Status of the darkblotched rockfish resource off the continental U.S. Pacific Coast in 2013

by

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Executive Summary

Stock

Darkblotched rockfish (*Sebastes crameri*) in the Northeast Pacific Ocean occur from the southeastern Bering Sea and Aleutian Islands to near Santa Catalina Island in southern California. This species is most abundant from off British Columbia to Central California. Commercially important concentrations are found from the Canadian border through Northern California. This assessment focuses on the portion of the population that occurs in coastal waters of the western United States, off Washington, Oregon and California, the area bounded by the U.S.-Canada border on the north and U.S.-Mexico border on the south. The population within this area is treated as a single coastwide stock, due to the lack of biological and genetic data supporting the presence of multiple stocks.

Catches

Darkblotched rockfish has always been caught primarily with commercial trawl gear, as part of a complex of slope rockfish, which includes Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*). Catches taken with non-trawl gear over the years comprised less than 2% of the total coastwide domestic catch. This species has not been taken recreationally.

Catch of darkblotched rockfish first became significant in the mid-1940s when balloon trawl nets (efficient in taking rockfish) were introduced, and due to increased demand during World War II. The largest removals of the species occurred in the 1960s, when foreign trawl fleets from the former Soviet Union, Japan, Poland, Bulgaria and East Germany came to the Northeast Pacific Ocean to target large aggregations of Pacific ocean perch, a species that co-occurs with darkblotched rockfish. In 1966 the removals of darkblotched rockfish reached 4,220 metric tons. By the late-1960s, the foreign fleet had more or less abandoned the fishery. Domestic landings of darkblotched rockfish rose again between the late-1970s and the late-1980s, peaking in 1987 with landings of 2,415 metric tons. In 2000, the species was declared overfished, and landings substantially decreased due to management regulations. During the last decade the average landings of darkblotched rockfish made by the domestic trawl fishery was around 120 metric tons. Since the mid-1970s, a small amount of darkblotched rockfish has been also taken as bycatch in the at-sea Pacific hake fishery, with a maximum annual removal of 49 metric tons that occurred in 1995.

In this assessment, removals are divided between two fleets, which include the domestic trawl fishery and bycatch in foreign Pacific ocean perch and at-sea Pacific hake fisheries. Reconstructed removals of darkblotched rockfish bycatch in the Pacific ocean perch and at-sea hake fisheries represent total catch that includes both retained and discarded catch. Discards in the domestic trawl fishery were explicitly modeled in the assessment; total catches were estimated simultaneously with other model parameters and derived quantities of management interest.

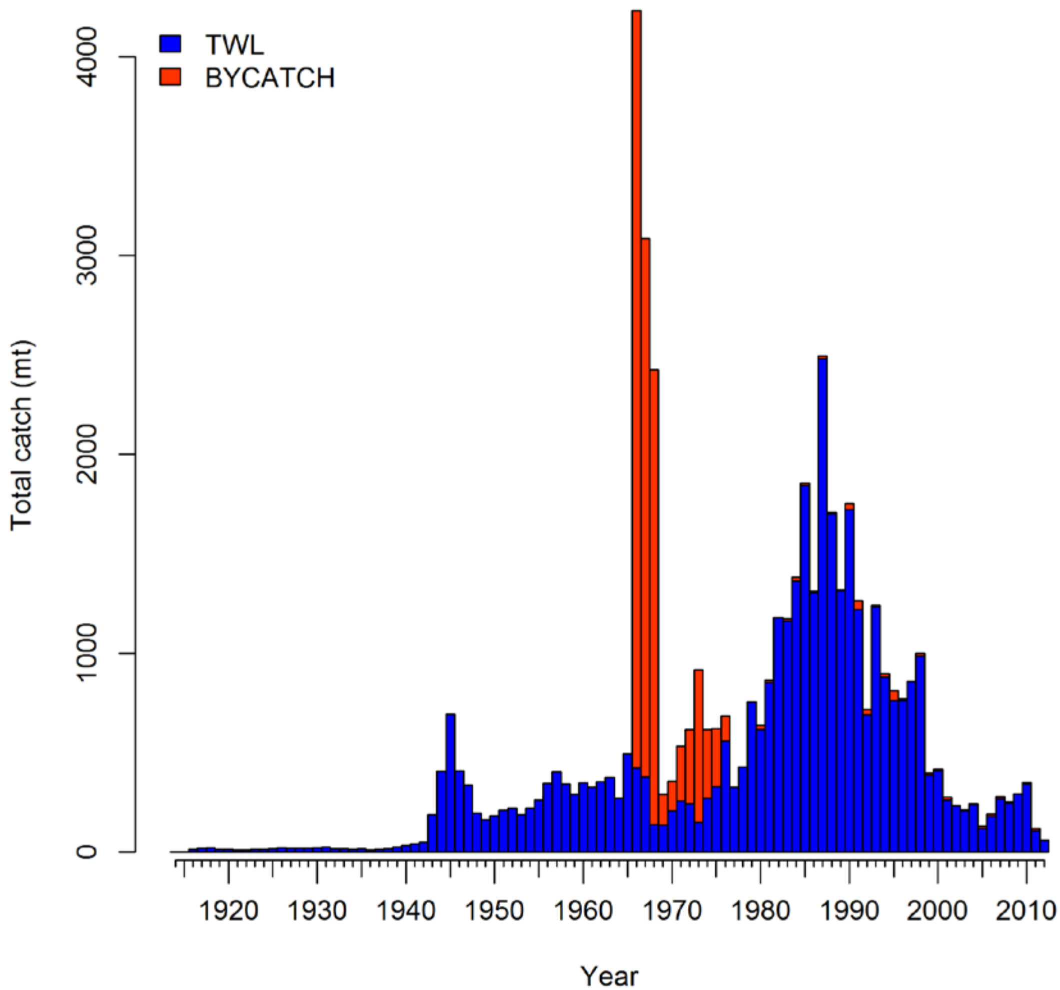

Figure ES-1: Darkblotched rockfish landings history between 1915 and 2012 by fleet (TWL = domestic trawl fleet, BYCATCH = darkblotched rockfish bycatch in Pacific ocean perch and at-sea Pacific hake fisheries).

Table ES-1: Recent darkblotched rockfish landings (mt) by component that comprised two fleets used in the assessment (domestic trawl removals by all three states were combined into TWL fleet and bycatch in foreign POP and at-sea hake fisheries were combined into BYCATCH fleet).

Year	Domestic trawl California	Domestic trawl Oregon	Domestic trawl Washington	Bycatch in foreign POP fishery	Bycatch in at-sea hake fishery	Total
2003	11	62	2	0	4	80
2004	39	136	7	0	7	189
2005	18	68	1	0	11	98
2006	23	71	2	0	11	107
2007	41	87	3	0	12	144
2008	34	74	3	0	6	117
2009	47	89	2	0	0	138
2010	17	152	7	0	8	184
2011	3	87	14	0	12	117
2012	7	70	15	0	2	94

Data and assessment

The last full assessment of darkblotched rockfish was conducted in 2007. The 2007 full assessment was subsequently updated in 2009 and 2011. This assessment uses the Stock Synthesis modeling framework developed by Dr. Richard Methot at the NWFSC. The most recent version (SSv3.24o, distributed on April 10, 2013) was used, since it included improvements in the output statistics for producing assessment results and several corrections to older versions.

The data used in the assessment include landings, length and age compositions from the retained commercial catch and, in recent years, discard ratios, length and age compositions as well as mean individual body weight of the discards. Also, data from four National Marine Fisheries Service (NMFS) bottom trawl surveys are used to estimate indices of relative stock abundance and generate length and age frequency distributions for each survey. The Northwest Fisheries Science Center (NWFSC) shelf-slope survey covers the period between 2003 and 2012 and provides information on the current trend of the stock. Three other surveys (which are discontinued) include the NWFSC slope survey (1999- 2002), the AFSC slope survey (1997-2001), and the AFSC shelf triennial survey (1980-2004).

The modeling period in the assessment begins in 1916, assuming that in 1915 the stock was in an unfished equilibrium condition. Females and males are treated separately to account for sexual dimorphism in growth exhibited by the species. Growth is assumed to follow the von Bertalanffy growth model, and the assessment explicitly estimates most parameters describing growth for both sexes. Externally estimated life history parameters, including those defining the weight-length relationship, female fecundity and maturity schedule, have been revised since the last assessment using the newest data available.

Recruitment dynamics are assumed to follow the Beverton-Holt stock-recruit function. Natural mortality is fixed at the value of 0.05 yr^{-1} for females and estimated for males.

Stock spawning output

The darkblotched rockfish assessment uses a non-proportional egg-to-weight relationship, and the spawning output is reported in the number of eggs. The unexploited level of spawning stock output is estimated to be 3,358 million eggs (95% confidence interval: 2,603-4,114 million eggs). At the beginning of 2013, the spawning stock output is estimated to be 1,214 million eggs (95% confidence interval: 414-2,013 million eggs), which represents 36% of the unfished spawning output level.

The spawning output of darkblotched rockfish started to decline in the 1940s, during World War II, but exhibited a sharp decline in in the 1960s during the time of the intense foreign fishery targeting Pacific ocean perch. Between 1965 and 1975, spawning output dropped from 89% to less than 57% of its unfished level. Spawning output continued to decline throughout the 1980s and 1990s and in 1999 reached its lowest estimated level of 13% of its unfished state. Since 2000, the spawning output has been slowly increasing, which corresponds to decreased removals due to management regulations.

Table ES-2: Recent trends in estimated darkblotched rockfish spawning biomass, recruitment and relative depletion.

Year	Spawning stock output (million eggs)	~95% confidence interval	Estimated recruitment (1000s)	~95% confidence interval	Estimated depletion	~95% confidence interval
2004	583	234-932	3,265	1,180-5,350	17%	9-26%
2005	648	253-1,044	3,004	1,042-4,966	19%	9-29%
2006	738	286-1,189	2,061	650-3,471	22%	11-33%
2007	818	312-1,324	1,434	383-2,486	24%	12-37%
2008	879	325-1,433	6,674	2,159-11,190	26%	12-40%
2009	937	338-1,536	1,216	206-2,226	28%	13-43%
2010	996	349-1,642	1,800	220-3,380	29%	13-46%
2011	1,054	357-1,751	2,858	0-6,154	31%	14-49%
2012	1,131	384-1,879	870	0-2,117	33%	15-53%
2013	1,214	414-2,013	2,254	0-5,691	36%	16-56%

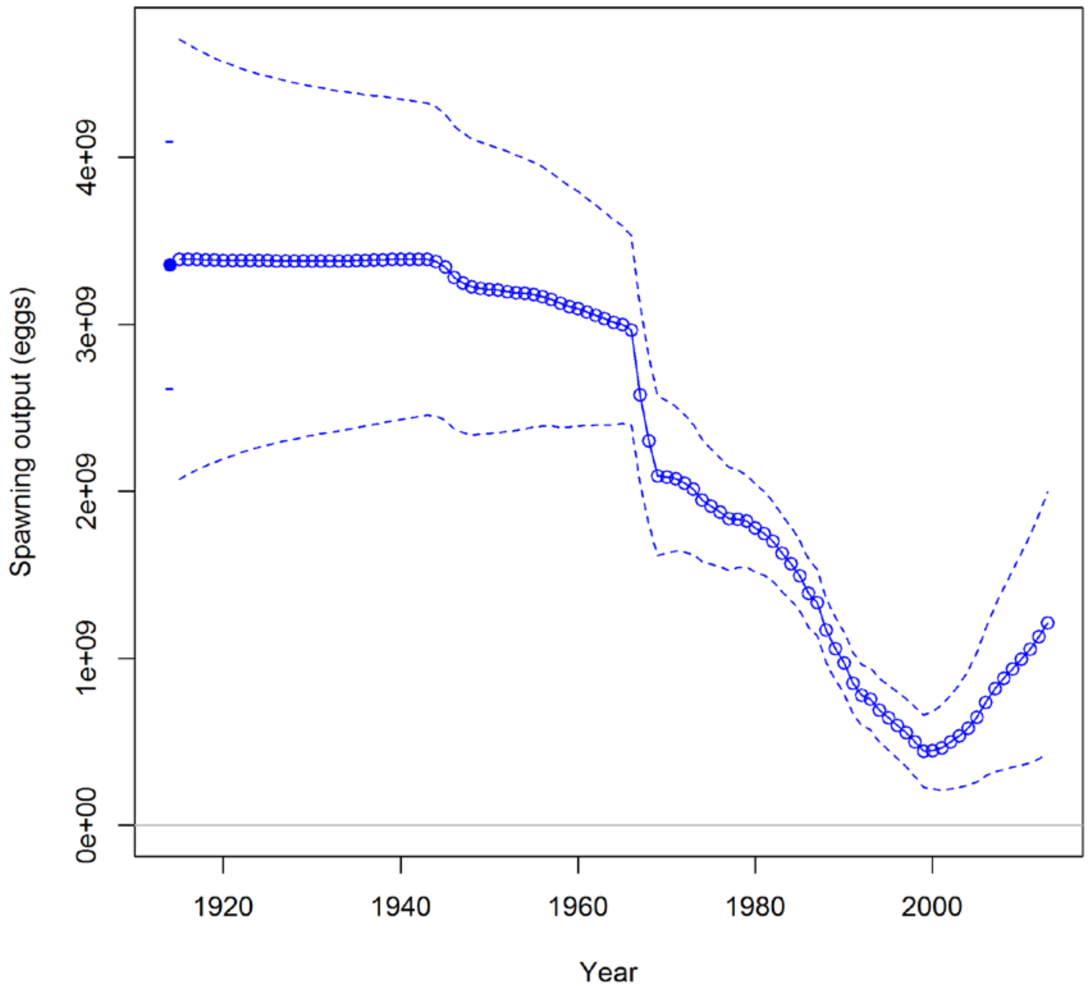

Figure ES-2: Estimated spawning biomass time-series (1915-2013) for the base-case model (circles) with ~ 95% interval (dashed lines).

Recruitment

Recruitment dynamics are assumed to follow a Beverton-Holt stock-recruit function. The level of virgin recruitment is estimated in order to assess the magnitude of the initial stock size. 'Main' recruitment deviations were estimated for modeled years that had information about recruitment, between 1960 and 2011 (as determined from the bias-correction ramp). We additionally estimated 'early' deviations between 1870 and 1959 so that age-structure in the initial modeled year (1915) would deviate from the stable age-structure. The Beverton-Holt steepness parameter (*h*) is fixed in the assessment at the value of 0.779, which is the mean of steepness prior probability distribution, derived from this year's meta-analysis of Tier 1 rockfish assessments.

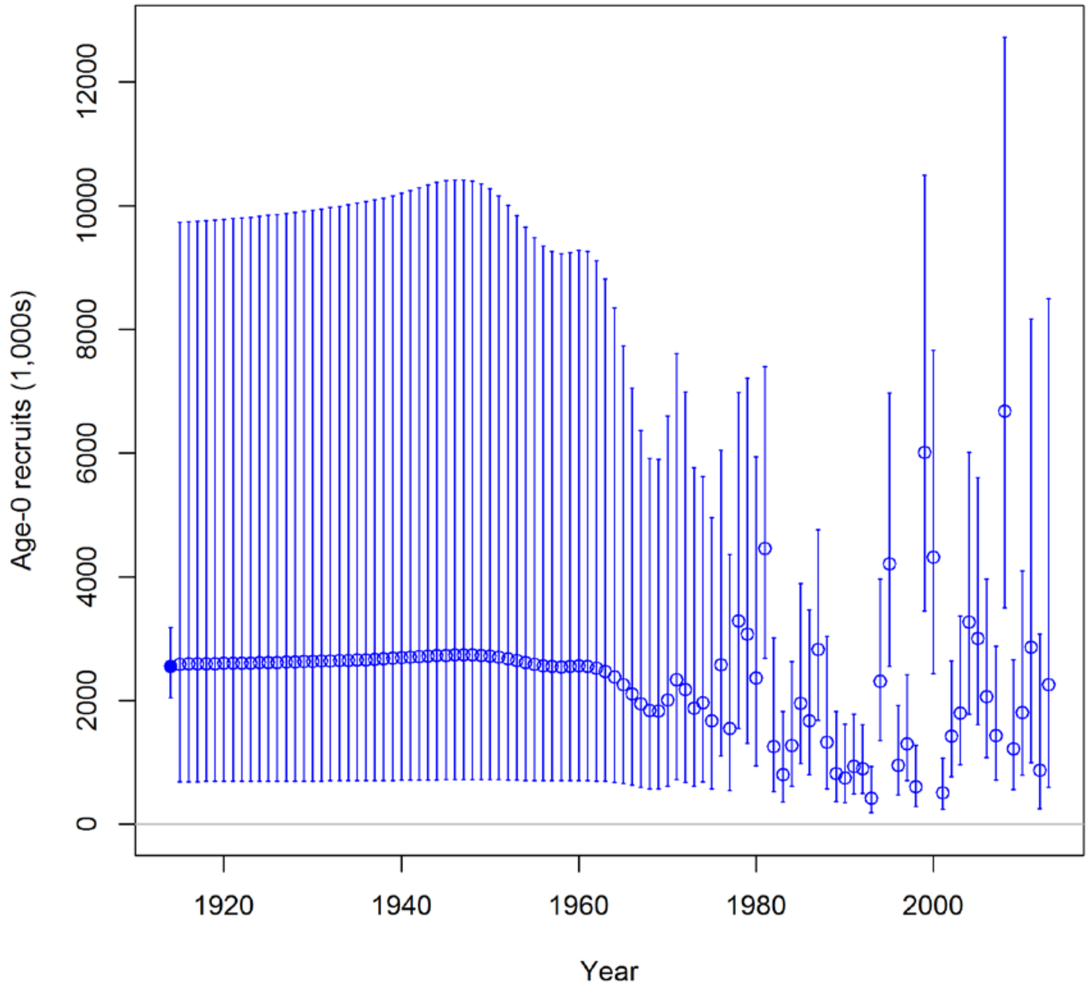

Figure ES-3: Time series of estimated darkblotched rockfish recruitments for the base-case model (solid line) with ~95% intervals (vertical lines).

Reference points

Unfished spawning stock output for darkblotched rockfish was estimated to be 3,358 million eggs (95% confidence interval: 2,603-4,114 million eggs). The stock is declared overfished if the current spawning output is estimated to be below 25% of unfished level. The management target for darkblotched rockfish is defined as 40% of the unfished spawning output ($SB_{40\%}$), which is estimated by the model to be 1,343 million eggs (95% confidence interval: 1,041-1,646), which corresponds to an exploitation rate of 0.0402. This harvest rate provides an equilibrium yield of 675 mt at $SB_{40\%}$ (95% confidence interval: 526-824 mt). The model estimate of maximum sustainable yield (MSY) is 742 mt (95% confidence interval: 578-906 mt). The estimated spawning stock output at MSY is 819 million eggs (95% confidence interval: 635-1,003 million of eggs). The exploitation rate corresponding to the estimated SPR_{MSY} of $F_{30\%}$ is 0.0665.

Table ES-3. Summary of reference points for the base case model.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning output (million eggs)	3,358	2,603-4,114
Unfished age 1+ biomass (mt)	36,171	28,181-44,161
Unfished recruitment (R0)	2,549	1,970-3,127
Depletion (2013)	36%	16-56%
Reference points based on $SB_{XX\%}$		
Proxy spawning output ($B_{40\%}$)(million eggs)	1,343	1,041-1,646
SPR resulting in $B40_{\%}$ ($SPR_{40\%}$)	44%	NA
Exploitation rate resulting in $B_{40\%}$	4.02%	3.96-4.08%
Yield with $SPR50_{\%}$ at $B_{40\%}$ (mt)	675	526-824
Reference points based on SPR proxy for MSY		
Spawning output (million eggs)	1,550	1,201-1,899
SPR_{proxy}	50%	NA
Exploitation rate corresponding to SPR_{proxy}	3.3%	3.25-3.35%
Yield with SPR_{proxy} at SB_{SPR} (mt)	625	487-763
Reference points based on estimated MSY values		
Spawning output at *MSY* (SB_{MSY}) (million eggs)	819	635-1,003
SPR_{MSY}	30%	29.38-30.13%
Exploitation rate corresponding to SPR_{MSY}	6.65%	6.47-6.83%
MSY (mt)	742	578-906

Exploitation status

The assessment shows that the stock of darkblotched rockfish off the continental U.S. Pacific Coast is currently at 36% of its unexploited level. This is above the overfished threshold of $SB_{25\%}$, but below the management target of $SB_{40\%}$ of unfished spawning biomass. Historically, the spawning output of darkblotched rockfish dropped below the $SB_{40\%}$ target for the first time in 1987, as a result of intense fishing by foreign and domestic fleets. It continued to decline and reached the level of 13% of its unfished output in 1999. Since 2000, when the stock was declared overfished, the spawning output was slowly increasing primarily due to management regulations instituted for the species.

This assessment estimates that the 2012 SPR is 86%, while the SPR-based management fishing mortality target is 50%. For the last 10 years, the relative SPR ratio (calculated as 1-SPR/1-$SPR_{Target=0.50}$) was below one, which means that overfishing of darkblotched rockfish has not been occurring. Historically, the darkblotched rockfish has been fished beyond the SPR-based target between 1966 and 1968, during the peak years of the Pacific ocean perch fishery and for a prolonged period between from 1981 and 2002. In the early-1970s the estimated darkblotched rockfish SPR ratio remained near the SPR target but exceeded it in 1973 and 1979.

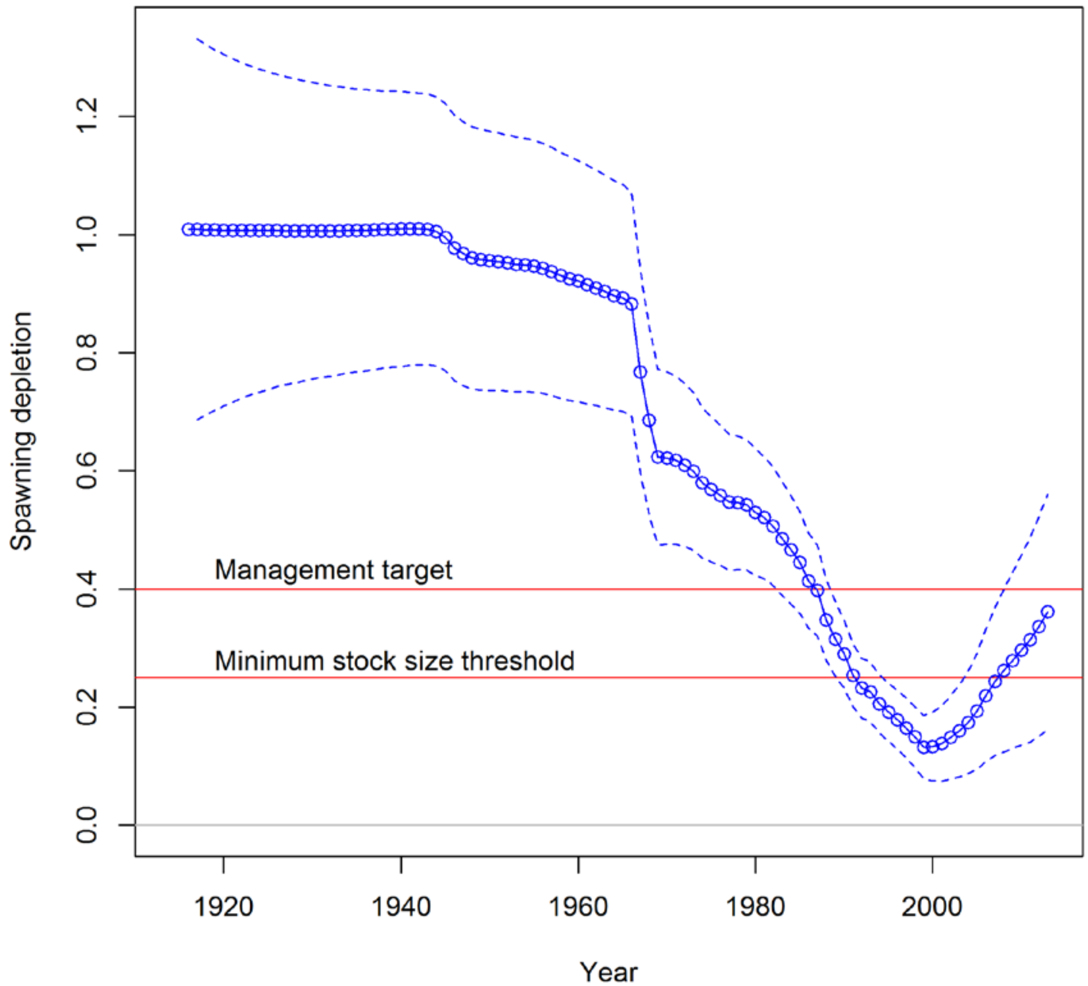

Figure ES-4. Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model.

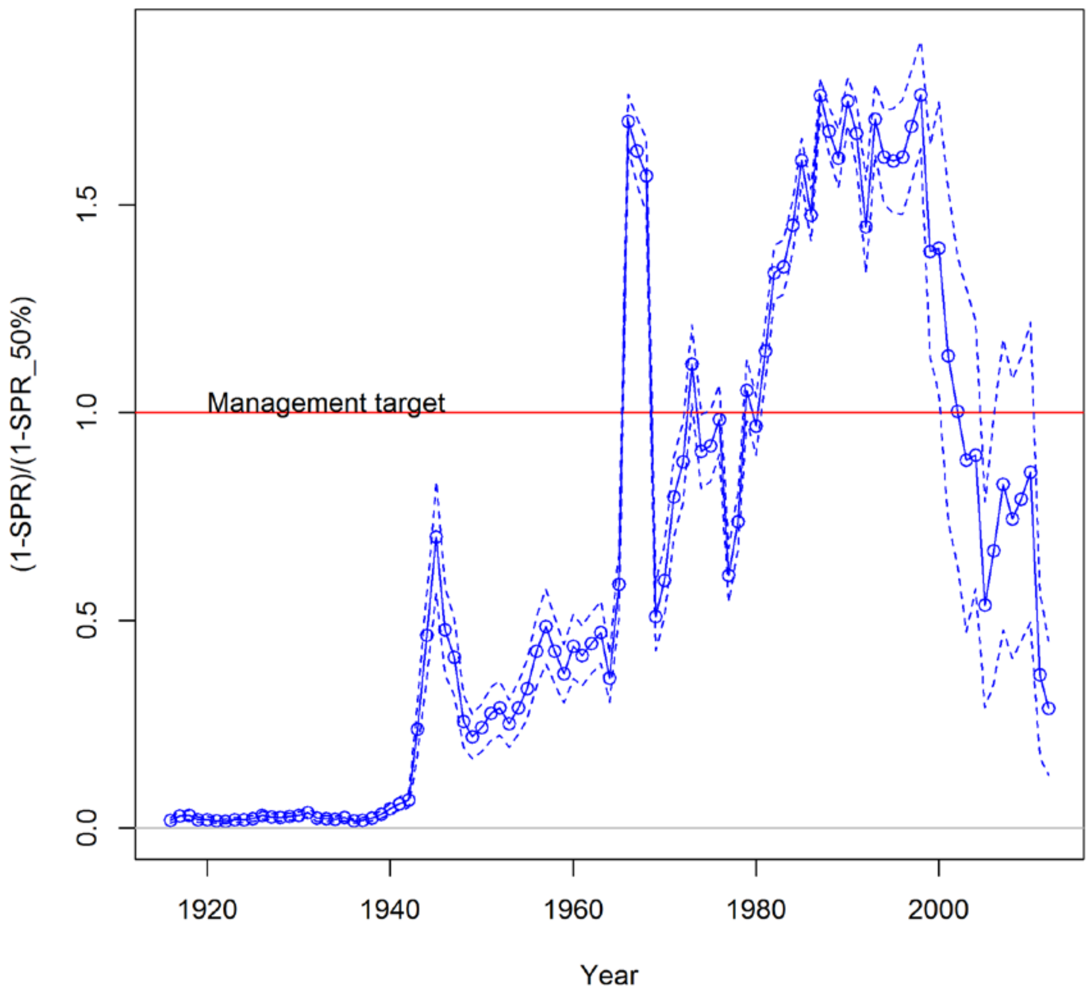

Figure ES-5. Time series of estimated relative spawning potential ratio (1-SPR/1-$SPR_{Target=0.50}$) for the base-case model (round points) with ~95% intervals (dashed lines). Values of relative SPR above 1.0 (100% in the table above) reflect harvests in excess of the current overfishing proxy.

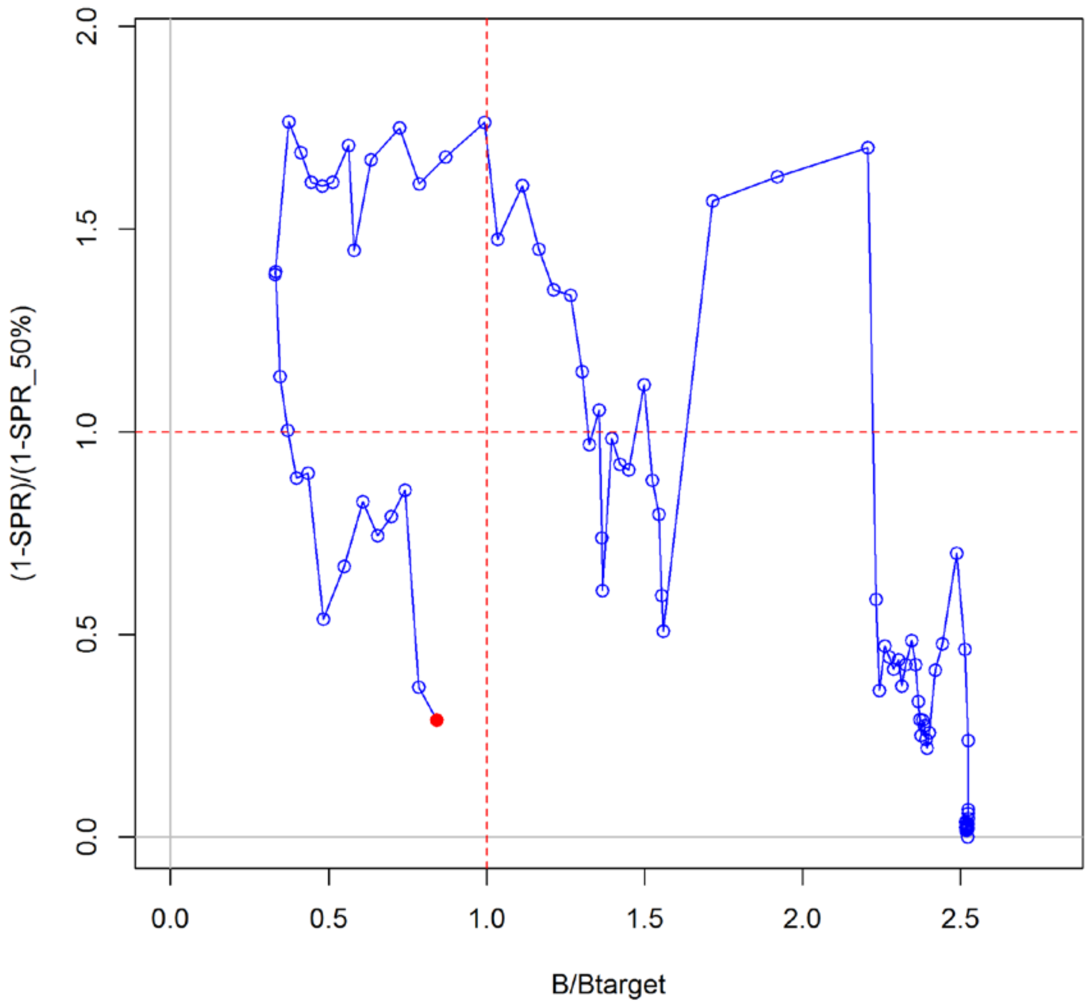

Figure ES-6. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 0.5 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 40% of the unfished spawning biomass. The red point indicates the year 2012.

Table ES-4. Recent trend in spawning potential ratio (SPR) and harvest rate.

Year	SPR (%)	Harvest rate (proportion)	~95% confidence interval
2003	56%	0.025	0.006-0.044
2004	55%	0.026	0.011-0.042
2005	73%	0.013	0.005-0.021
2006	67%	0.017	0.006-0.029
2007	59%	0.024	0.008-0.040
2008	63%	0.020	0.007-0.034
2009	60%	0.022	0.008-0.037
2010	57%	0.025	0.008-0.042
2011	82%	0.008	0.003-0.013
2012	86%	0.006	0.002-0.010

Ecosystem considerations

Darkblotched rockfish is most abundant from off British Columbia to Central California. This is a slope species that occurs at depths between 25 and 600 m, which majority of fish inhabiting at depths between 100 and 400 meters. Darkblotched rockfish co-occurs with an assemblage of slope rockfish, including Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*). Pacific ocean perch and darkblotched rockfish are the most abundant members of that assemblage off the coasts of Oregon and Washington, but splitnose rockfish and darkblotched rockfish dominate off the northern coast of California. Adults typically are observed resting on mud near cobble or boulders. They feed primarily on large planktonic organisms such as krill, gammarid amphipods, copepods and salps, and less frequently on fishes and octopi. Young darkblotched are eaten by king salmon and albacore.

In this assessment, ecosystem considerations were not explicitly included in the analysis. This is primarily due to lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment.

Management performance

Darkblotched rockfish have historically been managed with bimonthly cumulative landings limit (a.k.a. “trip limits”) as most of the catch came from the limited entry bottom trawl fishery. However, for the last two years, that allocation has been managed as a catch share fishery, using Individual Fishing Quotas (IFQ), where each permit holder has an annual quota. Darkblotched rockfish has had species-specific management guidelines since 2001. For the last 10 years, the total dead catch (as estimated in this assessment) exceeded the Annual Catch Limit (ACL) in 2003, 2004, 2009 and 2010. The total dead catch also exceeded the Overfishing Limit (OFL) in 2003 and 2004, but only by 4% and 2% respectively. Overall, total dead catch of darkblotched rockfish for the last decade has been only 57% of the sum of the OFLs and 81% of the ACLs.

Table ES-5. Recent trend in total catch and commercial landings (mt) relative to the management guidelines. Estimated total catch consists of commercial landings, plus the model-estimated discarded biomass.

Year	OFL (mt)	ACL (mt)	Commercial Landings (mt)	Estimated Total Catch (mt)
2003	205	172	80	212
2004	240	240	189	243
2005	269	269	98	129
2006	294	200	107	190
2007	456	290	144	279
2008	487	330	117	252
2009	437	285	138	293
2010	440	291	184	350
2011	508	298	117	120
2012	497	296	94	96

Unresolved problems and major uncertainties

Uncertainty in the model was explored though asymptotic variance and sensitivity analyses. Asymptotic confidence intervals were estimated within the model and reported throughout the assessment for key model parameters and management quantities. To explore uncertainty associated with alternative model configurations and evaluate the responsiveness of model outputs to changes in key model assumptions, a variety of sensitivity runs were performed, including increase and decrease of fishery removals, runs with different assumptions regarding life-history parameters, shape of selectivity curves, stock-recruitment parameters, and many others. The uncertainty regarding natural mortality, stock-recruit steepness and unfished recruitment level was also explored through likelihood profile analysis. Also, a retrospective analysis was conducted where the model was re-run after removing data from recent years.

A major source of uncertainty is related to main life history parameters, such as natural mortality and stock-recruit curve steepness. These quantities, which the model is unable to estimate reliably, are essential for understanding the dynamics of the stock. In the model, female natural mortality is fixed at the value estimated outside the model using other life history characteristics of the species, while male natural mortality is estimated within the model. Stock-recruit steepness is fixed at the value estimated outside the model using meta-analysis of species with similar life history characteristics.

Darkblotched rockfish age estimates, particularly from the early time period, have been a source of uncertainty since 2005. Since the 2005 assessment, and prior to this assessment, no age data generated prior to 2004 have been used due to concerns that criteria for estimating ages of darkblotched rockfish might have changed and that a bias may have existed in early age estimates compared to those made during and after 2004. In this assessment, instead of removing these data a prior, we conducted an ageing error analysis to compare recent estimates of darkblotched ages with those conducted prior to 2004. This analysis generated little evidence for ageing bias prior to 2004. We found, however, that a relatively wide aging error exists for the age data, and that imprecision in early age estimates is larger than in recent ones. Our analysis confirmed that it is extremely challenging to estimate ages reliably for long-lived rockfish species, such as darkblotched rockfish, and uncertainty associated with age estimates continue to be an issue.

Historically, darkblotched rockfish landings have not been sampled at the discrete species level; therefore, time series of catch remained a source of uncertainty. Although significant progress has been made in reconstructing historical California and Oregon landings, the lack of early species composition data does not allow to account for a gradual shift of fishing effort towards deeper areas, which can cause the potential to overestimate the historical contribution of slope species (including darkblotched rockfish) to overall landings of the mixed-species market category (i.e. “unspecified rockfish”). Also, it is known that the domestic trawl fishery has discarded a portion of the catch at sea. Previous to 2002, when the West Coast Groundfish Observer Program was established, only one study exists (limited in time and space) that informs pre-2002 discarding practices of darkblotched rockfish.

Decision table

The base model estimate for 2013 spawning depletion is 36%. The primary axis of uncertainty about this estimate used in the decision table was based on female natural mortality. Alternative states of nature were characterized using both the likelihood profile and the prior distribution for female natural mortality. The choice to use both sources of information for this fixed parameter was motivated by the observation that the data showed strong evidence against extremely low values of natural mortality, but was relatively flat for large values. In the absence of a fully integrated posterior distribution, the prior distribution based on maximum age was used as a proxy for the upper end of the range. The low and high states of nature for the decision table were therefore based on female natural mortality values of 0.036 and 0.082, both approximately half as likely as the value used in the base model (0.05). The lower value of natural mortality corresponded to a depletion estimate of 18%, while the higher value corresponded to 82%, illustrating the marked sensitivity of the assessment results to a poorly informed parameter.

Twelve-year forecasts for each state of nature were calculated based on removals at current rebuilding SPR of 64.9% for the base model. Twelve-year forecasts were also calculated based on removals at an SPR of 71.9% for the base model, as requested by the Groundfish Management Team (GMT). This lower catch stream that corresponds to SPR 71.9% was used in the Decision Table of the 2011 darkblotched assessment. Finally, twelve-year forecasts for each state of nature were produced with future catches fixed at the 2014 ACL set for darkblotched rockfish.

Under the middle state of nature (which corresponds to the base model), the spawning output and depletion are projected to increase under all three considered catch streams, and reach the $SB_{40\%}$ target in 2015. Under the low state of nature, spawning output and depletion are also projected to increase under all three catch streams considered, but will stay below the $SB_{40\%}$ target within the next 12 years. Under the middle state of nature, the spawning output remains above the 40% target level throughout the 12-year projection period.

Research and data needs

The following research could improve the ability of future stock assessments to determine the current status and productivity of the darkblotched rockfish population:

1) The base model does not use commercial age composition data for years that lacked coast wide samples. The additional age data could provide information necessary for the model to estimate such parameters as natural mortality. Future research could ascertain whether additional otoliths exist for these years, and whether they could be aged using current ageing methods. Also, alternative fleet structures (with state specific fisheries) could be explored to take use of as much available age data as possible.

2) The base model uses newly available information of female maturity collected within the NWFSC shelf-slope survey. This new information includes data on mass atresia (a form of skipped spawning), not previously available for the assessment. At present, Stock Synthesis allows incorporation of this information only when maturity is expressed as a function of age. Effort should be devoted to expand maturity options in Stock Synthesis to allow expression of maturity information (with mass atresia) as a function of female length. Also, continued collection of maturity samples would allow future researchers to explore differences in maturity at age, either spatially or over time.

3) Additional research would be important to explore whether other life history parameters, such as growth and fecundity vary spatially or change over time as well. This information will help in defining spatial structure of future models.

4) Given that the population range extends north to the border with Canada, it is important that future research would evaluate the impact of not accounting for any Canadian portion of population abundance. Such an analysis would require evaluation of movement of darkblotched along the coast, which information is currently lacking.

5) Future research could also improve existing meta-analyses for natural mortality and steepness, which both contribute to the implied yield curve. Directions for improvements include (1) explaining variability between methods in natural mortality estimates, included in the Hamel natural mortality method and (2) developing a larger database of species for estimating steepness, perhaps by including species from other regions, e.g., Canada and Alaska.

6) Imprecision in the indices of abundance derived from survey sampling, due a low probability the species occurrence, is one of the sources of uncertainty in this

assessment. Future research could explore the utility of model-based index standardization techniques; in particular, those using spatial modeling approaches. Spatial models could potentially account for the component of sampling variance arising from the random allocation of sampling tows either in or outside of suitable habitat. Such models could potentially decrease residual variance and imprecision of the resultant indices of abundance.

7) Finally, we note that Markov chain Monte Carlo sampling using the Metropolis algorithm was unable to obtain a sufficient number of independent samples within a feasible time period. However, it had trouble primarily with a single parameter (variance inflation for a survey index). We therefore recommend to improve MCMC options in ADMB, perhaps by making necessary changes to the Hamiltonian MCMC option (i.e., by allowing samples to be thinned during running, and hence making longer MCMC chains feasible for the ADMB implementation of Hamiltonian sampling).

Table ES-6. Summary table of 12-year projections beginning in 2015 for alternate states of nature based on female natural mortality. Columns range over low, mid, and high state of nature, and rows range over different assumptions of catch levels.

			State of nature					
			Low *Female M=0.036*		Base case Female M=0.05		High *Female M=0.082*	
Management decision	Year	Catch (mt)	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion
Catch calculated using SPR of 71.9% applied to the base model	2013	223	607	18%	1,214	36%	3,606	82%
	2014	240	648	19%	1,294	39%	3,770	85%
	2015	252	688	20%	1,374	41%	3,922	89%
	2016	260	722	21%	1,441	43%	4,032	91%
	2017	266	751	22%	1,496	45%	4,101	93%
	2018	271	776	23%	1,541	46%	4,135	94%
	2019	276	798	23%	1,578	47%	4,147	94%
	2020	280	821	24%	1,613	48%	4,150	94%
	2021	285	844	25%	1,646	49%	4,149	94%
	2022	289	867	25%	1,678	50%	4,146	94%
	2023	293	891	26%	1,709	51%	4,140	94%
	2024	297	915	27%	1,739	52%	4,133	94%
Catch calculated using current rebuilding SPR of 64.9% applied to the base model	2013	302	607	18%	1,214	36%	3,606	82%
	2014	323	641	19%	1,288	38%	3,764	85%
	2015	339	674	20%	1,360	41%	3,909	88%
	2016	347	701	20%	1,420	42%	4,011	91%
	2017	353	722	21%	1,467	44%	4,073	92%
	2018	358	738	21%	1,504	45%	4,101	93%
	2019	363	752	22%	1,533	46%	4,106	93%
	2020	368	766	22%	1,560	46%	4,102	93%
	2021	372	780	23%	1,586	47%	4,096	93%
	2022	377	796	23%	1,611	48%	4,087	93%
	2023	381	811	24%	1,635	49%	4,076	92%
	2024	385	826	24%	1,657	49%	4,064	92%
2014 ACL catch assumed for years between 2015 and 2024	2013	317	607	18%	1,214	36%	3,606	82%
	2014	330	640	19%	1,287	38%	3,762	85%
	2015	330	672	20%	1,358	40%	3,907	88%
	2016	330	699	20%	1,418	42%	4,010	91%
	2017	330	722	21%	1,467	44%	4,073	92%
	2018	330	740	22%	1,506	45%	4,103	93%
	2019	330	756	22%	1,538	46%	4,111	93%
	2020	330	773	23%	1,567	47%	4,110	93%
	2021	330	791	23%	1,597	48%	4,106	93%
	2022	330	811	24%	1,626	48%	4,101	93%
	2023	330	830	24%	1,654	49%	4,094	93%
	2024	330	850	25%	1,681	50%	4,085	92%

Table ES-7. Summary of recent trends in estimated darkblotched rockfish exploitation and stock level from the assessment model.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Commercial landings (mt)	80	189	98	107	144	117	138	184	117	94	NA
Estimated Total catch (mt)	212	243	129	190	279	252	293	350	120	96	NA
OFL (mt)	205	240	269	294	456	487	437	440	508	497	541
ACL (mt)	172	240	269	200	290	330	285	291	298	296	317
SPR	56%	55%	73%	67%	59%	63%	60%	57%	82%	86%	NA
Exploitation rate (catch/ age 1+ biomass)	0.025	0.026	0.013	0.017	0.024	0.020	0.022	0.025	0.008	0.006	NA
Age 1+ biomass (mt)	8,477	9,301	10,061	10,924	11,739	12,453	13,211	13,977	14,732	15,691	16,610
Spawning output (million eggs)	536	583	648	738	818	879	937	996	1,054	1,131	1,214
~95% Confidence Interval	220-851	234-932	253-1044	286-1189	312-1324	325-1433	338-1536	349-1642	357-1751	384-1879	414-2013
Recruitment	1,797	3,265	3,004	2,061	1,434	6,674	1,216	1,800	2,858	870	2,254
~95% Confidence Interval	617-2,977	1,180-5,350	1,042-4,966	650-3,471	383-2,486	2,159-11,190	206-2,226	220-3,380	0-6,154	0-2,117	0-5,691
Depletion (%)	16%	17%	19%	22%	24%	26%	28%	29%	31%	33%	36%
~95% Confidence Interval	8-24%	9-26%	9-29%	11-33%	12-37%	12-40%	13-43%	13-46%	14-49%	15-53%	16-56%

Table ES-8. Projection of potential OFL, ABC, estimated summary biomass (age-1 and older), spawning output, and depletion for the assessment model based on the 40:10 correction to the $F_{50\%}$ overfishing limit/target. The OFL and ABC values for 2013 and 2014 have been adopted by the Council based on the previous assessment, and are not based on the results of this assessment. Projections assume total catch of 317 and 330 mt (the Council's adopted ACLs) for 2013 and 2014, respectively.

Year	Predicted OFL (mt)	ABC (mt)	Summary biomass (mt)	Spawning output (million eggs)	Depletion (%)
2013	*541*	*517*	16,610	1,214	36%
2014	*553*	*529*	17,219	1,287	38%
2015	574	563	17,712	1,358	40%
2016	580	570	17,894	1,399	42%
2017	583	573	18,017	1,427	42%
2018	585	574	18,103	1,444	43%
2019	586	575	18,172	1,454	43%
2020	587	576	18,230	1,462	44%
2021	588	578	18,285	1,469	44%
2022	590	579	18,336	1,477	44%
2023	591	581	18,387	1,483	44%
2024	593	582	18,437	1,490	44%

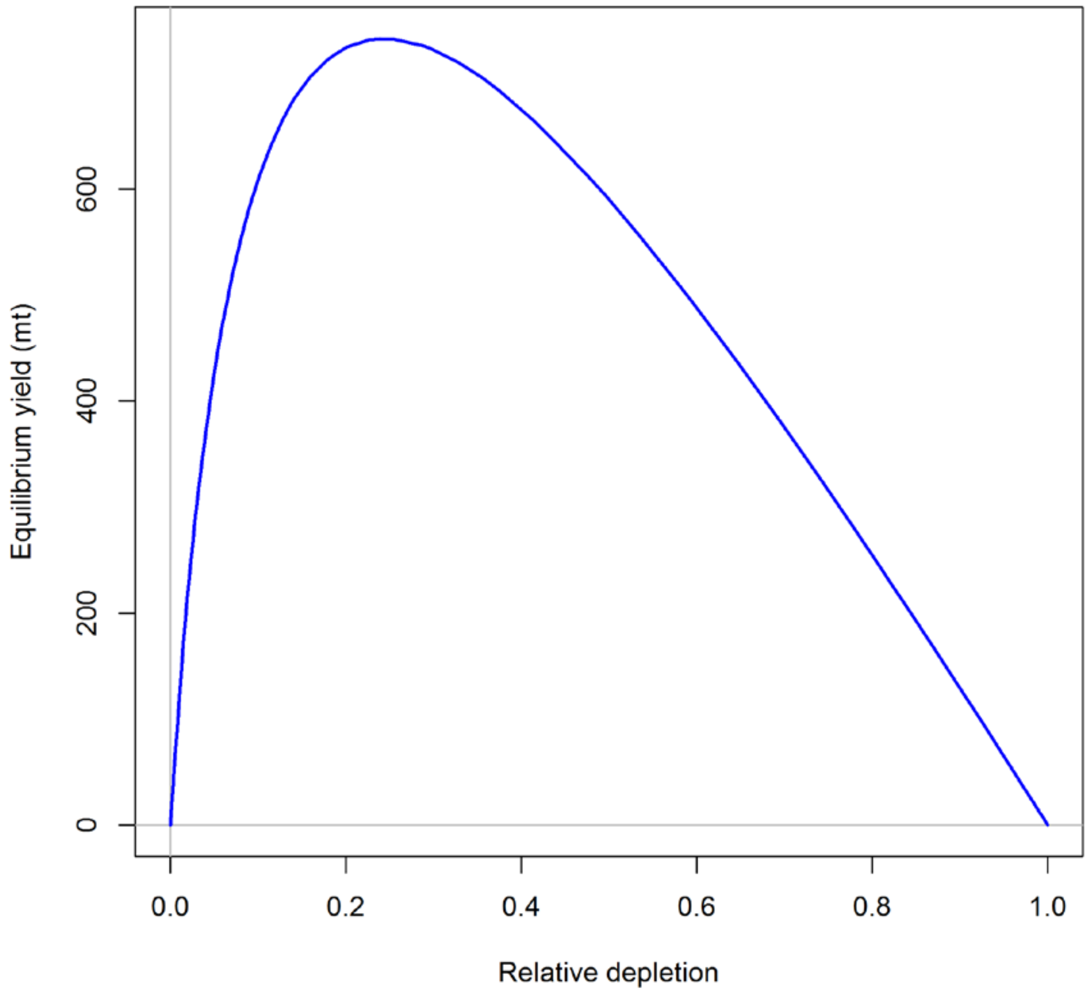

Figure ES-7. Equilibrium yield curve (derived from reference point values reported in Table ES-5) for the base case model. Values are based on 2012 fishery selectivity and distribution with steepness fixed at 0.779. The depletion is relative to unfished spawning biomass.

1 Introduction

1.1 Basic Information

Darkblotched rockfish (*Sebastes crameri*) are found in the Northeast Pacific Ocean from the southeastern Bering Sea and Aleutian Islands to near Santa Catalina Island in southern California. This species is most abundant from off British Columbia to Central California. Darkblotched rockfish occur at depths between 25 m and 900 m (Love et al., 2002), with the majority of fish inhabiting depths between 100 m and 600 m. Commercially important concentrations are found from the Canadian border through Northern California, on or near the bottom, at depths between 183 m and 366 m.

There are no clear stock delineations for darkblotched rockfish in the waters of the United States. There are no distinct breaks in the fishery landings and catch distributions (Figure 1). Survey catches exhibit a continuous distribution of fish over most of the species range (Figure 2), with areas of higher abundance present in the Columbia, Eureka and Monterey International North Pacific Fisheries Commission (INPFC) areas.

Microsatellite analyses of spatial genetic structure in darkblotched rockfish (Gomez-Uchida and Banks, 2005) suggested a possibility of genetic changes in the stock along the coast, but the level of genetic differentiation was found to be small and no distinct breaks in the stock were identified. Analysis of darkblotched rockfish length at age data collected within the NMFS Northwest Fisheries Science Center shelf-slope survey indicated a gradual cline in growth parameters, with growth coefficient decreasing with higher latitude, but again no district growth morphs and clear boundaries between them were identified.

For the purpose of this assessment, the species is treated as a single stock from the U.S.-Canadian border in the north to the U.S.-Mexican border in the south, due to the lack of biological and genetic data supporting the presence of multiple stocks. A map depicting the spatial scope of the assessment is shown in Figure 3.

1.2 Life History

Darkblotched rockfish are among the longer living rockfish; the data used in this assessment includes individuals that have been aged to be 98 years old. In the literature, the maximum darkblotched rockfish age is reported to be 105 years (Love et al., 2002). As with many other *Sebastes* species, darkblotched rockfish exhibit sexually dimorphic growth; females reach larger sizes than males, while males attain maximum length earlier than females (Love et al., 2002; Nichol, 1990; Rogers et al., 2000).

There are indications that darkblotched rockfish life history parameters, particularly those related growth, might be varying with latitude. Analysis conducted within this assessment detected continues gradient along the coast in growth parameters, which is common for *Sebastes* species on the West Coast of the United States, but did not identify specific areas with different growth. It was also suggested that maturity schedule of darkblotched rockfish may vary with latitude. Maturity parameters of fish collected in waters off California (Echeverria, 1987; Phillips, 1964) were found to be smaller than those of fish collected off Oregon (Nichol, 1990). However, Nichol (1990) argued that these differences are rather attributed to different criteria used to determine maturity in two studies. Also, Westrheim (1975) determined that the size at 50% maturity for darkblotched rockfish decreased, rather than increased, with increasing latitude from Oregon to Alaska. Size-at-age parameters reported in literature also vary widely. For instance, substantially smaller size-at-age was estimated for darkblotched rockfish off British Columbia, Canada, than for fish off Oregon (Hamel, 2008).

Darkblotched rockfish mate from August to December, eggs are fertilized from October through March, and larvae are released from November through April (Love et al., 2002). Fecundity increases with fish size, and all larvae released in one batch. Older larvae and pelagic juvenile darkblotched rockfish are found closer to the surface than many other rockfish species. Pelagic juvenile settle at 4 to 6 cm in length in about 55 to 200 m (Love et al., 2002). As many other *Sebastes*, this species exhibits ontogenetic movement, with fish migrating to deeper waters as they mature and increase in size and age (Lenarz, 1993; Nichol, 1990).

1.3 Ecosystem Considerations

In this assessment, ecosystem considerations were not explicitly included in the analysis. This is primarily due to lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment. Here, we briefly overview habitat preferences of the species and its ecosystem role and trophic relationships.

Darkblotched rockfish is a slope species. This species co-occurs with an assemblage of slope rockfish, including Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*) (Rogers and Pikitch, 1992; Rogers, 1994). Pacific ocean perch and darkblotched rockfish are the most abundant members of that assemblage off the coasts of Oregon and Washington, but splitnose rockfish and darkblotched rockfish dominate off the northern coast of California.

Adults typically are observed resting on mud near cobble or boulders (Love et al., 2002). Demersal juveniles are often found perched on the highest bit of structure in the benthic habitat. Juveniles occasionally are seen around the bottoms of deepwater oil platforms. Darkblotched rockfish feed primarily in midwater on large planktonic organisms such as krill, gammarid amphipods, copepods and salps. Occasionally, darkblotched rockfish take fishes and octopi. Young darkblotched are eaten by king salmon and albacore (Love et al., 2002).

1.4 Fishery Information and Summary of Management History

Darkblotched rockfish has always been caught primarily with commercial trawl gear, as part of a complex of slope rockfish, which includes Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*) (Rogers and Pikitch, 1992; Rogers, 1994). Over the years, catches with non-trawl gear comprised less than 2% of the total coastwide domestic catch (Figure 4). This species has not been taken recreationally as evident from RecFIN (www.recfin.com), a regional source of recreational data managed by the Pacific States Marine Fisheries Commission (PSMFC).

The rockfish fishery off the U.S. Pacific coast first developed off California in the late 19th century. At that time, most rockfish were taken by hook and line, with a minor amount taken by gillnets (Love et al., 2002). Until the 1940s, catches of rockfish were very small because almost all fishing efforts were directed toward the various salmon species and Pacific halibut.

The rockfish fishery was established in the early 1940s, when the United States became involved in World War II and wartime shortage of red meat created an increased demand for other sources of protein (Alverson et al., 1964; Harry and Morgan, 1961). Also, in 1943, the new balloon trawls were introduced. These balloon trawls were lighter than the old paranzellas and otter trawl nets. They were built to fish over low-lying rocky reefs and proved to be successful in taking rockfish (Love et al., 2002). With this new technology and increased demands during the World War II, the catch of rockfish increased in the mid-1940s. The increased demand caused the fishery to shift toward previously unexploited areas, including those preferred by darkblotched rockfish. The California fishery moved north, to the Eureka INPFC area; and both the California and Oregon fisheries had moved deeper into the slope area, those greater than 100 fm (183 m) (Harry and Morgan, 1961; Scofield, 1948) . This is when darkblotched rockfish catch first became significant (Figure 5).

Domestic demand for rockfish declined after World War II and rockfish catches dropped (Cleaver, 1951), but in the early 1950s, the Pacific ocean perch fishery developed in Oregon and Washington (Love et al., 2002), and landings of darkblotched rockfish, which co-occur with Pacific ocean perch, also increased. Prior to 1965, Pacific ocean perch and species incidentally caught in the Pacific ocean perch fishery off of the U. S. West Coast were harvested almost entirely by U. S. and Canadian vessels. Most of these vessels were of multi-purpose design and used in other fisheries, such as salmon and herring, when not engaged in the groundfish fishery. Generally under 200 gross tons and less than 33 m in length, these vessels had very little at-sea processing capabilities. These characteristics, for the most part, restricted the distance these vessels could fish from home ports, and limited the size of their landings.

In the mid-1960s, foreign trawl fleets from the former Soviet Union, Japan, Poland, Bulgaria and East Germany came to the Northeast Pacific Ocean to target large aggregations of Pacific ocean perch over high-relief rocky outcrops (Love et al., 2002). Using very large vessels (often called factory trawlers), foreign fleets, particularly the Soviet, had the capacity to operate independently, by processing and freezing their own catch. Support vessels, such as refrigerated transports, oil tankers, and supply ships permitted these large stern trawlers to operate at sea for extended periods of time. Foreign fleets were known not to discard fish (Rogers, 2003).

Foreign catch was particularly significant between 1966 and 1968 (Figure 5). Within a short period of time, catches of Pacific ocean perch and rockfish co-occurring with Pacific ocean perch (including darkblotched rockfish) skyrocketed. However, regulations increasingly reduced catch of slope rockfish by foreign fleets. Catches declined rapidly, and the fishery proceeded with more moderate landings (Figure 5). By the late-1960s, the Soviet fleet had more or less abandoned the fishery, although the Japanese fleet continued fishing for some time. In 1976, on-bottom trawling by foreign fleets was prohibited, and the depleted Pacific ocean perch fishery became largely domestic (Love et al., 2002).

A very small amount of darkblotched rockfish has also been taken as bycatch in the at-sea Pacific hake fishery (Figure 5). The at-sea Pacific hake fishery dates back to 1960s when foreign vessels participated. In the 1980s, the fishery evolved into a joint venture with U.S. catcher vessels delivering to foreign processing vessels. By 1991, foreign vessels were no longer allowed to fish in U.S. waters, the pacific hake fishery became completely domesticated, allowing only U.S. vessels to catch and process fish.

After the Pacific ocean perch fishery ended, domestic landings of rockfish rose again from the late-1970s. The fishery targeting slope rockfish at that time operated primarily between 244 m-515 m (134 fm and 282 fm) and used bottom trawl gear utilizing rollers (roller gear) with 3.5 inch cod end mesh, which is smaller than the mesh size used in the mid-1970s (Rogers, 2005). In 1992 and 1995, minimum codend mesh size changed again, increasing from 3 to 4.5 inches through regulatory changes (Appendix 1).

Prior to 1977, darkblotched rockfish in the waters off the United States were managed by the individual states (within the three miles). With implementation of the Magnuson-Stevens Fishery Conservation and Management Act (MFCMA) in 1976, primary responsibility for management of the groundfish stocks off Washington, Oregon and California shifted from the states to the Pacific Fishery Management Council (PFMC).

Limits on domestic rockfish catch were first instituted in 1983, with darkblotched rockfish managed as part of a group of around 50 species, designated as the *Sebastes* complex (Hamel, 2008). Commercial vessels were not required to separate most rockfish catches into individual species, and port biologists in each state routinely have sampled mixed-species market categories, such as the *Sebastes* complex, to determine the actual species composition of these mixed-species categories. In 1994, the *Sebastes* complex was divided into northern and southern areas, for annual harvest specifications and setting bimonthly cumulative landings limits (a.k.a. "trip limits"). In 1996, an assessment of the major species in the *Sebastes* complex was conducted (Rogers et al., 1996). This assessment led to a species-specific Overfishing Limit (OFL) (then called Acceptable Biological Catch (ABC)) for darkblotched rockfish in 1997.

The stock assessment conducted by Rogers et al. (2000) found the darkblotched rockfish stock to be depleted and an overfished determination was made. In 2001, darkblotched rockfish was given an individual ABC (then Optimum Yield (OY)). However, landed catch of darkblotched rockfish continued to be managed by trip limits established for the northern and southern minor slope rockfish complexes. Since 2000, when stock was declared overfished, landings of darkblotched rockfish decreased substantially, primarily due to management regulations instituted for the species.

In 2002, Rockfish Conservation Areas (RCAs), which are large marine areas closed to commercial fishing, were implemented by the PFMC as a measure to reduce bycatch of overfished rockfish species. Specific boundaries for the RCAs have varied among bimonthly periods, years and areas and there are a number of latitudinal differences in the extent of the current RCAs. The description of exact boundaries of the RCAs and how they change over time are available upon request. Trawl gear that is used shoreward of the RCAs is required to have small footropes (<8" diameter), which increases the risk of gear loss in rocky areas. Reductions in trip limits for shelf rockfish species have also reduced incentives to fish in rocky areas shoreward of the RCA. Since 2005, vessels using trawl gear shoreward of the RCA north of $40^{o}10'$ N latitude have also been required to use nets that are designed to be more selective for flatfish. A summary of the major management shifts on the West Coast of the United States related to groundfish species through 2005 (prepared by Daniel Erickson of PFMC' Groundfish Management team (GMT)) is provided in Appendix 1.

For the last two years (2011 and 2012), the shorebased trawl allocation (including non-hake groundfish trawl, and shorebased hake trips) has been managed as a catch share fishery, using Individual Fishing Quotas (IFQ), where each permit holder has an annual quota. Under this system, discard of darkblotched rockfish, and many other species has decreased dramatically, due to individual accountability; both landed and discarded fish count towards each fisher's annual quota.

1.5 Management Performance

Table 1 and Figure 6 present a summary of management performance for darkblotched rockfish over the last 10 years, which include a comparison of darkblotched rockfish Overfishing Limits (OFLs), Annual Catch Limits (ACLs), landings, and catch (i.e., landings plus discard). Between 2003 and 2012, the total dead catch (as estimated in this assessment) exceeded the ACLs in 2003, 2004, 2009 and 2010. The total dead catch also exceeded the OFLs in 2003 and 2004, but only by 4% and 2% respectively. Overall, total dead catch of darkblotched rockfish for the last decade has been only 57% of the sum of the OFLs and 81% of the ACLs.

1.6 Fisheries off Canada, Alaska, and/or Mexico

Darkblotched rockfish have a widespread distribution through the Canadian West Coast Exclusive Economic Zone; however, the highest concentrations occur along the shelf northwest of Vancouver Island and in Moresby Gully southeast of the Queen Charlotte Islands. Similarly to the Unites States, the Canadian commercial trawl fleet captures this species in slope rockfish assemblage and as a bycatch to the important Pacific ocean perch fishery, but in much lower numbers than those in the Unites States. A formal stock assessment of darkblotched rockfish has not been conducted in Canada. However, a review of darkblotched rockfish biology, distribution, and abundance trends along the Pacific coast of Canada was completed by Haigh and Starr (2008). In this review Haigh and Starr (2008) use values for natural mortality and individual growth drawn from the contemporary U.S. assessments. This review was not intended to advise fisheries managers on harvest policy and, therefore did not yield a conclusion on a status and long-term trends of the stock. In the future this review could serve as a basis for a stock assessment.

In the Gulf of Alaska and the Bering Sea-Aleutian Islands, darkblotched rockfish are rare but still occur in fishery catches. It is managed within other rockfish complex, with management measures set based on area-swept biomass estimates and natural mortality assumptions. The range of darkblotched rockfish does not extend beyond southern California; therefore, there is no information about whether a fishery in Mexico exists.

2 Assessment

2.1 Data

The darkblotched rockfish data used in the assessment are summarized Figure 7. These data include both fishery-dependent and fishery-independent sources.

2.1.1 Fishery-dependent data

The fishery removals in the assessment are divided among two fleets, which include domestic trawl fishery and bycatch in the foreign Pacific ocean perch (POP) and at-sea Pacific hake fisheries. The domestic trawl fishery has historically reported landed catch only, even though a portion of the darkblotched catch was discarded at sea. The foreign POP fishery, on the other hand, was known not to discard fish based on fish size or species, while the at-sea hake fishery reports total catch, which includes both retained and discarded fish. To account for differences in discarding practices and catch reporting, and most importantly avoid inflating darkblotched removals in POP and at-sea hake fisheries, the domestic trawl fleet and bycatch in foreign POP and at-sea hake fisheries were separated. The discarded portion of the domestic trawl fleet was estimated within the model based on data collected by the West Coast Groundfish Observer Program (WCGOP) and historical discard data provided in the Pikitch study (Pikitch et al., 1988) (both described in details below).

Landings of darkblotched rockfish were reconstructed back to 1916, and the assessment assumes a zero catch and equilibrium unfished biomass in 1915. The reconstructed time series of darkblotched rockfish landings by the domestic trawl fishery and removals by bycatch fleet are presented in Figure 5 and Table 2. Figure 1 shows the spatial distribution of darkblotched rockfish catch, as observed by the WCGOP between 2002 and 2008.

2.1.1.1 Domestic commercial landings

Estimates of recent commercial landings of darkblotched rockfish (between 1981 and 2012) were obtained from the Pacific Fisheries Information Network (PacFIN), a regional fisheries database that manages fishery-dependent information in cooperation with west coast state agencies and NOAA Fisheries (www.pacfin.com). Landings data were extracted by gear type on March 14, 2013 and then combined into the fishing fleets used in the assessment.

Time series of historical (pre-1981) landings were reconstructed by gear group (trawl and non-trawl) for each state separately and then combined to produce annual coastwide estimates for domestic trawl fleet. The methods used to reconstruct historical landings for each state are described below.

2.1.1.1.1 Washington

The records of rockfish landings in Washington go back to 1935 (Hongskul, 1975; Tagart and Kimura, 1982). Historically, rockfish landings in Washington were reported on fish tickets in two mixed species complexes “Pacific Ocean Perch” and “Other Rockfish” (Tagart and Kimura, 1982). In 1966, the Washington Department of Fish and Wildlife (WDFW) initiated a sampling program to estimate landings of each rockfish species within these mixed species complexes. Tagart and Kimura (1982) described methodology employed in calculating rockfish landings by species based on data collected by the WDFW sampling program, and Tagart (1985) provided time series of darkblotched rockfish landings by year between 1963 and 1980. The rockfish landings for the earlier time period (1935-1962) were compiled by Hongskul (1975), but no species-specific catches were estimated. To derive estimates of darkblotched rockfish from rockfish landings between 1935 and 1962, we first estimated the proportion of darkblotched rockfish in 1963-1967 rockfish landings, the earliest five years of the Tagart data (Tagart, 1985), and then applied this proportion to the 1935-1962 Hongskul (1975) landings by year. The time series of Washington landings of darkblocthed rockfish as used in this assessemnt are presented in Table 2.

2.1.1.1.2 Oregon

Oregon records of darkblotched rockfish landings go back to late 1930s. Similar to Washington, darkblotched rockfish were historically landed in Oregon in mixed species market categories, primarily within “Pacific Ocean Perch” and “Unspecified Rockfish”. A small portion of rockfish in Oregon between 1942 and the early 1980s were also landed in “Animal Food” category (also called “Mink Food” or “Miscellaneous” by some sources). This portion of catch went to feed mink for the fur trade. Mink food consisted mainly of red meat until World War II, when horsemeat became increasingly difficult and expensive to obtain. During this period, there was an abundance of fillet carcasses, which were used as a protein source for mink. When the demand exceeded the supply, whole fish were specifically targeted to supplement the carcasses(Niska, 1969).

A time series of Oregon historical landings of darkblotched rockfish through 1986 was provided by the Oregon Department of Fish and Wildlife (ODFW), which in collaboration with the National Marine Fisheries Service (NMFS) Northwest Fisheries Science Center (NWFSC), conducted a reconstruction of historical groundfish landings in Oregon (Karnowski et al., 2012). Karnowski et al. (2012) provide a detailed description of methods used in calculating rockfish landings by species. A variety of data sources were used to reconstruct historical landings of rockfish market categories, including Oregon Department of Fish and Wildlife’s Pounds and Value reports derived from the Oregon fish ticket line data (1969-1986), Fisheries Statistics of the United States (1927-1977), Fisheries statistics of Oregon (Cleaver, 1951; Smith, 1956), Reports of the

Technical Sub-Committee of the International Trawl Fishery Committee (now the Canada-U.S. Groundfish Committee) (1942-1975) and many others.

To inform species compositions of rockfish within different market categories, the ODFW has routinely sampled species compositions of multi-species rockfish categories from commercial bottom trawl landings since 1963. Rockfish landings by species estimated based on data collected by ODFW sampling program have been summarized in several ODFW reports, including (Barss and Niska, 1978; Douglas, 1998; Niska, 1976). The latter publication by Douglas (1998) was an expansion and improvement on earlier publications by (Niska, 1976) and (Barss and Niska, 1978). These sources were also used by Karnowski et al. (2012) in reconstructing historical landings of darkblotched rockfish in Oregon. The reconstructed landings of darkblotched rockfish in Oregon are presented in Table 2.

2.1.1.1.3 California

A time series of California landings of darkblotched rockfish during the most recent “historical” period (between 1969 and 1980) were available from the California Cooperative Groundfish Survey (CalCOM) database.

Earlier landing records (between 1916 and 1968) were reconstructed by the NMFS’s Southwest Fisheries Science Center (SWFSC) (Ralston et al., 2010). These reconstructed landings, in addition to apportioning catches to trawl and non-trawl gear included a portion assigned to unknown gear type. To assign unknown gear type landings to trawl and non-trawl catches, we calculated the proportion of trawl and non-trawl landings within landings assigned to trawl and non-trawl gear by year between 1916 and 1968, and applied these proportions to unknown gear type landings by years. The reconstructed landings of darkblotched rockfish in California are presented in Table 2.

2.1.1.2 Discard

There are three main sources of rockfish discard information on the West Coast of the United States. Since 2002, the WCGOP has collected bycatch and discard information on board fishing vessels in the trawl and fixed gear fleets along the entire coast, and produced discard ratio and total fishing mortality estimates for all species observed. The WCGOP was implemented in 2001 and began with gathering data for the limited entry trawl and fixed gear fleets. Observer coverage has expanded to include the California halibut trawl, the nearshore fixed gear and pink shrimp trawl fisheries. Since 2011, darkblotched rockfish was harvested with a catch share fishery, using Individual Fishing Quotas (IFQ), where each permit holder has an annual quota. The WCGOP provides 100% at-sea observer monitoring of catch for this new, catch share based IFQ fishery.

Prior to 2002, there were two studies of bycatch and discard in the trawl fishery, including the Enhanced Data Collection Project (EDCP) and the Pikitch study (Pikitch et al., 1988). The EDCP administered by the ODFW collected data on bycatch and discard of groundfish species off the Oregon coast from late 1995 to early 1999 (Sampson, pers.com.). The project had limited spatial coverage (Oregon waters only) and due to time constraints, the observers only recorded discarded catch for darkblotched rockfish.

Retained catch of darkblotched rockfish was recorded in the logbooks and fish tickets, but only as part of a mixed-species group of rockfish, which prevented calculation of the species-specific discard ratios for darkblotched rockfish. For this reason, the EDCP data were not included in the assessment.

The Pikitch study was conducted between 1985 and 1987. The northern and southern boundaries of the study were 48°42’ and 42°60’ North latitude respectively, which is primarily within the Columbia INPFC area (Pikitch et al., 1988; Rogers and Pikitch, 1992). Participation in the study was voluntary and included vessels using bottom, midwater and shrimp trawl gears. Observers of normal fishing operations on commercial fishing vessels collected the data, estimated the total weight of the catch by tow and recorded the weight of each species retained or discarded in the sample.

The WCGOP provided estimates of the discard ratios of darkblotched rockfish for the period between 2002 and 2011. The WCGOP data are collected by gear type, fishery (e.g., open access, limited entry) and species/management units. The discard ratios were computed as the total estimated discarded weight (in pounds) on observed trips divided by the estimated total catch (discarded and retained). To aggregate these ratios into the fleet modeled in this assessment, each state, fishery and gear combination was catch-weighted by the total estimated catch (discarded and retained weight). Thus, the discard rates used for each fleet represent the weighted estimates from each contributing segment within that fleet. Uncertainty in these values was quantified via bootstrapping the individual observations and then aggregating to the total estimate, providing a distribution of the discard rate. From this distribution a standard error associated with year specific discard ratio estimate was provided.

The estimates of discard ratios of darkblotched rockfish for 2000 and 2001 were retained from the previous assessments (Hamel, 2008; Rogers, 2005). They were originally computed using information from fish ticket, species composition samples, logbook, and observer data. Discard ratios for 1985 and 1987 were estimated from observations of retained and discarded catch collected in the Pikitch study following methods used in previous assessments (Hamel, 2008; Rogers, 2005). In previous assessment, however, the entire Pikicth study dataset was combined to estimate a single discard ratio, while in this assessment year specific discard ratios were calculated for 1985, 1986 and 1987.

2.1.1.3 Bycatch in the foreign POP fishery

As described in the Introduction, between mid-1960s and mid-1970s, foreign trawl fleets from the former Soviet Union, Japan, Poland, Bulgaria and East Germany targeted aggregations of Pacific ocean perch in the Northeast Pacific Ocean, in the waters off the U.S. West Coast (Love et al., 2002). Rogers (2003) estimated removals of POP and other species caught within this foreign POP fishery, including removals of darkblotched rockfish. In the assessment, we used estimates of darkblotched bycatch in the foreign POP fishery between 1966 and 1976 as estimated by Rogers (2003).

2.1.1.4 Bycatch in the at-sea Pacific hake fishery

As also described in the the Introduction, small amounts of darkblotched rockfish are also incidentally caught in in the Pacific hake fishery. The At-Sea Hake Observer Program (A-SHOP) monitors the at-sea hake processing vessels and collects total catch and bycatch data. Since the 1970s observers were deployed onto foreign fishing vessels that were catching Pacific hake. After 1991, observers continued to be deployed aboard U.S. flagged catcher processor and mothership vessels.

The annual amounts of darkblotched rockfish bycatch in the at-sea hake fishery, collected by A-SHOP, have been obtained from the North Pacific Database Program (NORPAC). Since 1991, virtually 100% of hauls in the at-sea hake fishery have been sampled for catch and species composition, and the total catch (retained and discarded) has been estimated for both targeted and bycatch species for each haul. To derive the total amount of darkblotched rockfish bycatch by year, we simply summed the estimated catch in every haul within a year. Prior to 1991 (time of foreign fishery and joint venture), not every haul was sampled. For these years, NORPAC provided an expansion factor (one for each year), which is a ratio of total hauls to sampled hauls. These year-specific expansion factors were used to estimate the total amount of darkblotched rockfish caught by multiplying the amount of total catch in sampled hauls by the expansion factor. The removals of darkblotched in the at-sea hake fishery between 1976 and 2012 are presented in Table 2 and Figure 4.

2.1.1.5 Fishery biological data

Biological information on domestic commercial landings was obtained from PacFIN (date of data extraction: March 14, 2013) and on commercial discard from the WCGOP and the Pikitch study. The fishery biological data included sex, length and age of individual fish (amount of data available varied by source, year and state). These biological data were used to generate length and age frequency distributions by sex (when possible), which were then used in the assessment to describe selectivity and retention of the domestic trawl fleet. The summary of sampling efforts, which include number of sampled trips, hauls (when available) and fish by source, year and state is provided in Table 3 and Table 4. The WCGOP also provided average weight for discarded fish. No biological information was available on darkblotched removals in foreign POP fishery. Biological data were available from at-sea hake fishery, however, given that at-sea hake fishery operates in the midwater (not the major habitat for darkblotched) and darkblotched bycatch represents tiny amount of overall darkblotched removals (Figure 4), these data were not used in the assessment, since the model interpreted the data as representative of the entire stock, and iterative tuning of the composition data resulted in them receiving implausibly high weight (e.g., at-sea-hake bycatch having equal weight to the NWFSC shelf-slope survey compositional data).

2.1.1.5.1 Length composition data

Length composition data from commercial fisheries were compiled into 30 length bins, ranging from 4 to 62 cm. Most of the length data from PacFIN were reported for females and males separately; therefore length frequency distributions of darkblotched rockfish in commercial landings were generated by year and sex. The number of fish sampled by port samplers from different trips has not been proportional to the amount of landed catch in these trips. Sampling effort also has varied among states. To account for non-proportional sampling of darkblotched rockfish among trips and states, and to generate length frequency distributions that would be more representative of coastwide species landings, the observed length composition data were expanded using the following algorithm:

1. Length composition data were acquired at the trip level by year, state and sex;
2. For each trip, raw length observations were scaled up to represent darkblotched rockfish landings for the entire trip:
    a. An expansion factor was calculated by dividing the total weight of trip landings by the total weight of darkblotched rockfish sampled for length within the same trip;
    b. The observed raw length composition data within each trip were multiplied by the expansion factor and then summed up by state.
3. The expanded and summed lengths in each state were then expanded again to account for differences in species landings among states:
    a. The expansion factor was computed by dividing the total weight of state landings by the total weight of organisms sampled for length within this state;
    b. The length frequency distributions for each state (from step 2 of this algorithm) were multiplied by the expansion factor (from step 3.a) and then summed up to determine the coastwide sex-specific length frequency distributions by year.

We only used randomly collected samples. The coastwide length frequency distributions of darkblotched rockfish (generated as described above) landed in the domestic trawl fishery by year and sex are shown in Figure 8 and Figure 9.

Length frequencies distributions were developed for the period between 1977 and 2012. Length distributions for 1977 and 1978, however, were not use in the assessment as those distributions were substantially different from distributions in the other years. More probably, 1977 and 1978 length data mainly represented catches in midwater trawl fishery targeting widow rockfish, the dominant rockfish fishery in the late-1970s on the U.S. West Coast. Landings of that period, however, were not distinguished between bottom and midwater trawl; therefore, we were unable to confirm our assumption regarding the reason for observed difference.

Length-frequency distributions of darkblotched rockfish that were discarded at sea were obtained from the WCGOP for the period between 2002 and 2011, and from the Pikitch study for the year of 1986. The discard length composition data were analyzed using a weighting method consistent with that applied to the port samples of landed catch described above. Length frequency distributions of discarded fish, however, were developed for both sexes combined, since the vast majority of data did now have sex information associated with length measurements. The length frequency distributions of darkblotched rockfish discarded at sea by year are shown in Figure 10.

The initial input sample sizes for length frequency distributions of darkblotched landings by year were calculated as a function of the number of trips and number of fish sampled using the method developed by Stewart and Miller (pers. com.):

$$N_{input} = N_{trips} + 0.138N_{fish} \quad \text{when} \quad \frac{N_{fish}}{N_{trips}} < 44$$

$$N_{input} = 7.06N_{trips} \quad \text{when} \quad \frac{N_{fish}}{N_{trips}} \geq 44$$

The method was developed based on analysis of the input and model-derived effective sample sizes from west coast groundfish stock assessments. A step-wise linear regression was used to estimate the increase in effective sample size per sample based on fish-per-sample and the maximum effective sample size for large numbers of individual fish.

2.1.1.5.2 Age composition data

Age composition data from commercial fisheries were compiled into 36 age bins, ranging from age 0 to age 35 fish. The amount of age data sampled from commercial landings varied among state (Table 4). In the assessment, we used data from only those years when age estimates were available from all three states (2002-2008) to account for gradient in length-at-age parameters along the coast observed. Age data on discarded fish were available from the WCGOP for 2004 and 2005.

The age data were used to derive marginal age compositions using the same weighting methods as used for the length frequency distributions. The marginal composition approach was preferred over the conditional age-at-length compositions (used for fishery-independent data) because the commercial fishery often operates over a more protracted season than the surveys (making age-at-length less stationary during a single year) and in order to speed the computation time of model runs. The marginal age compositions for commercial landings and discards used in the assessment are presented in Figure 11, Figure 12 and Figure 13.

In two previous full assessment of darkblotched rockfish (Rogers 2005, Hamel 2007), only age data aged in 2004 and later were used, as a way to deal with uncertainty in ageing (Rogers 2005). The concern was that criteria for estimating ages of darkblotched rockfish might have changed (Hamel 2007) and that a bias may have existed in “early” age data compared to those generated in 2004 and later (Rogers 2005). We re-evaluated all the age data available for darkblotched rockfish and, based on the communication with age readers involved in ageing of darkblotched rockfish over the years (McDonald, Kamikawa, Menkel, pers. com), established that no changes were made in ageing criteria for this species. We also explored a presence of potential bias in “early” age data by comparing double reads made by the same age reader in the “early” and “late” periods and found little support for “early” age data being biased relative to “late” age estimates or having different imprecision.

Since 2005, darkblotched rockfish age structures (otoliths) were read by a single reader (Reader 1) from the Ageing Laboratory in the Hatfield Marine Science Center in Newport (Oregon) using the break and burn method, with few other readers producing double-reads of the same age structures. Prior to 2005, several age readers were involved in ageing darkblotched rockfish, who use the same method (break and burn) and same criteria to estimate ages from darkblotched rockfish otoliths as the current age reader for this species. To account for the change in age readers in 2005, we estimated a separate pattern for ageing error in an "early" (prior to and including data aged in 2004) and "late" (after and including data aged in 2005) periods of age data (see "Ageing bias and impression" section for details).

2.1.1.5.3 Average weight of discarded fish

Also, average body weight estimates from the discarded catch were available from the WCGOP for years between 2002 and 2011. These estimates were available for some hauls where length data were not collected, as they were calculated via the sample weight divided by the count of fish in that haul. The smallest average fish weight was reported for the domestic trawl fishery discards in 2011, the first year of the IFQ fishery, which is consistent with other changes related to IFQ fishery. Such changes include negligible discard and changes in length frequency distributions, with smaller (relative to previous years) fish were discarded.

2.1.2 Fishery-independent data

2.1.2.1 Surveys used in the assessment

The assessment utilizes fishery-independent data from four bottom trawl surveys conducted on the continental shelf and slope of the Northeast Pacific Ocean by NWFSC and Alaska Fisheries Science Centers (AFSC), including: 1) the AFSC shelf survey (often called "triennial", since it was conducted every third year), 2) the AFSC slope survey, 3) the NWFSC slope survey, and 4) the NWFSC shelf-slope survey (often referred to as "combo" survey). Details on latitudinal and depth coverage of these surveys by year are presented in Table 5.

The AFSC triennial survey was conducted every third year between 1977 and 2004 (in 2004 this survey was conducted by the NWFSC using the same protocols). Survey methods 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. Over the years, the survey area varied in depth and latitudinal range (Table 5). Prior to 1995, the depth range was limited to 366 m (200 fm) and the surveyed area included four INPFC areas (Monterey, Eureka, Columbia and U.S. Vancouver). After 1995, the depth coverage was expanded to 500 m (275 fm) and the latitudinal range included not only the four INPFC areas covered in the earlier years, but also part of the Conception area with a southern border of $34^{o}50'$ N. latitude. For all years, except 1977, the shallower surveyed depth was 55 m (30 fm); in 1977 no tows were conducted shallower than 91 m (50 fm). The data from the 1977 survey were not used in the assessment, because of the differences in depths surveyed and the large number of "water hauls", when the trawl footrope failed to maintain contact with the bottom (Zimmermann et al., 2001). The tows conducted in Canadian and Mexican waters were also excluded. In the assessment, the triennial survey was divided into two periods: 1980- 1992, and 1995-2004; separate catchability coefficients (*Q*) were estimated for each time period. This was done to account for differences in spatial coverage before and after 1995 (Table 5) and to reflect a change in the timing of the survey. The survey was conducted from mid-summer to early fall in the earlier time period, and was conducted at least a full month earlier in the later time period (Figure 14).

The AFSC slope survey was initiated in 1984. The survey methods are described in Lauth (2000). Prior to 1997, the survey was conducted in different latitudinal ranges each year (Table 5). In this assessment, only data from 1997, 1999, 2000 and 2001 were used – these years were consistent in latitudinal range (from 34°30’ N. latitude to the U.S.-Canada border) and depth coverage (183-1280 m; 100-700 fm).

The NWFSC slope survey was conducted annually from 1999 to 2002 (Keller et al., 2007). The surveyed area ranged between 34°50’ and 48°07’ N. latitude, encompassing the U.S. Vancouver, Columbia, Eureka, Monterey INPFC areas, and a portion of the Conception area, and consistently covered depths from 100 to 700 fm (183-1280 m) (Table 5).

The NWFSC shelf-slope (combo) survey has been conducted annually since 2003, and the data between 2003 and 2012 were used in the assessment. The survey consistently covered depths between 55 and 1280 m (30 and 700 fm) and the latitudinal range between 32°34’ and 48°22’ N. latitude, the extent of all five INPFC areas on the U.S. west coast (Table 5). The survey is based on a random-grid design, and four industry chartered vessels per year are assigned an approximately equal number of randomly selected grid cells. The survey is conducted from late May to early October, and is divided into two passes, with two vessels operating during each pass. The survey methods are most recently described in detail in Bradburn et al. (2011).

2.1.2.2 Survey abundance indices
Indices of abundance for each of the four bottom trawl surveys were derived using a delta-generalized linear mixed model, or delta-GLMM (Maunder and Punt, 2004), implemented using the software from Thorson and Ward (In press). The analysis associated with this method and the new and improved software for constructing survey abundance indices were recently reviewed by the PFMC’s Scientific and Statistical Committee (SSC). The SSC endorsed the analysis and recommended using this software in stock assessments.

For each survey abundance index, spatial strata were first identified based on depth and latitude, via examination of trends in size across latitude and depth and evaluation of the presence (or absence) of darkblotched in certain depth- or latitudinal areas. Survey data are based on a randomly-stratified survey design with pre-specified strata. We attempted to retain strata already recognized by the survey, while balancing the need to inform strata designation by species-specific characteristics of the stock. Also, the number of positive tows in each strata x year combination were computed to ensure that each stratum x year combination has a sufficient number of positive tows, for the estimation model to perform adequately.

Darkblotched exhibit ontogenetic movement, when fish move into deeper water as they mature, a common phenomenon observed in the genus *Sebastes* (Love et al., 2002). Survey data we evaluated also exhibited a rapid increase in fish size over the shallowest depths to roughly 300 m. Therefore, 300 m was used as the depth break for AFSC slope, NWFSC slope surveys, and the NWFSC combo surveys as well as the late period (1995-2004) of the AFSC triennial shelf survey. In the early period (prior to 1995) the AFSC triennial survey went as deep as 400 meters and to satisfy requirement for a positive tow number, a single depth stratum was used for early AFSC survey. No darkblotched was found beyond 550 m, and in order to avoid extrapolating biomass into those deeper areas, for the analysis surveys that went passed 550 m, were cut at 549 m.

INPFC area boundaries were used as latitudinal breaks; however, due to few occurrences of darkblotched in the water off California, Conception and Monterey INPFC areas were combined into a single stratum. Also, Columbia and U.S. Vancouver INPFC areas were combined in the later period of the AFSC triennial shelf survey and AFSC slope survey, again due to very few positive tows in those areas. Finally, in case of NWFSC combo survey, the boundary at 34°5’ N. lat. maintained the break in sampling density to the north and south. There was only 3 occurrences of darkblotched rockfish south of 34°5’ N. lat. over the entire time series of the survey, therefore, we limited the survey to 34°5’ N. lat. on the south and eliminated data from 32° -34°5’ N. lat. from the analysis. Resultant strata for all the surveys are shown in Table 6. These strata were used in constructing survey abidance indices used in the assessment.

The delta-GLMM approach used to construct survey abundance indices, for every tow explicitly models both the probability that it encounters the target species (using a logistic regression), and the expected catch for an encounter (using a generalized linear model). The product of these two components yields an estimate of overall abundance. Year is always included in both model components (because it is the design variable), and strata are generally included as a fixed effect. The delta-mixed-model implementation is necessary to treat vessels as a random effect for the NWFSC slope and combined shelf-slope surveys, because these vessels are selected in an open-bid for the sampling contract from the population of all possible commercial vessels (Helser et al., 2004). Lognormal and gamma errors structures were considered for the model component representing positive catches, while a Bernoulli error structure was assumed for the presence/absence model component.

We also explored an option to model extreme catch events (ECEs, defined as hauls with extraordinarily large catches) as a mixture distribution (Thorson et al., 2011), which has been shown to improve precision for estimated indices of abundance in simulated data in some cases (Thorson et al., 2012). Model convergence was evaluated using the effective sample size of all estimates parameters (>500 was sought) and visual inspection of trace plots and autocorrelation plots (where a maximum lag-1 autocorrelation of <0.2 was sought). Model goodness-of-fit was evaluated using Bayesian posterior predictive checks and Q-Q plots. For all indices, Q-Q plots indicated that an ECE error structure was necessary. Also, a comparison of average deviance between lognormal-ECE and gamma-ECE indicated support for using the gamma-ECE error structure for all indices.

2.1.2.3 Length composition data

Length composition data collected by the surveys were used to derive length frequency distributions by survey, year and sex. Amount of length composition data available for the assessment varied by survey and year. A summary of sampling efforts in all surveys are summarized in Table 7, Table 8, Table 9 and Table 10. Length composition data were compiled into 30 length bins, ranging from 4 to 62 cm. The observed length compositions were expanded to account for differences in catches among tows and spatial strata. To generate coastwide length frequency distributions the following algorithm was used:

1. For a specific year and survey, length data by sex were acquired at the tow level;
2. For each tow, the raw length observations were expanded to represent the entire tow:
    a. An expansion factor was calculated by dividing the total weight of darkblotched within the tow by the total weight of darkblotched in this tow measured for length;
    b. The observed length frequencies were multiplied by the expansion factor and then summed up within a spatial stratum.
3. The expanded and summed length frequencies in each spatial stratum were then expanded again to account for differences in catches among spatial strata:
    a. The expansion factor was computed by dividing the total weight of darkblotched within a stratum by the total weight of darkblotched within this stratum measured for length;
    b. The length frequency distributions within each stratum (calculated via step 2 above) were multiplied by the second expansion factor (from step 3.a) and then summed up to produce annual sex-specific length frequency distributions for the entire survey area.

Spatial strata used to generate annual length frequency distributions were consistent with the strata used to compute survey abundance indices (Table 6). The coast-wide length frequency distributions of female and male darkblotched rockfish by survey, year and sex are shown in Figure 15 through Figure 22.

The initial input sample sizes for the survey length frequency distribution data were calculated as a function of both the number of fish and number of tows sampled using the method developed by Stewart and Miller (NWFSC, pers.com.):

$$N_{input} = N_{tows} + 0.0707 N_{fish} \qquad \text{when} \quad \frac{N_{fish}}{N_{tows}} < 55$$

$$N_{input} = 4.89 N_{tows} \qquad \text{when} \quad \frac{N_{fish}}{N_{tows}} \geq 55$$

2.1.2.4 Age composition data

Age composition data were collected for all the surveys, but the amount of data varied by survey and year. A summary of age data available for the assessment is presented in Table 7, Table 8, Table 9 and Table 10.

As in case of fishery-independent age data in several previous assessments (Hamel, 2008; Rogers, 2005), only age data generated in 2004 and later were used. The concern was that criteria for estimating ages of darkblotched rockfish might have changed (Hamel, 2008) and that a bias may have esisted in “early” age data (Rogers, 2005). We re-evaluated all the age data available for darkblotched rockfish and, based on the communication with age readers involved in ageing of darkblotched rockfish over the years (McDonald, Kamikawa, Menkel, pers. com), established that no changes were made in ageing criteria for this species. We also explored a presence of potential bias in “early” age data by comparing double reads made by the same age reader in the “early” and “late” periods of age data and found little support for “early” age data being biased relative to “late” age estimates or for those data having different imprecision.

Since 2005, darkblotched rockfish age structures (otoliths) were read by a single reader (Reader 1) from the Ageing Laboratory at the Hatfield Marine Science Center in Newport (Oregon) using the break and burn method, with few other readers producing double-reads of the same age structures. Prior to 2005, several age readers were involved in ageing darkblotched rockfish; all readers used the same method (break and burn) and same criteria to estimate ages from darkblotched rockfish otoliths as the current age reader for this species. To account for the change in age readers in 2005, we estimated a separate pattern for ageing error in an “early” (prior to and including data aged in 2004) and “late” (after and including data aged in 2005) periods of age data (see “Ageing bias and impression” section for details).

Age composition data from the surveys were compiled as conditional distributions of ages at length by survey, year and sex. Prior to that, the observed age compositions were expanded to account for differences in catches among tows and spatial strata, using the same approach as described for length composition data above. The conditional ages at length approach uses an age-length matrix, in which columns correspond to ages and rows to length bins. The distribution of ages in each column then is treated as a separate observation, conditioned on the corresponding length bin (row). The conditional ages at length approach has been used in most recent stock assessments on the West Coast of the United States, since it has several advantages over the use of marginal age frequency distributions. Age structures are usually collected from the individuals that have been measured for length. If the standard age compositions are used along with length frequency distributions in the assessment, the information on sex ratio and year class strength may be double-counted since the same fish are contributing to likelihood components that are assumed to be independent. The use of conditional age distributions within each length bin allows avoiding such double-counting. Also, the use of conditional ages at length distributions allows the reliable estimation of growth parameters within the assessment model.

The number of ages within each length bin was used as the initial input sample sizes for conditional ages and length distributions. Conditional ages at length compositions generated and used in the assessment are shown in Figure 23 through Figure 29.

2.1.3 Biological parameters

Several biological parameters used in the assessment were estimated outside the model or obtained from literature. Their values were treated in the model as fixed, and therefore uncertainty reported for the stock assessment results does not include any uncertainty in these quantities (however some were investigated via sensitivity analyses described later in this report). These parameters include weight-length relationship parameters, female maturity and fecundity parameters, natural mortality and ageing error and impression. The methods used to derive these parameters in the assessment are described below.

2.1.3.1 Weight-length relationship

The weight-length relationship used for this assessment is based on observations from 3167 females and 3558 males collected in the NWSFC shelf-slope survey between 2003 and 2010. Male and female weight-length curves were fit separately using the following relationship:

$$W = \alpha(L)^{\beta}$$

Where W is individual weight (kg), L is total natural length (cm) and α and β are coefficients used as constants.

The parameters derived from this analysis were the following: α = $1.110 \cdot 10^{-5}$ for females and $1.205 \cdot 10^{-5}$ for males, and β = 3.1351 for females and 3.122 for males. Estimated parameters fit the data well, and indicated little difference in the weight-length relationship between female and male darkblotched rockfish (Figure 30).

2.1.3.2 Maturity schedule

Maturity data on female darkblotched rockfish were produced via histological analysis of fish collected in the NWFSC shelf-slope survey in 2011 and 2012. Methods used for identifying maturity of darkblotched rockfish are described in McDermott (1994). A female was classified as 'mature' if histological analysis suggested it was producing eggs, and that atresia was less than 25%. The presence of old (and otherwise mature) female individuals with significant atresia suggests that darkblotched rockfish will skip spawning intermittently. We therefore estimated an asymptotic maturity rate less than one, where this maturity schedule represents the combined effect of maturation and atresia.

Maturity at age was estimated from 303 records of females that had maturity and age recorded. Maturity at age was modeled using three parameters:

$$\hat{m}(a) = m_{\infty} \frac{1}{1 + e^{-(\beta \cdot (a - \alpha))}}$$

Where m_∞ is the asymptotic maturity for an old female; α is the age at which maturity is 50% of m_∞, and β is the slope of maturity as a function of age.

Model selection using AIC supported the use of this model over one in which m_∞ was fixed at 1. Records were then assumed to be Bernoulli distributed given the prediction of maturity $\hat{m}(a)$. This resulted in estimates of α = 4.82, β = 1.03, and m_∞ = 0.915.

Maturity-at- relationship for female darkblotched rockfish used in the assessment, shown with fit to the data from the NWFSC shelf-slope survey samples is shown in Figure 31.

2.1.3.3 Fecundity

Fecundity (number of eggs) was assumed to be related to female body weight linearly as follows:

$$\frac{\Phi}{W} = a + bW$$

Where Φ is the number of eggs, *W* is female weight in kg, and *a* and *b* are constant coefficients.

This linear relationship follows the work of Dick (2009) who calculated this relationship for several species of rockfish and found the egg and female weight was not proportional. For darkblotched, Dick (2009) estimated parameters *a* and *b* to be 101100 and 44800 respectively, and we used these values in the assessment.

In several previous assessments, fecundity parameters were used as estimated by Nickol (1990) using data collected in waters off Oregon. Dick's (2009) analysis included data from several darkblotched fecundity studies, including those conducted using data from Oregon (Nickol and Pikitch, 1994), Washington (Snytko and Borets, 1973) and California (Phillips, 1964) waters. We explored the model sensitivity to fecundity parameters via a sensitivity analysis (Figure 128, Figure 129 and Figure 34).

2.1.3.4 Natural mortality

A fixed value for natural mortality, equal for males and females, has been assumed in all stock assessments of darkblotched rockfish. The value of 0.05 used by early assessments is consistent with results from the Hoenig (1983) method. Other life history-based methods provide wildly different estimates that are generally considered to be inconsistent with rockfish life history (Hamel, pers. com.). In Rogers (2005) and Hamel (2008) the value of 0.07 was used, based upon the estimates from the Hoenig (1983) maximum age method and Gunderson (2003) gonadosomatic index meta-analyses, and also based on model results, achieving a balance between natural mortality and steepness values (the steepness was 0.95 and 0.6 in Roger (2005) and Hamel (2008), respectively).

Exploration of the base model indicates that natural mortality in this assessment is estimated to have an implausibly large value. This was also true for many alternative model parameterizations (including those with Hamel natural mortality prior). A minority of runs estimated a natural mortality between 0.045 and 0.060, while most runs estimated this parameter to be greater than 0.10, which is inconsistent with the maximum observed age for this species. We, therefore, have chosen to fix this parameter *a priori* at the value of 0.05 yr^{-1} for females and estimate it for males. Dimorphic growth in fish is often accompanied by different rates of natural mortality. Even though model is unable to reliably estimate natural mortality for both sexes, compositional data can inform the difference between the sexes quite well, and estimating at least one sex would capture more of the uncertainty in the model results.

We explored the impact of using 0.07 yr^{-1} for natural mortality of both sexes (as assumed in previous several assessments) via a sensitivity analysis (Figure 128, Figure 129 and Figure 130). We also use alternative values of natural mortality in defining states of nature in the Decision Table, to further incorporate uncertainty in this parameter into the management process.

2.1.3.5 Ageing bias and imprecision

In the assessment, two ageing error matrices were used to account for the change in age readers in 2005. Separate patterns for ageing error were estimated in an "early" (prior to and including data aged in 2004) and "late" (after and including data aged in 2005) periods of age data.

To develop ageing error matrices, we analyzed all available data from double-reads using a state-space model developed by Punt et al. (2008) and software developed by Stewart et al. (2011). We did not use formal model selection tools, however, because this often resulted in patterns that were implausible (i.e. residual patterns for the unbiased reader).

For the "early" peroid, age reads made by Reader 3 (re-reads of early ages done by the current reader after 2005) were assumed to be unbiased. We therefore started with a model with different linear (1-parameter) bias and imprecision for each Readers 1-2 (assumed throughout to have the same bias and imprecision) and Reader 3. We then explored adding a quadratic term to the bias and imprecision for either Reader 1-2 or Reader 3, and found that each such change caused little difference in the estimated ageing error or bias schedules. We also found that the estimated ageing imprecision and bias was very similar for Readers 1-2 and Reader 3, so we used a model in which imprecision and bias were identical for all readers.

For the "late" period, age reads made by Reader 1 (the current darkblotched rockfish age reader) were assumed to be unbiased. Comparison of age estimates of Reader 1 with those made by all other readers indicated small but important differences in precision and bias among readers. However, the only the bias and imprecision schedule for Reader 1 is used in the assessment model (given that Reader 1 provided all age reads used in the model after and including 2005).

Comparison of results from the "early" and "late" periods indicates greater imprecision during the early than that of in the later period (Figure 32, Figure 33 and Figure 34).

2.2 History of Modeling Approaches Used for this Stock

2.2.1 Previous assessments

The first stock assessments of darkblotched rockfish was done in 1993 and stock assessments have been conducted frequently since then (Lenarz, 1993; Rogers et al., 1996; Rogers et al. 2000; Rogers, 2003; Rogers, 2005; Hamel, 2008; Wallace and Hamel, 2009; Stephens et al. 2011).

Lenarz (1993) reviewed the available life-history and fishery information on the species. Based on the Hoenig (1983) method and a maximum age of 60 to 105 years, Lenarz (1993) estimated the natural mortality rate to be between 0.025 and 0.05 yr^{-1}. Based on these values, the target fishing mortality rate ($F_{35\%}$) was estimated to be between 0.04 and 0.06, and the overfishing level ($F_{20\%}$) between 0.07 and 0.11. Analysis of length composition data, available at that time, indicated that average size of fish had decreased between 1983 and 1993, which was consistent with estimated fishing impacts. OFL (then called ABC) was not estimated.

Rogers et al. (1996) analyzed 13 commercially important rockfish species (including darkblotched) using an F = M approach, which was modified to derive OFLs under the assumption of an$F_{35\%}$ target fishing mortality rate. Rogers et al. (1996) averaged the AFSC triennial survey abundance indices for several species over the period between 1980 and 1995 and developed a proxy adjustment factor based on the OFLs from available stock assessments of U.S. West Coast rockfish species and characteristics of each species analyzed. For darkblotched rockfish, this proxy adjustment factor was 0.8. The OFL was determined under the assumption of natural mortality rate of 0.05 yr^{-1}. At the same time, darkblotched rockfish was also assessed using a simple stock synthesis model, mostly to confirm the F = M approach, used by Rogers et al. (1996). That was a two sex model, which included two survey indices of abundance (one was derived from AFSC triennial survey and the other was based on POP bycatch effort), as well as length and age composition data from the AFSC triennial survey and the commercial fishery. The model was structured to have northern and southern fishing fleets; the modeling time period spanned between 1980 and 1995, and assumed equilibrium condition in 1979, with an equilibrium catch of 300 mt. The model produced estimates of age-1 recruitment for the period between 1980 and 1993, estimated dome-shaped selectivity for the AFSC triennial survey and the southern fishery and asymptotic selectivity for the northern fishery. Catchability for the AFSC triennial survey was fixed at 1.0. The $F_{35\%}$ fishing mortality rate was estimated to be 0.04 for the northern fishery and 0.02 for the southern fishery.

Rogers et al. (2000) expanded the 1996 model to develop the first full assessment of the darkblotched rockfish stock. The model covered the period from 1963 to 1999, with an equilibrium catch of 200 mt assumed prior to the first year of the model. Five abundance indices were used. In addition to the AFSC triennial and POP bycatch indices (used in the 1996 assessment), 2000 assessment included AFSC slope survey and POP survey (Wilkins and Golden, 1983) abundance indices, as well as CPUE index developed based on commercial trawl fishery logbook data. Length composition data included samples from all years of the AFSC triennial, AFSC slope and POP surveys. The model included a single fishing fleet and discard assumptions were explored only via sensitivity analysis, because incorporating discard in the assessment complicated the model without substantially changing the model output. Fishery selectivity was assumed to be asymptotic, while survey selectivity was allowed to be dome-shaped. Age-1 recruits were estimated between 1963 and 1998, with the 1999 recruitment fixed at an assumed value.

The 2000 assessment included two models - a Stock Assessment Team (STAT) model and a Stock Assessment Review Panel (STAR) model. Both models produced similar results, but their assumptions were quite different. The STAT model included subjective weights on the log-likelihood components and informative prior distributions on some of the fitted parameters as well as assumed a Beverton-Holt stock-recruitment relationship. The STAR model had all weights on the likelihood components to be either 1 or 0, assumed no prior knowledge about the estimated parameters, and placed no bounds on the estimated recruitments. The STAT model considered CPUE and POP bycatch indices less reliable than the other indices of abundance, and the AFSC triennial survey index more reliable than AFSC slope or POP survey indices. The STAT model (similarly to the STAR model) estimated dome-shaped selectivity for all three surveys used in the assessment. The steepness prior probability distribution had a mean of 0.8 and a CV of 0.1; the estimated parameter value based on this prior was 0.83. Uncertainty in the 2000 assessment was expressed both through choice between the models and through assumptions regarding the amount of darkblotched foreign bycatch relative to the estimated catch of POP. The target fishing mortality ($F_{50\%}$) was estimated to be around 0.032, regardless of the choice of model or the foreign bycatch assumption. Given the range of foreign bycatch, spawning depletion in 1999 was estimated to be between 17% and 28% in the STAT model and between 13% and 26% in the STAR model. Base on this assessment, stock was declared overfished.

In the 2001 update assessment, selectivity parameters and survey catchability parameters were fixed at the values estimated in the 2000 assessment. Only the age-1 recruits were re-estimated, with 2000 and 2001 recruitment fixed at an assumed level. The fishing mortality rate at $F_{50\%}$ was estimated to be 0.032, the spawning depletion at the beginning of 2002 was 14%, and the 2002 OFL (then called ABC) was 187 mt.

The 2003 assessment was a comprehensive update of the 2000 assessment. The model structure and values of fixed parameters used in the assessment were not changed. However, the data used in the assessment were extended through 2002 and all the fitted parameters were estimated. Newly available age composition data were not included in the model, since they were not consistent with the growth curve and the aging error parameters fixed in the 2000 model. Management related discard was added to the 2001 and 2002 landings, using rates assumed by the PFMC (0.1 discard ratio in 2001 and 0.2 in 2002). Estimates of darkblotched catch in the foreign POP fishery between1966 and 1976 were included as estimated by Rogers (2003). The fishing mortality rate at $F_{50\%}$ was estimated to be 0.032, the 2004 spawning depletion 11%, and the 2004 OFL (then called ABC) was 240 mt.

In 2005, full assessment (Rogers, 2005) was conducted using the Stock Synthesis 2 (SS2 v1.) modeling framework. The time series of landings were extended back to 1928, assuming unfished equilibrium condition of the stock in 1927. Discard ratio estimates were calculated from the data available for 1986 and the period between 2000 and 2004, and the full time series of discards were estimated within the model. Retention curve parameters were also estimated within the model. Only age data from otoliths read in 2004 were included in the assessment due to a concern of a bias in earlier age data. The AFSC slope survey index was re-estimated using a GLM approach, and the NWFSC slope survey index (1999-2004) and length composition data (2000-2004) were added to the assessment. Most of the growth parameters were estimated within the assessment model, while natural mortality was fixed at the value of 0.07 yr^{-1}. The assessment used a Beverton-Holt model to describe the stock-recruitment relationship with the steepness parameter fixed at the value of 0.95. Spawning depletion at the start of 2005 was estimated to be 17% of the unfished level. Natural mortality was used as the main axis of uncertainty for the decision table, with three states of nature encompassing the range of *M* values (0.05, 0.07 and 0.09yr^{-1}) that corresponded to low, medium (base case) and high states of nature respectively.

The most recent full assessment (prior to the current assessment) was conducted in 2007 (Hamel, 2008). In the 2007 assessment, recent landings and discard ratio estimates were updated, while newly available landings, discard and NWFSC slope survey data were added. The shelf portion of the NWFSC shelf-slope (combo) survey (2003-2006) was also included in the assessment. The new GLMM approach was used to estimate abundance indices for all the surveys. Conditional ages-at-length compositions were used in the assessment for the first time for this stock to input age data from the fishery landings, fishery discards, the AFSC slope and NWFSC shelf and slope surveys. The use of age data was still limited to ages estimated during and after 2004. Data from the two year POP survey were no longer used in this assessment. Also, the average weight of discarded fish and mean size-at-age data were no longer used in the assessment since the conditional ages-at-length compositions encompass the same data sources and provide similar information. Natural mortality was fixed at the value of 0.07 yr^{-1} and spawner-recruit steepness was first estimated (with the prior) within the model and then fixed at the estimated value (0.6). The point estimate for the depletion of the spawning output at the start of 2007 was estimated to be 22.4% relative to spawning output in an unfished equilibrium condition. The decision table was developed based on uncertainty in the assumed value of natural mortality, with natural mortality values of 0.05, 0.07 and 0.09 yr^{-1} representing low, medium (base case) and high states of nature.

The 2007 assessment (Hamel, 2008) was updated twice; the first by Wallace and Hamel (2009) and then by Stephens et al. (2011). The 2009 update assessment retained the same model structure as the 2007 assessment, but updated the historical time series of catch with newly reconstructed California historical landings. It also included two more years of data that became available since the 2007 assessment. The point estimate of depletion was 27.5% at the start of 2009. The 2011 update assessment retained the same model structure as the 2007 full assessment, but, like the 2009 assessment, updated the time series of catch to incorporate the newly reconstructed Oregon historical landing of darkblotched rockfish. The data that became available since the 2009 were also included.

The spawner-recruit steepness was updated from 0.6 (as in the 2007 and 2009 assessments) to 0.76, based upon information from a new meta-analytic prior (Martin Dorn, pers.com.) and the model fit. In addition, selectivity for the NWFSC slope survey was found to be dome-shaped in that assessment, rather than the asymptotic as previously estimated. At the start of 2011, the spawning depletion was estimated to be 30%. The decision table was based on spawner-recruit steepness as the major axis of uncertainty (rather than natural mortality as in the 2007 full assessment and 2009 update assessment) with steepness of 0.76 to represent medium state of nature (base case). Alternative steepness values to represent low and high states of nature (0.54 and 0.95, respectively) were calculated as the 12.5% and 87.5% quantiles from the prior distribution on steepness.

In aggregate, these assessments have largely drawn the same conclusions regarding historical trends in stock dynamics: the darkblotched rockfish abundance declined rapidly in the 1960s and 1970s due to high fishing intensity, and continued to decline in the 1980s and 1990s reaching the lowest point around 2000 (Figure 139). For the last decade, the stock was slowly increasing primarily due to management efforts toward rebuilding of the stock.

