Agenda Item D.8
Attachment 3 (Entire Document Electronic Only)
June 2015

Status of the darkblotched rockfish resource off the continental U.S. Pacific Coast in 2015

by

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DRAFT
May 15, 2015

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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 is 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*). The species is managed with stock-specific harvest specifications (not within the current slope rockfish complexes). Catches taken with non-trawl gear over the years comprised 2% of the total coastwide shoreside 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. Shoreside 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 shoreside 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 three fleets, which include the shoreside commercial fishery (that included removals by all gear types), bycatch removals in foreign Pacific ocean perch and bycatch removals in 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 shoreside fishery were explicitly modeled in the assessment; total catches were estimated simultaneously with other model parameters and derived quantities of management interest.

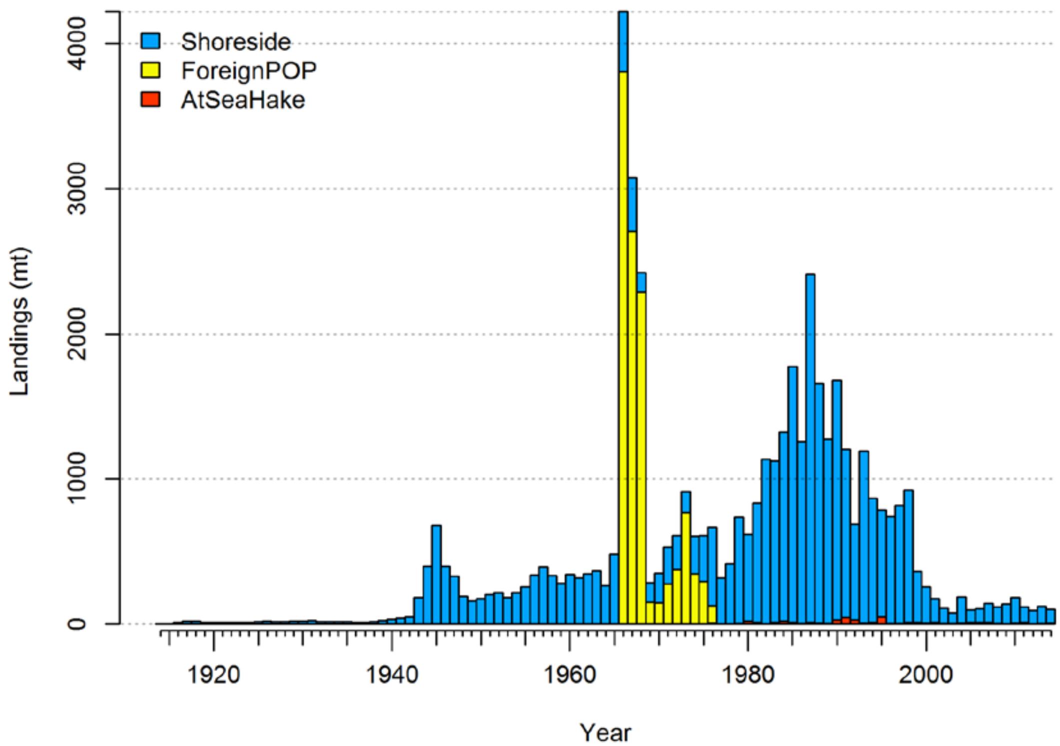

Figure ES-1: Darkblotched rockfish landings history between 1915 and 2014 by fleet.

Table ES-1: Recent darkblotched rockfish landings (mt) by component that comprised three fleets used in the assessment (removals by California, Oregon and Washington were combined into Shoreside fleet).

Year	California landings	Oregon landings	Washington landings	Bycatch in at-sea hake fishery	Total
2005	18	68	1	11	98
2006	23	71	2	11	107
2007	41	87	3	12	144
2008	34	74	3	6	117
2009	47	89	2	0	138
2010	17	152	7	8	184
2011	3	87	14	12	117
2012	7	70	15	2	94
2013	4	103	11	6	124
2014	4	77	11	11	103

Data and assessment

The last full assessment of darkblotched rockfish was conducted in 2013. This assessment uses the Stock Synthesis modeling framework developed by Dr. Richard Methot at the NWFSC. The most recent version (SSv3.24U, distributed on January 24, 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 of the retained commercial catch from Pacific Fisheries Information Network (PacFIN) and, for the first time since 2005, includes historical age data from 1980 forward. It includes discard ratios, length and age compositions of the discards from West Coast Groundfish Observer Program (WCGOP). The assessment also includes bycatch data within the at-sea hake fishery and, for the first time, length and age compositions of darkblotched bycatch from the At-Sea Hake Observer Program (ASHOP). Data from four National Marine Fisheries Service (NMFS) bottom trawl surveys are used to estimate indices of 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 2014 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, included those defining the weight-length relationship, female fecundity and maturity schedule. Recruitment dynamics are assumed to follow the Beverton-Holt stock-recruit function. Natural mortality is fixed at the value of 0.054 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 3,203 million eggs (95% confidence interval: 2,370-4,036 million eggs). At the beginning of 2015, the spawning stock output is estimated to be 1,261 million eggs (95% confidence interval: 340-2,181 million eggs), which represents 39% 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 1976, spawning output dropped from 94% to 65% of its unfished level. Spawning output continued to decline throughout the 1980s and 1990s and in 2000 reached its lowest estimated level of 16% 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
2006	716	237-1,196	2,168	598-3,738	22%	11-34%
2007	790	256-1,324	1,644	409-2,879	25%	12-38%
2008	856	269-1,443	6,240	1,784-10,695	27%	12-41%
2009	913	277-1,550	950	199-1,702	29%	13-44%
2010	961	279-1,643	2,243	619-3,867	30%	13-47%
2011	1,002	276-1,729	2,025	501-3,550	31%	13-49%
2012	1,061	289-1,832	956	132-1,779	33%	14-52%
2013	1,123	305-1,940	9,616	1,323-17,909	35%	15-55%
2014	1,189	321-2,056	2,466	1,679-3,253	37%	16-58%
2015	1,261	340-2,181	2,491	1,704-3,278	39%	17-62%

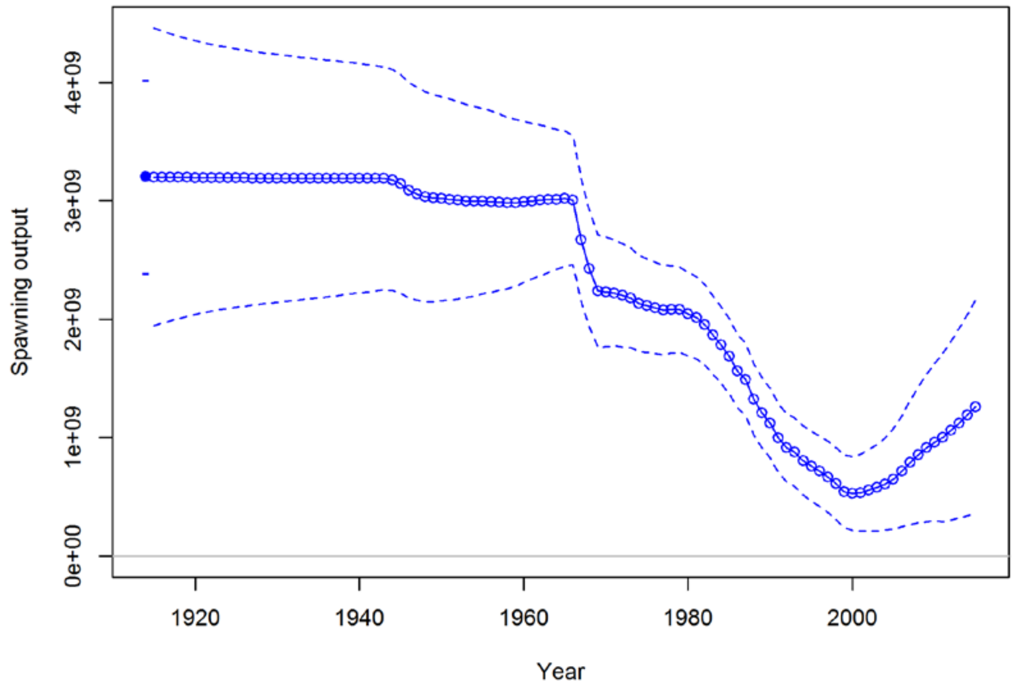

Figure ES-2: Estimated spawning biomass time-series (1915-2015) for the base-case model (circles) with ~ 95% interval (dashed lines). Spawning output is expressed in the number of eggs.

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 0.773, which is the mean of steepness prior probability distribution, derived from this year's meta-analysis of Tier 1 rockfish assessments.

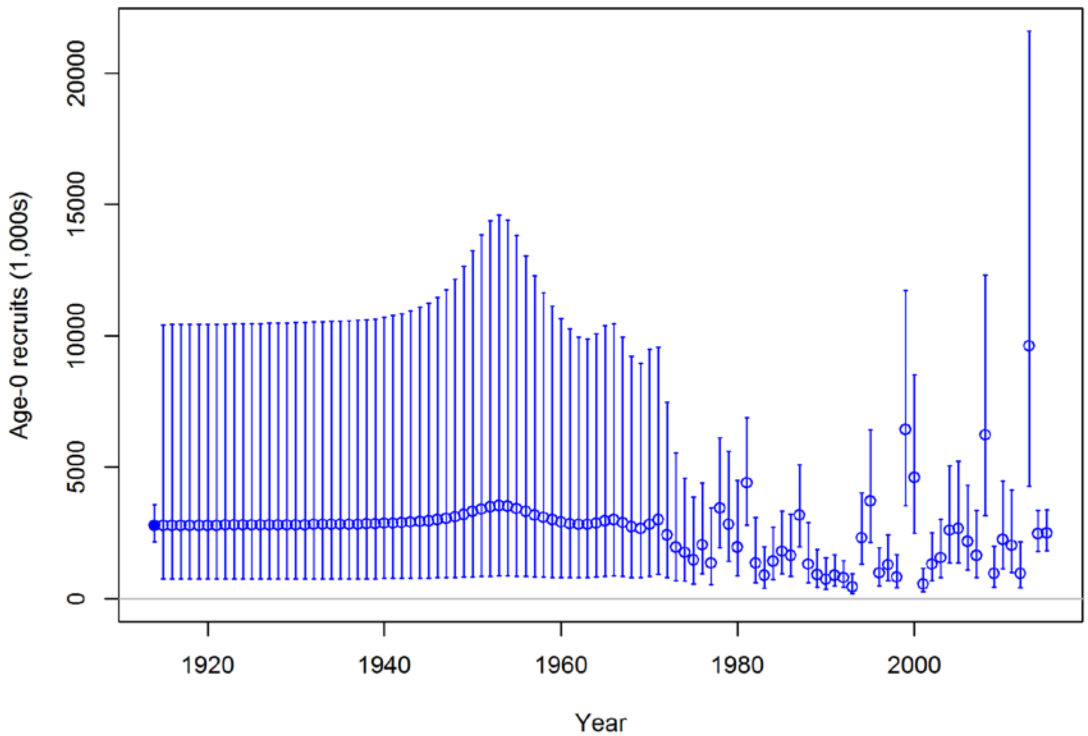

Figure ES-3: Time series of estimated darkblotched rockfish recruitments for the base-case model (solid line) with ~95% intervals (vertical lines).

Reference points

Unfished spawning stock output for darkblotched rockfish was estimated to be 3,203 million eggs (95% confidence interval: 2,370-4,036 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 1,281 million eggs (95% confidence interval: 948-1,614), which corresponds to an exploitation rate of 0.041. This harvest rate provides an equilibrium yield of 674 mt at $SB_{40\%}$ (95% confidence interval: 504-844 mt). The model estimate of maximum sustainable yield (MSY) is 728 mt (95% confidence interval: 544-912 mt). The estimated spawning stock output at MSY is 815 million eggs (95% confidence interval: 603-1,026 million of eggs). The exploitation rate corresponding to the estimated SPR_{MSY} of $F_{31\%}$ is 0.0655.

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

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning output (million eggs)	3,203	2,370-4,036
Unfished age 1+ biomass (mt)	36,459	27,360-45,557
Unfished recruitment (R0)	2,773	2,051-3,494
Depletion (2015)	39%	17-62%
Reference points based on $SB_{40\%}$		
Proxy spawning output ($B_{40\%}$)(million eggs)	1,281	948-1,614
SPR resulting in $B40_{\%}$ ($SPR_{B40\%}$)	44%	NA
Exploitation rate resulting in $B_{40\%}$	4.1%	3.98-4.29%
Yield with *SPR* at $B_{40\%}$ (mt)	674	504-844
Reference points based on SPR proxy for MSY		
Spawning output (million eggs)	1,474	1,091-1,858
SPR_{proxy}	50%	NA
Exploitation rate corresponding to SPR_{proxy}	3.4%	3.3-3.5%
Yield with SPR_{proxy} at SB_{SPR} (mt)	630	472-789
Reference points based on estimated MSY values		
Spawning output at *MSY* (SB_{MSY}) (million eggs)	815	603-1,026
SPR_{MSY}	31%	30-32%
Exploitation rate corresponding to SPR_{MSY}	6.55%	6.24-6.74%
MSY (mt)	728	544-912

Exploitation status

The assessment shows that the stock of darkblotched rockfish off the continental U.S. Pacific Coast is currently at 39% 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 1989, as a result of intense fishing by foreign and domestic fleets. It continued to decline and reached the level of 16% of its unfished output in 2000. The same year, the stock was declared overfished. Since then, the spawning output was slowly increasing primarily due to management regulations instituted for the species.

This assessment estimates that the 2014 SPR is 89%. The SPR used for setting the OFL is 50%, while the SPR-based management fishing mortality target, specified in the current rebuilding plan and is used to determine the ACL, is 64.9%. Historically, the darkblotched rockfish has been fished beyond the relative SPR ratio (calculated as 1-SPR/1-$SPR_{Target=0.5}$) between 1966 and 1968, during the peak years of the Pacific ocean perch fishery, in 1973 and for a prolonged period between from 1981 and 2000.

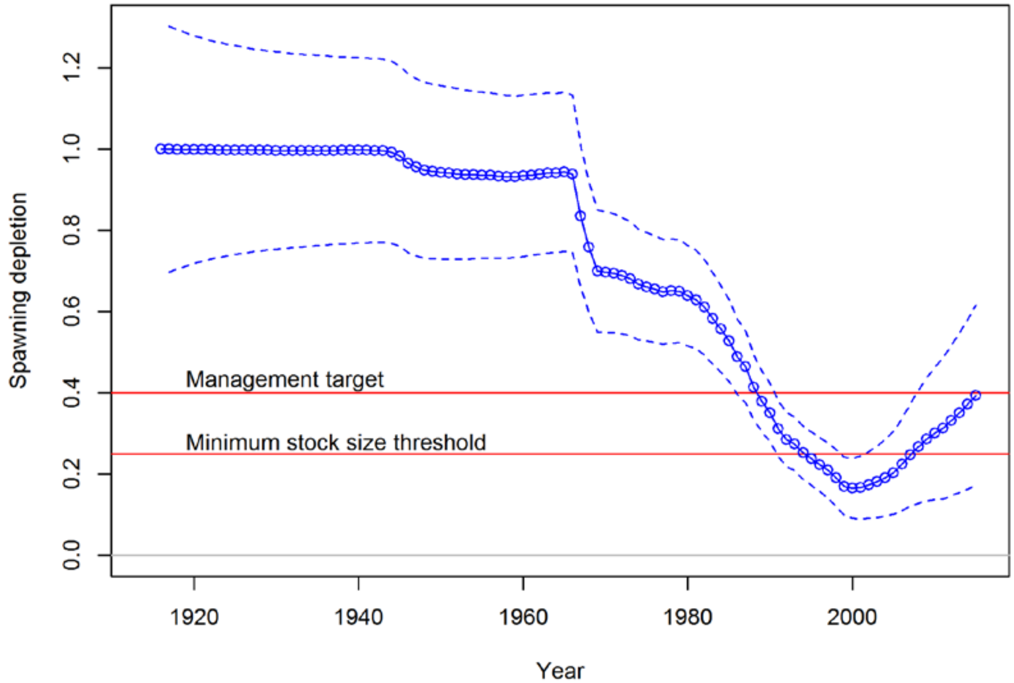

Figure ES-4. Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model.

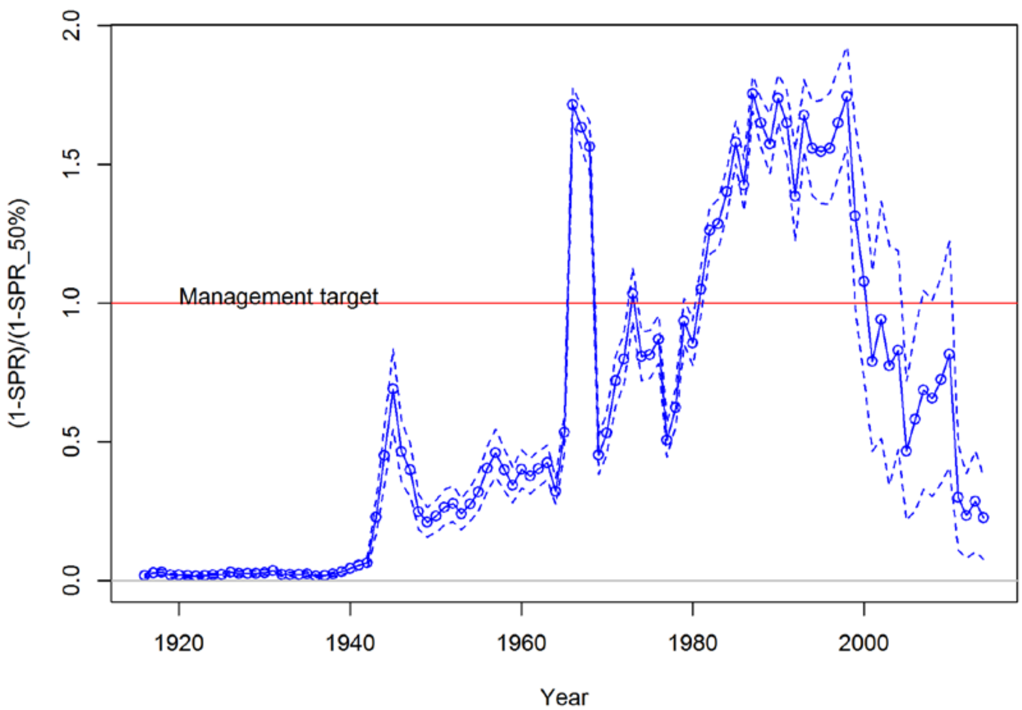

Figure ES-5. Time series of estimated relative spawning potential ratio (1-SPR/1-$SPR_{Target=0.5}$) for the base-case model (round points) with ~95% intervals (dashed lines). Values of relative SPR above 1.0 (100% in the table above) reflect harvests in excess of the current overfishing proxy.

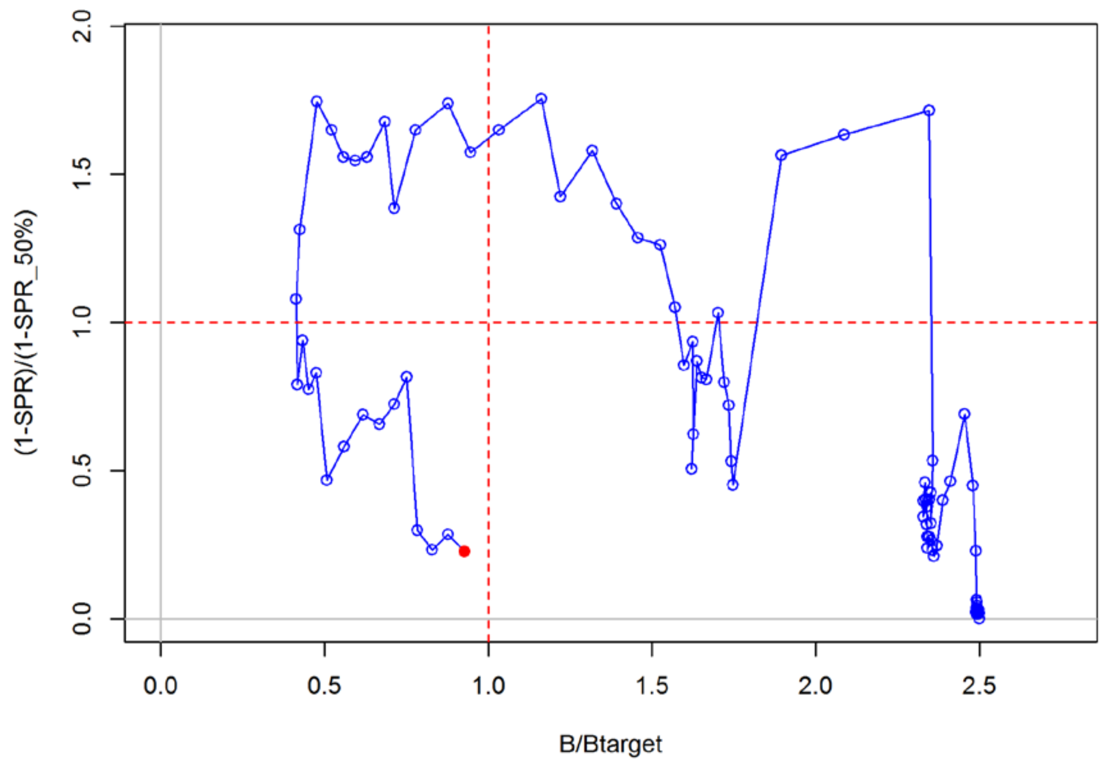

Figure ES-6. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 0.5 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 40% of the unfished spawning biomass. The red point indicates the year 2014.

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

Year	SPR (%)	Harvest rate (proportion)	~95% confidence interval
2005	77%	0.012	0.004-0.020
2006	71%	0.017	0.004-0.029
2007	66%	0.021	0.006-0.036
2008	67%	0.019	0.005-0.033
2009	64%	0.021	0.006-0.037
2010	59%	0.025	0.007-0.043
2011	85%	0.008	0.002-0.014
2012	88%	0.006	0.002-0.010
2013	86%	0.008	0.002-0.013
2014	89%	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 600m, with the 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 in the midwater 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 a lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment. However, we used the recently developed geostatistical delta-GLMM approach to estimate an abundance index from NWFSC shelf-slope survey data. This method uses information on the location of samples (i.e., whether located in high- or low-density habitats) to explain a portion of the variability in catch rates, and thus indirectly incorporates information on habitat quality that, in many respects, shapes spatial distribution of organisms and determines density of their occurrence.

Management performance

The stock has 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, since 2011, 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 been managed using species-specific harvest specifications since 2001. Over the last 10 years, the total dead catch (as estimated in this assessment) exceeded the Annual Catch Limit (ACL) in two years: 2009 and 2010. The total dead catch has not exceeded the Overfishing Limit (OFL) during the last decade.

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)	Landings (mt)	Estimated Total Catch (mt)
2005	269	122	98	129
2006	269	122	107	194
2007	456	260	144	261
2008	456	260	117	250
2009	437	282	138	289
2010	437	282	184	351
2011	508	298	117	118
2012	508	298	94	95
2013	541	317	124	125
2014	541	317	103	104

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 an 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 the unfished recruitment level was also explored through likelihood profile analysis. Additionally, a retrospective analysis was conducted where the model was re-run after successively removing data from recent years, one year at a time.

Main life history parameters, such as natural mortality and stock-recruit curve steepness, continue to be a major source of uncertainty. 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.

Historically, darkblotched rockfish landings have not been sampled at the discrete species level; therefore, the 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 shoreside 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 2015 spawning depletion is 39%. The primary axis of uncertainty about this estimate used in the decision table was based on female natural mortality. To identify female natural mortality values that correspond to low and high states of nature, we followed a multi-step algorithm. First, we selected alternative values of stock-recruit steepness. For this, we used a normal approximation to the prior distribution for steepness with an identical mean and standard deviation to the prior distribution from that analysis (mean=0.773, SD=0.147). We then identified two values from that normal distribution which are half as likely as the mode. Those values are:

$$h = 0.773 \pm 0.147(1.18) = (0.600, 0.946)$$

where 0.600 represents the low and 0.946 the high steepness alternatives.

We then determined depletion levels associated with alternative steepness values; depletion under low steepness was 9%, and it was 49% under high steepness. Finally, we identified female natural mortality values associated with these low and high depletion levels; they were 0.0412 and 0.059 respectively. We used these values to define low and high states of nature and construct the decision table.

Twelve-year forecasts for each state of nature were calculated based on average catch for the period between 2011 and 2014. They were also produced with future catches fixed at the 2016 darkblotched rockfish ACL. Finally, forecasts for each state of nature were calculated based on removals at a current rebuilding SPR of 64.9% for the base model.

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 depletion will stay below the $SB_{40\%}$ target within the next 12 years. Under the high 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) Additional population genetics research to elucidate potential spatial stock structure would be valuable for assessment and management, to ensure prevention of local depletion and preserve genetic diversity.

2) Additional research on darkblotched movement including migration patterns by latitude and depth, diurnal migration patterns through the water column, relative time spent off-bottom versus midwater, relating movements to size, age and sex would be valuable for further understanding this rockfish's ecological niche, stock structure, and lend insight to catchability and gear selectivity patterns.

3) 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; such information is currently lacking.

4) Continuing collection of maturity and fecundity data on darkblotched rockfish would allow further research into latitudinal variability in life history parameters that again would advance understanding this species stock structure. Multi-year data would also allow evaluation of temporal changes in darkblotched maturity and fecundity.

5) Additional research into natural mortality, as it relates to length and age would be valuable to enable more realistic and accurate modeling of this parameter, which is a common source of uncertainty in assessment of this, and other rockfish species. Councill and Harford method is an example of one approach; it models natural mortality as a decaying function of size, with assumptions that mortality rates should be constrained by lifetime mortality rate.

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

7) Research into establishing optimum methods for more precise modeling of selectivity patterns is needed. Either asymptotic or dome-shaped selectivity assumptions are frequently used in stock assessments, when neither may be the best available representation of selectivity. Assumptions of a dome shape can suggest a "cryptic" biomass, or create confounding with natural mortality assumptions, potentially inflating abundance indices (Crone et al.

2013). Assumptions of asymptotic shape may also not be realistic. Simulation studies could be performed to empirically evaluate varying degrees of intermediate selectivity shapes, and how best to effectively implement them in existing stock assessment software platforms.

8) Research assessing the effects of the unprecedented warm ocean conditions off the West Coast of the U.S. during 2014 and 2015, on rockfish populations is needed. Specifically, investigations are needed that focus on how temperature and other water conditions at depth, in rockfish habitat correspond to high sea-surface temperatures recorded throughout those years, and how the fish respond to those changing conditions. Research is needed that examines whether fish move in response to changing temperatures, where, and how they move, as well as whether the conditions influence life history parameters and aspects such as mortality, feeding, fecundity and other reproductive considerations. What oceanographic and climatic forces are responsible and how long these conditions are expected to persist are also critical pieces of knowledge.

Table ES-6. 12-year projections for alternate states of nature defined 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=0.0412*		Base case Female M=0.054		High *Female M=0.059*	
Management decision	Year	Catch (mt)	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion
Average catch for the period between 2011 and 2014	2015	110	263	9%	1,261	39%	1,660	49%
	2016	110	278	10%	1,331	42%	1,744	51%
	2017	110	291	10%	1,396	44%	1,820	53%
	2018	110	305	11%	1,459	46%	1,893	56%
	2019	110	324	12%	1,531	48%	1,976	58%
	2020	110	349	12%	1,618	51%	2,077	61%
	2021	110	379	13%	1,711	53%	2,183	64%
	2022	110	410	15%	1,799	56%	2,283	67%
	2023	110	442	16%	1,878	59%	2,369	69%
	2024	110	474	17%	1,948	61%	2,442	72%
	2025	110	507	18%	2,008	63%	2,503	73%
	2026	110	539	19%	2,062	64%	2,555	75%
2016 ACL catch assumed for years between 2015 and 2026	2015	338	263	9%	1,261	39%	1,660	49%
	2016	346	264	9%	1,317	41%	1,730	51%
	2017	346	260	9%	1,365	43%	1,790	53%
	2018	346	256	9%	1,411	44%	1,845	54%
	2019	346	256	9%	1,465	46%	1,911	56%
	2020	346	262	9%	1,534	48%	1,994	58%
	2021	346	271	10%	1,609	50%	2,082	61%
	2022	346	280	10%	1,677	52%	2,162	63%
	2023	346	288	10%	1,736	54%	2,229	65%
	2024	346	295	11%	1,786	56%	2,283	67%
	2025	346	302	11%	1,827	57%	2,327	68%
	2026	346	308	11%	1,863	58%	2,362	69%
Catch calculated using current rebuilding SPR of 64.9% applied to the base model (40-10 rule and buffer applied)	2015	388	263	9%	1,261	39%	1,660	49%
	2016	389	260	9%	1,314	41%	1,727	51%
	2017	386	253	9%	1,359	42%	1,783	52%
	2018	399	246	9%	1,400	44%	1,835	54%
	2019	438	241	9%	1,451	45%	1,897	56%
	2020	467	241	9%	1,513	47%	1,973	58%
	2021	474	241	9%	1,579	49%	2,053	60%
	2022	469	239	9%	1,637	51%	2,123	62%
	2023	461	236	8%	1,686	53%	2,180	64%
	2024	454	231	8%	1,725	54%	2,224	65%
	2025	450	226	8%	1,758	55%	2,259	66%
	2026	448	221	8%	1,784	56%	2,285	67%

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

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Landings (mt)	98	107	144	117	138	184	117	94	124	103	NA
Estimated Total catch (mt)	129	194	261	250	289	351	118	95	125	104	NA
OFL (mt)	269	269	456	456	437	437	508	508	541	541	574
ACL (mt)	122	122	260	260	282	282	298	298	317	317	338
SPR	77%	71%	66%	67%	64%	59%	85%	88%	86%	89%	NA
Exploitation rate (catch/ age 1+ biomass)	0.012	0.017	0.021	0.019	0.021	0.025	0.008	0.006	0.008	0.006	NA
Age 1+ biomass (mt)	10,850	11,631	12,319	12,906	13,519	14,129	14,721	15,524	16,288	17,038	17,897
Spawning output (million eggs)	649	716	790	856	913	961	1,002	1,061	1,123	1,189	1,261
~95% Confidence Interval	216-1,082	237-1,196	256-1,324	269-1,443	277-1,550	279-1,643	276-1,729	289-1,832	305-1,940	321-2,056	340-2,181
Recruitment	2,671	2,168	1,644	6,240	950	2,243	2,025	956	9,616	2,466	2,491
~95% Confidence Interval	785-4,557	598-3,738	409-2,879	1,784-10,695	199-1,702	619-3,867	501-3,550	132-1,779	1,323-17,909	1,679-3,253	1,704-3,278
Depletion (%)	20%	22%	25%	27%	29%	30%	31%	33%	35%	37%	39%
~95% Confidence Interval	10-30%	11-34%	12-38%	12-41%	13-44%	13-47%	13-49%	14-52%	15-55%	16-58%	17-62%

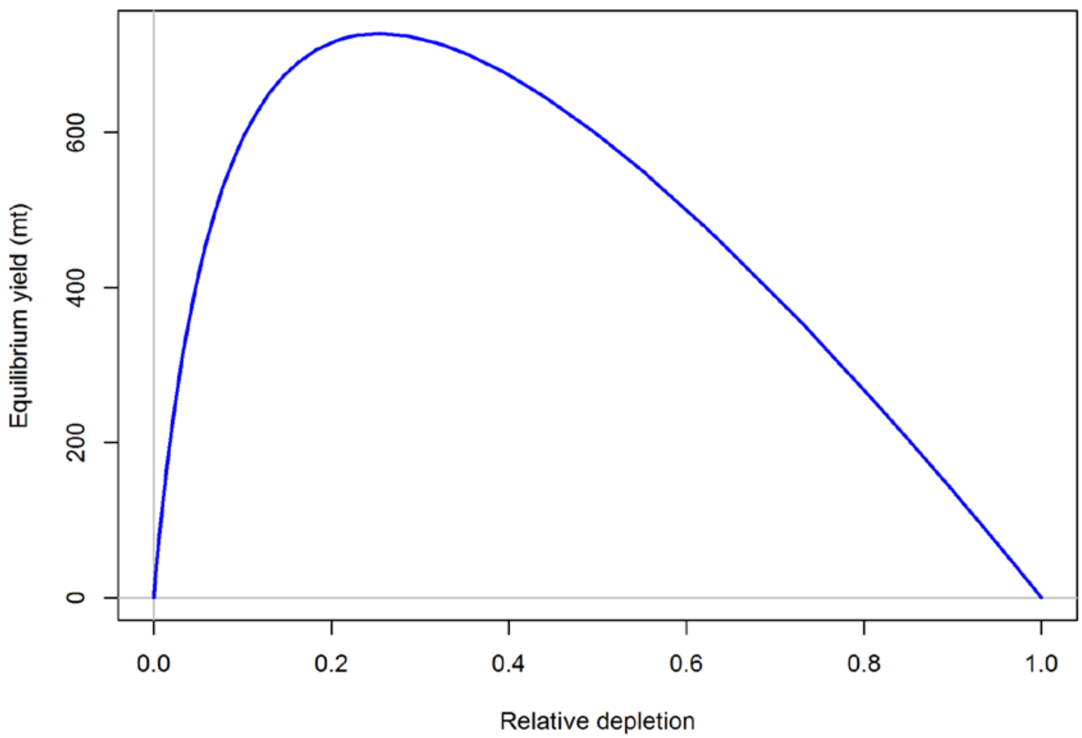

Figure ES-7. Equilibrium yield curve (derived from reference point values reported in Table ES-5) for the base case model. Values are based on 2014 fishery selectivity and distribution with steepness fixed at 0.773. The depletion is relative to unfished spawning biomass.

1 Introduction

1.1 Basic Information and Life History

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.

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.

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 some genetic differentiation in the stock along the coast, but the level of differentiation was low, it was indicated only in a few of the loci examined. No distinct breaks in the stock were identified. This is the most recent and perhaps the only population genetic study performed for this stock to date.

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).

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. 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).

It was 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.

A number of rockfish species were shown to exhibit variability in life history parameters with latitude, particularly those related to growth (Gertseva et al., 2010, Keller et al. 2012). Size-at-age parameters reported for darkblotched rockfish in literature 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).
For this assessment, we evaluated darkblotched rockfish size at-age data along the coast, using data collected within the NMFS Northwest Fisheries Science Center shelf-slope survey, and did not find evidence of latitudinal variability in growth. Plots showing size-at-age data by sex and state, together with growth function fits are shown in Figure 3 and Figure 4. Plots showing the same data coastwide and by sex, together with growth function fits for are shown in Figure 5 and Figure 6.

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 7.

No study has been conducted to evaluate movement patterns of darkblotched rockfish within the area of assessment. Adults of darkblotched rockfish typically are observed resting on mud near cobble or boulders (Love et al., 2002). However, they feed primarily in midwater on large planktonic organisms such as krill, gammarid amphipods, copepods and salps (Love et al., 2002). This suggests that darkblotched rockfish are not extremely sedentary and spend significant time off the bottom. This is also confirmed by the fact that darkblotched rockfish are among few rockfish species that are bycaught within at-sea hake fishery which operates in the mid-water. Therefore, it is reasonable to assume that mixing of individuals within assessment area happens not only at the stage of pelagic juveniles, but also at the adult life stages. Given that, the spatial scope of the assessment is treated as a single area.

1.2 Ecosystem Considerations

Darkblotched rockfish belong to groundfish of the California Current Large Marine Ecosystem. They interact with many other species throughout their long lives (Figure 8). Larvae and juveniles darkblotched are pelagic. They are also often found perched on the highest bit of structure in the benthic habitat. Juveniles occasionally are seen around the bottoms of deepwater oil platforms. Older larvae and pelagic juvenile darkblotched rockfish are found closer to the surface than many other rockfish species. They feed on plankton, and are vulnerable to predators by other fish and seabirds. Young darkblotched are eaten by king salmon and albacore (Love et al., 2002). As they grow and mature, they feed on variety of invertebrates and fishes. Occasionally, darkblotched rockfish take octopi. They are preyed upon by large fishes and marine mammals. Competition for prey and habitat may exist within and among groundfish, and many groundfish species prey upon other groundfish.

Basin-scale forces ultimately affect local production and the quality of the habitat types that groundfish use over the course of their lives. Circulation patterns and upwelling affect patchiness of food and retention of pelagic larvae and juveniles, and upwelling promotes spring/summer production. Temperature affects metabolic rates and growth. In some areas, strong productivity may produce excess phytoplankton, which settles to the bottom and can lead to hypoxia due to high microbial respiration (Figure 9).

Groundfish support extensive and valuable fisheries on the U.S. West Coast. Fisheries that operate with bottom trawl gear may degrade groundfish habitat. Conservation measures and precautionary fisheries management practices are implemented to sustain groundfish populations and their habitat. Also, habitat qualities and fishery opportunities may be affected by non-fishing activities related to various industrial, shipping, energy development, and land-use practices. Such activities can contribute to nutrient loading, changes in delivery of sediments, pollution and other forms of habitat alteration (Figure 10).

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. However, we used recently developed geostatistical delta-GLMM approach to estimate an abundance index from NWFSC shelf-slope survey data. This method uses information on the location of samples (i.e. whether located in high- or low-density habitats) to explain a portion of variability in catch rates, and thus indirectly incorporates information on habitat quality that, in many respects, shapes spatial distribution of organisms and determines density of their occurrence.

1.3 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 2% of the total coastwide shoreside landings (Figure 11). 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 12).

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 12). 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 12). 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 small amount of darkblotched rockfish has also been taken as bycatch in the at-sea Pacific hake fishery (Figure 12). The at-sea Pacific hake fishery dates back to the 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, and the pacific hake fishery became completely domesticated, allowing only U.S. vessels to catch and process fish. 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 a partnership between the National Marine Fisheries Service (NMFS) and the Pacific Fishery Management Council (PFMC). A summary of the major management shifts on the West Coast of the United States related to groundfish species through 2005 (prepared by PFMC' Groundfish Management team (GMT)) is provided in Appendix 1.

Limits on shoreside 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 managed with stock-specific harvest specifications with an ABC and an Optimum Yield (OY) specified. 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 the 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 NMFS as a measure to reduce bycatch of overfished rockfish species. Specific boundaries for the RCAs have varied considerably among bimonthly periods, years and areas; the extent and complexity of their structure has also waxed and waned since first instituted. 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°10' N latitude have also been required to use nets that are designed to be more selective for flatfish.

Since 2011, the shorebased trawl allocation (including non-hake groundfish trawl, and shorebased hake trips) has been managed under a catch share fishery, using Individual Fishing Quotas (IFQ), where each permit holder fishes an annual quota. Under this system, discard of darkblotched rockfish and many other species has decreased dramatically. This is evident in observer data. The primary driver for this is that both landed and discarded fish count towards each fisher's annual quota. Under the previous system of bimonthly landing accumulation limits (a.k.a. trip limits), discard rates could fluctuate wildly, and were negatively correlated with trip limits. Pre-IFQ discard rates for darkblotched averaged 44.2 % (2002-2010), whereas under IFQ, the annual discard rate has averaged just 2.4 % (2011-2013).

1.4 Management Performance

Table 1 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). The stock has 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, since 2011, 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 been managed using species-specific harvest specifications since 2001. Over the last 10 years, the total dead catch (as estimated in this assessment) exceeded the Annual Catch Limit (ACL) in two years: 2009 and 2010. The total dead catch has not exceeded the Overfishing Limit (OFL) during last decade.

1.5 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 the 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.

2 Assessment

2.1 Data

The darkblotched rockfish data used in the assessment are summarized Figure 13. 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 three fleets, which include shoreside fishery that contains catches from all gear types, historical catch in the foreign Pacific ocean perch (POP) fishery and bycatch in the at-sea Pacific hake fishery.

The shoreside 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 to avoid inflating darkblotched removals in POP and at-sea hake fisheries, the shoreside fleet and bycatch fisheries were separated. The historical discarded portion of the shoreside 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). Contemporary estimates of discard are provided by WCGOP annually (2002-present).

Catches in the shoreside fishery have been traditionally dominated by bottom trawl removals, with catches of all other gear types (including non-trawl gears and mid-water trawl) contributing 2% of overall darkblotched landings. For the assessment, we combined catches from all gear types within the shoreside fishery into one fishing fleet.

Shoreside fishery landings by state are shown in Figure 12. However, the port of landing does not always coincide with where the fish were caught. For instance, Oregon vessels, particularly those from northern ports such as Astoria/Warrenton, frequently fish in waters off of Washington but return to Oregon to land their fish. The fishery operates and is managed coastwide; length composition of landings made in different states do not differ (Figure 14). Therefore, in the assessment removals by California, Oregon and Washington were combined into one fleet.

Historically, landed catch of rockfish have been reported as mixed-species groups that have similar market value, rather than as individual species (Barss and Niska, 1978; Douglas, 1998; Lynde, 1986; Niska, 1976; Tagart and Kimura, 1982). These groups are called “market categories”. The species compositions of these mixed-species market categories have changed over time. In the 1960s, the state agencies in California, Oregon and Washington initiated sampling programs of commercial trawl rockfish landings, in which port biologists sampled species compositions of mixed-species category landings to determine contributions of different species to each market category and derive per species landings time series. Sampling efforts focused on rockfish landings in the trawl fishery, since commercial landings of rockfish species with other gear types have been low. Prior to the 1960s, many of the market categories were not sampled for composition by species, so that the annual contributions of different species to these categories are largely unknown (Barss and Niska, 1978; Douglas, 1998; Lynde, 1986; Niska, 1976).

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 shoreside fishery and removals by bycatch fleets are presented in Figure 12 and Table 2. Figure 1 shows the spatial distribution of darkblotched rockfish catch in shoreside fishery, as observed by the WCGOP between 2002 and 2008.

2.1.1.1 Shoreside landings

Estimates of recent shoreside landings of darkblotched rockfish (between 1981 and 2014) 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 6, 2015 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 shoreside 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 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 darkblotched rockfish as used in this assessement 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 the “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., 2014). Karnowski et al. (2014) 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. (2014) 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 2013. 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 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.

Discard ratios for 1985 and 1987 were estimated from observations of retained and discarded catch collected in the Pikitch study (Pikitch et al., 1988), as described in Wallace (2015). Rodgers and Pikitch (1992) produced post-hoc assemblages based on co-occurrence of species observed in the Pikitch study tows. Wallace (2015) developed a link between Rodgers and Pikitch (1992) post-hoc strategies and fisheries landings data reported in PacFIN and expanded discard ratios and length composition from the Pikitch et al. (1988) to a fleet-wide level.

2.1.1.3 Catch in the foreign POP fishery

As described in the Introduction, between the 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 Introduction, small amounts of darkblotched rockfish are 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 2014 are presented in Table 2 and Figure 11.

2.1.1.5 Fishery biological data

Biological information on shoreside landings was obtained from PacFIN (date of data extraction: March 6, 2015) and on commercial discard from the WCGOP and the Pikitch study. The fishery biological data were also obtained from NORPAC for darkblotched

removals in at-sea hake fishery. 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 shoreside 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. No biological information was available on darkblotched removals in foreign POP fishery.

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 shoreside fishery by year and sex are shown in Figure 15 and Figure 16.

Length frequencies distributions were developed for the period between 1977 and 2014. Length distributions between 1977 and 1979, however, were not use in the assessment as those distributions were substantially different from distributions in the other years. More probably, length data during these years mainly represented catches in midwater trawl fishery targeting widow rockfish, the dominant rockfish fishery in the late-1970s on the U.S. West Coast or pink shrimp trawl fishery. Landings of that period, however, were not distinguished between bottom midwater or shrimp trawls; 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 2003 and 2013, and from the Pikitch study for the year of 1986. The WCGOP discard length composition data were analyzed using a weighting method consistent with that applied to the port samples of landed catch described above. The Pikitch study length compositions were obtained from Wallace (2015). Length frequency distributions of discarded fish 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 17.

Length-frequency distributions of darkblotched rockfish bycaught at the at-sea hake fishery were available by sex for the period between 2003 and 2014. Again, these length composition data were analyzed using a weighting method consistent with the one applied to data from other sources. The length frequency distributions of darkblotched rockfish in the at-sea hake fishery by sex and year are shown in Figure 17.

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.):

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

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

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. Age estimated ages for darkblotched rockfish are available between 1980 and 2014. The amount of age data sampled from commercial landings varied among state (
Table 4). Age data on discarded fish were available from the WCGOP for 2004 and 2005. Age data from at-sea hake fishery were available for the period between 2003 and 2013.

The age data from fisheries 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, and removals in the at-sea hake fishery used in the assessment are presented in Figure 18, Figure 19 and Figure 20.

In several previous assessment of darkblotched rockfish (Rogers, 2005; Hamel, 2008), a concern was expressed that criteria for estimating ages of darkblotched rockfish might have changed (Hamel, 2008) and that a bias may have existed in “early” age data compared to those generated in 2004 and later (Rogers 2005). The last assessment (Gertseva and Thorson, 2014) 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. Gertseva and Thorson (2014) 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, a separate pattern for ageing error was 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 (see Ageing bias and impression section for details).

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 21).

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^{o}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^{o}50’ and 48^{o}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^{o}34’ and 48^{o}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 three out of four bottom trawl surveys (that include AFSC shelf, AFSC slope and NWFSC slope surveys) were retained from the last assessment (Gertseva and Thorson, 2013). These indices were derived using a delta-generalized

linear mixed model, or delta-GLMM (Maunder and Punt, 2004), implemented using the software from Thorson and Ward (2014).

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 late period (1995-2004) of the AFSC triennial shelf survey. In the early period (prior to 1995) the AFSC triennial survey went only to 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. 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 survey, 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; (Thorson et al., 2011)), the large and infrequent catches observed for many rockfishes. Thorson et al.,

(2011) dealt with them during index standardization by treating the distribution of positive catches as a mixture distribution composed of the distributions for solitary individuals, and the distribution for fish shoals (treated as a loglinear offset from the distribution of solitary individuals). Simulation testing indicates that this treatment of fish shoals decreases the sampling variance that otherwise occurs from a few infrequent observations have large leverage (Thorson et al., 2012). Such approach has been shown to improve precision for estimated indices of abundance in simulated data in some cases (Thorson et al., 2012).

Abundance index for the NWFSC shelf-slope survey was derived using new geostatistical delta-GLMMs method (version 3.2.0), which was tailored to analyze data from this very survey. Recent research has advocated the use of geostatistical delta-GLMMs for analyzing survey data of patchy species such as darkblotched rockfish (Shelton et al., 2014). This advice was supported by a recent comparison of stratified and geostatistical delta-GLMMs for West Coast species, where the geostatistical method decreased the imprecision of estimated abundance indices on average for simulated data (Thorson et al., In press). The geostatistical approach to index standardization treats spatial variation in either encounter rates of positive catch rates as a random function, where the value of this random function at 1000 pre-defined locations ("knots") is treated as a random effect. In this way, annual variation and the magnitude of residual variation and variation among vessels can be treated as fixed effects, and estimated via maximum marginal likelihood. Additionally, the model includes 'survey pass' as a covariate (levels: first or second), to account for unbalanced sampling between the first and second passes of the survey, specifically in 2013, when only second pass was not completed due to government shutdown. This new geostatistical model is described in details in Thorson et al. (In press). It is implemented as an R package *SpatialDeltaGLMM* and is publicly available online at: https://github.com/nwfsc-assess/geostatistical_delta-GLMM. For this assessment, we run the base model with non-spatial delta-GLMM as well, and found that model outputs when using non-spatial GLMM were very similar to those generated by the base model with abundance index estimated via new geostatistical approach (Table 16, Figure 110 through Figure 113).

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 (Figure 22 through Figure 24). 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.

We evaluated convergence of geostatistical model, following specific advice associated *SpatialDeltaGLMM* and made sure the final gradient of the marginal likelihood with respect to fixed effects is <0.01for all fixed effects and the generalized delta-method generates positive (not NA) estimates for all fixed, random, and derived values. Model goodness-of-fit was evaluated using Q-Q plots, where a model that explains the data will generally have data fall on the one-to-one line, and posterior predictive plots for outliers.

Lognormal and gamma errors structures were considered for the model component representing positive catches, and lognormal model was selected for this index. Figure 25 and Figure 26 show Q-Q and posterior predictive plots, respectively, associated with this model.

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 27 through Figure 30.

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 existed 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 31 through Figure 34.

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 4591 females and 5114 males collected in the NWSFC shelf-slope survey between 2003 and 2014. 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 = $1.149 \cdot 10^{-5}$ for females and $1.224 \cdot 10^{-5}$ for males, and β = 3.1254 for females and 3.1065 for males. Estimated parameters fit the data well, and indicated almost no difference in the weight-length relationship between female and male darkblotched rockfish (Figure 35).

2.1.3.2 Ageing bias and imprecision

Most of the age data for this species were generated by the Ageing Laboratory at the Hatfield Marine Science Center (HMSC) in Newport, Oregon. A small portion of ages were estimated by the ODFW, in collaboration with HMSC Ageing Laboratory. To describe ageing error associated with darkblotched age data in fisheries and surveys, we followed the approach used in 2013. 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 data from double-reads using a state-space model developed by Punt et al. (2008) and software developed by Stewart et al. (2011).

Separate patterns in ageing error were estimated for periods before and after 2005; since 2005, darkblotched rockfish age structures (otoliths) were read by a single reader (Reader 1) 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 used the same method (break and burn) and criteria.

Comparison of results from the “late” and “early” periods indicates greater imprecision during the early than that of in the later period (Figure 36).

2.1.3.3 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 of less than one, where this maturity schedule represents the combined effect of maturation and atresia.

Maturity as a function of length was estimated from 303 records of females that had maturity and length recorded, for the last full assessment, using three parameter model (with length of 50% maturity, the slope of maturity function and asymptotic maturity estimated) and was entered in the assessment model as a maturity-at-length matrix. The maturity-at-length relationship for female darkblotched rockfish produced from that matrix is shown in Figure 42.

2.1.3.4 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 Nichol (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 (Nichol 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.

2.1.3.5 Natural mortality

Natural mortality has been a major axis of uncertainty in several assessments of darkblotched rockfish. Exploration of the base model in this assessment indicated that when natural mortality was freely estimated for both sexes in the model, it resulted in implausibly large values for spawning depletion. This was true for many alternative model parameterizations (including those using the Hamel natural mortality prior; Hamel, 2015).

A number of methods have been developed to estimate natural mortality from life history traits, such as maximum age, the von Bertalanffy growth coefficient and some others. In the case of darkblotched rockfish, these different methods produce quite different estimates of natural mortality.

Then et al. (2015) evaluated the predictive performance of different life history-based methods in estimating natural mortality, and demonstrated that maximum age-based methods (particularly Hoenig, 1983) perform better than the others. They re-evaluated and extended a dataset used in past studies to estimate natural mortality and updated parameters based on this improved dataset for a Hoenig (1983) log-transformed linear regression model. They also explored fitting the Hoenig model as power functions using non-linear least squares, thus modelling M directly. Performance of non-linear and linear Hoenig estimators was very similar; values of cross-validation prediction error (CVPE) differ by a few thousandths (0.329 vs 0.323, for non-linear and linear estimator, respectively), which is expected since transformation process is known to introduce small error.

For this assessment, we chose to fix natural mortality at 0.054 yr^{-1}, as it was estimated from the classical Hoenig linear regression model, but with recently updated parameters based on an improved database (Then et al, 2015). We chose to use this model and not proposed formulation based on non-linear fitting, because the non-linear model produces quite different natural mortality estimates from the linear model, which should not be the case. The differences in estimates can indicate potential issues with non-linear model convergence, which should be explored further.

Dimorphic growth in fish is often accompanied by different rates of natural mortality. Therefore, we chose to follow the approach taken in the 2013 assessment to fix female natural mortality and estimate male natural mortality within the base model. Even when the model is unable to reliably estimate natural mortality for both sexes, compositional data can inform the difference between the sexes well, and estimating at least one sex captures more of the uncertainty in the model results than fixing both.

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, the 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.

In 2007, another full assessment was conducted (Hamel, 2008). In that 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.

The most recent full assessment (prior to the current assessment) was conducted in 2013 (Gertseva and Thorson, 2014). That assessment extended assessment time series back to 1915 (from 1928), divided fishery removals into two fisheries (instead of combining all removals into one fleet) and re-evaluated selectivity assumptions. The 2013 assessment 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 2007 assessment) and divided the AFSC triennial survey into two time-series (instead of treating it as a single time series). It updated most of life history parameters, including weight-length relationship, maturity, fecundity, and stock-recruit parameters. It also updated the value for natural mortality from fixed at 0.07 yr^{-1} for both sexes, to estimating natural mortality for males, while holding the value for females fixed at 0.05 yr^{-1}. The point estimate for the depletion of spawning output at the start of 2013 was estimated to be 36% relative to spawning output in an unfished equilibrium condition. The decision table was developed based on uncertainty in the assumed value of female natural mortality, with values of 0.036, 0.05 and 0.082 yr^{-1} representing low, medium (base case) and high states of nature.

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 125). For the last decade, the stock was slowly increasing primarily due to management efforts toward rebuilding of the stock.

2.2.2 Responses to 2013 STAR panel recommendation

The STAR panel report from the last full assessment (conducted in 2013) identified a number of recommendations for the next assessment as well as general long term recommendations for future assessments. Below, we list the 2013 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 made toward each of them.

For the next assessment the following recommendations were made:

1) *The base model does not use commercial age composition data for years that lacked coastwide samples. The additional age data could provide information necessary for the model to estimate such parameters as the CVs defining the distribution of lengths at older ages and 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 currently available age data as possible.*

The 2013 assessment used age data for only those years when age estimates were available from all three states. This is because the assessment operated on the assumption that darkblotched rockfish (like some groundfish species) exhibit latitudinal cline in growth parameters. For this assessment, we evaluated latitudinal variability in growth along the coast and did not find evidnece for differences in growth among states (Figure 5 and Figure 6). Therefore, all age data available from PacFIN were used in this assessment. These data range from 1980 to 2014. We contacted state agencies and they confirmed that all existing age data are uploaded to PacFIN and no additional (unread) age structures are currently present.

With more ages in the model, we were able to estimate CVs defining the distribution of lengths at older ages. However, those estimates were lower than CVs defining distribution of lengths at younger ages, which created an illogical decrease in standard deviations for length-at-age estimates. Therefore, for this assessment, we switched to a different Stock Synthesis CV growth option, that estimates standard deviations as a function of length-at-age (SS option 2) to describe uncertainty in of length at young and old ages, which produced reasonable estimates.

2) *There is a large quantity of age data from California that is currently being excluded from the model (<2002, and from other states >2008). Work should be continued to try to incorporate these data into the model, potentially by restructuring the fleets, reading additional historical ages, or other means. This would help to reconcile and make consistent the treatment of length data and age data over time and space. Additional ages may help to allow estimation of the CV parameters for male and female growth and perhaps explore alternate approaches to the growth parameters themselves.*

See response to request 1.

3) *Use a prior for female M in the next assessment – the current likelihood profile indicates that it may be estimable given a reasonably informative prior.*

For this assessment, we continued to explore the utility of natural mortality prior distribution developed from using different life history-based methods for estimating natural mortality (Hamel, 2015). The value of 0.05 yr^{-1} used by 2013 assessments is consistent with results from the maximum age based Hoenig's (1983) method. Other life history-based methods provide wildly different estimates that are generally considered to be inconsistent with rockfish life history. In the recent study, Then et al. (2015) evaluated the predictive performance of different life history-based methods in estimating natural mortality and demonstrated that these methods are not equal in their predictive power, and that maximum age-based methods, particularly Hoenig (1983), perform superior to the rest. Then et al. (2015) also re-evaluated and extended dataset used to estimate natural mortality in Hoenig (1983) and updated the Hoenig model parameters based on this improved data set. For darkblotched, the updated value of natural mortality estimated from this updated model was 0.054 yr^{-1}. In the assessment, this value is used for female natural mortality, while male natural mortality is estimated.

