The Status of Dover Sole (*Microstomus pacificus*) along the U.S. West Coast in 2011

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Executive Summary

Stock

This is an assessment of Dover sole (*Microstomus pacificus*) that reside in the waters off California, Oregon and Washington from the U.S./Canadian border in the north to the U.S./Mexico border in the south. Dover sole are also harvested from the waters off British Columbia and in the Gulf of Alaska, and although those catches were not included in this assessment, it is not certain if those populations contribute to the biomass of Dover sole off of the U.S. West Coast.

Landings

Dover sole were first landed in California in the early part of the 20th century and the fishery began increasing landings in Oregon and Washington in the 1940's. Landings remained relatively constant throughout the 1950's and 1960's before increasing rapidly into the early 1990's. Subsequently, the landings declined (mostly in California) until 2007 when harvest guidelines increased the allowable catch. Groundfish trawl fisheries land the majority of Dover sole while fixed gears, shrimp trawls, and recreational fisheries make up a very small amount of fishing mortality. Some discarding of Dover sole occurs in the fisheries, and appears to have different patterns based on location. These discards were estimated in the model and total catches are reported, as opposed to landings.

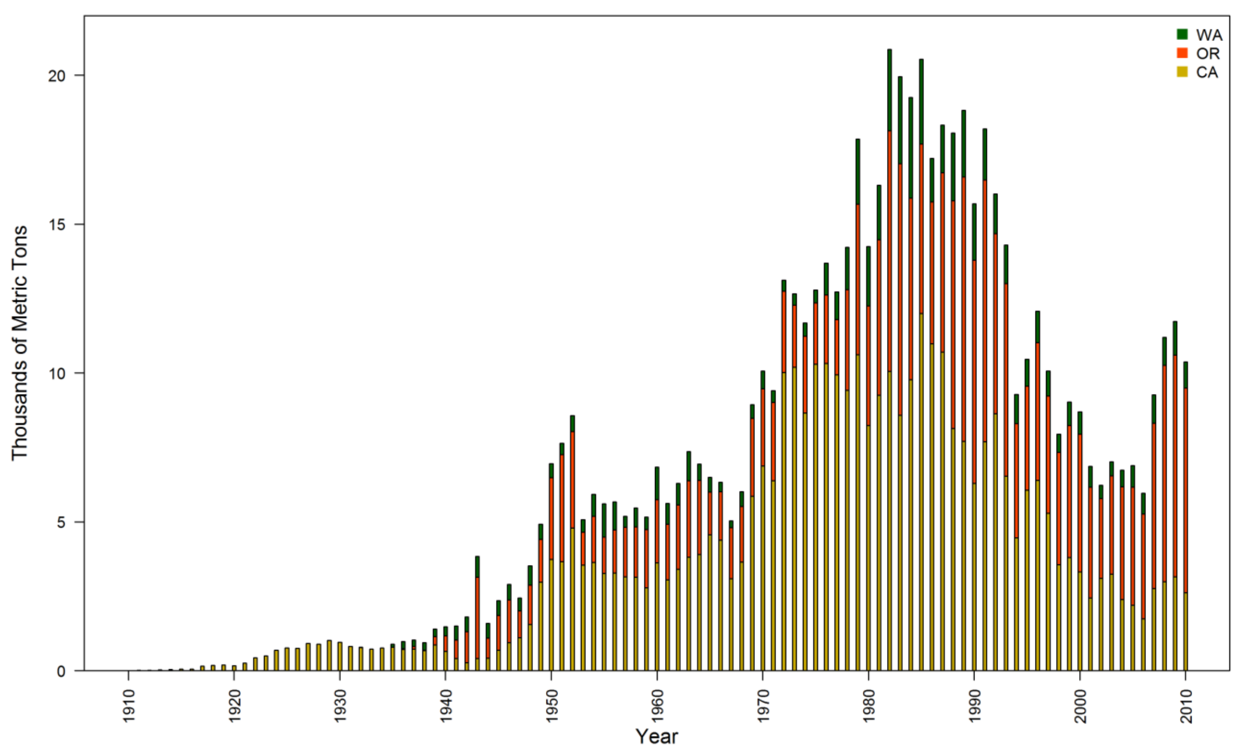

Figure a. Total Dover sole landings used in this assessment, by state from 1910-2010.

Table a. Recent commercial fishery landings (mt).

Year	CA	OR	WA	TOTAL
2001	2,446	3,715	704	6,865
2002	3,100	2,690	444	6,234
2003	3,239	3,313	465	7,017
2004	2,384	3,799	550	6,733
2005	2,202	3,969	721	6,892
2006	1,740	3,523	694	5,957
2007	2,759	5,550	955	9,264
2008	2,992	7,260	952	11,204
2009	3,154	7,452	1,125	11,731
2010	2,614	6,879	882	10,375

Data and Assessment

Dover sole off the west coast of the U.S. was assessed here using the length- and age-structured model Stock Synthesis (version 3.12f). The last assessment was done in 2005 and showed the stock to be increasing with a 2005 depletion level at 63.2% of virgin spawning biomass. This new assessment treats the commercial fleets differently than the 2005 assessment by separating them by states. In addition, new types of selectivity curves were used that allowed increased flexibility in shape, and natural mortality was estimated for males and females separately.

Population parameters were estimated using fishery landings, length data, and age data from state-specific fishing fleets, abundance indices and length data from the National Marine Fisheries Service (NMFS) triennial survey and the Alaska Fishery Science Center (AFSC) slope survey, and abundance indices, length data, and age data from the Northwest Fisheries Science Center (NWFSC) slope and shelf/slope surveys. The Triennial survey was split into two series (1980–1992 and 1995–2004) based on changes in survey timing. The extension of the NWFSC shelf/slope survey was new to this assessment and added a considerable amount of information, including age data which were fit in the model as conditional age-at-length vectors. Additionally, recent data on discarding collected by the West Coast Groundfish Observer Program (WCGOP), including length data, were used to determine retention curves and selectivity for the commercial fleets.

The base case model estimated parameters for male and female selectivity and retention curves based on length for all of the state-specific fishing fleets, gender-specific selectivity curves for the four surveys, length-at-age relationships for males and females, natural mortality for males and females, and recruitment deviations starting in 1910. A steepness parameter was fixed at 0.8 and not estimated.

Uncertainty for the parameter estimates and derived quantities was determined in two ways. First, approximate asymptotic 95% confidence intervals based on maximum likelihood theory were calculated using the base model. Second, fixed values of natural mortality were varied above and below the values assumed in the base model to define a range for the states of nature.

Although there is a plethora of data available for Dover sole, which were used in this assessment, there is little information about natural mortality, steepness, and historical recruitment. Estimates of steepness are uncertain partly because the stock has not been fished to low levels. Uncertainty in natural mortality appears to be related to some inconsistencies between length data and age data. These data indicate that larger fish tend to be caught deeper, at least in the summer, but there was no trend of age with depth. There was, however, a trend in sex ratio with depth (as seen in the data collected from the NWFSC shelf/slope survey). The data also showed differences in the overall sex ratios, with age data typically showing a higher proportion of females than the length data. This could be related to sampling and age data being more variable because fewer are sampled, but there also appears to be some behavioral aspects which may contribute to sampled data showing skewed sex ratios. Nevertheless, the uncertainty in M translates to a considerable amount of uncertainty in the estimates of spawning biomass. Finally, there is little information about the levels of historical recruitment mostly due to a lack of historical length or age data. This uncertainty was included in the predictions from this assessment.

Stock Biomass

The estimated spawning biomass has shown a slight decline over the entire time series with two periods of more significant decline (the early 1960's and the 1980's). Even though catches continued to increase in the 1970's, the spawning biomass also increased because of larger than average recruitment in the early 1960's. A period of smaller than average recruitments in the late 1970's and early 1980's along with the highest catches on record caused a decline in spawning biomass throughout the 1980's. More recently, spawning biomass has been increasing, although a recent increase in catch and low estimated recruitment in the early 2000's seem to be resulting in a slight downturn in spawning biomass. The level of depletion is well above the target of 25% of unfished spawning biomass.

Approximate confidence intervals based on the asymptotic variance estimates show that the uncertainty in the estimated spawning biomass is high. Sensitivities showed that this uncertainty can be largely attributed to uncertainty in natural mortality. The estimates of spawning biomass from the 2005 assessment are contained within the intervals estimated from this assessment, but the average spawning biomass from this assessment is approximately 40% larger.

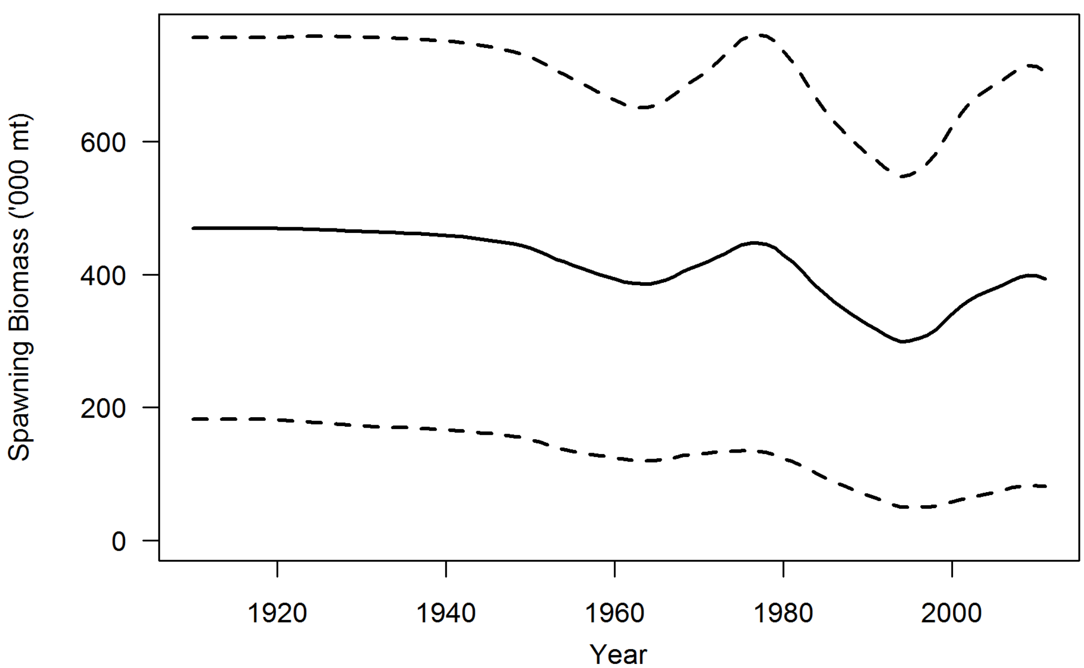

Figure b. Estimated female spawning biomass time-series from the base model (solid line) with an approximate asymptotic 95% confidence interval (thick dashed lines).

Table b. Recent trend in estimated female spawning biomass and relative depletion of the spawning biomass.

Year	Spawning Biomass	~ 95% Confidence Interval	Depletion %	~ 95% Confidence Interval
2002	361,507	64,665–658,349	76.9%	60–94%
2003	368,402	67,455–669,349	78.4%	61–96%
2004	373,512	69,622–677,402	79.5%	63–97%
2005	379,112	72,546–685,678	80.7%	64–98%
2006	384,556	75,519–693,593	81.8%	65–99%
2007	390,893	79,241–702,545	83.2%	67–100%
2008	396,088	81,659–710,517	84.3%	68–101%
2009	398,921	82,761–715,081	84.9%	68–101%
2010	397,836	82,407–713,265	84.7%	68–101%
2011	393,507	81,481–705,533	83.7%	67–100%

Recruitment

Recruitment deviations were estimated for the entire time series modeled. There is little information regarding recruitment prior to 1960, and the uncertainty in these estimates is expressed in the model. Estimates of recruitment appear to oscillate between periods of low recruitment and periods of high recruitment. The five largest recruitments were predicted in the years 2000, 1992, 1988, 1965, and 1991. The five smallest recruitments were predicted in 2003, 2002, 2004, 2006, and 1974.

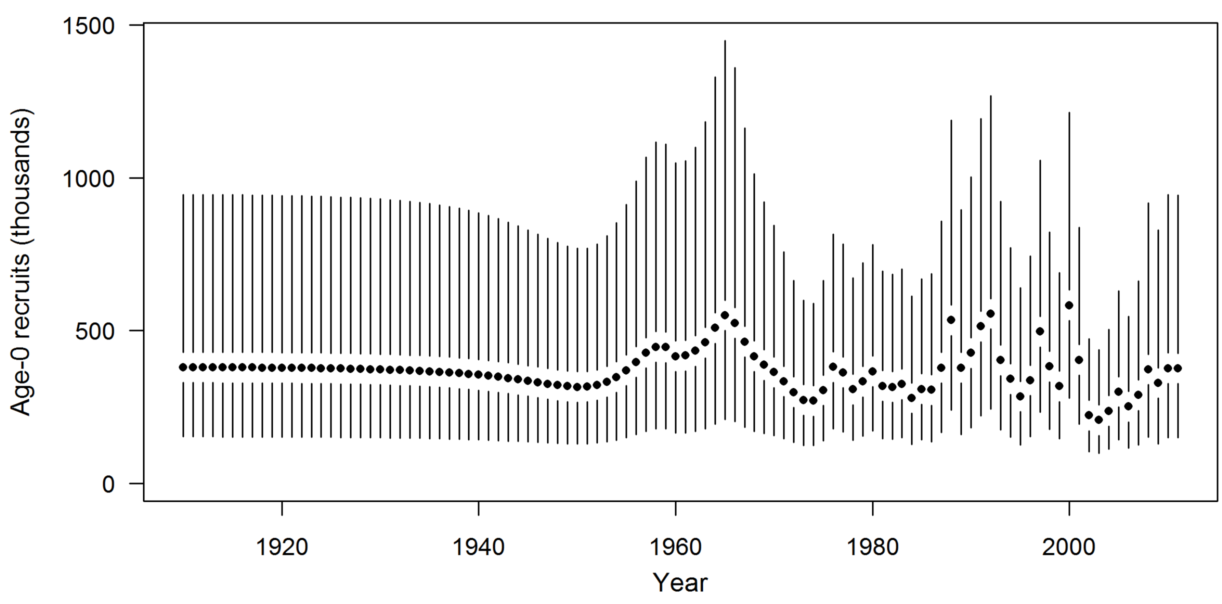

Figure c. Time-series of estimated recruitments for the base case model (round points) with approximate asymptotic 95% confidence interval (vertical bars).

Table c. Recent estimated trend in Dover sole recruitment with approximate 95% confidence intervals determined from the base model.

Year	Recruits	~ 95% confidence interval
2001	403,700	194,708–837,017
2002	222,419	104,697–472,508
2003	207,409	98,173–438,189
2004	237,284	111,899–503,167
2005	299,746	142,559–630,248
2006	251,610	115,888–546,282
2007	288,809	126,046–661,746
2008	372,962	151,584–917,645
2009	328,391	130,124–828,751
2010	376,517	150,161–944,086

Exploitation status

The spawning biomass of Dover sole reached a low in the mid 1990's before beginning to increase throughout the last decade. The estimated depletion has remained above the 25% of unfished spawning biomass target and it is unlikely that the stock has ever fallen below this threshold. Throughout the 1970's, 1980's, and 1990's the exploitation rate and *SPR* generally increased, but never exceeded current estimates of the harvest rate limit ($SPR_{30\%}$). Recent exploitation rates on Dover sole have been small, even after management increased catch levels in 2007.

Table d. Recent trend in spawning potential ratio (entered as 1-SPR) and summary exploitation rate (catch divided by biomass of age-5 and older fish)

Year	Estimated 1-SPR (%)	~95% confidence interval	Harvest rate (proportion)	~95% confidence interval
2001	12.8%	3–22%	1.3%	0.4–2.3
2002	11.6%	3–20%	1.2%	0.3–2.0
2003	12.7%	4–22%	1.3%	0.3–2.2
2004	10.8%	3–19%	1.1%	0.3–1.9
2005	10.9%	3–19%	1.1%	0.3–1.9
2006	9.3%	3–16%	0.9%	0.3–1.6
2007	13.8%	4–23%	1.4%	0.4–2.4
2008	16.2%	5–27%	1.8%	0.5–2.9
2009	17.0%	6–28%	1.9%	0.5–3.1
2010	15.5%	5–26%	1.7%	0.5–2.8

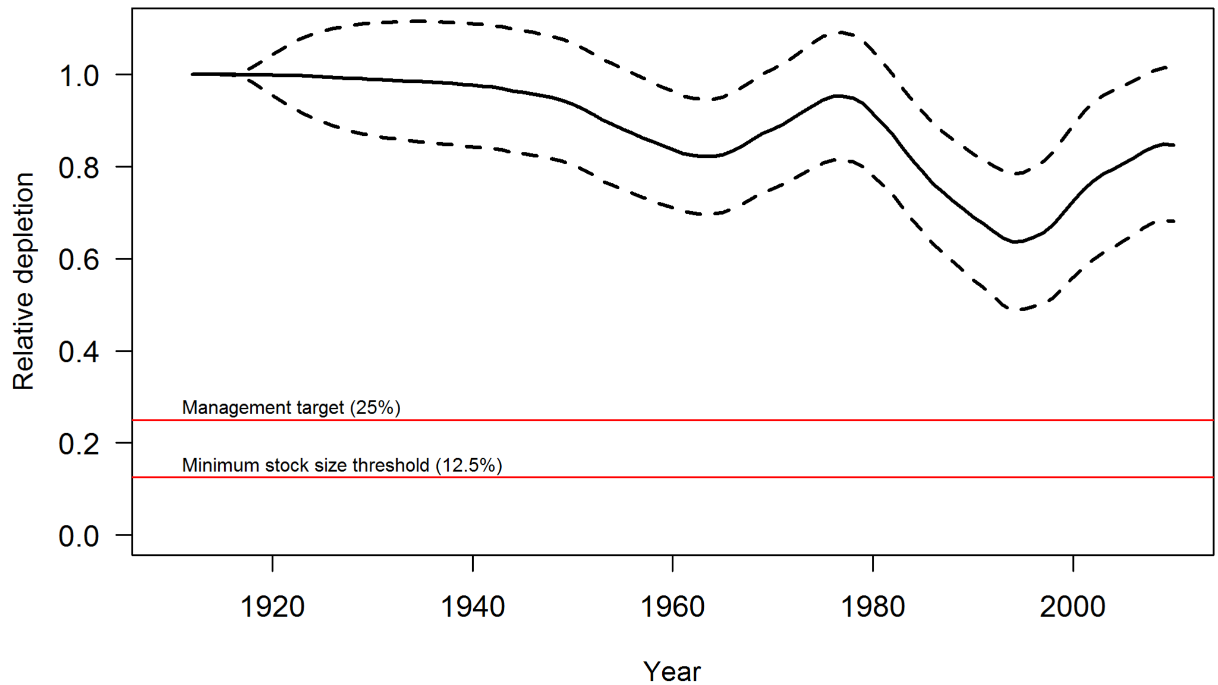

Figure d. Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model.

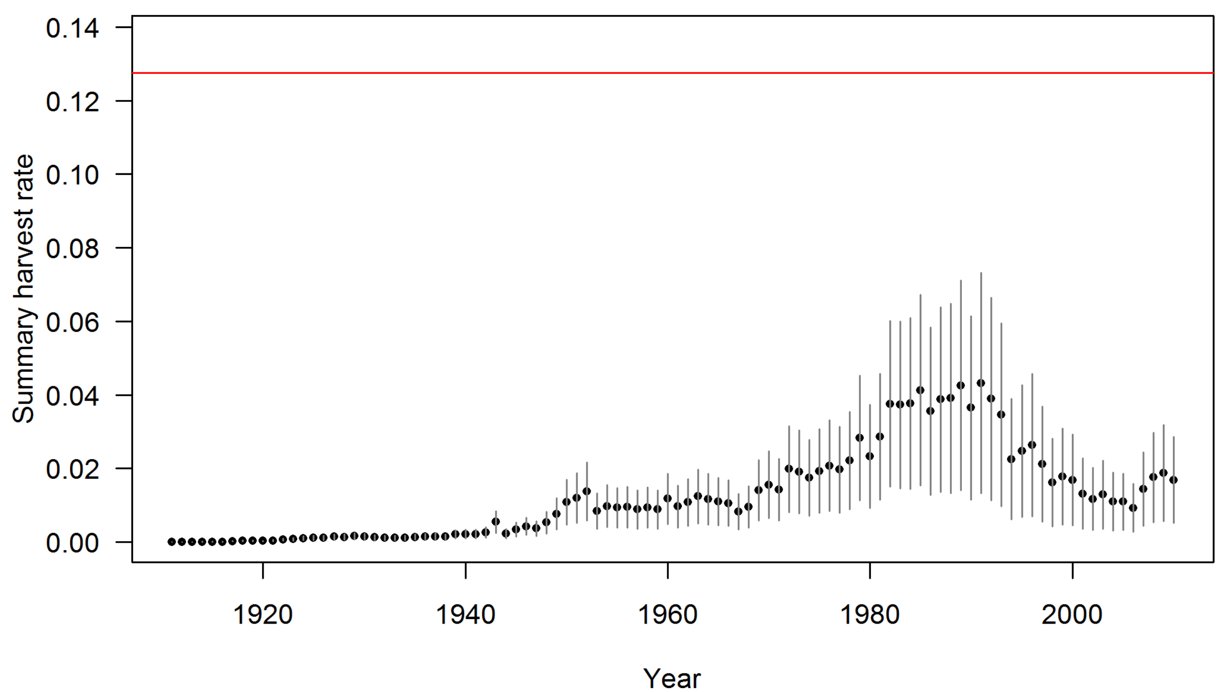

Figure e. Time-series of estimated summary harvest rate (total catch divided by age-5 and older biomass) for the base case model (round points) with approximate 95% asymptotic confidence intervals (grey lines). The red line is the harvest rate at the overfishing proxy using $SPR_{30\%}$.

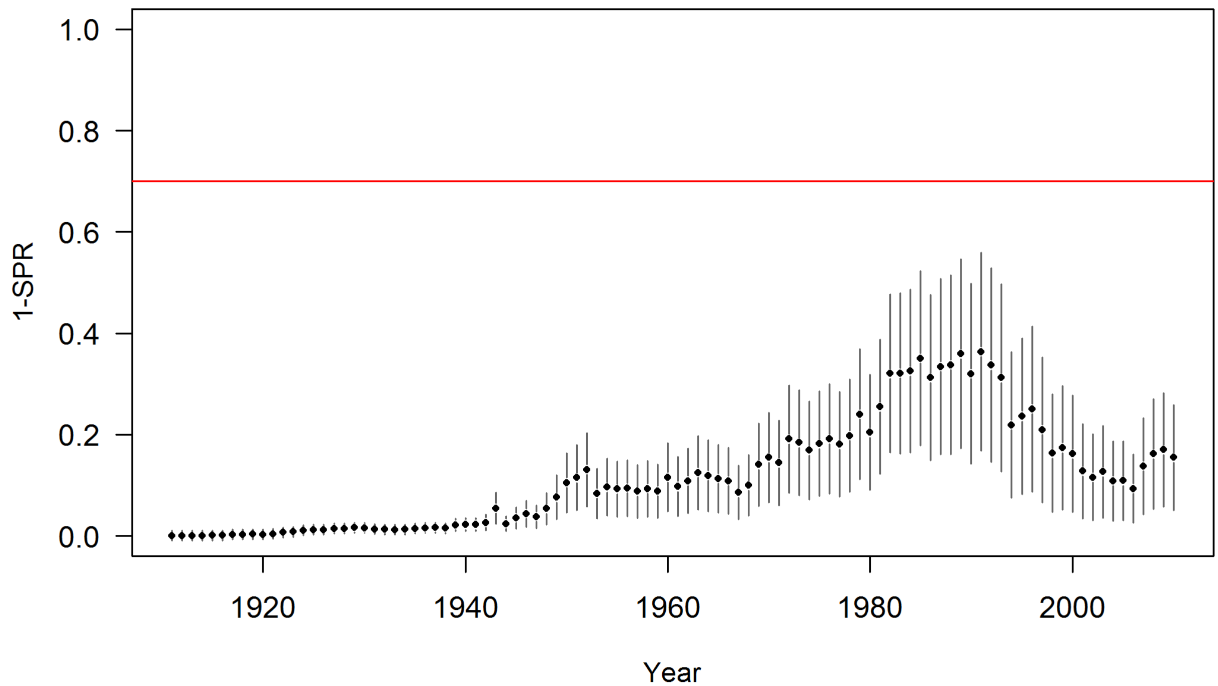

Figure f. Estimated spawning potential ratio (SPR) for the base case model with approximate 95% asymptotic confidence intervals. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{30\%}$.

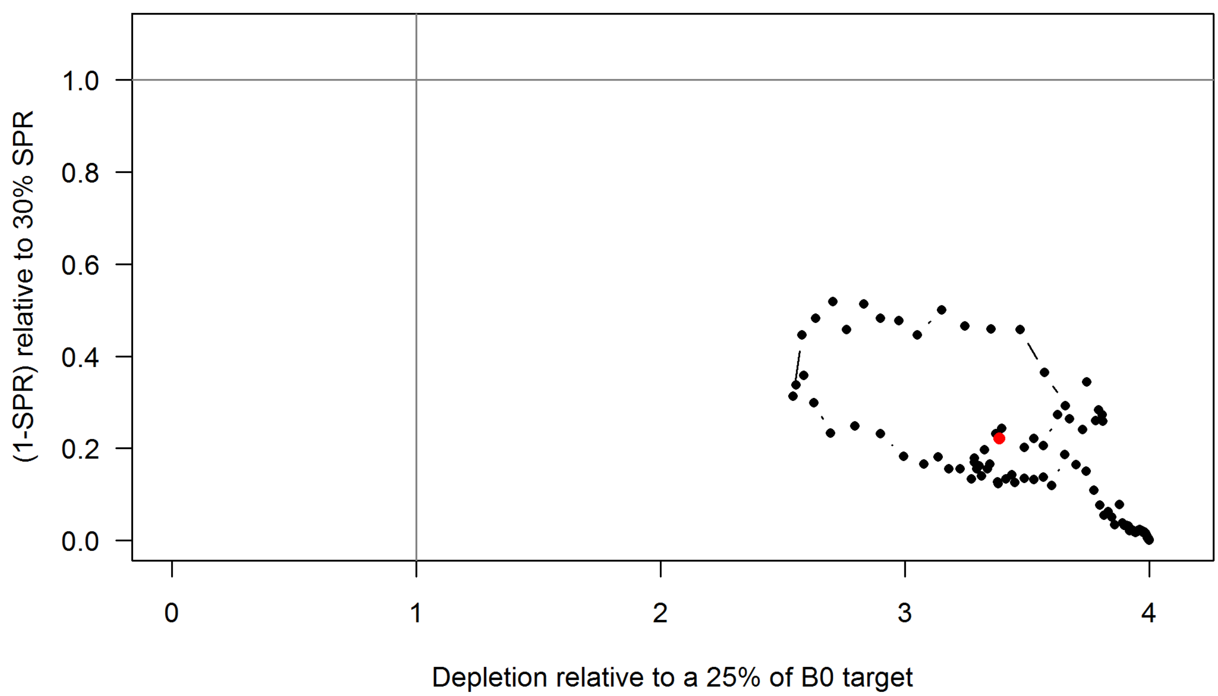

Figure g. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 0.3 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 25% of the unfished spawning biomass. The red point indicates the year 2010.

Reference points

Reference points were calculated using the estimated selectivities and a fleet distribution based on the last three years of landings (2008–2010. Sustainable total yields (landings plus discards) were 35,743 mt when using an $SPR_{30\%}$ reference harvest rate and ranged from 15,403 to 54,098 mt based on estimates of uncertainty. The value for 25% of the unfished spawning output (analogous to B25%) was 117,467 metric tons. The recent catches (landings plus discards) have been slightly less than the lower confidence bound of potential long-term yields calculated using an $SPR_{30\%}$ reference point. As a result, the spawning biomass of the stock has been increasing over the last decade except in the last three years which is partly due to recent low estimated recruitment levels.

Table e. Summary of Dover sole reference points for the base case model. Values are calculated using a fishery distribution based on the average of the landings from 2008 through 2010.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning biomass (mt)	469,866	182,741–756,991
Unfished age 5+ biomass (mt)	821,271	391,404–1,251,138
Unfished recruitment (R0)	380,777	123,519–638,034
Depletion (2011)	83.7%	67.4–100.1%
Reference points based on $SB_{25\%}$		
Proxy spawning biomass ($B_{25\%}$)	117,467	45,684–189,249
SPR resulting in $B_{25\%}$ ($SPR_{30\%}$)	0.297	
Exploitation rate resulting in $B_{25\%}$	0.129	0.120–0.138
Yield with $SPR30_{\%}$ at $B_{25\%}$ (mt)	34,751	15,403–54,098
Reference points based on SPR proxy for MSY		
Spawning biomass	119,033	46,293–191,772
SPR_{proxy}	0.30	
Exploitation rate corresponding to SPR_{proxy}	0.128	0.119–0.136
Yield with SPR_{proxy} at SB_{SPR} (mt)	34,743	15,402–54,082
Reference points based on estimated MSY values		
Spawning biomass at *MSY* (SB_{MSY})	114,398	45,640–183,155
SPR_{MSY}	0.291	0.286–0.296
Exploitation rate corresponding to SPR_{MSY}	0.131	0.122–0.141
MSY (mt)	34,757	15,400–54,114

Management performance

Exploitation rates on Dover sole have never exceeded the *MSY* proxy level and the base case model did not predict that the stock has ever fallen below the target biomass defined as 25% of unfished spawning biomass. In 2007, the exploitation rates have slightly increased due to increases in the allowable catch, but are still below target thresholds. A considerable increase in the OFL was put in place in 2011 due to the results of the 2005 stock assessment. A 4% reduction in the 2011 OFL due to scientific uncertainty (the P* approach) resulted in an ABC of 42,436 metric tons, and although the ACL could be set equal to the ABC for a stock above the target biomass, the ACL was set to 25,000 mt, which is higher than the maximum historical catch. Overall, Dover sole have been lightly exploited and the spawning biomass has remained well above target levels. Recent low recruitment coupled with a slight increase in catch has caused the trend in spawning biomass to level.

Table f. Recent trend in total catch and commercial landings (mt) relative to the management guidelines. The OFL (overfishing limit) was formerly known as the ABC, and the ACL (annual catch limit) is similar to what was formerly known as the OY. Estimated total catch reflect the commercial landings plus the model estimated discarded biomass.

Year	OFL (mt)	ACL (mt)	Commercial Landings (mt)	Estimated[1] Total Catch (mt)
2001	8,510	7,440	6,865	8,422
2002	8,510	7,440	6,234	7,697
2003	8,510	7,440	7,017	8,651
2004	8,510	7,440	6,733	7,429
2005	8,522	7,476	6,892	7,592
2006	8,589	7,564	5,957	6,548
2007	28,522	16,500	9,264	10,171
2008	28,442	16,500	11,204	12,245
2009	29,453	16,500	11,731	12,820
2010	28,582	16,500	10,375	11,313
2011	44,400	25,000	—	—

Unresolved problems and major uncertainties

The base case model was developed with the goal of balancing parsimony with realism and fitting the data. There were, however, some pieces of data that were fit poorly. Specifically, the commercial length and age data for the Washington and Oregon fleets showed some unsatisfactory patterns. It is uncertain if these patterns are related to a lack of fit due to retention curves, selectivity curves, or growth. It is possible that Dover sole exhibit different life-history patterns in the north and the model is unable to capture these differences without introducing additional complexity.

Natural mortality was estimated in this assessment for the first time in the history of U.S. West Coast Dover sole assessments. A prior was developed for gender-specific natural mortality, which had a median larger than values assumed in previous assessments. Additionally, the estimates from the base case model were larger than previous assumed values and natural mortality for males was uncertain. However, the 95% joint confidence interval from the joint likelihood profile over female and male natural mortality parameters did not encompass the 0.09 values assumed for female and male M in the 2005 assessment. It would be useful to investigate the life-history of Dover sole as well as the length and age data to determine if the larger values of *M* are reasonable.

Recruitment was estimated over the entire time series and although was uncertain, it showed an interesting pattern in the early years by dipping down below average recruitment before the era in which recruitment deviates could be somewhat estimated. These patterns may indicate model misspecification, but it may also be an indication that the stock may have been below unfished equilibrium biomass when fishing mortality really began to increase. This may be caused by greater than assumed historical fishing levels, or a period of low recruitment preceding the start of the fishery. Given that estimated recruitment from more recent periods shows periods of low and high recruitments, it may be that a period of low recruitment occurred prior to 1960.

Discards are problematic for many stocks because there is little quantitative information on historical discarding practices. This holds true for Dover sole and is further complicated by differences in discarding due to location as well as changes in discarding over time. Many assumptions were made regarding discarding behavior and although discards have been small for Dover sole, some lack of fit may be due to misspecification of retention curves. A better understanding of discard behavior and how it has changed over time would help to make better assumptions in the model.

Dover sole life-history parameters exhibit strong relationships with depth that indicate the stock is more complex than the model assumes. Small fish are found in shallow water, while mid-sized and larger fish are found in middle and deeper depths. There is not a trend of larger fish being found deeper, but there is a trend of fewer smaller fish found deeper. In addition, there is a pattern of sex ratio by depth with more males found in middle depths and more females found in shallow and deeper depths. These patterns are apparent in the summer fisheries and surveys, and there is some evidence that the patterns change in the winter during the spawning season. It is uncertain how the patterns affect the data (they may be a cause of the bimodal length distributions seen in the slope surveys) and if these patterns can be effectively modeled to produce better fits to the data and better predictions of biomass.

Forecasts

Forecasts and projections of the Dover sole population up to the year 2022 were constructed assuming that the next two years of landings (2011 and 2012) would be an average of the last three years of fleet-specific landings, and from 2013 onward, catches would reach the calculated OFL. This forecast table shows that even with these high catches from 2013 onward, the predicted spawning biomass does not drop below the target spawning biomass before 2023. However, it does show that even with catches less than the ACL in 2011 and 2012, the spawning biomass is predicted to decline slightly. This is due to recent predictions of poor recruitment.

Table g. Projection of potential OFL, landings, and catch, summary biomass (age-5 and older), spawning biomass, and depletion for the base case model projected with status quo catches in 2011 and 2012, and catches at the OFL from 2013 onward. The 2011 and 2012 OFL's are values specified by the PFMC and not predicted by this assessment. The OFL in years later than 2012 is the calculated total catch determined by F_{SPR}.

Year	Predicted OFL (mt)	Total Catch (mt)	Landings (mt)	Age 5+ biomass (mt)	Spawning Biomass	Depletion (%)
2011		12,116	11,100	657,004	393,507	83.75%
2012		12,120	11,100	643,291	386,143	82.18%
2013	90,411	90,411	82,806	635,535	377,601	80.36%
2014	75,517	75,517	69,049	552,798	329,875	70.21%
2015	64,885	64,885	59,211	493,274	289,904	61.70%
2016	57,488	57,488	52,356	449,636	257,415	54.78%
2017	52,453	52,453	47,687	417,699	231,552	49.28%
2018	49,065	49,065	44,545	394,200	211,322	44.97%
2019	46,768	46,768	42,417	376,478	195,658	41.64%
2020	45,158	45,158	40,929	362,720	183,522	39.06%
2021	43,964	43,964	39,829	351,675	174,030	37.04%
2022	43,017	43,017	38,958	342,513	166,488	35.43%

Decision Table

The axis of uncertainty chosen for this assessment was based on the joint profile of natural mortality for females and males. A one-dimensional decision table is given, but is quantified over female and male natural mortalities by finding the most likely combinations of joint *M* (based on the joint likelihood profile) that correspond to the 12.5% and 87.5% quantiles of 2011 spawning biomass in log space (251,000 and 616,000 mt, respectively). This satisfies the criteria specified in the terms of reference and the geometric mean is approximately equal to the base case estimate of current spawning biomass.

The average catch from the last three years was used for 2011 and 2012 catches with allocation and selectivities based on 2010. Three catch levels were chosen for the years 2013 and beyond in the decision table. First, it was assumed that the entire OFL would be caught in these years. Second, it was assumed that the current ACL of 25,000 mt would be taken every year from 2013 to 2022. And, lastly, it was assumed that status quo catches would be taken based on the average catch over the last three years.

Table h. Summary table of 12-year projections beginning in 2013 for alternate states of nature based on an axis uncertainty calculated using the joint likelihood profile on female and male natural mortality. Columns range over different combinations of natural mortality giving a low, mid, and high state of nature, and rows range over different assumptions of catch levels based on the predicted OFL's, the current ACL's, and status quo catches based on the average of catches from the last three years.

			State of nature					
			Low		Base case		High	
			$M_f = 0.110$ $M_m = 0.125$		$M_f = 0.117$ $M_m = 0.142$		$M_f = 0.120$ $M_m = 0.159$	
Relative probability of ln(SB_2011)			0.25		0.5		0.25	
Management decision	Year	Catch (mt)	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion
OFL	2013	82,720	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	68,982	195,787	57.2%	329,862	70.2%	621,804	81.7%
	2015	59,155	158,375	46.3%	289,882	61.7%	575,558	75.7%
	2016	52,306	127,486	37.3%	257,388	54.8%	538,477	70.8%
	2017	47,640	102,455	30.0%	231,524	49.3%	509,649	67.0%
	2018	44,500	82,514	24.1%	211,294	45.0%	487,882	64.1%
	2019	42,373	66,742	19.5%	195,631	41.6%	471,860	62.0%
	2020	40,885	54,170	15.8%	183,497	39.1%	460,272	60.5%
	2021	39,786	43,919	12.8%	174,009	37.0%	451,991	59.4%
	2022	38,916	35,268	10.3%	166,469	35.4%	446,137	58.6%
Current ACL	2013	25,000	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	25,000	227,248	66.4%	361,524	76.9%	653,840	85.9%
	2015	25,000	215,090	62.9%	346,496	73.7%	632,371	83.1%
	2016	25,000	204,122	59.7%	333,334	70.9%	614,130	80.7%
	2017	25,000	194,555	56.9%	322,280	68.6%	599,481	78.8%
	2018	25,000	186,429	54.5%	313,317	66.7%	588,306	77.3%
	2019	25,000	179,608	52.5%	306,205	65.2%	580,149	76.3%
	2020	25,000	173,840	50.8%	300,564	64.0%	574,353	75.5%
	2021	25,000	168,867	49.4%	296,019	63.0%	570,279	75.0%
	2022	25,000	164,477	48.1%	292,266	62.2%	567,414	74.6%
Status quo catches	2013	11,100	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	11,100	234,602	68.6%	368,952	78.5%	661,396	86.9%
	2015	11,100	229,773	67.2%	361,268	76.9%	647,348	85.1%
	2016	11,100	226,016	66.1%	355,273	75.6%	636,306	83.6%
	2017	11,100	223,478	65.3%	351,154	74.7%	628,578	82.6%
	2018	11,100	222,151	65.0%	348,847	74.2%	624,008	82.0%
	2019	11,100	221,873	64.9%	348,088	74.1%	622,119	81.8%
	2020	11,100	222,377	65.0%	348,483	74.2%	622,239	81.8%
	2021	11,100	223,401	65.3%	349,652	74.4%	623,727	82.0%
	2022	11,100	224,735	65.7%	351,294	74.8%	626,072	82.3%

Research and data needs

There are 5 topics for which additional research would greatly improve the assessment of Dover sole.

1. **Age reading error:** Estimates of ageing error were simplified because minimal data and cross-validation were available. There are many within-lab rereads from the Cooperative Ageing Project laboratory in Newport, OR, and some from the California ageing lab, but there is little organized data on cross-lab reads. A workshop in 2004 resulted in some cross-lab reads, but there is little data that can be used to characterize the differences between labs. Furthermore, a bomb calibration study of Dover sole ototliths from Alaska was done by the AFSC, and they concluded that there was little bias in ageing for easy to read otoliths. However, they state that the majority of Dover sole otoliths are difficult to read and result in uncertain ages through double-reads. A ground-truthing study on the U.S. West Coast would be useful to characterize potential bias in ageing Dover sole ototliths. Further research into quantifying the uncertainty of Dover sole ageing may help clear up some of the conflicts between the age and length data and may even give insight into the estimates of natural mortality.

2. **Patterns with depth:** As discussed above, there are patterns of length and sex ratios with depth which may indicate that the stock is more complex than currently modeled. Further research into the causes of these patterns as well as differences between seasons would help with understanding the stock characteristics such that a more realistic model could be built. This may also provide further insight into migration and help determine if there are localized populations.

3. **Recruitment patterns:** Even though recruitment variability is low compared to other West Coast groundfish, this assessment model predicted periods of low and high recruitment that affect the trend in biomass. These periods may correlate with the environment and would help predict future biomass levels. It would be useful to investigate these patterns in recruitment but to also further investigate the life-history of Dover sole to determine if that can also explain the estimated patterns.

4. **Stock boundaries:** A common question in stock assessments is whether or not the entire stock is being accounted for. Dover sole live deeper than the range of the fisheries and surveys. The assessment model attempts to account for out of area biomass through catchability coefficients and selectivity curves, but that portion of the stock is unknown and can only be guessed at. Research into abundance in deep areas would be useful to verify that the assessment adequately predicts the entire spawning stock of Dover sole.

5. **Variability of sex ratios in length and age data:** There were differences in predicted sex ratios from the length data and the age data which should be further explored. It is uncertain if this is simply an artifact of sampling or if there is a selection bias in age and/or length observations. This phenomenon may contribute to the conflict between age and length data.

Table i. Summary table of the results for the Dover sole assessment.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Commercial landings (mt)	6,865	6,234	7,017	6,733	6,892	5,957	9,264	11,204	11,731	10,375	NA
Estimated Total catch (mt)	8,422	7,697	8,651	7,429	7,592	6,548	10,171	12,245	12,820	11,313	NA
OFL (mt)	8,510	8,510	8,510	8,510	8,522	8,589	28,522	28,442	29,453	28,582	44,400
ACL (mt)	7440	7440	7440	7440	7476	7564	16500	16500	16500	16500	25000
1-SPR	12.75%	11.57%	12.66%	10.84%	10.89%	9.34%	13.77%	16.17%	16.99%	15.49%	NA
Exploitation rate (catch/ age 5+ biomass)	0.013	0.012	0.013	0.011	0.011	0.009	0.014	0.018	0.019	0.017	NA
Age 5+ biomass (mt)	657,004	643,291	635,535	552,798	493,274	449,636	417,699	394,200	376,478	362,720	351,675
Spawning Biomass	352,007	361,507	368,402	373,512	379,112	384,556	390,893	396,088	398,921	397,836	393,507
~95% Confidence Interval	61,454–642,559	64,665–658,349	67,455–669,349	69,622–677,402	72,546–685,678	75,519–693,593	79,241–702,545	81,659–710,517	82,761–715,081	82,407–713,265	81,481–705,533
Recruitment	403,700	222,419	207,409	237,284	299,746	251,610	288,809	372,962	328,391	376,517	376,215
~95% Confidence Interval	194,708–837,017	104,697–472,508	98,173–438,189	111,899–503,167	142,559–630,248	115,888–546,282	126,046–661,746	151,584–917,645	130,124–828,751	150,161–944,086	150,036–943,357
Depletion (%)	74.9%	76.9%	78.4%	79.5%	80.7%	81.8%	83.2%	84.3%	84.9%	84.7%	83.7%
~95% Confidence Interval	58–92%	60–94%	61–96%	63–97%	64–98%	65–99%	67–100%	68–101%	68–101%	68–101%	67–100%

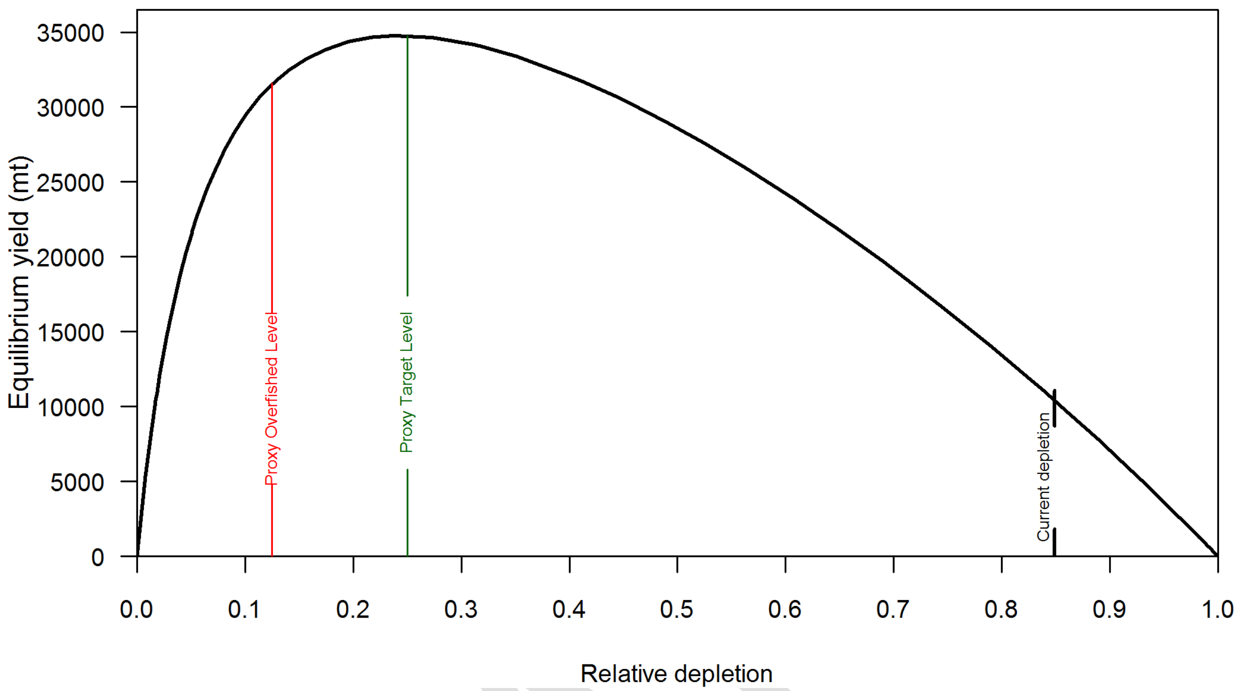

Figure h. Equilibrium yield curve (derived from reference point values reported in Table i) for the base case model. Values are based on 2010 fishery selectivity and distribution with steepness fixed at 0.8. The depletion is relative to unfished spawning biomass.

1 Introduction

The Dover sole, *Microstomus pacificus* (Lockington) is a flatfish belonging to the family Pleuronectidae and is called a sole although it is a flounder. Dover sole has also been known by several different common names including slippery sole, lemon sole, smear dab, rubber sole, short finned sole, slime sole, and tongue sole. Although there was little interest in Dover sole when the U.S. West Coast trawl fishery first began, the species is now commonly landed.

This is an assessment of the Dover sole population off of the U.S. West, including coastal waters of California, Oregon, and Washington from the U.S./Mexico border to the U.S./Canadian border. It does not include Canadian or Alaskan populations and assumes that these northern populations do not contribute to the stock being assessed here.

1.1 Distribution and Stock Structure

Dover sole range from Baja California to the Bering Sea and eastern Aleutian Islands (Kramer et al. 1995). Stock structure is not well understood and Westerheim et al (1992) reports that conventional stock-recruitment assessments of Dover sole are unlikely to be successful due to nonintermingling adult stocks, but larvae probably intermingle during their long pelagic life. Stepien (1999) used sequences of mitochondrial DNA extracted from Dover sole sampled at six sites ranging from southern California to the Gulf of Alaska and found phylogeographical structure in west coast Dover sole with spatial clustering of genetically similar individuals. However, there were several unusual clusters of specimens having apparently similar genetic make-up although they were geographically separated (e.g., fish from Alaska with similar genetics as fish from San Diego).

Results from tagging studies taking place between 1948-79 indicated seasonal movements of Dover sole onto the shelf in the summer and off the shelf in the winter, but little evidence of north-south movement or appreciable mixing between Pacific Marine Fisheries Commission (PMFC) statistical areas (Westrheim et al. 1992). A few tagged fish moved long distances, however. For example, Westrheim and Morgan (1963) reported that a fish caught and tagged in the Willapa Deep area off Washington was subsequently recaptured off Humboldt Bay, CA, 360 nautical miles south. Barss and Demory (1988) reported having records for 13 tagged fish that were recaptured after 10 or more years at liberty. The longest time a fish was at liberty was 22 years and was recaptured within 1 nautical mile of its original release location.

1.2 Life-History and Ecosystem Interactions

Dover sole are generally found on mud or mud-sand bottom deeper than 20 fathoms (37 m) and out to deeper than 1500 m (Jacobson & Hunter 1993). They feed on polychaete worms, pink shrimp, brittle stars, gammarid amphipods, and small bivalves (Pearcy and Hancock 1978, Gabriel and Pearcy 1981). Living to a maximum age greater than 50 years, female Dover sole attain a maximum length of 55 to 60 cm, about 5 to 10 cm longer than the males.

Based on samples from the commercial fishery in northern California Hagerman (1952) concluded that the spawning period for Dover sole is during November to March or April with heavy spawning during December to February. Spawning occurs in relatively deep water (Hagerman 1952) and prior to 1954 few Dover sole were caught during winter months because the fish are generally unavailable on the shelf during winter. Dover sole eggs and larvae are buoyant (Hagerman 1952) and this species has an extended larval phase lasting at least one year (Pearcy et al. 1977, Markle et al. 1992, Butler et al. 1996). Markle et al 1992 postulate that Dover sole larvae may extend settlement by delaying metamorphosis to avoid unfavorable oceanographic conditions.

Based on research survey tows, Jacobson and Hunter (1993) found that the catches of Dover sole in a given area and depth zone were not randomly distributed by sex, with males and females tending to occur in separate patches. Furthermore, Dover sole appear to undergo ontogenetic shifts in their distribution with fish gradually moving to deeper water as they grow (Jacobson et al 2001).

1.3 Historical and Current Fishery

Trawl fishing with boats powered by sail began in California waters in 1876 and caught many flatfishes, including Dover sole (Hagerman 1952). Even though there are reports of Dover sole being sold in summer markets in San Francisco as early as 1878 (Lockington 1880 as referenced by Hagerman 1952), it wasn't until the early part of the 20th century that landings of Dover sole were recorded. Fisheries for Dover sole didn't begin in Oregon and Washington until the 1930's.

Dover sole was considered a "repulsive" fish by some (Smith 1936) and was likely discarded as bycatch when pursuing other more desirable species such as petrale sole (*Eopseta jordani*) and English sole (*Parophrys vetulus)*. However, markets were eventually developed and landings began steadily increasing in the 1940's (Figure 1). Landings remained relatively constant throughout the 1950's and 1960's before increasing rapidly into the early 1990's. Subsequently, the landings declined (mostly in California) until 2007 when harvest guidelines increased the allowable catch.

Groundfish trawl fisheries land the majority of Dover sole while fixed gears, shrimp trawls, and recreational fisheries make up a very small amount of fishing mortality (Table 1). Shrimp trawls have been using excluders which have reduced bycatch of many species including Dover sole. The trawl fisheries typically catch Dover sole while targeting the depwater complex (DTS) consisting of Dover sole, sablefish (*Anoplopoma fimbria*), shortspine thornyhead (*Sebastolobus alascanus*), and longspine thornyhead (*Sebastolobus altivelis*). Discarding occurs in these fisheries due to small size, but also possibly due to trip limits or less desirable large Dover sole in a "jellied" or soft state (Sampson 2005).

1.4 Management History and Performance

Management restrictions for Dover sole came largely into place in the early 1980's with the implementation of trip limits and quotas on DTS species, which mostly limited catches of Dover sole because of more restrictive trip limits on the higher priced sablefish and thornyheads. Management actions important to Dover sole fisheries since 1989 are summarized in Table 2. More recently, the annual allowable catch level (ACL, but formerly known as the optimal yield or OY) has increased from just under 8,000 metric tons to 16,500 metric tons (Table 3), and catch levels have been substantially lower than the ACL since 2007. A considerable increase in the OFL was put in place in 2011 due to the results of the 2005 stock assessment done by Sampson (2005). A 4% reduction in the 2011 OFL due to scientific uncertainty (the P* approach) resulted in an ABC of 42,436 metric tons, and although the ACL could be set equal to the ABC for a stock above the target biomass, the ACL was set to 25,000 mt, which is higher than the maximum historical catch (July 2011 Pink Pages from the PFMC website, www.pcouncil.org).

Overall, Dover catches rarely exceeded the fishing limits. Since 2007, the annual landings have been much less than the ACL (Table 3).

1.5 Fisheries in Canada and Alaska

Dover sole in Canadian waters are treated as two distinct stocks; a northern stock and a southern stock. The fishery in the north began in the 1970's while the fishery off of the West Coast of Vancouver Island started in the late 1980's. Area quotas were used to manage the two stocks until the introduction of individual based quotas in 1996. A 1998 assessment reported that the stocks were being exploited at levels near the maximum sustainable yield (DFO 1999). For the two areas combined, MSY is estimated to be between 2000 and 2700 mt.

In the Gulf of Alaska the flatfish fishery has caught substantial quantities of Dover sole, with the peak of 9,740 mt in 1991, diminishing to 682 mt in 2004 (Turnock and A'mar 2004). Triennial bottom trawl survey estimates of biomass for Dover sole in the Gulf of Alaska (GOA) declined from 96,600 mt in 1990 to 63,800 mt in 1999, but rose to 99,300 mt in 2003. Bottom trawl surveys have indicated that Dover sole are a small component of the flatfish biomass in the Aleutian Islands and are negligible in the Bering Sea (Wilderbuer et al 1999). The GOA stock of Dover sole was recently assessed with an age-based model (Stockhausen et al 2009), which estimated that biomass had increased from 72,000 mt in 2007 to about 76,000 mt in 2009. The projected F40% yield for 2010 was 6,007 mt.

2 Data

2.1 Fishery-Independent Data

Data from three surveys were used in this assessment. The surveys covered different areas of the Dover sole habitat, and are described below.

Strata were defined by latitude and depth to analyze the catch-rates, length compositions, and age compositions using stratified random sampling theory. The latitude and depth breaks were chosen based on the design of the survey as well as by looking at biological patterns with latitude and depth. In addition, the strata were chosen such that at least 3 positive catch rates were available for each year in each stratum, which resulted in collapsing some deeper strata over a wider range of latitude.

Indices of abundance for all of the surveys were derived using a generalized linear mixed model (GLMM) following the methods of Helser et al. (2004). The surveys were stratified by latitude and depth, and vessel-specific differences in catchability (via inclusion of random effects for the NWFSC surveys and fixed effects for the AFSC and Triennial survey) were estimated for each survey time series. The Delta-GLMM approach explicitly models both the zero and non-zero catches and allows for skewness in the distribution of catch rates through the use of a gamma error structure. Initial investigations with many different species showed that gamma errors performed best for these analyses (pers comm, John Wallace, NWFSC , NOAA). This assessment's GLMM indexes were generated using the same basic method, but reprogrammed by John Wallace (personal com.) utilizing a R package which uses OpenBUGS (http://www.openbugs.info/).

2.1.1 AFSC slope survey

The AFSC slope survey operated during autumn (October-November) aboard the R/V *Miller Freeman*. Partial survey coverage of the U.S. west coast occurred during 1988–96 and complete coverage (north of 34° 30' S) during 1997, 1999, 2000, and 2001. Only the four years of consistent and complete surveys were used in this assessment. 'The number of tows ranged from 182 in 1997 to 208 in 2000 (Table 5). The number of tows with length and ages of Dover sole are also shown in Table 5.

The indices for this survey were developed using a GLMM with the stratification shown in Table 7. Figure 3 and Table 6 shows how the index increases over the entire time series.   Length frequencies for each year were expanded using the same stratification as the GLMM (Table 7) and are shown in Figure 4. Smaller males were less prevalent in the later years, but some smaller females were appearing in 2001. The proportion of females in the length data were between 0.35 and 0.43. Some age data were available for the AFSC slope survey and the proportion of females in these expanded data were between 0.52 and 0.64, much higher than the length data. Due to concerns about non-random sampling and potential biases due to incomplete coverage of the depth range of Dover sole, these data were not used in the assessment.

2.1.2 Triennial Bottom 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 Dover sole (Dark and Wilkins 1994). The sampling methods used in the survey over the 24-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 5). The survey design has changed slightly over the period of time (Table 8, Figure 6). In general, all of the surveys were conducted in the mid-summer through early fall: the survey in 1977 was conducted from early July through late September; the surveys from 1980 through 1989 ran from mid-July to late September; the survey in 1992 spanned from mid-July through early October; the survey in 1995 was conducted from early June to late August; the 1998 survey ran from early June through early August; and the 2001, 2004 surveys were conducted in May-July (Figure 6). Haul depths ranged from 91–457 m during the 1977 survey with no hauls shallower than 91 m. The surveys in 1980, 1983, and 1986 covered the West Coast south to 36.8°N latitude and a depth range of 55–366 meters. The surveys in 1989 and 1992 covered the same depth range but extended the southern range to 34.5°N (near Point Conception). From 1995–2004, the surveys covered the depth range 55–500 meters and surveyed south to 34.5°N. In the final year of the triennial series (2004), the Fishery Resource and Monitoring division (FRAM) at the NWFSC undertook the survey from the AFSC and followed very similar protocols as the AFSC.

Given the different depths surveyed during 1977 the results from the 1977 survey were not included in this assessment. Water hauls (Zimmermann et al. 2003) and tows located in Canadian waters were excluded from the analysis of this survey. The survey was analyzed as an early series (1980–1992) and a late series (1995–2004).

The indices for the early and late series of this survey were developed using a GLMM with the stratifications shown in Table 9. Figure 3 and Table 6 provide the two indices. The late series increases more than threefold from 1995 to 2004.   Length frequencies for each year were expanded using the same stratification as the GLMM (Figure 7). Female lengths showed a slight decline over the series, and a widening of the distribution in 2004. The male lengths showed a slight decline in lengths, then an increase over the last few surveys. There were no age data from this survey.

2.1.3 NWFSC Bottom Trawl Survey

The NWFSC fishery-independent bottom trawl survey produces three sources of information: an index of relative abundance, length-frequency distributions, and age-frequency distributions. The survey was split into two series, one for the years 1998-2002 representing the slope survey, and a second for 2003–2010 representing the shelf and slope regions. These surveys are discussed in more detail below.

NWFSC slope survey

The NWFSC slope survey covered waters throughout the summer from 183 m to 1280 m north of 34° 30' S, which is near Point Conception. The survey strata used to expand the data for this assessment are shown in Table 10. The number of tows per year for this survey has increased over the years, but was typically less than the Triennial survey (Table 5). Most tows caught Dover sole and sampled lengths, but about half of those tows had at least one age sampled (Table 5).

The indices for this survey are more constant than the Triennial and AFSC slope surveys during the same period (Figure 3 and Table 6). The length frequencies show an increasing trend in lengths from 1998 to 2002, with a switch from smaller fish in 2000 to larger fish in 2001 (Figure 19). The age frequencies are much more variable, but show the presence of some old fish greater than 20 years in 2001 for both males and females (Figure 20). The proportion of females in the expanded length data ranged from 38 to 41% and the expanded age data were similar.

Figure 21 shows the estimated length frequencies for all depths of the slope survey compared to length frequencies for depths between 182 m and 548 m, and depths greater than 548 m. The length frequencies in these depth ranges are quite difference and seem to give rise to a somewhat bimodal shape of the overall length frequencies, especially for females.

NWFSC shelf/slope survey

The NWFSC shelf/slope survey is based on a random-grid design; covering the coastal waters from a depth of 55 m to 1,280 m (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 which 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).

Dover sole are commonly caught in the shelf/slope survey with high catch rates occurring north of Point Conception (Figure 8). South of Point Conception, survey observations show lower densities (Figure 9). There is some variability in length off the coast of South and Central California. Small fish are common near Point Conception and tend to get larger at points farther south (Figure 10). In fact, only Dover sole greater than 35 cm have been observed around 32 degrees latitude. Moving north of Point Conception, fish tend to get larger until near San Francisco Bay, where only small fish have been observed by the survey. This may be due to unsurveyable grounds near there, though. North of about 40 degrees latitude, the length distribution appears constant (Figure 10). Age at latitude shows a similar pattern with young fish just south of Point Conception, very old fish at the southern-most point of the survey, young fish near San Francisco Bay, and constant ages north of about 40 degrees latitude (Figure 11).

As mentioned earlier, Dover sole undergo ontogenetic migration as well as seasonal migrations, moving onto the shelf in the summer. The shelf/slope survey data show a trend of larger fish in deeper water, but it appears that it is more a function of fewer small fish in deeper water (Figure 12). Some of the largest fish were observed at depths of about 100 meters, where some of the smallest fish were also observed. This pattern was apparent for both females and males, although larger females seemed to occur in shallow depths (Figure 13). Increasing age was apparent at deeper depths, but the oldest fish were found deeper and young fish were also found in deep water (Figure 14 and Figure 15). It seems that length has a stronger pattern with depth although ageing error may blur these results.

Figure 16 and Figure 17 confirm these observations and attempt to look at the interactions between depth and latitude. They show that Dover sole in shallow water are small at southern latitudes and more variable at higher latitudes with more large and older fish present. In the depth range of 549 to 900 meters, the lengths were larger than the shallower depths, but ages did not seem to be much older. The two deepest depth strata showed similar distribution at different latitudes, unlike the two shallower strata, which show increasing length and age with increasing latitude.

Survey indices for the NWFSC shelf/slope survey have been stable over the last eight years (Figure 3). Separating the indices by the shelf and slope components showed a slightly increasing biomass on the slope and a stable of slightly decreasing biomass on the shelf (Figure 18).

Expanded length frequencies from this survey show a trend of higher proportions of larger fish in recent years (Figure 19) and the expanded age frequencies show a similar pattern (Figure 20). The expanded age frequencies are shown for convenience and the conditional ages-at-length were fit in the model. Figure 22 shows the estimated length frequencies for all depths of the shelf/slope survey compared to length frequencies for depths less than 182 m, depths between 182 m and 548 m, and depths greater than 548 m. The length frequencies in the deepest depths were quite difference and the lengths from the middle depths seemed most similar to the overall length frequencies.

Sex ratios from the raw age data showed a higher percentage of females than from the length data (Figure 23) and it is uncertain if this an artifact of sampling or some other process. However, sex ratios from the expanded data (Figure 23) appeared to be closer indicating that tows may mostly consist of one gender. This is difficult to verify from the survey data because very few dover sole are sampled from each tow, although there does appear to be some spatial separation of sexes over depth.

2.2 Biological Data

2.2.1 Weight-Length Relationship

Weight-at-length data collected by the NWFSC fishery-independent shelf and slope trawl survey was used to estimate weight-length relationship for both sexes of Dover sole. Weight-at-length was generally similar between females and males (Figure 25). Males were estimated to weigh more at the larger lengths (>40cm) compared to females. However, the majority of observations of fish greater than 50cm are predominated by female fish because males generally do not tend to grow as large in comparison. The following pooled estimate of the weight-at-length relationship was used by sex in this assessment:

Females $\text{weight} = 2.805\text{E-6} \cdot \text{Length}^{3.345}$

Males $\text{weight} = 2.231\text{E-6} \cdot \text{Length}^{3.412}$

where weight is measured in grams and length in cm.

2.2.2 Maturity schedule

Estimates of maturity at length and age have been variable between studies. Hagerman (1952) reported that 50% of 35 cm female Dover sole were mature with all mature at a length of 45 cm. Yoklovich and Pikitch (1989) reported a smaller size at 50% mature. Hunter et al 1992 reported that different collection times and methods of analysis resulted in different estimates of maturity at length and suggest that differences reported between Hagerman (1952) and Yoklavich and Pikitch (1989) may have been due these differences rather than changes in maturity. Brodziak and Mikus (2000) found significant north-south differences in maturity curves derived for INPFC areas, with fish maturing at smaller sizes in the north. Their estimate of length at 50% mature was less than 35 cm, as reported by Hagerman (1952).

The 2005 assessment of Dover sole (Sampson 2005) assumed that maturity declined linearly from values for 50% mature of 36.5cm prior to 1957 to 33.4 cm from 1984 onward. Due to uncertainty in maturity schedules, we used a constant maturity curve for all years equal to the Hagerman (1952) estimates (Figure 26).

2.2.3 Fecundity

Fecundity is related to size with a 40 cm female producing about 40,000 oocytes and a 55 cm female producing about 160,000 oocytes (Yoklavich and Pikitch 1989). It is sometimes reasonable to model spawning output instead of spawning biomass, but the relationship of fecundity to weight is nearly linear when translated from length, and Yoklavich and Pikitch (1989) actually report fecundity as a linear function of weight.

2.2.4 Natural Mortality

Natural mortality is a parameter that is often highly uncertain in fish stocks. There are no current published estimates of natural mortality, aside from what has been used in previous assessments which were based upon maximum ages. Recent assessments of Dover sole off the West Coast have fixed this parameter at $0.09yr^{-1}$ for both males and females (Brodziak et al. 1997, Sampson 2005). The values were selected such that it resulted in 0.1% of Dover sole surviving to age 48 years in an unexploited stock, which was considered consistent with observed older ages.

In this assessment, natural mortality was estimated for both sexes. A lognormal prior based upon multiple life-history correlates (Table 15) were developed for each sex (pers comm, Owen Hamel, NWFSC, NOAA). The median of the prior was 0.101 for females and 0.103 for males) and the sigma was 0.337. Figure 29 shows that these prior distributions are wide and not highly informative.

2.2.5 Length-at-age

A number of ages were available from the NWFSC shelf/slope survey (Table 5) and are plotted in Figure 27. Females grow larger than males and appear to have an average maximum length around 45 cm. The average maximum size for males appears to be closer to 40 cm.

Brodziak & Mikus (2000) reported differences in growth curves between some INPFC areas using data collected on the continental slope (183–1280m). Using data collected during the NWFSC shelf/slope survey (55–1280m) we investigated length-at-age for four different regions along the coast: south of Point Conception, Point Conception to the 40°10' management line near Point Arena, the 40°10' management line to 47°, and north of 47°. Figure 28 shows that there was no difference between male growth curves in each of these areas. However, larger fish were present in areas north of 40°10', although the asymptote of the growth curve was nearly the same for all areas (north of 47° was influenced greatly by one large and old fish). It seems that variability in size may be greater in northern areas.

2.2.6 Sex ratios

The percentage of females showed interesting patterns with depth. First, because males grow to a smaller size, the proportion of females at intermediate lengths is less than 50%, and is 100% at larger lengths (Figure 24). This interplays with the pattern of larger fish in deeper water and results in fewer females at intermediate depths (250-750 m) and nearly all females in the deepest depths (Figure 23). Sex ratio was slightly variable over latitude but showed no specific pattern (Figure 23).

2.2.7 Ageing Bias and Imprecision

Uncertainty surrounding the ageing error process for Dover sole was incorporated by estimating ageing error by age. The most common and current method applied for age reads for Dover sole is break-and-burn (BB). All age composition data used in the model were from BB reads, except for a small select subset of early age data (1966-1984) from Oregon, which were produced by scale reads. Otoliths collected from commercial catches were aged by each state's ageing error laboratory. Samples from the NWFSC survey were also used in this assessment and were aged by the Cooperative Ageing Project (CAP) in Newport, Oregon.

Age validation has been done by bomb radiocarbon methods for Dover sole otoliths collected in Alaskan waters by the AFSC (Kastelle et al. 2008) which concluded there was little ageing error for easy to read otoliths by BB method for a wide range of ages (8 to 47 years). However, the author's state that the majority of Dover sole otoliths are difficult to read and the few otoliths of this type included in the study resulted in varying estimates of age by double-reads. Ideally to estimate bias and ageing error within-lab rereads along with cross-lab rereads would be used which would allow for estimates of bias and precision by lab and relative to each other. Currently for Dover sole only data from a 2004 workshop resulted in some cross-lab reads, however the number was relatively small and insufficient to estimate ageing error. Due to the lack of cross-lab reads, each lab where within-lab double-reads were available was used to estimate ageing error separately.

BB double readings of 3,764 Dover sole otoliths were performed by CAP (unpublished data). An ageing error estimate was made based on these double reads using a computational tool specifically developed for estimating ageing error (Punt et al. 2008), which produces a standard deviation in estimated age as a function of true age. A non-linear standard error was estimated by age where there is more variability in the estimated age of older fish (Table 16, Figure 30). California provided 195 BB double reads that were used to estimate ageing error for otoliths aged by that lab. A linear standard error by age was estimated based upon this data set (Table 16, Figure 31). The third and final data set of double-reads was provided by the state of Oregon which included comparisons between scale read and BB reads. Scale reads were typically low relative to the corresponding BB reads at older ages indicating a potential negative bias in reads of older aged fish by scale reads and a hockey-stick ageing error was applied (Table 16, Figure 32). In the absence of double-reads for an ageing lab (i.e., Washington), the estimated ageing error from CAP, the largest data source, was used.

2.3 Fishery dependent data

Dover sole have been targeted by fisheries since the early part of the 20th century, even though a 1936 biological report from the State of Washington Department of Fisheries stated that Dover sole "is very slimy and is repulsive to handle" and "[i]t has no value as a commercial fish." (Smith 1936). It was not long after 1936 that Dover sole were being landed in significant quantities up and down the U.S. coast. Discarding practices in the early 1900's are uncertain, but catches of Dover sole on the outer coast are likely small during this time.

Landings from the Pacific Fishery Information Network (PacFIN, Pacific States Marine Fisheries Commission) show that the majority of landings of Dover sole have occurred in the trawl fishery, but a very small proportion has been seen in the hook and line, net, and recreational fisheries. A slightly larger amount of Dover sole have been landed from the shrimp trawl fishery, but at most was 1.1% of the annual coastwide landings. Table 1 shows the percentage of Dover sole landings retrieved from the PacFIN database (Pacific Fisheries Information Network (PacFIN) retrieval dated March 9, 2001, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org) reported for various gear types.

2.3.1 Historical commercial catch reconstruction

PacFIN serves as a clearinghouse for commercial landings data since the early 1980's, and before that, landings for each state were reconstructed using the assumptions described below.

2.3.1.1 Washington

Historical commercial landings of non-shrimp trawl gear were reconstructed for Dover sole landed in Washington. Shrimp trawl, fixed gear, and recreational landings constitute a negligible amount of the total mortality. Historical landings of Dover sole landed in the state of Washington were determined as follows for the periods shown.

Pre-1935
As stated by Smith 1936 (also see above) Dover sole was "never retained in the commercial catch." The report also states, "[i]t is not abundant at any place in the fishery… few are taken in the extraterritorial fishery off the Washington Coast." Therefore, catch before 1935 was assumed to be zero in Washington.

1935–1950
Total sole landings were obtained from State of Washington Department of Fisheries Annual Reports and were first partitioned into Dover landings, then partitioned into outer coast landings, and lastly partitioned into landings caught in US waters. The proportions used for the partitioning were calculated using 1951–1954 data from a Washington marine fish ticket database supplied to me by Greg Lippert (pers comm., WDFW). Of the sole landings, 14.5% were considered to be Dover sole. Of the Dover sole landings, 1.5% were caught in Puget Sound, and of the outer coast Dover sole catch, 80.8% were taken in US waters.

1951–1969
Landings of Dover sole were obtained from the State of Washington Department of Fisheries Annual Reports and Yearly Fisheries Statistics. Puget Sound catches from an internal report at the Washington Department of Fish & Wildlife called the "Yellow Book" (Greg Lippert, pers comm, WDFW) were removed from these Dover sole landings. And the annual proportions of US catch (ranging from 40% to 87%) were calculated from the Washington Marine Fish Ticket database supplied by WDFW (Greg Lippert, pers comm, WDFW).

1970–1980

The 1981 Fisheries Statistical Report from the Washington Department of Fisheries published total landings of Dover sole, Puget Sound landings of Dover sole, and Pacific Ocean landings of Dover sole. The Total landings landings minus the Puget Sound landings were used for the outer coast landings of Dover sole. It was assumed that the proportion of Dover sole caught in the U.S. linearly increased from 1970 (assumed to be the average of the US proportion from 1967–1969, or 60.3%) to 100% in 1978 (entirely US catches).

2.3.1.2 Oregon

Historically reconstructed landings from Oregon for the years 1927–1980 were obtained from Vladlena Gertseva (NWFSC, NOAA). A description of the methods can be found in Gertseva et al (2010). These reconstructed landings matched closely with the landings used in the 2005 assessment, except in 1955 where the reconstructed landings were slightly less (Figure 33). Further comparison was not possible because the 2005 assessment reported landings by INPFC area.

2.3.1.3 California

Historical commercial fishery landings of Dover sole were obtained from the California Cooperative Groundfish Survey, also known as CALCOM (http://128.114.3.187/) for the years 1948–1980. Prior to that, the landings used in the 2005 assessment (Sampson 2005) were used. It was assumed that these landings were all trawl landings, and other gears extracted from the CALCOM database for 1969 and onward showed very little Dover sole landed. For the period of years which the 2005 assessment reported statewide landings (1948–1955), the historical reconstructed landings used in this assessment were slightly smaller than the landings used in 2005 (on average about 13% except for 1948 which was 52% less). A comparison after 1955 cannot be made because the landings in the 2005 assessment are reported by INPFC area and not state.

2.3.2 Recent commercial landings (1981–2010)

Recent landings for California, Oregon, and Washington were retrieved from PacFIN (Pacific Fisheries Information Network (PacFIN) retrieval dated March 9, 2011, Pacific States Marine Fisheries Commission, Portland, Oregon; www.psmfc.org). Puget Sound catches were removed and only non-shrimp trawl gear was used. Coastwide, the landings match relatively well with the landings used in the 2005 assessment (Figure 35).

2.3.3 Fishery-Catch-Per-Unit-Effort

For the 1997 assessment, Brodziak et al. (1997) included fishery catch-per-unit-effort (CPUE) as a tuning index derived by applying a general linear model (GLM) to trawl logbook data from California, Oregon, and Washington. Sampson (2005) included this index in the 2005 assessment with a fixed asymptotic selectivity curve. These data were not used in this assessment because standardized trawl surveys are available for a similar time period, much new data was available for recent years from the NWFSC shelf/slope survey, it is uncertain if CPUE data adequately index abundance, and it is uncertain what the selectivity is that should be applied when determining the fit. However, fits to the index are shown in the modeling results section.

A new standardized CPUE series was not developed because recent management changes make linking years difficult, even with proper standardization techniques. And, as mentioned above, data are available from surveys statistically design to provide an index for many groundfish species, and are particularly suited for indexing flatfish species since the area covered by the surveys are flatfish habitats. It is important to investigate catch-rates from the fishery, but one must use caution when using them to index abundance (Hilborn and Walters, 1992).

2.3.4 Fishery Biological Data

Expanded lengths and ages from the commercial fishery were used in this assessment. The numbers of trips sampled for the length compositions are shown in Table 11 and for age data in Table 12. Plots of sex-specific length compositions and age compositions for the three states are shown in

2.3.5 Discards

The West Coast Groundfish Observer Program (WCGOP) has been collecting at-sea data since 2002 to mainly record discard information. Their data are current through 2009 and are summarized here. A proportion of the fleet for various gear types has been observed in each year and the data collected are used to estimate the total mortality to various species. In 2011, under trawl rationalization, 100% observer coverage is required for some sectors, which will result in a large increase in data and ability to determine discard behavior. However, given the change in management, it is likely that there will be a change in behavior.

Table 17 shows discard ratios (total weight discarded divided by the sum of total discard weight plus total retained weight) for each state and year since the WCGOP has been collecting data. Figure 36 shows the discard ratios by area and depth. Discard rates were around 15-20% in 2002 and 2003, and dropped to around 6-14% afterwards. The Oregon fleet typically had the lowest discard rate while California had the highest. All of the states typically showed the lowest discard rates in depths between 150 and 300 m (Table 18 and Figure 36). Discard rates were generally higher in the 300+ m depths and average weights were greater, indicating that larger fish are being discarded (Table 19, Figure 37, and Figure 38). It is uncertain if those larger fish are purposefully discarded because they are unmarketable, or if trip limits are being reached. Weighted length frequencies of discards by area and depth strata show that discards in shallow depths consist of smaller fish in California, but some larger fish in Oregon and Washington (Figure 39 to Figure 42).

These discards were estimated in the model and estimated total catches, as opposed to landings, are reported where necessary.

3 History of Modeling Approaches

3.1 Previous Assessment

The previous assessment of Dover sole was done in 2005 by David Sampson and concluded that the biomass of Dover sole off of the U.S. West Coast was well above the target biomass, which was 40% at that time. The following is a summary of some of the assumptions in that model, but Sampson (2005) provides more detail.

- The modeled period was from 1910-2004, with the assumption that the stock initially was in equilibrium with a zero level of catch, but recruitment deviates were estimated starting in 1930.
- There were two fisheries (south - Eureka to Conception; north – U.S. Vancouver to Columbia), with sex-specific, domed selection curves based on length.
- Growth curves were derived by Synthesis based (in part) on average length-at-age data collected during the coastwide NMFS slope surveys, 1997-2004. None of the growth curve parameters were pre-specified, except for the coefficients of variation in length-at-age.
- The natural mortality coefficient (M) was assumed to be 0.09 yr -1 for both sexes.
- Sigma(R) was set to 0.35; steepness was fixed at 0.8.
- There were length-based discards based on logistic retention curves fixed during two periods, 1956-80, 1986-2004 with linear transitions in the curve parameters during 1981–85.
- The AFSC and NWFSC slope surveys were treated as entirely independent tuning indices.
- The AFSC coastwide biomass estimates (1992, 1996, 1997, 1999, 2000, and 2001) were coupled with coastwide length composition data for 1997, 1999, 2000, and 2001.
- The NWFSC coastwide annual biomass estimates (1998-2004, slope portion only) were coupled with coastwide length and age composition data (1998-2004).
- The NMFS triennial shelf survey biomass estimates (excluding "water hauls") for 1980, 1983, 1986, 1989, 1992, and 1995, and 1998 were used as a tuning index, coupled with length frequency data for 1986, 1989, 1992, and 1995, 1998, and 2001.
- Brodziak's index of relative abundance from commercial trawl fishery logbooks, 1978-94, was used as a tuning index, matched with an asymptotic size-selection curve having a fixed L50 of 33.8 cm and a slope coefficient of 0.55 cm^{-1}.
- The length-at-age and age composition data were down-weighted.
- In the fishery selection curves the ascending slope parameters were fixed at 0.1.
- In the survey selection curves the parameters for the female length at the peak were fixed: AFSC = 30, NWFSC = 32, Shelf = 30.
- In the slope survey selection curves the parameters for the female ascending slope were fixed at 0.1; the parameters for the male length-at-transition were fixed at 32; and the selection values at Lmax were forced to zero.
- The growth parameters were estimated, but were time-invariant.
- The parameter value for the length at 50% maturity varied in three stages. During 1910-1954 it was fixed at a value of 36.5, during 1984-2004 it was fixed at a value of 33.4, and during 1955-83 it changed incrementally to conform with a linear trend between the end-point values.
- There were year-to-year deviations in the female ascending inflection point parameters for both fisheries.

3.2 Pre-Assessment Workshop, GAP, and GMT Input

A pre-assessment workshop took place in April 2011 in Newport, OR and was attended by NWFS employees, ODFW employees, industry representatives, and a Makah tribal representative. Unfortunately, attendance was low for the Dover sole portion of the workshop as a meeting for the NWFSC shelf/slope trawl survey was concurrently taking place. However, Brad Pettinger, Craig Goode (ODFW), and John Devore (PFMC) provided insight into some of the issues that this assessment would have to address. Some of the more important anecdotal points coming from that workshop were:

- There are bigger fish on the shelf.
- Fish in the southern portion of the coast do not firm up as well in comparison to the quality of the meat up north.
- The change in mesh size in the 1980's was a good change for the fishery because it reduced sorting time and retained marketable fish.
- The 1990's saw lower catch rates and some areas were not fished, giving them a rest.
- Discards were not as substantial in the 1990's, but during the 2000's, when the population appeared to be coming back, discarding behaviors changed.
- In 2002 and 2003 the fishery was experiencing nice sized tows of Dover sole.
- The spring is when the best fishing occurs because the fish are a similar size. During the winter months, there is more diversity in the sizes.
- In the last few years, small fish are caught less frequently and few fish go overboard due to size sorting.
- In shallow water, boats are using a bigger mesh size to maximize the size of the fish and to reduce sorting.
- There is little bycatch in the shrimp fisheries, but tows that occur at night may catch larger Dover sole. However, these fish would be retained and landed.
- Fish excluders became mandatory for shrimp trawls in 2003, but most boats were using them in 2002.
- The price of Dover sole increased in 2011 to 42 cents/lb compared to 30 cents/lb in 2010.
- After the ACL increased, there was a lot of effort to develop the market. There are likely many recent market driven changes in the fishery that may affect the assessment.
- Dover sole move from winter deep water spawning areas onto the shelf.
- When Dover sole are transitionally moving in the late Spring, they are difficult to catch.
- In the 1990s, Dover sole seemed to be associated with a hard-bottom area. More recently, "you just drive by and look at the net and they jump in." It is postulated that the rocky areas may have been refuge, and/or Dover sole may be in rocky areas during certain times of the year.

3.3 Response to STAR Panel Recommendations in 2005

The STAR panel report from the 2005 review identified a number of recommendations for future assessments. Although all these recommendations could not be addressed for 2011 progress on each is summarized below:

1) *Investigate model structure to diagnose and solve convergence problems. Some of the following recommendations are considered elements of this investigation.*

Complex age-structured stock assessment models are prone to convergence problems that every stock assessment scientist should be aware of. This assessment did show some difficulty in convergence, but not anything more than has been seen in other stock assessments. Some things that were done to aid in convergence were: starting values were determined *a priori* based on first principles and prior knowledge of the stock, the assessment model was restructured to use state-specific fleets, numerous years of data were added from the NWFC shelf/slope survey, and natural mortality was estimated for each gender. The biggest convergence problem was apparent with the estimates of natural mortality. When the model began estimating male natural mortality, it would occasionally wander into a likelihood space of high M and very high biomasses from which it could not come back from (to more reasonable and expected values). Some experimentation showed that better likelihoods were obtained with these more reasonable values. Male natural mortality was estimated in the very last phase, after female natural mortality, to try and alleviate this problem. Tight bounds were not implemented on male natural mortality so that the model would not be restricted, especially when estimating uncertainty.

2) *Develop a model for this population to overcome limitations with handling size/sex related patterns either by having SS2 modified or use some other approach.*

Many improvements have been made to the modeling software called Stock Synthesis since the 2005 Dover sole assessment, some of which deal with the size/sex issues experienced then. An attempt was made to deal with these issues while also trying to maintain a parsimonious model. However, many of the size and sex related issues are also related to location of fishing (in particular relationships with depth). This would require collected depth specific data from fisheries and partitioning those fisheries not only by latitude, but by depth, for which there is little data and the data that are available are uncertain and typically summarized over a number of tows. Instead, alternative selectivity parameterizations were used, such as cubic splines and offsets to the proportion of females caught, which seemed to explain some of the inconsistencies seen in the 2005 assessment.

3) *Collect more information on length composition (by sex if possible) of discards, especially in the southern area.*

The West Coast Groundfish Observer Program has been collecting length data since 2006, although they do not determine gender. In 2011, with the start of trawl rationalization, some sectors of fishing fleets will have 100% observer coverage and much more data will be available. This may also result in a change in fishing practice such that discarding behavior is changed. However, historical discards remain uncertain.

4) *Determine factors underlying discard patterns in north and southern fishery. Factors such as change in acceptable size to markets, targeting by depth, problems with jellied condition of the larger fish in the south and changes in regulations (e.g., varying trip limits) were all suggested as having an influence.*

Discussions at a pre-assessment workshop (April 2011, Newport, OR) with industry representatives and stakeholders suggested that discards were not a major problem in the 1990's when the stock size appeared lower. In the 2000's, however, Dover seemed easier to catch and discards became more prevalent. Fortunately, the WCGOP began sampling then and those data were investigated for differences in discards in relation to latitude and depth. Interviews with various industry representatives are still ongoing and will be discussed at the STAR panel.

5) *Explore having the CV of length-at-age interpolated being a function of age instead of length.*

This option is implemented in the Stock Synthesis version 3 along with many other options. For the 2011 assessment, a lognormal distribution of length-at-age was used where the standard deviation in log space was a function of age. This distribution was chosen based on fit to the data.

6) *The commercial CPUE is only used up to 1995 because of problems with changes in regulations after this time. Extensions of this series should be investigated by determining how this index could be used as a biomass index accounting for problems with trip limits, bycatch limits, etc.*

The 2011 stock assessment of petrale sole investigated the use of CPUE as an index of abundance, attempting to account for seasonal differences, management changes, and fleet dynamics. This ended up being a lengthy undertaking for a small gain. A 2011 STAR panel determined that although petrale CPUE may show trends in abundance, it may not be linearly related to abundance. In addition, the NWFSC annual shelf/slope survey is designed to provide statistically designed abundance indices and is particularly suitable for flatfish. Therefore, due to time spent investigating petrale CPUE, the management changes that have taken place in the last few decades as well as the current restructuring of the fishery, and the availability of a coastwide survey, CPUE for Dover sole was not investigated.

4 Model Description

An age-structured stock assessment model was used to predict the biomass trajectory of Dover sole with an approach of balancing parsimony with complexity. This allowed for the determination of general trends in the biomass over time and not trying to format data into partitions that explain little additional variation.

Stock Synthesis v3.21f was used to estimate the parameters in the model. R4SS, revision 1.16, along with R version 2.13 were used to investigate and plot model fits. A summary of the data sources used in the mdoel (discussed above) is shown in Figure 43.

4.1 New modeling approaches

The modeling approach used in this assessment is similar to recent assessments done at the NWFSC, but included some new concepts, mainly new features of Stock Synthesis. First, a lognormal distribution was used to characterize the variability of length-at-age with the standard deviation in log space (similar to the coefficient of variation or CV) a function of age. Second, selectivity curves for the slope surveys were modeled using cubic splines which allows for a greater possibility of shapes. Lastly, the female selectivity curves were not forced to asymptote at one, allowing for the possibility of differential sex selection. All of these approaches appeared to improve the modeling capabilities.

4.2 General model specifications and assumptions

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

4.2.1 Summary of Fleets

Dover sole are found along the entire West Coast of the U.S. and it was decided to define the fleets by state landed due to data availability (historical reconstructions by state) and ease of summarizing commercial data such as lengths and ages. Only trawl landings were considered because they are typically more than 99% on the total coastwide landings (Table 1). And, in recent years at least, bycatch in other gears, including shrimp trawls, was a negligible proportion of the total catch.

The main Dover sole fishery appears to occur in the north and could possibly be more similar to Oregon fisheries than Southern and Central California fisheries. However, format of the historical data made it difficult to easily combine Northern California with Oregon. It is uncertain how much affect this has on the model results.

4.2.2 Other specifications

The specifications of the assessment are listed in Table 13. In summary, the model is a two-sex, age-structured model starting in 1910 with ages pooled at 60 years. Growth and natural mortality were estimated for each gender separately. The lengths in the population were tracked by 1 cm intervals, but the data were binned into 2cm intervals. Ageing imprecision was also introduced separately for CA observations and OR/WA observations.

The Triennial survey was split into an early and a late series, based mostly on timing of the survey (Figure 6), by estimating different catchability parameters for each period. The selectivity curves for each period were the same. Only years in which the AFSC slope survey surveyed its entire range were used (1997–2001). The NWFSC survey was split at 2003 with 1998–2002 representing just the slope area and 2003–2010 representing the shelf and slope areas. Age data were not available for the Triennial survey and were not used from the AFSC slope survey due to the possibility of non-random sampling. Age compositions were fit to the NWFSC slope survey because there is the possibility that larger fish live deeper, but the relationship is not as strong for age. Age-at-length data were derived from the NWFSC shelf/slope survey because that survey was more comprehensive in coverage and better represented the overall population length-at-age structure. Length-frequencies were calculated for each survey.

The specification of when to estimate recruitment deviations is an assumption that likely affects model uncertainty. It was decided to estimate the full set of recruitment deviations (1910–2010) to appropriately quantify uncertainty. Even though the earliest length-composition data occur in 1966, the most informed years for estimating recruitment deviations seemed to be in the mid-1960' to the mid-2000's. Therefore, the period from 1910–1959 was fit using an early series with no bias adjustment, the main period of recruitment deviates occurred from 1960–2009 with a ramping of bias adjustment (Figure 44) and 2010 onward was fit using forecast recruitment deviates with no bias adjustment. Methot and Taylor (2011) summarize the reasoning behind varying levels of bias adjustment based on the information available to estimate the deviates. Recruitment deviation was assumed to be 0.35, following the recommendations from the 2005 assessment (Sampson 2005), but the bias adjustment did not reach its maximum (Figure 44).

The recommended selectivity type in Stock Synthesis is the double normal and was used in this assessment for the fleets and surveys that covered the shelf (Triennial and NWFSC shelf/slope) with separate selectivity-at-length relationships for females and males. Offsets of the female to male selectivity at age 50 and selectivity at a defined peak were estimated to allow for a slightly different shape of the female selectivity curve as well as the maximum selectivity being less than zero.

The slope surveys showed a bimodal length composition, which may be due to stock distribution during the survey months, thus a cubic spline (a smooth piece-wise polynomial function) was used for selectivity curves to allow more flexibility in the shape of curve. Cubic splines work by specifying nodes or knots, where the curve passes through, and estimating the value at these nodes as well as the slope at the ends. Five nodes starting at 20 cm and ending at 56 cm were used. Offsets of the male to female selectivity at age 50 and selectivity at a defined peak were estimated to allow for a slightly different shape of the female selectivity curve. Having the offset of male to female for these selectivity curves seemed to behave better and allow for the maximum selectivity of females to be less than zero.

Female maturity at length has been modeled various ways over the past assessments. The 1999 assessment used a length at 50% maturity of 33.8. The 2005 assessment assumed that the length at 50% maturity changed from 36.5 to 33.4 between 1955 and 1983. Hunter et al. (1992) showed that estimates of the length at 50% mature are highly variable depending on when the samples were taken and how the samples were analyzed. They also dismissed a statistically significant difference seen between samples taken in 1940 and samples taken in the 1980's due to this. We chose to use the length at maturity reported by Hagerman 1952 with the length at 50% mature equal to 35.0 cm and a slope that leads to 100% at age 45.

Time blocks on selectivity and retention parameters were used to allow for shifts in these curves. The time blocks for the peak of the selectivity parameter were 1910–1980, 1981–1995, and 1996–2010. These blocks were based on what seemed to be large scale management changes to the DTS fishery, but were also influenced by the 2005 assessment (Sampson 2005). The time blocks for the fishery retention in Oregon were 1910–1988, 1989–2003, and 2004–2010. Washington and California did not have as much historical discard data, thus the time blocks on retention for those fleets was 1910–2003 and 2004–2010. The blocks for retention were decided on because management seemed to become more restrictive in 1989 and again in 2003 (Table 2). There also appeared to be changes in discard ratios in 2004 (Table 17).

4.2.3 Priors

Prior distributions were developed for the gender-specific natural mortality parameters from an analysis on maximum age, L_∞, k, W_∞, and average temperature (Table 15). The analysis was performed by Owen Hamel (pers comm, NWFSC, NOAA). It uses a combination of methods to provide a lognormal distribution of natural mortality. The medians of the lognormal prior for females and males were 0.101 and 0.103, respectively. The standard deviations in log space were 2.289 and 2.276 for females and males, respectively. These prior distributions are plotted in Figure 29.

When the steepness parameter was estimated (as a sensitivity), a prior developed from Myers et al (1999) was used. This prior was normal with a mean of 0.8 and a standard deviation of 0.09.

4.2.4 Sample Weights

The base case assessment model was iteratively reweighted so that the various data sources were mostly consistent with each other. For the fishery fleets and the NWFSC slope survey, age compositions were fit along with length compositions. To avoid double weighting of observations from the same fish, the lambdas were set to 0.5 for each dataset. The age compositions were not down-weighted from the other data, unlike the 2005 assessment. Length and age data started with a sample size of number of trips for port sampling from fleets and number of tows for survey samples. It is not often that these sample sizes are upweighted because catches from a tow tend be similar in size. However, this assessment model suggested that the fishery length and age compositions be up-weighted. This may be due to multiple tows making up a single trip. However, survey length comps were also up-weighted. The NWFSC survey historically lengthed more than 10 Dover sole from each tow, but recently has reduced that number to 5 per tow. The numbers of tows for the survey age comps were down-weighted by factors of 0.3 and 0.1 for the NWFSC slope and NWFSC shelf/slope surveys, respectively. One extra variability parameter was estimated for each survey index series. The variability supplied with the discard fractions and mean weight of discards was not changed.

4.2.5 Estimated and Fixed Parameters

There were 204 estimated parameters in the base case model. These included one parameter for R_0, 10 parameters for growth, two parameters for natural mortality, four parameters for extra variability on the survey indices, two parameters for the catchability of the two series of the Triennial survey (the catchability for other surveys was calculated analytically), 42 parameters for selectivity, retention, and time blocking of the fleets, 30 parameters for survey selectivity, 101 recruitment deviations for model years, and 12 forecast recruitment deviations.

Fixed parameters in the model were as follows. Steepness was fixed at 0.8, which is the value used in the last assessment as well as the mean from Myers (Myers et al. 1999) meta-analysis. A sensitivity analysis and a likelihood profile were done for steepness, but it was assumed that there is insufficient contrast in the data to adequately estimate the parameter. The standard deviation of recruitment deviates was fixed at 0.35, also used in the last assessment, and although the model results indicated that it should be less, it was kept at 0.35 following the same logic as Sampson (2005) that it is implausible that recruitment be nearly constant. However, the bias correction on recruitment deviates was not fully implemented which implies that the recruitment deviates were never fully and adequately estimated. As discussed above, though, the life history of Dover sole may indicate that they are less susceptible to variation in annual ocean conditions, and thus they may have a smaller variation in recruitment. Maturity at length was fixed with a length at 50% mature at 35.0 and 100% maturity occurring at 45.0 (Figure 26). Length-weight parameters were fixed at estimates from the NWFSC shelf/slope survey data (Figure 25 and Table 14). Finally, asymptotic male selectivity at length was assumed for the fleets, but female selectivity was allowed to possibly have a dome shape.

4.3 Link from the 2005 to the 2011 Assessment Models

This assessment began by recreating the 2005 assessment in SSv3.21 and slowly added as many of the new assumptions as possible to see what differences they made. Figure 45 compares the 2005 assessment spawning biomass with the spawning biomass estimated by SSv3.21. Simply putting in the estimated parameters resulted in a trajectory that was higher than the 2005 assessment, but lowering R_0 brought the two assessments pretty close into line. When SSv3.21 was allowed to estimate the parameters with the same assumptions as the 2005 assessment, the spawning biomass trajectory started at approximately the same place, but did not decline as quickly throughout the 1980's and 1990's, resulting in a higher final spawning biomass. It is uncertain if this is due to a change in the way SSv3.21 models the population or if it is a slight difference in how the model was set up in SSv3.21. Nevertheless, SSv3.21 produced similar results as the 2005 assessment done in SSv2.

The model was slowly built up from the 2005 reproduction in SSv3.21 to see how new assumptions and new data affect the estimates of spawning biomass (Figure 46). First, the CPUE data were removed, which resulted in a slight shift upward in spawning biomass and less decrease in the 1980's. Next, the NWFSC shelf/slope survey estimates for 2003 and 2004 were omitted because they are now part of the NWFSC shelf/slope survey and the new estimates of the NWFSC slope survey were input with the same CV's that were in the 2005 assessment, and the 1992 and 1996 AFSC slope survey estimates were omitted because they did not survey the same area as the later years of the AFSC slope survey. This run increased the estimates of spawning biomass considerably. The model was then extended to 2010 by adding catches for the North and South approximated by OR/WA and CA, respectively. And finally, the new landings were input, approximating OR/WA as the Northern area and CA as the Southern area, and input the NWSC slope survey and NWFSC shelf/slope survey indices, as well as the length frequencies for these surveys, although assumed the selectivity was the same for the surveys. These final two runs did not show much further difference from the run that modified the slope surveys. It appears that the CPUE indices and the 2005 assessment assumptions about the slope surveys have a decreasing effect on the estimates of spawning biomass.

4.4 Model selection and evaluation

The base case assessment model for Dover sole was developed to balance parsimony and realism, and the goal was to estimate a biomass trajectory for the population of Dover sole on the outer west coast of the United States and provide quality predictions of the future biomass under various catch assumptions. The model contains many assumptions to achieve parsimony and uses many different sources of data to estimate reality. A series of investigative model runs were done to achieve the final base case model.

4.4.1 Key Assumptions and Structural Choices

The key assumptions in the model were that the assessed population is a single stock, maturity at length has remained constant over the period modeled, weight-at-length has remained constant over the period modeled, the standard deviation in recruitment deviation is 0.35, and steepness is 0.8. These are simplifying assumptions that unfortunately cannot be verified or disproven. Sensitivities were done for most of these assumptions to determine their effect on the results.

Structurally, the model assumed that each state was a separate fleet, but within that state selectivity and retention were constant. The model also treated the Triennial survey as two series with the same selectivity curve but different catchability coefficients. The AFSC slope, NWFSC slope, and NWFSC shelf/slope surveys were each a constant series linearly indexing abundance. In the model, a plus group at 60 years was used and length was tracked by 1 cm bins between 5 cm and 65 cm. The model started at equilibrium in 1910 and fishing mortality before then was assumed negligible.

4.4.2 Alternate Models Explored

The exploration of models began with the reproduction of the 2005 assessment in SSv3.21, working through many runs to the current base model. *M* was fixed initially to hone in on the general behavior of the model. With M estimated, explorations of selectivity types and age or length based selectivities were done. Age based selectivity did not to explain the data better than length based selectivities. Length based selectivity with a declining age based selectivity was also explored and did not improve the fits to the data. In addition, the use of cubic spline selectivities were explored and it was decided that these are able to explain the bimodal distribution seen from the slope surveys (the slope surveys do not cover the entire range of Dover sole and may be encountering a large population of fish and a smaller population of fish).

Selectivities were a major source of investigation and time blocking was also used to explain residual patterns in the data. However, instead of basing the blocks on residual patterns, we made some *a priori* decisions of the blocks based on management history. And, in the spirit of parsimony, we used as few blocks as possible, and added new blocks when we felt they were justified by changes in management and they improved the fit to the data.

Natural mortality was also a major topic of investigation. It appeared that female natural mortality was somewhat defined, but male natural mortality was quite variable to the assumptions being made. In other assessments, it has been seen that the offset of male to female *M* is well defined in the data, thus fixed offset was attempted, but failed to produce desirable results. This will be discussed more when presenting likelihood profiles. After changes to the error distribution of length-at-age, removing the AFSC slope survey age data, dialing in the selectivity assumptions (in particular the cubic spline parameterizations), and tuning the data, the male estimate of *M* seemed to behave better, although is still quite uncertain.

In addition, and presented as a sensitivity, a simple production type model was fit to the data. This model assumed fixed recruitment, growth, and natural mortality, and used only length data. This model was not chosen as a base case model because assumptions were made which could be relaxed with a more complicated model, and poor residual patterns were explained much better with a slightly more complicated model.

4.4.3 Convergence Status

Proper convergence was determined by starting the minimization process from dispersed values of the maximum likelihood estimates to determine if the model found a better minimum. This was repeated 100 times and a better minimum was not found. The model did experience some convergence issues, but through the jittering done as explained above and likelihood profiles, it is likely that the base case as presented represents the best fit to the data given the assumptions made. There were no difficulties in inverting the Hessian, although much of the early model investigation was done without attempting to estimate a Hessian.

4.5 Response to STAR panel recommendations

The STAR panel thoroughly reviewed the data and the model presented in this assessment of Dover sole and concluded that given the data available, the model sufficiently balanced parsimony and realism. It seems that Dover sole have unique characteristics of migration, growth, and other life-history patterns which often lead to interesting observations in the data. Unfortunately, it is difficult to accurately investigate these patterns further without additional data collection. The STAR panel noted concern with long-term forecasts of the model and estimates of equilibrium reference points due to the lack of model complexity as well a large amount of uncertainty in the estimates, but the model is useful for more short-term . We agree with the STAR panel that the model is the best available science and additional data collection along with more detailed studies Dover sole would benefit the assessment and allow for a better understanding of the stock. Additionally, we agree with the STAR panel that it is difficult to estimate equilibrium reference points and other assessment model parameters when the stock has been lightly fished.

4.6 Base-Case Model Results

The base case model parameter estimates along with approximate asymptotic standard errors are shown in Table 21 and the likelihood components are shown in Table 20. Estimates of key derived parameters and approximate 95% asymptotic confidence intervals are shown in Table 22.

4.6.1 Parameter estimates

Many of the parameter estimates seem reasonable but there were some that should be noted. The cubic spline selectivity curves showed a bimodal shape, which helped to explain the bimodal length frequencies. It may be that the slope survey is selecting two segments of the population that have differing size distributions, and the survey is not gaining a complete picture of the entire population since it did not survey the shelf area. Also with the selectivity, the female selectivity curves reached a maximum value less than one, indicating that males are preferentially selected.

The estimates of natural mortality were higher than have been assumed in past assessments, and were higher than suggested by the median of the prior distribution. Estimating M is difficult in stock assessments, and the parameters may represent model misspecification instead of the actual life-history trait. However, when investigating models leading up to the base case model, the estimates of M were rarely less than 0.10, and cases when that happened was when some restrictions, such as equal natural mortality for males and females, were imposed.

Selectivity curves were estimated for commercial and survey fleets. The estimated selectivity, retention, and keep (the product of selectivity and retention) curves for the commercial fleets are shown in Figure 47, Figure 48, and Figure 49, respectively. The selectivity curves showed a shift to smaller fish in the 1981–1995 period. The retention curves showed a shift to retaining smaller fish in recent years (since 2003), and the resulting curves for actual kept fish (keep curves) showed that smaller fish are being landed more recently.