2.2.2 Responses to 2007 STAR panel recommendation

The STAR panel report from the last full assessment (conducted in 2007) identified a number of recommendations for the next assessment as well as general long term recommendations for future assessments. Below, we list the 2007 STAR panel recommendations and explain how these recommendations were taken into account in this assessment. Not all the long term recommendations could be addressed in this assessment, but we summarized the progress done toward each of them.

For the next assessment the following recommendations were made:

1) *GLMM survey index swept area biomass data for the NWFSC shelf and slope surveys were much higher than simple swept area biomass calculations. Although some differences might be expected, the magnitude and consistency of the differences was surprising. GLMM procedures and models used to standardize the survey data should be checked and differences should be explained.*

Since 2007, considerable progress has been made in applying the GLMM for constructing survey abundance indices, and this method has become the default approach to deal with survey abundance data. The software for constructing indices of abundance using a delta-GLMM method (i.e. the probability that a catch during a haul is positive and the size of the catch in the haul are modeled separately) has been most recently updated. New software (a) improves the speed with which analyses can be conducted, (b) allows additional fit diagnostics to be produced, (c) allows catches to be modeled as a mixture of distributions so that exceptional catch-rates can be modeled, (d) allows the coefficient of variation of the distribution for the positive catches to be estimated rather than pre-specified, and (e) treats effort as an offset. This new software was recently reviewed by the PFMC' SSC. The SSC endorsed the new software for the analysis of trawl survey data and recommends using it in stock assessments. Following the recommendation of the 2007 STAR Panel, we did calculate survey abundance indices using design-based approach and included them in the model data file for comparison.

2) *Assessment data and background information should be presented clearly and completely before dealing with assessment models and modeling results. Data tables should be distributed at the start of the review.*

In this assessment, we substantially extended sections describing background information and data used. We also provide additional Tables and Figures to clearly summarize data used in the assessment and set the stage for explaining the model results.

3) *Future assessments should include complete sets of model diagnostics for GLMM standardized abundance indices, and other types of model runs.*

The new delta-GLMM software by Thorson and Ward (in press) produces a standard set of diagnostics, which include a posterior predictive check for all positive catch rate data, which (in case of this assessment) indicated no evidence of poor model fit. We included Bayesian Q-Q plots obtained from these posterior predictive checks for all surveys used in the assessment (Figure 35 through Figure 38). These plots show that the model can account for the variability seen in the positive catch rate data. Also, these Q-Q plots indicated that a mixture distribution was necessary to use to account for extreme catches (Thorson et al. 2011, 2012), while a comparison of average deviance (as recommended by A. MacCall, pers. com.) indicated that the gamma-mixture distribution provided better fit than a lognormal-mixture model.

4) *Maps showing the spatial overlap of the darkblotched rockfish stock area, surveys, fishing grounds and prime habitat should be provided and considered in interpreting survey data.*

In addition to the map of spatial distribution of darkblotched rockfish catch as observed by the WCGOP in Figure 1 (a similar map was included in the 2007 assessment), we supplied a detailed (5 page) map of spatial distribution of darkblotched rockfish catches in the NWFSC shelf-slope (combo) survey (Figure 2). We also included a table (Table 5) that summarizes latitudinal and depth ranges from four NMFS trawl surveys. Finally, to help interpret survey data, we included maps with NWFSC combo and AFSC triennial surveys catches per haul data (Figure 39, Figure 40).

General or long term recommendation on 2007 STAR Panel included:

1) *Continued work to characterize effective sample size for length composition and, particularly, conditional age composition data is needed. For example, the procedure used to assign effective sample size initially for darkblotched rockfish was questioned in this assessment.*

Considerable work has been done to address this long-term recommendation (Stewart and Miller, pers. com., Stewart and Hamel, pers.com.). The current consensus is that a combination of the number of trips (or tows) and the number of fish should be used to estimate input sample sizes used in the assessment.

2) *A full Bayesian assessment.*

We have explored the ability for Metropolis sampling to provide sufficient independent samples from the Bayesian posterior to allow for a Bayesian analysis of the model. Achieving 1,000,000 samples requires approximately 24 hours, and after discarding the first half and thinning to every 1,000th sample, this still results in significant lag-1 autocorrelation for the extra standard deviation parameter for the AFSC triennial survey. Previous research has also identified this parameter as being difficult to sample. Based on observed autocorrelation, we estimate that Bayesian sampling would require a 10-fold increase in samples. We, therefore, did not pursue using a Bayesian assessment in 2013. It is worth pointing, however, that the estimated parameters and time series of depletion are very similar between maximum likelihood and Bayesian runs, which supports continued attempts to improve Markov chain Monte Carlo sampling methods in future assessments.

3) *It would be useful to routinely check model estimates of survey catchability to determine if they imply implausible biomass estimates. This can be done by comparing the prior and posterior for q in a fully Bayesian assessment. Other approaches involve calculating bounds for plausible q values, comparison of model and minimum swept-area biomass estimates from trawl surveys.*

We have estimated a parameter for ln(Q) for every survey, and have determined that these values are plausible. The ln(Q) for the early triennial survey time series is estimated to be 0.59 (SE = 0.177), and the late triennial time series has an additive offset (in log-space) of 0.13 (SE = 0.312). The ln(Q) for the Alaska slope is estimated to be -0.04 (SE = 0.402), for the NWFSC slope 0.17 (SE = 0.370), and for the NWFSC shelf-slope (combo) survey 0.68 (SE = 0.336). The ln(Q) for the NWFSC combo survey being greater than zero is more probably explained by a single extreme catch in 2003 (Figure 39). This very large positive residual contributes to a high average observed in the NWFSC combo survey and causes the design-based estimate for that year to be aberrantly high and the delta-GLMM estimate for 2003 to be higher than can be fit by the model. Similarly, the ln(Q) greater than zero for the AFSC triennial survey is more probably explained by extreme catches in 1983, 1986, and 1995 (Figure 40).

We additionally explored including an 'extra standard deviation' parameter for all survey indices. This extra standard deviation parameter accounts for process errors, which are not otherwise estimated during index standardization (e.g., the survey only encountering a portion of total abundance) (Maunder and Punt, 2004, Wilberg et al., 2010). This extra standard deviation was estimated to be zero for the Alaska slope and NWFSC slope surveys, but was non-zero for the AFSC triennial and NWFSC combo surveys. These latter two surveys were the ones with ln(Q) greater than zero, and the 'extra standard deviation' parameters indicate that these indices have one or more years that are outliers (i.e., the model has trouble fitting these years given other data types and assumptions about stock productivity).

4) *Assessment and review work would have been enhanced if the STAT had consisted of more than one person and if more time had been available to carry out the assessment.*

As in the 2009 and 2011 update assessments, the current STAT includes more than one stock assessment scientists, which makes the entire process of stock assessment less stressful and more efficient.

2.3 Model Description

2.3.1 Changes made from the last assessment

The last full assessment of darkblotched rockfish was conducted in 2007. It was updated since then twice, in 2009 and 2011. This assessment relies on much of the same data used in the 2007 assessment; however, nearly all aspects of the analysis have been revised to some degree. Below, we describe the most important changes made since the last full assessment and explain rationale for each change:

1) Upgraded to the newest SS version. *Rationale*: This is standard practice to capitalize on newly developed features, corrections to older versions of the code and increases in computational efficiency. Model results were nearly identical before and after this change.

2) Updated Washington historical landings and used the recently reconstructed Oregon and California landings conducted by SWFSC and ODFW in collaboration with NWFSC. *Rationale*: To utilize the best available information for the assessment. Portion (but not the entire time series) of the new estimates for California historical landings was included in in 2009 update assessment and Oregon reconstructed landings were included in 2011 update assessment. The updated estimates of landings used in this assessment were very close to those used in the most recent update assessment (Figure 41).

3) Extended assessment time series back to 1915 (from 1928). *Rationale:* The recently reconstructed historical landings show that non-zero darkblotched rockfish catch in California goes back to 1916 (see Table 2). We used 1916 as the first years of catch, and assumed that the stock was in unfished equilibrium condition in 1915. Model results were nearly identical before and after this change.

4) Changed the structure of fishing fleets and divided fishery removals between two fisheries (instead of combining all removals into one fleet as in the last assessment). *Rationale*: Domestic trawl fishery has historically reported landed catch only, even though a portion of the darkblotched catch was discarded at sea.

Foreign POP fishery, on the other hand, was known not to discard, while at-sea hake fishery reports total catch, which includes both retained and discarded fish. To avoid inflating darkblotched catch in POP and at-sea hake fisheries, the domestic trawl fleet (TWL) and bycatch in foreign POP and at-sea hake fisheries (BYCATCH) were treated separately.

5) Treated the NWFSC shelf-slope survey as a single survey time series (instead of dividing it into slope and shelf portions as was done in the last assessment). *Rationale*: In the 2007 assessment, NWFSC shelf-slope survey was divided into slope and shelf portions and the slope portion was used as continuation of NWFSC slope survey, to have a longer survey time series in the assessment. The change in this assessment was made to utilize the much longer time series of NWFSC shelf-slope survey now available (2003-2012) that runs consistently across all depths and geographic areas.

6) Divided AFSC triennial survey into two time-series, 1980-1992 and 1995-2004 (instead of treating it as a single time series). *Rationale*: The change was made to account for differences in spatial coverage during two periods (Table 5) and to reflect a change in the timing of the survey after 1992 (Figure 14).

7) Used the newest GLMM software to construct survey abundance indices. *Rationale*: This new software includes a number of improvements compared with the previously used.

8) Included discard ratio estimates from Pikitch study for 1985, 1986 and 1987 (instead of using three year the data combined to generate one discard ratio estimate, as it was previous done). *Rationale*: The examination of Pikitch data showed that sampling of retained and discarded catch was conducted throughout the entire three years of the study. Model results were nearly identical before and after this change.

9) Brought back to the assessment “early” age data (those read prior to 2004). *Rationale*: the 2005 and 2007 assessments did not use early ages due to concerns that criteria for estimating ages of darkblotched rockfish may have changed and that a bias may have existed in those early estimates. We re-evaluated all the age data available and established that no changes were made in ageing criteria. We also explored a presence of potential bias in early age data by comparing double reads made by the same age reader in the early and late periods and found little support for early age data being biased relative to late age.

10) Extend the range of modeled ages, setting the ‘plus group’ in the age data to 35 (from 30). *Rationale*: For avoid having a large percentage of the mass of the data in the ‘plus-group’ with addition of previously unused early age data (see above).

11) Restructured data length bins, which now range between 4 and 62 cm, in 2 cm increments (instead of bins between 6 and 51 cm with variable increments

between bins). *Rationale*: To include the entire range data and aid interpretation by having uniform step size.

12) Updated fishery and survey biological data. *Rationale*: This was done to account for changes in length and age bin structures and utilize updates made to the analysis and data weighting methods, to account for sampling differences among trips and states.

13) Updated the weight-length relationship. *Rationale*: The relationship had not been revisited in several assessments. The revised estimates are based on NWSFC shelf-slope survey data, not previously available. In this, assessment, we also estimated and used weight-length relationships for females and males separately, instead of using one set of parameters for both sexes, as was done in previous assessment. Model results were nearly identical before and after this change (see Sensitivity analysis section).

14) Updated the maturity parameters. *Rationale*: The last assessment used the maturity schedule as estimated by Nickol (1990). The new maturity data collected within the NWFSC shelf-slope survey became recently available. These data were used to develop maturity at age matrix used in the assessment. Model results were nearly identical before and after this change (see Sensitivity analysis section).

15) Update fecundity parameters. *Rationale*: In several previous assessments, fecundity parameters were used as estimated by Nickol (1990) using data collected in waters off Oregon. Dick's (2009) analysis included data from several darkblotched fecundity studies, including those conducted using data from Oregon (Nickol and Pikitch, 1994), Washington (Snytko and Borets, 1973) and California (Phillips, 1964) waters. Model results were nearly identical before and after this change (see Sensitivity analysis section).

16) Used an updated prior to inform stock-recruit steepness. *Rationale*: In initial runs, an attempt was made to estimate the stock recruitment steepness (h) using the prior probability distribution derived from this year's meta-analysis of Tier 1 rockfish assessments. The estimated value was hitting the upper bound of 1 for the parameter. Therefore, following the recommendation of the PFMC' SSC, h was fixed in the assessment at the value of 0.778, which is the mean of steepness prior probability distribution. In 2007, the steepness was fixed at the value of 0.6, and in 2011 update assessment, steepness value was updated to 0.76. Model results were nearly identical when 0.76 (instead of 0.779) steepness value was used in this assessment (see Sensitivity analysis section).

17) Extended the estimation of recruitment deviations. *Rationale*: 'Main' recruitment deviations were estimated for modeled years that had information about recruitment (as determined from the bias-correction ramp), i.e., 1960-2011. We additionally estimated 'early' deviations between 1870 and 1959 so that age-

structure in the initial modeled year (1915) would deviate from the stable age-structure to a degree that is consistent with estimated variability in recruitment. This resulted in an estimate of B_0 that is also consistent with estimated variability in recruitment given the assumption that initial catch was negligible.

18) Updated the value for natural mortality from fixed 0.07 yr^{-1} for both sexes, as used in previous assessment, to estimating natural mortality for male while holding the value for females fixed at 0.05 yr^{-1}. *Rationale*: Natural mortality has been a major axis of uncertainty in several darkblotched rockfish assessments. The fixed value of 0.07 was used for natural mortality for both sexes in the 2005 and 2007 assessments. This value was selected as a reasonable when the stock-recruit steepness of 0.6 was used the model. In and prior to the 2003 assessment, the fixed value of 0.05 was used for both sexes. The lower estimate was supported by the Hoenig method (1983). For this assessment, we went back to using female natural mortality value of 0.05 yr^{-1}, as we found it to be more plausible than other (much higher) values derived from different (than Hoenig) methods. Dimorphic growth in fish is often accompanied by different rates of natural mortality. Even though model is unable to reliably estimate natural mortality for both sexes, compositional data can inform the difference between the sexes quite well, and estimating at least one sex would capture more of the uncertainty in the model results.

19) Estimated the extra standard deviations for AFSC triennial and NWFSC shelf-slope survey indices. *Rationale*: Estimating the additional variance components speeds the process of iterative reweighting among data sources and propagates the uncertainty about the true survey index variance into the model results. The attempt was made to estimate extra standard deviations for the surveys, but for AFSC and NWFSC slope surveys, these extra standard deviations were estimated to be 0.

20) Employed age selectivity type 11 (to include age-0 fish) instead of 10 (that assumes that age 0 fish are not selected). *Rationale*: The survey data used in the assessment include age-0 fish.

21) Re-evaluated length-based selectivity assumptions. In the last assessment, the length-based selectivity curves of fishery and NWFSC slope survey were assumed to be asymptotic. This assessment assumes only fishery to be asymptotic, but does not force any of the surveys to be asymptotic. *Rationale*: Examination of length composition data showed that domestic trawl fleet is catching the largest fish observed, therefore, assumption of trawl fleet selectivity being   Plus, when allowed to be dome-shaped, the trawl fishery selectivity was essentially asymptotic (with a drop observed in the very last bin). The selectivity curves for slope surveys, on the other hand, were estimated to be dome-shaped. We attributed survey dome-shaped selectivity to differences in gear used in survey vs. fishery (roller gear vs. rockhoppers) and to potentially more complex dynamics of darkblotched rockfish in the water column that currently known.

22) Re-evaluated length-based selectivity blocks. *Rationale*: In this assessment, blocks were created after the careful analysis of management actions that are most likely affect length-based selectivity of the fishery. The new block (2011-2012) was created for fishery retention inflection and slope parameters to reflect changes in selectivity with the start of the IFQ fishery. The number of blocks applied to asymptotic retention parameter was used to reflect changes in discard rates caused by changes in trip limits. A new block was added to descending width parameter for the AFSC shelf survey, to account for changes in depth coverage of the survey during 1995-2004 period.

The list above documents only the most important changes made to this assessment, compared to previous one. We also updated a number of settings in the model files to new recommended defaults. Despite the large number of changes made to data sources and model configuration, the results of this assessment are very consistent with those from previous analyses. Comparison of spawning depletion between this assessment and 2011 update assessment is shown in Figure 42.

2.3.2 Modeling software

This assessment uses the Stock Synthesis modeling framework developed by Dr. Richard Methot (NMFS, NWFSC). The most recent version (SSv3.24o, distributed on April 10, 2013) was used, since it included improvements in the output statistics for producing assessment results and several corrections to older versions.

2.3.3 General model specifications

This assessment focuses on a portion of a population of darkblotched rockfish that occurs in coastal waters of the western United States, off Washington, Oregon and California, the area bounded by the U.S.-Canada border on the north and U.S.-Mexico border on the south. The population within this area is treated as a single coastwide stock, given the lack of data suggesting the presence of multiple stocks. The modeling period begins in 1916, assuming that in 1915 the stock was in an unfished equilibrium condition.

Fishery removals are divided among two fleets: 1) the domestic trawl fishery, 2) bycatch in the foreign POP and at-sea Pacific hake fisheries. As described earlier, these two fleets are treated separately to account for difference in handling and reporting the discards. The domestic trawl fishery is associated with a particular amount of catch discarded at sea. The foreign POP fishery is known not to discard fish (based on their size or species), while the at-sea hake fishery, which is managed under maximized retention regulations. There, the time series of discards, therefore, are estimated for the domestic trawl fleet only, and no discard is assumed for the bycatch fleet.

Historical catches for the domestic trawl fishery were reconstructed by state, and then combined into the coastwide fleet. Selectivity and retention parameters are estimated for the domestic trawl fleet, while selectivity of the bycatch fleet is mirrored to that of the domestic trawl fishery. Each survey is treated as a separate fleet with independently estimated selectivity and catchability parameters reflecting differences in depth and latitudinal coverage, design and methods among them. No seasons are used to structure removals or biological predictions; data collection is assumed to be relatively continuous throughout the year. Fishery removals occur instantaneously at the mid-point of each year and recruitment on the 1st of January. Error distribution assumptions associated with different data sources used in the assessment are listed in Table 11.

This is a sex-specific model. The sex-ratio at birth is assumed to be 1:1. Growth of darkblotched rockfish is assumed to follow the von Bertalanffy growth model, and separate growth parameters are estimated for females and males. Females and males also have separate weight-at-length parameters.

Recruitment dynamics are assumed to be governed by a Beverton-Holt stock-recruit function. ‘Main’ recruitment deviations were estimated for modeled years that had information about recruitment, between 1960 and 2011 (as determined from the bias-correction ramp). We additionally estimated ‘early’ deviations between 1870 and 1959 so that age-structure in the initial modeled year (1915) would deviate from the stable age-structure that is consistent with estimated variability in recruitment. This resulted in an estimate of B_0 that is also consistent with estimated variability in recruitment given the assumption that initial catch was negligible.

The length composition data are summarized into thirty 2-cm bins, ranging between 4 and 62 cm. Population length bins are defined at a finer, 1-cm scale. The age data are summarized into thirty six bins, ranging being age 0 and age 35. Age data beyond age 35 comprise less than 5% of all the age data available for the assessment. For the internal population dynamics, ages 0-45 are individually tracked, with the accumulator age of 45 determining when the ‘plus-group’ calculations are applied. This accumulator age is selected since little growth is predicted to occur at and beyond this age, since the model does not allow growth to continue in the plus-group.

Iterative re-weighting was used in the assessment to achieve consistency between the input sample sizes and the effective sample sizes for length and age composition samples based on model fit. This reduces the potential for particular data sources to have a disproportionate effect on total model fit.

2.3.4 Estimated and fixed parameters

In the assessment, there are parameters of three types, including life history parameters, stock-recruitment parameters and selectivity parameters. These parameters were either fixed or estimated within the model. Reasonable bounds were specified for all estimated parameters. A full list of all parameters used in the assessment is provided in Table 12.

2.3.4.1 Life history parameters

Life history parameters that were fixed in the model included weight-at-length parameters for females and males, female maturity-at-length and fecundity-at-length and natural mortality. These parameters were either derived from data or obtained from the literature, as described in Section 2.1.3.

The von Bertalanffy growth function (von Bertalanffy, 1938) was used to model the relationship between length and age in darkblotched rockfish. This is the most widely applied somatic growth model in fisheries (Haddon 2001), and has been commonly used to model growth in rockfish species, including darkblotched (Hamel, 2008; Love et al., 2002; Rogers, 2005).

Female darkblotched rockfish were reported to reach larger sizes than males; therefore, time-invariant growth was modeled for each sex separately. The Stock Synthesis modeling framework uses the following version of the von Bertalanffy function:

$$L_A = L_\infty + (L_1 - L_\infty)e^{-k(A-A_1)}$$

Where asymptotic length, L_∞, is calculated as:

$$L_\infty = L_1 + \frac{L_2 - L_1}{1 - e^{-k(A_2-A)}}$$

In these equations, L_A is length (cm) at age A, k is the growth coefficient, $L_\propto$ is asymptotic length, and L_1 and L_2 are the sizes associated with a minimum A_1 and maximum A_2 reference ages.

Ages A_1 and A_2 were set to be 2 and 30 years, respectively. Female parameters L_1, L_2, growth coefficient k and CV associated with L_1 estimates were estimated in the model. The male L_2 and growth coefficient k were estimated in the model while L_1 and CV associated with L_1 were set to be identical to those of for females. CVs associated with L_∞ were fixed in the model at the values estimated outside the model for both sexes. To estimate CV at L_∞ we used length and age data from the NWFSC shelf-slope survey. These data were used to fit a 5-parameter growth model (L_1, L_∞, k, CV_1 and CV_∞), which matches the one used in Stock Synthesis, i.e., errors are normally distributed around the von Bertalanffy growth curve, and the standard deviation of errors varies as a function of length, being linearly interpolated between CV at L_1 and CV at L_∞.

2.3.4.2 Stock recruitment parameters

Recruitment dynamics are assumed in the assessment to be governed by a Beverton-Holt stock-recruit function. This relationship is parameterized to include two estimated quantities: the log of unexploited equilibrium recruitment (R_0) and steepness (h).

In this assessment the log of R_0 was estimated, while h was fixed at its prior mean of 0.779. This prior was estimated using a likelihood profile approximation to a maximum marginal likelihood mixed-effect model for steepness from ten Tier-1 rockfish species off the U.S. West Coast (Pacific ocean perch, bocaccio, canary, chilipepper, black, darkblotched, gopher, splitnose, widow and yellowtail rockfish). Both northern and southern assessments of black rockfish were used, although the log-likelihood for each was given a 0.5 weighting, to ensure that the together these two assessments had an equal weighting to the other species. This likelihood profile model is intended to synthesize observation-level data from assessed species, while avoiding the use of model output and thus improving upon previous meta-analyses (Dorn, 2002; Forrest et al., 2010). This methodology has been simulation tested, and has been recommended by the PFMC' SSC for use in stock assessments.

We estimate lognormal deviations from the standard Beverton-Holt stock-recruit relationship for the period between 1870 and 2011. Deviations are penalized in the objective function, and the standard deviation of the penalty (σ_R) is specified as:

$$\hat{\sigma}_R = \sqrt{\frac{\sum_{y=1870}^{2011} \hat{r}_y^{\,2}}{2011-1870} + \left(\frac{\sum_{y=1870}^{2011} \hat{s}\left(\hat{r}_y\right)}{2011-1870+1} \right)^2}$$

Where $\hat{r}_y$ is the estimated recruitment deviation in year y, $\hat{s}(\hat{r}_y)$ is the estimated standard error of $\hat{r}_y$, the first summand on the right-hand side represents the sample variance of the recruitment deviations; the second summand on the right-hand side represents the average standard error-squared of recruitment deviations, as recommended in the "**Estimating σ_R**" subsection of Methot and Taylor (2011) and correcting for their typo.

'Main' recruitment deviations were estimated for modeled years that had information about recruitment (as determined from the bias-correction ramp), i.e., 1960-2011. We additionally estimated 'early' deviations between 1870 and 1959 so that age-structure in the initial modeled year (1915) would deviate from the stable age-structure to a degree that is consistent with estimated variability in recruitment. This resulted in an estimate of B_0 that is also consistent with estimated variability in recruitment given the assumption that initial catch was negligible.

Recruitment deviations are also bias-corrected following Methot and Taylor (2011), by providing a proportion of the total bias correction for year y that varies depending upon how informative the data are about r_y. Specifically, we used R4SS (Taylor et al., 2012) to estimate a five-parameter bias-correction ramp (Figure 43).

2.3.4.3 Selectivity parameters

Gear selectivity parameters used in this assessment were specified as a function of size. Separate size-based selectivity curves were fit to each fishery fleet and survey, for which length composition data were available. Age-based selectivity was assumed to be 1.0 for all ages beginning at age-0.

A double-normal selectivity curve was used for all fleets, except for bycatch fishery, which was "mirrored" to domestic trawl fleet. The double-normal selectivity curve has six parameters, including: 1) peak, which is the length at which selectivity is fully selected, 2) width of the plateau on the top, 3) width of the ascending part of the curve, 4) width of the descending part of the curve, 5) selectivity at the first size bin, and 6) selectivity at the last size bin.

The selectivity curve for the domestic trawl fleet was assumed to be asymptotic because examination of length composition data revealed that this fleet is catching the largest fish observed. The selectivity curve was forced to be asymptotic by fixing the selectivity at the last size bin (parameter 6) at a large value. We also fixed the width of the plateau on the top (parameter 2) and the width of the descending part of the curve (parameter 4) at intermediate values since these parameters are redundant when selectivity is fixed to be asymptotic. When allowed to be dome-shaped (not fixed asymptotic), the fishery selectivity was essentially asymptotic with a drop observed in the very last bin, and trends in spawning output, recruitment, spawning depletion, relative SPR ratio as well as estimated current depletion levels were nearly identical for both runs (Figure 131 through Figure 134, Table 16).

A separate retention curve was estimated for the domestic trawl fleet. This retention curve is defined as a logistic function of size. It is controlled by four parameters including 1) inflection, 2) slope, 3) asymptotic retention, and 4) male offset to inflection. Male offset to retention was fixed at 0 (i.e. no male offset was applied). Asymptotic retention was set as a time-varying quantity to match the observed amount of discard between 2000 and 2010. The base value of asymptotic retention used for the period prior to 2000 and after 2010 was assumed to be 1, since only a small portion of the catch was discarded prior to 2000 and since implementation of the IFQ fishery. Inflection and the slope of the retention curve were also allowed to change in 2011 (the beginning of the IFQ fishery) since analysis of length composition data of retain catch indicated a change relative to the pre-IFQ years, with smaller fish being retained. The time-varying parameters were set via use of time blocks.

The selectivity curves for all the surveys were estimated to be dome-shaped. The most important factors justifying dome-shaped selectivity for the slope surveys are related to differences in the specific types of trawl gear used in the survey versus the fishery. The NWFSC shelf-slope survey uses roller gear that is efficient in catching groundfish on the soft bottom and rock piles, but not in structurally complex habitats, where a number of rockfish, including darkblotched rockfish, reside as adults.

The fishery, on the other hand, has often been using large rollers, often called rockhopper gear for the last 30 years. Rockhopper gear (as well as other technological innovations to access areas with structurally complex habitats, such as rock pinnacles, boulder fields and deep sea coral forests) replaced bottom trawls that were historically dragged on relatively smooth bottoms in shallow water. Such trawls could not be used in the high relief habitats without risking expensive damage to the net from snagging on and rubbing against the rough bottom. With rockhoppers, fishing vessels are able to trawl in structurally complex habitats with a reduced probability of gear damage or loss, though with much greater destruction of important fish habitat and bottom dwelling species so that fishery management councils in the U.S. have enacted some limitation on the size of roller or rockhopper gear to protect rocky habitat and their inhabitants.

Another reason for bottom trawl surveys not taking largest individuals of darkblotched rockfish can be related to complex behavior of darkblotched rockfish in the water column. Adult darkblotched rockfish are known to spend most of their time on the sea floor. However, Love et al. (2002) reports that darkblotched rockfish feed primarily in the midwater. The fact that darkblotched rockfish are among few rockfish species being bycaught in at-sea hake fishery (which operates in the midwater) confirms that this species can spend significant amount of time off the bottom, and therefore being not selected by bottom trawl survey gear.

2.4 Model Selection and Evaluation

2.4.1 Key assumptions and structural choices

The structure of the base model was selected to balance model realism and parsimony. Exploratory model runs, when natural mortality and shape of fishery selectivity curve were both estimated, demonstrated that the model was extremely unstable (i.e. was subject to local minima and produced wildly different results based on small differences in model assumptions). We agreed that we have more *a priori* information about natural mortality than about the shape of selectivity curve and, therefore, chose to fix natural mortality at a value ($0.05yr^{-1}$) that is consistent with the Hoenig method and a number of earlier assessments. Given this specification, the domestic trawl fishery selectivity curve is estimated to be asymptotic even when given the opportunity to be a dome-shaped (i.e. a double-normal form). We have, therefore, chosen to specify that fishery selectivity is asymptotic, which is consistent with previous assessments.

We additionally sought to account for the effect of Rockfish Conservation Areas (RCAs) on fishery selectivity. RCAs were initiated in September of 2002, and could conceivably influence both the ascending and descending shape of a dome-shaped selectivity curve. When conducting a sensitivity run, in which the descending component was blocked to be asymptotic prior to RCAs and dome-shaped after RCAs, the model continued to estimate an asymptotic shape after RCAs. Additionally, sensitivity runs that specified a different block for the ascending limb resulted in implausible shapes for the ascending slope of selectivity prior to 2003. This occurs primarily because there is limited data to estimate blocks in the retention curve prior to 2003, and the retention curve estimated that after 2003 most fish smaller than 25cm are being discarded. There is therefore essentially no information in the retained fishery length composition data to estimate changes in selectivity for the ascending limb affecting fish smaller than 25cm prior to 2003. For this reason, we stipulate that fishery selectivity is constant prior to and after of implementation of RCAs.

Finally, earlier model structures explored splitting the fishery catches into several different fleets, corresponding to trawl and non-trawl gears, at-sea-hake bycatch and the foreign POP fishery removals. Such a split allowed us to separately estimate selectivity curves for at-sea-hake fishery and by non-trawl gear fleet. However, these fleets had similar selectivity to the trawl fishery, and contributed only 1-2% to the total catch of darkblotched rockfish (Figure 4). Nevertheless, the model interpreted their composition data as representative of the entire stock, and iterative tuning of the composition data resulted in them receiving implausibly high weight (e.g., at-sea-hake bycatch having equal weight to the NWFSC shelf-slope survey compositional data). We, therefore, chose not to use at-sea compositional data in the assessment, and selected the fleet structure defined in the base model.

2.4.2 Changes made during the STAR Panel meeting

During the STAR Panel meeting, analysis and evaluation of the base model were performed to further explore data sources and model assumptions to better understand model performance. The STAR Panel provided useful recommendations that were incorporated into the base model. Specific changes made to the pre-STAR model during the STAR Panel meeting included:

1) Change setting for the ages A_1 and A_2 in growth parameter specification section from 0 and 999 (the latter corresponds to L_∞) to 2 and 30 years, to improve estimability of CV parameters.
2) Assume a single CV for young ages for both sexes since estimating the CV for young males seems redundant.
3) Estimate the value for male natural mortality while holding the value for females fixed at 0.05 yr^{-1}. Dimorphic growth in fish is often accompanied by different rates of natural mortality. Even though model is unable to reliably estimate natural mortality for both sexes, compositional data can inform the difference between the sexes quite well, and estimating at least one sex would capture more of the uncertainty in the model results.

2.4.3 Evidence of search for global best estimates

For all model runs, we checked for evidence that the reported estimates were not the global optimum using three techniques. First, we used R4SS (Taylor et al. 2012) to do 25 re-estimates of the model after 'jittering' starting values using a standard deviation of 0.1 times their parameter range, and ensured that the reported estimates had the greatest log-likelihood of all runs. In the case of the base model, jittering resulted in recovery of the initial estimates 25 times out of the 25 tests. Second, we conducted a likelihood profile across different values of ln(R_0) from 7.0 to 9.0 by 0.2 increments, to ensure that the reported estimates were at the maximum log-likelihood of this profile. Third, we ran 1,000,000 samples of Markov chain Monte Carlo, extracted the sample with the maximum log-likelihood, and re-ran the optimizer from this location to ensure that this run resulted in the same final value as the reported estimates. For the base model, all three techniques yielded no evidence that the reported estimates differed from the global optimum.

2.4.4 Convergence criteria

A number of tests were done to verify convergence of the base model. Following conventional AD Model Builder methods (Fournier et al. 2012), we checked that the Hessian matrix for the base model was positive definite. We also confirmed that the final gradient was below 0.01.

2.5 Base-Model Results

The list of the all the parameters used in the assessment model and their values (either fixed or estimated) is provided in Table 12. The life history parameters estimated within the model are reasonable and consistent with what we know about the species. Both sexes follow the same trajectory in their growth. Males grow slightly faster than females, but with females reaching larger sizes (Figure 44). The estimated growth parameters for females and males are very close to the values used in previous assessments. Figure 45 through Figure 48 show weight-at-length relationships by sex, female maturity-at-length, fecundity-at-weight and spawning output-at-length generated based on fixed parameters that were derived outside the model. Female fecundity and spawning output in the assessment are expressed in number of eggs.

The base model was able to capture general trends for indices in all surveys (Figure 49 through Figure 52). Fit to the NWFSC slope and AFSC slope surveys was generally flat, as might be expected for such short time-series. We additionally explored including an extra standard deviation parameter for these two slope surveys, but it was estimated to be zero for both of them. With the offset estimate for the AFSC triennial survey beginning in 1995, predicted survey values fit the AFSC shelf survey abundance index well (Figure 49).

The NWFSC shelf-slope survey exhibits a slightly increasing trend in recent years, and the fit to the survey is mostly flat with a slight increase in recent years. The model was unable to fit the first (2003) point of the NWFSC survey time series. This is mostly because that survey abundance index reflects patchiness in the spatial distribution of darkblotched rockfish. The map of NWFSC survey catches by haul of the survey by year (Figure 39) shows that the NWFSC shelf-slope survey encountered one large haul of darkblotched rockfish in 2003, which causes the delta-GLMM estimate for 2003 to be higher than can be fit by the model, and also causes the design-based estimate for that year to be aberrantly high. For the AFSC triennial and NWFSC shelf-slope surveys, the model estimated non-zero extra SD parameters (0.01 and 0.06 for the AFSC shelf and NWFSC shelf-slope survey, respectively).

The model fit to length and age frequency distributions, by year and aggregated across year, and Pearson residuals for the fits by fleet, year and sex are shown in Figure 53 through Figure 80. The quality of fit varies among years and fleets, which reflects the differences in quantity and quality of data. The Pearson residuals, which reflect the noise in the data both within and among years, did not exhibit any strong trends.

Plots of observed and expected length composition for the trawl landings aggregated across all years (Figure 57, Figure 58) shows that the model is able to replicate the single-modal length composition, as well as the tighter peak in length composition seen for males because the distribution of male length at maximum age has less overlap with the selectivity of the trawl fleet than does females. Similarly, the model is able to largely match the observed length composition for surveys, which incorporates differences in selectivity at length for these fleets. The survey length composition generally exhibits smaller average length than the fishery, and hence is more likely to pick out individual cohorts. This is born out in length composition plots by year for the NWFSC shelf-slope survey, where multiple modes are frequently seen and are generally matched by the model (e.g., male and female length compositions in 2010). Finally, the model is able to predict the changes in length composition of discards, including a noticeable decline in average length of discards following implementation of IFQ fishery in 2011 (Figure 62).

Plots of observed and expected age compositions for the trawl fishery aggregated across all years (Figure 79, Figure 80) indicate general agreement between model and data, with the model able to replicate the large abundance of the data plus group. We also show the age compositions of trawl landings for years (1980-2001, and 2009-2012) that were not used in the model because age sampling was not conducted coastwide (Figure 81, Figure 82). These age compositions do not contribute to the likelihood and do not affect model fit in any way. These compositions are, therefore, often called "ghost" compositions. The fit to the "ghost" trawl age compositions shows that the model is able to reproduce a decline in the proportion of total abundance available to the fishery within the data plus group, despite these data not being included in the model log-likelihood. This ability to replicate data that are not included in the model provides additional support for the suitability of this model.

The fits to conditional ages at length and Pearson residuals for the fits by survey are shown in Figure 86 through Figure 99. These plots show that predicted average age at length is generally within predicted error bars around the observed average age at length, which provides support for the assumption that length at age is adequately approximated by the base model, as is necessary to model size at age internally to Stock Synthesis. For visual interpretation of fit to survey age composition data, we included the "ghost" marginal survey age compositions, with the likelihood contribution turned off so that they do not affect model fit (Figure 100 through Figure 103).

Estimated selectivity curves for fisheries and surveys are shown in Figure 104 through Figure 111. Selectivity curves for the trawl surveys are generally credible and broadly similar (Figure 104). Shelf surveys (the AFSC shelf and the NWFSC shelf-slope) have peak selectivity at length for smaller fishes than slope surveys, as is plausible for a species that has ontogenetic movement offshore. The AFSC shelf survey also would be expected to take fewer larger fish due to limited coverage of the depth range of the species. Trawl fishery selectivity curve, which is fixed to be asymptotic, shows that trawl fleet takes much larger fish than any of the surveys (Figure 104). The retention function, as expected shows changes in asymptote with changes in discard ratios as well as changes in slope and inflection of the curve at the start of the IFQ fishery. Estimated values for selectivity and retention parameters are provided in Table 12.

Discard ratios for domestic trawl fishery, as estimated from WCGOP and Pikitch study data, were fit by the model very well (Figure 112). Based on these data, year-specific discard fraction and discard amounts were estimated within the model (Figure 113, Figure 114). These estimates follow the assumption that discard amounts were minimal until 2000, when the species was declared overfished, and more restrictive management measures were implemented. Discard ratios increased following the implementation of management measures in the 2000s but decreased after the implementation of IFQ fishery. The retention curve is similarly estimated to shift to smaller fishes following IFQ implementation, as fishers are encouraged to retain broader sizes of fish. The mean body weights of individuals in the discard were also fit very well (Figure 115).

The deviations from the estimated stock-recruitment function had a very large uncertainty prior to the mid-1960s, when the data first become informative about incoming cohort strengths (Figure 116). Therefore, the relative bias adjustment was ramped to the maximum value during this period. Recruitment of darkblotched rockfish was estimated to be quite variable over the historical record, and the estimated stock-recruit function predicts a wide range of cohort sizes over the observed range of spawning biomass (Figure 117).

The estimated time series of total and summary biomass, spawning output, spawning depletion (relative to B_0), recruitment and fishing mortality are presented in Figure 118 through Figure 123 and Table 13. Trends in total and summary biomass, spawning output and spawning depletion track one another very closely. The spawning output of darkblotched rockfish started to decline in the 1940s, during the World War II, but exhibited a sharp decline in the 1960s during the time of the intense foreign fishery targeting Pacific ocean perch. Between 1965 and 1975, the spawning output dropped from 89% to under 57% of its unfished level. The spawning output continued to decrease throughout the 1980s and 1990s and in 1999 reached its lowest estimated level of 13% of its unfished state. Since 2000, the spawning output has been slowly increasing that corresponds to decreased removals due to management regulations. Currently, the spawning output is estimated to be 36% of its unfished level (Figure 121).

2.6 Uncertainty and Sensitivity Analyses

Parameter uncertainty in the assessment is explicitly captured in the asymptotic confidence intervals estimated within the model and reported throughout this assessment for key parameters and management quantities (Figure 120, Figure 121 and Figure 122). These intervals reflect the uncertainty in the model fits to the data sources in the assessment, but do not include the uncertainty associated with alternative model configurations and fixed parameters. To explore uncertainty associated with alternative model configurations and evaluate the responsiveness of model outputs to changes in model assumptions, a variety of sensitivity runs were performed.

2.6.1 Sensitivity Analyses

A large number of configurations of the base model addressing alternative assumptions regarding key model parameters and structural choices were explored via the sensitivity analysis. Only the most relevant ones are reported here. Results of these selected sensitivity runs are summarized in Table 14, Table 15, Table 16 and Figure 124 through Figure 134.

2.6.1.1 Alternative assumptions about fishery removals

Historically, darkblotched rockfish landings have not been sampled at the discrete species level; therefore, time series of catch remained a source of uncertainty. Although significant progress has been made in reconstructing historical California and Oregon landings, the lack of early species composition data does not allow to account for a gradual shift of fishing effort towards deeper areas, which can cause the potential to overestimate the historical contribution of slope species (including darkblotched rockfish) to overall landings of the mixed-species market category (i.e. "unspecified rockfish"). To explore the model sensitivity to uncertainty in darkblotched rockfish removals, we ran the model assuming: 1) landings in full time series of domestic trawl fishery doubled, 2) landings in full time series of domestic trawl fishery halved, 3) landings in historical (pre-1980) time series of domestic trawl fishery doubled, 4) landings in historical (pre-1980) time series of domestic trawl fishery halved, 5) catches in both fleets (TWL and BYCATCH) doubled, and 6) catches in both fleets (TWL and BYCATCH) halved. Although these runs differed in the absolute estimate of B_0 and R_0 (Figure 124Figure 125), the trends in spawning depletion, and relative SPR ratio as well as estimated depletion levels varied only slightly (Figure 126, Figure 127, Table 14).

2.6.1.2 Alternative assumptions about life history parameters

A major uncertainty in this assessment is associated with life history parameters, particularly natural mortality and stock-recruit curve steepness. These quantities, which the model is unable to estimate reliably, were fixed at the values estimated outside the model. The model response to different values of natural mortality and steepness was explored via detailed likelihood profile analyses described above.

In this assessment, we also updated such life history parameters as female maturity and fecundity as well as parameters of weight-length relationships for both sexes. We used the newly available maturity data (collected within the NWFSC shelf-slope survey) to develop maturity at age matrix for the assessment, and new female fecundity estimates generated by Dick (2009) to describe female fecundity at weight relationship. In previous several assessments, female maturity and fecundity parameters were used as estimated by Nickol (1990). For new weight-length parameters, we used previously unavailable data from NWFSC shelf-slope survey and estimated separate sets of parameters for females and males, instead using one set of parameters for both sexes, as was done in several previous assessments. To explore the model sensitivity to updated maturity, fecundity and weight-length parameters, we ran the model assuming: 1) maturity parameters from Nickol (1990) as used in the previous assessment, 2) female fecundity parameters from Nickol (1990) as used in the previous assessment, and 3) weight-length relationship parameters as used in the previous assessment. We also ran the model with stock-recruit steepness fixed at the value of 0.76, as used in the 2011 assessment, and not at the value of 0.779 as used in this assessment. Model results, including trends in spawning output, recruitment, spawning depletion and relative SPR ratio, were nearly identical before and after these changes (Figure 128 through Figure 130, Table 15). Estimated current depletion levels varied only slightly. Finally, ran the model with combination of assumed values of stock-recruit steepness (0.6) and natural mortality (0.07) as used in 2007 assessment. This ran produced the biggest change in model output, confining that combination of steepness and natural mortality parameters are essential for understanding the dynamics of the stock.

2.6.1.3 Alternative assumptions about selectivity parameters

In the base model, fishery selectivity curve was fixed asymptotic. We ran the model, allowing fishery selectivity to be dome-shaped. In this run, the fishery selectivity was essentially asymptotic with a drop in the very last bin, and trends in spawning output, recruitment, spawning depletion, relative SPR ratio as well as estimated current depletion levels were nearly identical for both runs (Figure 131 through Figure 134, Table 16).

In the assessment, the shape of selectivity curves for all the surveys were estimated and, therefore, allowed to be dome-shaped. In the previous assessment, NWFSC slope survey (which included a slope portion of NWFSC shelf-slope survey) was fixed asymptotic. In this assessment, we use NWFSC shelf-slope survey as a single time period, and to explore how sensitive model is to the assumption of this survey selectivity being dome-shaped vs. asymptotic, we ran the model with this survey selectivity fixed asymptotic. The results are shown in Figure 131 through Figure 134 and Table 16. Even though trends in spawning output, recruitment, spawning depletion, relative SPR ratio as well as estimated current depletion levels were only slightly different, overall model fit degraded as indicated by the increased in negative log-likelihood degraded (Table 16).

2.6.2 Retrospective analysis

A retrospective analysis was conducted, where the model is fitted to a series of shortened input data sets, with the most recent years of input data sequentially being dropped. A 5-year retrospective analysis was conducted by running the model using data only through 2007 (“5 year”), 2008, 2009, 2010 and 2011 (Figure 135 through Figure 138, Table 17). Little evidence of retrospective patterns was apparent.

The second type of retrospective analysis addresses assessment error, or at least the historical context of the current result given previous analyses. Figure 139 shows the spawning depletion time series for all assessment (full and update assessment) conducted since 2005. In aggregate, these assessments have largely drawn the same conclusions regarding historical trends: that the darkblotched resource declined rapidly due to high fishing intensity in the 1960s and 1970s, with continued decline in the 1980s and 1990s reaching the lowest point around 2000. For the last decade, the stock was slowly increasing due to management efforts toward rebuilding of the stock.

2.6.3 Likelihood profile analyses

The base model included several key parameters, such as natural mortality and stock-recruit steepness, which were fixed at the values determined based on life-history traits of the species of meta-analysis of species with similar life-history characteristics. To explore how informative the data in the model are in regard to these parameters, we performed likelihood profile analyses where we varied the values of these parameters and recorded the change the overall fit of the model.

A likelihood profile analysis conducted over a range of values for natural mortality shows that the negative log-likelihood for the base model declines with increasing natural mortality for all values between 0.02 and 0.10 (Figure 140). Natural mortality >0.10 is inconsistent with the age of old individuals that have been observed, as well as previous assessments, and we, therefore, conclude that the model is unable to reliably estimate natural mortality. Also, the fact that the length and age composition data available for the assessment were collected only after extremely high darkblotched removals by the foreign POP fishery (and, therefore, these data cannot be expected to represent unfished equilibrium) provides an additional argument for the model not being able to estimate natural mortality reliably.

Similarly, a likelihood profile for steepness shows that the negative log-likelihood for the base model declines with increasing steepness up to the value of 0.95 (Figure 141). This value of steepness is considered to be implausible for a slow growing rockfish, although it is logical for the model to prefer a high steepness value given the strong recruitments seen at low biomass in 1995, 1999, 2000 and 2005. Given this implausible value, have chosen to fix steepness at the mean of the prior distribution obtained from 10 Tier-1 rockfish assessments off the U.S. West Coast (h = 0.779). This approach is consistent with recommendation of the PFMC' SSC regarding the use of the steepness prior.

We also conducted a likelihood profile analysis for $\ln(R_0)$, which shows that the negative log-likelihood for the base model is optimized at a value of approximately 7.7 (as is estimated in the assessment), and that the primary source of information about $\ln(R_0)$ is in recruitment penalties (Figure 142). Exploratory analysis shows that different values of $\ln(R_0)$ scale recruitment deviations up or downward from the mean value of 0, with low values of $\ln(R_0)$ having high recruitment deviations and vice-versa (Figure 143, Figure 144). Additionally, resulting recruitment scales with of $\ln(R_0)$, with high values of $\ln(R_0)$ having higher recruitment and low values of $\ln(R_0)$ having lower recruitment. This indicates that available data cause the model to seek a particular value for recruitment, and changes in $\ln(R_0)$ cause the model to compensate by changing recruitment deviations to continue achieving that desired level of recruitment, which causes recruitment deviations to contribute the greatest change in log-likelihood to $\ln(R_0)$.

3 Reference Points

Unfished spawning stock output for darkblotched rockfish was estimated to be 3,358 million eggs (95% confidence interval: 2,603-4,114 million eggs). The stock is declared overfished if the current spawning output is estimated to be below 25% of unfished level. The management target for darkblotched rockfish is defined as 40% of the unfished spawning output ($SB_{40\%}$), which is estimated by the model to be 1,343 million eggs (95% confidence interval: 1,041-1,646), which corresponds to an exploitation rate of 0.0402. This harvest rate provides an equilibrium yield of 675 mt at $SB_{40\%}$ (95% confidence interval: 526-824 mt). The model estimate of maximum sustainable yield (MSY) is 742 mt (95% confidence interval: 578-906 mt). The estimated spawning stock output at MSY is 819 million eggs (95% confidence interval: 635-1,003 million of eggs). The exploitation rate corresponding to the estimated SPR_{MSY} of $F_{30\%}$ is 0.0665.

The assessment shows that the stock of darkblotched rockfish off the continental U.S. Pacific Coast is currently at 36% of its unexploited level. This is above the overfished threshold of $SB_{25\%}$, but below the management target of $SB_{40\%}$ of unfished spawning output. Historically, the spawning output of darkblotched rockfish dropped below the

$SB_{40\%}$ target for the first time in 1987, as a result of intense fishing by foreign and domestic fleets. It continued to decline and reached the level of 13% of its unfished spawning output in 1999. Since 2000, when the stock was declared overfished, the spawning output was slowly increasing primarily due to management regulations implemented for the species (Figure 121).

This assessment estimates that the 2012 SPR is 86%, while the SPR-based management fishing mortality target is 50%. For the last 10 years, the relative SPR ratio (calculated as $1\text{-}SPR/1\text{-}SPR_{Target=0.50}$) was below one, which means that overfishing of darkblotched rockfish has not been occurring (Figure 145). Historically, the darkblotched rockfish has been fished beyond the SPR-based target between 1966 and 1968, during the peak years of the Pacific ocean perch fishery and for a prolonged period between from 1981 and 2002. In the early-1970s the estimated darkblotched rockfish SPR ratio remained near the SPR target but exceeded it in 1973 and 1979. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model is shown in Figure 146, which also indicates that overfishing of darkblotched rockfish is not occurring.

A summary of reference points for the base model is provided in Table 18. A summary of recent trends in estimated darkblotched rockfish exploitation and stock level from the assessment model is given in Table 19.

4 Harvest Projections and Decision Table

The base model estimate for 2013 spawning depletion is 36%. The primary axis of uncertainty about this estimate used in the decision table was based on female natural mortality. Alternative states of nature were characterized using both the likelihood profile and the prior distribution for female natural mortality. The choice to use both sources of information for this fixed parameter was motivated by the observation that the data showed strong evidence against extremely low values of natural mortality, but was relatively flat for large values. In the absence of a fully integrated posterior distribution, the prior distribution based on maximum age was used as a proxy for the upper end of the range. The low and high states of nature for the decision table were therefore based on female natural mortality values of 0.036 and 0.082, both approximately half as likely as the value used in the base model (0.05). The lower value of natural mortality corresponded to a depletion estimate of 18%, while the higher value corresponded to 82%, illustrating the marked sensitivity of the assessment results to a poorly informed parameter.

Twelve-year forecasts for each state of nature were calculated based on removals at current rebuilding SPR of 64.9% for the base model. Twelve-year forecasts were also calculated based on removals at an SPR of 71.9% for the base model, as requested by the Groundfish Management Team (GMT). This lower catch stream that corresponds to SPR 71.9% was used in the Decision Table of the 2011 darkblotched assessment. Finally, twelve-year forecasts for each state of nature were produced with future catches fixed at the 2014 ACL set for darkblotched rockfish.

Under the middle state of nature (which corresponds to the base model), the spawning output and depletion are projected to increase under all three considered catch streams, and reach the SB40% target in 2015. Under the low state of nature, spawning output and depletion are also projected to increase under all three catch streams considered, but will stay below the SB40% target within the next 12 years. Under the middle state of nature, the spawning output remains above the 40% target level throughout the 12-year projection period.

5 Regional Management Considerations

This species is currently managed coastwide, with coastwide ACLs determined for management purposes. This assessment is not spatially structured. There are indications, however, that life history parameters, particularly growth, might be varying with latitude. Analysis conducted within this assessment did not allow to identify specific areas with different growth parameters, but rather detected continues gradient along the coast, which is common for *Sebastes* species on the West Coast of the United States. It was also suggested that maturity parameters may vary with latitude, as maturity schedule of fish collected in waters off California (Echeverria, 1987; Phillips, 1964) were found to be smaller than those of fish collected off Oregon (Nichol, 1990). However, Nichol (1990) argued that these differences can be rather attributed to different criteria used in different studies to determine maturity. Besides, Westrheim (1975) reported that the size at 50% maturity for darkblotched rockfish decreased, rather than increased, with increasing latitude increased from Oregon to Alaska. To evaluate appropriateness of coastwise management of darkblotched rockfish, further research should be conducted to evaluate latitudinal variability in life history characteristics of this species. Also, given that the population range extends north to the border with Canada, it is important that future research evaluates the feasibility of a joint assessment with Canada.

6 Research Needs

The following research could improve the ability of future stock assessments to determine the current status and productivity of the darkblotched rockfish population:

1) The base model does not use commercial age composition data for years that lacked coast wide samples. The additional age data could provide information necessary for the model to estimate such parameters as natural mortality. Future research could ascertain whether additional otoliths exist for these years, and whether they could be aged using current ageing methods. Also, alternative fleet structures (with state specific fisheries) could be explored to take use of as much available age data as possible.

2) The base model uses newly available information of female maturity collected within the NWFSC shelf-slope survey. This new information includes data on mass atresia (a form of skipped spawning), not previously available for the assessment. At present, Stock Synthesis allows incorporation of this information only when maturity is expressed as a function of age. Effort should be devoted to expand maturity options in Stock Synthesis to allow expression of maturity information (with mass atresia) as a function of female length. Also, continued

collection of maturity samples would allow future researchers to explore differences in maturity at age, either spatially or over time.

3) Additional research would be important to explore whether other life history parameters, such as growth and fecundity vary spatially or change over time as well. This information will help in defining spatial structure of future models.

4) Given that the population range extends north to the border with Canada, it is important that future research would evaluate the impact of not accounting for any Canadian portion of population abundance. Such an analysis would require evaluation of movement of darkblotched along the coast, which information is currently lacking.

5) Future research could also improve existing meta-analyses for natural mortality and steepness, which both contribute to the implied yield curve. Directions for improvements include (1) explaining variability between methods in natural mortality estimates, included in the Hamel natural mortality method and (2) developing a larger database of species for estimating steepness, perhaps by including species from other regions, e.g., Canada and Alaska.

6) Imprecision in the indices of abundance derived from survey sampling, due a low probability the species occurrence, is one of the sources of uncertainty in this assessment. Future research could explore the utility of model-based index standardization techniques; in particular, those using spatial modeling approaches. Spatial models could potentially account for the component of sampling variance arising from the random allocation of sampling tows either in or outside of suitable habitat. Such models could potentially decrease residual variance and imprecision of the resultant indices of abundance.

7) Finally, we note that Markov chain Monte Carlo sampling using the Metropolis algorithm was unable to obtain a sufficient number of independent samples within a feasible time period. However, it had trouble primarily with a single parameter (variance inflation for a survey index). We therefore recommend to improve MCMC options in ADMB, perhaps by making necessary changes to the Hamiltonian MCMC option (i.e., by allowing samples to be thinned during running, and hence making longer MCMC chains feasible for the ADMB implementation of Hamiltonian sampling).

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8 Tables

Table 1: Recent darkblotched rockfish Overfishing Limits (OFLs) and Annual Catch Limits (ACLs) relative to recent total landings and total dead catch estimated in this assessment.

Year	OFL (mt)	ACL (mt)	Commercial Landings (mt)	Estimated Total Catch (mt)*
2003	205	172	80	213
2004	240	240	189	244
2005	269	269	98	130
2006	294	200	107	192
2007	456	290	144	281
2008	487	330	117	253
2009	437	285	138	294
2010	440	291	184	350
2011	508	298	117	120
2012	497	296	94	96

*Includes discards estimated within the stock assessment and therefore may differ from total mortality reports used by management.

Table 2: Total landings (mt) of darkblotched rockfish for the domestic trawl fleet (provided here by state) and bycatch fleet (separated here as bycatch in foreign POP and in at-sea Pacific hake fisheries).

Year	Domestic trawl California	Domestic trawl Oregon	Domestic trawl Washington	Bycatch in foreign POP fishery	Bycatch in at-sea hake fishery	Total
1915	0	0	0	0	0	0
1916	13	0	0	0	0	13
1917	21	0	0	0	0	21
1918	21	0	0	0	0	21
1919	14	0	0	0	0	14
1920	14	0	0	0	0	14
1921	12	0	0	0	0	12
1922	11	0	0	0	0	11
1923	14	0	0	0	0	14
1924	14	0	0	0	0	14
1925	16	0	0	0	0	16
1926	21	0	0	0	0	21
1927	18	0	0	0	0	18
1928	18	0	0	0	0	18
1929	19	0	0	0	0	19
1930	21	0	0	0	0	21
1931	26	0	0	0	0	26
1932	16	0	0	0	0	16
1933	16	0	0	0	0	16
1934	15	0	0	0	0	15
1935	17	0	0	0	0	17
1936	11	0	0	0	0	12
1937	13	1	0	0	0	14
1938	16	0	0	0	0	17
1939	23	1	0	0	0	24
1940	20	13	0	0	0	33
1941	22	19	0	0	0	42
1942	12	36	1	0	0	48
1943	57	125	2	0	0	184
1944	177	218	3	0	0	398
1945	334	337	8	0	0	679
1946	189	209	4	0	0	401
1947	199	130	2	0	0	332
1948	99	89	3	0	0	191
1949	70	86	4	0	0	160

Year	Domestic trawl California	Domestic trawl Oregon	Domestic trawl Washington	Bycatch in foreign POP fishery	Bycatch in at-sea hake fishery	Total
1950	73	101	4	0	0	178
1951	106	96	3	0	0	206
1952	78	136	3	0	0	217
1953	87	96	1	0	0	185
1954	79	136	2	0	0	217
1955	131	123	2	0	0	256
1956	149	189	2	0	0	339
1957	190	205	1	0	0	396
1958	180	153	2	0	0	335
1959	139	142	2	0	0	283
1960	151	189	2	0	0	342
1961	120	197	2	0	0	319
1962	107	235	3	0	0	345
1963	136	225	7	0	0	368
1964	85	175	5	0	0	265
1965	97	380	6	0	0	483
1966	84	320	8	3807	0	4220
1967	102	262	6	2706	0	3076
1968	110	17	7	2288	0	2422
1969	43	80	11	153	0	287
1970	49	145	8	149	0	351
1971	65	174	11	278	0	528
1972	84	148	6	374	0	611
1973	67	67	13	768	0	914
1974	95	144	24	346	0	609
1975	106	102	111	293	0	612
1976	121	322	99	118	11	670
1977	123	130	62	0	2	318
1978	60	156	199	0	1	416
1979	148	497	88	0	4	736
1980	166	334	99	0	21	620
1981	522	266	37	0	12	836
1982	170	941	24	0	2	1136
1983	510	582	22	0	12	1126
1984	596	625	82	0	20	1323
1985	802	848	111	0	13	1774
1986	417	622	215	0	6	1260
1987	1647	686	68	0	14	2415
1988	750	789	108	0	10	1656

Year	Domestic trawl California	Domestic trawl Oregon	Domestic trawl Washington	Bycatch in foreign POP fishery	Bycatch in at-sea hake fishery	Total
1989	441	737	91	0	5	1274
1990	870	764	16	0	28	1679
1991	333	774	54	0	45	1206
1992	187	451	20	0	29	687
1993	285	892	9	0	8	1194
1994	292	550	9	0	15	866
1995	366	342	28	0	49	786
1996	408	309	19	0	6	743
1997	452	342	22	0	4	820
1998	497	395	20	0	14	927
1999	113	227	10	0	11	361
2000	114	129	8	0	8	259
2001	87	66	10	0	12	175
2002	50	52	7	0	3	112
2003	11	62	2	0	4	80
2004	39	136	7	0	7	189
2005	18	68	1	0	11	98
2006	23	71	2	0	11	107
2007	41	87	3	0	12	144
2008	34	74	3	0	6	117
2009	47	89	2	0	0	138
2010	17	152	7	0	8	184
2011	3	87	14	0	12	117
2012	7	70	15	0	2	94

Table 3: Summary of fishery sampling effort (number of trips, hauls and fish sampled) used to create length frequency distributions of the domestic trawl fishery.

Year	Lengths from retained catch						Lengths from discarded catch		
	California		Oregon		Washington				
	# Trips	# Fish	# Trips	# Fish	# Trips	# Fish	# Trips	#Hauls	# Fish
1977	0	0	5	304	0	0	0	0	0
1978	26	263	2	200	0	0	0	0	0
1979	11	86	0	0	0	0	0	0	0
1980	31	206	0	0	0	0	0	0	0
1981	29	195	0	0	0	0	0	0	0
1982	55	444	2	300	0	0	0	0	0
1983	115	792	0	0	0	0	0	0	0
1984	161	1925	1	70	0	0	0	0	0
1985	206	2985	0	0	0	0	0	0	0
1986	145	2436	0	0	0	0	5	0	145
1987	119	2644	0	0	0	0	0	0	0
1988	93	1339	0	0	0	0	0	0	0
1989	91	1098	0	0	0	0	0	0	0
1990	89	862	1	100	0	0	0	0	0
1991	72	756	2	200	0	0	0	0	0
1992	45	421	0	0	0	0	0	0	0
1993	42	509	0	0	0	0	0	0	0
1994	39	436	2	200	0	0	0	0	0
1995	40	745	7	188	0	0	0	0	0
1996	72	1003	23	833	0	0	0	0	0
1997	52	909	22	802	0	0	0	0	0
1998	70	1232	13	541	24	317	0	0	0
1999	37	712	9	430	24	332	0	0	0
2000	50	869	7	224	20	652	0	0	0
2001	39	692	30	1005	20	660	0	0	0
2002	39	861	21	611	47	1124	34	70	674
2003	27	436	59	1398	28	580	40	91	851
2004	29	526	58	1305	19	605	67	117	742
2005	33	567	54	1275	9	117	109	257	1526
2006	62	1129	62	1457	10	397	116	292	1152
2007	74	1520	79	2155	22	529	108	169	573
2008	81	1795	102	2689	12	350	121	202	674
2009	52	1214	136	2828	11	350	203	317	1154
2010	44	746	136	2855	5	206	89	138	538
2011	53	559	148	2570	17	869	82	125	349
2012	0	0	124	2301	17	729	0	0	0

Table 4: Summary of fishery sampling effort (number of trips, hauls and fish sampled) used to create age frequency distributions of the domestic trawl fishery.

Year	Ages from retained catch						Ages from discarded catch		
	California		Oregon		Washington				
	# Trips	# Fish	# Trips	# Fish	# Trips	# Fish	# Trips	#Hauls	# Fish
1980	28	185	0	0	0	0	0	0	0
1981	29	195	0	0	0	0	0	0	0
1982	52	413	0	0	0	0	0	0	0
1983	79	527	0	0	0	0	0	0	0
1985	198	2874	0	0	0	0	0	0	0
1986	17	169	0	0	0	0	0	0	0
1987	48	1071	0	0	0	0	0	0	0
1988	29	372	0	0	0	0	0	0	0
1990	75	798	0	0	0	0	0	0	0
1991	35	352	0	0	0	0	0	0	0
1993	37	468	0	0	0	0	0	0	0
1994	35	417	0	0	0	0	0	0	0
1995	17	354	0	0	0	0	0	0	0
1996	58	776	0	0	0	0	0	0	0
1997	48	810	1	33	0	0	0	0	0
1998	53	855	0	0	0	0	0	0	0
1999	23	500	1	24	0	0	0	0	0
2000	30	562	6	183	0	0	0	0	0
2001	27	620	25	843	0	0	0	0	0
2002	29	635	20	610	12	388	0	0	0
2003	22	319	51	1162	11	369	0	0	0
2004	15	243	27	753	11	414	42	62	229
2005	31	493	42	912	6	103	81	171	506
2006	46	856	54	1219	8	293	0	0	0
2007	30	559	66	1774	18	423	0	0	0
2008	21	309	87	2350	9	243	0	0	0
2009	0	0	35	905	11	272	0	0	0
2010	0	0	116	2331	4	120	0	0	0
2011	0	0	0	0	15	535	0	0	0
2012	0	0	16	421	10	455	0	0	0

Table 5: Latitudinal and depth ranges by year of four NMFS groundfish trawl surveys used in the assessment.

Survey	Year	Latitudes	Depths (fm)
AFSC shelf	1977	34° 00'- Border	50-250
	1980	36° 48'- 49° 15'	30-200
	1983	36° 48'- 49° 15'	30-200
	1986	36° 48'- Border	30-200
	1989	34° 30'- 49° 40'	30-200
	1992	34° 30'- 49° 40'	30-200
	1995	34° 30'- 49° 40'	30-275
	1998	34° 30'- 49° 40'	30-275
	2001	34° 30'- 49° 40'	30-275
	2004	34° 30'- Border	30-275
AFSC slope	1988	44° 05'- 45° 30'	100-700
	1990	44° 30'- 40° 30'	100-700
	1991	38° 20'- 40° 30'	100-700
	1992	45° 30'- Border	100-700
	1993	43° 00'- 45° 30'	100-700
	1995	40° 30'- 43° 00'	100-700
	1996	43° 00'- Border	100-700
	1997	34° 00'- Border	100-700
	1999	34° 00'- Border	100-700
	2000	34° 00'- Border	100-700
	2001	34° 00'- Border	100-700
NWFSC slope	1999	34° 50'- 48° 10'	100-700
	2000	34° 50'- 48° 10'	100-700
	2001	34° 50'- 48° 10'	100-700
	2002	34° 50'- 48° 10'	100-700
NWFSC shelf-slope	2003	32° 34'- 48° 27'	30-700
	2004	32° 34'- 48° 27'	30-700
	2005	32° 34'- 48° 27'	30-700
	2006	32° 34'- 48° 27'	30-700
	2007	32° 34'- 48° 27'	30-700
	2008	32° 34'- 48° 27'	30-700
	2009	32° 34'- 48° 27'	30-700
	2010	32° 34'- 48° 27'	30-700
	2011	32° 34'- 48° 27'	30-700
	2012	32° 34'- 48° 27'	30-700

Table 6: Spatial strata used in constructing survey abundance indices for surveys used in the assessment.

Survey	Latitude (N. lat.)	Depth (m)
AFSC shelf (1980-1992)	$36^0$5” – $40^0$5”	55-400
	$40^0$5” – 43^0	55-400
	43^0 – $47^0$5”	55-400
	$47^0$5” – 49^0	55-400
AFSC shelf (1995-2004)	$34^0$5” – $40^0$5”	55-300 300-500
	$40^0$5” – 43^0	55-300 300-500
	43^0 – 49^0	55-300 300-500
AFSC slope	$34^0$5” – 43^0	183-300 300-549
	43^0 – 49^0	183-300 300-549
NWFSC slope	$34^0$5”– $40^0$5”	183-300 300-549
	$40^0$5” – 43^0	183-300 300-549
	43^0 – $47^0$5”	183-300 300-549
	$47^0$5” – 49^0	183-300 300-549
NWFSC shelf-slope	$34^0$5” – $40^0$5”	55-300 300-549
	$40^0$5” – 43^0	55-300 300-549
	43^0 – $47^0$5”	55-300 300-549
	$47^0$5” – 49^0	55-300 300-549

Table 7: Summary of sampling effort used to produce AFSC shelf survey biomass index and generate length and age frequency distributions.

Year	Number of hauls	Number of positive hauls	Number of hauls with lengths	Number of lengths	Number of hauls with ages	Numbers of ages
1980	349	126	12	656	2	96
1983	521	232	44	4483	1	117
1986	484	188	39	1839	8	219
1989	505	198	91	3056	0	0
1992	482	159	43	1614	0	0
1995	512	172	163	2897	45	626
1998	528	169	169	3396	62	467
2001	506	186	186	2935	115	1030
2004	383	152	152	3578	148	1134

Table 8: Summary of sampling effort used to produce AFSC slope survey biomass index and generate length and age frequency distributions.

Year	Number of hauls	Number of positive hauls	Number of hauls with lengths	Number of lengths	Number of hauls with ages	Numbers of ages
1997	182	27	25	314	0	0
1999	199	32	32	259	0	0
2000	208	27	27	236	24	128
2001	207	22	22	363	18	191

Table 9: Summary of sampling effort used to produce NWFSC slope survey biomass index and generate length and age frequency distributions.

Year	Number of hauls	Number of positive hauls	Number of hauls with lengths	Number of lengths	Number of hauls with ages	Numbers of ages
1999	324	53	0	0	0	0
2000	329	54	25	296	25	291
2001	334	54	45	494	45	359
2002	426	56	54	1027	54	827

Table 10: Summary of sampling effort used to produce NWFSC shelf-slope survey biomass index and generate length and age frequency distributions.

Year	Number of hauls	Number of positive hauls	Number of hauls with lengths	Number of lengths	Number of hauls with ages	Numbers of ages
2003	376	101	100	2375	100	748
2004	347	92	90	1062	90	595
2005	466	112	110	1983	110	804
2006	455	130	130	1925	130	940
2007	499	132	132	2086	132	987
2008	493	111	111	1647	111	762
2009	500	126	126	2298	126	1159
2010	515	117	117	2239	117	912
2011	502	110	108	1828	108	796
2012	506	102	102	2205	102	791

Table 11: Error distribution assumptions regarding data sources used in the assessment.

Data sources used	Error distribution assumption
Landings	Assumed to be known without error (uncertainty explored via sensitivity analysis)
Abundance	Lognormal
Length composition	Multinomial
Age composition	Multinomial
Mean body weight	Normal
Discard	Normal

Table 12: List of parameter values used in the base model.

Parameter	Estimated value	Bounds (low, high)	Fixed value
Natural mortality (*M*, female)	-	NA	0.05
Natural mortality (*M*, male)	0.067	(0.01,0.15)	-
Individual growth			
Females:			
Length at A_1	15.34	(1,20)	-
Length at A_2	42.57	(20,60)	-
von Bertalanffy *K*	0.20	(0.05,0.3)	-
CV of length at A_1	0.11	(0.05,0.3)	-
CV of length at A_2	-	NA	0.046
Males:			
Length at A_1 (set equal to females)	-	NA	0.0
Length at A_2	37.63	(50,60)	-
von Bertalanffy *K*	0.264	(0.2,0.45)	-
CV of length at A_1 (set equal to females)	-	NA	0.0
CV of length at A_2	-	NA	0.046
Weight at length			
Females:			
Coefficient	-	NA	1.11E-05
Exponent	-	NA	3.13512
Males:			
Coefficient	-	NA	1.21E-05
Exponent	-	NA	3.10958
Fecundity at length			
Inflection	-	NA	101100
Slope	-	NA	44800
Stock and recruitment			
Ln(R_0)	7.84	(5,12)	-
Steepness (*h*)	-	NA	0.779
Recruitment SD (σ_r)	-	NA	Iterated to 0.75
Survey catchability and variability			
Ln(*Q*) – AFSC shelf (1980-1992)	0.555982	(-10,2)	
Ln(*Q*) – AFSC shelf offset (1995-2004) to early	0.023689	(-4,4)	
Ln(*Q*) – AFSC slope	-0.15737	(-10,2)	
Ln(*Q*) – NWFSC slope	0.019763	(-10,2)	
Ln(*Q*) – NWFSC shelf-slope	0.544378	(-10,2)	
Extra additive SD for AFSC shelf	0.010632	(0,1)	
Extra additive SD for NWFSC shelf-slope	0.049063	(0,1)	
Selectivity and retention			
TWL fishery (double-normal)			
Peak	36.2	(20, 45)	-
Top: width of plateau	-	NA	2
Ascending slope	4.9	(-1,9)	-
Descending slope	-	NA	0.6
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	9

Parameter	Estimated value	Bounds (low, high)	Fixed value
TWL retention (logistic function)			
Inflection base	27.84	(15,70)	-
Inflection block (2011-2012)	25.58	(15,70)	-
Slope base	1.58	(0.1,10)	-
Slope block (2011-2012)	1.50	(0.1,10)	-
Asymptotic retention base	-	NA	1
Asymptotic retention block (2000-2001)	0.66	(0,1)	-
Asymptotic retention block (2002)	0.51	(0,1)	-
Asymptotic retention block (2003)	0.40	(0,1)	-
Asymptotic retention block (2004)	0.85	(0,1)	-
Asymptotic retention block (2005)	0.79	(0,1)	-
Asymptotic retention block (2006)	0.57	(0,1)	-
Asymptotic retention block (2007)	0.52	(0,1)	-
Asymptotic retention block (2008)	0.48	(0,1)	-
Asymptotic retention block (2009)	0.50	(0,1)	-
Asymptotic retention block (2010)	0.54	(0,1)	-
Male offset to inflection	-	NA	0
AFSC shelf survey (double-normal)			
Peak	21.89	(10, 45)	-
Top: width of plateau	-	NA	-6
Ascending slope	3.40	(-1,9)	-
Descending slope base	4.94	(-1,9)	-
Descending slope block (1995-2004)	4.83	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
AFSC slope survey (double-normal)			
Peak	22.07	(10, 45)	-
Top: width of plateau	-1.74	(-6,4)	-
Ascending slope	1.69	(-1,9)	-
Descending slope	3.39	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
NWFSC slope survey (double-normal)			
Peak	24.32	(10, 45)	-
Top: width of plateau	-	NA	-6
Ascending slope	3.032	(-1,9)	-
Descending slope	4.99	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
NWFSC shelf-slope survey (double-normal)			
Peak	21.39	(8, 45)	-
Top: width of plateau	-	NA	-6
Ascending slope	3.41	(-1,9)	-
Descending slope	5.26	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999

Table 13: Time series of total biomass, summary biomass, spawning output, depletion relative to B_0, recruitment, and exploitation rate estimated in the base model.

Year	Total biomass (mt)	Summary biomass (mt)	Spawning output (million fish)	Depletion (%)	Age-0 Recruits (1000s)	Exploitation rate (catch/ age 1+ biomass)
1915	36,498	36,495	3,389	100%	2,588	
1916	36,502	36,498	3,389	100%	2,590	0.00036
1917	36,493	36,490	3,388	100%	2,592	0.00058
1918	36,478	36,475	3,386	100%	2,594	0.00060
1919	36,464	36,461	3,385	100%	2,596	0.00038
1920	36,460	36,456	3,384	100%	2,598	0.00040
1921	36,456	36,453	3,383	100%	2,601	0.00034
1922	36,456	36,452	3,382	100%	2,603	0.00032
1923	36,458	36,455	3,382	100%	2,606	0.00038
1924	36,460	36,456	3,382	100%	2,609	0.00039
1925	36,462	36,459	3,381	100%	2,612	0.00044
1926	36,465	36,461	3,381	100%	2,615	0.00060
1927	36,463	36,460	3,381	100%	2,619	0.00051
1928	36,466	36,463	3,380	100%	2,623	0.00051
1929	36,471	36,468	3,380	100%	2,626	0.00054
1930	36,477	36,474	3,380	100%	2,630	0.00059
1931	36,483	36,479	3,380	100%	2,635	0.00073
1932	36,486	36,482	3,380	100%	2,639	0.00046
1933	36,500	36,497	3,380	100%	2,644	0.00045
1934	36,517	36,513	3,381	100%	2,649	0.00043
1935	36,536	36,533	3,382	100%	2,654	0.00049
1936	36,555	36,552	3,384	100%	2,660	0.00033
1937	36,582	36,579	3,385	100%	2,666	0.00038
1938	36,609	36,606	3,387	100%	2,672	0.00047
1939	36,635	36,632	3,389	100%	2,680	0.00066
1940	36,656	36,653	3,390	100%	2,688	0.00091
1941	36,671	36,667	3,391	100%	2,698	0.00117
1942	36,679	36,676	3,391	100%	2,707	0.00134
1943	36,685	36,681	3,390	100%	2,716	0.00511
1944	36,557	36,554	3,377	100%	2,725	0.01111
1945	36,222	36,218	3,343	99%	2,731	0.01914
1946	35,616	35,613	3,282	97%	2,733	0.01150
1947	35,310	35,307	3,250	96%	2,734	0.00960
1948	35,090	35,087	3,225	95%	2,733	0.00557
1949	35,026	35,023	3,216	95%	2,727	0.00468
1950	35,003	35,000	3,210	95%	2,716	0.00519

Year	Total biomass (mt)	Summary biomass (mt)	Spawning output (million fish)	Depletion (%)	Age-0 Recruits (1000s)	Exploitation rate (catch/ age 1+ biomass)
1951	34,971	34,967	3,205	95%	2,697	0.00602
1952	34,915	34,912	3,197	94%	2,672	0.00635
1953	34,853	34,849	3,189	94%	2,644	0.00541
1954	34,824	34,821	3,185	94%	2,612	0.00637
1955	34,761	34,757	3,178	94%	2,582	0.00753
1956	34,654	34,650	3,168	93%	2,559	0.01000
1957	34,457	34,454	3,150	93%	2,545	0.01175
1958	34,197	34,194	3,126	92%	2,541	0.01001
1959	33,995	33,992	3,107	92%	2,546	0.00851
1960	33,841	33,838	3,094	91%	2,554	0.01033
1961	33,624	33,621	3,074	91%	2,553	0.00969
1962	33,430	33,426	3,056	90%	2,521	0.01055
1963	33,210	33,207	3,035	90%	2,465	0.01133
1964	32,969	32,966	3,012	89%	2,376	0.00822
1965	32,832	32,829	2,999	88%	2,254	0.01503
1966	32,468	32,465	2,965	87%	2,105	0.13028
1967	28,409	28,406	2,579	76%	1,943	0.10860
1968	25,535	25,533	2,304	68%	1,835	0.09499
1969	23,350	23,347	2,094	62%	1,830	0.01242
1970	23,298	23,296	2,087	62%	2,009	0.01529
1971	23,173	23,170	2,076	61%	2,335	0.02306
1972	22,870	22,867	2,048	60%	2,176	0.02698
1973	22,498	22,496	2,013	59%	1,877	0.04080
1974	21,851	21,848	1,948	57%	1,960	0.02819
1975	21,523	21,521	1,911	56%	1,674	0.02882
1976	21,199	21,196	1,875	55%	2,578	0.03230
1977	20,817	20,815	1,837	54%	1,543	0.01569
1978	20,804	20,800	1,834	54%	3,285	0.02054
1979	20,712	20,708	1,822	54%	3,072	0.03650
1980	20,343	20,340	1,780	53%	2,362	0.03131
1981	20,174	20,168	1,749	52%	4,454	0.04272
1982	19,870	19,868	1,700	50%	1,254	0.05919
1983	19,345	19,344	1,629	48%	801	0.06047
1984	18,865	18,863	1,566	46%	1,267	0.07306
1985	18,129	18,127	1,495	44%	1,951	0.10204
1986	16,841	16,839	1,390	41%	1,669	0.07756
1987	16,022	16,018	1,334	39%	2,827	0.15522
1988	14,000	13,998	1,168	34%	1,320	0.12178
1989	12,764	12,763	1,057	31%	816	0.10321

Year	Total biomass (mt)	Summary biomass (mt)	Spawning output (million fish)	Depletion (%)	Age-0 Recruits (1000s)	Exploitation rate (catch/ age 1+ biomass)
1990	11,928	11,927	972	29%	748	0.14655
1991	10,645	10,644	852	25%	932	0.11845
1992	9,798	9,797	779	23%	898	0.07308
1993	9,439	9,438	757	22%	418	0.13104
1994	8,513	8,510	690	20%	2,311	0.10499
1995	7,898	7,893	644	19%	4,213	0.10253
1996	7,410	7,409	599	18%	951	0.10349
1997	7,084	7,083	554	16%	1,298	0.12086
1998	6,780	6,779	501	15%	606	0.14685
1999	6,385	6,377	443	13%	6,012	0.06189
2000	6,630	6,625	447	13%	4,320	0.06326
2001	6,988	6,987	465	14%	508	0.03952
2002	7,668	7,666	499	15%	1,424	0.03080
2003	8,479	8,477	536	16%	1,797	0.02503
2004	9,305	9,301	583	17%	3,265	0.02618
2005	10,065	10,061	648	19%	3,004	0.01285
2006	10,927	10,924	738	22%	2,061	0.01738
2007	11,741	11,739	818	24%	1,434	0.02380
2008	12,462	12,453	879	26%	6,674	0.02027
2009	13,212	13,211	937	28%	1,216	0.02221
2010	13,979	13,977	996	29%	1,800	0.02502
2011	14,736	14,732	1,054	31%	2,858	0.00814
2012	15,692	15,691	1,131	33%	870	0.00615
2013	16,613	16,610	1,214	36%	2,254	NA

Table 14: Comparison among sensitivity analyses to alternative assumptions about darkblotched rockfish landings.

Model	Base	TWL landings doubled	TWL landings halved	TWL historical landings doubled	TWL historical landings halved	All landings doubled	All landings halved
Negative log-likelihood							
Total	1378.84	1378.57	1379.85	1379.71	1378.54	1378.84	1378.84
Indices	-12.65	-12.75	-12.47	-12.38	-12.80	-12.65	-12.65
Length frequencies	436.75	437.08	436.40	436.45	437.01	436.75	436.75
Age frequencies	991.03	990.79	991.31	991.22	990.86	991.03	991.03
Discard	-33.450	-33.447	-33.457	-33.464	-33.444	-33.450	-33.450
Mean body weight	-9.499	-9.499	-9.499	-9.499	-9.499	-9.499	-9.499
Selected parameters							
$\ln(R_0)$	7.843	8.416	7.360	8.039	7.733	8.536	7.150
Steepness (*h*)	0.779	0.779	0.779	0.779	0.779	0.779	0.779
Female *M*	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Male *M*	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Female L at A_1	15.34	15.34	15.34	15.34	15.34	15.34	15.34
Female L at A_2	42.57	42.55	42.59	42.59	42.56	42.57	42.57
Male L at A_1	15.34	15.34	15.34	15.34	15.34	15.34	15.34
Male L at A_2	37.63	37.63	37.63	37.63	37.63	37.63	37.63
Female von Bert *K*	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Male von Bert *K*	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Management quantities							
Equilibrium spawning output (million eggs)	3,358	5,945	2,075	4,088	3,003	6,716	1,679
2013 Spawning depletion	36%	35%	39%	39%	35%	36%	36%

Table 15: Comparison among sensitivity analyses to alternative assumptions about selected life history parameters.

Model	Base	2011 maturity	2011 fecundity	2011 W-L relationships	2011 steepness	2007 steepness and natural mortality
Negative log-likelihood						
Total	1378.84	1379.01	1378.97	1379.17	1378.90	1392.99
Indices	-12.65	-12.70	-12.69	-12.71	-12.68	-12.72
Length frequencies	436.75	436.90	436.88	437.04	436.81	445.93
Age frequencies	991.03	991.03	991.01	991.02	991.05	994.98
Discard	-33.450	-33.442	-33.44	-33.441	-33.446	-33.450
Mean body weight	-9.499	-9.499	-9.499	-9.428	-9.499	-9.535
Selected parameters						
$Ln(R_0)$	7.843	7.842	7.843	7.839	7.845	8.279
Steepness (h)	0.779	0.779	0.779	0.779	0.76	0.6
Female M	0.050	0.050	0.050	0.050	0.050	0.070
Male M	0.067	0.067	0.067	0.067	0.067	0.070
Female L at A_1	15.34	15.34	15.34	15.34	15.34	15.34
Female L at A_2	42.57	42.57	42.57	42.57	42.57	42.63
Male L at A_1	15.34	15.34	15.34	15.34	15.34	15.34
Male L at A_2	37.63	37.63	37.63	37.63	37.63	37.60
Female von Bert K	0.20	0.20	0.20	0.20	0.20	0.20
Male von Bert K	0.26	0.26	0.26	0.26	0.26	0.26
Management quantities						
2013 Spawning depletion	36%	32%	32%	37%	35%	48%

Table 16: Comparison among sensitivity analyses to alternative assumptions about selectivity parameters

Model	Base	TWL dome-shaped	NWFSC combo asymptotic
Negative log-likelihood			
Total	1378.84	1379.13	1411.36
Indices	-12.648	-12.663	-9.924
Length frequencies	436.748	437.179	447.233
Age frequencies	991.028	990.921	1004.74
Discard	-33.45	-33.451	-33.447
Mean body weight	-9.499	-9.498	-9.429
Selected parameters			
$\ln(R_0)$	7.84	7.84	7.79
Steepness (*h*)	0.779	0.779	0.779
Female *M*	0.05	0.05	0.05
Male *M*	0.067	0.067	0.066
Female L at A_1	15.342	15.338	15.42
Female L at A_2	42.57	42.57	42.71
Male L at A_1	15.34	15.34	15.42
Male L at A_2	37.63	37.63	37.61
Female von Bert *K*	0.2	0.2	0.193
Male von Bert *K*	0.26	0.26	0.25
Management quantities			
Equilibrium spawning output (million eggs)	3,358	3,354	3,203
2013 Spawning depletion	36%	36%	28%

Table 17: Results from the retrospective analysis. Likelihoods in italics are not comparable across rows

Model	Base	-1 year	-2 years	-3 years	-4 years	-5 years
Negative log-likelihood						
Total	*1378.84*	*1311.95*	*1263.19*	*1209.32*	*1133.38*	*1024.96*
Indices	*-12.65*	*-12.16*	*-11.70*	*-11.57*	*-10.54*	*-11.00*
Length frequencies	*436.75*	*418.29*	*401.44*	*383.61*	*356.42*	*324.68*
Age frequencies	*991.03*	*943.84*	*905.53*	*864.95*	*811.30*	*733.83*
Discard	*-33.45*	*-33.456*	*-29.014*	*-26.279*	*-24.088*	*-21.273*
Mean body weight	*-9.499*	*-9.532*	*-8.073*	*-7.251*	*-6.234*	*-5.215*
Selected parameters						
$Ln(R_0)$	7.84	7.84	7.84	7.84	7.87	7.86
Steepness (h)	0.779	0.779	0.779	0.779	0.779	0.779
Female M	0.05	0.05	0.05	0.05	0.05	0.05
Male M	0.067	0.067	0.068	0.067	0.067	0.068
Female L at A_1	15.34	15.39	15.37	15.36	15.27	15.36
Female L at A_2	42.57	42.58	42.54	42.5	42.42	42.36
Male L at A_1	15.34	15.39	15.37	15.36	15.27	15.36
Male L at A_2	37.63	37.64	37.62	37.58	37.55	37.56
Female von Bert K	0.200	0.202	0.203	0.207	0.212	0.217
Male von Bert K	0.260	0.262	0.263	0.266	0.272	0.276
Management quantities						
Equilibrium spawning output (million eggs)	3,358	3,360	3,348	3,359	3,438	3,411
2013 Spawning depletion	36%	NA	NA	NA	NA	NA

Table 18: Summary of reference points for the base model.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning output (million eggs)	3,358	2,603-4,114
Unfished age 1+ biomass (mt)	36,171	28,181-44,161
Unfished recruitment (R0)	2,549	1,970-3,127
Depletion (2013)	36%	16-56%
Reference points based on $SB_{XX\%}$		
Proxy spawning output ($B_{40\%}$)(million eggs)	1,343	1,041-1,646
SPR resulting in $B40_{\%}$ ($SPR_{40\%}$)	44%	NA
Exploitation rate resulting in $B_{40\%}$	4.02%	3.96-4.08%
Yield with $SPR50_{\%}$ at $B_{40\%}$ (mt)	675	526-824
Reference points based on SPR proxy for MSY		
Spawning output (million eggs)	1,550	1,201-1,899
SPR_{proxy}	50%	NA
Exploitation rate corresponding to SPR_{proxy}	3.3%	3.25-3.35%
Yield with SPR_{proxy} at SB_{SPR} (mt)	625	487-763
Reference points based on estimated MSY values		
Spawning output at *MSY* (SB_{MSY}) (million eggs)	819	635-1,003
SPR_{MSY}	30%	29.38-30.13%
Exploitation rate corresponding to SPR_{MSY}	6.65%	6.47-6.83%
MSY (mt)	742	578-906

Table 19: Summary of recent trends in estimated darkblotched rockfish exploitation and stock level from the base model.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Commercial landings (mt)	80	189	98	107	144	117	138	184	117	94	NA
Estimated Total catch (mt)	212	243	129	190	279	252	293	350	120	96	NA
OFL (mt)	205	240	269	294	456	487	437	440	508	497	541
ACL (mt)	172	240	269	200	290	330	285	291	298	296	317
SPR	56%	55%	73%	67%	59%	63%	60%	57%	82%	86%	NA
Exploitation rate (catch/ age 1+ biomass)	0.025	0.026	0.013	0.017	0.024	0.020	0.022	0.025	0.008	0.006	NA
Age 1+ biomass (mt)	8,477	9,301	10,061	10,924	11,739	12,453	13,211	13,977	14,732	15,691	16,610
Spawning output (million eggs)	536	583	648	738	818	879	937	996	1,054	1,131	1,214
~95% Confidence Interval	220-851	234-932	253-1044	286-1189	312-1324	325-1433	338-1536	349-1642	357-1751	384-1879	414-2013
Recruitment	1,797	3,265	3,004	2,061	1,434	6,674	1,216	1,800	2,858	870	2,254
~95% Confidence Interval	617-2,977	1,180-5,350	1,042-4,966	650-3,471	383-2,486	2,159-11,190	206-2,226	220-3,380	0-6,154	0-2,117	0-5,691
Depletion (%)	16%	17%	19%	22%	24%	26%	28%	29%	31%	33%	36%
~95% Confidence Interval	8-24%	9-26%	9-29%	11-33%	12-37%	12-40%	13-43%	13-46%	14-49%	15-53%	16-56%

Table 20: Summary table of 12-year projections beginning in 2015 for alternate states of nature based on female natural mortality. Columns range over low, mid, and high state of nature, and rows range over different assumptions of catch levels.

			State of nature					
			Low *Female M=0.036*		Base case Female M=0.05		High *Female M=0.082*	
Management decision	Year	Catch (mt)	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion
Catch calculated using SPR of 71.9% applied to the base model	2013	223	607	18%	1,214	36%	3,606	82%
	2014	240	648	19%	1,294	39%	3,770	85%
	2015	252	688	20%	1,374	41%	3,922	89%
	2016	260	722	21%	1,441	43%	4,032	91%
	2017	266	751	22%	1,496	45%	4,101	93%
	2018	271	776	23%	1,541	46%	4,135	94%
	2019	276	798	23%	1,578	47%	4,147	94%
	2020	280	821	24%	1,613	48%	4,150	94%
	2021	285	844	25%	1,646	49%	4,149	94%
	2022	289	867	25%	1,678	50%	4,146	94%
	2023	293	891	26%	1,709	51%	4,140	94%
	2024	297	915	27%	1,739	52%	4,133	94%
Catch calculated using current rebuilding SPR of 64.9% applied to the base model	2013	302	607	18%	1,214	36%	3,606	82%
	2014	323	641	19%	1,288	38%	3,764	85%
	2015	339	674	20%	1,360	41%	3,909	88%
	2016	347	701	20%	1,420	42%	4,011	91%
	2017	353	722	21%	1,467	44%	4,073	92%
	2018	358	738	21%	1,504	45%	4,101	93%
	2019	363	752	22%	1,533	46%	4,106	93%
	2020	368	766	22%	1,560	46%	4,102	93%
	2021	372	780	23%	1,586	47%	4,096	93%
	2022	377	796	23%	1,611	48%	4,087	93%
	2023	381	811	24%	1,635	49%	4,076	92%
	2024	385	826	24%	1,657	49%	4,064	92%
2014 ACL catch assumed for years between 2015 and 2024	2013	317	607	18%	1,214	36%	3,606	82%
	2014	330	640	19%	1,287	38%	3,762	85%
	2015	330	672	20%	1,358	40%	3,907	88%
	2016	330	699	20%	1,418	42%	4,010	91%
	2017	330	722	21%	1,467	44%	4,073	92%
	2018	330	740	22%	1,506	45%	4,103	93%
	2019	330	756	22%	1,538	46%	4,111	93%
	2020	330	773	23%	1,567	47%	4,110	93%
	2021	330	791	23%	1,597	48%	4,106	93%
	2022	330	811	24%	1,626	48%	4,101	93%
	2023	330	830	24%	1,654	49%	4,094	93%
	2024	330	850	25%	1,681	50%	4,085	92%

9 Figures

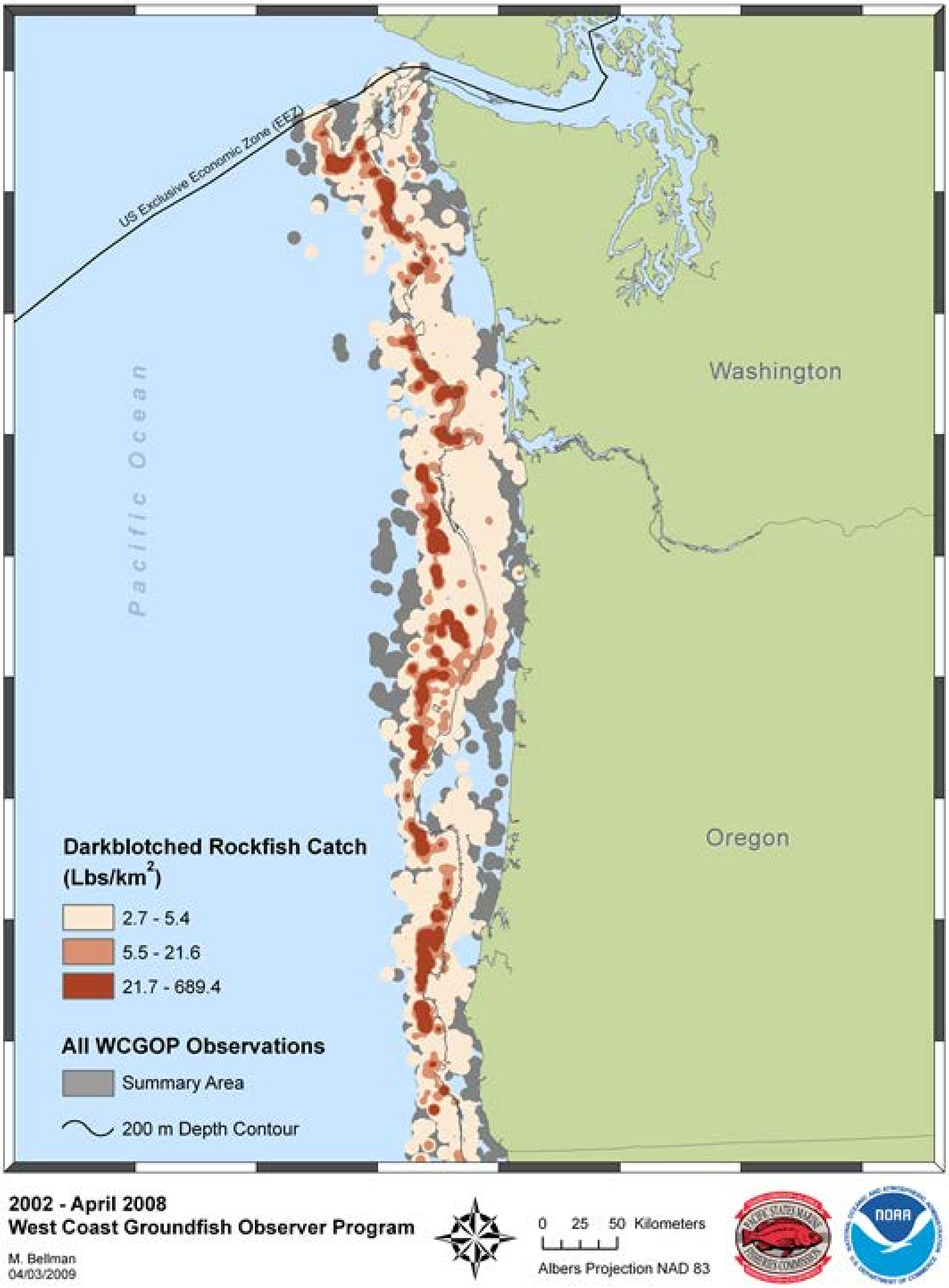

Figure 1: Spatial distribution of darkblotched rockfish catch (lbs/km^2) observed by the West Coast Groundfish Observer Program and the summary area of all observed fishing events.

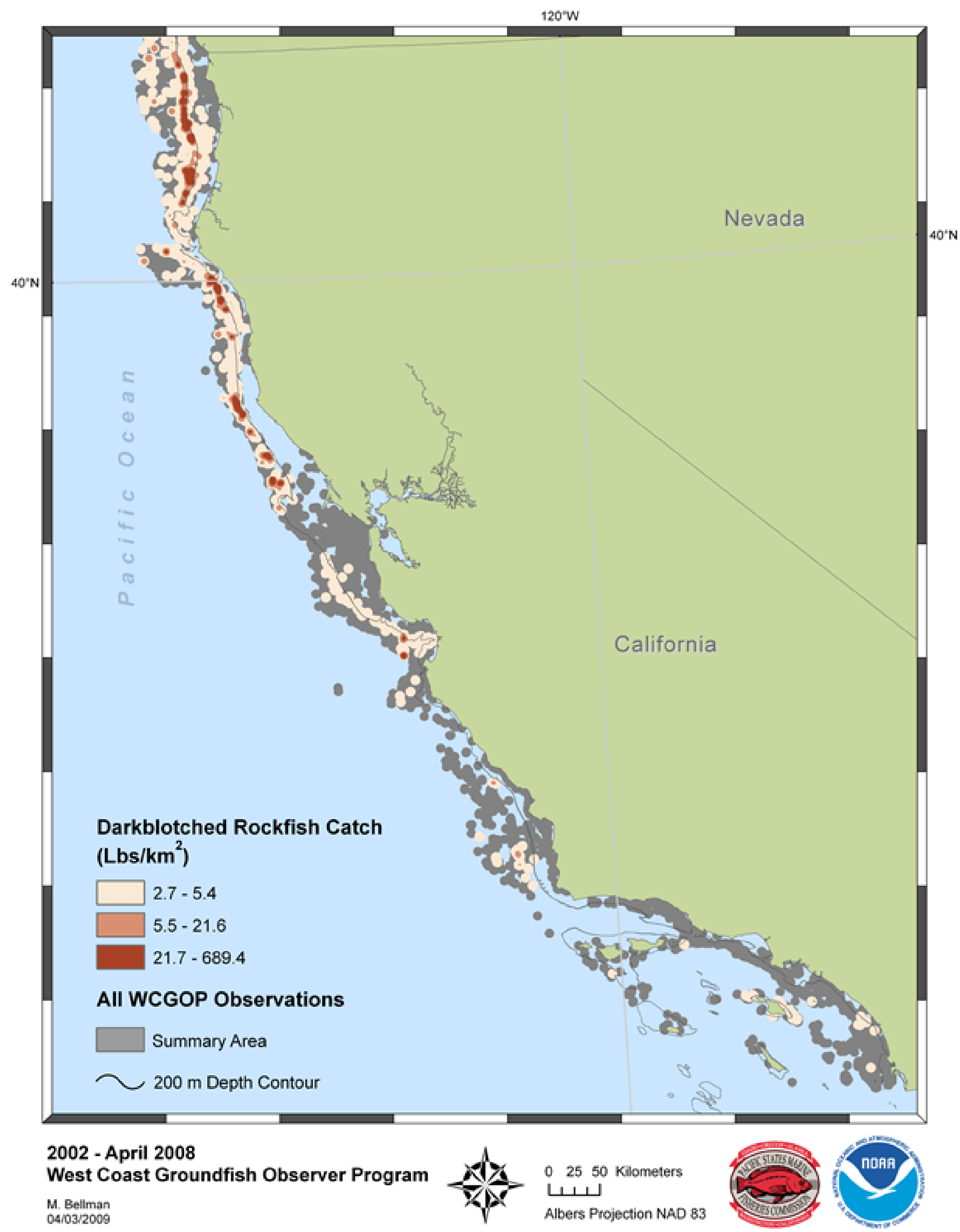

Figure 1 (continued): Spatial distribution of darkblotched rockfish catch (lbs/km^2) observed by the West Coast Groundfish Observer Program and the summary area of all observed fishing events.

