawning seasons at other deepwater spawning grounds, as far south as Eureka (northern California) and the Umpqua River (southern Oregon). However, Pederson (1975) reported that most of the fish (97%) recaptured from spawning grounds in winter were originally caught and tagged on those same grounds.

Mixing of fish from multiple deep water spawning grounds likely occurs during the spring and summer when petrale sole are feeding on the continental shelf. Fish that were captured, tagged, and released off the northwest coast of Washington during May and September were subsequently recaptured during winter from spawning grounds off Vancouver Island (British Columbia, 1 fish), Heceta Bank (central Oregon, 2 fish), Eureka (northern California, 2 fish), and Halfmoon Bay (central California, 2 fish) (Pederson, 1975). Fish tagged south of Fort Bragg (central California) during July 1964 were later recaptured off Oregon (11 fish), Washington (6 fish), and Swiftsure Bank (southwestern tip of Vancouver Island, 1 fish) (D. Thomas, California Department of Fish and Game, Menlo Park, CA, cited by Sampson and Lee, 1999).

The highest densities of spawning adults off of British Columbia, as well as of eggs, larvae and juveniles, are found in the waters around Vancouver Island. Adults may utilize nearshore areas as summer feeding grounds and non-migrating adults may stay there during winter (Starr and Fargo, 2004).

Past assessments completed by Demory (1984), Turnock et al. (1993), and Sampson and Lee (1999) considered petrale sole in the Columbia and U.S.-Vancouver INPFC areas a single stock. Sampson and Lee (1999) assumed that petrale sole in the Eureka and Monterey INPFC areas represented two additional distinct socks. The 2005 petrale sole assessment assumed two stocks, northern (U.S.-Vancouver and Columbia INPFC areas) and southern (Eureka, Monterey and Conception INPFC areas), to maintain continuity with previous assessments. Three stocks (west coast Vancouver Island, Queen Charlotte Sound, and Heceta Strait) are considered for petrale sole in the waters off British Columbia, Canada (Starr and Fargo, 2004). The 2009, 2011, and 2013 assessments integrate the previously separate north-south assessments to provide a coast-wide status evaluation. The decision to conduct a single-area assessment is based on strong evidence of a mixed stock from tagging studies, a lack of genetic studies on stock structure, and a lack of evidence for differences in growth between the 2005 northern and southern assessment areas and from examination of the fishery size-at-age data, as well as confounding differences in data collection between Washington, Oregon, and California. This 2013 assessment provides a coast-wide status evaluation for petrale sole using data through 2012.

Fishing fleets are separated both geographically and seasonally to account for spatial and seasonal patterns in catch given the coast-wide assessment area. The petrale sole fisheries possess a distinct seasonality, with catches peaking during the winter months, so the fisheries are divided into winter (November-February) and summer (March-October) fisheries (Figure 1). Note that the “fishing year” for this assessment (November 1 to October 31) differs from the standard calendar year. The U.S.-Canadian border is the northern boundary for the assessed stock, although the basis for this choice is due to political and current management needs rather than the population dynamics. Given the lack of clear information regarding the status of distinct biological populations, this assessment treats the U.S. petrale sole resource from the Mexican border to the Canadian border as a single coast-wide stock.

1.2 Map

A map showing the scope of the assessment and depicting boundaries for fisheries or data collection strata is provided in Figure 2.

1.3 Life History

Petrale sole spawn during the winter at several discrete deepwater sites (270-460 m) off the U.S. west coast, from November to April, with peak spawning taking place from December to February (Harry 1959; Best 1960; Gregory and Jow 1976; Castillo et al. 1993; Carison and Miller 1982; Reilly et al. 1994; Castillo 1995; Love 1996; Moser 1996a; Casillas et al. 1998). Females spawn once each year and fecundity varies with fish size, with one large female laying as many as 1.5 million eggs (Porter, 1964). Petrale sole eggs are planktonic, ranging in size from 1.2 to 1.3 mm, and are found in deep water habitats at water temperatures of 4–10 degrees C and salinities of 25–30 ppt (Best 1960; Ketchen and Forrester, 1966; Alderdice and Forrester 1971; Gregory and Jow 1976). The duration of the egg stage can range from approximately 6 to 14 days (Alderdice and Forrester 1971; Hart 1973; Love 1996, Casillas et al. 1998). The most favorable conditions for egg incubation and larval growth are 6–7 degrees C and 27.5–29.5 ppt (Ketchen and Forrester, 1966; Alderdice and Forrester, 1971; Castillo et al., 1995). Predators of petrale sole eggs include planktonic invertebrates and pelagic fishes (Casillas et al. 1998).

Petrale sole larvae are planktonic, ranging in size from approximately 3 to 20 mm, and are found up to 150 km offshore foraging upon copepod eggs and nauplii (Hart 1973; Moser 1996a; MBS Appl. Env. Sci 198; Casillas et al. 1998). The larval duration, including the egg stage, spans approximately 6 months with larvae settling at about 2.2 cm in length on the inner continental shelf (Pearcy 1977). Juveniles are benthic and found on sandy or sand-mud bottoms (Eschmeyer and Herald 1983; MBS Appl. Environ. Sci. 1987) and range in size from approximately 2.2 cm to the size at maturity, 50% of the population is mature at approximately 38 cm and 41 cm for males and females, respectively (Casillas et al. 1998). No specific areas have been identified as nursery grounds for juvenile petrale sole. In the waters off British Columbia, Canada larvae are usually found in the upper 50 m far offshore, juveniles at 19–82 m and large juveniles at 25–125 m (Starr and Fargo 2004).

Adult petrale sole achieve a maximum size of around 50 cm and 63 cm for males and females, respectively (Best 1963; Pedersen 1975). The maximum length reported for petrale sole is 70 cm (Hart

1973; Eschmeyer and Herald 1983; Love et al. 2005) while the maximum observed break and burn age is 31 years (Haltuch et al. 2013).

1.4 Ecosystem Considerations

Petrale sole juveniles are carnivorous, foraging on annelid worms, clams, brittle star, mysids, sculpin, amphipods, and other juvenile flatfish (Ford 1965; Casillas et al. 1998; Pearsall and Fargo 2007). Predators on juvenile petrale sole include adult petrale sole as well as other larger fish (Ford 1965; Casillas et al. 1998) while adults are preyed upon by marine mammals, sharks, and larger fishes (Trumble 1995; Love 1996; Casillas et al. 1998).

One of the ambushing flatfishes, adult petrale sole have diverse diets that become more piscivorous at larger sizes (Allen et al. 2006). Adult petrale sole are found on sandy and sand-mud bottoms (Eschmeyer and Herald 1983) foraging for a variety of invertebrates including, crab, octopi, squid, euphausiids, and shrimp, as well as anchovies. hake, herring, sand lance, and other smaller rockfish and flatfish (Ford 1965; Hart 1973; Kravitz et al. 1977; Birtwell et al. 1984; Reilly et al. 1994; Love 1996; Pearsall and Fargo 2007). In Canadian waters evidence suggests that petrale sole tend to prefer herring (Pearsall and Fargo 2007). On the continental shelf petrale sole generally co-occur with English sole, rex sole, Pacific sanddab, and rock sole (Kravitz et al. 1977).

Ecosystem factors have not been explicitly modeled in this assessment, but there are several aspects of the California current ecosystem that may impact petrale sole population dynamics and warrant further research. Castillo (1992) and Castillo et al. (1995) suggest that density-independent survival of early life stages is low and show that offshore Ekman transportation of eggs and larvae may be an important source of variation in year-class strength in the Columbia INPFC area. The effects of the Pacific Decadal Oscillation (PDO) on California current temperature and productivity (Mantua et al. 1997) may also contribute to non-stationary recruitment dynamics for petrale sole. The prevalence of a strong late 1990s year-class for many west coast groundfish species suggests that environmentally driven recruitment variation may be correlated among species with relatively diverse life history strategies. Although current research efforts along these lines are limited, a more explicit exploration of ecosystem processes may be possible in future petrale sole stock assessments.

1.5 Fishery Information

Petrale sole have been caught in the flatfish fishery off the U.S. Pacific coast since the late 19th century. The fishery first developed off of California where, prior to 1876, fishing in San Francisco Bay was by hand or set lines and beach seining (Scofield 1948). By 1880 two San Francisco based trawler companies were running a total of six boats, extending the fishing grounds beyond the Golden Gate Bridge northward to Point Reyes (Scofield 1948). Steam trawlers entered the fishery during 1888 and 1889, and four steam tugs based out of San Francisco were sufficient to flood market with flatfish (Scofield 1948). By 1915 San Francisco and Santa Cruz trawlers were operating at depths of about 45–100 m with catches averaging 10,000 lbs per tow or 3,000 lbs per hour (Scofield 1948). Flatfish comprised approximately 90% of the catch with 20–25% being discarded as unmarketable (Scofield 1948). During 1915 laws were enacted that prohibited dragging in California waters and making it illegal to possess a trawl net from Santa Barbara County southward (Scofield 1948). By 1934 twenty 56–72 foot diesel engine trawlers operated out of San Francisco fishing between about 55 and 185 m (Scofield 1948). From 1944-1947 the number of California trawlers fluctuated between 16 and 46 boats (Scofield 1948). Although the flatfish fishery in California was well developed by the 1950s and 1960s, catch statistics were not reported until 1970 (Heimann and Carlisle 1970). In this early California report petrale sole landings during 1916 to 1930 were not separated from the total flatfish landings. During 1931–68, the landings of petrale sole averaged about 700 mt annually.

The earliest trawl fishing off Oregon began during 1884-1885, and the fishery was solidly established by 1937, with the fishery increasing rapidly during WWII (Harry and Morgan, 1961). Initially trawlers stayed close to the fishing grounds adjacent to Newport and Astoria, operating at about 35–90 m between Stonewall Bank and Depoe Bay. Fishing operations gradually extended into deep water. For example, Newport-based trawlers were commonly fishing at about 185 m in 1949, at about 185–365 m by 1952, and at about 550 m by 1953.

Alverson and Chatwin (1957) describe the history of the petrale sole fishery off of Washington and British Columbia with fishing grounds ranging from Cape Flattery to Destruction Island. Petrale catches off of Washington were small until the late 1930s with the fishery extending to about 365 m following the development of deepwater rockfish fisheries during the 1950s.

By the 1950s the petrale sole fishery was showing signs of depletion with reports suggesting that petrale sole abundance had declined by at least 50% from 1942 to 1947 (Harry 1956). Sampson and Lee (1999) reported that three fishery regulations were implemented during 1957–67: 1) a winter closure off Oregon, Washington and British Columbia, 2) a 3,000 lb per trip limit, and 3) no more than two trips per month during 1957. With the 1977 enactment of the Magnuson Fishery Conservation and Management Act (MFCMA) the large foreign-dominated fishery that had developed since the late 1960s was replaced by the domestic fishery that continues today. Petrale sole are harvested almost exclusively by bottom trawls in the U.S. west coast groundfish fishery. Recent petrale sole catches exhibit marked seasonal variation, with substantial portions of the annual harvest taken from the spawning grounds during December and January. Evidence suggests that the winter fishery on the deepwater spawning grounds developed sporadically during the 1950s and 1960s as fishers discovered new locations (e.g., Alverson and Chatwin, 1957; Ketchen and Forrester, 1966). Both historical and current petrale sole fisheries have primarily relied upon trawl fleets. Fishery removals were divided among 4 fleets: 1) winter North trawl, 2) summer North trawl, 3) winter South trawl, and 4) summer South trawl. Landings for the North fleet are defined as fish landed in Washington and Oregon ports. Landings for the South fleet are defined as fish landed in California ports.

Historical landings reconstructions show peak catches from the summer fishery occurred during the 1940s and 1950s and subsequently declined, during which time the fleet moved to fishing in deeper waters during the winter. After the period of peak landings during the 1940s and 1950s, total landings were somewhat stable until about the late 1970s, and then generally declined until the mid-2000s. (Table 1,Figure 1). During 2009 the fishery was declared overfished and during 2010 management restrictions limited the catch to 701 mt (Table 1, Figure 1).

1.6 Summary of Management History and Performance

Beginning in 1983 the Pacific Fishery Management Council (PFMC) established coast-wide annual catch limits (ACLs) for the annual harvests of petrale sole in the waters off the US west coast (see, for example, PFMC, 2002). Previous assessments of petrale sole in the U.S.-Vancouver and Columbia INPFC areas have been conducted by Demory (1984), Turnock et al. (1993), Sampson and Lee (1999), and Lai at al. (2005) (Figure 2). Based on the 1999 assessment a coast-wide ACL of 2,762 mt was specified and remained unchanged between 2001 and 2006 (Table 2).

The 2005 assessment of petrale sole stock assessment split the stock into two areas, the northern area that included U.S.-Vancouver and Columbia INPFC areas and the southern area that included the Eureka, Monterey and Conception INPFC areas (Lai et al. 2005) (Figure 2). While petrale sole stock structure is not well understood, CPUE and geographical differences between states were used to support the use of two separate assessment areas. In 2005 petrale sole were estimated to be at 34 and 29 percent of unfished spawning stock biomass in the northern and southern areas, respectively. In spite of different models and data, the biomass trends were qualitatively similar in both areas, providing support for a coast-wide stock.

Based on the 2005 stock assessment results, ACLs were set at 3025 mt and 2919 mt for 2007 and 2008, respectively, with an ACT of 2499 mt for both years (Table 2). The 2009 coast-wide stock assessment estimated that the petrale sole stock had declined from its 2005 high to 11.6% of the unfished spawning stock biomass, resulting in an overfished declaration for petrale sole and catch restrictions. Recent coast-wide annual landings have not exceeded the ACL (PFMC 2006) (Table 2).

The 2005 stock assessment estimated that petrale sole had been below the Pacific Council's minimum stock size threshold of 25 percent of unfished biomass from the mid-1970s until just prior to the completion of the assessment, with estimated harvest rates in excess of the target fishing mortality rate implemented for petrale sole at that time ($F_{40\%}$). However, the 2005 stock assessment determined that the stock was in the precautionary zone and was not overfished (i.e., the spawning stock biomass (SB) was not below 25% of the unfished spawning stock biomass (SB_0)). In comparison to the 1999 assessment of petrale sole, the 2005 assessment represented a significant change in the perception of petrale sole stock status. The stock assessment conducted in 1999 (Washington-Oregon only) estimated the spawning stock biomass in 1998 at 39 percent of unfished stock biomass. Although the estimates of 1998 spawning-stock biomass were little changed between the 1999 and 2005 (Northern area) assessments, the estimated depletion in the 2005 assessment was much lower. The change in status between the 1999 and 2005 analyses was due to the introduction of a reconstructed catch history in 2005, which spanned the entire period of removals. The 1999 stock assessment used a catch history that started in 1977, after the bulk of the removals from the fishery had already taken place. Thus the 1999 stock assessment produced a more optimistic view of the petrale stock's level of depletion. The stock's estimated decline in status between the 2005 and 2009 assessments was driven primarily by a significant decline in the trawl-survey index over that period. The 2011 assessment concluded that the stock status continued to be below the target of 25% of unfished biomass.

The fishery for petrale sole (and groundfish in general) has been altered substantially by changes in fishery regulations implemented since 1998. Specifically, in 1996, the PFMC implemented 2-month cumulative vessel landing limits to reduce discards. Beginning in 2000, restrictions were placed on the use of large footropes (more than 8"). Large footrope gear has been prohibited from the waters inside of 275 m (150 fm) following the advent of rockfish conservation areas delineated by depth-based management lines. Although the January and February months of the winter petrale sole fishery have not been subject to vessel landing limits until recently, the 2-month limits restricted petrale sole landings from March through October, and beginning in 2006during November and February. The areas in which the winter petrale sole fishery has been allowed to operate have also been restricted by actions designed to reduce bycatch of slope rockfish. Effectively, many of the more marginal petrale sole winter fishing grounds were closed while the main fishing areas have remained open. Additionally, industry members indicated that after the 2003 vessel buyback program fishing effort for petrale sole during the winter declined. The skippers also indicated that small petrale limits during 2010 lead to large changes targeting strategies for petrale sole.

Area closures have been used by the PFMC for groundfish management since 2001. Current major area closures are: i) the Cowcod Conservation Areas (CCAs): adopted during 2000 and implemented in 2001; ii) the Yelloweye Rockfish Conservation Areas (YRCAs): the first was adopted during 2002 and implemented in 2003; and iii) the Rockfish Conservation Areas (RCAs) for several rockfish species: adopted during 2002, implemented as an emergency regulation during fall of 2002 and through regulatory amendment in 2003. Since then, RCAs have been specified continuously for regions north and south of $40^{o}10'$ N latitude for trawl and fixed-gear groups (Figure 2). The boundaries of the RCAs are delineated by depth-based management lines, and may be changed throughout the year in an effort to achieve fishery management objectives. The area between 180 m and 275 m has been continuously closed to most all bottom groundfish trawling since the implementation of the RCAs.

Vessels with exempted fishing permits (EFPs) issued under 50 CFR part 600 are allowed to operate in some conservation areas. Oregon EFP vessels were allowed to fish in the RCA using more selective 'pineapple'trawl gear (this gear has a longer headrope than footrope, allowing some rockfish a chance to escape capture) from February–October during 2003 and 2004. In pilot experiments, this gear was found to reduce the CPUE of some overfished rockfish and increase CPUE of flatfish relative to standard commercial flatfish gear (King et al. 2004). Beginning in 2005, this modified "selective flatfish" trawl gear has been required shoreward of the RCA, north of 40°10'N latitude. The skippers present at the 2011 pre-assessment workshop in Newport, OR indicated that, prior to the use of the pineapple trawl fishing took place around the clock. However, when using the pineapple trawl gear they only fish during the day because the skippers are unable to catch fish at night. The ACLs for several species under rebuilding plans have resulted in limited harvests of other groundfish in recent years.

Port sampling conducted by each state routinely samples market categories to determine the species composition of these mixed-species categories. Since 1967, various port sampling programs have been utilized by state and federal marine fishery agencies to determine the species compositions of the commercial groundfish landings off the U.S. Pacific coast (Sampson and Crone 1997). Current port sampling programs use stratified multi-stage sampling designs to evaluate the species compositions of the total landings in each market category, as well as for obtaining biological data on individual species (Crone 1995, Sampson and Crone 1997).

An IFQ program, referred to as catch shares, was implemented for the trawl fleet beginning in 2011, resulting in changes in fleet behavior and the distribution of fishing effort.

1.7 Fisheries off Canada, Alaska, and/or Mexico

The Canadian fishery developed rapidly during the late 1940s to mid-1950s following the discovery of petrale sole spawning aggregations off the west coast of Vancouver Island (Anon. 2001). Annual landings of petrale sole in British Columbia peaked at 4,800 mt in 1948 but declined significantly after the mid-1960s (Anon. 2001). By the 1970s, analysis conducted by Pederson (1975) suggested that petrale abundance was low and abundance remained low into the 1990s. In the early 1990s vessel trip quotas were established to try to halt the decline in petrale sole abundance (Anon. 2001). Winter quarter landings of petrale sole were limited to 44,000 lb per trip during 1985–91; to 10,000 lb per trip during 1991–95; and to 2,000 lb per trip in 1996. Biological data collected during 1980-1996 showed a prolonged decline in the proportion of young fish entering the population (Anon. 2001). Therefore, no directed fishing for petrale sole has been permitted in Canada since 1996 due to a continuing decline in long term abundance (Fargo, 1997, Anon. 2001). Current landings of petrale sole in Canada are very low due to the effect of the non-directed fishery. As of 2005 petrale sole off of British Columbia were treated as three "stocks" and were still considered to be at low levels. The recent assessments for the Canadian stocks have been based on catch histories and limited biological data.

The most recent assessment of petrale sole in British Columbia uses a single area combined sex delay-difference stock assessment model with knife edge recruitment (at 6 or 7 years old) and tuned to fishery CPUE, mean fish weight of the commercial landings, and a number of fishery independent surveys beginning in the early 1980s (P. Starr, pers. comm.). Stock predictions are based on average recruitment (P. Starr, pers. comm.) This assessment suggests that the stock is currently above the target reference point and that there is some evidence for above average recruitment (about 10% above average) since about 1996 (P. Starr, pers. comm.). Petrale sole in Canadian waters appear to have similar life history characteristics (Starr and Fargo 2004). The Canadian assessment has not been updated between the U.S. petrale sole 2011 and 2013 assessments.

In Alaska petrale sole are not targeted in the Bering Sea/Aleutian Island fisheries and are managed as a minor species in the "Other Flatfish" stock complex.

2 Assessment

2.1 Data

The following sources of data were used in building this assessment:

1) Fishery independent data including bottom trawl survey-based indices of abundance and biological data (age and length) from 2003-2012 (NWFSC survey) and 1980-2004 (Triennial survey).
2) Estimates of fecundity, maturity, length-weight relationships and ageing error from various sources.
3) Commercial landings from 1876-2012.
4) Estimates of discard length frequencies, mean weight, and fraction discarded in the fishery obtained from the West Coast Groundfish Observer Program (WCGOP) and the study by Pikitch et al (1988).
5) Fishery CPUE (North and South fleets, 1987-2009).

Data availability by source and year is presented in Table 3. A description of each of the specific data sources is presented below.

2.1.1 Fishery Independent Data: NWFSC trawl survey

Three sources of information are produced by this survey: an index of relative abundance, length-frequency distributions, and age-frequency distributions. Only years in which the NWFSC survey included the continental shelf (55-183 m) are considered (2003-2012) since the highest percent of positive survey tows with petrale sole are found on the continental shelf.

The NWFSC survey is based on a random-grid design; covering the coastal waters from a depth of 55 m to 1,280 m (Keller et al. 2007). This design uses four industry chartered vessels per year, assigned to a roughly equal number of randomly selected grid cells and is divided into two ‘passes’ of the coast that are executed from north to south. Two vessels fish during each pass, which have been conducted from late-May to early-October each year. This design therefore incorporates both vessel-to-vessel differences in catchability as well as variance associated with selecting a relatively small number (~700) of possible cells from a very large population of possible cells spread from the Mexican to the Canadian border. Much effort has been expended on appropriate analysis methods for this type of data, culminating in the west coast trawl survey workshop held in Seattle in November, 2006 (see background materials).

The NWFSC survey commonly encounters petrale sole along the U.S. west coast, except south of Point Conception (Table 4, Figure 3Figure 4). The survey did not fish shallower than 54 m and no petrale sole were caught deeper than 550 m. Figure 5 shows that the percentage of positive tows and the catch rate over depth peak around 100 m and decline as depth increases. The prevalence and density of petrale are generally higher in the northern latitudes (Figure 5).

Petrale sole are known to form winter spawning aggregations in deep water. It could therefore be expected that large-sized petrale sole would also appear more frequently in deep water. Figure 6 displays the mean fish length per tow of petrale sole against tow depth and shows that the mean length of females increases initially with depth and then levels out (even though the survey was conducted during the summer rather than winter). This trend of increasing size at depth is also apparent for males. Given the ontogenetic shift of increasing size at depth, the 2005 assessment (Lai et al. 2005) re-stratified the survey data into three depth strata. This assessment uses a similar approach, developed during the 2009 assessment, implementing a piece-wise linear regression (Neter et al., 1985) of year- and sex-specific mean length and depth data to aid in choosing a depth stratum boundary (Appendix A).

The NWFSC index of abundance is estimated using a delta-generalized linear mixed model (delta-GLMM, Maunder and Punt 2004), implemented using the software from Thorson and Ward (In press). For every tow, the delta-GLMM approach explicitly models both the probability that it encounters the target species (using a logistic regression), and the expected catch for an encounter (using a generalized linear model). The product of these two components yields an estimate of overall abundance (Pennington 1983). Year was always included in both model components (because it is the design variable), strata, and strata:year interactions are included as a fixed effects. The delta-mixed-model implementation was necessary to treat vessels, as vessel:year interactions as random effects for the NWFSC slope and combined shelf-slope surveys, because these vessels are selected in an open-bid for the sampling contract from the population of all possible commercial vessels (Helser et al. 2004). Lognormal and gamma errors structures were considered for the model component representing positive catches, while a Bernoulli error structure was assumed for the presence/absence model component. Additionally an option to model extreme catch events (ECEs, defined as hauls with extraordinarily large catches) as a mixture distribution was explored (Thorson et al. 2011), which has been shown to improve precision for estimated indices of abundance in simulated data in some cases (Thorson et al. 2012). However, as petrale sole are commonly encountered in the trawl survey the ECE model was not necessary. Model convergence was evaluated using the effective sample size of all estimates parameters (>500 was sought) and visual inspection of trace plots and autocorrelation plots (where a maximum lag-1 autocorrelation of <0.2 was sought). Model goodness-of-fit was evaluated using Bayesian posterior predictive checks and Q-Q plots. This method for constructing survey abundance indices was reviewed by the Pacific Fishery Management Council's Scientific and Statistical Committee (SSC). The SSC endorsed the analysis and recommended using this approach in stock assessments. When implementing the GLMM approach, it is recommended that there are at least three positive tows in each stratum/year combination. Based on the ontogenetic shift of increasing size at depth the survey tows were stratified into three depth zones (54.86–100 m, 100–183 m and 183–549 m) for each INPFC area (Figure 2). Since the Eureka Deep and Vancouver Deep strata had fewer than three observations in some years, these areas were combined with the Columbia deep area. The lognormal model with fixed strata:year interactions was chosen as it provided a lower deviance and better fit to the data compares to models with the gamma error distribution and random strata:year interactions (Figure 7). The coast-wide biomass index increases from 2003 to 2004, followed by a general decline through 2008 and 2009, and increases during 2009 through 2012 (Table 5, Figure 8).

Length bins from 12 to 62 cm in increments both 1 and 2 cm were used to summarize the length frequency of the survey catches in each year. Table 4 shows the number of lengths taken by the survey. The first bin includes all observations less than 14 cm and the last bin includes all fish larger than 62 cm. The length frequency distributions for the NWFSC survey from 2003-2012 generally show a strong cohort growing through 2005 and smaller fish entering the population beginning in 2007 (Figure 9). Age-frequency data from the NWFSC survey (Figure 10) were included in the model as conditional age-at-length distributions by sex and year. Individual length- and age-observations can be thought of as entries in an age-length key (matrix), with age across the columns and length down the rows. The approach consists of tabulating the sums within rows as the standard length-frequency distribution and, instead of also tabulating the sums to the age margin, instead the distribution of ages in each row of the age-length key is treated as a separate observation, conditioned on the row (length) from which it came. This approach has several benefits for analysis above the standard use of marginal age compositions. First, age structures are generally collected as a subset of the fish that have been measured. If the ages are to be used to create an external age-length key to transform the lengths to ages, then the uncertainty due to sampling and missing data in the key are not included in the resulting age-compositions used in the stock assessment. If the marginal age compositions are used with the length compositions in the assessment, the information content on sex-ratio and year class strength is largely double-counted as the same fish are contributing to likelihood components that are assumed to be independent. Using conditional age distributions for each length bin allows only the additional information provided by the limited age data (relative to the generally far more numerous length observations) to be captured, without creating a 'double-counting' of the data in the total likelihood. The second major benefit of using conditional age-composition observations is that in addition to being able to estimate the basic growth parameters (LminAge, LmaxAge, K) inside the assessment model, the distribution of lengths at a given age, governed by two parameters for the standard deviation of length at a young age and the standard deviation at an older age, are also quite reliably estimated. This information could only be derived from marginal age-composition observations where very strong and well-separated cohorts existed and where they were quite accurately aged and measured; rare conditions at best. By fully estimating the growth specifications within the stock assessment model, this major source of uncertainty is included in the assessment results, and bias due to size-based selectivity is avoided. Therefore, to retain objective weighting of the length and age data, and to fully include the uncertainty in growth parameters (and avoid potential bias due to external estimation where size-based selectivity is operating) conditional age-at-length compositions were developed using the NWFSC trawl survey age data.

Age distributions included bins from age 1 to age 17, with the last bin including all fish of greater age (Figure 10). These data show the growth trajectory of females reaching a maximum size near 56 cm and males reaching a maximum size of about 41 cm (Figure 11). The marginal NWFSC age-compositions, which allow for easier viewing of strong cohorts, show the strong 1998 cohort ageing from 2003 to 2007, with younger fish appearing in 2008-2012 (Figure 11). The exception to this is the female composition in 2005, where only one female fish was aged from the tow with the largest catch rate. The expansion of numbers to tow can greatly affect the marginal age distribution, but does not have as much effect on the conditional age-at-length data.

2.1.2 Fishery Independent Data: Triennial trawl survey

The triennial shelf trawl survey conducted by NMFS starting in 1977 is the second source of fishery-independent data regarding the abundance of petrale sole (Dark and Wilkins 1994). The sampling methods used in the survey over the 21-year period are most recently described in Weinberg et al. (2002); the basic design was a series of equally spaced transects from which searches for tows in a specific depth range were initiated (Figure 12). In general, all of the surveys were conducted in the mid-summer through early fall, although survey timing between years was variable (Figure 13). While the AFSC conducted all of the previous Triennial surveys, the 2004 survey was conducted by the NWFSC FRAM division following the AFSC survey protocols. Haul depths ranged from 91–457 m during the 1977 survey with no hauls shallower than 91 m. In all subsequent years the survey sampled depths from 55–366 m. Given the different depths surveyed during 1977 the results from the 1977 survey are not included in this assessment. Water hauls (Zimmermann et al., 2003) and tows located in Canadian and Mexican waters were also excluded from the analyses for this assessment. Due to changes in survey timing the Triennial data have been split into independent early (1980-1992) and late (1995-2004) survey time series. The splitting of this time series was investigated during the 2009 STAR panel due to the changes in survey timing and the expected change in petrale sole catchability because of its seasonal onshore-offshore migrations (Cook et al. 2009). Ultimately the 2009 STAR panel supported a split of the survey for the previous reasons as well as improved fits to the split time series and small changes in the estimation of the selectivity curves.

As with the NWFSC trawl survey, petrale sole were encountered throughout the West Coast (Table 6, Figure 14). Larger catch rates were observed around depths of 100 m but no trend in catch rate was apparent over latitude, other than low catch rates in the Conception INPFC area which was only partially sampled (Figure 15). An analysis of the mean length by depth also showed evidence of an ontogenetic movement of petrale to deeper water (Figure 16) and depth stratification similar to the strata used for the NWFSC survey was used for the triennial survey. Similarly to the NWFSC survey, the early and late Triennial trawl survey indices of abundance are based on a general linear model (GLM), however, random vessel effects are not included in the modeling of this survey. The early Triennial was partitioned into five strata using INPFC area and two depth strata (55 m -100 m and 100 m – 400 m): Vancouver-Columbia shallow, Eureka shallow, Vancouver-Columbia-Eureka deep, Monterey-Conception shallow, and Monterey-Conception deep. The late Triennial survey data are partitioned into seven strata, using INPFC areas and two depth strata (55 m -100 m and 100 m – 500 m) as follows: Vancouver-Columbia shallow, Vancouver- Columbia deep, Eureka shallow, Eureka deep, Monterey-Conception shallow, Monterey deep, and Conception deep. Strata were determined based on having an adequate sample size in each year-strata combination. The models fit the data well (Figure 17, Figure 18) and the estimated biomass indices are given in Table 5 and Figure 19.

Size distributions (for both 1 and 2 cm bins) were calculated following the same procedures as the NWFSC survey. The numbers of fish and number of hauls represented in each year of the survey are presented in Table 6. The length frequency distributions generally show little trend, although there is evidence of small fish in 1992 and large fish in 2004 (Figure 20).

There are no petrale sole age data from the Triennial survey.

2.1.3 Fishery Independent Data: Other

A series of trawl surveys was conducted by the ODFW during 1971–74, the data from which are stored in the survey database at the Alaska Fishery Science Center (RACEBASE). However, the data from these surveys are not included in the assessment owing to their very limited temporal and spatial coverage.

2.1.4 Biological Data: Weight-Length

The weight-length relationship is based on the standard power function: $W = a\ (L^b)$ where *W* is weight in grams and *L* is length in centimeters. The parameters from the 1999, 2005, and 2009 assessments (Sampson and Lee 1999; Lai et al. 2005) were re-estimated using data from the NWFSC survey (Figure 21). The previous assessments used length and weight data from ODFW (1971–86), WDFW market samples, and the ODFW flatfish surveys (1971–72; Demory et al., 1976). New length and weight data from the NWFSC survey estimate the following length weight relationships for males, W=0.00000305$L^{3.360544}$, and females, W=0.00000208296$L^{3.473703}$.

More recent length-weight parameters estimated for the British Columbia petrale sole suggest that petrale sole in British Columbia generally weigh less at a given size than petrale sole of the U.S. west coast (Starr and Fargo 2004).

2.1.5 Biological Data: Maturity and Fecundity

Petrale sole maturity-at-length information is generally sparse in space and time, has not been collected in a systematic fashion across time, is of varying quality, and does not always agree between studies. It is possible that maturity may have changed over time. However, it is not possible to assess this quantitatively owing to differences in when historical samples on which maturity ogives could be based were taken, and how maturity stage (visual vs. histological) was determined. The 2005 petrale sole assessment used the most recent study for the west coast of the U.S. that was based on observations collected during 2002 from Oregon and Washington (Hannah et al. 2002). The maturity observations were fitted to a logistic model:

$p_l - \frac{e^{B_0 + B_l^1}}{1 + e^{B_0 + B_l^1}}$ where p_l is the proportion of natural fish at length *l*, and B_0 and B_1 are the regression coefficients. Parameter estimates from the Hannah et al. (2002) are: β_0= -24.593, β_1=0.743. The length at 50% maturity for females is 33.1 cm (Figure 22).

2.1.6 Biological Data: Natural Mortality

The instantaneous rate of natural mortality for a wild fish population is notoriously difficult to estimate. One accepted method is to examine the age distribution of an unexploited or lightly exploited stock. This method cannot readily be applied to petrale sole given the long history of exploitation off the U.S. West Coast. Ketchen and Forrester (1966) estimated that the natural mortality coefficients were 0.18–0.26 yr^{-1} for males and 0.19–0.21 yr^{-1} for females based on a catch curve analysis (1943–45) Washington trawl data from Swiftsure Bank, off the southwest corner of Vancouver Island. However, petrale sole catches were relatively high during mid-1940s through the 1950s. Starr and Fargo (2004) estimated the instantaneous rate of natural mortality (*M*) using Hoenig's method (Hoenig 1983): $\ln(M) = 1.44 - 0.984\ln(t_{\max})$ where *M* is natural mortality and t_{max} is the maximum age of petrale sole. *M* Values of 0.22 and 0.15 were estimated given maximum ages of 20 and 30 years, respectively. An archived set of commercial samples collected between the late 1950s and early 1980s from Northern California recently found that multiple samples were aged between 20-31 years old suggesting a similar range of M values for U.S. west coast petrale sole. U.S. stock assessments prior to 2009 and current British Columbia stock assessments assumed a value of *M* = 0.2 for both sexes. A recent meta-analysis (O. Hamel, pers. comm.) produced the following normal prior distributions for females (mean = 0.151, standard deviation = 0.16) and males (mean = 0.206, standard deviation = 0.218). The Hamel priors are used for M in this stock assessment.

2.1.7 Biological Data: Length at age

Sager and Summler (1982) summarize the growth of petrale sole in length using several growth functions. Female petrale sole can grow to 70 cm total length, with males being smaller. Petrale sole can live to at least 30 yrs, although more recent data show that few are aged to be older than 17 yrs. This information on growth is subject to error for two reasons: 1) growth determination is difficult because two ageing techniques (otolith surface and break-and-burn) were used in the past, and 2) the observed lengths of young fish may be positively biased due to gear selectivity. Pederson (1975) estimated growth parameters for several locations (see Table 6 of Turnock et al. (1993)). Sampson and Lee (1999) estimated the values of the parameters of the von Bertalanffy growth curve using data based on BB readings for petrale sole older than age 3, and ODFW survey observations (1970–74) for younger ages. In the 2005 stock assessment the mean-length-at-age data used to estimate parameters for the growth equation were obtained from the 2004 NMFS triennial survey. The empirical estimate of the CV of length at age in the 2004 survey, used in Lai et al. (2005), is 0.08, the same value that was used by Sampson and Lee (1999). Beginning with the 2009 assessment length at age has been estimated inside the stock assessment model. Starting parameter values for the estimation were determined by fitting the von-Bertalanffy model ($L_i = L_\infty e^{(-k[t-t_0])}$) where L_i is length in cm at age *i*, *t* is age in years, *k* is the rate of increase in growth, t_0 is the intercept, and L_∞ is the maximum length estimated from the NWFSC survey data (Figure 11). Exploration of the NWFSC survey residuals across age and time did not show any evidence of time variation in growth (Cadigan et al. 2013).

2.1.8 Biological Data: Sex ratios

Both the Triennial and NWFSC sex ratios for petrale sole are generally about 50% each males and females. There is no indication of changes in sex ratio over time in the recent survey data. Canadian data from the most recent published stock assessment also suggests sex ratios of petrale sole in British Columbia are generally 50% males, 50% females (Starr and Fargo 2004). The fishery data show a somewhat higher proportion of females to males, as might be expected given dimorphic growth and winter fisheries that target spawning aggregations.

2.1.9 Biological Data: Aging precision and bias

Historically petrale sole have been aged using the otolith surface ageing technique by all three state agencies that provide age data (WA, OR, and CA). At some point during the 1980s the Oregon and Washington protocols for ageing petrale sole were: i) surface readings for all males, ii) surface readings for females up to age 10, and iii) BB readings for any females that appeared to be older than 10 years (Lai et al. 2005). However, age readers often failed to track gender, resulting the break and burn ages for males and females (Bob Hannah, ODFW, pers. comm.). Otoliths that were difficult to read and appeared older were also broken and burned, resulting in break and burn ages for fish younger than age 7 (Bob Hannah, ODFW, pers. comm.). The Cooperative Aging Project (CAP) formed in Newport, Oregon during 1996 and started aging petrale sole for the 1999 stock assessment. During 1999, otolith samples collected by ODFW between 1981 and 1999 were aged by three different age readers in the CAP using a combination of surface and break-and-burn (BB) techniques. The samples were not randomly distributed between age readers, that is, one reader aged all females, one reader aged primarily males (and some females), and one reader read both. Furthermore, while two of the age readers produced surface ages, one age reader was using a 'combination' ageing method where otoliths that appeared to be younger than about 10 years were surface aged and those that appeared older were broken and burned. The multitude of problems with the 1981-1999 age data for Oregon resulted in most of these data being removed from the 2005 stock assessment during the STAR panel review (Lai et al. 2005). Oregon otoliths aged for the 2005 stock assessment were solely surface aged. The Washington Department of Fish and Wildlife (WDFW) continued to use the 'combination' ageing method for all commercial otolith samples through 2008.
An unpublished study in 1981–82 by W. Barss (ODFW, Newport) indicated that ages based on otolith surface readings are biased relative to ages based on break-and-burn readings for male petrale sole, with significant under-aging for males older than about 10 years. However, the same study suggested that ages based on surface and break-and-burn (BB) readings were similar for females. Turnock et al. (1993) reported differences between ages based on surface and break-and-burn readings for males and also argued that there was no apparent bias for females. This unpublished information informed the ageing error used in the 1993 and 1999 assessments (Turnock et al., 1993; Sampson and Lee, 1999). However, given the variety of ageing protocols for petrale sole the results from early ageing bias and precision studies were reanalyzed for the 2009 stock assessment and have been applied to subsequent stock assessments.

More recent comparisons of surface and BB readings were conducted by the CAP laboratory as well as comparisons of the 'combination' and break and burn methods by the WDFW for the 2005 petrale sole stock assessment. Lai et al. (2005) concluded that CAP ages based on surface readings are younger than those based on BB readings, but the differences were not statistically significant. However, the results of the CAP study are not consistent with those from the WDFW data analyzed by Lai et al. (2005). Nevertheless, both data sets suggested that the differences in age estimates between the surface and break and burn techniques are smaller than implied by the ageing error matrix reported by Turnock et al. (1993). The September 2005 STAR Panel discussed the ageing error matrices used in the 2005 stock assessment and the implied ageing error coefficients of variation. It was concluded that the 2005 ageing error matrices are not informative and should be used with caution because the ageing method is not standardized between agencies.

Currently, Oregon commercial samples from 2000 to 2004 are exclusively surface aged. Oregon commercial samples from 2007 forward, WDFW samples from 2009 forward, and the NWFSC survey otoliths were aged using the break and burn method for most fish except those very young fish (generally age 0-3 year olds that are very clear) (P. MacDonald, pers. comm.) for which the age readers believe surface ages are reliable. It is common procedure for the CAP lab to surface read young fish with clear otoliths, no matter the species.

In order to conduct a comprehensive estimation of ageing bias and imprecision the 2009 assessment compiled and analyzed all of the available double-read data from the state of Oregon, the CAP, and the WDFW, as well information from a bomb radiocarbon age validation study for petrale sole off the U.S. west coast (Table 7) (Haltuch et al. 2013). In the 2009 analysis, all sources of ageing information were revisited both through inspection of the various cross- and double-read efforts as well as through simultaneous estimation of bias and imprecision for all studies in a rigorous statistical framework programmed in AD Model Builder (Otter Research Ltd. 2005) by A. Punt, University of Washington (Punt et al. 2008). This program estimates the underlying age distribution of a sample and can do this for multiple samples simultaneously. The most important assumption of the estimation technique is that at least one ageing method must be unbiased, so it is therefore not an age-validation. Functional forms can be explored for each method for both the age bias (none, linear, type 2) and imprecision (constant CV, or type 2 increase in CV with age) as well as the choice of minus and plus ages. Model selection is based on AIC. Sample sizes for these analyses are on the order of hundreds of double and triple reads.

The 2009 aging error analysis compressed data sets with three or more reads down into double-read data for analyses, because this reduced the number of age compositions, improving model performance. However, since 2009 the aging error model has been improved to better deal with otoliths with more than two reads. Therefore, both the 2011 and 2013 analyses used the triple read data available from the bomb radiocarbon study. The WDFW aging lab was able to re-age most of the otoliths used for the bomb radiocarbon study, both break and burn and surface ages, so the estimation of aging error for the Washington commercial samples was much improved during the 2011 assessment compared to the 2009 assessment.

Results from the bomb radiocarbon study indicated that age reader #1 break-and-burn ages are unbiased (Haltuch et al. 2013). Therefore, these ages are used as the unbiased ‘radiocarbon’ ages in the age error analysis. Sex and age reader information is available for some, but not all, of the samples. In order to increase the power of the analysis and reduce the total number of data sets in the analysis samples are pooled over age reader and sex.

The aging error analyses found that the best fit model included a non-linear bias, except for the combination age reads from both labs and the WDFW break and burn age reads, which had linear bias. The best fit models for the CAP break and burn and surface ages and the WDFW surface ages fit the standard deviation of the aging bias as a non-linear function but the best fit models for both the CAP and WDFW combination age reads as well as the WDFW break and burn reads fit a linear function for the standard deviation. Generally, all of the ageing methods applied to petrale sole are negatively biased (under ageing), particularly for older ages (Table 7, Figure 24). The break-and-burn and combination ages show a smaller negative bias at older ages than the surface ages. The WDFW break and burn and combination ages show very little bias while the surface ages show stronger negative bias, particularly after approximately age 13 (Table 7,Figure 24).

Prior age error analyses pooled all surface age reads for the CAP and WDFW labs, regardless of the time period in which those ages were produced. However, this 2013 stock assessment evaluated the possibility that surface age reads done prior to the advent of break and burn ageing were likely to produce younger surface age reads in comparison to surface age reads as break and burn age methods were being developed and researchers were realizing that surface reads produced negatively biased ages (i.e., older surface ages are likely to be more bias than more recent surface reads). Estimation of aging error for surface read otoliths completed prior to the 1990’s found a stronger negative age bias in comparison to surface ages from the later time period (Table 7, Figure 24).

2.1.10 Biological Data: Research removals

Catches of petrale sole for research purposes are very small in comparison to the trawl fishery catches and are therefore included in the total catches.

2.1.11 Biological Data: Ecosystem data

While there are studies that suggest potential qualitative ecosystem relationships for petrale sole that could be included in future stock assessments recent rigorous analysis of these relationships are lacking and time series of potentially relevant environmental data are not readily available for evaluation within the stock assessment.

2.1.12 Fishery Dependent Data: Landings

All landings for the 2013 assessment were summarized by port of landing, where available, as well as for a northern fleet consisting of Washington and Oregon and a southern fleet consisting of California. Landings for Washington and Oregon are summed into a single northern fleet due to the fact that vessels commonly fish and land in each other's waters and ports. In contrast, the 2009 and 2011 stock assessments summarized landings by catch area for each state individually. The CDFG and SWFSC provided comprehensive landings reconstruction for the California commercial fishery (Ralston et al. 2009). In some cases early CDFG data were only recorded by general catch area and subsequently allocated to port complexes. The ODFW and the NWFSC also recently completed a historical landings reconstruction that is limited to providing annual catches based on the port of landing (Gertseva et al. 2010). The California and Oregon landings reconstructions represent the best available data on landings in each state. At the time of this assessment, a comprehensive historical catch reconstruction is not available for Washington. In 2009, WDFW provided improved landings data for a few years previously reconstructed by Lai et al. (2005). The main change to the catches used in the 2013 assessment was the use of the Oregon catch reconstruction, which had slightly larger landings from approximately 1960 to 1980 and the change to summarizing California landings by port, which had slightly larger landings from approximately 1950 through the mid-1960s (Table 1, Figure 1). The landings used in this assessment begin in 1916 with the commercial landings data obtained from the following sources:

1. The PacFIN database (1981–2012 for CA and WA; 1987-2012 for OR);
2. The Pacific Marine Fisheries Commission (PMFC) Data Series for 1956-1980 (PMFC, 1979) for Washington. A comprehensive set of these data were not available for the 2005 stock assessment. The paper document was key punched after the 2007 round of assessments and is generally accepted as the best data currently available for WA catches during this period.
3. State of California landings reconstruction extending from 1931-1980 (Ralston et al. 2009). CDFG Fish Bulletins for 1916–1930 landings (Heimann and Carlisle, 1970) as reconstructed by Lai et al. (2005). The California fishery began in 1876 but no landings data are available from 1876-1915. Therefore a linear interpolation between landings of 1 ton in 1876 and the landings recorded for 1916 are used to filling this period. Lai et al. (2005) and Haltuch et al. (2009) found that this early assumed increase in the petrale sole fishery did not impact the model;
4. Oregon landings reconstruction for 1932 to 1986 (Gertseva et al. 2010);
5. WDFW landings reconstruction for 1935, 1939 and 1949– 1969 (pers. comm. T. Tsou and G. Lippert). These catches from WDFW grey literature are much larger than the catches used for Washington in the 2005 (Lai et al. 2005) stock assessment. Therefore landings for the early years that have not yet been reconstructed by WDFW are filled in by interpolating between the years with landings data;

Landings data from 1981 (1986 for Oregon) – 2012 were extracted from PacFIN (4 April 2013), as updates and corrections to the PacFIN database can cause small changes to this portion of the catch history. Monthly data are mostly unavailable for the early petrale fisheries. In years where monthly landings data were not available, all landings are assumed to be from the summer fishery because it is likely that most of the fleets operating early in the development of the fishery did not fish in deep water during winter.

Landings for the fishing year, beginning on 1 November, are summarized by fleet in Table 1 and Figure 1. The landings of petrale sole by gear types other than groundfish-trawl have been inconsequential, averaging less than 2.5% of the coast-wide landings. The non-trawl landings are included in the trawl landings but do not include discarded petrale sole (Table 8. Pikitch discard ratios.

Fishing	North winter		North summer	
Year	Mean	SD	Mean	SD
1985	0.0222	0.1103	0.0346	0.0419
1986	0.0215	0.1162	0.0343	0.0432
1987	0.027	0.1186	0.0315	0.045

Table 9). The post-World War II period witnessed a steady decline in the amount and proportion of annual landings occurring during the summer months (March-October). Conversely, petrale landings during the winter season (November–February), when the fishery targets spawning aggregations, has exhibited a steadily increasing trend since the 1940's. In the past few decades there has been a distinct seasonality in petrale sole landings that corresponds to the targeting of spawning aggregations during winter. Due to the seasonal harvesting pattern, landings in this assessment, as in previous assessments, are separated into two time periods: winter (November-February) and summer (March–October).

Although they are not used in this assessment, the Canadian landings of petrale sole can be found in Starr and Fargo (2004).

2.1.13 Fishery Dependent Data: Discards

The catch statistics in Table 1 do not include discards. Prior to the 2001 creation of the Northwest Fishery Science Center West Coast Groundfish Observer Program (NWFSC WCGOP), data on fishery discard for petrale sole was sparse and of mostly questionable quality. While several historical studies report discard estimates, in most cases the original data and estimation methods, which likely varied between studies, are not reported.

A limited 1950 study of Astoria, Oregon based trawlers estimated that 32.5% of the "number" of the petrale sole caught were discarded (Harry 1956). However, the details of the data collection as well as the original data are missing, so this value is not used in the assessment. A 1977–81 study reported annual discard factors for the U.S Vancouver and Columbia INPFC areas (total catch weight / retained catch) that ranged from 1.1 to 1.4 with an average value of 1.21 (meaning 17% of the total catch weight was discarded) (Demory 1984). However, Demory (1984) did not provide the data used to derive the discard factor, f = 1 + Discard/Retained, from which the discard rate is derived. Therefore the Demory measures of discard are not used. Scofield (1948) reported that 20–25% of the catches of sole in California were discarded during the 1940s and 1950s, but no specific date, data sources, or analyses were reported, so this value is not used in the assessment. Data collected by Pikitch et al. (1988) off the Oregon coast during 1986-1987 inform discard rates for the Oregon fisheries. Due to different analyses producing different discard rates for the Pkitch et al. (1988) data (Sampson and Lee 1999, D. Erickson , pers. comm. 2011) the NWFSC completed a comprehensive reanalysis of the data in preparation for the 2013 stock assessment cycle NWFSC staff (Table 8, J. Wallace , pers. comm.).

Discard observations for the trawl fleet from the WCGOP provide yearly discard rates (Table 9) and average weight of the discard (Table 10) based on at-sea observer data for 2002-2012 (2012 includes only the first half of the winter fishing season). While discard rates for petrale sole have typically been small, during 2011 the trawl fishery transitioned into an ITQ program referred to as catch shares, with 100%

observer coverage, resulting in many fleets with zero or near zero discard rates for 2011-2012. Length data are available from both the Pikitch et al. (1988) data (sex specific) as well as from the WCGOP data as of 2006 (sexes combined), providing length compositions of the discard (Figure 30 -Figure 35). These length compositions are used to estimate the retention curves for each fleet.

Several studies have reported retention curves for petrale sole. TenEyck and Demory (1975) reported that the age-at-50%-retention is 5.6 years for male petrale sole and 5.1 years for females, equivalent to a ~ 30 cm length-at-50%-retention. Turnock et al. (1993) estimated a logistic length-retention curve using the unpublished data collected during a mesh-size study (Wallace et al., 1996), and reported that the length-at-50%-retention was 21.3 cm. Sampson and Lee (1999) estimated the length-at-50%-retention to be 28.6 cm for males and 29.5 cm for females, based on unpublished data from the discard study by Pikitch et al. (1988).

2.1.14 Fishery Dependent Data: Foreign landings

The impact of landings of petrale sole by foreign fishing fleets prior to the institution of the exclusive economic zone (EEZ) of the U.S. west coast is currently not quantified and remains an area for research.

2.1.15 Fishery Dependent Data: Logbooks

Sampson and Lee (1999) used commercial logbook data from PacFIN to construct a delta-GLM-based standardized CPUE indices of abundance for the Oregon fleets from 1987-1997. These indices were also used in the 2005 northern area stock assessment (Lai et al. 2005) and in the 2009 coast-wide stock assessment. The logbook data for the years prior to 1987 were not included, because information on fishing location is not available for much of these data. Beginning in 1998, the west coast groundfish fishery has been subjected to a series of regulatory changes that would render extension of the Sampson and Lee index unreliable.

Lai et al. (2005) produced delta GLM-based indices of abundance for the 2005 southern area assessment using data filtered in a similar manner to Sampson and Lee (1999). However the southern area CPUE indices used more vessels that had been in the fishery a relatively short amount of time and extended the index to 2004, well beyond the time where regulatory changes began to restrict the groundfish fishery. These problems with the CPUE indices were noted during the 2005 STAR panel review.

Due to multiple changes in management beginning in the early 2000s and resulting changes in fishing behavior, for which limited data are available, and spatial closures, the 2009 stock assessment did not include commercial CPUE indices. One example of a regulatory induced change in fishing behavior is the switch from fishing around the clock to fishing only during the day with the selective flatfish trawl (‘pineapple trawl’) that began to be used in 2003 and was used coast-wide by 2005. Many of these types of changes are not well documented or are not documented at all in the logbook data.

Management and fishing behavior changes beginning during the early 2000s suggest that the changes in CPUE are likely not proportional to changes in stock abundance. In addition to the impact of changing management actions and resulting changes in fishing behavior on commercial CPUE the winter fleets were not analyzed due to concerns regarding the likelihood that changes in winter catch rates would not be proportional to changes in spawning stock biomass due to the spawning aggregations that are the target of the winter fishery (Hilborn and Walters 2001). However, in 2009 plots of raw CPUE (lbs/hour) for all fleets were calculated for comparison with the fishery independent NWFSC survey index. The downturn in the NWFSC survey index (from the summer season) between 2005 and 2008 was also apparent in the raw CPUE from the summer fisheries, although the magnitude of the changes in the CPUE was much larger than those from the survey (Haltuch et al. 2009). During the 2009 assessment review process there were concerns regarding the lack of a recent CPUE analysis for all fleets, regardless of the management impacts on the fishery. Therefore, the 2011 assessment attempted to conduct a CPUE analysis that considers some of the management impacts on the petrale fleet (Haltuch et al. 2011).

While the 2011 analysis attempted to account for the impact of management measures on the fishery it was unable to account for changes in fishing behavior, or changes in spawning aggregation dynamics with stock size during the winter spawning/fishing season. Changes in the CPUE indices from approximately the years 2000-2003 forward could be due to management measures, fishing behavior, and spawning aggregation dynamics (winter only) that were not been captured in the analysis. For example, industry reports that the 2003 vessel buyback removed some of the more productive vessels in the fleet, but there is not information on the skippers that fished those vessels, many of which may have switched to fishing on different vessels. The 2011 CPUE analysis was also unable to capture changes in fishing behavior and targeting strategies for petrale sole and the Dover-thornyhead-sablefish deep water fishery, which likely increased, as rockfish fishing opportunities became increasingly limited between the late 1990s and present. During the summer, the spatial management restrictions have changed on an annual basis and are captured only at a gross level. During the winter, the spatial areas that have remained open to fishing since 2003 have been more stable, however, little is known about petrale sole spawning aggregation dynamics and how these spawning aggregation dynamics change as the stock increased from historical low levels in the 1990s to higher levels in the mid-2000s. Ancillary evidence suggests that the timing of spawning (historically December - February) has shifted to be later in the winter season. This issue may have been captured by limiting the data used in the analysis to January-February. However little is known about how the timing of peak spawning, the duration of the spawning season, size of spawning aggregations, and density of spawning aggregations change with changes in the size of the spawning stock. It was not possible to capture these dynamics in the CPUE analysis competed for the 2011 stock assessment as there is a lack of understanding between how changes in catch rates and changes in the true population are related.

During the 2011 STAR the summer CPUE was excluded from the stock assessment model as a viable index due to the annual changes in spatial management. While the summer CPUE indices were removed from the 2011 assessment the general trends in the commercial summer CPUE were similar to the trend from the NWFSC fishery independent survey during the period of overlap. STAR panel discussions lead to the inclusion of the winter CPUE indices, modeled with a power function, due to the more consistent spatial management during the winter, regardless of the possible issues with spawning aggregation dynamics.

In preparation for the 2013 stock assessment the CPUE analyses were reanalyzed and improved (Appendix B). The major changes include the calculation of a prediction interval around the CPUE indices, the division of fishing grounds into finer spatial grids than the areas used in the 2011 analysis, the aggregation of tow by tow data to the trip level, the calculation and inclusion of new covariates to represent changes in fishing tactics over time, and evaluating the impact of modeling CPUE using a mixed effects model with vessel as the random effect. Both the summer and winter CPUE indices computed for the 2013 assessment explain a greater amount of the variation in the data than those computed for the 2011 stock assessment and generally show the same trends as the NWFSC fishery independent survey (Appendix B). The winter CPUE time series are used in the base assessment model. The north shows relatively clear periods of decline and increase during the early part of the time series, followed by a large increase in both the index and its variance between 2003 and 2004 after which the index is fairly stable (Figure 36). The southern index is more variable and shows fewer strong trends during years prior to 2004, but does show the same large increase in the index and its variance as the northern index from 2003 to 2004 (Figure 37).

2.1.16 Fishery Dependent Data: Biological sampling

Commercial landings and the biological characteristics of these landings were not consistently sampled for scientific purposes until the mid-1950s. Statewide sampling of landed catches began in 1955 in Washington, 1966 in Oregon, and sporadically in 1948 in California. The first rigorous monitoring programs that included routine collection of biological data (e.g., sex, age, size, maturity, etc.) began in 1980. Currently, port biologists employed by each state fishery agency (California Department Fish and Game, Oregon Department of Fish and Wildlife - ODFW, and Washington Department of Fish and Wildlife - WDFW) collect species-composition information and biological data from the landed catches of commercial trawling vessels. The sampling sites are commonly processing facilities located at ports in California, Oregon and Washington. The monitoring programs currently in place vary between the states but are generally based on stratified, multistage sampling designs.

The PacFIN BDS database contains data from ODFW (1966–present) and WDFW (1955– present), but only 2001– present data from CDFG. The CDFG dataset for the years prior to 2000 was extracted and provided from CALCOM by Brenda Erwin (CDFG). Demory and Bailey (1967) provide length compositions for the Columbia INPFC area for 1949–51, 1960, and 1963–65. However no information is provided on the total size of the landings or sampling protocol, making it impossible to expand the raw length data. Therefore, the Demory and Bailey (1967) data are not used in the current assessment.

Commercial length-frequency distributions based on the fishing year were developed for each state for which observations were available, following the same bin structure as was used for research observations. For each fleet, the raw observations (compiled from the PacFIN and CalCOM databases) were expanded to the sample level, to allow for any fish that were not measured, then to the trip level to account for the relative size of the landing from which the sample was obtained. The expanded length observations were then expanded by the landings in each state. Age frequencies were computed in the same manner. Length and age data collected from commercial landings for each fleet are summarized by the number of tows (Table 11 -Table 12). Figure 38 -Figure 53 show plots of the commercial length and age composition data.

2.1.17 Ecosystem data

Due to staffing constraints this assessment was unable to generate new analyses to evaluate potential ecosystem data and methodologies for this stock assessment. Given a lack of recent rigorous ecosystem analyses and peer review publications for petrale sole specifically this assessment does not directly incorporate environmental or ecosystem data.

2.2 History of Modeling Approaches Used for this Stock

2.2.1 Previous assessments

United States

Early stock assessments only assessed petrale sole in the combined U.S.-Vancouver and Columbia INPFC areas, i.e. petrale in these areas were treated as a unit stock, using time series of data that began during the 1970s (Demory 1984, Turnock et al. 1993). The first assessment used stock reduction analysis and the second assessment used the length-based Stock Synthesis model (Methot 1989). The third petrale sole assessment utilized the hybrid length-and-age-based Stock Synthesis 1 model, using data from 1977–1998 (Sampson and Lee 1999). During the 1999 stock assessment an attempt was made to include separate area assessments for the Eureka and Monterey INPFC areas but acceptable models could not be configured due to a lack of data (Sampson and Lee 1999).

The 2005, petrale sole assessment was conducted as two separate stocks, the northern stock encompassing the U.S. Vancouver and Columbia INPFC areas and the southern stock including the Eureka, Monterey and Conception INPFC areas, using Stock Synthesis 2, a length-age structured model (Methot 2000). Both the northern- and southern-area models specified the fishing year as beginning on November 1 and continuing through October 31 of the following year, with a November–February winter fishery and a March–October summer fishery. Landings prior to 1957 were assumed to have been taken during the summer season in years where monthly data were not available to split the catches seasonally. The complete catch history was reconstructed for petrale sole for the 2005 stock assessment, with the northern area model starting in 1910 and the southern area model in 1876. In 2005, the STAR panel noted that the petrale sole stock trends were similar in both northern and southern areas, in spite of the different modeling choices made for each area, and that a single coast-wide assessment should be considered. The 2009 and 2011 assessments treated petrale sole as a single coast-wide stock, with the fleets and landings structured by state (WA, OR, CA) area of catch. During the 2011 STAR panel concerns were raised regarding the difficulty of discriminating landings from Washington and Oregon waters, particularly in light of the OR historical landings reconstruction that includes a summary of data by port of landing but not by catch area, due to the fact that the OR and WA vessels commonly fish in each other's waters and land in each other's ports. The availability of the historical comprehensive landings reconstruction for OR by port of landing lead the STAR panel to recommend combining the Washington and Oregon fleets within the coast-wide stock assessment using port of landing rather than catch area. This 2013 stock assessment continues with the coast-wide stock assessment, but is restructured to summarize petrale sole landings by the port of landing and combines Washington and Oregon into a single fleet.

Canada

Ketchen and Forrester (1966) conducted the first assessment of petrale sole off British Columbia. A recent series of petrale sole assessments in Canadian waters were conducted by Tyler and Fargo (1990), Fargo (1997, 1999), Fargo et al. (2000), Starr and Fargo (2004), and Starr (2009). The 2004 stock assessment of petrale sole was based on three areas: the west coast of Vancouver Island, Queen Charlotte Sound, and Hecate Strait (Starr and Fargo, 2004). In the most recent 2006 assessment in British Columbia petrale sole are assessed using a single area, combined sex, delay-difference stock assessment model with knife edge recruitment (at 6 or 7 years old) (Starr 2009). The model is tuned to fishery CPUE, mean fish weight of the commercial landings, and a number of fishery independent surveys beginning in the early 1980s. Stock predictions are based on average recruitment.

2.2.2 GAP and GMT input

The GMT representative on the 2009 petrale sole STAR panel compiled a history of regulatory actions that impacted the petrale sole fishery, and more generally the groundfish fishery (Appendix C). The GAP representative provided ancillary information on the comparative catches of petrale sole by the fishery, indicating that during the 1980s catch rates were very poor but that recently catch rates have much improved (B. Pettinger , pers. comm.). The GAP representative, as well as other fishery participants who were present at the 2009 STAR panel, provided invaluable information regarding the history of the fishery and the timing of the impact of management regulations on fleet behavior. This information from the 2009 STAR panel GAP representative and fleet members was used to make decisions regarding the time blocking of fishery selectivity in the model. Information provided by the GAP and GMT representatives regarding the fishery for petrale sole helped guide the use of the commercial CPUE indices during the 2011 stock assessment. Discussion with industry members present at the 2013 March PFMC GAP meeting contributed the following comments that are relevant to the petrale sole fishery and stock assessment.

1. The fleet has changed fishing locations in recent years, such as moving deeper, to avoid petrale and other species with limited quotas (other overfished stocks) and non-target species (such as dogfish).
2. The petrale tribal fishery has changed since IFQ management was implemented in 2011 but not due to IFQ management. The tribal fishery generally fishes off of Cape Flattery about 20 miles, mostly in the spring and summer for smaller fish. The landings were very large in 2011; by the

July/August time period the landings were about double the tribal allocation (~100 tons). The 2012 tribal landings were ~70 tons and, due to an inability to avoid petrale, the bottom trawl fishery was cut short. These observations corroborate survey and past assessment evidence of strong incoming late 2010s year classes of petrale that are starting to move into the fishery.

3. In the Eureka-Ft. Bragg area (roughly Cape Blanco to Pt. Reyes/San Francisco) shelf fishing has either been very limited or stopped completely during the summer in favor of moving off shore so landings of shelf species like English and petrale soles are lower. This is due to bycatch avoidance of species like canary and darkblotched. There has also been a lack of observers in this area for the winter petrale fishery.
4. The winter petrale fishery, at least in the Eureka area, in recent years has been delayed and/or limited due to the Dungeness crab fishery opening during the same time period. This has limited the winter landings of petrale as many fishers choose to fish for crab due to higher value and the greater ability to retain crew for the rest of the groundfish season.
5. There is an interaction between the timing of the Canadian petrale fishery and the U.S. petrale fishery that drives when fishers are choosing to target petrale. The Canadian fishery ends in Feb, the same time as the winter U.S. petrale fishery. This results in lower prices when the Canadian fish are coming onto the market and pushes the U.S. fishery towards summer targeting as prices are higher. The timing of the Canadian and U.S. fisheries have likely been this way for a long time but with the introduction of the IFQ program fishers are paying more attention to price and the best time to fish. Prior to the IFQ there was no 'penalty' for fishing petrale in the winter, but now that petrale is limited the fishery will likely trend towards summer when prices are higher for the U.S. fleet.
6. In CA, the vessels leaving the fleet have been small 'beach' boats that fished shoreward of the RCA; they did not have enough bycatch quota to keep trawling. This may impact the size comps in CA. Some of these vessels have switched to fixed gear sablefish; some are selling quotas.
7. Due to strong bycatch penalties for yelloweye and canary in the north there has been avoidance of the beach fishery.

2.3 Response to STAR Panel Recommendations

The STAR panel report from 2011 outlined a number of research and modeling recommendations (Chen et al. 2011). Where possible, the current assessment has addressed these recommendations, the details follow.

1. The STAR panel identified the overarching unresolved problem / major uncertainty for the petrale sole stock assessment as stock structure with respect to the Canadian border and connectivity of the U.S. and Canadian 'stocks'. As there is no political or management framework to facilitate joint stock assessments and management for most groundfish species that are undoubtedly connected the STAR concluded that resolution of this issue is beyond the scope of what can be reasonably expected from the STAT. However, the 2011 STAR panel found it critical for the credibility of the management system to establish a formal framework and to conduct petrale sole assessments (and perhaps other transboundary stocks) jointly with Canada.
   - Response: A formal framework for joint stock assessment and management of U.S-Canadian transboundary groundfish stocks does not exist, with the exception of Pacific hake, so this stock assessment follows the PFMC terms of reference for groundfish stock assessments and is restricted to petrale sole in U.S. waters.

2. Conduct a formal review of all historical catch reconstructions and if possible stratify by month and area. The mixing of U.S. and Canadian catches is of particular concern for the Washington fleet.
   - Response: The PFMC is the body responsible for formal review of the California and Oregon landings reconstructions, resources to complete such a review has not been available. These catch

reconstructions have not substantially changed since those that were available during the 2011 stock assessment. A comprehensive landings reconstruction for Washington is not available.

3. Discard estimates from the WCGOP should be documented, presented and, reviewed (similar to catch reconstructions) outside of the STAR panel process. The reviewed WCGOP data should then be made available to the assessment process.
   - Response: The WCGOP discard estimates have been documented (see background materials) but have not yet been review by the PFMC.

4. Consider combining Washington and Oregon fleets in future assessments within a coast-wide model.
   - Response: Washington and Oregon fleets have been combined, and the landings are summarized by port of landing. Sensitivity to fleet structure is included in this assessment.

5. The petrale sole maturity and fecundity information is dated and should be updated.
   - Response: These data have not been updated as there are higher priority groundfish species for which such data are being collected and analyzed.

6. As noted by the previous STAR Panel, the current assessment platform (SS3) is structurally complex, making it difficult to understand how individual data elements are affecting outcomes. The Panel recommends, where possible, investigating simpler, less structured models, including statistical catch/length models, to compare and contrast results as data and assumptions are changed.
   - Response: As part of the NWFSC research into data poor/moderate stock assessment methods a simple model has been produced for petrale sole (Figure 54) that shows similar results to the full stock assessment model (J. Cope , pers. comm).

7. The length binning structure in the stock assessment should be evaluated, including tail compression fitting options.
   - Response: Much of the discussion during the 2011 STAR panel focused on the choice of values for the small constant added to expected frequencies and the bin size. The constant added to expected frequencies was chosen based on the minimum value observed in the data. The impact of changing the bin size from 2 cm to 1 cm bins was also explored.

8. The residual patterns in the age-conditioned, length compositions from the surveys should be investigated and the potential for including time-varying growth, selectivity changes, or other possible solutions should be examined.
   - Response: Options for better fitting all of the length and age data have been explored via selectivity and fleet/model structure. These are discussed in the sensitivity section of this document. The NMFS Fisheries and the Environment (FATE) program funded a project to investigate and conduct a meta-analysis of time-varying growth for California Current groundfish. However, at the time of this stock assessment results are not ready for inclusion in this stock assessment.

9. Management strategy evaluation is recommended to examine the likely performance of new flatfish control rules.
   - Response: The NWFSC has not had the resources available to conduct an MSE for the PFMC flatfish control rule.

2.4 Model Description

2.4.1 Transition from 2011 to 2013 stock assessment

As with the 2009 and 2011 petrale sole stock assessments, the current model is implemented as a single-area model. The current assessment has been upgraded to a new version of SS (3.24o). A thorough description of the 2013 assessment model is presented separately below; this section linking the two models is intended to clearly identify where substantive changes were made. These changes include:

1. Landings summarized by port of landing rather than area of catch.
2. Combining the Washington and Oregon fleets into a single northern fleet.
3. Use of the Oregon historical landings reconstruction.
4. Specification of the male growth parameters to be directly estimated rather than estimated as an offset to the female growth parameters.
5. Use of an early, pre-1990s, age error matrix for surface ages.
6. Addition of data for 2011 and 2012.

2.4.2 Summary of data for fleets and areas

Fishery removals were divided among 4 fleets: 1) winter North trawl, 2) summer North trawl, 3) winter South trawl, and 4) summer South trawl. Landings for the North fleet are defined as fish landed in Washington and Oregon ports. Landings for the South fleet are defined as fish landed in California ports. Other removals are very small and are included in the trawl fishery removals. The data available for each fleet are described in Table 3.

2.4.3 Modeling software

This assessment used the Stock Synthesis 3 modeling framework written by Dr. Richard Methot at the NWFSC. The most recent version (SS-V3.24o) was used, since it included improvements and corrections to older versions (Methot 2007).

2.4.4 Data weighting

Indices of relative abundance all had variance estimates generated as part of the analysis of raw catch data. These variances are converted to standard deviations in log space for use in the model; additional variances for the indices of abundance were estimated inside the model. The number of trawl tows was used as the initial input sample sizes for length and marginal age compositional data. The number of fish aged was used as the input sample sizes for the survey conditional length-at-age compositions.

This assessment follows the iterative re-weighting approach to developing consistency between the input composition sample sizes (or standard errors) and the effective sample sizes based on model fit. This approach attempts to reduce the potential for particular data sources to have a disproportionate effect on total model fit, while creating estimates of uncertainty that are commensurate with the uncertainty inherent in the input data. Iterative re-weighting was applied to all compositional data. This consisted of comparing the mean input sample size for compositional data with the mean effective sample size based on model fit. A single iteration was completed using a multiplicative scalar to tune the input sample sizes for all length- or age-compositions for a given fleet or survey such that the ratio between the input sample sizes and the model effective sample sizes were approximately one (Stewart et al. In prep.).

A second weighting issue arises when both length and age data are included from the same individual fish and samples. In this case, it is appealing to treat the age data as conditional to the length observations, as for the survey data, to avoid duplication of information. However, due to unacceptably long run times, this approach was not used for the commercial age samples. Instead the lambda values (a direct multiplier on the likelihood component), were reduced to 0.5 for length and age data for fleets where both types of data are available. This is consistent with many other west coast groundfish assessments. Sensitivity to completing the iterative re-weighting of compositional data and then adjusting the lambdas to 0.5 and vice-versa produced nearly identical model results.

The value of σ_R was determined using an iterative procedure to ensure that the value of σ_R assumed by the assessment model and the empirical variance in recruitment were self-consistent. This involved setting σ_R to an initial value, fitting the model and calculating the variance of the recruitment deviations for the years for which recruitments are estimated in the model, then replacing the assumed value of σ_R by the calculated value. Very little iterative reweighting was necessary for σ_R.

2.4.5 Priors

Priors were applied only to parameters for steepness (Figure 55) and natural mortality (Figure 56). The steepness prior is based on the Myers (Myers et al. 1999) meta-analysis of flatfish steepness and the natural mortality prior is based on a meta-analysis completed by Hamel (In prep.).

2.4.6 General model specifications

Stock synthesis has a broad suite of structural options available. Where possible, the 'default' or most commonly used approaches are applied to this stock assessment. The assessment is sex-specific, including the estimation of separate growth curves, natural mortality, and selectivity for males and females. Therefore, the assessment only tracks female spawning biomass for use in calculating stock status.

This is a coast-wide assessment that captures seasons and regions using fleets to structure landings. The time-series of landings begins during 1876, at the documented start of the fishery, so the stock is assumed to be in equilibrium at the beginning of the modeled period. The sex-ratio at birth is fixed at 1:1, although by allowing increased natural mortality for males, size-based selectivity, and dimorphic growth, the sex ratio can vary.

The internal population dynamics include ages 0-40, where age 40 is the 'plus-group'. As there is little growth occurring at age 40, the data use a plus group of age 17; there are relatively few observations in the age compositions that are greater than age 17.

The following likelihood components are included in this model: catch, indices, discards, mean weight of the discards, length compositions, age compositions, recruitments, parameter priors, and parameter soft bounds. See the SS technical documentation for details (Methot and Wetzel 2013).

Model data, control, starter, and forecast files can be found in Appendices D-G.

2.4.7 Estimated and fixed parameters

A full list of all estimated and fixed parameters is provided in Table 13. Time-invariant, sex-specific growth is estimated in this assessment with the length at age 1 assumed to be equal for males and females. The log of the unexploited recruitment level for the Beverton-Holt stock-recruit function is treated as an estimated parameter. Annual recruitment deviations are estimated beginning in 1845 in order to obtain more reasonable estimates of uncertainty in recruitment variability (and therefore derived quantities such as unfished spawning biomass) in the early years of the model. Asymptotic selectivity is used for both the triennial and NWFSC surveys and for all fishing fleets in the base case model. Selectivity and retention for the fishing fleets is modeled as time-varying using time blocks (Table 14). The survey catchability parameters are calculated analytically (set as scaling factors) such that the estimate is median unbiased, which is comparable to the way q is treated in most groundfish assessments. The commercial CPUE catchability and power parameters are estimated.

2.5 Model Selection and Evaluation

2.5.1 Key assumptions and structural choices

All structural choices for stock assessment models are likely to be important under some circumstances. In this assessment these choices are generally made to 1) be as objective as possible, 2) follow generally accepted methods of approaching similar models and data and 3) address the previous STAR panel concerns. The relative effect on assessment results of each of these choices is often unknown; however an effort is made to explore alternate choices through sensitivity analysis. Major choices in the structuring of this stock assessment model include a coast-wide model with seasonal fleet structure for two regions, north and south, splitting the triennial survey into an early and late time period, and estimates of selectivity and retention curves for each fleet.

2.5.2 Alternate models explored

Comparison of key model assumptions, include comparisons based on nested models (e.g., asymptotic vs. domed selectivity, constant vs. time-varying selectivity). Many variations on the base case model were explored during this analysis; only the most relevant and recent are reported in this document. Some of these are reported as sensitivity and retrospective analyses. Prior to the STAR panel, detailed exploration was made to evaluate:

1. Estimation of natural mortality with and without a prior.
2. Estimation of the stock-recruitment steepness as well as values for h fixed at 0.78 and 0.91, based on the 12.5 and 87.5 midpoints of the lower 25% probability and upper 25% probability regions from the base model.
3. Tuning of composition sample sizes and interaction with the choice of composition lambdas.
4. The period over which recruitment deviations are estimated.
5. Time varying, combined female and male versus sex specific selectivity, and asymptotic versus dome-shaped selectivity for fishing fleets and surveys.
6. The tuning of recruitment variability.
7. Commercial age data and aging error estimates.
8. Revised commercial CPUE indices and the inclusion of the summer commercial CPUE.
9. The choice of 1 cm versus 2 cm bins for length data.
10. The use of an early, pre 1990s, surface age error matrix compared to a later surface age error matrix.
11. Landings summarized by port of landing rather than area of catch.
12. Combining the Washington and Oregon fleets into a single fleet or separate fleets.
13. Use of the Oregon historical landings reconstruction.
14. Specification of the male growth parameters to be directly estimated rather than estimated as an offset to the female growth parameters.
15. The impact of the 2012 NWFSC survey data on derived model outputs.
16. Time blocking of retention parameters.
17. Estimation of the NWFSC survey added standard deviation parameter (went to zero).
18. Fleet structure such that the model with 4 fleets, WA and OR combined into a single northern fleet, retained separate age and length compositions for the WA and OR compositions with selectivity mirrored.
19. Model structure similar to the 2011 assessment with 6 fleets, winter and summer fleets for WA, OR, and CA, respectively.

2.5.3 Convergence

Convergence testing through use of over dispersed starting values often requires very extreme values to actually explore new areas of the multivariate likelihood surface. For this reason, a good target for convergence testing is to ‘jitter’ or randomly adjust starting values between reasonable upper and lower bounds by a factor. Jitter is a SS option that allows for the generation of a uniform random number equal to the product of the input value and the range between upper and lower parameter bounds for each parameter. These random numbers are then added to initial parameter values in the input files and the model minimization started at these new conditions. The SS jitter option was used to explore the identification of a global best estimate for the base model and none of these trials found a different global minimum. A total of 100 jittered model runs, using a jitter value of 0.01 resulted in 87% of the model runs returning to the base case and 13% finding local minima. These results, in conjunction with other convergence checks, indicate that it is likely that the base case model result represents the global minimum.

2.6 Base-Model Results

The biological parameters estimated from the base-case model (Table 15, Figure 57) are reasonable and are similar to those estimated in past assessments for petrale sole (Hatuch et al. 2009, Haltuch et al. 2011). Female and male petrale sole have similar growth trajectories until about age 5; beyond age 5, females grow to a maximum size of approximately 60 cm while males grow to approximately 45 cm (Figure 57). Both sexes show a similar distribution of lengths-at-age and relative CVs at age. Natural mortality for females is estimated to be lower, 0.16, compared to males, 0.18 (Table 16). This difference in sex-specific natural mortality suggests that the sex ratios will be dominated by females at older ages.

Estimated selectivity curves for the NWFSC and triennial surveys were generally similar, although in the later years, the triennial survey selected a slightly higher fraction of small petrale sole than in the early years (Figure 58 -Figure 63). The catchability values for the NWFSC and the early and late triennial surveys are different, 3.36 and 0.55 and 0.72, respectively (Table 16). The catchability estimates are similar to those estimated in past assessments. A power function was used to relate the winter commercial CPUE indices to the population size. The estimates of the Beta parameters for the winter north and winter south are -0.22 and -1.01, respectively (Table 16). These values are lower than those estimated in the 2011 stock assessment but given the ~95% confidence intervals suggest that the model cannot clearly discriminate between estimates of *Beta* greater than or less than zero (Table 16). However, the revised commercial CPUE indices explain a greater proportion of the variability in the commercial data due to the inclusion of targeting covariates and show a less marked increase at the end of the time series. Furthermore, this assessment models the decrease in petrale effort that took place between 2003 and 2004 due to the vessel buyback program with a time step in *q* between these years (P. Leipzip, pers. comm.), providing an alternative persective on changes in petrale winter commercial CPUE.

Selectivity curves for the fishing fleets largely showed, as expected, a tendency towards larger fish being caught in the winter fisheries and smaller fish being captured in the summer fisheries (Figure 64 -Figure 71). Time blocks were implemented to account for some of the residual patterns in the composition data that are likely due to the impact of changing management regulations. Time blocks beginning in 1973, 1983, 1993, 2003, and 2011 are used to estimate different selectivity curves for each fleet and sex (Figure 72 -Figure 79). These time blocks were chosen based on changes in fishing practices, the timing of management measures implemented for the groundfish fishery (Appendix C), and the implementation of the trawl ITQ program. Similarly to selectivity, time blocks were also implemented for fishery retention to account for management impacts driving changes in discard practices (Figure 80 -Figure 87). Time blocks were implemented for data collected during the early years of the WCGOP observer program (2003-2008 for summer and 2003-2009 for winter), the period of time in which catch limits were decreased and the fishery was being declared overfished (2009-2010 for summer and 2010 for winter), and the implementation of the trawl IFQ program (2011-2012). During the 2011-2012 IFQ period discards in the winter fishery are essentially zero and the discard rates for the summer fisheries are very small (Table 9).

The base-case model was able to fit the triennial and NWFSC fishery independent indices of abundance, as well as the winter commercial CPUE indices well (Figure 88 -Figure 92). The estimated additional standard deviations for the early triennial and late triennial were 0.16 and 0.19, respectively (Table 16). The estimated additional standard deviations for the winter north and winter south indices in earlier model runs were deemed to be to small incomparison to those from the surveys. Therefore, the maximum standard deviation from the NWFSC survey was added to the bootstrap standard errors from the CPUE analysis. Fits to the fishery independent length and age distributions are good (Figure 93-Figure 94, Figure 105. Slight residual patterns in the last few years of NWFSC survey compositions (Figure 95-Figure 96, Figure 104-Figure 105) suggest that there are proportionally more small/young fish in the population than expected.

The discard rates for petrale sole are generally quite small, resulting in small values for the standard deviations around the weights. The standard deviations on the discard ratios, particularly those that had only partial observer coverage during 2003-2010, WCGOP data are likely underestimates; therefore a small additional standard deviation is added to the estimates provided by the WCGOP. Model fits to the discard rates are generally good, with the exception of some observations for the summer south fleet (Figure 106 -Figure 109). The time series of estimated total discards from the model were an order of mangnitude less than the landed catches. The fits to the average weight of the discarded catch and the summer fleets and WCGOP discard length compositions are good (Figure 110 -Figure 113). Fits to the Pikitch discard length compositions are poor, but the sample sizes are very small (Figure 114-Figure 115) but fits to the WCGOP length compositions are good (Figure 116).

The model fits the time aggregated fishery dependent length compositions well even though it fails to fit some specific years during periods of strong recruitments and early in the data when a higher proportion of large fish are observed in the population (Appendix H). The Pearson residuals reflect the noise in the data both within and between years. The model does not fit the time aggregated fishery age compositions as well as the lengths, in many cases missing the peak of the age distributions (Appendix H). The fishery length- and age-frequency data required some tuning of input sample sizes to make the average effective sample sizes equal to or greater than average input sample sizes (Appendix H). The lack of fit, particularly in the early years of length and age comps could be due to aging methodolies applied at that time as the more recent, improved, age and length data do not show the same lack of fit.

The estimated recruitment deviations show relatively low variability. The recruitment variability was estimated to be 0.34 (input value of 0.4), which is similar to the output values from previous stock assessments. The choice of start year for estimating the main recruitment deviations, 1959, is based on the availability of more reliable length and age composition data. Early recruitment deviations begin in 1845 but are not bias corrected until 1945, shortly before the first age and length compositions became available. The time-series of estimated recruitments shows a weak relationship with the decline in spawning biomass, punctuated by larger recruitments (Table 17-Table 18, Figure 120 -Figure 122). The three weakest recruitments since 1959 are estimated to be from 1986, 1987, and 1992, while the five strongest recruitments since 1959 are estimated to be from 1966, 1998, and 2007-2009 (Table 17-Table 18, Figure 120 -Figure 122). Until 2007 the most recent large recruitment event, is estimated to be in 1998, this was the recruitment that supported the increase in the stock and the fishery through 2005. The estimate of stock-recruitment steepness is 0.86 (Table 16), which is similar to the value estimated in the 2011 assessment.

The biomass time series shows a strong decline from the late-1930s through the mid-1960s, followed by a small recovery through the mid-1970s, and another decline to its lowest point during the early 1990s (Table 17-Table 18, Figure 123). This general pattern of stock decline is coincident with increasing catches and the movement of the fishery from summer fishing in shallow waters to winter fishing on spawning aggregations in deeper waters (Figure 1). From the mid-1990s through 2005 the stock increased slightly, then declined through 2010 (Table 17-Table 18, Figure 123). The stock has increased strongly since 2010 in response to three years of strong recruitment.

2.7 Uncertainty and Sensitivity Analyses

The base-case assessment model includes parameter uncertainty from a variety of sources, but underestimates the considerable uncertainty in recent trend and current stock status. For this reason, in addition to asymptotic confidence intervals (based upon the model's analytical estimate of the variance near the converged solution), two alternate states of nature regarding the female rate of natural mortality are presented in a decision table. Much additional exploration of uncertainty was performed prior to and during the STAR panel. Some of that exploration of other sources of uncertainty is provided below.

2.7.1 Sensitivity analysis

Sensitivity analysis was performed to determine the model behavior under different assumptions than those of the base case model. The model provided highly consistent behavior in the numerous sensitivity model runs that were explored. Results from the base case and sensitivity runs are shown in Table 19 and selected models in Figure 125 -Figure 126. The sensitivity model runs produce similar trajectories of stock decline and recovery, with the estimates of unfished biomass falling within the 95% confidence intervals from the base model run. The base stock status was estimated at 22.3% while the model sensitivities ranged from 22.1% to 24.8%. The largest range in results was obtained from the model runs with low and high values of female M that were used as the axis of uncertaintly for the decision table (Table 19, Figure 125). Sensitivities exploring the treatmentof the winter commercial CPUE were all generally similar to the base model results (Table 19, Figure 126).

Many model runs were completed to explore alternative selectivity options. Model runs exploring non-time varying commercial selectivity failed to fit the composition data well and were not pursed further. Model runs including time varying selectivity for the commercial fleets as random walks, rather than time blocks as in the base model, resulted in long run times (~1.5 hours without a hessian), had problems converging, poor gradients, and were slightly more pessimistic than the model sensitivities presented in this document. Model runs exploring dome-shaped selectivity for the surveys clearly supported asymptotic selectivity. Model runs exploring dome-shaped selectivity for the commercial fleets resulted in very long run times (generally greater than 2.5 hours without a hessian), also had convergence problems, and poor gradients. Furthermore model runs investigating dome-shaped selectivity produced inconsistent results by sex and fleet. None of the model runs investigating alternative options for modeling selectivity were deemed to outperform the base case model.

2.7.2 Retrospective analysis

A retrospective analysis was conducted by running the model using data only through 2008, 2009, 2010, 2011, and 2012 (Table 20, Figure 127). The retrospective model runs were nearly identical to the base model, well within the 95% confidence levels from the current base model. The stock depletion in a given year is similar across retrospective model runs.

2.7.3 Historical assessment analysis

Comparisons between the base model estimates for spawning biomass and stock depletion from assessments conducted during 2005, 2009, and 2011 are similar, with trends at the end of each time series being driven by the available data (Figure 128). The 1999 stock assessment started during the late 1970s, after the bulk of the removal from the stock has already taken place, and while trends in spawning biomass are similar, estimates of stock depletion are much higher due to this shifting baseline.

2.7.4 Likelihood profiles

Likelihood profiles for steepness and female natural mortality were completed to investigate the uncertainty in the estimates of *h* and female *M* (Figure 129 -Figure 130). Plausible values for *h* range from approximately 0.7 to 1.0 while values for female *M* range from approximately 0.12 to 0.22. The length and age composition data most strongly inform the estimates of *h* and *M*, while the indices suggest a lower value for *h*. Likelihood profiles for R_o also show the length and age composition data more strongly informing the estimate of R_o, with the indices suggesting a higher value for R_o (Figure 131). Evaluating R_o likelihood profiles for likelihood components for each fleet/survey provided mixed results (Figure 132) and was hard to interpret. The indices generally suggested larger values, except for the NFWSC survey index which suggests a lower value. Ages from the winter south fleet trend towards higher values, while the ages from the other fleets/surveys provide little information regarding R_o or trend towards lower values. Lengths from the early triennial and NWFSC surveys show opposite trends compare do the rest of the fleets/surveys.

3 Rebuilding parameters

The petrale sole stock has been declared overfished and is being managed under a rebuilding plan that essentially impliments the current flatfish 25:5 control rule. See both this stock assessment as well as the most recent rebuilding plan for petrale sole for further information (Haltuch 2011).

4 Reference Points

The 2009 stock assessment estimated petrale sole to be at 11.6% of unfished spawning stock biomass in 2010. Based on the 2009 stock assessment, the 2010 coast-wide ACL was reduced to 1,200 mt to reflect the overfished status of the stock and the 2011 coast-wide OFL and ACL were set at 1,021 mt and 976 mt, respectively (Table 21). Recent coast-wide annual landings have not exceeded the ACL. The 2005, 2009, and 2011 stock assessments estimated that petrale sole have been below 25 percent of unfished biomass from the 1960s until recently, with estimated harvest rates in excess of a fishing mortality rate of $F_{30\%}$. The length of time that the petrale sole stock had been below the 25 percent of unfished level while sustaining relatively stable annual landings lead the 2009 STAR panel and SSC to investigate new reference points for all flatfish managed by the PFMC. The end result is that new reference points were specified for flatfish. The new reference points are as follows: the target reference point is 25 percent of the unfished biomass, the overfished reference point is 12.5 percent of the unfished level, the limit reference point is 5% of the unfished level, and the F target is $F_{30\%}$. The 2011 assessment continued to estimate that petrale sole have been below the $SB_{25\%}$ management target since the 1960s and below the new overfished threshold between the early 1980s and the early 2000s with fishing mortality rates in excess of the current F-target for flatfish of $SPR_{30\%}$ since the mid-1930s (Figure 133 -Figure 134). This 2013 assessment is consistent with the previous two assessments for petrale sole.

While the base model indicates that the spawning biomass was generally below 25% of the unfished level between the 1960s and 2013, the total biomass of the stock has increased since 2010 as a large recruitment(s) during the late 2000s move into the population (Figure 135). The estimated relative depletion level in 2013 is 22.3% (~95% asymptotic interval: ±15.1% - 29.5%, ~ 75% interval based on the range of states of nature: 18.2% - 27.6%), 7,233 mt (~95% asymptotic interval: 5,668 – 8,796 mt, states of nature interval: 6,800 – 7,846 mt) of female spawning biomass in the base model (Table 21). Unfished spawning stock biomass was estimated to be 32,425 mt in the base case model. The target stock size (SB25%) is 8,106 mt which gives a catch of 2,749 mt. Current F (catch/biomass of age-3 and older fish) is estimated to have been 0.08 during 2012. Model estimates of spawning biomass at MSY are slightly lower than those specified under the current harvest control rule. Maximum sustained yield (MSY) applying recent fishery selectivity and allocations was estimated at 2,760 mt, occurring at a spawning stock biomass of 7,146 mt (SPR = 0.25).

5 Harvest Projections and Decision Tables

The forecast of stock abundance and yield was developed using the base model. The total catches in 2013 and 2014 are set to the PFMC adopted ACLs (Table 21). The exploitation rate for 2015 and beyond is based upon an SPR of 30%. The 25:5 control rule reduces forecasted yields below those corresponding to

$F_{30\%}$ if the stocks are estimated to be lower than the management target of $SB_{25\%}$. The average 2011-2012 exploitation rate was used to distribute catches among the fisheries.

Current medium-term projections of expected petrale sole catch, spawning biomass and depletion from the base model using the 25-5 control rule predict an increasing trend in abundance and catch through 2016 followed by a small decline as spawning biomass and stock depletion stabilize in later years, with ACL values for 2015 set at 2,828 mt under the 25-5 harvest policy (Table 21). The stock is expected to remain above the target stock size of $SB_{25\%}$ during the projection period, assuming average recruitment based on the stock-recruit curve.

Uncertainty in the forecasts is based upon the three states of nature agreed upon at the STAR panel. The states of nature were based on the likelihood profile of female M, chosen using a change of 1.2 NLL units (75% interval) from the minimum value to correspond to the midpoints of the lower 25% probability and upper 25% probability regions, from the base model and are low (0.12, rounded to the second decimal place) and high (0.19, rounded to the second decimal place) values for female natural mortality. Each forecast scenario includes random variability in future recruitment deviations. Current medium-term forecasts based on the alternative states of nature also project that the stock, under the current control rule as applied to the base model, will increase through 2016-2017 as large recruitments move into the population, reaching peak stock depletion between 25.6% and 35.7%. In and absence of strong recruitments into the future the stock is then expected to decline between 2016-1-2017 and 2024.

Two alternative catch projections were evaluated based on GMT requests, the catches that stabilize the stock at approximately 30% of unfished spawning biomass, and the catches that stabilize the stock at approximately 40% of unfished biomass (Table 22. Decision table of 12-year projections for alternate states of nature (columns) and management options (rows) beginning in 2011. Relative probabilities of each state of nature are based on low and high values for the rate of female natural mortality.Table 22). Both of these scenarios are more conservative than implementing the current control rule, with the second option extending the period of stock inceases allowing for catches ranging between 1,460 mt during 2015 and 2,172 during 2024.

6 Regional Management Considerations

Currently petrale sole are managed using a coast-wide harvest; therefore this assessment does not provide a recommended method for allocating harvests regionally. The resource is modeled as a single stock. There is currently no genetic evidence that there are distinct biological stocks of petrale sole off the U.S. coast and the limited tagging data that describes adult movement suggests that movement may be significant across depth and latitude.

7 Research Needs

Progress on a number of research topics would substantially improve the ability of this assessment to reliably and precisely model petrale sole population dynamics in the future and provide better monitoring of progress toward rebuilding:

1. In the past many assessments have derived historical catches independently. The states of California and Oregon have completed comprehensive historical catch reconstructions. At the time of this assessment, a comprehensive historical catch reconstruction is not available for Washington. Completion of a Washington catch reconstruction would provide the best possible estimated catch series that accounts for all the catch and better resolves historical catch uncertainty for flatfish as a group.
2. Due to limited data, new studies on both the maturity and fecundity relationships for petrale sole would be beneficial.

3. Increased collection of commercial fishery age data as well as re-aging any available historical samples from California would help reduce uncertainty. While some recent age data were made available from California, sample sizes could be increased and this data collection needs to continue into the future. Without good age data, the ability to estimate year-class strength and the extent of variation in recruitment is compromised.
4. Where possible, historical otolith samples aged using a combination of surface and break-and-burn methods should be re-aged using the break-and-burn method. Early surface read otoliths should also be re-aged using the break and burn method. Historical otoliths aged with a standard method will allow the further evaluation of the potential impacts of consistent under aging using surface methods, changes in selectivity during early periods of time without any composition information, and potential changes in growth.
5. The effect of the implementation of the IFQ (catch shares) program that began during 2011 on fleet behavior, including impacts on discards, fishery selectivity, and fishing locations would benefit from further study.
6. Studies on stock structure and movement of petrale sole, particularly with regard to the winter-summer spawning migration of petrale sole and the likely trans-boundary movement of petrale sole between U.S. and Canadian waters seasonally.
7. The extent of spatial variability on productivity processes such as growth, recruitment, and maturity is currently unknown and would benefit from further research.

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10 Tables

Table 1. Total landed catches (mt) of petrale sole by fleet and season used in the assessment model. See text for a description of sources.

Fishing year	North Winter	North Summer	South Winter	South Summer	Total Winter	Total Summer
1876	0.00	0.00	0.00	1.00	0	1
1877	0.00	0.00	0.00	1.00	0	1
1878	0.00	0.00	0.00	1.00	0	1
1879	0.00	0.00	0.00	1.00	0	1
1880	0.00	0.00	0.00	11.55	0	11.55
1881	0.00	0.00	0.00	22.10	0	22.1
1882	0.00	0.00	0.00	32.65	0	32.65
1883	0.00	0.00	0.00	43.20	0	43.2
1884	0.00	0.00	0.00	53.75	0	53.75
1885	0.00	0.00	0.00	64.30	0	64.3
1886	0.00	0.00	0.00	74.85	0	74.85
1887	0.00	0.00	0.00	85.40	0	85.4
1888	0.00	0.00	0.00	95.95	0	95.95
1889	0.00	0.00	0.00	106.50	0	106.5
1890	0.00	0.00	0.00	117.05	0	117.05
1891	0.00	0.00	0.00	127.60	0	127.6
1892	0.00	0.00	0.00	138.15	0	138.15
1893	0.00	0.00	0.00	148.71	0	148.71
1894	0.00	0.00	0.00	159.26	0	159.26
1895	0.00	0.00	0.00	169.81	0	169.81
1896	0.00	0.24	0.00	180.36	0	180.6
1897	0.00	0.20	0.00	190.91	0	191.11
1898	0.00	0.15	0.00	201.46	0	201.61
1899	0.00	0.15	0.00	212.01	0	212.16
1900	0.00	0.15	0.00	222.56	0	222.71
1901	0.00	0.14	0.00	233.11	0	233.25
1902	0.00	0.14	0.00	243.66	0	243.8
1903	0.00	0.13	0.00	254.21	0	254.34
1904	0.00	0.13	0.00	264.76	0	264.89
1905	0.00	0.13	0.00	275.31	0	275.44
1906	0.00	0.12	0.00	285.86	0	285.98
1907	0.00	0.12	0.00	296.41	0	296.53
1908	0.00	0.11	0.00	306.96	0	307.07
1909	0.00	0.11	0.00	317.51	0	317.62
1910	0.00	0.10	0.00	328.06	0	328.16
1911	0.00	0.10	0.00	338.61	0	338.71
1912	0.00	0.10	0.00	349.16	0	349.26
1913	0.00	0.09	0.00	359.71	0	359.8
1914	0.00	0.09	0.00	370.26	0	370.35
1915	0.00	0.08	0.00	380.81	0	380.89
1916	0.00	0.08	0.00	386.42	0	386.5
1917	0.00	0.08	0.00	526.41	0	526.49
1918	0.00	0.07	0.00	423.85	0	423.92
1919	0.00	0.07	0.00	333.44	0	333.51
1920	0.00	0.06	0.00	230.49	0	230.55
1921	0.00	0.06	0.00	293.76	0	293.82
1922	0.00	0.05	0.00	424.78	0	424.83
1923	0.00	0.05	0.00	427.36	0	427.41

Fishing year	North Winter	North Summer	South Winter	South Summer	Total Winter	Total Summer
1924	0.00	0.05	0.00	532.86	0	532.91
1925	0.00	0.04	0.00	528.47	0	528.51
1926	0.00	0.04	0.00	521.67	0	521.71
1927	0.00	0.04	0.00	632.04	0	632.08
1928	0.00	0.00	0.00	620.09	0	620.09
1929	0.00	1.54	0.00	706.04	0	707.58
1930	0.00	1.23	0.00	658.83	0	660.06
1931	0.00	81.45	63.39	530.88	63.39	612.33
1932	1.99	250.88	36.40	519.91	38.39	770.79
1933	5.96	408.43	38.57	392.08	44.53	800.51
1934	9.93	567.86	139.41	896.36	149.34	1464.22
1935	13.90	649.96	155.38	777.21	169.28	1427.17
1936	15.88	769.79	95.49	431.51	111.37	1201.3
1937	19.75	1051.41	74.53	741.05	94.28	1792.46
1938	27.49	1186.87	47.86	890.00	75.35	2076.87
1939	35.22	1544.54	30.84	1028.96	66.06	2573.5
1940	39.09	1736.58	161.81	596.70	200.9	2333.28
1941	41.40	1802.66	110.81	331.17	152.21	2133.83
1942	46.00	2919.25	24.37	215.56	70.37	3134.81
1943	50.61	2867.31	71.66	344.72	122.27	3212.03
1944	55.21	2046.97	85.53	446.91	140.74	2493.88
1945	59.82	1866.05	101.75	439.34	161.57	2305.39
1946	64.43	2492.36	71.91	1115.57	136.34	3607.93
1947	69.03	1777.99	153.68	1092.66	222.71	2870.65
1948	73.64	2314.74	272.66	1778.02	346.3	4092.76
1949	75.94	1808.65	616.96	1812.18	692.9	3620.83
1950	156.21	2322.24	424.24	1638.09	580.45	3960.33
1951	117.97	1665.62	208.45	992.79	326.42	2658.41
1952	131.01	1390.43	326.31	881.70	457.32	2272.13
1953	46.07	737.10	533.36	981.17	579.43	1718.27
1954	26.56	903.36	800.58	1073.40	827.14	1976.76
1955	57.14	862.59	525.58	1051.75	582.72	1914.34
1956	137.25	759.22	508.30	800.73	645.55	1559.95
1957	170.95	1103.29	527.21	1027.18	698.16	2130.47
1958	99.18	1152.19	567.97	957.29	667.15	2109.48
1959	332.10	946.78	379.04	723.17	711.14	1669.95
1960	240.87	1374.20	519.64	643.74	760.51	2017.94
1961	216.66	1546.63	542.06	1028.73	758.72	2575.36
1962	294.86	1511.89	514.91	859.37	809.77	2371.26
1963	663.29	1038.41	534.03	977.64	1197.32	2016.05
1964	282.32	1090.04	377.62	926.80	659.94	2016.84
1965	370.46	950.39	373.69	852.88	744.15	1803.27
1966	366.06	971.69	324.88	924.63	690.94	1896.32
1967	408.63	793.42	532.28	874.08	940.91	1667.5
1968	284.40	810.62	360.61	870.76	645.01	1681.38
1969	190.34	887.30	421.00	848.00	611.34	1735.3
1970	411.71	1081.31	472.00	1071.00	883.71	2152.31
1971	742.62	882.61	540.00	1016.00	1282.62	1898.61
1972	730.42	1016.88	703.00	1000.00	1433.42	2016.88
1973	497.47	1271.83	417.00	742.00	914.47	2013.83
1974	516.99	1610.53	665.00	893.00	1181.99	2503.53
1975	538.95	1559.16	561.00	901.00	1099.95	2460.16
1976	505.73	951.12	713.00	737.00	1218.73	1688.12

Year	North Winter	North Summer	South Winter	South Summer	Total Winter	Total Summer
1977	682.08	742.77	484.00	495.00	1166.08	1237.77
1978	746.25	1097.75	419.00	801.00	1165.25	1898.75
1979	734.31	1085.56	353.00	945.00	1087.31	2030.56
1980	382.50	976.23	518.00	680.00	900.5	1656.23
1981	760.67	467.91	359.66	895.22	1120.33	1363.13
1982	1041.19	770.69	261.53	502.07	1302.72	1272.76
1983	696.32	935.35	272.60	361.12	968.92	1296.47
1984	415.77	739.01	259.83	328.99	675.6	1068
1985	392.13	552.89	273.26	471.13	665.39	1024.02
1986	474.12	714.44	402.91	355.06	877.03	1069.5
1987	854.04	572.67	311.09	556.08	1165.13	1128.75
1988	742.90	610.43	349.11	411.04	1092.01	1021.47
1989	695.99	583.01	392.60	414.73	1088.59	997.74
1990	640.66	459.82	319.43	372.68	960.09	832.5
1991	792.58	397.34	448.01	310.12	1240.59	707.46
1992	639.53	365.97	271.71	307.26	911.24	673.23
1993	685.39	392.08	237.09	233.99	922.48	626.07
1994	518.13	355.43	245.86	299.41	763.99	654.84
1995	591.37	453.92	235.56	287.43	826.93	741.35
1996	591.03	439.75	405.92	393.94	996.95	833.69
1997	621.05	430.04	447.63	442.28	1068.68	872.32
1998	522.14	577.35	220.73	300.46	742.87	877.81
1999	463.34	504.25	286.80	266.64	750.14	770.89
2000	610.16	585.53	373.62	241.46	983.78	826.99
2001	691.41	596.99	308.34	260.30	999.75	857.29
2002	666.97	713.85	335.16	195.12	1002.13	908.97
2003	544.48	713.44	256.21	179.67	800.69	893.11
2004	1009.91	749.51	177.24	267.16	1187.15	1016.67
2005	963.68	1068.76	337.18	533.41	1300.86	1602.17
2006	537.45	1011.62	125.28	453.54	662.73	1465.16
2007	930.38	536.11	404.35	474.86	1334.73	1010.97
2008	842.46	353.82	519.44	414.02	1361.9	767.84
2009	846.71	641.75	469.66	250.38	1316.37	892.13
2010	258.09	292.34	77.60	120.95	335.69	413.29
2011	221.60	423.11	39.59	77.70	261.19	500.81
2012	406.05	477.71	124.46	107.63	530.51	585.34

Table 2. Recent trend in estimated total petrale sole catch and commercial landings (mt) relative to management guidelines.

Year	OFL (mt) for the Calendar Year	ACL (mt) for the Calendar Year	Commercial Landings (mt) for the Calendar Year	Estimated Total Catch (mt) for the Calendar Year	Estimated Total Catch (mt) for the Fishing Year
2002	2,762	2,762	1,796	2,067	1,911
2003	2,762	2,762	1,931	1,750	1,694
2004	2,762	2,762	1,953	2,249	2,204
2005	2,762	2,762	2,734	2,956	2,903
2006	2,762	2,762	2,609	2,171	2,128
2007	3,025	2,499	2,253	2,373	2,346
2008	2,919	2,499	2,220	2,153	2,130
2009	2,811	2,433	1,767	2,263	2,208
2010	2,751	1,200	797	871	749
2011	1,021	976	928	787	762
2012	1,279	1,160	1,092	1,144	1,116
2013	2,711	2,592			
2014	2,774	2,652			

[1] Estimated total catches reflect the commercial landings plus the model estimated annual discard biomass (commercial landings * retained catch/total catch) for the fishing year. The total amounts of discard may differ from those reported in the NWFSC reports on total catch for some years.

Table 3. Summary of data sources available in 2013.

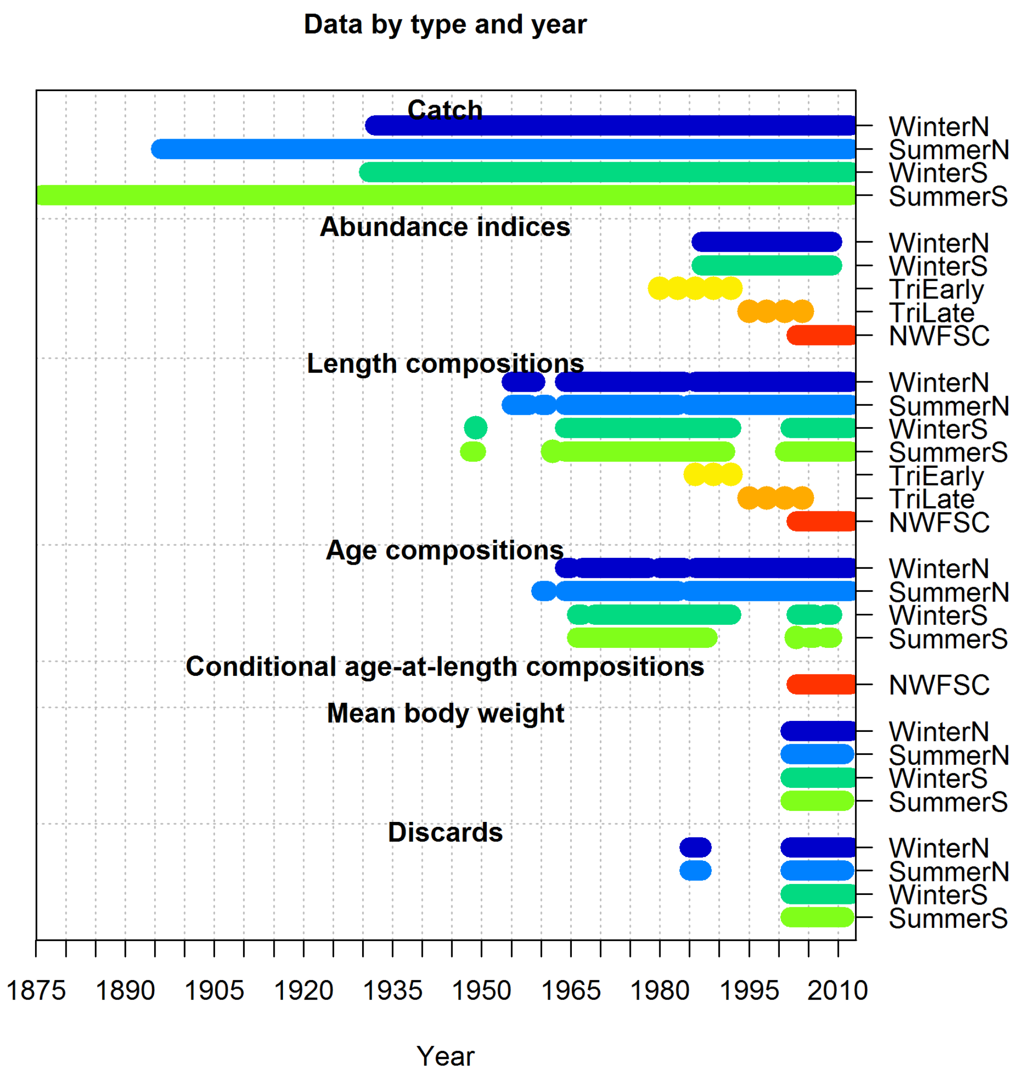


Table 4. Summary of the tow data from the NWFSC survey.

Year	Number of tows	Number of tows with petrale	Percent of tows with petrale
2003	541	198	36.6%
2004	471	216	45.9%
2005	637	279	43.8%
2006	642	248	38.6%
2007	688	258	37.5%
2008	681	258	37.9%
2009	682	279	40.9%
2010	713	325	45.6%
2011	697	323	46.3%
2012	701	299	42.7%

Year	Number of tows with lengths	Percent petrale tows with lengths	Number of lengths
2003	197	99%	2837
2004	213	99%	3371
2005	277	99%	4551
2006	248	100%	3743
2007	258	100%	3435
2008	258	100%	3053
2009	278	100%	3440
2010	325	100%	6052
2011	322	100%	6187
2012	298	100%	5407

Year	Number of tows with ages	Percent petrale tows with ages	Number of ages
2003	173	87%	765
2004	168	78%	725
2005	236	85%	750
2006	237	96%	783
2007	197	76%	695
2008	226	88%	749
2009	259	93%	779
2010	297	91%	801
2011	291	90%	804
2012	272	91%	790

Table 5. Indices of biomass (mt) and standard errors (of the natural log of biomass).

	Triennial		NWFSC	
Year	Estimate (B)	SE(logB)	Estimate (B)	SE(logB)
1980	1864	0.329		
1981				
1982				
1983	2300	0.128		
1984				
1985				
1986	2193	0.146		
1987				
1988				
1989	3234	0.109		
1990				
1991				
1992	2126	0.117		
1993				
1994				
1995	2407	0.148		
1996				
1997				
1998	3548	0.112		
1999				
2000				
2001	3832	0.115		
2002				
2003			18298	0.156
2004	9713	0.141	27552	0.221
2005			21671	0.132
2006			19572	0.149
2007			20789	0.173
2008			15597	0.134
2009			15784	0.141
2010			22574	0.137
2011			30367	0.127
2012			36852	0.152

Table 6. Summary of the tow data from the Triennial survey.

Year	Number of tows	Number of tows with petrale	Percent of tows with petrale
1980	301	139	46
1983	479	250	52
1986	483	268	55
1989	440	275	63
1992	421	251	60
1995	441	209	47
1998	468	291	62
2001	466	256	55
2004	383	244	64

Year	Number of tows with lengths	Percent petrale tows with lengths	Number of lengths
1980	1	1	16
1983	2	1	30
1986	36	13	540
1989	141	51	1419
1992	116	46	1015
1995	145	69	1369
1998	236	81	2624
2001	254	99	3016
2004	239	98	4676

Table 7. The estimates of bias and imprecision (SD of observed age at true age) from the best fit models that are used for the various age reading methods in the assessment.

	CAP								WDFW					
	Break and Burn		Surface		Surface pre 1990		Combo		Break and Burn		Surface		Combo	
True Age	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev
0.5	0.262	0.169	0.159	0.119	0.000	0.000	0.475	0.127	0.503	0.151	0.132	0.103	0.488	0.133
1.5	1.346	0.169	1.271	0.119	0.711	0.000	1.425	0.127	1.510	0.151	1.323	0.103	1.465	0.133
2.5	2.406	0.229	2.353	0.179	2.020	0.082	2.375	0.254	2.516	0.301	2.470	0.206	2.442	0.267
3.5	3.442	0.293	3.406	0.246	3.241	0.168	3.325	0.382	3.522	0.452	3.577	0.309	3.418	0.400
4.5	4.454	0.363	4.429	0.320	4.381	0.259	4.274	0.509	4.529	0.602	4.643	0.413	4.395	0.534
5.5	5.443	0.439	5.424	0.402	5.444	0.354	5.224	0.636	5.535	0.753	5.672	0.516	5.371	0.667
6.5	6.409	0.521	6.393	0.492	6.435	0.456	6.174	0.763	6.541	0.903	6.663	0.619	6.348	0.801
7.5	7.353	0.610	7.335	0.592	7.361	0.562	7.124	0.890	7.548	1.054	7.618	0.722	7.325	0.934
8.5	8.275	0.706	8.251	0.703	8.224	0.675	8.074	1.017	8.554	1.204	8.539	0.825	8.301	1.068
9.5	9.177	0.810	9.142	0.825	9.030	0.793	9.024	1.145	9.560	1.355	9.427	0.928	9.278	1.201
10.5	10.058	0.923	10.008	0.959	9.782	0.919	9.974	1.272	10.567	1.505	10.283	1.031	10.255	1.335
11.5	10.918	1.045	10.851	1.108	10.483	1.051	10.924	1.399	11.573	1.656	11.108	1.135	11.231	1.468
12.5	11.759	1.177	11.671	1.273	11.137	1.190	11.873	1.526	12.579	1.806	11.904	1.238	12.208	1.602
13.5	12.581	1.320	12.469	1.455	11.748	1.337	12.823	1.653	13.586	1.957	12.671	1.341	13.185	1.735
14.5	13.384	1.475	13.244	1.656	12.318	1.492	13.773	1.781	14.592	2.107	13.410	1.444	14.161	1.869
15.5	14.168	1.643	13.999	1.878	12.849	1.656	14.723	1.908	15.599	2.258	14.122	1.547	15.138	2.002
16.5	14.935	1.824	14.733	2.123	13.345	1.828	15.673	2.035	16.605	2.408	14.809	1.650	16.114	2.135
17.5	15.684	2.021	15.447	2.395	13.808	2.010	16.623	2.162	17.611	2.559	15.471	1.753	17.091	2.269
18.5	16.416	2.234	16.141	2.694	14.239	2.202	17.573	2.289	18.618	2.710	16.110	1.857	18.068	2.402
19.5	17.131	2.465	16.816	3.026	14.642	2.405	18.522	2.416	19.624	2.860	16.725	1.960	19.044	2.536
20.5	17.830	2.715	17.473	3.392	15.018	2.618	19.472	2.544	20.630	3.011	17.318	2.063	20.021	2.669
21.5	18.513	2.985	18.112	3.796	15.369	2.844	20.422	2.671	21.637	3.161	17.890	2.166	20.998	2.803
22.5	19.180	3.278	18.733	4.243	15.696	3.081	21.372	2.798	22.643	3.312	18.441	2.269	21.974	2.936
23.5	19.832	3.595	19.338	4.737	16.001	3.332	22.322	2.925	23.649	3.462	18.972	2.372	22.951	3.070
24.5	20.470	3.938	19.926	5.283	16.286	3.597	23.272	3.052	24.656	3.613	19.485	2.475	23.927	3.203
25.5	21.092	4.310	20.497	5.887	16.552	3.876	24.222	3.180	25.662	3.763	19.979	2.579	24.904	3.337
26.5	21.700	4.712	21.054	6.553	16.800	4.170	25.171	3.307	26.668	3.914	20.455	2.682	25.881	3.470
27.5	22.295	5.148	21.595	7.290	17.031	4.481	26.121	3.434	27.675	4.064	20.913	2.785	26.857	3.604
28.5	22.876	5.620	22.121	8.104	17.247	4.808	27.071	3.561	28.681	4.215	21.356	2.888	27.834	3.737

	CAP								WDFW					
	Break and Burn		Surface		Surface pre 1990		Combo		Break and Burn		Surface		Combo	
True Age	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev	Bias	Stdev
29.5	23.443	6.131	22.633	9.004	17.448	5.154	28.021	3.688	29.688	4.365	21.782	2.991	28.811	3.871
30.5	23.998	6.684	23.130	9.998	17.636	5.519	28.971	3.815	30.694	4.516	22.193	3.094	29.787	4.004
31.5	24.539	7.283	23.615	11.097	17.811	5.903	29.921	3.943	31.700	4.666	22.589	3.197	30.764	4.137
32.5	25.069	7.932	24.086	12.312	17.975	6.309	30.871	4.070	32.707	4.817	22.971	3.301	31.740	4.271
33.5	25.586	8.634	24.544	13.653	18.127	6.737	31.821	4.197	33.713	4.967	23.340	3.404	32.717	4.404
34.5	26.092	9.395	24.989	15.136	18.270	7.188	32.770	4.324	34.719	5.118	23.695	3.507	33.694	4.538
35.5	26.586	10.218	25.423	16.775	18.403	7.665	33.720	4.451	35.726	5.268	24.037	3.610	34.670	4.671
36.5	27.068	11.110	25.844	18.586	18.527	8.167	34.670	4.579	36.732	5.419	24.367	3.713	35.647	4.805
37.5	27.540	12.076	26.254	20.587	18.642	8.697	35.620	4.706	37.738	5.570	24.685	3.816	36.624	4.938
38.5	28.001	13.121	26.653	22.799	18.750	9.256	36.570	4.833	38.745	5.720	24.991	3.919	37.600	5.072
39.5	28.451	14.253	27.041	25.243	18.851	9.846	37.520	4.960	39.751	5.871	25.287	4.023	38.577	5.205
40.5	28.891	15.479	27.418	27.944	18.945	10.468	38.470	5.087	40.757	6.021	25.572	4.126	39.553	5.339

Table 8. Pikitch discard ratios.

Fishing	North winter		North summer	
Year	Mean	SD	Mean	SD
1985	0.0222	0.1103	0.0346	0.0419
1986	0.0215	0.1162	0.0343	0.0432
1987	0.027	0.1186	0.0315	0.045

Table 9. WCGOP petrale sole discard ratios (discard/discard+retained) and bootstrap estimated standard deviations for the commercial fisheries used in the model.

Fishing	North winter		North summer		South winter		South summer	
Year	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2002	0.0077	0.0034	0.1856	0.0253	0.0372	0.0244	0.0569	0.0158
2003	0.01	0.0064	0.1111	0.0252	0.0062	0.0026	0.0325	0.0126
2004	0.0019	0.0008	0.0843	0.0244	0.0526	0.0521	0.0343	0.0153
2005	0.0013	0.0009	0.0421	0.0112	0.0069	0.0071	0.0122	0.0035
2006	0.0131	0.0073	0.078	0.0171	0.0598	0.0446	0.036	0.0157
2007	0.0037	0.0015	0.1138	0.0232	0.0194	0.0139	0.061	0.0209
2008	0.0275	0.0146	0.0502	0.0167	0.0099	0.0056	0.0259	0.0147
2009	0.0253	0.0151	0.2018	0.0673	0.0221	0.0147	0.0233	0.0082
2010	0.1971	0.0444	0.1037	0.0308	0.2584	0.0717	0.0554	0.0119
2011	0.0017	0	0.037	0	0.0009	0	0.0411	0
2012	0.0006	0	0	0	0.0046	0	0	0

Table 10. WCGOP petrale sole mean weight of the discards.

Fishing	North winter		North summer		South summer		South winter	
Year	Mean	CV	Mean	CV	Mean	CV	Mean	CV
2002	0.411	0.471	0.241	0.453	0.410	0.658	0.190	0.738
2003	0.297	0.453	0.234	0.546	0.178	0.407	0.175	0.409
2004	0.332	0.477	0.274	0.368	0.309	0.394	0.183	0.472
2005	0.316	0.538	0.304	0.412	0.270	0.664	0.252	0.438
2006	0.417	0.624	0.267	0.447	0.284	0.668	0.318	0.643
2007	0.401	0.314	0.259	0.399	0.217	0.470	0.366	0.629
2008	0.522	0.443	0.241	0.475	0.300	0.445	0.219	0.427
2009	0.416	0.453	0.217	0.525	0.554	0.416	0.213	1.049
2010	0.601	0.547	0.258	0.544	0.417	0.969	0.183	0.369
2011	0.276	0.516	0.246	0.530	0.326	0.132	0.246	0.666
2012	0.264	0.512	0.000	0.000	0.202	0.687	0.000	0.000

Table 11. Summary of number of tows generating length-frequency distributions used in the assessment model for the trawl fleets.

Year	North Winter	Year	North Summer	Year	South Winter	Year	South Summer
1955	1	1955	3	1949	10	1948	4
1956	1	1956	8	1964	1	1949	4
1957	10	1957	11	1965	2	1962	3
1958	1	1958	3	1966	8	1964	22
1959	2	1960	2	1967	20	1965	14
1964	4	1961	1	1968	11	1966	33
1965	3	1964	3	1969	14	1967	44
1966	2	1965	2	1970	13	1968	87
1967	4	1966	37	1971	7	1969	49
1968	15	1967	44	1972	23	1970	29
1969	14	1968	66	1973	12	1971	37
1970	11	1969	62	1974	31	1972	39
1971	12	1970	64	1975	11	1973	41
1972	4	1971	24	1976	12	1974	35
1973	4	1972	33	1977	8	1975	19
1974	5	1973	25	1978	17	1976	26
1975	12	1974	56	1979	7	1977	38
1976	3	1975	27	1980	6	1978	33
1977	2	1976	6	1981	36	1979	13
1978	4	1977	21	1982	26	1980	81
1979	2	1978	21	1983	26	1981	65
1980	9	1979	24	1984	13	1982	34
1981	10	1980	44	1985	13	1983	33
1982	5	1981	37	1986	10	1984	19
1983	4	1982	17	1987	20	1985	17

Year	North Winter	Year	North Summer	Year	South Winter	Year	South Summer
1984	3	1983	1	1988	12	1986	32
1986	3	1985	5	1989	18	1987	29
1987	7	1986	9	1990	4	1988	12
1988	4	1987	16	1991	24	1989	18
1989	10	1988	8	1992	9	1990	2
1990	4	1989	13	2002	15	1991	2
1991	11	1990	11	2003	7	2001	9
1992	4	1991	7	2004	12	2002	10
1993	7	1992	11	2005	9	2003	30
1994	9	1993	8	2006	26	2004	15
1995	8	1994	9	2007	42	2005	36
1996	3	1995	2	2008	58	2006	47
1997	5	1996	4	2009	62	2007	103
1998	5	1997	12	2010	31	2008	97
1999	9	1998	22	2011	18	2009	62
2000	14	1999	15	2012	32	2010	52
2001	18	2000	24			2011	23
2002	9	2001	18			2012	40
2003	20	2002	31				
2004	27	2003	35				
2005	25	2004	30				
2006	16	2005	35				
2007	37	2006	51				
2008	61	2007	46				
2009	43	2008	36				
2010	38	2009	66				

Year	North Winter	Year	North Summer	Year	South Winter	Year	South Summer
2011	33	2010	59				
2012	35	2011	47				
		2012	44				

Table 12. Summary of the number of tows and the aging agency and aging method applied to generate age-frequency distributions used in the assessment model for the trawl fleets.

North Winter				North Summer				South Winter				South Summer			
Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N
1964	W/O	CAP Early Surface	3	1960	W/O	CAP Early Surface	1	1966	C	CAP Early Surface	8	1966	C	CAP Early Surface	27
1965	W/O	CAP Early Surface	3	1961	W/O	CAP Early Surface	1	1967	C	CAP Early Surface	13	1967	C	CAP Early Surface	11
1967	W/O	CAP Early Surface	4	1964	W/O	CAP Early Surface	2	1969	C	CAP Early Surface	8	1968	C	CAP Early Surface	56
1968	W/O	CAP Early Surface	15	1965	W/O	CAP Early Surface	2	1970	C	CAP Early Surface	10	1969	C	CAP Early Surface	31
1969	W/O	CAP Early Surface	14	1966	W/O	CAP Early Surface	35	1971	C	CAP Early Surface	6	1970	C	CAP Early Surface	29
1970	W/O	CAP Early Surface	8	1967	W/O	CAP Early Surface	44	1972	C	CAP Early Surface	23	1971	C	CAP Early Surface	37
1971	W/O	CAP Early Surface	5	1968	W/O	CAP Early Surface	56	1973	C	CAP Early Surface	12	1972	C	CAP Early Surface	38
1972	W/O	CAP Early Surface	4	1969	W/O	CAP Early Surface	57	1974	C	CAP Early Surface	29	1973	C	CAP Early Surface	38
1973	W/O	CAP Early Surface	4	1970	W/O	CAP Early Surface	61	1975	C	CAP Early Surface	9	1974	C	CAP Early Surface	34
1974	W/O	CAP Early Surface	5	1971	W/O	CAP Early Surface	22	1976	C	CAP Early Surface	12	1975	C	CAP Early Surface	18
1975	W/O	CAP Early Surface	11	1972	W/O	CAP Early Surface	32	1977	C	CAP Early Surface	8	1976	C	CAP Early Surface	23
1976	W/O	CAP Early Surface	3	1973	W/O	CAP Early Surface	24	1978	C	CAP Early Surface	9	1977	C	CAP Early Surface	33
1977	W/O	CAP Early Surface	2	1974	W/O	CAP Early Surface	47	1979	C	CAP Early Surface	5	1978	C	CAP Early Surface	32
1978	W/O	CAP Early Surface	4	1975	W/O	CAP Early Surface	24	1980	C	CAP Early Surface	6	1979	C	CAP Early Surface	11
1980	W/O	CAP Early Surface	7	1976	W/O	CAP Early Surface	5	1981	C	CAP Early Surface	18	1980	C	CAP Early Surface	50

North Winter				North Summer				South Winter				South Summer			
Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N
1981	W/O	CAP Early Surface	3	1977	W/O	CAP Early Surface	19	1982	C	CAP Early Surface	1	1981	C	CAP Early Surface	27
1981	O	CAP Combo	5	1978	W/O	CAP Early Surface	16	1983	C	CAP Early Surface	12	1982	C	CAP Early Surface	18
1982	O	CAP Combo	5	1979	W/O	CAP Early Surface	21	1984	C	CAP Early Surface	6	1983	C	CAP Early Surface	8
1983	O	CAP Combo	3	1980	W/O	CAP Early Surface	38	1985	C	CAP Early Surface	2	1984	C	CAP Early Surface	3
1984	O	CAP Combo	2	1981	O	CAP Combo	37	1986	C	CAP BB	4	1985	C	CAP Early Surface	4
1986	O	CAP BB	3	1982	O	CAP Combo	16	1987	C	CAP BB	10	1986	C	CAP BB	16
1987	O	CAP Combo	7	1983	O	CAP Combo	1	1988	C	CAP BB	5	1987	C	CAP BB	12
1988	O	CAP Combo	4	1985	O	CAP BB	5	1989	C	CAP BB	2	1988	C	CAP BB	6
1989	O	CAP BB	10	1986	O	CAP BB	9	1990	C	CAP BB	2	2003	C	CAP BB	5
1990	O	CAP BB	4	1987	O	CAP Combo	16	1991	C	CAP BB	15	2005	C	CAP BB	10
1991	O	CAP Combo	11	1988	O	CAP Combo	8	1992	C	CAP BB	1	2006	C	CAP BB	7
1992	O	CAP Combo	4	1989	O	CAP BB	12	2003	C	CAP BB	1	2008	C	CAP BB	18
1993	O	CAP Combo	7	1990	O	CAP BB	11	2004	C	CAP BB	1	2009	C	CAP BB	3
1994	O	CAP Combo	9	1991	O	CAP Combo	7	2005	C	CAP BB	3				
1995	O	CAP Combo	8	1992	O	CAP Combo	11	2006	C	CAP BB	2				
1996	O	CAP Combo	3	1993	O	CAP Combo	8	2008	C	CAP BB	3				
1997	O	CAP Combo	5	1994	O	CAP Combo	9	2009	C	CAP BB	4				

North Winter				North Summer				South Winter				South Summer			
Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N
1998	W	WDFW Combo	1	1995	O	CAP Combo	2								
1998	O	CAP BB	1	1996	O	CAP Combo	4								
1998	O	CAP Surface	3	1997	O	CAP Combo	11								
1999	W	WDFW Combo	2	1998	W	WDFW Combo	11								
1999	O	CAP BB	4	1998	O	CAP BB	6								
2000	W	WDFW Combo	5	1998	O	WDFW Combo	5								
2000	O	CAP BB	1	1999	W	WDFW Combo	9								
2001	W	WDFW Combo	6	1999	O	CAP BB	4								
2002	W	WDFW Combo	5	2000	W	WDFW Combo	12								
2002	O	CAP Surface	4	2001	W	WDFW Combo	10								
2003	W	WDFW Combo	5	2001	O	CAP Surface	1								
2003	O	CAP Surface	7	2002	W	WDFW Combo	10								
2004	W	WDFW Combo	7	2002	O	CAP Surface	10								
2004	O	CAP Surface	8	2003	W	WDFW Combo	19								
2005	W	WDFW Combo	5	2003	O	CAP Surface	7								
2006	W	WDFW Combo	5	2004	W	WDFW Combo	18								
2007	W	WDFW Combo	5	2004	O	CAP Surface	6								

North Winter				North Summer				South Winter				South Summer			
Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N	Year	Agency	Method	N
2007	O	CAP BB	4	2005	W	WDFW Combo	18								
2008	W	WDFW Combo	3	2006	W	WDFW Combo	14								
2008	O	CAP BB	4	2007	W	WDFW Combo	16								
2009	W	WDFW BB	3	2007	O	CAP BB	8								
2009	W	WDFW Combo	3	2008	W	WDFW Combo	17								
2009	O	CAP BB	28	2008	O	CAP BB	9								
2010	W	WDFW BB	4	2009	W	WDFW BB	8								
2010	O	CAP BB	21	2009	W	WDFW Combo	1								
2011	W	WDFW BB	1	2009	O	CAP BB	31								
2011	O	CAP BB	11	2010	W	WDFW BB	4								
2012	W	WDFW BB	2	2010	O	CAP BB	30								
2012	O	CAP BB	12	2011	W	WDFW BB	11								
				2011	O	CAP BB	31								
				2012	W	WDFW BB	10								

Table 13. Description of model parameters in the base-case assessment model.

Parameter	Number estimated	Bounds (low, high)	Prior (Mean, SD) Type
Natural mortality (*M*, female)	1	(0.005,0.5)	(-1.888, 0.33) Lognormal
Natural mortality (*M*, male)	1	(000.5,0.6)	(-1.58, 0.33) Lognormal
	Stock and recruitment		
Ln(R_0)	1	(5,20)	-
Steepness (*h*)	1	(0.2,1)	(.8,.09) Normal
σ_r	-	-	-
Ln(Early Recruitment Deviations): 1845-1958	114	(-4,4)	-
Ln(Main Recruitment Deviations): 1959-2009	51	(-4,4)	-
Ln(Forecast Recruitment Deviations): 2010-2024	15	(-4,4)	-
	Indices		
Ln(*q*) – NWFSC survey	-	Analytic solution	
Ln(*q*) – Triennial survey (early and late)	-	Analytic solution	
Ln (q) – North winter commercial CPUE	2	(-20,5)	-
Ln (q) – South winter commercial CPUE	2	(-20,5)	-
Beta (power) – North winter commercial CPUE	1	(-5,5)	-
Beta (power) – South winter commercial CPUE	1	(-5,5)	-
Extra SD – Early Triennial	1	(0.001, 2)	-
Extra SD – Late Triennial	1	(0.001, 2)	-
	Selectivity (asymptotic, sex specific, with retention curves)		
Fisheries:			
Length at peak selectivity	4	(15, 75)	-
Width of top (as logistic)	-		-
Ascending width (as exp(width))	4	(-4,12)	-
Descending width (as exp(width))	-		-
Initial selectivity (as logistic)	-		-
Final selectivity (as logistic)	-		-
Male 1	4	(-15,15)	-
Male 2	4	(-15,15)	-
Male 3	-		-
Male 4	-		-
Male 5	-		-
Retention 1	4	(10,40)	-
Retention 2	4	(0.1,10)	-
Retention 3	4	(0.001,1)	-
Retention 4	-		-
Selectivity time block parameters (Peak)	20	(-3,2)	-
Retention time block parameters (Inflection, Slope, Asymptote)	36	(-3,4)	-
Surveys:			-
Length at peak selectivity	3	(15,61)	-
Width of top (as logistic)	-		-
Ascending width (as exp(width))	3	(-4,12)	-
Descending width (as exp(width))	-		-
Initial selectivity (as logistic)	-		-
Final selectivity (as logistic)	-		-
Male 1	3	(-15,15)	-
Male 2	3	(-15,15)	-
Male 3	-		-
Male 4	-		-
Male 5	-		-

Parameter	Number estimated	Bounds (low, high)	Prior (Mean, SD) Type
<u>Individual growth</u>			
Females:			
Length at age min	1	(10,45)	-
Length at age max	1	(35,80)	-
von Bertalanffy *K*	1	(0.04,0.5)	-
CV of length at age min	1	(0.01,1)	-
CV of length at age max	1	(0.01,1)	-
Males:			
Length at age min	1	(-1,2)	-
Length at age max	1	(-1,2)	-
von Bertalanffy K	1	(0.04,0.5)	-
CV of length at age min	1	(0.01,1)	-
CV of length at age max	1	(0.01,1)	-
Total: 118 + 180 recruitment deviations =298 estimated parameters			

Table 14. Time blocks

Block Pattern					
#1 Selectivity	1973-1982	1983-1992	1993-2002	2003-2010	2011-2012
#2 Retention, Winter			2003-2009	2010-2010	2011-2012
#3 Retention, Summer			2003-2008	2009-2010	2011-2012

Table 15. Estimates of the growth parameters from the base case model. Age min is 2 and Age max is 17.

Parameter	Value
Females:	
Length at age min	15.88
Length at Linf	54.31
von Bertalanffy *K*	0.13
CV of length at age min	0.18
CV of length at age max	0.03
Males:	
Length at age min	16.35
Length at Linf	42.57
von Bertalanffy *K*	0.21
CV of length at age min	0.13
CV of length at age max	0.05

Table 16. Petrale sole catchability, power, index extra standard deviation, and productivity parameters.

Parameter	Value	~95% CI	
Catchability, Power, Extra SD:			
NWFSC survey catchability (*q*)	3.36		
Triennial survey catchability (*q*) early, late	0.55, 0.72		
North winter commercial CPUE (*q*)	0.002, 1.82	0.00001, 0.41	1.25, 2.64
South winter commercial CPUE (*q*)	0.87, 2.17	0.009, 85.93	1.38, 3.40
North winter commercial CPUE (*Beta*)	-0.22	-0.92, 0.47	
South winter commercial CPUE (*Beta*)	-1.01	-1.57, -0.44	
Q_extraSD Triennial survey early	0.16	-0.04, 0.35	
Q_extraSD Triennial survey late	0.19	0.04, 0.42	
Productivity:			
R_0	9.72	9.28, 10.16	
Steepness (*h*)	0.86	0.75, 0.97	
Female natural mortality (*M*)	0.15	0.12, 0.19	
Male natural mortality (*M*)	0.17	0.13, 0.21	

Table 17. Time-series of population estimates from the base case model.

Fishing year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	SPR	Relative exploitation rate
1876	50,700	32,426	1.000	16,673	1.0	0	0
1877	50,699	32,425	1.000	16,673	1.0	0	0
1878	50,699	32,425	1.000	16,673	1.0	0	0
1879	50,698	32,424	1.000	16,673	1.0	0	0
1880	50,697	32,424	1.000	16,673	11.6	0	0
1881	50,687	32,416	1.000	16,673	22.2	0	0
1882	50,667	32,402	0.999	16,673	32.8	0.01	0
1883	50,638	32,381	0.999	16,673	43.4	0.01	0
1884	50,601	32,355	0.998	16,673	54.1	0.01	0
1885	50,557	32,323	0.997	16,672	64.7	0.01	0
1886	50,506	32,287	0.996	16,672	75.3	0.02	0
1887	50,450	32,246	0.994	16,672	85.9	0.02	0
1888	50,388	32,200	0.993	16,671	96.5	0.02	0
1889	50,321	32,152	0.992	16,671	107.1	0.02	0
1890	50,250	32,100	0.990	16,670	117.7	0.03	0
1891	50,176	32,045	0.988	16,670	128.3	0.03	0
1892	50,098	31,987	0.986	16,670	138.9	0.03	0
1893	50,017	31,928	0.985	16,669	149.6	0.03	0
1894	49,934	31,866	0.983	16,669	160.2	0.03	0
1895	49,848	31,803	0.981	16,669	170.8	0.04	0
1896	49,761	31,738	0.979	16,669	181.6	0.04	0
1897	49,671	31,671	0.977	16,669	192.2	0.04	0
1898	49,581	31,604	0.975	16,669	202.8	0.04	0
1899	49,489	31,535	0.973	16,670	213.4	0.05	0
1900	49,396	31,466	0.970	16,670	224.0	0.05	0
1901	49,302	31,395	0.968	16,671	234.6	0.05	0
1902	49,207	31,325	0.966	16,672	245.2	0.05	0.01
1903	49,112	31,253	0.964	16,674	255.8	0.05	0.01
1904	49,017	31,181	0.962	16,676	266.4	0.06	0.01
1905	48,921	31,109	0.959	16,678	277.0	0.06	0.01
1906	48,825	31,037	0.957	16,681	287.7	0.06	0.01
1907	48,728	30,964	0.955	16,685	298.3	0.06	0.01
1908	48,632	30,891	0.953	16,689	308.9	0.07	0.01
1909	48,536	30,818	0.950	16,694	319.5	0.07	0.01
1910	48,440	30,746	0.948	16,700	330.1	0.07	0.01
1911	48,345	30,673	0.946	16,706	340.7	0.07	0.01
1912	48,250	30,600	0.944	16,714	351.3	0.08	0.01
1913	48,156	30,528	0.941	16,723	361.9	0.08	0.01
1914	48,062	30,456	0.939	16,734	372.6	0.08	0.01
1915	47,970	30,385	0.937	16,745	383.2	0.08	0.01
1916	47,878	30,314	0.935	16,758	388.8	0.08	0.01
1917	47,793	30,247	0.933	16,773	529.6	0.11	0.01
1918	47,585	30,094	0.928	16,787	426.5	0.09	0.01
1919	47,494	30,021	0.926	16,805	335.5	0.07	0.01
1920	47,504	30,018	0.926	16,827	231.9	0.05	0
1921	47,620	30,090	0.928	16,853	295.6	0.06	0.01
1922	47,676	30,122	0.929	16,880	427.4	0.09	0.01
1923	47,609	30,069	0.927	16,908	430.0	0.09	0.01
1924	47,548	30,019	0.926	16,937	536.1	0.11	0.01

Fishing year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	SPR	Relative exploitation rate
1925	47,397	29,905	0.922	16,969	531.7	0.11	0.01
1926	47,266	29,803	0.919	17,002	524.9	0.11	0.01
1927	47,159	29,716	0.916	17,038	636.0	0.13	0.01
1928	46,964	29,566	0.912	17,076	623.9	0.13	0.01
1929	46,803	29,439	0.908	17,117	712.0	0.15	0.02
1930	46,581	29,269	0.903	17,163	664.2	0.14	0.01
1931	46,432	29,147	0.899	17,217	682.2	0.14	0.01
1932	46,294	29,031	0.895	17,281	815.9	0.16	0.02
1933	46,061	28,844	0.890	17,367	852.4	0.17	0.02
1934	45,834	28,657	0.884	17,496	1,629.6	0.29	0.04
1935	44,912	27,986	0.863	17,685	1,613.3	0.29	0.04
1936	44,094	27,376	0.844	17,970	1,326.0	0.25	0.03
1937	43,649	27,008	0.833	18,365	1,904.1	0.33	0.04
1938	42,745	26,313	0.811	18,797	2,171.3	0.37	0.05
1939	41,717	25,512	0.787	19,082	2,662.9	0.43	0.06
1940	40,378	24,472	0.755	18,884	2,562.7	0.42	0.06
1941	39,323	23,607	0.728	18,082	2,312.0	0.4	0.06
1942	38,675	23,023	0.710	17,008	3,239.4	0.49	0.09
1943	37,295	21,953	0.677	16,179	3,373.5	0.51	0.09
1944	35,916	20,952	0.646	15,975	2,667.4	0.47	0.08
1945	35,261	20,537	0.633	16,095	2,498.7	0.46	0.07
1946	34,751	20,284	0.626	15,451	3,788.5	0.58	0.11
1947	32,990	19,201	0.592	13,929	3,132.5	0.54	0.1
1948	31,833	18,512	0.571	12,610	4,497.3	0.65	0.14
1949	29,336	16,917	0.522	11,785	4,384.7	0.67	0.15
1950	26,907	15,403	0.475	11,614	4,610.8	0.7	0.17
1951	24,242	13,752	0.424	12,076	3,029.8	0.62	0.13
1952	23,054	13,100	0.404	12,923	2,775.0	0.61	0.12
1953	22,064	12,565	0.387	13,427	2,343.8	0.59	0.11
1954	21,449	12,226	0.377	13,562	2,865.8	0.65	0.14
1955	20,348	11,479	0.354	13,383	2,546.8	0.63	0.13
1956	19,615	10,897	0.336	13,146	2,253.1	0.61	0.12
1957	19,241	10,535	0.325	13,028	2,888.5	0.68	0.15
1958	18,342	9,848	0.304	12,805	2,841.9	0.69	0.16
1959	17,564	9,279	0.286	12,744	2,433.0	0.67	0.14
1960	17,240	9,030	0.278	17,612	2,846.7	0.71	0.17
1961	16,602	8,581	0.265	18,091	3,415.8	0.76	0.21
1962	15,565	7,820	0.241	11,675	3,263.2	0.77	0.22
1963	14,849	7,168	0.221	11,987	3,300.1	0.79	0.23
1964	14,208	6,553	0.202	17,159	2,759.6	0.77	0.2
1965	14,111	6,404	0.197	16,163	2,629.1	0.76	0.19
1966	14,196	6,519	0.201	33,816	2,662.5	0.76	0.2
1967	14,401	6,638	0.205	14,761	2,690.0	0.76	0.2
1968	14,888	6,640	0.205	14,975	2,397.8	0.74	0.17
1969	15,900	6,793	0.209	13,595	2,433.4	0.74	0.16
1970	16,954	7,136	0.220	13,493	3,152.7	0.77	0.19
1971	17,264	7,503	0.231	13,108	3,290.5	0.77	0.2
1972	17,244	8,015	0.247	10,799	3,560.5	0.78	0.21
1973	16,708	8,175	0.252	8,785	3,057.5	0.75	0.19

Fishing year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	SPR	Relative exploitation rate
1974	16,302	8,277	0.255	10,892	3,850.0	0.8	0.24
1975	14,851	7,644	0.236	11,104	3,710.2	0.81	0.26
1976	13,303	6,874	0.212	14,470	3,041.0	0.8	0.24
1977	12,257	6,329	0.195	13,314	2,502.4	0.77	0.21
1978	11,744	5,944	0.183	9,974	3,190.6	0.83	0.28
1979	10,665	5,078	0.157	10,095	3,270.5	0.86	0.32
1980	9,568	4,206	0.130	11,661	2,739.1	0.86	0.3
1981	8,969	3,801	0.117	9,930	2,638.8	0.86	0.31
1982	8,444	3,571	0.110	8,641	2,713.2	0.87	0.34
1983	7,853	3,287	0.101	10,063	2,444.8	0.87	0.32
1984	7,418	3,108	0.096	14,574	1,890.5	0.84	0.27
1985	7,446	3,164	0.098	9,179	1,821.4	0.84	0.26
1986	7,559	3,238	0.100	5,322	2,094.8	0.85	0.29
1987	7,426	3,109	0.096	6,803	2,464.5	0.88	0.35
1988	6,870	2,759	0.085	10,840	2,295.7	0.89	0.34
1989	6,356	2,593	0.080	14,194	2,257.5	0.89	0.37
1990	5,823	2,472	0.076	13,875	1,917.6	0.88	0.35
1991	5,662	2,333	0.072	10,230	2,086.4	0.9	0.4
1992	5,506	1,936	0.060	5,704	1,738.4	0.9	0.34
1993	5,787	1,803	0.056	10,531	1,680.1	0.89	0.31
1994	6,175	1,954	0.060	13,530	1,541.7	0.86	0.26
1995	6,666	2,427	0.075	8,195	1,682.8	0.85	0.27
1996	7,016	2,849	0.088	9,787	1,932.6	0.85	0.29
1997	7,098	2,948	0.091	9,824	2,046.1	0.86	0.3
1998	7,038	2,831	0.087	21,894	1,729.0	0.84	0.26
1999	7,309	2,936	0.091	13,879	1,615.8	0.82	0.23
2000	7,876	3,167	0.098	10,683	1,914.6	0.83	0.27
2001	8,384	3,221	0.099	8,309	1,971.2	0.84	0.25
2002	8,932	3,278	0.101	9,588	2,052.9	0.83	0.24
2003	9,375	3,556	0.110	8,511	1,748.1	0.79	0.19
2004	9,969	4,228	0.130	9,841	2,248.0	0.81	0.23
2005	9,961	4,618	0.142	9,779	2,955.8	0.84	0.31
2006	9,126	4,353	0.134	15,448	2,171.2	0.81	0.25
2007	8,902	4,230	0.130	22,443	2,373.5	0.82	0.28
2008	8,619	3,867	0.119	33,214	2,153.4	0.82	0.27
2009	8,921	3,612	0.111	16,584	2,264.7	0.84	0.28
2010	9,718	3,377	0.104	11,349	870.2	0.66	0.1
2011	12,245	4,146	0.128	11,219	787.2	0.58	0.07
2012	15,015	5,465	0.169	13,824	1,144.2	0.6	0.08

Table 18. Asymptotic standard deviation estimates for spawning biomass and recruitment.

Fishing year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)	Year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)	Year	SD Spawning biomass (mt)	SD Age-0 recruits (1000s)
1876	4,270.3	7,647.8	1923	4,083.4	7,822.8	1970	606.0	3,197.2
1877	4,271.0	7,647.9	1924	4,070.0	7,845.7	1971	611.6	3,099.2
1878	4,271.5	7,648.0	1925	4,054.6	7,869.6	1972	617.2	2,625.0
1879	4,271.9	7,648.1	1926	4,037.5	7,895.9	1973	607.8	2,201.4
1880	4,272.3	7,648.2	1927	4,018.2	7,924.2	1974	579.8	2,458.3
1881	4,273.3	7,648.2	1928	3,995.9	7,953.6	1975	532.6	2,565.2
1882	4,275.1	7,648.2	1929	3,970.9	7,986.1	1976	480.5	3,099.1
1883	4,277.2	7,648.1	1930	3,942.3	8,021.4	1977	429.0	3,044.5
1884	4,279.4	7,647.9	1931	3,910.8	8,062.8	1978	381.6	2,645.7
1885	4,281.2	7,647.7	1932	3,875.6	8,111.2	1979	338.1	2,750.2
1886	4,282.5	7,647.4	1933	3,835.8	8,172.9	1980	307.2	3,009.5
1887	4,283.3	7,647.1	1934	3,791.5	8,263.4	1981	289.0	2,579.9
1888	4,283.5	7,646.8	1935	3,736.5	8,391.0	1982	276.3	2,230.8
1889	4,283.3	7,646.5	1936	3,675.3	8,581.9	1983	266.5	2,429.9
1890	4,282.4	7,646.2	1937	3,609.3	8,846.4	1984	255.0	2,965.5
1891	4,281.1	7,645.9	1938	3,532.0	9,132.3	1985	239.6	2,192.5
1892	4,279.4	7,645.6	1939	3,444.9	9,305.7	1986	218.9	1,412.6
1893	4,277.3	7,645.4	1940	3,346.1	9,138.3	1987	197.9	1,769.3
1894	4,274.7	7,645.3	1941	3,238.6	8,569.2	1988	180.6	2,633.8
1895	4,271.9	7,645.2	1942	3,123.1	7,844.0	1989	170.6	3,273.5
1896	4,268.7	7,645.2	1943	2,992.5	7,300.5	1990	163.5	3,497.9
1897	4,265.3	7,645.2	1944	2,852.0	7,164.4	1991	155.9	2,738.0
1898	4,261.6	7,645.6	1945	2,712.4	7,280.5	1992	147.8	1,698.0
1899	4,257.7	7,645.9	1946	2,577.5	6,929.3	1993	147.6	2,486.7
1900	4,253.5	7,646.4	1947	2,443.8	6,012.3	1994	156.8	2,961.9
1901	4,249.2	7,647.1	1948	2,325.9	5,246.0	1995	171.0	2,089.0
1902	4,244.7	7,648.0	1949	2,203.3	4,769.9	1996	181.0	2,159.5
1903	4,239.9	7,649.2	1950	2,076.6	4,638.7	1997	182.2	2,148.8
1904	4,235.0	7,650.6	1951	1,945.9	4,830.6	1998	180.6	3,782.6
1905	4,229.9	7,652.3	1952	1,829.7	5,241.0	1999	183.1	2,557.4
1906	4,224.5	7,654.4	1953	1,721.9	5,489.4	2000	185.1	1,962.4
1907	4,219.0	7,657.0	1954	1,625.2	5,481.9	2001	182.8	1,555.3
1908	4,213.3	7,660.1	1955	1,532.6	5,264.5	2002	184.8	1,750.0
1909	4,207.3	7,663.7	1956	1,444.9	4,963.3	2003	202.6	1,635.9
1910	4,201.1	7,667.9	1957	1,348.9	4,658.8	2004	227.2	1,912.0
1911	4,194.7	7,672.7	1958	1,231.5	4,287.9	2005	240.5	2,002.3
1912	4,187.9	7,678.4	1959	1,100.1	4,197.1	2006	243.1	3,140.9
1913	4,180.8	7,684.9	1960	965.4	4,810.1	2007	245.0	4,615.9
1914	4,173.4	7,692.5	1961	829.8	4,502.7	2008	254.0	6,902.3
1915	4,165.6	7,701.1	1962	709.7	3,134.0	2009	279.7	4,117.8
1916	4,157.3	7,710.6	1963	624.2	3,049.6	2010	330.8	3,642.4
1917	4,148.5	7,721.3	1964	574.2	3,994.9	2011	419.1	4,471.2
1918	4,138.3	7,731.9	1965	561.6	4,170.3	2012	567.9	6,029.7
1919	4,127.9	7,745.6	1966	572.7	6,947.0			
1920	4,117.3	7,762.0	1967	589.2	4,008.3			
1921	4,107.0	7,781.3	1968	597.9	3,632.0			
1922	4,095.8	7,801.7	1969	602.2	3,276.7			

Table 19. Results from sensitivity model runs.