Additional survey variability (process error added directly to each year's input variability) was estimated in the model and resulted in a large addition to the Triennial survey (0.23), moderate additions to the AFSC slope and NWFSC slope surveys (0.06 and 0.04, respectively), and virtually no addition to the NWFSC shelf/slope survey. It is not surprising that the slope and Triennial surveys require extra variability since they do not survey the entire stock. The NWFSC shelf/slope survey covers much more range of the stock and the GLMM is used to obtain reasonable estimates of variance.

The estimates of maximum size for both females and males were slightly less than anticipated when looking at the survey data alone. This is not uncommon, especially when using a lognormal distribution for length-at-age. The skewed lognormal distribution is able to explain those larger fish.

4.6.2 Fits to the data

There are four types of data for which the fits are discussed: survey abundance indices, discard biomass and discard average weight estimates, length composition data, and conditional age-at-length observations.

Fits to the three series of survey abundances are shown in Figure 51. The increasing trend in the late Triennial series is not fit well, but the general trend of the two slope surveys and the NWFSC slope/shelf survey are captured.

The total discard ratios (discard divided by total catch) were fit quite well with the time blocks used in the base case model (Figure 52). The Washington fleet showed the most variable annual discard fraction and the time block in 2004 did not have much effect. The 1986 data for the Oregon trawl fleet predicted a much higher discard ratio. The input standard errors on the discard ratios were high, and given the good fits could possibly be reduced. However, it was felt that the variances should not be reduced from the bootstrapped estimates of variance for the 2002 to 2009 data and the earlier data should have a higher variance than the recent data.

Fits to the mean weight of discards were relatively good for the Oregon and Washington fisheries (Figure 53). The fits to the mean weight of discards from California were good for the years 2002 and 2003, but after the time block in 2004, the mean weights were consistently overestimated. With the discard ratios fit well, it may be that larger fish are discarded less frequently in recent years, but the model was unable to capture that.

Fits to the length-composition data are displayed in two different ways: the Pearson residuals-at-length are shown for each year for all types of length compositions, and the fits to aggregates of all years are shown for the female and male retained and well as the combined sexes discards. These fits are shown in Figure 54 to Figure 67. More detailed plots of fitted lines drawn over the plotted proportions at length are shown in Appendix A.

The fits to the California length frequencies were overall good. Some patterns were discernible, but the residuals were generally small. The aggregate fit to the discard data showed that smaller fish were predicted, which was also seen in the mean weight data. The fits to the Oregon length composition data were worse than for California. Some patterns were seen in the residuals and the size of the residuals were slightly larger. Males before 1980 were mostly over-predicted throughout the entire length range, and larger males were often predicted but not observed. There was additional discard data for the Oregon fleets other than the more recent WCGOP data. Even though blocks were used in the model to fit these data, the model was unable to fit them well. The Pikitch data (1986–1987) showed almost no fish being discarded larger than 30cm. This seems unlikely for the Dover sole fishery. The WCGOP length composition data for the Oregon fleet was fit well given the noise in the observed data. The fits to the Washington length frequency data were problematic in that the model commonly predicted more small females than the observations indicated, although the residuals were small. Poor fits were as not as common for the male fish. Given the noisy discard length frequencies, they were fit reasonably well.

The fits to the survey length frequencies were overall good. The bimodal shape was fit for females in the slope surveys while maintaining the smaller males, the triennial survey showed a slight pattern where later in time the smaller fish were underfit, but residuals were generally small. The NWFSC shelf/slope survey was fit very well, but there was some lack of fit in the 2010 with larger fish being under-predicted.

Age data showed inconsistent fits for each of the fleets. The fit to the age data for the California fleet was quite good with small residuals (Figure 76) and show good correspondence with the aggregated age compositions (Figure 77). The residuals of the fits to the Oregon fleet age compositions were typically larger than those from the California fleet (Figure 78) and showed an over-prediction of the ages younger than 10 and an under-prediction of the ages between 10 and 15, as can also be seen in the plots of aggregated age compositions (Figure 79). The fits to the age compositions from the Washington fleet were troublesome. The model often over-predicted the proportion of older age fish in the 15-30 year range and under-predicted the younger ages (Figure 78 and Figure 79). Introducing a declining selectivity at older ages in the model did not reduce this pattern.

The fits to the NWFSC slope survey age compositions did not show any troublesome patterns, except for the occasional large residual which was likely caused by sampling variability and expanding a small sample to a large tow (Figure 82 and Figure 83). Although conditional age-at-length distributions were fit to from the NWFSC shelf/slope survey, the implied fits to the age compositions are shown (Figure 84). There are a few large residuals, again likely due to small sample sizes, and no worrisome pattern can be seen except that in 2010 the small females were under-predicted and the small males were over-predicted. The fits to the conditional age-at-length data from the NWFSC shelf/slope survey are shown in Figure 85. The residuals for these data are quite small in 2010, and show some larger residuals in 2003. The fits to the female data appeared to have larger residuals.

4.6.3 Population trajectory

The predicted spawning biomass (in metric tons) is given in Table 23 and plotted in Figure 86. The trajectory shows a decline starting in the late 1940's with an increase occurring throughout late 1960's and 1970's. A larger decline occurred in the 1980's and early 1990's before increasing quickly during the first decade of the 21st century. The spawning biomass trajectory was predicted to have leveled out in 2009 and has since shown a very slight decrease. The trajectory of the age 5+ biomass shows a very similar pattern, except with more decline recently (Figure 87). Estimated depletion never dips below the management target of 25% of unfished biomass (Figure 88).

Estimated recruits showed the strongest cohorts in 2000, 1992, 1988, 1965, and 1991, respectively, and the weakest in 2003, 2002, 2004, 2006, and 1974 (Table 23, Figure 89). The estimates of recruitment were uncertain which contributed to the uncertainty in spawning biomass. The recruitment estimates showed an oscillating pattern of a group of years of good recruitment and a group of years of poor recruitment. It may be worthwhile to investigate this further to see if it is an artifact of the data or a result of environment.

4.7 Uncertainty and Sensitivity Analysis

Two types of uncertainty are presented for the assessment of Dover sole. First, uncertainty in the parameter estimates was determined using approximate asymptotic estimates of the standard error. These estimates were based on the likelihood theory that the inverse of the Hessian matrix (the second derivative of the parameter vector) approaches the true uncertainty of the parameter estimates as the sample size approaches infinity. This approach takes into account the uncertainty in the data and supplies correlation estimates between parameters, but does not capture possible skewness in the error distribution of the parameters and may not accurately estimate the standard error in some cases.

The second type of uncertainty that is presented is related to modeling error. This uncertainty cannot be captured in the base case model as it is related to errors in the assumptions used in the base case model. Therefore, sensitivity analyses were done where assumptions were modified to determine the effect they have on the model results.

4.7.1 Parameter uncertainty

Parameter estimates are shown in Table 21 along with approximate asymptotic standard errors. Some selectivity parameters showed large uncertainty, indicating that they were poorly estimated. Most correlations between parameters were below an absolute value of 0.9, although the correlation between the natural log of R_0 and male M was 0.97. Estimates of key derived parameters are given in Table 22 along with approximate 95% asymptotic confidence intervals. There is a considerable amount of uncertainty in the estimates of biomass and the coefficient of variation (CV) on the 2011 estimate of depletion was 10.2%. The confidence interval on current depletion is entirely above the management target of 25% of the unfished spawning biomass.

4.7.2 Sensitivity Analysis

Sensitivity analysis was performed to determine the model behavior under different assumptions than those of the base case model. Six sensitivities were conducted to explore the potential differences in model structure and assumptions and included

1. Fixing natural mortality (M) at 0.09 for males and females.
2. Fixing M for males to be equal to females, but estimating female M.
3. Estimating steepness.
4. Downweight age data by a factor of 5.
5. Downweight length data by a factor of 5.
6. Force male and female selectivity to reach a maximum of 1 while still allowing for dome shaped selectivity in the surveys.

Likelihood values and estimates of key parameters are shown in Table 24, predicted population trajectories are shown in Figure 90, and recruitment estimates are shown in Figure 91.

The current status of the stock in the sensitivity runs ranged from 0.467 to 0.841, all above the current management target. Excluding the downweighting sensitivities, the best fit to the length data was seen when estimating steepness, but it was insignificant, and the best fit to the age data was with the base case model. The fits to the survey indices improved slightly when downweighting the length data and when forcing selectivity maximum to one. When downweighting the age data, estimates of M were smaller and maximum size at age was smaller. Estimates of M were similar to the base case when downweighting the length data, but maximum size at age was slightly larger. Estimates of biomass related quantities decreased with smaller M and increased when more weight was given to the age data.

4.7.3 Retrospective Analysis

A 5-year retrospective analysis was conducted by running the model using data only through 2005, 2006, 2007, 2008, and 2009 (Table 25 and Figure 93). There was little to no retrospective pattern in the estimate of spawning biomass as the terminal year of data was removed. Over the last two decades, the spawning biomass trajectories were relatively similar when subsequent years of data were removed (Figure 93). The retrospective where the most data were removed (2006) resulted in scaling the spawning biomass estimate higher throughout the time-series, however the resulting depletion in the final year with data did not differ greatly from the other estimates (Figure 94). The estimated recruitment over time showed comparable patterns, although the estimates of the 2000 year class were inflated for the 2006 retrospective run relative to the other model runs (Figure 95).

The current model produced estimates of spawning biomass that were greater than the previous two assessments (Figure 96). This is mostly due to an higher value of natural mortality in the current assessment, but is also partly due to the addition of the NWFSC shelf/slope survey, as was seen in Figure 46.

4.7.4 Likelihood Profiles

Likelihood profiles were done for steepness (even though it was not estimated in the base case) and jointly over female and male natural mortality. These likelihood profiles were done without priors on the parameters being profiled, thus the MLE estimates from the base case may be different than the MLE in the likelihood profile. For steepness, the negative log-likelihood was minimized near 1, but the 95%

confidence interval extends down to near 0.5 (Figure 97). Likelihoods components by data source for various values of steepness are shown in Table 26 and Figure 98 show that the index and length data have little influence on the estimate of steepness, although they typically prefer high values. The age data show more influence on the estimate of steepness with CA and OR commercial data supporting high values and other age data supporting low values. The NWFSC shelf/slope survey strongly supports low values of steepness, which is contradictory to most other data sources.

For natural mortality, the joint likelihood profile showed that small values were likely for females and large values for males (Figure 99). The difference between the two genders was not well defined. Estimates of spawning biomass did not change greatly with changes in female *M*, but did increase greatly with increase in male *M* (Figure 99). The joint 95% confidence interval for natural mortality ranged between about 0.12 and 0.17 for males, and 0.10 and 0.13 for females (Figure 99). Likelihood components by data source (Table 27 and Figure 100) showed that index data had little influence on the estimates of male natural mortality, and length data supported values from 0.12 to 0.16. Age data from the commercial fisheries supported male natural mortality estimates from 0.11 to 0.13, and the NWFSC shelf/slope survey was very influential with high support of large values from male *M*. Changing the value of male natural mortality did not have much effect on the estimated male selectivity, but did affect the right portion of the estimated female selectivity (Figure 101 and Figure 102). This is mostly an artifact of the model setup and the linking between male and female selectivity through offsets. Unlinking the gender-specific selectivities and estimating them independently of one another would likely improve the model behavior.

5 Reference points

Reference points were calculated using the estimated selectivities and a fleet distribution based on the last year with catch observations (2010) and are shown in Table 22. Sustainable total yields (landings plus discards) were 34,751 mt when using an $SPR_{30\%}$ reference harvest rate and ranged from 15,403 to 54,098 mt based on estimates of uncertainty. The value for 25% of the unfished spawning output (analogous to $B_{25\%}$) was 117,467 metric tons. The recent catches (landings plus discards) have been slightly less than the lower confidence bound of potential long-term yields calculated using an $SPR_{30\%}$ reference point. As a result, the spawning biomass of the stock has been increasing over the last decade except in the last three years which is partly due to recent low recruitment levels.

The spawning biomass of Dover sole reached a low in the mid 1990's before beginning to increase throughout the last decade (Figure 86). The estimated depletion has remained above the 25% of unfished spawning biomass target and it is unlikely that the stock has ever fallen below this threshold (Figure 88). Throughout the 1970's, 1980's, and 1990's the exploitation rate and *SPR* have generally increased and never exceeded current estimates of the harvest rate limit ($SPR_{30\%}$), as seen in Figure 103. Recent exploitation rates on Dover sole have been small, even after management increased catch levels in 2007 (Figure 104). Overall, the stock has remained in the safe area of higher than the target biomass and exploitation rates less than the target (Figure 105).

The equilibrium yield plot is shown in Figure 106, but steepness was fixed at 0.8, thus this curve may not represent the best curve fit to the available data.

6 Harvest projections and decision tables

Forecasts and projections of the Dover sole population up to the year 2022 were constructed assuming that the next two years of catch (2011 and 2012) would be an average of the last three years of fleet-specific catch, and from 2013 onward, catches would reach the calculated OFL. This forecast table (Table 28) shows that even with these high catches from 2013 onward, the predicted spawning biomass does not drop below the target spawning biomass before 2023. However, it does show that even with catches less than the ACL in 2011 and 2012, the spawning biomass is predicted to decline slightly. This is due to recent predictions of poor recruitment.

The axis of uncertainty chosen for this assessment was based on the joint profile of natural mortality for females and males. A one-dimensional decision table is given (Table 29), but is quantified over female and male natural mortalities by finding the most likely combinations of joint M (based on the joint likelihood profile) that correspond to the 12.5% and 87.5% quantiles of 2011 spawning biomass in log space (251,000 and 616,000 mt, respectively). This satisfies the criteria specified in the terms of reference and the geometric mean is approximately equal to the base case estimate of current spawning biomass.

The average catch from the last three years was used for 2011 and 2012 catches with allocation and selectivities based on 2010. Three catch levels were chosen for the years 2013 and beyond in the decision table. First, it was assumed that the entire OFL would be caught in these years. Second, it was assumed that the current ACL of 25,000 mt would be taken every year from 2013 to 2022. And, lastly, it was assumed that status quo catches would be taken based on the average catch over the last three years.

7 Research needs

There are 5 topics for which additional research would greatly improve the assessment of Dover sole.

1. **Age reading error:** Estimates of ageing error were simplified because minimal data and cross-validation were available. There are many within-lab rereads from the Cooperative Ageing Project laboratory in Newport, OR, and some from the California ageing lab, but there is little organized data on cross-lab reads. A workshop in 2004 resulted in some cross-lab reads, but there is little data that can be used to characterize the differences between labs. Furthermore, a bomb calibration study of Dover sole ototliths from Alaska was done by the AFSC, and they concluded that there was little bias in ageing for easy to read otoliths. However, they state that the majority of Dover sole otoliths are difficult to read and result in varying ages through double-reads. A ground-truthing study on the U.S. West Coast would be useful to characterize potential bias in ageing Dover sole ototliths. Further research into quantifying the uncertainty of Dover sole ageing may help clear up some of the conflicts between the age and length data and may even give insight into the values of natural mortality.

2. **Patterns with depth:** As discussed above, there are patterns of length and sex ratios with depth which may indicate that the stock is more complex than currently modeled. Further research into the causes of these patterns as well as differences between seasons would help with understanding the stock characteristics such that a more realistic model could be built. This may also provide further insight into migration and help determine if there are localized populations.

3. **Recruitment patterns:** Even though recruitment variability is low compared to other West Coast groundfish, this assessment model predicted periods of low and high recruitment that affect the trend in biomass. These periods may correlate with the environment and would help predict

future biomass levels. It would be useful to investigate these patterns in recruitment but to also further investigate the life-history of Dover sole to determine if that can also explain the estimated patterns.

4. **Stock boundaries:** A common question in stock assessments is whether or not the entire stock is being accounted for. Dover sole live deeper than the range of the fisheries and surveys. The assessment model attempts to account for out of area biomass through catchability coefficients and selectivity curves, but that portion of the stock is unknown and can only be guessed at. Research into abundance in deep areas would be useful to verify that the assessment adequately predicts the entire spawning stock of Dover sole.

5. **Variability of sex ratios in length and age data:** There were differences in predicted sex ratios from the length data and the age data which should be further explored. It is uncertain if this is simply an artifact of sampling or if there is a selection bias in age and/or length observations. This phenomenon may contribute to the conflict between age and length data.

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10 Tables

Table 1. Percentage of landings by various gear types from 1981–2010 as retrieved from the PacFIN database.

Year	HKL	NET	POT	TWL	TWS	Other
1981	0	0	0.06	99.37	0.58	0
1982	0	0	0	99.52	0.47	0
1983	0	0	0	99.66	0.33	0
1984	0	0	0	99.91	0.08	0
1985	0.08	0	0	99.76	0.16	0
1986	0.03	0.07	0.23	99.14	0.47	0.07
1987	0.05	0.14	0.06	99.27	0.48	0
1988	0.02	0.1	0.21	99.42	0.25	0
1989	0.01	0.02	0.05	99.76	0.16	0.01
1990	0.01	0.1	0	99.63	0.26	0
1991	0.01	0.17	0.01	99.68	0.13	0
1992	0.01	0.06	0.01	99.74	0.18	0
1993	0.01	0.05	0.01	99.58	0.33	0.01
1994	0.03	0	0.01	98.87	1.08	0
1995	0.06	0	0	98.84	1.1	0
1996	0.05	0	0	99.12	0.81	0.02
1997	0.05	0	0.01	99.44	0.51	0
1998	0.03	0	0	99.39	0.56	0.01
1999	0.05	0	0	98.76	1.15	0.05
2000	0.03	0	0.01	99.43	0.52	0
2001	0.05	0	0.01	99.55	0.32	0.07
2002	0.03	0.08	0.01	99.72	0.16	0
2003	0.02	0	0.02	99.95	0.01	0
2004	0.04	0	0.01	99.9	0.01	0.04
2005	0.02	0	0.02	99.95	0	0
2006	0.03	0	0.01	99.96	0	0
2007	0.02	0	0.01	99.97	0	0
2008	0.02	0	0.01	99.97	0	0
2009	0.04	0	0.01	99.92	0	0.03
2010	0.04	0	0	99.96	0	0

Table 2. Management regulation for the fishery for Dover sole, 1989-2011

Effective Date	Management action taken
01/01/89	Established a coastwide trawl trip of 1,000 pounds or 45% of the deepwater complex (consisting of sablefish, Dover sole, arrowtooth flounder and thornyheads), whichever is greater.
04/26/89	Established coastwide weekly trip limit on the deepwater complex (consisting of sablefish, Dover sole, arrowtooth flounder and thornyheads) of only 1 landing above 4,000 pounds per week, not to exceed 30,000 pounds. No limit on the number of landings of deepwater complex less than 4,000 pounds. For each landing of the deepwater complex, no more than 1,000 pounds or 25% of the deepwater complex, whichever is greater, may be sablefish. If fishing under the 25% limit, no more than 5,000 pounds may be sablefish under 22 inches (total length).
01/31/90	Continued in effect the coastwide trawl trip of 1,000 pounds or 25% of the deepwater complex (consisting of sablefish, Dover sole, arrowtooth flounder and thornyheads), whichever is greater.
10/03/90	In order to reduce trawl sablefish landings so the trawl quota would not be exceeded, established a 15,000-pound trip limit on the deepwater complex (sablefish, Dover sole and thornyheads); allowed only one landing per week of the deepwater complex above 1,000 pounds; and maintained the current sablefish trip limit of 1,000 pounds or 25% of the deepwater complex, whichever is greater. Biweekly and twice weekly landing options are provided.
01/01/91	Established a coastwide weekly trawl trip for the deepwater complex (sablefish, Dover sole and thornyheads) of 27,500 pounds (including no more sablefish than 1,000 pounds or 25% of the deepwater complex, whichever is greater, and no more than 7,500 pounds of thornyheads). Only one landing above 4,000 pounds of deepwater complex per week. Biweekly and twice weekly options available.
01/01/92	For the deepwater complex (sablefish, Dover sole, and thornyheads), established a cumulative landing limit per specified 2-week period of 55,000 pounds of which no more than 25,000 pounds may be thornyheads. In any landing, no more than 25% of the deepwater complex may be sablefish, unless less than 1,000 pounds of sablefish are landed, in which case the percentage does not apply.
01/01/93	For the deepwater complex (sablefish, Dover sole and thornyheads), established a cumulative landing limit per specified 2-week period of 45,000 pounds of which no more than 20,000 pounds may be thornyheads. In any landing, no more than 25% of the deepwater complex may be sablefish, unless less than 1,000 pounds of sablefish are landed, in which case the percentage does not apply. In any landing, no more than 5,000 pounds of sablefish may be smaller than 22 inches (TL).
12/01/93	Reduced the cumulative trip limits for the Dover sole/thornyhead/trawl-caught sablefish (DTS) complex. The previous limit was 60,000 pounds per 4-week period, of which no more than 35,000 pounds could be thornyheads and, in any trip, the limit for trawl-caught sablefish was the greater of 1,000 pounds or 25% of the complex up to 3,000 pounds. The new limit allows no more than 5,000 pounds of species in the DTS complex to be taken, retained, possessed or landed per vessel per trip, of which no more than 1,000 pounds may be sablefish. Only one landing of fish in the DTS complex may be made in any 1-week period.
01/01/94	For the DTS complex established a cumulative limit of 50,000 pounds per month of which no more than 30,000 pounds may be thornyheads and no more than 12,000 pounds may be trawl-caught sablefish. The sablefish trip limit is 1,000 pounds or 25% of the DTS complex, whichever is greater, and applies to each trip.
07/01/94	Reduced the trip limits for the DTS complex to 30,000 pounds of the DTS complex per vessel per calendar month of which no more than 8,000 pounds may be thornyheads and no more than 6,000 pounds may be trawl-caught sablefish.
12/01/94	Reduced the monthly cumulative trip limit for Dover sole to 6,000 pounds north of 36°N latitude. Prohibited all commercial sablefish fishing north of 36°N latitude. Reduced the thornyhead monthly cumulative trip limit to 1,500 pounds north of 36°N latitude.
01/01/95	Established a cumulative DTS limit of 35,000 pounds per month north of Cape Mendocino and 50,000 pounds per month south of Cape Mendocino. Within the DTS complex limit not more than 20,000 pounds may be thornyheads, of which not more than 4,000 pounds per month may be shortspine thornyhead. For trawl-caught sablefish the cumulative limit is 6,000 pounds per month including a trip limit of 1,000 pounds or 25% of the DTS complex, whichever is greater, per trip.

Table 2 (cont). Management regulation for the fishery for Dover sole, 1985-2011

04/01/95	Reduced the cumulative monthly limit of the two thornyhead species to 15,000 pounds, not more than 3,000 pounds of which may be shortspine thornyhead.
05/01/95	The cumulative monthly limit for trawl-caught sablefish increased from 6,000 to 7,000 pounds.
07/01/95	Dover sole, thornyheads, and trawl-caught sablefish (DTS) complex cumulative limit of 35,000 pounds per month north of Cape Mendocino, California and 50,000 pounds per month south of Cape Mendocino; within the DTS complex limit, not more than 20,000 pounds may be thornyheads, of which not more than 4,000 pounds per month may be shortspine thornyhead. For trawl-caught sablefish, the cumulative limit is 6,000 pounds per month including a trip limit of 1,000 pounds or 25% of the DTS complex, whichever is greater, per trip. In any landing, no more than 500 pounds of sablefish may be smaller than 22 inches.
07/14/95	Removed the trip limit that required trawl-caught sablefish to comprise no more than 1,000 pounds or one third of the Dover sole and thornyheads.
09/01/95	Reduced the thornyhead portion of the DTS complex cumulative monthly limit from 15,000 pounds, no more than 3,000 pounds of which may be shortspine thornyhead, to 8,000 pounds, no more than 1,500 pounds of which may be shortspine thornyhead.
09/08/95	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. Changed the term "doubleply mesh" to "double-bar mesh."
11/30/95	Prohibited further landings of thornyheads and trawl-caught sablefish for the remainder of the year and reduce the cumulative monthly limit of Dover sole to 3,000 pounds per vessel.
01/01/96	Established cumulative vessel limits for specified 2-month periods rather than 1-month periods, with the target harvest level per month being 50% of the 2-month limit. However, vessels could land as much as 60% of the 2-month limit in either of the two months, so long as the total did not exceed the specified limit.
01/01/96	Established a cumulative DTS limit of 70,000 pounds per two month period north of Cape Mendocino and 100,000 pounds per month south of Cape Mendocino. Within the DTS complex not more than 20,000 pounds may be thornyheads, of which not more than 4,000 pounds per two months may be shortspine thornyhead. For trawl-caught sablefish the cumulative limit is 12,000 pounds per 2-months.
07/01/96	Reduced the cumulative 2-month limit for Dover sole north of Cape Mendocino to be 38,000 pounds.
01/01/97	Established a cumulative DTS limit of 70,000 pounds per two months period north of Cape Mendocino and 100,000 pounds per month south of Cape Mendocino. Within the DTS complex not more than 20,000 pounds may be thornyheads, of which not more than 4,000 pounds per two months may be shortspine thornyhead. For trawl-caught sablefish the cumulative limit is 12,000 pounds per 2-months. For Dover sole north of Cape Mendocino the cumulative limit is 38,000 pounds per two months.
05/01/97	Reduced the DTS complex cumulative 2-month limit for Dover sole north of Cape Mendocino to 30,000 pounds. Reduced the overall limit of thornyheads to 15,000 pounds and reduced the two-month cumulative limit on shortspines to 3,000 pounds. The cumulative limit for DTS complex was reduced to 57,000 pounds per two months north of Cape Mendocino.
09/01/97	Changed from two month cumulative limits to one month cumulative limits for Dover sole, thornyheads, and trawl-caught sablefish.
10/01/97	Reduced the monthly limit of DTS complex to 11,000 pounds north of Cape Mendocino and 38,500 pounds south of Cape Mendocino. Within these limits, no more than 1,500 pounds could be Dover sole north of Cape Mendocino, and 30,000 pounds south of Cape Mendocino; no more than 2,000 pounds coast wide could be trawl-caught sablefish; and no more than 7,500 pounds coast wide could be thornyheads. No more than 1,500 pounds of the thornyheads could be shortspine thornyheads.
01/01/98	Established coast wide cumulative limit of 40,000 pounds of Dover sole in the January-February period and 18,000 pounds per two-month period thereafter; not more than 5,000 pounds of sablefish, not more than 10,000 pounds of longspine thornyheads, and not more than 4,000 pounds of shortspine thornyhead.

Table 2 (cont). Management regulation for the fishery for Dover sole, 1985-2011

05/01/98	Increased the 2-month cumulative limit for Dover sole to 22,000 pounds, for longspine thornyheads to 12,000 pounds, for shortspine thornyheads to 5,000 pounds, and for trawl-caught sablefish to 6,000 pounds. The overall DTS complex cumulative limit was removed.
09/01/98	All limited entry cumulative limits became monthly limits
10/01/98	The Dover sole monthly cumulative limit increased to 18,000 pounds.
12/01/98	The Dover sole monthly limit increased to 36,000 pounds.
01/01/99	A new three-phase cumulative limit period system was introduced. Phase 1 is a single cumulative limit period that is three months long, from January 1- March 31. Phase 2 has three separate 2-month cumulative limit periods of April 1- May 31, June 1-July 31, and August 1- September 30. Phase 3 has three separate 1-month cumulative limit periods of October 1-31, November 1-30, and December 1-31. For all species except POP and bocaccio, there was no monthly limit within the cumulative landing limit periods. An option was available to apply cumulative trip limits lagged by 2 weeks (from the 16th to the 15th) to limited entry trawl vessels when their permits were renewed for 1999. Vessels authorized to operate in this “B” platoon could take and retain, but not land, groundfish during January 1-15, 1999. Dover sole coast wide landings limits were 70,000 pounds per period for Phase 1, 20,000 pounds per period for Phase 2; and 22,000 pounds per period for Phase 3.
05/01/99	(05/16/99 for “B” platoon vessels) Dover sole 2-month cumulative limit for the period April 1- May 31 increased from 20,000 pounds to 25,000 pounds. Beginning June 1, the 2-month cumulative limits for Dover sole reverted to 20,000 pounds.
01/01/00	New cumulative trip limit periods were defined as follows: A cumulative trip limit is the maximum amount that may be taken and retained, possessed, or landed per vessel in a specified period of time without a limit on the number of landings or trips, unless otherwise specified. The limits for Dover sole were 55,000 pounds per 2-month period for January-April, 20,000 pounds per 2-month period for May-October, and 20,000 pounds per month for each of November-December.
01/01/01	DTS complex. For 2001, differential trip limits are introduced for the >>DTS complex== (Dover sole, shortspine thornyhead, longspine thornyhead, sablefish) north and south of the management line at 40°10= N. lat. Vessels operating in the limited entry trawl fishery are subject to crossover provisions when making landings that include any one of the four species in the >>DTS complex.== [Example: The January-February cumulative limit for Dover sole north of 40°10= N. lat. is 65,000 lb (29,484 kg) and the cumulative limit for sablefish in that same period and area is 5,000 lb (2,268 kg), while the cumulative limits south of 40°10= N. lat. are 35,000 lb (15,876 kg) for Dover sole and 8,000 lb (3,629 kg) for sablefish. Under the crossover provisions, a vessel may not take and retain Dover sole north of 40°10= N. lat. and then travel south of 40°10= N. lat. in that same 2-month period to take and retain the higher sablefish limit in the south.]
2001 final	Differential cumulative trip limits north and south of the management line at 40 deg.10' N. lat were introduced for landings of Dover sole, thornyheads, sablefish. In the northern area the limits for Dover sole were 65,000 pounds bimonthly for January-April, 20,000 pounds bimonthly for May-June, 15,000 pounds bimonthly for July-August, and 7,500 pounds for September. The fishery was closed during October-November and there was a 1,000-pound limit per trip during December. In the southern area the limits for Dover sole were 35,000 pounds bimonthly for January-June, 30,000 pounds bimonthly July-August, and 15,000 pounds for September. The fishery was closed during October-November and there was a 1,000-pound per trip limit during December.
2002 final	Differential limits were introduced this year in the northern area for large versus small footrope trawls. In the northern area the limits for Dover sole were 30,000 pounds bimonthly for January-February, 28,000 pounds bimonthly for March-April, 14,000 pounds bimonthly for May-August, and 20,000 pounds bimonthly for September-October in times and areas that were not closed. During November-December the limit was 22,000 pounds bimonthly if only large-footrope gear was used during the entire period and 12,000 pounds bimonthly if small-footrope gear was used at any time in any area (North or South). In the southern area the limits were 22,000 pounds bimonthly for the entire year.

Table 2 (cont). Management regulation for the fishery for Dover sole, 1985-2011

2003 final	In the northern area the limits for Dover sole during January-April were 26,000 pounds bimonthly. For Dover sole taken during May-October the limits were 31,000 pounds bimonthly during May-June and 34,000 pounds bimonthly for July-October if only large-footrope gear was used during the entire period. The limits during May-October were 12,500 pounds bimonthly if small-footrope gear was used at all during the period in any area (North or South). During November-December the Dover sole limits were 30,000 pounds bimonthly. In the southern area the limits for Dover sole were 26,000 pounds bimonthly for January-April, 31,000 pounds bimonthly for May-June, 34,000 pounds bimonthly for July-October, and 30,000 pounds bimonthly for November-December.
2004 final	In the northern area the limits for Dover sole taken with large-footrope trawls were 67,500 pounds bimonthly for January-April, 32,000 pounds bimonthly for May-June, 31,000 pounds bimonthly for July-August, and 40,000 pounds bimonthly for September-December. The limits for Dover sole taken with small-footrope trawls were 10,000 pounds bimonthly for January-April, 27,000 pounds bimonthly for May-August, and 40,000 pounds bimonthly for September-December. In the southern area the limits for Dover sole were 39,000 pounds bimonthly for January-April, 49,000 pounds bimonthly for May-June, and 48,000 pounds bimonthly for July-December.
04/08/05	Lower trawl trip limits for petrale sole, Dover sole, Other Flatfish, and arrowtooth flounder to avoid early attainment of petrale sole and Dover sole.
09/23/05	Increase the trawl RCA to 0-250 fm north of 36° N lat. and 50-250 fm south of 36° N lat. with changes in Dover sole, thornyhead, and sablefish limited entry trawl trip limits to respond to conservation concerns for petrale sole and canary rockfish.
2005 final	Regulations required selective flatfish gear shoreward of the RCA north of 40° 10’ N latitude. In the northern area the limits for Dover sole taken with gear other than selective flatfish gear were 69,000 pounds bimonthly for January-April, 30,000 pounds bimonthly for May-August, 35,000 pounds bimonthly for September-October, and 20,000 pounds bimonthly for November-December. The limits for Dover sole taken with selective flatfish gear were 20,000 pounds bimonthly for January-February, 35,000 pounds bimonthly for March-October, and 20,000 pounds bimonthly for November-December. In the southern area the limits for Dover sole were 50,000 pounds bimonthly for January-April, 40,000 pounds bimonthly for May-October, and 30,000 pounds bimonthly for November-December.
2006 final	In the northern area the limits for Dover sole taken with gear other than selective flatfish gear were 25,000 pounds monthly for January-February, 50,000 pounds bimonthly for March-April, and 35,000 pounds bimonthly for September-December. The limits for Dover sole taken with selective flatfish gear were 10,000 pounds monthly for January-February, 28,000 pounds bimonthly for March-October, and 20,000 pounds bimonthly for November-December. In the southern area the limits for Dover sole were 25,000 pounds monthly for January-February, 50,000 pounds bimonthly for March-April, and 35,000 pounds bimonthly for June-December.
2007 final	In the northern area the limits for Dover sole taken with gear other than selective flatfish gear were 80,000 pounds bimonthly for January-April, 60,000 pounds bimonthly for May-August, and 95,000 pounds bimonthly for September-December. The limits for Dover sole taken with selective flatfish gear were 40,000 pounds bimonthly for January-April, 38,000 pounds bimonthly for May-October, and 25,000 pounds bimonthly for November-December. In the southern area the limits for Dover sole were 70,000 pounds bimonthly for January-June, 80,000 pounds bimonthly for July-August, and 95,000 pounds bimonthly for September-December.
2008 final	The limits for Dover sole taken with gear other than selective flatfish gear were 80,000 pounds bimonthly for January-October and 90,000 pounds bimonthly for November-December. The limits for Dover sole taken with selective flatfish gear were 40,000 pounds bimonthly for January-February, 50,000 pounds bimonthly for March-April, 40,000 pounds bimonthly for May-June, and 50,000 pounds bimonthly for July-December. In the southern area the limits for Dover sole were 80,000 pounds bimonthly for January-October and 90,000 pounds bimonthly for period November-December.

Table 2 (cont). Management regulation for the fishery for Dover sole, 1985-2011

2009 final	The limits for Dover sole taken with gear other than selective flatfish gear were 110,000 pounds bimonthly for January-December. The limits for Dover sole taken with selective flatfish gear were 40,000 pounds bimonthly for January-February, 45,000 pounds bimonthly for March-October, and 40,000 pounds bimonthly for November-December. In the southern area the limits for Dover sole were 110,000 pounds bimonthly for January-December.
2010 final	The limits for Dover sole taken with gear other than selective flatfish gear were 110,000 pounds bimonthly for January-December. The limits for Dover sole taken with selective flatfish gear were 65,000 pounds bimonthly for January-December. In the southern area the limits for Dover sole were 110,000 pounds bimonthly for January-December.

Table 3. Catch limits and commercial landings from 1995 to 2011. OFL is the overfishing limit and was formerly known as the Allowable Biological Catch (ABC). The ACL is the Annual Catch Limit, which take into account scientific uncertainty and harvest control rules. The ACL was formerly known as the OY, or Optimum Yield.

Year	OFL (mt)	ACL (mt)	Commercial Landings (mt)
1995	14,300	—	10,461
1996	11,855	—	12,069
1997	11,859	—	10,063
1998	9,426	—	7,951
1999	9,426	—	9,024
2000	9,426	—	8,690
2001	8,510	7,440	6,864
2002	8,510	7,440	6,234
2003	8,510	7,440	7,017
2004	8,510	7,440	6,733
2005	8,522	7,476	6,892
2006	8,589	7,564	5,957
2007	28,522	16,500	9,264
2008	28,442	16,500	11,204
2009	29,453	16,500	11,732
2010	28,582	16,500	10,375
2011	44,400	25,000	—

Table 4. Dover sole landings (mt) by state for 1910–2010.

Year	California	Oregon	Washington	Total	Year	California	Oregon	Washington	Total
1910	0.0	0.0	0.0	0.0					
1911	10.0	0.0	0.0	10.0	1961	3046.4	1867.6	708.5	5622.5
1912	20.0	0.0	0.0	20.0	1962	3406.5	2160.3	731.6	6298.4
1913	30.0	0.0	0.0	30.0	1963	3808.6	2578.8	969.2	7356.6
1914	40.0	0.0	0.0	40.0	1964	3898.0	2501.4	546.4	6945.8
1915	50.0	0.0	0.0	50.0	1965	4563.8	1439.3	497.4	6500.5
1916	55.8	0.0	0.0	55.8	1966	4383.1	1629.2	313.5	6325.8
1917	152.1	0.0	0.0	152.1	1967	3091.0	1718.8	226.9	5036.7
1918	183.7	0.0	0.0	183.7	1968	3647.1	1873.7	491.7	6012.5
1919	192.7	0.0	0.0	192.7	1969	5860.0	2621.0	460.9	8941.9
1920	166.5	0.0	0.0	166.5	1970	6876.9	2590.1	597.2	10064.2
1921	254.6	0.0	0.0	254.6	1971	6383.4	2632.7	394.4	9410.5
1922	429.6	0.0	0.0	429.6	1972	10016.1	2728.0	369.8	13113.9
1923	493.9	0.0	0.0	493.9	1973	10199.3	2075.5	383.5	12658.3
1924	692.8	0.0	0.0	692.8	1974	8657.9	2578.3	441.0	11677.2
1925	763.5	0.0	0.0	763.5	1975	10291.3	2068.3	428.5	12788.1
1926	753.7	0.0	0.0	753.7	1976	10322.3	2295.0	1072.7	13690.0
1927	913.1	0.0	0.0	913.1	1977	9944.5	1854.4	928.4	12727.3
1928	895.9	0.0	0.0	895.9	1978	9421.1	3383.8	1422.2	14227.1
1929	1020.0	0.0	0.0	1020.0	1979	10611.5	5064.9	2186.5	17862.9
1930	951.8	0.0	0.0	951.8	1980	8231.9	4024.7	1990.0	14246.6
1931	820.2	0.0	0.0	820.2	1981	9250.7	5228.1	1834.2	16313.0
1932	774.7	9.4	0.0	784.1	1982	10050.4	8083.4	2738.2	20872.0
1933	724.2	4.4	0.0	728.6	1983	8578.1	8449.4	2922.8	19950.3
1934	767.7	1.6	0.0	769.3	1984	9779.0	6099.4	3376.4	19254.8
1935	785.2	4.7	95.0	884.9	1985	12001.8	5695.2	2846.2	20543.2
1936	719.3	18.3	244.0	981.6	1986	10981.9	4771.9	1451.0	17204.8
1937	726.1	92.7	210.9	1029.7	1987	10708.3	6016.8	1606.3	18331.4
1938	680.0	1.9	260.3	942.2	1988	8138.0	7647.4	2270.2	18055.6
1939	861.5	288.6	245.6	1395.7	1989	7706.4	8886.0	2235.5	18827.9
1940	655.5	518.5	296.9	1470.9	1990	6297.3	7489.6	1897.1	15684.0
1941	412.2	618.9	467.9	1499.0	1991	7686.1	8793.9	1716.6	18196.6
1942	273.9	1031.6	500.6	1806.1	1992	8630.5	6055.0	1334.8	16020.3
1943	408.8	2732.1	696.9	3837.8	1993	6534.0	6462.7	1308.8	14305.5
1944	417.7	676.5	498.8	1593.0	1994	4457.6	3842.9	979.8	9280.3
1945	683.3	1170.7	500.9	2354.9	1995	6060.9	3503.1	897.3	10461.3
1946	944.7	1427.2	526.7	2898.6	1996	6391.0	4629.4	1048.6	12069.0
1947	1104.0	905.4	434.5	2443.9	1997	5292.0	3937.7	833.6	10063.3
1948	1554.9	1321.9	639.0	3515.8	1998	3561.9	3769.3	619.7	7950.9
1949	2977.6	1431.9	512.9	4922.4	1999	3804.8	4430.6	788.3	9023.7
1950	3731.9	2750.3	471.7	6953.9	2000	3323.4	4625.1	741.9	8690.4
1951	3662.3	3601.8	379.0	7643.1	2001	2446.3	3714.5	703.6	6864.4
1952	4796.8	3234.0	532.0	8562.8	2002	3099.7	2689.5	444.3	6233.5
1953	3545.5	1111.0	420.6	5077.1	2003	3239.0	3312.9	464.7	7016.6
1954	3638.1	1543.7	736.9	5918.7	2004	2384.4	3798.6	550.1	6733.1
1955	3267.7	1214.3	1130.0	5612.0	2005	2202.4	3968.7	721.2	6892.3
1956	3286.1	1447.2	932.5	5665.8	2006	1739.7	3523.4	694.0	5957.1
1957	3159.1	1656.1	365.3	5180.5	2007	2758.7	5550.2	955.2	9264.1
1958	3136.0	1690.7	642.3	5469.0	2008	2992.1	7259.6	951.9	11203.6
1959	2784.0	1952.8	423.7	5160.5	2009	3154.3	7452.4	1124.8	11731.5
1960	3619.7	2127.3	1091.7	6838.7	2010	2613.6	6878.9	882.1	10374.6

Table 5. Number of tows in each year for each survey. The NWFSC survey consists of the slope survey (1998–2002) and the shelf/slope survey (2003–2010).

	Number of tows			Number of tows with lengths			Number of tows with ages		
Year	AFSC slope	Triennial	NWFSC	AFSC slope	Triennial	NWFSC	AFSC slope	Triennial	NWFSC
1980		301			28				
1981									
1982									
1983		479			35				
1984									
1985									
1986		483			125				
1987									
1988									
1989		440			323				
1990									
1991									
1992		421			243				
1993									
1994									
1995		441			296				
1996									
1997	182			162					
1998		468	301		374	272			139
1999	199		324	166		282			131
2000	208		329	176		291			126
2001	207	466	334	179	454	292			132
2002			426			367			140
2003			540			438			381
2004		383	471		371	402			207
2005			635			544			518
2006			642			529			505
2007			686			577			550
2008			679			553			541
2009			682			543			536
2010			712			597			573

Table 6: Survey indices of abundance used in the base case model.

	Triennial		AFSC		NWFSC	
Year	Estimate (B)	SE(logB)	Estimate (B)	SE(logB)	Estimate (B)	SE(logB)
1980	17,880	0.0730				
1981						
1982						
1983	23,399	0.0650				
1984						
1985						
1986	26,576	0.0733				
1987						
1988						
1989	26,576	0.0733				
1990						
1991						
1992	26,576	0.0733				
1993						
1994						
1995	26,576	0.0733				
1996						
1997			115,287	0.091		
1998	45,344	0.0581			131,311	0.063
1999			116,305	0.096	148,025	0.074
2000			133,776	0.091	137,962	0.068
2001	67,085	0.0544	181,507	0.093	124,823	0.066
2002					172,914	0.063
2003					293,435	0.077
2004	113,327	0.0590			255,789	0.060
2005					253,880	0.057
2006					267,902	0.054
2007					299,383	0.049
2008					278,503	0.052
2009					252,248	0.053
2010					266,348	0.057

Table 7. Strata defined for the AFSC slope survey.

Strata	Area	Depth1	Depth2	Latitude1	Latitude2
A	5828.867	183	549	49	45
B	4023.608	549	900	49	45
C	9258.571	900	1280	49	40.5
D	6210.903	183	549	45	40.5
E	5264.062	549	900	45	40.5
F	6951.654	183	549	40.5	34.5
G	7801.3	549	900	40.5	34.5
H	8058.58	900	1280	40.5	34.5

Table 8: Depth ranges and limits of the southern latitude in the Triennial survey for the different years.

Years	Depth range (m)	Southern latitude
1977	91–457	34.05
1980–1986	55–366	36.8
1989–1992	55–366	34.5
1995–2004	55–500	34.5

Table 9. Stratifications used for the early and late series of the Triennial survey

1980-1992

Strata	Area	Depth1	Depth2	Latitude1	Latitude2
A	11787.265	55	183	45	49
B	3800.6086	183	400	45	49
C	11255.125	55	183	40.5	45
D	3867.1965	183	400	40.5	45
E	8905.6568	55	183	36.5	40.5
F	1843.7036	183	400	36.5	40.5

1995-2004

Strata	Area (km2)	Depth1	Depth2	Latitude1	Latitude2
A	11787.265	55	183	49	45
B	5356.7258	183	500	49	45
C	11255.125	55	183	45	40.5
D	5427.2737	183	500	45	40.5
E	10687.856	55	183	40.5	34.5
F	5708.5405	183	500	40.5	34.5

Table 10. Strata used for the NWFSC slope and NWFSC shelf/slope surveys

NWFSC slope (1998-2002)

Strata	Area	Depth1	Depth2	Latitude1	Latitude2
A		183	549	45	49
B		549	900	45	49
C		900	1280	40.5	49
D		183	549	40.5	45
E		549	900	40.5	45
F		183	549	34.5	40.5
G		549	900	34.5	40.5
H		900	1280	34.5	40.5

NWFSC shelf/slope (2003-2010)

Strata	Area	Depth1	Depth2	Latitude1	Latitude2
A		55	183	49	45
B		183	549	49	45
C		549	900	49	45
D		900	1280	49	40.5
E		55	183	45	40.5
F		183	549	45	40.5
G		549	900	45	40.5
H		55	183	40.5	34.5
I		183	549	40.5	34.5
J		549	900	40.5	34.5
K		900	1280	40.5	34.5
L		55	183	34.5	30
M		183	549	34.5	30
N		549	900	34.5	30
O		900	1280	34.5	30

Table 11. Number of trips sampled in the expanded commercial fishery length data by fleet. Numbers in italics indicate that the composition was unsexed. Blank cells indicate there were no data.

Year	CA	OR	WA	Year	CA	OR	WA
1965			*1*	1988	94	52	22
1966		34	1	1989	127	64	20
1967		26	*4*	1990	101	65	16
1968		27	7	1991	133	91	18
1969		28	*4*	1992	130	88	17
1970		27	*32*	1993	85	33	17
1971		4	*9*	1994	70	36	17
1972		20	*7*	1995	97	31	21
1973		24	3	1996	94	26	20
1974		22	2	1997	88	37	20
1975		16	3	1998	90	49	19
1976		11	6	1999	83	46	24
1977		12	2	2000	74	46	23
1978	64	5		2001	80	42	19
1979	38	21		2002	119	49	18
1980	115	26		2003	114	65	23
1981	80	37		2004	76	63	19
1982	68	35		2005	97	68	17
1983	106	30	1	2006	83	86	*12*
1984	88	38		2007	85	100	22
1985	121	50	11	2008	91	134	23
1986	100	36	11	2009	71	106	10
1987	98	39	18	2010		30	12

Table 12. Number of trips sampled in the expanded commercial fishery age data by fleet. Numbers in italics indicate that the data were scale reads and were not used. Blank cells indicate there were no data.

Year	CA	OR	WA
1966		*34*	
1967		*26*	
1968		*27*	
1969		*28*	
1970		*27*	
1971		*16*	
1972		*20*	
1973		*24*	
1974		*22*	
1975		*16*	
1976		*11*	
1977		*12*	
1978		*5*	
1979		*21*	
1980	*56*	*25*	
1981	48	*36*	
1982	28	*35*	
1983	38	*30*	
1984	54	*37*	
1985	80	36	6
1986	75	23	7
1987	72	39	13
1988	71	50	17
1989	105	62	12
1990	26	63	12
1991	26	91	9
1992	43	87	17
1993	29	33	15
1994	25	36	17
1995	35	30	21
1996	40	26	20
1997	42	34	8
1998	48	40	18
1999	42	41	24
2000	65	39	23
2001	61	40	12
2002	67	33	18
2003	65	52	21
2004	8	53	19
2005		28	7
2006	10	52	12
2007	22	59	22
2008	6	52	
2009		76	

Table 13: Specification of the assessment model.

Starting year	1910
Population characteristics	
Maximum age	60
Genders	2
Population lengths	5-65 cm by 1 cm bins
Summary biomass (mt)	Age 5+
Data characteristics	
Data lengths	8-60 cm by 2 cm bins
Data ages	1-60
Minimum age for growth calcs	1
Maximum age for growth calcs	50
First mature age	2
Starting year of estimated recruitment	1910
Fishery characteristics	
Fishery timing	0.5
AFSC slope survey timing	0.825
Triennial survey timing	0.55
NWFSC slope survey timing	0.65
NWFSC combo survey timing	0.65
Fishing mortality method	Hybrid method
Maximum F	3.5
Catchability	Estimated and analytic
Fishery Selectivity	Double Normal
AFSC Survey Selectivity	Cubic Spline
Triennial Survey Selectivity	Double normal
NWFSC Slope Survey Selectivity	Cubic Spline
NWFSC Combo Survey Selectivity	Double Normal

Table 14. Description of biological parameters in the base case assessment model. The lognormal (LN) prior distribution is specified with the median of the parameter and the standard deviation of the log of the parameter.

Parameter	Initial value	Number estimated	Bounds (low, high)	Prior distribution
Biological				
Females:				
Natural mortality (M, female)	0.101	1	(0.05-0.20)	LN(0.101, 0.337)
Length at age 1	15	1	(3-25)	
Length at age 45	47.5	1	(35-60)	
von Bertalanffy K	0.096	1	(0.03-0.2)	
SD of length at age 1	0.13	1	(0.01-1.0)	
SD of length at age 45	0.05	1	(0.01-1.0)	
Maturity inflection	35	0		
Maturity slope	-0.775	0		
Fecundity intercept	1	0		
Fecundity slope	0	0		
Length-weight intercept		0		
Length-weight slope		0		
Males:				
Natural mortality (M, male)	0.103	1	(0.05-0.20)	LN(0.103, 0.337)
Length at age 1	15	1	(3-25)	
Length at age 45	43.7	1	(35-60)	
von Bertalanffy K	0.097	1	(0.03-0.20)	
SD of length at age 1	0.13	1	(0.01-1)	
SD of length at age 45	0.05	1	(0.01-1)	
Length-weight intercept		0		
Length-weight slope		0		

Table 15. Parameter values used for the analysis for the prior distribution on natural mortality. Length and weight parameters were estimated directly from the NWFSC shelf/slope survey data and differ from the estimates coming from the full Stock Synthesis model.

	Female	Male
Max Age	70	70
L_∞ (cm)	51.3	44
k	0.166	0.111
W_∞ (g)	1450	890
Temperature	6	6

Table 16: Ageing error used by data source in the base case model

	Standard Deviation				Standard Deviation		
True Age	**CAP**	**CA**	**Scale**	**True Age**	**CAP**	**CA**	**Scale**
1	0.210	0.140	0.214	**31**	4.464	4.337	2.818
2	0.284	0.280	0.356	**32**	4.715	4.477	2.882
3	0.361	0.420	0.499	**33**	4.975	4.617	2.947
4	0.441	0.560	0.641	**34**	5.247	4.757	3.011
5	0.525	0.700	0.784	**35**	5.530	4.897	3.075
6	0.612	0.839	0.926	**36**	5.824	5.037	3.139
7	0.703	0.979	1.069	**37**	6.131	5.176	3.203
8	0.797	1.119	1.211	**38**	6.450	5.316	3.267
9	0.896	1.259	1.354	**39**	6.783	5.456	3.331
10	0.998	1.399	1.471	**40**	7.129	5.596	3.396
11	1.105	1.539	1.536	**41**	7.490	5.736	3.460
12	1.216	1.679	1.600	**42**	7.866	5.876	3.524
13	1.332	1.819	1.664	**43**	8.257	6.016	3.588
14	1.452	1.959	1.728	**44**	8.664	6.156	3.652
15	1.578	2.099	1.792	**45**	9.089	6.296	3.716
16	1.709	2.238	1.856	**46**	9.531	6.436	3.780
17	1.845	2.378	1.920	**47**	9.991	6.575	3.845
18	1.987	2.518	1.985	**48**	10.470	6.715	3.909
19	2.134	2.658	2.049	**49**	10.969	6.855	3.973
20	2.288	2.798	2.113	**50**	11.489	6.995	4.037
21	2.448	2.938	2.177	**51**	12.031	7.135	4.101
22	2.615	3.078	2.241	**52**	12.594	7.275	4.165
23	2.789	3.218	2.305	**53**	13.182	7.415	4.229
24	2.970	3.358	2.369	**54**	13.793	7.555	4.294
25	3.158	3.498	2.434	**55**	14.430	7.695	4.358
26	3.354	3.637	2.498	**56**	15.093	7.835	4.422
27	3.559	3.777	2.562	**57**	15.784	7.974	4.486
28	3.771	3.917	2.626	**58**	16.503	8.114	4.550
29	3.993	4.057	2.690	**59**	17.252	8.254	4.614
30	4.224	4.197	2.754	**60**	18.032	8.394	4.678

Table 17. Discard ratios (discards divided by total catch) for the three states and the years 2002 to 2009.

Year	Fleet	Value	Error
2002	CA	0.232	0.069
2002	OR	0.158	0.119
2002	WA	0.133	0.079
2003	CA	0.203	0.060
2003	OR	0.179	0.086
2003	WA	0.229	0.111
2004	CA	0.112	0.121
2004	OR	0.062	0.152
2004	WA	0.044	0.103
2005	CA	0.125	0.064
2005	OR	0.091	0.133
2005	WA	0.131	0.083
2006	CA	0.168	0.088
2006	OR	0.109	0.181
2006	WA	0.213	0.088
2007	CA	0.163	0.080
2007	OR	0.067	0.207
2007	WA	0.111	0.143
2008	CA	0.112	0.092
2008	OR	0.034	0.216
2008	WA	0.035	0.212
2009	CA	0.144	0.089
2009	OR	0.042	0.113
2009	WA	0.057	0.129

Table 18. Discard ratios for trawl gear by area and three depth ranges.

	S CA			N CA			OR			WA		
Year	0-150m	150-300m	300+m	0-150m	150-300m	300+m	0-150m	150-300m	300+m	0-150m	150-300m	300+m
2002	0.96	0.04	0.25	0.14	0.04	0.39	0.17	0.09	0.24	0.14	0.03	0.38
2003	0.88	0.12	0.17	0.80	0.02	0.17	0.52	0.06	0.09	0.32	0.05	0.25
2004	0.62	0.08	0.13	0.11	0.03	0.13	0.21	0.02	0.09	0.07	0.01	0.03
2005	1.00	0.16	0.11	0.04	0.01	0.12	0.11	0.07	0.14	0.16	0.06	0.10
2006	0.69	0.20	0.29	0.00	0.02	0.32	0.16	0.08	0.14	0.30	0.05	0.14
2007	0.96	0.28	0.09	0.01	0.02	0.38	0.06	0.02	0.30	0.19	0.07	0.10
2008	0.59	0.10	0.12	0.04	0.00	0.23	0.08	0.01	0.09	0.03	0.03	0.06
2009	0.86	0.17	0.60	0.15	0.01	0.20	0.09	0.03	0.06	0.15	0.02	0.07

Table 19. Median of the average weight (lbs) of the discard by area and depth strata.

	S CA			N CA			OR			WA		
Year	0-150m	150-300m	300+m	0-150m	150-300m	300+m	0-150m	150-300m	300+m	0-150m	150-300m	300+m
2002	0.30	0.81	1.44	0.48	0.71	1.70	0.52	0.67	1.50	0.52	0.75	1.41
2003	0.26	0.73	0.85	0.36	0.63	1.61	0.49	0.64	1.29	0.52	0.62	1.35
2004	0.40	0.59	1.18	0.44	0.53	1.64	0.45	0.53	1.15	0.45	0.72	0.78
2005	0.33	0.59	0.82	0.64	0.54	1.58	0.51	0.51	1.26	0.55	0.83	1.06
2006	0.36	0.54	1.50	0.30	0.50	1.46	0.50	0.55	1.19	0.51	0.66	1.03
2007	0.38	0.48	1.52	0.34	0.53	1.49	0.51	0.60	1.12	0.54	0.71	0.92
2008	0.44	0.57	1.49	0.41	0.55	1.57	0.40	0.59	1.13	0.57	0.71	0.88
2009	0.40	0.58	1.70	0.72	0.64	1.43	0.54	0.63	1.17	0.50	0.63	0.92

Table 20: Likelihood components and other quantities related to the minimization of the base case model.

Description	Values
Nparameters	216
Gradient	0.0000399
Negative log-likelihoods	
Total	1892.27
Indices	-39.49
Length-frequency data	885.55
Age-frequency data	1028.86
Discard biomass	86.82
Discard mean weight	-50.40
Recruitment	-19.66
Priors	0.54

Table 21. Parameter estimates and approximate asymptotic standard deviations for the base case model (from final year for commercial selectivity and retention).

Parameter	**Estimate**	**SD**
Stock and recruitment		
Ln(R0)	12.85	0.345
Catchability ln(q)		
AFSC	0.719	
Early triennial	0.090	
Late triennial	0.235	
NWFSC Slope	0.911	
NWFSC Combo	0.696	

Selectivity (sex specific)

	CA trawl		OR trawl		WA trawl	
	Est	SD	Est	SD	Est	SD
Length at peak selectivity	38.953	0.610	38.160	0.441	41.142	0.956
Width of top	-1.483	77.064	0.387	59.81	0.532	90.015
Ascending width	3.967	0.122	3.907	0.092	4.594	0.111
Female descending width offset	-0.764	0.116	-0.833	0.114	-0.881	0.133
Female final offset	-2.259	0.602	-1.867	0.580	-1.257	0.661
Retention inflection	26.962	0.639	25.414	0.712	27.607	0.760
Retention slope	1.065	0.260	1.877	0.270	3.005	0.368
Retention asymptote	0.869	0.005	0.947	0.004	0.949	0.008

Slope surveys:	AFSC slope		NWFSC slope	
	Est	SD	Est	SD
Gradient at the first node	0.3969	0.0422	0.6194	0.1719
Gradient at the last node	-0.2933	0.4430	0.0092	0.0289
Value at Node 1	-2.2101	0.1603	-3.7000	0.4077
Value at Node 2	0.1893	0.0940	-0.0491	0.0910
Value at Node 4	0.4777	0.1808	0.6202	0.1714
Value at Node 5	-1.2094	1.0897	-0.7559	0.4670
Male offset at dogleg	1.2665	0.1529	1.3125	0.1491
Male offset at max	-1.3427	4.2823	-4.4868	5.0058

Shelf surveys	Triennial		NWFSC combo	
	Est	SD	Est	SD
Length at peak selectivity	30.527	0.410	33.120	0.457
Width of top	-9.533	12.253	1.697	28.691
Ascending width	3.896	0.089	3.928	0.071
Descending width	3.613	0.240	0.665	246.436
Final selectivity	-1.544	0.272	1.844	78.339
Female descending width offset	-0.443	0.109	-0.723	0.114
Female final offset	0.100	0.011	-1.455	0.581

Biological	Female		Male	
	Est	SD	Est	SD
Natural mortality (M)	0.1165	0.0056	0.1417	0.0120
Length at age 1	5.40	0.7243	9.04	0.6883
Length at age 50	47.81	0.8287	39.91	0.3238
Von Bertalanffy K	0.1497	0.0078	0.1713	0.0073
SD (log) at age 1	0.0945	0.0068	0.0741	0.0050
SD (log) at age 50	0.1143	0.0132	0.1341	0.0114

Table 22. Estimates of key derived parameters and reference points with approximate 95% asymptotic confidence intervals.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning biomass (mt)	469,866	182,741–756,991
Unfished age 5+ biomass (mt)	821,271	391,404–1,251,138
Unfished recruitment (R0)	380,777	123,519–638,034
Depletion (2011)	83.7%	67.4–100.1%
Reference points based on $SB_{25\%}$		
Proxy spawning biomass ($B_{25\%}$)	117,467	45,684–189,249
SPR resulting in $B_{25\%}$ ($SPR_{30\%}$)	0.297	
Exploitation rate resulting in $B_{25\%}$	12.9%	12.0–13.8%
Yield with $SPR_{30\%}$ at $B_{25\%}$ (mt)	34,751	15,403–54,098
Reference points based on SPR proxy for MSY		
Spawning biomass	119,033	46,293–191,772
SPR_{proxy}	0.30	
Exploitation rate corresponding to SPR_{proxy}	12.8%	11.9–13.6%
Yield with SPR_{proxy} at SB_{SPR} (mt)	34,743	15,402–54,082
Reference points based on estimated MSY values		
Spawning biomass at *MSY* (SB_{MSY})	114,398	45,640–183,155
SPR_{MSY}	0.291	0.286–0.296
Exploitation rate corresponding to SPR_{MSY}	13.1%	12.2–14.1%
MSY (mt)	34,757	15,400–54,114

Table 23. Time-series of population estimates from the base case model.

Year	Total biomass (mt)	Spawning Biomass	Total Biomass 5+ (mt)	Depletion	Age-0 recruits	Total catch (mt)	1-SPR	Relative exploitation rate
1910	853,954	469,866	821,271	100.0%	379,820	0	0.000	0.000
1911	853,951	469,866	821,271	100.0%	379,720	12	0.000	0.000
1912	853,930	469,860	821,260	100.0%	379,609	25	0.000	0.000
1913	853,881	469,848	821,238	100.0%	379,484	37	0.000	0.000
1914	853,801	469,830	821,206	100.0%	379,346	50	0.001	0.000
1915	853,688	469,806	821,102	100.0%	379,193	62	0.001	0.000
1916	853,541	469,776	820,965	100.0%	379,023	69	0.001	0.000
1917	853,366	469,735	820,802	100.0%	378,833	189	0.002	0.000
1918	853,062	469,619	820,511	99.9%	378,617	228	0.003	0.000
1919	852,711	469,467	820,175	99.9%	378,374	239	0.003	0.000
1920	852,344	469,297	819,823	99.9%	378,103	207	0.003	0.000
1921	852,001	469,135	819,497	99.8%	377,801	316	0.004	0.000
1922	851,548	468,911	819,065	99.8%	377,463	533	0.007	0.001
1923	850,894	468,574	818,434	99.7%	377,083	613	0.008	0.001
1924	850,177	468,200	817,741	99.6%	376,659	860	0.011	0.001
1925	849,245	467,706	816,838	99.5%	376,176	948	0.012	0.001
1926	848,257	467,179	815,881	99.4%	375,649	935	0.012	0.001
1927	847,306	466,671	814,965	99.3%	375,045	1,133	0.015	0.001
1928	846,192	466,077	813,891	99.2%	374,368	1,112	0.014	0.001
1929	845,121	465,509	812,865	99.1%	373,603	1,266	0.016	0.002
1930	843,923	464,878	811,717	98.9%	372,751	1,181	0.015	0.001
1931	842,818	464,304	810,668	98.8%	371,793	1,018	0.013	0.001
1932	841,861	463,823	809,774	98.7%	370,718	972	0.013	0.001
1933	840,922	463,369	808,906	98.6%	369,509	904	0.012	0.001
1934	840,005	462,947	808,068	98.5%	368,144	955	0.013	0.001
1935	838,983	462,489	807,136	98.4%	366,598	1,084	0.014	0.001
1936	837,781	461,944	806,035	98.3%	364,848	1,180	0.016	0.001
1937	836,427	461,324	804,794	98.2%	362,867	1,235	0.016	0.002
1938	834,935	460,657	803,429	98.0%	360,624	1,131	0.015	0.001
1939	833,439	460,013	802,079	97.9%	358,092	1,660	0.022	0.002
1940	831,331	459,069	800,135	97.7%	355,221	1,717	0.022	0.002
1941	829,059	458,061	798,049	97.5%	351,994	1,714	0.022	0.002
1942	826,665	457,005	795,864	97.3%	348,395	2,038	0.026	0.003
1943	823,810	455,742	793,247	97.0%	344,411	4,318	0.055	0.005
1944	818,718	453,279	788,422	96.5%	340,032	1,818	0.024	0.002
1945	815,816	452,057	785,819	96.2%	335,423	2,702	0.035	0.003
1946	811,838	450,320	782,172	95.8%	330,632	3,340	0.044	0.004
1947	807,027	448,183	777,721	95.4%	325,866	2,855	0.038	0.004
1948	802,399	446,209	773,481	95.0%	321,448	4,103	0.054	0.005
1949	796,335	443,481	767,818	94.4%	317,826	5,853	0.076	0.008
1950	788,409	439,762	760,294	93.6%	315,783	8,215	0.105	0.011
1951	778,197	434,756	750,458	92.5%	316,552	8,977	0.115	0.012
1952	767,343	429,309	739,918	91.4%	321,748	10,142	0.131	0.014
1953	755,612	423,200	728,379	90.1%	332,334	6,099	0.084	0.008
1954	747,961	419,132	720,710	89.2%	348,113	7,042	0.096	0.010
1955	739,837	414,482	712,248	88.2%	369,683	6,645	0.092	0.009
1956	732,857	409,953	704,513	87.2%	397,479	6,712	0.094	0.010
1957	726,954	405,383	697,394	86.3%	427,303	6,168	0.088	0.009
1958	723,167	401,180	691,939	85.4%	446,773	6,481	0.093	0.009
1959	721,258	396,968	687,950	84.5%	445,716	6,099	0.089	0.009
1960	722,245	393,362	686,697	83.7%	416,076	8,065	0.116	0.012

Table 23 (Continued). Time-series of population estimates from the base case model.

Year	Total biomass (mt)	Spawning Biomass	Total Biomass 5+ (mt)	Depletion	Age-0 recruits	Total catch (mt)	SPR	Relative exploitation rate
1961	724,129	389,373	686,778	82.9%	418,345	6,647	0.098	0.010
1962	729,708	387,193	691,791	82.4%	433,351	7,451	0.109	0.011
1963	736,366	386,012	699,194	82.2%	461,059	8,685	0.125	0.012
1964	743,359	385,954	707,227	82.1%	508,260	8,250	0.119	0.012
1965	752,084	388,093	715,020	82.6%	549,865	7,838	0.113	0.011
1966	762,684	392,157	723,628	83.5%	524,723	7,624	0.109	0.011
1967	775,321	397,437	733,417	84.6%	463,273	6,020	0.086	0.008
1968	791,261	403,949	746,545	86.0%	416,182	7,176	0.099	0.010
1969	807,218	409,958	762,035	87.2%	387,378	10,735	0.141	0.014
1970	819,849	414,477	778,016	88.2%	363,766	12,121	0.155	0.016
1971	830,034	419,193	792,641	89.2%	333,517	11,335	0.144	0.014
1972	838,666	425,820	804,538	90.6%	298,177	15,940	0.191	0.020
1973	839,898	431,550	808,134	91.8%	272,644	15,446	0.184	0.019
1974	837,956	437,983	808,505	93.2%	270,022	14,143	0.169	0.017
1975	833,196	444,120	806,310	94.5%	304,907	15,579	0.182	0.019
1976	823,127	447,437	798,423	95.2%	380,803	16,566	0.191	0.021
1977	808,957	447,599	784,965	95.3%	362,965	15,435	0.181	0.020
1978	793,981	445,617	768,468	94.8%	307,935	17,022	0.198	0.022
1979	777,027	440,070	748,217	93.7%	333,361	21,200	0.240	0.028
1980	756,493	429,735	725,172	91.5%	366,423	16,869	0.204	0.023
1981	740,759	419,622	711,390	89.3%	318,750	20,345	0.255	0.029
1982	721,729	408,010	694,005	86.8%	315,526	26,059	0.321	0.038
1983	698,276	393,918	669,057	83.8%	324,923	24,961	0.321	0.037
1984	677,160	381,420	647,736	81.2%	279,134	24,371	0.325	0.038
1985	657,787	370,120	630,616	78.8%	308,811	26,029	0.351	0.041
1986	637,650	358,570	610,803	76.3%	306,214	21,710	0.312	0.036
1987	622,586	349,662	596,113	74.4%	378,285	23,094	0.334	0.039
1988	607,000	340,868	581,586	72.5%	533,723	22,734	0.338	0.039
1989	593,081	332,854	565,397	70.8%	378,467	24,087	0.359	0.043
1990	580,765	324,399	549,966	69.0%	426,593	20,087	0.320	0.037
1991	575,790	317,819	539,103	67.6%	513,563	23,299	0.363	0.043
1992	571,123	309,617	530,639	65.9%	554,739	20,638	0.337	0.039
1993	572,856	302,904	537,307	64.5%	402,621	18,609	0.312	0.035
1994	580,510	298,655	540,427	63.6%	341,595	12,177	0.219	0.023
1995	597,202	300,146	553,851	63.9%	284,405	13,704	0.236	0.025
1996	613,204	303,874	572,678	64.7%	337,026	15,108	0.251	0.026
1997	627,012	308,715	595,397	65.7%	496,785	12,613	0.209	0.021
1998	641,010	316,856	612,860	67.4%	382,499	9,920	0.163	0.016
1999	655,742	328,510	627,436	69.9%	318,032	11,202	0.174	0.018
2000	667,807	340,701	634,056	72.5%	582,600	10,715	0.162	0.017
2001	678,618	352,007	640,768	74.9%	403,700	8,422	0.128	0.013
2002	691,092	361,507	657,891	76.9%	222,419	7,697	0.116	0.012
2003	703,918	368,402	669,079	78.4%	207,409	8,651	0.127	0.013
2004	714,105	373,512	673,753	79.5%	237,284	7,429	0.108	0.011
2005	722,134	379,112	694,786	80.7%	299,746	7,592	0.109	0.011
2006	725,675	384,556	706,623	81.8%	251,610	6,548	0.093	0.009
2007	726,096	390,893	706,360	83.2%	288,809	10,171	0.138	0.014
2008	719,466	396,088	697,087	84.3%	372,962	12,245	0.162	0.018
2009	708,295	398,921	683,759	84.9%	328,391	12,820	0.170	0.019
2010	695,649	397,836	671,510	84.7%	376,517	11,313	0.155	0.017
2011	684,685	393,507	657,004	83.7%	376,215	NA	NA	NA

Table 24. Results from the sensitivity analyses compared to the base case model. See text for explanations.

Description	Base Case	Fix M = 0.09, for both sexes	Estimate M, equal for sexes	Estimate steepness	Down weight age data by 5x	Down weight length data by 5x	Selectivty asymptote=1 for both sexes
Nparameters	204	202	203	205	204	204	197
Negative log-likelihoods							
Total	1892.27	1907.72	1902.21	1892.22	1041.58	1139.69	2007.38
Indices	-39.49	-39.34	-39.63	-39.50	-39.88	-39.29	-39.01
Length-frequency data	885.55	886.21	885.84	885.50	842.25	214.78	945.23
Age-frequency data	1028.86	1042.32	1039.15	1028.90	223.56	957.11	1084.06
Discard biomass	86.82	86.19	86.98	86.82	85.98	81.61	86.59
Discard mean weight	-50.40	-50.47	-50.42	-50.40	-50.16	-52.15	-50.14
Recruitment	-19.66	-17.26	-19.78	-19.71	-20.35	-23.13	-20.03
Priors	0.54	0.00	0.02	0.58	0.12	0.72	0.62
Select parameters							
Stock-recruit, productivity							
log(R_{0})	12.85	11.67	12.06	12.84	12.31	13.02	12.92
Steepness (*h*)	0.800	0.800	0.800	0.826	0.800	0.800	0.800
Female M	0.117	0.090	0.108	0.116	0.106	0.117	0.141
Male M	0.142	0.090	0.000	0.142	0.120	0.150	0.124
Survey catchability							
AFSC	0.719	1.945	1.481	0.721	1.141	0.702	0.368
Early Triennial	0.090	0.185	0.147	0.091	0.130	0.085	0.066
Late Triennial	0.235	0.620	0.449	0.235	0.338	0.232	0.174
NWFSC slope	0.911	2.449	1.862	0.913	1.421	0.904	0.427
NWFSC combo	0.696	1.639	1.218	0.696	0.899	0.693	0.455
Individual growth							
Female length at age min	5.405	4.986	4.896	5.403	3.506	7.281	4.579
Female length at age max	47.806	46.596	46.534	47.800	44.956	49.055	47.738
Female von Bertalanffy *K*	0.150	0.160	0.161	0.150	0.184	0.132	0.151
Female CV length-at-age min	0.094	0.090	0.089	0.094	0.089	0.102	0.097
Female CV length-at-age max	0.114	0.126	0.125	0.114	0.150	0.074	0.106
Male length at age min	9.041	8.853	8.882	9.041	7.811	10.143	8.499
Male length at age max	39.911	39.617	39.580	39.910	39.441	40.778	38.610
Male von Bertalanffy *K*	0.171	0.177	0.177	0.171	0.191	0.154	0.198
Male CV length-at-age min	0.074	0.073	0.073	0.074	0.057	0.083	0.069
Male CV length-at-age max	0.134	0.137	0.140	0.134	0.171	0.097	0.158
Management quantities							
Unfished Spawning Biomass	469,866	238,594	240,956	467,732	311,435	559,049	318,288
2011 Spawning Biomass	393,507	111,498	142,333	392,768	233,467	470,118	259,000
2011 Depletion	0.837	0.467	0.591	0.840	0.750	0.841	0.814
2010 1-*SPR*	0.155	0.451	0.341	0.155	0.234	0.132	0.188
2010 exploitation rate	0.017	0.051	0.039	0.017	0.026	0.015	0.018
SSB at SPRproxy	119,033	60,444	61,042	122,115	78,897	141,626	80,633
MSY at SPRproxy	34,757	15,522	19,095	35,777	24,168	39,419	33,657

Table 25. Results from retrospective runs, sequentially removing data over the last five years using the base case assumptions.

Year Assessed	Last year of data	Unfished Spawning Biomass	2006 Spawning Biomass	2006 Depletion	2011 Depletion	Female M	Male M
2011	2010	469,866	384,556	81.84%	83.75%	0.1165	0.1417
2010	2009	453,992	358,771	79.03%	80.76%	0.1172	0.1415
2009	2008	439,269	336,492	76.60%	81.50%	0.1196	0.1433
2008	2007	411,169	295,684	71.91%	76.03%	0.1207	0.1419
2007	2006	432,985	304,711	70.37%	75.10%	0.1219	0.1451
2006	2005	505,234	366,232	72.49%	86.37%	0.1279	0.1544

Table 26: Likelihood values, parameter estimates, and derived parameters from the joint likelihood profile on *h*.

negloglike	1898.94	1896.64	1894.95	1893.89	1893.18	1892.66	1892.27	1891.96	1891.77
surveylike	-37.608	-38.487	-38.972	-39.209	-39.344	-39.430	-39.489	-39.532	-39.558
discardlike	86.908	86.865	86.843	86.833	86.827	86.824	86.821	86.819	86.818
discardWtlike	-50.337	-50.362	-50.378	-50.388	-50.394	-50.398	-50.401	-50.404	-50.405
lengthlike	889.557	888.349	887.298	886.612	886.137	885.801	885.550	885.355	885.228
agelike	1025.740	1026.810	1027.630	1028.130	1028.470	1028.700	1028.860	1028.990	1029.070
h	0.22	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.98
Female *M*	0.1216	0.1201	0.1187	0.1179	0.1173	0.1168	0.1165	0.1162	0.1161
Male *M*	0.1583	0.1519	0.1477	0.1452	0.1436	0.1425	0.1417	0.1411	0.1407
LatAminF	5.74	5.58	5.50	5.45	5.43	5.42	5.40	5.40	5.39
LatAmaxF	48.53	48.23	48.04	47.94	47.88	47.84	47.81	47.78	47.77
LkF	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
LatAminM	9.08	9.05	9.04	9.04	9.04	9.04	9.04	9.04	9.04
LatAmaxM	39.98	39.96	39.94	39.93	39.92	39.91	39.91	39.91	39.91
LkM	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
lnR0	13.37	13.18	13.04	12.96	12.91	12.88	12.85	12.83	12.82
Depletion	0.684	0.727	0.768	0.795	0.814	0.827	0.837	0.845	0.851
Unfished spawning biomass	731,953	616,681	549,874	515,114	493,893	479,842	469,867	462,427	457,726
Bmsy	360,416	281,161	226,084	190,300	162,571	138,295	114,399	86,953	52,664
2011 spawning biomass	500,520	448,383	422,577	409,755	401,987	396,990	393,508	390,945	389,349

Table 27: Likelihood values, parameter estimates, and derived parameters from a slice of the joint likelihood profile on *M*, with female natural mortality fixed at 0.115 and male natural mortality ranging from 0.08 to 0.18.

negloglike	2129.86	2019.46	1945.51	1911.89	1897.37	1892.75	1891.81	1892.01	1891.92	1893.09	1895.68
surveylike	-39.79	-39.97	-39.69	-39.66	-39.70	-39.67	-39.52	-39.25	-38.92	-38.50	-37.98
discardlike	97.49	92.64	89.05	87.59	86.93	86.75	86.79	86.90	86.99	87.04	87.05
discardWtlike	-48.58	-49.28	-50.34	-50.38	-50.40	-50.41	-50.41	-50.40	-50.37	-50.33	-50.30
lengthlike	1013.48	945.68	900.90	889.99	884.88	884.43	885.64	887.08	887.46	888.73	890.39
agelike	1113.62	1081.47	1063.87	1043.93	1035.79	1031.69	1028.95	1026.80	1025.36	1024.22	1024.05
Female *M*	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115
Male *M*	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
LatAminF	4.78	4.71	4.83	4.85	4.95	5.17	5.44	5.70	6.05	6.22	6.11
LatAmaxF	47.55	47.22	47.01	46.64	46.67	47.22	47.86	48.41	48.92	49.22	49.26
LkF	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.14	0.14	0.14	0.14
LatAminM	9.41	9.10	8.86	8.89	8.91	8.97	9.05	9.11	9.17	9.21	9.19
LatAmaxM	39.25	39.16	39.12	39.43	39.66	39.81	39.91	39.98	40.05	40.12	40.19
LkM	0.17	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.17
lnR0	11.863	11.982	12.006	12.143	12.321	12.545	12.804	13.094	13.414	13.795	14.310
Depletion	0.394	0.461	0.539	0.599	0.676	0.757	0.830	0.890	0.937	0.977	1.013
Unfished spawning biomass	185,374	203,364	203,882	228,836	272,891	348,690	462,996	631,075	883,680	1,307,590	2,195,770
Bmsy	48,227	50,781	49,630	55,849	66,813	85,284	112,912	153,375	213,786	315,316	528,653
2011 spawning biomass	73,019	93,762	109,885	137,136	184,563	263,887	384,086	561,624	827,729	1,277,000	2,223,860

Table 28. Projection of potential OFL, landings, and catch, summary biomass (age-5 and older), spawning biomass, and depletion for the base case model projected with status quo catches in 2011 and 2012, and catches at the OFL from 2013 onward. The 2011 and 2012 OFL's are values specified by the PFMC and not predicted by this assessment. The OFL in years later than 2012 is the calculated total catch determined by F_{SPR}.

Year	OFL (mt)	Total Catch (mt)	Landings (mt)	Age 5+ biomass (mt)	Spawning Biomass	Depletion (%)
2011	44,400	12,116	11,100	657,004	393,507	83.75%
2012	44,826	12,120	11,100	643,291	386,143	82.18%
2013	92,955	90,411	82,806	635,535	377,601	80.36%
2014	77,774	75,517	69,049	552,798	329,875	70.21%
2015	66,871	64,885	59,211	493,274	289,904	61.70%
2016	59,221	57,488	52,356	449,636	257,415	54.78%
2017	53,958	52,453	47,687	417,699	231,552	49.28%
2018	50,371	49,065	44,545	394,200	211,322	44.97%
2019	47,910	46,768	42,417	376,478	195,658	41.64%
2020	46,170	45,158	40,929	362,720	183,522	39.06%
2021	44,877	43,964	39,829	351,675	174,030	37.04%
2022	43,854	43,017	38,958	342,513	166,488	35.43%

Table 29. Summary table of 12-year projections beginning in 2013 for alternate states of nature based on an axis uncertainty calculated using the joint likelihood profile on female and male natural mortality. Columns range over different combinations of natural mortality giving a low, mid, and high state of nature, and rows range over different assumptions of catch levels based on the predicted OFL's, the current ACL's, and status quo catches based on the average of catches from the last three years.

			State of nature					
			Low		Base case		High	
			$M_f = 0.110$ $M_m = 0.125$		$M_f = 0.117$ $M_m = 0.142$		$M_f = 0.120$ $M_m = 0.159$	
Relative probability of ln(SB_2011)			0.25		0.5		0.25	
Management decision	Year	Catch (mt)	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion	Spawning biomass (mt)	Depletion
OFL	2013	82,720	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	68,982	195,787	57.2%	329,862	70.2%	621,804	81.7%
	2015	59,155	158,375	46.3%	289,882	61.7%	575,558	75.7%
	2016	52,306	127,486	37.3%	257,388	54.8%	538,477	70.8%
	2017	47,640	102,455	30.0%	231,524	49.3%	509,649	67.0%
	2018	44,500	82,514	24.1%	211,294	45.0%	487,882	64.1%
	2019	42,373	66,742	19.5%	195,631	41.6%	471,860	62.0%
	2020	40,885	54,170	15.8%	183,497	39.1%	460,272	60.5%
	2021	39,786	43,919	12.8%	174,009	37.0%	451,991	59.4%
	2022	38,916	35,268	10.3%	166,469	35.4%	446,137	58.6%
Current ACL	2013	25,000	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	25,000	227,248	66.4%	361,524	76.9%	653,840	85.9%
	2015	25,000	215,090	62.9%	346,496	73.7%	632,371	83.1%
	2016	25,000	204,122	59.7%	333,334	70.9%	614,130	80.7%
	2017	25,000	194,555	56.9%	322,280	68.6%	599,481	78.8%
	2018	25,000	186,429	54.5%	313,317	66.7%	588,306	77.3%
	2019	25,000	179,608	52.5%	306,205	65.2%	580,149	76.3%
	2020	25,000	173,840	50.8%	300,564	64.0%	574,353	75.5%
	2021	25,000	168,867	49.4%	296,019	63.0%	570,279	75.0%
	2022	25,000	164,477	48.1%	292,266	62.2%	567,414	74.6%
Status quo catches	2013	11,100	240,029	70.2%	377,601	80.4%	677,185	89.0%
	2014	11,100	234,602	68.6%	368,952	78.5%	661,396	86.9%
	2015	11,100	229,773	67.2%	361,268	76.9%	647,348	85.1%
	2016	11,100	226,016	66.1%	355,273	75.6%	636,306	83.6%
	2017	11,100	223,478	65.3%	351,154	74.7%	628,578	82.6%
	2018	11,100	222,151	65.0%	348,847	74.2%	624,008	82.0%
	2019	11,100	221,873	64.9%	348,088	74.1%	622,119	81.8%
	2020	11,100	222,377	65.0%	348,483	74.2%	622,239	81.8%
	2021	11,100	223,401	65.3%	349,652	74.4%	623,727	82.0%
	2022	11,100	224,735	65.7%	351,294	74.8%	626,072	82.3%

11 Figures

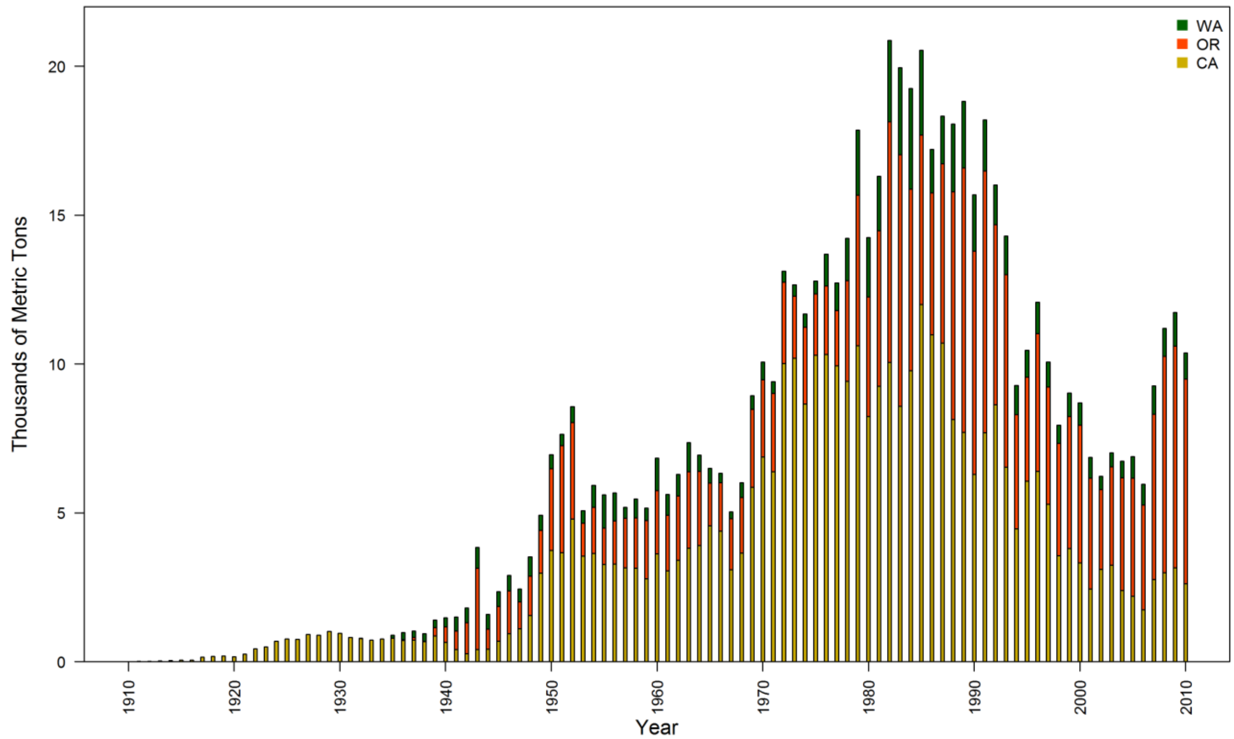


Figure 1. Landings of Dover sole (mt) from 1910–2010 separated by the state where landed.

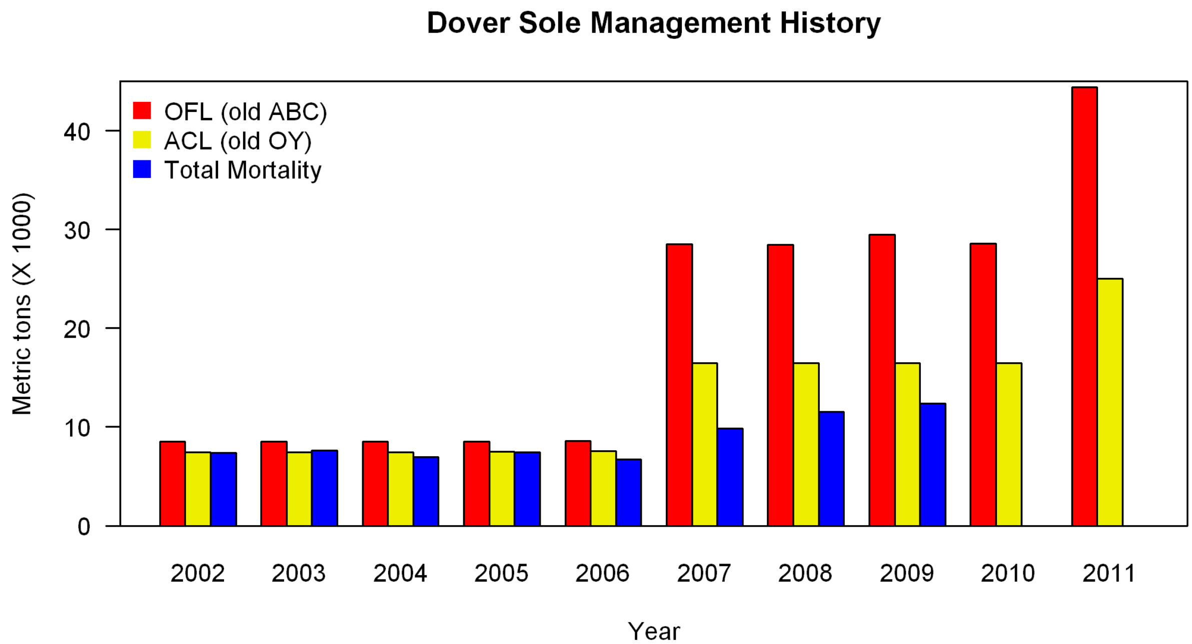


Figure 2. Recent management history and performance showing the OFL (formerly known as the ABC), the ACL (formerly known as the OY), and the estimated total mortality estimated from landings and discard data (pers. comm., WCGOP program, NWFSC, NMFS) in metric tons for the years 2002 to 2011.

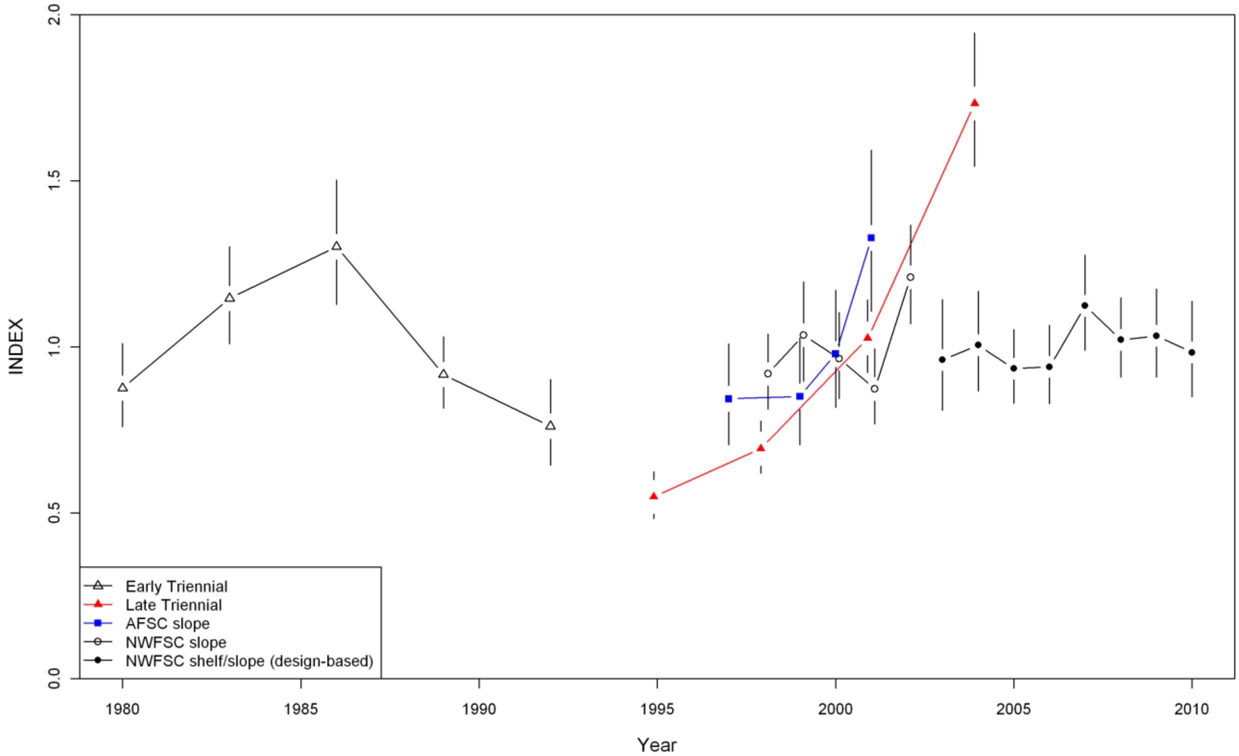


Figure 3. Survey indices for the four surveys, each centered around 1 for comparison.

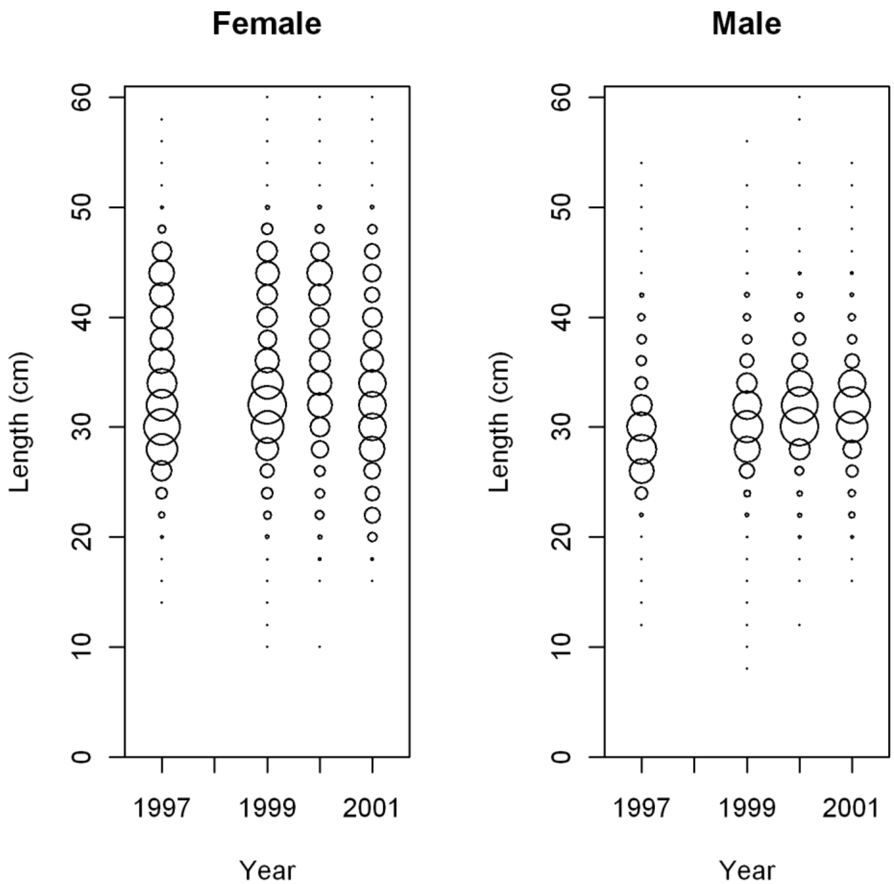


Figure 4. Expanded length frequencies by 2 cm bins for the AFSC slope survey.

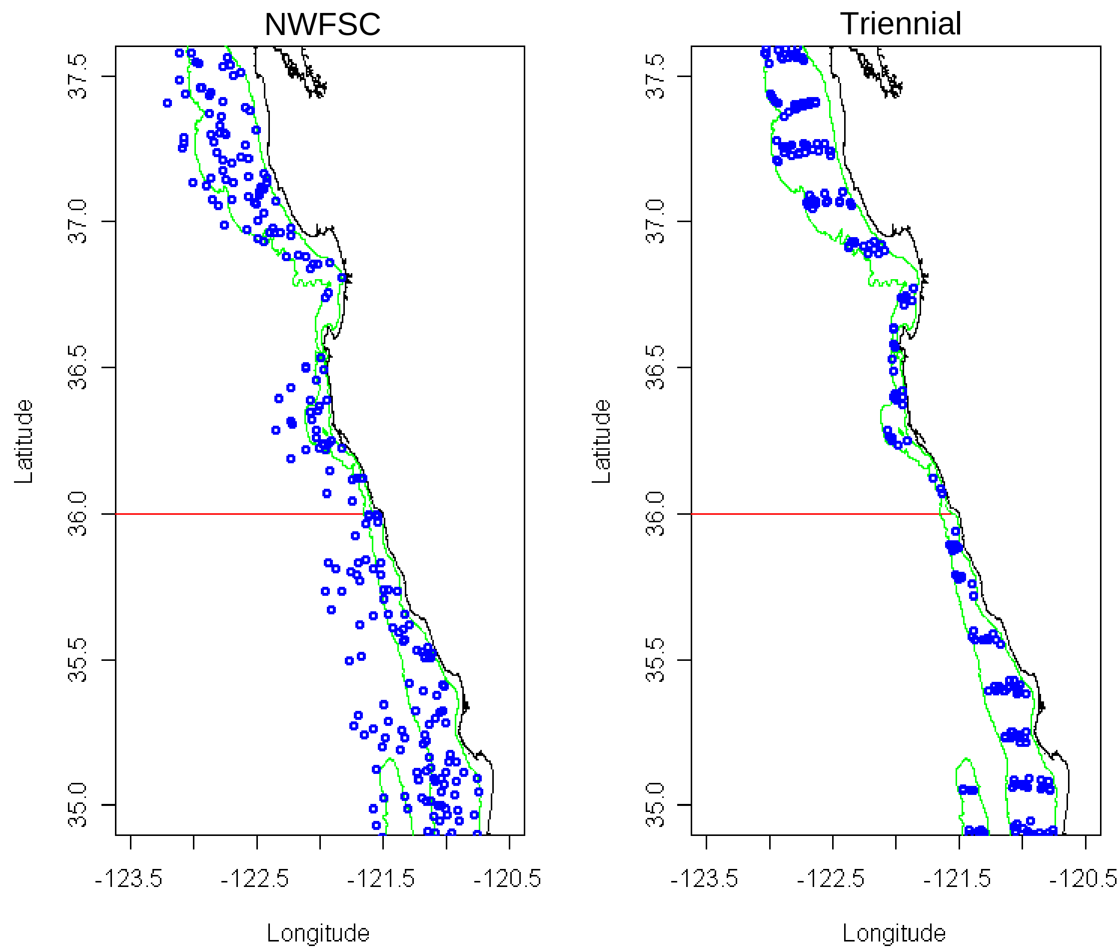


Figure 5. Survey tow locations in 2004, showing the difference in station design for the NWFSC survey relative to the Triennial trawl survey (Figure from Stewart (2007)).

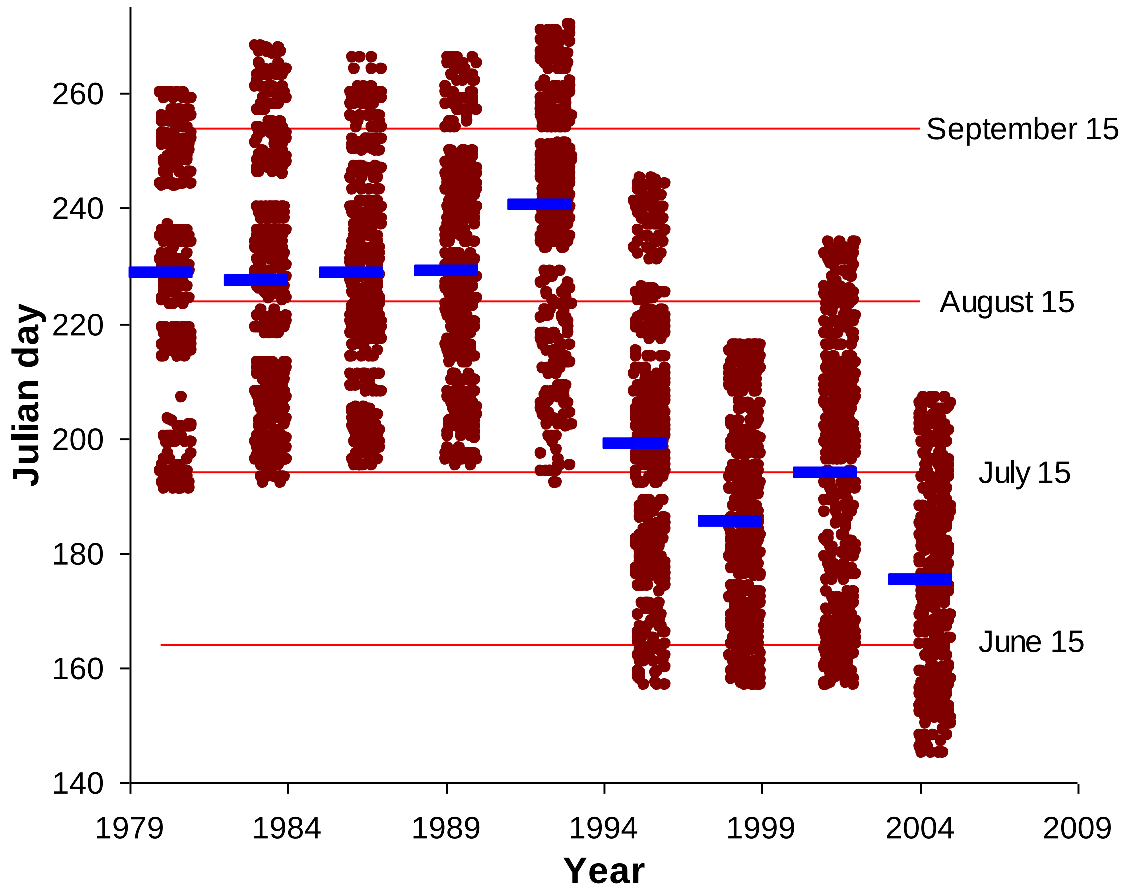


Figure 6. Distribution of dates of operation for the triennial survey (1980-2004). Solid bars show the mean date for each survey year, points represent individual hauls dates, but are jittered to allow better delineation of the distribution of individual points (Figure from Stewart (2007)).