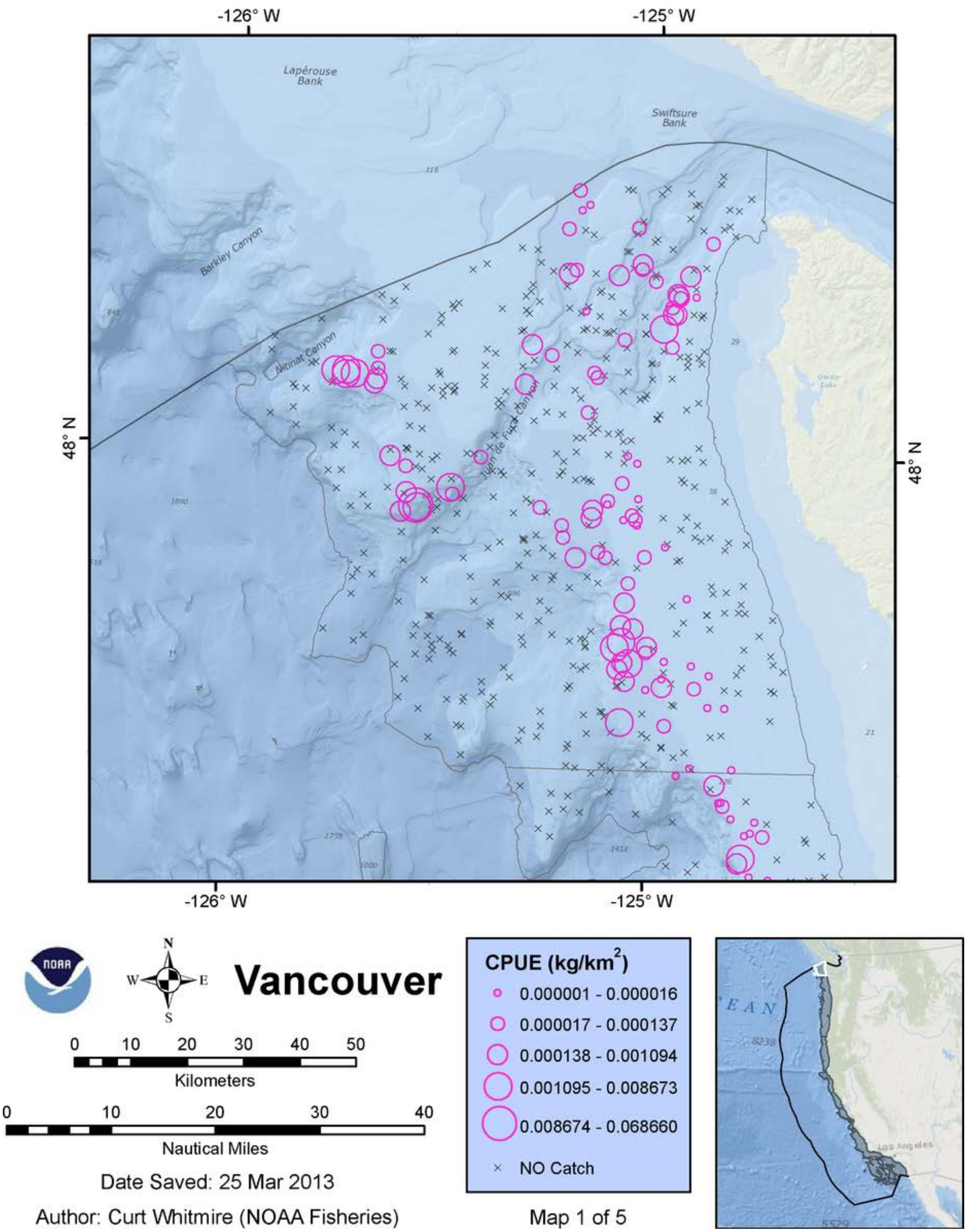

Figure 2: Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

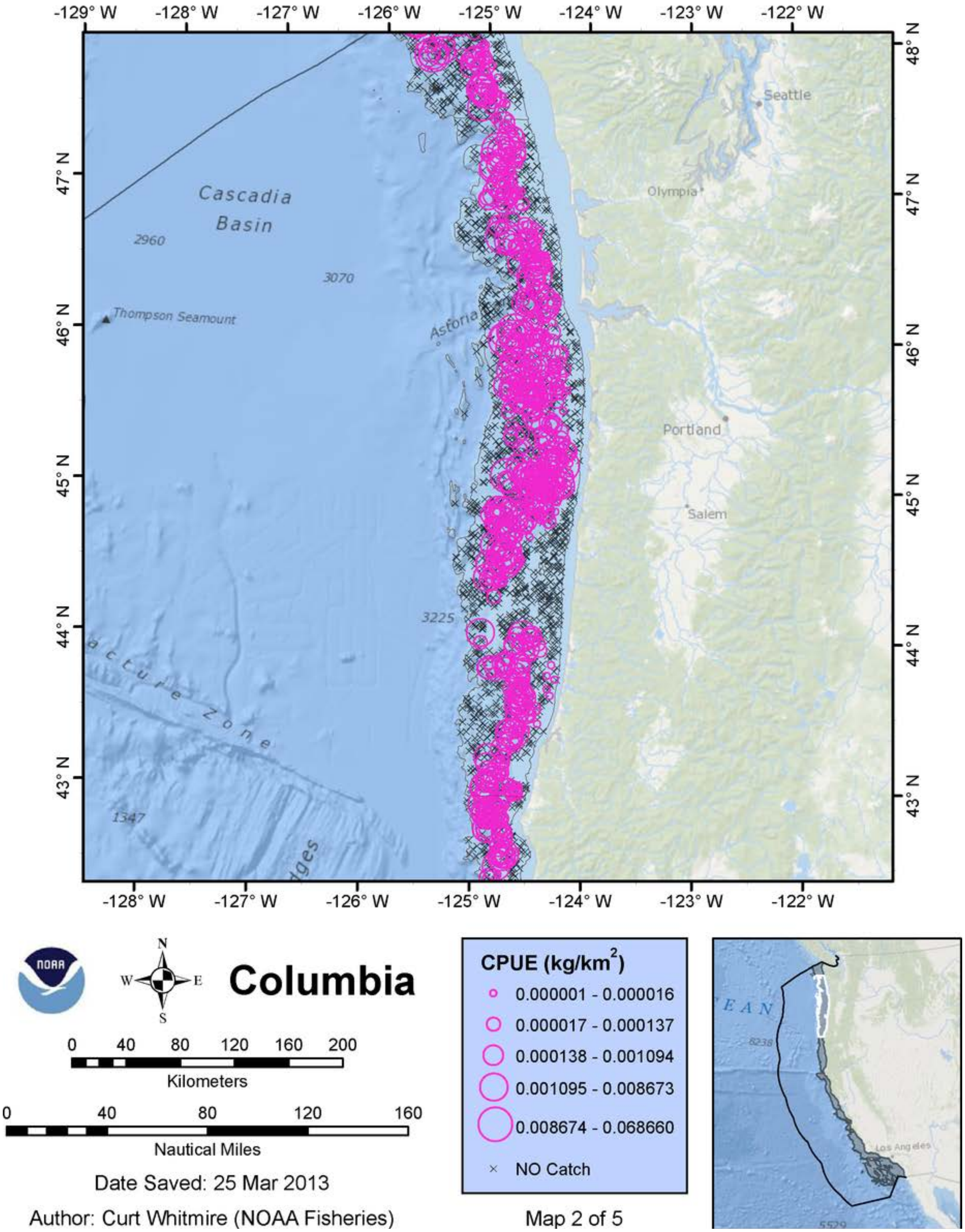

Figure 2 (continued): Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

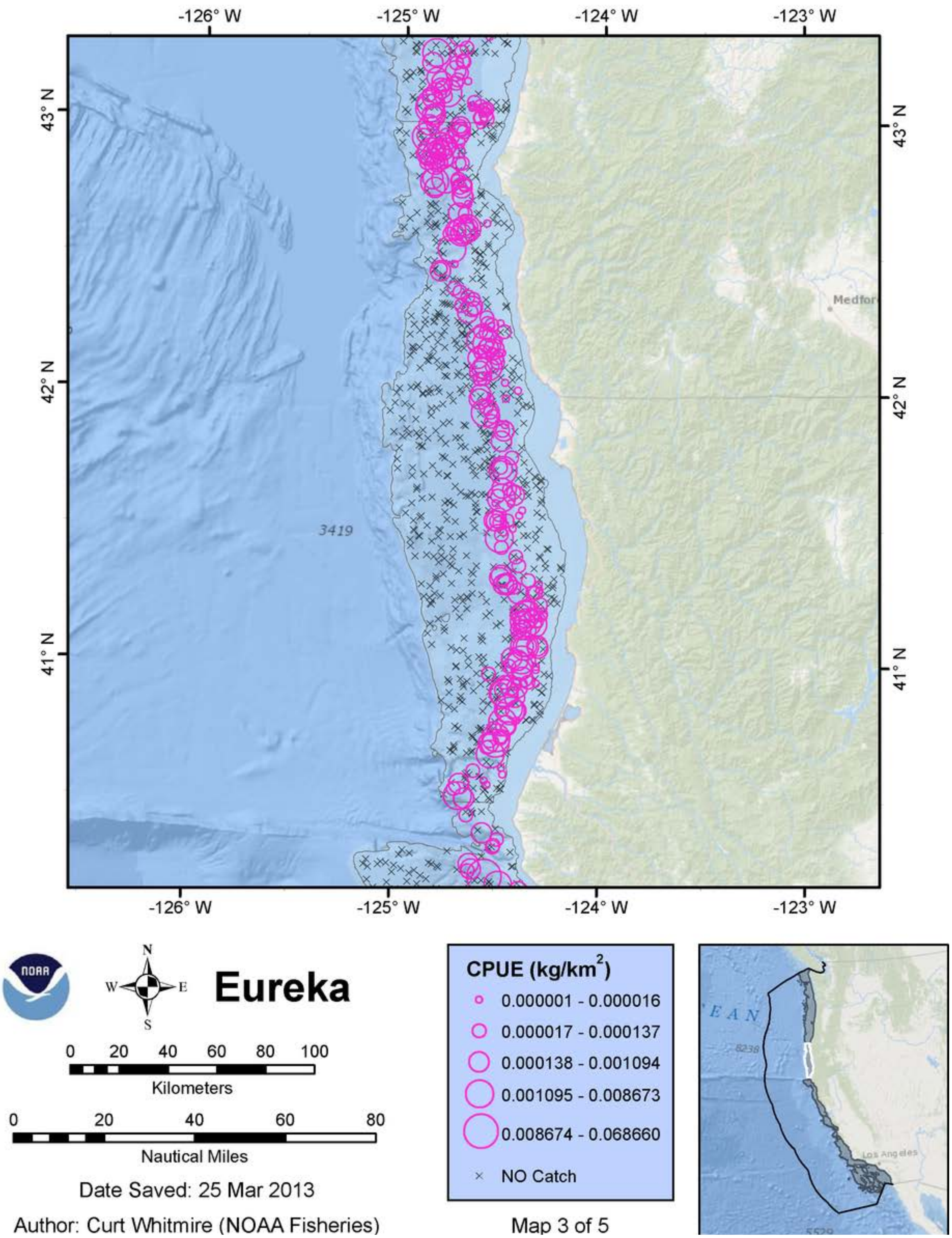

Figure 2 (continued): Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

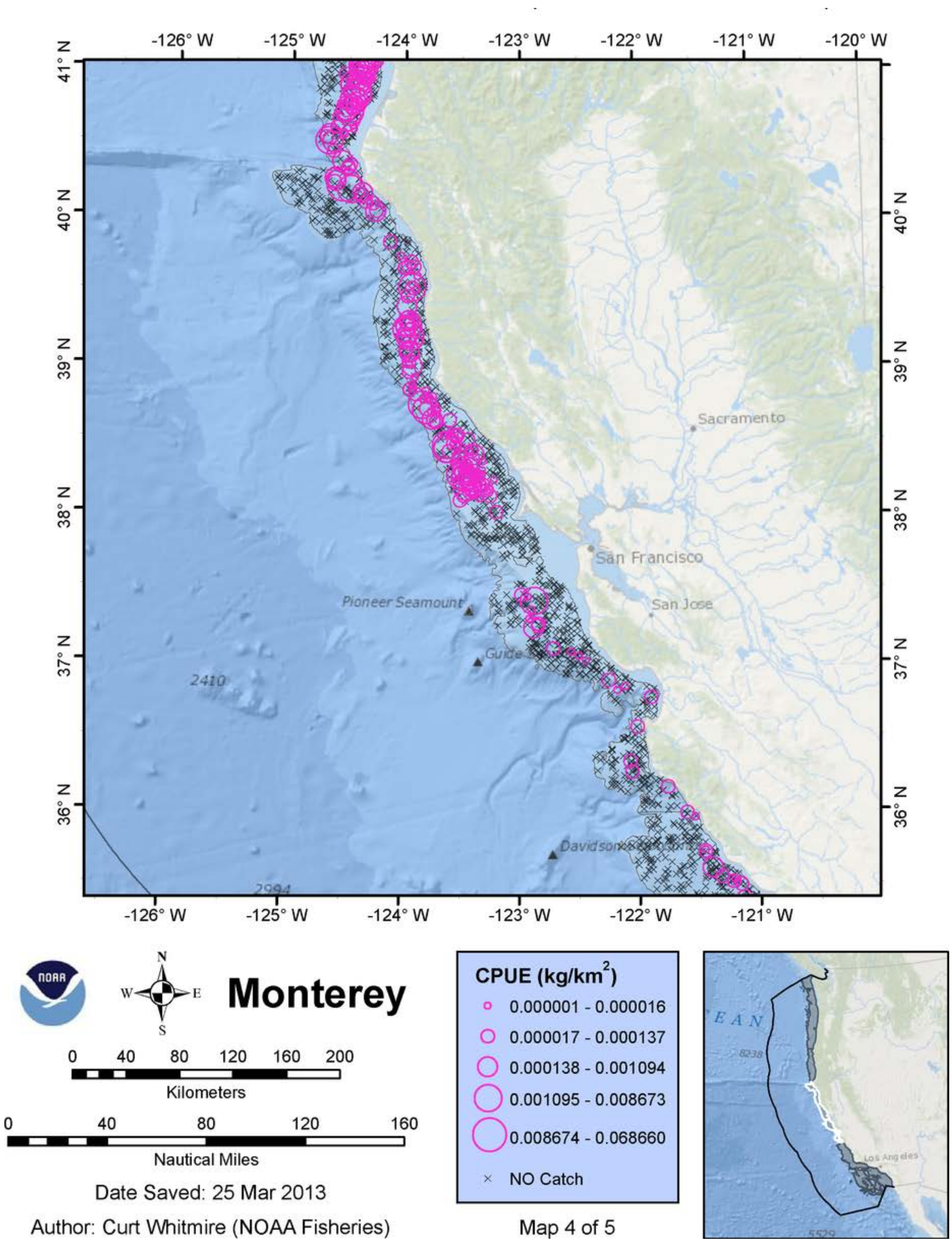

Figure 2 (continued): Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

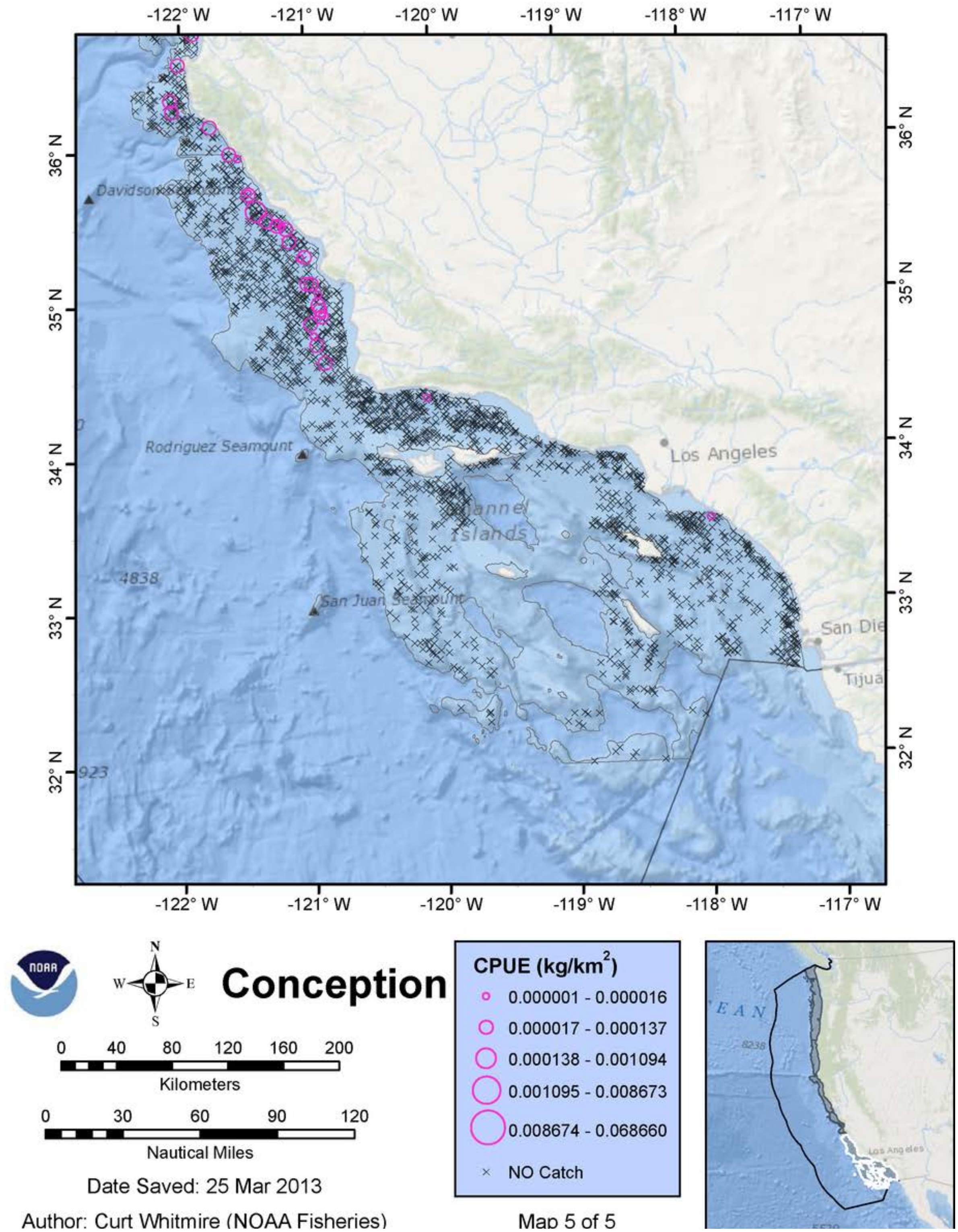

Figure 2 (continued): Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

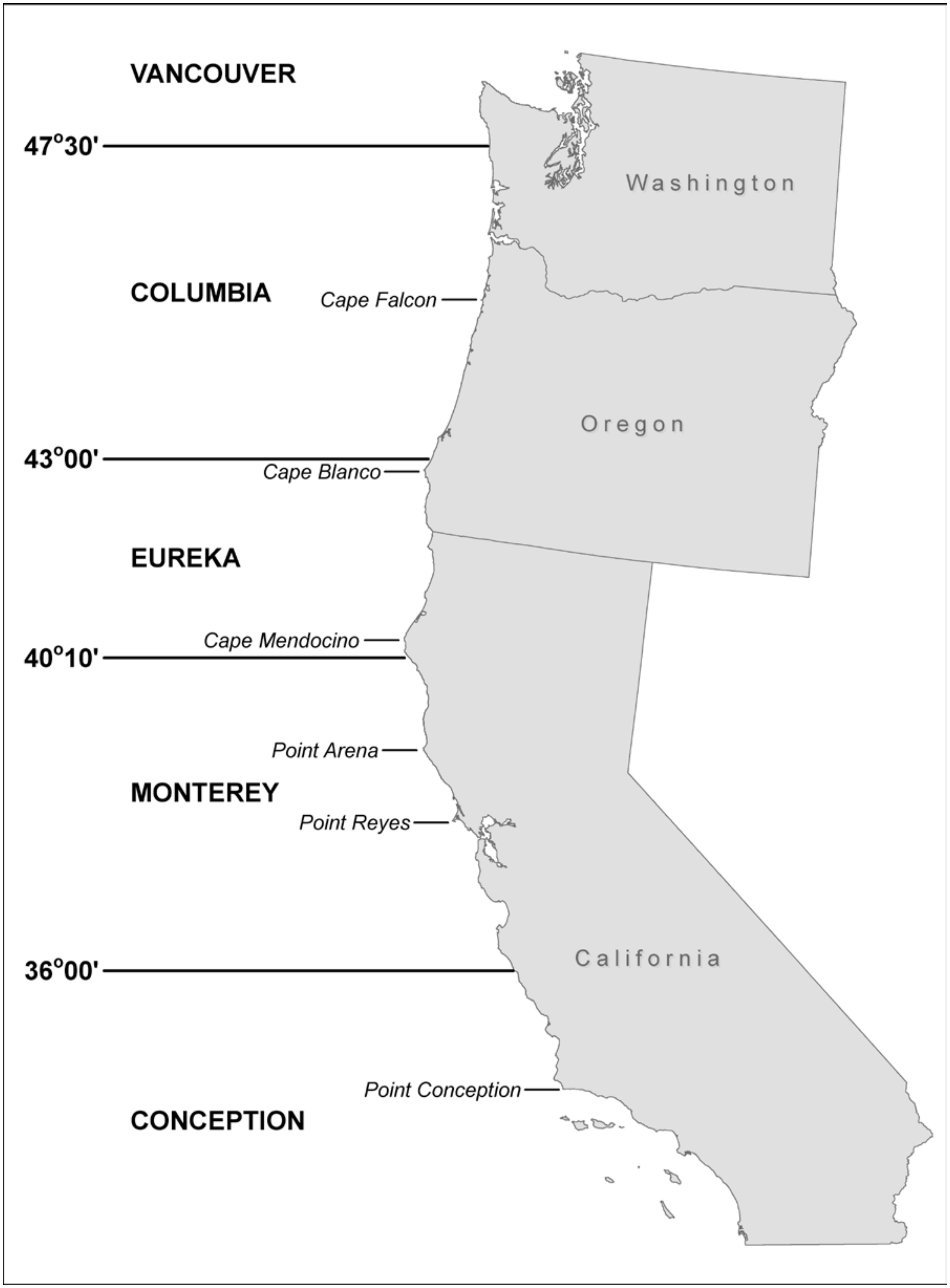

Figure 3: A map of the assessment area that includes coastal waters off three U.S. west coast states and five International North Pacific Fisheries Commission (INPFC) areas.

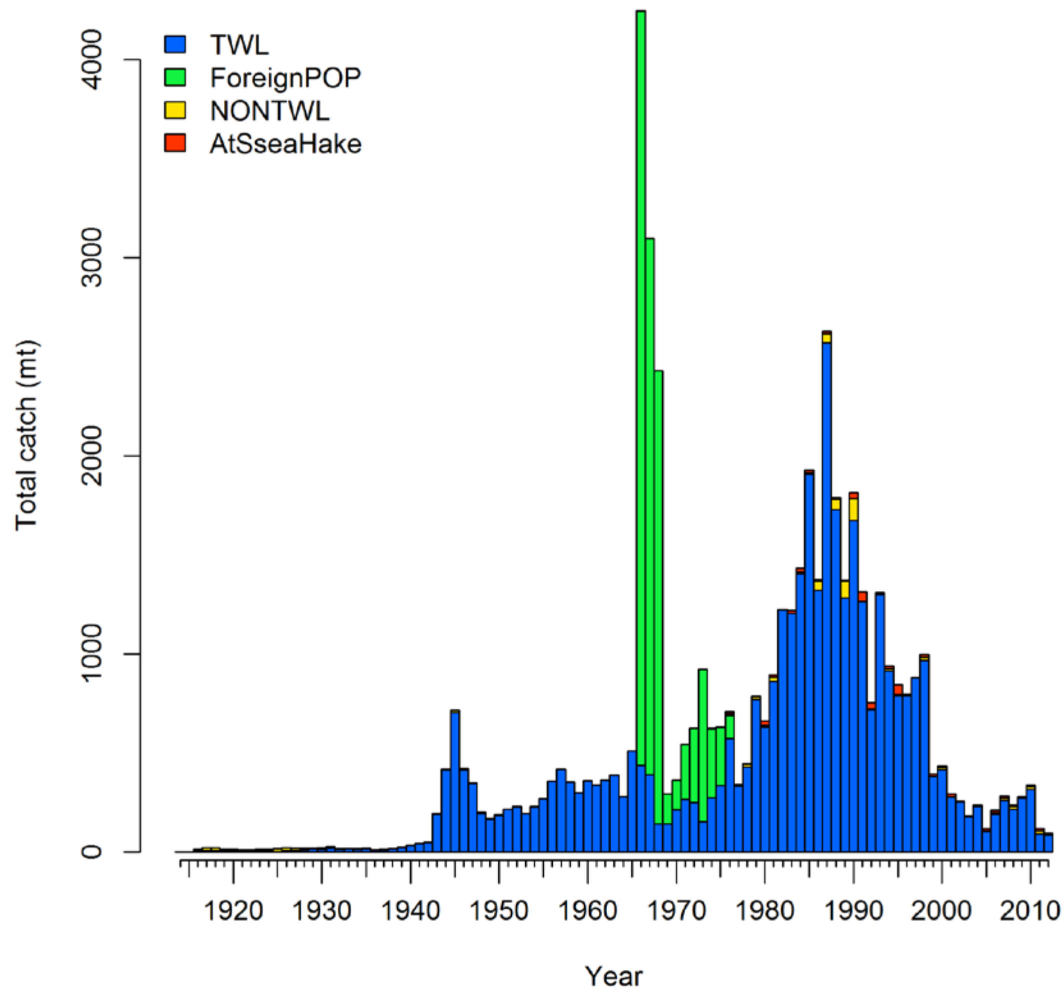

Figure 4: Darkblotched rockfish landings history, 1915-2012, with separate contribution of domestic trawl and non-trawl landings, bycatch in foreign POP and at-sea Pacific hake fisheries.

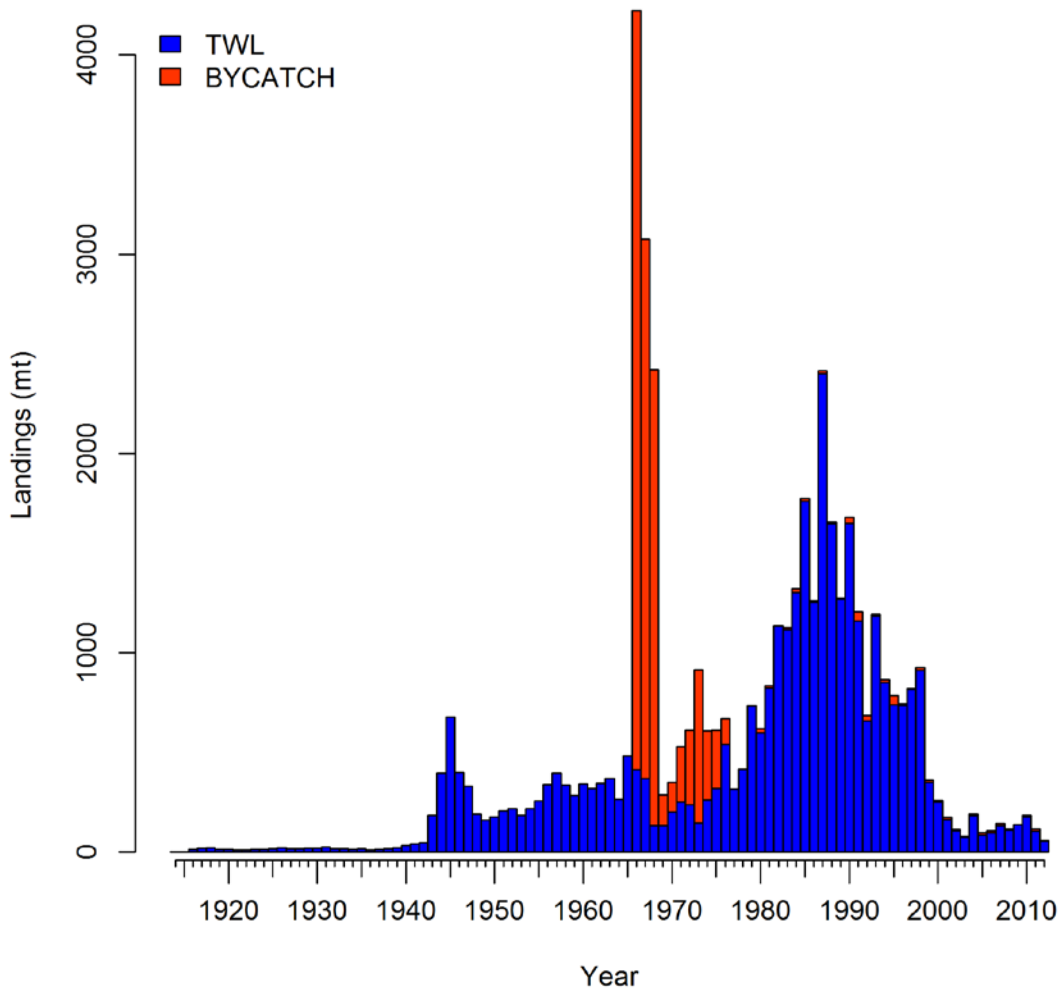

Figure 5: Darkblotched rockfish landings history, 1915-2012. Landings in the assessment are divided between two fleets that include domestic trawl fishery (TWL) and bycatch in foreign POP fishery and at-sea hake fishery (BYCATCH).

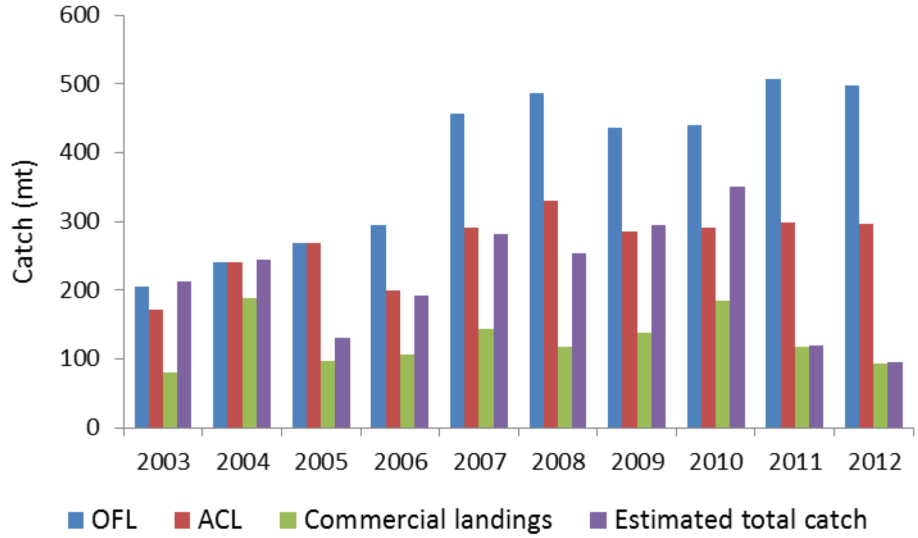

Figure 6: Recent darkblotched rockfish Overfishing Limits (OFLs) and Annual Catch Limits (ACLs) relative to recent total landings and total dead catch estimated in this assessment.

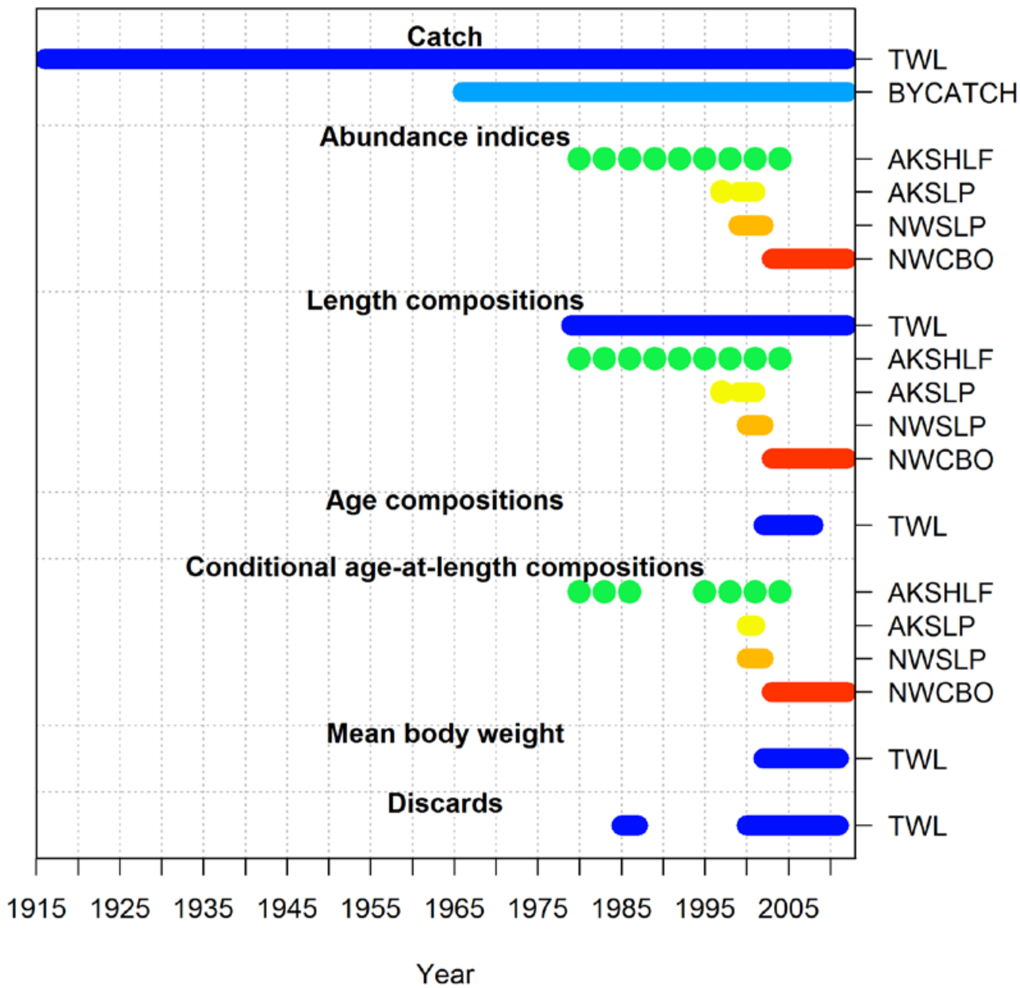

Figure 7: Summary of sources and data used in the assessment.

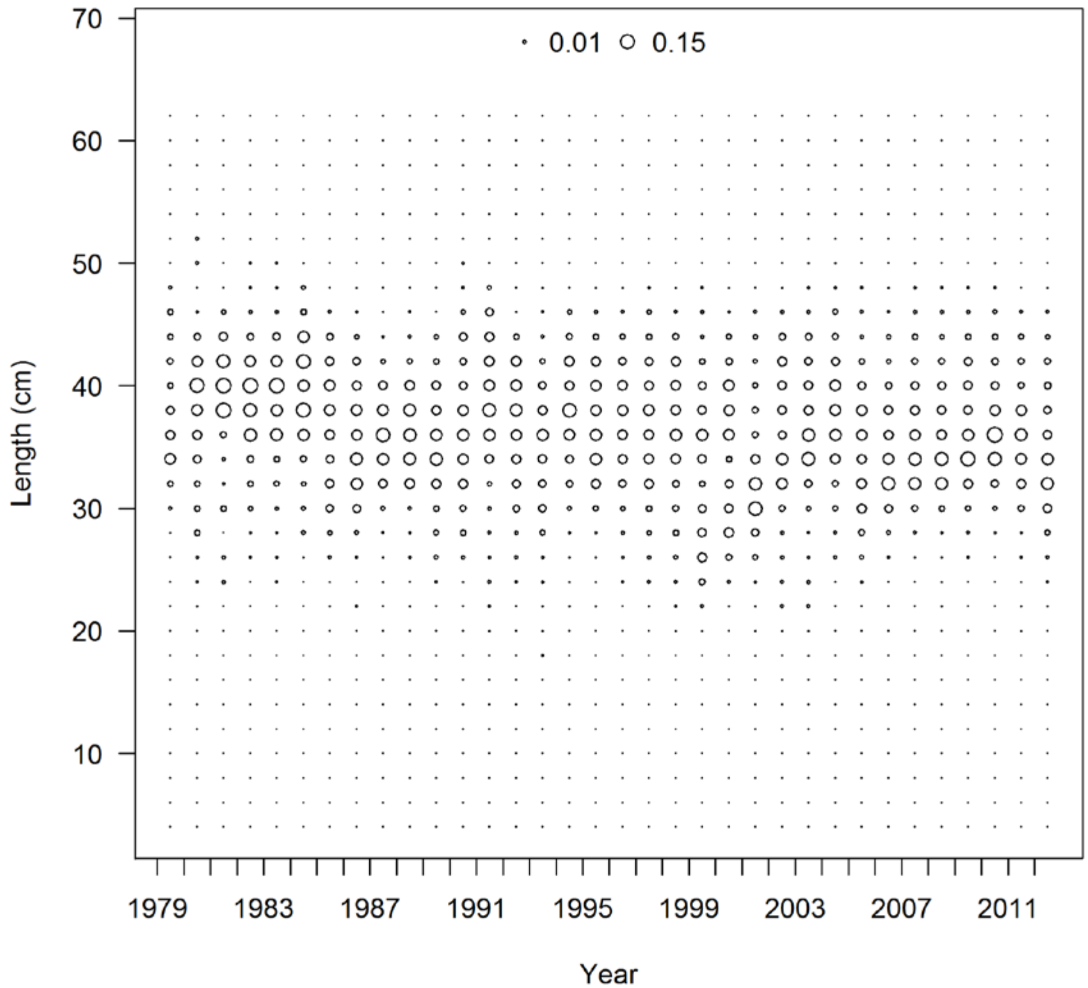

Figure 8: Length-frequency distributions for female darkblotched rockfish from the domestic trawl landings by year.

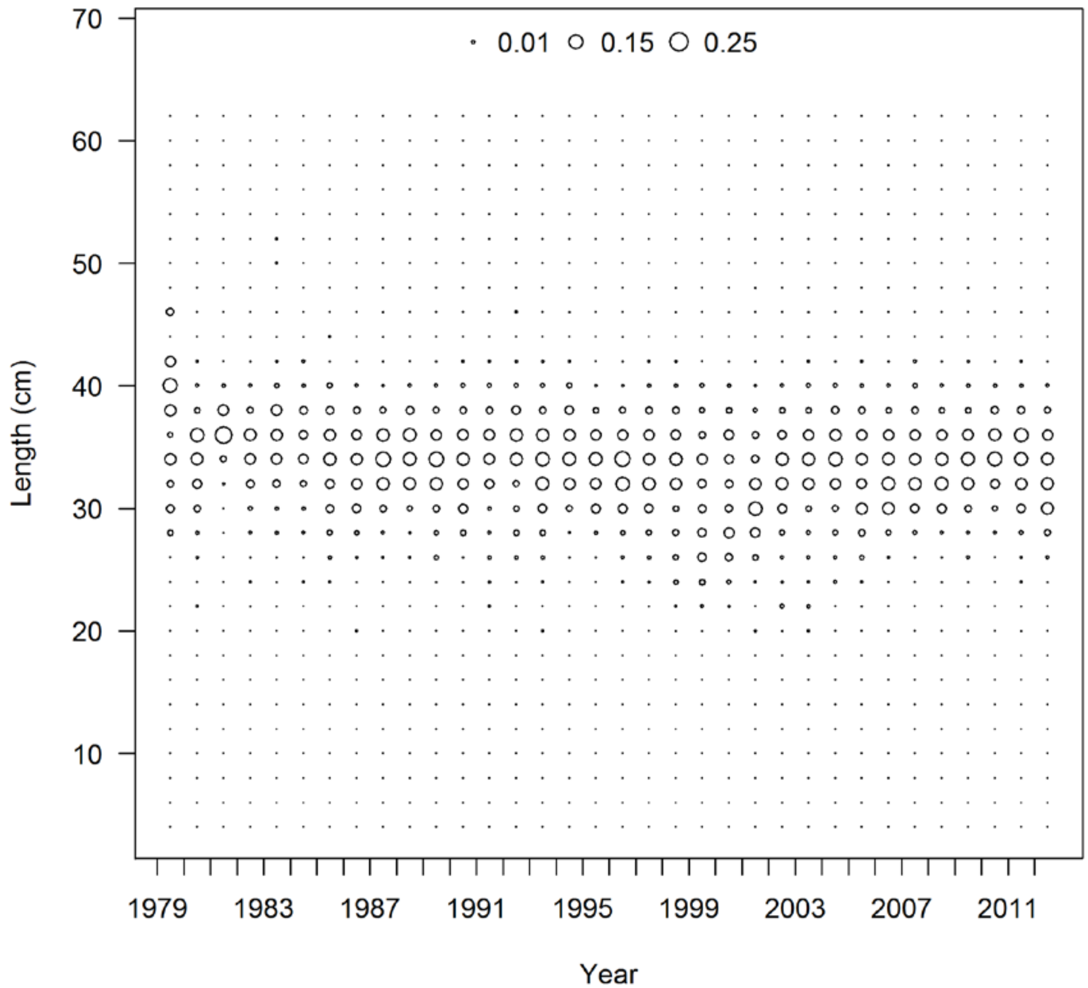

Figure 9: Length-frequency distributions for male darkblotched rockfish from the domestic trawl landings by year.

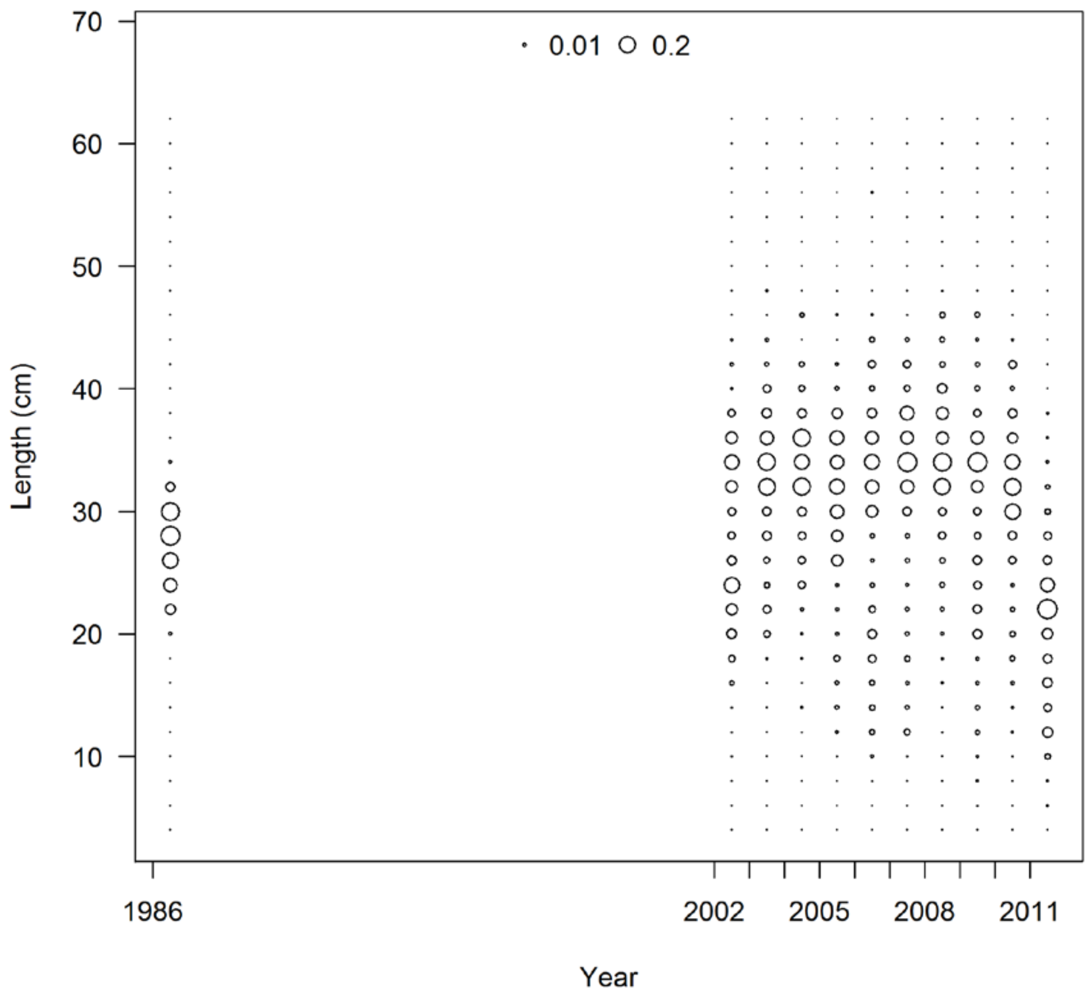

Figure 10: Length-frequency distributions for darkblotched rockfish (sexes combined) from the domestic trawl discards by year.

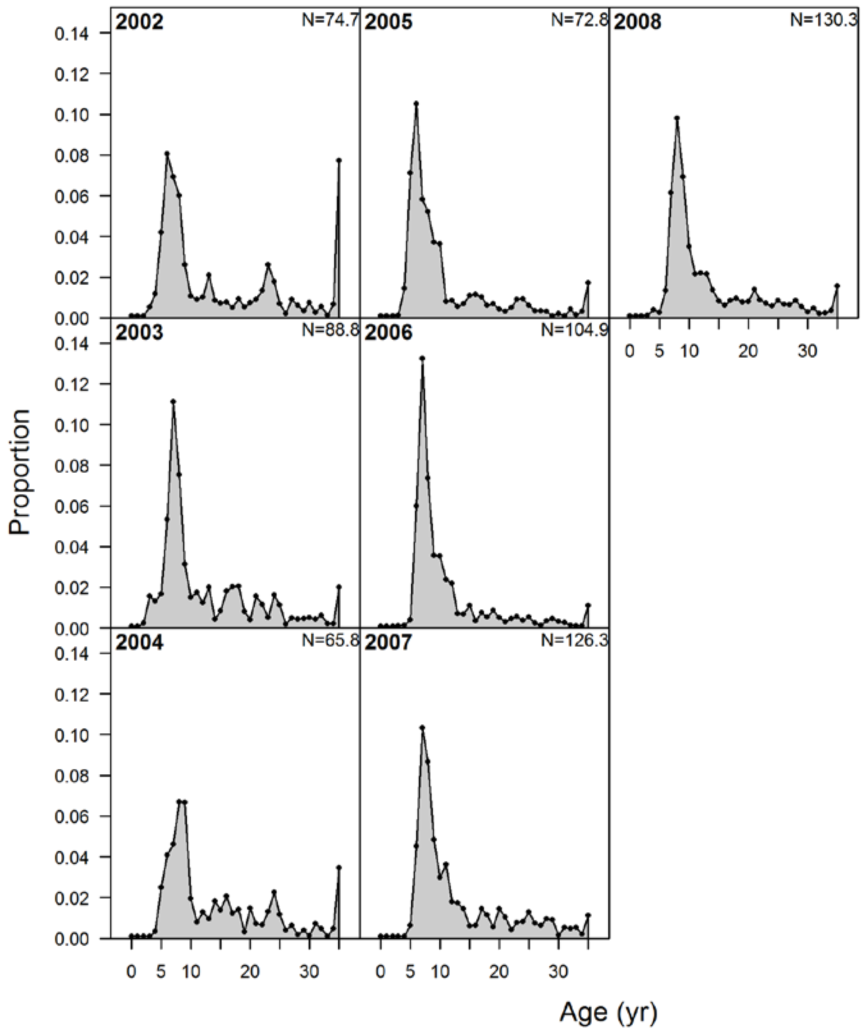

Figure 11: Age-frequency distributions for female darkblotched rockfish from the domestic trawl landings by year.

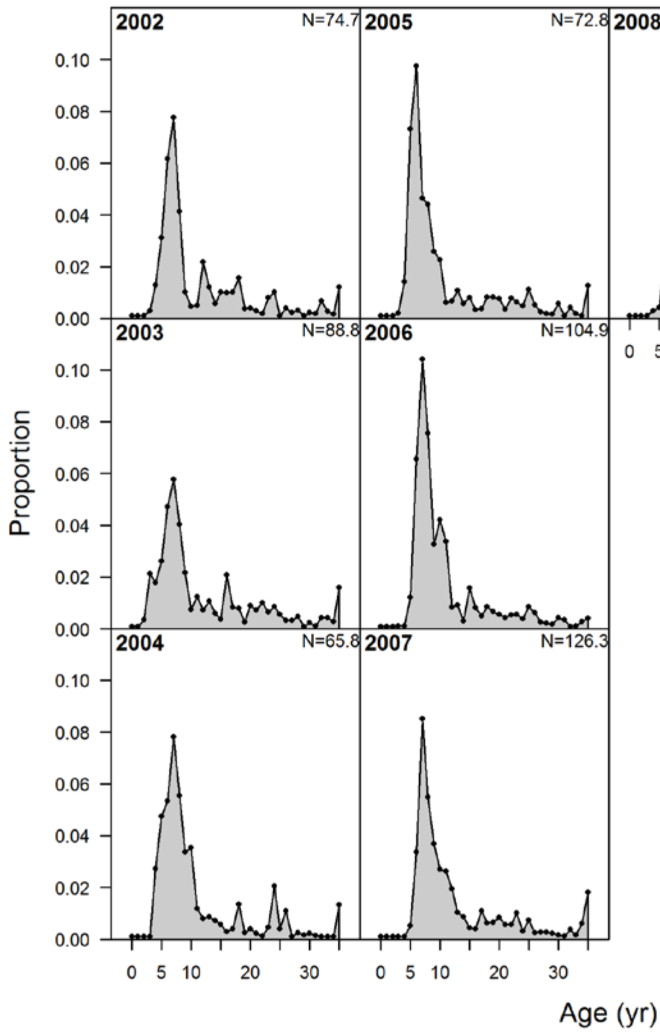

Figure 12: Age-frequency distributions for male darkblotched rockfish from the domestic trawl landings by year.

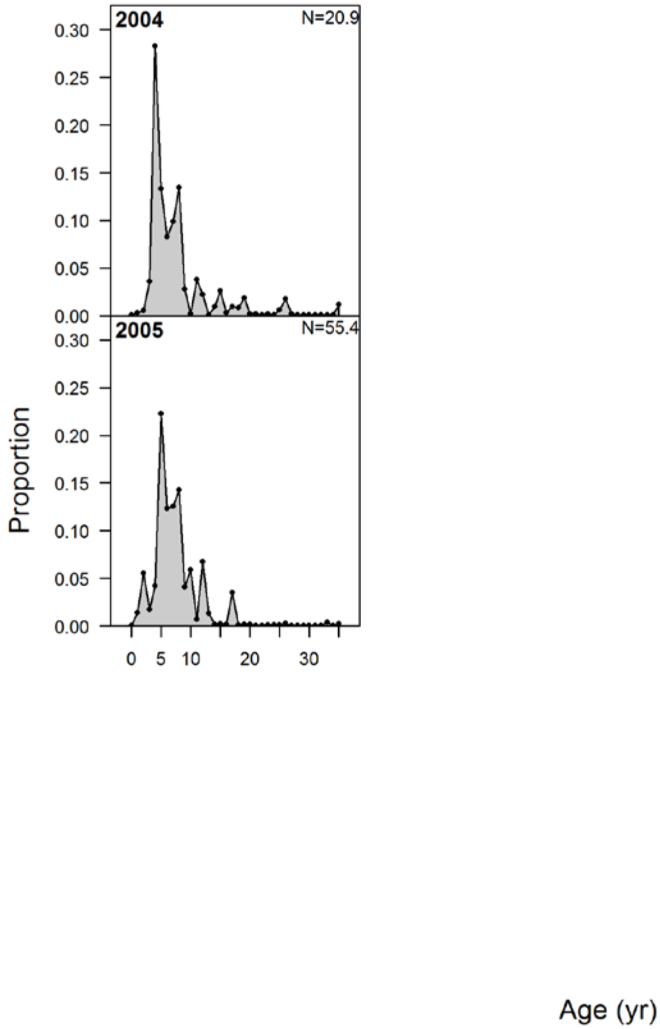

Figure 13: Age-frequency distributions for darkblotched rockfish (sexes combined) from the domestic trawl discards by year.

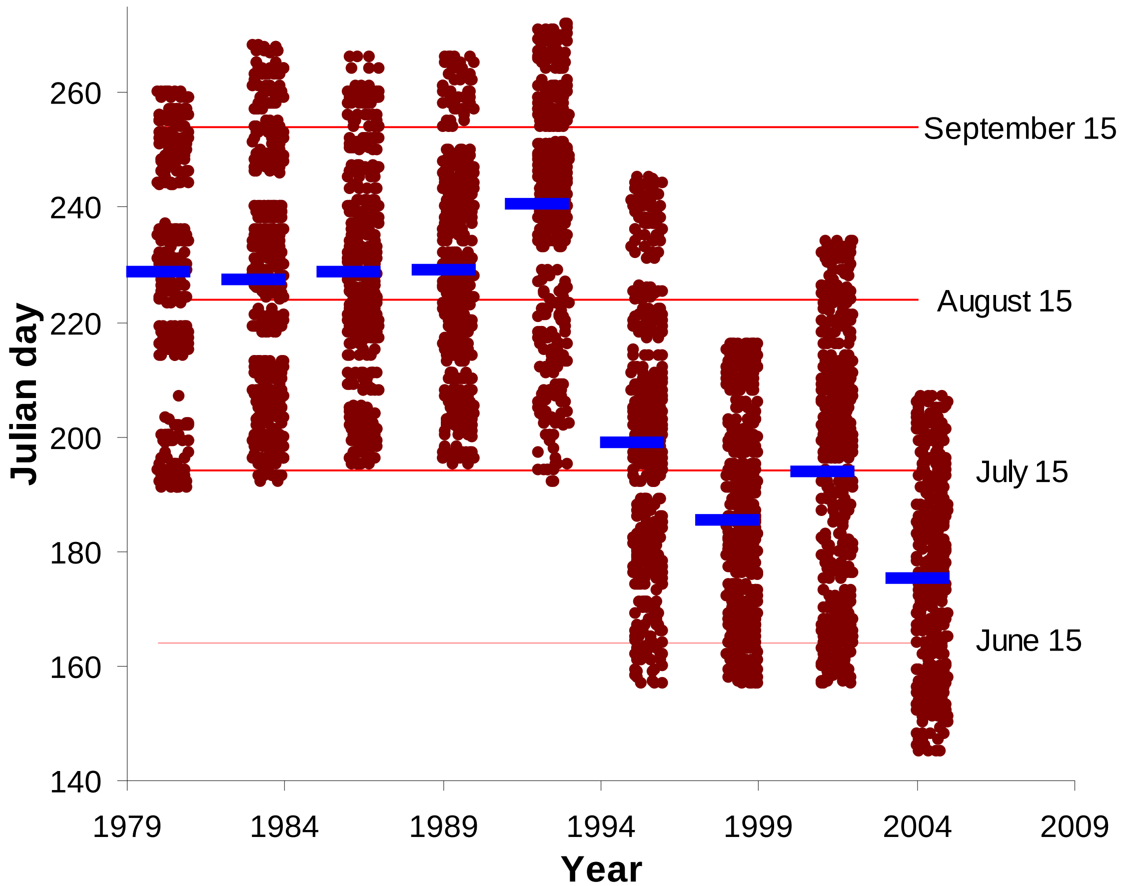

Figure 14: Distribution of dates of operation for the AFSC shelf (triennial) bottom trawl survey (1980-2004). Solid bars show the mean date for each survey year, points represent individual hauls dates, but are jittered to allow better delineation of the distribution of individual points.

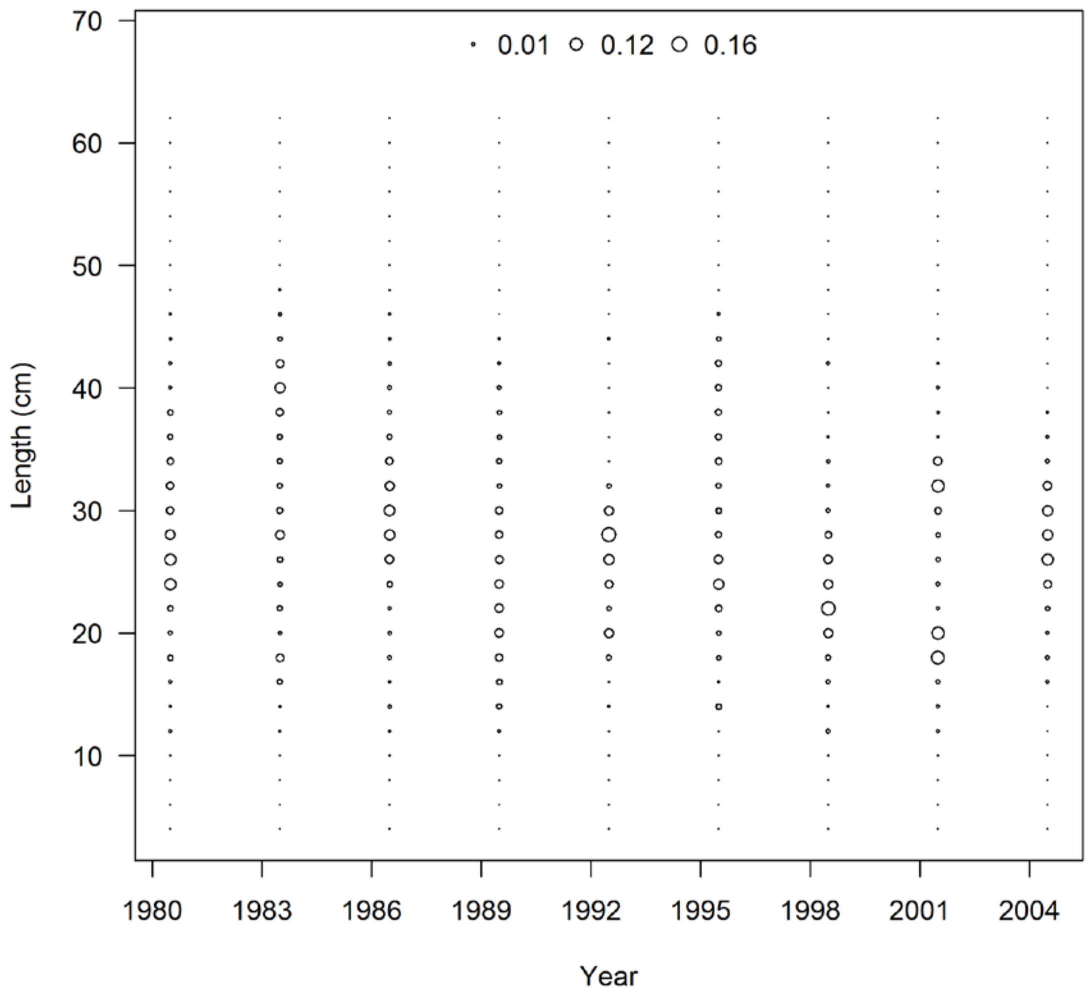

Figure 15: Length-frequency distributions for female darkblotched rockfish from the AFSC shelf survey.

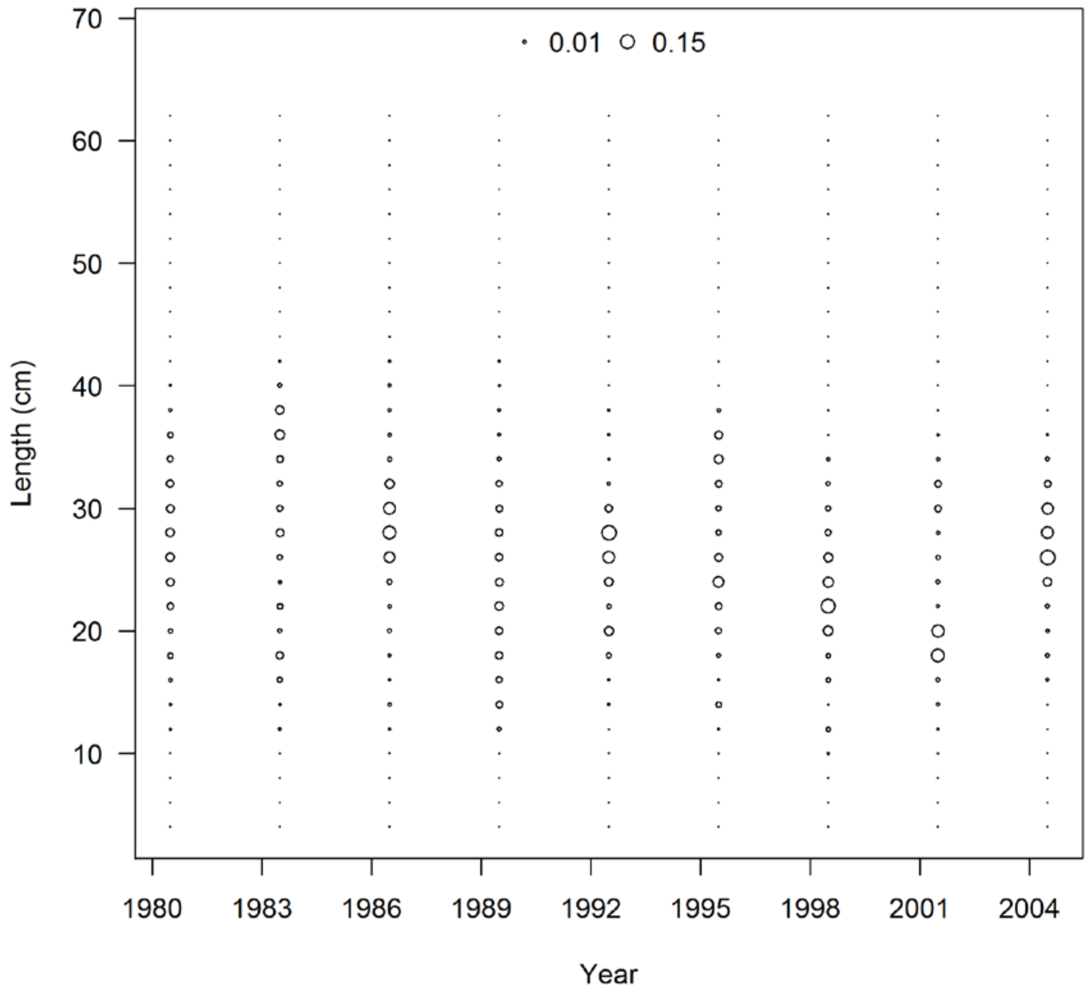

Figure 16: Length-frequency distributions for male darkblotched rockfish from the AFSC shelf survey.

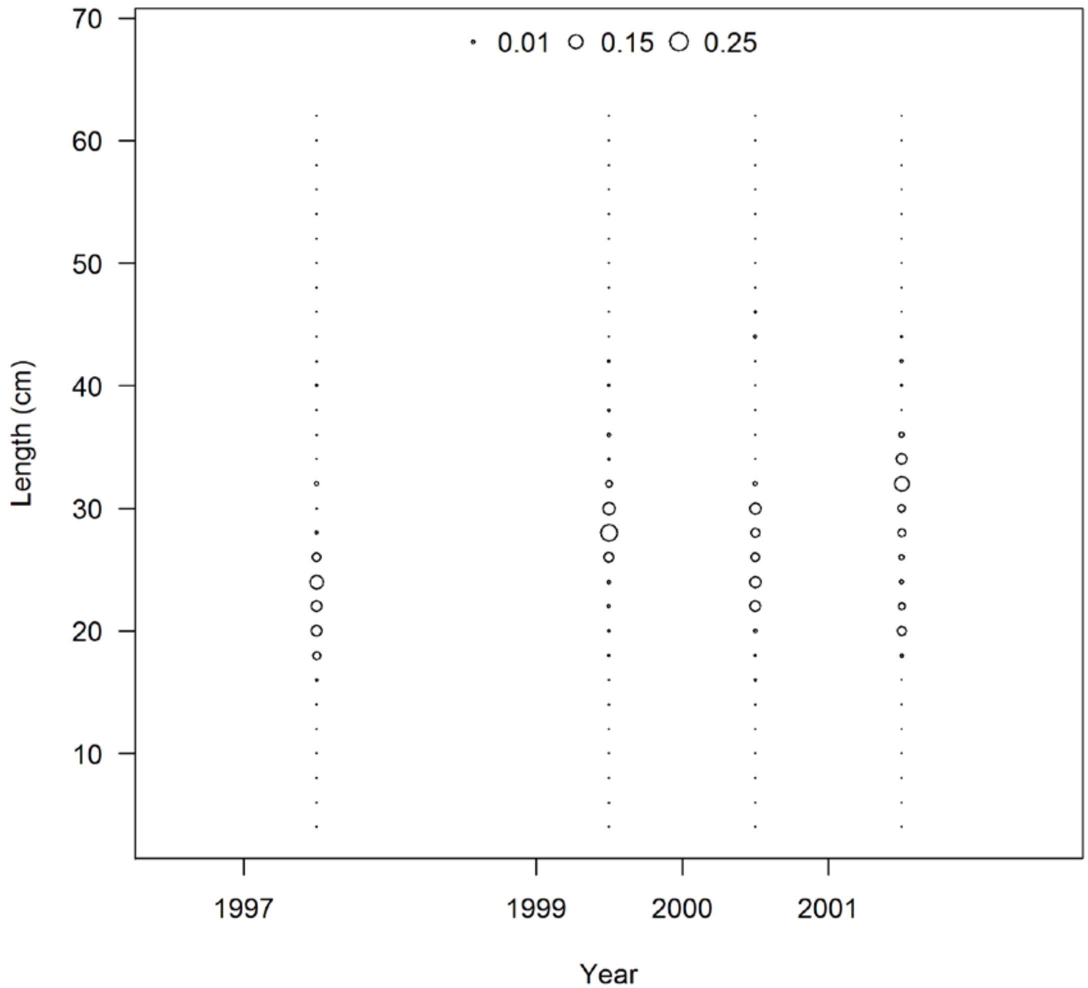

Figure 17: Length-frequency distributions for female darkblotched rockfish from the AFSC slope survey.

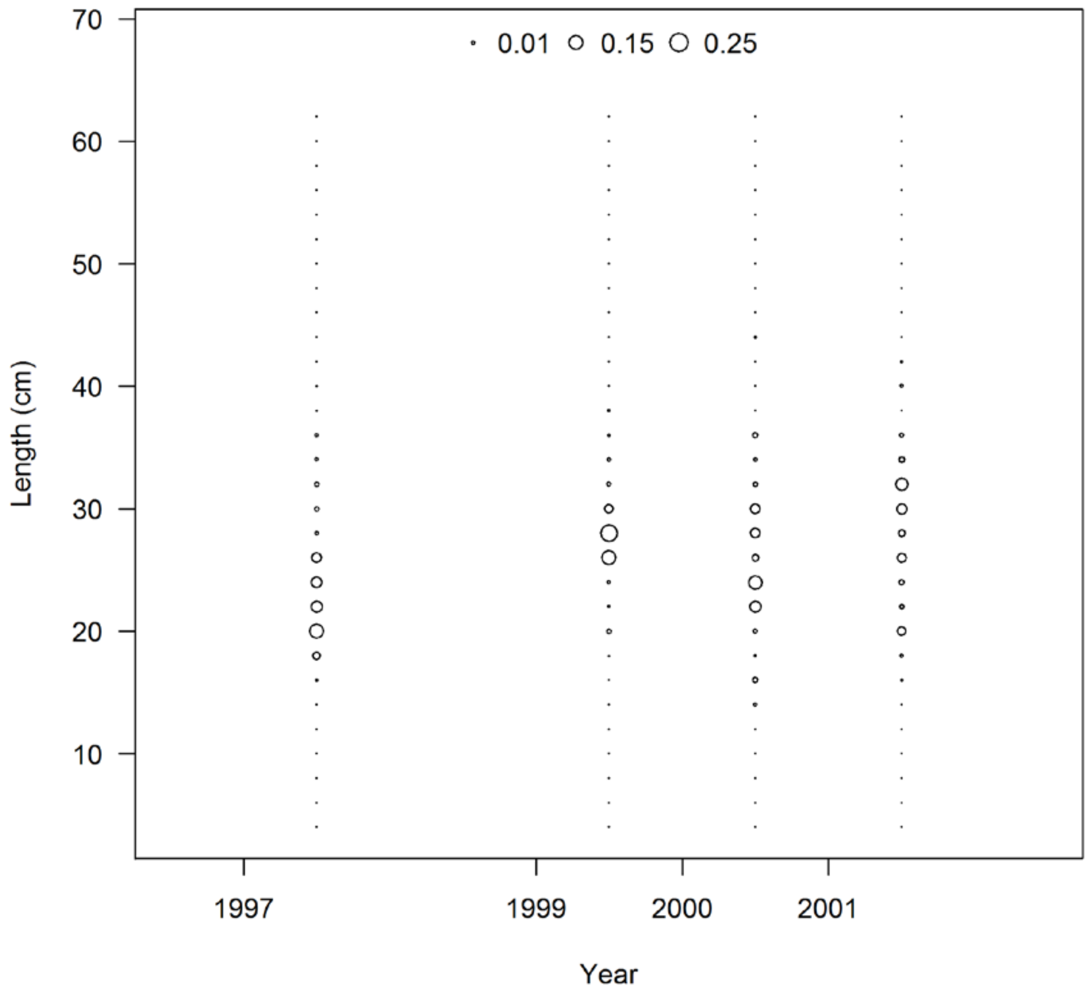

Figure 18: Length-frequency distributions for male darkblotched rockfish from the AFSC slope survey.

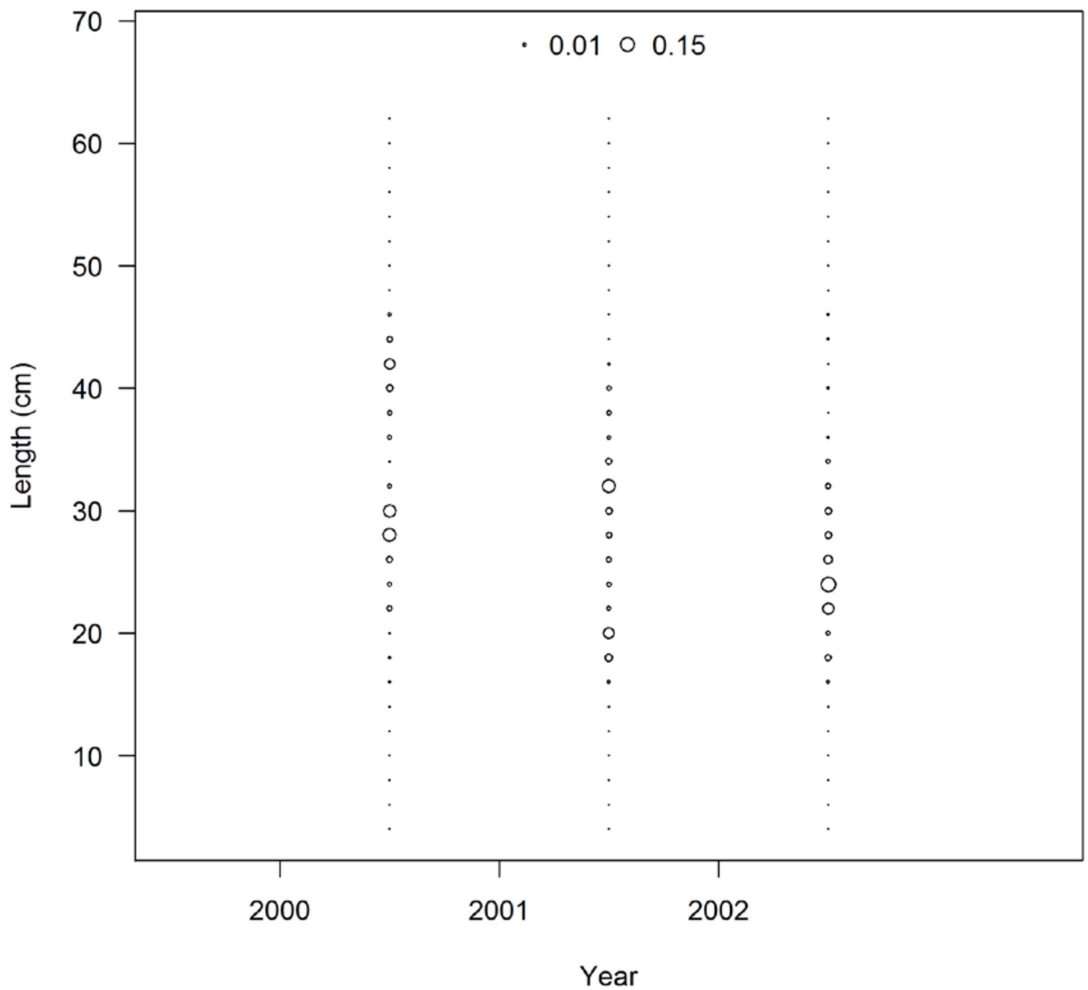

Figure 19: Length-frequency distributions for female darkblotched rockfish from the NWFSC slope survey.

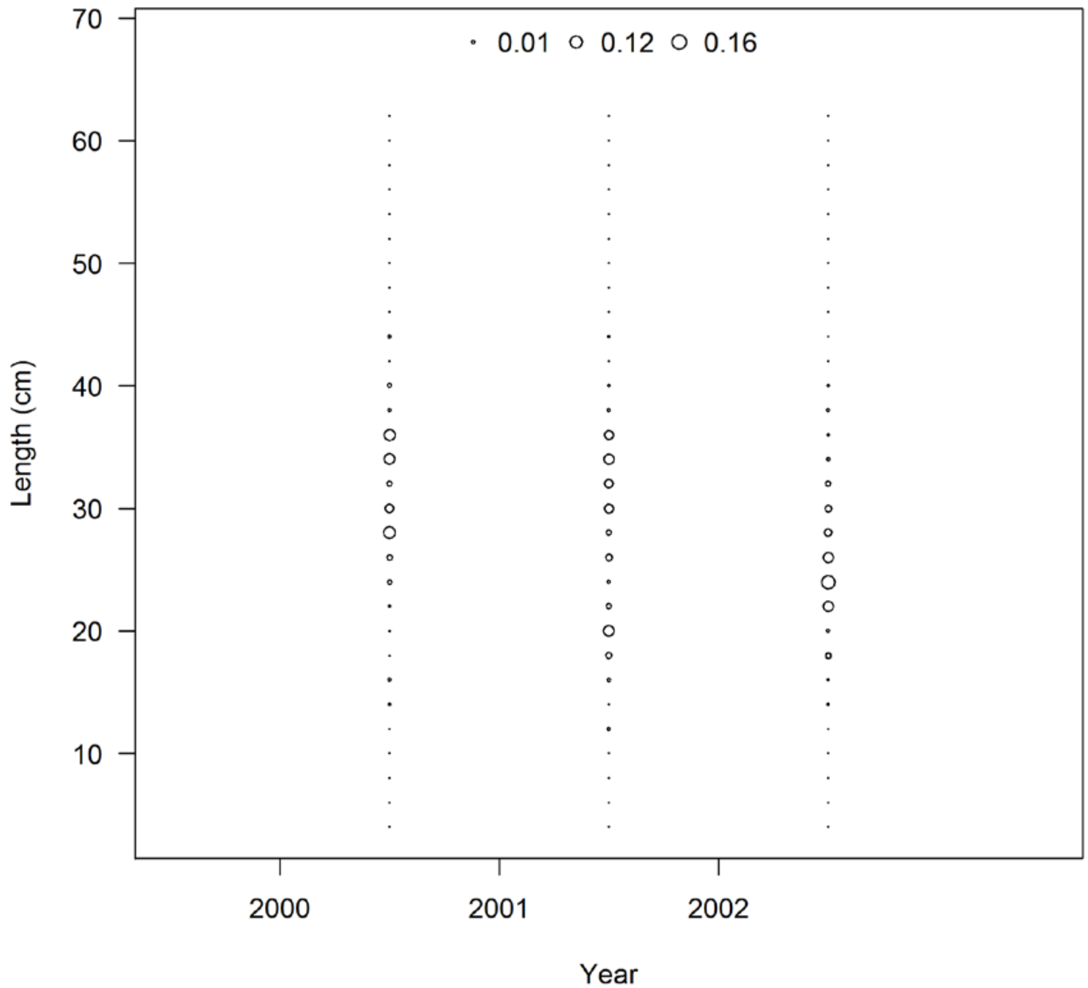

Figure 20: Length-frequency distributions for male darkblotched rockfish from the NWFSC slope survey.

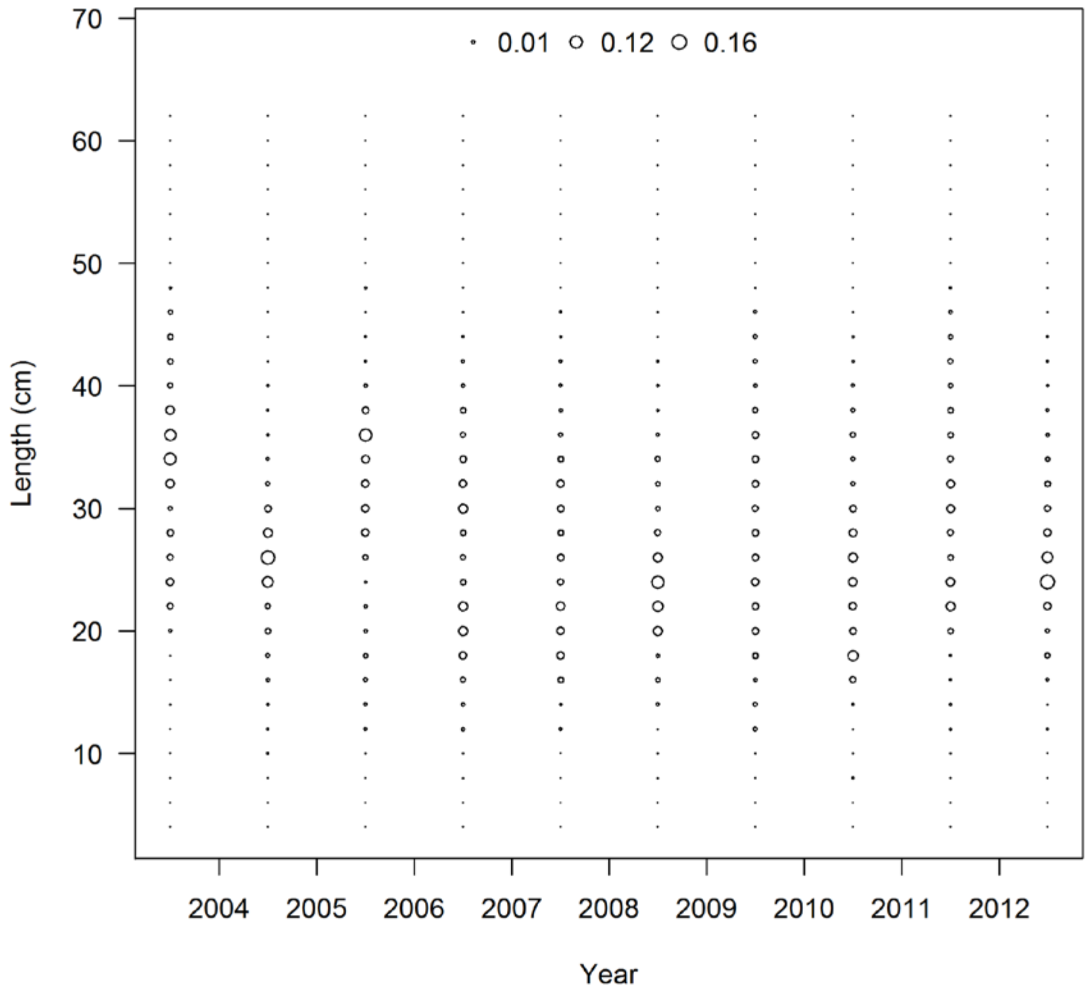

Figure 21: Length-frequency distributions for female darkblotched rockfish from the NWFSC shelf-slope survey.

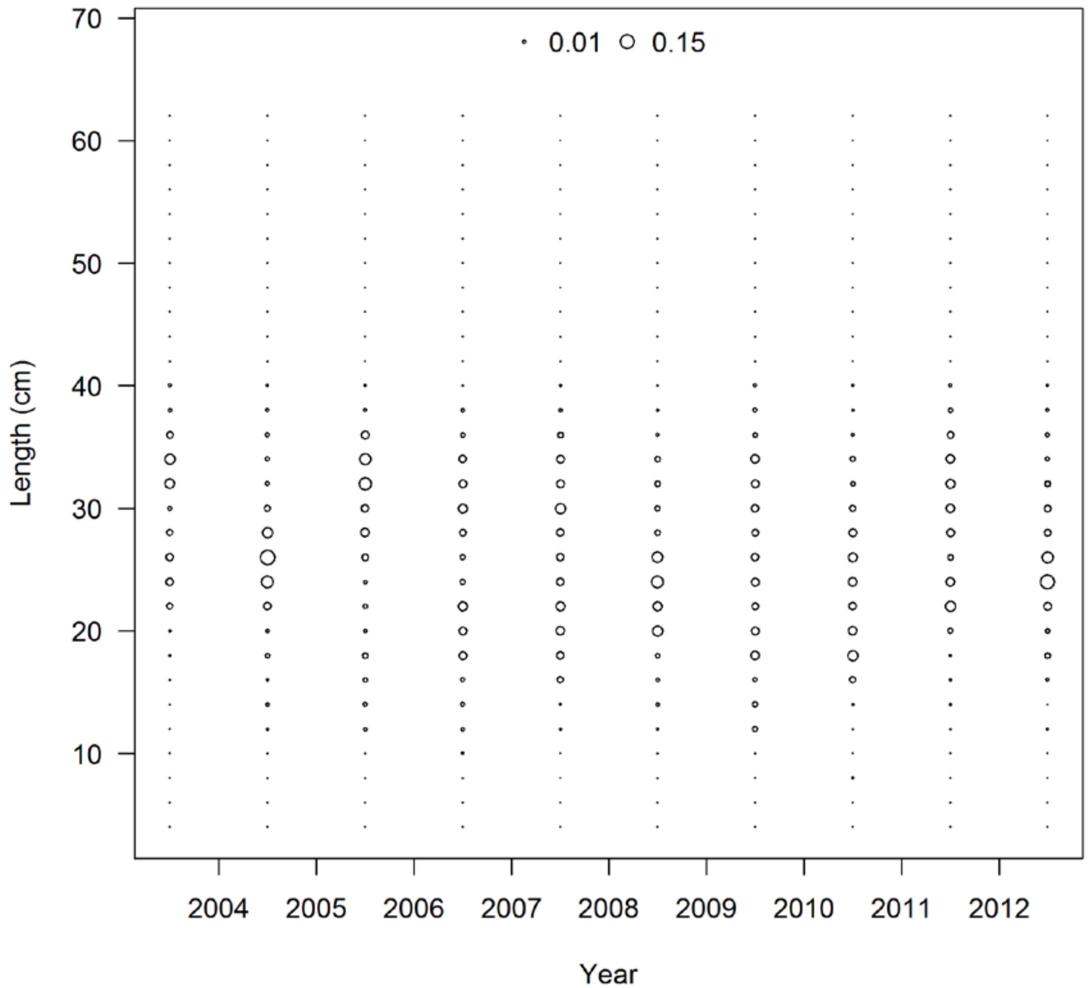

Figure 22: Length-frequency distributions for male darkblotched rockfish from the NWFSC shelf-slope survey.

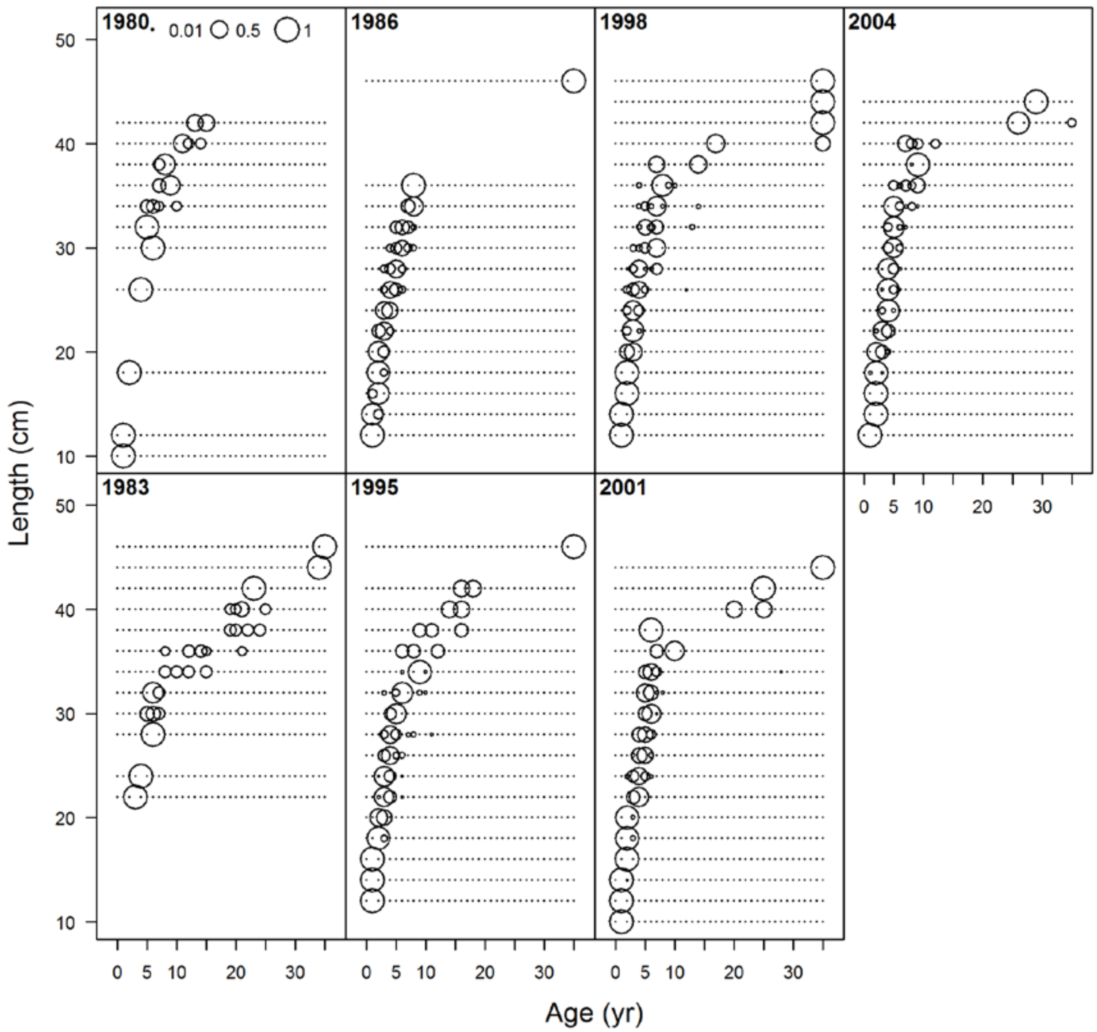

Figure 23: Conditional age-frequency distributions for female darkblotched rockfish from the AFSC shelf survey.

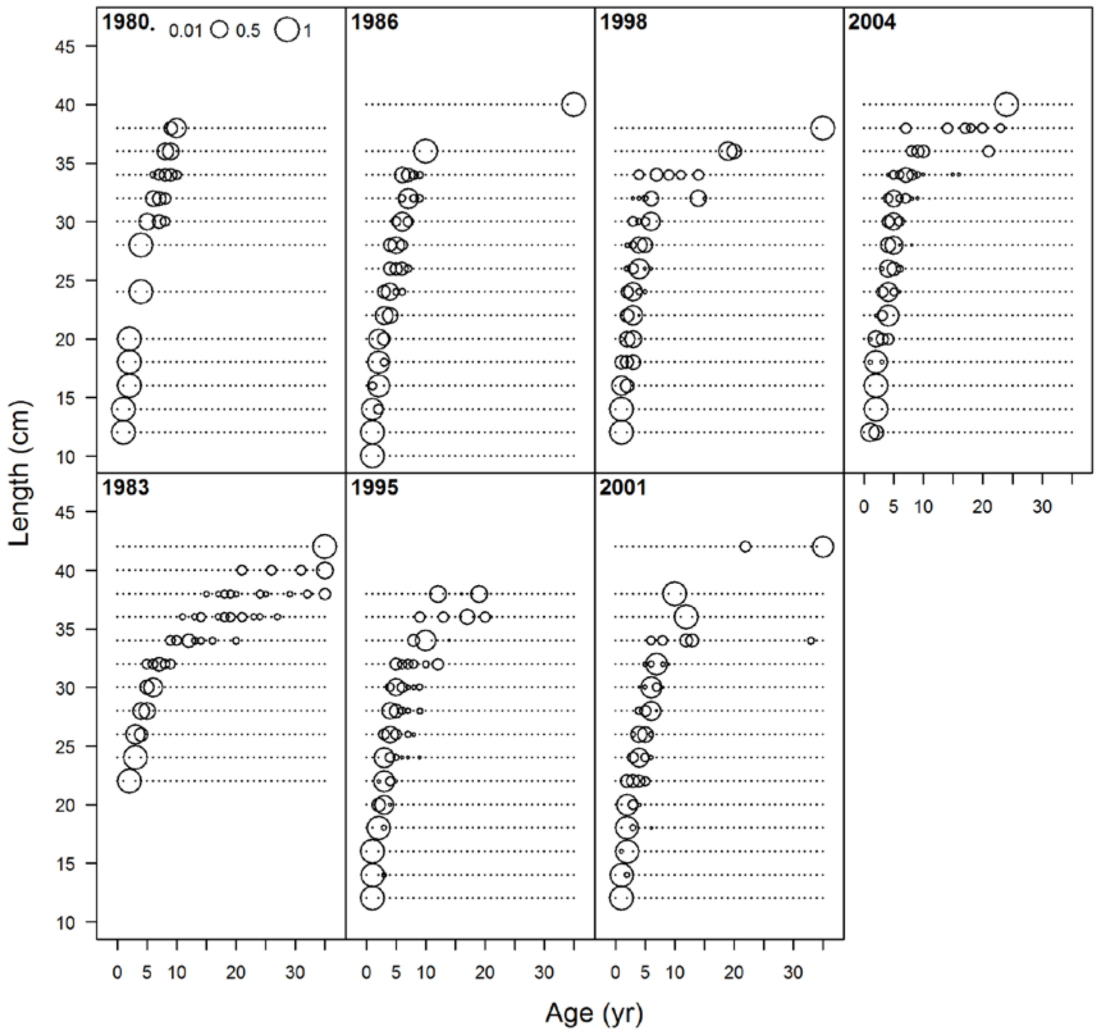

Figure 24: Conditional age-frequency distributions for male darkblotched rockfish from the AFSC shelf survey.

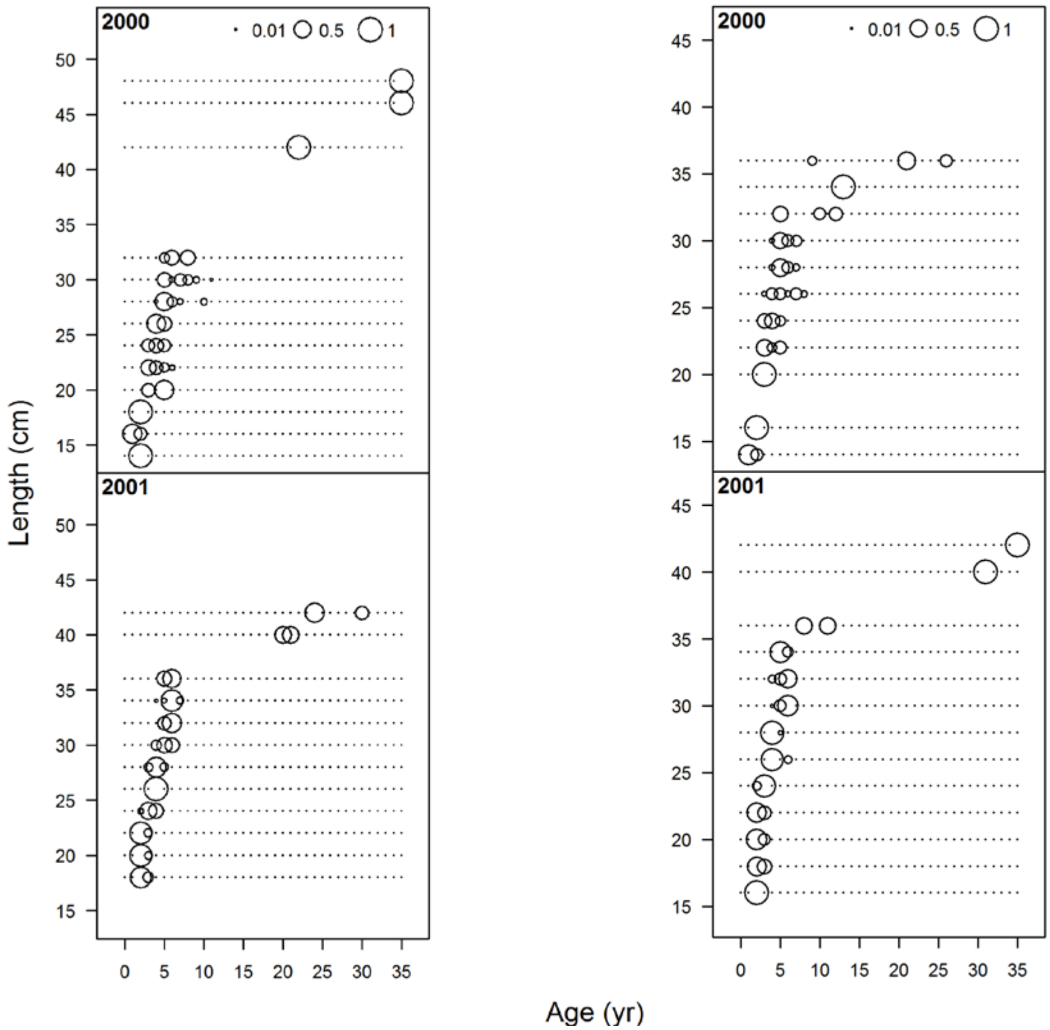

Figure 25: Conditional age-frequency distributions for female (left panel) and male (right panel) darkblotched rockfish from the AFSC slope survey.

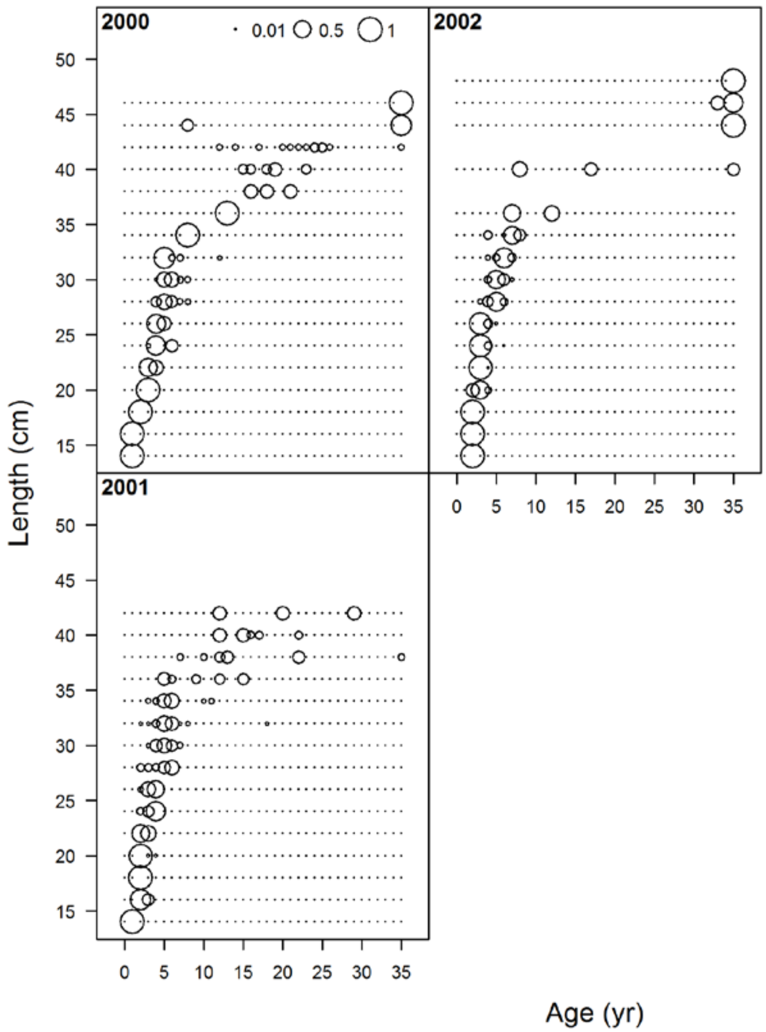

Figure 26: Conditional age-frequency distributions for female darkblotched rockfish from the NWFSC slope survey.

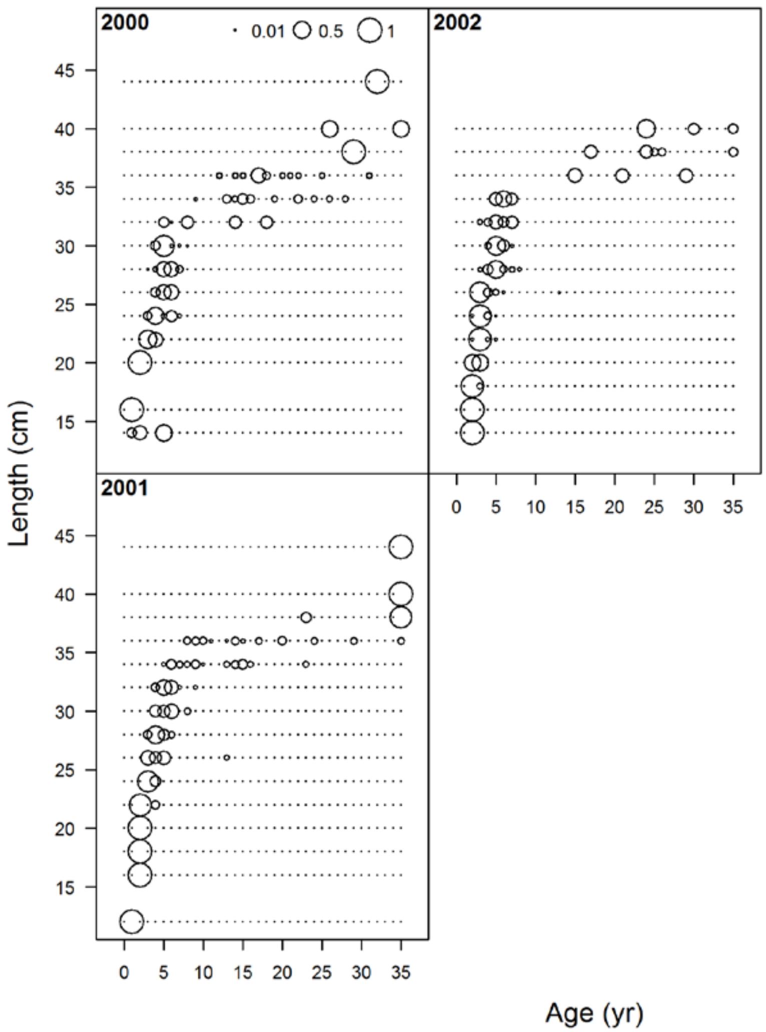

Figure 27: Conditional age-frequency distributions for male darkblotched rockfish from the NWFSC slope survey.

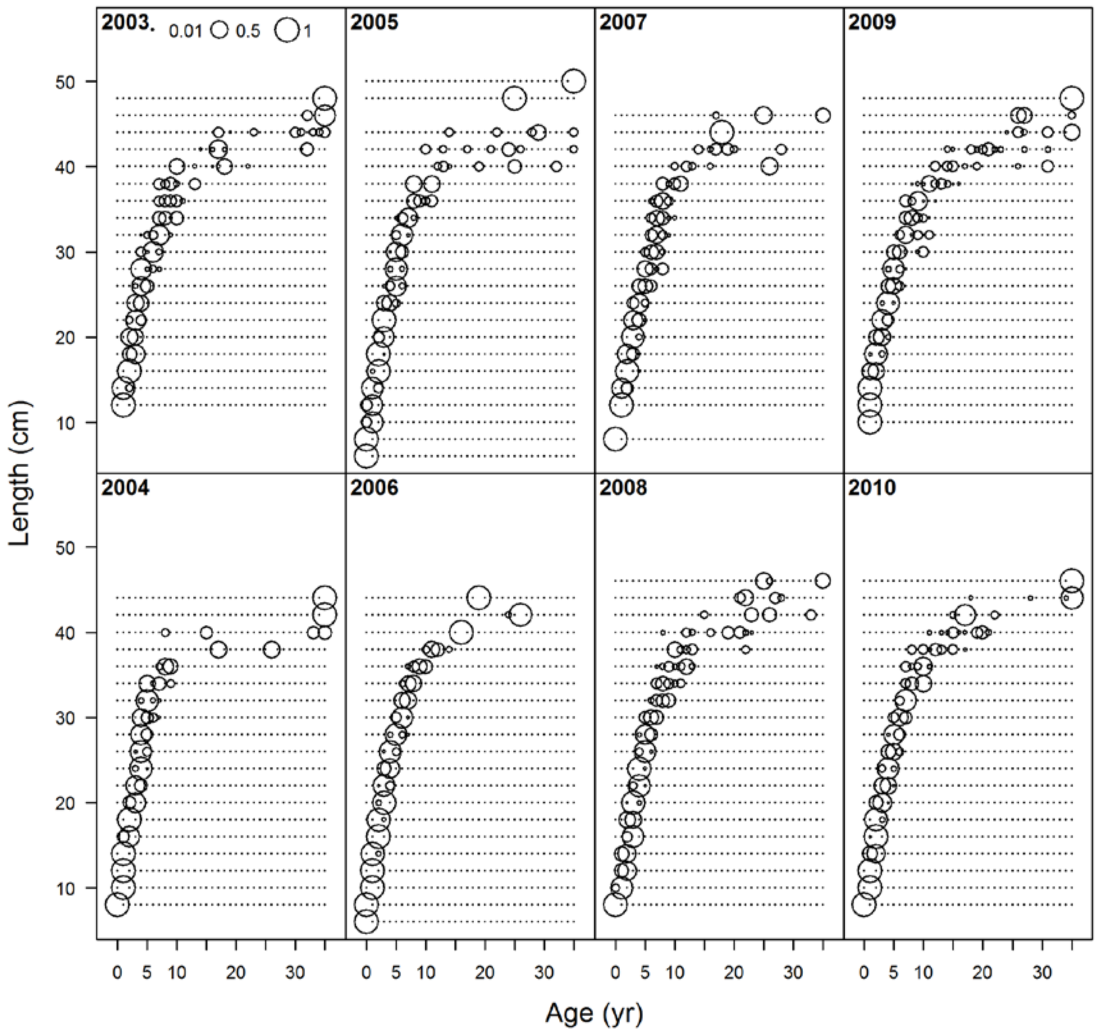

Figure 28: Conditional age-frequency distributions for female darkblotched rockfish from the NWFSC shelf-slope survey.

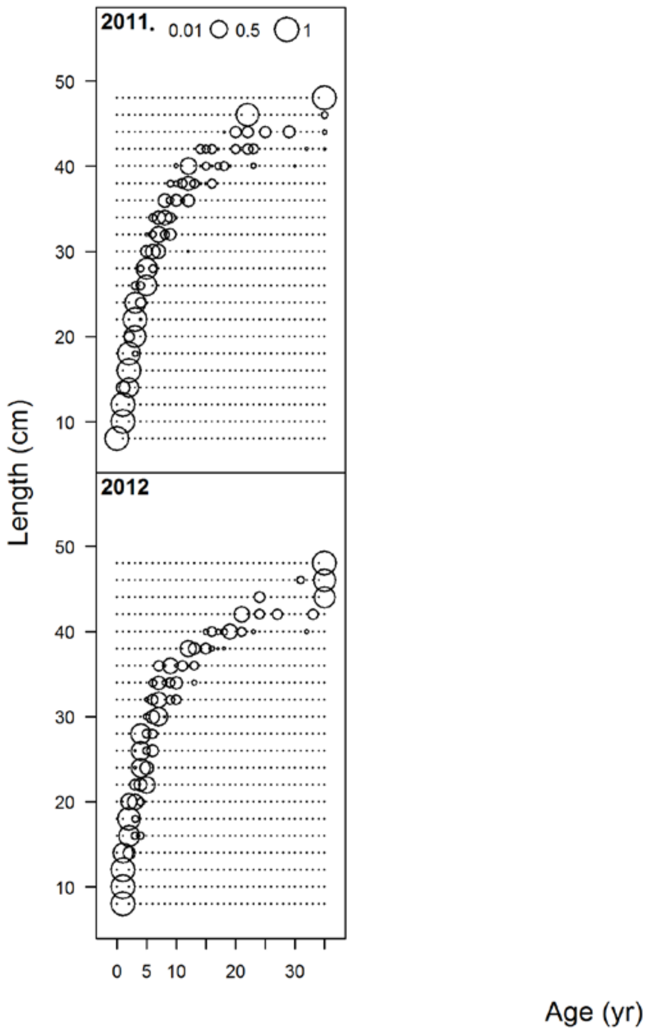

Figure 28 (continued): Conditional age-frequency distributions for female darkblotched rockfish from the NWFSC shelf-slope survey.

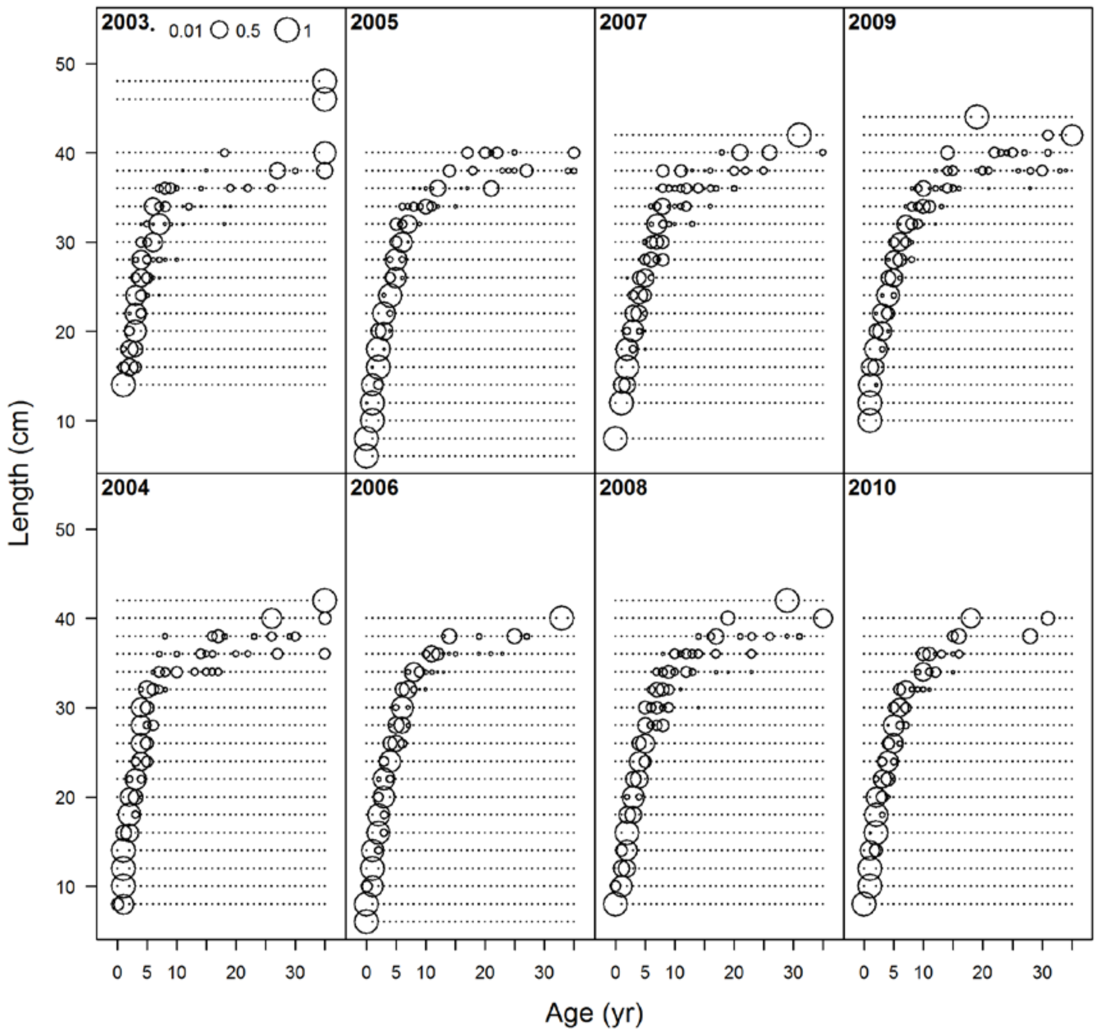

Figure 29: Conditional age-frequency distributions for male darkblotched rockfish from the NWFSC shelf-slope survey.

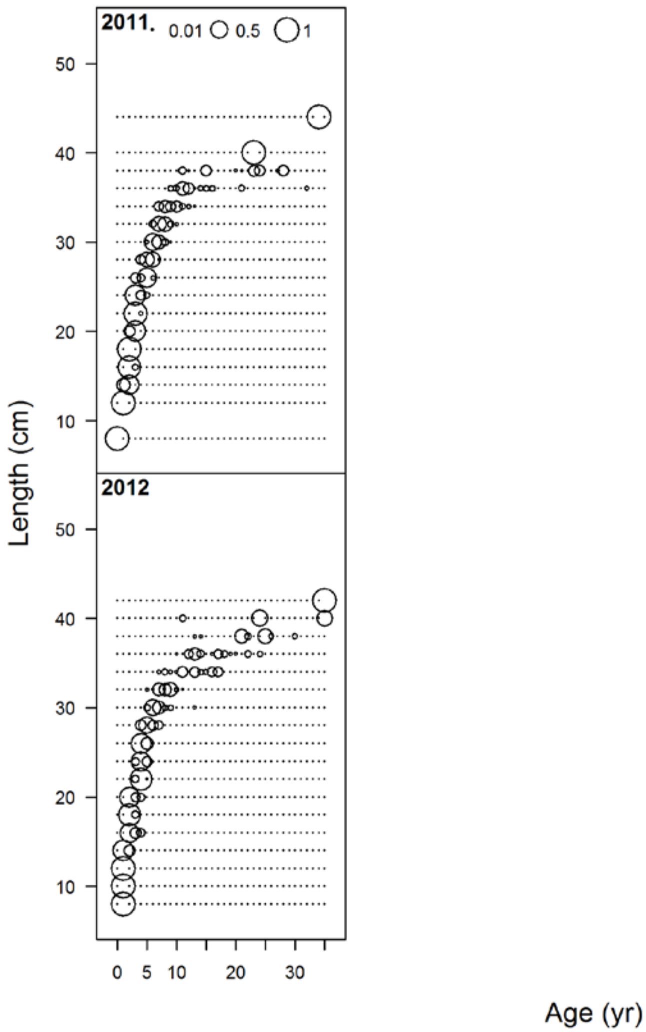

Figure 29 (continued): Conditional age-frequency distributions for male darkblotched rockfish from the NWFSC shelf-slope survey.

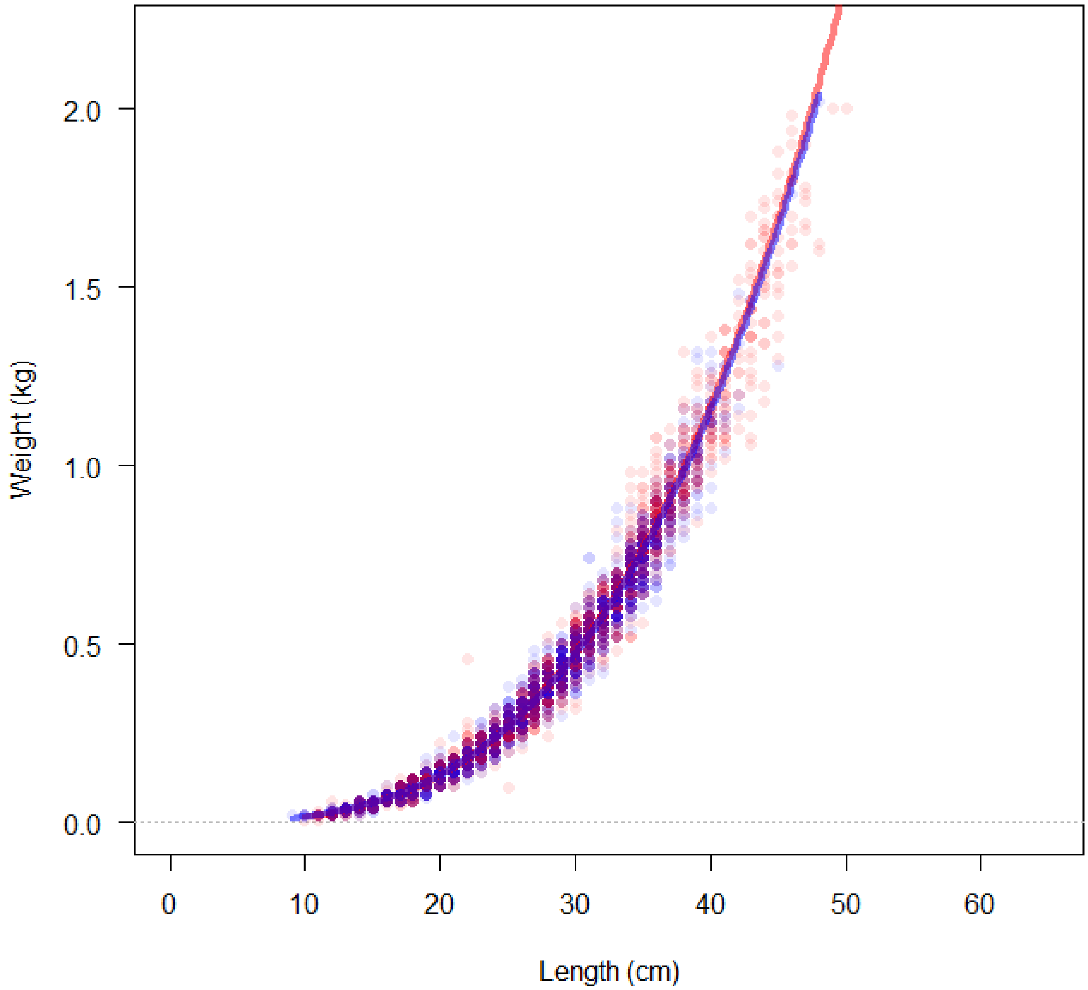

Figure 30: Weight-length relationship for female (red) and male (blue) darkblotched rockfish used in the assessment, shown with fit to the data from the NWFSC shelf-slope survey samples (shaded points).

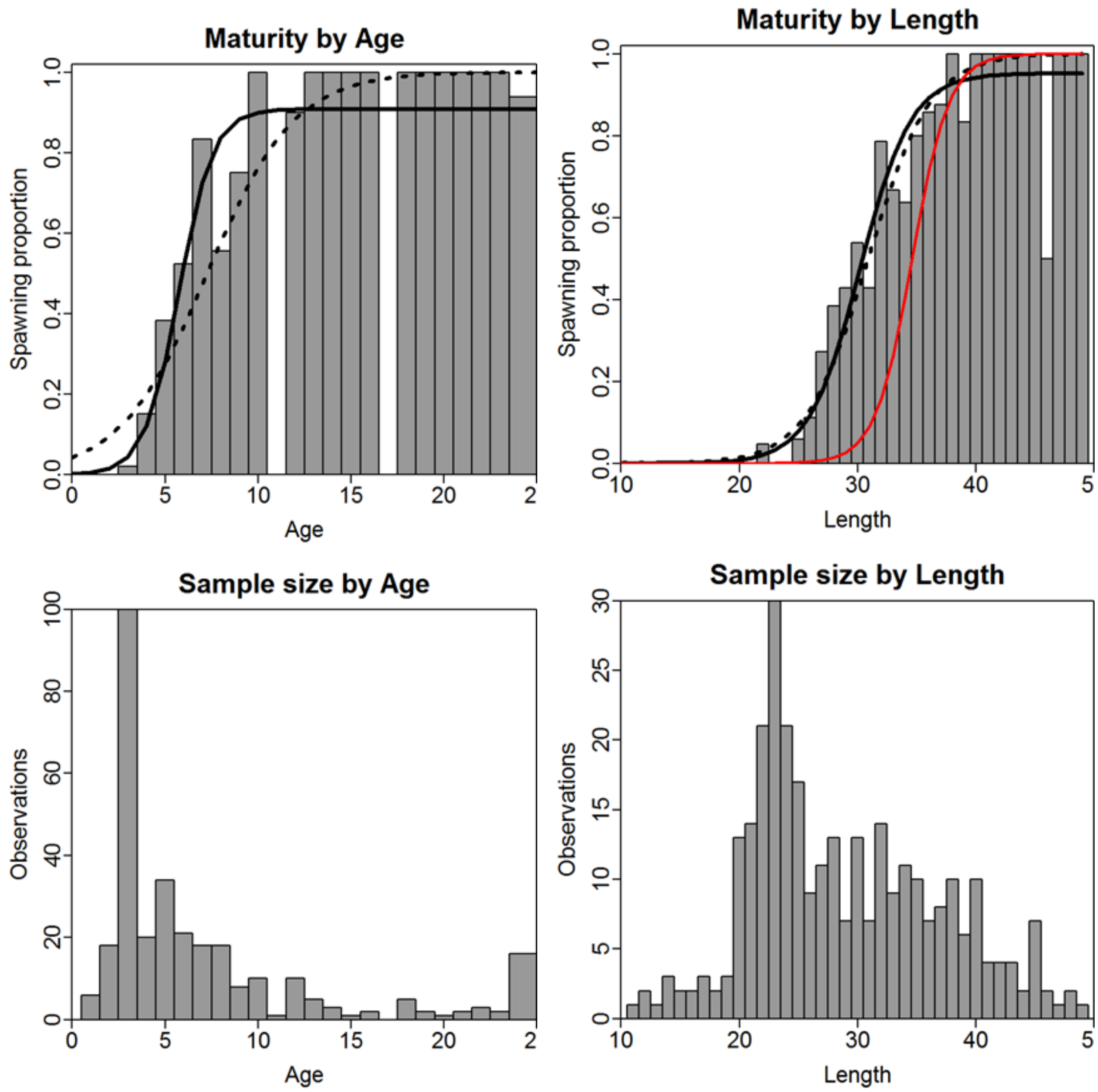

Figure 31: Maturity-at-age (left column) relationship for female darkblotched rockfish used in the assessment, shown with fit to the data from the NWFSC shelf-slope survey samples using a three-parameter (black line) and two-parameter (dashed line) model (top row) and the data availability by age (bottom row), and maturity-at-length (right column) relationship estimated using these same data (displayed identically to maturity at age except the addition red line shows the maturity-at-length schedule from the 2011 assessment).