Label	Base	High M	Low M	No Comm. CPUE	Increase Comm. CPUE SD	Comm. CPUE, TVQ	Comm. CPUE, BlockQ
TOTAL_like	1454.3	1455.9	1455.9	1502.2	1463.6	1458.2	1458.8
Survey_like	-70.62	-70.43	-70.72	-22.19	-63.91	-67.25	-66.68
Discard_like	-143.14	-143.18	-143.08	-143.21	-143.06	-143.09	-143.10
Mean_body_wt_like	-75.76	-75.77	-75.76	-75.74	-75.79	-75.77	-75.77
Length_comp_like	813.91	813.41	814.98	814.41	817.80	815.00	814.97
Age_comp_like	950.91	951.76	950.25	950.15	948.89	950.48	950.44
SR_BH_steep	0.86	0.76	0.94	0.85	0.85	0.86	0.86
NatM_p_1_Fem_GP_1	0.15	0.19	0.12	0.15	0.16	0.15	0.15
L_at_Amin_Fem_GP_1	15.88	15.83	15.92	15.88	15.82	15.87	15.87
L_at_Amax_Fem_GP_1	54.31	54.42	54.18	54.26	54.29	54.30	54.30
VonBert_K_Fem_GP_1	0.13	0.13	0.13	0.13	0.13	0.13	0.13
CV_young_Fem_GP_1	0.18	0.18	0.18	0.18	0.18	0.18	0.18
CV_old_Fem_GP_1	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NatM_p_1_Mal_GP_1	0.17	0.21	0.13	0.17	0.17	0.17	0.17
L_at_Amin_Mal_GP_1	16.35	16.29	16.39	16.34	16.32	16.34	16.34
L_at_Amax_Mal_GP_1	42.57	42.64	42.48	42.55	42.54	42.56	42.56
VonBert_K_Mal_GP_1	0.21	0.21	0.21	0.21	0.21	0.21	0.21
CV_young_Mal_GP_1	0.13	0.13	0.13	0.13	0.13	0.13	0.13
CV_old_Mal_GP_1	0.05	0.05	0.05	0.05	0.05	0.05	0.05
SSB_Unfished_thou_mt	32.425	28.418	37.281	32.277	32.161	32.512	32.473
Bratio_2012	0.169	0.162	0.102	0.168	0.187	0.167	0.169
Bratio_2013	0.223	0.211	0.136	0.222	0.248	0.221	0.224
F_2012	0.08	0.07	0.09	0.08	0.07	0.08	0.08
F_2013	0.15	0.17	0.10	0.13	0.14	0.13	0.13
SSB_Btgt_thou_mt	8.106	7.105	9.32	8.069	8.04	8.128	8.118
SPR_Btgt	0.28	0.31	0.26	0.28	0.28	0.28	0.28
Fstd_Btgt	0.17	0.18	0.16	0.17	0.17	0.17	0.17
TotYield_Btgt_thou_mt	2.749	2.762	2.671	2.747	2.78	2.749	2.752
SSB_SPRtgt_thou_mt	8.739	6.832	10.763	8.677	8.612	8.762	8.749
Fstd_SPRtgt	0.16	0.19	0.14	0.16	0.16	0.16	0.16
TotYield_SPRtgt_thou_mt	2.731	2.76	2.61	2.73	2.765	2.731	2.734
SSB_MSY_thou_mt	7.146	7.173	6.994	7.146	7.146	7.168	7.16
SPR_MSY	0.25	0.31	0.20	0.25	0.26	0.25	0.25
Fstd_MSY	0.19	0.18	0.20	0.19	0.19	0.19	0.19
TotYield_MSY_thous_mt	2.76	2.762	2.715	2.757	2.79	2.76	2.763
RetYield_MSY	2724	2723	2682	2721	2753	2724	2727

Table 20. Results from the retrospective model runs. Shaded values are for are forecast values.

Assessment Year	Base	2011	2010	2009	2008	2007
SSB Unfished	32,425	32,013	32,034	31,893	31,473	31,961
2007 Depletion	0.130	0.131	0.132	0.140	0.135	0.152
2008 Depletion	0.119	0.119	0.121	0.130	0.125	0.153
2009 Depletion	0.111	0.111	0.113	0.124	0.121	0.161
2010 Depletion	0.104	0.103	0.105	0.118	0.124	0.169
2011 Depletion	0.128	0.126	0.128	0.146	0.161	0.204
2012 Depletion	0.169	0.166	0.170	0.188	0.202	0.237
2013 Depletion	0.223	0.221	0.219	0.230	0.235	0.263

Table 21. Projection of potential petrale sole OFL, ACL, spawning biomass and depletion for the base case model based on the SPR= 0.3 fishing mortality target and $F_{30\%}$ overfishing limit/target (OFL). Assuming the ACLs of 2,592 and 2,652 mt are attained in 2013 and 2014.

Year	Predicted OFL (mt)	ACL Catch (mt)	Age 3+ biomass (mt)	Spawning Biomass (mt)	Depletion (%)
2013	2,711	2,592	16,954	7,233	0.22
2014	2,774	2,652	17,656	8,540	0.26
2015	2,946	2,828	18,043	9,462	0.29
2016	3,044	2,922	18,037	9,740	0.3
2017	3,015	2,895	17,803	9,592	0.3
2018	2,936	2,820	17,546	9,331	0.29
2019	2,864	2,751	17,368	9,122	0.28
2020	2,821	2,708	17,284	9,007	0.28
2021	2,804	2,692	17,269	8,966	0.28
2022	2,804	2,692	17,289	8,969	0.28
2023	2,811	2,698	17,318	8,990	0.28
2024	2,818	2,706	17,343	9,012	0.28

Table 22. Decision table of 12-year projections for alternate states of nature (columns) and management options (rows) beginning in 2011. Relative probabilities of each state of nature are based on low and high values for the rate of female natural mortality.

			State of nature					
			Low Female M = 0.12		Base case Female M = 0.15		High Female M = 0.19	
Relative probability			0.25		0.5		0.25	
Manage-ment decision	Year	Catch (mt)	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion
ABC 25:5 Rule	2015	2828	9095	0.244	9461	0.292	10017	0.352
	2016	2922	9519	0.255	9739	0.300	10137	0.357
	2017	2895	9531	0.256	9592	0.296	9819	0.346
	2018	2820	9393	0.252	9330	0.288	9427	0.332
	2019	2751	9255	0.248	9122	0.281	9145	0.322
	2020	2708	9159	0.246	9006	0.278	9005	0.317
	2021	2692	9103	0.244	8966	0.276	8971	0.316
	2022	2692	9072	0.243	8969	0.277	8993	0.316
	2023	2698	9052	0.243	8989	0.277	9033	0.318
	2024	2706	9033	0.242	9011	0.278	9066	0.319
Catch that stabilizes the stock at $\sim SB_{30\%}$	2015	2367	9095	0.244	9461	0.292	10017	0.352
	2016	2533	9784	0.262	9999	0.308	10389	0.366
	2017	2576	10049	0.270	10092	0.311	10297	0.362
	2018	2566	10130	0.272	10028	0.309	10081	0.355
	2019	2544	10164	0.273	9966	0.307	9918	0.349
	2020	2533	10199	0.274	9951	0.307	9850	0.347
	2021	2536	10243	0.275	9979	0.308	9859	0.347
	2022	2549	10290	0.276	10034	0.309	9911	0.349
	2023	2565	10334	0.277	10097	0.311	9975	0.351
	2024	2581	10370	0.278	10157	0.313	10034	0.353
Catch that stabilizes the stock at $\sim SB_{40\%}$	2015	1460	9095	0.244	9461	0.292	10017	0.352
	2016	1678	10304	0.276	10509	0.324	10886	0.383
	2017	1815	11120	0.298	11128	0.343	11288	0.397
	2018	1900	11717	0.314	11537	0.356	11498	0.405
	2019	1960	12199	0.327	11863	0.366	11666	0.411
	2020	2009	12607	0.338	12154	0.375	11838	0.417
	2021	2055	12958	0.348	12419	0.383	12018	0.423
	2022	2098	13260	0.356	12661	0.390	12198	0.429
	2023	2138	13518	0.363	12878	0.397	12368	0.435
	2024	2172	13736	0.368	13069	0.403	12519	0.441

11 Figures

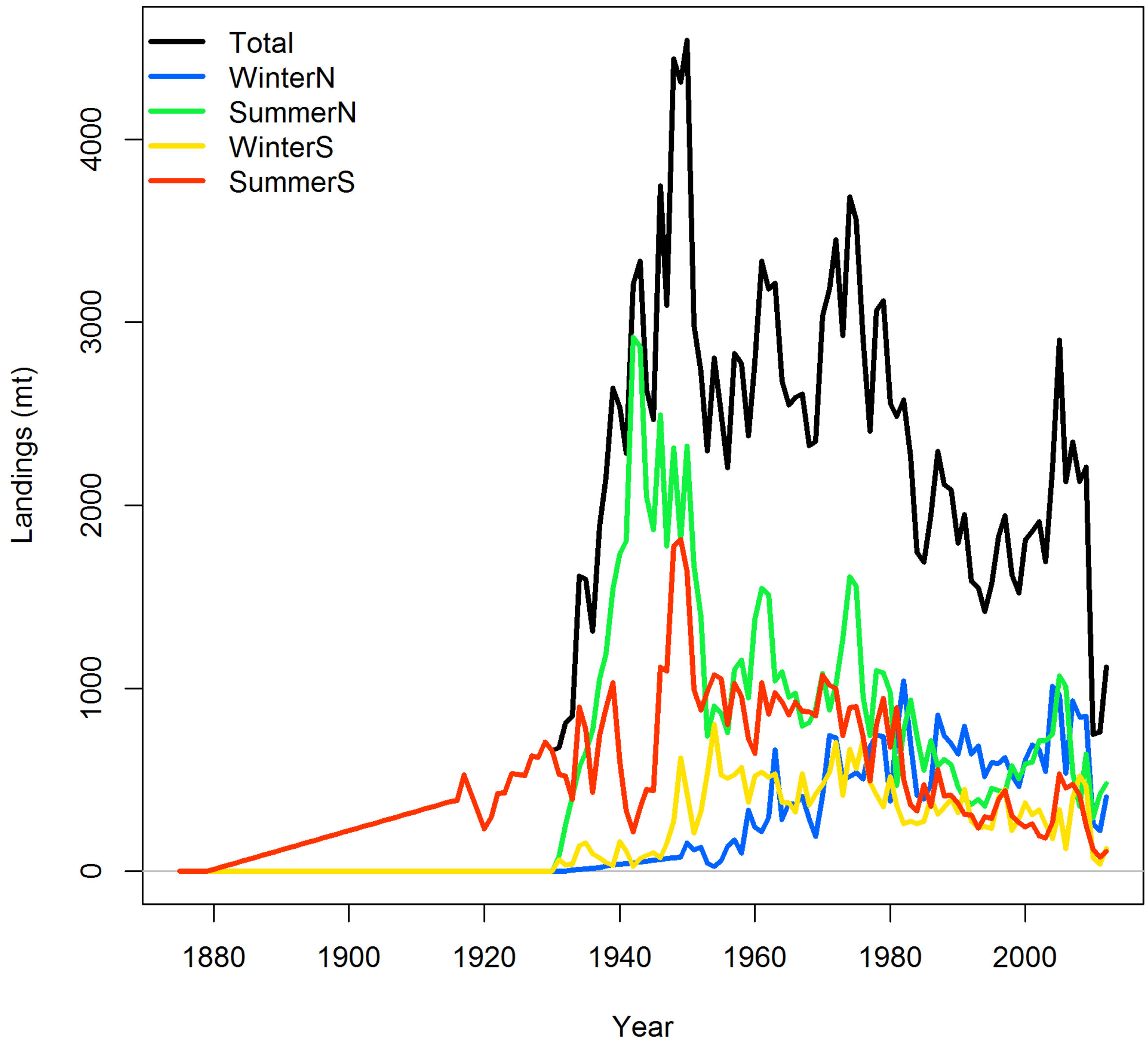


Figure 1. Time series of total landings and landings for each fleet**.**

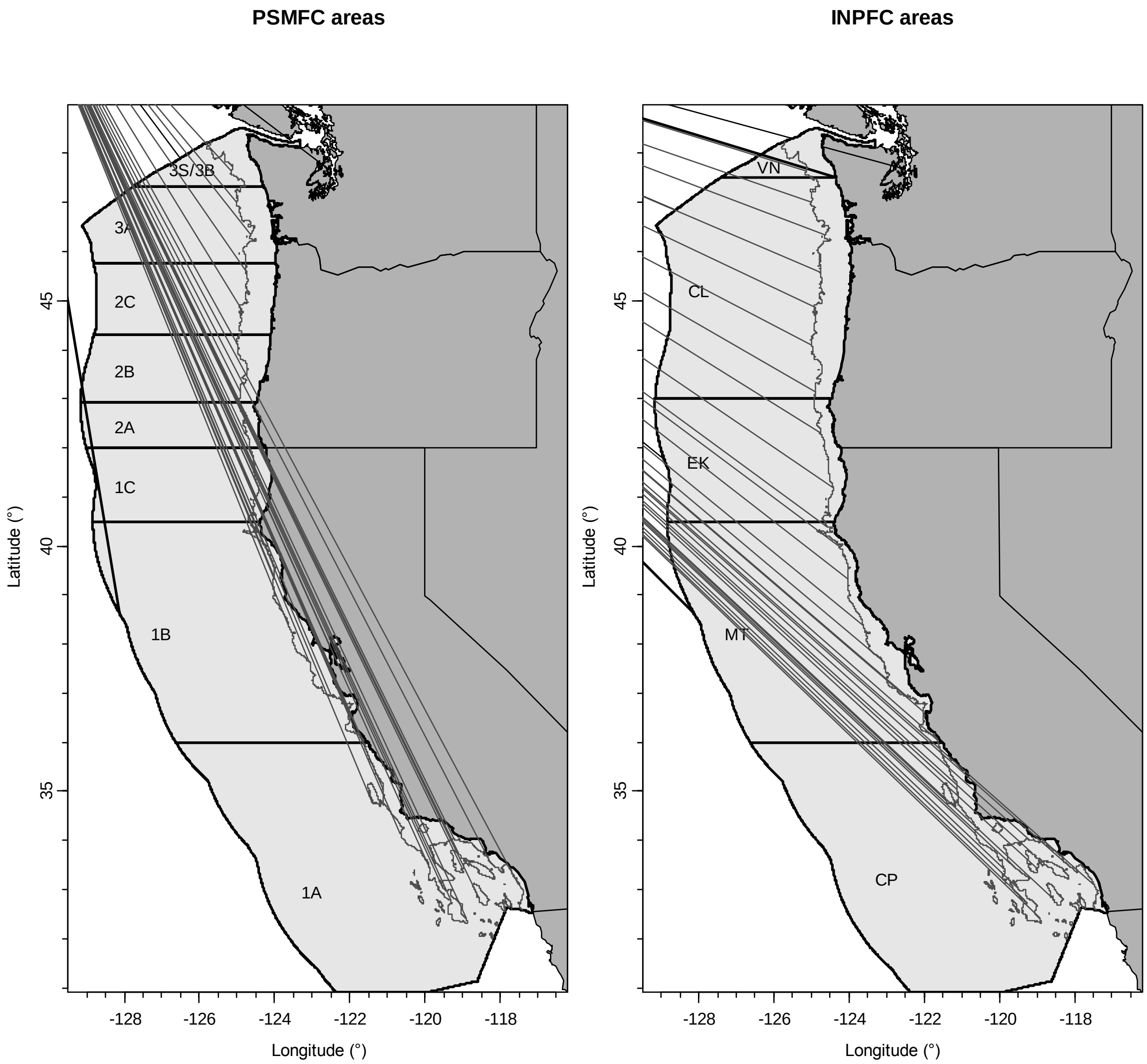


Figure 2. Map showing PSMFC and INPFC boundaries. The solid gray line off the coast is the 300 fathom depth contour.

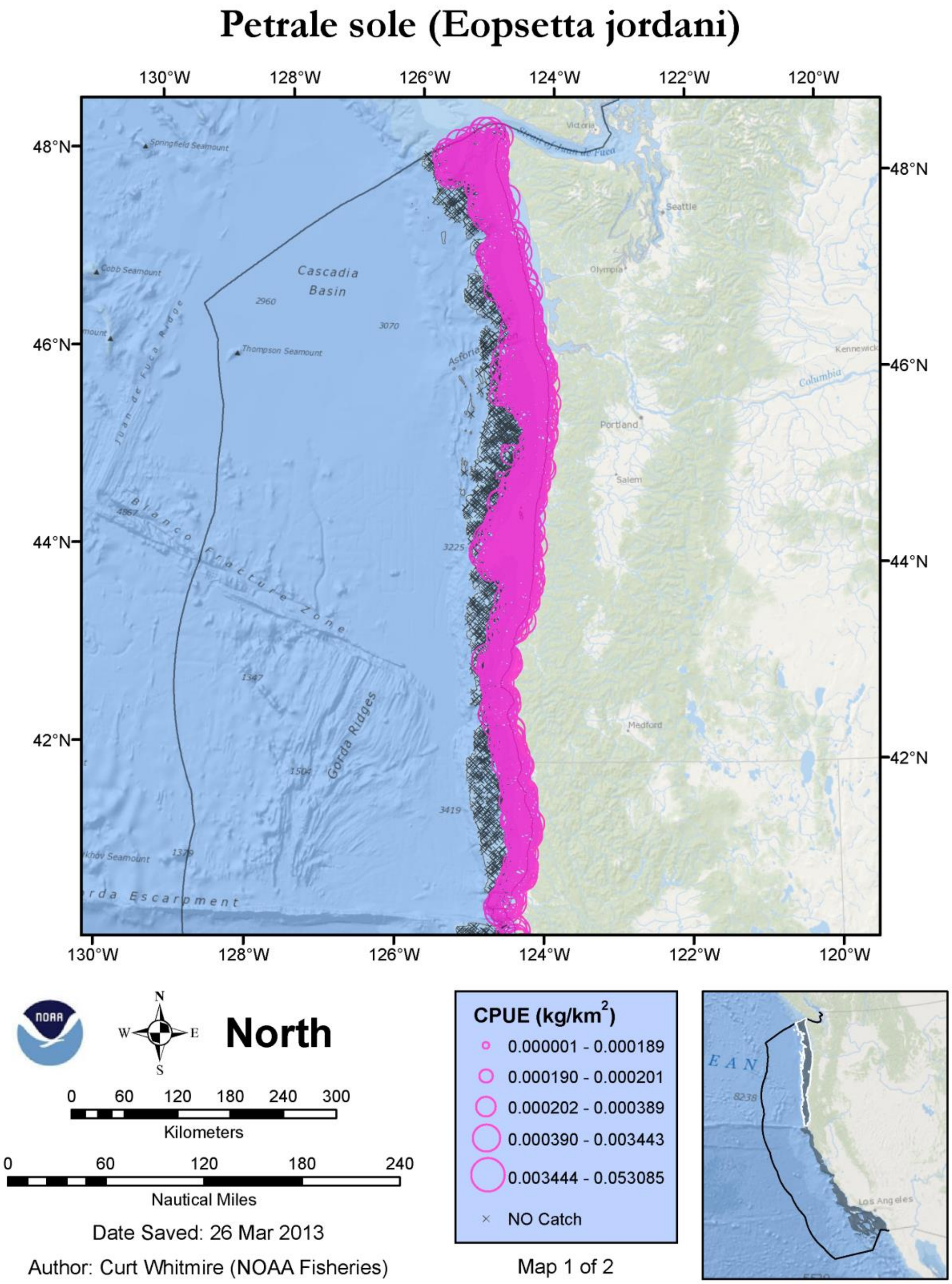


Figure 3. NWFSC survey catch rates, north.

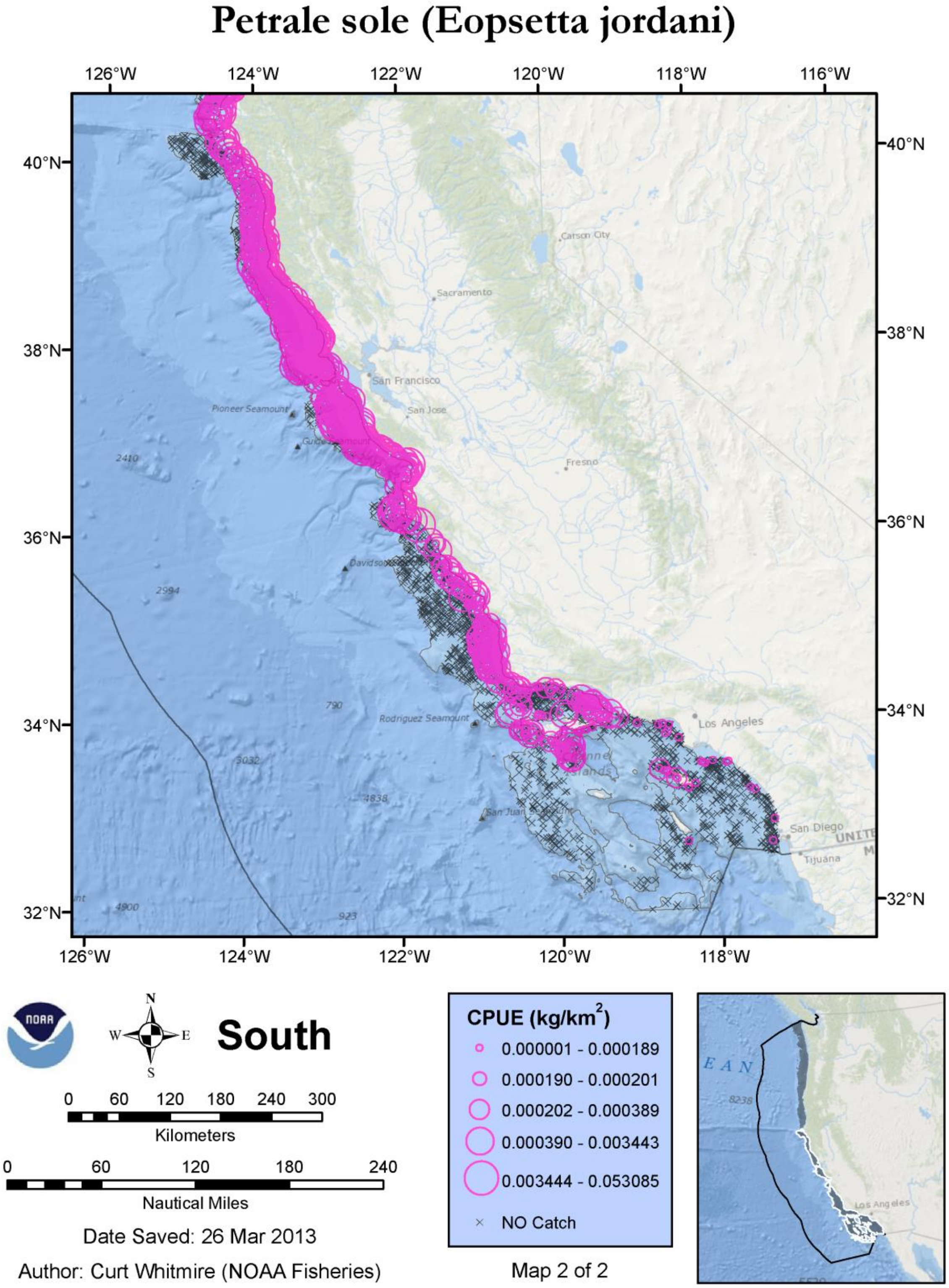


Figure 4. NWFSC survey catch rates, south.

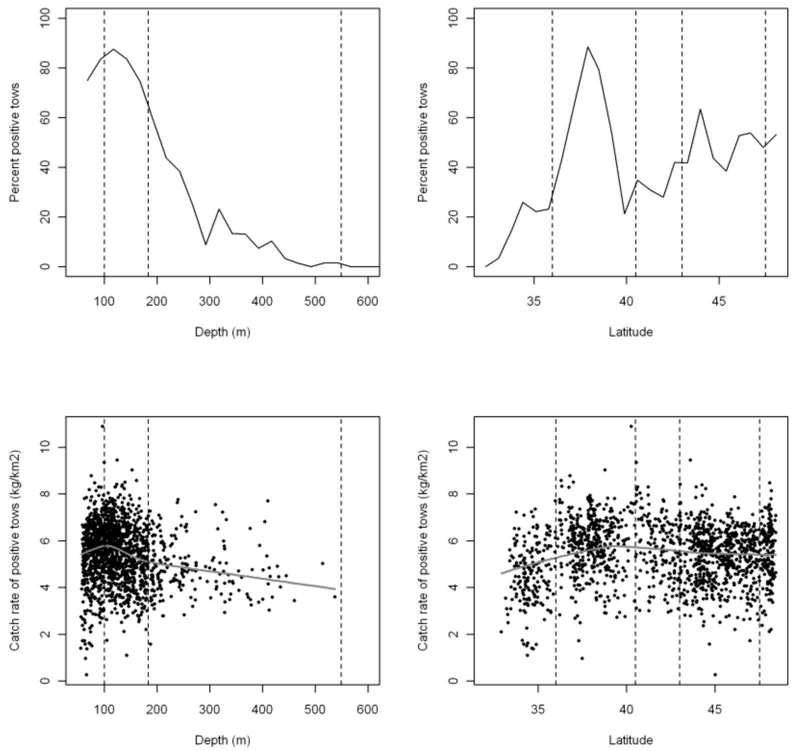


Figure 5. Plots of the percentage of positive tows and the catch rates for all positive tows over depth and latitude for the NWFSC survey.

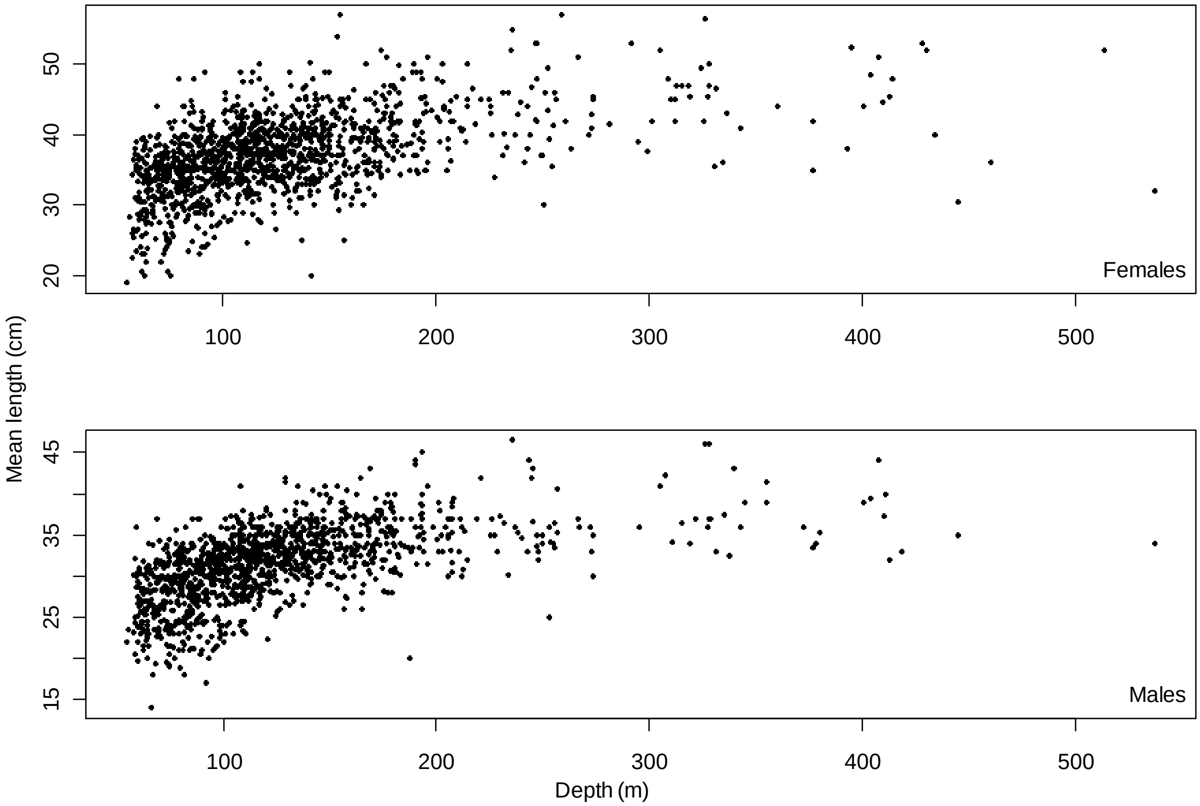


Figure 6. NWFSC survey mean length per tow by depth for females and males.

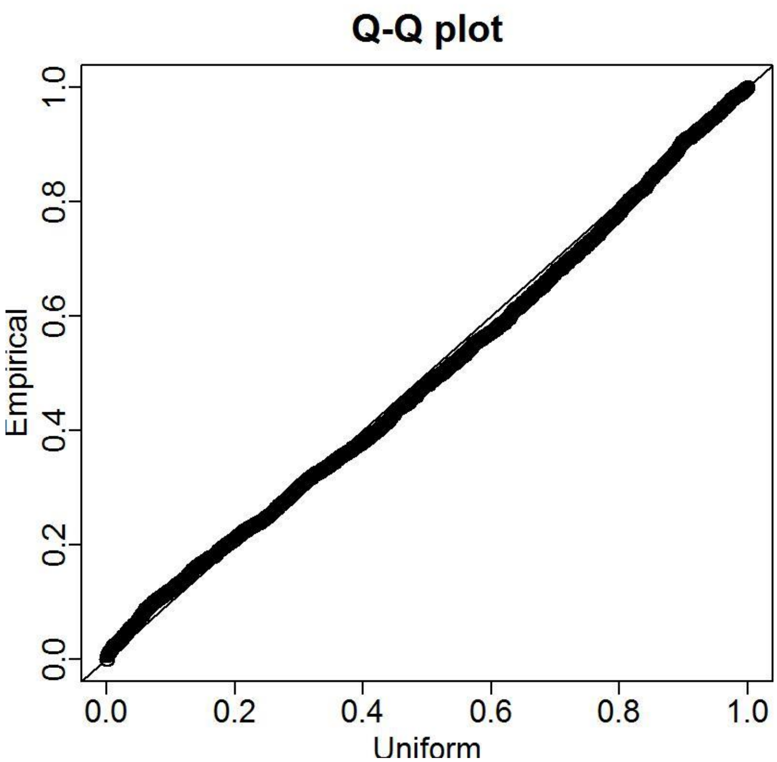


Figure 7. NWFSC GLMM Q-Q plot.

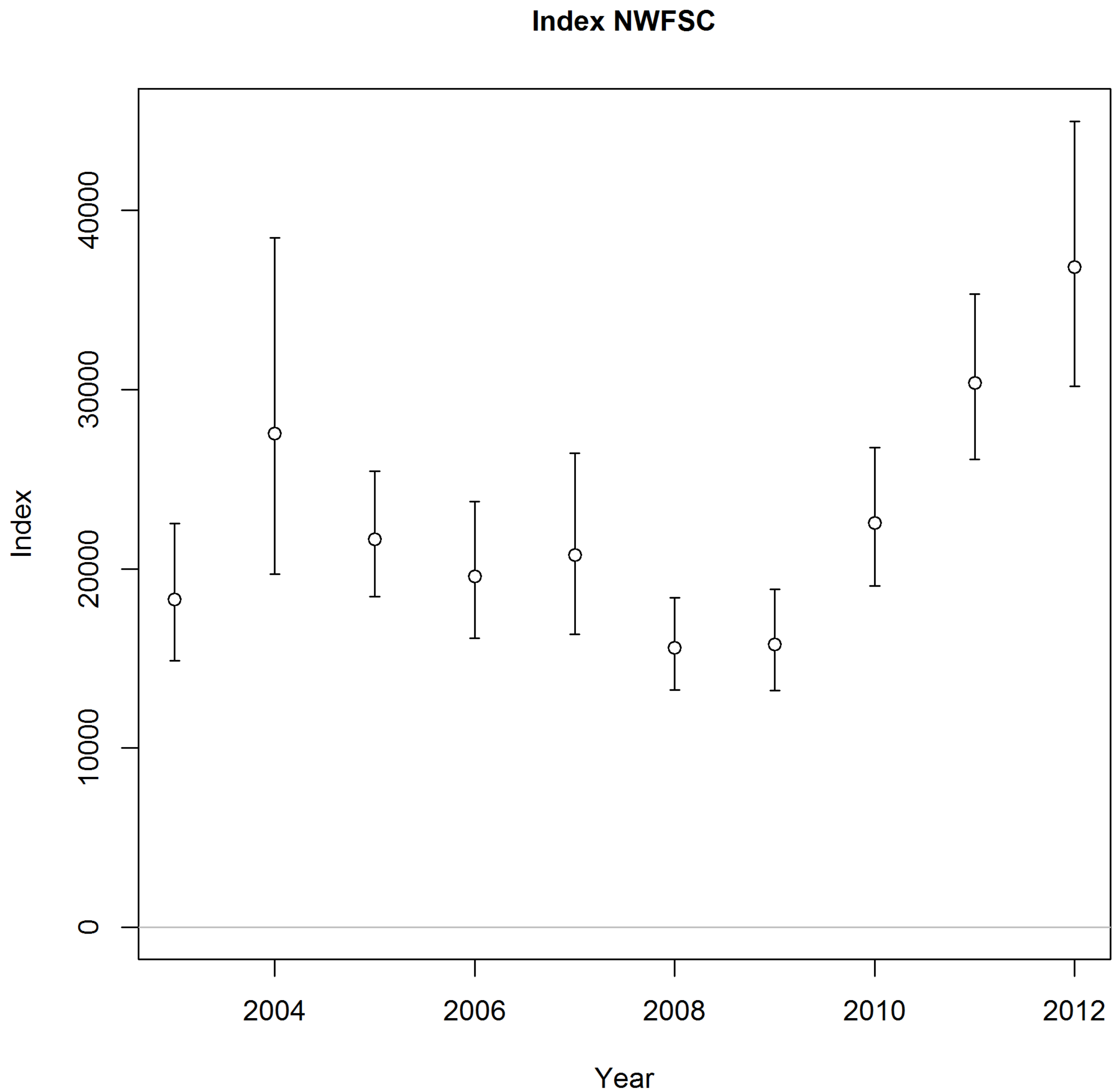


Figure 8. GLMM biomass estimates from the NWFSC survey.

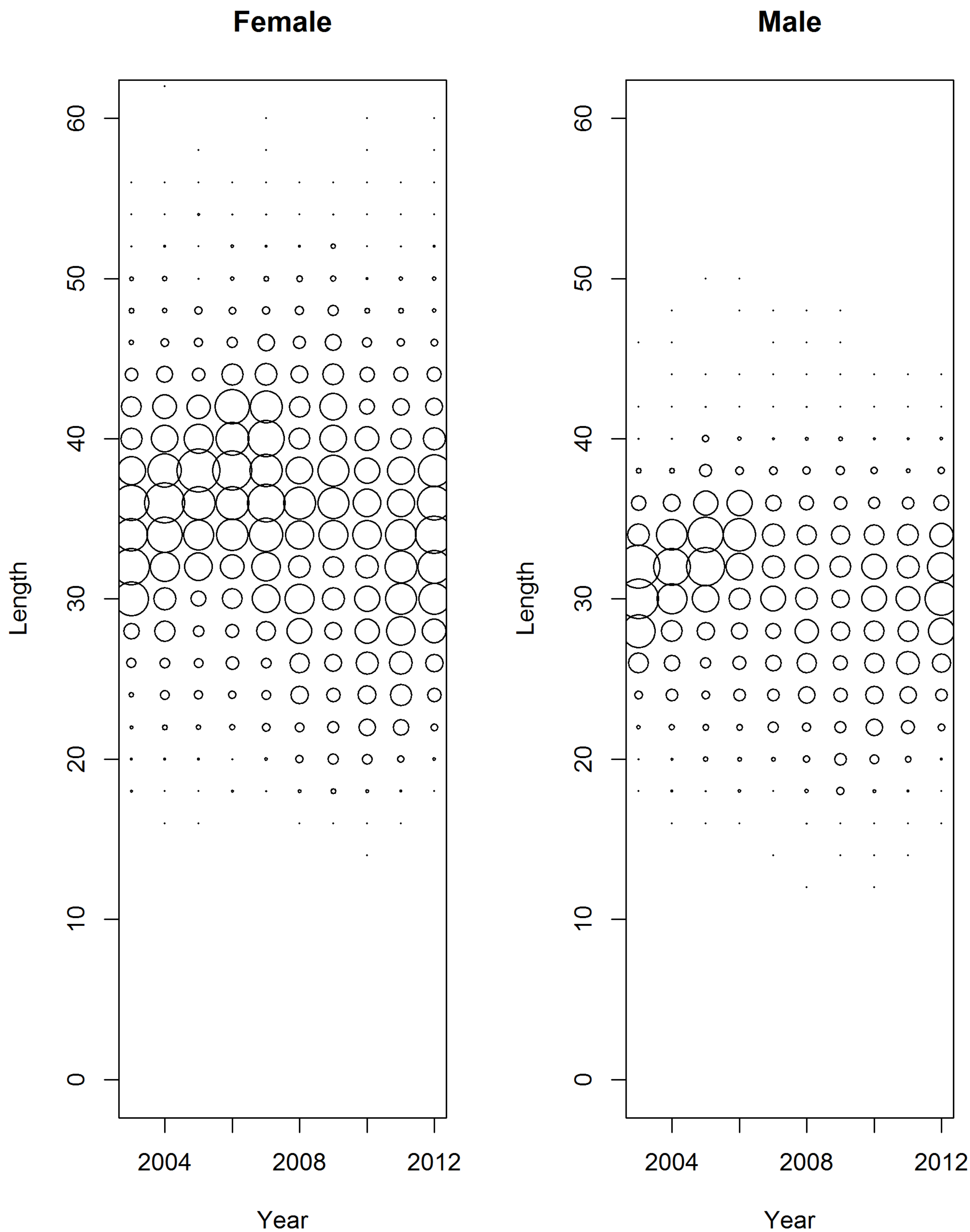


Figure 9. Female (left panel) and male (right panel) length frequencies for the NWFSC survey.

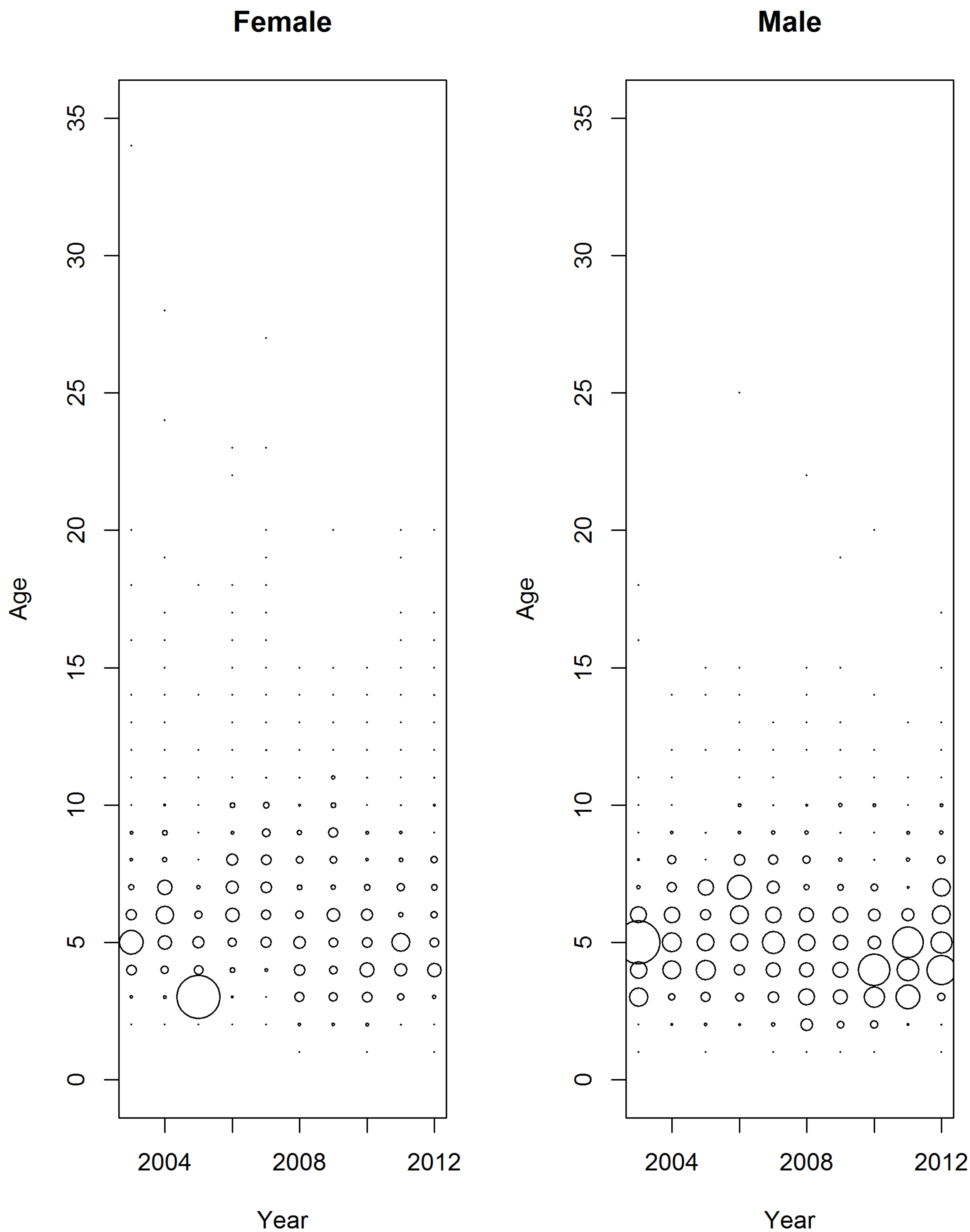


Figure 10. Female (left panel) and male (right panel) age frequencies from the NWFSC survey.

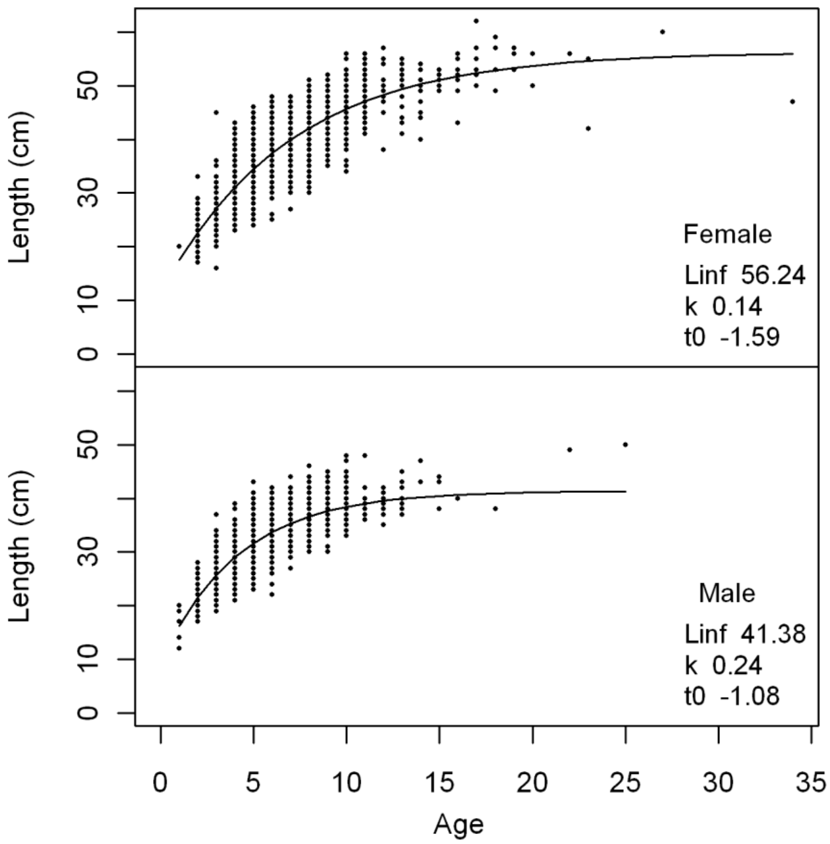


Figure 11. Length at age for males and females from the NWFSC survey with fits to the von Bertalanffy growth curve.

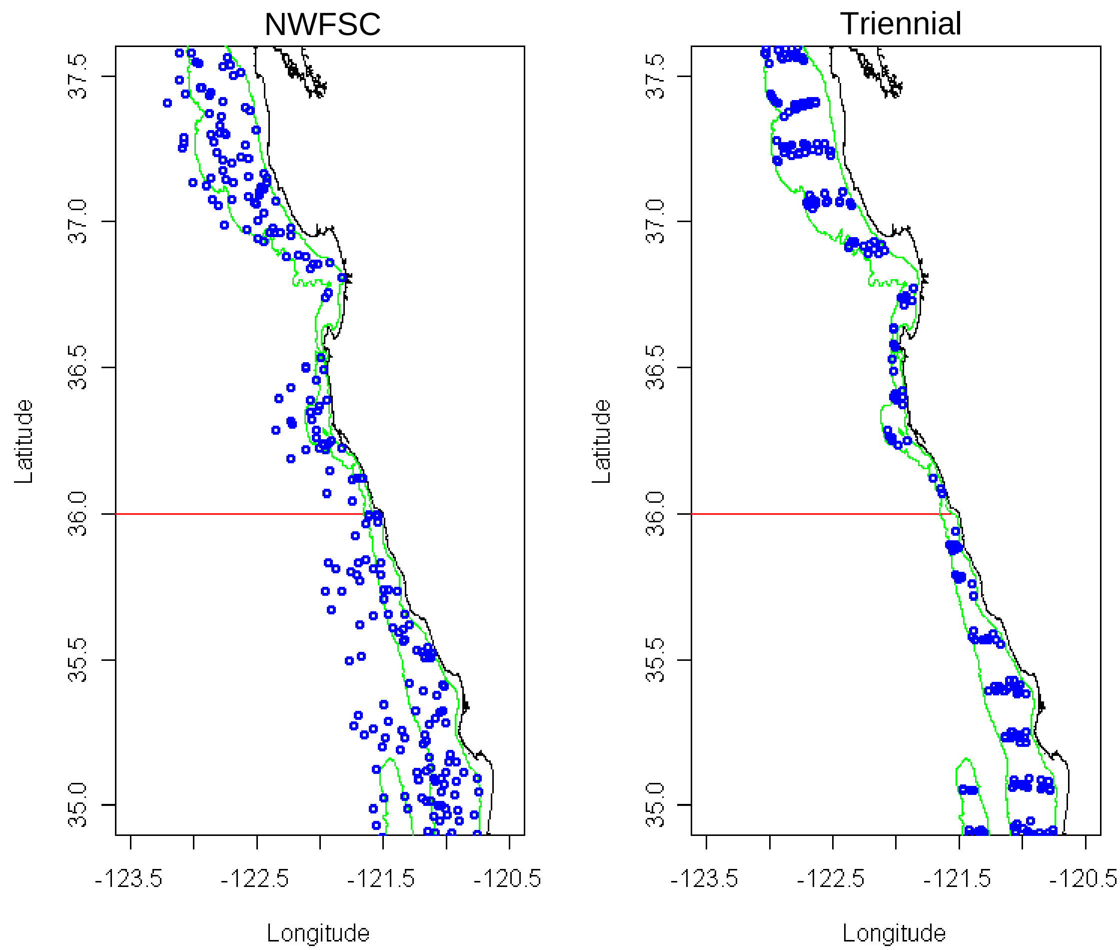


Figure 12. Survey tow locations in 2004, showing the difference in station design for the NWFSC trawl survey relative to the Triennial trawl survey.

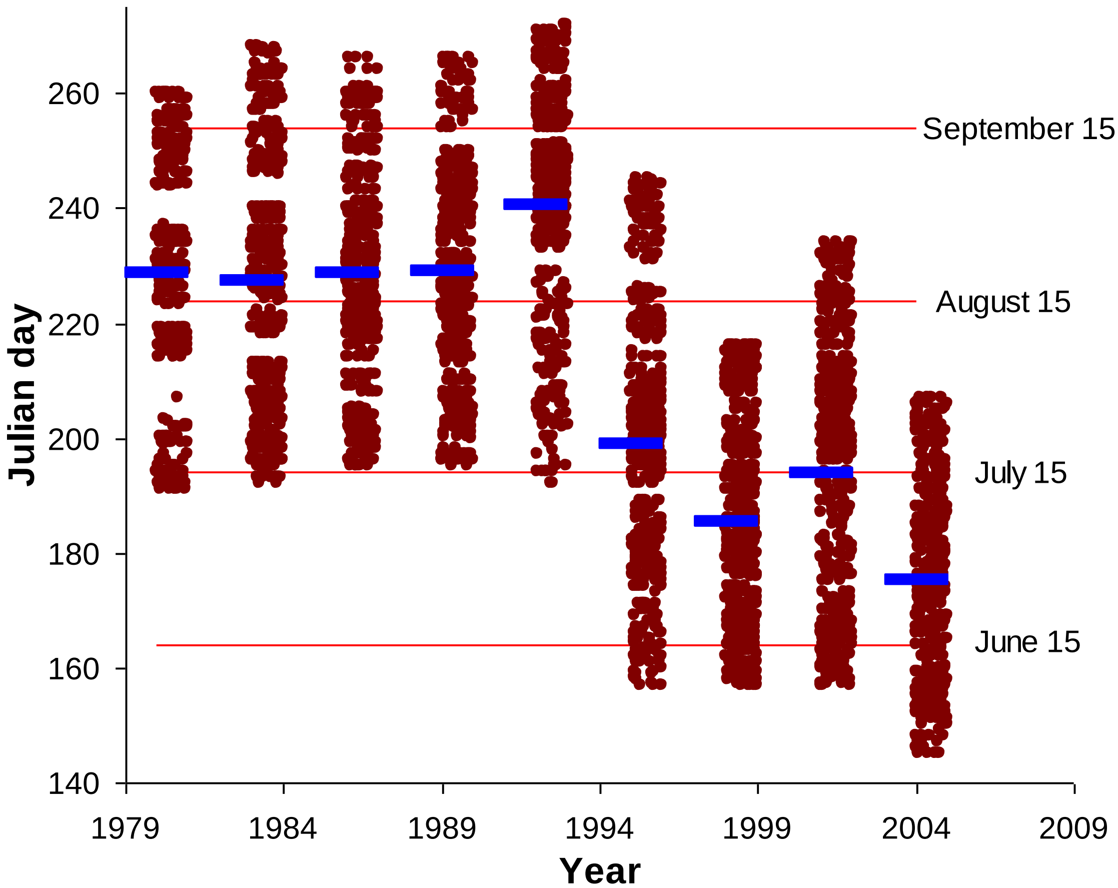


Figure 13. Distribution of dates of operation for the triennial survey (1980-2004). Solid bars show the mean date for each survey year, points represent individual hauls dates, but are jittered to allow better delineation of the distribution of individual points.

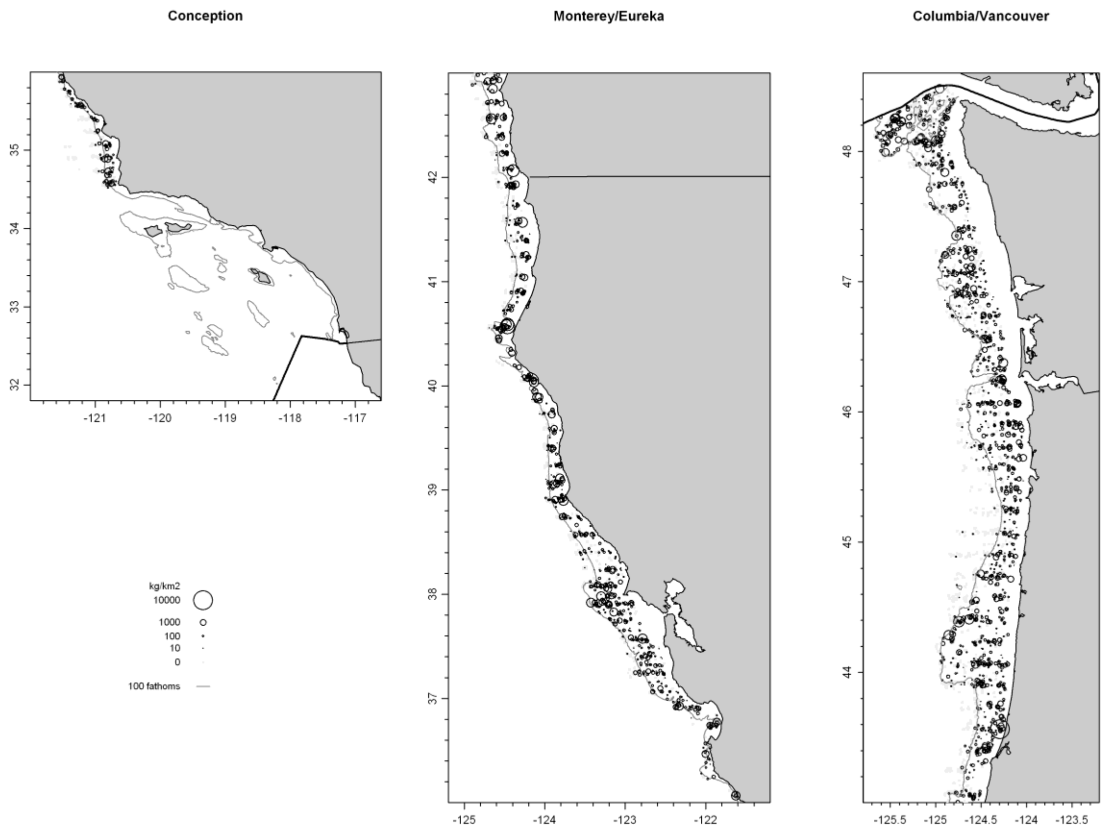


Figure 14. Catch rates over all years for the Triennial survey.

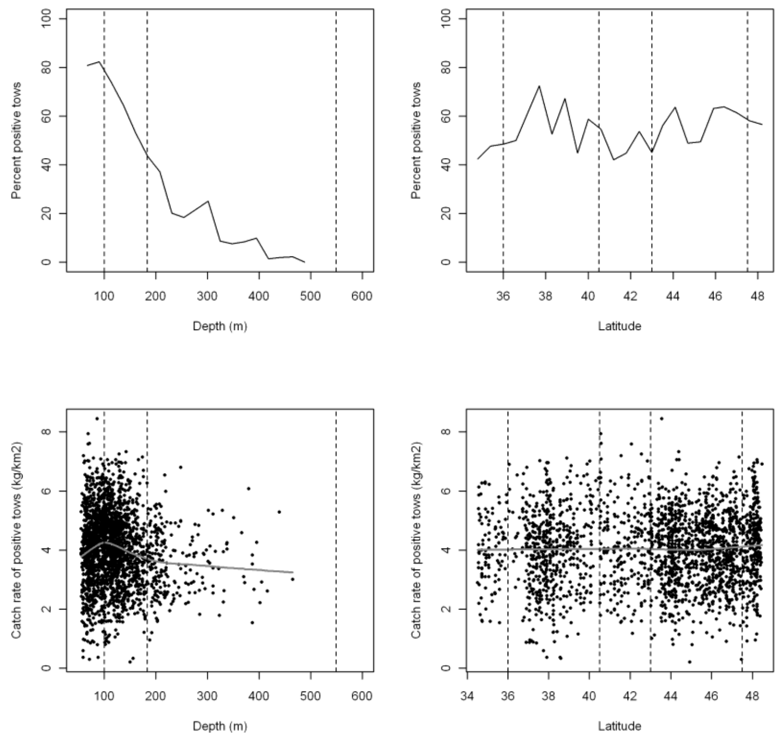


Figure 15. Plots of the percentage of positive tows and the catch rates for all positive tows over depth and latitude for the Triennial Survey.

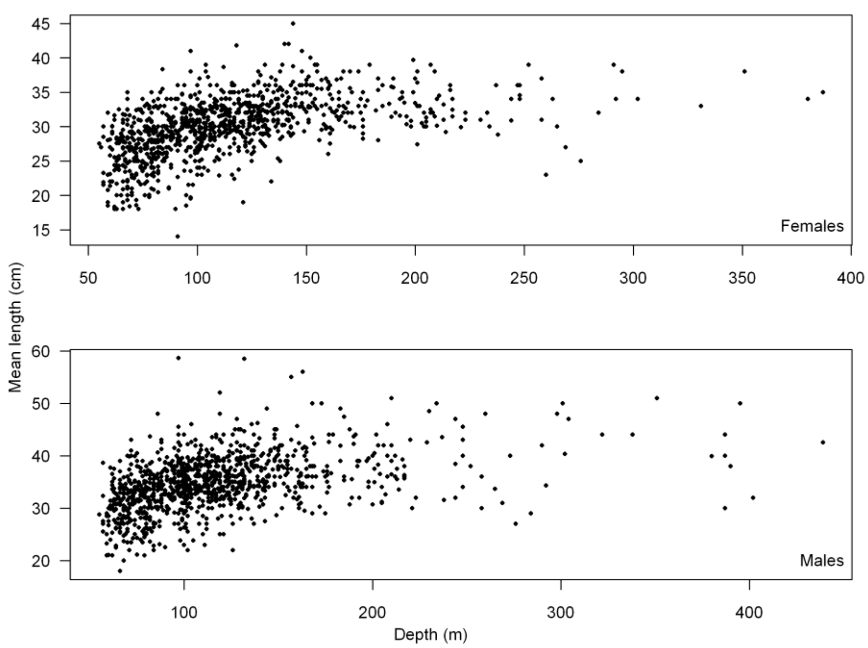


Figure 16. The mean length per tow from the Triennial trawl survey data plotted over depth for females and males.

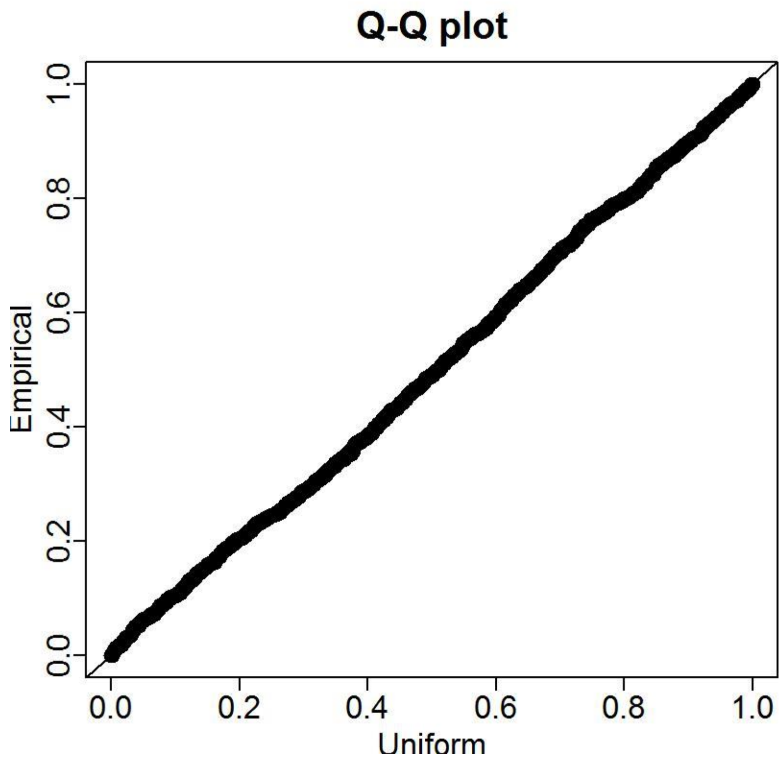


Figure 17. Early triennial survey GLM Q-Q plot.

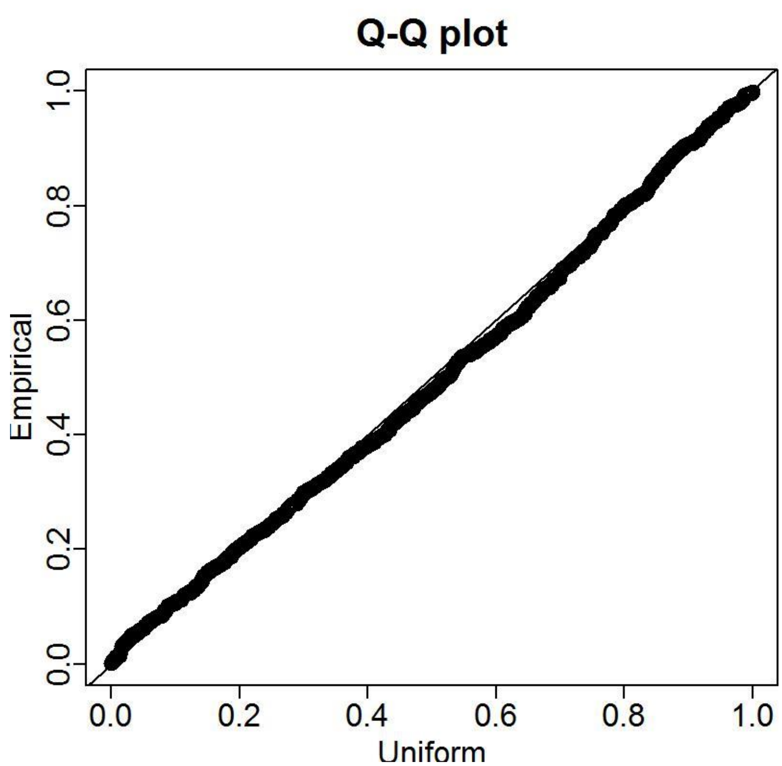
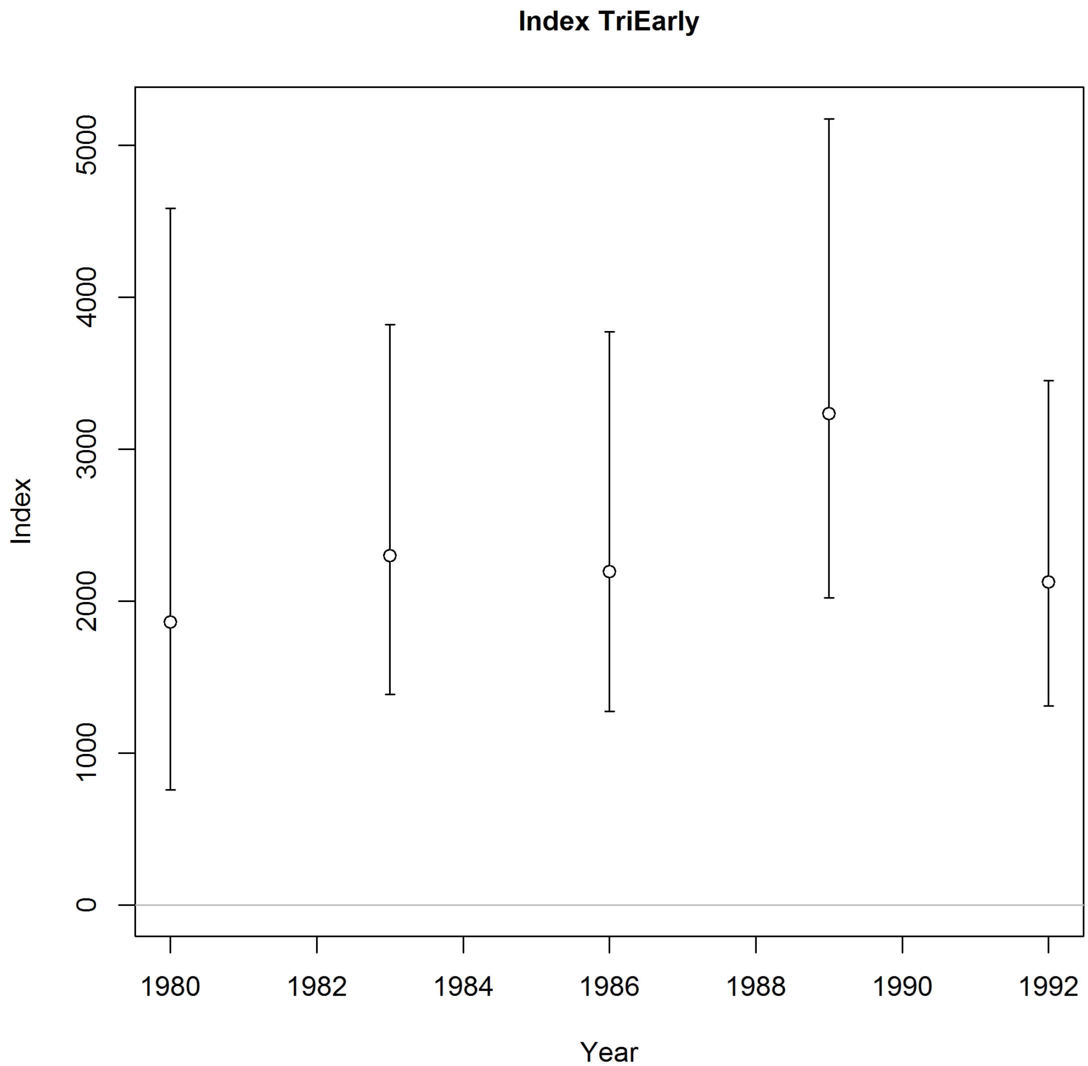


Figure 18. Late triennial survey GLM Q-Q plot.


Index TriEarly
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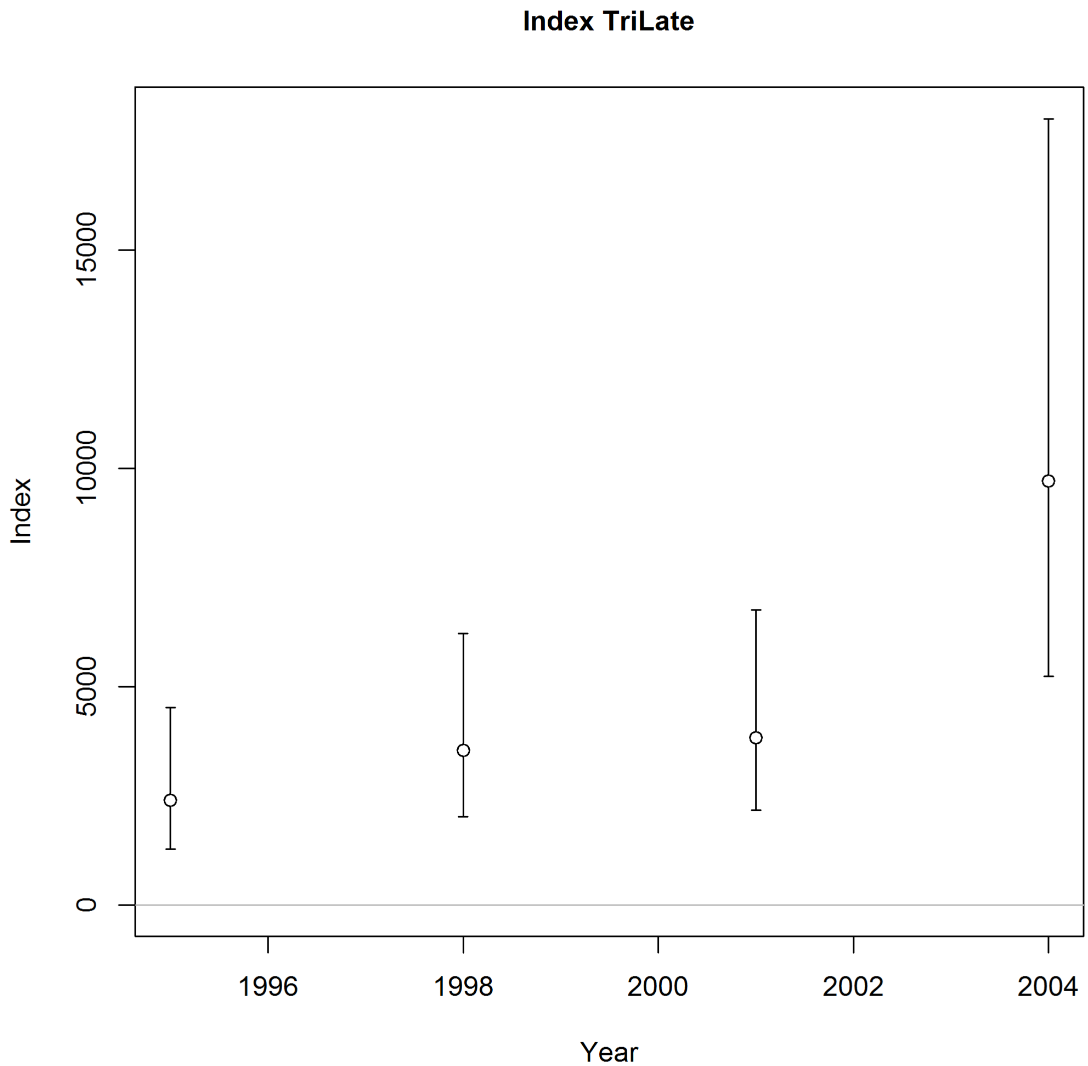


Figure 19. GLMM biomass estimates from the early (top panel) and late (bottom panel) Triennial survey.

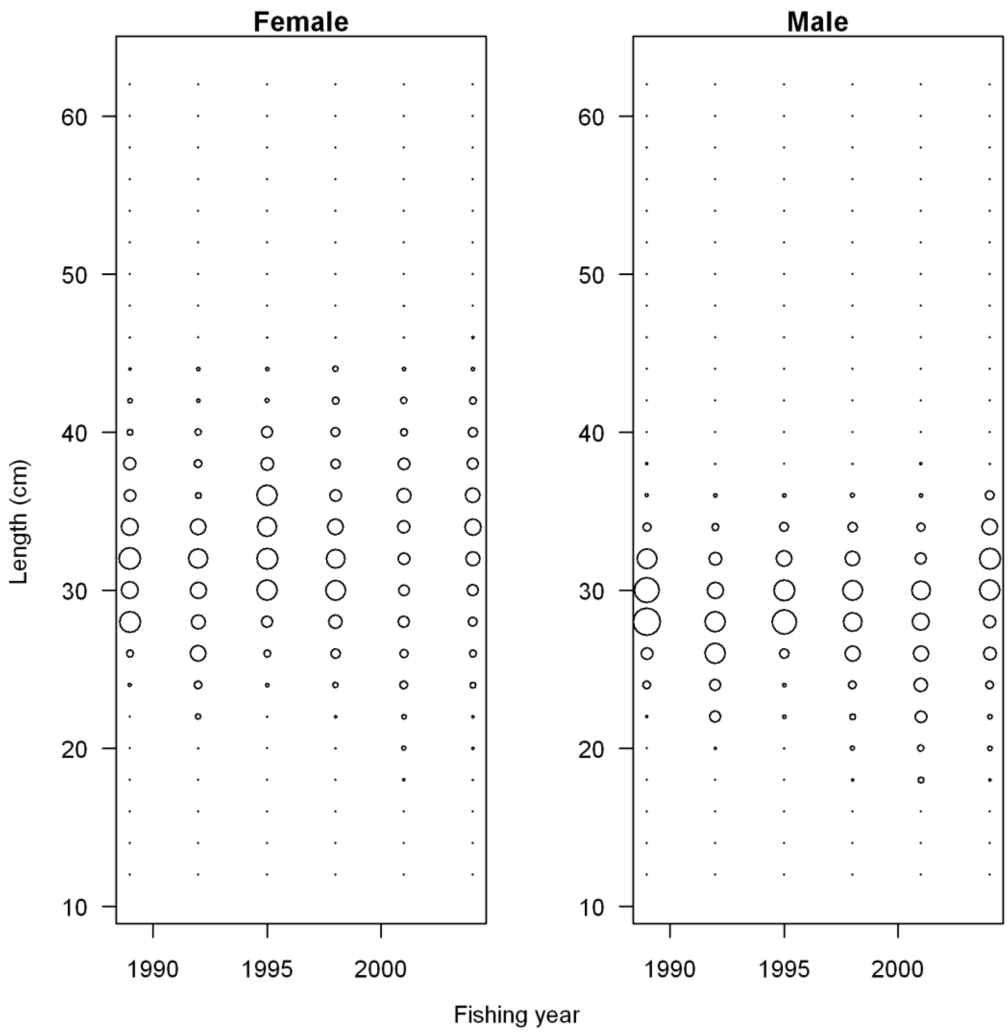


Figure 20. Plots of length frequencies from the triennial survey.

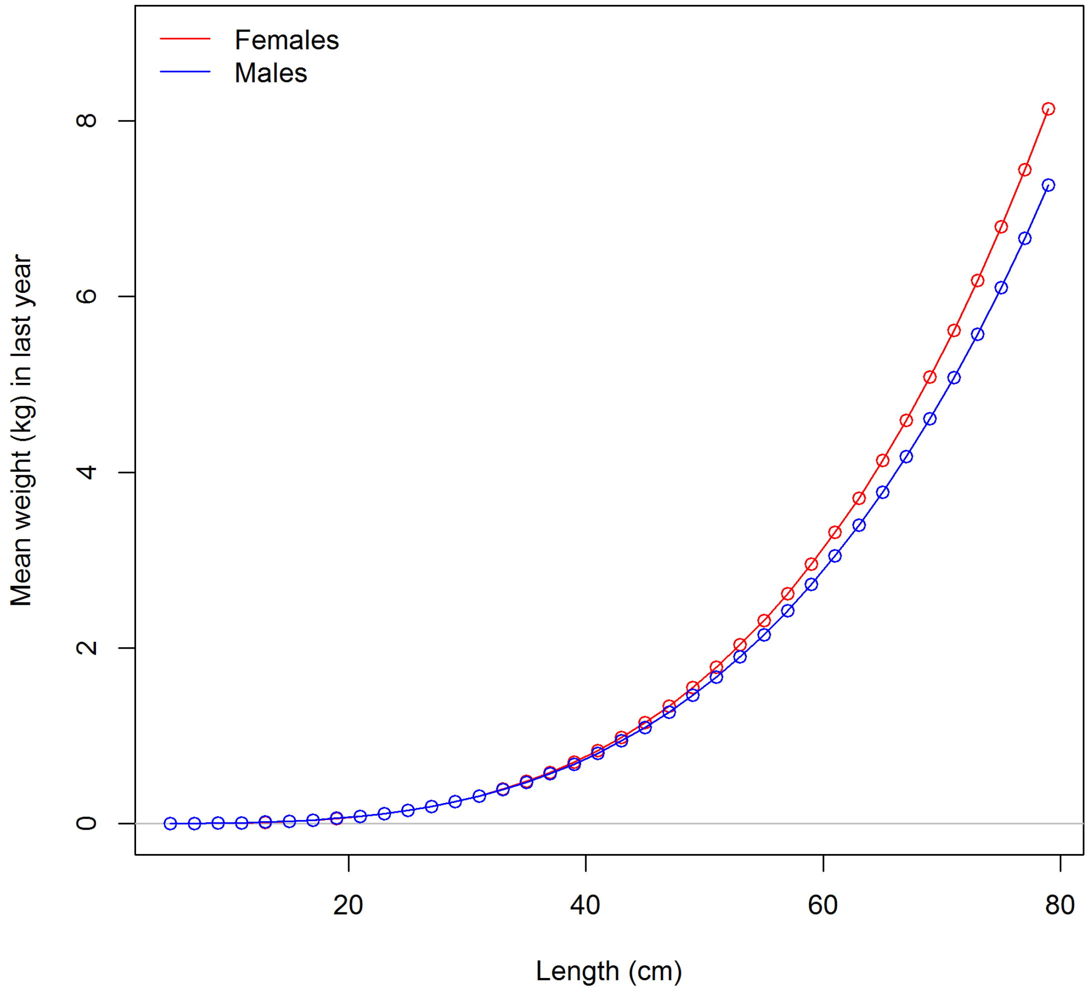


Figure 21. Petrale sole weight-length relationship.

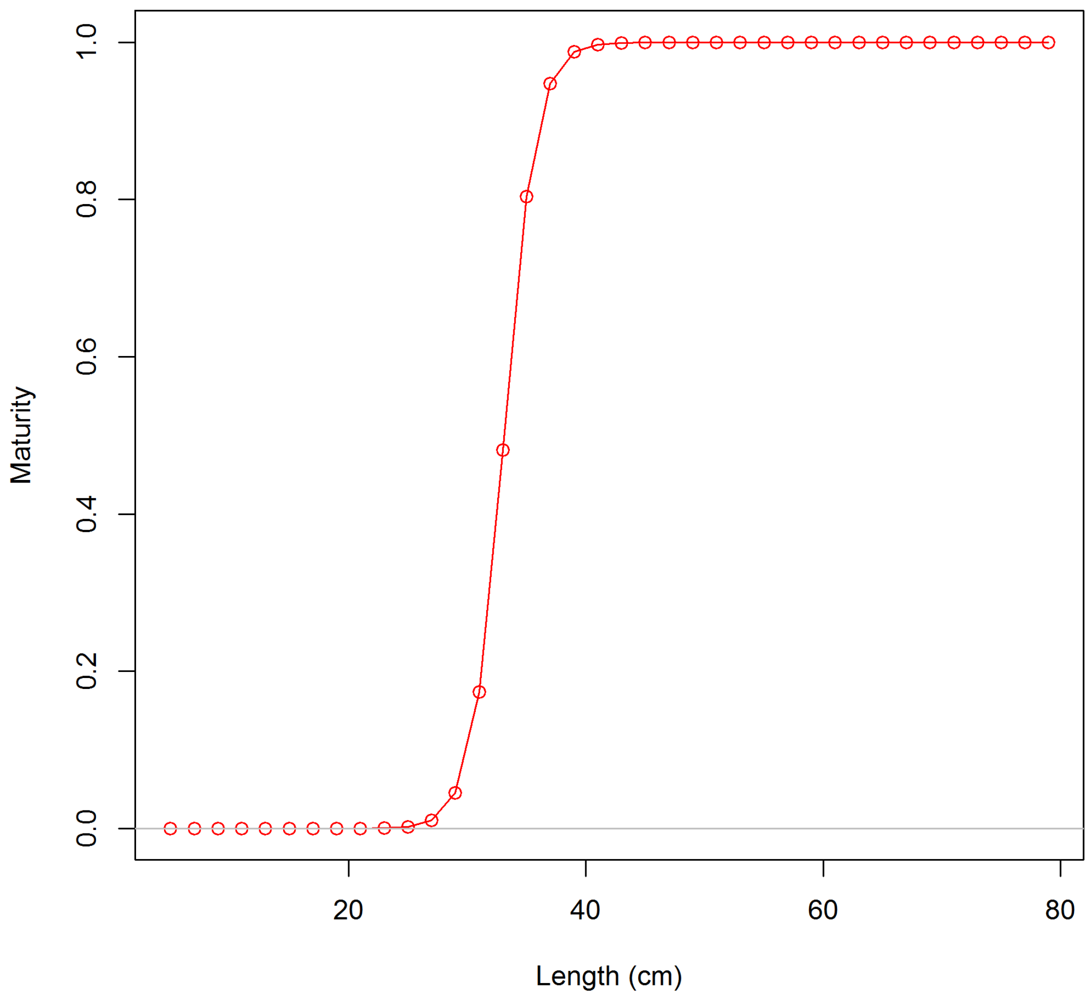


Figure 22. Petrale sole maturity ogive (females only).

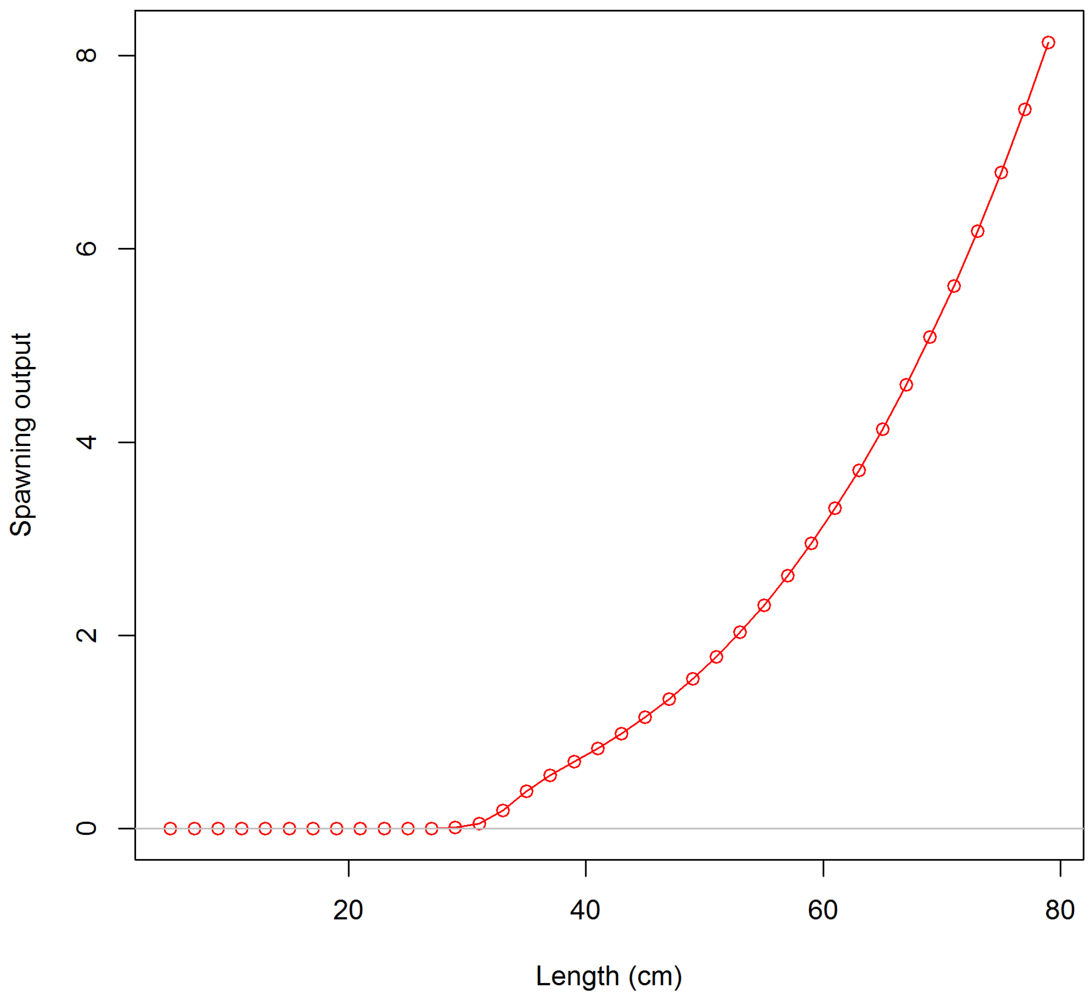


Figure 23. Petrale sole spawning output as a function of length.

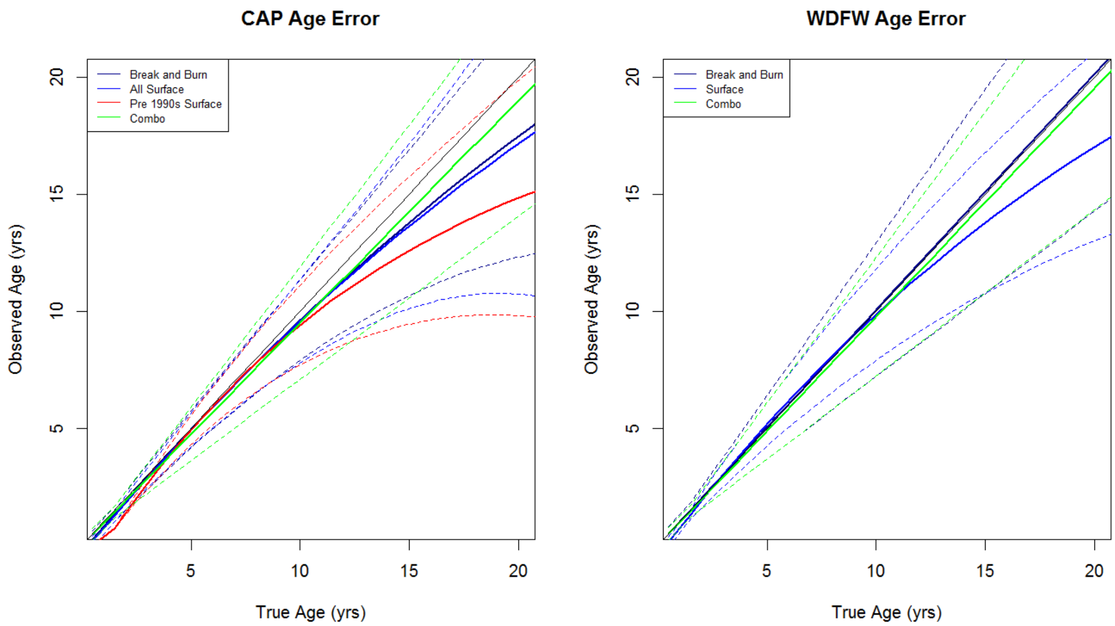


Figure 24. Plots of bias and imprecision for each data set. The 1:1 line is the dark bold line.

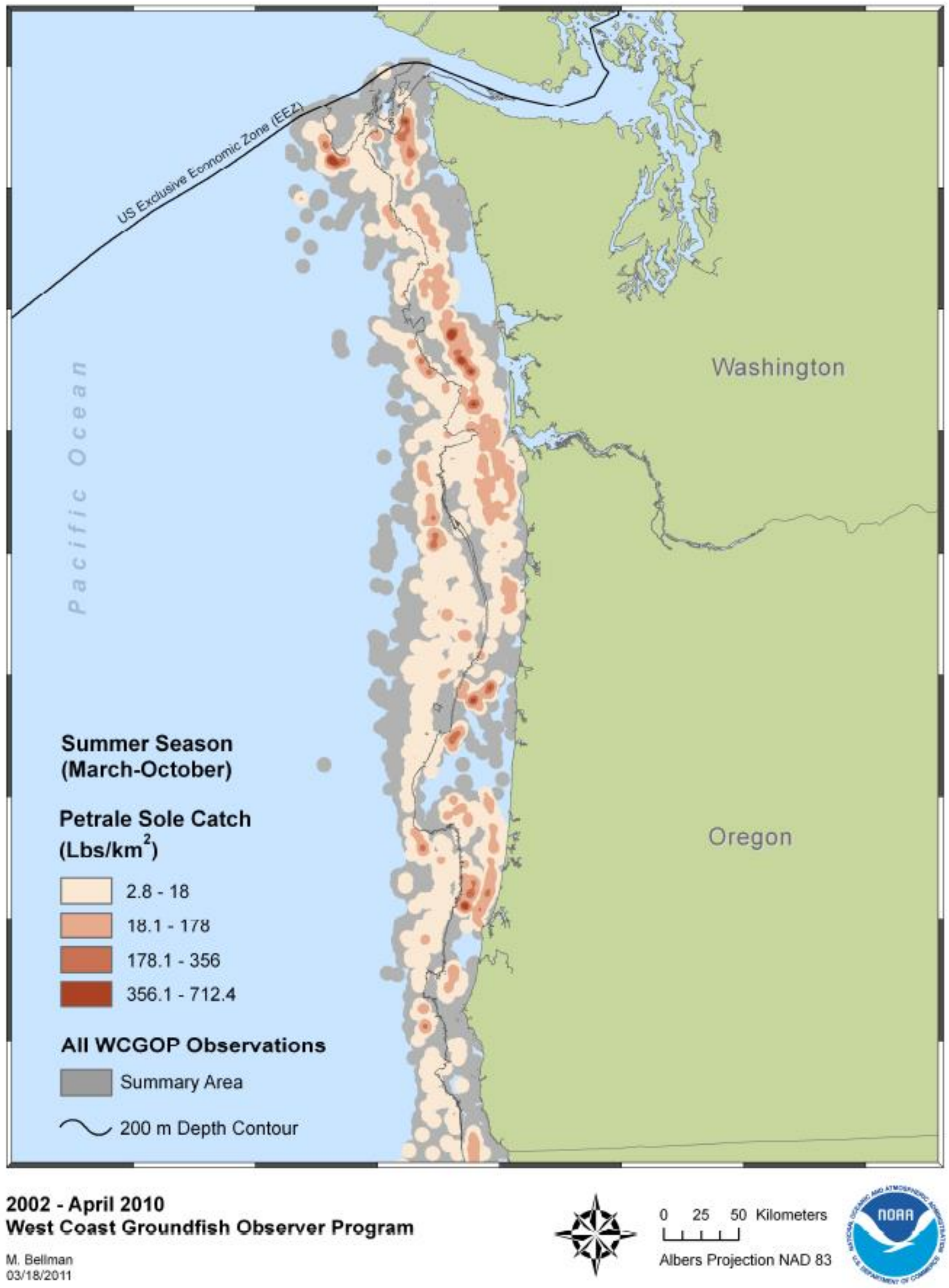


Figure 25. Spatial distribution of northern petrale sole catch (lbs/km2), in the summer (March-October) season, observed by the West Coast Groundfish Observer Program from 2002 – April 2010 and the summary area of all observed fishing events. The range of catch (minimum to maximum value) was mapped; the two highest classifications were defined by dividing the maximum value in half, and the resulting value in half, and the remaining observations were then allocated into equal proportions into the two lowest classifications.

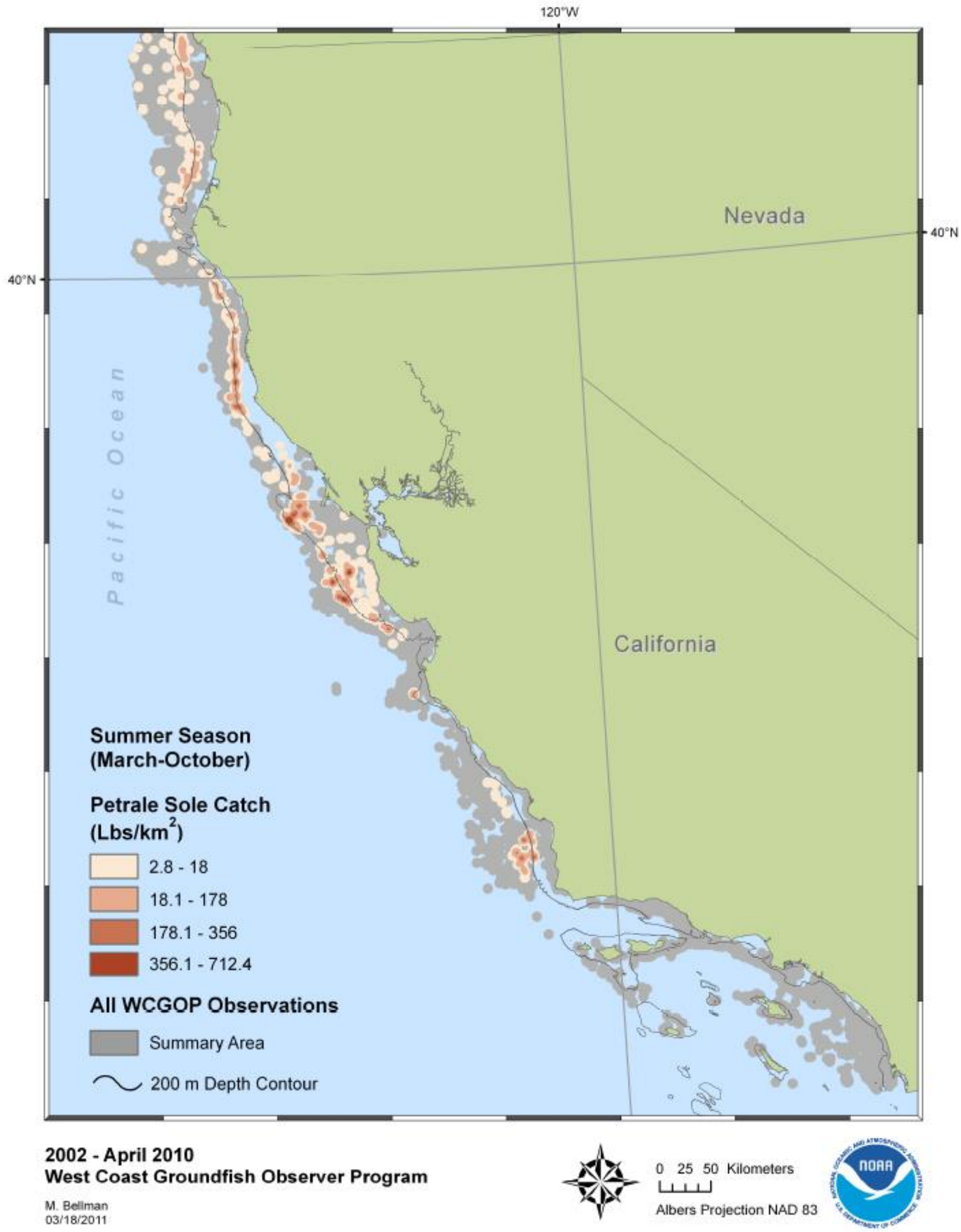


Figure 26. Spatial distribution of southern petrale sole catch (lbs/km2), in the summer (March-October) season, observed by the West Coast Groundfish Observer Program from 2002 – April 2010 and the summary area of all observed fishing events. The range of catch (minimum to maximum value) was mapped; the two highest classifications were defined by dividing the maximum value in half, and the resulting value in half, and the remaining observations were then allocated into equal proportions into the two lowest classifications.

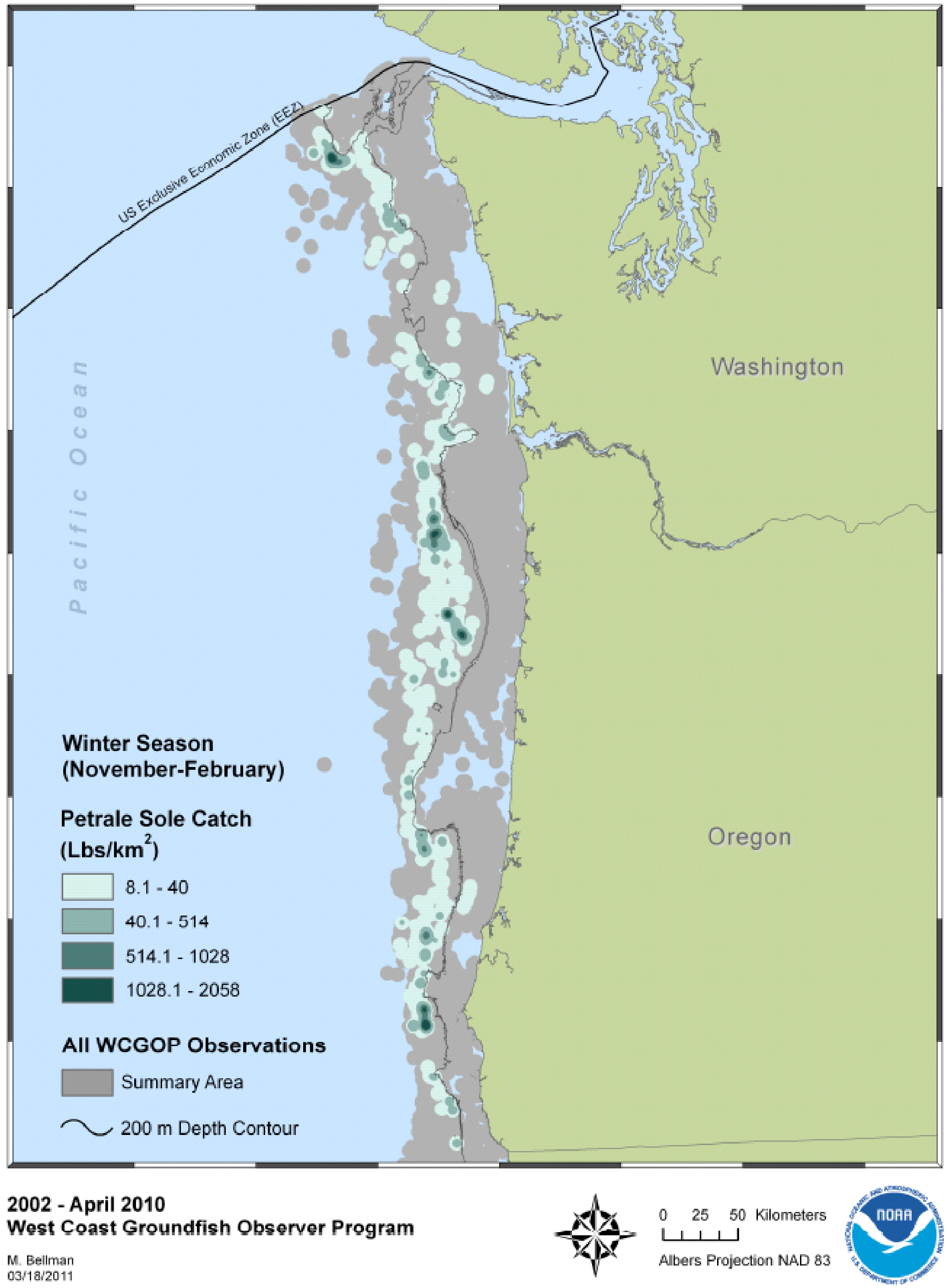


Figure 27. Spatial distribution of northern petrale sole catch (lbs/km2), in the winter season (November-February), observed by the West Coast Groundfish Observer Program from 2002 – April 2010 and the summary area of all observed fishing events. The range of catch (minimum to maximum value) was mapped; the two highest classifications were defined by dividing the maximum value in half, and the resulting value in half, and the remaining observations were then allocated into equal proportions into the two lowest classifications.

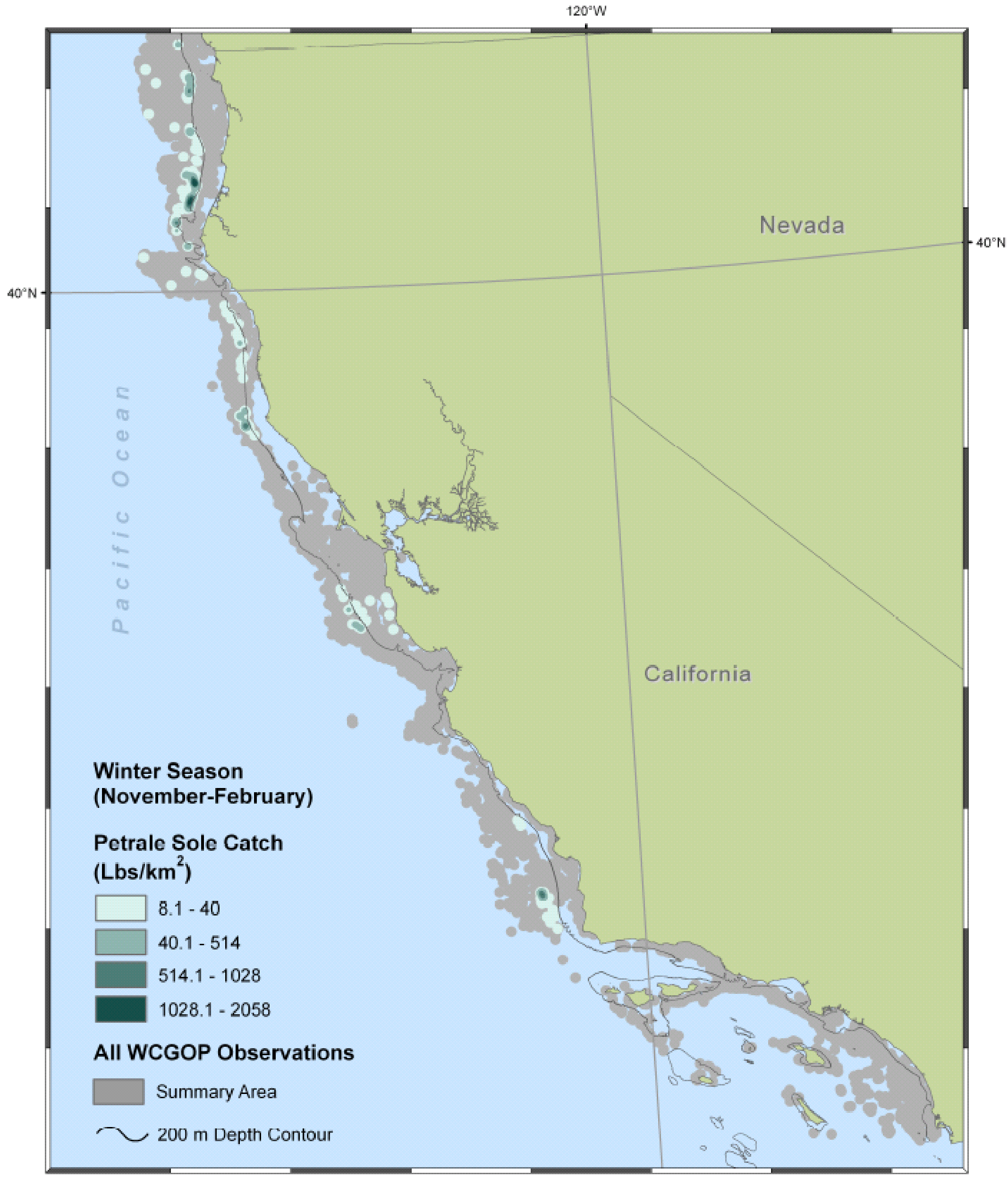


Figure 28. Spatial distribution of southern petrale sole catch (lbs/km2), in the winter season (November-February), observed by the West Coast Groundfish Observer Program from 2002 – April 2010 and the summary area of all observed fishing events. The range of catch (minimum to maximum value) was mapped; the two highest classifications were defined by dividing the maximum value in half, and the resulting value in half, and the remaining observations were then allocated into equal proportions into the two lowest classifications.

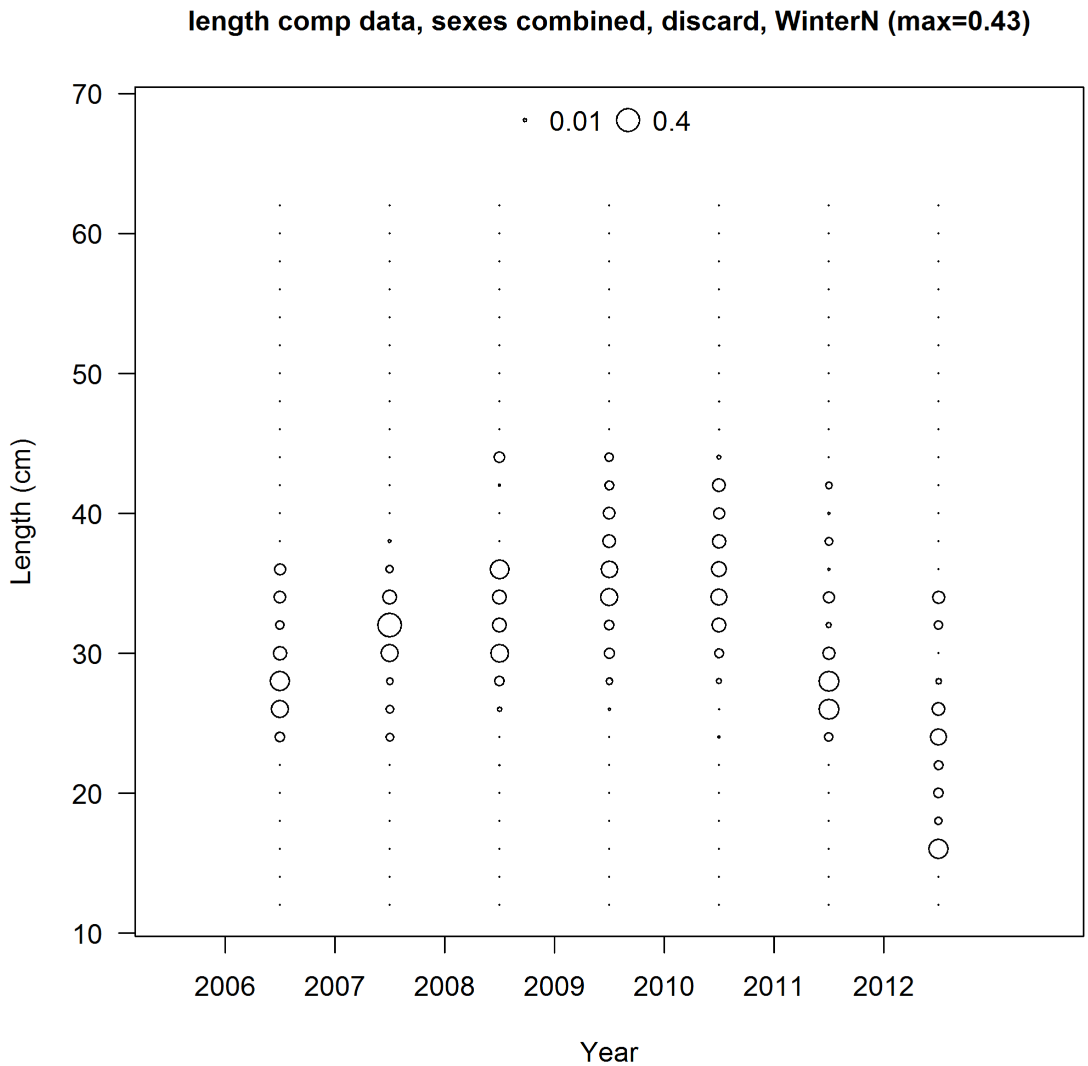


Figure 29. WCGOP winter north discard length compositions, sex combined.

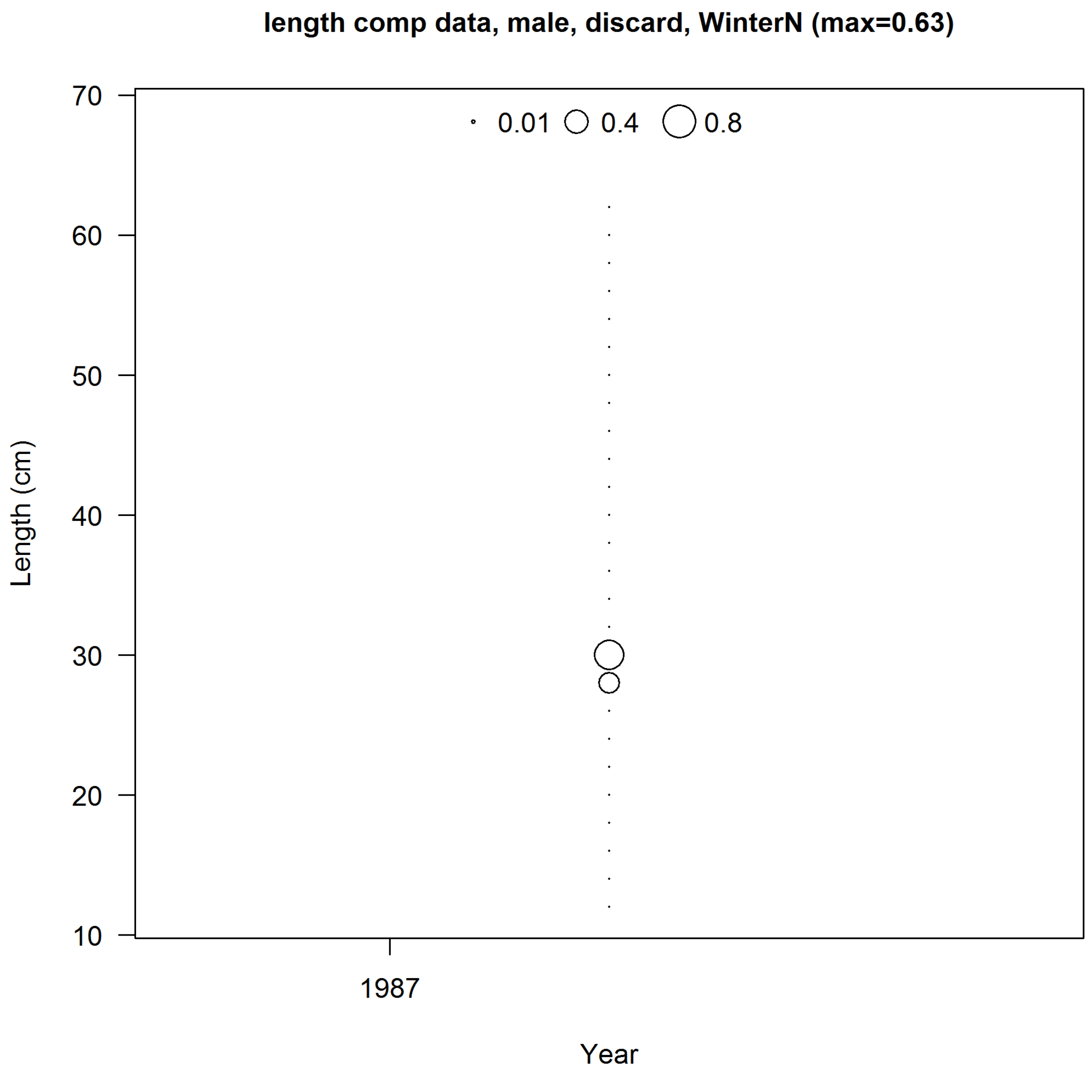


Figure 30. Pikitch winter north discard length compositions, males.

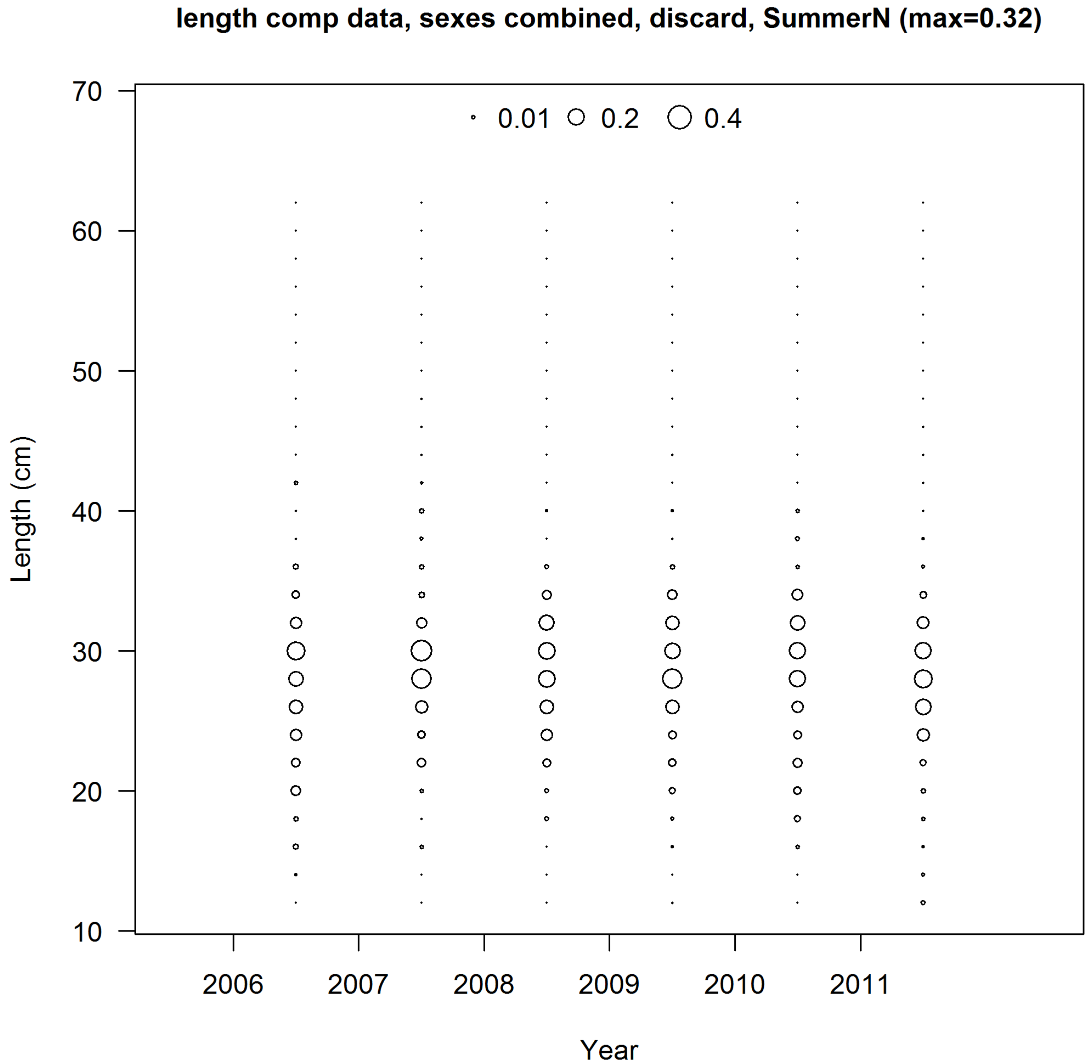


Figure 31. WCGOP summer north discard length compositions, sexes combined.

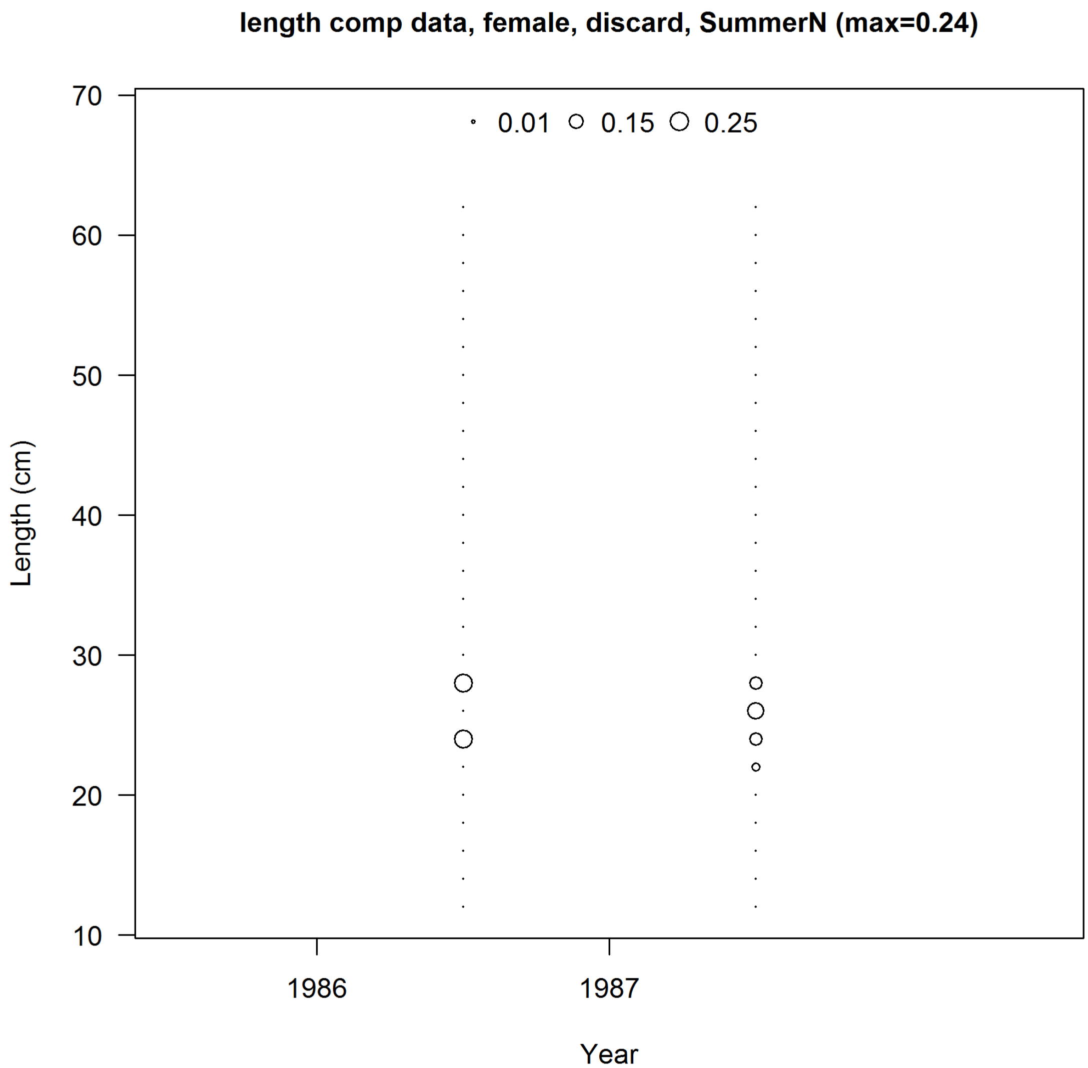


Figure 32. Pikitch summer north discard length compositions, females.

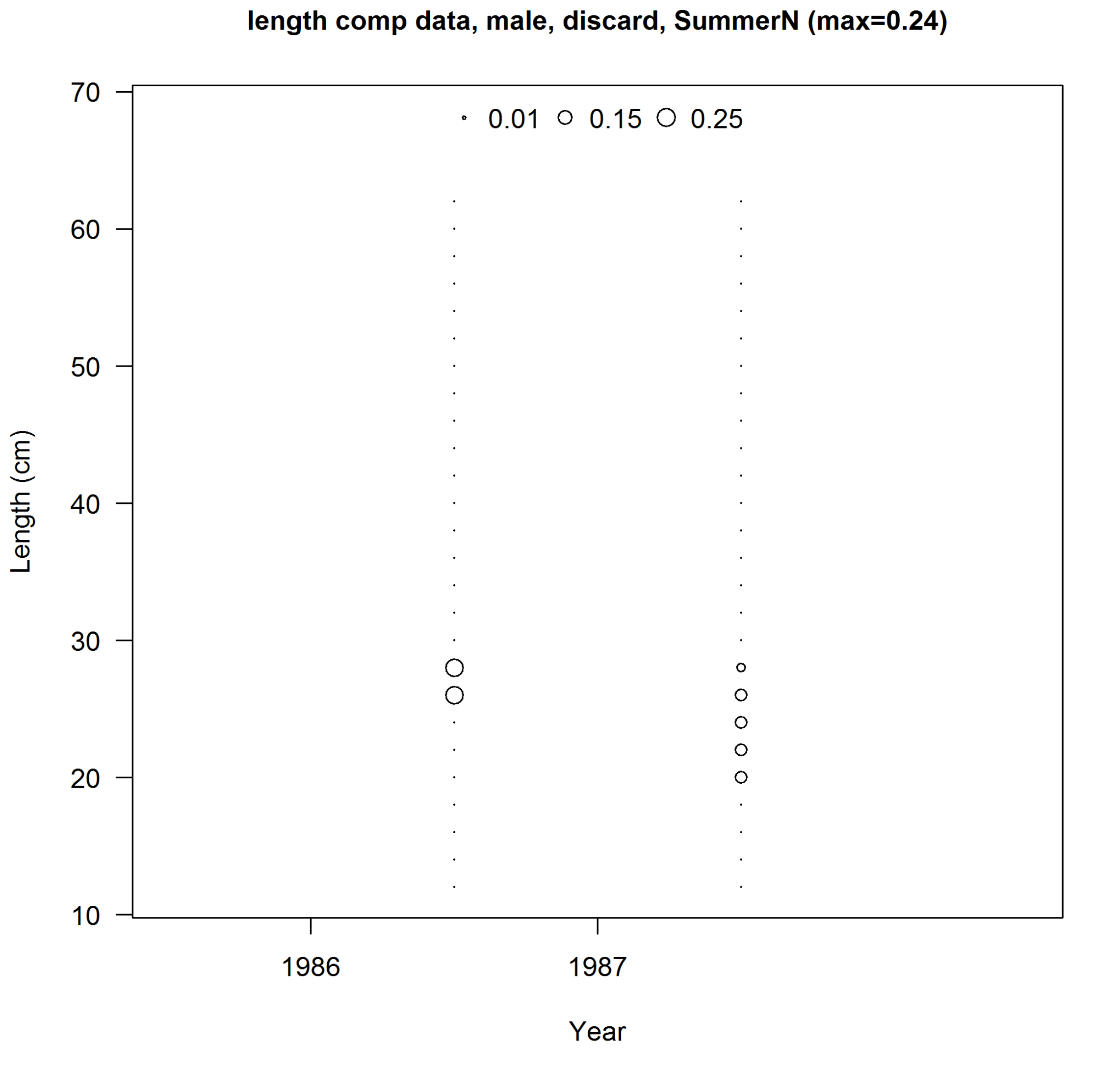


Figure 33. Pikitch summer north discard length compositions, males.

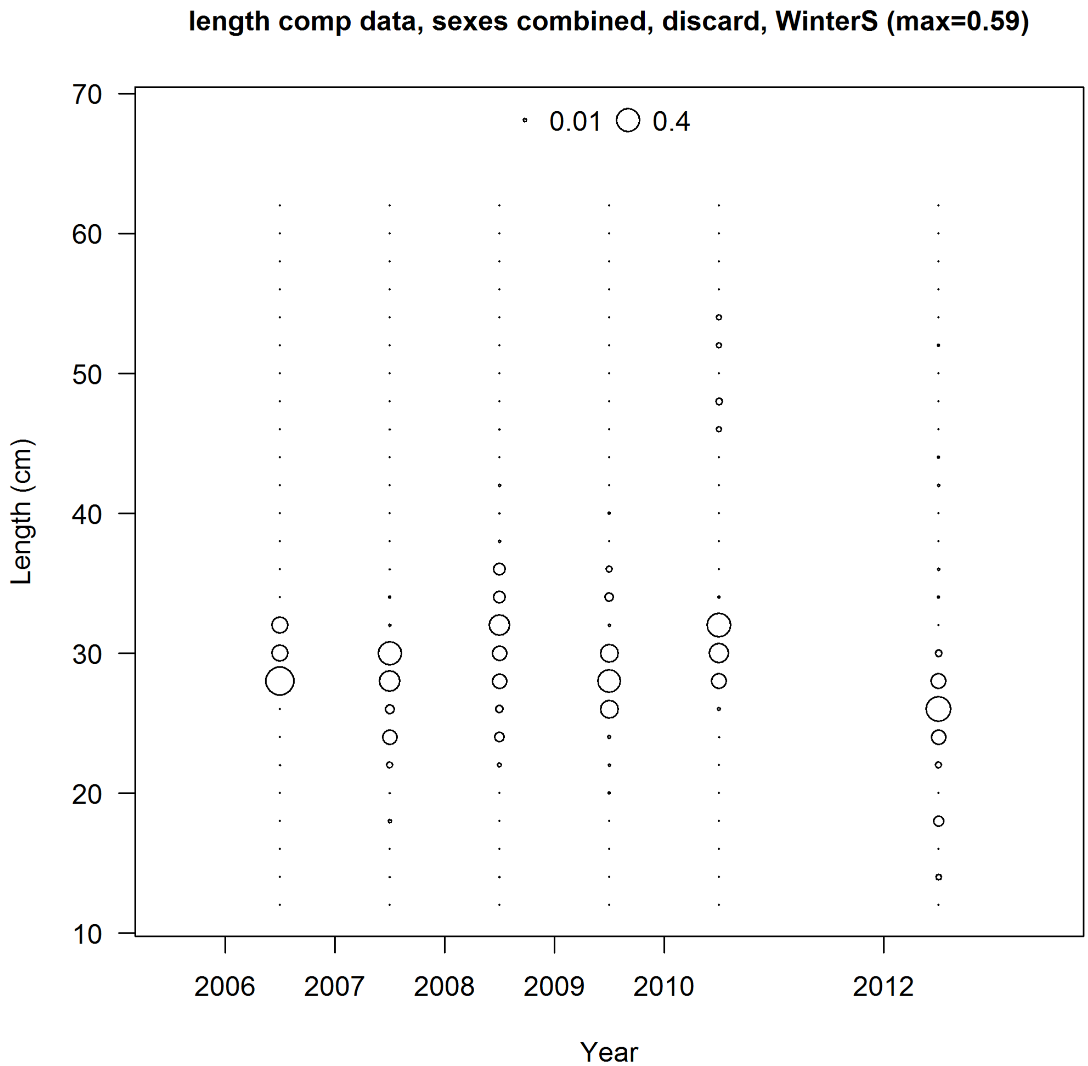


Figure 34. WCGOP winter south discard length compositions, sexes combined.

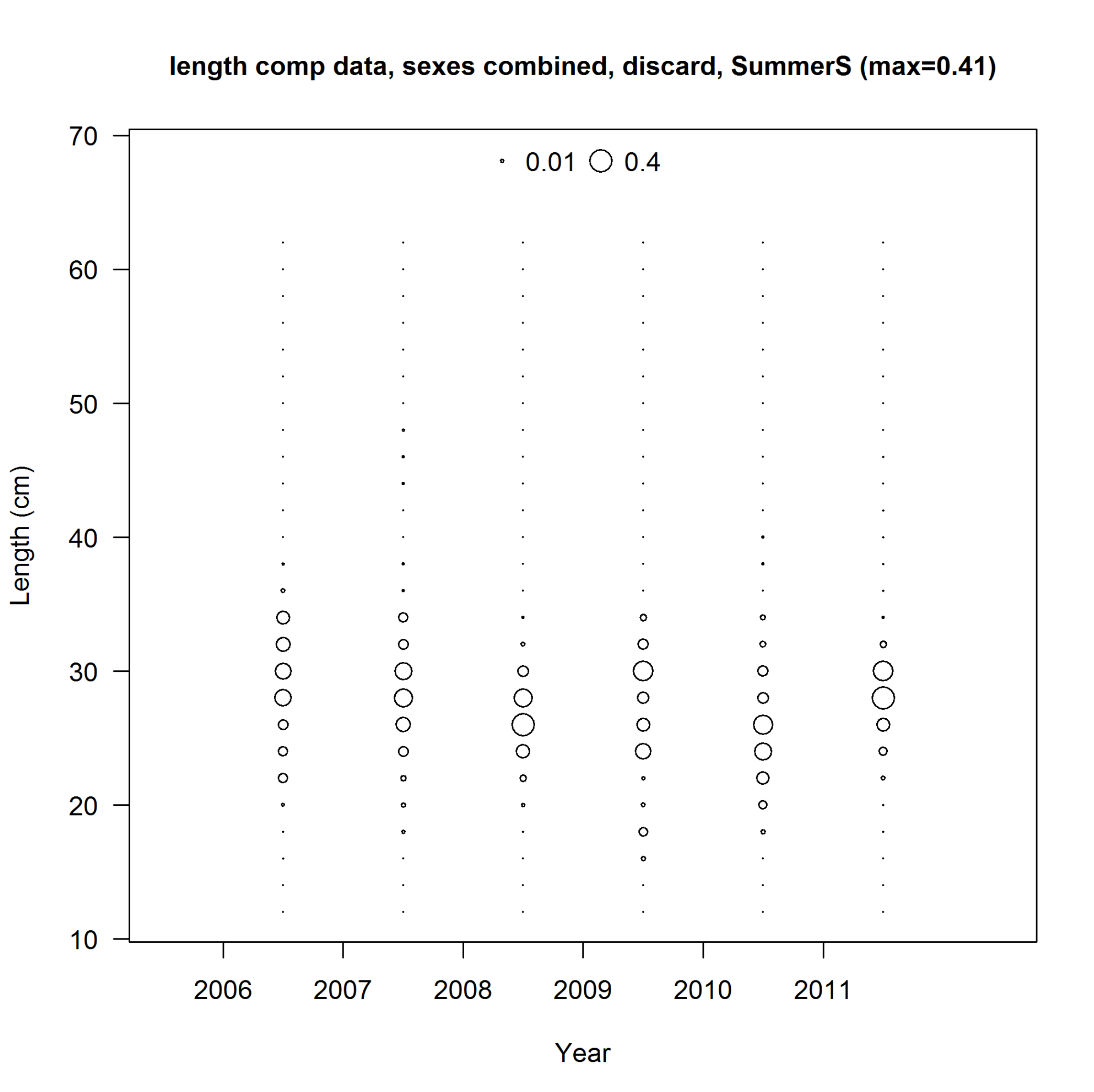


Figure 35. WCGOP summer south discard length compositions, sexes combined.

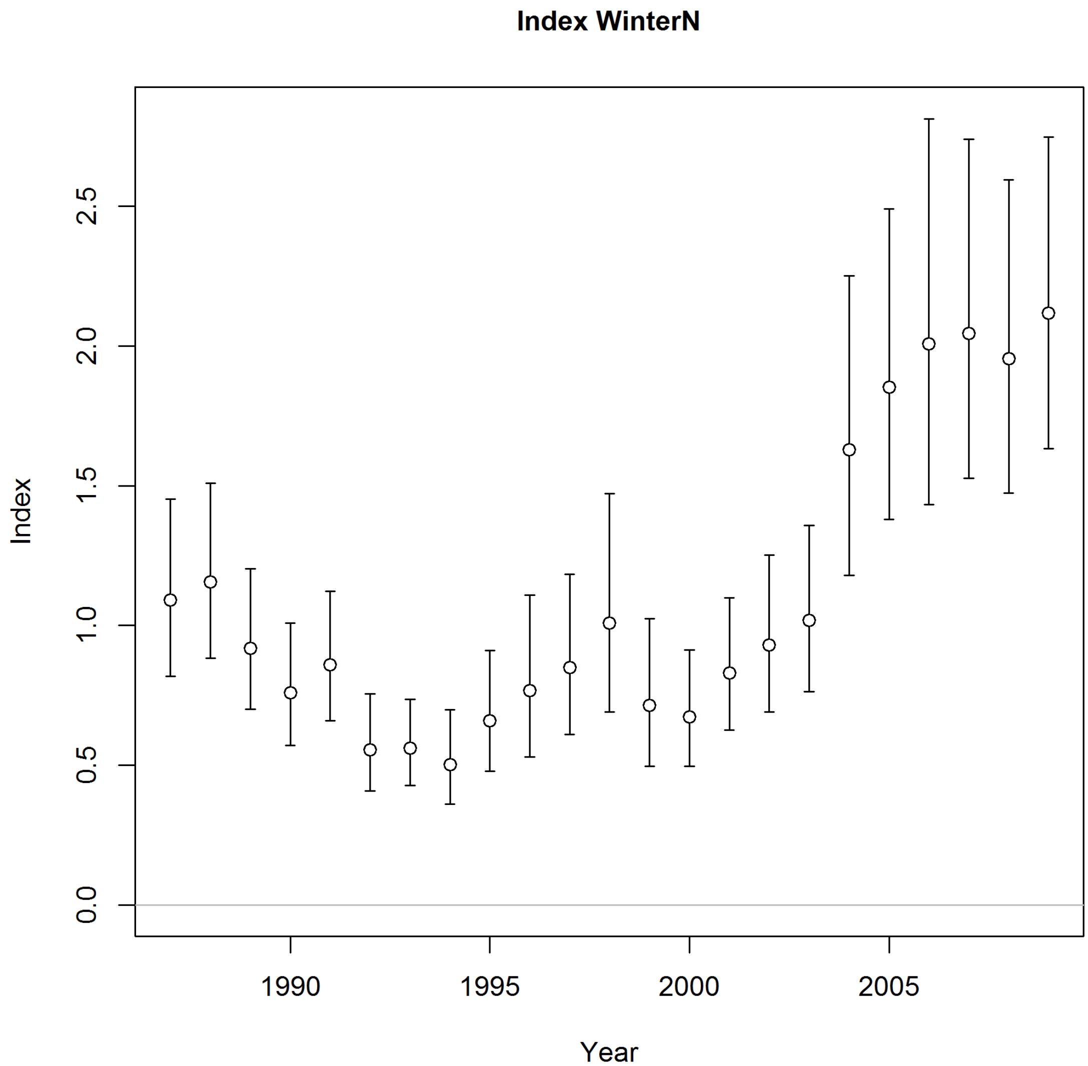


Figure 36. Winter north standardized commercial CPUE index.

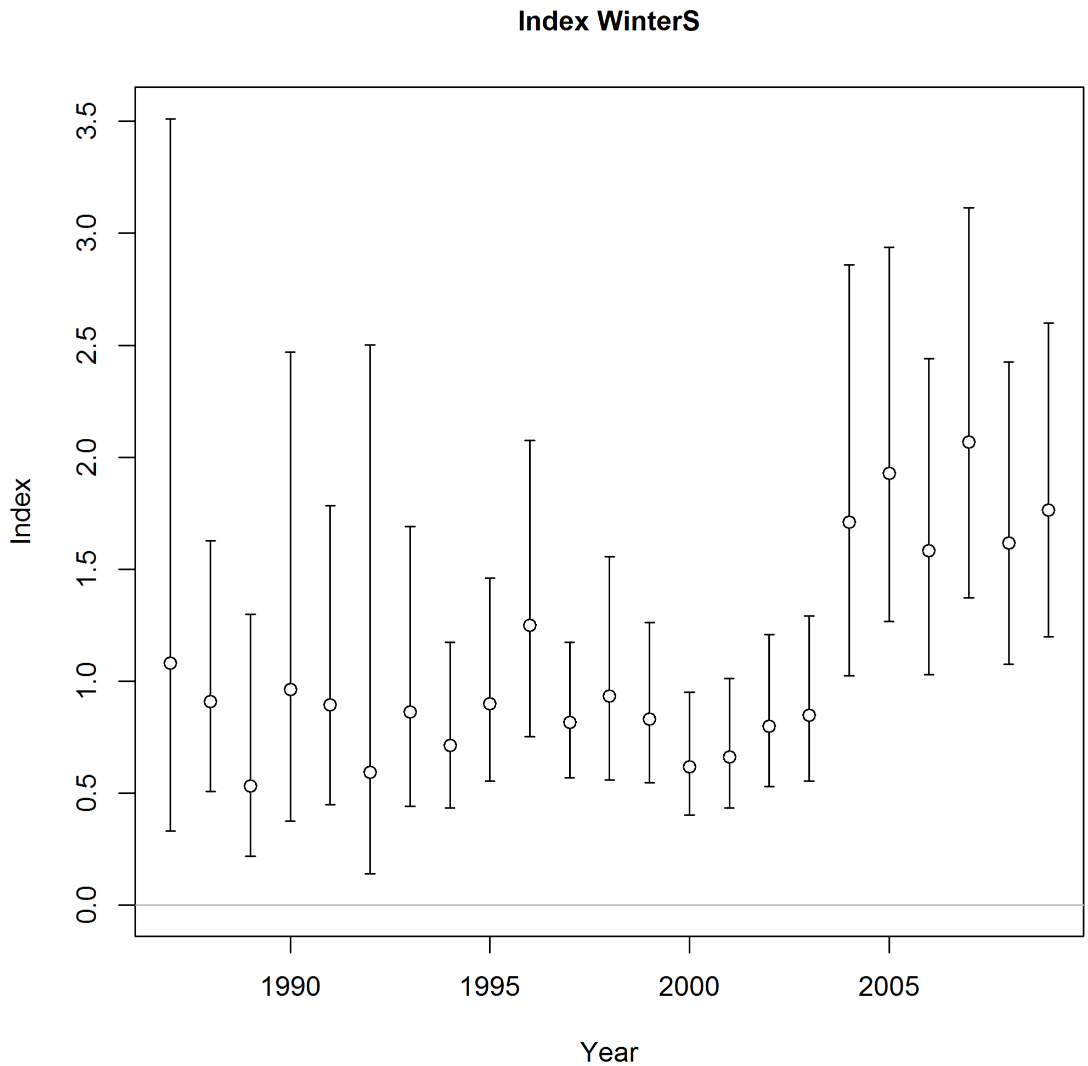


Figure 37. Winter south standardized CPUE index.

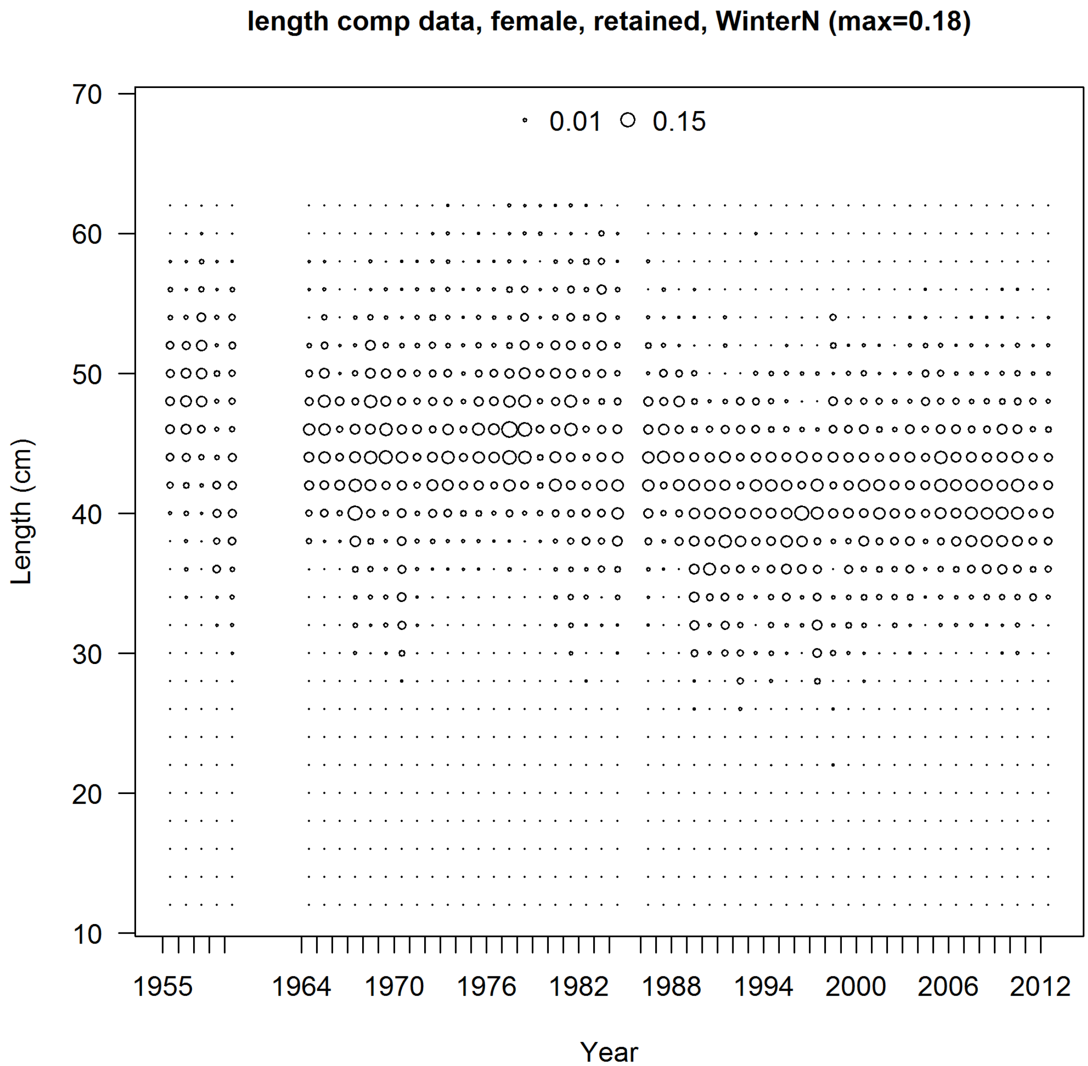


Figure 38.Winter north length-frequency data, females.

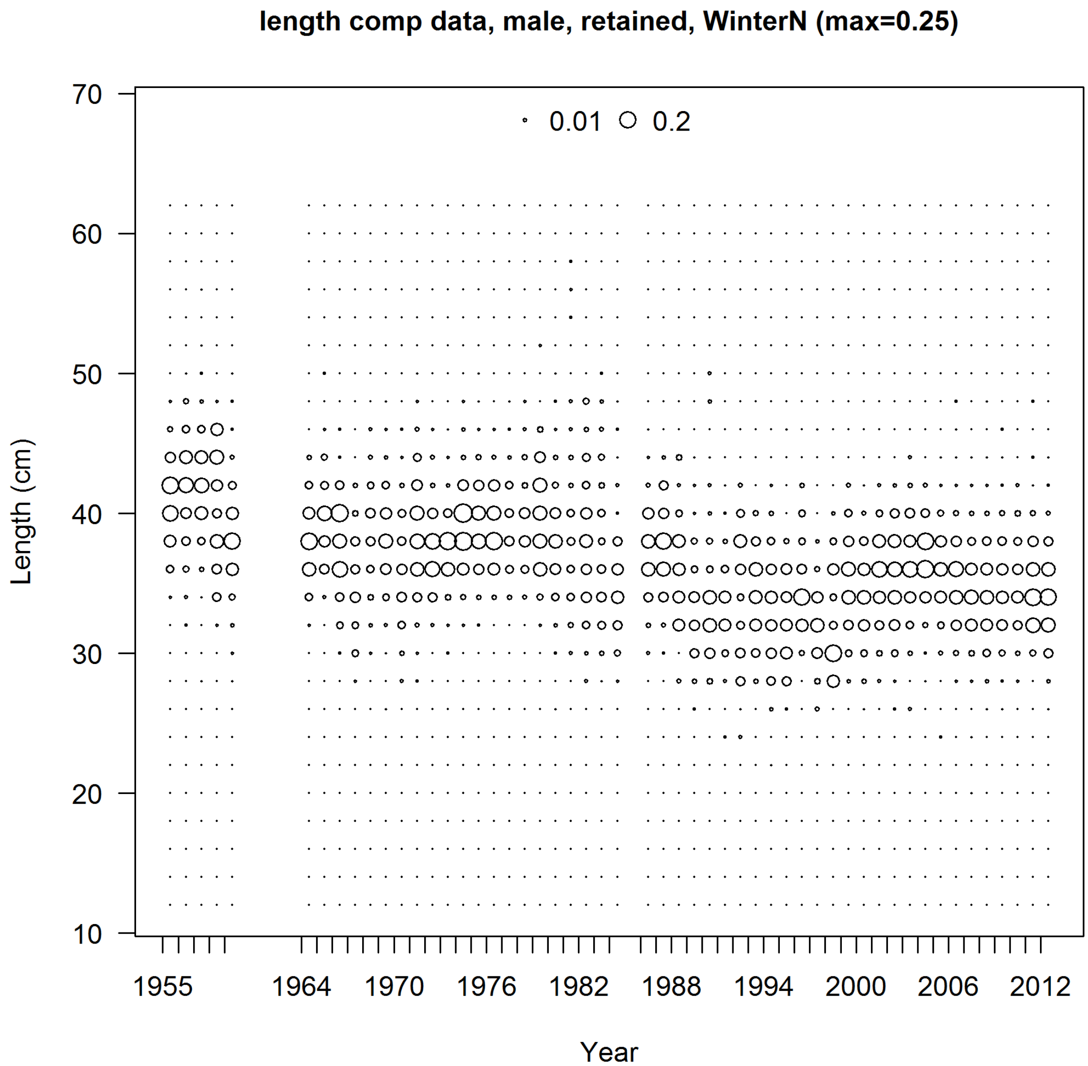


Figure 39. Winter north length-frequency data, males

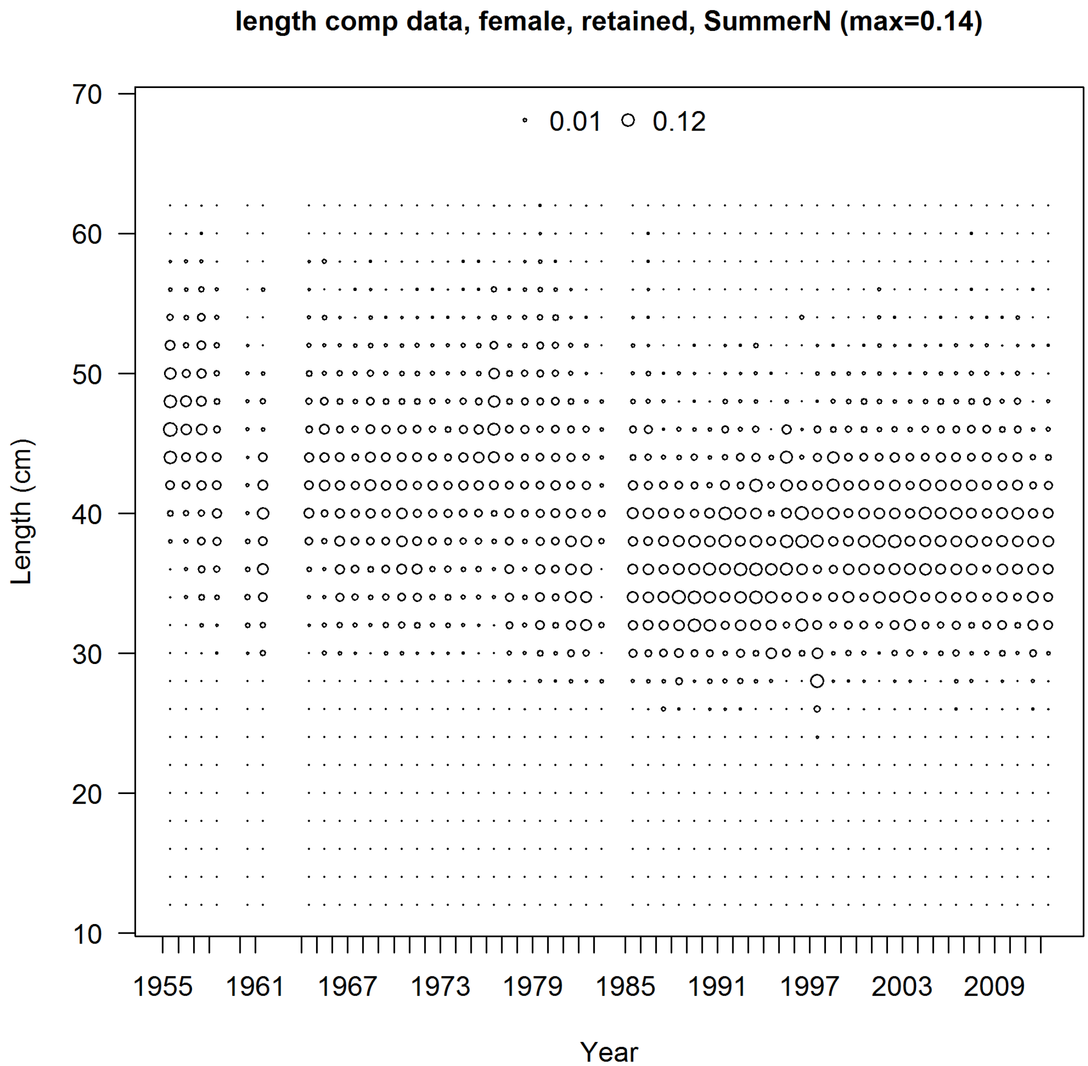


Figure 40. Summer north length-frequency data, females.

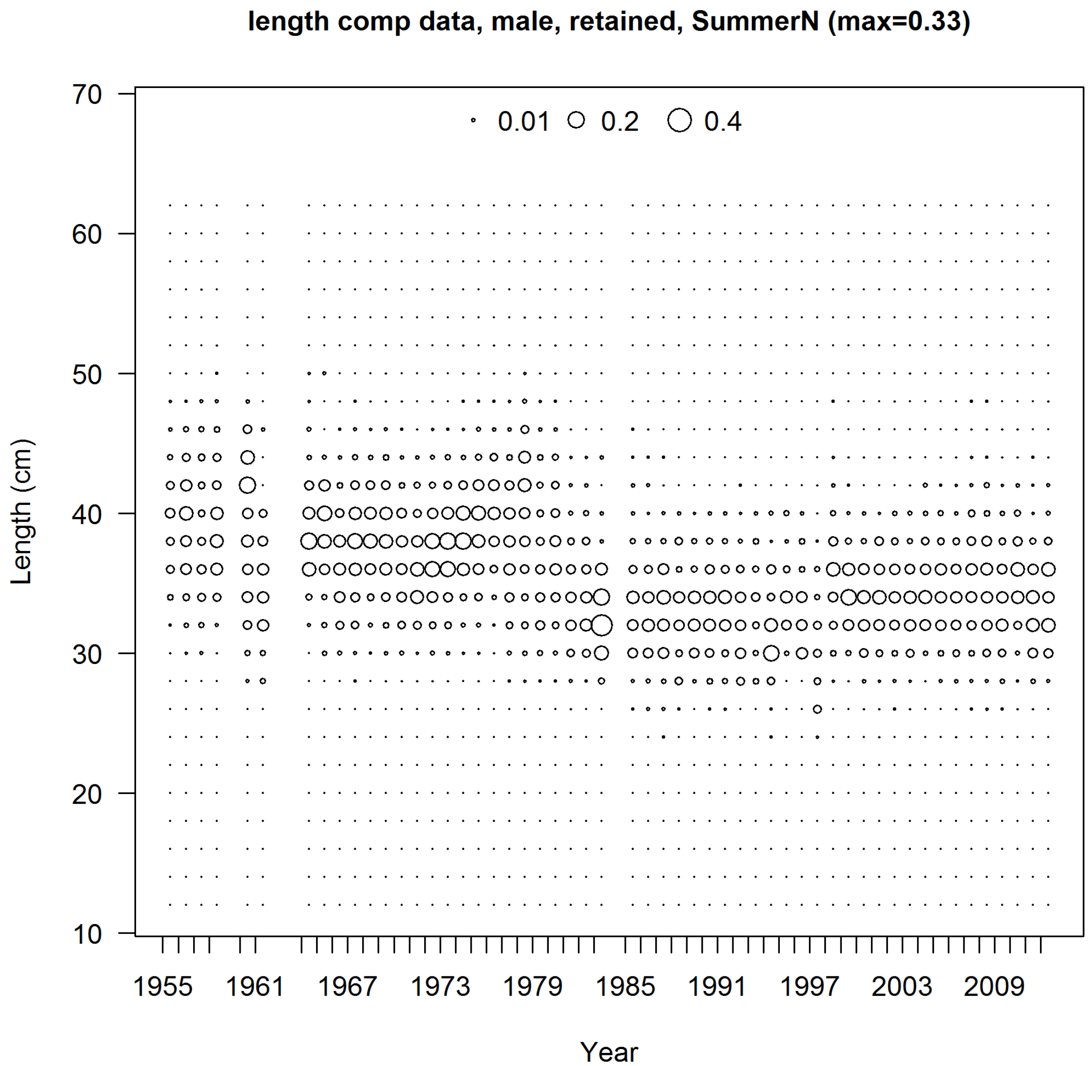


Figure 41. Summer north length-frequency data, males.