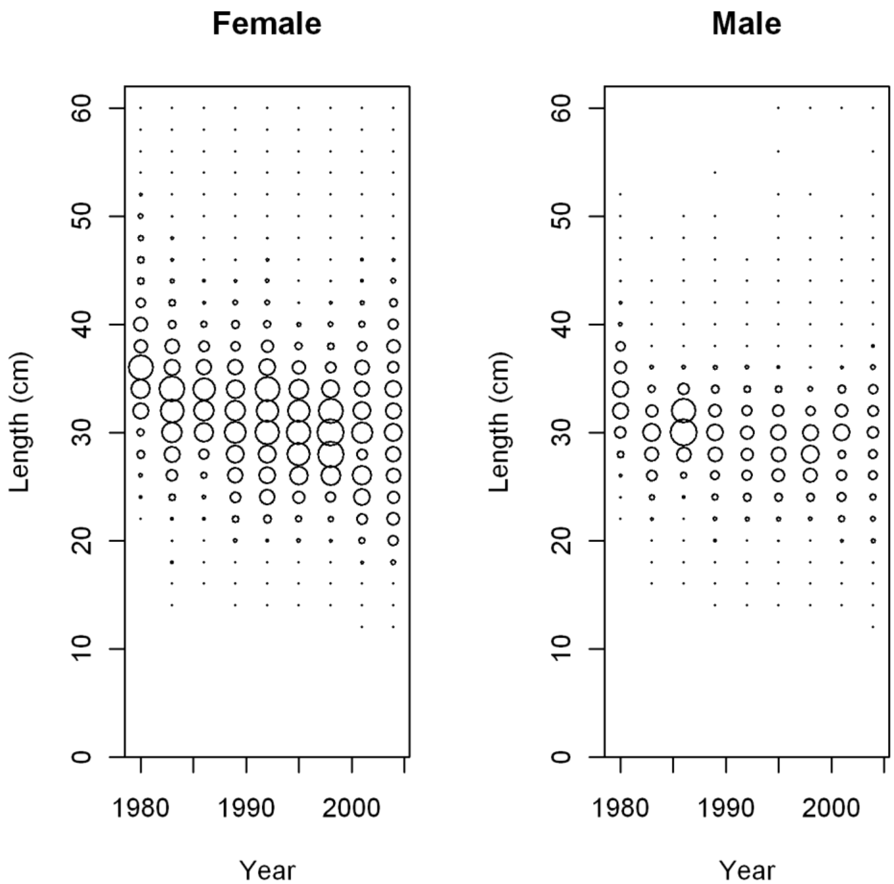


Figure 7. Expanded length frequencies from the Triennial survey.

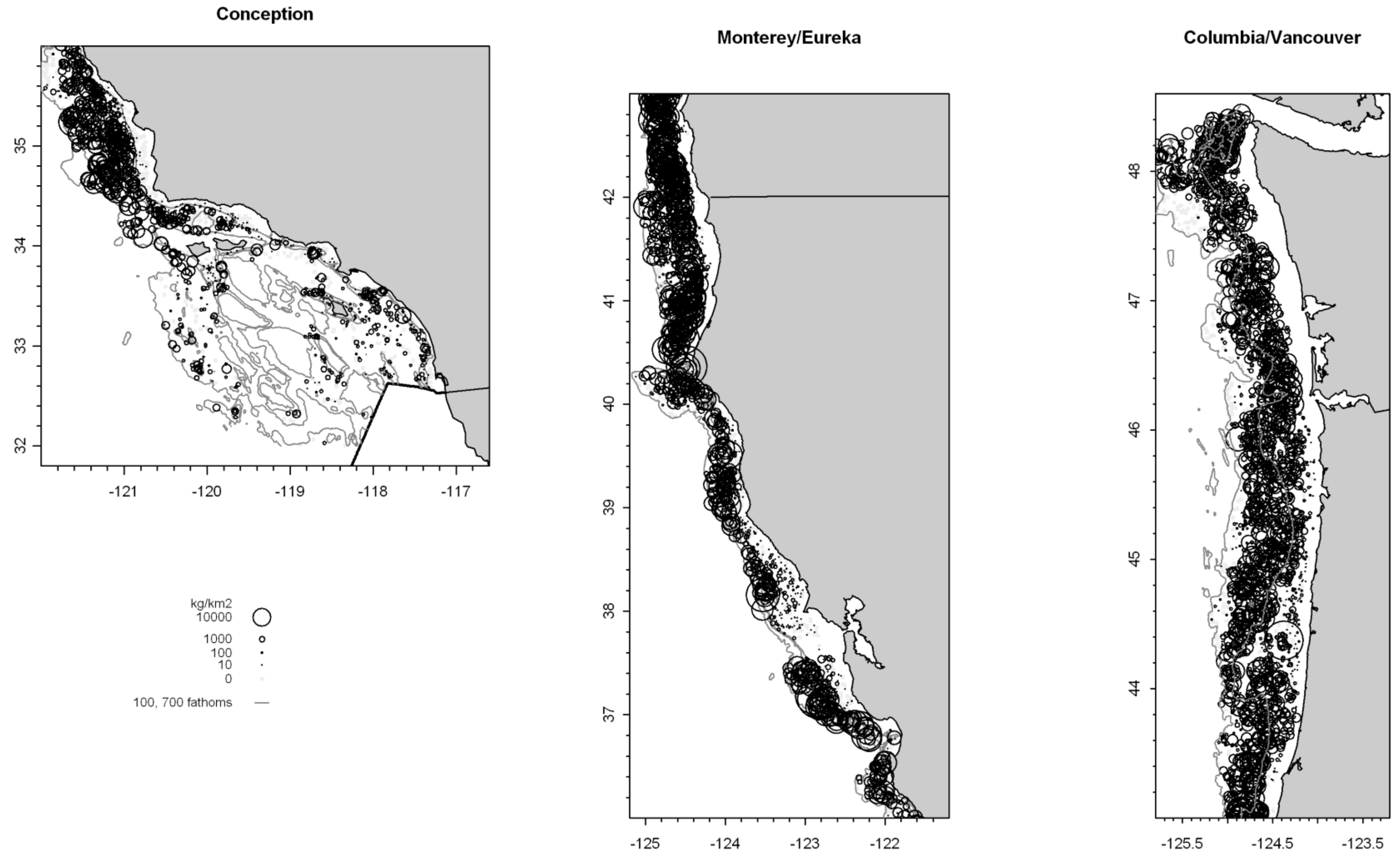


Figure 8. Catch rates plotted by location for the years 2003–2010 of the NWFSC shelf/slope trawl survey.

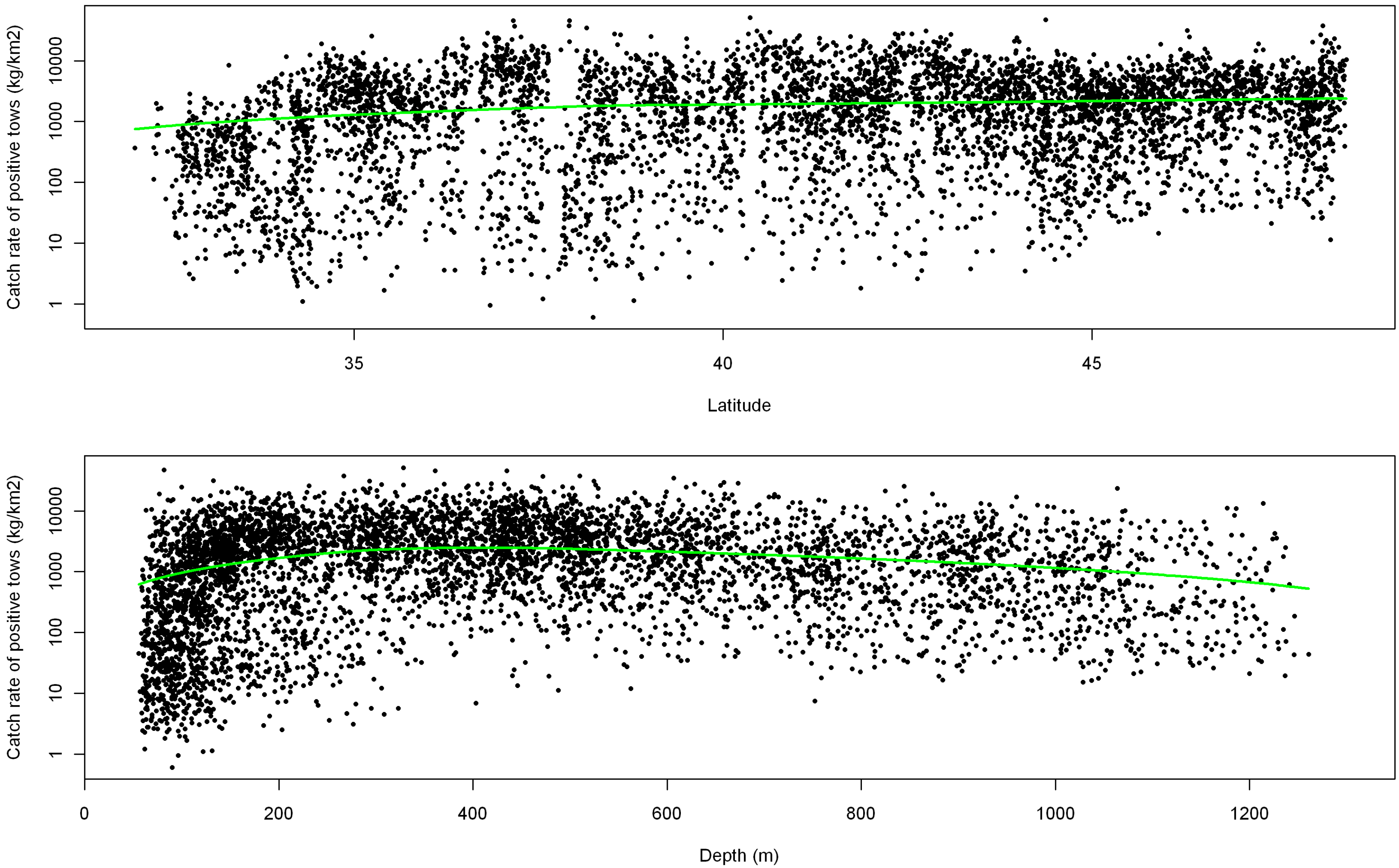


Figure 9. Catch rate (kg/km^2) from the NWFSC shelf/slope survey (2003–2010) plotted over latitude (top) and depth (bottom). The green line is a smoothed line to help define the trends.

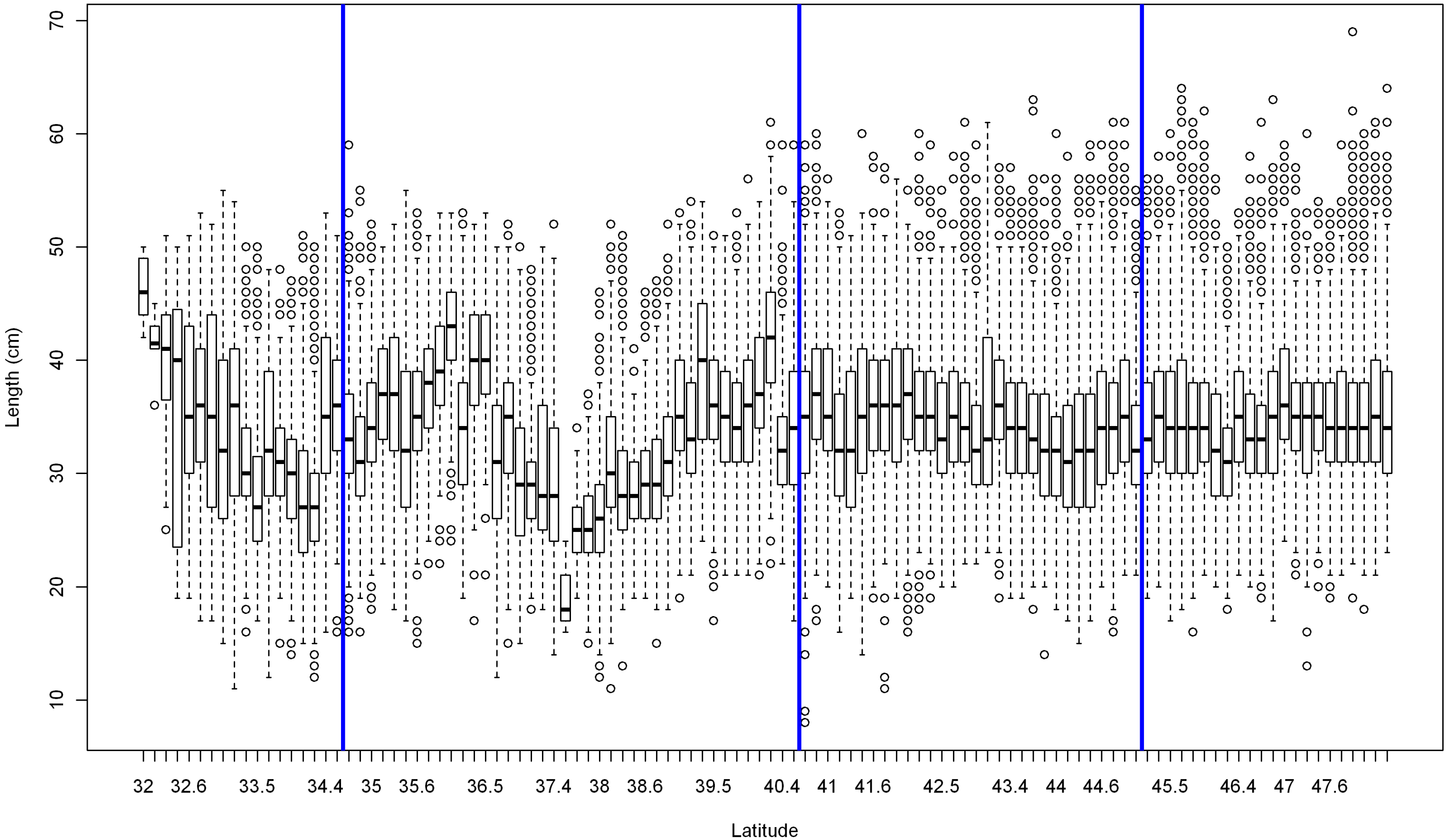


Figure 10. Boxplots of length from the NWFSC shelf/slope survey (2003–2010) binned by latitude. The vertical blue lines are the strata used in the analysis of these survey data. The most southern break occurs at Point Conception.

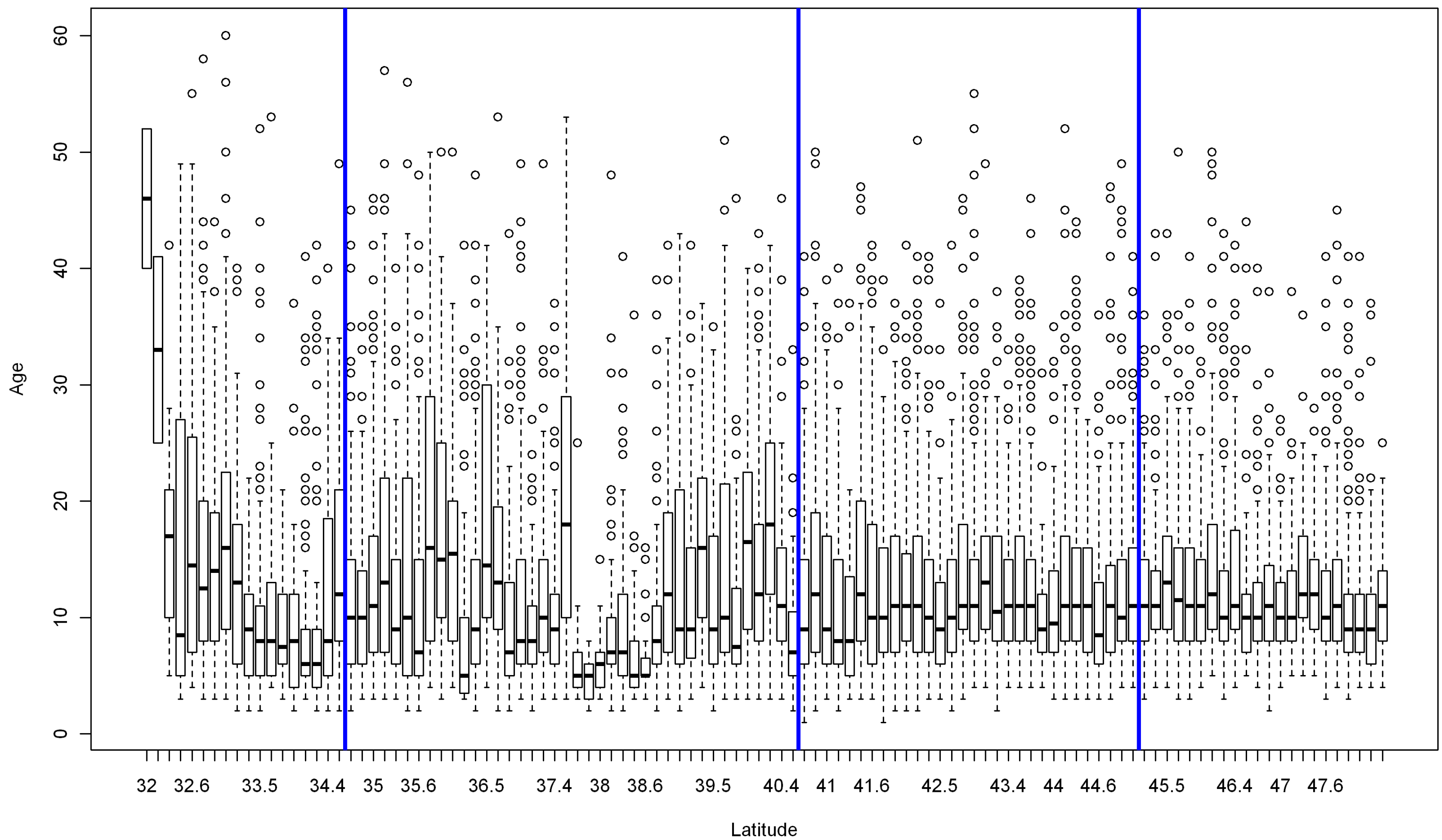


Figure 11. Boxplots of ages from the NWFSC shelf/slope survey (2003–2010) binned by latitude. The vertical blue lines are the strata used in the analysis of these survey data. The most southern break occurs at Point Conception.

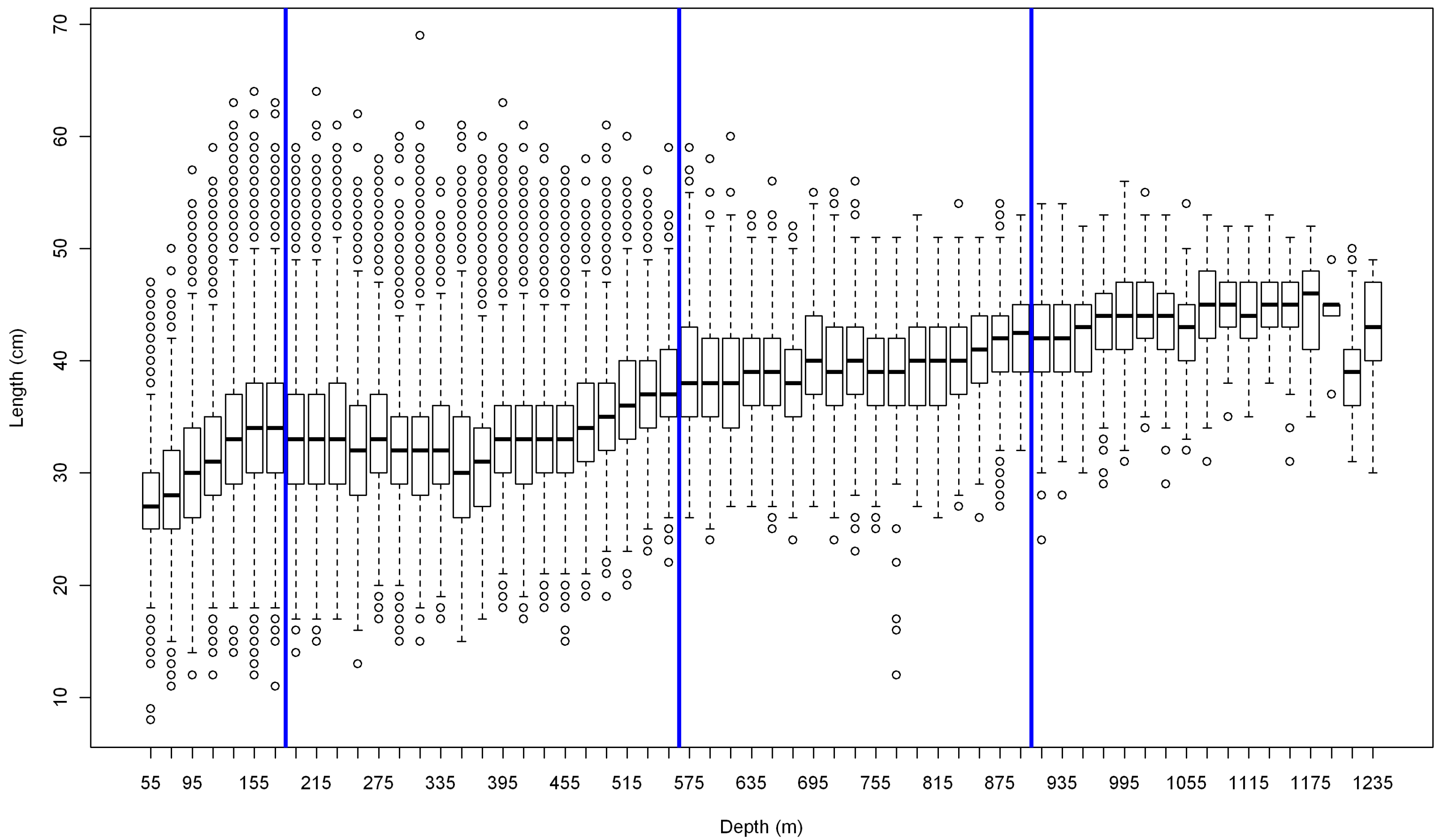


Figure 12. Boxplots of lengths from the NWFSC shelf/slope survey (2003–2010) by 20 m depth intervals. The vertical blue lines show the depth breaks in the stratification used in this assessment. The depth break at 183 m is considered the shelf/slope break.

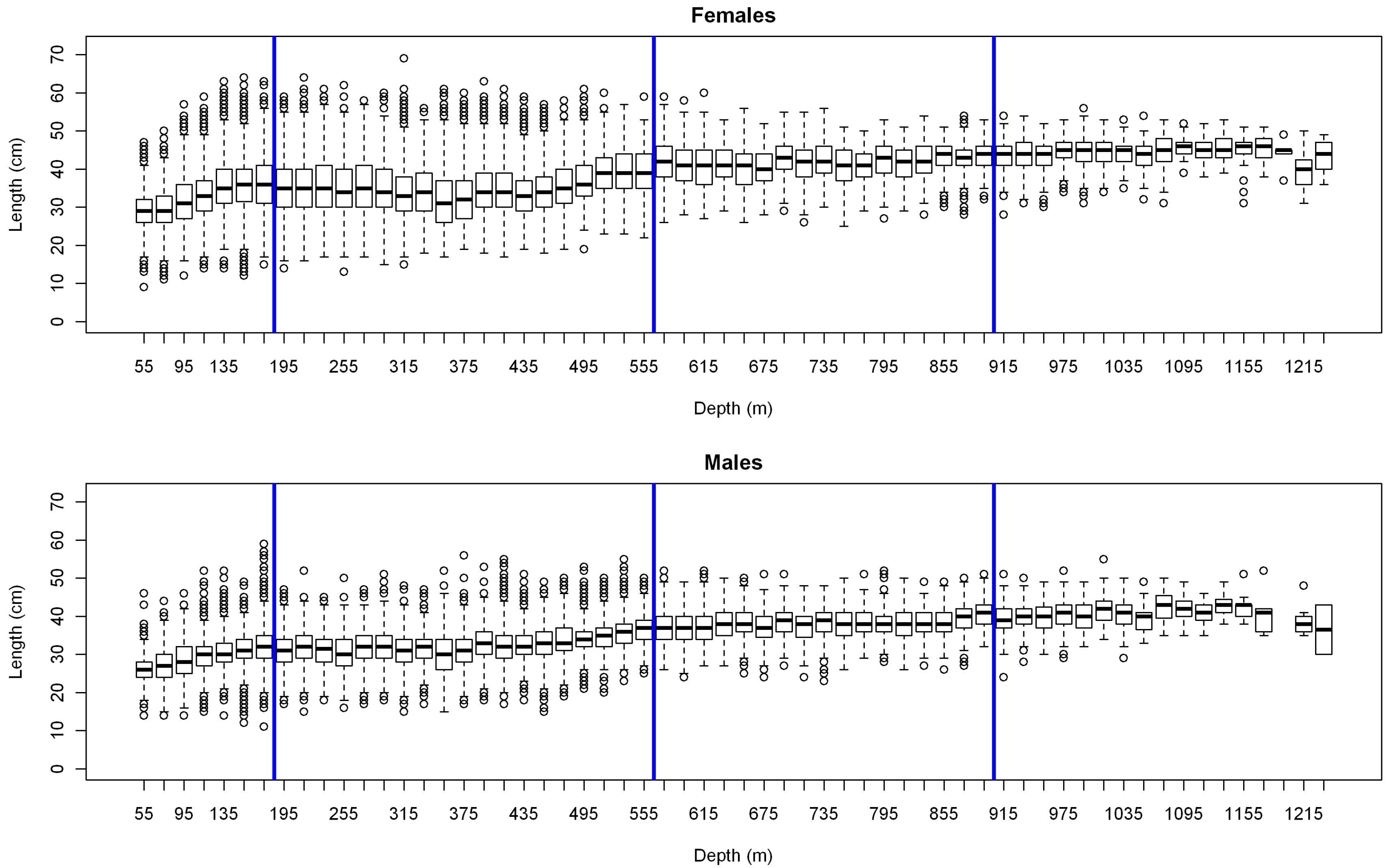


Figure 13. Lengths from the NWFSC shelf/slope survey (2003–2010) binned by 20 m depth intervals for females (top) and males (bottom). The vertical blue lines show the depth breaks in the stratification used in this assessment. The depth break at 183 m is considered the shelf/slope break.

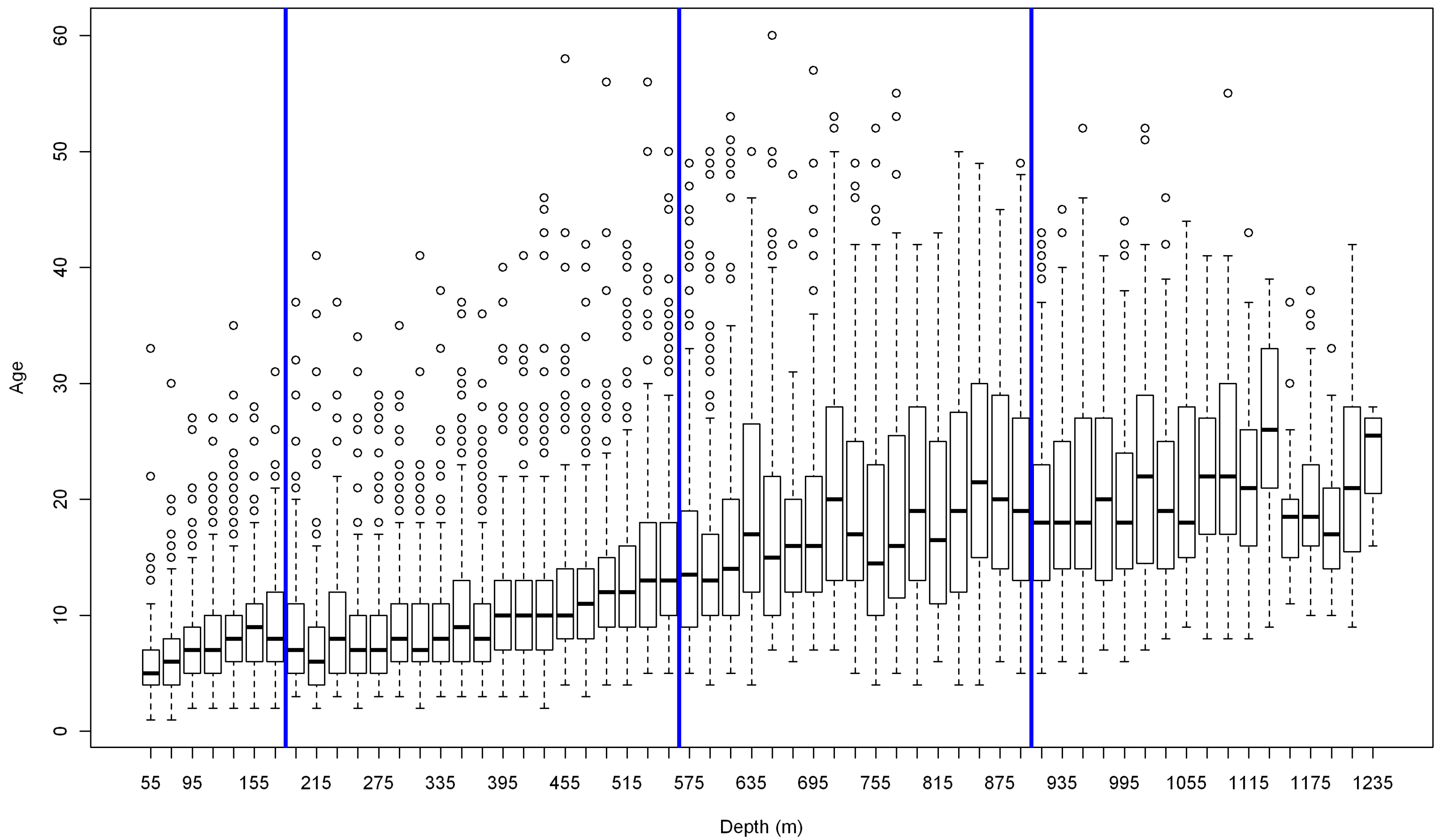


Figure 14. Boxplots of ages from the NWFSC shelf/slope survey (2003–2010) by 20 m depth intervals. The vertical blue lines show the depth breaks in the stratification used in this assessment. The depth break at 183 m is considered the shelf/slope break.

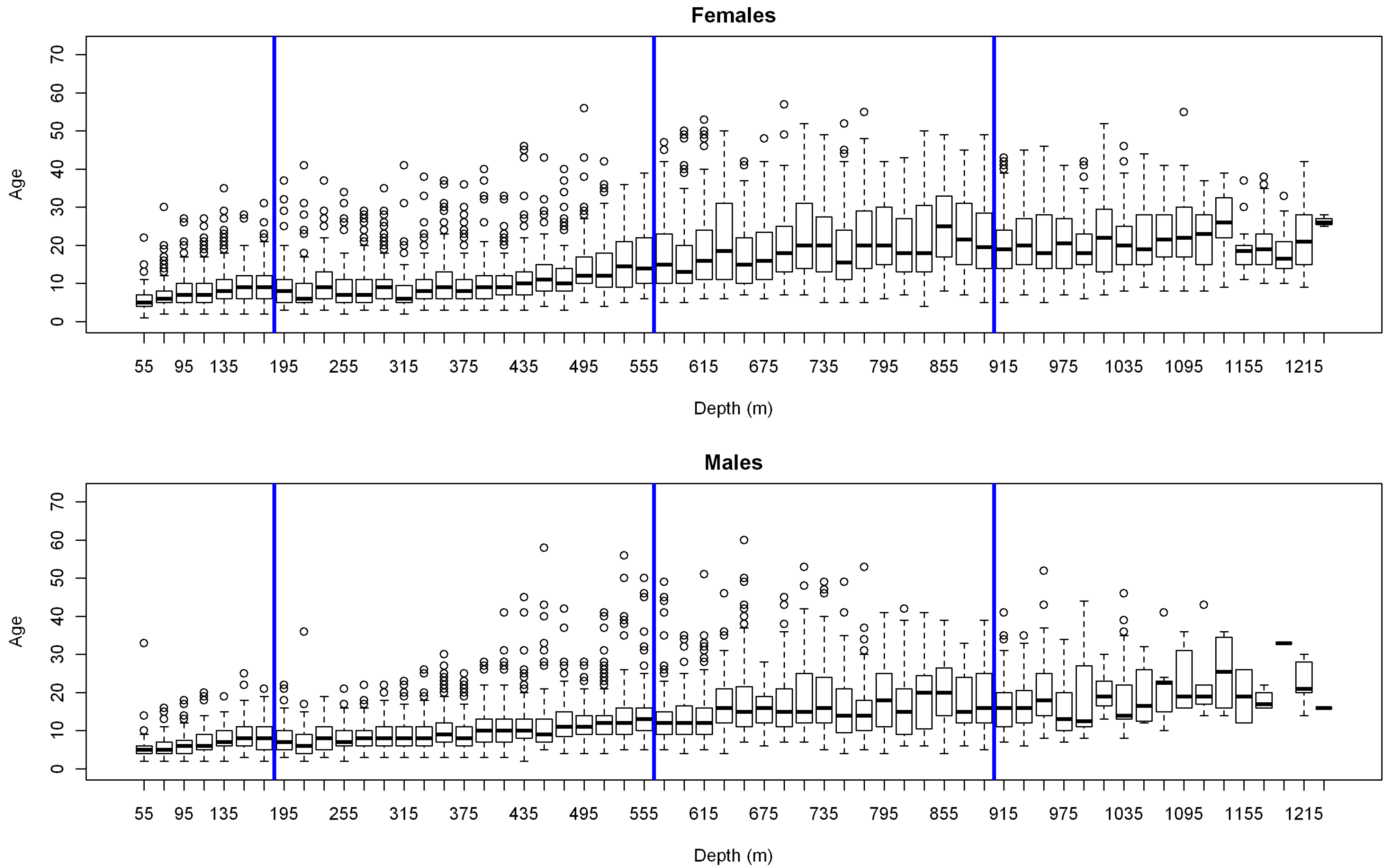


Figure 15. Ages from the NWFSC shelf/slope survey (2003–2010) binned by 20 m depth intervals for females (top) and males (bottom). The vertical blue lines show the depth breaks in the stratification used in this assessment. The depth break at 183 m is considered the shelf/slope break.

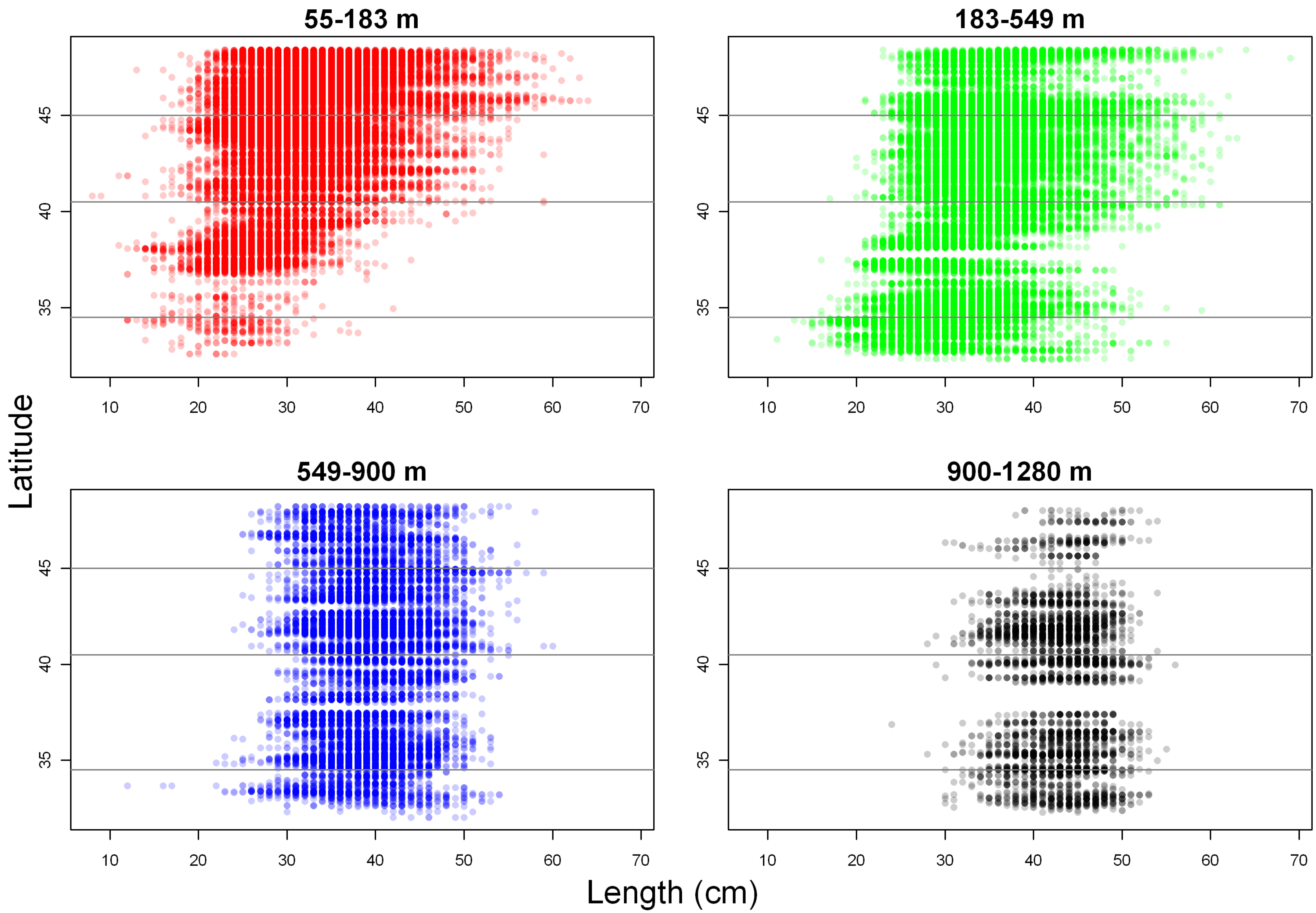


Figure 16. Length by depth strata (panels) and latitude (y-axis) from the NWFSC shelf/slope survey.

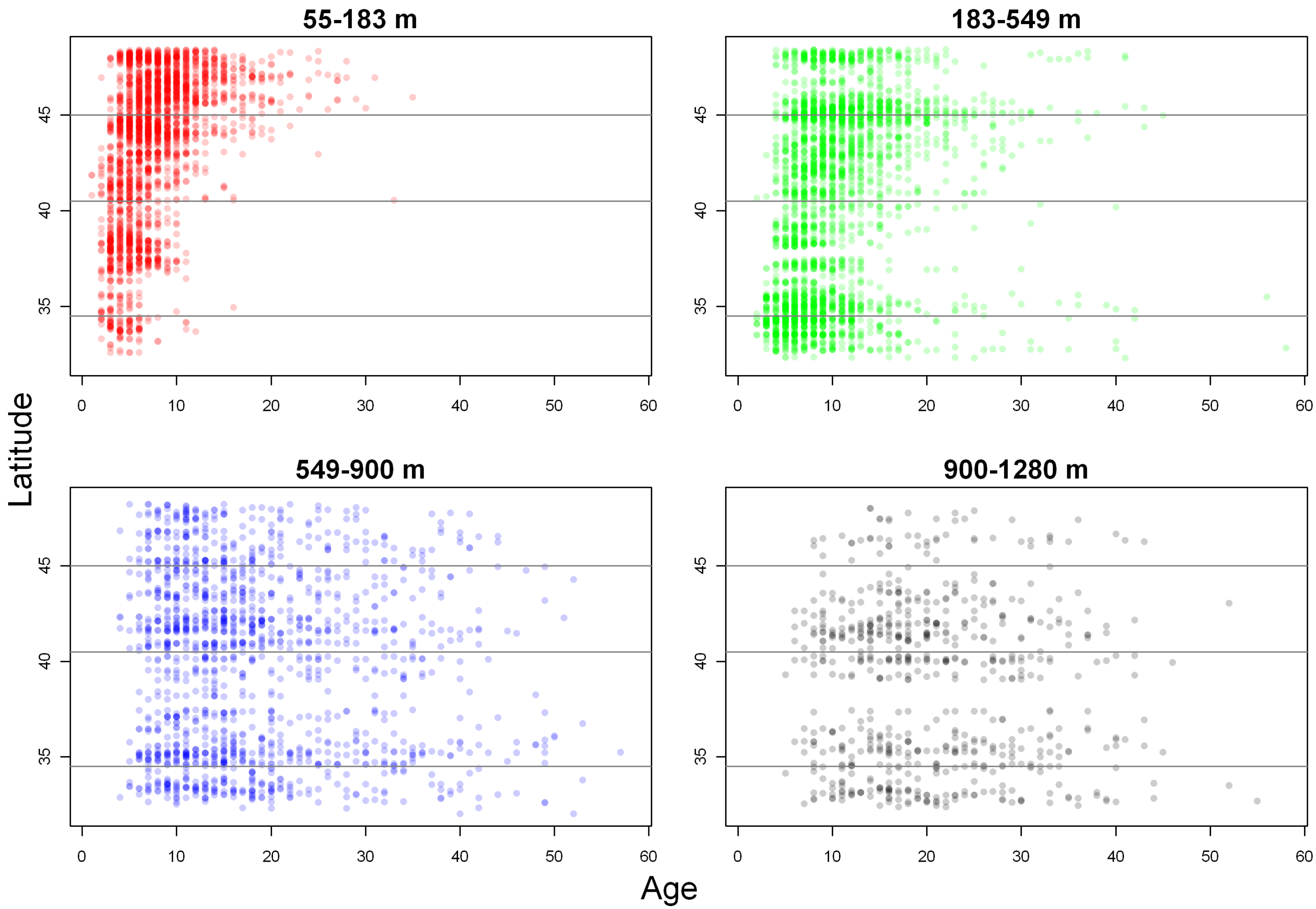


Figure 17. Age by depth strata (panels) and latitude (y-axis) from the NWFSC shelf/slope survey.

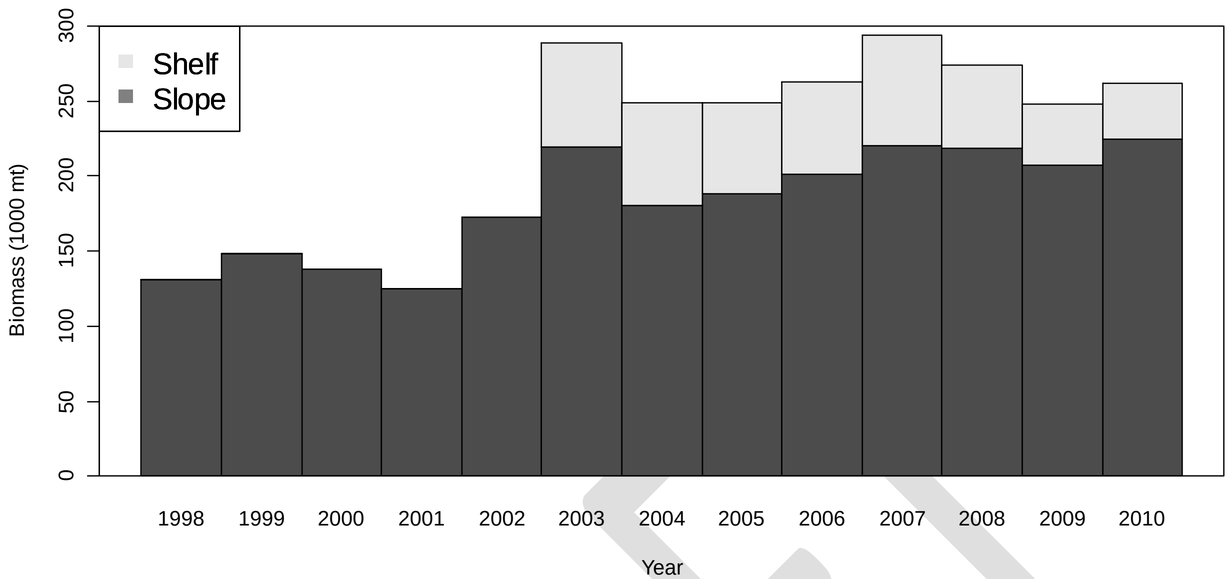


Figure 18: Area-swept biomass estimates for shelf and slope components of the NWFSC surveys.

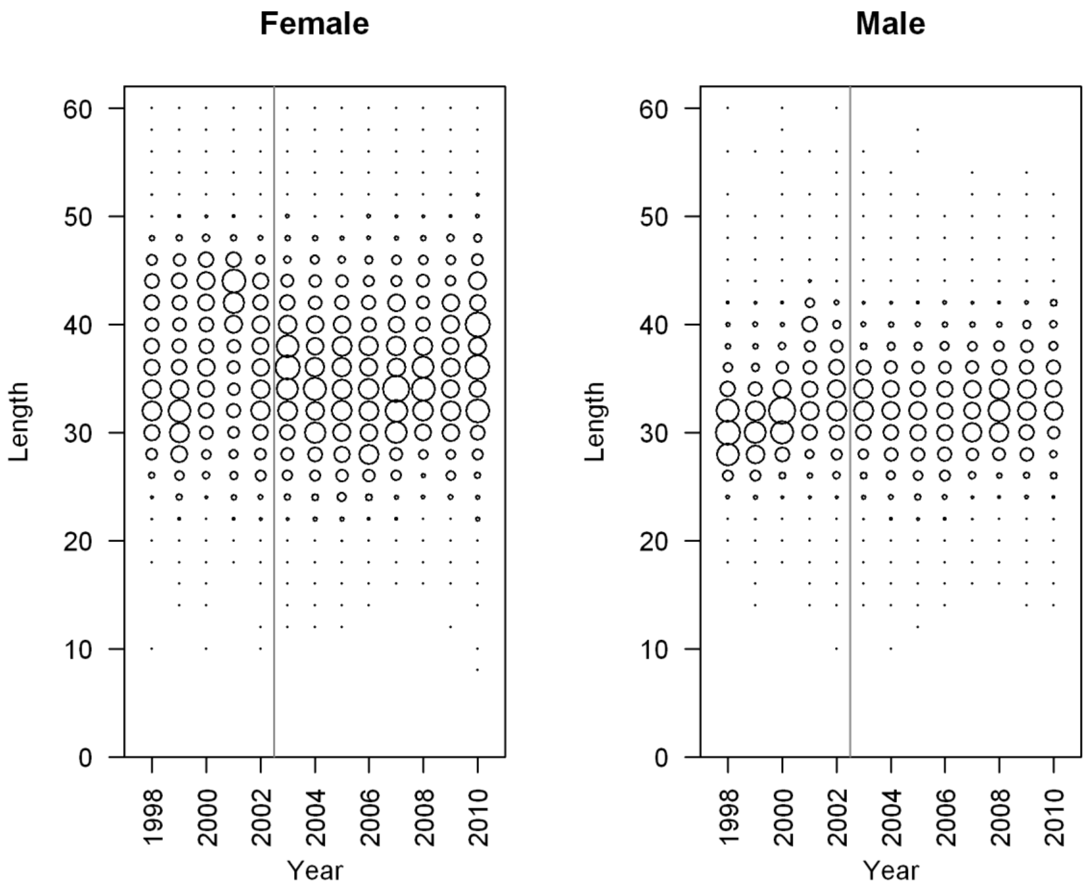


Figure 19. Length frequencies for the NWFSC surveys. The vertical line separates the slope and shelf/slope surveys.

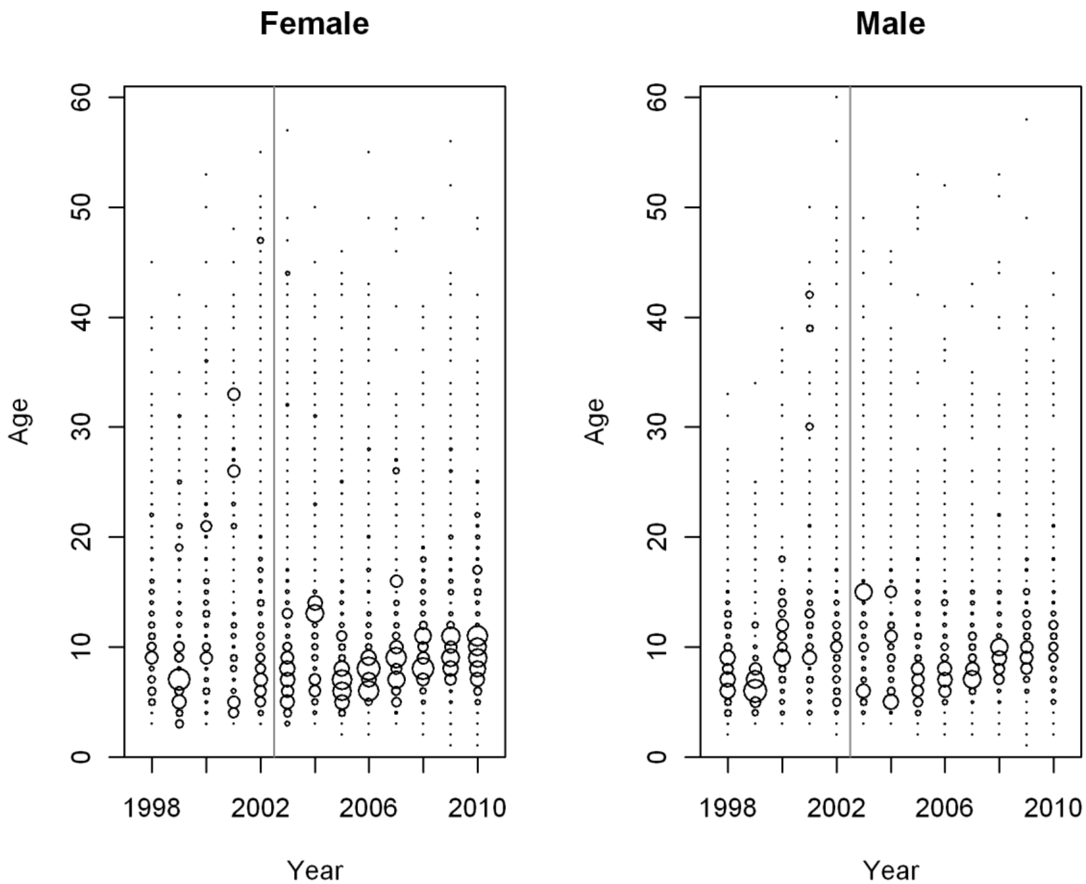


Figure 20. Expanded age frequencies from the NWFSC surveys. The gray vertical line separates the slope and shelf/slope surveys.

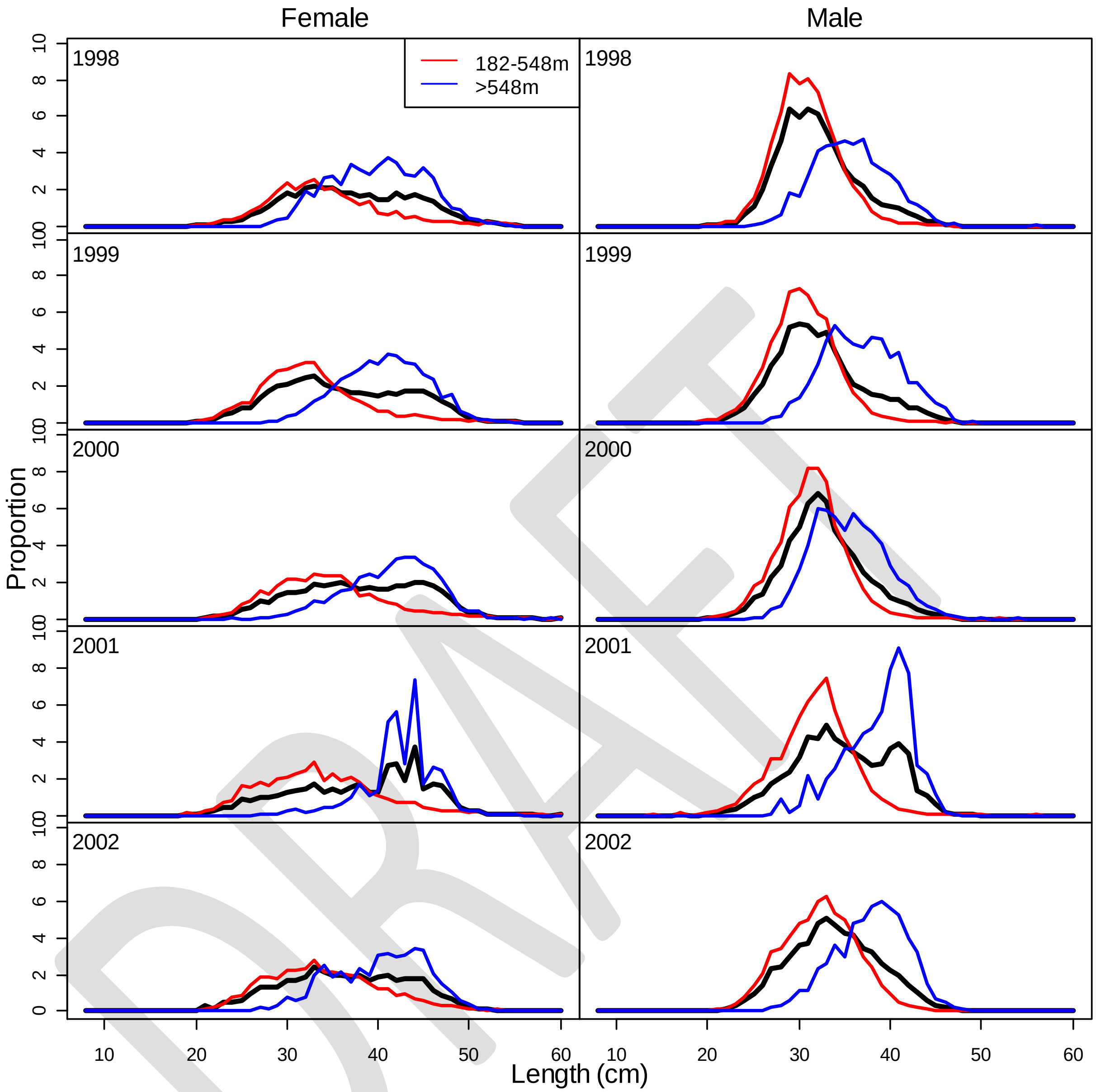


Figure 21: Length frequencies for the NWFSC slope survey over all depths between 182 m and 1280 m (black), depths between 182 m and 548 m, and depths greater than 548 m. Females are shown on the left and males are shown on the right.

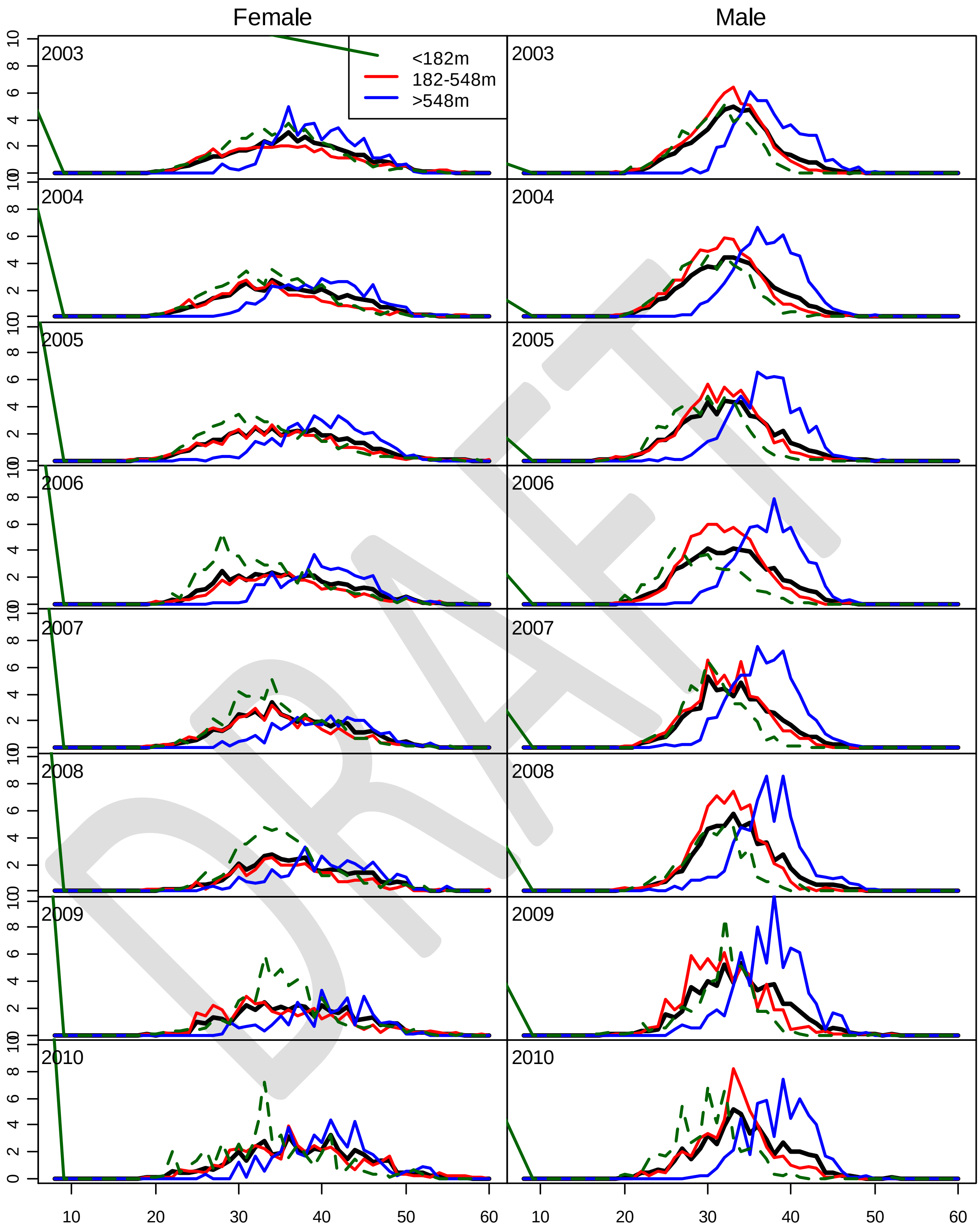


Figure 22: Length frequencies for the NWFSC shelf/slope survey over all depths between 55 m and 1280 m (black), depths between 55 m and 182 m (green broken line), depths between 182 m and 548 m, and depths greater than 548 m. Females are shown on the left and males are shown on the right

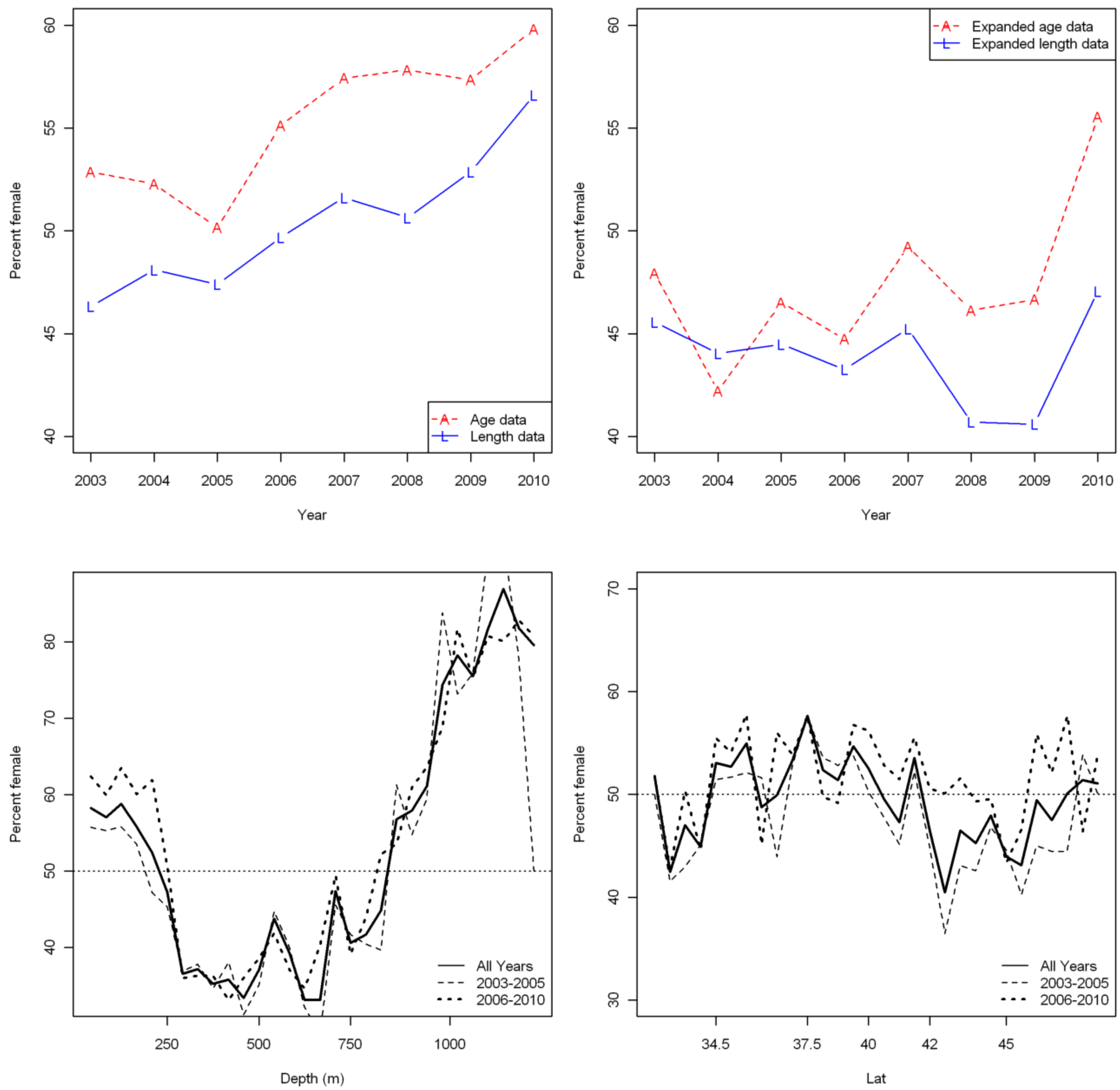


Figure 23. Sex ratio (as percent female) from the raw age data and length data from the NWFSC shelf/slope survey (top left panel) and the expanded age and length data from the NWFSC shelf/slope survey (top right panel). The bottom panels show the percent females by depth (left) and latitude (right) using the length data from the NWFSC shelf/slope survey. The dashed lines represent early and late periods in the survey series.

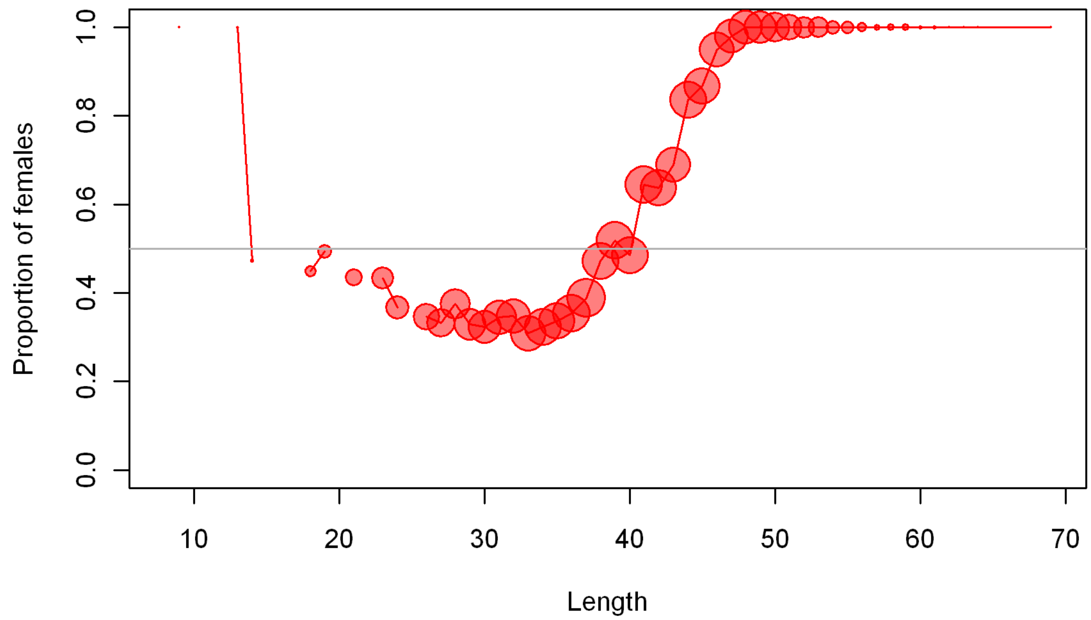


Figure 24. Sex ratio by length from the NWFSC shelf/slope survey. The line represents the median sex ratio for that length over all tows that recorded lengths of Dover sole. The circles indicate the number of observations at that length with bigger circles representing more samples.

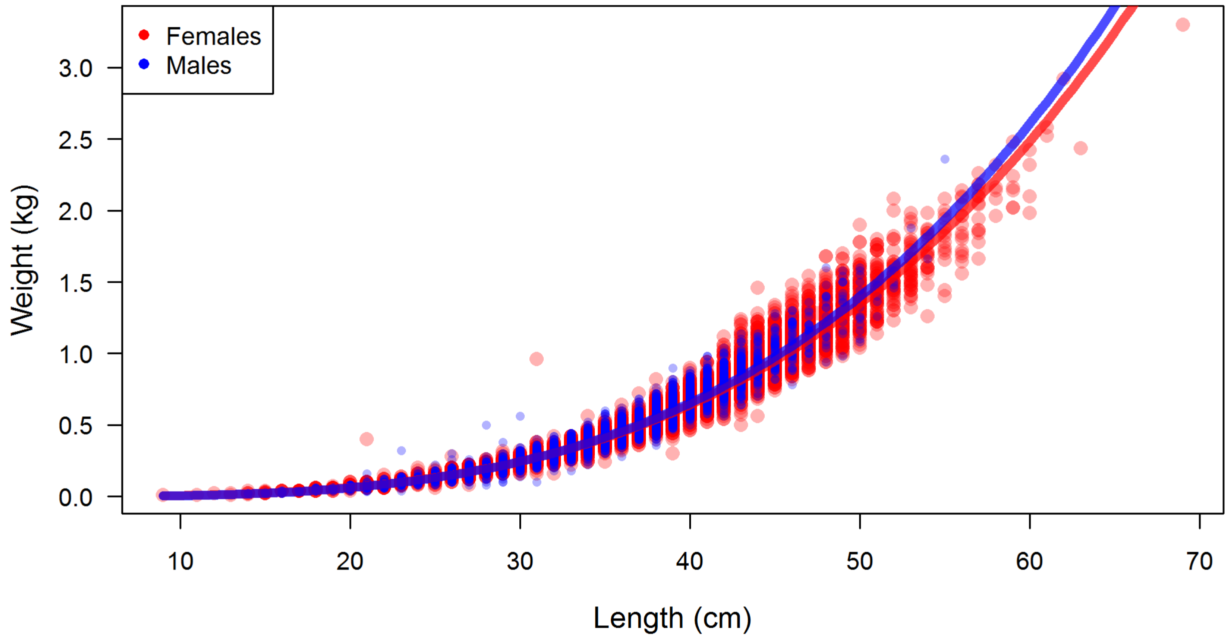


Figure 25. Weight-length relationship from NWFSC shelf/slope survey data.

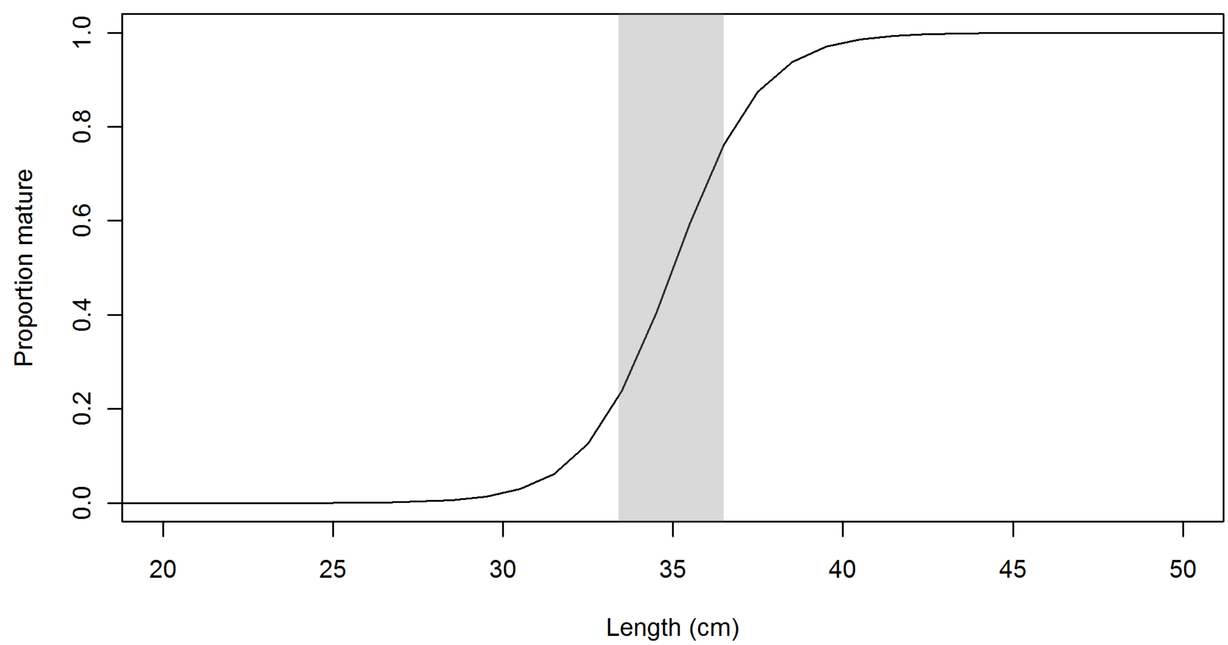


Figure 26. Maturity curve used in the 2011 base case assessment. The grey box shows the range of length at 50% mature used in the 2005 assessment.

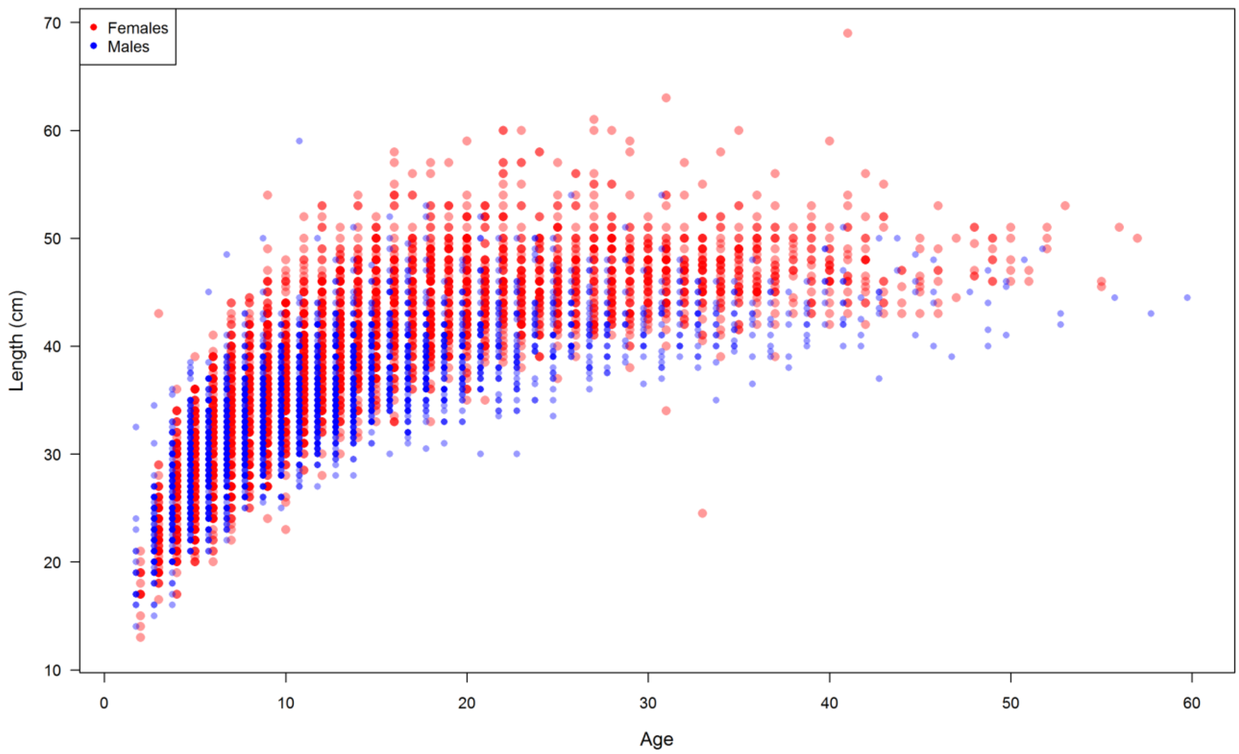


Figure 27. Length-at-age observations for the NWFSC shelf/slope survey (2003–2010).

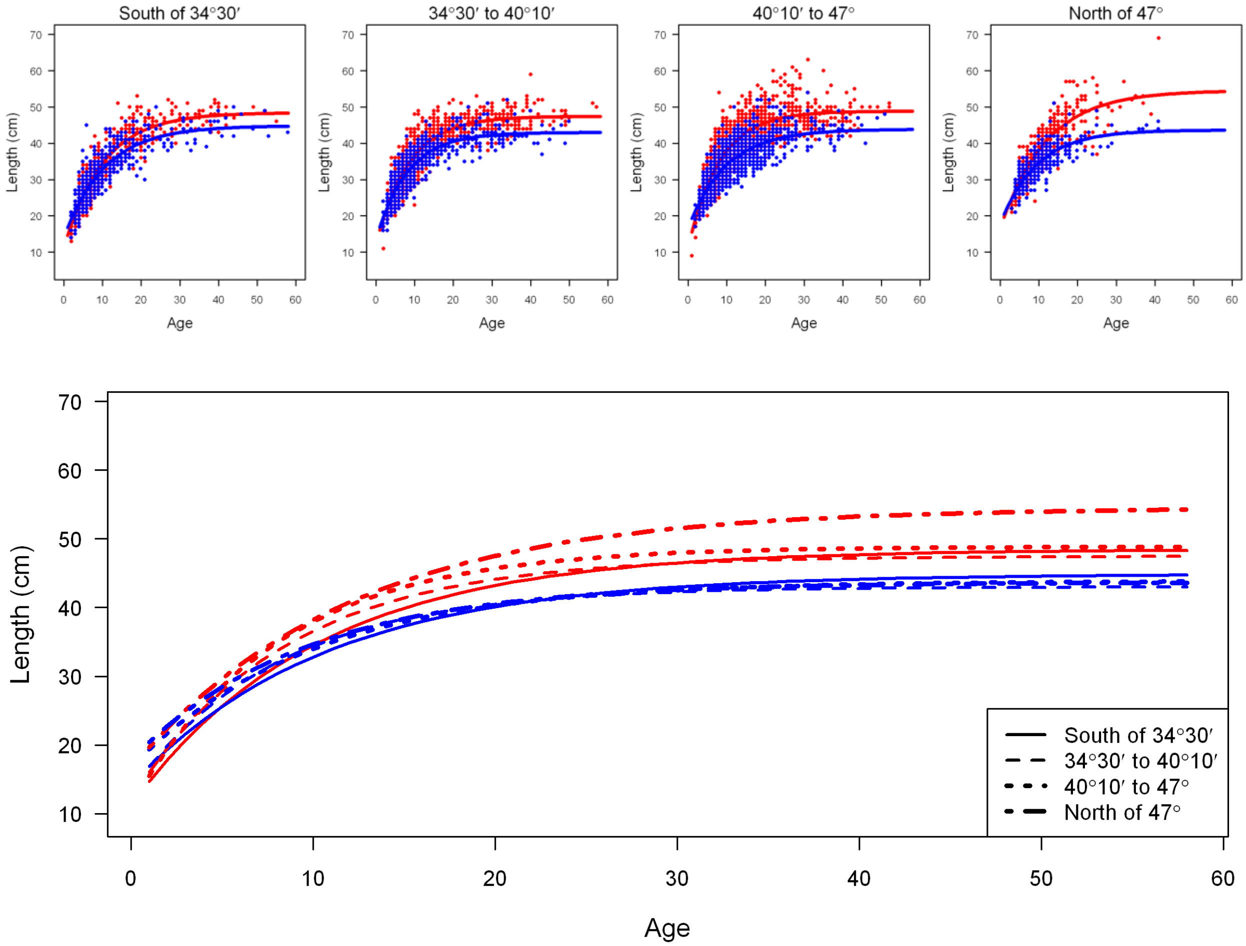


Figure 28. Length at age observations and fitted von Bertalanffy growth curves by latitudinal areas. Red lines and points indicate female observations and fits while blue lines and points indicate male observations and fits.

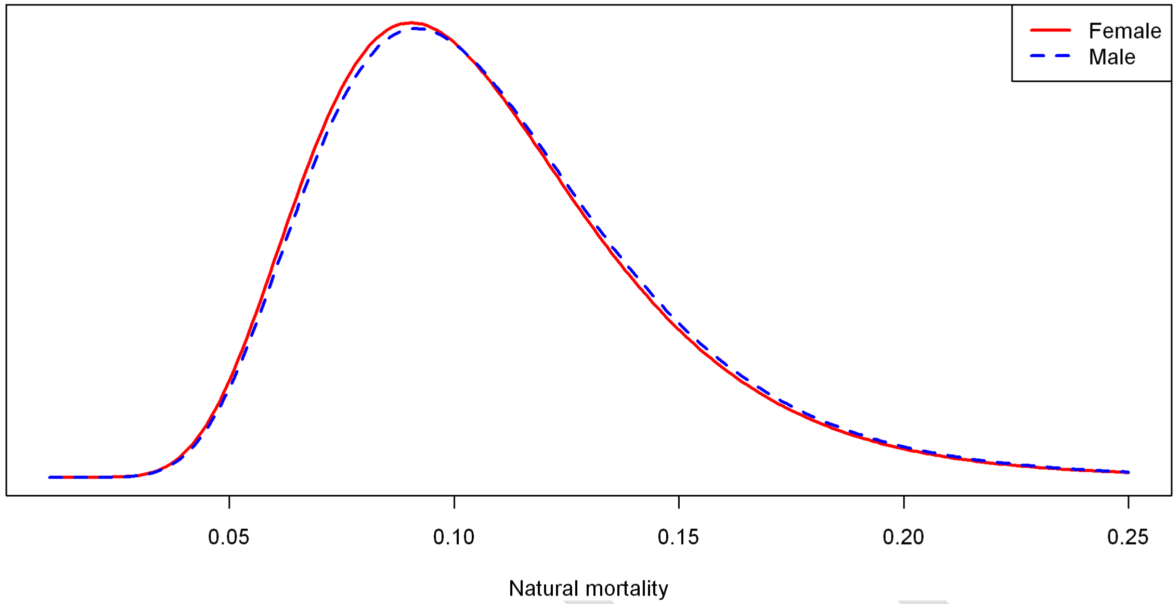


Figure 29. Prior distributions for female and male natural mortality parameters.

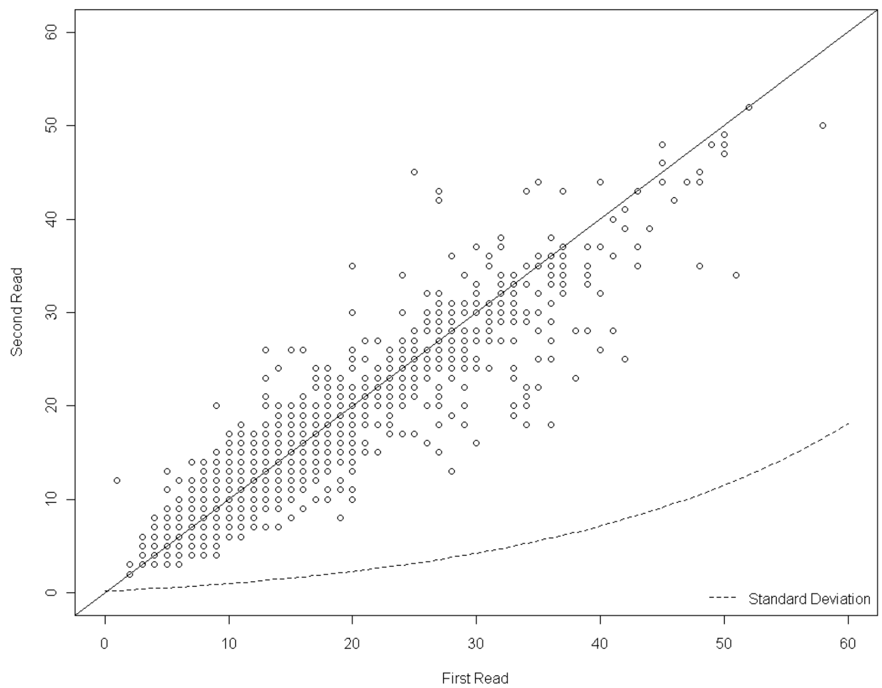


Figure 30. Ageing double-reads by break and burn by the Cooperative Ageing Project (CAP) laboratory with the estimated standard deviation by age (dashed line).

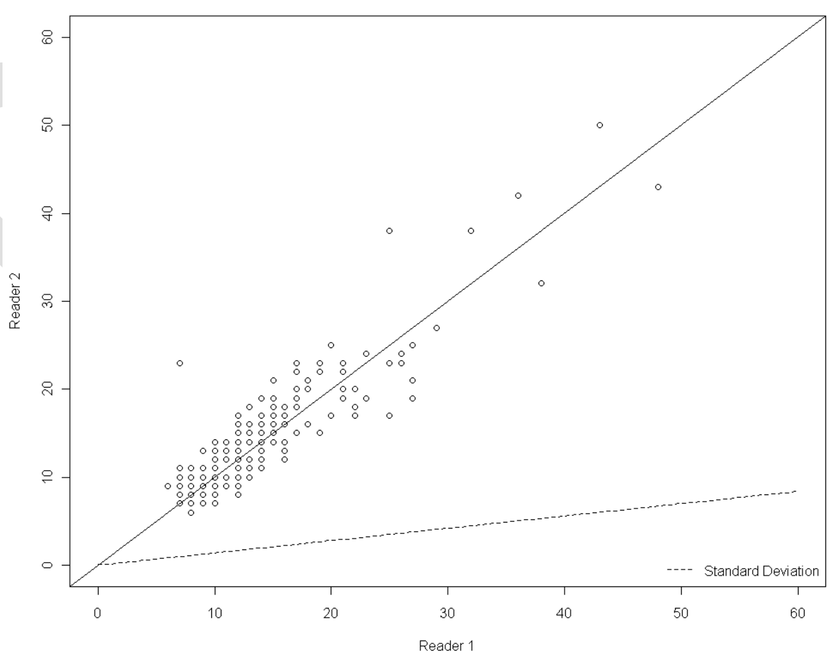


Figure 31. Ageing double-reads by break and burn by California with the estimated standard deviation by age (dashed line).

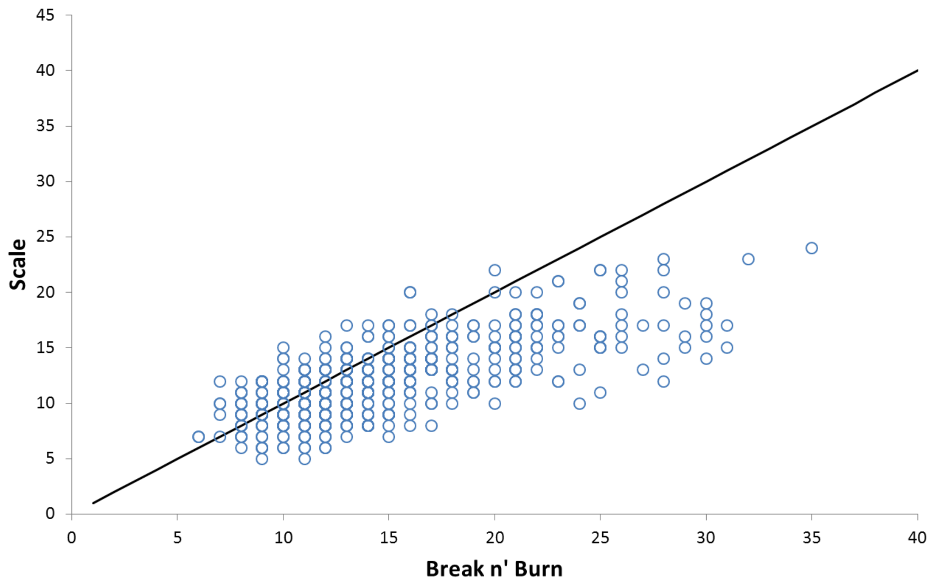


Figure 32. Ageing double-reads by break and burn and scale reads.

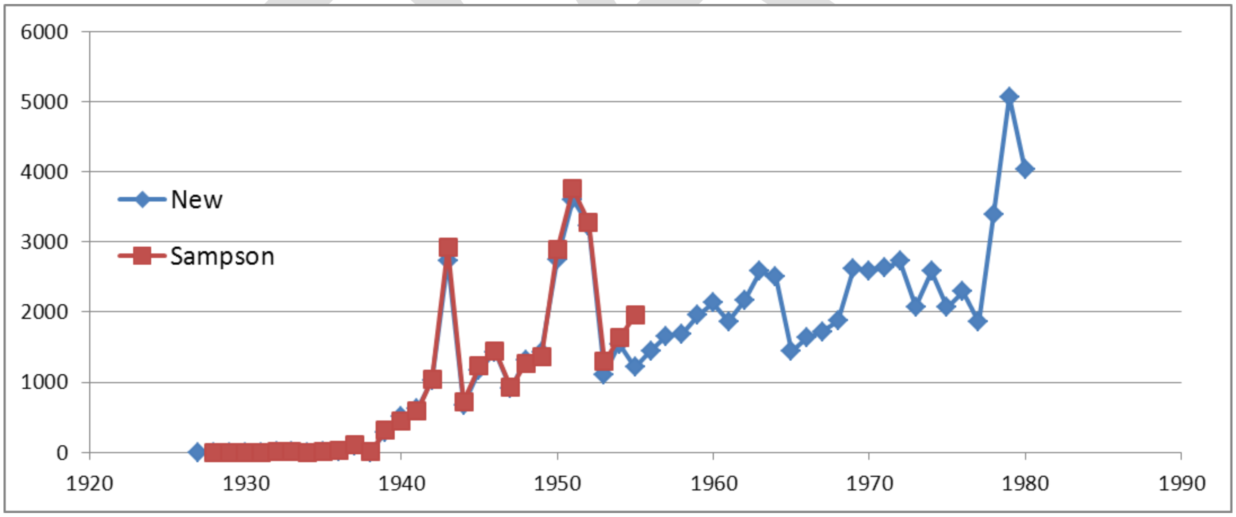


Figure 33. A comparison of the Oregon reconstructed landings with the landings used in the 2005 assessment (Sampson 2005).

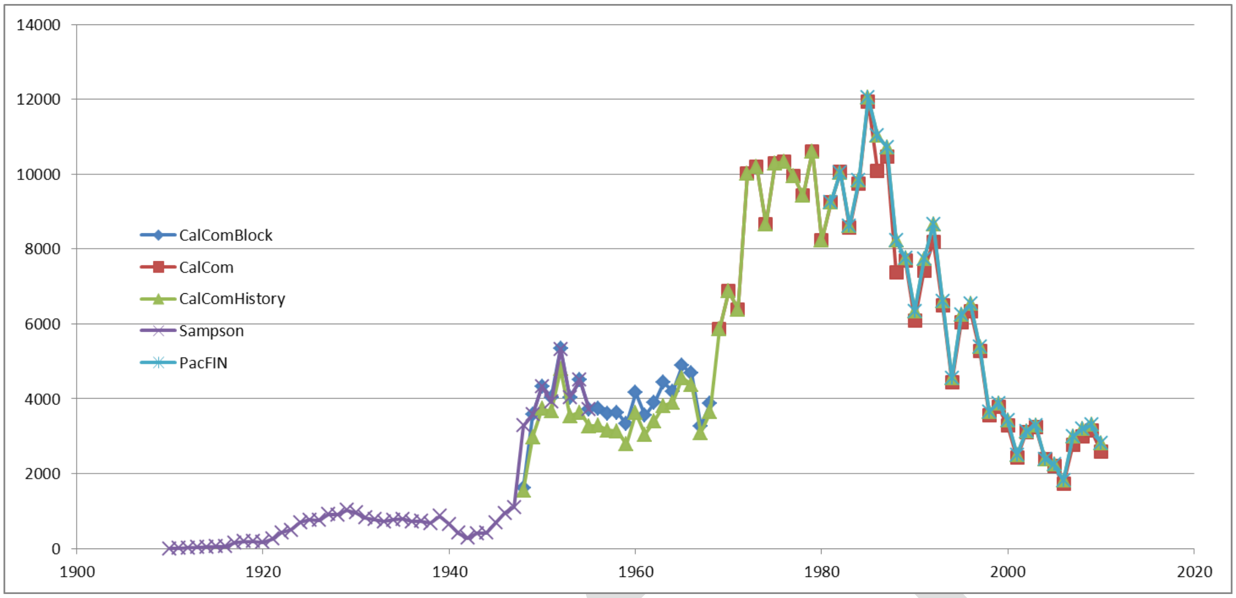


Figure 34. A comparison of California landings of Dover sole obtained from CALCOM, PacFIN, and the 2005 assessment (Sampson 2005).

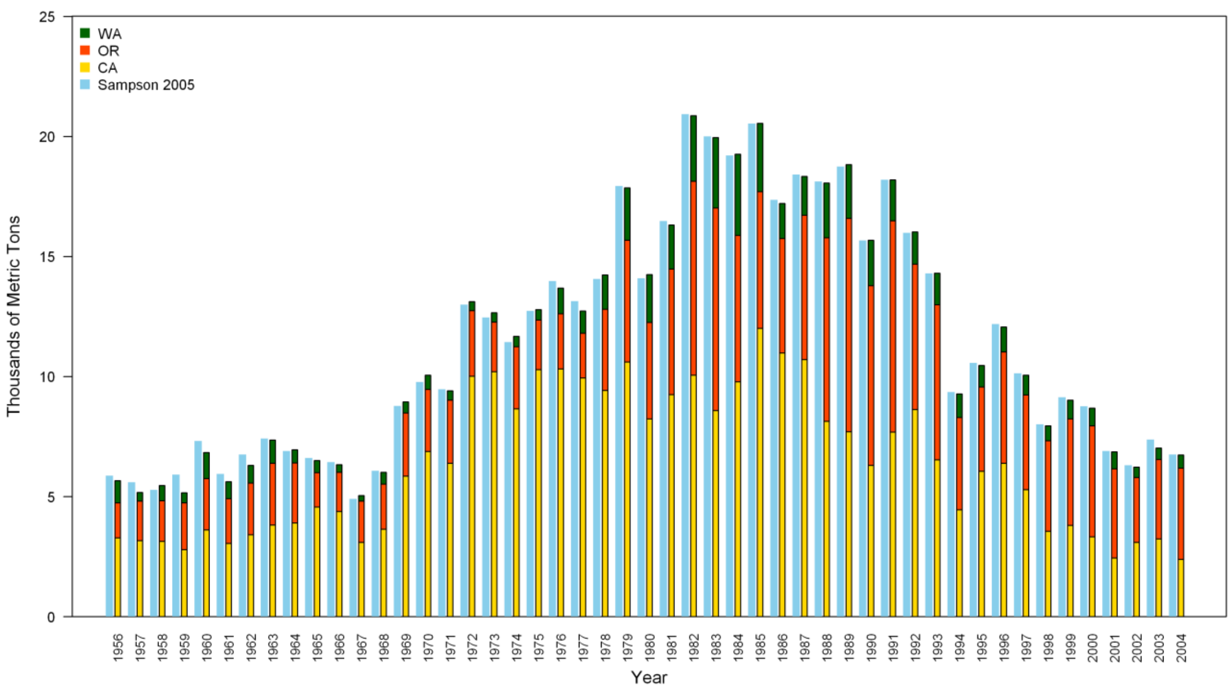


Figure 35. Coastwide landings used in this assessment from 1956 to 2004 compared to the landings used in the 2005 assessment (Sampson 2005) shown in light blue bars.

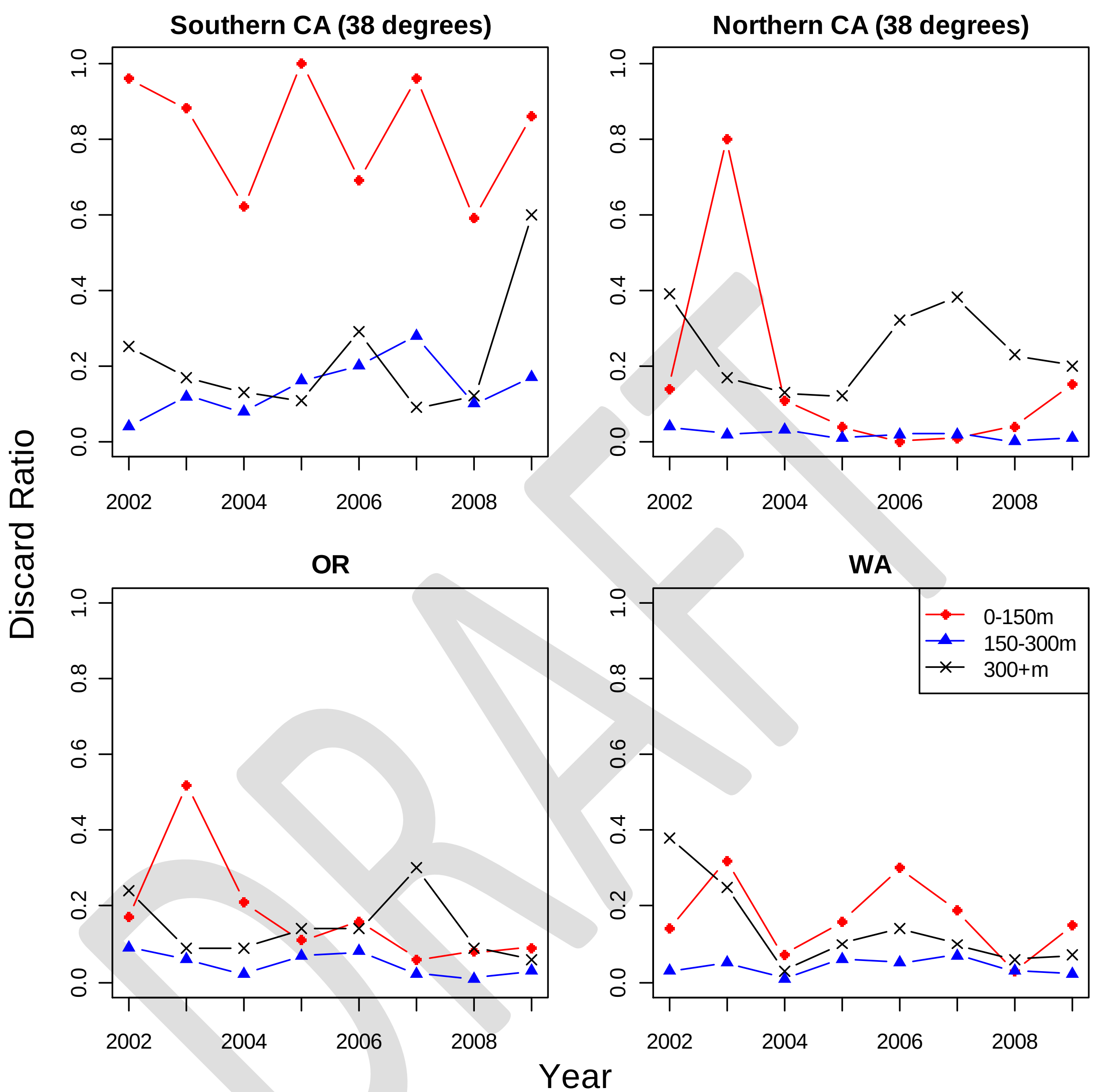


Figure 36. Ratio of discards to total catch by area for three different depths.

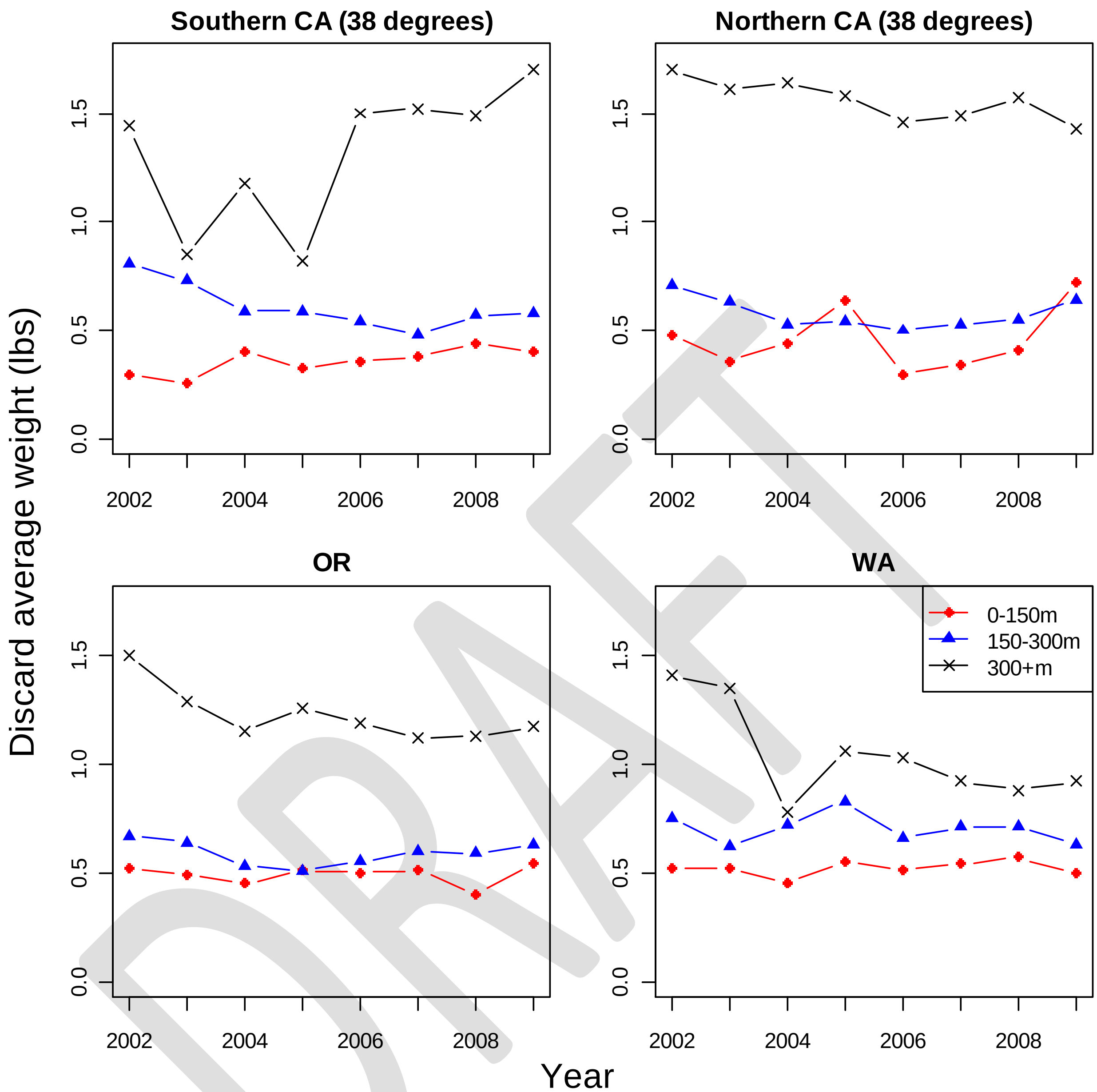


Figure 37. Catch weighted average weight of discards by area for three different depths

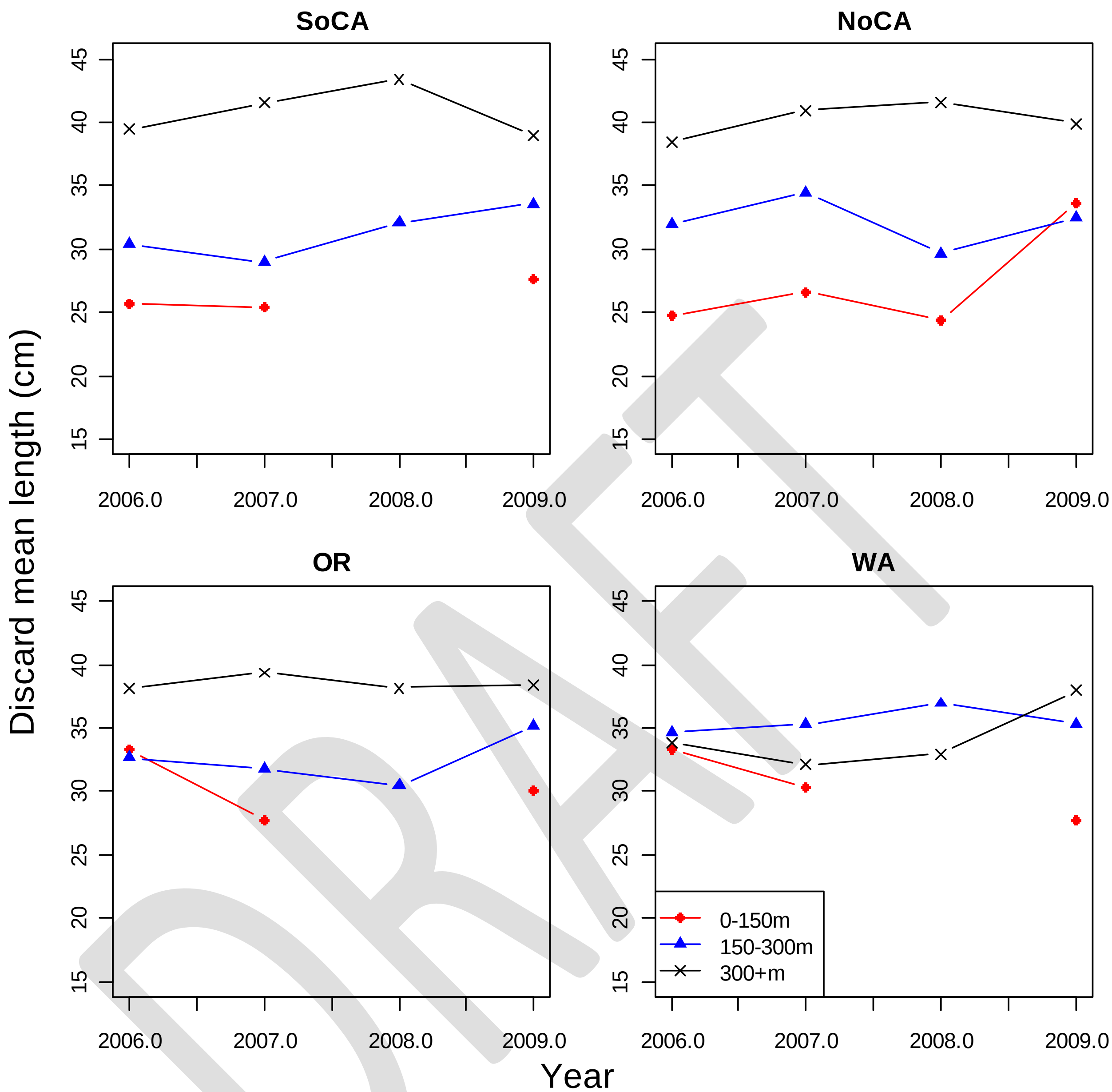


Figure 38: Catch weighted mean length of discards by area for three different depths.