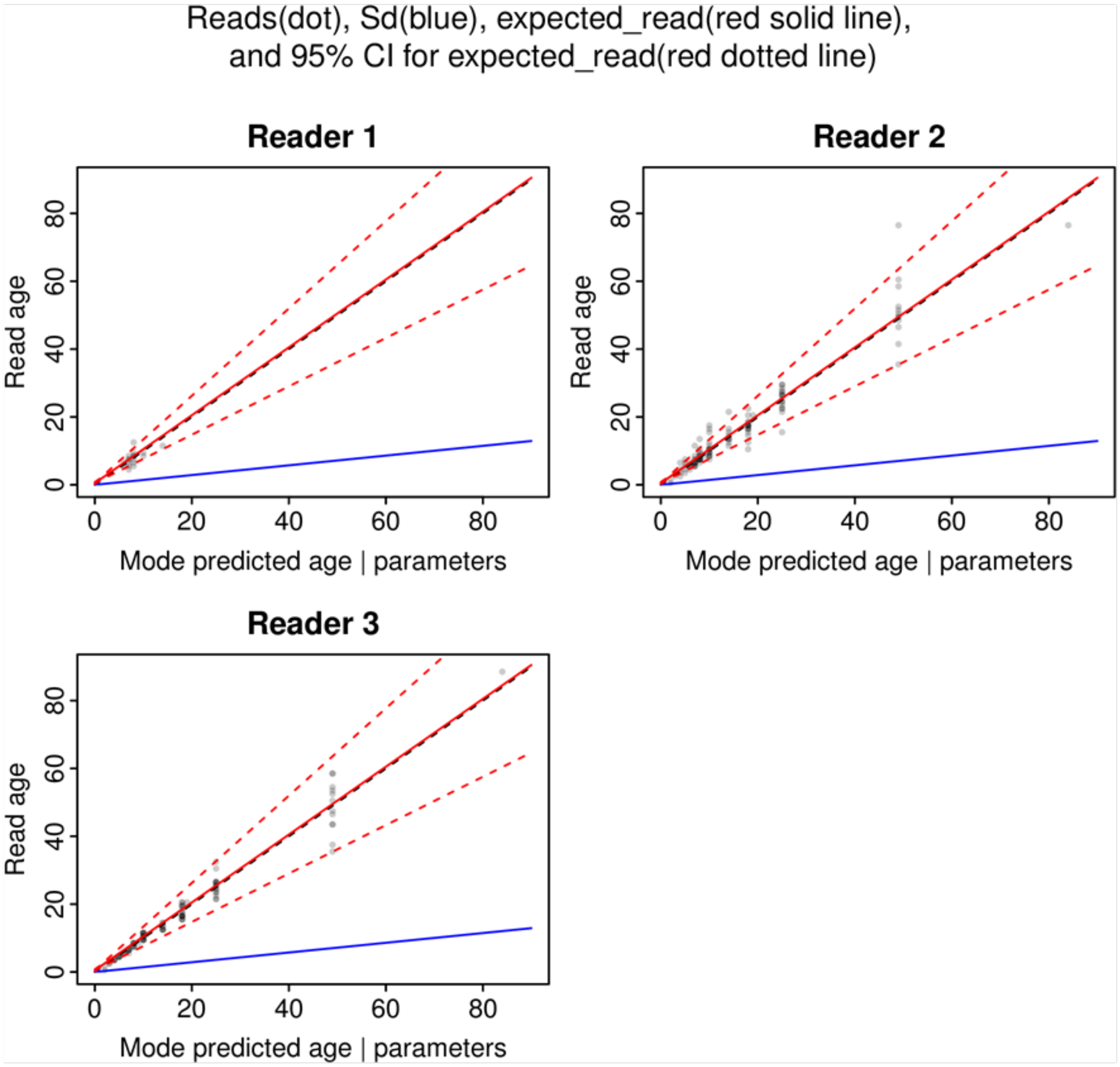

Figure 32: Ageing error figure for “early” reads (Reader 3 is recent re-reads of otoliths that were read prior to 2005, and hence is specified as unbiased).

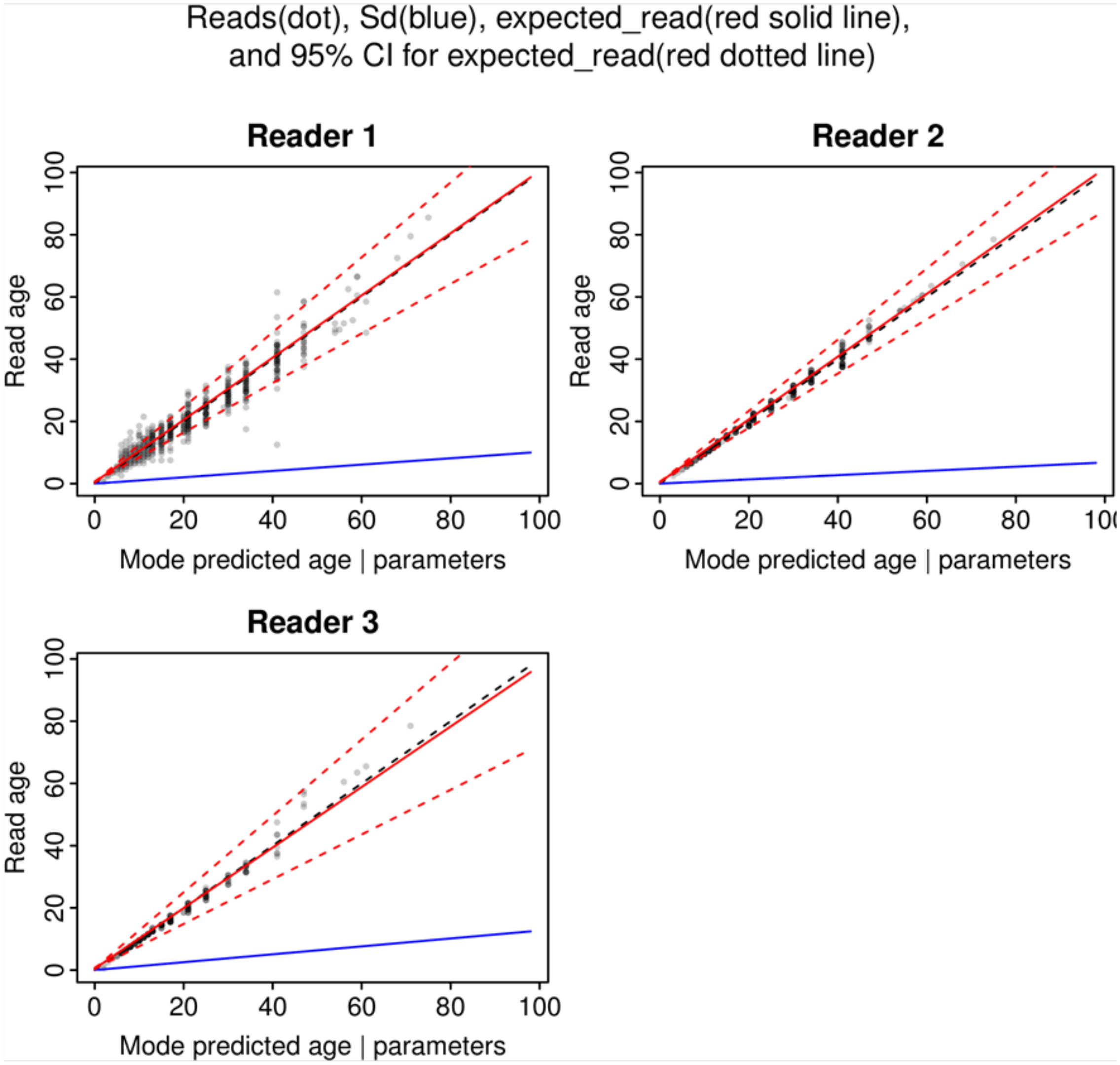

Figure 33: Ageing error figure for "late" reads (where Reader 1 is the reader of retained compositional data after 2005, and is believed *a priori* to be unbiased, while bias and imprecision are estimated separately for Readers 2-3).

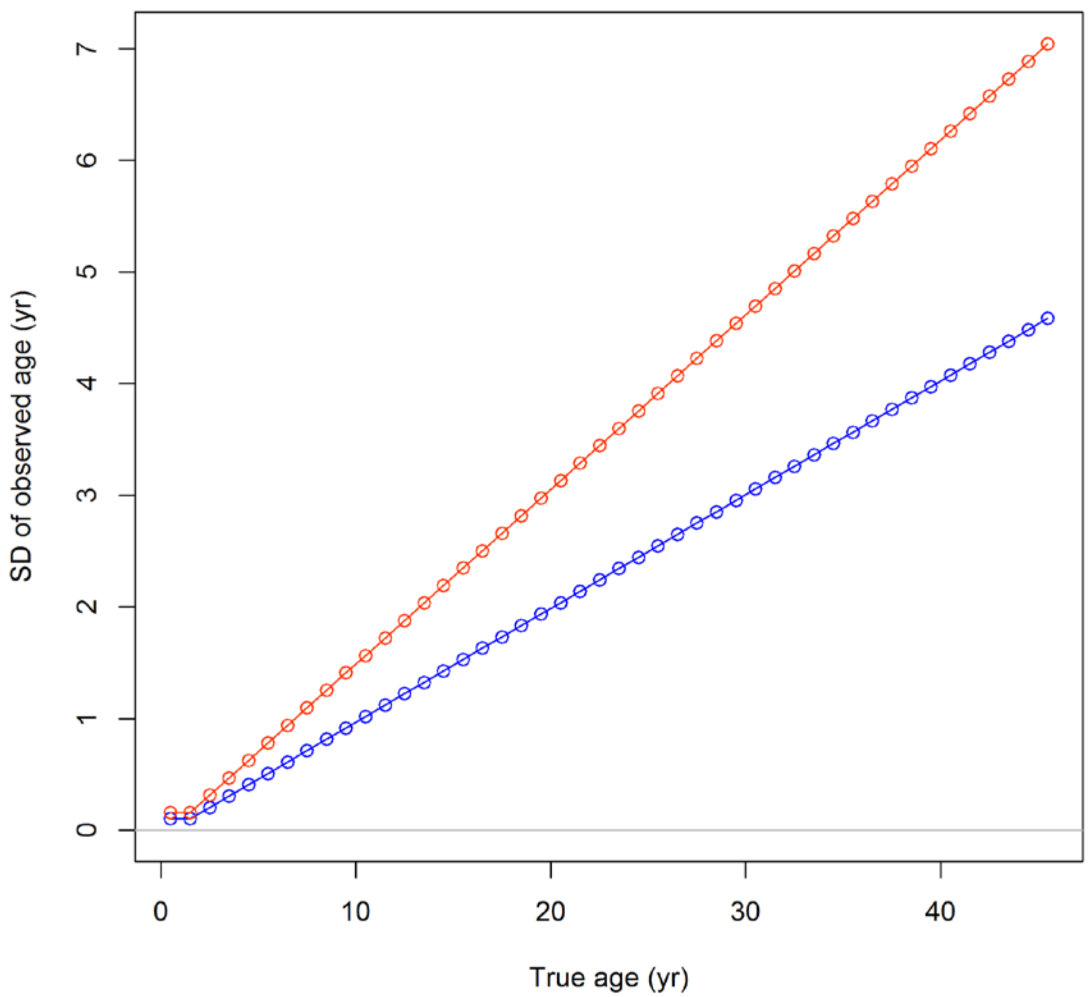

Figure 34: SD of observed age versus true age for “early” (red) and “late” (blue) age data used in the assessment.

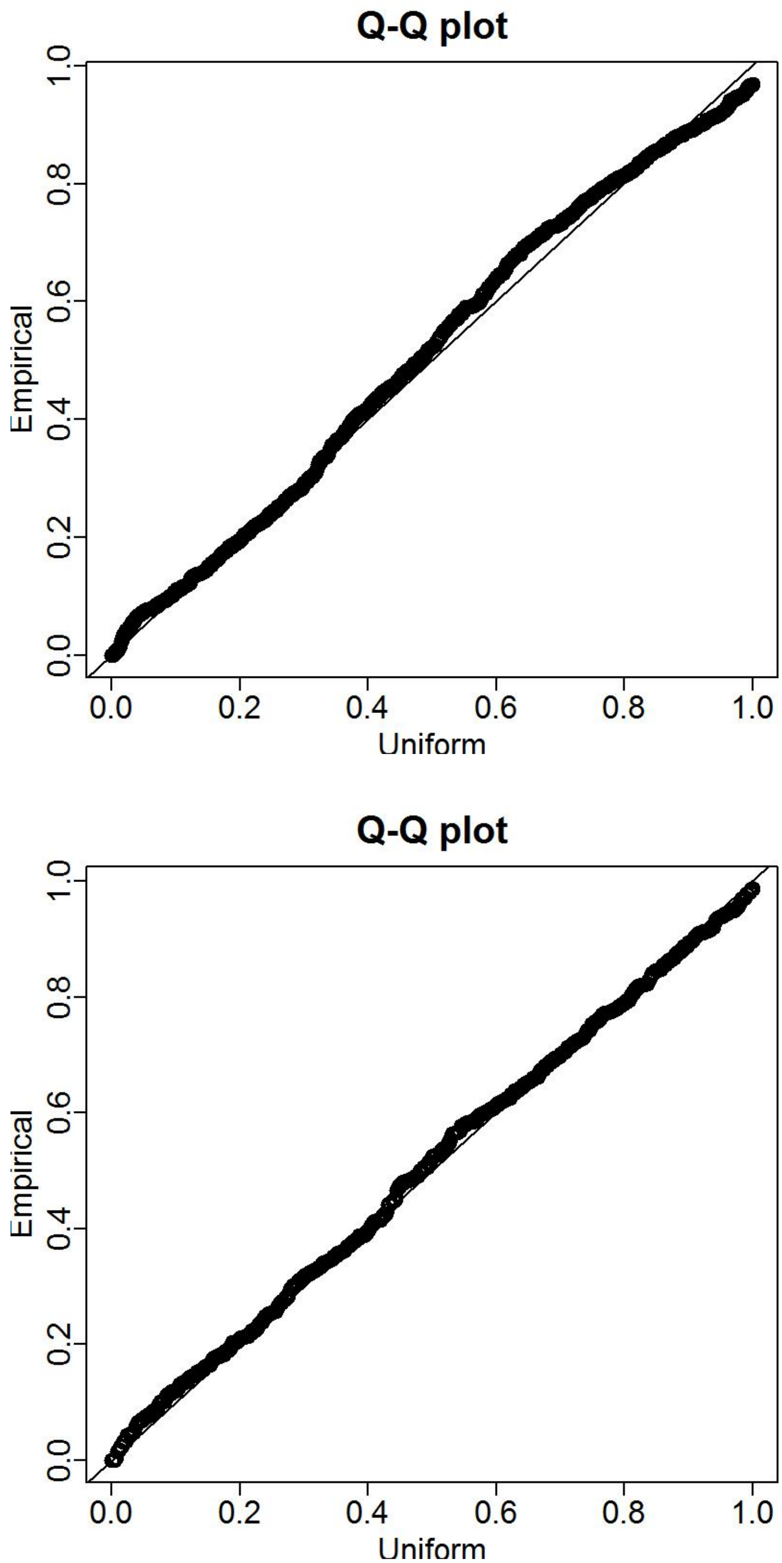

Figure 35: Bayesian Q-Q plot for AFSC shelf survey for 1980-1992 (upper panel) and 1995-2004 (lower panel).

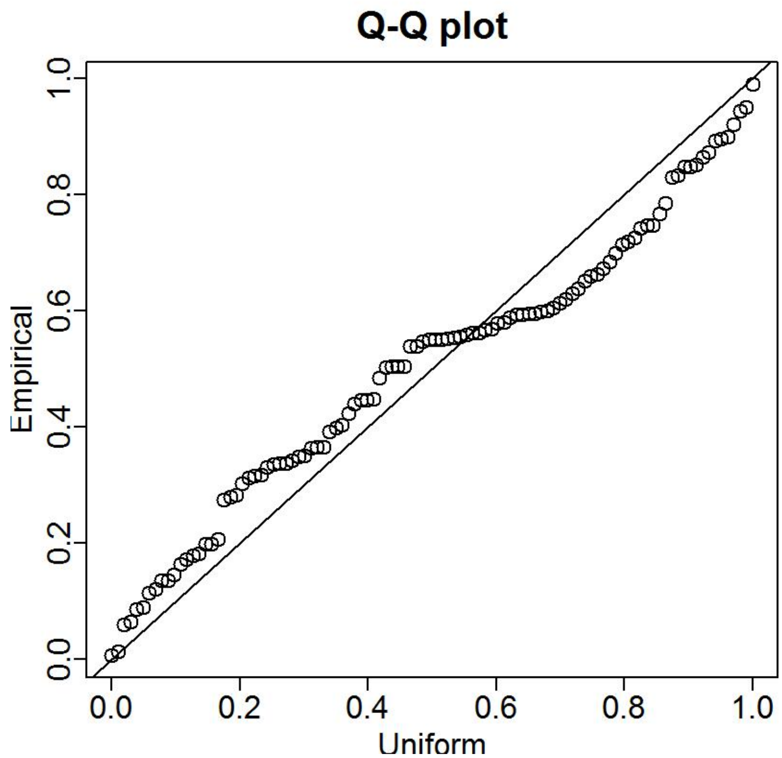

Figure 36: Bayesian Q-Q plot for AFSC slope survey.

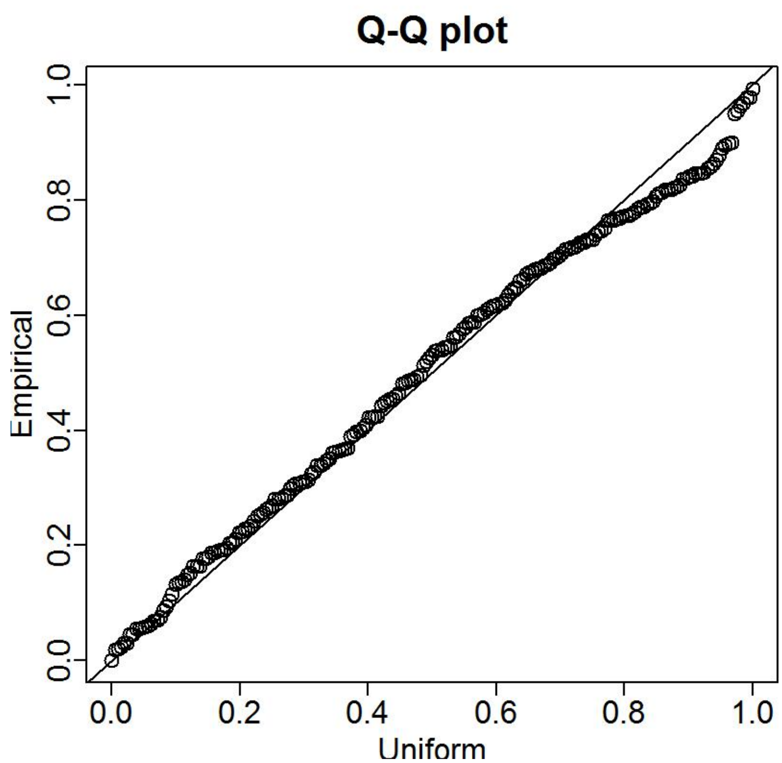

Figure 37: Bayesian Q-Q plot for NWFSC slope survey.

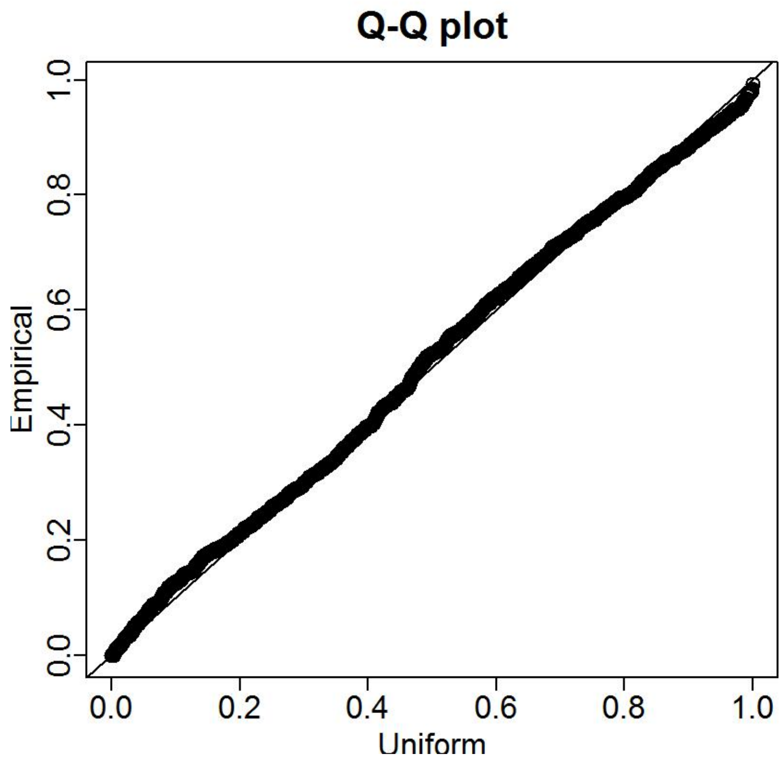

Figure 38: Bayesian Q-Q plot for NWFSC shelf-slope survey.

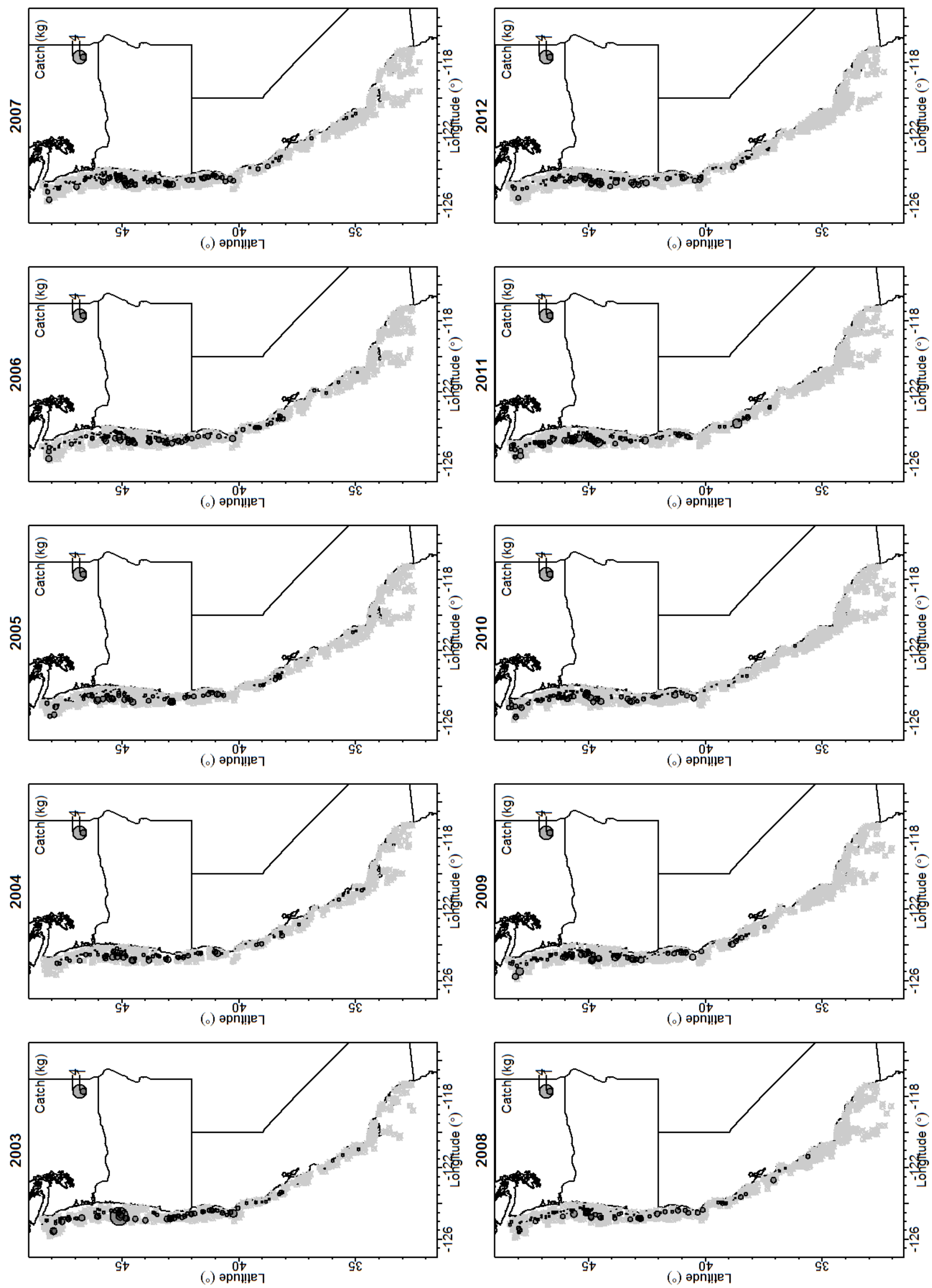

Figure 39: Distribution of darkblotched rockfish catch by haul observed within the NWFSC shelf-slope survey, by year and latitude.

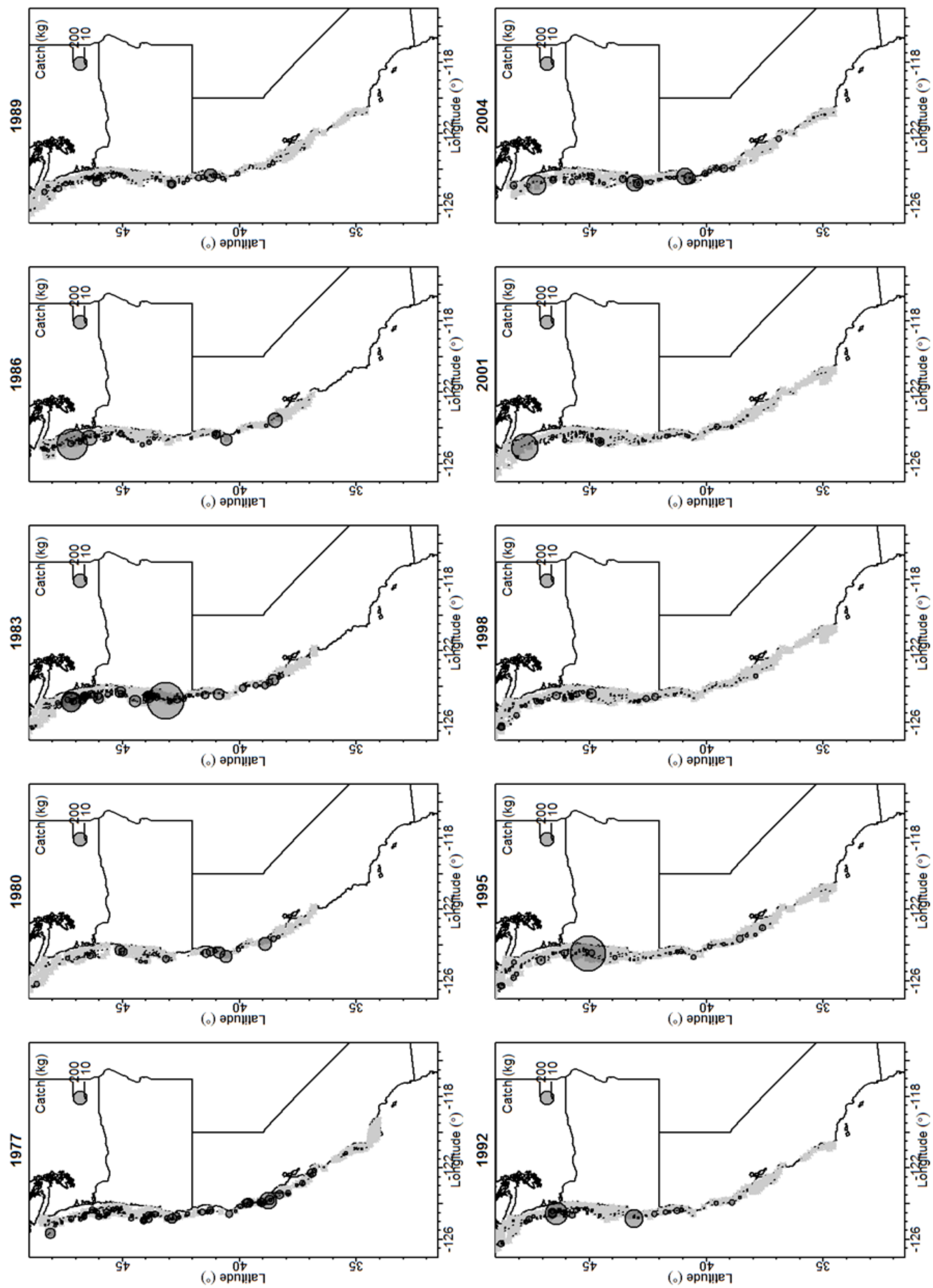

Figure 40: Distribution of darkblotched rockfish catch by haul observed within the AFSC triennial shelf survey, by year and latitude.

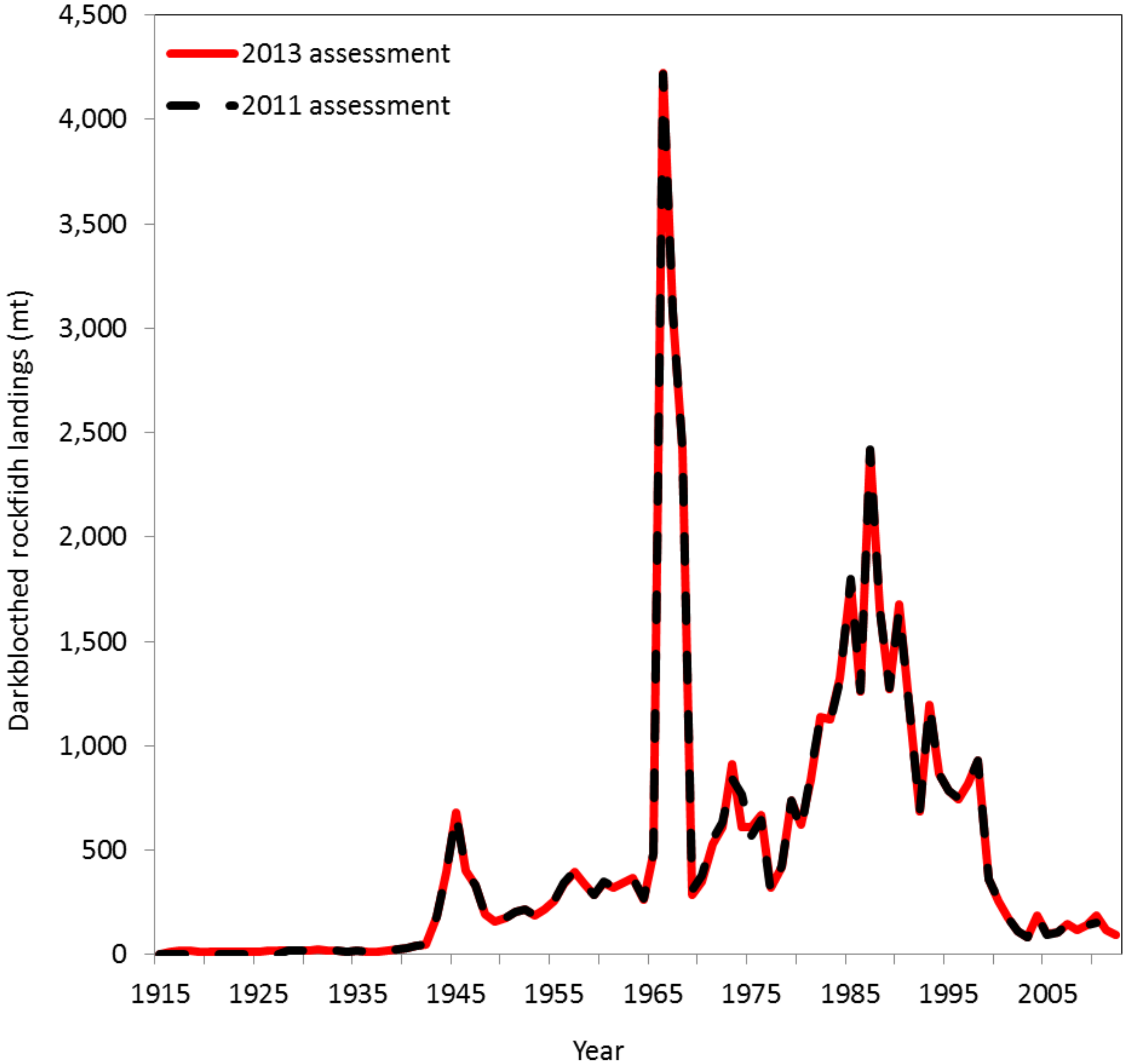

Figure 41: Time series of darkblotched rockfish landings used in this and 2011 assessments.

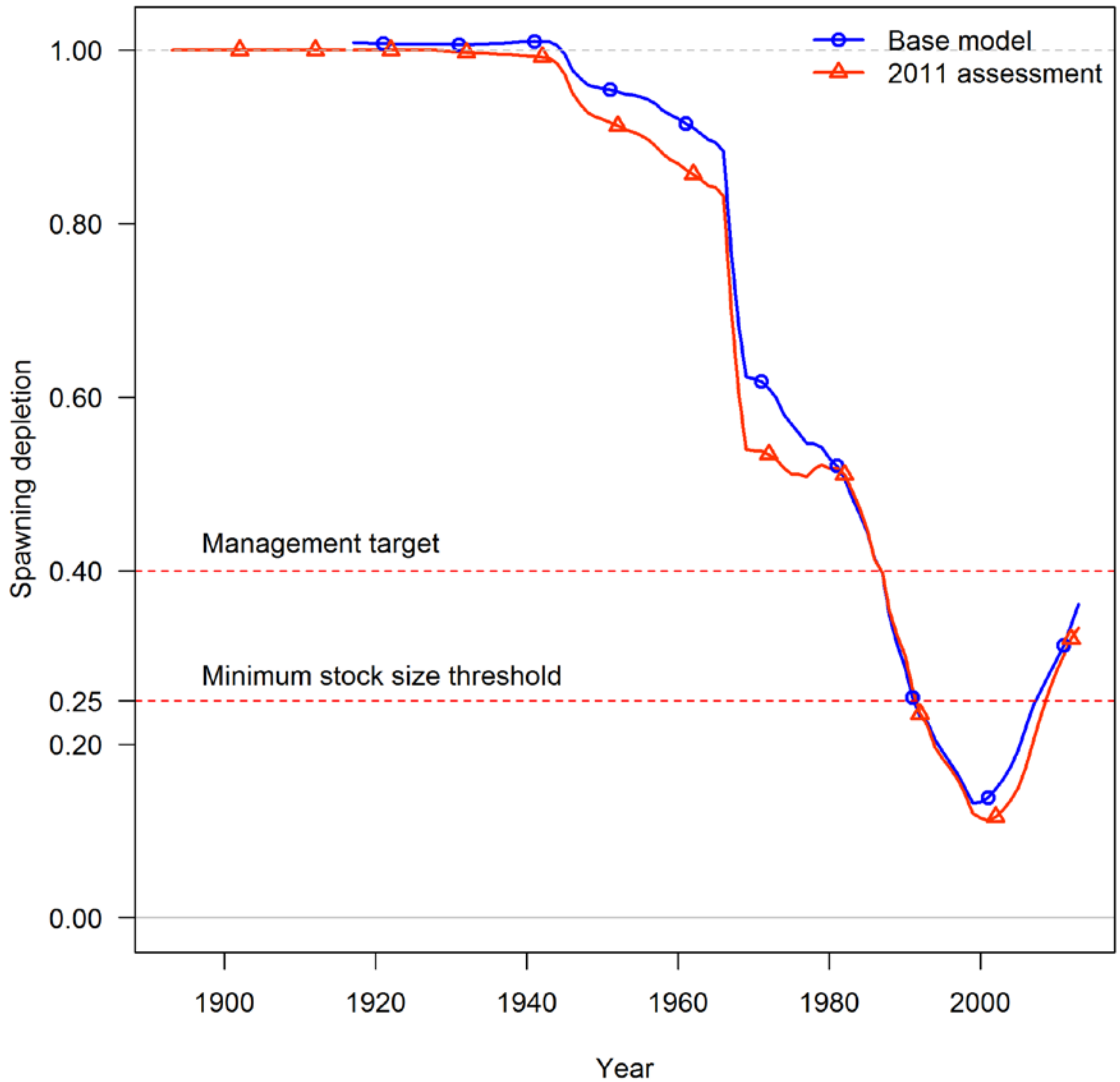

Figure 42: Time series of spawning depletion from this and 2011 assessments.

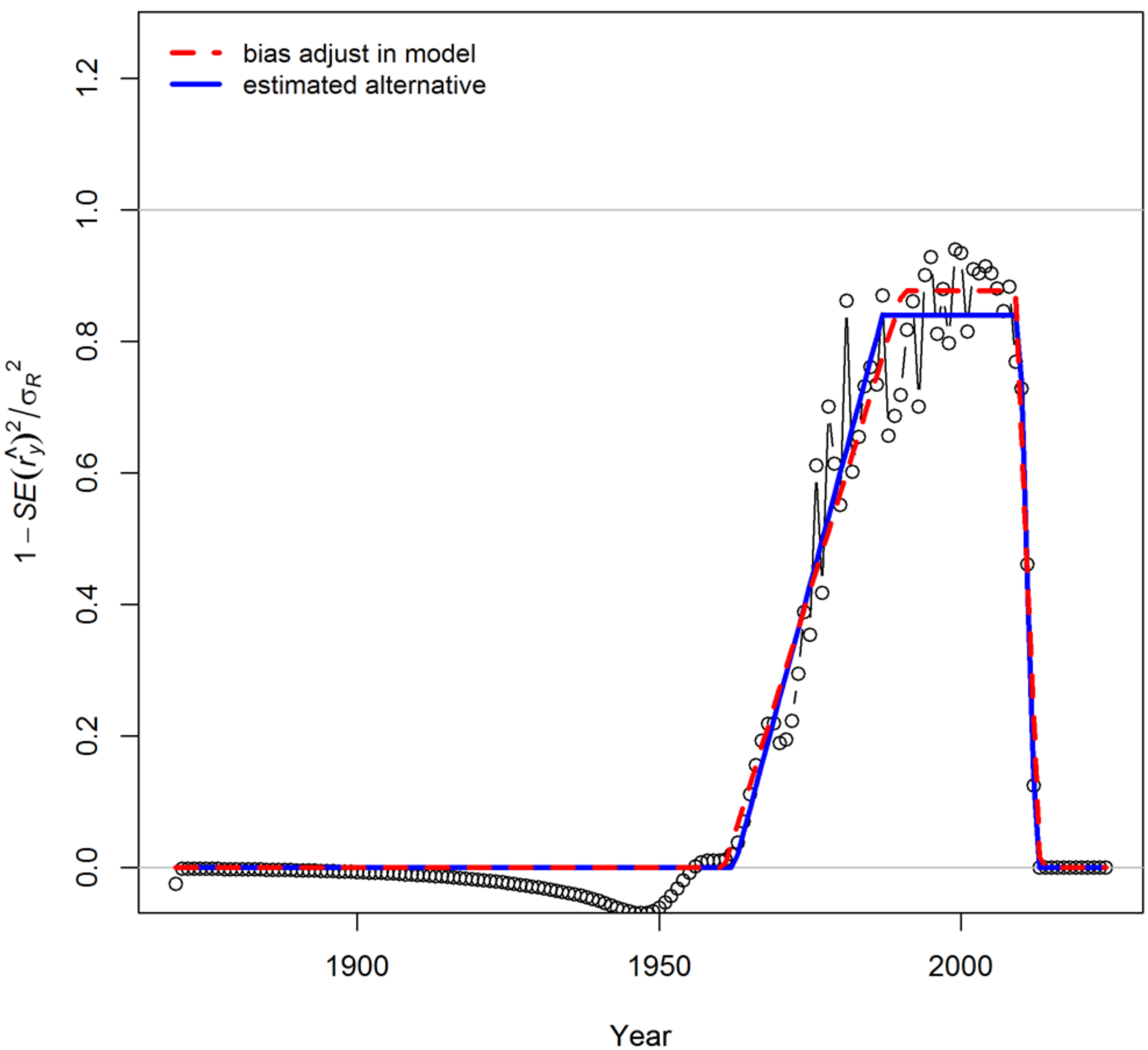

Figure 43: Bias correction ramp estimated by R4SS using particle swarm optimization to avoid local minima.

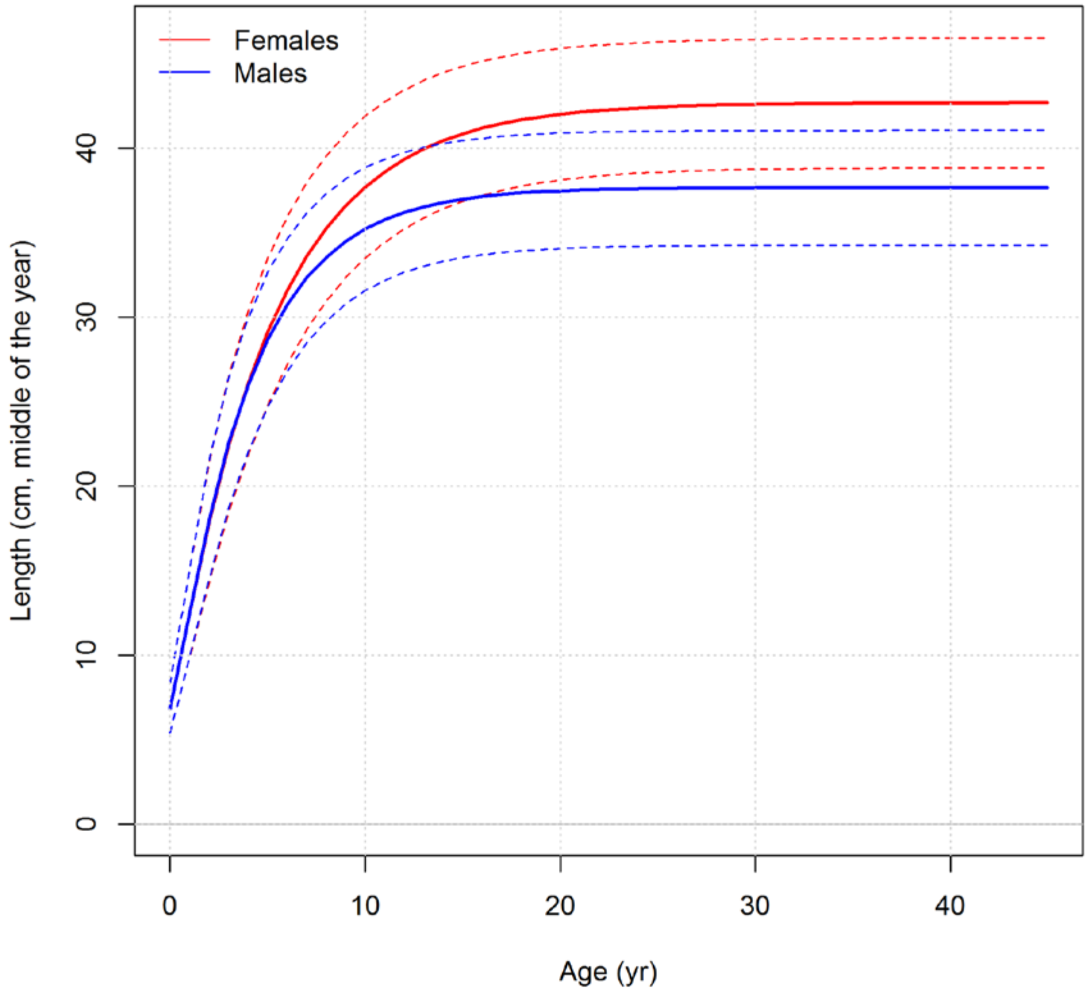

Figure 44: Growth curves for females and males of darkblotched rockfish used in the assessment model.

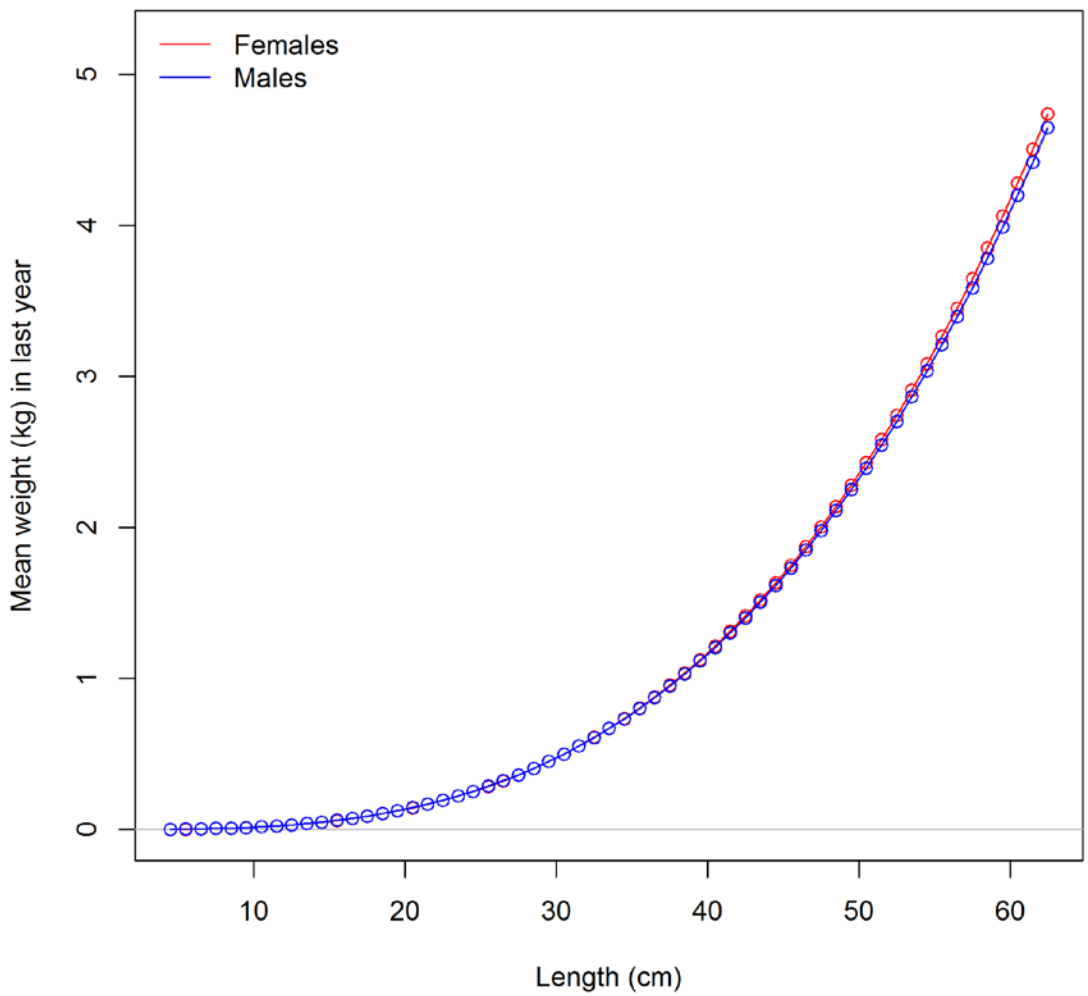

Figure 45: Weight-at-length relationship for females and males of darkblotched rockfish used in the assessment model.

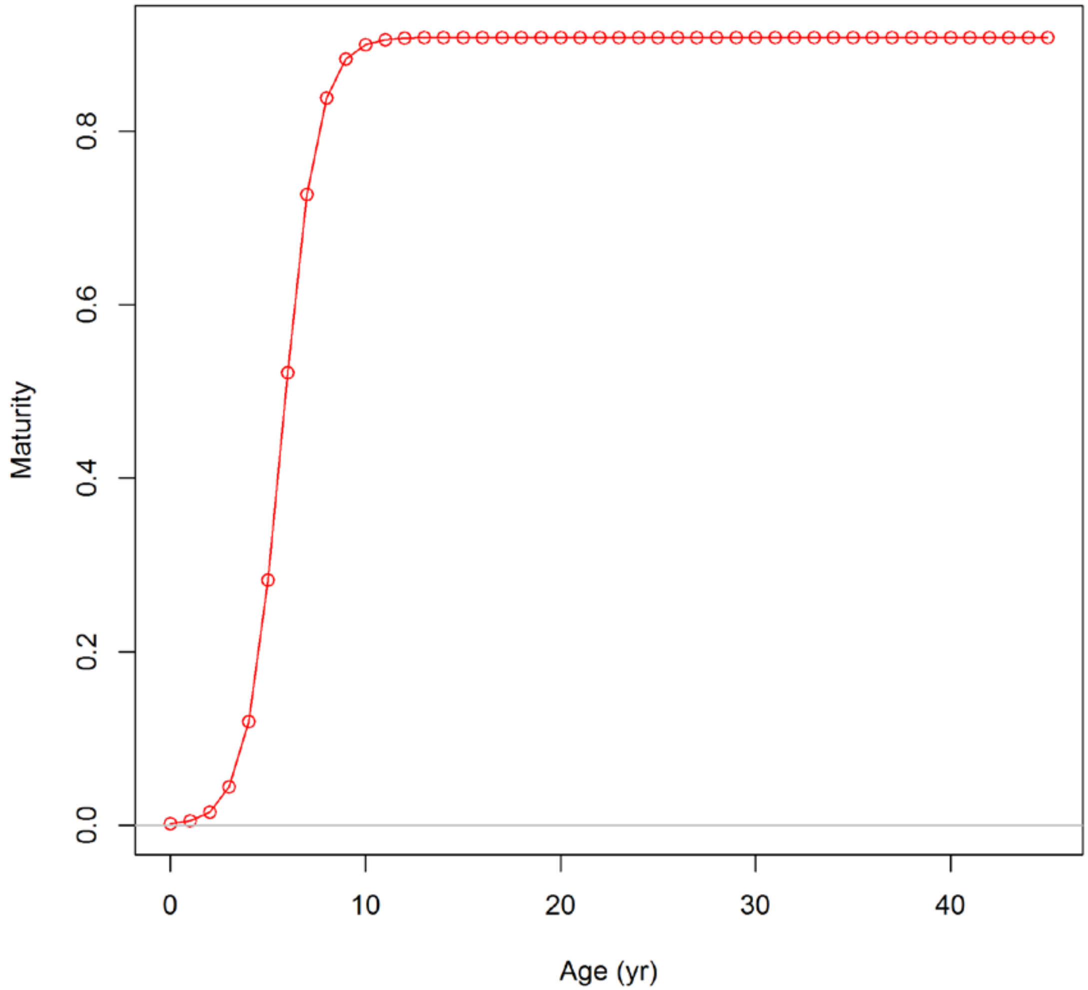

Figure 46: Female maturity at age relationship used in the assessment model. The parameters were estimated from the data collected within the NWFSC shelf-slope survey between 2011 and 2012.

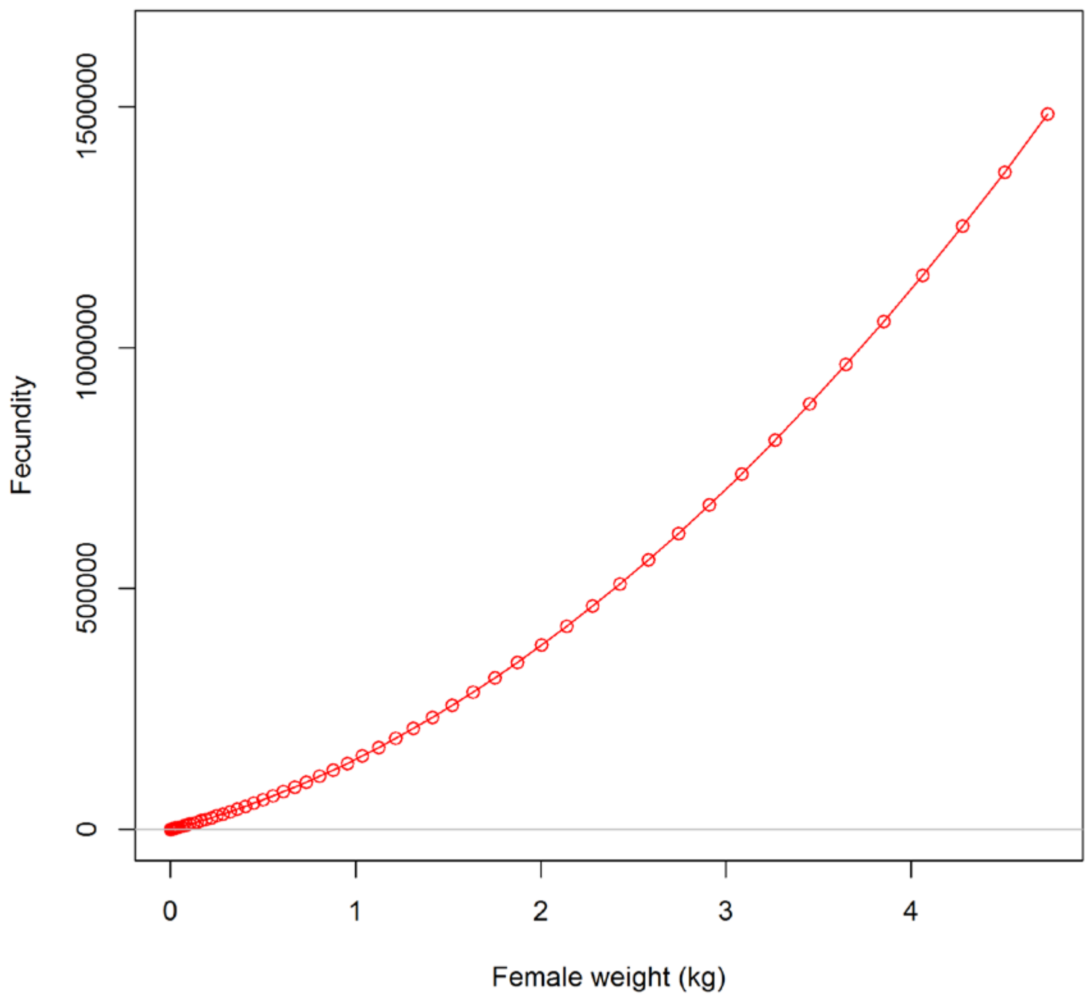

Figure 47: Female darkblotched rockfish fecundity at weight relationship used in the assessment, based on the parameters estimated by Dick (2009).

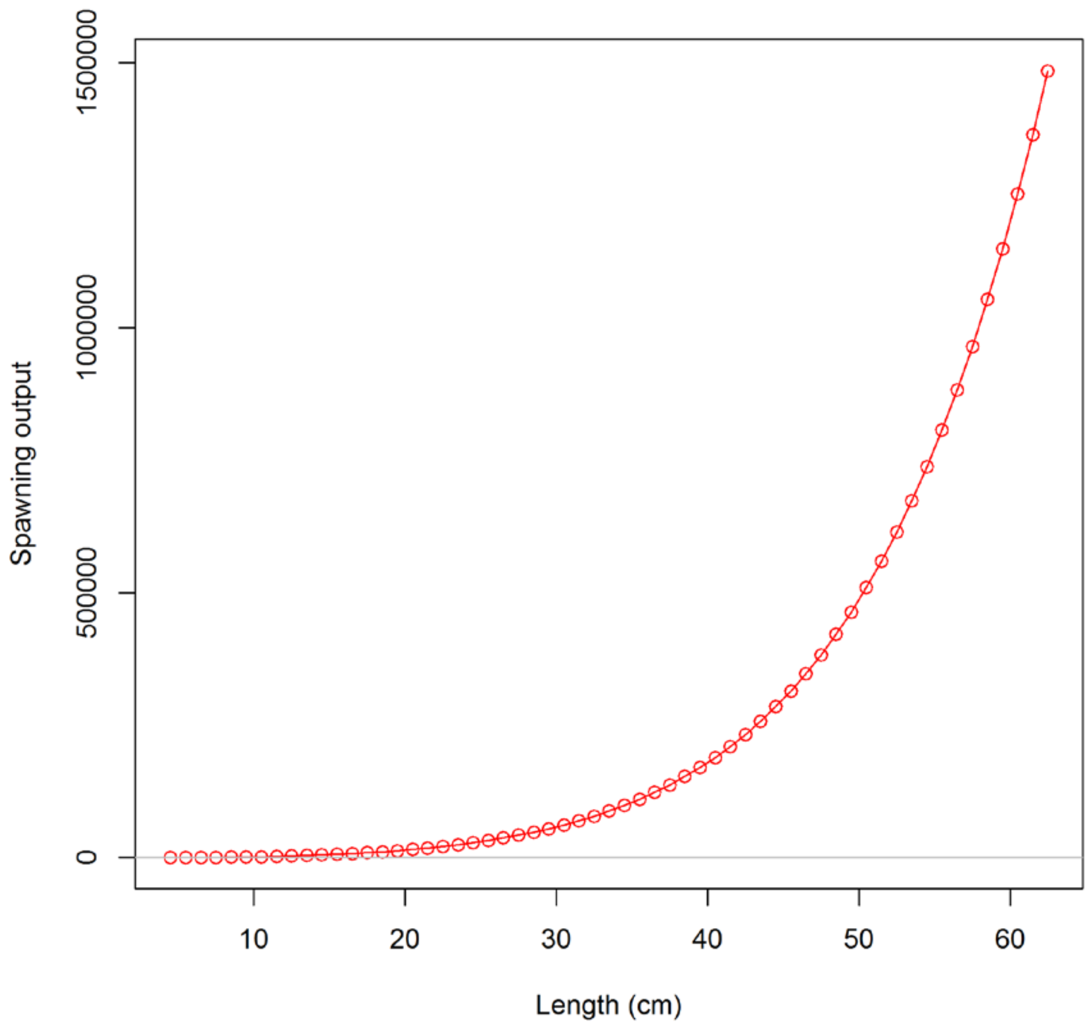

Figure 48: Female darkblotched rockfish spawning output-at-length relationship used in the assessment model.

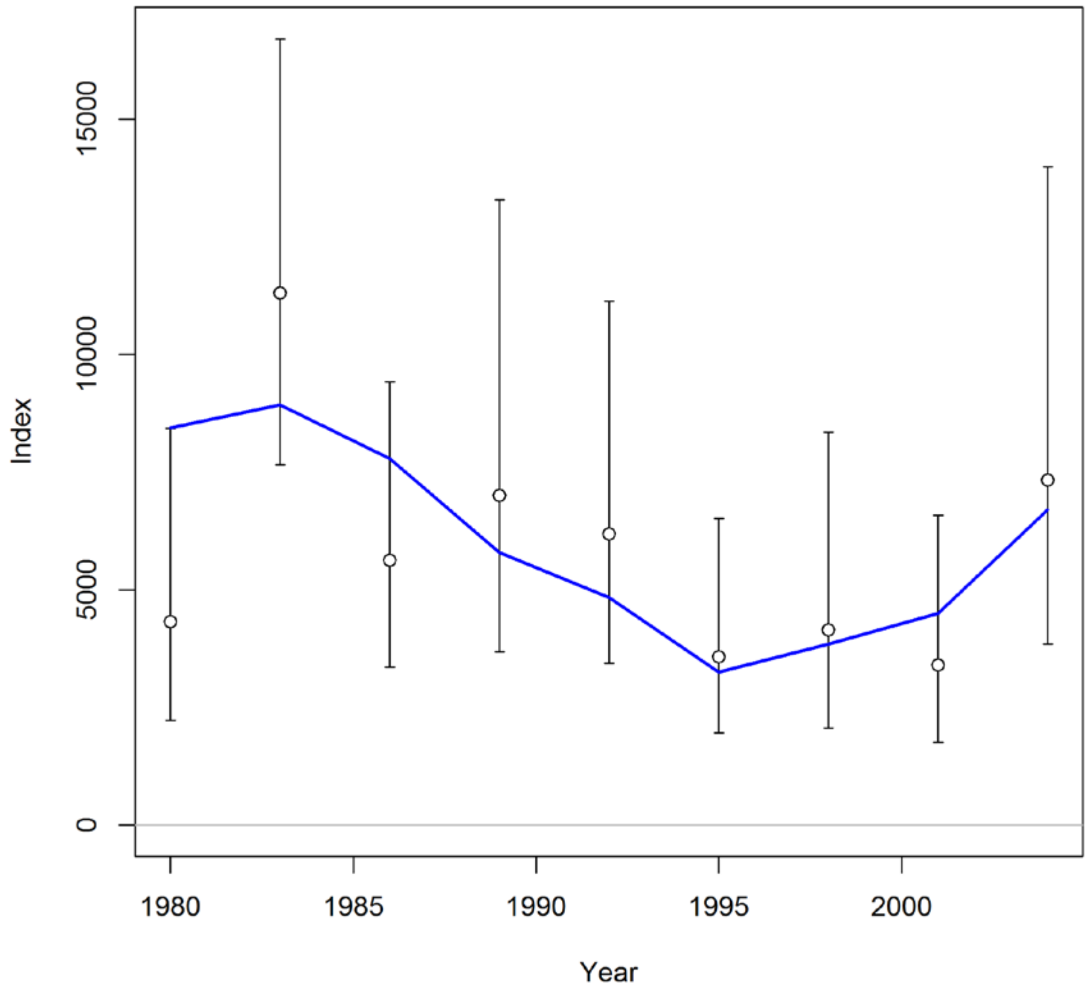

Figure 49: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC shelf survey.

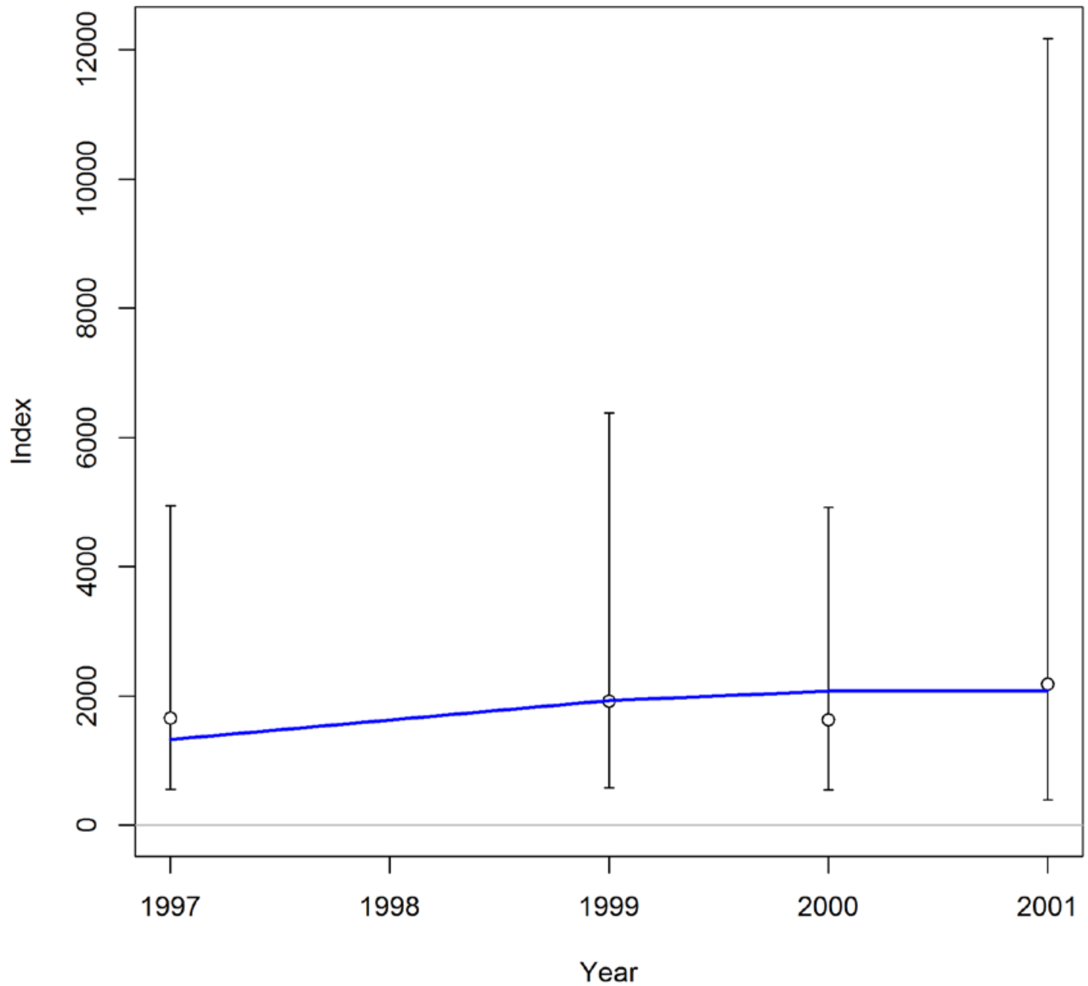

Figure 50: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC slope survey.

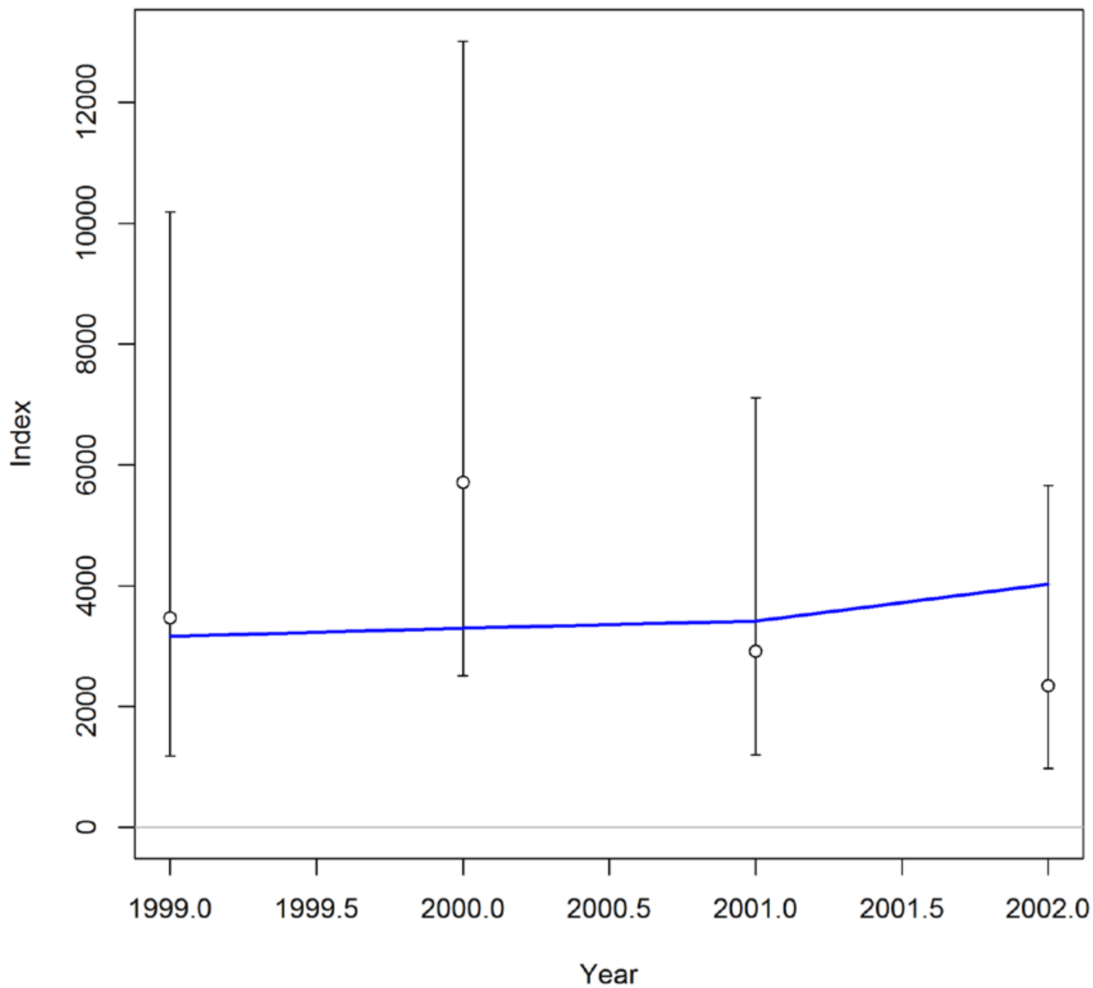

Figure 51: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC slope survey.

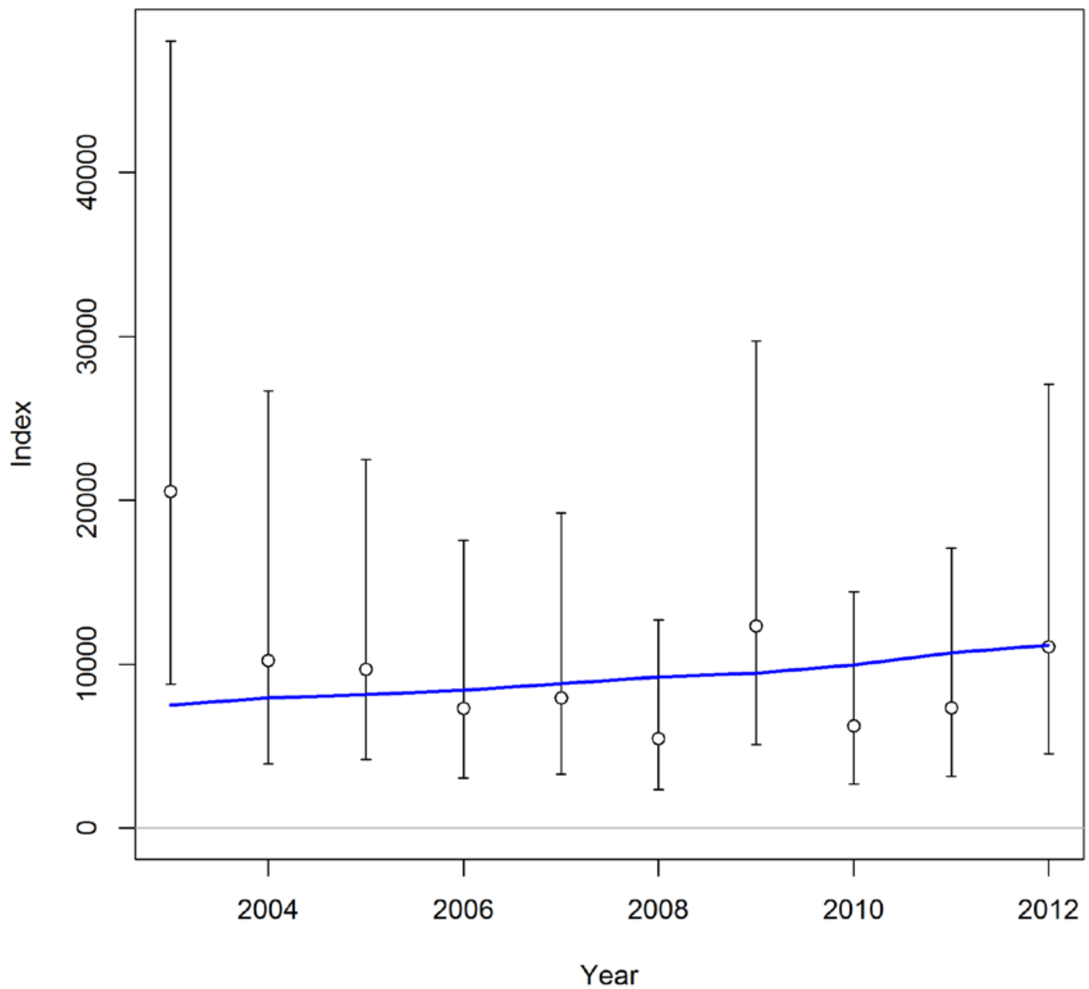

Figure 52: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC shelf-slope survey.

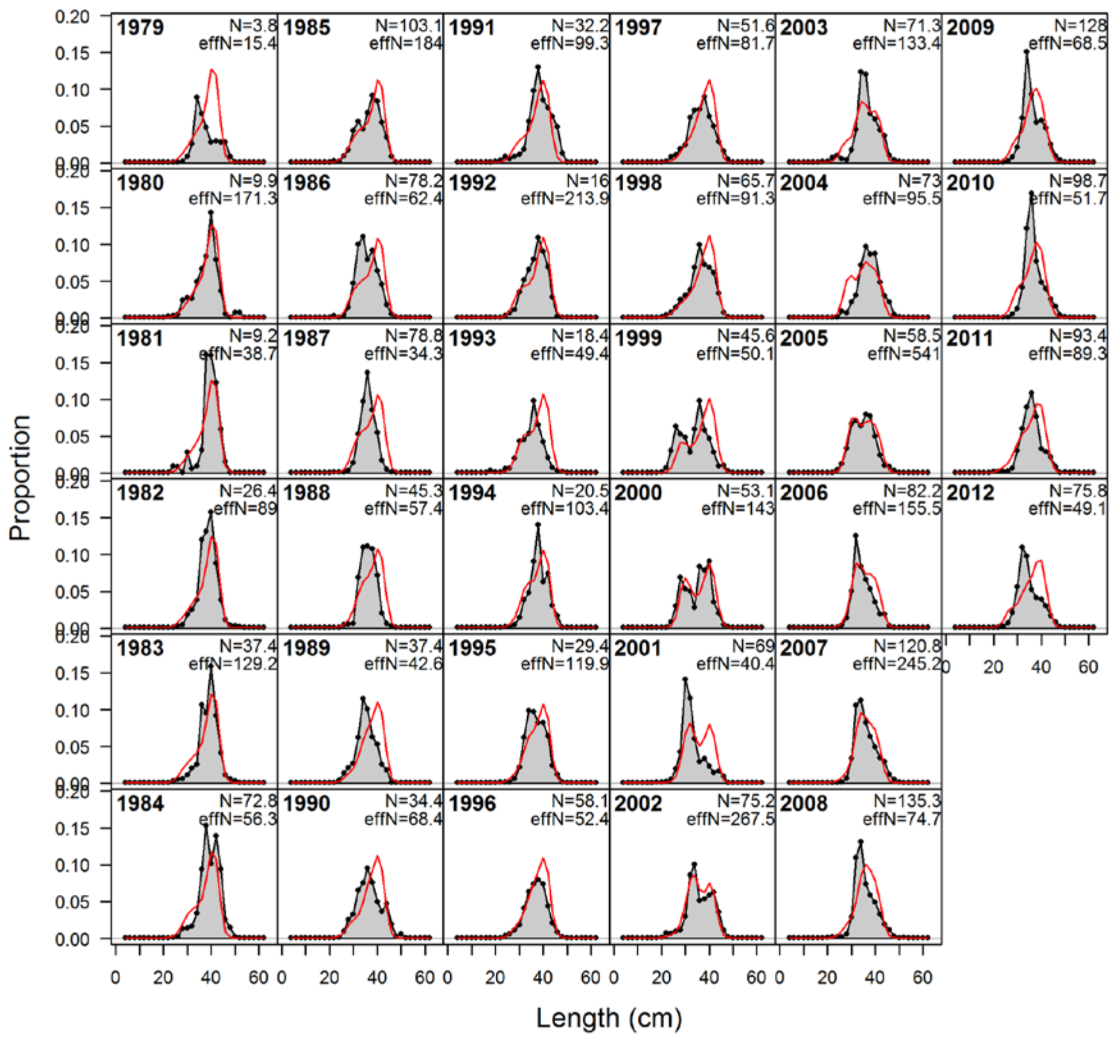

Figure 53: Fit to length-frequency distributions of female darkblotched rockfish for the domestic trawl fishery landings, by year.

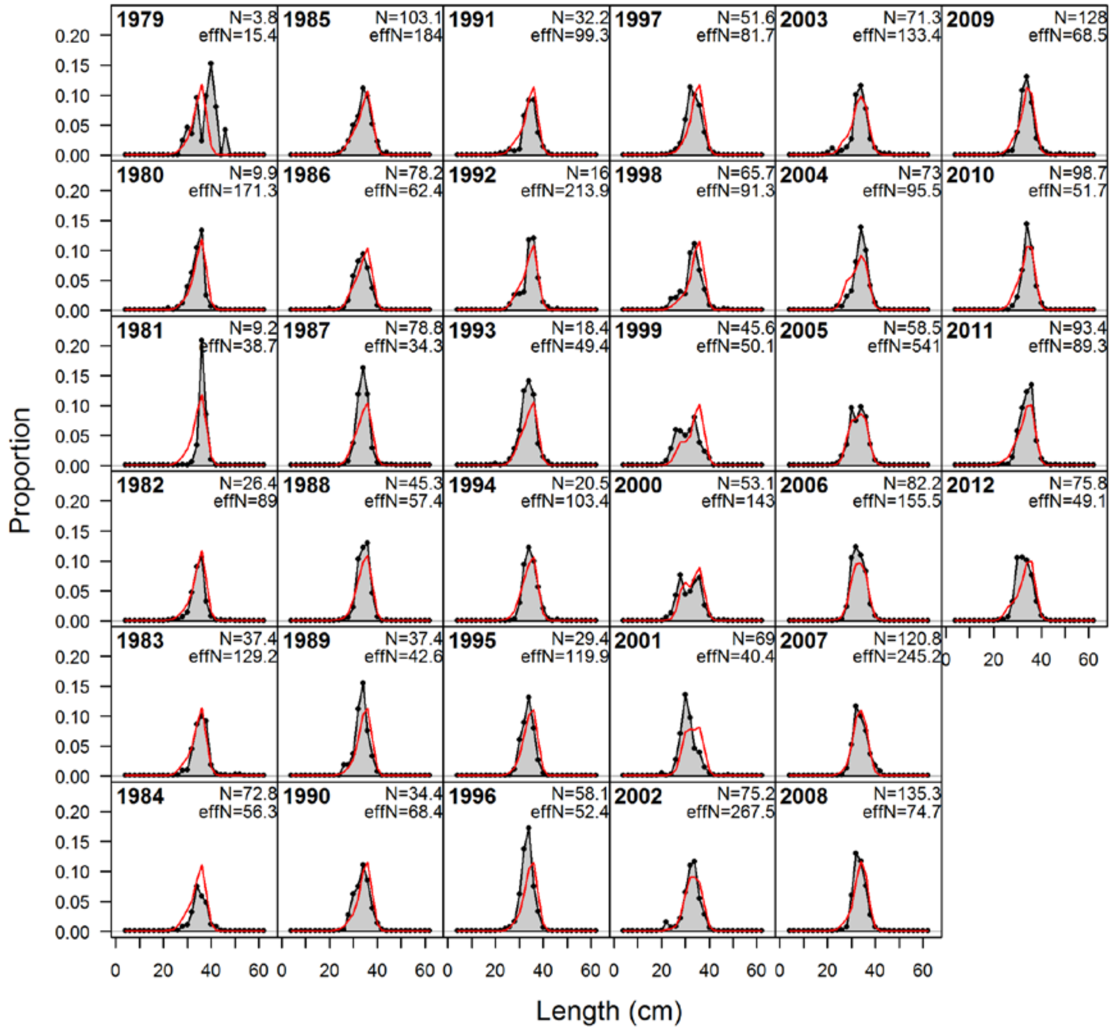

Figure 54: Fit to length-frequency distributions of male darkblotched rockfish for the domestic trawl fishery landings, by year.

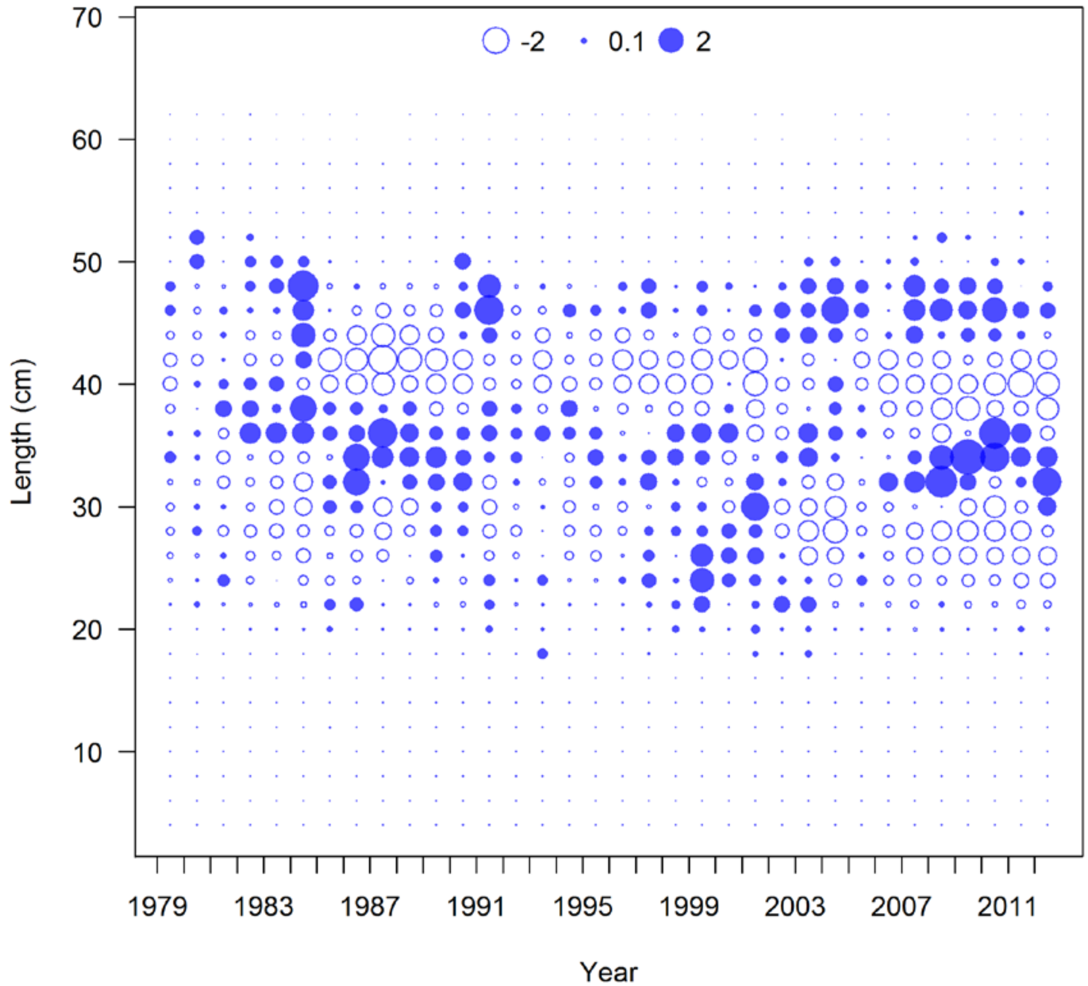

Figure 55: Pearson residuals for the fit to length-frequency distributions of female darkblotched rockfish for the domestic trawl fishery landings, by year.

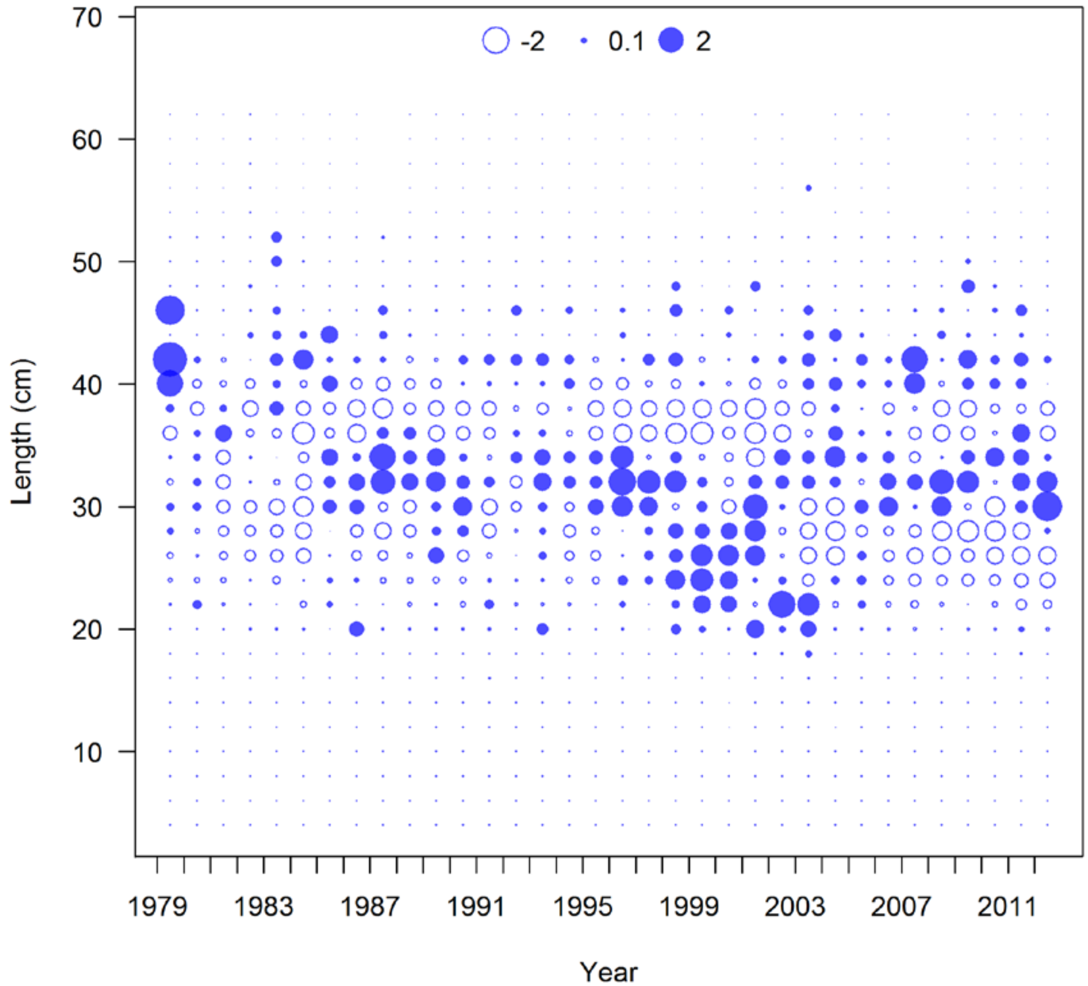

Figure 56: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish for the domestic trawl fishery landings, by year.

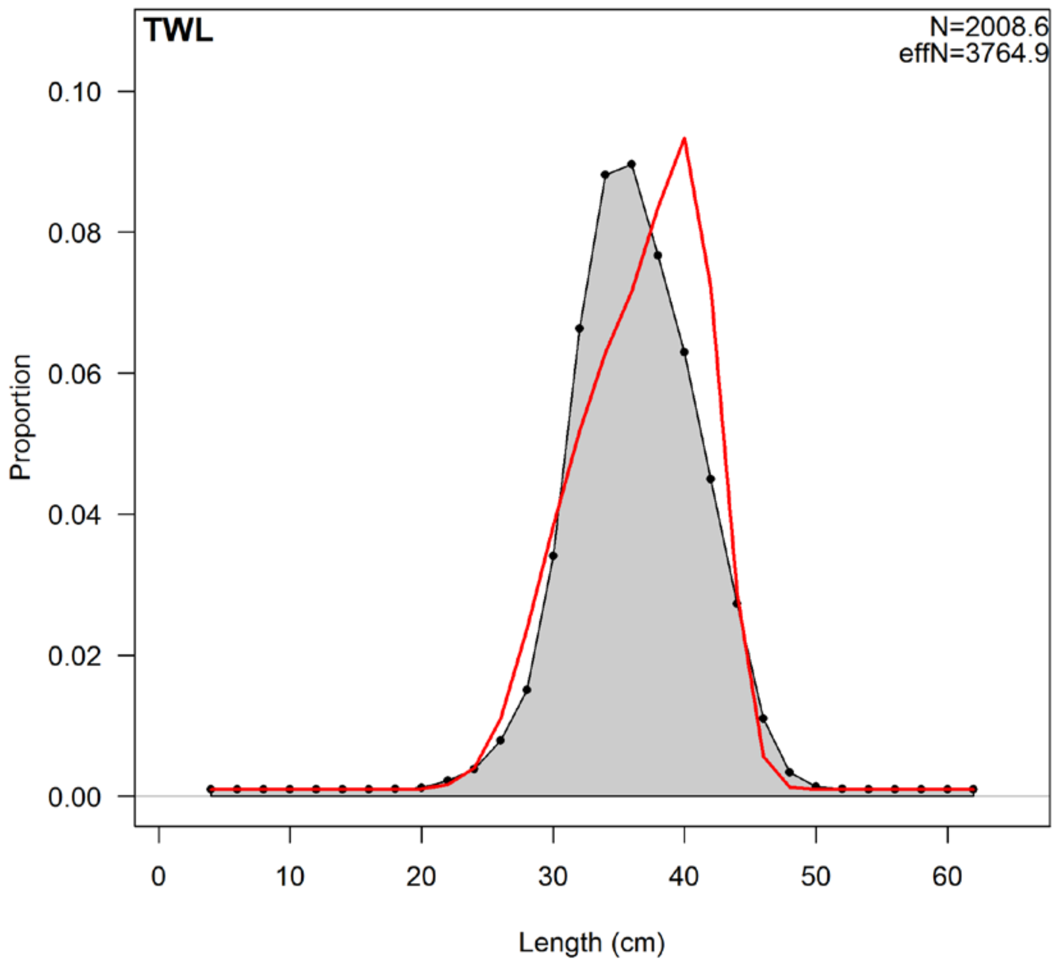

Figure 57: Fit to length-frequency distributions of female darkblotched rockfish from domestic trawl fishery landings, aggregated across all years.

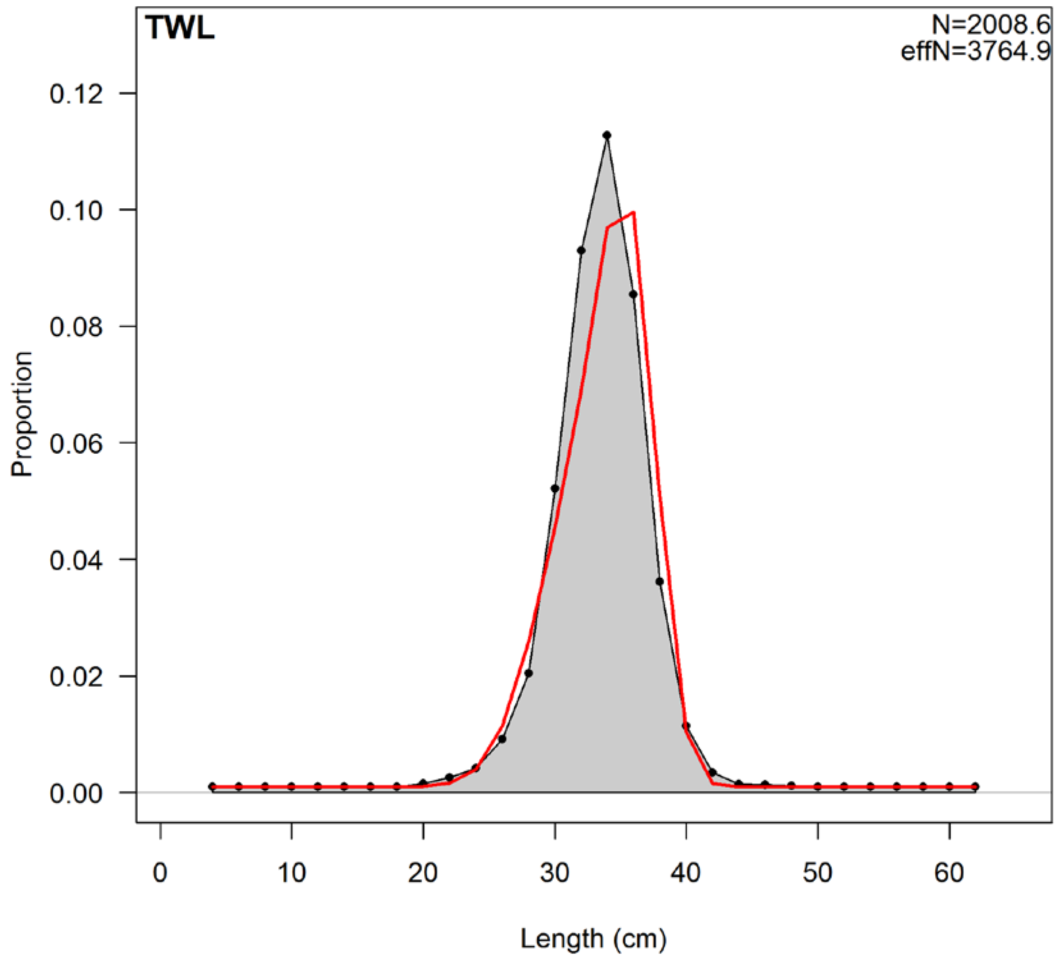

Figure 58: Fit to length-frequency distributions of male darkblotched rockfish from domestic trawl fishery landings, aggregated across all years.

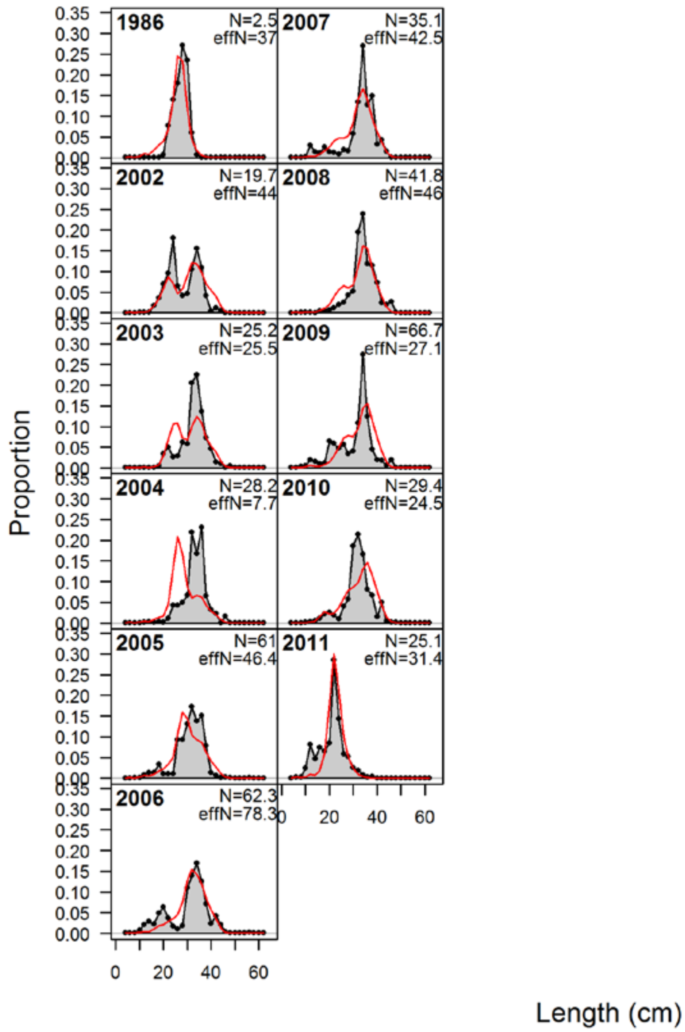

Figure 59: Fit to length-frequency distributions of darkblotched rockfish (sexes combined) for the domestic trawl fleet discard, by year.

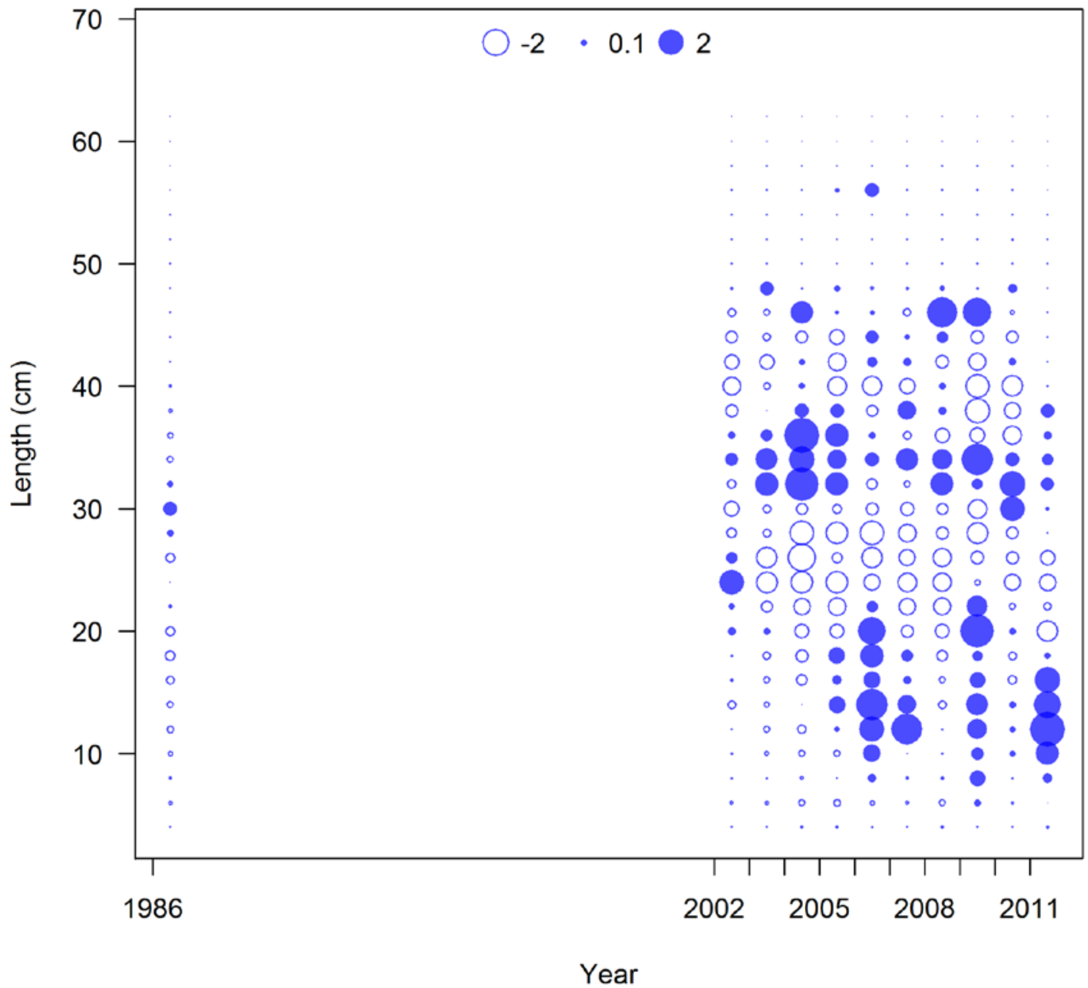

Figure 60: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (sexes combined) for the domestic trawl fleet discard, by year.

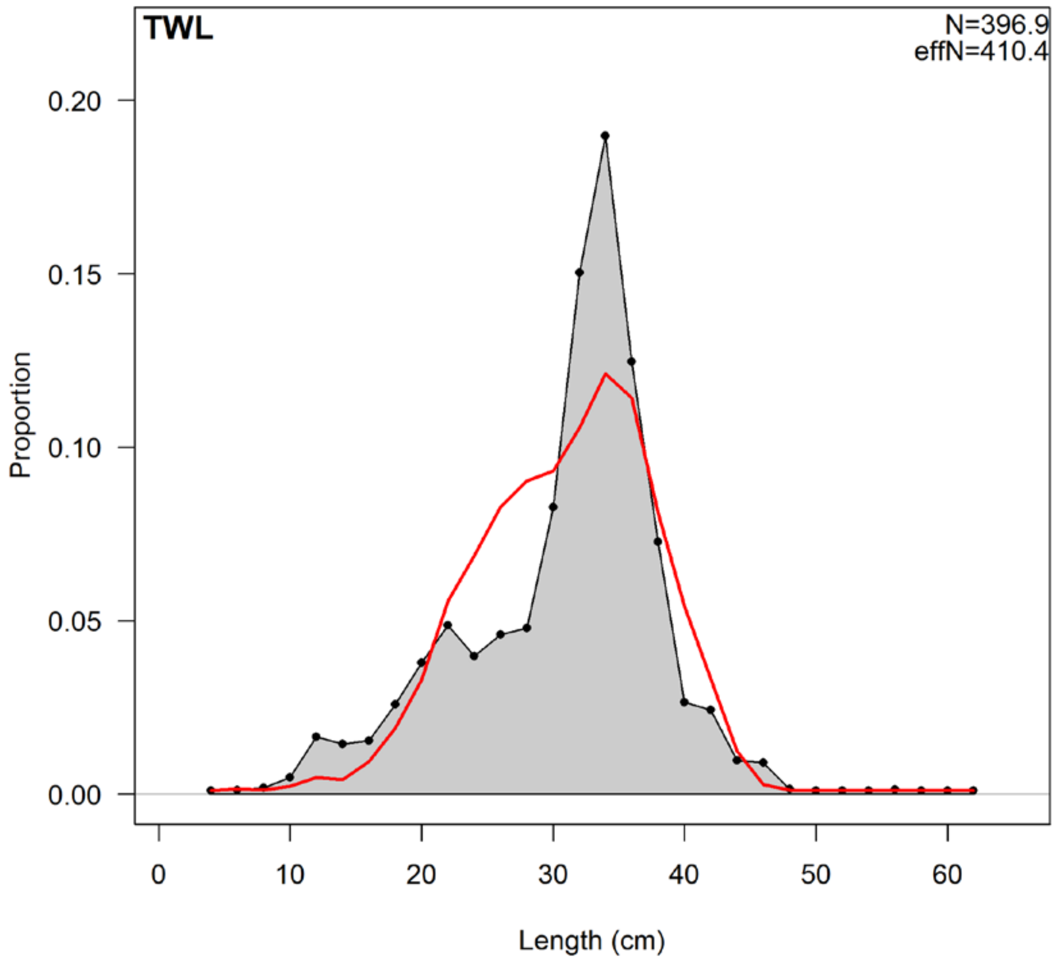

Figure 61: Fit to length-frequency distributions of darkblotched rockfish (sexes combined) from domestic trawl fishery discard, aggregated across all years.

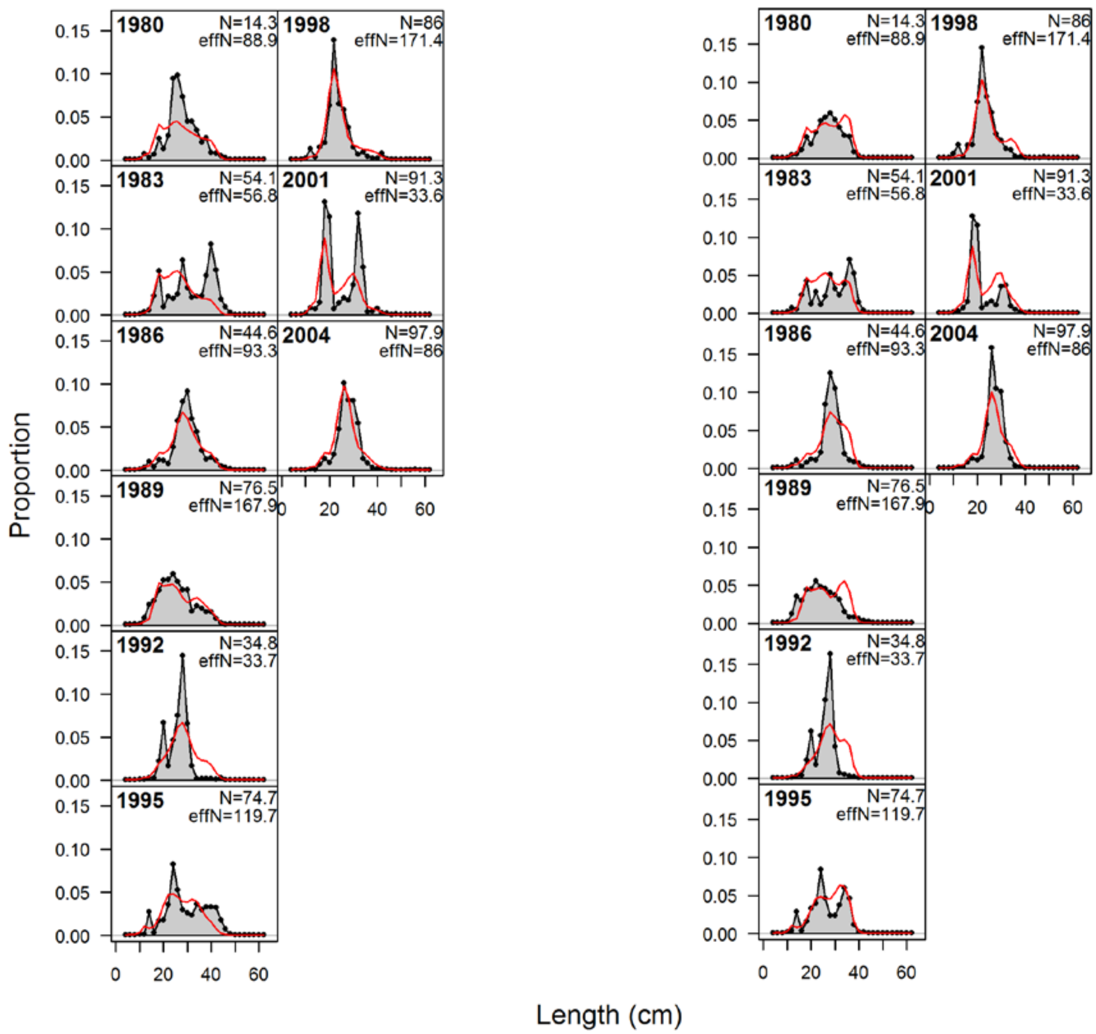

Figure 62: Fit to length-frequency distributions of female (left panel) and male (right panel) darkblotched rockfish from the AFSC shelf survey, by year.

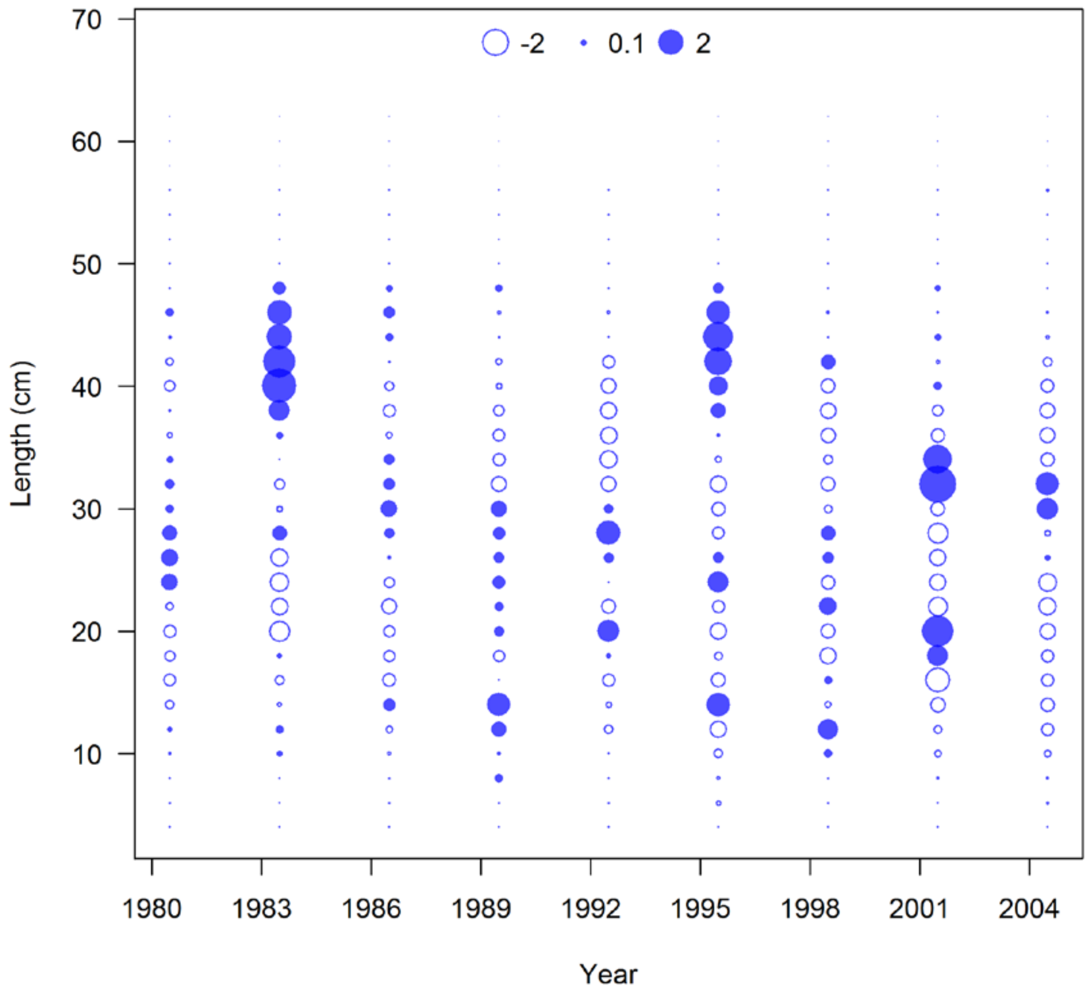

Figure 63: Pearson residuals for the fit to length-frequency distributions of female darkblotched rockfish from the AFSC shelf survey, by year.

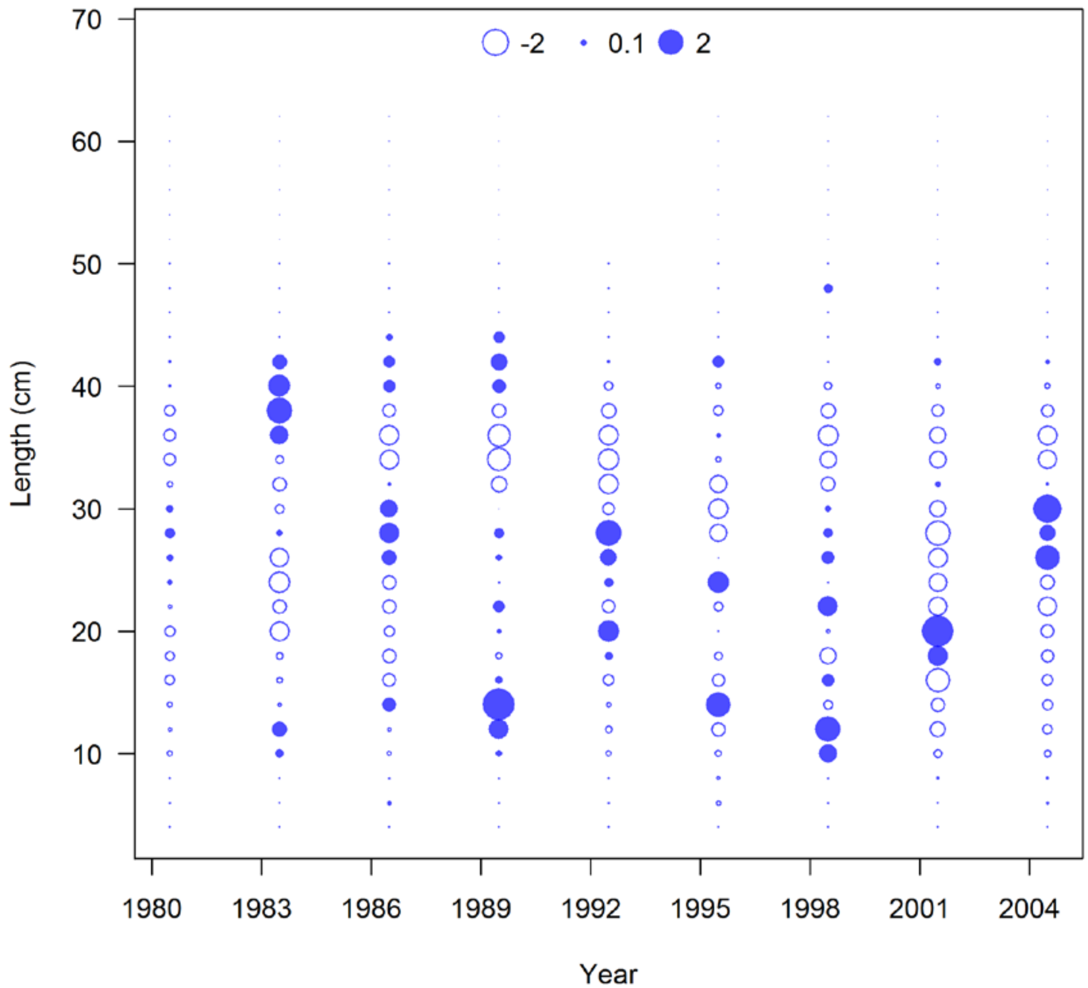

Figure 64: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish from the AFSC shelf survey, by year.