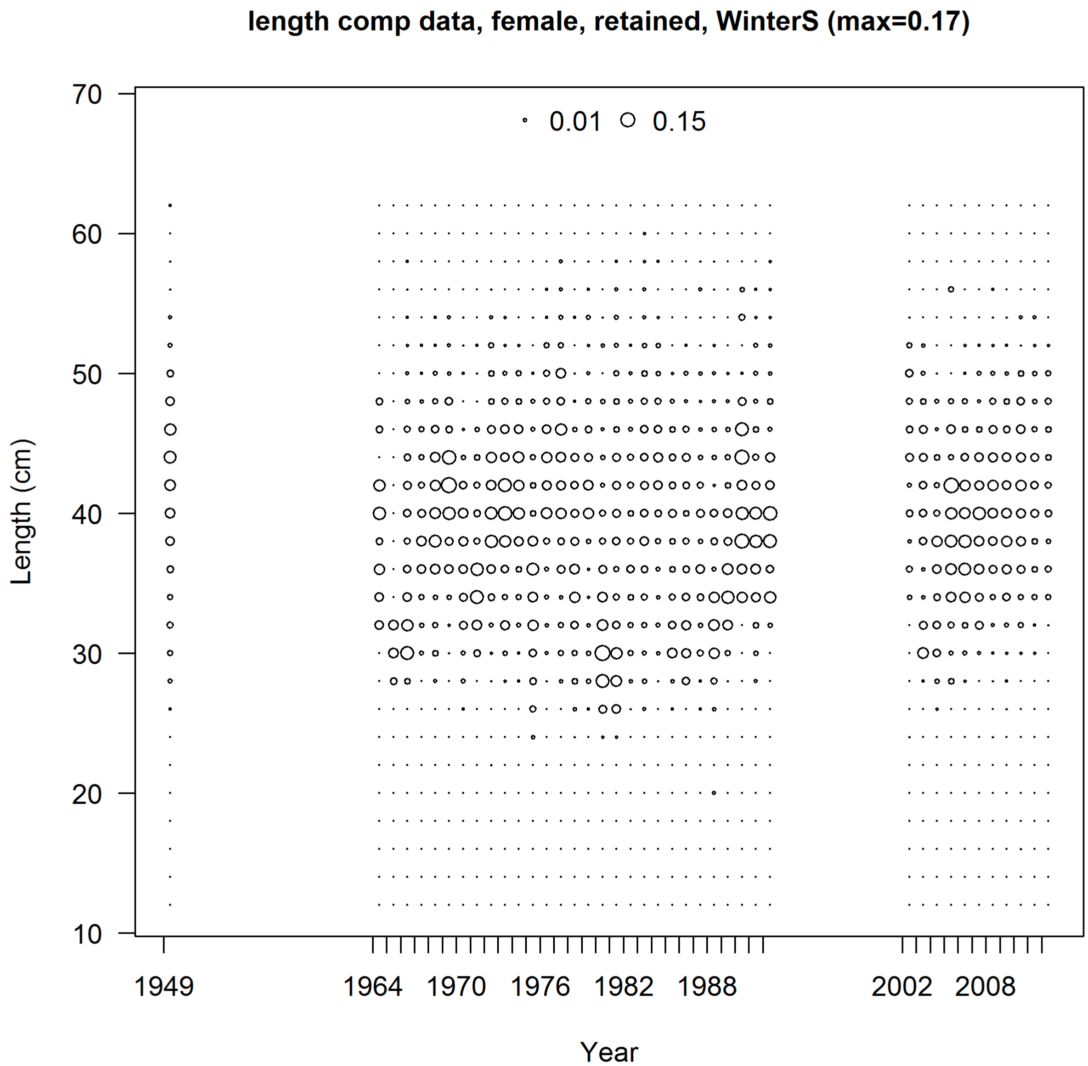


Figure 42. Winter south length-frequency data, females.

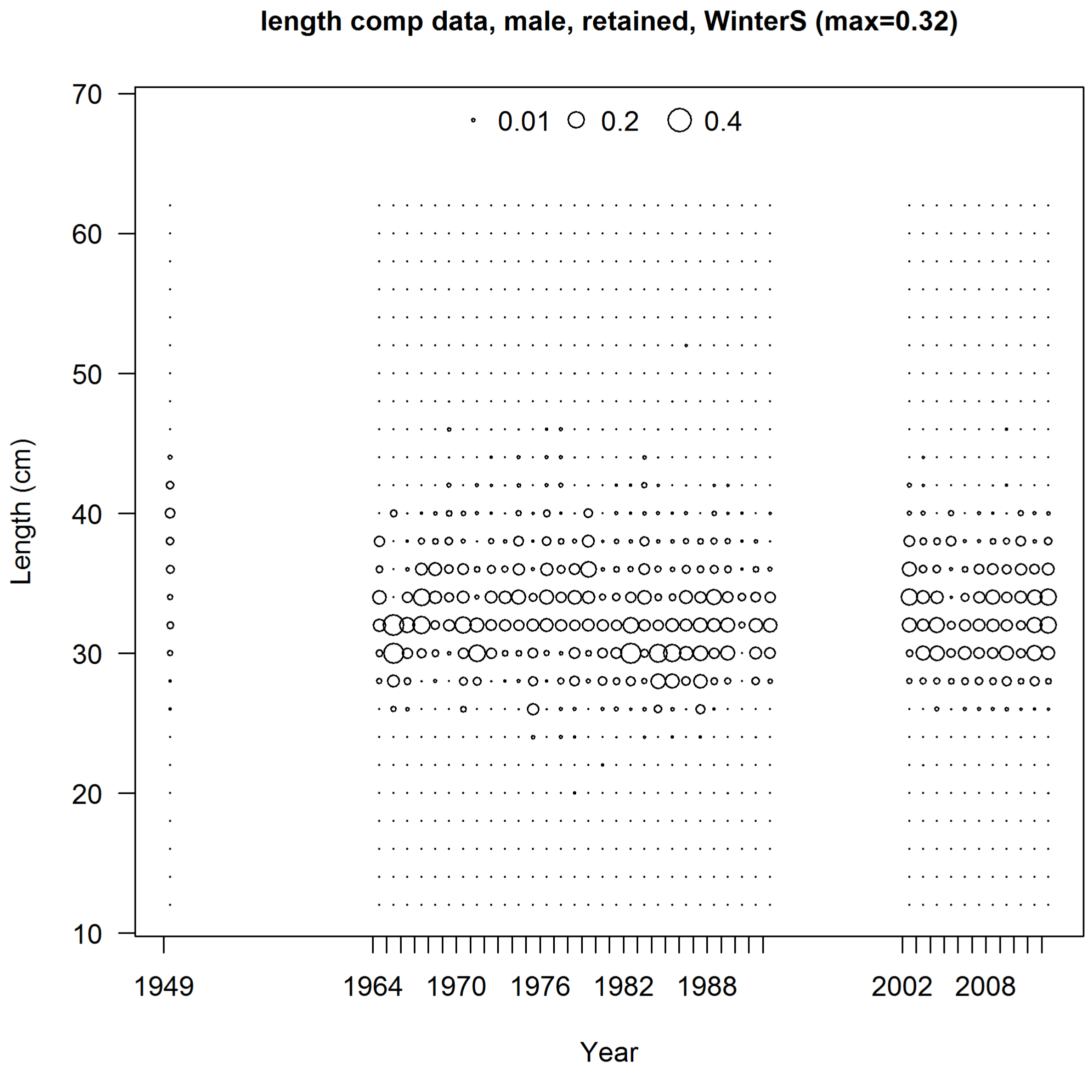


Figure 43. Winter south length-frequency data, males.

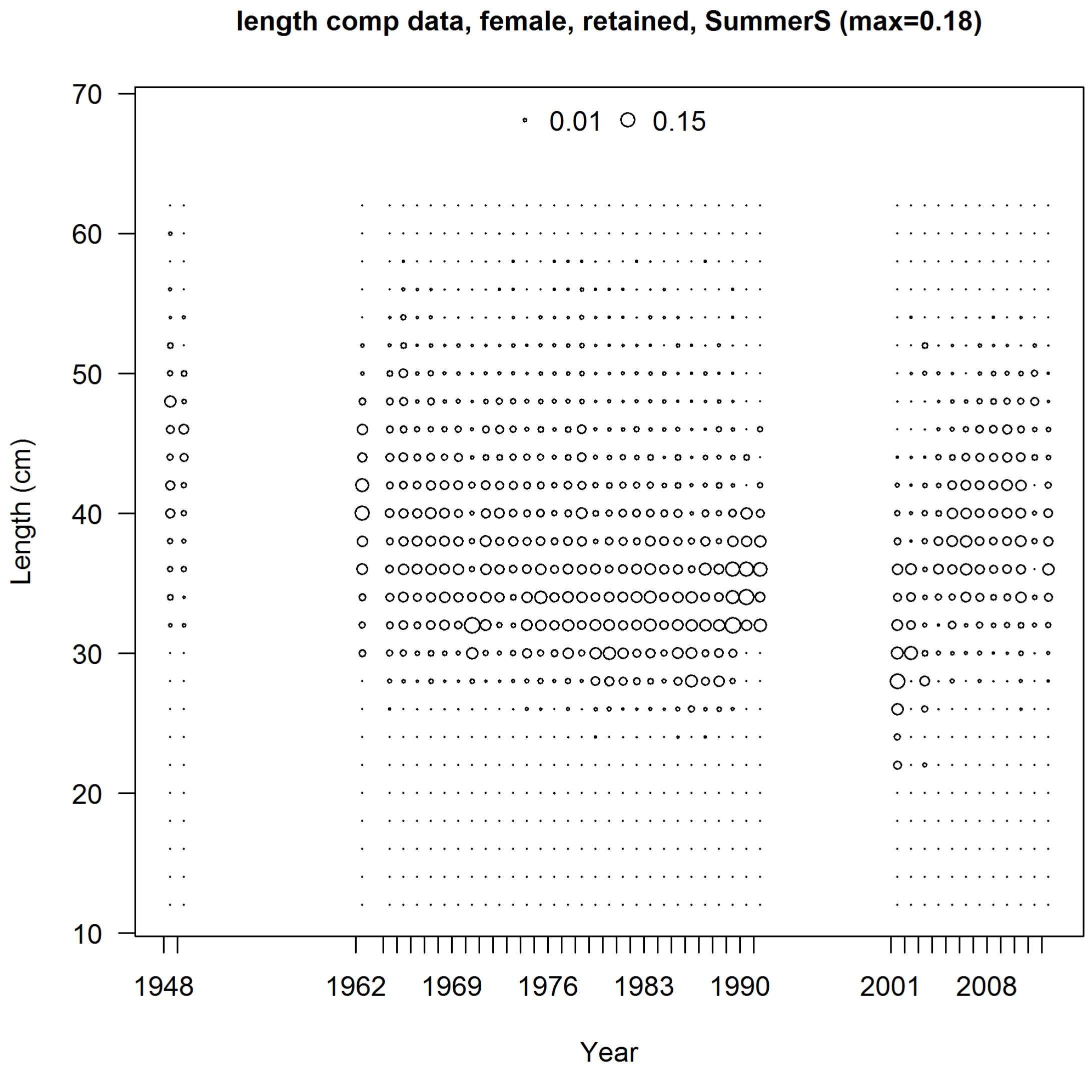


Figure 44. Summer south length-frequency data, females.

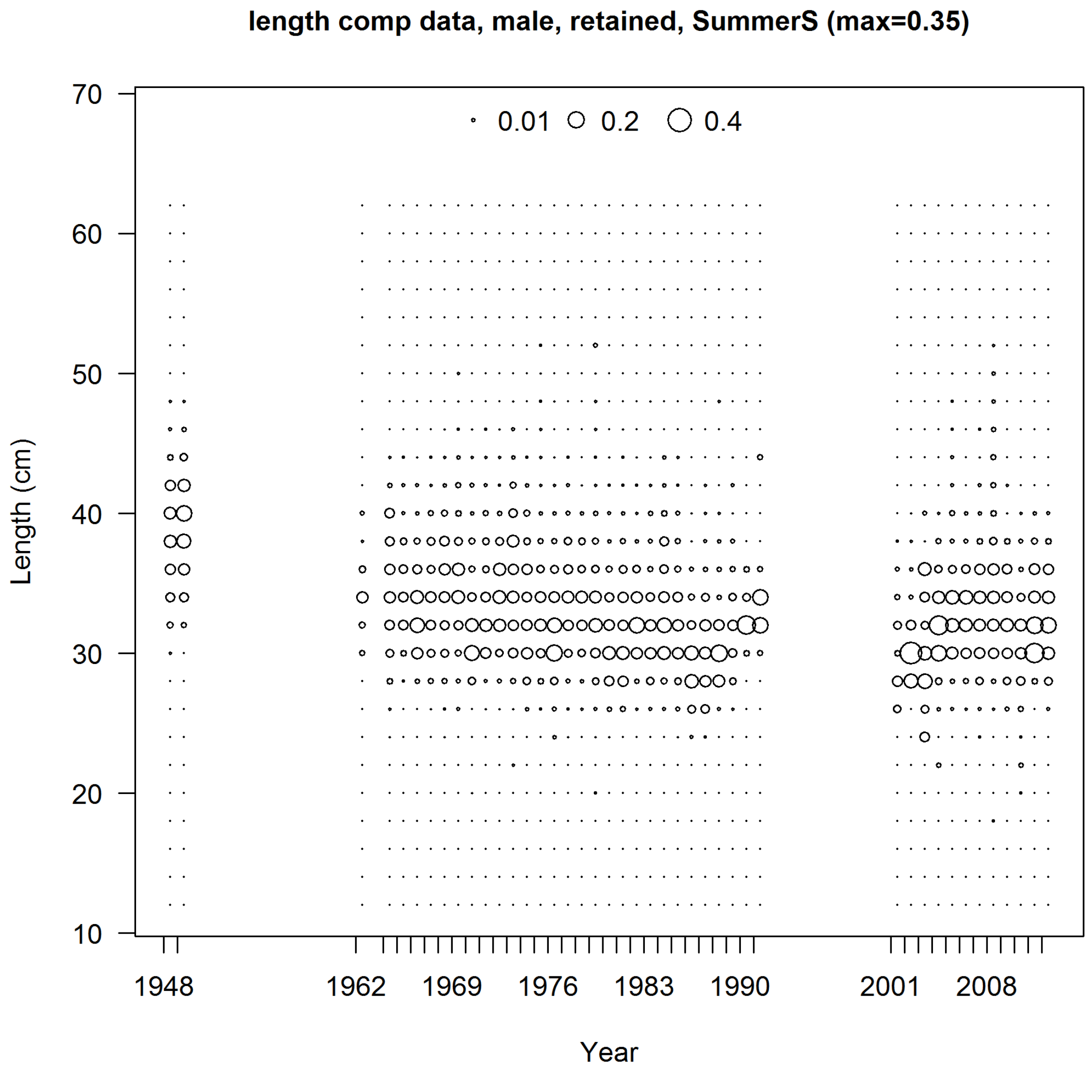


Figure 45. Summer south length-frequency data, males.

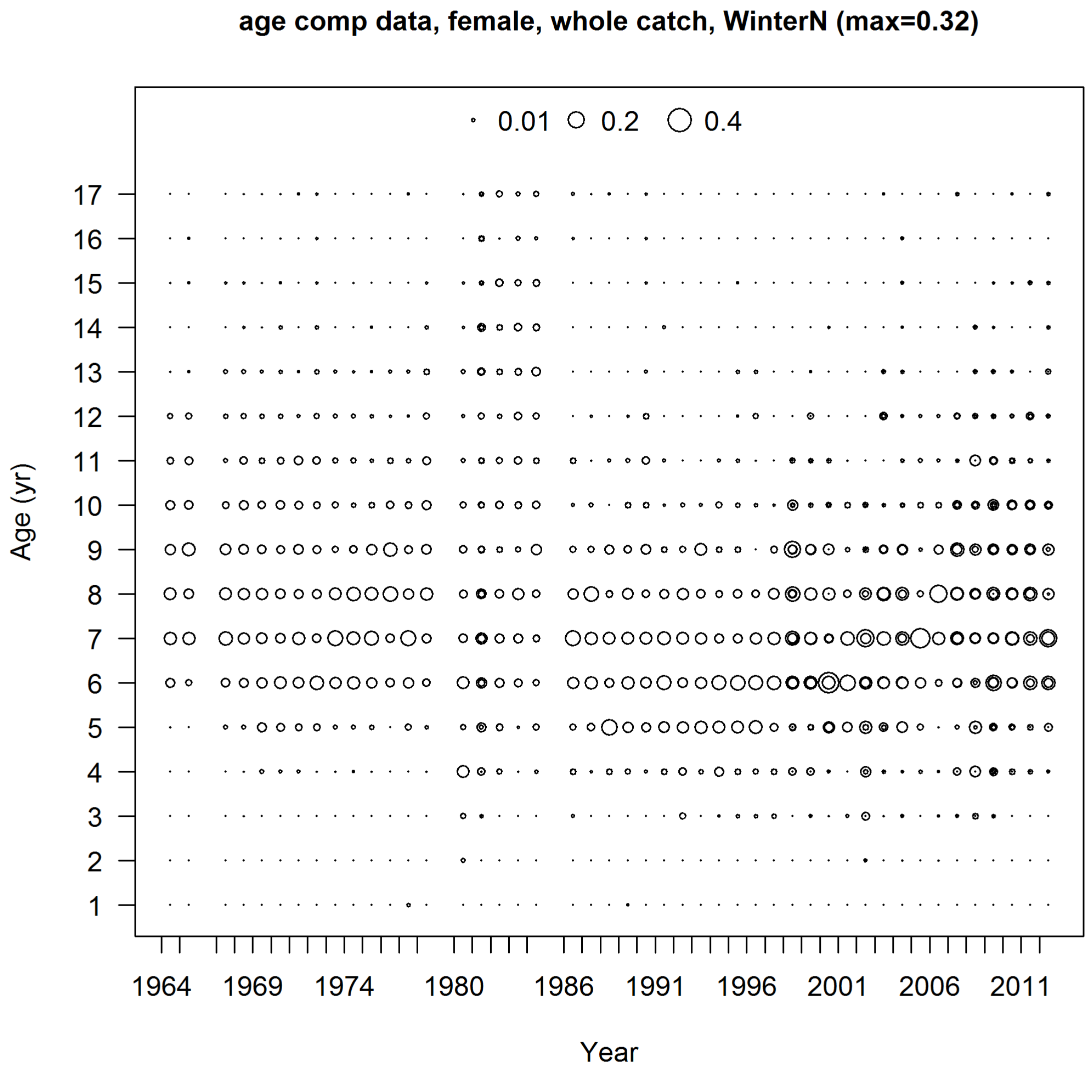


Figure 46. Winter north age-frequency data, females.

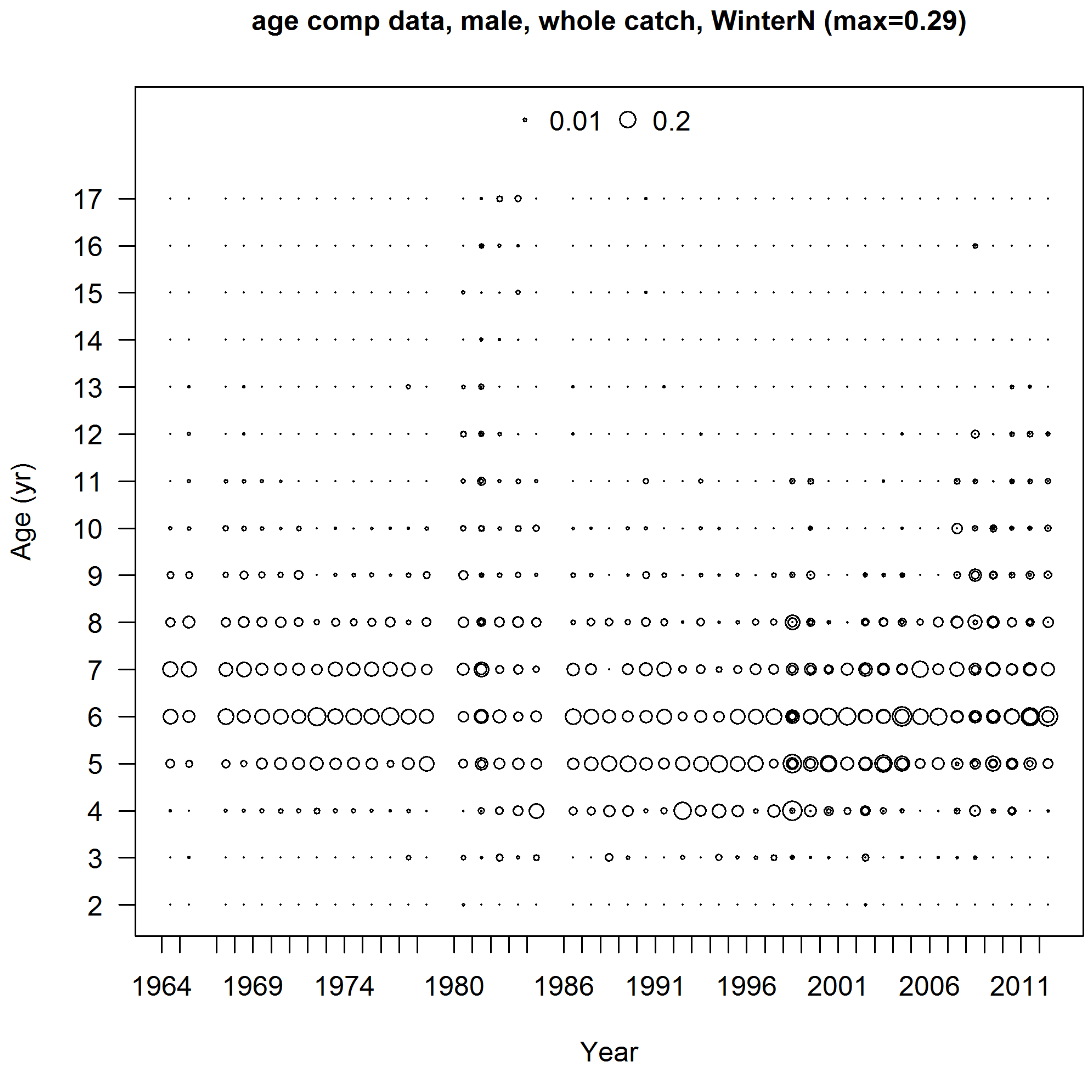


Figure 47. Winter north age-frequency data, males.

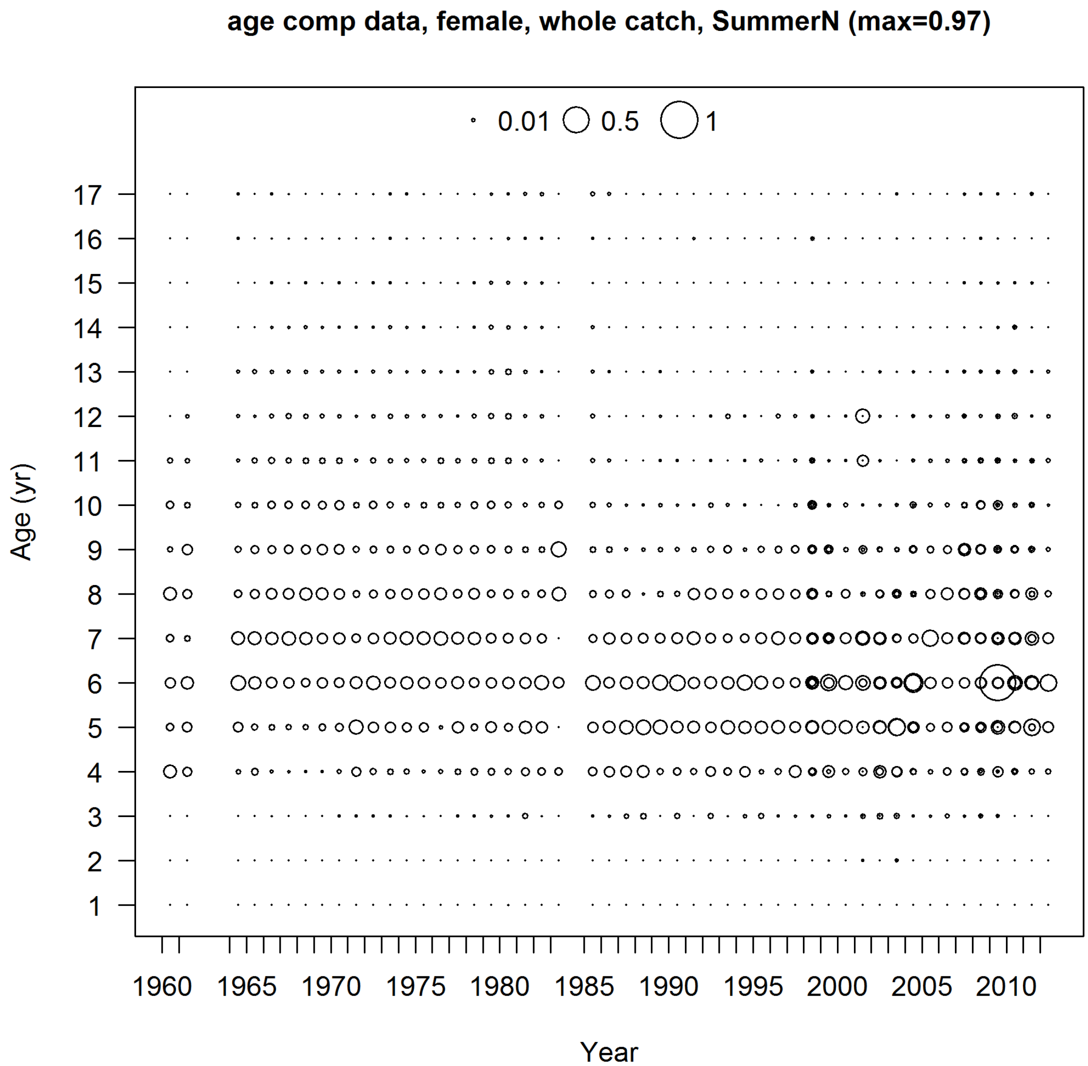


Figure 48. Summer north age-frequency data, females.

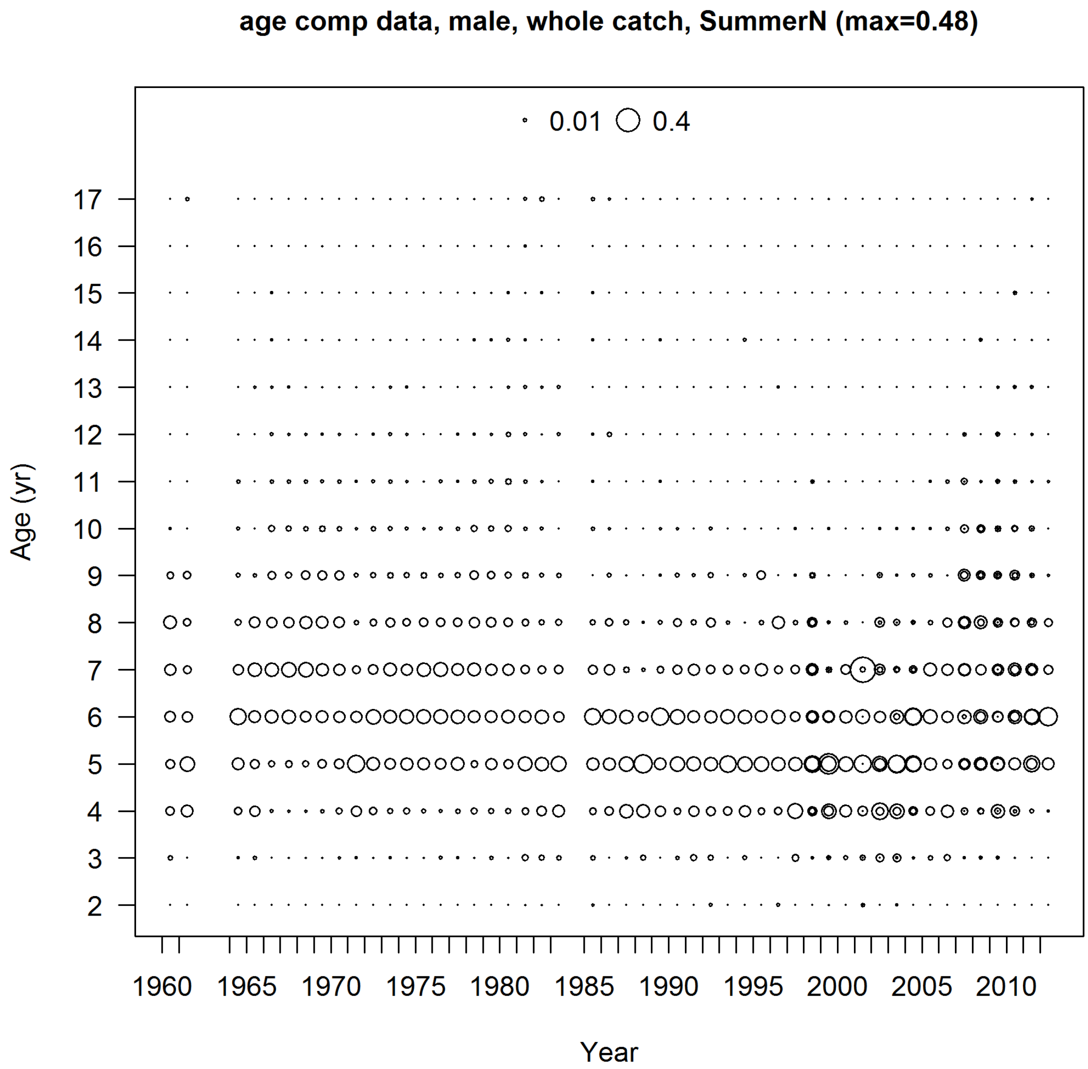


Figure 49. Summer north age-frequency data, males.

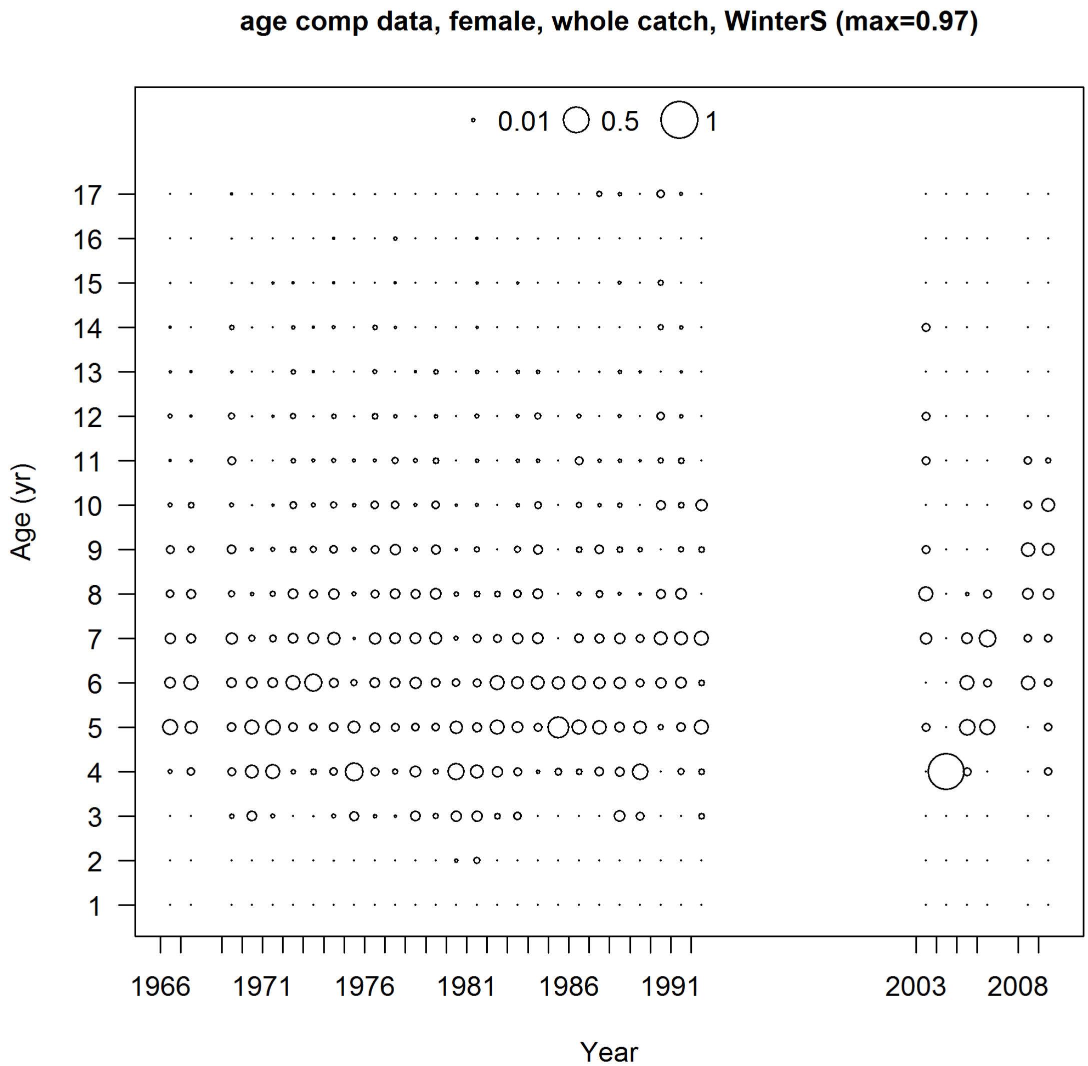


Figure 50. Winter south age-frequency data, females.

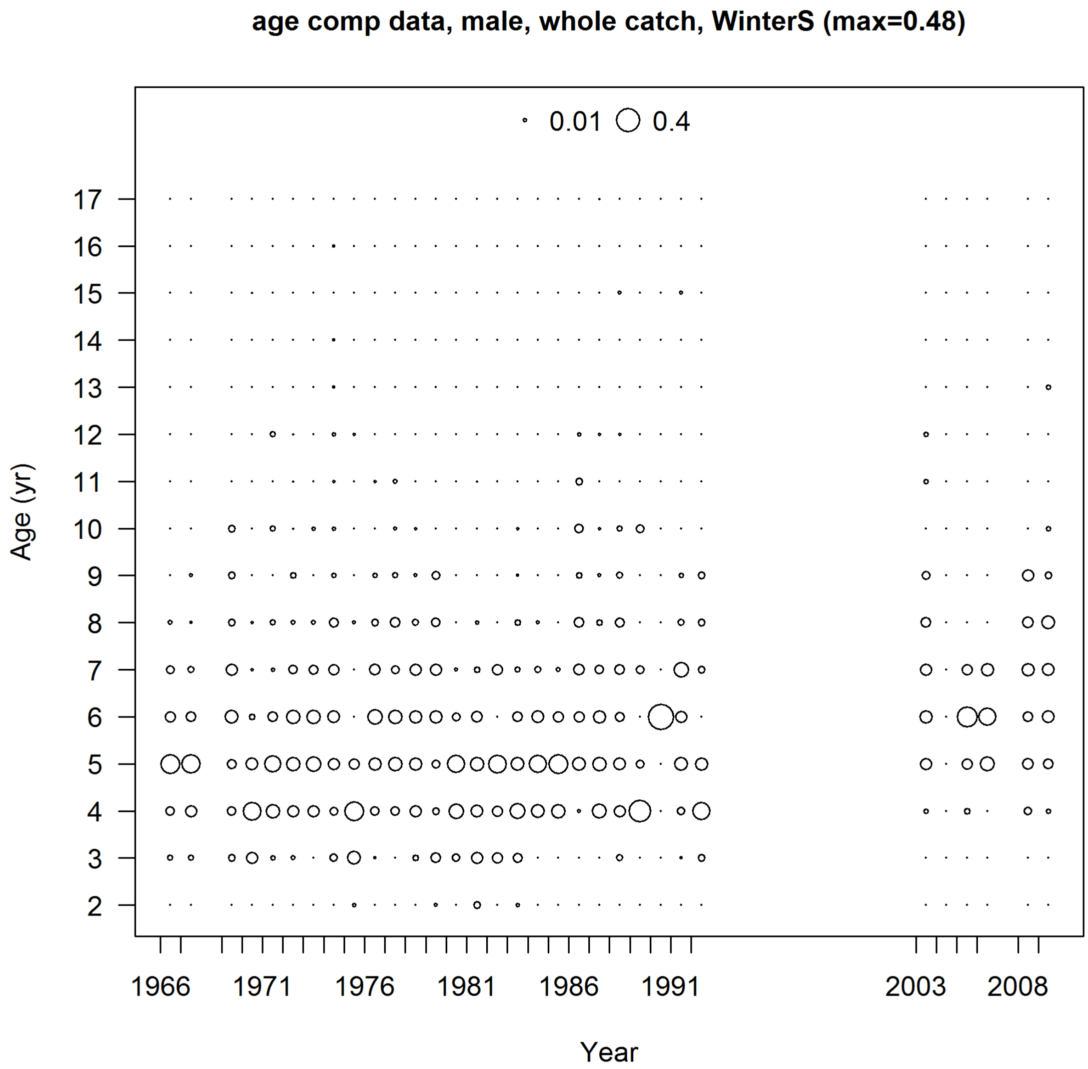


Figure 51. Winter south age-frequency data, males.

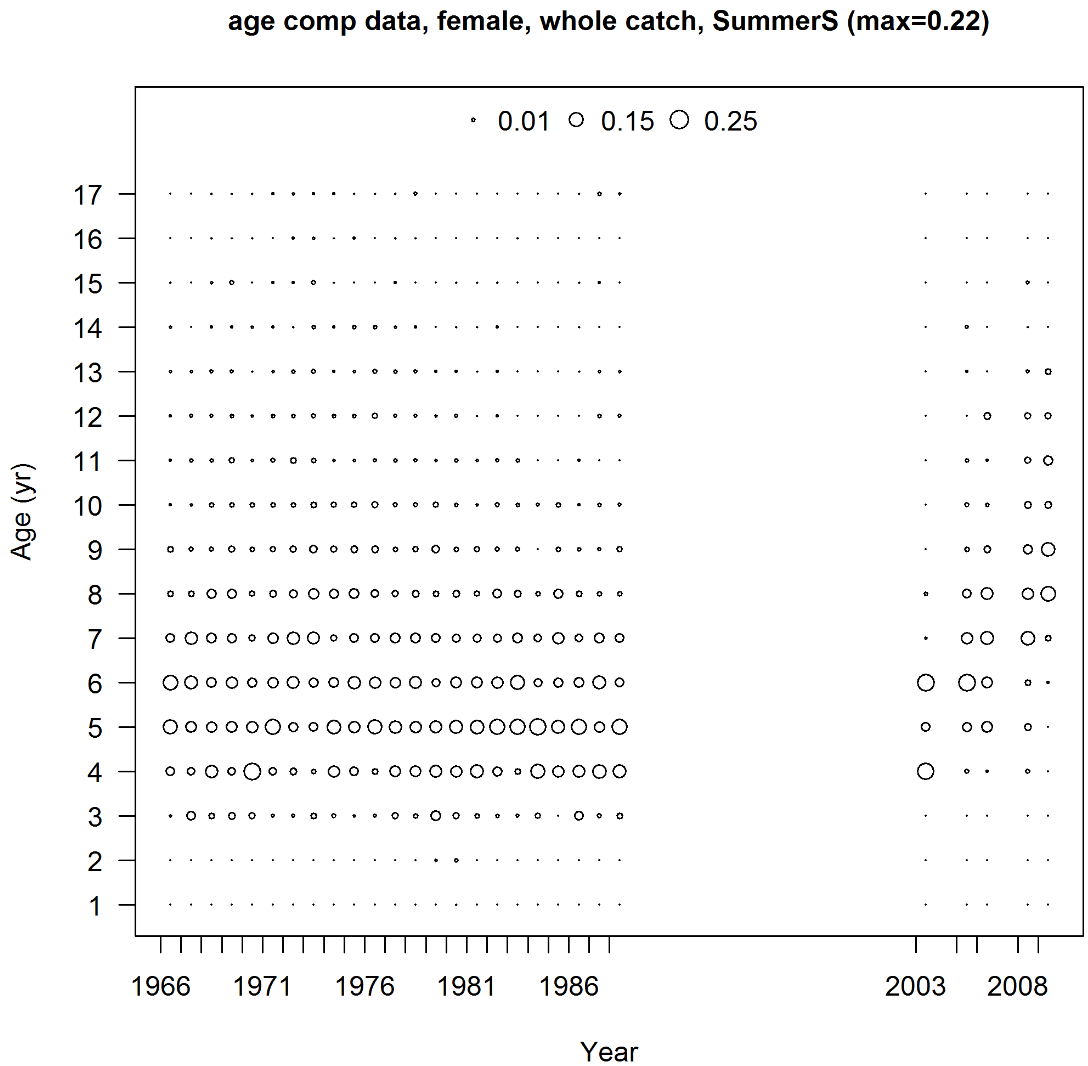


Figure 52. Summer south age-frequency data, females.

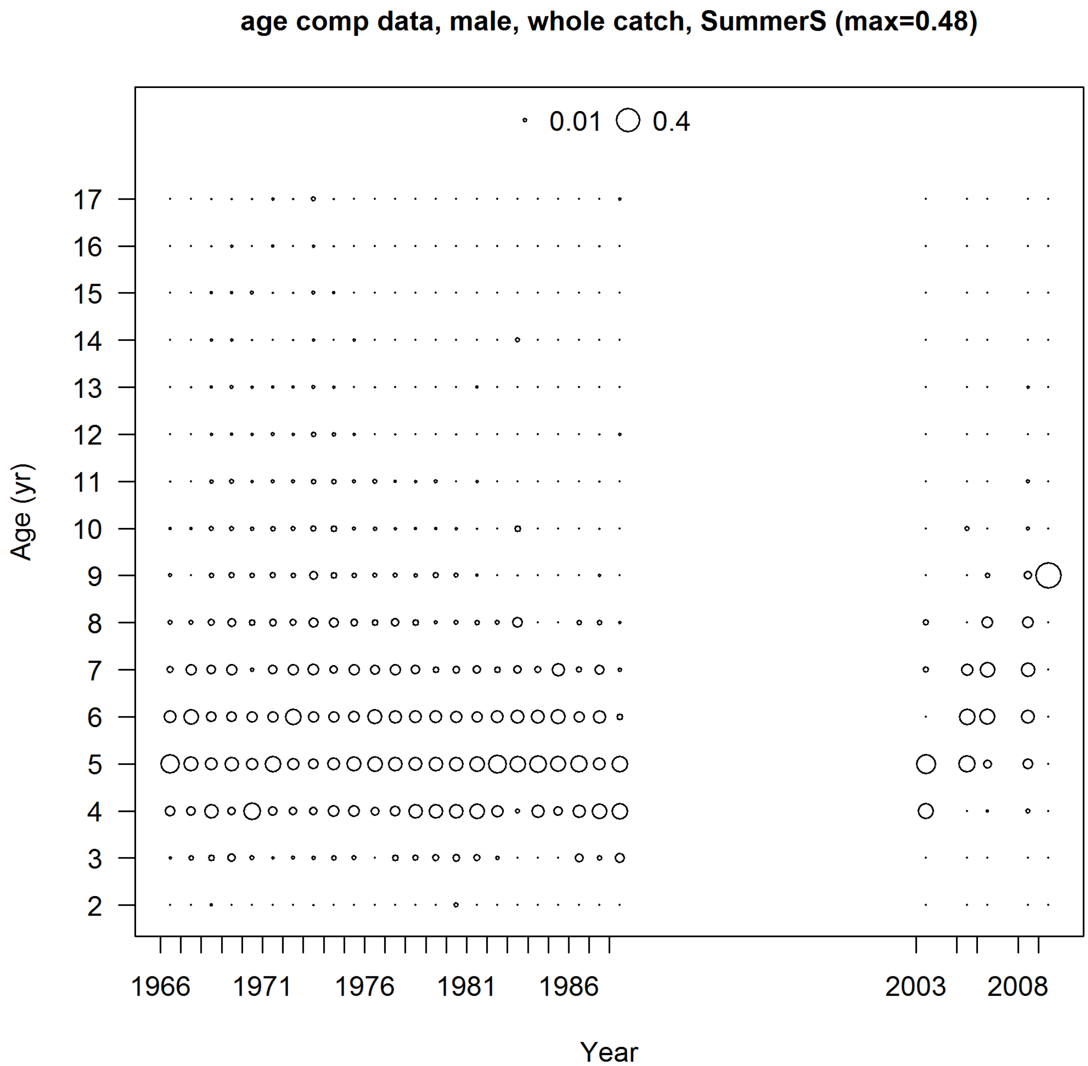


Figure 53. Summer south age-frequency data, males.

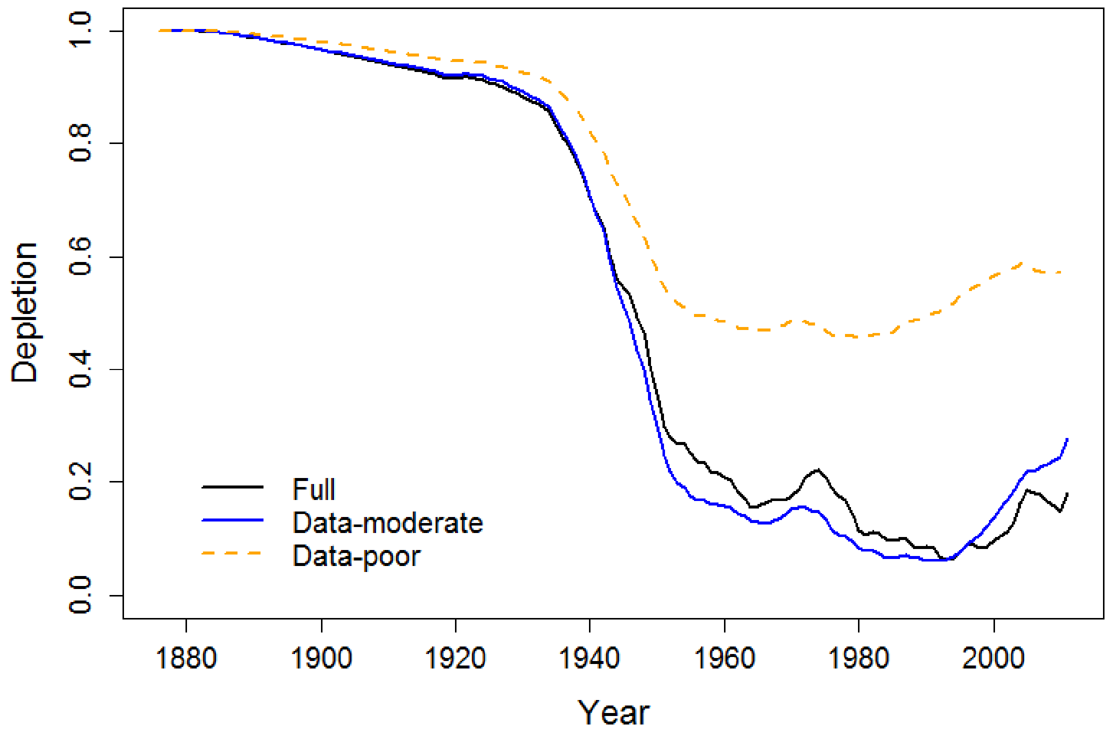


Figure 54. Times series of depletion for three petrale sole models through 2011. The "data-poor" model refers to a catch and life history only implementation of SS (Cope 2013), which assumes a terminal depletion value of around 60%, based on a preliminary relationship of the Productivity-Susceptibility Analysis to depletion. The data-moderate model uses catch, life history, and all available indices of abundance, while estimating natural mortality, steepness, and R0. Recruitment is assumed deterministic Beverton-Holt and informative priors are used on natural mortality and steepness. The "full" model is the 2011 petrale sole assessment.

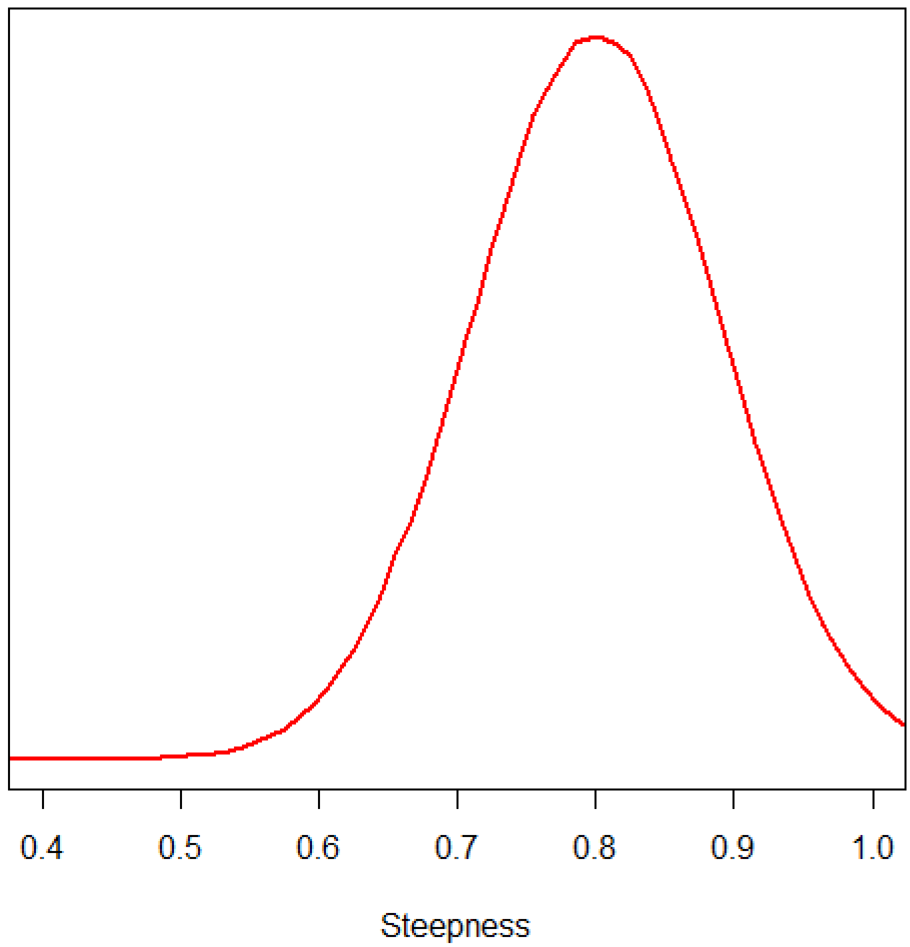


Figure 55. Prior for steepness

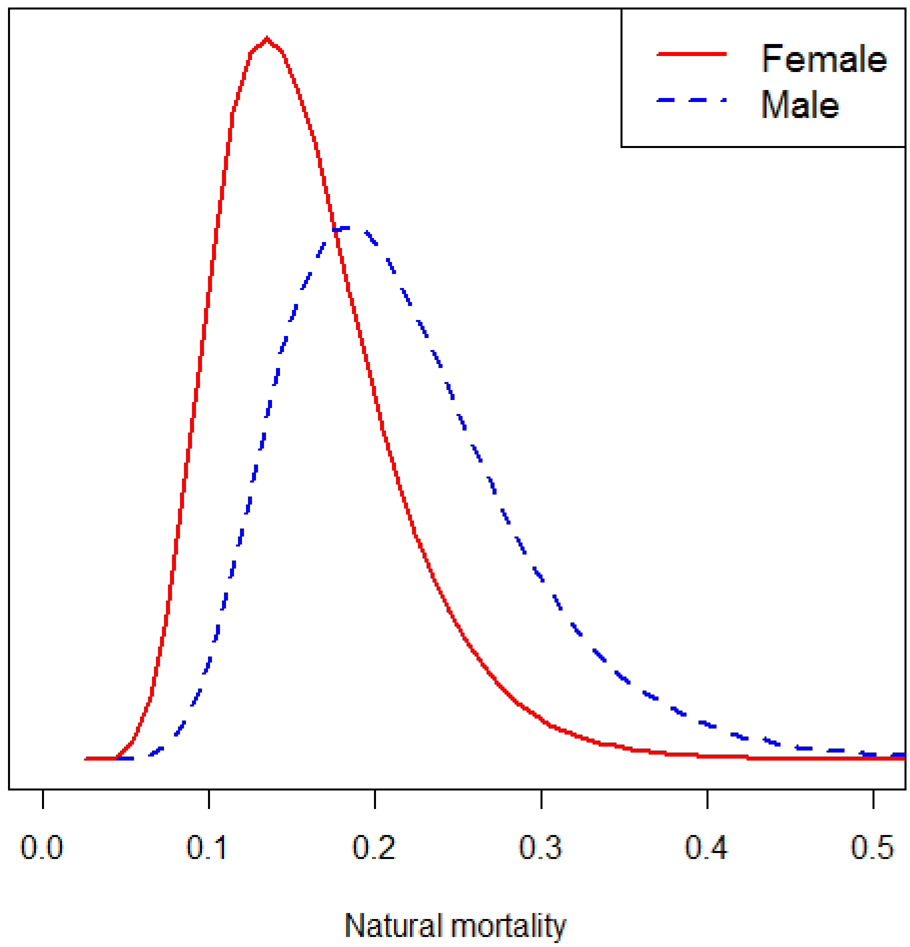


Figure 56. Priors for female (red solid line) and male (blue dashed line) for M.

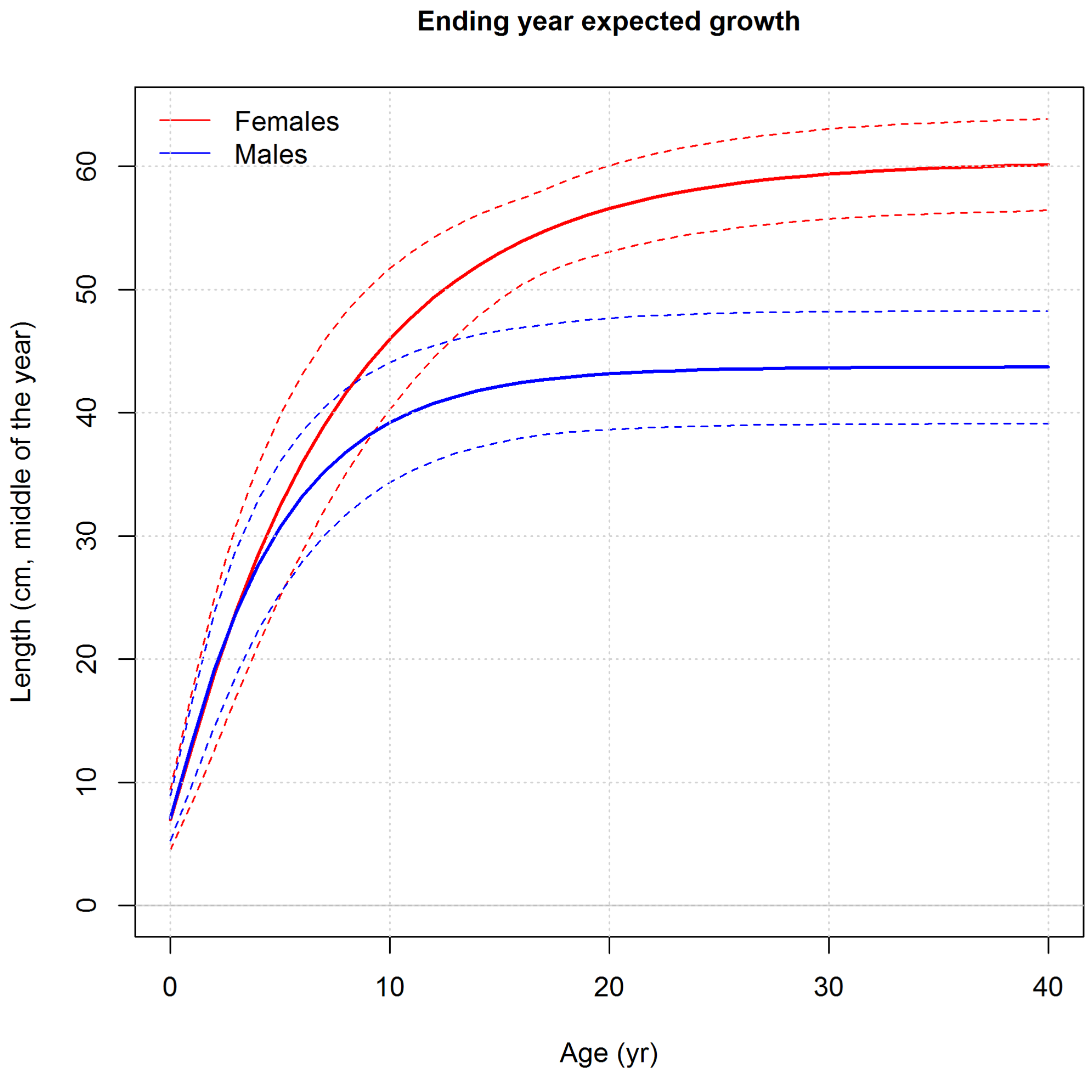


Figure 57. The growth curve for females (upper solid line) and males (lower solid line) with ~95% interval (dashed lines) indicating the estimated variability of length-at-age for the base case model.

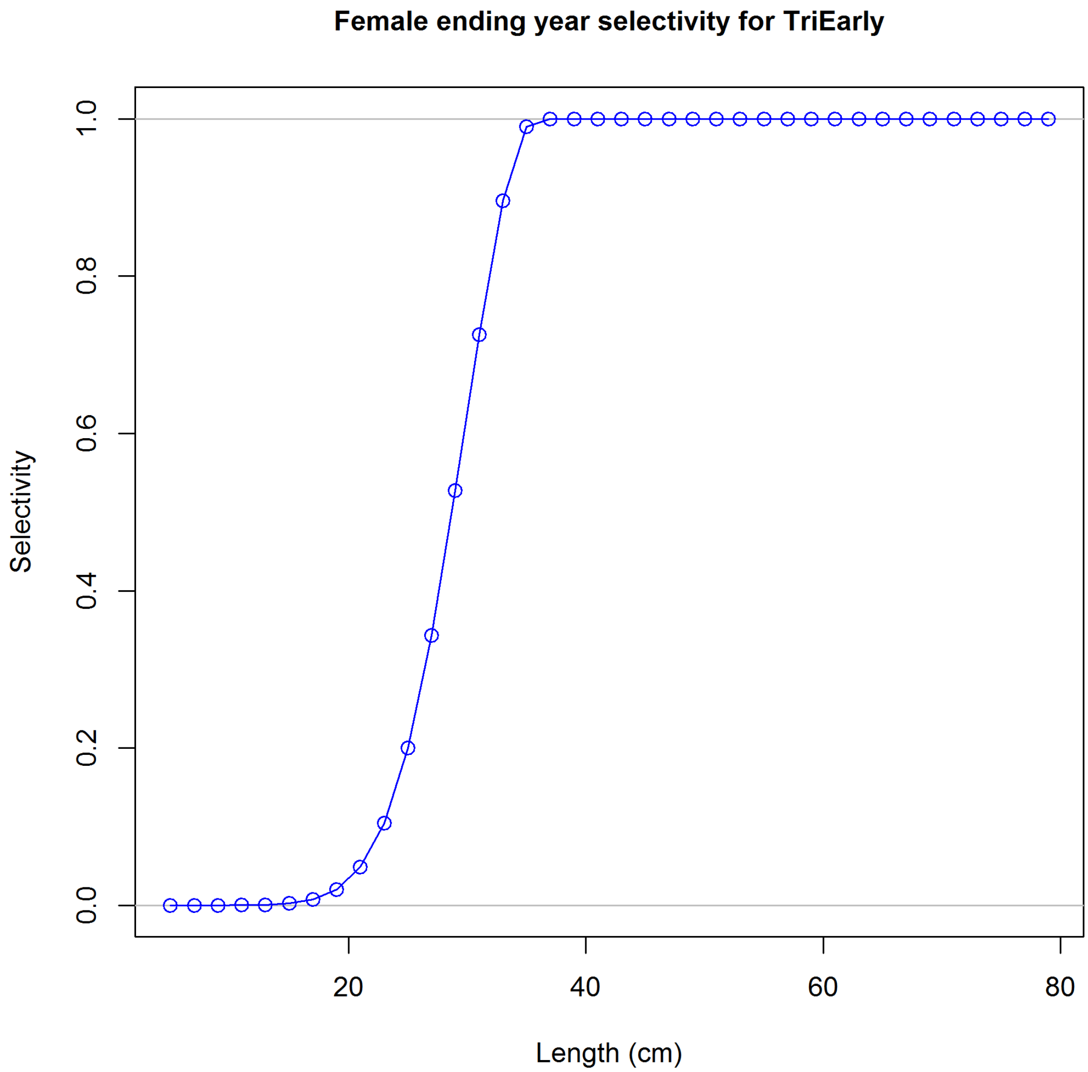


Figure 58. Estimated length-based selectivity curves for the early triennial survey, females.

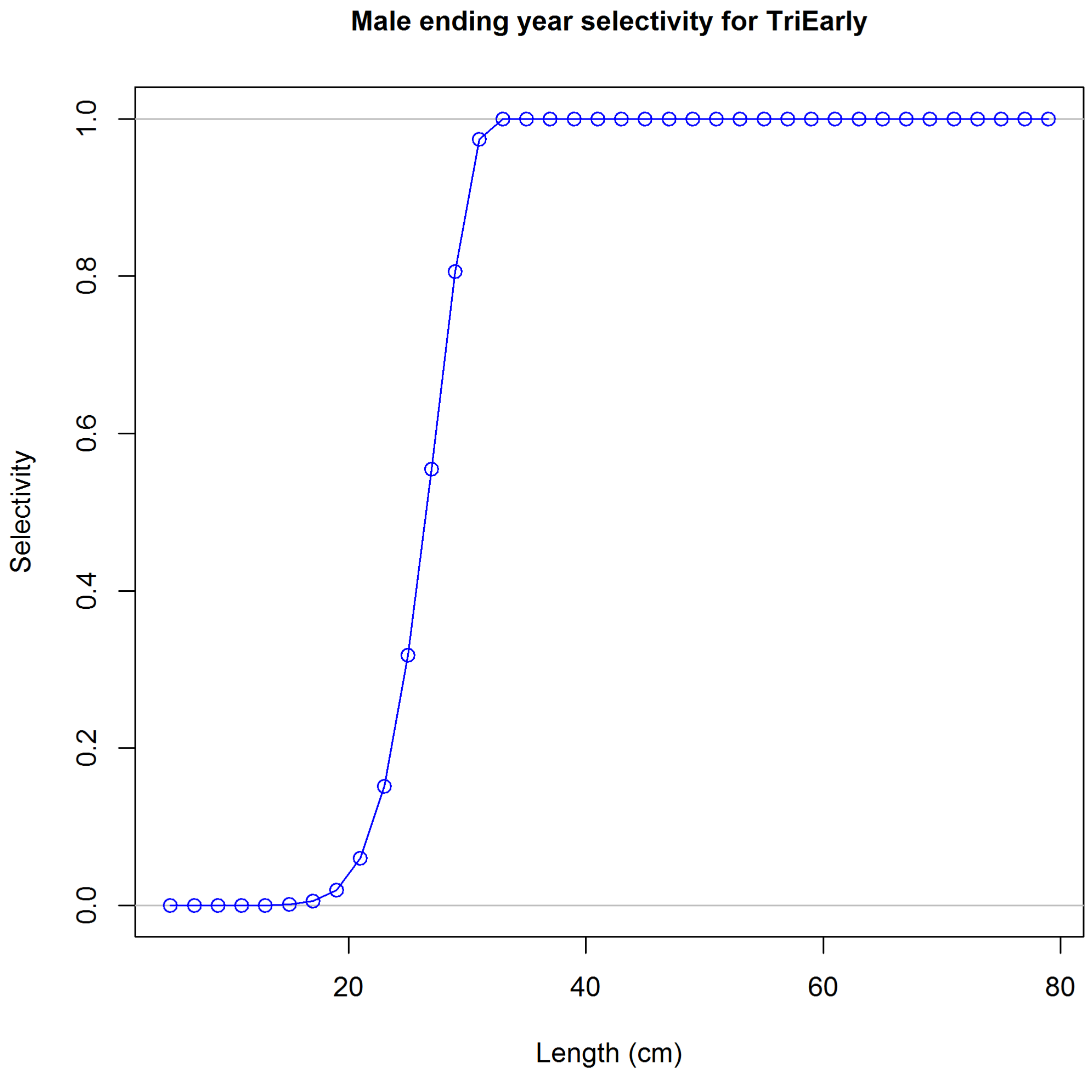


Figure 59. Estimated length-based selectivity curves for the early triennial survey, males.

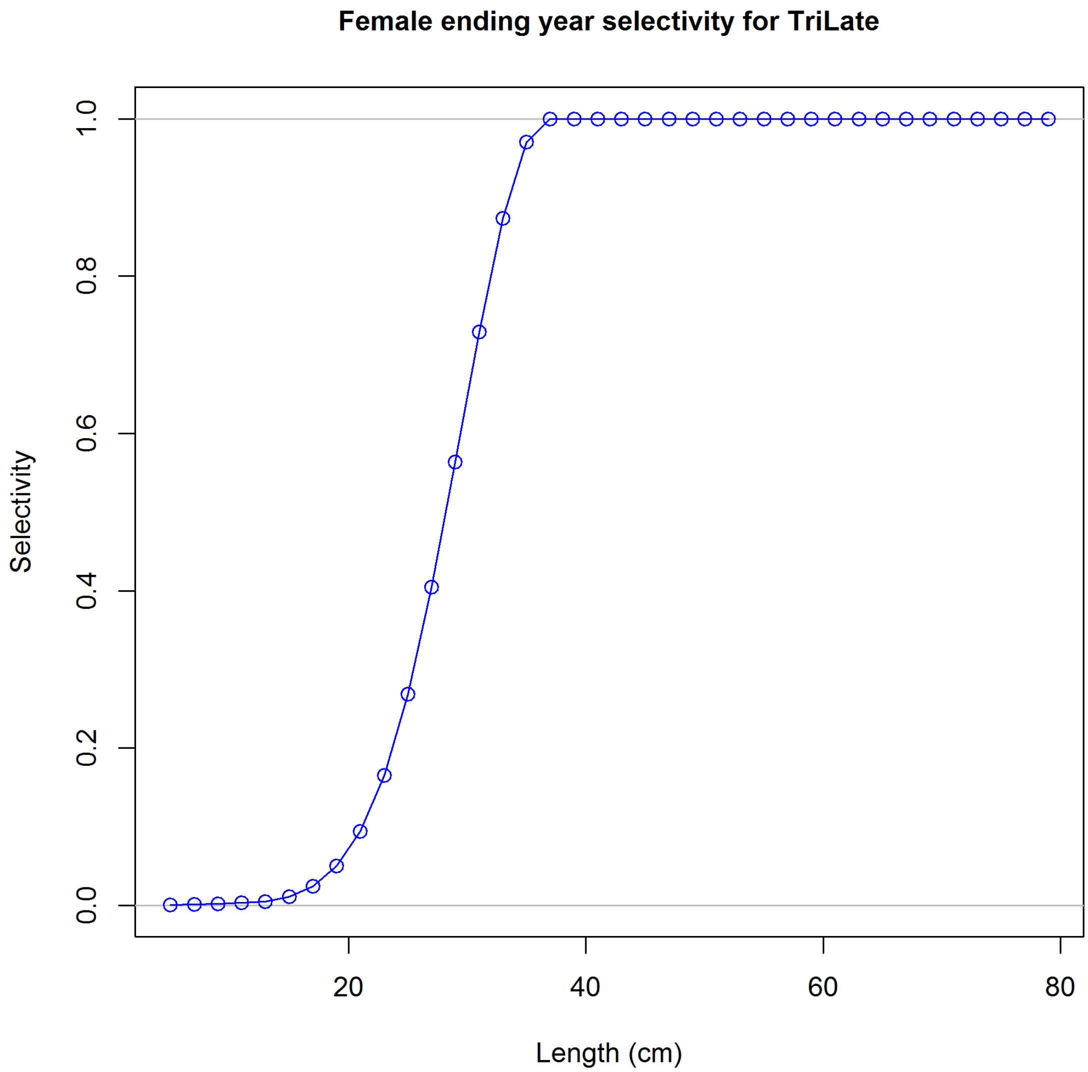


Figure 60. Estimated length-based selectivity curves for the late triennial survey, females.

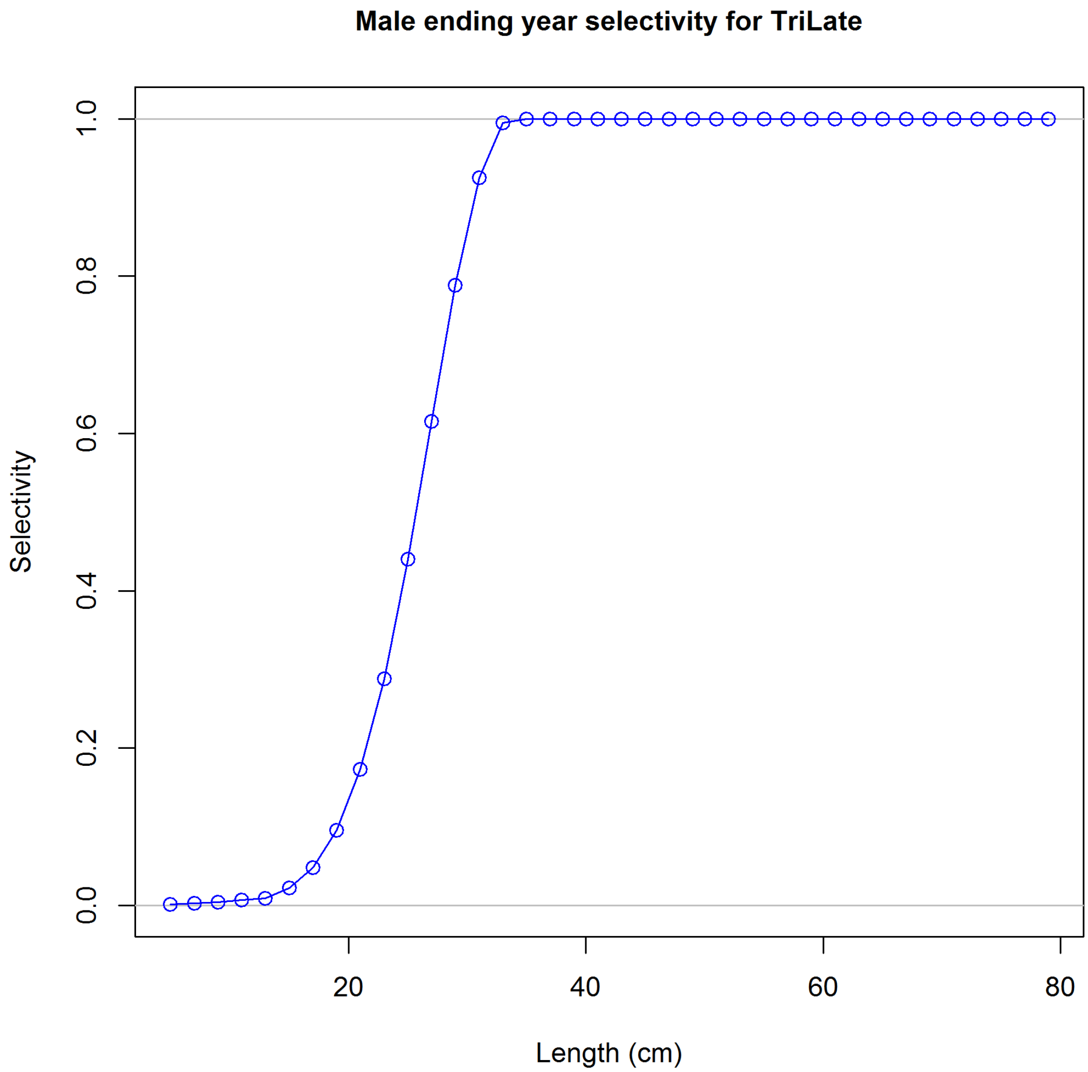


Figure 61. Estimated length-based selectivity curves for the late triennial survey, males.

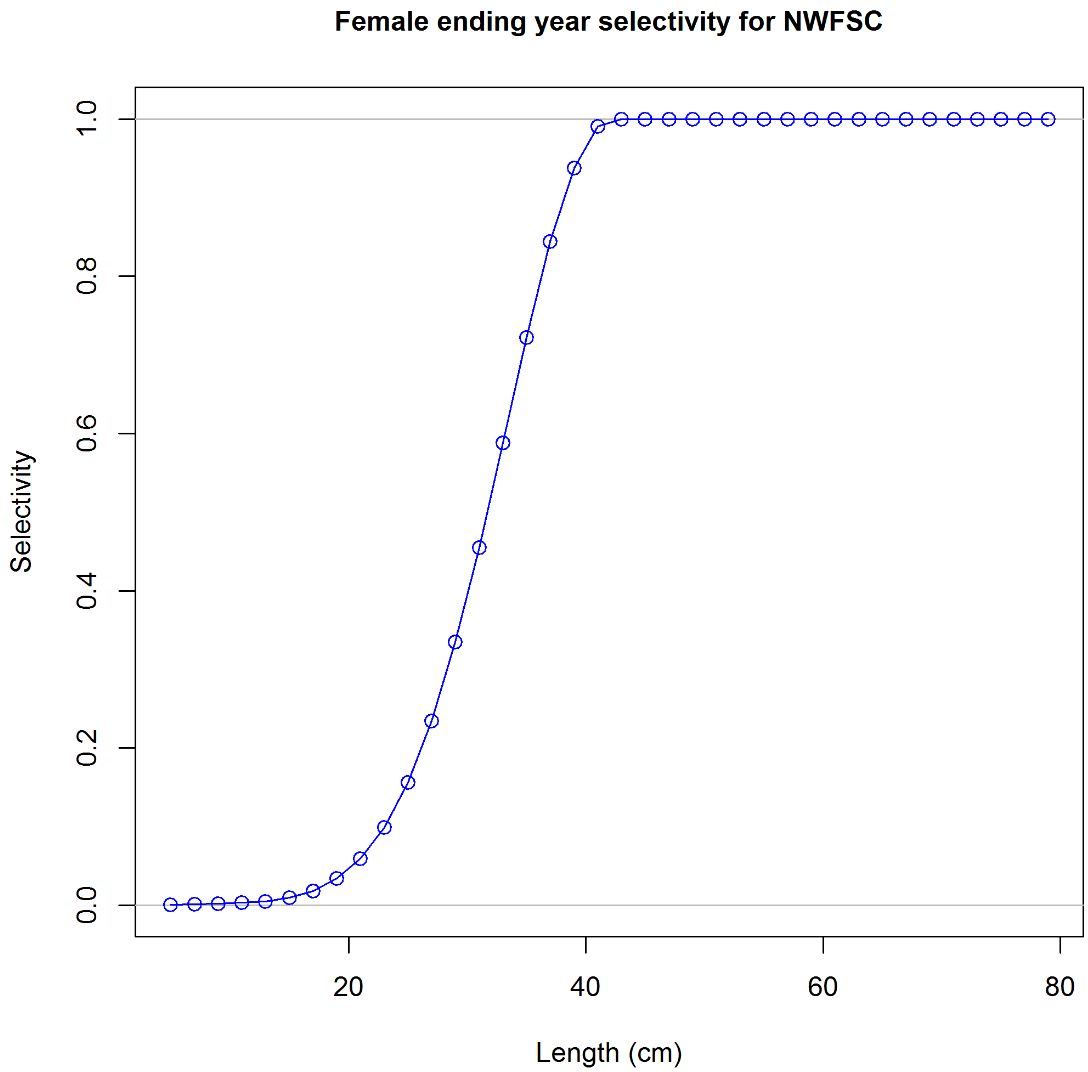


Figure 62. Estimated length-based selectivity curves for the NWFSC survey, females.

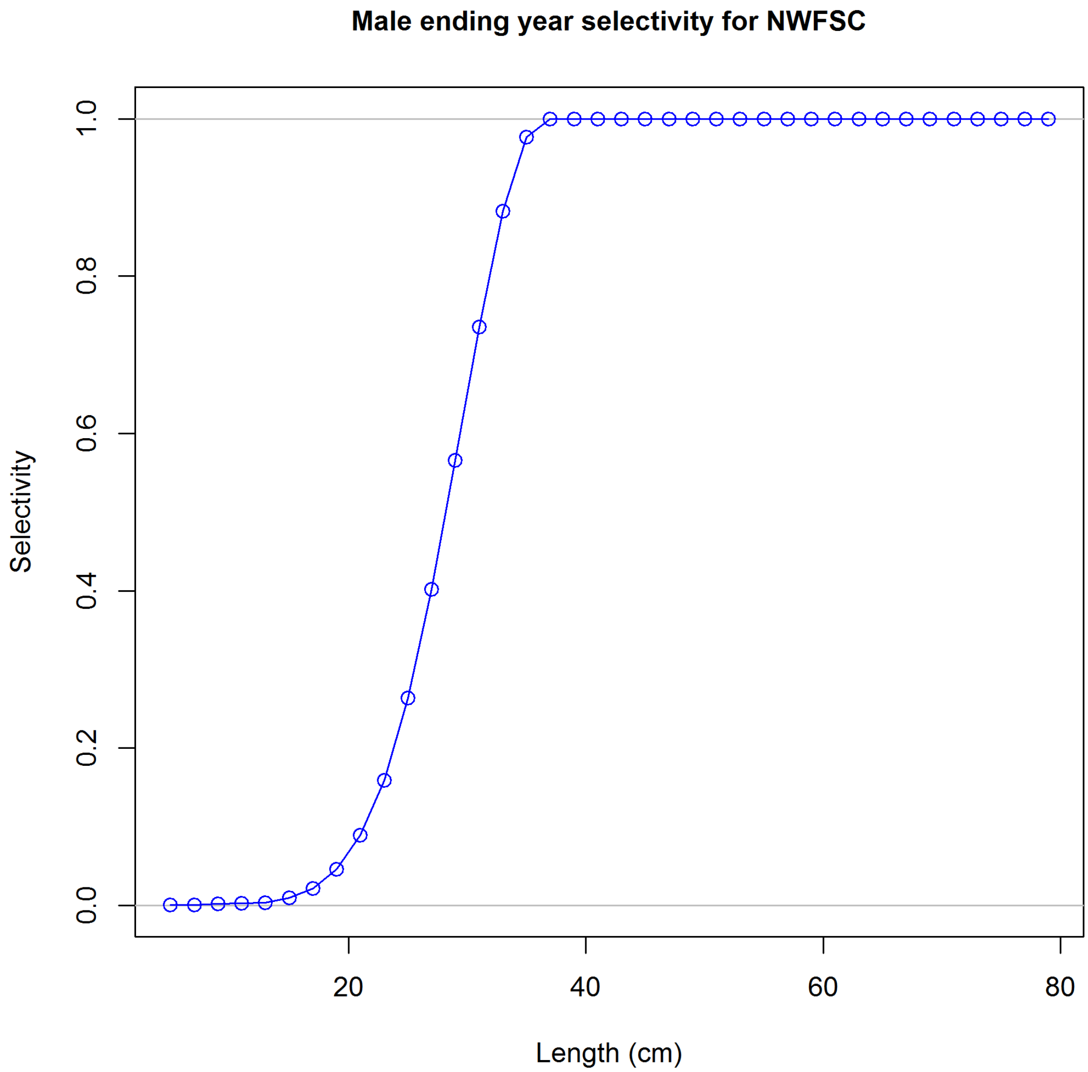


Figure 63. Estimated length-based selectivity curves for the NWFSC survey, males.

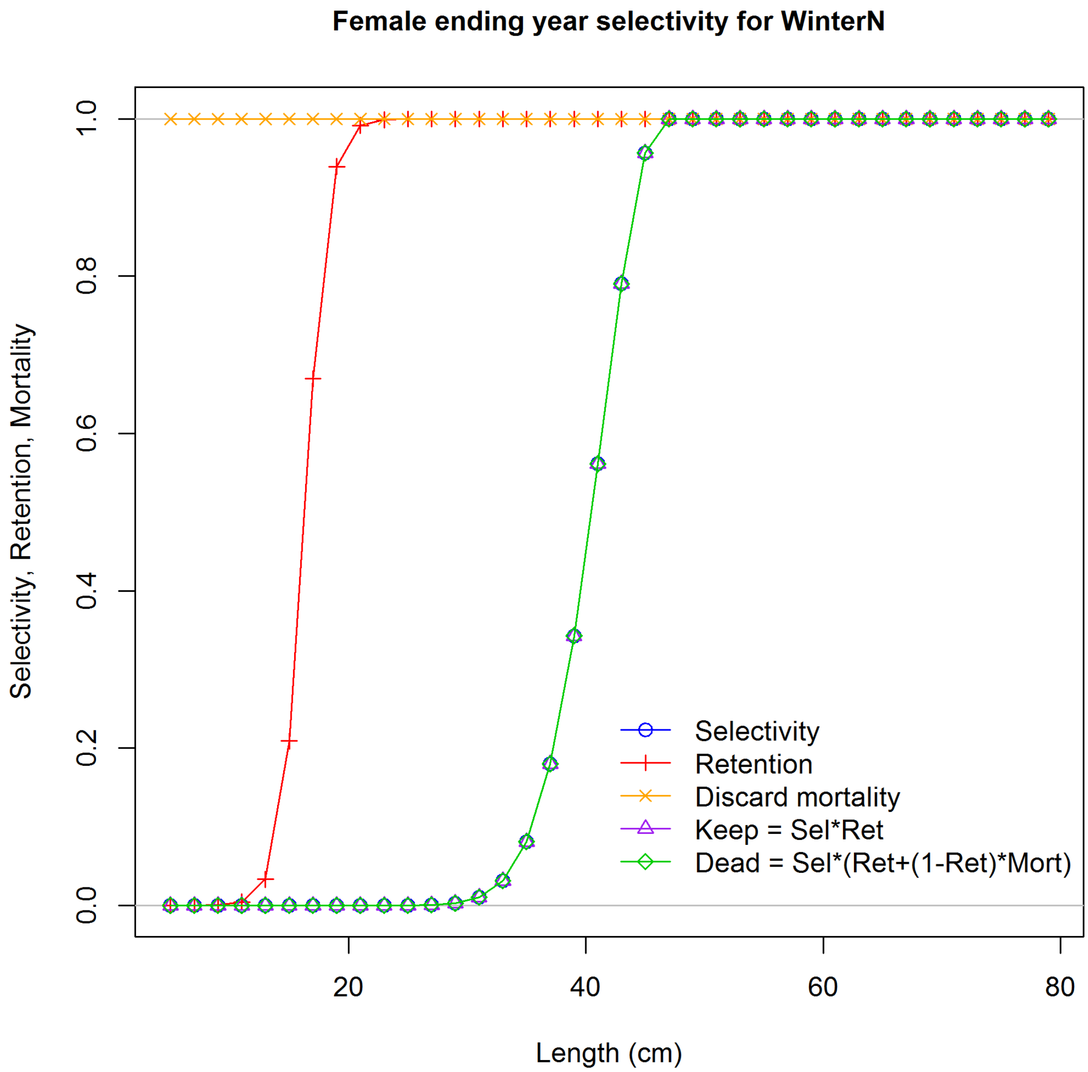


Figure 64. Estimated end year length-based selectivity curves for the winter north fleet, females.

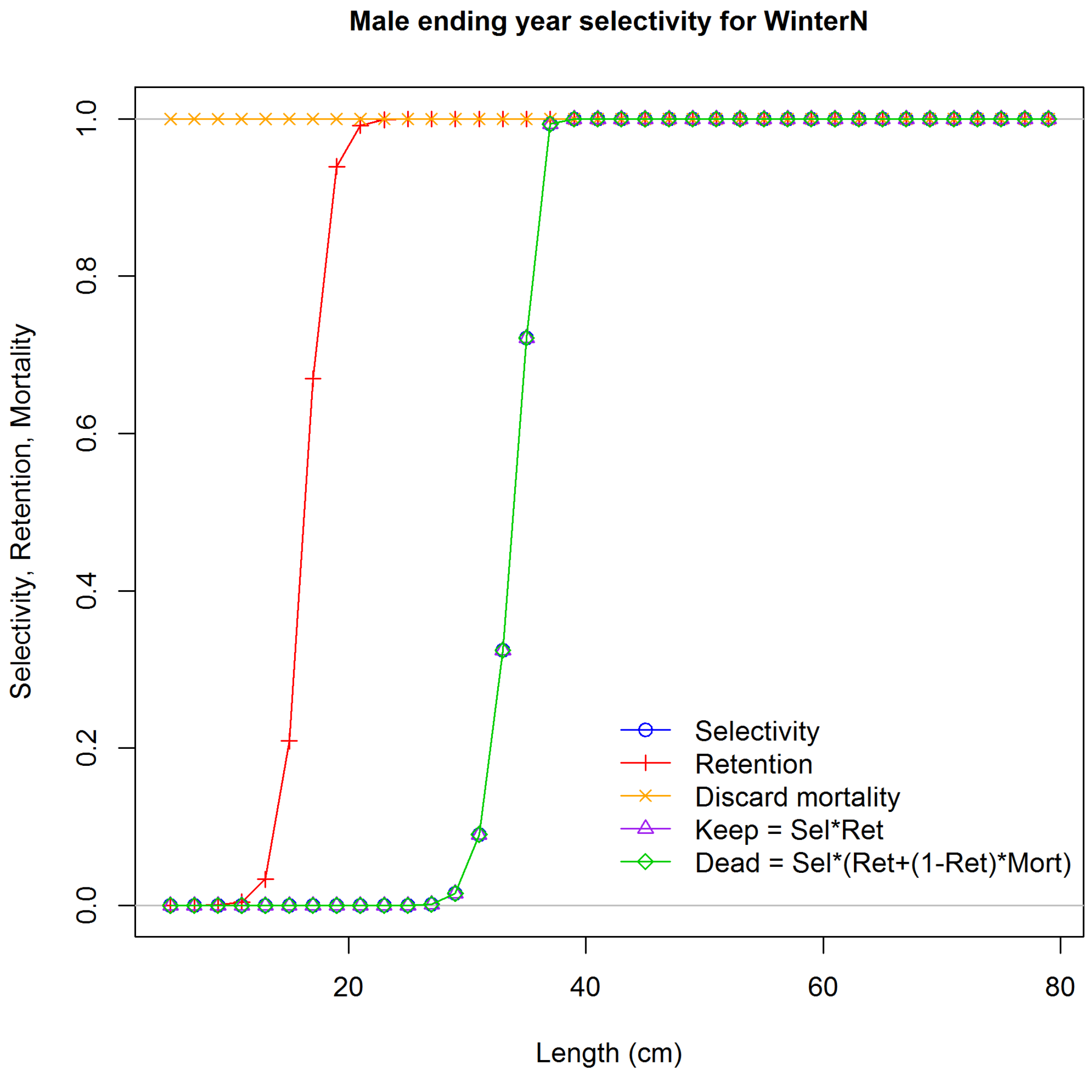


Figure 65. Estimated end year length-based selectivity curves for the winter north fleet, males.

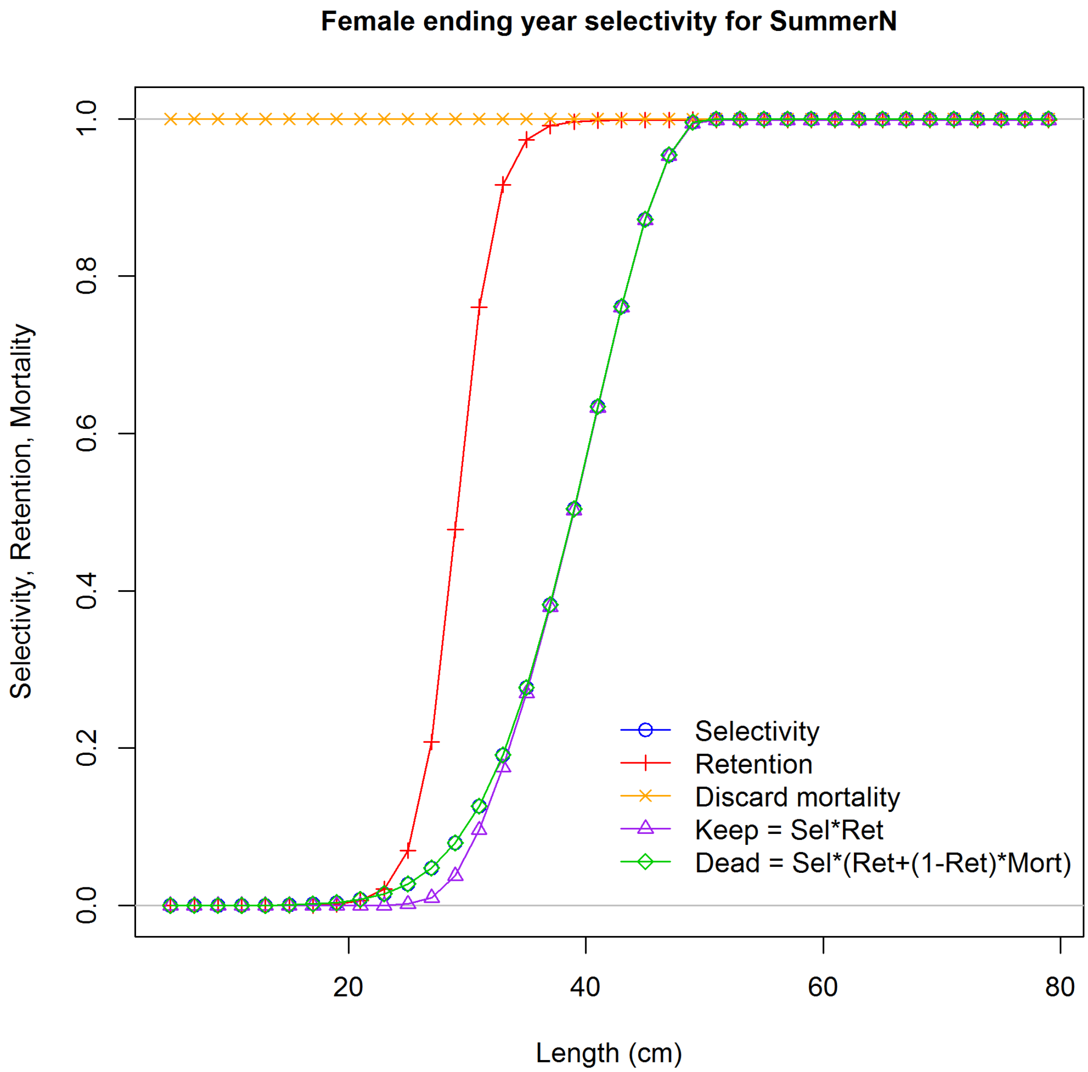


Figure 66. Estimated end year length-based selectivity curves for the summer north fleet, females.

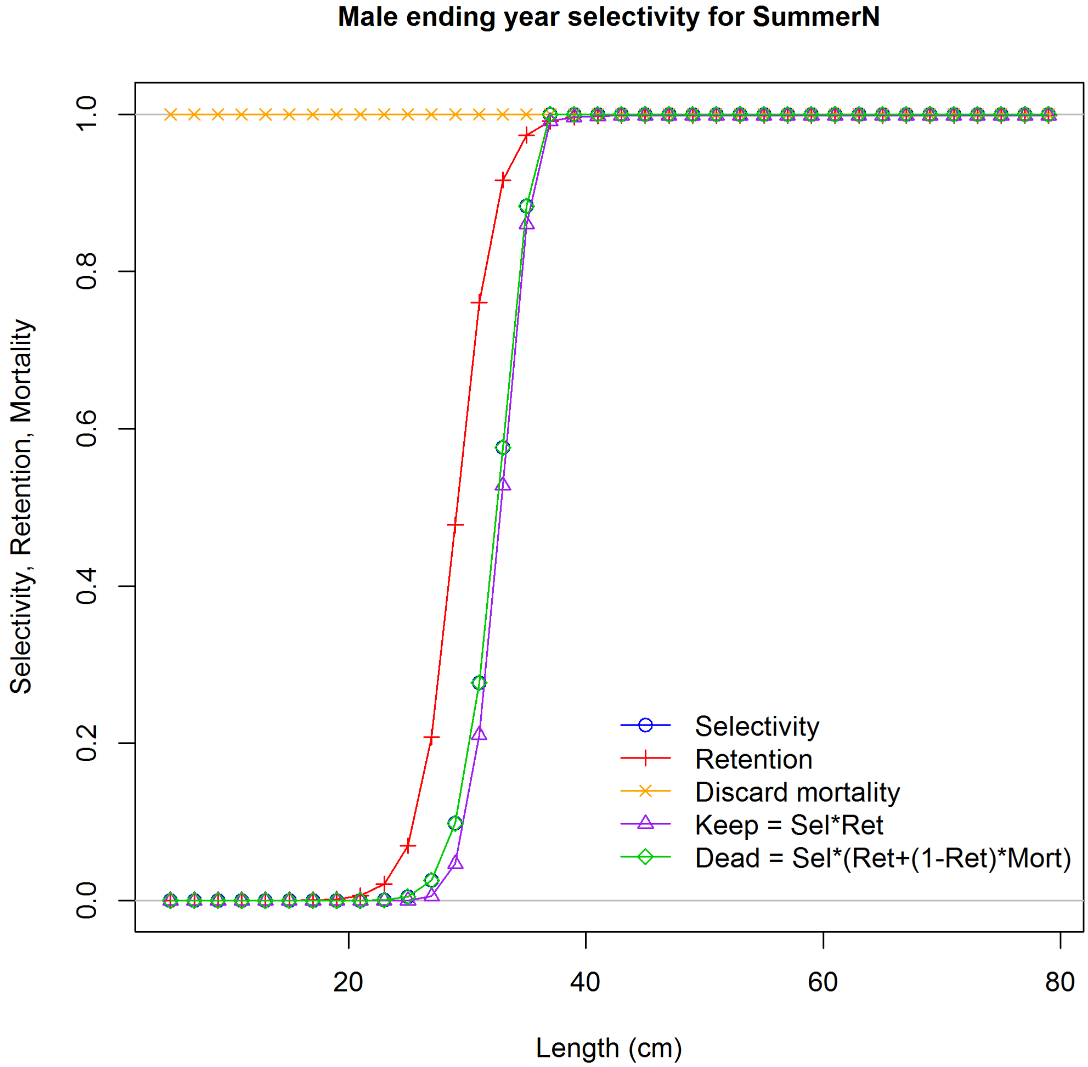


Figure 67. Estimated end year length-based selectivity curves for the summer north fleet, males.

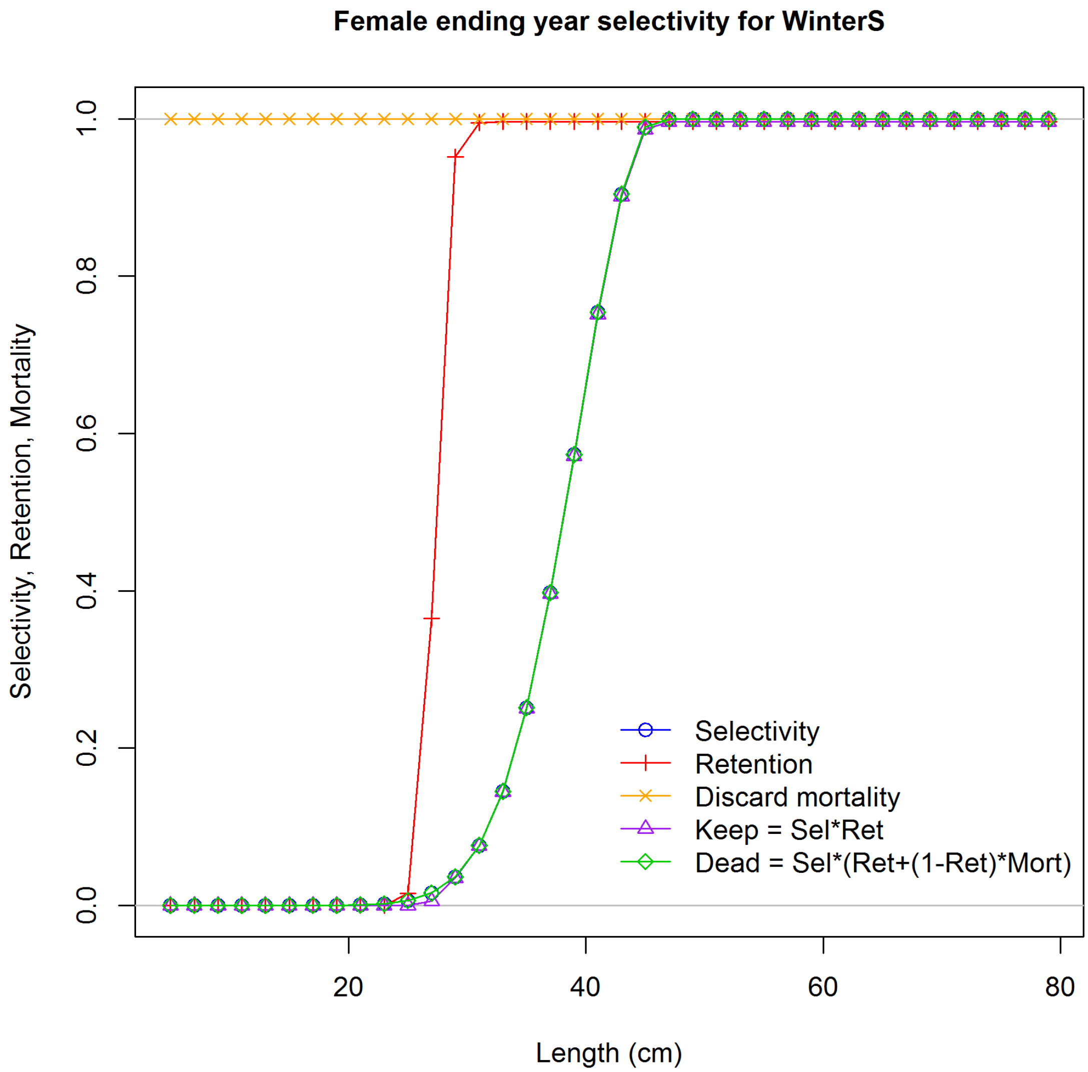


Figure 68. Estimated end year length-based selectivity curves for the winter south fleet, females.

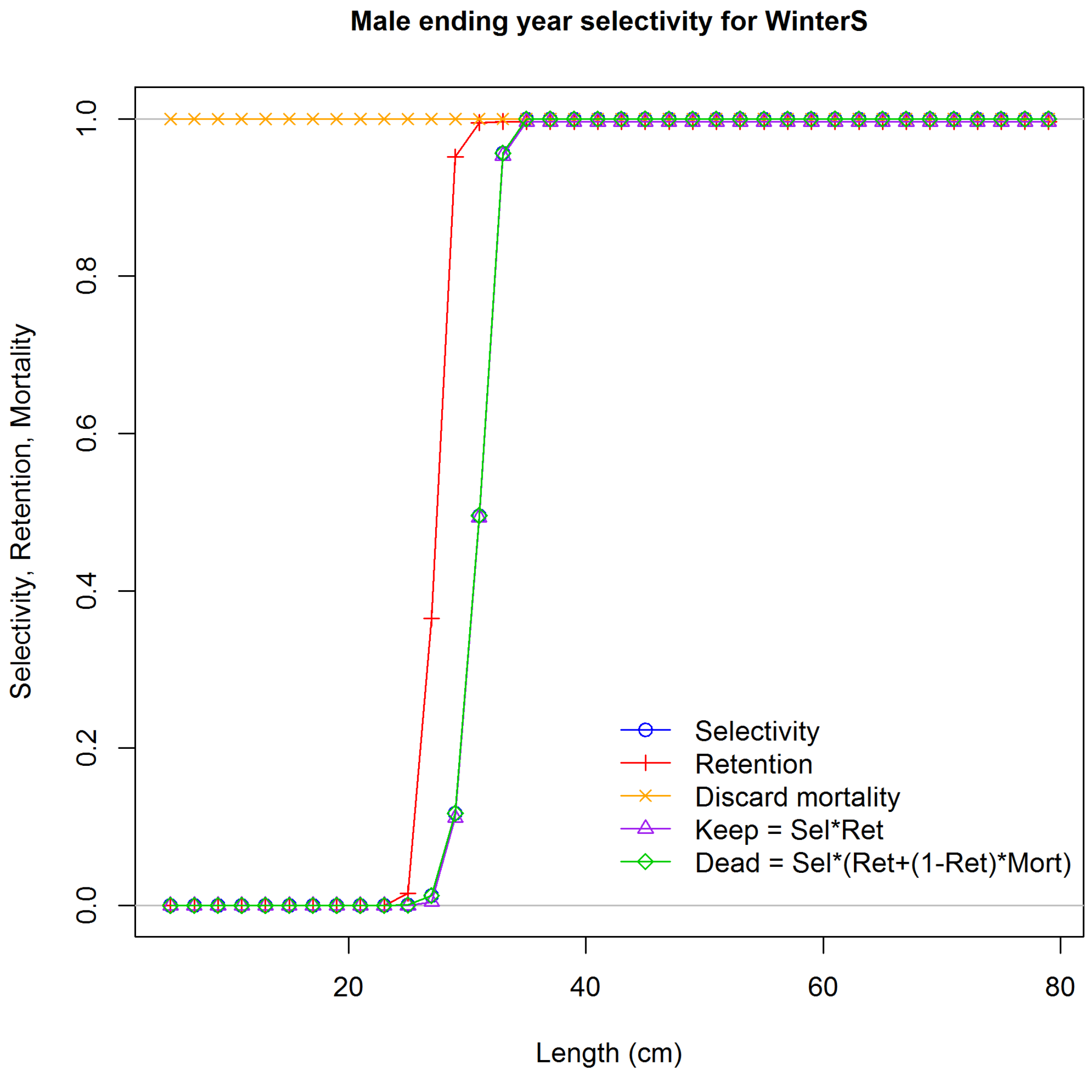


Figure 69. Estimated end year length-based selectivity curves for the winter south fleet, males.

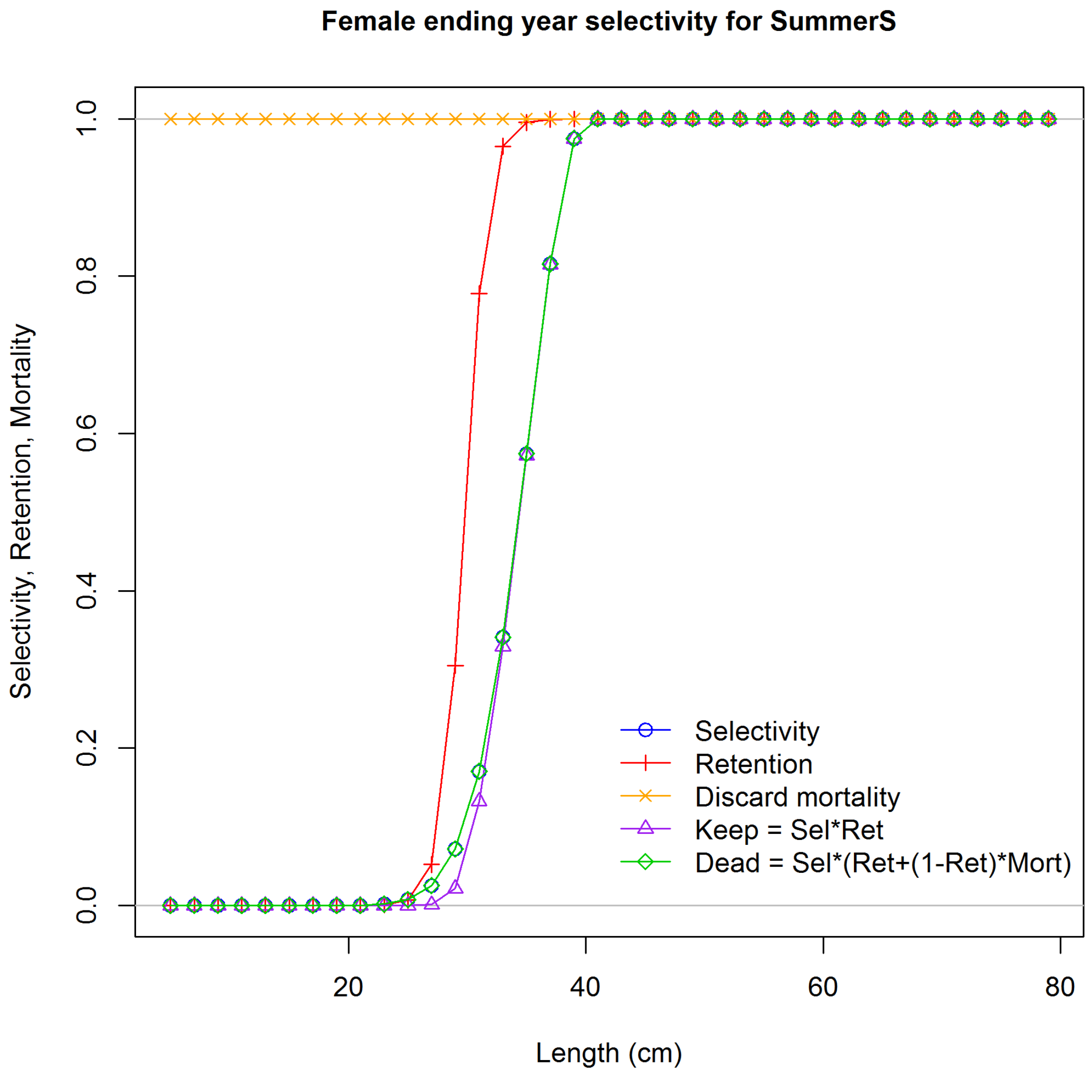


Figure 70. Estimated end year length-based selectivity curves for the summer south fleet, females.

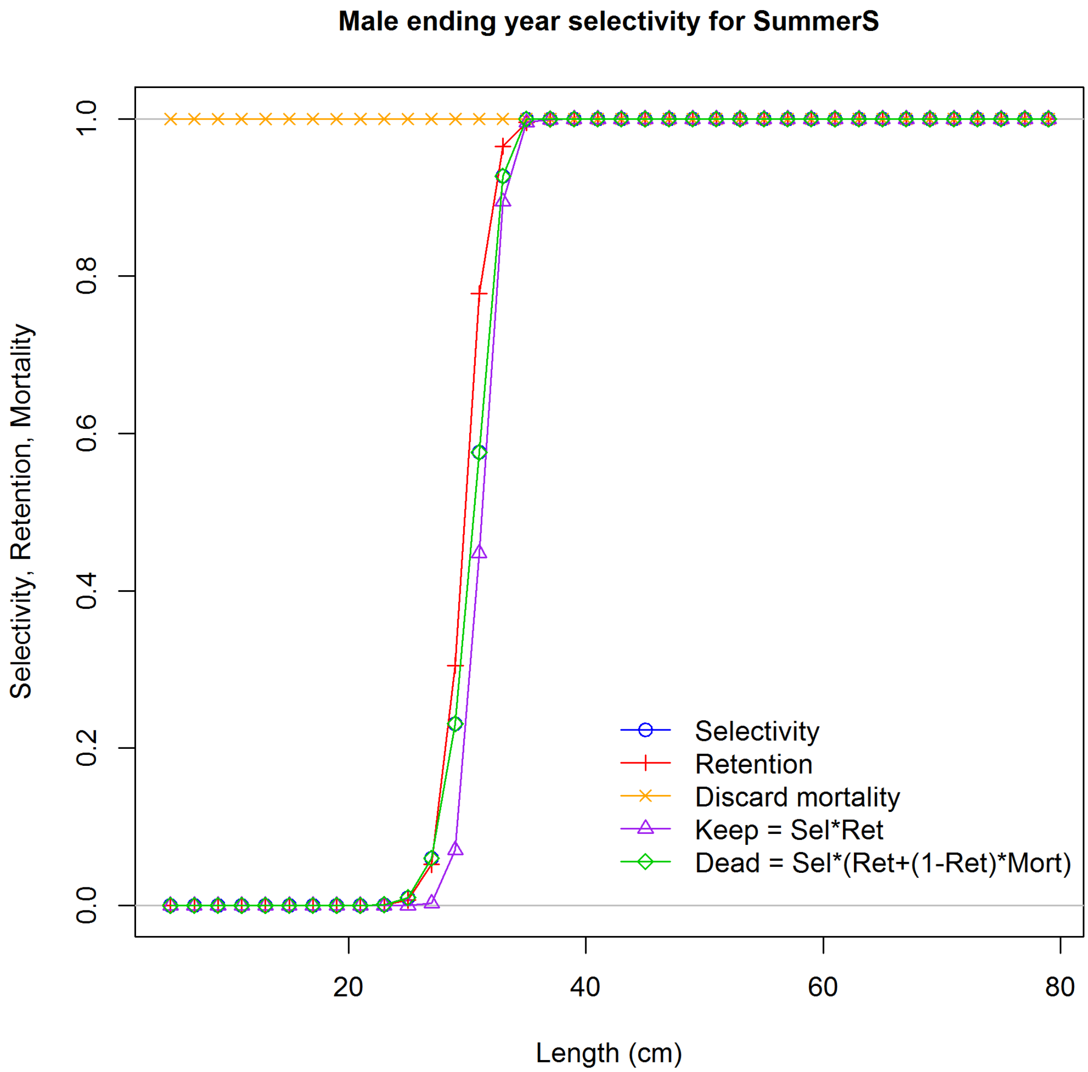


Figure 71. Estimated end year length-based selectivity curves for the summer south fleet, males.

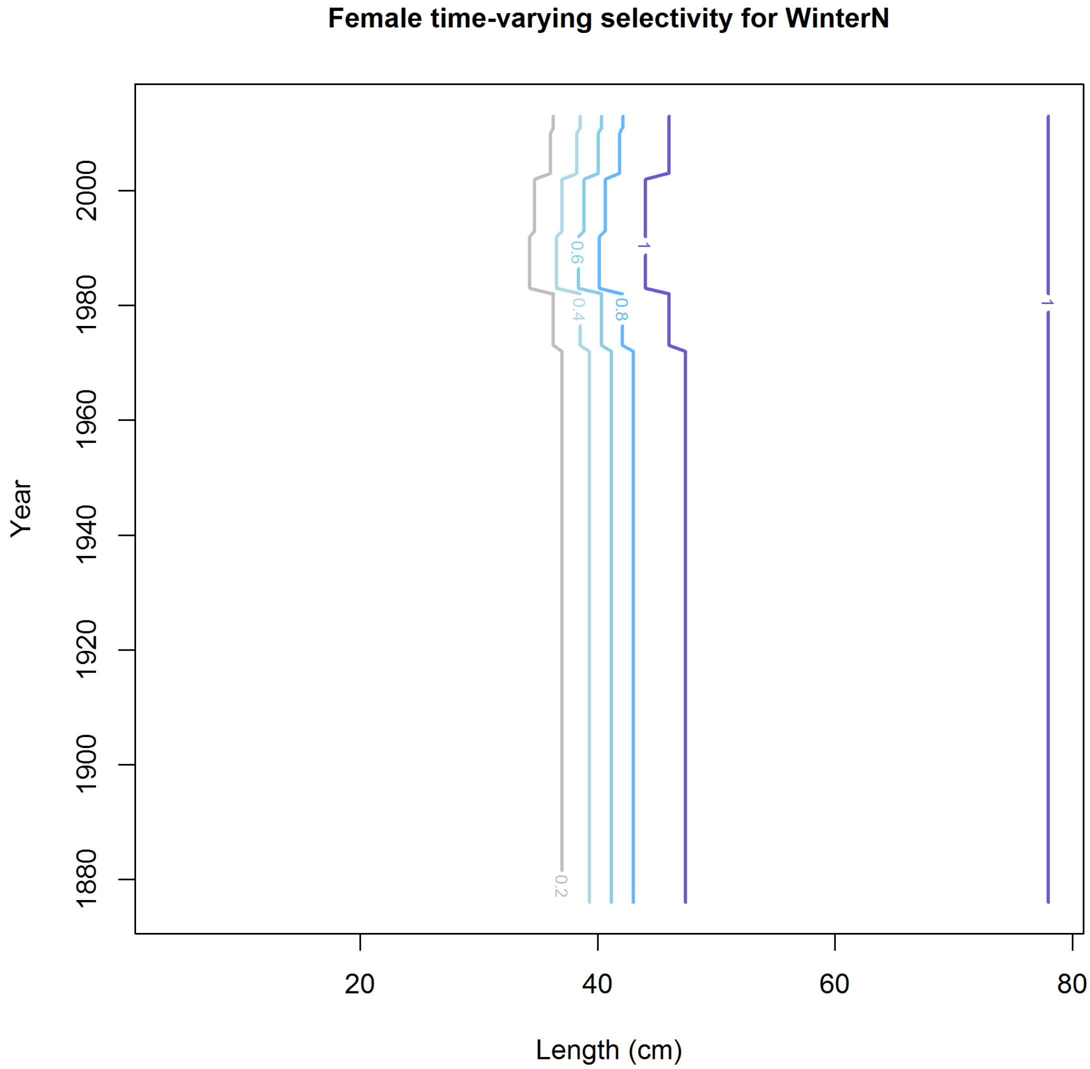


Figure 72. Estimated time varying length-based selectivity curves for the winter north fleet, females.

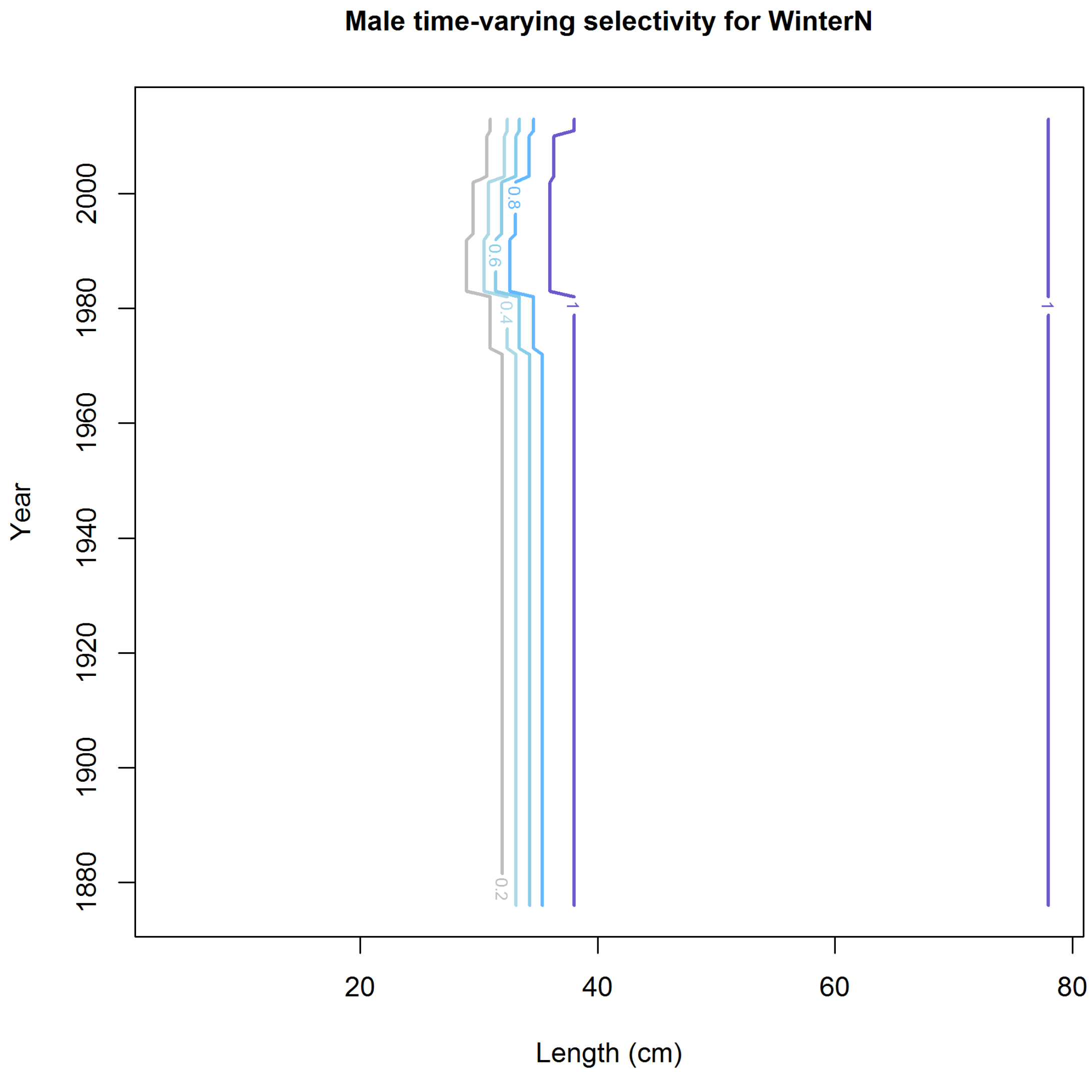


Figure 73.Estimated time varying length-based selectivity curves for the winter north fleet, males.

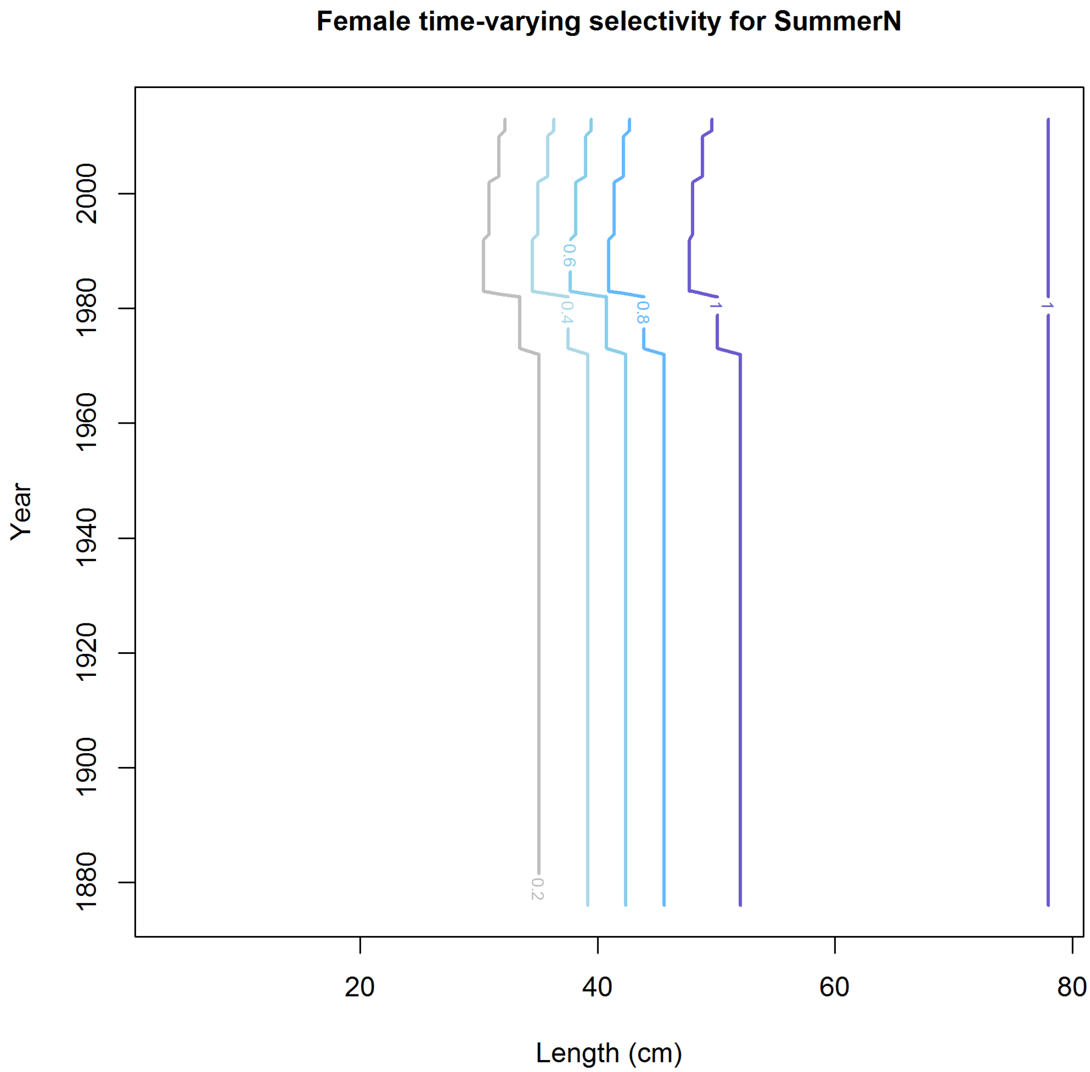


Figure 74. Estimated time varying length-based selectivity curves for the summer north fleet, females.

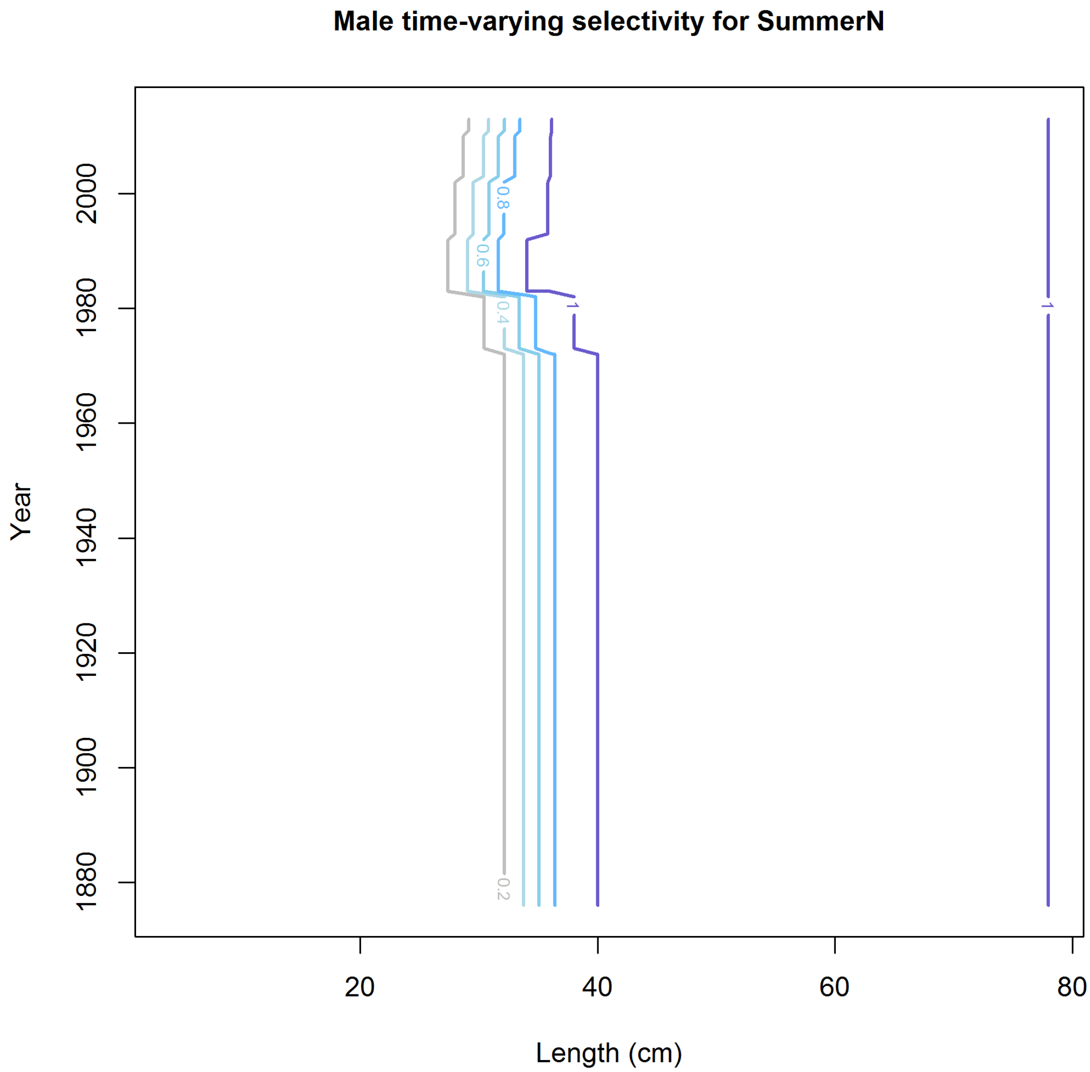


Figure 75. Estimated time varying length-based selectivity curves for the summer north fleet, males.

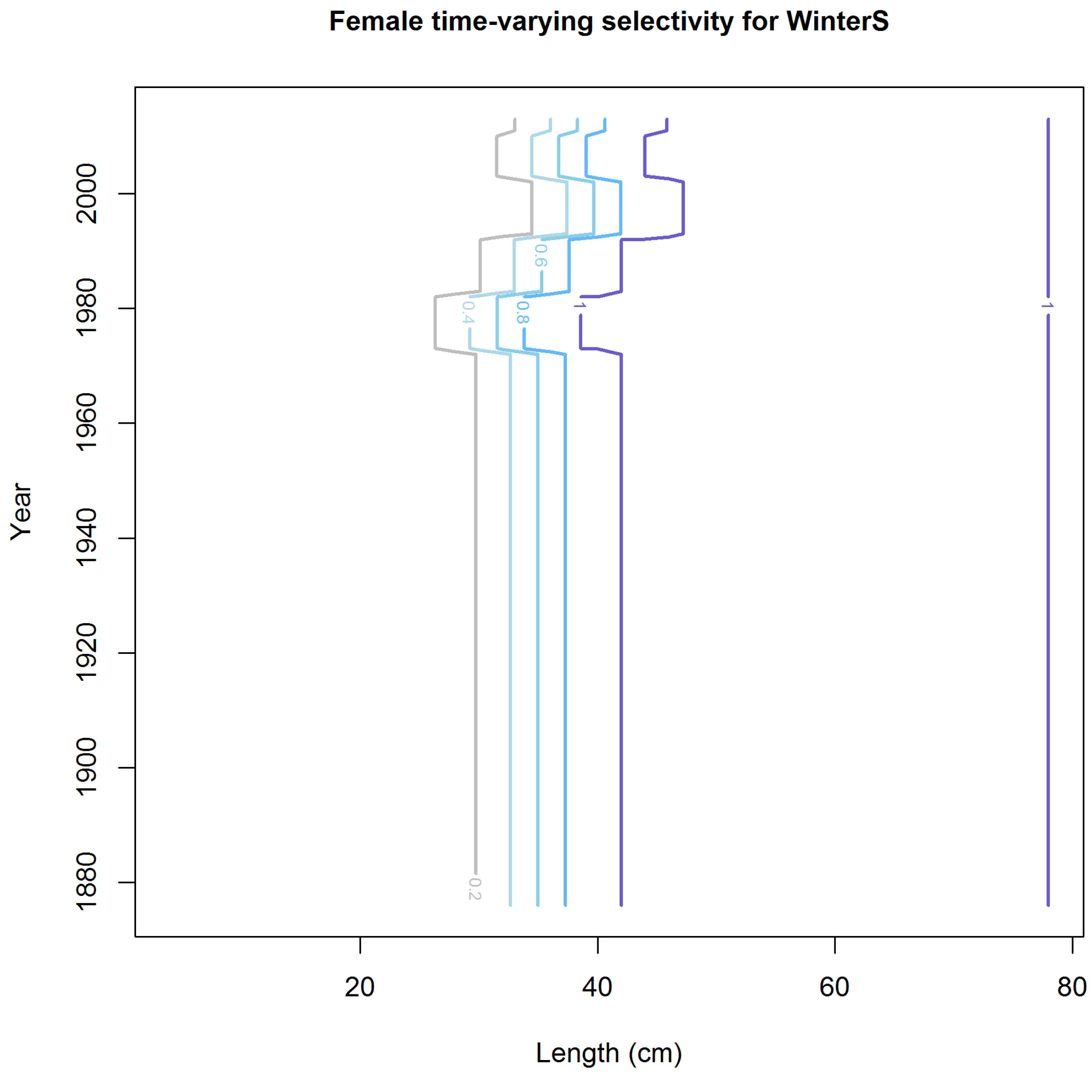


Figure 76. Estimated time varying length-based selectivity curves for the winter south fleet, females.

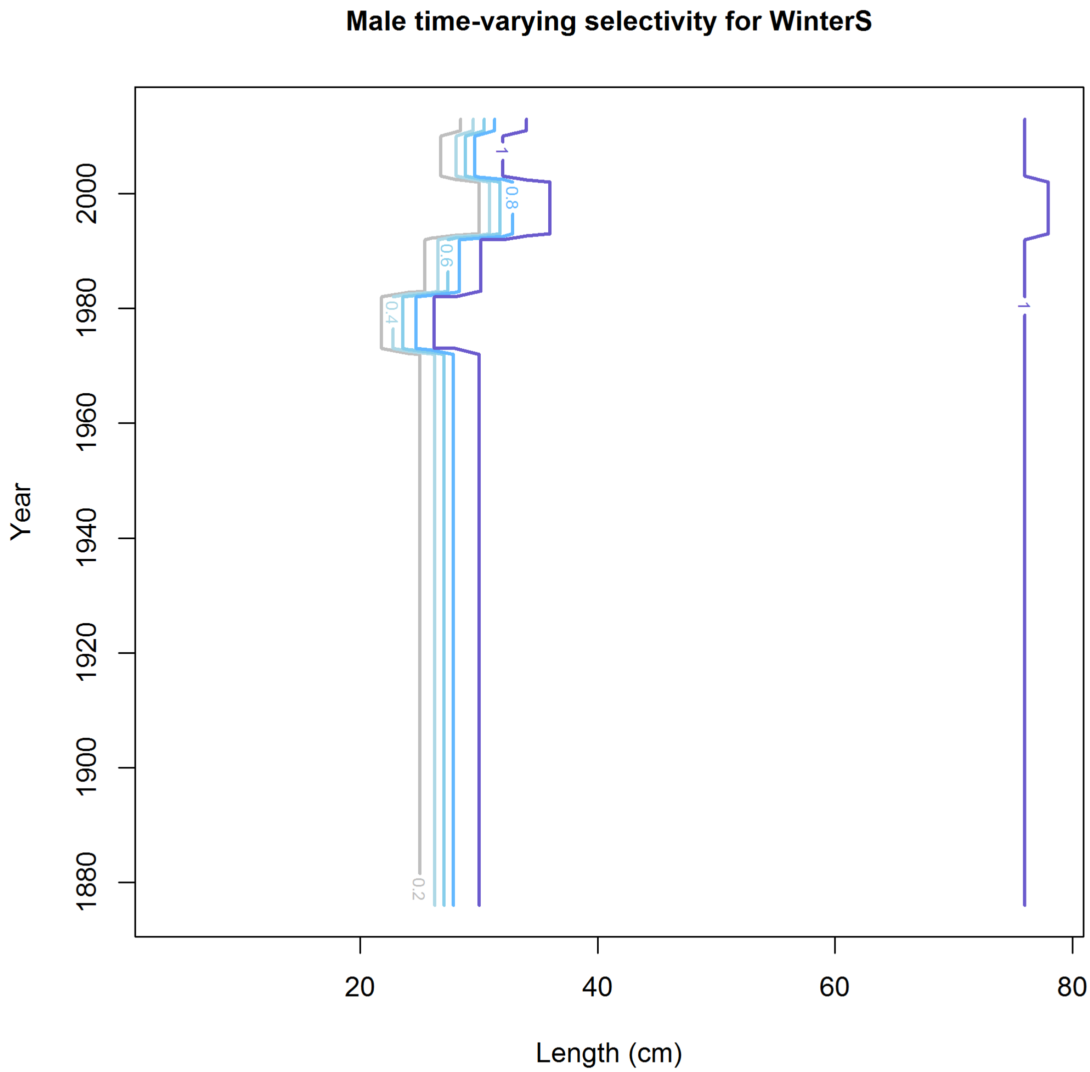


Figure 77.Estimated time varying length-based selectivity curves for the winter south fleet, males.

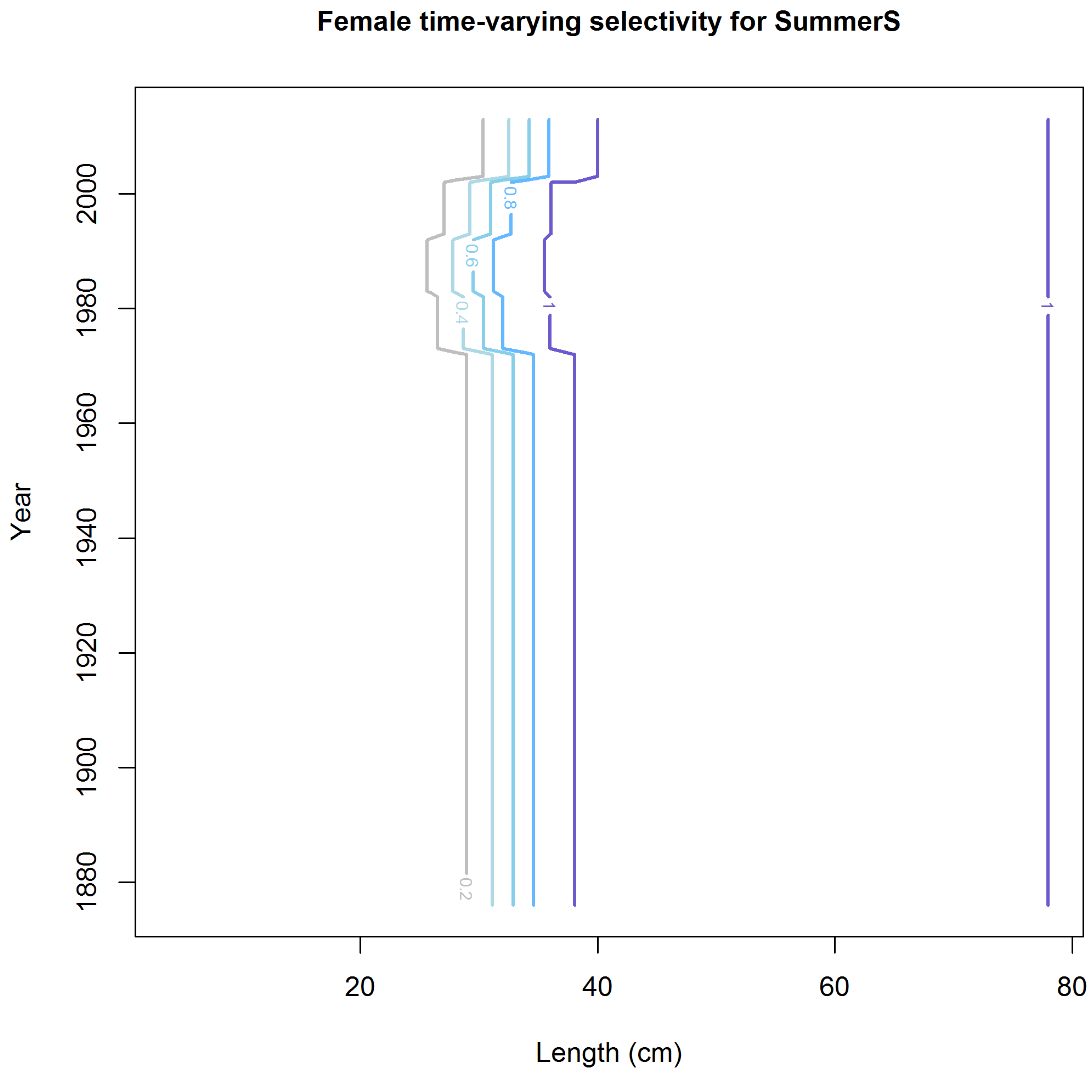


Figure 78. Estimated time varying length-based selectivity curves for the summer south fleet, females.

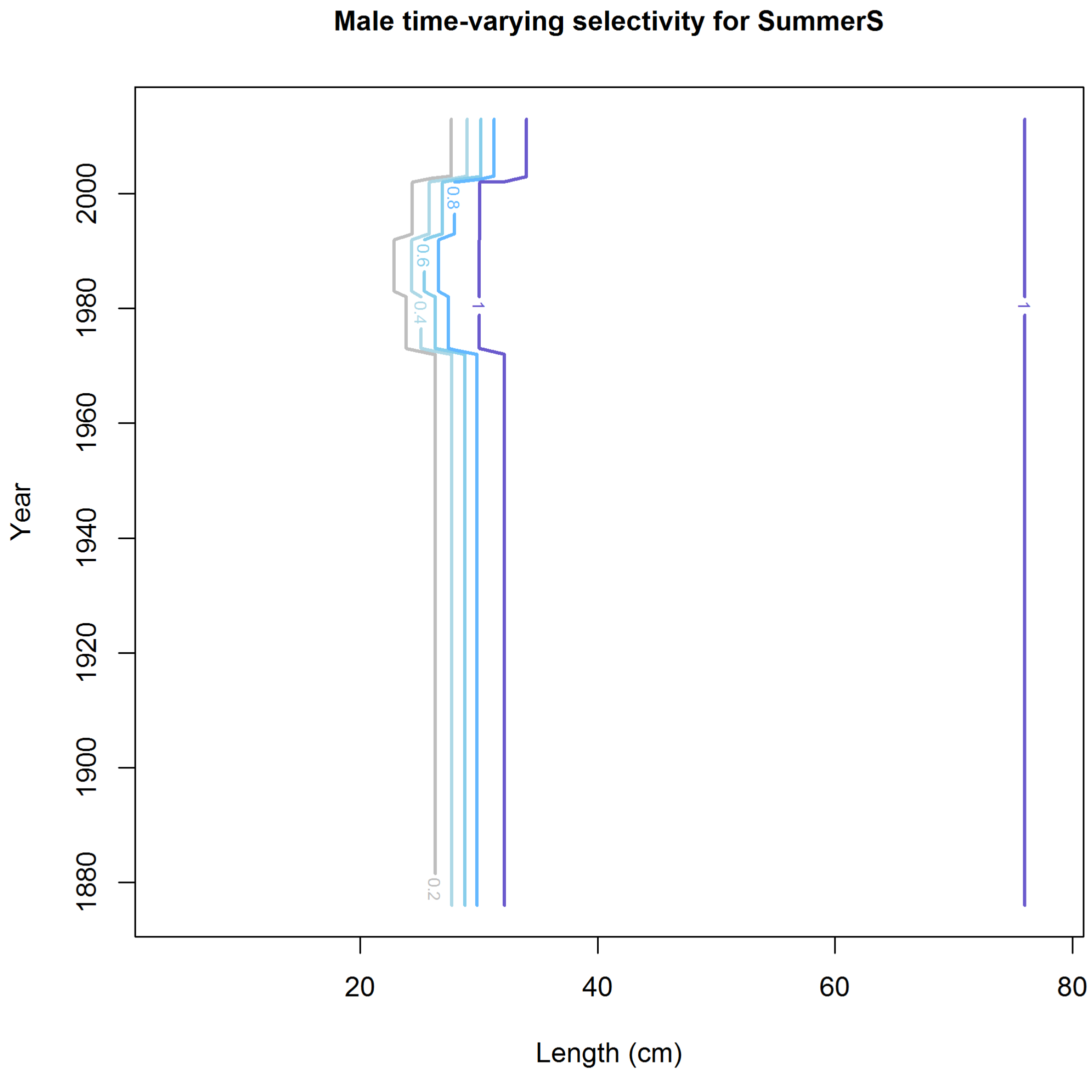


Figure 79. Estimated time varying length-based selectivity curves for the summer south fleet, males.

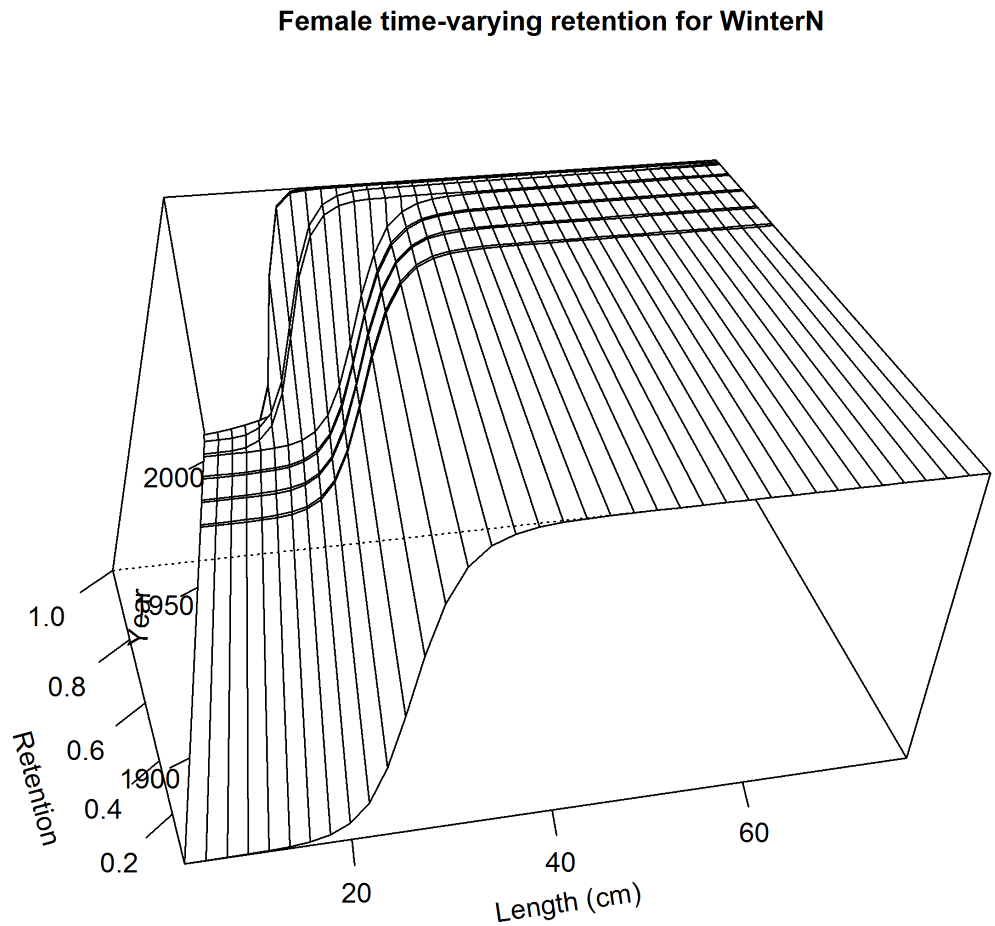


Figure 80. Estimated time varying length-based retention curves for the winter north fleet, females.

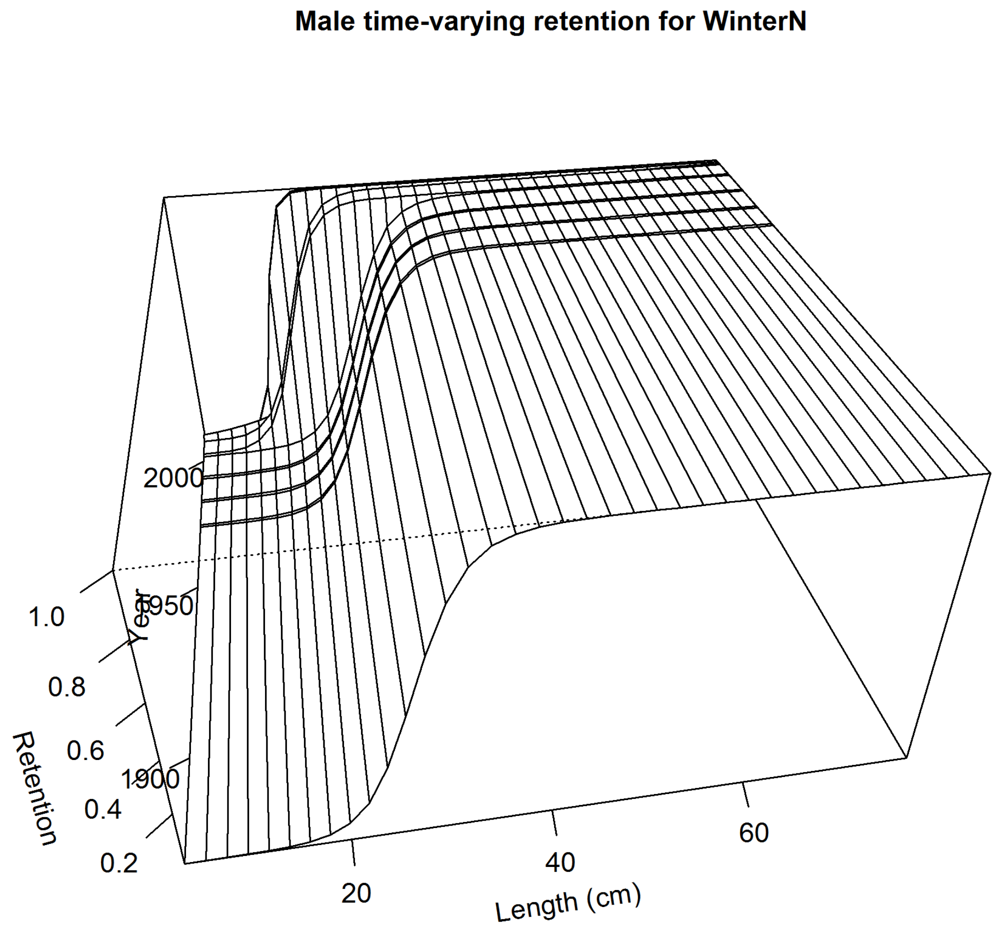


Figure 81.Estimated time varying length-based retention curves for the winter north fleet, males.

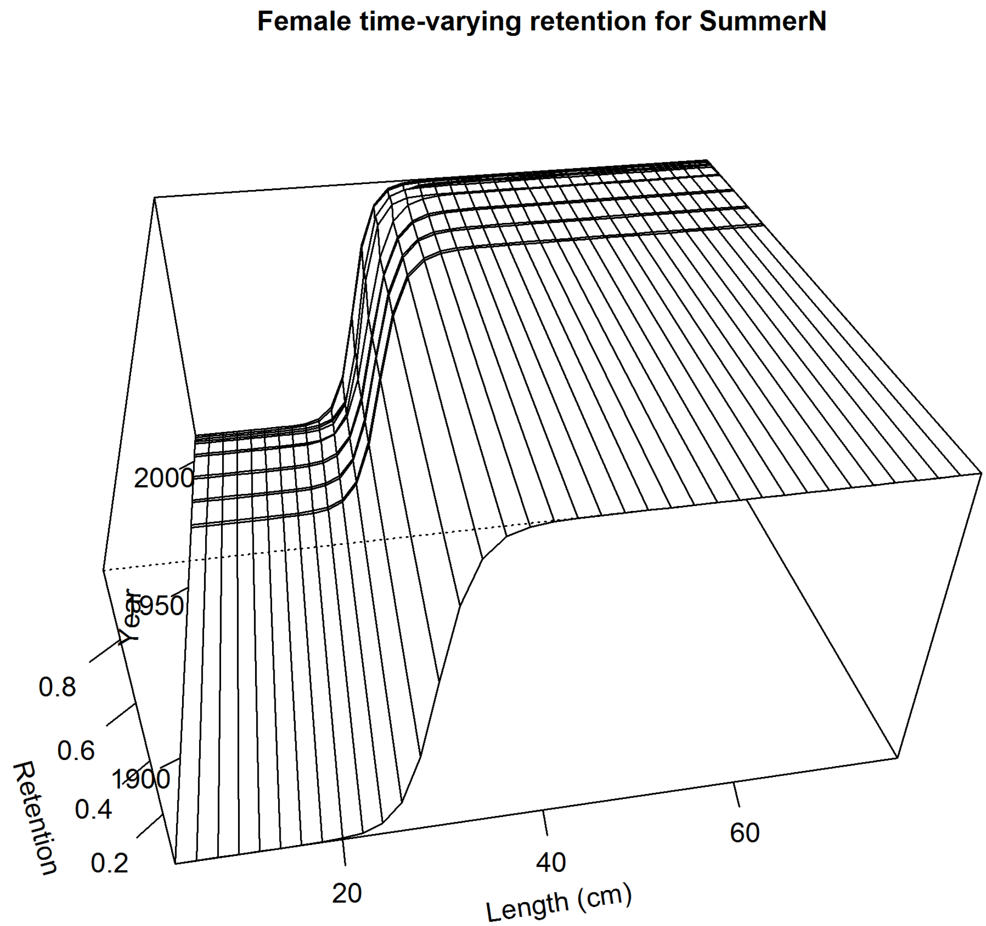


Figure 82. Estimated time varying length-based retention curves for the summer north fleet, females.

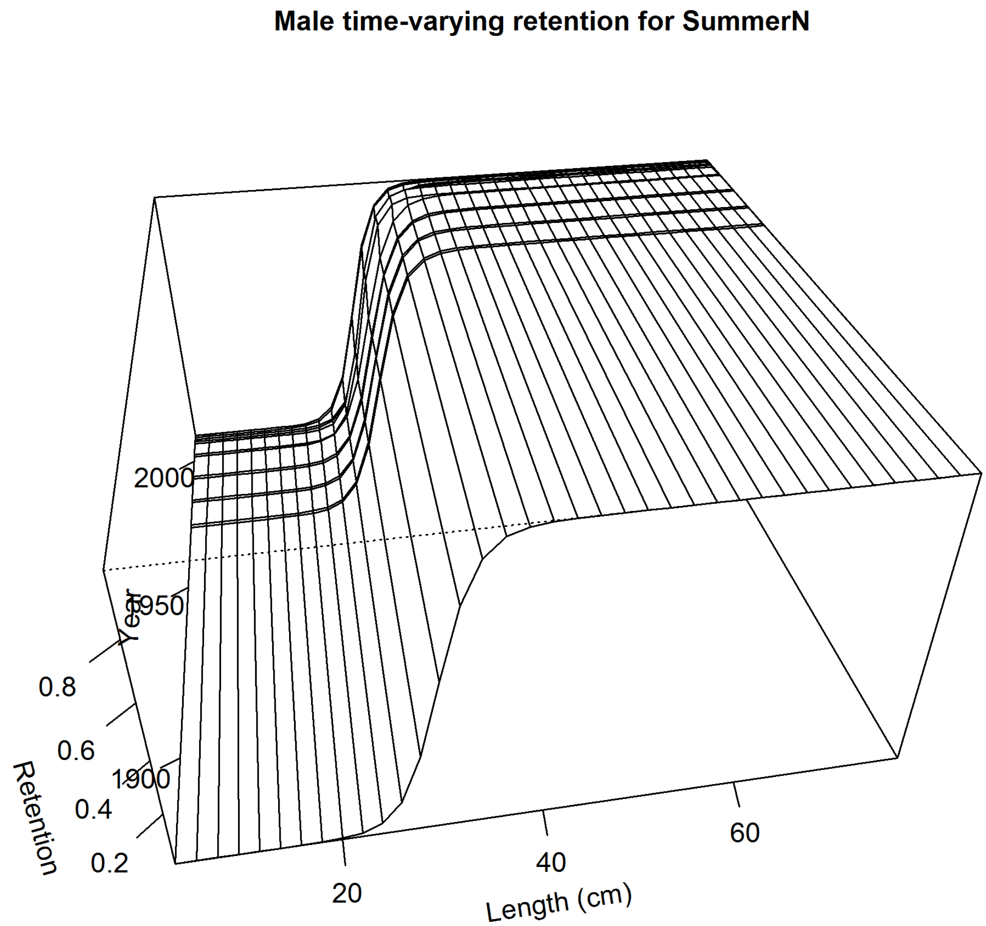


Figure 83. Estimated time varying length-based retention curves for the summer north fleet, males.