4) *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.*

The option of inputting a maturity-at-length matrix (that allows accounting for mass atresia) was added to Stock Synthesis, and we used this option in this assessment.

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

No new maturity samples were available for this assessment; however, more samples are scheduled be collected within NWFSC shelf-slope survey, which will enable progress in exploring temporal and spatial variability in darkblotched maturity parameters.

6) *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.*

For this assessment we evaluated differences in size-at-age data among states, and did not find evidence of spatial variability in growth. At present, there are no other life history data available to explore potential latitudinal variability in darkblotched life history traits.

7) *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 (including larvae) along the coast, which information is currently lacking.*

As the STAR panel mentioned, information regarding movement of darkblotched (including larvae) is not currently available. No additional information became available since last assessment.

8) *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.*

As mentioned above, Then at al. (2015) evaluated the performance of different life history-based methods (some of those were used to estimate Hamel prior), for informing natural morality and demonstrated that maximum age-based models perform the best, such as the Hoenig (1983) method used in this and the 2013 assessment. No changes to the method used to generate the steepness prior was made; it is based on 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.

We investigated using a new method that incorporates age-specific natural mortality (via an allometric function), but did not use it at this time, since the method (and its application in stock assessment) has not been thorough evaluated yet.

9) *As a diagnostic, a natural mortality value, as indicated by the likelihood profile, that is very different value than that used in the model indicates some model misspecification. Additional effort should be made to determine what features (such as the CV of length at age for old fish, selectivity, steepness, or other model structure) might be creating this pattern.*

We made a number of changes to 2013 assessment. However, these changes still did not aid an option to freely estimate natural mortality for both sexes.

10) *Continue to pursue making this assessment fully Bayesian. This will allow for probabilistic interpretation of the results, as well as far more efficient reporting and treatment of uncertainty in terms of the decision table, use of priors, etc.*

We did not pursue using a Bayesian assessment in 2015, due to time constrains. Analysis conducted in 2013 indicated that the estimated parameters and time series of depletion are very similar between maximum likelihood and Bayesian runs.

General recommendation for all species made by 2013 STAR Panel included:

1) *Recommend that STAT teams to present a sensitivity analysis (Tables and Figures) in the draft document for any axis of uncertainty that is likely to be considered for the decision table. This would facilitate efficient discussions during the meeting.*

In the pre-STAR draft of this document, we provided results (Tables and Figures) for a number of sensitivity runs, to aid in selection of the major axis of uncertainty. Alternative values of female natural mortality were used to construct the Decision Table, but exact values of natural mortality for low and high states of nature were selected based on uncertainty in both natural mortality and stock-recruit steepness (see Harvest Projections and Decision Table section for details).

2) *It would be helpful to routinely include a time-series of species-specific Canadian (B.C.) landings for comparison with U.S. landings and trends.*

Time series of darkblotched catches from British Columbia waters were obtained from Haigh and Starr (2008). We used these time series in sensitivity analysis to evaluate the impact of B.C. removals on model output. The results of this sensitivity analysis are presented Figure 114 through Figure 117 and Table 16.

3) *The specific treatment and results of model tuning procedures should be reported in the document including all input/output sample sizes, effective sample sizes, sigmas, RMSEs (including recruitment deviations), that are applicable.*

This information is provided in Table 11 and Table 12.

4) *For survey GLMM analyses, the STAT teams need to report a standard summary of the raw data, and fitting of the model including both results and diagnostics. Additional research should attempt to identify (and perhaps simulation test) a method for model selection including the error distribution, the treatment of random vs. fixed effects and the inclusion of ECE mixture distributions that can be reliably applied across all species.*

Fir this assessment, indices of abundance for three out of four bottom trawl surveys (that include AFSC shelf, AFSC slope and NWFSC slope surveys) were retained from the last assessment (Gertseva and Thorson, 2013). Abundance index for the NWFSC shelf-slope survey was derived using new geostatistical delta-GLMMs method (Thorson et al, (In press). Lognormal and gamma errors structures were considered for the model component representing positive catches, and lognormal model was selected for this index. Figure 25and Figure 26show Q-Q and posterior predictive plots, respectively, associated with this lognormal model.

5) *General recommendation to identify where and when E.J. Dicks fecundity relationships are better than existing data for a given species assessment.*

Dick (2009) remains the most recent and thorough evaluation of rockfish fecundity relationships. The STAT confirmed with E.J. Dick that his analysis included all earlier studies on darkblotched rockfish fecundity that include Nichol and Pikitch (1994), Phillips (1964) and Snytko and Borets (1973).

2.3 Model Description

2.3.1 Changes made from the last assessment

The last full assessment of darkblotched rockfish was conducted in 2013. For this assessment, we retained a number of features of the 2013 assessment, including the extent of the modelling period, historical catch information, survey fleet structure, age and length bin structures and many others. At the same time, we included a number of improvements related to use of data and modeling techniques. 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) Changed the structure of fishing fleets and divided fishery removals among three fisheries (instead of two as used in the last assessment). The bycatch fleet from the 2013 assessment was divided into bycatch in the historical foreign POP fishery and in the at-sea hake fishery. *Rationale*: The foreign POP fishery operated with bottom trawl gear, while the at-sea hake fishery uses midwater trawl gear. The selectivities of those two gear types are not the same. To accurately account for length composition of catch in the assessment, the removals by these two bycatch fleets were separated.

3) Brought in biological information on darkblotched bycatch (length and age data) collected from the at-sea hake fishery. *Rationale*: The biological information on darkblotched removals by the at-sea hake fishery has been collected by the at-sea hake observer program (ASHOP) since 2003. The use of these data allowed estimating darkblotched selectivity within the at-sea-hake fishery. Previously, selectivity of darkblotched bycatch within this fishery was assumed to be the same as in the bottom trawl fleet, even though at-sea hake fishery operates with midwater trawl gear.

4) Updated discard length and age frequencies for the shoreside fleet, to account for non-proportional (disproportional to discard amounts) sampling for lengths and ages and accurately describe the compositions of darkblotched removals within the shoreside fleet. *Rationale*: Biological sampling of discarded portion of the catch made by different gear type and within latitudinal strata is not proportional to discard amounts made by different gear types and within different areas. The normalized length and age compositions (provided from the WCGOP biological data processing script) are calculated based only upon the weighted data from the sampled trips; no information on total discard amounts by gear or area are used. To properly scale these compositions up to combined gears and areas (states, in case of this assessment), the individual normalized compositions were weighted by the total estimated darkblotched discard within each gear and area. This is analogous to the routinely used approach to generate coastwide length compositions of the landed catch from PacFIN biological data, described in this report.

5) Included biological data from shrimp trawl discard. *Rationale*: The pink shrimp fishery has existed since the 1950s. Landings of darkblotched in this fishery are hardly present. However, WCGOP observes some amount of discard of the small darkblotched individuals in this fishery. This is the first time that length and age data from pink shrimp fishery discard (weighted by the amount discarded) have been included in the assessment, in order to more accurately describe the compositions of darkblotched removals within shoreside fleet.

6) Used all age data from the shoreside fleet (unlike limiting age data to years with coastwide sampling as was done in 2013 assessment). *Rationale*: the 2013 assessments did not use ages when samples were not available from all three states, due to concerns that darkblotched rockfish may exhibit a latitudinal cline in growth. We evaluated darkblotched size-at-age data collected by California, Oregon and Washington and did not find evidence of systematic difference in growth among states.

7) Updated discard ratio estimates and length compositions from Pikitch study. *Rationale*: Wallace (2015) re-estimated Pikitch discard ratios and length composition using Pikitch data and fisheries landings reported in PacFIN. He used fish assemblages identified by Rodgers and Pikitch (1992) to expand discard ratios and length composition observed in Pikitch study to a fleet-wide level. Model results were nearly identical before and after this change.

8) Used the newest geostatistical delta GLMM software to construct NWFSC shelf-slope survey abundance indices. *Rationale*: Recent research suggests that geostatistical models can explain a substantial portion of variability in catch rates via the location of samples (i.e. whether located in high- or low-density habitats), and thus use available catch-rate data more efficiently than conventional "design-based" or stratified estimators. This new software is designed to estimate spatial variation in species density from fishery-independent data and estimate total species abundance. The SSC has approved use of the geostatistical delta-GLMM for use when estimating abundance indices using data from the NWFSC shelf-slope survey. Model results were not sensitive to this change (see Sensitivity analysis section).

9) Updated the weight-length relationship. *Rationale*: The revised estimates are based on NWSFC shelf-slope survey data from 2003 through 2014 (and not from 2003 through 2010, as in the last assessment). Model results were nearly identical before and after this change (see Sensitivity analysis section).

10) Updated the maturity settings. *Rationale*: The last assessment used newly available information of female maturity collected within the NWFSC shelf-slope survey. This new information included data on mass atresia (a form of skipped spawning). The 2013 assessment estimated an asymptotic maturity rate less than one, where this maturity schedule represents the combined effect of maturation and atresia. At the time of the 2013 assessment, however, the only option to incorporate this new maturity information into a Stock Synthesis model was as a maturity-at-age matrix. This current assessment uses a maturity-at-length matrix instead since this new option became available in Stock Synthesis since the last assessment. Model results were nearly identical before and after this change (see Sensitivity analysis section).

11) Used an updated prior to inform stock-recruit steepness. *Rationale*: For this assessment cycle, this stock-recruit steepness prior was updated 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. In the model, stock recruit steepness is fixed at the level of mean of the prior (0.773). Model results were nearly identical when last year prior mean of 0.779 (instead of 0.773) was used (see Sensitivity analysis section).

12) Used an updated value for the female Hoenig natural mortality estimate. *Rationale*: In the 2013 assessment, the fixed value of 0.05 yr-1was used for natural mortality for of females, while natural mortality for male was estimated for males. This value of 0.05 yr-1was estimated outside the model using the Hoenig method, which uses the maximum age of organisms in the stock to inform natural mortality. For this assessment, we used an updated Hoenig model published in Then et al. (2015). Then et al. (2015) evaluated the predictive performance of different life history-based methods in estimating natural mortality and concluded that maximum age-based methods, and particularly the Hoenig (1983), perform superior to better than the rest. Then et al. (2015) also re-evaluated and extended (compared to Hoenig (1983)) the data set to estimate natural mortality, and updated the model parameters based on this improved data set. For darkblotched, the natural mortality value estimated using these updated parameters reported in Then et al. (2015) was 0.054 yr-1. We used this updated value in the assessment.

13) Re-evaluated length-based selectivity assumptions. In the last assessment, the length-based selectivity curve of the shoreside fishery was assumed to be asymptotic, while the selectivity curve of NWFSC shelf-slope survey was estimated to be dome-shaped. This assessment fully estimated fishery selectivity, and assumes the selectivity of NWFSC shelf-slope survey to have an intermediate shape. *Rationale*: When fixed asymptotic, the fit to fishery length compositions exhibited a residual pattern, wherein the model systematically predicted the presence of more large individuals than observed in the data. In this assessment, we discovered that selectivity tended to be asymptotic in past assessments (when estimated) only because the initial value for selectivity parameter 2 (width of the plateau on top of the curve) was set too high. In this assessment, fishery selectivity is fully estimated and is dome-shaped. We also allowed shoreside fishery selectivity to be time-varying by putting a block on selectivity parameters for the period of the IFQ fishery (2011-2014). All of these changes helped to resolve the residual pattern.

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 output and depletion between this assessment and 2013 assessment is shown in Figure 37 and Figure 38, respectively.

2.3.2 Modeling software

This assessment uses the Stock Synthesis modeling framework developed by Dr. Richard Methot (NMFS, NWFSC). The most recent version (SSv3.24U, distributed on January 24, 2015) 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 three fleets: 1) the shoreside fishery, 2) bycatch in the historical foreign POP fishery, and 3) bycatch in the at-sea Pacific hake fishery. As described earlier, shoreside fleet was treated separately to account for difference in handling and reporting the discards. The shoreside 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 shoreside fleet only, and no discard is assumed for the bycatch fleet. Bycatch fleets were treated separately, since they operate with different gear types, historical foreign POP fishery used bottom trawl gear, while at-sea hake fishery operates with midwater trawl gear.

Historical catches for the shoreside fishery were reconstructed by state, and then combined into the coastwide fleet. Selectivity and retention parameters are estimated for the shoreside fleet and at-sea hake fishery bycatch fleet, while selectivity of the POP fishery bycatch fleet is mirrored to that of the shoreside 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 13.

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 14.

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:

$$L_\infty = L_1 + \frac{L_2 - L_1}{1 - e^{-k(A_2 - A_1)}}$$

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 standard deviations 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 standard deviation associated with L_1 were set to be identical to those of for females (the suggested default setting).

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 0.773. 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 39).

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. The foreign POP fishery was “mirrored” to that of the shoreside 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 shoreside fleet was fully estimated. It also was allowed to be time-varying, to reflect changes associated with implementation of the IFQ fishery. To accomplish this, a time block on selectivity parameters was created for the period of 2011-2014. A separate retention curve was estimated for the shoreside 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 2002 and 2010. The base value of asymptotic retention used for the period prior to 2002 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.

For bycatch in the at-sea hake fishery, five out of six selectivity parameters were estimated, and only one parameter, selectivity at the first size bin, was fixed, since no fish at smallest size bin was selected within this fleet. The selectivity curves of both fishery fleets were estimated to be of varying degree selectivity between dome-shaped and asymptotic.

The selectivity curves for AFSC shelf, AFSC slope and NWFS slope survey were set up similarly to that of at-sea hake bycatch fleet, and estimated to be dome-shaped. The NWFSC shelf-slope survey selectivity curve had more complex settings. In initial runs, the selectivity for this survey was fully estimated, when selectivity for shoreside fleet was fixed asymptotic. Later, five of the six parameters (all, but selectivity at the final bin) were fixed at the estimated values. In later runs, when fishery selectivity was allowed to be dome-shaped, the selectivity at the last bin was estimated to be above its minimum value (indicating that survey is catching a portion of the largest fish), making the entire selectivity curve half-dome. For the base model, we fixed at the last bin (parameter 6) at that estimated value. These settings, although complicated in algorithm to achieve them, were retained for the base model because they resulted in the best fit to length composition data of the shoreside fleet, while producing a reasonable picture of stock dynamics.

2.4 Model Selection and Evaluation

2.4.1 Key assumptions and structural choices

A large number of alternative model configurations of different levels of complexity were explored in order to formulate a base model that would realistically describe the population dynamics of this stock and would balance realism and parsimony.

We evaluated the alternative models based on overall model fit and convergence criteria. Key assumptions and structural choices were made based on whether the model-estimated parameters and outputs make sense and are consistent with information available for the species. The base model reflects the best aspects from these exploratory analyses. It appears to be parameterized sufficiently to fit the observed data, while maintaining reasonable parameter values and parsimonious explanations for the underlying model processes.

Earlier model configurations explored splitting the shoreside fishery catches into several different fleets, corresponding to trawl, non-trawl, and midwater trawl fishery gears. Splitting midwater and bottom trawl gears proved to be challenging since historically, midwater landings were often reported combined with bottom trawl catches. Even recent data often does not separate catches by these two gears types. Separating trawl from non-trawl gear allowed us to separately estimate selectivity curves separately for these two fleets. However, non-trawl had similar selectivity to the trawl fishery, and contributed only 1-2% to the total catch of darkblotched rockfish (Figure 11). Nevertheless, the model interpreted their composition data as representative of the entire stock, and iterative tuning of the composition data could not prevent them from receiving implausibly high weight. We therefore chose to combine all gear types from shoreside fishery into one fishing fleet, but undertook careful weighting of biological samples from different gear types (as described in Section 2.1.1.5), to accurately represent length compositions of shoreside fleet removals.

Significant efforts were devoted to exploration of selectivity settings. In several past assessments, fishery selectivity was forced to be asymptotic. But even when estimated, the fishery selectivity curve tended to be asymptotic. At the same time, fit to fishery length compositions exhibited a residual pattern, when the model systematically predicted the presence of more large individuals than observed in the data. In this assessment, we discovered that selectivity tended to be asymptotic (when estimated) only because the initial value for selectivity parameter 2 (width of the plateau on the top) was set too high. We experimented with different initial values for this parameter, and found that when it is not set as high, the fishery is estimated to be dome-shaped, and no residual pattern is present. However, with all fleets (fisheries and surveys) being dome-shaped, the model produced unrealistic results, estimating current spawning output above its virgin level, which is inconsistent with our knowledge of darkblotched rockfish. We therefore focused on finding a balance that would exhibit a better fit to the length composition data, while producing reasonable output. Balance was achieved by fixing NWFSC shelf-slope survey selectivity at half-dome as described in Section 2.3.4.3, and fully estimating fishery selectivity (to be half-dome).

In this assessment, we also explored a highly flexible, non-parametric selectivity option (Stock Synthesis length selectivity option 6), to resolve the residual pattern observed in previous assessments. However, the dome-shaped double normal option (selectivity option 24), produced a much more stable model and a reasonable result.

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 various selectivity components were blocked for the period after RCAs were implemented (from 2002 forward), selectivity at both periods (before and after RCAs) were almost identical.

This could have several explanations. This could occur because there are limited data to inform estimation for blocks in the retention curve prior to 2003, and the estimated retention curve showed that after 2003, most fish smaller than 25cm are being discarded. Additionally, there is 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.

Also, although RCAs prevent removal of darkblotched from relatively large areas along the coast, fishing still occurs in the larger areas with both small and large fish. That is, the RCA boundaries expand and contract over time, both within and between years, and those patterns change over time, so fishing in one area is prohibited one season, yet allowed in another. This dynamic can introduce noise into the relationship of RCA to selectivity. Additionally, heavy fishing effort routinely occurs just outside of those boundaries, which are moving over time. Thus, the amount of removals decreases with RCAs, but length composition of the catch may stay the same. The available data on landed catch does not indicate changes in length composition of retained catch before and after the RCAs (before IFQ started). For all these reasons, we stipulate that fishery selectivity is constant prior to and after of implementation of RCAs.

We also explored an option of using age-specific natural mortality estimates (as opposed to a single estimate for all ages), since it is well established that natural mortality rates changes through fishes' larval, juvenile and adult life stages. It is reasonable to expect that natural mortality declines as fish grow larger, since larger individuals generally are less susceptible to predation. Senescence can dramatically increase mortality, but this is usually not a crucial aspect of exploited fish stocks when survivorship to the very oldest ages is low. In early model configurations, we estimated age-specific natural mortality following an approach developed by Councill and Harford (In review). However, outputs from this model run were drastically different from the model with a single natural mortality value. For this assessment, we chose to use a single parameter natural mortality option (but separate for females and males) until we fully explore how to best parameterize natural mortality using Councill and Harford approach.

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, and 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) Including a block on the Shoreside fishery selectivity parameters to reflect changes associated with start of the IFQ program and improve fit to length composition data of this fleet for the IFQ period.
2) Extending the end year recruitment residuals from 2011 to 2013.
3) Turning estimation of forecast recruitment deviations off, to limit the impact of a large 2013 year-class into the future.

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 following techniques. We assessed the model's ability to recover similar likelihood estimates when initialized from dispersed starting points (jitter option in SS). We re-estimated the model 25 times 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. We also 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. For the base model, these 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 14. 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 females reach larger sizes (Figure 40). The estimated growth parameters for females and males are very close to the values used in previous assessments. Figure 41 through Figure 44 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 45, Figure 47, Figure 49 and Figure 51). Fit to index data on log scale are presented in Figure 46, Figure 48, Figure 50and Figure 52. With the offset estimate for the AFSC triennial survey beginning in 1995, predicted survey values fit the AFSC shelf survey abundance index well (Figure 45), This survey had the lowest index values in 1995 and highest estimate in 1983. The expected index values from the base model showed a slow decline from 1980–1995 and an increase over the period 1995–2004. The model was unable to fit the first point of this survey time series (1980), and accommodate a large difference between index value in 1980 and 1983, which is the highest value in the entire index time series. The model expectations for all other indices fell within the 95% intervals of all observations. 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. The NWFSC shelf-slope survey was generally flat, but exhibited a slight decrease in the last two years but the overall trend is mostly slowly increasing with flattening in the last two years. The expected index values from the base model showed a slow increase from 2003–2012 and is estimated flat 2013-2014. For the AFSC triennial and NWFSC shelf-slope surveys, the model estimated non-zero extra SD parameters (0.0176 and 0.082 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 86. 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 shoreside landings aggregated across all years (Figure 55) shows that the model was able to replicate the length composition pretty well. 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. 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 61).

The fits to conditional ages at length and Pearson residuals for the fits by survey are shown in Figure 79 through Figure 86. 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. These age compositions do not contribute to the likelihood and do not affect model fit in any way (Figure 87 through Figure 90).

Selectivity curves for fisheries and surveys are shown in Figure 91 through Figure 98. Both fisheries were estimated to be intermediate between asymptotic and dome-shaped, which is reasonable given that we do observe large fish in the fishery landings. Intermediate-shaped selectivity curve allowed better fit to fishery length composition data. 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 14.The AFSC shelf has peak selectivity at length for slightly smaller fishes than other surveys, as is plausible for a species that has ontogenetic movement offshore. It is also estimated to be dome-shaped, which is reasonable since the AFSC shelf survey also would be expected to take fewer larger fish due to limited coverage of the depth range of the species. Selectivity curves for the slope surveys are broadly similar, which is reasonable given that they had similar coverage, and estimated to be dome-shaped (Figure 91). It is not clear why the slope surveys, which include deep waters in which larger darkblotched rockfish occur, would have dome-shape. However, the footrope and roller gear used by this survey may play a role in the catchability of darkblotched. The length compositions observed for these three fleets with strongly dome-shaped selectivity show a smaller proportion of large fish than fisheries.

Discard ratios for shoreside fishery, as estimated from WCGOP and Pikitch study data, were fit by the model well (Figure 99). Based on these data, year-specific discard fraction and discard amounts were estimated within the model (Figure 100, Figure 101). 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 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 102). 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 103).

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 104 through Figure 109 and Table 15. 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 1976, spawning output dropped from 95% to less than 65% of its unfished level. Spawning output continued to decline throughout the 1980s and 1990s and in 2000 reached its lowest estimated level of 16% of its unfished state. Since 2000, the spawning output has been slowly increasing, which corresponds to decreased removals due to management regulations. Currently, the spawning output is estimated to be 38% of its unfished level (Figure 107).

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 106, Figure 107 and Figure 108). 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 analyses. Only the most relevant ones are reported here.

2.6.1.1 Sensitivity to changes from 2013 model

For this assessment, we made a few changes in settings for the life history parameters, mainly in response to 2013 STAR panel recommendations. These changes included: 1) using a new geostatistical delta-GLMM approach to estimate the abundance index for the NWFSC shelf-slope survey, 2) expressing maturity as a function of length when the maturity function does not proceed asymptotically to 1.0 (this option was not available in 2013), 3) setting CV of the growth pattern to SD=f(LAA), which means “standard deviations as a function of length-at-age”; and 4) updating weight-length parameters with the most recent data. Results of these sensitivity runs are summarized in Table 16 and Figure 110 through Figure 113. The model was not sensitive to any of these changes. The current spawning depletion varied only slightly among these model runs (within 5%).

2.6.1.2 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 enable one to account for a gradual shift of fishing effort towards deeper areas (with increasing vessel size and horsepower), which creates 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 historical removals, we ran the model assuming landings in historical (pre-1980) time series of shoreside fishery halved and doubled. These runs differed a little in the absolute estimate of B_0 and R_0, trends in spawning depletion, and relative SPR ratio as well as estimated depletion levels varied only slightly (Figure 116 through Figure 117, Table 16). We also performed a run to explore the impact of including catches from British Columbia waters, and found that the model exhibited some sensitivity to this change especially in the recent years, when relative contribution of B.C. catches increased (Figure 116 through Figure 117, Table 16).

2.6.1.3 Alternative assumptions about life history parameters

A major uncertainty in darkblotched assessment has been commonly associated with life history parameters, particularly natural mortality and stock-recruit curve steepness. In this assessment 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 below. Here we present results of selected runs with values used in 2013 assessment, as well as runs that estimate natural mortality and steepness values when using priors.

Results of the model runs with assumed female natural mortality of 0.05 $^{yr-1}$ and stock-recruit steepness of 0.779 (as used in the 2013 assessment) did not differ substantially from the results of the base model (Table 17, Figure 118). However, using Hamel prior for natural mortality produced much different absolute estimate of B_0 and overly optimistic view on relative spawning depletion (100%) (Table 17, Figure 118). The steepness, when estimated with a prior, was 0.82, and, thus, exceeded the mean of the prior (0.773) (Table 17, Figure 118). For this assessment, we, therefore, chose to fix steepness value at the mean of the prior distribution (0.773) obtained from 10 Tier-1 rockfish assessments off the U.S. West Coast. The stock-recruit steepness in the past darkblotched assessments ranged between 0.6 and 0.95.

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 4-year retrospective analysis was conducted by running the model using data only through 2010, 2011, 2012 and 2013 (Figure 119 through Figure 122, Table 16). No systematic pattern was observed. All retrospective runs align well with one another, and together appear somewhat higher than the base model in spawning depletion. This is due addition of length data from the most recent year (2014) of the NWFSC shelf-slope survey (Figure

123, Figure 124, Table 16). The relative contribution of smaller lengths was higher in 2014 than in any other year of the survey since 2003. We can hypothesize that recent environmental changes might cause similar changes in observed length distributions with in the sampled areas. Large areas off the West Coast have become substantially and persistently warmer than normal since 2014. This event is unprecedented and the effects it may have on groundfish populations are largely unknown.

The second type of retrospective analysis addresses assessment error, or at least the historical context of the current result given previous analyses. Figure 125 shows the spawning depletion time series for all assessment (full and update assessment) conducted since 2000. 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. The 2003, 2005, 2007, 2009, 2011 and 2013 assessments estimated spawning depletion at terminal year of each assessment to be 13%, 17%, 22%, 28%, 30%, and 36% respectively. This assessment estimate stock to be at 38% of its unfished state.

2.6.3 Likelihood profile analyses

The base model included several key parameters, including natural mortality and stock-recruit steepness, which were fixed at the values determined based on life-history traits of the species in a meta-analysis, using those with similar life-history characteristics. Likelihood profiles were conducted to look at the sensitivity of the model to assumptions about natural mortality (M) and steepness (h). Also, likelihood profile analysis over the $\ln(R_0)$ parameter was conducted to explore the influence of different data sources on the scale of the population and stock status.

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 values between 0.04 and 0.09 (Figure 126). A value for natural mortality of 0.9 is considered to be inconsistent with the age of old individuals that have been observed, as well as previous assessments, and we therefore concluded 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 (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. However, as described in Section 2.1.3.4, we only fixed female natural mortality, while male natural mortality is estimated in the base model. Dimorphic growth is often accompanied by different rates of natural mortality. Although the data are insufficient to estimate natural mortality for both males and females, when female M is fixed, the compositional data should be informative about the difference in natural mortality between the sexes. Estimating natural mortality for at least one sex would capture more of the uncertainty in the model results. Time series of spawning depletion associated with different values of natural mortality ranging from 0.04 to 0.1 are shown in Figure 127.

When estimated with a meta-analytical prior, stock-recruit steepness was 0.82. However, a likelihood profile of the base model indicated that the negative log-likelihood is the lowest with steepness value around 0.5 (Figure 128). Profile analysis also indicated that there is tension between length and age composition likelihoods, when length compositions likelihoods for all fleets have the lowest values (negative) associated with higher steepness and age composition likelihoods, on the contrary, with lower steepness. The model run associated with steepness of 0.5 produces unreasonable output when population drops to 6% of its virgin level in 2015 (Figure 129).

A likelihood profile analysis for $\ln(R_0)$ shows that the negative log-likelihood for the base model is optimized at a value of approximately 7.9 (same value estimated in the assessment). 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 130). Additionally, recruitment scales with $\ln(R_0)$; high values of $\ln(R_0)$ coincide with higher recruitment, and low values of $\ln(R_0)$ coincide with lower recruitment (Figure 131). This indicates that the 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 in order to continue achieving that desired level of recruitment, which in turn 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 3,203 million eggs (95% confidence interval: 2,370-4,036 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 1,281 million eggs (95% confidence interval: 948-1,614), which corresponds to an exploitation rate of 0.041. This harvest rate provides an equilibrium yield of 674 mt at $SB_{40\%}$ (95% confidence interval: 504-844 mt). The model estimate of maximum sustainable yield (MSY) is 728 mt (95% confidence interval: 544-912 mt). The estimated spawning stock output at MSY is 815 million eggs (95% confidence interval: 603-1,026 million of eggs). The exploitation rate corresponding to the estimated SPR_{MSY} of $F_{31\%}$ is 0.0655.

The assessment shows that the stock of darkblotched rockfish off the continental U.S. Pacific Coast is currently at 39% 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 1989, as a result of intense fishing by foreign and domestic fleets. It continued to decline and reached the level of 16% of its unfished output in 2000. The same year, the stock was declared overfished. Since then, the spawning output was slowly increasing primarily due to management regulations instituted for the species (Figure 107).

This assessment estimates that the 2014 SPR is 89%. The SPR used for setting the OFL is 50%, while the SPR-based management fishing mortality target, specified in the current rebuilding plan and is used to determine the ACL, is 64.9%. Historically, the darkblotched rockfish has been fished beyond the relative SPR ratio (calculated as 1-SPR/1-$SPR_{Target=0.5}$) between 1966 and 1968, during the peak years of the Pacific ocean perch fishery, in 1973 and for a prolonged period between from 1981 and 2000 (Figure 132). Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model is shown in Figure 133.

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 2015 spawning depletion is 39%. The primary axis of uncertainty about this estimate used in the decision table was based on female natural mortality. To identify female natural mortality values that correspond to low and high states of nature, we followed a multi-step algorithm. First, we selected alternative values of stock-recruit steepness. For this, we used a normal approximation to the prior distribution for steepness with an identical mean and standard deviation to the prior distribution from that analysis (mean=0.773, SD=0.147). We then identified two values from that normal distribution which are half as likely as the mode. Those values are:

$$h = 0.773 \pm 0.147(1.18) = (0.600, 0.946)$$

where 0.600 represents the low and 0.946 the high steepness alternatives.

We then determined depletion levels associated with alternative steepness values; depletion under low steepness was 9%, and it was 49% under high steepness. Finally, we identified female natural mortality values associated with these low and high depletion levels; they were 0.0412 and 0.059 respectively (Figure 134). We used these values to define low and high states of nature and construct the decision table (Table 20).

Twelve-year forecasts for each state of nature were calculated based on average catch for the period between 2011 and 2014. They were also produced with future catches fixed at the 2016 darkblotched rockfish ACL. Finally, forecasts for each state of nature were calculated based on removals at a current rebuilding SPR of 64.9% for the base model.

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 depletion will stay below the $SB_{40\%}$ target within the next 12 years. Under the high state of nature, the spawning output remains above the 40% target level throughout the 12-year projection period.

5 Regional Management Considerations

In the waters of the western United States, off California, Oregon and Washington, this species is managed coastwide, with coastwide ACLs determined for management purposes. The population within the assessed area is treated as a single coastwide stock, due to the lack of biological and genetic data indicating the presence of multiple stocks. Analysis conducted within this assessment did not find support for regional management considerations as well. However, below we identify several of areas of research that may aid evidence for regional management considerations for the future.

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) Additional population genetics research to elucidate potential spatial stock structure would be valuable for assessment and management, to ensure prevention of local depletion and preserve genetic diversity.

2) Additional research on darkblotched movement including migration patterns by latitude and depth, diurnal migration patterns through the water column, relative time spent off-bottom versus midwater, relating movements to size, age and sex would be valuable for further understanding this rockfish's ecological niche, stock structure, and lend insight to catchability and gear selectivity patterns.

3) 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; such information is currently lacking.

4) Continuing collection of maturity and fecundity data on darkblotched rockfish would allow further research into latitudinal variability in life history parameters that again would advance understanding this species stock structure. Multi-year data would also allow evaluation of temporal changes in darkblotched maturity and fecundity.

5) Additional research into natural mortality, as it relates to length and age would be valuable to enable more realistic and accurate modeling of this parameter, which is a common source of uncertainty in assessment of this, and other rockfish species. Councill and Harford (in review) is an example of one approach; it models natural mortality as a decaying function of size, with assumptions that mortality rates should be constrained by lifetime mortality rate.

6) Future research could also improve existing meta-analyses for natural mortality and steepness, which both contribute to the implied yield curve. Directions for improvements could include (1) weighting methods in natural mortality prior estimates included in the Hamel meta-analysis, and (2) developing a larger

database of species for estimating steepness, perhaps by including species from other regions, e.g., Canada and Alaska.

7) Research into establishing optimum methods for more precise modeling of selectivity patterns is needed. Either asymptotic or dome-shaped selectivity assumptions are frequently used in stock assessments, when neither may be the best available representation of selectivity. Assumptions of a dome shape can suggest a “cryptic” biomass, or create confounding with natural mortality assumptions, potentially inflating abundance indices (Crone et al 2013). Assumptions of asymptotic shape may also not be realistic. Simulation studies could be performed to empirically evaluate varying degrees of intermediate selectivity shapes, and how best to effectively implement them in existing stock assessment software platforms.

8) Research assessing the effects of the unprecedented warm ocean conditions off the West Coast of the U.S. during 2014 and 2015, on rockfish populations is needed. Specifically, investigations are needed that focus on how temperature and other water conditions at depth, in rockfish habitat correspond to high sea-surface temperatures recorded throughout those years, and how the fish respond to those changing conditions. Research is needed that examines whether fish move in response to changing temperatures, where, and how they move, as well as whether the conditions influence life history parameters and aspects such as mortality, feeding, fecundity and other reproductive considerations. What oceanographic and climatic forces are responsible and how long these conditions are expected to persist are also critical pieces of knowledge.

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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)*
2005	269	122	98	129
2006	269	122	107	194
2007	456	260	144	261
2008	456	260	117	250
2009	437	282	138	289
2010	437	282	184	351
2011	508	298	117	118
2012	508	298	94	95
2013	541	317	124	125
2014	541	317	103	104

*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 shoreside fleet (provided here by state) and bycatch fleet (separated here as bycatch in foreign POP and in at-sea Pacific hake fisheries).

Year	Shoreside California	Shoreside Oregon	Shoreside 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	Shoreside California	Shoreside Oregon	Shoreside 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	Shoreside California	Shoreside Oregon	Shoreside 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
2013	4	103	11	0	6	124
2014	4	77	11	0	11	103

Table 3: Summary of fishery sampling effort (number of trips, hauls and fish sampled) used to create length frequency distributions of the shoreside 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	0	0	0
2003	27	436	59	1398	28	580	5	18	408
2004	29	526	58	1305	19	605	107	412	3488
2005	33	567	54	1275	9	117	154	357	2268
2006	62	1129	62	1457	10	397	134	307	1182
2007	74	1520	79	2155	22	529	179	343	1245
2008	81	1795	102	2689	12	350	195	403	1508
2009	52	1214	136	2828	11	350	276	486	1827
2010	44	746	136	2855	5	206	201	415	1675
2011	53	559	148	2570	17	869	268	685	3223
2012	56	697	125	2309	17	729	292	659	2968
2013	46	380	120	2320	8	701	279	509	2234
2014	0	0	117	2003	11	372	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 shoreside 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	28	193	0	0	0	0	0	0	0
1982	51	411	0	0	0	0	0	0	0
1983	79	527	0	0	0	0	0	0	0
1985	197	2872	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	26	356	0	0	0	0	0	0	0
1990	69	779	0	0	0	0	0	0	0
1991	34	336	0	0	0	0	0	0	0
1993	35	466	0	0	0	0	0	0	0
1994	32	397	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	47	809	1	33	0	0	0	0	0
1998	52	854	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	26	583	20	610	12	388	0	0	0
2003	18	245	51	1162	11	369	0	0	0
2004	15	243	27	753	9	410	66	113	387
2005	26	448	40	897	6	103	114	222	619
2006	41	829	44	1070	7	272	0	0	0
2007	26	540	60	1705	18	423	0	0	0
2008	19	295	77	2233	9	243	0	0	0
2009	0	0	107	2486	11	272	0	0	0
2010	0	0	79	1864	4	120	0	0	0
2011	0	0	78	1652	13	532	0	0	0
2012	0	0	84	1768	10	455	0	0	0
2013	0	0	32	859	6	400	0	0	0
2014	0	0	102	335	0	0	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	34º 00'- Canadian border	50-250
	1980	36º 48'- 49º 15'	30-200
	1983	36º 48'- 49º 15'	30-200
	1986	36º 48'- Border	30-200
	1989	34º 30'- 49º 40'	30-200
	1992	34º 30'- 49º 40'	30-200
	1995	34º 30'- 49º 40'	30-275
	1998	34º 30'- 49º 40'	30-275
	2001	34º 30'- 49º 40'	30-275
	2004	34º 30'- Canadian border	30-275
AFSC slope	1988	44º 05'- 45º 30'	100-700
	1990	44º 30'- 40º 30'	100-700
	1991	38º 20'- 40º 30'	100-700
	1992	45º 30'- Border	100-700
	1993	43º 00'- 45º 30'	100-700
	1995	40º 30'- 43º 00'	100-700
	1996	43º 00'- Canadian border	100-700
	1997	34º 00'- Canadian border	100-700
	1999	34º 00'- Canadian border	100-700
	2000	34º 00'- Canadian border	100-700
	2001	34º 00'- Canadian border	100-700
NWFSC slope	1999	34º 50'- 48º 10'	100-700
	2000	34º 50'- 48º 10'	100-700
	2001	34º 50'- 48º 10'	100-700
	2002	34º 50'- 48º 10'	100-700
NWFSC shelf-slope	2003	32º 34'- 48º 27'	30-700
	2004	32º 34'- 48º 27'	30-700
	2005	32º 34'- 48º 27'	30-700
	2006	32º 34'- 48º 27'	30-700
	2007	32º 34'- 48º 27'	30-700
	2008	32º 34'- 48º 27'	30-700
	2009	32º 34'- 48º 27'	30-700
	2010	32º 34'- 48º 27'	30-700
	2011	32º 34'- 48º 27'	30-700
	2012	32º 34'- 48º 27'	30-700
	2013	32º 34'- 48º 27'	30-700
	2014	32º 34'- 48º 27'	30-700

Table 6: Spatial strata used in constructing survey abundance indices via stratified delta-GLMM method.

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

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	149	53	0	0	0	0
2000	153	52	25	296	25	137
2001	165	54	45	494	45	184
2002	205	55	54	1027	54	301

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	541	101	100	2375	100	748
2004	470	92	90	1062	90	594
2005	637	112	110	1983	110	804
2006	641	130	130	1925	130	940
2007	688	132	132	2086	132	987
2008	681	111	111	1647	111	762
2009	682	126	126	2298	126	1159
2010	714	117	117	2239	117	912
2011	697	110	108	1828	108	796
2012	701	102	102	2205	102	791
2013	471	89	89	1548	89	687
2014	685	116	114	1517	114	767

Table 11: Information on inputs and sample size adjustments for length and age composition data.

	mean(inputN*Adj)	HarMean(effN)	Var_Adj	HarEffN/MeanInputN
Length composition data				
Shoreside	54.2229	52.5015	0.133114	0.9682533
At-sea hake	59.7518	59.6686	0.120528	0.9986076
AKSHLF	71.9324	70.8665	0.297514	0.9851819
AKSLP	26.8877	26.369	0.572078	0.9807087
NWSLP	38.9633	38.0429	0.485021	0.9763778
NWCBO	68.7904	66.7461	0.281543	0.9702822
Age composition data				
Shoreside	74.1563	75.2779	0.333243	1.0151248
At-sea hake	30.5763	30.74	0.167389	1.0053538
AKSHLF	3.00929	3.00631	0.170828	0.9990097
AKSLP	1.5566	1.6068	0.19336	1.0322498
NWSLP	2.81111	2.82061	0.157214	1.0033794
NWCBO	3.35207	3.42274	0.143452	1.0210825

Table 12: Root mean squared error (r.m.s.e.) of the observations around the expected values for each survey.

Fleet	Obs (SdLog)	Input (SdLog)
AKSHLF	0.302399	0.311325
AKSLP	0.164986	0.652762
NWSLP	0.402318	0.468656
NWCBO	0.278081	0.275922

Table 13: 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 14: List of parameter values used in the base model.

Parameter	Estimated value	Bounds (low, high)	Fixed value
Natural mortality (*M*, female)	-	NA	0.054
Natural mortality (*M*, male)	0.069	(0.01,0.15)	-
	Individual growth		
Females:			
Length at A_1	15.186	(1,20)	-
Length at A_2	42.66	(20,60)	-
von Bertalanffy *K*	0.20	(0.05,0.3)	-
SD of length at A_1	1.81	(0.5,15)	-
SD of length at A_2	2.15	(0.5,15)	-
Males:			
Length at A_1 (set equal to females)	-	NA	0.0
Length at A_2	38.35	(50,60)	-
von Bertalanffy *K*	0.245	(0.05,0.3)	-
SD of length at A_1 (set equal to females)	-	NA	0.0
SD of length at A_2	1.17	(0.5,15)	-
	Weight at length		
Females:			
Coefficient	-	NA	1.15E-05
Exponent	-	NA	3.12536
Males:			
Coefficient	-	NA	1.22E-05
Exponent	-	NA	3.10647
	Fecundity at length		
Inflection	-	NA	101100
Slope	-	NA	44800
	Stock and recruitment		
Ln(R_0)	7.93	(5,12)	-
Steepness (*h*)	-	NA	0.773
Recruitment SD (σ_r)	-	NA	0.75
	Survey catchability and variability		
Ln(*Q*) – AFSC shelf (1980-1992)	0.585	(-10,2)	
Ln(*Q*) – AFSC shelf offset (1995-2004) to early	0.0089	(-4,4)	
Ln(*Q*) – AFSC slope	-0.123	(-10,2)	
Ln(*Q*) – NWFSC slope	0.047	(-10,2)	
Ln(*Q*) – NWFSC shelf-slope	0.347	(-10,2)	
Extra additive SD for AFSC shelf	0.016	(0,1)	
Extra additive SD for NWFSC shelf-slope	0.082	(0,1)	
	Selectivity and retention		
Shoreside fishery (double-normal)			
Peak	34.19	(20, 45)	-
Peak block (2011-2014)	32.74	(20, 45)	-
Top: width of plateau	-5.93	(-6, 4)	-
Top: width of plateau block (2011-2014)	-3.52	(-6, 4)	-
Ascending slope	2.68	(-1,9)	-
Ascending slope block (2011-2014)	1.80	(-1,9)	-

Parameter	Estimated value	Bounds (low, high)	Fixed value
Descending slope	1.15	(-1,9)	-
Descending slope block (2011-2014)	1.99	(-1,9)	-
Selectivity at first bin	-2.32	(-1,9)	-
Selectivity at last bin	0.26	(-1,9)	-
Selectivity at last bin block (2011-2014)	-1.07	(-1,9)	-
Shoreside retention (logistic function)			
Inflection base	25.13	(15,70)	-
Inflection block (2011-2014)	20.10	(15,70)	-
Slope base	1.67	(0.1,10)	-
Slope block (2011-2014)	2.21	(0.1,10)	-
Asymptotic retention base	-	NA	1
Asymptotic retention block (2002)	0.45	(0,1)	-
Asymptotic retention block (2003)	0.40	(0,1)	-
Asymptotic retention block (2004)	0.80	(0,1)	-
Asymptotic retention block (2005)	0.75	(0,1)	-
Asymptotic retention block (2006)	0.53	(0,1)	-
Asymptotic retention block (2007)	0.54	(0,1)	-
Asymptotic retention block (2008)	0.46	(0,1)	-
Asymptotic retention block (2009)	0.48	(0,1)	-
Asymptotic retention block (2010)	0.52	(0,1)	-
Male offset to inflection	-	NA	0
At-sea hake fishery (double-normal)			
Peak	33.17	(10, 45)	-
Top: width of plateau	-4.48	(-6,4)	-
Ascending slope	3.82	(-1,9)	-
Descending slope base	-0.74	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	0.33	(-1,9)	-
AFSC shelf survey (double-normal)			
Peak	22.11	(10, 45)	-
Top: width of plateau	-5.97	(-6,4)	-
Ascending slope	3.42	(-1,9)	-
Descending slope base	4.86	(-1,9)	-
Descending slope block (1995-2004)	4.75	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
AFSC slope survey (double-normal)			
Peak	22.20	(10, 45)	-
Top: width of plateau	-1.68	(-6,4)	-
Ascending slope	1.84	(-1,9)	-
Descending slope	3.27	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
NWFSC slope survey (double-normal)			
Peak	24.7	(10, 45)	-
Top: width of plateau	-5.97	(-6,4)	-6
Ascending slope	3.1	(-1,9)	-

Parameter	Estimated value	Bounds (low, high)	Fixed value
Descending slope	4.85	(-1,9)	-
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-999
NWFSC shelf-slope survey (double-normal)			
Peak	-	NA	24.4731
Top: width of plateau	-	NA	-6
Ascending slope	-	NA	4.13751
Descending slope	-	NA	3
Selectivity at first bin	-	NA	-999
Selectivity at last bin	-	NA	-0.841911

Table 15: 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	36,459	36,454	3,201	100%	2,783	
1916	36,464	36,458	3,201	100%	2,784	0.00036
1917	36,455	36,450	3,201	100%	2,785	0.00057
1918	36,439	36,434	3,199	100%	2,786	0.00059
1919	36,424	36,418	3,198	100%	2,787	0.00038
1920	36,417	36,411	3,197	100%	2,788	0.00040
1921	36,410	36,404	3,196	100%	2,790	0.00034
1922	36,406	36,400	3,196	100%	2,791	0.00031
1923	36,404	36,398	3,195	100%	2,793	0.00038
1924	36,400	36,395	3,195	100%	2,795	0.00038
1925	36,398	36,392	3,194	100%	2,797	0.00044
1926	36,394	36,388	3,193	100%	2,799	0.00059
1927	36,386	36,380	3,192	100%	2,801	0.00051
1928	36,382	36,376	3,192	100%	2,803	0.00050
1929	36,379	36,374	3,191	100%	2,806	0.00053
1930	36,377	36,371	3,191	100%	2,809	0.00058
1931	36,374	36,369	3,190	100%	2,811	0.00072
1932	36,368	36,362	3,189	100%	2,814	0.00045
1933	36,373	36,367	3,189	100%	2,818	0.00044
1934	36,380	36,374	3,189	100%	2,821	0.00042
1935	36,389	36,383	3,189	100%	2,825	0.00048
1936	36,397	36,391	3,190	100%	2,829	0.00033
1937	36,412	36,407	3,190	100%	2,834	0.00037
1938	36,427	36,422	3,191	100%	2,840	0.00046
1939	36,441	36,435	3,192	100%	2,850	0.00066
1940	36,450	36,444	3,192	100%	2,860	0.00090
1941	36,451	36,446	3,192	100%	2,875	0.00116
1942	36,447	36,441	3,190	100%	2,892	0.00133
1943	36,440	36,434	3,189	100%	2,911	0.00507
1944	36,302	36,297	3,176	99%	2,935	0.01103
1945	35,959	35,953	3,145	98%	2,965	0.01901
1946	35,349	35,343	3,090	96%	3,003	0.01142
1947	35,043	35,036	3,059	96%	3,054	0.00953
1948	34,829	34,822	3,035	95%	3,122	0.00553
1949	34,780	34,774	3,025	94%	3,205	0.00464
1950	34,787	34,781	3,018	94%	3,304	0.00515

Year	Total biomass (mt)	Summary biomass (mt)	Spawning output (million fish)	Depletion (%)	Age-0 Recruits (1000s)	Exploitation rate (catch/ age 1+ biomass)
1951	34,805	34,798	3,012	94%	3,408	0.00596
1952	34,826	34,819	3,005	94%	3,497	0.00627
1953	34,872	34,865	2,999	94%	3,544	0.00533
1954	34,991	34,984	2,998	94%	3,520	0.00625
1955	35,116	35,109	2,997	94%	3,434	0.00735
1956	35,236	35,230	2,995	94%	3,314	0.00970
1957	35,298	35,292	2,989	93%	3,191	0.01131
1958	35,316	35,310	2,982	93%	3,084	0.00956
1959	35,395	35,389	2,983	93%	2,995	0.00806
1960	35,511	35,505	2,992	93%	2,919	0.00971
1961	35,540	35,534	2,998	94%	2,855	0.00904
1962	35,558	35,553	3,006	94%	2,814	0.00978
1963	35,512	35,506	3,011	94%	2,817	0.01044
1964	35,404	35,398	3,013	94%	2,874	0.00754
1965	35,366	35,360	3,020	94%	2,959	0.01375
1966	35,081	35,075	3,006	94%	2,992	0.12040
1967	31,052	31,046	2,673	83%	2,889	0.09917
1968	28,234	28,229	2,428	76%	2,726	0.08583
1969	26,138	26,133	2,238	70%	2,665	0.01101
1970	26,232	26,226	2,230	70%	2,818	0.01345
1971	26,282	26,276	2,222	69%	2,994	0.02018
1972	26,173	26,168	2,202	69%	2,431	0.02344
1973	25,997	25,993	2,180	68%	1,945	0.03523
1974	25,518	25,515	2,134	67%	1,748	0.02396
1975	25,319	25,316	2,115	66%	1,457	0.02426
1976	25,061	25,057	2,097	65%	2,048	0.02689
1977	24,674	24,671	2,076	65%	1,345	0.01298
1978	24,574	24,567	2,083	65%	3,451	0.01705
1979	24,329	24,324	2,081	65%	2,823	0.03046
1980	23,760	23,757	2,045	64%	1,963	0.02627
1981	23,355	23,346	2,012	63%	4,399	0.03610
1982	22,790	22,788	1,954	61%	1,349	0.05029
1983	21,998	21,996	1,867	58%	883	0.05168
1984	21,267	21,264	1,782	56%	1,414	0.06281
1985	20,319	20,316	1,688	53%	1,791	0.08808
1986	18,871	18,868	1,564	49%	1,654	0.06723
1987	17,906	17,900	1,489	46%	3,181	0.13561
1988	15,769	15,767	1,322	41%	1,303	0.10596
1989	14,412	14,410	1,210	38%	900	0.08932

Year	Total biomass (mt)	Summary biomass (mt)	Spawning output (million fish)	Depletion (%)	Age-0 Recruits (1000s)	Exploitation rate (catch/ age 1+ biomass)
1990	13,468	13,466	1,122	35%	732	0.12611
1991	12,110	12,108	996	31%	895	0.10064
1992	11,210	11,208	912	28%	792	0.06189
1993	10,793	10,792	877	27%	439	0.11156
1994	9,819	9,814	806	25%	2,306	0.08894
1995	9,143	9,136	759	24%	3,707	0.08671
1996	8,575	8,574	715	22%	965	0.08755
1997	8,144	8,141	668	21%	1,281	0.10231
1998	7,722	7,721	611	19%	828	0.12228
1999	7,247	7,234	543	17%	6,440	0.05091
2000	7,424	7,415	528	16%	4,611	0.03560
2001	7,863	7,862	533	17%	549	0.02278
2002	8,586	8,583	555	17%	1,308	0.02959
2003	9,338	9,335	578	18%	1,562	0.02134
2004	10,140	10,135	608	19%	2,609	0.02370
2005	10,855	10,850	649	20%	2,671	0.01187
2006	11,635	11,631	716	22%	2,168	0.01669
2007	12,322	12,319	790	25%	1,644	0.02115
2008	12,918	12,906	856	27%	6,240	0.01939
2009	13,521	13,519	913	29%	950	0.02139
2010	14,133	14,129	961	30%	2,243	0.02486
2011	14,725	14,721	1,002	31%	2,025	0.00799
2012	15,526	15,524	1,061	33%	956	0.00610
2013	16,307	16,288	1,123	35%	9,616	0.00766
2014	17,043	17,038	1,189	37%	2,466	0.00608
2015	17,902	17,897	1,261	39%	2,491	NA

Table 16: Comparison among selected sensitivity runs. Likelihoods in italics are not comparable across rows.

Model	Base	High catch	Low catch	B.C. catches included	Data -1 year	Data -2 years	Data -3 years	Data -4 years	No 2014 NWCBO comps
Negative log-likelihood									
Total	1854.24	1855.52	1853.58	1852.86	*1776.33*	*1703.77*	*1609.01*	*1535.73*	1791.22
Indices	-18.6734	-18.1939	-19.0412	-19.4939	*-19.3873*	*-18.4621*	*-17.7784*	*-16.7257*	-18.6346
Length frequencies	540.814	540.688	540.785	540.403	*516.003*	*486.048*	*463.221*	*438.636*	521.387
Age frequencies	1357.46	1357.14	1357.79	1357.67	*1304.27*	*1257.3*	*1187.29*	*1134.99*	1312.59
Selected parameters									
$\ln(R_0)$	7.928	8.140	7.810	7.968	7.987	7.985	7.984	7.982	7.991
Steepness (*h*)	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773
Female *M*	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
Male *M*	0.069	0.070	0.069	0.069	0.070	0.070	0.070	0.071	0.070
Female L at A_1	15.187	15.188	15.187	15.189	15.135	15.091	15.121	15.038	15.139
Female L at A_2	42.662	42.672	42.666	42.673	42.653	42.620	42.572	42.525	42.637
Male L at A_1	15.187	15.188	15.187	15.189	15.135	15.091	15.121	15.038	15.139
Male L at A_2	38.347	38.344	38.329	38.351	38.339	38.352	38.319	38.357	38.355
Female von Bert *K*	0.198	0.198	0.198	0.194	0.198	0.198	0.197	0.198	0.198
Male von Bert *K*	0.245	0.245	0.245	0.243	0.245	0.245	0.246	0.245	0.245
Management quantities									
Equilibrium spawning output (million eggs)	3,203	3,965	2,848	3,339	3,405	3,394	3,387	3,377	3,415
2015 Spawning depletion	39%	44%	37%	34%	51%	51%	50%	48%	52%

Table 17: Comparison among selected sensitivity runs.