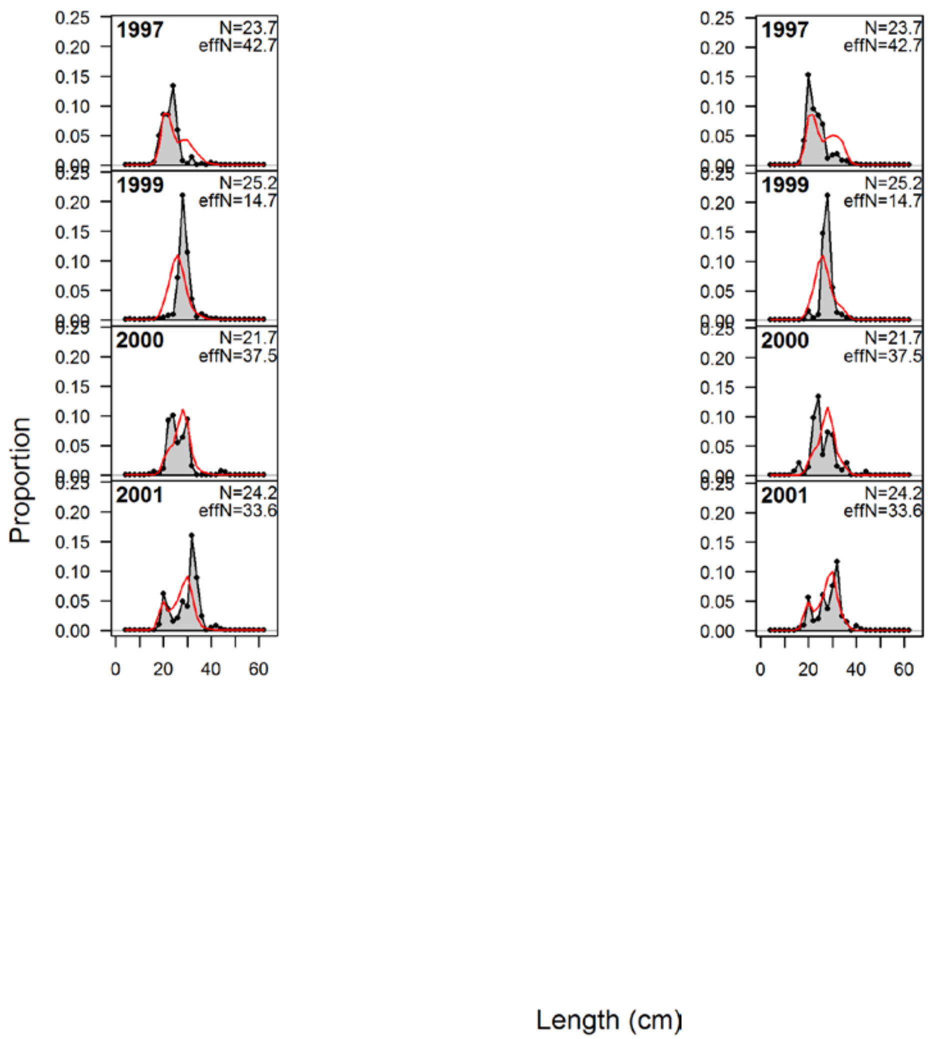

Figure 65: Fit to length-frequency distributions of female (left panel) and male (right panel) darkblotched rockfish from the AFSC slope survey, by year.

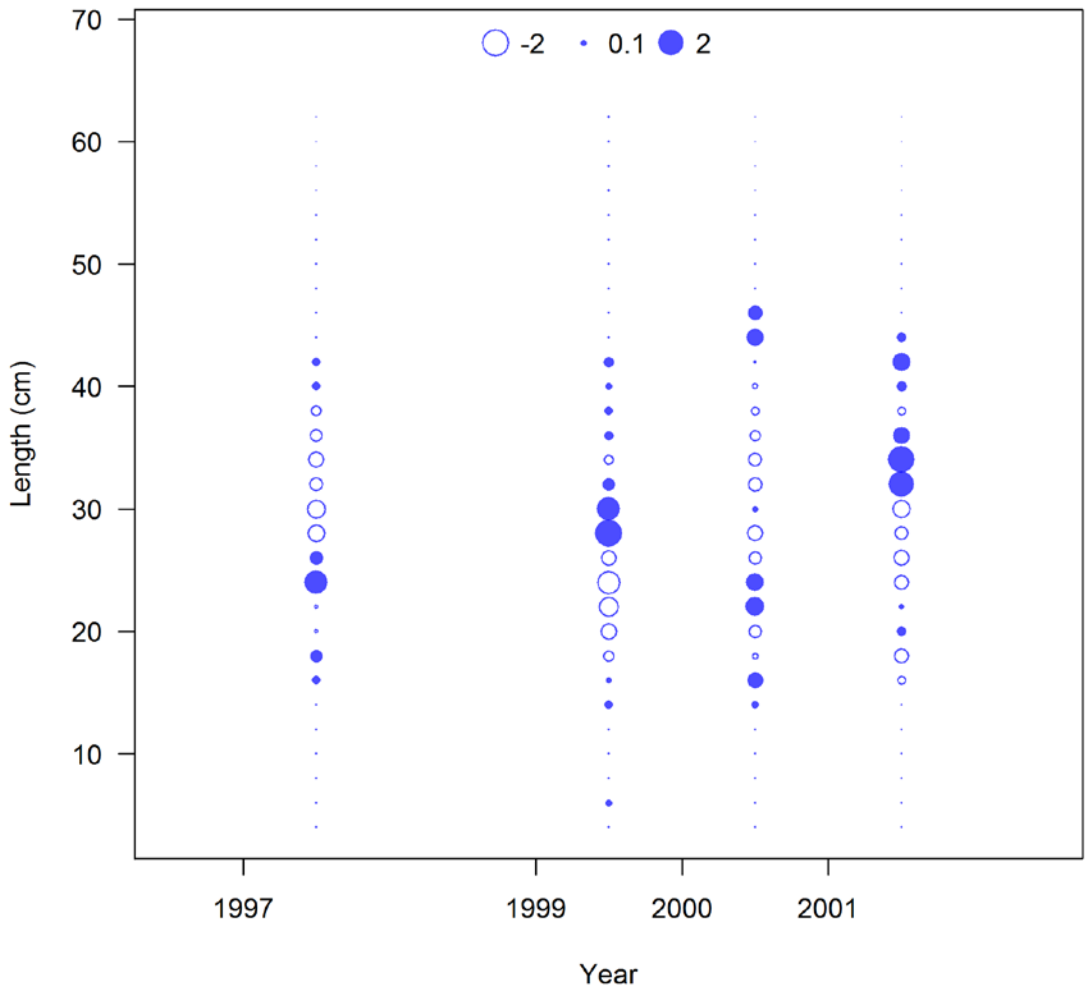

Figure 66: Pearson residuals for the fit to length-frequency distributions of female darkblotched rockfish from the AFSC slope survey, by year.

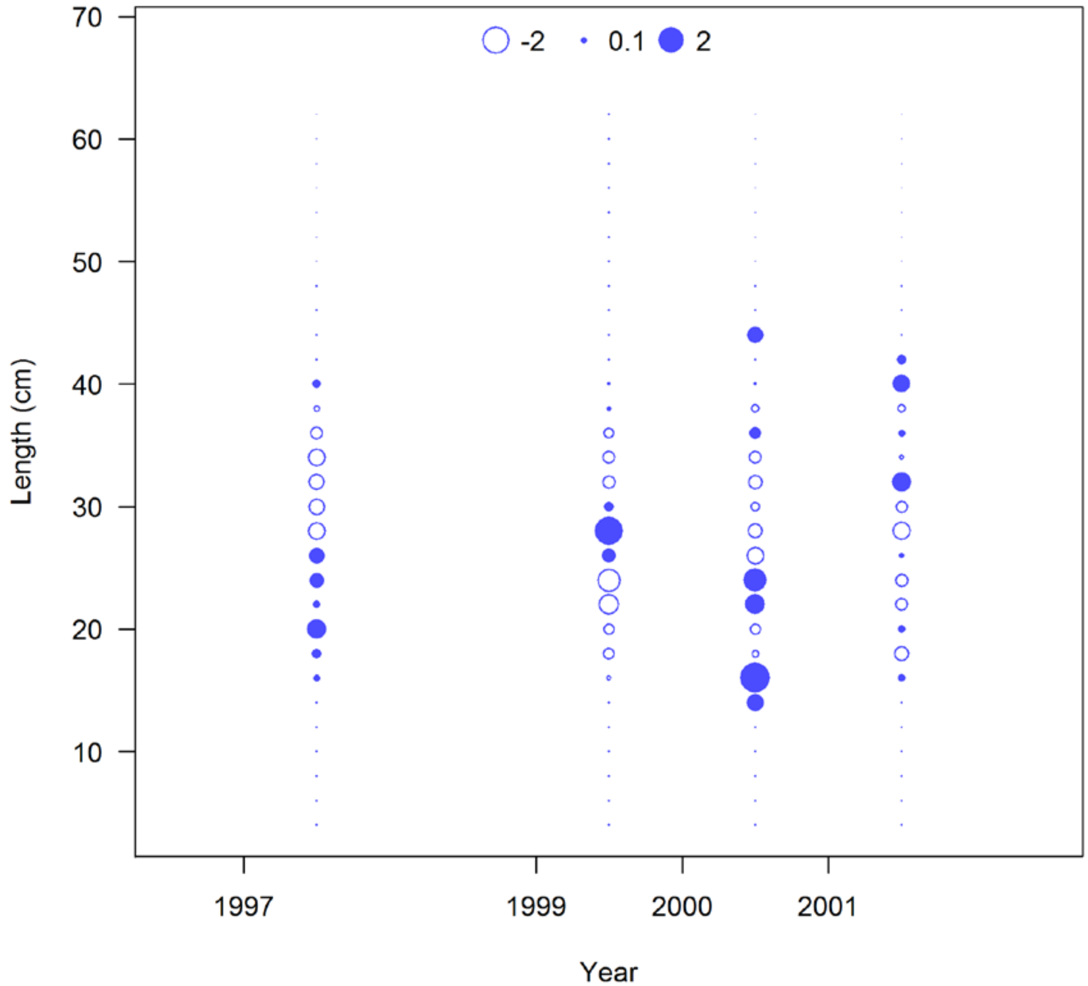

Figure 67: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish from the AFSC slope survey, by year.

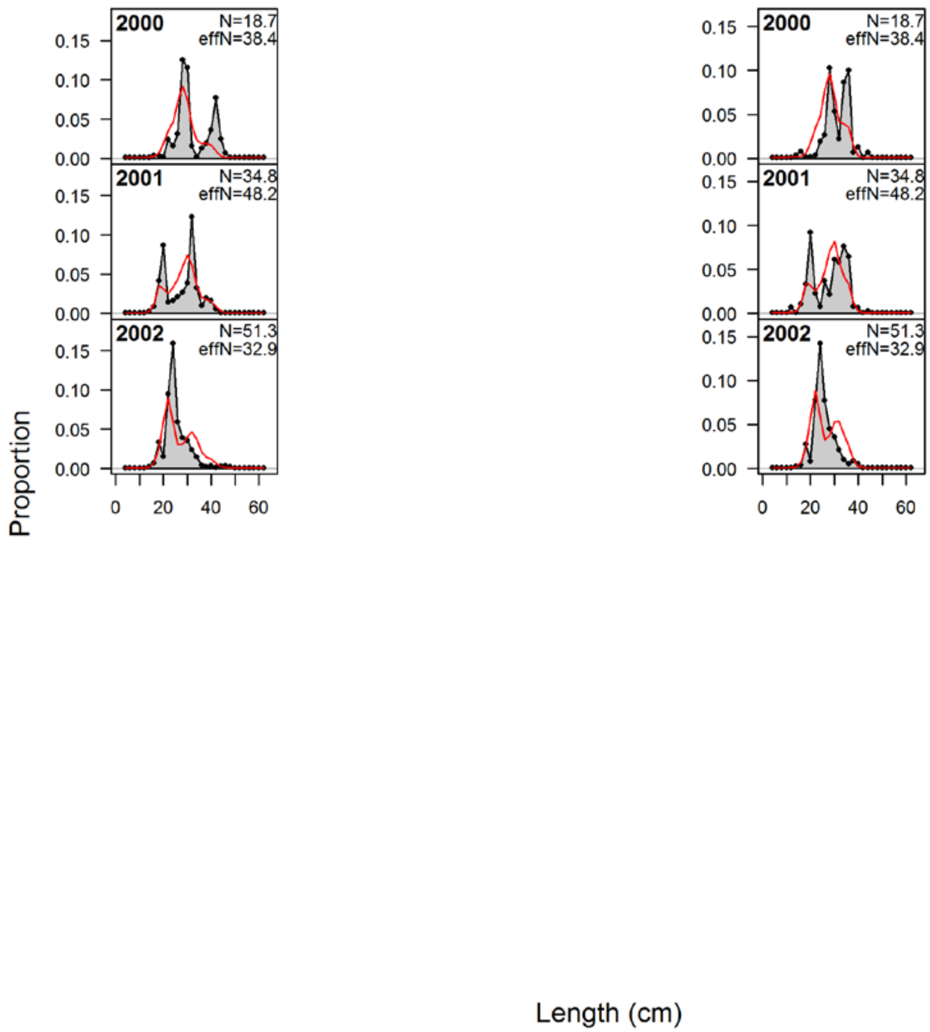

Figure 68: Fit to length-frequency distributions of female (left panel) and male (right panel) darkblotched rockfish from the NWFSC slope survey, by year.

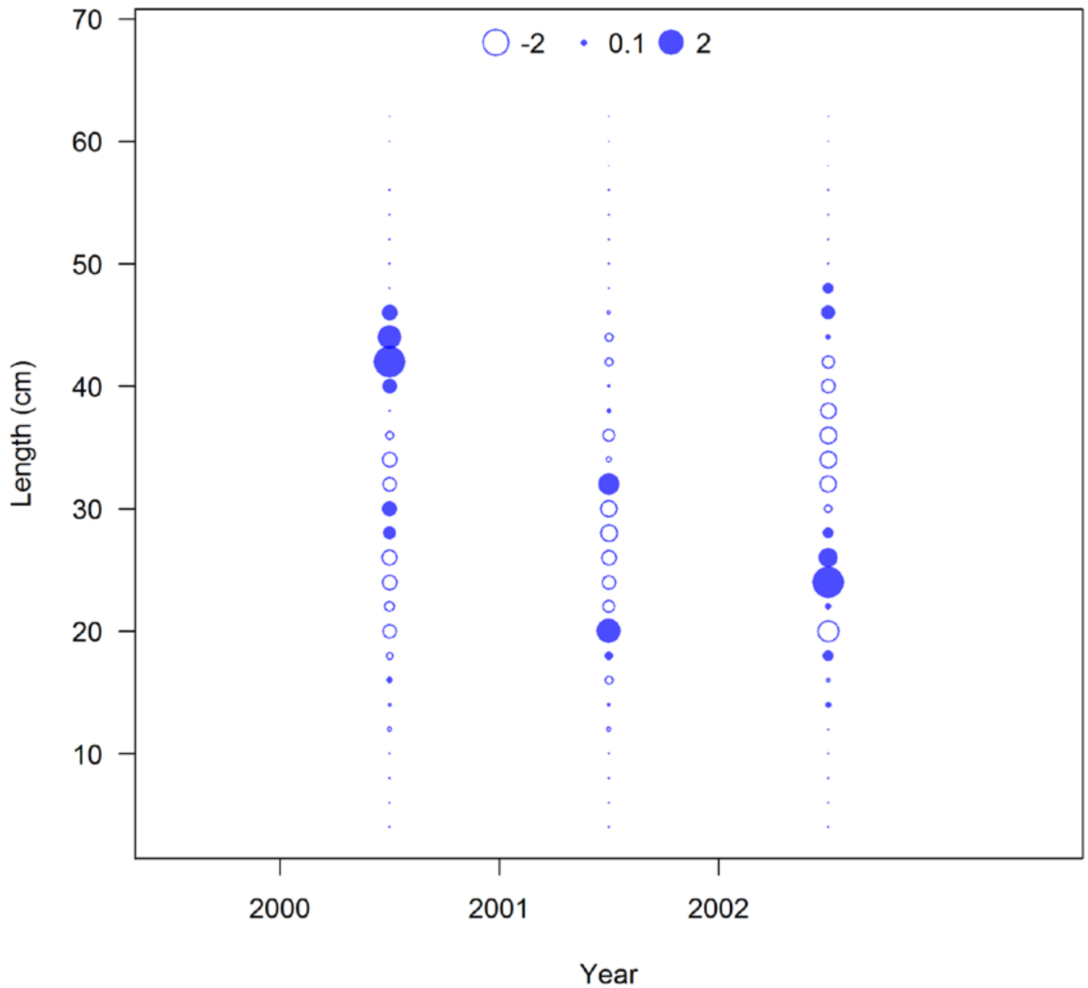

Figure 69: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish from the NWFSC slope survey, by year.

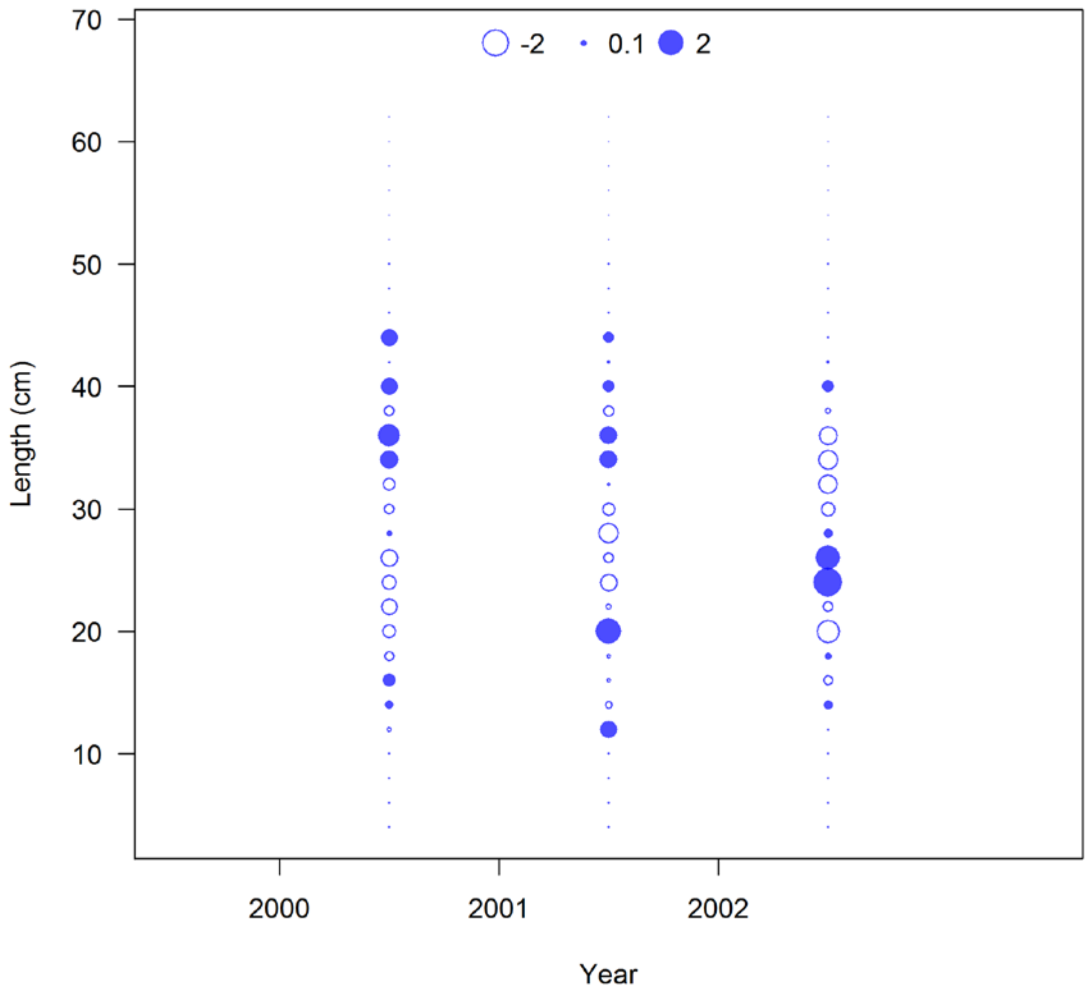

Figure 70: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish from the NWFSC slope survey, by year.

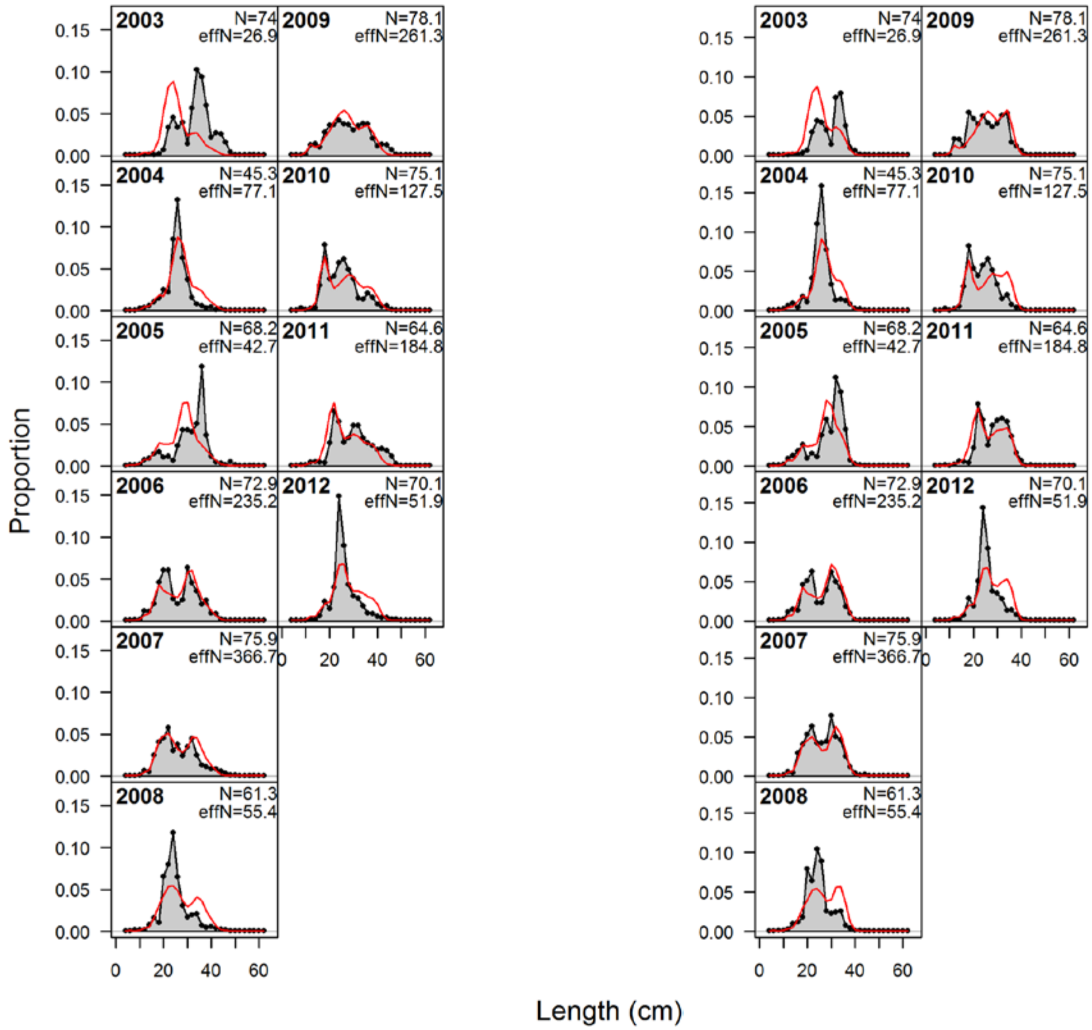

Figure 71: Fit to length-frequency distributions of female (left panel) and male (right panel) darkblotched rockfish from the NWFSC shelf-slope survey by year.

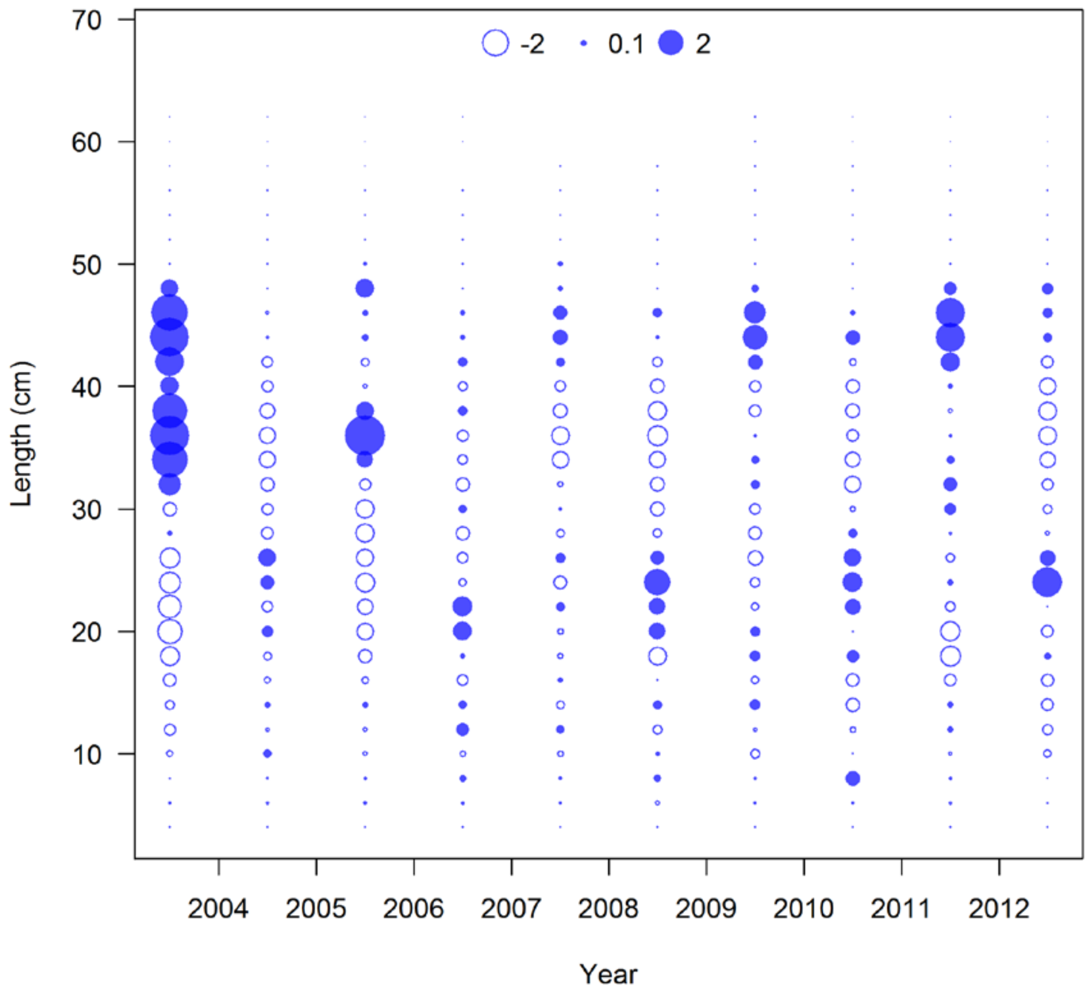

Figure 72: Pearson residuals for the fit to length-frequency distributions of female darkblotched rockfish from the NWFSC shelf-slope survey by year.

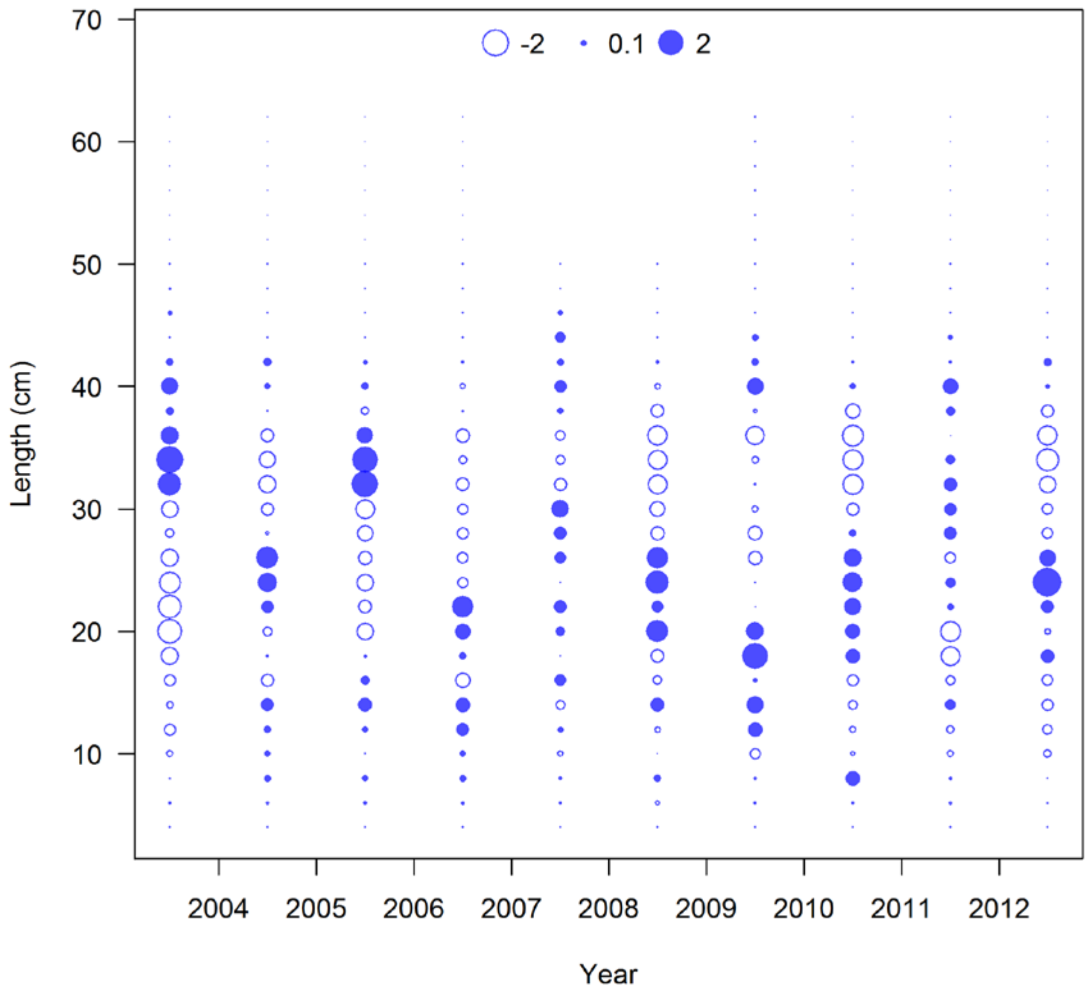

Figure 73: Pearson residuals for the fit to length-frequency distributions of male darkblotched rockfish from the NWFSC shelf-slope survey by year.

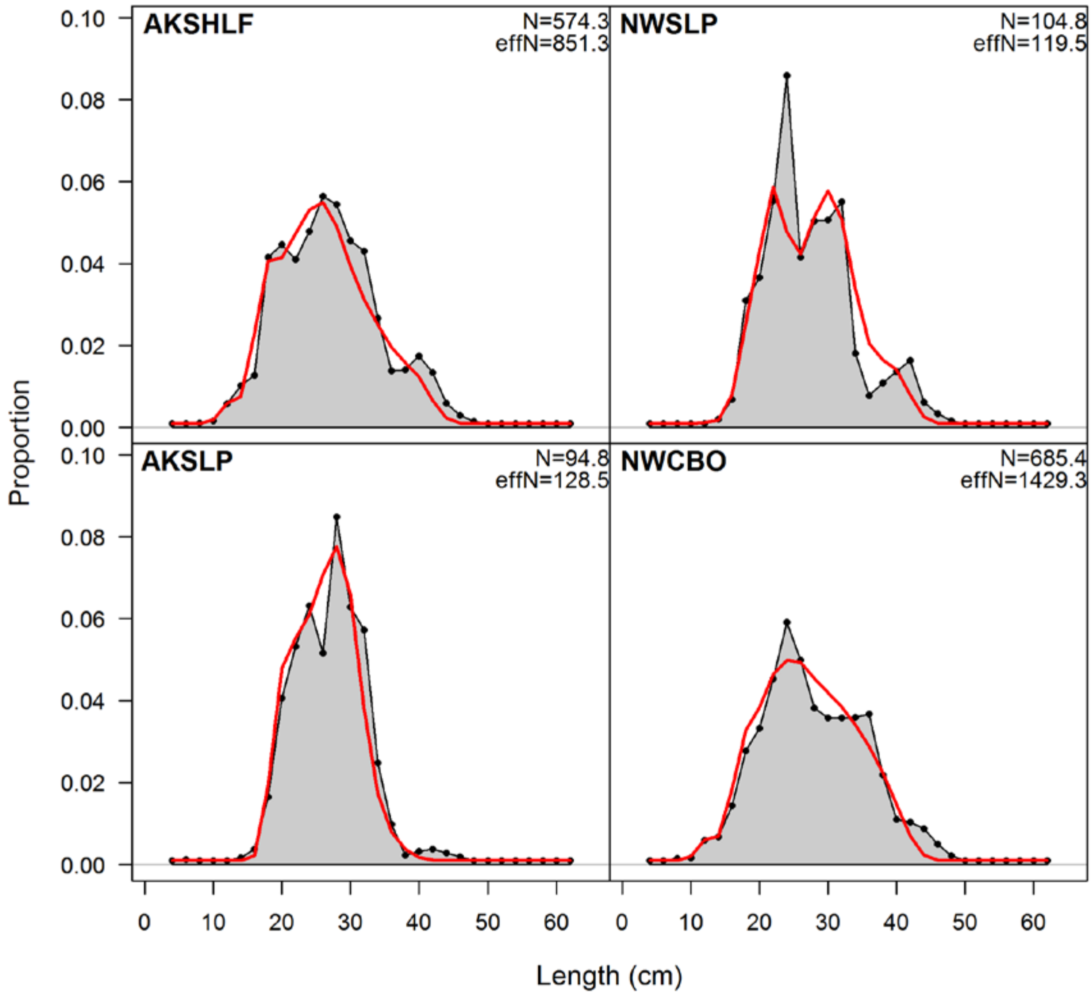

Figure 74: Fit to length-frequency distributions of female darkblotched rockfish from the fishery-independent surveys, aggregated across all years.

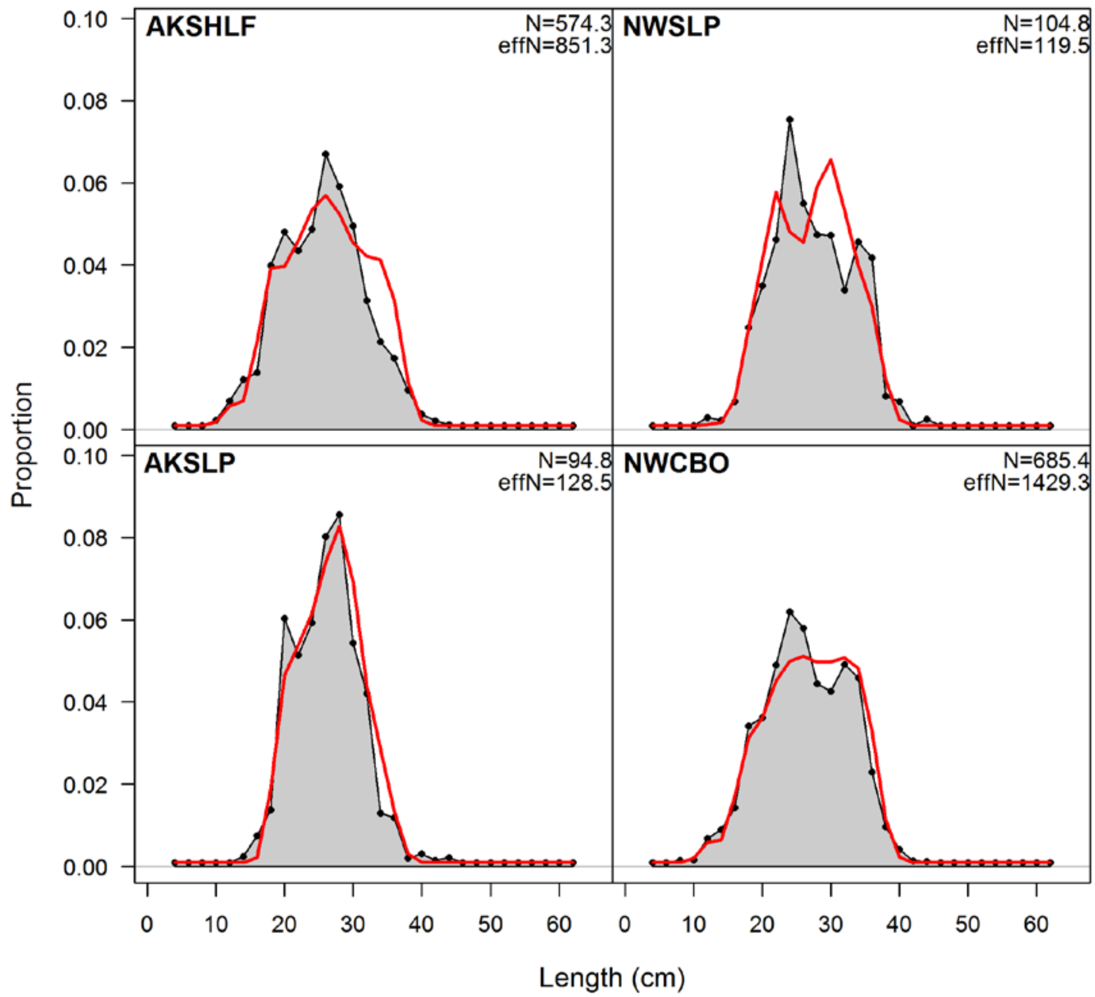

Figure 75: Fit to length-frequency distributions of male darkblotched rockfish from the fishery-independent surveys, aggregated across all years.

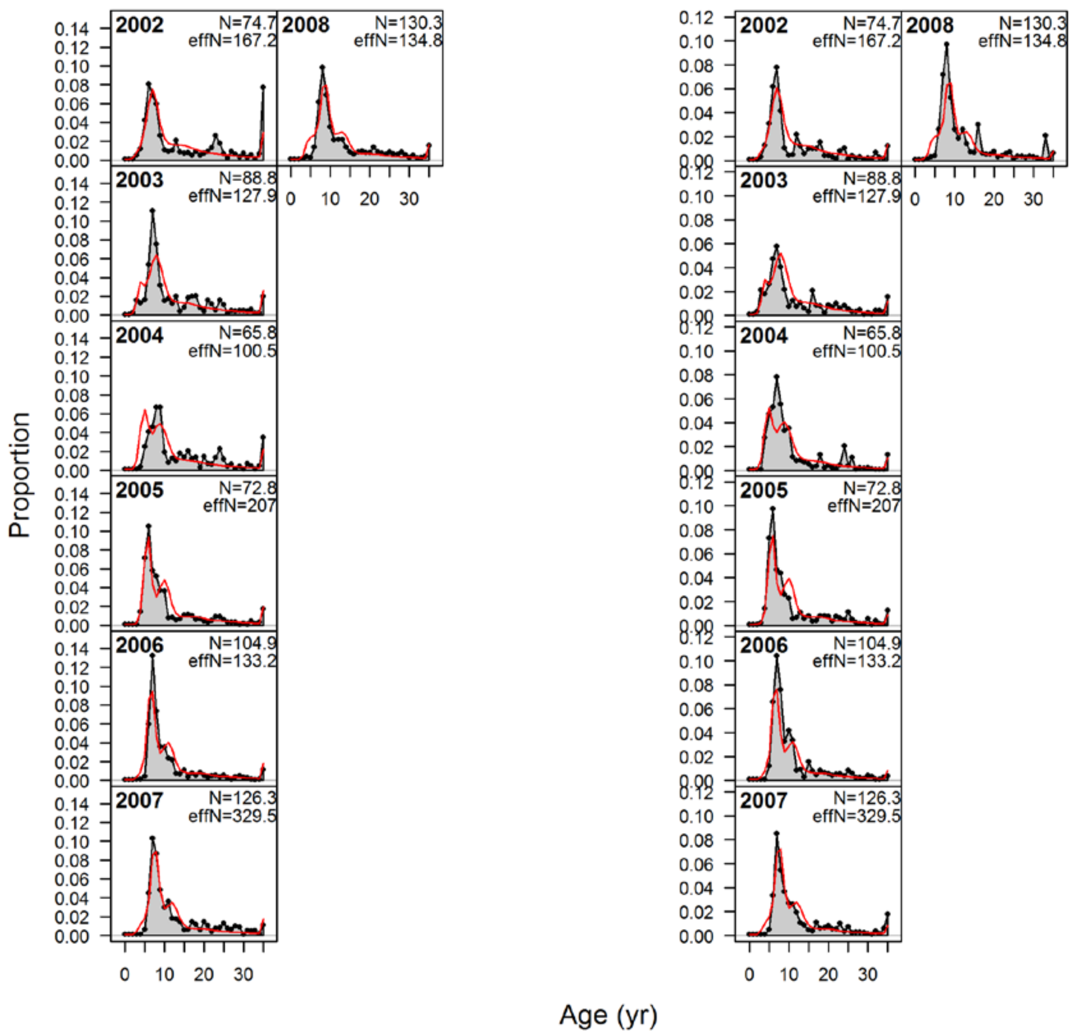

Figure 76: Fit to age-frequency distributions of female (left panel) and male (right panel) darkblotched rockfish from the domestic trawl fishery landings by year.

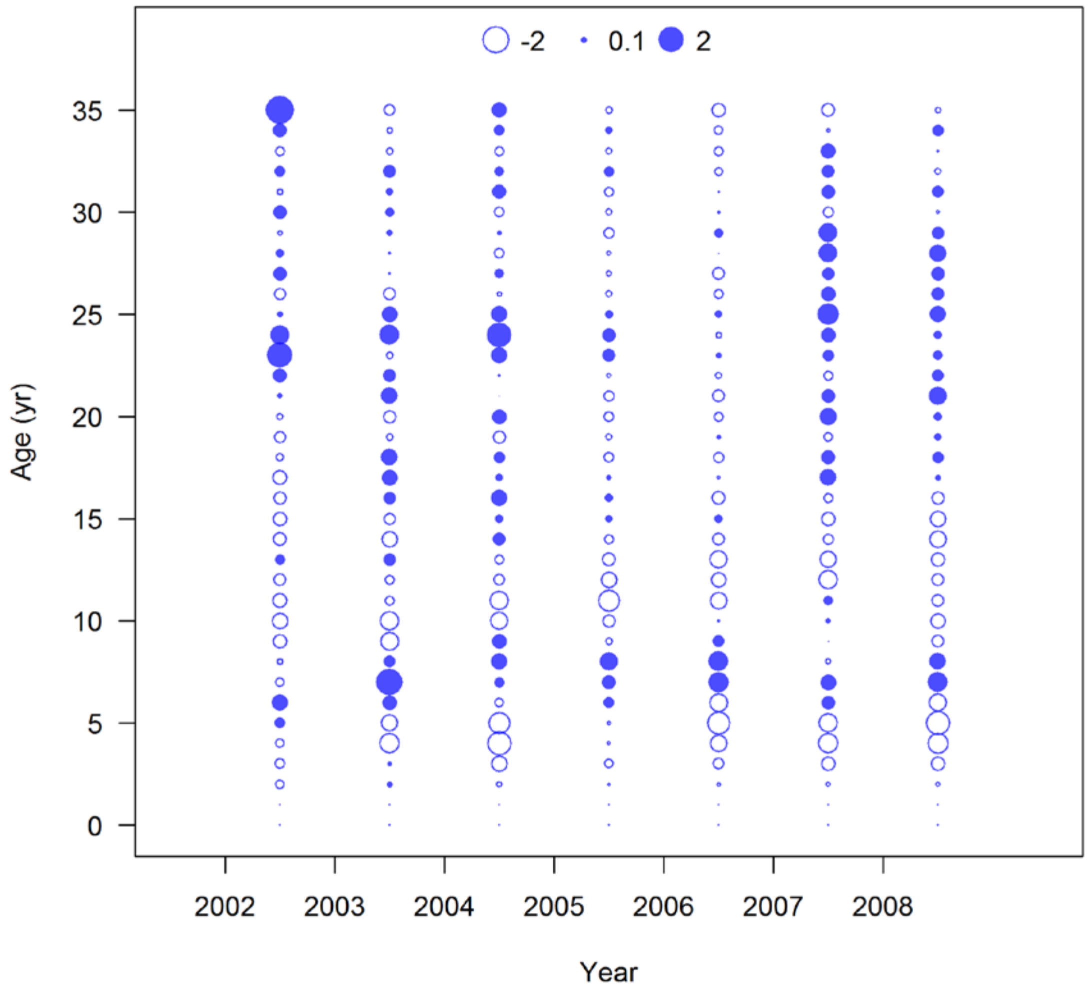

Figure 77: Pearson residuals for the fit to age-frequency distributions of female darkblotched rockfish from the domestic trawl fishery landings.

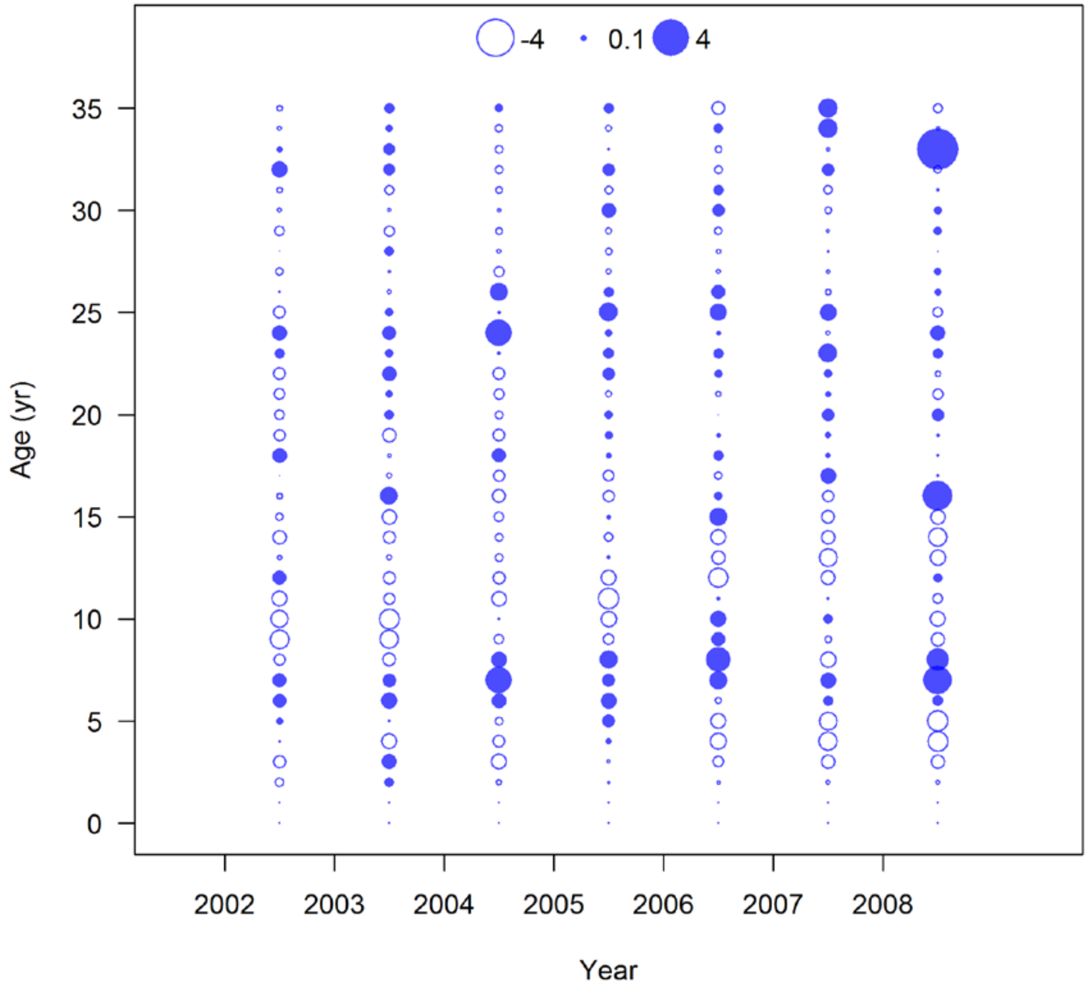

Figure 78: Pearson residuals for the fit to age-frequency distributions of male darkblotched rockfish from the domestic trawl fishery landings.

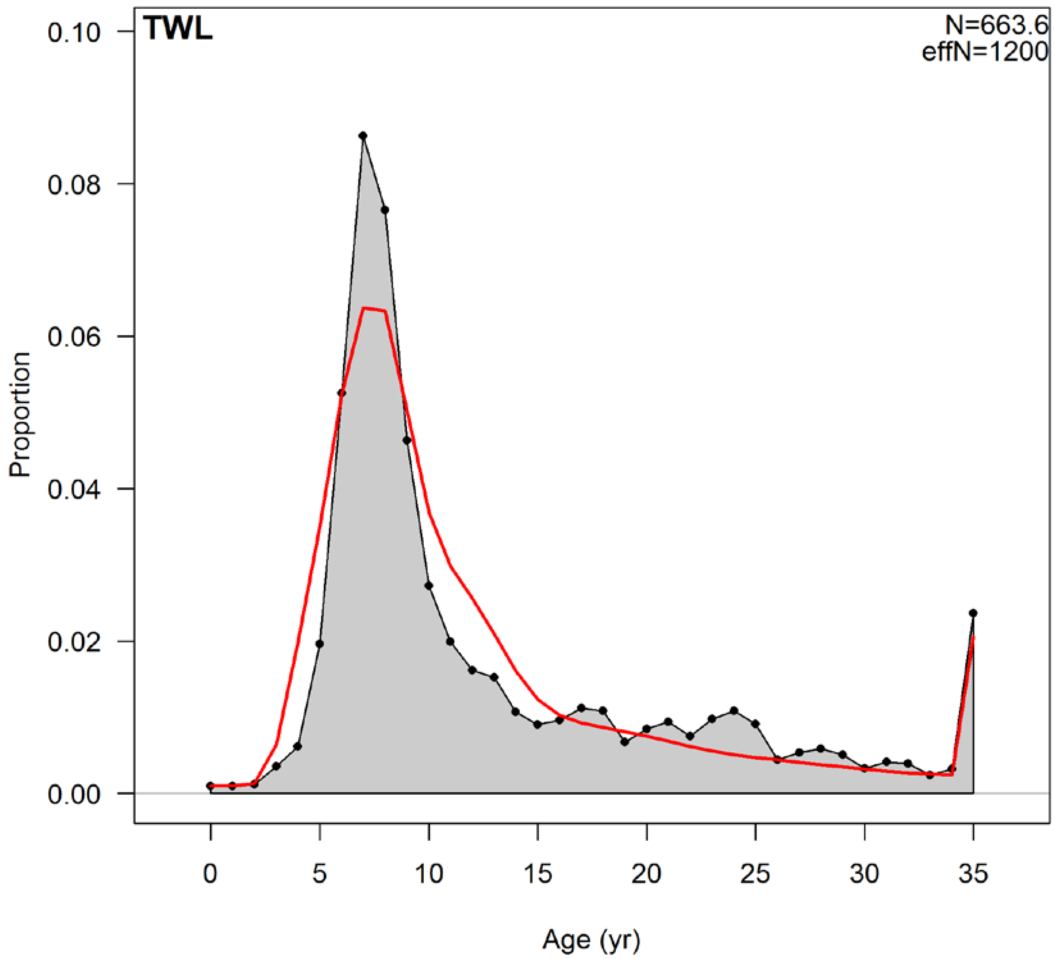

Figure 79: Fit to age-frequency distributions of female darkblotched rockfish from the domestic trawl fishery landings, aggregated across all years.

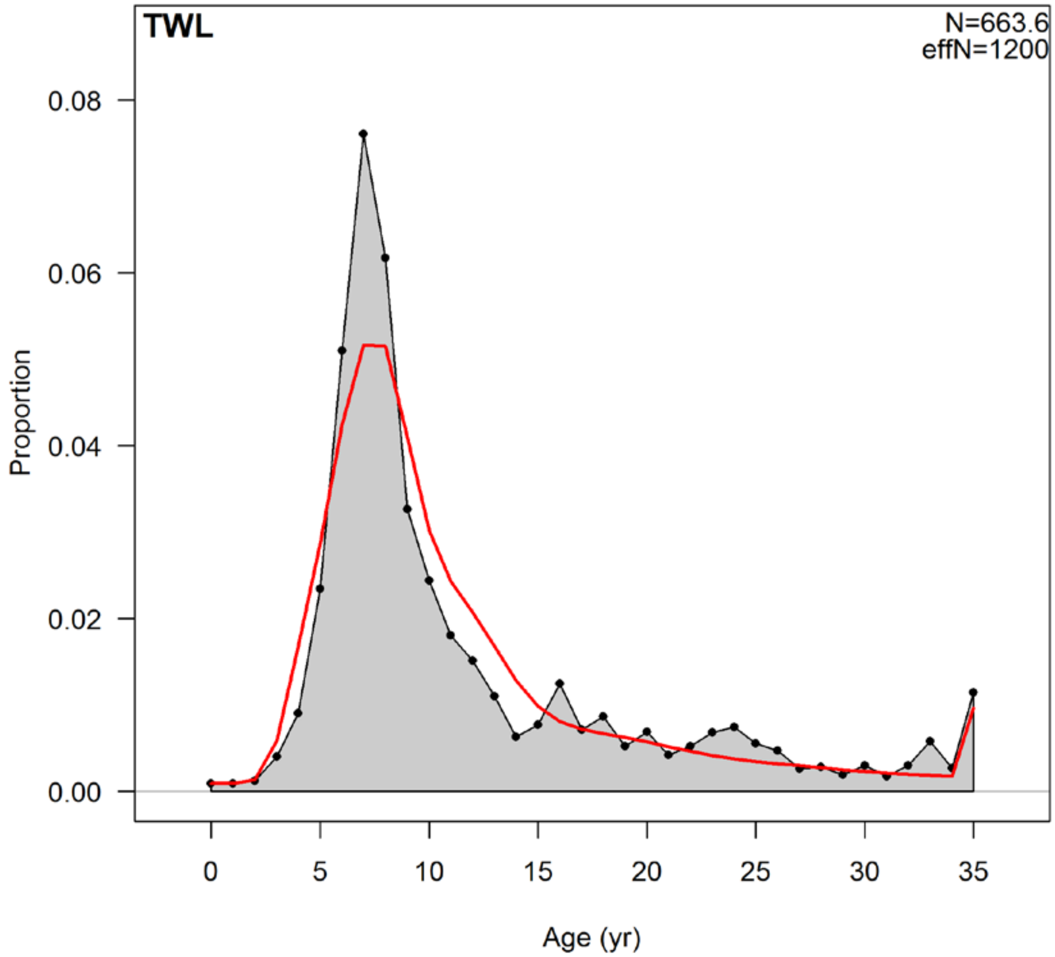

Figure 80: Fit to age-frequency distributions of male darkblotched rockfish from the domestic trawl fishery landings, aggregated across all years.

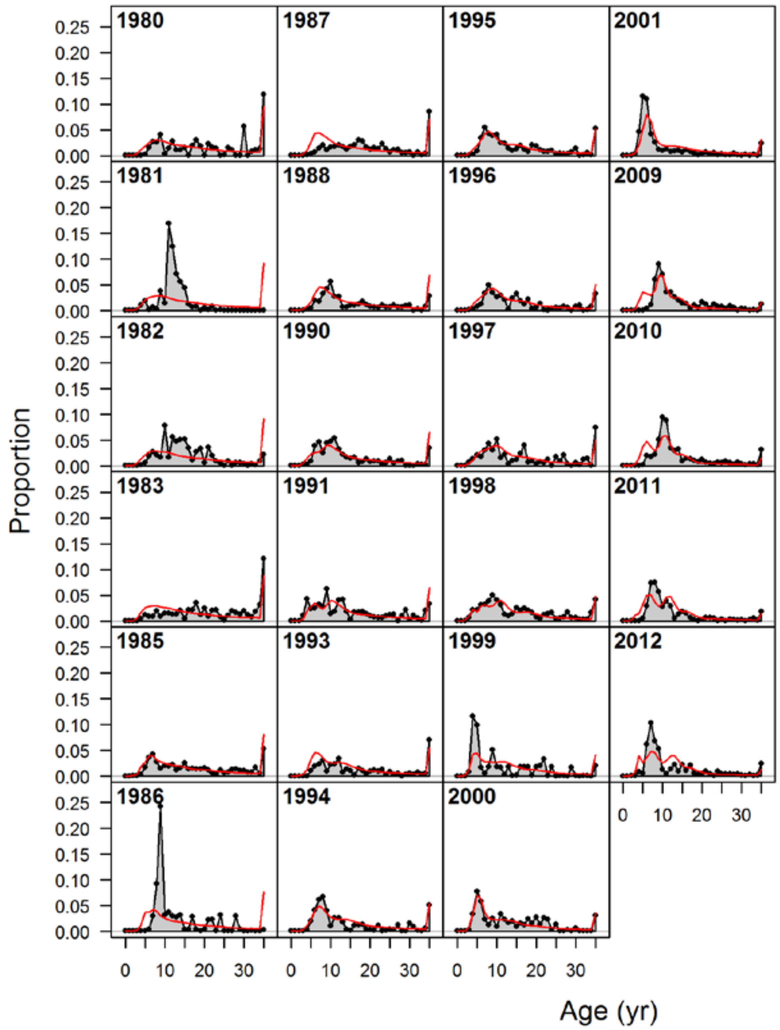

Figure 81: Implied fit to "ghost" marginal age compositions for female darkblotched rockfish from the domestic trawl landings. Age data from these years were not explicitly used in the assessment. Fits are provided for evaluation only, but not included in the model likelihood.

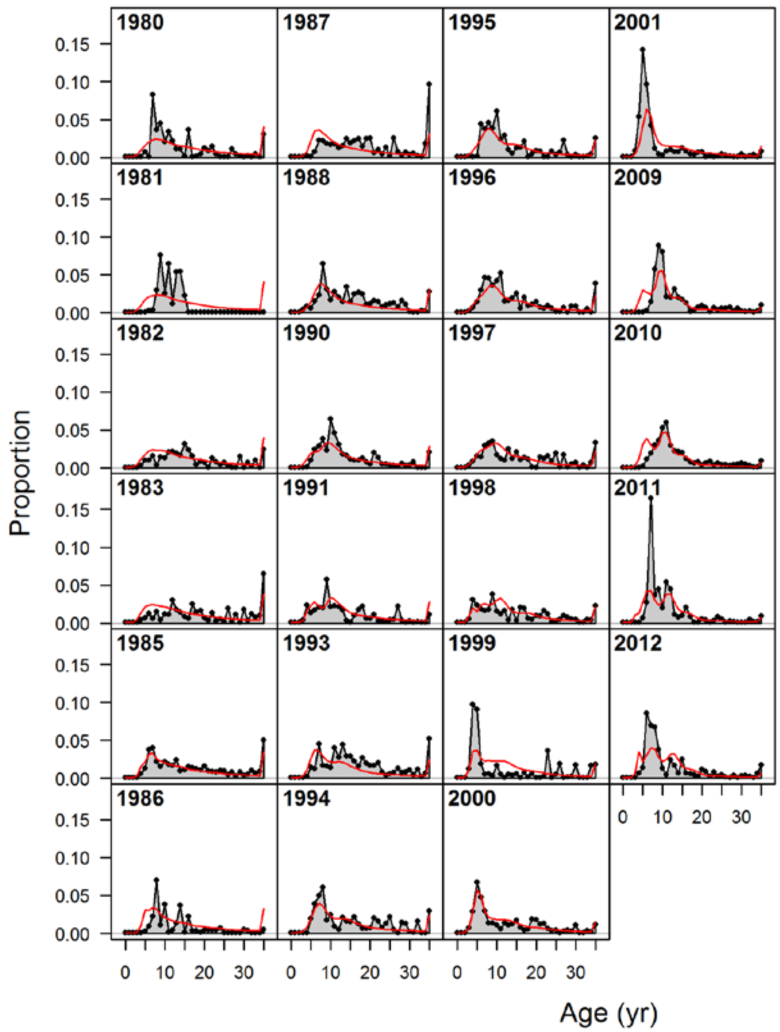

Figure 82: Implied fit to "ghost" marginal age compositions for male darkblotched rockfish from the domestic trawl landings. Age data from these years were not explicitly used in the assessment. Fits are provided for evaluation only, but not included in the model likelihood.

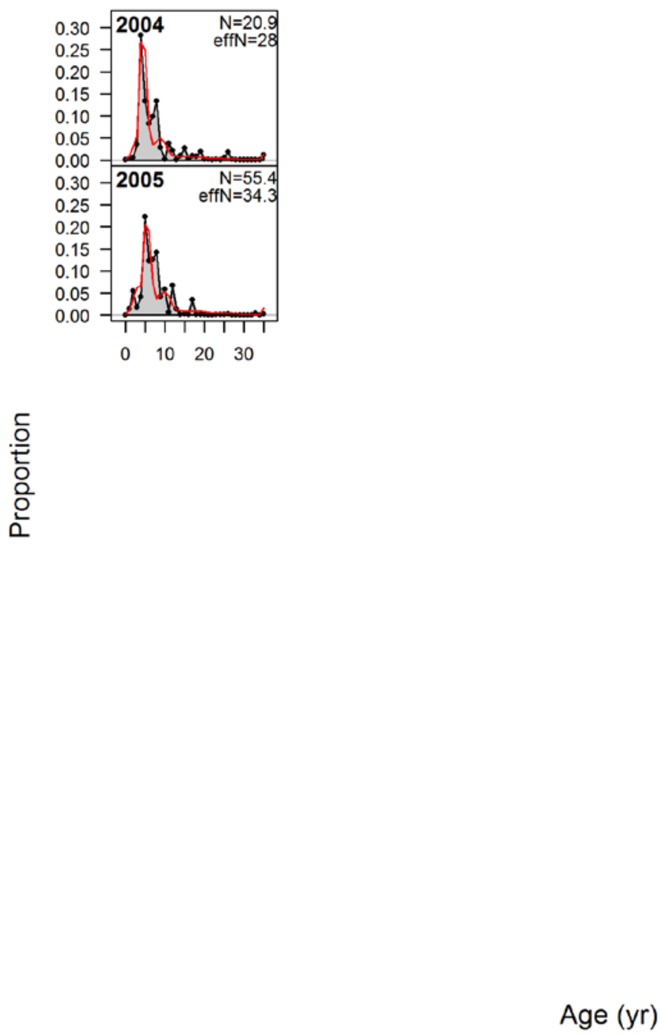

Figure 83: Fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the domestic trawl fishery discard by year.

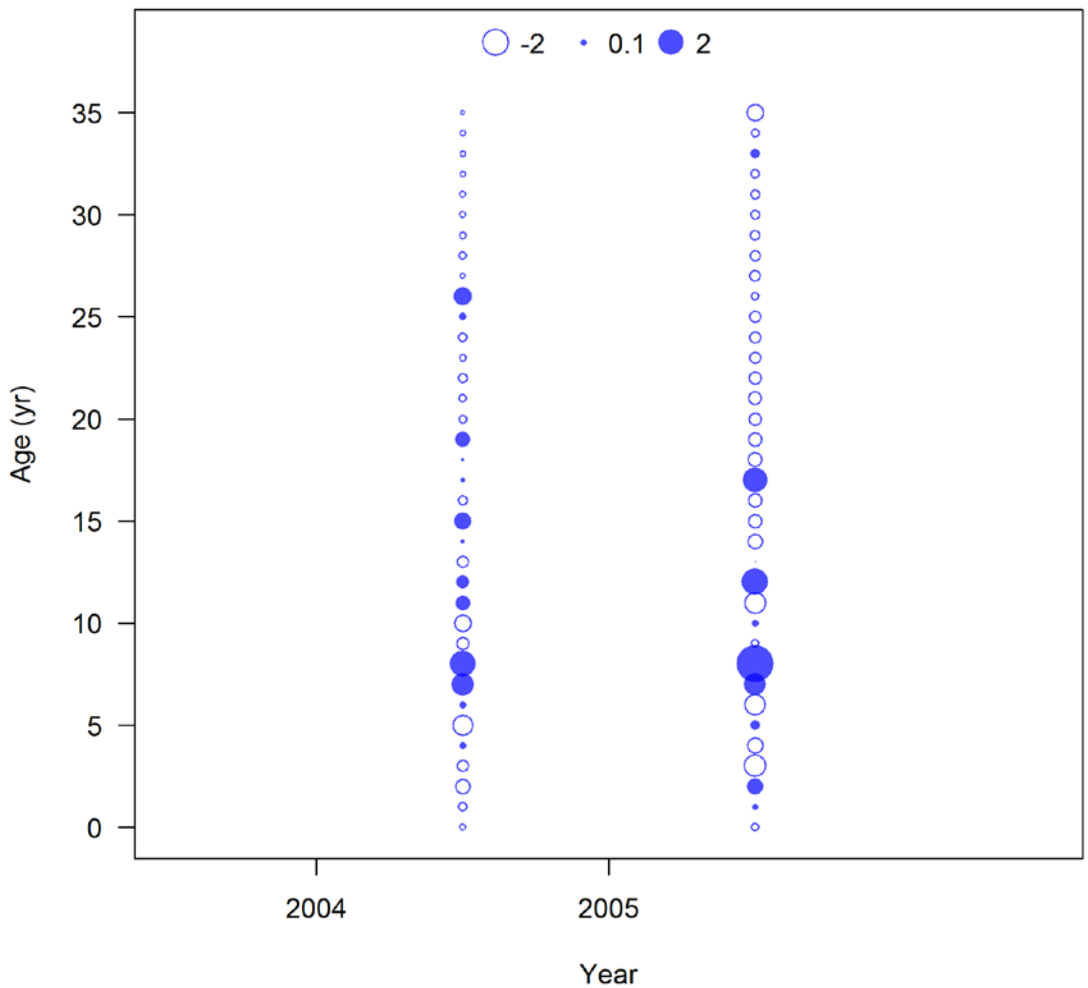

Figure 84: Pearson residuals for the fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the domestic trawl fishery discard**.**

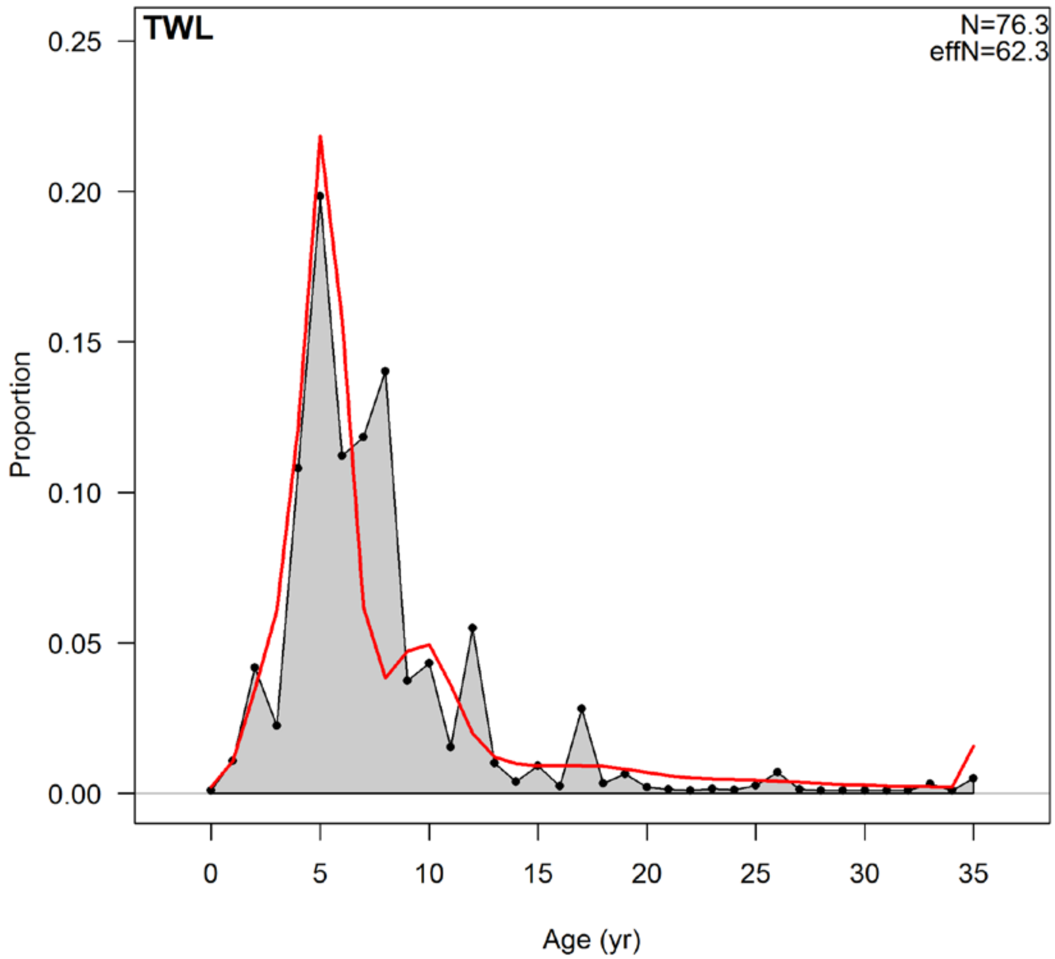

Figure 85: Fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the domestic trawl fleet discard, aggregated across all years.

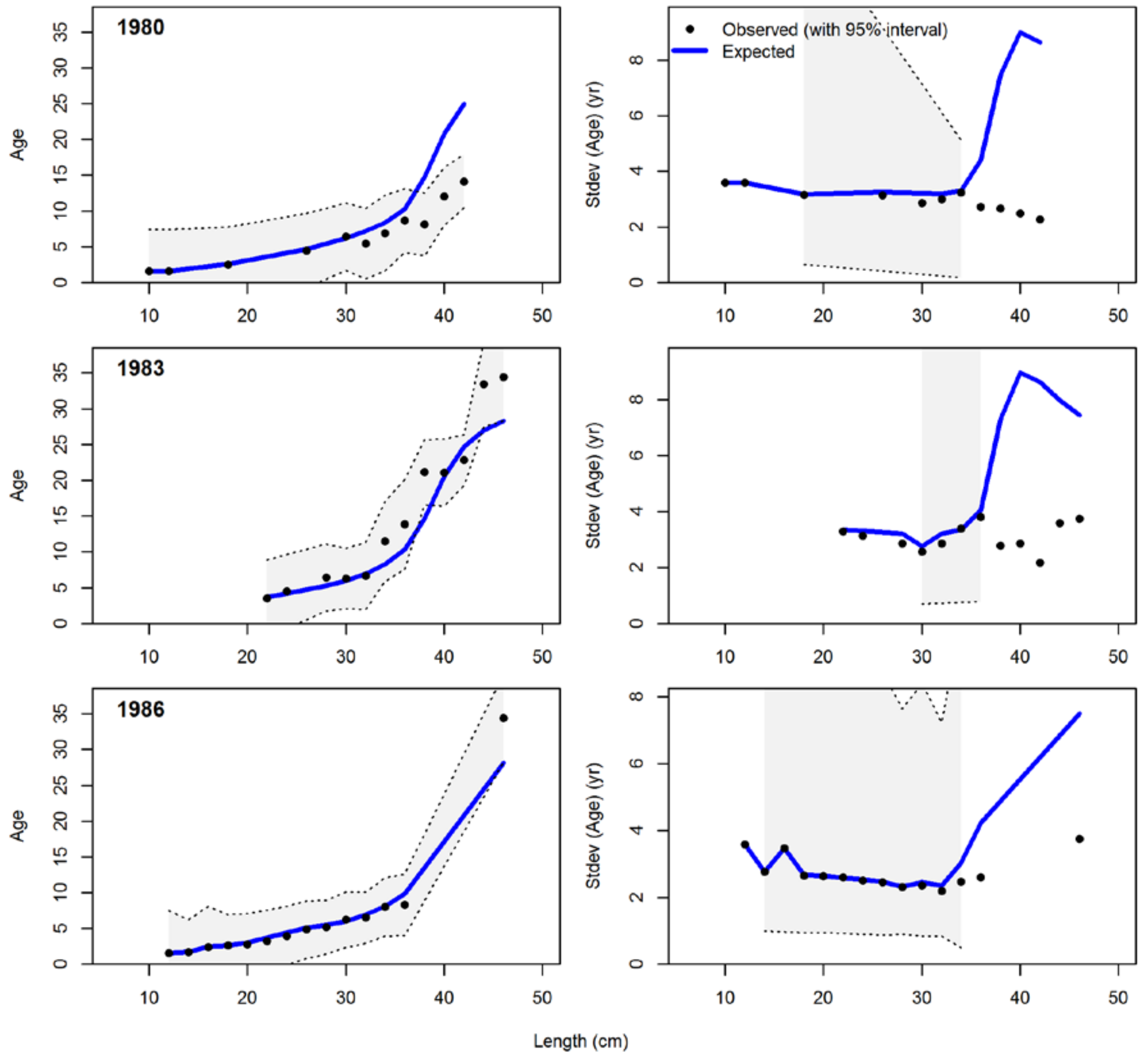

Figure 86: Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

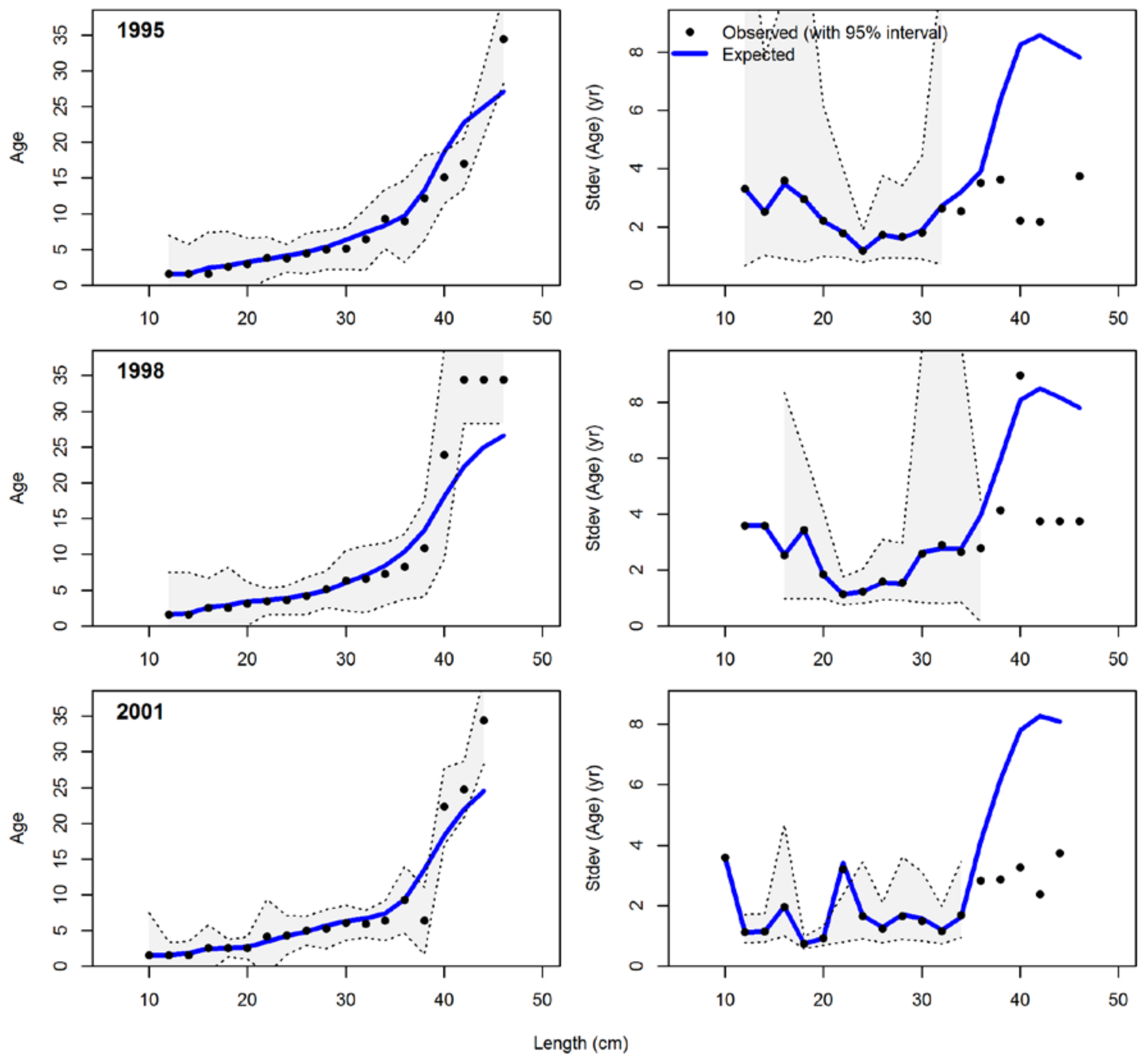

Figure 86 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

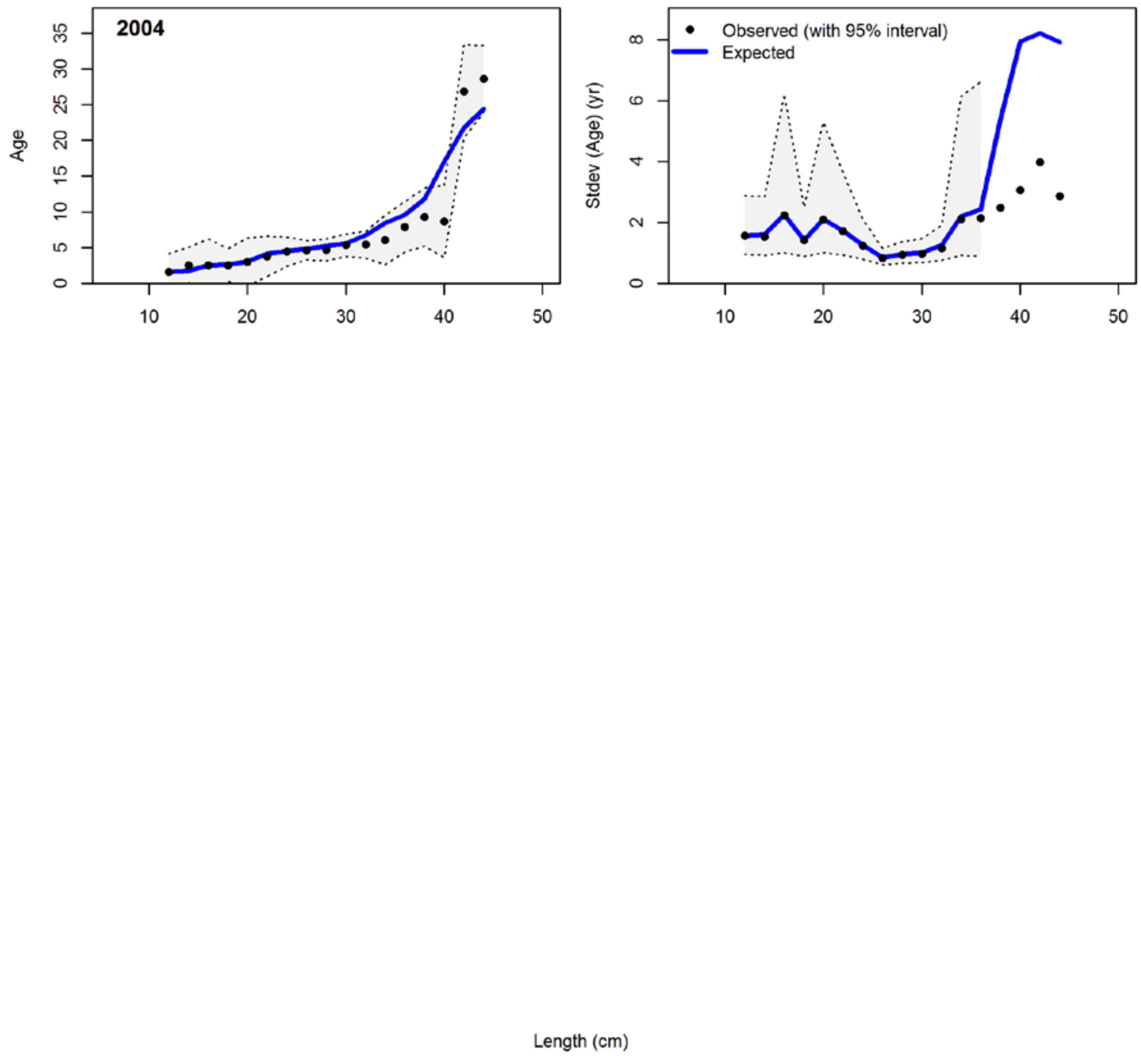

Figure 86 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

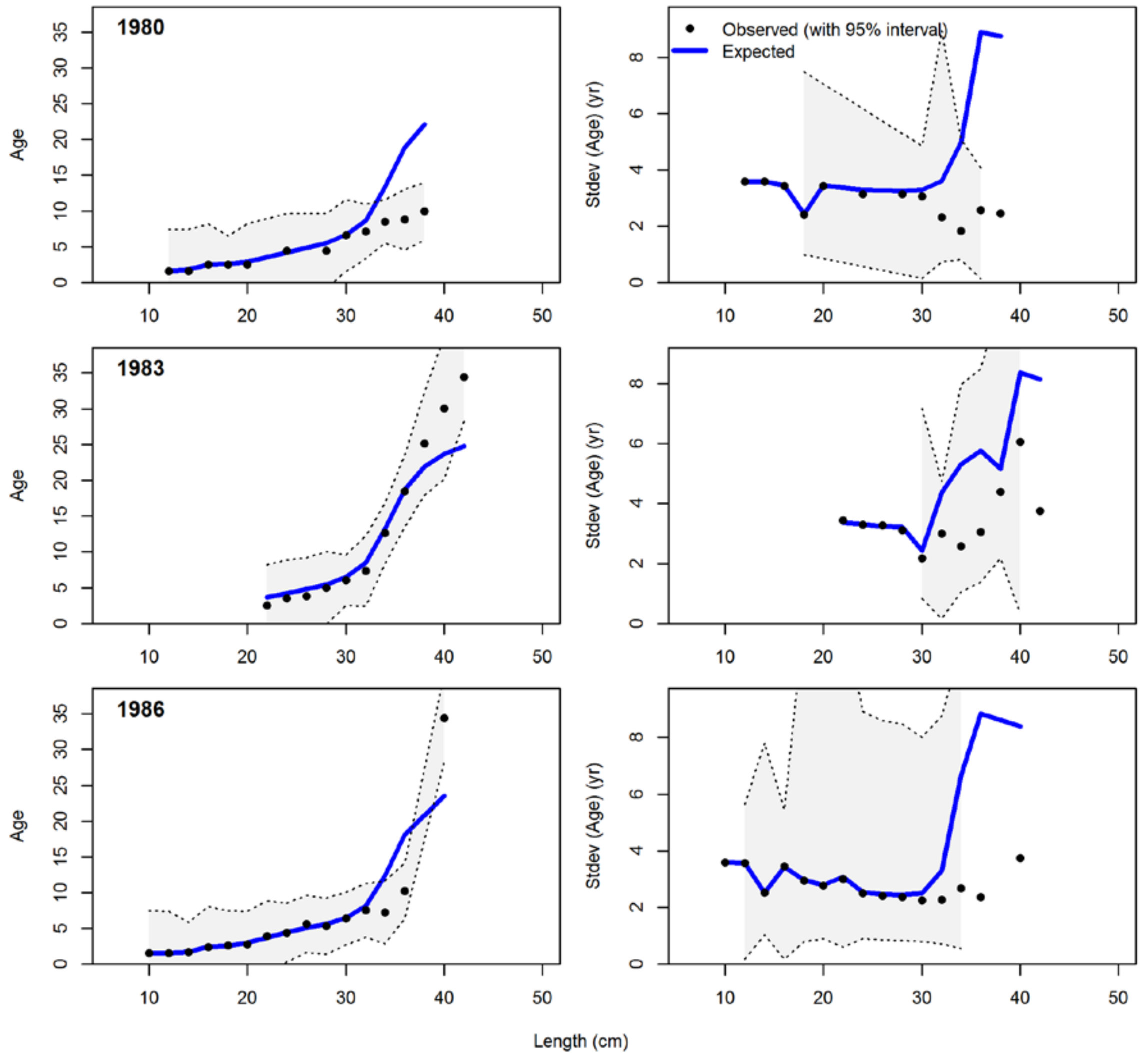

Figure 87: Fit to conditional ages-at-length compositions of male darkblotched rockfish from the AFSC shelf survey.

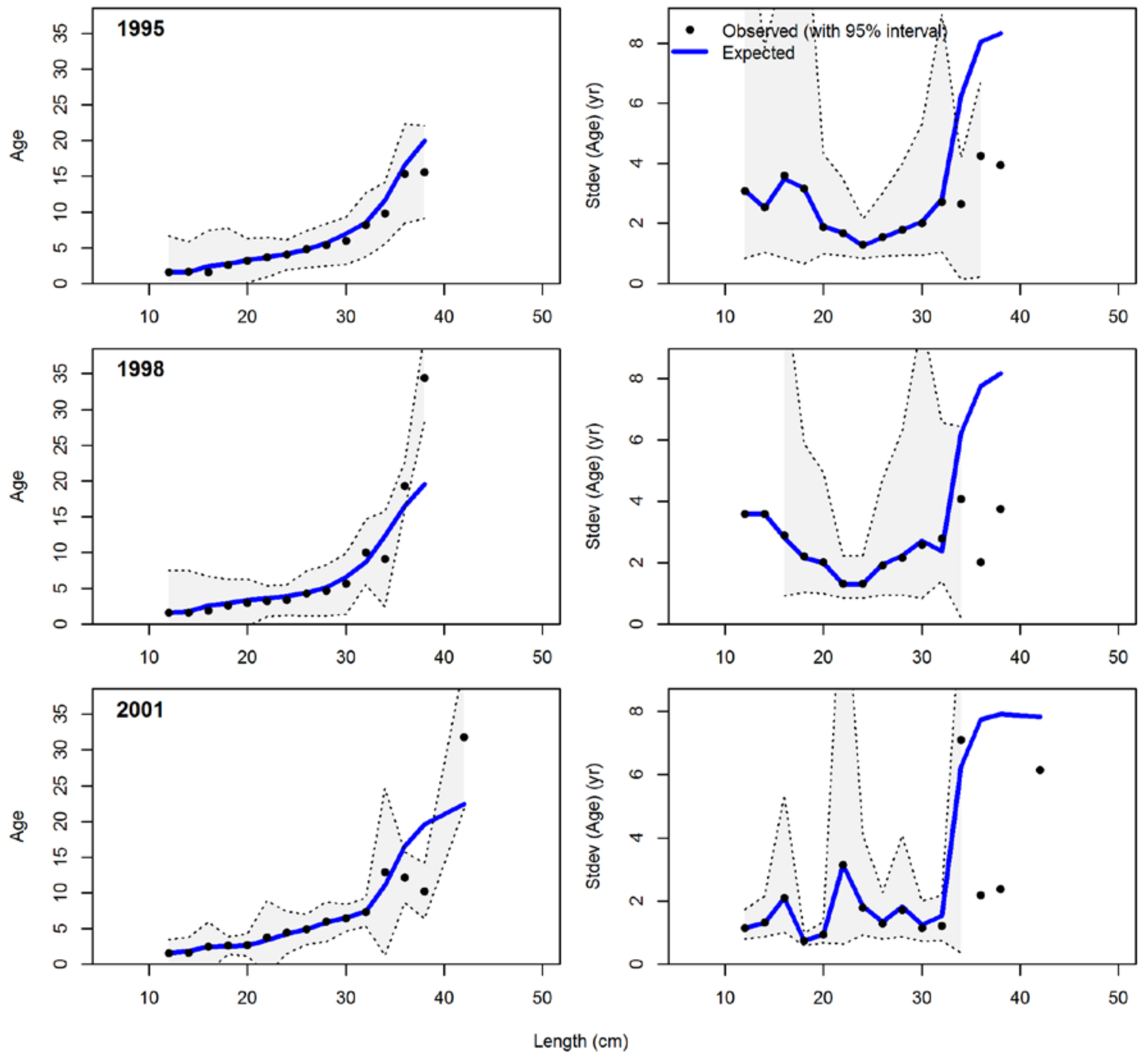

Figure 87 (continued): Fit to conditional ages-at-length compositions of male darkblotched rockfish from the AFSC shelf survey.

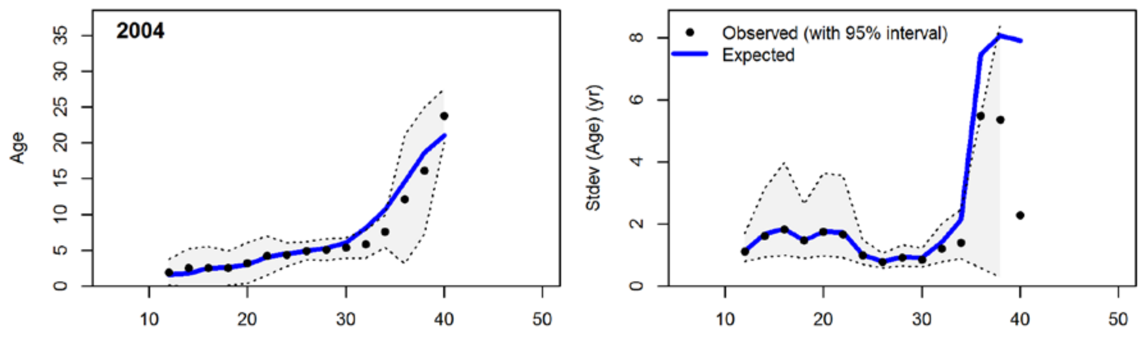

Figure 87 (continued): Fit to conditional ages-at-length compositions of male darkblotched rockfish from the AFSC shelf survey.

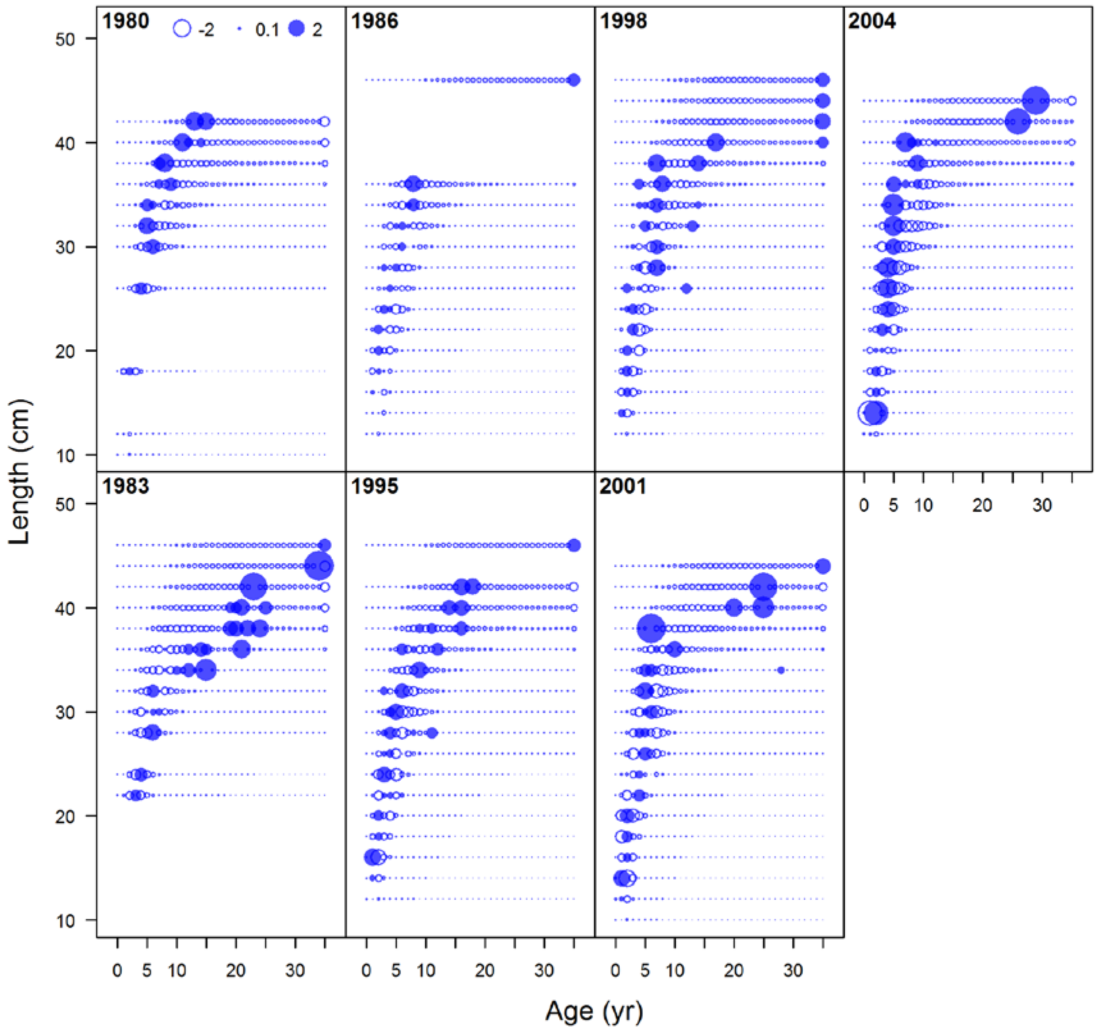

Figure 88: Pearson residuals for the fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

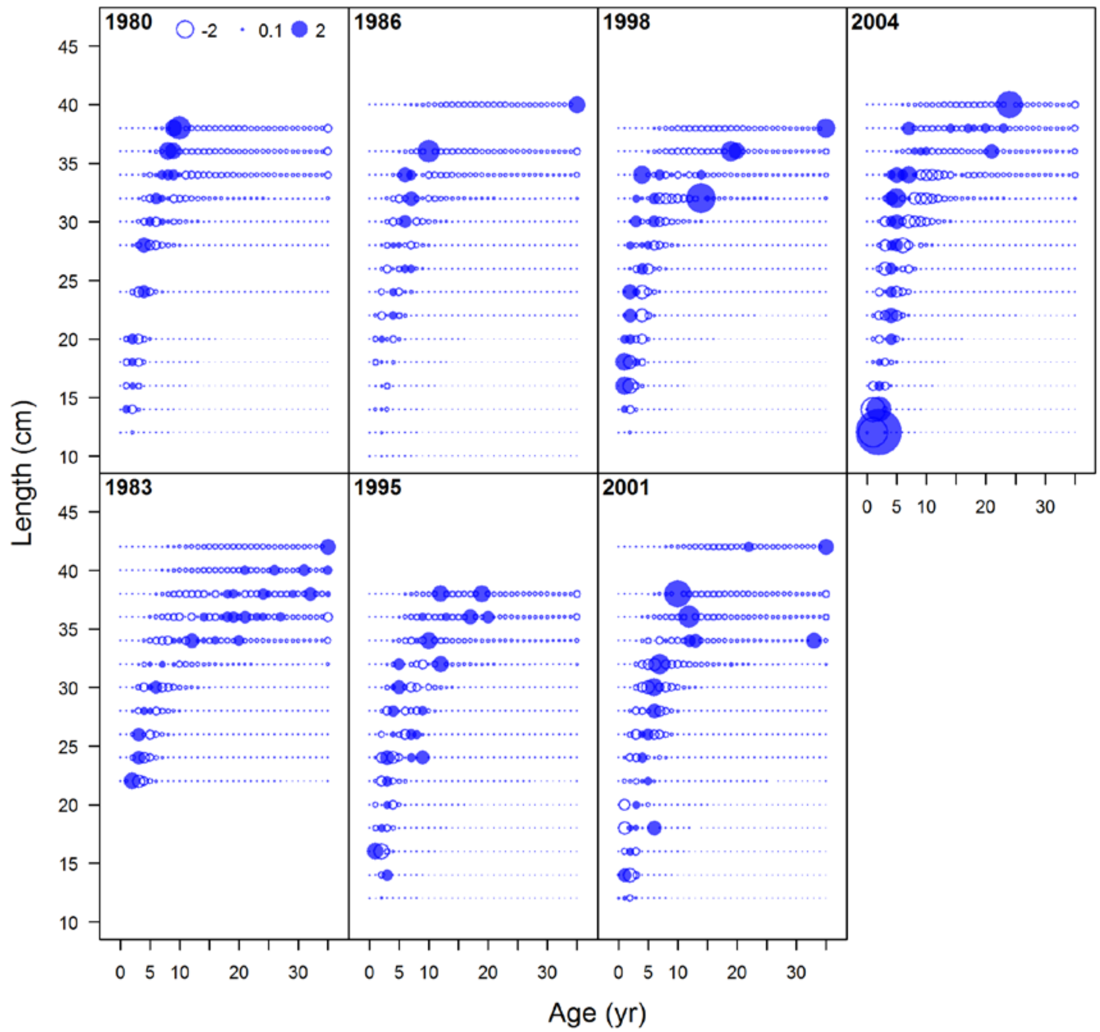

Figure 89: Pearson residuals for the fit to conditional ages-at-length compositions of male darkblotched rockfish from the AFSC shelf survey.

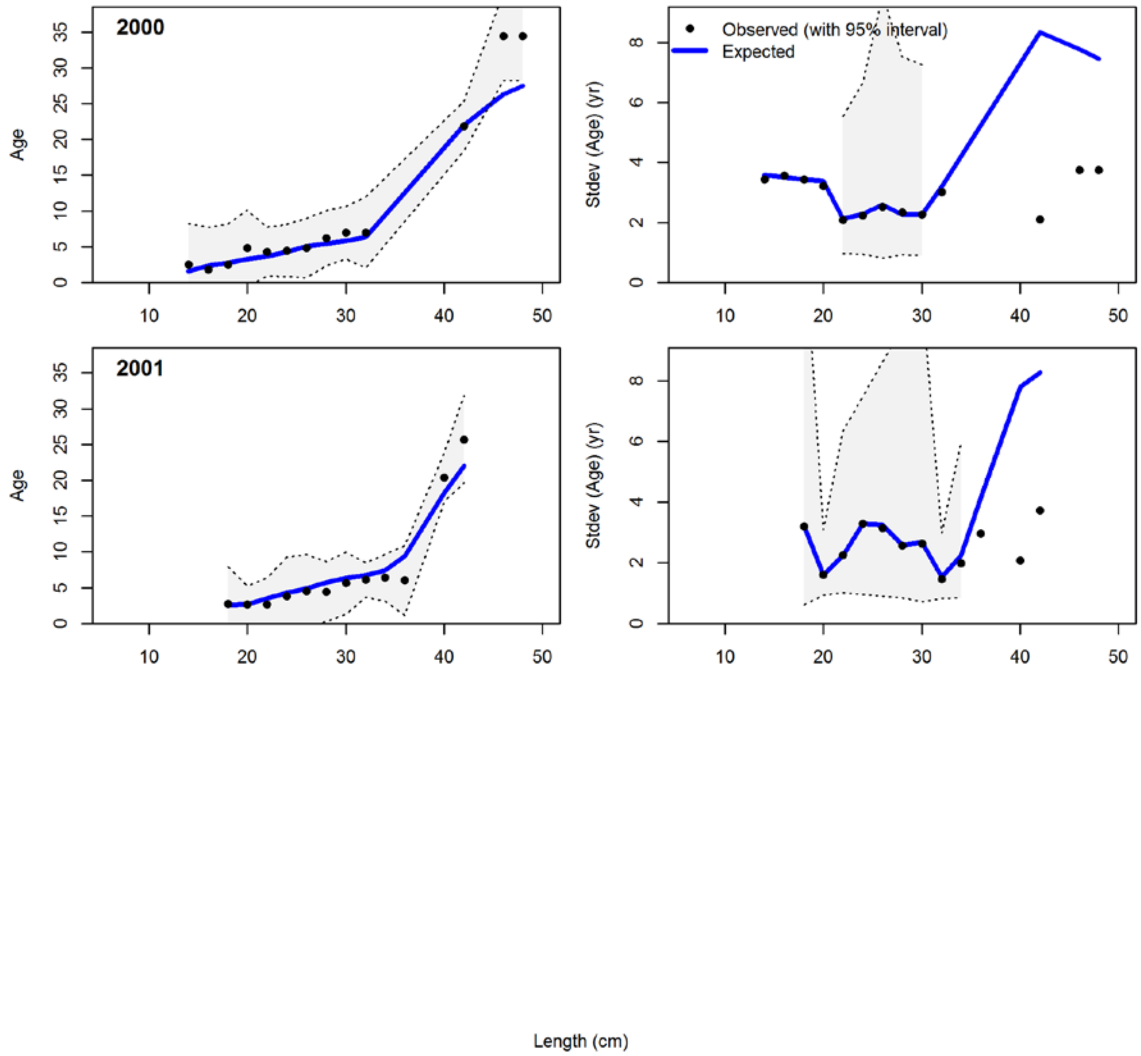

Figure 90: Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC slope survey.

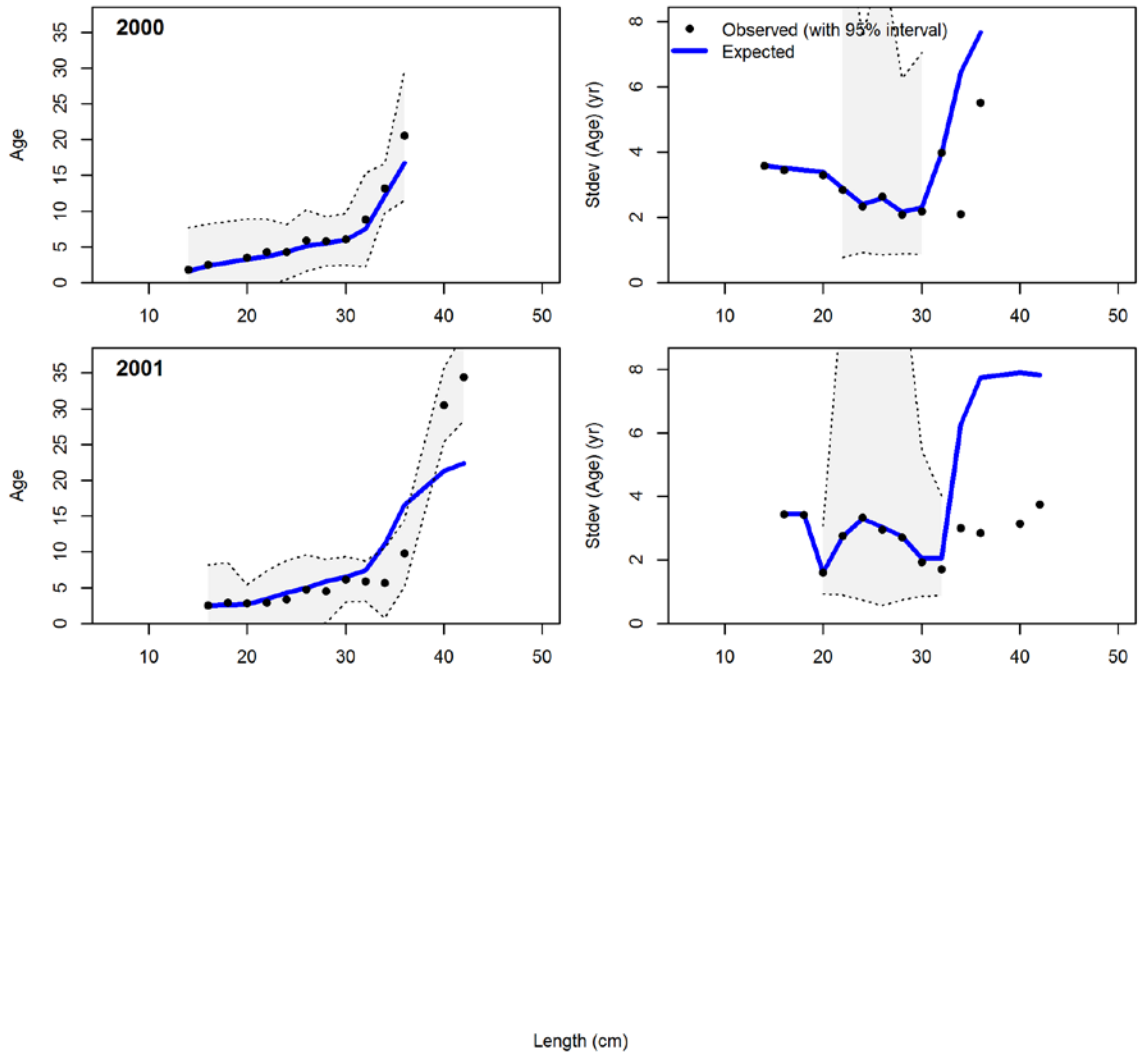

Figure 91: Fit to conditional ages-at-length compositions of male darkblotched rockfish from the AFSC slope survey.

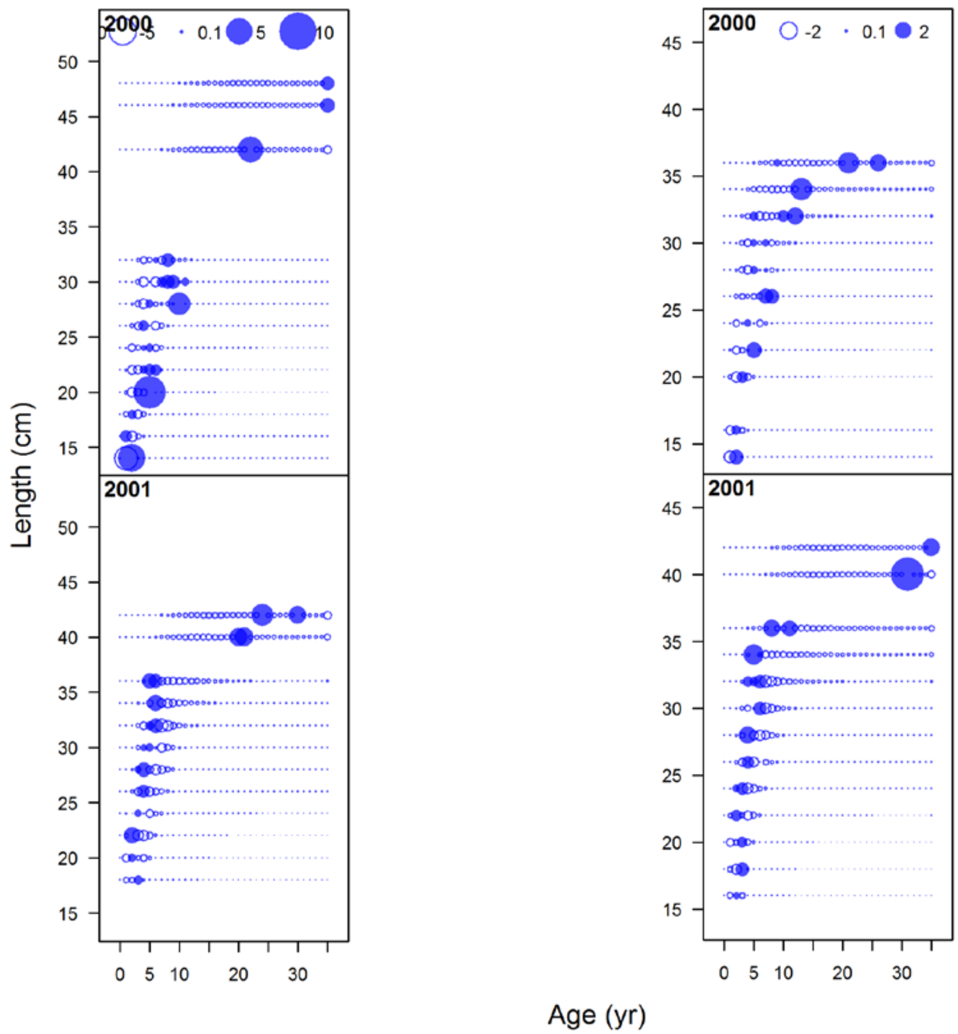

Figure 92: Pearson residuals for the fit to conditional ages-at-length compositions of female (left) and male (right) darkblotched rockfish from the AFSC slope survey.