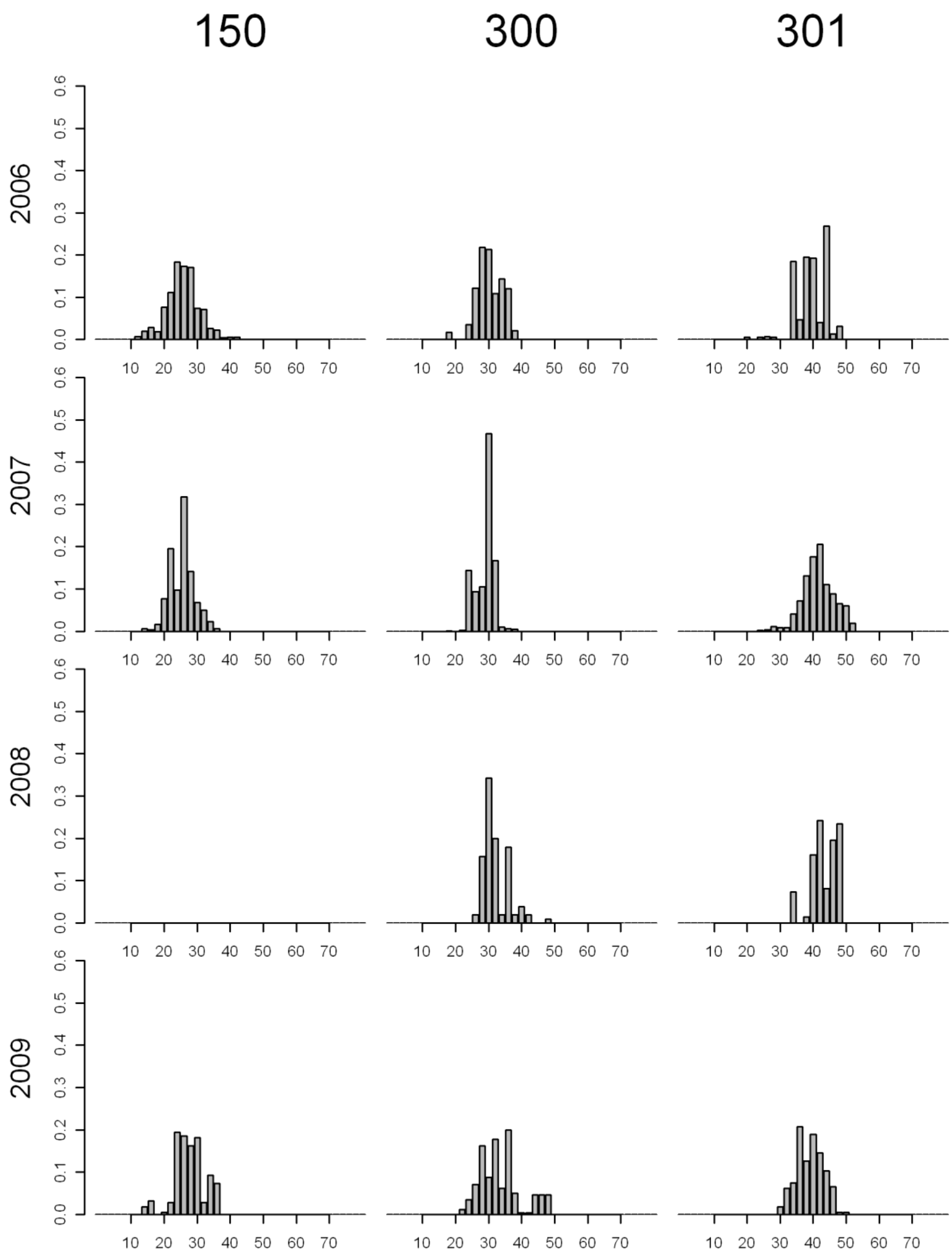


Figure 39. Weighted length frequencies of discards from Southern California by depth strata (columns) and years (rows).

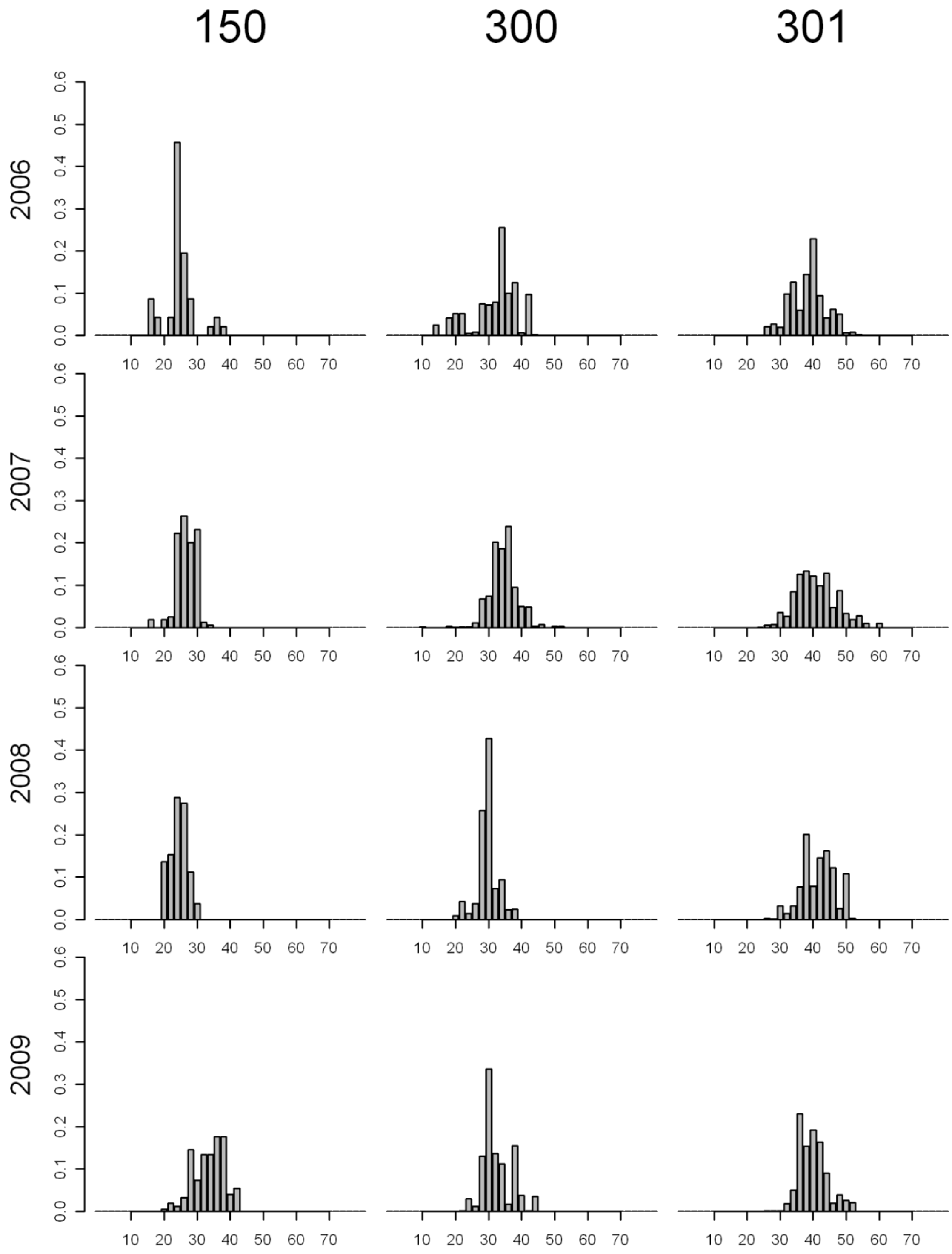


Figure 40. Weighted length frequencies of discards from Northern California by depth strata (columns) and years (rows).

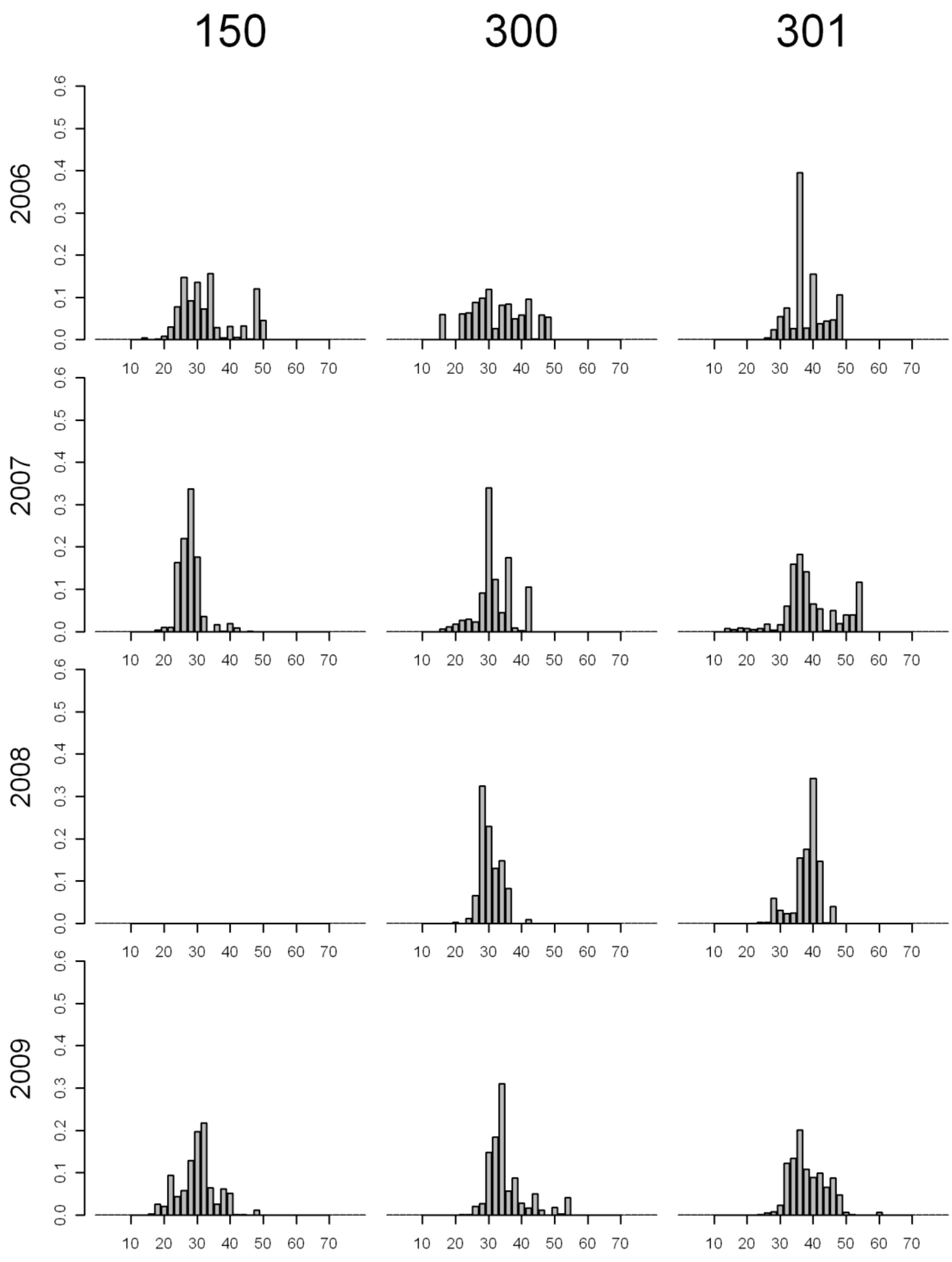


Figure 41. Weighted length frequencies of discards from Oregon by depth strata (columns) and years (rows).

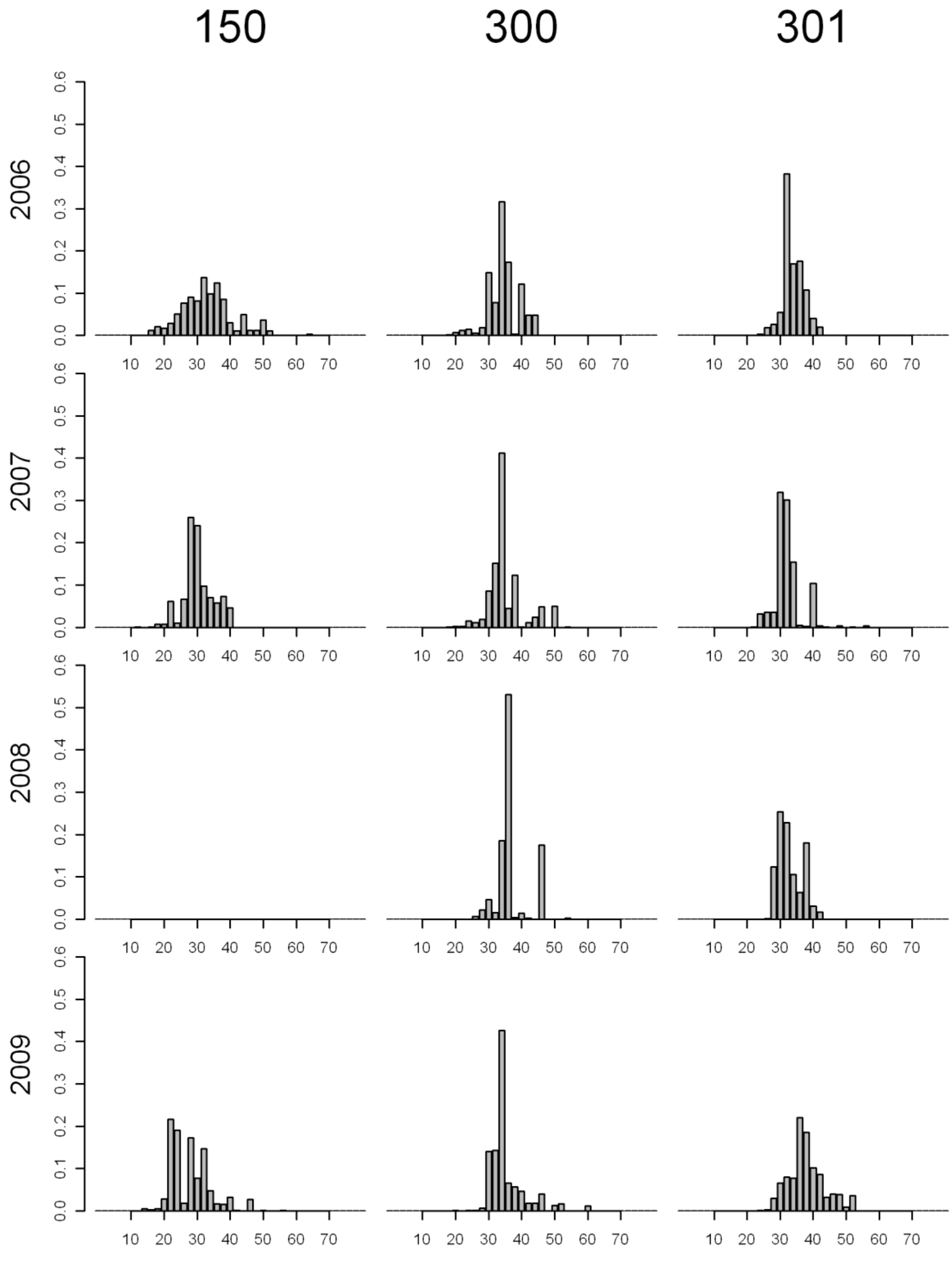


Figure 42. Weighted length frequencies of discards from Washington by depth strata (columns) and years (rows).

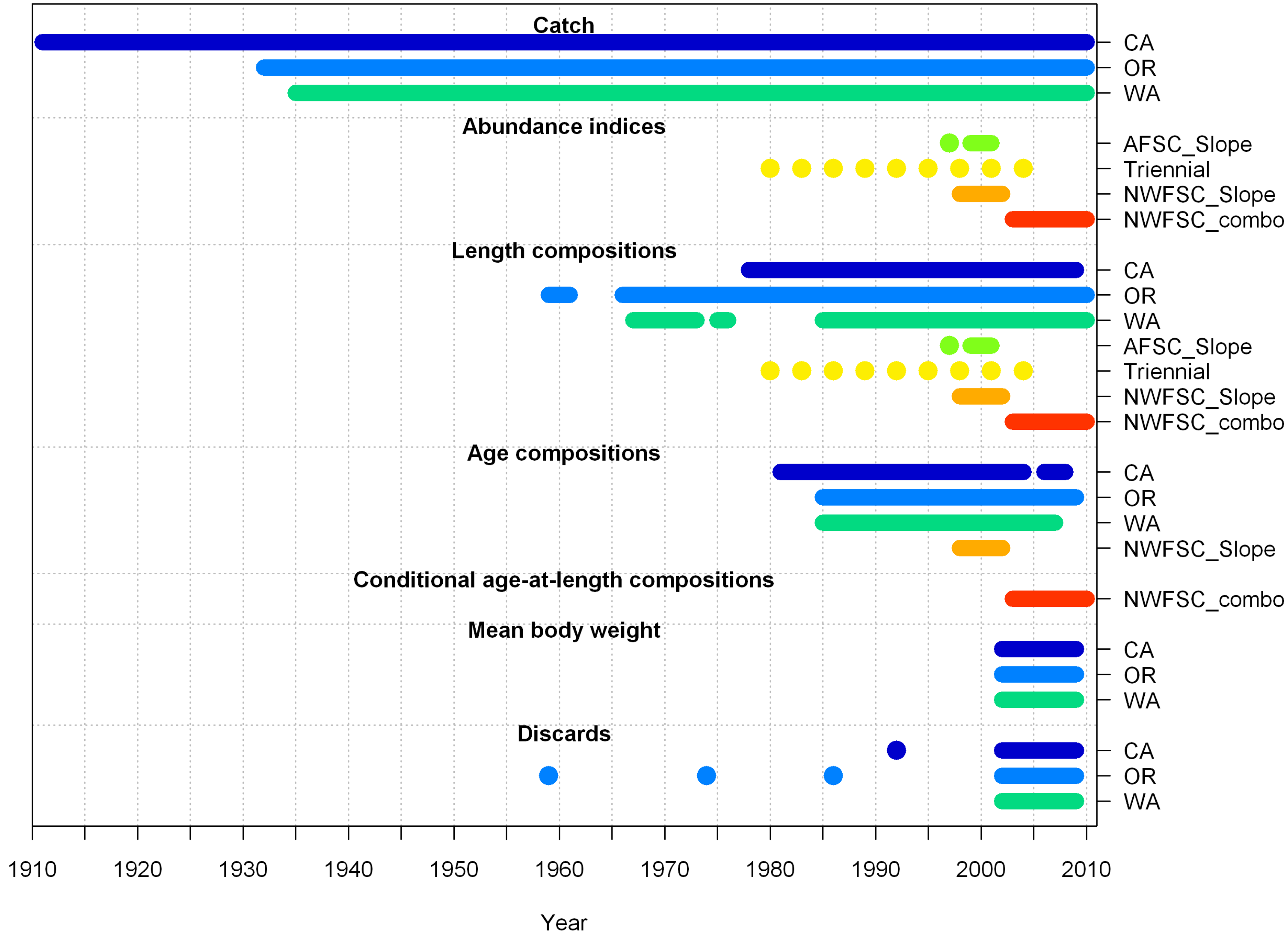


Figure 43. Summary of the years of catch data and the survey and fishery data fitted to in the model.

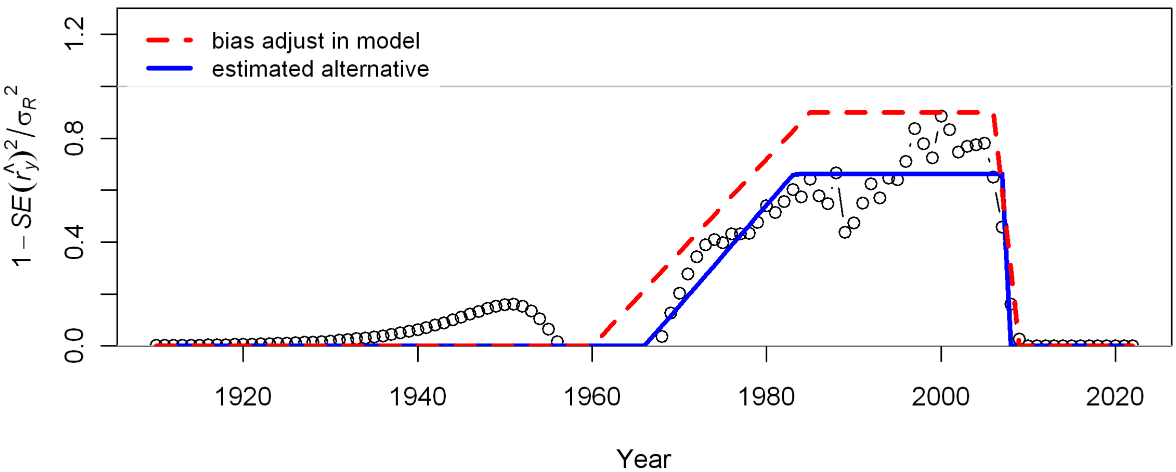


Figure 44. Bias adjustment ramping in the model for the recruitment deviate estimates.

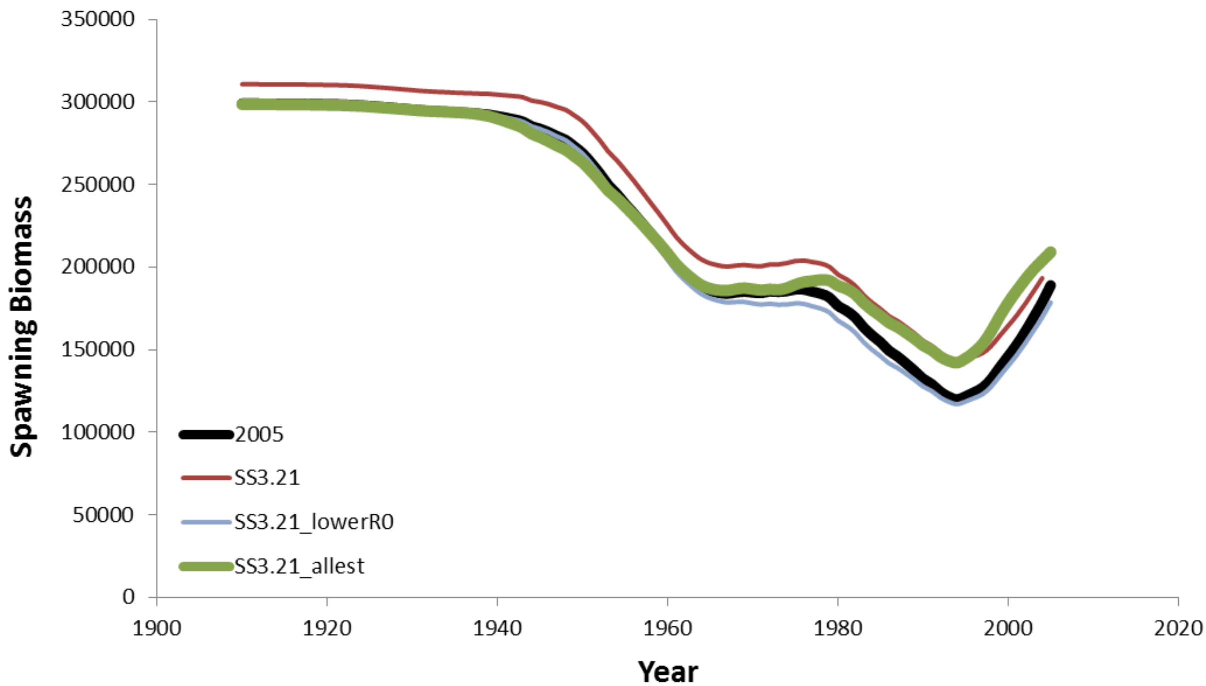


Figure 45. Estimates of spawning biomass from the 2005 assessment in black (*2005*), SSv3.21 with the same parameters as the 2005 assessment and kept fixed in red (*SS3.21*), SSv3.21 with a lower R0 to line up the start with the 2005 assessment in blue (*SS3.21_lowerR0*), and SS3.21a with the same parameters estimated that were estimated in the 2005 assessment in green (*SS3.21_allest*).

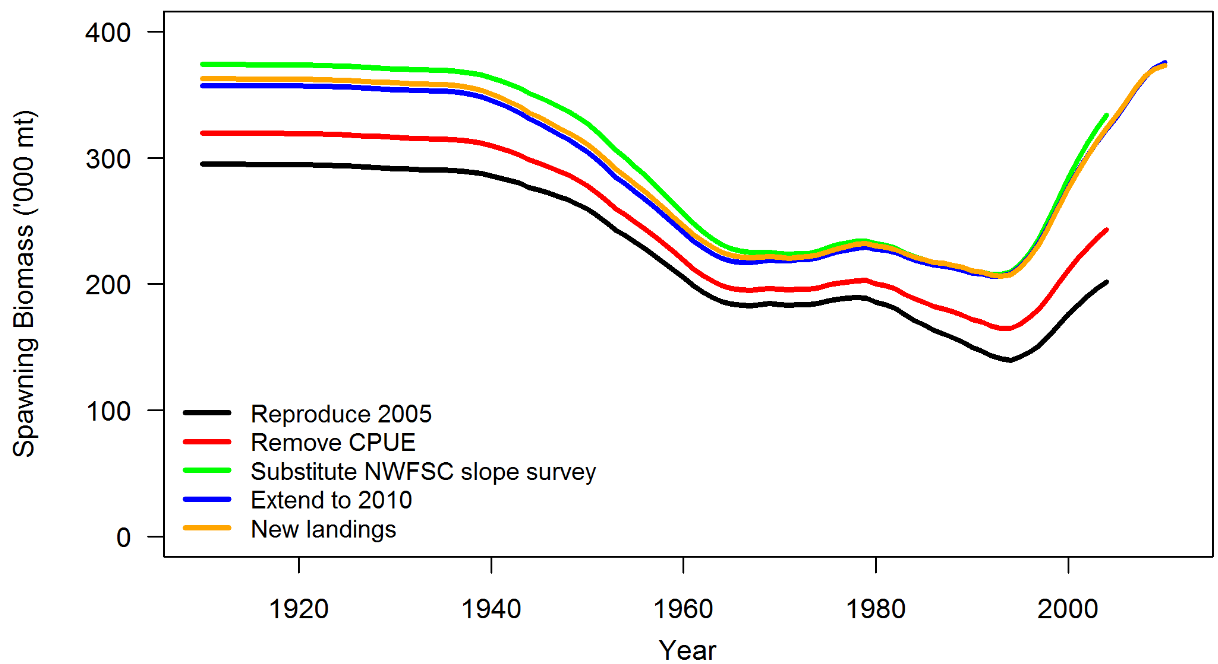


Figure 46. Estimated spawning biomass from models transitioning from the reproduced 2005 assessment in SSv3.21 (*Reproduce 2005*) to extending the model with new landings and adding recent survey data (*New landings*). The intermediate models build sequentially from the reproduced 2005 assessment by removing the CPUE series (*Remove CPUE*), adding in the NWFSC shelf/slope survey and removing the 1992 and 1996 AFSC survey values (*Substitue NWFSC slope survey*), and then extending the model to 2010 with recent catches, the entire NWFSC shelf/slope survey series, and length frequencies from the NWFSC shelf/slope survey (*Extend to 2010*). Note: the "New landings" contained a small error and were slightly different than the landings used in the base case model. However, the results should not be noticeably different.

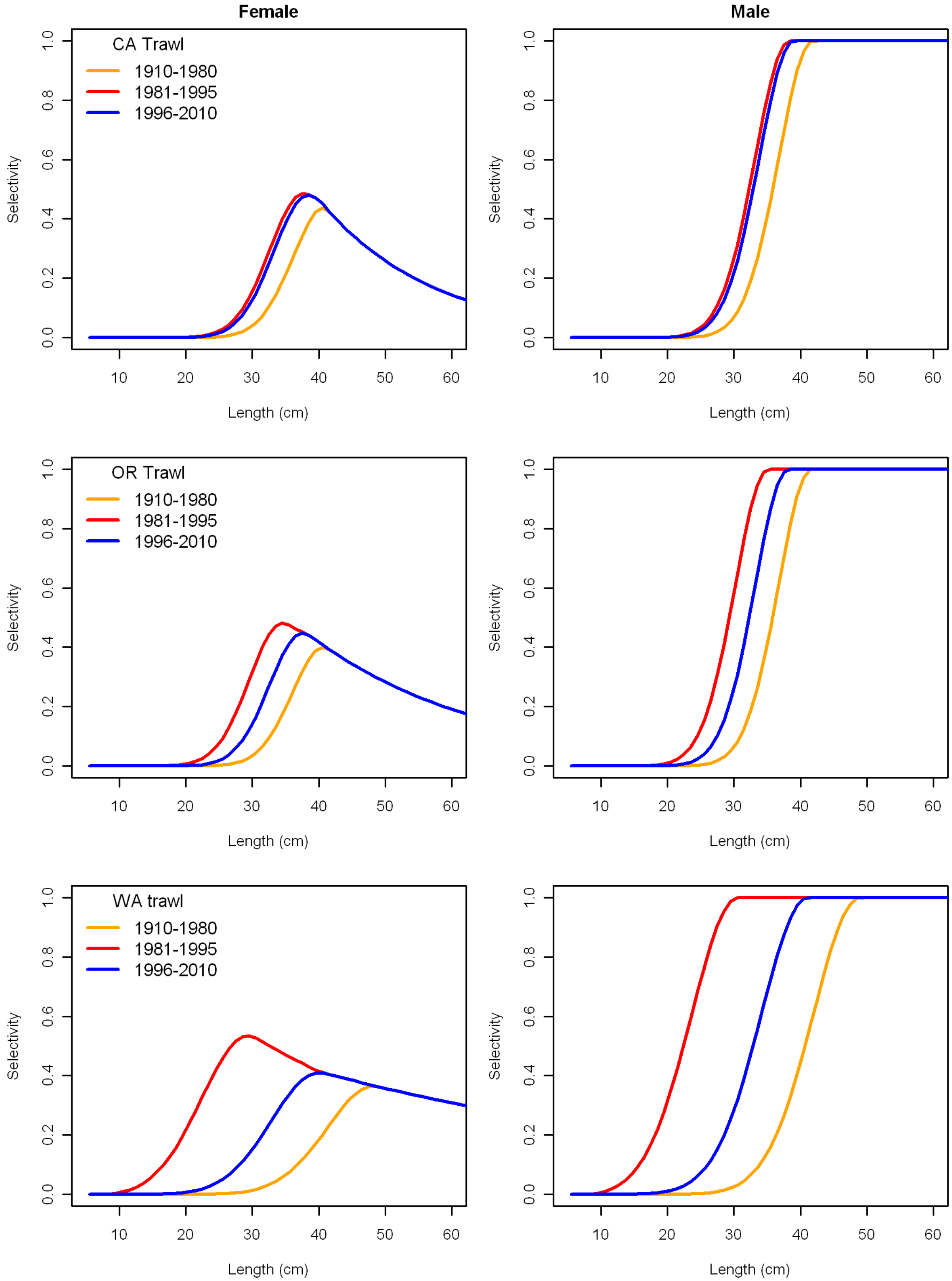


Figure 47. Estimated selectivity curves for the three fleets (CA at the top, OR in the middle, and WA at the bottom) with time blocks changes.

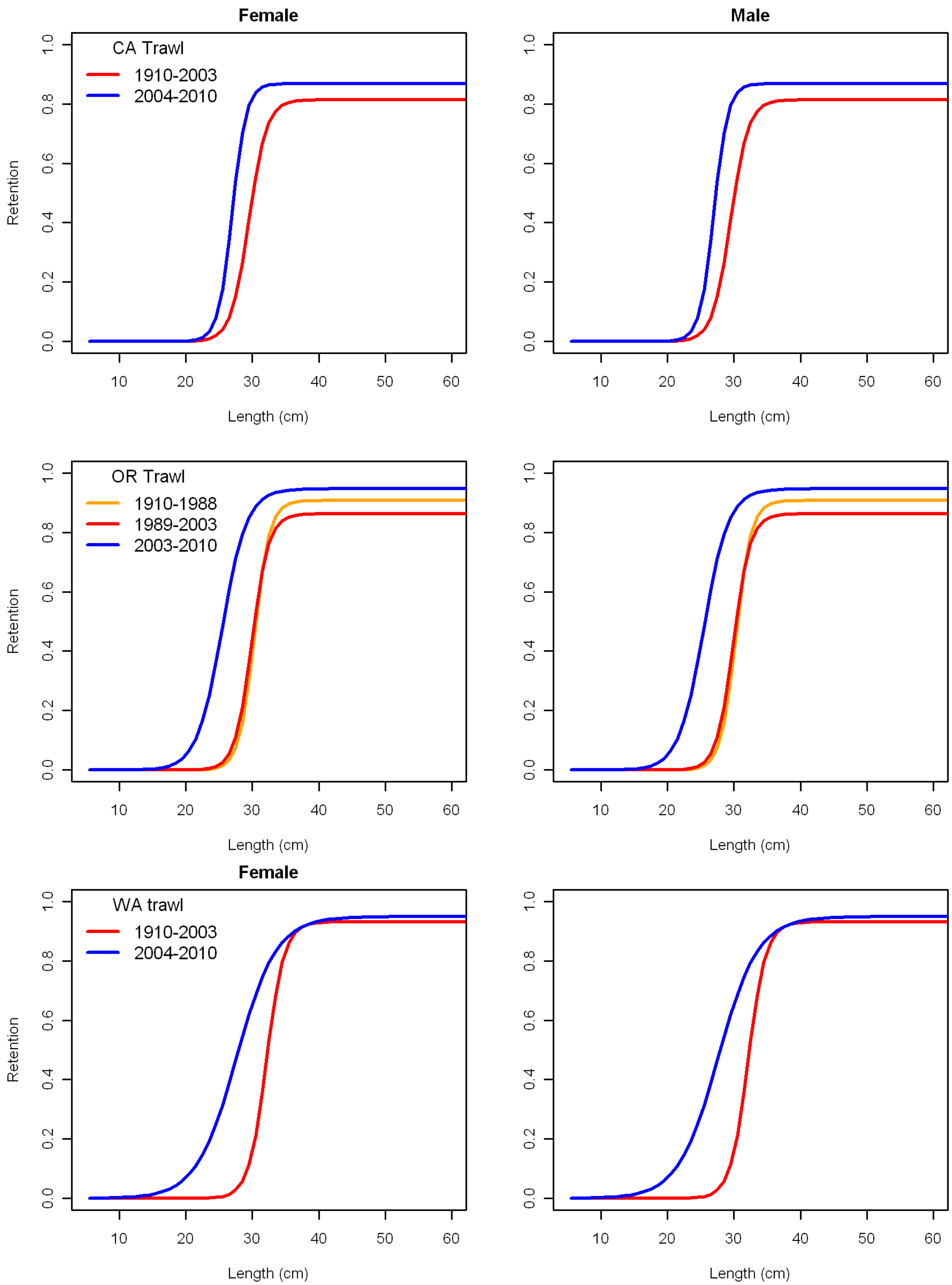


Figure 48. Estimated retention curves for the three fleets (CA at the top, OR in the middle, and WA at the bottom) with time blocks changes.

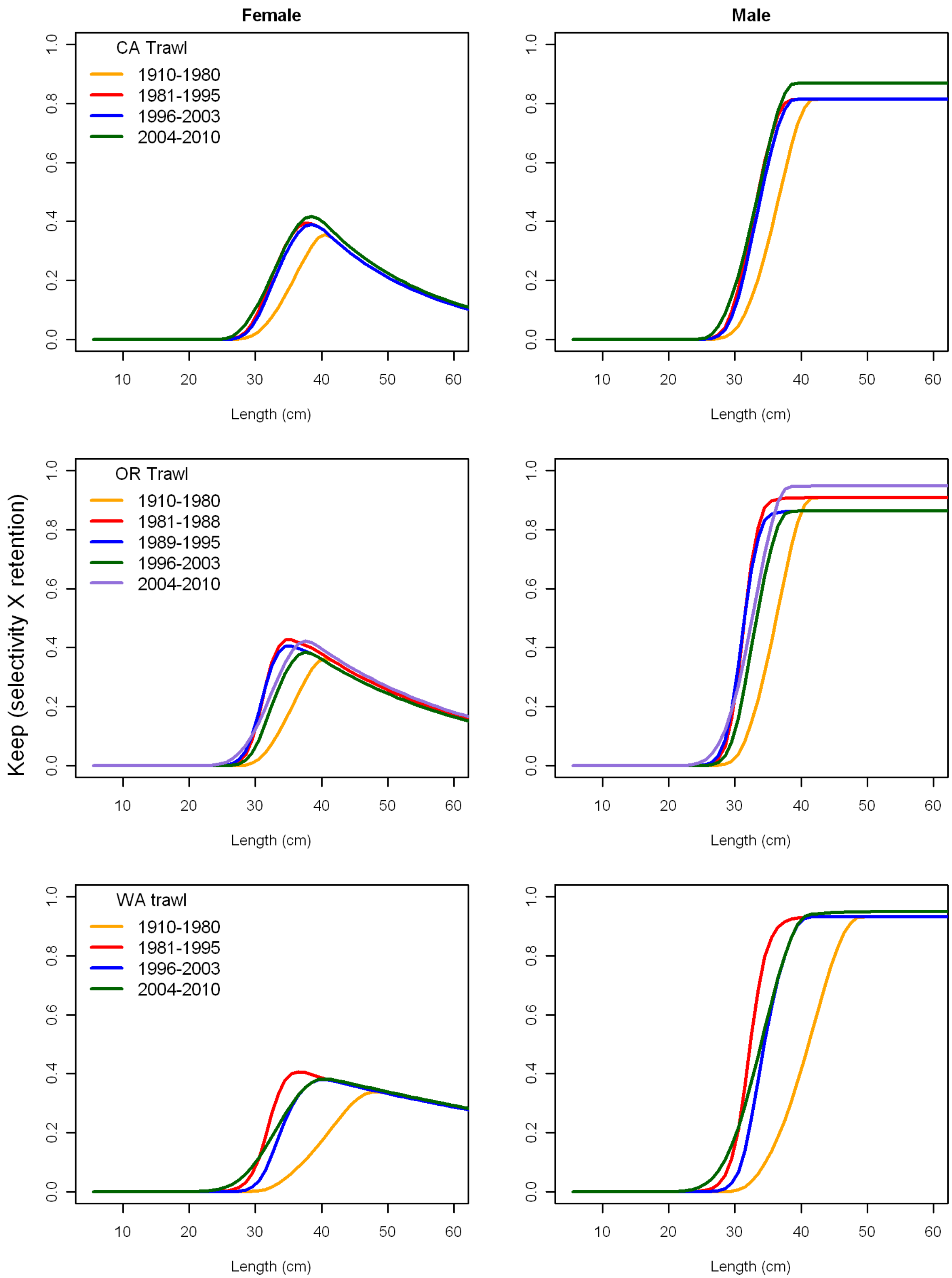


Figure 49. Estimated keep curves (the product of selectivity and retention) for the three fleets (CA at the top, OR in the middle, and WA at the bottom) with time blocks changes.

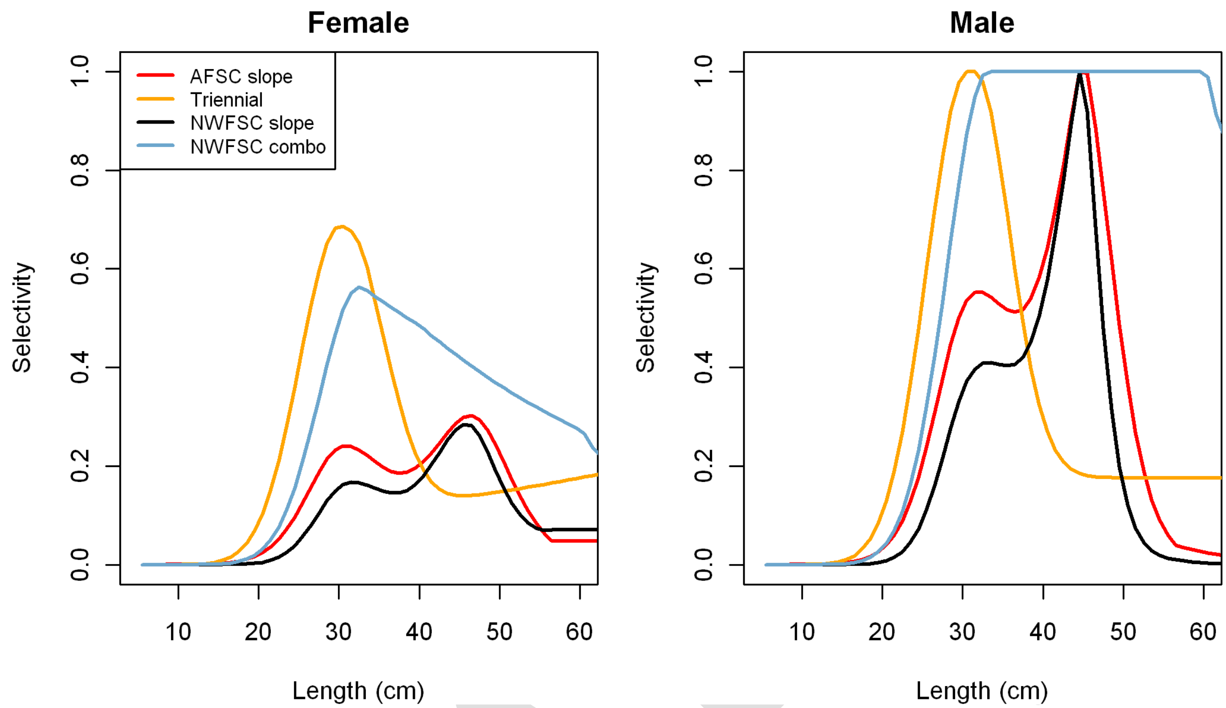


Figure 50. Estimated survey selectivity curves for females (left) and males (right).

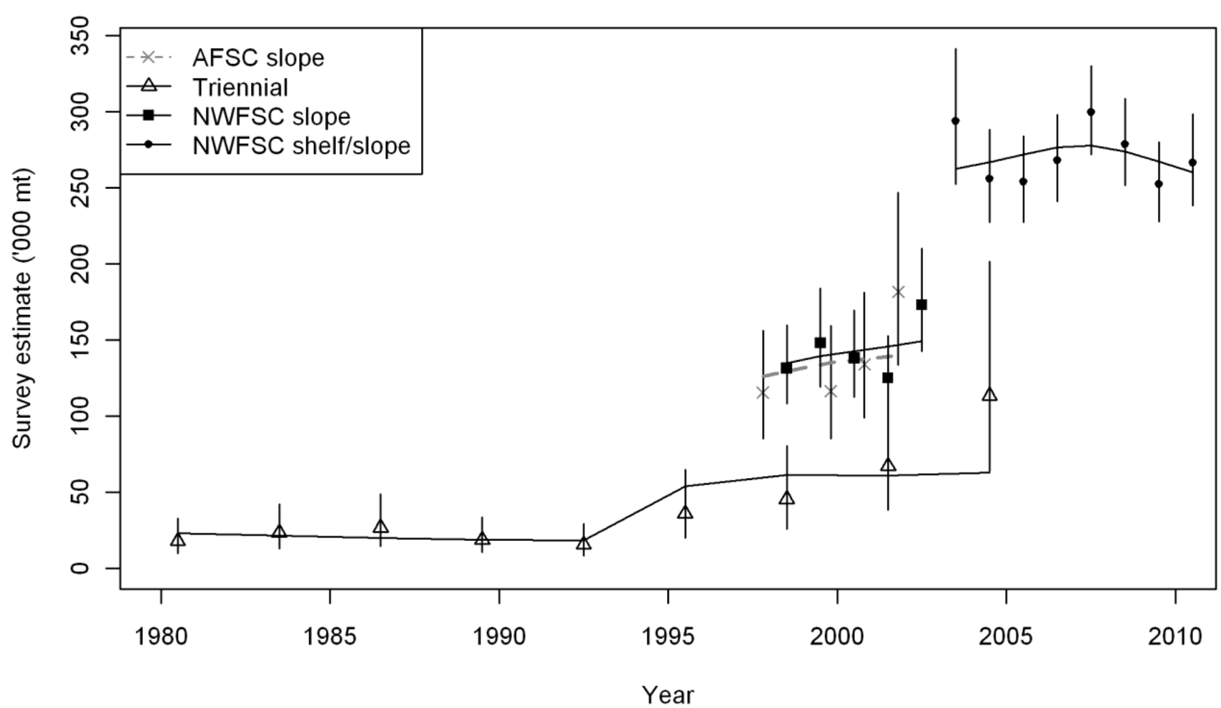


Figure 51. Fits to the survey abundance estimates for the base case model.

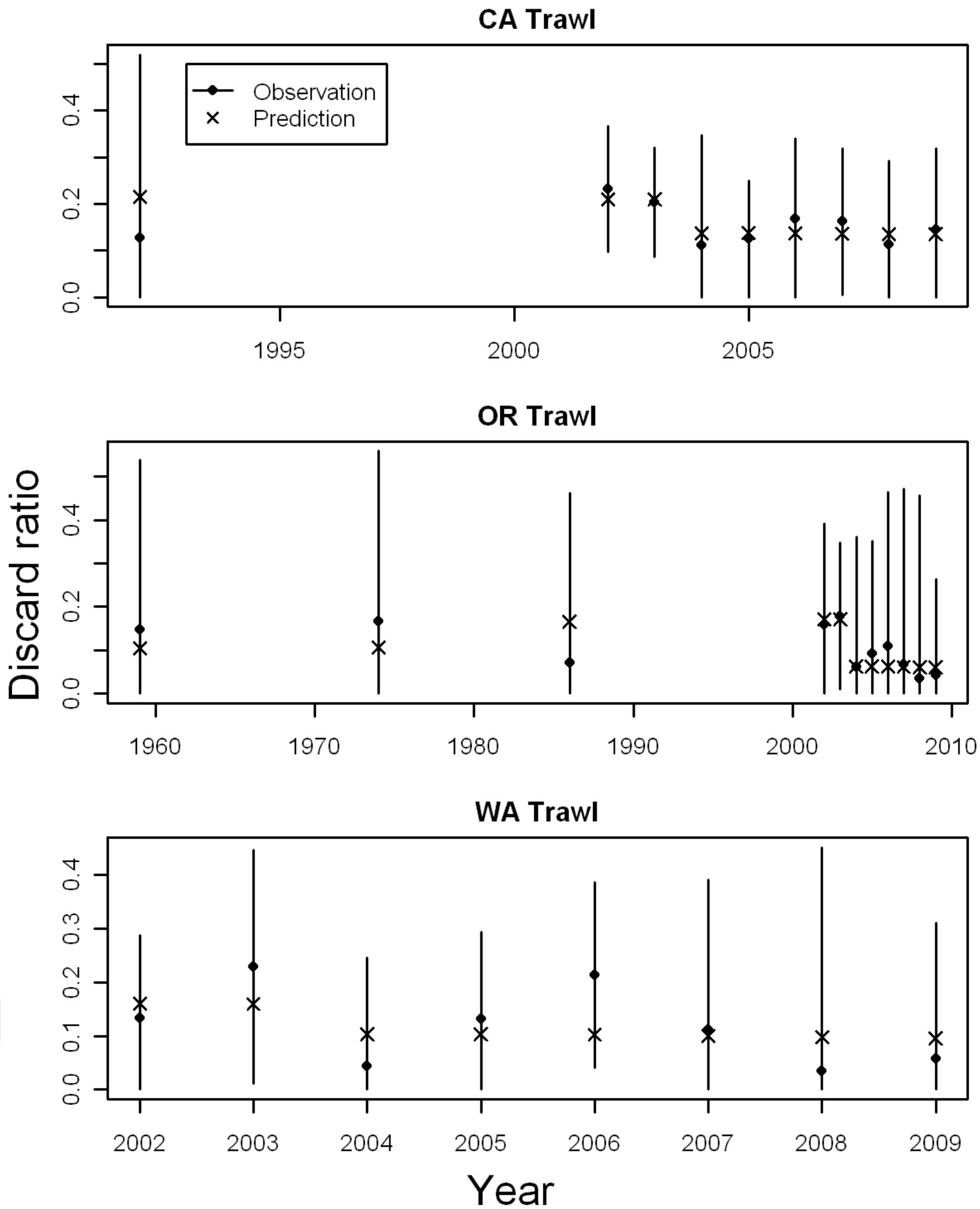


Figure 52. Predicted and observed discard ratios from the Dover sole base model. Note that the x-axis for each fleet is on a different scale due to different data sources.

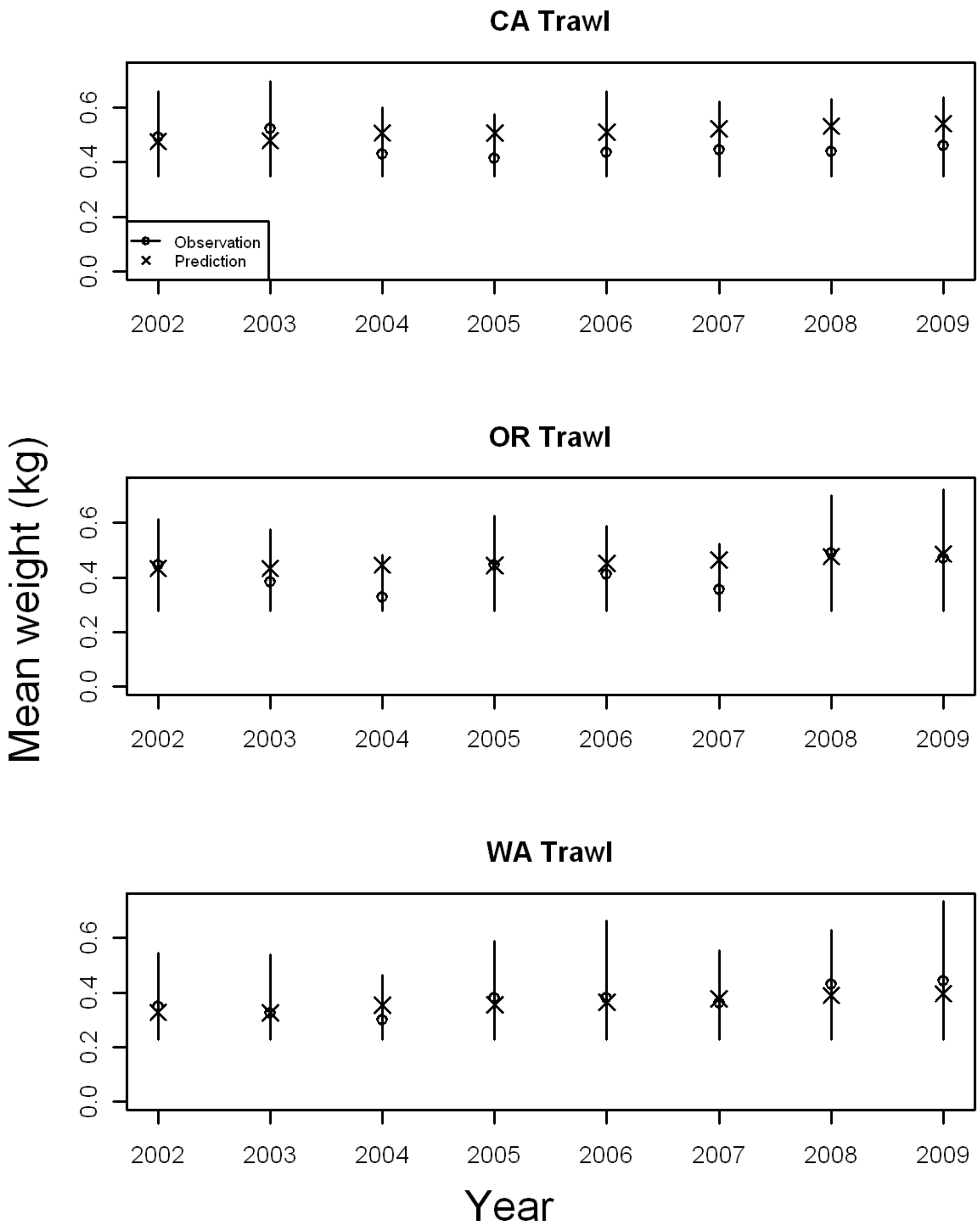
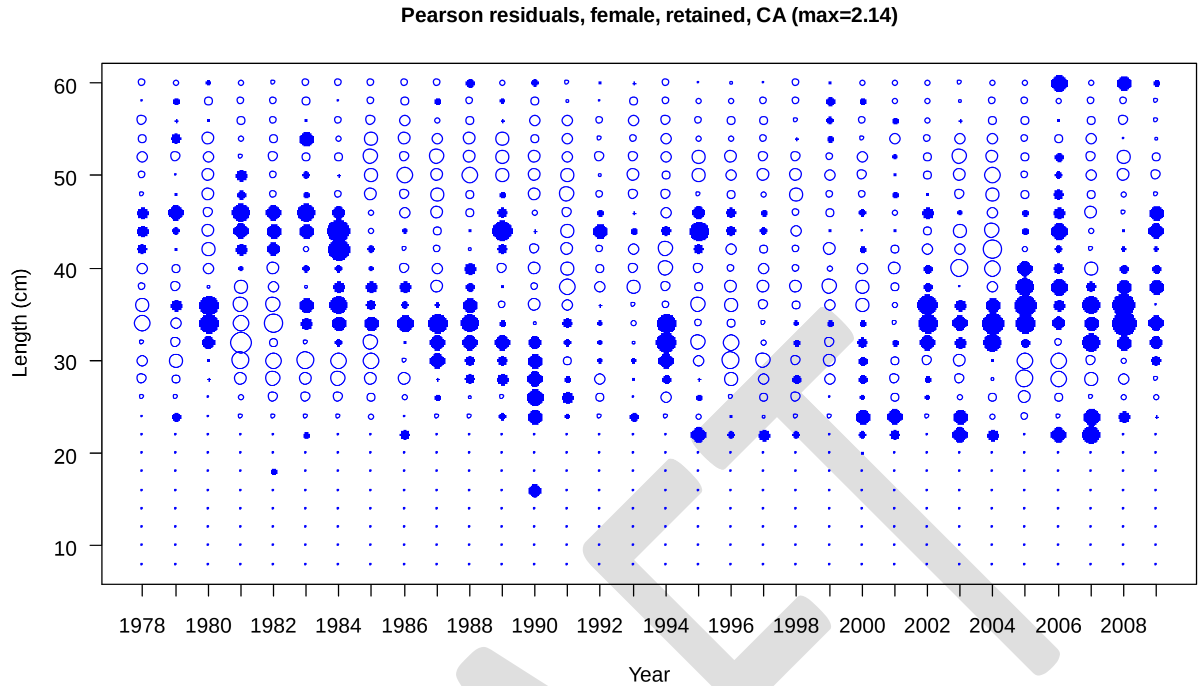


Figure 53. Fits to the mean weight of the discards for each fleet from the base case model.



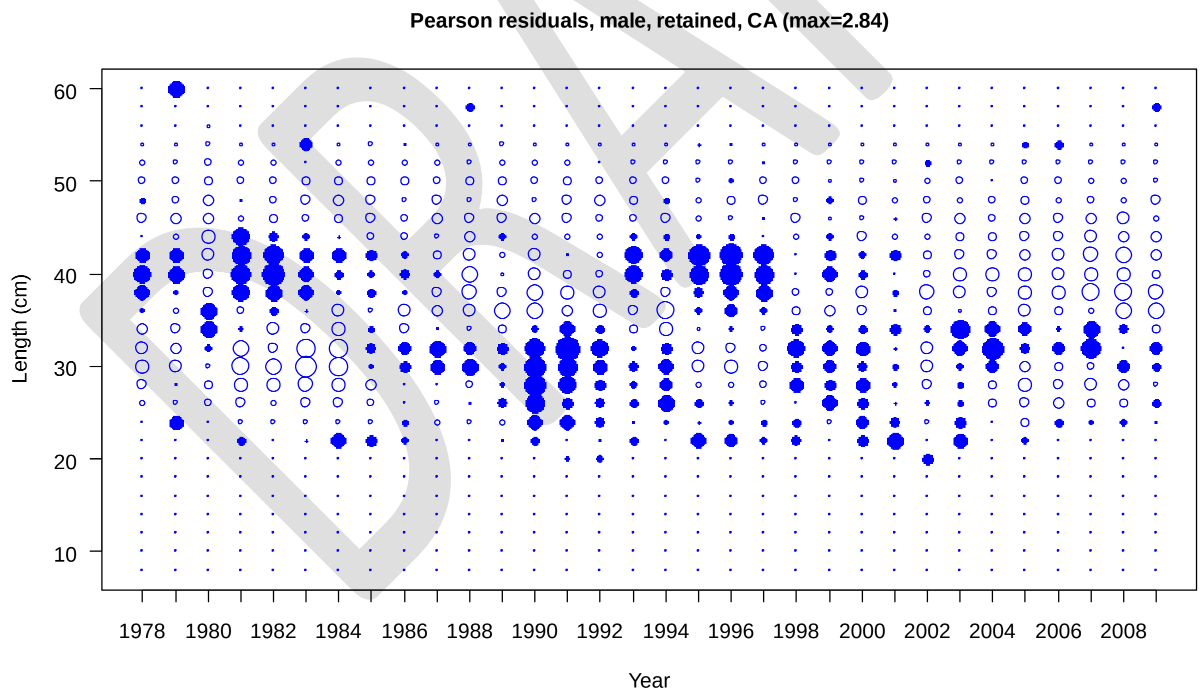


Figure 54. Fits to the retained length composition data for the California fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

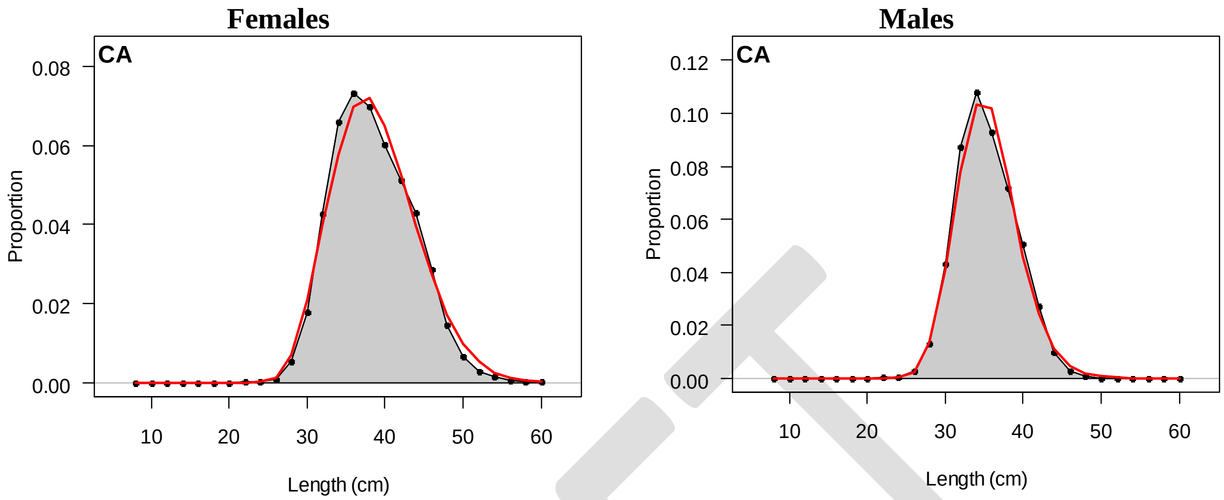


Figure 55. Fits to the retained length frequencies aggregated over all years for the CA fleet. The filled distribution represents the observations and the line represents the model predictions.

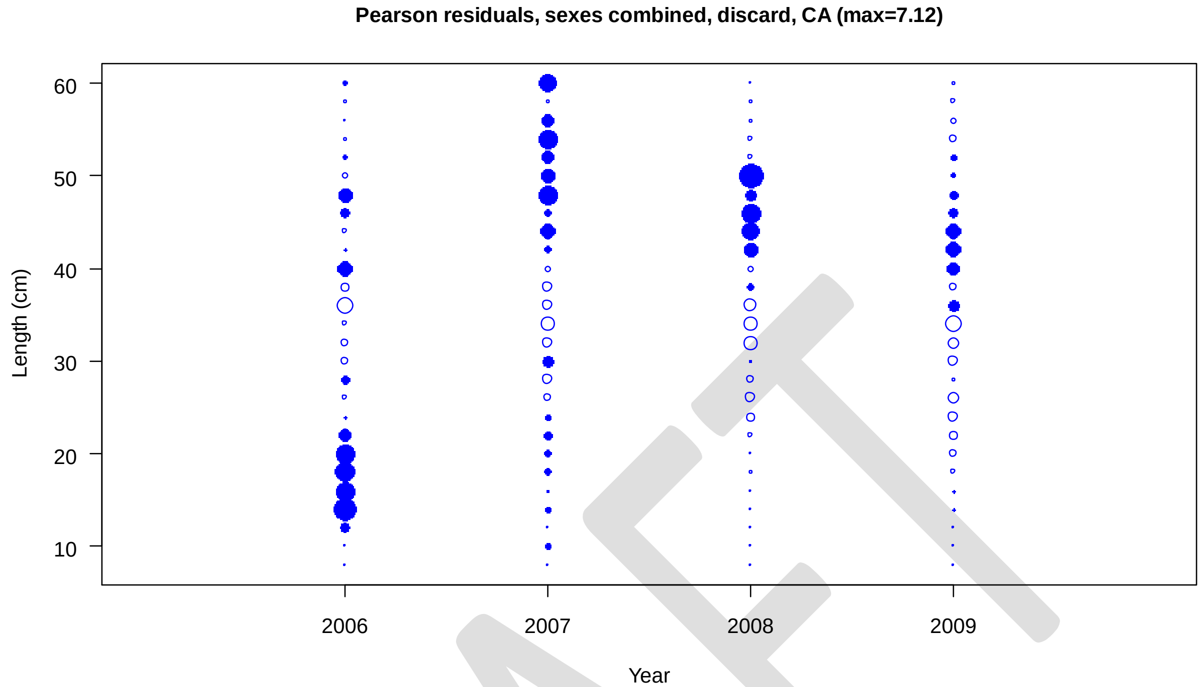


Figure 56. Fits to the discard length composition data for the California fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

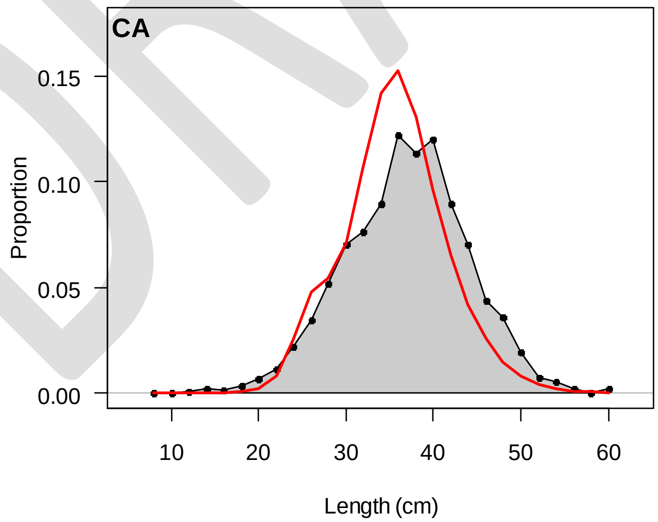
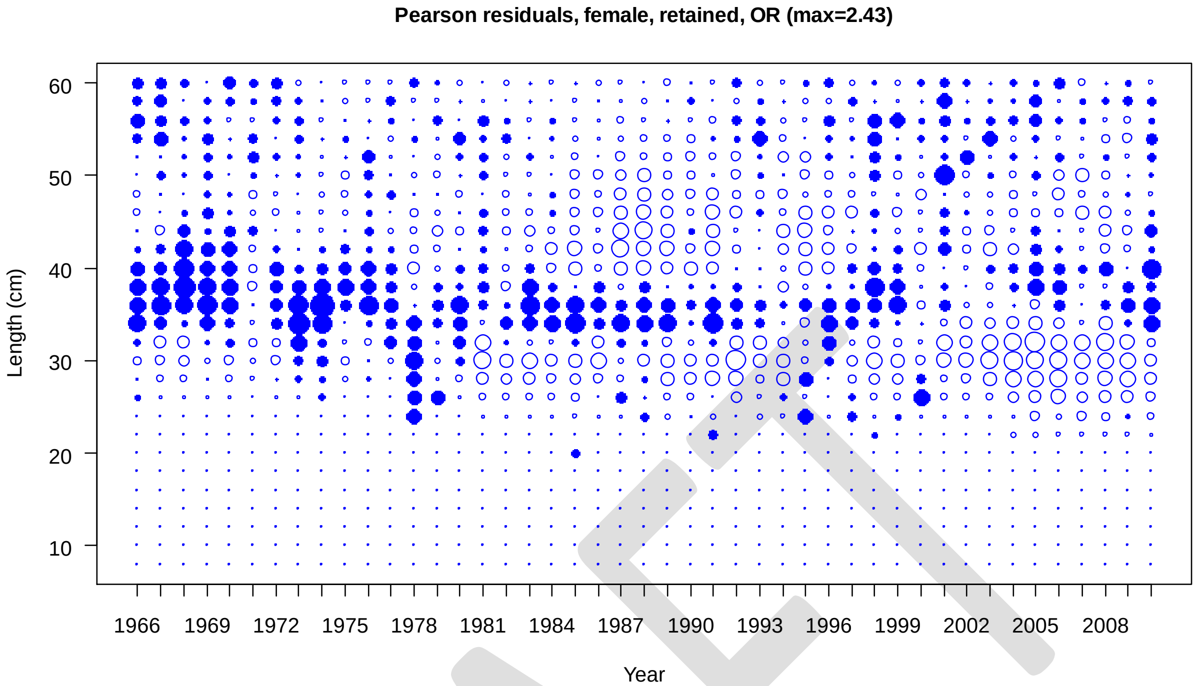


Figure 57. Fits to the discard length frequencies aggregated over all years for the CA fleet. The filled distribution represents the observations and the line represents the model predictions.



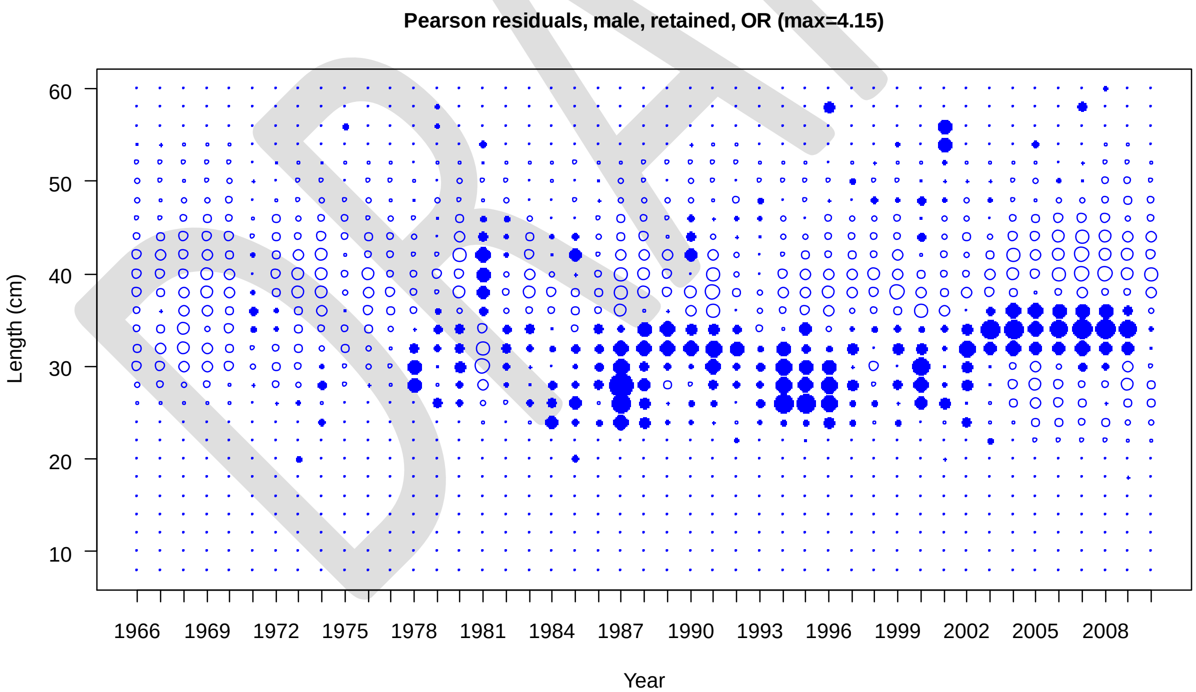


Figure 58. Fits to the retained length composition data for the Oregon fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

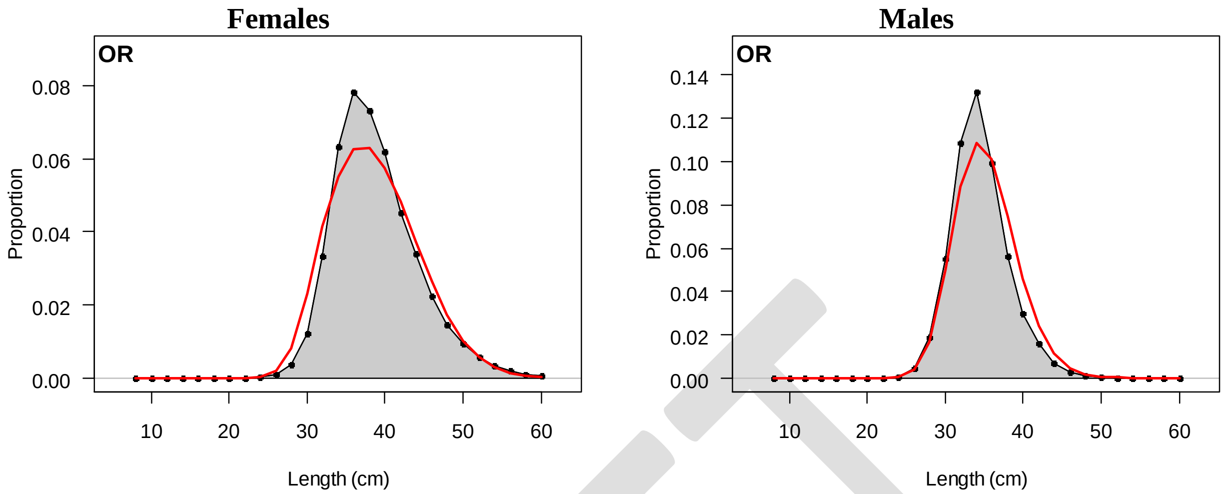


Figure 59. Fits to the retained length frequencies aggregated over all years for the OR fleet. The filled distribution represents the observations and the line represents the model predictions.

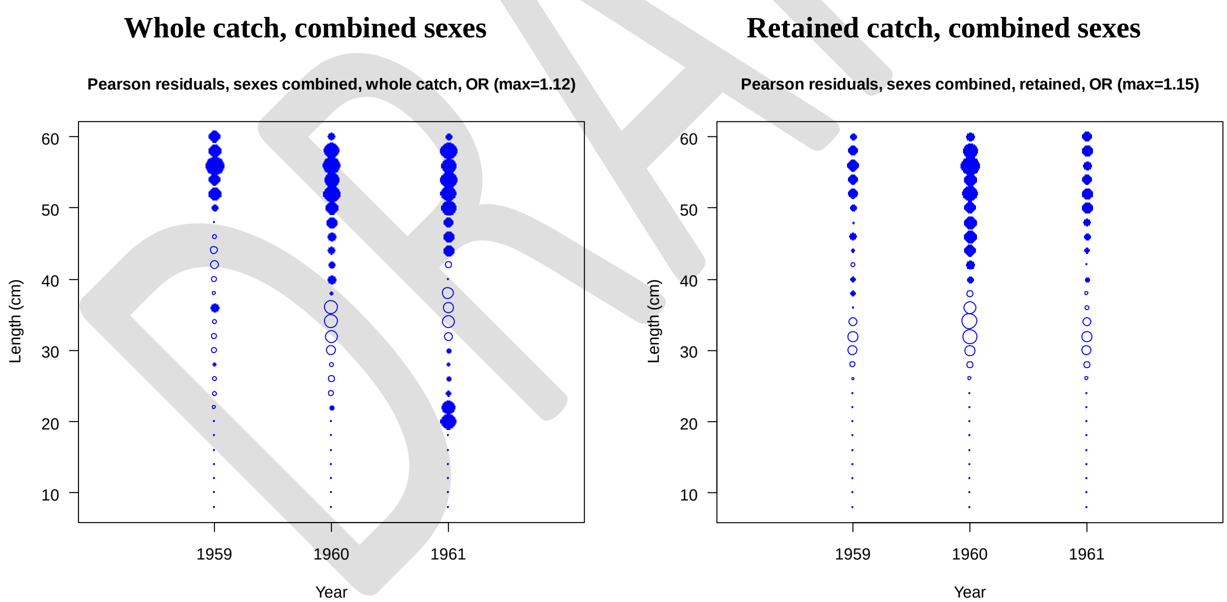


Figure 60. Fits to the length composition data collected in 1959-1960 as part of the 1959–1961 study for the Oregon fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

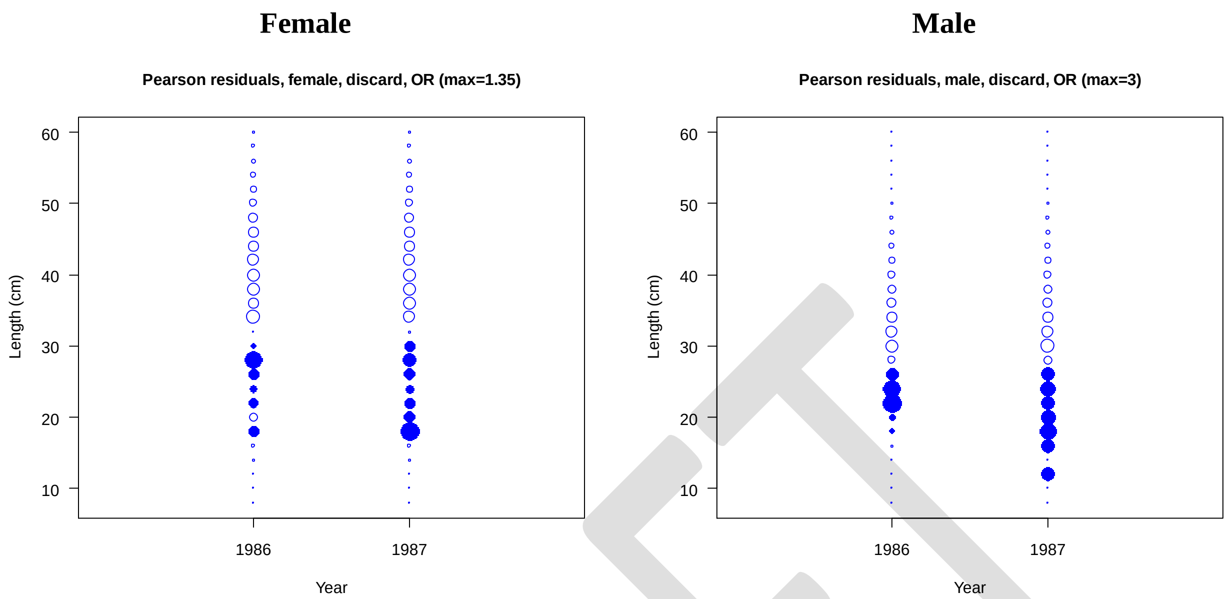


Figure 61. Fits to the Pikitch discard length composition data for the Oregon fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

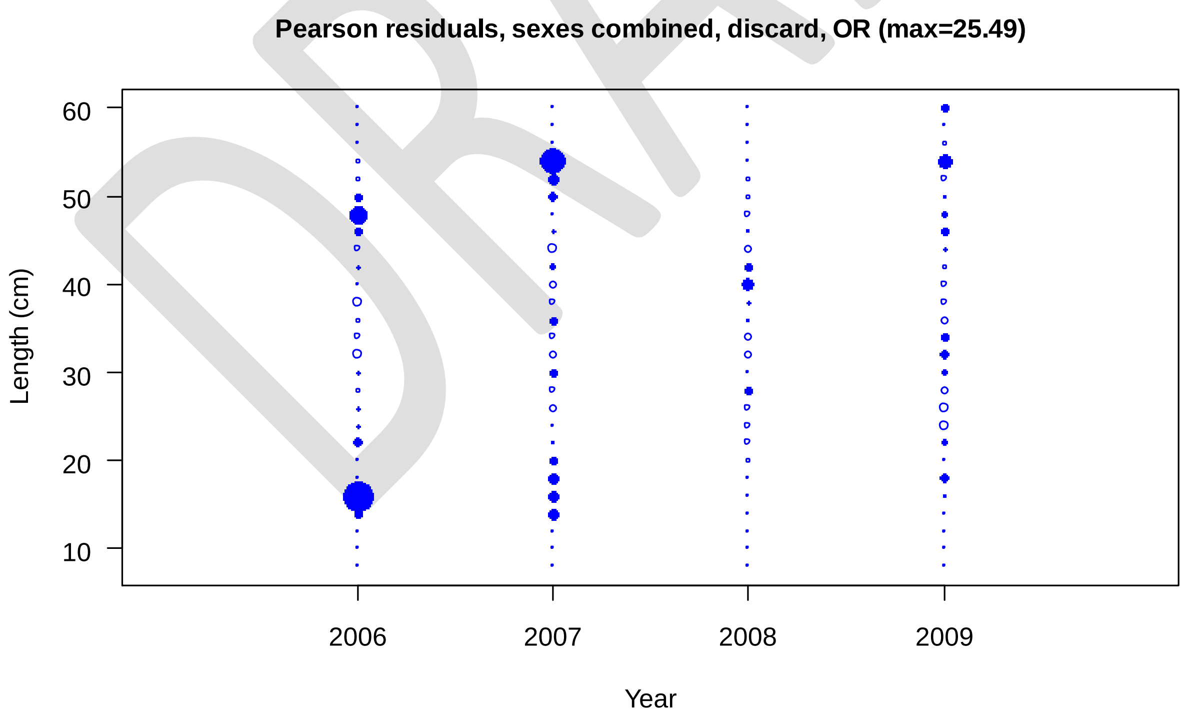


Figure 62. Fits to the discard length composition data collected by the WCGOP for the Oregon fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

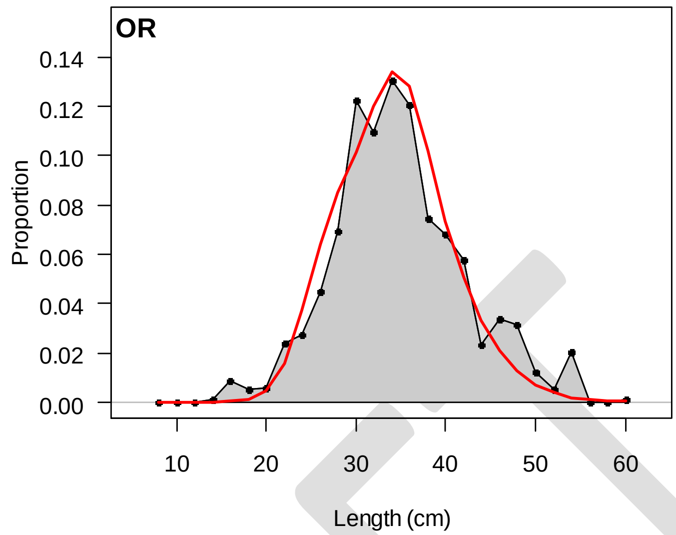


Figure 63. Fits to the sex combined discard length frequencies collected by the WCGOP aggregated over all years (2006-2009) for the OR fleet. The filled distribution represents the observations and the line represents the model predictions.

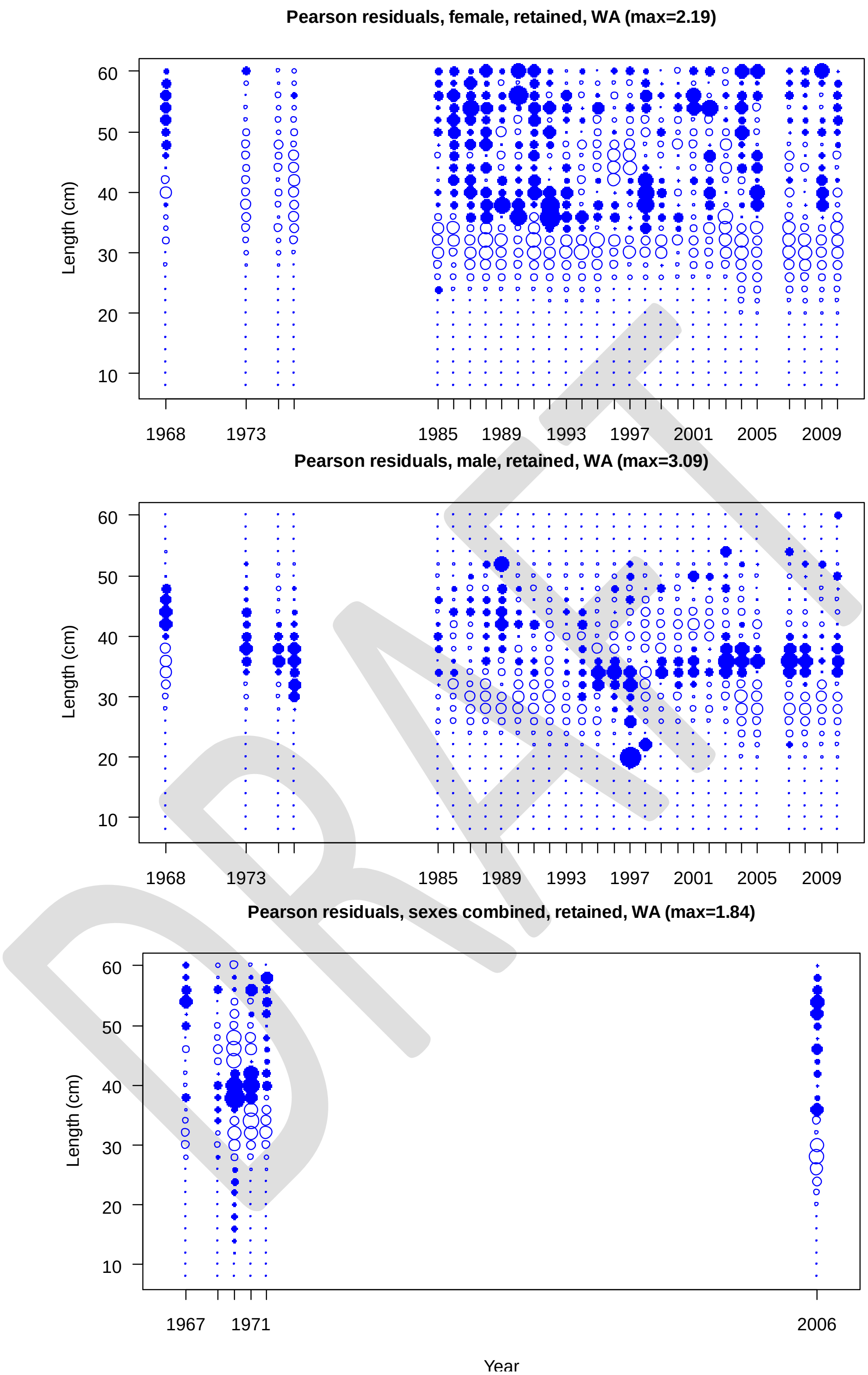


Figure 64. Fits to the retained length composition data for the Washington fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

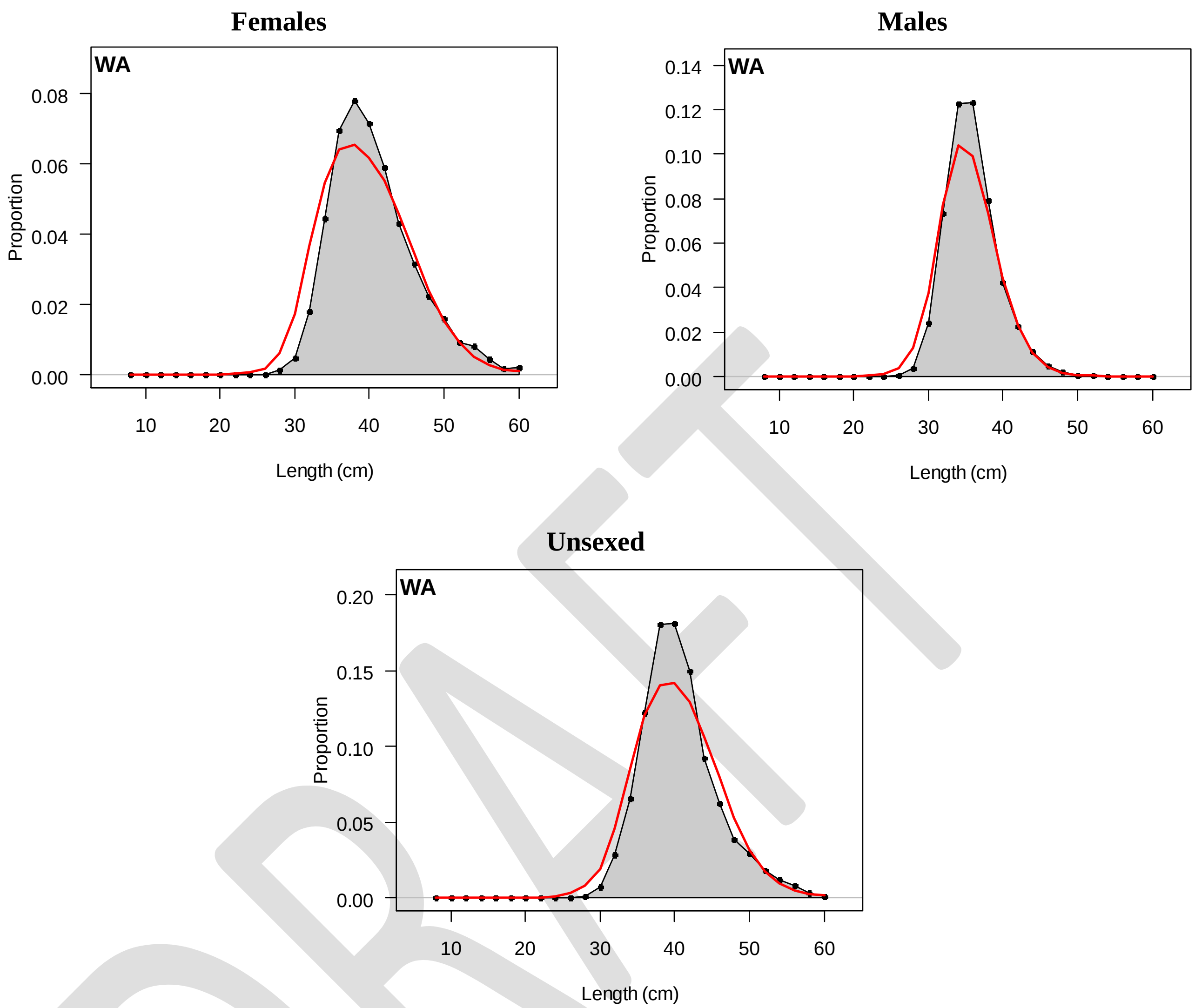


Figure 65. Fits to the retained length frequencies aggregated over all years for the WA fleet. The filled distribution represents the observations and the line represents the model predictions.

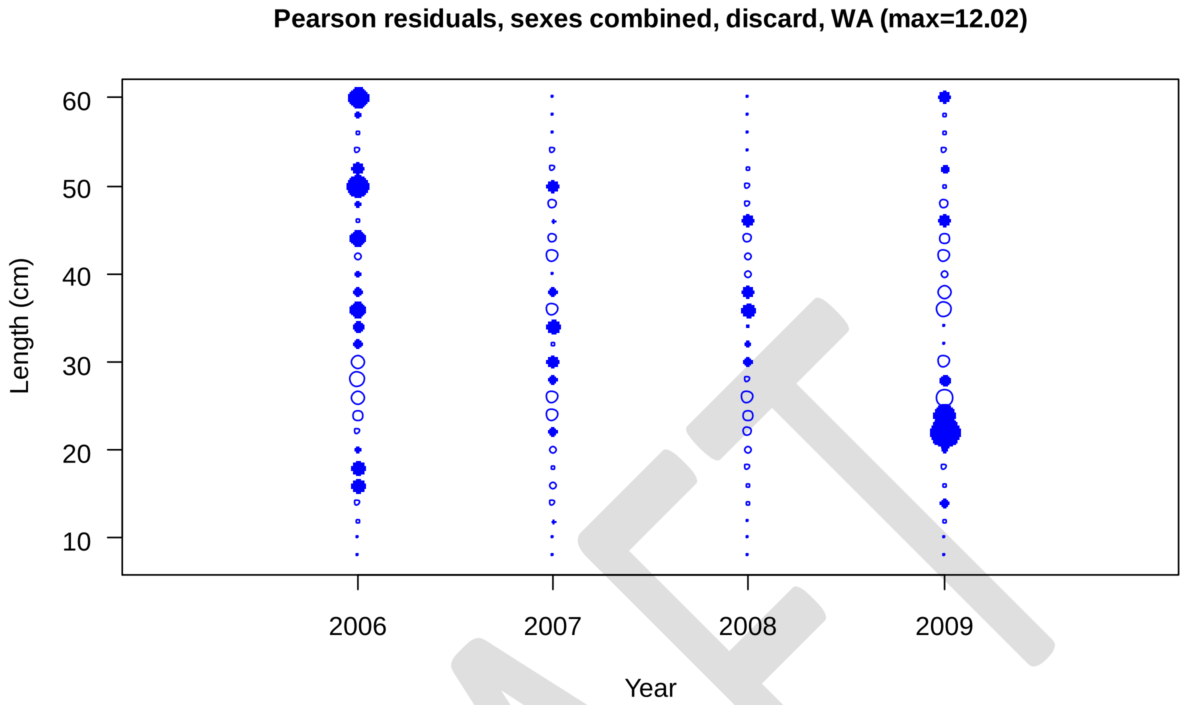


Figure 66. Fits to the discard length composition data collected by the WCGOP for the Washington fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

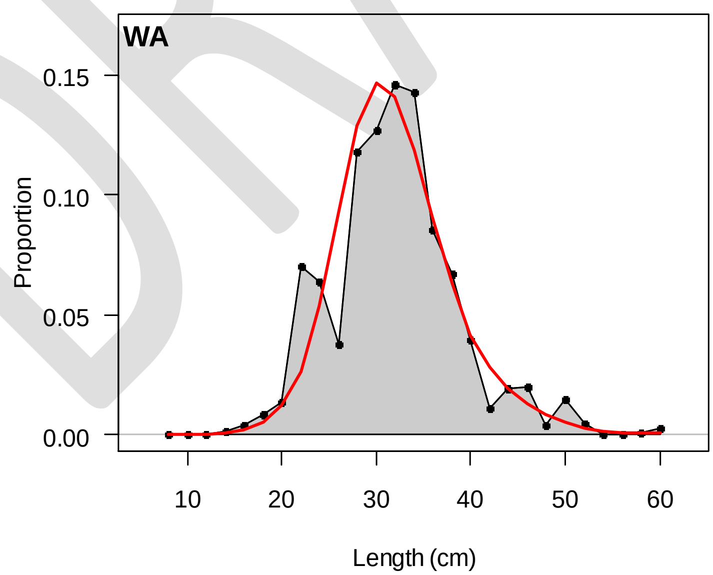


Figure 67. Fits to the sex combined discard length frequencies collected by the WCGOP aggregated over all years (2006-2009) for the WA fleet. The filled distribution represents the observations and the line represents the model predictions.

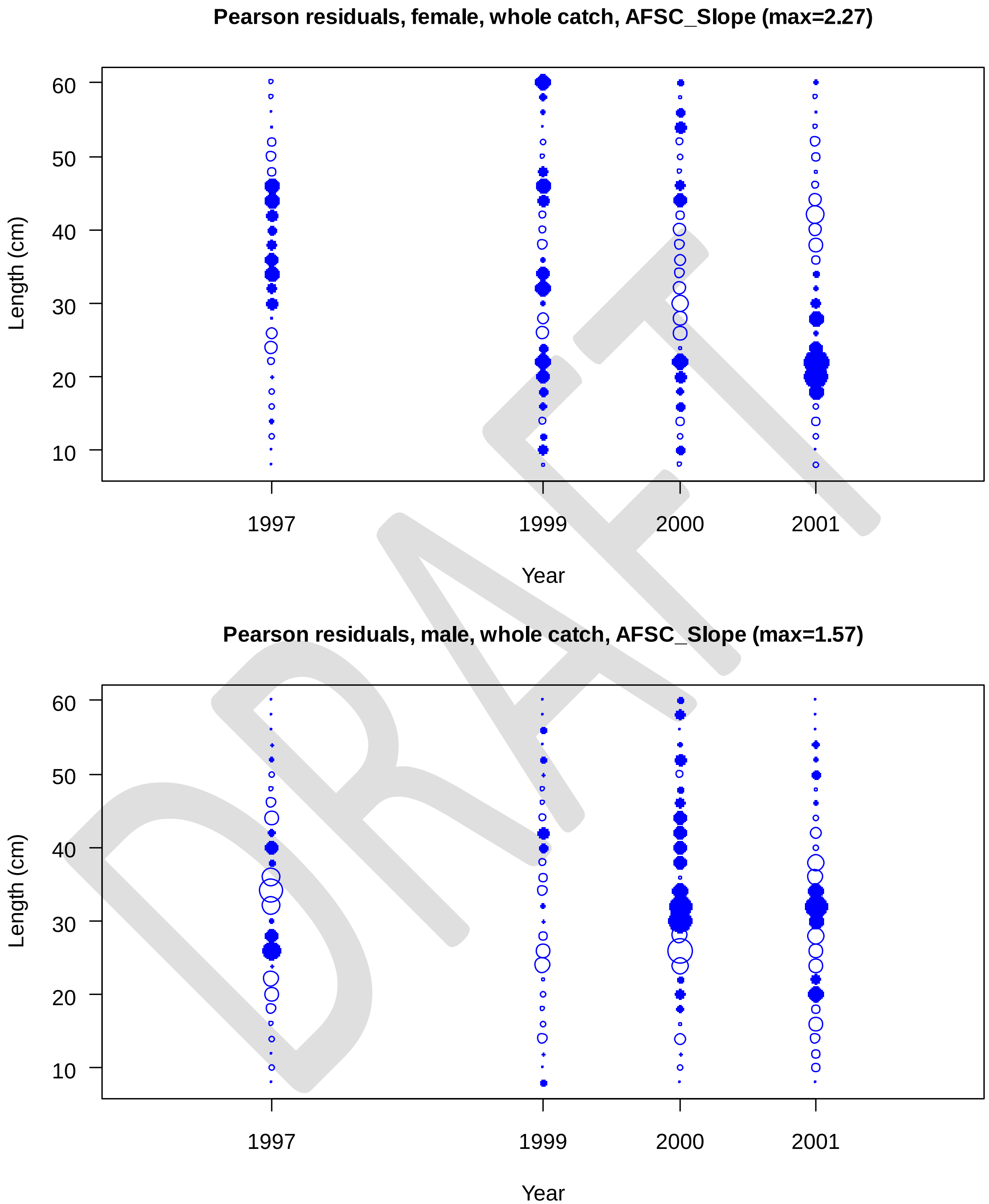


Figure 68. Fits to the retained length composition data for the AFSC slope survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

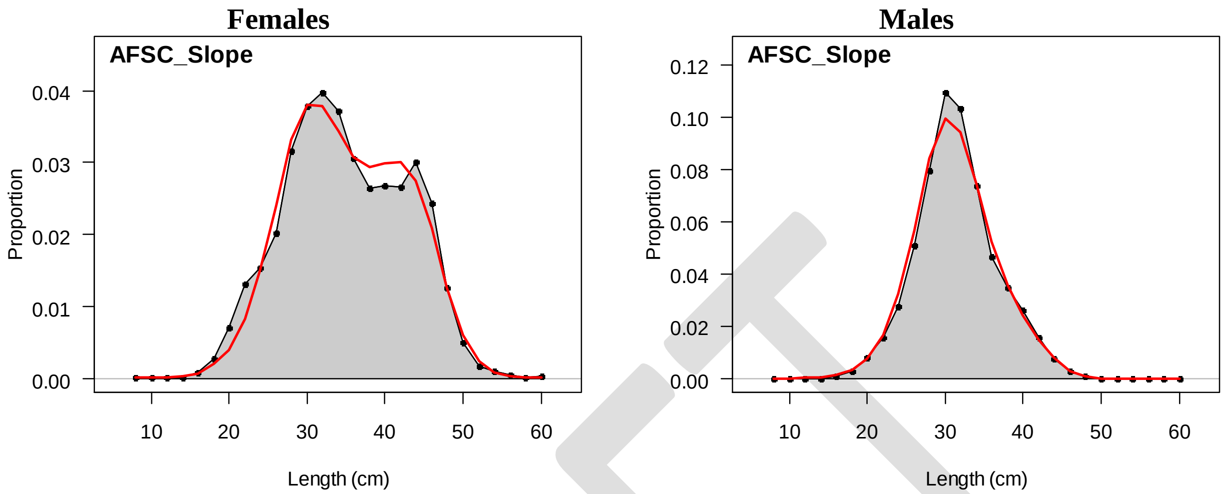
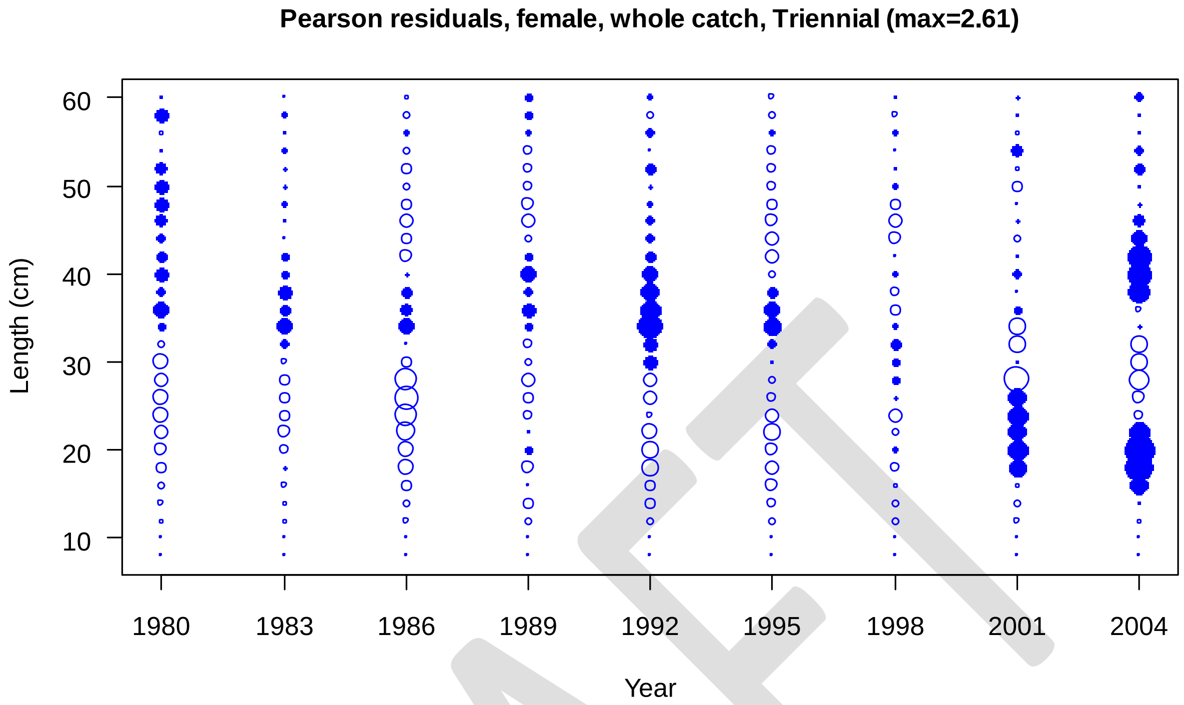


Figure 69. Fits to the retained length frequencies aggregated over all years for the AFSC slope. The filled distribution represents the observations and the line represents the model predictions.