Model	Base	Non-spatial GLMM	2013 maturity settings	2013 growth CV settings	2013 WL parameters	2013 female M	M estimated with Hamel prior	2013 steepness	Steepness estimated with prior
Negative log-likelihood									
Total	1854.24	1857.39	1856.44	1887.04	1856.46	1854.9	1851.72	1854.2	1854.16
Indices	-18.6734	-15.8398	-18.7151	-18.4874	-18.7748	-18.6442	-21.5288	-18.6737	-18.5517
Length frequencies	540.814	540.826	541.893	546.608	541.847	541.071	541.901	540.706	540.637
Age frequencies	1357.46	1357.64	1357.95	1382.94	1358.06	1358.2	1353.13	1357.53	1357.41
Selected parameters									
$Ln(R_0)$	7.928	7.938	7.939	7.946	7.937	7.775	10.392	7.931	7.936
Steepness (*h*)	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.779	0.824
Female *M*	0.054	0.054	0.054	0.054	0.054	0.050	0.088	0.054	0.054
Male *M*	0.069	0.069	0.070	0.070	0.070	0.065	0.110	0.070	0.070
Female L at A_1	15.187	15.183	15.193	15.499	15.194	15.188	15.180	15.187	15.188
Female L at A_2	42.662	42.660	42.659	42.772	42.666	42.654	42.747	42.669	42.671
Male L at A_1	15.187	15.183	15.193	15.499	15.194	15.188	15.180	15.187	15.188
Male L at A_2	38.347	38.344	38.329	38.351	38.339	38.352	38.319	38.357	38.355
Female von Bert *K*	0.198	0.198	0.198	0.194	0.198	0.198	0.197	0.198	0.198
Male von Bert *K*	0.245	0.245	0.245	0.243	0.245	0.245	0.246	0.245	0.245
Management quantities									
Equilibrium spawning output (million eggs)	3,203	3,235	3,304	3,286	3,245	3,096	16,279	3,216	3,234
2015 Spawning depletion	39%	41%	44%	44%	41%	32%	100%	40%	43%

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

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning output (million eggs)	3,203	2,370-4,036
Unfished age 1+ biomass (mt)	36,459	27,360-45,557
Unfished recruitment (R0)	2,773	2,051-3,494
Depletion (2015)	39%	17-62%
Reference points based on $SB_{40\%}$		
Proxy spawning output ($B_{40\%}$)(million eggs)	1,281	948-1,614
SPR resulting in $B40_{\%}$ ($SPR_{B40\%}$)	44%	NA
Exploitation rate resulting in $B_{40\%}$	4.1%	3.98-4.29%
Yield with *SPR* at $B_{40\%}$ (mt)	674	504-844
Reference points based on SPR proxy for MSY		
Spawning output (million eggs)	1,474	1,091-1,858
SPR_{proxy}	50%	NA
Exploitation rate corresponding to SPR_{proxy}	3.4%	3.3-3.5%
Yield with SPR_{proxy} at SB_{SPR} (mt)	630	472-789
Reference points based on estimated MSY values		
Spawning output at *MSY* (SB_{MSY}) (million eggs)	815	603-1,026
SPR_{MSY}	31%	30-32%
Exploitation rate corresponding to SPR_{MSY}	6.55%	6.24-6.74%
MSY (mt)	728	544-912

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

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Landings (mt)	98	107	144	117	138	184	117	94	124	103	NA
Estimated Total catch (mt)	129	194	261	250	289	351	118	95	125	104	NA
OFL (mt)	269	269	456	456	437	437	508	508	541	541	
ACL (mt)	122	122	260	260	282	282	298	298	317	317	
SPR	77%	71%	66%	67%	64%	59%	85%	88%	86%	89%	NA
Exploitation rate (catch/ age 1+ biomass)	0.012	0.017	0.021	0.019	0.021	0.025	0.008	0.006	0.008	0.006	NA
Age 1+ biomass (mt)	10,850	11,631	12,319	12,906	13,519	14,129	14,721	15,524	16,288	17,038	17,897
Spawning output (million eggs)	649	716	790	856	913	961	1,002	1,061	1,123	1,189	1,261
~95% Confidence Interval	216-1,082	237-1,196	256-1,324	269-1,443	277-1,550	279-1,643	276-1,729	289-1,832	305-1,940	321-2,056	340-2,181
Recruitment	2,671	2,168	1,644	6,240	950	2,243	2,025	956	9,616	2,466	2,491
~95% Confidence Interval	785-4,557	598-3,738	409-2,879	1,784-10,695	199-1,702	619-3,867	501-3,550	132-1,779	1,323-17,909	1,679-3,253	1,704-3,278
Depletion (%)	20%	22%	25%	27%	29%	30%	31%	33%	35%	37%	39%
~95% Confidence Interval	10-30%	11-34%	12-38%	12-41%	13-44%	13-47%	13-49%	14-52%	15-55%	16-58%	17-62%

Table 20: 12-year projections for alternate states of nature defined 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=0.0412*		Base case Female M=0.054		High *Female M=0.059*	
Management decision	Year	Catch (mt)	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion
Average catch for the period between 2011 and 2014	2015	110	263	9%	1,261	39%	1,660	49%
	2016	110	278	10%	1,331	42%	1,744	51%
	2017	110	291	10%	1,396	44%	1,820	53%
	2018	110	305	11%	1,459	46%	1,893	56%
	2019	110	324	12%	1,531	48%	1,976	58%
	2020	110	349	12%	1,618	51%	2,077	61%
	2021	110	379	13%	1,711	53%	2,183	64%
	2022	110	410	15%	1,799	56%	2,283	67%
	2023	110	442	16%	1,878	59%	2,369	69%
	2024	110	474	17%	1,948	61%	2,442	72%
	2025	110	507	18%	2,008	63%	2,503	73%
	2026	110	539	19%	2,062	64%	2,555	75%
2016 ACL catch assumed for years between 2015 and 2026	2015	338	263	9%	1,261	39%	1,660	49%
	2016	346	264	9%	1,317	41%	1,730	51%
	2017	346	260	9%	1,365	43%	1,790	53%
	2018	346	256	9%	1,411	44%	1,845	54%
	2019	346	256	9%	1,465	46%	1,911	56%
	2020	346	262	9%	1,534	48%	1,994	58%
	2021	346	271	10%	1,609	50%	2,082	61%
	2022	346	280	10%	1,677	52%	2,162	63%
	2023	346	288	10%	1,736	54%	2,229	65%
	2024	346	295	11%	1,786	56%	2,283	67%
	2025	346	302	11%	1,827	57%	2,327	68%
	2026	346	308	11%	1,863	58%	2,362	69%
Catch calculated using current rebuilding SPR of 64.9% applied to the base model (40-10 rule and buffer applied)	2015	388	263	9%	1,261	39%	1,660	49%
	2016	389	260	9%	1,314	41%	1,727	51%
	2017	386	253	9%	1,359	42%	1,783	52%
	2018	399	246	9%	1,400	44%	1,835	54%
	2019	438	241	9%	1,451	45%	1,897	56%
	2020	467	241	9%	1,513	47%	1,973	58%
	2021	474	241	9%	1,579	49%	2,053	60%
	2022	469	239	9%	1,637	51%	2,123	62%
	2023	461	236	8%	1,686	53%	2,180	64%
	2024	454	231	8%	1,725	54%	2,224	65%
	2025	450	226	8%	1,758	55%	2,259	66%
	2026	448	221	8%	1,784	56%	2,285	67%

9 Figures

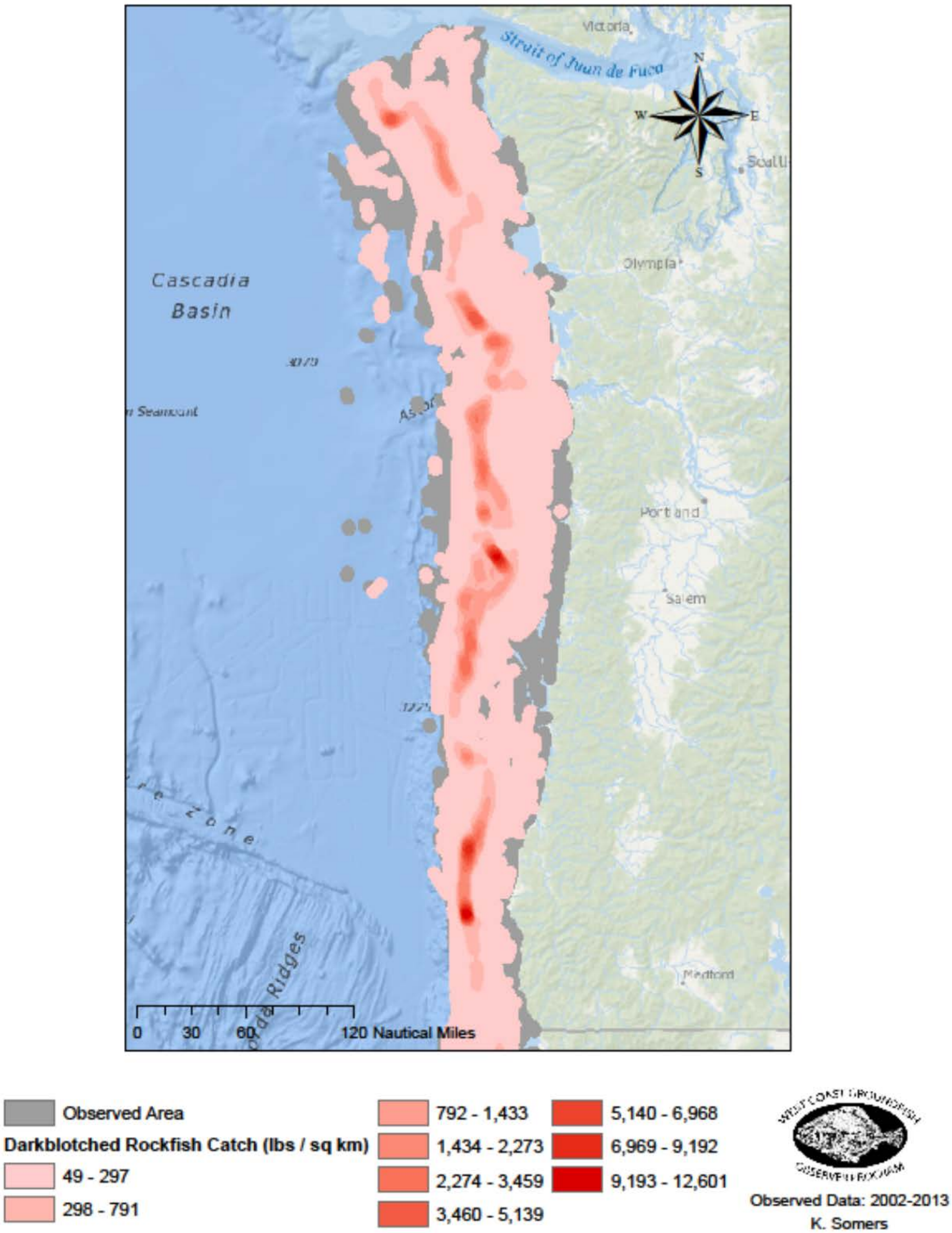

Figure 1: Spatial distribution of darkblotched rockfish catch observed by the West Coast Groundfish Observer Program and the summary area of all observed fishing events.

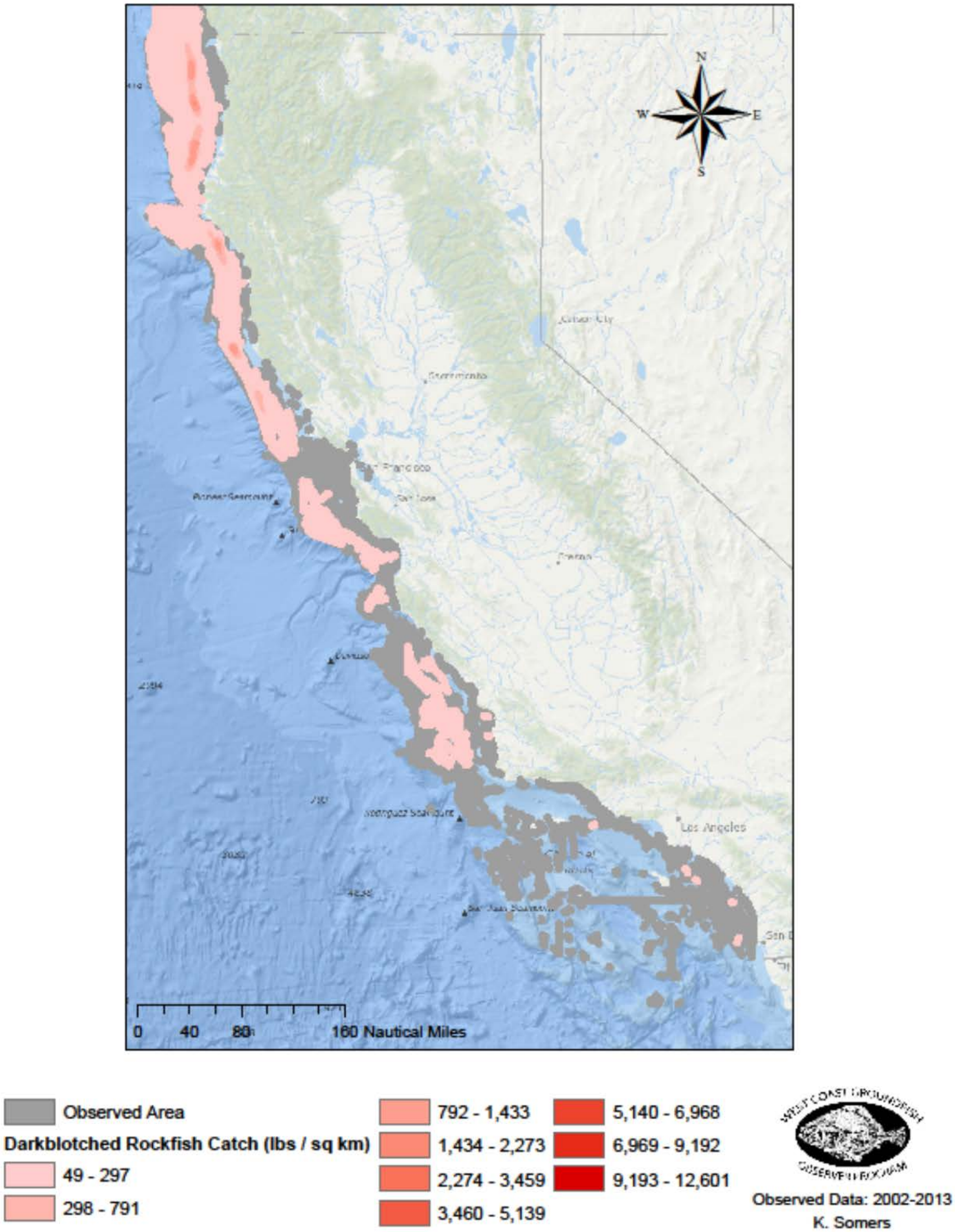

Figure 1 (continued): Spatial distribution of darkblotched rockfish catch observed by the West Coast Groundfish Observer Program and the summary area of all observed fishing events.

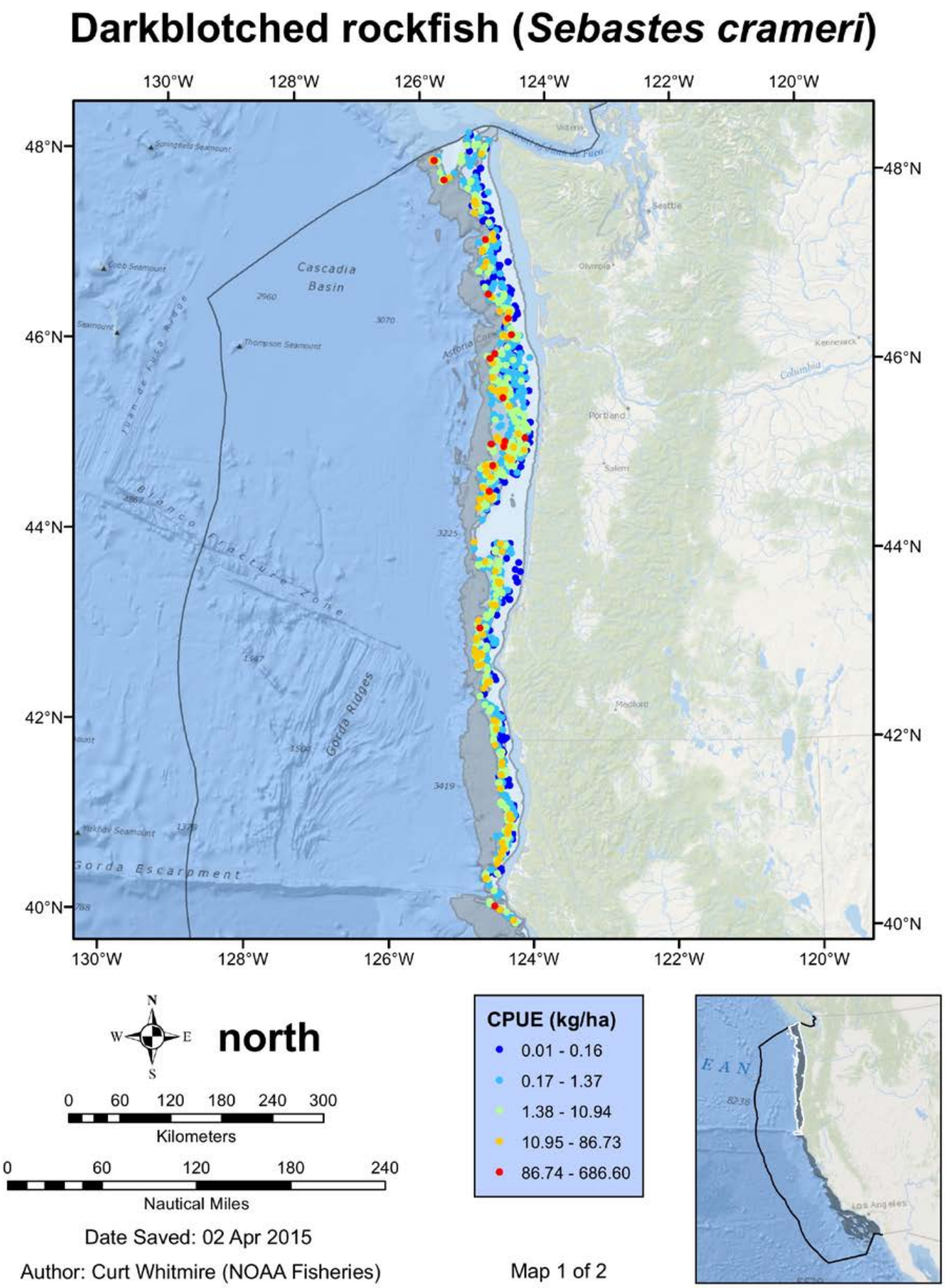

Figure 2: Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

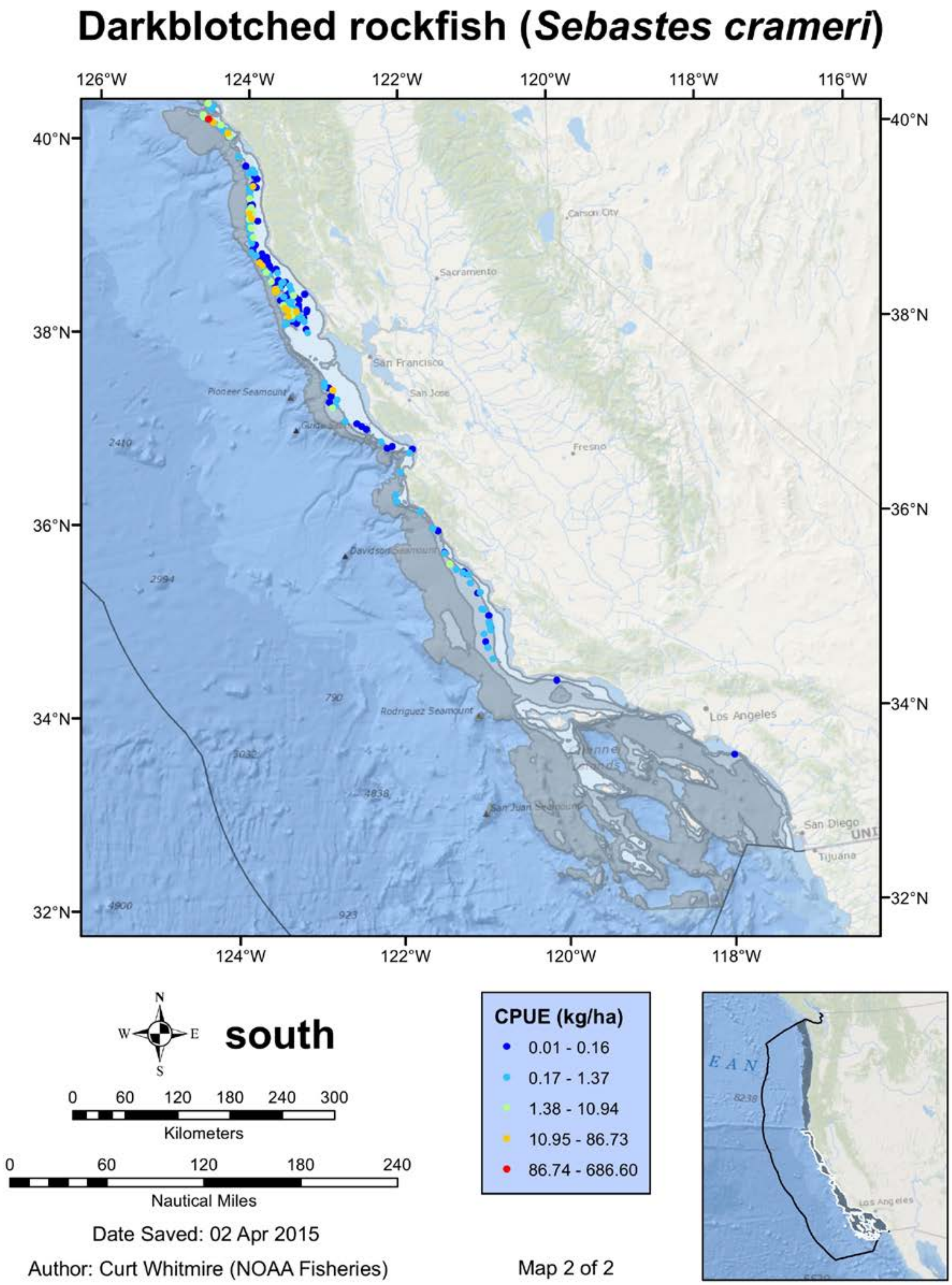

Figure 2 (continued): Spatial distribution of darkblotched rockfish (*Sebastes crameri*) catch in the NWFSC groundfish survey (2003-2012) by INPFC area.

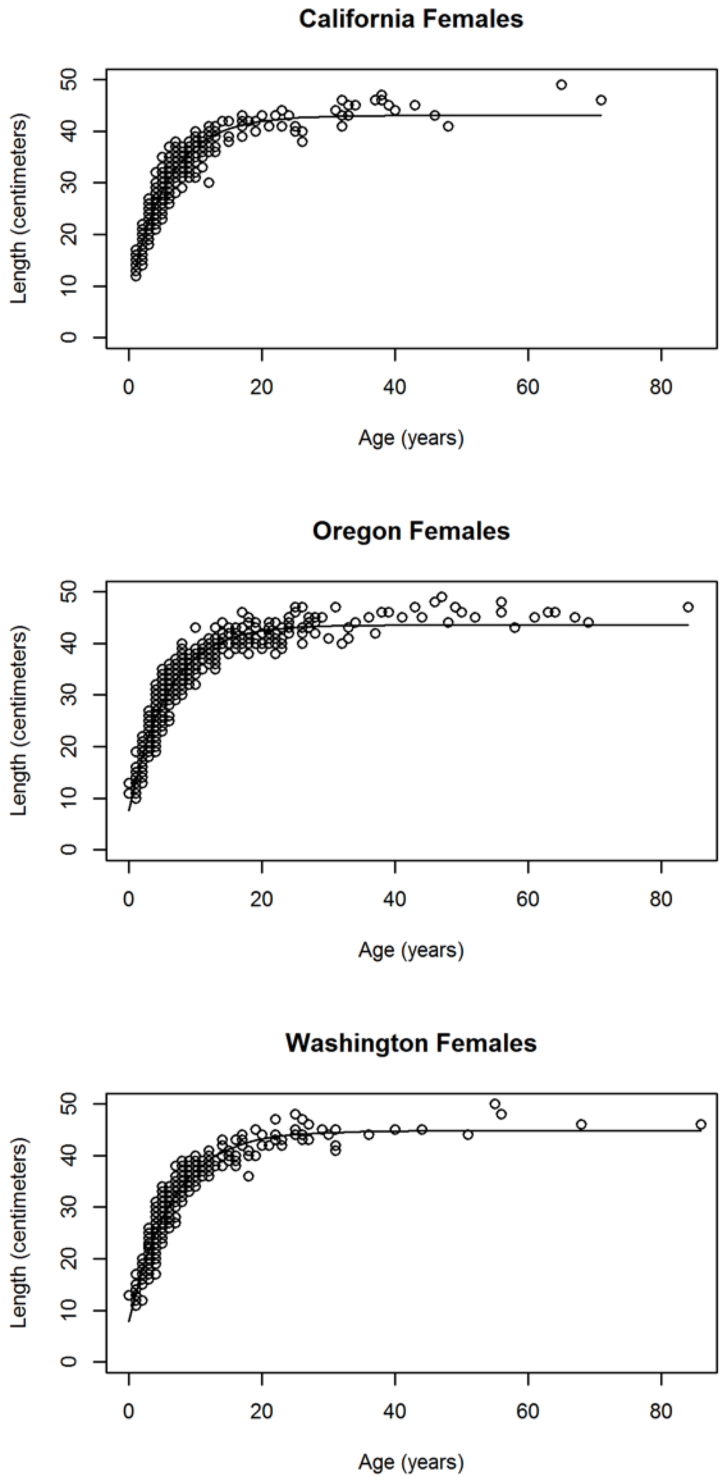

Figure 3: Fits to length-at-age data for female darkblotched rockfish, by state.

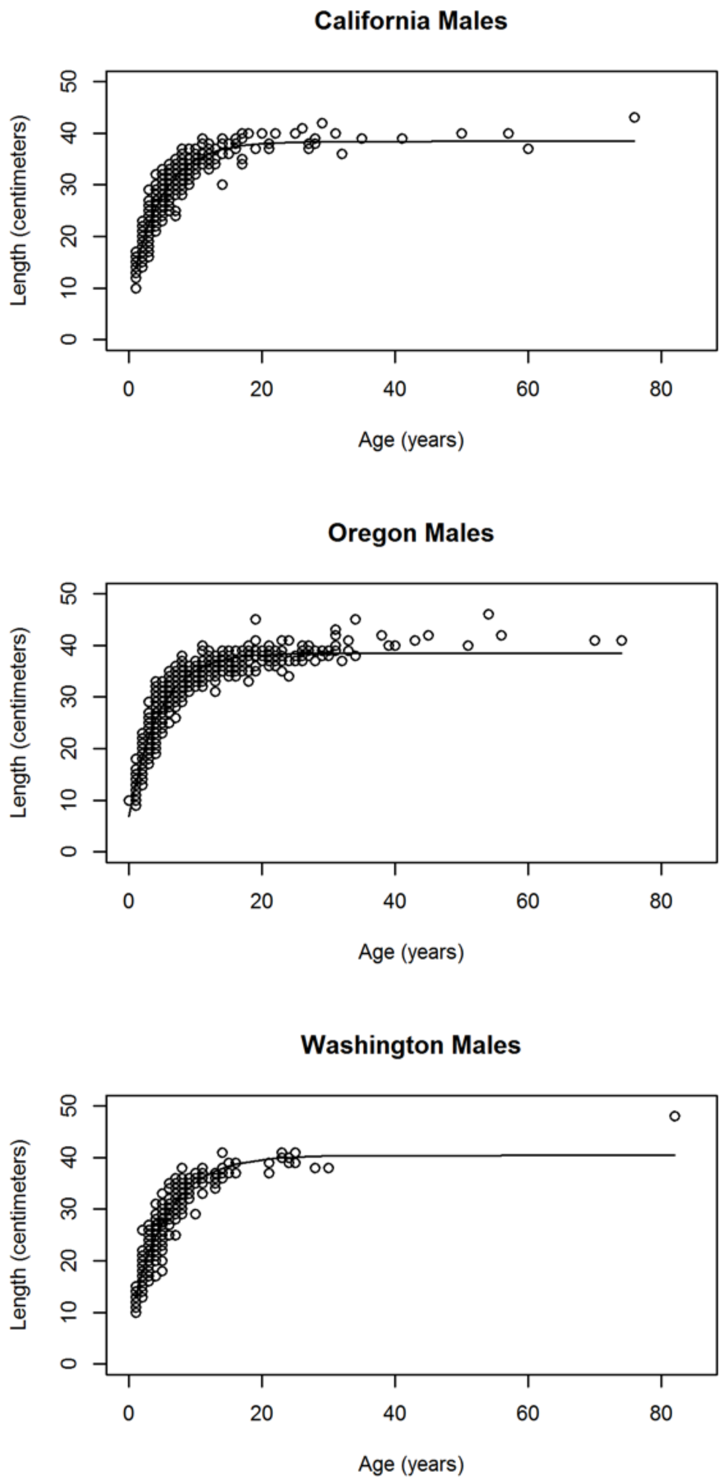

Figure 4: Fits to length-at-age data for male darkblotched rockfish, by state.

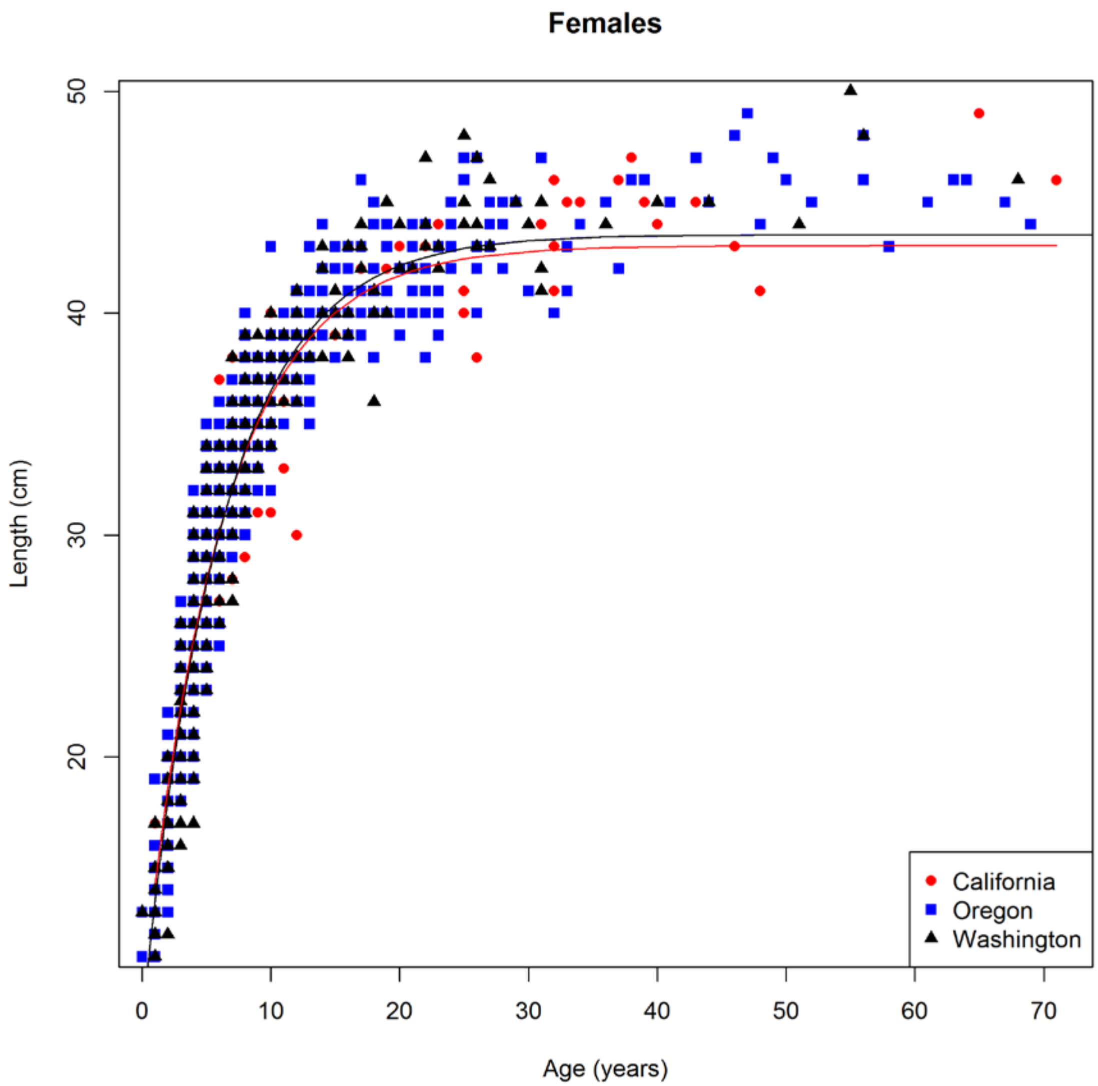

Figure 5: Female length-at-age data and von Bertalanffy model fits that illustrate no differences in growth among state.

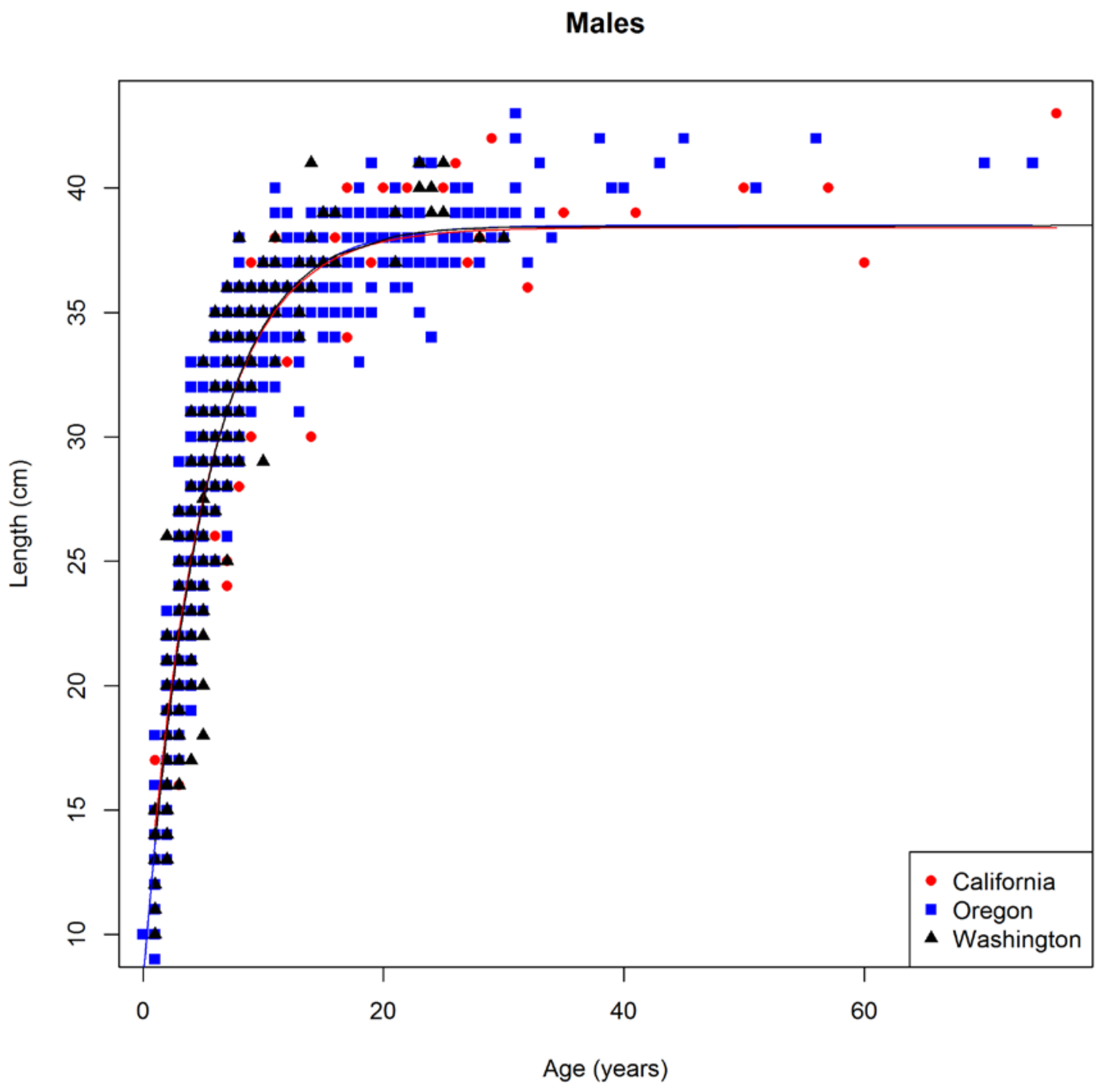

Figure 6: Male length-at-age data and von Bertalanffy model fits that illustrate no differences in growth among state.

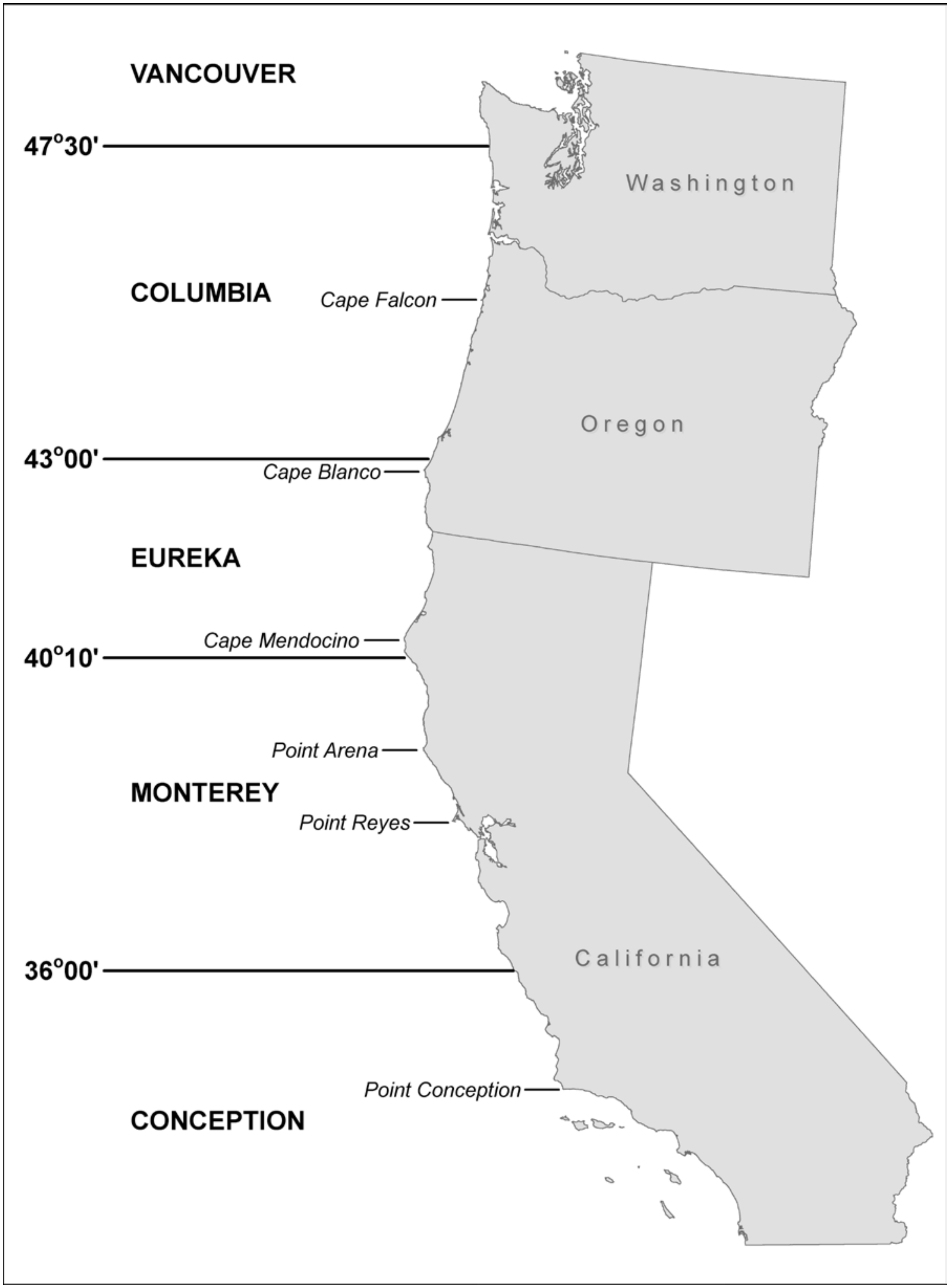

Figure 7: A map of the assessment area that includes coastal waters off three U.S. west coast states and five International North Pacific Fisheries Commission (INPFC) areas.

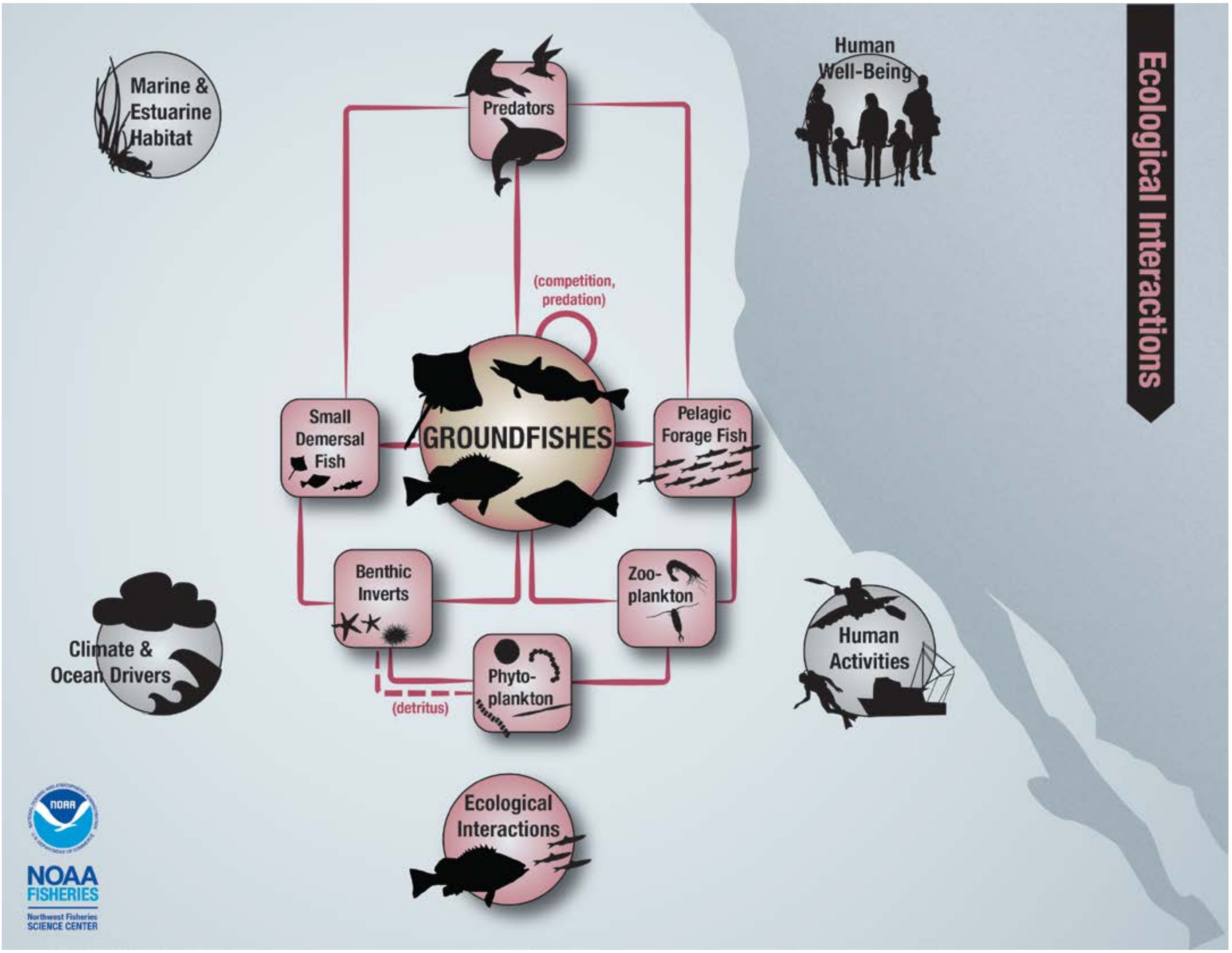

Figure 8: Conceptual diagram of ecological interactions of groundfish species in California Current large marine ecosystem.

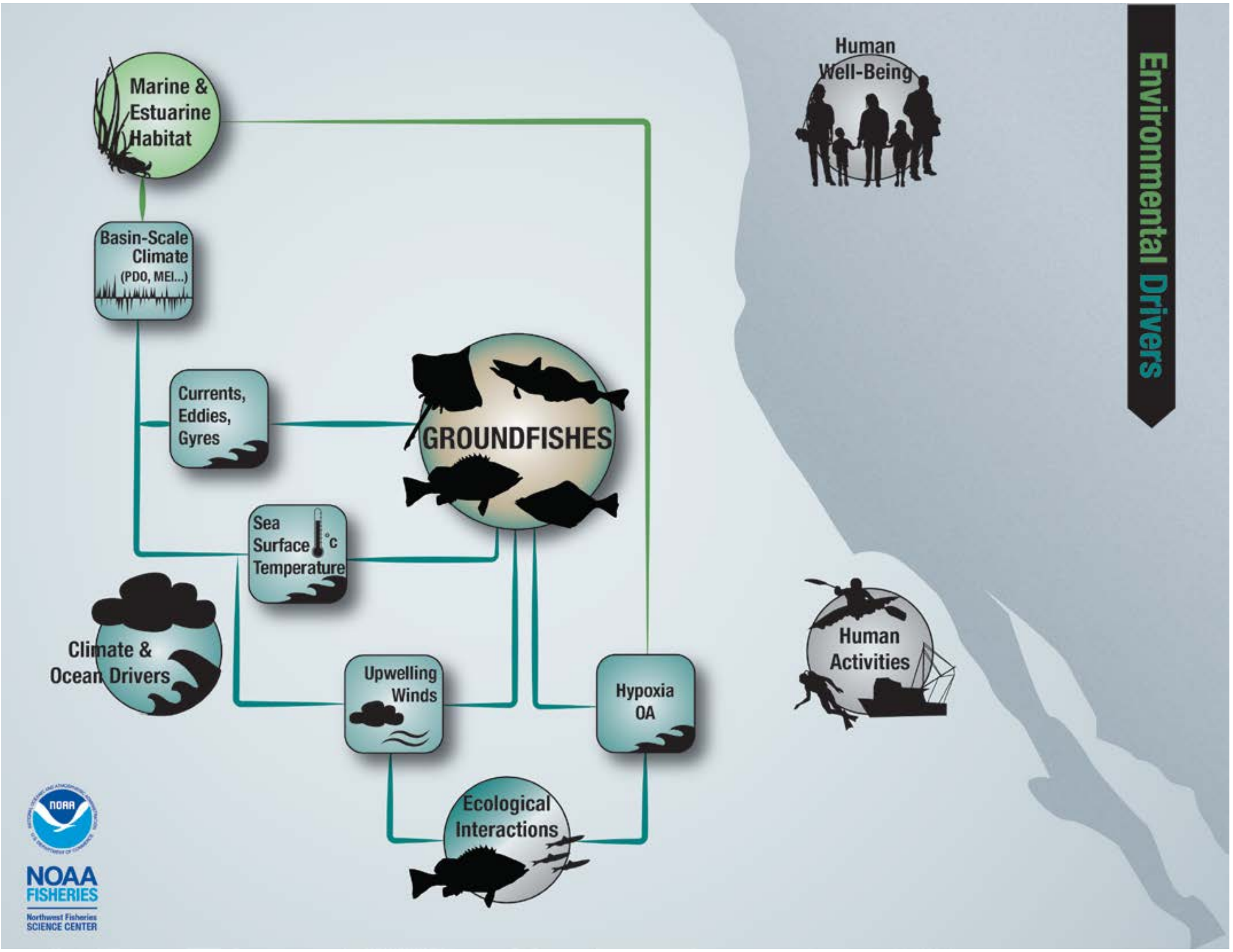

Figure 9: Conceptual diagram of environmental drivers that impact groundfish species in California Current large marine ecosystem.

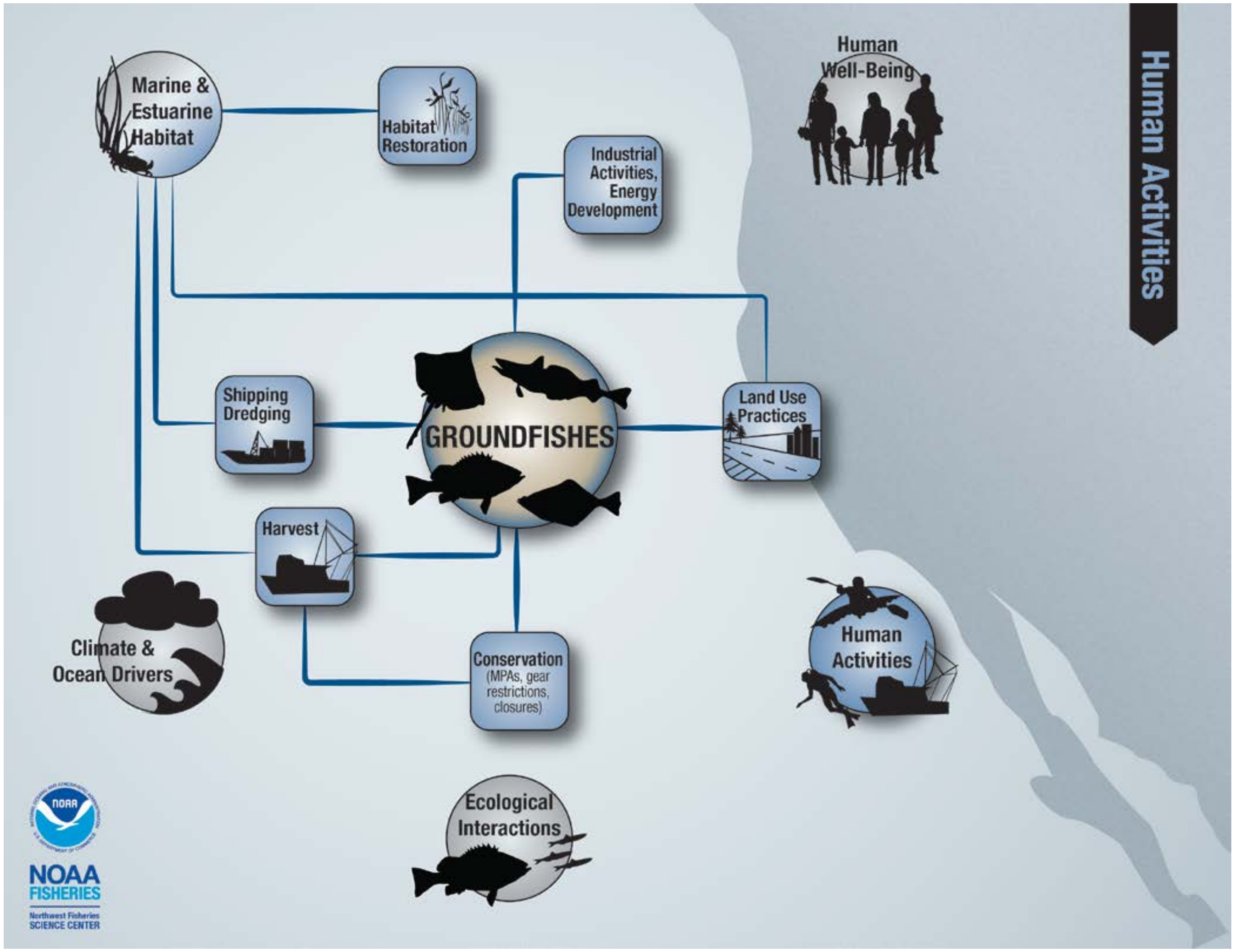

Figure 10: Conceptual diagram of human activities that affect groundfish species in California Current large marine ecosystem.

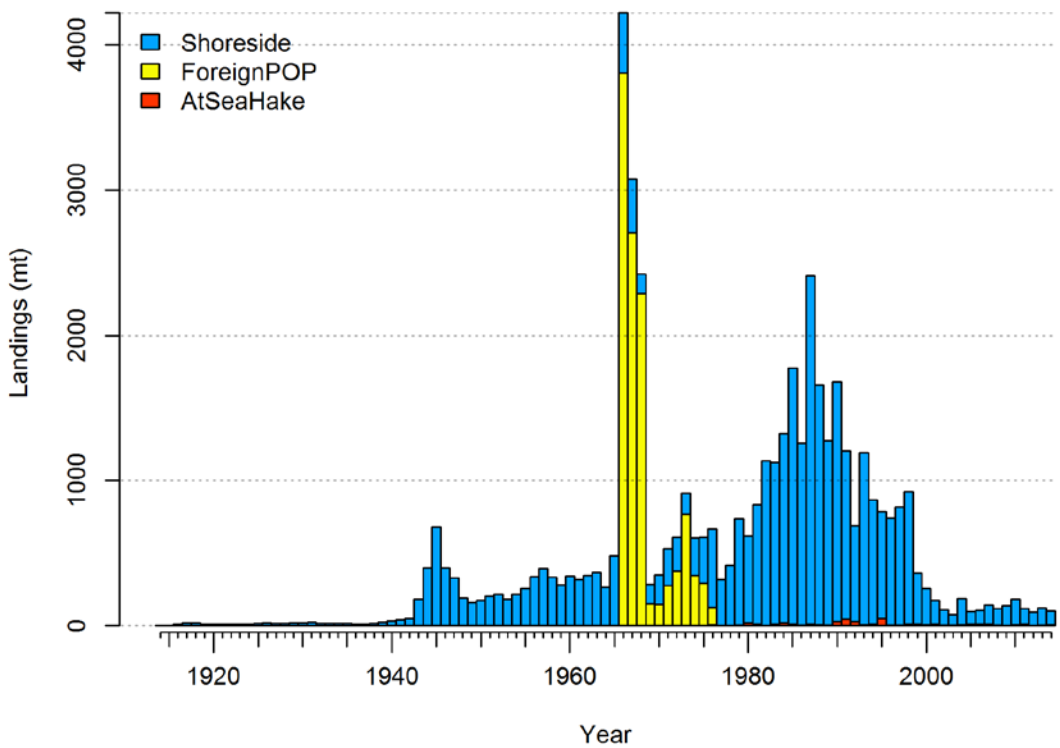

Figure 11: Darkblotched rockfish landings history, 1915-2014, by fleet.

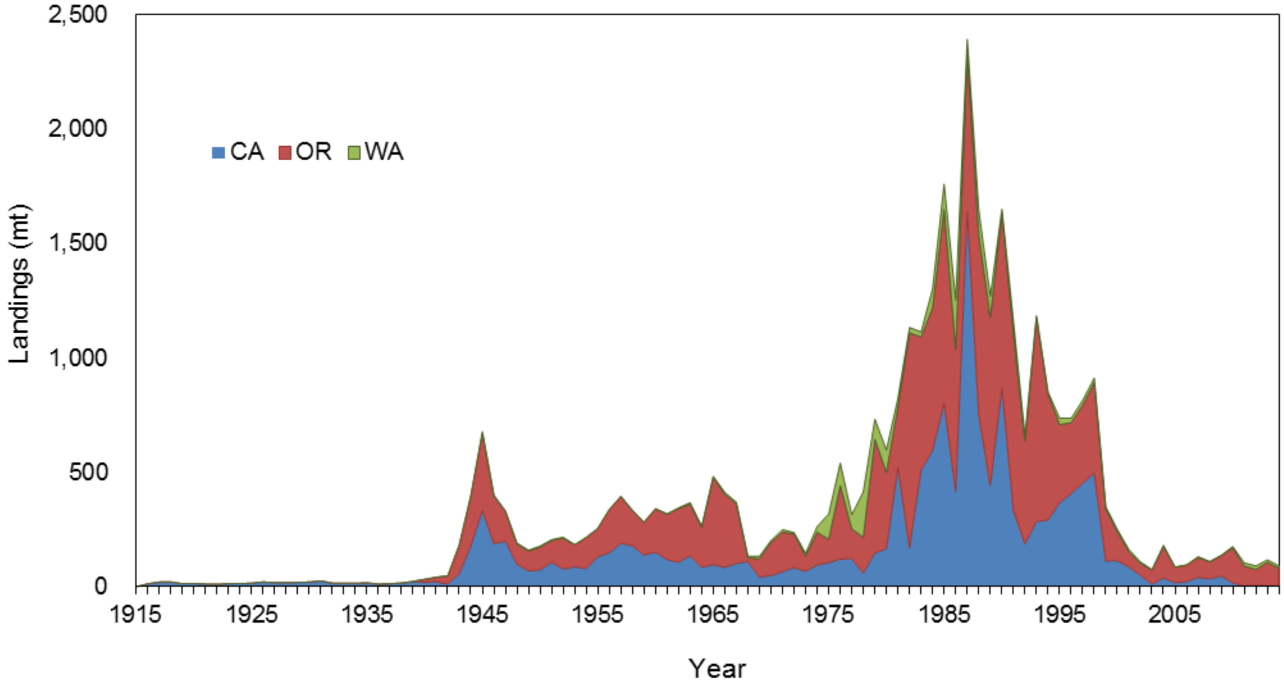

Figure 12: Darkblotched rockfish landings history, 1915-2014, by state.