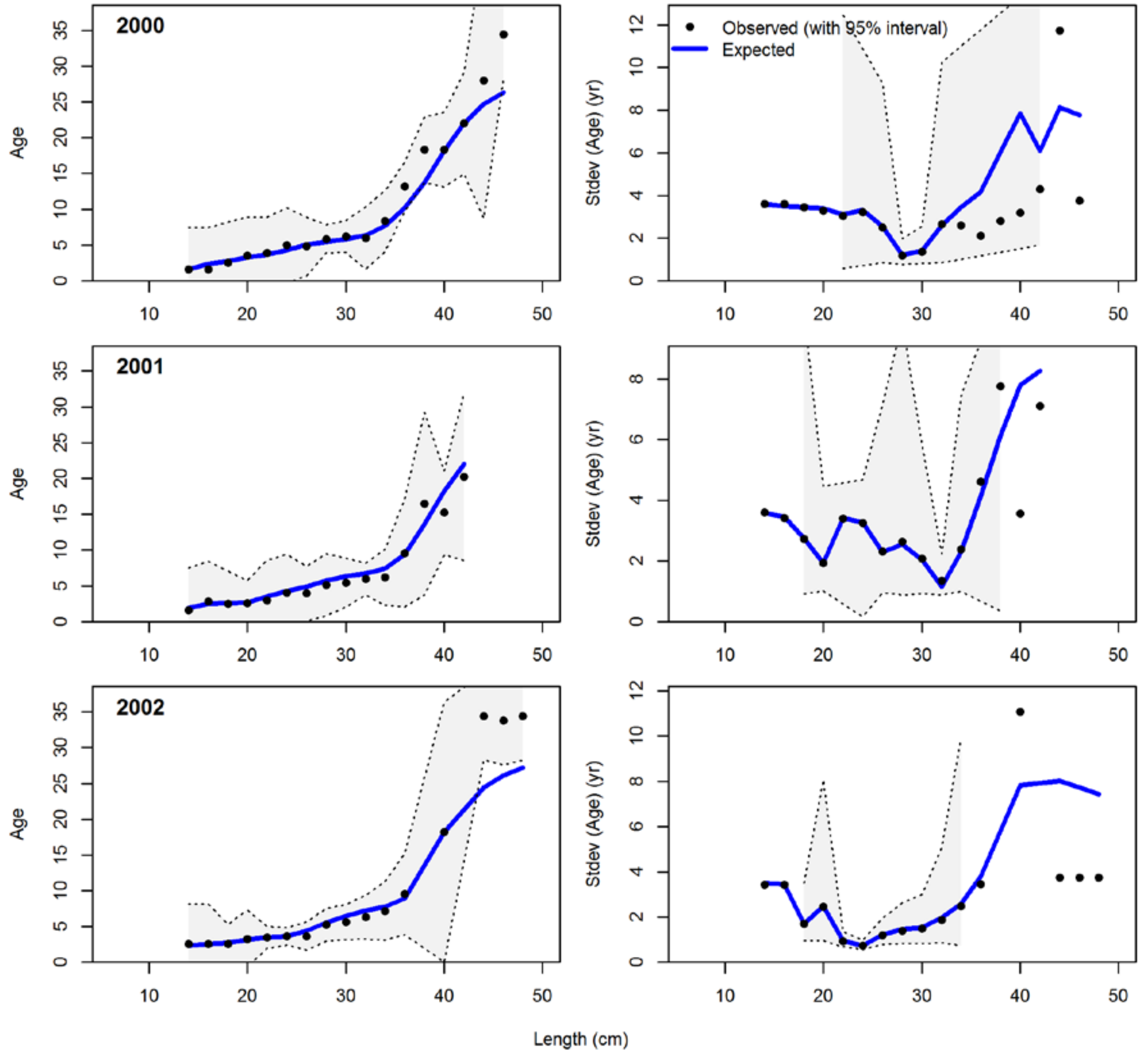

Figure 93: Fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC slope survey.

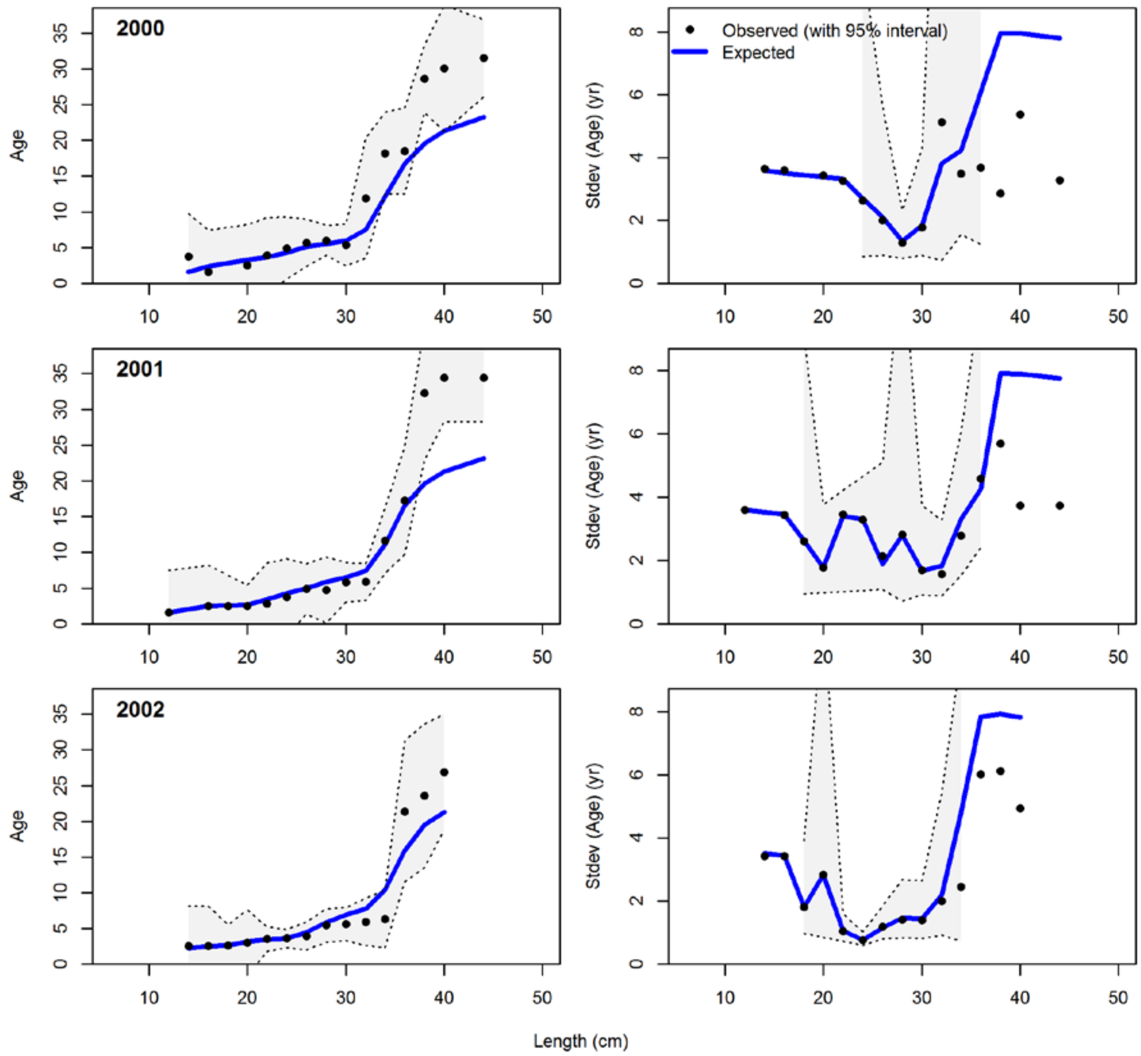

Figure 94: Fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC slope survey.

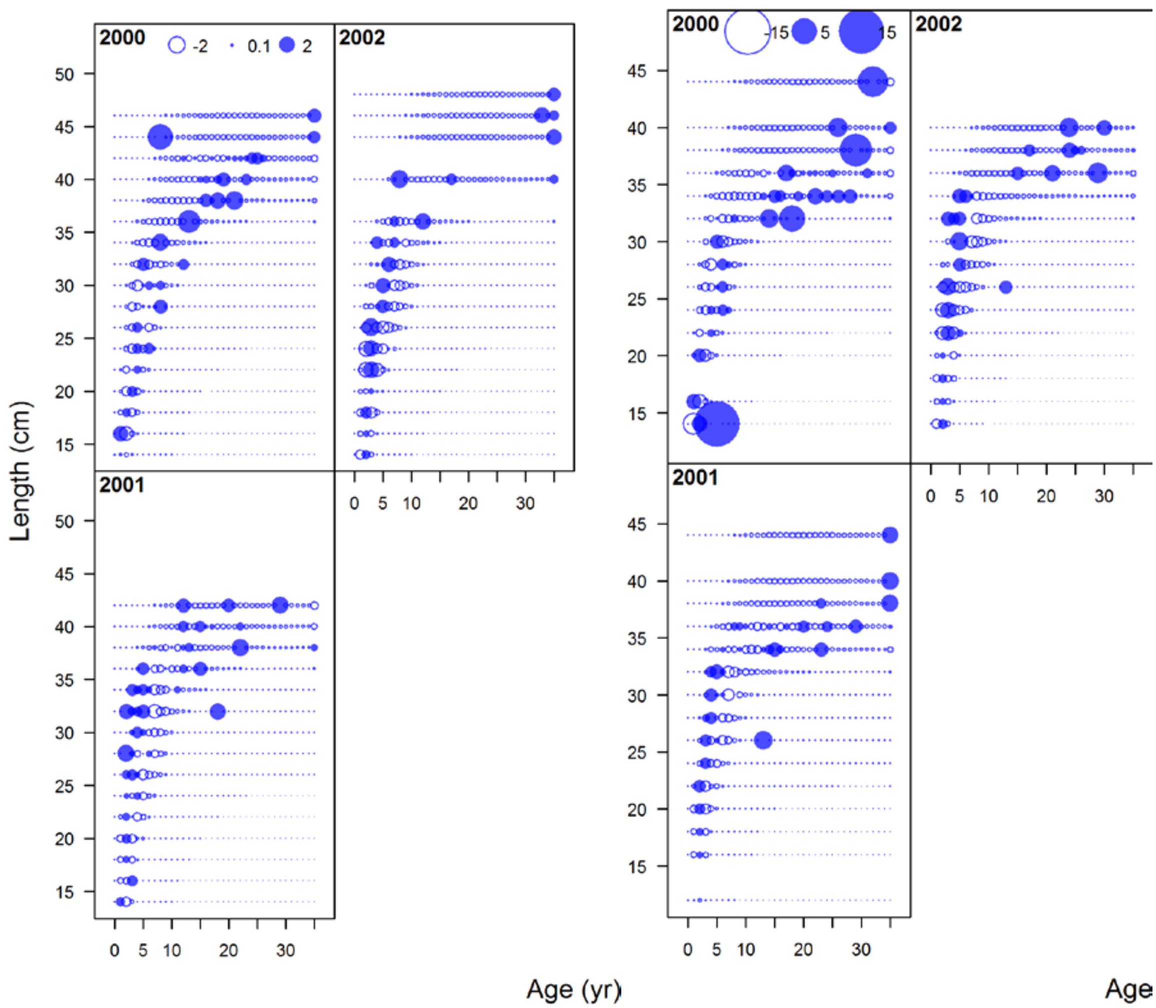

Figure 95: Pearson residuals for the fit to conditional ages-at-length compositions of female (left) and male (right) darkblotched rockfish from the NWFSC slope survey.

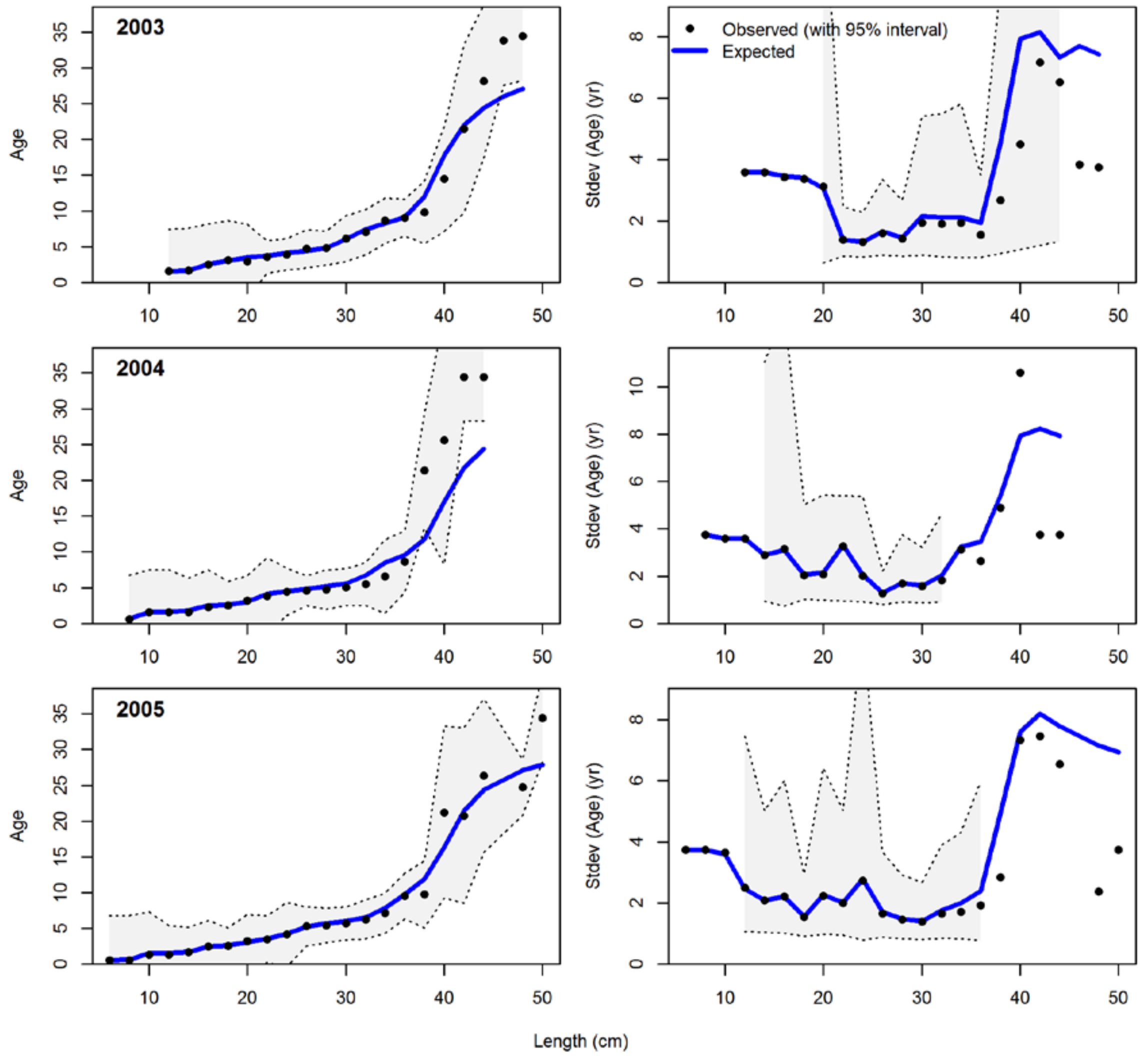

Figure 96: Fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

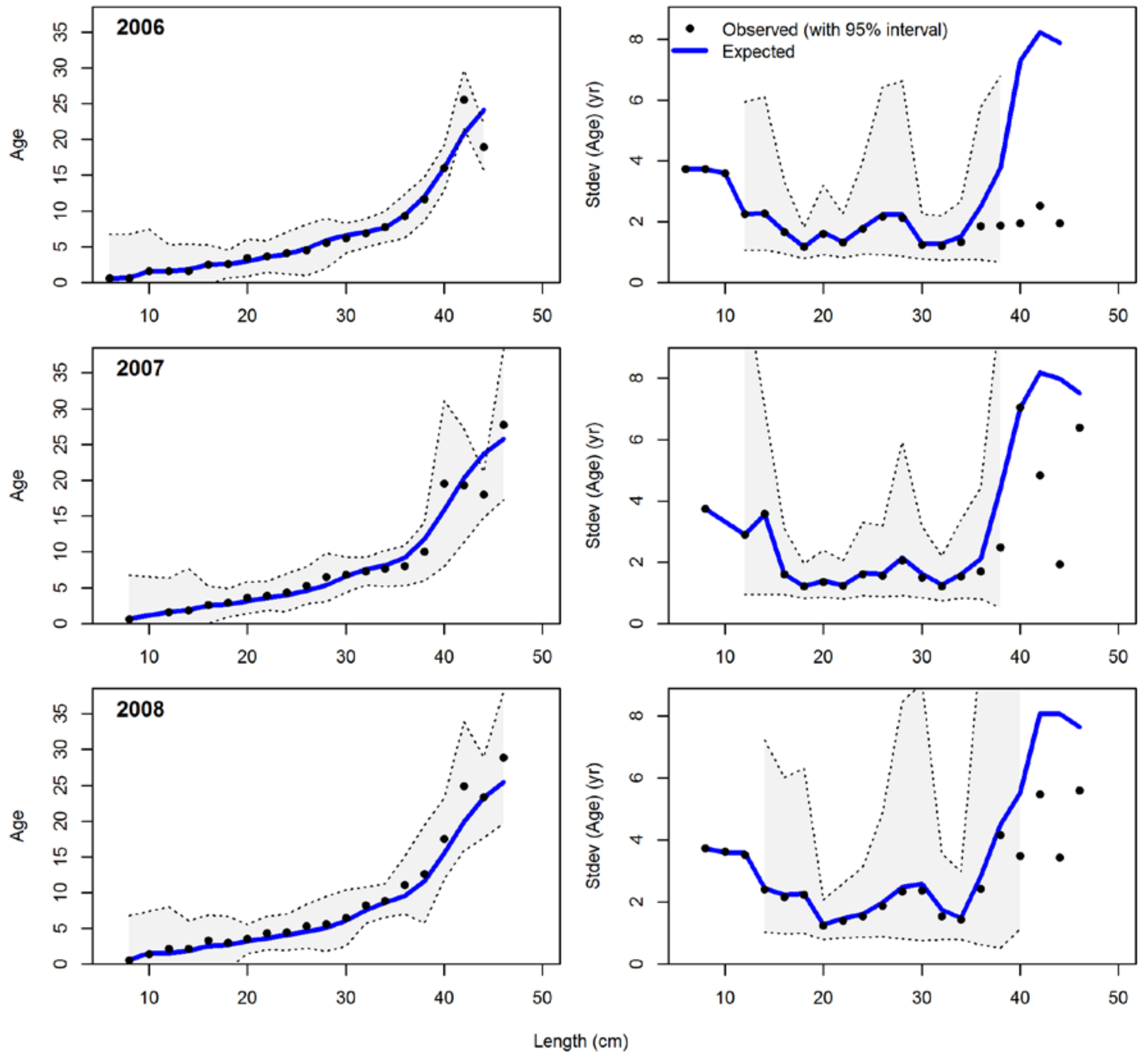

Figure 96 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

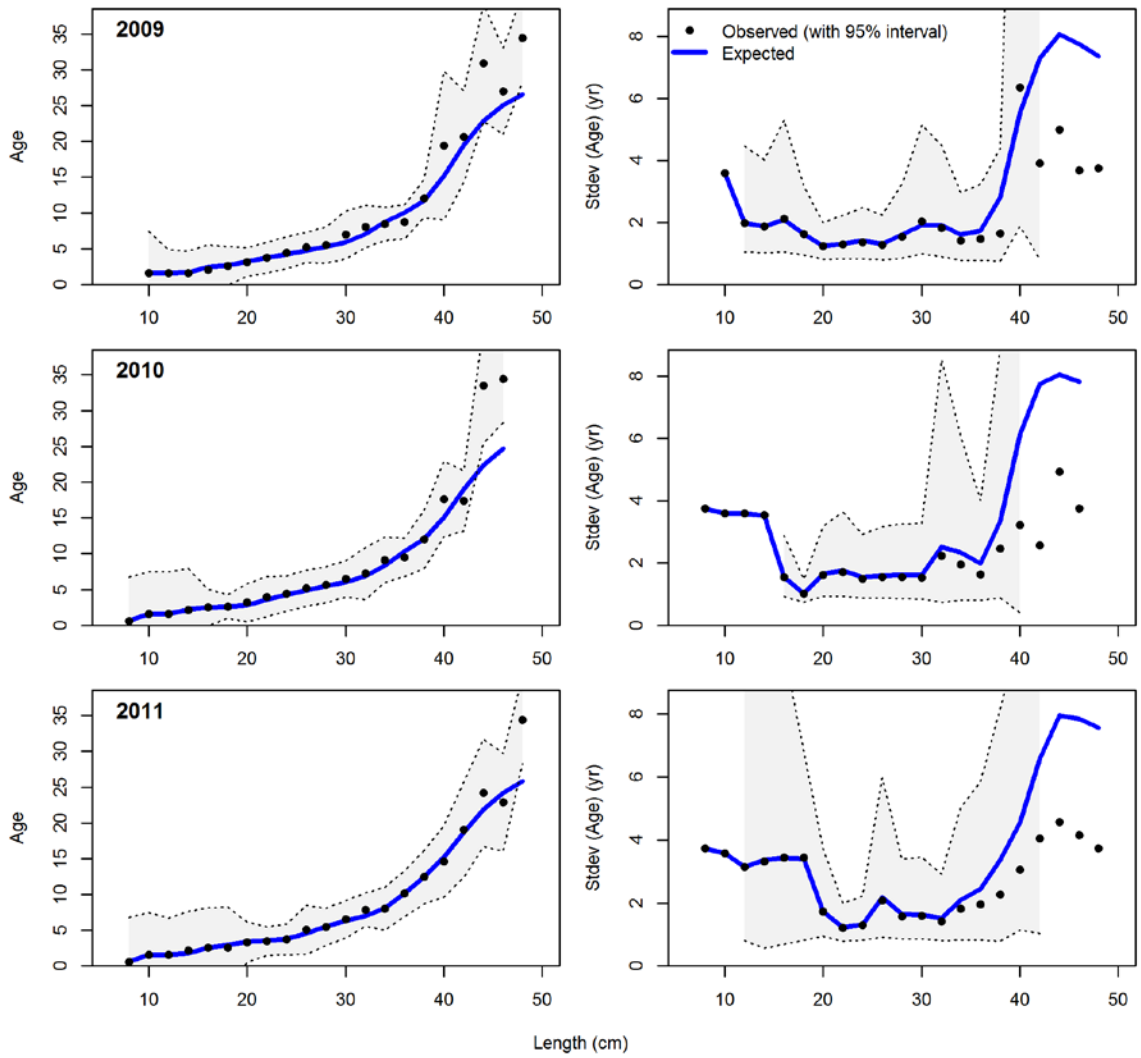

Figure 96 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

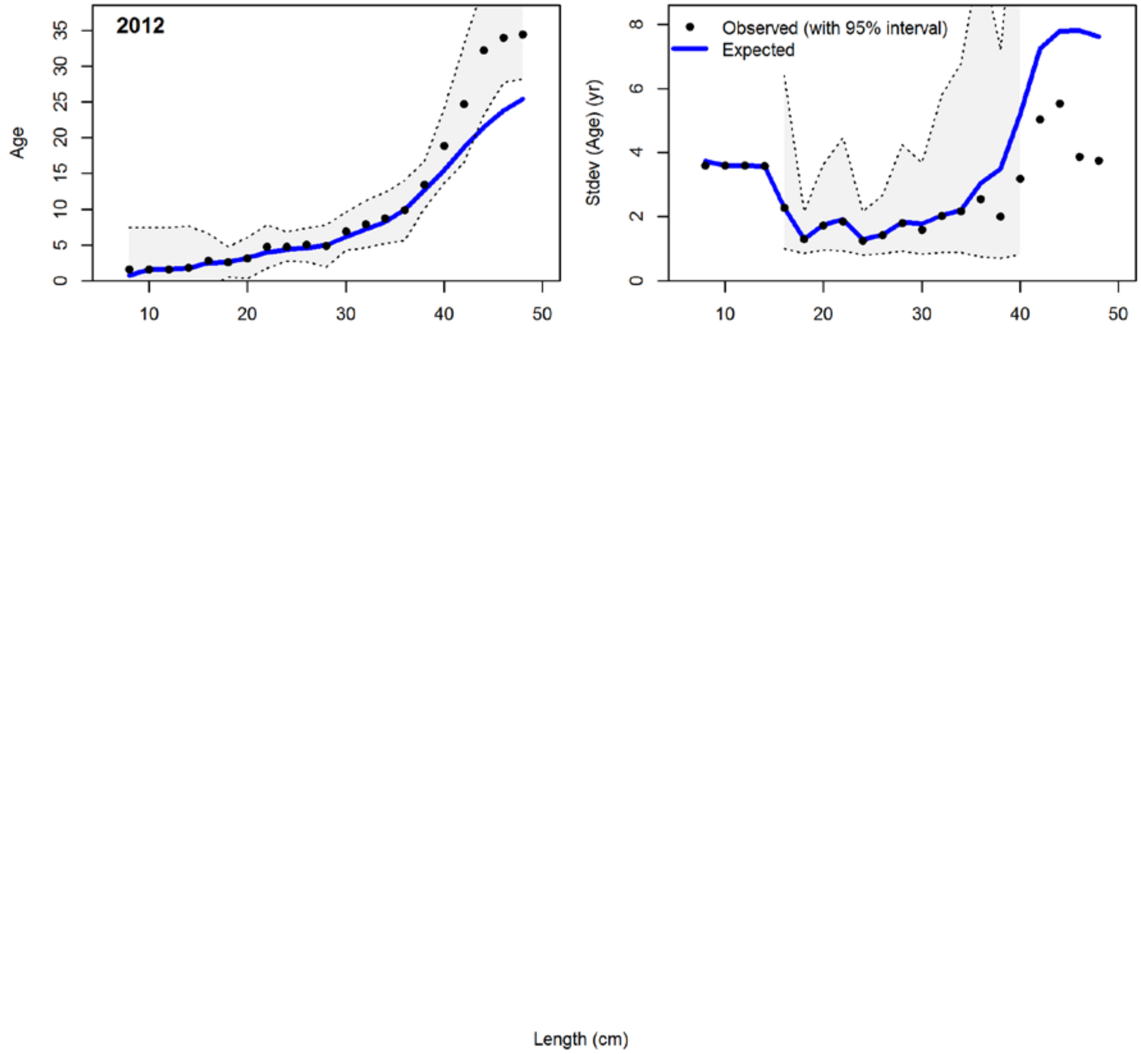

Figure 96 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

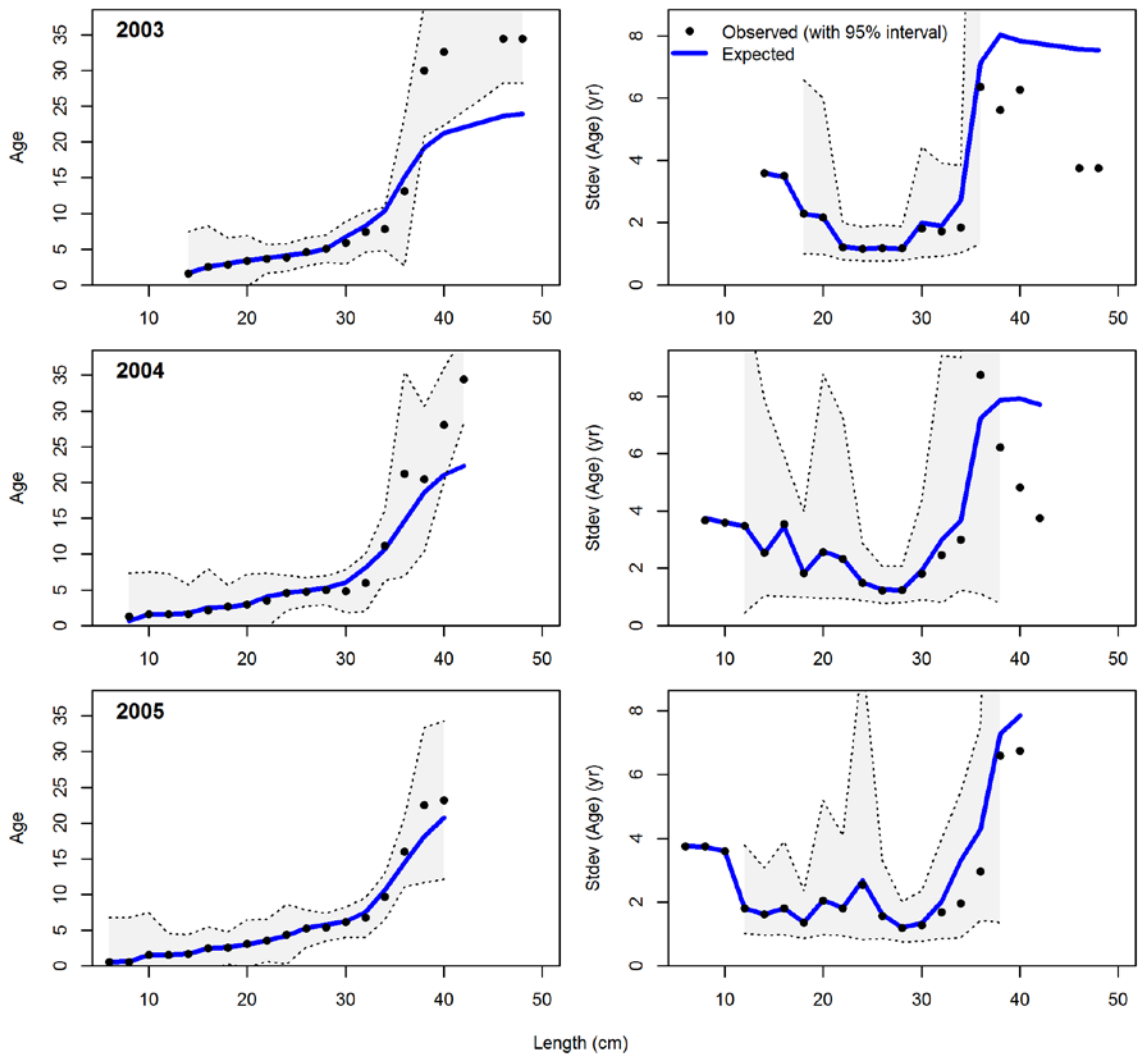

Figure 97: Fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

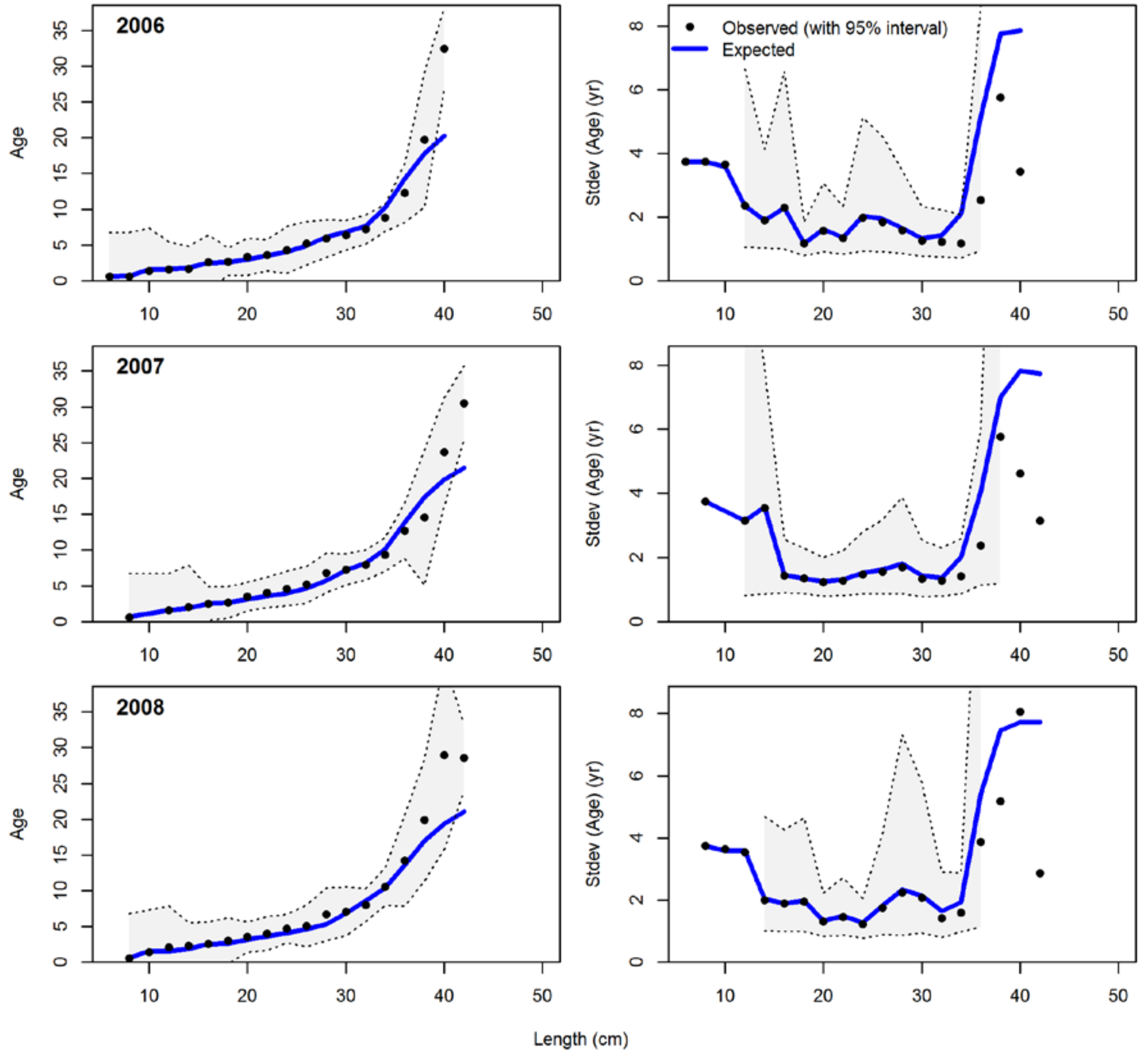

Figure 97 (continued): Fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

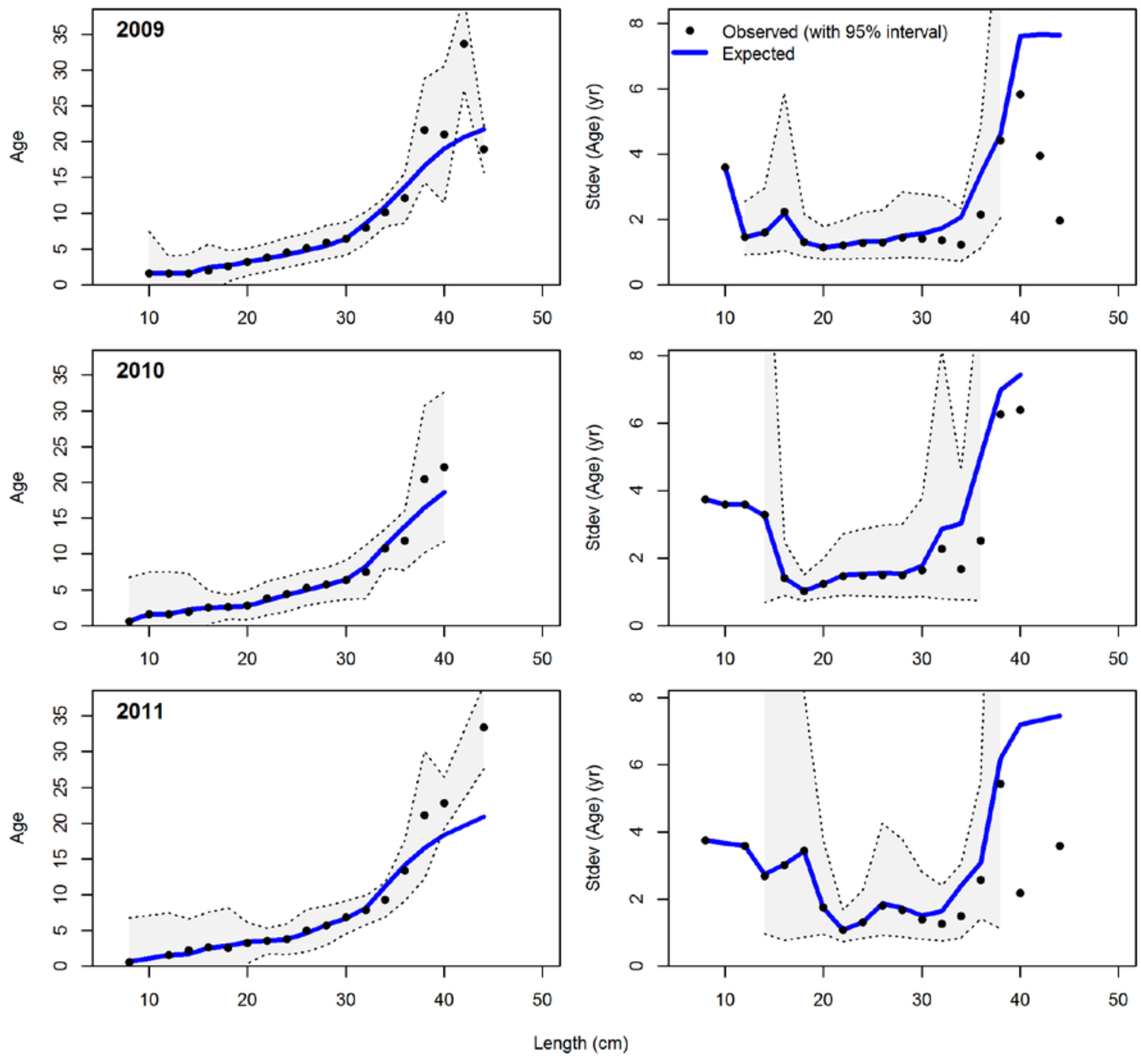

Figure 97 (continued): Fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

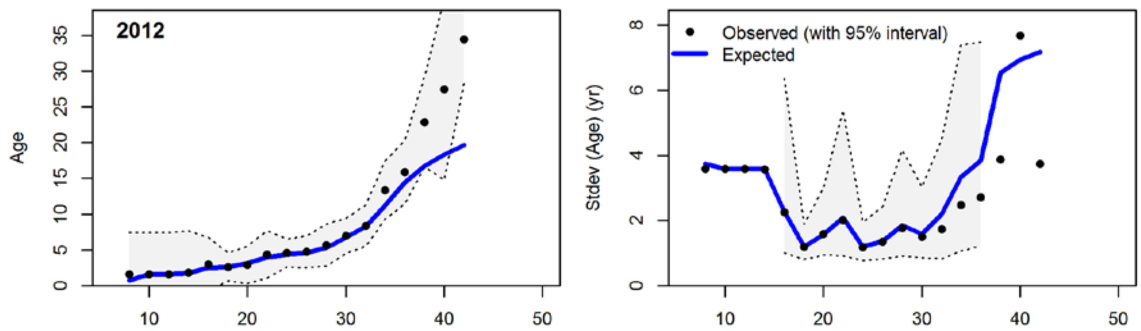

Figure 97 (continued): Fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

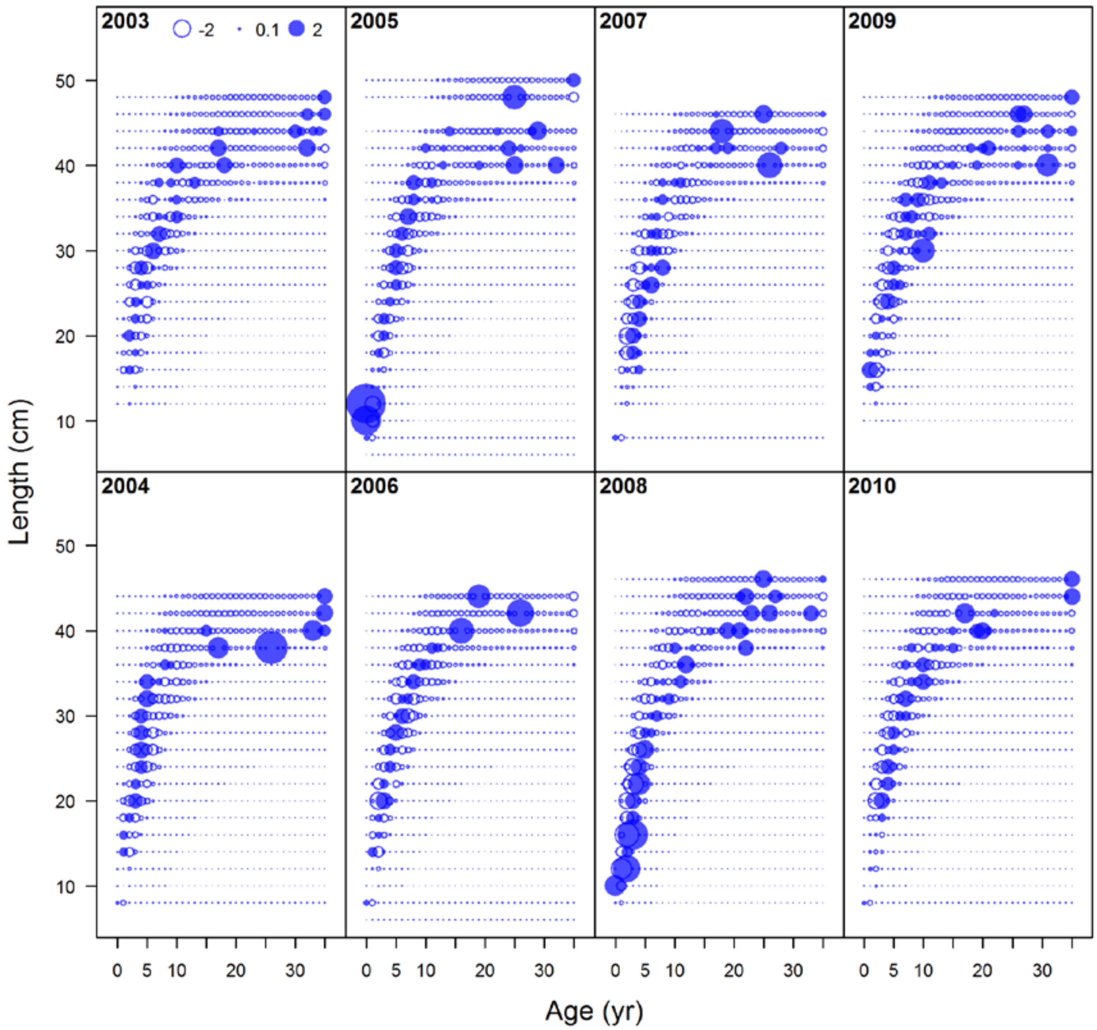

Figure 98: Pearson residuals for the fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

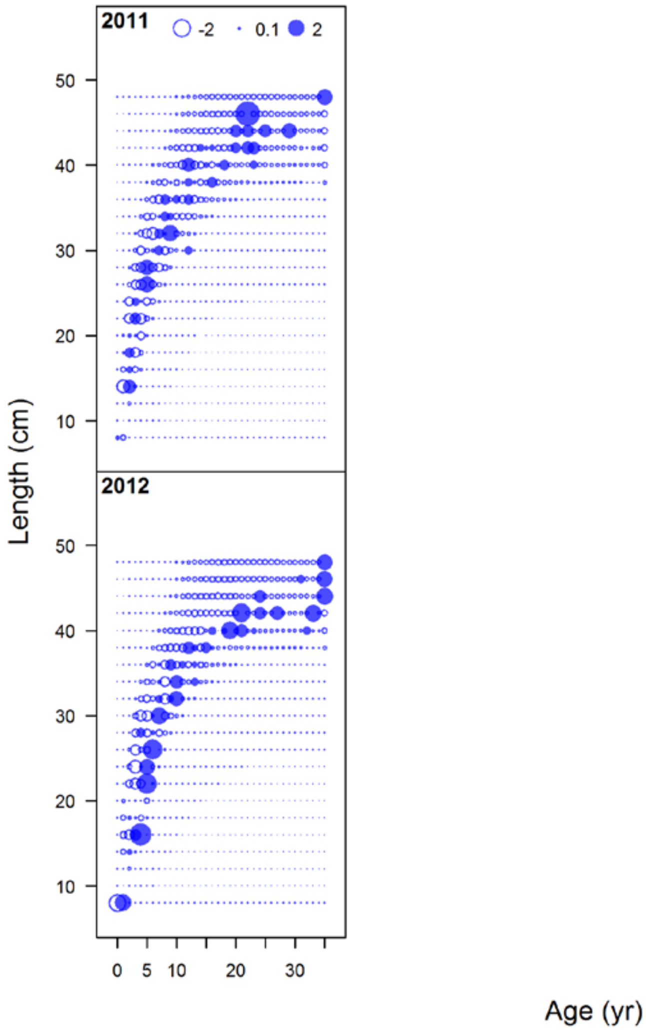

Figure 98 (continued): Pearson residuals for the fit to conditional ages-at-length compositions of female darkblotched rockfish from the NWFSC shelf-slope survey.

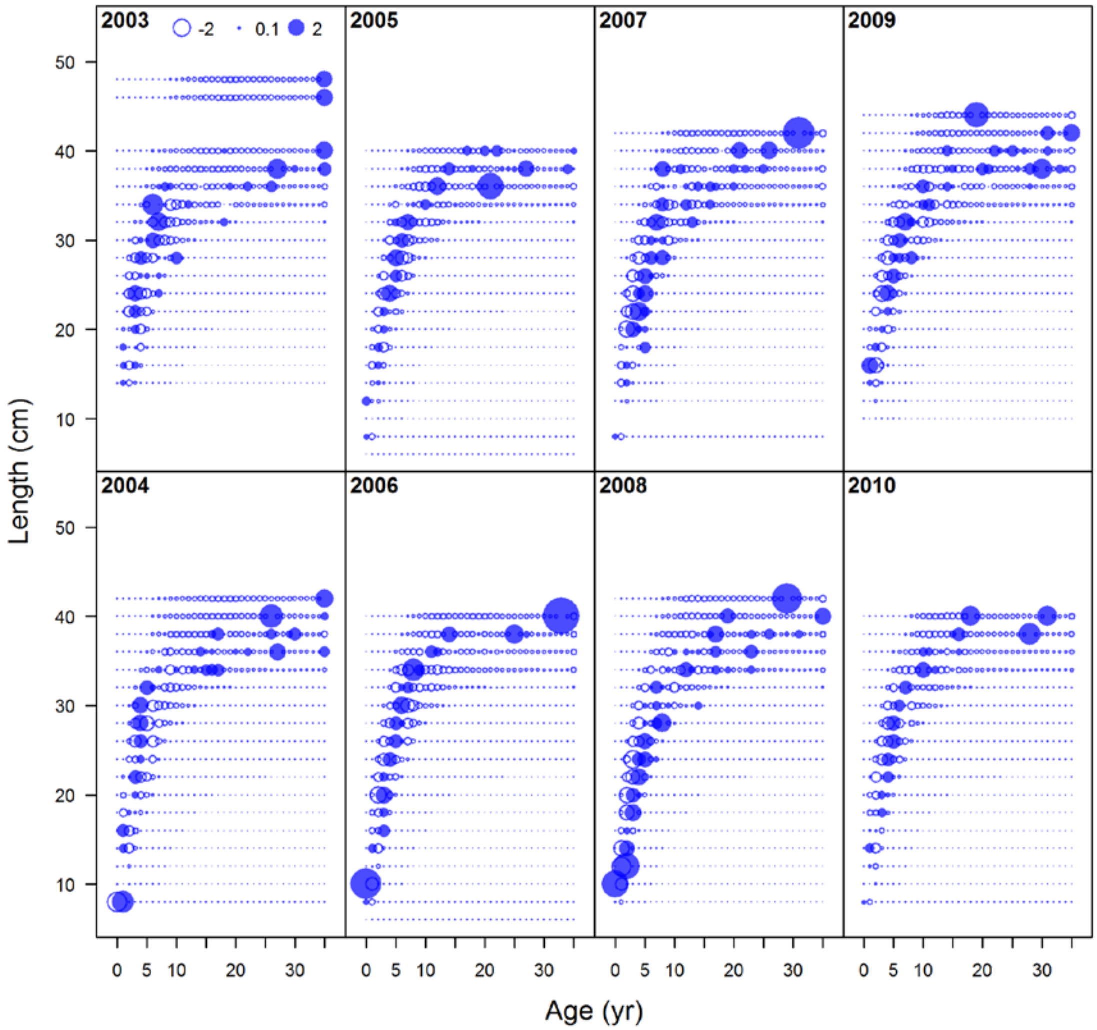

Figure 99: Pearson residuals for the fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

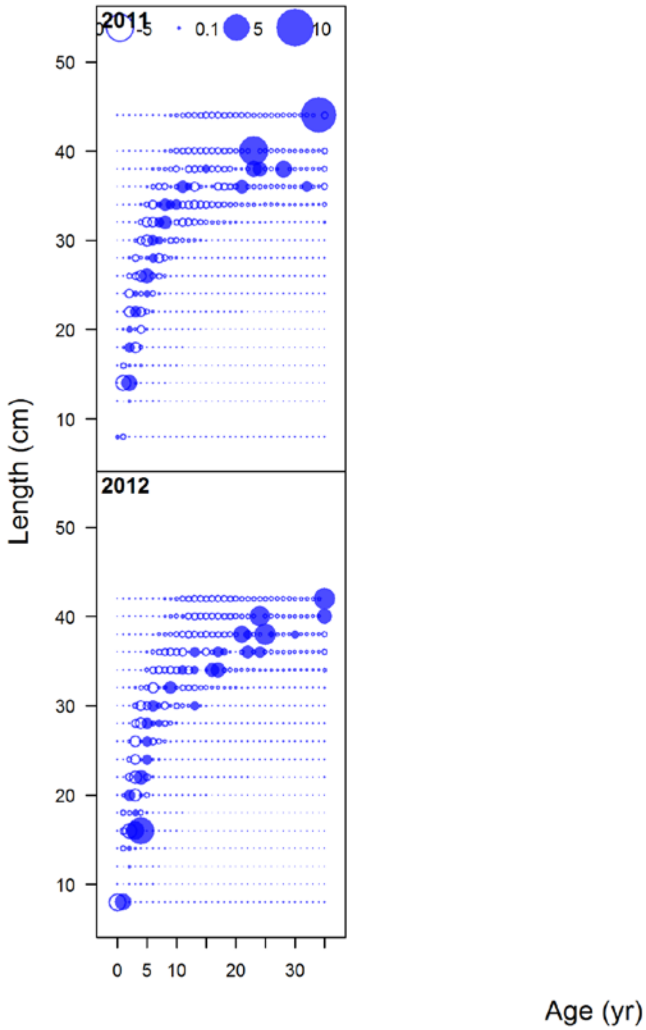

Figure 99 (continued): Pearson residuals for the fit to conditional ages-at-length compositions of male darkblotched rockfish from the NWFSC shelf-slope survey.

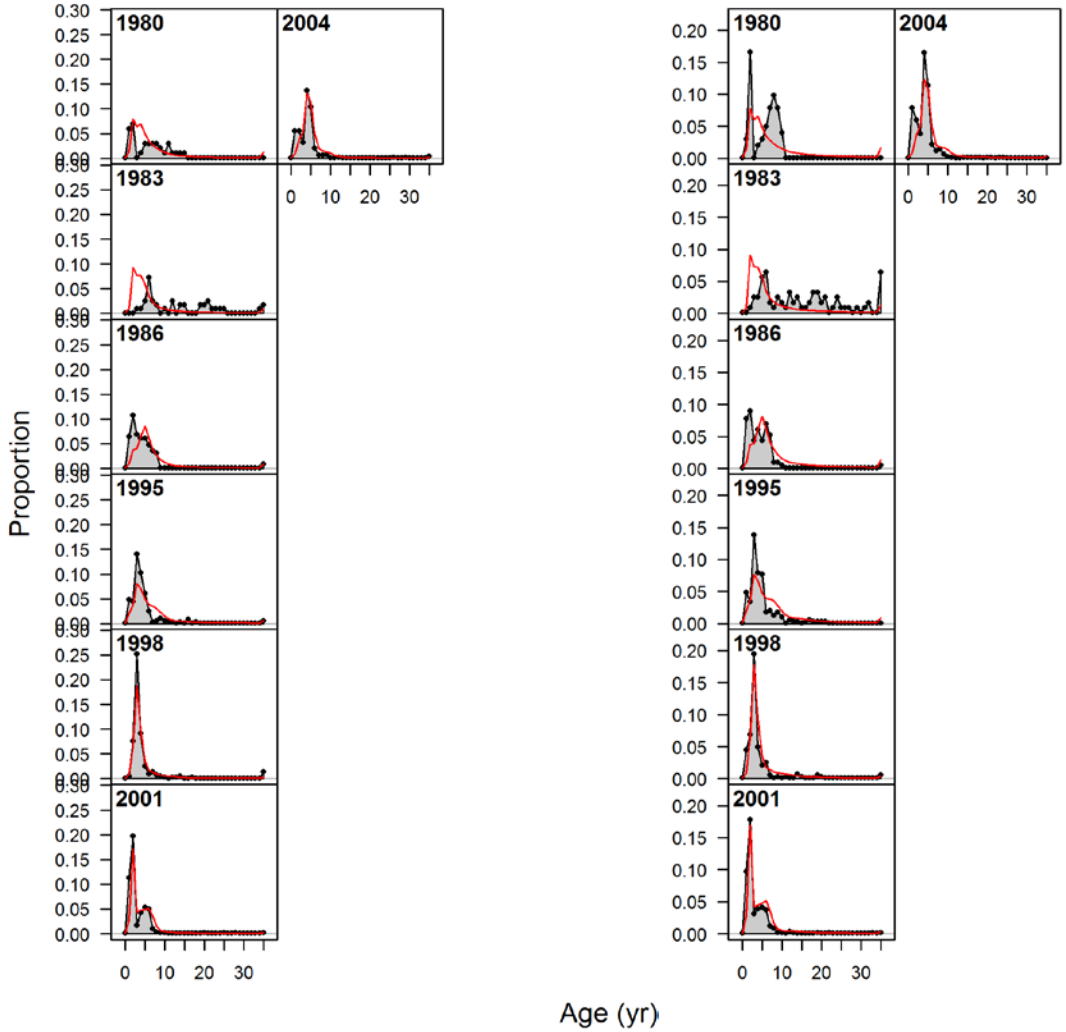

Figure 100: Implied fit to conditional ages-at-length compositions of female (left panel) and male (right panel) darkblotched rockfish from the AFSC shelf survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

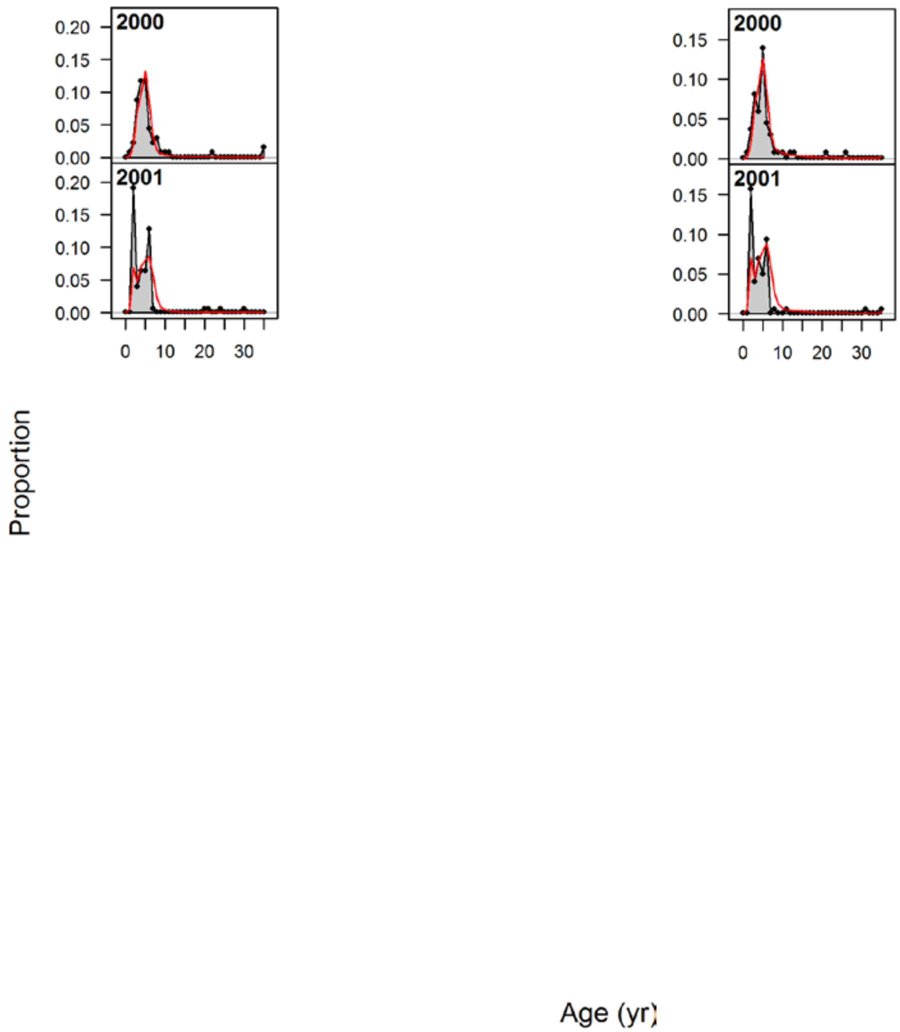

Figure 101: Implied fit to conditional ages-at-length compositions of female (left panel) and male (right panel) darkblotched rockfish from the AFSC slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

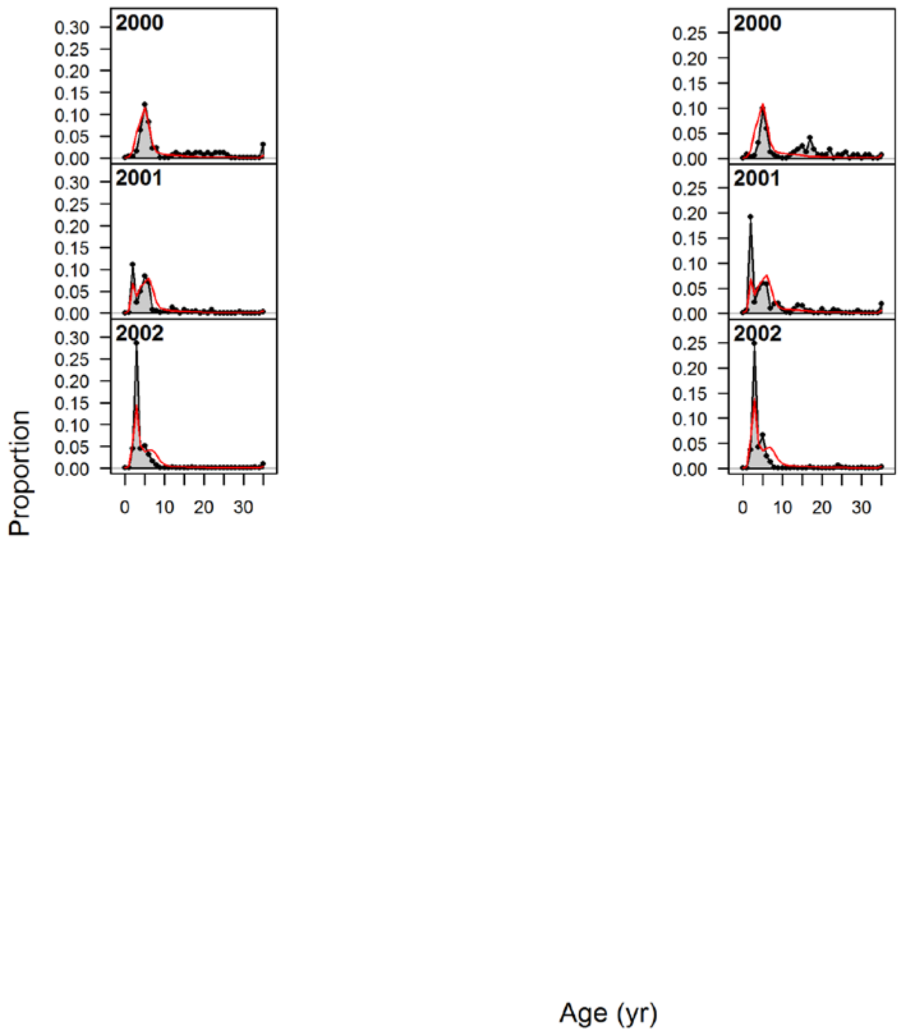

Figure 102: Implied fit to conditional ages-at-length compositions of female (left panel) and male (right panel) darkblotched rockfish from the NWFSC slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

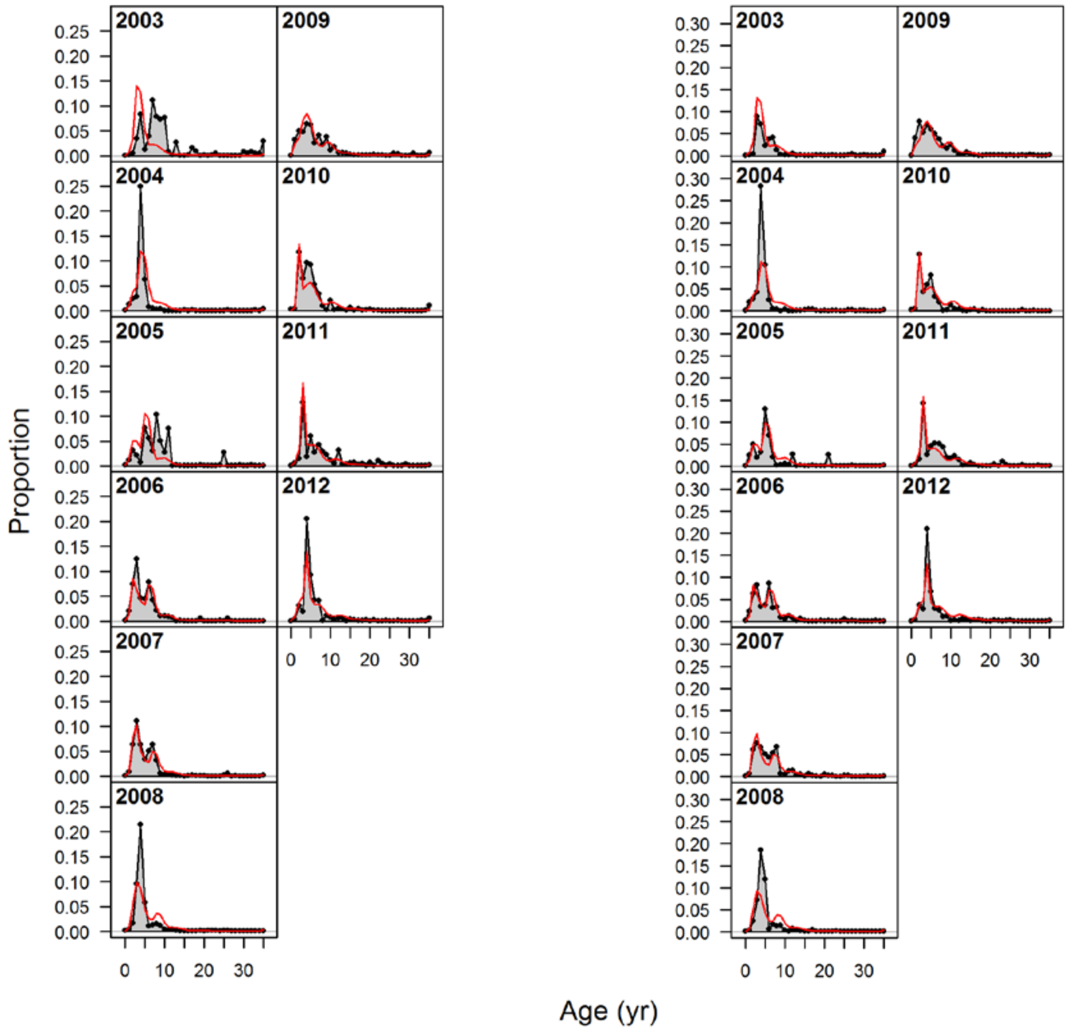

Figure 103: Implied fit to conditional ages-at-length compositions of female (left panel) and male (right panel) darkblotched rockfish from the NWFSC shelf-slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

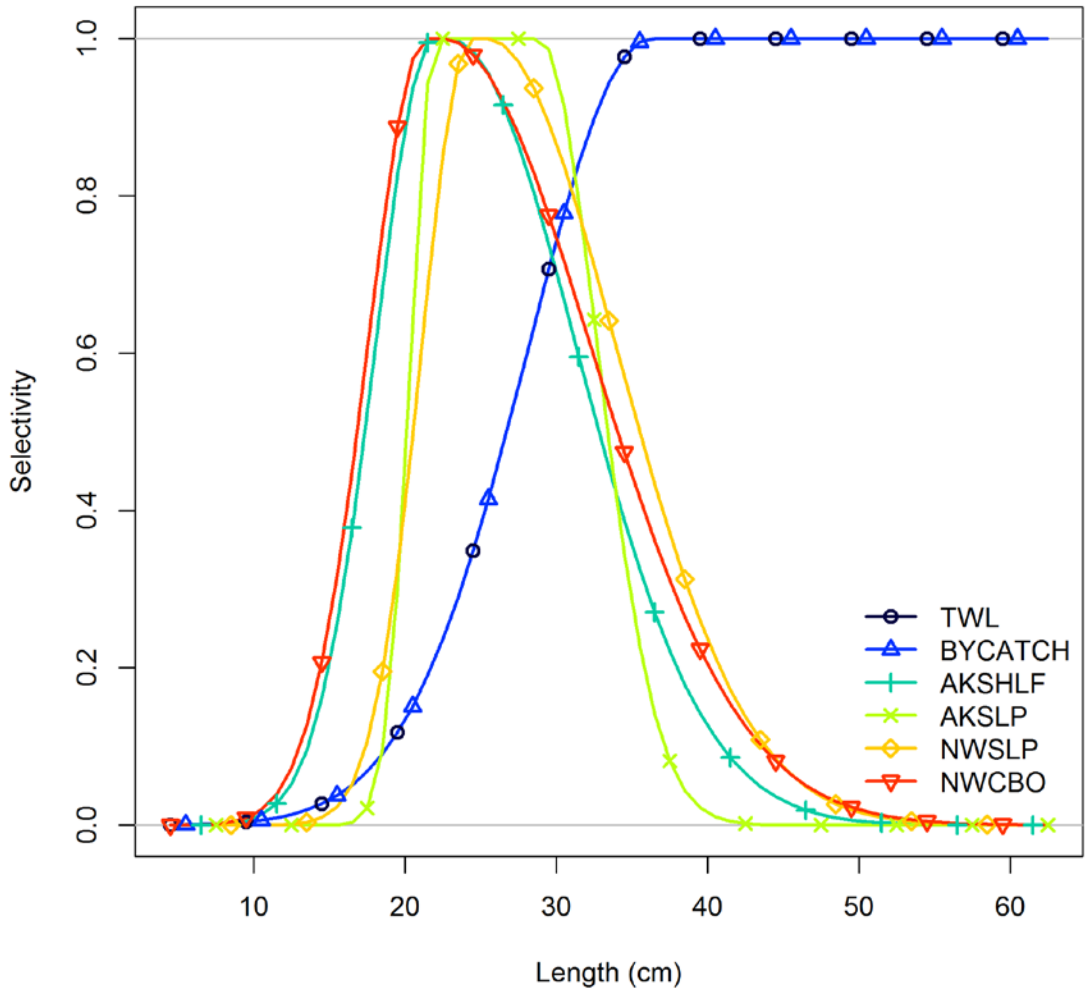

Figure 104: Length-based selectivity curves estimated for the all fleets used in the assessment.

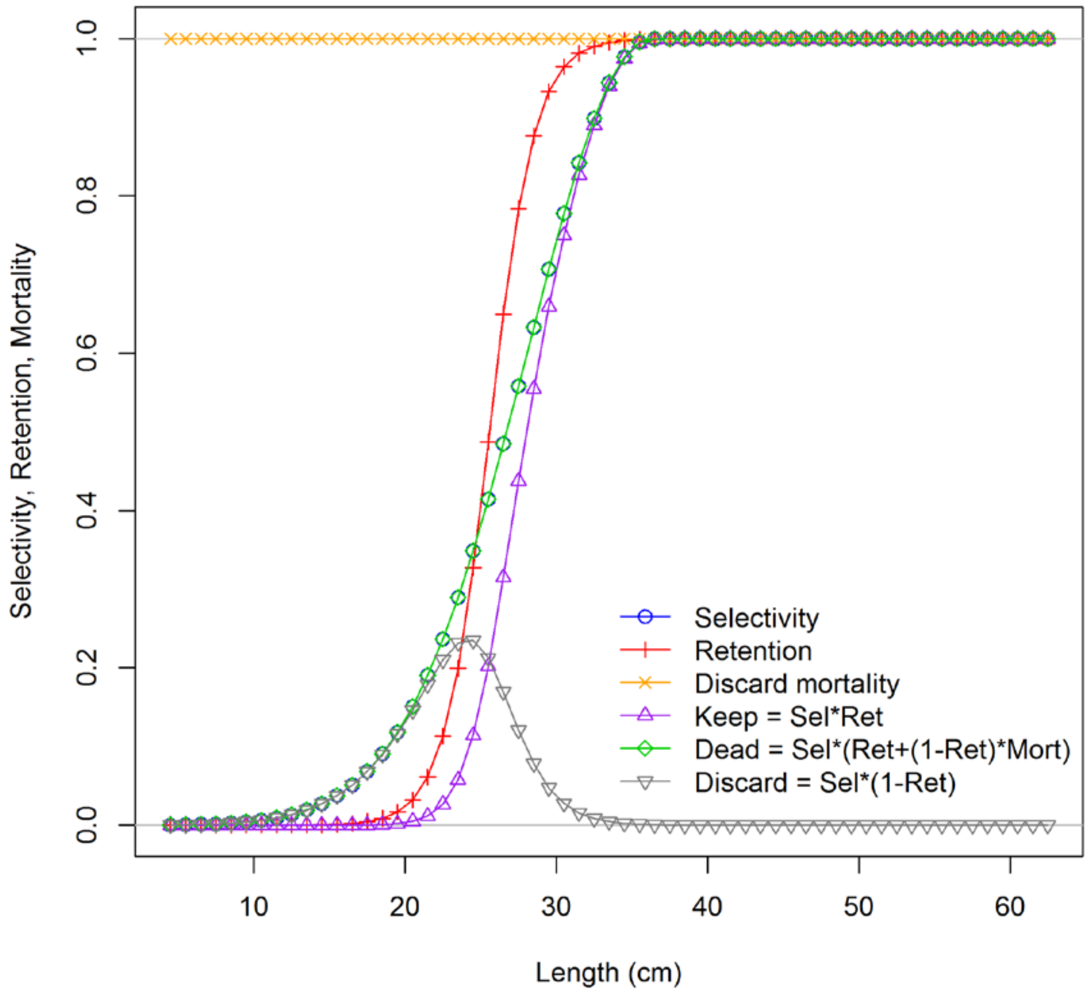

Figure 105: Estimated 2012 length-based selectivity, retention and discard mortality curves for the domestic trawl fishery.

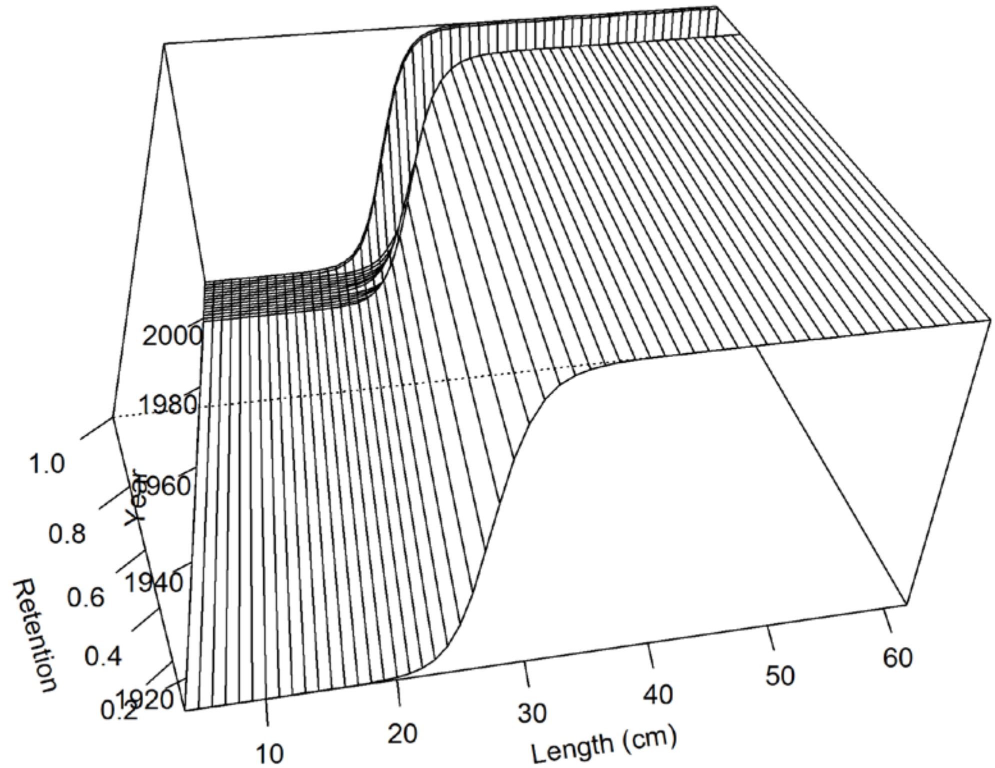

Figure 106: Estimated time-varying length-based retention of domestic trawl fishery.

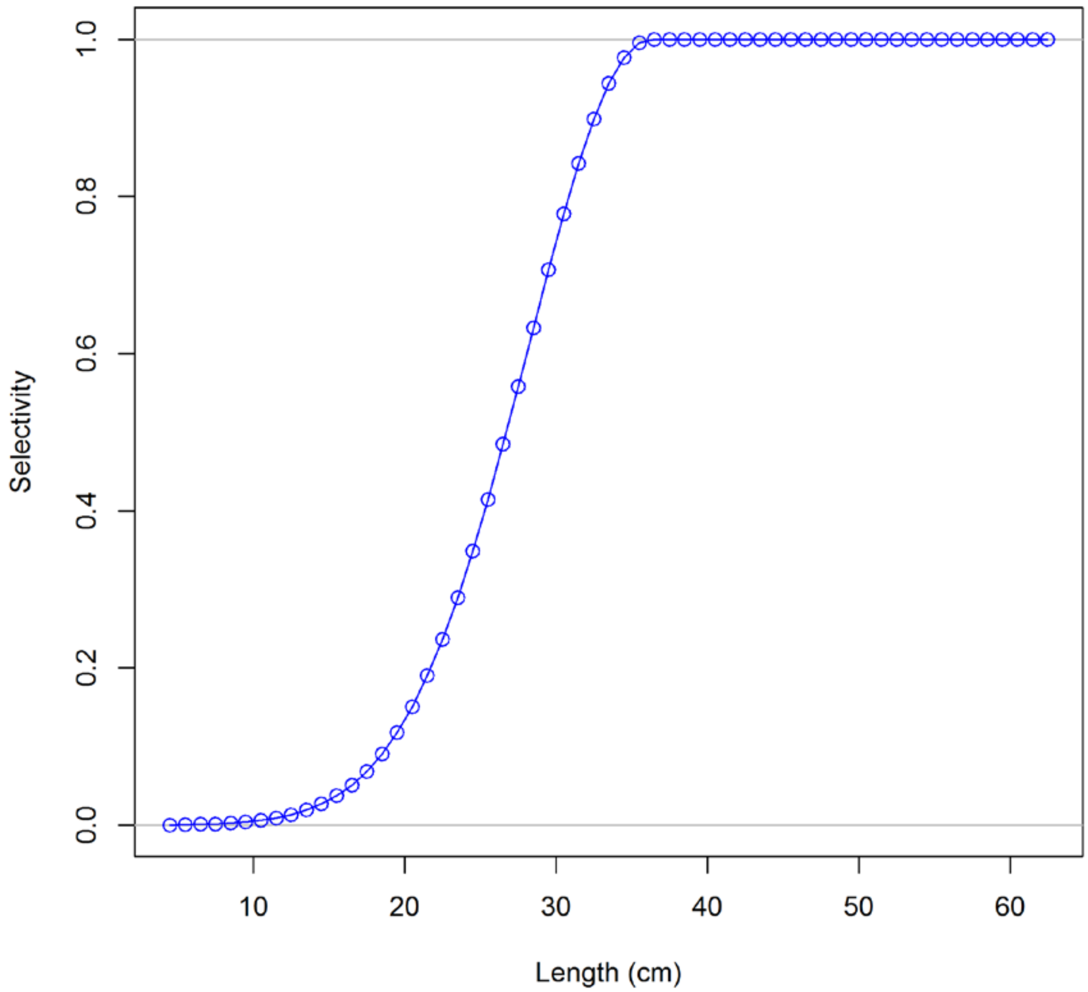

Figure 107: Length-based selectivity curve for bycatch fleet, mirrored to selectivity curve of domestic trawl fishery in the assessment.

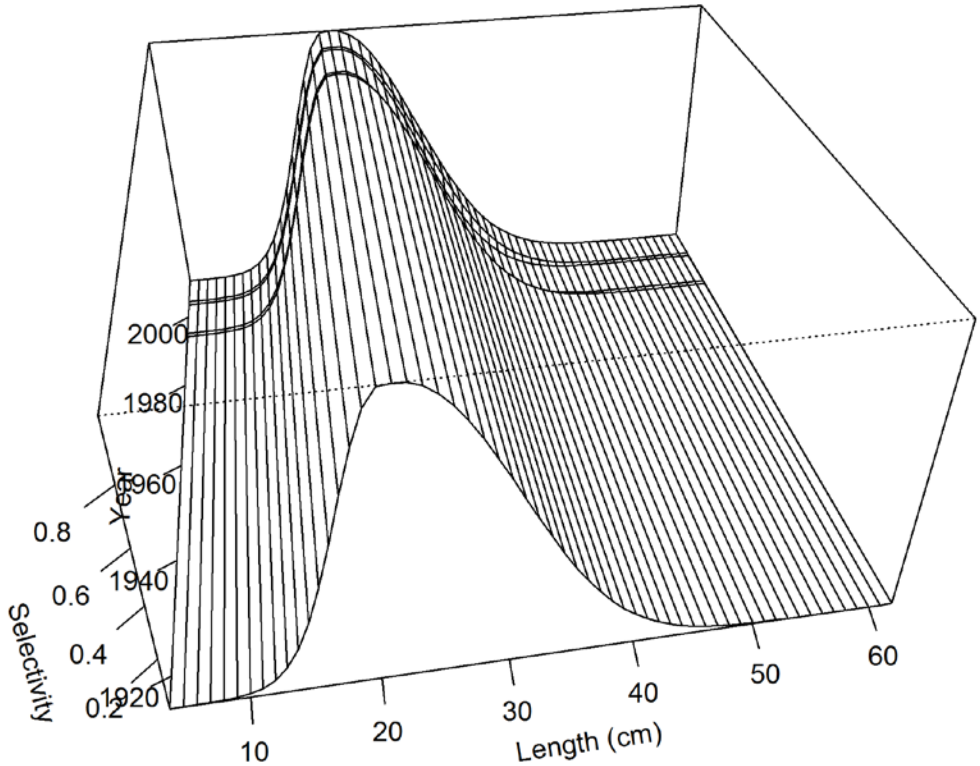

Figure 108: Estimated time-varying length-based selectivity curve for the AFSC shelf survey.

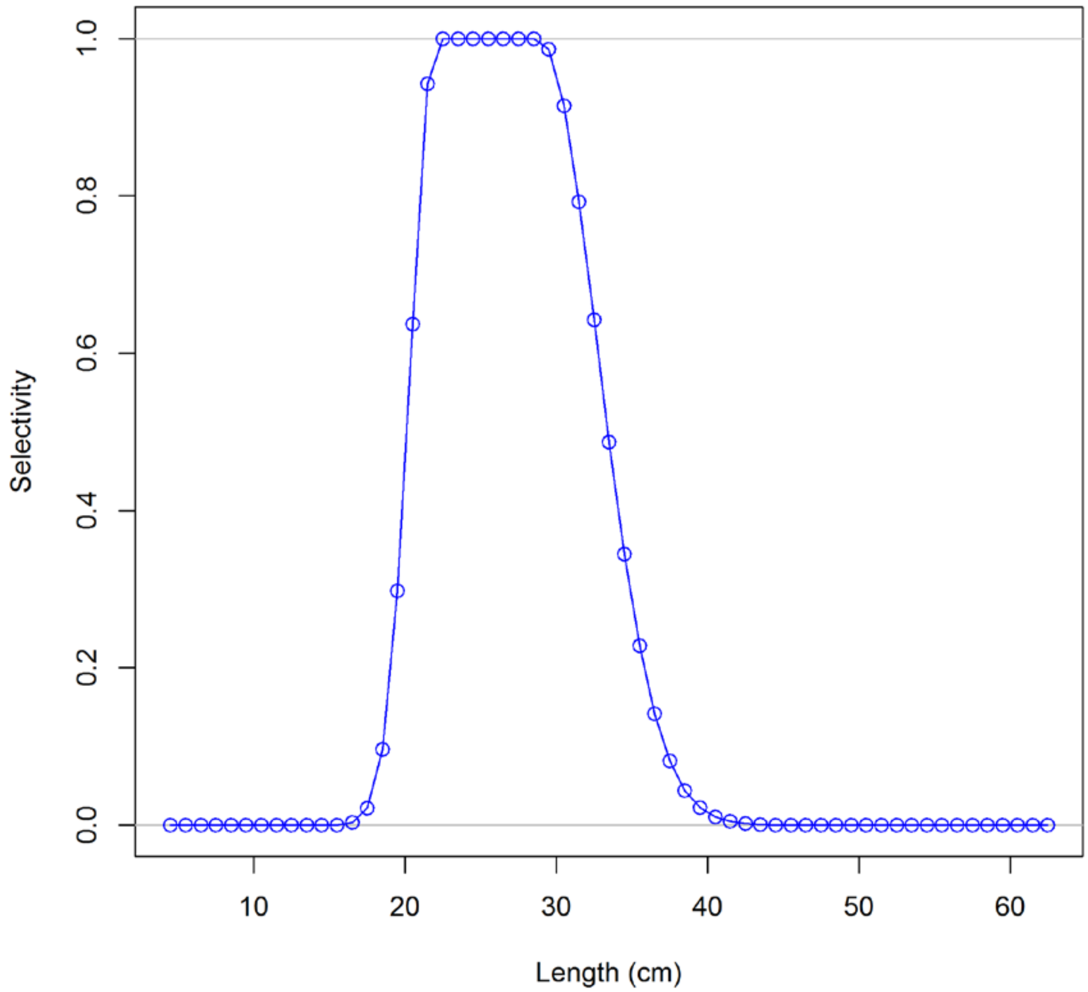

Figure 109: Estimated length-based selectivity curve for the AFSC slope survey.

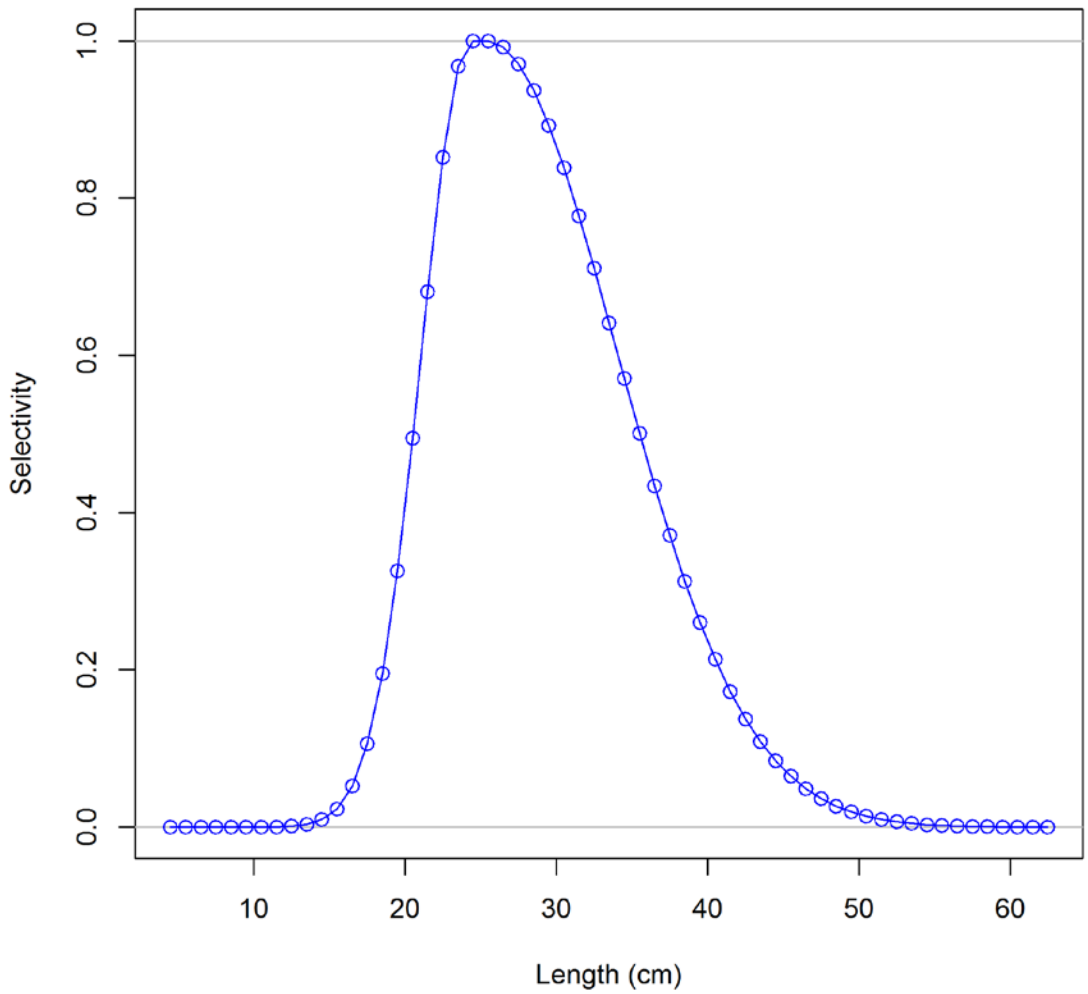

Figure 110: Estimated length-based selectivity curve for the NWFSC slope survey.

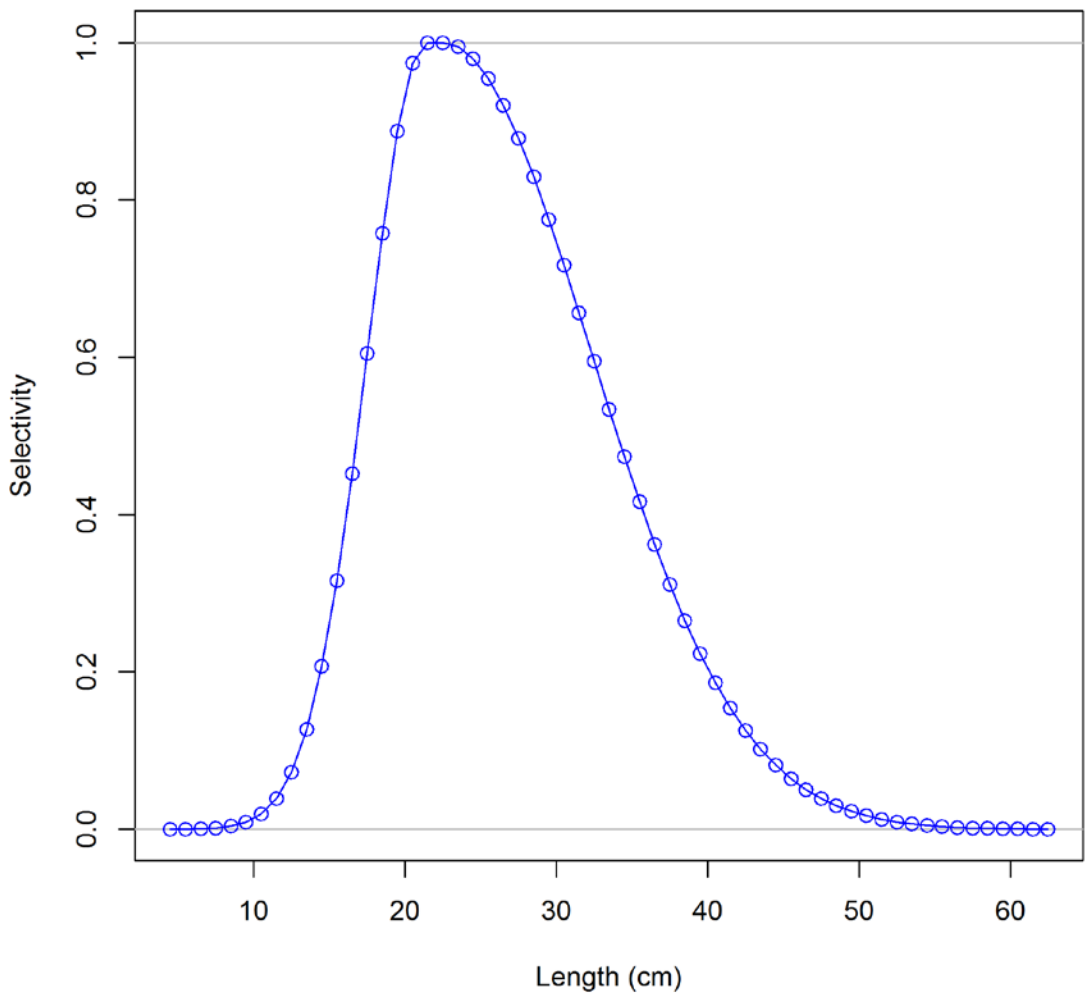

Figure 111: Estimated length-based selectivity curve for the NWFSC shelf-slope survey.

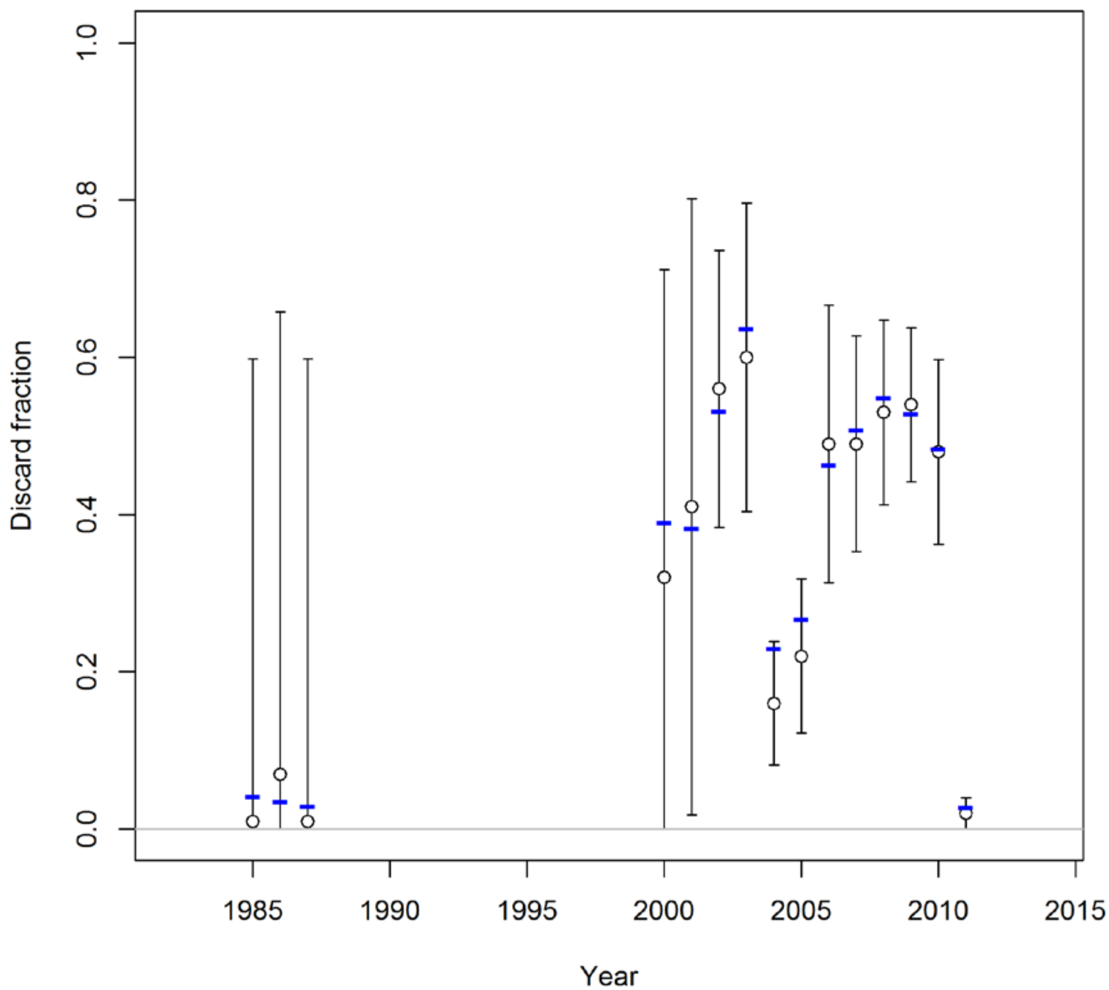

Figure 112: Fit to the discard ratio data of the domestic trawl fishery.

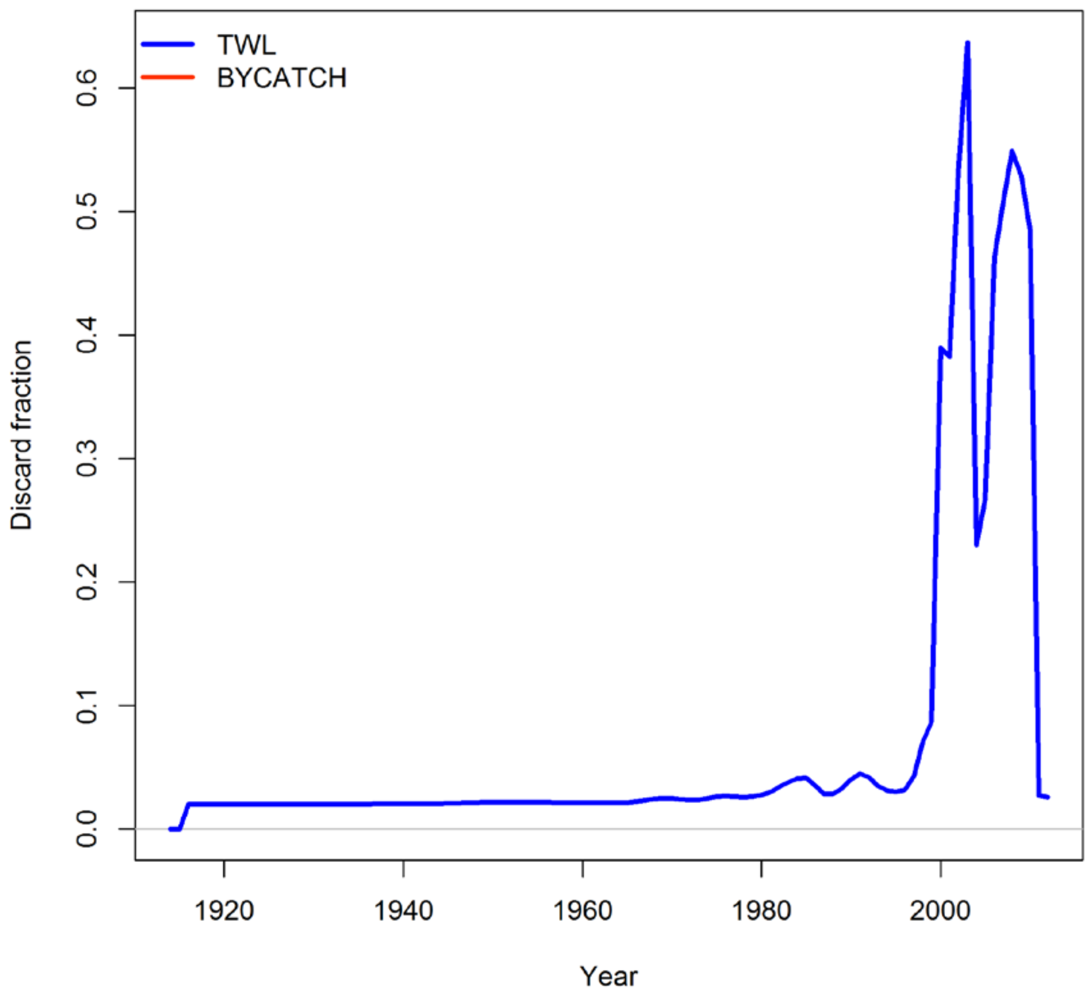

Figure 113: Discard fraction for the domestic trawl fishery estimated in the assessment.

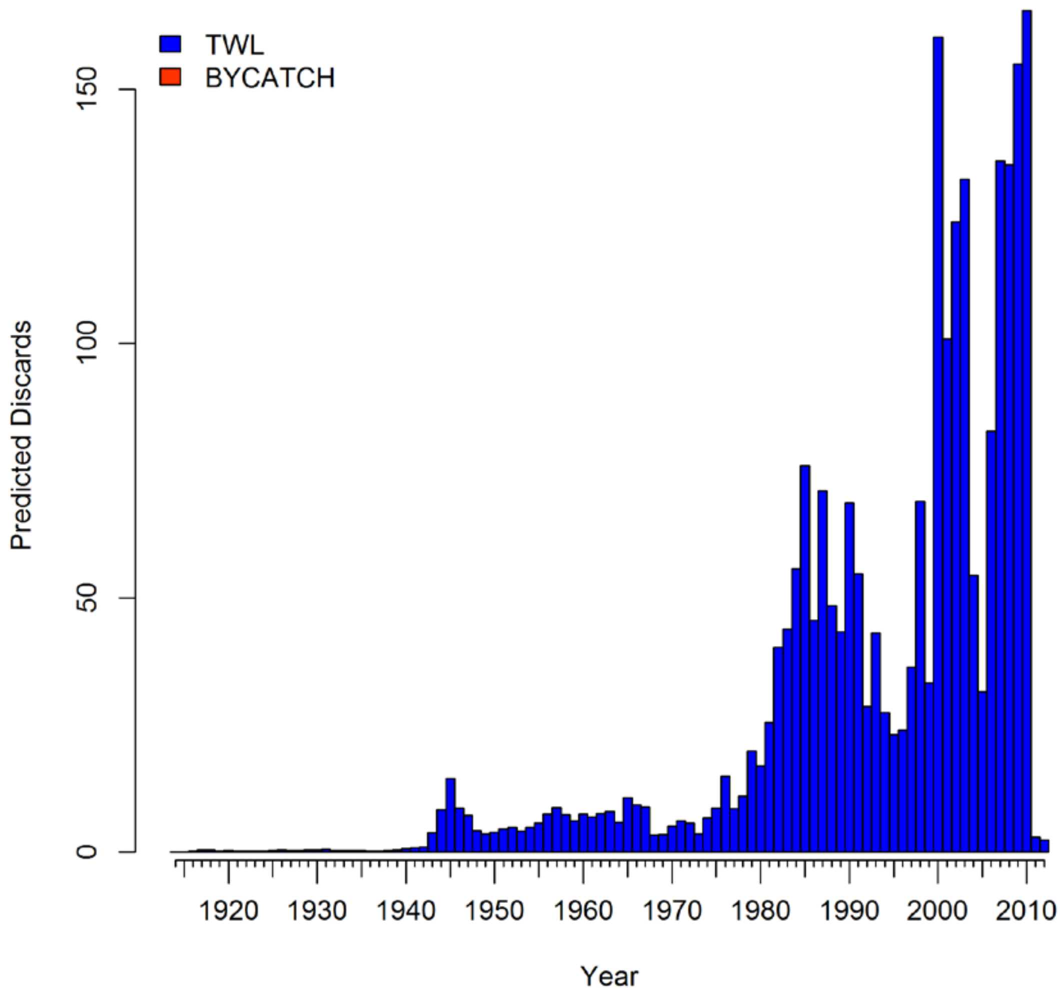

Figure 114: Predicted discard for the domestic trawl fishery.

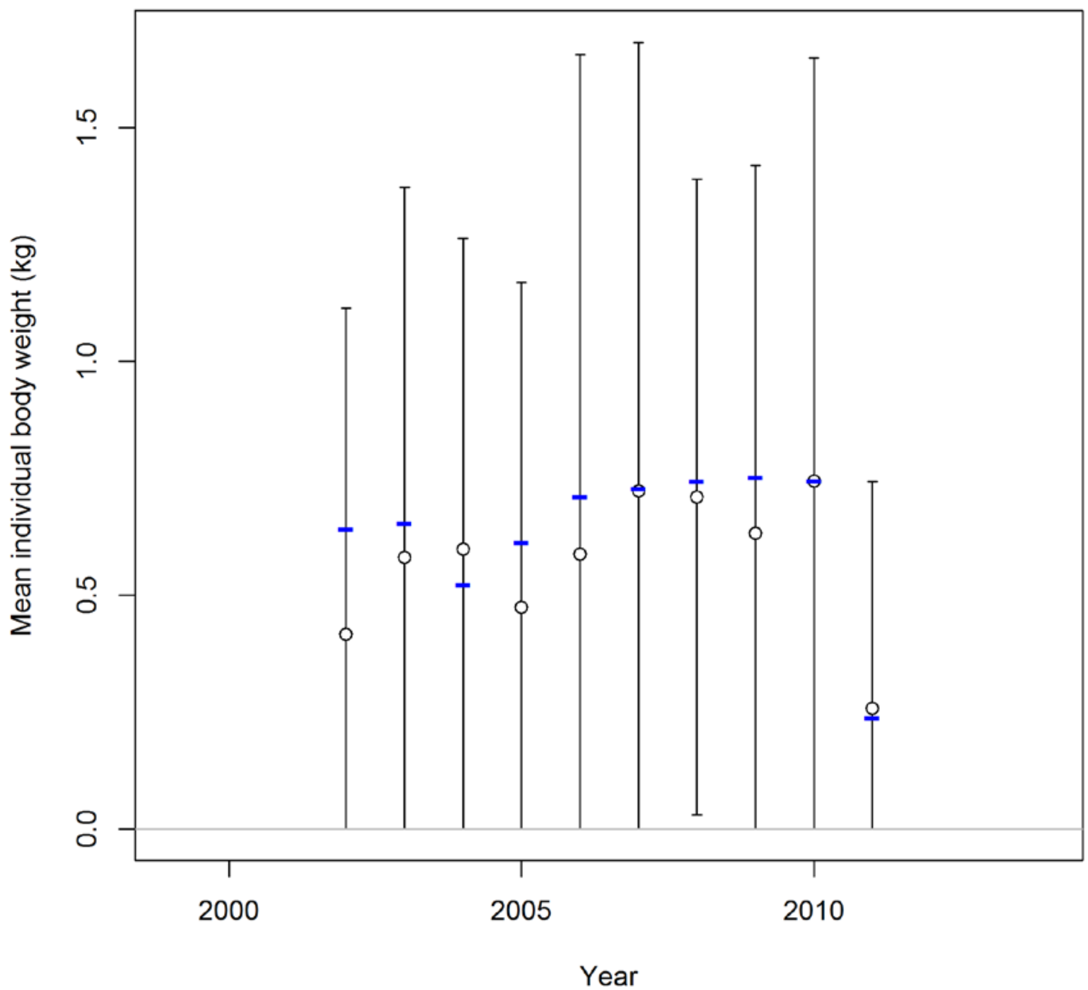

Figure 115: Fit to the mean body weight data for the domestic trawl fishery discard**.**

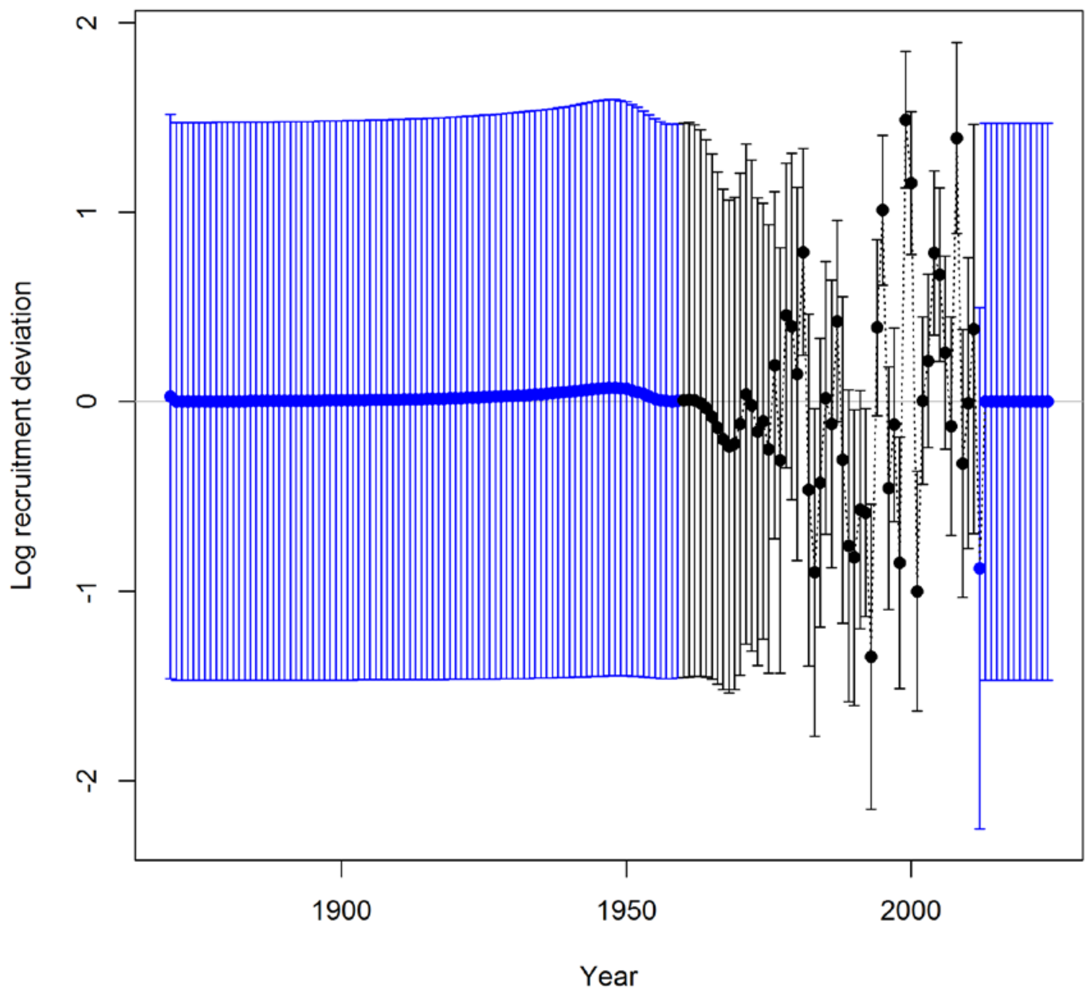

Figure 116: Recruitment deviation time-series estimated in the assessment model.

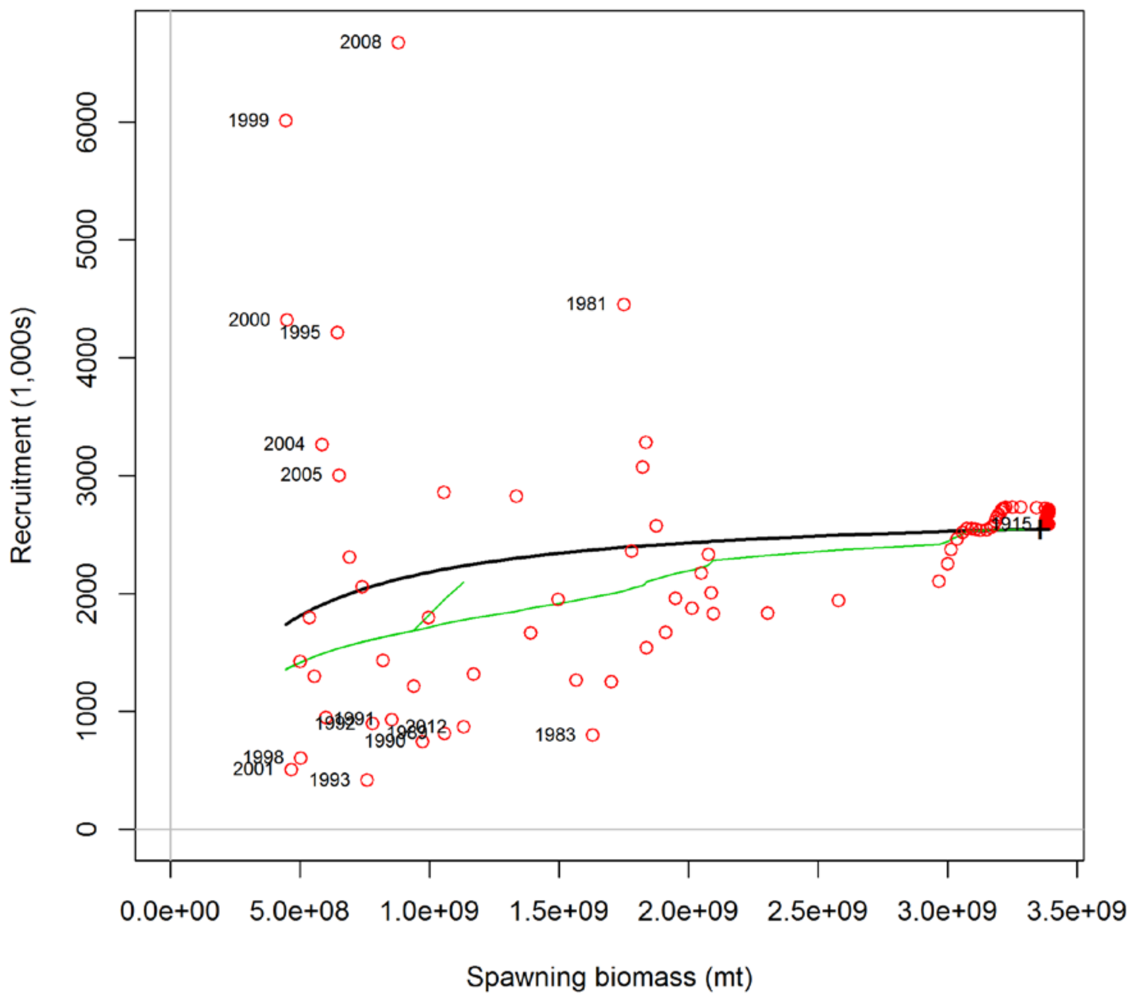

Figure 117: Estimated stock-recruit function for the assessment model.