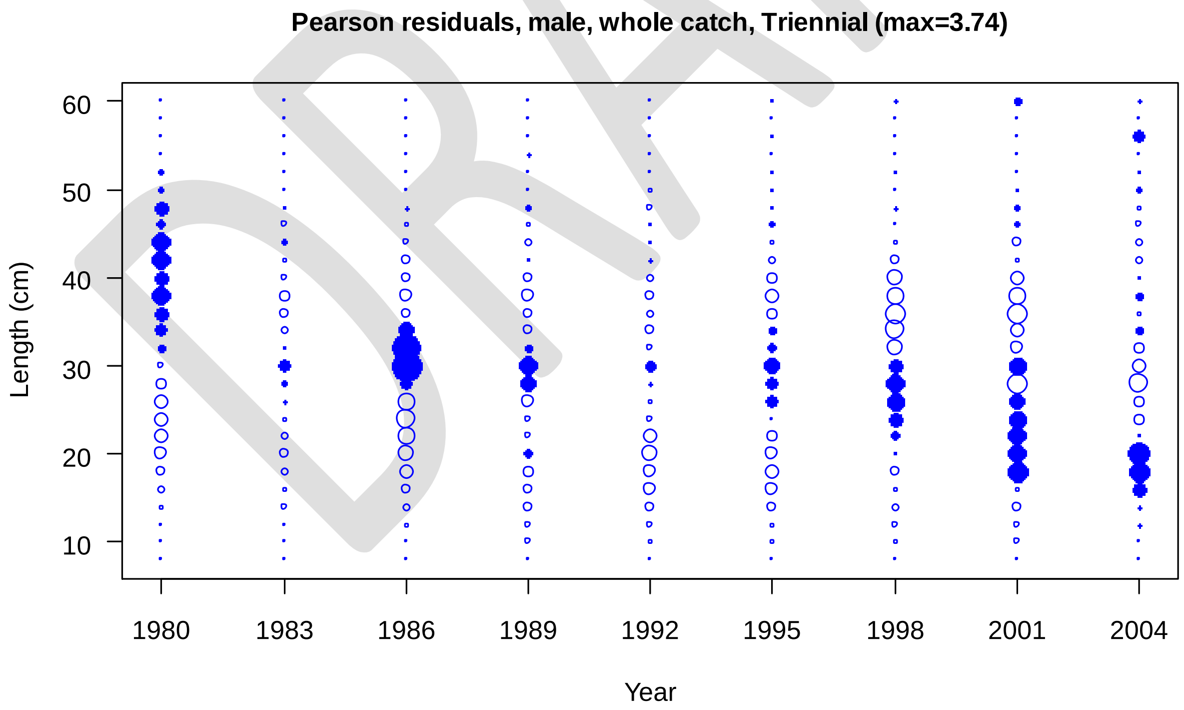


Figure 70. Fits to the retained length composition data for the Triennial survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

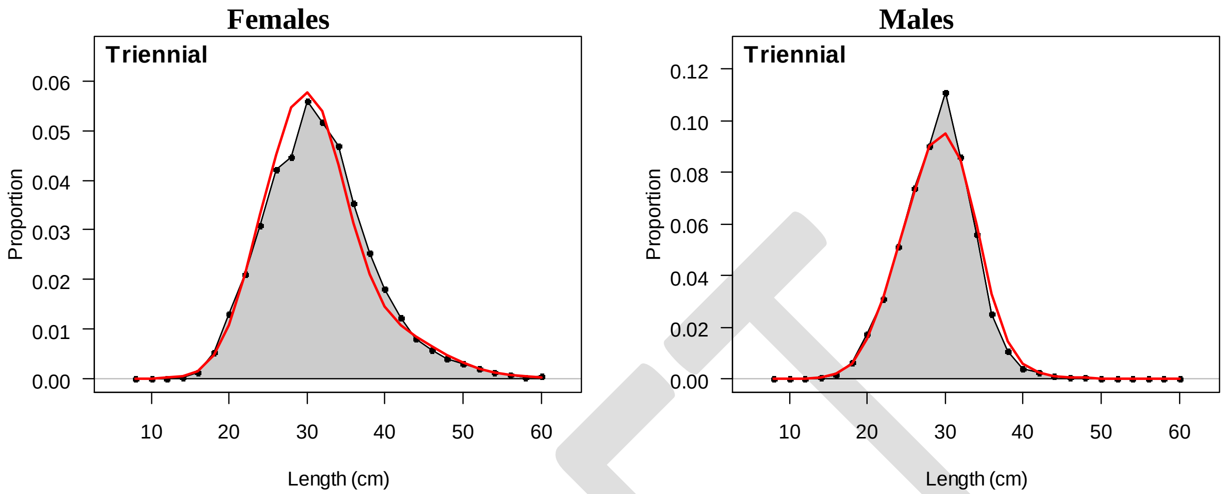


Figure 71. Fits to the retained length frequencies aggregated over all years for the Triennial survey. The filled distribution represents the observations and the line represents the model predictions.

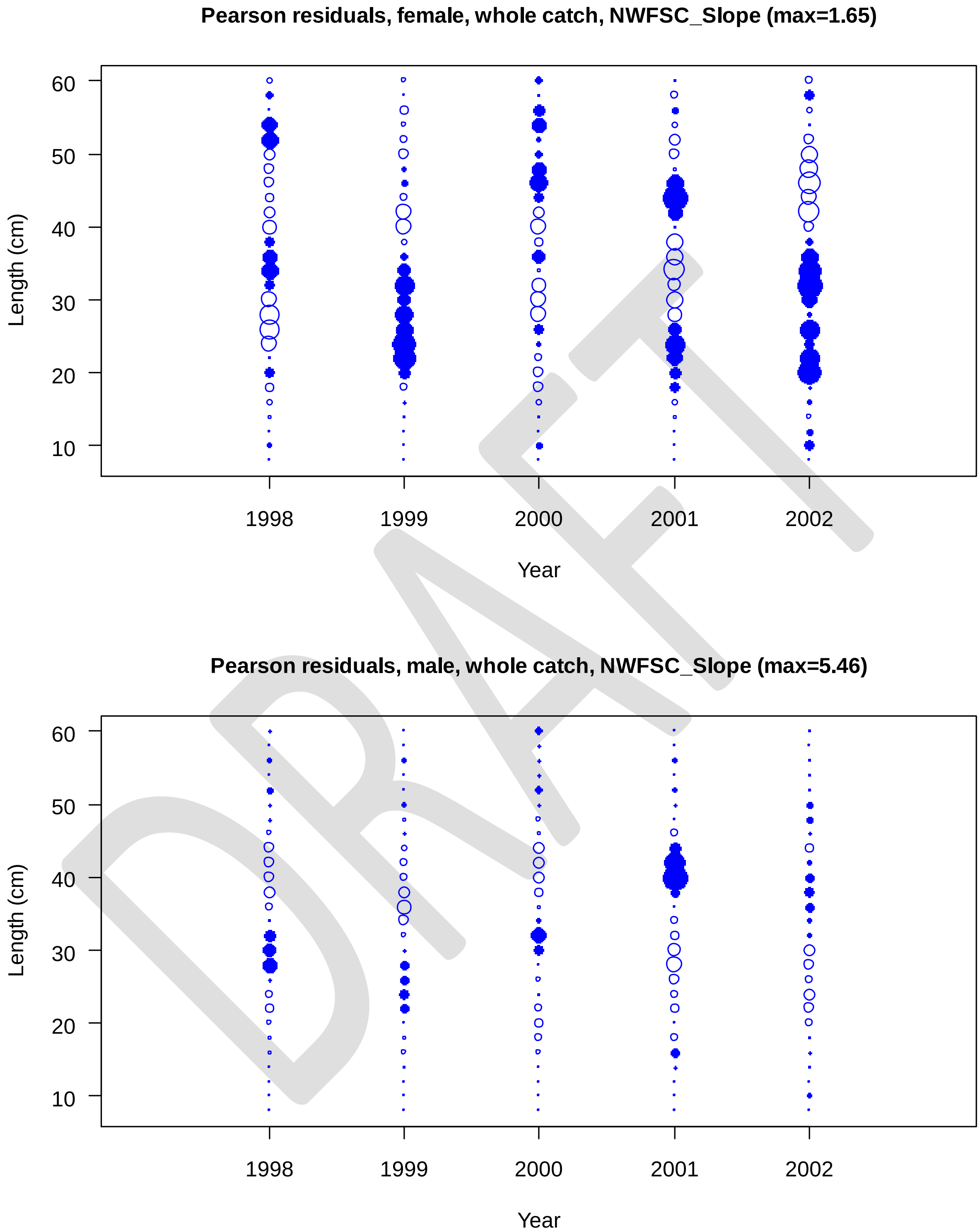


Figure 72. Fits to the retained length composition data for the NWFSC slope survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

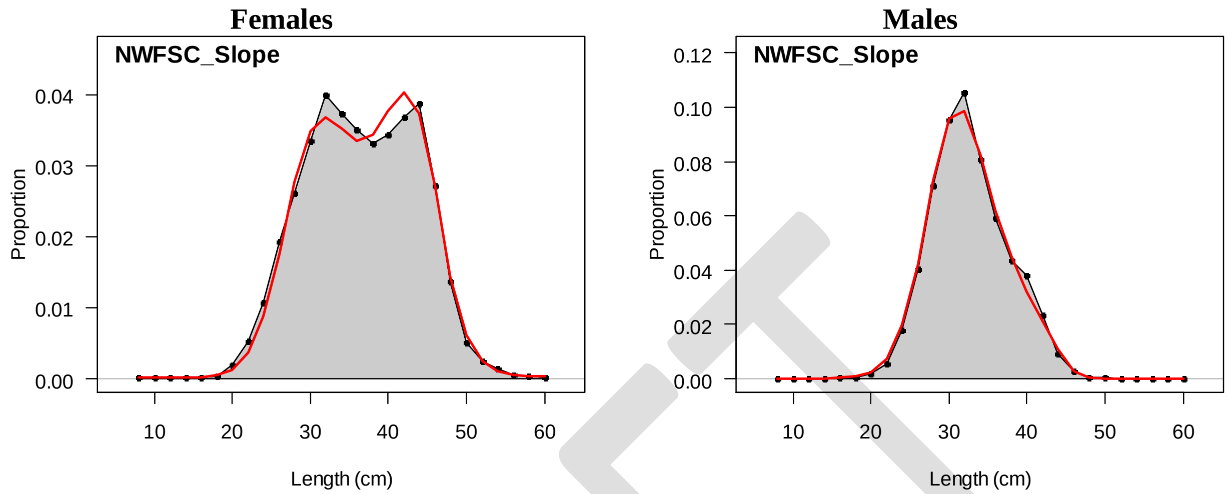


Figure 73. Fits to the retained length frequencies aggregated over all years for the NWFSC slope survey. The filled distribution represents the observations and the line represents the model predictions.

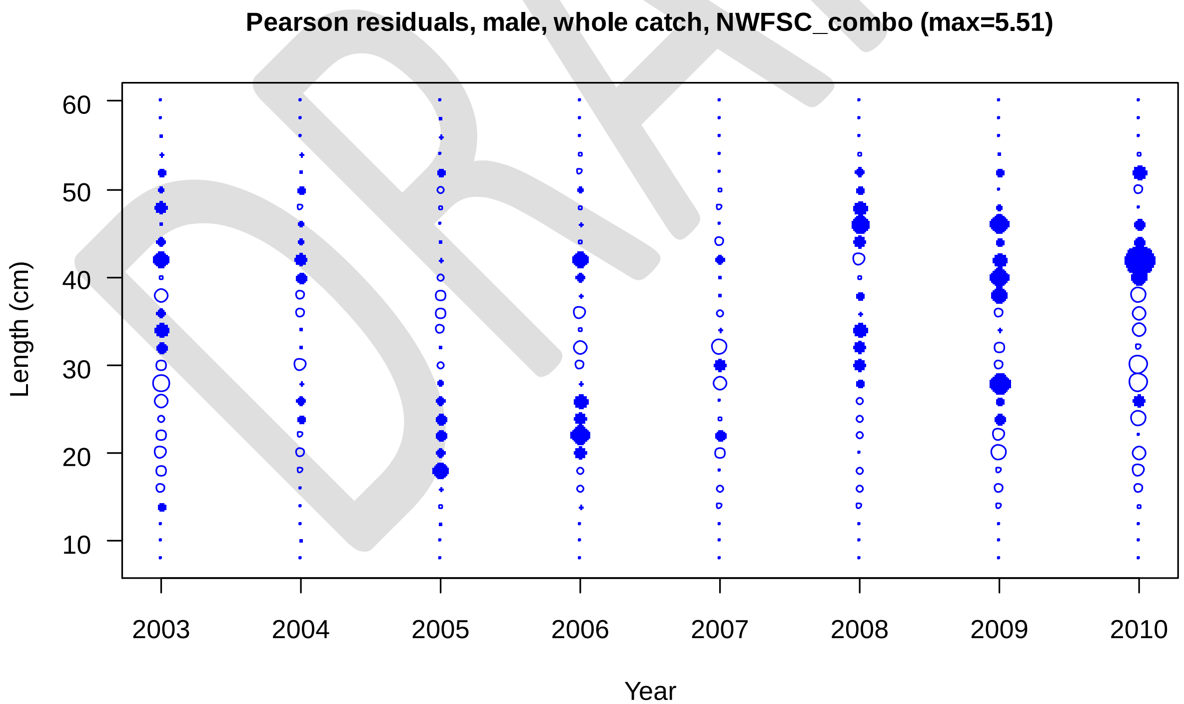


Figure 74. Fits to the retained length composition data for the NWFSC shelf/slope survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

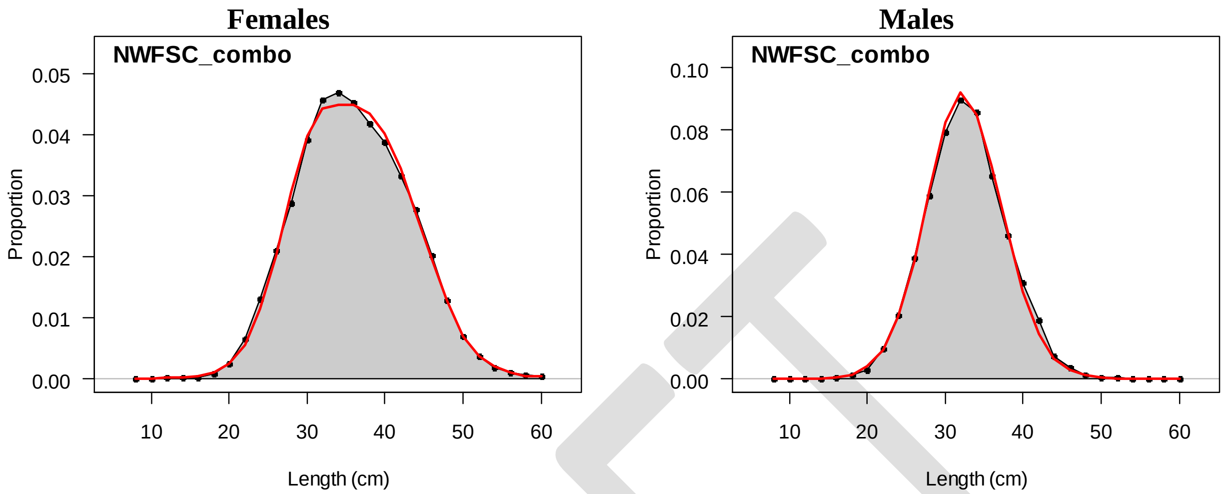
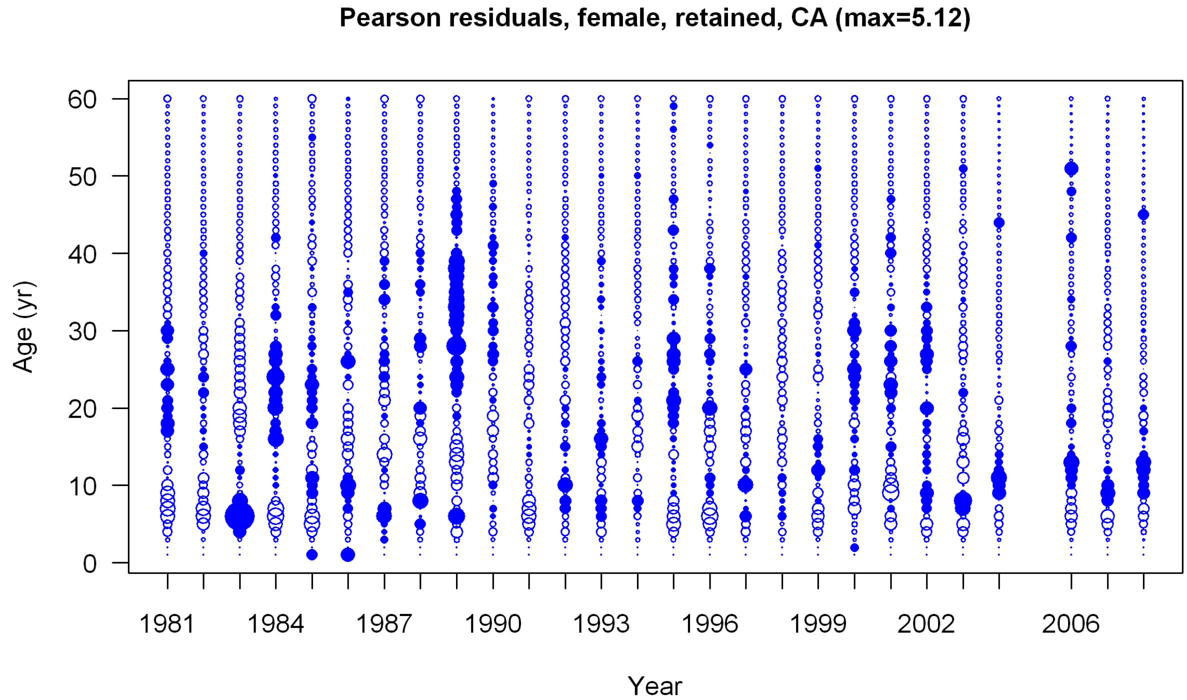


Figure 75. Fits to the retained length frequencies aggregated over all years for the NWFSC shelf/slope survey. The filled distribution represents the observations and the line represents the model predictions.



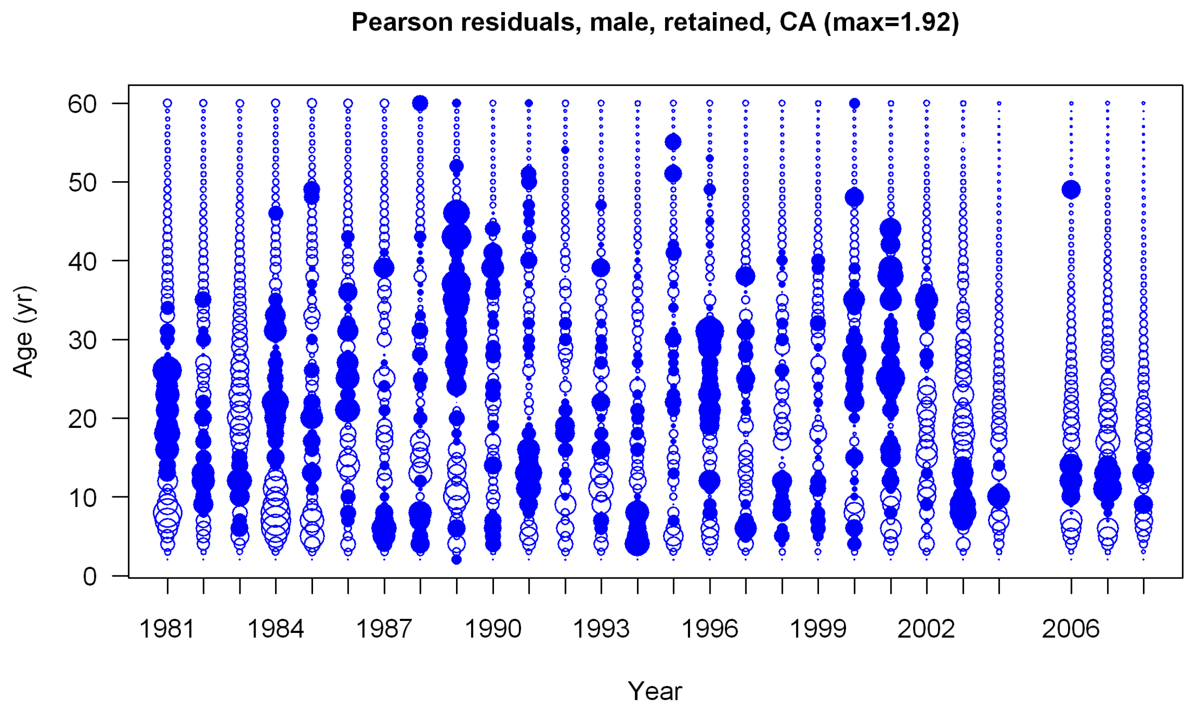


Figure 76. Fits to the retained age composition data for the California fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

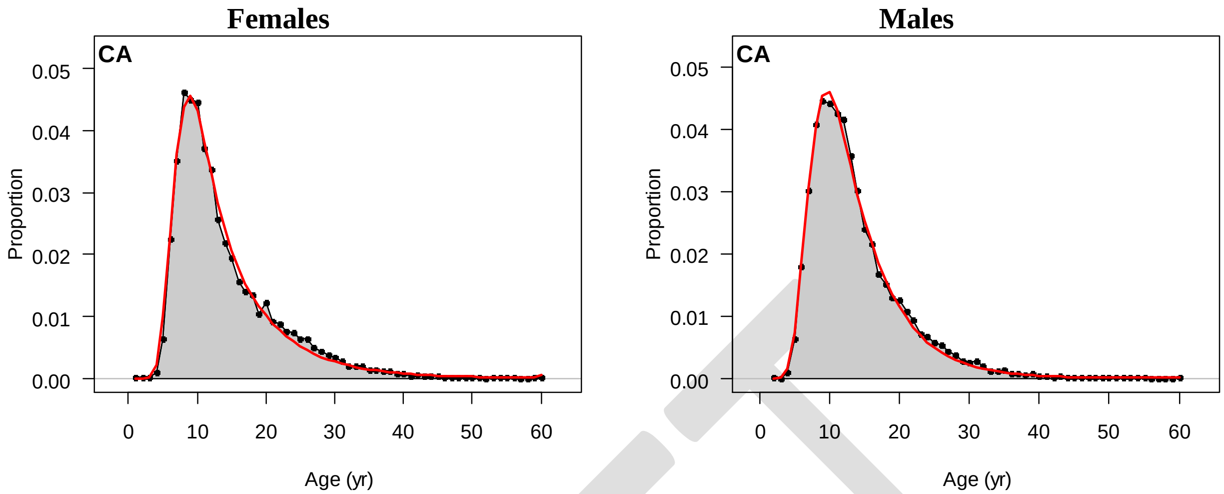


Figure 77. Fits to the retained age frequencies aggregated over all years for the CA fleet. The filled distribution represents the observations and the line represents the model predictions.

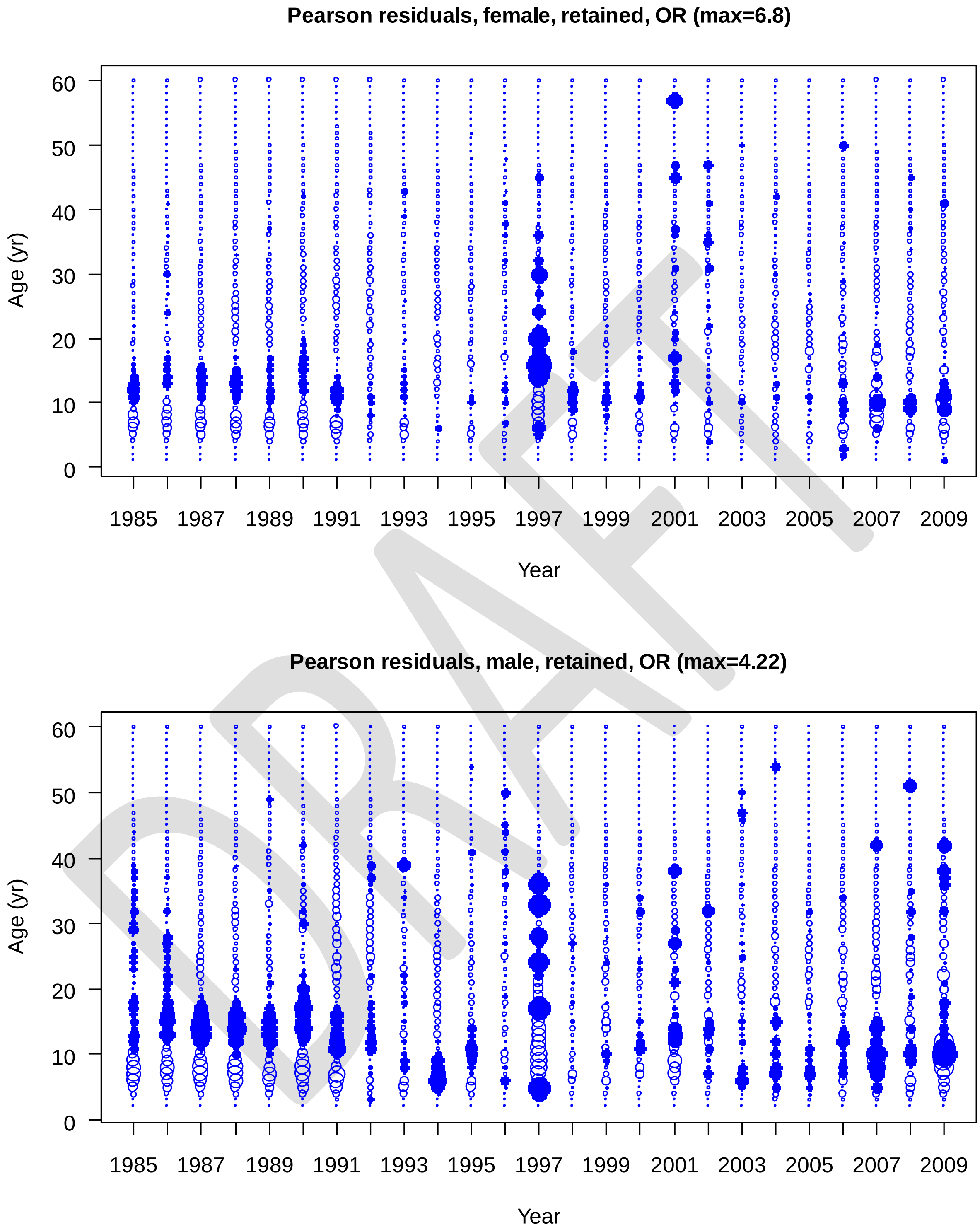


Figure 78. Fits to the retained age composition data for the Oregon fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

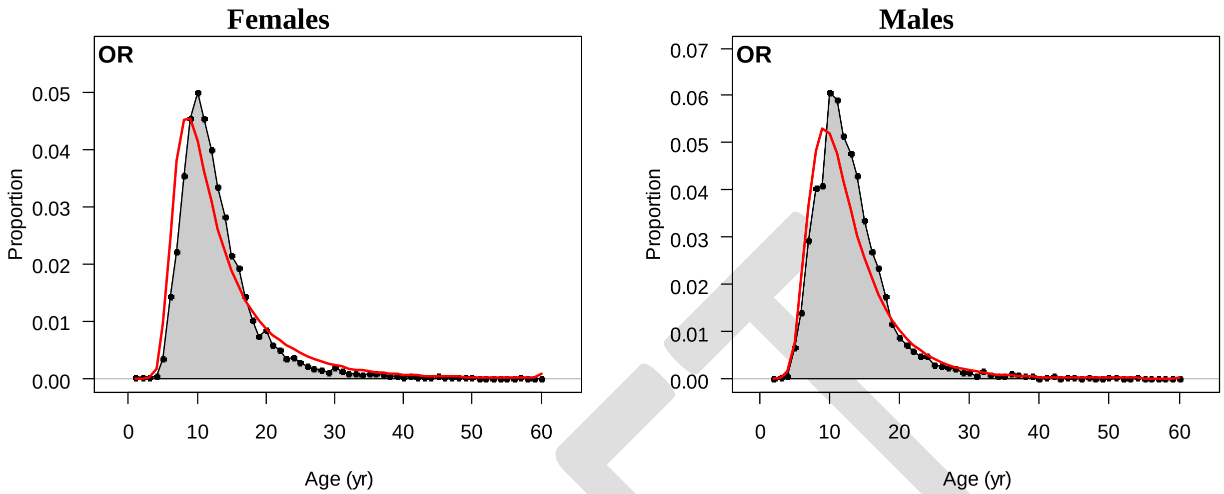


Figure 79. Fits to the retained age frequencies aggregated over all years for the OR fleet. The filled distribution represents the observations and the line represents the model predictions.

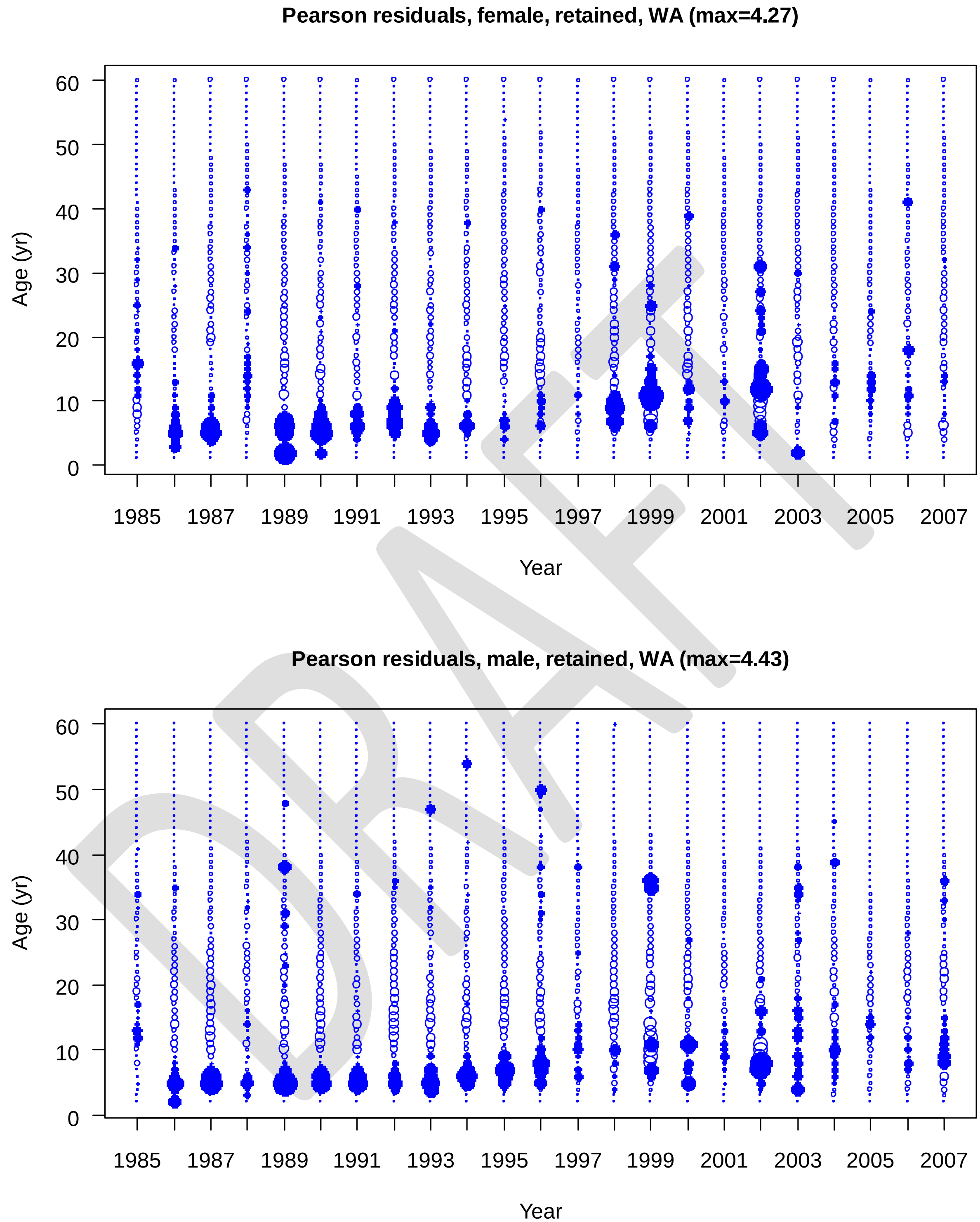


Figure 80. Fits to the retained age composition data for the Washington fleet as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

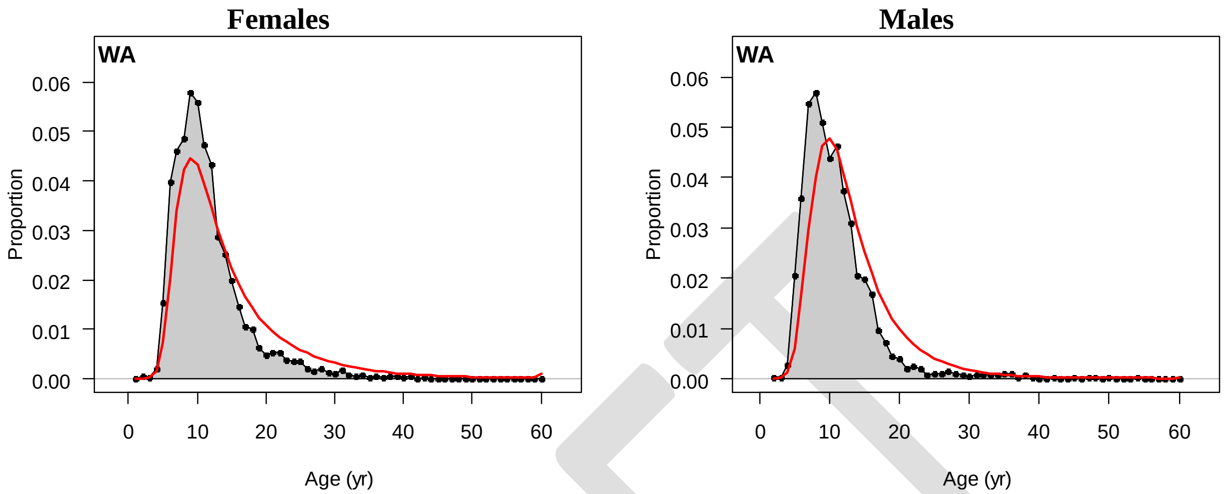
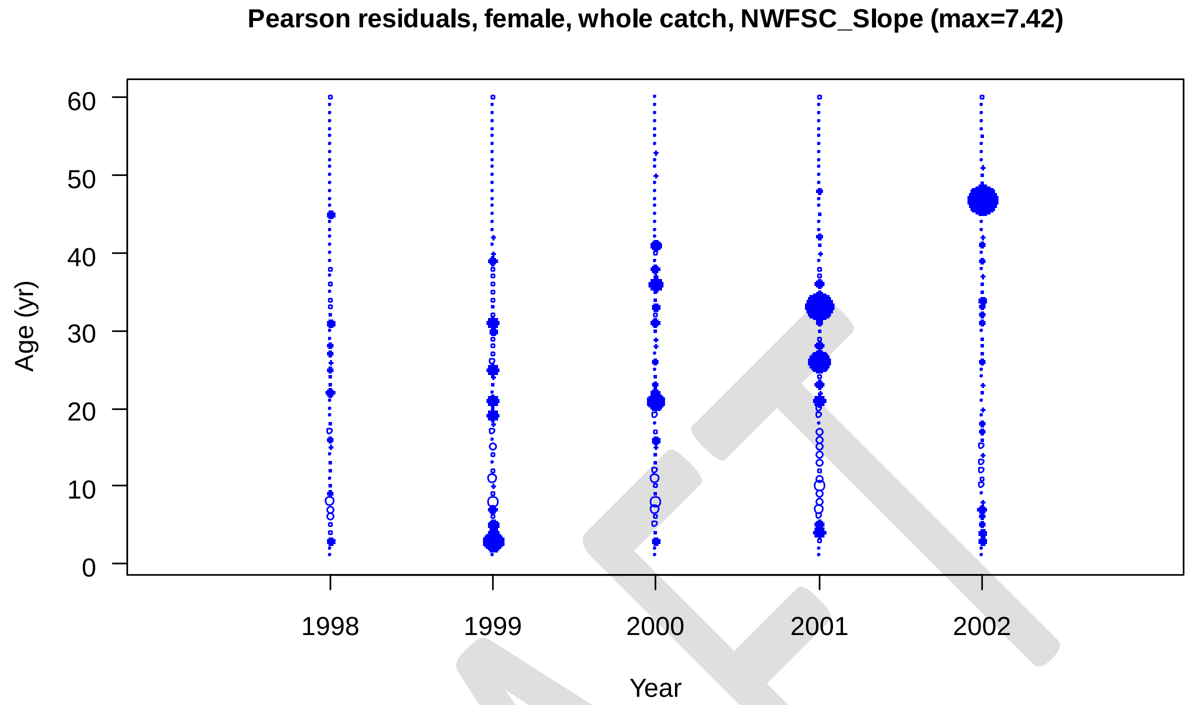


Figure 81. Fits to the retained age frequencies aggregated over all years for the WA fleet. The filled distribution represents the observations and the line represents the model predictions.



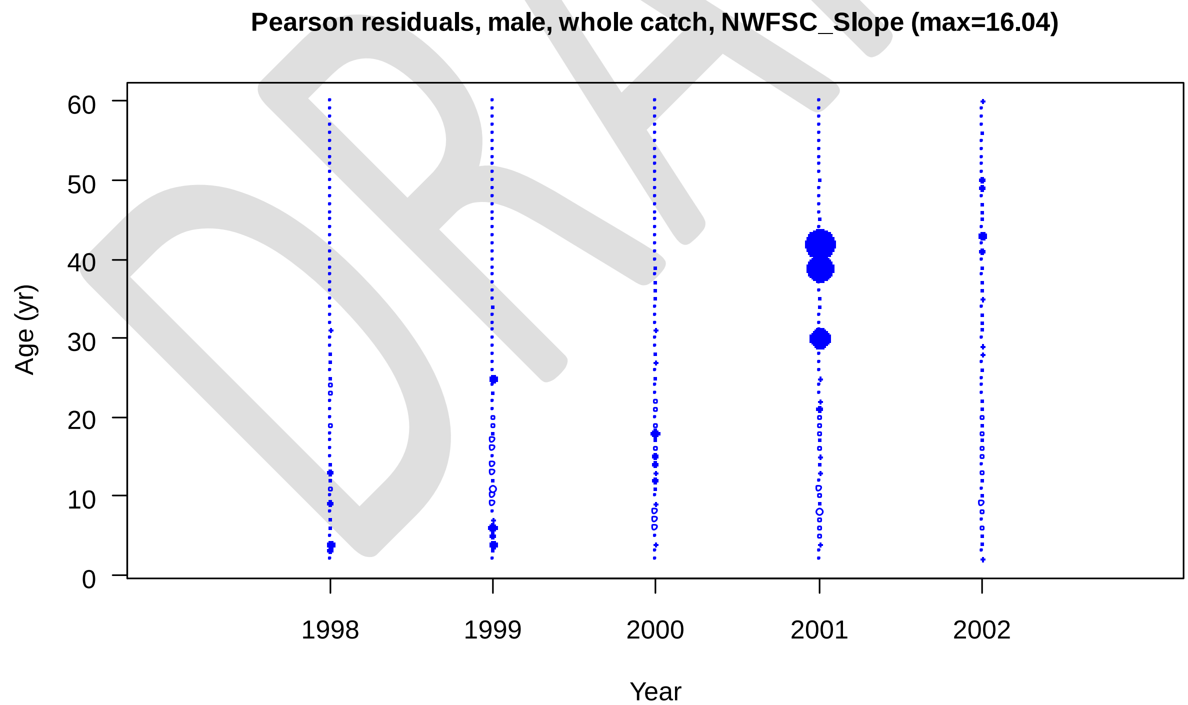


Figure 82. Fits to the retained age composition data for the NWFSC slope survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

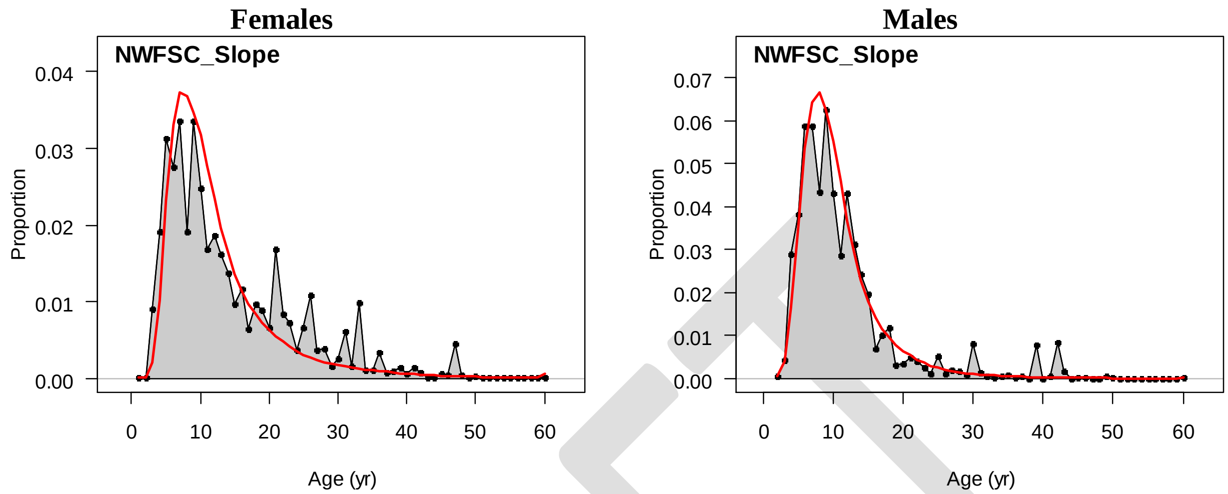
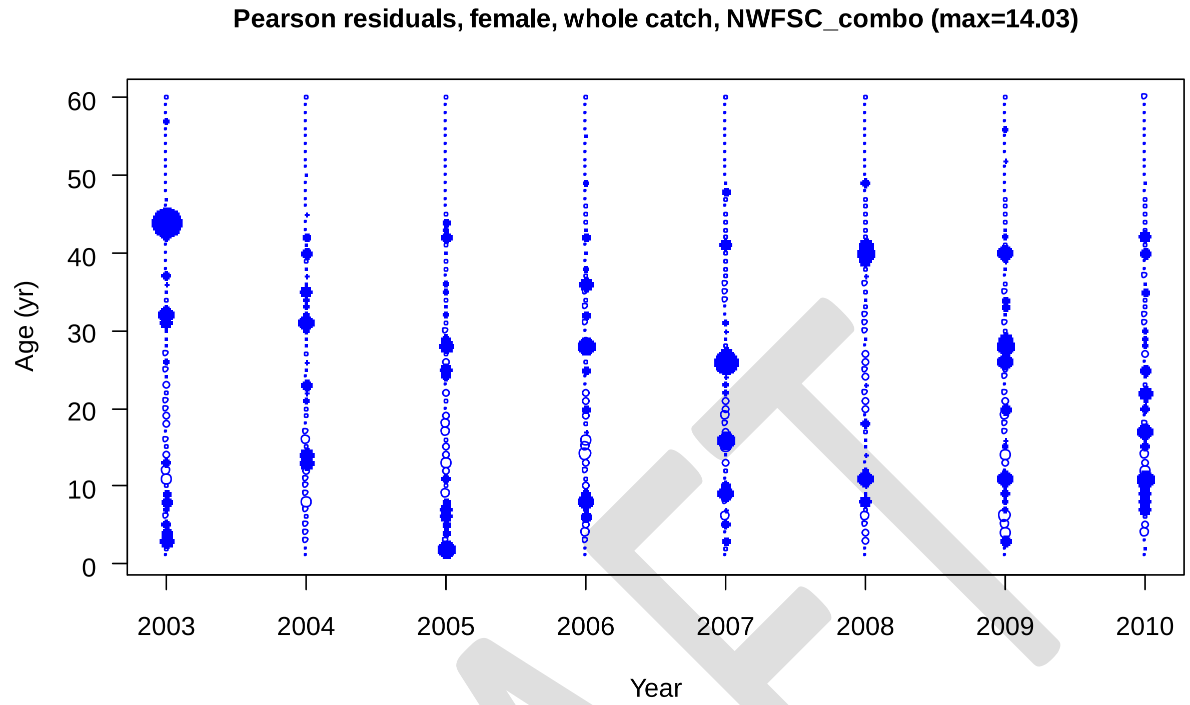


Figure 83. Fits to the retained age frequencies aggregated over all years for the NWFSC slope survey. The filled distribution represents the observations and the line represents the model predictions.



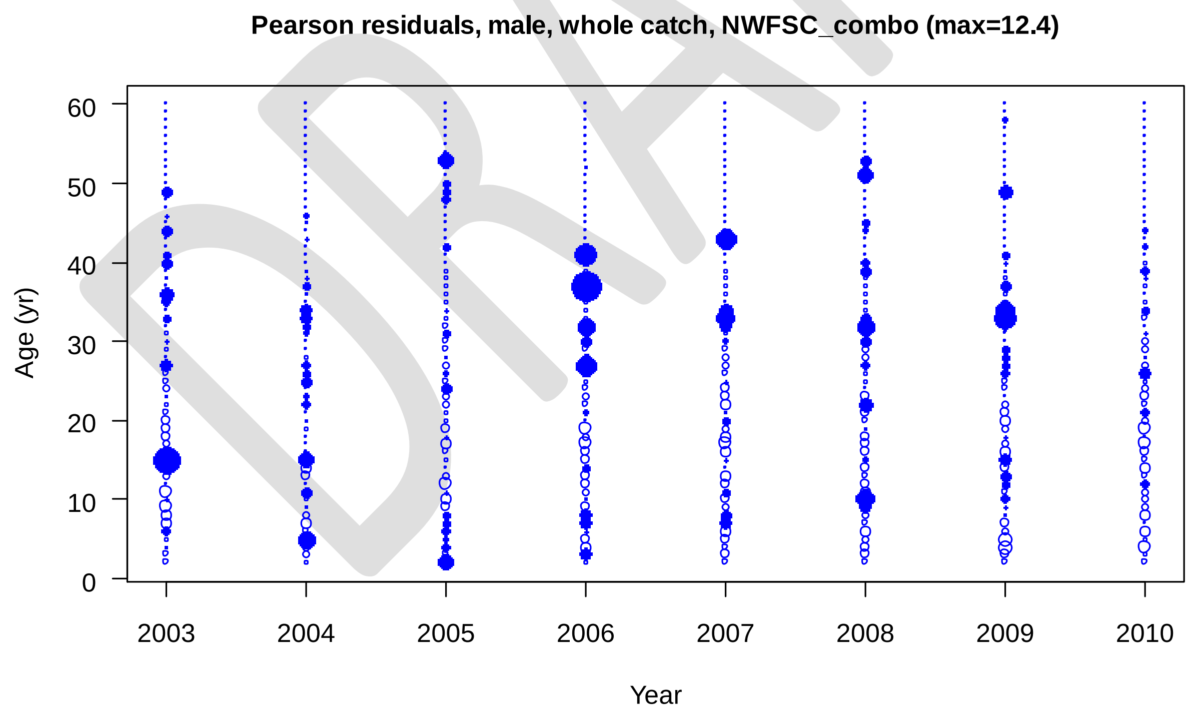


Figure 84. Implied fits to the retained age composition data for the NWFSC shelf/slope survey as shown with Person's residuals. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title. These data were fit to via length-at-age vectors.

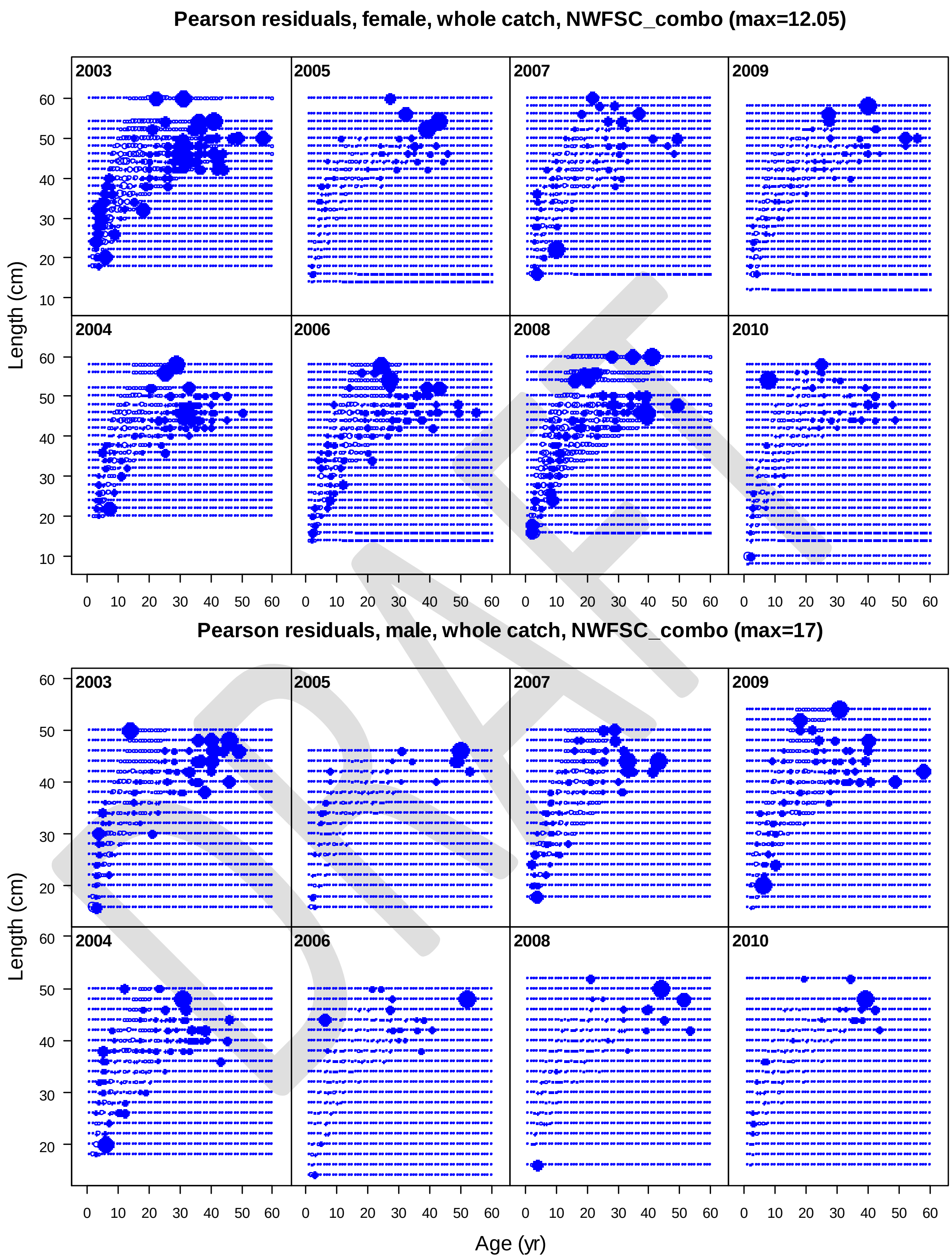


Figure 85. Fits to the conditional length-at-age frequencies for the NWFSC shelf/slope survey. A filled circle indicates that the model underfit the observation. The maximum size of the circles are given in the title.

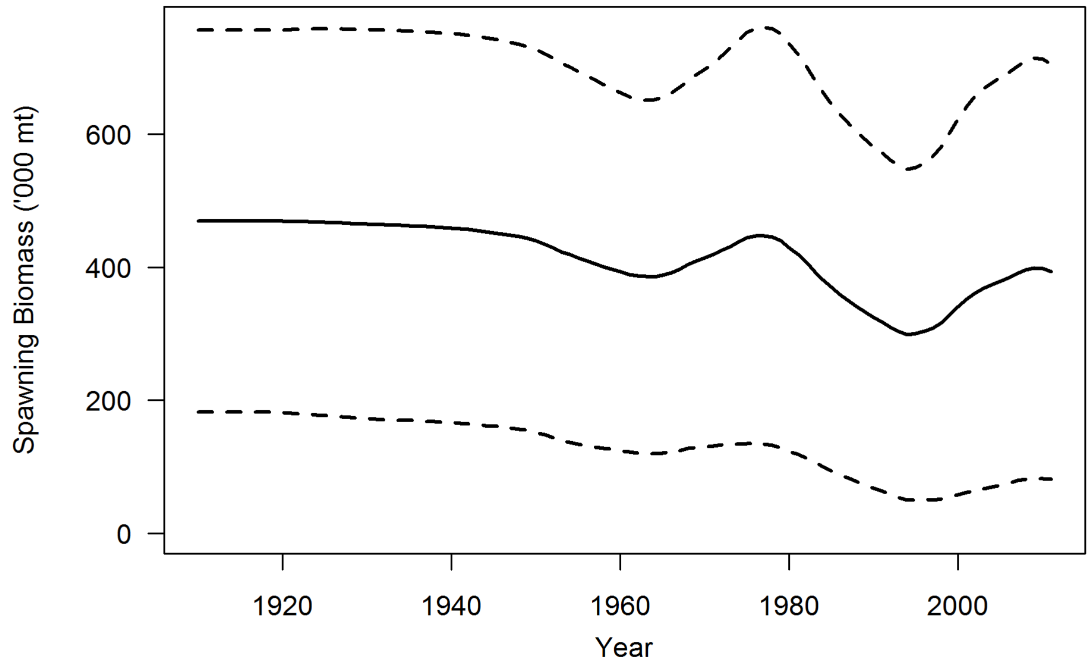


Figure 86: Predicted spawning biomass (mt) from the Dover sole base case assessment. The solid line is the MLE estimate and the dashed lines are the approximate asymptotic 95% confidence intervals.

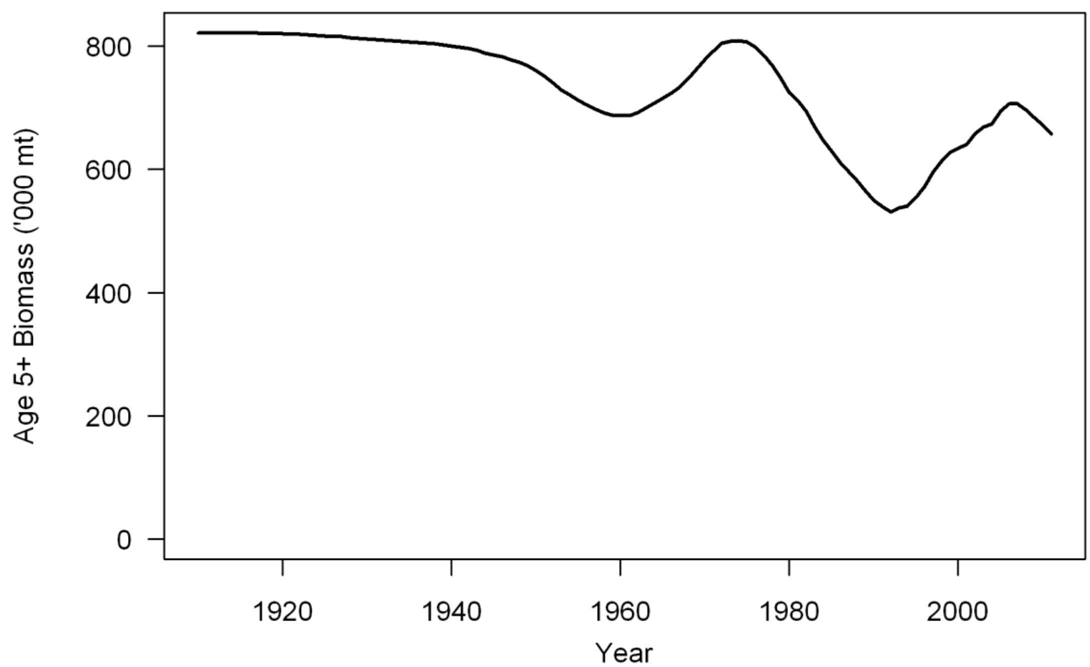


Figure 87: Predicted trajectory of the age 5+ biomass from the Dover sole base case assessment.

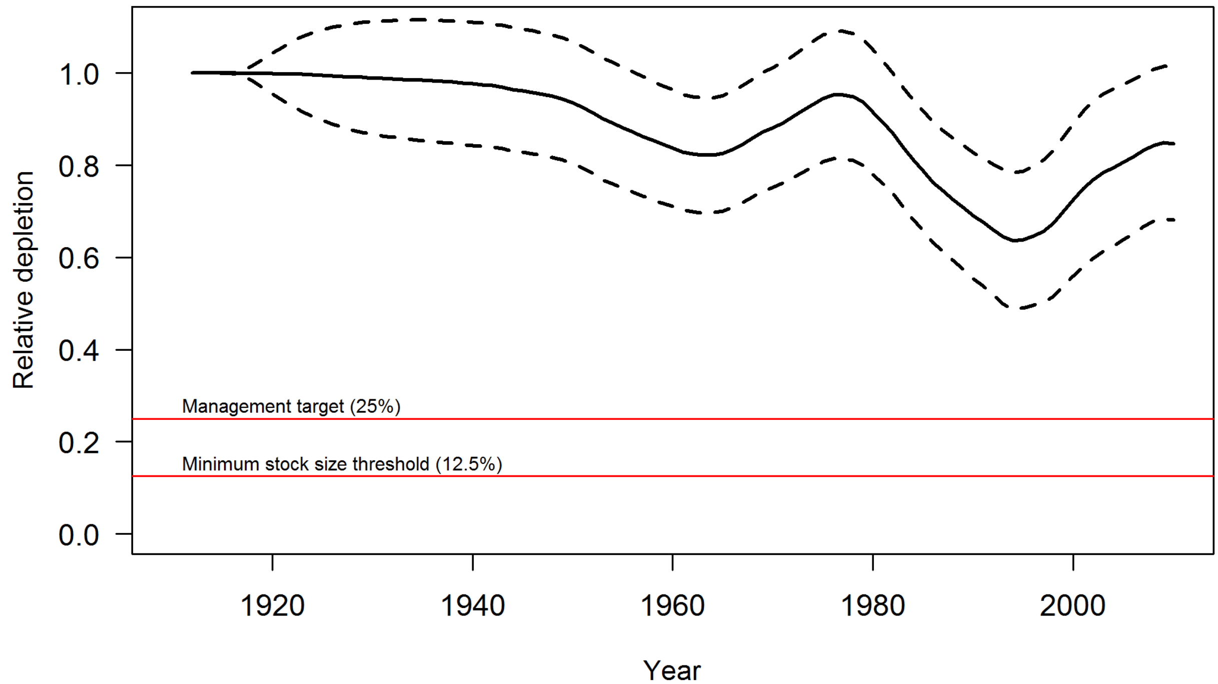


Figure 88. Predicted depletion relative to unfished biomass from the Dover sole base case assessment. The solid line is the MLE estimate and the dashed lines are the approximate asymptotic 95% confidence intervals. The red lines show the management target of 25% of unfished biomass and the minimum stock size threshold of 12.5% of unfished biomass.

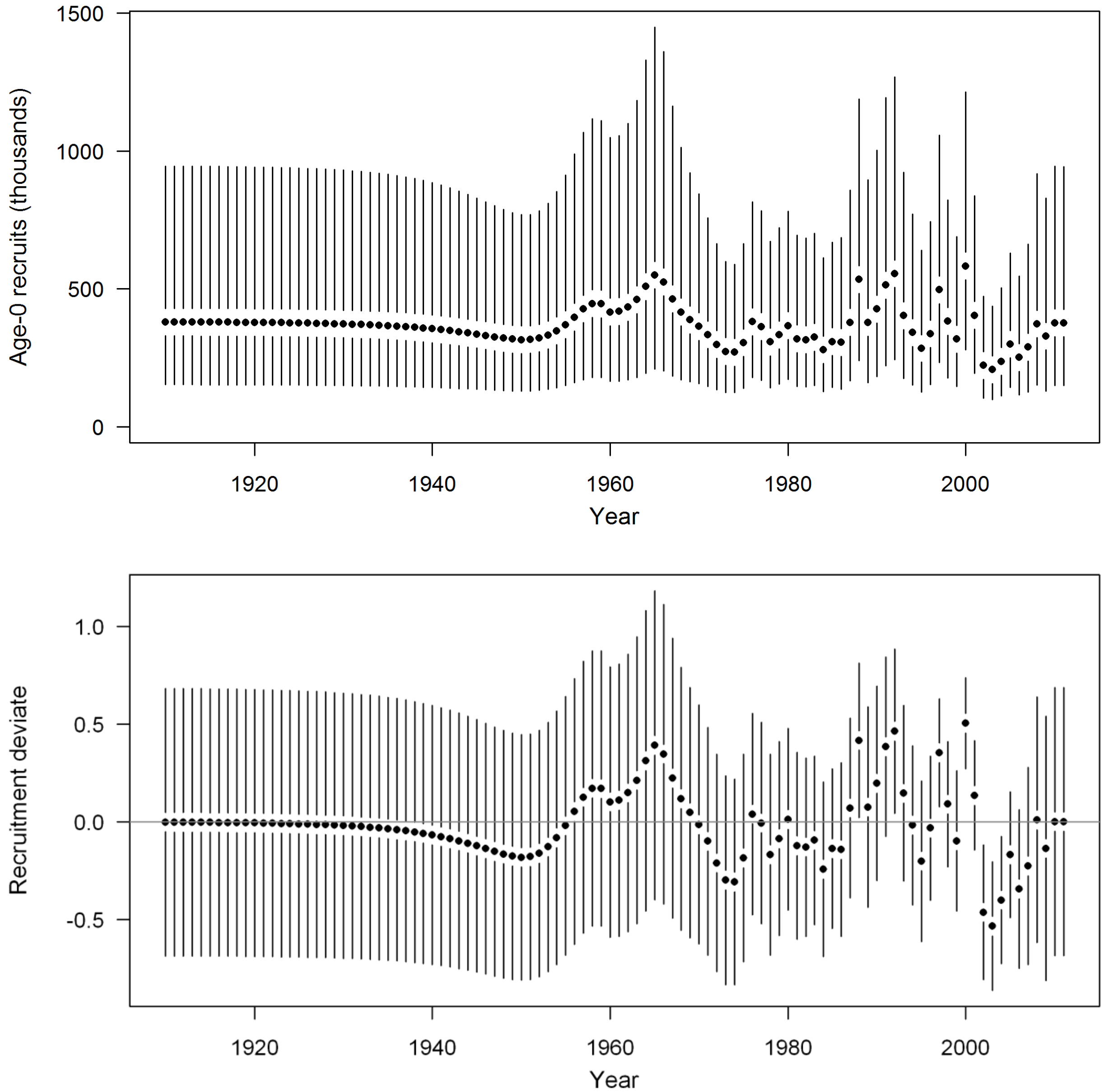


Figure 89: Estimates of recruitment (upper) and recruitment deviates (lower) with approximate asymptotic confidence intervals (lines) from the MLE estimates.

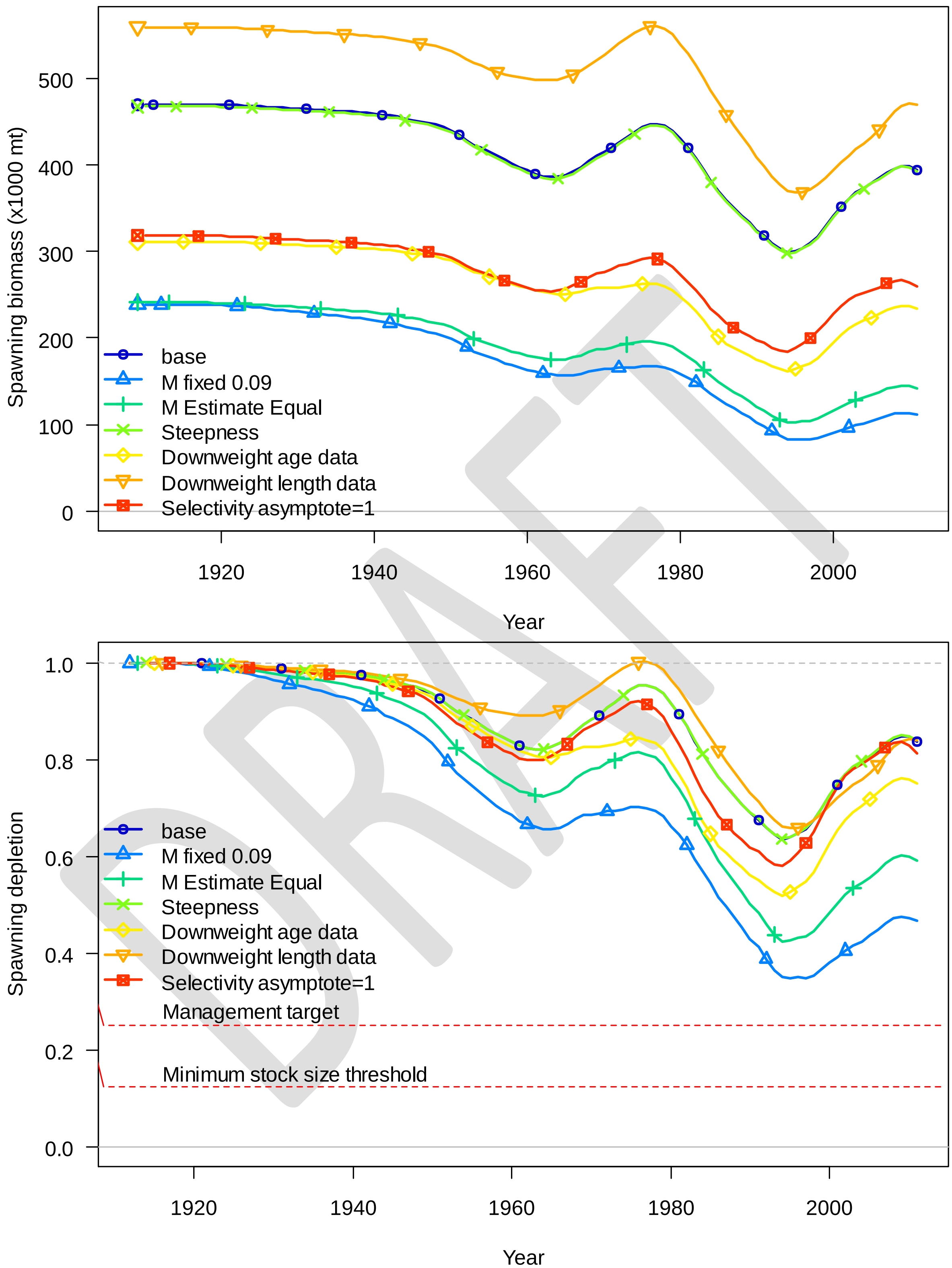


Figure 90. Spawning biomass and depletion trajectories from the base case model and sensitivity runs.

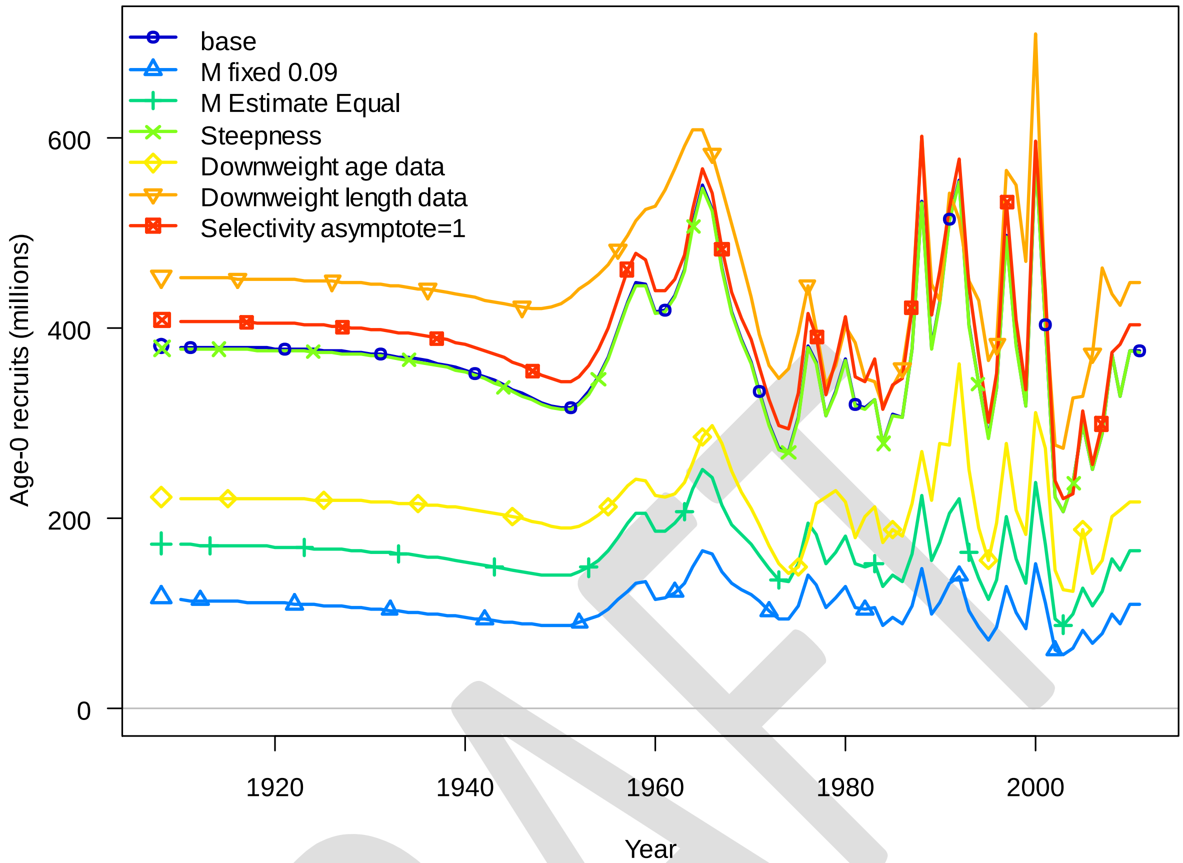


Figure 91. Estimates of recruitment from the base case model and the sensitivity runs.

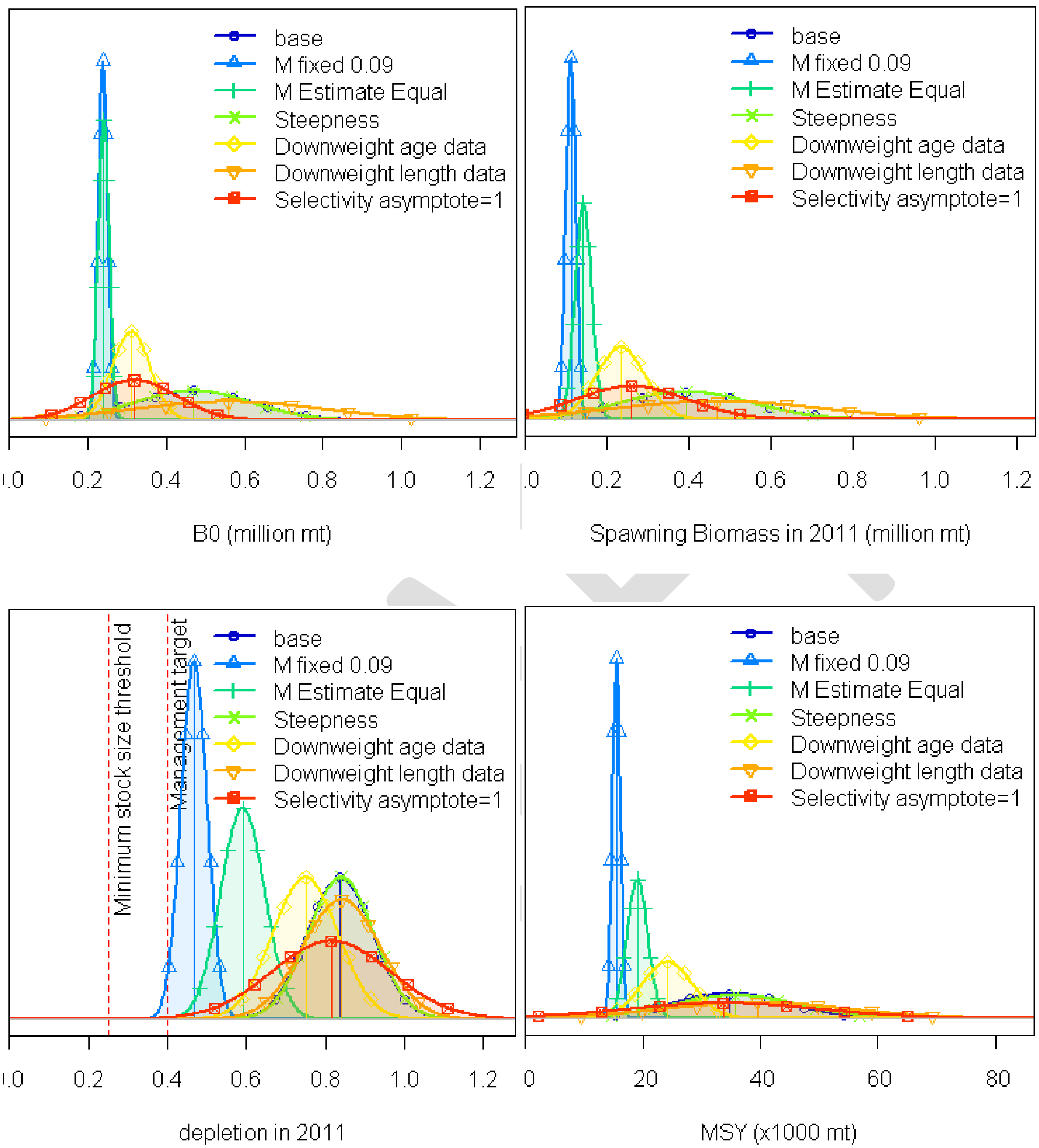


Figure 92: Approximate asymptotic normal density estimates of unfished spawning biomass (B0), spawning biomass in 2011, depletion in 2011, and MSY for the base case and sensitivities.

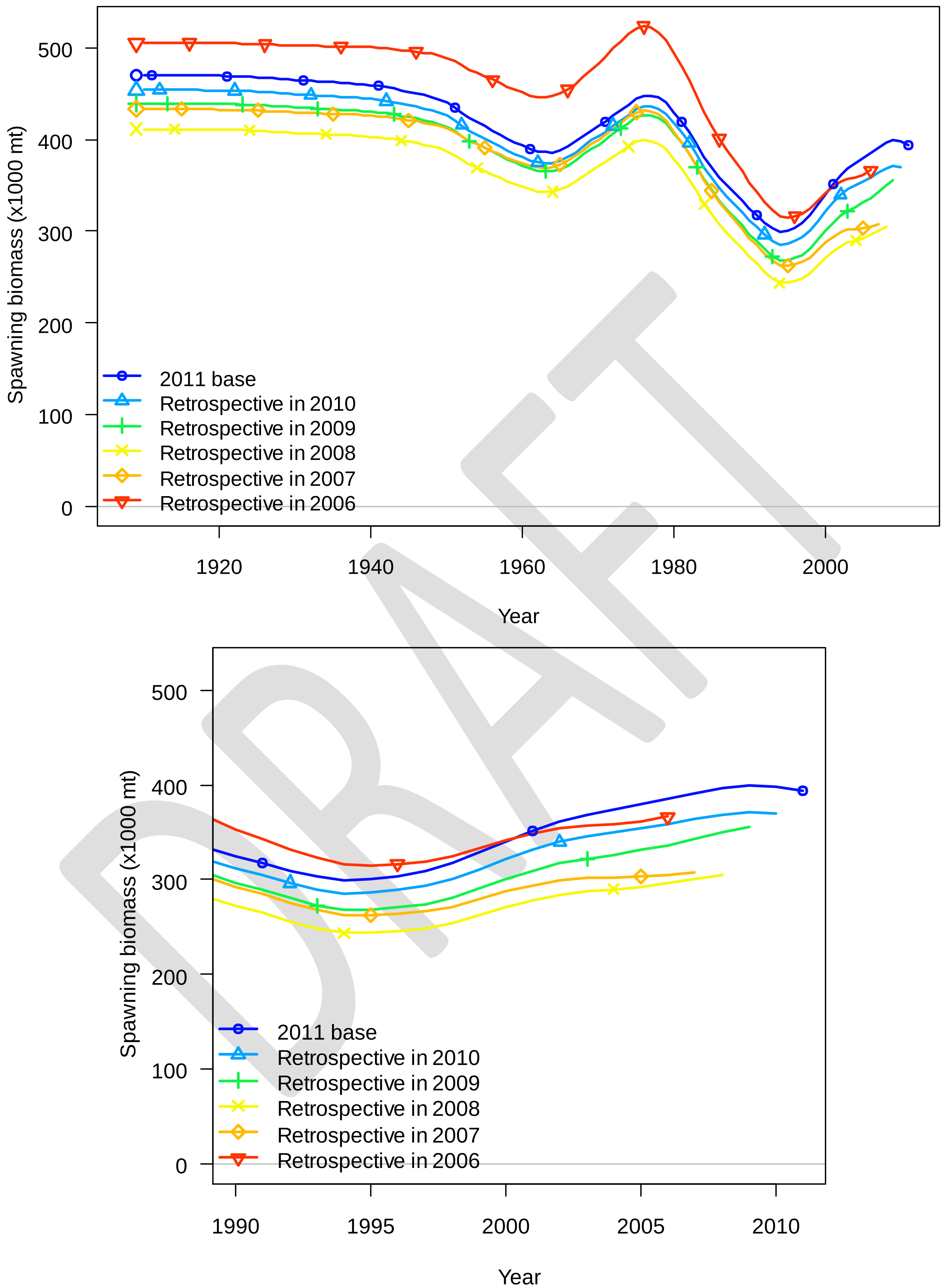


Figure 93. Spawning biomass estimates from the retrospective analysis sequentially removing data for the last five years. The bottom plot shows spawning biomass estimates over the last two decades.

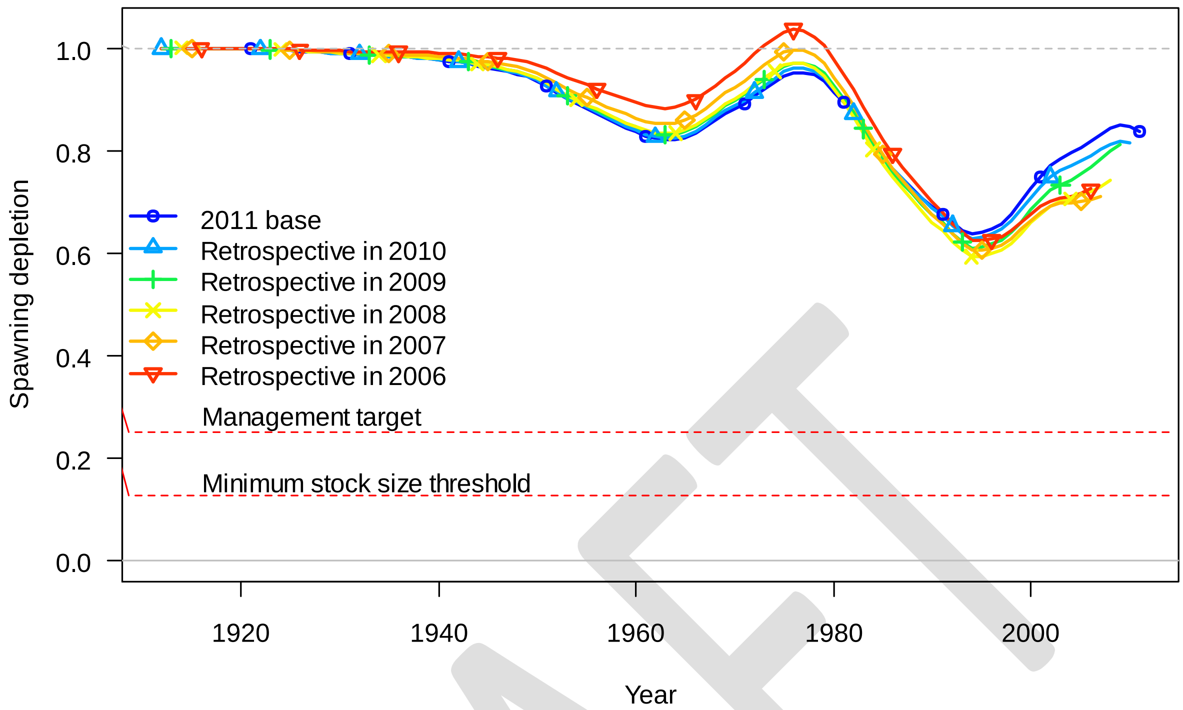


Figure 94. Depletion estimates from the retrospective analysis sequentially removing data for the last five years.

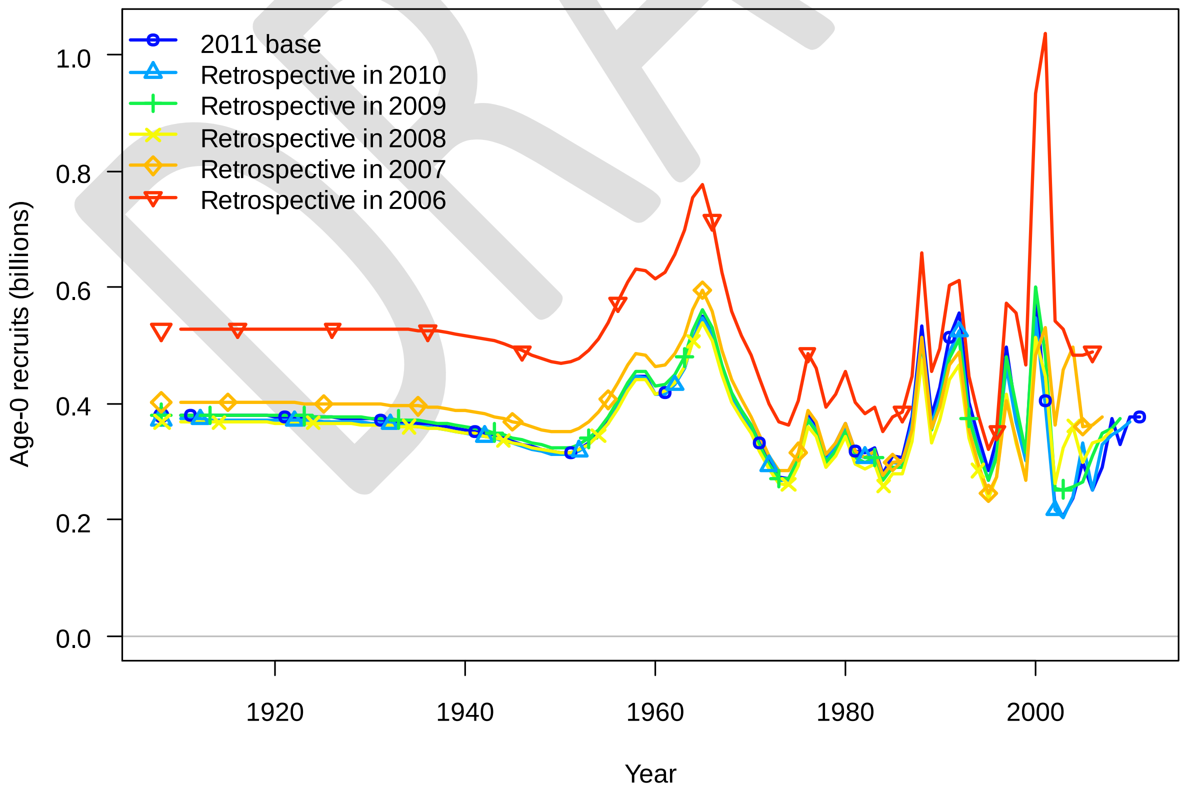


Figure 95. Estimates of recruitment for the retrospective analysis.

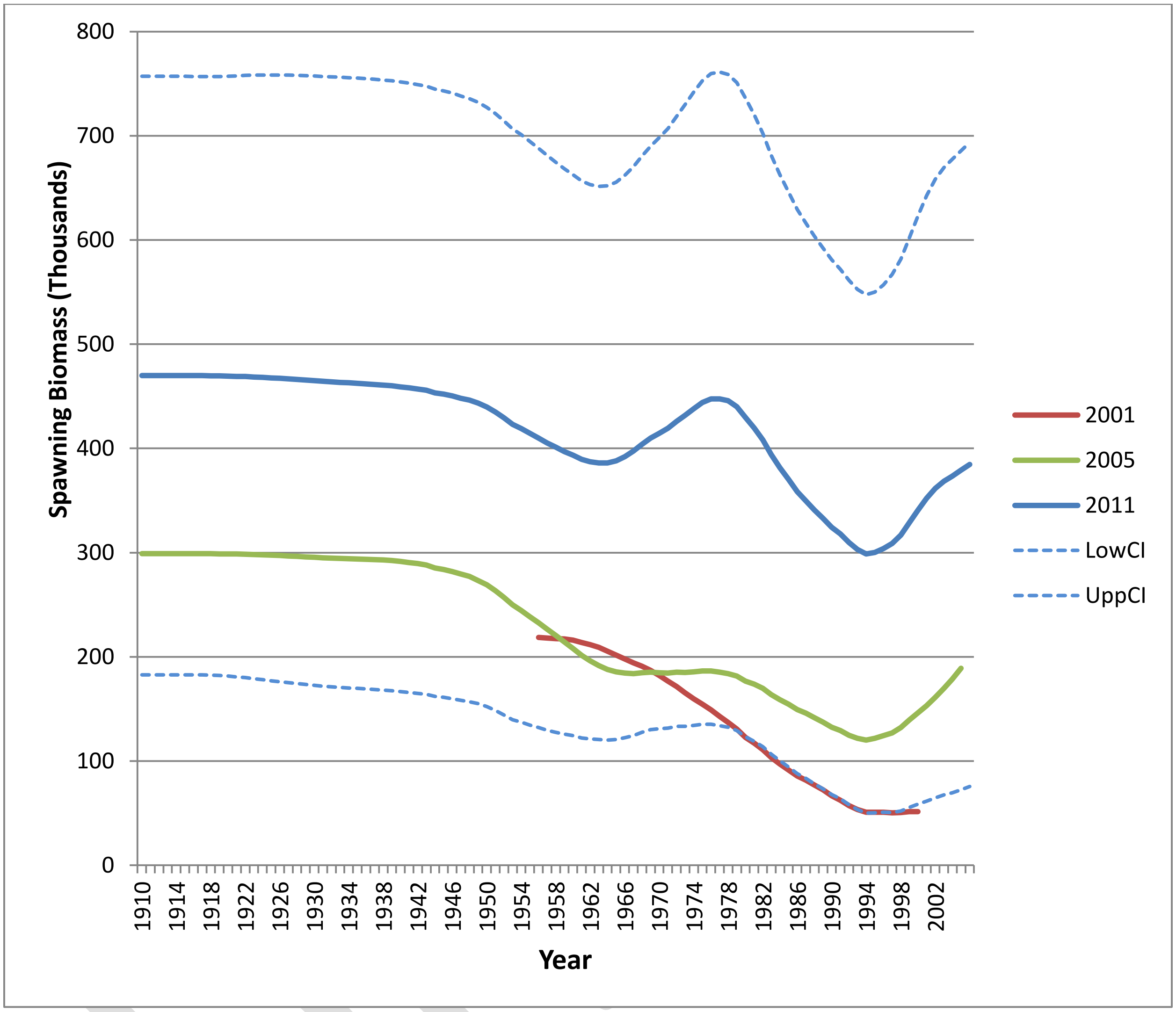


Figure 96: Estimated spawning biomass trajectories from the 2001 assessment (red), 2005 assessment (green), and the current basecase assessment (blue) for Dover sole. 95% confidence intervals from the current assessment are shown as dotted blue lines.

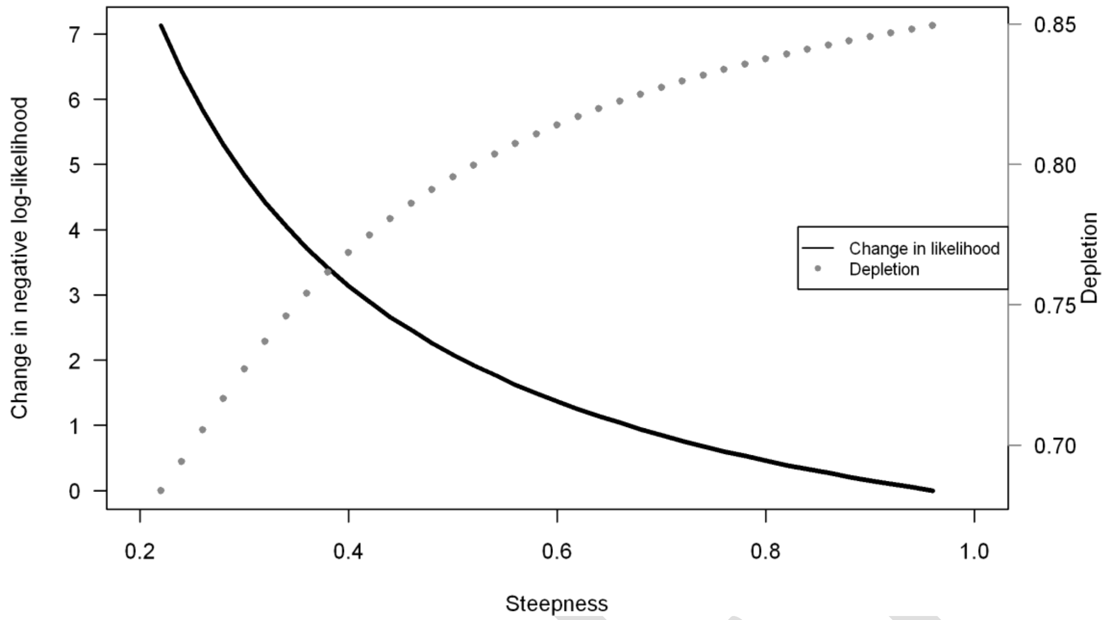


Figure 97. Likelihood profile on steepness (*h*). The change in negative log-likelihood from the likelihood when steepness was 0.98 is plotted. The estimates of depletion are also shown.

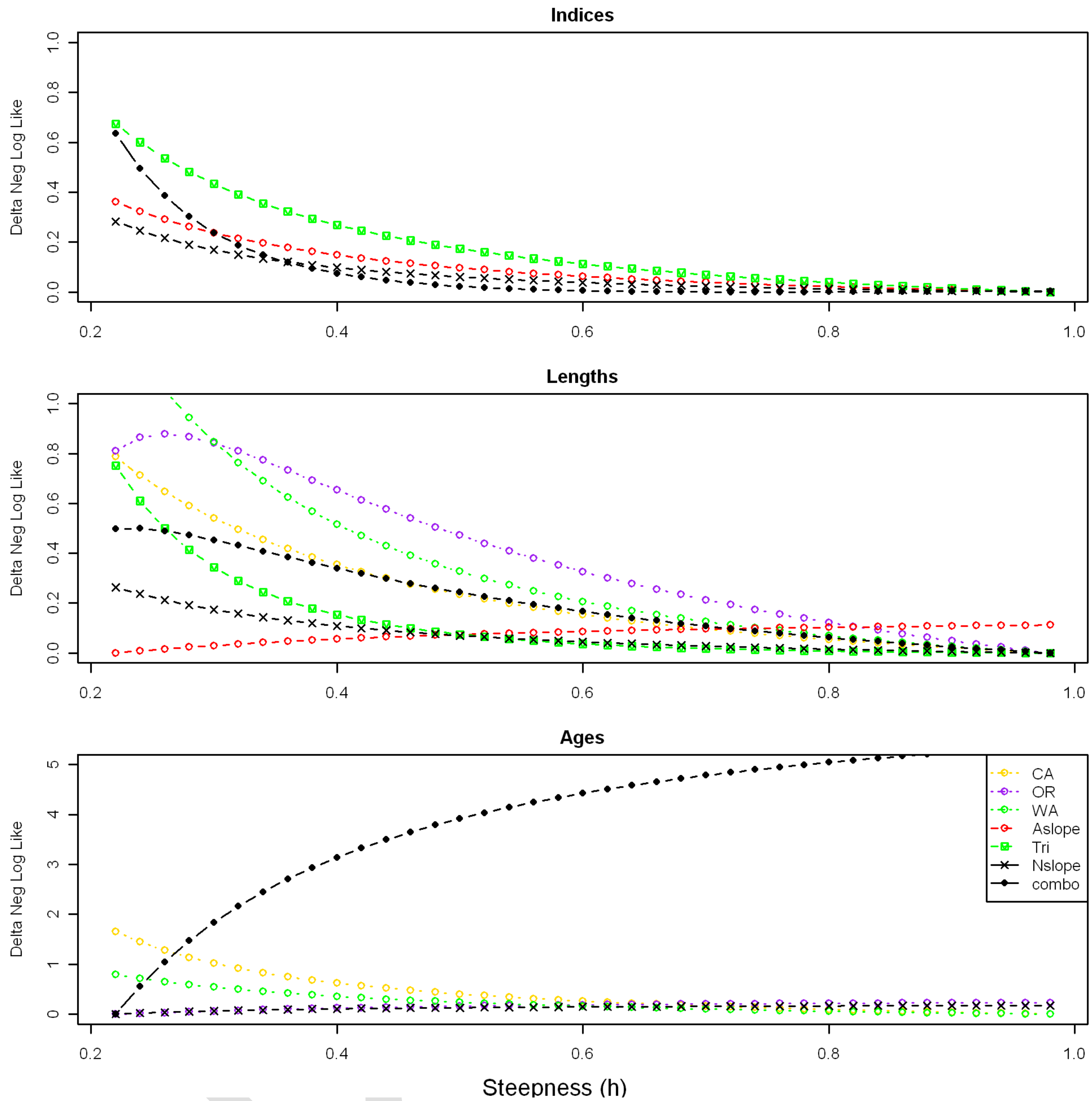


Figure 98: Likelihoods components for the profile over steepness relative to the minimum likelihood for that data source.

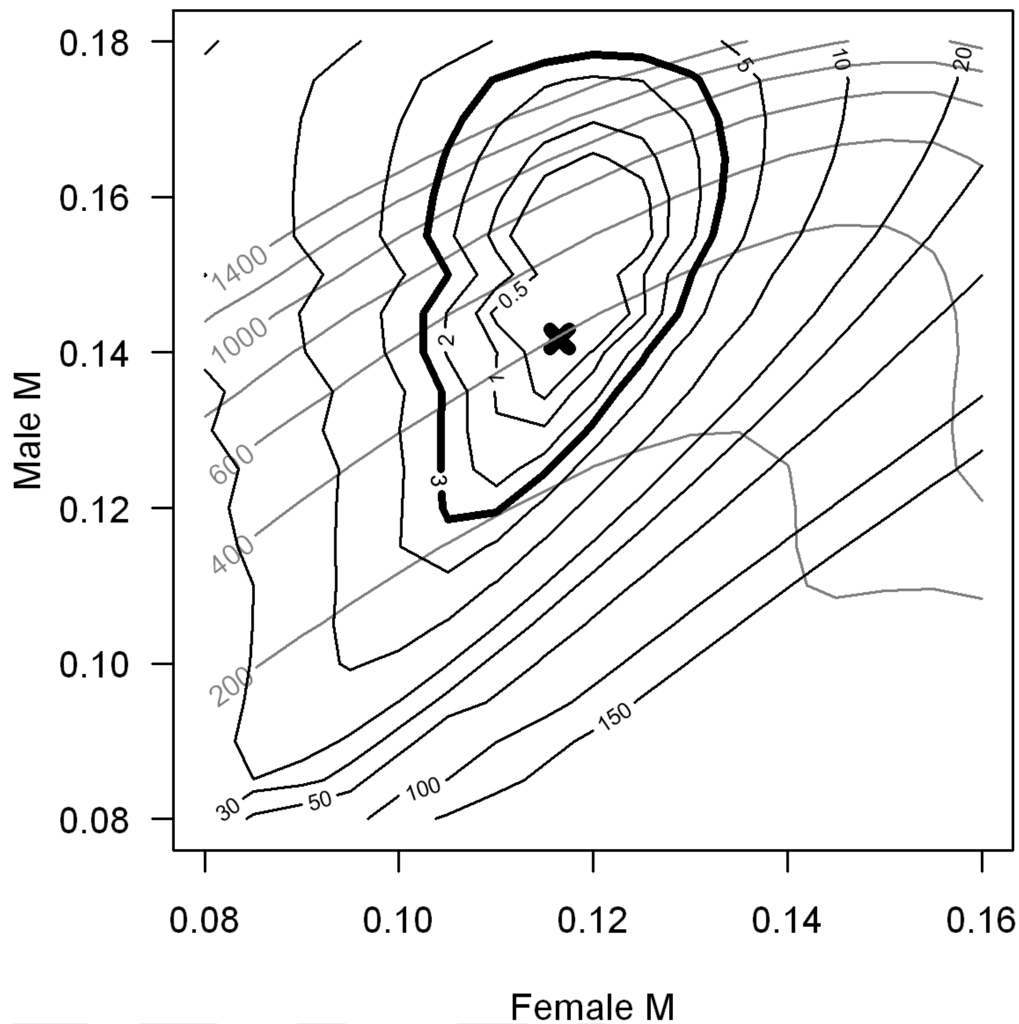


Figure 99. Joint likelihood profile on female and male natural mortality. The black circular lines are the difference in negative log-likelihood from the minimum negative log-likelihood in the profile. The X marks the location of the base case estimates of female and male natural mortality, showing the influence of the priors. The grey contour lines show the estimates of 2011 spawning biomass (200 to 1400 times 1,000mt).

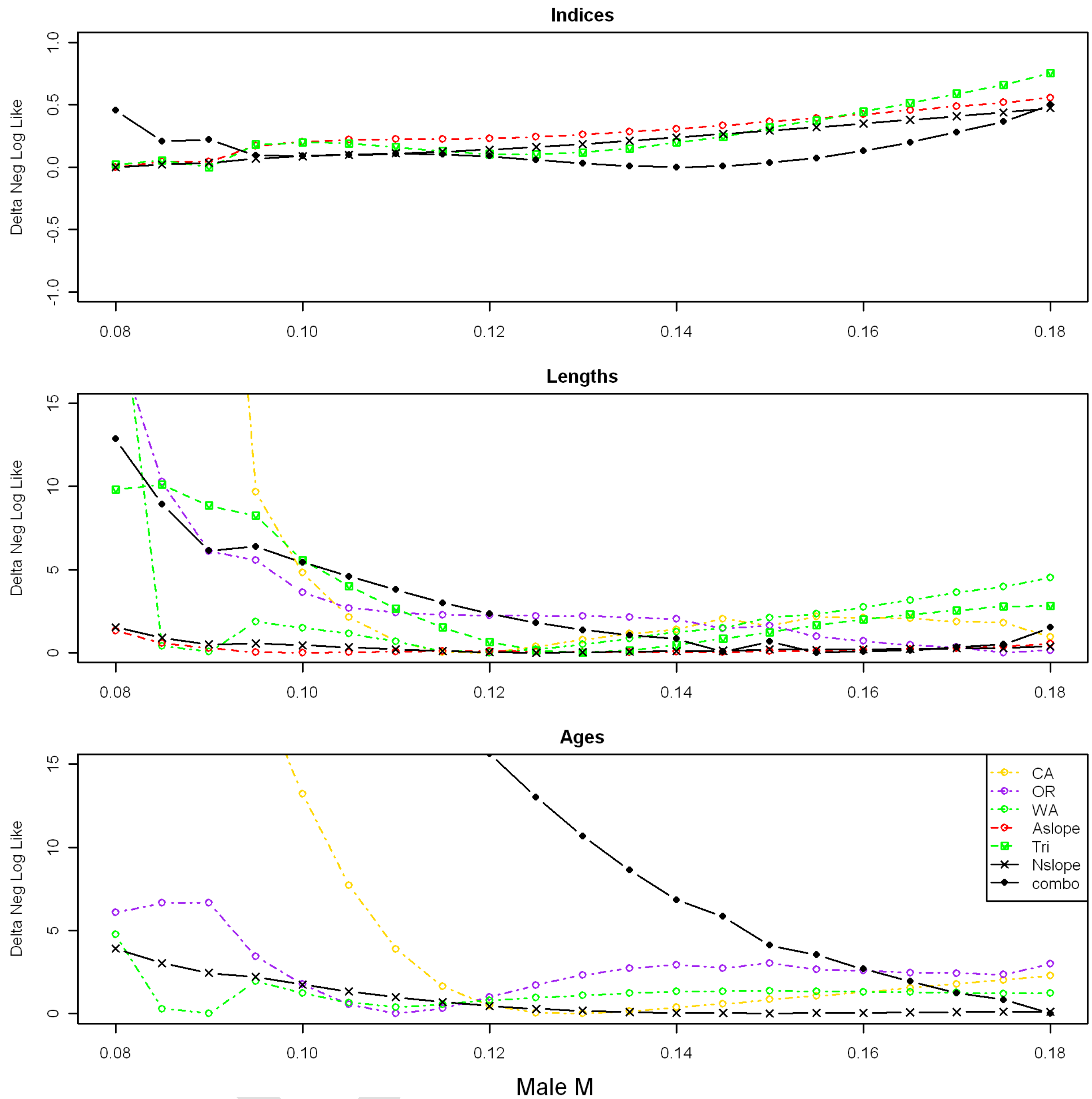


Figure 100: Likelihood components for a slice of the joint profile over natural mortality relative to the minimum likelihood for that data source. Female *M* was fixed at 0.115 and male *M* ranged from 0.08 to 0.18.