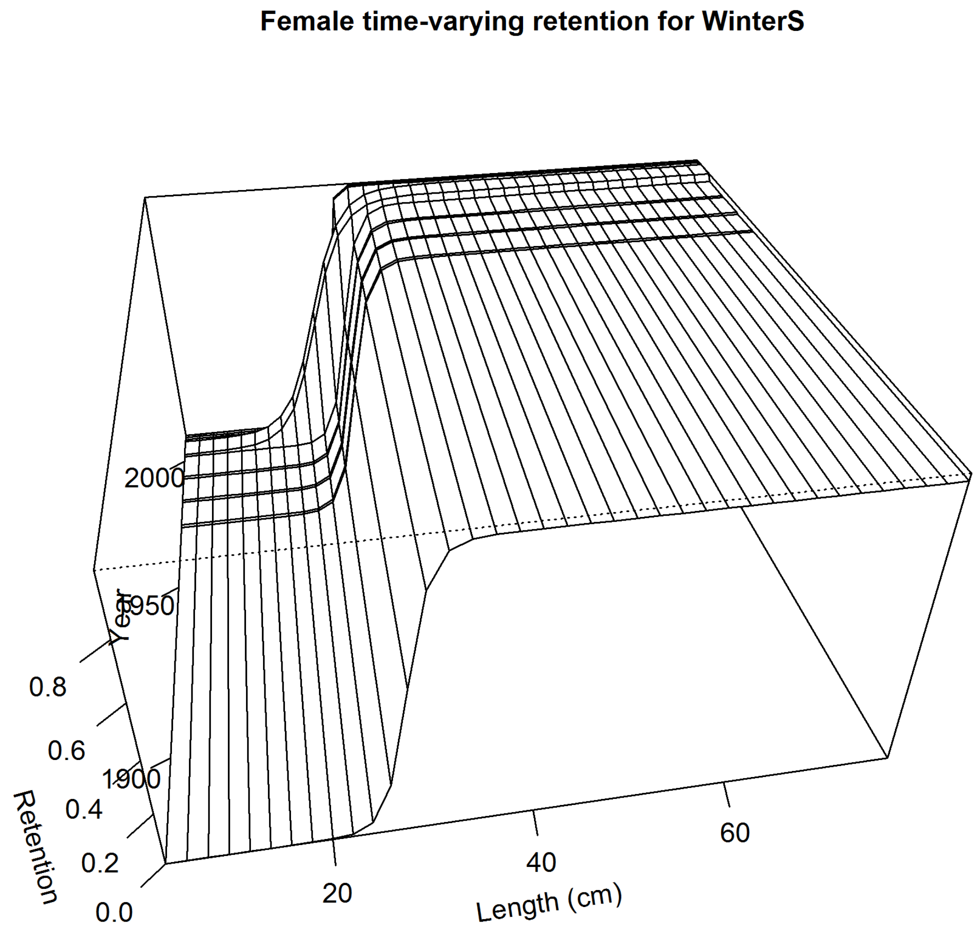


Figure 84. Estimated time varying length-based retention curves for the winter south fleet, females.

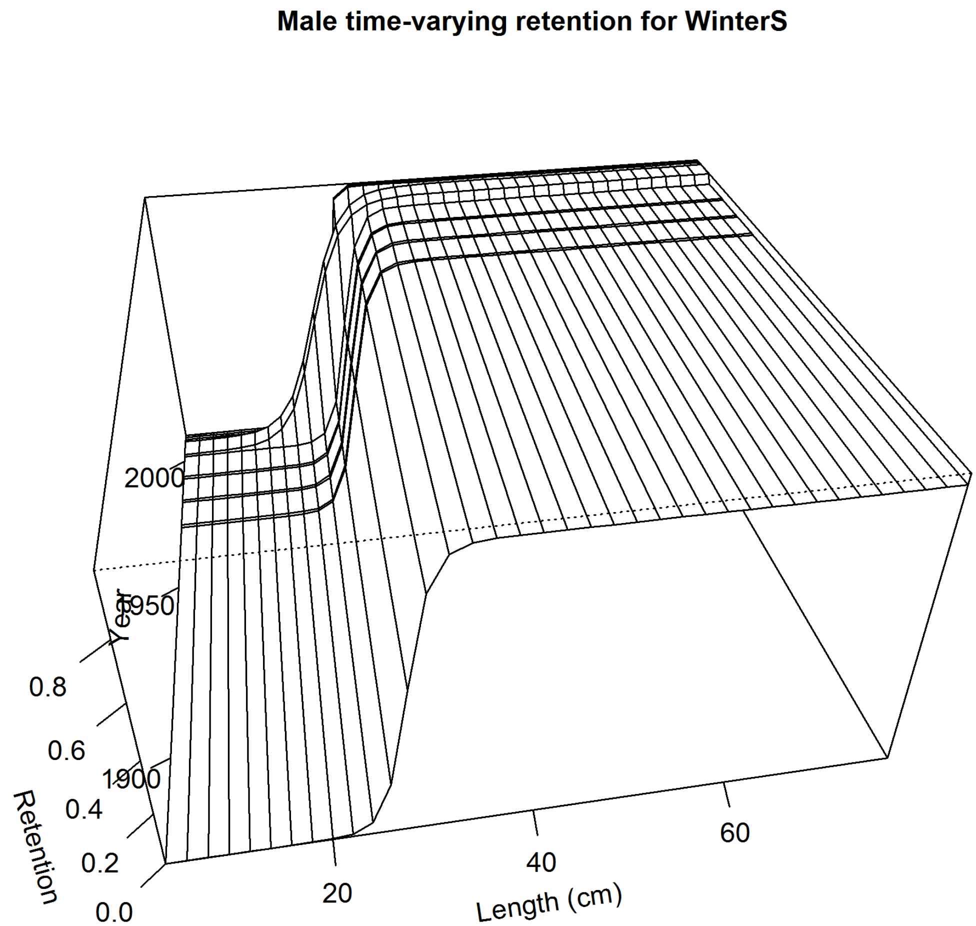


Figure 85.Estimated time varying length-based retention curves for the winter south fleet, males.

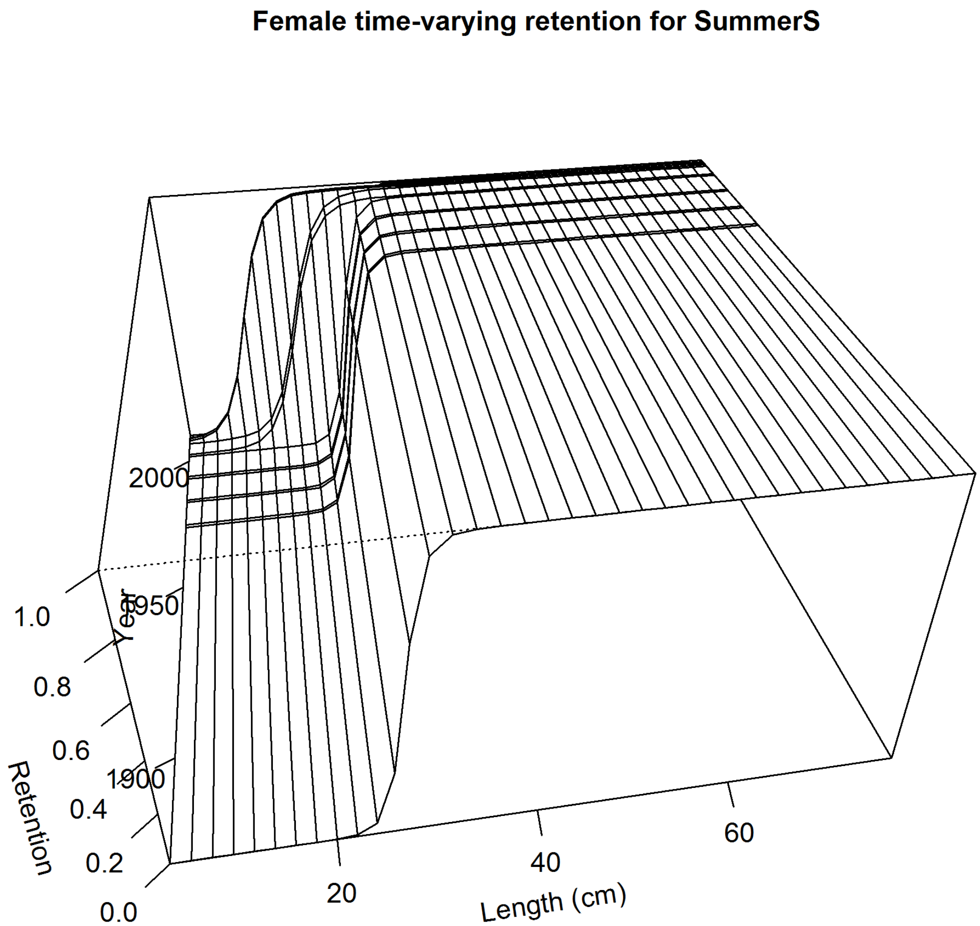


Figure 86. Estimated time varying length-based retention curves for the summer south fleet, females.

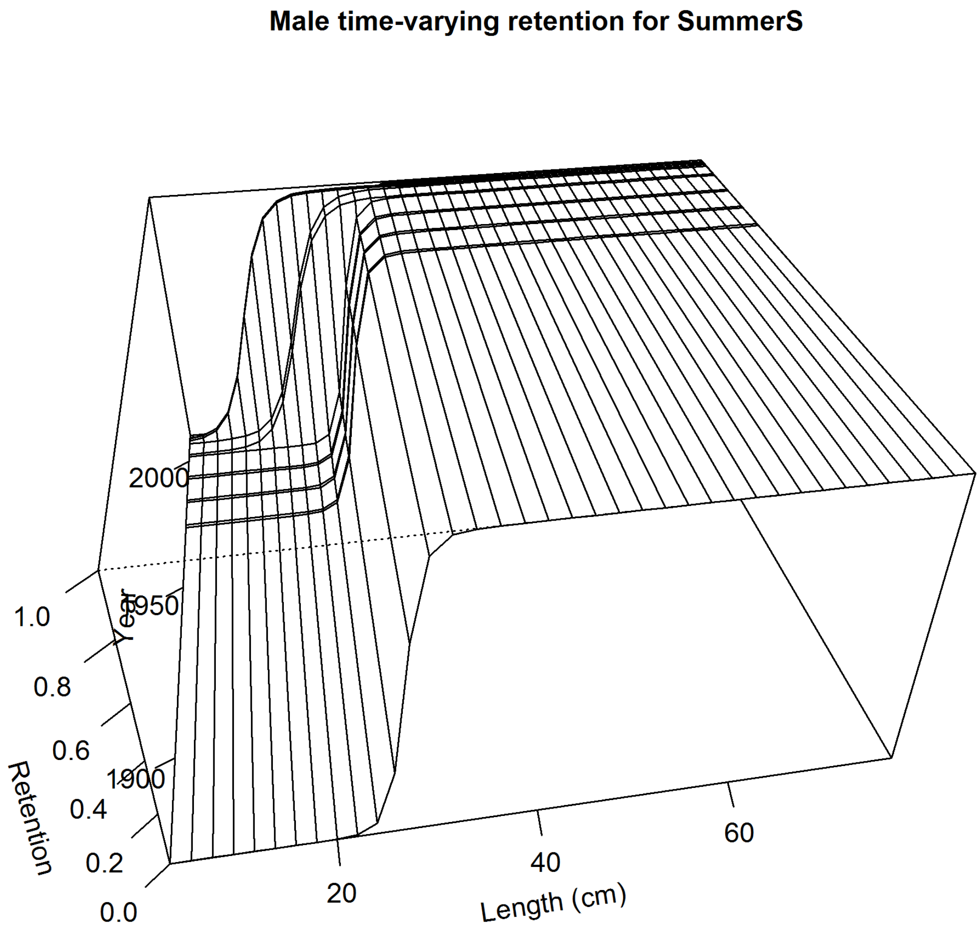


Figure 87. Estimated time varying length-based retention curves for the summer south fleet, males.

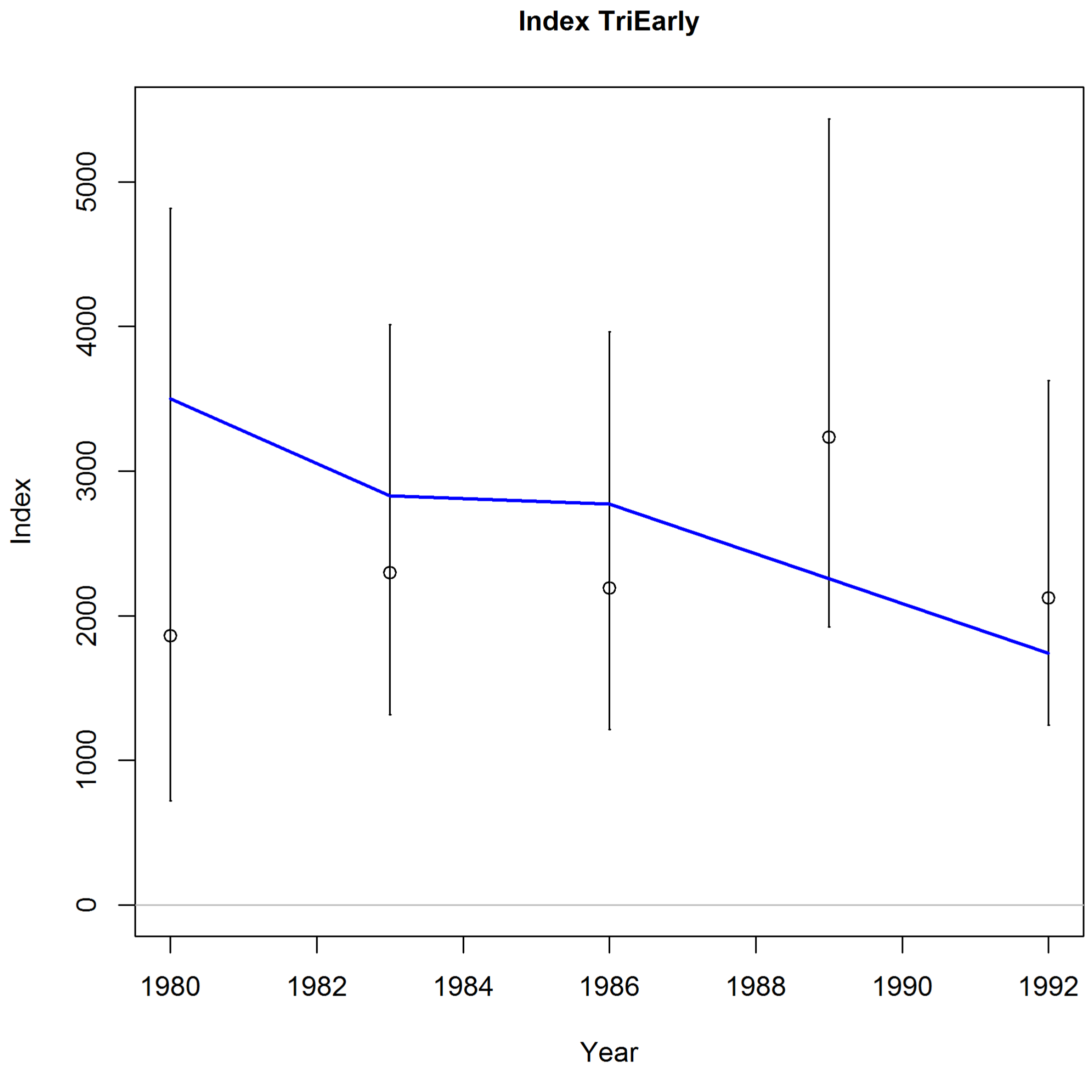


Figure 88. Fit to the early triennial.

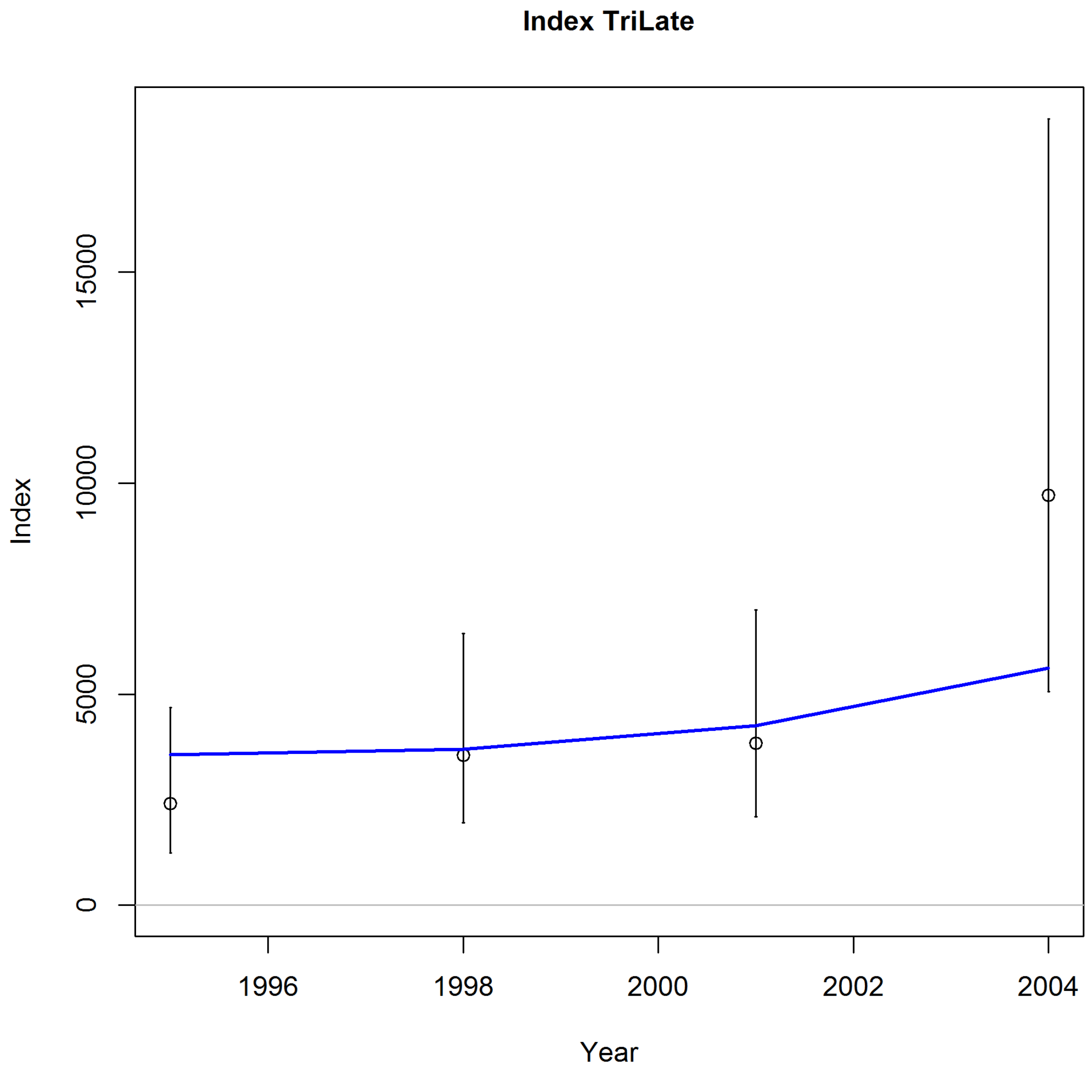


Figure 89. Fit to the late triennial.

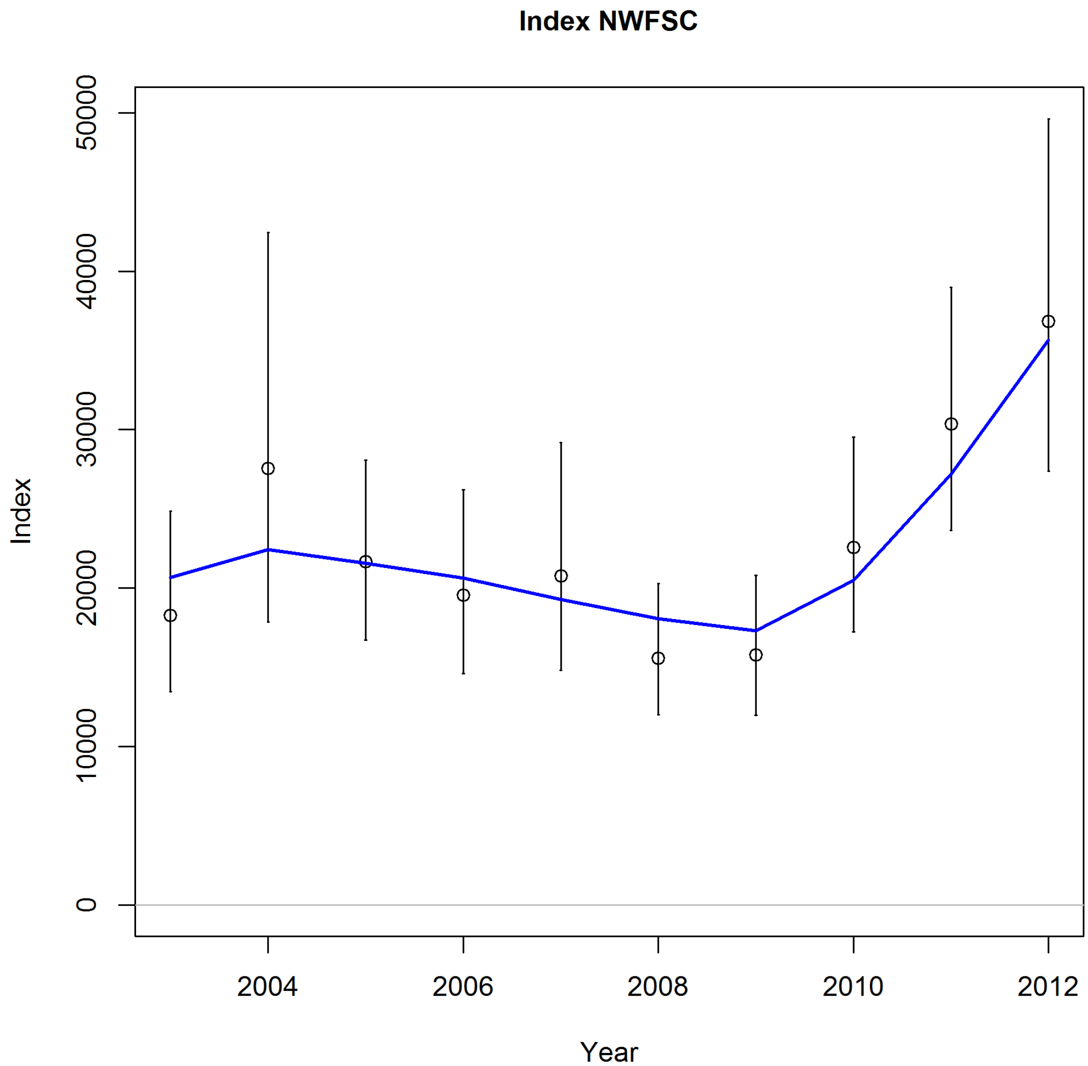


Figure 90. Fit to NWFSC survey.

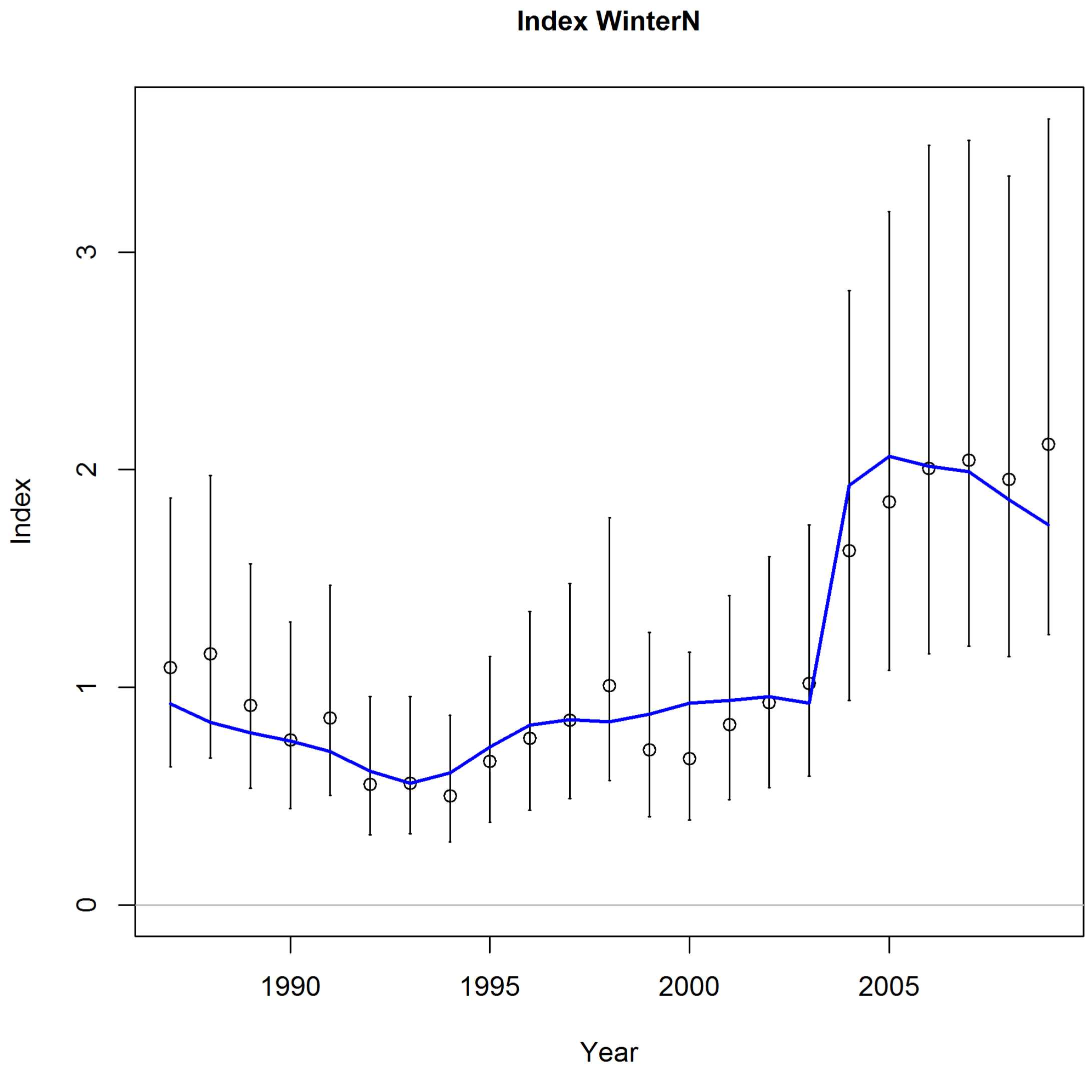


Figure 91. Fit to winter north commercial CPUE.

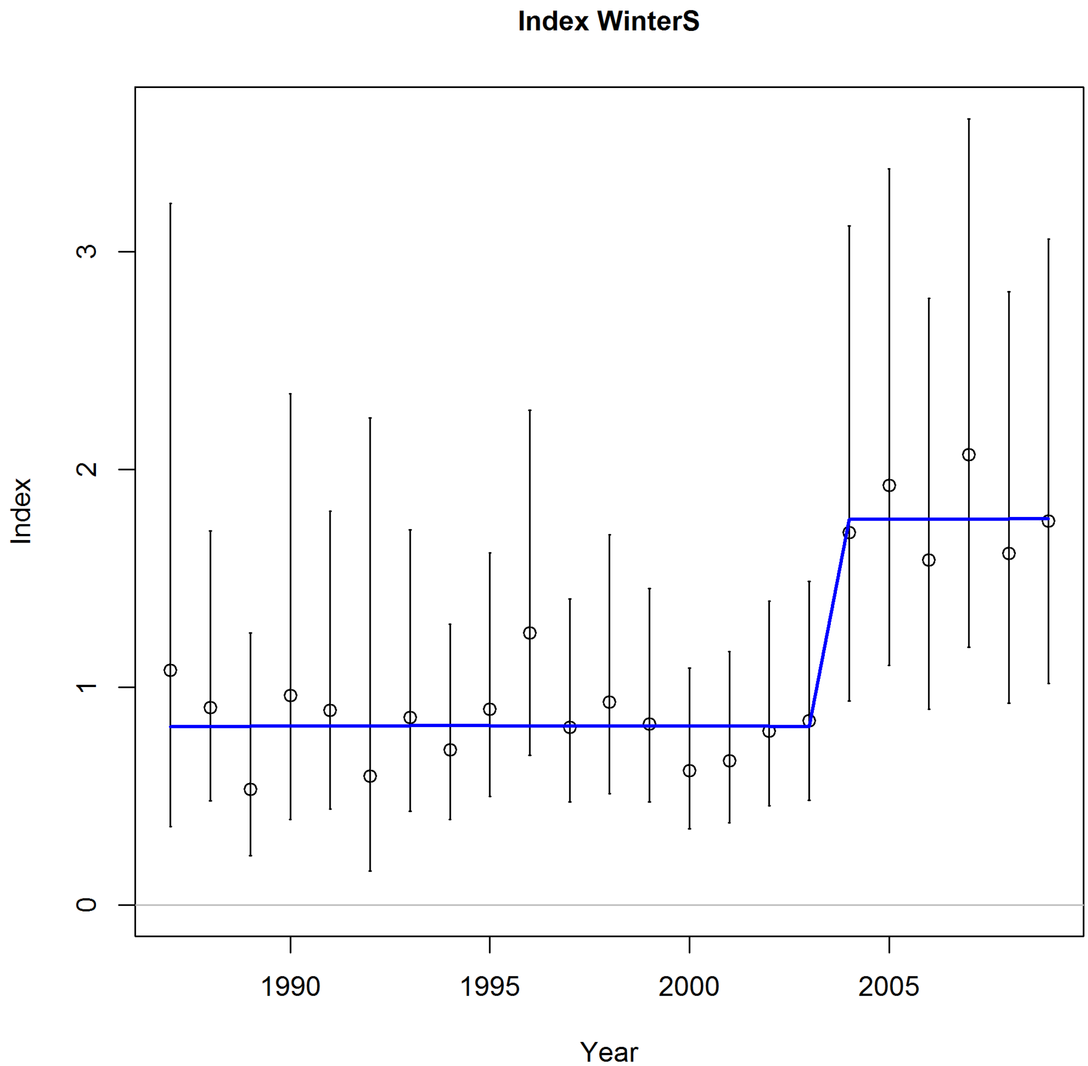


Figure 92. Fit to winter south commercial CPUE.

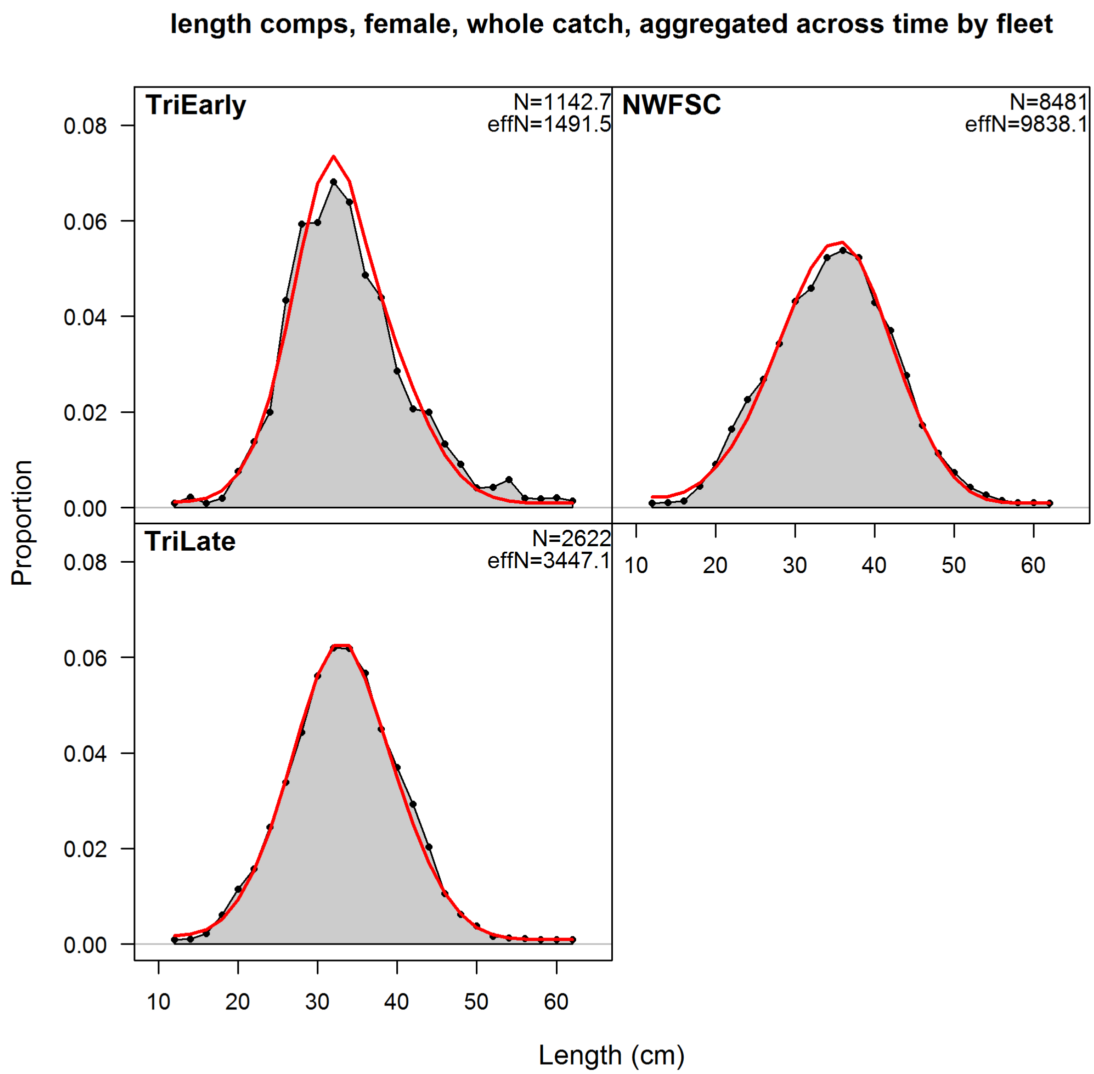


Figure 93. Fit to the composite survey length-frequencies, females.

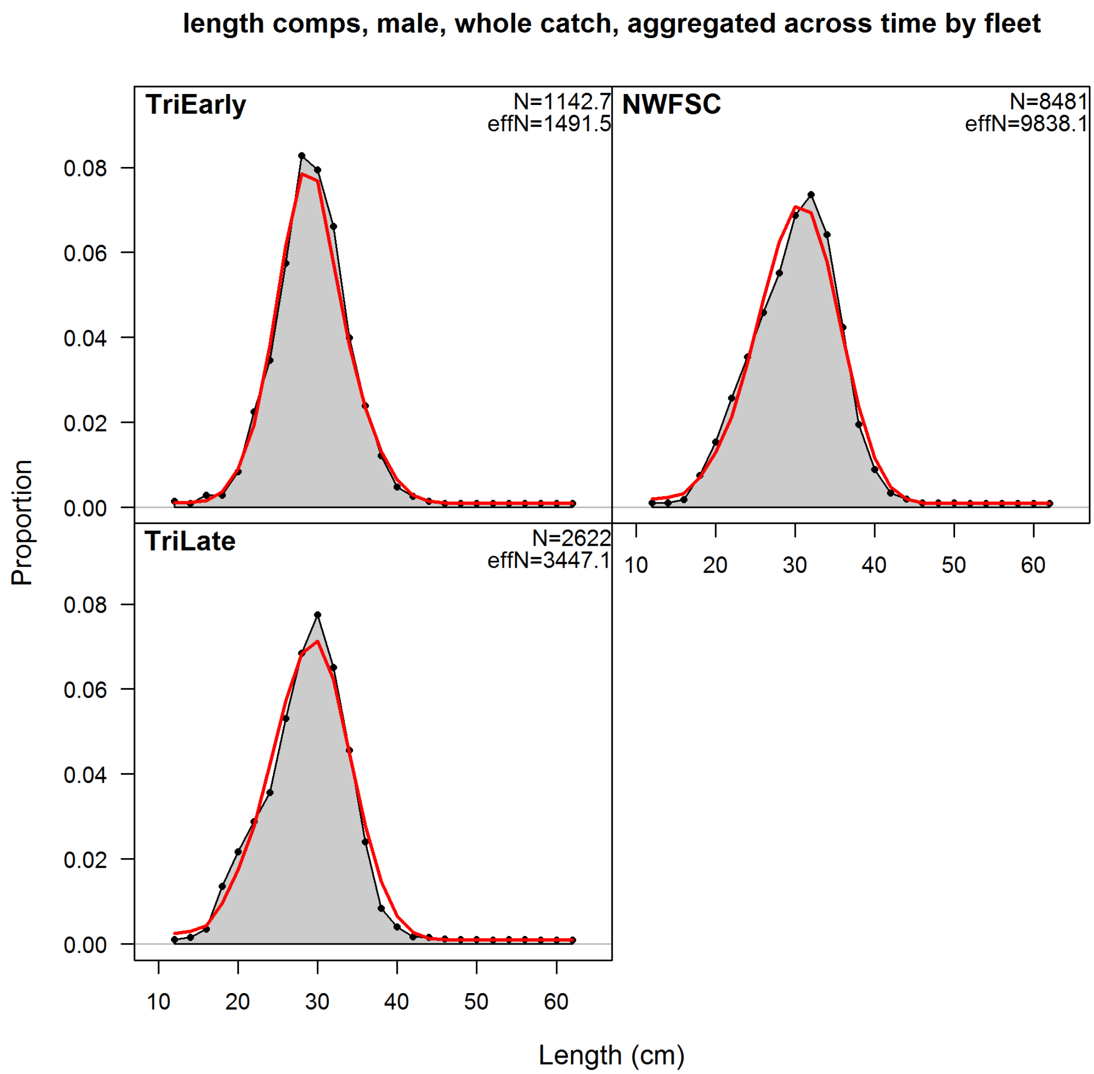


Figure 94. Fit to the composite survey length-frequencies, males.

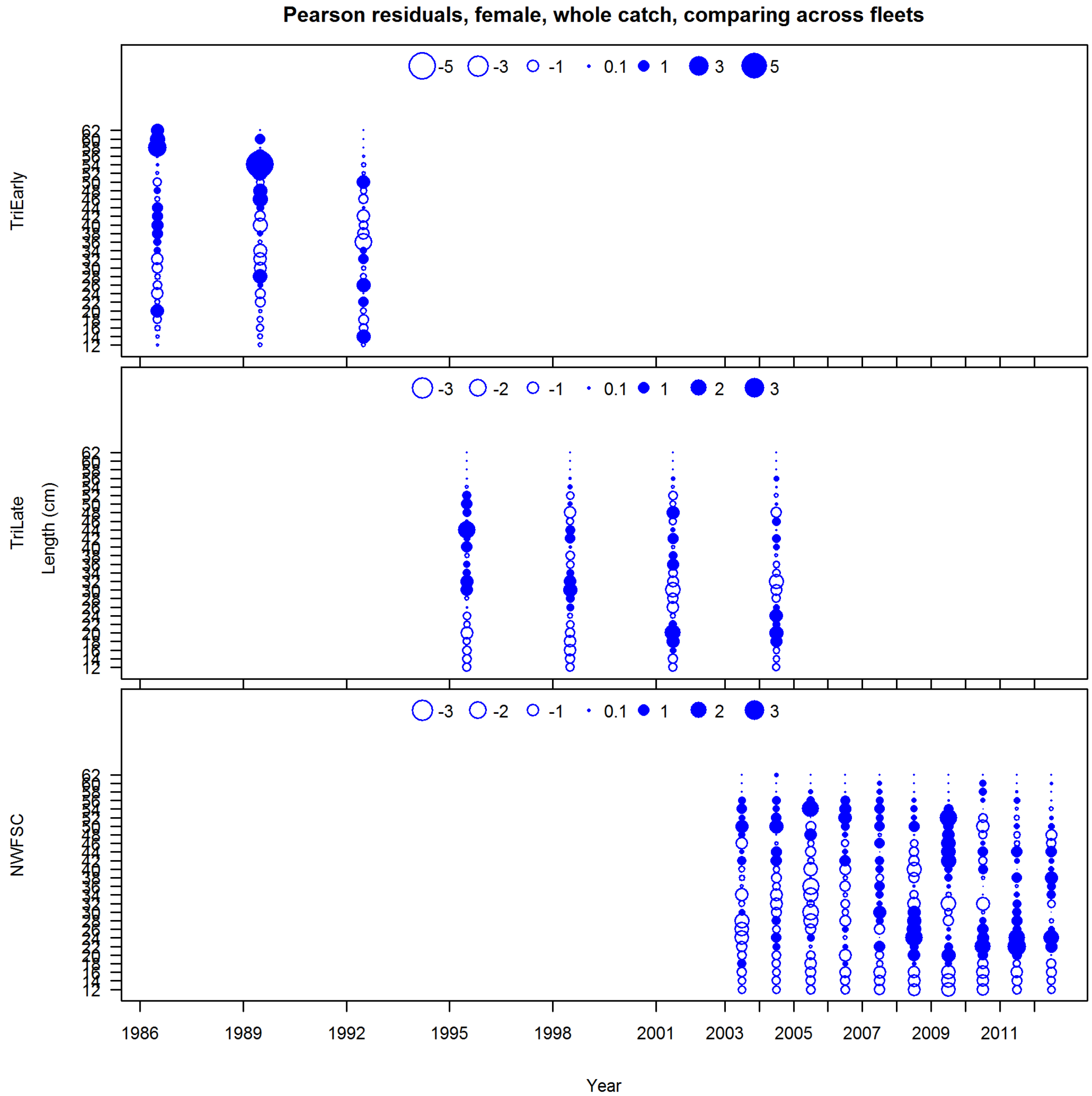


Figure 95. Pearson residuals for the fit to survey length-frequencies, females.

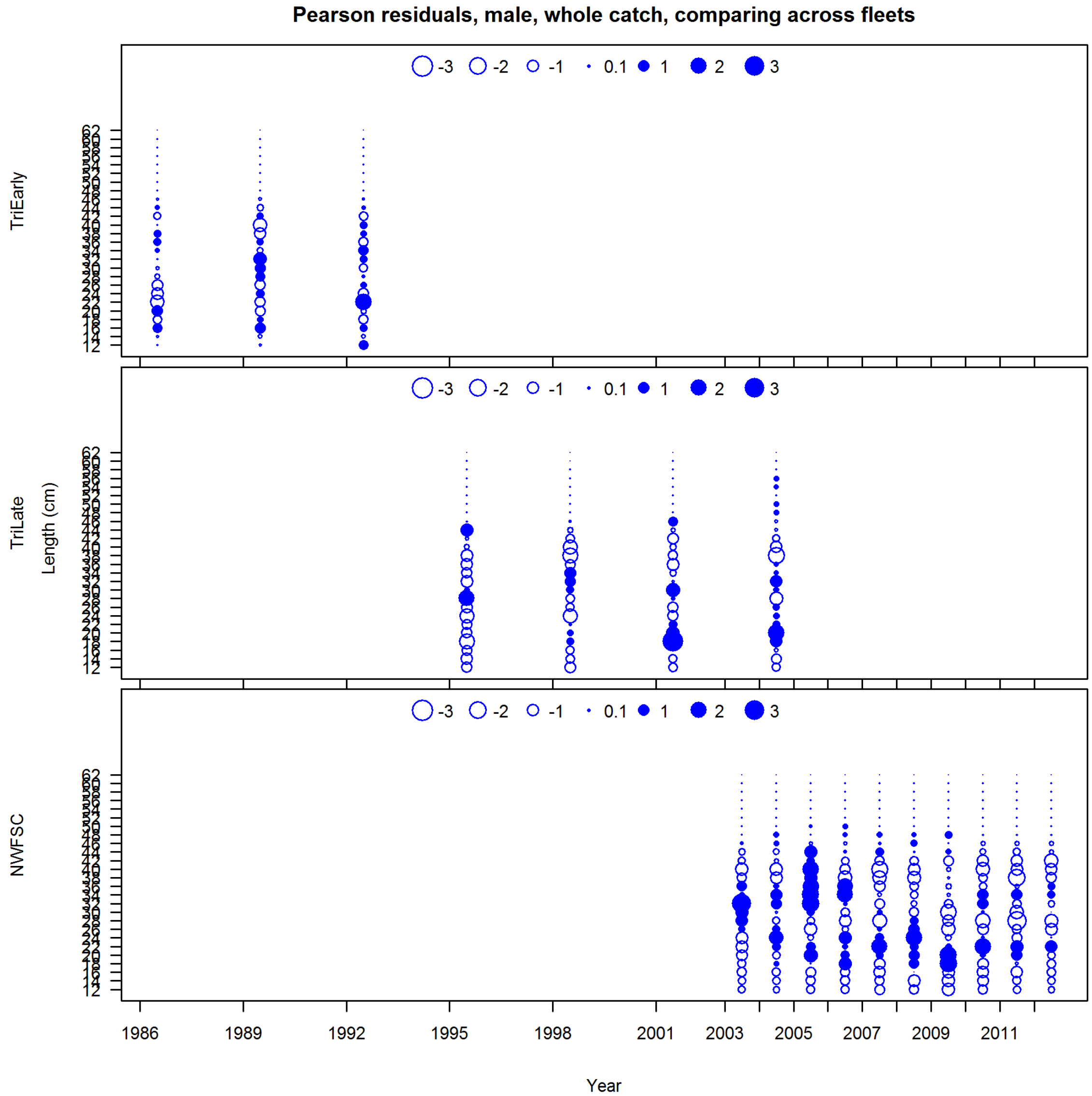


Figure 96. Pearson residuals for the fit to survey length-frequencies, males.

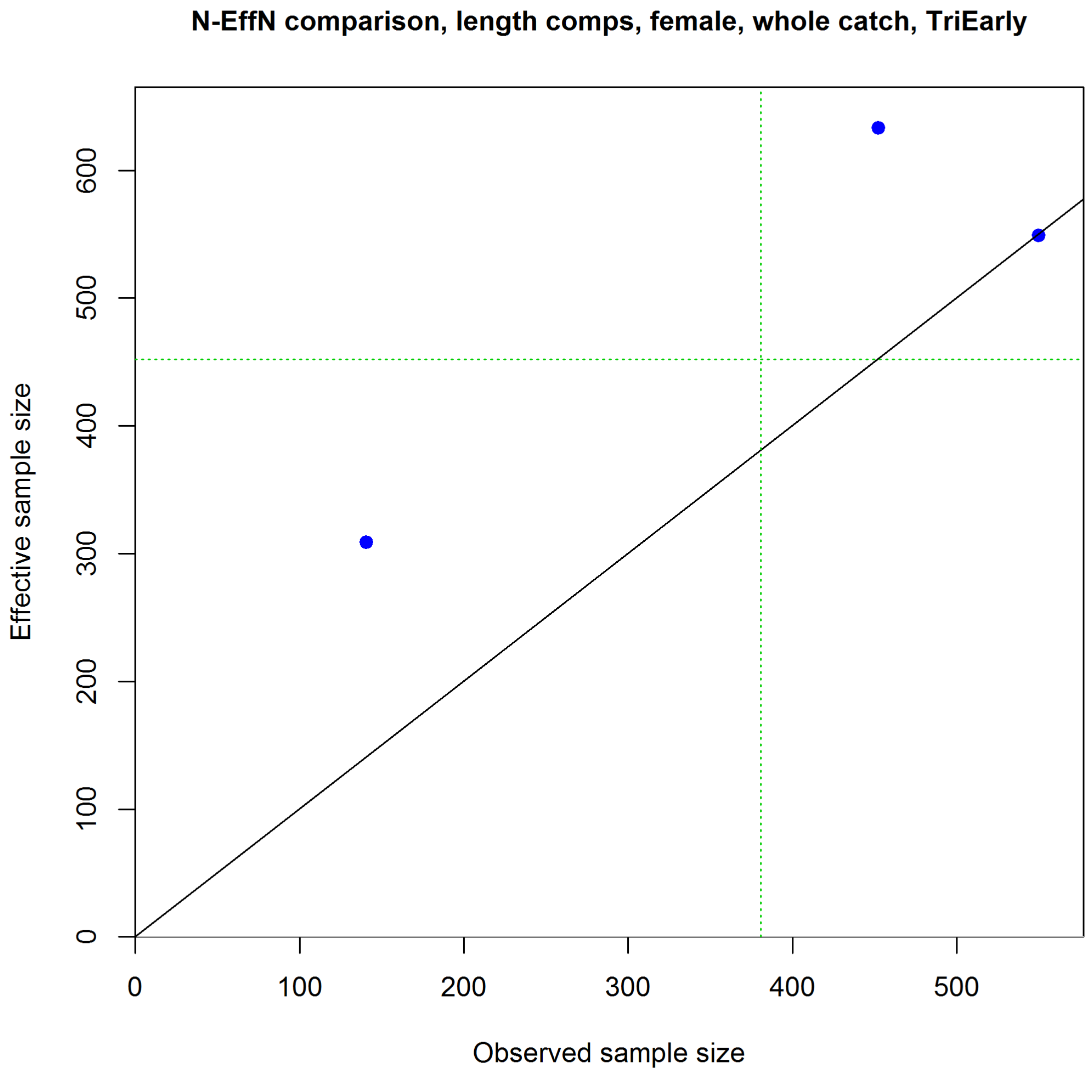


Figure 97. Observed and effective sample sizes for the early triennial survey length-frequency observations, females.

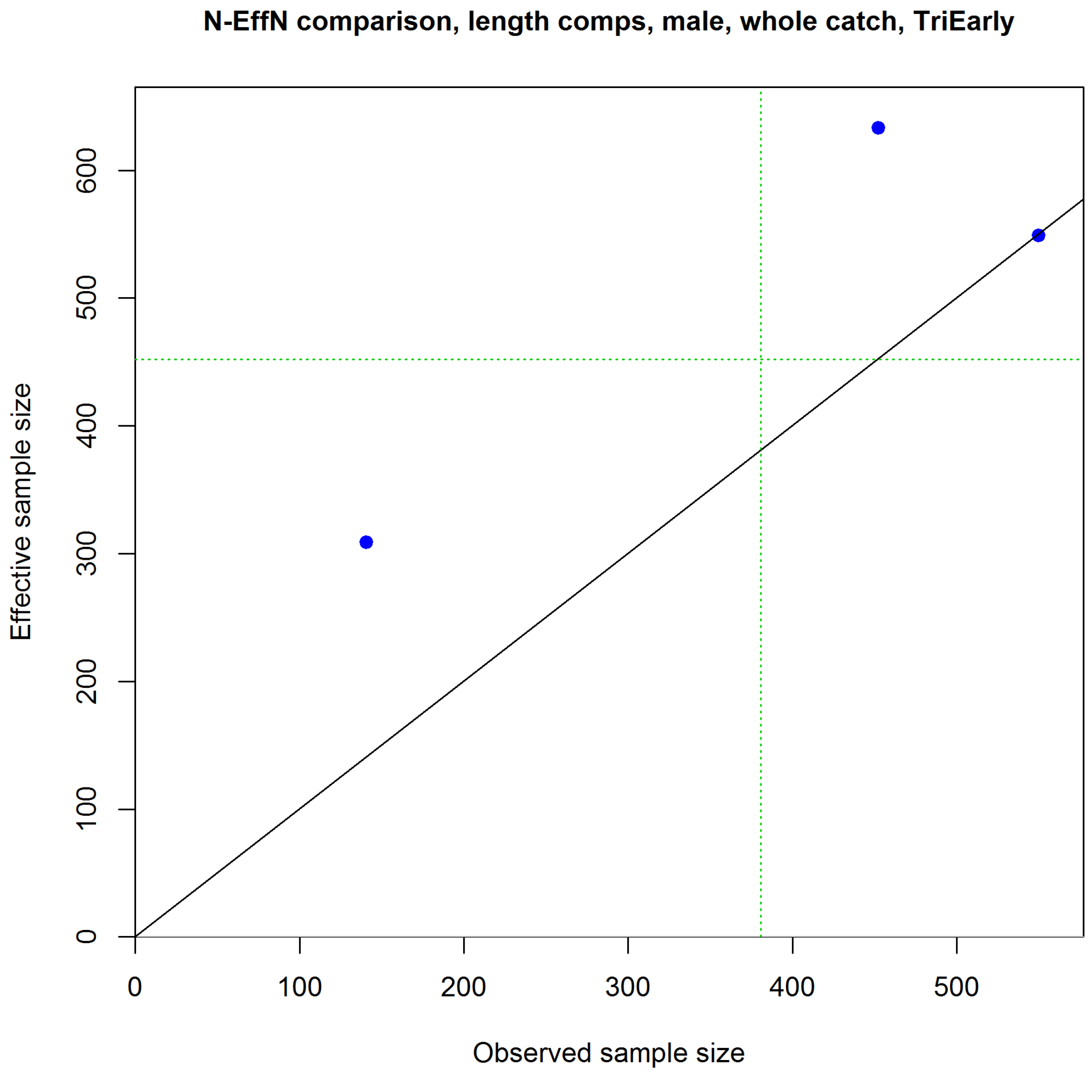


Figure 98. Observed and effective sample sizes for the early triennial survey length-frequency observations, males.

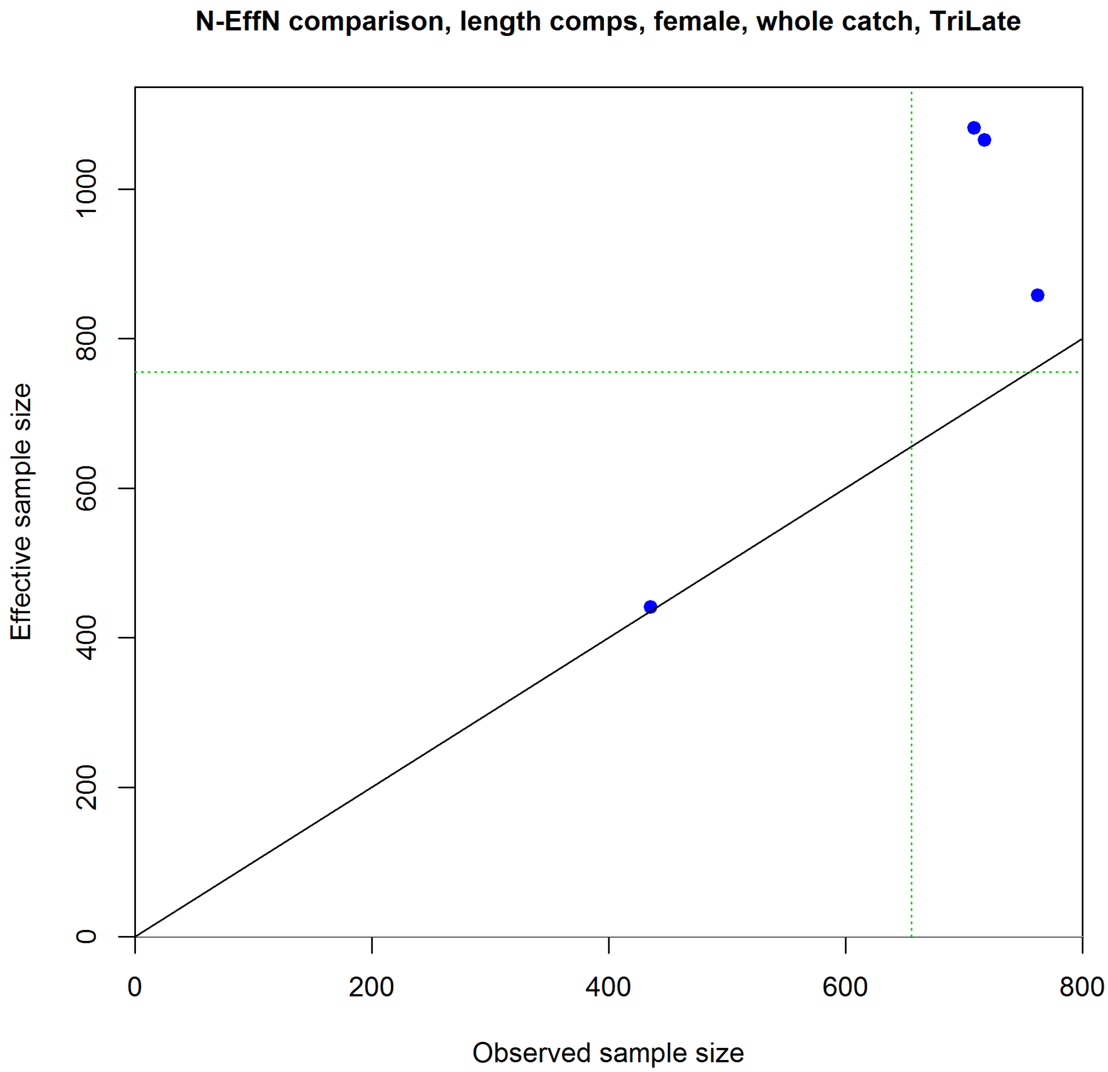


Figure 99. Observed and effective sample sizes for the late triennial survey length-frequency observations, females.

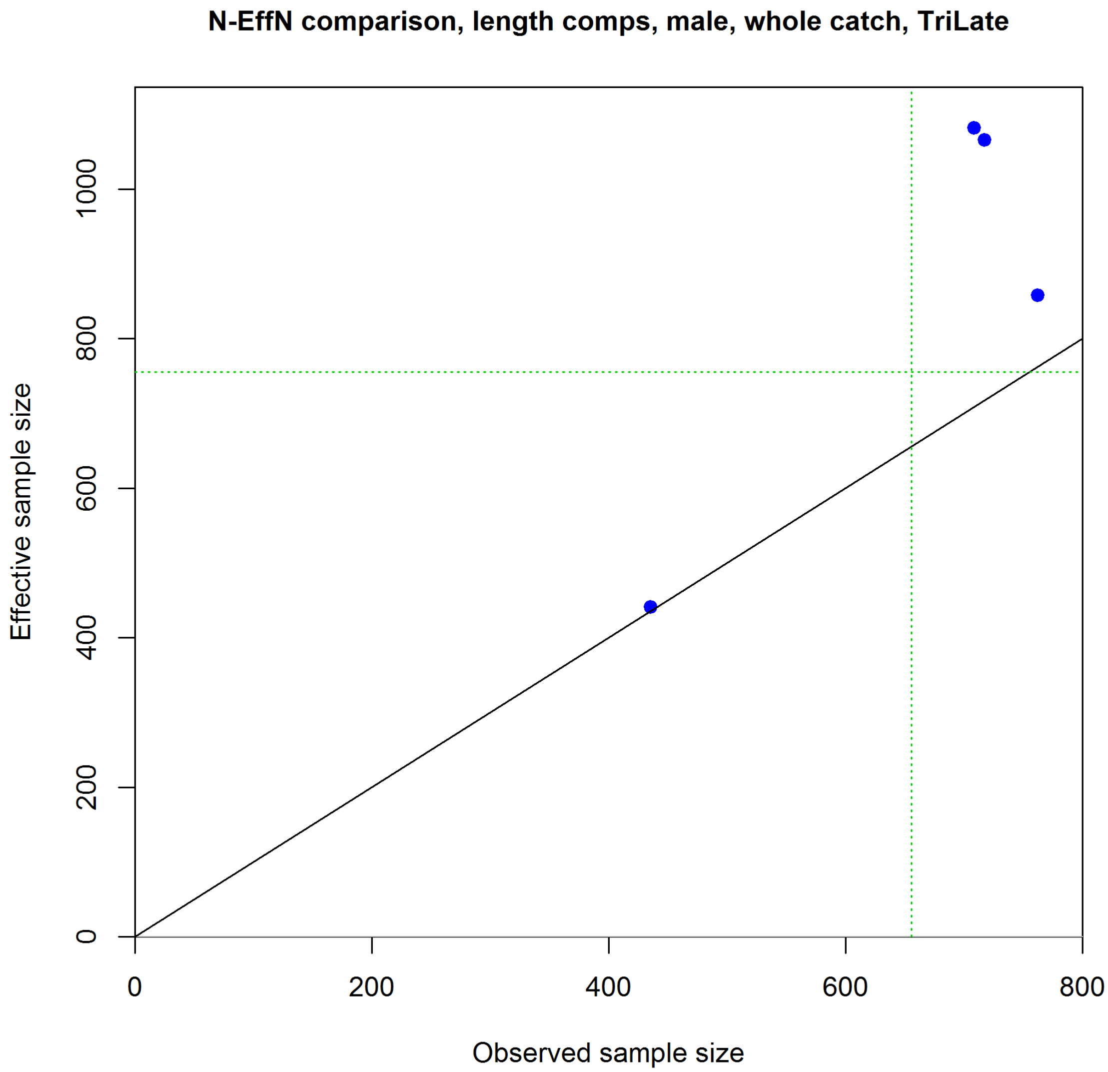


Figure 100. Observed and effective sample sizes for the late triennial survey length-frequency observations, males.

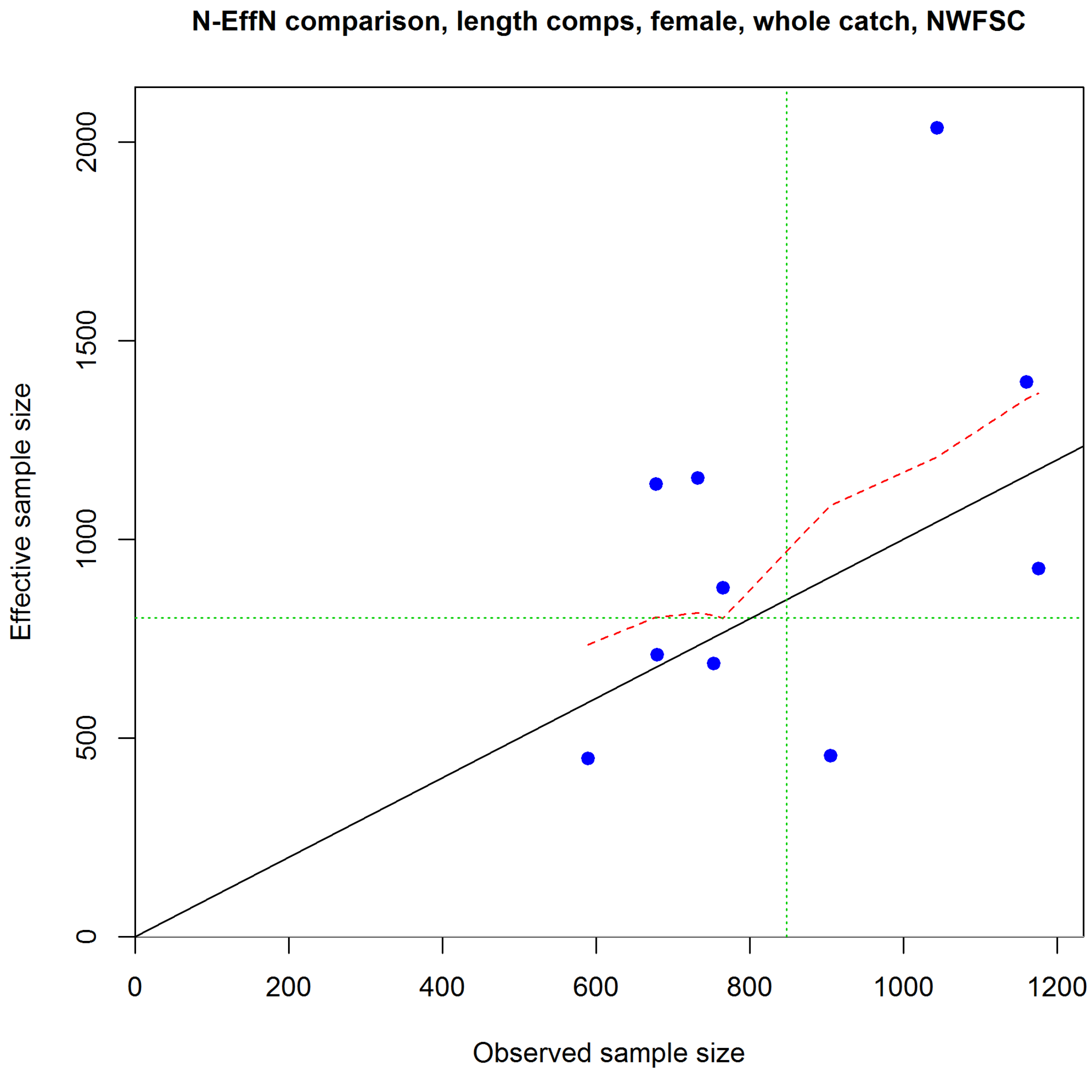


Figure 101. Observed and effective sample sizes for the NWFSC length-frequency observations, females.

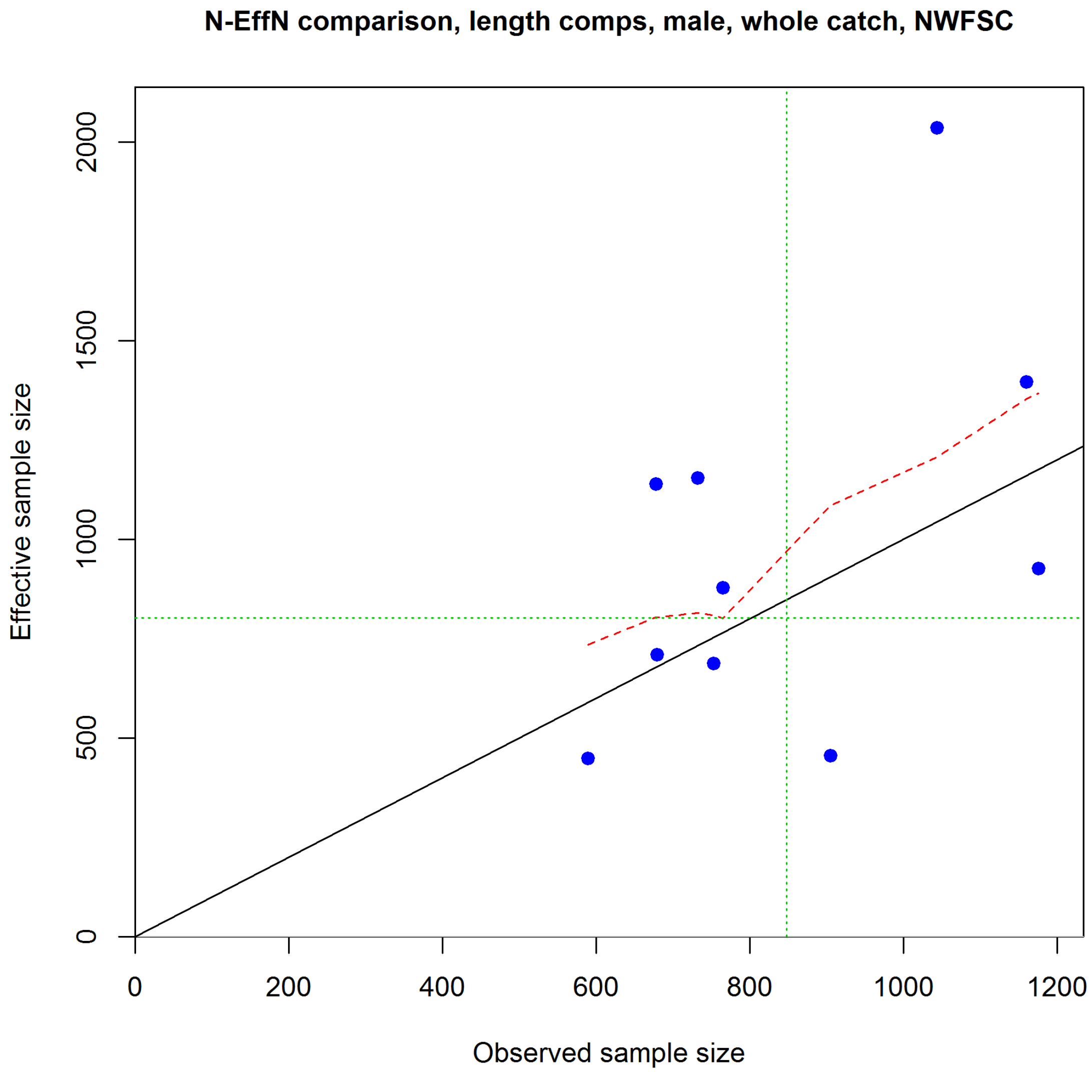
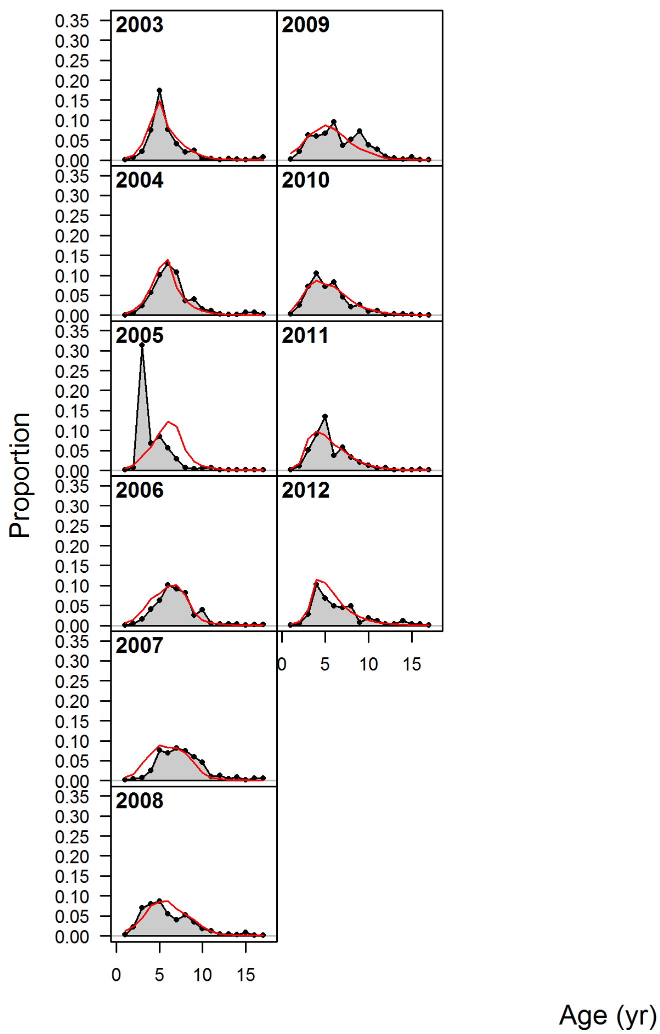


Figure 102. Observed and effective sample sizes for the NWFSC length-frequency observations, males.

ghost age comps, female, whole catch, NWFSC



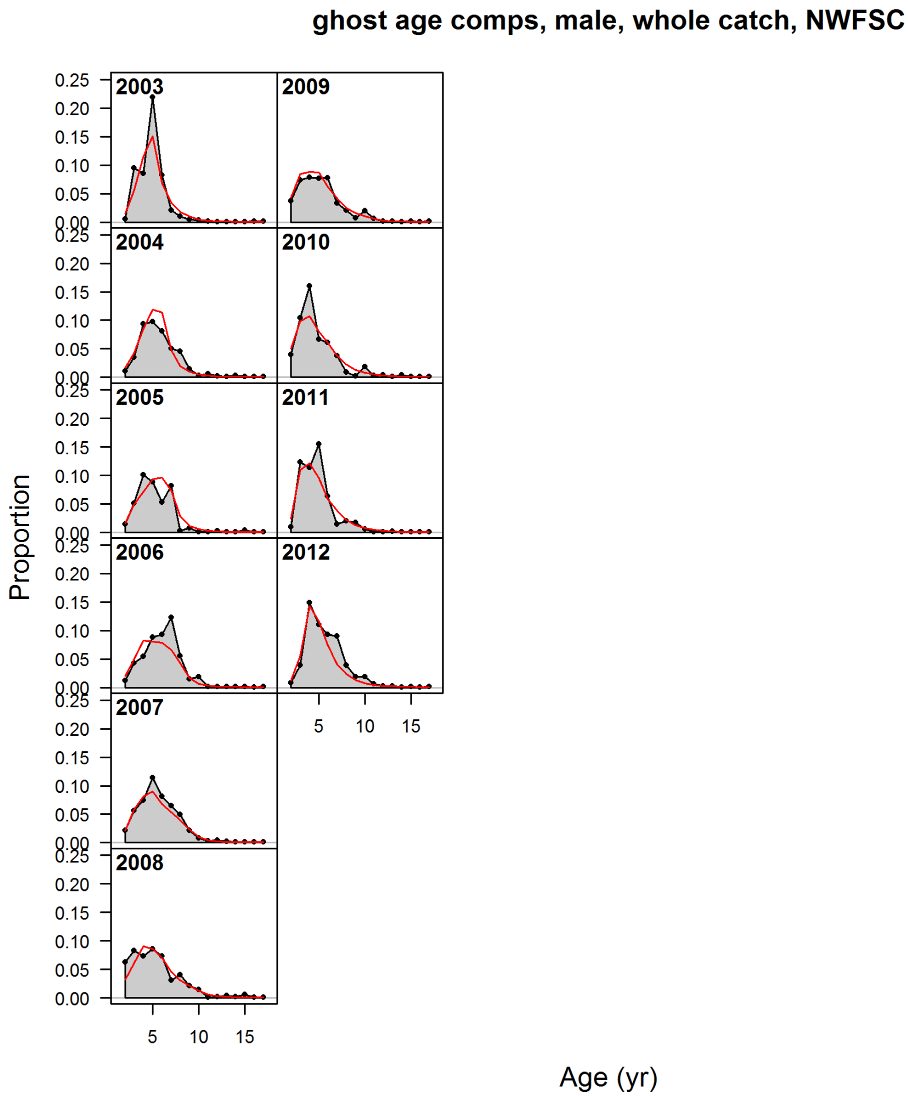
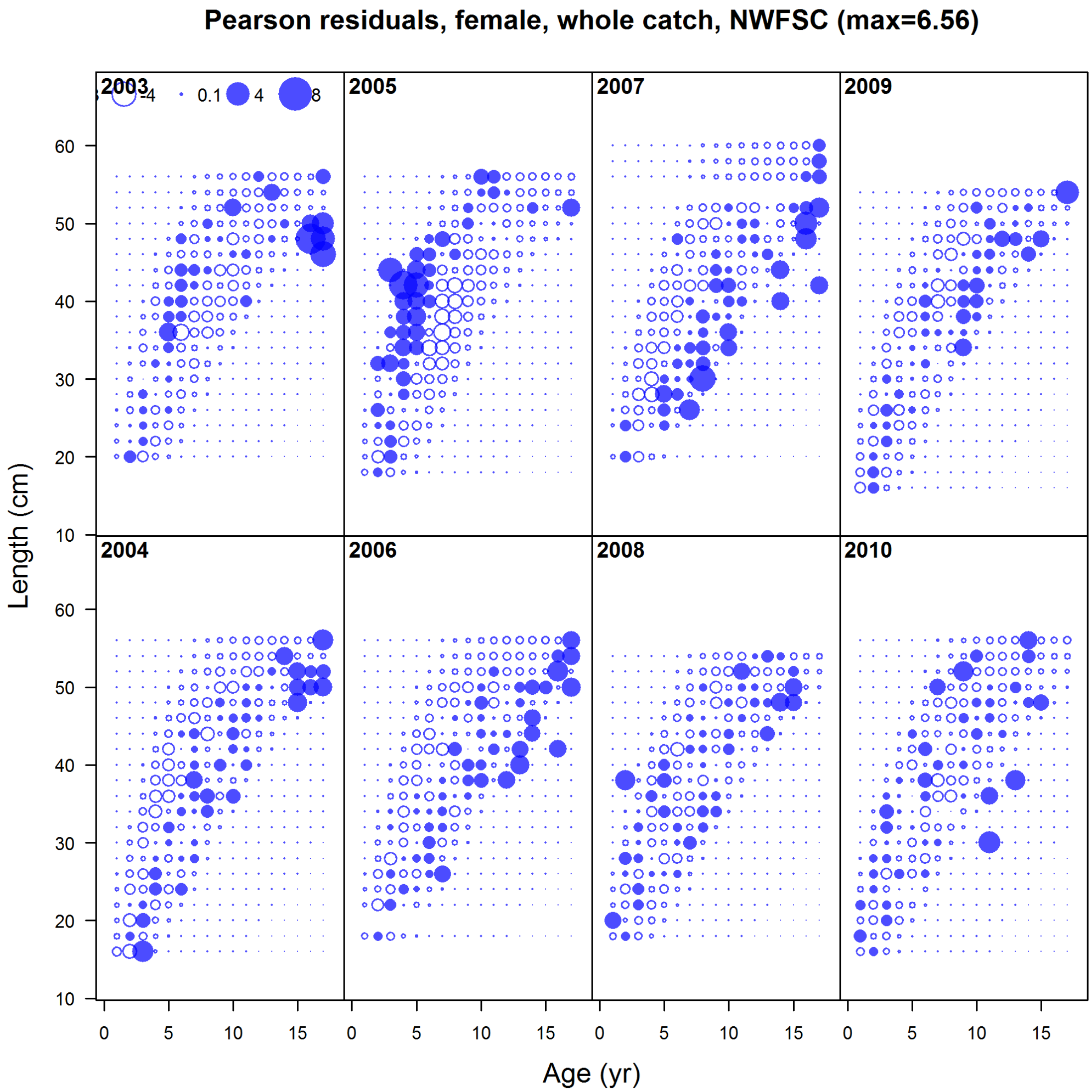
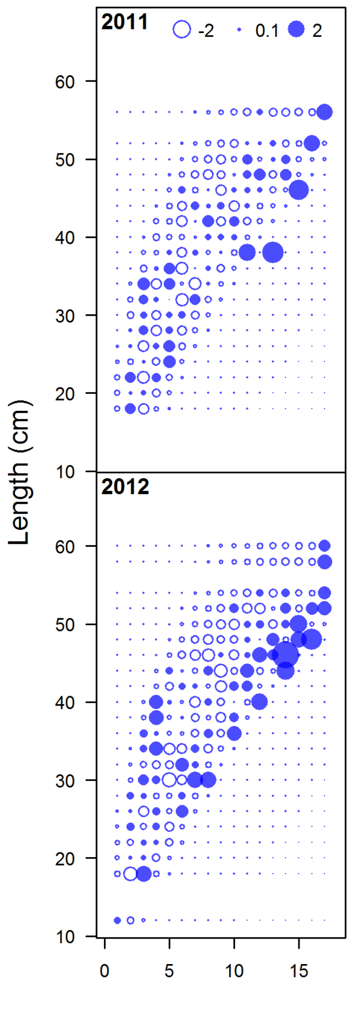
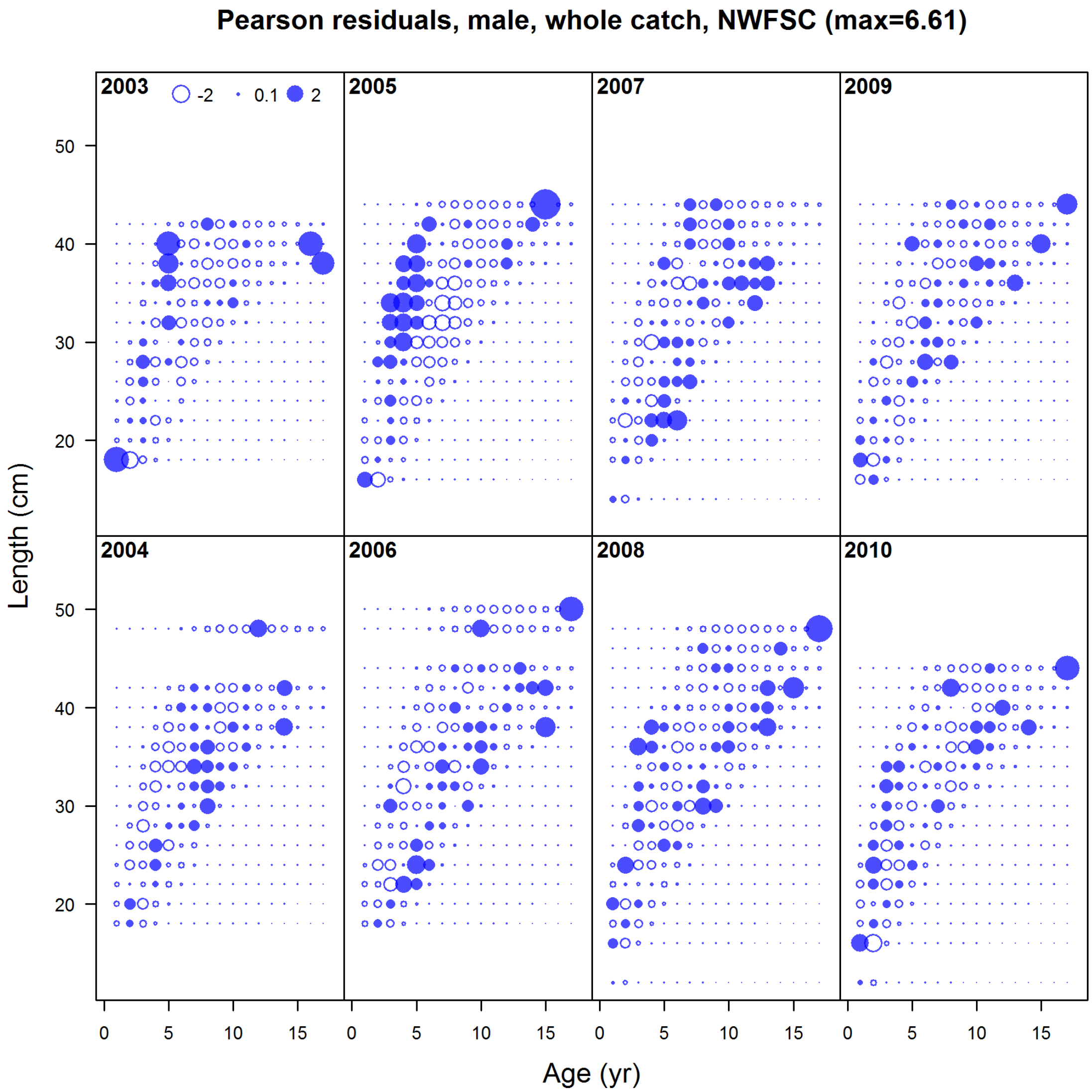


Figure 103. Model fits to the NWFSC marginal age-at-length data.


Pearson residuals, female, whole catch, NWFSC (max=6.56)
2003
2004
2005
2006
2007
2008
2009
2010
-4
0.1
4
8
Length (cm)
Age (yr)

Pearson residuals, female, whole catch, NWFSC (max=6.56)




Pearson residuals, male, whole catch, NWFSC (max=6.61)
2003
2005
2007
2009
2004
2006
2008
2010
-2
0.1
2
Length (cm)
Age (yr)
20
30
40
50
0
5
10
15

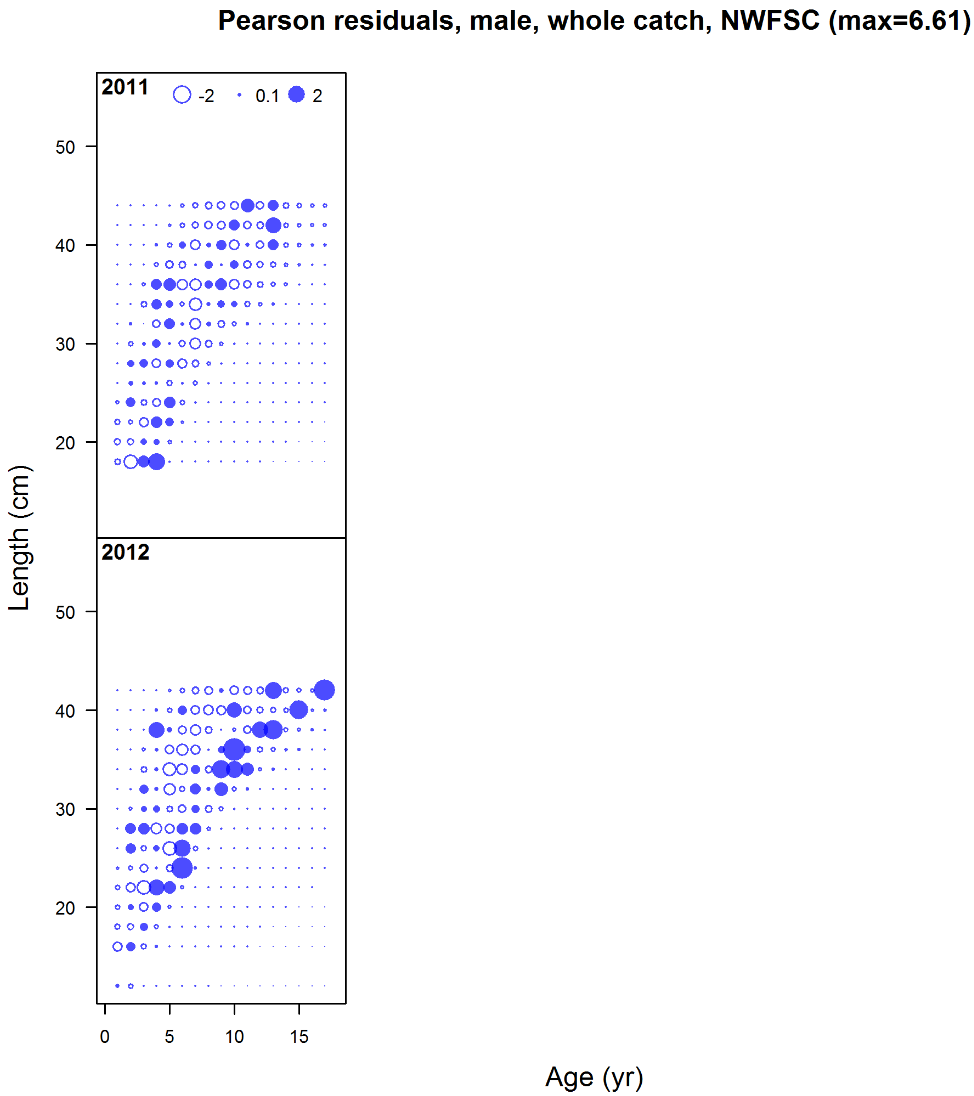
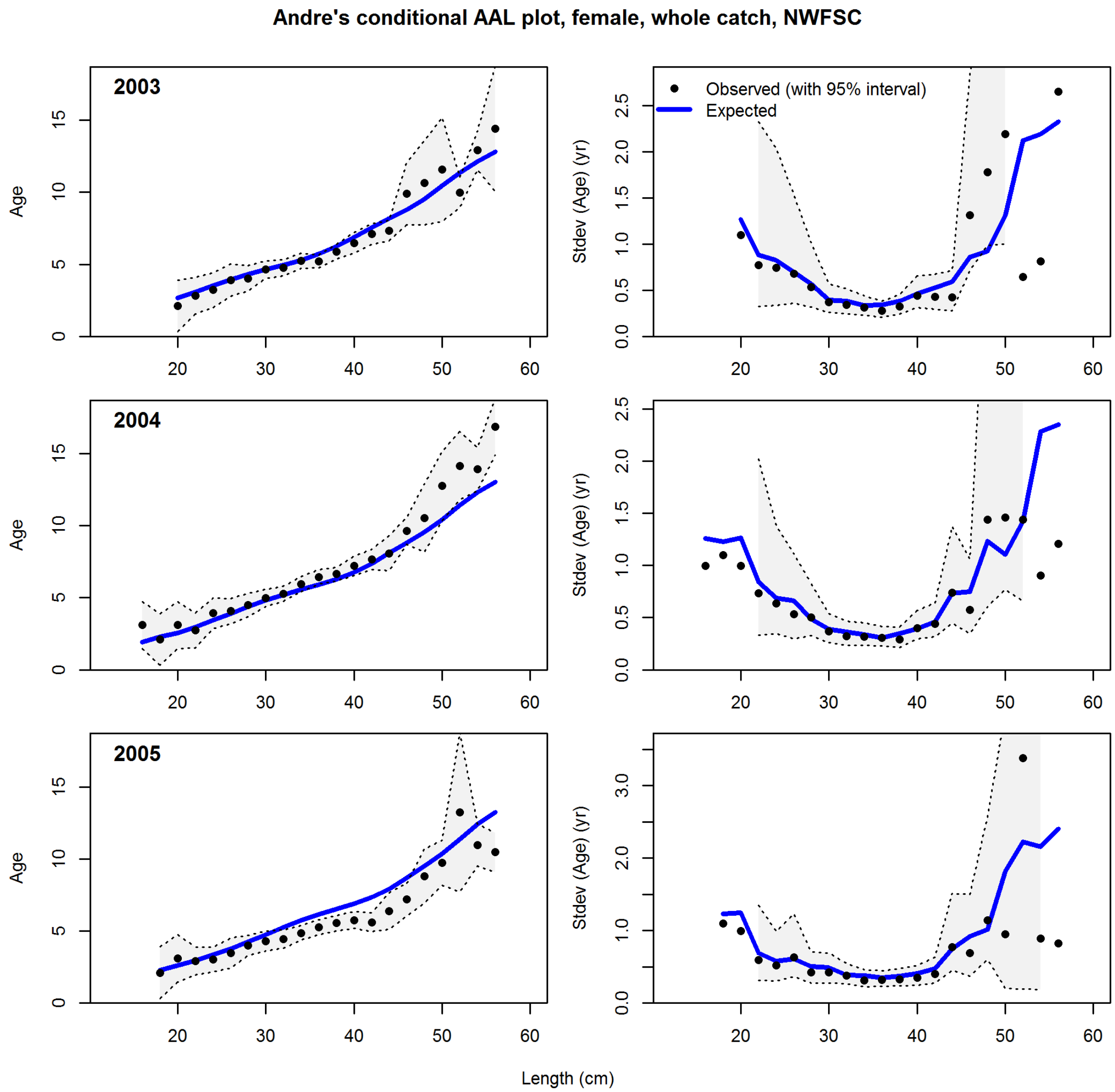
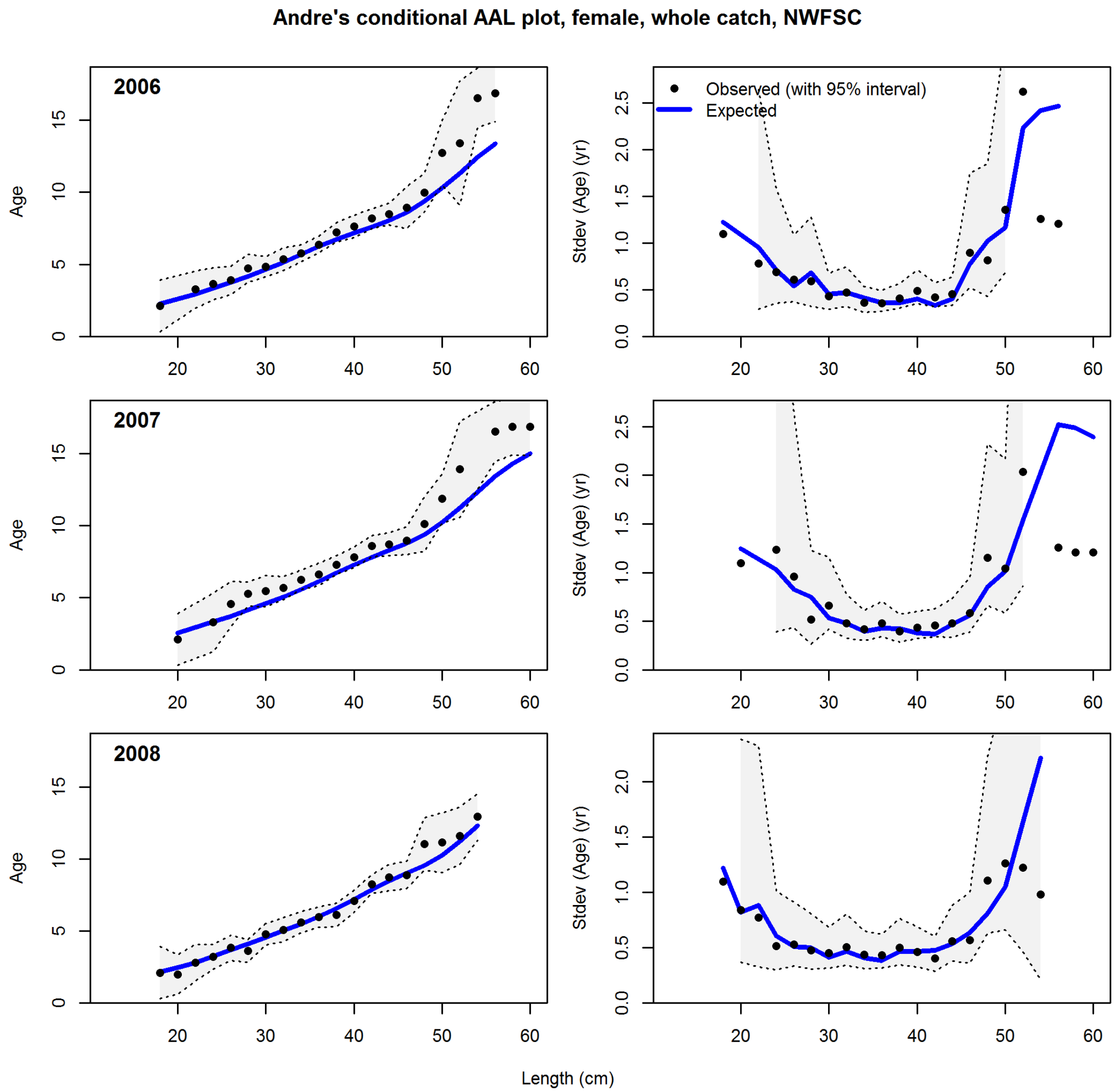


Figure 104. Pearson residuals for the fit to the NWFSC survey conditional age-at-length frequencies.

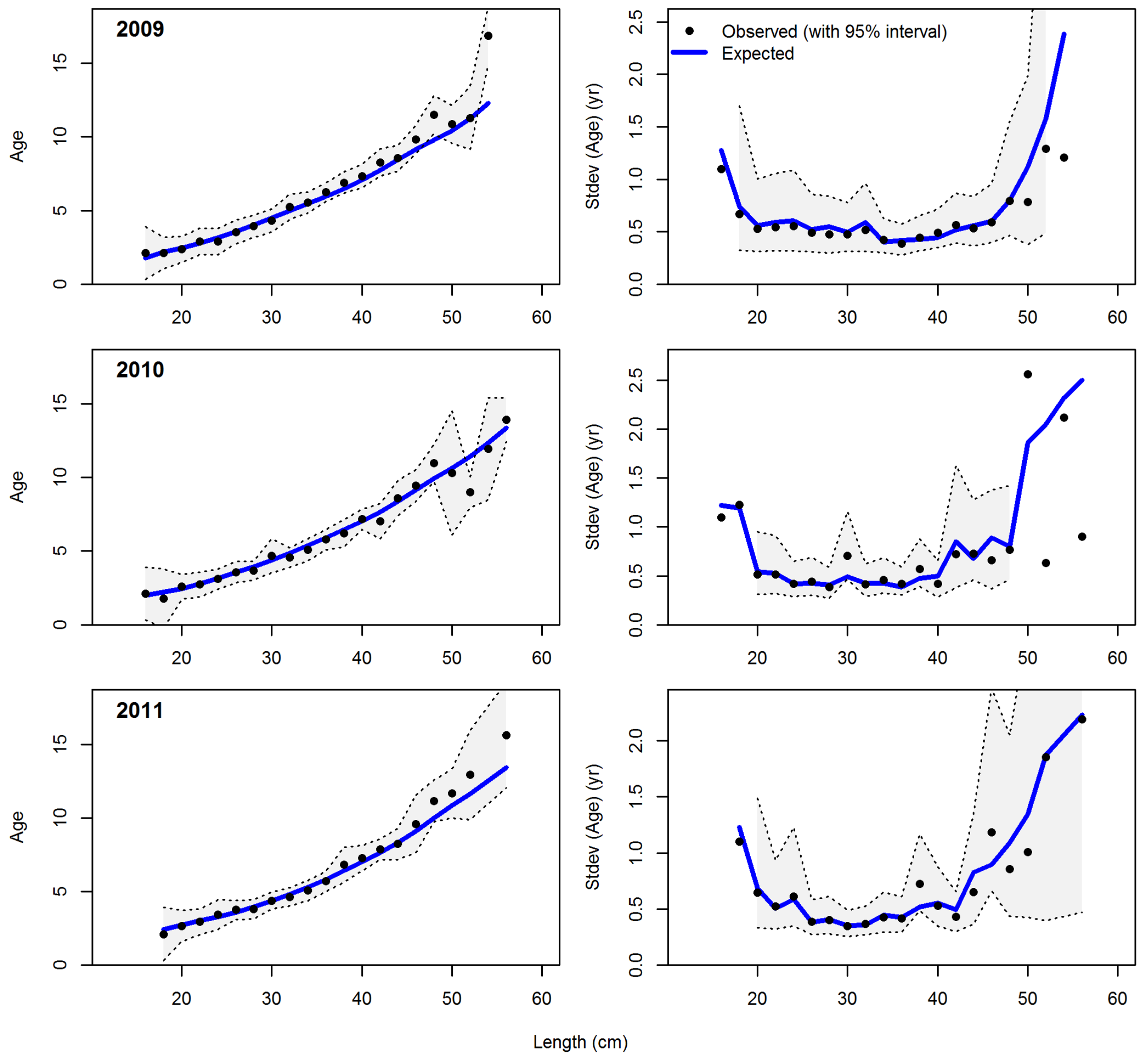


Andre's conditional AAL plot, female, whole catch, NWFSC
2003
2004
2005
Age
Stdev (Age) (yr)
Observed (with 95% interval)
Expected
Length (cm)

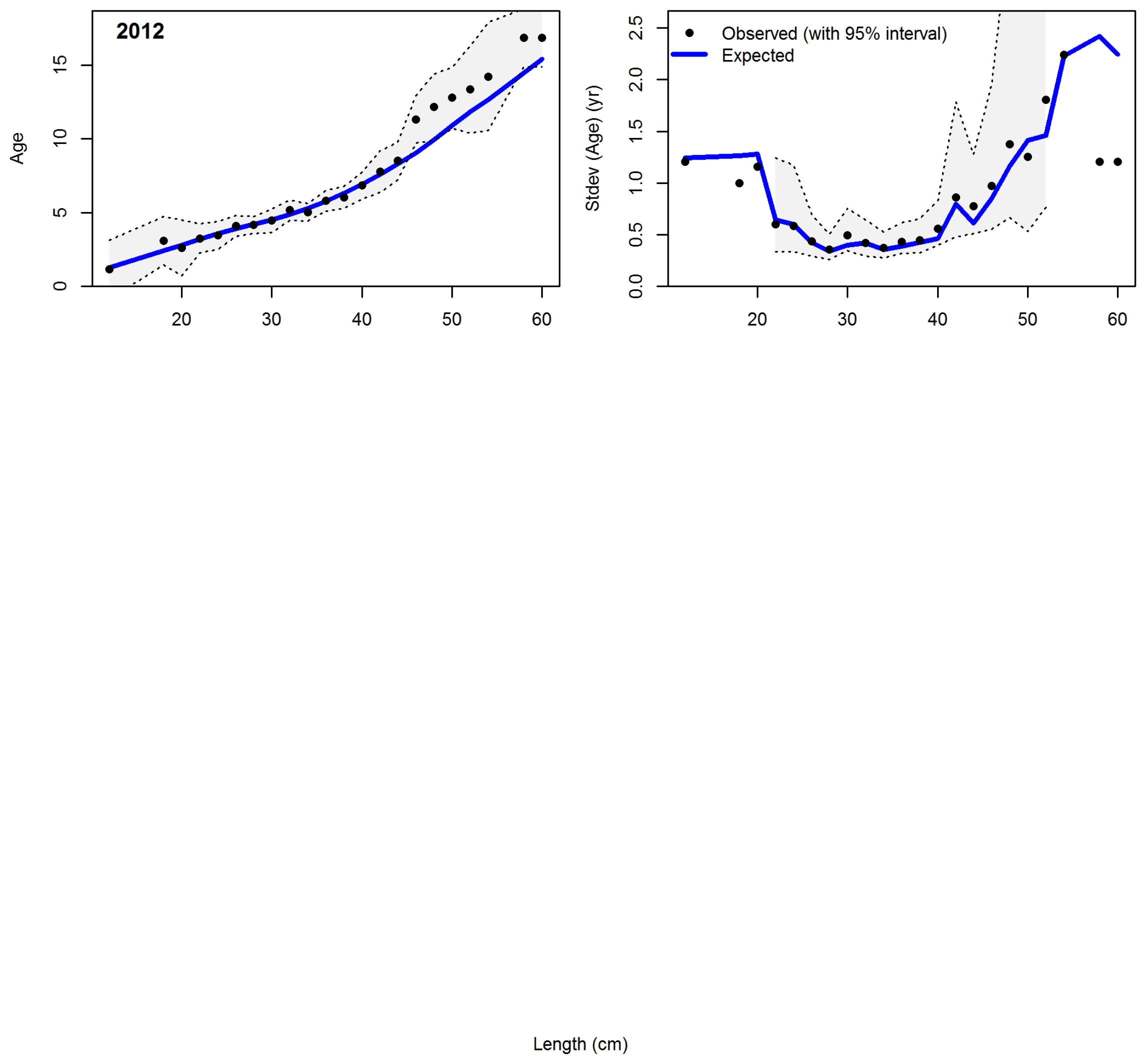


Andre's conditional AAL plot, female, whole catch, NWFSC
2006
2007
2008
Age
Stdev (Age) (yr)
Observed (with 95% interval)
Expected
Length (cm)

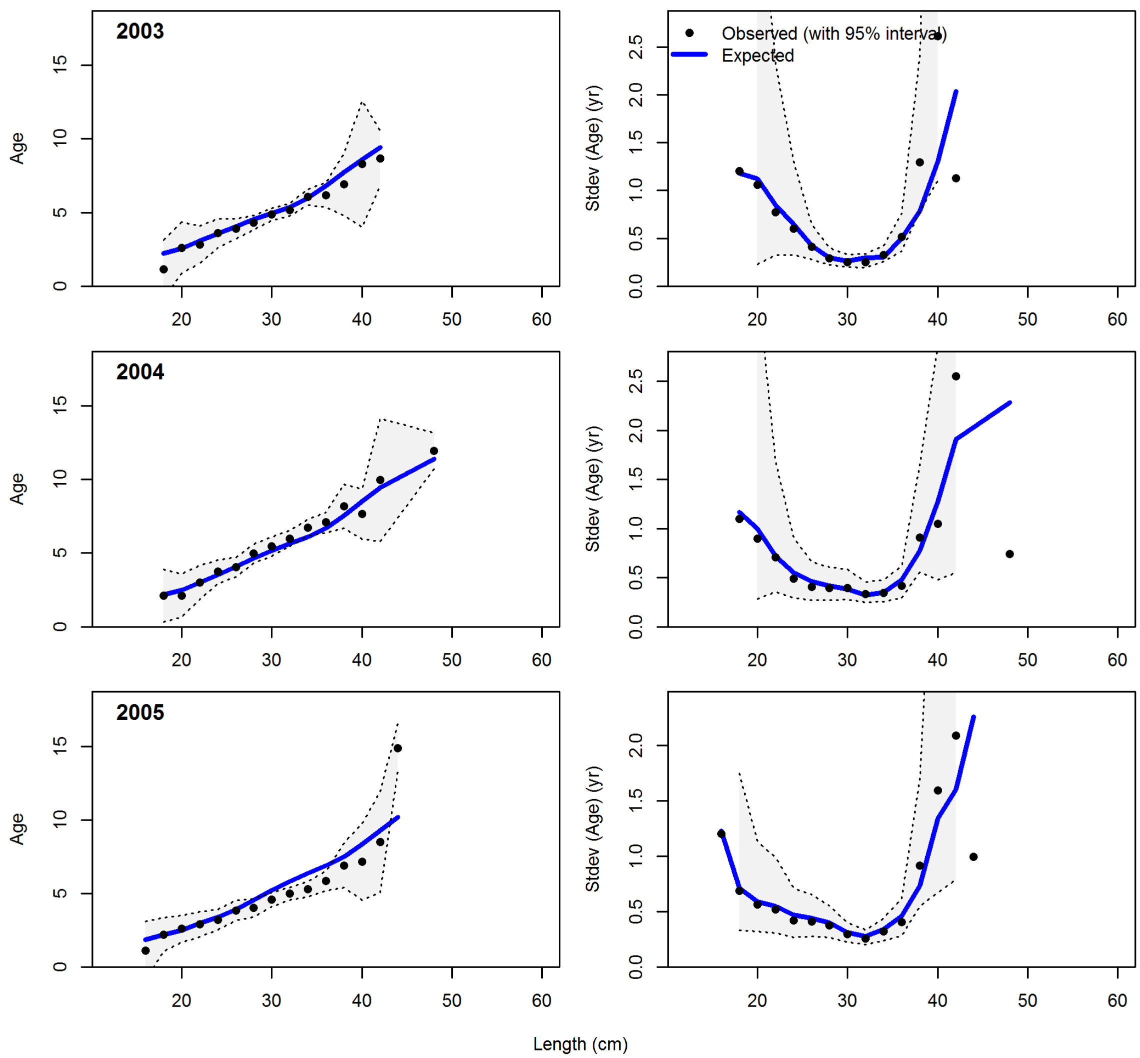
Andre's conditional AAL plot, female, whole catch, NWFSC

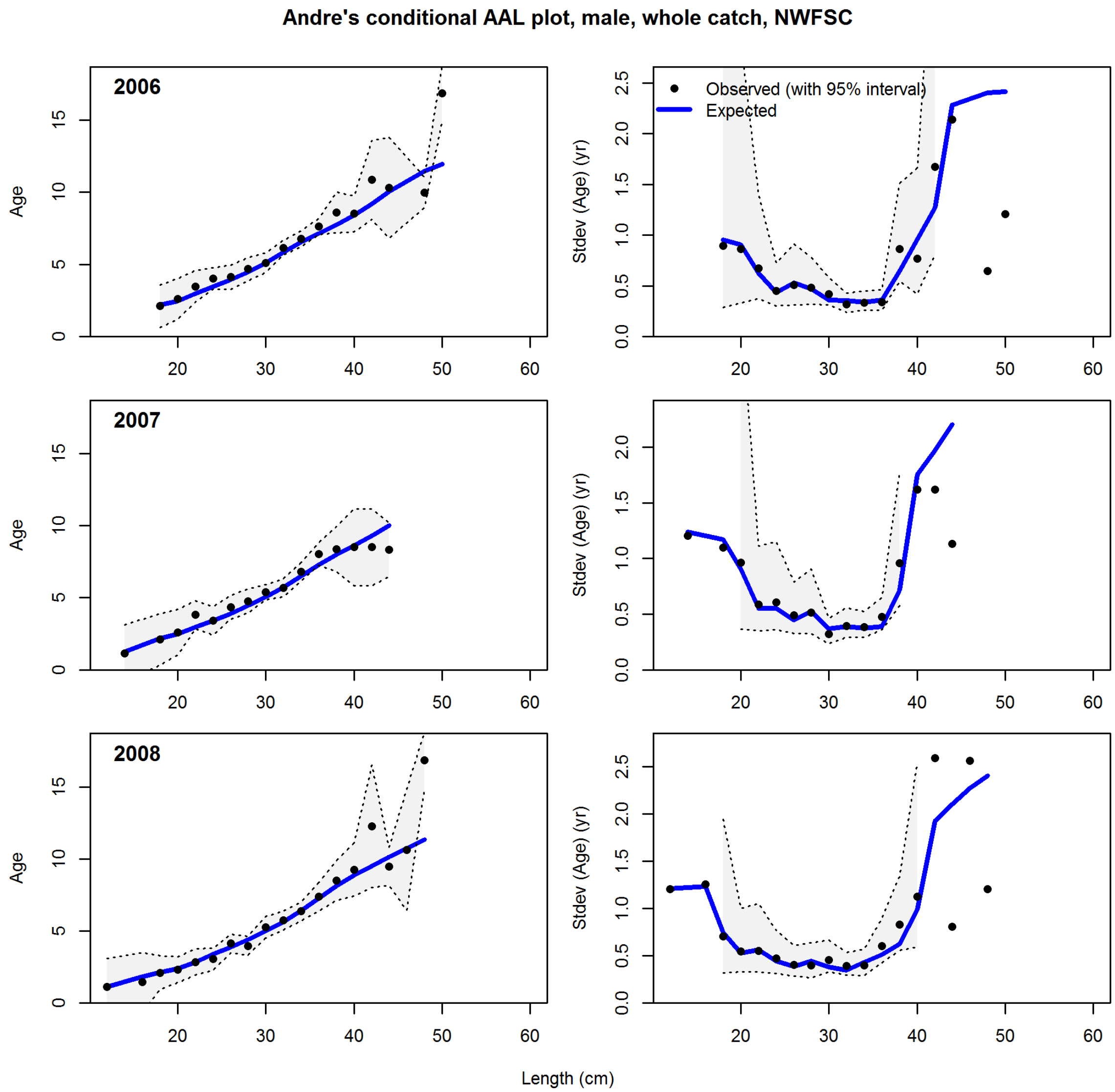


Andre's conditional AAL plot, female, whole catch, NWFSC

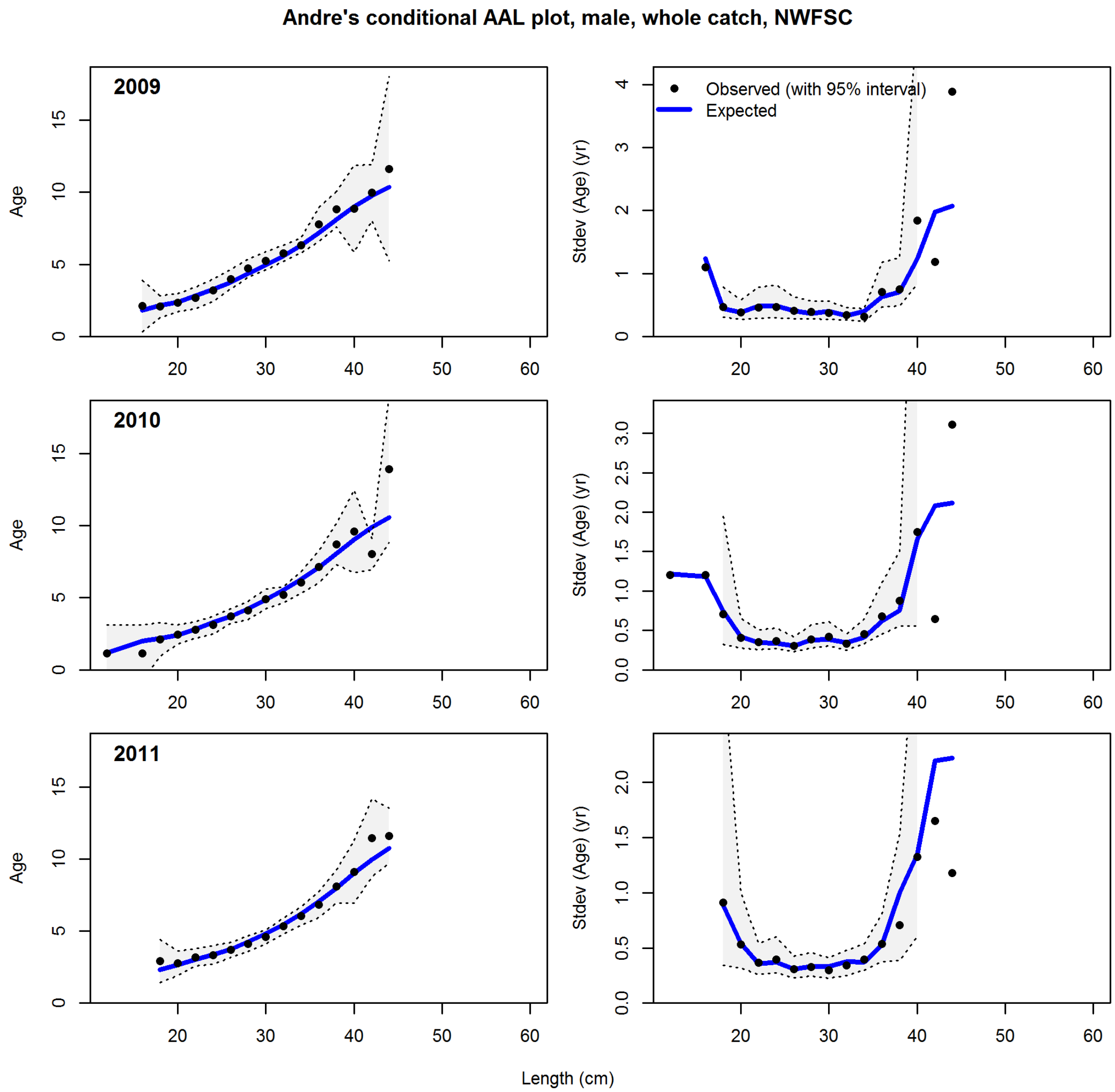


Andre's conditional AAL plot, male, whole catch, NWFSC





Andre's conditional AAL plot, male, whole catch, NWFSC
2006
2007
2008
Age
Stdev (Age) (yr)
Observed (with 95% interval)
Expected
Length (cm)


Andre's conditional AAL plot, male, whole catch, NWFSC
2009
2010
2011
Age
Stdev (Age) (yr)
Observed (with 95% interval)
Expected
Length (cm)

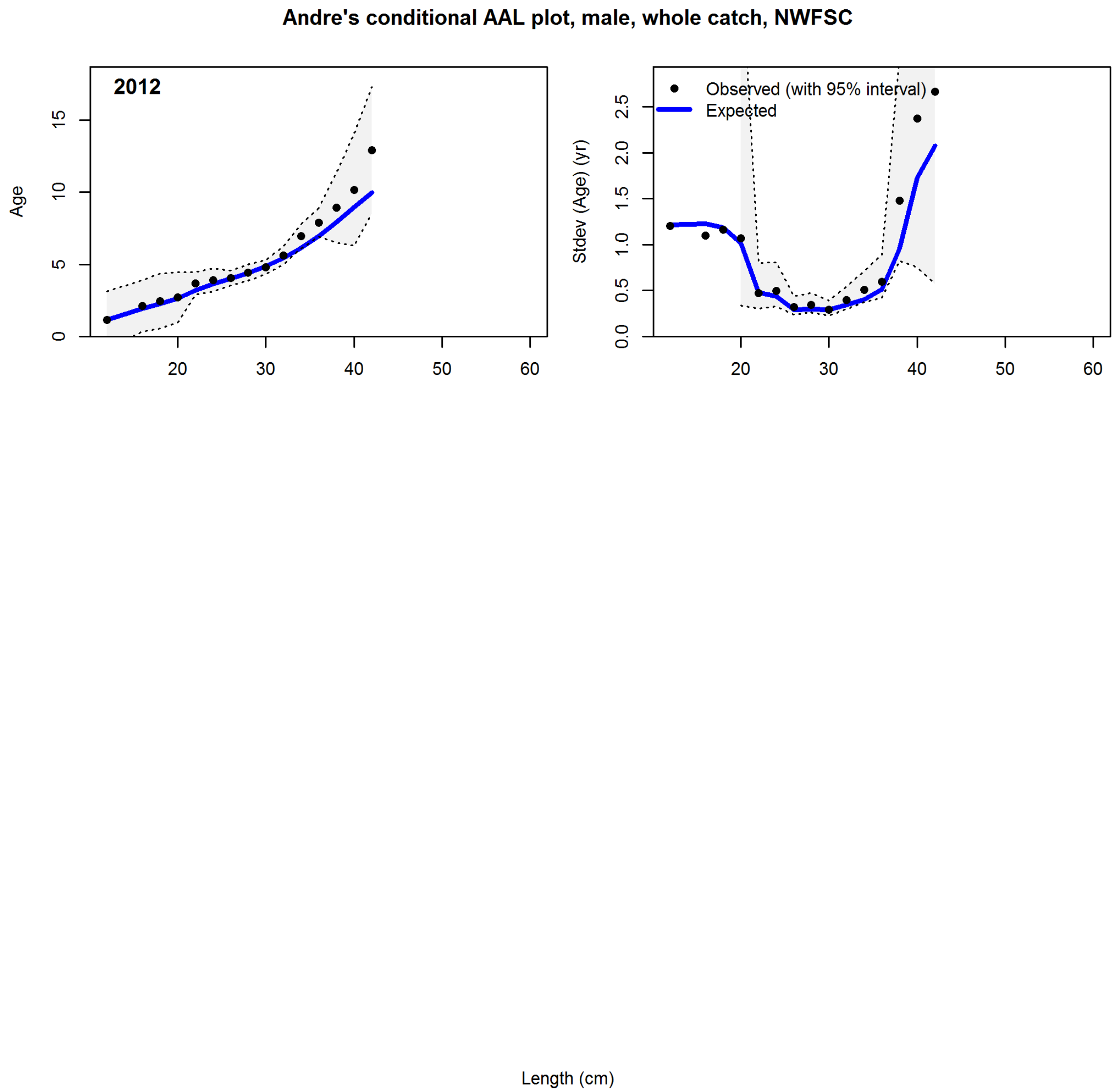


Figure 105. Conditional age-at-length and standard deviations of age-at-length for the NWFSC survey, females and males.

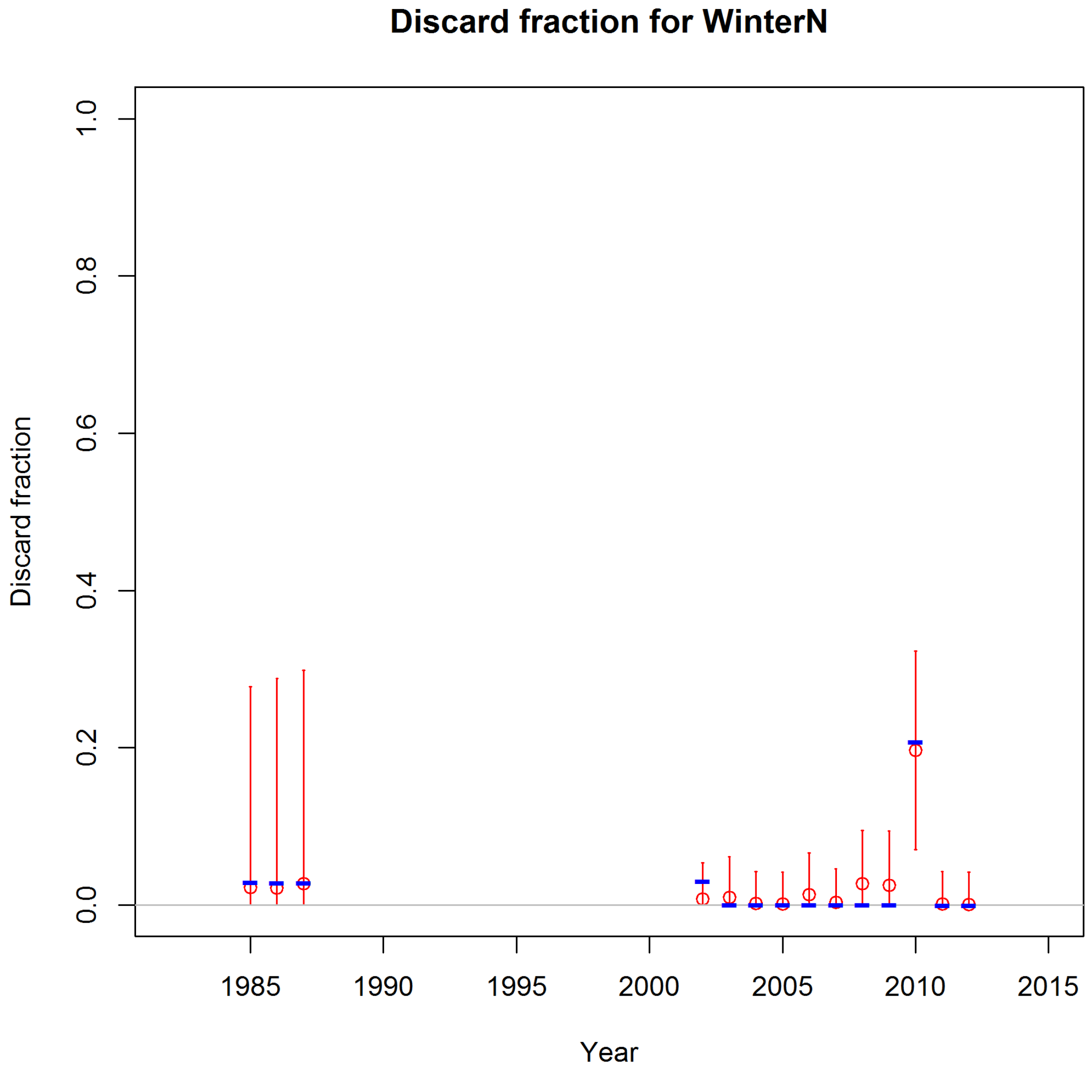


Figure 106. Winter north fits to the discard ratios.

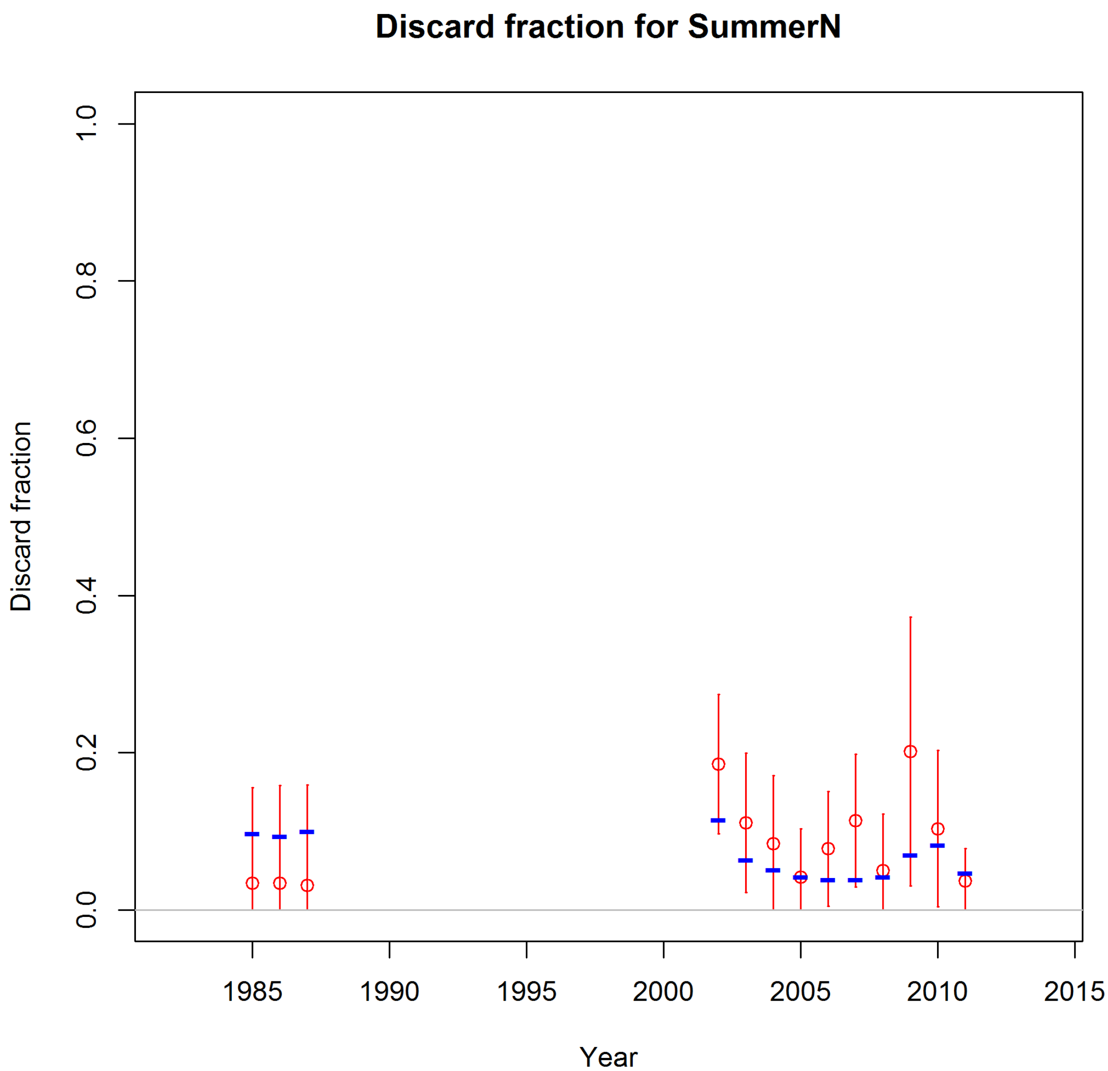


Figure 107. Winter north fits to the discard ratios.

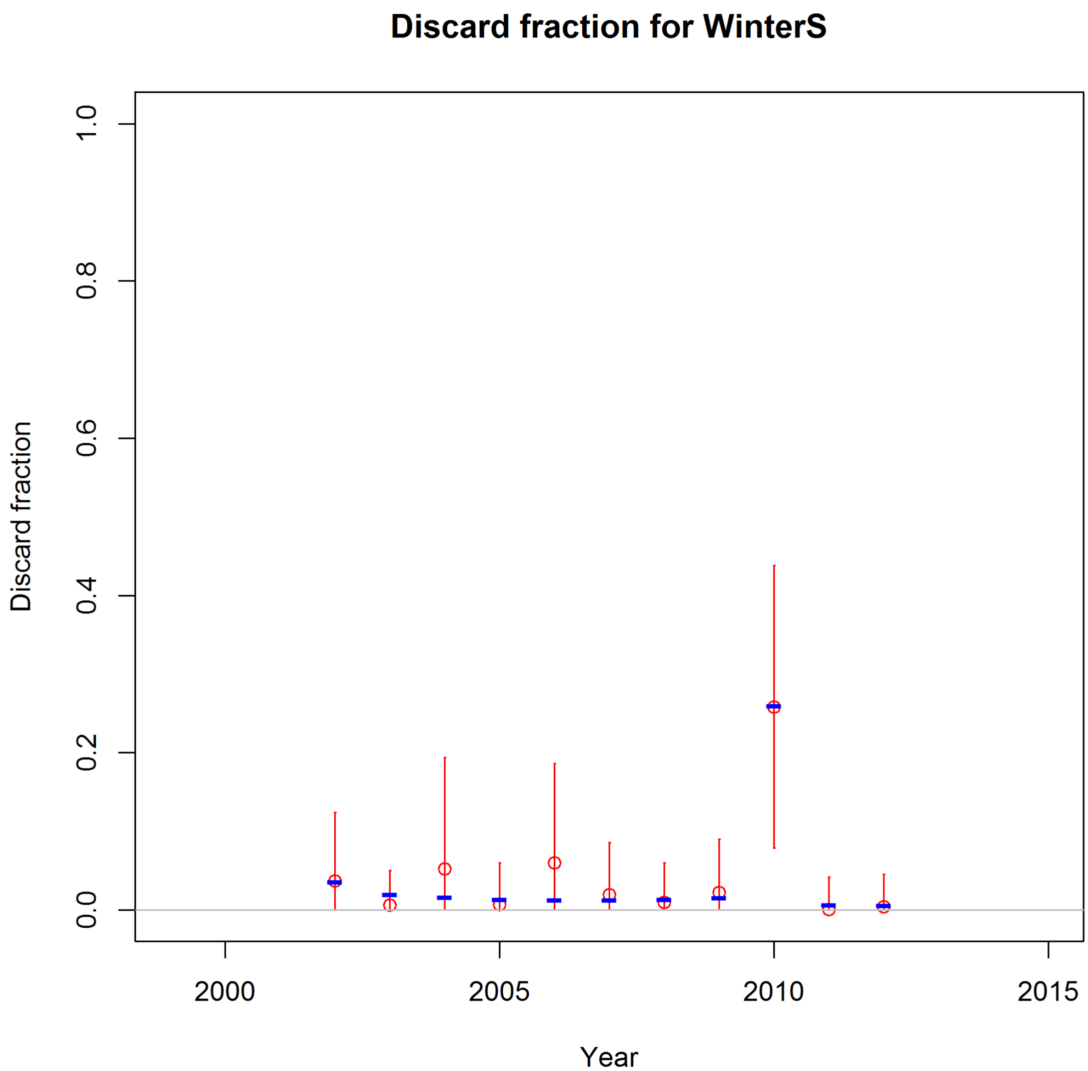


Figure 108. Winter south fits to the discard ratios.

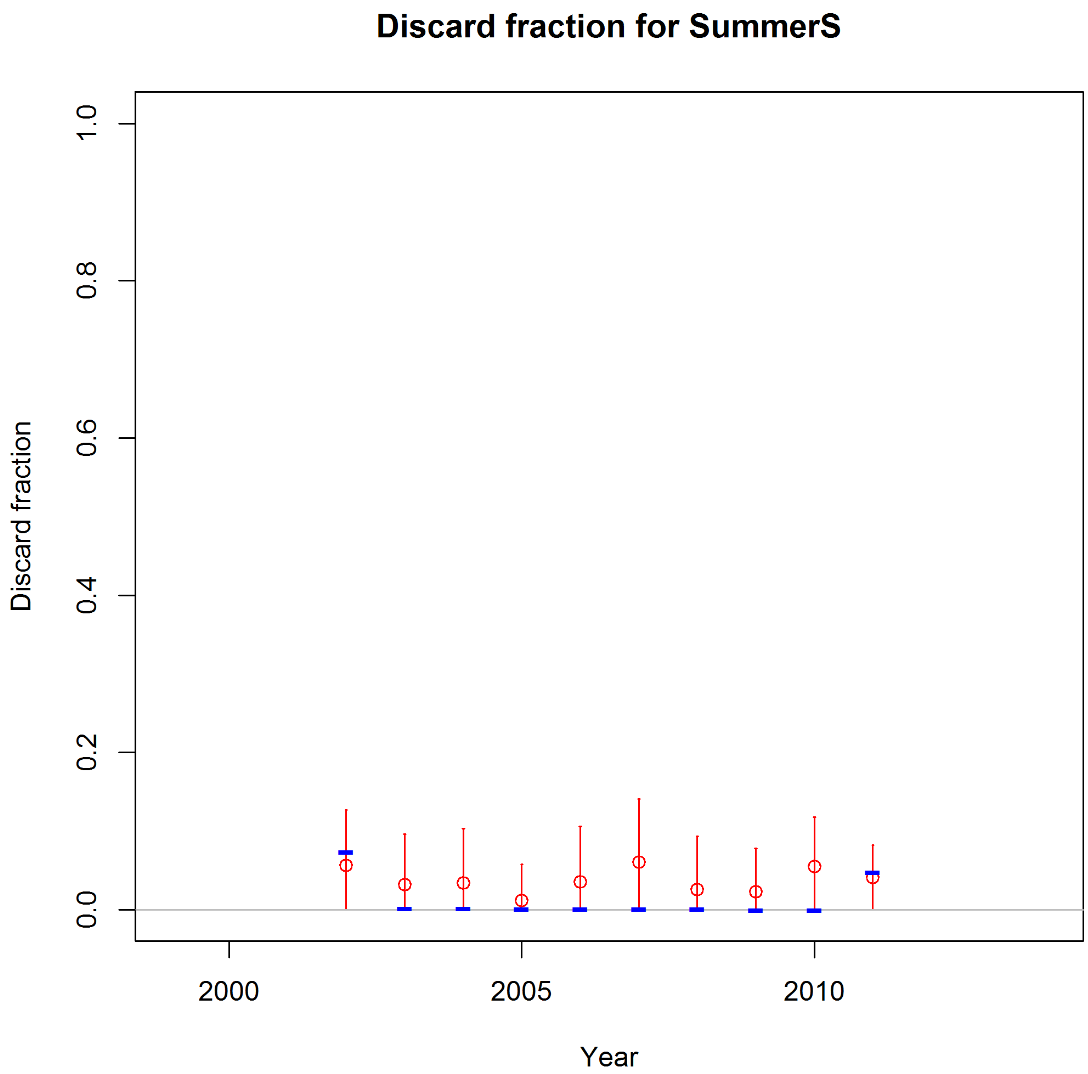


Figure 109. Winter south fits to the discard ratios.

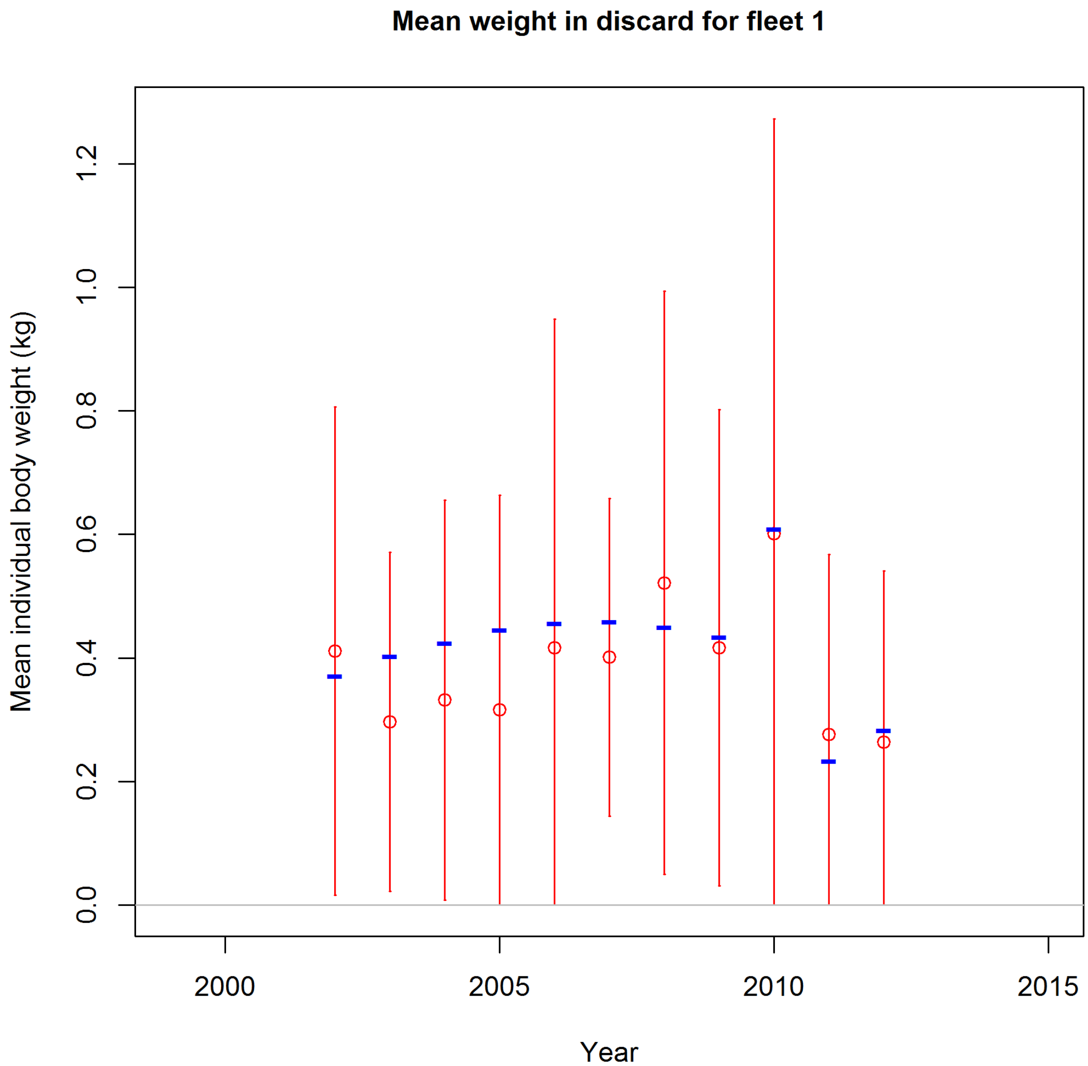


Figure 110. Winter north fit to the mean weight of the discards.

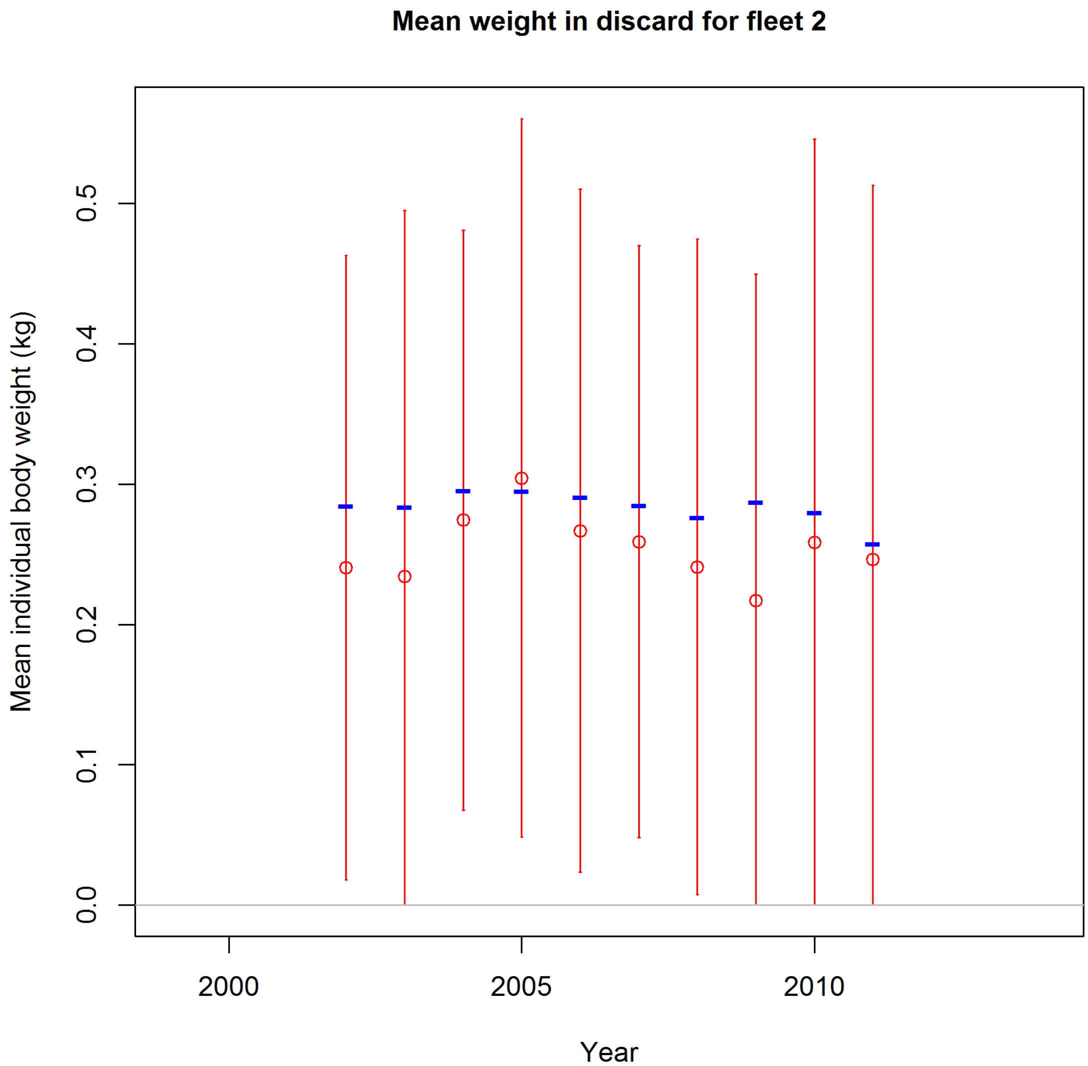


Figure 111. Summer north fit to the mean weight of the discards.

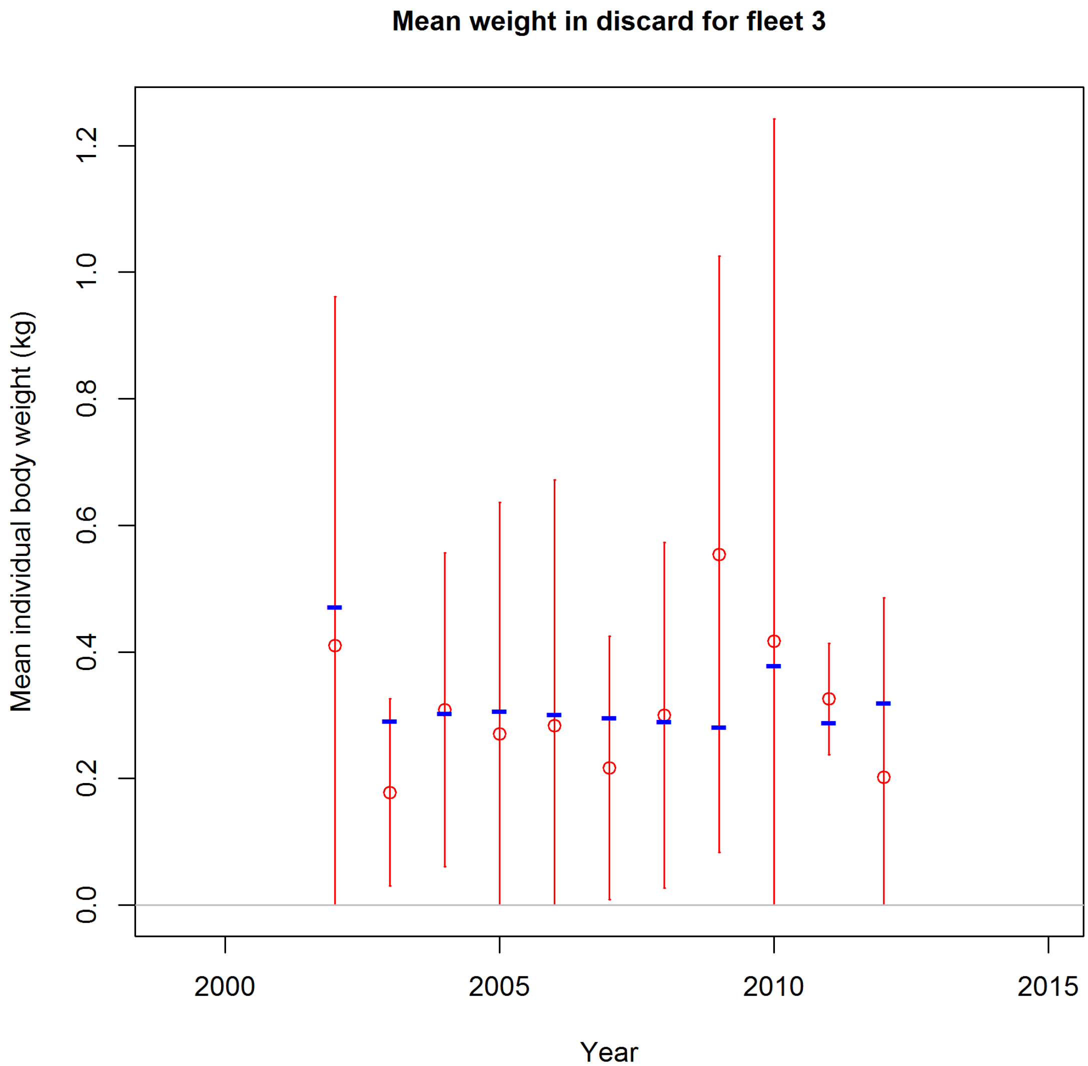


Figure 112. Winter south fit to the mean weight of the discards.

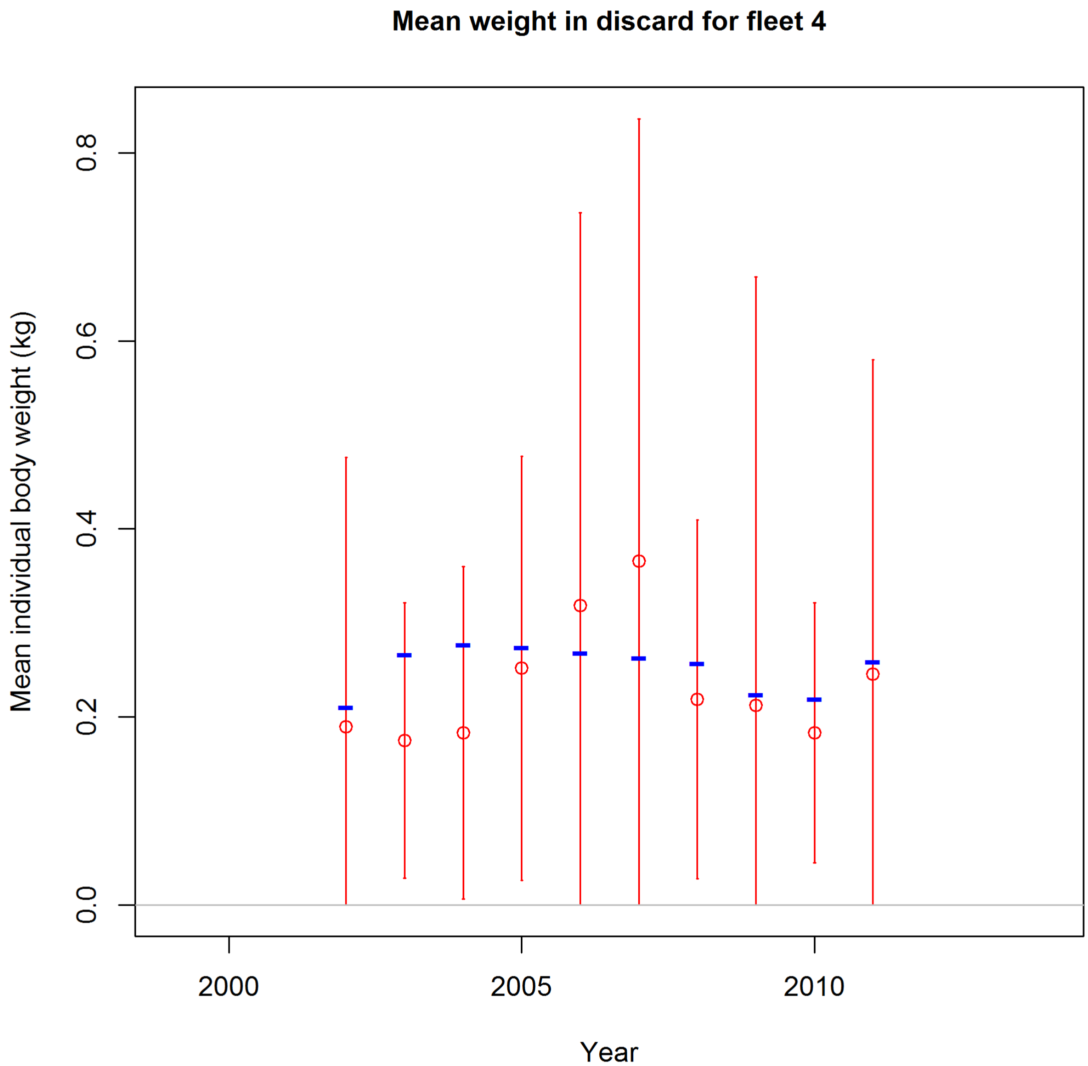


Figure 113. Summer south fit to the mean weight of the discards.

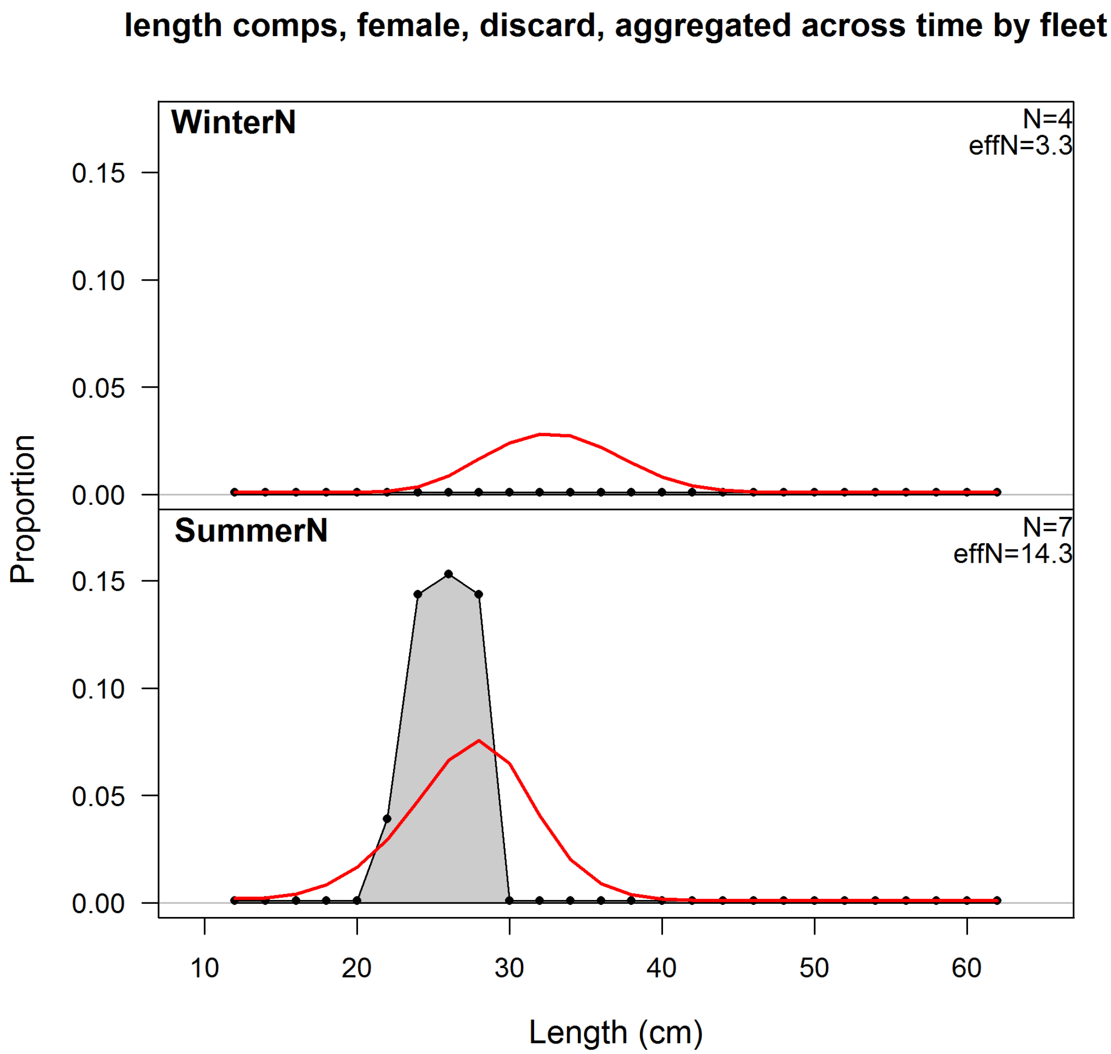


Figure 114. Winter north Pikitch discard length compositions fits, female.