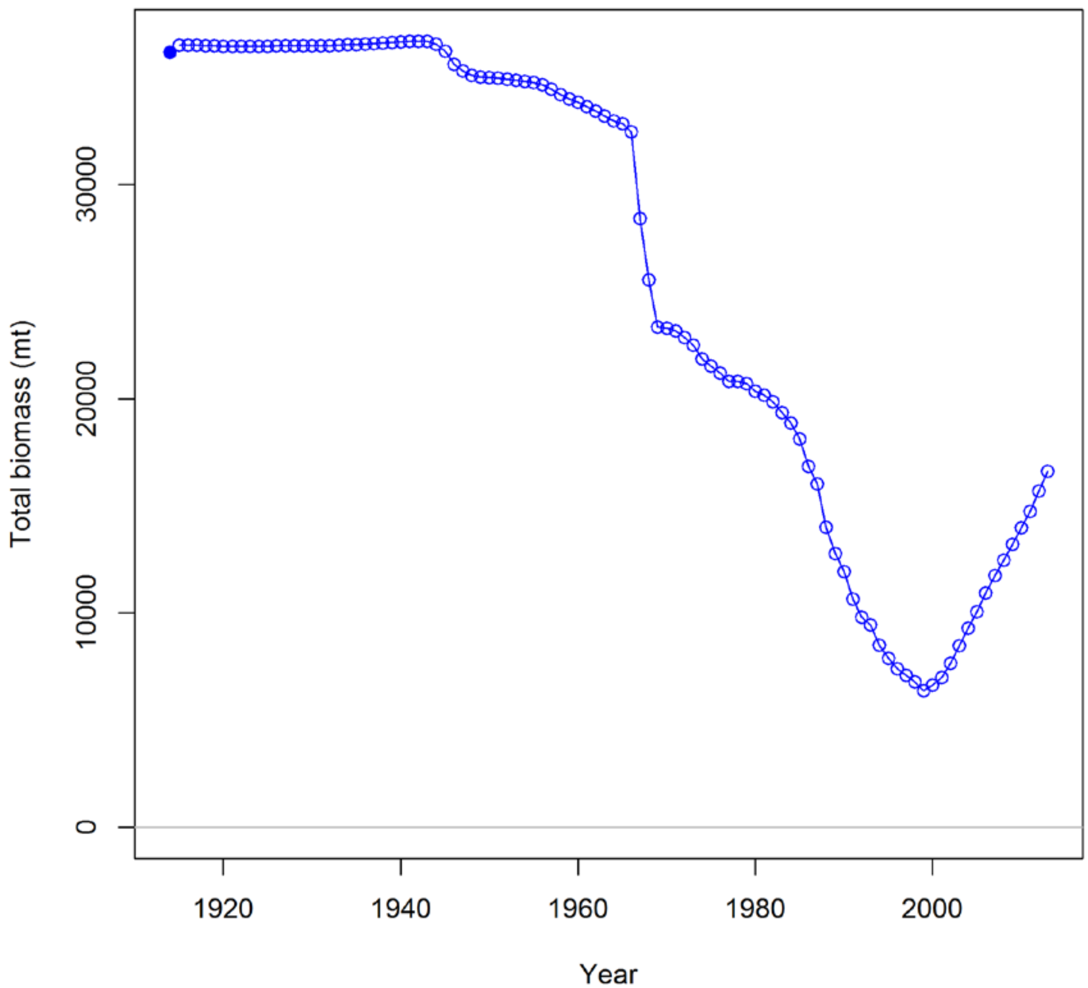

Figure 118: Time series of total biomass (mt) estimated in the assessment model.

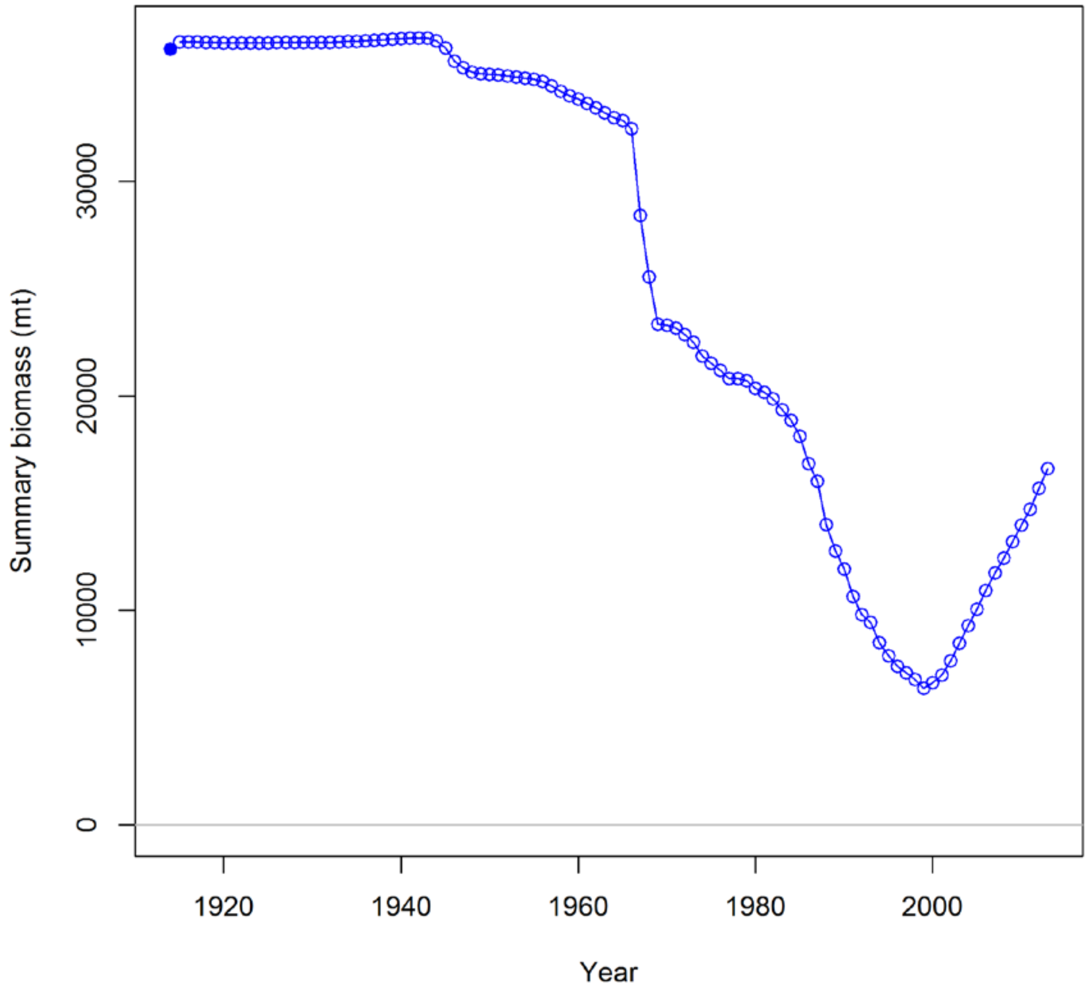

Figure 119: Time series of summary biomass (mt) estimated in the assessment model.

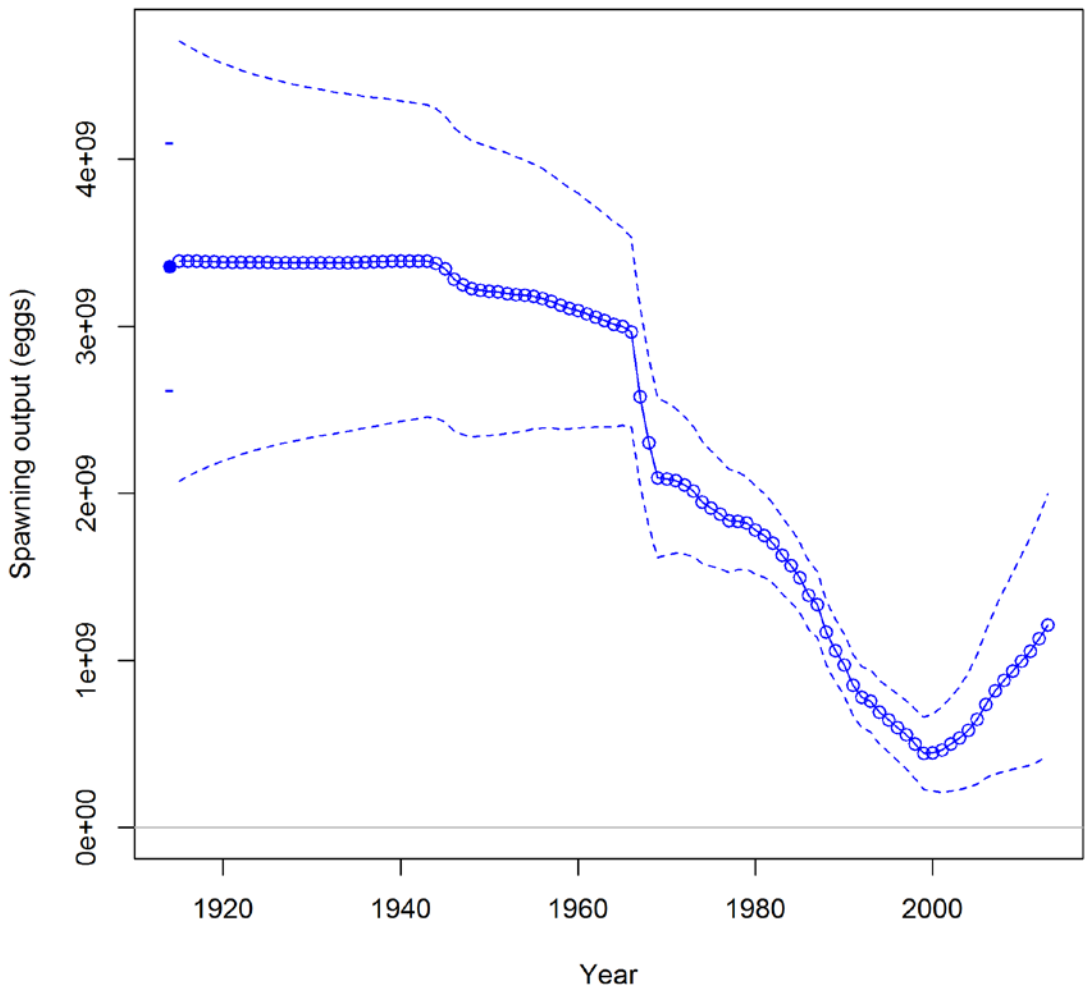

Figure 120: Time series of spawning output estimated in the assessment model (solid line) with ~ 95% interval (dashed lines).

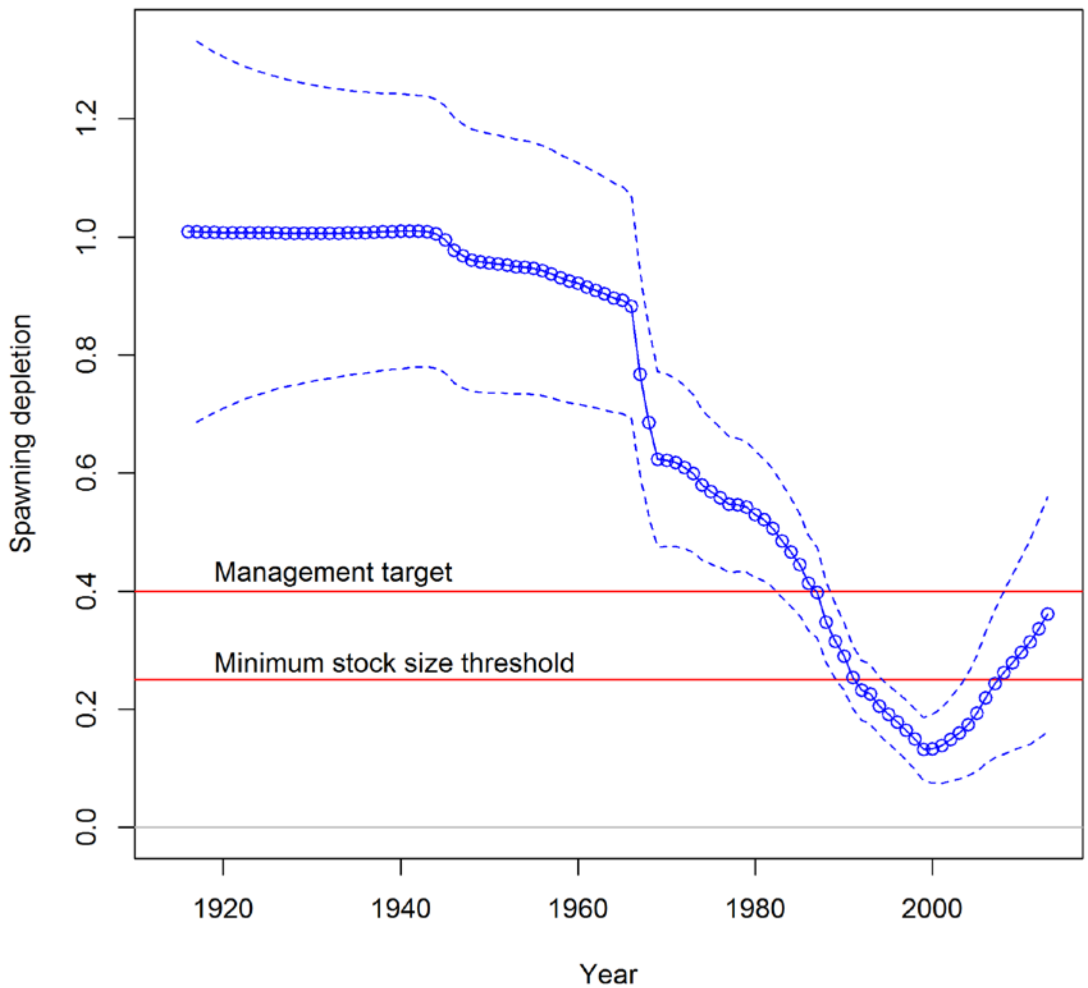

Figure 121: Time series of spawning depletion estimated in the assessment model (solid line) with ~ 95% interval (dashed lines).

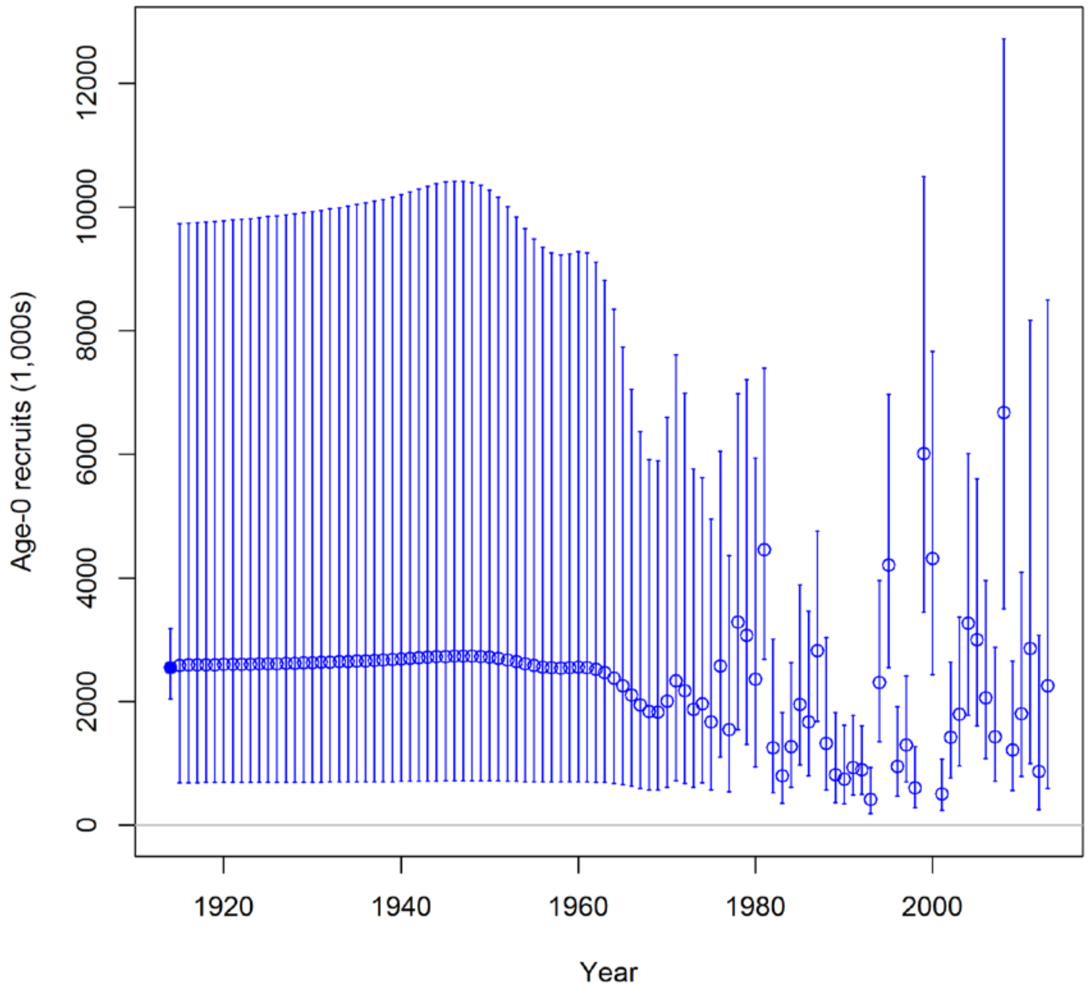

Figure 122: Time series of recruitment estimated in the assessment model with ~ 95% interval.

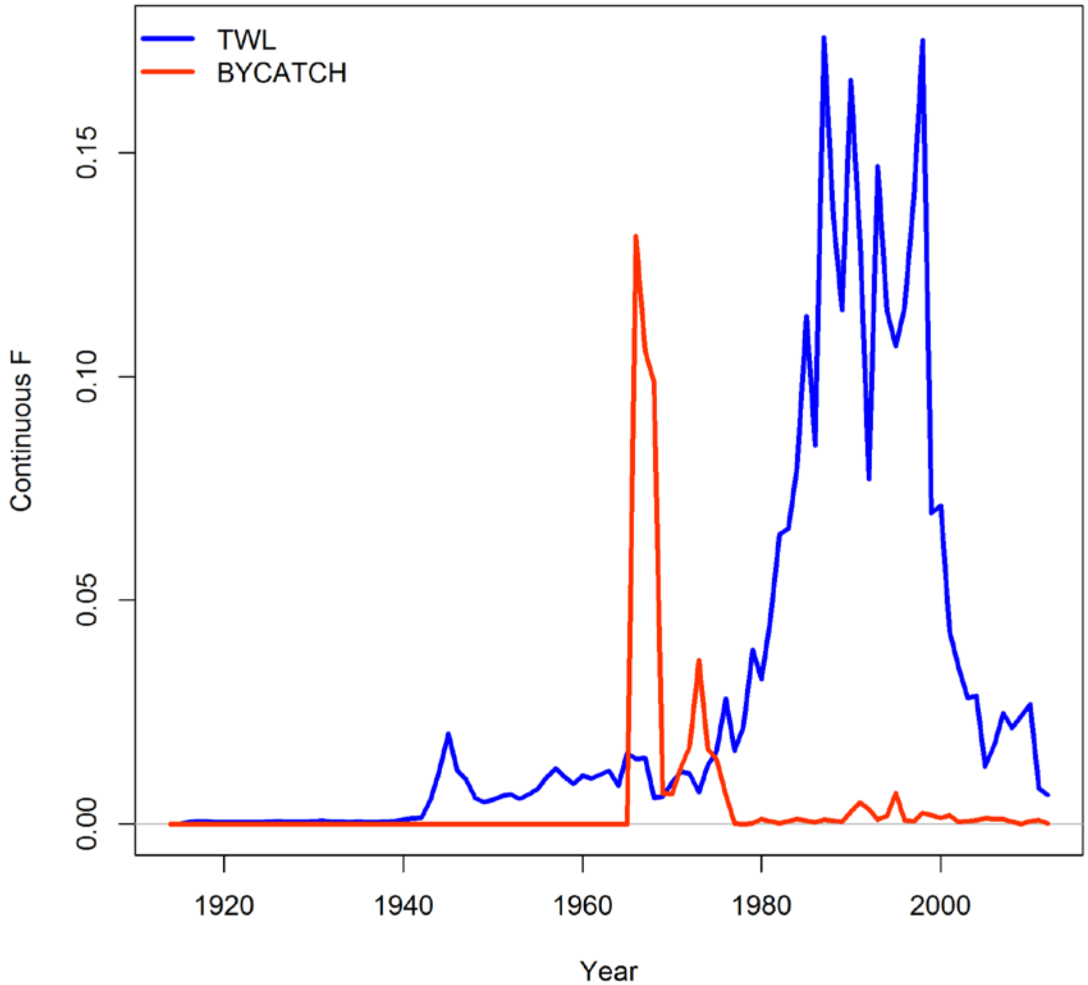

Figure 123: Time series of fishing mortality of darkblotched rockfih estimated by the assessment model.

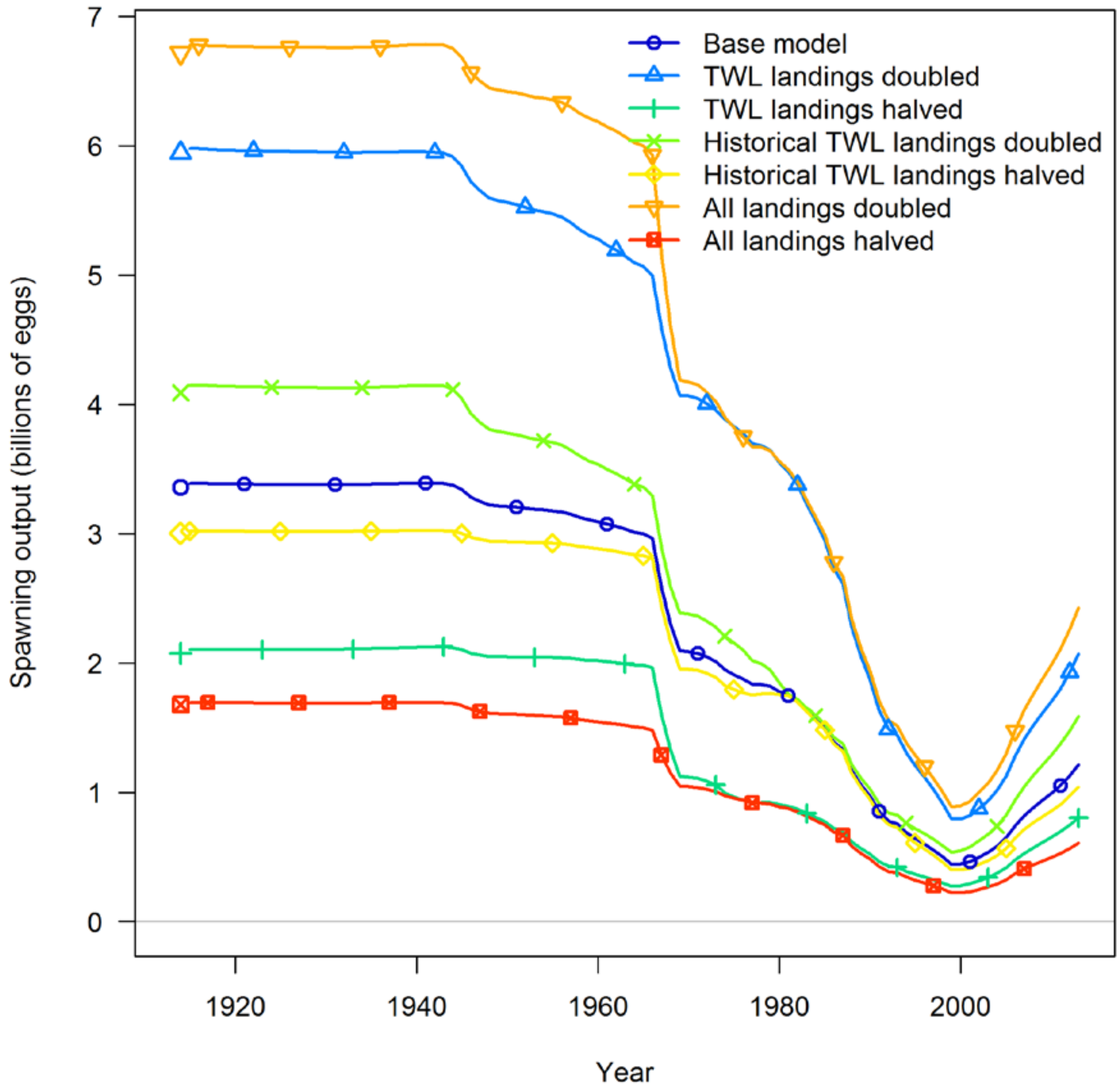

Figure 124: Sensitivity of darkblotched rockfish spawning output to alternative assumptions about fishery removals.

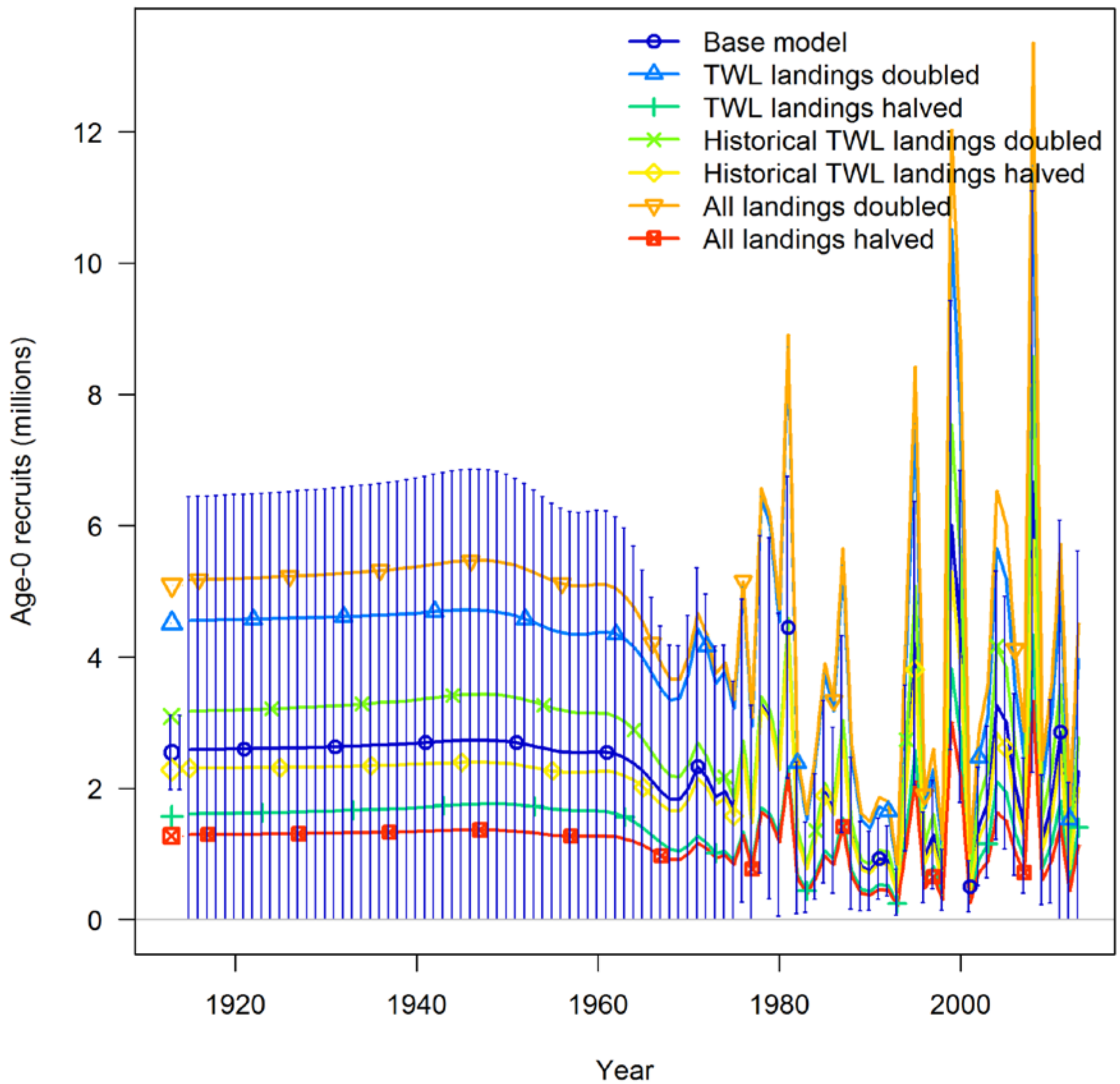

Figure 125: Sensitivity of darkblotched rockfish recruitment to alternative assumptions about fishery removals. Recruitment time series of this assessment are provided with ~ 95% interval.

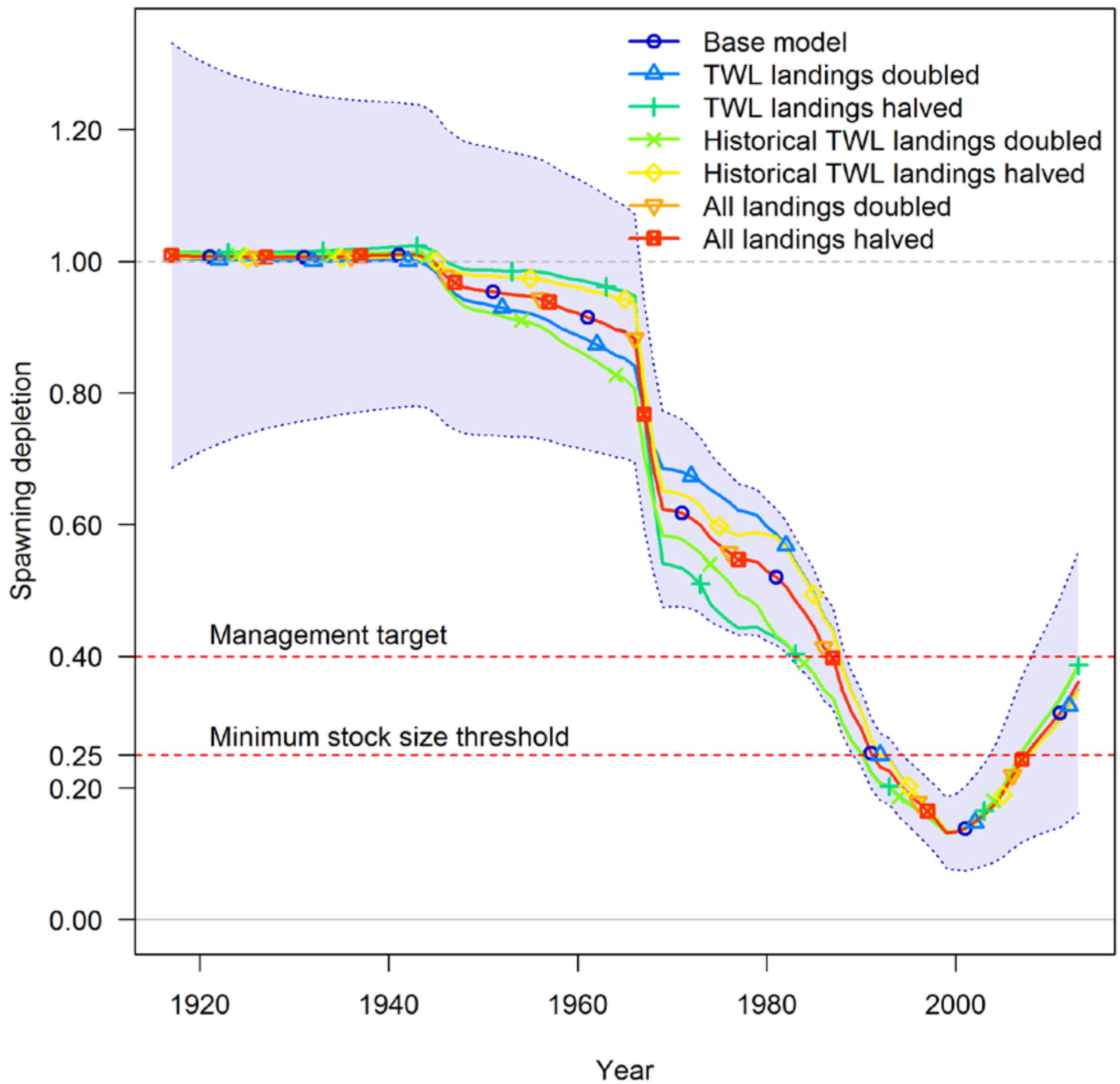

Figure 126: Sensitivity of darkblotched rockfish spawning depletion to alternative assumptions about fishery removals. Depletion time series of this assessment are provided with ~ 95% interval.

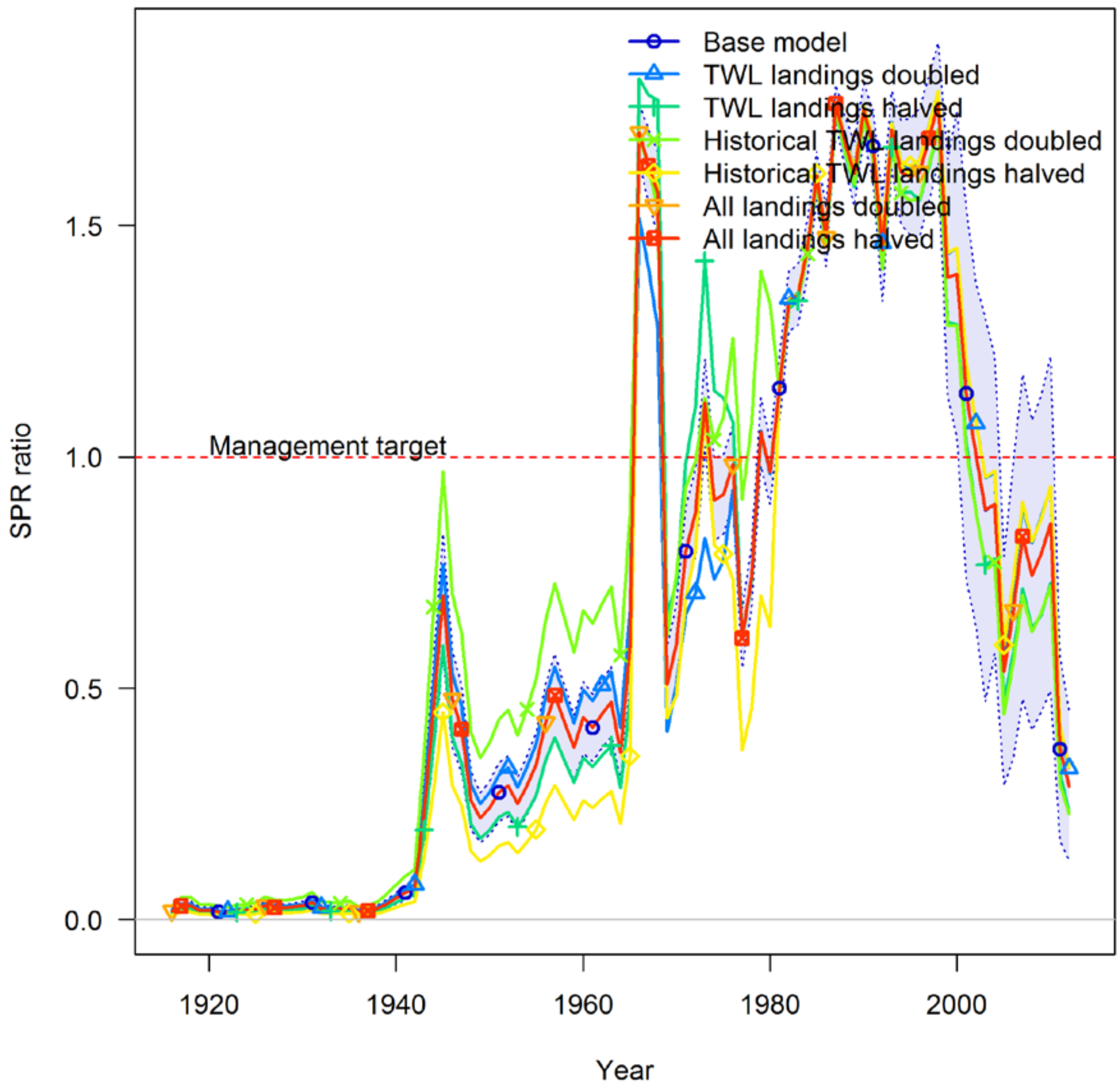

Figure 127: Sensitivity of darkblotched rockfish relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) to alternative assumptions about fishery removals. Relative SPR ratio time series of this assessment are provided with ~ 95% interval.

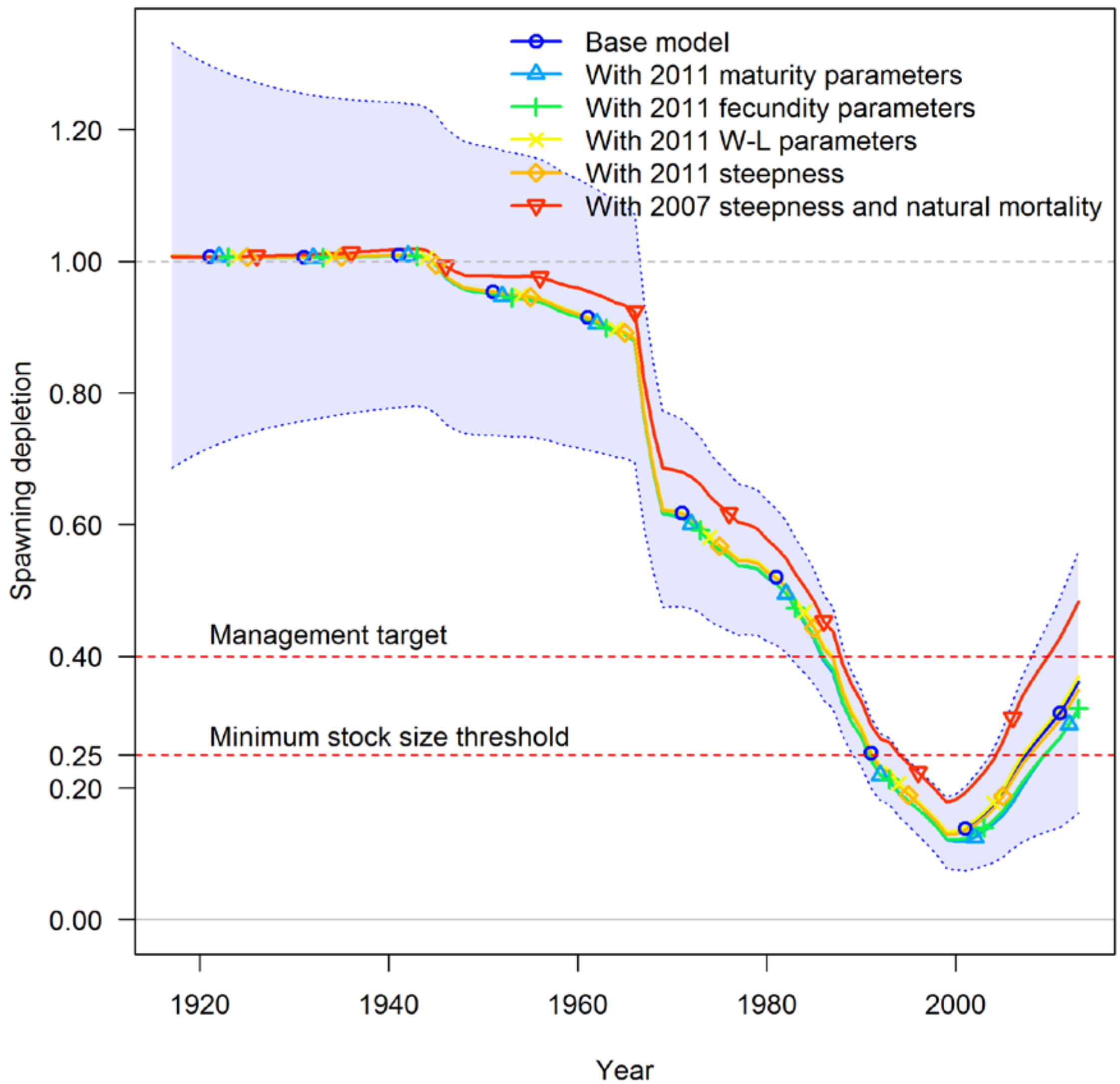

Figure 128: Sensitivity of darkblotched rockfish spawning depletion to updated maturity and fecundity parameters, weight-length relationships and stock-recruit steepness value (in combination with value for natural mortality). Depletion time series of this assessment are provided with ~ 95% interval.

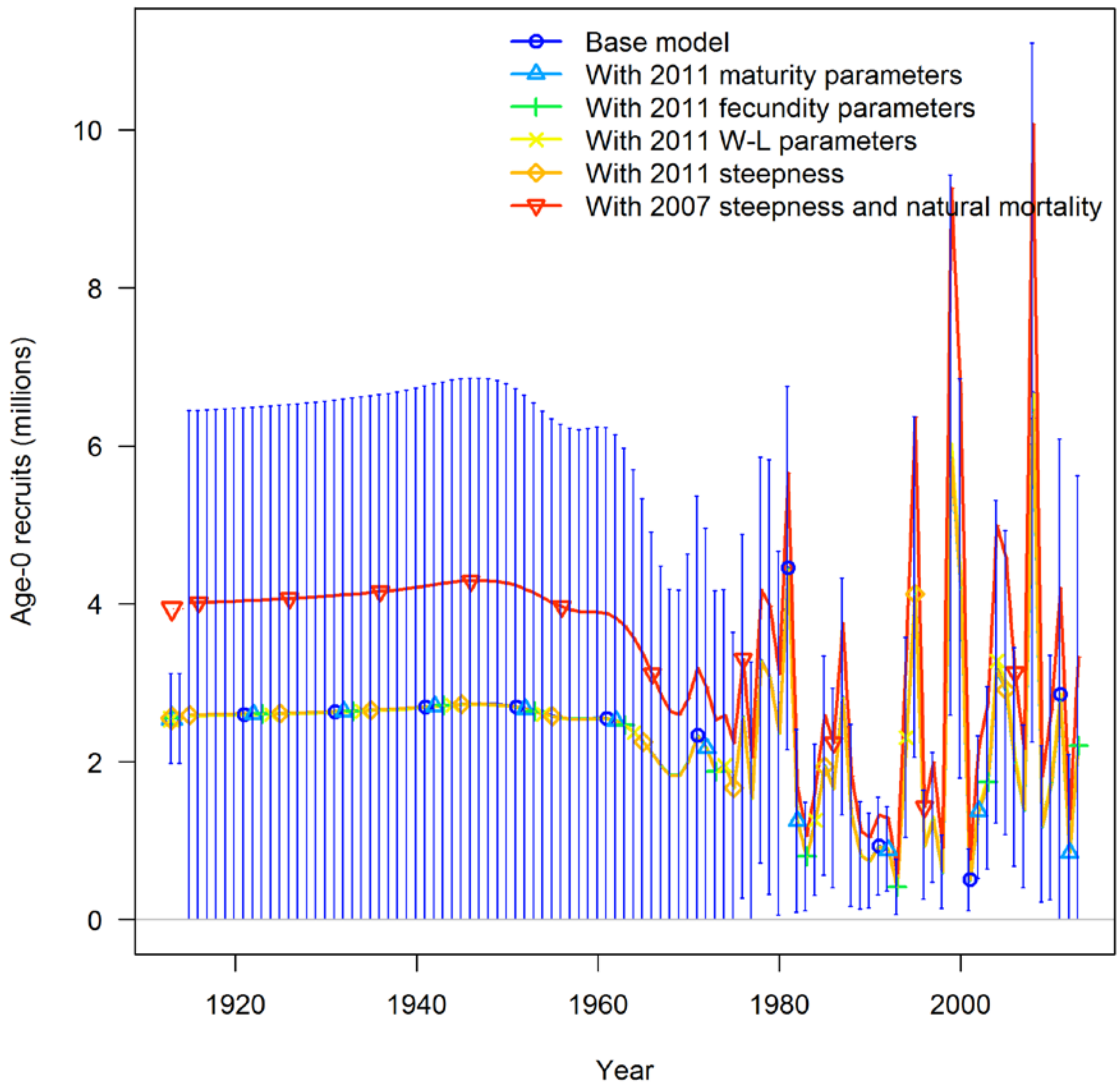

Figure 129: Sensitivity of darkblotched rockfish recruitment to updated maturity and fecundity parameters, weight-length relationships and stock-recruit steepness value (in combination with value for natural mortality). Recruitment time series of this assessment are provided with ~ 95% interval.

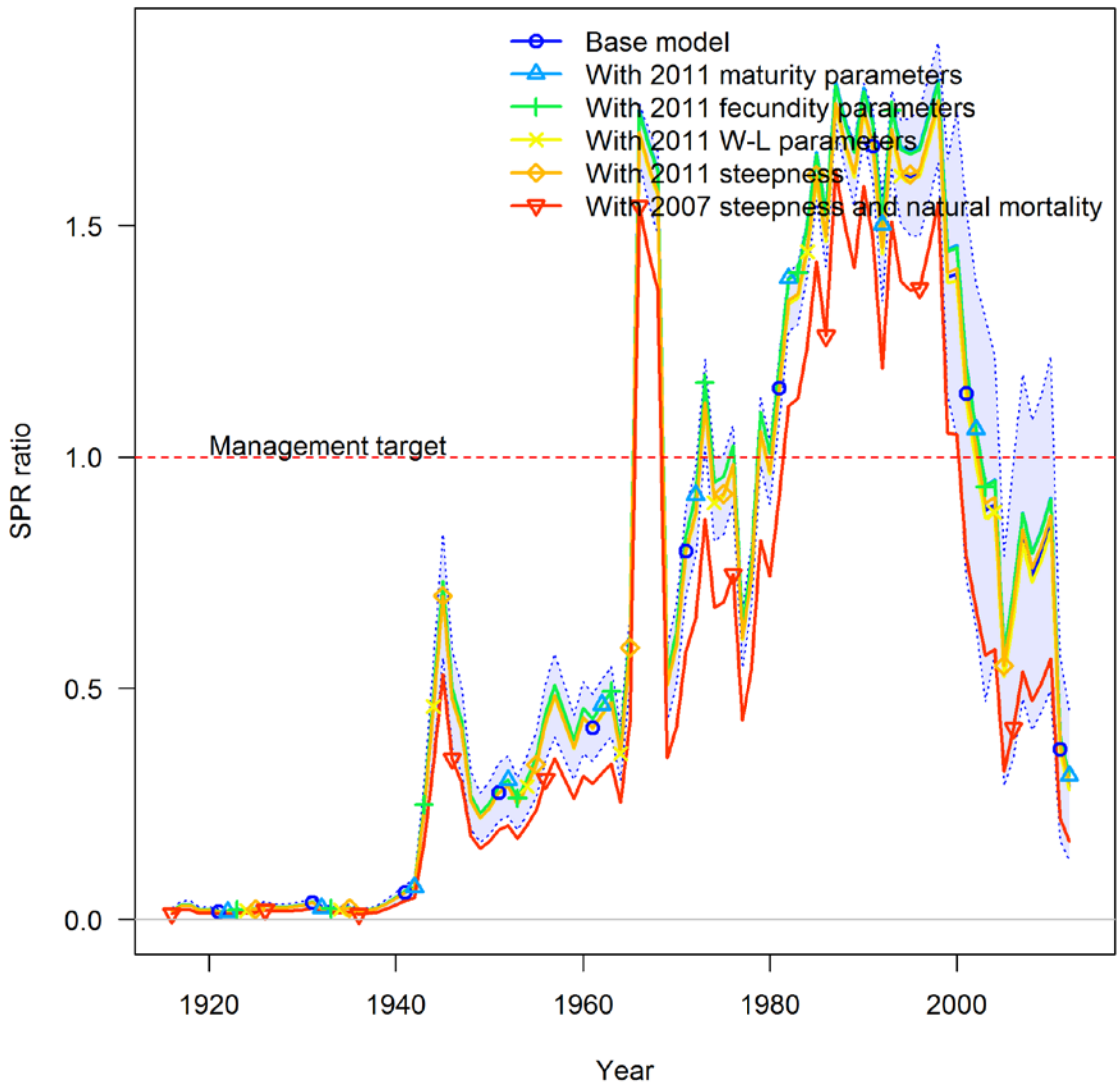

Figure 130: Sensitivity of darkblotched rockfish relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) to updated maturity and fecundity parameters, weight-length relationships and stock-recruit steepness value (in combination with value for natural mortality). Relative SPR ratio time series of this assessment are provided with ~ 95% interval.

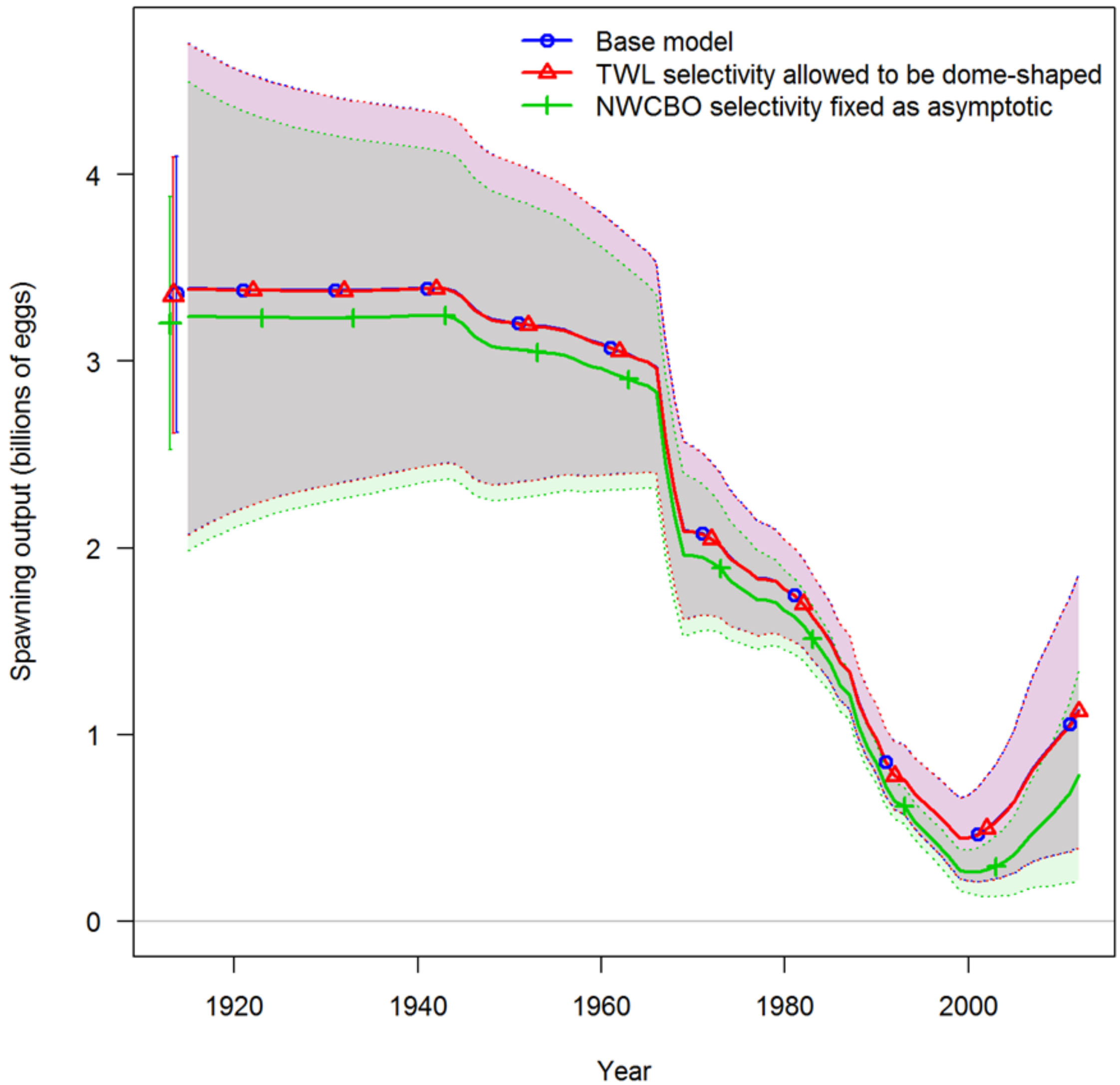

Figure 131: Sensitivity of darkblotched rockfish spawning output to alternative assumptions about selectivity. Spawning output time series of this assessment are provided with ~ 95% interval.

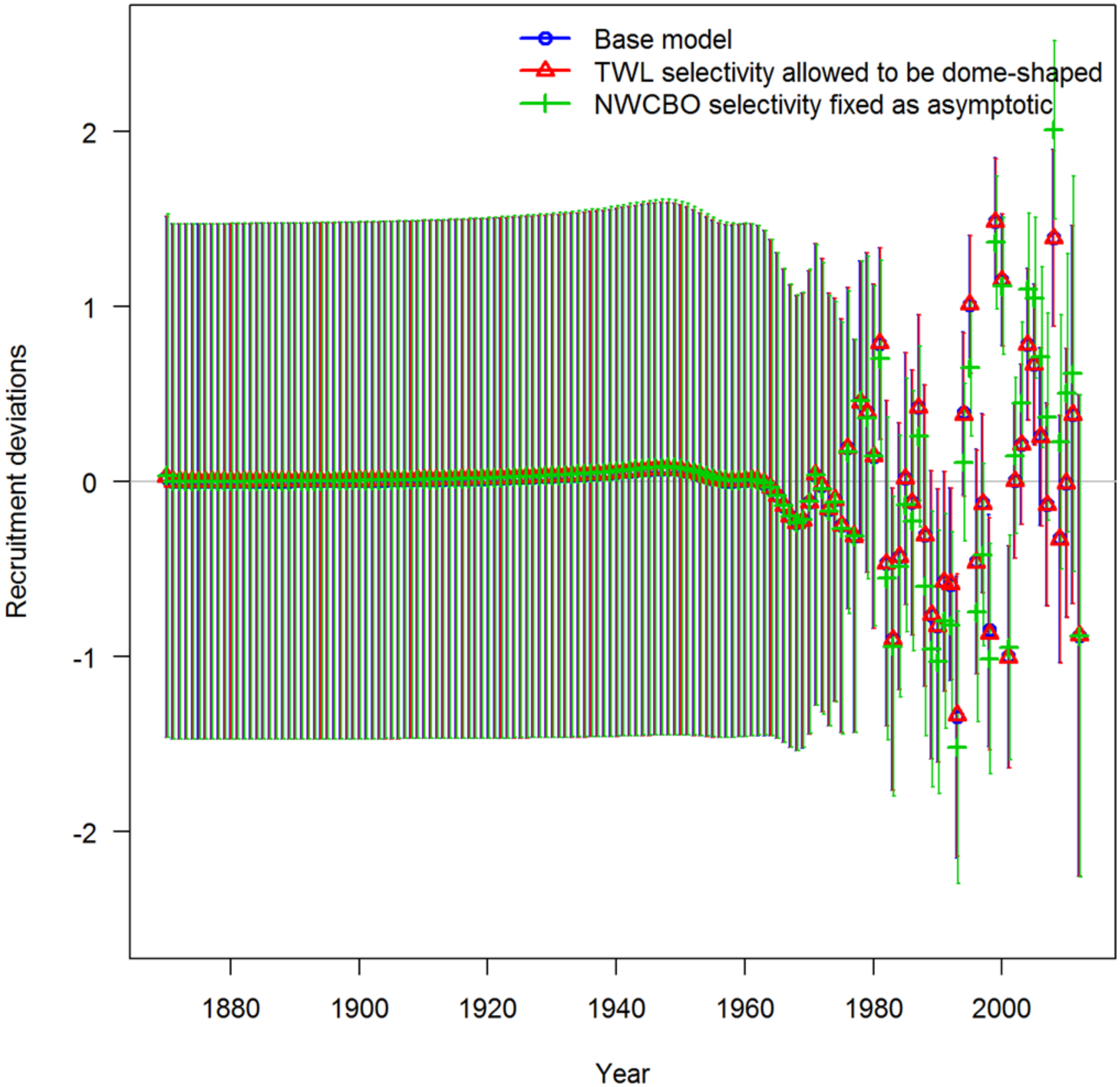

Figure 132: Sensitivity of darkblotched rockfish recruitment to alternative assumptions about selectivity. Recruitment time series of this assessment are provided with ~ 95% interval.

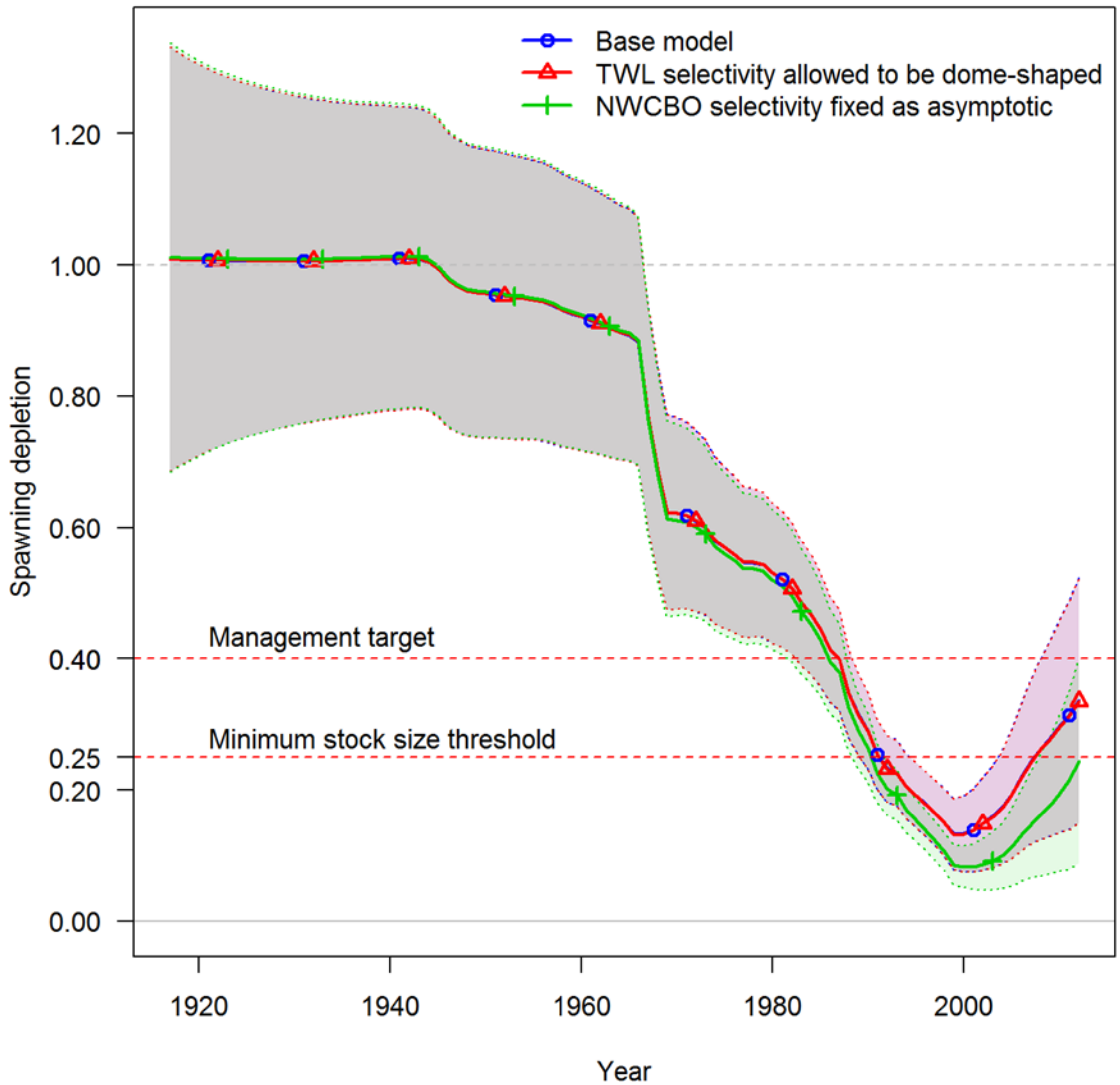

Figure 133: Sensitivity of darkblotched rockfish depletion to alternative assumptions about selectivity. Depletion time series of this assessment are provided with ~ 95% interval.

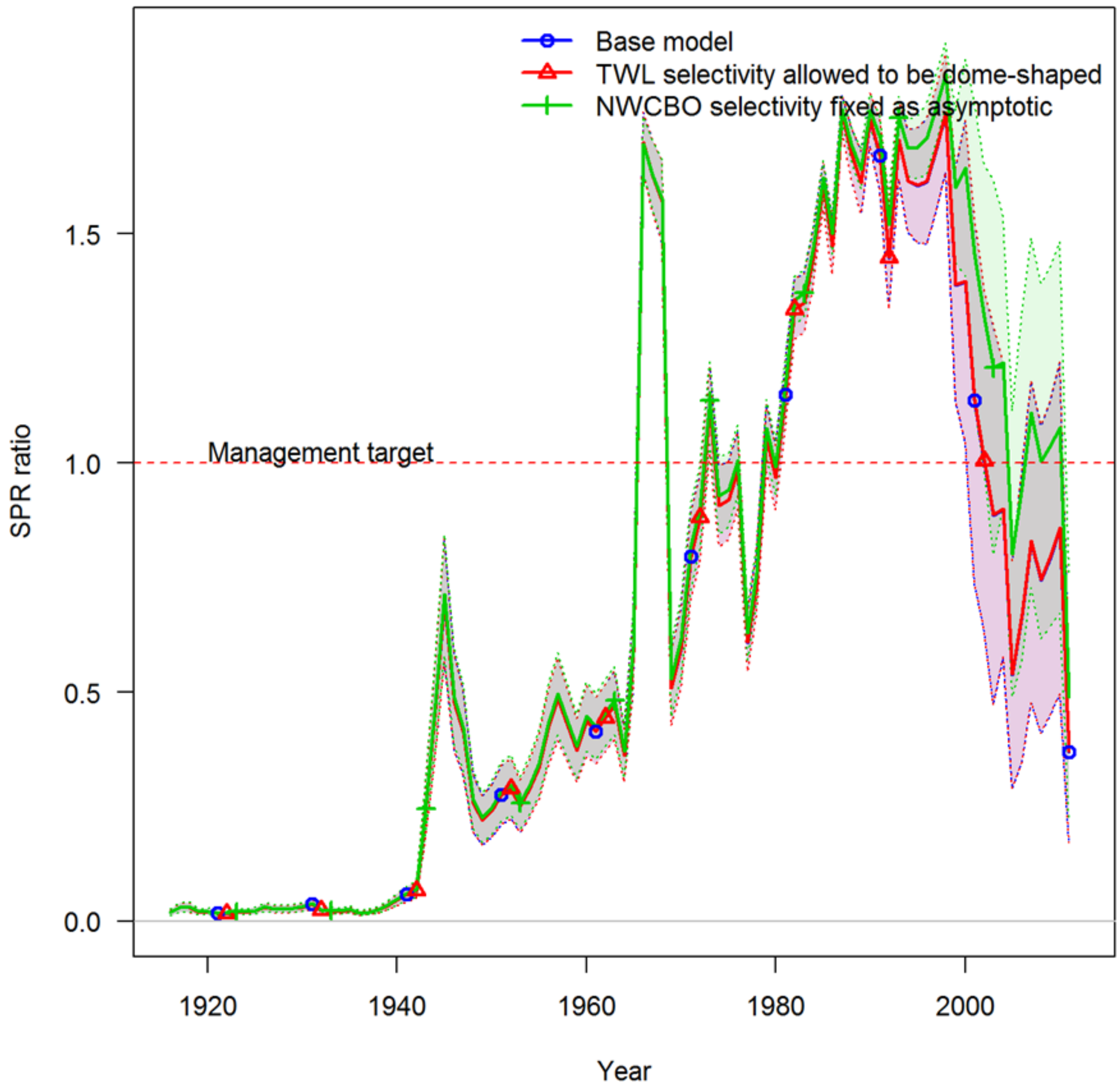

Figure 134: Sensitivity of darkblotched rockfish relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) to alternative assumptions about selectivity. Time series of this assessment are provided with ~ 95% interval.

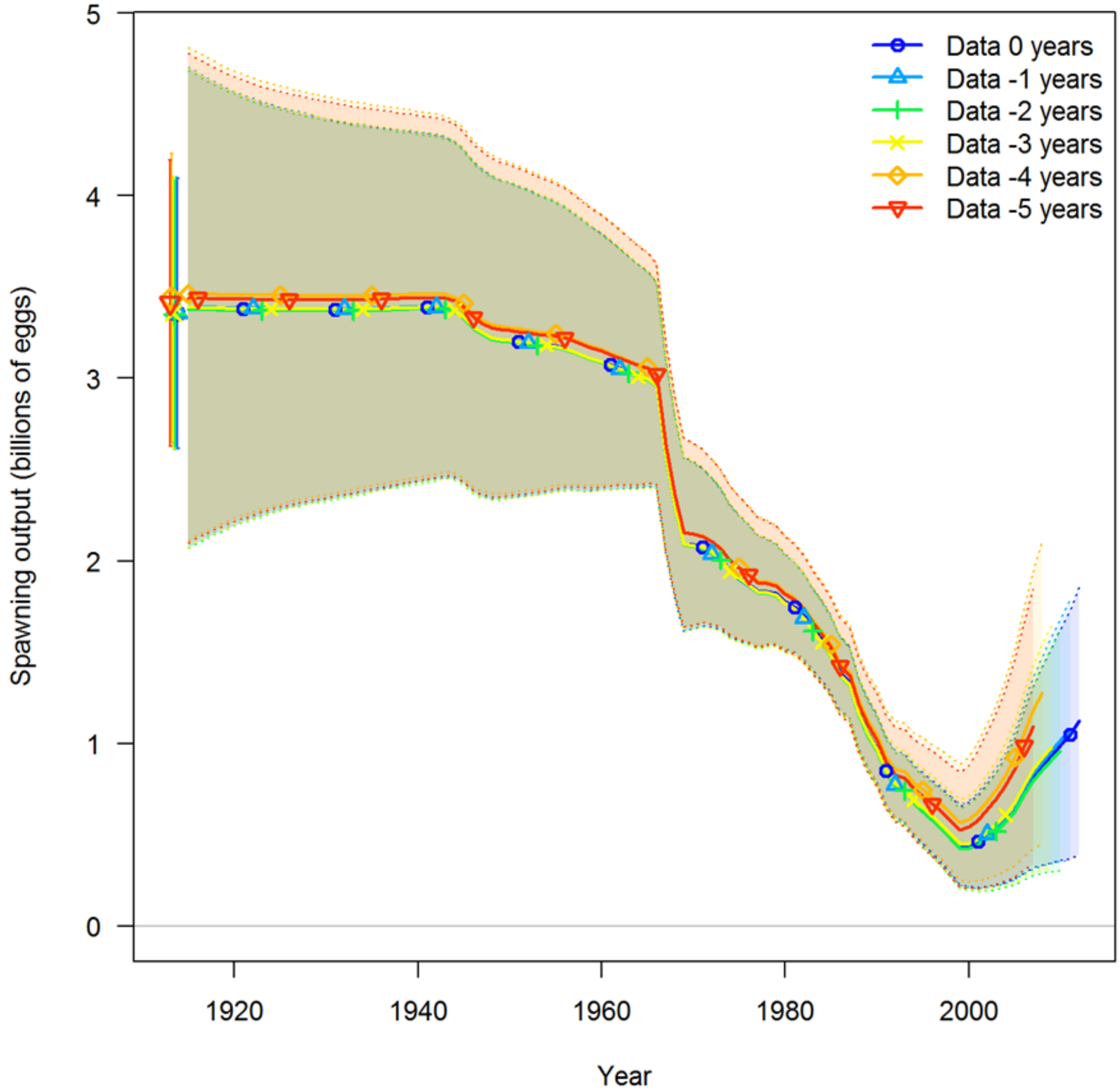

Figure 135: Results of retrospective analysis. Spawning output ime series of the base model are provided with ~ 95% interval.

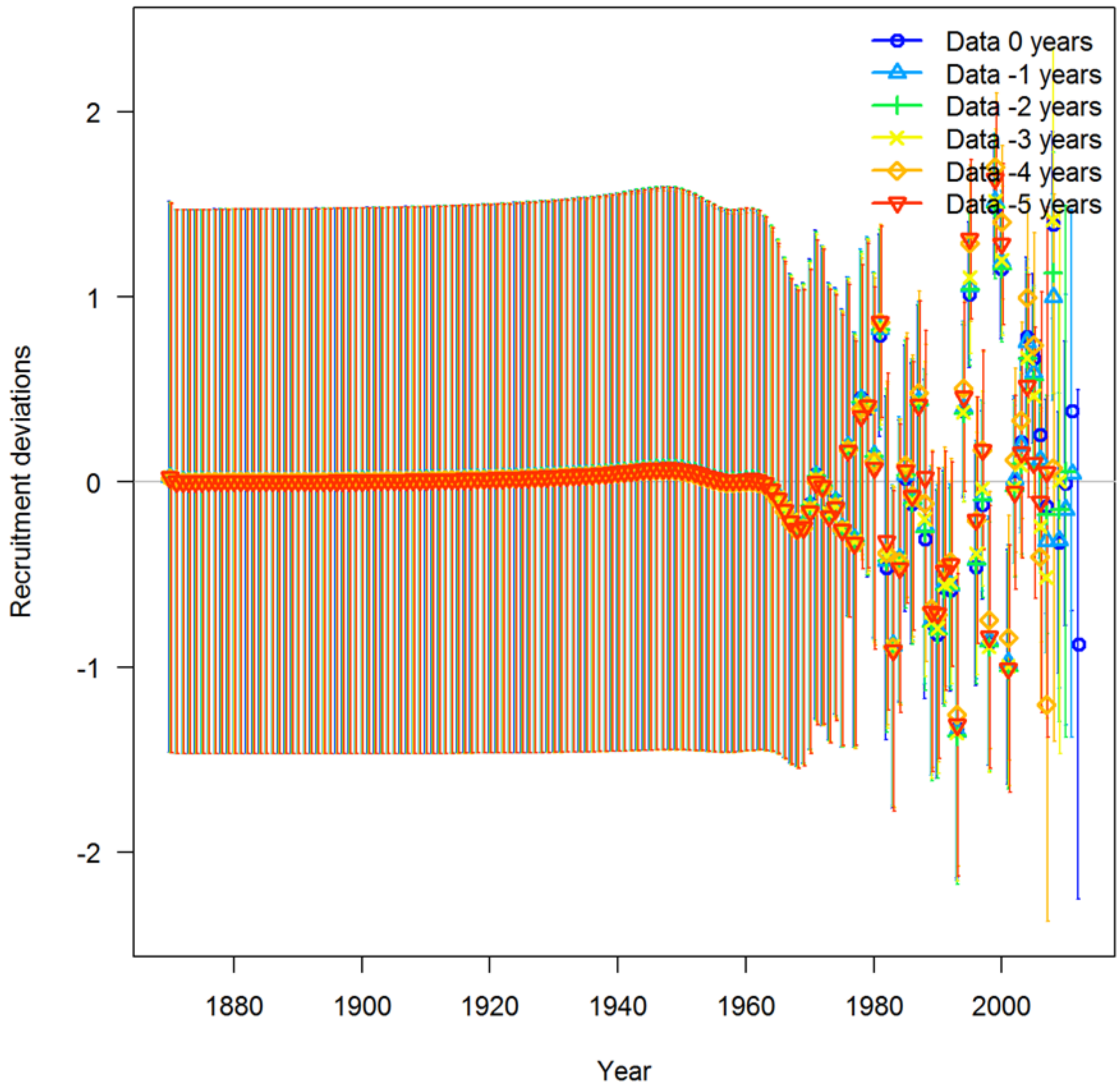

Figure 136: Results of retrospective analysis. Recruitment of the base model are provided with ~ 95% interval.

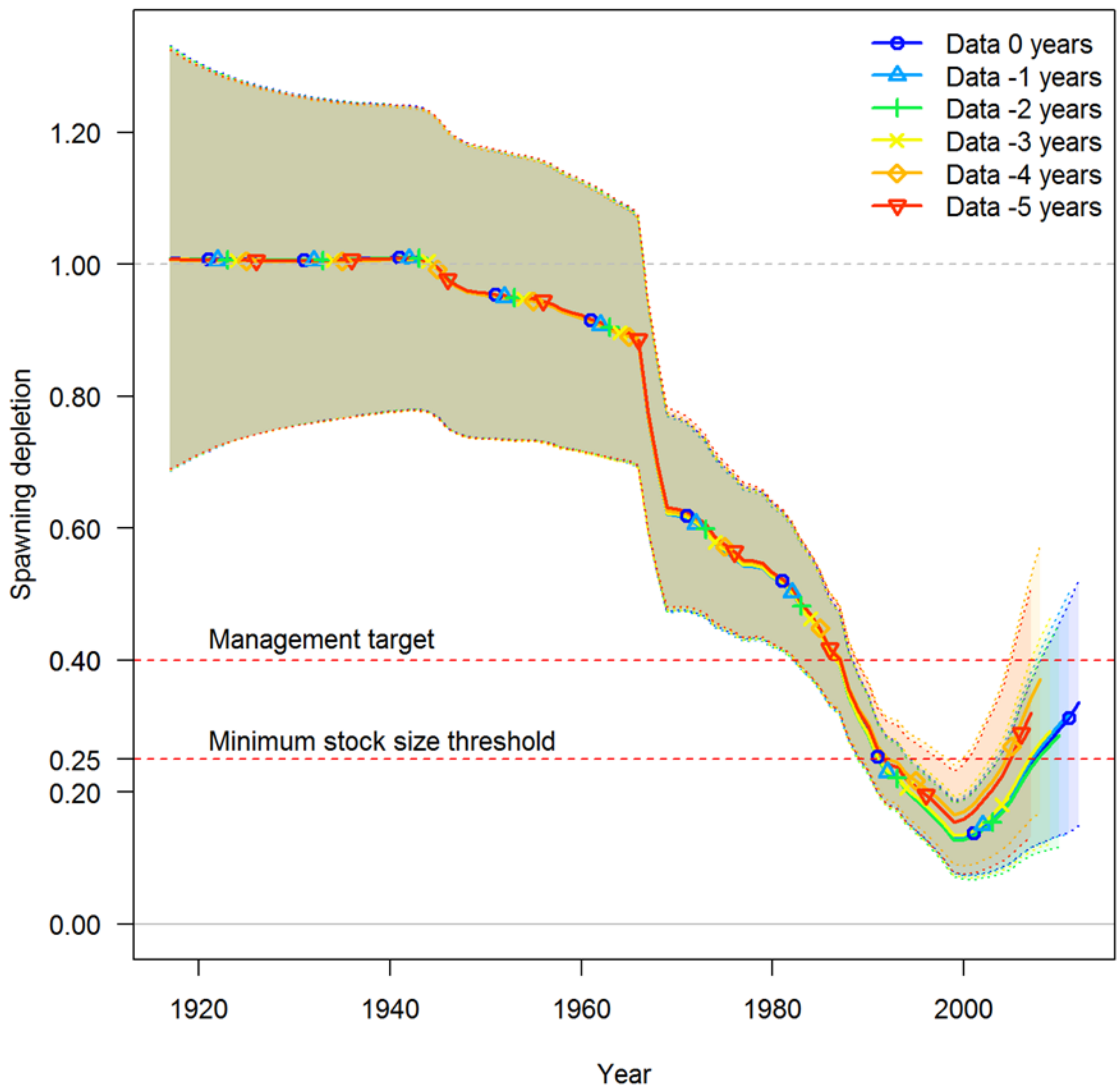

Figure 137: Results of retrospective analysis. Depletion of the base model are provided with ~ 95% interval.

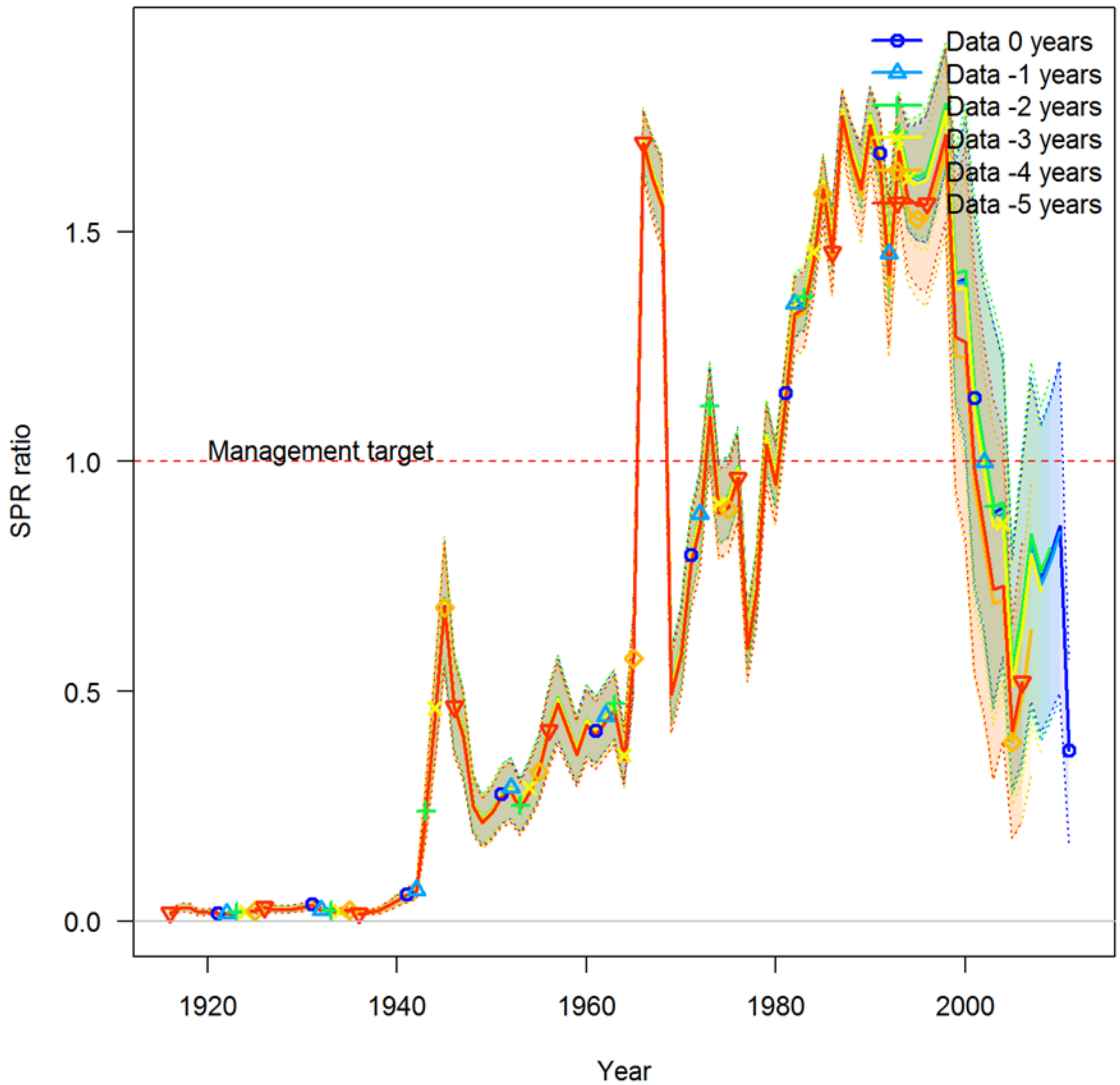

Figure 138: Results of retrospective analysis. Relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) of the base model are provided with ~ 95% interval.

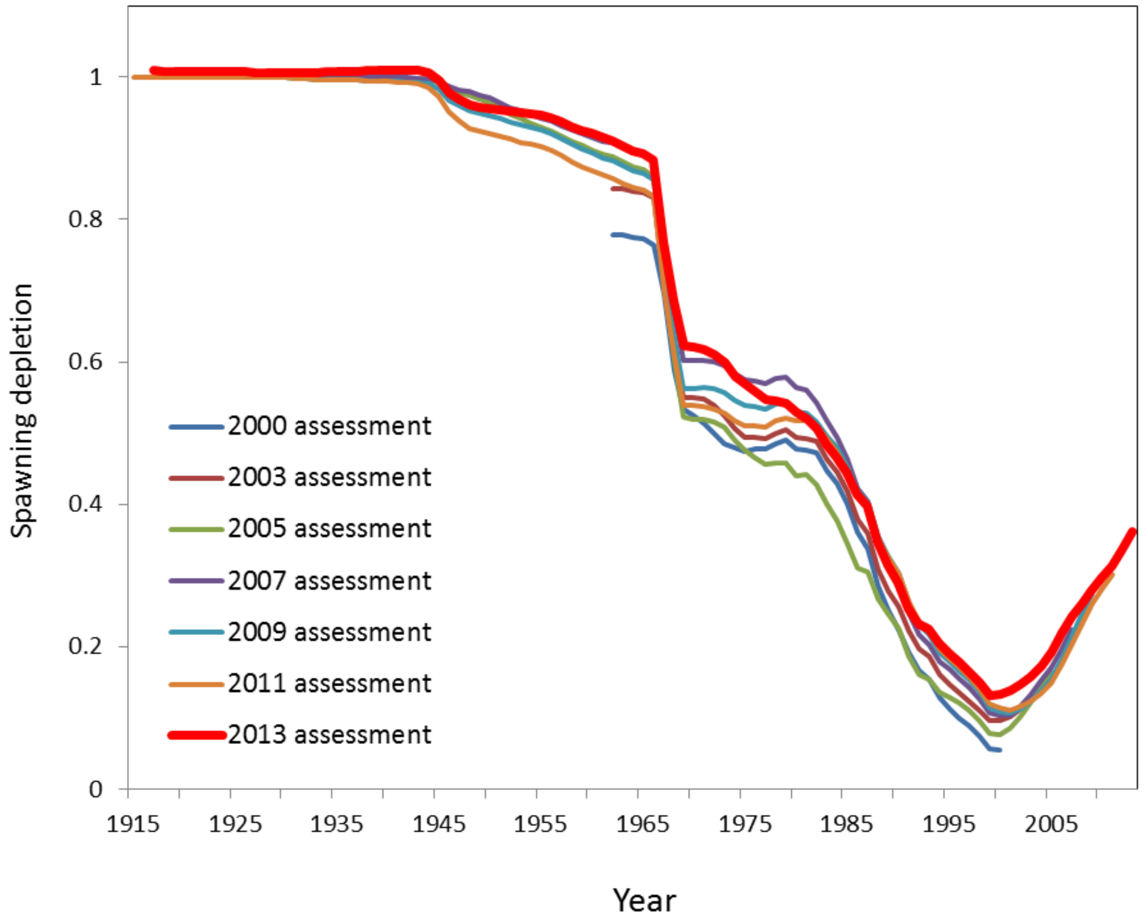

Figure 139: Comparison of spawning depletion time series among darkblotched rockfish assessments.

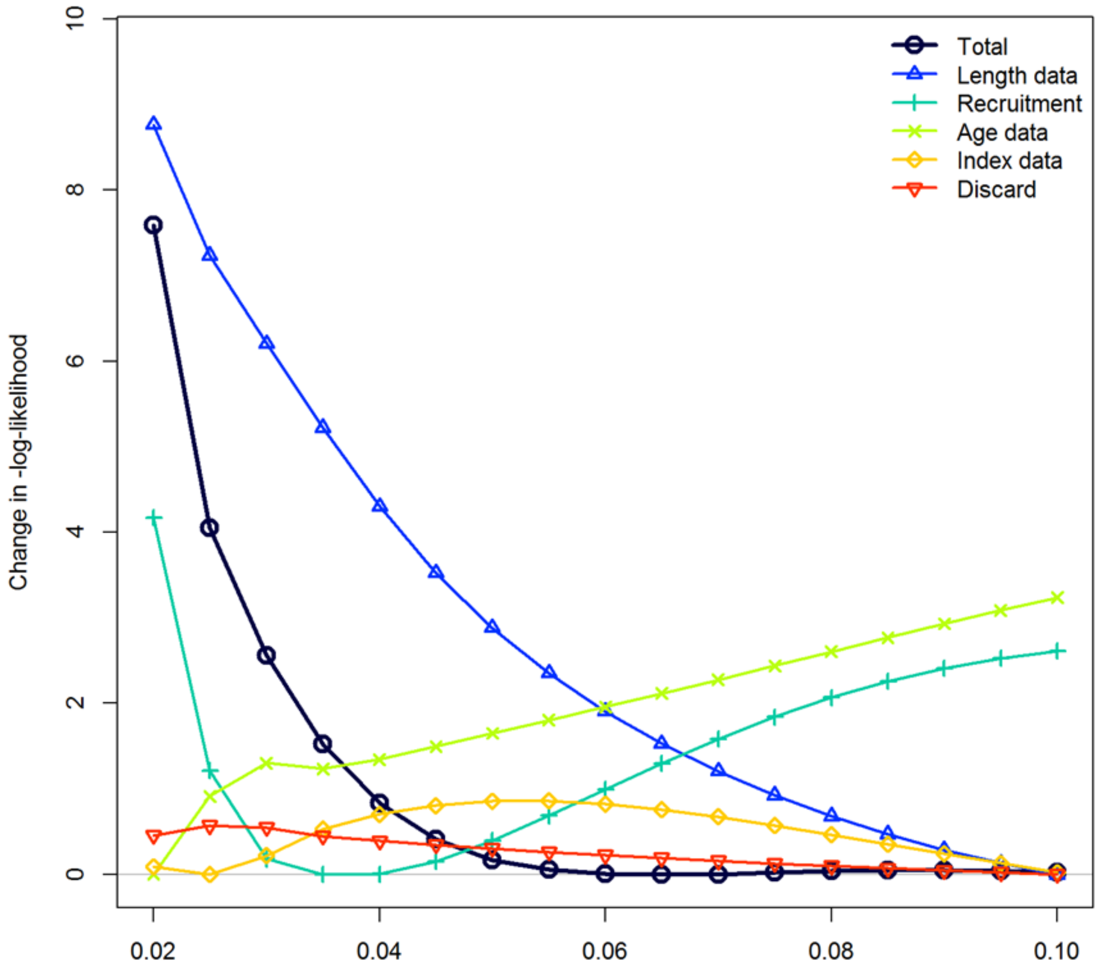

Figure 140: Negative log-likelihood profile for each data component and in total given different values of natural mortality ranging from 0.02 to 0.1 by increments of 0.005.

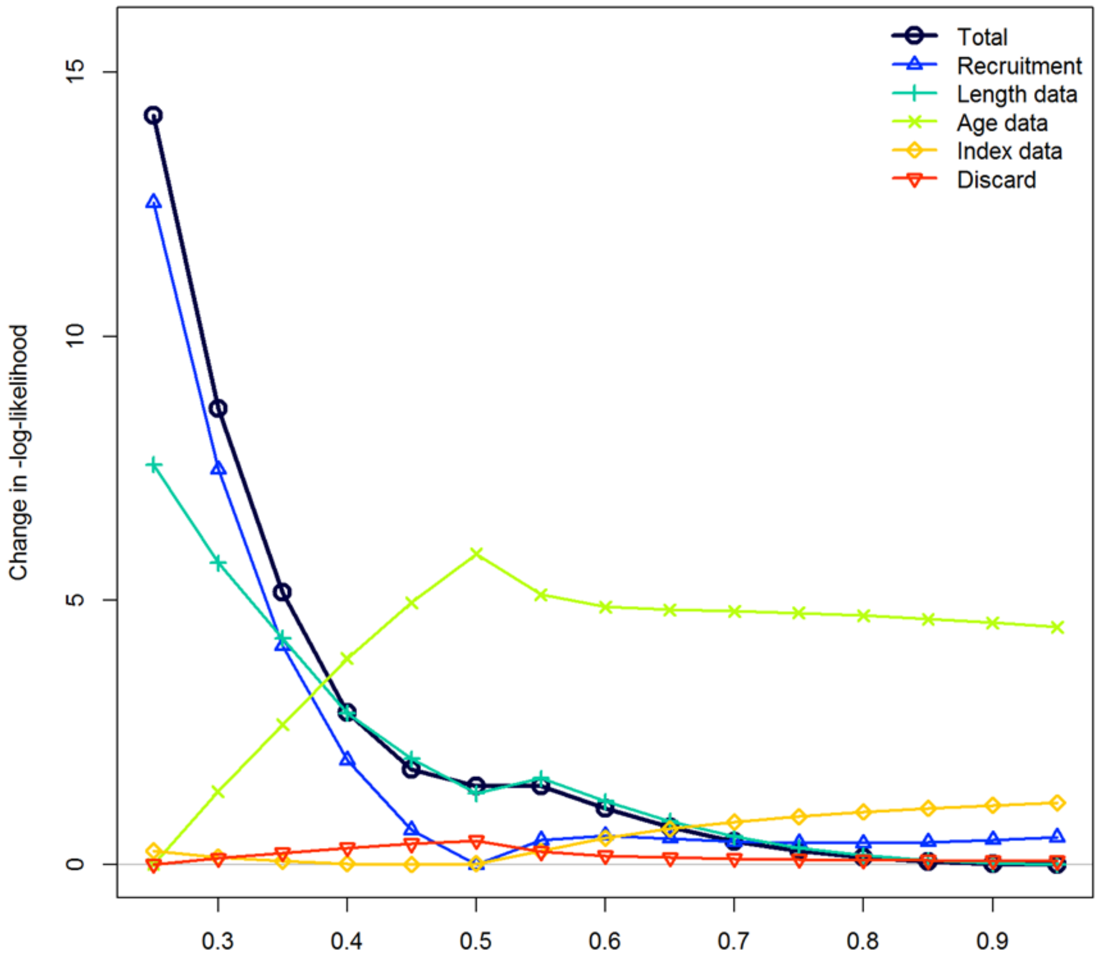

Figure 141: Negative log-likelihood profile for each data component and in total given different values of stock-recruit steepness ranging from 0.25 to 0.95 by increments of 0.05.

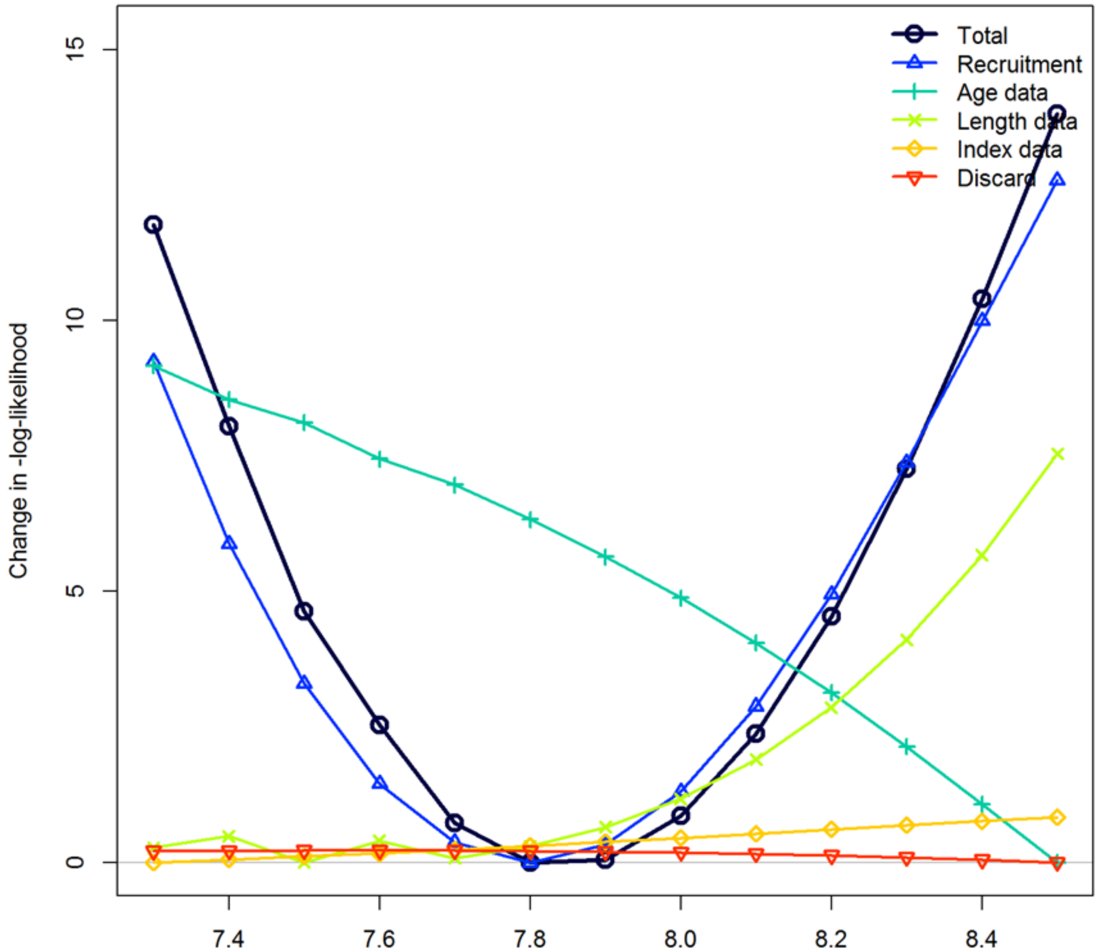

Figure 142: Negative log-likelihood profile for each data component and in total given different values of ln(R_0) ranging from 7.3 to 8.4 by increments of 0.1.

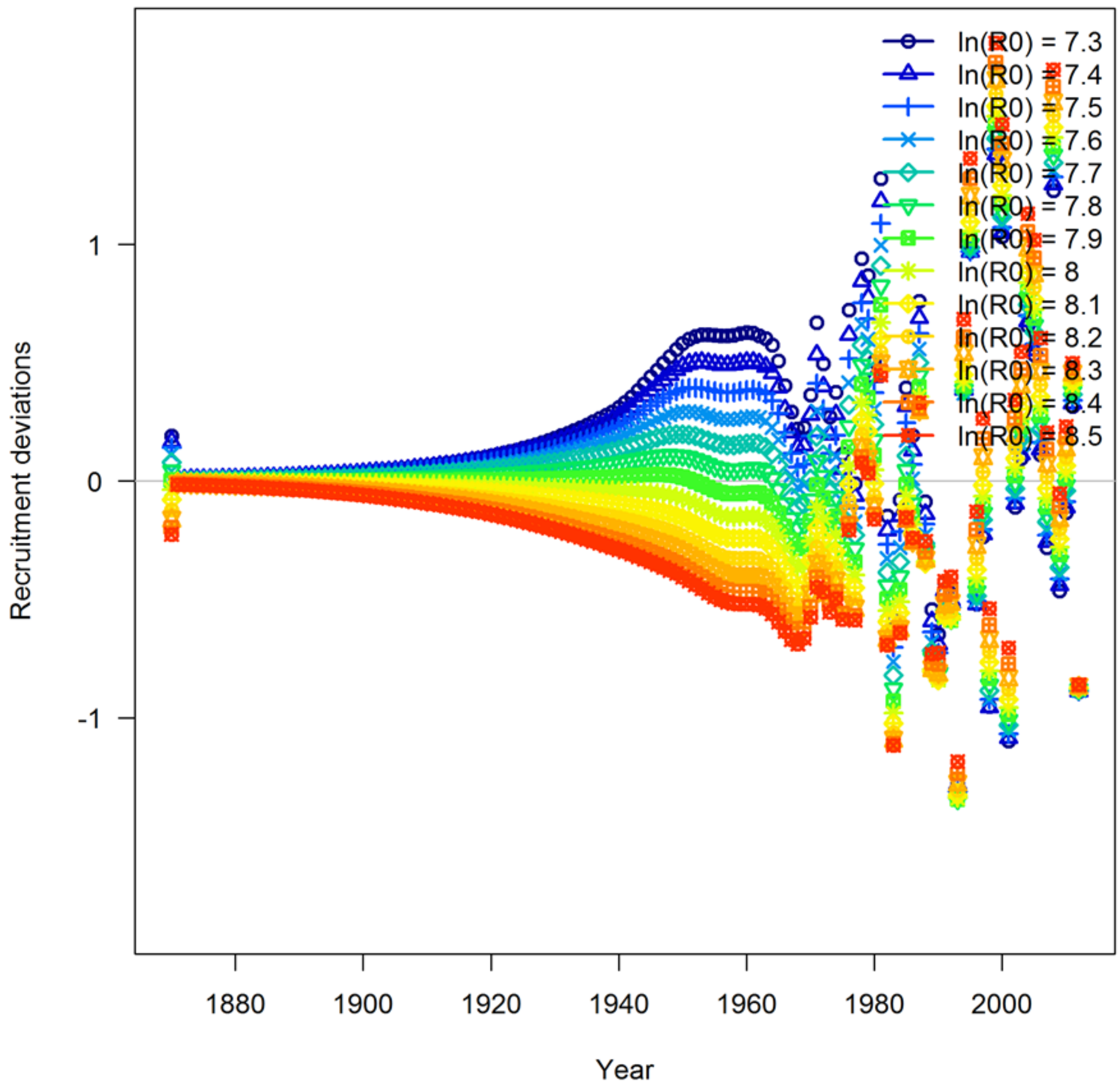

Figure 143: Values of recruitment deviations given different values of ln(R_0) ranging from 7.3 to 8.4 by increments of 0.1.

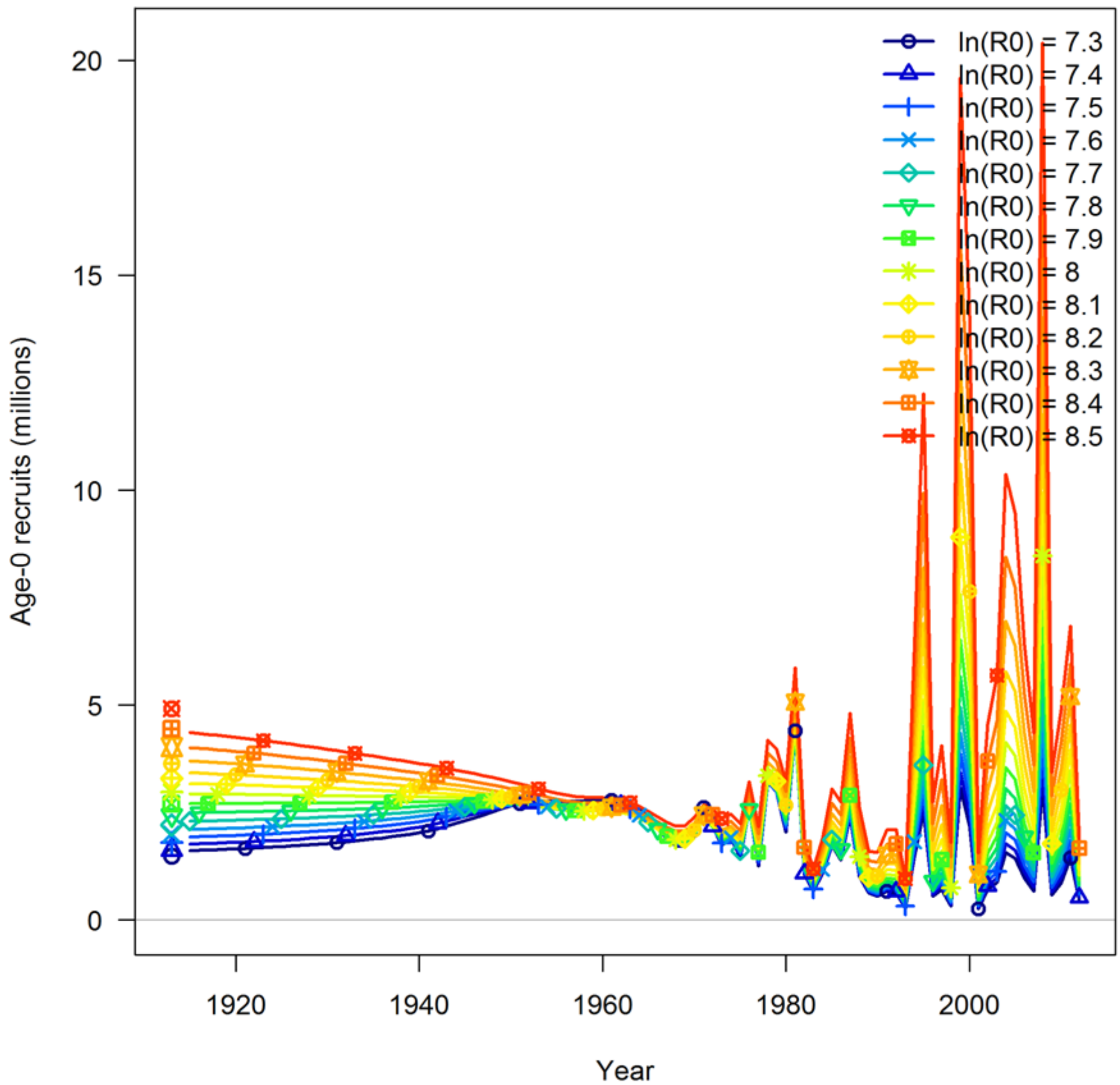

Figure 144: Values of estimated recruitment given different values of ln(R_0) ranging from 7.3 to 8.4 by increments of 0.1.

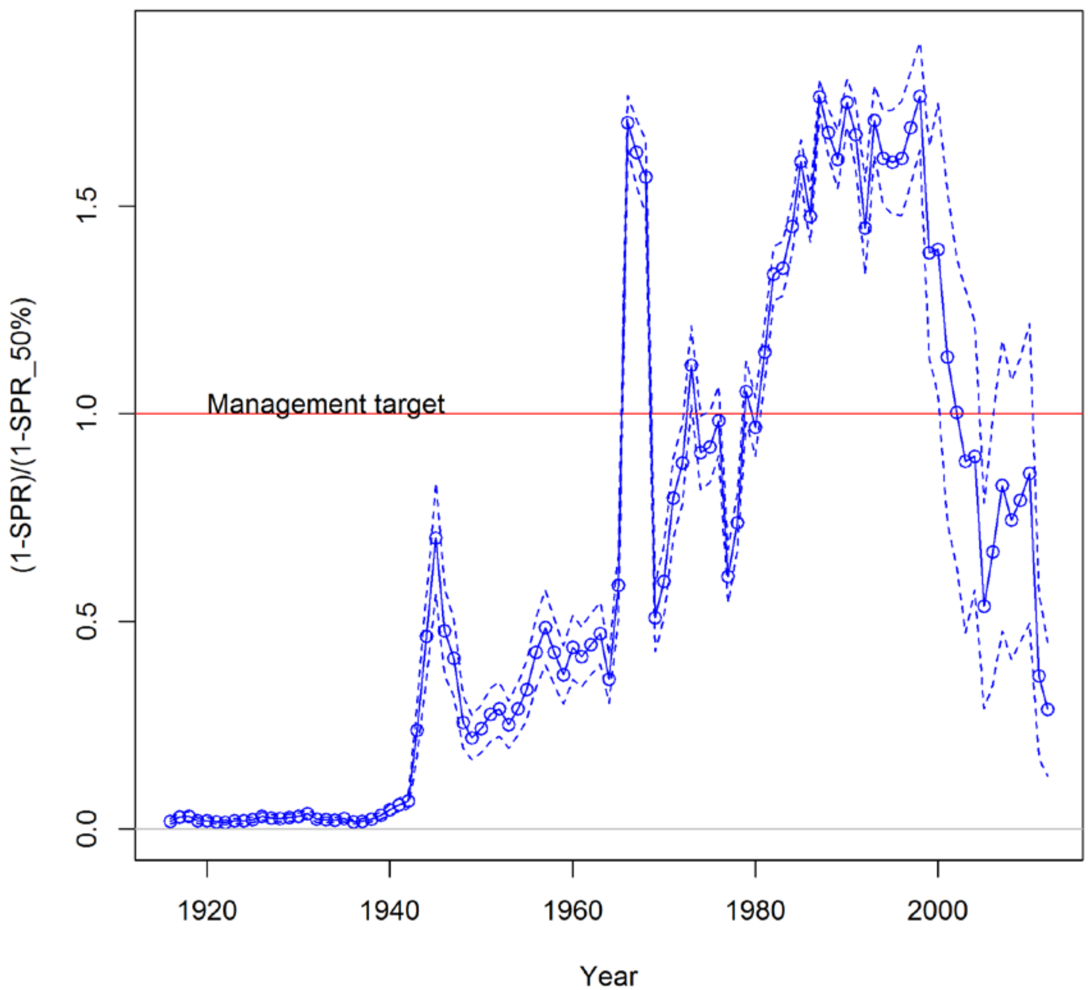

Figure 145: Time series of estimated relative spawning potential ratio (1-SPR/1-$SPR_{Target=0.50}$) for the base model (round points) with ~95% intervals (dashed lines). Values of relative SPR above 1.0 reflect harvests in excess of the current overfishing.

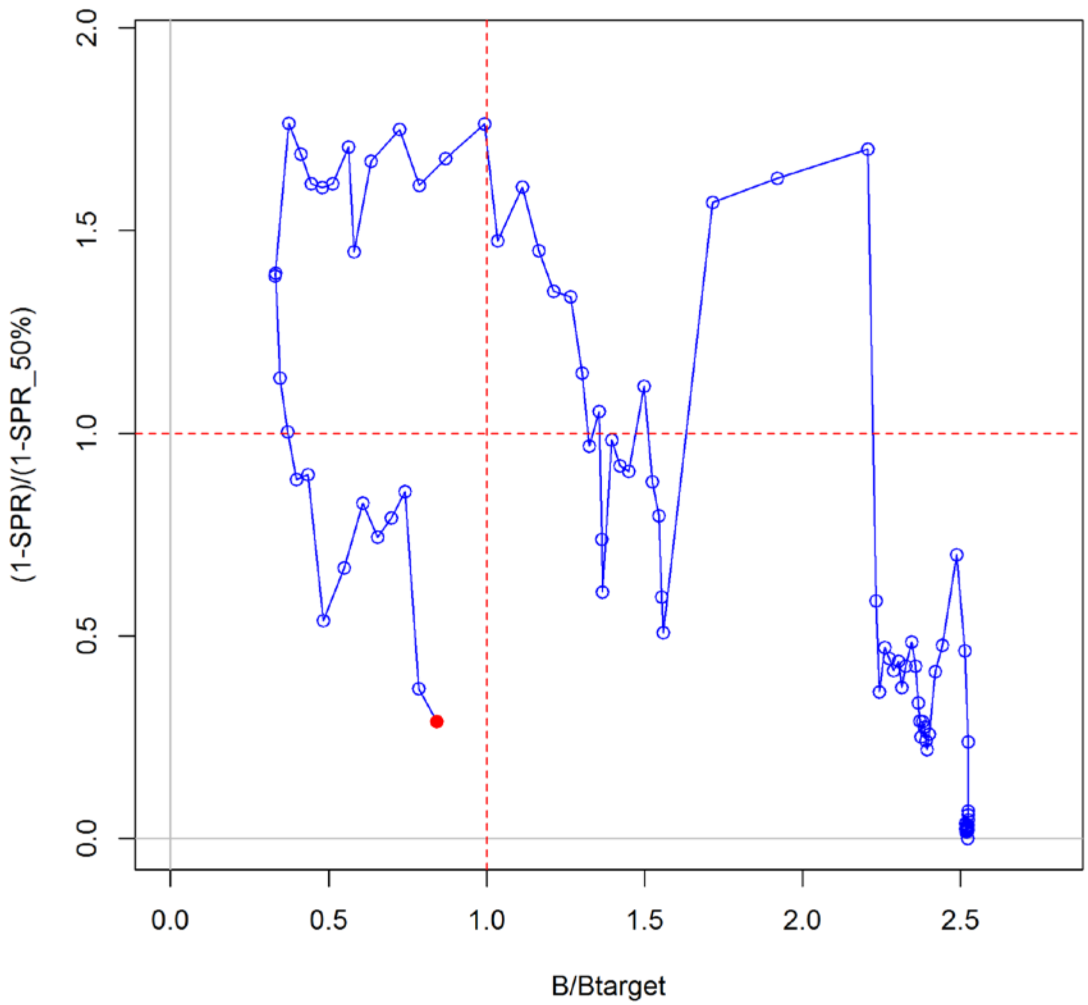

Figure 146: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base model. The relative (1-SPR) is (1-SPR) divided by 0.5 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 40% of the unfished spawning biomass. The red point indicates the year 2012.

Appendix A. Management shifts related to West Coast groundfish species

Effective October 18, 1982

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

Effective January 1, 1992

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

Effective May 9, 1992

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

Effective January 1, 1994

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

Effective September 8, 1995

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

Effective January 1, 1999:

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

Effective January 1, 2000

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

New rockfish categories in 2000.

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

New Limited Entry Trawl Gear Restrictions in 2000.

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

Effective during 2001:

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

Effective during 2002:

- Darkblotched Conservation Area was established.

Effective during 2003:

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

Effective during 2004:

- Vessel Monitoring System (VMS) was initiated.