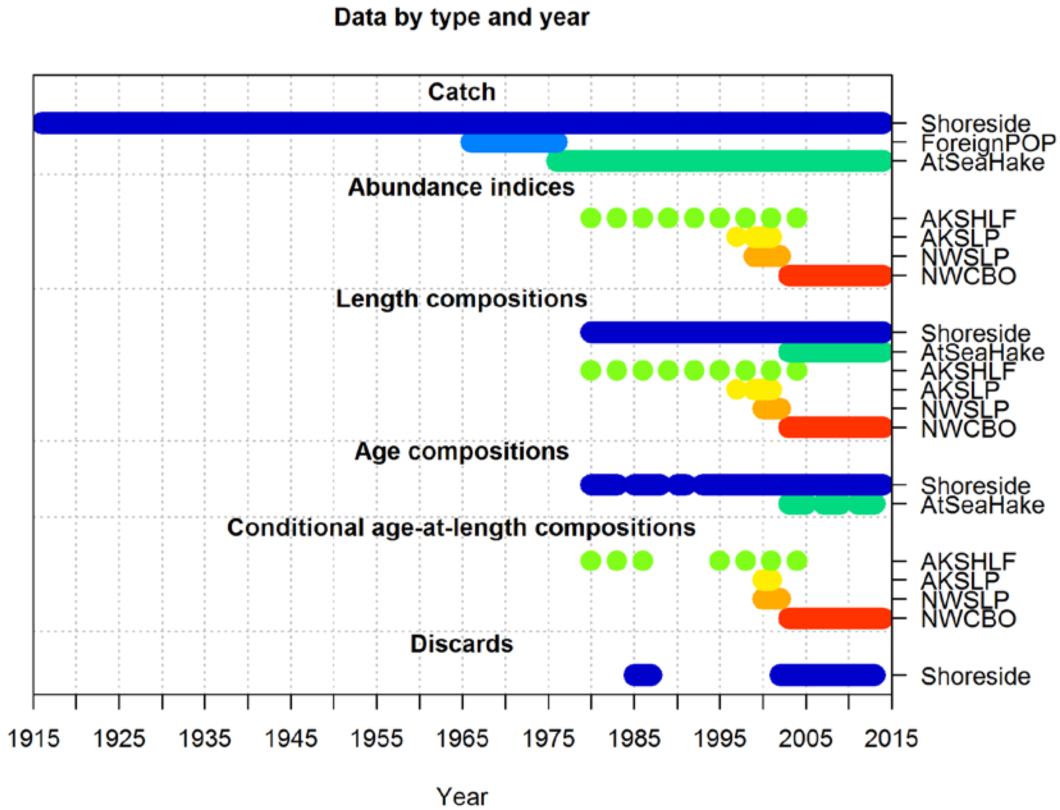

Figure 13: Summary of sources and data used in the assessment.

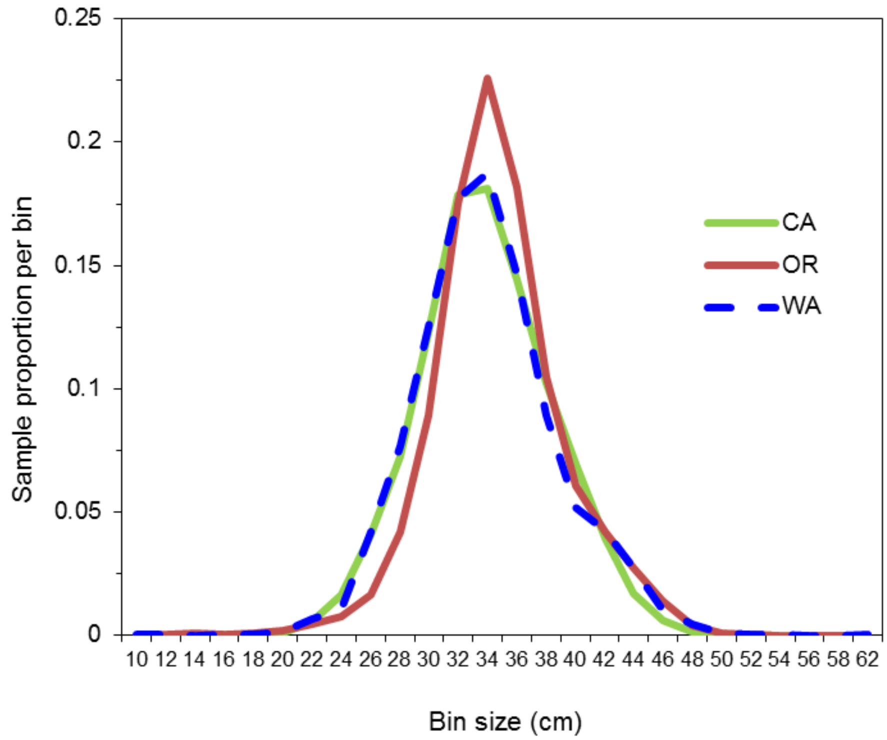

Figure 14: Comparison of darkblotched length compositions sampled from the landed catch in California, Oregon and Washington.

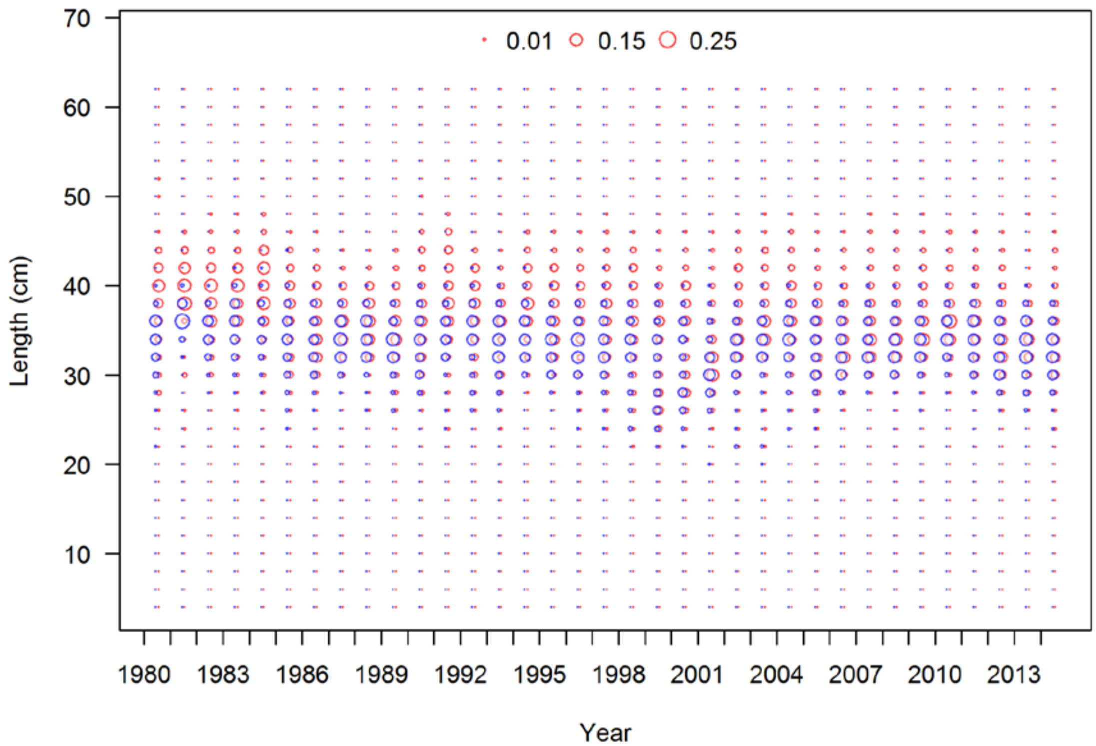

Figure 15: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the shoreside landings by year.

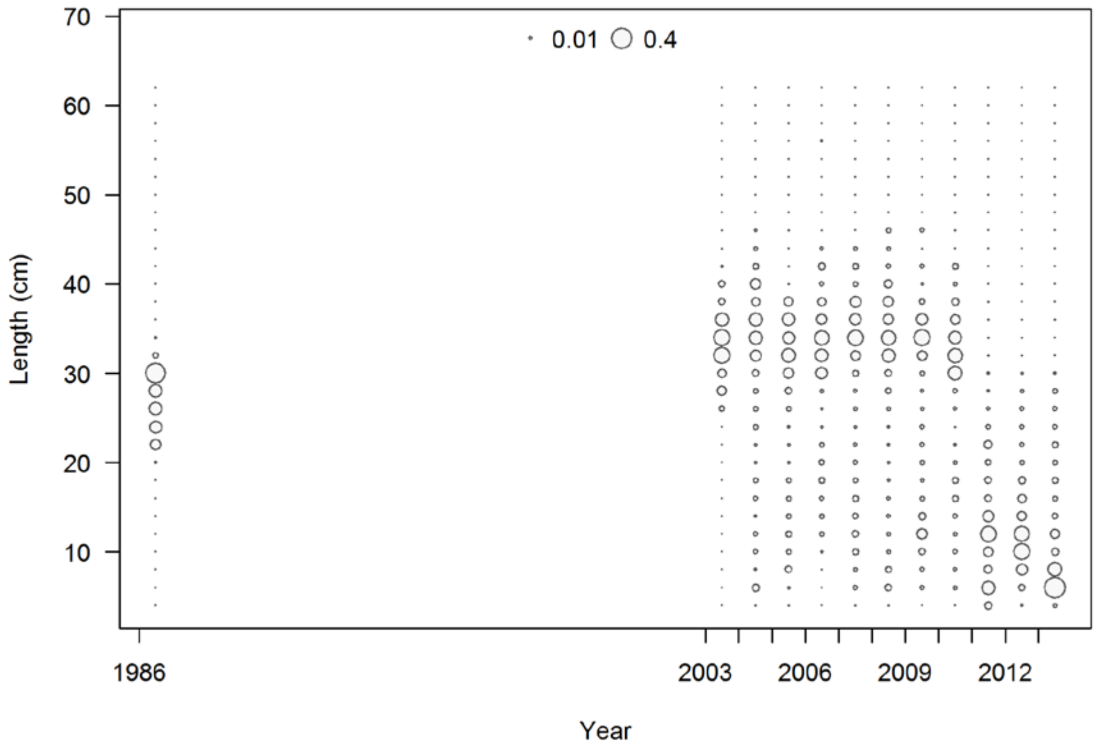

Figure 16: Length-frequency distributions for darkblotched rockfish (sexes combined) from the shoreside fleet discards by year.

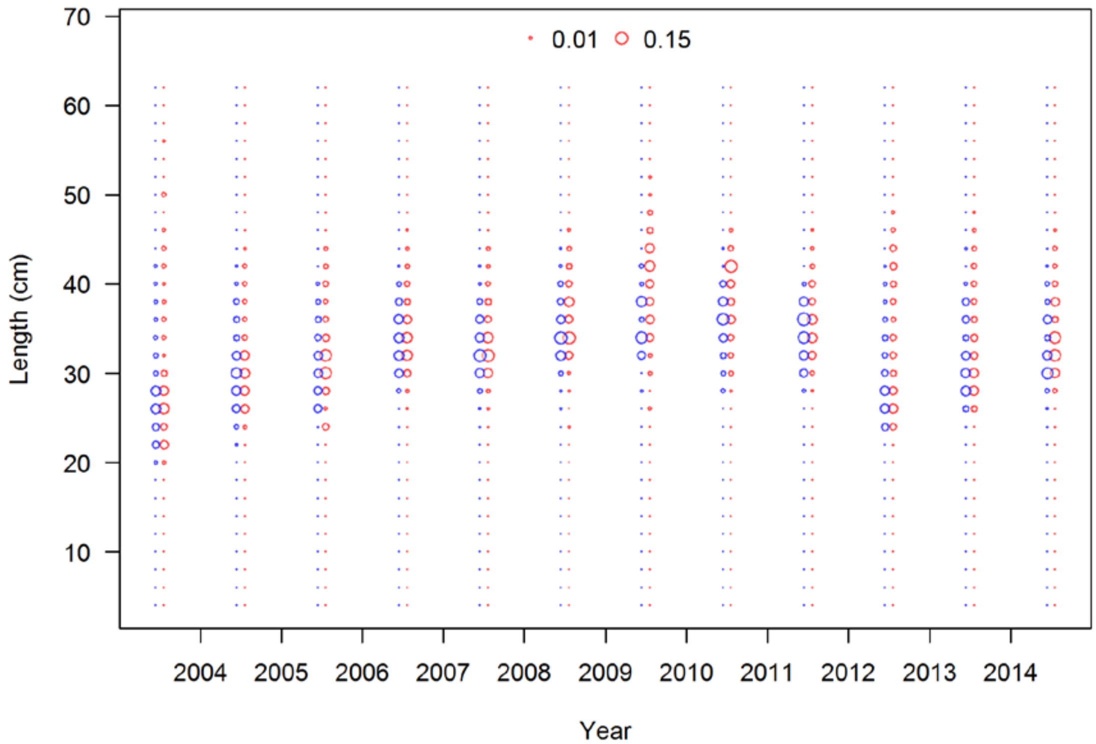

Figure 17: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the at-sea hake fishery removals by year.

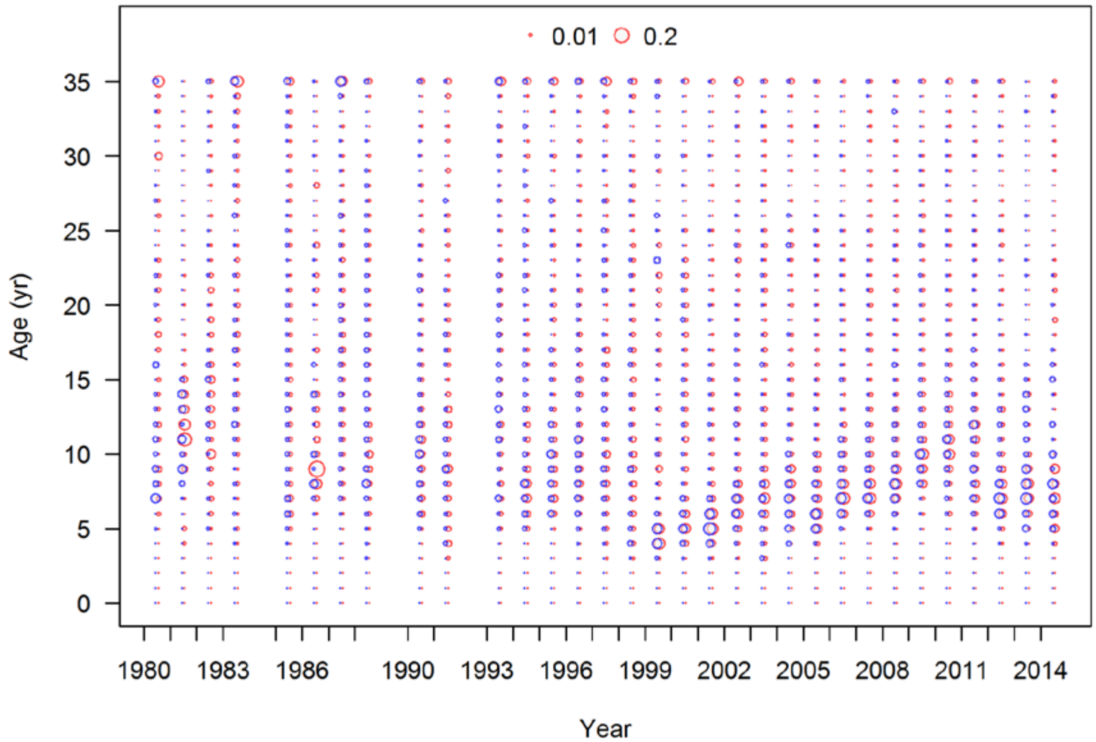

Figure 18: Age-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the shoreside landings by year.

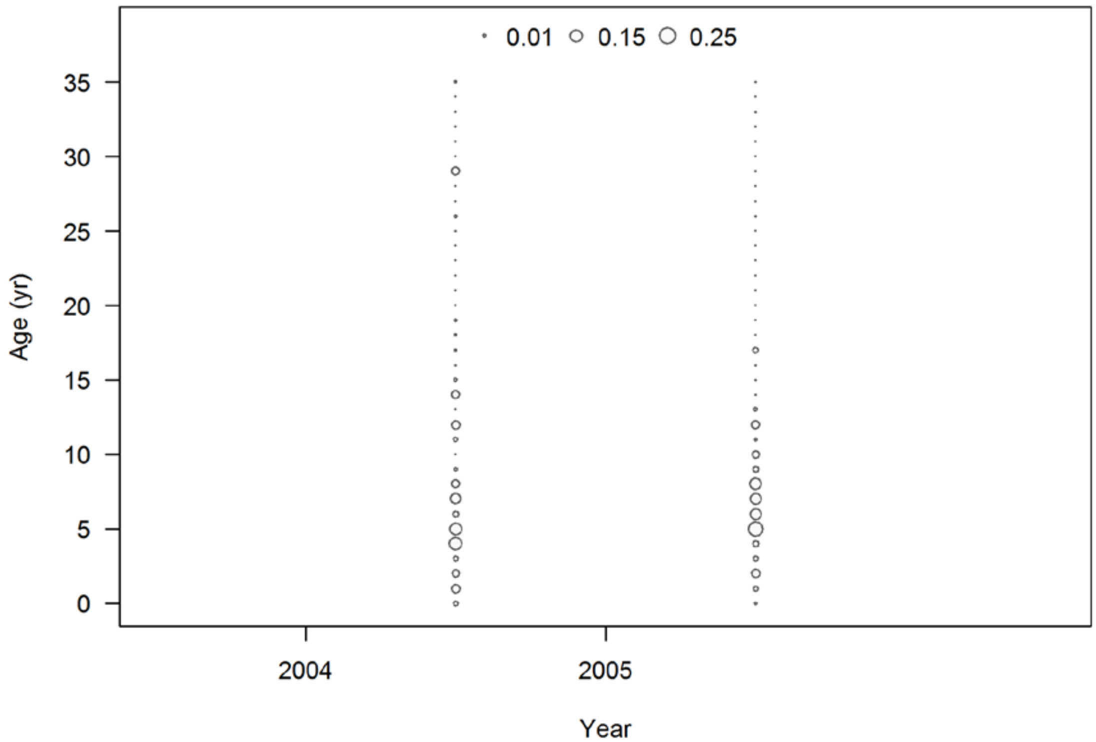

Figure 19: Age-frequency distributions for darkblotched rockfish (sexes combined) from the shoreside fleet discards by year.

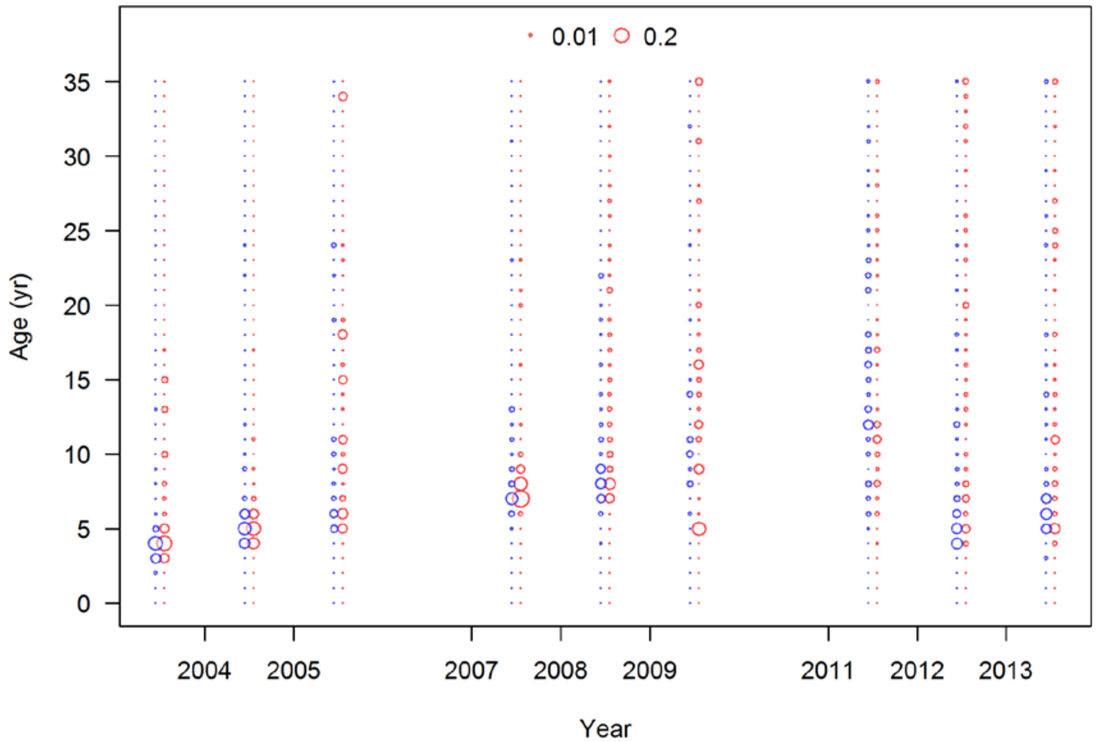

Figure 20: Age-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the at-sea hake fishery removals by year.

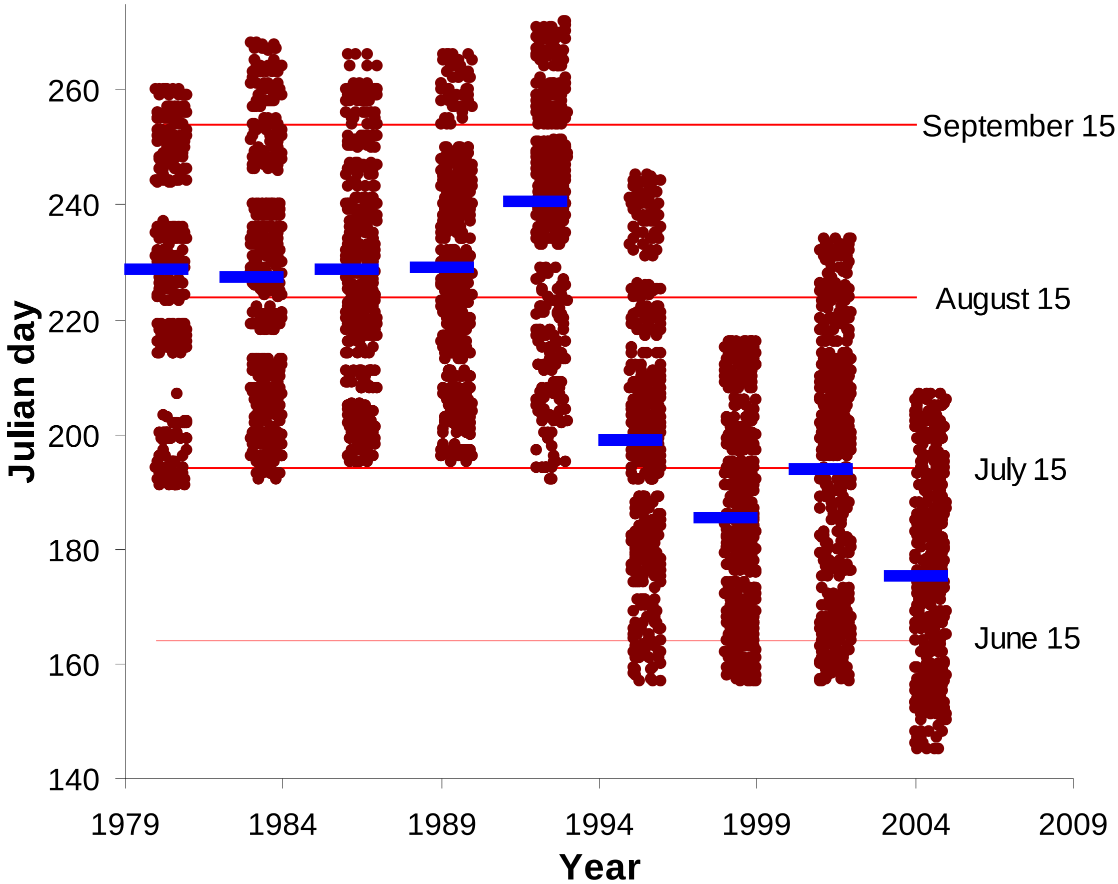

Figure 21: Distribution of dates of operation for the AFSC shelf (triennial) bottom trawl survey (1980-2004). Solid bars show the mean date for each survey year, points represent individual hauls dates, but are jittered to allow better delineation of the distribution of individual points.

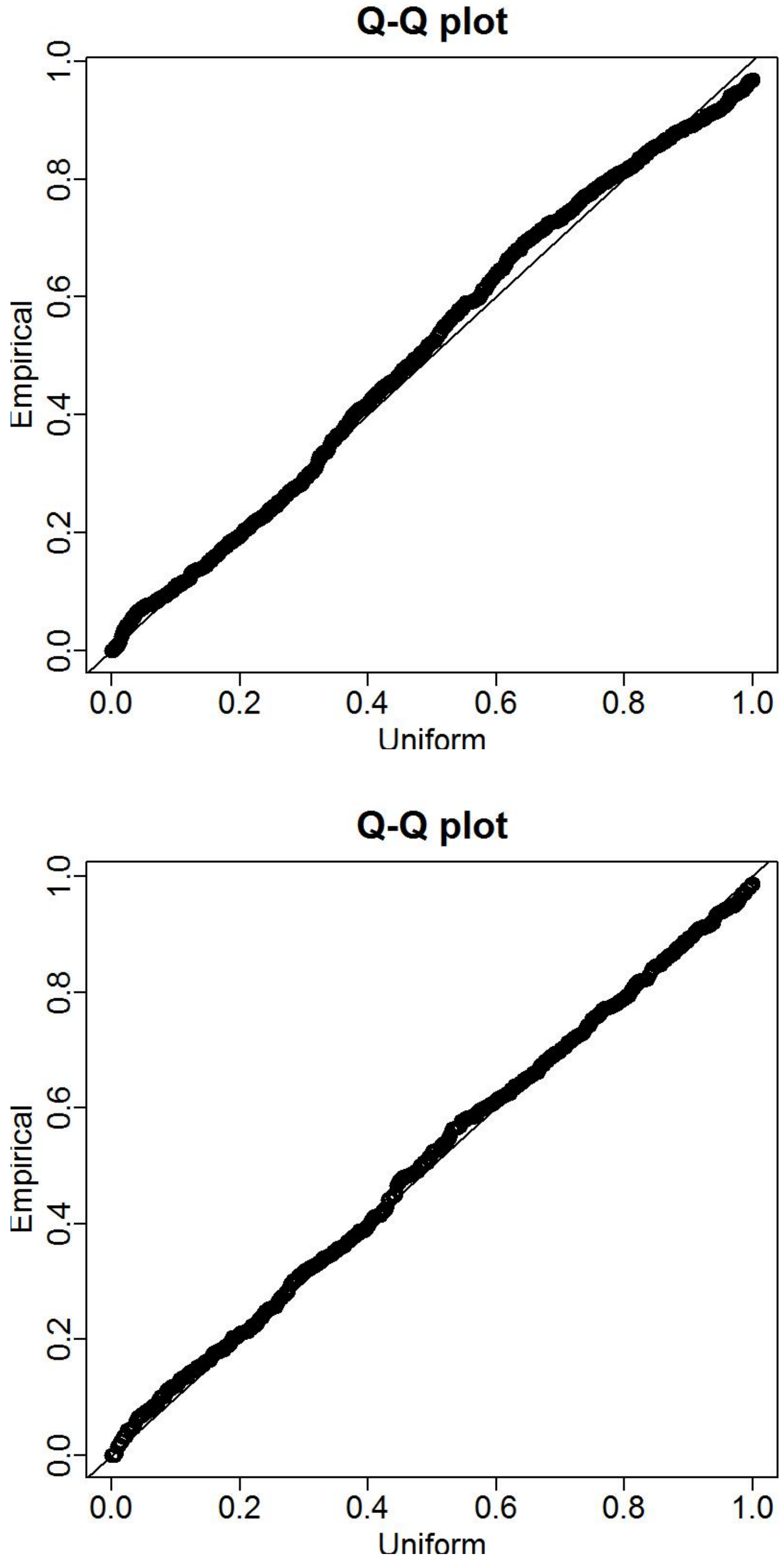

Figure 22: Bayesian Q-Q plot for AFSC shelf survey for 1980-1992 (upper panel) and 1995-2004 (lower panel).

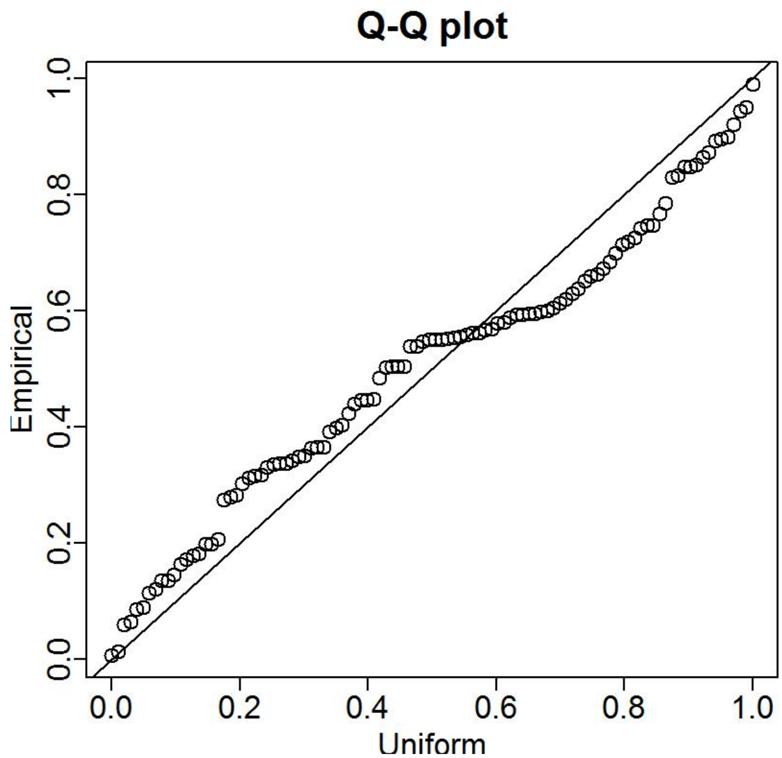

Figure 23: Bayesian Q-Q plot for AFSC slope survey.

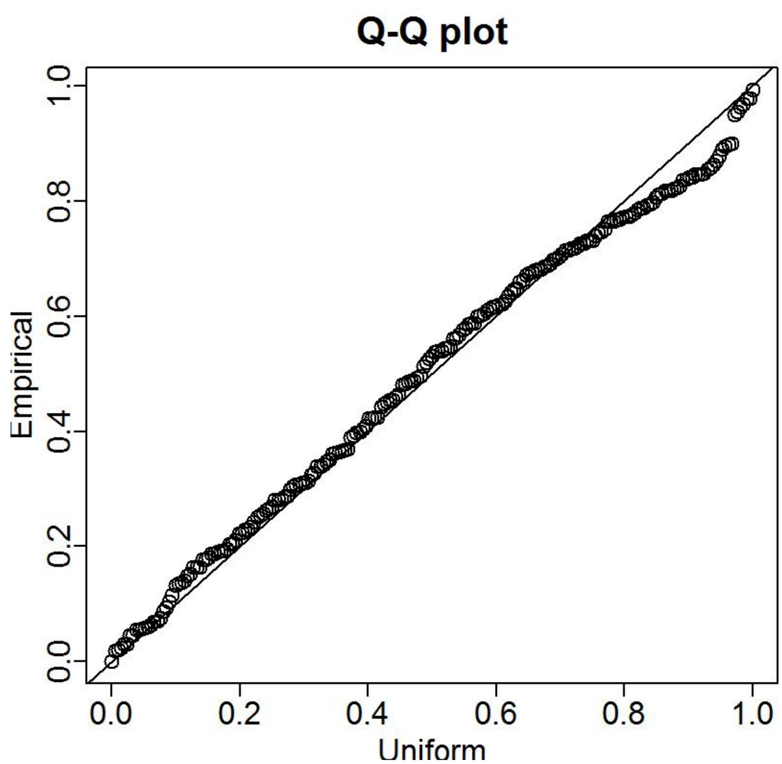

Figure 24: Bayesian Q-Q plot for NWFSC slope survey.

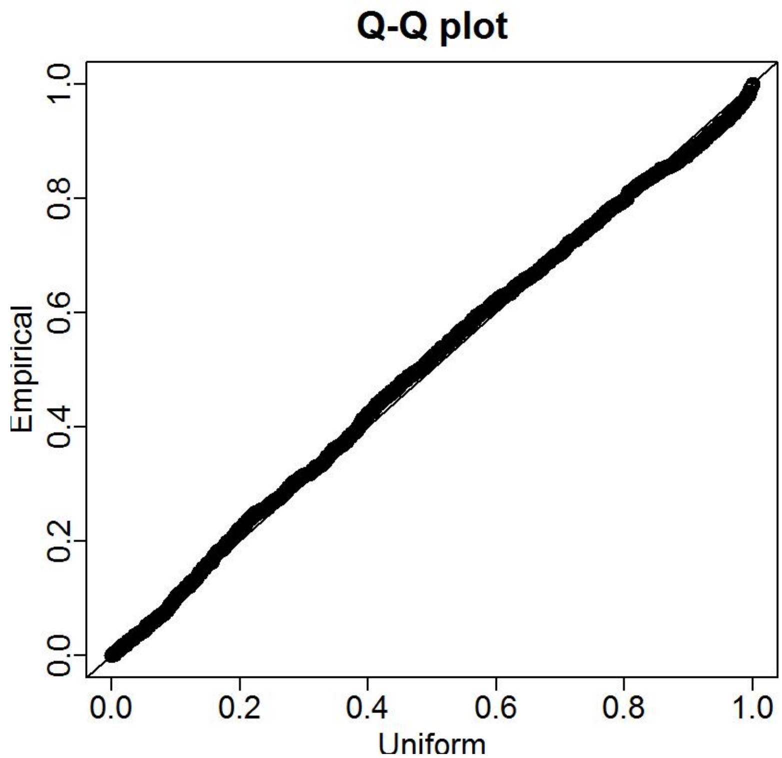

Figure 25: Q-Q plot for lognormal model used in the geostatistical delta-GLMM for the NWFSSC shelf-slope survey.

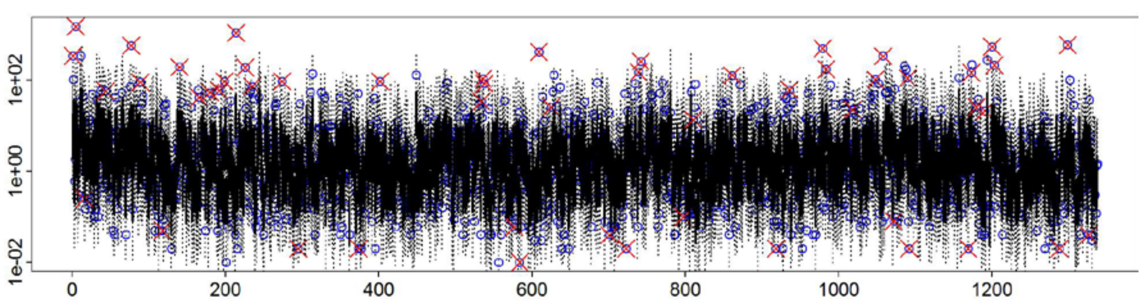

Figure 26: Posterior predictive plot for lognormal model used in the geostatistical delta-GLMM for the NWFSSC shelf-slope survey.

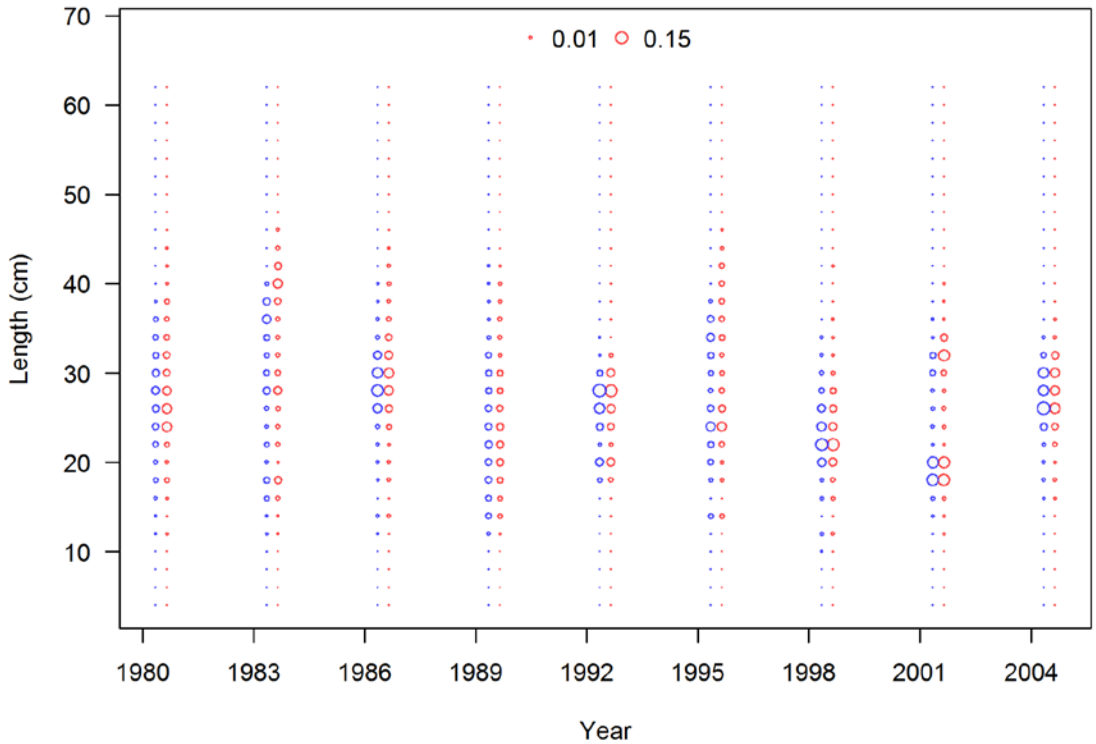

Figure 27: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the AFSC shelf survey.

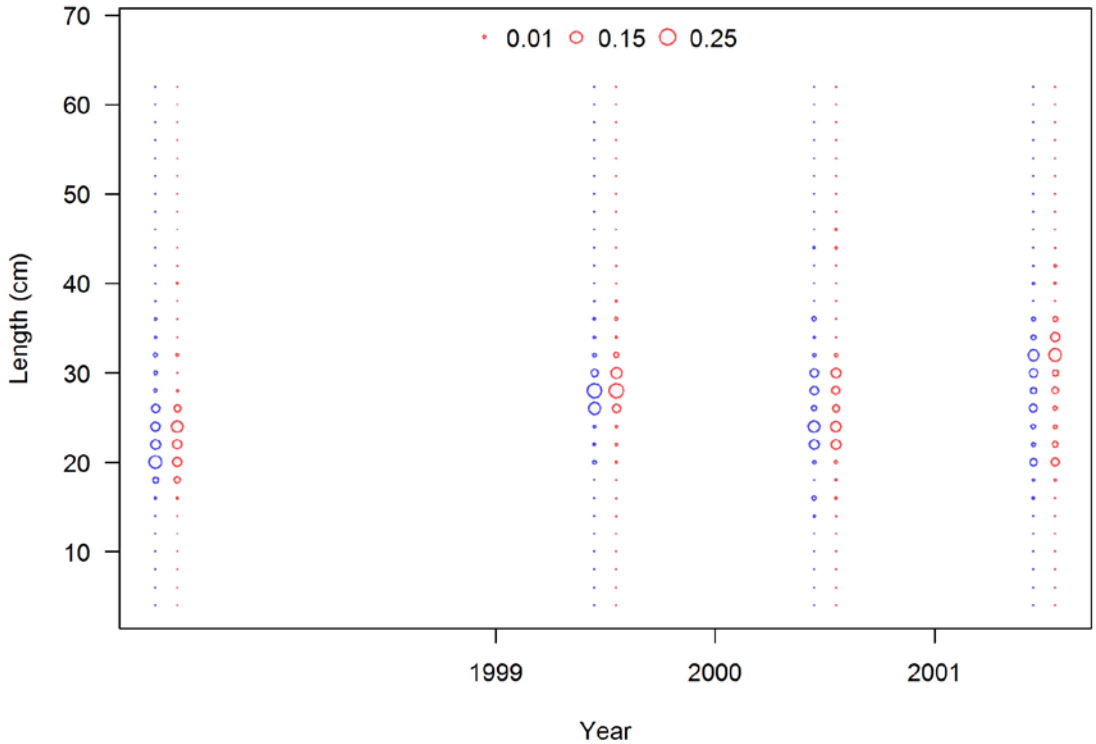

Figure 28: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the AFSC slope survey.

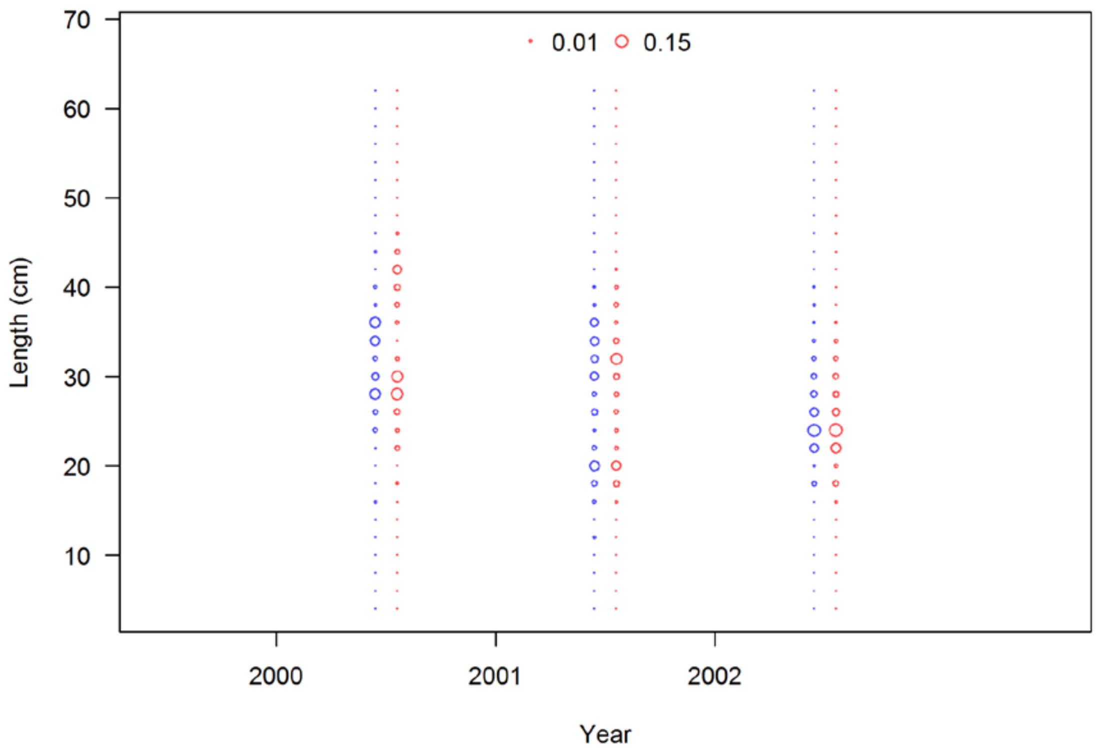

Figure 29: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the NWFSC slope survey.

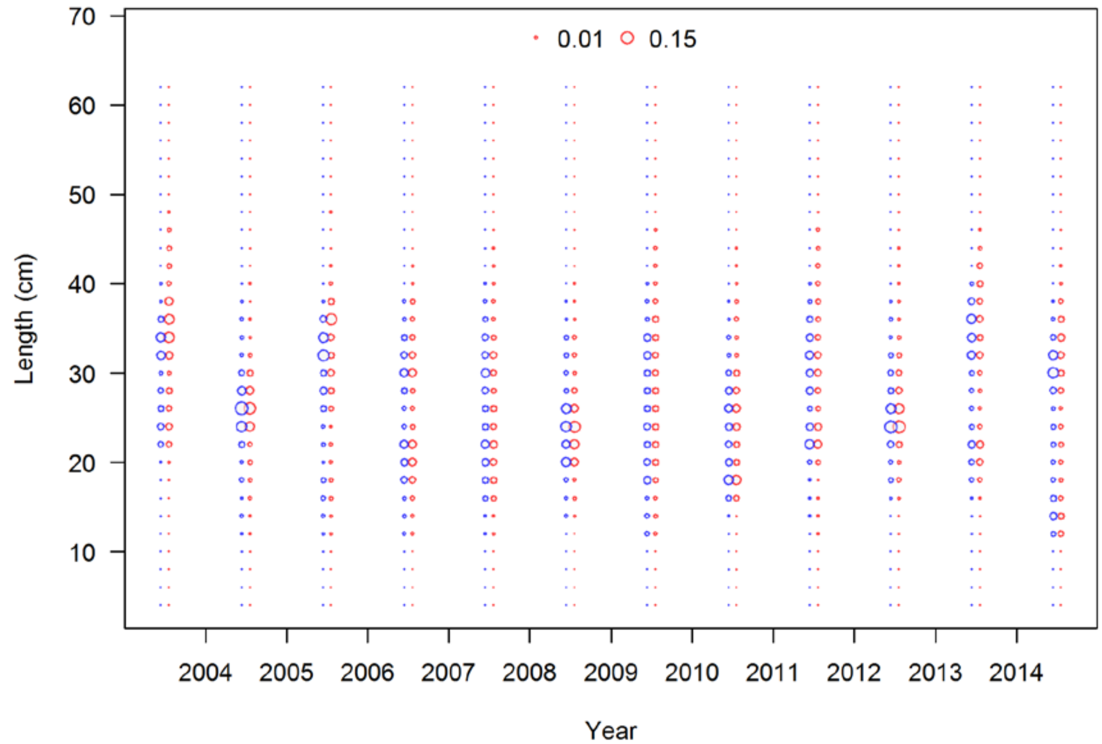

Figure 30: Length-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the NWFSC shelf-slope survey.

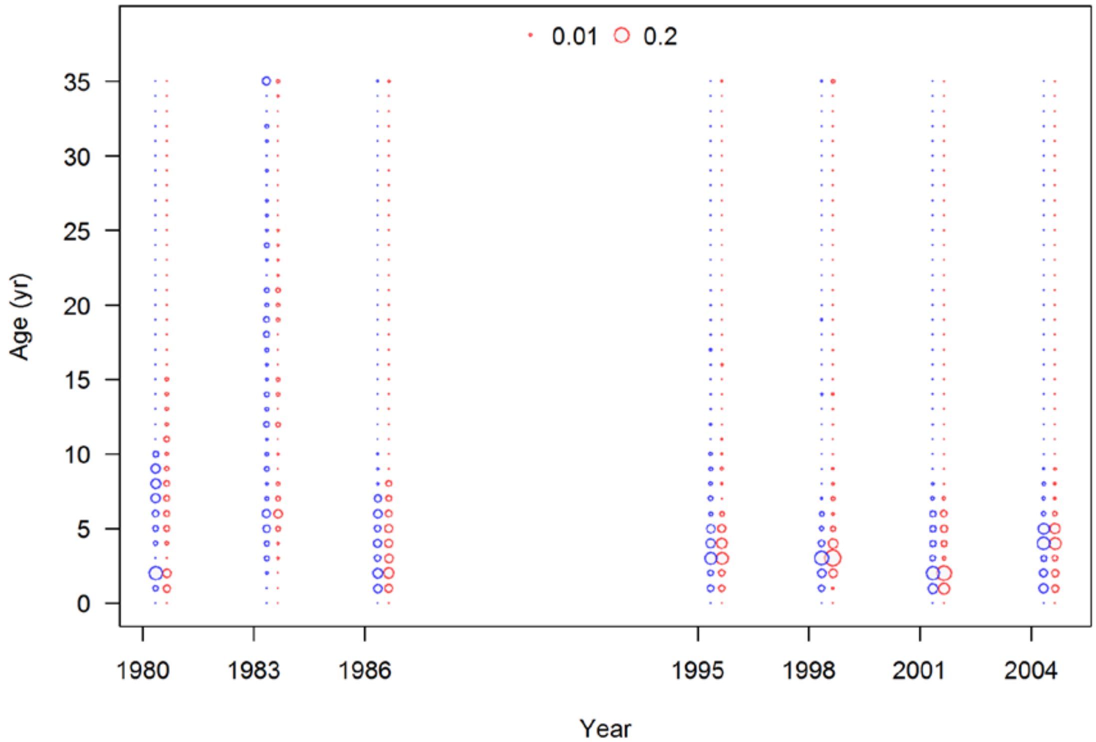

Figure 31: Age-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the AFSC shelf survey.

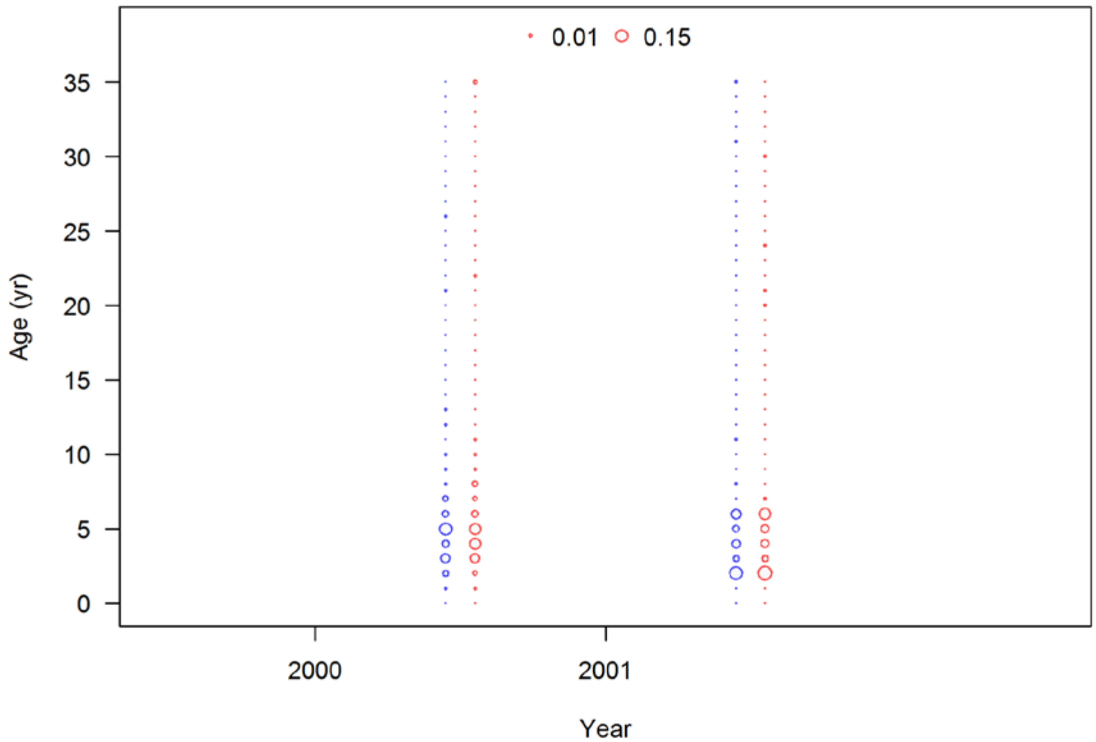

Figure 32: Age-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the AFSC slope survey.

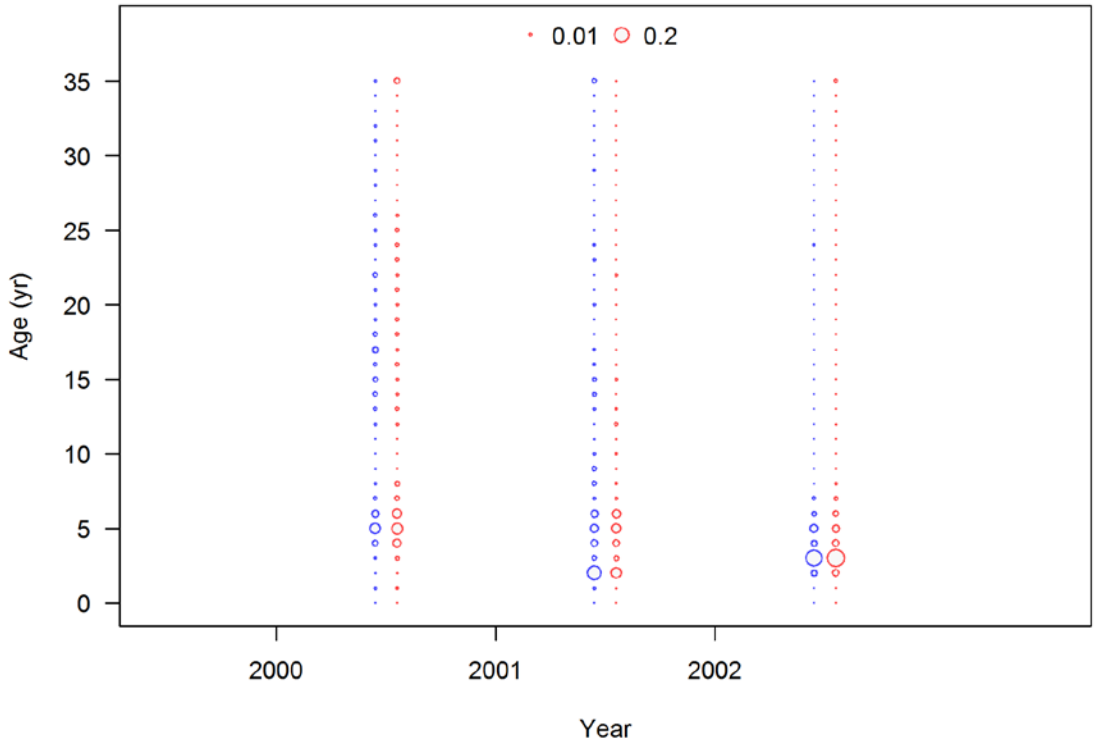

Figure 33: Age-frequency distributions for darkblotched rockfish (females are shown in red, males in blue) from the NWFSC slope survey.

Figure 34: Age-frequency distributions for darkblotched (females are shown in red, males in blue) rockfish from the NWFSC shelf-slope survey.