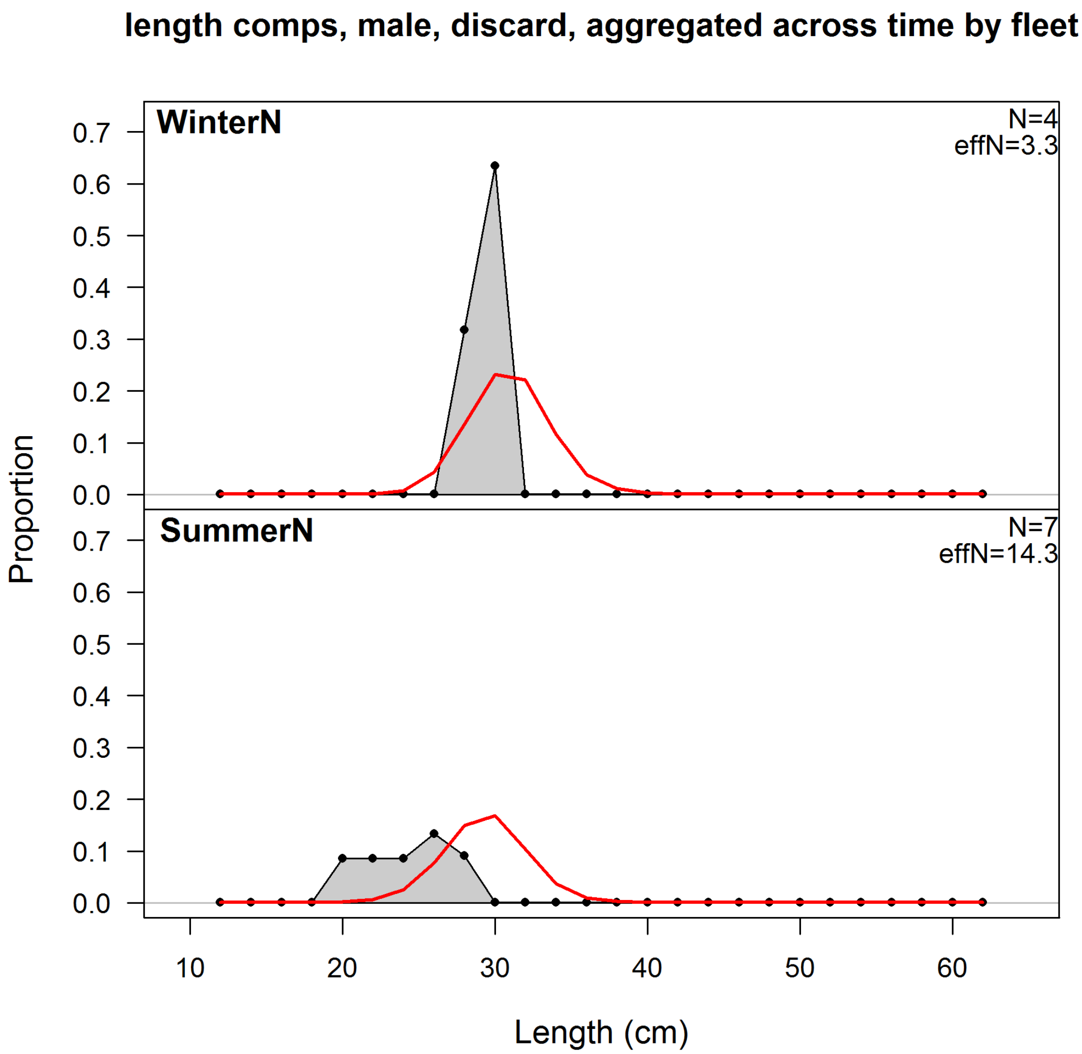


Figure 115. Summer north Pikitch discard length compositions fits, male.

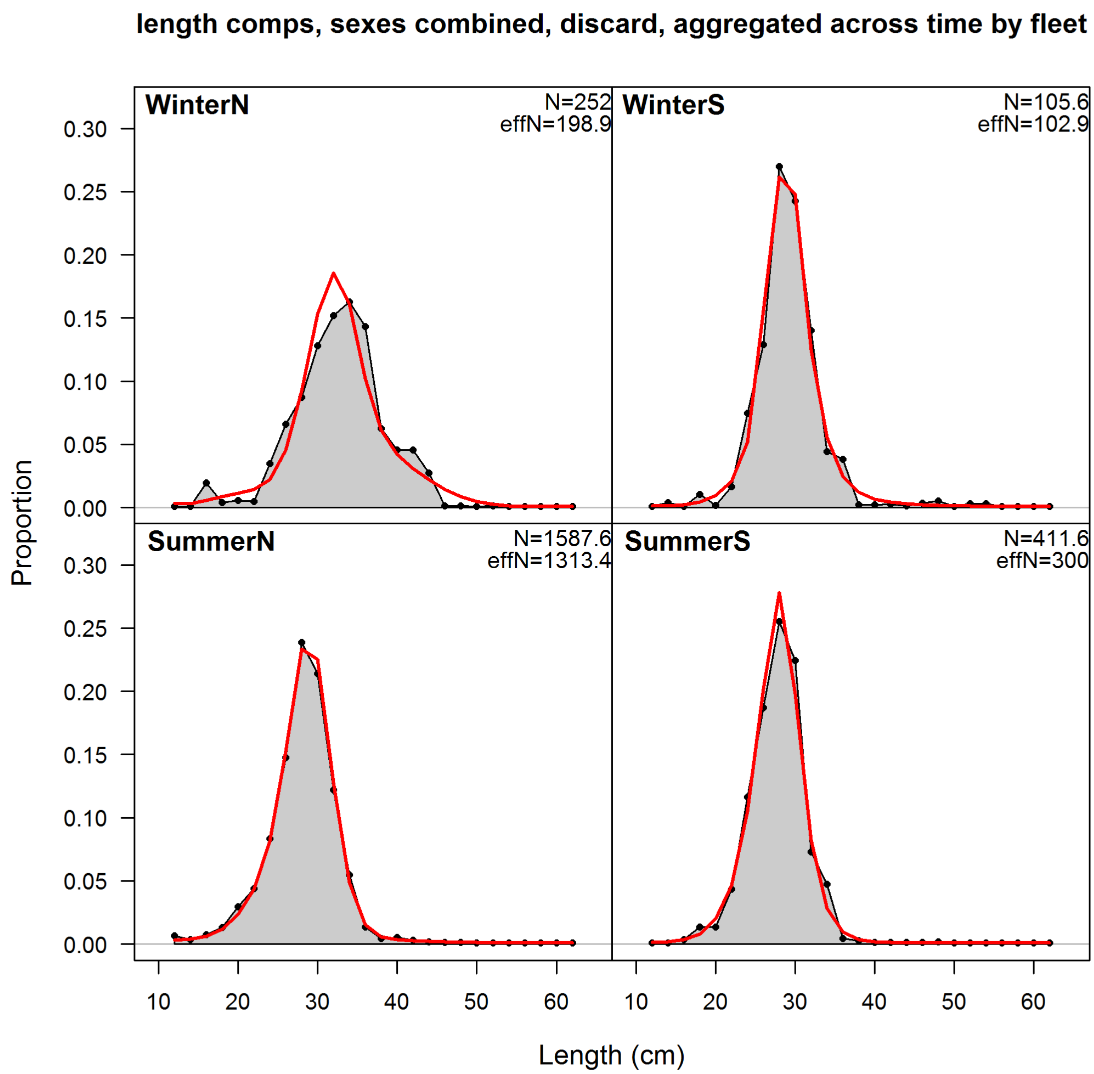


Figure 116. Composite WCGOP discard length compositions fits.

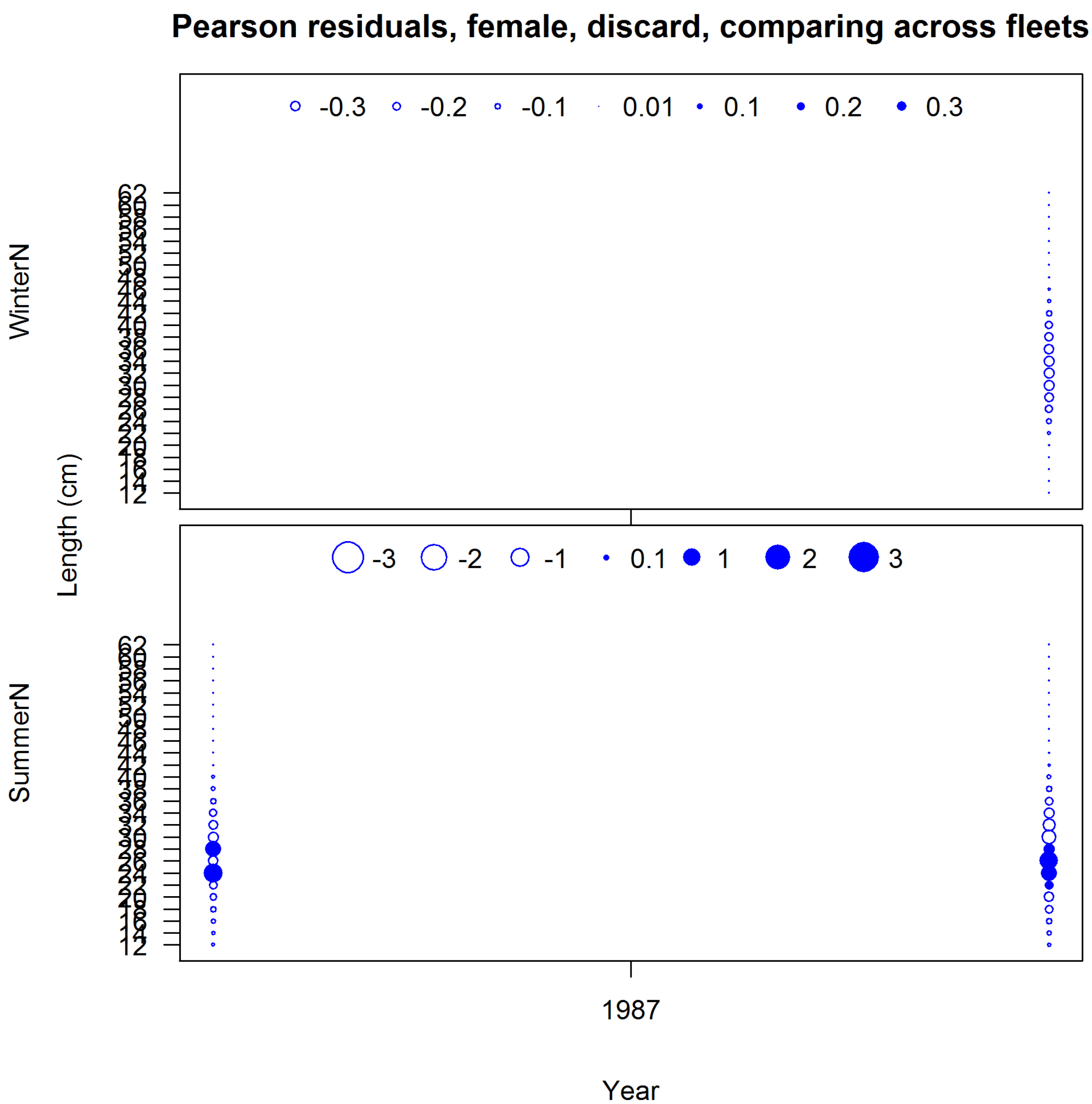


Figure 117. Pearson residuals Pikitch length compositions, females.

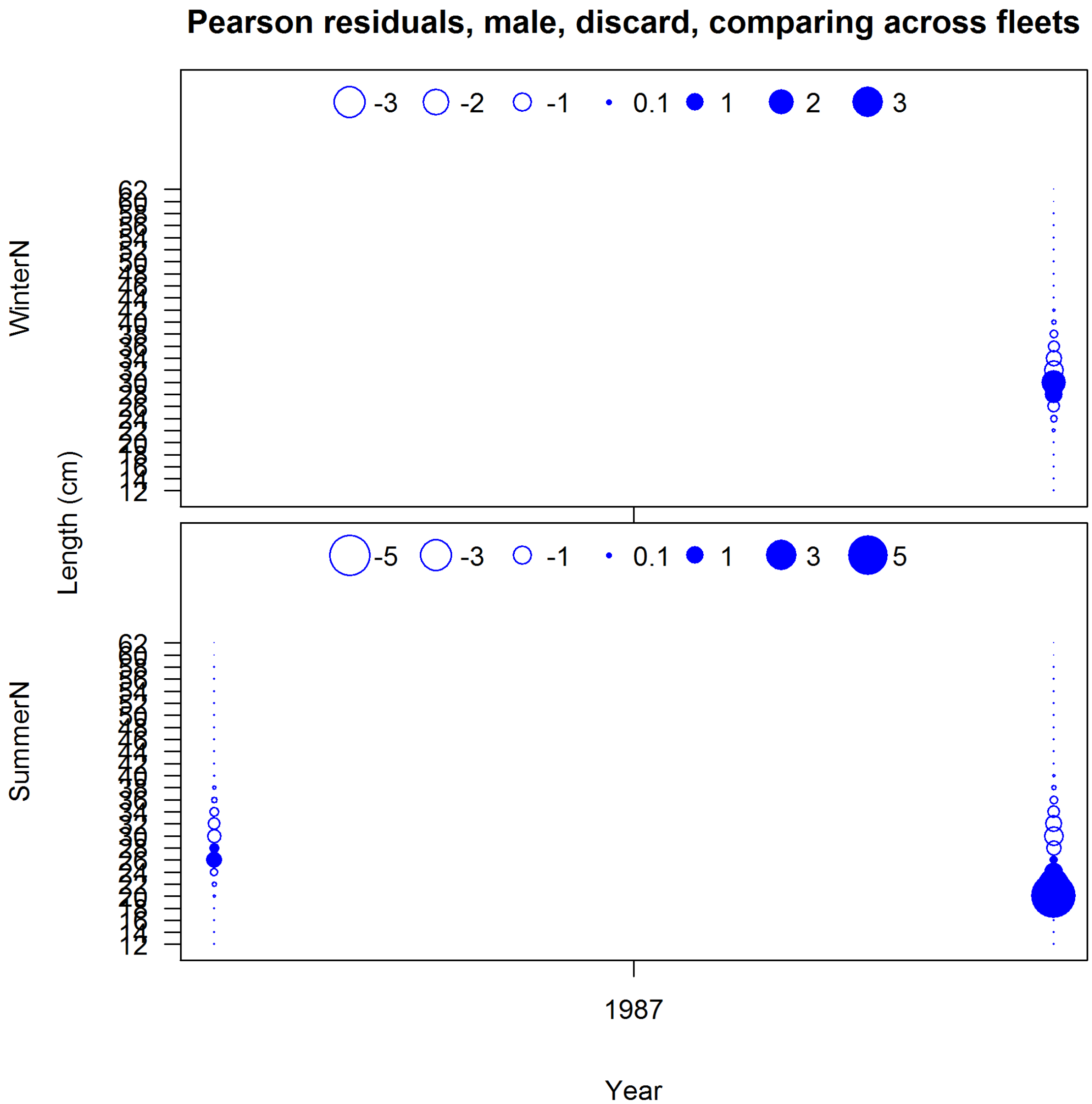


Figure 118. Pearson residuals Pikitch length compositions, males.

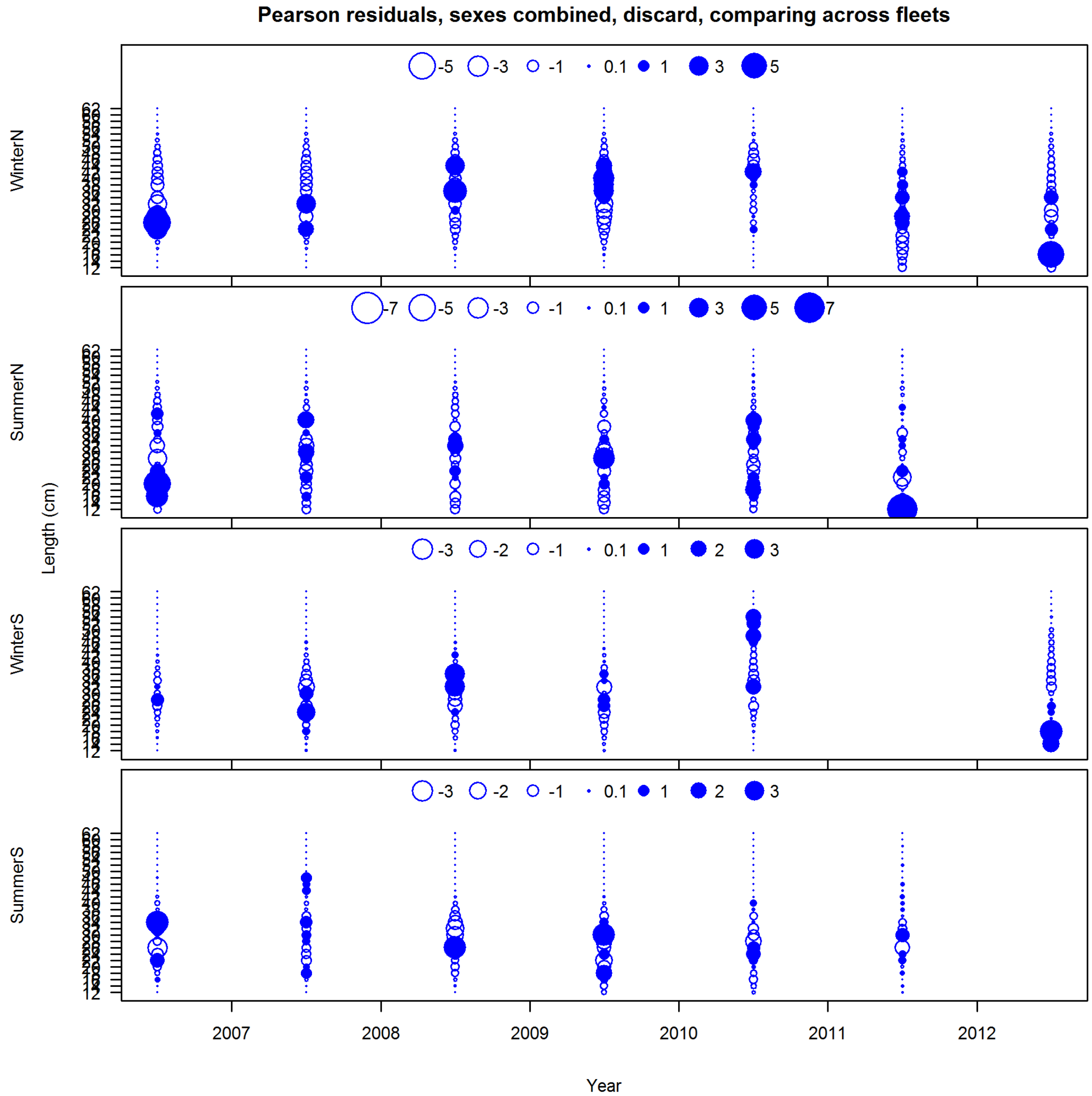


Figure 119. Pearson residuals WCGOP length compositions, all fishing fleets.

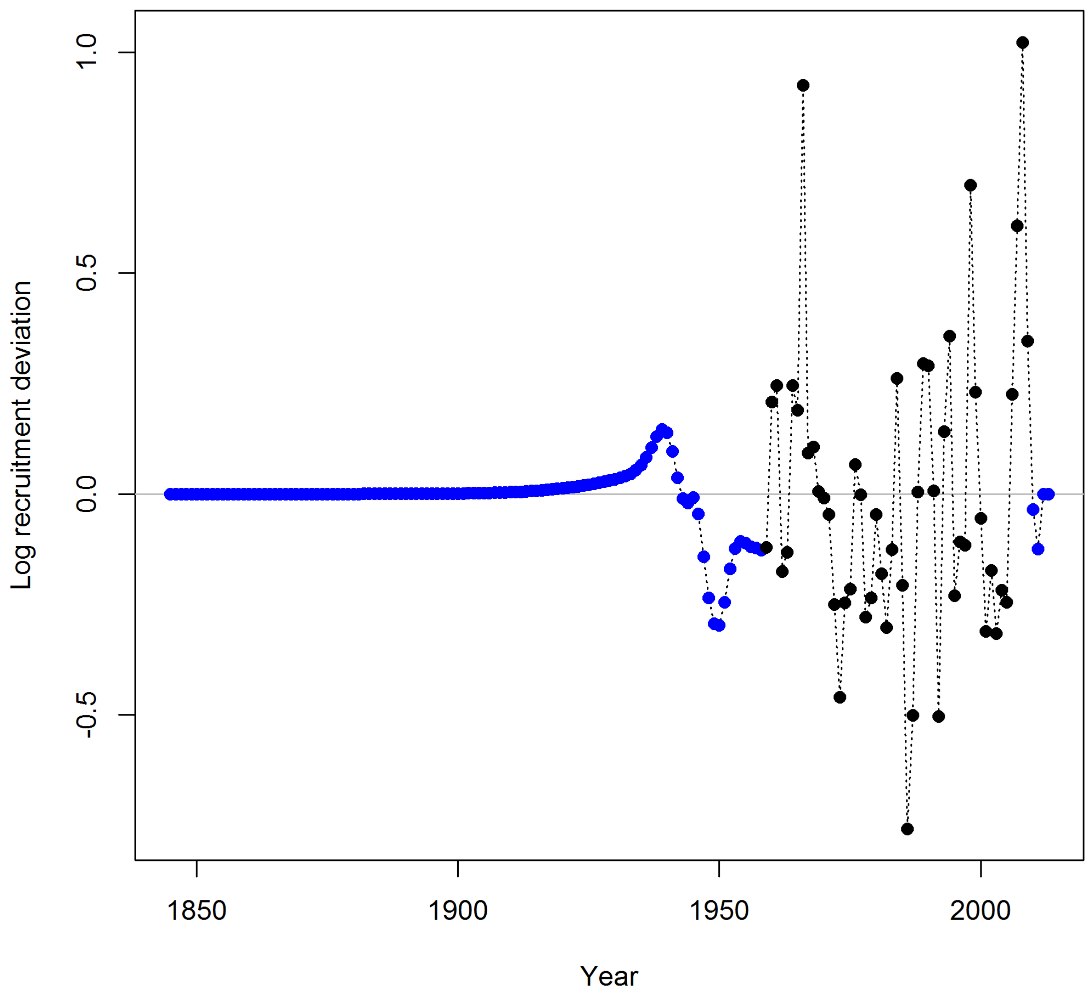


Figure 120 . Log recruitment deviations from the base case model run.

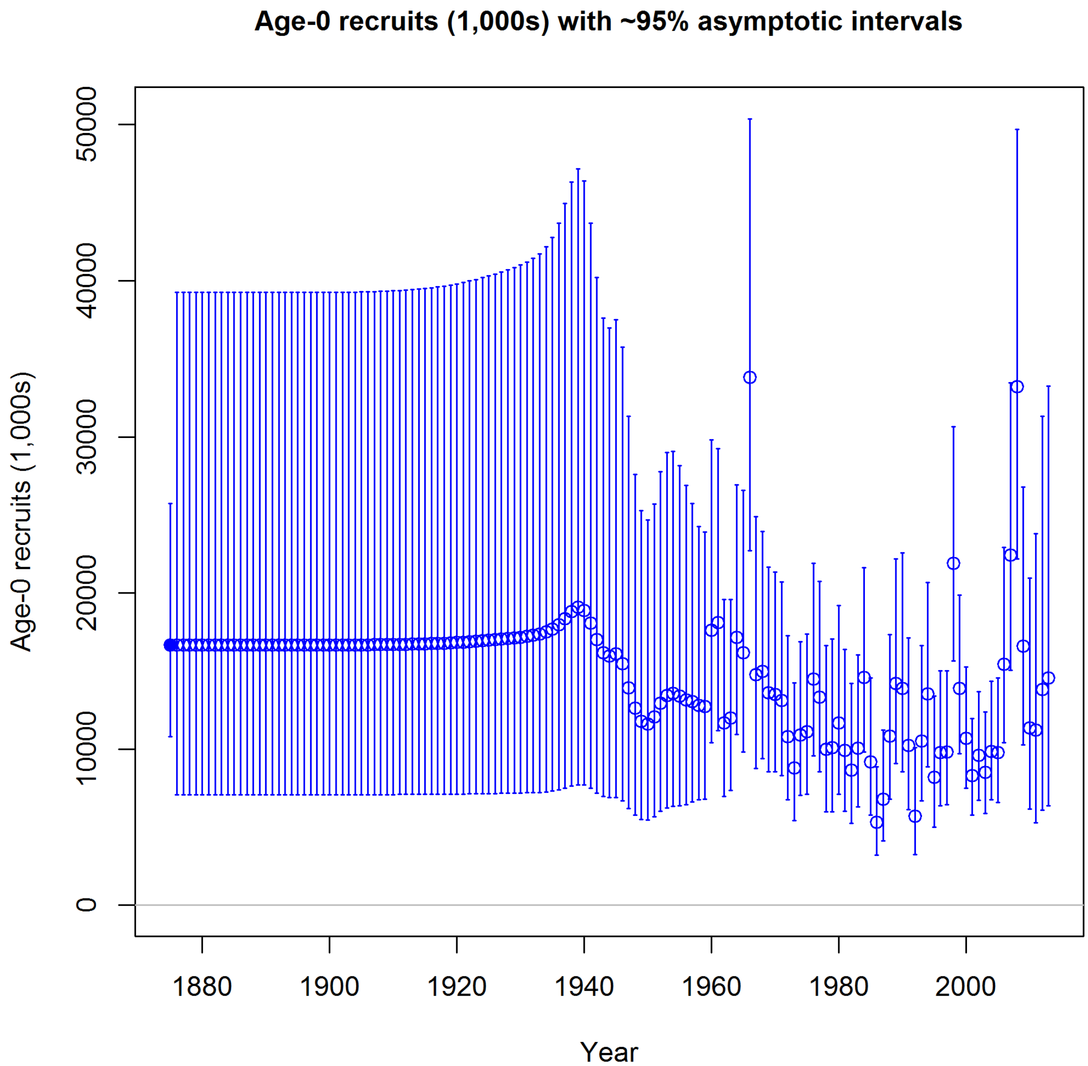


Figure 121. Time series of estimated petrale sole recruitments for the base case model (round points) with approximate asymptotic 95% confidence interval (horizontal lines).

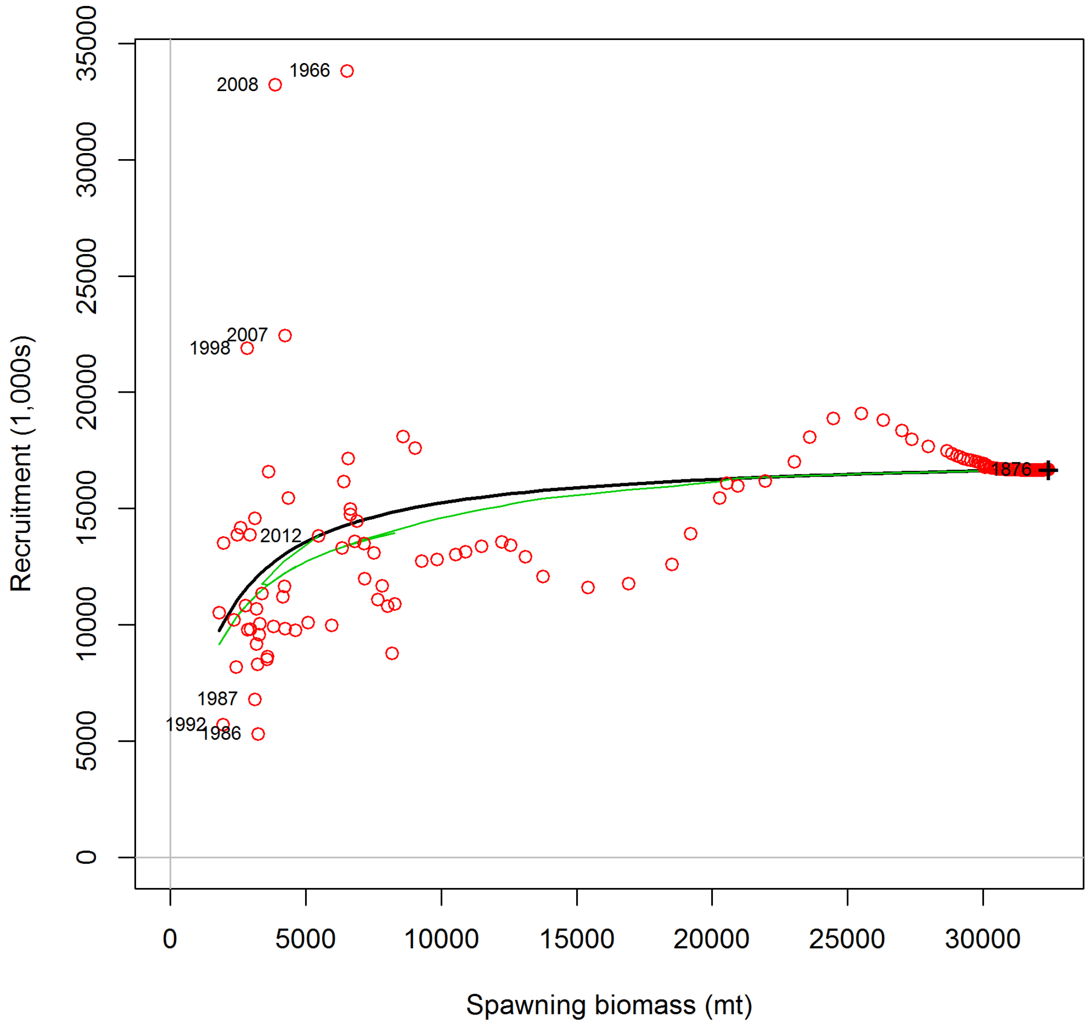


Figure 122. Stock-recruit function with predicted recruitments (points) and bias-corrected expectation (light line).

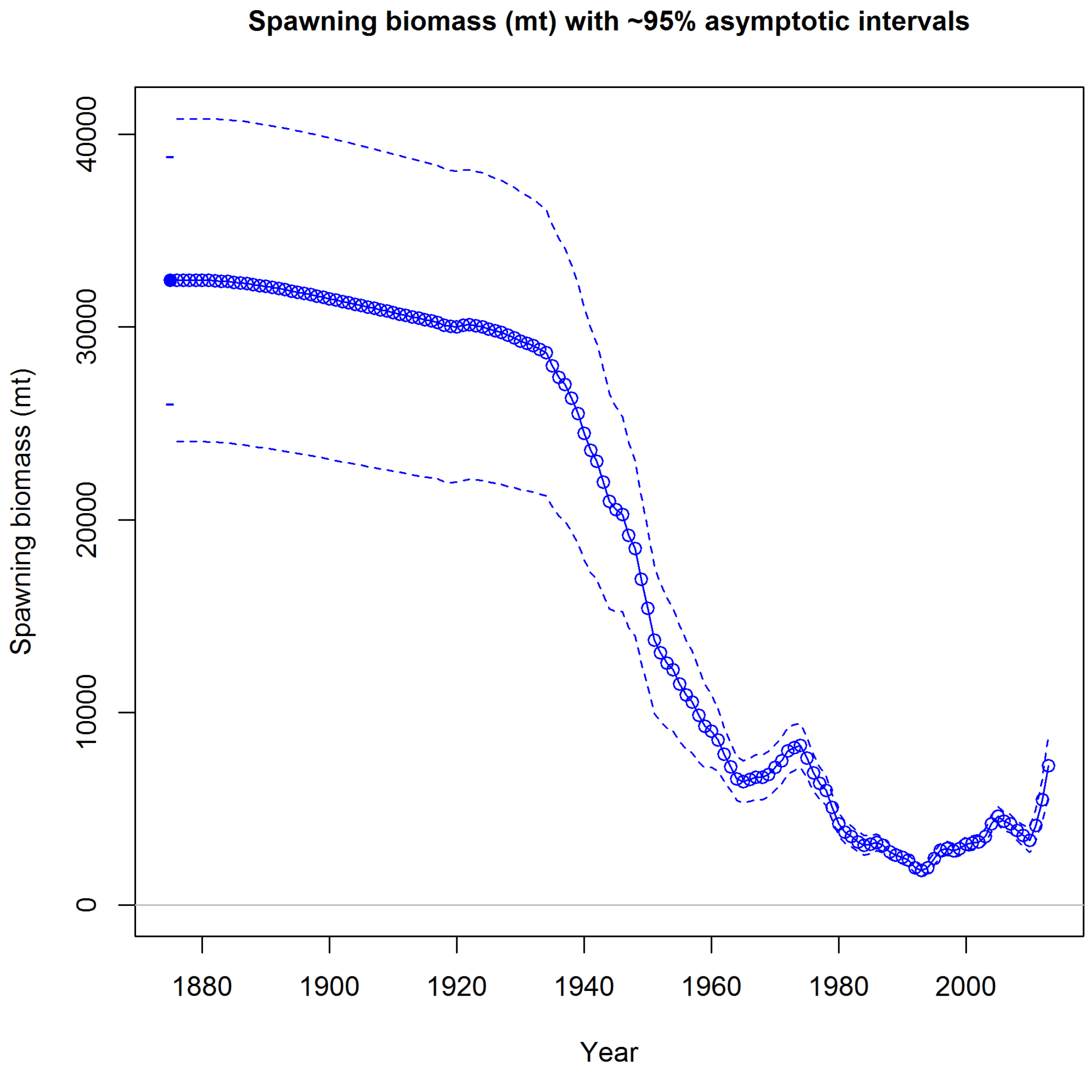


Figure 123. Estimated spawning biomass time-series for the base case model (solid line) with approximate asymptotic 95% confidence interval (dashed lines).

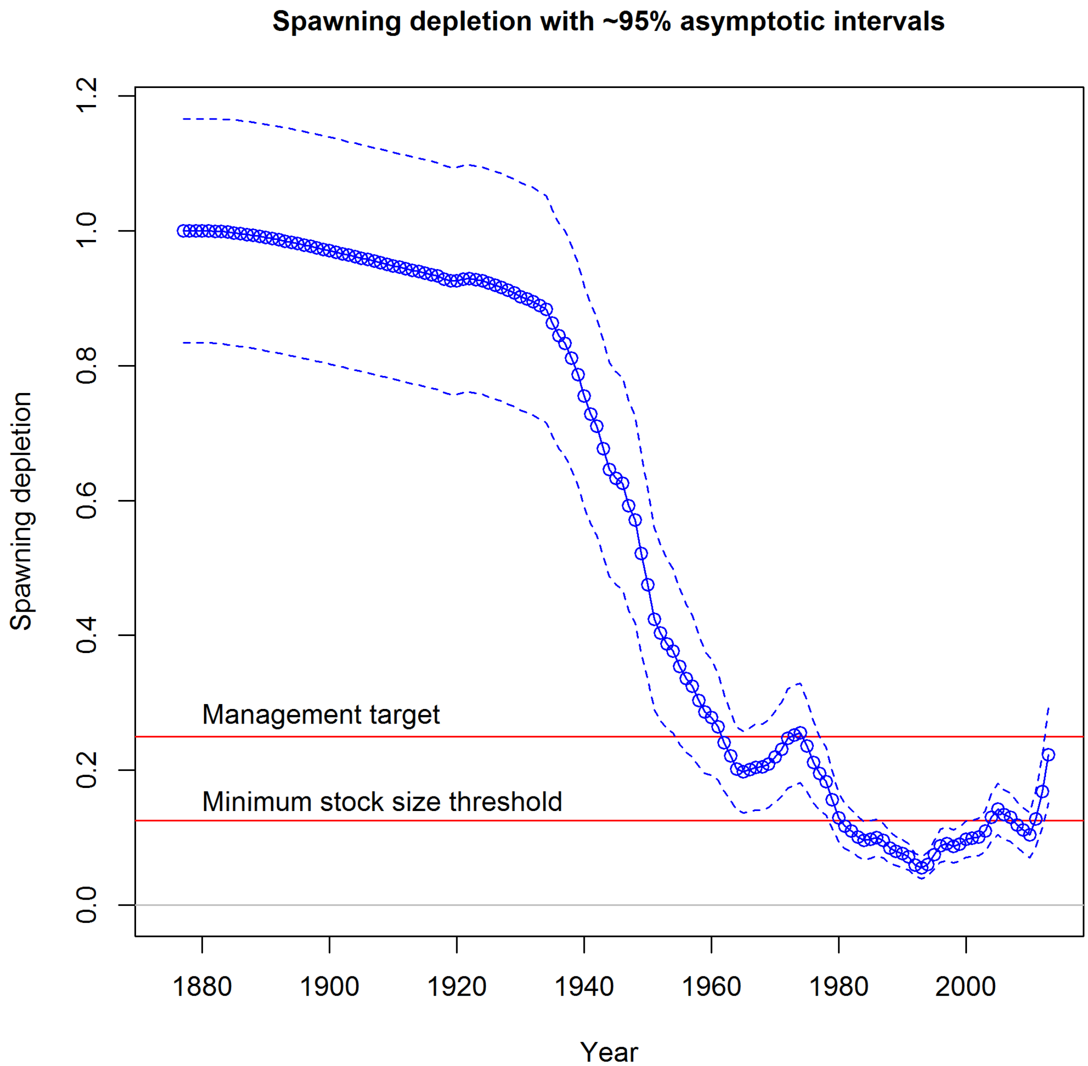


Figure 124. Time series of depletion level as estimated in the base case model (round points) with approximate asymptotic 95% confidence interval (dashed lines).

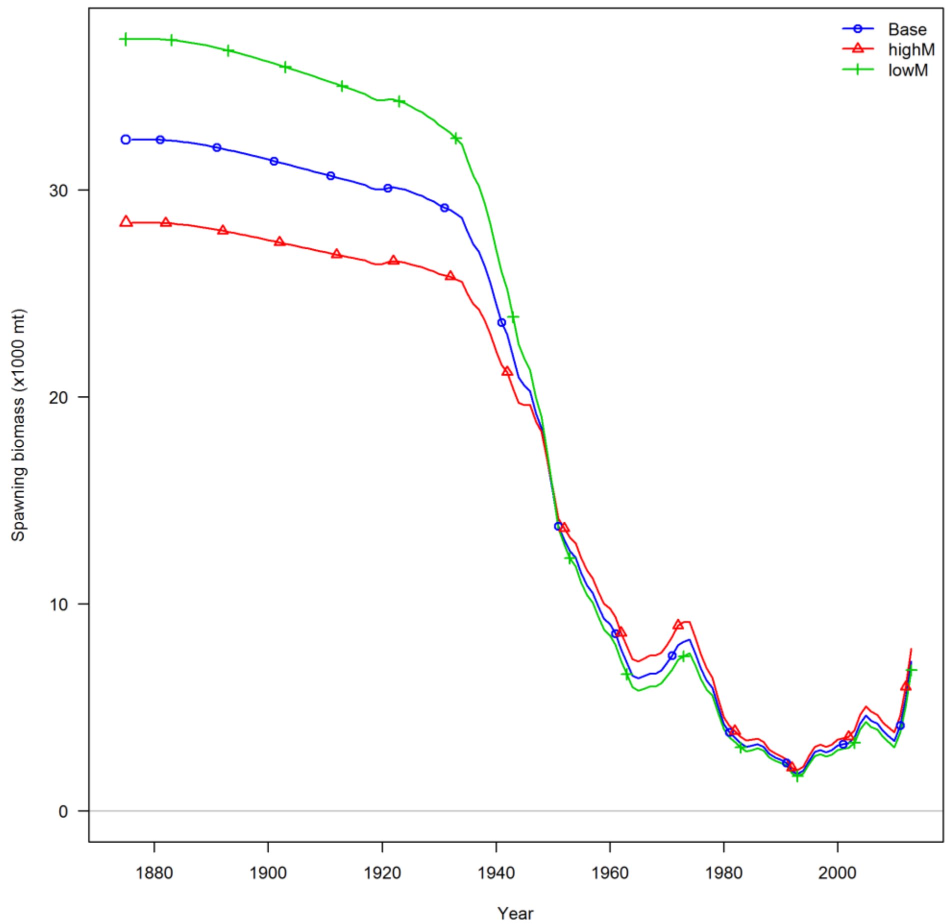


Figure 125. Spawning biomass for sensitivity to model structure for the base model (blue), model with high female M (red), and low female M.

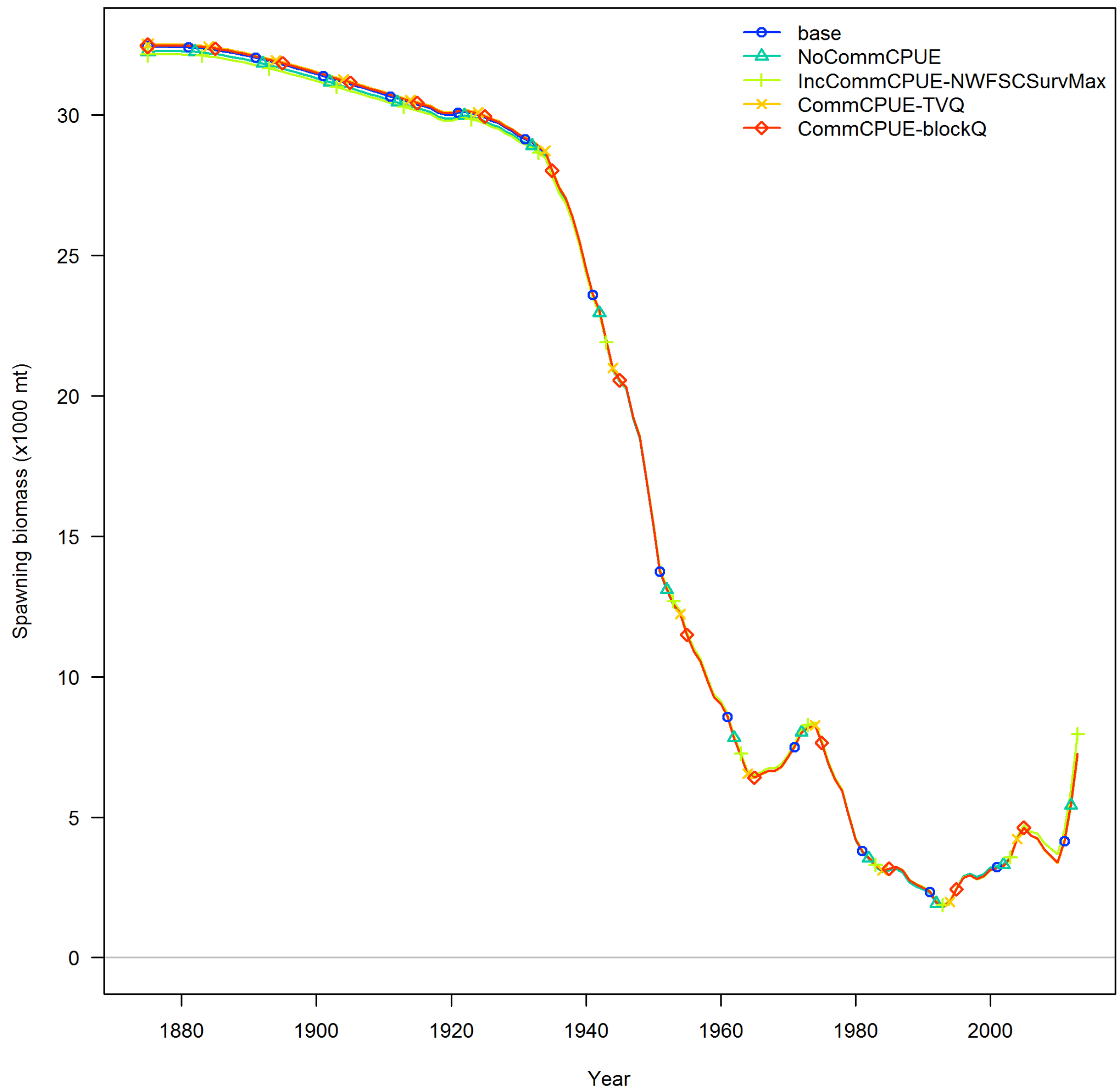


Figure 126. Spawning biomass for sensitivity to the treatment of the winter commercial CPUE for the base model (blue), the model removing the winter commercial CPUE (green), the model increasing the standard deviations from the bootstrap by adding the maximum value estimated for the NWFSC survey (light green), the model allowing for time varying q between 2006-2009 (ornange), and the model allowing for a time block in *q* between 2003 and 2004.

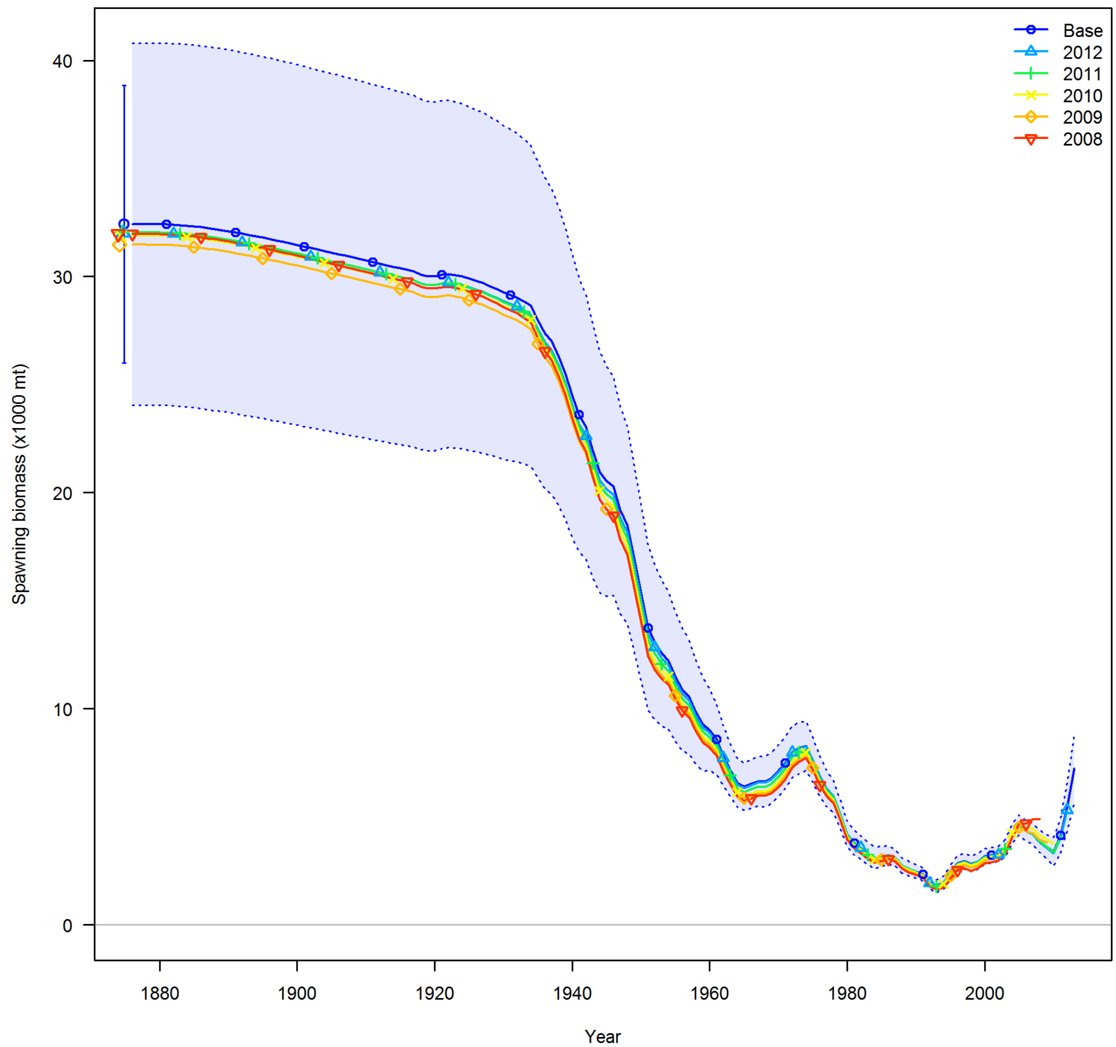


Figure 127. Retrospective analysis results for spawning biomass. Each year of retrospective is performed as if the assessment were conducted in that year (i.e., retrospective in 2012 includes data through 2011).

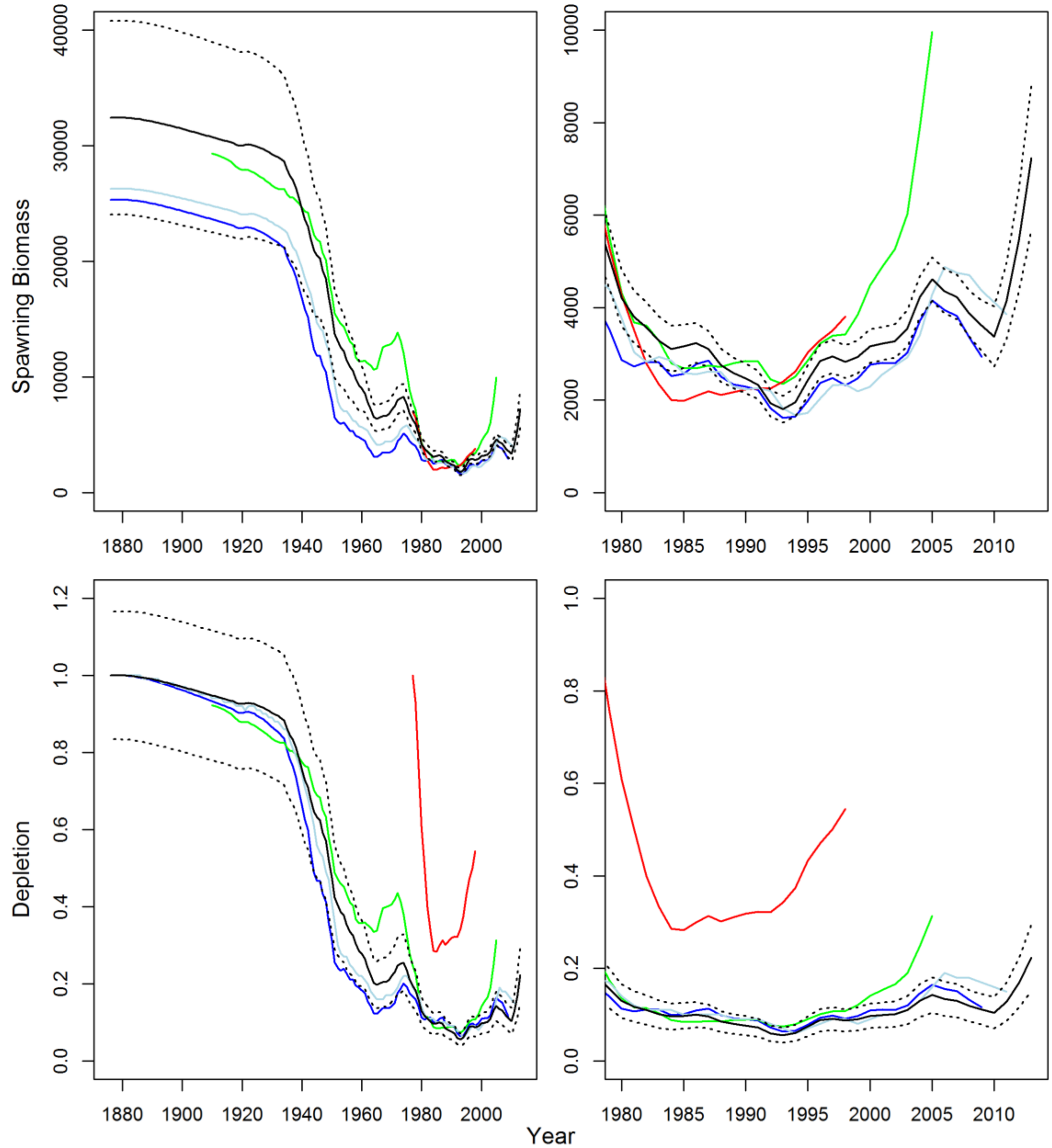


Figure 128. Comparisons of the model estimated spawning biomass and stock depletion for the 1999 (red), 2005 (green), 2009 (blue), 2011 (light blue), and 2013 (black) assessment models. The ~95% confidence intervals from the 2013 model are shown as broken lines.

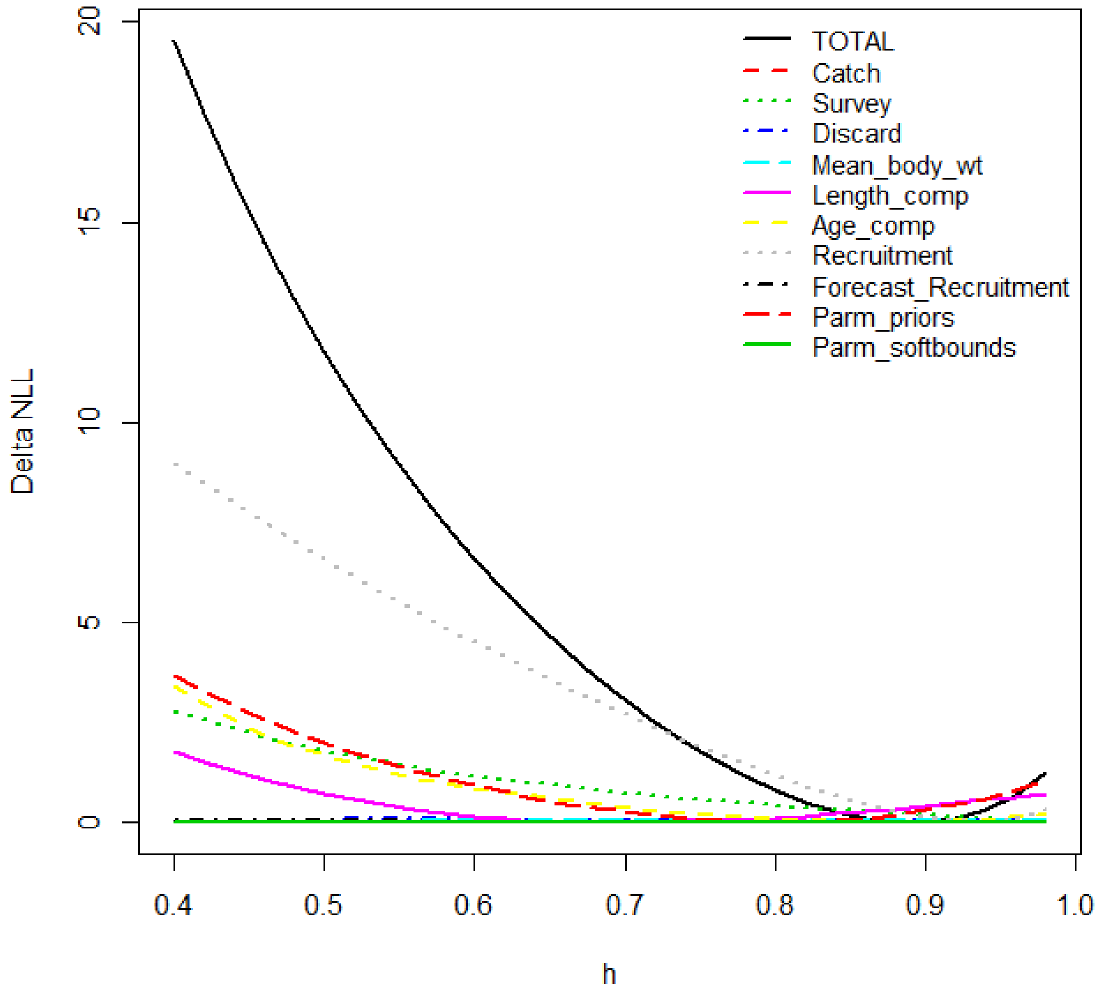


Figure 129. Likelihood profile for the stock-recruitment steepness (h).

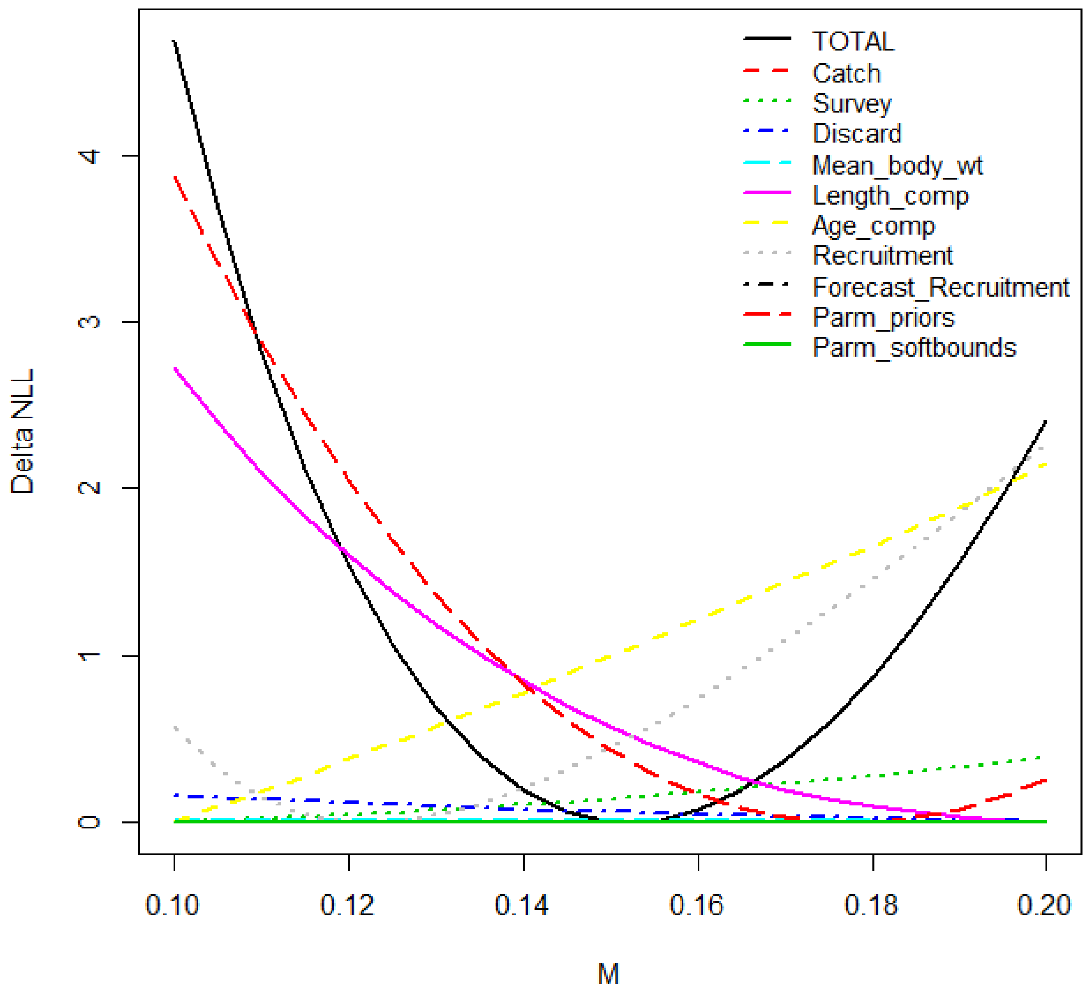


Figure 130. Likelihood profile for female natural mortality (M).

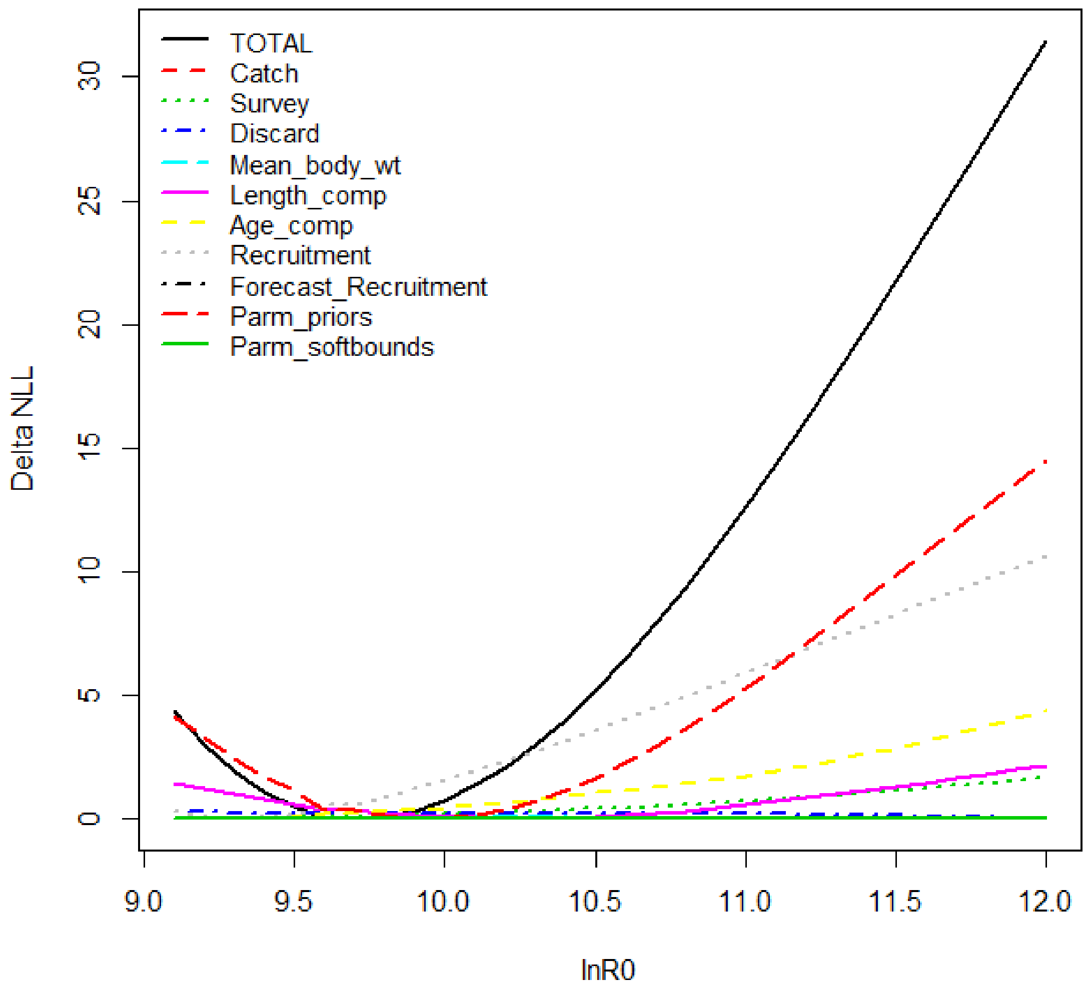


Figure 131. Likelihood profile for unfished recruitment (Ro) for total likelihoods.

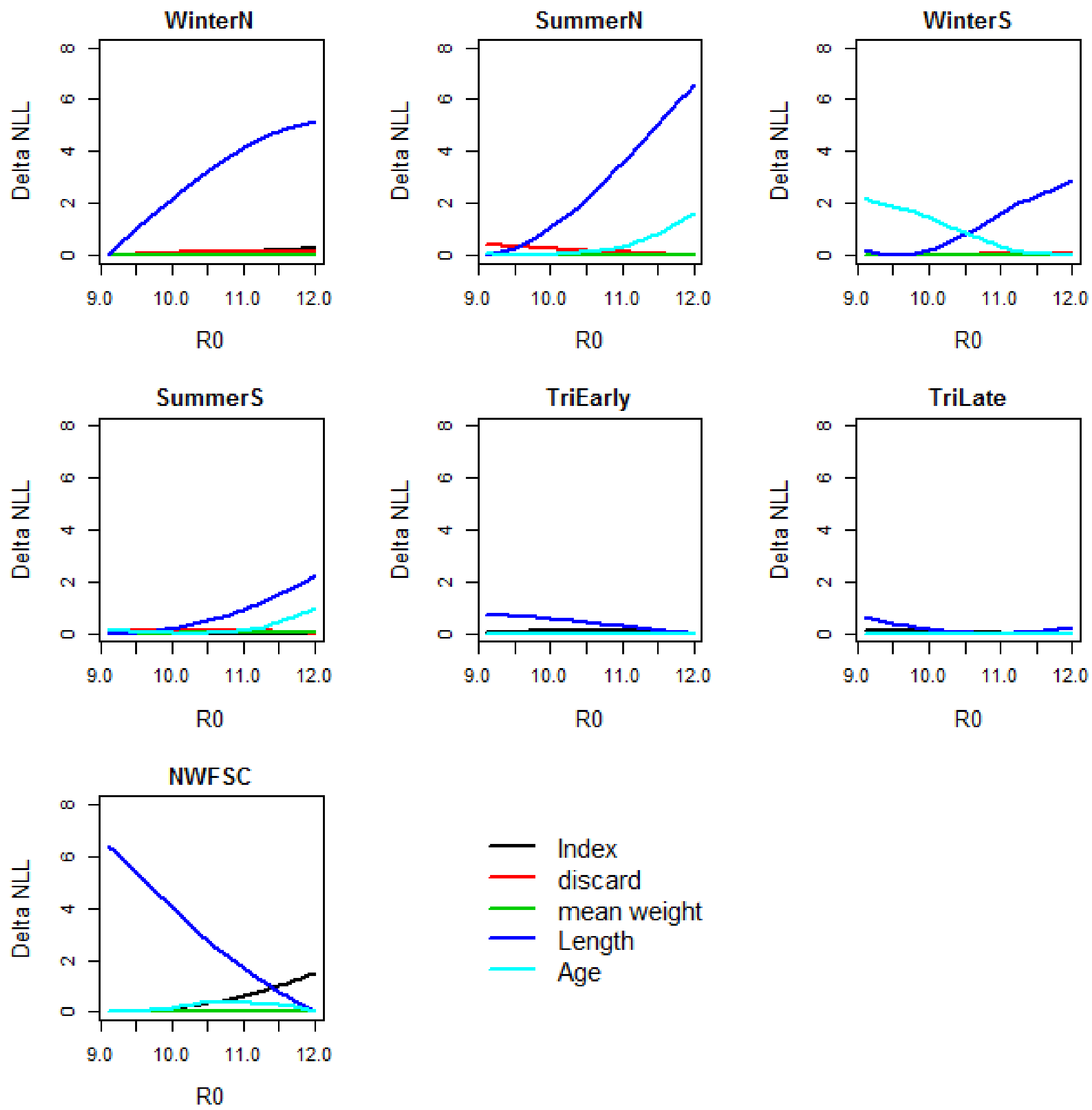


Figure 132. Likelihood profile for unfished recruitment (Ro) for likelihood components by fleet/survey.

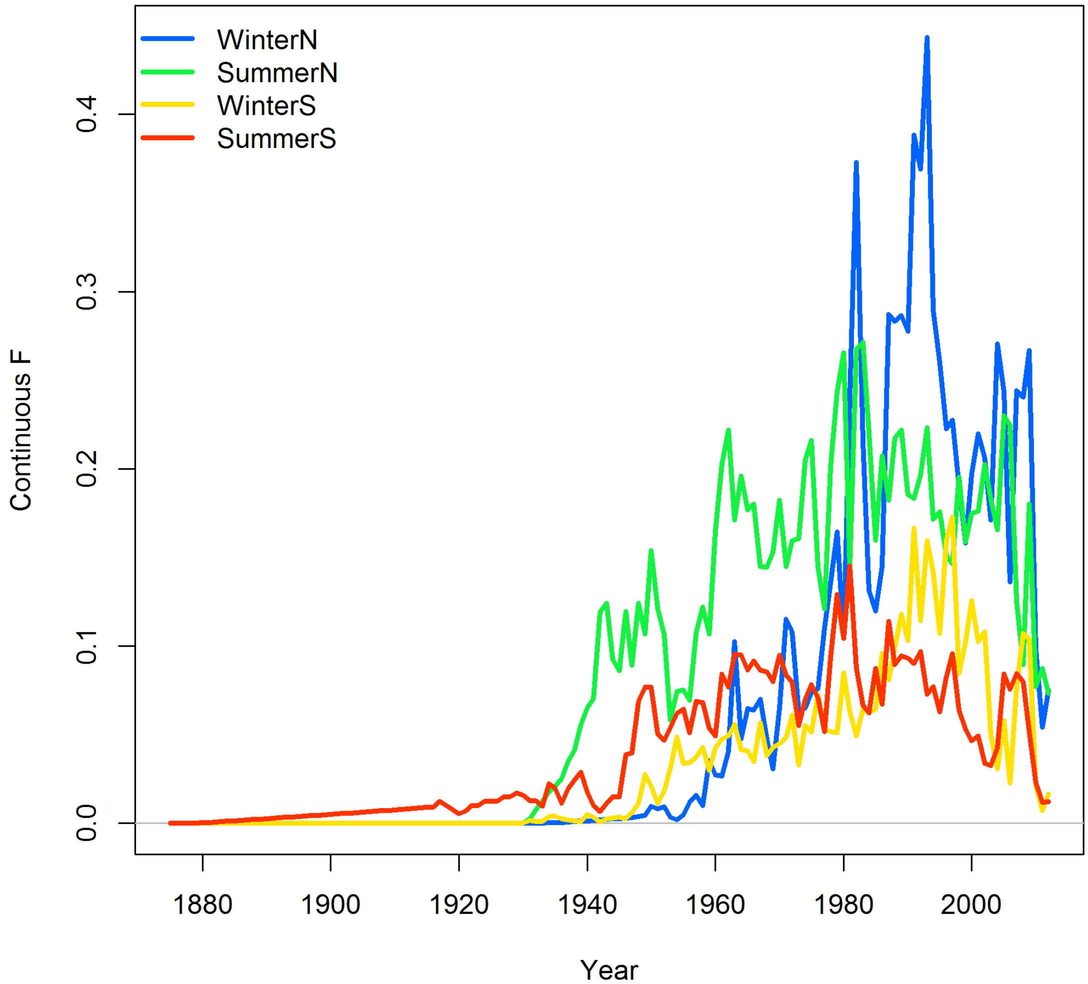


Figure 133. F time-series for each fleet.

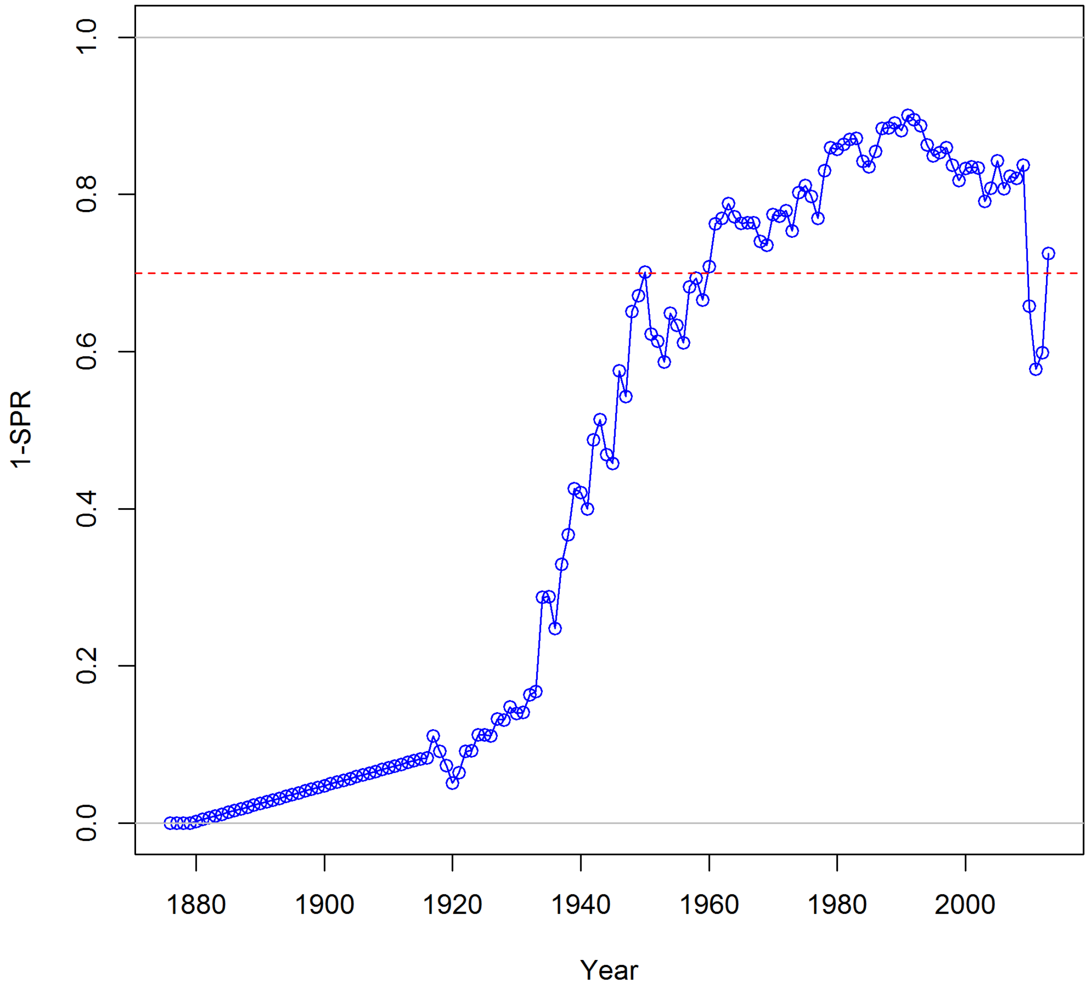


Figure 134. Time series of estimated spawning potential ratio (displayed as 1-SPR). Values of SPR above 0.7 reflect harvests in excess of the current overfishing proxy. The last year in the time series is 2013.

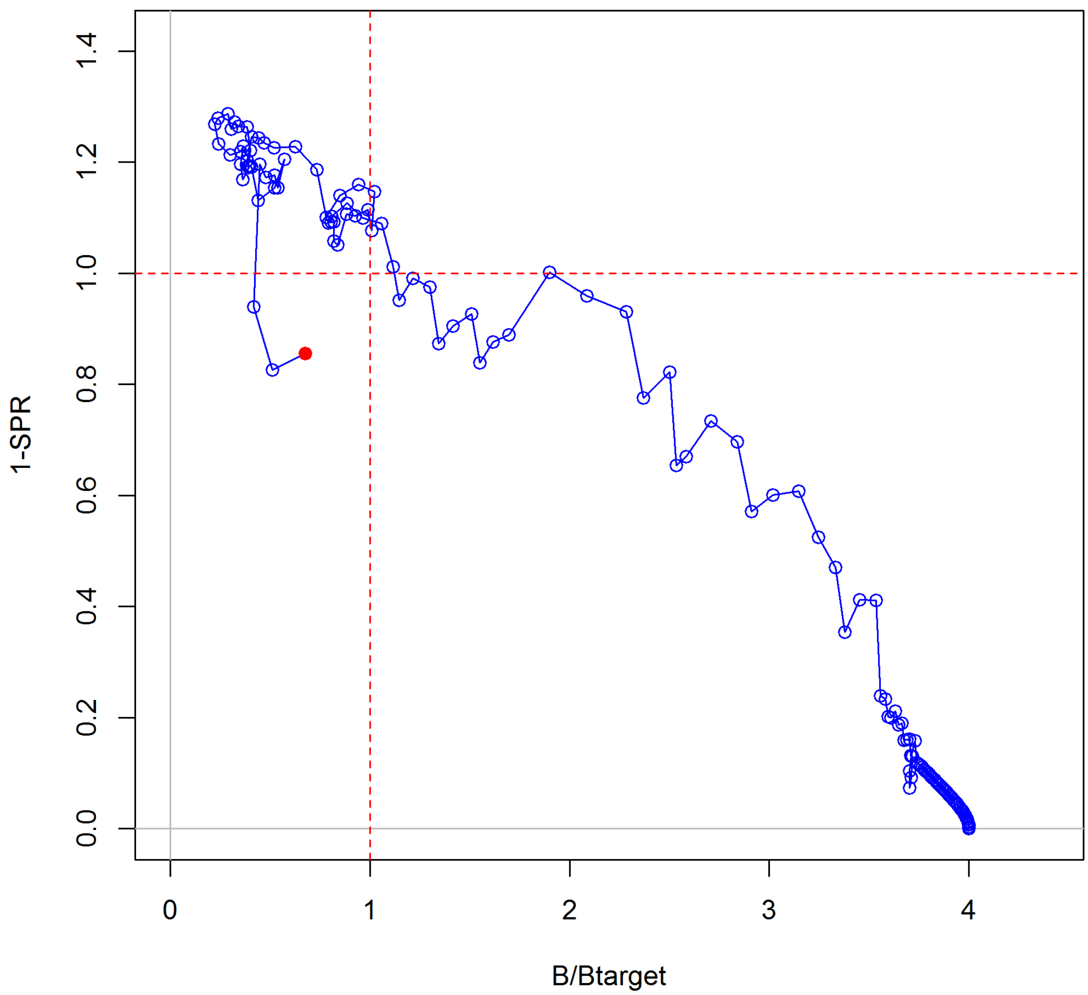


Figure 135. Phase plot of estimated fishing intensity vs. relative spawning biomass for the base case model. Fishing intensity is the relative exploitation rate divided by the level corresponding to the overfishing proxy (0.125). Relative spawning biomass is annual spawning biomass relative to virgin spawning biomass divided by the 25% rebuilding target.

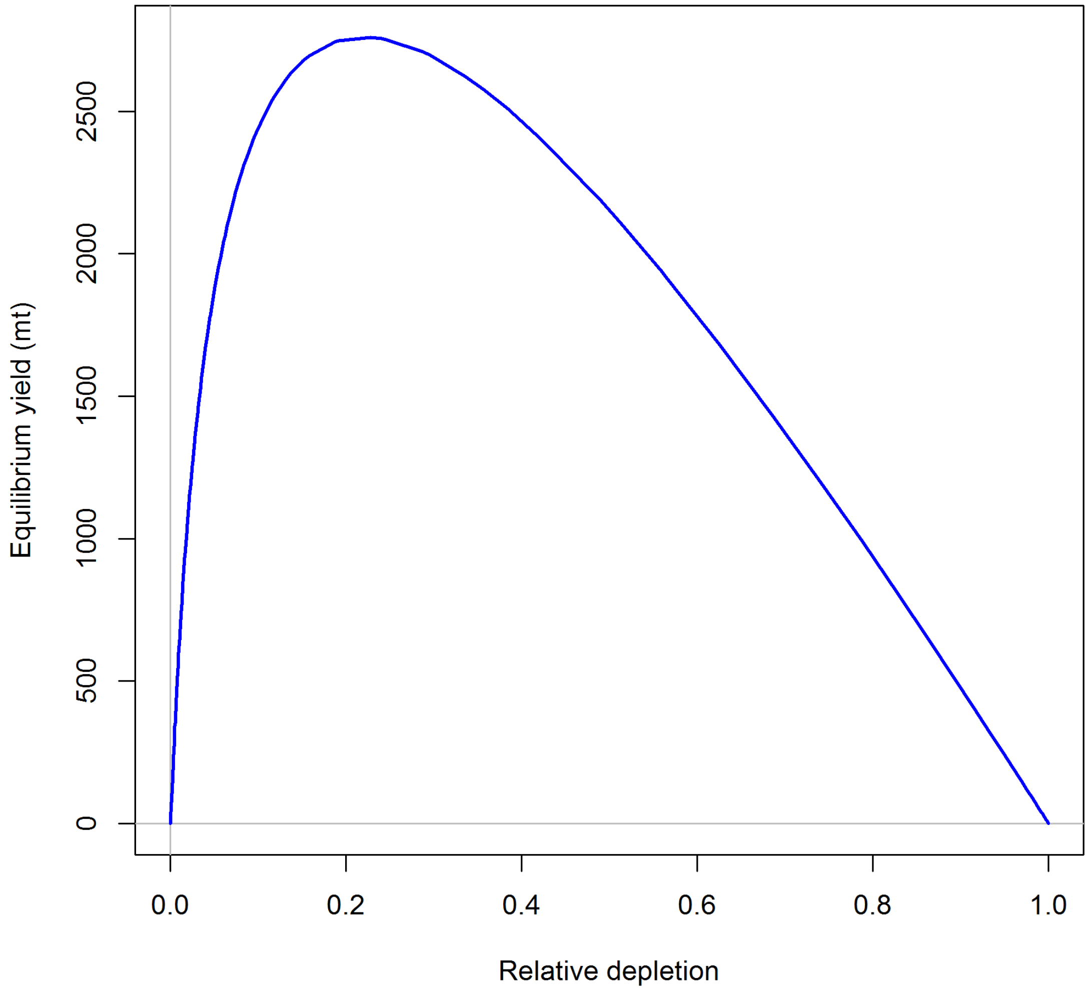


Figure 136. Equilibrium yield curve for the base case model. Values are based on 2012 fishery selectivity.

Appendix A. Survey post stratification

The default stratification from the Triennial and NWFSC surveys is not necessarily the best stratification when analyzing the survey data for Petrale sole. The last Petrale assessment (Lai et al) post-stratified the Triennial survey data based on a Bayesian change point analysis of the length as a function of depth. The reasoning behind the change point analysis was that Petrale show an ontogenetic migration to deeper water. Therefore the mean length would increase with depth until some point when the slope of the relationship would decrease due to mixing of adult fish. Their results showed median change points of 114 m and 144 m for females and males, respectively, and they chose to post-stratify the survey data into three strata (50–100 m, 100–155 m, and 155–700 m).

We chose to revisit the post-stratification because the NWFSC survey was not analyzed in the 2005 assessment. Lai et al (2005) used Bayesian statistics with uninformative priors and MCMC sampling to calculate the posterior distribution. However, we used a frequentist approach since there is no prior information for any of the parameters, and the problem in the frequentist paradigm allows for quick point estimates which are used as guidance for the strata definitions.

Piecewise linear regression is similar to linear regression except that the data are split into two parts by a breakpoint, and separate linear relationships describe each part. In mathematical terms,

$$
\begin{aligned}
L &= \alpha_1 + \beta_1 d \quad d \le \delta \\
L &= \alpha_2 + \beta_2 d \quad d \ge \delta
\end{aligned}
$$

Furthermore, because we are assuming that the fish are migrating to deeper water, the relationship at the breakpoint (δ) should be continuous. In other words, the relationships to the two pieces are equal at the breakpoint.

$$
\begin{aligned}
\alpha_1 + \beta_1\delta &= \alpha_2 + \beta_2\delta \\
\alpha_2 &= \beta_1 + \delta(\beta_1 - \beta_2)
\end{aligned}
$$

Substituting in and rearranging the equations we arrive at the same model used by Lai et al. (2005).

$$
\begin{aligned}
L &= \omega + \beta_1(d - \delta) \quad d \le \delta \\
L &= \omega + \beta_2(d - \delta) \quad d \ge \delta
\end{aligned}
$$

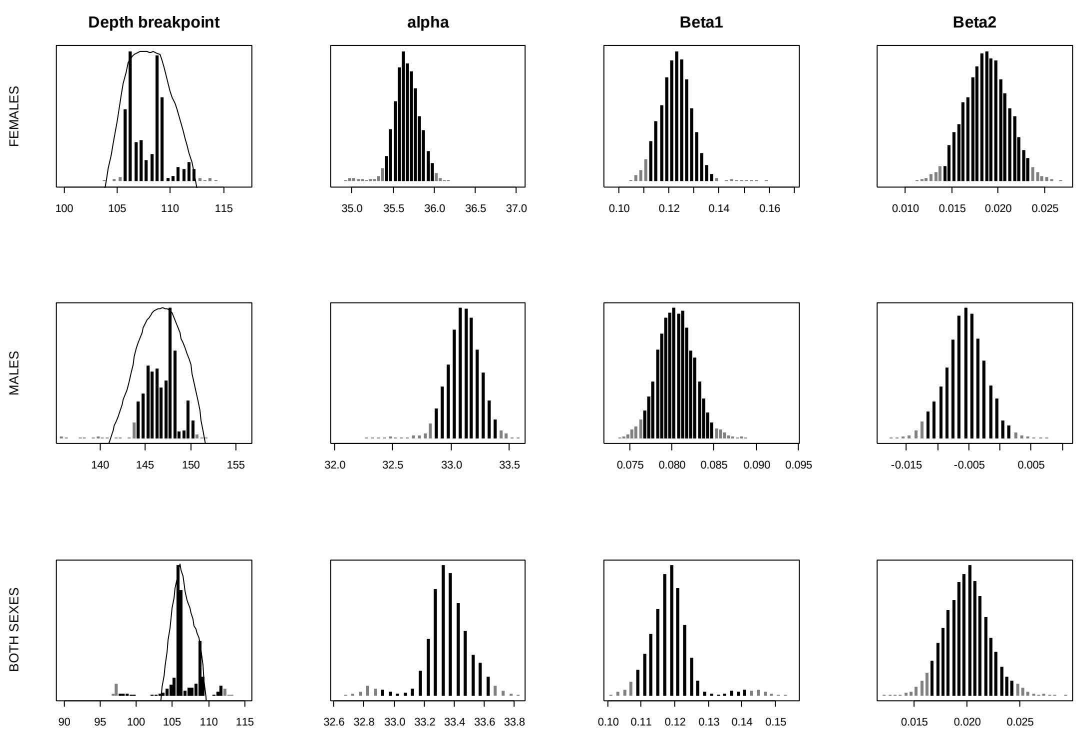
where $\omega = \alpha_1 + \beta_1\delta = \alpha_2 + \beta_2\delta$, or the length at the breakpoint. There are four parameters to estimate.

The parameters were estimated by minimizing the sum of the squared residuals and non-parametric bootstrapping was used to estimate the 95% confidence intervals. Furthermore, likelihood profiles were compared with these confidence intervals after assuming that the residuals were normally distributed with equal variance.

The results here agreed with the analysis performed by Lai et al (2005), and we also chose a breakpoint at 100 m. A breakpoint around 110 m may be more reasonable, but strata specific values, such as stratum area, is more easily available with a breakpoint at 100 m.

Table A3: 95% confidence intervals of the breakpoint from the likelihood profiles and bootstraps for each survey.

	Triennial		NWFSC	
	Profile	Bootstrap	Profile	Bootstrap
Female	**104.2–112.2**	**105.2–112.1**	**105.2–121.2**	**104.3–120.4**
Male	**141.2–151.4**	**143.7–150.0**	**146.0–159.8**	**144.2–160.8**
Both	**103.6–109.4**	**97.0–112.0**	**112.6–120.8**	**112.8–120.4**



FigureA1: Plot of the Triennial survey bootstrap results from piecewise regression for each sex and all years combined. The line in the depth breakpoint plot is a likelihood profile (the 95% CI is where the profile crosses zero).

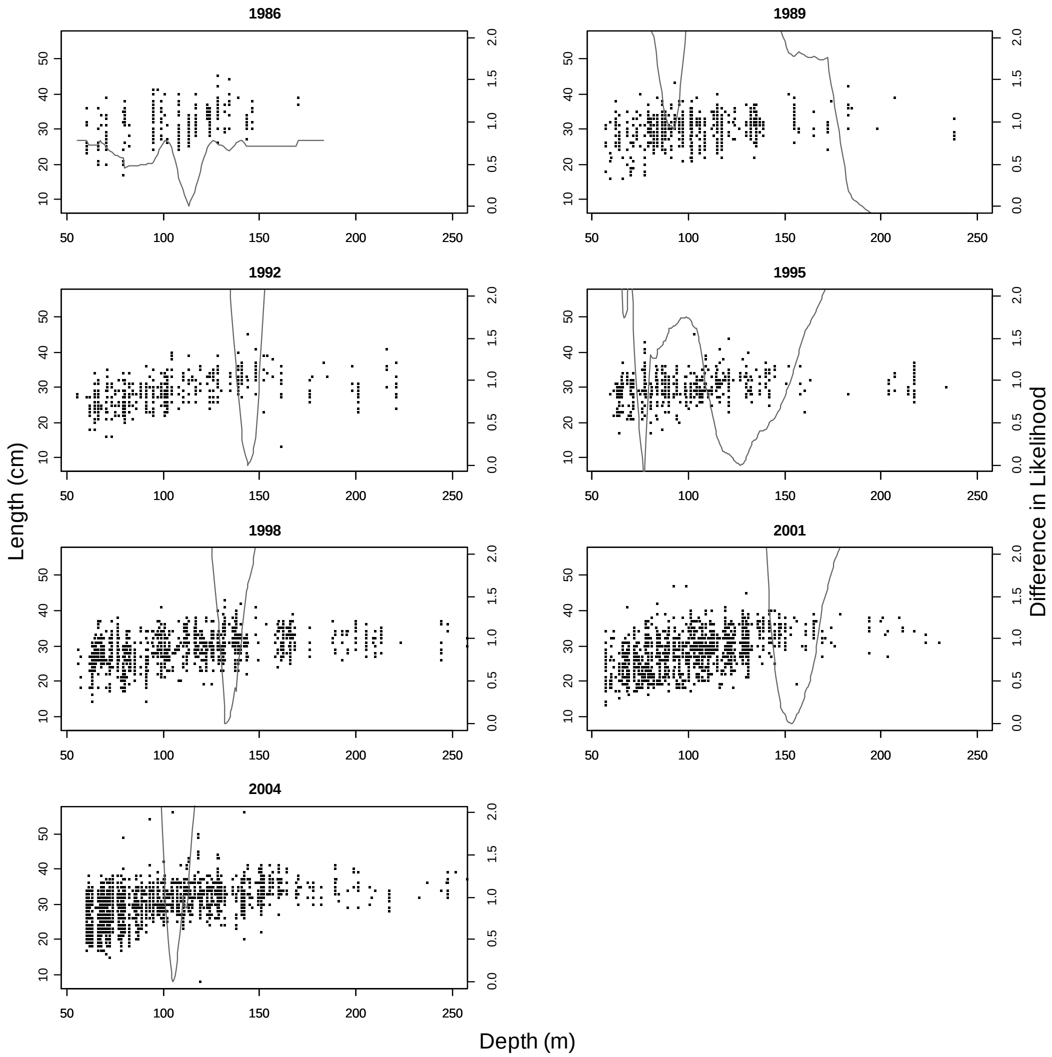


Figure A2: Plots of length vs. depth from the Triennial survey for each year and males only with the likelihood profile of the breakpoint overlayed.

NWFSC Survey

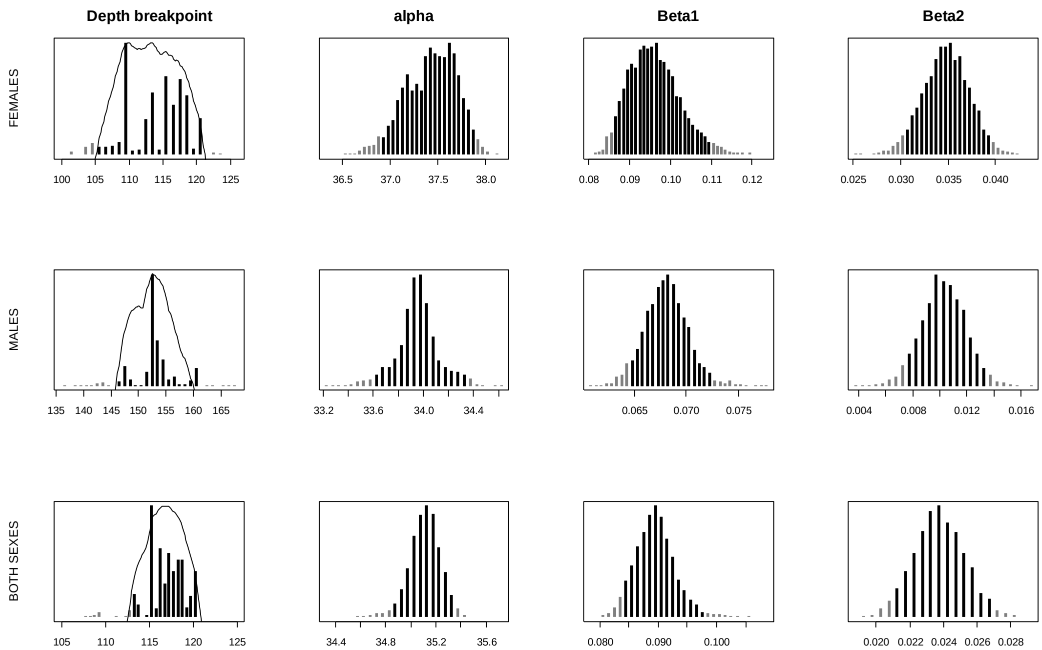


Figure A3: Plot of NWFSC survey bootstrap results from piecewise regression for each sex. The line in the depth breakpoint plot is a likelihood profile (the 95% CI is where the profile crosses zero).

Appendix B. Commercial logbook CPUE

Commercial logbook data for the west coast limited-entry groundfish fishery are archived in a regional Pacific Fisheries Information Network (PacFIN) database. These logbook data are used in a three step analysis to produce a CPUE index for each petrale sole fishing fleet from 1987-2009. Logbook data prior to 1987 were not considered because the spatial location of each tow was not available. The data for 2010 to present were not included due to restrictions on the petrale sole fishery due to its overfished status as well as the implementation of the West Coast Groundfish Trawl Catch Share Program. The summer season was defined as May-October, the same period that the NWFSC survey operates, while the winter was defined as November-February. The first step of the analysis is to define the spatial extent of recent petrale sole fishing grounds because spatial management measures began to impact the fleet during 2003, and have restricted the area open to fishing. The goal is to identify areas that have remained open to fishing for the duration over which standardized CPUE indices are desired, 1987 – 2009. The second step was to filter the data for quality, and based on information from the industry present at a 2011 pre-assessment workshop in Newport, OR. The final step was to conduct the CPUE standardization using a delta-GLM analysis.

Appendix B.1. Spatial analysis

Logbook records from PacFIN were queried for Washington, Oregon and California commercial fishing trips that caught petrale sole using bottom trawl gear from 2003 through 2008, a period of relatively stable management for petrale sole. Records include geographic positions where the vessel set and retrieved the trawl gear. Both set and up points were used to create line representations of each tow event. Any line intersecting the line representing the coastline or crossing seaward of the line representing the 700-fm isobath was flagged and removed from the data set. For each line, average vessel speed (knots) was calculated as a quotient of calculated linear distance between set and retrieval points versus recorded tow duration. Trawl events with calculated vessel speeds greater than 5 knots were removed, as were records with calculated straight-line distance greater than 20 nm.

Petrale fishing grounds that have remained open during 1987-2009 were identified using tows that caught petrale for both the summer and winter seasons. Only tows seaward of the 150-fathom line were retained in the winter and only tows shoreward of the 75-fathom line were retained in the summer to account for areas that have been closed in recent years. In order to investigate how sensitive the identification of fishing grounds are to the choice of positive catch rate data three criteria were investigated for each season: 1) using all tows with positive catch rates, 2) removing tows with the lowest 10% of the catch rates, and 3) removing tows with the lowest 20% of catch rates during the 2011 assessment (Table B1). Each of the six sets of fishing grounds (the above three fishing ground identification methods and two seasons) were identified using a convex hull minimum bounding geometry. A common analogy used to conceptualize convex hulls is an elastic band being stretched over a set of points (Figure B1). Convex hulls were computed for each set of selected lines within a regular network of contiguous 10x10 km cells.

Once fishing grounds were identified, logbook data from 1987 – 2009 was overlaid on the maps of the fishing grounds. Tows that fell within the fishing grounds were retained for CPUE standardization. Based on feedback from the fleet and lack of sensitivity to the identification of fishing grounds, the data set that removed the lowest 10% of catch rates was retained for both the 2011 and 2013 CPUE analyses.

Appendix B.2. Data filtering/preparation

The following data filters were applied for data quality:

1. Remove midwater trawl tows.
2. Remove records with large depth discrepancies (> 70 fathoms) between the logbook recorded catch and the GIS map depth.
3. Remove tows with a duration less than or equal to 0.2 hours as duration was incorrect for many of these records.

The following filters were applied based on knowledge of the petrale sole fishery. The tow duration and minimum number of years the vessel had been in the fishery were chosen based on discussions with industry members present at the 2011 pre-assessment workshop in Newport, OR.

1. Retain tows with depths less than or equal to 300 fathoms in summer and 400 fathoms in winter.
2. Retain tows with tow duration <= 4 hours during the summer and <= 6 hours during the winter.
3. Retain vessels fishing five or more years. This rule was chosen to capture skippers that have fished petrale sole for most of the time series that likely switched vessels during the vessel buyback program. Sensitivity of the model results to this parameter was examined.

Tows were assigned to states based on the state waters where the catch was taken such that the PSMFC areas 3A, 3B, 3S, 3C were assigned to Washington. PSMFC areas 2B,2C,2A,2E,2F were assigned to Oregon and PSMFC areas 1A,1B,1C were assigned to California. In the 2011 analysis, standardized CPUE was prepared for Washington, Oregon, and California to match the fleet structure in the 2011 stock assessment model. In the 2013 analysis, standardized CPUE was prepared for a northern area (Washington and Oregon combined) and California to match the fleet structure in the 2013 stock assessment model.

After filtering, the 2011 winter data set contained 13,777 tows, from 179 distinct vessels, which delivered to 47 different ports. The tows were concentrated in Washington and Oregon compared to California (Figure B2). The winter fishery targets petrale on their spawning grounds, which is different from the summer fishery which catches a mixed species complex. The summer data contained 123,375 tows, from 295 distinct vessels, which delivered to 47 different ports. For the 2013 analyses, the winter data contained 13,777 tows, from 179 distinct vessels, which delivered to 24 different ports (same as to the 2011 analyses). The 2013 summer data, on the other hand, contained fewer data points than the 2011 analyses with 96,164 tows from 261 distinct vessels, which

delivered to 30 different ports. This is due to some data filtering error in the 2011 analysis.
The fishery has undergone changes in gear type during the time period of interest, although these gear changes differ between the winter and summer fishery, and between states (Figure B3). The Washington and Oregon winter fisheries have been using rolling trawls almost exclusively since 2000. The California winter fishery switched from primarily groundfish otter trawls to groundfish trawls with a footrope greater than 8 inches between 2002 and 2004. In the summer, both the Washington and Oregon fishery went from a variety of gear types to almost exclusive use of selective flatfish trawl in 2005. Meanwhile the California summer fishery diversified gear in 2002, moving from mostly groundfish otter trawls to a variety of gear types.

The winter fishery is clustered around distinct fishing grounds whereas the summer fishery is conducted much more uniformly across latitude (Figure B2).

Appendix B.3. Analytical methods

CPUE is modeled as pounds per hour using the fish ticket-adjusted catch and the skipper’s logbook entry of tow duration. All covariates are factors and include year, bimonthly period, port of landing, vessel ID, gear type, and fishing area, and in 2013 covariates for fishing target. Depth was not used a covariate because the depth ranges of the data sets after spatial filtering were restricted.

The Delta-Lognormal approach (Maunder & Punt, 2004) was used to standardize the catch and effort data for each season (summer and winter) for each region (the 2011 analysis treated each state individually, the 2013 analysis groups Washington/Oregon and California). In 2013, the WA and OR data were grouped together because the port landings data (used in the SS3 model) came from a mixture of catches in WA and OR waters and recent catch reconstructions do not compile the landings by both port of landing and catch area. For the Delta-Lognormal model, the presence-absence data were analyzed using a logistic model assuming a logit link and binomial error distribution to estimate the probability that a tow (in 2011) or trip (in 2013) caught (and retained) petrale sole. Then the catch and effort data for the positive tows (in 2011) or trip (in 2013) were modeled using a linear model with a log link under the assumption of Gaussian errors to estimate the catch rate given the presence of petrale sole.

For all regions, seasons (summer and winter), and for both portions of the model (binomial and lognormal), a base model that included all the main effects was fit and compared with models with different combination of covariates. The most parsimonious model was then selected using the information theoretic approach (Burnham & Anderson, 1998) based on the Akaike Information Criterion (AIC, Akaike, 1974).

The final CPUE model selected in 2011 (used in the assessment) didn’t include interaction terms for reasons including erratic and non-realistic behavior of the derived index of abundance, model convergence and problems dealing with missing interaction terms (Haltuch et al. 2011). Therefore, the 2013 CPUE standardization analysis considered the main effect models only, but investigated the influence of interaction terms as sensitivity tests (although the same problems as in 2011 persist). Several additional changes were made for the 2013 CPUE modeling approach. These are described below, and the influence of each change to the derived index of abundance is shown in a step by step manner in Figure B4 (the red line with dots represents the 2011 model result).

1. Some data filtering steps were not correctly applied to the 2011 summer data and a total of 27,211 points were removed from the analysis as their geographic coordinates indicated a point outside of the identified fishing grounds. This reduced the total number of tows for the summer data from 123,375 to 96,164. To evaluate the impact of this change, we reran the 2011 model with this new data set (the blue line in Figure B4).
2. A "reference" level was chosen for covariates retained in the model so that the derived index of abundance could be interpreted as CPUE per unit reference level of covariate (e.g. CPUE per reference gear, bimonth, etc…). The "reference" level was chosen as the most frequently observed level for a categorical variable (Punt et al. 2001) or the mean value for a continuous variable (Maunder and Punt 2004). In 2011, the "reference" level was chosen as the weighted average of the estimated coefficients obtained from the model fit. This later is statistically valid, but is harder to interpret. The green line in Figure B4 is the resulting index of abundance using the 2011 data and selected model with the change in "reference" level calculations.
3. In order to calculate a prediction interval around the derived index of abundance, the standardized CPUE was divided by its geometric mean instead of the 2004 CPUE value as was done in the 2011 analysis. Again, this change was applied to the 2011 model after taking into account the modifications in points 1-2. This resulted in the purple line (Figure B4).
4. The fishing grounds were divided into finer spatial grids (1 degree x 1 degree grid) within each region (WA, OR, CA) to capture more detailed population dynamics and the tow by tow data were aggregated to the trip level to respect the assumption of independent observations. By dividing the fishing grounds into finer grid cells it introduces some missing observation for a specific year and area combination, but this didn't impact the final GLM result as the 'year:area' interaction was not selected. All tows from the same vessel, trip, and area using the same gear were combined to create a single average catch per unit effort (lbs/hr) by trip. This reduced the number of data points two to three fold (Table B1). The impact of this change is shown by the light blue line in Figure B4. The model has the exact same covariates as the 2011 model and includes the changes in points 1-3. Sensitivity of the final index of abundance to the choice of spatial grid size was also examined.
5. New covariates that represent fishing tactics were included into the 2013 model to capture the targeting behavior of the vessels (following Winker et al. [2013]). A principal component analysis (PCA) was performed on the squared root transformed trip by trip catch composition data (only 7 "species categories" were present in the dataset: petrale sole, dover sole, thornyheads, widow rockfish, sablefish, whiting and "others") and the first 4 axes (that usually explained more than 90% of the total variation) were retained as new covariates in the model (Figure B5). The loadings of each data point to the PC axes were then determined

and included in the data set used for the modeling. These loadings provide information about the fishing tactics of each fishing trip. Model selection was performed using AIC to determine the best combination of covariates that parsimoniously explained variation in both the presence-absence model and the positive catch data model. The 2013 CPUE index was therefore calculated so that it represents a fishery with some “reference” unit of covariates that targets the petrale sole. The “reference” level for the covariates involved a fishing tactic that predicted a catch composition that was 100% (or close to 100%) petrale sole. The result of this step is shown by the pink line with dots in Figure B4.

6. Finally, the above model was reformulated within a mixed effect model framework where the vessels were considered as random effects. A model selection using AIC was again performed to choose the best combination of covariates. The result of this step is shown by the line in orange in Figure B4.

For each of the models presented above the CPUE index was calculated following the methods of Maunder & Punt (2004).

Because each of these steps either changed the data or didn’t change the GLM model structure, information based model comparisons (e.g. AIC) between steps was not possible or did not change at all. Therefore the between-steps model comparison was done via examination of model residual structure (Figure B6a-f) and a goodness of fit measure (% deviance explained) (Table B2). Residual plots for the binomial model were not plotted due to the difficulty in interpreting them.

Once the above retrospective model comparison was done, we produced the 2013 final index of abundance for the WA/OR and CA regions by fitting a linear mixed effects model and performing model selection based on AIC (to choose the best combination of covariates) (Table B3). Prediction intervals around the index of abundance were generated using parametric bootstrap sampling (for each bootstrap sample, a new dataset was generated by adding random errors (from both the random effect and the residuals) to the predicted data and the model was refit to produce the new bootstrap index of abundance) using a sample size of 999 (Figure B7).

Appendix B.4. Results

The indices of abundance derived for the 2013-AIC selected model show the same general trend as the NWFSC fishery independent survey during the period of overlap for both summer and winter time (Table B4). In the summer fishery, the index generally decreased from 1987 through the mid-1990s, then increased until 2004-2005 but decreased in the last few years for both regions. The winter indices follow the same general pattern, but the winter California CPUE index trend was more variable and had greater uncertainty than the other CPUE indices (Figure B6, Table B4). For all models, the fishing tactics was an important factor explaining variation in CPUE (Table B3). In each one of them, the tactics targeting petrale sole came up as the most or the second most important tactics as seen by the dominance of petrale sole in the loadings of the first or the second principal component axis (Figure B5). Interestingly, some tactics commonly caught dover sole with petrale sole while others avoided them. Other main fishing tactics that came out from the analysis is a tactics targeting “other species” (probably composed of many rockfish species although we don't have the data to confirm it) or sablefish (Figure B5). While the first four PC axes used in the analysis generally explained more than 90% of the total catch variation, the contribution of each axis differed significantly. The first PC axis generally explained more than 50% of the total variation, the second axis explained about 20%, and the other two axes explained about 10% and 5% respectively.

The winter fishery has been subject to more consistent spatial management measures than the summer fishery, but it is also known that CPUE standardization based on spawning aggregation could lead to a CPUE index that is not proportional to stock abundance (e.g. Erisman et al. 2011). Therefore a nonlinear relationship between CPUE and abundance should be considered for inclusion in the stock assessment model. On the other hand, while the summer fishery has been subject to more changes in management measures the relationship between CPUE and index of abundance might be more linear, although complex vessel, population and management dynamics could lead to a nonlinear relationship.

Appendix B.5. Sensitivity to the choice of the spatial stratification (0.5 vs 1 degree grid size)

The derived index of abundance was not sensitive to the size of spatial grid during the stratification process. The index of abundance had exactly the same shape (Figure B8). This is because the 2013 model didn't include any interaction effect and we only estimated the marginal effect of each covariate.

Appendix B.6. Sensitivity to the number of years fishing in the fishery (5 vs 10years)

The derived index of abundance was not sensitive to the choice of minimum number of fishing years during the data filtering process. The index of abundance had exactly the same shape (Figure B9). The index of abundance when the data are restricted to vessels which fished forat least 10 years couldn't be calculated for CA due to the lack of contrast and too few data points.

Appendix B.7. Sensitivity to the inclusion of 'year:area' interaction term in the model

For each model (region and season combination), there were between 0 to 35% of missing data for year:area strata. If fixed year:area interaction terms were to be included in the model, this would have involved a large amount of data imputation to properly derive the index of abundance. This data imputation could potentially impact the accuracy of the derived index of abundance and needs to be simulation tested before being applied to real data for use in a management context. Therefore, a model with existing year:area interactions (ignoring the missing interactions) was implemented by treating the year:area interaction as random effect (Figure B10). The results didn't show any major change in the trends in the abundance, except for the CA summer fishery. The results for the CA summer fishery show some differences, with the non-interaction model during the early 90s and for the timing of peak abundance in the mid-2000s (Figure B9). However a likelihood ratio test between the model with and without the year:area interaction term was performed and showed that the model without the interaction term was better (p.value≈1). The CA fishery is also relatively data poor compared to the other region-season combinations.

Appendix B.8. References:

Akaike, H., 1974. A new look at the statistical model identification. IEEE Transaction on Automatic Control, AC-19, 716-723.

Burnham, K.P., and D.R. Anderson. 1998. Model selection and multimodel inference, a practical information-theoretic approach. 2nd ed. Springer, New York.

Erisman, B.E., Allen, L.G., Claisse, J.T., Pondella II, D.J., Miller, E.F., and Murray, J.H. 2011. he illusion of plenty: hyperstability masks collapses in two recreational fisheries that target fish spawning aggregations. Can. J. Fish. Aquat. Sci. 68: 1705-1716.

Haltuch, M.A., A.C. Hicks and Kevin S. 2011. Status of the U.S. petrale sole resource in 2010. Pacific Fishery Management Council. Portland, Oregon.

Maunder, M.M and A.E. Punt. 2004. Standardizing catch and effort data: a review of recent approaches. Fish. Res. 70:141-159.

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Winker H, Kerwath S.E., and Attwood, C.G. 2013. Comparison of two approaches to standardize catch-per-unit-effort for targeting behaviour in a multispecies had-line fishery. Fish. Res. 139: 118-131

Appendix B.9. FIGURES

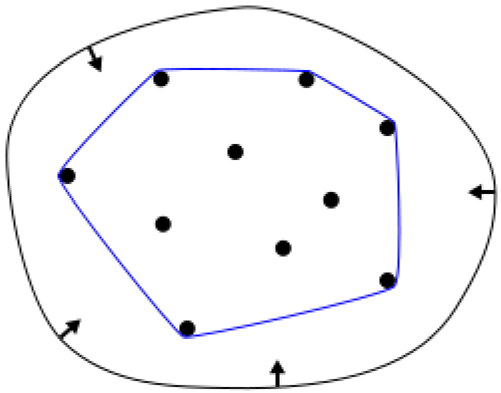
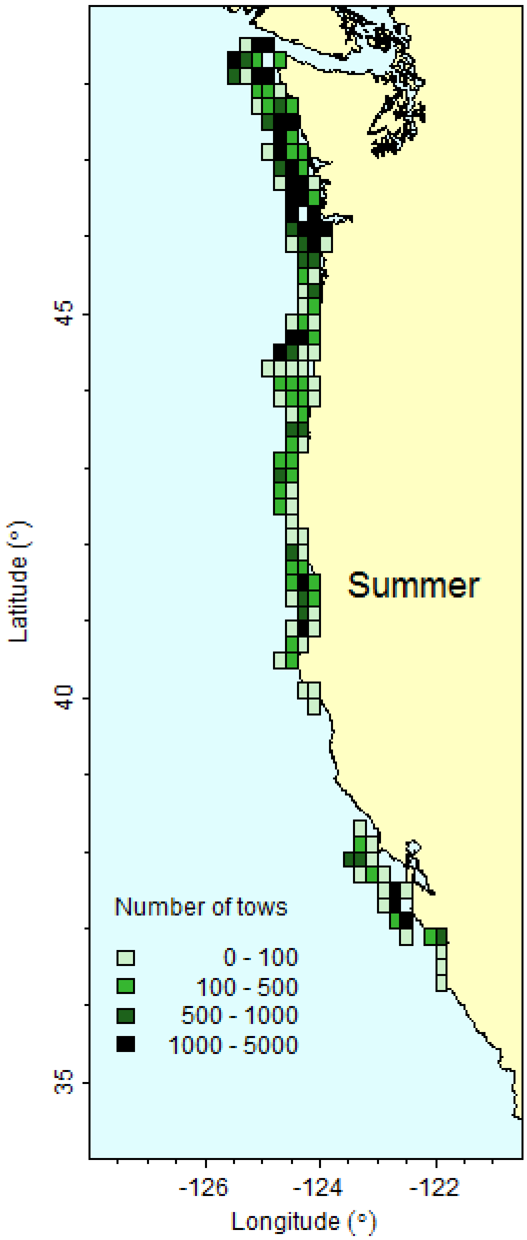


Figure B1. Example of a convex hull for a set of points. The curved outer line shows a conceptual elastic band contracting around a set of points. Image source: Wikipedia, "Convex hull".


Summer
Number of tows
0 - 100
100 - 500
500 - 1000
1000 - 5000
Latitude (°)
45
40
35
Longitude (°)
-126
-124
-122

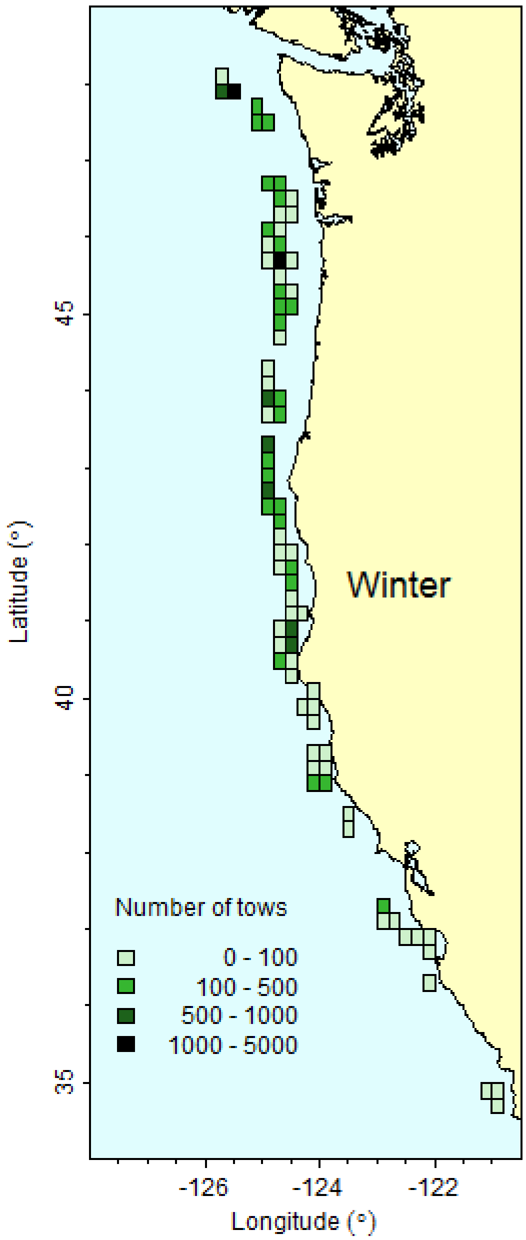


Figure B2: Tow number by areas during summer and winter

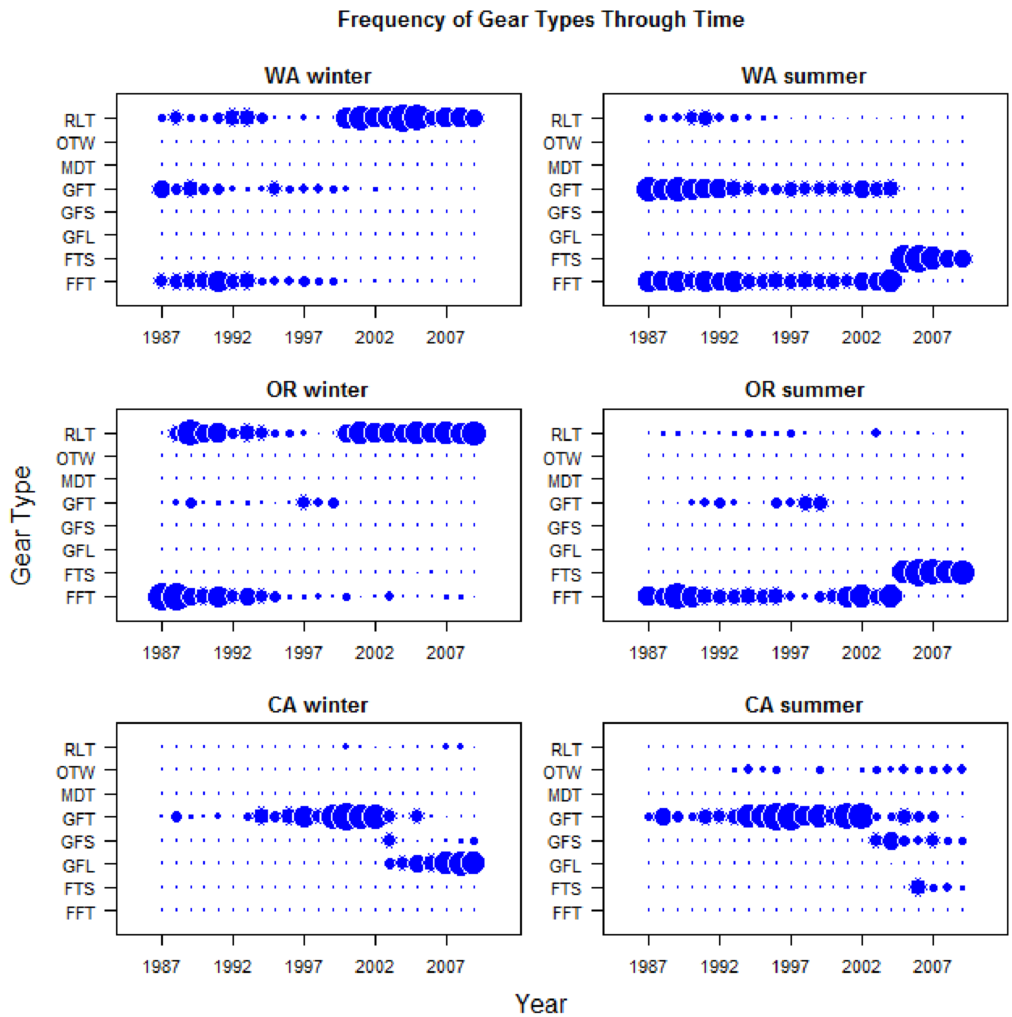


Figure B3. Frequency of gear used over time by state. The size of the circles corresponds to the percentage of tows in each year that used each gear type. RLT – roller trawl, OTW – other trawl gear, GFT – groundfish trawl (otter), GFS – groundfish trawl (footrope < 8in), GFL – groundfish trawl (footrope > 8in), FTS – selective flatfish trawl (small footrope), FFT – flatfish trawl.

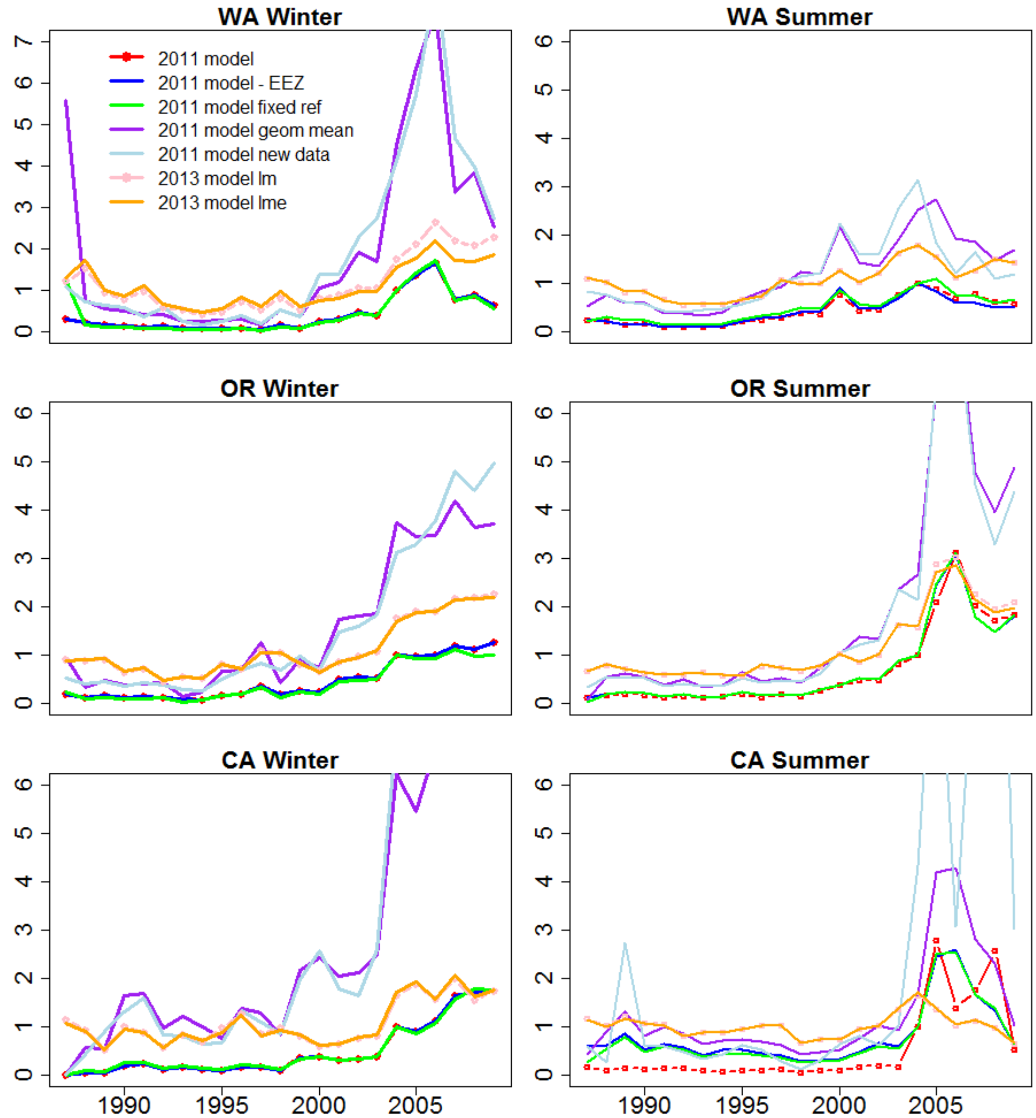


Figure B4: The influence of each modification made in the 2013 CPUE standardization on the final index of abundance. There are a total of 6 changes in addition to the 2011 model and they are described in the main text.

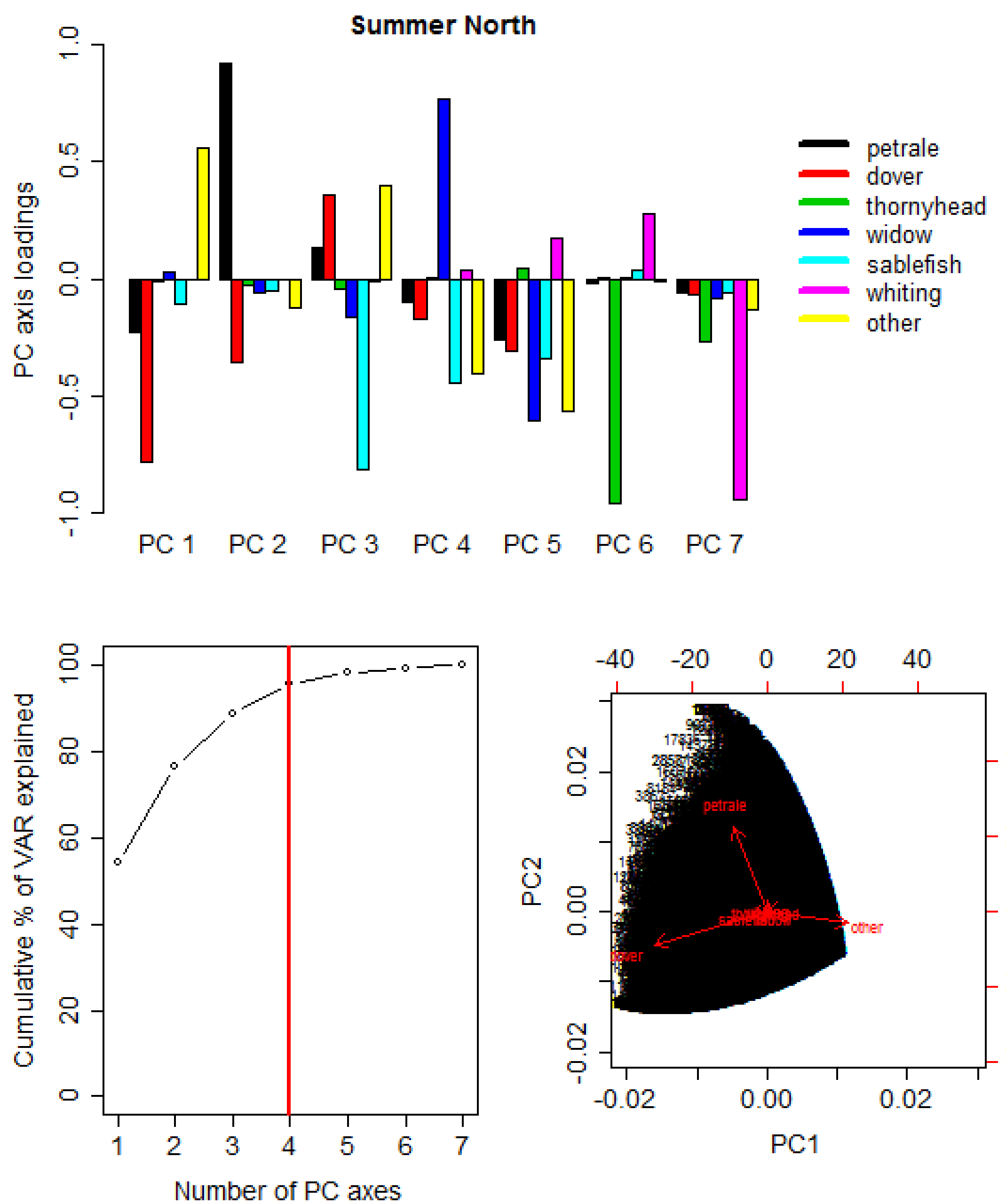


Figure B5a: Results of the PCA analysis on the square root transformed species catch composition data for the Summer North data

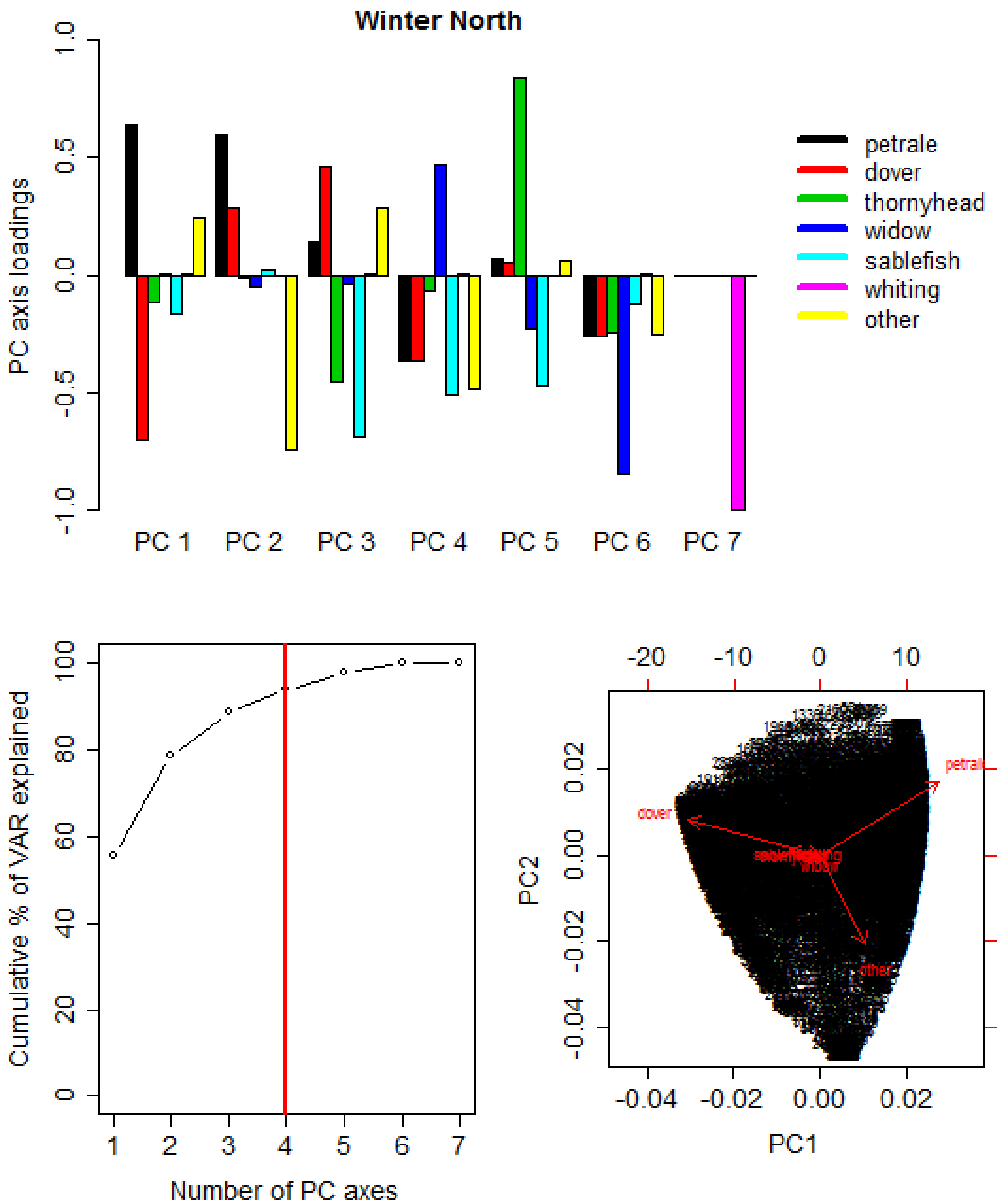


Figure B5b: Results of the PCA analysis on the square root transformed species catch composition data for the Winter North data

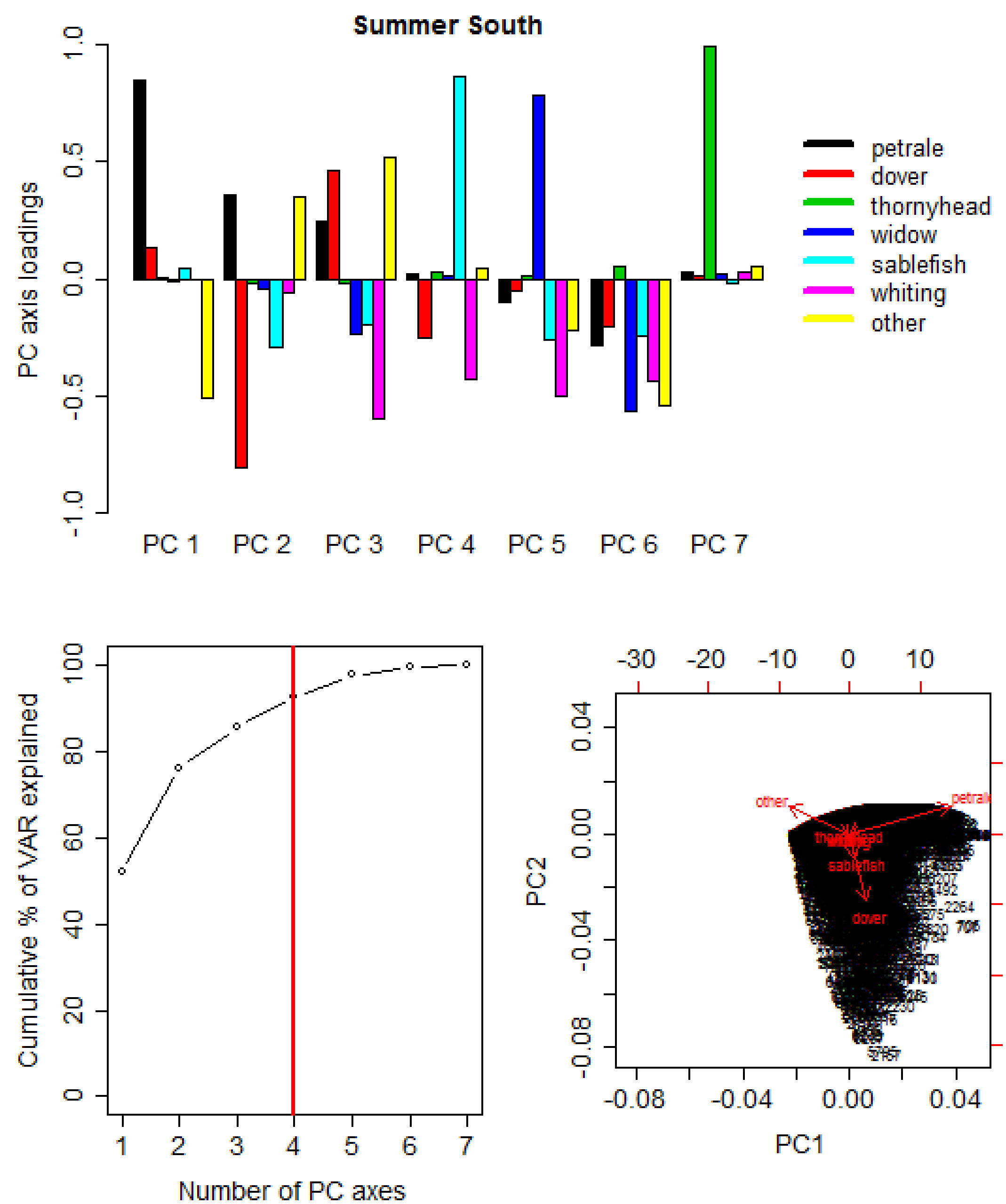


Figure B5c: Results of the PCA analysis on the square root transformed species catch composition data for the Summer South data

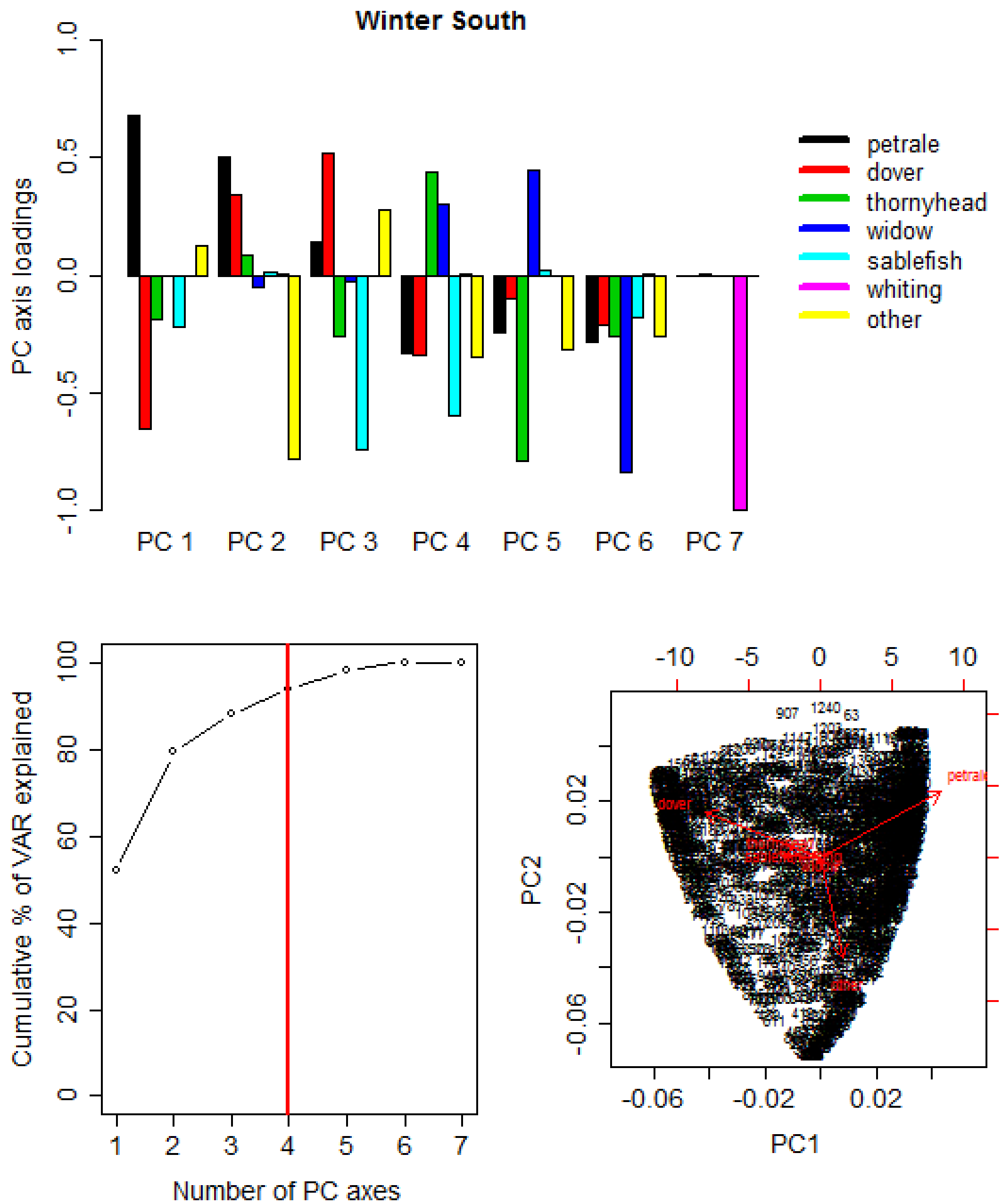


Figure B5d: Results of the PCA analysis on the square root transformed species catch composition data for the Winter South data

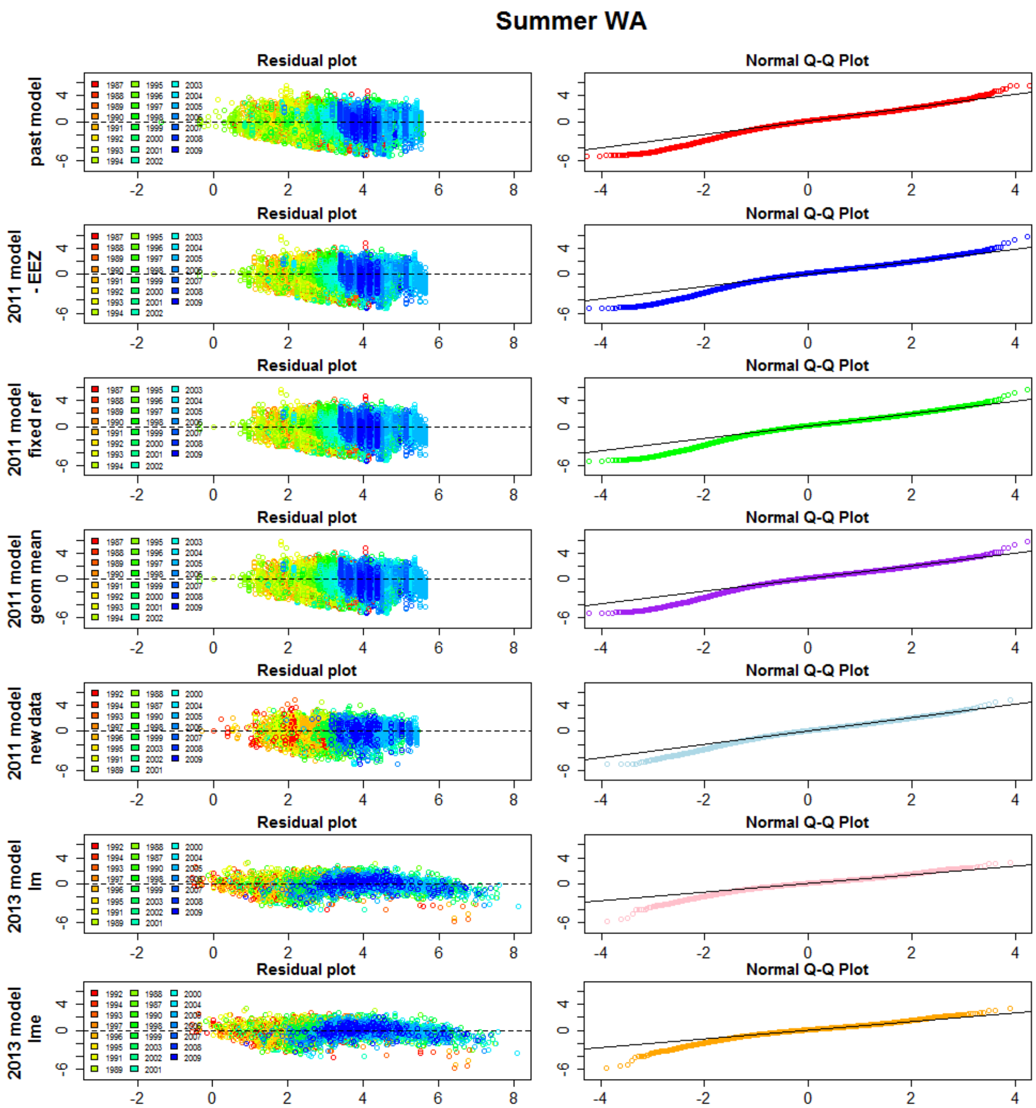


Figure B6a: Changes in residuals and QQ-plots pattern for the WA Summer fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

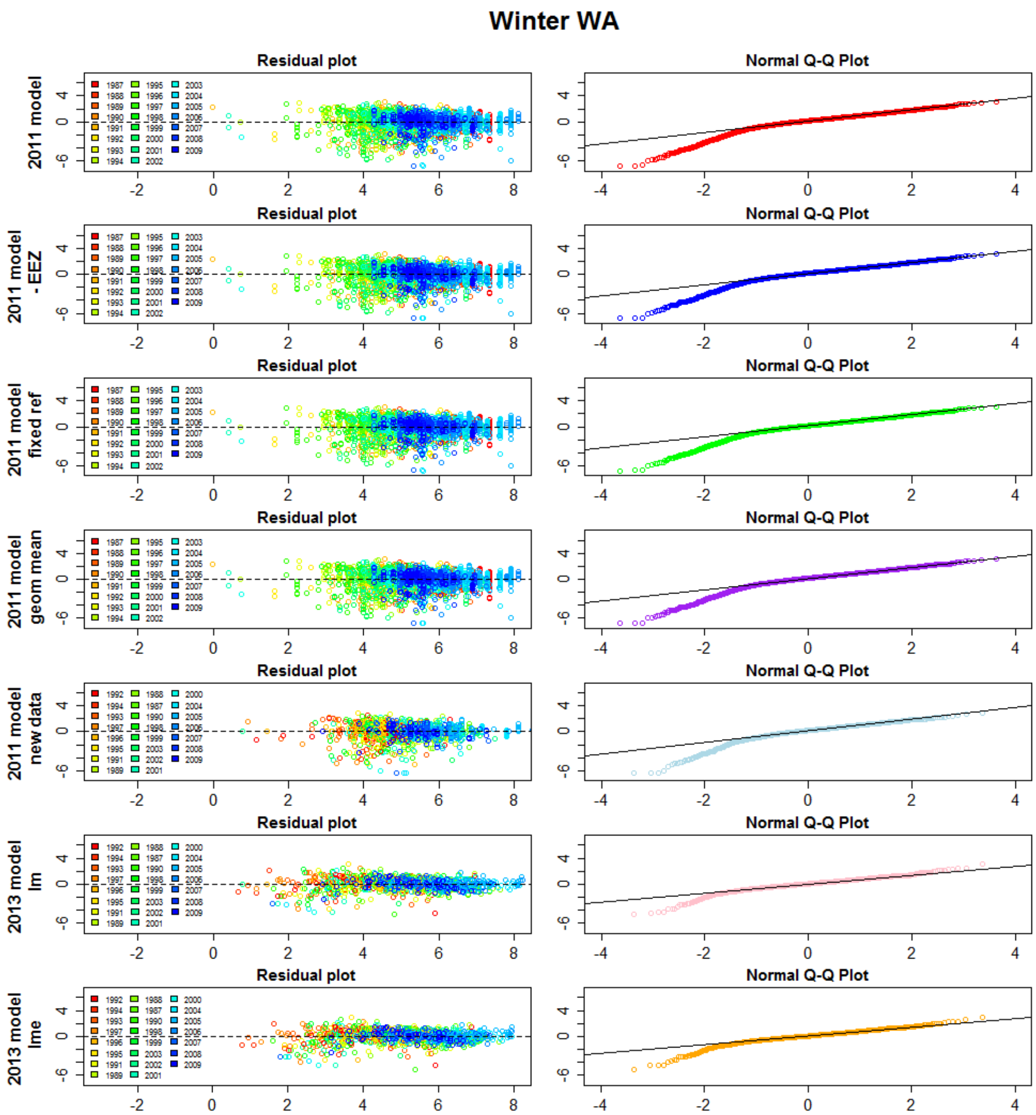


Figure B6b: Changes in residuals and QQ-plots pattern for the WA Winter fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

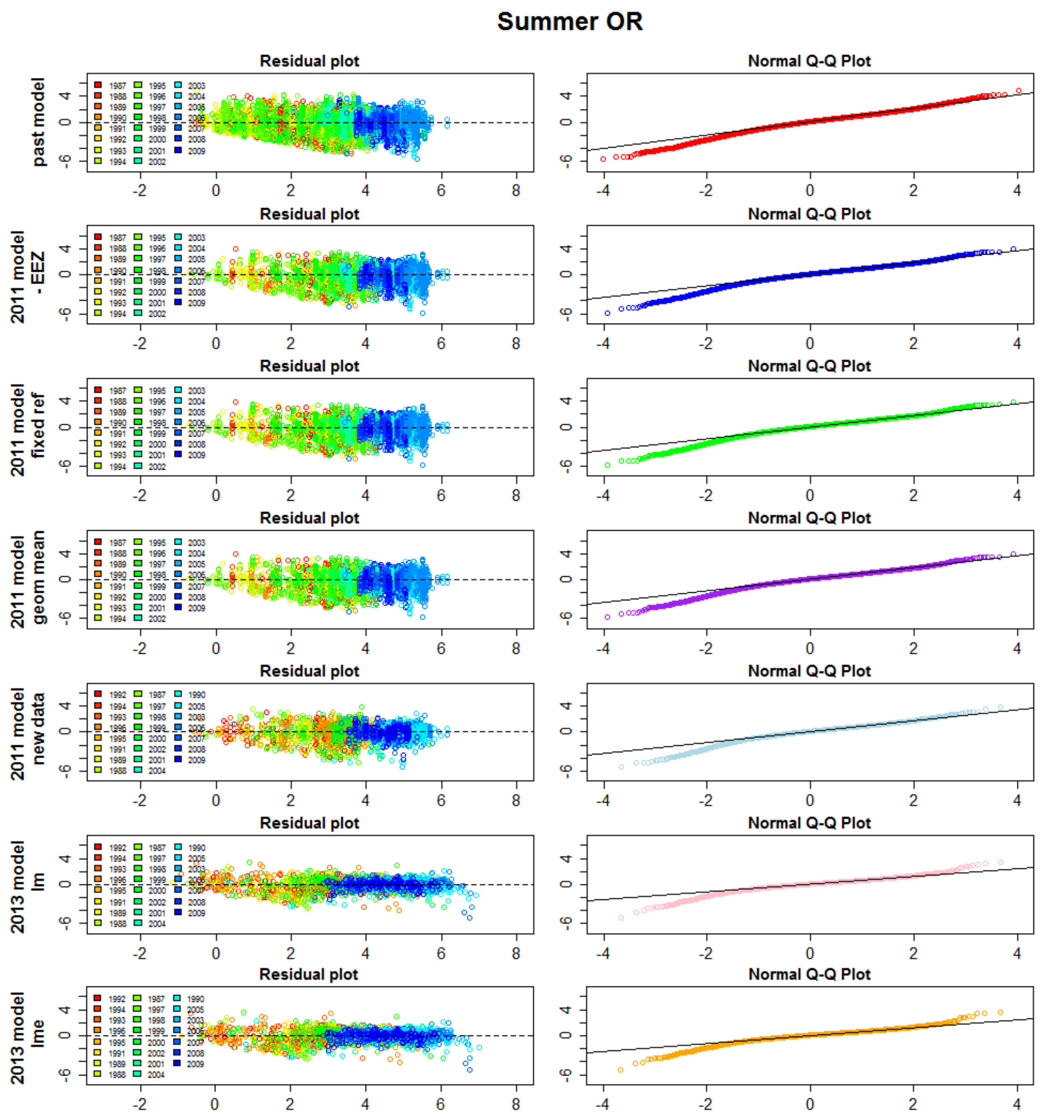


Figure B6c: Changes in residuals and QQ-plots pattern for the OR Summer fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

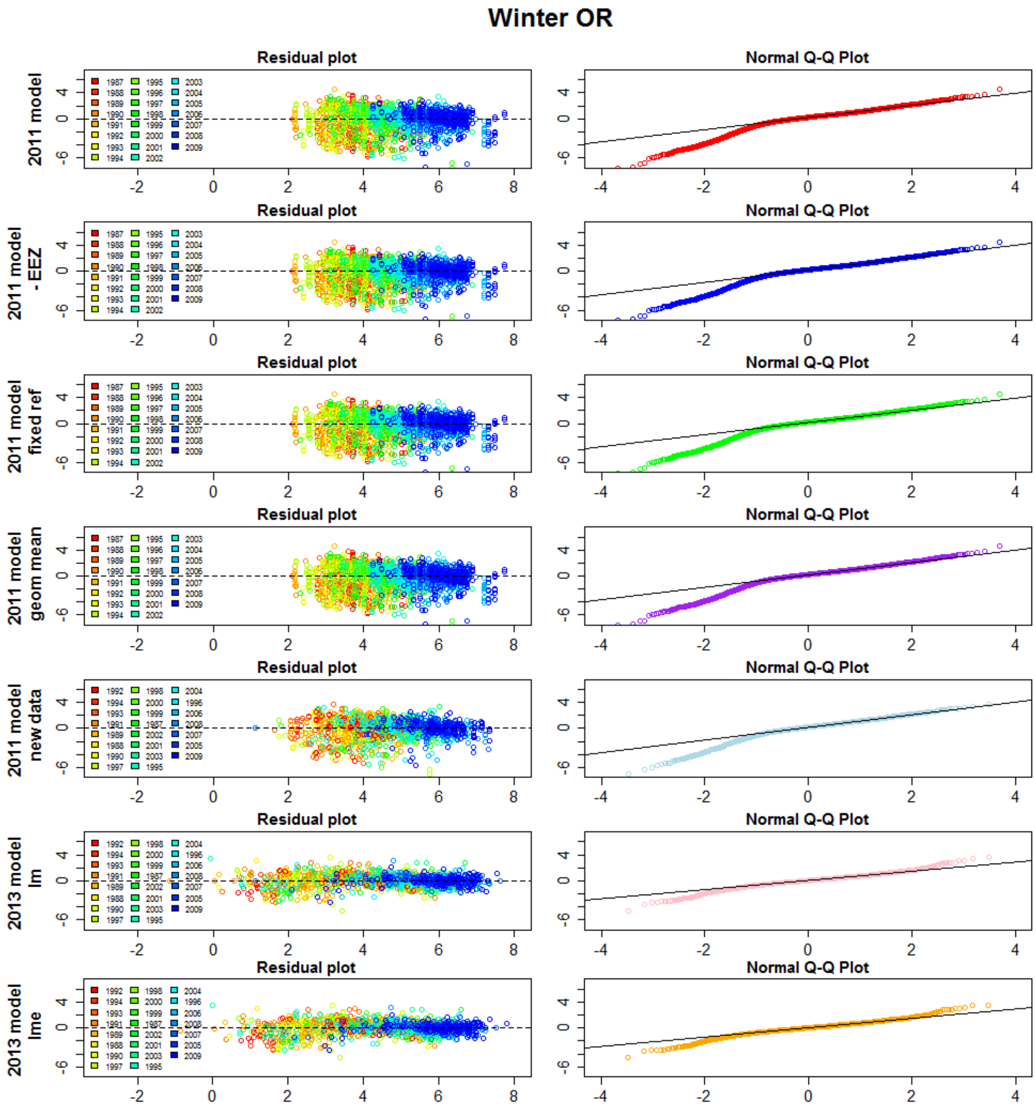


Figure B6d: Changes in residuals and QQ-plots pattern for the OR Winter fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

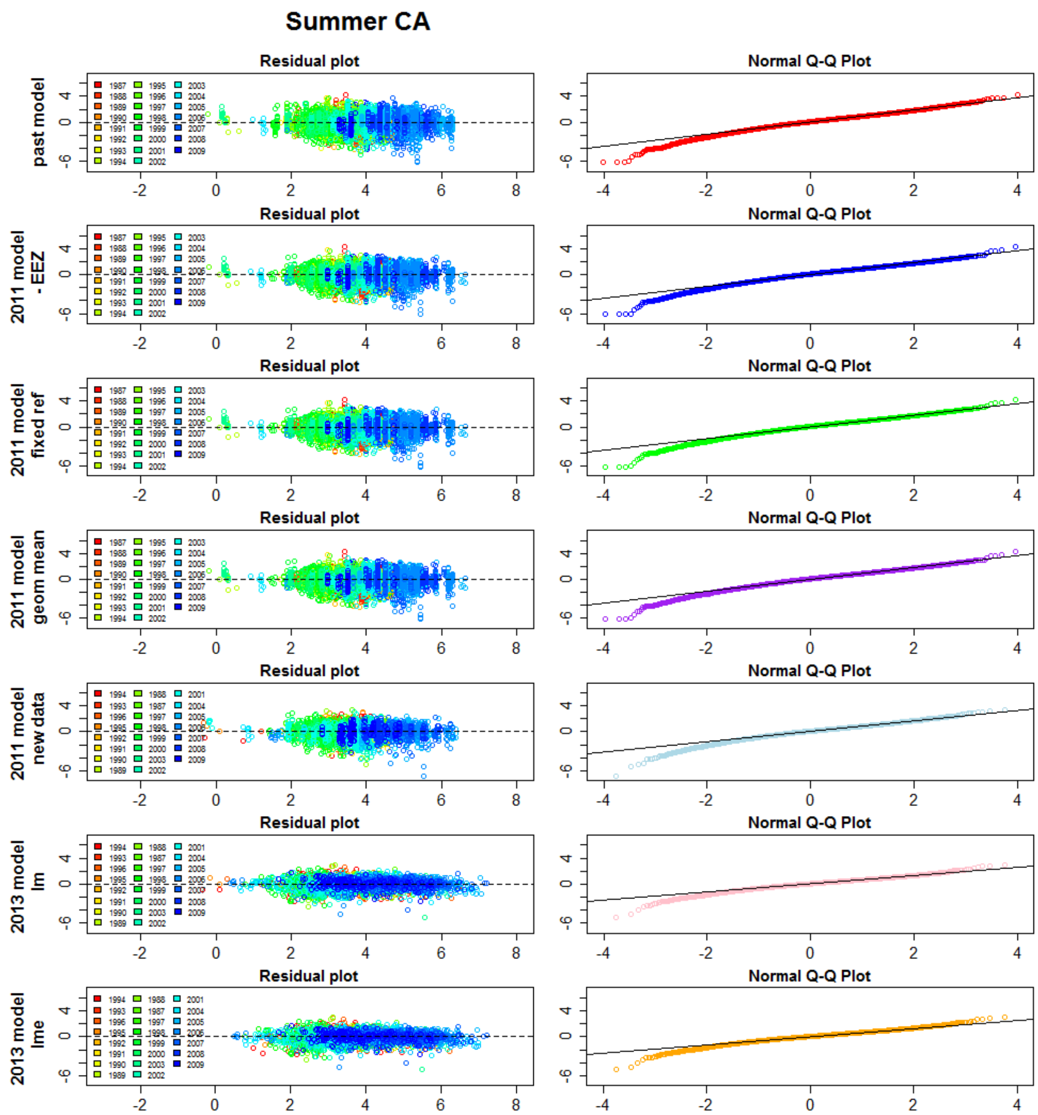


Figure B6e: Changes in residuals and QQ-plots pattern for the CA Summer fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

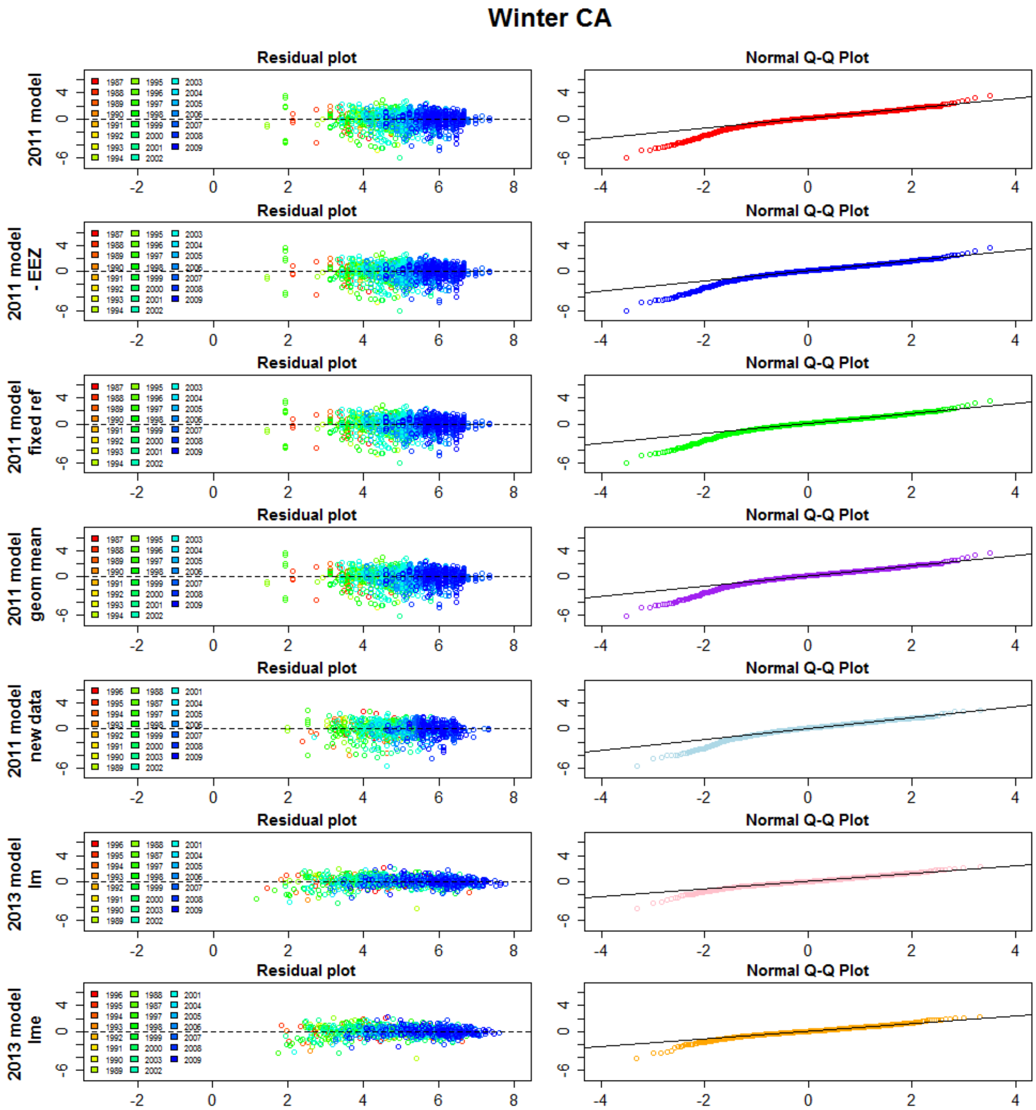


Figure B6f: Changes in residuals and QQ-plots pattern for the CA Winter fishery between the 2011 model and the 6 model updates described in the main text. The residual plot is coded in color.