Effective during 2005:

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

Appendix B. Assessment model files

Appendix B.1. SS data file

```
#Global specifications
1915 # Start year
2012 # End year
1   # N seasons per year
12  # Months per season
1   # Spawning Season
2   # N fishing fleets
4   # N surveys
1   # Number of areas
TWL%BYCATCH%AKSHLF%AKSLP%NWSLP%NWCBO #Names divided by "%"
0.5   0.5   0.5   0.5   0.5  0.5 #Timing of each fishery/survey
1   1   1   1   1   1  # Area of each fleet
1   1   # Units for catch by fishing fleet:
1=Biomass(mt),2=Numbers(1000s)
0.01 0.01 # SE of log(catch) by fleet for equilibrium and continuous
options
2  # Number of Genders
45 # Accumulator age

#Landings section
# Initial equilibrium catch (landings + discard) by fishing fleet
0  0 # Initial equilibrium catch (landings + discard) by fishing fleet
98       # Number of lines catch data
# Landed catch (only) time series by fleet
# Catch(by fleet) Year Season
0         0           1915   1
13.009    0           1916   1
20.633    0           1917   1
21.345    0           1918   1
13.733    0           1919   1
14.439    0           1920   1
12.312    0           1921   1
11.311    0           1922   1
13.643    0           1923   1
13.863    0           1924   1
15.798    0           1925   1
21.328    0           1926   1
18.319    0           1927   1
18.159    0           1928   1
19.318    0           1929   1
21.079    0           1930   1
26.002    0           1931   1
16.433    0           1932   1
16.044    0           1933   1
15.249    0           1934   1
17.499    0           1935   1
11.881    0           1936   1
13.537    0           1937   1
16.741    0           1938   1
23.738    0           1939   1
32.725    0           1940   1
41.860    0           1941   1
48.165    0           1942   1
183.614   0           1943   1
```

397.657	0	1944	1
678.760	0	1945	1
401.009	0	1946	1
331.568	0	1947	1
191.102	0	1948	1
160.203	0	1949	1
177.770	0	1950	1
205.861	0	1951	1
216.837	0	1952	1
184.548	0	1953	1
216.901	0	1954	1
256.018	0	1955	1
339.045	0	1956	1
396.068	0	1957	1
335.049	0	1958	1
283.182	0	1959	1
342.106	0	1960	1
318.933	0	1961	1
345.280	0	1962	1
368.227	0	1963	1
264.989	0	1964	1
482.897	0	1965	1
413.119	3807	1966	1
370.119	2706	1967	1
133.875	2288	1968	1
133.554	153	1969	1
202.068	149	1970	1
250.117	278	1971	1
237.284	374	1972	1
146.314	768	1973	1
263.084	346	1974	1
318.595	293	1975	1
541.032	128.759	1976	1
315.707	2.396	1977	1
415.123	1.075	1978	1
732.379	3.716	1979	1
598.373	21.430	1980	1
824.186	11.848	1981	1
1134.167	1.653	1982	1
1114.261	11.559	1983	1
1302.935	19.582	1984	1
1760.872	12.769	1985	1
1254.632	5.720	1986	1
2401.271	13.985	1987	1
1646.800	9.519	1988	1
1268.669	5.289	1989	1
1650.955	28.252	1990	1
1161.030	44.969	1991	1
657.876	29.453	1992	1
1185.669	8.026	1993	1
851.283	14.734	1994	1
737.049	49.066	1995	1
736.793	5.993	1996	1
815.790	3.879	1997	1
912.558	14.058	1998	1
350.348	11.114	1999	1
250.741	8.145	2000	1

```
162.871   12.357       2001   1
109.061   3.217        2002   1
75.486    4.371        2003   1
181.873   7.274        2004   1
86.647    11.059       2005   1
95.978    11.148       2006   1
131.538   12.052       2007   1
111.054   6.317        2008   1
138.071   0.353        2009   1
176.168   8.176        2010   1
104.814   12.197       2011   1
91.828    2.225        2012   1

#Survey Indices section
27   # number of Survey data points    (#_N_cpue)
#_Units:  0=numbers; 1=biomass; 2=F
#_Errtype:  -1=normal; 0=lognormal; >0=T
#_Fleet Units Errtype
1 1 0 # fleet (fishery or survey) # TWL
2 1 0 # fleet (fishery or survey) # BYCATCH
3 1 0 # fleet (fishery or survey) # AKSHLF
4 1 0 # fleet (fishery or survey) # AKSLP
5 1 0 # fleet (fishery or survey) # NWSLP
6 1 0 # fleet (fishery or survey) # NWCBO
#
#Year   Seas     Flt/Svy    Value         se(log)
#AKSHLF triennial early (N=5)
#Random-SY, Random-VY, GammaECE,
"C:\Users\thorsonja\Dropbox\Darkblotched\delta-GLMM\AFSC triennial
early\2012-11-01 -- PRELIMINARY=2 (1e6 1e6)\Model=2"
1980      1        3       4329.510695 0.328855581
1983      1        3      11307.197   0.188300112
1986      1        3       5626.360727 0.2519586
1989      1        3        7000.510252 0.316365157
1992      1        3       6185.453803 0.289054054
#AKSHLF triennial late (N=4)
#Random-SY, Random-VY, GammaECE,
"C:\Users\thorsonja\Dropbox\Darkblotched\delta-GLMM\AFSC triennial
late\2012-10-31 -- PRELIMINARY=2 (RandomSY 1e6 1e6)\Model=2"
1995      1        3       3574.325258 0.295860335
1998      1        3        4152.80707  0.345400667
2001      1        3       3408.702865 0.325285022
2004      1        3       7329.157077 0.31872779
#AKSLP survey (N=4)
#Random-SY, no-VY, GammaECE,
"C:\Users\thorsonja\Dropbox\Darkblotched\delta-GLMM\AFSC slope\2012-10-
31 -- FINAL=1 (syRandom 1e7 1e7)\Model=1"
1997      1        4         1655.059106 0.558034217
1999      1        4         1917.966195 0.612989277
2000      1        4         1633.165459 0.56262013
2001      1        4         2180.37366  0.87740395
#NWSLP survey (N=4)
#Random-SY, Random-VY, GammaECE,
"C:\Users\thorsonja\Dropbox\Darkblotched\delta-GLMM\NWFSC Slope\2012-
10-27 FINAL=1 (randomSY 1e6 1e6)\Model=1"
# DESIGN-BASED ESTIMATOR FOR COMPARISON (NOT FOR USE IN FINAL VERSION)
#1999     1        5        1980.11701  0.307066331
```

```
#2000     1        5       12126.93371  0.572797746
#2001     1        5        2005.12022  0.396825554
#2002     1        5        2574.42879  0.26878881
# DELTA-GLMM ESTIMATOR
1999      1        5        3467.103363  0.550010623
2000      1        5        5715.048007  0.419764141
2001      1        5        2917.12162  0.454480825
2002      1        5        2341.556201  0.450368493
#NWCBO survey (N=8)
#Random-SY, Random-VY, GammaECE,
"C:\Users\thorsonja\Dropbox\Darkblotched\delta-GLMM\NWFSC Shelf-
Slope\2012-20-25 -- FINAL=1 (randomSY 1e5 1e5)\Model=1"
# DESIGN-BASED ESTIMATOR FOR COMPARISON (NOT FOR USE IN FINAL VERSION)
#2003     1        6       29491.70636  0.447743895
#2004     1        6        7145.27004  0.350662071
#2005     1        6      18703.44015  0.594542112
#2006     1        6        6926.73444  0.313141466
#2007     1        6        6637.2545  0.246326496
#2008     1        6        7959.38225  0.455466139
#2009     1        6        8541.61435  0.24777762
#2010   1     6        5760.22799  0.239968945
#2011     1        6        9205.62902  0.365206277
#2012   1     6       10828.18408  0.326540118
# DELTA-GLMM ESTIMATOR
2003      1        6        20552.13635  0.384022882
2004      1        6        10230.08715  0.43975924
2005      1        6         9694.664868 0.380098505
2006      1        6        7307.025971 0.398102335
2007      1        6        7939.416324 0.402346728
2008      1        6        5457.79612  0.382583144
2009      1        6       12320.90375  0.400567506
2010   1     6         6238.576159 0.378720104
2011      1        6        7332.597194 0.383124894
2012   1     6        11078.9046  0.407218248

1 #_N_fleets_with_discard
#_discard_units (1=same_as_catchunits(bio/num); 2=fraction; 3=numbers)
#_discard_errtype:  >0 for DF of T-dist(read CV below); 0 for normal
with CV; -1 for normal with se; -2 for lognormal

#_Fleet units errtype
 1     2     -1 # TWL

15   # Discards N observations
# Year  seas    fleet   obs      err
#TWL from Pikitch study
1985   1     1     0.01   0.3
1986   1     1     0.07   0.3
1987   1     1     0.01   0.3
#TWL not updated from 2011 assessment
2000   1     1     0.32   0.2
2001   1     1     0.41   0.2
#TWL from WCGOP, updated for 2013 assessment
2002   1     1     0.56  0.09
2003   1     1     0.60  0.10
2004   1     1     0.16  0.04
2005   1     1     0.22  0.05
```

```
2006   1     1     0.49  0.09
2007   1     1     0.49  0.07
2008   1     1     0.53  0.06
2009   1     1     0.54  0.05
2010   1     1     0.48    0.06
2011  1     1    0.02  0.01
# Mean Body Weight
10 # Number of mean body weight observations
30  # Degrees of freedom for mean body weight for T-distribution
# Partition: 0=whole catch, 1=discarded catch, 2=retained catch
# Must be in kilograms
# TWL discards (N=8), from WCGOP (BOTTOM TWL data only used)
# Year  seas    fleet   partition  Wghtd.AVG_W (kg)  CV
2002  1    1    1      0.416450827     0.819466364
2003  1    1    1      0.581344497     0.665118295
2004  1    1    1      0.598224386     0.544009321
2005  1    1    1      0.474385534     0.716121165
2006  1    1    1      0.588179866     0.888292027
2007  1    1    1      0.723247633     0.648731964
2008  1    1    1      0.709967399     0.468556145
2009  1    1    1      0.632089049     0.609463429
2010  1    1    1      0.74342529      0.596264103
2011  1    1    1      0.258565477     0.917604301

# Population Length Structure
2 # Population Length Bin Option (1=use databins; 2=generate from
binwidth,min,max below; 3=read vector)
1
4
62

-1 # Minimum proportion for compressing tails of observed compositional
data
0.001 # Constant added to expected frequencies

0 # Combine males and females at and below this bin number

30 # Number of Observed Length Bins
# Data length bins
4 6 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 62

71   # Length Composition Observations
#TWL updated with final BDS data (N=36)
#Year  Seas  Fleet Gender Partition Nsamp   F-4 F-6 F-8 F-10 F-12 F-14
F-16 F-18 F-20 F-22 F-24 F-26 F-28 F-30 F-32 F-34 F-36 F-38 F-40 F-42
F-44 F-46 F-48 F-50 F-52 F-54 F-56 F-58 F-60 F-62 M-4 M-6 M-8 M-10 M-12
M-14 M-16 M-18 M-20 M-22 M-24 M-26 M-28 M-30 M-32 M-34 M-36 M-38 M-40
M-42 M-44 M-46 M-48 M-50 M-52 M-54 M-56 M-58 M-60 M-62
#1977  1     1   3     2    35    0 0 0 0 0 0 0 0 0 0 1914.311761
8447.189383 23282.71024 40963.27848 38691.86716 24160.47346 6366.774088
249.0473021 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2631.266311
3929.259234 15502.25843 55012.6241 33762.55328 16064.29309 1674.110431
0 27.64792253 0 0 0 0 221.3993796 0 0 0 0 0 0 0
#1978  1     1   3     2    92    0 0 0 0 0 0 0 0 0 0 0 2654.541186
11288.73276 24730.62613 37302.99765 46770.13087 20279.60283 3196.226015
2680.221187 4813.686321 3993.711816 2326.003466 800.3764266 0 0 0 0 0 0
```

0 0 0 0 0 0 0 0 0 0 0 0 159.5999888 16258.39831 38571.91764 62212.25422
25371.65385 12533.24112 6234.264334 10100.90814 3771.698166 944.3406064
9.002974819 0 0 0 0 0 0 0 0 0
1979 1 1 3 2 23 0 0 0 0 0 0 0 0 0 0 0 0 187.0178901
986.9114107 3337.553785 11771.8282 8763.342485 6310.989136 3631.702319
3803.127859 3658.610074 3644.368124 986.9114107 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 3108.096232 6037.31718 4639.289159 12631.05806
2975.776975 13027.97433 20300.11892 10603.51199 0 5487.915112 0 0 0 0 0
0 0 0
1980 1 1 3 2 59 0 0 0 0 0 0 0 14.1245199 0 341.5827773
465.1675222 806.7502995 4608.982179 5332.078349 4972.459065 9550.955786
12853.63294 16273.10718 27904.15002 15354.37974 7103.884406 846.9172915
0 1293.988275 1293.988275 0 0 0 0 0 0 0 0 0 0 0 0 0 0 601.0434002 0
1022.492419 2187.417316 7613.442179 12114.84818 20347.6575 26001.46245
4802.886545 1145.186135 579.9361702 0 0 0 0 0 0 0 0 0 0
1981 1 1 3 2 55 0 0 0 0 0 0 0 0 0 0 4111.398272
3808.044462 0 12411.23447 2153.625383 4088.080409 13733.90088
73028.35079 72587.42033 55758.71499 26673.4204 6885.995675 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 568.5416305 0 2574.767331 14909.6067
94828.06148 38417.77327 4322.912438 0 0 0 0 0 0 0 0 0 0 0
1982 1 1 3 2 158 0 0 0 0 0 0 0 0 0 141.107601
391.7627012 3332.307139 4666.822319 22212.68479 30211.57036 47038.94247
149357.272 163726.4129 196877.531 110032.1401 47445.21335 13850.36024
4317.368022 2903.41653 1265.619761 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
842.5759597 3007.607563 1454.220001 8192.365199 17140.79626 58768.54555
111735.468 131941.1415 40437.51449 9174.058524 1221.213789 900.1212691
186.0885041 372.1770083 131.1479027 0 0 0 0 0 0
1983 1 1 3 2 224 0 0 0 0 0 0 0 0 0 1033.104686
2289.135478 2456.429082 5048.709867 9459.491108 12226.57873 51884.06434
46236.28544 77169.8221 44374.84056 19693.23106 5304.930922 2459.051214
1114.837508 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 237.3667002 305.9650694
531.3125784 4292.571954 4851.707936 21568.5045 42013.42948 48689.14646
44623.64969 8596.168177 2152.257731 643.2970558 456.7044719 0
880.9075103 880.9075103 0 0 0 0 0
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11019.27794 8334.636251 3523.390988 881.1727372 128.6275731 6.73213462
0 0 0 0 0 0 0 0 0
#TWL discard from Pikitch study (N=1)
#year season fleet gender partition Nsamp   4  6      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 62 4  6      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 62
1986  1    1   0     1    15   0  0      0      0      0      0      0
0      18     228     415     533     804     698     179     18     0
0      0      0      0      0      0      0      0  0  0      0  0  0
0  0      0      0      0      0      0      0      18     228     415
533     804     698     179     18     0      0      0      0      0
0      0      0      0  0  0  0  0  0
#TWL discard from WCGOP (N=10)
#year season fleet gender partition Nsamp     4 6 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 62 4 6 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 62
2002  1    1   0     1    118   0 0 0 0.00041424 0.000828481 0.00041424
0.017062756 0.035664119 0.070091189 0.09759817 0.185357737 0.066220353
0.041935635 0.047463792 0.106649823 0.158820597 0.111288431 0.041535877
0.003648064 0.011358431 0.003648064 0 0 0 0 0 0 0 0 0 0 0 0 0.00041424
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0.185357737 0.066220353 0.041935635 0.047463792 0.106649823 0.158820597
0.111288431 0.041535877 0.003648064 0.011358431 0.003648064 0 0 0 0 0 0
0 0 0
2003  1    1   0     1    151   0 0 0 0 0.000159582 0.000159582
0.000478745 0.004422749 0.034585672 0.05051657 0.026343116 0.029120547
0.063290815 0.0590463 0.210750216 0.230833919 0.139644332 0.073853911
0.0472177 0.014213054 0.010368959 0.001004692 0.003989539 0 0 0 0 0 0 0
0 0 0 0 0.000159582 0.000159582 0.000478745 0.004422749 0.034585672
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0.230833919 0.139644332 0.073853911 0.0472177 0.014213054 0.010368959
0.001004692 0.003989539 0 0 0 0 0 0 0
2004  1    1   0     1    169   0 0 0 0 0.000877672 0.003170212
0.001316508 0.003344787 0.001852744 0.011556348 0.043422163 0.043740165
0.049823976 0.067722578 0.225189881 0.171296712 0.237653043 0.066468373
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0.237653043 0.066468373 0.03325045 0.022716034 0 0.016378935
0.000219418 0 0 0 0 0 0 0
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0.012492418 0.012549572 0.033116664 0.011074908 0.01059667 0.010323573
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0.024203799 0.020496041 0.027099379 0.000601776 0 0 0 0 0 0 0
2009 1 1 0 1 399 0 0.00075435 0.003063823 0.004993623
0.019323389 0.01565856 0.009737843 0.01126201 0.065455708 0.059766056
0.048658789 0.057091309 0.034382952 0.041093452 0.110455815 0.280892895
0.127942659 0.04483543 0.019870622 0.018562175 0.006039979 0.019926453
0.000232108 0 0 0 0 0 0 0 0 0.00075435 0.003063823 0.004993623
0.019323389 0.01565856 0.009737843 0.01126201 0.065455708 0.059766056
0.048658789 0.057091309 0.034382952 0.041093452 0.110455815 0.280892895
0.127942659 0.04483543 0.019870622 0.018562175 0.006039979 0.019926453
0.000232108 0 0 0 0 0 0 0
2010 1 1 0 1 176 0 0.00010837 0 0.001062027 0.002227275
0.005150579 0.010316502 0.021524613 0.025572076 0.019244472 0.009994735
0.040721305 0.059260631 0.190968716 0.219714411 0.170839415 0.08290886
0.068215058 0.015157367 0.049796139 0.003922998 0.001517182 0.0016689 0
0.00010837 0 0 0 0 0 0 0.00010837 0 0.001062027 0.002227275 0.005150579
0.010316502 0.021524613 0.025572076 0.019244472 0.009994735 0.040721305
0.059260631 0.190968716 0.219714411 0.170839415 0.08290886 0.068215058
0.015157367 0.049796139 0.003922998 0.001517182 0.0016689 0 0.00010837
0 0 0 0 0
2011 1 1 0 1 150 0 0.002185965 0.002595833 0.024728729
0.083032514 0.04702671 0.075279169 0.066503593 0.086260228 0.293040714
0.146802349 0.060185319 0.053015343 0.025548466 0.019218275 0.007741959
0.002732456 0.004102377 0 0 0 0 0 0 0 0 0 0 0 0 0.002185965
0.002595833 0.024728729 0.083032514 0.04702671 0.075279169 0.066503593
0.086260228 0.293040714 0.146802349 0.060185319 0.053015343 0.025548466
0.019218275 0.007741959 0.002732456 0.004102377 0 0 0 0 0 0 0 0 0 0 0 0
#AKSHLF (N=9)
#year season fleet gender partition Nsamp F4 F6 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 F62 M4 M6 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 M62
1980 1 3 3 0 54 0 0 0 0.085607806
0.711003314 0.200154463 0.652158114 2.557541498 1.260406023 2.906166924
9.908796555 10.28368534 7.689484089 4.690205958 4.657968323 3.559396444

2.131293919 2.61906414 0.839453953 0.767149676 0.385689688 0.239313408
0 0 0 0 0 0 0 0 0 0 0 0
0.432028738 0.472686992 1.123652283 2.858100866 1.893887677 3.537584122
5.111525401 5.637092768 6.212701515 5.331207926 4.243478161 3.087463828
2.891183848 0.767149676 0.255716559 0 0 0 0 0
0 0 0 0 0 0
1983 1 3 3 0 205 0 0 0 0.086023124 0.3585804
0.51813282 2.264531039 5.338247026 0.927737264 2.18513411 1.924821789
2.466371005 6.629168062 3.280167597 2.053156578 2.241027248 2.267714515
4.744853944 8.593220892 5.466384428 1.883872555 0.956207327 0.227324737
0 0 0 0 0 0 0 0 0 0 0.156365982 0.708496832
0.477867002 2.433433717 4.444196623 1.24022505 2.900394269 1.116787267
2.283165536 5.344864813 3.392759828 2.459123033 3.990177612 7.402880004
5.508537704 1.421172582 0.306875686 0 0 0 0 0 0 0
0 0 0
1986 1 3 3 0 169 0 0 0 0.053815215
0.242891337 0.971017847 0.311189555 1.213975355 1.124803031 0.732900647
2.722865806 5.978745739 8.297019285 9.604379846 6.245260118 4.646361021
2.310650342 1.220978627 1.450753973 1.121910196 0.435395154 0.254992794
0.072565859 0 0 0 0 0 0 0 0 0.040268329 0
0.036179609 0.336353558 1.02419469 0.241435399 0.748094887 1.236745417
1.039758187 2.128656175 8.821745928 13.17018685 11.06471071 6.321238845
1.962735543 1.035821841 0.817565154 0.671573697 0.217697577 0.072565859
0 0 0 0 0 0 0 0 0
1989 1 3 3 0 290 0 0 0.084666398 0.084666398
0.837369999 2.444690636 2.919222382 4.160137442 5.492347168 5.504379982
6.187020475 5.240222359 4.246492909 4.258320736 1.65210194 2.299252401
1.991027032 1.584011336 1.544172328 0.725273927 0.219000854 0
0.066797771 0 0 0 0 0 0 0 0 0 0 0.115560065
1.251205106 3.700303599 3.048366894 4.62217863 4.705095039 5.803122303
4.968807042 4.776544259 4.2600844 3.845534396 3.246055374 1.53949547
0.763877113 0.756251917 0.564839545 0.34099881 0.150505565 0 0
0 0 0 0 0 0 0
1992 1 3 3 0 132 0 0 0 0.054486168
0.054486168 0.218205444 0.182146301 2.268320846 7.01389238 1.6554459
4.855550731 7.887346149 15.22556089 6.883371569 1.644770483 0.112573343
0.122852083 0.127107246 0.127107246 0.061426041 0.197043615 0 0
0 0 0 0 0 0 0 0 0 0 0 0.108972336
0.23359587 0.311420817 2.425038515 6.477672676 1.817369823 5.909217268
10.83569646 17.27887851 4.331847336 0.685692719 0.450157279 0.249959329
0.192788451 0 0 0 0 0 0 0 0 0 0 0 0
1995 1 3 3 0 283 0 0 0 0.055323155 0.0579755
2.792784601 0.236992885 1.755948779 1.78378972 3.660065015 8.668013886
5.514997139 3.097656194 2.664315337 2.389944969 3.733799442 3.10280146
3.414274403 3.418135549 3.313054844 1.804610227 0.728667829 0.127285669
0 0 0 0 0 0 0 0 0 0 0.116914925 0.315134709
2.930393003 0.315778198 1.58013033 3.389929469 4.131112006 8.843210707
4.799606732 2.395783102 2.447876919 3.887925042 6.256735921 4.825103632
1.14876664 0.127285669 0.167876394 0 0 0 0 0 0 0
0 0 0
1998 1 3 3 0 326 0 0 0 0.166015745
1.319666735 0.294360889 1.517200187 2.053249422 6.610049534 14.62690127
6.828416444 6.059522665 3.897657058 1.469067917 0.646272334 0.914011098
0.353257498 0.156332023 0.114508974 0.781017589 0.063506183 0.026200241
0 0 0 0 0 0 0 0 0 0 0 0.538549148
1.792917766 0.182440366 1.704065447 1.773135705 7.728668443 15.26098968
8.487142675 6.28323573 3.330782271 2.378119371 1.245993906 1.074043899

0.157574172 0.076595262 0 0 0 0 0.088532353 0
0 0 0 0 0 0
2001 1 3 3 0 346 0 0 0 0.09907038 0.769176408
0.684721928 1.489401487 13.78491152 11.95740645 0.633662764 1.421645471
1.99667697 1.755009519 3.607731529 12.37694765 5.750071042 0.331091695
0.378693774 0.724012424 0.214069416 0.107861605 0.015398948 0.045781676
0 0 0 0 0 0 0 0 0 0 0.067182638 0.198675374
0.724878222 1.562376727 13.45399567 12.11491129 0.706608743 1.228201382
1.586385352 1.061585726 3.677888738 3.851749235 0.883647734 0.459457028
0.182818659 0.033610622 0.062684209 0 0 0 0 0 0 0
0 0 0
2004 1 3 3 0 371 0 0 0 0 0.026982377 0
0.632555449 1.338322352 0.853609908 1.861618112 4.957416326 10.60213384
8.532965525 8.456054094 5.665285118 1.310081415 0.763634564 0.222228973
0.096744577 0.070686156 0.025602645 0 0 0 0 0
0.013448734 0 0 0 0 0 0 0 0.142021439 0.141172911
0.712824867 1.261012608 1.078808505 1.469344458 6.037390534 16.72390925
11.08084273 10.5775407 3.641786464 1.286554655 0.24891405 0.126909368
0.01655363 0.025043673 0 0 0 0 0 0 0 0 0 0
#AKSLP (N=4)
#year season fleet gender partition Nsamp F4 F6 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 F62 M4 M6 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 M62
1997 1 4 3 0 47 0 0 0 0 0 0
0.483162203 5.119658032 8.865704307 8.871780439 14.07394753 6.189300967
0.637362583 0.168815878 1.351805773 0 0.179069811 0
0.36200366 0.17880465 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0.377983001 4.307832576
16.17938986 10.02465972 8.801847767 7.278500158 1.134848524 1.70471581
1.928873074 0.723727788 0.705238785 0.180397765 0.170569338 0 0
0 0 0 0 0 0 0 0 0
1999 1 4 3 0 50 0 0.099160609 0 0 0
0.139853068 0.139853068 0.197350748 0.396223048 0.681712152 0.892409864
7.477594831 22.21741689 11.99273985 3.648955742 0.539458418 1.000717512
0.527481208 0.210531573 0.225324974 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0.098190139 1.618514132 0.365488712 0.873598364 15.49188846 22.3447159
5.792986841 1.362207991 0.928480591 0.466937394 0.270207919 0 0
0 0 0 0 0 0 0 0 0 0
2000 1 4 3 0 43 0 0 0 0 0
0.117518001 0.591502381 0.327465736 1.063852711 9.675612167 10.638987
5.644377709 6.683279066 9.920151445 1.552642188 0 0 0 0
0 0.672361804 0.463870373 0 0 0 0 0 0 0 0 0
0 0 0 0 0.659822575 2.158128245 0.236368494
1.419502066 10.21468483 14.13108349 3.690707155 7.738720595 7.201697718
1.619338982 0.899508649 2.123863372 0 0 0 0.554953249 0
0 0 0 0 0 0 0 0
2001 1 4 3 0 48 0 0 0 0 0 0 0
0.925327417 6.447317712 3.656054471 1.565475095 2.121317613 5.088532782
4.149888463 16.8723884 9.318815706 2.452712986 0 0.360956128
0.760390194 0.195289092 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.411283982 0.81097655 5.879927088
1.612469747 2.044653958 6.329925363 3.818834612 7.998944915 12.29789765

2.504858221 1.458560509 0 0.721912255 0.195289092 0 0 0
0 0 0 0 0 0 0
#NWSLP (N=3)
#year Season Fleet gender partition Nsamp F4 F6 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 F62 M4 M6 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 M62
2000 1 5 3 0 43 0 0 0 0 0
0.055422438 0.298781534 0.338302827 0.067843015 2.44029948 1.580276293
3.17521869 13.16970592 12.17986314 1.564683908 0.066446577 1.249039861
1.932550514 3.747126601 8.118776642 2.54487793 0.624523439 0 0
0 0 0 0 0 0 0 0 0 0 0 0.295707968
0.732077213 0.053808465 0.108325674 0.279301579 1.948170968 2.723250042
10.8111998 5.545857682 2.283084452 9.062965026 10.50441857 0.624523439
1.249046879 0 0.624523439 0 0 0 0 0 0 0 0 0
2001 1 5 3 0 80 0 0 0 0 0
0.128910665 0.823697599 4.305546968 9.115705484 1.378814823 1.599758602
2.147109527 2.726391318 3.967119371 12.91594837 3.328774137 0.994580904
1.971576336 1.660380252 0.500233731 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.64710087 0 1.041549698
3.446233221 9.64297286 2.296623144 0.698101214 3.849215084 2.158907376
6.401656151 6.089272862 7.984818617 6.724847951 0.696221473 0.568918481
0 0.189012913 0 0 0 0 0 0 0 0 0
2002 1 5 3 0 118 0 0 0 0 0
0.119564461 0.609046108 3.471583472 1.507528554 9.94582967 16.73643556
6.191392653 4.057452087 3.646068812 2.384830379 1.439924091 0.337223562
0.098783216 0.25588888 0.049384722 0.206504158 0.308096767 0.154048384
0 0 0 0 0 0 0 0 0 0 0 0 0.186893493
0.303510846 2.809241526 0.793984043 8.137599663 14.95340746 8.108280066
4.643830249 3.662484481 2.165367208 0.977352023 0.443305692 0.858338423
0.436819299 0 0 0 0 0 0 0 0 0 0 0
#NWCBO (N=10)
#year Season Fleet gender partition Nsamp F4 F6 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 F62 M4 M6 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 M62
2003 1 6 3 0 268 0 0 0 0 0.009661759
0.064115111 0.048337562 0.127862008 0.607772204 3.452489019 4.726184253
3.464001433 4.108514403 1.411052155 5.893019051 10.74680449 9.860567278
6.221079688 2.243290534 2.771110627 2.644775169 1.633686852 0.376394363
0 0 0 0 0 0 0 0 0 0 0 0 0.126051627
0.133649859 0.31517893 0.600035893 3.069303809 4.589951149 4.368660813
3.364083349 1.444939269 7.695890247 8.301280572 3.91675591 0.945197344
0.61115708 0.072142924 0 0.025957108 0.009046153 0 0 0 0 0
0 0
2004 1 6 3 0 164 0 0 0.02055708 0.22882472
0.364659185 0.580345692 1.024302284 1.531700874 2.529457048 2.279617294
8.958001836 13.92555905 6.58279921 3.843400442 1.568357607 0.759263521
0.531817754 0.256281651 0.394324475 0.085428913 0.116549482 0 0
0 0 0 0 0 0 0 0 0 0.074102166 0.165525198
0.571359602 0.951004084 0.385216264 1.880306201 1.101294653 4.267079816

11.56215639 16.68674629 8.126356023 3.48749837 1.312493204 1.441463436
1.245061912 0.839537899 0.19906275 0.122487628 0 0 0 0
0 0 0 0 0 0
2005 1 6 3 0 247 0 0.034332186 0.026858867 0.125028112
0.695285723 0.850273002 1.417745891 1.671703499 1.016596838 1.174726032
0.596044897 2.446154388 4.46929116 4.509581194 4.203528829 5.240752721
12.45120191 3.815772796 1.131533367 0.369514891 0.225656096 0.063119204
0.438508714 0.022170269 0 0 0 0 0 0 0 0.034332186
0.05939815 0.154827756 0.891977938 1.336489583 1.925678446 2.785058147
0.93052362 1.585234941 1.132729792 4.048871 6.169774741 4.452381691
11.78537945 9.893471388 4.809145123 0.748715621 0.228752928 0.031876915
0 0 0 0 0 0 0 0 0 0
2006 1 6 3 0 264 0 0.023445712 0.064551679 0.07757188
1.189940013 1.128602477 2.09308497 4.772336117 6.340411285 6.331090271
2.69392517 2.115630722 2.600755931 6.677650854 4.738412299 3.66480673
2.044060524 2.503162863 0.935958435 0.851046621 0.190493488 0.047464126
0 0 0 0 0 0 0 0 0 0 0.023445712 0.064557523
0.203560441 1.160603653 1.493542115 1.374525322 4.830447822 5.324654446
6.588233397 2.370938865 2.374106256 4.097126492 6.492153897 5.209541376
4.410160642 1.835404206 0.984340053 0.078255616 0 0 0 0
0 0 0 0 0 0 0
2007 1 6 3 0 275 0 0 0.023683149 0.033904175
0.618285289 0.462967357 2.594178714 4.208857822 4.726808051 6.033860883
3.086900487 3.967552466 2.472035711 3.633991638 4.62066217 2.576601558
1.291547663 1.120128431 0.841585201 0.83830938 0.541014097 0.256359087
0.032636675 0.032636675 0 0 0 0 0 0 0 0 0.023688936
0.041358695 0.513250641 0.36009151 2.991114536 4.238363367 5.507304388
6.613617648 4.332395654 4.368620685 4.557084607 8.023523177 5.223158693
4.825962426 2.594855872 1.171331954 0.375926577 0.065892631 0.125314647
0.032636675 0 0 0 0 0 0 0 0
2008 1 6 3 0 222 0 0 0.086163009 0.097809384
0.09536221 0.712123675 1.658776567 1.016352744 6.823957497 8.349066411
12.36473499 6.773811766 3.190544431 1.688034061 1.971820892 2.091394996
0.660837739 0.375662497 0.5376685 0.296344593 0.179299105 0.143669652
0 0 0 0 0 0 0 0 0 0 0.086163009 0.060341642
0.19269457 0.94668004 1.154026627 1.847767412 8.286785646 6.674532527
10.95567874 9.341742458 2.601613265 2.356605025 2.517664735 2.650696357
0.739314063 0.375887435 0.066566228 0.031805502 0 0 0 0
0 0 0 0 0 0
2009 1 6 3 0 283 0 0 0 0.106325939
1.275794266 1.422107182 0.986268933 2.873716348 3.769751332 3.838106293
4.406887966 3.884690266 3.832962796 3.160537183 3.691262378 3.946079231
3.865520277 2.076460806 1.107611363 1.358454719 1.283003262 0.623200142
0.063575963 0 0 0 0 0 0 0 0 0 0 0.056083468
2.175109749 2.054325319 1.210134804 5.724086709 4.885039691 4.125962128
5.225810995 4.313954019 3.749798344 4.204514082 5.306540949 5.656492248
1.746570496 1.226451795 0.637469633 0.075428957 0.053909969 0 0
0 0 0 0 0 0 0
2010 1 6 3 0 272 0 0 0.248112791 0.05252704
0.176611055 0.255095037 3.115667149 8.235133989 3.960662556 4.298732529
5.935334568 6.464792107 5.124615141 3.967368605 1.534784981 1.391869892
2.150460002 1.554665602 0.778117199 0.508273271 0.514084444 0.051604544
0 0 0 0 0 0 0 0 0 0 0.248101743 0.019366895
0.151504798 0.520077907 3.15156164 8.663039618 5.588940034 4.618059812
6.029998138 6.893487658 5.390724892 3.449991899 1.582323914 2.049300292
0.727158954 0.372997776 0.224851526 0 0 0 0 0
0 0 0 0 0 0

```
2011  1    6   3    0    234    0  0      0.020313128 0.047110092
0.404284202 0.425786275 0.370262119 0.315392605 2.806783353 6.868667731
5.49934146 2.862639642 3.45470957 5.004066958 5.057357632 3.441876679
2.845387923 2.495385984 1.948038633 2.099819098 1.834804976 1.172832856
0.20949478  0      0  0  0      0  0  0  0  0      0.020313128 0
0.157729997 0.577513791 0.515698342 0.344731116 2.338252865 8.243072285
6.124586288 2.702680977 5.330299649 5.99526579 6.32053096 5.865800885
3.910392726 1.688834451 0.645817888 0      0.034123167 0      0      0
0  0  0  0  0  0
2012  1    6   3    0    254    0  0      0.00830749 0.00830749
0.188935526 0.113834048 0.604845807 2.374385373 1.491594764 4.171217376
15.67937323 9.440892348 4.557474707 3.076960799 2.777494051 1.787950931
0.937195846 0.866812241 0.538414248 0.341335113 0.34829689 0.151655821
0.144845317  0      0  0  0      0  0  0  0  0      0.00830749
0.00830749 0.215210013 0.105485588 0.653660192 2.964138398 1.960466872
5.250850754 15.12388703 9.705216143 3.944857173 3.676820851 2.872406182
1.336670785 1.464056505 0.774818446 0.236032315 0.088678362 0      0
0      0      0  0  0  0  0  0

#Age composition set-up
36 # Number of Age Bins
0 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

2 # Number of Ageing Error Sets
# Ageing error for "late" period (2005 forward)
0.5    1.5    2.5    3.5    4.5    5.5    6.5    7.5    8.5    9.5
10.5    11.5   12.5   13.5   14.5   15.5   16.5   17.5   18.5   19.5
20.5   21.5   22.5   23.5   24.5   25.5   26.5   27.5   28.5   29.5
30.5   31.5   32.5   33.5   34.5   35.5   36.5   37.5   38.5   39.5
40.5   41.5   42.5   43.5   44.5   45.5
0.101891  0.101891  0.203782  0.305673  0.407564  0.509455  0.611346
0.713238  0.815129  0.91702  1.01891  1.1208  1.22269 1.32458 1.42648
1.52837 1.63026 1.73215 1.83404 1.93593 2.03782 2.13971 2.2416  2.34349
2.44539 2.54728 2.64917 2.75106 2.85295 2.95484 3.05673 3.15862 3.26051
3.36241 3.4643  3.56619 3.66808 3.76997 3.87186 3.97375 4.07564 4.17753
4.27943 4.38132 4.48321 4.5851
# Ageing error for "early" dataset
0.5    1.5    2.5    3.5    4.5    5.5    6.5    7.5    8.5    9.5
10.5    11.5   12.5   13.5   14.5   15.5   16.5   17.5   18.5   19.5
20.5   21.5   22.5   23.5   24.5   25.5   26.5   27.5   28.5   29.5
30.5   31.5   32.5   33.5   34.5   35.5   36.5   37.5   38.5   39.5
40.5   41.5   42.5   43.5   44.5   45.5
0.156547  0.156547  0.313095  0.469642  0.626189  0.782737  0.939284
1.09583  1.25238  1.40893  1.56547  1.72202 1.87857 2.03512 2.19166
2.34821 2.50476 2.6613  2.81785 2.9744  3.13095 3.28749 3.44404 3.60059
3.75714 3.91368 4.07023 4.22678 4.38333 4.53987 4.69642 4.85297 5.00951
5.16606 5.32261 5.47916 5.6357  5.79225 5.9488  6.10535 6.26189 6.41844
6.57499 6.73154 6.88808 7.04463

773    # Number of age comp observations
3    # Age-Length Bin Option (1=poplenbins; 2=datalenbins; 3=lengths)
0    # Combine Males & Females Below this Bin
#TWL updated for 2013 assessment (N=762)
#TWL marginal ages (N=30), 2002-2008 are used in the model, the rest
are ghost compositions
```

#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp Age_0
Age_1 Age_2 Age_3 Age_4 Age_5 Age_6 Age_7 Age_8 Age_9 Age_10 Age_11
Age_12 Age_13 Age_14 Age_15 Age_16 Age_17 Age_18 Age_19 Age_20 Age_21
Age_22 Age_23 Age_24 Age_25 Age_26 Age_27 Age_28 Age_29 Age_30 Age_31
Age_32 Age_33 Age_34 Age_35 Age_0 Age_1 Age_2 Age_3 Age_4 Age_5 Age_6
Age_7 Age_8 Age_9 Age_10 Age_11 Age_12 Age_13 Age_14 Age_15 Age_16
Age_17 Age_18 Age_19 Age_20 Age_21 Age_22 Age_23 Age_24 Age_25 Age_26
Age_27 Age_28 Age_29 Age_30 Age_31 Age_32 Age_33 Age_34 Age_35
1980 1 -1 3 2 2 -1 -1 53   0 0 0 0 0 376.7662985 2843.551403
5160.263577 4903.886209 7733.666772 568.3924995 2667.128815 5374.743042
2012.772082 2030.397967 2796.774388 0 3769.835618 5711.024613
3494.212323 0 4381.56719 3134.737997 2634.364797 0 259.6560989
2804.285868 2071.017044 0 0 10883.29991 0 1427.270943 2025.317571
2393.658294 22971.9882 0 0 0 0 0 1257.63867 0 15929.72404 6952.989348
8579.441933 3898.922305 6562.591537 4062.953191 2071.496895 2071.496895
191.626201 6944.83384 0 175.896067 778.9682966 2256.636993 1614.689998
2664.988008 778.9682966 0 0 0 2025.317571 778.9682966 200.6240796 0
376.7662985 0 778.9682966 0 5768.694955
1981 1 -1 3 2 2 -1 -1 55   0 0 0 0 4425.280631 8592.731461 868.6052688
2940.063655 1182.487627 17443.62336 6650.643821 77748.468 57258.98998
32881.53155 25799.78651 20177.3663 5834.873454 3024.518522 3534.70714 0
2181.515293 568.5416305 3557.910226 0 568.5416305 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 868.6052688 1522.428144 13521.24659 34718.29918 11401.54918
29576.21243 4874.147767 24289.31756 24815.28483 9939.814952 0
47.37846921 0 0 0 47.37846921 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1982 1 -1 3 2 2 -1 -1 106   0 0 0 0 325.1388715 1004.248345
3504.736206 5157.875771 3949.348127 3134.431887 15115.03152 3094.420069
10800.81047 9104.121769 9710.599113 9920.963524 6718.26057 2066.516647
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921.4293185 0 1730.672532 0 1017.75708 1126.850647 652.0191128 0
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1852.166269 1728.524557 2852.830301 499.1197521 2662.022277 2283.442156
3902.02018 4039.469674 3580.487408 2989.149676 6001.876627 4477.263946
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1170.493941 291.1595564 1715.837956 0 4529.297721
1983 1 -1 3 2 2 -1 -1 150   0 0 0 11.37607129 1907.191721 5882.956858
3977.133359 4209.093813 9334.205478 4241.766628 7415.88334 7354.287524
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10590.82388 9070.818605 7851.572532 3350.478701 1286.354204 1077.591889
1225.309277 2652.157506 1026.56143 842.8437814 917.2388002 539.8688277
1113.604071 580.3930524 876.2774011 1089.951682 1659.747706 3355.025351
2222.23525 788.1527314 173.4098036 1088.875001 685.0917577 345.0025577
889.9709292 243.9873535 608.9410316 63.7247921 771.5707412 10134.58386
0 0 0 252.9161132 1586.99014 4012.119639 8069.158269 10179.55613
5379.938414 1230.956569 484.3600775 550.9563388 2768.35042 1482.690765

645.3232175 1221.450797 1194.765014 1212.618748 1956.152553 382.5541725
396.9977278 263.3793179 118.7742379 928.2426514 1235.815523 12.0572291
420.4114031 187.7758974 297.4082324 24.92968219 185.4670327 123.122946
776.2557392 245.0014094 110.3349758 1482.11052
2003 1 1 3 2 2 -1 -1 332 0 0 143.3159424 1342.613987 1116.831725
1423.62872 4757.037806 9957.719465 6719.998595 2758.833985 1287.77649
1506.683115 1040.283396 1734.744743 321.0835887 681.3414284 1556.010879
1736.393531 1782.249065 640.0735199 277.0330819 1332.99666 964.6261014
389.1351725 1379.599849 943.5441251 93.92972385 356.1485233 319.3923868
335.3098738 375.7632272 303.2961279 476.9170706 104.5294978 118.8583863
1723.682096 0 0 216.5193184 1843.868996 1536.928415 2282.953276
4182.830159 5144.736745 3558.746003 1873.598272 594.9523941 1033.08804
577.7862093 877.1126538 457.2022309 239.1516937 1789.657557 675.5489364
632.5812727 147.6306855 729.271685 561.9662342 822.0016795 488.1661454
685.6553365 415.9569828 212.8292723 208.3811783 343.6601955 0
128.4966855 9.187417237 306.5140232 295.3913483 170.3321394 1352.962063
2004 1 1 3 2 2 -1 -1 246 0 0 0 0 480.6959127 4977.95682 8245.251095
9341.852456 13619.09078 13607.21826 3821.201899 1455.339923 2456.063675
1808.669775 3541.485635 2662.009587 4078.410734 2329.358883 2747.821144
468.0788873 2840.301767 1258.034102 1155.760407 2518.512114 4482.720872
2217.755896 624.6515424 1116.308443 143.9024748 638.8212889 51.30417067
1266.140594 794.2164364 12.21115416 799.1822403 6973.802631 0 0 0
2.684521774 5439.426758 9593.406918 10819.72968 15951.49013 11252.77173
6757.955065 7082.442153 2221.470208 1472.770948 1567.552751 1269.864348
947.9965137 401.1854402 606.7523649 2596.069845 322.7999702 628.2854262
288.1689809 59.41824369 767.8618828 4033.588125 618.6248338 2060.812538
0 312.1724593 156.7103141 248.7968885 91.64244896 0 0 0 2556.421078
2005 1 1 3 2 1 -1 -1 272 0 0 0 27.18839295 1530.874907 7913.339397
11731.06248 6438.34458 5768.518788 4070.377121 4002.232747 809.0455446
853.2358257 527.4153269 674.1597166 1148.939467 1207.642384 1041.184043
573.2731756 691.4323069 389.3303537 260.0847321 460.308107 935.2991462
948.6595751 589.5704433 276.5280472 277.4141444 258.8952255 20.70908434
137.6264976 20.70908434 381.8455202 84.98924686 259.6951599 1824.737088
0 0 0 133.0685726 1484.028975 8143.488011 10879.54384 5129.682864
4858.767888 2797.871945 2436.423996 575.9543788 653.99468 1114.255968
540.6240308 805.2395877 275.1511438 329.4696505 815.6421685 828.4386798
751.8198723 308.7898677 764.6619433 597.4926003 436.9299515 1156.441548
486.2266004 168.8750012 95.33865723 83.60112702 530.2204169 0
358.5374634 107.653046 13.39919689 1335.912353
2006 1 1 3 2 1 -1 -1 392 0 0 0 29.77233037 41.36739723 382.7993195
7322.259599 16350.67124 9030.408111 4324.657883 4262.138651 2823.832304
2605.839923 744.5436329 743.0565688 1247.85281 321.7873759 837.6951042
550.3823255 950.8935265 531.8434815 260.3667142 463.8969668 589.1098044
359.1710734 565.8393384 203.1373096 46.4439492 338.022042 461.6372644
278.1505747 228.4560461 65.05431149 15.15910416 29.704547 1258.860796 0
0 0 9.2652127 22.4453692 1385.414663 8033.191131 12842.43903
9275.037581 3937.839569 5111.462343 4082.669153 926.7178716 1021.403403
247.8345693 1833.082454 892.9588622 486.4551611 953.7727246 716.0612034
585.4889945 419.0868106 557.2052631 580.640465 356.3306129 952.4074072
656.5308419 201.713872 165.14291 86.85659229 407.3509137 307.5832312
4.80869583 20.68087665 223.4079597 383.8253761
2007 1 1 3 2 1 -1 -1 472 0 0 0 0 9.504166146 845.9857981 6782.184534
15720.83472 13178.63686 7293.235977 4430.767429 5415.745058 2594.731353
2508.706305 2069.645382 774.9326102 811.5999974 2071.972557 1632.46543
722.9465751 2054.194663 1462.968558 510.1924753 1021.63089 1139.907132
1828.508957 1015.860457 838.9841695 1347.502009 1241.772384 80.43038705
680.4601813 587.1896862 663.8937178 167.435322 1591.825474 0 0 0 0

9.504166146 653.6057639 5013.367583 12937.73343 8269.00172 5495.741858
3999.421066 3872.980141 2834.247824 1450.482995 1170.016369 533.223491
451.5441649 1533.996181 805.5475895 839.7847174 1150.082165 733.049224
730.8193935 1390.703047 336.0805126 995.7077598 228.2019207 257.0705342
275.198865 209.709811 98.85295136 23.20176026 425.7433441 96.54880546
788.5104365 2633.553418
2008 1   1 3 2 1 -1 -1 487 0 0 0 57.39442787 384.9719484 224.6263289
1639.79547 7902.562836 12673.99631 8907.151335 4457.320734 2678.075787
2742.162747 2702.411853 1673.274425 957.4620778 698.1517773 985.5101078
1132.6203 894.1331169 931.3036596 1705.782097 1016.325119 818.5885451
662.0328717 1002.324029 745.8846375 722.2451603 984.6800384 617.6931633
259.0301687 504.3928375 145.4220996 203.1699987 377.2156454 1924.545292
0 0 0 21.59090411 254.1586327 413.0080073 3237.19097 9241.844194
12515.98981 6738.786431 3274.36564 2315.87777 3290.411957 1707.903685
843.5063968 756.4644421 3789.099446 692.5311181 593.1872667 571.6207324
903.4003857 248.8219945 383.9850621 640.5634628 815.661292 97.73969753
348.3720434 338.1310535 217.5372284 314.7878908 282.6564449 142.2029225
37.99069188 2627.024351 73.37183197 672.6252378
2009 1 -1 3 2 1 -1 -1 208 0 0 0 0 19.27934417 14.45950813 421.9057626
1229.010153 6384.29241 9583.684507 7455.922783 3764.888711 3748.303496
2771.191521 2070.220779 1547.621543 1433.664454 509.7473658 1095.136221
578.7427136 1723.048495 1327.494381 449.7039115 1265.706562 872.5114198
872.7859942 346.2908893 905.4378927 575.8418941 103.103013 356.3494262
309.0462758 0 207.9834567 0 1274.968238 0 0 0 4.819836042 0 28.91901625
229.6258958 1438.322144 6020.053288 9328.820013 8503.704849 2174.999259
2065.967335 3265.357581 2103.837035 1798.675501 1331.730284 116.3798257
299.5481332 696.1933709 925.9857024 596.5182939 69.69047734 623.1756772
324.2247445 559.5845673 531.103076 681.2909602 173.1708179 578.5215862
161.1303564 77.20930929 140.7291798 0 141.3973999 1008.012516
2010 1 -1 3 2 1 -1 -1 356 0 0 0 0 0 299.3291942 3475.066304
3047.701908 3838.13269 8957.487378 16710.06916 15673.78637 6135.760835
5142.575021 5677.271253 1475.710841 2551.085564 2394.826809 1705.737303
1419.035358 2212.198828 1136.243021 829.8812826 506.448341 1209.36639
1022.962038 1504.901035 920.128297 449.4539968 1180.62724 626.1684037
216.6341581 619.3714329 666.9915517 171.0290558 5470.123986 0 0 0
9.185359511 15.86990628 282.5922026 1851.346443 3347.775036 5253.651532
6255.34215 9285.999835 10621.50575 5123.410473 3868.629455 3719.653207
3437.982187 1987.749183 1284.403405 1007.352001 1212.078026 434.3419446
1004.770404 1366.56597 453.7915315 951.2924 579.1581825 666.0219391
319.9235573 666.2274136 697.4234884 966.1845845 736.7732498 376.3672274
108.511248 126.2148425 1530.346868
2011 1 -1 3 2 1 -1 -1 86   0 0 0 0 0 92.92483906 467.4173939 1211.8888
1224.411082 924.8745852 460.7342874 638.4516741 473.5845356 87.43533278
207.2514306 294.5595283 250.6589657 97.89243262 27.43652768 4.256968051
26.19952849 111.4016041 95.9424549 77.20708371 4.256968051 54.60082685
0 46.87806342 27.43652768 12.64227209 38.8830715 0 30.55108854
89.14319124 19.44153575 294.7673106 0 0 0 0 0 95.90118399 438.985251
2717.751683 587.589026 728.5633546 322.282062 887.3588557 727.772153
175.8838739 116.9225977 149.7256163 335.0463369 129.9281556 0
10.71211449 73.13206881 57.76554796 0 44.33576782 120.3613667
81.46405176 4.256968051 27.43652768 19.44153575 0 0 0 62.63489638
12.64227209 19.44153575 140.0107273
2012 1 -1 3 2 1 -1 -1 135   0 0 6.179673638 67.30416185 886.6412031
550.6700692 6611.328116 11143.48545 7304.334842 5737.136084 1346.581415
374.6860793 1458.843144 2318.752458 970.6366802 2318.092849 1137.824109
2196.833497 475.0835805 343.4233549 355.6707695 928.3243086 425.3876416
87.36959433 958.0146702 359.376092 363.5538861 432.2214323 289.151354

366.9192216 165.7530397 23.68512103 310.8220629 56.45418228 175.5099698
2590.480965 0 0 6.179673638 0 653.8303494 1422.273366 9126.10652
7473.766436 7193.941677 3983.78204 1302.655444 399.4455939 2478.444882
1738.479683 633.4787481 2557.356855 599.287357 525.3464671 372.9421716
170.0591451 1169.796349 844.3761187 166.0767416 771.9203761 132.4434086
368.8182608 80.17770866 13.92819095 301.1826601 37.93701389 256.2794554
330.8812469 181.2542564 13.92819095 610.6637763 1834.371295
#TWL WCGOP discard marginal ages (N=2)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp 0 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 0 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
2004 1   1   0   1   1   -1   -1   78   0 0.002521126 0.005042252
0.036309947 0.292008225 0.137401718 0.08493528 0.101543199 0.13816349
0.027801917 0.001260563 0.038447174 0.022311967 0 0.008823942
0.026408797 0.002521126 0.009139082 0.007563378 0.018656334 0.001260563
0.001260563 0 0.001260563 0 0.005357393 0.01739577 0.001260563 0 0 0 0
0 0 0 0.011345068 0 0.002521126 0.005042252 0.036309947 0.292008225
0.137401718 0.08493528 0.101543199 0.13816349 0.027801917 0.001260563
0.038447174 0.022311967 0 0.008823942 0.026408797 0.002521126
0.009139082 0.007563378 0.018656334 0.001260563 0.001260563 0
0.001260563 0 0.005357393 0.01739577 0.001260563 0 0 0 0 0 0 0
0.011345068
2005 1   1   0   1   1   -1   -1   207   0 0.013171064 0.056466155
0.017012383 0.042506283 0.229761351 0.126660875 0.129269256 0.146692004
0.041659433 0.059906629 0.006018945 0.068701636 0.012993603 0.000868422
0.001736844 0.001143422 0.035373714 0.000578948 0.000872186 0.001157896
0 0 0.000289474 0.000289474 0.000289474 0.001948949 0 0 0 0 0 0
0.003184213 0 0.00144737 0 0.013171064 0.056466155 0.017012383
0.042506283 0.229761351 0.126660875 0.129269256 0.146692004 0.041659433
0.059906629 0.006018945 0.068701636 0.012993603 0.000868422 0.001736844
0.001143422 0.035373714 0.000578948 0.000872186 0.001157896 0 0
0.000289474 0.000289474 0.000289474 0.001948949 0 0 0 0 0 0 0.003184213
0 0.00144737
#
#AKSHLF updated for 2013 assessment (N=210)
#AKSHLF CAAL (N=203)
#AKSHLF females
#year Season Fleet gender partition ageErr LbinLo LbinHi Nsamp F0 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 F0.1 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
1980 1   3   1   0   2   10   10   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 0 100 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
1980 1   3   1   0   2   12   12   5   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 0 100 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
1980 1   3   1   0   2   18   18   7   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 0 100 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
1980 1   3   1   0   2   26   26   1   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 0 100 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

1980 1 3 1 0 2 30 30 1 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 0 100 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
1980 1 3 1 0 2 32 32 1 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 0 100 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
1980 1 3 1 0 2 34 34 6 0 0 0 0 0 33.33333333
33.33333333 16.66666667 0 0 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 33.33333333 33.33333333 16.66666667 0 0
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
1980 1 3 1 0 2 36 36 3 0 0 0 0 0 0 0 33.33333333
0 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 33.33333333 0 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
1980 1 3 1 0 2 38 38 4 0 0 0 0 0 0 0 25 75 0 0 0
0 0 0 0 0 0 0 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 75 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1980 1 3 1 0 2 40 40 5 0 0 0 0 0 0 0 0 0 0 0 0 60
20 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
60 20 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1980 1 3 1 0 2 42 42 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
50 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 50 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1983 1 3 1 0 2 22 22 1 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 0 100 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
1983 1 3 1 0 2 24 24 1 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 0 100 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
1983 1 3 1 0 2 28 28 3 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 0 100 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
1983 1 3 1 0 2 30 30 8 0 0 0 0 0 37.5 37.5 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 37.5 37.5
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
1983 1 3 1 0 2 32 32 4 0 0 0 0 0 0 75 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 75 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
1983 1 3 1 0 2 34 34 4 0 0 0 0 0 0 0 0 25 0 25 0
25 0 0 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 25 0
25 0 25 0 0 25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1983 1 3 1 0 2 36 36 7 0 0 0 0 0 0 0 0
14.28571429 0 0 0 28.57142857 0 28.57142857 14.28571429 0 0 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 14.28571429 0 0
0 28.57142857 0 28.57142857 14.28571429 0 0 0 0 0 14.28571429 0 0 0 0 0
0 0 0 0 0 0 0 0 0
1983 1 3 1 0 2 38 38 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 25 25 0 25 0 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 25 25 0 25 0 25 0 0 0 0 0 0 0 0 0 0 0
1983 1 3 1 0 2 40 40 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 20 20 40 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 20 20 40 0 0 0 20 0 0 0 0 0 0 0 0 0 0
1983 1 3 1 0 2 42 42 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 0 100 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 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0

1983 1   3   1   0   2   44   44   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 0 100 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 0 100 0
1983 1   3   1   0   2   46   46   2   0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 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 0 100
1986 1   3   1   0   2   12   12   5   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 0 100 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
1986 1   3   1   0   2   14   14   10   0 84.06365806 15.93634194
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
84.06365806 15.93634194 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
1986 1   3   1   0   2   16   16   5   0 14.5118006 85.4881994 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
14.5118006 85.4881994 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1986 1   3   1   0   2   18   18   10   0 0 90 10 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 90 10 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1986 1   3   1   0   2   20   20   10   0 0 73.83901213
26.16098787 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 73.83901213 26.16098787 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
1986 1   3   1   0   2   22   22   10   0 0 33.22333564
55.70221915 11.07444521 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 33.22333564 55.70221915 11.07444521 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1986 1   3   1   0   2   24   24   10   0 0 0 52.28087763
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0 0 0 0 0 0 0 0 0 0 0
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1986 1   3   1   0   2   28   28   11   0 0 0 10.10164254
20.20328508 57.29372241 12.40134997 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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12.40134997 0 0 0 0 0 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
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19.75063597 19.08346903 0 0 15.13254653 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 86.8889835 0 0 0 0 0 0 0 13.1110165 0 0 0 0
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#AKSHLF males
#year Season Fleet gender partition ageErr LbinLo LbinHi Nsamp M0 M1
M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21
M22 M23 M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35 M0.1 M1.1 M2.1
M3.1 M4.1 M5.1 M6.1 M7.1 M8.1 M9.1 M10.1 M11.1 M12.1 M13.1 M14.1 M15.1
M16.1 M17.1 M18.1 M19.1 M20.1 M21.1 M22.1 M23.1 M24.1 M25.1 M26.1 M27.1
M28.1 M29.1 M30.1 M31.1 M32.1 M33.1 M34.1 M35.1
1980 1 3 2 0 2 12 12 2 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 0 100 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

1980 1   3   2   0   2   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 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
1980 1   3   2   0   2   16   16   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 0 100 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
1980 1   3   2   0   2   18   18   12   0 0 100 0 0 0 0 0 0 0 0 0
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1980 1   3   2   0   2   24   24   1   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 0 100 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
1980 1   3   2   0   2   28   28   1   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 0 100 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
1980 1   3   2   0   2   30   30   6   0 0 0 0 0 50 0 33.33333333
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 50 0 33.33333333 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
1980 1   3   2   0   2   32   32   9   0 0 0 0 0 0 44.44444444
33.33333333 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
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1980 1   3   2   0   2   34   34   14   0 0 0 0 0 0 7.142857143
21.42857143 28.57142857 28.57142857 14.28571429 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0
1980 1   3   2   0   2   36   36   6   0 0 0 0 0 0 0 0 50 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 50 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
1980 1   3   2   0   2   38   38   3   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 33.33333333 66.66666667 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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1983 1   3   2   0   2   22   22   1   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 0 100 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
1983 1   3   2   0   2   24   24   1   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 0 100 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
1983 1   3   2   0   2   26   26   3   0 0 0 66.66666667
33.33333333 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 66.66666667 33.33333333 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
1983 1   3   2   0   2   28   28   4   0 0 0 0 50 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 50 50 0 0 0 0 0
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0 0 0 0 0 0 0 0 0
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16.66666667 33.33333333 16.66666667 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 16.66666667 16.66666667
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3.545642625 7.581495371 37.21250511 0 0 0 0 0 0 47.09357256
2.471357827 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.095426505
3.545642625 7.581495371 37.21250511 0 0 0 0 0 0 47.09357256
2.471357827 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1998 1 3 2 0 2 34 34 6 0 0 0 0 17.0624472 0 0
30.82677261 0 18.37276537 0 14.57742371 0 0 19.16059112 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 17.0624472 0 0 30.82677261 0
18.37276537 0 14.57742371 0 0 19.16059112 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1998 1 3 2 0 2 36 36 3 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 61.55180621 38.44819379 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 61.55180621 38.44819379 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1998 1 3 2 0 2 38 38 2 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 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 0 100
2001 1 3 2 0 2 12 12 58 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 0 100 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
2001 1 3 2 0 2 14 14 44 0 94.48203416 5.517965842
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
94.48203416 5.517965842 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 16 16 16 0 2.919198916 97.08080108
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.919198916 97.08080108 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 18 18 123 0 0 90.96027907
7.725469243 0.238704504 0 1.07554718 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 90.96027907 7.725469243 0.238704504 0
1.07554718 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 20 20 79 0 0 80.42540348
17.28390358 2.290692934 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 80.42540348 17.28390358 2.290692934 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 22 22 7 0 0 29.16007459
29.36933011 25.88346652 15.58712878 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 29.16007459 29.36933011 25.88346652
15.58712878 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 24 24 19 0 0 0 20.51636809
62.44647781 13.79677928 3.240374822 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.51636809 62.44647781 13.79677928
3.240374822 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 26 26 35 0 0 0 5.084223772
46.74657177 43.47154206 4.697662398 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.084223772 46.74657177 43.47154206
4.697662398 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 28 28 18 0 0 0 0 10.44067167
23.10316802 65.66544511 0.790715202 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 10.44067167 23.10316802 65.66544511
0.790715202 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 30 30 37 0 0 0 0 0.594117561
3.44806314 80.76516425 14.05927308 1.133381971 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.594117561 3.44806314
80.76516425 14.05927308 1.133381971 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 32 32 33 0 0 0 0 0 4.157331011
7.25010035 82.41304922 4.485684502 1.309225253 0 0 0 0 0 0 0 0 0
0.384609666 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.157331011
7.25010035 82.41304922 4.485684502 1.309225253 0 0 0 0 0 0 0 0 0
0.384609666 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 34 34 6 0 0 0 0 0 0 12.83335798 0
17.69088243 0 0 0 30.11020273 30.11020273 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 9.255354122 0 0 0 0 0 0 0 0 12.83335798 0 17.69088243 0 0 0
30.11020273 30.11020273 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
9.255354122 0 0
2001 1 3 2 0 2 36 36 2 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
0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 3 2 0 2 38 38 1 0 0 0 0 0 0 0 0 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
2001 1 3 2 0 2 42 42 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 20.53252618 0 0 0 0 0 0 0 0 0 0 0 0 79.46747382 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.53252618 0 0 0 0 0 0 0 0 0 0 0
0 79.46747382
2004 1 3 2 0 2 12 12 60 0 61.43520244 38.56479756
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
61.43520244 38.56479756 0 0 0 0 0 0 0 0 0 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 3 2 0 2 14 14 27 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 0 100 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
2004 1 3 2 0 2 16 16 21 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 0 100 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
2004 1 3 2 0 2 18 18 33 0 4.594011802 91.76455271
3.641435493 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 4.594011802 91.76455271 3.641435493 0 0 0 0 0 0 0 0 0 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 3 2 0 2 20 20 23 0 2.349634533 47.6750817
26.88176897 23.0935148 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 2.349634533 47.6750817 26.88176897 23.0935148 0 0 0 0 0
0 0 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 3 2 0 2 22 22 22 0 0 2.216785706
18.86155744 78.92165686 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 2.216785706 18.86155744 78.92165686 0 0 0 0 0 0 0 0 0
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 3 2 0 2 24 24 62 0 0 0 23.26001465
62.52937977 12.39308251 1.817523068 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 23.26001465 62.52937977 12.39308251
1.817523068 0 0 0 0 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    3   2    0     2    26   26   99   0 0 0 3.537778082
54.09725416 33.48720822 8.877759545 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.537778082 54.09725416 33.48720822
8.877759545 0 0 0 0 0 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    3   2    0     2    28   28   69   0 0 0 0.205825284
41.20025859 56.60580134 0.675056534 0.427130357 0.885927895 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.205825284 41.20025859
56.60580134 0.675056534 0.427130357 0.885927895 0 0 0 0 0 0 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    3   2    0     2    30   30   78   0 0 0 0 28.04557288
54.91745415 17.03697298 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 28.04557288 54.91745415 17.03697298 0 0 0 0 0 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    3   2    0     2    32   32   41   0 0 0 0 17.61117288
50.04149102 10.1700716 17.58752944 2.657576316 1.654838436 0
0.277320299 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
17.61117288 50.04149102 10.1700716 17.58752944 2.657576316 1.654838436
0 0.277320299 0 0 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    3   2    0     2    34   34   35   0 0 0 0 2.833836605
12.99562455 12.69356547 39.0422165 19.2004814 7.709244825 1.518564087 0
0 0 0 1.929724572 2.076741995 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 2.833836605 12.99562455 12.69356547 39.0422165 19.2004814
7.709244825 1.518564087 0 0 0 0 1.929724572 2.076741995 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2004 1    3   2    0     2    36   36   4    0 0 0 0 0 0 0 0
20.77606409 27.2299022 28.18187223 0 0 0 0 0 0 0 0 0 0 23.81216148 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.77606409 27.2299022
28.18187223 0 0 0 0 0 0 0 0 0 0 23.81216148 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2004 1    3   2    0     2    38   38   6    0 0 0 0 0 0 0 18.78101783
0 0 0 0 0 0 18.14660412 0 0 18.78101783 13.50537047 0 16.98981354 0 0
13.7961762 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 18.78101783 0 0 0 0 0
0 18.14660412 0 0 18.78101783 13.50537047 0 16.98981354 0 0 13.7961762
0 0 0 0 0 0 0 0 0 0 0 0
2004 1    3   2    0     2    40   40   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 0 100 0 0 0 0 0 0 0 0 0 0 0 0
# AKSHLF ghost marginal ages (N=7)
#Year Seas  Fleet Gender Partition AgeError LbinLo LbinHi Nsamp 0 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 0 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
1980 1    -3   3    0     2    -1   -1   96   0 6 7 0 1 3 3 3 3 2 1 3 1
1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 17 0 2 3 5 8 10 8 4 0
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    -3   3    0     2    -1   -1   117   0 0 0 1 1 3 9 3 2 0 1 0
3 0 2 2 0 0 0 2 2 3 1 1 1 1 0 0 0 0 0 0 0 0 1 2 0 0 1 3 3 7 8 2 1 3 2 1
4 2 3 1 1 2 4 4 2 3 0 1 3 1 1 1 0 1 0 1 2 0 0 8
1986 1    -3   3    0     2    -1   -1   219   0 15 25 16 14 14 11 8 7
0 0 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 0 18 21 10 14 10
16 12 2 2 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 1
1995 1    -3   3    0     2    -1   -1   393   0 20 18 59 43 25 10 1 2
4 2 2 1 0 1 0 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 20 14 58 33 32
7 8 5 7 4 0 2 1 1 0 1 2 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1998 1    -3   3    0     2    -1   -1   428   0 2 34 114 41 11 4 6 3 2
1 0 1 1 2 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0 20 31 88 22 9 11
2 0 1 0 1 0 0 3 1 0 0 0 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
```

```
2001 1    -3   3    0     2    -1   -1   1019  0 121 212 17 45 57 53 10
3 1 2 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 2 0 0 1 0 0 0 0 0 0 2 0 104 192 32 41
44 39 12 8 1 1 0 3 1 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1
2004 1    -3   3    0     2    -1   -1   1134  0 62 62 35 156 118 23 6
6 7 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 3 0 89 67 43 187
129 24 12 15 6 2 1 0 0 1 1 1 1 1 0 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0
#
#AKSLP updated for 2013 assessment (N=51)
#AHSLP CAAL (N=49)
#AKSLP females
#year Season Fleet gender partition ageErr LbinLo LbinHi Nsamp F0 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 F0.1 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
2000 1    4   1    0     2    14   14   1   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 0 100 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
2000 1    4   1    0     2    16   16   2   0 69.17759437 30.82240563 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
69.17759437 30.82240563 0 0 0 0 0 0 0 0 0 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    4   1    0     2    18   18   1   0 0 100 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 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
2000 1    4   1    0     2    20   20   3   0 0 0 33.33333333 0
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 33.33333333 0 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
2000 1    4   1    0     2    22   22   13  0 0 0 44.69480571
32.65873989 16.95370719 5.692747203 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 44.69480571 32.65873989 16.95370719
5.692747203 0 0 0 0 0 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    4   1    0     2    24   24   11  0 0 0 31.11291151
38.55779617 30.32929232 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 31.11291151 38.55779617 30.32929232 0 0 0 0 0 0 0 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    4   1    0     2    26   26   8   0 0 0 0 63.18298085
36.81701915 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 63.18298085 36.81701915 0 0 0 0 0 0 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    4   1    0     2    28   28   10  0 0 0 0 3.180049447
60.97433427 18.55883306 8.019935167 0 0 9.266848052 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.180049447 60.97433427
18.55883306 8.019935167 0 0 9.266848052 0 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    4   1    0     2    30   30   10  0 0 0 0 0 37.54134503
7.544265464 26.63390255 18.04292173 8.717222804 0 1.520342418 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 37.54134503 7.544265464
26.63390255 18.04292173 8.717222804 0 1.520342418 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    4   1    0     2    32   32   5   0 0 0 0 0 18.65054414
41.14864293 0 40.20081293 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 18.65054414 41.14864293 0 40.20081293 0 0 0 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 4 1 0 2 42 42 1 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 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 4 1 0 2 46 46 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 0 100 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 0 100
2000 1 4 1 0 2 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 0 100 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 0 100
2001 1 4 1 0 2 18 18 6 0 0 80.12751331 19.87248669
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
80.12751331 19.87248669 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1 4 1 0 2 20 20 24 0 0 89.05582432 10.94417568
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
89.05582432 10.94417568 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1 4 1 0 2 22 22 12 0 0 86.32451839 13.67548161
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
86.32451839 13.67548161 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1 4 1 0 2 24 24 5 0 0 5.707612438 52.85380622
41.43858134 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 5.707612438 52.85380622 41.43858134 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 26 26 3 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 0 100 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
2001 1 4 1 0 2 28 28 8 0 0 0 14.22801764
73.09980806 12.6721743 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 14.22801764 73.09980806 12.6721743 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 30 30 7 0 0 0 0 17.80416572
44.50441173 37.69142255 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 17.80416572 44.50441173 37.69142255 0 0 0 0 0 0 0 0 0
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2001 1 4 1 0 2 32 32 21 0 0 0 0 0 31.82677186
68.17322814 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 31.82677186 68.17322814 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 34 34 11 0 0 0 0 2.473996013
4.661640977 82.54088257 10.32348044 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.473996013 4.661640977 82.54088257
10.32348044 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 36 36 3 0 0 0 0 0 40.78356144
59.21643856 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 40.78356144 59.21643856 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 40 40 2 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 50 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 4 1 0 2 42 42 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 66.7570103 0 0 0 0 0 33.2429897 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 66.7570103 0 0 0 0 0 33.2429897 0
0 0 0 0
#AKSLP males

#year Season Fleet gender partition ageErr LbinLo LbinHi Nsamp M0 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21 M22 M23 M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35 M0.1 M1.1 M2.1 M3.1 M4.1 M5.1 M6.1 M7.1 M8.1 M9.1 M10.1 M11.1 M12.1 M13.1 M14.1 M15.1 M16.1 M17.1 M18.1 M19.1 M20.1 M21.1 M22.1 M23.1 M24.1 M25.1 M26.1 M27.1 M28.1 M29.1 M30.1 M31.1 M32.1 M33.1 M34.1 M35.1
2000 1 4 2 0 2 14 14 2 0 73.02329463 26.97670537 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 73.02329463 26.97670537 0 0 0 0 0 0 0 0 0 0 0 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 4 2 0 2 16 16 4 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 0 100 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
2000 1 4 2 0 2 20 20 1 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 0 100 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
2000 1 4 2 0 2 22 22 7 0 0 0 51.54489519 17.39157285 31.06353196 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 51.54489519 17.39157285 31.06353196 0 0 0 0 0 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 4 2 0 2 24 24 10 0 0 0 36.7604527 44.30764538 18.93190192 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 36.7604527 44.30764538 18.93190192 0 0 0 0 0 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 4 2 0 2 26 26 8 0 0 0 5.427530023 26.04818707 26.15997676 7.569610583 26.04818707 8.746508498 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.427530023 26.04818707 26.15997676 7.569610583 26.04818707 8.746508498 0 0 0 0 0 0 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 4 2 0 2 28 28 11 0 0 0 0 7.498000048 56.90301359 26.1441846 9.454801769 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.498000048 56.90301359 26.1441846 9.454801769 0 0 0 0 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 4 2 0 2 30 30 10 0 0 0 0 5.502131626 48.0891056 24.24066711 22.16809567 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.502131626 48.0891056 24.24066711 22.16809567 0 0 0 0 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 4 2 0 2 32 32 4 0 0 0 0 0 43.30581346 0 0 0 0 25.35369866 0 31.34048788 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 43.30581346 0 0 0 0 25.35369866 0 31.34048788 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 4 2 0 2 34 34 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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
2000 1 4 2 0 2 36 36 3 0 0 0 0 0 0 0 0 0 0 14.21501161 0 0 0 0 0 0 0 0 0 0 0 0 58.13063623 0 0 0 0 27.65435215 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 14.21501161 0 0 0 0 0 0 0 0 0 0 0 0 58.13063623 0 0 0 0 27.65435215 0 0 0 0 0 0 0 0 0
2001 1 4 2 0 2 16 16 2 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 0 100 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
2001 1 4 2 0 2 18 18 3 0 0 62.31818439 37.68181561 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 62.31818439 37.68181561 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 4 2 0 2 20 20 24 0 0 74.81060723 25.18939277 0 0 0 0 0 0 0 0 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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74.81060723 25.18939277 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1    4   2    0     2    22   22   8   0 0 67.39957843 32.60042157
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
67.39957843 32.60042157 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1    4   2    0     2    24   24   3   0 0 14.30455071 85.69544929
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
14.30455071 85.69544929 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2001 1    4   2    0     2    26   26   6   0 0 0 0 87.799809 0
12.200191 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 87.799809 0 12.200191 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2001 1    4   2    0     2    28   28   7   0 0 0 0 95.41634496
4.583655042 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 95.41634496 4.583655042 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2001 1    4   2    0     2    30   30   12  0 0 0 0 2.197363768
24.4661159 73.33652034 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 2.197363768 24.4661159 73.33652034 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1    4   2    0     2    32   32   16  0 0 0 0 11.19482091
28.4431382 60.36204089 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 11.19482091 28.4431382 60.36204089 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1    4   2    0     2    34   34   2   0 0 0 0 0 79.49727051
20.50272949 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 79.49727051 20.50272949 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2001 1    4   2    0     2    36   36   2   0 0 0 0 0 0 0 0 50 0 0 50 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 50 0 0 50
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1    4   2    0     2    40   40   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 0 100 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 0 100 0 0 0 0
2001 1    4   2    0     2    42   42   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 0 100 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 0 100
# AKSLP ghost marginal ages (N=2)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp  0 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 0 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
2000 1    -4   3    0     2    -1   -1   128   0 1 3 12 16 16 6 3 4 1 1
1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 1 5 11 8 19 6 4 1 1
1 0 1 1 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
2001 1    -4   3    0     2    -1   -1   191   0 0 39 8 13 13 26 1 0 0
0 0 0 0 0 0 0 0 0 0 1 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 32 8 14 10 19 0
1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1
#
#NWSLP updated for 2013 assessment (N=94)
#NWSLP CAAL (N=91)
#NWSLP females
#year Season Fleet gender partition ageErr LbinLo LbinHi nSamps F0 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 F0.1 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
2000 1 5 1 0 2 14 14 0.5 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 0 100 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
2000 1 5 1 0 2 16 16 2.5 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 0 100 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
2000 1 5 1 0 2 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 0 100 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
2000 1 5 1 0 2 20 20 1 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 0 100 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
2000 1 5 1 0 2 22 22 8 0 0 0 60.69761758 39.30238242 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 60.69761758 39.30238242 0 0 0 0 0 0 0 0 0 0 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 5 1 0 2 24 24 4.5 0 0 0 4.055968277 67.8684186 0 28.07561312 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.055968277 67.8684186 0 28.07561312 0 0 0 0 0 0 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 5 1 0 2 26 26 11 0 0 0 1.755413427 63.03443642 35.21015015 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.755413427 63.03443642 35.21015015 0 0 0 0 0 0 0 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 5 1 0 2 28 28 48 0 0 0 0 18.27659028 43.18709708 24.7130521 7.122094949 6.701165598 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 18.27659028 43.18709708 24.7130521 7.122094949 6.701165598 0 0 0 0 0 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 5 1 0 2 30 30 34.5 0 0 0 0 2.002339119 41.21616959 40.17092592 9.339515018 7.27105035 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.002339119 41.21616959 40.17092592 9.339515018 7.27105035 0 0 0 0 0 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 5 1 0 2 32 32 10.5 0 0 0 0 0 78.3215177 8.787296539 8.620773427 0 0 0 0 4.270412332 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 78.3215177 8.787296539 8.620773427 0 0 0 0 4.270412332 0 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 5 1 0 2 34 34 1 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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
2000 1 5 1 0 2 36 36 2 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 0 100 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
2000 1 5 1 0 2 38 38 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.33333333 0 33.33333333 0 0 33.33333333 0 0 0 0 0 0 0 0 0 0 0 0 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 0 33.33333333 0 0 33.33333333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 5 1 0 2 40 40 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.66669788 16.66669788 0 16.66669788 33.33320849 0 0 0 16.66669788 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.66669788 16.66669788 0 16.66669788 33.33320849 0 0 0 16.66669788 0 0 0 0 0 0 0 0 0 0 0 0

2000 1 5 1 0 2 42 42 13 0 0 0 0 0 0 0 0 0 0 0 0 0
7.692314341 0 7.692314341 0 0 7.692314341 0 0 7.692314341 7.692314341
7.692314341 7.692314341 15.38454225 15.38462868 7.692314341 0 0 0 0 0 0
0 0 7.692314341 0 0 0 0 0 0 0 0 0 0 0 0 7.692314341 0 7.692314341 0 0
7.692314341 0 0 7.692314341 7.692314341 7.692314341 7.692314341
15.38454225 15.38462868 7.692314341 0 0 0 0 0 0 0 0 7.692314341
2000 1 5 1 0 2 44 44 5 0 0 0 0 0 0 0 0
24.54034082 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
75.45965918 0 0 0 0 0 0 0 0 24.54034082 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 75.45965918
2000 1 5 1 0 2 46 46 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 0 100 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 0 100
2001 1 5 1 0 2 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 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
2001 1 5 1 0 2 16 16 4 0 0 74.12309729
25.87690271 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 74.12309729 25.87690271 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 18 18 11 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 0 100 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
2001 1 5 1 0 2 20 20 22 0 0 96.32390612
1.838046941 1.838046941 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 96.32390612 1.838046941 1.838046941 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 22 22 2 0 0 55.55808138
44.44191862 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 55.55808138 44.44191862 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 24 24 7 0 0 10.80640983
23.50394138 65.68964879 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 10.80640983 23.50394138 65.68964879 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 26 26 14 0 0 6.756289743
40.54004239 52.70366786 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 6.756289743 40.54004239 52.70366786 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 28 28 11 0 0 11.52317881
11.97223986 10.64138619 28.22371405 37.63948109 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11.52317881 11.97223986
10.64138619 28.22371405 37.63948109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 30 30 16 0 0 0 4.001943659
28.6957551 37.30516689 22.49785076 7.499283587 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.001943659 28.6957551
37.30516689 22.49785076 7.499283587 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 32 32 50 0 0 2.247344021
2.391417187 11.17474891 42.60125087 32.94953295 2.375825707 3.884054653
0 0 0 0 0 0 0 0 0 2.375825707 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.247344021 2.391417187 11.17474891 42.60125087 32.94953295 2.375825707
3.884054653 0 0 0 0 0 0 0 0 0 2.375825707 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0
2001 1 5 1 0 2 34 34 14 0 0 0 4.680233007
9.300205504 36.01183578 39.70858635 0 0 0 4.098487307 6.20065205 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.680233007 9.300205504
36.01183578 39.70858635 0 0 0 4.098487307 6.20065205 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 5 1 0 2 36 36 6 0 0 0 0 0 31.13090673
12.17627279 0 0 15.48286237 0 0 18.66851513 0 0 22.54144298 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 31.13090673 12.17627279 0 0
15.48286237 0 0 18.66851513 0 0 22.54144298 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2001 1 5 1 0 2 38 38 7 0 0 0 0 0 0 0 9.219776685
0 0 9.219776685 0 18.43955337 26.95055829 0 0 0 0 0 0 0 0 26.95055829 0
0 0 0 0 0 0 0 0 0 0 0 9.219776685 0 0 0 0 0 0 0 9.219776685 0 0
9.219776685 0 18.43955337 26.95055829 0 0 0 0 0 0 0 0 26.95055829 0 0 0
0 0 0 0 0 0 0 0 0 9.219776685
2001 1 5 1 0 2 40 40 5 0 0 0 0 0 0 0 0 0 0 0 0
33.22334882 0 0 33.22334882 10.82191005 11.36569616 0 0 0 0 11.36569616
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.22334882 0 0
33.22334882 10.82191005 11.36569616 0 0 0 0 11.36569616 0 0 0 0 0 0 0 0
0 0 0 0 0
2001 1 5 1 0 2 42 42 3 0 0 0 0 0 0 0 0 0 0 0 0
33.33333333 0 0 0 0 0 0 0 33.33333333 0 0 0 0 0 0 0 33.33333333 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.33333333 0 0 0 0 0 0 0 33.33333333 0 0
0 0 0 0 0 0 33.33333333 0 0 0 0 0 0
2002 1 5 1 0 2 14 14 1 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 0 100 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
2002 1 5 1 0 2 16 16 6 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 0 100 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
2002 1 5 1 0 2 18 18 28 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 0 100 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
2002 1 5 1 0 2 20 20 13 0 0 31.39277352
59.95154627 8.655680205 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 31.39277352 59.95154627 8.655680205 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 1 0 2 22 22 85 0 0 0 98.55105246
1.448947536 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 98.55105246 1.448947536 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2002 1 5 1 0 2 24 24 137.5 0 0 0 87.16400221
11.71221723 0.396500205 0.727280361 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 87.16400221 11.71221723 0.396500205
0.727280361 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 1 0 2 26 26 52.5 0 0 0 83.58594843
14.47164307 1.942408501 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 83.58594843 14.47164307 1.942408501 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 1 0 2 28 28 34 0 0 0 5.271420436
19.77898512 63.71292691 11.23666754 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.271420436 19.77898512 63.71292691
11.23666754 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 1 0 2 30 30 29 0 0 0 0 10.51301288
61.26185041 24.61113808 3.613998628 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 10.51301288 61.26185041 24.61113808
3.613998628 0 0 0 0 0 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
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2002 1 5 1 0 2 44 44 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2002 1 5 1 0 2 46 46 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 66.66666667
2002 1 5 1 0 2 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 0 100 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 0 100
#NWSLP males
#year Season Fleet gender partition ageErr LbinLo LbinHi nSamps M0 M1
M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21
M22 M23 M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35 M0.1 M1.1 M2.1
M3.1 M4.1 M5.1 M6.1 M7.1 M8.1 M9.1 M10.1 M11.1 M12.1 M13.1 M14.1 M15.1
M16.1 M17.1 M18.1 M19.1 M20.1 M21.1 M22.1 M23.1 M24.1 M25.1 M26.1 M27.1
M28.1 M29.1 M30.1 M31.1 M32.1 M33.1 M34.1 M35.1
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0 0 48.7828969 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 17.33356746 33.88353564 0 0 48.7828969 0 0 0 0 0 0 0 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 5 2 0 2 16 16 6.5 0 100 0 0 0 0 0 0 0 0 0 0 0
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2000 1 5 2 0 2 20 20 1 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
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2000 1 5 2 0 2 28 28 38 0 0 0 0.635279847
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2000 1 5 2 0 2 34 34 16 0 0 0 0 0 0 0 0 0
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6.974021578 0 0 13.94796479 0 6.974021578 0 6.974021578 0 6.974021578 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.364011359 0 0 0 13.94796479 6.974021578
20.92198637 13.94796479 0 0 6.974021578 0 0 13.94796479 0 6.974021578 0
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2000 1 5 2 0 2 38 38 1 0 0 0 0 0 0 0 0 0 0 0 0 0
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2000 1 5 2 0 2 44 44 1 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 79.22054916 20.77945084 0 0 0 0 0 0 0 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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2001 1 5 2 0 2 28 28 9 0 0 0 13.4395729
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 25.50802282 26.85728874 38.69508724 0
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35.67173667 3.217128832 0 3.378785136 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2001 1 5 2 0 2 34 34 25 0 0 0 0 0 3.643683032
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0 0 0 0 8.404140994 0 0 0 0 0 8.404140994 0 0 0 0 0 0 0 0 10.28478292
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0 81.71717172
2001 1 5 2 0 2 40 40 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2001 1 5 2 0 2 44 44 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2002 1 5 2 0 2 14 14 2 0 0 100 0 0 0 0 0 0 0 0 0 0
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2002 1 5 2 0 2 16 16 3 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
2002 1 5 2 0 2 20 20 10 0 0 51.40246703
48.59753297 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 51.40246703 48.59753297 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 2 0 2 22 22 68 0 0 1.510654273
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2002 1 5 2 0 2 24 24 127.5 0 0 1.592674218
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15.49666698 7.473859414 1.494838261 0 0 0 0 0 0 1.358928788 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0
2002 1 5 2 0 2 28 28 34 0 0 0 4.4966058
18.78785778 56.7058297 10.7876939 6.383112831 2.838899989 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.4966058 18.78785778
56.7058297 10.7876939 6.383112831 2.838899989 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 2 0 2 30 30 33 0 0 0 0 8.084272415
65.33282005 24.05193533 2.530972213 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.084272415 65.33282005 24.05193533
2.530972213 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 5 2 0 2 32 32 17 0 0 0 5.265603024
11.82628729 34.19587229 21.01850025 27.69373715 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.265603024 11.82628729
34.19587229 21.01850025 27.69373715 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2002 1 5 2 0 2 34 34 10 0 0 0 0 0 29.12049559
46.39756566 24.48193875 0 0 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
2002 1 5 2 0 2 36 36 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 34.68335788 0 0 0 0 0 32.65832106 0 0 0 0 0 0 0 32.65832106 0 0 0 0
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0 0 0 0 0 32.65832106 0 0 0 0 0 0
2002 1 5 2 0 2 38 38 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 30.8505453 0 0 0 0 0 0 30.8505453 12.27685371 11.19844026 0 0 0
0 0 0 0 0 14.82361543 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 30.8505453 0 0
0 0 0 0 30.8505453 12.27685371 11.19844026 0 0 0 0 0 0 0 0 0 14.82361543
2002 1 5 2 0 2 40 40 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 59.63021845 0 0 0 0 0 23.72961196 0 0 0 0
16.64016958 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 59.63021845
0 0 0 0 0 23.72961196 0 0 0 0 16.64016958
NWSLP ghost marginal ages (N=3)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp F0 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 M0 M1 M2 M3 M4
M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21 M22 M23
M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35
2000 1 -5 3 0 2 -1 -1 270 0 0.354203749 0.284494183
1.668875353 6.697577743 13.11093498 8.758101 2.219822316 2.465665372 0
0 0 0.692366017 1.249039073 0.624523045 0.624523045 1.24904609
0.624523045 1.24904609 1.249039073 0.624523045 1.24904609 0.624523045
1.24904609 1.249039073 1.24904609 0.624523045 0 0 0 0 0 0 0 0
3.169406385 0 0.787492136 0.216651211 0.554743306 3.196205341
10.62364939 6.245469036 1.31733115 0.69096958 0.211697018 0 0
0.624523045 1.249039073 1.873569135 2.498085162 1.249039073 4.259202536
1.873562117 0.624523045 0.624523045 0.624523045 1.873562117 0
0.624523045 0.624523045 1.24904609 0 0.624523045 0.624523045 0
0.624523045 0.624523045 0 0 0.624523045
2001 1 -5 3 0 2 -1 -1 357 0 0.128910793 11.79726675
2.53198902 5.259669175 9.003375128 7.422041371 0.793993529 0.48675449
0.129825931 0.329721754 0.198510749 1.332342016 0.580271702 0

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20.54405697 2.27592351 5.106742193 6.389815157 6.169242162 0.944249297
1.87066577 2.067420444 0.839948297 0.1890131 0 0.908608382 1.748581412
1.609208366 0.580271702 0.580271702 0 0 0.908633115 0 0 0.710097633
0.576512216 0 0 0 0 0.580271702 0 0 0 0 0 1.929828206
2002 1 -5 3 0 2 -1 -1 819 0 0 4.737140295
30.52981506 4.725338105 5.379526491 3.208006099 1.669644987 0.707511702
0 0 0 0.134024406 0 0 0 0 0.166304843 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166304843 0 0.976565835 0 0 3.906841745 26.5118234 4.464904941
7.013572106 2.582600184 1.286934521 0.124053828 0 0 0 0 0.112774955 0
0.077836616 0 0.278928312 0 0 0 0.073292015 0 0 0.557856623 0.110998429
0.101248195 0 0 0.073292015 0.110998429 0 0 0 0 0.211861022
#
#NWCBO final (N=386)
#NWCBO CAAL (N=376)
#NWCBO females
#year Season Fleet gender partition ageErr LbinLo LbinHi nSamps F0 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 F0.1 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
2003 1 6 1 0 2 12 12 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 0 100 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
2003 1 6 1 0 2 14 14 4 0 89.82767374
10.17232626 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 89.82767374 10.17232626 0 0 0 0 0 0 0 0 0 0 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 6 1 0 2 16 16 3.5 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 0 100 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
2003 1 6 1 0 2 18 18 7 0 0 37.95245125
62.04754875 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 37.95245125 62.04754875 0 0 0 0 0 0 0 0 0 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 6 1 0 2 20 20 10 0 0 54.63202559
45.36797441 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 54.63202559 45.36797441 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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#NWCBO males
#year Season Fleet gender partition ageErr LbinLo LbinHi nSamps M0 M1
M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21
M22 M23 M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35 M0.1 M1.1 M2.1
M3.1 M4.1 M5.1 M6.1 M7.1 M8.1 M9.1 M10.1 M11.1 M12.1 M13.1 M14.1 M15.1
M16.1 M17.1 M18.1 M19.1 M20.1 M21.1 M22.1 M23.1 M24.1 M25.1 M26.1 M27.1
M28.1 M29.1 M30.1 M31.1 M32.1 M33.1 M34.1 M35.1
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0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#NWCBO ghost marginal ages (N=10)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp F0 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 M0 M1 M2 M3 M4
M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21 M22 M23
M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35
2003 1 -6 3 0 2 -1 -1 748 0 0.067354237
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8.347924897 7.724762523 8.121425875 0.8231769 0.05167833 2.807979938
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0 0 0.148072033 0 0 0 0 0 0.123836051 0 0.419980118 0.020551991
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0.123836051 0 0 0 0 0.267644017
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3.265156121 1.977999204 21.86302932 9.903355448 4.494942184 4.344241265
0.144463998 1.15250055 0.822167463 0.254985779 0.599226666 0.583970002
0.013403551 0.290472256 0.172563236 0.052725467 0.077610123 0.255282025
0 0.240933008 0 0.020475634 0.076437745 0 0 0.066106957 0 0 0
0.035486477 0.021061823 0.066106957 0 0.623632285 0 0.337619476
3.798477529 2.991840915 22.45886807 7.246533978 3.109513568 2.634259508
1.049183217 1.181201735 0.129421639 0.320434062 0.147171181 0.670618776
0.214589184 0.066106957 0.261638706 0.39033864 0.087657271 0.025064294
0.021061823 0.254361772 0.153764228 0 0.174331257 0.307585184
0.035486477 0 0 0 0.035486477 0 0 0 0 0.167700392
#
#
```

```
0       # Mean Size at Age Observations
0       # Total number of environmental variables
0       # Total number of environmental observations
0       # No Weight frequency data
0       # No tagging data
0       # No morph composition data

999 # End data file
```

Appendix B.2. SS control file

```
# Morph setup
1 # Number of growth patterns
1 # N sub morphs within growth patterns

3 # Blocks
1 10 1 #1: blocks in each design
2011 2012  #1: Retention inflection and slope, to reflect IFQ
2000 2001 2002 2002 2003 2003 2004 2004 2005 2005 2006 2006 2007 2007
2008 2008 2009 2009 2010 2010 #2: TWL retention asymptote to fit
changes in discard ratios
1995 2004 #3: AKSHLF selectivity for later period

# Mortality and growth specifications
0.5 # Fraction female at birth
0  # M setup: 0=single
Par,1=N_breakpoints,2=Lorenzen,3=agespecific;_4=agespec_withseasinterpo
late
 # no additional input for selected M Option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2;
3=notimplemented; 4=notimplemented
2  # Age for growth Lmin
30 # Age for growth Lmax or 999 = Linf
0  # SD constant added to LAA (0.1 mimics v1.xx for compatibility only)
0  # CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
3  # Maturity option: 1=length logistic, 2=age logistic, 3=read age-
maturity matrix by growth_pattern
0.001739756 0.005167382 0.015234516 0.043959551 0.119591027 0.282761575
0.521345184 0.727124058 0.838074814 0.883280433 0.899554999 0.905148746
0.90704054 0.907676833 0.90789045 0.907962122 0.907986163 0.907994227
0.907996932 0.907997839 0.907998143 0.907998245 0.90799828 0.907998291
0.907998295 0.907998296 0.907998297 0.907998297 0.907998297 0.907998297
0.907998297 0.907998297 0.907998297 0.907998297 0.907998297 0.907998297
0.907998297 0.907998297 0.907998297 0.907998297 0.907998297 0.907998297
0.907998297 0.907998297 0.907998297 0.9079982972
# First age allowed to mature, from Nickols 1990
1 # fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b;
(4)eggs=a+b*L; (5)eggs=a+b*W
0 # hermaphroditism option: 0=none; 1=age-specific fxn
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=logistic transform
keeps in Base parm bounds; 3=standard w/ no bound check)

# Maturity & Growth Parameters
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev devmnyr devmxyr
devstd Block Block_Fxn
# female growth
 0.01 0.15 0.05 0.08 -1 99 -3 0 0 0 0 0 0 0 # NatM
 1 20 14.5 14.6 -1 99 2 0 0 0 0 0 0 0 # L_at_Amin
 20 60 42.44 42.5 -1 99 2 0 0 0 0 0 0 0 # L_at_Amax
 0.05 0.3 0.2 0.2 -1 99 2 0 0 0 0 0 0 0 # VonBert_K
 0.05 0.3 0.1 0.2 -1 99 3 0 0 0 0 0 0 0 # CV_young
 0.03 0.3 0.046 0.1 -1 99 -3 0 0 0 0 0 0 0 # CV_old
# male growth as direct estimates (parameter offset approach = 1)
```

```
 0.01 0.15 0.05 0.08 -1 99 3 0 0 0 0 0 0 0 # NatM
 -3 3 0 0 -1 99 -3 0 0 0 0 0 0 0 # L_at_Amin (set equal to females)
 20 60 42.44 42.5 -1 99 2 0 0 0 0 0 0 0 # L_at_Amax
 0.05 0.3 0.2 0.2 -1 99 2 0 0 0 0 0 0 0 # VonBert_K
 -3 3 0 0 -1 99 -3 0 0 0 0 0 0 0 # CV_young
 0.03 0.3 0.046 0.1 -1 99 -3 0 0 0 0 0 0 0 # CV_old
# female weight and maturity
 0 1 1.11E-05 1.11E-05 -1 99 -3 0 0 0 0 0 0 0 # Wtlen coeff # estimated
from NWFSC shelf-slope survey data 2003-2010
 2 4 3.13512 3.13512 -1 99 -3 0 0 0 0 0 0 0 # Wtlen Exp # estimated
from NWFSC shelf-slope survey data 2003-2010
 0 60 34.59 55 -1 99 -3 0 0 0 0 0 0 0 # Mat50%_Fem # from 2005
assessment, from Nickol 1990
 -3 3 -0.6429 -0.6429 -1 99 -3 0 0 0 0 0 0 0 # Mat_slope # from 2005
assessment, from Nickol 1990
 -3 150000 101100 101100 -1 99 -3 0 0 0 0 0 0 0 # eggs/kg intercept,
from E.J.Dick 2009
 0 50000 44800 44800 -1 99 -3 0 0 0 0 0 0 0 # eggs/kg slope, from
E.J.Dick 2009
# male weight as direct assignment
 0 1 1.21E-05 1.21E-05 -1 99 -3 0 0 0 0 0 0 0 # Wtlen coeff # estimated
from NWFSC shelf-slope survey data 2003-2010
 2 4 3.10958 3.10958 -1 99 -3 0 0 0 0 0 0 0 # Wtlen Exp # estimated
from NWFSC shelf-slope survey data 2003-2010
# stuff that we don't need for this model
 0 2 1 1 -1 99 -5 0 0 0 0 0 0 0 # Recruitment apportionment by growth
pattern
 0 2 1 1 -1 99 -5 0 0 0 0 0 0 0 # Rec app by Area
 0 2 1 1 -1 99 -5 0 0 0 0 0 0 0 # Rec app by Season
 0 2 1 1 -1 99 -5 0 0 0 0 0 0 0 # Cohort growth deviation
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1, femwtlen2, mat1, mat2, fec1, fec2,
Malewtlen1, malewtlen2, L1, K

3 #Recruitment Function 1 BH w/flat top, 2 Ricker, 3 BH, 4 none
# Recruitment Parms
# Low High Init Prior PrType SD  phase
 5  12 8.2 8  -1  99  1  # R0
 0.2 1  0.779 0.779 2  0.152 -2  # h
 0  2  0.75 0.75 -1  99  -1  # sigma R
 -5  5  0  0  -1  99  -3  # Env link coeff
 -5  5  0  0  -1  99  -3  # Init Equilb offset to virgin
 -1  1  0  0  -1  99  -1  # placeholder for Autocorrelation

0 # index of environmental variable to be used
0 # env target parameter: 0=none, 1=rec devs, 2=R0, 3=steepness

# Recruitment residuals
2  # rec dev type: 0=none, 1=devvector (zero-sum), 2=simple deviations
(no sum constraint)
1960 # Start year recruitment residuals
2011 # End year recruitment residuals
3 # Phase

1  # Read 11 advanced recruitment options: 0=no, 1=yes
1870 # first year for early rec devs
3  # phase for early rec devs
```

```
5  # Phase for forecast recruit deviations
1  # Lambda for forecast recr devs before endyr+1
 1960.754 #_last_early_yr_nobias_adj_in_MPD
 1990.399 #_first_yr_fullbias_adj_in_MPD
 2008.982 #_last_yr_fullbias_adj_in_MPD
 2013.077 #_first_recent_yr_nobias_adj_in_MPD
  0.877 #_max_bias_adj_in_MPD (1.0 to mimic pre-2009 models)
0  # placeholder
-5 # Lower bound rec devs
5 # Upper bound rec devs
0 # read intitial values for rec devs

# Fishing mortality setup
0.2  # F ballpark for tuning early phases
-1999 # F ballpark year
3  #  F_Method:  1=Pope; 2=instan.  F; 3=hybrid  (hybrid is
recommended)
4 #  max F  or harvest rate,  depends on F_Method
#  no additional F  input  needed for Fmethod 1
#  if Fmethod=2; read  overall start  F  value; overall phase; N
detailed  inputs to read
#  if Fmethod=3; read  N  iterations for tuning for Fmethod 3
4  #  N  iterations for tuning F  in hybrid method (recommend 3  to 7)

# Initial Fishing Mortality Parameters
#LO  HI  INIT  PRIOR PR_type SD  PHASE
0  1  0  0.01  -1  99 -1 # InitF_1TWL
0  1  0  0.01  -1  99 -1 # InitF_2BYCATCH

# Catchability Specification (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
# A  B  C  D
0  0    0     0 # 1 TWL
0  0    0     0 # 2 BYCATCH
0  0    1     4 # 3 AKSHLF
0  0    0     2 # 4 AKSLP
0  0    0     2 # 5 NWSLP
0  0    1     2 # 6 NWCBO
#
1 #_If q has random component, Then 0=read one parm For each fleet With
random  q; 1=read a parm For each Year of index
#_Q_parms(if_any)
# Lo  Hi  Init    Prior   Prior_type Prior_sd   Phase
0 1   0.4 0.1 -1     99     3   # Q_extraSD_5_AKSHLF
0 1   0.4 0.1 -1     99     3   # Q_extraSD_8_NWCBO

# bnd bnd  value mean type SD phase Early period
-10 2 -0.0003 0 -1 99  1 # AKSHLF (log) base parameter (1980)
-4 4  0 0 -1 99 -5 # AKSHLF 1983 deviation
```

```
-4 4  0 0 -1 99 -5 # AKSHLF 1986 deviation
-4 4  0 0 -1 99 -5 # AKSHLF 1989 deviation
-4 4  0 0 -1 99 -5 # AKSHLF 1992 deviation
# Late period
-4 4  0 0 -1 99  1 # AKSHLF 1995 deviation
-4 4  0 0 -1 99 -5 # AKSHLF 1998 deviation
-4 4  0 0 -1 99 -5 # AKSHLF 2001 deviation
-4 4  0 0 -1 99 -5 # AKSHLF 2004 deviation

# Other catchability parameters
-10 2 -0.0003 0 -1 99  1 # AKSLP (log) base parameter
-10 2 -0.0003 0 -1 99  1 # NWSLP (log) base parameter
-10 2 -0.0003 0 -1 99  1 # NWCBO (log) base parameter

# Selectivity Specification
#_size_selex_types
#_Pattn Discard Male    Special
24  1   0   0   # 1 TWL
15  0   0   1   # 2 BYCATCH
24  0   0   0   # 3 AKSHLF
24  0   0   0   # 4 AKSLP
24  0   0   0   # 5 NWSLP
24  0   0   0   # 6 NWCBO
#_age_selex_types
#_Pattn Discard Male    Special
11  0   0   0   # 1 TWL
11  0   0   0   # 2 BYCATCH
11  0   0   0   # 3 AKSHLF
11  0   0   0   # 4 AKSLP
11  0   0   0   # 5 NWSLP
11  0   0   0   # 6 NWCBO

# Length-based selectivity, retention and discard mortality section
#TWL
#Low High Init Prior PrType SD Phase env usedev minyr maxyear sd block
blswitch
 20 45 36 32 -1 99 2 0 0 0 0 0 0 0 0 # PEAK
-6 4 2 0 -1 99 -3 0 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 4 4 -1 99 2 0 0 0 0 0 0 0 0 # Asc_width
-1 9 0.6 5.5 -1 99 -3 0 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -2 -1 99 -2 0 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-5 9 9 5 -1 99 -3 0 0 0 0 0 0 0 0 # FINAL:_selectivity_at_last_bin
#TWL retention
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_min dev_max
dev_std Block Block_Fxn
15 70 27 35 -1 99 2 0 0 0 0 0 1 2 #Inflection
0.1 10 2 1 -1 99 2 0 0 0 0 0 1 2 #Slope # 1 means that parm’ = baseparm
+ blockparm
0.001 1 1 1 -1 99 -3 0 0 0 0 0 2 2 #Asymptotic retention # 2 means that
parm’ = blockparm
0 0 0 0 -1 99 -3 0 0 0 0 0 0 0 #Male offset To inflection
#AKSHLF
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_min dev_max
dev_std Block Block_Fxn
10 45 21 23 -1 99 2 0 0 0 0 0 0 0 0 # PEAK
-6 4 -6 -1 -1 99 -2 0 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 4 4 -1 99 3 0 0 0 0 0 0 0 0 # Asc_width
```

```
-1 9 4 6 -1 99 4 0 0 0 0 0 3 2 # Desc_width
-999 9 -999 -4 -1 99 -2 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-999 9 -999 -1 -1 99 -3 0 0 0 0 0 0 0 # FINAL:_selectivity_at_last_bin
#AKSLP
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_min dev_max
dev_std Block Block_Fxn
 10 45 23 28 -1 99 2 0 0 0 0 0 0 0 # PEAK
-6 4 -1 -1 -1 99 2 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 2 4 -1 99 3 0 0 0 0 0 0 0 # Asc_width
-1 9 2 4 -1 99 3 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -4 -1 99 -4 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-999 9 -999 -2 -1 99 -3 0 0 0 0 0 0 0 # FINAL:_selectivity_at_last_bin
#NWSLP
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_min dev_max
dev_std Block Block_Fxn
10 45 25 28 -1 99 2 0 0 0 0 0 0 0 # PEAK
-6 4 -6 1 -1 99 -5 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 3 4 -1 99 4 0 0 0 0 0 0 0 # Asc_width
-1 9 .1 4 -1 99 4 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -4 -1 99 -5 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-999 9 -999 1 -1 99 -4 0 0 0 0 0 0 0 # FINAL:_selectivity_at_last_bin
#NWCBO
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_min dev_max
dev_std Block Block_Fxn
 8 45 18 20 -1 99 2 0 0 0 0 0 0 0 # PEAK
-6 4 -6 -1 -1 99 -3 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 -0.5 2 -1 99 3 0 0 0 0 0 0 0 # Asc_width
-1 9 3 4 -1 99 4 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -3 -1 99 -4 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-999 9 -999 -4 -1 99 -3 0 0 0 0 0 0 0 # FINAL:_selectivity_at_last_bin

# age sel: select all ages following user manual instructions:
# "If it is desired that age 0 fish be selected, then use pattern #11
and set the minimum age to 0.1"
# all ages selected for fleets 1 & 2
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected
0 1 0.1 0.1 -1 99 -3 0 0 0 0 0.5 0 0 # Min age selected
0 100 100 100 -1 99 -3 0 0 0 0 0.5 0 0 # Max age selected

1 # Selex block setup: 0=Read one line apply all, 1=read one line each
parameter

# Lo Hi Init Prior P_type SD Phase
#TWL retention inflection and slope, to reflect changes with IFQ
15  70  27  35  -1  99   2  #Inflection
0.1  10  2   1   -1  99   2  #Slope
#TWL Retention asymptote, to fit discard ratio
0    1   0.6   0.6    -1   99   3
```

```
0    1   0.44  0.44   -1   99   3
0    1   0.4   0.4    -1   99   3
0    1   0.84  0.84   -1   99   3
0    1   0.78  0.78   -1   99   3
0    1   0.51  0.51   -1   99   3
0    1   0.51  0.51   -1   99   3
0    1   0.47  0.47   -1   99   3
0    1   0.46  0.46   -1   99   3
0    1   0.52  0.52   -1   99   3
#AKSHLF selectivity parameters 1995-2004
-1  9   5   5  -1   99  4  # Desc_width

1 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep
in base parm bounds)
0 # Tagging flag: 0=none,1=read parameters for tagging

### Likelihood related quantities ###
# variance/sample size adjustment by fleet
1 # Do variance adjustments
0  0 0 0 0  0  # const added to survey CV
0   0 0  0  0  0  # const added to discard sd
0   0 0  0  0  0  # const added to body weight sd
0.1670494 1 0.2639248 0.5042809 0.4347276 0.276025 # mult scalar for
length comps
0.2675704 1 0.1684169 0.1924211 0.1440778 0.1182449 # mult scalar for
age comps
1   1 1  1  1  1  # mult scalar for length at age obs

2 # Max N lambda phases: read this N values for each item below
1 # SD offset (CPUE, discard, mean body weight, recruitment devs):
0=omit log(s) term, 1=include

2 # N changes to default Lambdas = 1.0
# Component codes:
#  1=survey
#  2=discard
#  3=mean body weight
#  4=length frequency
#  5=age frequency
#  6=Weight frequency
#  7=size at age
#  8=catch
#  9=initial equilibrium catch
#  10=rec devs
#  11=parameter priors
#  12=parameter deviations
#  13=Crash penalty
#  14=Morph composition
#  15=Tag composition
#  16=Tag return
# Component fleet/survey  phase  value  wtfreq_method
4 1   1    0.5  1   #TWL length comps
5 1   1    0.5  1   #TWL age comps
0 # extra SD pointer
```

Appendix B.3. SS starter file

```
darkblotched_data.SS # Data file
darkblotched_control.SS # Control file
1 # Read initial values from .par file: 0=no,1=yes
1 # DOS display detail: 0,1,2
2 # Report file detail: 0,1,2
0 # Detailed checkup.sso file (0,1)
0 # Write parameter iteration trace file during minimization
2 # Write cumulative report: 0=skip,1=short,2=full
0 # Include prior likelihood for non-estimated parameters
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # N bootstrap datafiles to create
25 # Last phase for estimation
0 # MCMC burn-in
1 # MCMC thinning interval
0 # Jitter initial parameter values by this fraction
-1 # Min year for spbio sd_report (neg val = styr-2, virgin state)
-2 # Max year for spbio sd_report (-1=endyr+1, -2=entire forecast)
0 # N individual SD years
0.0001 # Ending convergence criteria
0 # Retrospective year relative to end year (i.e. -4)
1 # Min age for summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel
X*B_styr
1 # Fraction (X) for Depletion denominator (e.g. 0.4)
1 # (1-SPR)_reporting: 0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-
SPR_Btarget); 4=notrel
1 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num);
3=sum(frates)
#0 45  #_min and max age over which average F will be calculated
0 # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt

999 # end of file marker
```

Appendix B.4. SS forecast file

```
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to
F(endyr)
0.5 # SPR target (e.g. 0.40)
0.4 # Biomass target (e.g. 0.40)
#_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
# 2010 2010 2010 2010 2010 2010 # after processing
1 #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
0.20 # 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
# 1180659524 1667592815 7631713 0 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.40 # Control rule Biomass level for constant F (as frac of Bzero,
e.g. 0.40); (Must be > the no F level below)
0.10 # 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=OFL only; 2=ABC; 3=get F from forecast ABC
catch with allocations applied)
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)
#-65534 #_Forecast loop control #5 (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)
2001 # Rebuilder: first year catch could have been set to zero
(Ydecl)(-1 to set to 1999)
2011 # Rebuilder: year for current age structure (Yinit) (-1 to set to
endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x
fleet(col) below
# 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: FISHERY
# 0
# max totalcatch by fleet (-1 to have no max) must enter value for each
fleet
```

```
-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
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
0 # Number of forecast catch levels to input (else calc catch from
forecast F)
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch;
99=input Hrate(F) (units are from fleetunits; note new codes in
SSV3.20)
#
999 # verify end of input
```