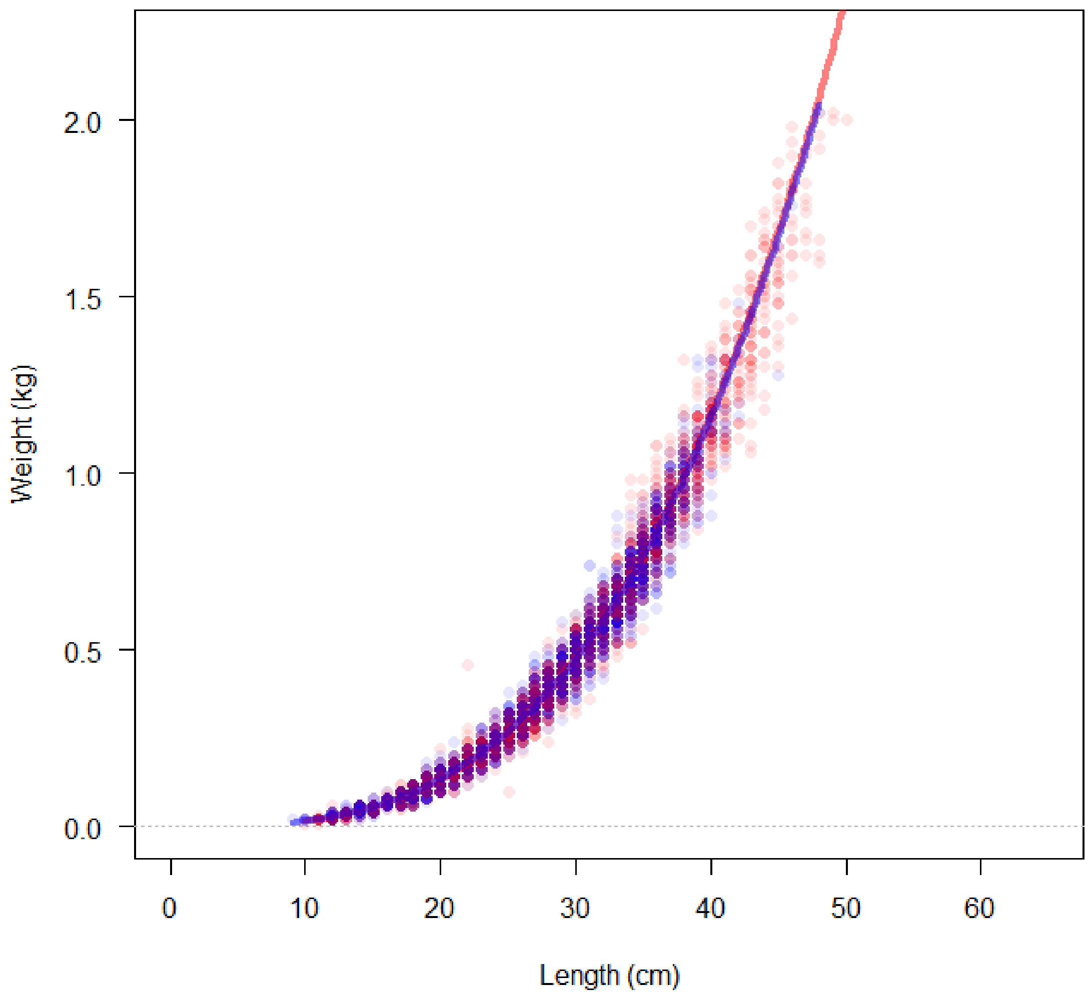

Figure 35: Weight-length relationship for female (red) and male (blue) darkblotched rockfish used in the assessment, shown with fit to the data from the NWFSC shelf-slope survey samples (shaded points).

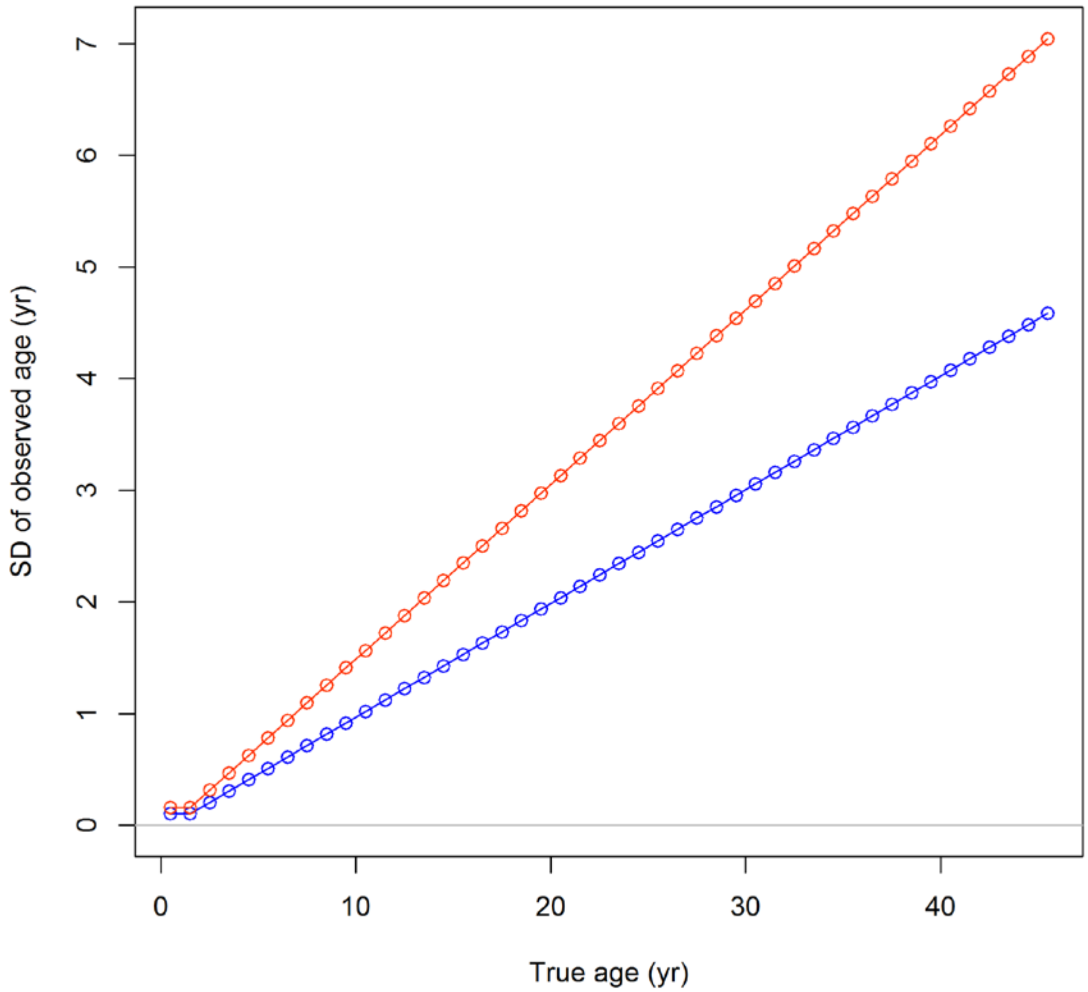

Figure 36: SD of observed age versus true age for "early" (red) and "late" (blue) age data used in the assessment.

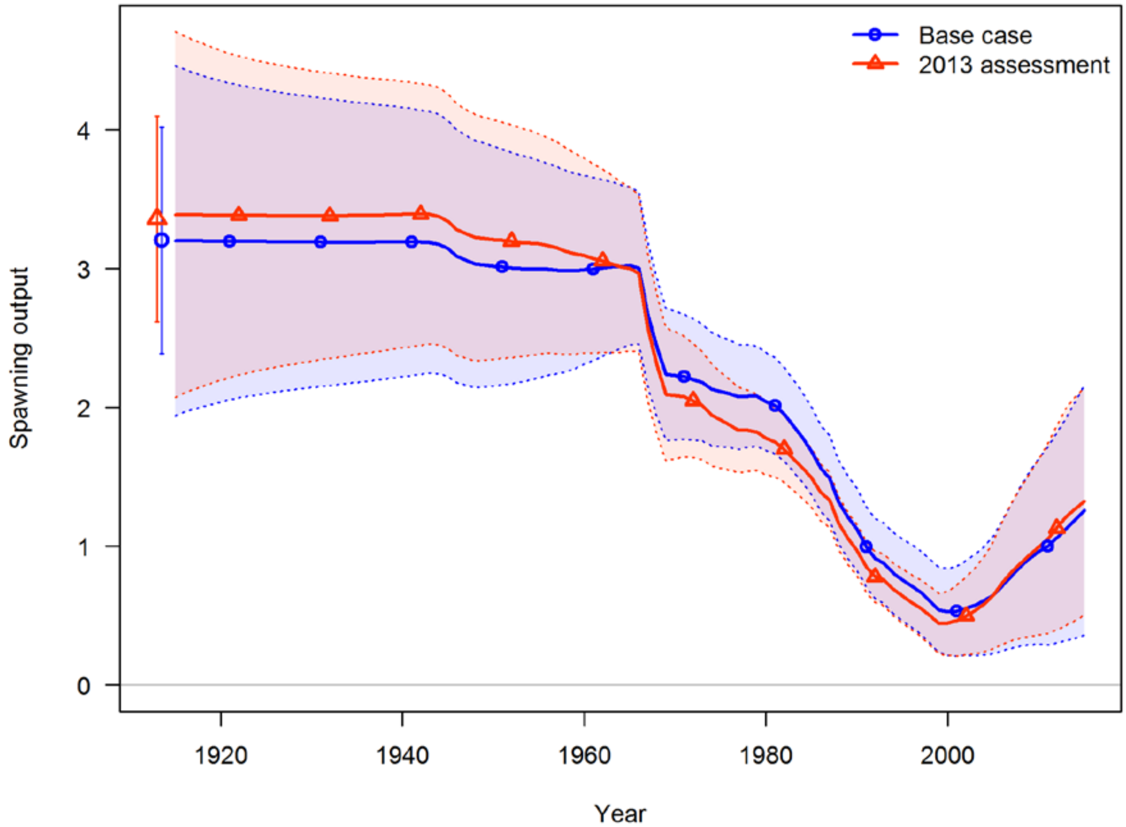

Figure 37: Time series of spawning output from this and 2013 assessments with approximate 95% asymptotic confidence intervals.

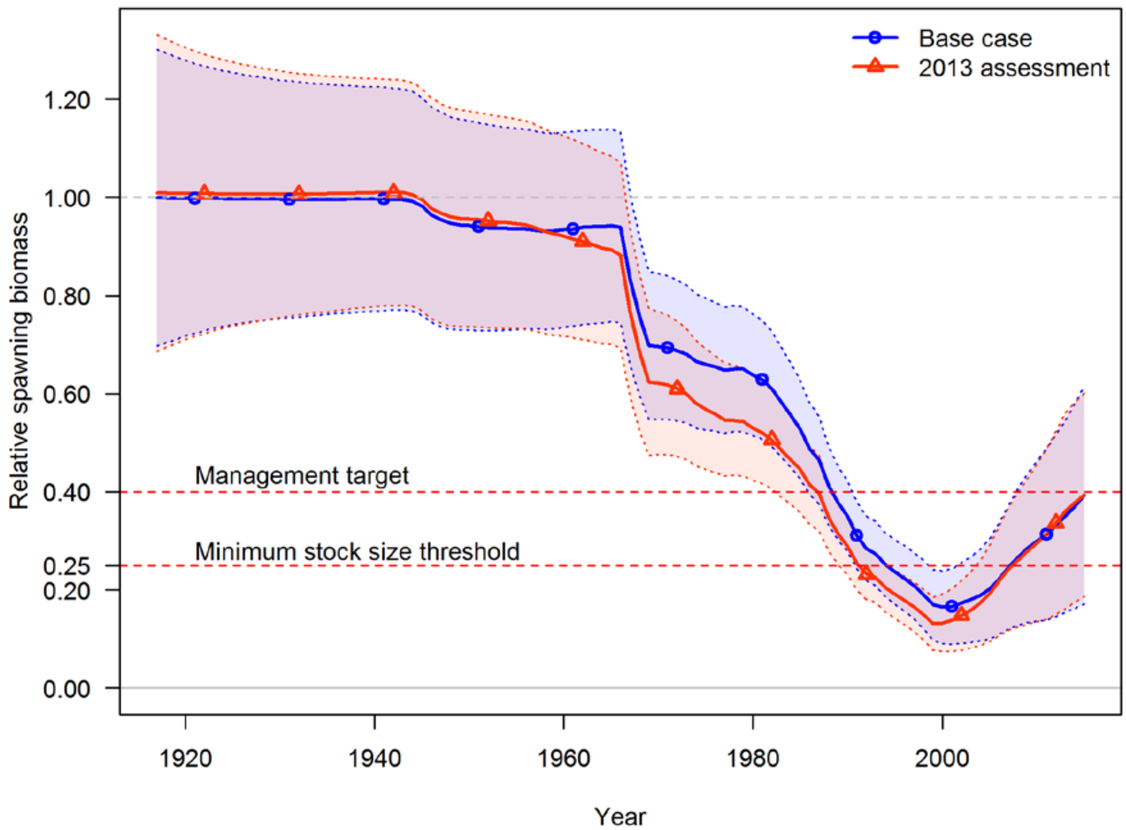

Figure 38: Time series of spawning depletion from this and 2013 assessments with approximate 95% asymptotic confidence intervals.

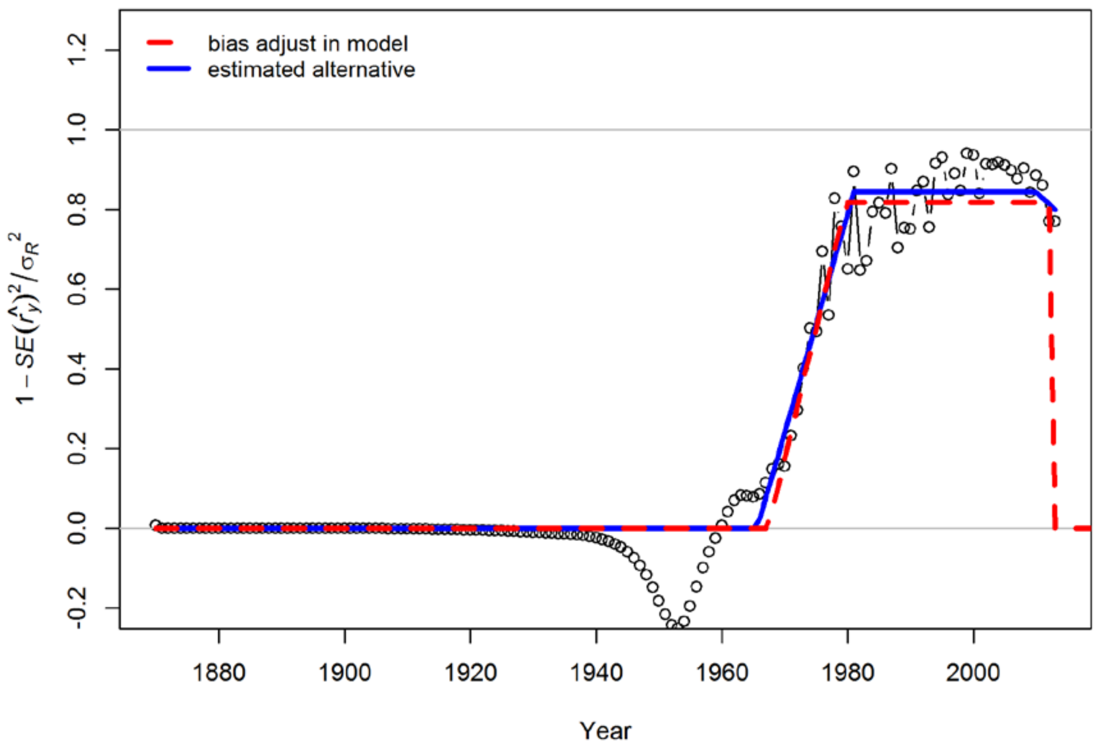

Figure 39: Bias correction ramp estimated by R4SS using particle swarm optimization to avoid local minima.

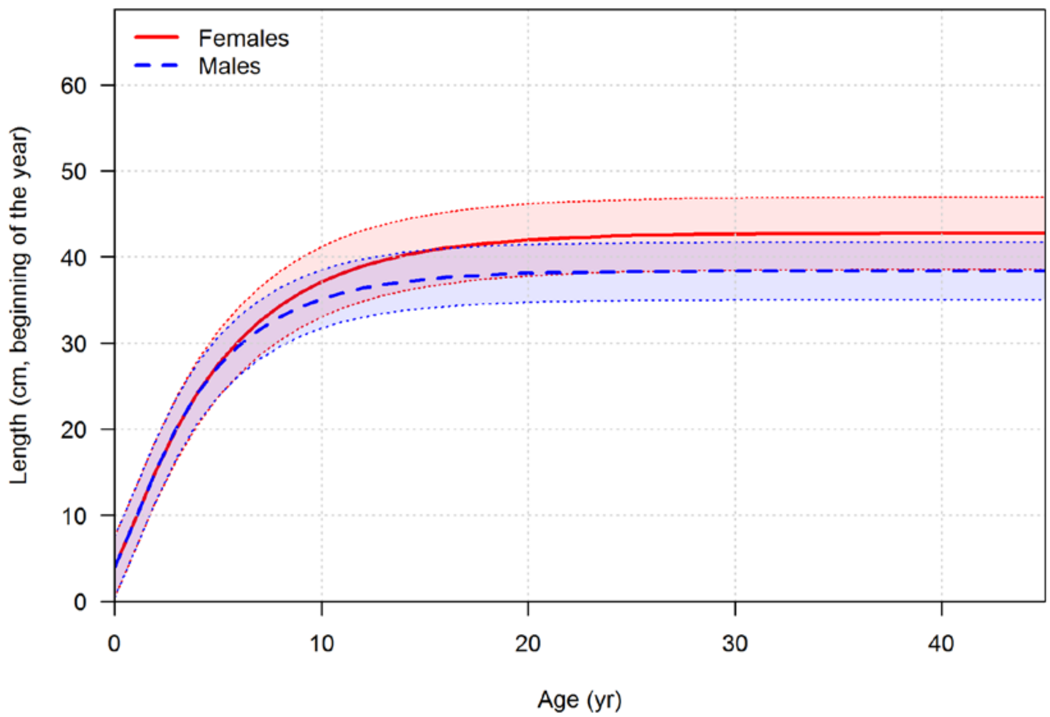

Figure 40: Growth curves for females and males of darkblotched rockfish used in the assessment model.

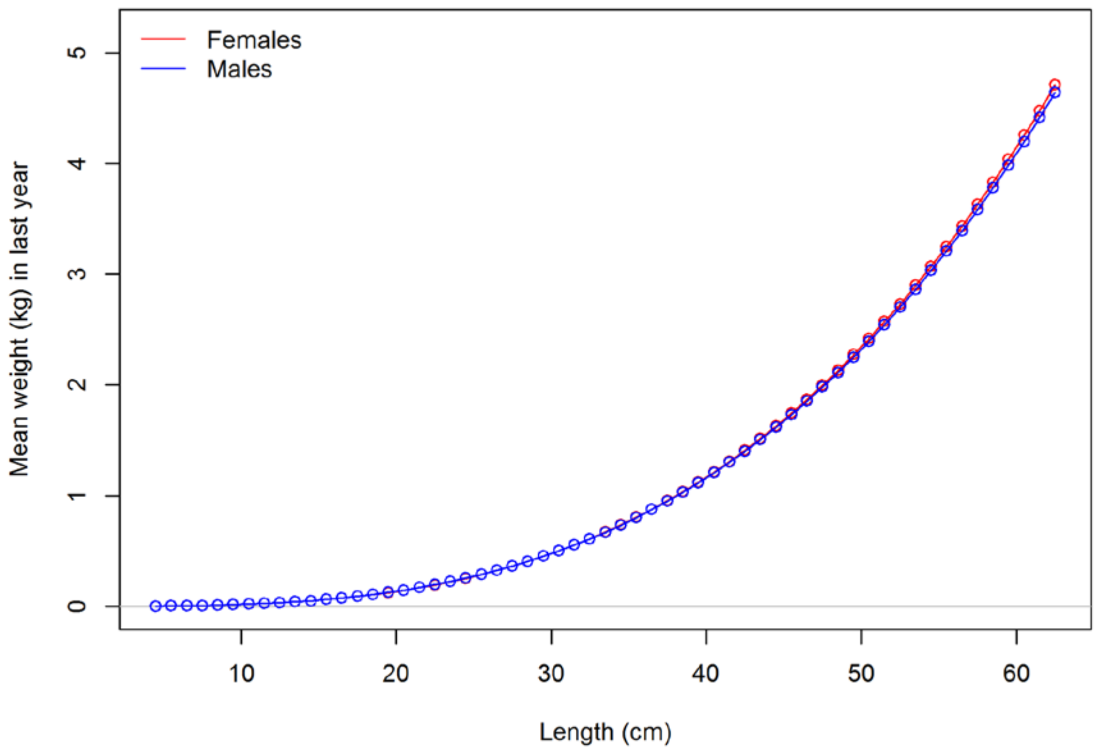

Figure 41: Weight-at-length relationship for females and males of darkblotched rockfish used in the assessment model.

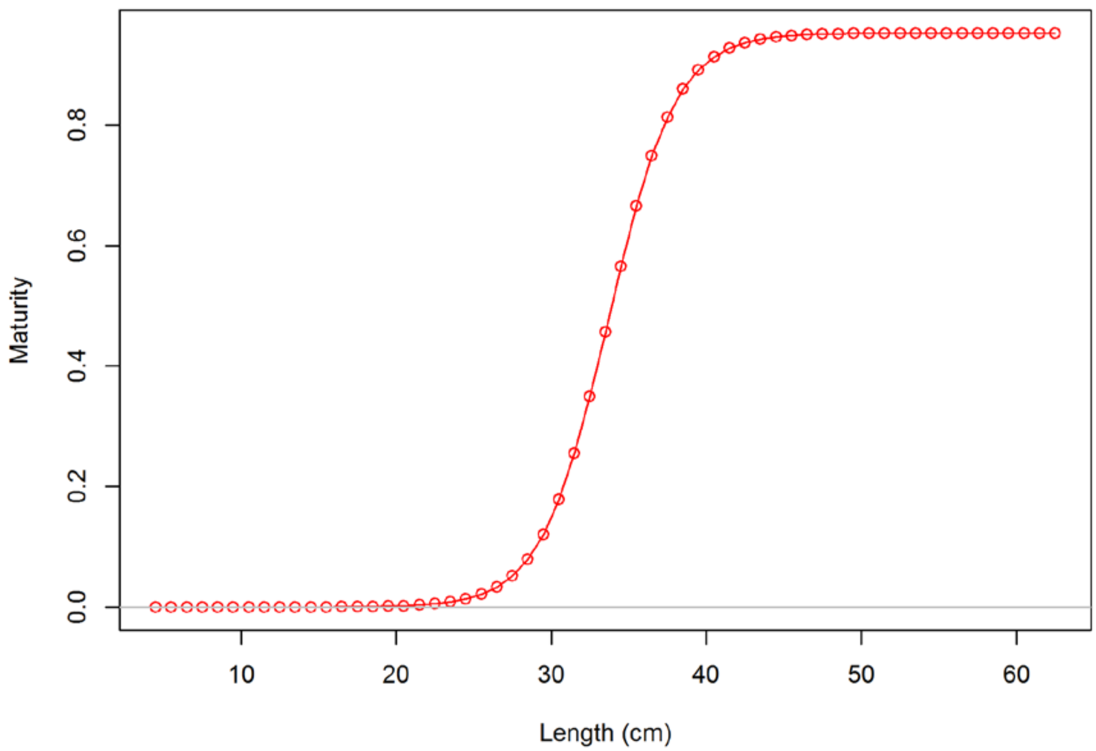

Figure 42: Female maturity at length relationship used in the assessment model. The parameters were estimated from the data collected within the NWFSC shelf-slope survey between 2011 and 2012.

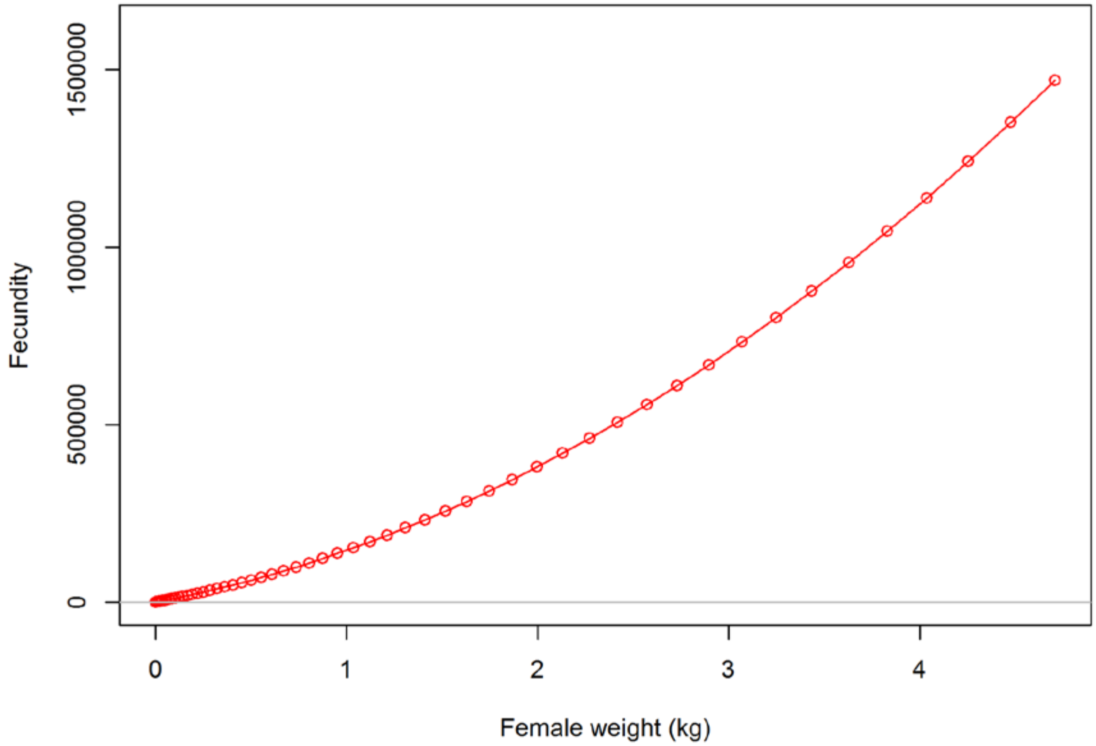

Figure 43: Female darkblotched rockfish fecundity at weight relationship used in the assessment, based on the parameters estimated by Dick (2009).

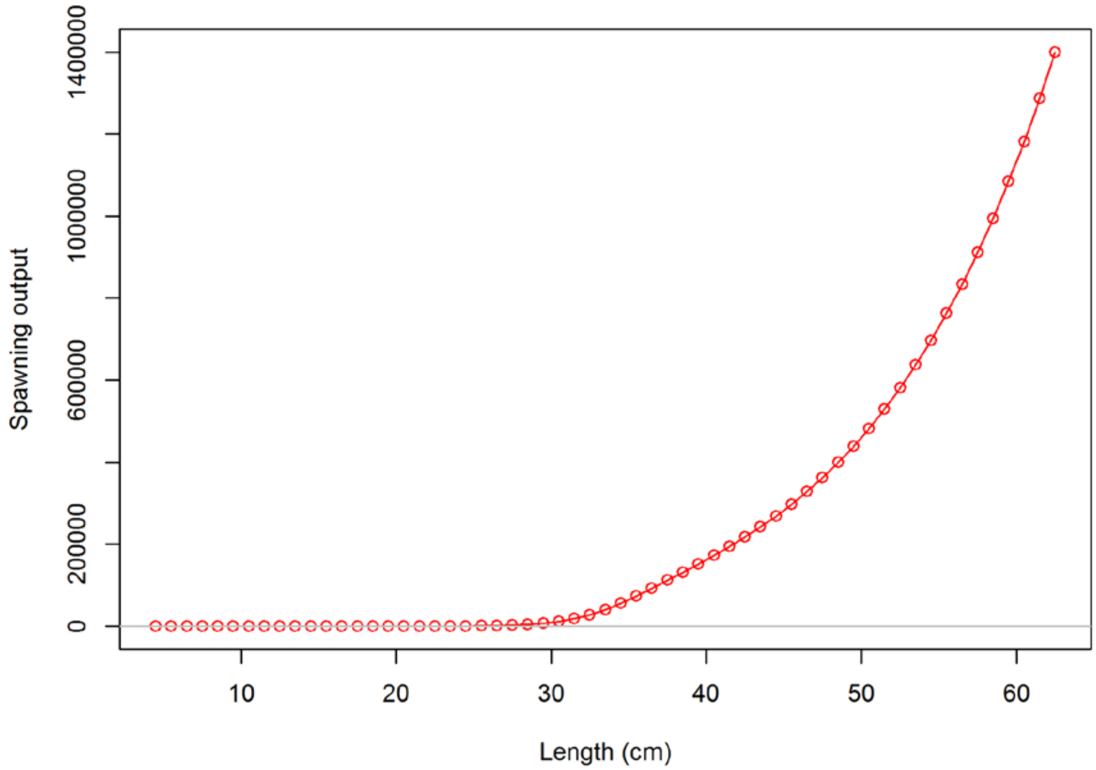

Figure 44: Female darkblotched rockfish spawning output-at-length relationship used in the assessment model.

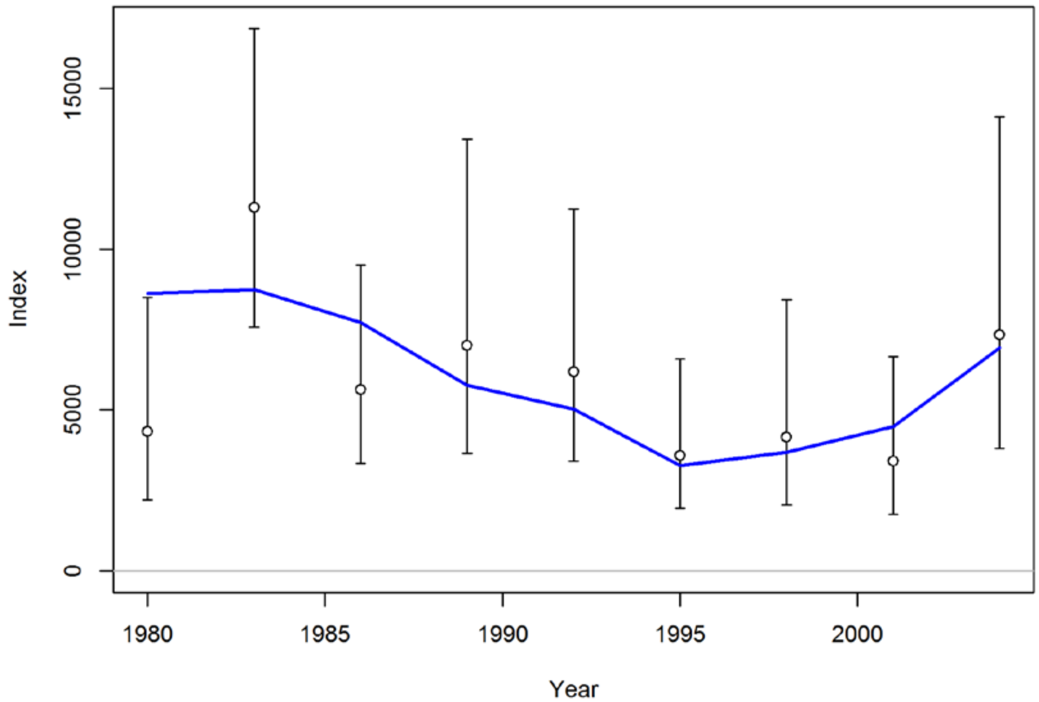

Figure 45: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC shelf survey.

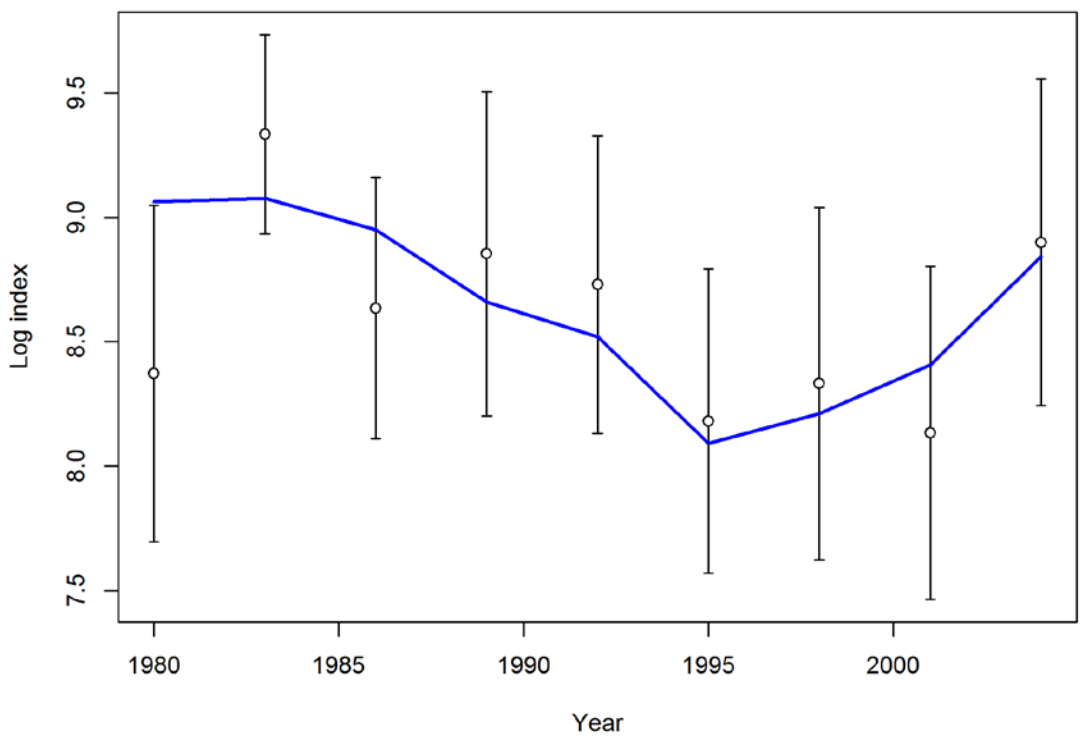

Figure 46: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC shelf survey, on log scale.

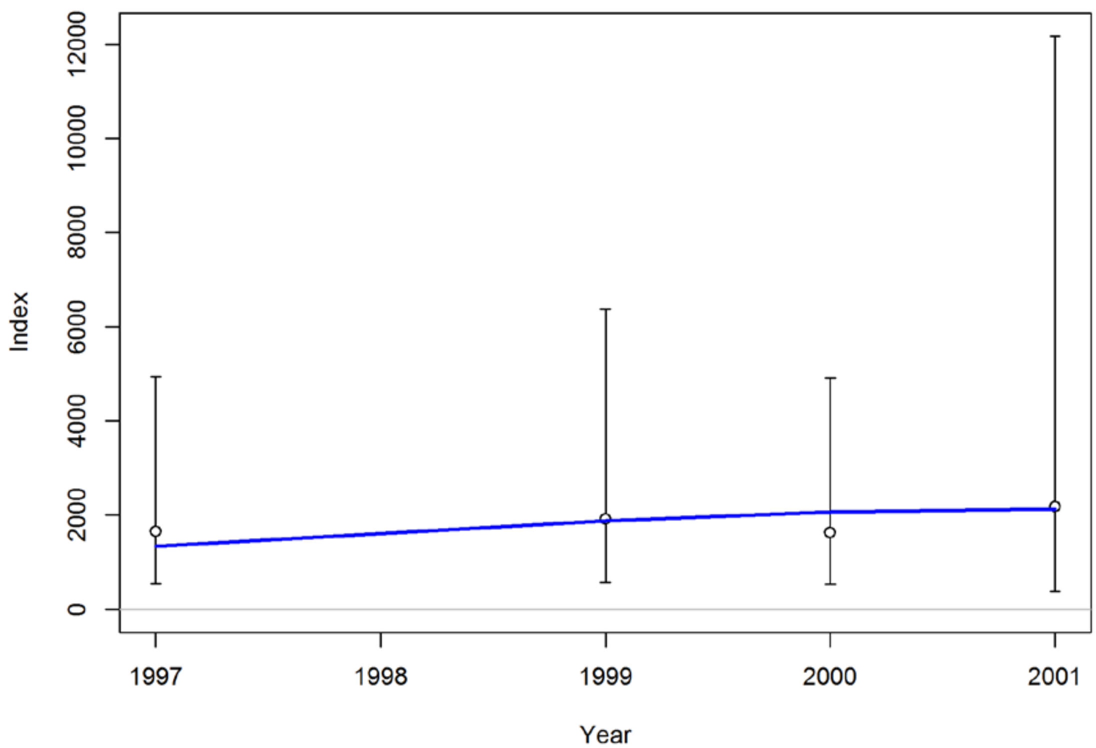

Figure 47: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC slope survey.

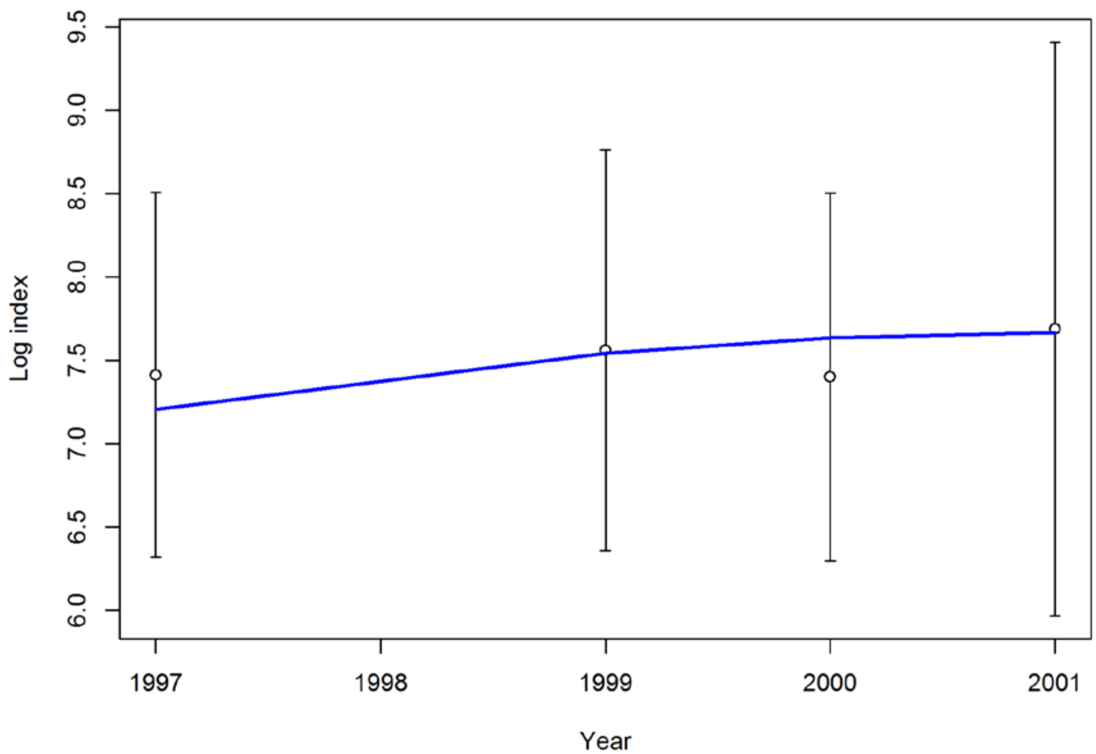

Figure 48: Observed and expected values of darkblotched rockfish biomass index (mt) for the AFSC slope survey, on log scale.

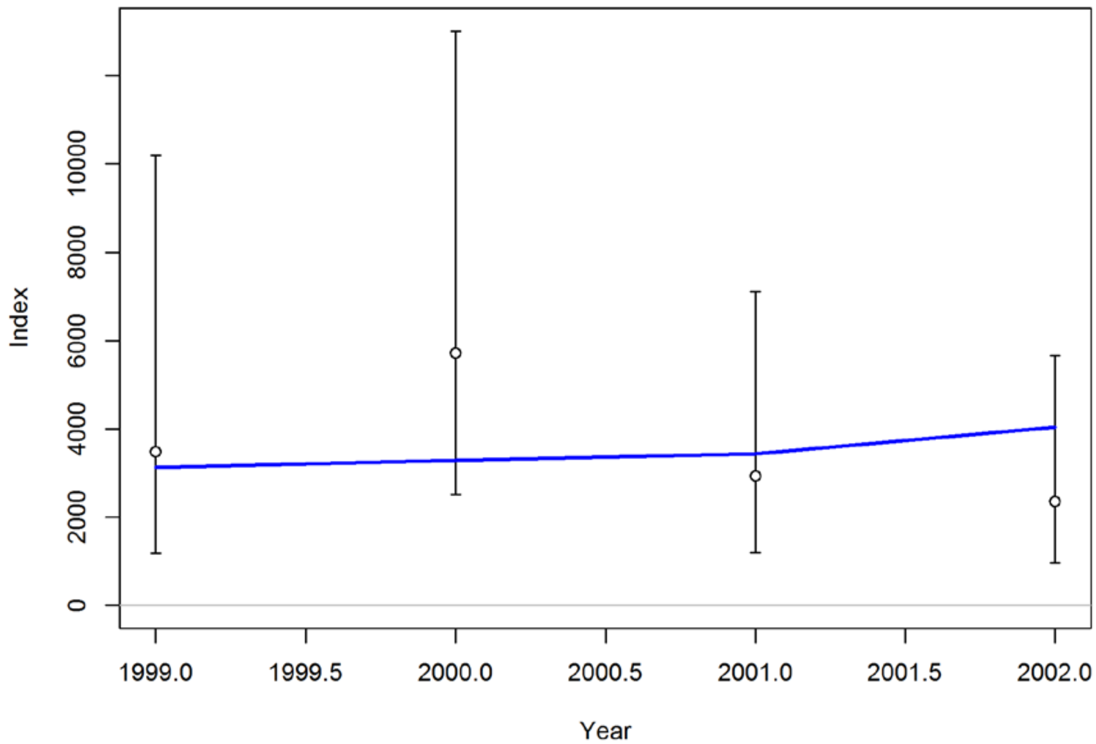

Figure 49: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC slope survey.

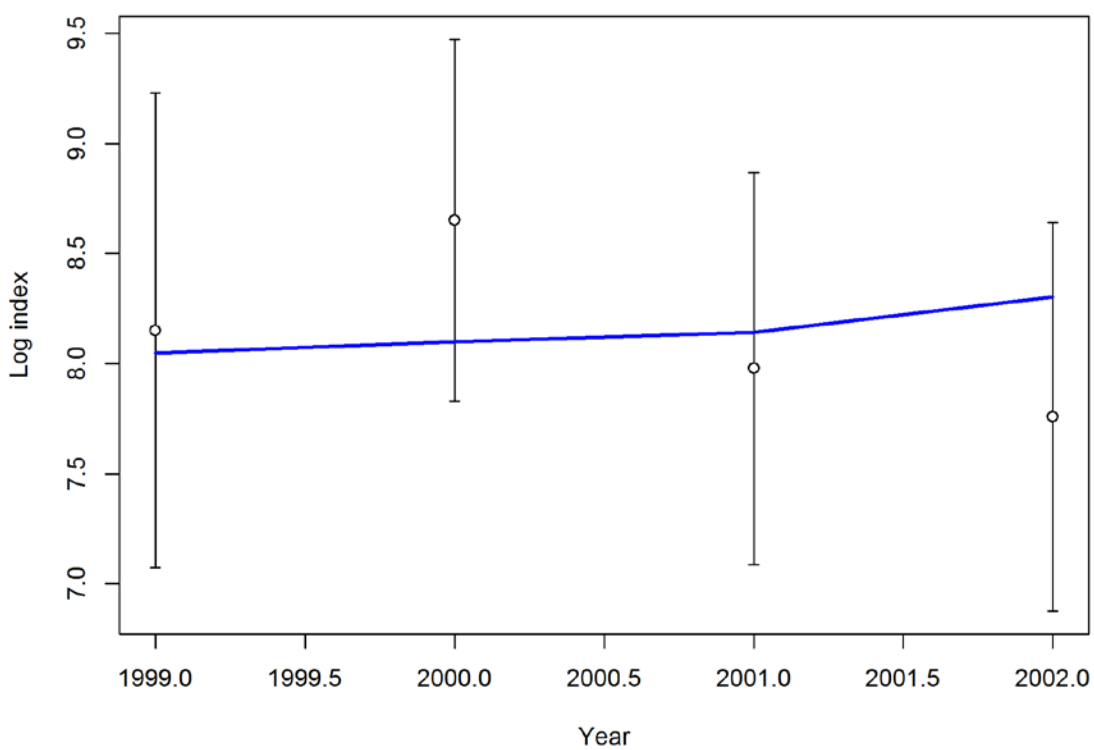

Figure 50: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC slope survey, on log scale.

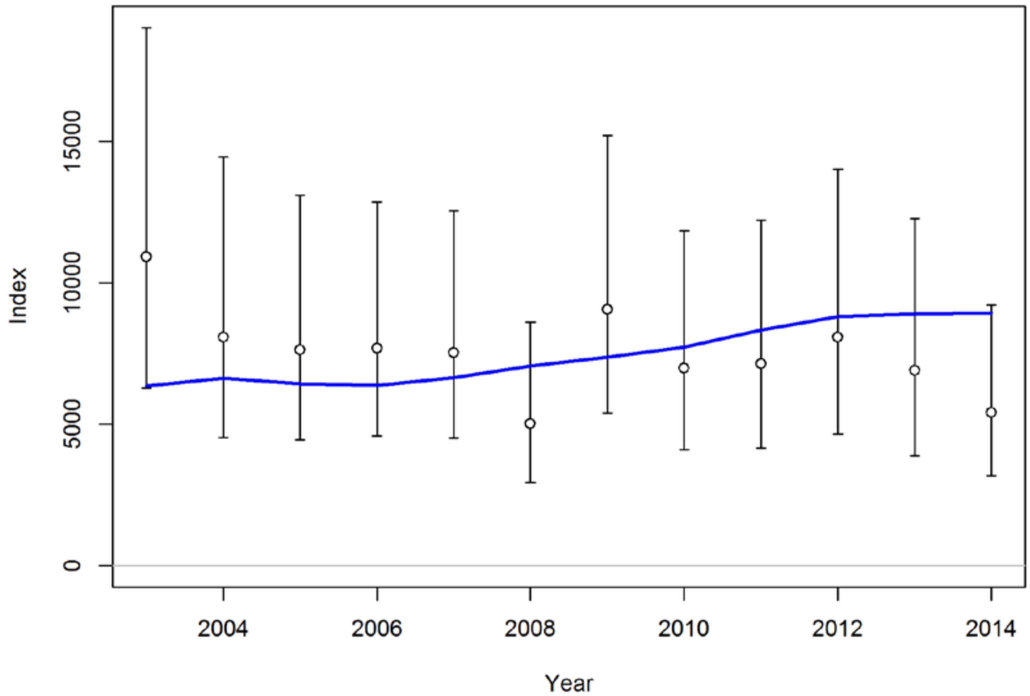

Figure 51: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC shelf-slope survey.

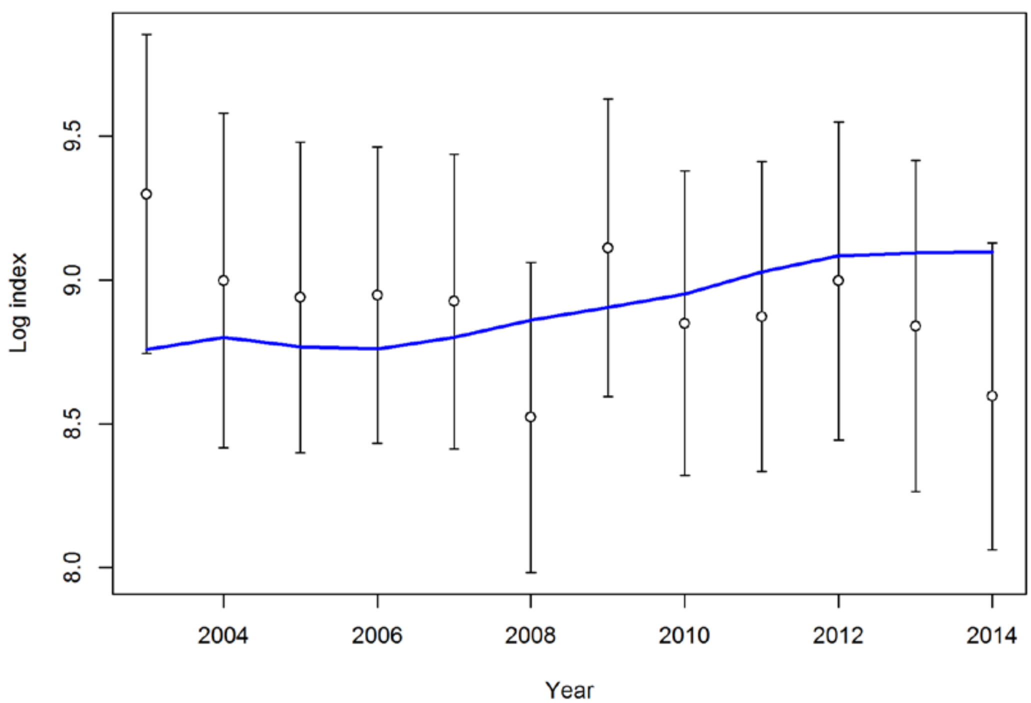

Figure 52: Observed and expected values of darkblotched rockfish biomass index (mt) for the NWFSC shelf-slope survey, on log scale.

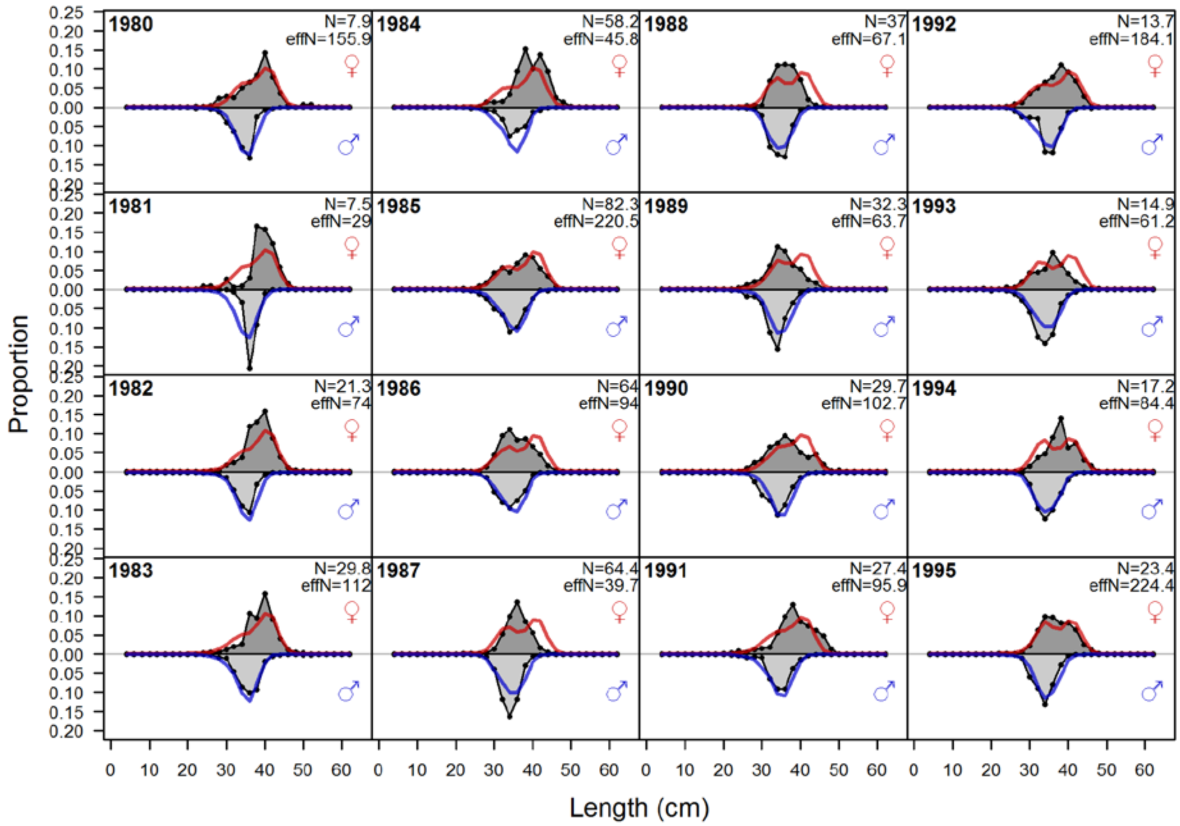

Figure 53: Fit to length-frequency distributions of darkblotched rockfish for the shoreside landings, by year.

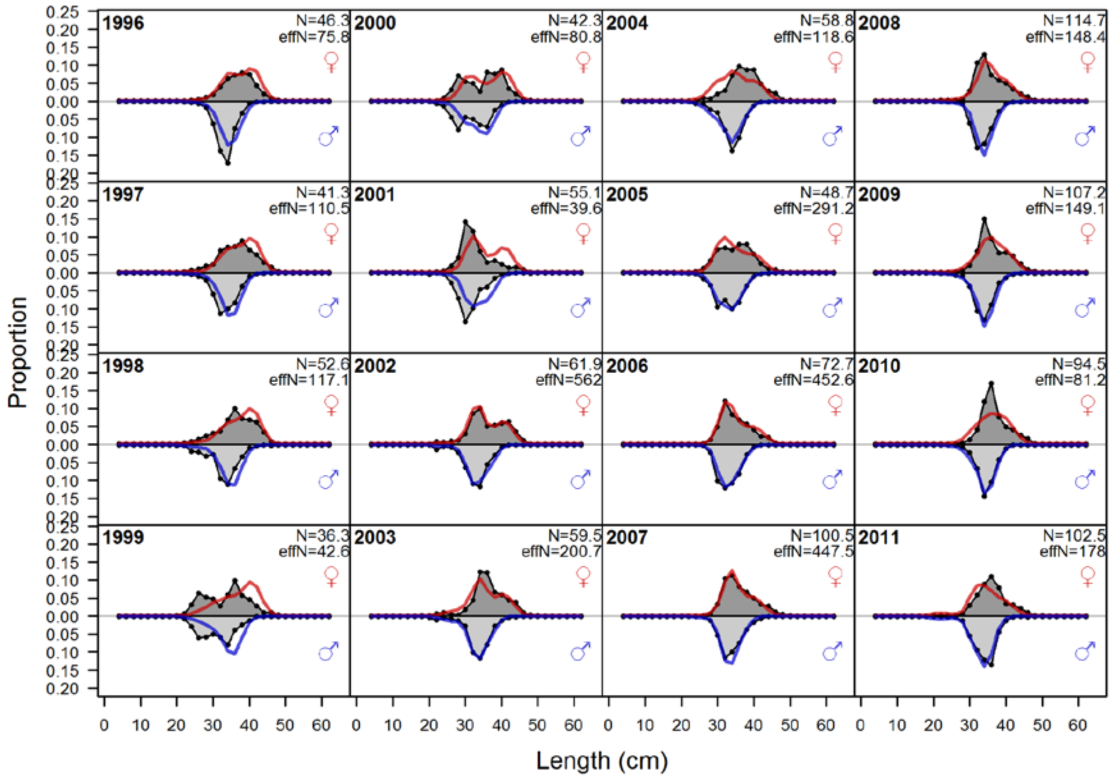

Figure 53 (continued): Fit to length-frequency distributions of darkblotched rockfish for the shoreside landings, by year.