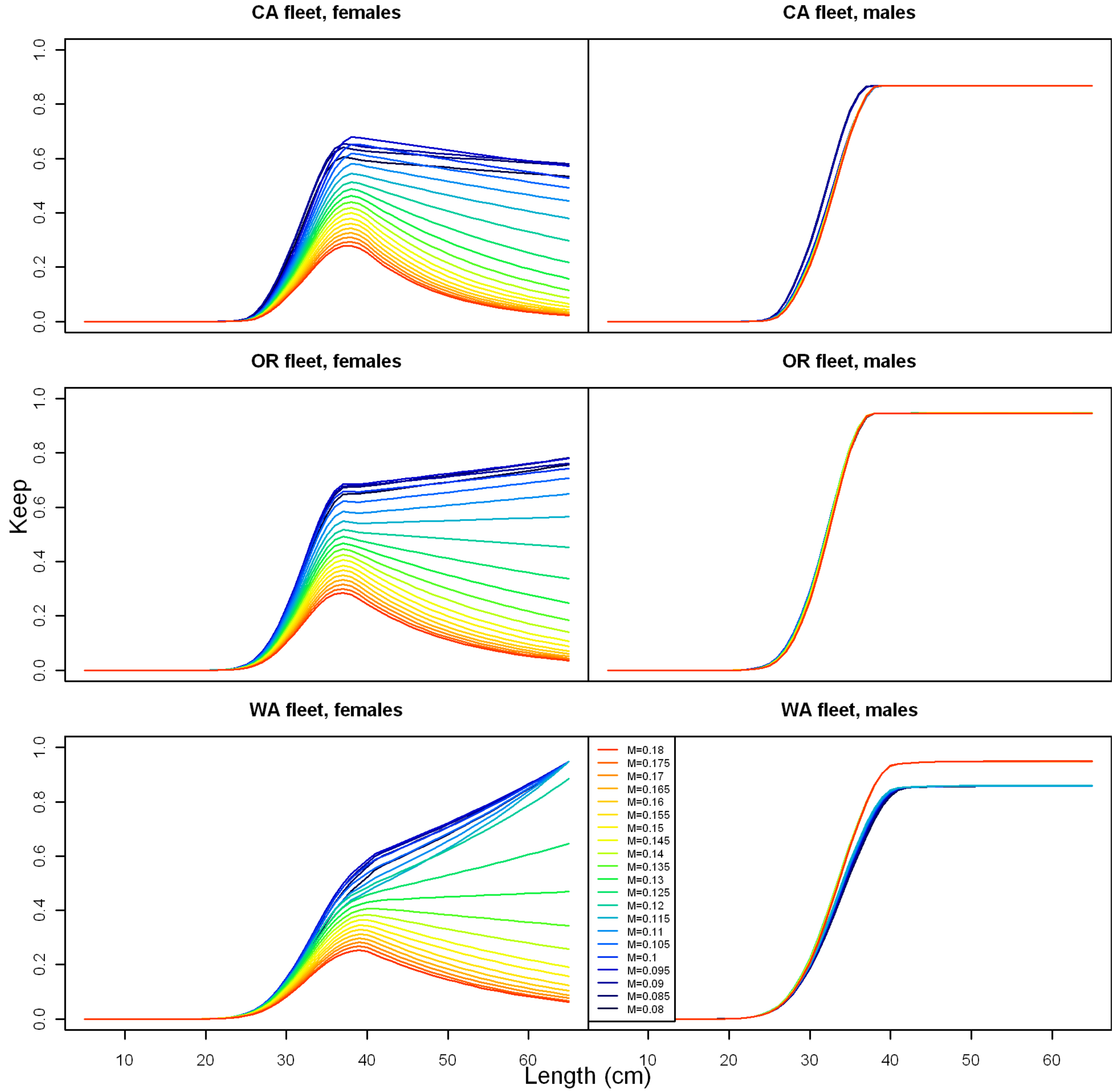


Figure 101: Estimated keep curves (selectivity times retention) for the commercial fleets with changing male natural mortality and female natural mortality fixed at 0.115. Blue colors indicate small values of male *M* and increasing values of male *M* proceed through oranges, yellow, greens and finally reds.

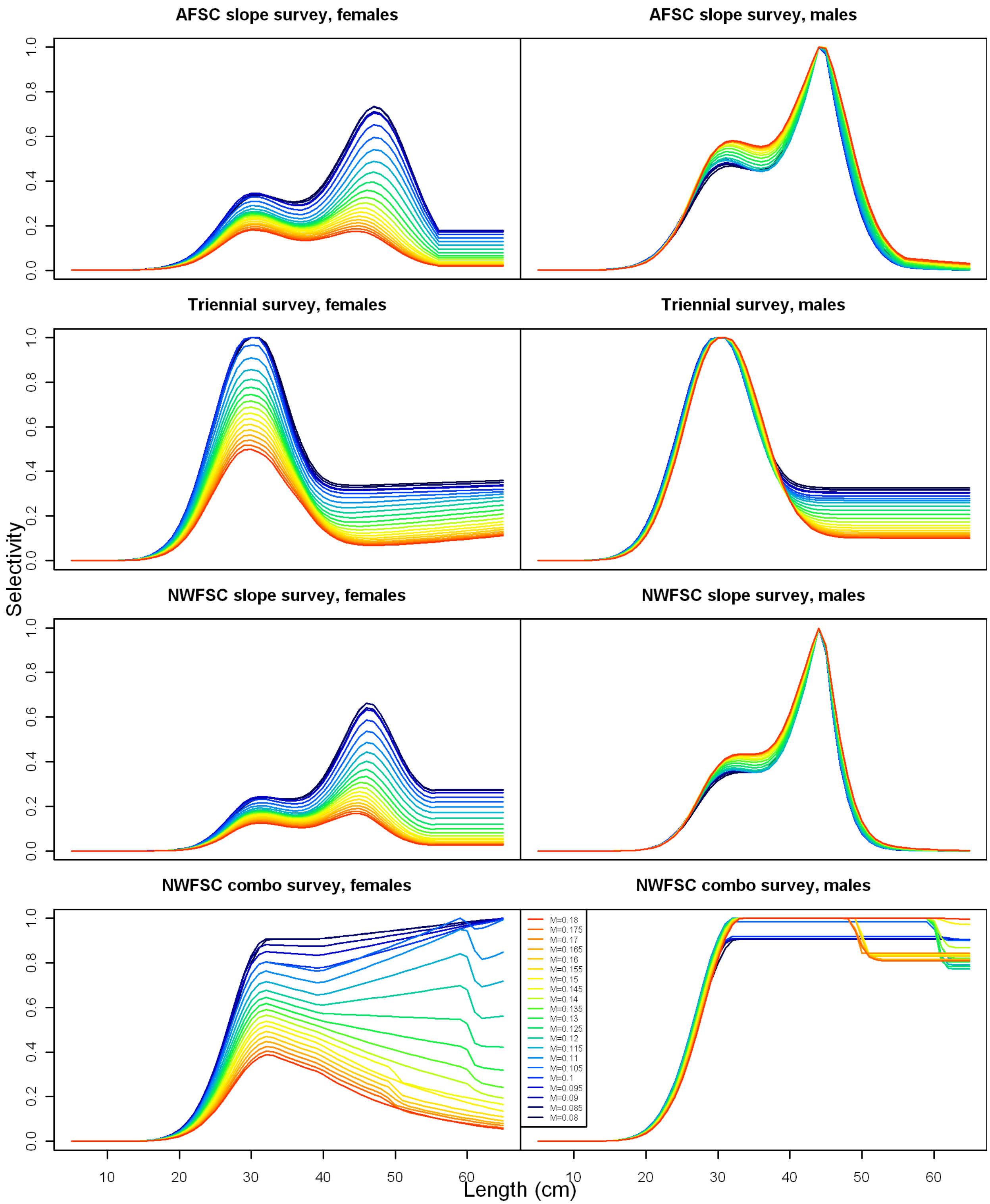


Figure 102: Estimated selectivity curves for surveys with changing male natural mortality and female natural mortality fixed at 0.115. Blue colors indicate small values of male *M* and increasing values of male *M* proceed through oranges, yellow, greens and finally reds.

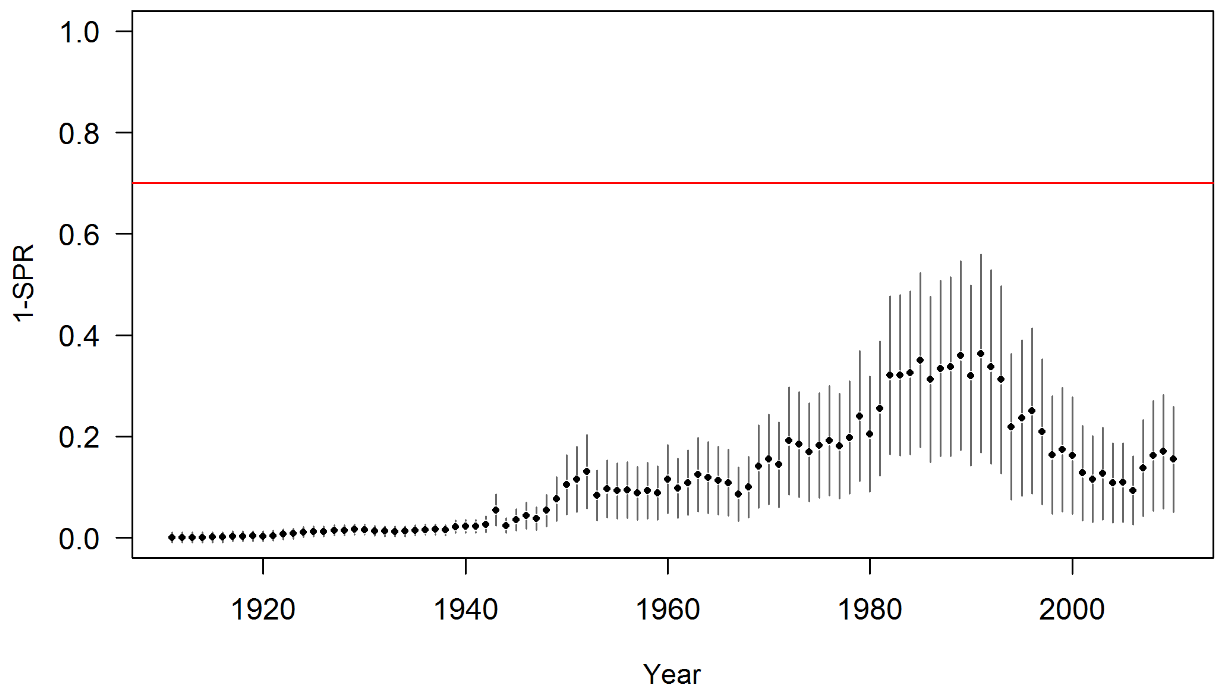


Figure 103. Estimated spawning potential ratio (SPR) for the base case model with approximate 95% asymptotic confidence intervals. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{30\%}$..

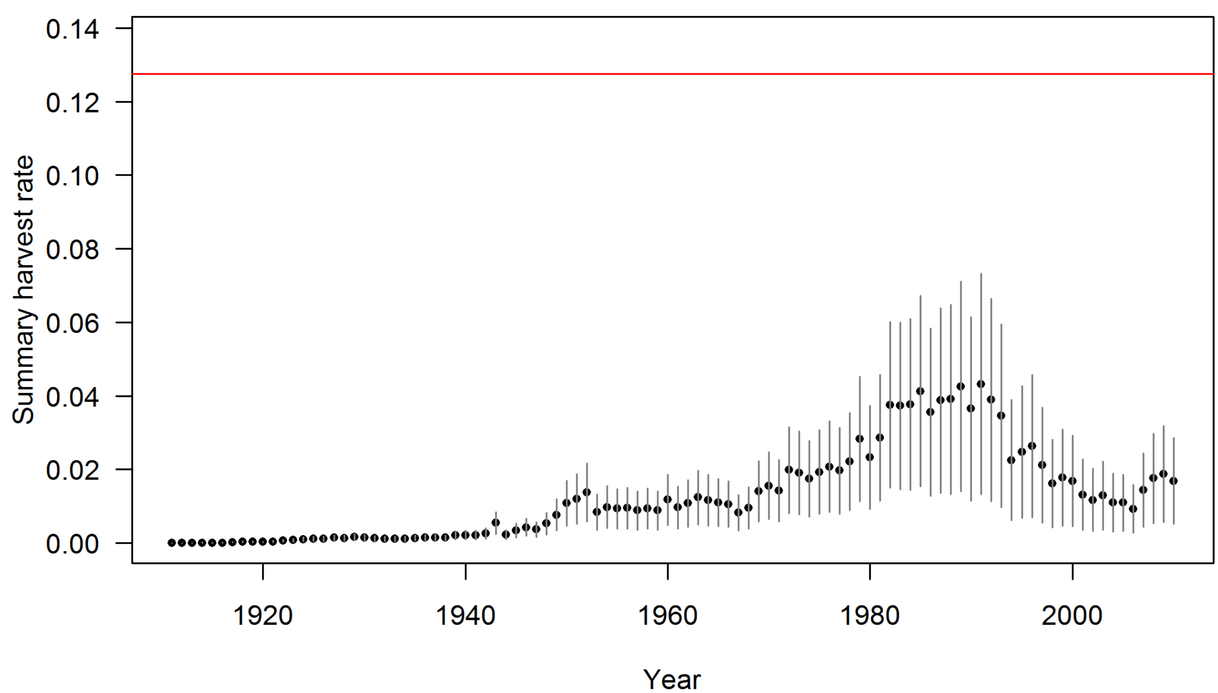


Figure 104. Time-series of estimated summary harvest rate (total catch divided by age-5 and older biomass) for the base case model (round points) with approximate 95% asymptotic confidence intervals (grey lines). The red line is the harvest rate at the overfishing proxy using $SPR_{30\%}$.

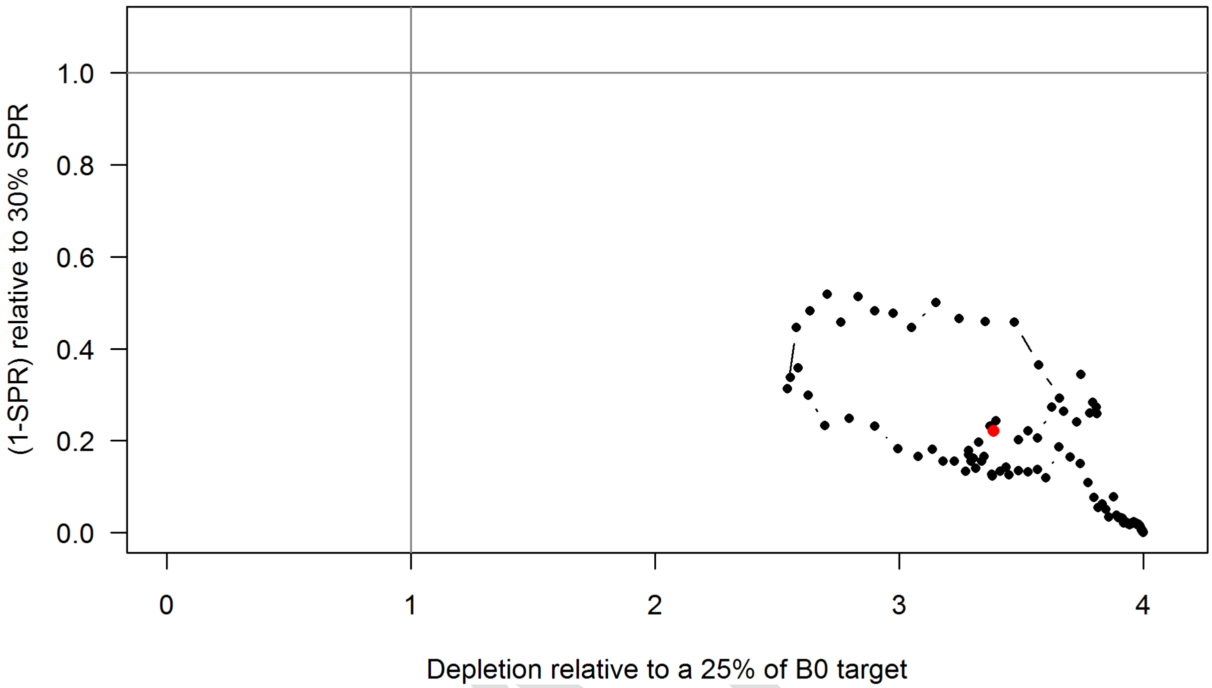


Figure 105. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 0.3 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 25% of the unfished spawning biomass. The red point indicates the year 2010.

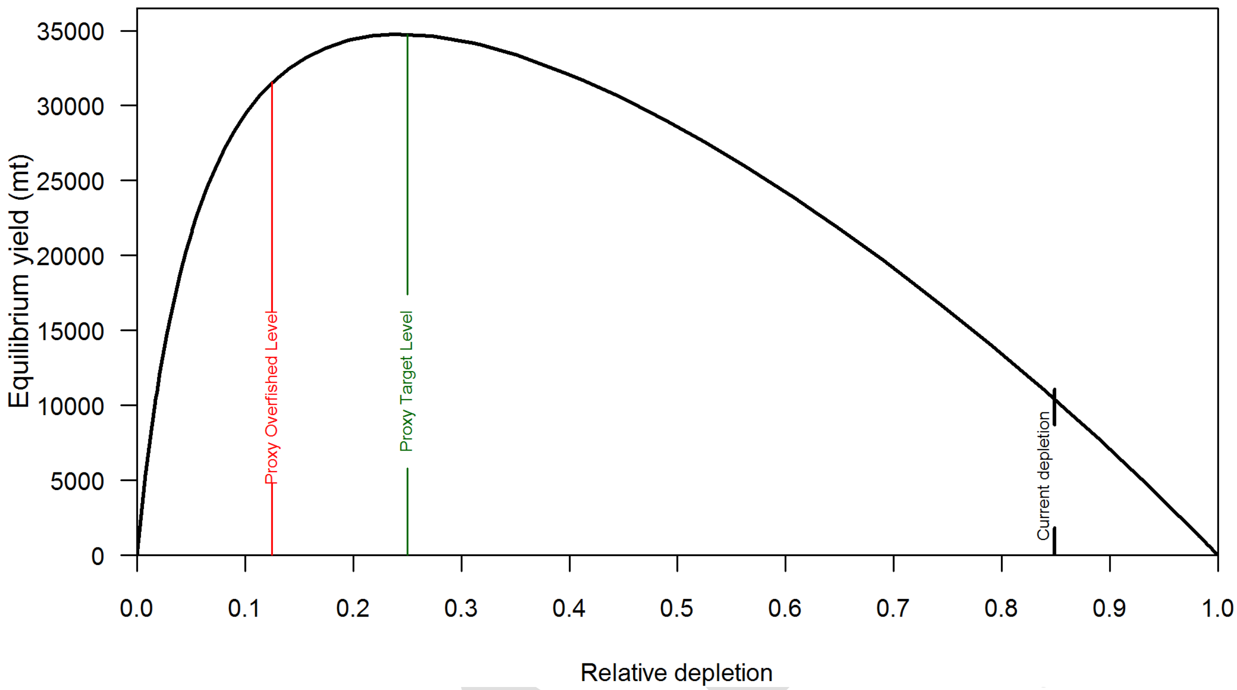


Figure 106. Equilibrium yield curve (derived from reference point values reported in Table i) for the base case model. Values are based on 2010 fishery selectivity and distribution with steepness fixed at 0.8. The depletion is relative to unfished spawning biomass.

Appendix A. Fits to length and age composition data

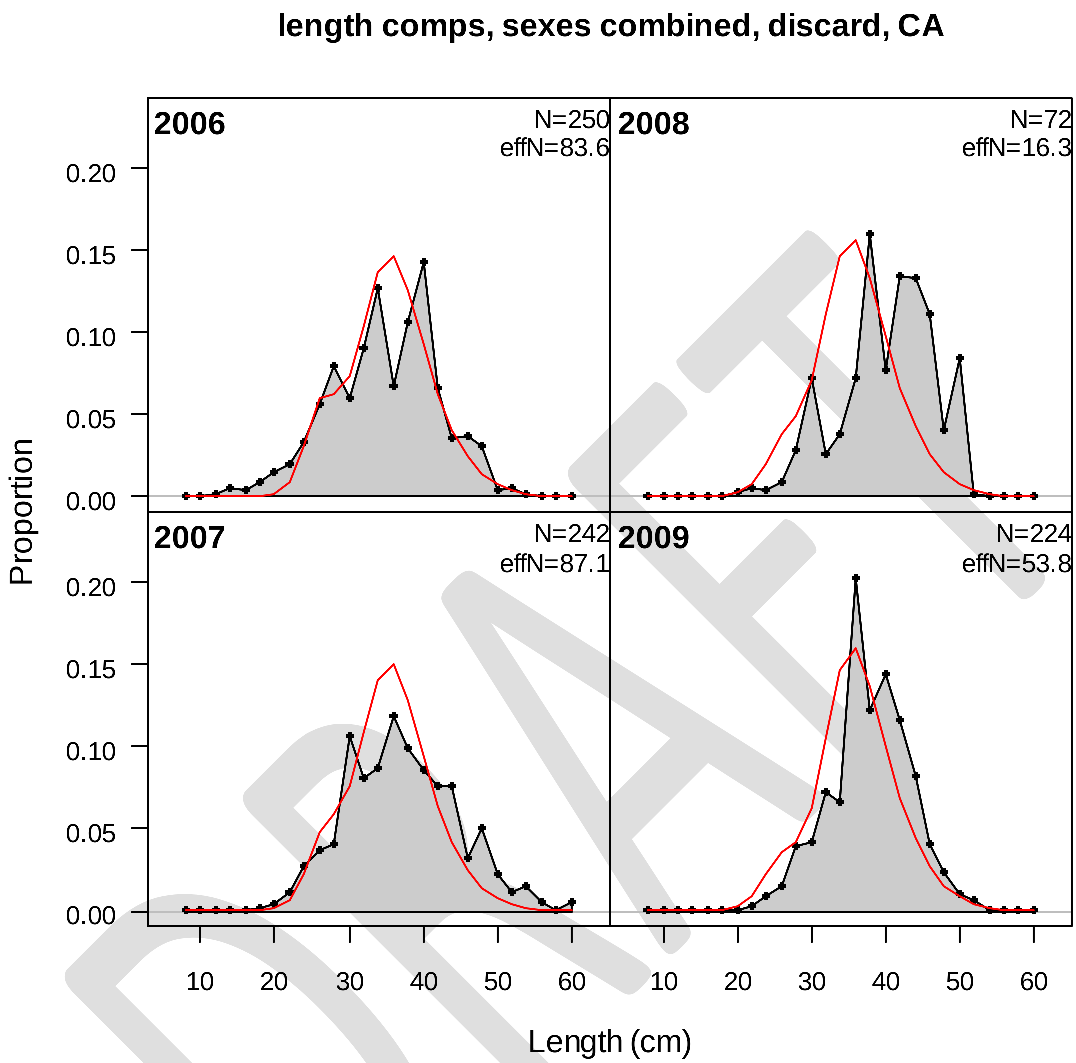


Figure A.1. Model fits (red line) to observed discard length composition data (both sexes) for California.

length comps, female, retained, CA

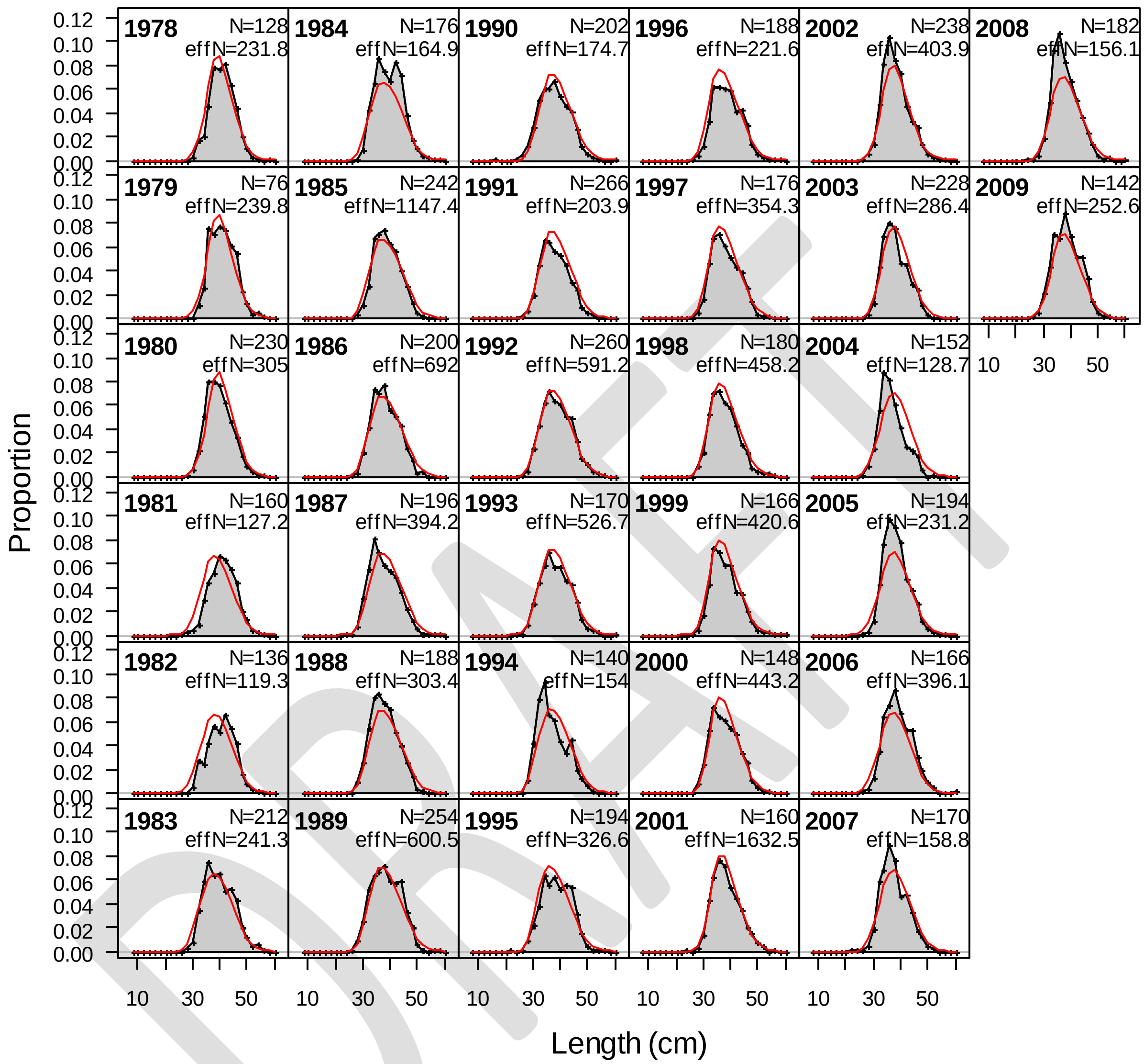


Figure A.2. Model fits (red line) to observed female length composition data for California.

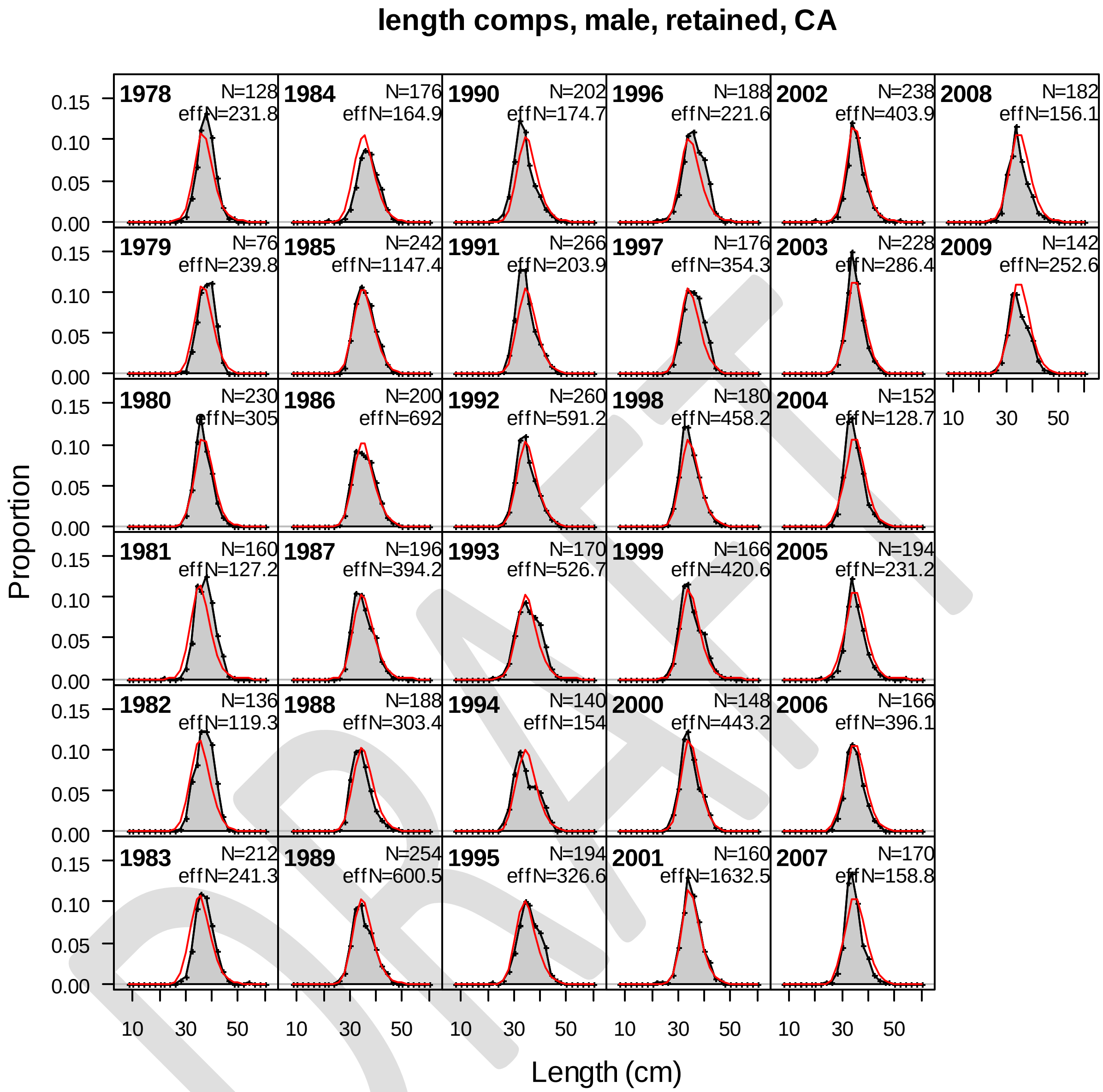


Figure A.3. Model fits (red line) to observed male length composition data for California.

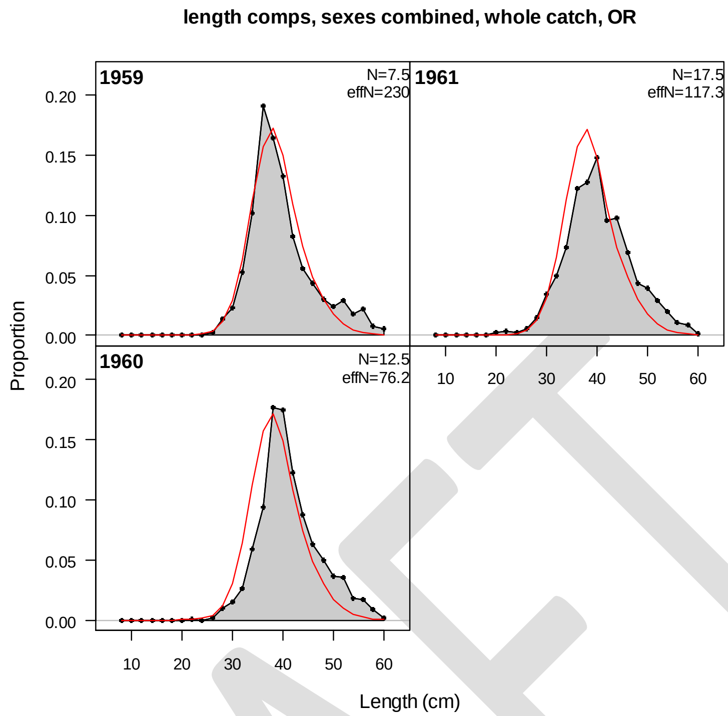


Figure A.4. Model fits (red line) to observed whole catch length composition data (sexes combined) for Oregon.

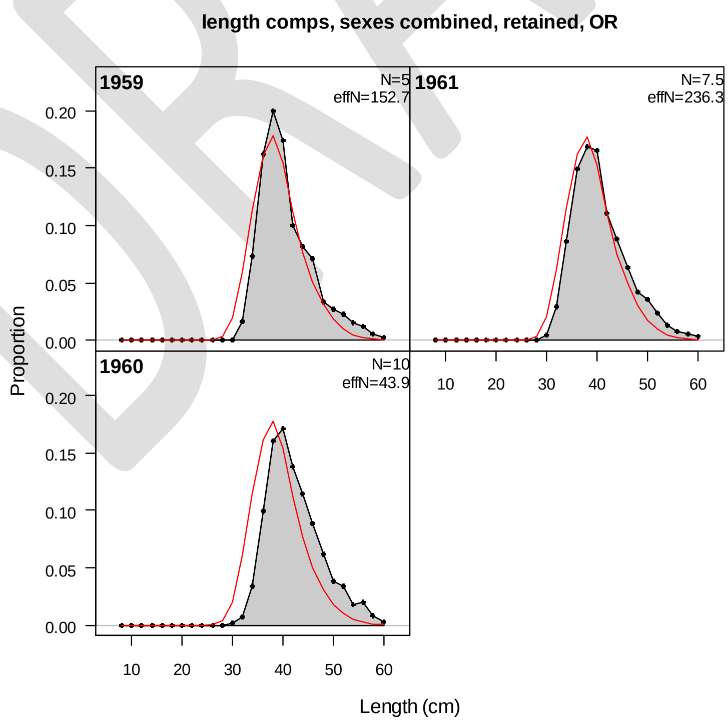
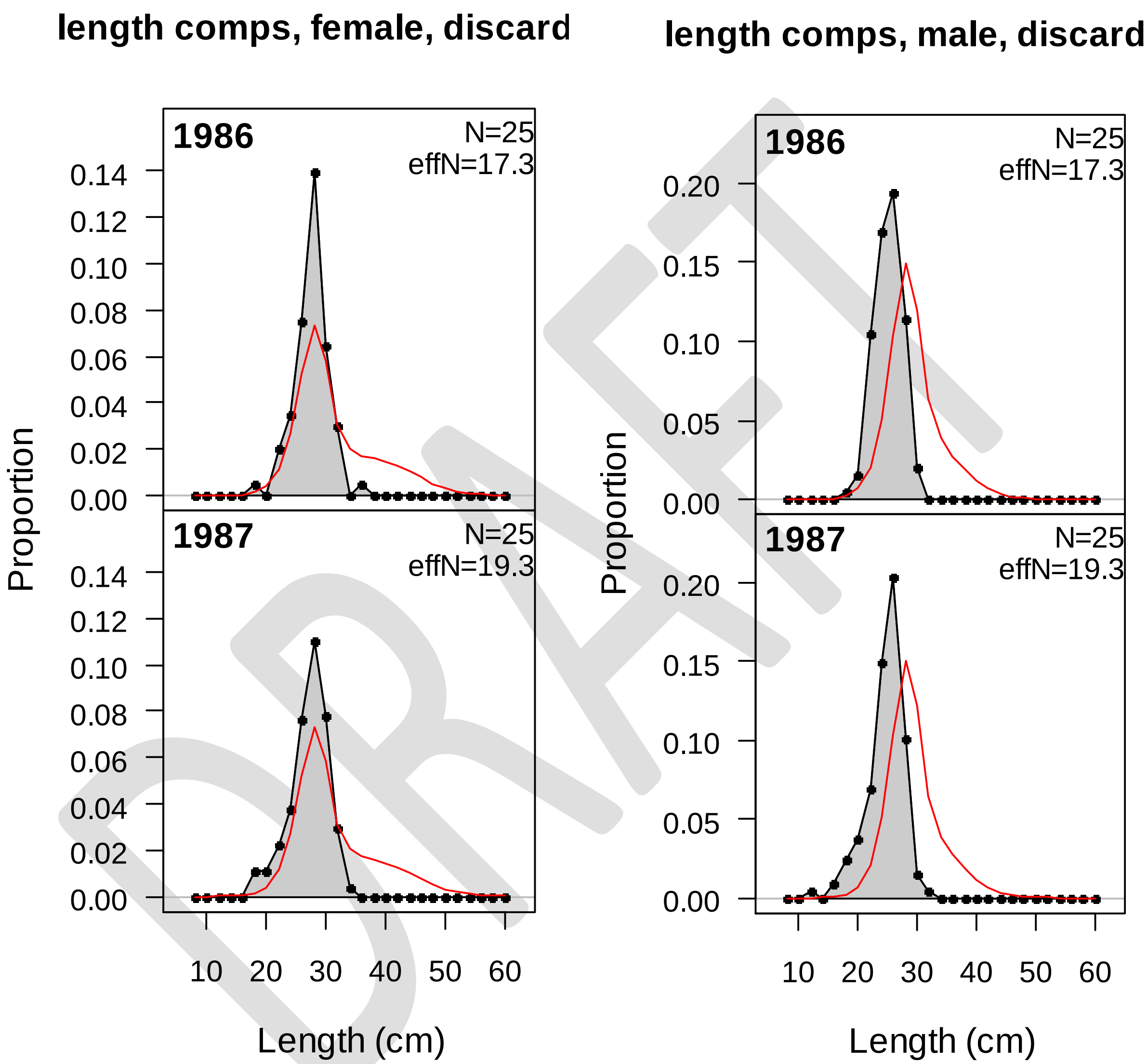


Figure A.5. Model fits (red line) to observed retained length composition data (sexes combined) for Oregon.

length comps, female, discard, OR　　　　length comps, male, discard, OR



Length (cm)

Figure A.6. Model fits (red line) to the Pikitch study discard length composition data for female (left) and male (right) fish for Oregon.

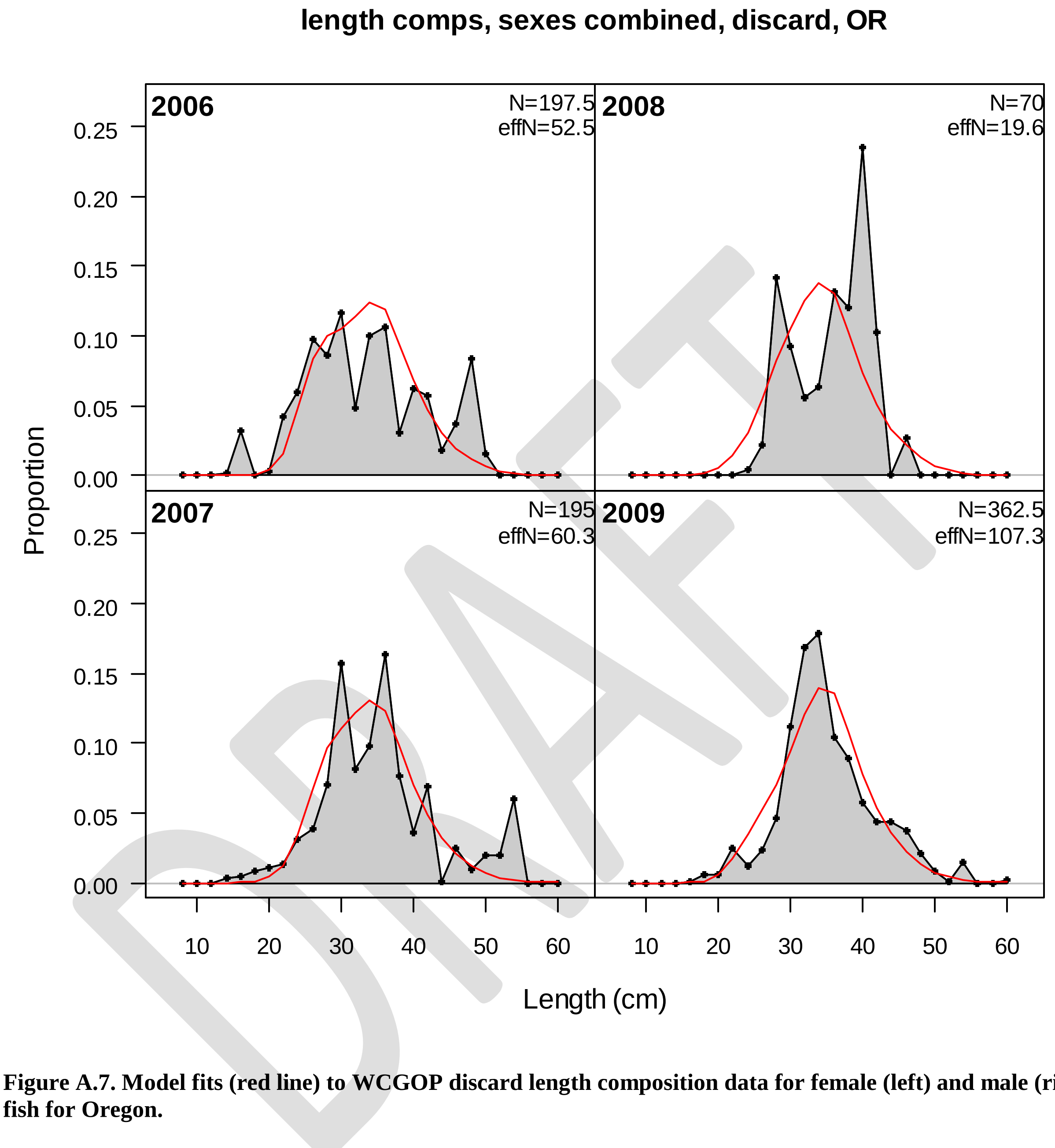


Figure A.7. Model fits (red line) to WCGOP discard length composition data for female (left) and male (right) fish for Oregon.

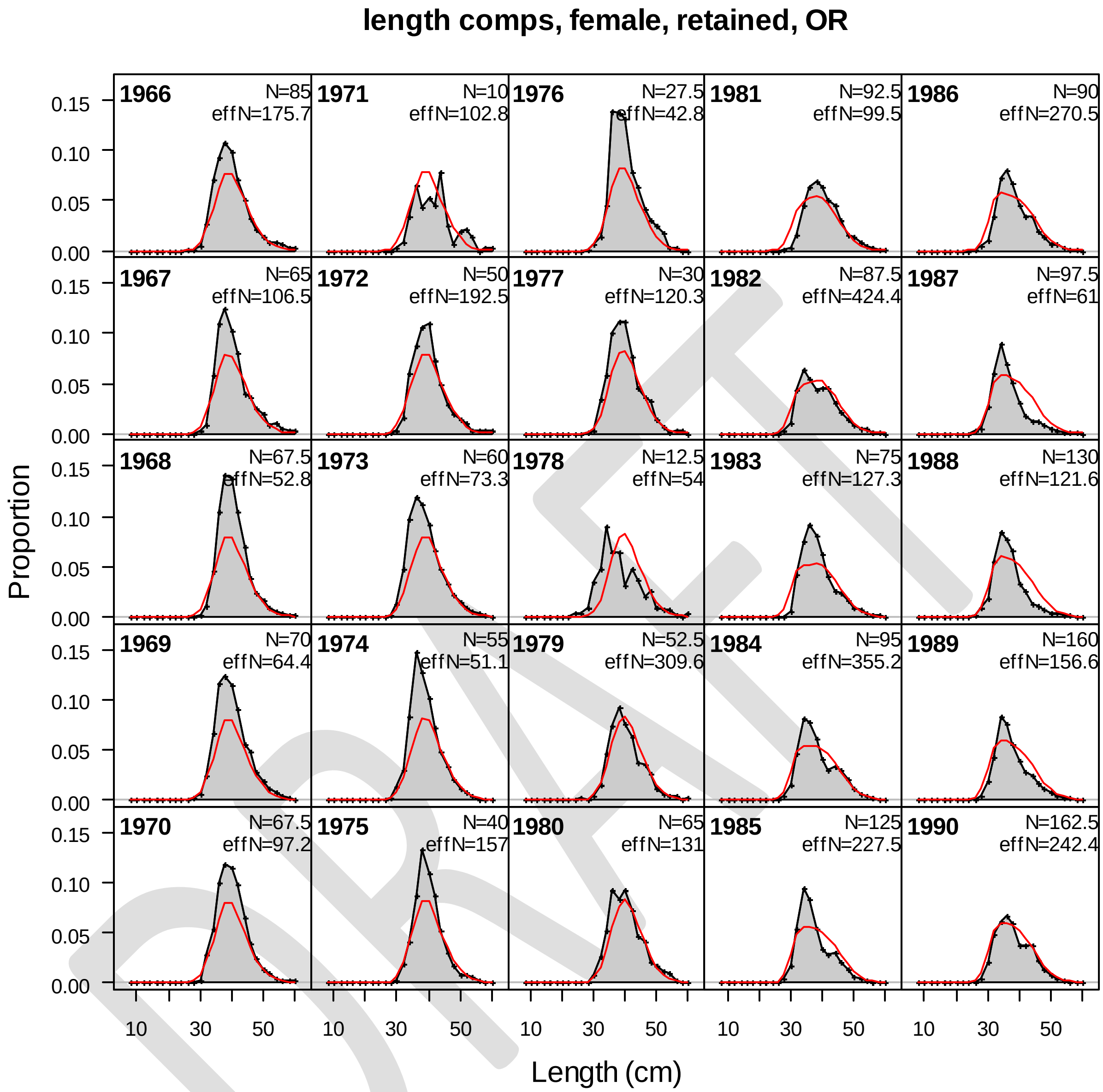


Figure A.8. Model fits (red line) to commercial length composition data for females for Oregon.

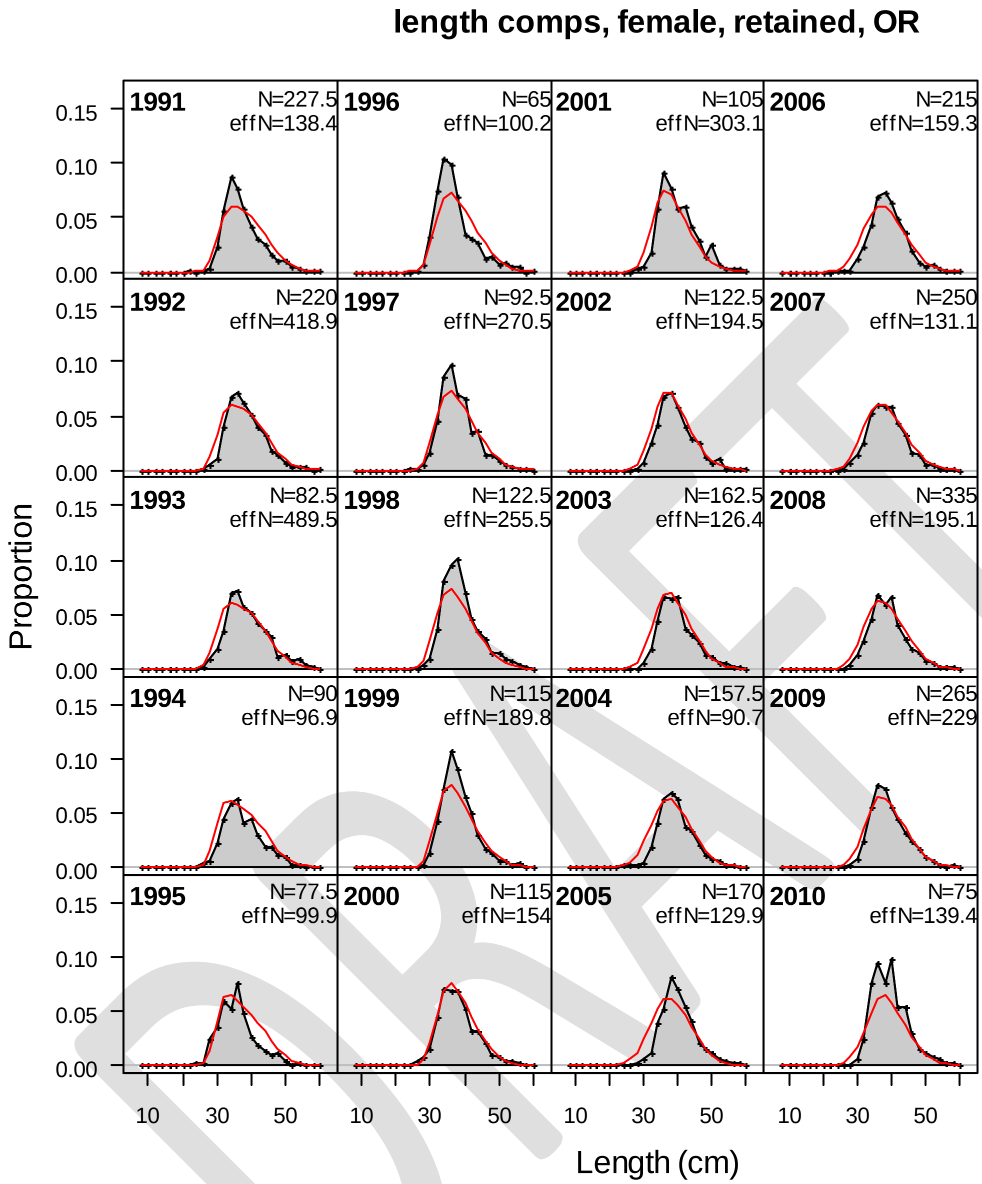


Figure A.8. (cont). Model fits (red line) to commercial length composition data for females for Oregon.

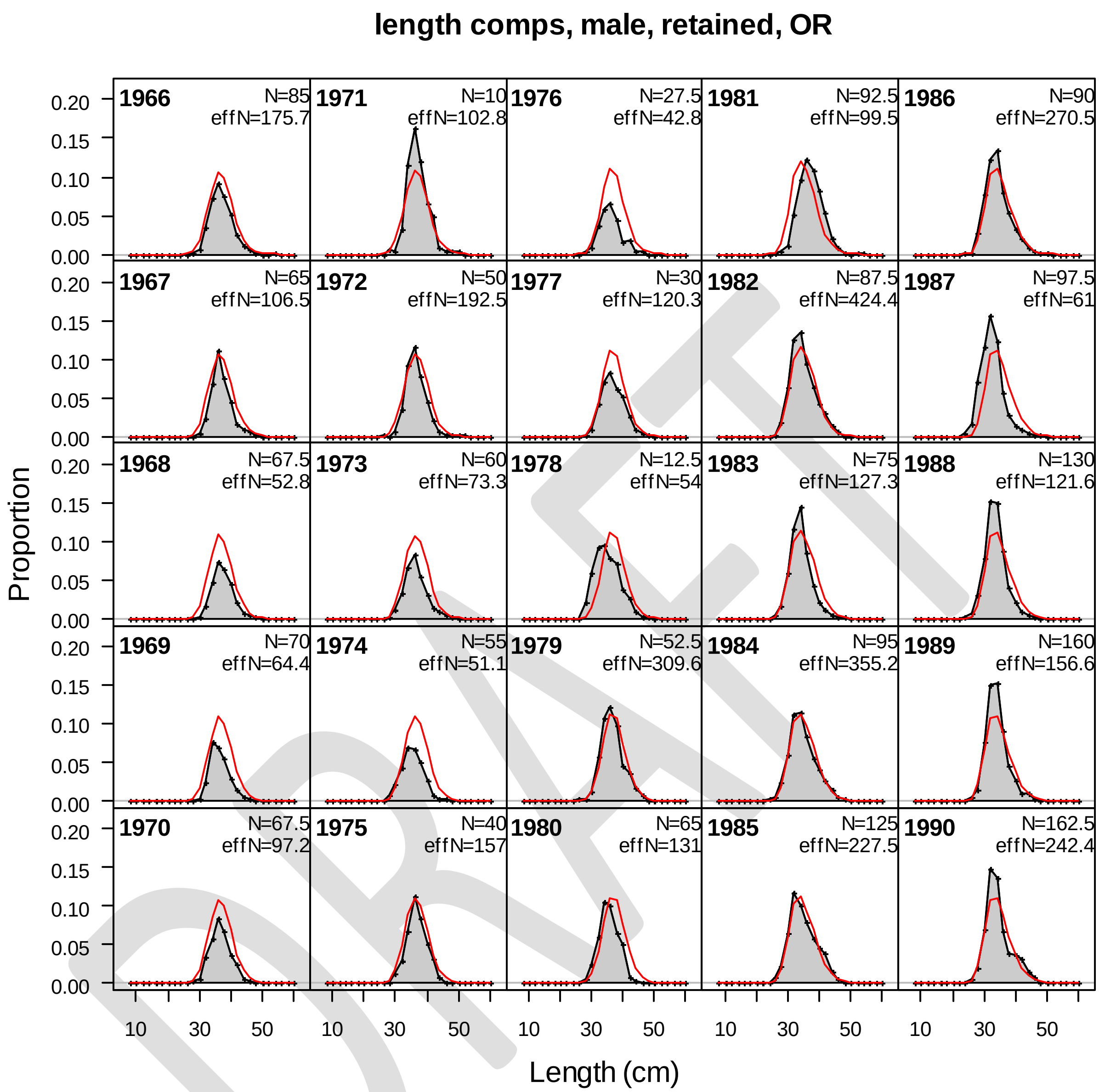


Figure A.9. Model fits (red line) to commercial length composition data for males for Oregon.

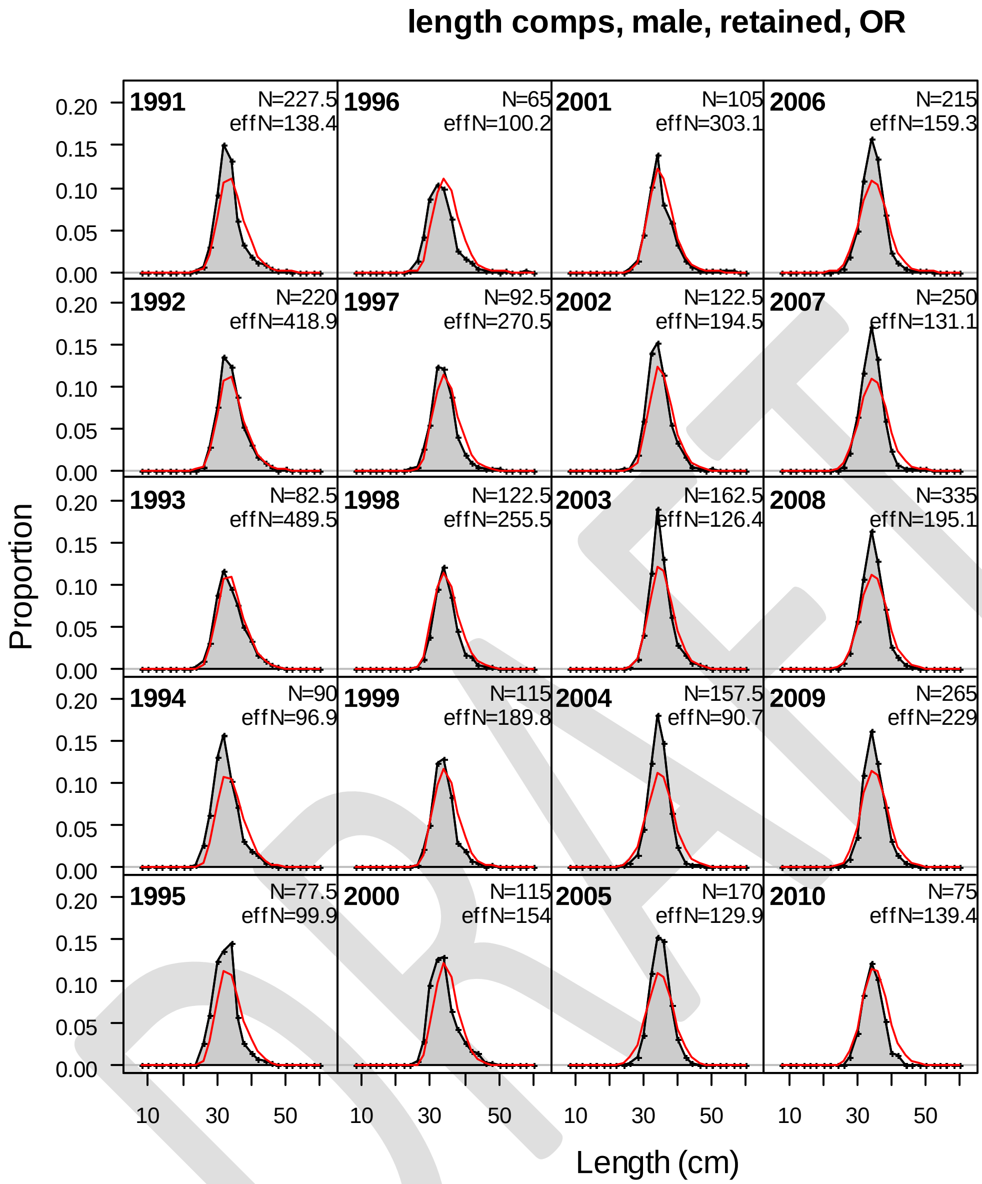


Figure A.9. (cont). Model fits (red line) to commercial length composition data for females for Oregon.

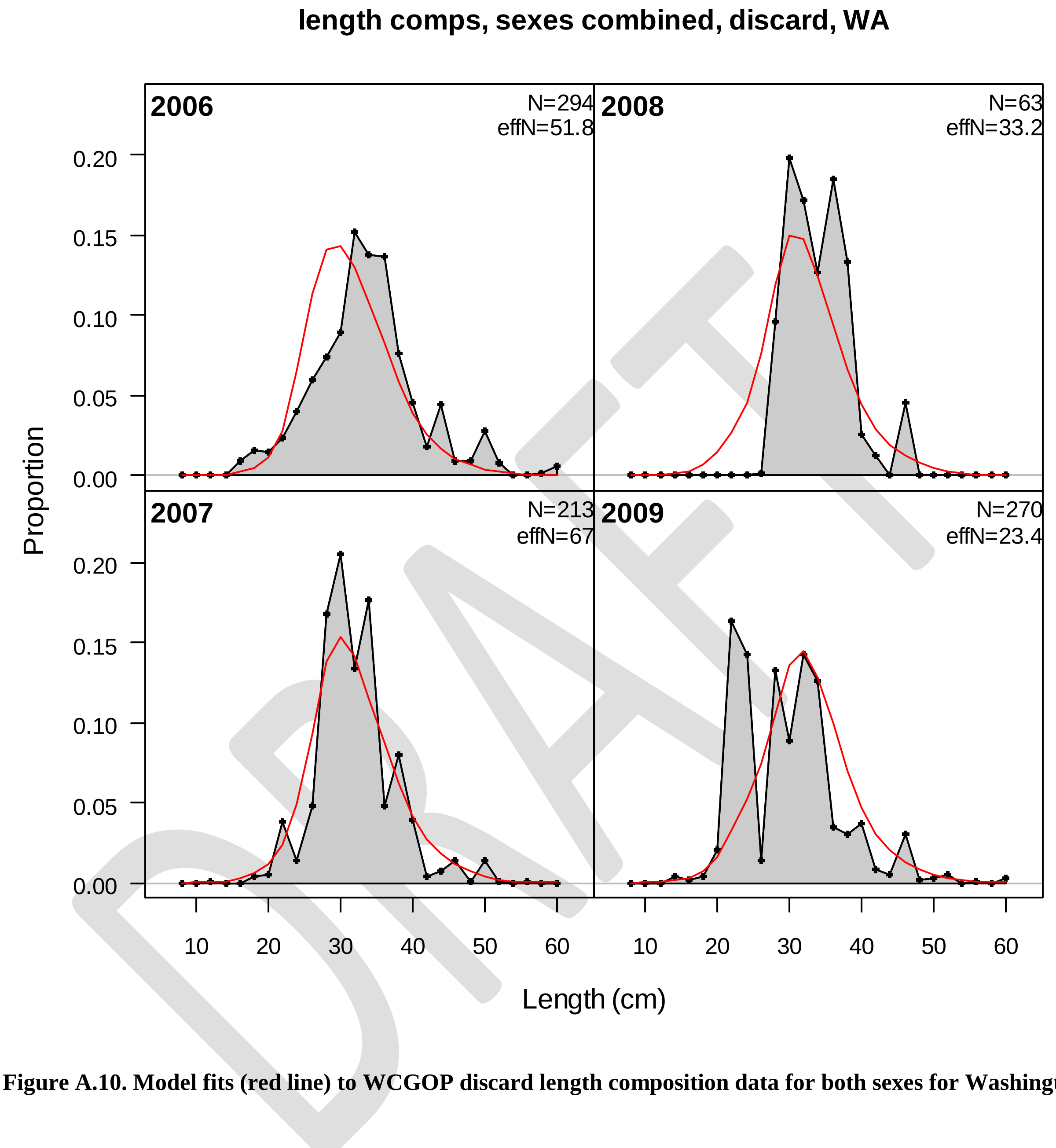


Figure A.10. Model fits (red line) to WCGOP discard length composition data for both sexes for Washington.

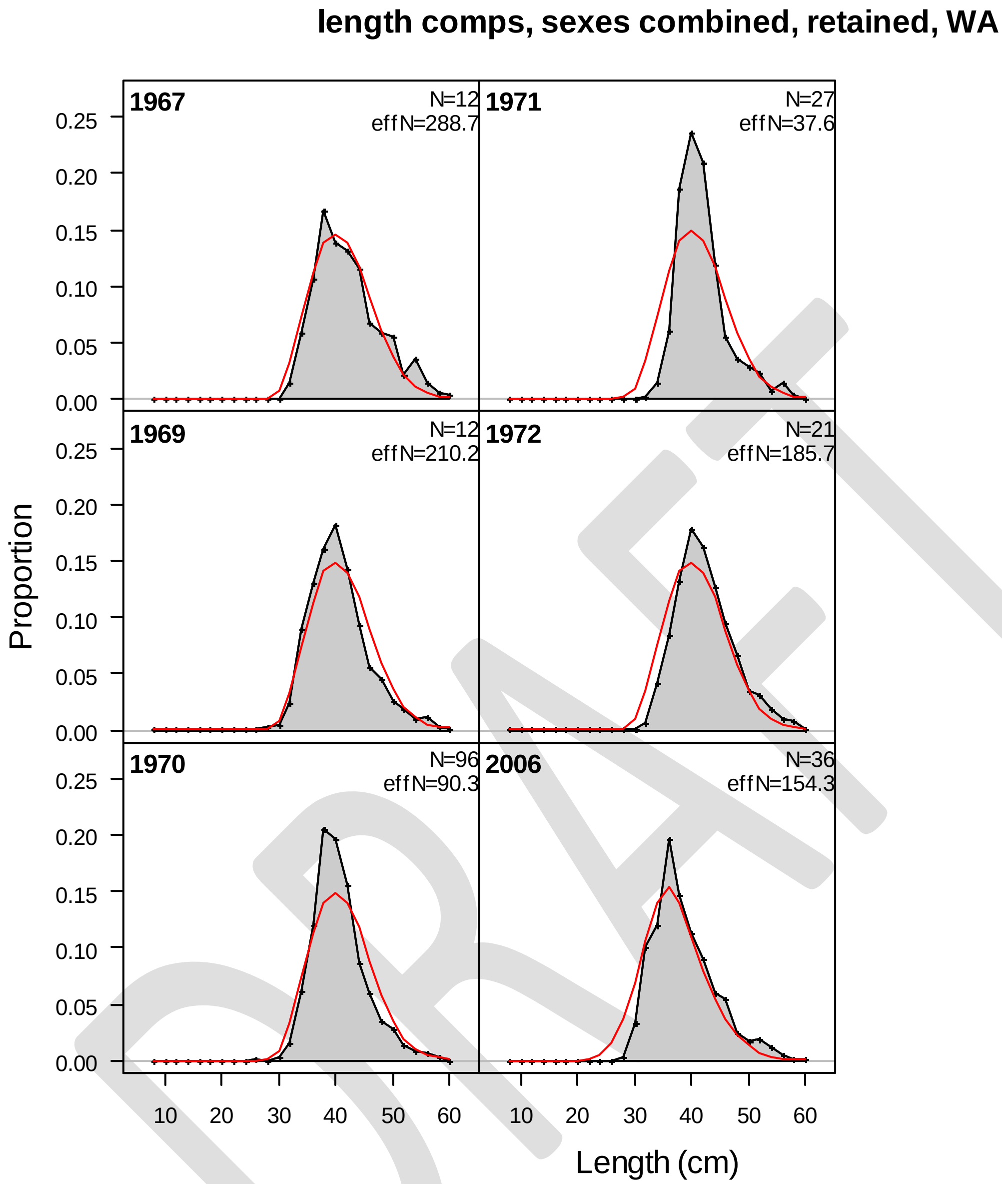


Figure A.11. Model fits (red line) to commercial length composition data for sexes combined for Washington.

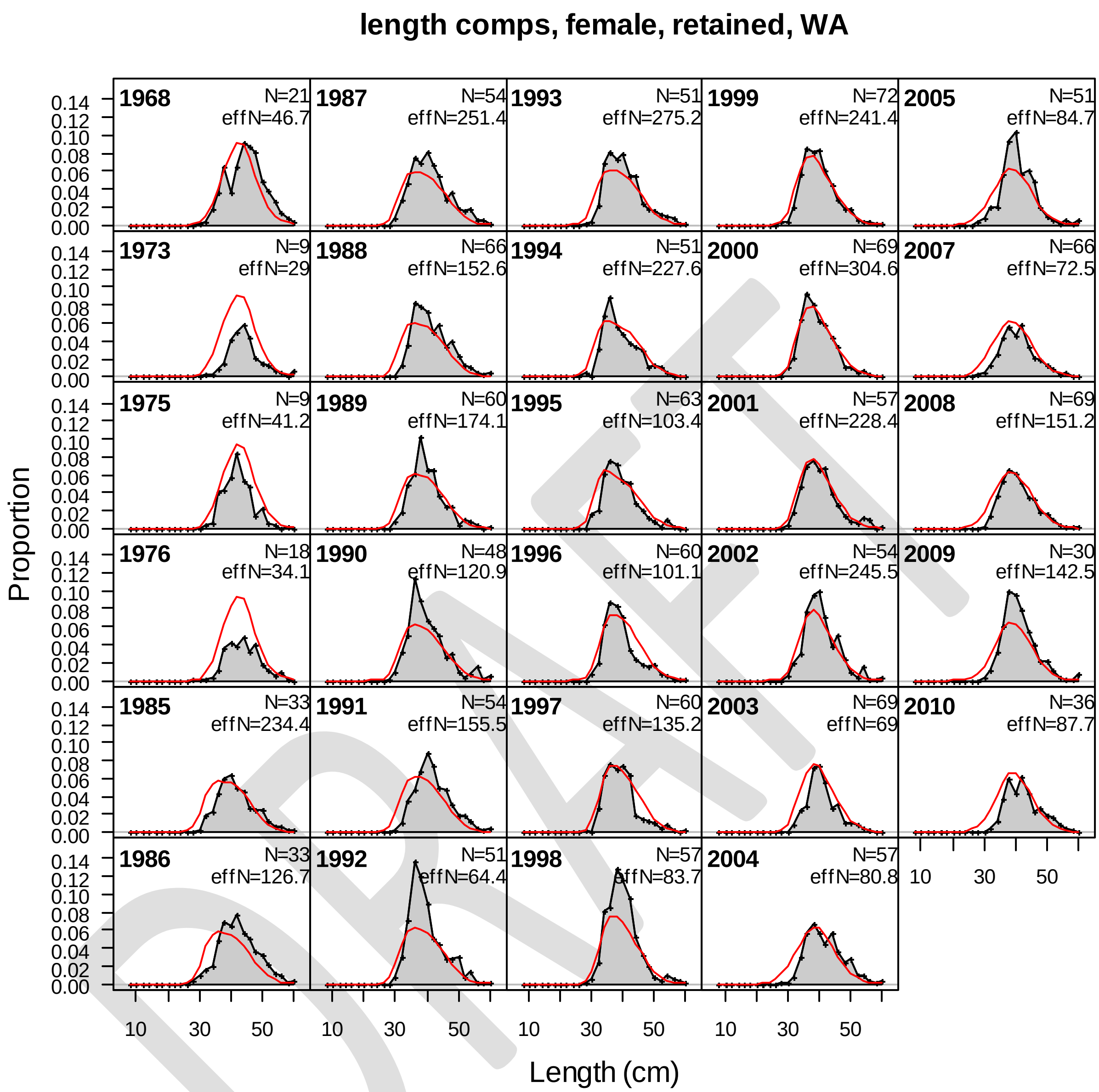


Figure A.12. Model fits (red line) to commercial length composition data for females for Washington.

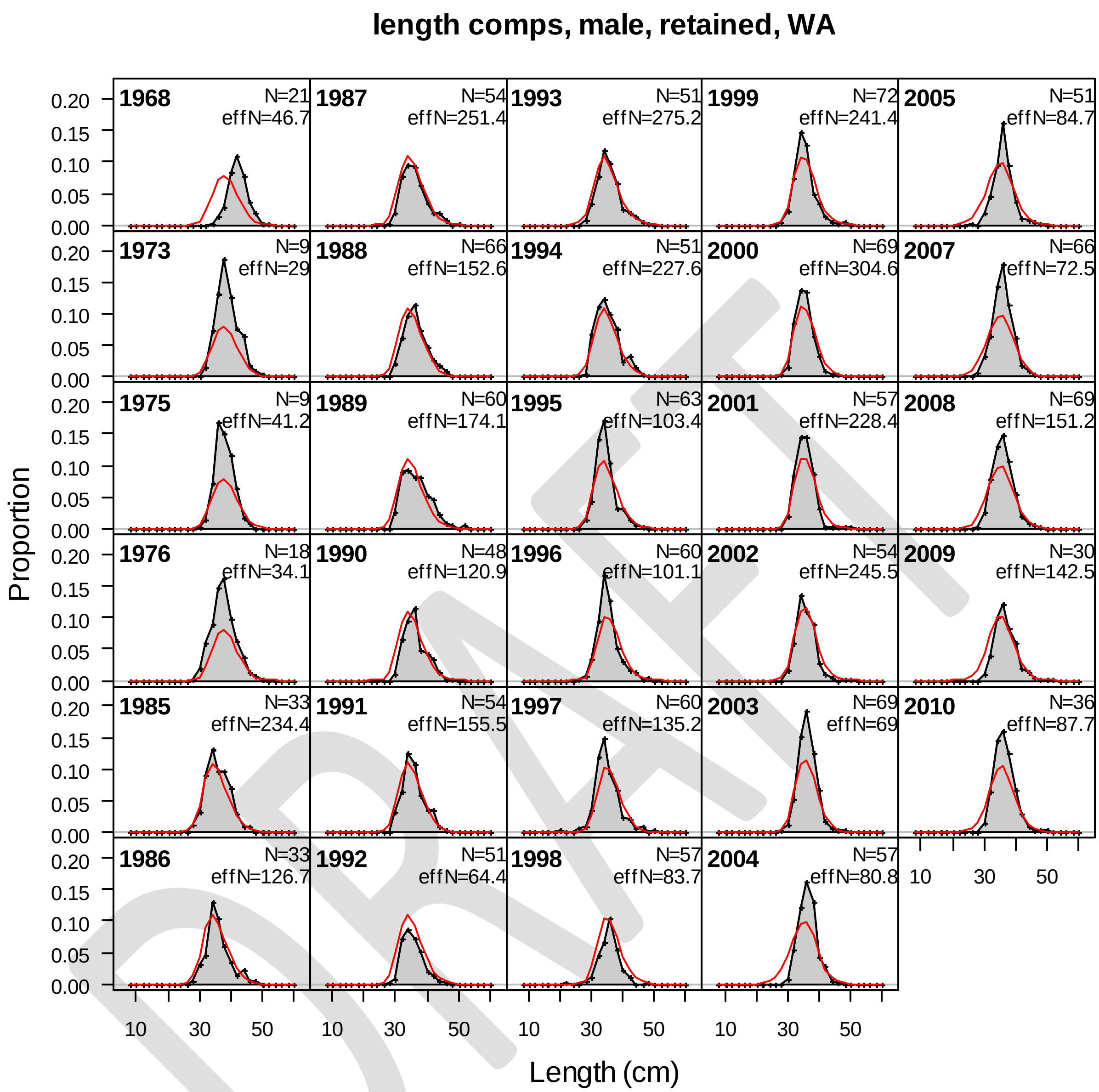


Figure A.13. Model fits (red line) to commercial length composition data for males for Washington.

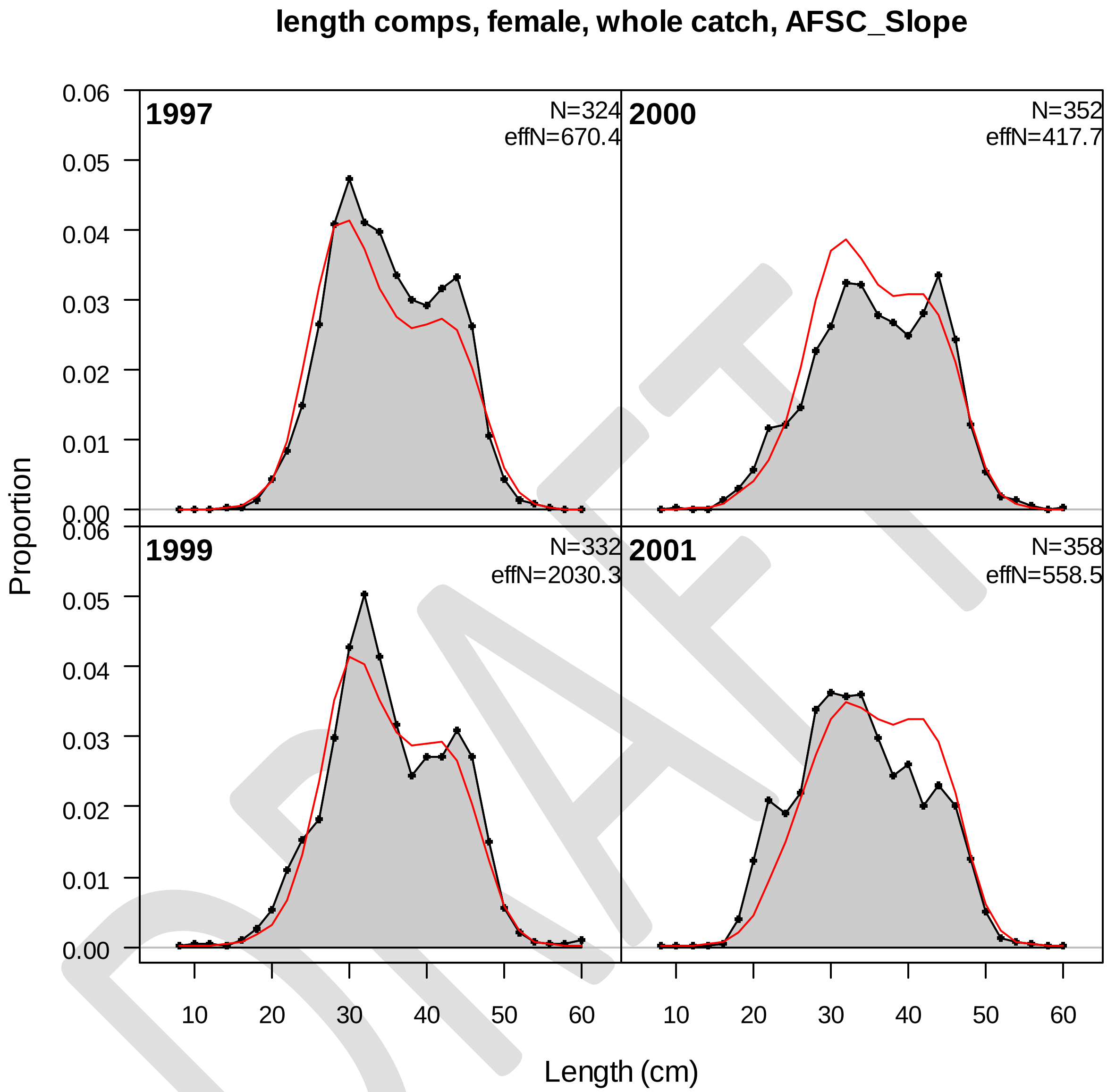


Figure A.14. Model fits (red line) to survey length composition data for females by the AFSC slope survey.

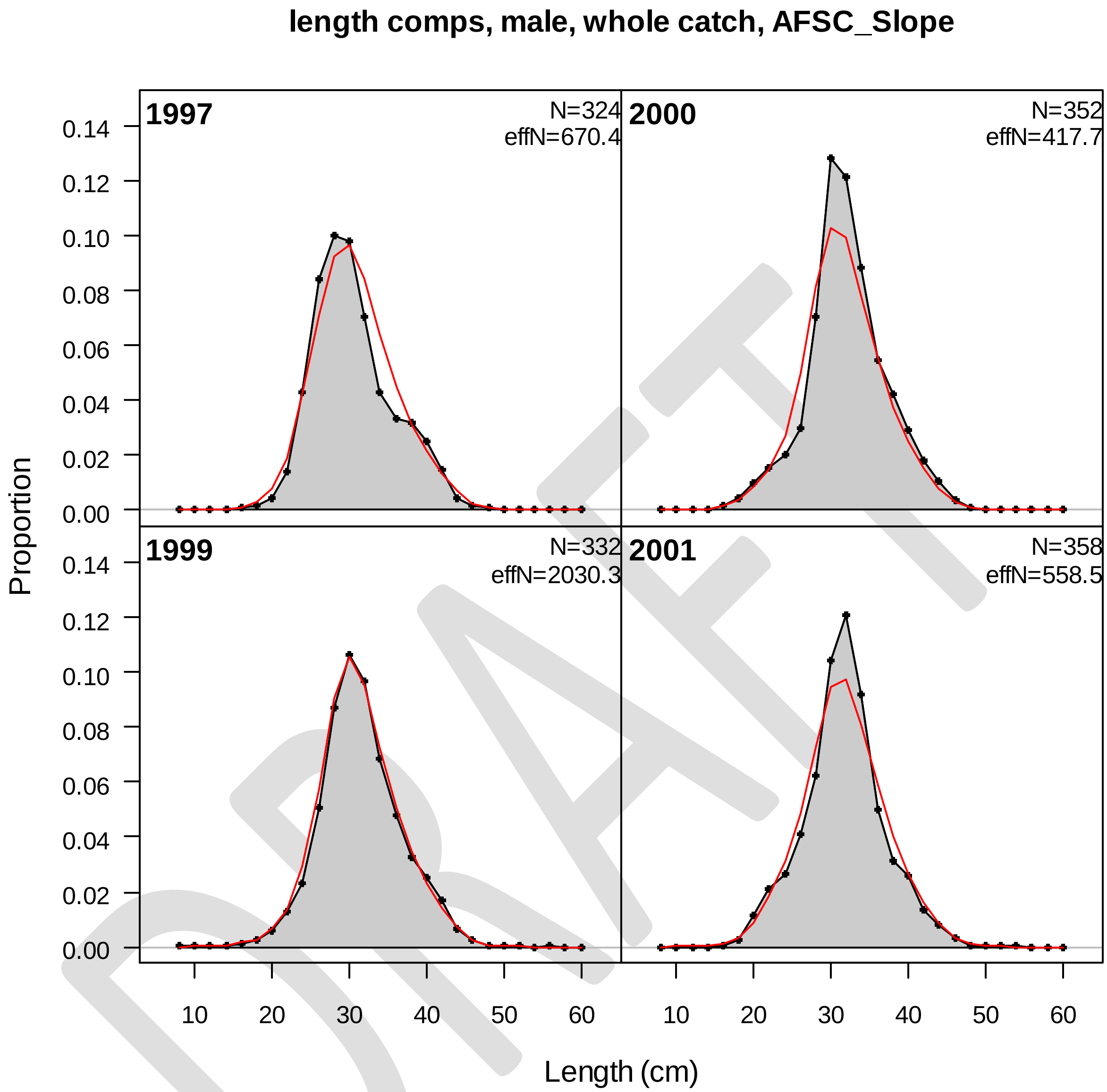


Figure A.15. Model fits (red line) to survey length composition data for males by the AFSC slope survey.

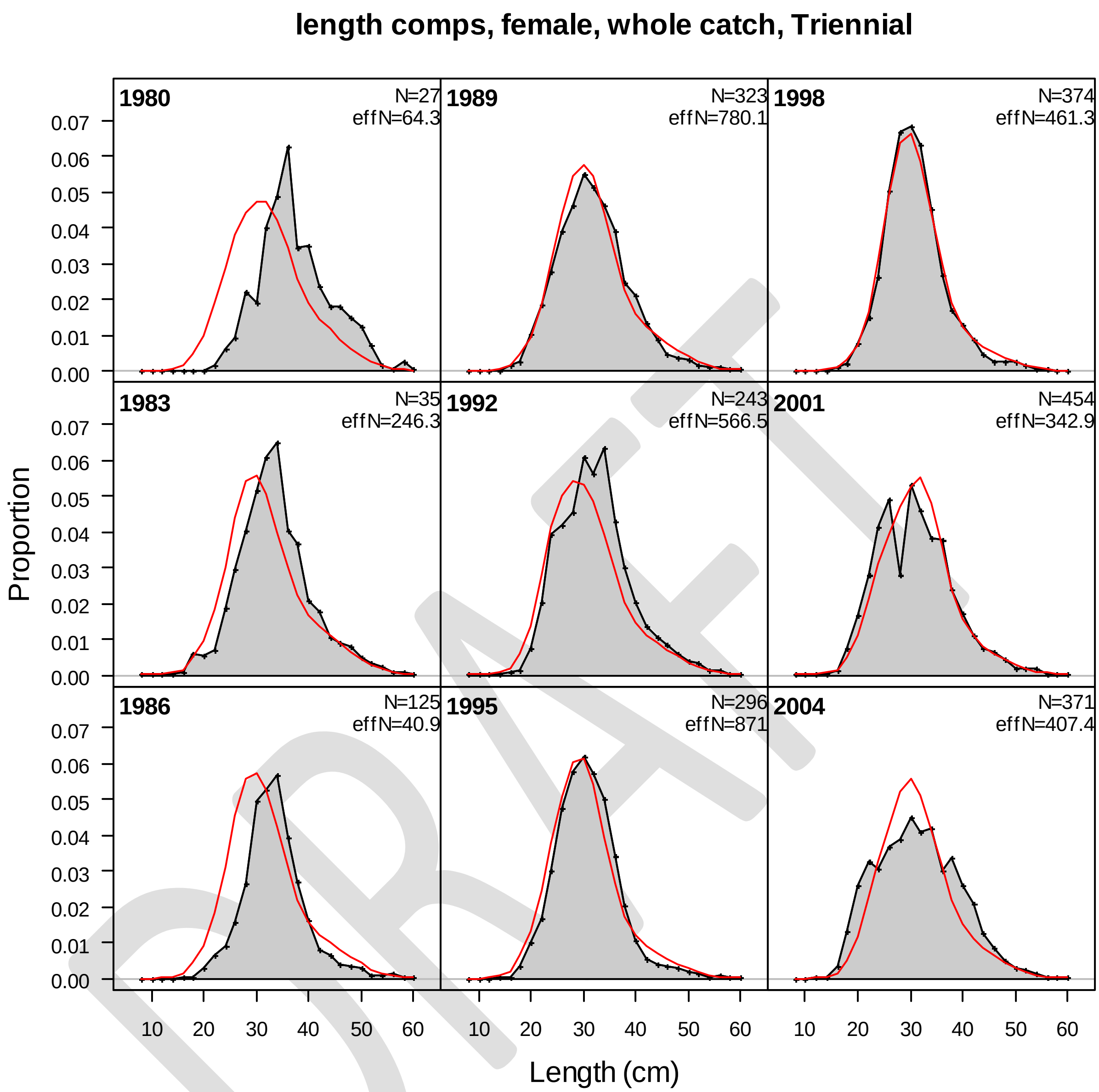


Figure A.16. Model fits (red line) to survey length composition data for females by the Triennial survey.

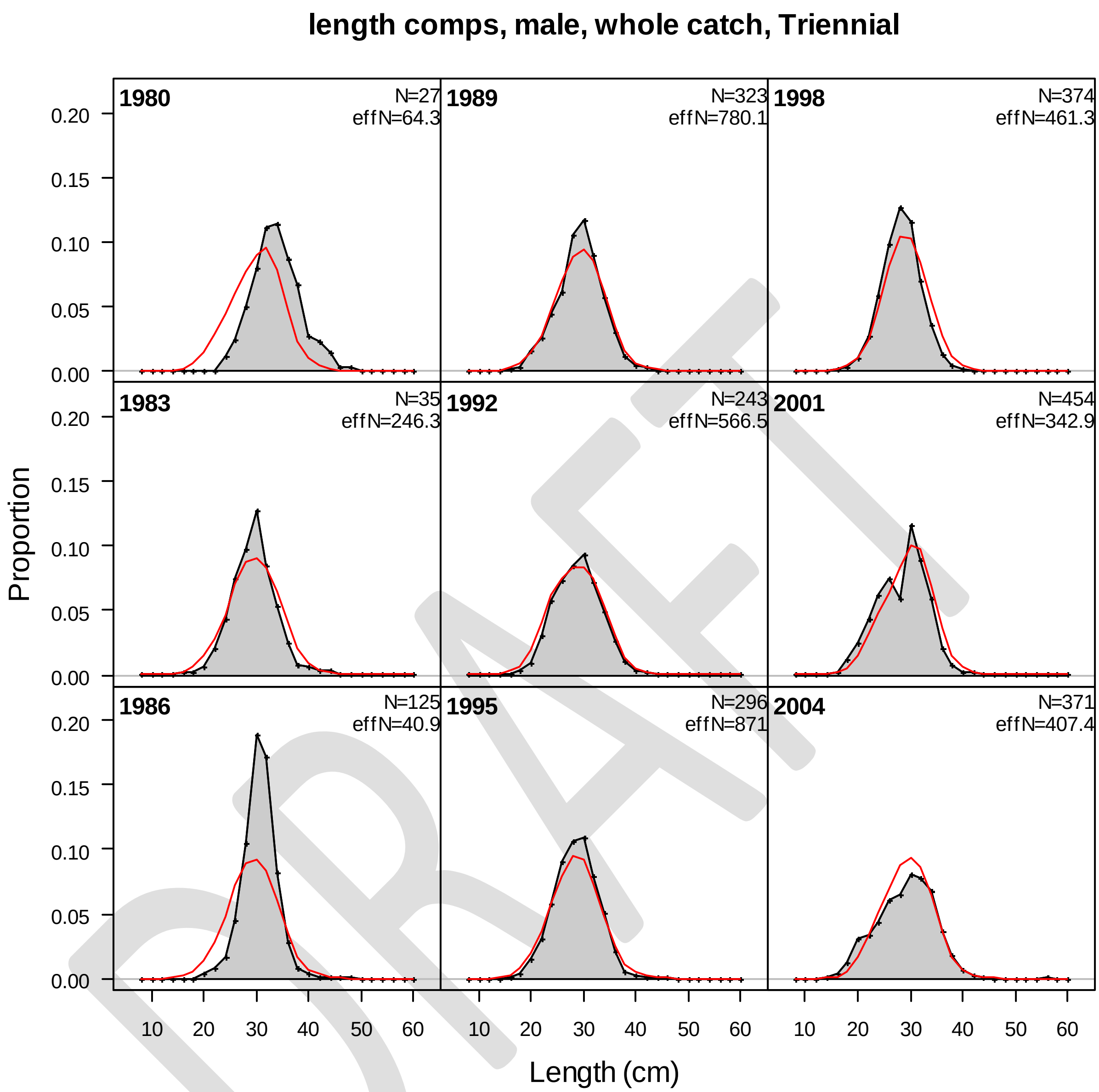


Figure A.17. Model fits (red line) to survey length composition data for males by the Triennial survey.

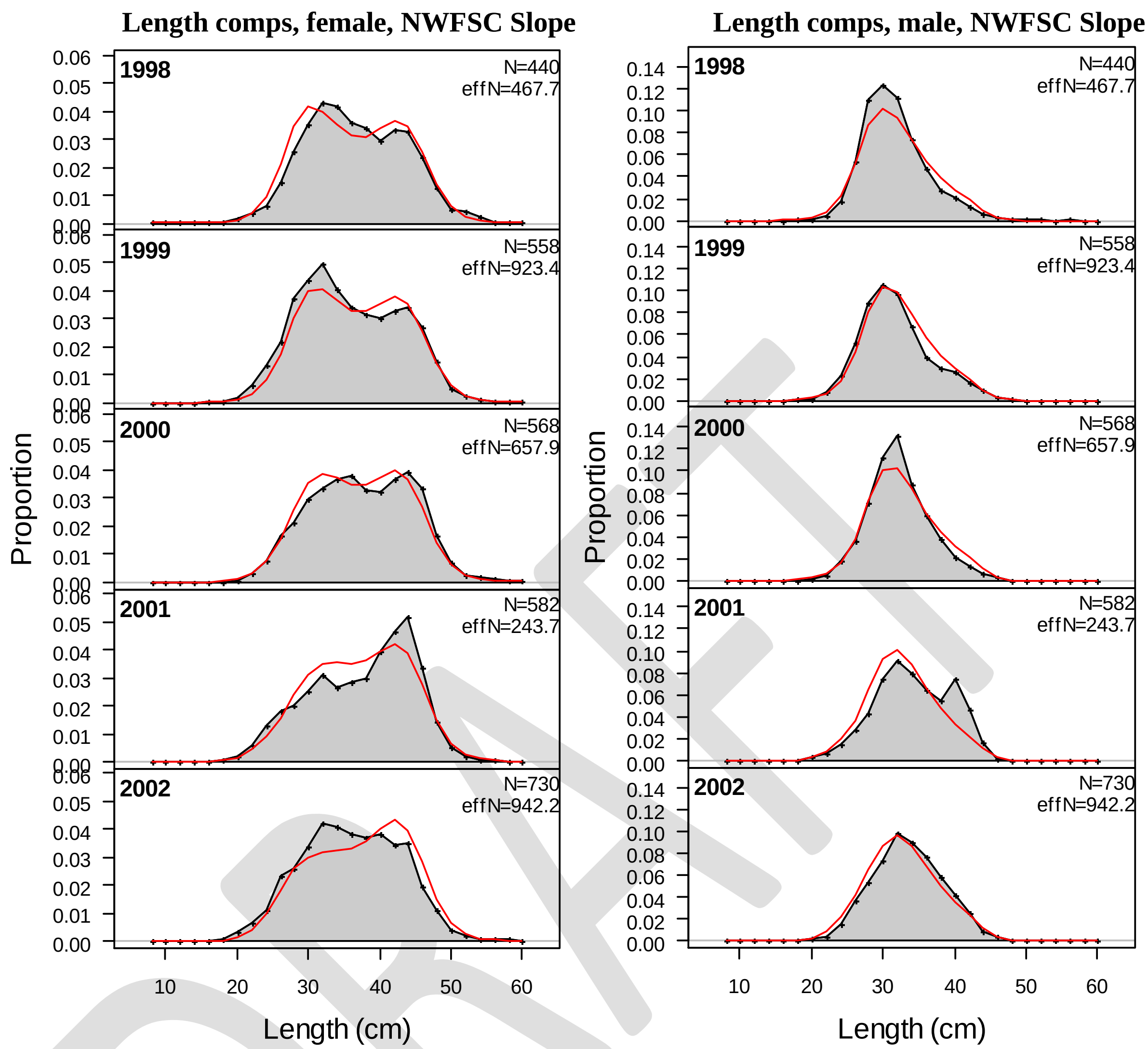


Figure A.18. Model fits (red line) to survey length composition data for females (left) and males (right) by the NWFSC slope survey.

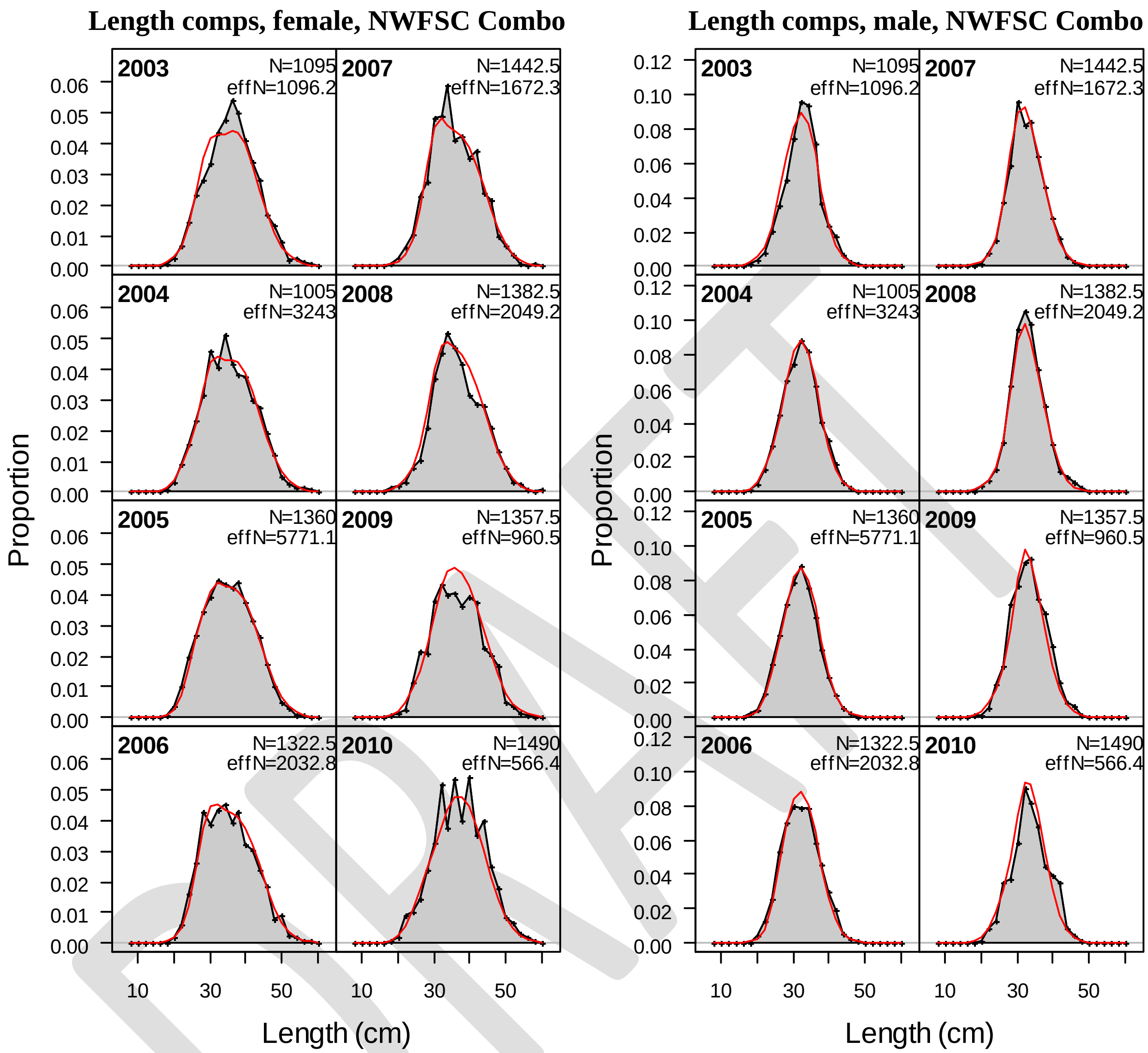


Figure A.19. Model fits (red line) to survey length composition data for females (left) and males (right) by the NWFSC combo survey.

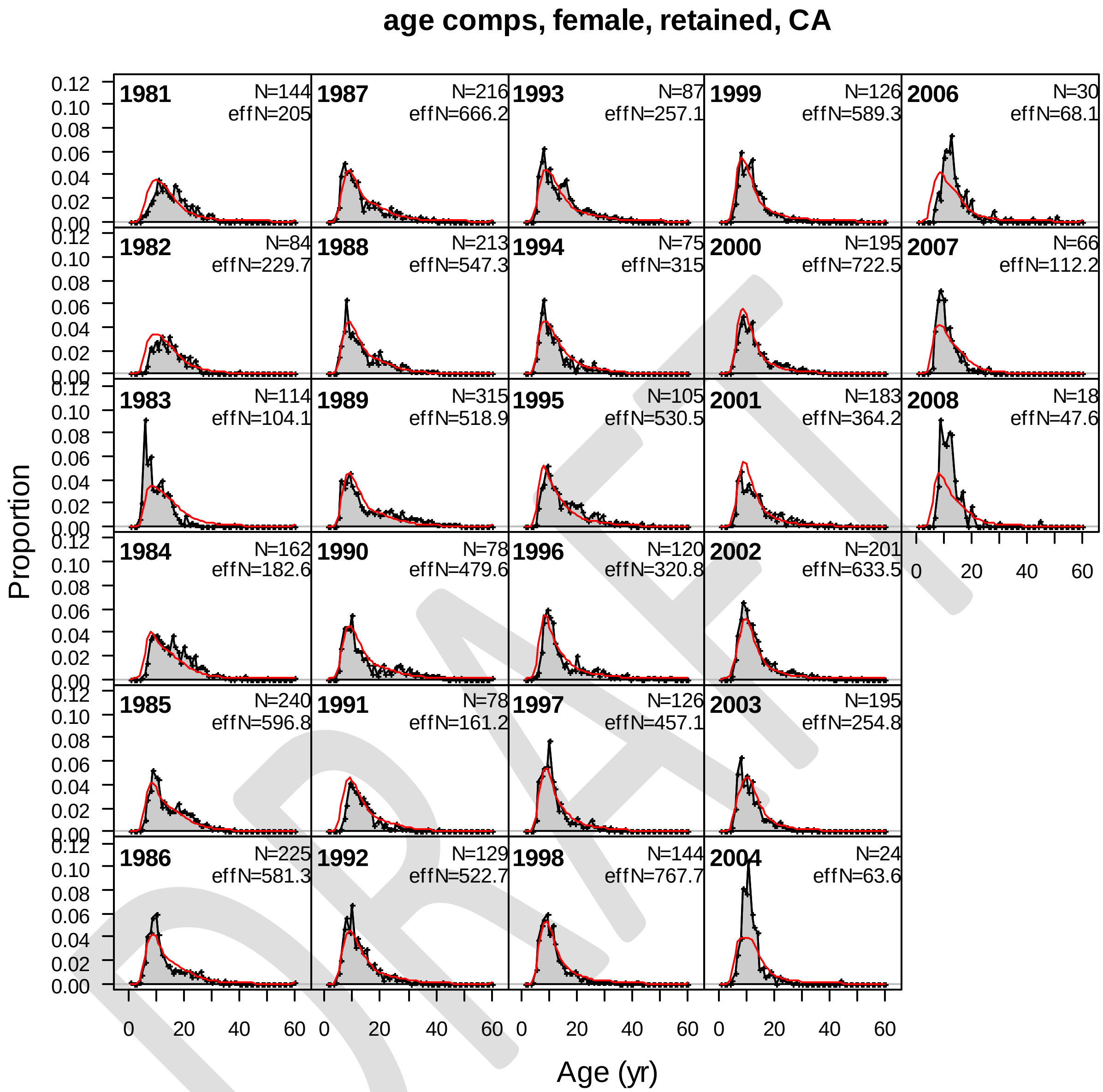


Figure A.20. Model fits (red line) to commercial age composition data for females from California.

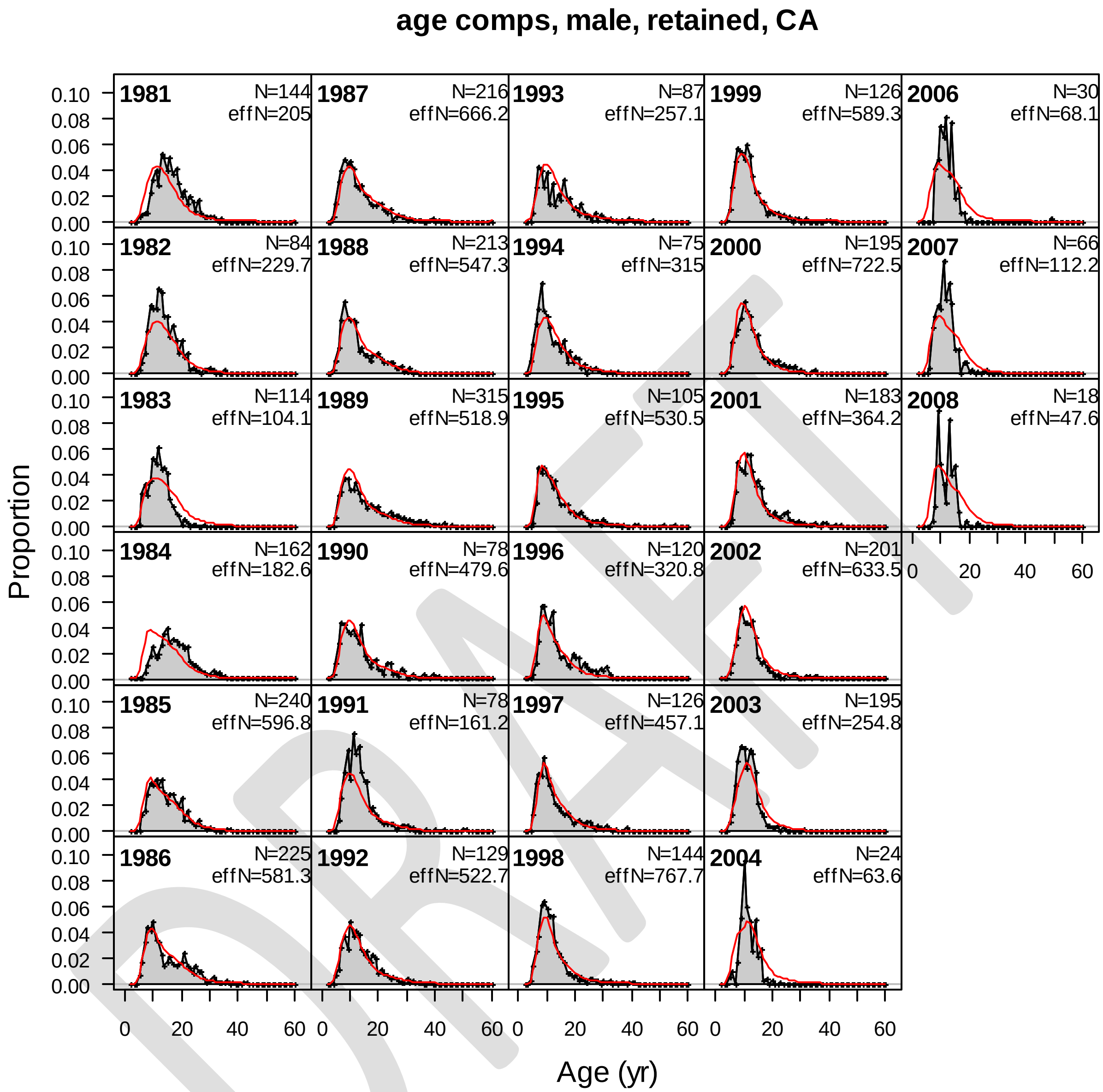


Figure A.21. Model fits (red line) to commercial age composition data for males from California.