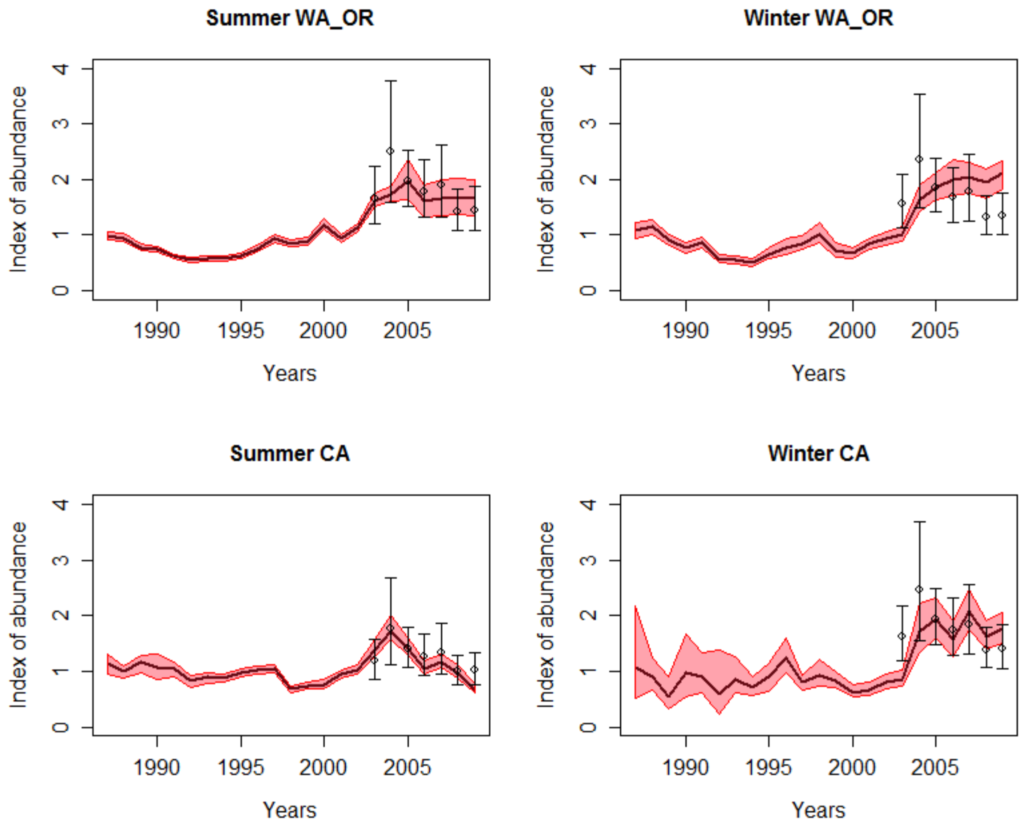


Figure B7: Final index of abundance based on the 2013 CPUE standardization model for the two regions (WA/OR and CA) and two seasons (summer and winter) with the prediction interval determined using a parametric bootstrap. The barplots correspond to the survey CPUE index with its confidence interval. The later was standardized so that the 2005 survey and fishery CPUE have the same mean to facilitate visualization.

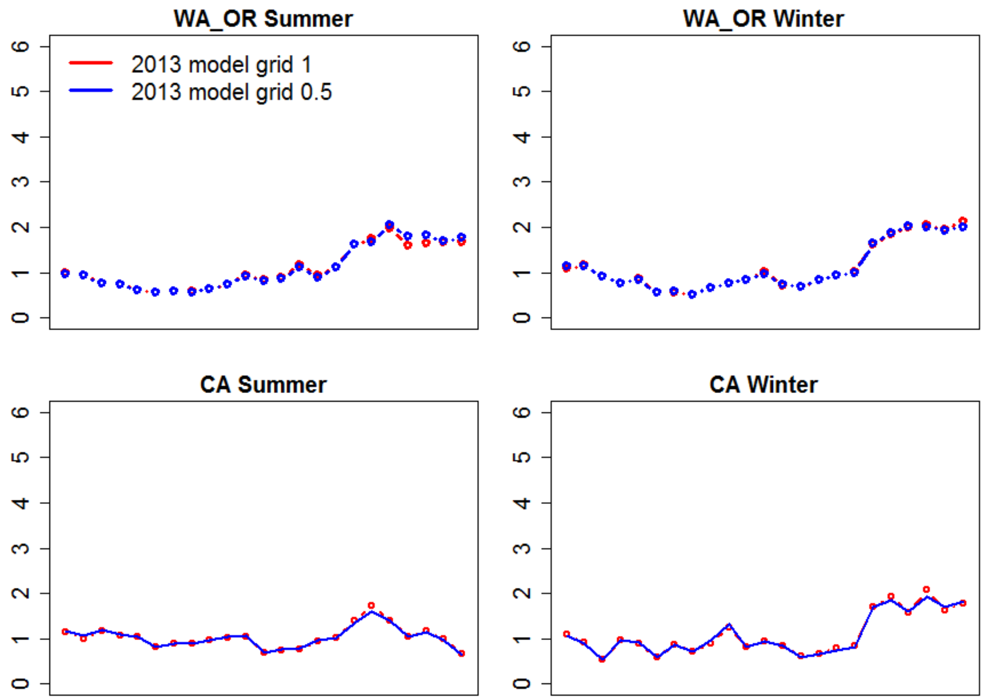


Figure B8: Sensitivity to the size of the spatial grid (0.5 degree grid vs 1 degree grid)

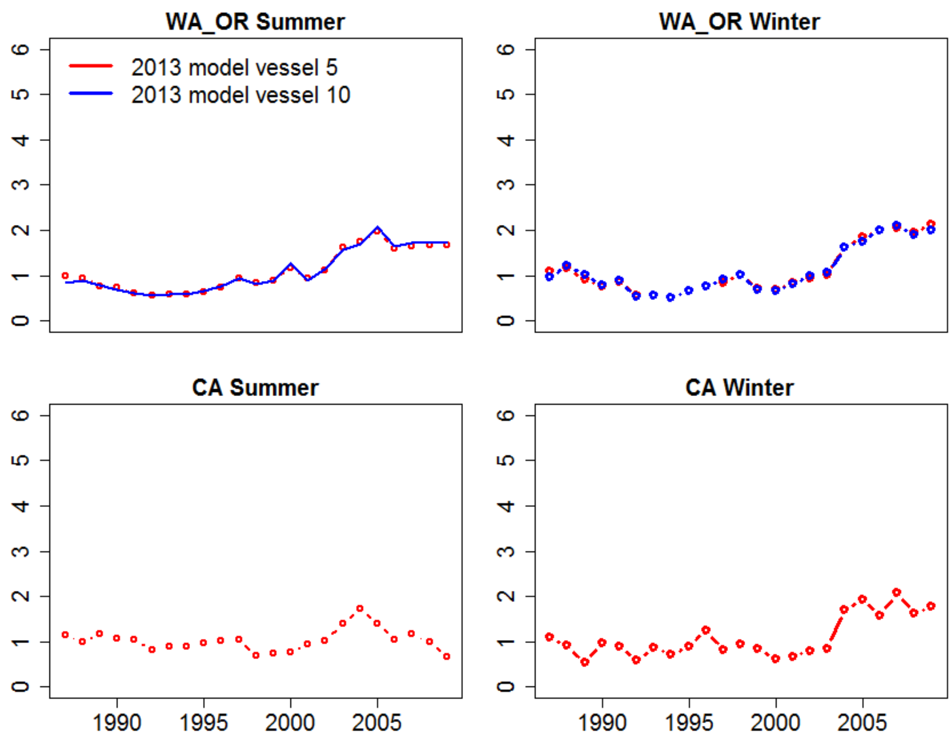


Figure B9: Model sensitivity to the choice of number of years a vessel had to be fishing to be included into the analysis (5 years vs 10 years)

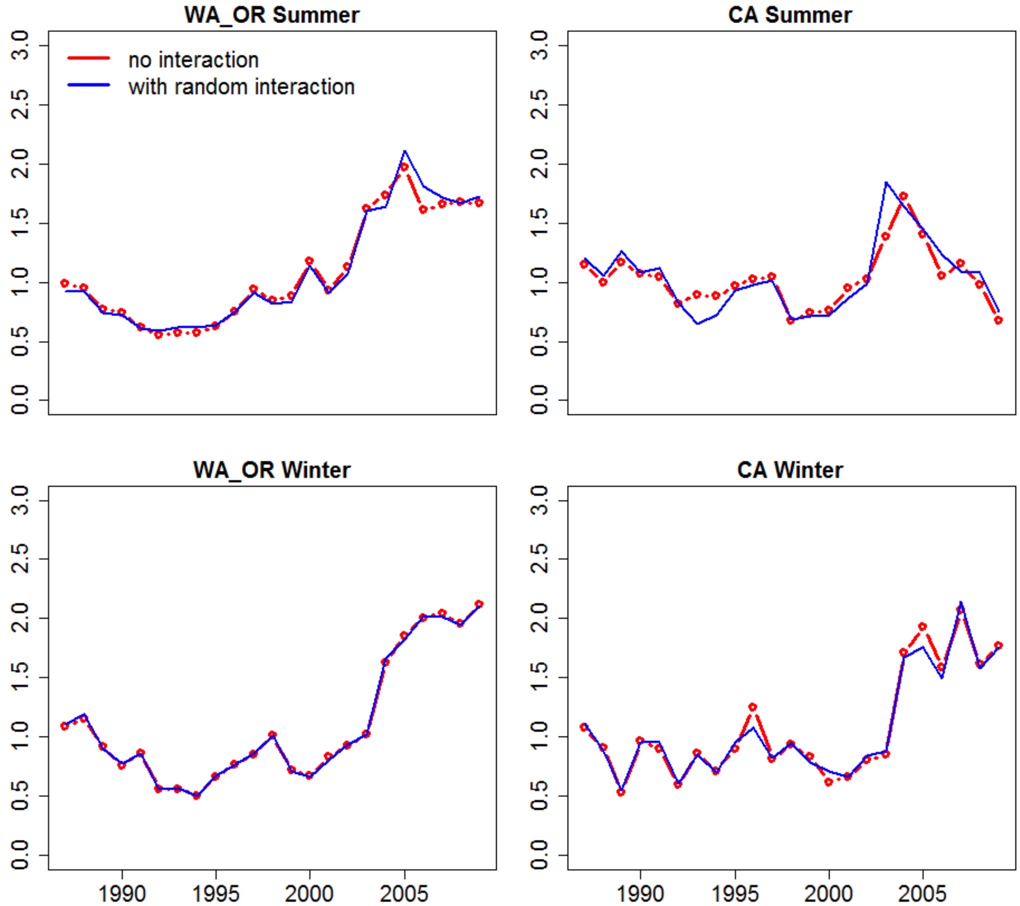


Figure B10: Sensitivity to the use of a random year:area interaction term for each region (WA/OR and CA) and season (summer and winter) combination.

Appendix B.10. TABLES

		Tow by tow data	Trip by trip data
Summer	WA	66834	13910
	OR	12918	4717
	CA	16405	6645
Winter	WA	4982	1613
	OR	5954	2370
	CA	2841	1307

Table B1: The number of data points within each type of data type (tow by tow *VS* trip)

Model name	Summer			Winter		
	WA	OR	CA	WA	OR	CA
2011 model	30%	52%	40%	43%	34%	40%
1. 2011 model – points outside of fishing grounds removed	27%	42%	40%	43%	34%	40%
2. 2011 model fixed reference	27%	42%	40%	43%	34%	40%
3. 2011 model geometric mean	27%	42%	40%	43%	34%	40%
4. 2011 model by trip	32%	47%	42%	34%	35%	34%
5. 2013 model with targeting covariates in lm	66%	71%	65%	66%	74%	72%
6. 2013 model with targeting covariates in lme	67%	71%	65%	44%	68%	74%

Table B2: Percent deviance explained by the final model for each of the 6 steps described in the main text and the 2011 model.

Season	Region	Model	Selected covariates for the 2013 model
Summer	WA/OR	Binomial	Year + Area + Bimonth + Port + PC1 + PC2 + PC3 + PC4 + (1|vessel)
		LogNornal	Year + Area + Gear + Bimonth + PC1 + PC2 + PC3 + PC4 + (1|vessel)
	CA	Binomial	Year + Area + Bimonth + PC1 + PC2 + PC3 + PC4 + (1|vessel)
		LogNornal	Year + Area + Gear + Bimonth + Port + PC1 + PC2 + PC3 + PC4 + (1|vessel)
Winter	WA/OR	Binomial	Year + Area + PC1 + PC2 + PC3 + PC4 + (1|vessel)
		LogNornal	Year + Area + PC1 + PC2 + PC3 + PC4 + (1|vessel)
	CA	Binomial	Year + Area + PC1 + PC2 + PC3 + PC4 + (1|vessel)
		LogNornal	Year + Area + PC1 + PC2 + PC3 + PC4 + (1|vessel)

Table B3: Covariates selection for the 2013 final models (both binomial and lognormal) for each season (Summer and Winter) and region (WA/OR and CA)

	Summer				Winter			
	WA/OR (mean)	WA/OR (sd)	CA (mean)	CA (sd)	WA/OR (mean)	WA/OR (sd)	CA (mean)	CA (sd)
1987	0.987	0.036	1.152	0.080	1.091	0.071	1.080	0.562
1988	0.950	0.038	0.999	0.043	1.155	0.064	0.908	0.170
1989	0.770	0.033	1.165	0.066	0.918	0.052	0.533	0.188
1990	0.743	0.031	1.077	0.115	0.759	0.049	0.963	0.367
1991	0.614	0.022	1.040	0.068	0.860	0.047	0.895	0.218
1992	0.555	0.022	0.821	0.054	0.556	0.042	0.592	0.408
1993	0.573	0.026	0.890	0.048	0.561	0.032	0.863	0.202
1994	0.574	0.028	0.878	0.034	0.503	0.044	0.713	0.102
1995	0.629	0.029	0.970	0.044	0.660	0.055	0.900	0.122
1996	0.748	0.033	1.026	0.039	0.767	0.082	1.250	0.184
1997	0.937	0.041	1.042	0.045	0.850	0.075	0.817	0.060
1998	0.844	0.036	0.676	0.035	1.009	0.113	0.933	0.140
1999	0.879	0.037	0.745	0.037	0.714	0.074	0.831	0.084
2000	1.177	0.057	0.757	0.046	0.674	0.050	0.618	0.067
2001	0.932	0.038	0.951	0.038	0.830	0.052	0.663	0.069
2002	1.126	0.043	1.026	0.044	0.930	0.066	0.799	0.079
2003	1.620	0.073	1.383	0.097	1.018	0.067	0.847	0.088
2004	1.737	0.075	1.726	0.143	1.629	0.137	1.711	0.258
2005	1.969	0.195	1.399	0.104	1.853	0.129	1.929	0.198
2006	1.608	0.151	1.050	0.067	2.007	0.183	1.584	0.172
2007	1.656	0.171	1.161	0.077	2.045	0.139	2.068	0.201
2008	1.675	0.179	0.981	0.066	1.955	0.124	1.616	0.154
2009	1.665	0.166	0.674	0.052	2.118	0.109	1.765	0.151

Table B4: Index of abundance for each region (WA/OR and CA) and season (summer and winter) with the associated standard deviation (sd).

Appendix C. Management actions impacting the petrale fishery prior to the implementation of the trawl ITQ program

Dan Erickson, ODFW Marine Resource Program, in collaboration with Brad Pettinger and members of industry compiled the following summaries of how management actions may have impacted the petrale sole fishery.

Major Management Shifts that could Impact Stock Assessments.

Effective October 18, 1982

- First trip limits established (widow rockfish and sablefish).

Effective January 1, 1992

- First **cumulative trip limits** for various species and species groups (widow RF; Sebastes complex; Pacific ocean perch; deepwater complex; non-trawl sablefish).

Effective May 9, 1992

- Increased the **minimum legal codend mesh size** for roller trawl gear north of Point Arena, California (40^{o} 30' N latitude) from 3.0 inches to 4.5 inches; prohibited double-walled codends; removed provisions regarding rollers and tickler chains for roller gear with codend mesh smaller than 4.5 inches.

Effective January 1, 1994

- Divided the commercial groundfish fishery into two components: the **limited entry** fishery and the open access fishery.
  - A federal limited entry permit is required to participate in the limited entry segment of the fishery. Permits are issued based on the fishing history of qualifying fishing vessels.

Effective September 8, 1995

- The **trawl minimum mesh size** now applies throughout the net; removed the legal distinction between bottom and roller trawls and the requirement for continuous riblines; clarified the distinction between bottom and pelagic (midwater) trawls; modified chafing gear requirements;

Effective January 1, 1999:

- Dividing line between north and south management areas moved to 40^{o} 10'.

Effective January 1, 2000

- **Chafing gear** may be used only on the last 50 meshes of a small footrope trawl, running the length of the net from the terminal (closed) end of the codend.

New rockfish categories in 2000.

- Rockfish (except thornyheads) are divided into new categories north and south of 40° 10' N. lat., depending on the depth where they most often are caught: nearshore, shelf, or slope. New trip limits have been established for "minor rockfish" species according to these categories.
  - Nearshore: numerous minor rockfish species including black and blue rockfishes.
  - Shelf: shortbelly, widow, yellowtail, bocaccio, chilipepper, cowcod rockfishes, and others.

- Slope: Pacific ocean perch, splitnose rockfish, and others

New Limited Entry Trawl Gear Restrictions in 2000.

- Limited entry trip limits may vary depending on the type of trawl gear that is onboard a vessel during a fishing trip: large footrope, small footrope, or midwater trawl gear.
  - **Large footrope trawl gear** is bottom trawl gear, with a footrope diameter larger than 8 in. (20 cm) (including rollers, bobbins or other material encircling or tied along the length of the footrope).
  - **Small footrope trawl gear** is bottom trawl gear, with a footrope diameter 8 in. (20 cm) or smaller (including rollers, bobbins or other material encircling or tied along the length of the footrope), except chafing gear may be used only on the last 50 meshes of a small footrope trawl, running the length of the net from the terminal (closed) end of the codend.
  - **Midwater trawl gear** is pelagic trawl gear, The footrope of midwater trawl gear may not be enlarged by encircling it with chains or by any other means.

Effective during 2001:

- First conservation area was established (Cowcod Conservation Area)
- The West Coast Observer Program was initiated
- It is unlawful to take and retain, possess or land petrale sole from a fishing trip if large footrope gear is onboard and the trip is conducted at least in part between May 1 and October 31

Effective during 2002:

- Darkblotched Conservation Area was established.

Effective during 2003:

- Vessel buyback program was initiated (December 4, 2003)
- Yelloweye Rockfish Conservation Area was established
- Rockfish Conservation areas for several rockfish species were established.

Effective during 2004:

- Vessel Monitoring System (VMS) was initiated.

Effective during 2005:

- Selective flatfish trawl required shoreward of the RCA North of 40^{o} 10'.

Petrale Sole – First Major Regulations

Effective 1983

- First established coast-wide ABC limits for annual harvest of petrale sole.

Effective April 1, 1999 (April 16, 1999 for "B" platoon vessels)

- Limited Entry and Open Access *Sebastes* complex: north and south of Cape Mendocino, if a vessel takes and retains, possesses, or lands any splitnose or chilipepper rockfish south of Cape Mendocino, then the more restrictive *Sebastes* complex cumulative trip limit applies throughout the same cumulative limit period, no matter where the *Sebastes* complex is taken and retained, possessed, or landed.

Effective during 2000:

- For Limited Entry: large footrope trawl gear may be used to take………petrale sole from January 1-February 29 and November 1-December 31……., but these exceptions apply only on a trip that is conducted entirely during the periods in which use of large footrope gear is authorized. The presence of rollers or bobbins larger than 8 in. (20 cm) in diameter on board the vessel, even if not attached to a trawl, will be considered to mean a large footrope trawl is on board. Dates will be adjusted for the "B" platoon.

<u>Effective during 2001</u>:

- It is unlawful to take and retain, possess or land petrale sole from a fishing trip if large footrope gear is onboard and the trip is conducted at least in part between May 1 and October 31

<u>Effective 2002</u>:

- First cumulative trip limits for petrale sole
  - In 2001, no restrictions except requirement for small footrope.
  - In 2002, monthly limit of 15,000 pounds during July and August.

<u>Effective 2003</u>:

- Bimonthly cumulative trip limits for summer petrale sole were initiated.

Effective 2004:

- Vessel buy back program came into effect. GAP members indicated that this resulted in a decrease in effort for petrale compared to earlier years.

Effective 2006-2009:

- Progressively decreasing trip limits implemented for the winter petrale fishery, however GAP members indicated that these trip limits were not actually restrictive because that were all well over 10,000 lbs, which is a typical winter petrale trip.

Table C1. Annual RCA depth boundaries 2002 – 2009 (does not include in-season changes).

<table>
<tr><th>Year</th><th>Location</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td rowspan="10">2008</td><td>North 48 10</td><td colspan="2">0 - [m]200</td><td colspan="2">0 - 200</td><td colspan="6">0 - 150</td><td colspan="2">0 - [m]200</td></tr>
<tr><td>48 10 - 46 38.17</td><td colspan="2" rowspan="4">75 - [m]200</td><td colspan="2">60 - 200</td><td colspan="5">60 - 150</td><td rowspan="2">75 - 150</td><td colspan="2" rowspan="4">75 - [m]200</td></tr>
<tr><td>46 38.17 - 46 16</td><td colspan="4">60 - 200</td><td colspan="3">60 - 150</td></tr>
<tr><td>46 16 - 45 46</td><td colspan="2">75 - 200</td><td colspan="4">75 - 150</td><td colspan="2">75 - 200</td></tr>
<tr><td>45 46 - 43 20.83</td><td colspan="8">75 - 200</td></tr>
<tr><td>43 20.83 - 42 40.50</td><td colspan="2">0 - [m]200</td><td colspan="8">0 - 200</td><td colspan="2">0 - [m]200</td></tr>
<tr><td>42 40.5 - 40 10</td><td colspan="2">75 - [m]200</td><td colspan="2">75 - 200</td><td colspan="5">60 - 200</td><td>75 - 200</td><td colspan="2">75 - [m]200</td></tr>
<tr><td>40 10 - 34 27</td><td colspan="12" rowspan="2">100 - 150</td></tr>
<tr><td>South 34 27 (mainland)</td></tr>
<tr><td>South 34 27 (islands)</td><td colspan="12">0 - 150</td></tr>
<tr><td rowspan="8">2007</td><td>North 48 10</td><td colspan="2">0 - [m]200</td><td colspan="2">0 - 200</td><td colspan="6">0 - 150</td><td colspan="2">0 - [m]200</td></tr>
<tr><td>48 10 - 46 16</td><td colspan="2" rowspan="2">75 - [m]200</td><td colspan="2">60 - 200</td><td colspan="4">60 - 150</td><td colspan="2">75 - 150</td><td colspan="2" rowspan="2">75 - [m]200</td></tr>
<tr><td>46 16 - 43 20.83</td><td colspan="8">75 - 200</td></tr>
<tr><td>43 20.83 - 42 40.50</td><td colspan="2">0 - [m]200</td><td colspan="8">0 - 200</td><td colspan="2">0 - [m]200</td></tr>
<tr><td>42 40.50 - 40 10</td><td colspan="2">75 - [m]200</td><td colspan="8">75 - 200</td><td colspan="2">75 - [m]200</td></tr>
<tr><td>40 10 - 34 27</td><td colspan="12" rowspan="2">100 - 150</td></tr>
<tr><td>South 34 27 (mainland)</td></tr>
<tr><td>South 34 27 (islands)</td><td colspan="12">0 - 150</td></tr>
<tr><td rowspan="5">2006</td><td>North 40 10</td><td colspan="2">75 - [m]200</td><td colspan="4">75 - 200</td><td colspan="2">100 - 250</td><td colspan="2">75 - 250</td><td colspan="2">75 - [m]200</td></tr>
<tr><td>40 10 – 38</td><td colspan="2" rowspan="3">75 - 150</td><td colspan="4" rowspan="3">100 - 150</td><td colspan="2">100 - 200</td><td colspan="2">100 - 250</td><td colspan="2">75 - [m]250</td></tr>
<tr><td>38 - 34 27</td><td colspan="4" rowspan="2">100 - 150</td><td colspan="2" rowspan="2">75 - 150</td></tr>
<tr><td>South 34 27 (mainland)</td></tr>
<tr><td>South 34 27 (islands)</td><td colspan="12">0 - 150</td></tr>
<tr><td rowspan="2">2005</td><td>North 40 10</td><td colspan="2">75 - [m]200</td><td colspan="7">100 - 200</td><td colspan="3" rowspan="2">0 - 250</td></tr>
<tr><td>40 10 – 38</td><td colspan="2">75 - 150</td><td colspan="2">100 - 200</td><td colspan="5">100 - 150</td></tr>
</table>

	38 – 36		100 - 150				0 - 200	
	36 - 34 27						50 - 200	
	South 34 27 (mainland)							
	South 34 27 (islands)	0 - 150					0 - 200	
2004	North 40 10	75 - [m]200	60 - 200	60 - 150	75 - 150		0 - 250	
	40 10 – 38							
	38 – 36	75 - 150		100 - 150		75 - 150	0 - 200	
	36 - 34 27						0 - 150	
	South 34 27 (mainland)							
	South 34 27 (islands)	0 - 150						
2003	North 40 10	100 - [m]250	100 - 250	50 - 200	75 - 200	50 - 200		0 - [m]200
	40 10 – 38	50 - [m]250	60 - 250	60 - 200				
	38 - 34 27	50 - 150	60 - 150					
	South 34 27 (mainland)	100 - 150		100 - 200				0 - 200
	South 34 27 (islands)	0 - 150		0 - 200				
2002	North 40 10	Within DBCA - CLOSED TO TRAWLING;				Special footrope requirements outside DBCA		

[m]The "modified" depth" line is modified to exclude certain petrale sole areas from the RCA.

Appendix D. SS data file

#C 2013 Assessent of Petrale (Haltuch, Ono, Valero) run with SS3.24O
#_bootstrap file: 1
#year is from Nov-Oct
#Winter in yr 1 includes Nov-Dec from yr-1
1876 #_styr
2012 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
4 #_Nfleet
3 #_Nsurveys
1 #_N_areas
WinterN%SummerN%WinterS%SummerS%TriEarly%TriLate%NWFSC
0.16 0.67 0.16 0.67 0.73 0.67 0.67 #_surveytiming_in_season
1 1 1 1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 1 1 #_units of catch: 1=bio; 2=num
0.01 0.01 0.01 0.01 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
40 #_Nages

0 0 0 0 #_init_equil_catch_for_each_fishery
137 #_N_lines_of_catch_to_read

#WinterN	SummerN	WinterS	SummerS	Year	Season
0.000	0.000	0.000	1.000	1876	1
0.000	0.000	0.000	1.000	1877	1
0.000	0.000	0.000	1.000	1878	1
0.000	0.000	0.000	1.000	1879	1
0.000	0.000	0.000	11.550	1880	1
0.000	0.000	0.000	22.100	1881	1
0.000	0.000	0.000	32.650	1882	1
0.000	0.000	0.000	43.200	1883	1

0.000	0.000	0.000	53.750	1884	1
0.000	0.000	0.000	64.300	1885	1
0.000	0.000	0.000	74.850	1886	1
0.000	0.000	0.000	85.400	1887	1
0.000	0.000	0.000	95.950	1888	1
0.000	0.000	0.000	106.500	1889	1
0.000	0.000	0.000	117.050	1890	1
0.000	0.000	0.000	127.600	1891	1
0.000	0.000	0.000	138.150	1892	1
0.000	0.000	0.000	148.710	1893	1
0.000	0.000	0.000	159.260	1894	1
0.000	0.000	0.000	169.810	1895	1
0.000	0.242	0.000	180.360	1896	1
0.000	0.198	0.000	190.910	1897	1
0.000	0.154	0.000	201.460	1898	1
0.000	0.150	0.000	212.010	1899	1
0.000	0.146	0.000	222.560	1900	1
0.000	0.142	0.000	233.110	1901	1
0.000	0.138	0.000	243.660	1902	1
0.000	0.133	0.000	254.210	1903	1
0.000	0.129	0.000	264.760	1904	1
0.000	0.125	0.000	275.310	1905	1
0.000	0.121	0.000	285.860	1906	1
0.000	0.117	0.000	296.410	1907	1
0.000	0.113	0.000	306.960	1908	1
0.000	0.108	0.000	317.510	1909	1
0.000	0.104	0.000	328.060	1910	1
0.000	0.100	0.000	338.610	1911	1
0.000	0.096	0.000	349.160	1912	1
0.000	0.092	0.000	359.710	1913	1
0.000	0.088	0.000	370.260	1914	1
0.000	0.083	0.000	380.810	1915	1
0.000	0.079	0.000	386.420	1916	1
0.000	0.075	0.000	526.410	1917	1

0.000	0.071	0.000	423.8501918		1		
0.000	0.067	0.000	333.4401919		1		
0.000	0.063	0.000	230.4901920		1		
0.000	0.058	0.000	293.7601921		1		
0.000	0.054	0.000	424.7801922		1		
0.000	0.050	0.000	427.3601923		1		
0.000	0.046	0.000	532.8601924		1		
0.000	0.042	0.000	528.4701925		1		
0.000	0.038	0.000	521.6701926		1		
0.000	0.035	0.000	632.0401927		1		
0.000	0.0005	0.000	620.0901928		1		
0.000	1.542	0.000	706.0401929		1		
0.000	1.225	0.000	658.8301930		1		
0.000	81.451	63.393	530.8791931		1		
1.990	250.87836.396		519.9121932		1		
5.960	408.43138.566		392.0801933		1		
9.930	567.855139.408896.3631934				1		
13.900	649.957155.383777.2061935				1		
15.880	769.78695.492		431.5061936		1		
19.750	1051.408		74.525	741.0461937		1	
27.490	1186.868		47.860	890.0001938		1	
35.220	1544.538		30.839	1028.962		1939	1
39.090	1736.581		161.807596.6961940			1	
41.400	1802.657		110.810331.1661941			1	
46.000	2919.254		24.368	215.5561942		1	
50.610	2867.305		71.659	344.7171943		1	
55.210	2046.967		85.530	446.9131944		1	
59.820	1866.047		101.753439.3431945			1	
64.430	2492.355		71.912	1115.569		1946	1
69.030	1777.987		153.6801092.655			1947	1
73.640	2314.744		272.6621778.018			1948	1
75.940	1808.645		616.9581812.179			1949	1
156.2102322.237			424.2381638.087			1950	1
117.9701665.615			208.450992.7941951			1	

131.0101390.431 326.309881.6991952 1
46.070 737.103533.360981.1671953 1
26.560 903.363800.5801073.403 1954 1
57.140 862.592525.5791051.745 1955 1
137.251759.217508.296800.7301956 1
170.9471103.287 527.2121027.183 1957 1
99.180 1152.193 567.972957.2881958 1
332.103946.779379.043723.1701959 1
240.8681374.201 519.638643.7371960 1
216.6561546.633 542.0561028.728 1961 1
294.8551511.890 514.912859.3691962 1
663.2941038.412 534.032977.6391963 1
282.3191090.041 377.620926.7981964 1
370.455950.391373.691852.8821965 1
366.063971.694324.878924.6261966 1
408.625793.421532.275874.0791967 1
284.404810.617360.610870.7571968 1
190.3398 887.2988 421 848 1969 1
411.7056 1081.3056 472 1071 1970 1
742.6239 882.6067 540 1016 1971 1
730.4228 1016.8779 703 1000 1972 1
497.4696 1271.8321 417 742 1973 1
516.9943 1610.5252 665 893 1974 1
538.9519 1559.1587 561 901 1975 1
505.7288 951.1170 713 737 1976 1
682.0842 742.7714 484 495 1977 1
746.2496 1097.7504 419 801 1978 1
734.3089 1085.5609 353 945 1979 1
382.4983 976.2298 518 680 1980 1
760.671467.912359.662895.2191981 1
1041.185 770.688261.527502.0681982 1
696.317935.345272.602361.1191983 1
415.773739.012259.829328.9891984 1
392.131552.894273.264471.1291985 1

474.121714.443402.910355.0561986 1
854.042572.666311.090556.0801987 1
742.900610.432349.106411.0351988 1
695.992583.013392.604414.7321989 1
640.655459.820319.426372.6801990 1
792.584397.337448.010310.1171991 1
639.526365.974271.705307.2601992 1
685.385392.080237.092233.9851993 1
518.127355.428245.861299.4061994 1
591.366453.922235.561287.4251995 1
591.033439.746405.922393.9421996 1
621.054430.036447.633442.2781997 1
522.143577.351220.734300.4581998 1
463.344504.248286.802266.6431999 1
610.157585.531373.622241.4602000 1
691.412596.985308.335260.2952001 1
666.972713.850335.160195.1152002 1
544.484713.444256.210179.6702003 1
1009.912 749.507 177.237 267.160 2004 1
963.6821068.763 337.181 533.414 2005 1
537.4461011.620 125.283 453.537 2006 1
930.384536.108404.351474.8642007 1
842.461353.816519.444414.0242008 1
846.710641.747469.659250.3792009 1
258.086292.34377.602 120.9522010 1
221.604423.10539.585 77.704 2011 1
406.049477.707124.4597 107.6337 2012 1

#Abundance indices
65 #nobs
#_Fleet/Survey (explicitly entered for future capability), Units (0=num; 1=bio; 2=F), Error distribution (-1=normal; 0=lognorm; >0=df_T). 1-4 and 8-9 have all a normal error distribution because it was obtained from a GLM with parametric bootstrap so we should -1 BUT as we only use Winter N and CA indices, just use -1 for these. there is an error message when using normal error with the Q type. So we only put -1 to the one we actually use

1	1	0
2	1	0
3	1	0
4	1	0
5	1	0
6	1	0
7	1	0

#Year	Seas	Fleet	Value	SE(log(B))		
#winter commercial			cpue for the 2013		assessment	
1987	1	1	1.091	0.275191152	#	N
1988	1	1	1.155	0.27307458	#	N
1989	1	1	0.918	0.273326837	#	N
1990	1	1	0.759	0.275069479	#	N
1991	1	1	0.86	0.272921696	#	N
1992	1	1	0.556	0.277838058	#	N
1993	1	1	0.561	0.273408906	#	N
1994	1	1	0.503	0.281294972	#	N
1995	1	1	0.66	0.280043585	#	N
1996	1	1	0.767	0.287869483	#	N
1997	1	1	0.85	0.281530226	#	N
1998	1	1	1.009	0.2897726	#	N
1999	1	1	0.714	0.286685059	#	N
2000	1	1	0.674	0.27747458	#	N
2001	1	1	0.83	0.274629538	#	N
2002	1	1	0.93	0.276636644	#	N
2003	1	1	1.018	0.275365709	#	N
2004	1	1	1.629	0.280271487	#	N
2005	1	1	1.853	0.276294839	#	N
2006	1	1	2.007	0.28245981	#	N
2007	1	1	2.045	0.275886433	#	N
2008	1	1	1.955	0.274806968	#	N
2009	1	1	2.118	0.272303222	#	N
1987	1	3	1.08	0.557798105	#	S

1988	1	3	0.908	0.325509688	#	S
1989	1	3	0.533	0.434469417	#	S
1990	1	3	0.963	0.455100518	#	S
1991	1	3	0.895	0.359359883	#	S
1992	1	3	0.592	0.678342845	#	S
1993	1	3	0.863	0.353331697	#	S
1994	1	3	0.713	0.302924029	#	S
1995	1	3	0.9	0.299520506	#	S
1996	1	3	1.25	0.304861401	#	S
1997	1	3	0.817	0.277277663	#	S
1998	1	3	0.933	0.306219382	#	S
1999	1	3	0.831	0.285779429	#	S
2000	1	3	0.618	0.288425341	#	S
2001	1	3	0.663	0.286839292	#	S
2002	1	3	0.799	0.285013103	#	S
2003	1	3	0.847	0.286776015	#	S
2004	1	3	1.711	0.306572346	#	S
2005	1	3	1.929	0.286329601	#	S
2006	1	3	1.584	0.288489098	#	S
2007	1	3	2.068	0.284440853	#	S
2008	1	3	1.616	0.283803782	#	S
2009	1	3	1.765	0.280707101	#	S

#early triennial

#Year	Season	Fleet	Value	seLogB
1980	1	5	1863.939037	0.328810444
1983	1	5	2299.824418	0.128134397
1986	1	5	2192.978622	0.146227217
1989	1	5	3234.011806	0.109135043
1992	1	5	2125.822633	0.116710279
#late	triennial			
1995	1	6	2407.101199	0.147946883
1998	1	6	3547.914184	0.112120606
2001	1	6	3831.630638	0.115111377
2004	1	6	9713.248317	0.140543239

glmm NWFSC index for the 2013 assessment

#Year	Season	Fleet	Value	seLogB
2003	1	7	18297.78731	0.156022881
2004	1	7	27551.88827	0.22060519
2005	1	7	21670.60066	0.132358805
2006	1	7	19571.86613	0.14894693
2007	1	7	20788.85206	0.172820929
2008	1	7	15597.49455	0.133771849
2009	1	7	15783.65562	0.140730792
2010	1	7	22573.61379	0.136966137
2011	1	7	30366.63363	0.12732552
2012	1	7	36852.04055	0.151725306

#_Discards
4 # N fleets with discard
#Fleet, Units#(1=biomass,2=fraction), Error
1 2 -1
2 2 -1
3 2 -1
4 2 -1

48 #nobs_disc
#Pikitch Winter

#Year	Seas	Fleet	Ratio	stdev
1985	1	1	0.0222	0.1103
1986	1	1	0.0215	0.1162
1987	1	1	0.0270	0.1186

#Pikitch Summer

#Year	Seas	Fleet	Ratio	stdev
1985	1	2	0.0346	0.0419
1986	1	2	0.0343	0.0432
1987	1	2	0.0315	0.0450

#WCGOP
#Years SeasonsFleet Mean_ratio STDEV_ratio

2002	1	1	0.0077	0.0034	#2mo data	Jan-Feb	NCS
2003	1	1	0.0100	0.0064			
2004	1	1	0.0019	0.0008			
2005	1	1	0.0013	0.0009			
2006	1	1	0.0131	0.0073			
2007	1	1	0.0037	0.0015			
2008	1	1	0.0275	0.0146			
2009	1	1	0.0253	0.0151			
2010	1	1	0.1971	0.0444			
2011	1	1	0.0017	0.0000	#2mo data	Jan-Feb	CS
2012	1	1	0.0006	0.0000	#2mo data	Nov-Dec	CS
2002	1	2	0.1856	0.0253			
2003	1	2	0.1111	0.0252			
2004	1	2	0.0843	0.0244			
2005	1	2	0.0421	0.0112			
2006	1	2	0.0780	0.0171			
2007	1	2	0.1138	0.0232			
2008	1	2	0.0502	0.0167			
2009	1	2	0.2018	0.0673			
2010	1	2	0.1037	0.0308			
2011	1	2	0.0370	0.0000			
#2012	1	2	0.0000	0.0000			
2002	1	3	0.0372	0.0244	#2mo data	Jan-Feb	NCS
2003	1	3	0.0062	0.0026			
2004	1	3	0.0526	0.0521			
2005	1	3	0.0069	0.0071			
2006	1	3	0.0598	0.0446			
2007	1	3	0.0194	0.0139			
2008	1	3	0.0099	0.0056			
2009	1	3	0.0221	0.0147			
2010	1	3	0.2584	0.0717			
2011	1	3	0.0009	0.0000	#2mo data	Jan-Feb	CS
2012	1	3	0.0046	0.0000	#2mo data	Nov-Dec	CS
2002	1	4	0.0569	0.0158			

2003	1	4	0.0325	0.0126
2004	1	4	0.0343	0.0153
2005	1	4	0.0122	0.0035
2006	1	4	0.0360	0.0157
2007	1	4	0.0610	0.0209
2008	1	4	0.0259	0.0147
2009	1	4	0.0233	0.0082
2010	1	4	0.0554	0.0119
2011	1	4	0.0411	0.0000
#2012	1	4	0.0000	0.0000

#_Mean_BodyWt
42 #nobs_mnwt #N_observations
30 #Degrees of freedom for Student's T distribution
#must be in kilograms

#	YEAR	Season	Fleet	Partition	Wghtd.Ave_W_kg	CV
2002	1	1	1	0.41109668	0.470839818	
2003	1	1	1	0.296714264	0.453253348	
2004	1	1	1	0.331760125	0.477172719	
2005	1	1	1	0.316130396	0.537503426	
2006	1	1	1	0.416980449	0.623837895	
2007	1	1	1	0.401019299	0.31406069	
2008	1	1	1	0.52169398	0.442717768	
2009	1	1	1	0.416490854	0.45259457	
2010	1	1	1	0.601361841	0.546528198	
2011	1	1	1	0.276266811	0.51633137	
2012	1	1	1	0.264194046	0.512322722	
2002	1	2	1	0.240597372	0.45254476	
2003	1	2	1	0.234067327	0.545932003	
2004	1	2	1	0.27436362	0.368487531	
2005	1	2	1	0.304357202	0.411846662	
2006	1	2	1	0.266883914	0.446533464	
2007	1	2	1	0.259009322	0.398513855	
2008	1	2	1	0.241003278	0.474617864	

2009	1	2	1	0.217003824	0.524842144
2010	1	2	1	0.258471662	0.544325765
2011	1	2	1	0.246277526	0.529968419
2002	1	3	1	0.409963075	0.658202015
2003	1	3	1	0.178195615	0.40686274
2004	1	3	1	0.308563012	0.393827606
2005	1	3	1	0.270195088	0.664186516
2006	1	3	1	0.28395648	0.668245725
2007	1	3	1	0.216647402	0.470450153
2008	1	3	1	0.300154174	0.44548394
2009	1	3	1	0.554297324	0.415971442
2010	1	3	1	0.416960247	0.969237939
2011	1	3	1	0.325914252	0.132070642
2012	1	3	1	0.201967068	0.686972489
2002	1	4	1	0.189944455	0.738276131
2003	1	4	1	0.175143939	0.408831844
2004	1	4	1	0.183139252	0.47245741
2005	1	4	1	0.251891827	0.438407262
2006	1	4	1	0.318454956	0.642855376
2007	1	4	1	0.365889327	0.629305567
2008	1	4	1	0.218877948	0.427333515
2009	1	4	1	0.212614882	1.049014551
2010	1	4	1	0.183166651	0.369473321
2011	1	4	1	0.245672185	0.666042157

#Population length bins
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
4 # minimum size in the population (lower edge of first bin and size at age 0.00)
78 # maximum size in the population (lower edge of last bin)

#Length bins
-1 #min_tail #min_proportion_for_compressing_tails_of_observed_composition
0.001 #min_comp #constant_added_to_expected_frequencies

0 #_combine males into females at or below this bin number
#_Length_Composition_Data

26 #nlength #N_length_bins

#len_bins(1,nlength) #_lower_edge_of_length_bins

12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
52 54 56 58 60 62

#LENGTH_COMPOSITIONS

237 #nobs length

#lendata(1,nobsl,1,6+gender*nlength) #Sorted_by_year_fleet_mkt:_0:Survey_1:Discard_2:Fisheries
#year Season Fleet gender partition nSamps F12 F14 F16 F18 F20 F22 F24 F26 F28 F30 F32
F34 F36 F38 F40 F42 F44 F46 F48 F50 F52 F54 F56 F58 F60 F62 M12 M14
M16 M18 M20 M22 M24 M26 M28 M30 M32 M34 M36 M38 M40 M42 M44 M46 M48
M50 M52 M54 M56 M58 M60 M62
1955 1 1 3 2 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0.788954635 3.15581854 4.733727811 5.522682446 5.719921105 4.930966469 4.142011834
1.775147929 1.972386588 0.394477318 0 0 0 0 0 0 0 0 0 0 0
0 0 0.394477318 4.142011834 11.04536489 18.93491124 21.69625247 8.08678501 2.169625247
0.394477318 0 0 0 0 0 0 0

1956 1 1 3 2 1 0 0 0 0 0 0 0 0 0 0 0
0.432900433 1.01010101 0.721500722 1.731601732 2.741702742 5.339105339 7.215007215 8.802308802
7.647907648 4.906204906 1.443001443 0.432900433 0.432900433 0.144300144 0 0 0 0 0
0 0 0 0 0 0 0.288600289 0.865800866 3.463203463 5.772005772 9.523809524
17.74891775 12.6984127 4.184704185 2.308802309 0.144300144 0 0 0 0 0 0
1957 1 1 3 2 10 0 0 0 0 0 0 0 0 0 0 0 0
0.011355959 0.129897292 0.40190161 1.158393538 2.030338951 4.524230798 7.940308334 7.897405459
8.62573406 5.971472386 2.352581948 1.683024178 0.437690478 0.123473177 0 0 0 0 0
0 0 0 0.151566192 0 0.003160279 0.149325519 1.784554501 4.321016621 13.36858884
17.29184057 13.6538557 4.389940862 1.172677118 0.230525757 0.119356784 0 0.075783096 0 0
0
1958 1 1 3 2 1 0 0 0 0 0 0 0 0 0 0 0.432900433
0.432900433 4.329004329 3.03030303 5.194805195 4.329004329 1.731601732 1.298701299 1.298701299
2.597402597 0.865800866 1.298701299 0.432900433 0.432900433 0 0 0 0 0 0 0
0 0 0 0 0 0.432900433 5.627705628 7.792207792 14.71861472 6.493506494 9.956709957
15.15151515 11.68831169 0.432900433 0 0 0 0 0 0 0
1959 1 1 3 2 2 0 0 0 0 0 0 0 0 0.113249961 0.566249807
0.79146326 1.244463106 1.921389934 4.618805485 4.838873056 5.172190589 5.057654157 2.365384488
3.046170727 3.155561278 3.725670496 3.391066493 1.811999384 0.338463414 0.111963491 0 0 0
0 0 0 0 0 0 0.113249961 0.566249807 1.019249653 3.483732929 12.32884873
20.38893362 12.54762983 5.375534046 1.344848364 0.223926982 0.225213453 0.111963491 0 0 0
0 0 0
1964 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0 0 0
0.080893299 2.153631437 3.459014096 6.604186039 7.365343009 9.814503092 4.935395577 4.039977739
1.651922699 0.137467235 0.548487413 0.53959007 0 0 0 0 0 0 0 0 0
0 0 0 0.54042377 4.467317854 14.12316621 22.51171618 10.91479623 4.185025007 1.927143043
0 0 0 0 0 0 0 0 0
1965 1 1 3 2 3 0 0 0 0 0 0 0 0 0 0 0 0
0 0.370246816 4.140363842 5.950662575 10.06140302 10.42324776 11.00290988 7.081870698 3.720025958
2.090272774 0.839922126 0.370246816 0 0 0 0 0 0 0 0 0 0 0
0 0 0.740493632 7.127544601 9.778519103 16.91446578 5.308843793 3.358934861 0.370246816 0
0.349779142 0 0 0 0 0 0
1966 1 1 3 2 2 0 0 0 0 0 0 0 0 0 0 0 0
0 0.524958883 2.362314976 7.005324848 4.199671068 3.412232743 5.873787003 0.524958883 0.524958883

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.262479442
3.593092106 6.136266445 19.90205591 15.07818667 23.93848682 6.136266445 0.262479442 0.262479442 0
0 0 0 0 0 0 0
1967 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0.600623872
1.674328102 1.07370423 2.748032333 8.515978493 16.08815014 11.68042461 8.801486215 7.04314132
3.661276269 2.049711248 0.862524013 0.976007018 0 0 0 0 0 0 0 0 0
0 0 0 0.536852115 3.949280077 3.772025315 8.531764286 6.716840836 6.243760478 2.749041008
1.725048026 0 0 0 0 0 0 0 0 0 0
1968 1 1 3 2 15 0 0 0 0 0 0 0 0 0 0.047456836
0.459539429 1.542932976 2.417856282 2.857902979 5.432175912 8.76082549 11.95495985 7.180044832
11.77703601 7.78655964 7.188475947 2.071405003 0.453720901 0.845564127 0.046792292 0 0 0
0 0 0 0 0 0 0 0.413027558 1.0546359 2.644531229 4.48628516 6.888398848
7.782760899 3.867078344 1.369559666 0.670473891 0 0 0 0 0 0 0 0
1969 1 1 3 2 14 0 0 0 0 0 0 0 0 0 0.470424919
1.373453457 1.208845349 0.716326225 0.844949961 2.06367077 5.022491106 12.9212845 12.09640865
7.076290011 6.377982627 2.303091421 1.174527757 0.696780479 0.10254711 0 0 0 0 0
0 0 0 0 0.06492176 0.042302565 0.138676982 0.60999272 3.678055314 9.433223556
15.25247701 10.25221177 4.566034506 0.974004525 0.454577121 0.084447827 0 0 0 0 0
0 0
1970 1 1 3 2 11 0 0 0 0 0 0 0 0 0.305687082 2.640724324
4.765660996 5.581372454 5.255268575 5.814031488 5.606717451 6.928776728 9.801691081 6.725250737
4.324314952 4.386224476 1.681994063 0.430539831 0.330666955 0.2302258 0.016601266 0 0 0
0 0 0 0 0 0 0.800704778 1.760283151 4.116203453 7.477678118 7.972571929
5.603446574 5.060355534 1.795199828 0.39250269 0.195305687 0 0 0 0 0 0 0
0
1971 1 1 3 2 12 0 0 0 0 0 0 0 0 0.091553925 0.087778115
0.428261782 0.35488827 0.676601406 1.507756348 1.961185621 3.330564555 4.536036848 5.594949115
3.307903974 3.356448517 1.624797108 1.280621422 0.856091997 0.282025348 0 0.165148016 0 0
0 0 0 0 0 0 0.270885966 0.398845483 1.545838742 6.678235639 13.78965191
16.20886054 15.13030881 9.406554525 5.069182715 1.389452797 0.57650153 0.093068981 0 0 0
0 0 0
1972 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0.002019805
0.054813545 0.081586494 0.343706743 1.7548656 5.16961121 8.973796436 7.432737544 3.91470469
5.412316707 3.673341736 3.329603856 2.612635877 0.944192299 0.719599726 0.387840459 0 0 0

0 0 0 0 0 0 0.009346865 0.021465694 0.600691089 6.191894759 17.94153906
18.97100945 8.149524347 1.631924674 1.254086784 0.42114455 0 0 0 0 0 0 0
0
1973 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0 0
0.12483795 0.20806325 0.852027762 4.705742283 9.496454655 11.91241261 8.427622348 5.288162975
4.670596417 1.722048608 1.436230132 1.270356091 0.942176886 0.613997681 0.204665894 0 0 0
0 0 0 0 0 0 0.190947357 0.371116494 2.879456771 13.78815203 23.40393841
5.846621799 1.166488431 0.394657856 0.0832253 0 0 0 0 0 0 0 0
1974 1 1 3 2 5 0 0 0 0 0 0 0 0 0 0 0.032737246
0.065474493 0.410362308 0.78798737 2.73369446 4.827187438 5.143944495 3.984100587 1.728496101
1.193214218 0.806496345 0.272949103 0.360107383 0.158890946 0.126153699 0 0 0 0 0
0 0 0 0 0 0 0.368034489 2.249077331 10.97892766 24.96992733 26.30146942
9.093861461 1.968109607 1.004858184 0.433938325 0 0 0 0 0 0 0
1975 1 1 3 2 12 0 0 0 0 0 0 0 0 0 0 0
0.044921799 0.241246341 0.639548083 2.796992254 6.857473187 10.20234017 10.63872796 6.251335553
3.526745929 2.034036783 1.315698538 0.779632131 0.226906573 0.23848989 0.021395919 0 0 0
0 0 0 0.015659491 0 0 0 0.229009734 1.913016238 8.091611918 16.89470404
15.69144061 8.403895363 2.269401942 0.432058755 0.137965315 0.084349557 0.021395919 0 0 0
0 0
1976 1 1 3 2 3 0 0 0 0 0 0 0 0 0 0 0 0
0 0.310365869 1.279393265 3.692205269 7.931945935 8.697137892 5.721873223 4.55125546 1.279811425
1.041440195 0.620731739 0.329148072 0.091195002 0 0 0 0 0 0 0 0 0
0 0 0 1.753785097 11.06956799 23.98037545 15.62502381 9.883897444 1.556112442 0.584734419
0 0 0 0 0 0 0 0
1977 1 1 3 2 2 0 0 0 0 0 0 0 0 0 0 0
0.147358949 0.976330095 0.294717897 3.924125554 10.35396972 14.51763063 18.77346794 10.20661077
6.577203115 2.855619055 1.160682903 2.708260106 0.773788602 0.386894301 0.773788602 0 0 0
0 0 0 0 0 0 0 0 1.750118697 4.900455649 7.184827595 5.913163116
4.494756175 0.884153692 0.294717897 0.147358949 0 0 0 0 0 0 0
1978 1 1 3 2 4 0 0 0 0 0 0 0 0 0.006888557 0.034442783
0.055108452 0.02066567 0.075774122 0.166138143 1.396698079 4.35960267 12.21221948 14.47684264
11.48962503 9.37201507 5.811149555 4.399334404 3.338994095 0.514763731 0.824347957 0.410359011 0
0 0 0 0 0 0 0.006888557 0 0.027644536 0.041511958 1.248130185 5.20621984

10.01661097 8.697766145 2.608161053 2.051795054 0.615538516 0.514763731 0 0 0 0 0
0 0
1979 1 1 3 2 2 0 0 0 0 0 0 0 0 0 0 0 0
0 0.428034901 2.140174504 2.568209405 2.628405143 4.340544746 2.200370242 4.460936221 2.26056598
0.428034901 0.428034901 0 0.976461277 0.488230639 0 0 0 0 0 0 0 0
0 0 0.488230639 2.996244306 14.29240947 15.20867501 15.32906648 15.87749286 9.162655393
2.808992356 0 0 0.488230639 0 0 0 0 0
1980 1 1 3 2 9 0 0 0 0 0 0 0 0 0.030720589 0.122882356
0.484976759 0.880556864 0.914201678 1.455491713 3.987071117 10.9043403 9.094967491 5.864500272
5.086352727 7.149524743 5.595815894 2.143321036 1.326111028 1.048051118 0.139086515 0.266965937 0
0 0 0 0 0 0 0.057485068 0 0.270775462 1.130660235 4.285809854 8.717974427
14.31954643 8.683171705 3.414863088 1.889465009 0.397280418 0.249824518 0.088205657 0 0 0
0 0 0
1981 1 1 3 2 10 0 0 0 0 0 0 0 0 0.164395416 0.975511733
1.611133949 2.073815965 1.817430805 3.182034165 4.069038953 6.038800116 5.701803791 12.42268498
11.19747506 6.396505413 5.553905381 4.47200298 3.883058421 1.484575966 0.498092533 0.697596296 0
0 0 0 0 0 0 0 0.033294731 0.874454462 2.266953688 4.121318912 4.69672612
5.378787535 4.329641723 1.632502853 1.802312778 0.818810085 0.793854908 0 0 0.240799501
0.578010584 0.192670195 0 0
1982 1 1 3 2 5 0 0 0 0 0 0 0 0 0.224096393 0
0.288881843 1.200819581 0.936736345 4.125683712 4.458766041 5.316760572 3.774042294 3.008587458
2.186366127 3.523989429 3.637614691 2.492759803 1.780149461 2.570476912 0.075760044 0.33984328 0
0 0 0 0 0 0 0 0.672289178 1.185267414 4.201407157 8.379185826 8.507768621
13.10458339 9.707121336 4.285673759 5.220227534 1.824942787 2.970199014 0 0 0 0 0
0 0
1983 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0 0.471486212
0.157162071 3.169103096 2.998077257 4.743458184 8.596965524 5.820465377 4.919361583 2.573387042
4.785931269 6.741773172 5.569548636 6.501682251 3.373665619 2.340416474 0 0 0 0 0
0 0 0 0 0.157162071 1.571620707 4.818371911 7.753206222 5.965239341 3.591487456
4.508244822 2.850343174 3.382248645 1.249545512 1.034761625 0.355284747 0 0 0 0 0
0
1984 1 1 3 2 3 0 0 0 0 0 0 0 0 0.132805896 0.265611793
0.265611793 1.692974915 2.79669873 7.718061808 9.614989086 9.997396974 8.570033853 6.04917502
4.026705678 2.155275239 2.018096358 1.171238366 1.760489465 0.195206394 0.585619183 0 0 0

0 0 0 0 0 0 0.531223586 3.344673186 6.461379306 11.74765833 10.38269571
6.946723268 0.328012291 0.780825577 0.132805896 0.195206394 0.132805896 0 0 0 0 0
0 0
1986 1 1 3 2 3 0 0 0 0 0 0 0 0 0 0.134151412
0.189518767 0.379037535 1.128578655 3.550807418 6.967463424 9.941524127 9.617166873 6.501107882
6.311245577 0.726124417 2.949956926 0.670413525 0 0.670413525 0 0 0 0 0 0
0 0 0 0 0 0.702707715 1.83982032 6.888679367 14.17591014 14.71217225 10.01005655
1.341170588 0.457821592 0.134151412 0 0 0 0 0 0 0 0
1987 1 1 3 2 7 0 0 0 0 0 0 0 0 0 0 0.032194652
0.032194652 0.23686902 1.141367323 2.053219838 4.023077515 10.85775777 8.078818042 5.257001037
4.495579615 1.282362947 0.407143628 0.974144601 0.014828748 0.029657496 0 0 0 0 0
0 0 0 0 0 0.354368668 1.396786475 7.370082428 15.20365385 20.2884727 8.578983662
6.708144113 1.168462482 0.014828748 0 0 0 0 0 0 0 0
1988 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0 0 0
0 5.414182505 3.590767055 8.768828386 7.708943895 5.336284993 7.938073373 3.675805334 0.501424425
0.250712212 0 0 0.096993036 0.096993036 0 0 0 0 0 0 0 0
1.251234282 0 10.76682488 11.55208765 12.60001738 13.49210488 3.796296523 0.659957589 2.502468564
0 0 0 0 0 0 0 0 0
1989 1 1 3 2 10 0 0 0 0 0 0 0 0.34424008 0.330796382
3.81952636 6.541956418 7.361780057 7.59152069 7.066144549 8.206904769 9.295185623 5.970110846
2.914800514 2.58048306 2.171983947 0.087785609 0.313269217 0.37350195 0 0 0 0 0
0 0 0 0 0 0.345361225 1.958219416 6.968055683 8.193471753 9.428992594 4.017906941
3.080807574 0.530835572 0.419009373 0.0873498 0 0 0 0 0 0 0 0 0
1990 1 1 3 2 4 0 0 0 0 0 0 0 0 0 0.599811832
0.857858979 3.935693756 11.22877823 6.674330144 7.959835465 7.855341964 6.471716354 3.040280437
0.753365478 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.657294474 8.146213034 14.55776561 14.6558859 3.522450166 3.181418309 1.074875522 0.76776823
0.153553646 0 1.143457479 0.762304986 0 0 0 0 0 0
1991 1 1 3 2 11 0 0 0 0 0 0 0 0 0 3.464300445
5.119916385 4.283911957 5.068698207 12.44688454 9.464922943 7.629213297 8.966000933 5.213202034
1.962746687 0.145949618 1.01228213 0.795163802 0 0 0.152273352 0 0 0 0 0
0 0 0.208967128 0 0.689898263 3.985225782 11.44112597 11.18605512 4.724360819 1.598715358
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0 0
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0.854237965 0.037854456 0 0 0 0 0 0 0 0 0 0
#DISCARDS, Pikitch

#
#Year season fleet sex prt Nsamp 12 14 16 18 20 22 24 26 28 30 32 34
36 38 40 42 44 46 48 50 52 54 56 58 60 62 12 14 16
18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
52 54 56 58 60 62

No Discards1986 1 1 3 1 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 0 0
0 0 0 0 0 0 0 0
1987 1 1 3 1 2 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 0.333333333 0.666666667 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1986 1 2 3 1 1 0 0 0 0 0 0 0.5 0 0.5 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0.5 0.5 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1987 1 2 3 1 4 0 0 0 0 0 0.1 0.25 0.4 0.25 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0.222222222 0.222222222 0.222222222 0.222222222 0.111111111 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
DISCARDS WCGOP
Year Season Fleet gender partition Nsamps12 14 16 18 20 22 24 26 28 30
32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62

2006 1 1 0 1 18 0 0 0 0 0 0 0.075895721 0.231680178
0.291933163 0.143608615 0.054401188 0.106566711 0.095914423 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.075895721 0.231680178
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0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0.051270043 0.048805137
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0 0 0 0 0 0 0
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0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.060040161
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2012 1 1 0 1 8 0 0 0.298642534 0.045248869 0.073529412 0.062217195
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0 0 0 0 0 0 0 0 0 0 0.298642534 0.045248869 0.073529412
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0 0 0 0 0 0 0 0 0 0
2006 1 2 0 1 143 0 0.002037609 0.023673173 0.018144774 0.071814246 0.059160597
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0 0 0 0 0 0 0 0 0 0 0 0 0.013797043 0.012483644
0.046855883 0.096193836 0.137350094 0.215752272 0.218458782 0.178808324 0.065695543 0.012077565 0
0.002527015 0 0 0 0 0 0 0 0 0 0 0
2009 1 2 0 1 262 0.001446324 0.000112344 0.002389159 0.007122263 0.031241673
0.045131059 0.05191938 0.139593551 0.289461568 0.192146293 0.140920925 0.075926148 0.017475034
0.000639961 0.002536379 0.000228701 0.001251836 0 0.000228701 0 0.000228701 0 0 0
0 0 0.001446324 0.000112344 0.002389159 0.007122263 0.031241673 0.045131059 0.05191938
0.139593551 0.289461568 0.192146293 0.140920925 0.075926148 0.017475034 0.000639961 0.002536379
0.000228701 0.001251836 0 0.000228701 0 0.000228701 0 0 0 0 0
2010 1 2 0 1 121 0 0.0003481 0.010710001 0.032907534 0.042989381 0.060534478
0.052862215 0.102098183 0.201486473 0.208345334 0.165605355 0.088831813 0.01077449 0.011981703
0.009900932 0.000245146 0 0 0 0 0 0.000378862 0 0 0 0 0
0.0003481 0.010710001 0.032907534 0.042989381 0.060534478 0.052862215 0.102098183 0.201486473
0.208345334 0.165605355 0.088831813 0.01077449 0.011981703 0.009900932 0.000245146 0 0 0
0 0 0.000378862 0 0 0 0
2011 1 2 0 1 402 0.014998784 0.005996519 0.002905119 0.00976079 0.01763487
0.029955428 0.12075857 0.190202589 0.249283408 0.198242181 0.107186288 0.039483363 0.006396441
0.002899667 0.001458823 0.001025463 0.001179283 0.000410185 0.000136728 0 0 0 0 0
8.54975E-05 0 0.014998784 0.005996519 0.002905119 0.00976079 0.01763487 0.029955428 0.12075857
0.190202589 0.249283408 0.198242181 0.107186288 0.039483363 0.006396441 0.002899667 0.001458823
0.001025463 0.001179283 0.000410185 0.000136728 0 0 0 0 0 8.54975E-05 0
2006 1 3 0 1 2 0 0 0 0 0 0.0008 0 0 0.599520.199840.19984
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0.0008 0 0 0.599520.199840.199840 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2007 1 3 0 1 17 0 0.000842841 0 0.008639117 0.000842841 0.032980356
0.158321046 0.066472036 0.315724354 0.406514843 0.005448363 0.002528522 0.000842841 0 0 0
0 0.000842841 0 0 0 0 0 0 0 0 0 0.000842841 0 0.008639117
0.000842841 0.032980356 0.158321046 0.066472036 0.315724354 0.406514843 0.005448363 0.002528522
0.000842841 0 0 0 0 0.000842841 0 0 0 0 0 0 0 0

2008 1 3 0 1 18 0 0.000776548 0 0 0 0.011842361 0.068258591
0.0430596 0.16909338 0.157483984 0.324752475 0.106853038 0.106853038 0.005280528 0.000776548
0.004193361 0 0.000776548 0 0 0 0 0 0 0 0 0 0.000776548 0
0 0 0.011842361 0.068258591 0.0430596 0.16909338 0.157483984 0.324752475 0.106853038
0.106853038 0.005280528 0.000776548 0.004193361 0 0.000776548 0 0 0 0 0 0
0 0
2009 1 3 0 1 16 0 0 0 0 0.002826887 0.005653773 0.006784528
0.24480838 0.393637278 0.245086614 0.005653773 0.058233864 0.033922639 0 0.003392264 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0.002826887 0.005653773
0.006784528 0.24480838 0.393637278 0.245086614 0.005653773 0.058233864 0.033922639 0 0.003392264
0 0 0 0 0 0 0 0 0 0 0
2010 1 3 0 1 7 0 0 0 0 0 0 0.001004751 0.005941712
0.172763852 0.29336061 0.426566991 0.002411402 0 0 0 0 0 0.019590136 0.039180273
0 0.019590136 0.019590136 0 0 0 0 0 0 0 0 0 0 0.001004751
0.005941712 0.172763852 0.29336061 0.426566991 0.002411402 0 0 0 0 0 0.019590136
0.039180273 0 0.019590136 0.019590136 0 0 0 0
2012 1 3 0 1 6 0 0.02676399 0 0.080291971 0 0.031054601 0.159694425
0.466211443 0.180728881 0.037987599 0 0.002302279 0.005755697 0 0 0.004604557 0.002302279
0 0 0 0.002302279 0 0 0 0 0 0 0.02676399 0 0.080291971 0
0.031054601 0.159694425 0.466211443 0.180728881 0.037987599 0 0.002302279 0.005755697 0 0
0.004604557 0.002302279 0 0 0 0.002302279 0 0 0 0 0
2006 1 4 0 1 76 0 0 0.00138187 0.001439448 0.005815369 0.073770714
0.072056735 0.084518954 0.226088617 0.214720397 0.166067372 0.136188223 0.013230915 0.004145609
0.00028789 0 0 0 0.00028789 0 0 0 0 0 0 0 0 0
0.00138187 0.001439448 0.005815369 0.073770714 0.072056735 0.084518954 0.226088617 0.214720397
0.166067372 0.136188223 0.013230915 0.004145609 0.00028789 0 0 0 0.00028789 0 0
0 0 0 0 0
2007 1 4 0 1 43 0 0 0 0.010325433 0.018662264 0.023863223 0.08321534
0.171519116 0.282297524 0.240945252 0.080755089 0.07258443 0.003365326 0.003441811 0 0
0.002829933 0.002065087 0.004130173 0 0 0 0 0 0 0 0 0 0
0.010325433 0.018662264 0.023863223 0.08321534 0.171519116 0.282297524 0.240945252 0.080755089
0.07258443 0.003365326 0.003441811 0 0 0.002829933 0.002065087 0.004130173 0 0 0
0 0 0 0

2008 1 4 0 1 55 0 0 0.000270227 0.000648544 0.008647251 0.0396292
0.153762812 0.412527812 0.274939014 0.094550541 0.012970877 0.001783496 0.000270227 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.000270227 0.000648544
0.008647251 0.0396292 0.153762812 0.412527812 0.274939014 0.094550541 0.012970877 0.001783496
0.000270227 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 4 0 1 47 0 0 0.015980749 0.067563054 0.011719216 0.010440756
0.195633531 0.136583186 0.106753467 0.331209574 0.086992237 0.03712423 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0.015980749 0.067563054 0.011719216
0.010440756 0.195633531 0.136583186 0.106753467 0.331209574 0.086992237 0.03712423 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2010 1 4 0 1 36 0 0 0 0.015650049 0.057688853 0.125529186 0.249381589
0.304387378 0.099702285 0.088499484 0.030775967 0.023033985 0 0.002675612 0.002675612 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.015650049 0.057688853
0.125529186 0.249381589 0.304387378 0.099702285 0.088499484 0.030775967 0.023033985 0 0.002675612
0.002675612 0 0 0 0 0 0 0 0 0 0 0
2011 1 4 0 1 86 0.000164167 0.000328334 0 0.000820834 0.000755167 0.012474639
0.057607477 0.135052524 0.42357887 0.325180244 0.038456075 0.002134168 0.0004925 0.000656667
0.0004925 0.000656667 0.000164167 0.0004925 0 0 0.000328334 0 0 0.000164167 0
0 0.000164167 0.000328334 0 0.000820834 0.000755167 0.012474639 0.057607477 0.135052524
0.42357887 0.325180244 0.038456075 0.002134168 0.0004925 0.000656667 0.0004925 0.000656667
0.000164167 0.0004925 0 0 0.000328334 0 0 0.000164167 0 0
Early Triennial
year season fleet gender partition Nsamp F120 F140 F160 F180 F200 F220 F240 F260 F280 F300 F320
F340 F360 F380 F400 F420 F440 F460 F480 F500 F520 F540 F560 F580 F600 F620 M120 M140
M160 M180 M200 M220 M240 M260 M280 M300 M320 M340 M360 M380 M400 M420 M440 M460 M480
M500 M520 M540 M560 M580 M600 M620 # Nsamp
1980 1 5 3 0 3 0 0 0 0 0 0 0 0 0 6.25 6.25
12.5 6.25 0 0 6.25 12.5 12.5 6.25 12.5 0 0 0 0 6.25 0 0 0
0 0 0 0 0 0 0 6.25 0 6.25 0 0 0 0 0 0 0
0 0 0 0 0 0 0 # 3
1983 1 5 3 0 6 0 0 0 0 0 0 0 0 0 0 0
6.822302 0 3.231572 6.642723 6.822302 3.231572 3.231572 3.4111508 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 3.411151 3.411151

6.463144 13.285446 26.570891 0 13.4650245 0 0 0 0 0 0 0 0
0 0 0 # 6
1986 1 5 3 0 108 0 0 0 0 1.6596962 1.0041337 0.8354633
2.303782 4.058277 4.182472 4.791801 7.882887.350428 6.827802 5.986836 4.478384
3.434614 1.3090633 1.2332347 0.1166741 0.16013406 0.11667405 0 0.779496 0.4666962
0.3500223 0 0 0.3109241 0 1.740464 0.1373429 1.674172 3.482537 6.477298
7.342662 6.517345 5.345761 4.046476 2.4557747 0.8926017 0.08997406 0.15810508 0
0 0 0 0 0 0 0 0 # 108
1989 1 5 3 0 423 0 0 0 0.1052069 0.3588284 0.5028671 1.2169388
3.259815 6.730053 6.187266 7.194915 6.631582 6.421608 5.175934 2.302481 1.90465
1.934135 1.8950102 1.1990297 0.2007844 0.61579352 1.0539511 0.20778636 0 0.1142395
0 0 0 0.1828081 0.24676949 0.2584429 0.789397 3.079195 4.484612 9.072959
10.093828 8.410339 4.135139 2.788852 0.8127312 0.1065291 0.32552306 0 0 0
0 0 0 0 0 0 0 # 423
1992 1 5 3 0 348 0 0.32474368 0 0.1394901 0.8133533 2.4790727
3.320116 6.583255 6.061974 6.792717.625509 6.235333 2.576828 3.017801 2.67297
1.521939 1.628344 0.5814746 0.3306431 0.5680355 0.06839995 0 0 0 0 0
0.11792894 0 0.1749639 0.19041256 1.1222446 4.707394.696595 8.496584 8.701466.313356
5.073841 3.679695 1.466543 1.2328105 0.6198415 0 0.06434122 0 0 0 0
0 0 0 0 0 # 348
Late triennial
year season fleet gender partition Nsamp F120 F130 F140 F150 F160 F170 F180 F190 F200 F210
F220 F230 F240 F250 F260 F270 F280 F290 F300 F310 F320 F330 F340 F350 F360 F370 F380
F390 F400 F410 F420 F430 F440 F450 F460 F470 F480 F490 F500 F510 F520 F530 F540 F550
F560 F570 F580 F590 F600 F610 F620 M120 M130 M140 M150 M160 M170 M180 M190 M200 M210
M220 M230 M240 M250 M260 M270 M280 M290 M300 M310 M320 M330 M340 M350 M360 M370 M380
M390 M400 M410 M420 M430 M440 M450 M460 M470 M480 M490 M500 M510 M520 M530 M540 M550
M560 M570 M580 M590 M600 M610 M620
1995 1 6 3 0 435 0 0 0.07113167 0.3083666 0.3002779 1.0183571
1.615746 3.182806 4.682894 7.976058 9.403384 8.463475 7.125601 4.737101
4.117477 2.183041 2.379451 0.6279602 0.4756187 0.353512 0.17624917 0 0 0
0 0 0 0 0.1479033 0.06763529 1.0742453 1.6033388 2.028175 4.437839
10.357724 8.828668 5.842812 3.848924 1.624353 0.4160944 0.2297767 0.06059428
0.23341073 0 0 0 0 0 0 0 0 0 # 435

1998 1 6 3 0 708 0 0 0 0.1586272 0.6080436 1.2437724 2.2963795
4.126429 5.761948 7.596899 7.509087 6.218312 4.620368 3.801603 3.741353
3.456325 2.447267 1.0059622 0.262176 0.2705981 0 0.0443206 0 0 0 0
0 0.10668527 0.2330066 1.0904484 1.8345259 2.6689145 3.175284 6.063336 7.278262
7.960775 6.496724.838427 2.206804 0.675890.1366078 0.06484532 0 0 0 0 0
0 0 0 0 0 # 708
2001 1 6 3 0 762 0 0 0.32694347 0.9743474 2.105 2.515713.2258802
3.558763 4.257112 3.832461 4.541249 4.756083 5.675763 4.643002 3.300652
2.971125 1.746044 0.9005112 1.0294343 0.249347 0.02490968 0.02289351 0.02402995 0
0 0 0.04157596 0.10822993 0.4084969 2.58638596 3.2142443 4.7297788 5.427194
5.973989 6.624309 7.334986 5.207461 3.781314 2.034424 1.1740123 0.5313371
0.02555972 0.02484693 0.09059624 0 0 0 0 0 0 0 0 # 762
2004 1 6 3 0 717 0 0.02139436 0.08299942 0.5802772 1.0488736 1.1848177
2.3620079 2.879266 3.638375 4.819311 5.524271 7.105853 6.528354 5.366425 4.13232
3.020991.742089 1.3468938 0.3893162 0.3487207 0.12168253 0.05431382 0.04138902 0 0
0 0.01373919 0.01136348 0.215975 1.00410174 2.1033238 2.0606149 3.217523 5.016838
5.432054 8.442793 9.185533 6.038449 3.555717 0.7214951 0.3462715 0.14573032
0.04220321 0 0.02931007 0.0269788 0 0.02253336 0.02751366 0 0 0 # 717
NWFSC Survey
year Season Fleet gender partition nSamps F12 F14 F16 F18 F20 F22 F24 F26 F28 F30
F32 F34 F36 F38 F40 F42 F44 F46 F48 F50 F52 F54 F56 F58 F60 F62 M12
M14 M16 M18 M20 M22 M24 M26 M28 M30 M32 M34 M36 M38 M40 M42 M44 M46
M48 M50 M52 M54 M56 M58 M60 M62
2003 1 7 3 0 589 0 0 0 0.424100167 0.319529102 0.563595495 0.813488274
1.615674824 2.712507824 5.769492898 6.234768119 5.569111307 6.06493576 4.827237289 3.713920644
3.440910943 2.209292977 0.841428208 0.920977771 0.764590114 0.245729952 0.190300685 0.072022941 0
0 0 0 0 0 0.207001771 0.44827548 0.975233377 2.184496776 5.50919698 8.970057534
10.79016413 11.68445422 6.021151408 3.975138724 1.396100738 0.329151547 0.168784447 0 0.027177579
0 0 0 0 0 0 0 0
2004 1 7 3 0 678 0 0 0.056665384 0.137830878 0.293202759 0.933753947
1.587794745 1.712898469 3.484314325 3.811270434 4.983188179 6.078973093 6.895308785 5.74832426
4.590631511 4.068533985 2.760201997 1.364295823 0.813854326 0.840747825 0.345478381 0.118609311
0.09178123 0 0 0.021948813 0 0 0.042697547 0.462156738 0.595929454 1.566434693

3.236511546 4.289244754 5.697377297 8.167097015 9.99042531 8.344244014 4.61047793 1.480051563
0.434895545 0.247315528 0.021231473 0.039974812 0.03432632 0 0 0 0 0 0 0
2005 1 7 3 0 905 0 0 0.017867442 0.081489124 0.34546188 0.804915532
1.474441634 1.527869347 1.873948065 2.589279653 4.763935584 5.162726482 5.655278744 7.356713186
5.017972494 4.044375331 2.238017592 1.453529857 1.304427631 0.263771572 0.196099633 0.397526853
0.071883523 0.022722436 0 0 0 0 0.027268062 0.399775941 1.291255755 1.742113524
2.26629727 2.884263257 4.813791327 7.324271272 10.39898202 9.555416334 6.65494066 3.397545092
1.870444422 0.445012037 0.250252368 0 0 0.014117063 0 0 0 0 0 0
2006 1 7 3 0 765 0 0 0 0.388187659 0.247937425 0.99203782 1.301517323
2.188692613 2.257025726 3.409002937 4.123763473 5.414717262 5.660651304 6.699402402 5.635953692
5.890280937 3.651681483 1.818365755 1.206537069 0.692669476 0.502321217 0.243147079 0.106580484 0
0 0 0 0 0.051700192 0.8204982 1.164156376 1.653770655 3.294349683 3.637442388
4.392230183 5.864780895 7.27209512 8.86520691 6.8909193 2.205155893 0.995401026 0.298614384
0.111314283 0 0.023327019 0.028564356 0 0 0 0 0 0
2007 1 7 3 0 732 0 0 0 0.275661813 0.470355266 1.417292206 1.531377298
1.725134754 3.276290057 4.762498499 4.881883394 5.736263154 6.444902996 5.537581543 6.190850485
5.487222448 3.783859777 2.890068007 1.275161665 0.882434599 0.362011367 0.221483603 0.079938451
0.038826621 0.023950857 0 0 0.032049258 0 0.258607275 1.200923712 2.815654751 3.272151639
4.296193999 4.181858473 6.734003709 6.119185738 6.151548039 4.226814461 2.220805741 0.605292097
0.313975045 0.210223475 0.029582486 0.036081242 0 0 0 0 0 0 0

2008 1 7 3 0 679 0 0 0.070419581 0.585166223 1.310437963 1.514508362
3.027855982 3.366589837 4.225019855 4.980236708 3.799722786 4.836204641 5.477437869 4.59279985
3.57983941 3.551048151 2.912759835 2.134162786 1.439580137 1.031642554 0.354756937 0.157688885
0.049505534 0 0 0 0.043874034 0 0.333729226 1.083834675 1.835328193 2.393476994
4.565041895 5.279164298 6.306563422 5.933110595 6.362847421 5.382442905 3.90723449 2.035117275
0.965214966 0.343604156 0.133671485 0.069396611 0.028963475 0 0 0 0 0 0 0
2009 1 7 3 0 753 0 0 0.07870442 0.888481971 1.823425862 1.984771251
2.403341974 2.980443734 2.96627747 3.868397091 3.482600435 4.96923127 5.348374478 5.28063806
4.55962336 4.546440495 3.590124652 2.804279434 1.798471739 0.94796138 0.851709338 0.209334088
0.02738752 0 0 0 0 0.050924131 0.172224797 2.081483984 3.258692547 3.088679661
3.798250902 3.957221958 5.077357931 4.789437549 5.734829687 5.128081247 3.526915414 2.282516766
1.139121778 0.265384889 0.16327675 0.016578988 0.059000998 0 0 0 0 0 0 0

```
2010 1 7 3 0 1160 0 0.038361335 0.153941419 0.602970781 1.689476477 2.8765107
3.128893231 3.836446751 4.191894609 4.359944066 3.900164425 4.866337427 4.759797616 4.311143716
4.116257471 2.636000943 2.520076524 1.660274083 0.91307721 0.325585974 0.1710123 0.093818843
0.039077242 0.054976994 0.037423653 0 0.018271193 0.039896256 0.220789241 0.969388748 2.471505732
4.556715403 4.810378007 5.354148331 5.471570708 6.783182487 6.776466968 5.514587385 3.103204229
1.754194087 0.609575413 0.195203345 0.067458678 0 0 0 0 0 0 0 0 0
2011 1 7 3 0 1176 0 0 0.030461083 0.337255039 1.105257703 2.70184995
3.654667497 3.896869199 4.912841762 5.35357626 5.516320893 5.208139426 4.627569468 4.642703766
3.490224166 2.827080451 2.437257187 1.328191447 0.87187191 0.672686262 0.251381733 0.090703128
0.057967489 0 0 0 0 0.014396431 0.030745002 0.546671376 1.741268757 3.601475292
4.583940664 6.219455406 5.585754197 6.504167883 6.159798842 5.727083036 3.28246803 1.107873924
0.651445311 0.181911535 0.046668497 0 0 0 0 0 0 0 0 0
2012 1 7 3 0 1044 0 0 0 0.110178811 0.455459838 1.214930517 2.404958016
2.986348694 4.056630075 5.317829262 5.605263444 6.404336368 5.810001137 5.443091592 3.851027722
2.926445613 2.472394851 1.187298748 0.664285986 0.687212829 0.345537222 0.09805622 0.024897681
0.007788615 0.009875542 0 0 0 0.02518857 0.176253272 0.570787915 1.974273099 3.234176629
5.002516455 7.090356286 8.973921444 7.674192832 6.373080497 4.107163335 1.800852657 0.719553528
0.110992766 0.082841934 0 0 0 0 0 0 0 0 0

#_AGE_DATA
17 #n_abins #_N_agebins #(<=_#_of_age,_the_model_always_start_at_age_0)
#age_bins1(1,n_abins) #_lower_age_of_agebins
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

#_Age_error


8 #N_ageerr
#age_err(1,N_ageerr,1,2,0,nages) #_vector_with_stddev_of_ageing_precision_for_each_AGE_and_type


#Age0 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 36 37 38 39 40
```

#perfect_age_(ageerr=1_given_but_not_used)

-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 -1 -1 -1
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001 0.001 0.001 0.001

#CAP BB use this for Survey, ORComm 2007-present, CAComm 2005-present

0.261729 1.346392.406253.441874.453815.4426 6.408787.352878.275369.1767710.057610.918211.759212.580913.383814.168414.935
15.684116.416117.131317.830218.513119.180419.832420.469521.092 21.700322.294722.875523.443 23.997624.539425.068925.5862
26.091826.585727.068427.54 28.000828.451128.8912
0.169177 0.169177 0.228825 0.293411 0.363345 0.439070.521065 0.609848 0.705983
0.810078 0.922792 1.044841.176991.320081.475031.6428 1.824462.021162.234162.464782.7145 2.9849 3.277693.59472
3.938 4.309714.712195.147995.619886.130856.684127.2832 7.931888.634279.3948310.218411.110112.075613.121114.253215.479
#CAP Surface All data use this for CA1990-2005; OR2000-2006

0.159212 1.271442.353263.405514.428985.424486.392757.334568.250629.1416310.008310.851211.671212.468613.244313.998814.7327
15.446516.140816.816117.472918.111818.733219.337619.925520.497321.053521.594522.120722.632523.130323.614524.085524.5436
24.989225.422625.844126.254126.652927.040827.4181
0.118733 0.118733 0.179327 0.246288 0.320286 0.402060.492428 0.592293 0.702651
0.824607 0.959379 1.108311.2729 1.454781.655781.877892.123352.394612.694373.025633.3917 3.796244.243294.73732
5.283275.886596.553317.2901 8.104319.004099.9984211.097212.311513.653415.136416.775118.586120.587422.798925.242927.9438
CAP combo use this for OR commercial ages from 1981-1997 where a combination of methods were used

0.474933 1.4248 2.374663.324534.2744 5.224266.174137.123998.073869.023729.9735910.923511.873312.823213.773114.722915.6728
16.622617.572518.522419.472220.422121.372 22.321823.271724.221625.171426.121327.071228.021 28.970929.920830.870631.8205
32.770433.720234.670135.62 36.569837.519738.4696

0.127182 0.127182 0.254364 0.381546 0.508728 0.635910.763092 0.890274 1.017461.144641.27182
1.399 1.526181.653371.780551.907732.034912.162092.289282.416462.543642.670822.798 2.925193.052373.179553.306733.43391
3.5611 3.688283.815463.942644.069824.197 4.324194.451374.578554.705734.832914.9601 5.08728
#WDFW combo bias and stdev from WDFW combo method,post 1982 to 2008 , improved for 2011 assessment using WDFW reads of radiocarbon data

0.488313 1.464942.441563.418194.394825.371446.348077.324698.301329.2779510.254611.231212.207813.184514.161115.137716.1143
17.091 18.067619.044220.020820.997521.974122.950723.927324.904 25.880626.857227.833828.810529.787130.763731.740332.717
33.693634.670235.646836.623537.600138.576739.5534
0.133467 0.133467 0.266935 0.400402 0.533869 0.667337 0.800804 0.934271 1.067741.20121
1.334671.468141.601611.735071.868542.002012.135482.268942.402412.535882.669352.802812.936283.069753.203223.336683.47015
3.603623.737083.870554.004024.137494.270954.404424.537894.671364.804824.938295.071765.205225.33869
#WDFW Surface bias and stdev from WDFW surface age method, pre 1982 , new for 2011 assessment, estimated using WDFS reads of radiocarbon oties

These surface reads could be much better than those from the pre 1990s, sensitivity to using age error from CAP pre1990s should be explored, no WDFW surface double reads are available from the 80s

0.132002 1.322652.470423.576864.643465.671666.662837.618318.539399.4273 10.283211.108411.903812.670513.409714.122214.8091
15.471216.109616.724917.318 17.889818.441118.972419.484719.978520.454520.913321.355721.782122.193222.589422.971423.3397
23.694624.036824.366724.684724.991225.286825.5716
0.103143 0.103143 0.206285 0.309428 0.412570.515713 0.618856 0.721998 0.825141
0.928283 1.031431.134571.237711.340851.444 1.547141.650281.753421.856571.959712.062852.165992.269142.372282.47542
2.578562.681712.784852.887992.991143.094283.197423.300563.403713.506853.609993.713133.816283.919424.022564.1257
#WDFW BB bias and stdev from WDFW break and burn age method,post 2008 , new for 2011 assessment, estimated using WDFS reads of radiocarbon oties

0.503178 1.509532.515893.522244.5286 5.534956.541317.547678.554029.5603810.566711.573112.579413.585814.592215.598516.6049
17.611218.617619.623920.630321.636622.643 23.649424.655725.662126.668427.674828.681129.687530.693831.700232.706633.7129
34.719335.725636.732 37.738338.744739.751 40.7574
0.150528 0.150528 0.301056 0.451584 0.602112 0.752640.903168 1.0537 1.204221.354751.505281.65581
1.806341.956862.107392.257922.408452.558982.7095 2.860033.010563.161093.311613.462143.612673.7632 3.913734.064254.21478
4.365314.515844.666374.816894.967425.117955.268485.419015.569535.720065.870596.02112

#CAP surface early, pre1990s; use this for OR pre 1990s, CA pre1990s

0	0.711119	2.019953.241124.380515.443586.435467.360918.224389.030019.7816910.483	11.137411.747912.317612.849113.345
13.807714.239414.642215.018	15.368615.695816.001	16.285816.551616.799517.030817.246717.448	17.635917.811217.974818.1274
18.269818.402718.526618.642318.750218.850918.9448
3.77E-09	3.77E-09	0.0816479	0.167778	0.258636	0.354481	0.455587	0.562244	0.674755
0.793443	0.918645	1.050721.190051.337021.492061.655611.828142.010142.202142.404672.618312.843693.081443.33223
3.5968	3.875894.1703	4.480874.808485.154085.518665.903246.308946.736917.188367.664618.166998.696959.256	9.8457410.4679

#_AGE_COMPOSITIONS
534 #nobsa	#ageerr:_2:imprecision_age(BB)_3:Biased_age(Surface)

3 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths

1 #_combine males into females at or below this bin number

#year	Season	Fleet	gender	partition	ageErr	LbinLo	LbinHi	nSamps	F1	F2	F3	F4	F5	F6	F7	F8
F9	F10	F11	F12	F13	F14	F15	F16	F17	M1	M2	M3	M4	M5	M6	M7	M8
M9	M10	M11	M12	M13	M14	M15	M16	M17
1964	1	1	3	0	8	-1	-1	3	0	0	0	0.121264151	6.229284628
11.95147855	10.7397618	8.132150987	6.303707299	4.015014558	2.264809725	0.121264147	0	0.121264147
0	0	0	0	0	0.273374451	5.379338525	16.27507557	17.24288768	6.484210605	3.656735517
0.688377653	0	0	0	0	0	0	0
1965	1	1	3	0	8	-1	-1	3	0	0	0	0	2.980648708	11.58155603
7.35965932	13.47192024	5.880098011	4.782990738	3.113354149	0.249748606	0	0.330275712	0.249748606
0	0	0	0.318522766	0	3.62802351	11.09118953	17.70773815	10.47411947	3.970689511
1.034984633	0.739747672	0.716461867	0.318522765	0	0	0	0
1967	1	1	3	0	8	-1	-1	4	0	0	0	1.246972998	5.350066141
14.60468348	10.69593453	9.397383785	4.019928393	1.198496078	1.879943572	1.198496078	0	0.408094982

0 0 0 0 0 0.641577599 5.295336491 18.97766947 13.99337428 6.079643715 2.067462497
2.067462317 0.877473599 0 0 0 0 0 0
1968 1 1 3 0 8 -1 -1 15 0 0 0.110313639 0.122954385 1.37471224
6.502226806 10.0501439 9.511734387 7.020405639 6.299171961 4.429851584 2.099011658 1.329143496
0.548313419 0.512467449 0.012640745 0.076908667 0 0 0 0.672682983 3.00805933 12.74627776
16.85990759 8.559938775 5.155196559 1.59183067 0.98647599 0.239069241 0.180561132 0 0 0
0
1969 1 1 3 0 8 -1 -1 14 0 0 0 1.265254547 6.279333239 8.282216947
9.220052223 9.707976704 5.634194996 4.253592841 2.497407403 1.826060066 0.763133519 0.084114871
0.102547815 0 0.084114871 0 0 0.126830228 1.468888154 9.337534305 15.88640039 10.9504725
7.017753644 3.364245887 1.098115678 0.749759178 0 0 0 0 0 0
1970 1 1 3 0 8 -1 -1 8 0 0 0 0.588597774 5.085101126 11.18315445
7.541435627 7.245248456 4.797174167 5.709030038 3.554796562 1.85520895 1.059128229 0.915941872
0.228658536 0.160304908 0.076219512 0 0 0 1.798347118 10.56265606 15.91169532 10.54857116
8.226022679 2.012002625 0.367647058 0.573057769 0 0 0 0 0 0
1971 1 1 3 0 8 -1 -1 5 0 0 0 0.817009128 3.512146933 8.745505481
11.58815206 6.269505268 7.054816224 5.056565393 5.443669548 0.817009128 0.347810002 0 0 0
0.347810002 0 0 0 1.380685225 11.23635584 13.54388139 10.90683784 5.688197188 5.364746413
1.879296938 0 0 0 0 0 0 0
1972 1 1 3 0 8 -1 -1 4 0 0 0 0.09471094 4.013530139 13.73342561
5.995886484 6.348405733 5.199882486 3.81932545 4.211282679 2.121209264 1.901286538 1.165108122
0.472592697 0.461676949 0.461676949 0 0 0.01764505 2.824365292 13.34782996 23.90129993
7.716833579 2.165944859 0.02608128 0 0 0 0 0 0 0 0
1973 1 1 3 0 8 -1 -1 4 0 0 0 0.10481915 1.463654503 9.581106771
18.04857754 10.48201307 2.942477157 3.071158802 2.12846124 1.524083633 0.653648369 0 0 0
0 0 0 0 1.456461853 9.484386521 18.24980454 14.91117193 5.029983066 0.639421501
0.228770346 0 0 0 0 0 0 0
1974 1 1 3 0 8 -1 -1 5 0 0 0 0.244494654 1.229978895 11.7573746
12.92666295 13.58333909 4.469129981 1.618038293 2.34395612 1.1841736 0.473720879 0 0.169130915
0 0 0 0 0 1.458281044 10.72512446 19.05319742 13.34516279 3.935711714 1.113458995
0.171361694 0.131801269 0.065900635 0 0 0 0 0
1975 1 1 3 0 8 -1 -1 11 0 0 0 0.05232027 1.68882095 7.678072049
15.224655 12.4539039 7.699179899 2.585812185 1.10570497 0.94913334 0.312196271 0.2502012 0

0 0 0 0 0 0.7024664 10.315765 17.14924 14.72096895 5.066920239 1.5045185
0.43332847 0.106792415 0 0 0 0 0 0
1976 1 1 3 0 8 -1 -1 3 0 0 0 0 0 5.395743433 6.048408981
16.1338488 14.35658425 4.092882692 2.727581961 0.414983329 0.829966661 0 0 0 0 0
0 0 0.259746349 3.629857989 23.17800943 14.7090848 7.444062477 0.519492498 0.259746344 0
0 0 0 0 0 0
1977 1 1 3 0 8 -1 -1 2 1.136363635 0 0 0 3.198653197 8.459595942
17.42424225 8.038720528 5.050505052 3.914141419 1.543209881 0.308641976 0.617283952 0 0 0
0.308641976 0 0 1.709401713 0.961538448 11.11111126 16.02564101 14.63675215 1.923076918
1.923076996 0.32051282 0 0 1.388888892 0 0 0 0
1978 1 1 3 0 8 -1 -1 4 0 0 0 0.138888889 0.972222226 4.364445284
6.408568459 12.14353715 7.296701219 6.702564881 4.913111797 2.955115145 2.552171747 1.04725317
0.505420883 0 0 0 0 0 0.071348252 16.15798659 14.8766286 8.418175305 5.523994259
3.961492586 0.990373562 0 0 0 0 0 0 0
1980 1 1 3 0 8 -1 -1 7 0 1.478945422 1.97192723 10.71162591 2.234598726
11.0711209 5.717194803 5.030728792 4.22122139 3.364310994 1.214700972 0.688364634 1.335419468
0.47778455 0.392402865 0 0.089653569 0 0.55121884 1.899843963 0.0634761 5.729795367
8.440423315 11.13176283 7.816430646 6.246360021 2.310745842 1.486158558 2.52623283 1.09457001 0
0.702981461 0 0
1981 1 1 3 0 8 -1 -1 3 0 0 0 0.149890781 1.388702808 3.883958972
10.29474056 7.308700992 3.917756823 3.201367603 2.624591345 3.43062996 4.642998446 5.14040313
0.7752052 2.545219768 0.695833624 0 0 0 0.106328751 4.823290028 14.67821008 16.7039361
2.183309518 0.425315102 2.076980742 5.1676545 1.970651971 0.106328773 0 0.106328771 1.651665654
0
1998 1 1 3 0 5 -1 -1 1 0 0 0 0 3.703703706 12.96296297
7.407407513 16.66666668 5.555555559 1.851851853 1.851851853 0 0 0 0 0 0 0
0 0 2.173913054 26.08695654 8.695652015 4.347826107 6.521739141 2.173913004 0 0 0
0 0 0 0 0
1999 1 1 3 0 5 -1 -1 2 0 0 0.651910329 4.329644241 2.607641345
8.333333333 12.33702247 11.68511208 8.379446882 0 1.675889371 0 0 0 0 0 0
0 0 0.325355034 10.92083073 16.68200946 15.38058947 5.018411439 1.672803816 0 0 0
0 0 0 0 0 0
2000 1 1 3 0 5 -1 -1 5 0 0 0.04849022 0.765315456 6.696363013
12.43062732 6.079212512 12.37054502 8.618794967 0.815684892 1.603612028 0 0 0.571354581 0

0 0 0 0 0.458186446 1.858631604 20.51233104 21.67758254 4.467975109 1.025293242 0
0 0 0 0 0 0 0 0
2001 1 1 3 0 5 -1 -1 6 0 0 0.612353388 0 7.179698234 19.34949634
13.82606806 4.480689421 1.936770409 2.490271382 0.124652796 0 0 0 0 0 0 0
0 0 3.885550518 12.80896156 22.42794961 10.81090165 0.06663663 0 0 0 0 0
0 0 0 0
2002 1 1 3 0 5 -1 -1 5 0 0.843765141 4.770461913 8.249231152 11.62985625
12.0257656 8.483376461 3.284388685 0.291271999 0.421882573 0 0 0 0 0 0 0
0 0.505034243 3.813400898 7.593211515 14.45926443 13.76104094 7.185284417 2.682763788 0 0
0 0 0 0 0 0 0
2003 1 1 3 0 5 -1 -1 5 0 0 0.06589267 0.984270976 1.934521002
9.874610762 14.03537552 13.86413642 4.604123256 0 0 4.604123256 0 0 0.032946336 0
0 0 0.00888168 0.03932906 0.12609775 23.72076403 13.69312102 7.447083759 4.964722516 0
0 0 0 0 0 0 0 0
2004 1 1 3 0 5 -1 -1 7 0 0.07782417 0.622593353 0.272384591 9.12123764
10.76402805 13.95656806 5.307898873 7.990221885 0.943621674 0.618857693 0 0 0.324763981 0
0 0 0 0 0.218587601 1.245838155 10.00130954 29.75024463 7.036788481 1.248941795
0.249144901 0 0 0.249144926 0 0 0 0 0
2005 1 1 3 0 5 -1 -1 5 0 0 0.03127279 1.083222143 3.413270193
7.915077185 28.81214444 3.320145194 1.033185698 2.513802185 1.253773813 0.624106304 0 0 0
0 0 0 0 0.00575205 0.01725615 6.976810986 19.12116146 20.91187376 2.967145644 0
0 0 0 0 0 0 0 0
2006 1 1 3 0 5 -1 -1 5 0 0.054289725 0.332736025 0.323920005 0.14439455
3.675826048 11.40915799 23.59437864 6.543495546 2.473412399 0.72845998 0.7199291 0 0 0
0 0 0 0.02760237 0.26543433 0.16030895 10.51134549 22.31306349 9.218598044 7.489374441
0.01427288 0 0 0 0 0 0 0 0
2007 1 1 3 0 5 -1 -1 5 0 0.039095365 0.77922603 4.219115843 1.475388699
6.224504047 7.674541996 10.74625694 14.42725024 2.179858704 0.054903615 2.179858704 0 0 0
0 0 0 0 0.430230135 2.404445099 9.652880495 11.42919349 15.31488659 10.768364 0
0 0 0 0 0 0 0 0
2008 1 1 3 0 5 -1 -1 3 0 0 2.87072267 9.226919952 12.10271853
6.201953865 7.056984074 6.781174322 3.166835933 2.162638418 0 0.430052965 0 0 0 0
0 0 0 0.984105035 8.636067991 8.112202086 11.82393712 11.31257967 1.729932098 5.189795055
2.211380213 0 0 0 0 0 0 0

2009 1 1 3 0 7 -1 -1 3 0 0 0.543553157 4.710794017 1.99302824
9.369116405 6.900984967 6.521460769 4.959251376 9.001086457 4.760911462 1.239812839 0 0 0
0 0 0 0 0 1.687701092 4.574850478 14.28599793 15.31998123 9.817150238 3.720063482
0.594255862 0 0 0 0 0 0 0
2009 1 1 3 0 5 -1 -1 3 0 0 1.162790702 2.325581399 4.651162807
18.60465118 8.139535013 0 9.302325615 1.162790702 4.651162797 0 0 0 0 0 0
0 0 0 0 17.16420153 9.008095514 12.66015387 11.16754887 0 0 0 0 0
0 0 0 0
2010 1 1 3 0 7 -1 -1 4 0 0 0 2.433869708 3.179492998 7.780676095
11.64223399 8.499113244 4.755609197 7.592713615 2.570573053 1.212416169 0.333301705 0 0 0
0 0 0 0 5.006114697 10.28202199 17.56684349 10.21958304 6.475343066 0 0
0.450093935 0 0 0 0 0 0
2011 1 1 3 0 7 -1 -1 1 0 0 0 1.724137929 0 5.172413796
13.79310349 13.79310344 5.172413796 6.89655172 1.724137929 1.724137929 0 0 0 0 0
0 0 0 0 11.76470599 24.99999998 10.29411764 2.205882353 0.735293999 0 0 0
0 0 0 0 0
2012 1 1 3 0 7 -1 -1 2 0 0 0 0.752408086 5.155666357 14.60340072
23.53781703 0.376204051 1.393625902 2.787251854 0 1.393625927 0 0 0 0 0 0
0 0 0.488684601 6.89696451 29.94222604 12.67212492 0 0 0 0 0 0 0
0 0 0
1998 1 2 3 0 5 -1 -1 11 0 0 0.20683261 4.790693177 13.24924846
12.87442341 9.686799504 4.979396802 2.947256051 0.75422529 0.37836629 0.014040135 0 0
0.118718535 0 0 0 0 0.541011205 6.298853953 17.83099451 12.39827851 5.774545603
4.261634447 2.872308001 0 0.02237352 0 0 0 0 0
1999 1 2 3 0 5 -1 -1 9 0 0.161674761 0.949275484 11.19829476 14.40100911
8.023576134 9.181342039 2.069721209 2.008806609 1.16092411 0.566049982 0.161674761 0.058825562 0
0.058825562 0 0 0 0.04748355 1.528416181 16.36725227 17.43440357 10.48107204 2.763302862
0.671391783 0.1128724 0.317345076 0.112872415 0.05071535 0 0 0 0 0.112872413
2000 1 2 3 0 5 -1 -1 12 0 0 0.24937415 3.012345818 12.87274884
15.46442359 8.643779995 6.023600647 1.935143499 1.355024844 0.262558625 0.180999985 0 0 0
0 0 0 0 1.406779329 11.33890269 16.73574399 12.20558549 7.207609796 1.105378699 0
0 0 0 0 0 0 0 0
2001 1 2 3 0 5 -1 -1 10 0 0.307075335 1.732388148 4.990650978 12.25028558
16.89735043 10.72234199 1.622452898 1.086354499 0.218986555 0.03969127 0 0.114801365 0.01762067

0 0 0 0 0.925511954 1.982680332 7.62677934 22.46685347 14.68100798 2.285293947
0.008599695 0.023273565 0 0 0 0 0 0 0 0
2002 1 2 3 0 5 -1 -1 10 0 0.01979558 2.848977848 11.96469204 11.380866
8.185508037 8.594190039 4.48921357 1.575724907 0.465502622 0 0.452668372 0.022860976 0 0
0 0 0 0.038197835 5.160844043 21.51854985 10.24110455 9.505125543 2.446217861 0.875633864
0 0.214326466 0 0 0 0 0 0 0
2003 1 2 3 0 5 -1 -1 19 0 0.624559628 2.27249594 7.867221225 21.47569754
8.749805288 5.042999022 1.959044109 1.176342905 0.390905257 0 0 0.175765209 0 0
0.074560417 0.190603526 0 0.307830441 5.235390313 16.50403432 22.8176776 3.203506514 1.677093657
0.128262356 0.003297007 0.122907721 0 0 0 0 0 0 0
2004 1 2 3 0 5 -1 -1 18 0 0.00708993 0.32612033 3.186707578 6.548497356
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1992 1 3 3 0 2 -1 -1 1 0 0 2.499999997 2.499999997 14.99999998
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0 0 0 0 0
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0 1.724137953 10.34482752 12.06896552 10.34482752 6.896551736 5.172413809 0 1.724137933
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0 1.785714297 0 0 0 0
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0 0 0
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1986 1 4 3 0 2 -1 -1 16 0 0 5.347989607 11.00932711 17.96584777
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1987 1 4 3 0 2 -1 -1 12 0 0 1.2954391 14.01781965 7.877954548
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1.662802889 0.43341965 0.072587525 0.072587525 0.07144018 0 0 0 0.09257835 0
1988 1 4 3 0 2 -1 -1 6 0 0 2.47569886 13.2475976 17.18768657
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0 0.370197191 0 0 6.364135505 19.35878447 19.02527457 2.57570301 1.141229004 0.583228757
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NWFSC Conditional age-at-length

NWFSC female year Season Fleet gender partition ageErr LbinLo LbinHi nSamps F1 F2 F3 F4 F5
F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16 F17 F1.1 F2.1 F3.1 F4.1 F5.1
F6.1 F7.1 F8.1 F9.1 F10.1 F11.1 F12.1 F13.1 F14.1 F15.1 F16.1 F17.1
2003 1 7 1 0 2 20 20 1 0 100 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0
2003 1 7 1 0 2 22 22 7 0 28.57142857 71.42857143 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 28.57142857 71.42857143 0 0
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2003 1 7 1 0 2 24 24 8 0 12.5 62.5 25 0 0 0 0 0
0 0 0 0 0 0 0 0 0 12.5 62.5 25 0 0 0 0 0
0 0 0 0 0 0 0 0
2003 1 7 1 0 2 26 26 11 0 0 45.45454545 27.27272727 27.27272727 0
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27.27272727 0 0 0 0 0 0 0 0 0 0 0 0
2003 1 7 1 0 2 28 28 16 0 0 31.25 43.75 25 0 0 0 0
0 0 0 0 0 0 0 0 0 0 31.25 43.75 25 0 0 0 0
0 0 0 0 0 0 0 0
2003 1 7 1 0 2 30 30 32 0 0 9.375 34.375 46.875 9.375 0 0 0
0 0 0 0 0 0 0 0 0 0 9.375 34.375 46.875 9.375 0 0 0
0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 2.941176471 35.29411765
50 11.76470588 0 0 0 0 0 0 0 0 0 0 0
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0 0
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9.615384615 0 0 0 0 0 0 0 0 0 0 0 0 0 11.53846154
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0 0 0
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22.22222222 11.11111111 2.777777778 0 2.777777778 0 0 0 0 0 0 0 0
0 0 22.22222222 38.88888889 22.22222222 11.11111111 2.777777778 0 2.777777778 0 0
0 0 0 0
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0 0

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0 0 0 0 7.692307692 0 23.07692308 30.76923077 0 7.692307692 0 7.692307692
0 0 15.38461538 7.692307692
2003 1 7 1 0 2 50 50 8 0 0 0 0 0 0 0 25 12.5
12.5 12.5 0 0 12.5 0 12.5 12.5 0 0 0 0 0 0 0 25 12.5
12.5 12.5 0 0 12.5 0 12.5 12.5
2003 1 7 1 0 2 52 52 1 0 0 0 0 0 0 0 0 0
100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
100 0 0 0 0 0 0 0
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2003 1 7 1 0 2 56 56 2 0 0 0 0 0 0 0 0 0
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2004 1 7 1 0 2 16 16 1 0 0 100 0 0 0 0 0 0
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0 0 0 0 0 0 0 0
2004 1 7 1 0 2 22 22 8 0 37.5 62.5 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 37.5 62.5 0 0 0 0 0 0
0 0 0 0 0 0 0 0

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0 8.333333333 0 0 0 0 0 0 0 0 0 0 0
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20.51282051 12.82051282 10.25641026 2.564102564 0 0 0 0 0 0 0 0 0

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2004 1 7 1 0 2 44 44 17 0 0 0 0 0 17.64705882 35.29411765
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0
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	0	0															
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2009 1 7 1 0 2 54 54 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100
2010 1 7 1 0 2 16 16 1 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2010 1 7 1 0 2 18 18 3 33.33333333 66.66666667 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 33.33333333 66.66666667 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 1 0 2 20 20 17 0 52.94117647 47.05882353 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 52.94117647 47.05882353 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 1 0 2 22 22 19 5.263157895 31.57894737 57.89473684 5.263157895 0
0 0 0 0 0 0 0 0 0 0 0 0 5.263157895 31.57894737
57.89473684 5.263157895 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 1 0 2 24 24 30 0 26.66666667 50 20 3.333333333 0 0
0 0 0 0 0 0 0 0 0 0 0 26.66666667 50 20 3.333333333
0 0 0 0 0 0 0 0 0 0 0 0

2010 1 7 1 0 2 26 26 29 0 13.79310345 34.48275862 44.82758621 3.448275862
3.448275862 0 0 0 0 0 0 0 0 0 0 0 0 13.79310345
34.48275862 44.82758621 3.448275862 3.448275862 0 0 0 0 0 0 0 0 0
0 0
2010 1 7 1 0 2 28 28 33 0 6.060606061 42.42424242 39.39393939 12.12121212
0 0 0 0 0 0 0 0 0 0 0 0 0 6.060606061 42.42424242
39.39393939 12.12121212 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 1 0 2 30 30 24 0 0 20.83333333 41.66666667 16.66666667 12.5
4.166666667 0 0 0 4.166666667 0 0 0 0 0 0 0 0 20.83333333
41.66666667 16.66666667 12.5 4.166666667 0 0 0 4.166666667 0 0 0 0 0
0
2010 1 7 1 0 2 32 32 34 0 0 17.64705882 32.35294118 35.29411765
11.76470588 2.941176471 0 0 0 0 0 0 0 0 0 0 0 0
17.64705882 32.35294118 35.29411765 11.76470588 2.941176471 0 0 0 0 0 0 0
0 0 0
2010 1 7 1 0 2 34 34 35 0 0 11.42857143 22.85714286 34.28571429
17.14285714 11.42857143 2.857142857 0 0 0 0 0 0 0 0 0 0 0
11.42857143 22.85714286 34.28571429 17.14285714 11.42857143 2.857142857 0 0 0 0 0
0 0 0 0
2010 1 7 1 0 2 36 36 44 0 0 2.272727273 11.36363636 27.27272727
43.18181818 11.36363636 0 2.272727273 0 2.272727273 0 0 0 0 0 0 0
0 2.272727273 11.36363636 27.27272727 43.18181818 11.36363636 0 2.272727273 0 2.272727273
0 0 0 0 0 0
2010 1 7 1 0 2 38 38 30 0 0 0 6.666666667 16.66666667 56.66666667
10 6.666666667 0 0 0 0 3.333333333 0 0 0 0 0 0 0
6.666666667 16.66666667 56.66666667 10 6.666666667 0 0 0 0 3.333333333 0 0
0 0
2010 1 7 1 0 2 40 40 29 0 0 0 0 3.448275862 24.13793103
41.37931034 17.24137931 13.79310345 0 0 0 0 0 0 0 0 0 0 0
0 3.448275862 24.13793103 41.37931034 17.24137931 13.79310345 0 0 0 0 0 0
0 0
2010 1 7 1 0 2 42 42 11 0 0 0 0 0 45.45454545 27.27272727
9.090909091 18.18181818 0 0 0 0 0 0 0 0 0 0 0 0 0
45.45454545 27.27272727 9.090909091 18.18181818 0 0 0 0 0 0 0 0

2010	1	7	1	0	2	44	44	20	0	0	0	0	5	5	15	25	15
	25	5	5	0	0	0	0	0	0	0	0	0	5	5	15	25	15
	25	5	5	0	0	0	0	0									
2010	1	7	1	0	2	46	46	13	0	0	0	0	0	0	7.692307692		
	7.692307692	38.46153846	23.07692308	23.07692308	0	0	0	0	0	0	0	0	0				
	0	0	0	7.692307692	7.692307692	38.46153846	23.07692308	23.07692308	0	0	0	0					
	0	0															
2010	1	7	1	0	2	48	48	17	0	0	0	0	0	0	0	0	
	11.76470588	35.29411765	29.41176471	5.882352941	5.882352941	5.882352941	5.882352941	0	0	0							
	0	0	0	0	0	0	0	11.76470588	35.29411765	29.41176471	5.882352941	5.882352941					
	5.882352941	5.882352941	0	0													
2010	1	7	1	0	2	50	50	3	0	0	0	0	0	0	33.33333333	0	
	0	0	33.33333333	0	33.33333333	0	0	0	0	0	0	0	0	0	0		
	33.33333333	0	0	0	33.33333333	0	33.33333333	0	0	0	0						
2010	1	7	1	0	2	52	52	1	0	0	0	0	0	0	0	0	100
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
	0	0	0	0	0	0	0	0									
2010	1	7	1	0	2	54	54	2	0	0	0	0	0	0	0	0	0
	50	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0
	50	0	0	0	50	0	0	0									
2010	1	7	1	0	2	56	56	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	100	0	0	0									
2011	1	7	1	0	2	18	18	1	0	100	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0									
2011	1	7	1	0	2	20	20	10.6	0	43.39622642	56.60377358	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	43.39622642	56.60377358	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0					
2011	1	7	1	0	2	22	22	19	0	36.84210526	42.10526316	21.05263158	0	0			
	0	0	0	0	0	0	0	0	0	0	0	0	36.84210526	42.10526316			
	21.05263158	0	0	0	0	0	0	0	0	0	0	0	0	0			

2011 1 7 1 0 2 24 24 14 0 7.142857143 64.28571429 14.28571429 14.28571429
0 0 0 0 0 0 0 0 0 0 0 0 0 7.142857143 64.28571429
14.28571429 14.28571429 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 1 0 2 26 26 34 0 5.882352941 38.23529412 38.23529412 17.64705882
0 0 0 0 0 0 0 0 0 0 0 0 0 5.882352941 38.23529412
38.23529412 17.64705882 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 1 0 2 28 28 32 0 3.125 43.75 31.25 21.875 0 0 0 0
0 0 0 0 0 0 0 0 0 3.125 43.75 31.25 21.875 0 0 0 0
0 0 0 0 0 0 0 0
2011 1 7 1 0 2 30 30 45 0 0 22.22222222 35.55555556 31.11111111
11.11111111 0 0 0 0 0 0 0 0 0 0 0 0 0 22.22222222
35.55555556 31.11111111 11.11111111 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 1 0 2 32 32 45 0 0 13.33333333 37.77777778 35.55555556
4.444444444 8.888888889 0 0 0 0 0 0 0 0 0 0 0 0
13.33333333 37.77777778 35.55555556 4.444444444 8.888888889 0 0 0 0 0 0 0
0 0 0
2011 1 7 1 0 2 34 34 31 0 0 9.677419355 12.90322581 51.61290323
22.58064516 0 3.225806452 0 0 0 0 0 0 0 0 0 0 0
9.677419355 12.90322581 51.61290323 22.58064516 0 3.225806452 0 0 0 0 0 0
0 0 0
2011 1 7 1 0 2 36 36 37 0 0 0 13.51351351 43.24324324 16.21621622
18.91891892 8.108108108 0 0 0 0 0 0 0 0 0 0 0 0
13.51351351 43.24324324 16.21621622 18.91891892 8.108108108 0 0 0 0 0 0 0
0 0
2011 1 7 1 0 2 38 38 26 0 0 0 3.846153846 23.07692308 19.23076923
30.76923077 11.53846154 3.846153846 0 3.846153846 0 3.846153846 0 0 0 0 0
0 0 3.846153846 23.07692308 19.23076923 30.76923077 11.53846154 3.846153846 0 3.846153846
0 3.846153846 0 0 0 0
2011 1 7 1 0 2 40 40 24 0 0 0 0 8.333333333 20.83333333
29.16666667 25 12.5 4.166666667 0 0 0 0 0 0 0 0 0 0 0
8.333333333 20.83333333 29.16666667 25 12.5 4.166666667 0 0 0 0 0 0 0
2011 1 7 1 0 2 42 42 32 0 0 0 0 3.125 6.25 28.125 40.625 9.375
12.5 0 0 0 0 0 0 0 0 0 0 0 3.125 6.25 28.125 40.625 9.375
12.5 0 0 0 0 0 0 0

2011 1 7 1 0 2 44 44 13 0 0 0 0 0 0 30.76923077
30.76923077 30.76923077 0 7.692307692 0 0 0 0 0 0 0 0 0 0
0 0 30.76923077 30.76923077 30.76923077 0 7.692307692 0 0 0 0 0 0
2011 1 7 1 0 2 46 46 13 0 0 0 0 0 7.692307692 7.692307692
23.07692308 7.692307692 23.07692308 15.38461538 7.692307692 0 0 7.692307692 0 0 0
0 0 0 0 7.692307692 7.692307692 23.07692308 7.692307692 23.07692308 15.38461538
7.692307692 0 0 7.692307692 0 0
2011 1 7 1 0 2 48 48 10 0 0 0 0 0 0 0 0 10
20 30 30 0 10 0 0 0 0 0 0 0 0 0 0 0 10
20 30 30 0 10 0 0 0
2011 1 7 1 0 2 50 50 7 0 0 0 0 0 0 0 0 0
14.28571429 42.85714286 14.28571429 14.28571429 14.28571429 0 0 0 0 0 0 0
0 0 0 0 0 14.28571429 42.85714286 14.28571429 14.28571429 14.28571429 0 0
0
2011 1 7 1 0 2 52 52 4 0 0 0 0 0 0 0 0 0
0 25 25 25 0 0 25 0 0 0 0 0 0 0 0 0 0
0 25 25 25 0 0 25 0
2011 1 7 1 0 2 56 56 4 0 0 0 0 0 0 0 0 0
0 0 25 0 0 0 0 75 0 0 0 0 0 0 0 0 0
0 0 25 0 0 0 0 75
2012 1 7 1 0 2 12 12 0.6 100 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 1 0 2 18 18 1 0 0 100 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 1 0 2 20 20 2 0 50 50 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 50 50 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 1 0 2 22 22 13 0 15.38461538 53.84615385 30.76923077 0 0
0 0 0 0 0 0 0 0 0 0 0 0 15.38461538 53.84615385
30.76923077 0 0 0 0 0 0 0 0 0 0 0 0 0

2012 1 7 1 0 2 24 24 14 0 14.28571429 35.71428571 50 0 0 0
0 0 0 0 0 0 0 0 0 0 0 14.28571429 35.71428571 50 0
0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 1 0 2 26 26 27 0 3.703703704 18.51851852 59.25925926 11.11111111
7.407407407 0 0 0 0 0 0 0 0 0 0 0 0 3.703703704
18.51851852 59.25925926 11.11111111 7.407407407 0 0 0 0 0 0 0 0 0
0 0
2012 1 7 1 0 2 28 28 42 0 2.380952381 21.42857143 50 19.04761905
7.142857143 0 0 0 0 0 0 0 0 0 0 0 0 2.380952381
21.42857143 50 19.04761905 7.142857143 0 0 0 0 0 0 0 0 0 0
0
2012 1 7 1 0 2 30 30 32 0 0 18.75 56.25 9.375 3.125 9.375 3.125 0
0 0 0 0 0 0 0 0 0 0 18.75 56.25 9.375 3.125 9.375 3.125 0
0 0 0 0 0 0 0 0
2012 1 7 1 0 2 32 32 31 0 0 3.225806452 29.03225806 29.03225806
32.25806452 6.451612903 0 0 0 0 0 0 0 0 0 0 0 0
3.225806452 29.03225806 29.03225806 32.25806452 6.451612903 0 0 0 0 0 0 0
0 0 0
2012 1 7 1 0 2 34 34 46 0 0 4.347826087 39.13043478 26.08695652
17.39130435 13.04347826 0 0 0 0 0 0 0 0 0 0 0 0
4.347826087 39.13043478 26.08695652 17.39130435 13.04347826 0 0 0 0 0 0 0
0 0 0
2012 1 7 1 0 2 36 36 43 0 0 2.325581395 13.95348837 30.23255814
30.23255814 11.62790698 9.302325581 0 2.325581395 0 0 0 0 0 0 0 0
0 2.325581395 13.95348837 30.23255814 30.23255814 11.62790698 9.302325581 0 2.325581395 0
0 0 0 0 0 0
2012 1 7 1 0 2 38 38 39 0 0 0 15.38461538 20.51282051 33.33333333
17.94871795 10.25641026 0 2.564102564 0 0 0 0 0 0 0 0 0 0
15.38461538 20.51282051 33.33333333 17.94871795 10.25641026 0 2.564102564 0 0 0 0
0 0 0
2012 1 7 1 0 2 40 40 36 0 0 0 8.333333333 13.88888889 25
16.66666667 25 5.555555556 2.777777778 0 2.777777778 0 0 0 0 0 0 0
0 8.333333333 13.88888889 25 16.66666667 25 5.555555556 2.777777778 0 2.777777778 0
0 0 0 0

2012 1 7 1 0 2 42 42 13 0 0 0 0 0 23.07692308 30.76923077
23.07692308 0 15.38461538 7.692307692 0 0 0 0 0 0 0 0 0 0
0 23.07692308 30.76923077 23.07692308 0 15.38461538 7.692307692 0 0 0 0 0
0
2012 1 7 1 0 2 44 44 24 0 0 0 0 4.166666667 8.333333333
16.66666667 37.5 4.166666667 8.333333333 16.66666667 0 0 4.166666667 0 0 0 0
0 0 0 4.166666667 8.333333333 16.66666667 37.5 4.166666667 8.333333333 16.66666667 0
0 4.166666667 0 0 0
2012 1 7 1 0 2 46 46 14 0 0 0 0 0 0 0 0
28.57142857 7.142857143 14.28571429 21.42857143 7.142857143 21.42857143 0 0 0 0 0
0 0 0 0 0 0 28.57142857 7.142857143 14.28571429 21.42857143 7.142857143
21.42857143 0 0 0
2012 1 7 1 0 2 48 48 9 0 0 0 0 0 0 0 0
11.11111111 11.11111111 22.22222222 11.11111111 22.22222222 0 11.11111111 11.11111111 0 0
0 0 0 0 0 0 0 11.11111111 11.11111111 22.22222222 11.11111111 22.22222222
0 11.11111111 11.11111111 0
2012 1 7 1 0 2 50 50 7 0 0 0 0 0 0 0 0 0
0 28.57142857 28.57142857 0 14.28571429 28.57142857 0 0 0 0 0 0 0
0 0 0 0 0 28.57142857 28.57142857 0 14.28571429 28.57142857 0 0
2012 1 7 1 0 2 52 52 7 0 0 0 0 0 0 0 0 0
28.57142857 0 0 14.28571429 28.57142857 0 14.28571429 14.28571429 0 0 0 0
0 0 0 0 0 28.57142857 0 0 14.28571429 28.57142857 0 14.28571429
14.28571429
2012 1 7 1 0 2 54 54 3 0 0 0 0 0 0 0 0 0
0 0 33.33333333 0 33.33333333 0 0 33.33333333 0 0 0 0 0 0
0 0 0 0 0 33.33333333 0 33.33333333 0 0 33.33333333
2012 1 7 1 0 2 58 58 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100
2012 1 7 1 0 2 60 60 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 100

# NWFSC male		year	Season	Fleet	gender	partition		ageErr	LbinLo	LbinHi	nSamps	M1	M2	M3	M4	M5	M6
	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M1.1	M2.1	M3.1	M4.1	M5.1	M6.1
	M7.1	M8.1	M9.1	M10.1	M11.1	M12.1	M13.1	M14.1	M15.1	M16.1	M17.1						
2003	1	7	2	0	2	18	18	1	100	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0									
2003	1	7	2	0	2	20	20	4	0	50	50	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0
	0	0	0	0	0	0	0	0									
2003	1	7	2	0	2	22	22	7	0	28.57142857		71.42857143		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	28.57142857		71.42857143		0	0
	0	0	0	0	0	0	0	0	0	0	0	0					
2003	1	7	2	0	2	24	24	12	0	0	58.33333333		33.33333333		8.333333333		0
	0	0	0	0	0	0	0	0	0	0	0	0	0	58.33333333		33.33333333	
	8.333333333		0	0	0	0	0	0	0	0	0	0	0	0			
2003	1	7	2	0	2	26	26	28	0	0	39.28571429		39.28571429		21.42857143		0
	0	0	0	0	0	0	0	0	0	0	0	0	0	39.28571429		39.28571429	
	21.42857143		0	0	0	0	0	0	0	0	0	0	0	0			
2003	1	7	2	0	2	28	28	55	0	0	21.81818182		34.54545455		41.81818182		
	1.818181818		0	0	0	0	0	0	0	0	0	0	0	0	0	21.81818182	
	34.54545455		41.81818182		1.818181818		0	0	0	0	0	0	0	0	0	0	0
2003	1	7	2	0	2	30	30	71	0	0	5.633802817		28.16901408		47.88732394		
	16.90140845		1.408450704		0	0	0	0	0	0	0	0	0	0	0	0	
	5.633802817		28.16901408		47.88732394		16.90140845		1.408450704		0	0	0	0	0	0	0
	0	0	0														
2003	1	7	2	0	2	32	32	64	0	0	1.5625	12.5	64.0625	15.625	6.25	0	0
	0	0	0	0	0	0	0	0	0	0	1.5625	12.5	64.0625	15.625	6.25	0	0
	0	0	0	0	0	0	0	0									
2003	1	7	2	0	2	34	34	78	0	0	0	8.974358974		35.8974359		24.35897436	
	15.38461538		8.974358974		3.846153846		2.564102564		0	0	0	0	0	0	0	0	0
	0	8.974358974		35.8974359		24.35897436		15.38461538		8.974358974		3.846153846		2.564102564		0	0
	0	0	0	0	0												
2003	1	7	2	0	2	36	36	36	0	0	0	5.555555556		41.66666667		19.44444444	
	13.88888889		11.11111111		2.777777778		5.555555556		0	0	0	0	0	0	0	0	0

0 5.555555556 41.66666667 19.44444444 13.88888889 11.11111111 2.777777778 5.555555556 0 0
0 0 0 0 0
2003 1 7 2 0 2 38 38 17 0 0 0 0 41.17647059 17.64705882
17.64705882 5.882352941 11.76470588 0 0 0 0 0 0 0 5.882352941 0 0
0 0 41.17647059 17.64705882 17.64705882 5.882352941 11.76470588 0 0 0 0 0
0 0 5.882352941
2003 1 7 2 0 2 40 40 7 0 0 0 0 42.85714286 0 0
28.57142857 0 0 14.28571429 0 0 0 0 14.28571429 0 0 0 0 0
42.85714286 0 0 28.57142857 0 0 14.28571429 0 0 0 0 14.28571429 0
2003 1 7 2 0 2 42 42 3 0 0 0 0 0 0 0 66.66666667
0 33.33333333 0 0 0 0 0 0 0 0 0 0 0 0 0 0
66.66666667 0 33.33333333 0 0 0 0 0 0 0
2004 1 7 2 0 2 18 18 2 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2004 1 7 2 0 2 20 20 5 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2004 1 7 2 0 2 22 22 10 0 30 50 20 0 0 0 0 0
0 0 0 0 0 0 0 0 0 30 50 20 0 0 0 0 0
0 0 0 0 0 0 0 0
2004 1 7 2 0 2 24 24 17 0 0 41.17647059 52.94117647 5.882352941 0
0 0 0 0 0 0 0 0 0 0 0 0 0 41.17647059 52.94117647
5.882352941 0 0 0 0 0 0 0 0 0 0 0 0
2004 1 7 2 0 2 26 26 25 0 0 20 68 8 4 0 0 0
0 0 0 0 0 0 0 0 0 0 20 68 8 4 0 0 0
0 0 0 0 0 0 0 0
2004 1 7 2 0 2 28 28 31 0 0 0 38.70967742 38.70967742 16.12903226
6.451612903 0 0 0 0 0 0 0 0 0 0 0 0 0 38.70967742
38.70967742 16.12903226 6.451612903 0 0 0 0 0 0 0 0 0 0
2004 1 7 2 0 2 30 30 36 0 0 0 19.44444444 38.88888889 30.55555556
5.555555556 5.555555556 0 0 0 0 0 0 0 0 0 0 0 0
19.44444444 38.88888889 30.55555556 5.555555556 5.555555556 0 0 0 0 0 0 0
0 0

2004 1 7 2 0 2 32 32 52 0 0 0 3.846153846 36.53846154 32.69230769
17.30769231 7.692307692 1.923076923 0 0 0 0 0 0 0 0 0 0 0
3.846153846 36.53846154 32.69230769 17.30769231 7.692307692 1.923076923 0 0 0 0 0
0 0 0
2004 1 7 2 0 2 34 34 49 0 0 0 0 14.28571429 30.6122449
34.69387755 14.28571429 4.081632653 2.040816327 0 0 0 0 0 0 0 0 0
0 0 14.28571429 30.6122449 34.69387755 14.28571429 4.081632653 2.040816327 0 0 0
0 0 0 0
2004 1 7 2 0 2 36 36 35 0 0 0 0 5.714285714 28.57142857
31.42857143 28.57142857 2.857142857 0 2.857142857 0 0 0 0 0 0 0 0
0 0 5.714285714 28.57142857 31.42857143 28.57142857 2.857142857 0 2.857142857 0 0
0 0 0 0
2004 1 7 2 0 2 38 38 18 0 0 0 0 0 16.66666667 33.33333333
22.22222222 0 16.66666667 5.555555556 0 0 5.555555556 0 0 0 0 0 0
0 0 16.66666667 33.33333333 22.22222222 0 16.66666667 5.555555556 0 0 5.555555556
0 0 0
2004 1 7 2 0 2 40 40 8 0 0 0 0 0 25 25 37.5 0
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2.173913043 15.2173913 47.82608696 26.08695652 4.347826087 4.347826087 0 0 0 0 0
0 0 0 0

2011 1 7 2 0 2 34 34 56 0 0 0 12.5 30.35714286 28.57142857
10.71428571 10.71428571 5.357142857 1.785714286 0 0 0 0 0 0 0 0 0
0 12.5 30.35714286 28.57142857 10.71428571 10.71428571 5.357142857 1.785714286 0 0 0
0 0 0 0
2011 1 7 2 0 2 36 36 34 0 0 0 5.882352941 23.52941176 14.70588235
14.70588235 23.52941176 17.64705882 0 0 0 0 0 0 0 0 0 0 0
5.882352941 23.52941176 14.70588235 14.70588235 23.52941176 17.64705882 0 0 0 0 0
0 0 0
2011 1 7 2 0 2 38 38 12 0 0 0 0 0 8.333333333 25
33.33333333 16.66666667 16.66666667 0 0 0 0 0 0 0 0 0 0 0
0 8.333333333 25 33.33333333 16.66666667 16.66666667 0 0 0 0 0 0 0
2011 1 7 2 0 2 40 40 8 0 0 0 0 0 12.5 0 25 37.5
0 12.5 0 12.5 0 0 0 0 0 0 0 0 0 12.5 0 25 37.5
0 12.5 0 12.5 0 0 0 0
2011 1 7 2 0 2 42 42 2 0 0 0 0 0 0 0 0 0
50 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0
50 0 0 50 0 0 0 0
2011 1 7 2 0 2 44 44 3 0 0 0 0 0 0 0 0 0
0 66.66666667 0 33.33333333 0 0 0 0 0 0 0 0 0 0 0
0 0 0 66.66666667 0 33.33333333 0 0 0 0
2012 1 7 2 0 2 12 12 0.4 100 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 2 0 2 16 16 1 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 2 0 2 18 18 3 0 66.66666667 33.33333333 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 66.66666667 33.33333333 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 2 0 2 20 20 5 0 60 20 20 0 0 0 0 0
0 0 0 0 0 0 0 0 0 60 20 20 0 0 0 0 0
0 0 0 0 0 0 0 0

2012 1 7 2 0 2 22 22 22 0 9.090909091 31.81818182 50 9.090909091 0
0 0 0 0 0 0 0 0 0 0 0 0 9.090909091 31.81818182 50
9.090909091 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 2 0 2 24 24 25 0 4 36 44 4 12 0 0 0
0 0 0 0 0 0 0 0 0 4 36 44 4 12 0 0 0
0 0 0 0 0 0 0 0
2012 1 7 2 0 2 26 26 54 0 3.703703704 22.22222222 59.25925926 3.703703704
11.11111111 0 0 0 0 0 0 0 0 0 0 0 0 3.703703704
22.22222222 59.25925926 3.703703704 11.11111111 0 0 0 0 0 0 0 0 0
0 0
2012 1 7 2 0 2 28 28 54 0 1.851851852 18.51851852 42.59259259 20.37037037
12.96296296 3.703703704 0 0 0 0 0 0 0 0 0 0 0 1.851851852
18.51851852 42.59259259 20.37037037 12.96296296 3.703703704 0 0 0 0 0 0 0
0 0 0
2012 1 7 2 0 2 30 30 64 0 0 6.25 40.625 34.375 12.5 6.25 0 0
0 0 0 0 0 0 0 0 0 0 6.25 40.625 34.375 12.5 6.25 0 0
0 0 0 0 0 0 0 0
2012 1 7 2 0 2 32 32 53 0 0 3.773584906 20.75471698 26.41509434
24.52830189 16.98113208 3.773584906 3.773584906 0 0 0 0 0 0 0 0 0
0 3.773584906 20.75471698 26.41509434 24.52830189 16.98113208 3.773584906 3.773584906 0 0
0 0 0 0 0 0
2012 1 7 2 0 2 34 34 46 0 0 0 8.695652174 13.04347826 21.73913043
26.08695652 6.52173913 15.2173913 6.52173913 2.173913043 0 0 0 0 0 0 0
0 0 8.695652174 13.04347826 21.73913043 26.08695652 6.52173913 15.2173913 6.52173913
2.173913043 0 0 0 0 0 0
2012 1 7 2 0 2 36 36 35 0 0 0 2.857142857 8.571428571 14.28571429
17.14285714 17.14285714 11.42857143 25.71428571 2.857142857 0 0 0 0 0 0 0
0 0 2.857142857 8.571428571 14.28571429 17.14285714 17.14285714 11.42857143 25.71428571
2.857142857 0 0 0 0 0 0
2012 1 7 2 0 2 38 38 13 0 0 0 7.692307692 7.692307692 7.692307692
7.692307692 15.38461538 15.38461538 7.692307692 0 15.38461538 15.38461538 0 0 0 0
0 0 0 7.692307692 7.692307692 7.692307692 7.692307692 15.38461538 15.38461538 7.692307692
0 15.38461538 15.38461538 0 0 0 0

2012	1	7	2	0	2	40	40	5	0	0	0	0	0	20	0	0	0
	60	0	0	0	0	20	0	0	0	0	0	0	0	20	0	0	0
	60	0	0	0	0	20	0	0									
2012	1	7	2	0	2	42	42	4	0	0	0	0	0	0	0	0	25
	0	0	0	50	0	0	0	25	0	0	0	0	0	0	0	0	25
	0	0	0	50	0	0	0	25									

0 #N mean size-at-age obs
0 #N_envvar
0 #N_envdata
0 #N sizefreq methods to read
0 #Do_TagData(0/1)
0 #no morphcomp data

999

ENDDATA

Appendix E. SS control file

#C 2013 Assessent of Petrale (Haltuch, Ono, Valero) run with SS3.24O
#_data_and_control_files: petrale13.dat // petrale13.ctl
1   #_N_Growth_Patterns
1   #_N_Morphs_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond 1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)

#Recruitment occurs in season 2 (summer)
#1   # N recruitment designs goes here if N_GP*nseas*area>1
#0   # placeholder for recruitment interaction request
#1 2 1   # recruitment design element for GP=1, seas=2, area=1

#_Cond 0 # N_movement_definitions goes here if N_areas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10

3 #_Nblock_Patterns
5 3 3 #_blocks_per_pattern
begin and end years of blocks
1973 1982 1983 1992 1993 2002 2003 2010 2011 2012 # For selectivities of all fleets
2003 2009 2010 2010 2011 2012 # For retention of winter fleets
2003 2008 2009 2010 2011 2012 # For retention of summer fleets

0.5 #_fracfemale
0   #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#2 #_N_breakpoints
4 15 # age(real) at M breakpoints

1   # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented
2   #_Growth_Age_for_L1 (minimum age for growth calcs

```
17  #_Growth_Age_for_L2 (999 to use as Linf) (maximum age for growth calcs)
0.0 #_SD_add_to_LAA
0   #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
1   #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity
#_placeholder for empirical age-maturity by growth pattern
3   #_First_Mature_Age
1   #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0   #hermaphrodite
1   #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
1   #_env/block/dev_adjust_method (1=standard; 2=with logistic trans to keep within base parm bounds)

#_growth_parms
#GP_1_Female
#LO     HI      INIT     PRIOR    PR_type SD  PHASE   env-var use_dev dev_minyr dev_maxyr dev_stddev  Block   Block_Fxn
0.005    0.50   0.1549     -1.888  3     0.3333 6      0       0       0          0       0.5        0       0          #1 F_M_young
10      45      16.27  17.18  -1      10    2       0       0       0          0       0.5        0       0          #2 F_L@Amin (Amin is age entered above)
35      80      47.86    58.7   -1      10    3       0       0       0          0       0.5        0       0          #3 F_L@Amax
0.04    0.5     0.27   0.13   -1      0.8   2       0       0       0          0       0.5        0       0          #4 F_VBK
0.01    1.00    0.08   3.0    -1      0.8   3       0       0       0          0       0.5        0       0          #5 CV@LAAFIX
0.01    1.0     0.08    0.0     -1      1       4       0 0 0 0 0 0 0  # CV@LAAFIX2
#GP_1:::Male (Direct Estimation)
0.005    0.60   0.1749     -1.580  3     0.3326 6      0       0       0          0       0.5        0       0          #1 M_M_young
10      45      16.27  17.18  -1      10    2       0       0       0          0       0.5        0       0          #2 M_L@Amin (Amin is age entered above)
35      80      47.86    58.7   -1      10    3       0       0       0          0       0.5        0       0          #3 M_L@Amax
0.04    0.5     0.27   0.13   -1      0.8   2       0       0       0          0       0.5        0       0          #4 M_VBK
0.01    1.00    0.08   3.0    -1      0.8   3       0       0       0          0       0.5        0       0          #5 M_CV@LAAFIX
0.01    1.0     0.08    0.0     -1      1       4       0 0 0 0 0 0 0  # M_CV@LAAFIX2

#LW_female
#LO     HI      INIT        PRIOR       PR_type SD  PHASE   env-var use_dev dev_minyr dev_maxyr dev_stddev  Block   Block_Fxn
-3      3       2.08296E-06    2.08296E-06    0       0.8 -3      0       0       0  0   0.5 0   0   #WL_intercept_female
1       5       3.473703       3.473703       0       0.8 -3      0       0       0  0   0.5 0   0   #WL_slope_female
#Female_maturity
10      50      33.1        33.1        0       0.8 -3  0   0   0   0   0.5 0   0   #mat_intercept  #L50
```

-3 3 -0.743 -0.743 0 0.8 -3 0 0 0 0 0.5 0 0 #mat_slope From Hannah et al 2002
#Fecundity___Assume_same_as_spawning_biomass
-3 3 1 1 0 1 -3 0 0 0 0 0.5 0 0 #mat_intercept #L50
-3 3 0 0 0 1 -3 0 0 0 0 0.5 0 0 #mat_slope
#LW_Male
-3 3 3.05E-06 3.05E-06 0 0.8 -3 0 0 0 0 0.5 0 0 #WL_intercept_male
-3 5 3.360544 3.360544 0 0.8 -3 0 0 0 0 0.5 0 0 #WL_slope_slope_male

#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#Allocate_R_by_areas_x_gmorphs
0 1 1 0.2 0 9.8 -3 0 0 0 0 0.5 0 0 #frac to GP 1 in area 1
#Allocate_R_by_areas_(1_areain_this_case)
0 1 1 1 0 9.8 -3 0 0 0 0 0.5 0 0 #frac R in area 1
#Allocate_R_by_season_(2seasons_in_this_case)
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
-4 4 0 1 0 9.8 -3 0 0 0 0 0.5 0 0 #frac R in season 1

#CohortGrowDev
#SS3 manual says it must be given a value of 1 and a negative phase
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0 1 1 1 -1 0 -4 0 0 0 0 0 0 0

#_Cond 0 #custom_MG-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters

#_Cond 0 #custom_MG-block_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters

#_seasonal_effects_on_biology_parms
0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,L1,K,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters

#_Cond -4 #_MGparm_Dev_Phase

```
#_Spawner-Recruitment
3   #_SR_function
#_LO    HI  INIT    PRIOR   PR_type SD  PHASE
5       20  10      9       -1      10   1       #Ln(R0)
0.2     1   0.85    0.8     0       0.09  5      #steepness(h)
0       2   0.4     0.9     0       5       -99    #sigmaR
-5      5   0       0       0       1       -99    #Env_link_parameter
-5      5   0       0       0       0.2     -2     # SR_R1_offset
0       0   0       0       -1      0       -99    # SR_autocorr
0   #_SR_env_link
0   #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness

1   #do_recdev:  0=none; 1=devvector; 2=simple deviations

1959    # first year of main recr_devs; early devs can preceed this era
2009    # last year of main recr_devs; forecast devs start in following year
1   #_recdev phase
1   # (0/1) to read 13 advanced options
1845 #_Cond 0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
3   #_recdev_early_phase
0   #_Cond 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
1   #_Cond 1 #_lambda for prior_fore_recr occurring before endyr+1
1944    #_last_early_yr_nobias_adj_in_MPD
1964    #_first_yr_fullbias_adj_in_MPD
2009    #_last_yr_fullbias_adj_in_MPD
2012    #_first_recent_yr_nobias_adj_in_MPDadj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated recdevs)
0.80   #max bias
0   #period of cycles in recruitment
-4  #min rec_dev
4   #max rec_dev
0 #67   #_read_recdevs
#_end of advanced SR options

#Fishing Mortality info
```

0.3 # F ballpark for tuning early phases
-2001   # F ballpark year (neg value to disable)
3   # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
4   # max F or harvest rate, depends on F_Method
no additional F input needed for Fmethod 1
read overall start F value; overall phase; N detailed inputs to read for Fmethod 2
NUM ITERATIONS, FOR CONDITION 3
5   # read N iterations for tuning for Fmethod 3 (recommend 3 to 7)
#Fleet Year Seas F_value se phase (for detailed setup of F_Method=2)

#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
0   1   0   0.0001 0   99 -1 #Fleet1_(WinterN)
0   1   0   0.0001 0   99 -1 #Fleet2_(SummerN)
0   1   0   0.0001 0   99 -1 #Fleet3_(WinterS)
0   1   0   0.0001 0   99 -1 #Fleet4_(SummerS)

#_Q_setup
#D=devtype(<0=mirror, 0/1=none, 2=cons, 3=rand, 4=randwalk)
#E=0=num/1=bio, F=err_type
#DISCUSS WHICH OPTION FOR Q (0 OR 1, OR 2)
#do power, env-var, extra SD, dev type
#do power for commercial CPUE, estimating extra SD, estimating q
1   0   0   4   #Fleet1_(WinterN)
0   0   0   0   #Fleet2_(SummerN)
1   0   0   4   #Fleet3_(WinterS)
0   0   0   0   #Fleet4_(SummerS)
0   0   1   0   #Fleet5 Triennial
0   0   1   0   #Fleet6 Triennial
0   0   0   0   #Fleet7 NWFSC