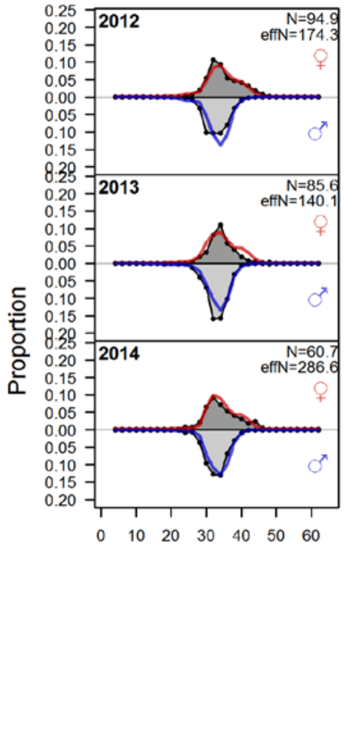

Figure 53 (continued): Fit to length-frequency distributions of darkblotched rockfish for the shoreside landings, by year.

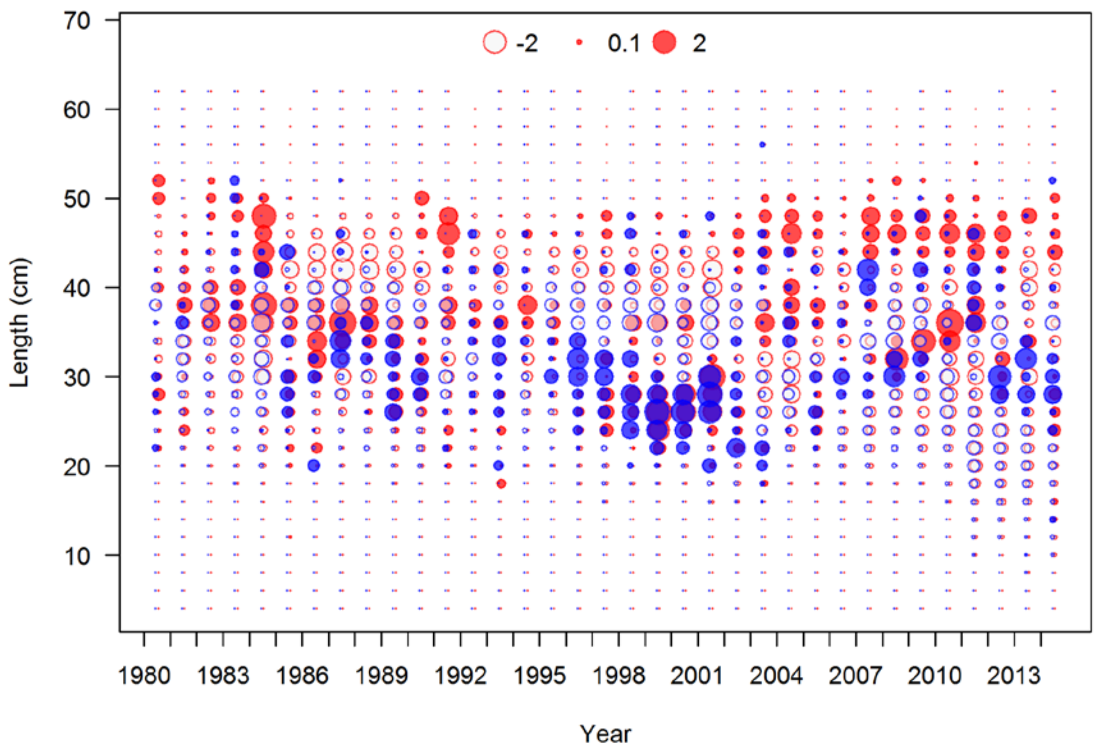

Figure 54: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) for the shoreside landings, by year.

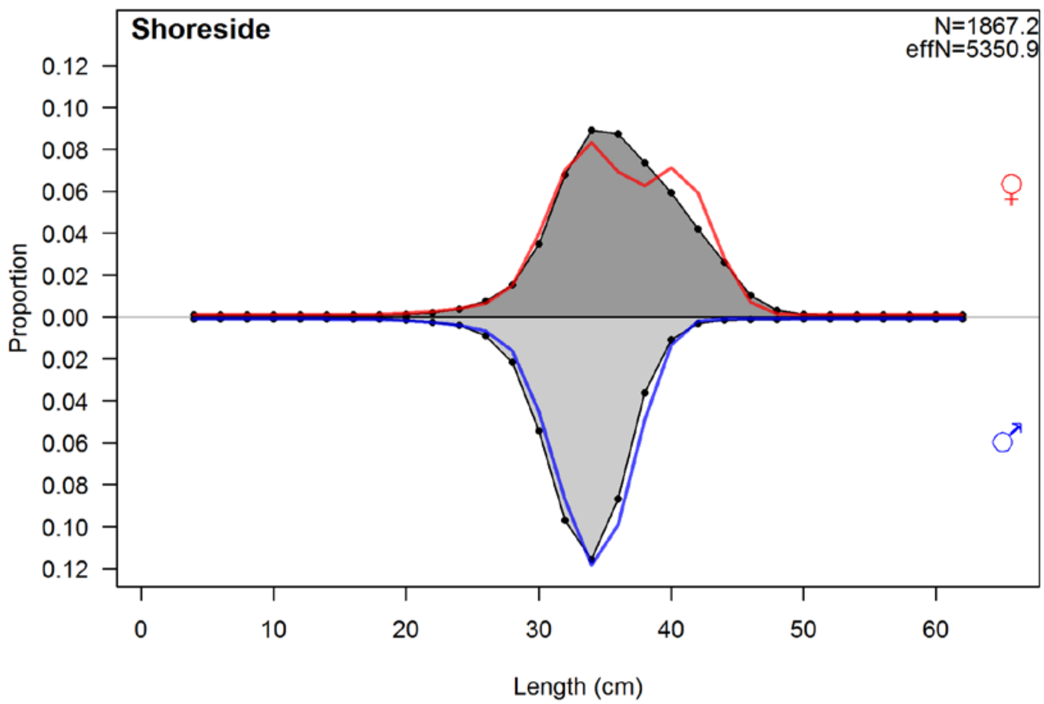

Figure 55: Fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from shoreside landings, aggregated across all years.

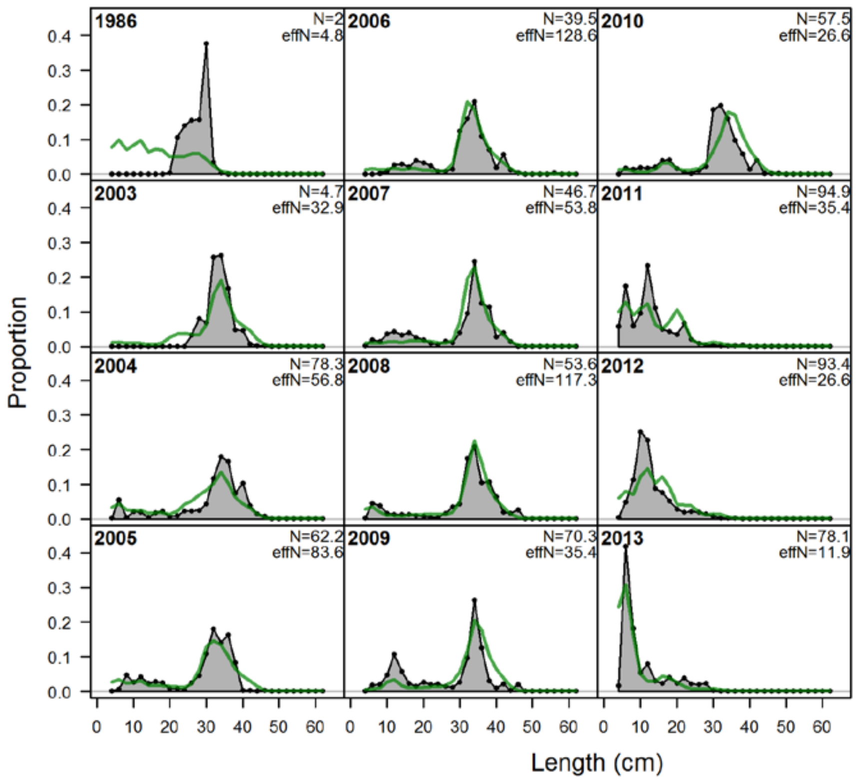

Figure 56: Fit to length-frequency distributions of darkblotched rockfish (sexes combined) for the shoreside fleet discard, by year.

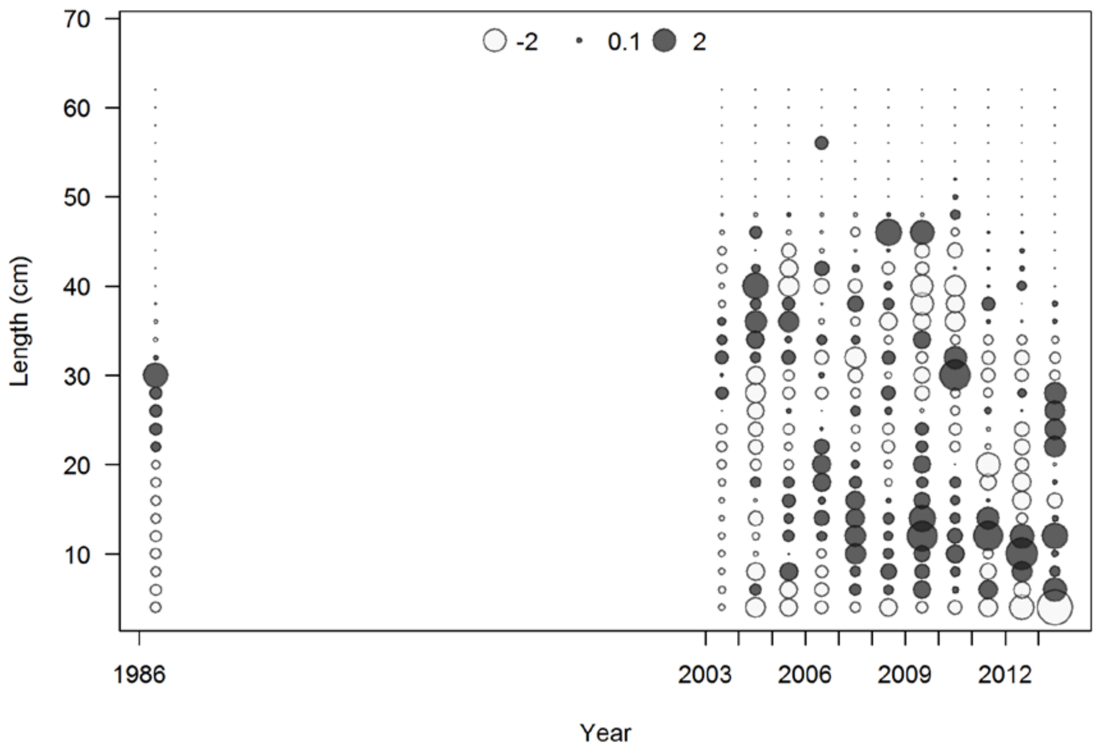

Figure 57: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (sexes combined) for the shoreside fleet discard, by year.

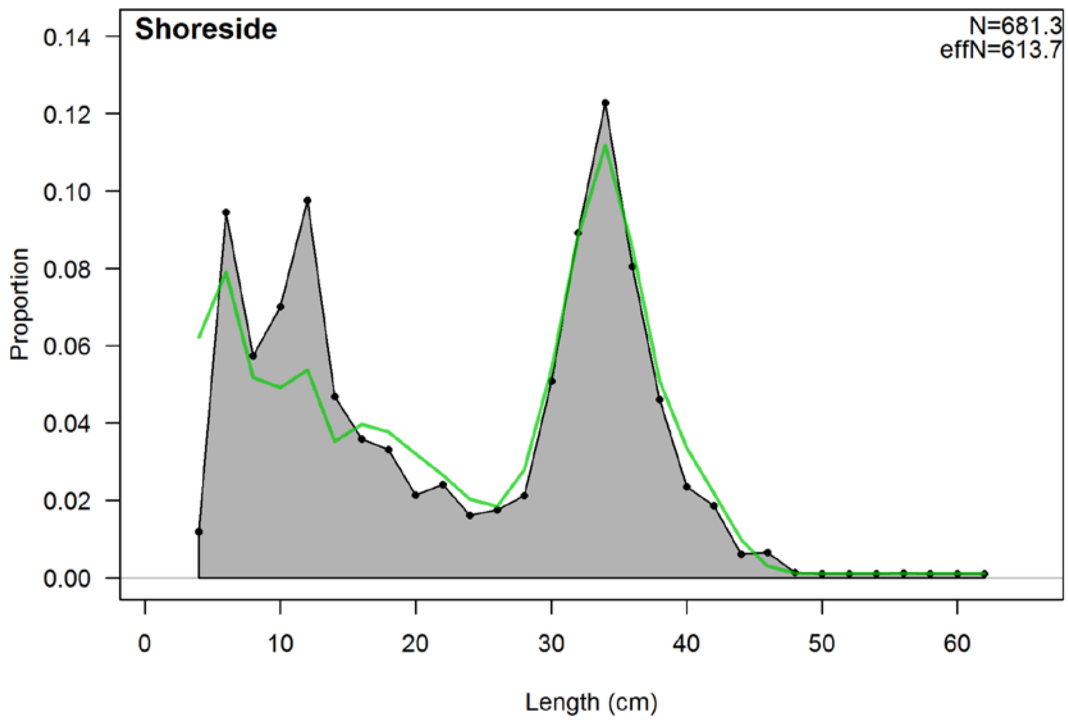

Figure 58: Fit to length-frequency distributions of darkblotched rockfish (sexes combined) from shoreside fishery discard, aggregated across all years.

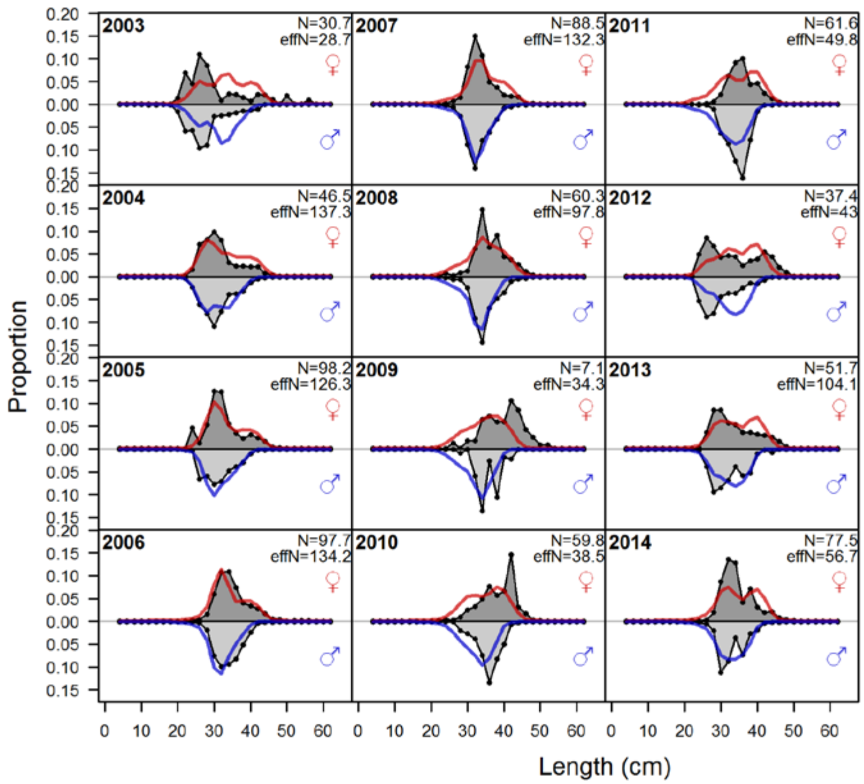

Figure 59: Fit to length-frequency distributions of darkblotched rockfish for at sea hake fishery bycatch, by year.

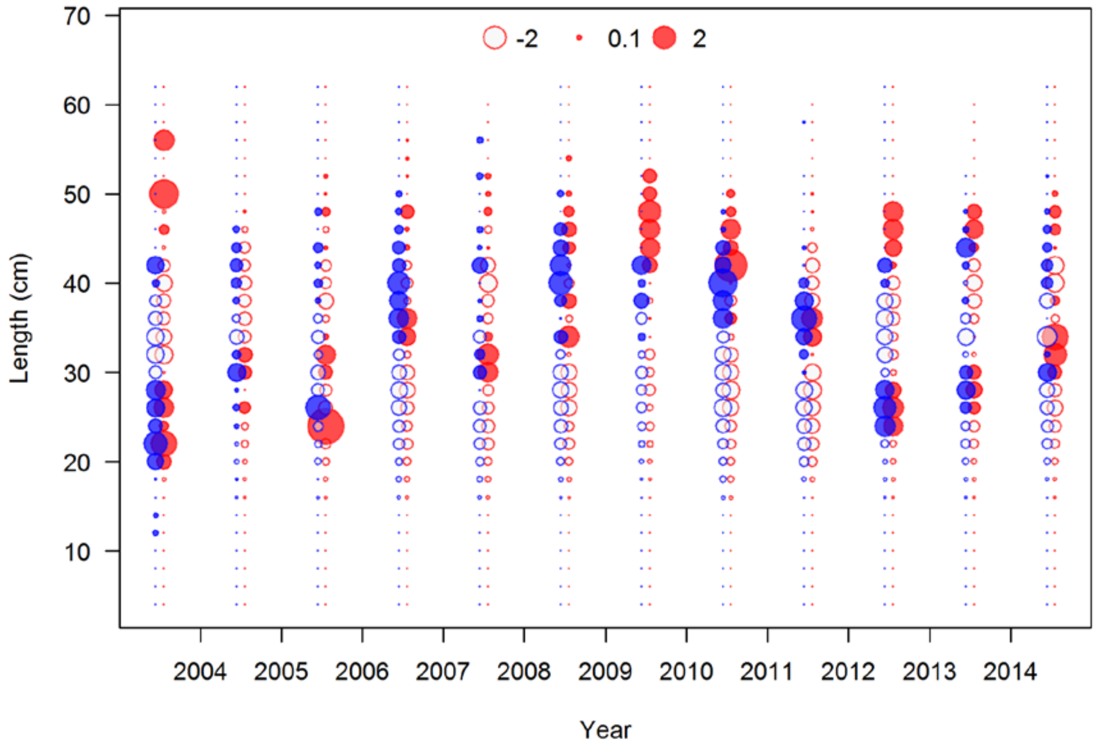

Figure 60: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) for the shoreside landings, by year.

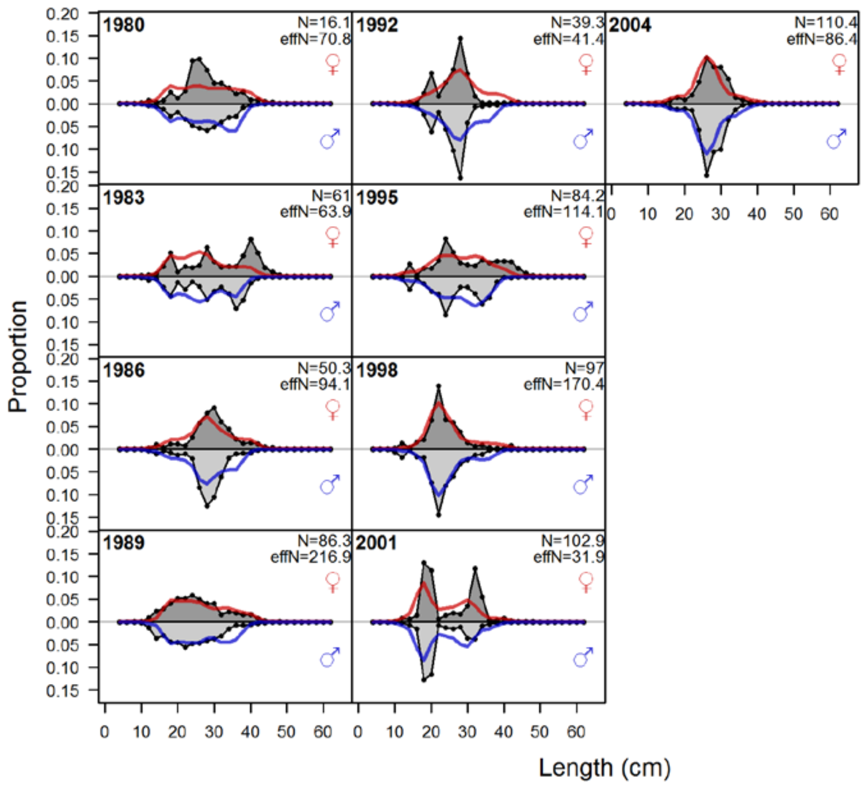

Figure 61: Fit to length-frequency distributions of darkblotched rockfish from the AFSC shelf survey, by year.

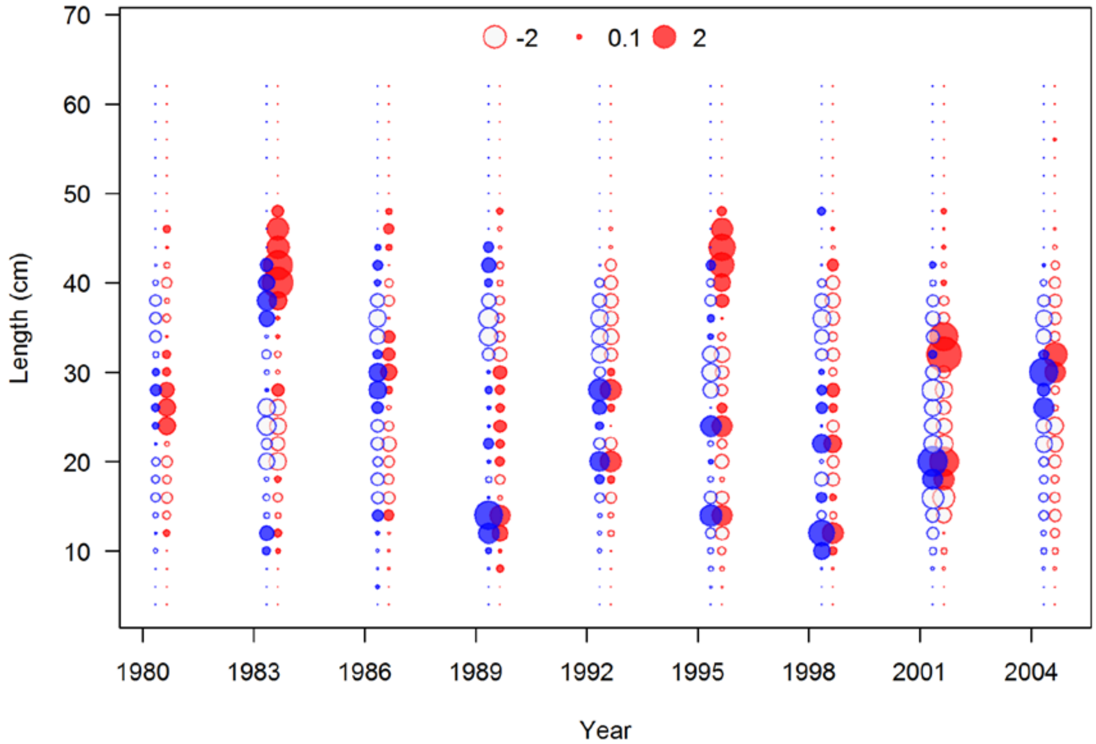

Figure 62: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the AFSC shelf survey, by year.

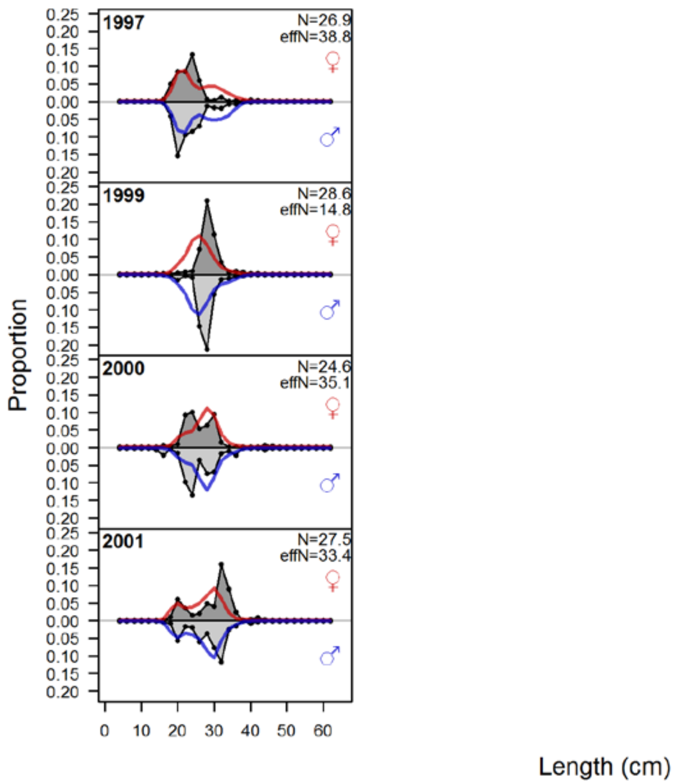

Figure 63: Fit to length-frequency distributions of darkblotched rockfish from the AFSC slope survey, by year.

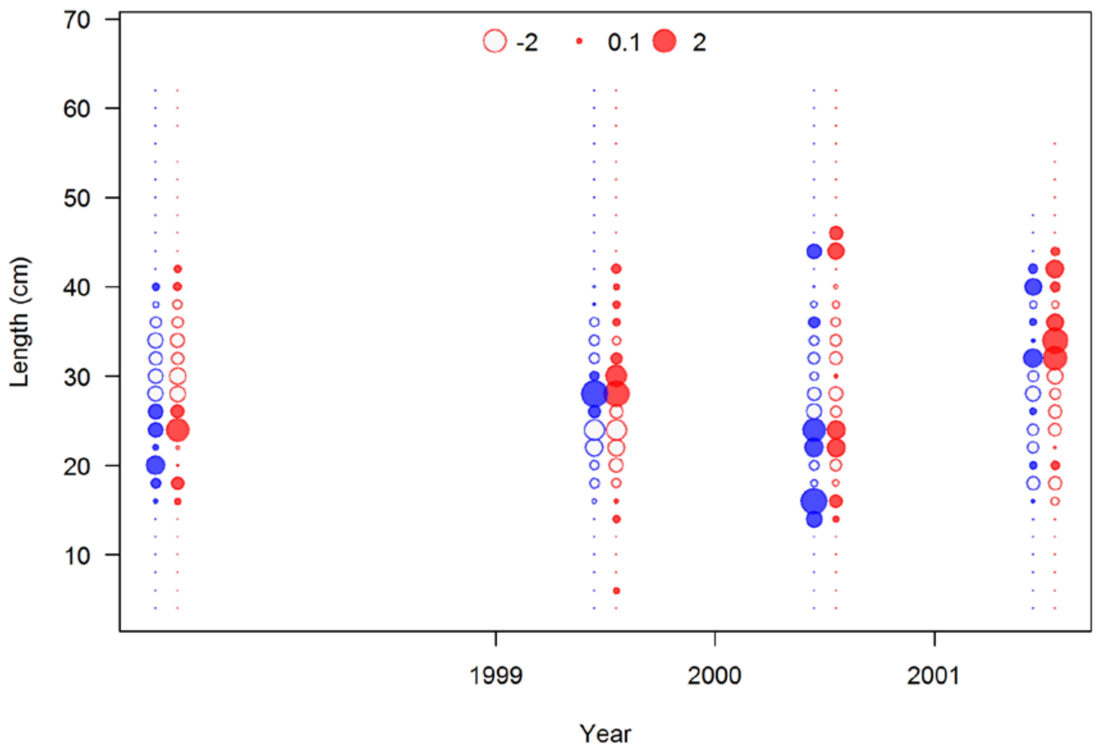

Figure 64: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the AFSC slope survey, by year.

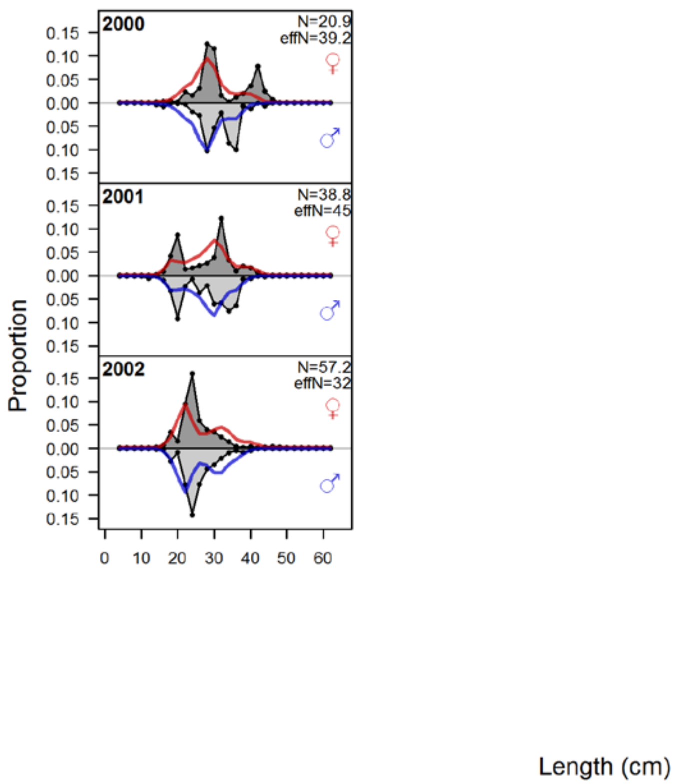

Figure 65: Fit to length-frequency distributions of darkblotched rockfish from the NWFSC slope survey, by year.

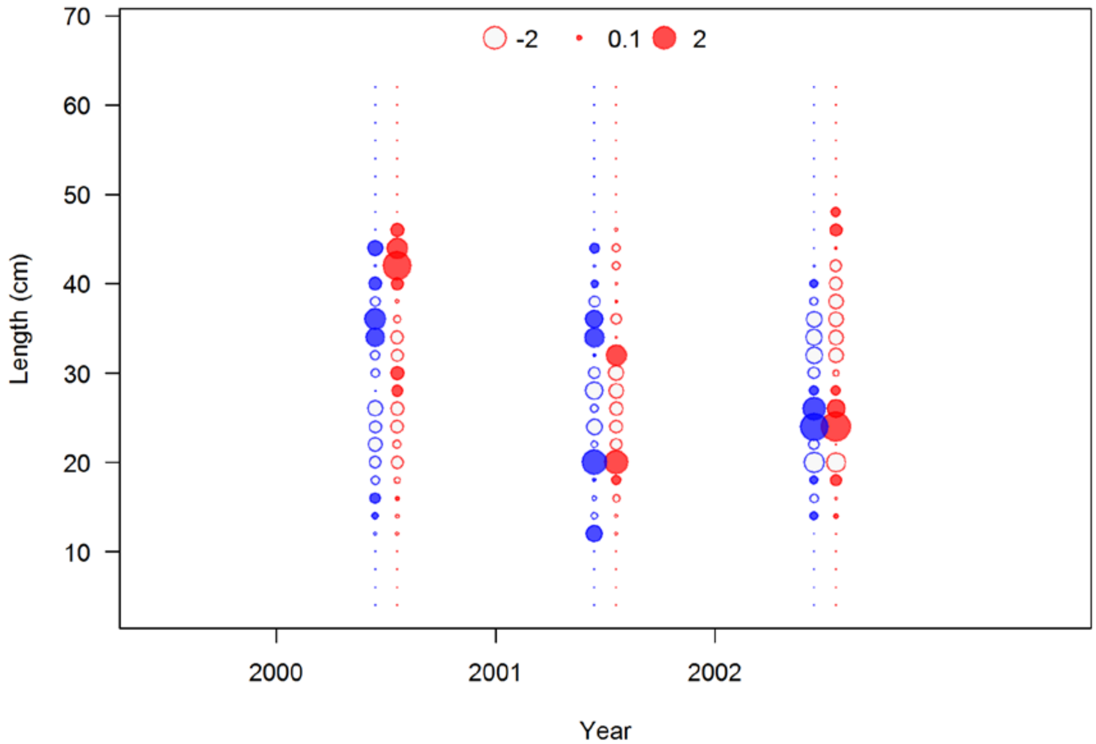

Figure 66: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the NWFSC slope survey, by year.

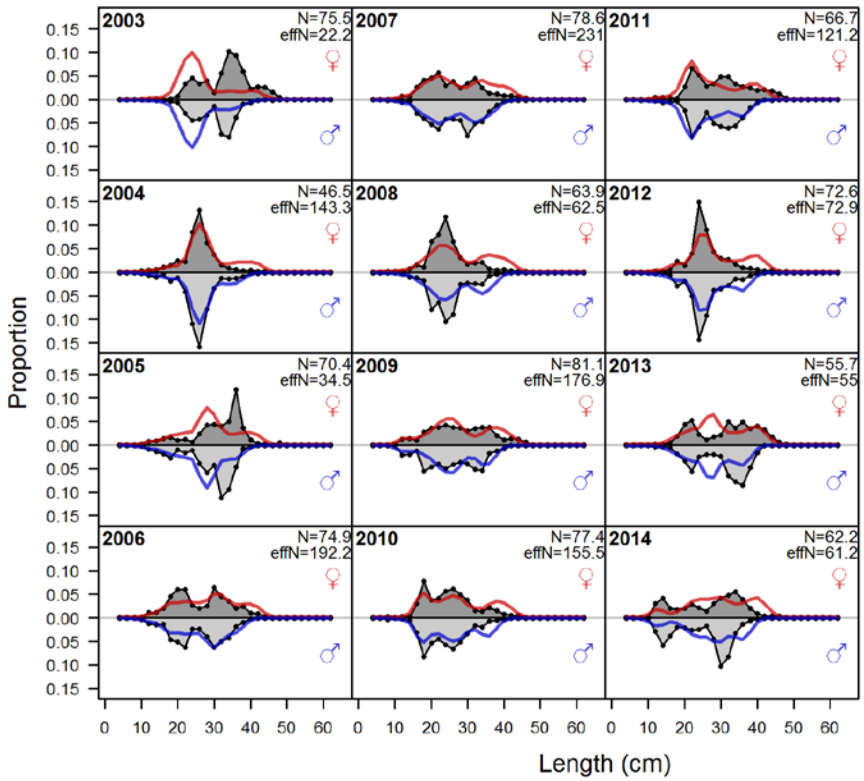

Figure 67: Fit to length-frequency distributions of darkblotched rockfish from the NWFSC shelf-slope survey by year.

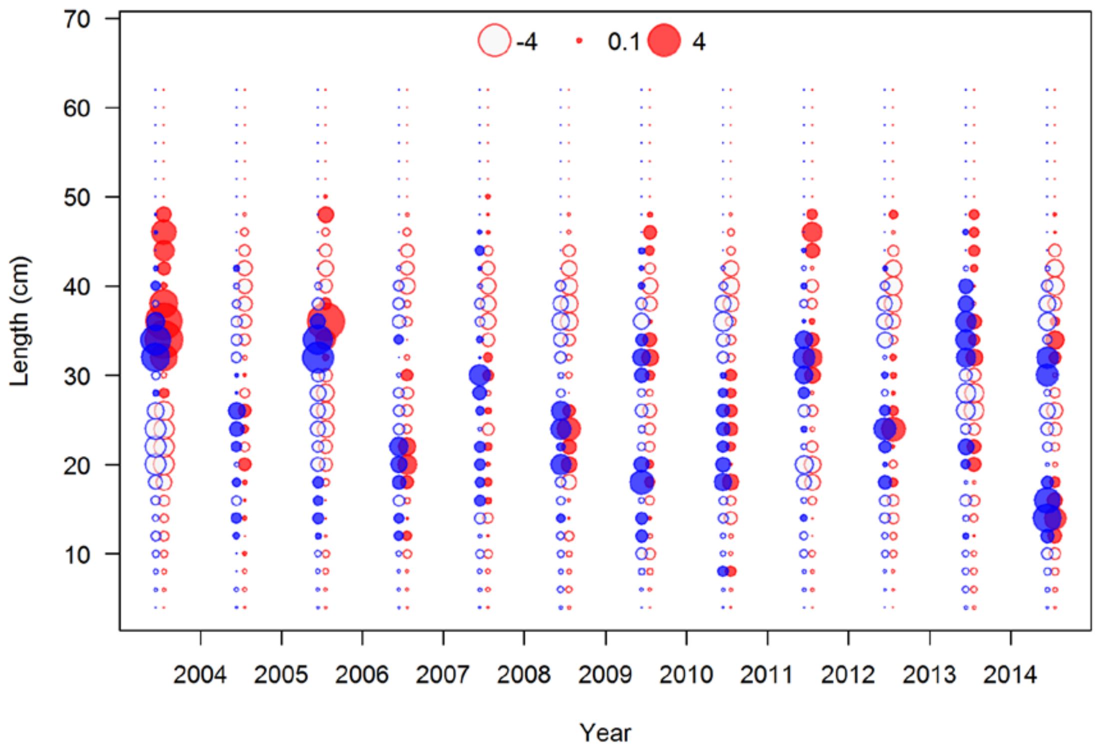

Figure 68: Pearson residuals for the fit to length-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the NWFSC shelf-slope survey by year.

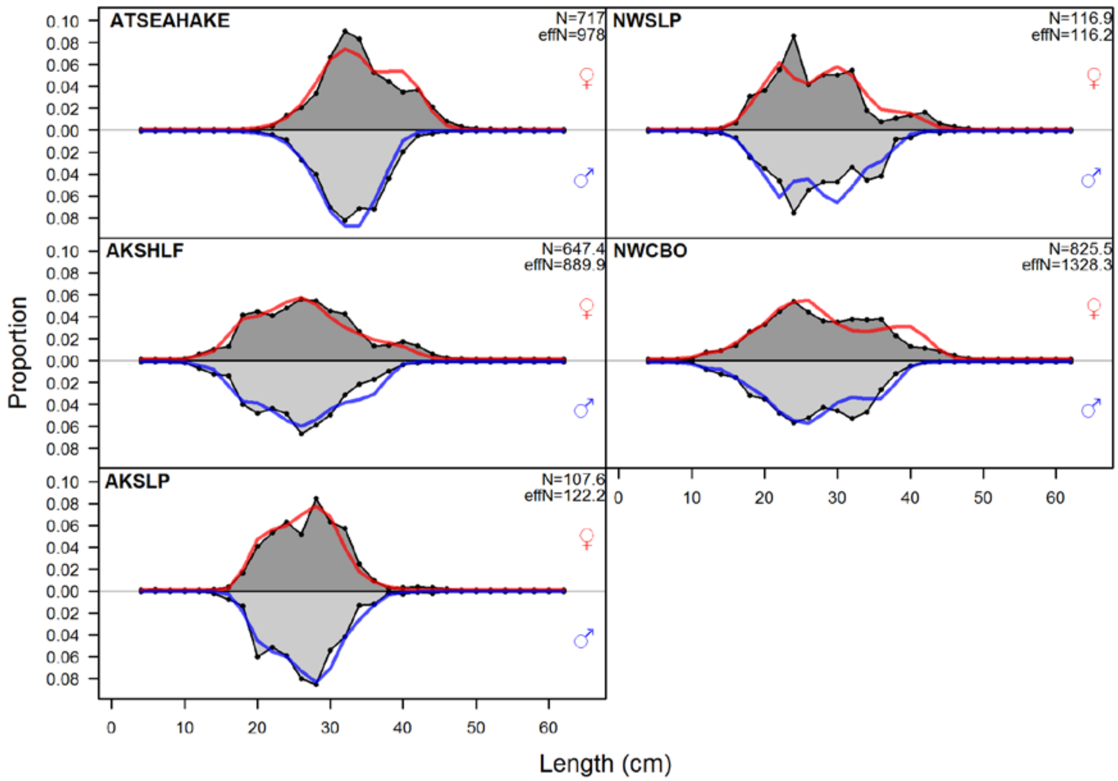

Figure 69: Fit to length-frequency distributions of darkblotched rockfish from the at-sea hake fishery bycatch and fishery-independent surveys, aggregated across all years.

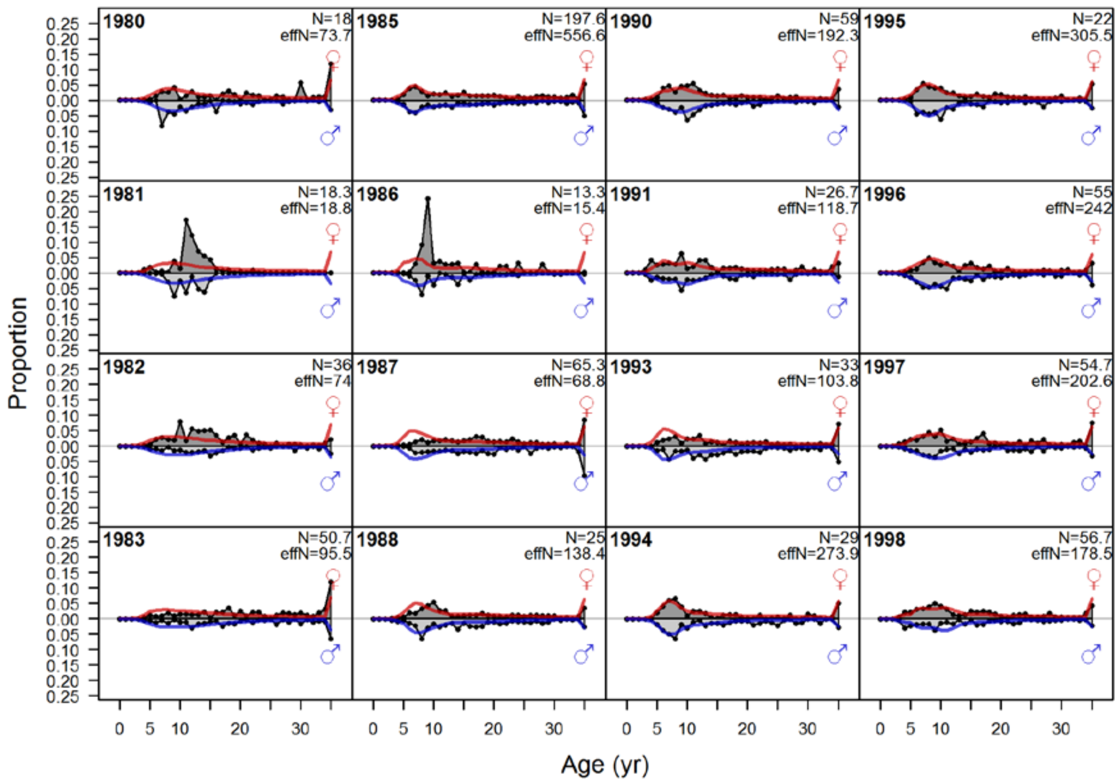

Figure 70: Fit to age-frequency distributions of darkblotched rockfish from the shoreside landings by year.

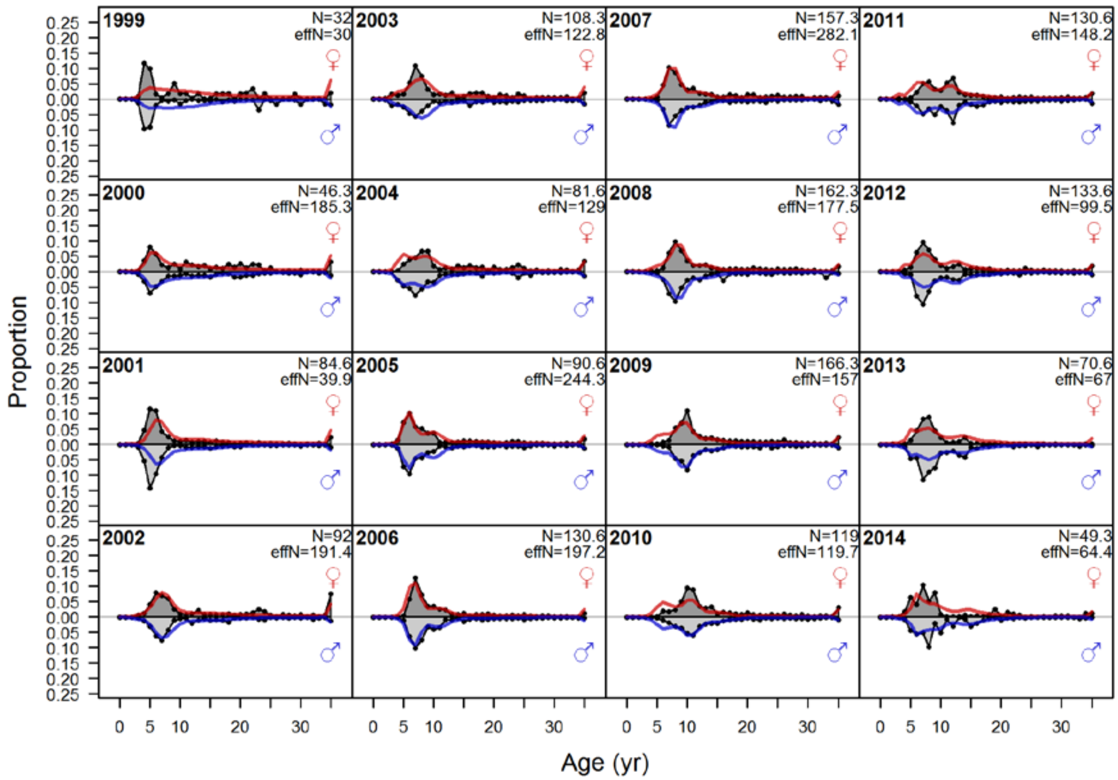

Figure 70 (continued): Fit to age-frequency distributions of darkblotched rockfish from the shoreside landings by year.

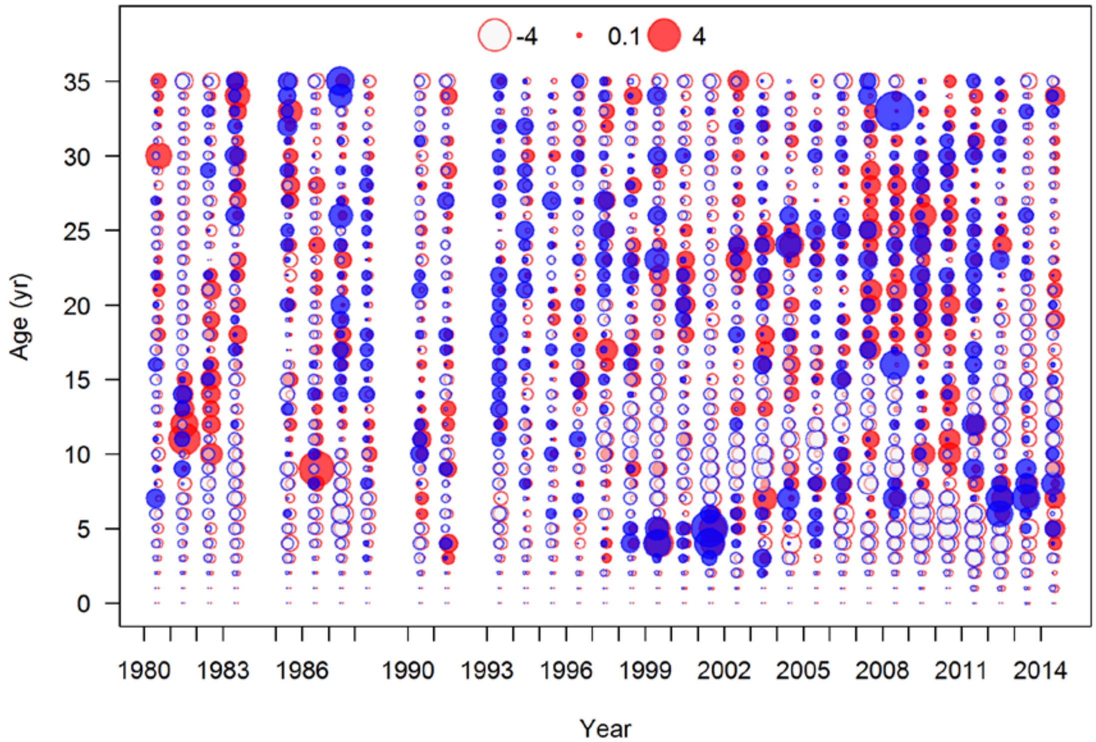

Figure 71: Pearson residuals for the fit to age-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the shoreside landings.

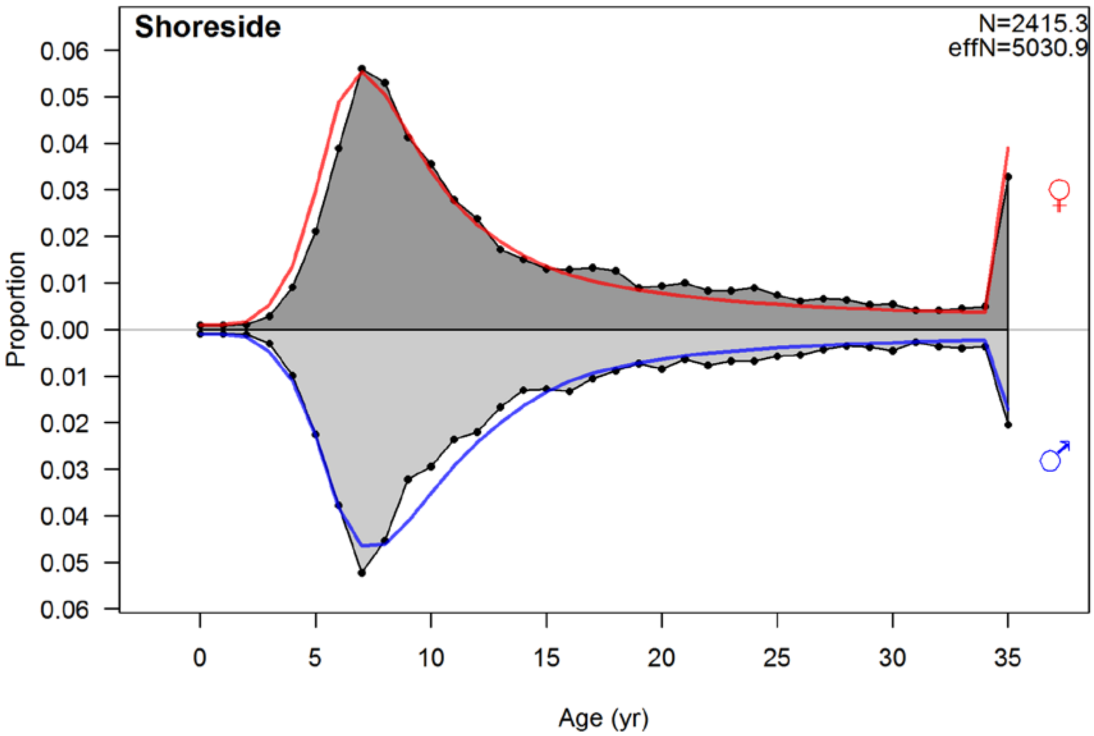

Figure 72: Fit to age-frequency distributions of darkblotched rockfish from the shoreside landings, aggregated across all years.

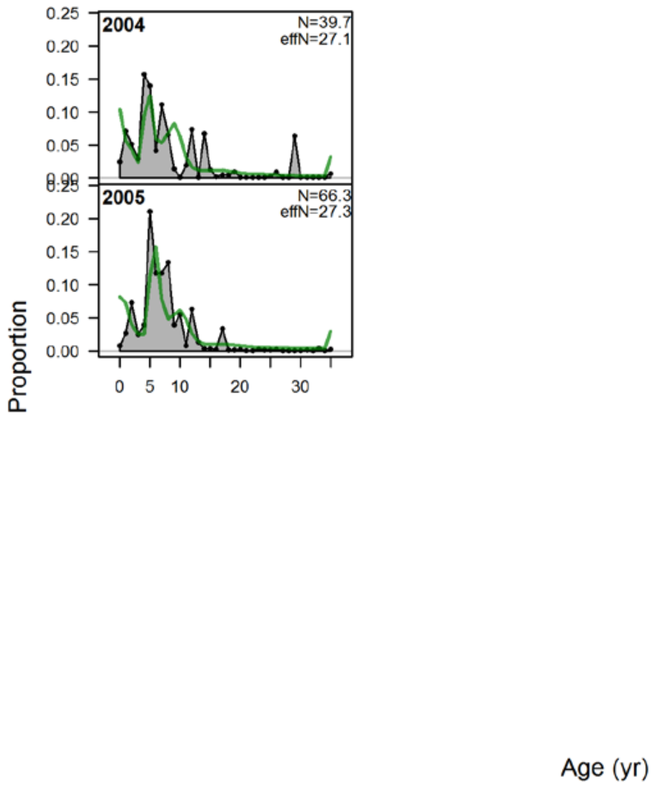

Figure 73: Fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the shoreside fishery discard by year.

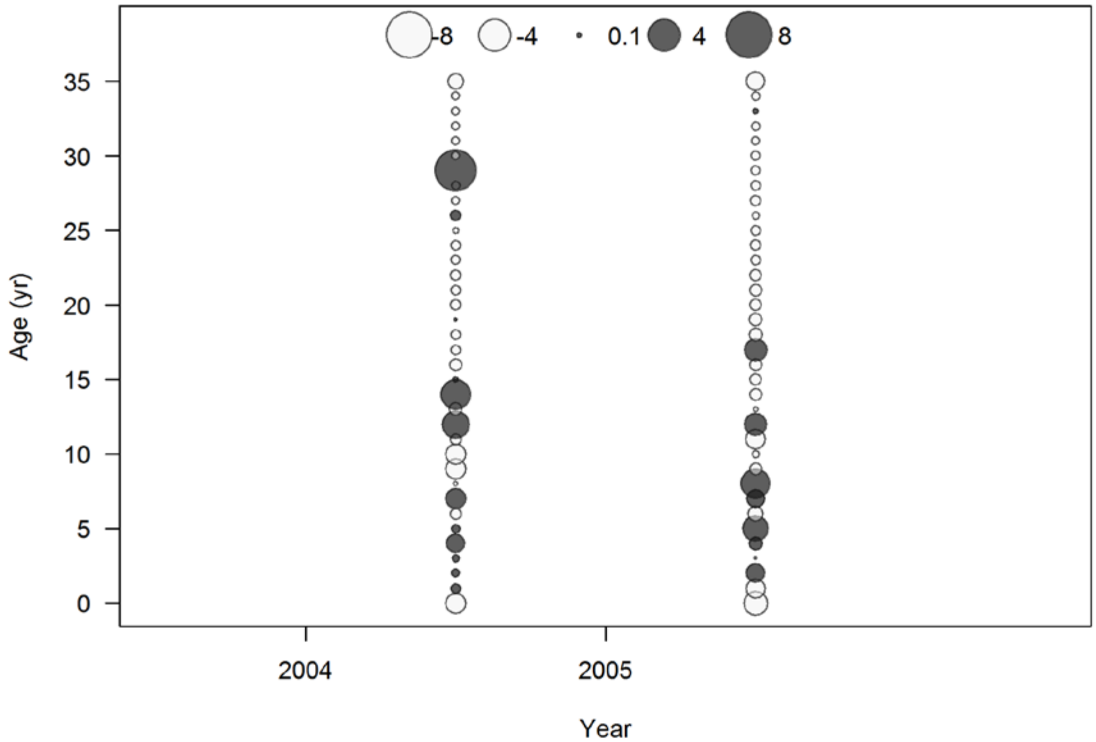

Figure 74: Pearson residuals for the fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the shoreside fishery discard**.**

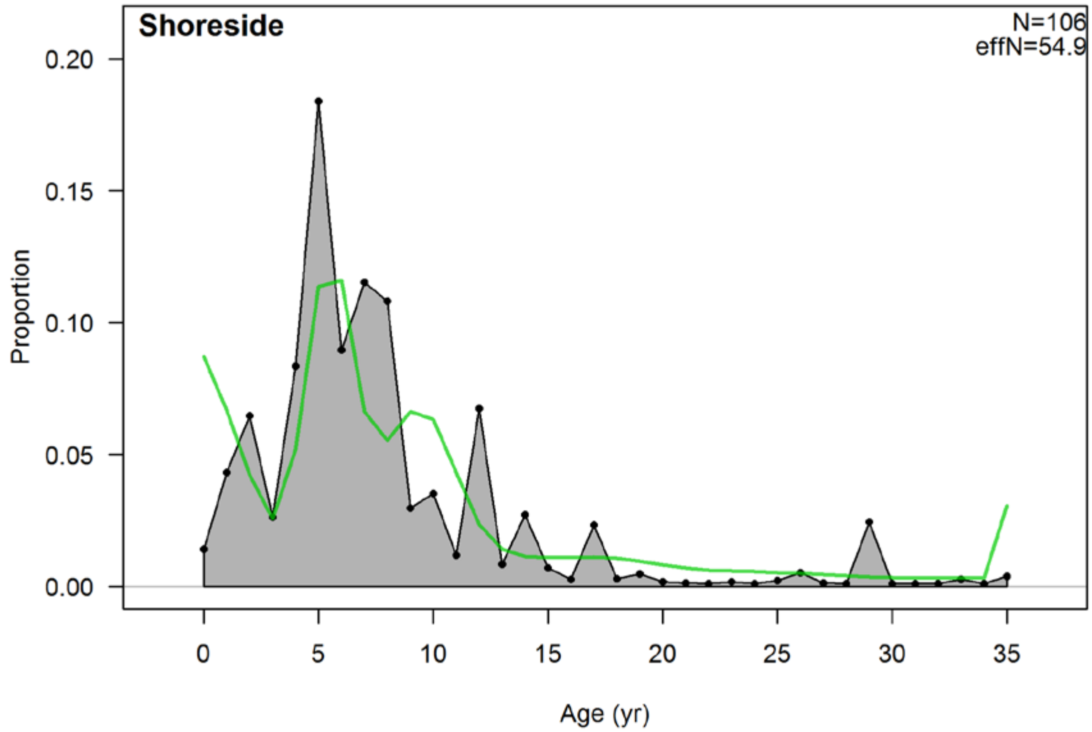

Figure 75: Fit to age-frequency distributions of darkblotched rockfish (sexes combined) from the shoreside fleet discard, aggregated across all years.