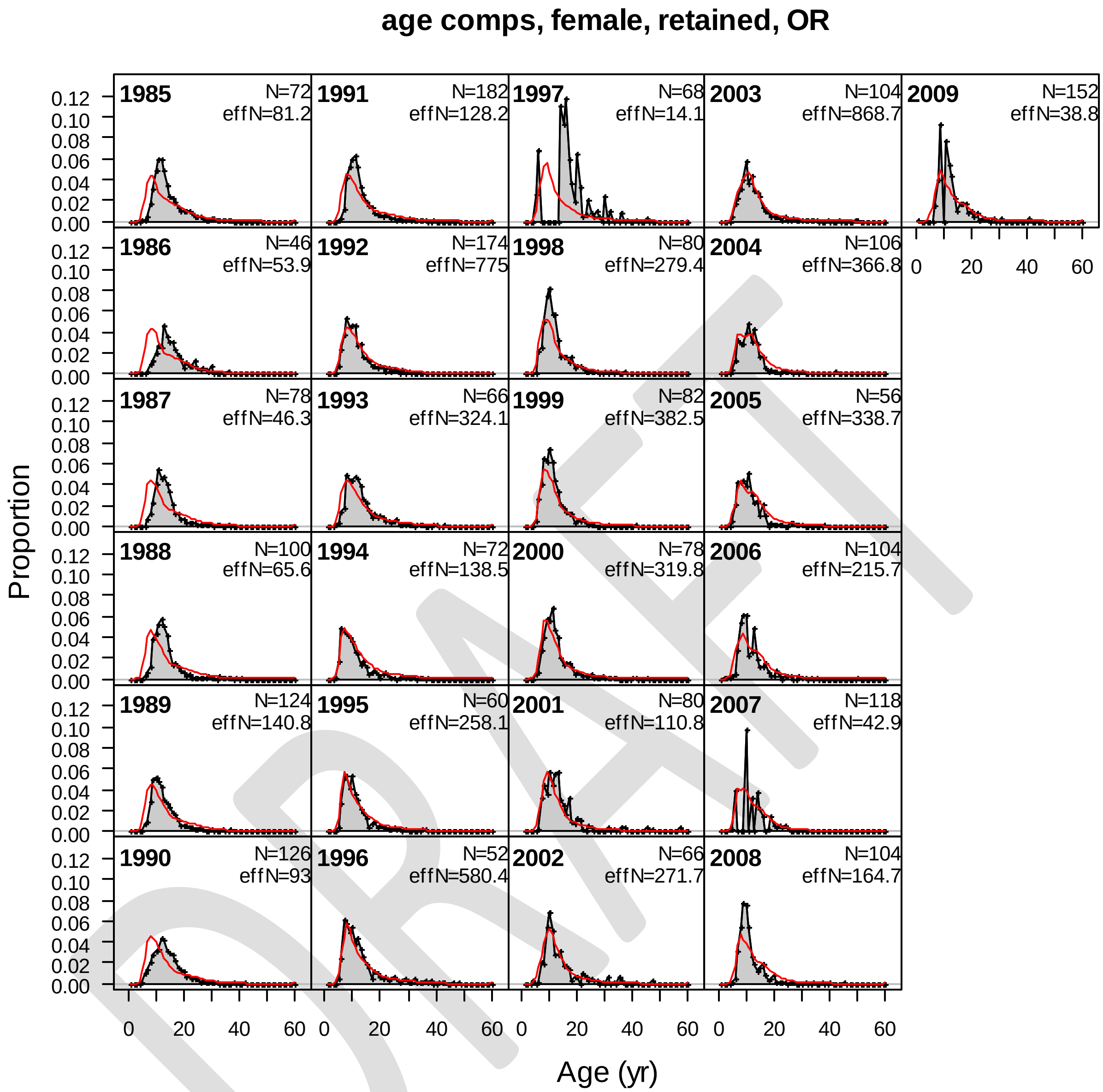


Figure A.22. Model fits (red line) to commercial age composition data for females from Oregon.

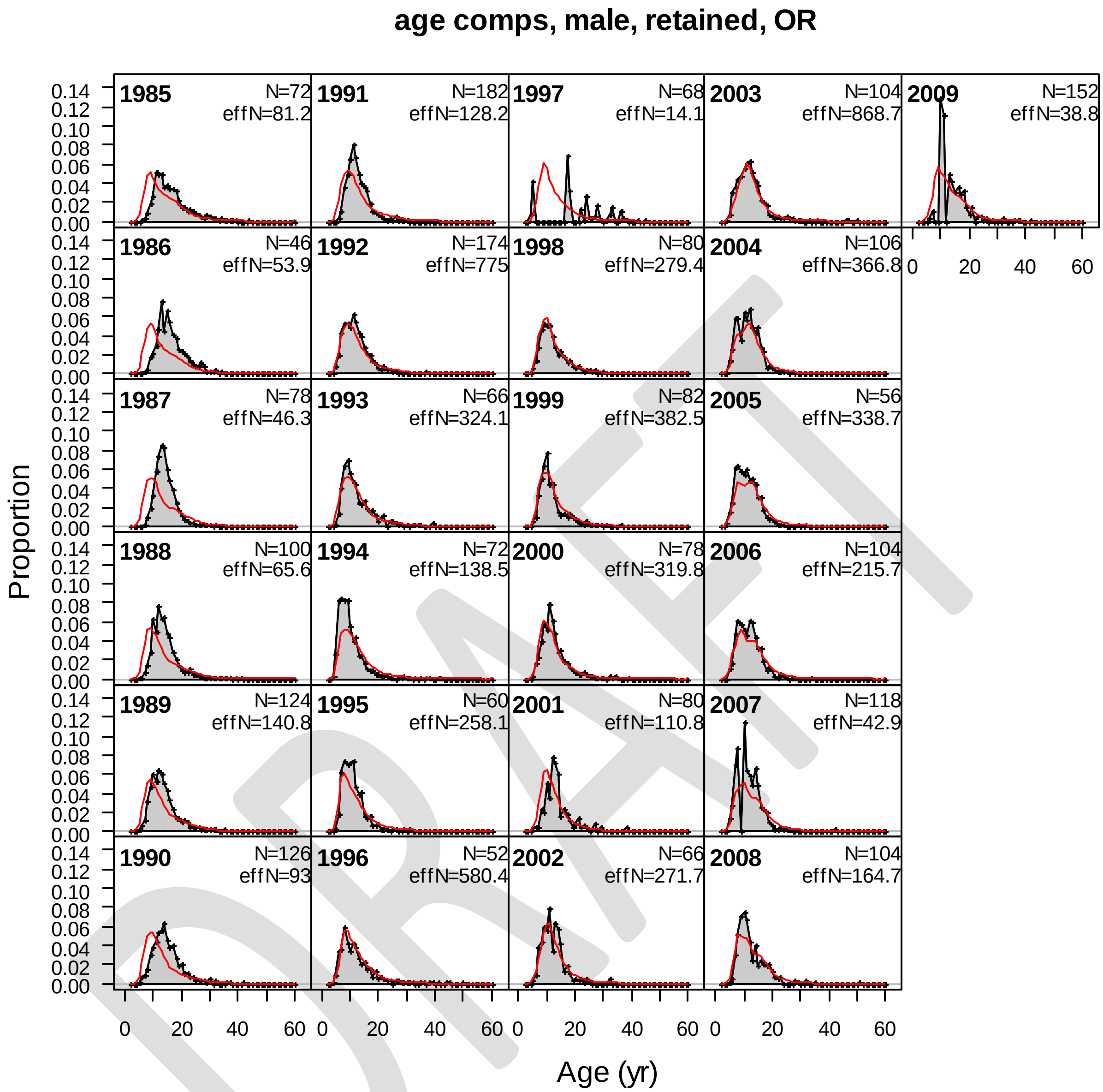


Figure A.23. Model fits (red line) to commercial age composition data for males from Oregon.

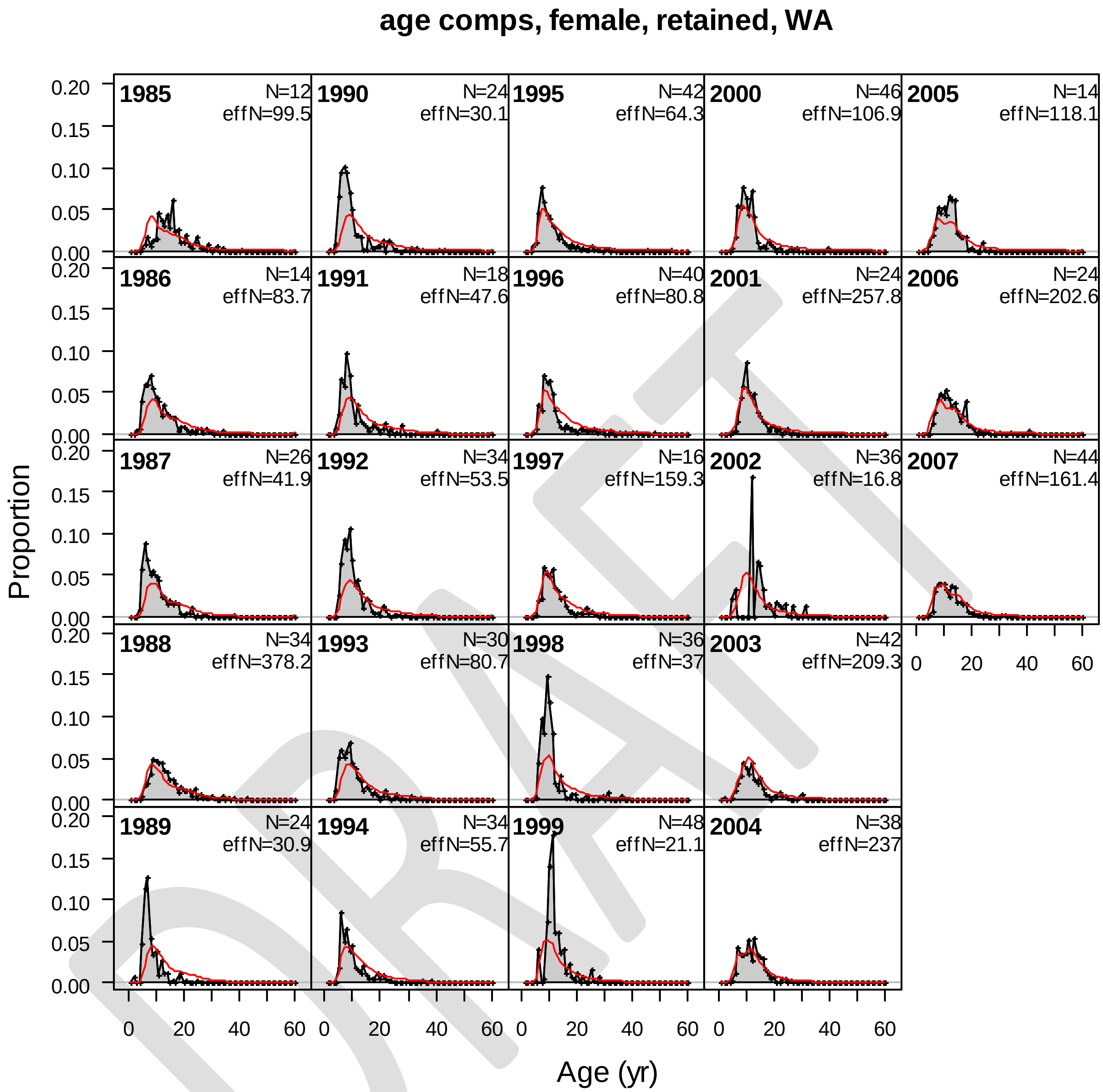


Figure A.24. Model fits (red line) to commercial age composition data for females from Washington.

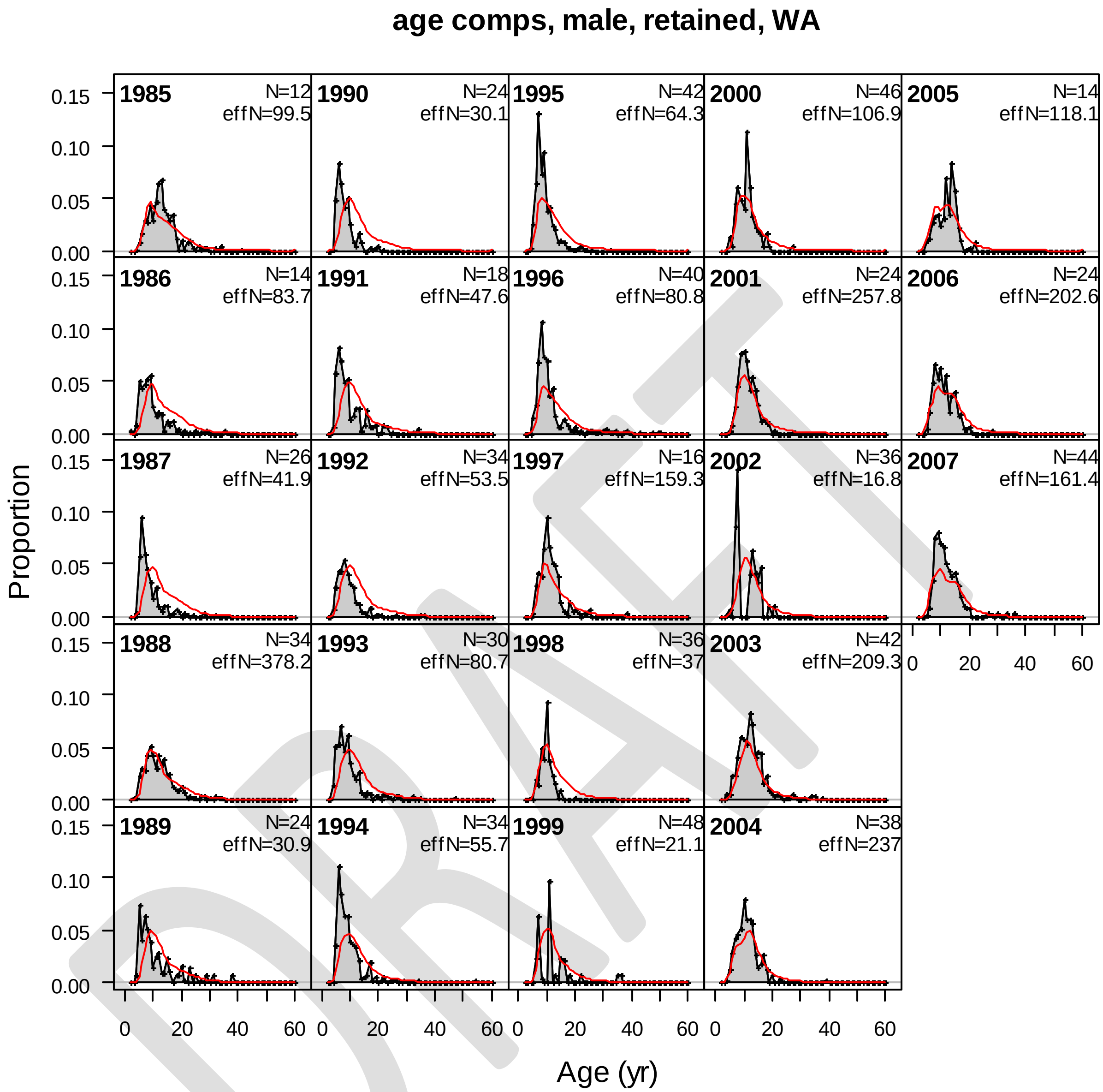
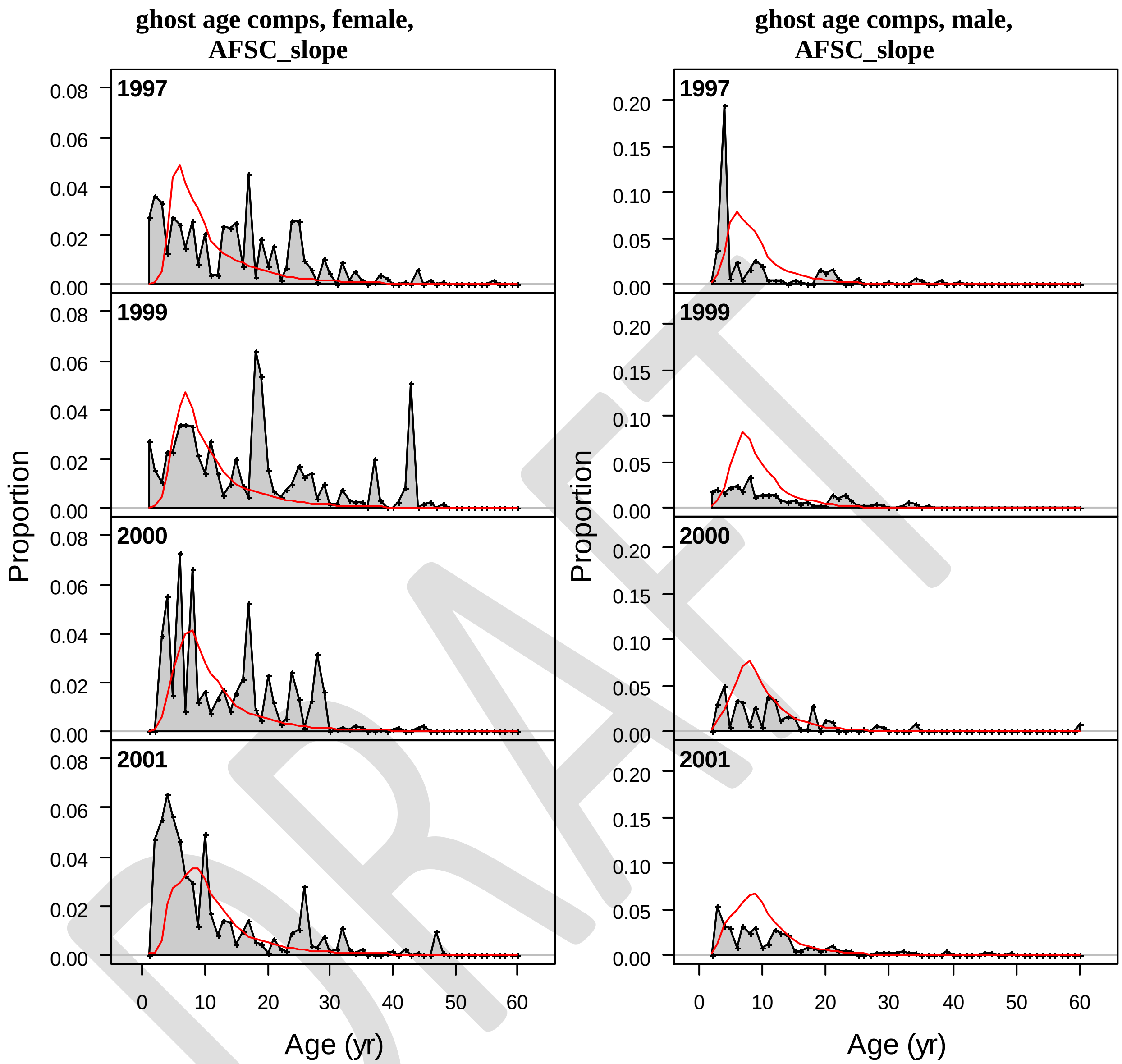
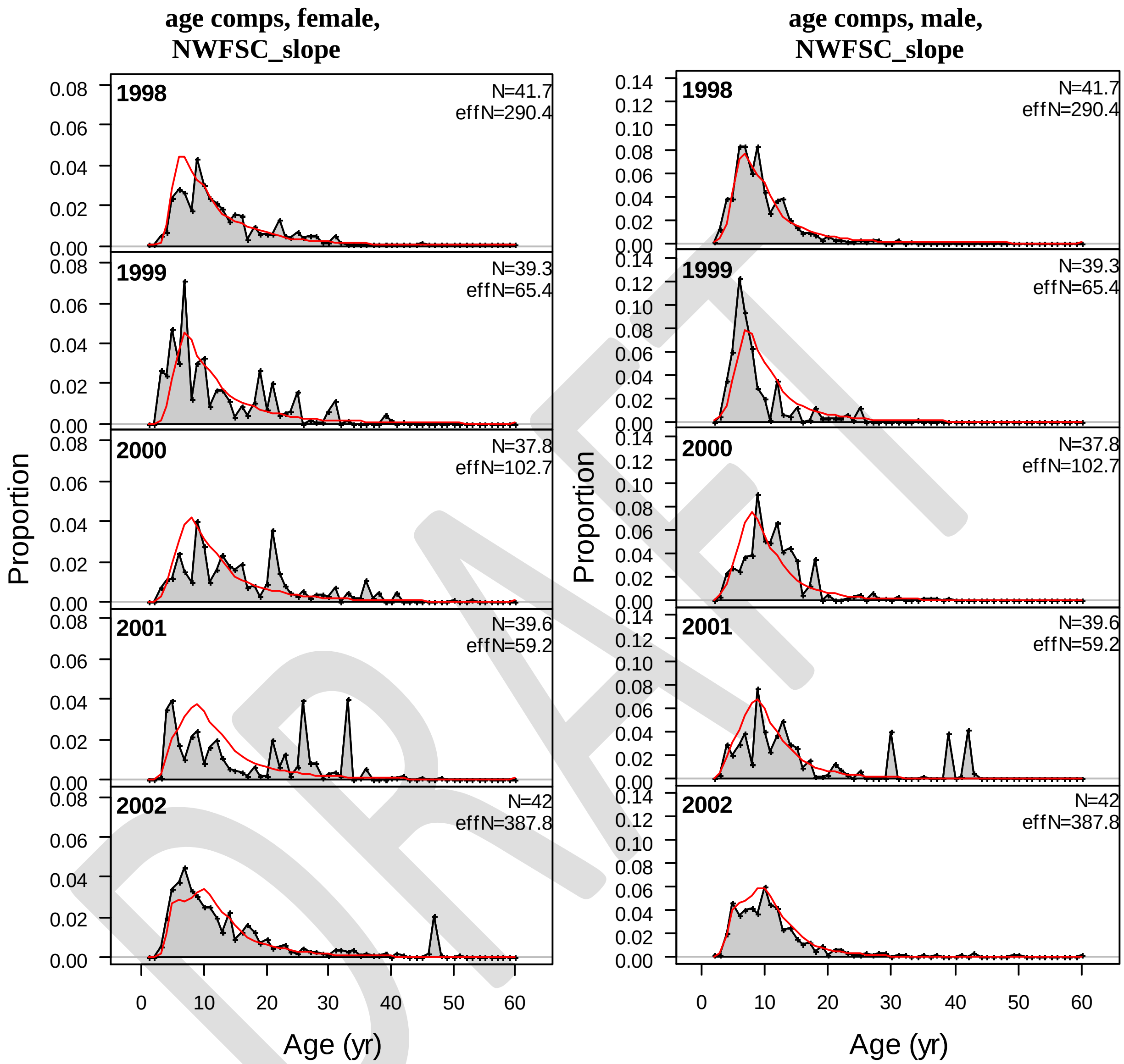


Figure A.25. Model fits (red line) to commercial age composition data for males from Washington.



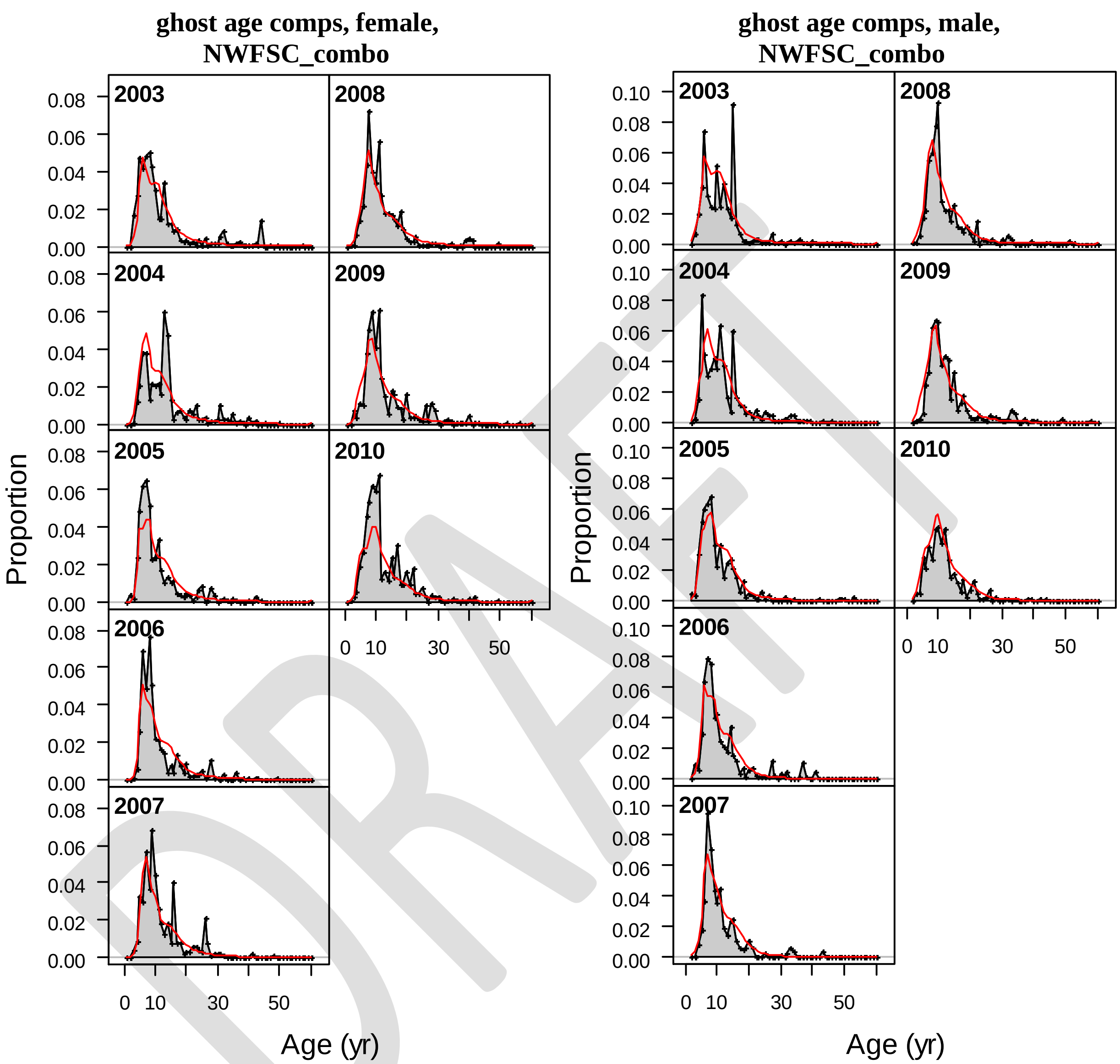
Age (yrs)

Figure A.26. Implied model fits (red line) to survey age composition data for females (left) and males (right) from the AFSC slope survey. These data were not actually fit to in the model.



Age (yr)

Figure A.27. Model fits (red line) to survey age composition data for females (left) and males (right) by the NWFSC slope survey.



Age (yr)

Figure A.28. Implied model fits (red line) to survey age composition data for females (left) and males (right) by the NWFSC combo survey. The conditional age-at-length distributions were fit to in the model.

Appendix B. Predicted numbers at age by sex

Table B.1 Female numbers at age for the base case model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1910	189,910	169,452	150,817	134,232	119,470	106,332	94,639	84,231	74,968	66,724	371,576	115,902	36,152	11,277	3,517	1,595
1911	189,860	169,025	150,817	134,232	119,470	106,332	94,639	84,231	74,968	66,724	371,576	115,902	36,152	11,277	3,517	1,595
1912	189,804	168,981	150,438	134,232	119,470	106,332	94,639	84,231	74,968	66,723	371,571	115,901	36,152	11,277	3,517	1,595
1913	189,742	168,931	150,398	133,894	119,470	106,332	94,638	84,231	74,967	66,723	371,562	115,898	36,151	11,276	3,517	1,594
1914	189,673	168,876	150,354	133,859	119,170	106,332	94,638	84,231	74,967	66,722	371,547	115,893	36,150	11,276	3,517	1,594
1915	189,597	168,815	150,305	133,820	119,138	106,064	94,638	84,230	74,966	66,721	371,530	115,886	36,148	11,275	3,517	1,594
1916	189,512	168,747	150,250	133,776	119,103	106,037	94,400	84,230	74,966	66,720	371,509	115,878	36,145	11,275	3,517	1,594
1917	189,417	168,671	150,190	133,727	119,064	106,005	94,375	84,018	74,965	66,719	371,488	115,869	36,143	11,274	3,517	1,594
1918	189,309	168,586	150,122	133,673	119,021	105,971	94,347	83,994	74,773	66,713	371,421	115,845	36,136	11,272	3,516	1,594
1919	189,187	168,490	150,047	133,613	118,973	105,932	94,316	83,969	74,751	66,541	371,344	115,815	36,127	11,269	3,515	1,593
1920	189,051	168,382	149,961	133,546	118,920	105,889	94,282	83,941	74,728	66,521	371,122	115,783	36,118	11,266	3,514	1,593
1921	188,900	168,261	149,865	133,470	118,860	105,842	94,244	83,911	74,704	66,501	370,926	115,756	36,110	11,264	3,513	1,593
1922	188,732	168,127	149,758	133,384	118,792	105,789	94,201	83,875	74,674	66,476	370,693	115,714	36,098	11,260	3,512	1,592
1923	188,542	167,977	149,638	133,289	118,716	105,728	94,153	83,834	74,637	66,440	370,380	115,644	36,077	11,254	3,510	1,591
1924	188,330	167,808	149,504	133,182	118,631	105,660	94,099	83,790	74,598	66,403	370,047	115,563	36,054	11,247	3,508	1,590
1925	188,088	167,619	149,354	133,063	118,536	105,584	94,037	83,739	74,552	66,358	369,629	115,451	36,021	11,237	3,505	1,589
1926	187,824	167,404	149,186	132,929	118,430	105,500	93,969	83,683	74,503	66,314	369,199	115,328	35,985	11,226	3,502	1,587
1927	187,522	167,169	148,995	132,780	118,311	105,406	93,894	83,622	74,454	66,271	368,800	115,206	35,949	11,215	3,498	1,586
1928	187,184	166,901	148,786	132,610	118,178	105,299	93,809	83,553	74,395	66,219	368,344	115,059	35,905	11,201	3,494	1,584
1929	186,801	166,599	148,546	132,424	118,026	105,181	93,715	83,478	74,333	66,167	367,923	114,916	35,861	11,188	3,490	1,582
1930	186,376	166,259	148,278	132,211	117,861	105,046	93,609	83,391	74,262	66,105	367,505	114,709	35,812	11,174	3,486	1,580
1931	185,896	165,880	147,975	131,972	117,671	104,899	93,489	83,298	74,188	66,046	367,141	114,515	35,765	11,160	3,481	1,578
1932	185,359	165,453	147,638	131,702	117,459	104,730	93,359	83,194	74,109	65,986	366,857	114,346	35,725	11,148	3,478	1,577
1933	184,754	164,975	147,258	131,402	117,219	104,541	93,209	83,079	74,018	65,918	366,592	114,187	35,686	11,136	3,474	1,575
1934	184,072	164,437	146,833	131,064	116,952	104,328	93,041	82,946	73,917	65,840	366,343	114,042	35,649	11,125	3,471	1,573
1935	183,299	163,830	146,354	130,685	116,651	104,090	92,851	82,796	73,798	65,748	366,044	113,898	35,610	11,114	3,467	1,572
1936	182,424	163,141	145,813	130,259	116,314	103,822	92,639	82,626	73,662	65,639	365,663	113,741	35,564	11,100	3,463	1,570
1937	181,433	162,363	145,201	129,778	115,934	103,522	92,400	82,437	73,510	65,517	365,211	113,572	35,511	11,085	3,458	1,568
1938	180,312	161,481	144,507	129,233	115,506	103,184	92,133	82,224	73,340	65,379	364,694	113,408	35,457	11,068	3,453	1,566
1939	179,046	160,483	143,723	128,616	115,021	102,803	91,833	81,987	73,154	65,233	364,173	113,264	35,406	11,053	3,449	1,564
1940	177,611	159,356	142,835	127,918	114,472	102,371	91,492	81,713	72,929	65,046	363,380	113,075	35,322	11,031	3,442	1,561
1941	175,997	158,079	141,832	127,127	113,850	101,882	91,107	81,410	72,685	64,846	362,518	112,881	35,235	11,008	3,435	1,557
1942	174,198	156,642	140,695	126,234	113,147	101,329	90,672	81,069	72,418	64,633	361,616	112,683	35,146	10,984	3,428	1,554
1943	172,206	155,041	139,416	125,223	112,352	100,703	90,179	80,679	72,107	64,383	360,533	112,442	35,045	10,955	3,419	1,550
1944	170,016	153,268	137,991	124,085	111,452	99,995	89,614	80,212	71,703	64,022	358,489	111,893	34,853	10,898	3,402	1,542
1945	167,711	151,319	136,413	122,816	110,439	99,194	88,992	79,739	71,350	63,755	357,425	111,672	34,764	10,872	3,394	1,539
1946	165,316	149,268	134,679	121,412	109,310	98,293	88,276	79,174	70,905	63,406	355,927	111,330	34,644	10,836	3,383	1,534
1947	162,933	147,136	132,853	119,868	108,060	97,287	87,471	78,529	70,386	62,985	354,087	110,894	34,501	10,791	3,369	1,528

Table B.1 (continued) Female numbers at age for the base case model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1948	160,724	145,015	130,955	118,243	106,686	96,175	86,578	77,818	69,823	62,540	352,339	110,515	34,382	10,754	3,357	1,522
1949	158,913	143,049	129,068	116,554	105,240	94,951	85,584	77,008	69,160	61,993	349,959	109,949	34,213	10,700	3,341	1,515
1950	157,891	141,437	127,318	114,874	103,737	93,663	84,487	76,099	68,390	61,328	346,719	109,149	33,986	10,622	3,318	1,505
1951	158,276	140,528	125,883	113,317	102,241	92,324	83,332	75,093	67,518	60,548	342,422	108,023	33,668	10,516	3,286	1,490
1952	160,874	140,870	125,074	112,040	100,855	90,993	82,137	74,055	66,602	59,741	337,785	106,778	33,320	10,401	3,251	1,475
1953	166,167	143,183	125,379	111,320	99,718	89,758	80,947	72,976	65,647	58,879	332,661	105,349	32,922	10,271	3,212	1,457
1954	174,057	147,894	127,437	111,591	99,078	88,749	79,864	71,968	64,792	58,187	329,212	104,436	32,682	10,191	3,188	1,446
1955	184,842	154,916	131,630	113,423	99,319	88,178	78,962	70,994	63,875	57,395	325,320	103,361	32,396	10,098	3,159	1,433
1956	198,739	164,515	137,880	117,154	100,949	88,393	78,456	70,200	63,024	56,604	321,522	102,298	32,112	10,007	3,131	1,421
1957	213,652	176,884	146,423	122,717	104,271	89,844	78,647	69,747	62,313	55,841	317,588	101,215	31,826	9,918	3,104	1,408
1958	223,386	190,156	157,432	130,321	109,221	92,800	79,939	69,918	61,916	55,218	313,796	100,211	31,567	9,839	3,079	1,397
1959	222,858	198,820	169,245	140,119	115,989	97,206	82,568	71,064	62,062	54,857	309,932	99,130	31,285	9,755	3,053	1,386
1960	208,038	198,350	176,956	150,633	124,710	103,229	86,489	73,405	63,085	54,996	306,510	98,096	31,017	9,678	3,027	1,374
1961	209,173	185,160	176,538	157,496	134,067	110,989	91,840	76,866	65,114	55,832	302,986	96,759	30,652	9,573	2,992	1,359
1962	216,675	186,170	164,798	157,124	140,176	119,318	98,750	81,640	68,220	57,678	301,365	95,631	30,348	9,489	2,964	1,347
1963	230,529	192,848	165,697	146,675	139,844	124,754	106,156	87,768	72,430	60,392	301,408	94,405	30,008	9,395	2,933	1,333
1964	254,130	205,178	171,640	147,475	130,545	124,458	110,986	94,330	77,828	64,065	303,549	93,012	29,613	9,284	2,897	1,317
1965	274,932	226,183	182,615	152,765	131,257	116,182	110,724	98,626	83,656	68,853	309,078	91,701	29,245	9,183	2,864	1,303
1966	262,362	244,698	201,310	162,532	135,965	116,816	103,363	98,400	87,480	74,029	318,593	90,440	28,896	9,089	2,834	1,289
1967	231,637	233,510	217,789	179,172	144,658	121,006	103,928	91,863	87,289	77,428	331,910	89,208	28,560	8,999	2,806	1,277
1968	208,091	206,163	207,830	193,838	159,468	128,745	107,666	92,396	81,552	77,357	347,637	88,173	28,284	8,928	2,784	1,267
1969	193,689	185,207	183,492	184,975	172,521	141,924	114,546	95,703	81,993	72,224	361,143	87,031	27,963	8,844	2,759	1,256
1970	181,883	172,389	164,840	163,313	164,633	153,538	126,250	101,753	84,803	72,437	367,010	85,609	27,527	8,723	2,724	1,239
1971	166,759	161,881	153,431	146,712	145,353	146,516	136,573	112,125	90,119	74,856	371,785	84,259	27,051	8,589	2,685	1,220
1972	149,089	148,420	144,079	136,558	130,578	129,359	130,333	121,312	99,340	79,596	378,393	83,396	26,615	8,467	2,649	1,204
1973	136,322	132,693	132,098	128,235	121,540	116,206	115,045	115,676	107,282	87,471	385,889	82,645	26,052	8,303	2,602	1,182
1974	135,011	121,330	118,101	117,571	114,132	108,164	103,351	102,119	102,325	94,507	399,149	82,667	25,518	8,148	2,557	1,161
1975	152,454	120,164	107,988	105,113	104,642	101,572	96,206	91,764	90,390	90,236	416,912	83,682	25,031	8,006	2,516	1,142
1976	190,402	135,688	106,950	96,112	93,554	93,125	90,337	85,400	81,182	79,640	427,016	85,560	24,508	7,855	2,473	1,122
1977	181,483	169,463	120,767	95,188	85,542	83,257	82,821	80,182	75,534	71,498	425,027	88,235	23,950	7,693	2,426	1,101
1978	153,968	161,525	150,827	107,486	84,720	76,128	74,048	73,524	70,945	66,566	416,016	91,392	23,427	7,543	2,384	1,082
1979	166,681	137,036	143,762	134,241	95,665	75,395	67,704	65,720	65,019	62,464	403,193	93,807	22,863	7,376	2,335	1,061
1980	183,211	148,351	121,966	127,952	119,477	85,133	67,039	60,046	58,023	57,087	387,649	94,064	22,202	7,170	2,275	1,034
1981	159,375	163,064	132,037	108,553	113,881	106,327	75,711	59,496	53,094	51,075	371,366	94,632	21,706	7,000	2,226	1,012
1982	157,763	141,849	145,130	117,483	96,503	101,027	93,930	66,490	51,952	46,175	350,249	95,688	21,350	6,846	2,181	993
1983	162,461	140,414	126,248	129,113	104,374	85,466	88,943	82,041	57,649	44,821	324,160	96,840	21,003	6,652	2,123	968
1984	139,567	144,595	124,971	112,309	114,683	92,398	75,197	77,637	71,103	49,729	299,039	99,316	20,840	6,464	2,067	943
1985	154,405	124,219	128,693	111,162	99,724	101,475	81,271	65,636	67,287	61,323	280,092	102,578	20,878	6,276	2,010	919
1986	153,107	137,425	110,557	114,480	98,731	88,274	89,263	70,876	56,765	57,846	273,754	103,686	21,090	6,073	1,949	892
1987	189,142	136,270	122,312	98,372	101,772	87,565	77,887	78,154	61,576	49,038	269,040	102,347	21,603	5,896	1,897	870
1988	266,862	168,342	121,283	108,827	87,437	90,215	77,167	68,054	67,719	53,038	258,500	98,963	22,144	5,710	1,841	846

Table B.1 (continued) Female numbers at age for the base case model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1989	189,234	237,515	149,828	107,896	96,676	77,413	79,357	67,297	58,884	58,286	254,171	94,921	22,550	5,531	1,787	823
1990	213,297	168,424	211,393	133,289	95,843	85,560	68,016	69,057	58,060	50,518	255,199	90,528	22,513	5,349	1,729	798
1991	256,781	189,840	149,901	188,069	118,429	84,887	75,307	59,374	59,842	50,075	252,082	85,917	22,539	5,206	1,681	778
1992	277,370	228,543	168,962	133,365	167,111	104,868	74,617	65,540	51,209	51,308	248,806	80,043	22,531	5,064	1,626	754
1993	201,311	246,867	203,409	150,336	118,543	148,124	92,382	65,155	56,748	44,080	248,941	73,931	22,752	4,971	1,577	733
1994	170,797	179,172	219,718	180,985	133,628	105,081	130,535	80,757	56,534	48,995	244,067	68,224	23,343	4,936	1,533	714
1995	142,203	152,015	159,468	195,512	160,931	118,607	92,923	114,846	70,716	49,347	245,950	64,514	24,352	4,994	1,504	702
1996	168,513	126,565	135,297	141,903	173,864	142,864	104,891	81,724	100,463	61,623	244,968	63,753	24,905	5,103	1,472	689
1997	248,392	149,982	112,646	120,418	126,288	154,628	126,721	92,544	71,634	87,565	254,530	62,873	24,689	5,249	1,435	673
1998	191,249	221,077	133,488	100,258	107,169	112,333	137,249	111,997	81,361	62,694	288,499	61,120	24,136	5,437	1,404	661
1999	159,016	170,218	196,765	118,808	89,229	95,341	99,774	121,512	98,766	71,509	297,029	61,057	23,503	5,619	1,380	651
2000	291,300	141,529	151,499	175,126	105,737	79,377	84,667	88,297	107,080	86,723	310,587	62,412	22,792	5,701	1,356	641
2001	201,850	259,266	125,965	134,838	155,860	94,067	70,502	74,960	77,870	94,123	337,612	62,557	21,918	5,781	1,337	632
2002	111,210	179,652	230,754	112,112	120,005	138,671	83,589	62,496	66,251	68,650	369,040	63,285	20,862	5,901	1,328	624
2003	103,704	98,980	159,896	205,378	99,780	106,776	123,250	74,131	55,276	58,462	374,118	64,794	19,657	6,074	1,329	617
2004	118,642	92,300	88,095	142,312	182,786	88,778	94,888	109,262	65,522	48,733	370,556	64,740	18,431	6,329	1,339	610
2005	149,873	105,595	82,150	78,407	126,658	162,638	78,911	84,168	96,677	57,853	358,200	65,843	17,567	6,655	1,366	603
2006	125,805	133,392	93,983	73,116	69,782	112,695	144,558	69,994	74,472	85,359	355,138	66,354	17,528	6,872	1,409	597
2007	144,405	111,970	118,722	83,647	65,073	62,092	100,187	128,289	61,986	65,835	374,183	70,100	17,544	6,911	1,470	591
2008	186,481	128,524	99,657	105,666	74,445	57,894	55,167	88,776	113,311	54,600	365,605	80,054	17,171	6,800	1,533	582
2009	164,196	165,974	114,391	88,697	94,042	66,228	51,420	48,840	78,289	99,599	353,154	82,477	17,155	6,622	1,584	573
2010	188,258	146,139	147,721	101,811	78,939	83,658	58,814	45,508	43,048	68,766	379,228	86,329	17,543	6,424	1,608	563
2011	188,107	167,555	130,068	131,476	90,610	70,227	74,310	52,081	40,150	37,861	371,929	93,939	17,597	6,181	1,631	556

Table B.2 Male numbers at age for the base case model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1910	189,910	165,233	143,401	124,454	108,010	93,739	81,353	70,604	61,275	53,179	264,627	64,149	15,551	3,770	914	292
1911	189,860	164,817	143,401	124,454	108,010	93,739	81,353	70,604	61,275	53,179	264,627	64,149	15,551	3,770	914	292
1912	189,804	164,774	143,040	124,454	108,010	93,739	81,353	70,604	61,275	53,179	264,622	64,147	15,550	3,770	914	292
1913	189,742	164,726	143,003	124,141	108,010	93,739	81,353	70,604	61,275	53,178	264,612	64,143	15,549	3,769	914	292
1914	189,673	164,672	142,961	124,108	107,738	93,739	81,353	70,604	61,274	53,178	264,598	64,137	15,548	3,769	914	292
1915	189,597	164,612	142,914	124,072	107,710	93,503	81,353	70,604	61,274	53,177	264,581	64,129	15,546	3,768	914	292
1916	189,512	164,546	142,862	124,031	107,678	93,479	81,148	70,603	61,274	53,176	264,561	64,119	15,543	3,768	913	292
1917	189,417	164,472	142,805	123,986	107,643	93,451	81,127	70,426	61,273	53,176	264,542	64,108	15,540	3,767	913	292
1918	189,309	164,389	142,740	123,936	107,604	93,420	81,103	70,406	61,117	53,172	264,475	64,078	15,532	3,765	913	292
1919	189,187	164,296	142,669	123,880	107,561	93,386	81,076	70,385	61,099	53,035	264,401	64,041	15,523	3,763	912	292
1920	189,051	164,190	142,588	123,818	107,512	93,349	81,047	70,361	61,080	53,019	264,219	64,004	15,513	3,761	912	292
1921	188,900	164,072	142,496	123,748	107,458	93,307	81,014	70,336	61,060	53,003	264,067	63,973	15,505	3,759	911	292
1922	188,732	163,941	142,394	123,668	107,397	93,260	80,977	70,307	61,036	52,983	263,878	63,925	15,492	3,756	910	291
1923	188,542	163,795	142,280	123,580	107,328	93,207	80,936	70,272	61,006	52,955	263,610	63,842	15,470	3,750	909	291
1924	188,330	163,630	142,153	123,481	107,251	93,147	80,889	70,236	60,975	52,927	263,331	63,749	15,445	3,744	908	290
1925	188,088	163,446	142,010	123,371	107,165	93,080	80,836	70,193	60,938	52,892	262,972	63,618	15,410	3,736	906	290
1926	187,824	163,236	141,850	123,246	107,070	93,005	80,778	70,146	60,899	52,857	262,611	63,477	15,371	3,726	903	289
1927	187,522	163,008	141,668	123,108	106,962	92,922	80,713	70,095	60,859	52,824	262,294	63,342	15,333	3,717	901	288
1928	187,184	162,745	141,470	122,950	106,842	92,828	80,640	70,037	60,811	52,783	261,923	63,181	15,287	3,706	899	288
1929	186,801	162,452	141,242	122,778	106,705	92,724	80,559	69,974	60,761	52,742	261,596	63,029	15,242	3,695	896	287
1930	186,376	162,120	140,987	122,580	106,555	92,605	80,468	69,902	60,703	52,693	261,259	62,833	15,192	3,683	893	286
1931	185,896	161,750	140,699	122,359	106,384	92,475	80,365	69,824	60,642	52,646	260,985	62,660	15,145	3,671	890	285
1932	185,359	161,334	140,378	122,109	106,192	92,327	80,253	69,736	60,578	52,598	260,798	62,523	15,105	3,661	888	284
1933	184,754	160,868	140,017	121,830	105,975	92,160	80,124	69,639	60,503	52,543	260,628	62,405	15,068	3,651	886	283
1934	184,072	160,343	139,613	121,517	105,733	91,972	79,980	69,528	60,420	52,480	260,473	62,309	15,034	3,643	883	283
1935	183,299	159,751	139,157	121,166	105,461	91,762	79,816	69,403	60,323	52,407	260,269	62,216	14,999	3,633	881	282
1936	182,424	159,080	138,643	120,771	105,156	91,526	79,634	69,260	60,212	52,320	259,995	62,116	14,961	3,623	879	281
1937	181,433	158,320	138,061	120,325	104,813	91,261	79,429	69,101	60,087	52,223	259,675	62,016	14,920	3,612	876	280
1938	180,312	157,461	137,402	119,819	104,426	90,964	79,199	68,923	59,949	52,113	259,291	61,916	14,879	3,600	873	280
1939	179,046	156,488	136,656	119,247	103,988	90,628	78,941	68,724	59,796	51,997	258,928	61,844	14,844	3,590	871	279
1940	177,611	155,389	135,811	118,600	103,491	90,247	78,648	68,495	59,613	51,848	258,285	61,698	14,782	3,574	867	277
1941	175,997	154,143	134,858	117,867	102,929	89,816	78,317	68,241	59,414	51,689	257,604	61,549	14,721	3,558	863	276
1942	174,198	152,743	133,777	117,039	102,293	89,328	77,943	67,954	59,195	51,519	256,930	61,410	14,664	3,542	859	275
1943	172,206	151,181	132,561	116,101	101,575	88,776	77,519	67,627	58,941	51,319	256,084	61,220	14,596	3,524	854	274
1944	170,016	149,452	131,206	115,046	100,760	88,151	77,033	67,238	58,615	51,032	254,250	60,665	14,440	3,484	845	270
1945	167,711	147,552	129,706	113,870	99,845	87,446	76,498	66,839	58,324	50,822	253,562	60,516	14,387	3,468	841	269
1946	165,316	145,552	128,056	112,568	98,824	86,651	75,883	66,367	57,960	50,542	252,425	60,223	14,301	3,444	834	267
1947	162,933	143,473	126,320	111,137	97,694	85,765	75,191	65,827	57,538	50,208	250,972	59,827	14,193	3,414	827	265
1948	160,724	141,405	124,516	109,630	96,452	84,784	74,424	65,231	57,078	49,855	249,685	59,511	14,106	3,389	821	263
1949	158,913	139,488	122,721	108,064	95,144	83,705	73,569	64,553	56,538	49,421	247,808	59,002	13,973	3,353	812	260
1950	157,891	137,916	121,058	106,506	93,785	82,569	72,626	63,794	55,915	48,897	245,106	58,212	13,774	3,300	799	256

Table B.2 (continued) Male numbers at age for the base case model.

	Age															
Year	0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1951	158,276	137,030	119,693	105,062	92,433	81,388	71,632	62,953	55,209	48,283	241,405	57,050	13,484	3,225	780	250
1952	160,874	137,363	118,924	103,879	91,180	80,214	70,605	62,083	54,464	47,646	237,504	55,783	13,166	3,144	761	244
1953	166,167	139,618	119,214	103,211	90,153	79,126	69,582	61,180	53,687	46,965	233,301	54,366	12,808	3,054	739	237
1954	174,057	144,212	121,171	103,462	89,573	78,237	68,651	60,331	52,981	46,413	231,025	53,620	12,608	3,002	726	232
1955	184,842	151,059	125,157	105,161	89,791	77,733	67,876	59,515	52,229	45,776	228,328	52,758	12,375	2,943	711	228
1956	198,739	160,419	131,100	108,620	91,265	77,923	67,441	58,848	51,533	45,143	225,808	51,999	12,161	2,889	697	223
1957	213,652	172,480	139,223	113,778	94,268	79,202	67,605	58,469	50,951	44,533	223,117	51,249	11,946	2,834	684	219
1958	223,386	185,422	149,691	120,828	98,744	81,808	68,715	58,613	50,626	44,036	220,499	50,590	11,750	2,785	671	215
1959	222,858	193,871	160,923	129,912	104,862	85,692	70,976	59,573	50,746	43,748	217,806	49,919	11,547	2,733	658	210
1960	208,038	193,412	168,255	139,660	112,747	91,002	74,346	61,535	51,582	43,859	215,443	49,327	11,359	2,686	646	206
1961	209,173	180,550	167,857	146,024	121,206	97,842	78,946	64,438	53,245	44,528	212,847	48,482	11,108	2,624	630	201
1962	216,675	181,535	156,695	145,678	126,729	105,185	84,885	68,439	55,783	46,002	211,855	47,873	10,912	2,574	617	197
1963	230,529	188,046	157,549	135,991	126,429	109,977	91,252	73,578	59,227	48,166	212,028	47,165	10,694	2,518	602	193
1964	254,130	200,070	163,200	136,732	118,022	109,715	95,403	79,080	63,645	51,098	213,686	46,297	10,444	2,454	586	187
1965	274,932	220,552	173,635	141,637	118,665	102,420	95,178	82,682	68,412	54,920	217,928	45,499	10,217	2,395	571	182
1966	262,362	238,606	191,411	150,693	122,922	102,978	88,851	82,492	71,540	59,052	225,221	44,775	10,016	2,342	558	178
1967	231,637	227,696	207,080	166,120	130,781	106,673	89,337	77,012	71,383	61,762	235,281	44,088	9,833	2,292	545	174
1968	208,091	201,031	197,611	179,719	144,170	113,495	92,550	77,456	66,684	61,699	247,128	43,635	9,712	2,255	536	171
1969	193,689	180,596	174,469	171,501	155,972	125,113	98,464	80,229	67,045	57,602	256,867	43,070	9,568	2,212	525	167
1970	181,883	168,097	156,734	151,417	148,840	135,350	108,525	85,308	69,356	57,780	260,079	42,129	9,334	2,148	510	162
1971	166,759	157,851	145,887	136,025	131,409	129,160	117,397	94,006	73,714	59,724	262,404	41,177	9,077	2,079	493	156
1972	149,089	144,725	136,995	126,611	118,051	114,035	112,033	101,706	81,255	63,513	266,388	40,563	8,856	2,018	478	151
1973	136,322	129,390	125,603	118,894	109,881	102,439	98,892	96,990	87,770	69,810	270,714	39,765	8,534	1,935	458	145
1974	135,011	118,310	112,294	109,007	103,183	95,350	88,839	85,622	83,721	75,441	279,886	39,446	8,241	1,860	439	139
1975	152,454	117,172	102,678	97,457	94,603	89,539	82,697	76,937	73,949	72,031	292,874	39,747	7,993	1,796	423	133
1976	190,402	132,310	101,691	89,111	84,579	82,092	77,653	71,603	66,417	63,572	299,825	40,420	7,722	1,729	406	128
1977	181,483	165,244	114,828	88,255	77,336	73,393	71,192	67,229	61,799	57,075	297,569	41,459	7,440	1,661	389	122
1978	153,968	157,504	143,411	99,656	76,593	67,109	63,651	61,645	58,044	53,139	290,265	42,768	7,189	1,601	374	117
1979	166,681	133,624	136,693	124,462	86,488	66,463	58,197	55,102	53,195	49,863	279,992	43,568	6,916	1,537	358	112
1980	183,211	144,657	115,969	118,632	108,015	75,046	57,625	50,348	47,479	45,576	267,130	42,988	6,576	1,457	338	106
1981	159,375	159,004	125,544	100,646	102,956	93,729	65,079	49,883	43,441	40,777	254,596	42,865	6,341	1,398	322	101
1982	157,763	138,317	137,978	108,877	87,155	88,886	80,486	55,462	42,153	36,420	234,888	42,543	6,095	1,330	305	95
1983	162,461	136,918	120,019	119,612	94,168	75,040	75,940	68,046	46,360	34,872	210,899	41,839	5,792	1,243	284	89
1984	139,567	140,996	118,802	104,029	103,415	81,020	64,043	64,122	56,807	38,311	189,660	41,832	5,561	1,162	264	82
1985	154,405	121,126	122,335	102,950	89,890	88,906	69,107	54,069	53,544	46,962	174,866	42,161	5,395	1,085	245	76
1986	153,107	134,004	105,099	106,030	88,998	77,332	75,869	58,321	45,068	44,115	169,642	41,214	5,250	1,003	226	70
1987	189,142	132,877	116,285	91,147	91,816	76,808	66,310	64,435	48,986	37,456	166,359	39,479	5,223	938	211	65
1988	266,862	164,151	115,305	100,838	78,902	79,172	65,743	56,149	53,898	40,506	158,267	36,818	5,174	871	195	60
1989	189,234	231,602	142,435	99,952	87,202	67,900	67,560	55,462	46,786	44,413	154,723	34,048	5,086	809	181	55
1990	213,297	164,231	200,961	123,467	86,423	74,996	57,846	56,819	46,007	38,339	154,597	31,134	4,866	747	167	51
1991	256,781	185,114	142,506	174,226	106,807	74,416	64,052	48,860	47,432	38,007	151,978	28,571	4,713	701	156	47

Table B.2 (continued) Male numbers at age for the base case model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40-49	50-59	60+
1992	277,370	222,853	160,630	123,556	150,727	91,936	63,454	53,901	40,535	38,851	148,301	25,496	4,521	651	143	43
1993	201,311	240,721	193,383	139,297	106,961	129,956	78,652	53,677	45,022	33,464	147,784	22,735	4,416	615	133	40
1994	170,797	174,712	208,889	167,701	120,589	92,228	111,218	66,603	44,931	37,294	144,067	20,500	4,422	591	124	37
1995	142,203	148,230	151,613	181,185	145,283	104,195	79,310	95,006	56,481	37,851	147,280	19,512	4,591	590	120	36
1996	168,513	123,414	128,634	131,513	156,991	125,568	89,625	67,745	80,511	47,509	148,917	19,615	4,643	594	114	34
1997	248,392	146,248	107,107	111,636	114,116	136,094	108,532	77,018	57,749	68,031	158,212	19,531	4,513	600	109	32
1998	191,249	215,573	126,924	92,954	96,872	98,949	117,726	93,447	65,886	49,055	185,413	19,188	4,353	614	104	31
1999	159,016	165,980	187,089	110,153	80,664	84,015	85,662	101,559	80,221	56,260	193,514	19,649	4,214	632	101	30
2000	291,300	138,005	144,049	162,368	95,587	69,953	72,718	73,861	87,107	68,412	205,315	20,657	4,053	636	98	29
2001	201,850	252,811	119,771	125,015	140,899	82,900	60,559	62,729	63,405	74,380	226,499	21,159	3,873	641	96	28
2002	111,210	175,180	219,407	103,945	108,487	122,216	71,807	52,313	53,986	54,347	250,906	21,990	3,685	656	95	27
2003	103,704	96,516	152,034	190,416	90,205	94,110	105,891	62,067	45,068	46,341	254,698	23,204	3,486	679	95	27
2004	118,642	90,002	83,763	131,945	165,244	78,247	81,525	91,487	53,428	38,639	250,932	23,696	3,297	713	96	26
2005	149,873	102,966	78,110	72,695	114,503	143,348	67,799	70,479	78,844	45,888	241,136	24,903	3,218	759	98	26
2006	125,805	130,071	89,361	67,789	63,085	99,328	124,202	58,610	60,735	67,712	238,681	25,996	3,334	791	102	25
2007	144,405	109,182	112,885	77,554	58,828	54,728	86,082	107,430	50,560	52,242	254,315	28,709	3,461	801	107	25
2008	186,481	125,325	94,756	97,969	67,300	51,025	47,395	74,326	92,380	43,285	248,806	34,245	3,464	788	112	25
2009	164,196	161,842	108,766	82,236	85,014	58,367	44,170	40,881	63,793	78,865	238,216	35,674	3,548	763	115	24
2010	188,258	142,501	140,458	94,394	71,361	73,726	50,517	38,084	35,064	54,409	257,932	37,803	3,734	734	116	23
2011	188,107	163,384	123,672	121,898	81,913	61,891	63,828	43,585	32,703	29,957	252,750	41,711	3,831	703	117	23

Appendix C. SS Data File

```
#C Dover Sole 2011 assessment (Allan Hicks, Chantel Wetzel)

1910    #_styr
2010    #_endyr
1       #_nseas
12      #_months/season
1       #_spawn_seas
3       #N fisheries
4       #N surveys
1       #N_areas
CA%OR%WA%AFSC_Slope%Triennial%NWFSC_Slope%NWFSC_combo
0.5 0.5 0.5 0.825 0.55 0.65 0.65 #timing_in_season
1 1 1 1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 1 #_units of catch:  1=bio; 2=num
0.01 0.01 0.01 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
60 #_Nages

0 0 0 #_init_equil_catch_for_each_fishery
101             #_N_lines_of_catch_to_read
#CA     OR      WA      Year    Season
0.0     0.0     0.0     1910    1
10.0    0.0     0.0     1911    1
20.0    0.0     0.0     1912    1
30.0    0.0     0.0     1913    1
40.0    0.0     0.0     1914    1
50.0    0.0     0.0     1915    1
55.8    0.0     0.0     1916    1
152.1   0.0     0.0     1917    1
183.7   0.0     0.0     1918    1
192.7   0.0     0.0     1919    1
166.5   0.0     0.0     1920    1
254.6   0.0     0.0     1921    1
429.6   0.0     0.0     1922    1
493.9   0.0     0.0     1923    1
692.8   0.0     0.0     1924    1
763.5   0.0     0.0     1925    1
753.7   0.0     0.0     1926    1
913.1   0.0     0.0     1927    1
895.9   0.0     0.0     1928    1
1020.0  0.0     0.0     1929    1
951.8   0.0     0.0     1930    1
820.2   0.0     0.0     1931    1
774.7   9.4     0.0     1932    1
724.2   4.4     0.0     1933    1
767.7   1.6     0.0     1934    1
785.2   4.7     95.0    1935    1
719.3   18.3    244.0   1936    1
726.1   92.7    210.9   1937    1
680.0   1.9     260.3   1938    1
861.5   288.6   245.6   1939    1
655.5   518.5   296.9   1940    1
412.2   618.9   467.9   1941    1
273.9   1031.6  500.6   1942    1
408.8   2732.1  696.9   1943    1
417.7   676.5   498.8   1944    1
683.3   1170.7  500.9   1945    1
944.7   1427.2  526.7   1946    1
1104.0  905.4   434.5   1947    1
1554.9  1321.9  639.0   1948    1
2977.6  1431.9  512.9   1949    1
3731.9  2750.3  471.7   1950    1
3662.3  3601.8  379.0   1951    1
4796.8  3234.0  532.0   1952    1
3545.5  1111.0  420.6   1953    1
3638.1  1543.7  736.9   1954    1
```

```
3267.7  1214.3  1130.0  1955    1
3286.1  1447.2  932.5   1956    1
3159.1  1656.1  365.3   1957    1
3136.0  1690.7  642.3   1958    1
2784.0  1952.8  423.7   1959    1
3619.7  2127.3  1091.7  1960    1
3046.4  1867.6  708.5   1961    1
3406.5  2160.3  731.6   1962    1
3808.6  2578.8  969.2   1963    1
3898.0  2501.4  546.4   1964    1
4563.8  1439.3  497.4   1965    1
4383.1  1629.2  313.5   1966    1
3091.0  1718.8  226.9   1967    1
3647.1  1873.7  491.7   1968    1
5860.0  2621.0  460.9   1969    1
6876.9  2590.1  597.2   1970    1
6383.4  2632.7  394.4   1971    1
10016.1 2728.0  369.8   1972    1
10199.3 2075.5  383.5   1973    1
8657.9  2578.3  441.0   1974    1
10291.3 2068.3  428.5   1975    1
10322.3 2295.0  1072.7  1976    1
9944.5  1854.4  928.4   1977    1
9421.1  3383.8  1422.2  1978    1
10611.5 5064.9  2186.5  1979    1
8231.9  4024.7  1990.0  1980    1
9250.7  5228.1  1834.2  1981    1
10050.4 8083.4  2738.2  1982    1
8578.1  8449.4  2922.8  1983    1
9779.0  6099.4  3376.4  1984    1
12001.8 5695.2  2846.2  1985    1
10981.9 4771.9  1451.0  1986    1
10708.3 6016.8  1606.3  1987    1
8138.0  7647.4  2270.2  1988    1
7706.4  8886.0  2235.5  1989    1
6297.3  7489.6  1897.1  1990    1
7686.1  8793.9  1716.6  1991    1
8630.5  6055.0  1334.8  1992    1
6534.0  6462.7  1308.8  1993    1
4457.6  3842.9  979.8   1994    1
6060.9  3503.1  897.3   1995    1
6391.0  4629.4  1048.6  1996    1
5292.0  3937.7  833.6   1997    1
3561.9  3769.3  619.7   1998    1
3804.8  4430.6  788.3   1999    1
3323.4  4625.1  741.9   2000    1
2446.3  3714.5  703.6   2001    1
3099.7  2689.5  444.3   2002    1
3239.0  3312.9  464.7   2003    1
2384.4  3798.6  550.1   2004    1
2202.4  3968.7  721.2   2005    1
1739.7  3523.4  694.0   2006    1
2758.7  5550.2  955.2   2007    1
2992.1  7259.6  951.9   2008    1
3154.3  7452.4  1124.8  2009    1
2613.6  6878.9  882.1   2010    1


#Abundance     indices
26
#_Units:  0=numbers; 1=biomass; 2=F
#_Errtype:  -1=normal; 0=lognormal; >0=T
#_Fleet Units Errtype
1 1 0 # CA
2 1 0 # OR
3 1 0 # WA
4 1 0 # AFSC slope
5 1 0 # Triennial
6 1 0 # NWFSC slope
7 1 0 # NWFSC combo
```

```
#Year   Seas    Fleet   Value   SE(log(B))
#AFSC slope             fleet=4 Median
1997  1  4  115287   0.09129261
1999  1  4  116304.8 0.09623537
2000  1  4  133776   0.09146446
2001  1  4  181507.3 0.09268572
#early Triennial              fleet=5
1980  1  5  17879.62  0.07298857
1983  1  5  23398.54  0.06499434
1986  1  5  26575.62  0.07334597
1989  1  5  18716.04  0.05991776
1992  1  5  15544.73  0.08627467
#late Triennial               fleet=5
1995  1  5  35859.58   0.06544357
1998  1  5  45343.85   0.05805078
2001  1  5  67084.99   0.05440894
2004  1  5  113326.52  0.0589862
#NWFSC_Slope            fleet=6
1998  1  6  131311.2   0.0627629
1999  1  6  148025.2   0.07379278
2000  1  6  137961.7   0.06827921
2001  1  6  124823     0.06603929
2002  1  6  172913.7   0.06255329
#NWFSC_Combo            fleet=7
2003  1  7  293434.6   0.07699773
2004  1  7  255788.7   0.06025355
2005  1  7  253880.2   0.05664991
2006  1  7  267902     0.05420957
2007  1  7  299382.6   0.04907333
2008  1  7  278502.9   0.05175503
2009  1  7  252247.9   0.05260745
2010  1  7  266347.5   0.05725072


#_Discards
3       #_N_fleets_with_discard
#Fleet Units Err_Type
#_discard_units (1=same_as_catchunits(bio/num);2=fraction; 3=numbers)

#_discard_error:  >0 for DF of T-dist(read CV below); 0 for normal with CV; -1 for normal with
se; -2 for lognormal with se in log space
#Fleet  Units   Error
1       2       -2
2       2       -2
3       2       -2
28      #nobs_disc
# Year  Seas    Fleet   Value   Error
1992    1       1       0.1271  0.2     # Humboldt State University study
1959    1       2       0.1465  0.2     # Hermann and Harry (1963)
1974    1       2       0.167   0.2     # Methot et al (1990) based on TenEyck and Demory (1975)
1986    1       2       0.07    0.2     # Pikitch study
2002    1       1       0.232125545    0.068944819
2002    1       2       0.157901557    0.119007613
2002    1       3       0.133399084    0.078908815
2003    1       1       0.203113758    0.059834439
2003    1       2       0.178569276    0.086140416
2003    1       3       0.228919933    0.111126444
2004    1       1       0.111893249    0.120534811
2004    1       2       0.062234531    0.152444324
2004    1       3       0.04404019     0.103040781
2005    1       1       0.12471805     0.063502045
2005    1       2       0.091372665    0.132519747
2005    1       3       0.131077363    0.082992192
2006    1       1       0.167871942    0.087901932
2006    1       2       0.109009151    0.181441127
2006    1       3       0.213451921    0.087873794
2007    1       1       0.162606146    0.080141759
2007    1       2       0.067312476    0.206500451
2007    1       3       0.111201871    0.142774737
2008    1       1       0.112377748    0.091753302
2008    1       2       0.03370918     0.216252586
```

```
2008	1	3	0.035152131	0.212366644
2009	1	1	0.144438259	0.089267311
2009	1	2	0.041777754	0.113055143
2009	1	3	0.057377194	0.129324783


#_Mean_BodyWt
24	#nobs meanwt
30	#degrees of freedom for meanwt t-distn
#Year	Seas	Type	Partition	Value	CV
2002	1	1	1	0.490566942	0.176332583
2002	1	2	1	0.445147843	0.194378017
2002	1	3	1	0.35032816	0.283023071
2003	1	1	1	0.52339686	0.169887183
2003	1	2	1	0.384117905	0.252789016
2003	1	3	1	0.323329211	0.338282413
2004	1	1	1	0.429157794	0.204920027
2004	1	2	1	0.327226833	0.243105638
2004	1	3	1	0.300457571	0.279897793
2005	1	1	1	0.414446216	0.197262172
2005	1	2	1	0.445233464	0.206508047
2005	1	3	1	0.381844341	0.27779069
2006	1	1	1	0.435172012	0.262609593
2006	1	2	1	0.411322616	0.220213686
2006	1	3	1	0.379793576	0.380502945
2007	1	1	1	0.446243677	0.199786602
2007	1	2	1	0.355818132	0.241683037
2007	1	3	1	0.362023165	0.27167789
2008	1	1	1	0.437647043	0.226674874
2008	1	2	1	0.48875268	0.220375603
2008	1	3	1	0.429695212	0.238527025
2009	1	1	1	0.459920164	0.197406524
2009	1	2	1	0.469166492	0.274947503
2009	1	3	1	0.444393179	0.333852267


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


#Length bins
-1	#min_tail	#min_proportion_for_compressing_tails_of_observed_composition
0.0001	#min_comp	#constant_added_to_expected_frequencies
0 #_combine males into females at or below this bin number
#_Length_Composition_Data


27	#nlength	#N_length_bins


#len_bins(1,nlength)	#_lower_edge_of_length_bins
8	10	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

#LENGTH_COMPOSITIONS:Replicates_(by_state)_must_be_contigent_within_Year-Seas-Fleet-Sex
163	#nobs length
```

nTows

```
#year  Season Fleet  gender partition     nSamps F8     F10    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    M8     M10    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

#Commercial reatined LFs. WA years 1965, 1967, 1969:1972, and 2006 are unsexed (unsexed lengths
greater than 25% of all lengths)




1978   1      1      3      2      64     0      0      0      0      0      0      0
       0      0      0      0      0.339899734   1.741067788   2.100462231   4.572913046
       7.865397341   7.629908084   8.167721043   6.312695052   4.384372247   2.093411046
       1.028791241   0.26921715    0.147323333   0      0.051242495   0      0      0
       0      0      0      0      0      0      0      0      0.09445667    0.603469681
       2.969623255   6.751952849   11.23199383   13.33270554   10.45892873   5.454482543
       1.678067189   0.361825328   0.358072557   0      0      0      0      0      0

1979   1      1      3      2      38     0      0      0      0      0      0      0
       0      0.036952175   0      0      0.019693728   1.144775488   2.65004214
       7.544125617   7.18141051    7.775731218   7.401851183   6.1515027     5.51564895
       2.30756747    1.259539822   0.291823151   0.545535061   0.161770652   0.112659611
       0      0      0      0      0      0      0      0      0      0.128082612   0
       0.328214936   0.290009447   2.811172005   6.483739667   9.95166858    10.87540109
       11.27626953   5.96576916    1.465352085   0.063015348   0.098905413   0      0
       0      0      0      0.161770652

1980   1      1      3      2      115    0      0      0      0      0      0      0
       0      0      0.015855856   0.159769026   0.650379342   2.184050956   5.191653215
       7.97772675    8.053838505   7.785978238   6.206602276   4.699540021   3.340058421
       1.730296325   0.886888207   0.400039688   0.107271452   0.151596356   0.000899878
       0.052976783   0      0      0      0      0      0      0      0      0      0
       0.169389296   1.387984057   4.510661255   10.4798072    13.58524365   9.306003515
       6.548284788   2.913666831   1.02446173    0.38012736    0.074102908   0.024846113
       0      0      0      0      0

1981   1      1      3      2      80     0      0      0      0      0      0      0
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0.403971691	0	0	0	0	0	0	0	0	0	0
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4.390434774	2.78698744	0.501581715	0.113002706	0.045270551	0
0.06384938	0	0	0	0

2005	1	3	3	2	17	0	0	0	0	0	0	0
0	0	0	0.418181745	0.759694999	1.963170507	2.008393064
5.684246125	9.363573782	10.44430678	5.731129468	6.149381872	4.804668111
1.948735798	0.8841876	0.517859194	0.040733223	0.459193773	0.120535879
0.442113965	0	0	0	0	0	0	0	0	0
0.268732197	0	2.042881699	4.529417516	9.686402598	16.23241356
9.416475359	3.805472832	0.939985788	0.725947325	0.43361687	0.139853986
0	0.03869438	0	0	0	0

2006	1	3	0	2	12	0	0	0	0	0	0	0
0	0	0	0.291677269	3.335683171	10.12696229	12.07542008
19.7682989	14.69662484	11.25282069	8.940815011	6.002725456	5.40199777
2.408649286	1.780882666	1.880329756	1.241170177	0.510043785	0.212260138
0.073638712	0	0	0	0	0	0	0	0	0	0
0.291677269	3.335683171	10.12696229	12.07542008	19.7682989	14.69662484
11.25282069	8.940815011	6.002725456	5.40199777	2.408649286	1.780882666
1.880329756	1.241170177	0.510043785	0.212260138	0.073638712

2007	1	3	3	2	22	0	0	0	0	0	0	0
0	0	0	0.332936207	0.435424798	1.27639088	2.451883435
4.460772241	5.637013465	4.659332319	5.897089497	3.410725539	2.160211546
1.961126524	1.35633517	0.903093337	0.305051818	0.407345656	0.15771959
0.140053122	0	0	0	0	0	0	0	0.146082916	0
0.145363547	0.562834848	3.252598431	6.501476718	14.40359048	17.94481434
11.46684134	6.123971856	1.859877139	0.86654267	0.502379147	0.177991386
0	0	0.09313004	0	0	0

2008	1	3	3	2	23	0	0	0	0	0	0	0
0	0	0	0	0.248295972	1.350331571	3.611366374	5.367075136
6.463855227	6.048744368	5.222189365	3.507459205	3.29297022	1.867209643
1.599077439	0.921482855	0.441634873	0.228331615	0.238821805	0.171142836
0	0	0	0	0	0	0	0	0	0.004424729
0.282711912	2.679204918	8.017291556	13.23549351	14.96188582	10.78776221
5.512000541	2.133060501	0.925319091	0.517898317	0.19605842	0.08666258
0.080237387	0	0	0	0

2009	1	3	3	2	10	0	0	0	0	0	0	0
0	0	0	0	0.232853738	1.077315122	3.246489685	6.045787311
9.956004829	9.473645719	7.994015086	5.489132042	3.978399751	2.07874761
2.165184861	1.048405738	0.295861983	0.126112649	0.196985523	0.645888683
0	0	0	0	0	0	0	0	0	0	0
1.177651825	4.066448489	10.21109492	12.24496375	8.351190508	5.905970093
2.023246268	1.302333292	0.356953534	0.079690731	0.055604421	0.174021832
0	0	0	0

2010	1	3	3	2	12	0	0	0	0	0	0	0
0	0	0	0	0.009313589	0.415109276	1.261706497	3.827027562
5.988462333	4.439213476	6.114432176	4.281226519	2.28205729	2.768490133
1.962385002	1.603507442	0.903385314	0.536735649	0.269573563	0.090031363
0	0	0	0	0	0	0	0	0.082391479	0
0.173632634	1.477374545	6.457226169	14.78038818	16.12756943	12.57521435
6.7241557	2.903344654	0.941454734	0.34294241	0.250035681	0.329221368
0	0	0	0	0.082391479

#WCGOP discards
```

2006 1 1 0 1 125 0 0 0.000926208 0.004785409
0.004139951 0.008574132 0.015188117 0.01984461 0.0326924 0.056434934
0.080241277 0.060501885 0.090695921 0.127727609 0.066846271 0.106952529
0.143199006 0.065719277 0.035547845 0.037144797 0.030941833 0.004245121
0.005248513 0.001360368 0.000574056 0 0.000467928 0 0
0.000926208 0.004785409 0.004139951 0.008574132 0.015188117 0.01984461
0.0326924 0.056434934 0.080241277 0.060501885 0.090695921 0.127727609
0.066846271 0.106952529 0.143199006 0.065719277 0.035547845 0.037144797
0.030941833 0.004245121 0.005248513 0.001360368 0.000574056 0
0.000467928

2007 1 1 0 1 121 0 0.000271355 0 0.000334101
0.000229962 0.0015797 0.004365384 0.01176795 0.027971933 0.037783097
0.041200884 0.107102431 0.081054379 0.086646158 0.119163724 0.099166337
0.086208396 0.075745016 0.076754622 0.032359232 0.050888676 0.022583657
0.012033136 0.014984304 0.004902783 0 0.004902783 0 0.000271355
0 0.000334101 0.000229962 0.0015797 0.004365384 0.01176795
0.027971933 0.037783097 0.041200884 0.107102431 0.081054379 0.086646158
0.119163724 0.099166337 0.086208396 0.075745016 0.076754622 0.032359232
0.050888676 0.022583657 0.012033136 0.014984304 0.004902783 0
0.004902783

2008 1 1 0 1 36 0 0 0 0 0 0
0.002273106 0.004649534 0.00449455 0.008332261 0.028199795 0.072422033
0.026528177 0.037871809 0.072012629 0.160571361 0.076725187 0.134592615
0.133618474 0.111559016 0.040089319 0.084226152 0.001833983 0 0
0 0 0 0 0 0 0 0 0.002273106 0.004649534
0.00449455 0.008332261 0.028199795 0.072422033 0.026528177 0.037871809
0.072012629 0.160571361 0.076725187 0.134592615 0.133618474 0.111559016
0.040089319 0.084226152 0.001833983 0 0 0 0

2009 1 1 0 1 112 0 0 0 0.000154 0.000277398
0 0.000128334 0.002738312 0.009564022 0.015821158 0.039482559
0.041581008 0.072154318 0.066198432 0.203552989 0.122171204 0.144958746
0.116523292 0.082398562 0.04126676 0.02364462 0.010572726 0.00681156
0 0 0 0 0 0 0 0.000154 0.000277398 0
0.000128334 0.002738312 0.009564022 0.015821158 0.039482559 0.041581008
0.072154318 0.066198432 0.203552989 0.122171204 0.144958746 0.116523292
0.082398562 0.04126676 0.02364462 0.010572726 0.00681156 0 0
0 0

2006 1 2 0 1 79 0 0 0 0.001510655 0.031620712
0.000637847 0.002939035 0.042179695 0.059920408 0.097427948 0.086205538
0.116919206 0.048768086 0.100064179 0.106554862 0.031175848 0.061972236
0.056952312 0.01821955 0.037593346 0.083516713 0.015821826 0 0
0 0 0 0 0 0 0.001510655 0.031620712 0.000637847
0.002939035 0.042179695 0.059920408 0.097427948 0.086205538 0.116919206
0.048768086 0.100064179 0.106554862 0.031175848 0.061972236 0.056952312
0.01821955 0.037593346 0.083516713 0.015821826 0 0 0 0
0
2007 1 2 0 1 78 0 0 0 0.003446779 0.004902973
0.008874751 0.011398128 0.013216374 0.030969272 0.039224227 0.069643642
0.157969993 0.082013321 0.098705454 0.163231792 0.076024963 0.035973919
0.068710282 0.000789626 0.025325212 0.009901813 0.019935496 0.019935496
0.059806487 0 0 0 0 0 0 0.003446779 0.004902973
0.008874751 0.011398128 0.013216374 0.030969272 0.039224227 0.069643642
0.157969993 0.082013321 0.098705454 0.163231792 0.076024963 0.035973919
0.068710282 0.000789626 0.025325212 0.009901813 0.019935496 0.019935496
0.059806487 0 0 0

2008 1 2 0 1 28 0 0 0 0 0 0
0.000525404 0 0.004728632 0.022066947 0.142579427 0.092579629
0.056598118 0.063311123 0.131651881 0.120107242 0.235275691 0.102729521
0.000525404 0.027320982 0 0 0 0 0 0 0 0
0 0 0 0 0 0.000525404 0 0.004728632 0.022066947
0.142579427 0.092579629 0.056598118 0.063311123 0.131651881 0.120107242
0.235275691 0.102729521 0.000525404 0.027320982 0 0 0 0
0 0 0

2009 1 2 0 1 145 0 0 0 0 0.000402053
0.006422435 0.005379327 0.024374788 0.011931455 0.023815225 0.045924604
0.112416105 0.168653119 0.178535325 0.10398685 0.088774504 0.057104794
0.044105282 0.043115932 0.037608404 0.021447291 0.008623123 0.000871116
0.01436008 0 0 0.002148188 0 0 0 0.000402053
0.006422435 0.005379327 0.024374788 0.011931455 0.023815225 0.045924604
0.112416105 0.168653119 0.178535325 0.10398685 0.088774504 0.057104794
0.044105282 0.043115932 0.037608404 0.021447291 0.008623123 0.000871116
0.01436008 0 0 0.002148188

2006 1 3 0 1 98 0 0 0 0 0.009113645
0.01633445 0.014600469 0.023272621 0.040545836 0.060254654 0.074222728
0.089264886 0.152698862 0.137956566 0.136897684 0.076007056 0.045149932
0.017596585 0.044832089 0.009409231 0.008835111 0.028140932 0.00833429
0 0 0.000959556 0.005572819 0 0 0 0 0.009113645
0.01633445 0.014600469 0.023272621 0.040545836 0.060254654 0.074222728
0.089264886 0.152698862 0.137956566 0.136897684 0.076007056 0.045149932
0.017596585 0.044832089 0.009409231 0.008835111 0.028140932 0.00833429
0 0 0.000959556 0.005572819

2007 1 3 0 1 71 0 0 0.000755784 0 7.56E-05
0.0041256 0.005083409 0.037890341 0.013794204 0.047895596 0.167642149
0.205051663 0.134401366 0.176661415 0.048330072 0.080262457 0.039026746
0.00339196 0.006823809 0.013898808 0.000314406 0.014124973 9.49E-05
4.03E-05 0.000314406 0 0 0 0 0.000755784 0 7.56E-
05 0.0041256 0.005083409 0.037890341 0.013794204 0.047895596 0.167642149
0.205051663 0.134401366 0.176661415 0.048330072 0.080262457 0.039026746
0.00339196 0.006823809 0.013898808 0.000314406 0.014124973 9.49E-05
4.03E-05 0.000314406 0 0

2008 1 3 0 1 21 0 0 0 0 0 0 0
0 0 0.001785869 0.095914109 0.19888876 0.171928804 0.126666259
0.185777398 0.133755442 0.025887815 0.012778202 0 0.046001526 0
0 0 0.000615817 0 0 0 0 0 0 0 0
0 0 0 0 0.001785869 0.095914109 0.19888876 0.171928804
0.126666259 0.185777398 0.133755442 0.025887815 0.012778202 0
0.046001526 0 0 0 0.000615817 0 0 0

2009 1 3 0 1 90 0 0 0 0.003824324 0.001869526
0.003580741 0.021012856 0.163366024 0.143293187 0.01369326 0.132847238
0.089043518 0.143251997 0.125725991 0.035004102 0.030841685 0.037391624
0.007822289 0.004838358 0.030312588 0.001626908 0.003079947 0.004904971
0 0.0002787 0 0.002390166 0 0 0 0.003824324
0.001869526 0.003580741 0.021012856 0.163366024 0.143293187 0.01369326
0.132847238 0.089043518 0.143251997 0.125725991 0.035004102 0.030841685
0.037391624 0.007822289 0.004838358 0.030312588 0.001626908 0.003079947
0.004904971 0 0.0002787 0 0.002390166

#AFSC slope

1997 1 4 3 0 162 0.003528442 0 0 0.03673502
0.036630891 0.142271224 0.424232052 0.851926768 1.495698319 2.648490588
4.10372333 4.745275554 4.123784068 3.97339075 3.355485152 3.003994867
2.917691754 3.177001492 3.340176914 2.638323618 1.052115712 0.431501227
0.147478832 0.080146379 0.021279265 0.004101525 0 0 0
0.011303083 0.019969766 0.085340847 0.189775717 0.451935566 1.373125235
4.2758098 8.450393666 10.06940315 9.804180429 7.04224715 4.291888848
3.338767662 3.217675169 2.498302473 1.464026997 0.43540032 0.154101464
0.057141582 0.004450217 0.00651808 0.00325904 0 0 0

1999 1 4 3 0 166 0.002861942 0.02534599 0.036610875
0.014081106 0.095016865 0.245255371 0.51473855 1.082242469 1.518737005
1.814363829 2.988997384 4.291333051 5.036216354 4.14334059 3.166524921
2.45104609 2.719597663 2.710238386 3.092223314 2.711527787 1.498748685
0.546444465 0.184346392 0.074310316 0.034800493 0.027657393 0.082837998
0.006089615 0.011264885 0.016897327 0.014081106 0.127130903 0.255122923
0.564283628 1.303943128 2.287593005 5.074064499 8.713612815 10.65448429

```
        9.679191496    6.861615717    4.805086114    3.293619591    2.52103839     1.701521148
        0.675333419    0.238309516    0.052141144    0.018815363    0.009178791    0
        0.006135906    0       0

2000    1       4       3       0       176     0       0.019227469    0       0       0.128124399
        0.295600576    0.573623389    1.170521208    1.217773961    1.45951267     2.269833878
        2.635478665    3.249617876    3.229651496    2.790633655    2.691979209    2.493193689
        2.830582119    3.364478116    2.432002489    1.211502761    0.543675092    0.178038912
        0.150319023    0.057382643    0.007883644    0.021207924    0       0       0.014964623
        0       0.131021777    0.427818007    0.99157604     1.550740365    2.02171448
        3.000607757    7.057818476    12.85131487    12.16450774    8.834363211    5.459001757
        4.208575803    2.910708558    1.826156131    1.037552405    0.347630062    0.090363706
        0       0.026388874    0.003785522    0       0.015571936    0.005973039

2001    1       4       3       0       179     0       0       0       0       0.040396478
        0.376613281    1.240382419    2.103562592    1.917005841    2.195797785    3.394068346
        3.646437888    3.587457651    3.616471741    2.993071784    2.450485425    2.616663486
        2.022634362    2.316190211    2.000315149    1.252128451    0.482973594    0.117997359
        0.058017727    0.026155679    0.001689307    0.015206678    0       0       0       0
        0.006282132    0.224858464    1.171675248    2.086922602    2.640629365    4.121584281
        6.221559445    10.43772821    12.13639111    9.219048536    5.003763733    3.161819261
        2.561709129    1.354584876    0.764384993    0.303849443    0.062653615    0.033625642
        0.00632186     0.008884818    0       0       0

#early Triennial



1980    1       5       3       0       27      0       0       0       0       0       0       0
        0.146439979    0.598201848    0.939907418    2.198174324    1.9339223      4.032376743
        4.890853341    6.306939204    3.437309884    3.529091266    2.389346984    1.805586928
        1.789009947    1.486110371    1.249293371    0.738211138    0.149697433    0.03930921
        0.270229318    0.045011699    0       0       0       0       0       0       0
        0.077470036    1.13240989     2.413547754    5.027921618    8.031157468    11.17775617
        11.5024629     8.743031118    6.677777482    2.700487016    2.334117871    1.450733097
        0.277401546    0.381507698    0.048597813    0.048597813    0       0       0       0

1983    1       5       3       0       35      0       0       0       0.028573024    0.045582267
        0.57611109     0.528717364    0.672225271    1.851864291    2.938358038    4.06123781
        5.167809743    6.07706173     6.489954813    4.062346473    3.699189264    2.091286911
        1.761092938    1.070113636    0.894453934    0.791013768    0.498494085    0.323904394
        0.235700012    0.0772673      0.087498284    0.018053176    0       0       0       0
        0.152573642    0.241952967    0.651977366    2.094689724    4.291921826    7.470098421
        9.774219216    12.75306883    8.474185661    5.398789891    2.559493706    0.847012644
        0.609607783    0.307406611    0.28252097     0       0.042571131    0       0       0
        0       0       0

1986    1       5       3       0       125     0       0       0       0       0.024636945
        0.023768132    0.273694941    0.623546346    0.924568642    1.572942716    2.659054114
        4.959349181    5.273547567    5.686284329    3.966347401    2.713754233    1.627276966
        0.79006811     0.669110931    0.375178952    0.335036897    0.305297734    0.102031029
        0.071602238    0.112942874    0.006951067    0.014231352    0       0       0       0
        0.014764172    0.012470709    0.314287481    0.826705018    1.741161249    4.463797588
        10.59506278    19.01166825    17.26375834    8.253077204    2.821455096    0.866671603
        0.405631605    0.146175017    0.078720385    0.030172993    0.036705438    0.006492381
        0       0       0       0       0

1989    1       5       3       0       323     0       0       0       0.014206181    0.134247906
        0.265367437    1.055880932    1.868512145    2.768101909    3.948373554    4.619467002
        5.535754512    5.146542464    4.656984879    3.905479221    2.502772451    2.133595546
        1.340767191    0.881521477    0.464978014    0.37614531     0.291741656    0.178628541
        0.093855576    0.09765593     0.06446977     0.047215288    0       0       0
        0.011509297    0.137777645    0.351524057    1.657758505    2.620868399    4.483961875
        6.113949417    10.61289531    11.78498439    9.061787662    5.68383738     3.033821387
        1.123058852    0.496942396    0.285276875    0.066449069    0.037023774    0.034651226
        0.003797467    0       0.00586012     0       0       0

1992    1       5       3       0       243     0       0       0       0.006409271    0.056924404
        0.122452325    0.729565043    2.041068353    3.949381586    4.177573208    4.541078542
```

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        6.117943153     5.631206962     6.349480742     4.274601654     3.031055252     2.019695167
        1.350580697     1.036631736     0.845667558     0.560173096     0.375195578     0.339329609
        0.118837665     0.118540517     0.012652639     0.039279615     0       0       0
        0.022823017     0.07426007      0.371017468     0.925600482     3.075070042     5.836963667
        7.296613857     8.507200697     9.338116434     7.256414703     4.87011211      2.684193342
        1.074398199     0.409238904     0.257322652     0.108294068     0.047035915     0       0
        0       0       0       0       0

#late Triennial

1995    1       5       3       0       296     0       0       0       0.011366385     0.054050229
        0.342754958     1.028415775     1.687540506     3.041057391     4.751326195     5.815483457
        6.239817976     5.730127974     5.008780009     3.411201673     2.022614101     1.079694279
        0.568947465     0.395657309     0.33429604      0.277394447     0.203386422     0.115335769
        0.045234491     0.072479061     0.007679807     0.008914544     0       0       0
        0.011632955     0.053012553     0.400097059     1.46909094      3.052923629     5.768332853
        9.105249622     10.62210848     11.01304493     7.985446167     5.144234265     2.03683626
        0.596194404     0.243049595     0.108852014     0.056672303     0.050335911     0.014970605
        0.004928149     0.004968396     0       0.001666457     0       0.002796192

1998    1       5       3       0       374     0       0       0       0.014218194     0.081391643
        0.231473856     0.791969379     1.513255358     2.615749053     5.046207524     6.688764137
        6.851569155     6.32991047      4.536452863     2.70923826      1.716745286     1.285699944
        0.86609798      0.49234783      0.27000053      0.266753761     0.284151692     0.157839192
        0.080054994     0.062068127     0.012351043     0.019569668     0       0       0
        0.017079872     0.155872762     0.285707426     1.07422082      2.733113558     5.888712078
        9.955463022     12.7536701      11.53900337     6.977366813     3.619000398     1.282963253
        0.483502073     0.107396756     0.090976291     0.057508407     0.028366651     0.016960097
        0       0.00292627      0       0       0       0.006310043

2001    1       5       3       0       454     0       0       0.004173168     0.021335553
        0.119137712     0.736566674     1.670292836     2.814560671     4.162409316     4.900169987
        2.819919945     5.30986934      4.581658111     3.841066421     3.769981292     2.367147373
        1.692612666     1.098145706     0.721409381     0.61350707      0.405483743     0.179051495
        0.153004953     0.158084292     0.041199253     0.027012885     0.025790342     0       0
        0       0.010843876     0.163424342     1.162512026     2.428055017     4.408510274
        6.142919596     7.430587427     5.981032853     11.71038421     8.862634129     5.953679079
        2.073526736     0.829998201     0.268535473     0.203504275     0.038810492     0.055455236
        0.022614835     0.007146905     0       0       0       0       0.012234831

2004    1       5       3       0       371     0       0       0.004852806     0.032421242
        0.317633902     1.301036496     2.62040872      3.279387782     3.071695469     3.712036074
        3.882339893     4.510756676     4.079136704     4.211490143     3.015108355     3.392138472
        2.60262653      2.098971841     1.251695333     0.842527704     0.472564972     0.298739489
        0.24113971      0.137216162     0.052465437     0.025141778     0.043445856     0       0
        0.012784353     0.05078846      0.320007745     1.235271326     3.075970297     3.439875737
        4.377762642     6.162893178     6.535200947     8.081667417     7.843733175     6.82481773
        3.657025169     1.86254029      0.674579731     0.195743548     0.064475001     0.021720773
        0.008639225     0.013940908     0.003977745     0       0.034885667     0       0.004721389

#NWFSC_Slope

1998    1       6       3       0       220     0       0.003084882     0       0       0
        0.010785728     0.158953283     0.356214657     0.639242067     1.42894831      2.557262706
        3.52276505      4.318362848     4.173012167     3.596027413     3.373955295     2.931701492
        3.326305848     3.274169342     2.359258049     1.235404746     0.46247455      0.423055939
        0.21008777      0.049390576     0.037084432     0.009902876     0       0       0       0
        0       0.029500434     0.154273331     0.384247998     1.785461579     5.330932253
        11.05223451     12.37539588     11.30978996     7.445411168     4.712916199     2.691707565
        2.107487967     1.297763605     0.574234187     0.183878094     0.058818177     0.015670164
        0.016755646     0       0.010032243     0       0.006039006
```

```
1999	1	6	3	0	279	0	0	0	0.003144058	0.010357983
	0.016373901	0.150430866	0.61675183	1.352368267	2.181114477	3.739306961
	4.380378864	4.988662977	4.06400721	3.429456974	3.176581778	3.041764674
	3.262237862	3.420974471	2.676396663	1.444736894	0.501563917	0.202184826
	0.090607068	0.023737367	0.021768467	0.011336553	0	0	0
	0.008000612	0.00491301	0.045473238	0.183284522	0.835416412	2.314166661
	5.209981659	9.00171669	10.65135804	9.719271261	6.840514692	3.966472529
	2.99709795	2.57859348	1.599308197	0.880505547	0.294293688	0.033401077
	0.02130741	0	0	0.008678419	0	0

2000	1	6	3	0	284	0	0.005846419	0	0.003527331
	0.00232484	0.012626532	0.078941419	0.285106008	0.773687874	1.668439222
	2.116796712	2.974382826	3.386380706	3.685173477	3.813482953	3.311354282
	3.232823918	3.698889382	3.9393955	3.353046109	1.694098739	0.666035848
	0.25608711	0.183914683	0.086912902	0.023643353	0.0296976	0	0
	0	0	0	0.008220724	0.111664801	0.462258217	1.719855653
	3.597949599	7.191277893	11.34982764	13.26142797	8.788351077	5.990742765
	3.793419463	2.16665443	1.346052562	0.570357726	0.247293516	0.026460922
	0.015507754	0.02542063	0.007558511	0.006742152	0.006742152	0.023598106

2001	1	6	3	0	291	0	0	0	0	0	0.070968619
	0.207124402	0.589742596	1.321171944	1.824202378	2.018650122	2.552270238
	3.105879494	2.654926576	2.826813228	2.950770968	3.973415675	4.685071321
	5.172719591	3.35968581	1.436262912	0.50923944	0.16866174	0.083101094
	0.06197192	0.010022519	0.017800622	0	0	0	0.01094893
	0.059506629	0.00987839	0.250652108	0.58921896	1.573637291	2.847972013
	4.400571079	7.448164353	9.111469799	8.01074553	6.542774354	5.519673692
	7.494228659	4.649118367	1.63320707	0.174981637	0.04014537	0.01187806
	0.009508853	0	0.00936684	0	0		#I removed a suspect 2cm fish

2002	1	6	3	0	365	0	0.010185893	0.005092947	0
	0.010185893	0.035920584	0.31837323	0.64566824	1.102153063	2.338300812
	2.616534312	3.405893947	4.236675024	4.123637334	3.843931883	3.719416751
	3.81288683	3.438160405	3.519845815	1.972885444	1.078004985	0.407085803
	0.180239377	0.099927047	0.039674875	0.041463373	0.005720603	0
	0.010185635	0	0.009547107	0.029375357	0.059296322	0.118418711
	0.415425998	1.527654953	3.745303114	5.425648373	7.344158322	9.851452201
	8.963176758	7.590839209	5.873966675	4.189153019	2.500452812	0.879228907
	0.332298402	0.087639216	0.026430677	0.004180839	0.003719609	0.001866922
	0	0.002716394

#NWFSC_Combo



2003	1	7	3	0	438	0	0	0.006872914	0.016116601
	0.021501054	0.070022989	0.248336255	0.665639697	1.435573092	2.323731436
	2.808653454	3.388326347	4.359330173	4.767373682	5.463610767	5.011557473
	4.133547938	3.4446529	2.82712639	1.718526615	1.334281914	0.816615716
	0.218145974	0.243477876	0.113385603	0.083088335	0.032970132	0	0
	0	0.036024177	0.015890321	0.095203271	0.355378955	0.796503849
	2.108566979	3.550629014	5.058487078	7.483985061	9.648528916	9.348094382
	7.121385813	3.628607748	2.39697617	1.706596281	0.643359707	0.214775563
	0.161634328	0.041874481	0.025564417	0.00626496	0.003203203	0	0

2004	1	7	3	0	402	0	0	0.004593645	0.008553004
	0.017357318	0.080920615	0.300937371	0.93638383	1.546361546	2.360960535
	3.199216317	4.623298103	4.048783319	5.154701706	4.213832981	3.849670775
	3.75055176	2.980599236	2.74085706	1.925135439	1.223028254	0.475208319
	0.277556118	0.129536581	0.145290246	0.044972906	0.008031413	0
	0.003627471	0	0.006473589	0.027739177	0.123751184	0.415944345
	1.29717983	2.670647563	4.528021807	6.559862903	7.441147786	8.822871007
	8.196018121	6.166799819	4.119250137	2.96624149	1.608218074	0.605506533
	0.26294537	0.058773375	0.054079994	0.01034636	0.008215669	0	0
	0
2005	1	7	3	0	544	0	0	0.008280477	0.01553034
	0.029128912	0.094837379	0.379338139	1.017700955	2.00798828	2.699085171
	3.488780784	3.964873986	4.507529144	4.37380272	4.254661968	4.399338569
	3.792646171	3.149478942	2.631443312	1.723062309	1.001688711	0.468082116
```

```
        0.27997332      0.073164705     0.079954512     0.021730451     0.022813787     0       0
        0.001723046     0.001309933     0.03525337      0.227268314     0.455110434     1.44351149
        3.085842355     4.81784381      6.573135719     7.882887743     8.812625627     7.62357508
        5.882366175     4.000572789     2.398236332     1.35519489      0.591097779     0.218271752
        0.069254766     0.007835768     0.025698349     0       0.003815689     0.002653631     0

2006    1       7       3       0       529     0       0       0       0.001668402     0.006850571
        0.013041135     0.199512924     0.632991761     1.619785732     2.643973927     4.327831183
        3.871491366     4.386499079     4.521225571     3.969417153     4.30364935      3.219963003
        3.067307197     2.382515067     1.839964707     0.796225136     0.905980507     0.23220651
        0.175135826     0.077027198     0.053751174     0.013675453     0       0       0
        0.013340665     0.004506884     0.04353509      0.399060604     1.341481003     2.585233162
        5.341177537     7.00466844      7.960693607     7.920672453     7.938153312     5.841591061
        4.55938054      2.945013713     1.893770952     0.57383864      0.253795999     0.075146238
        0.043250167     0       0       0       0       0

2007    1       7       3       0       577     0       0       0       0       0.00485549
        0.072761606     0.265981419     0.599916742     1.005883493     2.291226916     2.782712407
        4.877621321     4.912091713     5.943535535     4.135427478     4.241048681     3.538690037
        3.781123401     2.397349891     2.187756162     0.963571975     0.662445948     0.37667473
        0.090552492     0.033566669     0.055504402     0.023774576     0       0       0       0
        0.016641622     0.091036657     0.154031165     0.790295384     1.57054103      3.755863631
        5.842430119     9.603547576     8.191503981     8.445663585     6.410307987     4.649303743
        2.768178006     1.588468206     0.522747815     0.251170824     0.0677758       0.025497608
        0.009030161     0.001892019     0       0       0

2008    1       7       3       0       553     0       0       0       0       0.006591351
        0.108314705     0.196093268     0.290396674     0.801232315     1.040768908     2.102884818
        3.698722449     4.577580535     5.19875697      4.747847731     4.171079427     3.149698828
        2.854366045     2.815364544     2.105611987     1.328010104     0.77530462      0.319259573
        0.230536779     0.069402412     0.038249522     0.074054932     0       0       0       0
        0.008052036     0.075173147     0.325093623     0.624379975     1.289653638     2.85593332
        6.193250036     9.541706693     10.59737633     9.810677087     7.108755963     5.075034306
        2.847634762     1.189623303     0.906344721     0.544411538     0.210876941     0.059724574
        0.036169517     0       0       0       0