1 #_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
LO HI INIT PRIOR PR_type SD PHASE
-5   5   0.38   0   -1   99   3   #   (log)   power   parameter N Winter

```
-5      5       0.16    0       -1      99      3       #       (log)   power   parameter S Winter
#parameter lines for extra SD for fishery CPUE and surveys
#Prior type -1 = none, 0=normal, 1=symmetric beta, 2=full beta, 3=lognormal
#-5     5       0.4      0.5      -1  99  5     #
#-5     5       0.4      0.5      -1  99  5     #
0.001   2       0.28    0.22    -1      99      5       #
0.001   2       0.15    0.16    -1      99      4       #
#-1     2       0   0.06 -1     99      5       #
#parameter lines for winter index q's
-20     5       -9      0       -1      99      1       #       estimate q parameter N Winter
-20 5   0 -1   -1  99 -1 #1988
-20 5   0 -1   -1  99 -1 #1989
-20 5   0 -1   -1  99 -1 #1990
-20 5   0 -1   -1  99 -1 #1991
-20 5   0 -1   -1  99 -1 #1992
-20 5   0 -1   -1  99 -1 #1993
-20 5   0 -1   -1  99 -1 #1994
-20 5   0 -1   -1  99 -1 #1995
-20 5   0 -1   -1  99 -1 #1996
-20 5   0 -1   -1  99 -1 #1997
-20 5   0 -1   -1  99 -1 #1998
-20 5   0 -1   -1  99 -1 #1999
-20 5   0 -1   -1  99 -1 #2000
-20 5   0 -1   -1  99 -1 #2001
-20 5   0 -1   -1  99 -1 #2002
-20 5   0 -1   -1  99 -1 #2003
-20 5   0 -1   -1  99 7 #2004
-20 5   0 -1   -1  99 -7 #2005
-20 5   0 -1   -1  99  -7 #2006
-20 5   0 -1   -1  99  -7 #2007
-20 5   0 -1   -1  99  -7 #2008
-20 5   0 -1   -1  99  -7 #2009

-20     5       -6      0       -1      99      1       #       estimate q parameter S Winter
```

```
-20 5    0 -1   -1  99 -1 #1988
-20 5    0 -1   -1  99 -1 #1989
-20 5    0 -1   -1  99 -1 #1990
-20 5    0 -1   -1  99 -1 #1991
-20 5    0 -1   -1  99 -1 #1992
-20 5    0 -1   -1  99 -1 #1993
-20 5    0 -1   -1  99 -1 #1994
-20 5    0 -1   -1  99 -1 #1995
-20 5    0 -1   -1  99 -1 #1996
-20 5    0 -1   -1  99 -1 #1997
-20 5    0 -1   -1  99 -1 #1998
-20 5    0 -1   -1  99 -1 #1999
-20 5    0 -1   -1  99 -1 #2000
-20 5    0 -1   -1  99 -1 #2001
-20 5    0 -1   -1  99 -1 #2002
-20 5    0 -1   -1  99 -1 #2003
-20 5    0 -1   -1  99 7 #2004
-20 5    0 -1   -1  99 -7 #2005
-20 5    0 -1   -1  99  -7 #2006
-20 5    0 -1   -1  99  -7 #2007
-20 5    0 -1   -1  99  -7 #2008
-20 5    0 -1   -1  99  -7 #2009

#Seltype(1,2*Ntypes,1,4)    #SELEX_&_RETENTION_PARAMETERS
#Size_Slectivity,_enter_4_cols
#N_sel  Do_retain   Do_male Special
24      1          3      0   #Fleet(WinterN)
24      1          3      0   #Fleet(SummerN)
24      1          3      0   #Fleet(WinterS)
24      1          3      0   #Fleet(SummerS)
24      0          3      0   #Triennial early
24      0          3      0   #Triennial late
24      0          3      0   #NWFSC
```

```
#Age_selectivity    #set_to_1
10      0           0       0   #Fleet(WinterN)
10      0           0       0   #Fleet(SummerN)
10      0           0       0   #Fleet(WinterS)
10      0           0       0   #Fleet(SummerS)
10      0           0       0   #Triennial early
10      0           0       0   #Triennial late
10      0           0       0   #NWFSC

#Selectivity parameters
#Size_selectivity for FISHERY WINTER N
#FEMALE
#LO     HI  INIT    PRIOR   PR_TYPE SD  PHASE   env-var use_dev dev_yr1 dev_yr2 dev_sd  nblks   blk_pat #
15      75  50        43.1    -1      5   1   0   0   0   0   0.5 1   1   #PEAK (see Selex24.xls)
-5      3   3.0        0.7    -1    5   -3  0   0   0   0   0.5 0   0   #TOP (see Selex24.xls)
-4      12  4         3.42    -1     5   2   0   0   0   0   0.5 0   0   #ASC_WIDTH (see Selex24.xls)
-2      15   14.0       0.21   -1    5   -3  0   0   0   0   0.5 0   0   #DSC_WIDTH (see Selex24.xls)
-15     5   -999       -8.9    -1    5  -4   0   0   0   0   0.5 0   0   #INIT (see Selex24.xls)
-5      5   -999       0.15   -1    5   -4  0   0   0   0   0.5 0   0   #FINAL (see Selex24.xls)
#RETENTION
10      40  26.47        15      -1  9   1   0   0   0   0   0   2   1   # Retain_1 Inflection
0.1     10  3.026         3      -1  9  2   0   0   0   0   0   2   1   # Retain_2 Slope
0.001   1   0.9945      1       -1  9   4   0   0   0   0   0   2   1   # Retain_3 Asymptote
-10     10  0           0       -1  9   -2  0   0   0   0   0   0   0   # Retain_4 Male offset (additive)
#...DO_MALE (AS OFFSET)
-15     15      -4        0   -1      5   3   0   0   0   0   0.5 0   0   #PEAK (see Selex24.xls)
-15     15      -1        0   -1      5   4   0   0   0   0   0.5 0   0   #ASC_WIDTH (see Selex24.xls)
-15     15      0           0   -1    5   -4  0   0   0   0   0.5 0   0   #DSC_WIDTH (see Selex24.xls)
-15     15      0           0   -1    5   -4  0   0   0   0   0.5 0   0   #FINAL (see Selex24.xls)
-15     15      1           0   -1    5   -4  0   0   0   0   0.5 0   0   #APICAL SEL (see Selex24.xls)
#Size_selectivity for FISHERY SUMMER N
#FEMALE
#LO     HI  INIT    PRIOR   PR_TYPE SD  PHASE   env-var use_dev dev_yr1 dev_yr2 dev_sd  nblks   blk_pat #
15      75  50      43.1    -1      5   1   0   0   0   0   0.5 1   1   #PEAK (see Selex24.xls)
```

-5 3 3.0 0.7 -1 5 -3 0 0 0 0 0.5 0 0 #TOP (see Selex24.xls)
-4 12 4.5 3.42 -1 5 2 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-2 15 14.0 0.21 -1 5 -3 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 5 -999 -8.9 -1 5 -4 0 0 0 0 0.5 0 0 #INIT (see Selex24.xls)
-5 5 -999 0.15 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
#RETENTION
10 40 30.869 15 -1 9 1 0 0 0 0 0 3 1 # Retain_1 Inflection
0.1 10 1.2977 3 -1 9 2 0 0 0 0 0 3 1 # Retain_2 Slope
0.001 1 0.9935 1 -1 9 4 0 0 0 0 0 3 1 # Retain_3 Asymptote
-10 10 0 0 -1 9 -2 0 0 0 0 0 0 0 # Retain_4 Male offset (additive)
#...DO_MALE (AS OFFSET)
-20 15 0 0 -1 -5 3 0 0 0 0 0.5 0 0 #PEAK (see Selex24.xls)
-15 15 -1.0 0 -1 -5 4 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
-15 15 1 0 -1 5 -4 0 0 0 0 0.5 0 0 #APICAL SEL (see Selex24.xls)
#Size_selectivity for FISHERY WINTER S
#FEMALE
#LO HI INIT PRIOR PR_TYPE SD PHASE env-var use_dev dev_yr1 dev_yr2 dev_sd nblks blk_pat #
15 75 44.5116 43.1 -1 5 1 0 0 0 0 0.5 1 1 #PEAK (see Selex24.xls)
-5 3 3.0 0.7 -1 5 -3 0 0 0 0 0.5 0 0 #TOP (see Selex24.xls)
-4 12 4.5070 3.42 -1 5 2 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-2 15 14.0 0.21 -1 5 -3 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 5 -999 -8.9 -1 5 -4 0 0 0 0 0.5 0 0 #INIT (see Selex24.xls)
-5 5 -999 0.15 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
#RETENTION
10 40 27.716 15 -1 9 1 0 0 0 0 0 2 1 # Retain_1 Inflection
0.1 10 1.8483 3 -1 9 2 0 0 0 0 0 2 1 # Retain_2 Slope
0.001 1 0.999 1 -1 9 4 0 0 0 0 0 2 1 # Retain_3 Asymptote
-10 10 0 0 -1 9 -2 0 0 0 0 0 0 0 # Retain_4 Male offset (additive)
#...DO_MALE (AS OFFSET)
-15 15 -11.5284 0 -1 5 3 0 0 0 0 0.5 0 0 #PEAK (see Selex24.xls)
-15 15 -2.5591 0 -1 5 4 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)

-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
-15 15 1 0 -1 5 -4 0 0 0 0 0.5 0 0 #APICAL SEL (see Selex24.xls)
#Size_selectivity for FISHERY SUMMER S
#FEMALE
#LO HI INIT PRIOR PR_TYPE SD PHASE env-var use_dev dev_yr1 dev_yr2 dev_sd nblks blk_pat #
15 75 39.7903 43.1 -1 5 1 0 0 0 0 0.5 1 1 #PEAK (see Selex24.xls)
-5 3 3.0 0.7 -1 5 -3 0 0 0 0 0.5 0 0 #TOP (see Selex24.xls)
-4 12 3.9017 3.42 -1 5 2 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-2 15 14.0 0.21 -1 5 -3 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 5 -999 -8.9 -1 5 -4 0 0 0 0 0.5 0 0 #INIT (see Selex24.xls)
-5 5 -999 0.15 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
#RETENTION
10 40 27.346 15 -1 9 1 0 0 0 0 0 3 1 # Retain_1 Inflection
0.1 10 1.68 3 -1 9 2 0 0 0 0 0 3 1 # Retain_2 Slope
0.001 1 0.9995 1 -1 9 4 0 0 0 0 0 3 1 # Retain_3 Asymptote
-10 10 0 0 -1 9 -2 0 0 0 0 0 0 0 # Retain_4 Male offset (additive)
#...DO_MALE (AS OFFSET)
-15 15 -5.6710 0 -1 5 3 0 0 0 0 0.5 0 0 #PEAK (see Selex24.xls)
-15 15 -1.5100 0 -1 5 4 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 15 0 0 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
-15 15 1 0 -1 5 -4 0 0 0 0 0.5 0 0 #APICAL SEL (see Selex24.xls)
#Size_selectivity for TRIENNIAL SURVEY early
#FEMALE
#LO HI INIT PRIOR PR_TYPE SD PHASE env-var use_dev dev_yr1 dev_yr2 dev_sd nblks blk_pat #
15 61 35.4319 43.1 -1 5 1 0 0 0 0 0.5 0 0 #PEAK (see Selex24.xls)
-5 3 3.0 0.7 -1 5 -2 0 0 0 0 0.5 0 0 #TOP (see Selex24.xls)
-4 12 4.2436 3.42 -1 5 1 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)
-2 15 14.0 0.21 -1 5 -2 0 0 0 0 0.5 0 0 #DSC_WIDTH (see Selex24.xls)
-15 5 -999 -8.9 -1 5 -4 0 0 0 0 0.5 0 0 #INIT (see Selex24.xls)
-5 5 -999 0.15 -1 5 -4 0 0 0 0 0.5 0 0 #FINAL (see Selex24.xls)
#...DO_MALE (AS OFFSET)
-15 15 -4.1823 0 -1 5 2 0 0 0 0 0.5 0 0 #PEAK (see Selex24.xls)
-15 15 -0.5322 0 -1 5 2 0 0 0 0 0.5 0 0 #ASC_WIDTH (see Selex24.xls)

```
-15   15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #DSC_WIDTH (see Selex24.xls)
-15   15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #FINAL (see Selex24.xls)
-15   15  1      0   -1      5   -4  0   0   0   0   0.5 0   0   #APICAL SEL (see Selex24.xls)
#Size_selectivity for TRIENNIAL SURVEY late
#FEMALE
#LO    HI  INIT    PRIOR   PR_TYPE SD  PHASE   env-var use_dev dev_yr1 dev_yr2 dev_sd  nblks   blk_pat #
15     61  38.3545  43.1    -1      5   1   0   0   0   0   0.5 0   0   #PEAK (see Selex24.xls)
-5     3   3.0      0.7     -1      5   -2  0   0   0   0   0.5 0   0   #TOP (see Selex24.xls)
-4     12  4.8335   3.42    -1      5   1   0   0   0   0   0.5 0   0   #ASC_WIDTH (see Selex24.xls)
-2     15   14.0      0.21    -1      5   -2  0   0   0   0   0.5 0   0   #DSC_WIDTH (see Selex24.xls)
-15     5   -999     -8.9    -1      5   -4   0   0   0   0   0.5 0   0   #INIT (see Selex24.xls)
-5     5   -999     0.15    -1      5   -4  0   0   0   0   0.5 0   0   #FINAL (see Selex24.xls)
#...DO_MALE (AS OFFSET)
-15  15  -4.0542  0  -1      5   2       0       0       0       0       0.5     0       0       #PEAK (see Selex24.xls)
-15  15  -0.1367  0  -1      5   2       0       0       0       0       0.5     0       0       #ASC_WIDTH (see Selex24.xls)
-15  15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #DSC_WIDTH (see Selex24.xls)
-15  15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #FINAL (see Selex24.xls)
-15  15  1      0   -1      5   -4  0   0   0   0   0.5 0   0   #APICAL SEL (see Selex24.xls)
#Size_selectivity for NWFSC SURVEY
#FEMALE
#LO    HI  INIT    PRIOR   PR_TYPE SD  PHASE   env-var use_dev dev_yr1 dev_yr2 dev_sd  nblks   blk_pat #
15     61  42.7077   43.1    -1      5   1   0   0   0   0   0.5 0   0   #PEAK (see Selex24.xls)
-5     3   3.0       0.7     -1      5   -2  0   0   0   0   0.5 0   0   #TOP (see Selex24.xls)
-4     12  5.1017    3.42    -1      5   1   0   0   0   0   0.5 0   0   #ASC_WIDTH (see Selex24.xls)
-2     15   14.0       0.21    -1      5   -2  0   0   0   0   0.5 0   0   #DSC_WIDTH (see Selex24.xls)
-15     5   -999      -8.9    -1      5   -4   0   0   0   0   0.5 0   0   #INIT (see Selex24.xls)
-5     5   -999     0.15    -1      5   -4  0   0   0   0   0.5 0   0   #FINAL (see Selex24.xls)
#...DO_MALE (AS OFFSET)
-15   15  -7.3384  0  -1      5   2       0       0       0       0       0.5     0       0       #PEAK (see Selex24.xls)
-15   15  -0.5892  0  -1      5   2       0       0       0       0       0.5     0       0       #ASC_WIDTH (see Selex24.xls)
-15   15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #DSC_WIDTH (see Selex24.xls)
-15   15  0      0   -1      5   -3      0       0       0       0       0.5     0       0       #FINAL (see Selex24.xls)
-15   15  1      0   -1      5   -4  0   0   0   0   0.5 0   0   #APICAL SEL (see Selex24.xls)
```

```
1 #_custom block setup (0/1)
 -3 2 0 0 -1 99 4 # SizeSel_1P_1_WinterN_BLK1add_1973
 -3 2 0 0 -1 99 4 # SizeSel_1P_1_WinterN_BLK1add_1983
 -3 2 0 0 -1 99 4 # SizeSel_1P_1_WinterN_BLK1add_1993
 -3 2 0 0 -1 99 4 # SizeSel_1P_1_WinterN_BLK1add_2003
 -3 2 0 0 -1 99 4 # SizeSel_1P_1_WinterN_BLK1add_2011
 -3 2 0 0 -1 99 4 # Retain_1P_1_WinterN_BLK2add_2003
 -3 2 0 0 -1 99 4 # Retain_1P_1_WinterN_BLK2add_2010
 -3 2 0 0 -1 99 4 # Retain_1P_1_WinterN_BLK2add_2011
 -3 2 0 0 -1 99 4 # Retain_1P_2_WinterN_BLK2add_2003
 -3 2 0 0 -1 99 4 # Retain_1P_2_WinterN_BLK2add_2010
 -3 2 0 0 -1 99 4 # Retain_1P_2_WinterN_BLK2add_2011
 -3 2 0 0 -1 99 4 # Retain_1P_3_WinterN_BLK2add_2003
 -3 2 0 0 -1 99 4 # Retain_1P_3_WinterN_BLK2add_2010
 -3 2 0 0 -1 99 4 # Retain_1P_3_WinterN_BLK2add_2011
 -3 2 0 0 -1 99 4 # SizeSel_2P_1_SummerN_BLK1add_1973
 -3 2 0 0 -1 99 4 # SizeSel_2P_1_SummerN_BLK1add_1983
 -3 2 0 0 -1 99 4 # SizeSel_2P_1_SummerN_BLK1add_1993
 -3 2 0 0 -1 99 4 # SizeSel_2P_1_SummerN_BLK1add_2003
 -3 2 0 0 -1 99 4 # SizeSel_2P_1_SummerN_BLK1add_2011
 -3 2 0 0 -1 99 4 # Retain_2P_1_SummerN_BLK3add_2003
 -3 2 0 0 -1 99 4 # Retain_2P_1_SummerN_BLK3add_2009
 -3 2 0 0 -1 99 4 # Retain_2P_1_SummerN_BLK3add_2011
 -3 2 0 0 -1 99 4 # Retain_2P_2_SummerN_BLK3add_2003
 -3 2 0 0 -1 99 4 # Retain_2P_2_SummerN_BLK3add_2009
 -3 2 0 0 -1 99 4 # Retain_2P_2_SummerN_BLK3add_2011
 -3 2 0 0 -1 99 4 # Retain_2P_3_SummerN_BLK3add_2003
 -3 2 0 0 -1 99 4 # Retain_2P_3_SummerN_BLK3add_2009
 -3 2 0 0 -1 99 4 # Retain_2P_3_SummerN_BLK3add_2011
 -3 2 0 0 -1 99 4 # SizeSel_3P_1_WinterCA_BLK1add_1973
 -3 2 0 0 -1 99 4 # SizeSel_3P_1_WinterCA_BLK1add_1983
 -3 2 0 0 -1 99 4 # SizeSel_3P_1_WinterCA_BLK1add_1993
 -3 2 0 0 -1 99 4 # SizeSel_3P_1_WinterCA_BLK1add_2003
 -3 2 0 0 -1 99 4 # SizeSel_3P_1_WinterCA_BLK1add_2011
```

-3 2 0 0 -1 99 4 # Retain_3P_1_WinterCA_BLK2add_2003
-3 2 0 0 -1 99 4 # Retain_3P_1_WinterCA_BLK2add_2010
-3 2 0 0 -1 99 4 # Retain_3P_1_WinterCA_BLK2add_2011
-3 2 0 0 -1 99 4 # Retain_3P_2_WinterCA_BLK2add_2003
-3 2 0 0 -1 99 4 # Retain_3P_2_WinterCA_BLK2add_2010
-3 2 0 0 -1 99 4 # Retain_3P_2_WinterCA_BLK2add_2011
-3 4 0 0 -1 99 4 # Retain_3P_3_WinterCA_BLK2add_2003
-3 2 0 0 -1 99 4 # Retain_3P_3_WinterCA_BLK2add_2010
-3 2 0 0 -1 99 4 # Retain_3P_3_WinterCA_BLK2add_2011
-3 2 0 0 -1 99 4 # SizeSel_4P_1_SummerCA_BLK1add_1973
-3 2 0 0 -1 99 4 # SizeSel_4P_1_SummerCA_BLK1add_1983
-3 2 0 0 -1 99 4 # SizeSel_4P_1_SummerCA_BLK1add_1993
-3 2 0 0 -1 99 4 # SizeSel_4P_1_SummerCA_BLK1add_2003
-3 2 0 0 -1 99 4 # SizeSel_4P_1_SummerCA_BLK1add_2011
-3 2 0 0 -1 99 4 # Retain_4P_1_SummerCA_BLK3add_2003
-3 2 0 0 -1 99 4 # Retain_4P_1_SummerCA_BLK3add_2009
-3 2 0 0 -1 99 4 # Retain_4P_1_SummerCA_BLK3add_2011
-3 2 0 0 -1 99 4 # Retain_4P_2_SummerCA_BLK3add_2003
-3 2 0 0 -1 99 4 # Retain_4P_2_SummerCA_BLK3add_2009
-3 2 0 0 -1 99 4 # Retain_4P_2_SummerCA_BLK3add_2011
-3 2 0 0 -1 99 4 # Retain_4P_3_SummerCA_BLK3add_2003
-3 2 0 0 -1 99 4 # Retain_4P_3_SummerCA_BLK3add_2009
-3 2 0 0 -1 99 4 # Retain_4P_3_SummerCA_BLK3add_2011

2 #logistic bounding

Tag loss and Tag reporting parameters go next
0 # TG_custom: 0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0 #_placeholder if no parameters

1 #_Variance_adjustments_to_input_values
0 0 0 0 0 0 0 #_add_to_survey_CV
0.02 0.02 0.02 0.02 0 0 0 #_add_to_discard_stddev
0 0 0 0 0 0 0 #_add_to_bodywt_CV

```
2     1.4     1.6     1.2     1.3     1     1     #_mult_by_lencomp_N
7 1.7 1.9 1.4 1 1 0.3    #_mult_by_agecomp_N
1 1 1 1 1 1 1  #_mult_by_size-at-age_N

15 #_maxlambdaphase
1 #_sd_offset

10 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin
#like_comp fleet/survey  phase  value  sizefreq_method
1 1 1 1.0 1  #Winter N CPUE
1 3 1 1.0 1  #Winter S CPUE
5 1 1 0.5 1  #commercial age comps
5 2 1 0.5 1  #commercial age comps
5 3 1 0.5 1  #commercial age comps
5 4 1 0.5 1  #commercial age comps
4 1 1 0.5 1  #commercial lgth comps
4 2 1 0.5 1  #commercial lgth comps
4 3 1 0.5 1  #commercial lgth comps
4 4 1 0.5 1  #commercial lgth comps

0 # (0/1) read specs for more stddev reporting
# 1 1 -1 5 1 5 # selex type, len/age, year, N selex bins, Growth pattern, N growth ages
# -5 16 27 38 46 # vector with selex std bin picks (-1 in first bin to self-generate)
# 1 2 14 26 40 # vector with growth std bin picks (-1 in first bin to self-generate)

999
```

Appendix F. SS starter file

#C 2013 Assessent of Petrale (Haltuch, Ono, Valero)
petrale13.dat
petrale13.ctl
1 # changed from 1 to 0; 0=use init values in control file; 1=use ss3.par
1 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
0 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
0 # 1 is example file; Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of bootstrap datafiles to produce: 1st is input, 2nd is estimates, 3rd and higher are bootstrap
10 # Turn off estimation for parameters entering after this phase
10 # MCMC eval burn interval
2 # MCMC thin interval
0.000 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values
1973 1976
0.001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
3 # min age for calc of summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # 0.25 in example; Fraction (X) for Depletion denominator (e.g. 0.4)
4 # 3 in example; SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
1 # 4 in example; F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates); 4=true F for range of ages
4 20 #_min and max age over which average F will be calculated
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

Appendix G. SS forecast file

```
#C
# for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # Forecast method, MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.25 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
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 (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
1 # F scalar (only used for Do_Forecast==5)
#_Fcast_years:  beg_selex, end_selex, beg_relF, end_relF  (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 -10 0
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.25 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.05 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
0.956 # 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
0 #_Forecast loop control #3 (reserved for future bells&whistles)
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 years with fixed inputs)
0.0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
1 # Do West Coast gfish rebuilder output (0/1)
2011 # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
-1 # 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
# Note that fleet allocation is used directly as average F if Do_Forecast=4
```

2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1 FISHERY2 FISHERY3
max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1 -1 -1 -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)
 0 0 0 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
8 # 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)
Input fixed catch values
#Year Seas Fleet Catch(or_F)
#allocation for each fleet is based on the average 2011-2012 landings for each fleet

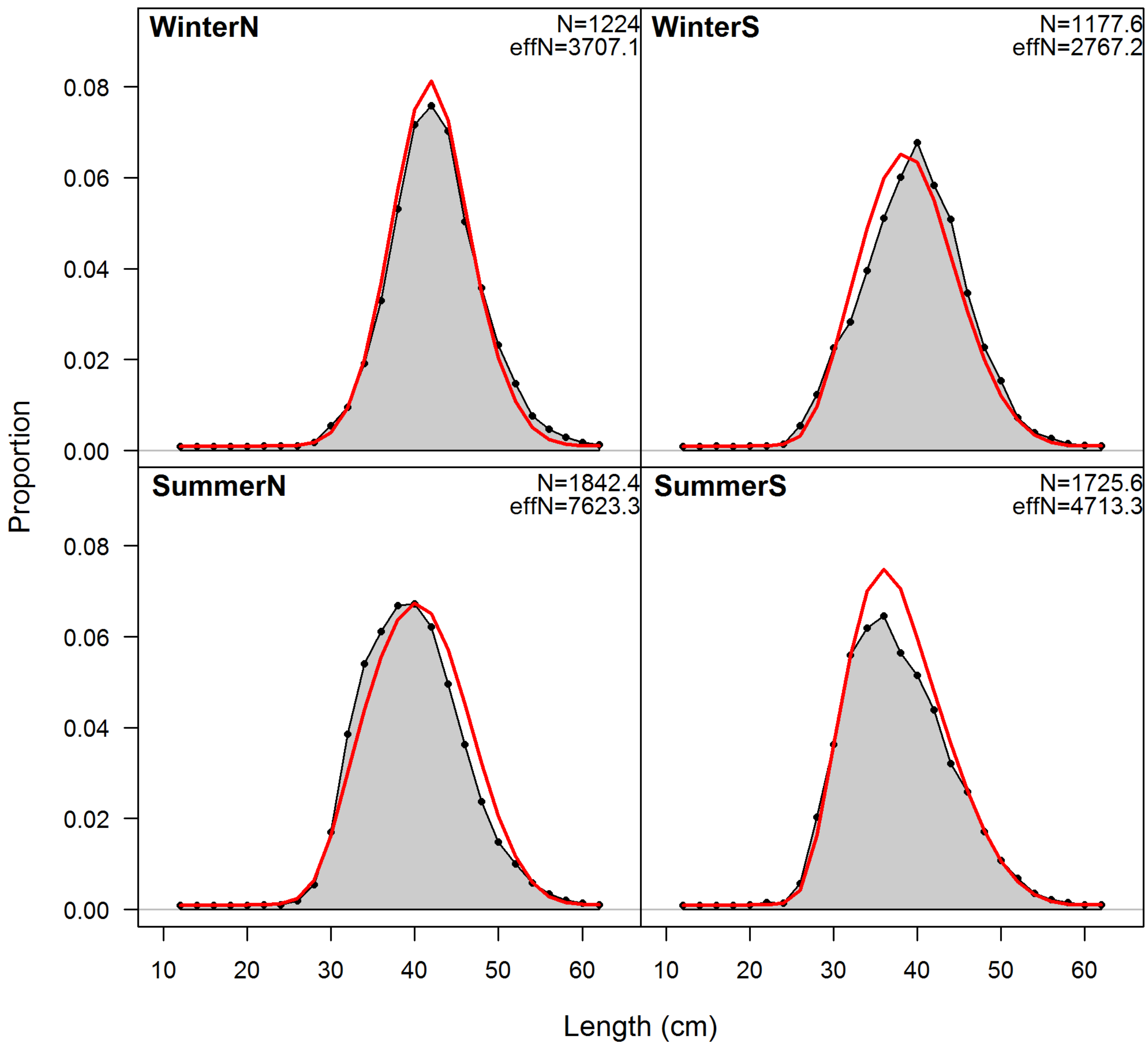
2013	1	1	866.35
2013	1	2	1243.39
2013	1	3	226.43
2013	1	4	255.82
2014	1	1	886.41
2014	1	2	1272.18
2014	1	3	231.67
2014	1	4	261.74

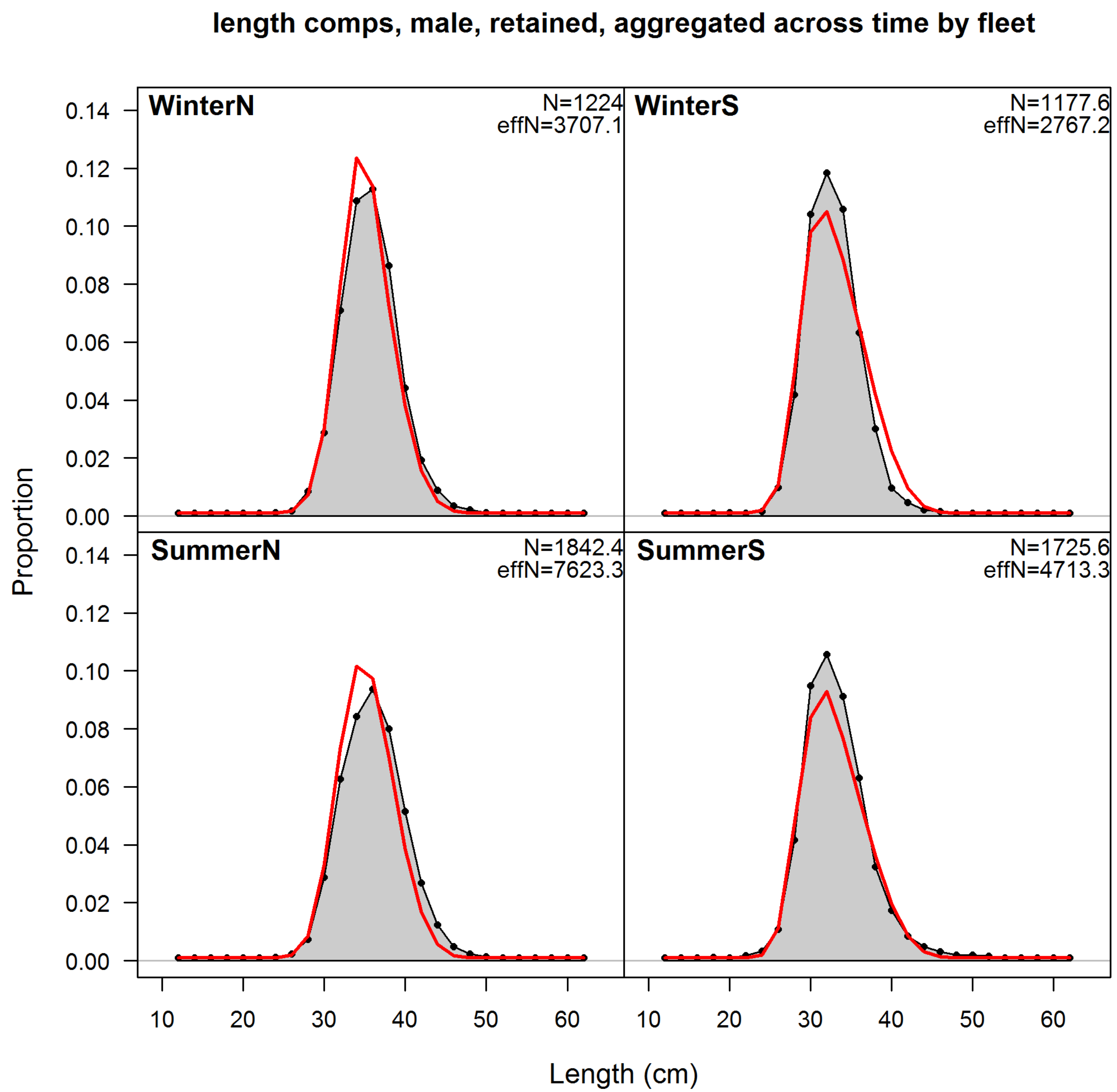
999 # verify end of input

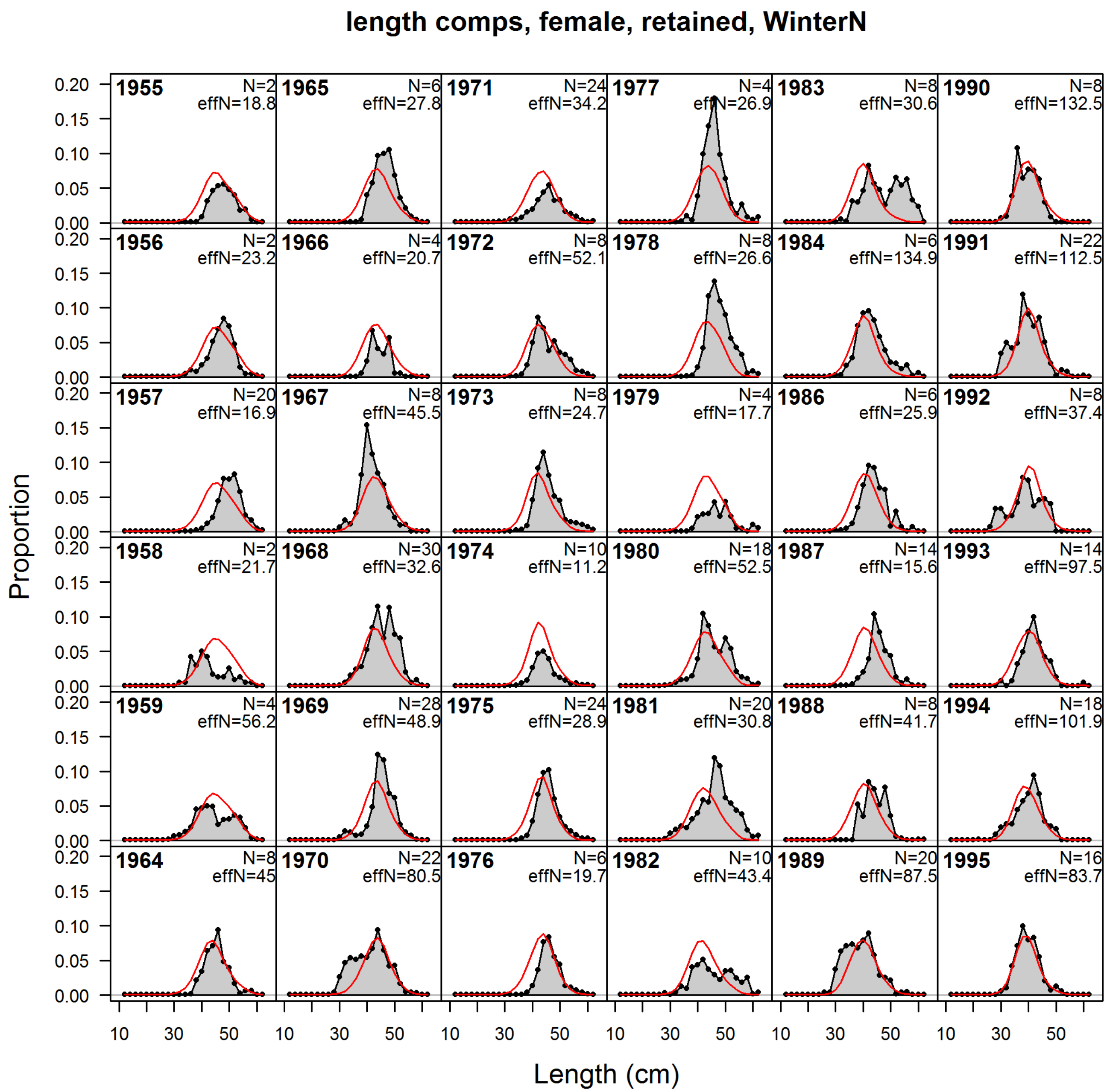
Appendix H. Fishery age and length composition fits

Appendix H.11. Fishery length composition fits

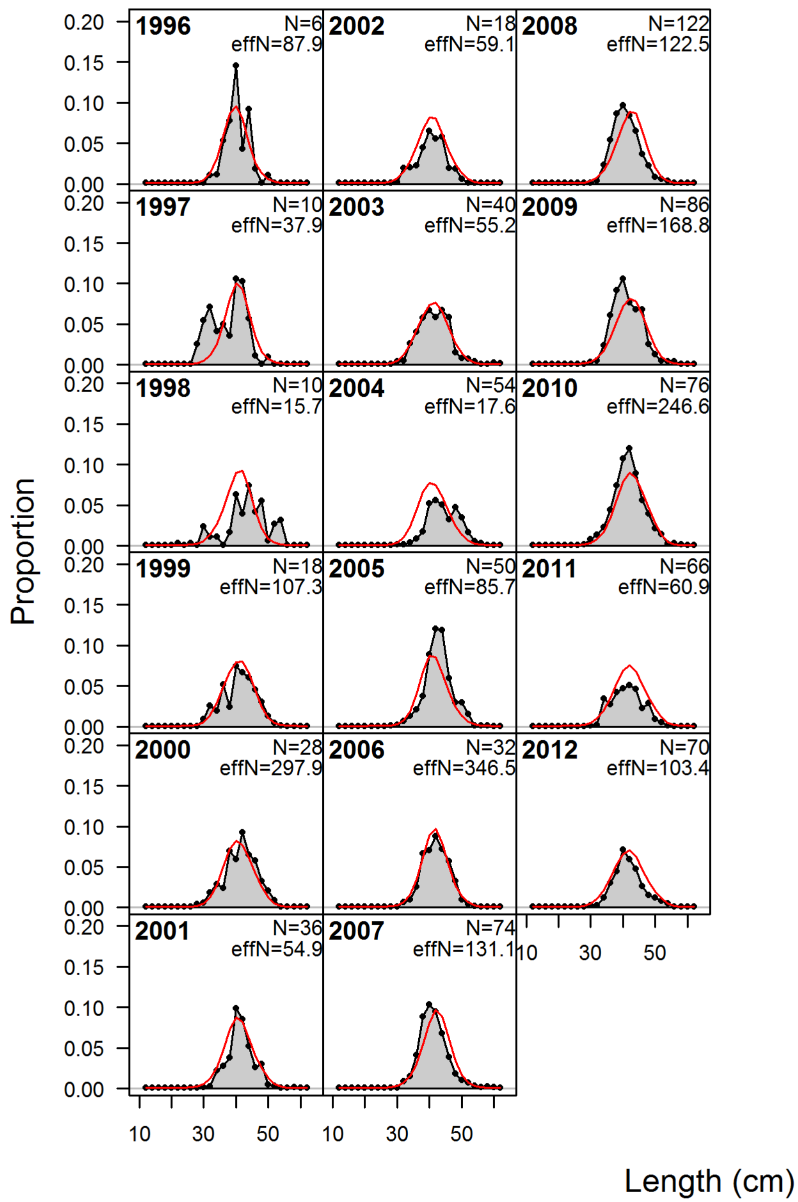
length comps, female, retained, aggregated across time by fleet

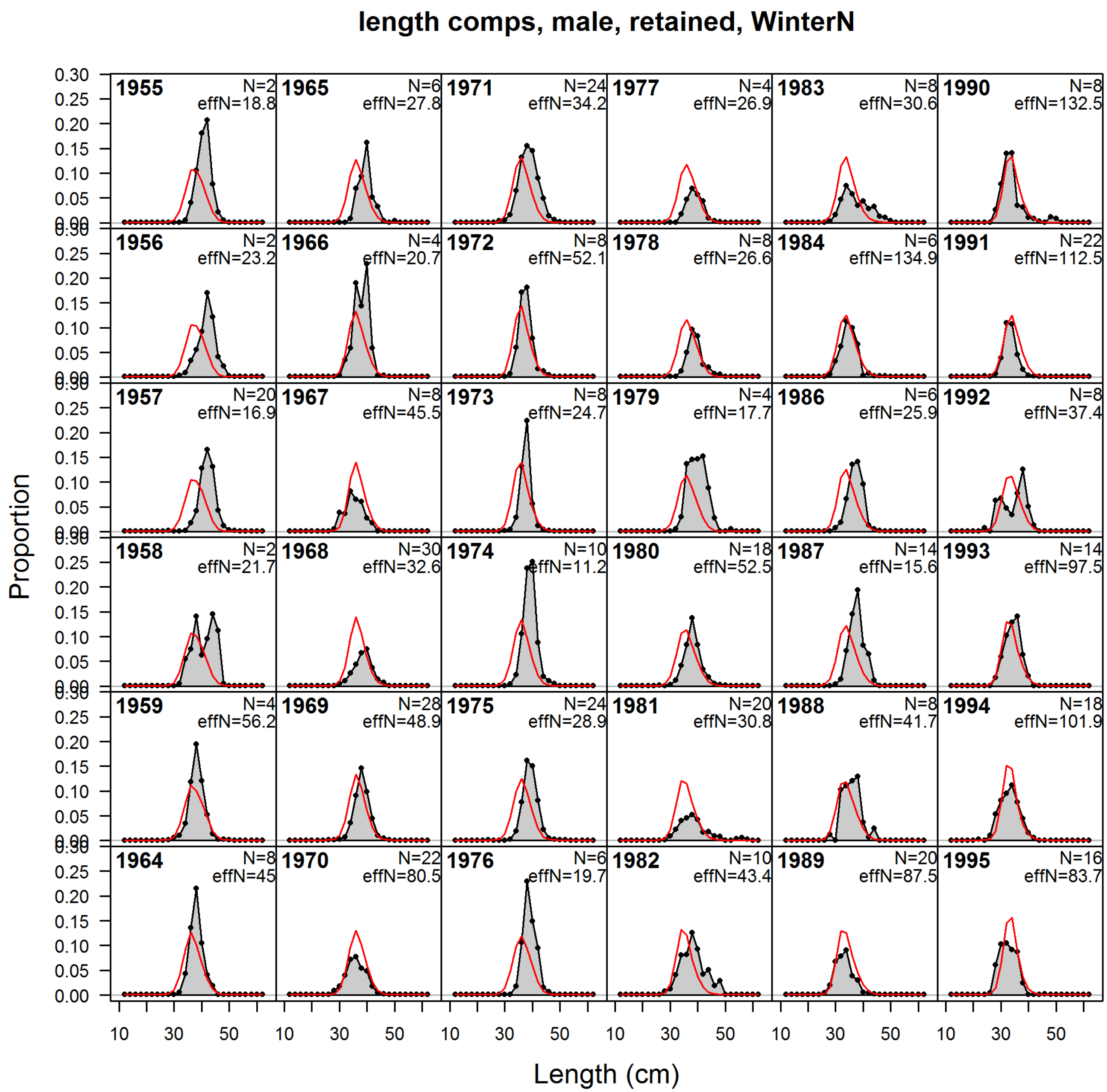


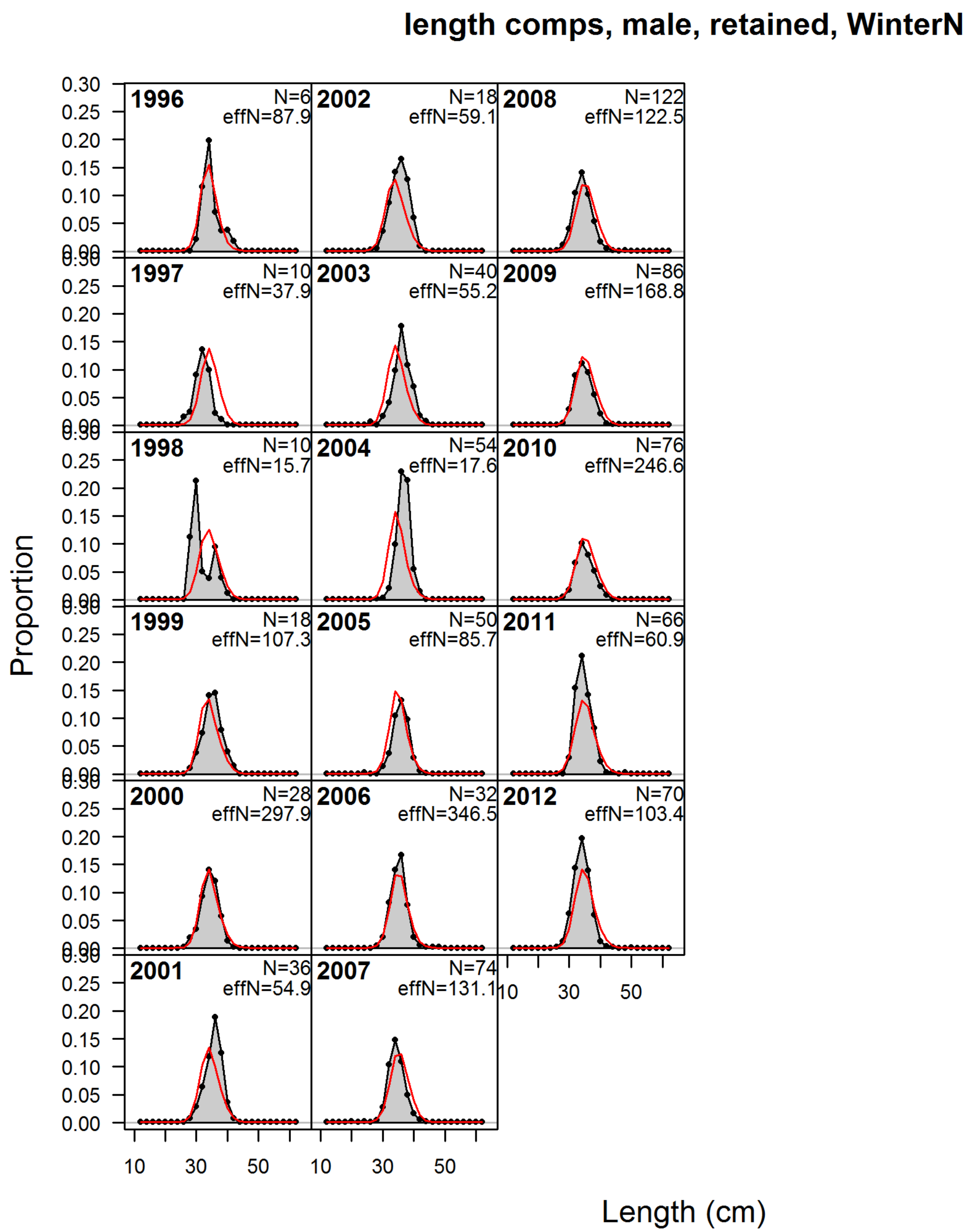

length comps, male, retained, aggregated across time by fleet
WinterN
N=1224
effN=3707.1
WinterS
N=1177.6
effN=2767.2
SummerN
N=1842.4
effN=7623.3
SummerS
N=1725.6
effN=4713.3
Proportion
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
10
20
30
40
50
60
Length (cm)


length comps, female, retained, WinterN
Proportion
Length (cm)
0.00
0.05
0.10
0.15
0.20
10
30
50
1955 N=2 effN=18.8
1956 N=2 effN=23.2
1957 N=20 effN=16.9
1958 N=2 effN=21.7
1959 N=4 effN=56.2
1964 N=8 effN=45
1965 N=6 effN=27.8
1966 N=4 effN=20.7
1967 N=8 effN=45.5
1968 N=30 effN=32.6
1969 N=28 effN=48.9
1970 N=22 effN=80.5
1971 N=24 effN=34.2
1972 N=8 effN=52.1
1973 N=8 effN=24.7
1974 N=10 effN=11.2
1975 N=24 effN=28.9
1976 N=6 effN=19.7
1977 N=4 effN=26.9
1978 N=8 effN=26.6
1979 N=4 effN=17.7
1980 N=18 effN=52.5
1981 N=20 effN=30.8
1982 N=10 effN=43.4
1983 N=8 effN=30.6
1984 N=6 effN=134.9
1986 N=6 effN=25.9
1987 N=14 effN=15.6
1988 N=8 effN=41.7
1989 N=20 effN=87.5
1990 N=8 effN=132.5
1991 N=22 effN=112.5
1992 N=8 effN=37.4
1993 N=14 effN=97.5
1994 N=18 effN=101.9
1995 N=16 effN=83.7

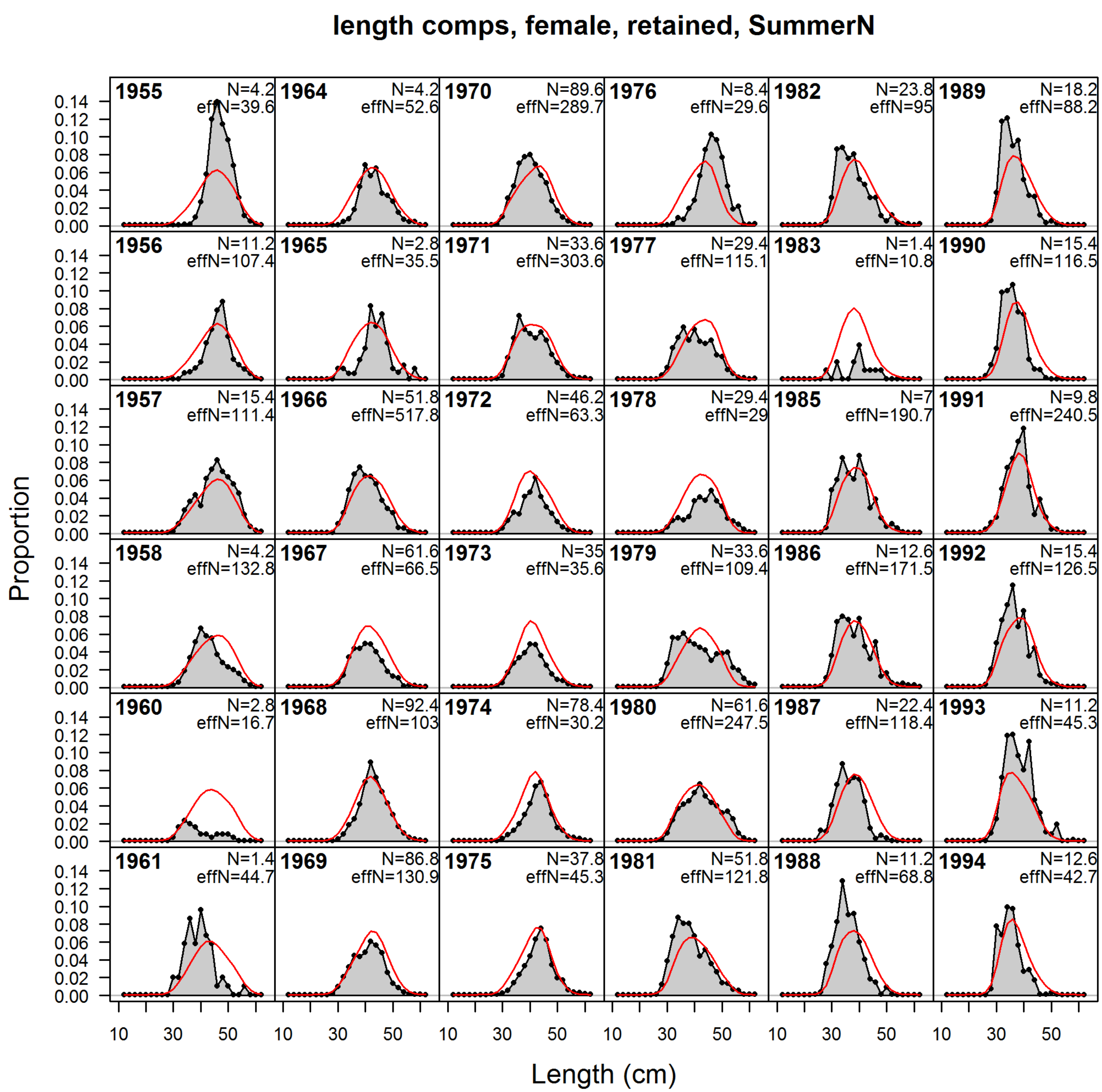
length comps, female, retained, WinterN



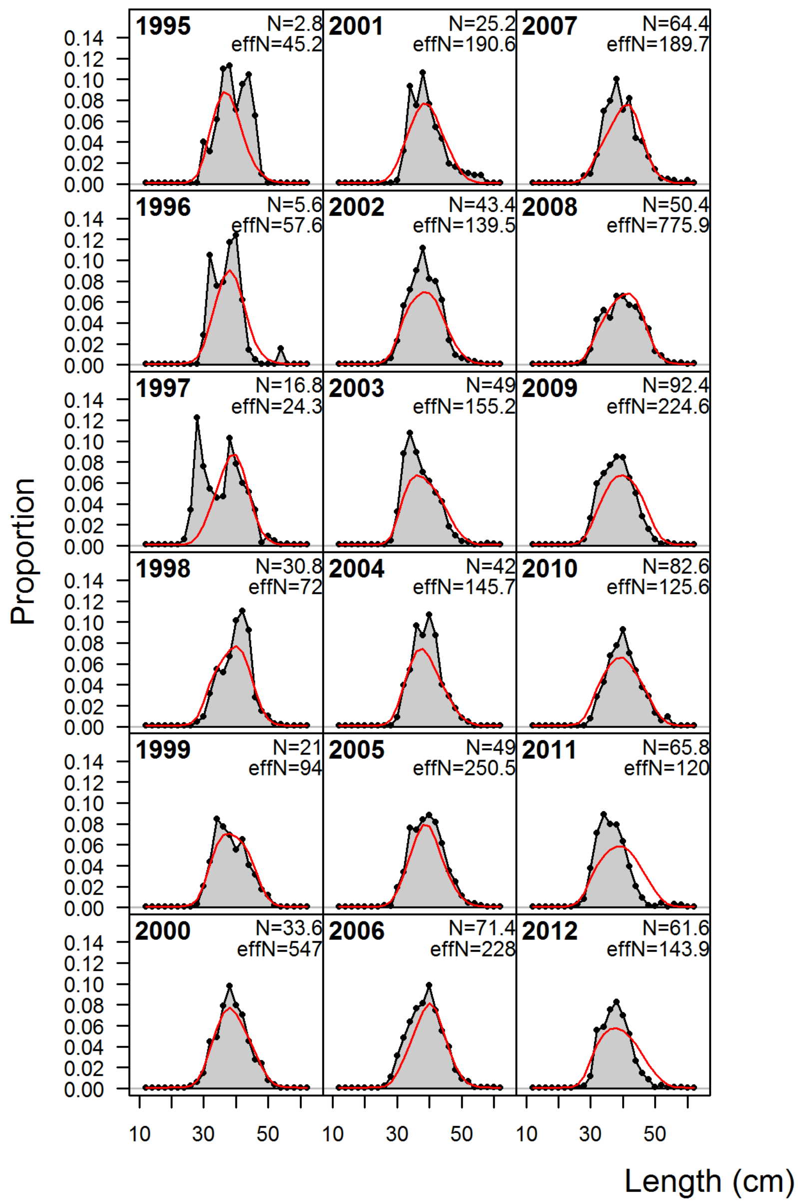

length comps, male, retained, WinterN
Proportion
Length (cm)
1955 N=2 effN=18.8
1965 N=6 effN=27.8
1971 N=24 effN=34.2
1977 N=4 effN=26.9
1983 N=8 effN=30.6
1990 N=8 effN=132.5
1956 N=2 effN=23.2
1966 N=4 effN=20.7
1972 N=8 effN=52.1
1978 N=8 effN=26.6
1984 N=6 effN=134.9
1991 N=22 effN=112.5
1957 N=20 effN=16.9
1967 N=8 effN=45.5
1973 N=8 effN=24.7
1979 N=4 effN=17.7
1986 N=6 effN=25.9
1992 N=8 effN=37.4
1958 N=2 effN=21.7
1968 N=30 effN=32.6
1974 N=10 effN=11.2
1980 N=18 effN=52.5
1987 N=14 effN=15.6
1993 N=14 effN=97.5
1959 N=4 effN=56.2
1969 N=28 effN=48.9
1975 N=24 effN=28.9
1981 N=20 effN=30.8
1988 N=8 effN=41.7
1994 N=18 effN=101.9
1964 N=8 effN=45
1970 N=22 effN=80.5
1976 N=6 effN=19.7
1982 N=10 effN=43.4
1989 N=20 effN=87.5
1995 N=16 effN=83.7

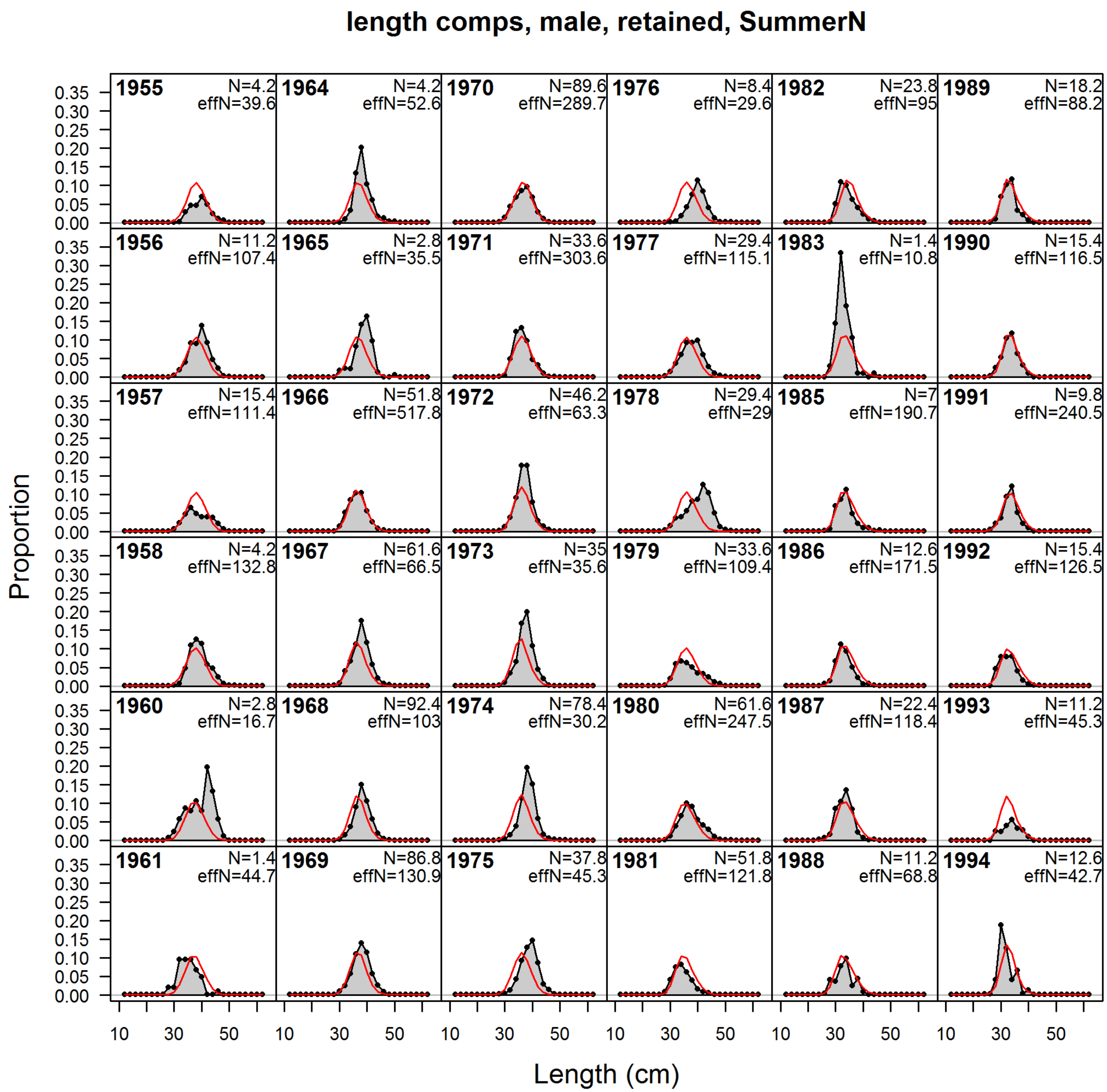


length comps, male, retained, WinterN
Proportion
Length (cm)
1996 N=6 effN=87.9
2002 N=18 effN=59.1
2008 N=122 effN=122.5
1997 N=10 effN=37.9
2003 N=40 effN=55.2
2009 N=86 effN=168.8
1998 N=10 effN=15.7
2004 N=54 effN=17.6
2010 N=76 effN=246.6
1999 N=18 effN=107.3
2005 N=50 effN=85.7
2011 N=66 effN=60.9
2000 N=28 effN=297.9
2006 N=32 effN=346.5
2012 N=70 effN=103.4
2001 N=36 effN=54.9
2007 N=74 effN=131.1

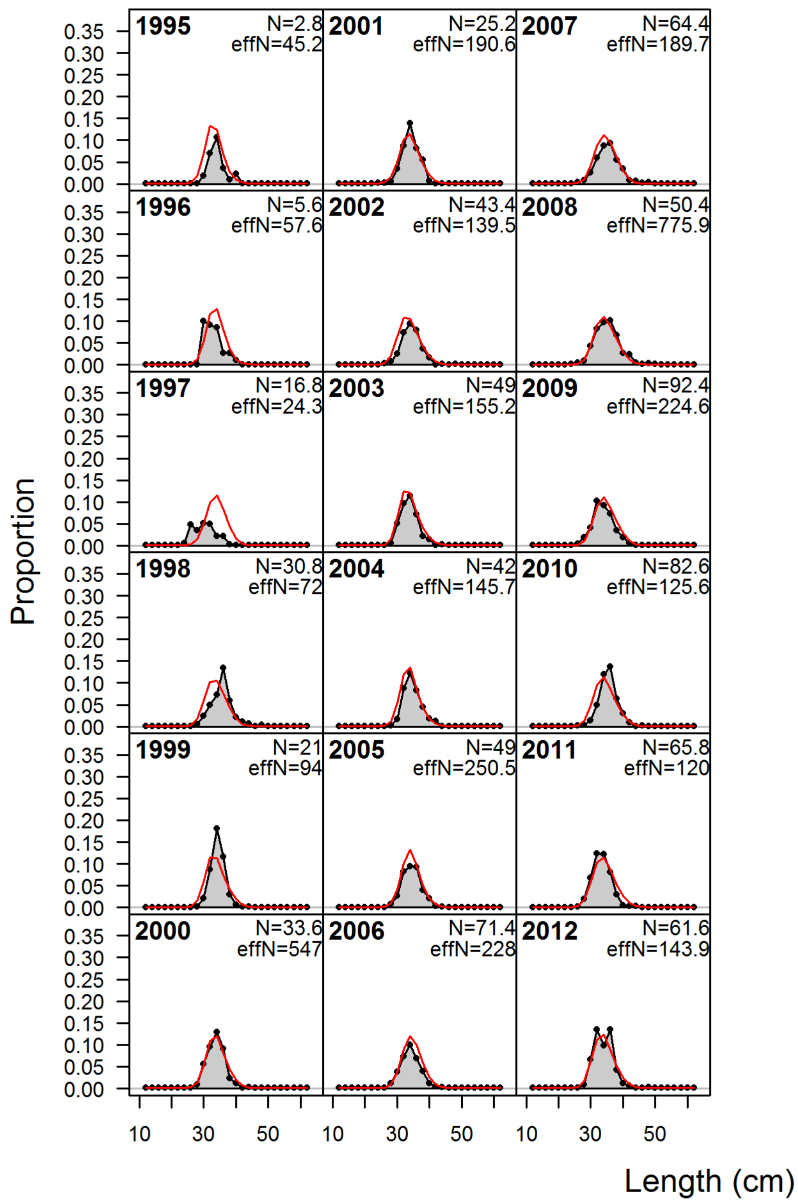

length comps, female, retained, SummerN
Proportion
Length (cm)
1955 N=4.2 effN=39.6
1956 N=11.2 effN=107.4
1957 N=15.4 effN=111.4
1958 N=4.2 effN=132.8
1960 N=2.8 effN=16.7
1961 N=1.4 effN=44.7
1964 N=4.2 effN=52.6
1965 N=2.8 effN=35.5
1966 N=51.8 effN=517.8
1967 N=61.6 effN=66.5
1968 N=92.4 effN=103
1969 N=86.8 effN=130.9
1970 N=89.6 effN=289.7
1971 N=33.6 effN=303.6
1972 N=46.2 effN=63.3
1973 N=35 effN=35.6
1974 N=78.4 effN=30.2
1975 N=37.8 effN=45.3
1976 N=8.4 effN=29.6
1977 N=29.4 effN=115.1
1978 N=29.4 effN=29
1979 N=33.6 effN=109.4
1980 N=61.6 effN=247.5
1981 N=51.8 effN=121.8
1982 N=23.8 effN=95
1983 N=1.4 effN=10.8
1985 N=7 effN=190.7
1986 N=12.6 effN=171.5
1987 N=22.4 effN=118.4
1988 N=11.2 effN=68.8
1989 N=18.2 effN=88.2
1990 N=15.4 effN=116.5
1991 N=9.8 effN=240.5
1992 N=15.4 effN=126.5
1993 N=11.2 effN=45.3
1994 N=12.6 effN=42.7

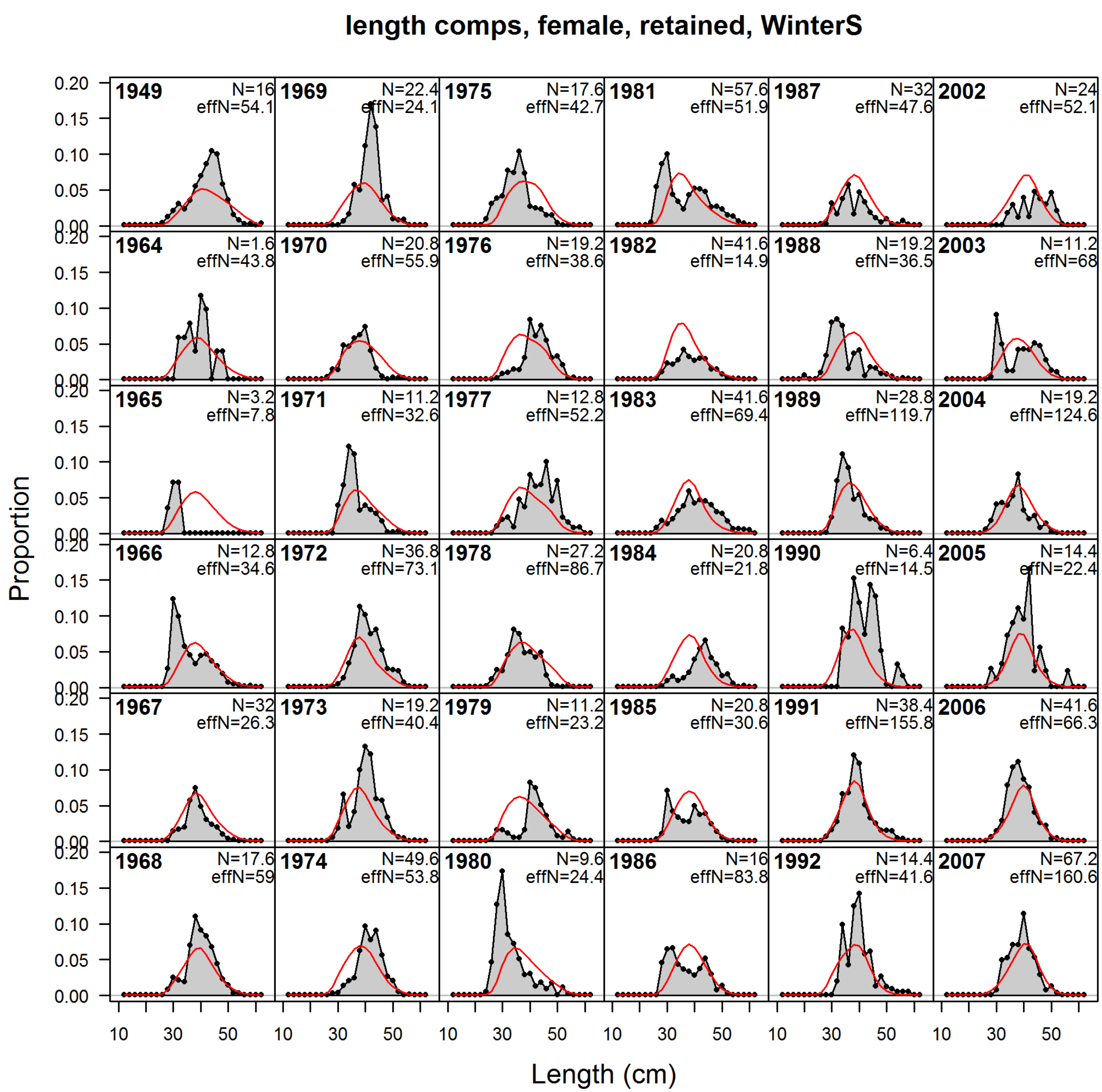
length comps, female, retained, SummerN

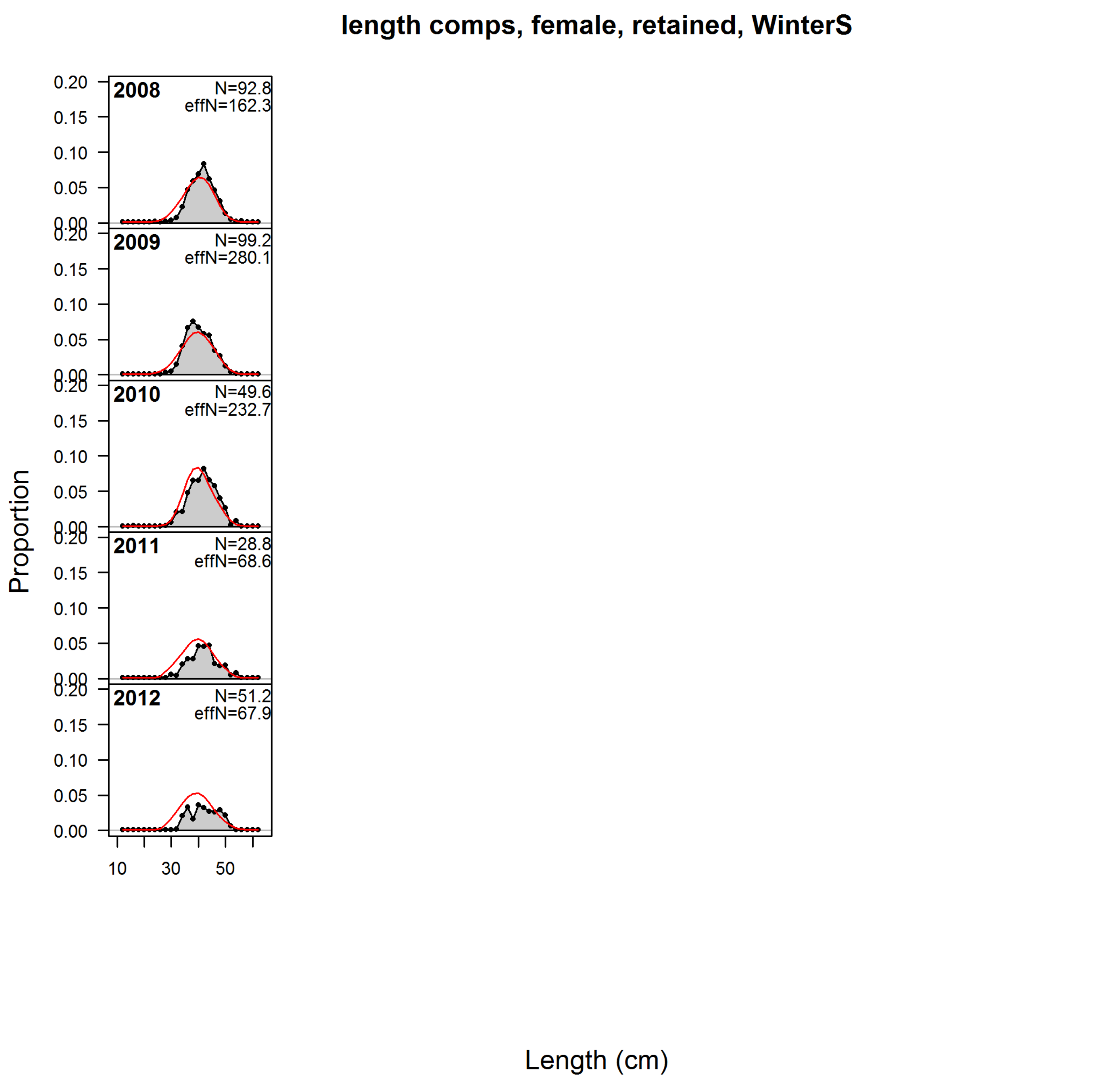



length comps, male, retained, SummerN
1955 N=4.2 effN=39.6
1964 N=4.2 effN=52.6
1970 N=89.6 effN=289.7
1976 N=8.4 effN=29.6
1982 N=23.8 effN=95
1989 N=18.2 effN=88.2
1956 N=11.2 effN=107.4
1965 N=2.8 effN=35.5
1971 N=33.6 effN=303.6
1977 N=29.4 effN=115.1
1983 N=1.4 effN=10.8
1990 N=15.4 effN=116.5
1957 N=15.4 effN=111.4
1966 N=51.8 effN=517.8
1972 N=46.2 effN=63.3
1978 N=29.4 effN=29
1985 N=7 effN=190.7
1991 N=9.8 effN=240.5
1958 N=4.2 effN=132.8
1967 N=61.6 effN=66.5
1973 N=35 effN=35.6
1979 N=33.6 effN=109.4
1986 N=12.6 effN=171.5
1992 N=15.4 effN=126.5
1960 N=2.8 effN=16.7
1968 N=92.4 effN=103
1974 N=78.4 effN=30.2
1980 N=61.6 effN=247.5
1987 N=22.4 effN=118.4
1993 N=11.2 effN=45.3
1961 N=1.4 effN=44.7
1969 N=86.8 effN=130.9
1975 N=37.8 effN=45.3
1981 N=51.8 effN=121.8
1988 N=11.2 effN=68.8
1994 N=12.6 effN=42.7
Proportion
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35
Length (cm)
10 30 50

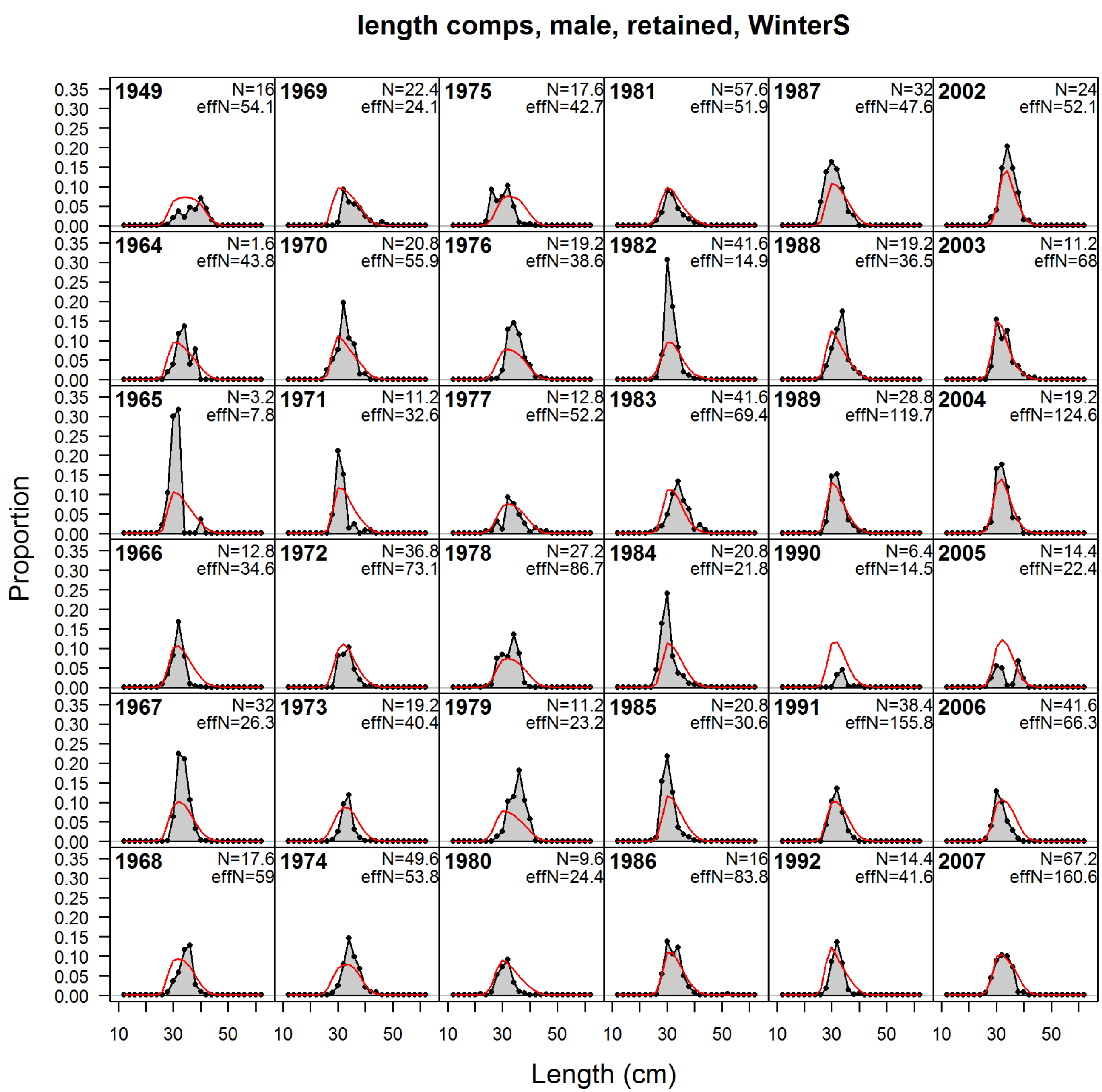
length comps, male, retained, SummerN




length comps, female, retained, WinterS
Proportion
Length (cm)
1949 N=16 effN=54.1
1969 N=22.4 effN=24.1
1975 N=17.6 effN=42.7
1981 N=57.6 effN=51.9
1987 N=32 effN=47.6
2002 N=24 effN=52.1
1964 N=1.6 effN=43.8
1970 N=20.8 effN=55.9
1976 N=19.2 effN=38.6
1982 N=41.6 effN=14.9
1988 N=19.2 effN=36.5
2003 N=11.2 effN=68
1965 N=3.2 effN=7.8
1971 N=11.2 effN=32.6
1977 N=12.8 effN=52.2
1983 N=41.6 effN=69.4
1989 N=28.8 effN=119.7
2004 N=19.2 effN=124.6
1966 N=12.8 effN=34.6
1972 N=36.8 effN=73.1
1978 N=27.2 effN=86.7
1984 N=20.8 effN=21.8
1990 N=6.4 effN=14.5
2005 N=14.4 effN=22.4
1967 N=32 effN=26.3
1973 N=19.2 effN=40.4
1979 N=11.2 effN=23.2
1985 N=20.8 effN=30.6
1991 N=38.4 effN=155.8
2006 N=41.6 effN=66.3
1968 N=17.6 effN=59
1974 N=49.6 effN=53.8
1980 N=9.6 effN=24.4
1986 N=16 effN=83.8
1992 N=14.4 effN=41.6
2007 N=67.2 effN=160.6

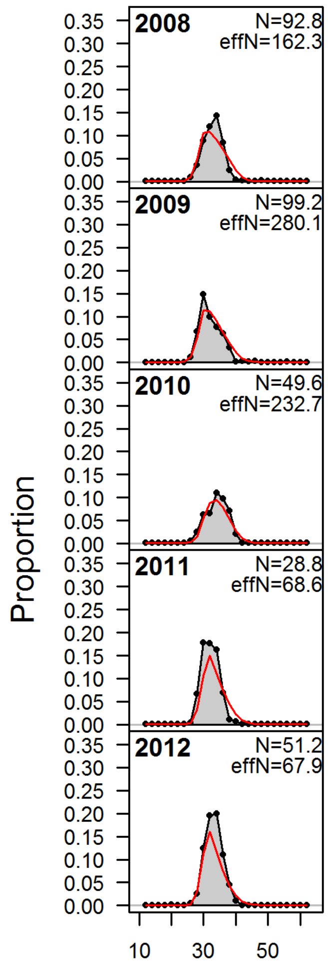


length comps, female, retained, WinterS
2008
N=92.8
effN=162.3
2009
N=99.2
effN=280.1
2010
N=49.6
effN=232.7
2011
N=28.8
effN=68.6
2012
N=51.2
effN=67.9
Proportion
Length (cm)

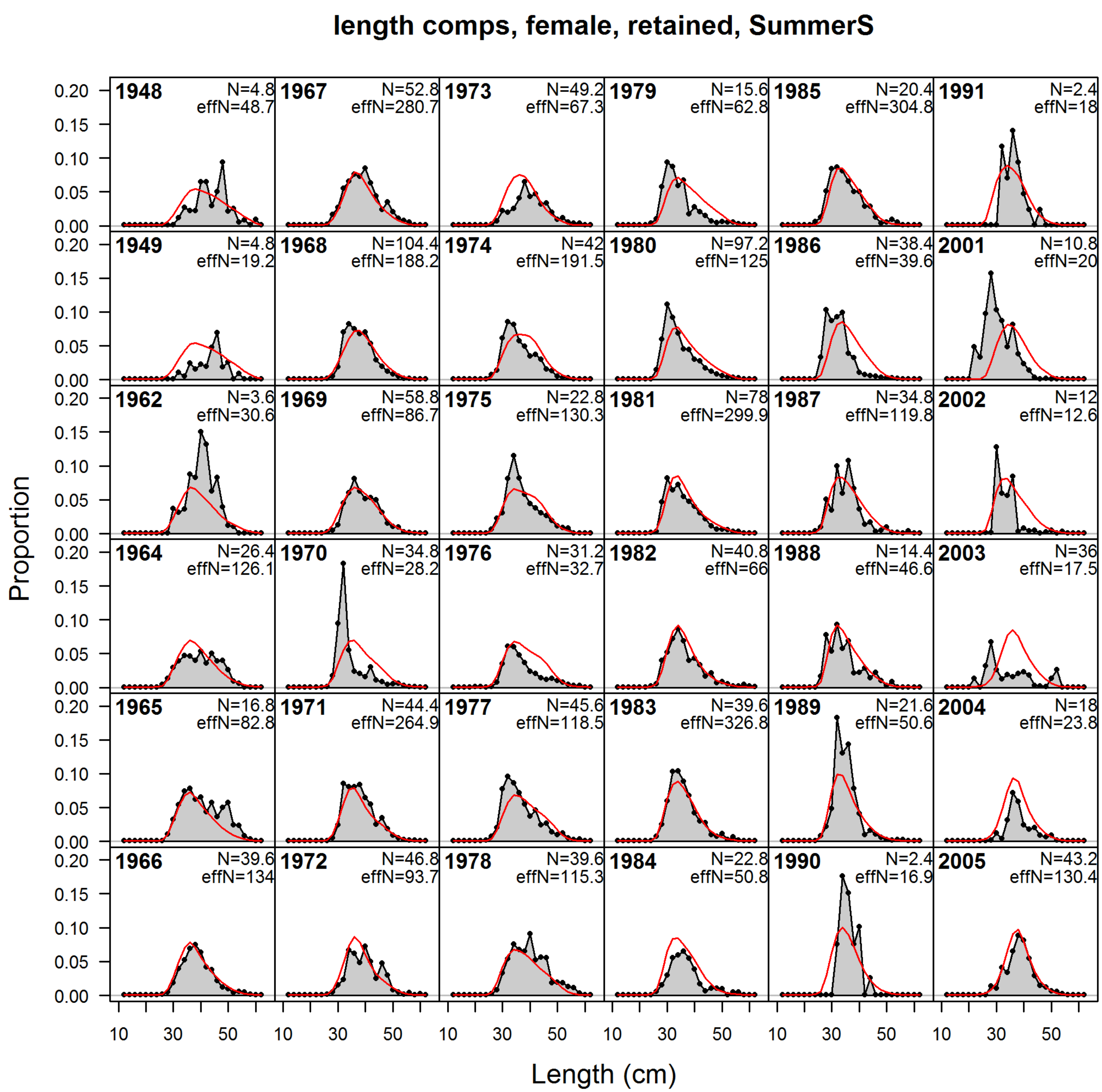


length comps, male, retained, WinterS
Proportion
Length (cm)
1949 N=16 effN=54.1
1969 N=22.4 effN=24.1
1975 N=17.6 effN=42.7
1981 N=57.6 effN=51.9
1987 N=32 effN=47.6
2002 N=24 effN=52.1
1964 N=1.6 effN=43.8
1970 N=20.8 effN=55.9
1976 N=19.2 effN=38.6
1982 N=41.6 effN=14.9
1988 N=19.2 effN=36.5
2003 N=11.2 effN=68
1965 N=3.2 effN=7.8
1971 N=11.2 effN=32.6
1977 N=12.8 effN=52.2
1983 N=41.6 effN=69.4
1989 N=28.8 effN=119.7
2004 N=19.2 effN=124.6
1966 N=12.8 effN=34.6
1972 N=36.8 effN=73.1
1978 N=27.2 effN=86.7
1984 N=20.8 effN=21.8
1990 N=6.4 effN=14.5
2005 N=14.4 effN=22.4
1967 N=32 effN=26.3
1973 N=19.2 effN=40.4
1979 N=11.2 effN=23.2
1985 N=20.8 effN=30.6
1991 N=38.4 effN=155.8
2006 N=41.6 effN=66.3
1968 N=17.6 effN=59
1974 N=49.6 effN=53.8
1980 N=9.6 effN=24.4
1986 N=16 effN=83.8
1992 N=14.4 effN=41.6
2007 N=67.2 effN=160.6

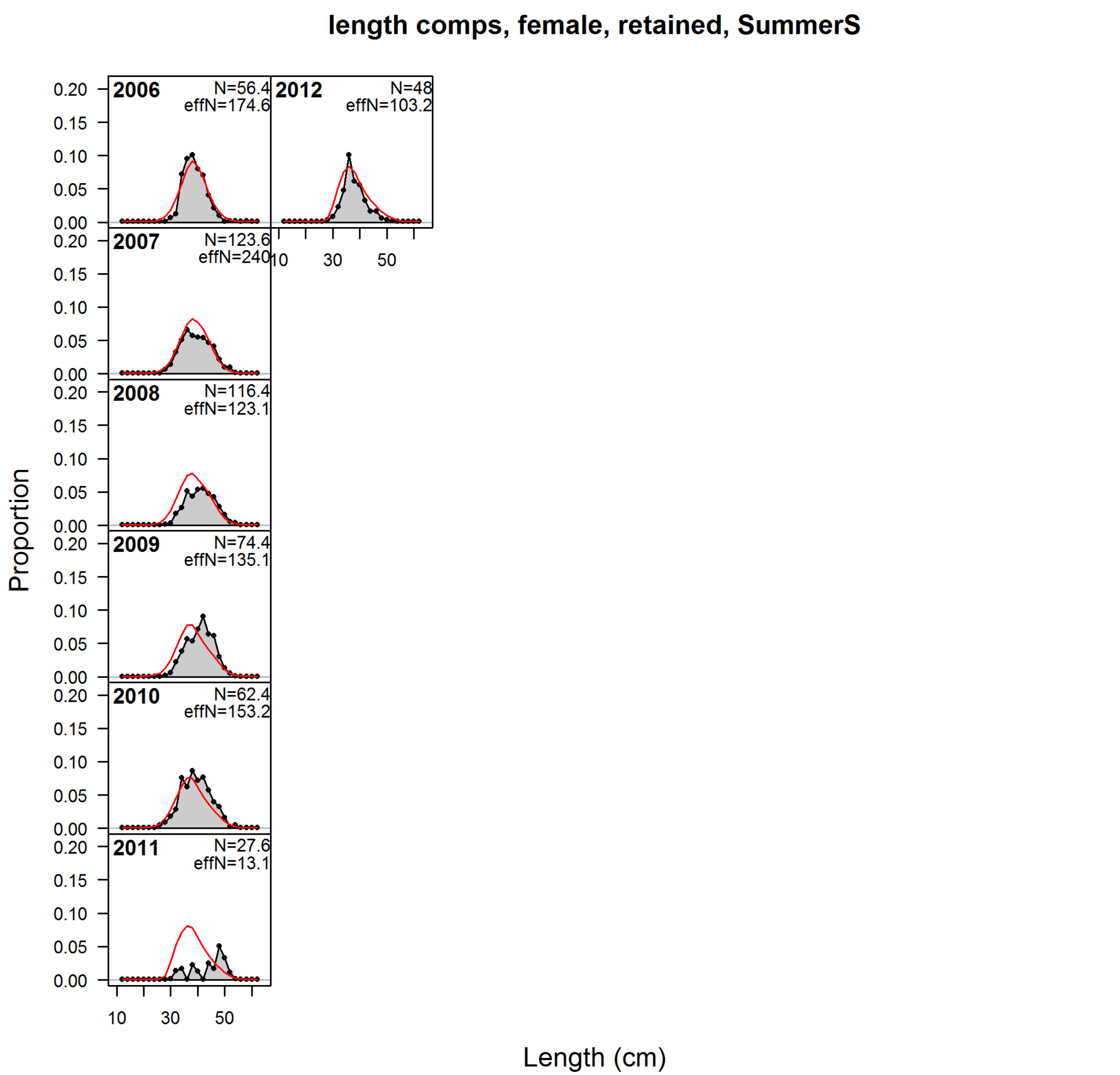
length comps, male, retained, WinterS



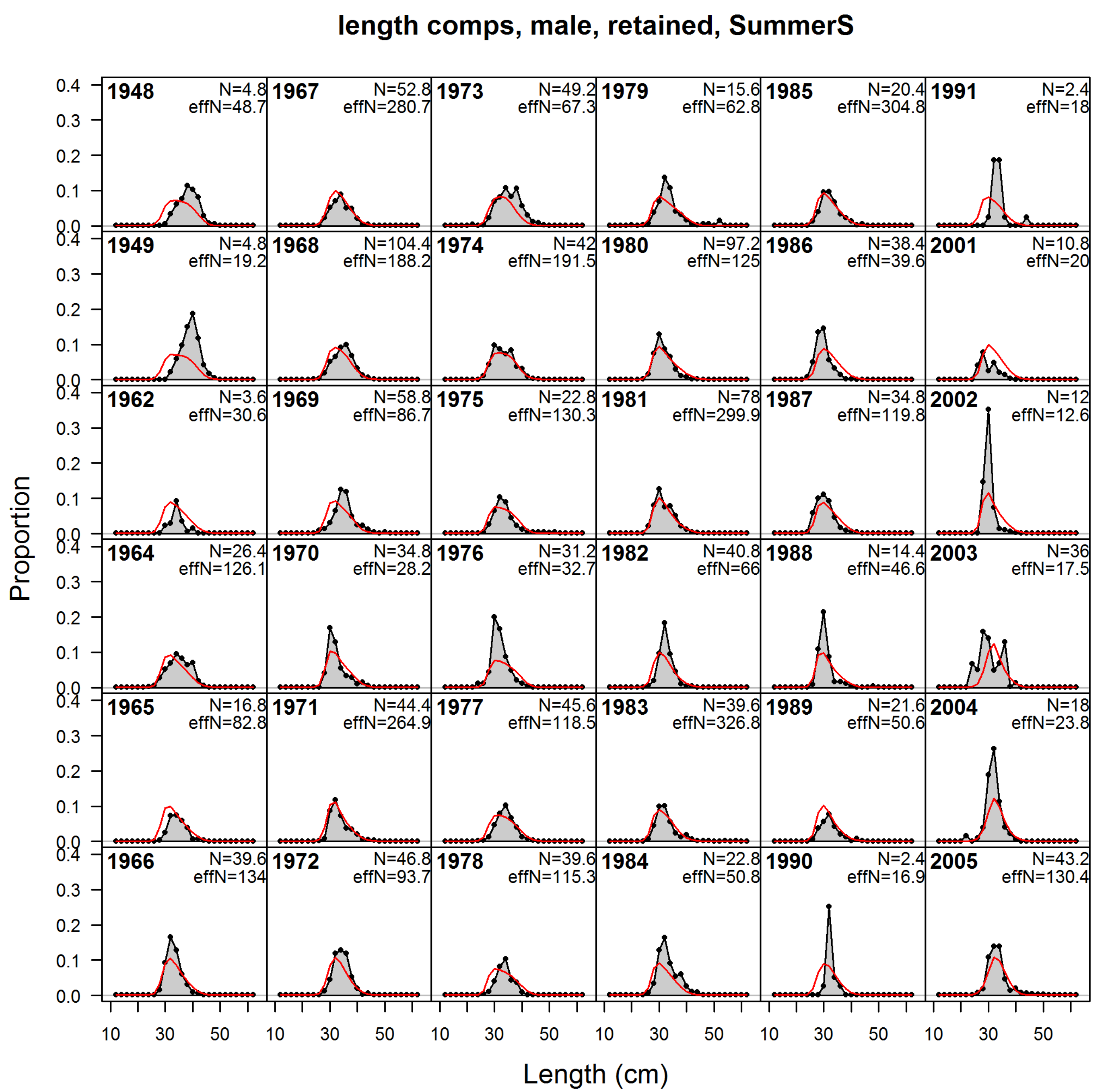
Length (cm)

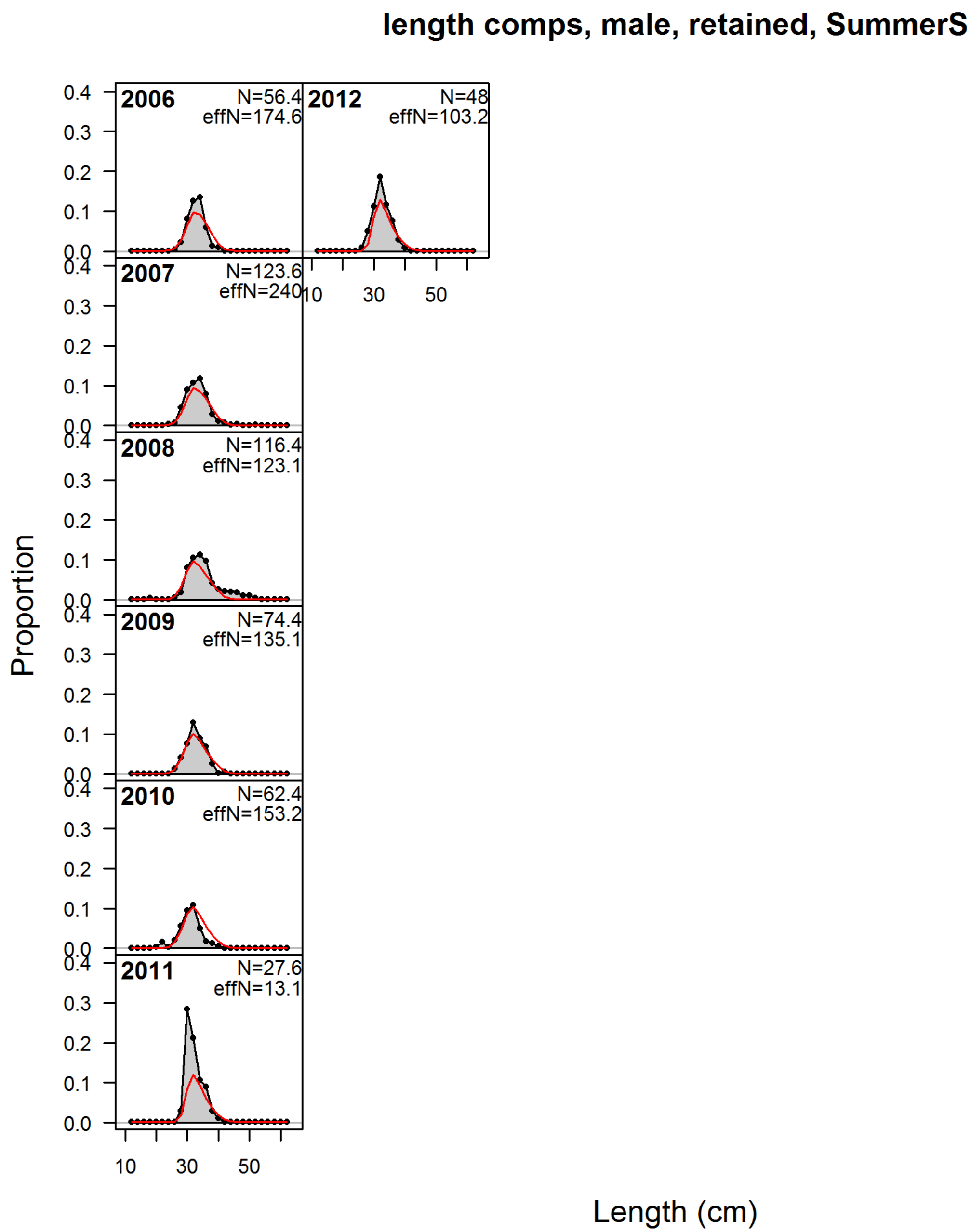


length comps, female, retained, SummerS
1948 N=4.8 effN=48.7
1967 N=52.8 effN=280.7
1973 N=49.2 effN=67.3
1979 N=15.6 effN=62.8
1985 N=20.4 effN=304.8
1991 N=2.4 effN=18
1949 N=4.8 effN=19.2
1968 N=104.4 effN=188.2
1974 N=42 effN=191.5
1980 N=97.2 effN=125
1986 N=38.4 effN=39.6
2001 N=10.8 effN=20
1962 N=3.6 effN=30.6
1969 N=58.8 effN=86.7
1975 N=22.8 effN=130.3
1981 N=78 effN=299.9
1987 N=34.8 effN=119.8
2002 N=12 effN=12.6
1964 N=26.4 effN=126.1
1970 N=34.8 effN=28.2
1976 N=31.2 effN=32.7
1982 N=40.8 effN=66
1988 N=14.4 effN=46.6
2003 N=36 effN=17.5
1965 N=16.8 effN=82.8
1971 N=44.4 effN=264.9
1977 N=45.6 effN=118.5
1983 N=39.6 effN=326.8
1989 N=21.6 effN=50.6
2004 N=18 effN=23.8
1966 N=39.6 effN=134
1972 N=46.8 effN=93.7
1978 N=39.6 effN=115.3
1984 N=22.8 effN=50.8
1990 N=2.4 effN=16.9
2005 N=43.2 effN=130.4
Proportion
0.00
0.05
0.10
0.15
0.20
Length (cm)
10
30
50

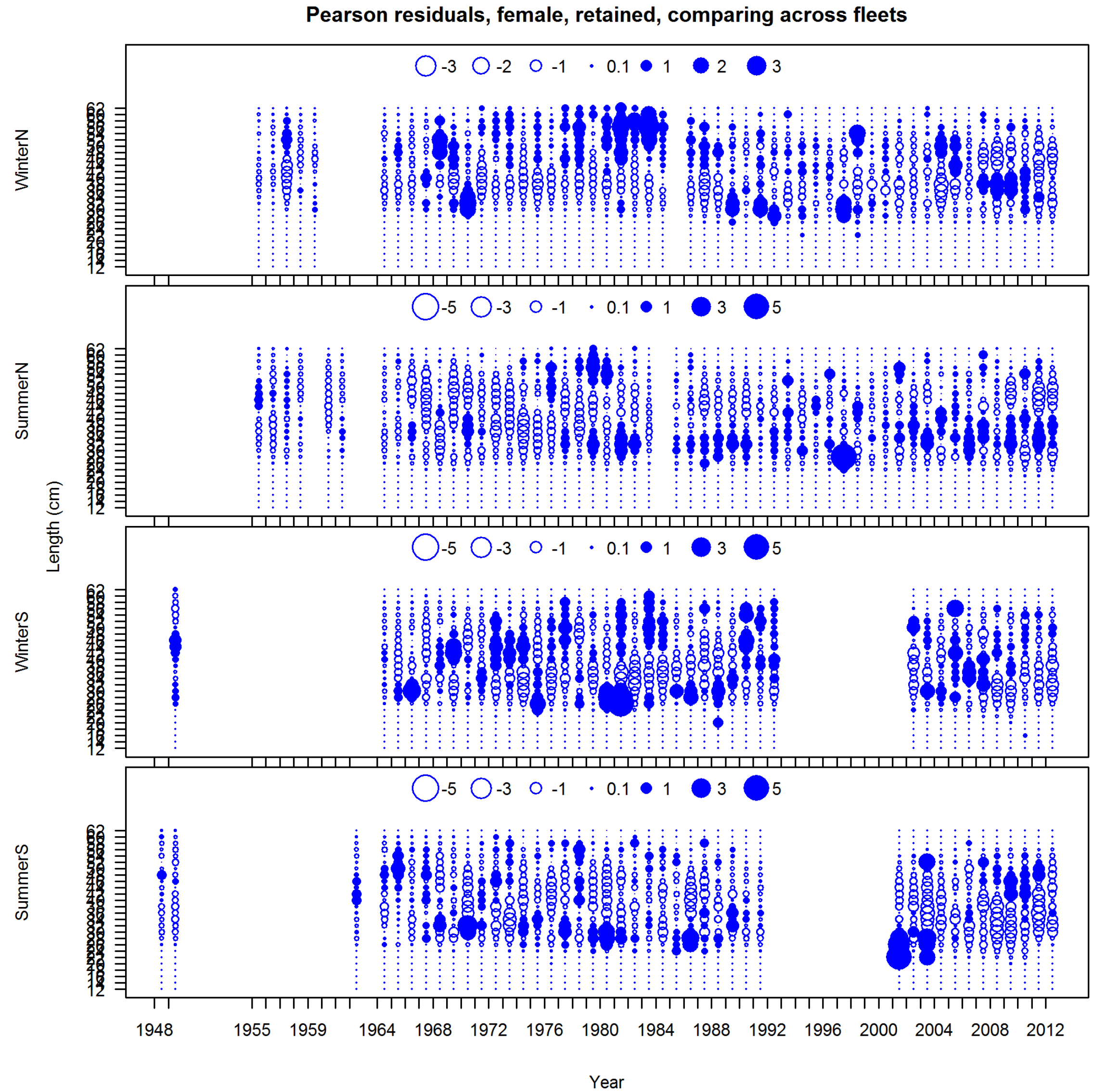


length comps, female, retained, SummerS
2006
N=56.4
effN=174.6
2012
N=48
effN=103.2
2007
N=123.6
effN=240
2008
N=116.4
effN=123.1
2009
N=74.4
effN=135.1
2010
N=62.4
effN=153.2
2011
N=27.6
effN=13.1
Proportion
Length (cm)

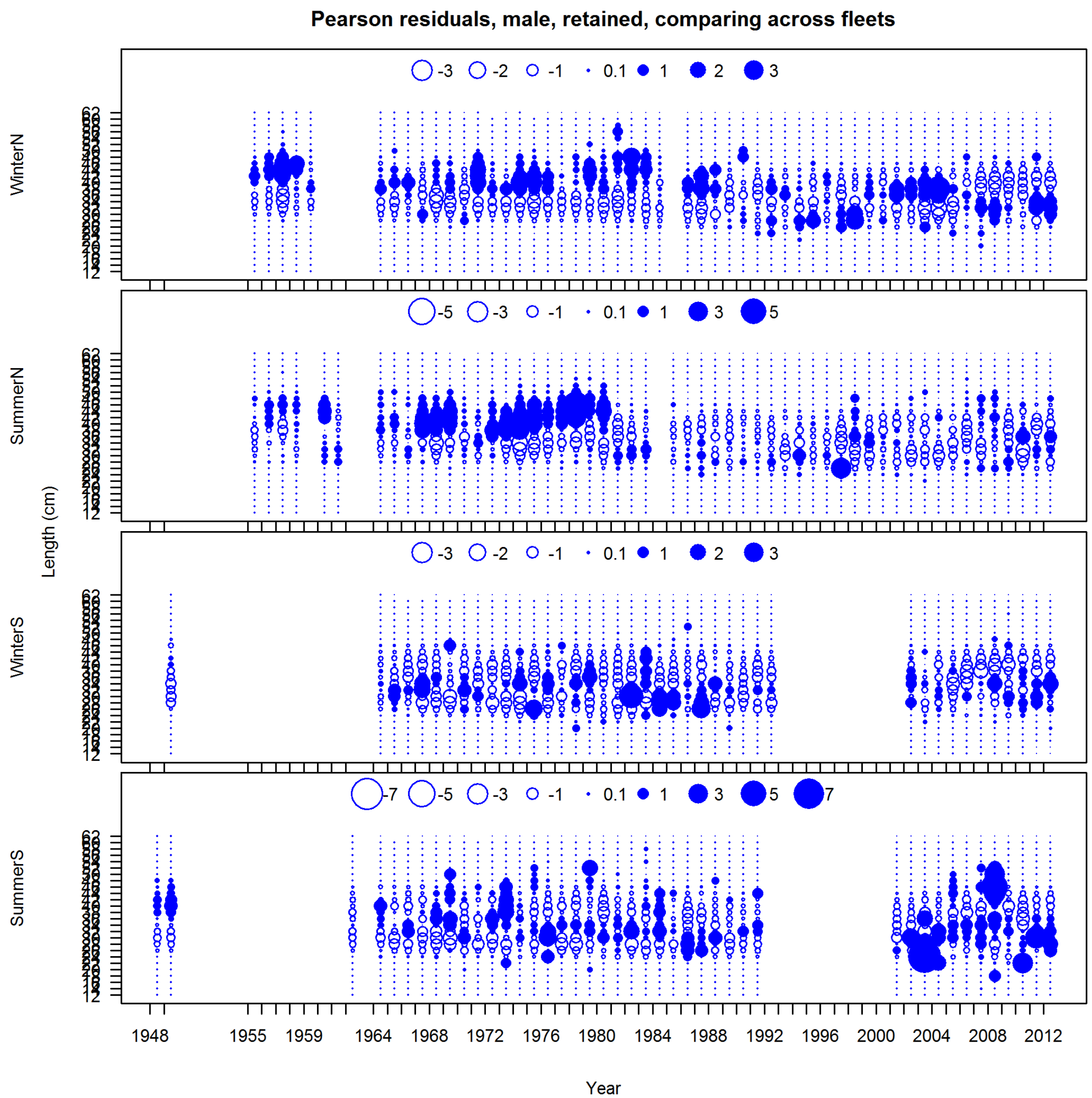

length comps, male, retained, SummerS
Proportion
Length (cm)
1948 N=4.8 effN=48.7
1967 N=52.8 effN=280.7
1973 N=49.2 effN=67.3
1979 N=15.6 effN=62.8
1985 N=20.4 effN=304.8
1991 N=2.4 effN=18
1949 N=4.8 effN=19.2
1968 N=104.4 effN=188.2
1974 N=42 effN=191.5
1980 N=97.2 effN=125
1986 N=38.4 effN=39.6
2001 N=10.8 effN=20
1962 N=3.6 effN=30.6
1969 N=58.8 effN=86.7
1975 N=22.8 effN=130.3
1981 N=78 effN=299.9
1987 N=34.8 effN=119.8
2002 N=12 effN=12.6
1964 N=26.4 effN=126.1
1970 N=34.8 effN=28.2
1976 N=31.2 effN=32.7
1982 N=40.8 effN=66
1988 N=14.4 effN=46.6
2003 N=36 effN=17.5
1965 N=16.8 effN=82.8
1971 N=44.4 effN=264.9
1977 N=45.6 effN=118.5
1983 N=39.6 effN=326.8
1989 N=21.6 effN=50.6
2004 N=18 effN=23.8
1966 N=39.6 effN=134
1972 N=46.8 effN=93.7
1978 N=39.6 effN=115.3
1984 N=22.8 effN=50.8
1990 N=2.4 effN=16.9
2005 N=43.2 effN=130.4

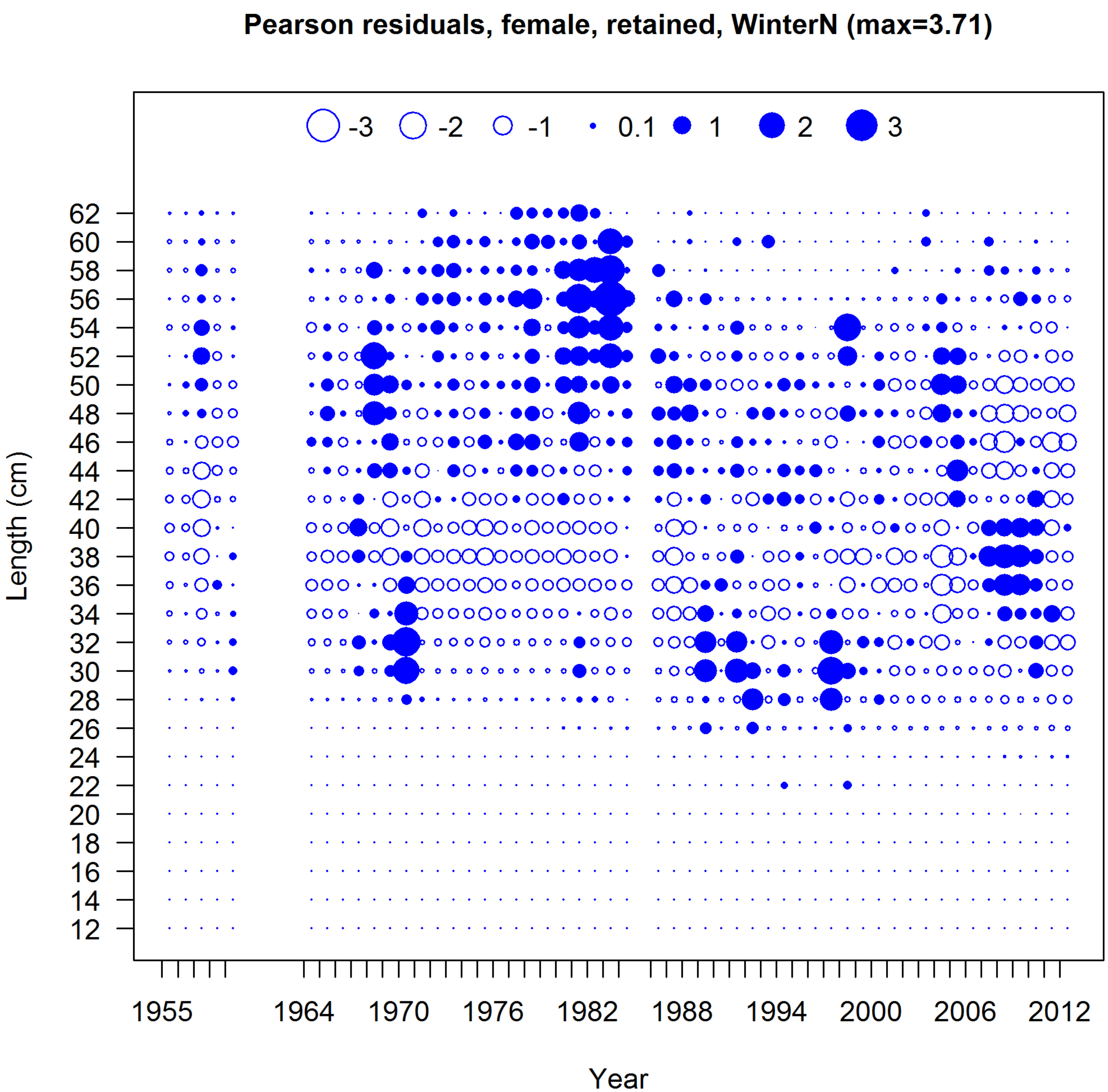

length comps, male, retained, SummerS
2006
N=56.4
effN=174.6
2012
N=48
effN=103.2
2007
N=123.6
effN=240
2008
N=116.4
effN=123.1
2009
N=74.4
effN=135.1
2010
N=62.4
effN=153.2
2011
N=27.6
effN=13.1
Proportion
Length (cm)
0.0
0.1
0.2
0.3
0.4
10
30
50

Appendix H.12. Fishery length composition Pearson residuals

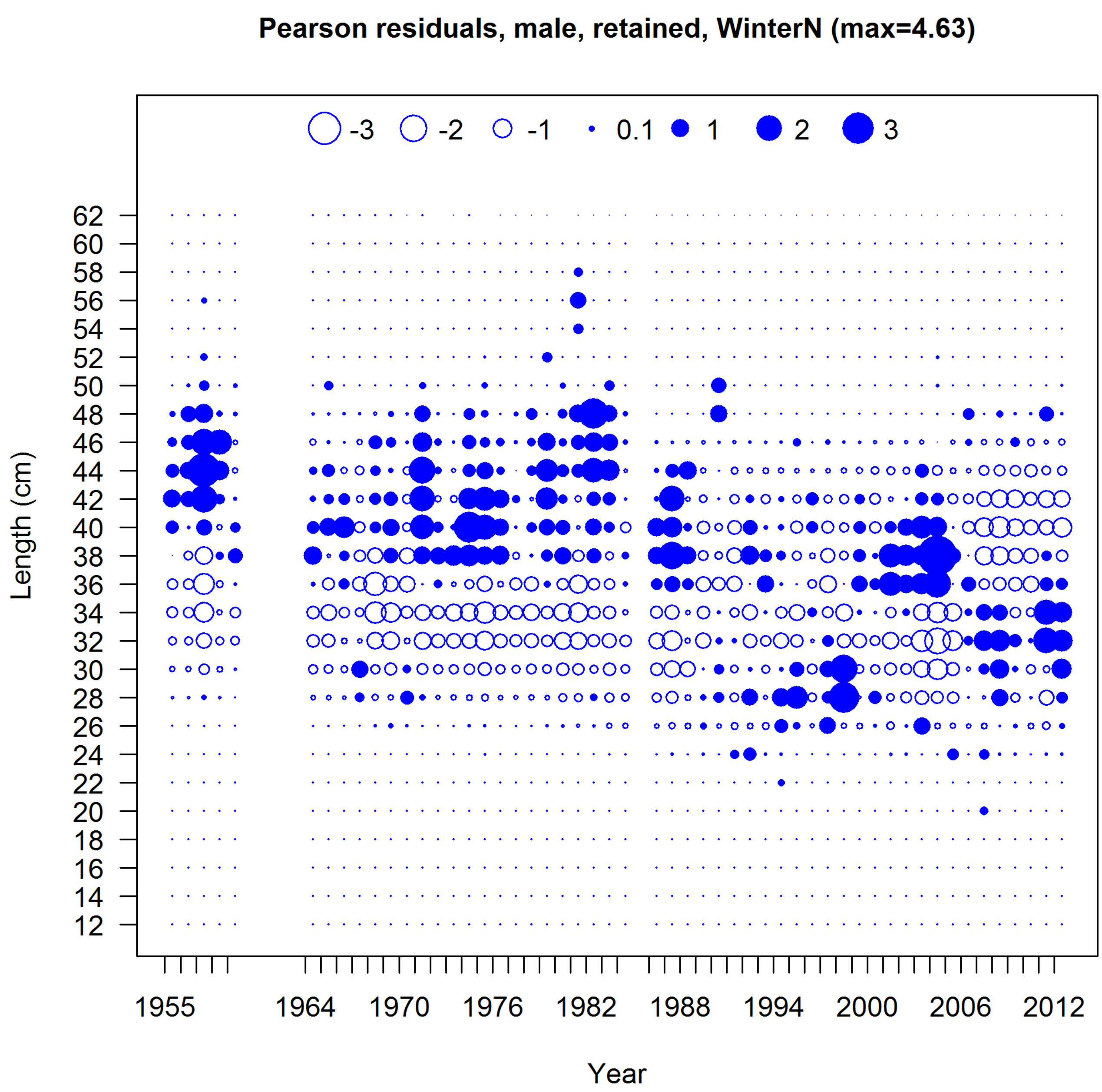


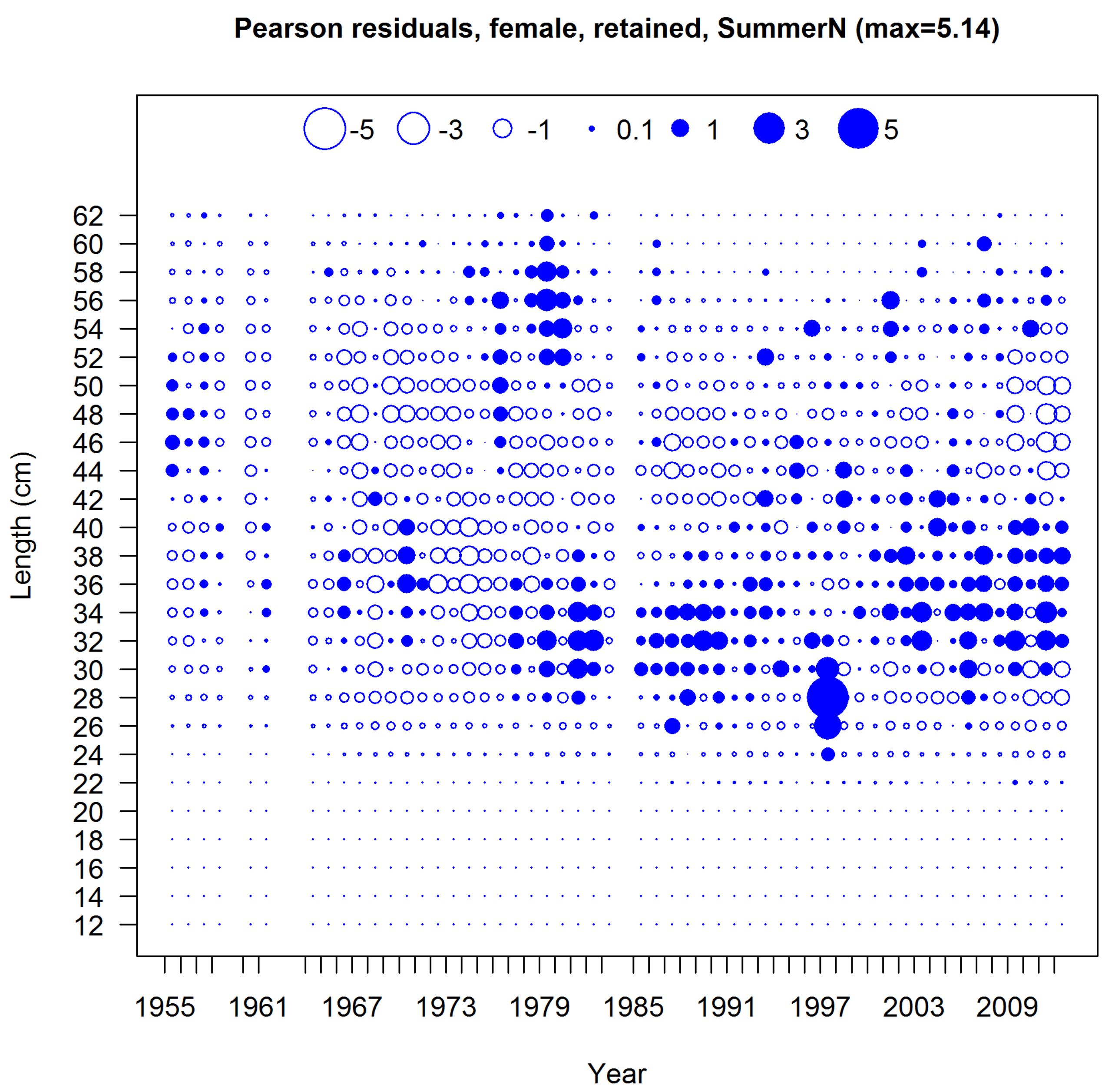
Pearson residuals, female, retained, comparing across fleets
WinterN
SummerN
WinterS
SummerS
Length (cm)
Year
-3 -2 -1 0.1 1 2 3
-5 -3 -1 0.1 1 3 5
1948 1955 1959 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012


Pearson residuals, male, retained, comparing across fleets
-3
-2
-1
0.1
1
2
3
-5
5
-7
7
WinterN
SummerN
WinterS
SummerS
Length (cm)
Year
1948
1955
1959
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012

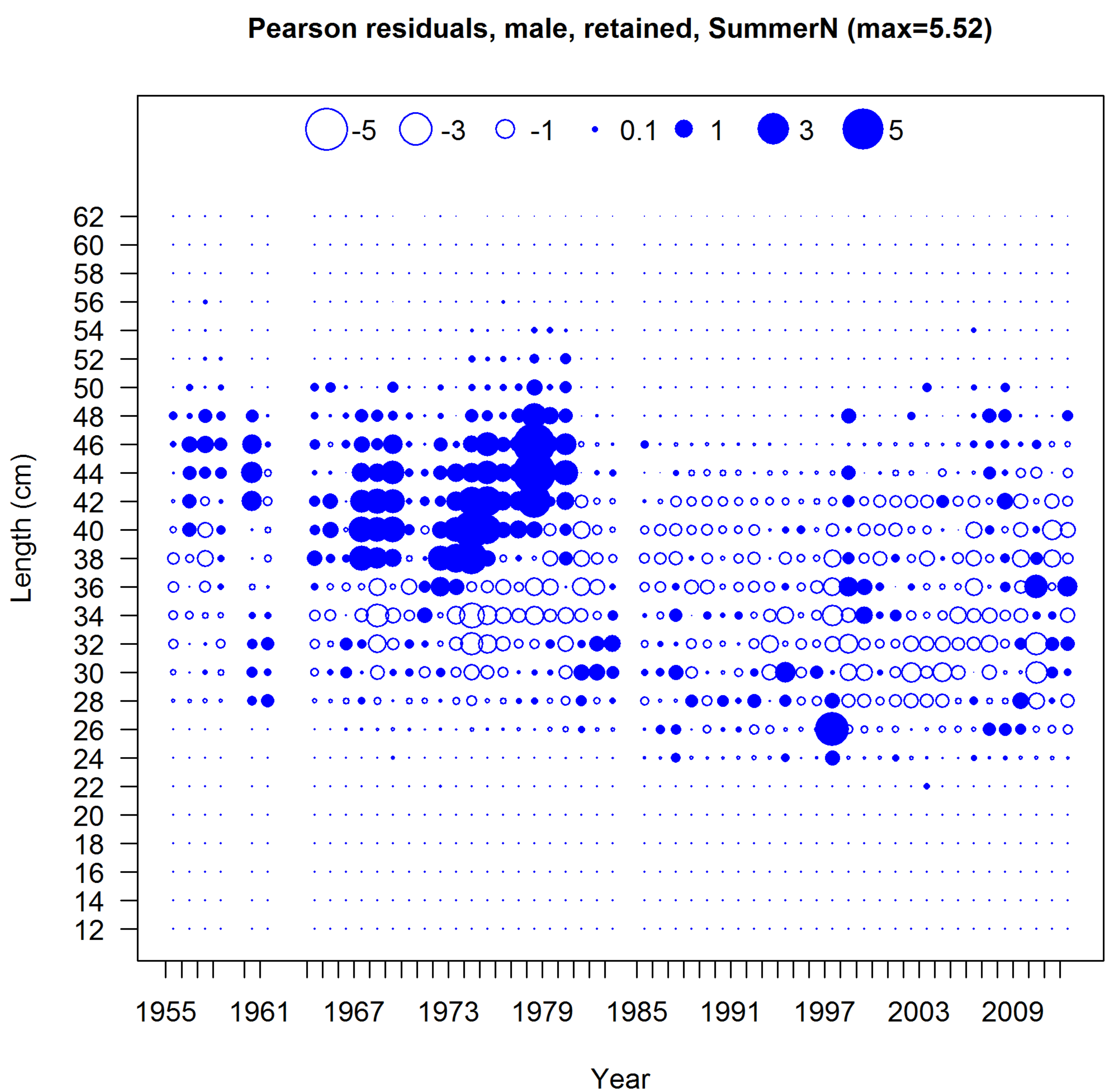


Pearson residuals, female, retained, WinterN (max=3.71)
-3
-2
-1
0.1
1
2
3
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
Length (cm)
1955
1964
1970
1976
1982
1988
1994
2000
2006
2012
Year

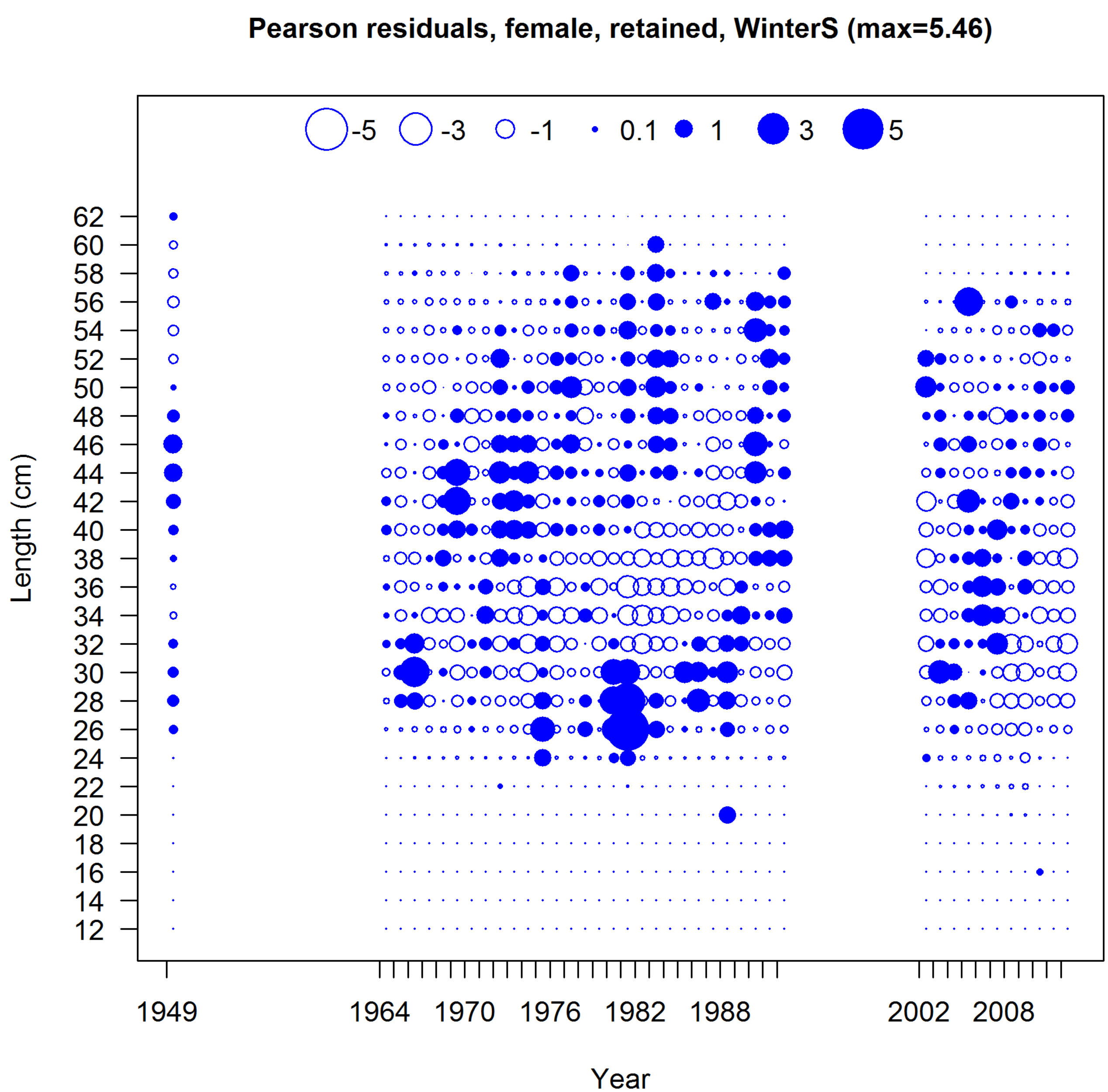

Pearson residuals, male, retained, WinterN (max=4.63)
-3
-2
-1
0.1
1
2
3
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1955
1964
1970
1976
1982
1988
1994
2000
2006
2012
Year



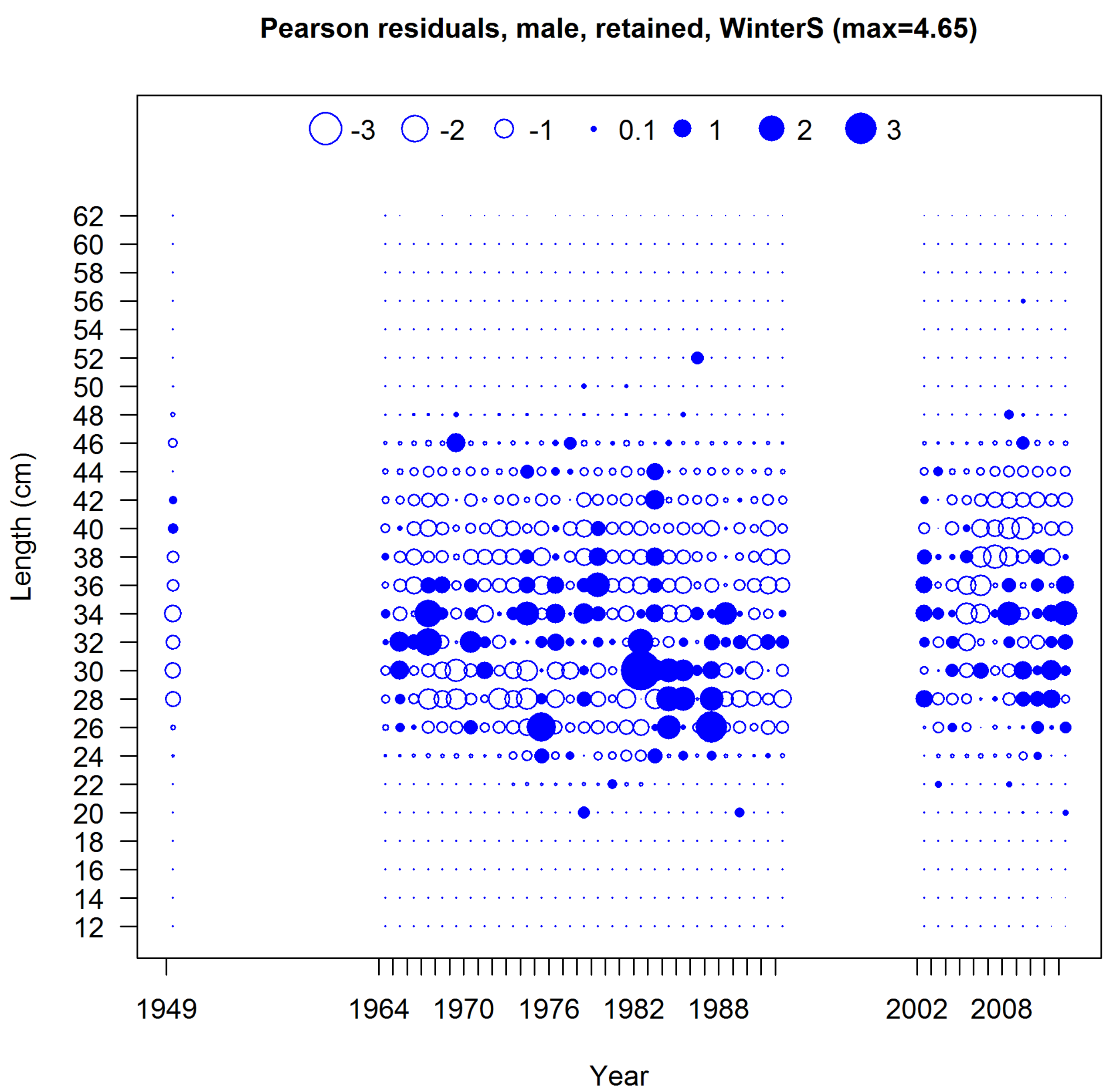
Pearson residuals, female, retained, SummerN (max=5.14)
-5
-3
-1
0.1
1
3
5
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1955
1961
1967
1973
1979
1985
1991
1997
2003
2009
Year

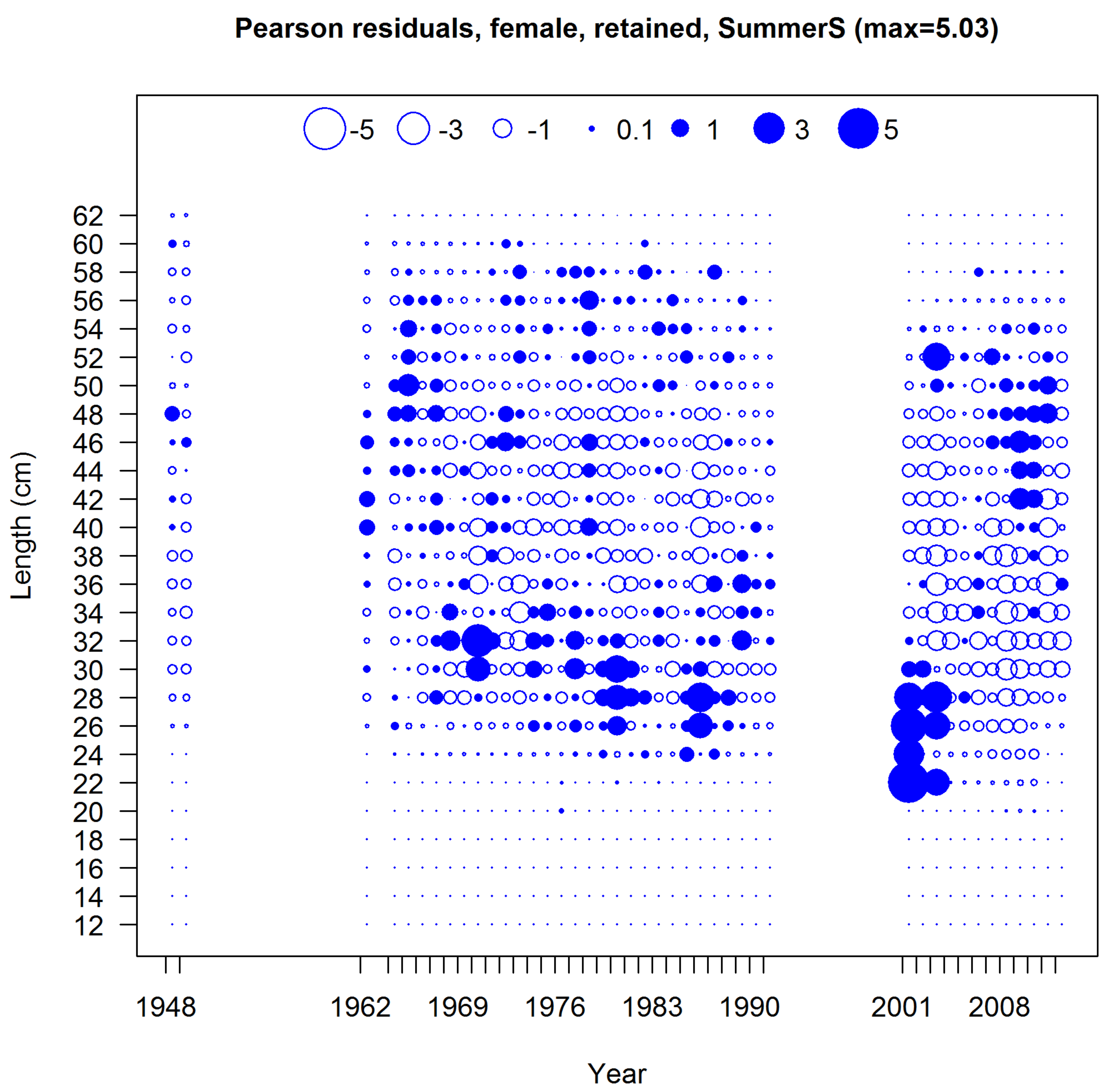


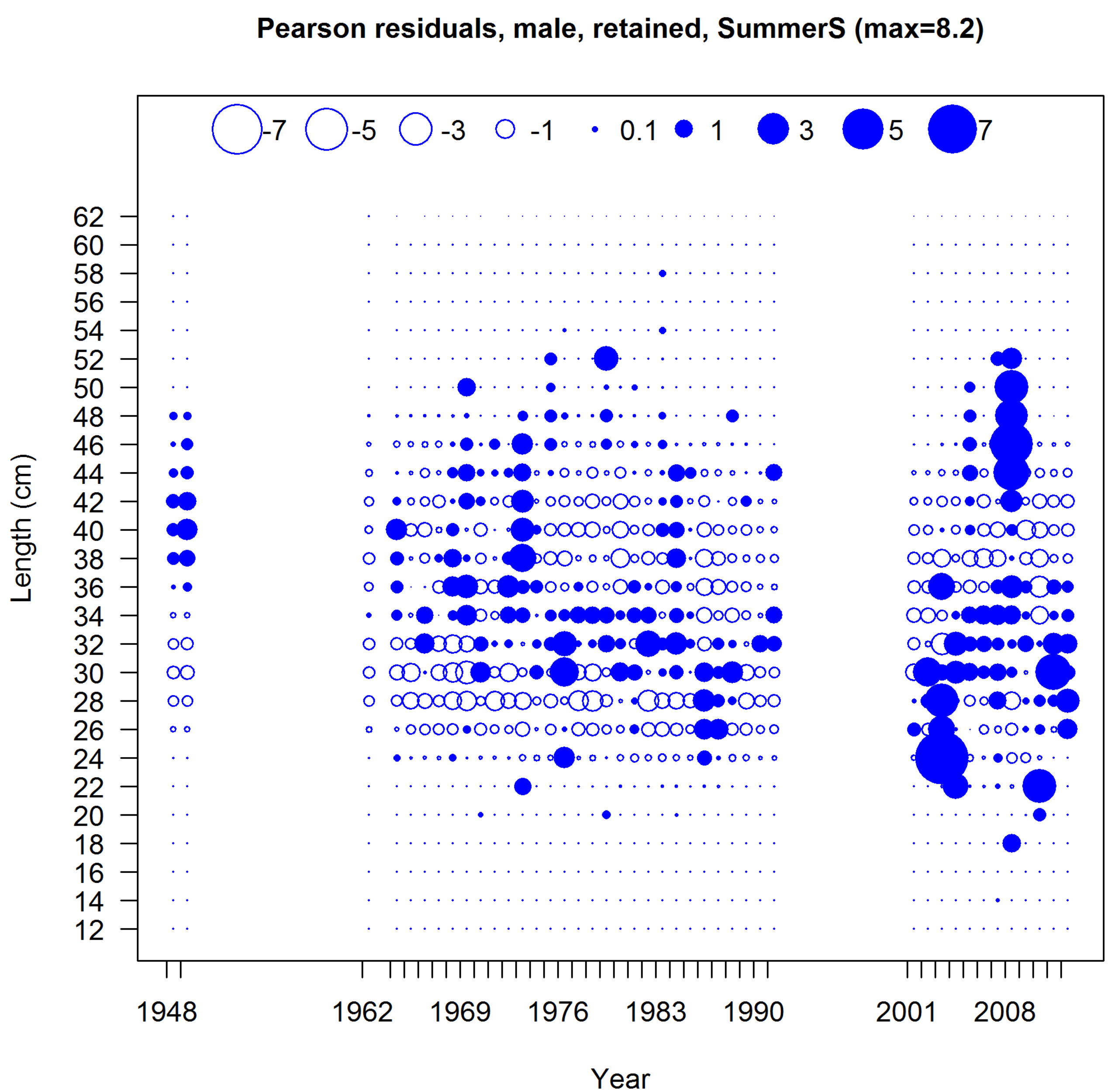
Pearson residuals, male, retained, SummerN (max=5.52)
-5
-3
-1
0.1
1
3
5
Length (cm)
62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12
1955 1961 1967 1973 1979 1985 1991 1997 2003 2009
Year



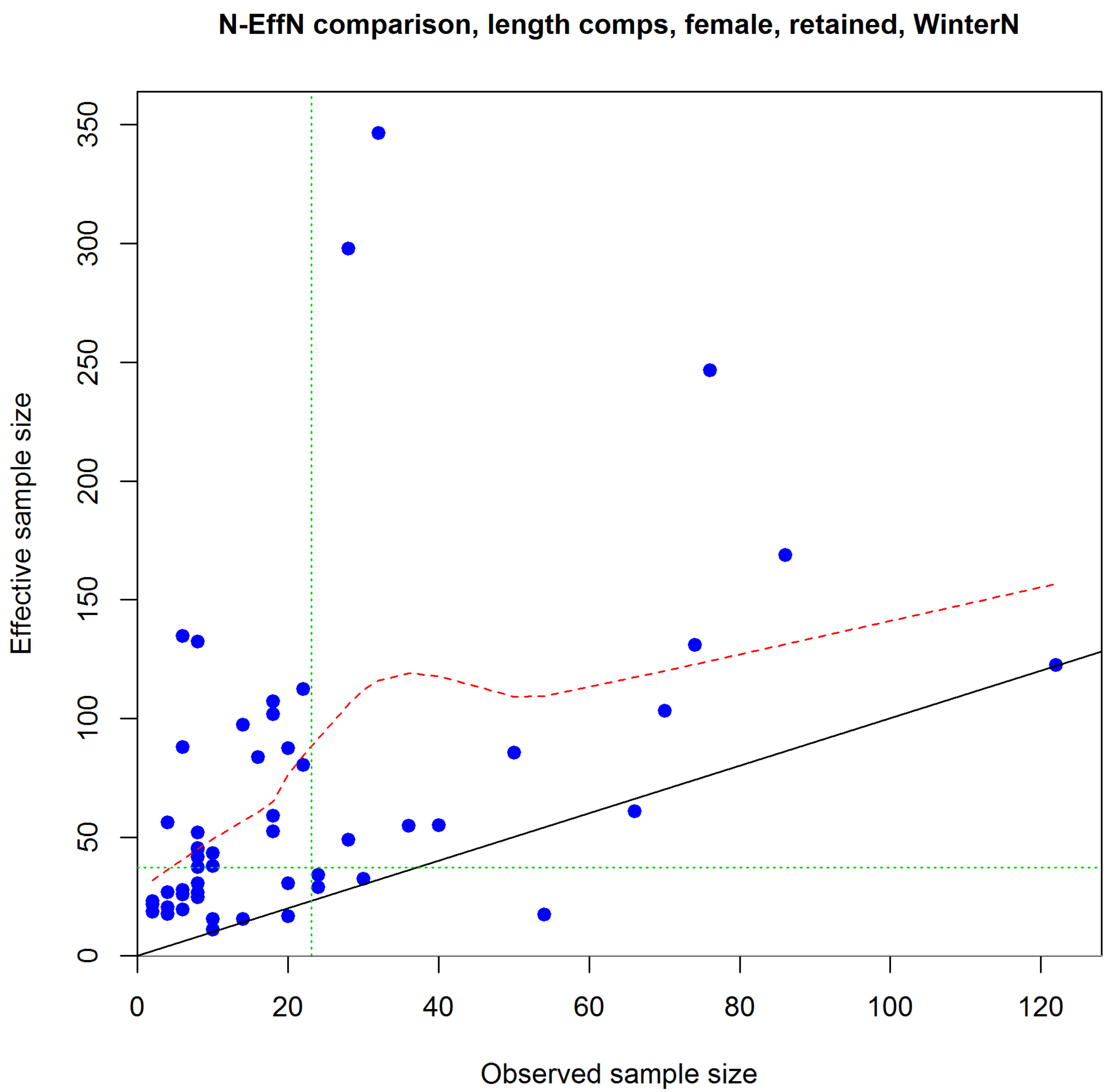
Pearson residuals, female, retained, WinterS (max=5.46)
-5
-3
-1
0.1
1
3
5
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1949
1964
1970
1976
1982
1988
2002
2008
Year

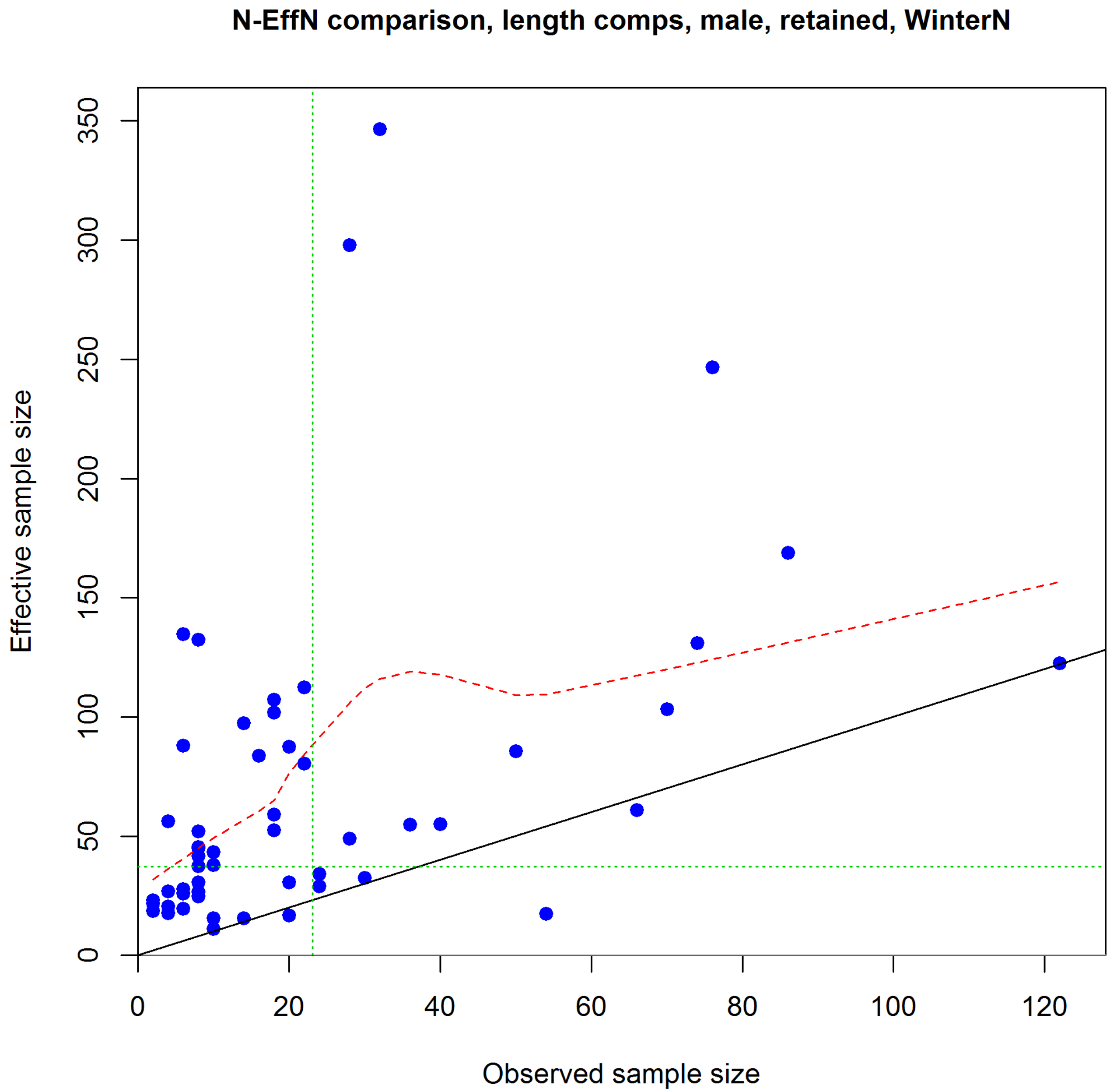

Pearson residuals, male, retained, WinterS (max=4.65)
-3
-2
-1
0.1
1
2
3
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1949
1964
1970
1976
1982
1988
2002
2008
Year

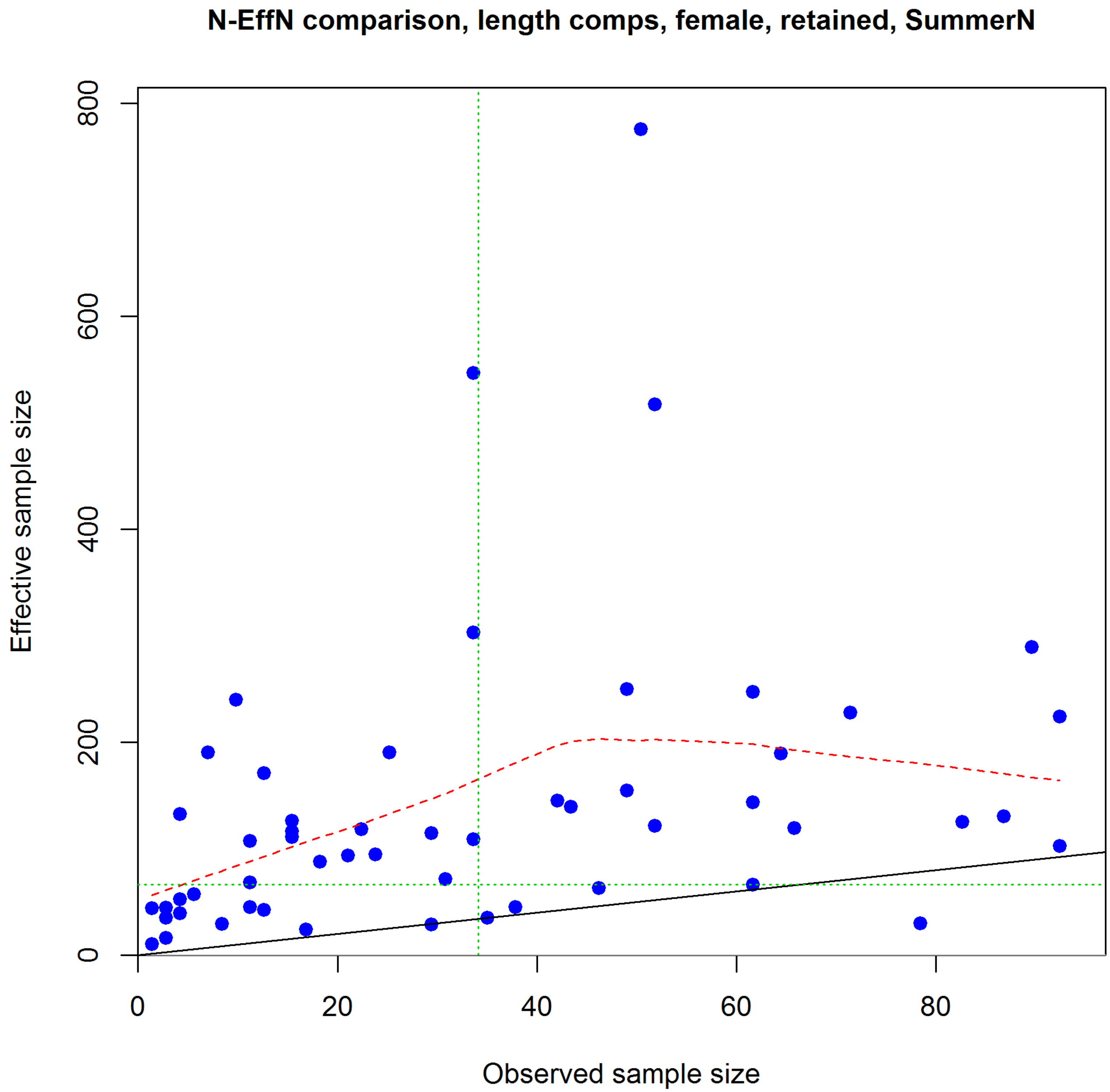

Pearson residuals, female, retained, SummerS (max=5.03)
-5
-3
-1
0.1
1
3
5
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1948
1962
1969
1976
1983
1990
2001
2008
Year


Pearson residuals, male, retained, SummerS (max=8.2)
-7 -5 -3 -1 0.1 1 3 5 7
Length (cm)
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
1948
1962
1969
1976
1983
1990
2001
2008
Year

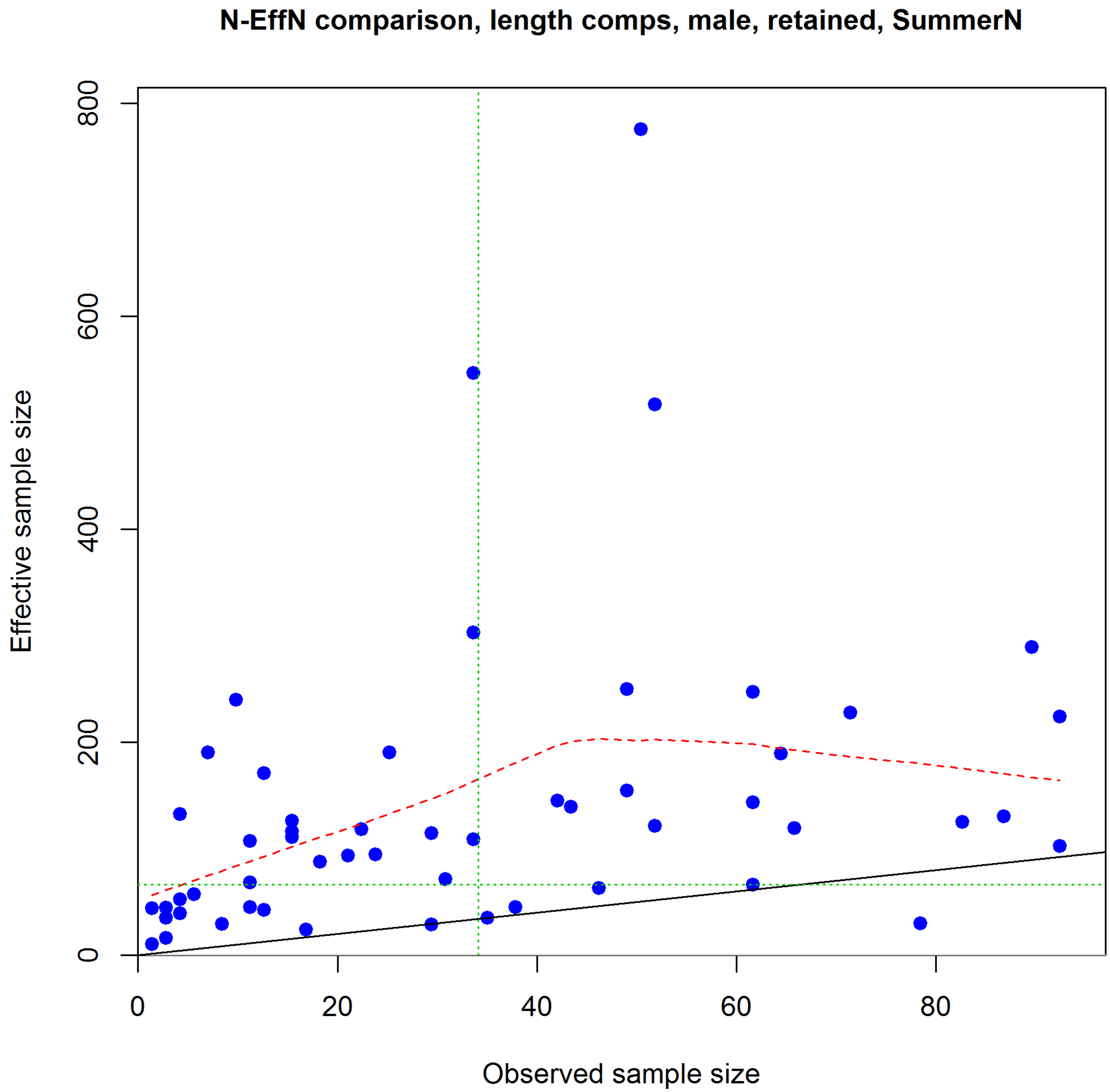
Appendix H.13. Fishery length composition effective sample sizes