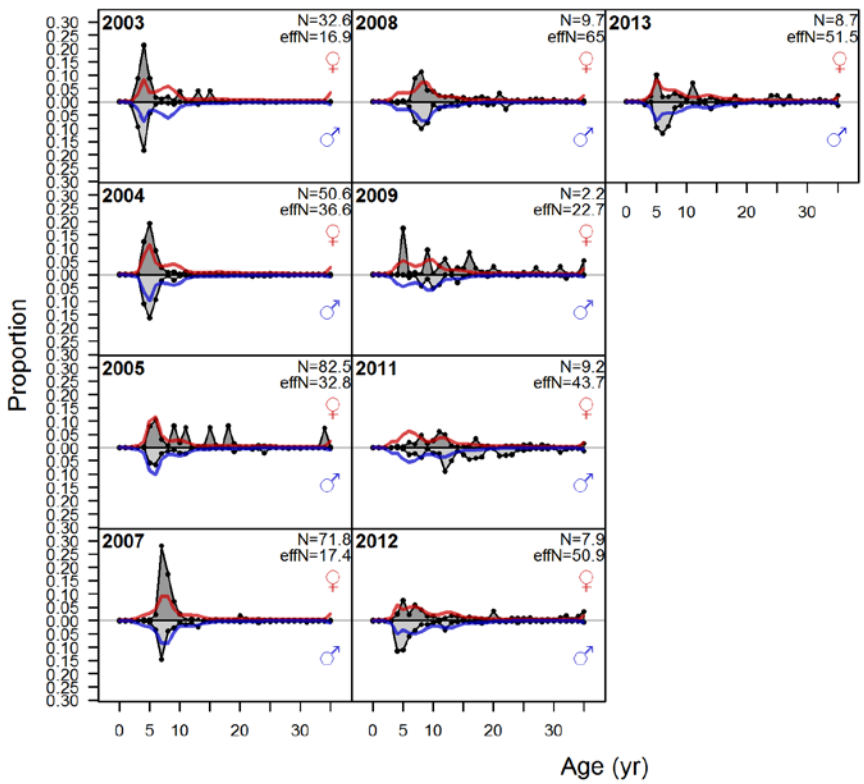

Figure 76: Fit to age-frequency distributions of darkblotched rockfish from the at-sea hake fishery bycatch by year.

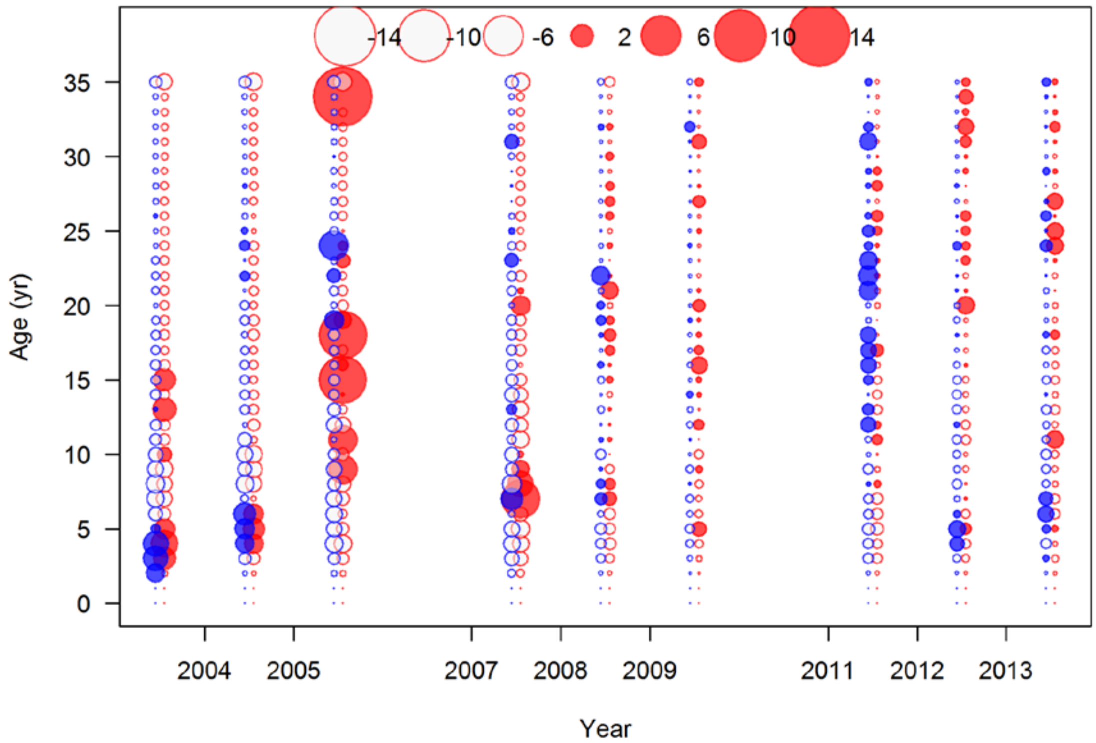

Figure 77: Pearson residuals for the fit to age-frequency distributions of darkblotched rockfish (females are shown in red, males in blue) from the shoreside landings.

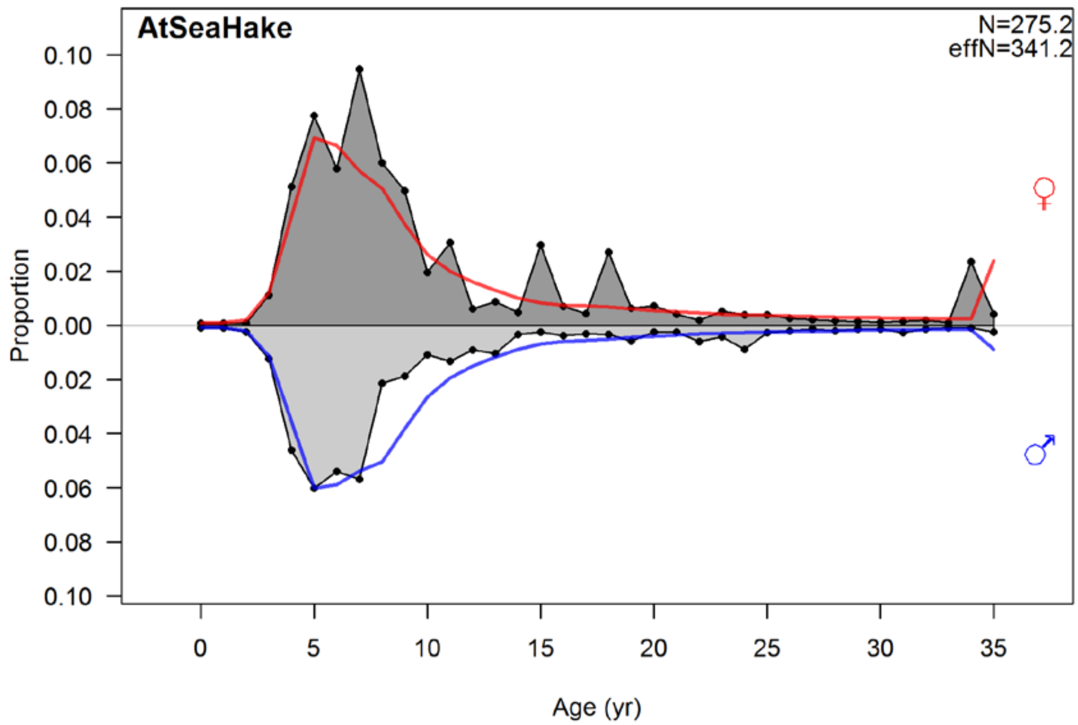

Figure 78: Fit to age-frequency distributions of darkblotched rockfish from the at-sea fishery bycatch, aggregated across all years.

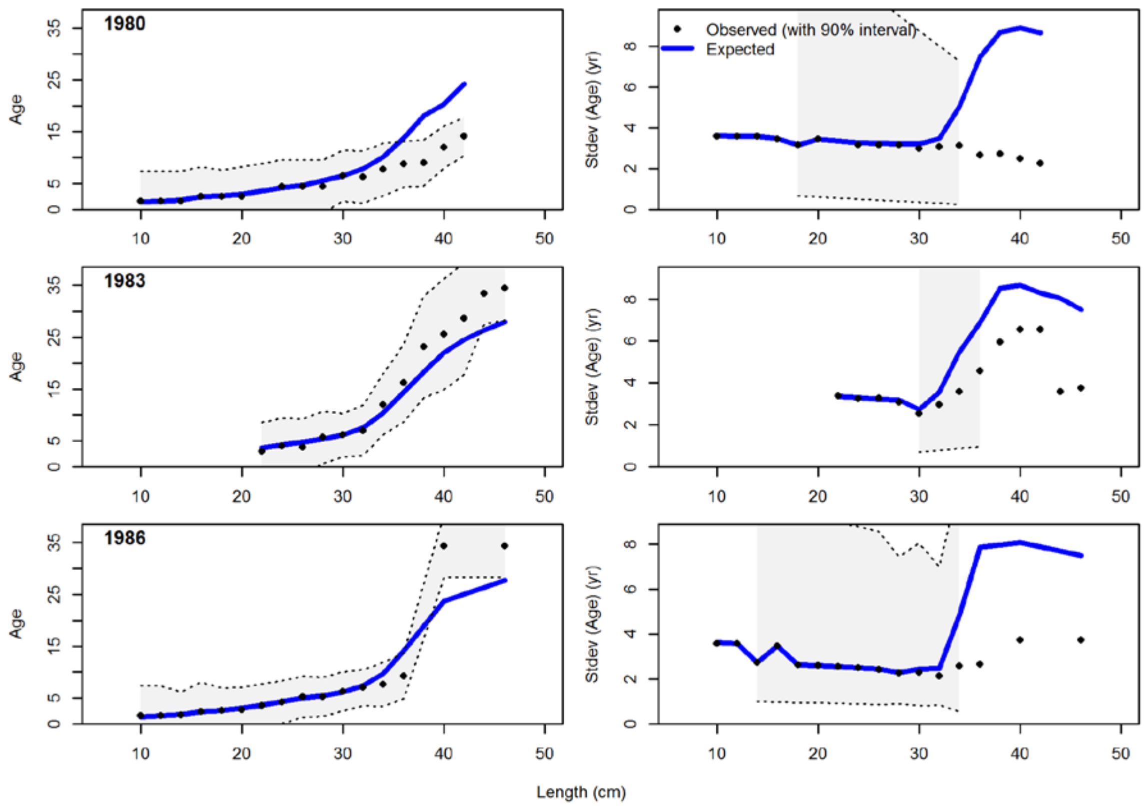

Figure 79: Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

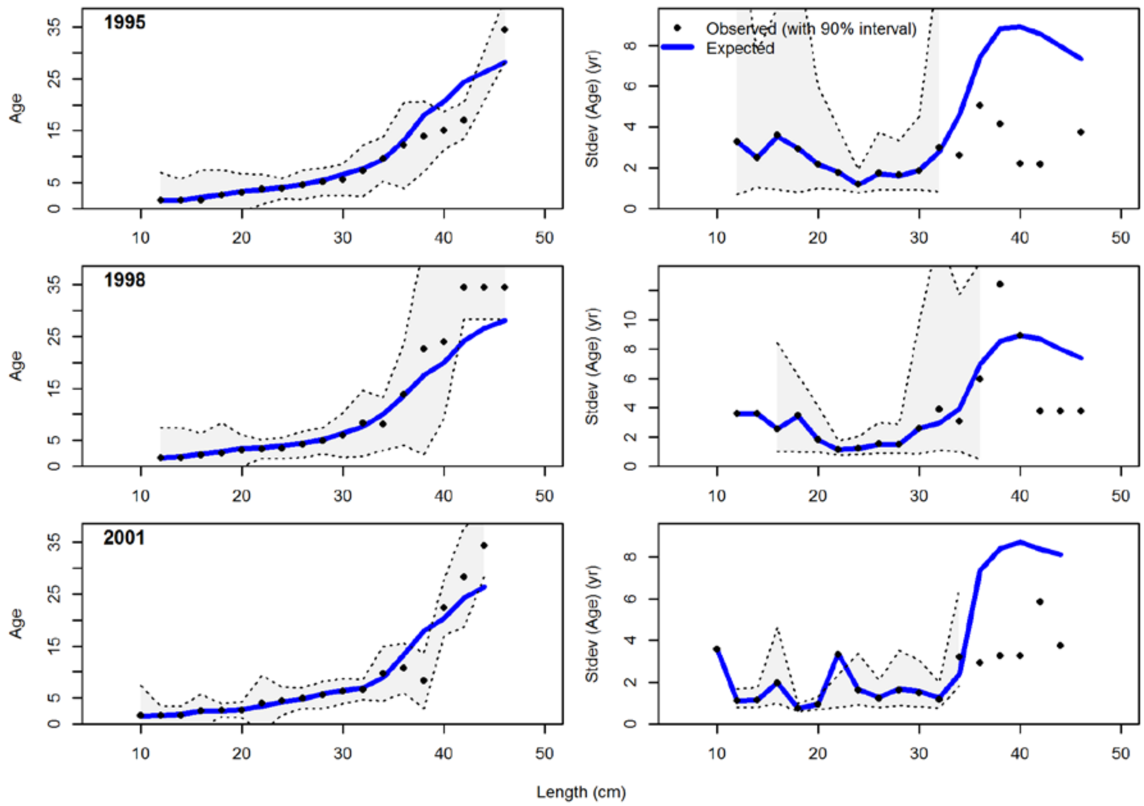

Figure 79 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

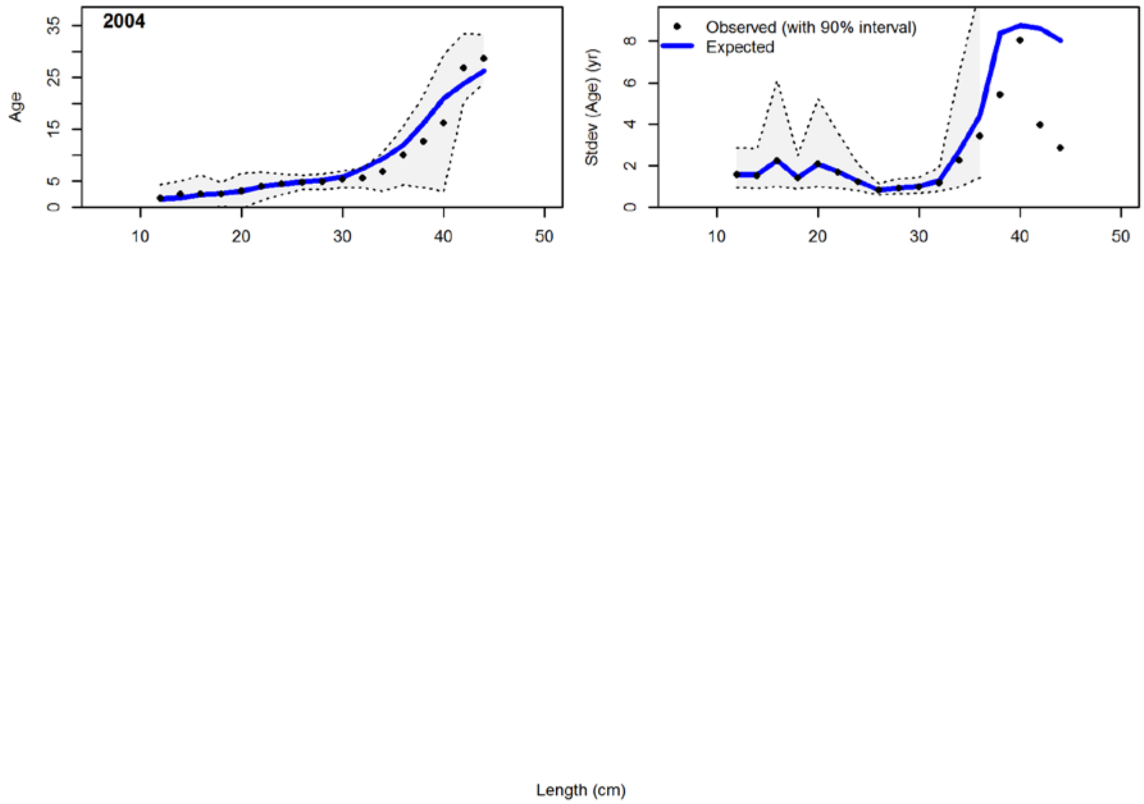

Figure 79 (continued): Fit to conditional ages-at-length compositions of female darkblotched rockfish from the AFSC shelf survey.

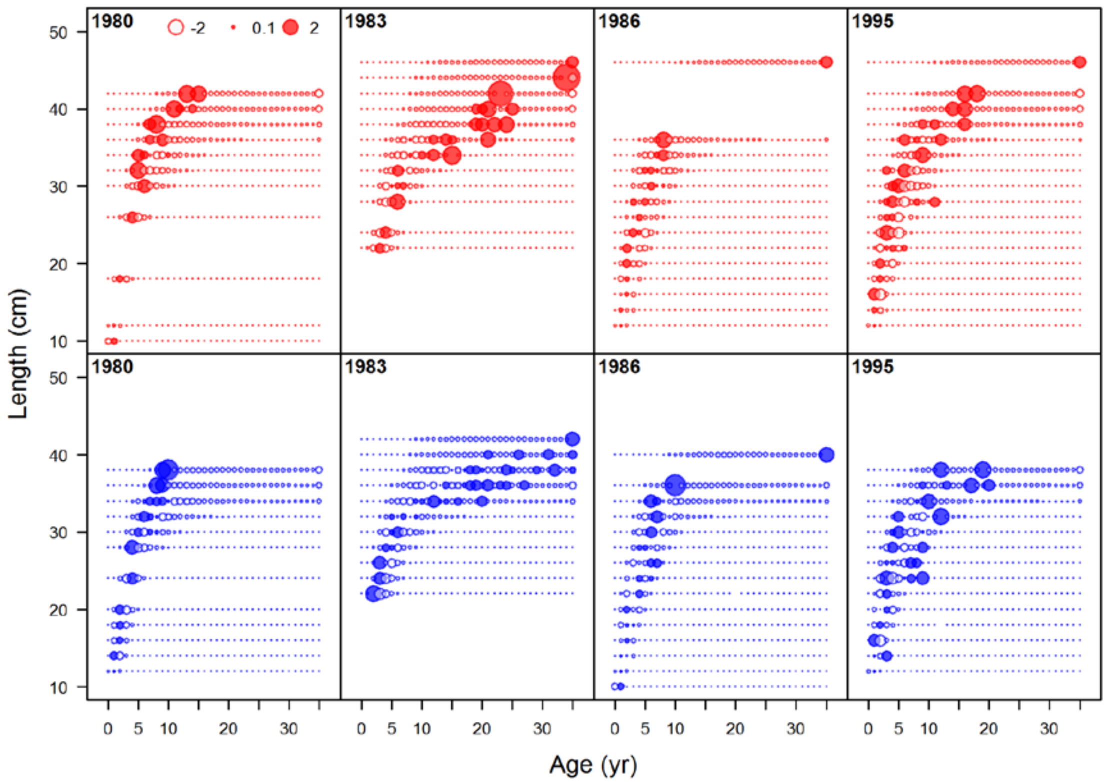

Figure 80: Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown in red, males in blue) from the AFSC shelf survey.

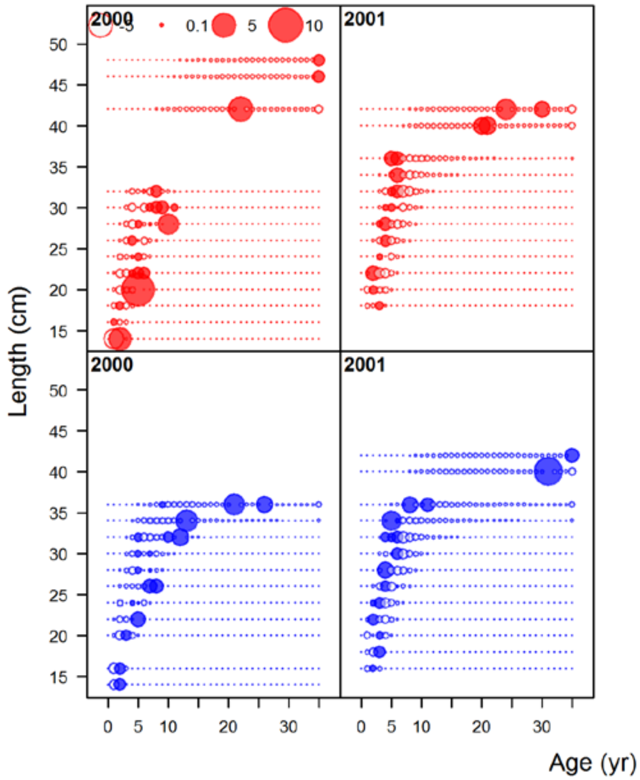

Figure 80 (continued): Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown in red, males in blue) from the AFSC shelf survey.

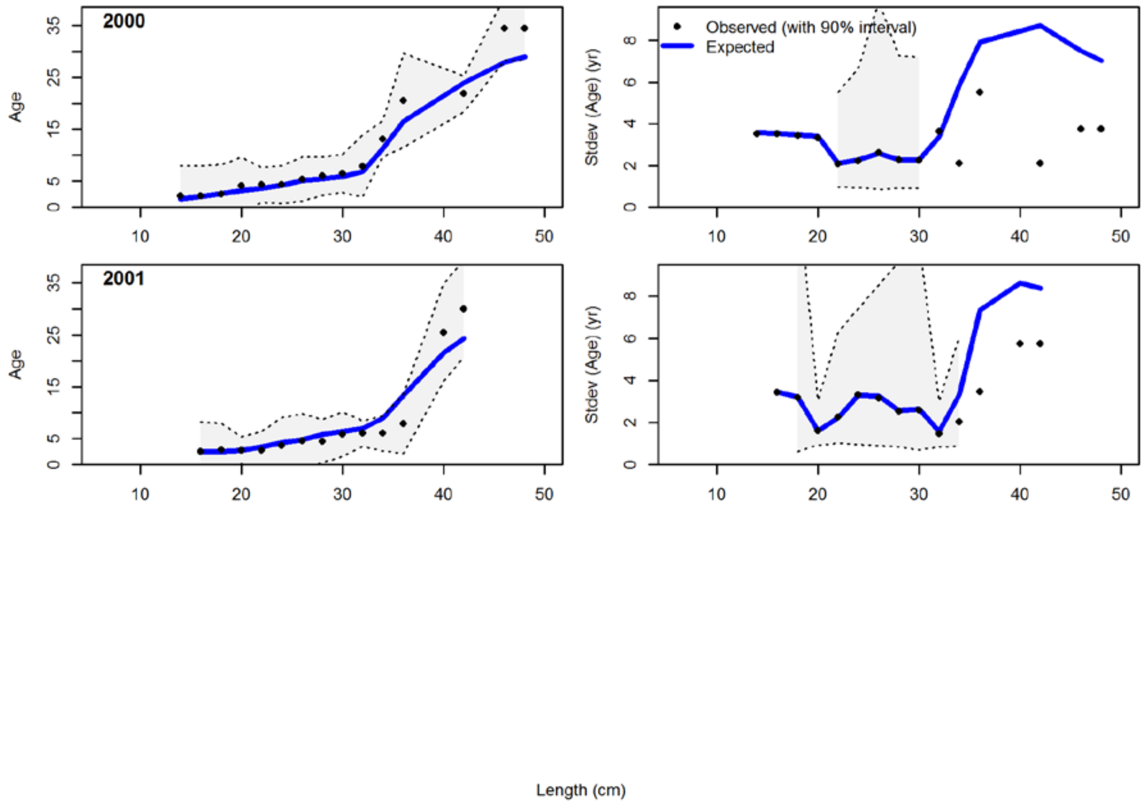

Figure 81: Fit to conditional ages-at-length compositions of darkblotched rockfish from the AFSC slope survey.

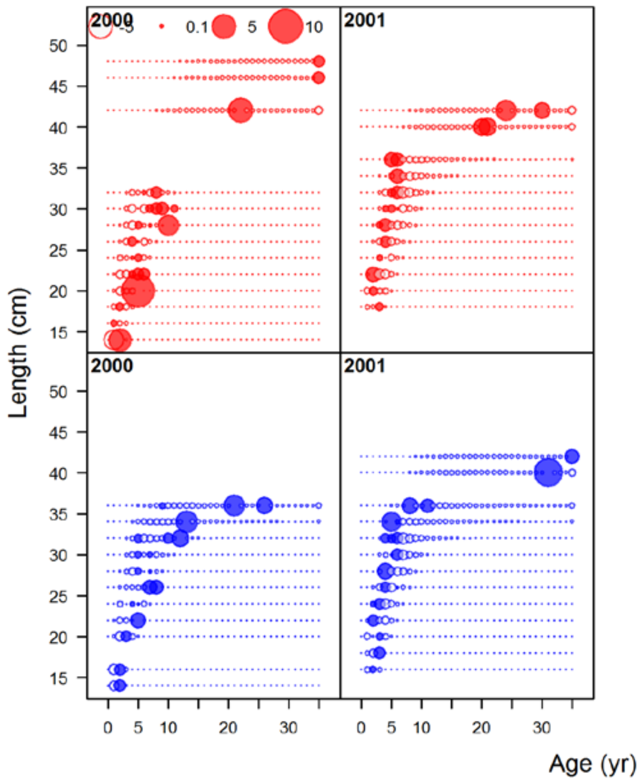

Figure 82: Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown red, males in blue) from the AFSC slope survey.

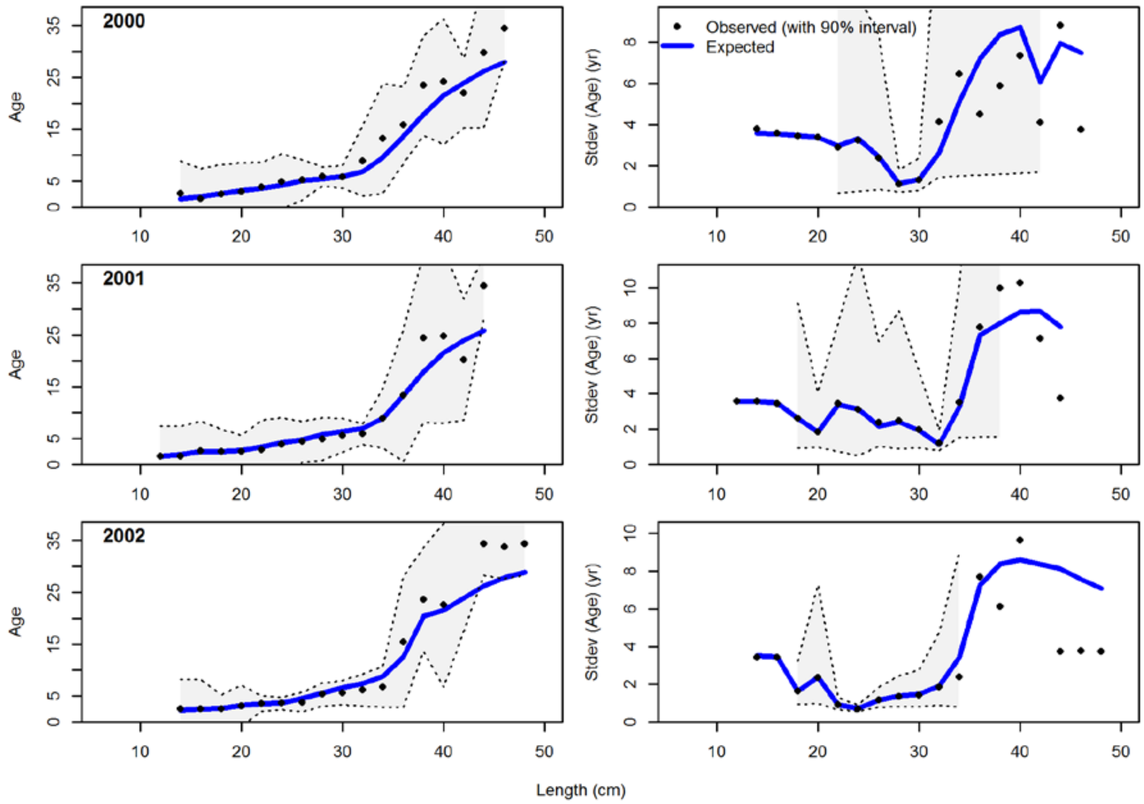

Figure 83: Fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC slope survey.

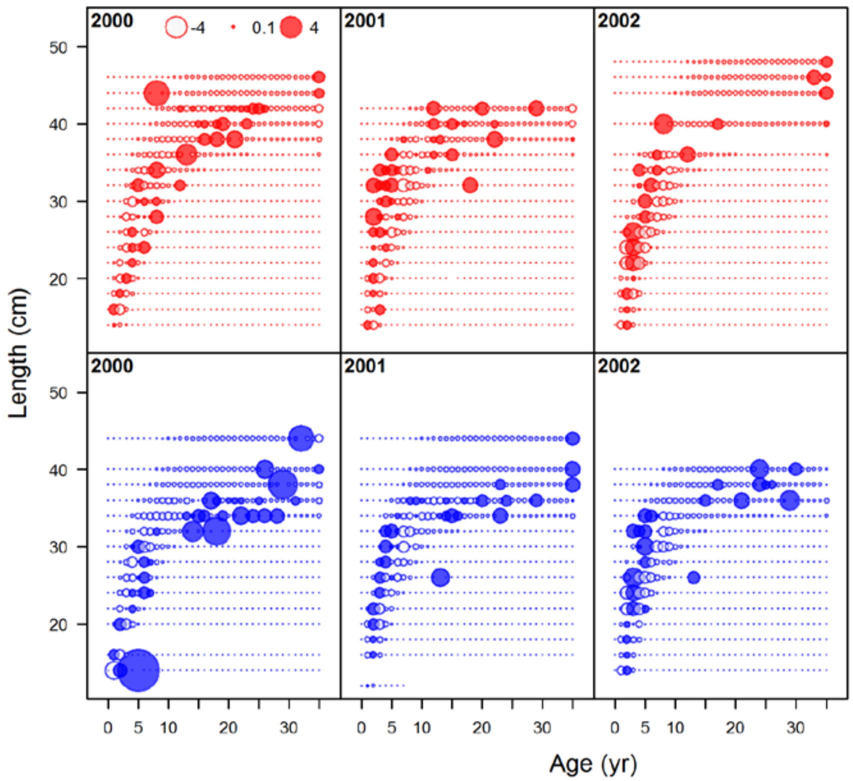

Figure 84: Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown in red, males in blue) from the NWFSC slope survey.

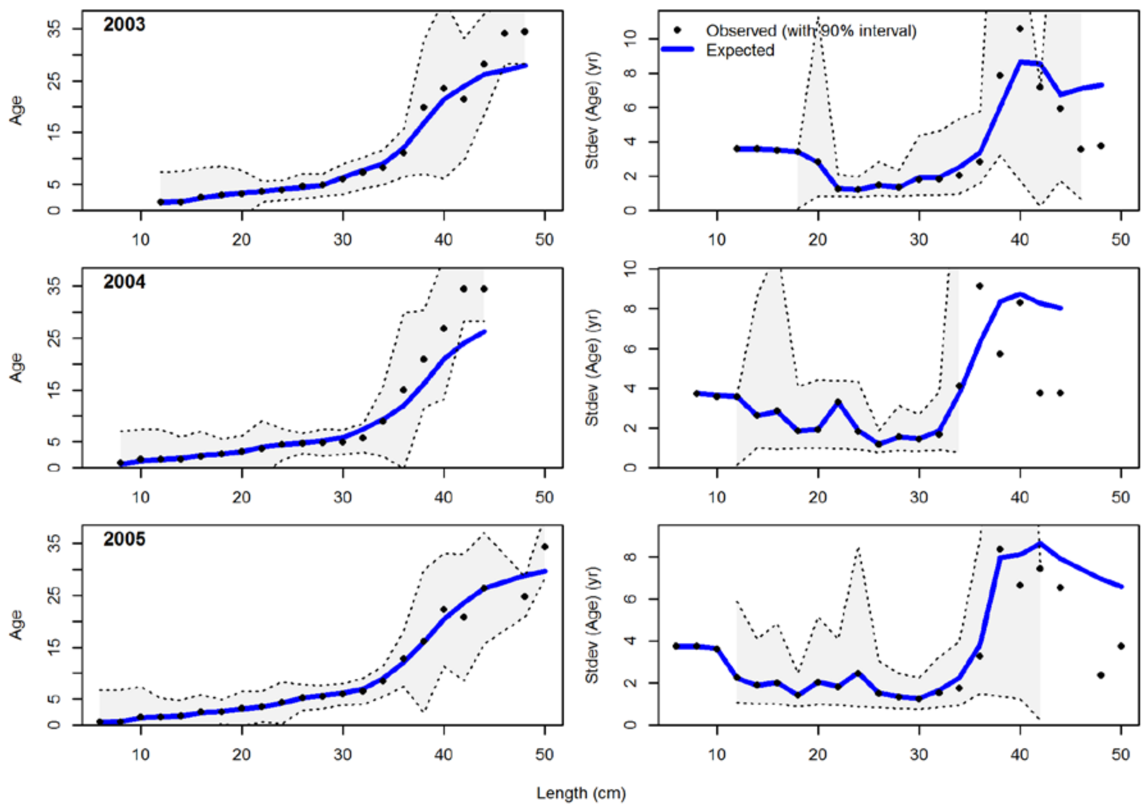

Figure 85: Fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC shelf-slope survey.

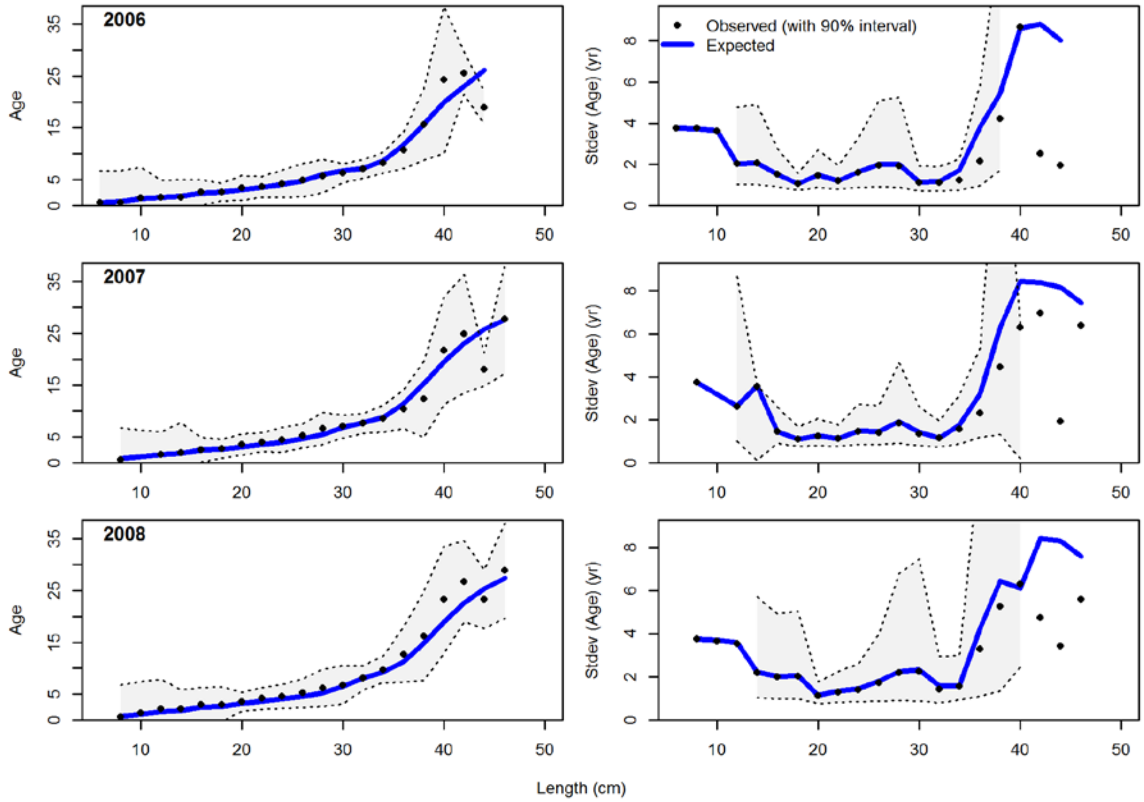

Figure 85 (continued): Fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC shelf-slope survey.

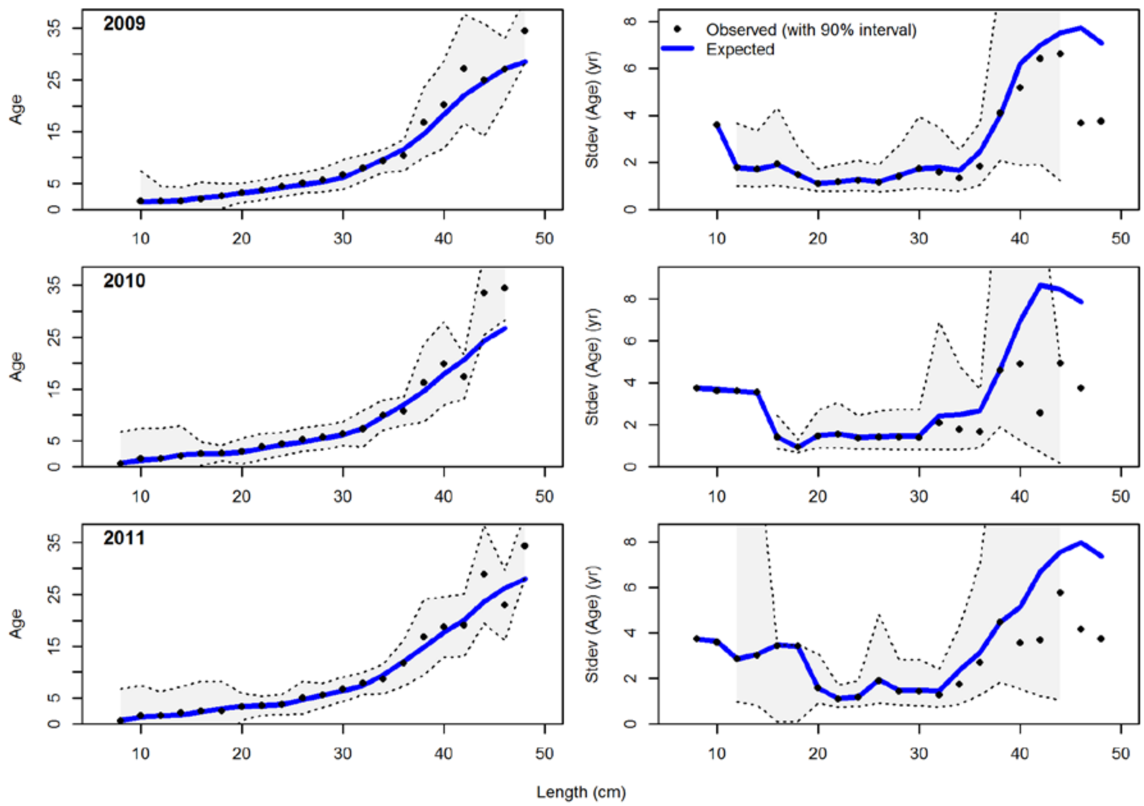

Figure 85 (continued): Fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC shelf-slope survey.

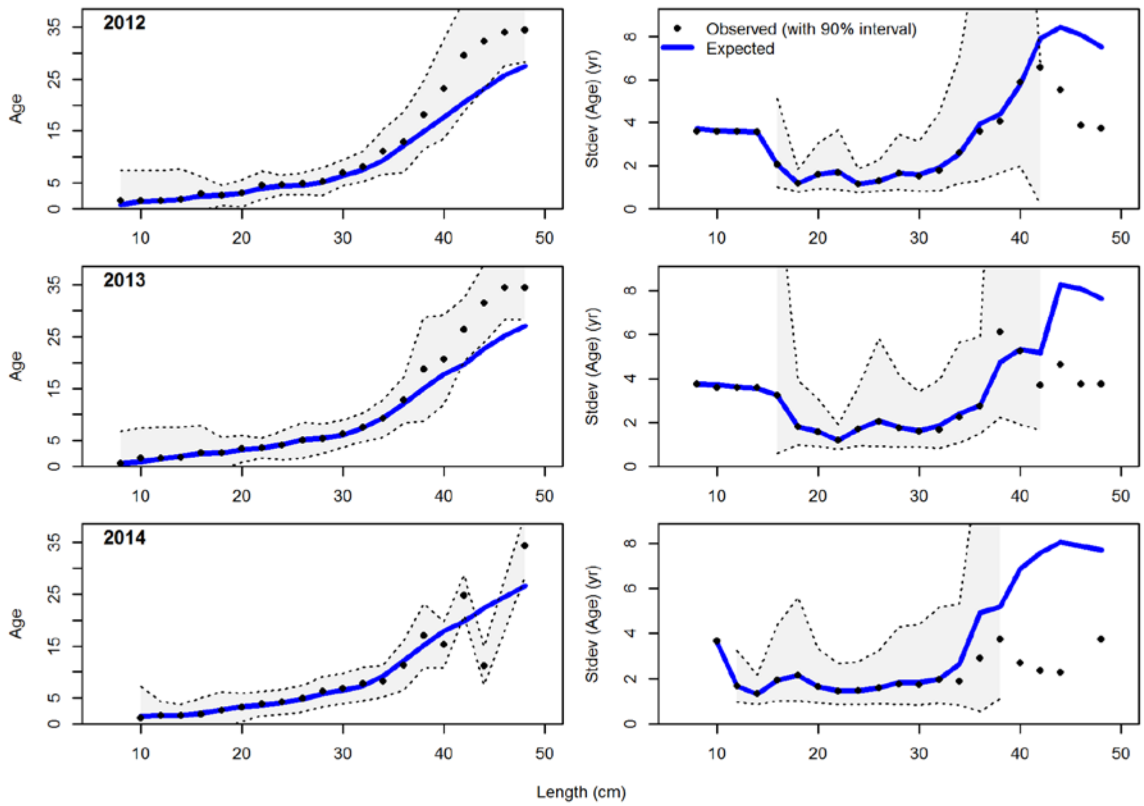

Figure 85 (continued): Fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC shelf-slope survey.

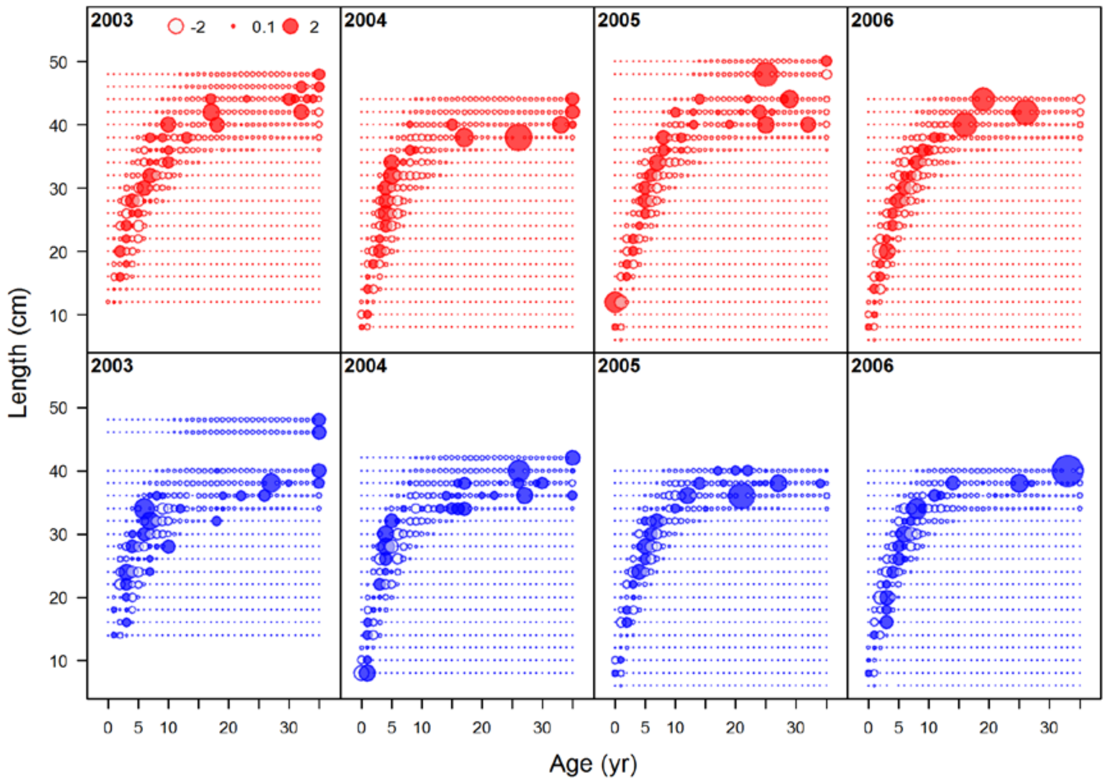

Figure 86: Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown in red, males in blue) from the NWFSC shelf-slope survey.

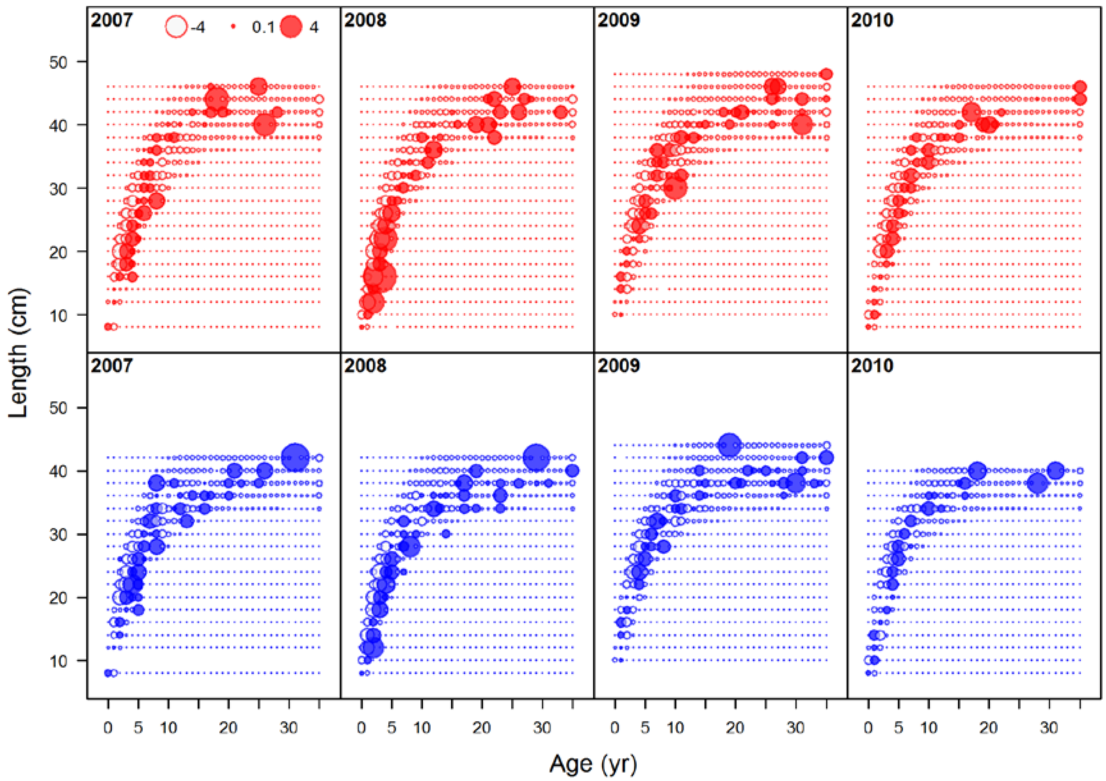

Figure 86 (continued): Pearson residuals for the fit to conditional ages-at-length compositions of darkblotched rockfish (females are shown in red, males in blue) from the NWFSC shelf-slope survey.

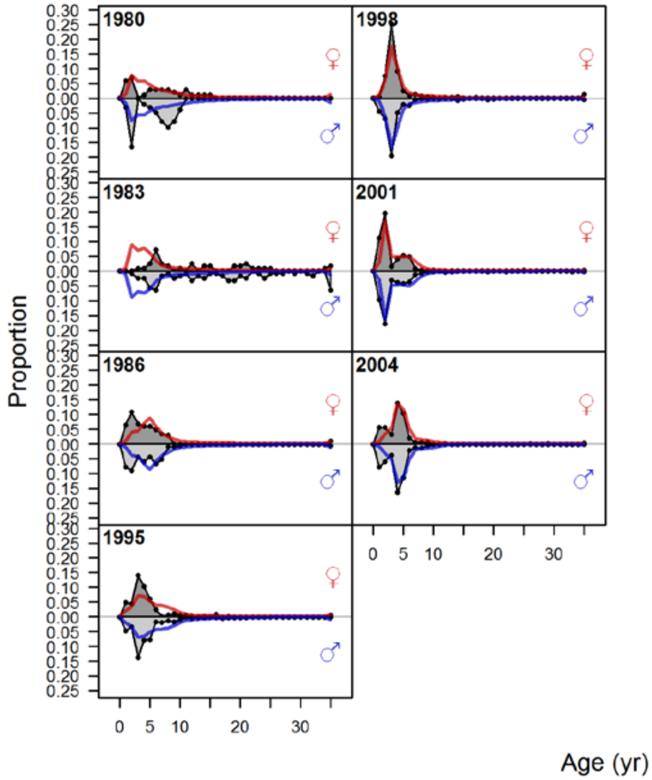

Figure 87: Implied fit to conditional ages-at-length compositions of darkblotched rockfish from the AFSC shelf survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

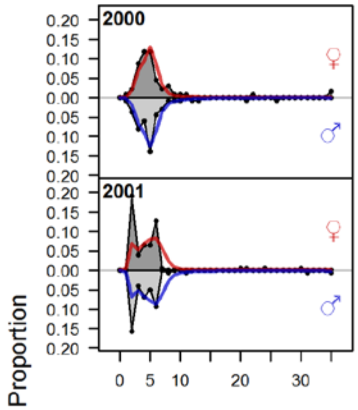

Figure 88: Implied fit to conditional ages-at-length compositions of darkblotched rockfish from the AFSC slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

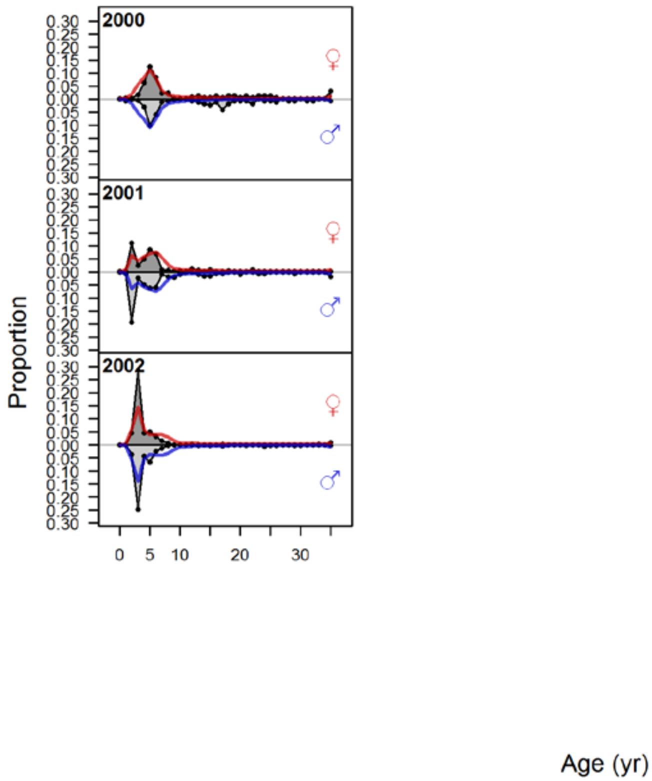

Figure 89: Implied fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

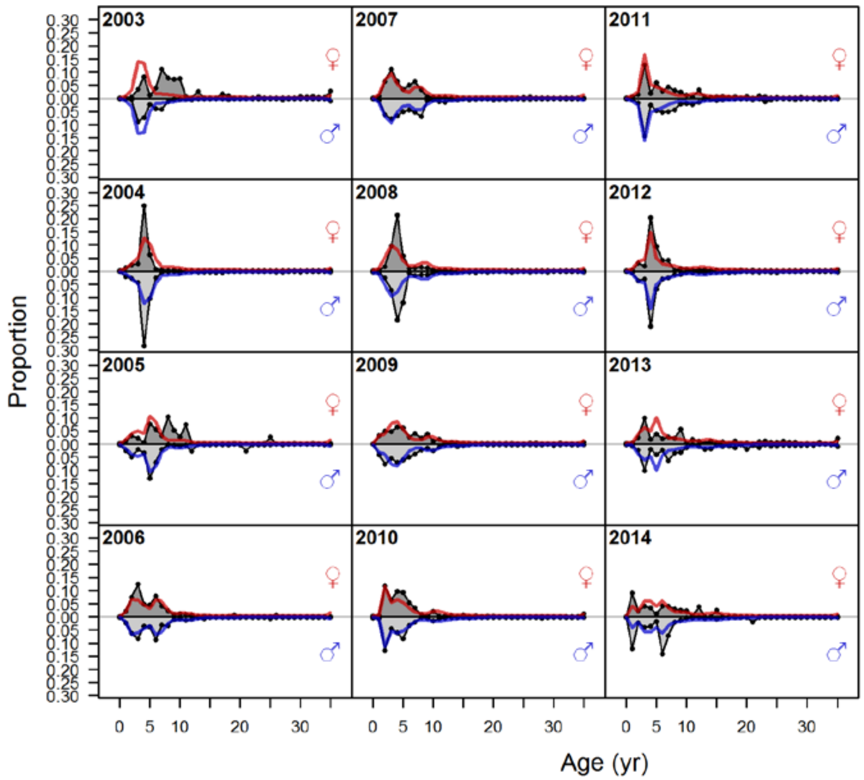

Figure 90: Implied fit to conditional ages-at-length compositions of darkblotched rockfish from the NWFSC shelf-slope survey marginal age frequencies. Fits are provided for evaluation only, but not included in the model likelihood.