2009    1       7       3       0       543     0       0       0.002704664     0       0.004547152
        0.046798166     0.141211457     0.22291839      1.129070569     2.187488366     2.073671802
        3.832139942     4.373643545     3.99565232      4.095037406     3.621633336     3.975037269
        3.757964777     2.254923903     2.066259903     1.687963522     0.514240123     0.369295395
        0.112572461     0.084432954     0.031756372     0.018614405     0       0       0
        0.001474222     0.008346803     0.083462646     0.094925671     0.595837962     1.924436015
        3.036176496     6.618231734     7.684864343     9.090190801     9.303706459     6.969901119
        6.136367341     4.159907581     2.008959592     0.830658257     0.644518059     0.138513913
        0.038113881     0.027512838     0.004316071     0       0       0

2010    1       7       3       0       596     0.001669464     0.001726938     0       0.003481665
        0.014927707     0.072750757     0.206169391     0.92414691      1.039254066     1.420608176
        2.367556224     3.29835594      5.167965012     3.737008682     5.397925851     4.021773009
        5.450572508     3.506801739     4.003503004     2.496242673     1.81814725      0.855844971
        0.65730838      0.330820073     0.197006494     0.05510117      0.008516585     0       0
        0       0.007424591     0.019023053     0.044335335     0.149509492     0.837747176
        1.294494134     3.533836117     3.697454374     5.850606936     9.086954165     8.192113409
        6.800279812     4.464271203     3.934203175     3.498994835     0.921438715     0.428428377
        0.117733667     0.002411566     0.063555229     0       0       0       0

# Pikitch discard study


1986    1       2       3       1       10      0       0       0       0       0       0.005   0
        0.02    0.035   0.075   0.14    0.065   0.03    0       0.005   0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0
        0       0.005   0.015   0.105   0.17    0.195   0.115   0.02    0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0

1987    1       2       3       1       10      0       0       0       0       0       0.01124 0.01124
        0.02247 0.03745 0.07678 0.11049 0.07865 0.02996 0.00375 0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0.00375 0
```

```
        0.00936 0.02434 0.03745 0.06929 0.14981 0.20412 0.10112 0.01498 0.00375 0       0       0
        0       0       0       0       0       0       0       0       0       0       0

# OR study of at-sea vs landed sizes




1959    1       2       0       0       3       0       0       0       0       0       0       0
        0       0       0.00193 0.01349 0.02312 0.05299 0.10212 0.19075 0.16474 0.13295 0.08189 0.05588
        0.04335 0.02987 0.02408 0.0289  0.01734 0.02216 0.00771 0.00578 0.00096 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

1959    1       2       0       2       2       0       0       0       0       0       0       0
        0       0       0       0       0       0.017   0.073   0.163   0.2     0.174   0.1     0.082
        0.071   0.034   0.027   0.023   0.015   0.012   0.006   0.003   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

1960    1       2       0       0       5       0       0       0       0       0       0       0
        0.0007  0       0.00141 0.00986 0.01479 0.02606 0.05915 0.09437 0.17676 0.17535 0.12254 0.08803
        0.06338 0.0493  0.03662 0.03521 0.01831 0.0169  0.00845 0.00211 0.0007  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

1960    1       2       0       2       4       0       0       0       0       0       0       0
        0       0       0       0       0.00168 0.00712 0.03435 0.09929 0.16045 0.17051 0.13741 0.11395
        0.0884  0.062   0.03854 0.03435 0.0176  0.02011 0.00838 0.00293 0.00209 0.00084 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

1961    1       2       0       0       7       0       0       0       0       0       0       0.00251
        0.00335 0.00251 0.00587 0.01425 0.03437 0.04946 0.07293 0.12238 0.12741 0.14753 0.09556 0.09723
        0.06873 0.04359 0.0394  0.0285  0.02012 0.0109  0.00838 0.00168 0.00335 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

1961    1       2       0       2       3       0       0       0       0       0       0       0
        0       0       0       0       0.00472 0.029   0.08564 0.14902 0.16858 0.16521 0.11059 0.08833
        0.06339 0.04248 0.03574 0.0236  0.01349 0.00742 0.00607 0.00405 0.00202 0.00067 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


#_AGE_DATA
60      #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      18      19      20      21      22      23      24      25
        26      27      28      29      30      35      40      50
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      41      42      43      44      45      46      47      48      49
        50      51      52      53      54      55      56      57      58      59      60

#_Age_error



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



# Unbiased break & burn otolith ages
```

```
#_Vector_w_mean_mid-year_ages.                              # -1 means TRUE mid-year ages




#NWFSC CAP Break & Burn ageing error
-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      -1      -1      -1      -1      -1      -1      -1      -1
        -1      -1      -1      -1      -1      -1      -1      -1      -1      -1      -1      -1
0.209737        0.209737        0.283800574     0.360932713     0.441260551     0.524916492
        0.612038422     0.702769944     0.797260608     0.895666162     0.998148804     1.104877454
        1.216028032     1.331783744     1.452335388     1.577881665     1.708629513     1.844794438
        1.986600879     2.134282573     2.288082939     2.448255484     2.615064216     2.788784082
        2.969701422     3.158114436     3.354333682     3.558682585     3.771497967     3.993130607
        4.223945818     4.464324047     4.714661505     4.975370817     5.246881704     5.529641692
        5.824116847     6.130792548     6.450174279     6.782788472     7.129183367     7.489929918
        7.865622737     8.256881069     8.664349818     9.088700603     9.530632875     9.990875059
        10.47018576     10.96935502     11.48920561     12.03059438     12.5944137      13.18159289
        13.79309979     14.42994233     15.09317021     15.78387661     16.5032 17.25232603
        18.03248948
#CA Break and Burn Ageing Error



-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      -1      -1      -1      -1      -1      -1      -1      -1
        -1      -1      -1      -1      -1      -1      -1      -1      -1      -1      -1      -1
0.139903        0.139903        0.279806        0.419709        0.559612        0.699515
        0.839418        0.979321        1.119224        1.259127        1.39903 1.538933
        1.678836        1.818739        1.958642        2.098545        2.238448        2.378351
        2.518254        2.658157        2.79806 2.937963        3.077866        3.217769
        3.357672        3.497575        3.637478        3.777381        3.917284        4.057187
        4.19709 4.336993        4.476896        4.616799        4.756702        4.896605
        5.036508        5.176411        5.316314        5.456217        5.59612 5.736023
        5.875926        6.015829        6.155732        6.295635        6.435538        6.575441
        6.715344        6.855247        6.99515 7.135053        7.274956        7.414859
        7.554762        7.694665        7.834568        7.974471        8.114374        8.254277
        8.39418
# Biased scale ages Hockey-stick model BreakPoint =  9.685 Slope =  0.450
-1      1.5     2.5     3.5     4.5     5.5     6.5     7.5     8.5     9.5     10.33   10.78   11.23
        11.68   12.13   12.58   13.03   13.48   13.93   14.38   14.83   15.28   15.73   16.18   16.63
        17.08   17.53   17.98   18.43   18.88   19.33   19.78   20.23   20.68   21.13   21.58   22.03
        22.48   22.93   23.38   23.83   24.28   24.73   25.18   25.63   26.08   26.53   26.98   27.43
        27.88   28.33   28.78   29.23   29.68   30.13   30.58   31.04   31.49   31.94   32.39   32.84


0.142   0.214   0.356   0.499   0.641   0.784   0.926   1.069   1.211   1.354   1.471   1.536   1.600
        1.664   1.728   1.792   1.856   1.920   1.985   2.049   2.113   2.177   2.241   2.305   2.369
        2.434   2.498   2.562   2.626   2.690   2.754   2.818   2.882   2.947   3.011   3.075   3.139
        3.203   3.267   3.331   3.396   3.460   3.524   3.588   3.652   3.716   3.780   3.845   3.909
        3.973   4.037   4.101   4.165   4.229   4.294   4.358   4.422   4.486   4.550   4.614   4.678



#_AGE_COMPOSITIONS(duplicates_must_be_contigent_within_Year-Seas-Fleet-
Sex_because_of_ageerr_and_states)
```

```
432	#nobsa

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	F18	F19	F20	F21	F22	F23	F24	F25	F26	F27
	F28	F29	F30	F31	F32	F33	F34	F35	F36	F37	F38	F39
	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50	F51
	F52	F53	F54	F55	F56	F57	F58	F59	F60	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	F18.1	F19.1	F20.1	F21.1	F22.1	F23.1	F24.1	F25.1	F26.1	F27.1
	F28.1	F29.1	F30.1	F31.1	F32.1	F33.1	F34.1	F35.1	F36.1	F37.1	F38.1	F39.1
	F40.1	F41.1	F42.1	F43.1	F44.1	F45.1	F46.1	F47.1	F48.1	F49.1	F50.1	F51.1
	F52.1	F53.1	F54.1	F55.1	F56.1	F57.1	F58.1	F59.1	F60.1
#Commercial ages. OR 1966-1984 are scales. 1985 onward are break & burn.  CA and WA are all break
& burn

-1980	1	1	3	2	2	-1	-1	56	0	0	0	0
	1.096841106	3.087793492	5.120854377	6.942898955	7.857390602	7.216049244
	4.464904365	4.050300388	2.514823124	1.626101177	0.438522829	0.842697254
	0.085955567	0.165728211	0	0.052646462	0.113081749	0.051755091	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	0.511282621	2.626055214	7.022545288
	10.84168903	13.77069654	8.643611729	3.489987952	2.850845115	2.361001184
```

```
        0.88679428    0.569030133   0.438444724   0.227172318   0.03249988    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
1981    1       1     3       2     2       -1    -1      48    0       0     0       0
        0.44962536    0.531658181   0.871106778   1.54405267    1.80662979    2.441535252
        3.598751719   2.685729771   3.139995958   2.438724208   2.196167968   1.920386034
        3.055062145   2.70697066    1.834924159   1.889008694   1.451121057   0.738291039
        1.408455973   0.531296149   1.200620922   0.640000965   0.288772739   0.339024533
        0.574534931   0.642222814   0.290635588   0.033368749   0       0.078133097   0
        0       0     0       0.033368749   0     0.029887046   0       0     0       0
        0       0     0       0     0       0     0       0     0       0     0       0
        0       0     0       0     0       0     0       0.327151848   0.517765666
        0.634907543   0.604810336   2.32395901    3.228716421   4.009666273   2.824494901
        5.328354955   4.965255917   3.969669144   5.020396588   3.656800706   4.094127339
        3.058778263   1.985260537   2.392299761   1.389215463   1.904576145   1.483525745
        0.76050624    1.616721865   0.607253609   0.385012336   0.314864621   0.415663227
        0.388328539   0.165515868   0       0.236337435   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
1982    1       1     3       2     2       -1    -1      28    0       0     0
        0.170780796   0       0.170780796   0.707844431   2.224341534   1.926625181
        2.687022329   2.100671446   3.235090495   2.595026469   1.931575572   3.182105057
        2.321230963   2.418778287   1.346888765   1.66250874    1.476662499   0.756553824
        1.52583028    0.704561174   1.209221602   0.726384994   0.277802099   0
        0.170780796   0     0       0.170780796   0.071073768   0       0     0       0
        0       0     0       0.170780796   0     0       0     0       0     0       0
        0       0     0       0     0       0     0       0     0       0     0       0
        0       0     0       0     0       0.306229354   0.903676881   1.623291982
        3.407071247   5.468938901   5.168079264   5.129895075   6.722450801   6.470995093
        4.459092516   4.466714106   2.987009669   3.746572078   2.681217572   1.613551672
        2.616283683   1.394620629   1.640114965   0.375068551   0.501145501   0.341561593
        0.191228997   0.071073768   0.338633098   0.277802099   0.503500136   0.310915683
        0       0     0       0.341561593   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
1983    1       1     3       2     2       -1    -1      38    0       0     0
        0.619535573   2.127591225   9.223495917   5.440445811   6.052550074   3.199037632
        2.972578272   3.432720242   3.922381113   2.641138769   2.821176266   2.624421623
        1.676964607   1.070208982   0.609222102   0.353152251   0.168228917   0.890796803
        0.171646572   0.233561354   0.213725515   0.178159361   0       0     0       0
        0       0     0.178159361   0.084453733   0     0       0     0       0.084453733
        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       0.043428955   0.134543207   2.554560161   3.367243793   2.513223855
        3.608182658   5.33525992    4.857235438   6.245588314   4.413785052   4.626291368
        4.134553304   2.144004848   1.628899337   1.059246451   0.903598359   0.072258799
        0.534478082   0.261904736   0       0.178159361   0.178159361   0.037429472   0
        0.178159361   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
1984    1       1     3       2     2       -1    -1      54    0       0     0       0
        0.159444702   0.359309768   1.394794546   3.360897922   3.780414337   3.815482243
        3.403768631   3.152690967   2.709635818   2.749124181   2.194672256   3.692993541
        2.800073752   2.290089681   1.330305752   2.7270985     1.939952946   1.878204014
        1.125646473   2.027216029   0.833588413   1.047894666   1.029879464   0.749850059
        0.279864847   0.238472336   0.240610068   0.449697634   0.294827561   0.182969543
        0.05149398    0.05149398    0       0     0.079066829   0.075175378   0
        0.166708427   0     0       0     0       0     0       0     0       0.044875565   0
        0       0     0       0     0       0     0       0     0.05149398    0       0
        0       0     0       0     0.443059159   1.075943448   1.776150554   2.520526356
        1.66813801    2.021216426   2.674253037   3.525185612   3.954728487   2.896954271
        3.077691824   3.022747115   2.708017829   2.733337835   2.36747326    2.520352132
        1.359159177   1.092598798   1.063125562   0.753641365   0.704472489   0.498995595
        0.344345379   0.313347619   0.651765998   0.418579477   0.451740725   0.220244389
        0.212937725   0.044455194   0       0.044455194   0     0       0       0       0
        0       0     0.080581169   0     0       0     0       0     0       0     0
        0       0     0       0     0       0
1985    1       1     3       2     2       -1    -1      80    0       0     0
        0.027755656   0.105336482   0.964284581   2.663203343   3.558049577   5.264058247
```

4.647024747 4.459809337 2.063404722 2.62839745 1.941288136 1.601582812
1.822191499 1.800907536 2.359958833 1.567294969 1.85436489 1.616484117
1.392686895 1.52606286 1.000676468 0.925632645 0.570835789 0.548905111
0.578903468 0.445116021 0.228309926 0.300973717 0.159551944 0.29945494
0.160054823 0.030567335 0.087916919 0.088407651 0.11975922 0
0.053492216 0 0 0.066028031 0.078890882 0.034020775 0 0
0 0 0.035600126 0 0 0 0 0.048203391 0 0
0 0 0 0.046308645 0 0 0.013877828 0.012809553
1.336973932 1.571471093 2.884055061 3.806353105 3.685132183 4.056334476
3.506298236 4.06747538 3.020985594 2.149186531 2.935962021 2.987424589
2.252488857 1.883518941 2.57766393 0.91756401 1.623846332 0.887813119
0.610066338 0.463396817 0.822080842 0.389429988 0.349162046 0.202916934
0.343993465 0.214290557 0.07123898 0 0.085047462 0.06113467
0.114256781 0.112057964 0 0.066028031 0 0 0 0 0
0 0 0 0.072953812 0.072953812 0 0 0 0 0
0 0 0 0 0 0
1986 1 1 3 2 2 -1 -1 75 0 0 0
0.131981706 0.789026621 1.805643217 4.169893747 4.49422862 5.703443658
6.039345525 4.245383633 2.45086247 2.314883975 1.497401475 1.492032811
0.936988004 1.265267285 1.122667677 1.017693347 0.865229708 1.125073298
1.010561631 0.53259699 0.893549547 0.641489508 1.156590172 0.609447774
0.257251454 0.380562186 0.146535802 0.333330265 0.20118645 0.082123813
0.031061859 0.279320742 0.021955101 0.088865246 0.088865246 0.090508503
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.088504973 0.07889918
0 0 0.02938778 0.617187965 1.681744807 3.340416266 4.501211636
4.094623944 4.929310962 3.489521089 3.289636093 2.298923298 1.464492148
1.73892888 2.158355868 1.593445184 1.390477997 1.623245426 1.64344926
2.381463101 1.358839081 1.288240514 0.815797267 1.365654233 0.949662651
0.948414843 0.468448326 0.141718466 0.264294111 0.538941848 0.320581299
0.120339317 0.161939887 0.076929686 0.257986924 0 0.048907933 0
0 0 0.050299001 0.076929686 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1987 1 1 3 2 2 -1 -1 72 0 0 0.06060422
0.28031996 1.17725798 3.911855374 4.994888457 4.301850909 4.409102144
3.606735897 3.156966703 3.434247737 2.026274499 0.902787207 1.699073068
1.24471477 1.618360196 1.19003491 1.56035058 1.125049499 0.552690383
0.641900234 0.602042691 1.191110894 0.386140341 0.933983832 0.751147165
0.2405504 0.461889413 0.382945755 0.282688099 0.183582891 0.16533626
0.390698866 0.156799488 0.284185084 0.087922746 0.144631969 0.200386261
0 0 0.029726667 0 0.040382652 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0.320417146 1.410550892 3.1216704 4.043036152 4.910592854
4.438339487 4.656025975 4.189057153 2.859867022 2.544112911 2.807763673
2.081059128 1.918865524 1.323177684 1.186383219 1.177875095 1.436582153
1.464237598 0.965865525 0.675361126 0.989219398 0.094921742 0.42867056
0.504461709 0.381392551 0.308383139 0.104116605 0.184470282 0.104116605
0.109015208 0.029726667 0.078783686 0 0 0.062408567 0.215847792
0 0.062408567 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
1988 1 1 3 2 2 -1 -1 71 0 0 0
0.115663905 1.492983244 2.396842354 3.713088832 6.451920484 3.299940237
3.623808934 2.895113171 2.756708834 2.585722714 1.988834169 1.678361772
0.800317102 1.047864535 1.698954182 0.767997853 1.9214767 1.063528726
1.028000996 1.04104843 0.898827637 0.673838144 0.541003199 0.381817643
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0.192644887 0.265998862 0.276971949 0.124117757 0.156491566 0.157185139
0.168712659 0.013081709 0 0.072372373 0.024752842 0.034754366 0
0 0.041394519 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0.390699486 1.071869543 2.071012083
4.254260851 5.703742501 4.433490379 4.190804274 4.187382846 4.141574148
1.796259846 2.093601796 1.421269041 1.468910547 0.999192457 1.437126487
1.470763606 1.612868128 1.233376321 0.913137547 0.838447622 0.940844172
0.921579141 0.506946659 0.480334087 0.620358 0.241545575 0.157662076
0.42684683 0.106607966 0.216367705 0.105382674 0.092188844 0.105270553
0.082789039 0 0.035897139 0.060649981 0.041394519 0.043429104
0.06777233 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0.084043505
1989 1 1 3 2 2 -1 -1 105 0 0 0 0
0.760591814 3.929355725 3.373699736 3.790875996 4.653757057 3.532708638
2.928886089 2.80558086 1.702637581 1.382766437 1.154418961 1.178659887

1.225611606 1.15287324 1.472728003 0.863283169 1.062746231 1.272358456
1.323146243 1.383699872 0.914630744 0.982924352 0.613983804 1.335783042
0.560572898 0.606395506 0.74116138 0.602278475 0.666102577 0.575073146
0.460035763 0.34403406 0.393465544 0.41729816 0.336381727 0.199588978
0.081516237 0.066824084 0.146614067 0.135491074 0.1479964 0.100690245
0.116706722 0.08180704 0.010166614 0 0.03675598 0 0 0
0 0 0 0 0 0.033297125 0 0.012736985 0 0
0.660918473 2.375361095 2.680015519 3.758716198 3.729239209 2.876351813
2.944470223 3.500108261 2.540383824 2.035626656 2.046954362 1.433950001
1.729087537 1.607358878 1.238229179 1.514156119 0.985599086 0.945996171
0.879426538 1.180880585 0.824254062 0.867524052 0.8993786 0.604894356
0.676275271 0.403823382 0.48850987 0.418049479 0.260829806 0.385114043
0.405904819 0.113397179 0.375274584 0.128705023 0.122374256 0.068489835
0.087975093 0.009469907 0.22742416 0.009469907 0.022885407 0.156433267
0.023089371 0 0 0 0.016194756 0.038460095 0 0 0
0 0 0 0 0.032271365
1990 1 1 3 2 2 -1 -1 26 0 0 0 0
0.725518396 2.645213168 4.336609718 4.444693268 4.299410885 5.488952329
2.451591617 2.475884315 2.23745796 1.612515945 1.906513525 1.240476581
0.465347722 1.162823297 0.227175123 0.789240582 1.275441595 0.47818264
0.777063886 0.459486547 0.767795659 1.114555667 1.169498143 0.844999821
0.439607981 0.799917075 0.619057531 0.318038071 0.597006152 0.266923891
0.176751954 0.346759292 0.299195657 0.16287805 0.234348862 0.200886776
0.281258492 0.14281064 0.097986804 0 0 0.132077031 0 0
0.097986804 0 0 0 0 0 0 0 0 0 0
0.092334491 0 0 0 0.402720995 1.296787087 2.882625848
4.410713289 4.329640374 3.737303442 3.586053178 3.817237888 3.466235922
2.896387535 4.249076363 1.750051127 1.525656361 0.880374417 1.421169695
1.591578715 0.830898198 0.6925067 0.311087392 1.269018871 1.181143074
0.3813398 0.525252323 0.180926924 0.756925619 0.612332724 0.11002926
0.135996517 0.31891098 0.245487064 0 0 0.298954248 0.214535798
0 0.374191926 0.180926924 0.234849755 0.046408737 0 0.132077031
0 0.020313957 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1991 1 1 3 2 2 -1 -1 26 0 0 0 0
0 0.246596191 1.211636942 2.2746043 4.185983189 3.802879435
3.295886462 3.292857205 2.451457215 2.822717181 2.4048556 1.953590424
1.578201705 0.558218269 0.886485474 1.091544818 0.378972162 0.715485994
0.166279064 0.184833271 0.138073915 0.614686552 0.357885596 0.176516577
0.159273978 0.221509791 0.192764929 0.063444765 0 0 0.037418055
0.037418055 0.143260706 0.011911283 0.09190211 0.069292793 0.102834299
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0 1.257636079 0.986683115 0.057460953 0.016572354 0 0
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0 0 0 0 0 0 0 0 0 0 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
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0 0 0 0.548516014 0 0 0 0 0 0 0

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     0 0 0 0 0 0 0 0 0 0 0.769006611
     0.769006611 0 0 0 0 0 0 0 0 0 0
     0 0 0 0 0 0 0 0 0 0 0 0
     0 0
2000 1 3 3 2 1 -1 -1 23 0 0 0 0
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2001 1 3 3 2 1 -1 -1 12 0 0 0 0
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#AK slope marginal age comps
```

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0.152768599 0.531689219 0.174562109 0 0.074811817 0.397376571
0.234870025 0 0 0.062634748 0 0.605251478 0 0.205619316
0 0.135405697 0 0 0 0 0 0 0 0.164311382
0 0 0 0 2.229646064 0.433923731 3.755678089 19.78926136
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0.126767483 0.089969559 1.699717894 1.302684896 1.658887642 0.662499181
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0.152699385 0.098072389 0.551665072 0 0 0.286910036 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
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#NWFSC
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        0       0       16.66666667     0       0       0       0       0       0       0       0
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        46.15384615     15.38461538     7.692307692     0       0       0       0       0       0
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        39.28571429     17.85714286     7.142857143     3.571428571     0       0       0       0
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2003    1       7       1       0       1       26      26      35      0       0       5.714285714
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        8.571428571     0       5.714285714     0       0       0       0       0       0       0
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        37.5    21.875  6.25    9.375   3.125   0       0       0       0       0       0       0
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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 3.125 18.75
37.5 21.875 6.25 9.375 3.125 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0
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22.85714286 5.714285714 8.571428571 5.714285714 2.857142857 2.857142857
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	0	0	0	0	0	0	0	0				
2004	1	7	1	0	1	28	28	16	0	0	0	25
	31.25	31.25	6.25	6.25	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	0	0	0	25
	31.25	31.25	6.25	6.25	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				
2004	1	7	1	0	1	30	30	32	0	0	0	6.25
	18.75	28.125	21.875	9.375	3.125	3.125	9.375	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	6.25
	18.75	28.125	21.875	9.375	3.125	3.125	9.375	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				
2004	1	7	1	0	1	32	32	30	0	0	0	0
	6.666666667		36.66666667		16.66666667		13.33333333		6.666666667		6.666666667	
	3.333333333		3.333333333		6.666666667		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	6.666666667		
	36.66666667		16.66666667		13.33333333		6.666666667		6.666666667		3.333333333	
	3.333333333		6.666666667		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									
2004	1	7	1	0	1	34	34	29	0	0	0	0
	3.448275862		17.24137931		31.03448276		10.34482759		3.448275862		6.896551724	
	20.68965517		6.896551724		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 3.448275862 17.24137931
31.03448276 10.34482759 3.448275862 6.896551724 20.68965517 6.896551724
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
2004 1 7 1 0 1 36 36 39 0 0 0 0
7.692307692 7.692307692 12.82051282 7.692307692 23.07692308 12.82051282
7.692307692 5.128205128 5.128205128 0 5.128205128 0 0
2.564102564 0 0 0 0 0 0 2.564102564 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 7.692307692 7.692307692 12.82051282 7.692307692 23.07692308
12.82051282 7.692307692 5.128205128 5.128205128 0 5.128205128 0
0 2.564102564 0 0 0 0 0 0 2.564102564 0
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2004 1 7 1 0 1 38 38 38 0 0 0 0
0 5.263157895 7.894736842 5.263157895 7.894736842 18.42105263
18.42105263 2.631578947 13.15789474 10.52631579 2.631578947 2.631578947
0 0 0 2.631578947 0 0 0 2.631578947 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 5.263157895 7.894736842 5.263157895 7.894736842
18.42105263 18.42105263 2.631578947 13.15789474 10.52631579 2.631578947
2.631578947 0 0 0 2.631578947 0 0 0 2.631578947
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2004 1 7 1 0 1 40 40 40 0 0 0 0
0 0 2.5 5 5 12.5 7.5 15 10 7.5 15 0
7.5 0 2.5 0 2.5 0 2.5 0 0 0 2.5 0
0 0 0 0 2.5 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 0 0 0 0 0 0
0 0 2.5 5 5 12.5 7.5 15 10 7.5 15 0
7.5 0 2.5 0 2.5 0 2.5 0 0 0 2.5 0
0 0 0 0 2.5 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 0 0
2004 1 7 1 0 1 42 42 49 0 0 0 0
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12.24489796 6.12244898 8.163265306 4.081632653 6.12244898 6.12244898
2.040816327 0 2.040816327 2.040816327 2.040816327 2.040816327
4.081632653 2.040816327 4.081632653 0 0 2.040816327 0
2.040816327 0 0 2.040816327 0 0 2.040816327 0
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0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 6.12244898 6.12244898 12.24489796
2.040816327 12.24489796 6.12244898 8.163265306 4.081632653 6.12244898
6.12244898 2.040816327 0 2.040816327 2.040816327 2.040816327
2.040816327 4.081632653 2.040816327 4.081632653 0 0 2.040816327
0 2.040816327 0 0 2.040816327 0 0 2.040816327 0
2.040816327 0 0 0 0 0 0 0 0 0 0
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2 10 4 2 6 4 10 4 6 0 0 0
0 4 6 6 2 8 2 4 2 0 0 2
0 0 0 0 2 0 0 0 0 0 0 0
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0 0 0 0 0 2 0 4 2 2 2 2
2 10 4 2 6 4 10 4 6 0 0 0
0 4 6 6 2 8 2 4 2 0 0 2
0 0 0 0 2 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

2004 1 7 1 0 1 46 46 51 0 0 0 0
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5.882352941 3.921568627 1.960784314 1.960784314 1.960784314 1.960784314
3.921568627 3.921568627 1.960784314 3.921568627 0 3.921568627
1.960784314 3.921568627 5.882352941 9.803921569 9.803921569 3.921568627
1.960784314 5.882352941 1.960784314 0 1.960784314 1.960784314 0
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0 3.921568627 1.960784314 3.921568627 5.882352941 9.803921569
9.803921569 3.921568627 1.960784314 5.882352941 1.960784314 0
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2004 1 7 1 0 1 48 48 19 0 0 0 0
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10.52631579 10.52631579 5.263157895 0 0 5.263157895 0 0
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5.263157895 5.263157895 5.263157895 5.263157895 10.52631579 5.263157895
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0 0 6.25 0 0 0 6.25 6.25 0 6.25 0 0
6.25 6.25 0 0 6.25 0 0 0 0 0 0 0
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0 6.25 6.25 12.5 0 6.25 0 0 6.25 0 18.75 0
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6.25 6.25 0 0 6.25 0 0 0 0 0 0 0
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0 0
2004 1 7 1 0 1 56 56 1 0 0 0 0
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0 0 0 0 0 0 0 0 100 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0
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100 0 0 0 0 0 0 0 0 0 0 0
0 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

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2005	1	7	1	0	1	14	14	1	0	100	0	0
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2005	1	7	1	0	1	16	16	2	0	100	0	0
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	0	0	0	0	0	0	0	0	0	100	0	0
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	0	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	0	0	0	0	0	0	0				
2005	1	7	1	0	1	18	18	3	0	33.33333333		
	66.66666667		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	0	0	0	0	0	0	0	0	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	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											
2005	1	7	1	0	1	20	20	7	0	0	57.14285714	
	28.57142857		14.28571429		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	0	0	0	0	0	0	0	0	0	0	0
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	0	57.14285714		28.57142857		14.28571429		0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0										
2005	1	7	1	0	1	22	22	15	0	0	20	
	53.33333333		26.66666667		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	0	0	0	0
	0	20	53.33333333		26.66666667		0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0											
2005	1	7	1	0	1	24	24	31	0	0	0	
	41.93548387		41.93548387		9.677419355		6.451612903		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
	0	0	0	0	41.93548387		41.93548387		9.677419355		6.451612903	
	0	0	0	0	0	0	0	0	0	0	0	0
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0 0 0 0 0
2005 1 7 1 0 1 26 26 45 0 0 0
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2005 1 7 1 0 1 28 28 36 0 0 0
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0 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
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0 0 0 0 0 0 13.88888889 30.55555556 30.55555556
16.66666667 5.555555556 2.777777778 0 0 0 0 0 0
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2005 1 7 1 0 1 30 30 51 0 0 0
7.843137255 21.56862745 29.41176471 21.56862745 15.68627451 3.921568627
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0 0 0 0 0 0 7.843137255 21.56862745 29.41176471
21.56862745 15.68627451 3.921568627 0 0 0 0 0 0
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2005 1 7 1 0 1 32 32 43 0 0 0
2.325581395 13.95348837 32.55813953 18.60465116 11.62790698 6.976744186
9.302325581 2.325581395 0 2.325581395 0 0 0 0 0
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13.95348837 32.55813953 18.60465116 11.62790698 6.976744186 9.302325581
2.325581395 0 2.325581395 0 0 0 0 0 0 0
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0 0 0 0
2005 1 7 1 0 1 34 34 44 0 0 0
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6.818181818 11.36363636 2.272727273 2.272727273 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 2.272727273
6.818181818 15.90909091 22.72727273 18.18181818 11.36363636 6.818181818
11.36363636 2.272727273 2.272727273 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0
2005 1 7 1 0 1 36 36 32 0 0 0 0
3.125 9.375 18.75 21.875 9.375 9.375 12.5 12.5 0 3.125 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

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     3.125   9.375   18.75   21.875  9.375   9.375   12.5    12.5    0       3.125   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
2005 1       7       1       0       1       38      38      39      0       0       0       0
     2.564102564     2.564102564     15.38461538     7.692307692     7.692307692     7.692307692
     17.94871795     12.82051282     7.692307692     7.692307692     2.564102564     0
     2.564102564     2.564102564     0       0       0       0       0       2.564102564     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       2.564102564     2.564102564     15.38461538     7.692307692
     7.692307692     7.692307692     17.94871795     12.82051282     7.692307692     7.692307692
     2.564102564     0       2.564102564     2.564102564     0       0       0       0       0
     2.564102564     0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0
2005 1       7       1       0       1       40      40      39      0       0       0       0
     0       2.564102564     2.564102564     7.692307692     17.94871795     2.564102564
     15.38461538     15.38461538     2.564102564     5.128205128     2.564102564     2.564102564
     0       7.692307692     5.128205128     2.564102564     0       0       2.564102564
     5.128205128     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       2.564102564     2.564102564
     7.692307692     17.94871795     2.564102564     15.38461538     15.38461538     2.564102564
     5.128205128     2.564102564     2.564102564     0       7.692307692     5.128205128
     2.564102564     0       0       2.564102564     5.128205128     0       0       0       0
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0
2005 1       7       1       0       1       42      42      36      0       0       0       0
     0       0       0       2.777777778     5.555555556     0       11.11111111     11.11111111
     0       2.777777778     8.333333333     11.11111111     2.777777778     8.333333333
     5.555555556     11.11111111     2.777777778     2.777777778     2.777777778     0
     2.777777778     0       0       0       5.555555556     0       0       0       0       0
     0       0       0       0       2.777777778     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       2.777777778
     5.555555556     0       11.11111111     11.11111111     0       2.777777778     8.333333333
     11.11111111     2.777777778     8.333333333     5.555555556     11.11111111     2.777777778
     2.777777778     2.777777778     0       2.777777778     0       0       0       5.555555556
     0       0       0       0       0       0       0       0       0       2.777777778     0
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0
2005 1       7       1       0       1       44      44      33      0       0       0       0
     0       0       3.03030303      0       3.03030303      9.090909091     6.060606061
     3.03030303      12.12121212     0       3.03030303      0       12.12121212     3.03030303
     0       3.03030303      9.090909091     0       3.03030303      0       6.060606061     0
     0       3.03030303      6.060606061     0       3.03030303      3.03030303      0       0
     0       6.060606061     0       0       0       0       0       0       0       3.03030303
     0       0       0       0       0       0       0       0       0       0       0       0
     0       0       0       0       0       0       0       0       0       0       3.03030303
     0       3.03030303      9.090909091     6.060606061     3.03030303      12.12121212     0
     3.03030303      0       12.12121212     3.03030303      0       3.03030303      9.090909091
     0       3.03030303      0       6.060606061     0       0       3.03030303      6.060606061
     0       3.03030303      3.03030303      0       0       0       6.060606061     0       0
     0       0       0       0       0       3.03030303      0       0       0       0       0
     0       0       0       0       0       0       0       0       0       0       0
2005 1       7       1       0       1       46      46      15      0       0       0       0
     0       0       0       0       0       0       0       0       0       6.666666667     0
     0       6.666666667     6.666666667     0       0       13.33333333     0       0
     13.33333333     13.33333333     6.666666667     0       0       0       0       0       0
     13.33333333     0       6.666666667     0       0       0       0       6.666666667     0
     0       0       0       0       6.666666667     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       6.666666667     0
     0       6.666666667     6.666666667     0       0       13.33333333     0       0
     13.33333333     13.33333333     6.666666667     0       0       0       0       0       0
```

	13.33333333	0	6.666666667	0	0	0	0	6.666666667	0			
	0	0	0	0	6.666666667	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0				
2005	1	7	1	0	1	48	48	23	0	0	0	0
	0	0	0	0	0	0	0	0	0	4.347826087		
	8.695652174	8.695652174	4.347826087	4.347826087	0	0	0	0				
	0	13.04347826	4.347826087	0	4.347826087	4.347826087	4.347826087					
	4.347826087	0	0	4.347826087	0	17.39130435	0	4.347826087				
	0	0	0	0	8.695652174	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	4.347826087	8.695652174	8.695652174	4.347826087	4.347826087	0					
	0	0	0	13.04347826	4.347826087	0	4.347826087					
	4.347826087	4.347826087	4.347826087	0	0	4.347826087	0					
	17.39130435	0	4.347826087	0	0	0	0	8.695652174	0			
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0							
2005	1	7	1	0	1	50	50	5	0	0	0	0
	0	0	0	0	0	0	20	0	0	0	0	0
	20	0	20	0	0	0	0	0	0	0	0	0
	0	20	0	0	0	20	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	20	0	0	0	0	0
	20	0	20	0	0	0	0	0	0	0	0	0
	0	20	0	0	0	20	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2005	1	7	1	0	1	52	52	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	100	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	0	0	0	0	0	0	0	100	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2005	1	7	1	0	1	54	54	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	100	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	0	0	0	0	0
	0	0	100	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2005	1	7	1	0	1	56	56	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	100	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	0	0	0	0
	0	0	0	100	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2005	1	7	1	0	1	60	60	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	100	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	0	0	0	0	0	0	0	100	0
	0	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2006	1	7	1	0	1	14	14	1	0	100	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
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	0	0	0	0	0	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
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2006	1	7	1	0	1	16	16	1	0	100	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	0	0	0	0	0	0	0	100	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	0	0	0	0	0	0				
2006	1	7	1	0	1	18	18	3	0	0	100	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	0	0	0	0	0	0	0	100	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	0	0	0	0	0				
2006	1	7	1	0	1	20	20	5	0	20	40	20
	20	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	0	0	0	0	20	40	20
	20	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	0	0	0				
2006	1	7	1	0	1	22	22	11	0	0	45.45454545	
	27.27272727		9.090909091		9.090909091		9.090909091		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
	0	0	0	45.45454545		27.27272727		9.090909091		9.090909091		
	9.090909091		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	0					
2006	1	7	1	0	1	24	24	23	0	0	4.347826087	
	30.43478261		39.13043478		8.695652174		8.695652174		8.695652174		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	0	0	4.347826087		30.43478261		39.13043478		8.695652174	
	8.695652174		8.695652174		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				

```
2006	1	7	1	0	1	26	26	33	0	0	0
	18.18181818	33.33333333	33.33333333	6.060606061	6.060606061	3.03030303
	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	0	0	18.18181818	33.33333333	33.33333333
	6.060606061	6.060606061	3.03030303	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
2006	1	7	1	0	1	28	28	47	0	0	0
	6.382978723	23.40425532	40.42553191	12.76595745	10.63829787	4.255319149
	0	0	2.127659574	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	6.382978723	23.40425532
	40.42553191	12.76595745	10.63829787	4.255319149	0	0	2.127659574
	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
2006	1	7	1	0	1	30	30	43	0	0	0
	2.325581395	4.651162791	34.88372093	30.23255814	23.25581395	2.325581395
	2.325581395	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	0	2.325581395	4.651162791
	34.88372093	30.23255814	23.25581395	2.325581395	2.325581395	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
2006	1	7	1	0	1	32	32	30	0	0	0	0
	20	13.33333333	13.33333333	26.66666667	13.33333333	0	13.33333333
	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	0	20	13.33333333	13.33333333	26.66666667
	13.33333333	0	13.33333333	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
2006	1	7	1	0	1	34	34	48	0	0	0
	2.083333333	6.25	16.66666667	16.66666667	22.91666667	14.58333333	6.25
	2.083333333	10.41666667	0	0	0	0	0	0	0	0
	2.083333333	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	2.083333333	6.25
	16.66666667	16.66666667	22.91666667	14.58333333	6.25	2.083333333
	10.41666667	0	0	0	0	0	0	0	0	2.083333333
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0
2006	1	7	1	0	1	36	36	42	0	0	0	0
	2.380952381	4.761904762	19.04761905	11.9047619	21.42857143	14.28571429
	7.142857143	4.761904762	4.761904762	4.761904762	0	0	2.380952381
	0	0	2.380952381	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
	2.380952381	4.761904762	19.04761905	11.9047619	21.42857143	14.28571429
	7.142857143	4.761904762	4.761904762	4.761904762	0	0	2.380952381
	0	0	2.380952381	0	0	0	0	0	0	0	0
```

```
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
2006	1	7	1	0	1	38	38	33	0	0	0	0
	0	0	15.15151515	15.15151515	24.24242424	15.15151515	12.12121212
	6.060606061	0	3.03030303	6.060606061	0	0	3.03030303	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
	15.15151515	15.15151515	24.24242424	15.15151515	12.12121212	6.060606061
	0	3.03030303	6.060606061	0	0	3.03030303	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
2006	1	7	1	0	1	40	40	39	0	0	0	0
	0	0	5.128205128	5.128205128	12.82051282	10.25641026	20.51282051
	10.25641026	2.564102564	0	7.692307692	2.564102564	12.82051282
	2.564102564	0	0	5.128205128	0	0	0	0	2.564102564
	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	5.128205128	5.128205128	12.82051282	10.25641026
	20.51282051	10.25641026	2.564102564	0	7.692307692	2.564102564
	12.82051282	2.564102564	0	0	5.128205128	0	0	0	0
	2.564102564	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
2006	1	7	1	0	1	42	42	43	0	0	0	0
	0	0	2.325581395	2.325581395	4.651162791	11.62790698
	4.651162791	13.95348837	9.302325581	4.651162791	11.62790698	2.325581395
	2.325581395	4.651162791	11.62790698	0	0	0	2.325581395	0
	2.325581395	2.325581395	2.325581395	0	2.325581395	0	0	0
	0	0	0	0	0	0	0	2.325581395	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
	2.325581395	2.325581395	4.651162791	11.62790698	4.651162791	13.95348837
	9.302325581	4.651162791	11.62790698	2.325581395	2.325581395	4.651162791
	11.62790698	0	0	0	2.325581395	0	2.325581395	2.325581395
	2.325581395	0	0	2.325581395	0	0	0	0	0	0	0
	0	0	0	2.325581395	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
2006	1	7	1	0	1	44	44	33	0	0	0	0
	0	0	0	0	0	3.03030303	6.060606061	9.090909091
	6.060606061	6.060606061	9.090909091	3.03030303	9.090909091	3.03030303
	9.090909091	6.060606061	3.03030303	3.03030303	0	0	0	0
	0	6.060606061	3.03030303	3.03030303	0	3.03030303	3.03030303
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	3.03030303	6.060606061	9.090909091	6.060606061	6.060606061
	9.090909091	3.03030303	9.090909091	3.03030303	9.090909091	6.060606061
	3.03030303	3.03030303	0	0	0	0	0	6.060606061
	3.03030303	3.03030303	0	3.03030303	3.03030303	0	0	0
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	0	0
2006	1	7	1	0	1	46	46	42	0	0	0	0
	0	0	0	0	2.380952381	0	0	7.142857143	0
	4.761904762	7.142857143	2.380952381	11.9047619	11.9047619	4.761904762
	4.761904762	2.380952381	7.142857143	2.380952381	9.523809524	0
	2.380952381	0	2.380952381	0	0	2.380952381	0	0	0
	2.380952381	0	0	0	2.380952381	0	2.380952381	2.380952381
	0	0	0	0	0	2.380952381	0	0	0	0	0
	2.380952381	0	0	0	0	0	0	0	0	0	0
	0	0	0	2.380952381	0	0	0	7.142857143	0
	4.761904762	7.142857143	2.380952381	11.9047619	11.9047619	4.761904762
	4.761904762	2.380952381	7.142857143	2.380952381	9.523809524	0
	2.380952381	0	2.380952381	0	0	2.380952381	0	0	0
	2.380952381	0	0	0	2.380952381	0	2.380952381	2.380952381
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2.380952381	0	0	0	0	0
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0	0	5.263157895	10.52631579	5.263157895	5.263157895	0
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5.263157895	5.263157895	0	0	5.263157895	5.263157895	0	0
0	0	0	0	0	5.263157895	0	0	0	0	0
0	5.263157895	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	5.263157895
0	0	0	10.52631579	0	0	0	5.263157895	10.52631579
5.263157895	5.263157895	0	10.52631579	0	5.263157895	0	0
5.263157895	5.263157895	5.263157895	5.263157895	0	0	5.263157895
5.263157895	0	0	0	0	0	0	0	0	5.263157895	0
0	0	0	0	0	5.263157895	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	8.333333333
0	8.333333333	0	0	8.333333333	0	0	0	0	0
0	8.333333333	0	8.333333333	8.333333333	0	8.333333333	0
0	0	16.66666667	0	8.333333333	8.333333333	8.333333333	0
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0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	8.333333333	0
8.333333333	0	0	8.333333333	0	0	0	0	0	0
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0	16.66666667	0	8.333333333	8.333333333	8.333333333	0	0
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0	0	0	0	0	0	0	0
2006	1	7	1	0	1	54	54	1	0	0	0	0
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0 10 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 50 40
0 10 0 0 0 0 0 0 0 0 0 0
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7.692307692 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0
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0 0 3.333333333 16.66666667 46.66666667 20 10 3.333333333
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0 0 0 0 0 0 0 0 0 0 0 0

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0 2.777777778 0 2.777777778 0 0 0 0 0 0
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0 0 0 0 0 0 8.333333333 19.44444444 16.66666667
0 11.11111111 5.555555556 2.777777778 5.555555556 13.88888889 0
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9.090909091 15.15151515 6.060606061 9.090909091 3.03030303 3.03030303
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2007	1	7	1	0	1	56	56	2	0	0	0	0
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2007	1	7	1	0	1	60	60	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
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2008	1	7	1	0	1	18	18	6	0	50	50	0
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	0	0	0	0	0	0	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
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2008	1	7	1	0	1	20	20	7	0	0	42.85714286	
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	0	0										
2008	1	7	1	0	1	22	22	19	0	0	26.31578947	
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0								
2008	1	7	1	0	1	24	24	22	0	0	18.18181818	
	27.27272727		36.36363636		13.63636364		0	0	4.545454545		0	0
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	0	0	0	18.18181818		27.27272727		36.36363636		13.63636364		0
	0	4.545454545		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	0	0	0	0	0						
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	16.66666667		25	25	4.166666667		20.83333333		4.166666667		0	0
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	0	0	0	4.166666667		16.66666667		25	25	4.166666667		
	20.83333333		4.166666667		0	0	0	0	0	0	0	0
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2008	1	7	1	0	1	44	44	47	0	0	0	0
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	6.060606061	6.060606061	6.060606061	9.090909091	12.12121212	3.03030303
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	11.11111111	
	11.11111111	11.11111111	22.22222222	0	0	0	11.11111111	0				
	11.11111111	0	0	0	0	0	0	0	0	0	0	
	0	0	0	11.11111111	11.11111111	0	0	0	0	0		
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2009	1	7	1	0	1	54	54	2	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	50	50
	0	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	0	0	0	0	0	0	0	0	0	50	50
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2009	1	7	1	0	1	56	56	1	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
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2009	1	7	1	0	1	58	58	1	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	100
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2010	1	7	1	0	1	10	10	1	0	100	0	0
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2010	1	7	1	0	1	14	14	2	0	100	0	0
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	0	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
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2010	1	7	1	0	1	20	20	19	0	10.52631579		
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	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	10.52631579		73.68421053		15.78947368		0	0	0	0	0
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	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									
2010	1	7	1	0	1	22	22	23	0	0	60.86956522	
	26.08695652		4.347826087		4.347826087		4.347826087		0	0	0	0
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	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	60.86956522		26.08695652		4.347826087		4.347826087		
	4.347826087		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	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0					
2010	1	7	1	0	1	24	24	23	0	0	13.04347826	
	21.73913043		34.7826087		21.73913043		8.695652174		0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
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	8.695652174		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	0	0	0	0	0	0					
2010	1	7	1	0	1	26	26	32	0	0	12.5	12.5
	43.75	9.375	15.625	3.125	3.125	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	12.5	12.5
	43.75	9.375	15.625	3.125	3.125	0	0	0	0	0	0	0
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13.33333333 4.444444444 0 2.222222222 0 0 0 0 0
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2010 1 7 1 0 1 38 38 51 0 0 0 0
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2010 1 7 1 0 1 40 40 39 0 0 0 0
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7.692307692 7.692307692 5.128205128 12.82051282 0 5.128205128
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20.51282051 17.94871795 7.692307692 7.692307692 5.128205128 12.82051282
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0 0 0 0 0 0 0 0 100 0 0 0
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0 0 0 0 0 0 0 0

2003	1	7	2	0	1	16	16	1	0	0	100	0
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	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	100	0
	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0				
2003	1	7	2	0	1	18	18	2	0	0	100	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	100	0
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2003	1	7	2	0	1	20	20	4	0	0	100	0
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	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0				
2003	1	7	2	0	1	22	22	11	0	0	72.72727273	
	9.090909091		9.090909091		0	9.090909091		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	0
	0	0	72.72727273		9.090909091		9.090909091		0	9.090909091		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	0								
2003	1	7	2	0	1	24	24	16	0	0	25	50
	25	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	0	0	0	0	0	25	50
	25	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	0	0	0				
2003	1	7	2	0	1	26	26	27	0	0	0	
	25.92592593		37.03703704		22.22222222		0	11.11111111		3.703703704		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	0	0	25.92592593		37.03703704		22.22222222		0
	11.11111111		3.703703704		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					
2003	1	7	2	0	1	28	28	32	0	0	0	15.625
	28.125	34.375	9.375	3.125	3.125	6.25	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	0	15.625
	28.125	34.375	9.375	3.125	3.125	6.25	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
2003	1	7	2	0	1	30	30	54	0	0	0
	12.96296296	18.51851852	27.77777778	12.96296296	7.407407407	7.407407407
	9.259259259	0	0	1.851851852	0	0	0	0	0	0
	0	1.851851852	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	12.96296296
	18.51851852	27.77777778	12.96296296	7.407407407	7.407407407	9.259259259
	0	0	1.851851852	0	0	0	0	0	0	0
	1.851851852	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
2003	1	7	2	0	1	32	32	60	0	0	0	0
	5	10	18.33333333	11.66666667	13.33333333	15	6.666666667
	6.666666667	5	1.666666667	3.333333333	0	3.333333333	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	5	10
	18.33333333	11.66666667	13.33333333	15	6.666666667	6.666666667	5
	1.666666667	3.333333333	0	3.333333333	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
2003	1	7	2	0	1	34	34	63	0	0	0	0
	4.761904762	1.587301587	6.349206349	12.6984127	11.11111111	9.523809524
	11.11111111	12.6984127	11.11111111	4.761904762	7.936507937	3.174603175
	0	0	0	1.587301587	0	0	1.587301587	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	4.761904762	1.587301587	6.349206349	12.6984127	11.11111111
	9.523809524	11.11111111	12.6984127	11.11111111	4.761904762	7.936507937
	3.174603175	0	0	0	1.587301587	0	0	1.587301587	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
2003	1	7	2	0	1	36	36	54	0	0	0	0
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	9.259259259	7.407407407	5.555555556	20.37037037	7.407407407	5.555555556
	1.851851852	1.851851852	0	1.851851852	1.851851852	1.851851852	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	1.851851852	0	5.555555556	5.555555556
	11.11111111	11.11111111	9.259259259	7.407407407	5.555555556	20.37037037
	7.407407407	5.555555556	1.851851852	1.851851852	0	1.851851852
	1.851851852	1.851851852	0	0	0	0	0	0	0	0
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	0	0	0	0	0
2003	1	7	2	0	1	38	38	47	0	0	0	0
	0	0	0	0	0	10.63829787	4.255319149	12.76595745
	8.510638298	6.382978723	17.0212766	12.76595745	6.382978723	2.127659574
	2.127659574	2.127659574	2.127659574	0	0	0	0	0
	2.127659574	2.127659574	0	2.127659574	2.127659574	0	0	0
	0	0	0	4.255319149	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
	10.63829787	4.255319149	12.76595745	8.510638298	6.382978723	17.0212766
	12.76595745	6.382978723	2.127659574	2.127659574	2.127659574	2.127659574
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0 0 0 0 0 2.127659574 2.127659574 0 2.127659574
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13.04347826 17.39130435 13.04347826 0 0 0 0 4.347826087
4.347826087 0 4.347826087 8.695652174 4.347826087 0 0 0
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2003 1 7 2 0 1 42 42 16 0 0 0 0
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2003 1 7 2 0 1 44 44 11 0 0 0 0
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2003 1 7 2 0 1 46 46 8 0 0 0 0
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2003 1 7 2 0 1 48 48 3 0 0 0 0
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33.33333333 0 0 0 0 0 33.33333333 0 0 0
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2003 1 7 2 0 1 50 50 1 0 0 0 0
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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	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0				
2004	1	7	2	0	1	18	18	1	0	0	100	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2004	1	7	2	0	1	20	20	3	0	0	0	
	33.33333333		33.33333333		33.33333333		0	0	0	0	0	0
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2007	1	7	2	0	1	22	22	12	0	0	41.66666667	
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	6.25	12.5	46.875	25	3.125	0	3.125	0	0	3.125	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2008	1	7	2	0	1	20	20	9	0	11.11111111		
	66.66666667		22.22222222		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	0	0	0	0
	0	11.11111111		66.66666667		22.22222222		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	0
	0	0	0									
2008	1	7	2	0	1	22	22	11	0	0	63.63636364	
	36.36363636		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
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	63.63636364		36.36363636		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	0	0	0	0
2008	1	7	2	0	1	24	24	21	0	0	4.761904762	
	38.0952381		4.761904762		28.57142857		19.04761905		4.761904762		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	0	0	4.761904762		38.0952381		4.761904762		28.57142857	
	19.04761905		4.761904762		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				
2008	1	7	2	0	1	26	26	26	0	0	3.846153846	
	23.07692308		23.07692308		19.23076923		19.23076923		11.53846154		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	0	0	3.846153846		23.07692308		23.07692308		19.23076923	
	19.23076923		11.53846154		0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0				
2008	1	7	2	0	1	28	28	33	0	0	0	0
	6.060606061		15.15151515		39.39393939		18.18181818		15.15151515		6.060606061	
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	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	6.060606061		15.15151515		39.39393939	
	18.18181818		15.15151515		6.060606061		0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
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2008	1	7	2	0	1	30	30	44	0	0	0	
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	13.63636364		4.545454545		0	0	0	0	0	0	0	0
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4.545454545 18.18181818 27.27272727 20.45454545 13.63636364 4.545454545
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2008 1 7 2 0 1 32 32 52 0 0 0 0
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9.615384615 9.615384615 1.923076923 1.923076923 3.846153846 0
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15.38461538 9.615384615 9.615384615 1.923076923 1.923076923 3.846153846
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2008 1 7 2 0 1 36 36 38 0 0 0 0
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2008 1 7 2 0 1 38 38 42 0 0 0 0
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2008 1 7 2 0 1 44 44 9 0 0 0 0
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2008 1 7 2 0 1 50 50 1 0 0 0 0
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2008 1 7 2 0 1 52 52 1 0 0 0 0
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2009	1	7	2	0	1	16	16	3	0	100	0	0
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2009	1	7	2	0	1	18	18	3	0	33.33333333		
	66.66666667		0	0	0	0	0	0	0	0	0	0
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	33.33333333		66.66666667		0	0	0	0	0	0	0	0
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	0											
2009	1	7	2	0	1	20	20	3	0	0	33.33333333	
	33.33333333		0	33.33333333		0	0	0	0	0	0	0
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	0	33.33333333		33.33333333		0	33.33333333		0	0	0	0
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	0	0										
2009	1	7	2	0	1	22	22	14	0	0	28.57142857	
	42.85714286		14.28571429		14.28571429		0	0	0	0	0	0
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	0	0	0	0								
2009	1	7	2	0	1	24	24	17	0	0	5.882352941	
	23.52941176		29.41176471		23.52941176		11.76470588		0	0	5.882352941	
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	11.76470588		0	0	5.882352941		0	0	0	0	0	0
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	0	0	0	0	0	0	3.448275862		34.48275862		24.13793103	
	10.34482759		20.68965517		6.896551724		0	0	0	0	0	0
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15.78947368 23.68421053 13.15789474 21.05263158 2.631578947 0 0
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4.347826087 0 2.173913043 0 0 0 0 0 0 0
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19.56521739 32.60869565 8.695652174 21.73913043 4.347826087 0
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2009 1 7 2 0 1 32 32 56 0 0 0 0
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14.28571429 5.357142857 1.785714286 3.571428571 0 0 0 0
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3.571428571 7.142857143 8.928571429 32.14285714 21.42857143 14.28571429
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2009 1 7 2 0 1 34 34 59 0 0 0 0
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2009 1 7 2 0 1 38 38 42 0 0 0 0
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9.523809524 11.9047619 7.142857143 4.761904762 9.523809524 9.523809524
14.28571429 2.380952381 7.142857143 0 2.380952381 0 0 0

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2009 1 7 2 0 1 40 40 36 0 0 0 0
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2.777777778 13.88888889 8.333333333 11.11111111 2.777777778 2.777777778
5.555555556 5.555555556 0 2.777777778 0 0 2.777777778 0
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13.88888889 8.333333333 11.11111111 2.777777778 2.777777778 5.555555556
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2009 1 7 2 0 1 44 44 13 0 0 0 0
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25 0 0 0 0 0 0 0 0 0 0 25
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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	50	0	0	0	0
	25	0	0	0	0	0	0	0	0	0	0	25
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2009	1	7	2	0	1	50	50	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	50	0	0	0	50	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2009	1	7	2	0	1	52	52	1	0	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
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	100	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0				
2009	1	7	2	0	1	54	54	1	0	0	0	0
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	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	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	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	0	0	0	0	0	0	0				
2010	1	7	2	0	1	16	16	3	0	100	0	0
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	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	100	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
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
2010	1	7	2	0	1	18	18	5	0	20	80	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
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	0	0	0	0	0	0	0	0	0	20	80	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	0	0	0	0	0				
2010	1	7	2	0	1	20	20	12	0	8.333333333		75
	16.66666667		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	0	0	0	0	0	
	8.333333333		75	16.66666667		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 0 0 0
0
2010 1 7 2 0 1 22 22 26 0 0 53.84615385
26.92307692 15.38461538 3.846153846 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0
0 0 53.84615385 26.92307692 15.38461538 3.846153846 0 0
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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
2010 1 7 2 0 1 24 24 28 0 0 32.14285714
46.42857143 17.85714286 0 3.571428571 0 0 0 0 0
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0 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 0 32.14285714 46.42857143 17.85714286 0 3.571428571 0
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2010 1 7 2 0 1 26 26 24 0 0 8.333333333
16.66666667 33.33333333 20.83333333 20.83333333 0 0 0 0
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20.83333333 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0
2010 1 7 2 0 1 28 28 29 0 0 0
3.448275862 17.24137931 37.93103448 17.24137931 13.79310345 3.448275862
3.448275862 0 3.448275862 0 0 0 0 0 0 0
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37.93103448 17.24137931 13.79310345 3.448275862 3.448275862 0
3.448275862 0 0 0 0 0 0 0 0 0 0
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2010 1 7 2 0 1 30 30 30 0 0 0
3.333333333 16.66666667 26.66666667 13.33333333 16.66666667 10 10
0 3.333333333 0 0 0 0 0 0 0 0 0
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13.33333333 16.66666667 10 10 0 3.333333333 0 0 0
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0 0 0 0 0 0 0 0 0
2010 1 7 2 0 1 32 32 43 0 0 0
2.325581395 2.325581395 4.651162791 4.651162791 9.302325581 20.93023256
20.93023256 13.95348837 16.27906977 0 2.325581395 0 0 0
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2010 1 7 2 0 1 34 34 45 0 0 0 0
0 0 6.666666667 8.888888889 24.44444444 13.33333333 8.888888889
15.55555556 8.888888889 6.666666667 0 2.222222222 0 2.222222222
2.222222222 0 0 0 0 0 0 0 0 0 0
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15.55555556 8.888888889 6.666666667 0 2.222222222 0 2.222222222
2.222222222 0 0 0 0 0 0 0 0 0 0
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2010 1 7 2 0 1 36 36 46 0 0 0 0
0 4.347826087 10.86956522 6.52173913 10.86956522 10.86956522
10.86956522 6.52173913 13.04347826 8.695652174 8.695652174 0
2.173913043 2.173913043 2.173913043 0 0 0 0 0
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10.86956522 10.86956522 10.86956522 6.52173913 13.04347826 8.695652174
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2010 1 7 2 0 1 38 38 38 0 0 0 0
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15.78947368 18.42105263 7.894736842 7.894736842 2.631578947 5.263157895
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2010 1 7 2 0 1 40 40 24 0 0 0 0
0 0 0 0 4.166666667 4.166666667 0 4.166666667 0
0 8.333333333 25 8.333333333 12.5 0 12.5 4.166666667 0
4.166666667 4.166666667 0 4.166666667 0 4.166666667 0 0
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8.333333333 25 8.333333333 12.5 0 12.5 4.166666667 0
4.166666667 4.166666667 0 4.166666667 0 4.166666667 0 0
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0 0 0 0 0 0
2010 1 7 2 0 1 42 42 23 0 0 0 0
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13.04347826 4.347826087 8.695652174 4.347826087 8.695652174 0
4.347826087 4.347826087 4.347826087 4.347826087 0 0 0
4.347826087 4.347826087 0 0 4.347826087 4.347826087 0 0
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0 0 8.695652174 13.04347826 13.04347826 4.347826087 8.695652174
4.347826087 8.695652174 0 4.347826087 4.347826087 4.347826087
4.347826087 0 0 0 4.347826087 4.347826087 0 0
4.347826087 4.347826087 0 0 0 0 0 0 0 0

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	0	0	0	4.347826087	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
2010	1	7	2	0	1	44	44	9	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	11.11111111	11.11111111	11.11111111	0
	22.22222222	11.11111111	0	0	0	0	0	0	0	0
	11.11111111	11.11111111	0	11.11111111	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	11.11111111	11.11111111	11.11111111	0	22.22222222	11.11111111
	0	0	0	0	0	0	0	0	11.11111111	11.11111111
	0	11.11111111	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0
2010	1	7	2	0	1	46	46	7	0	0	0	0
	0	0	0	0	0	0	0	0	14.28571429	0
	14.28571429	0	0	14.28571429	0	0	0	0	0	0
	0	0	0	0	0	0	14.28571429	0	14.28571429	0
	0	0	0	14.28571429	0	0	0	14.28571429	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	14.28571429	0	14.28571429	0	0
	14.28571429	0	0	0	0	0	0	0	0	0	0
	0	0	14.28571429	0	14.28571429	0	0	0	0
	14.28571429	0	0	0	14.28571429	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0
2010	1	7	2	0	1	48	48	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	100	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
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	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
2010	1	7	2	0	1	52	52	2	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	50	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	50	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	50	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	50	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
#NWFSC marginalAgeCompsToSeeFit
#negative sample size means it predict values, but doesn't include them in likelihood
1998	1	6	3	0	1	-1	-1	139	0	0	0.529032062
	0.701600317	2.381007632	2.863121637	2.649359607	1.771051005	4.355771714
	3.014459075	2.359543394	2.120034401	1.820432747	1.188764329	1.622825541
	1.521395497	0.347415556	0.989649917	0.603891331	0.565282055	0.542778365
	1.309472113	0.541198671	0.417815208	0.636121195	0.431028108	0.497982523
	0.489350053	0.165561069	0.138720857	0.533774792	0.16463468	0.019607812
	0	0.082867156	0	0.049540395	0	0.049540395	0.012687703	0
	0	0	0	0.177481948	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.016349037
	1.123093729	3.78762843	3.832881539	8.297956238	8.395300048	5.990137456
	8.273104662	4.389237068	2.555894139	3.677098618	3.803629615	1.922908626
	1.298355898	0.914640657	0.866890126	0.711195193	0.182416611	0.590414921
	0.310217747	0.240625493	0.010899662	0.034609664	0.305432618	0.094256454
	0.211789349	0.234641803	0	0	0.253313195	0	0.010280549	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
1999	1	6	3	0	1	-1	-1	131	0	0	2.69024466
	2.391663412	4.788084434	3.012877957	7.202628485	1.239934371	2.999628286
```

3.343039521 0.828709696 1.65777758 1.661372735 1.130688099 0.339567007
0.88976398 0.376690959 1.091345034 2.666989249 0.724209758 2.040927546
0.399012094 0.527480835 0.578100547 1.580798486 0.005228562 0.128372229
0.036683844 0.019870195 0.586404559 1.14121255 0 0.14986754 0
0.010184503 0 0 0 0.419036177 0.113094148 0 0.101529292
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.39239157 3.574191387
5.961942913 12.39319746 9.481741333 6.372782867 2.942902118 1.963205873
0.180959327 3.530319223 0.600886996 0.358258495 1.117738246 0.023336667
0.123436188 1.169324405 0.271123419 0.251489032 0.266666953 0.271124746
0.520029181 0.08113508 1.164095843 0 0 0 0 0 0
0 0 0.11470235 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
2000 1 6 3 0 1 -1 -1 126 0 0 0.686970255
1.070831819 1.134407235 2.406004111 1.474442073 0.982423904 4.039206651
2.754276707 0.955120614 1.609813028 2.334047175 1.761501935 1.589099791
1.839820054 0.66048315 0.806270145 0.273967163 0.884234418 3.593158987
1.382468859 0.779829044 0.464918446 0.25807398 0.544357143 0.134795523
0.333789431 0.319798124 0.230936304 0.692371108 0 0.453235383
0.185218052 0.160320764 1.063171027 0.177599047 0.413792058 0.0196678
0 0.432746415 0 0 0 0.018046164 0 0 0 0
0.064608586 0 0 0.064608586 0 0 0 0 0 0
0 0 0 0.219962083 2.294994116 2.816076757 2.419648855
3.641709926 3.917978049 9.09245374 5.169164929 4.941069364 6.672423053
4.103568732 4.509961453 3.375367136 0.430483791 1.199315613 3.568857832
0.005988169 0.446432563 0 0 0.147337708 0.238745075 0.388131489
0.005988169 0.537011093 0.200221444 0.056230133 0 0.257843577
0.031321727 0 0 0.068206471 0.056230133 0.080615629 0
0.056230133 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2001 1 6 3 0 1 -1 -1 132 0 0 0.093244379
3.520595673 3.985955684 1.683393458 0.991878418 2.167543375 2.468828129
0.805151087 1.65748652 1.963562368 1.063338042 0.502881539 0.466754004
0.318657112 0.201180942 0.660788621 0.217607463 0.212123299 2.015651357
0.632983064 1.241444727 0.151890206 0.62065366 3.996090214 0.82024341
0.82106694 0.047144182 0.245649178 0.343791254 0.206219669 4.055144333
0.016736968 0.104869236 0.516584097 0.012808664 0 0.007155385
0.129595689 0.063089026 0.192016409 0 0 0.053982777 0 0
0.104869236 0 0 0 0 0 0 0 0 0
0 0 0 0 0.234760576 2.919734228 1.995650466 2.907174405
3.923926345 1.229610891 7.727181452 4.03154612 2.29582359 3.697197534
4.894914507 2.980764276 2.630763475 0.86933906 1.534927231 0.190751971
0.202094164 0.23416988 1.221899842 0.820725388 0.288342308 0.069882323
0.588370476 0.059259775 0.032935788 0 0.013166524 3.986653284
0.037428212 0 0.013166524 0.057661939 0.112392749 0 0 0
3.887221403 0 0.117511201 4.238849636 0.499196639 0 0.053982777
0 0 0 0 0.020373247 0 0 0 0 0 0
0 0 0 0
2002 1 6 3 0 1 -1 -1 140 0 0 0.574583872
1.993170539 3.470596341 3.82742409 4.531236296 3.360269292 3.042123223
2.574497556 2.5223392 2.01924478 1.305046171 2.306736809 0.872342768
1.313160346 1.622283764 1.29294728 0.689248529 0.920548632 0.480326137
0.537956397 0.609085161 0.238457208 0.200983364 0.495656665 0.273315286
0.264996341 0.214951178 0.111290875 0.389015751 0.339972874 0.312674945
0.350412809 0.143246301 0.146079831 0.139619414 0.057890901 0.18361942
0.043758334 0.195244323 0.092645554 0.033693899 0.012899264 0.018629469
0.184001416 2.128718184 0.056264428 0.023672081 0.041087998 0.055812529
0 0 0 0.012208292 0 0 0 0 0 0
0.180825649 0.17802824 2.072358647 4.629813188 3.622561514 4.112148855
4.27561056 3.754383525 6.127790395 4.480626714 4.271954309 2.407633745
2.583419121 1.542216285 1.114861871 1.326287768 0.519139307 0.879743883
0.17176246 0.688248062 0.672120539 0.277806992 0.145525806 0.23905255
0.299106798 0.144225979 0.33765335 0.358448765 0.074412114 0.115870934
0.18440602 0.086278168 0.036122824 0.224124028 0.079436016 0.119852791
0 0.078633304 0 0.192161586 0 0.262831435 0 0.017077317
0.025823994 0.01558987 0 0.18440602 0.119852791 0 0 0
0 0 0.023927005 0 0 0 0.119852791
2003 1 7 3 0 1 -1 -1 -381 0 0 1.668654031
2.780321731 4.787296042 4.185107741 4.895796829 5.125537327 4.360934313
3.036282665 1.489220873 1.509730034 3.478273043 1.249529239 1.231660199

0.792709344 0.907019249 0.347119426 0.250559085 0.301443484 0.161925006
0.25269606 0.031235011 0.294574647 0.056454728 0.391351652 0.060695901
0.172151479 0.159133942 0.145129616 0.525299474 0.842007442 0.097399136
0.02464823 0.090658133 0.106319889 0.275996122 0.043186601 0.0413956
0.038534554 0.028548017 0.170650729 0.003364355 1.430862878 0 0
0.027506325 0 0.006485988 0 0 0 0 0 0 0
0.052238467 0 0 0 0 0 0.616102323 1.968892425
3.739251501 7.506541482 3.182972687 2.457067299 2.344581337 5.18991045
2.410724484 3.980288024 2.368383725 1.733862672 9.309528151 1.23425443
0.634839166 0.179956299 0.13004787 0.036857457 0.191891828 0.280126504
0.343777688 0.00944078 0.044812564 0.034176363 0.600269464 0.097231147
0.041327585 0.131750534 0.001751504 0.026715551 0.133244073 0.026438903
0.174111616 0.332503295 0.017994253 0.027272781 0 0.1796826
0.093680284 0 0 0.115813605 0 0.028467055 0 0
0.115813605 0 0 0 0 0 0 0 0 0 0
0
2004 1 7 3 0 1 -1 -1 -207 0 0 0.109858686
1.218890475 2.061330343 3.829129103 3.877901418 1.343320423 2.228582244
2.097187657 2.162512433 1.638590798 6.03853683 4.838985032 1.31007592
0.229299331 0.622995796 0.703752999 0.368820081 0.300344464 0.709513494
0.530520069 1.080113182 0.275958081 0.30213512 0.362597096 0.083494261
0.167535798 0.174027349 0.260124724 1.058035417 0.240002226 0.253048465
0.197879985 0.577296978 0.094692794 0.142267054 0.092549689 0
0.313873262 0.040330458 0.17561303 0 0.076165448 0 0
0 0 0.02409369 0 0 0 0 0 0 0 0
0 0 0 0 0.176719534 1.529455726 8.429926017 4.457397198
3.054981074 3.503683888 4.312531315 3.522893131 6.460959104 3.734735541
1.654260446 0.665037085 6.076165858 1.618485213 1.207720806 0.980172894
0.560320812 0.679874431 0.341099529 0.84308997 0.458862041 0.223532071
0.680741685 0.4677267 0.465593292 0.024554828 0.045393272 0.028331869
0.180418328 0.174696843 0.447783246 0.39552771 0.024128868 0.049250139
0.135195756 0.05181334 0.03355501 0 0 0 0.034472323 0
0.007681262 0.049250139 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2005 1 7 3 0 1 -1 -1 -518 0 0.362613992
0.160472912 2.407294604 4.947139283 6.304887698 6.572179959 5.20880838
2.30644954 2.412778583 3.365108977 1.698198126 1.000175033 1.371584188
1.027871312 1.158004703 0.426043689 0.372426412 0.255108108 0.491639141
0.353118213 0.062664634 0.275459739 0.637315528 0.857699169 0.01722025
0.124653203 0.739697038 0.387762345 0.023818067 0.062657954 0.202106058
0.110236862 0.024060512 0.141766041 0.122218647 0.02816456 0
0.008037862 0.052748051 0 0.224527225 0.08785866 0.113387379 0
0.017631305 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.494970183 0.305925267 3.089000432
5.190900692 6.071042691 6.455978741 6.959048345 3.647371248 2.200480462
3.732748415 1.546778708 2.491954005 2.688538716 2.137865834 1.539997118
0.619382927 1.244515204 0.254207831 0.494719254 0.348311382 0.108824075
0.097807737 0.623210772 0.088224222 0.279921588 0 0.132797033 0
0 0.161279857 0 0 0.060737172 0.004513659 0 0 0
0 0 0 0.067204469 0 0 0 0 0 0.076679668
0.044616858 0.043288196 0 0 0.173563299 0 0 0 0
0 0 0
2006 1 7 3 0 1 -1 -1 -505 0 0.007184414
0.073997189 0.534098835 2.630400912 6.956329477 4.976487072 7.734440832
5.173040429 2.19441897 2.143719849 1.651368273 1.495870915 0.395789474
0.796099371 0.426093318 1.311934859 0.750303925 0.407390748 0.912208972
0.194784904 0.148602184 0.284101258 0.253977225 0.489647198 0.138594411
0.219002306 1.08117895 0.087526283 0.092730928 0 0.255612789
0.015083885 0.021407953 0 0.407123964 0.00291871 0.124694802
0.038692475 0.05263951 0.014835031 0.135122525 0.048098474 0 0
0 0 0 0.050705657 0 0 0 0 0.017646659
0 0 0 0 0 0 0.019545991 1.005822032 0.597217012
2.982814602 6.502717969 7.977246119 7.643926629 4.03215 4.278088329
2.55249781 2.108955575 1.836925481 3.420008805 1.598477229 1.202532745
0.407905046 0.741310671 0.058749077 0.637611076 0.724059329 0.238311676
0.10015079 0.094199919 0.140571332 0.145192469 1.182546358 0.268784606
0 0.338847561 0.132062882 0.504020216 0 0 0 0.165228124
1.015400469 0.110188894 0 0 0.47884544 0 0 0 0
0 0 0 0 0 0 0.011181826 0 0 0 0
0 0 0 0

2007 1 7 3 0 1 -1 -1 -550 0 0 0.440770511
0.856037541 3.305846791 3.051820477 5.746038181 3.685288679 6.910601456
4.513013027 2.604955209 1.900032198 1.295888032 1.876569574 0.740625904
4.11505588 0.74964084 0.744567453 0.209234004 0.304316899 0.262906114
0.612976669 0.559874326 0.381725989 0.347491043 2.099807205 0.763532901
0.101414139 0.160669378 0.200677585 0.184023893 0.065975075 0.052576729
0 0 0 0.011983669 0 0 0 0.237747543 0 0
0 0 0.018700363 0 0.101414139 0.019963092 0 0 0
0 0 0 0 0 0 0 0 0 0.012045108
0.057638016 0.846267262 1.764813503 3.68886065 9.528138544 7.226951207
4.396376844 3.616813916 4.495884005 1.969652468 1.425730859 2.414673925
2.517247399 1.083336615 0.56412433 0.537830623 0.658558576 1.142330697
0.62169525 0.010325434 0.052422266 0 0.272359454 0.053971922 0
0 0.033523915 0.172405247 0.017786943 0.277181897 0.60306874
0.315863421 0.017059412 0 0 0 0 0 0.007147398 0
0.364151648 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2008 1 7 3 0 1 -1 -1 -541 0 0.010499526
0.052729861 0.584471102 1.404272742 2.140552724 4.39523149 7.362954104
4.071699829 3.492509932 5.65375083 2.758442586 1.771772997 1.814990347
1.65341742 1.538574321 1.150288465 1.903161535 0.893400357 0.398347143
0.250263307 0.276972418 0.523294395 0.082695484 0.09557646 0.00503144
0.03697322 0.154912345 0.162216825 0.03073405 0 0.009194193
0.04446405 0.101535751 0.019895303 0 0.088013003 0 0.306754349
0.477725001 0.313143378 0 0 0 0 0 0 0
0.101280141 0 0 0 0 0 0 0 0 0 0
0 0 0.003056347 0.064434992 0.575278149 1.714474559 2.183978743
5.595536586 6.024410704 7.817679627 9.353086536 2.803616607 2.268167681
2.2674113 1.457750836 2.520294662 1.139405788 0.993670454 0.790904515
1.166553316 0.625010296 0.190980564 1.46540729 0 0.272402778
0.159888518 0.130535262 0.352879957 0.011760398 0 0.338620313
0.120457679 0.575666791 0.258464108 0 0 0 0 0
0.146174283 0.110183295 0 0 0 0.047702141 0.051620089 0
0 0 0 0 0.19116532 0 0.079627092 0 0 0
0 0 0 0
2009 1 7 3 0 1 -1 -1 -536 0.002536722 0.010037149
0.727048396 0.343854942 1.120497136 1.026373952 3.866814236 5.095318781
6.059713796 4.182752739 6.213005707 2.533853002 1.555824377 0.58707471
1.848130944 1.58395261 0.966548125 0.887098686 0.287364004 1.56735081
0.376361274 0.315838948 0.443827059 0.237204974 0.204357696 1.070302166
0.168845888 1.127381015 0.706566462 0.079785964 0.009766929 0.138848411
0.249565514 0.189954363 0 0.015310856 0.054430848 0.059843701
0.09314993 0.437884336 0 0.08909817 0.044263971 0.002077579 0
0 0 0 0 0 0 0.033268176 0 0 0
0.053486616 0 0 0 0 0.002536722 0.007697998 0.067070448
0.172640113 0.572594693 2.49361792 3.343666122 6.25323829 6.74214536
6.597119754 3.78069252 4.350636522 4.119561848 1.533765136 3.33407082
0.85189669 1.318008814 1.733953259 0.850236164 0.353356071 0.216717083
0.311356105 0.433084571 0.23454179 0.122288509 0.465825567 0.350473983
0.289847297 0.226961605 0.077209843 0.0619897 0.206604787 0.816397567
0.540664356 0.015310856 0.00625138 0.172283984 0 0.029212764
0.034104204 0.071101836 0 0 0 0 0 0 0
0.1419569 0 0 0 0 0 0 0 0 0.030738372
0 0
2010 1 7 3 0 1 -1 -1 -573 0.002507081 0.038510338
0.263806413 0.543104326 1.949153243 2.710626604 4.650388589 5.374787532
6.288930198 5.980776689 6.871055649 1.211726387 1.588008965 1.190287398
2.442663084 1.380376549 3.10044431 0.912972541 0.967110323 1.58578995
0.91112837 1.794114481 0.429195394 0.448647335 0.796016745 0.256626605
0 0.349962218 0.270279397 0.253903106 0.046431638 0.001882412
0.053000855 0.050920095 0.184940306 0.068050905 0 0.050337869
0.02114609 0.207684314 0 0.259755203 0 0 0 0 0
0.008275973 0.031000861 0 0 0 0 0 0 0 0
0 0 0 0 0.023384646 0.448093684 0.500404104 2.789629285
2.137776218 3.569332563 2.765282737 4.788905871 4.906407544 3.802714879
4.802906612 2.779939875 1.492315872 1.803878692 1.142955841 0.585881871
1.444137766 0.239675022 0.637088771 1.312369347 0.496324949 0.152726877
0.151779683 0.231209946 0.687125337 0.026858672 0.159567981 0 0
0.134145649 0.044821954 0.001618088 0.125910438 0.001882412 0.022167875
0 0.042443253 0.101377519 0 0 0.052754181 0 0.047877643

```
        0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0


0       #_N_size@age_observations;_values_on_row1;_N_on_row2
# Year  Season  Fleet   Gender  Mkt     ageerr  Nsamp   Fem_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
        35      40      50      Mal_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      35      40      50


#_environmental_data
0       #N_envvar
0       #N_observations


0       # N sizefreq methods to read
#25     #Sizefreq N bins per method
#2      #Sizetfreq units(bio/num) per method
#3      #Sizefreq scale(kg/lbs/cm/inches) per method
#1e-005 #Sizefreq mincomp per method
#0      #Sizefreq N obs per method
#_Sizefreq bins
#26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 68 72 76 80 90
#_Year season Fleet Partition Gender SampleSize <data>
#1 1971 1 1 3 0 125  0 0 0 0 0 0 0 0 0 4 1 1 2 4 1 5 6 2 3 11 8 4 5 0 0 0 0 0 0 0 0 0 1 0 1 3 0
3 4 2 4 5 9 17 8 3 8 0 0

0 # no tag data

0 # no morphcomp (stock) data

999

ENDDATA
```

Appendix D. SS Control File

```
#C 2011 dover sole 2011 assessment in SS3
# Initial parameter values from Run 248.MC.A05, the final base model.
# Uses environment variables for trends in retention parameters and female maturity L50.

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)

#_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
2 1 2 #_blocks_per_pattern
# begin and end years of blocks
1910 1980 1981 1995 #Blocks for changes in fishery selection
1910 2003 #Blocks for changes in fishery retention for CA/WA
1910 1988 1989 2003 #Blocks for changes in fishery retention for OR


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
1.0     #_Growth_Age_for_L1 (minimum age for growth calcs)
50 #_Growth_Age_for_L2 (999 to use as Linf) (maximum age for growth calcs)
0.0     #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
4       #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 Lognormal
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
2       #_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)
2       #_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
0.05   0.20   0.101   -2.289  3    0.337  6    0 0 0 0 0 0 0  #_natM with prior LN(median=0.101,sd_log=0.337)
3    25    15    15    -1    10    2    0 0 0 0 0 0 0  #_Lmin from data but reduced slightly
35    60    47.5   47.5   -1    1    3    0 0 0 0 0 0 0  #_Lmax from prediction of NWFSC data
0.03   0.2   0.096   0.096   -1    1    2    0 0 0 0 0 0 0  #_VBK
0.01   1.0   0.13   0.13   -1    1    3    0 0 0 0 0 0 0  #_CV_at_Amin
0.01   1.0   0.05   0.0    -1    1    4    0 0 0 0 0 0 0  #_CV_at_Amax_as_exponential_offset_(rel_young)
#GP_1:::Male (Direct Estimation)
0.05   0.20   0.103   -2.276  3    0.337  7    0 0 0 0 0 0 0  #_natM with prior LN(median=0.103,sd_log=0.337)
3    25    15    15    -1    10    2    0 0 0 0 0 0 0  #_Lmin from data but reduced slightly
35    60    43.7   43.7   -1    10    3    0 0 0 0 0 0 0  #_Lmax from prediction of NWFSC data
0.03   0.2   0.097   0.097   -1    0.05   2    0 0 0 0 0 0 0  #_VBK
0.01   1.0   0.13    0    -1    1    3    0 0 0 0 0 0 0  #_CV-at_Amin
0.01   1.0   0.05    0.0   -1    1    4    0 0 0 0 0 0 0  #_CV_at_Amax
#LW_female
0    0.1  2.805E-06  2.805E-06  -1  0.2    -9    0 0 0 0 0 0 0 #_a
2    4    3.345  3.345   -1    2    -9    0 0 0 0 0 0 0 #_b
#Female_maturity
20    40    35.0   33.4   -1    5    -9    0 0 0 0 0 0 0 #_L50
-1    0    -0.775 -0.2988 -1    0.4    -9    0 0 0 0 0 0 0 #_slope
#Fecundity
-3    3    1    1    -1    0.8    -9    0 0 0 0 0 0 0 #_eggs / gm intercept
-3    3    0    0    -1    0.8    -9    0 0 0 0 0 0 0 #_eggs / gm slope
#LW_Male
0    0.1  2.231E-06 2.231E-06 -1    0.2    -9    0 0 0 0 0 0 0 #_a
```

```
2      4      3.412     3.412  -1     2      -9      0 0 0 0 0 0 0 #_b
#Allocate_R_by_areas_x_gmorphs
0      1      1      0.2     -1      9.8     -3            0 0 0 0 0 0 0 #frac to GP 1 in area 1
#Allocate_R_by_areas_(1_areain_this_case)
0      1      1      1      -1      9.8     -3      0 0 0 0 0 0 0 #frac R in area 1
#Allocate_R_by_season
-4     4      0      1      -1      9.8     -3      0 0 0 0 0 0 0 #frac R in season 1 (in log space)
#CohortGrowDev
#SS3 manual says it must be given a value of 1 and a negative phase
0     1     1       1       -1        0     -4       0 0 0 0 0 0 0

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

#0  #custom_MG-block_setup (0/1)
#-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 #enter parameter line when seasonal MG parameters

#_Cond -4 #_MGparm_Dev_Phase

#_Spawner-Recruitment
3              #_SR_function
#_LO        HI            INIT          PRIOR      PR_type        SD      PHASE
6      17    12.5    11       -1          5       1   #_Ln(R0)
0.22    1     0.8     0.8       0          0.09    -7   #_steepness
0.15    0.55  0.35    0.35     -1          0.2    -99  #_SD_recruitments
-2      2     0       0        -1          2      -99  #_Env_link
-2      2     0       0        -1          2      -99  #_ln(init_eq_R_multiplier)
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

1960           # 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
5              #_recdev phase
1              # (0/1) to read 11 advanced options
1910       #_recdev_early_start (0=none; neg value makes relative to recdev_start)
6      #_recdev_early_phase
6      #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
1    #_lambda for prior_fore_recr occurring before endyr+1
1960 #_last_early_yr_nobias_adj_in_MPD
1985 #_first_yr_fullbias_adj_in_MPD
2006 #_last_yr_fullbias_adj_in_MPD
2009 #_first_recent_yr_nobias_adj_in_MPD
0.9    #_max_bias_adj_in_MPD
0.0  # placeholder for future use
-5 #min rec_dev
5  #max rec_dev
0              #_read_recdevs
#_end of advanced SR options


#Fishing Mortality info
0.04           # 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)
3.5            # 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
0   1   0   0.0001   0        99   -1   #Fleet2
0   1   0   0.0001   0        99   -1   #Fleet2

#_Q_setup
# A=do power: 0=skip, survey is prop. to abundance, 1= add par for non-linearity
# B=env. link: 0=skip, 1= add par for env. effect on Q
# C=extra SD: 0=skip, 1= add par. for additive constant to input SE (in ln space)
# D=type: <0=mirror lower abs(#) fleet, 0=no par Q is median unbiased, 1=no par Q is mean unbiased, 2=estimate par for ln(Q)
#          3=ln(Q) + set of devs about ln(Q) for all years. 4=ln(Q) + set of devs about Q for indexyr-1
#D=devtype(<0=mirror, 0/1=none, 2=cons, 3=rand, 4=randwalk)
# A   B   C   D
0   0   0   0   #Fleet1_(CA_TWL)
0   0   0   0   #Fleet2_(OR_TWL)
0   0   0   0   #Fleet3_(WA_TWL)
0   0   1   0   #AFSC_Slope
0   0   1   4   #Trienial
0   0   1   0   #NWFSC_slope
0   0   1   0   #NWFSC_combo

# Q parameters
1 # Par setup: 0=read one parm for each fleet with random q; 1=read a parm for each year of index


#Extra SD parameters for surveys
#Lo   Hi   Init   Prior  Prior Prior Phase
0  2  0.01  0   -1  99  3  #AFSC slope
0  2  0.01  0   -1  99  3  #Triennial
0  2  0.01  0   -1  99  3  #NWFSC_slope
0  2  0.01  0   -1  99  3  #NWFSC_combo

# Lo   Hi   Init   Prior  Prior Prior Param
# bnd  bnd  value  mean  type  SD   phase
# Early period
 -10   2   -2   0   -1   99   1  # Triennial (log) base parameter (1980)
 -4   4   0   0   -1   99   -50 # Triennial 1983 deviation
 -4   4   0   0   -1   99   -50 # Triennial 1986 deviation
 -4   4   0   0   -1   99   -50 # Triennial 1989 deviation
 -4   4   0   0   -1   99   -50 # Triennial 1992 deviation
# Late period
 -4   4   0   0   -1   99   1   # Triennial 1995 deviation
 -4   4   0   0   -1   99   -50 # Triennial 1998 deviation
 -4   4   0   0   -1   99   -50 # Triennial 2001 deviation
 -4   4   0   0   -1   99   -50 # Triennial 2004 deviation

#Seltype(1,2*Ntypes,1,4)        #SELEX_&_RETENTION_PARAMETERS
# Size-based setup
# A=Selex option: 1-24
# B=Do_retention: 0=no, 1=yes
# C=Male offset to female: 0=no, 1=yes
# D=Mirror selex (#)
# A B C D
#Size_Slectivity,_enter_4_cols    #27 is cubic spline
#Pattern Retention Male Special
24 1 2 0  #Fleet1_(CA_TWL)
24 1 2 0  #Fleet2_(OR_TWL)
24 1 2 0  #Fleet3_(WA_TWL)
27 0 1 5  #AFSC_Slope
24 0 2 0  #Triennial
27 0 1 5  #NWFSC_slope
24 0 2 0  #NWFSC_combo
#Age_selectivity
10 0 0 0 # CA_TWL
10 0 0 0 # OR_TWL
10 0 0 0 # WA_TWL
10 0 0 0 # #AFSC_Slope
10 0 0 0 # #Trienial
10 0 0 0 # #NWFSC_slope
10 0 0 0 # #NWFSC_combo
```

```
#Selectivity parameters
#LO HI INIT PRIOR PR_TYPE SD PHASE env-var use_dev dev_yr1 dev_yr2 dev_sd nblks blk_pat
#1 CA Length selection
15 55 36 36 -1 5 2 0 0 0 0 0 1 2 #Peak
-7 7 -0.5 -0.5 -1 2 3 0 0 0 0 0 0 0 #Top (width)
-10 10 2 1.75 -1 5 3 0 0 0 0 0 0 0 #ASC_WIDTH
-10 10 6 0.1 -1 2 -4 0 0 0 0 0 0 0 #DESC_WIDTH
-20 30 -20 -1 -1 5 -9 0 0 0 0 0 0 0 #INIT (first bin)
-10 10 10 1 -1 5 -4 0 0 0 0 0 0 0 #Final (last bin)
#RETENTION
15 40 34 34 -1 99 2 0 0 0 0 0 2 2 #inflection
0.1 5 1.0 1.0 -1 99 3 0 0 0 0 0 2 2 #slope
0.5 1 1 1 -1 99 3 0 0 0 0 0 2 2 #asymptote
-10 10 0.0 0.0 -1 99 -9 0 0 0 0 0 0 0 # male offset to inflection (arithmetic)
#Females as offset
-10 60 40 0 -1 5 -4 0 0 0 0 0 0 0 # Dogleg_location
-10 10 0 0 -1 5 -5 0 0 0 0 0 0 0 # OffsetAtZero
-10 0 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtDogleg (can fix this at 0 to match male selex at peak)
-10 0.1 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtMaxage
#2 OR Length selection
15 55 36 36 -1 5 2 0 0 0 0 0 1 2 #Peak
-5 5 -0.5 -0.5 -1 2 3 0 0 0 0 0 0 0 #Top (width)
-10 10 2 1.75 -1 5 3 0 0 0 0 0 0 0 #ASC_WIDTH
-10 10 6 0.1 -1 2 -4 0 0 0 0 0 0 0 #DESC_WIDTH
-20 30 -20 -1 -1 5 -9 0 0 0 0 0 0 0 #INIT (first bin)
-10 10 10 1 -1 5 -4 0 0 0 0 0 0 0 #Final (last bin)
#RETENTION
15 40 34 34 -1 99 2 0 0 0 0 0 3 2 #inflection
0.1 5 1.0 1.0 -1 99 3 0 0 0 0 0 3 2 #slope
0.5 1 1 1 -1 99 3 0 0 0 0 0 3 2 #asymptote
-10 10 0.0 0.0 -1 99 -9 0 0 0 0 0 0 0 # male offset to inflection (arithmetic)
#Females as offset
-10 60 39 0 -1 5 -4 0 0 0 0 0 0 0 # Dogleg_location
-10 10 0 0 -1 5 -5 0 0 0 0 0 0 0 # OffsetAtZero
-10 0 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtDogleg (can fix this at 0 to match male selex at peak)
-10 0.1 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtMaxage
#3 WA Length selection
15 55 36 36 -1 5 2 0 0 0 0 0 1 2 #Peak
-5 5 -0.5 -0.5 -1 2 3 0 0 0 0 0 0 0 #Top (width)
-10 10 2 1.75 -1 5 3 0 0 0 0 0 0 0 #ASC_WIDTH
-10 10 6 0.1 -1 2 -4 0 0 0 0 0 0 0 #DESC_WIDTH
-20 30 -20 -1 -1 5 -9 0 0 0 0 0 0 0 #INIT (first bin)
-10 10 10 1 -1 5 -4 0 0 0 0 0 0 0 #Final (last bin)
#RETENTION
15 40 34 34 -1 99 2 0 0 0 0 0 2 2 #inflection
0.1 5 1.0 1.0 -1 99 3 0 0 0 0 0 2 2 #slope
0.5 1 1 1 -1 99 3 0 0 0 0 0 2 2 #asymptote
-10 10 0.0 0.0 -1 99 -9 0 0 0 0 0 0 0 # male offset to inflection (arithmetic)
#Females as offset
-10 60 40 0 -1 5 -4 0 0 0 0 0 0 0 # Dogleg_location
-10 10 0 0 -1 5 -5 0 0 0 0 0 0 0 # OffsetAtZero
-10 0 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtDogleg (can fix this at 0 to match male selex at peak)
-10 0.1 0 0 -1 5 5 0 0 0 0 0 0 0 # OffsetAtMaxage
#4 AFSC slope
0 2 0 0 -1 0 -9 0 0 0 0 0 0 0 #spline setup
-0.001 10 1 0 -1 0.1 3 0 0 0 0 0 0 0 # AgeSpline_GradLo
-10 0.01 -0.001 0 -1 0.1 3 0 0 0 0 0 0 0 # AgeSpline_GradHi
1 60 20 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Knot_1
1 60 29 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Knot_2
1 60 38 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Knot_3
1 60 47 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Knot_4
1 60 56 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Knot_5
-9 7 -7 0 -1 0 2 0 0 0 0 0 0 0 # AgeSpline_Val_1
-9 7 -1 0 -1 0 2 0 0 0 0 0 0 0 # AgeSpline_Val_2
-9 7 0 0 -1 0 -99 0 0 0 0 0 0 0 # AgeSpline_Val_3
-9 7 0 0 -1 0 2 0 0 0 0 0 0 0 # AgeSpline_Val_4
-9 7 0 0 -1 0 2 0 0 0 0 0 0 0 # AgeSpline_Val_5
#Males as offset
-10 60 45 0 -1 5 -4 0 0 0 0 0 0 0 # Dogleg_location
-10 10 0 0 -1 5 -5 0 0 0 0 0 0 0 # MaleOffsetAtZero
```

```
-10   10    0     0     -1      5     5     0 0 0 0 0 0 0 # MaleOffsetAtDogleg (can fix this at 0 to match female selex at peak)
-10   10    0     0     -1      5     5     0 0 0 0 0 0 0 # MaleOffsetAtMaxage
#5 Triennial
15    55    36    36    -1      5    2      0 0 0 0 0 0 0  #Peak
-10    5    -0.5  -0.5  -1      2    3      0 0 0 0 0 0 0 #Top (width)
-10   10    2     1.75  -1      5    3      0 0 0 0 0 0 0 #ASC_WIDTH
-10   10    2     0.1   -1      2    4      0 0 0 0 0 0 0 #DESC_WIDTH
-20   30    -20  -1     -1      5    -9     0 0 0 0 0 0 0 #INIT (first bin)
-10   10    1     1     -1      5   4       0 0 0 0 0 0 0 #Final (last bin)
#Females as offset
-10   60    35     0    -1      5    -4     0 0 0 0 0 0 0 # Dogleg_location
-10   10    0      0    -1      5    -5     0 0 0 0 0 0 0 # OffsetAtZero
-10   0     0      0    -1      5     5     0 0 0 0 0 0 0 # OffsetAtDogleg (can fix this at 0 to match male selex at peak)
-10   0.1   0      0    -1      5     5     0 0 0 0 0 0 0 # OffsetAtMaxage
#6 NWFSC slope
0     2     0     0     -1      0    -9     0 0 0 0 0 0 0 #spline setup
-0.001 10    1    0     -1      0.1  3      0 0 0 0 0 0 0 # AgeSpline_GradLo
-10   0.01   -0.001 0   -1      0.1  3      0 0 0 0 0 0 0 # AgeSpline_GradHi
1     60    20    0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Knot_1
1     60    29    0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Knot_2
1     60    38    0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Knot_3
1     60    47    0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Knot_4
1     60    56    0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Knot_5
-9    7     -7    0     -1      0    2      0 0 0 0 0 0 0 # AgeSpline_Val_1
-9    7     -1    0     -1      0    2      0 0 0 0 0 0 0 # AgeSpline_Val_2
-9    7     0     0     -1      0    -99    0 0 0 0 0 0 0 # AgeSpline_Val_3
-9    7     0     0     -1      0    2      0 0 0 0 0 0 0 # AgeSpline_Val_4
-9    7     0     0     -1      0    2      0 0 0 0 0 0 0 # AgeSpline_Val_5
#Males as offset
-10   60    45     0    -1      5    -4     0 0 0 0 0 0 0 # Dogleg_location
-10   10    0     0     -1      5    -5     0 0 0 0 0 0 0 # MaleOffsetAtZero
-10   10    0     0     -1      5     5     0 0 0 0 0 0 0 # MaleOffsetAtDogleg (can fix this at 0 to match female selex at peak)
-10   10    0     0     -1      5     5     0 0 0 0 0 0 0 # MaleOffsetAtMaxage
#7 NWFSC_combo
15    55    36    36    -1      5    2      0 0 0 0 0 0 0  #Peak
-5    5     -0.5  -0.5  -1      2    3      0 0 0 0 0 0 0 #Top (width)
-10   10    2     1.75  -1      5    3      0 0 0 0 0 0 0 #ASC_WIDTH
-10   10    2     0.1   -1      2    4      0 0 0 0 0 0 0 #DESC_WIDTH
-20   30    -20  -1     -1      5    -9     0 0 0 0 0 0 0 #INIT (first bin)
-10   10    1     1     -1      5   4       0 0 0 0 0 0 0 #Final (last bin)
#Females as offset
-10   60    40     0    -1      5    -4     0 0 0 0 0 0 0 # Dogleg_location
-10   10    0      0    -1      5    -5     0 0 0 0 0 0 0 # OffsetAtZero
-10   0     0      0    -1      5     5     0 0 0 0 0 0 0 # OffsetAtDogleg (can fix this at 0 to match male selex at peak)
-10   0.1   0      0    -1      5     5     0 0 0 0 0 0 0 # OffsetAtMaxage


1 #_custom block setup (0/1)
#LO HI INIT PRIOR PR_TYPE SD PHASE
#CA blocks
15  55 36 0 -1 99 4   #peak selex, 1910-1980
15  55 36 0 -1 99 4   #peak selex, 1981-1995
15  40 34 0 -1 99 4   #retention inflection 1910-2003
0.1  5  1 0 -1 99 4   #retention slope      1910-2003
0.7  1  1 0 -1 99 4   #retention asymptote  1910-2003
#OR blocks
15  55 36 0 -1 99 4   #peak selex, 1910-1980
15  55 36 0 -1 99 4   #peak selex, 1981-1995
15  40 34 0 -1 99 4   #retention inflection 1910-1988
15  40 34 0 -1 99 4   #retention inflection 1989-2003
0.1  5  1 0 -1 99 4   #retention slope      1910-1988
0.1  5  1 0 -1 99 4   #retention slope      1989-2003
0.5  1  1 0 -1 99 4   #retention asymptote  1910-1988
0.5  1  1 0 -1 99 4   #retention asymptote  1989-2003
#WA blocks
15  55 36 0 -1 99 4   #peak selex, 1910-1980
15  55 36 0 -1 99 4   #peak selex, 1981-1995
15  40 34 0 -1 99 4   #retention inflection 1910-2003
0.1  5  1 0 -1 99 4   #retention slope      1910-2003
0.7  1  1 0 -1 99 4   #retention asymptote  1910-2003
```

```
1 #selparm_adjust_method: 1=standard; 2=logistic trans to keep in base parm bounds

# 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
#CA OR WA AFSCslope Triennial NWFSCslope NWFSCcombo
 0  0  0  0      0     0     0      #Survey SE(log)
 0  0  0  0      0     0     0      #Discard stddev
 0  0  0  0      0     0     0      #Mean bodywt CV
 2  2.5  3  2    1     2     2.5     #Length Comp
 3   2  2  1     1     0.3   0.1     #Age Comp
 1   1  1  1     1     1     1      #Size at age

1 #_maxlambdaphase
1 #_sd_offset

14 # 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
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    1    1   # lgth comps AKslope
4     5     1    1    1   # lgth comps Triennial
4     6     1    0.5  1   # lgth comps NWslope
4     7     1    1    1   # lgth comps NWcombo
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 AKslope
5     5     1    1    1   #commercial age comps Triennial
5     6     1    0.5  1   #commercial age comps NWslope
5     7     1    1    1   #commercial age comps NWcombo


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 E. SS Starter File

#C Dover Sole 2011 assessment: recreate 2005 assessment in SS3 (Allan Hicks, Chantel Wetzel)
dover2011.dat
dover2011.ctl
1 # 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 # Cumulative Report
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
0 # Number of bootstrap datafiles to produce (N-2), 1 means reporduce data, 2 means add expected values
10 # Turn off estimation for parameters entering after this phase
1 # MCMC burn interval
1 # MCMC thin interval
0.0001 # 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
0.00001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
5 # 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 # Fraction (X) for Depletion denominator (e.g. 0.4)
4 # (1-SPR)_reporting: 0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-SPR_Btarget); 4=notrel
1 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)
0 # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt
999 # check value for end of file

Appendix F. SS Forecast File

```
#Dover sole 2011 V3.21f
# 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 # 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
0 #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 0 0
#  0 0 0 0 # after processing
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)
1 # 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 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
-1 # 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:  CA OR WA
#  0 0 0
# max totalcatch by fleet (-1 to have no max) must enter value for each fleet
-1 -1 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
-1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0 0 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 1 allocation groups
#
6 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # 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
#average of last 3 years
#Year     Seas     Fleet     Catch(or_F)
2011      1        1         2900
2011      1        2         7200
2011      1        3         1000
2012      1        1         2900
2012      1        2         7200
2012      1        3         1000
#
999 # verify end of input
```