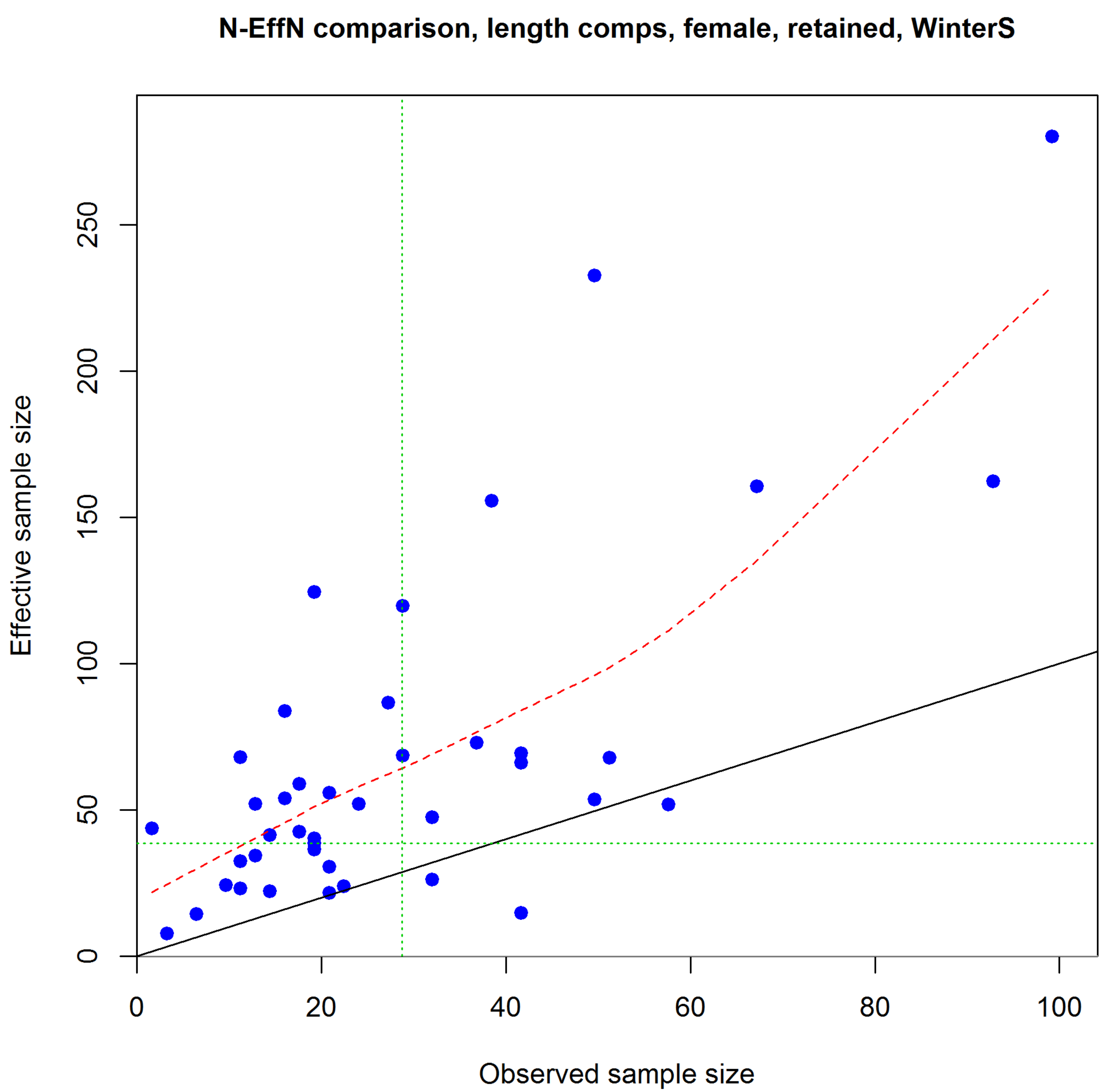

N-EffN comparison, length comps, female, retained, WinterN
Effective sample size
Observed sample size
0
50
100
150
200
250
300
350
0
20
40
60
80
100
120


N-EffN comparison, length comps, male, retained, WinterN
Effective sample size
0
50
100
150
200
250
300
350
0
20
40
60
80
100
120
Observed sample size

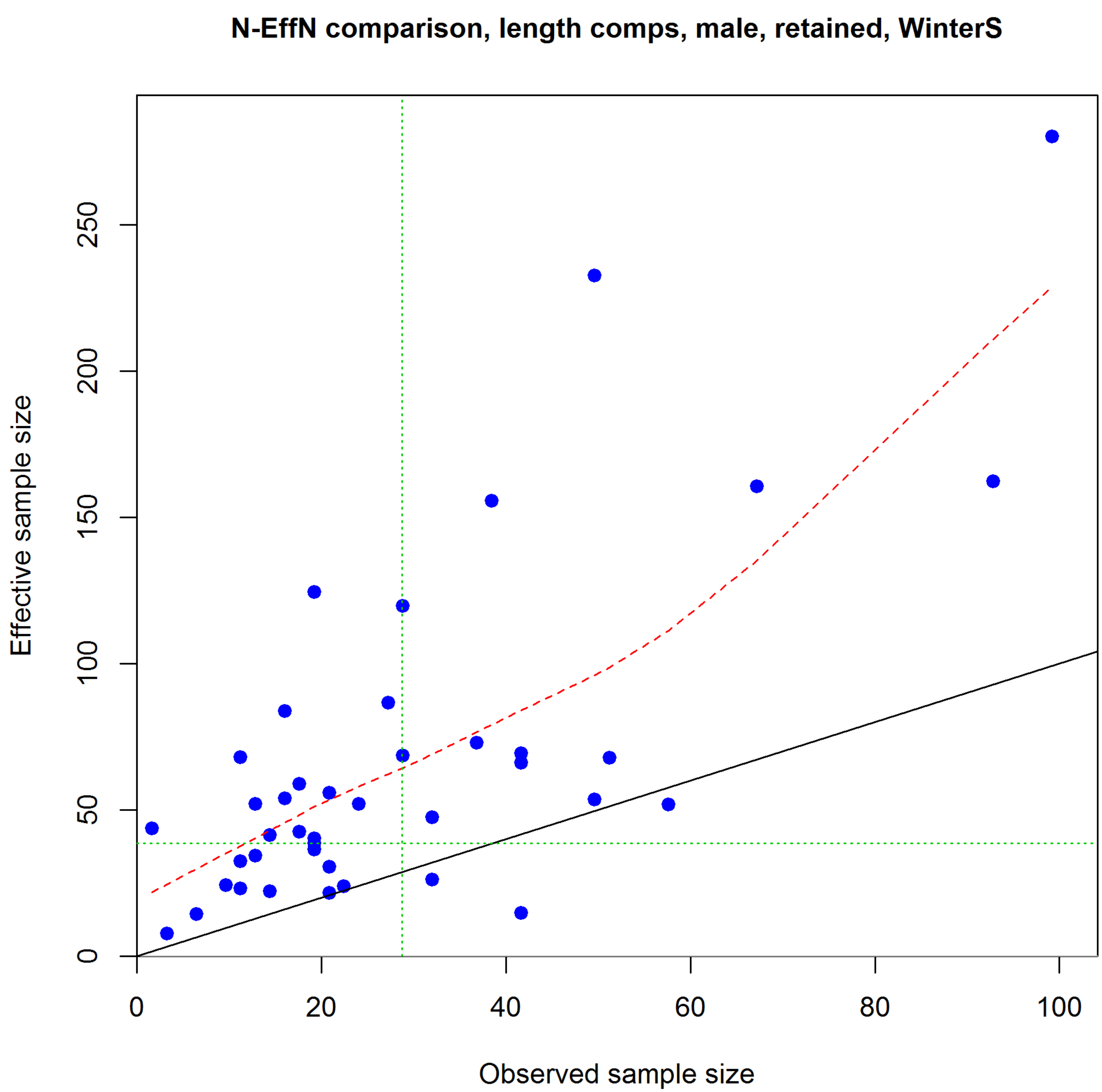


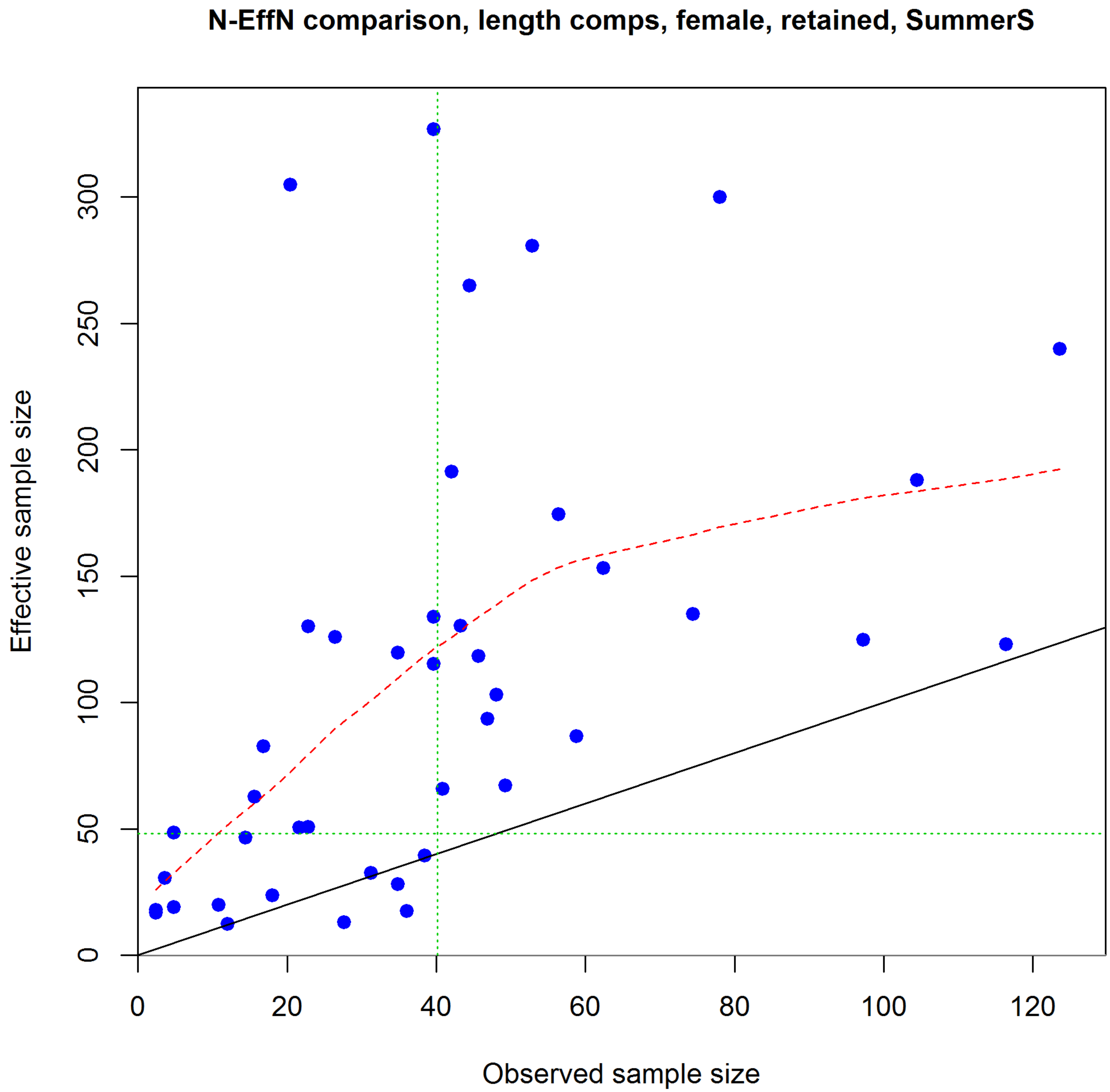
N-EffN comparison, length comps, female, retained, SummerN
Effective sample size
Observed sample size
0
200
400
600
800
0
20
40
60
80


N-EffN comparison, length comps, male, retained, SummerN
Effective sample size
0
200
400
600
800
0
20
40
60
80
Observed sample size

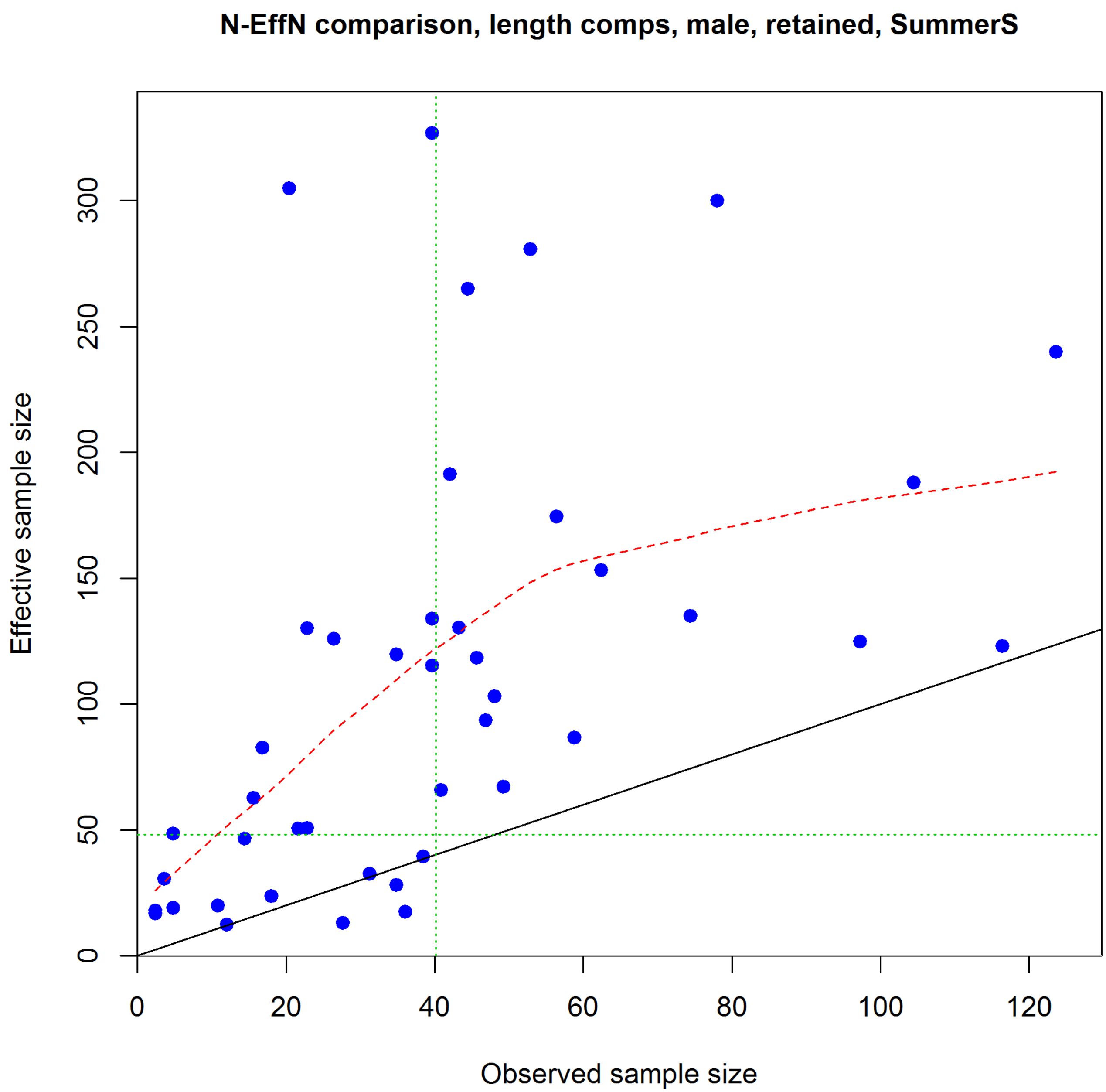


N-EffN comparison, length comps, female, retained, WinterS
Effective sample size
0
50
100
150
200
250
0
20
40
60
80
100
Observed sample size


N-EffN comparison, length comps, male, retained, WinterS
Effective sample size
Observed sample size
0
50
100
150
200
250
0
20
40
60
80
100

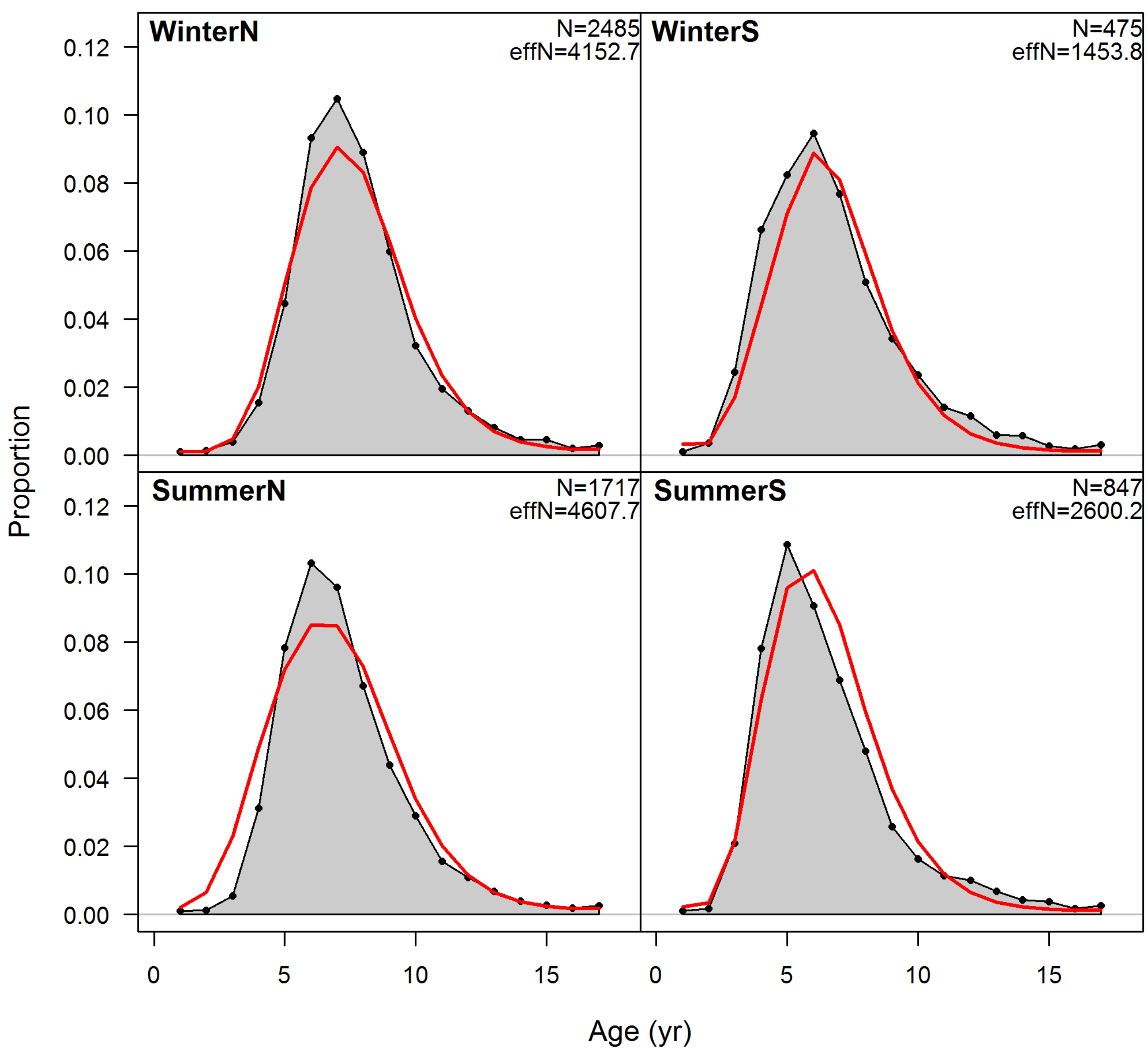


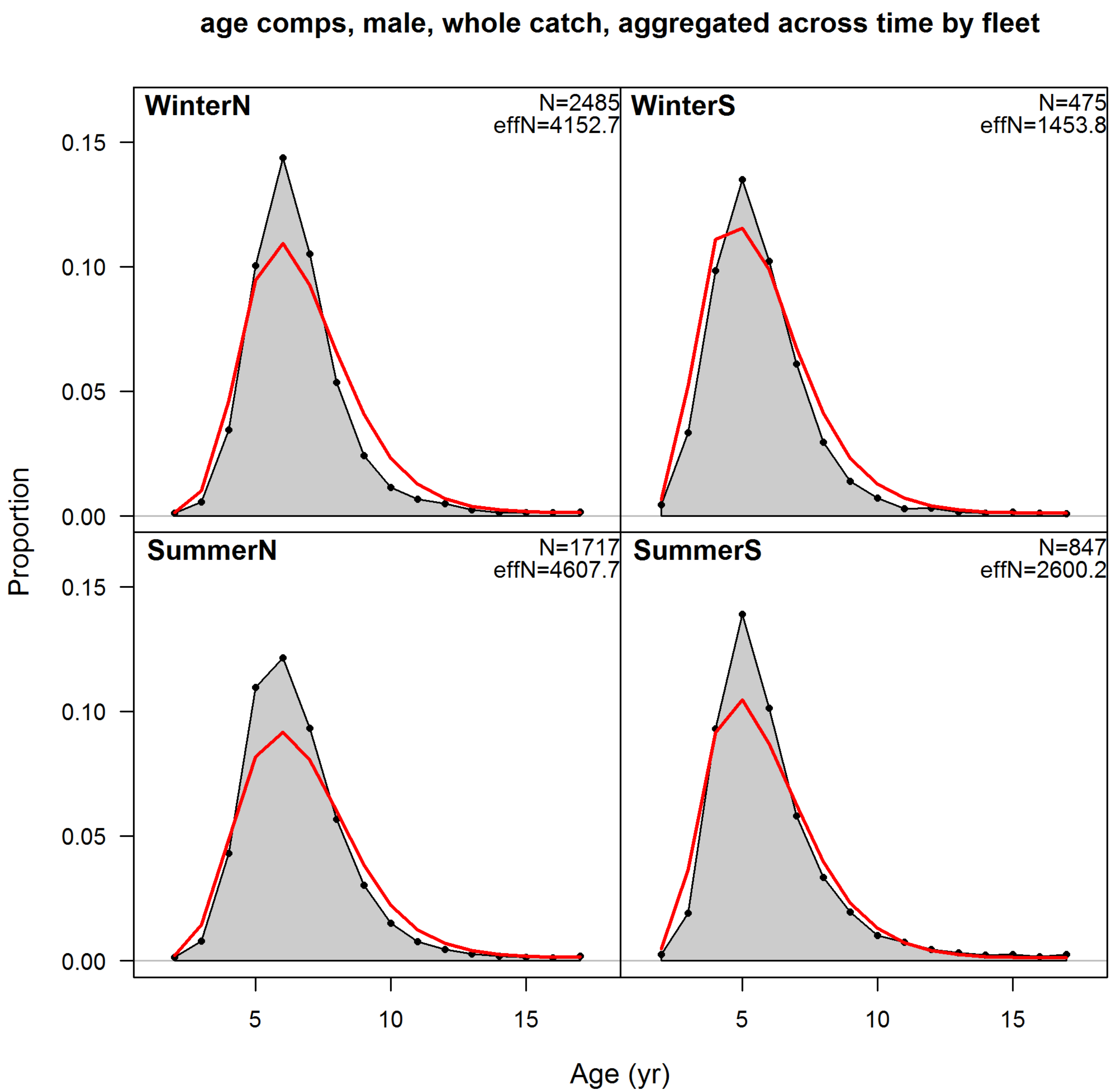
N-EffN comparison, length comps, female, retained, SummerS
Effective sample size
Observed sample size
0
50
100
150
200
250
300
0
20
40
60
80
100
120

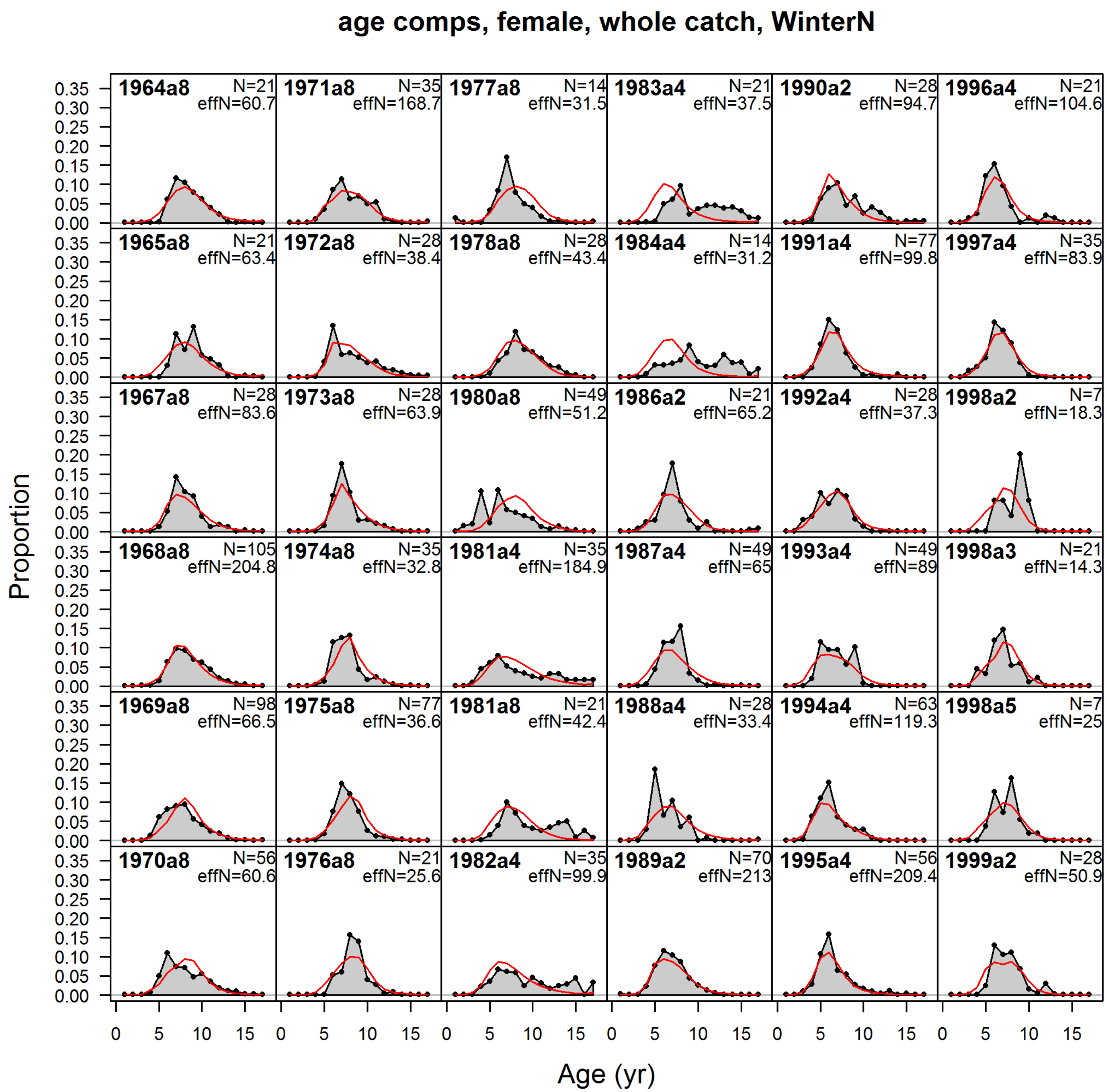

N-EffN comparison, length comps, male, retained, SummerS
Effective sample size
Observed sample size
0
50
100
150
200
250
300
0
20
40
60
80
100
120

Appendix H.14. Fishery age composition fits

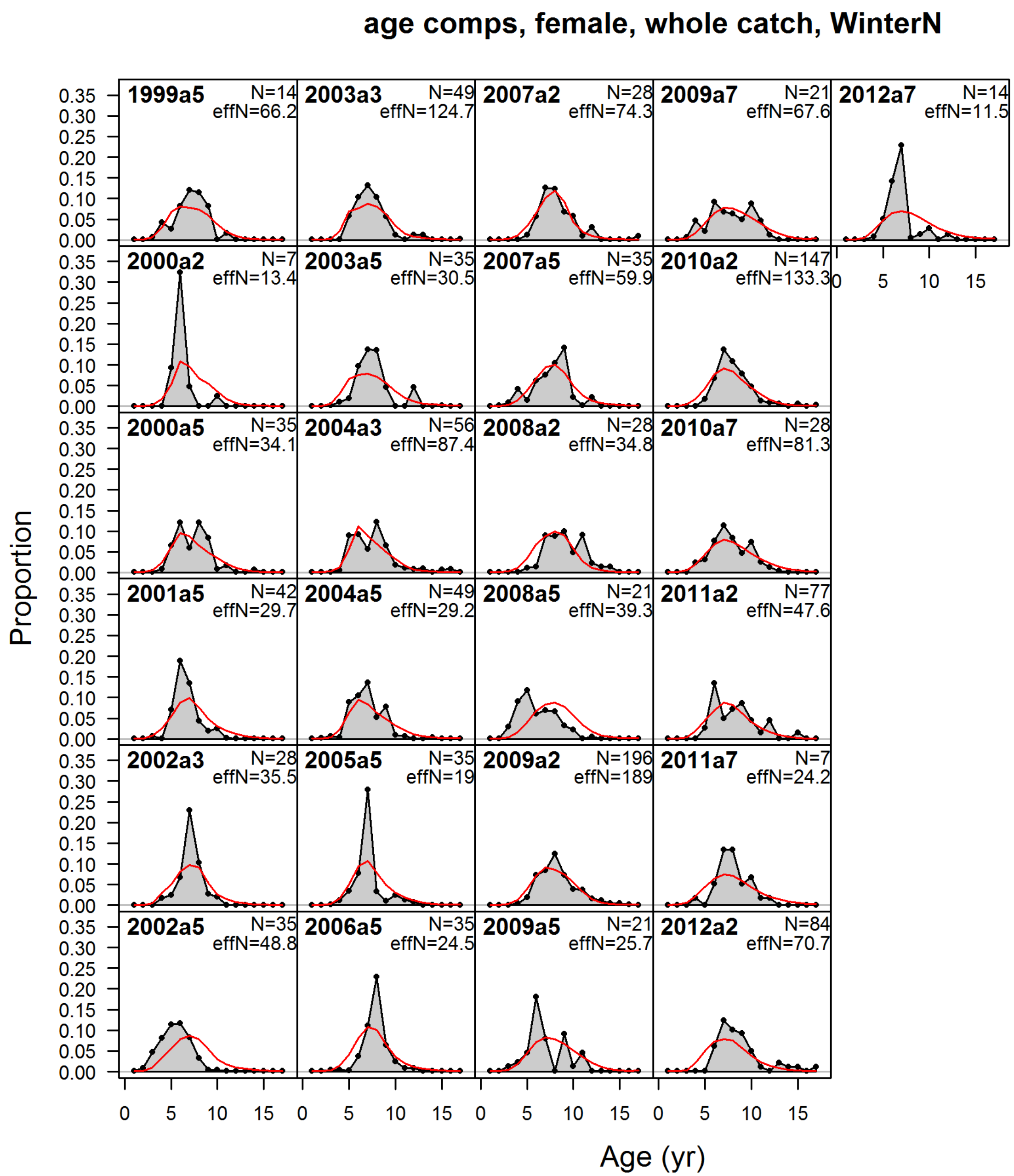
age comps, female, whole catch, aggregated across time by fleet

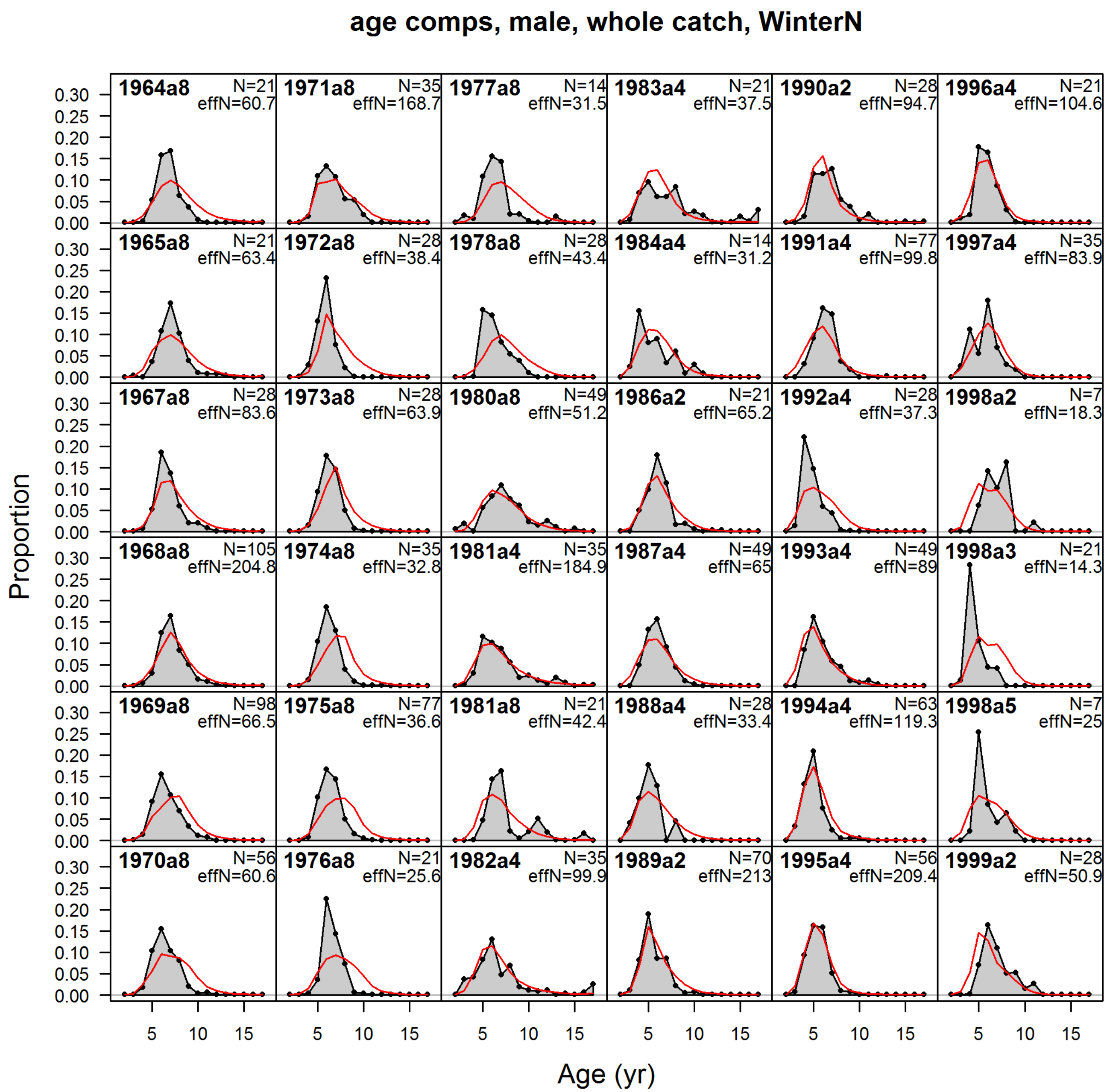



age comps, male, whole catch, aggregated across time by fleet
WinterN
N=2485
effN=4152.7
WinterS
N=475
effN=1453.8
SummerN
N=1717
effN=4607.7
SummerS
N=847
effN=2600.2
Proportion
0.00
0.05
0.10
0.15
5
10
15
Age (yr)

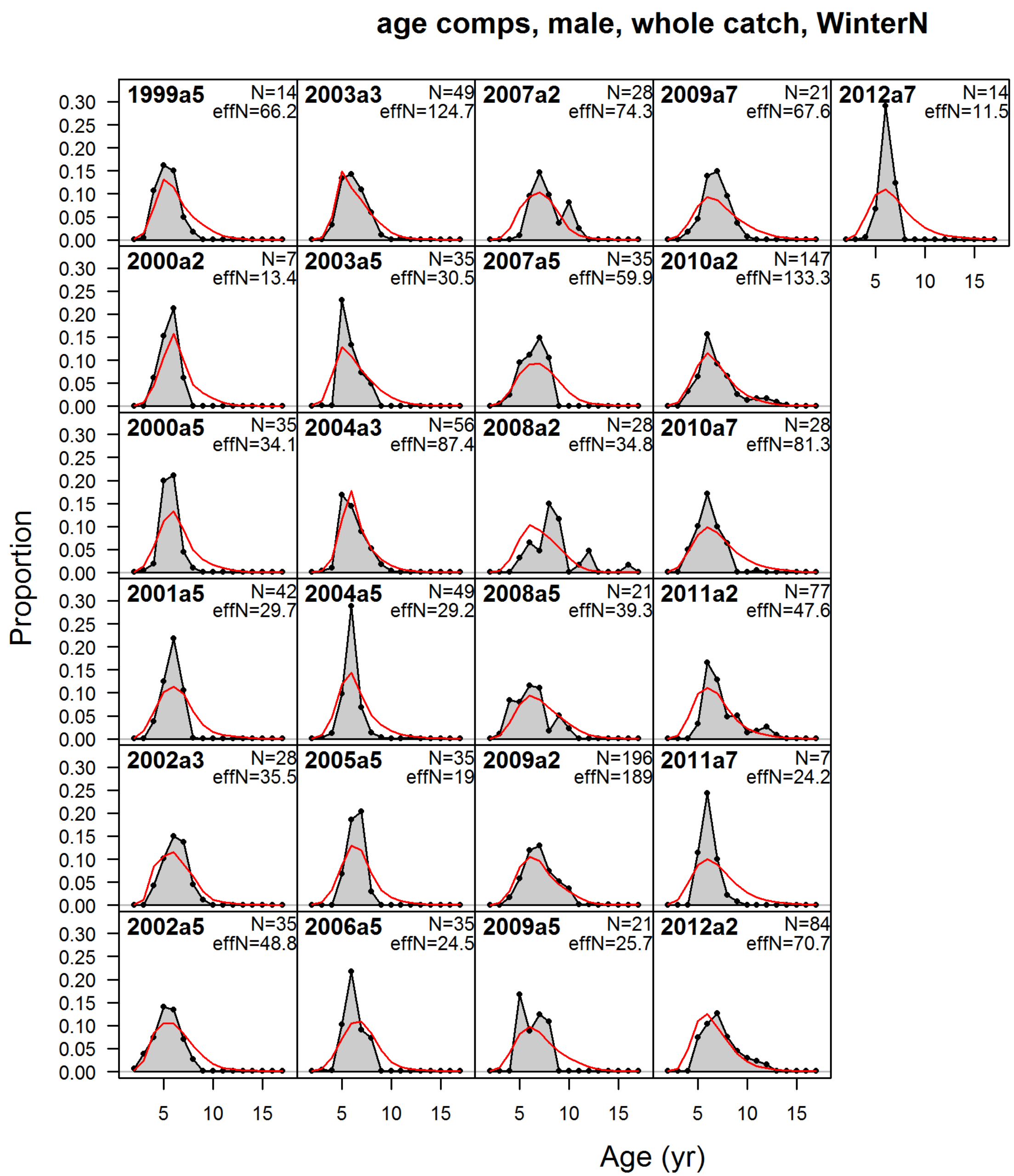


age comps, female, whole catch, WinterN
Proportion
Age (yr)
1964a8 N=21 effN=60.7
1971a8 N=35 effN=168.7
1977a8 N=14 effN=31.5
1983a4 N=21 effN=37.5
1990a2 N=28 effN=94.7
1996a4 N=21 effN=104.6
1965a8 N=21 effN=63.4
1972a8 N=28 effN=38.4
1978a8 N=28 effN=43.4
1984a4 N=14 effN=31.2
1991a4 N=77 effN=99.8
1997a4 N=35 effN=83.9
1967a8 N=28 effN=83.6
1973a8 N=28 effN=63.9
1980a8 N=49 effN=51.2
1986a2 N=21 effN=65.2
1992a4 N=28 effN=37.3
1998a2 N=7 effN=18.3
1968a8 N=105 effN=204.8
1974a8 N=35 effN=32.8
1981a4 N=35 effN=184.9
1987a4 N=49 effN=65
1993a4 N=49 effN=89
1998a3 N=21 effN=14.3
1969a8 N=98 effN=66.5
1975a8 N=77 effN=36.6
1981a8 N=21 effN=42.4
1988a4 N=28 effN=33.4
1994a4 N=63 effN=119.3
1998a5 N=7 effN=25
1970a8 N=56 effN=60.6
1976a8 N=21 effN=25.6
1982a4 N=35 effN=99.9
1989a2 N=70 effN=213
1995a4 N=56 effN=209.4
1999a2 N=28 effN=50.9

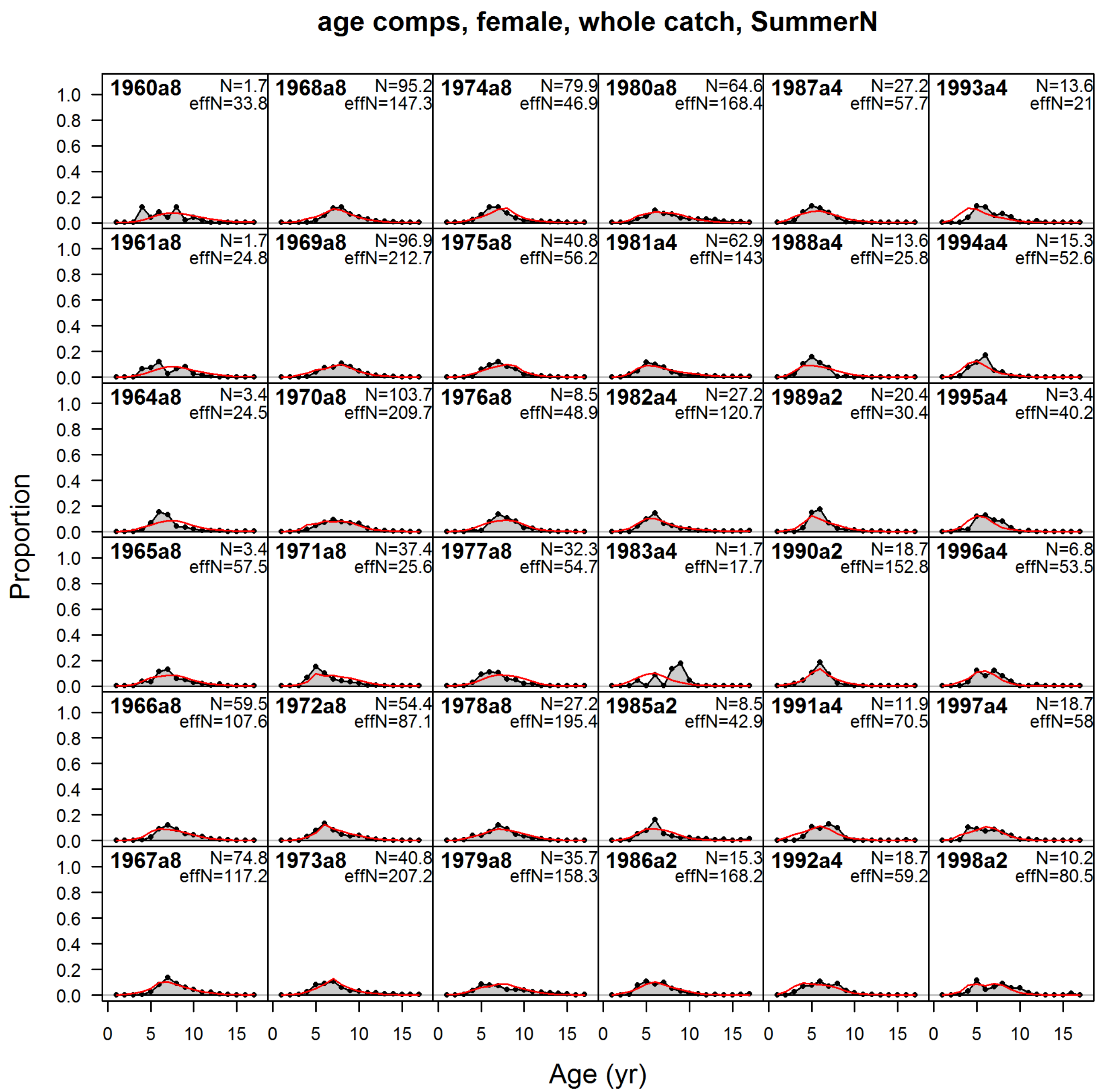

age comps, female, whole catch, WinterN
1999a5 N=14 effN=66.2
2003a3 N=49 effN=124.7
2007a2 N=28 effN=74.3
2009a7 N=21 effN=67.6
2012a7 N=14 effN=11.5
2000a2 N=7 effN=13.4
2003a5 N=35 effN=30.5
2007a5 N=35 effN=59.9
2010a2 N=147 effN=133.3
2000a5 N=35 effN=34.1
2004a3 N=56 effN=87.4
2008a2 N=28 effN=34.8
2010a7 N=28 effN=81.3
2001a5 N=42 effN=29.7
2004a5 N=49 effN=29.2
2008a5 N=21 effN=39.3
2011a2 N=77 effN=47.6
2002a3 N=28 effN=35.5
2005a5 N=35 effN=19
2009a2 N=196 effN=189
2011a7 N=7 effN=24.2
2002a5 N=35 effN=48.8
2006a5 N=35 effN=24.5
2009a5 N=21 effN=25.7
2012a2 N=84 effN=70.7
Proportion
Age (yr)

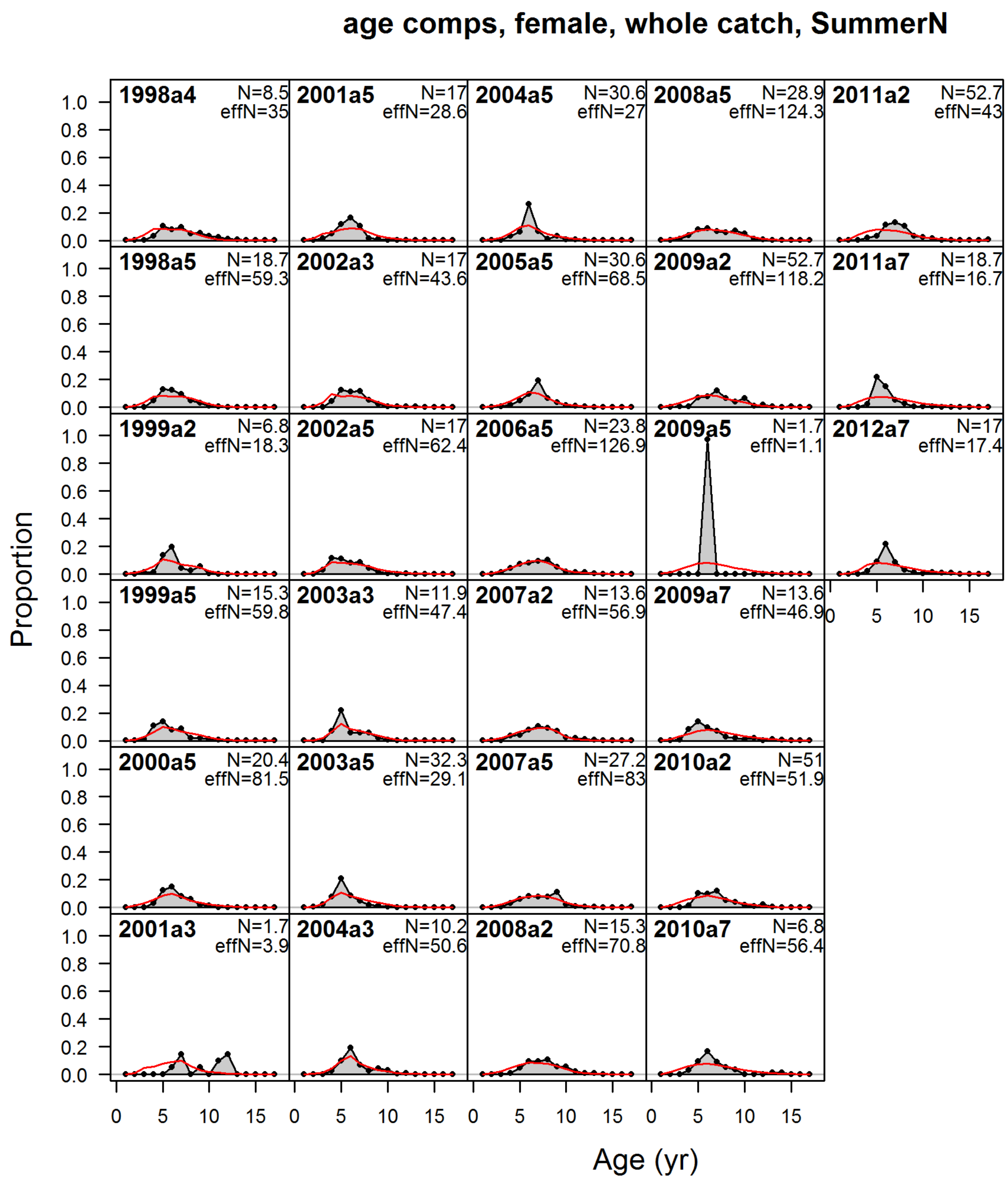


age comps, male, whole catch, WinterN
1964a8 N=21 effN=60.7
1971a8 N=35 effN=168.7
1977a8 N=14 effN=31.5
1983a4 N=21 effN=37.5
1990a2 N=28 effN=94.7
1996a4 N=21 effN=104.6
1965a8 N=21 effN=63.4
1972a8 N=28 effN=38.4
1978a8 N=28 effN=43.4
1984a4 N=14 effN=31.2
1991a4 N=77 effN=99.8
1997a4 N=35 effN=83.9
1967a8 N=28 effN=83.6
1973a8 N=28 effN=63.9
1980a8 N=49 effN=51.2
1986a2 N=21 effN=65.2
1992a4 N=28 effN=37.3
1998a2 N=7 effN=18.3
1968a8 N=105 effN=204.8
1974a8 N=35 effN=32.8
1981a4 N=35 effN=184.9
1987a4 N=49 effN=65
1993a4 N=49 effN=89
1998a3 N=21 effN=14.3
1969a8 N=98 effN=66.5
1975a8 N=77 effN=36.6
1981a8 N=21 effN=42.4
1988a4 N=28 effN=33.4
1994a4 N=63 effN=119.3
1998a5 N=7 effN=25
1970a8 N=56 effN=60.6
1976a8 N=21 effN=25.6
1982a4 N=35 effN=99.9
1989a2 N=70 effN=213
1995a4 N=56 effN=209.4
1999a2 N=28 effN=50.9
Proportion
0.00 0.05 0.10 0.15 0.20 0.25 0.30
Age (yr)
5 10 15



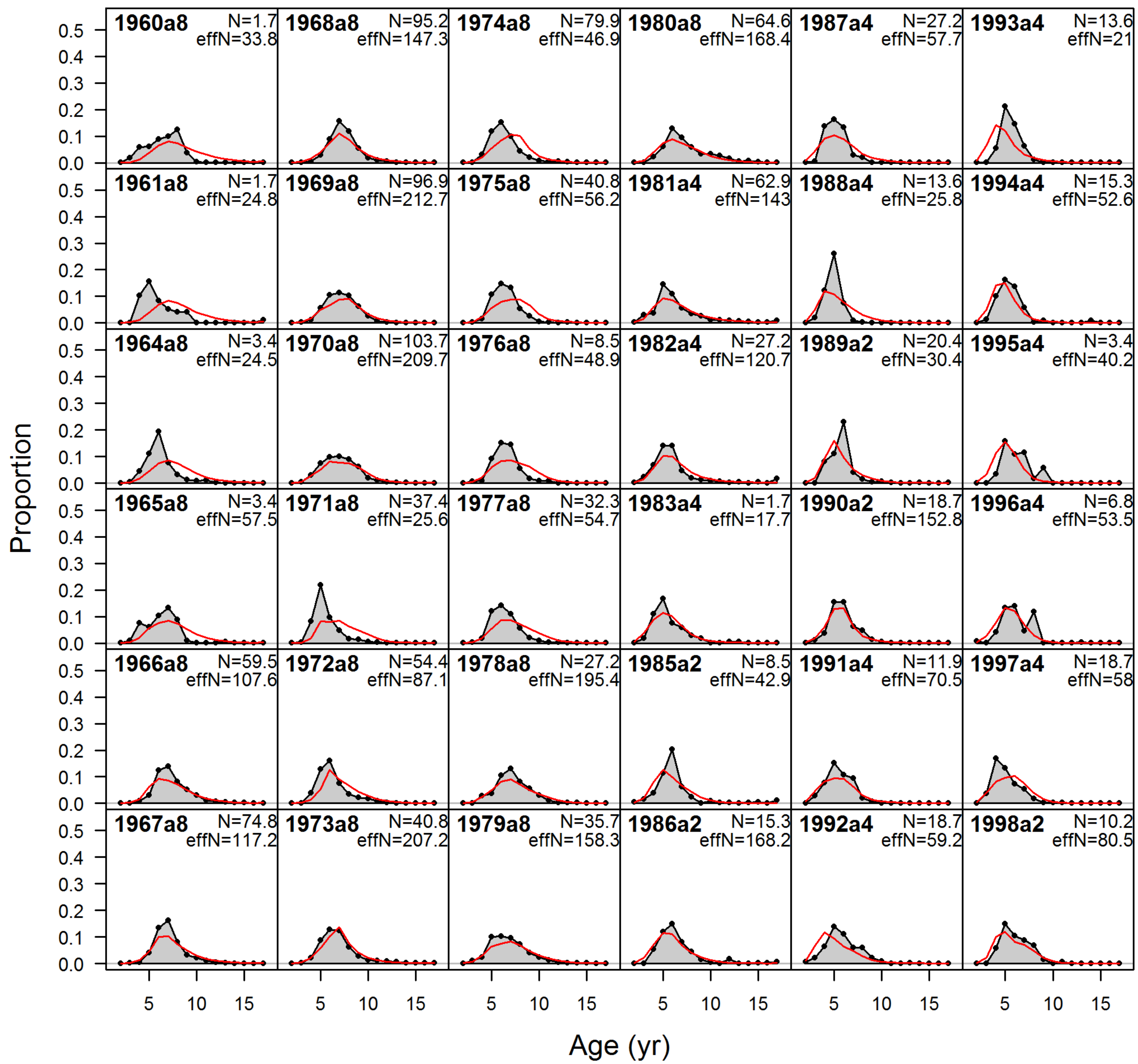
age comps, male, whole catch, WinterN
1999a5 N=14 effN=66.2
2003a3 N=49 effN=124.7
2007a2 N=28 effN=74.3
2009a7 N=21 effN=67.6
2012a7 N=14 effN=11.5
2000a2 N=7 effN=13.4
2003a5 N=35 effN=30.5
2007a5 N=35 effN=59.9
2010a2 N=147 effN=133.3
2000a5 N=35 effN=34.1
2004a3 N=56 effN=87.4
2008a2 N=28 effN=34.8
2010a7 N=28 effN=81.3
2001a5 N=42 effN=29.7
2004a5 N=49 effN=29.2
2008a5 N=21 effN=39.3
2011a2 N=77 effN=47.6
2002a3 N=28 effN=35.5
2005a5 N=35 effN=19
2009a2 N=196 effN=189
2011a7 N=7 effN=24.2
2002a5 N=35 effN=48.8
2006a5 N=35 effN=24.5
2009a5 N=21 effN=25.7
2012a2 N=84 effN=70.7
Proportion
Age (yr)

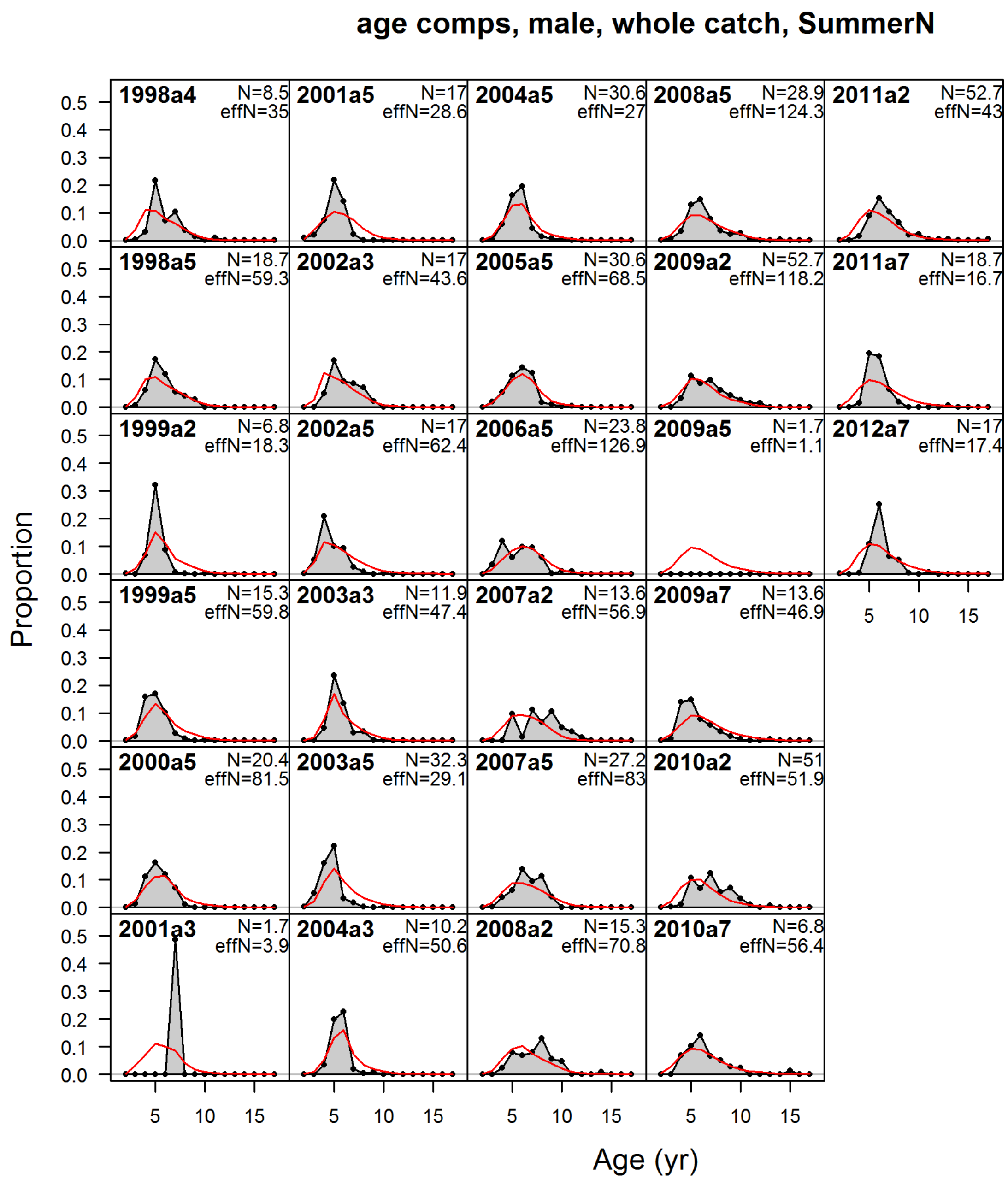

age comps, female, whole catch, SummerN
Proportion
Age (yr)
1960a8 N=1.7 effN=33.8
1968a8 N=95.2 effN=147.3
1974a8 N=79.9 effN=46.9
1980a8 N=64.6 effN=168.4
1987a4 N=27.2 effN=57.7
1993a4 N=13.6 effN=21
1961a8 N=1.7 effN=24.8
1969a8 N=96.9 effN=212.7
1975a8 N=40.8 effN=56.2
1981a4 N=62.9 effN=143
1988a4 N=13.6 effN=25.8
1994a4 N=15.3 effN=52.6
1964a8 N=3.4 effN=24.5
1970a8 N=103.7 effN=209.7
1976a8 N=8.5 effN=48.9
1982a4 N=27.2 effN=120.7
1989a2 N=20.4 effN=30.4
1995a4 N=3.4 effN=40.2
1965a8 N=3.4 effN=57.5
1971a8 N=37.4 effN=25.6
1977a8 N=32.3 effN=54.7
1983a4 N=1.7 effN=17.7
1990a2 N=18.7 effN=152.8
1996a4 N=6.8 effN=53.5
1966a8 N=59.5 effN=107.6
1972a8 N=54.4 effN=87.1
1978a8 N=27.2 effN=195.4
1985a2 N=8.5 effN=42.9
1991a4 N=11.9 effN=70.5
1997a4 N=18.7 effN=58
1967a8 N=74.8 effN=117.2
1973a8 N=40.8 effN=207.2
1979a8 N=35.7 effN=158.3
1986a2 N=15.3 effN=168.2
1992a4 N=18.7 effN=59.2
1998a2 N=10.2 effN=80.5



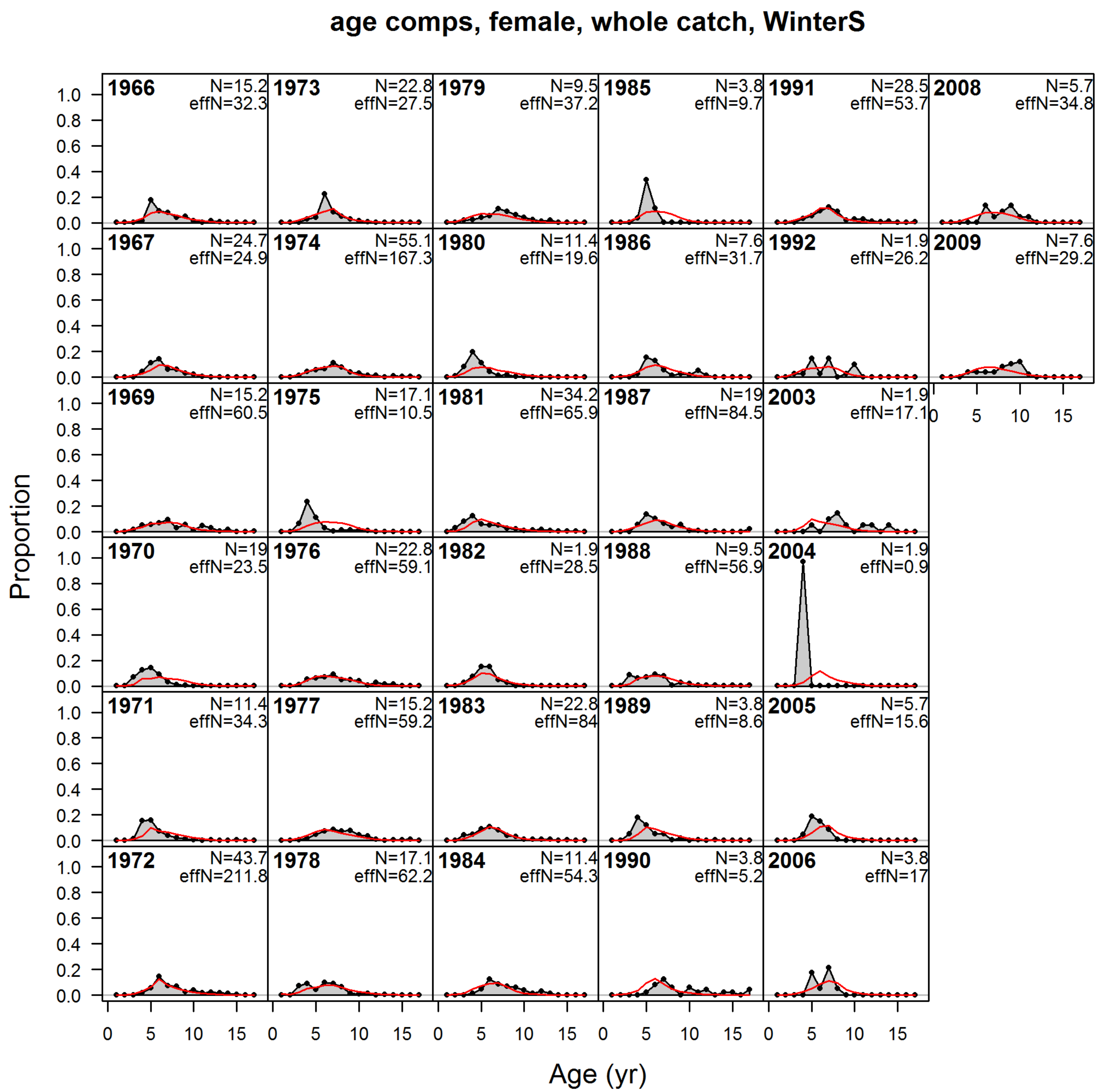
age comps, female, whole catch, SummerN
1998a4 N=8.5 effN=35
2001a5 N=17 effN=28.6
2004a5 N=30.6 effN=27
2008a5 N=28.9 effN=124.3
2011a2 N=52.7 effN=43
1998a5 N=18.7 effN=59.3
2002a3 N=17 effN=43.6
2005a5 N=30.6 effN=68.5
2009a2 N=52.7 effN=118.2
2011a7 N=18.7 effN=16.7
1999a2 N=6.8 effN=18.3
2002a5 N=17 effN=62.4
2006a5 N=23.8 effN=126.9
2009a5 N=1.7 effN=1.1
2012a7 N=17 effN=17.4
1999a5 N=15.3 effN=59.8
2003a3 N=11.9 effN=47.4
2007a2 N=13.6 effN=56.9
2009a7 N=13.6 effN=46.9
2000a5 N=20.4 effN=81.5
2003a5 N=32.3 effN=29.1
2007a5 N=27.2 effN=83
2010a2 N=51 effN=51.9
2001a3 N=1.7 effN=3.9
2004a3 N=10.2 effN=50.6
2008a2 N=15.3 effN=70.8
2010a7 N=6.8 effN=56.4
Proportion
Age (yr)

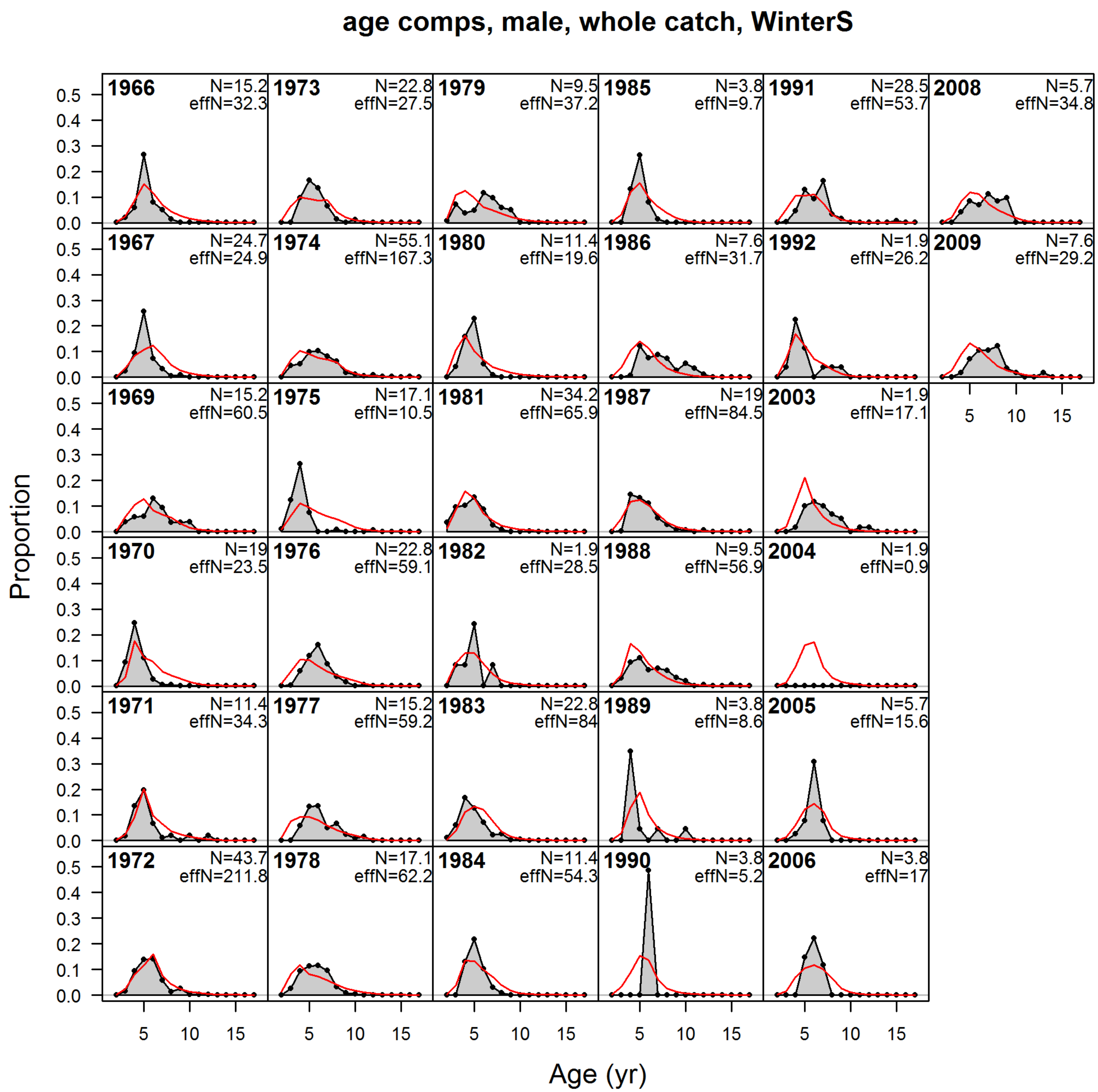
age comps, male, whole catch, SummerN

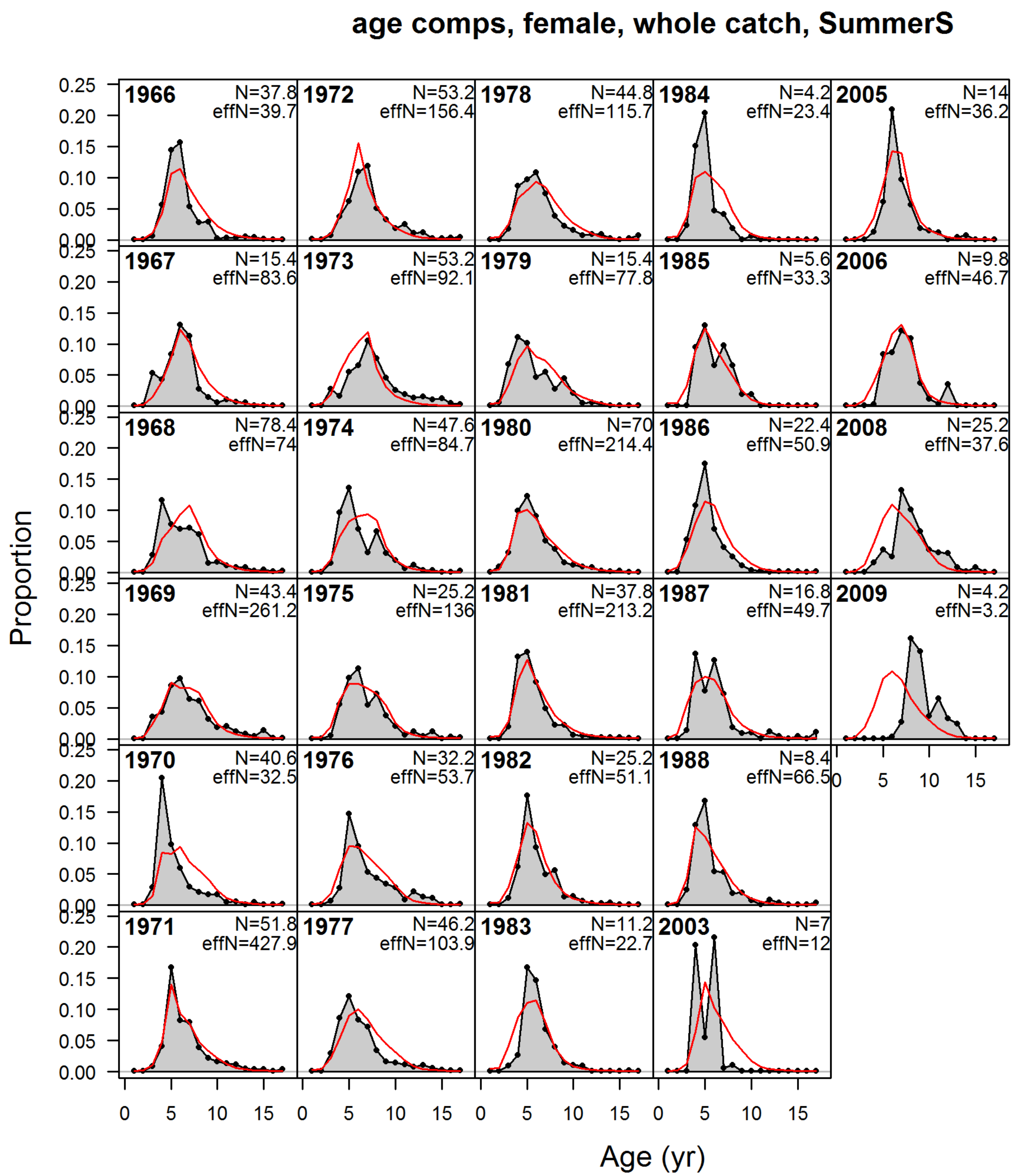


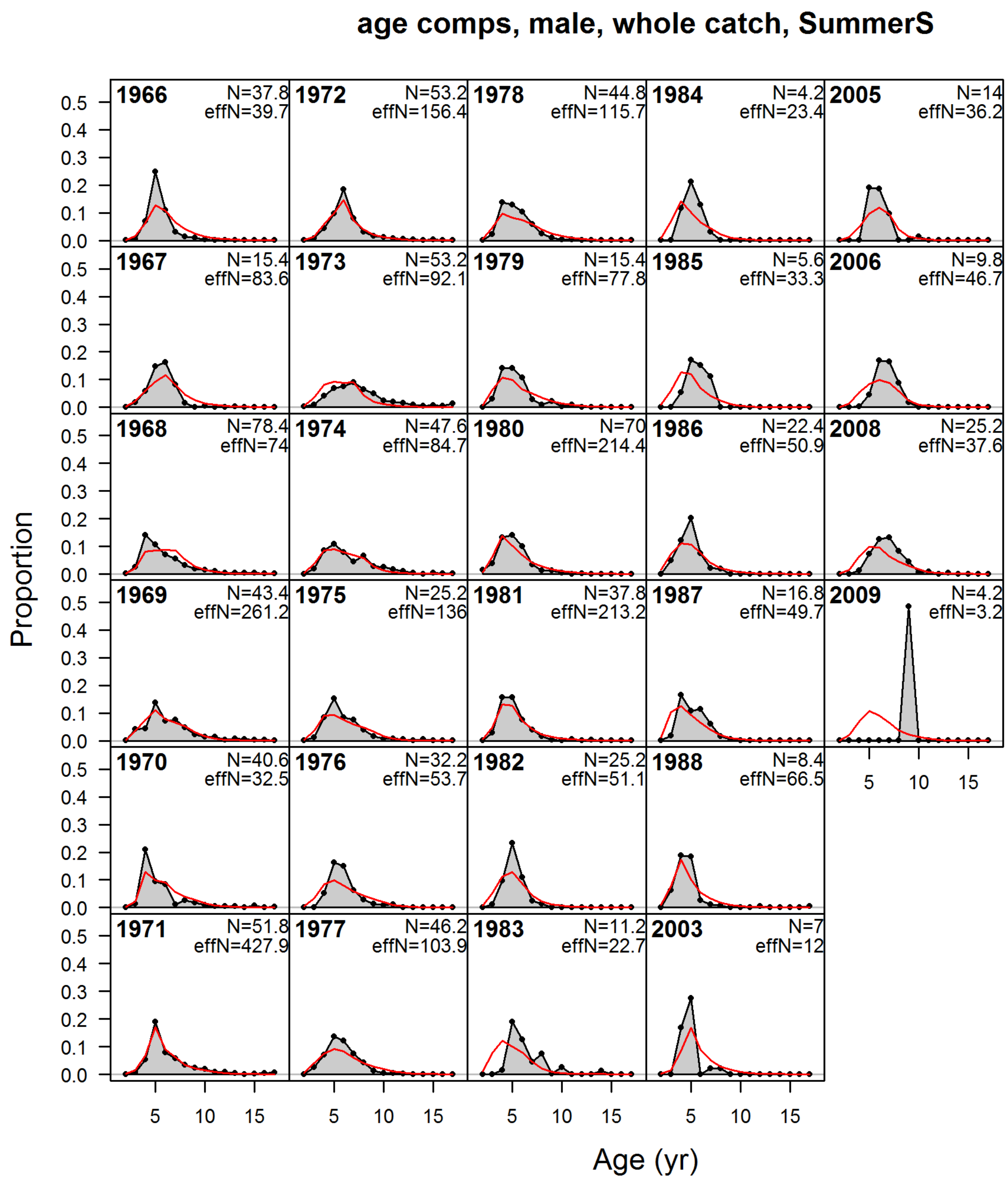


age comps, male, whole catch, SummerN
1998a4 N=8.5 effN=35
2001a5 N=17 effN=28.6
2004a5 N=30.6 effN=27
2008a5 N=28.9 effN=124.3
2011a2 N=52.7 effN=43
1998a5 N=18.7 effN=59.3
2002a3 N=17 effN=43.6
2005a5 N=30.6 effN=68.5
2009a2 N=52.7 effN=118.2
2011a7 N=18.7 effN=16.7
1999a2 N=6.8 effN=18.3
2002a5 N=17 effN=62.4
2006a5 N=23.8 effN=126.9
2009a5 N=1.7 effN=1.1
2012a7 N=17 effN=17.4
1999a5 N=15.3 effN=59.8
2003a3 N=11.9 effN=47.4
2007a2 N=13.6 effN=56.9
2009a7 N=13.6 effN=46.9
2000a5 N=20.4 effN=81.5
2003a5 N=32.3 effN=29.1
2007a5 N=27.2 effN=83
2010a2 N=51 effN=51.9
2001a3 N=1.7 effN=3.9
2004a3 N=10.2 effN=50.6
2008a2 N=15.3 effN=70.8
2010a7 N=6.8 effN=56.4
Proportion
Age (yr)

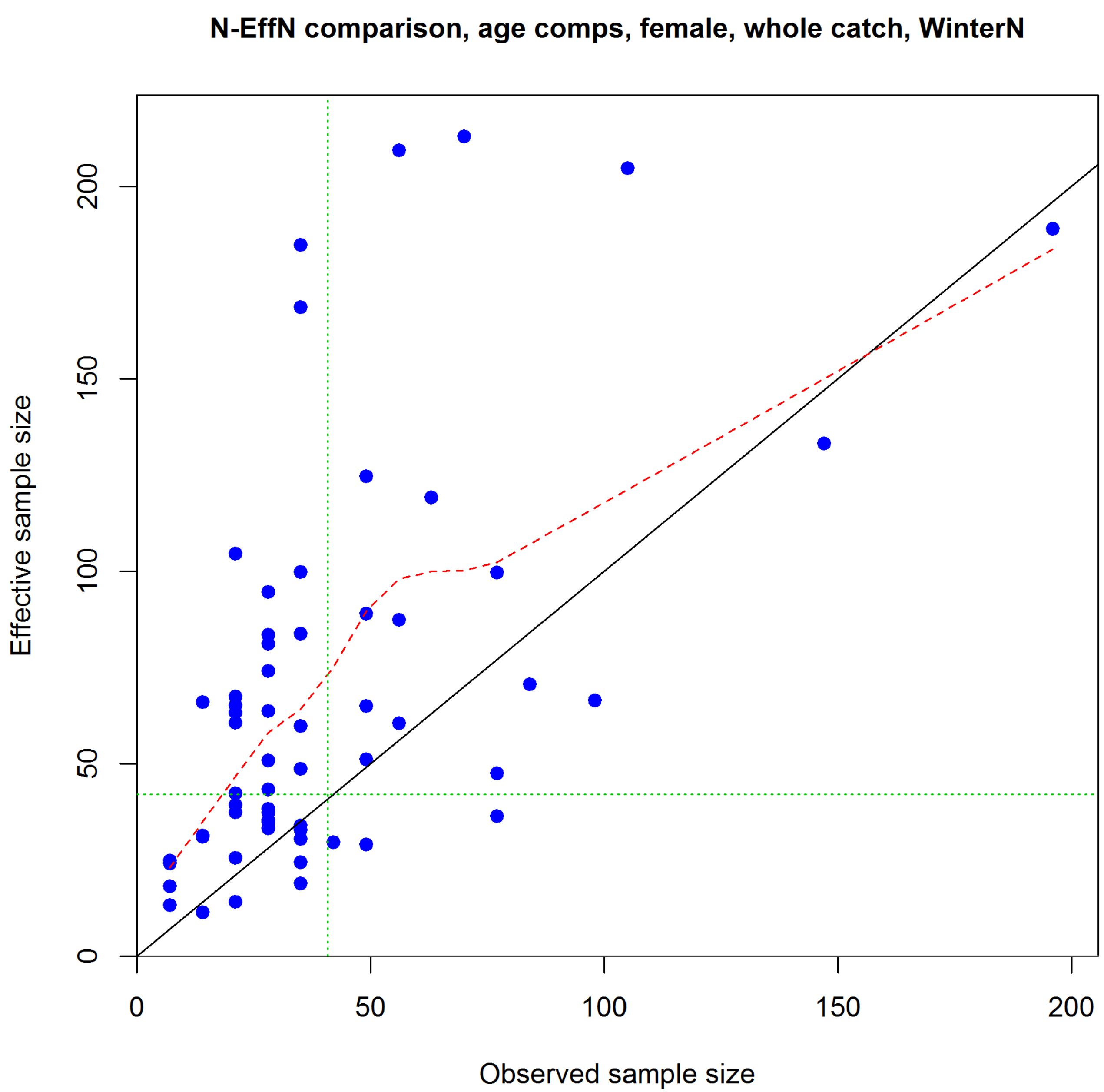

age comps, female, whole catch, WinterS
Proportion
Age (yr)
1966 N=15.2 effN=32.3
1973 N=22.8 effN=27.5
1979 N=9.5 effN=37.2
1985 N=3.8 effN=9.7
1991 N=28.5 effN=53.7
2008 N=5.7 effN=34.8
1967 N=24.7 effN=24.9
1974 N=55.1 effN=167.3
1980 N=11.4 effN=19.6
1986 N=7.6 effN=31.7
1992 N=1.9 effN=26.2
2009 N=7.6 effN=29.2
1969 N=15.2 effN=60.5
1975 N=17.1 effN=10.5
1981 N=34.2 effN=65.9
1987 N=19 effN=84.5
2003 N=1.9 effN=17.1
1970 N=19 effN=23.5
1976 N=22.8 effN=59.1
1982 N=1.9 effN=28.5
1988 N=9.5 effN=56.9
2004 N=1.9 effN=0.9
1971 N=11.4 effN=34.3
1977 N=15.2 effN=59.2
1983 N=22.8 effN=84
1989 N=3.8 effN=8.6
2005 N=5.7 effN=15.6
1972 N=43.7 effN=211.8
1978 N=17.1 effN=62.2
1984 N=11.4 effN=54.3
1990 N=3.8 effN=5.2
2006 N=3.8 effN=17

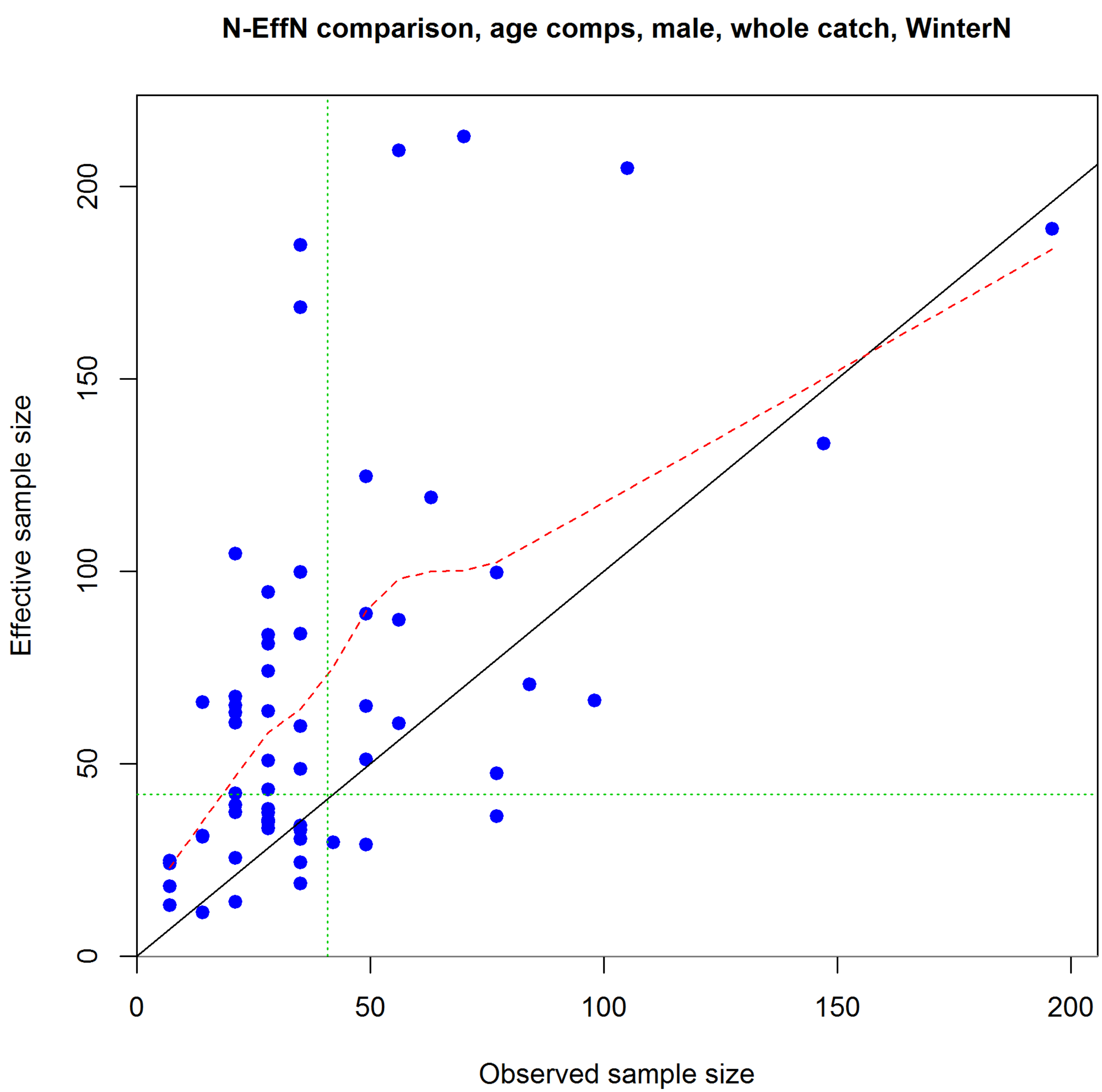

age comps, male, whole catch, WinterS
1966 N=15.2 effN=32.3
1973 N=22.8 effN=27.5
1979 N=9.5 effN=37.2
1985 N=3.8 effN=9.7
1991 N=28.5 effN=53.7
2008 N=5.7 effN=34.8
1967 N=24.7 effN=24.9
1974 N=55.1 effN=167.3
1980 N=11.4 effN=19.6
1986 N=7.6 effN=31.7
1992 N=1.9 effN=26.2
2009 N=7.6 effN=29.2
1969 N=15.2 effN=60.5
1975 N=17.1 effN=10.5
1981 N=34.2 effN=65.9
1987 N=19 effN=84.5
2003 N=1.9 effN=17.1
1970 N=19 effN=23.5
1976 N=22.8 effN=59.1
1982 N=1.9 effN=28.5
1988 N=9.5 effN=56.9
2004 N=1.9 effN=0.9
1971 N=11.4 effN=34.3
1977 N=15.2 effN=59.2
1983 N=22.8 effN=84
1989 N=3.8 effN=8.6
2005 N=5.7 effN=15.6
1972 N=43.7 effN=211.8
1978 N=17.1 effN=62.2
1984 N=11.4 effN=54.3
1990 N=3.8 effN=5.2
2006 N=3.8 effN=17
Proportion
Age (yr)

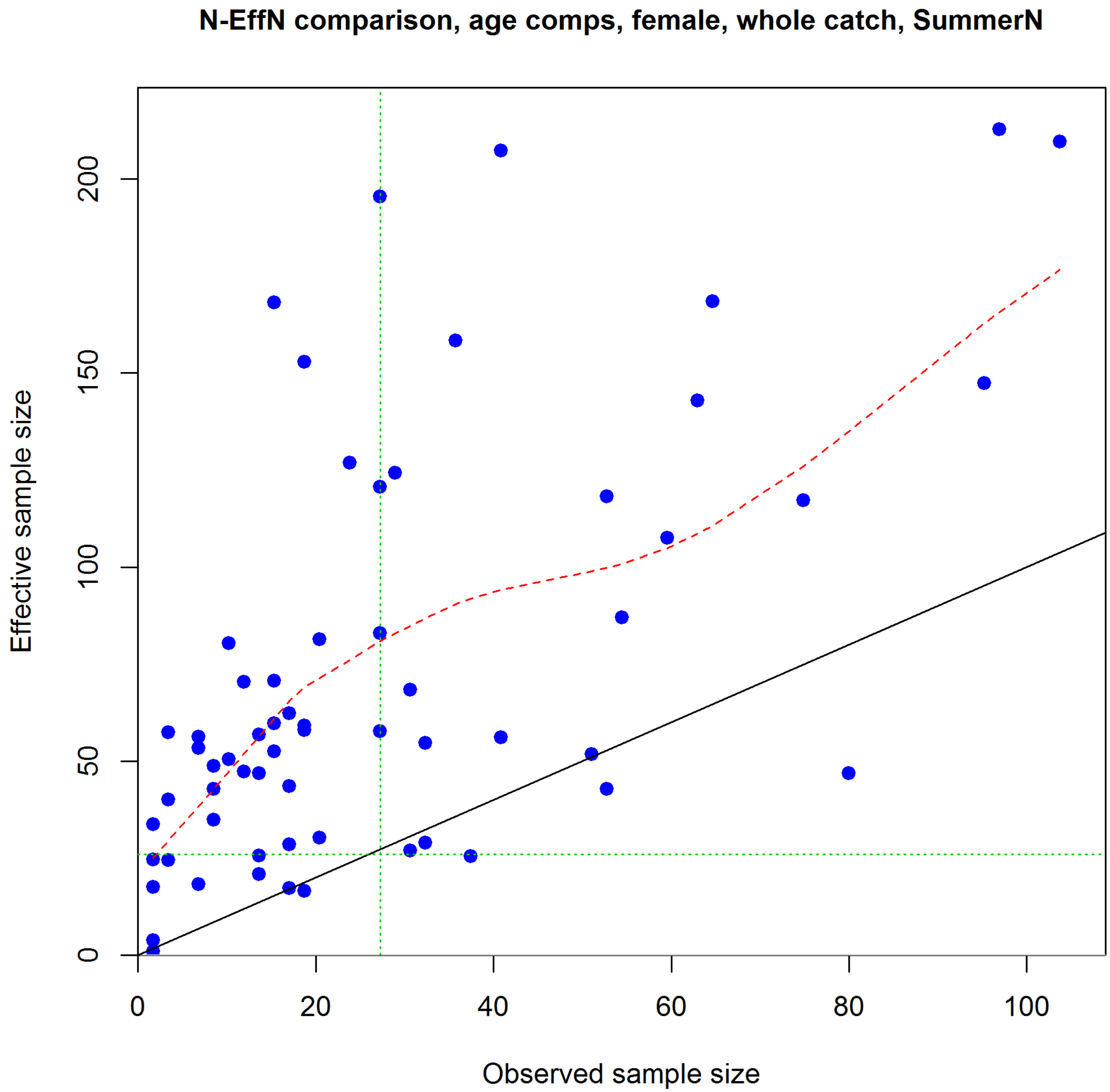

age comps, female, whole catch, SummerS
Proportion
Age (yr)
1966 N=37.8 effN=39.7
1972 N=53.2 effN=156.4
1978 N=44.8 effN=115.7
1984 N=4.2 effN=23.4
2005 N=14 effN=36.2
1967 N=15.4 effN=83.6
1973 N=53.2 effN=92.1
1979 N=15.4 effN=77.8
1985 N=5.6 effN=33.3
2006 N=9.8 effN=46.7
1968 N=78.4 effN=74
1974 N=47.6 effN=84.7
1980 N=70 effN=214.4
1986 N=22.4 effN=50.9
2008 N=25.2 effN=37.6
1969 N=43.4 effN=261.2
1975 N=25.2 effN=136
1981 N=37.8 effN=213.2
1987 N=16.8 effN=49.7
2009 N=4.2 effN=3.2
1970 N=40.6 effN=32.5
1976 N=32.2 effN=53.7
1982 N=25.2 effN=51.1
1988 N=8.4 effN=66.5
1971 N=51.8 effN=427.9
1977 N=46.2 effN=103.9
1983 N=11.2 effN=22.7
2003 N=7 effN=12


age comps, male, whole catch, SummerS
Proportion
Age (yr)
1966 N=37.8 effN=39.7
1972 N=53.2 effN=156.4
1978 N=44.8 effN=115.7
1984 N=4.2 effN=23.4
2005 N=14 effN=36.2
1967 N=15.4 effN=83.6
1973 N=53.2 effN=92.1
1979 N=15.4 effN=77.8
1985 N=5.6 effN=33.3
2006 N=9.8 effN=46.7
1968 N=78.4 effN=74
1974 N=47.6 effN=84.7
1980 N=70 effN=214.4
1986 N=22.4 effN=50.9
2008 N=25.2 effN=37.6
1969 N=43.4 effN=261.2
1975 N=25.2 effN=136
1981 N=37.8 effN=213.2
1987 N=16.8 effN=49.7
2009 N=4.2 effN=3.2
1970 N=40.6 effN=32.5
1976 N=32.2 effN=53.7
1982 N=25.2 effN=51.1
1988 N=8.4 effN=66.5
1971 N=51.8 effN=427.9
1977 N=46.2 effN=103.9
1983 N=11.2 effN=22.7
2003 N=7 effN=12

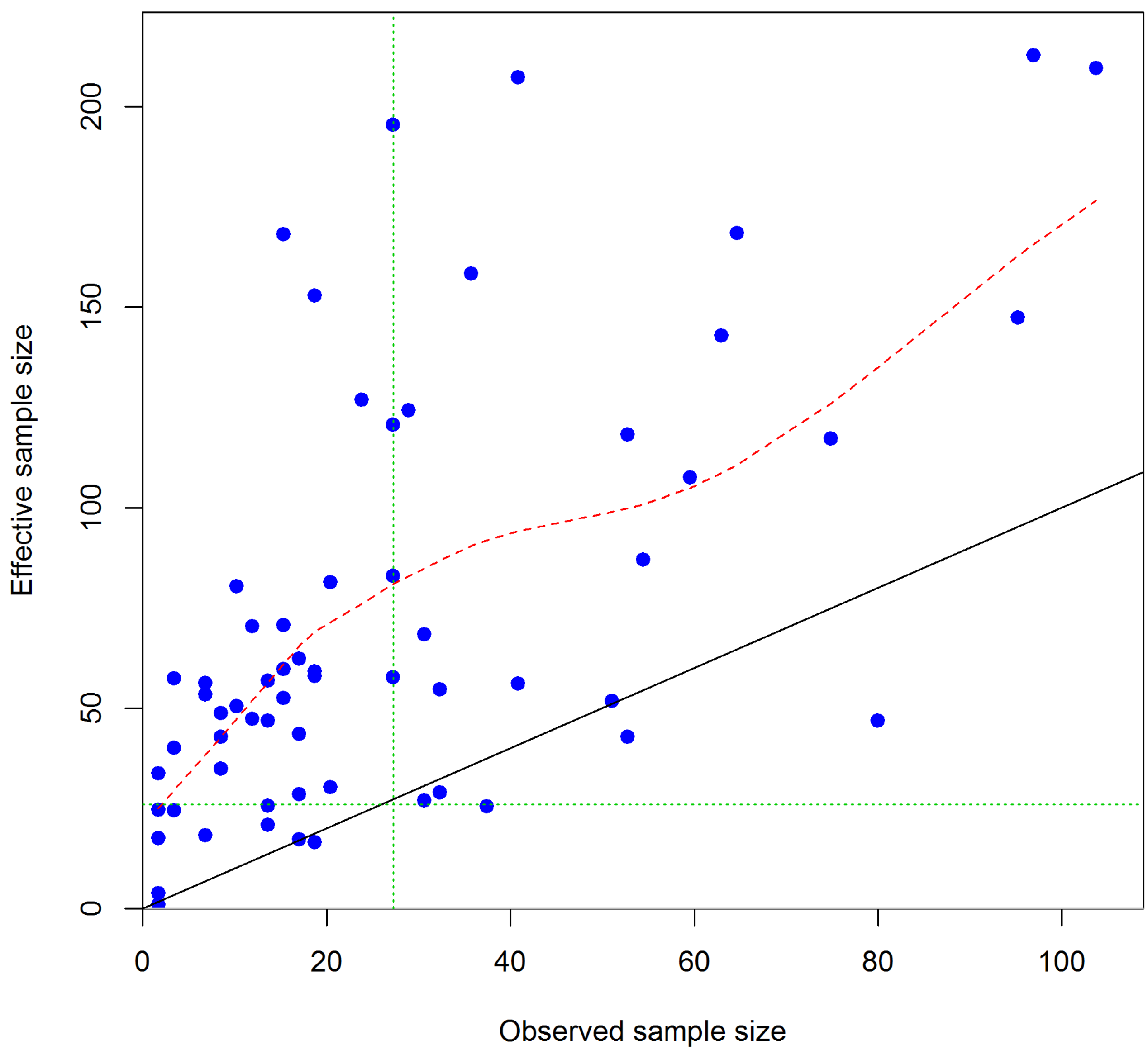
Appendix H.15. Fishery age composition effective sample sizes


N-EffN comparison, age comps, female, whole catch, WinterN
Effective sample size
Observed sample size
0
50
100
150
200
0
50
100
150
200

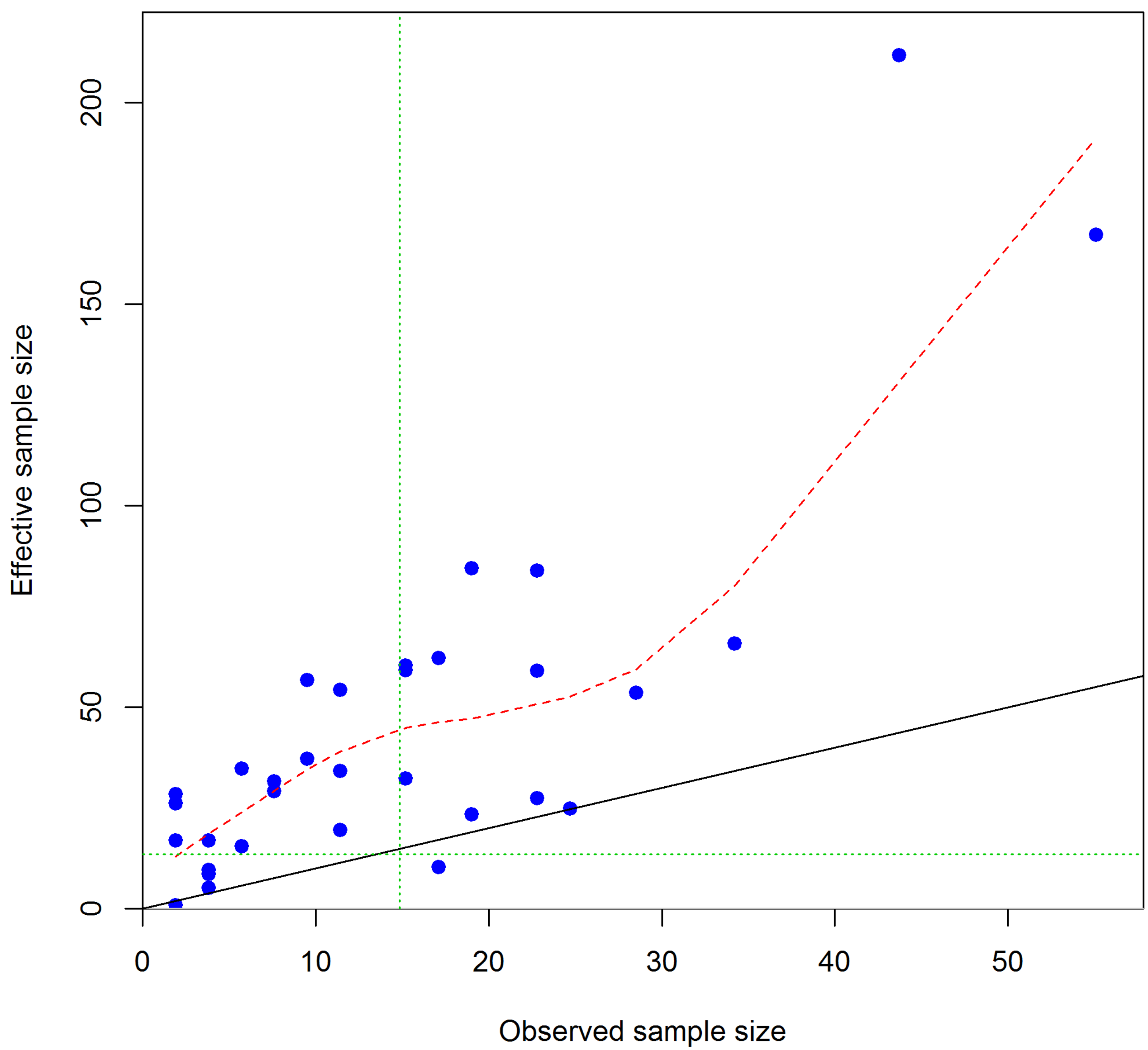

N-EffN comparison, age comps, male, whole catch, WinterN
Effective sample size
Observed sample size
0
50
100
150
200
0
50
100
150
200

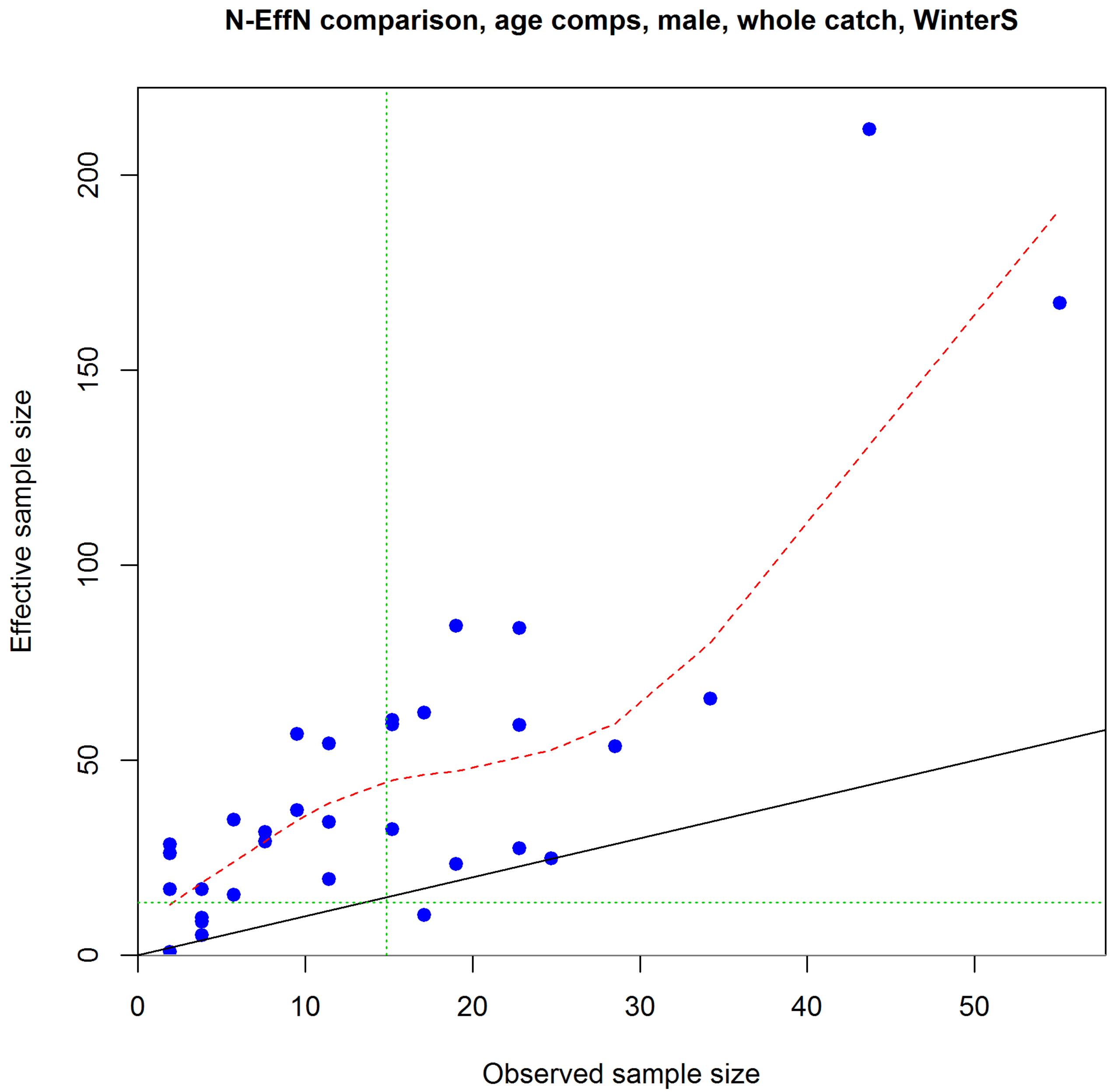

N-EffN comparison, age comps, female, whole catch, SummerN
Effective sample size
Observed sample size
0
50
100
150
200
0
20
40
60
80
100

N-EffN comparison, age comps, male, whole catch, SummerN

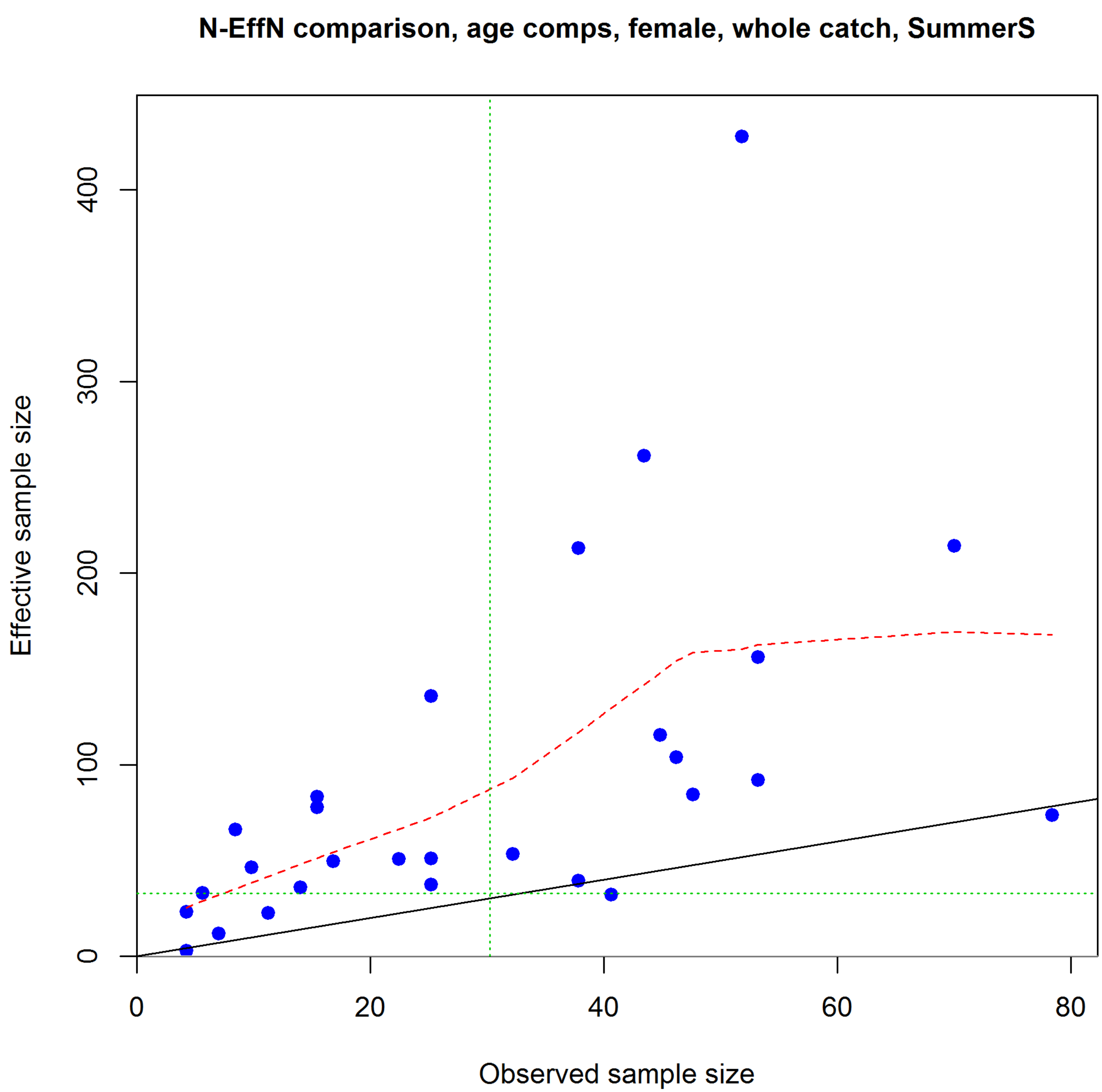


N-EffN comparison, age comps, female, whole catch, WinterS

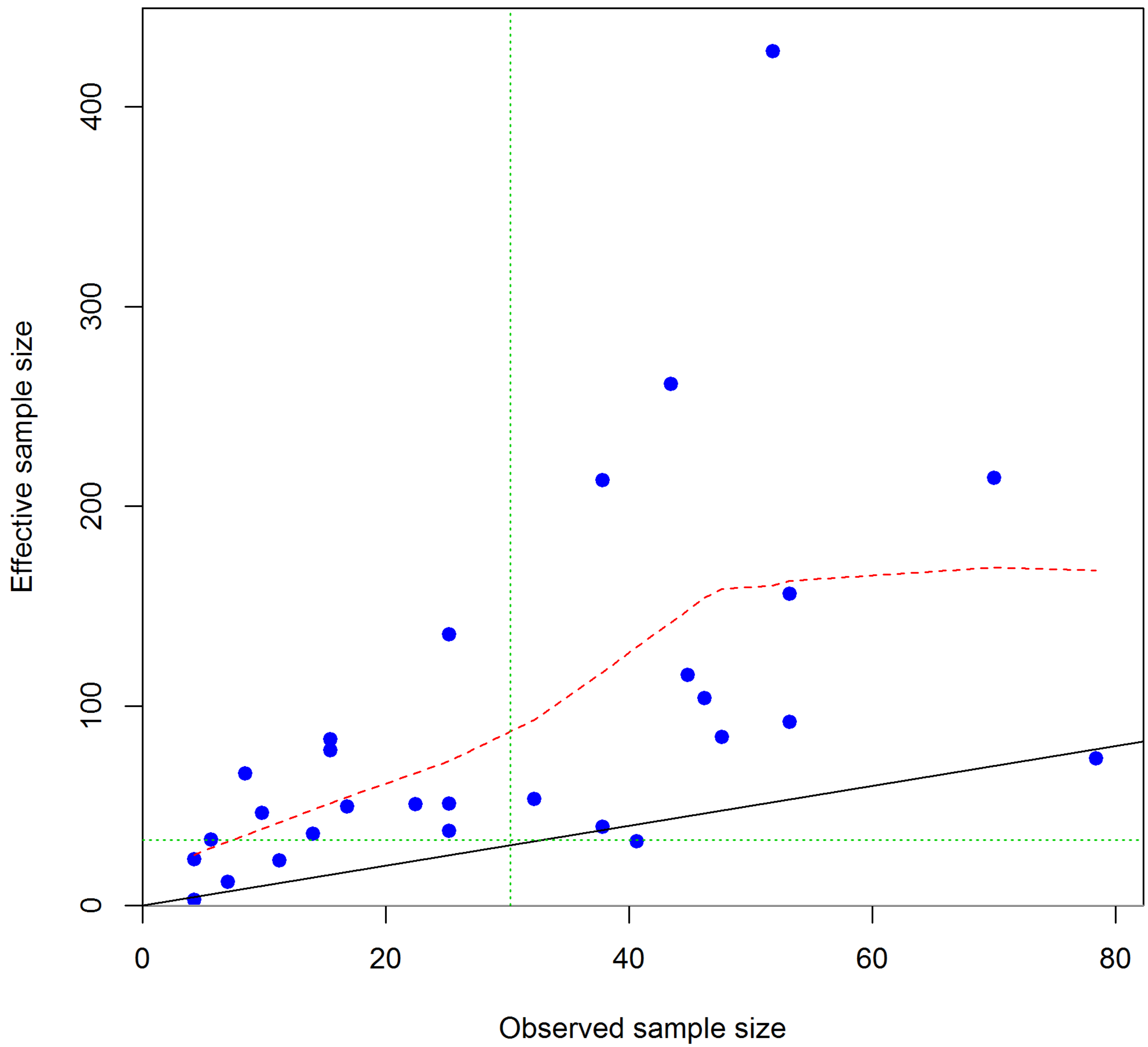




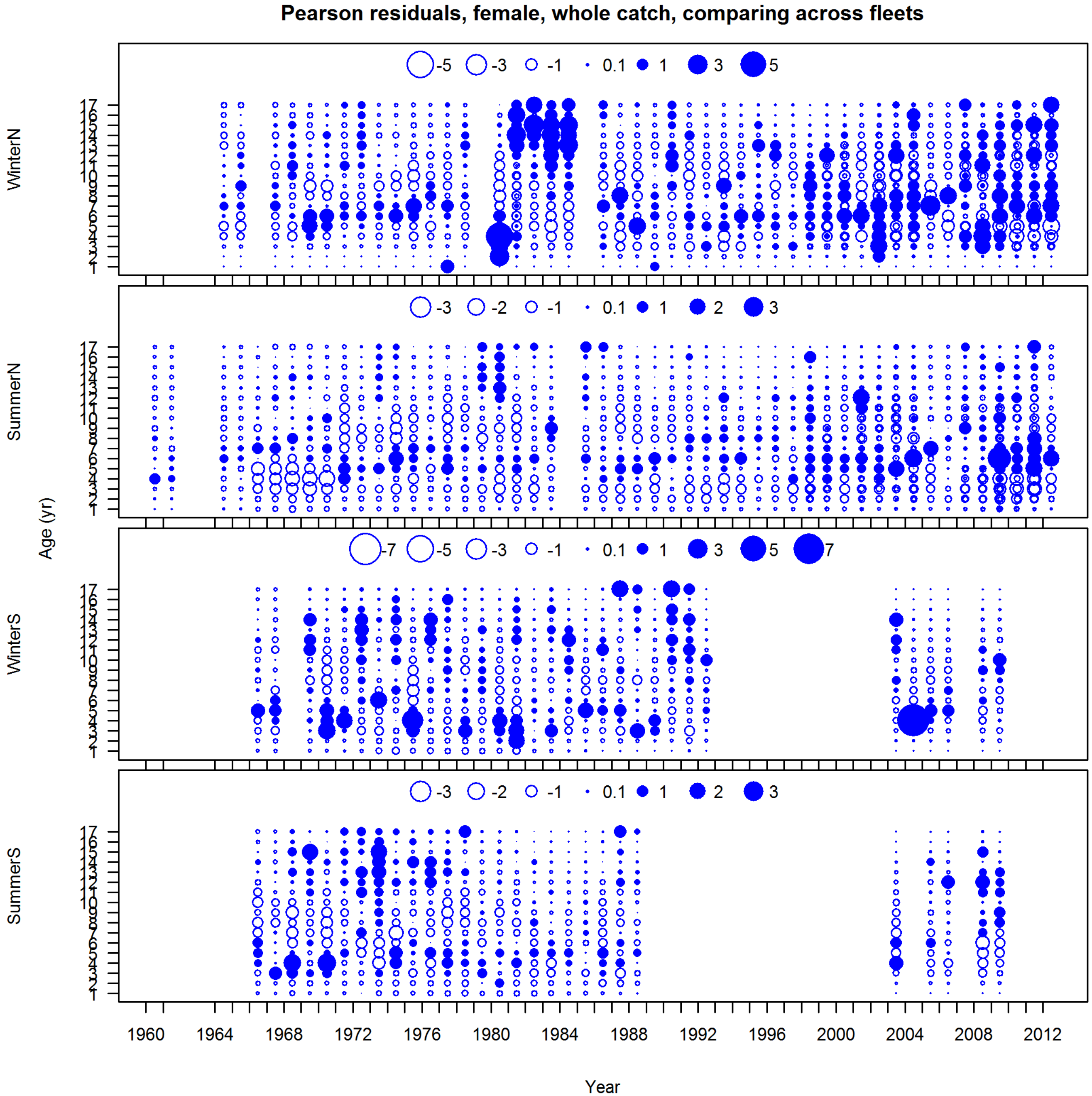
N-EffN comparison, age comps, male, whole catch, WinterS
Effective sample size
Observed sample size
0
50
100
150
200
0
10
20
30
40
50


N-EffN comparison, age comps, female, whole catch, SummerS
Effective sample size
0
100
200
300
400
0
20
40
60
80
Observed sample size

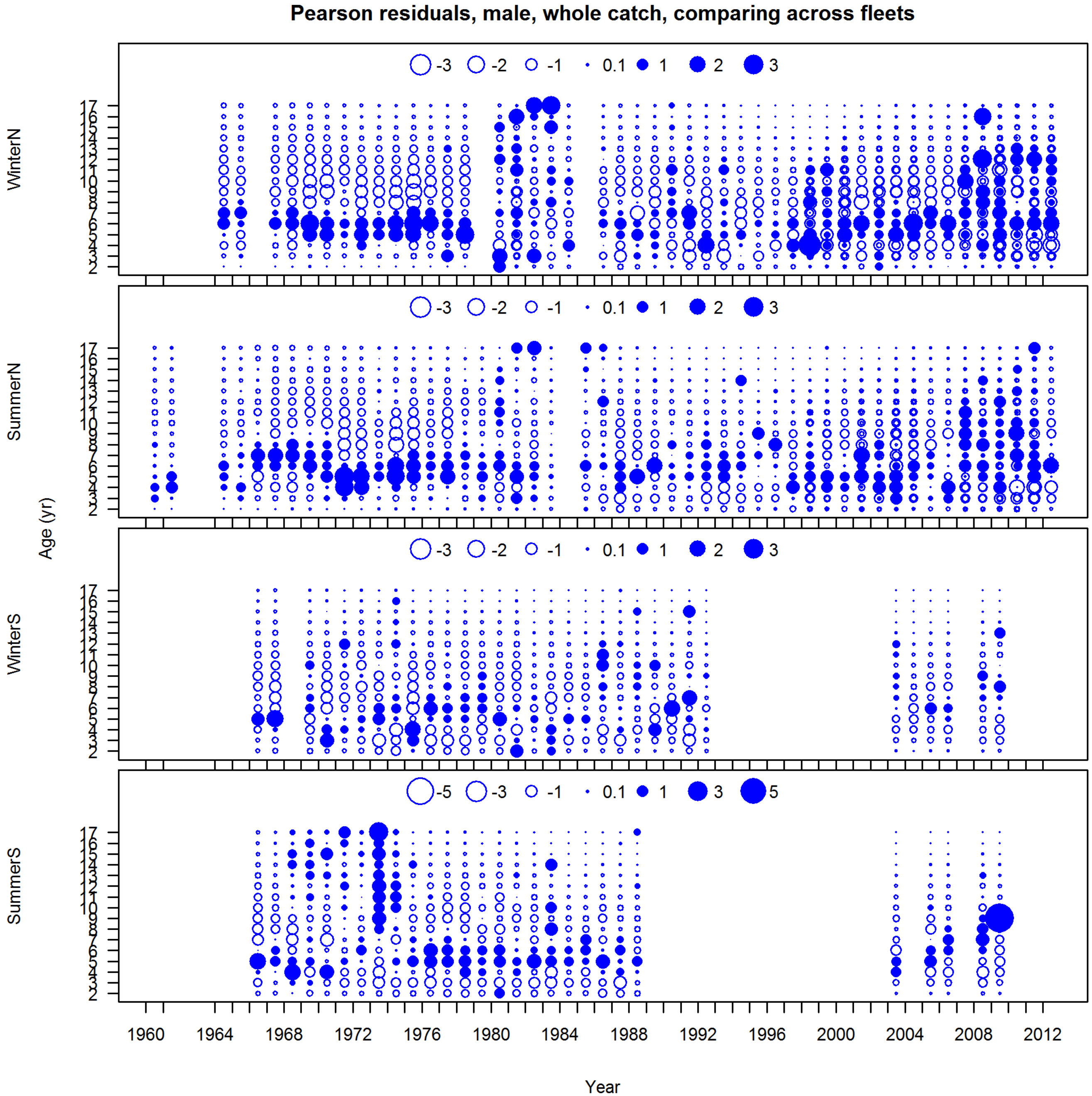
N-EffN comparison, age comps, male, whole catch, SummerS



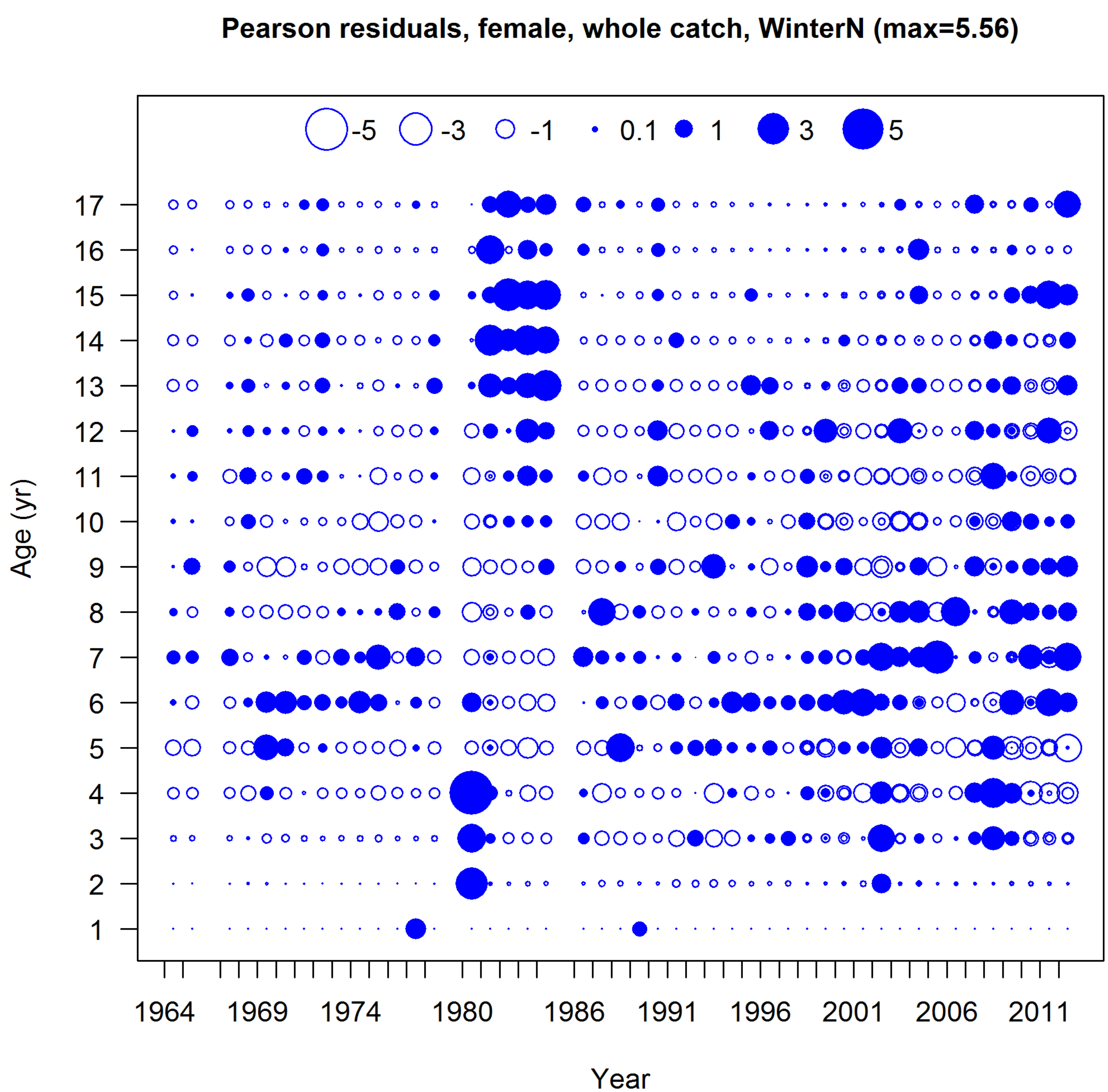
Appendix H.16. Fishery age composition Pearson residuals



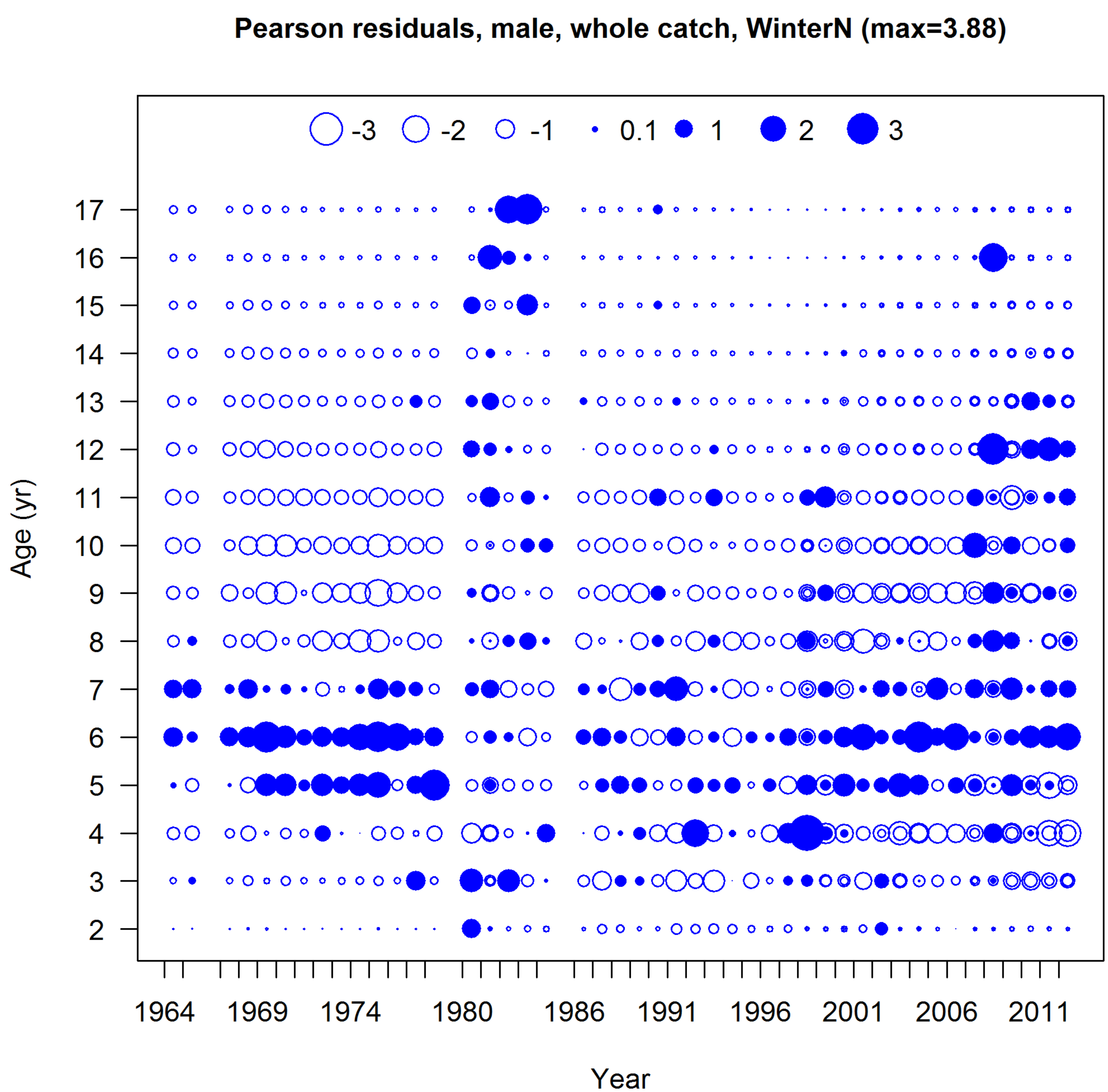
Pearson residuals, female, whole catch, comparing across fleets
-5 -3 -1 0.1 1 3 5
WinterN
-3 -2 -1 0.1 1 2 3
SummerN
-7 -5 -3 -1 0.1 1 3 5 7
WinterS
-3 -2 -1 0.1 1 2 3
SummerS
Age (yr)
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012
Year



Pearson residuals, male, whole catch, comparing across fleets
-3 -2 -1 0.1 1 2 3
-5 -3 -1 0.1 1 3 5
WinterN
SummerN
WinterS
SummerS
Age (yr)
Year
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012

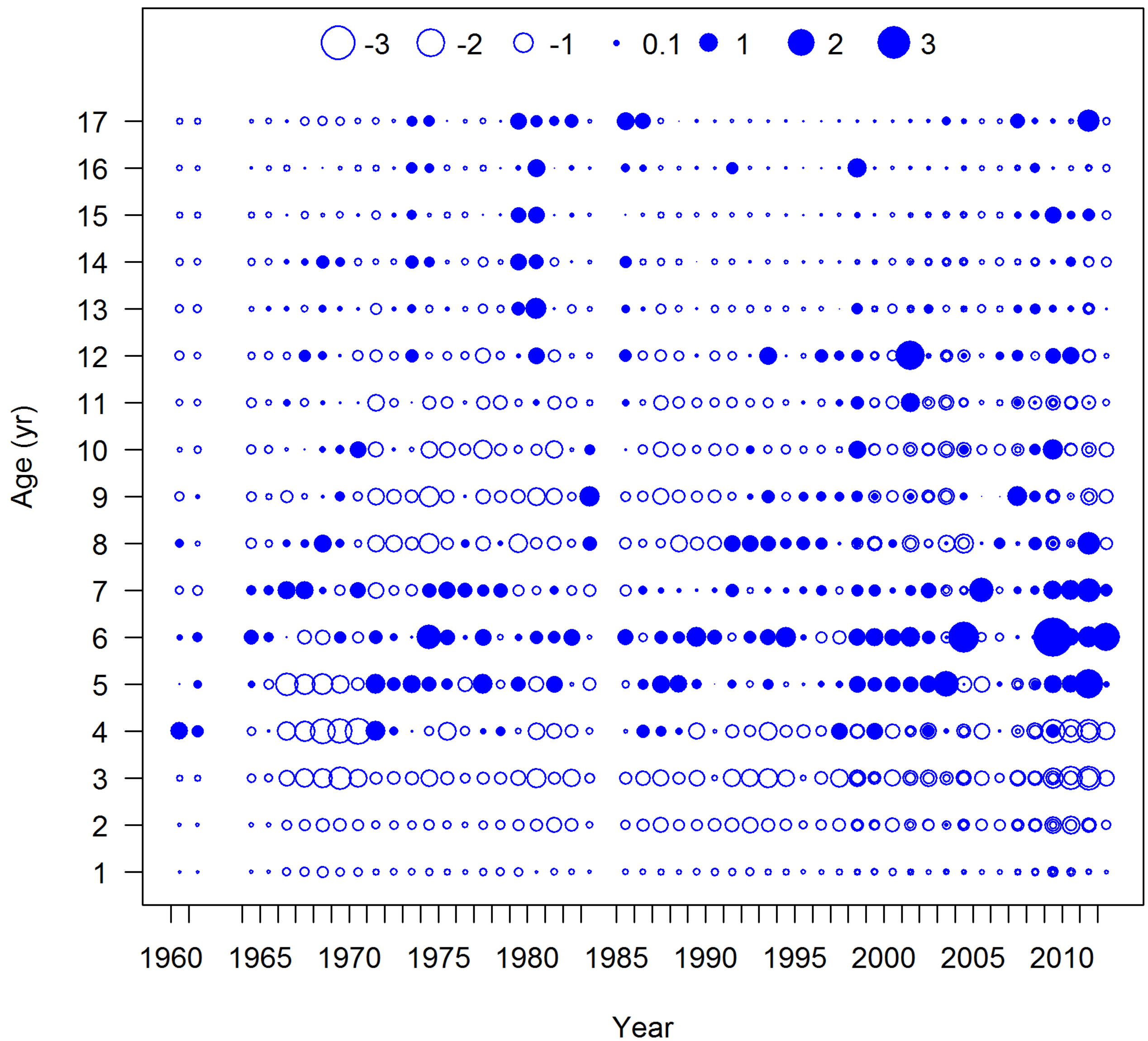


Pearson residuals, female, whole catch, WinterN (max=5.56)
-5
-3
-1
0.1
1
3
5
Age (yr)
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1964
1969
1974
1980
1986
1991
1996
2001
2006
2011
Year

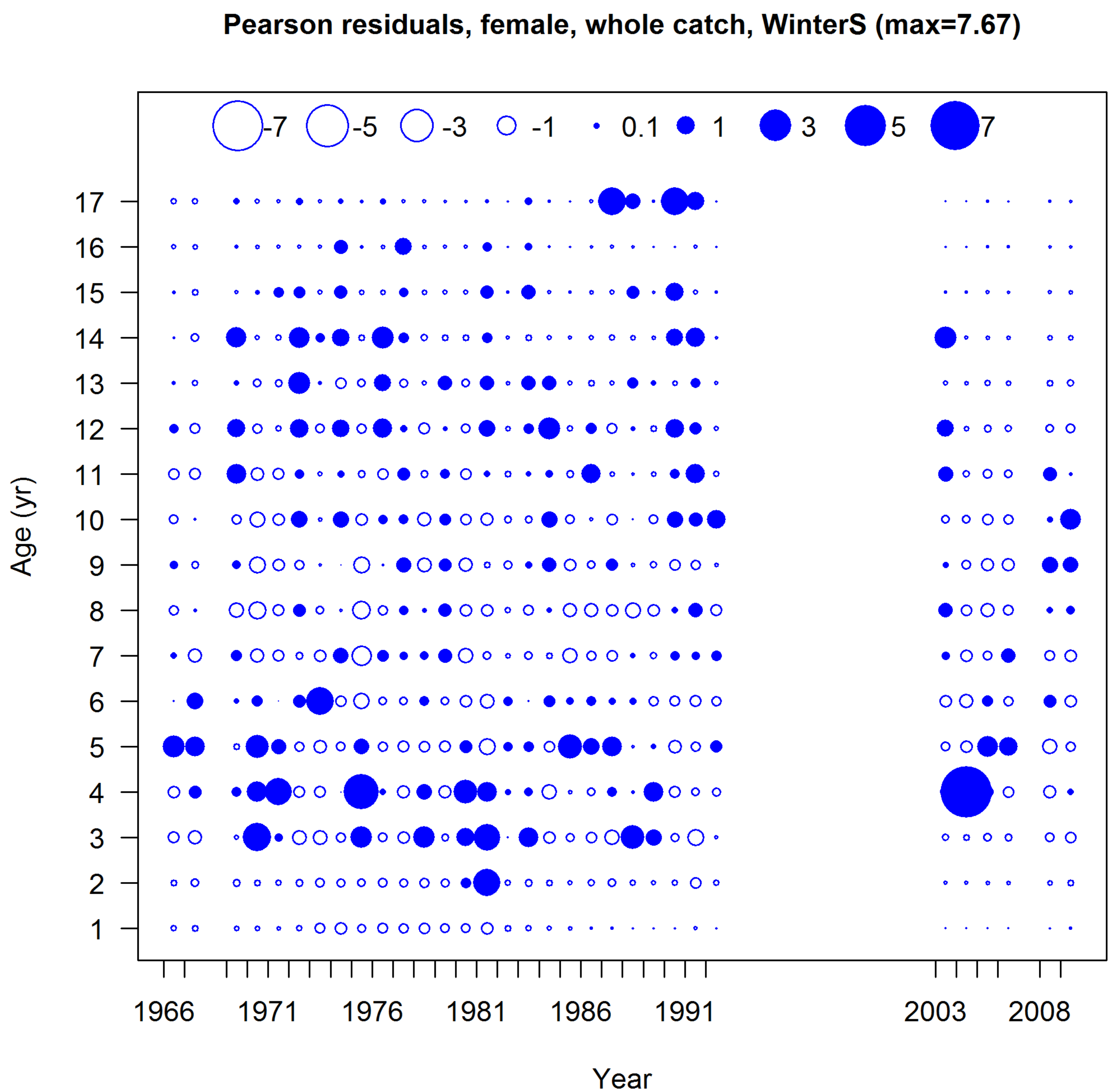


Pearson residuals, male, whole catch, WinterN (max=3.88)
-3
-2
-1
0.1
1
2
3
Age (yr)
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1964
1969
1974
1980
1986
1991
1996
2001
2006
2011
Year

Pearson residuals, female, whole catch, SummerN (max=4.23)

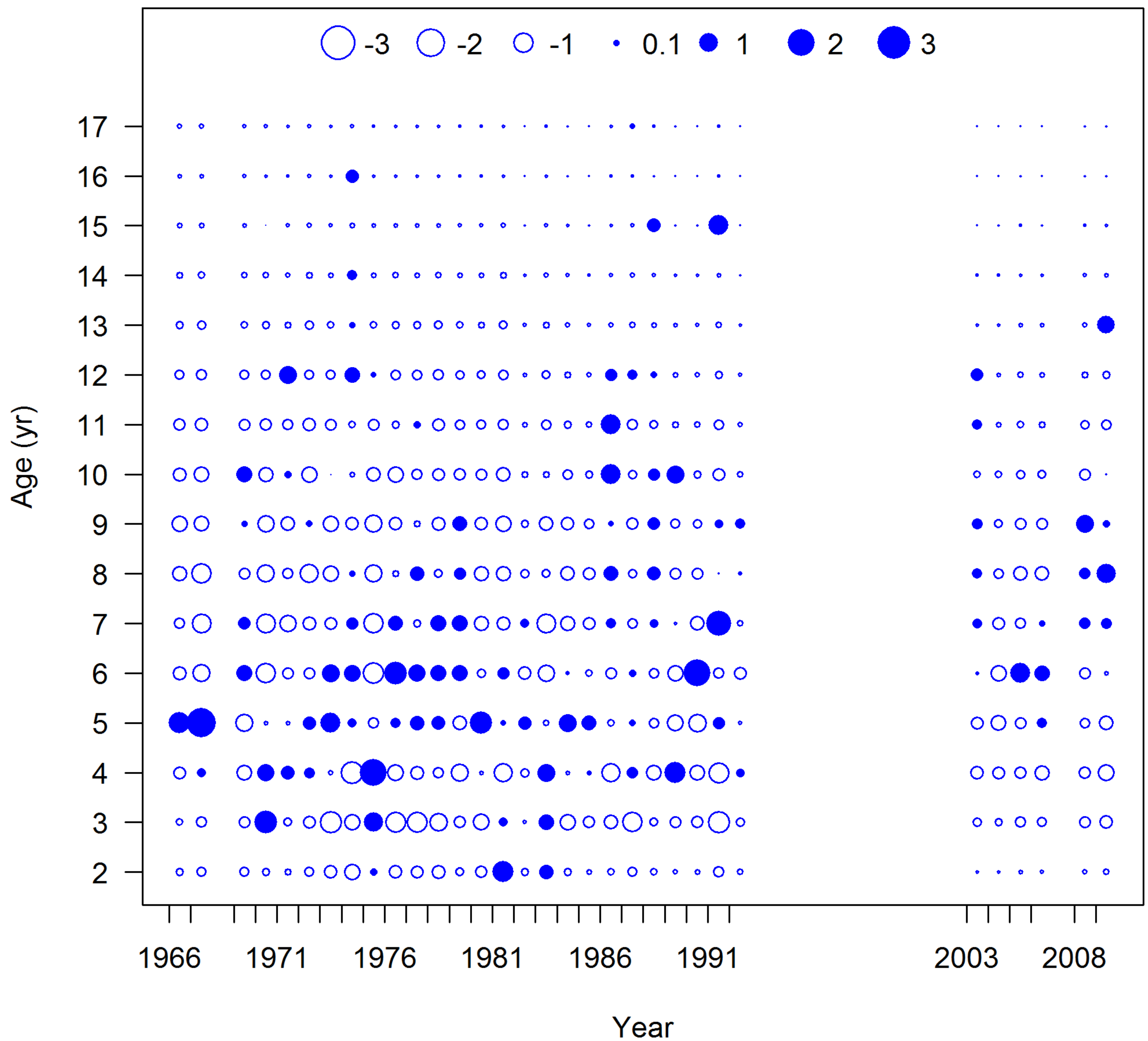



Pearson residuals, male, whole catch, SummerN (max=3)
-3
-2
-1
0.1
1
2
3
Age (yr)
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Year
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

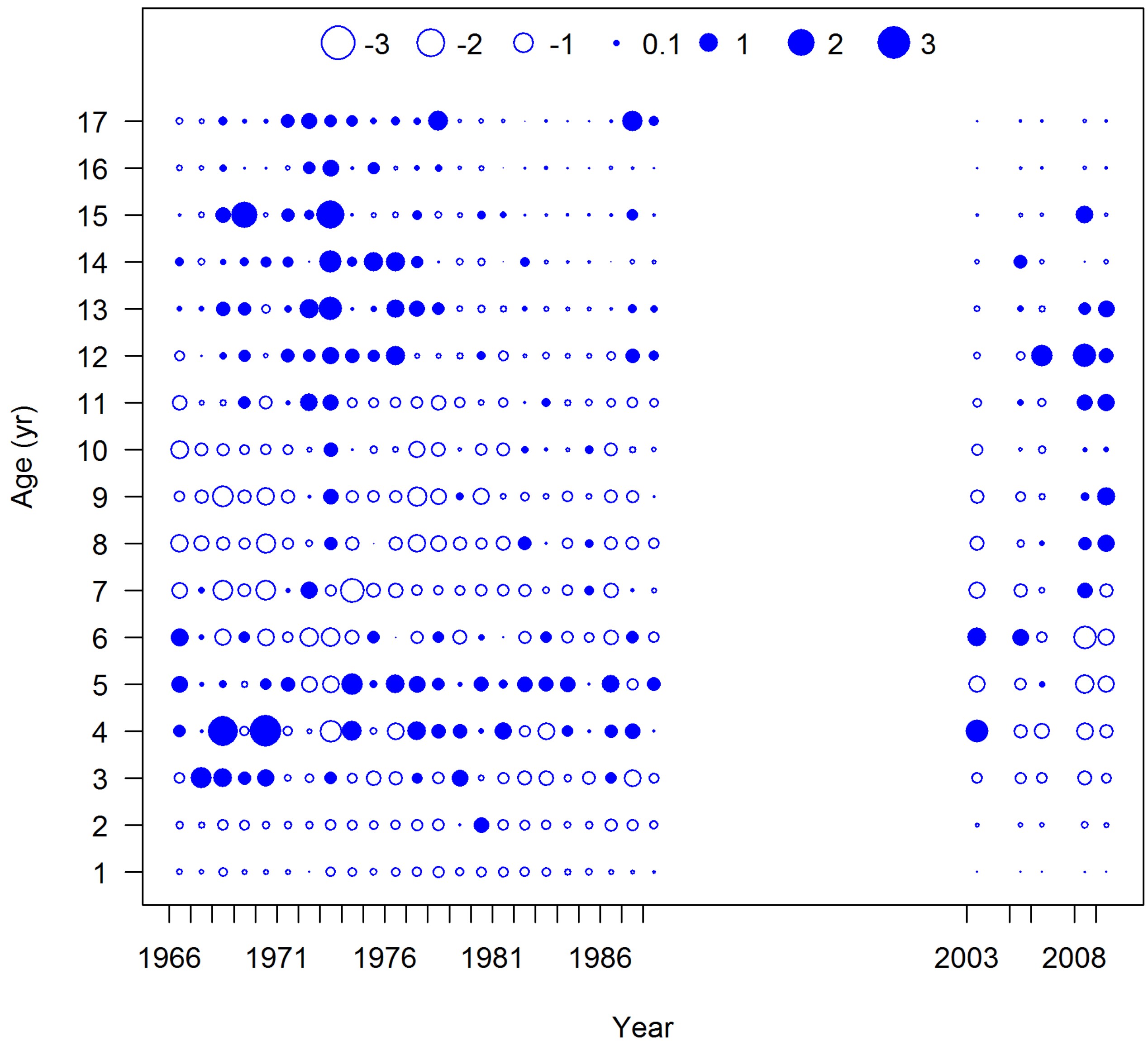


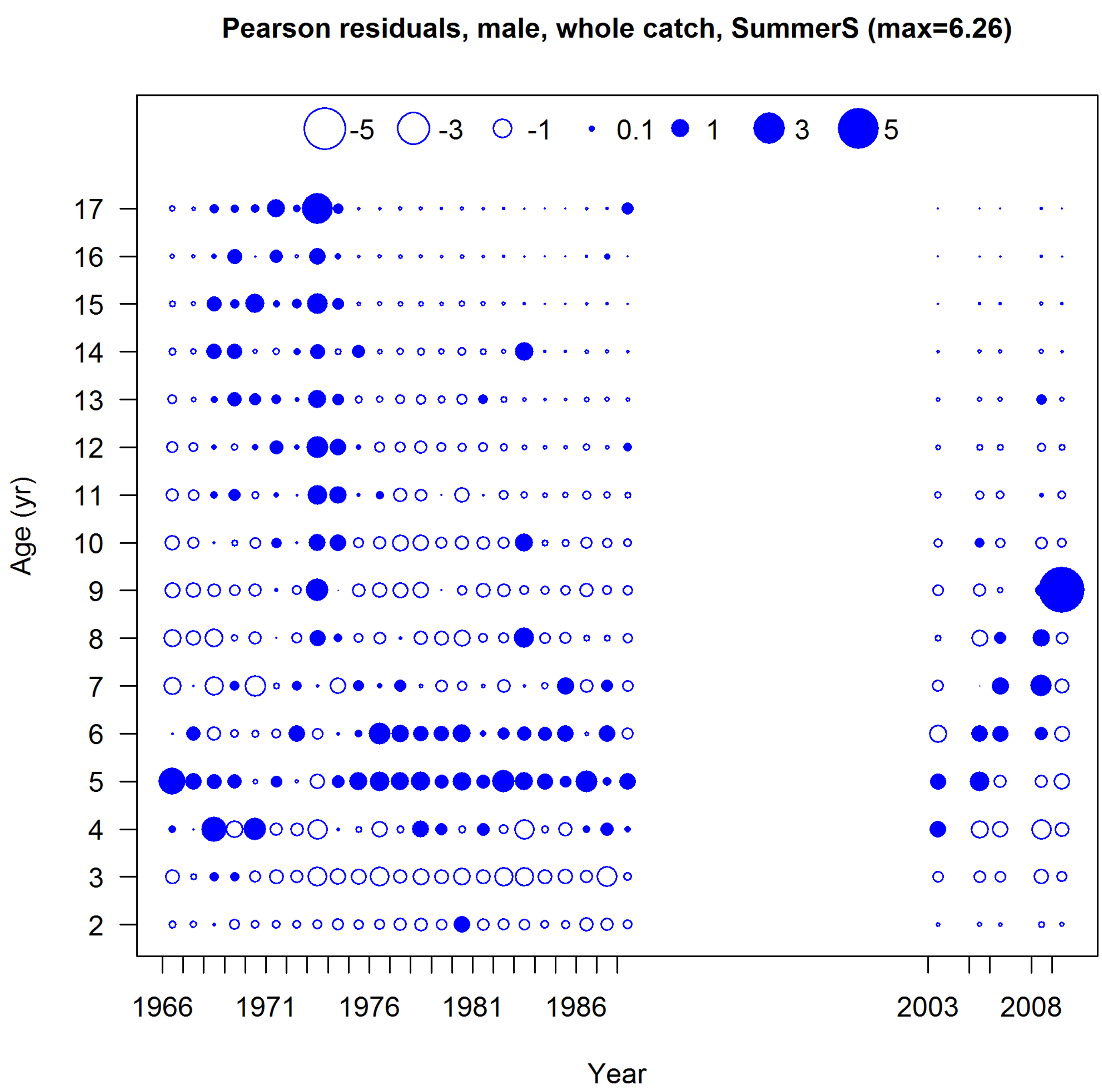
Pearson residuals, female, whole catch, WinterS (max=7.67)
-7
-5
-3
-1
0.1
1
3
5
7
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Age (yr)
1966
1971
1976
1981
1986
1991
2003
2008
Year

Pearson residuals, male, whole catch, WinterS (max=2.39)



Pearson residuals, female, whole catch, SummerS (max=2.75)




Pearson residuals, male, whole catch, SummerS (max=6.26)
-5
-3
-1
0.1
1
3
5
Age (yr)
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1966
1971
1976
1981
1986
2003
2008
Year

Appendix I. Base model numbers at age

See Excel spreadsheet titled Petrale2013Base-NatAge