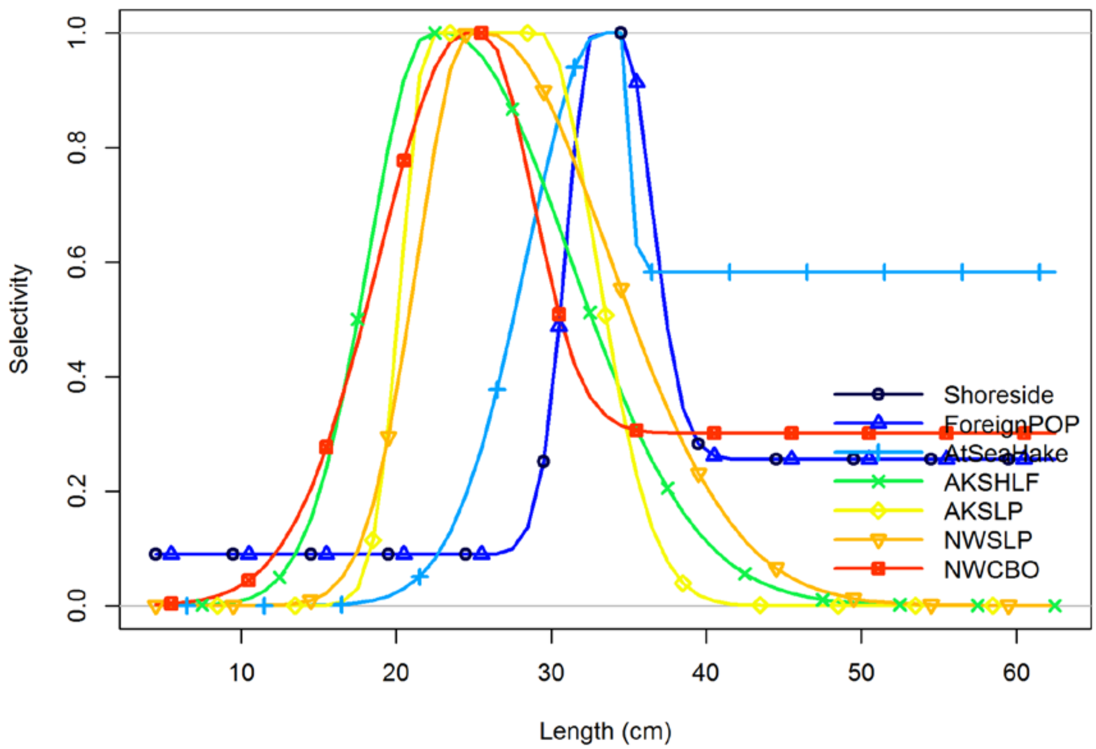

Figure 91: Final year selectivity curves for the all fleets used in the assessment.

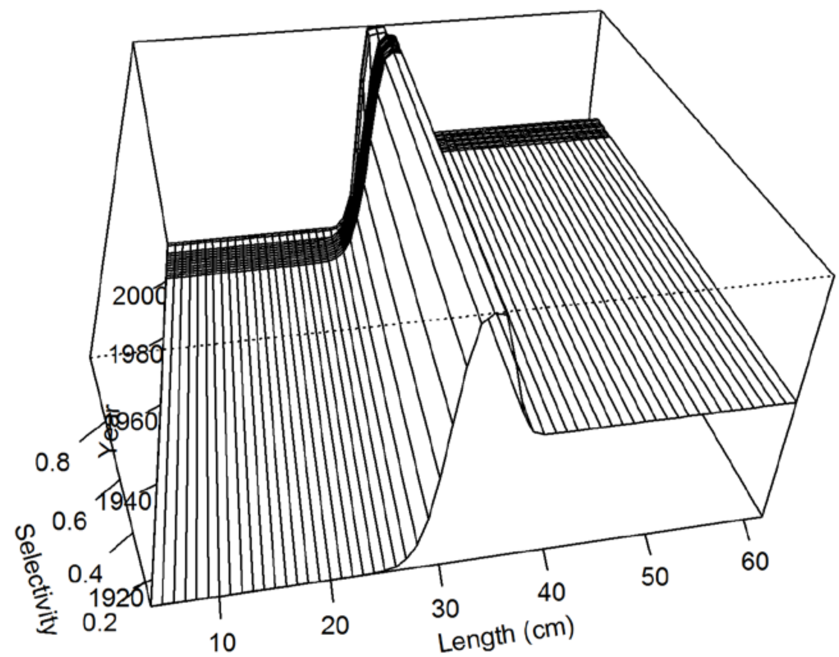

Figure 92: Estimated time-varying selectivity for the shoreside fishery.

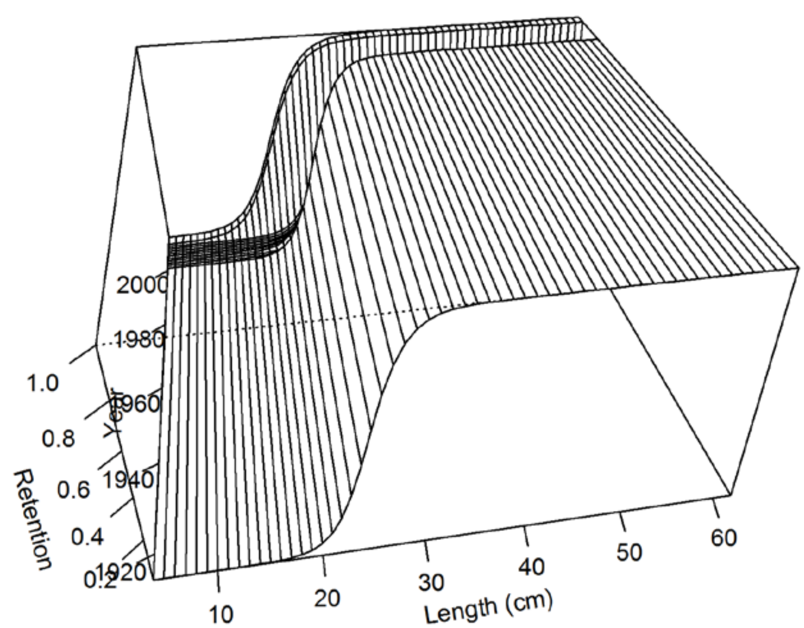

Figure 93: Estimated time-varying length-based retention of shoreside fishery.

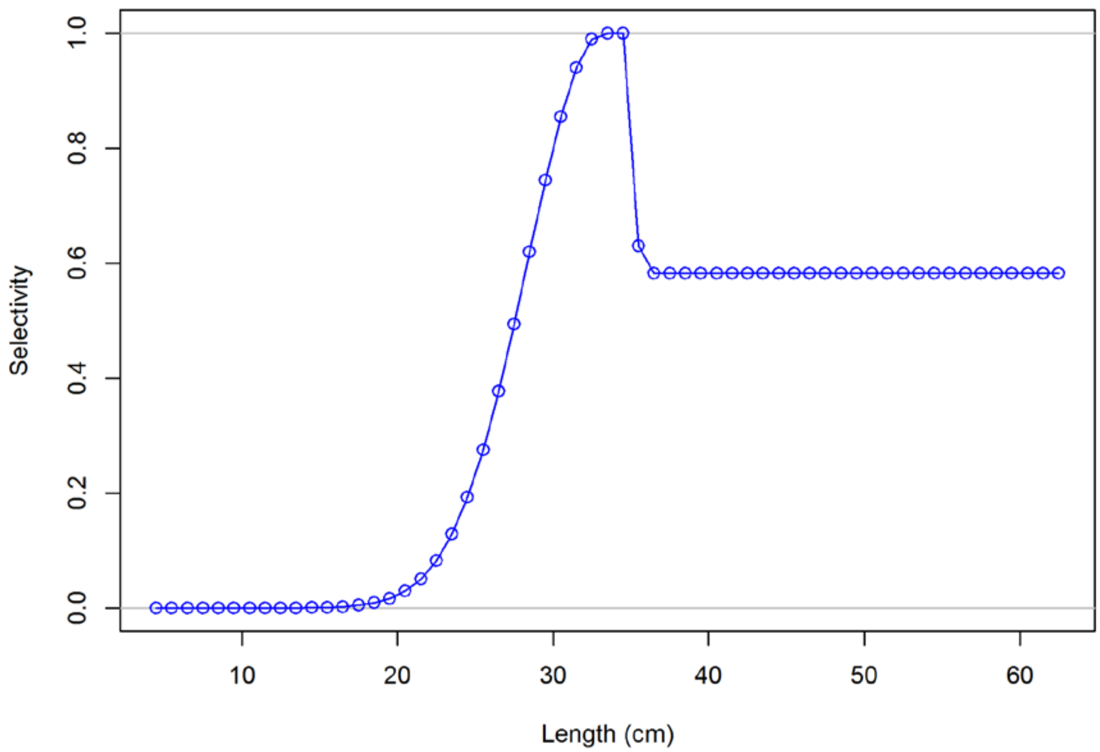

Figure 94: Length-based selectivity curve for historical at-sea hake bycatch fleet.

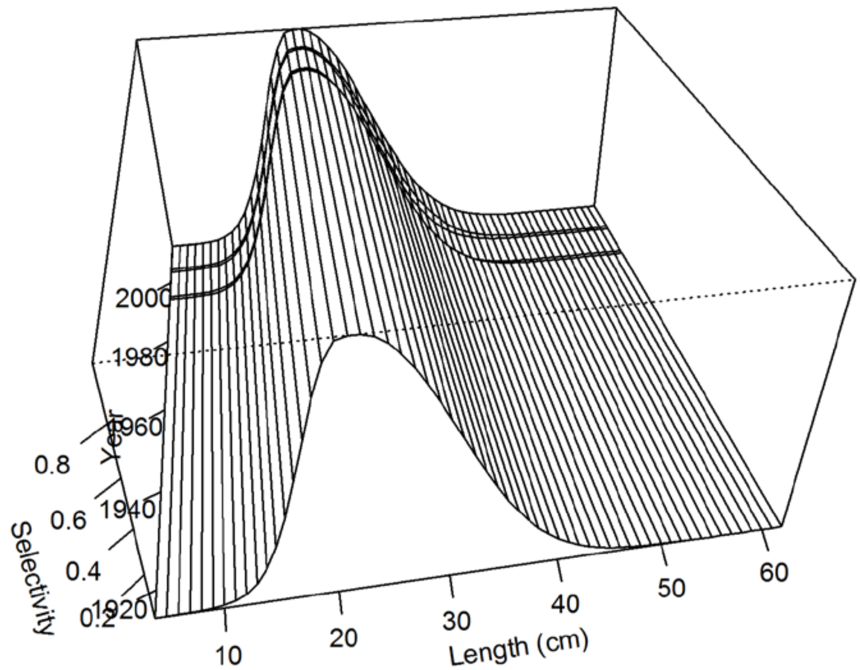

Figure 95: Estimated time-varying length-based selectivity curve for the AFSC shelf survey.

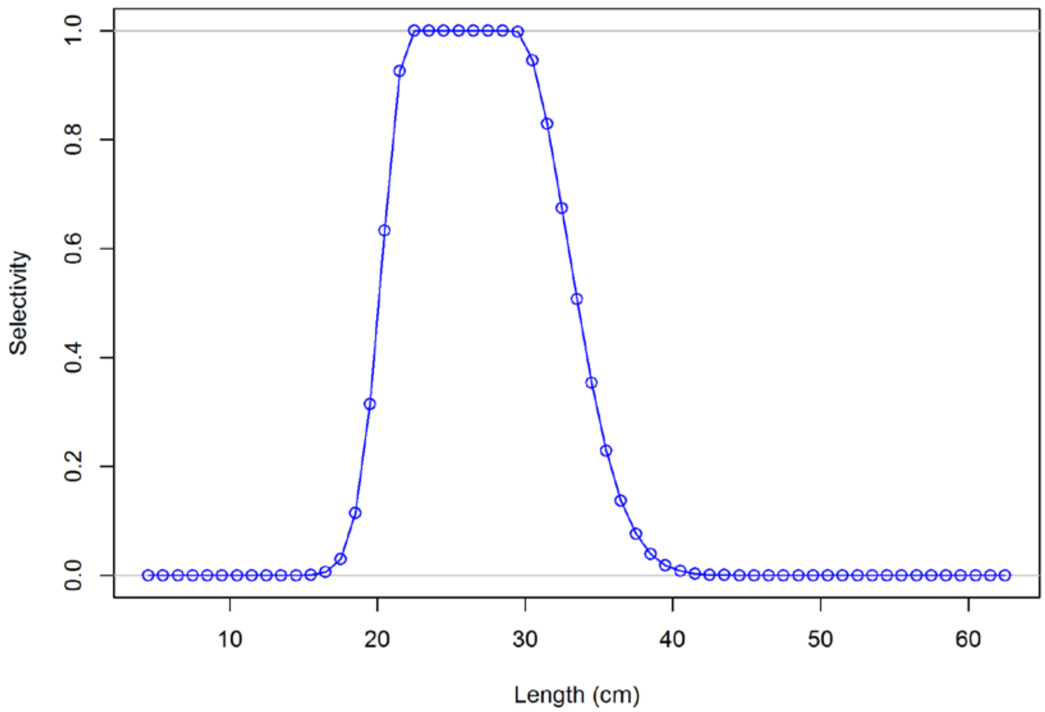

Figure 96: Estimated length-based selectivity curve for the AFSC slope survey.

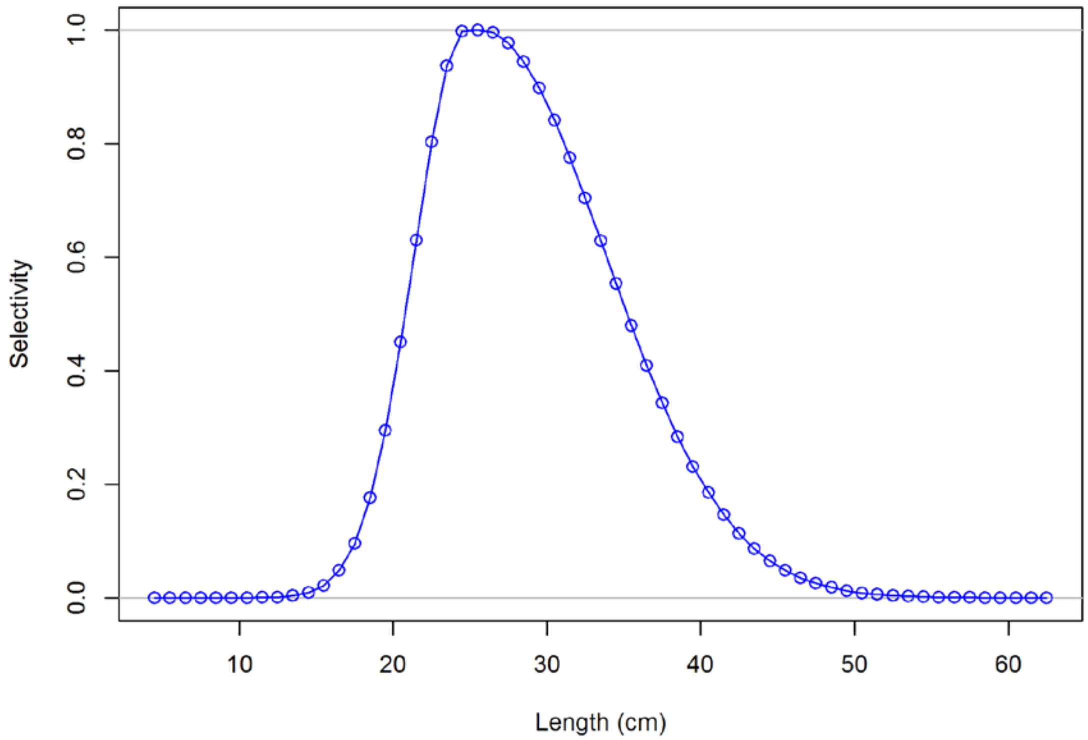

Figure 97: Estimated length-based selectivity curve for the NWFSC slope survey.

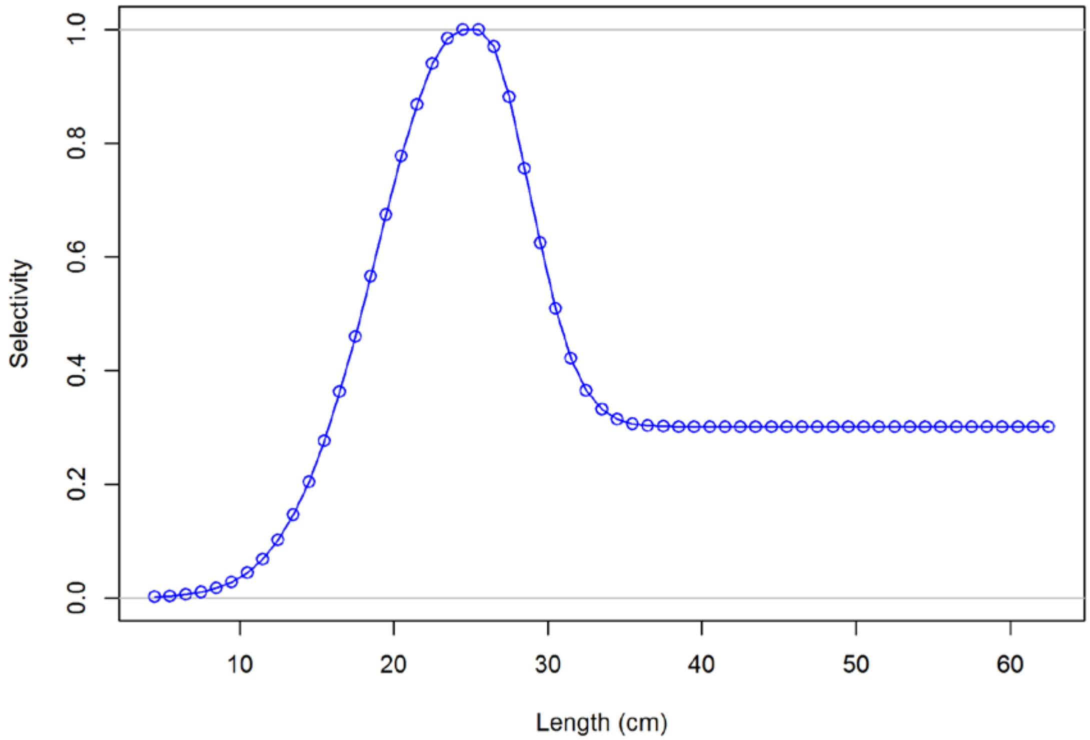

Figure 98: Estimated length-based selectivity curve for the NWFSC shelf-slope survey.

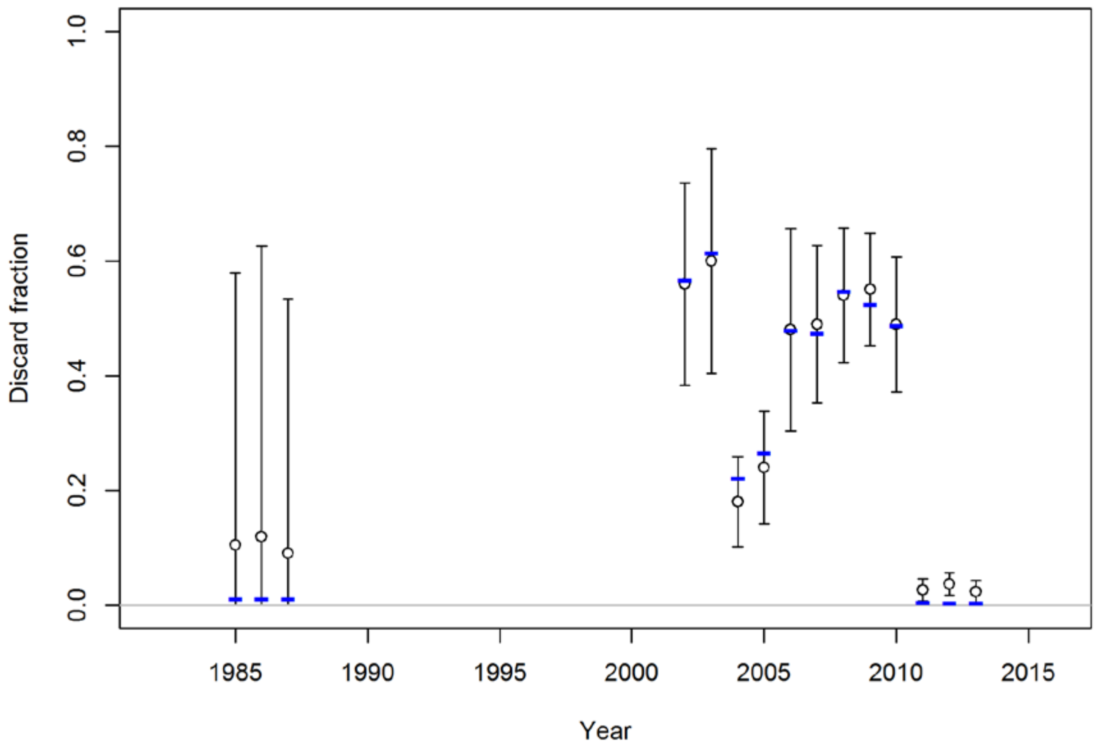

Figure 99: Fit to the discard ratio data of the shoreside fishery.

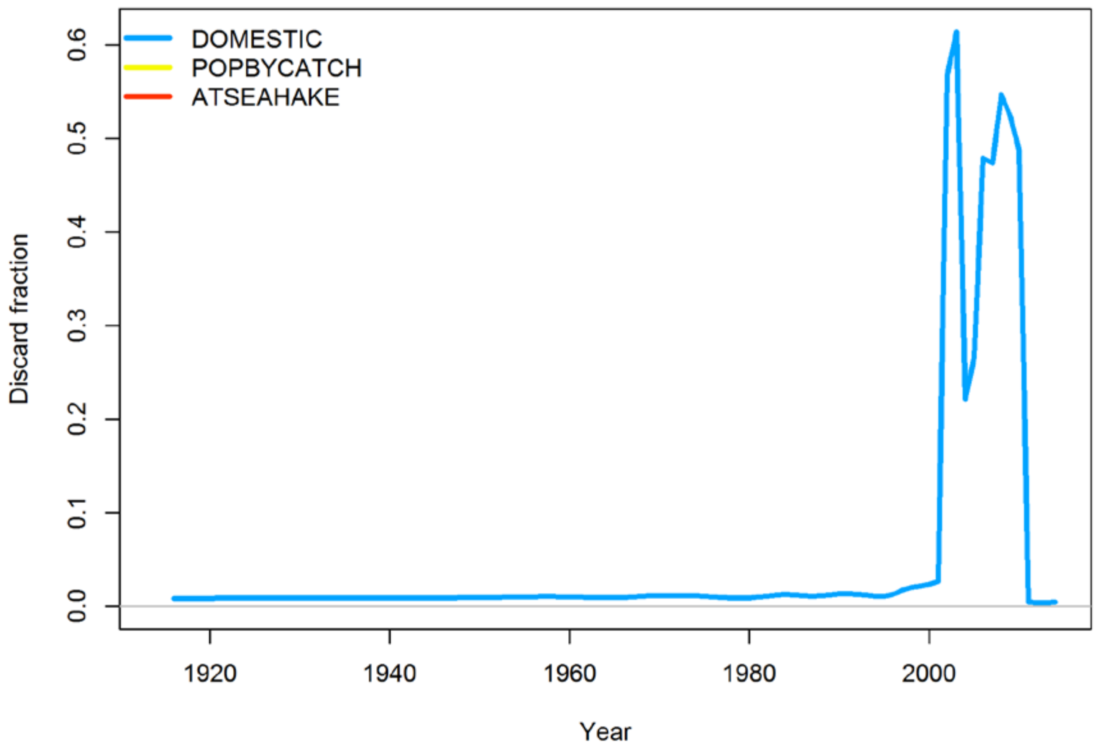

Figure 100: Discard fraction for the shoreside fishery estimated in the assessment.

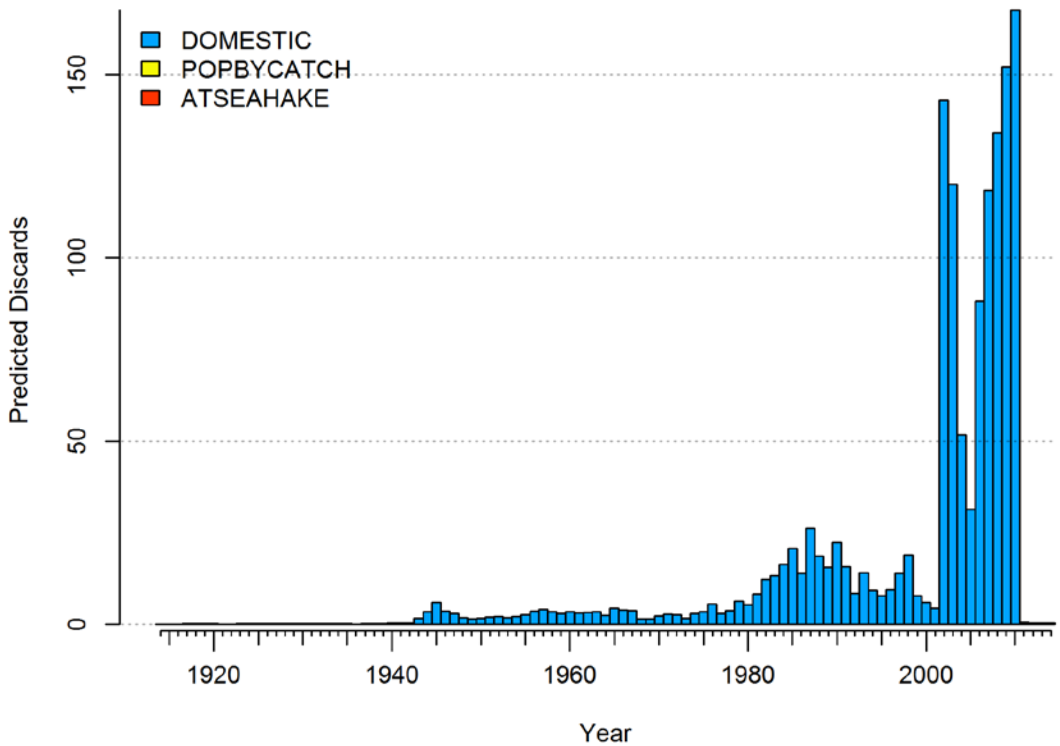

Figure 101: Predicted discard for the shoreside fishery.

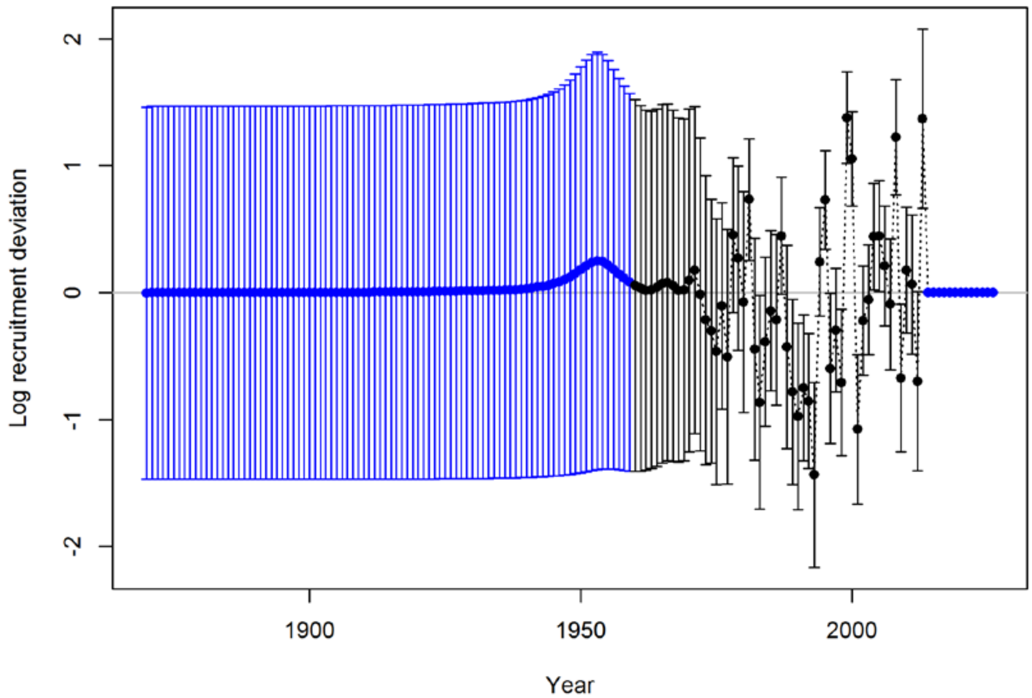

Figure 102: Recruitment deviation time-series estimated in the assessment model.

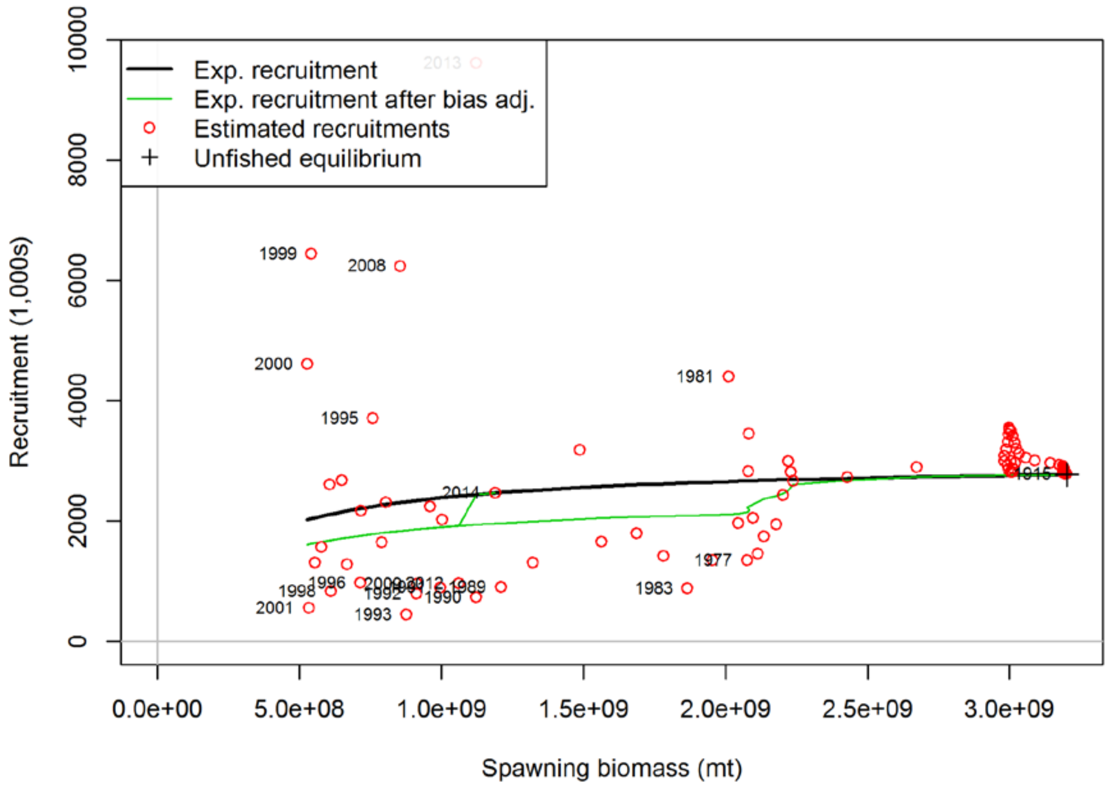

Figure 103: Estimated stock-recruit function for the assessment model.

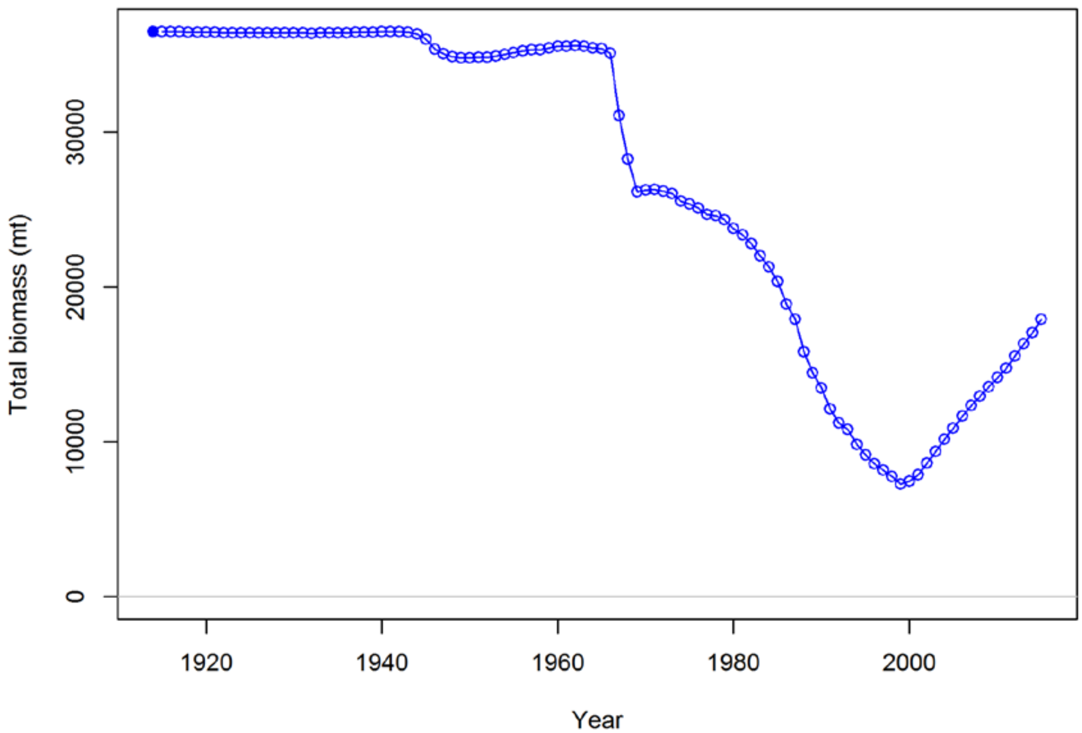

Figure 104: Time series of total biomass (mt) estimated in the assessment model.

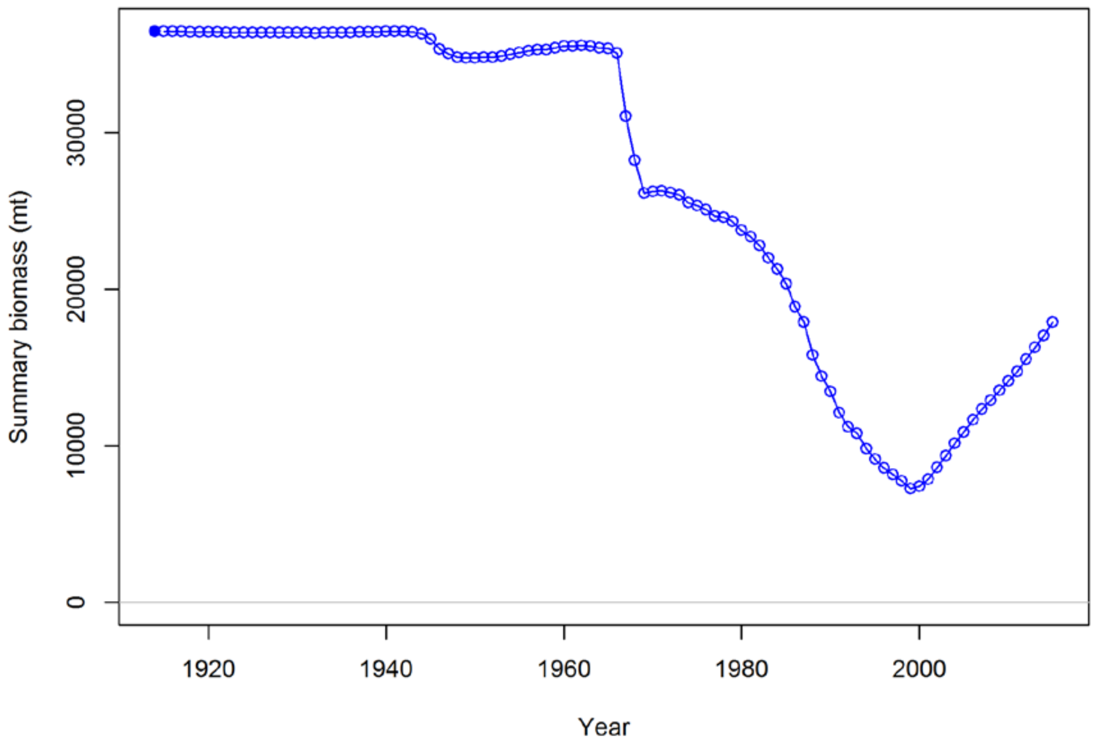

Figure 105: Time series of summary biomass (mt) estimated in the assessment model.

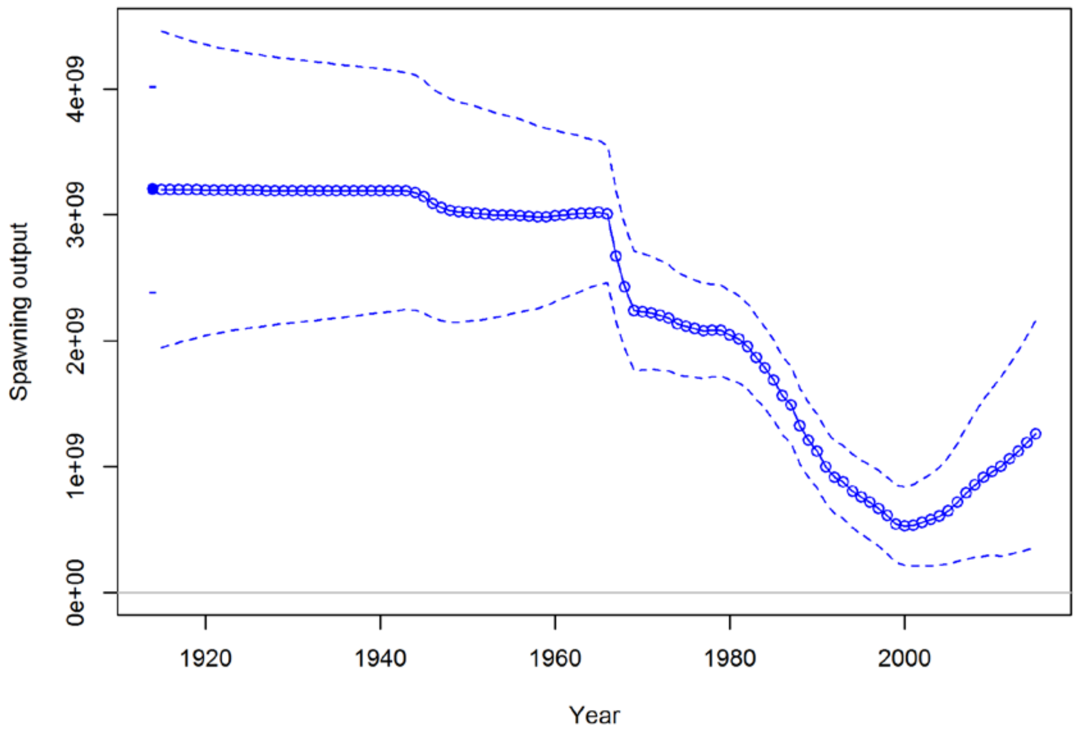

Figure 106: Time series of spawning output estimated in the assessment model (solid line) with ~ 95% interval (dashed lines). Spawning output is expressed in number of eggs.

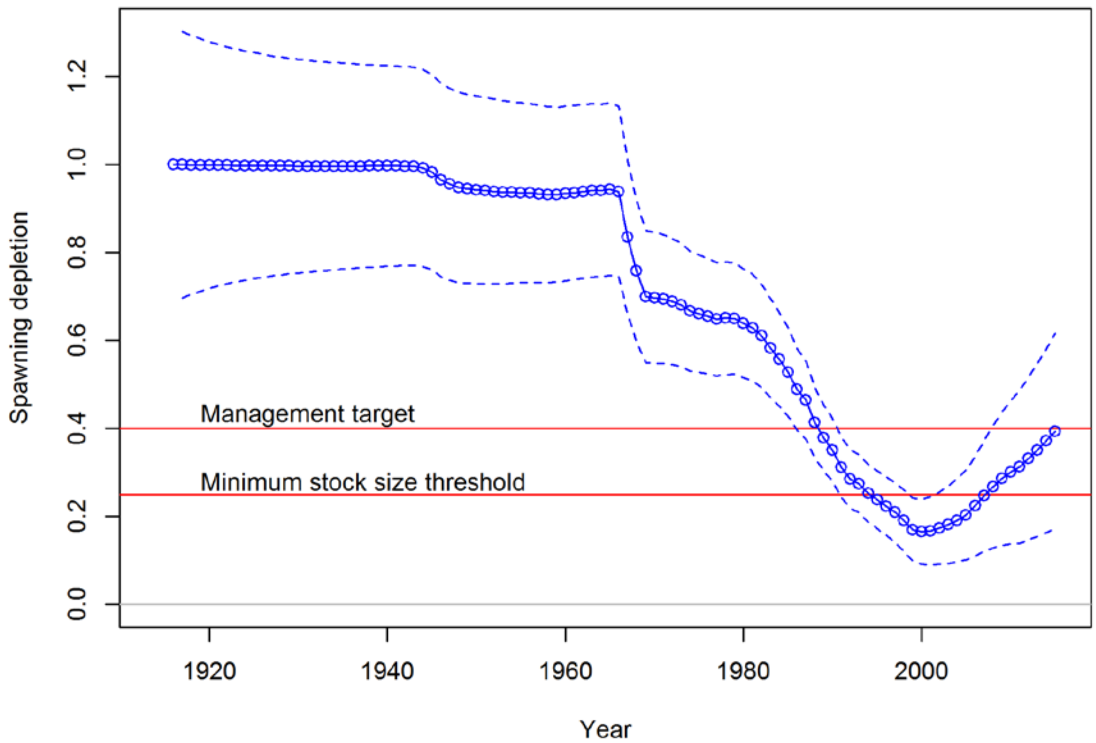

Figure 107: Time series of spawning depletion estimated in the assessment model (solid line) with ~ 95% interval (dashed lines).

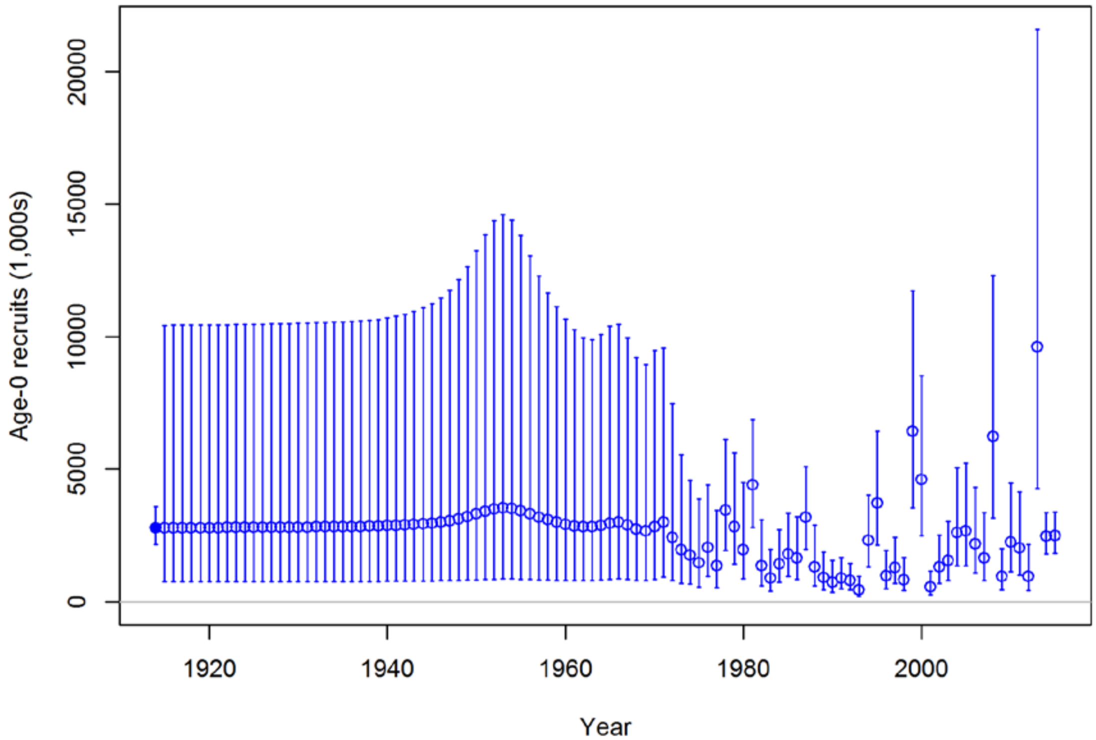

Figure 108: Time series of recruitment estimated in the assessment model with ~ 95% interval.

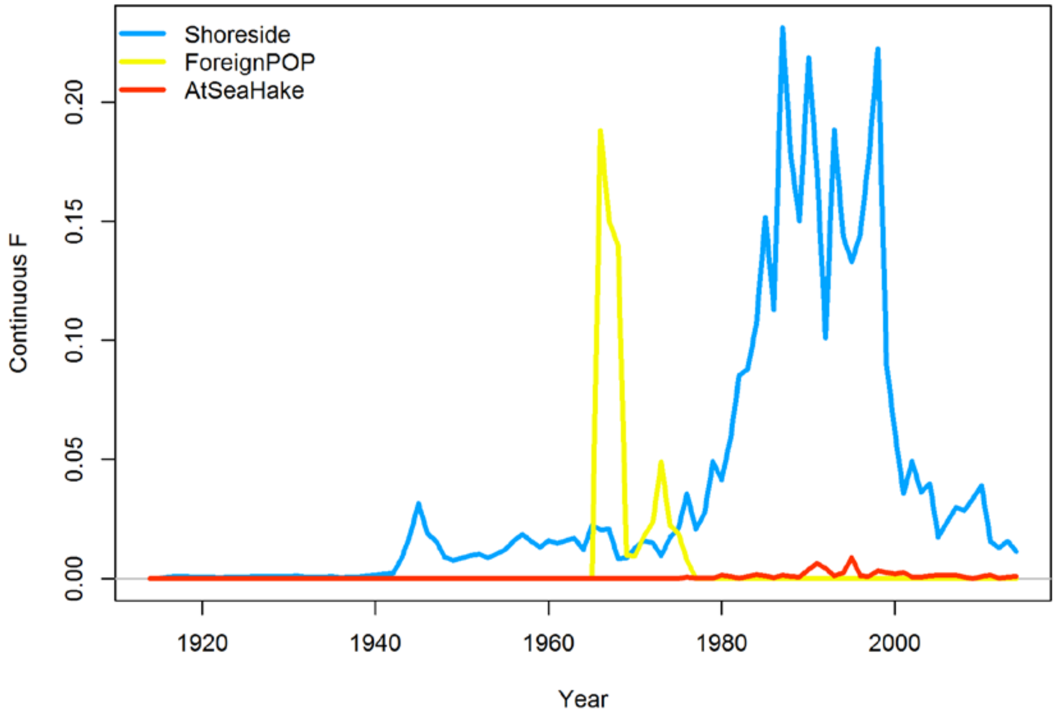

Figure 109: Time series of fishing mortality of darkblotched rockfish estimated by the assessment model.

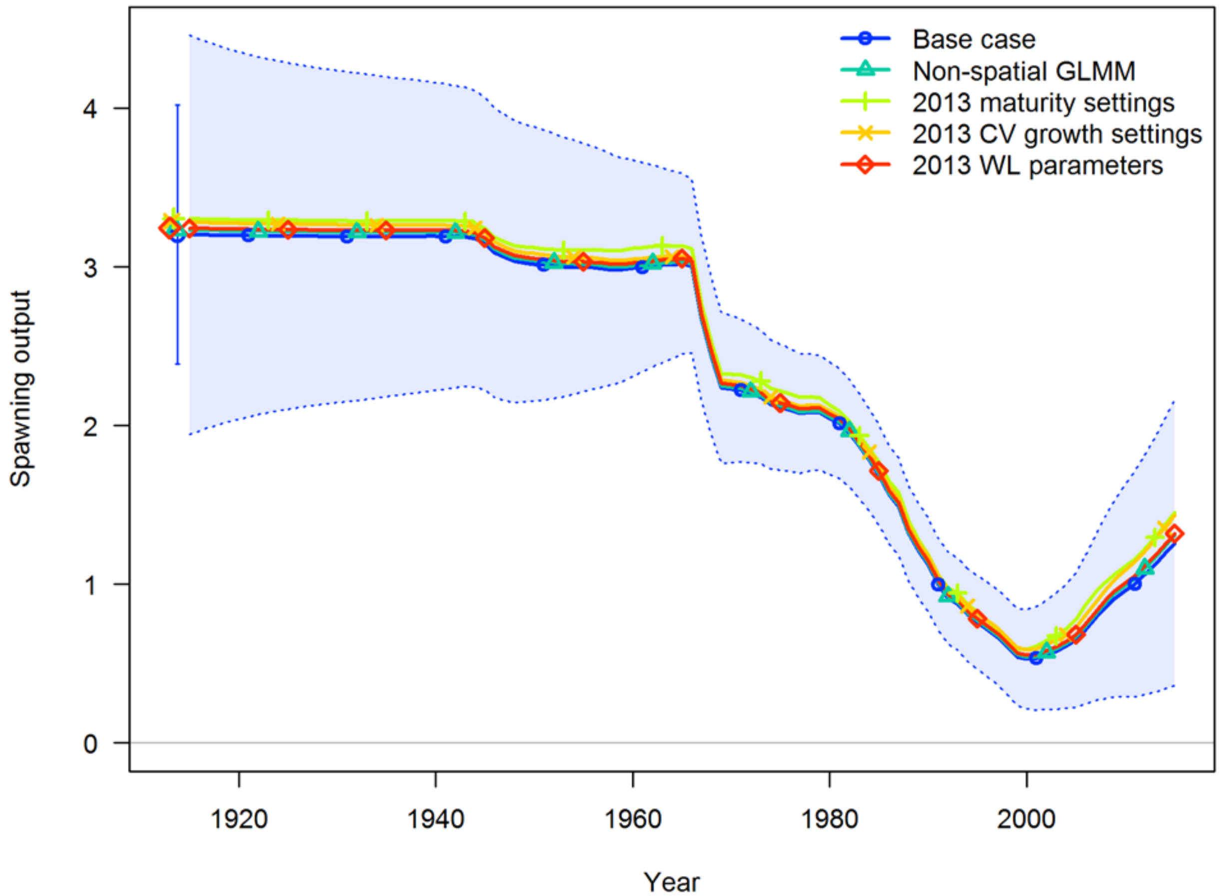

Figure 110: Sensitivity of darkblotched rockfish spawning output to selected changes made from 2013 assessment. Spawning output time series of this assessment base model are provided with ~ 95% interval.

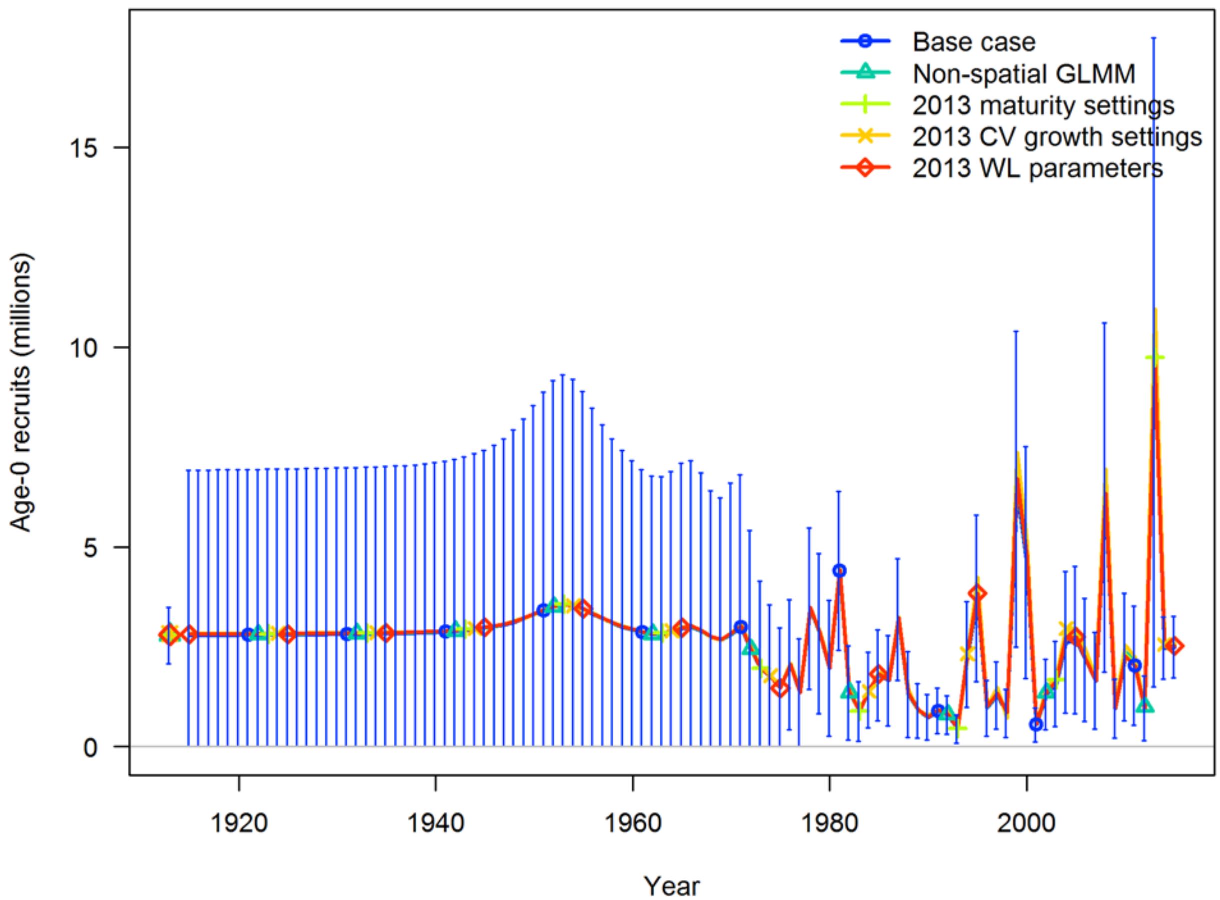

Figure 111: Sensitivity of darkblotched rockfish recruitment to selected changes made from 2013 assessment. Recruitment time series of this assessment base model are provided with ~ 95% interval.

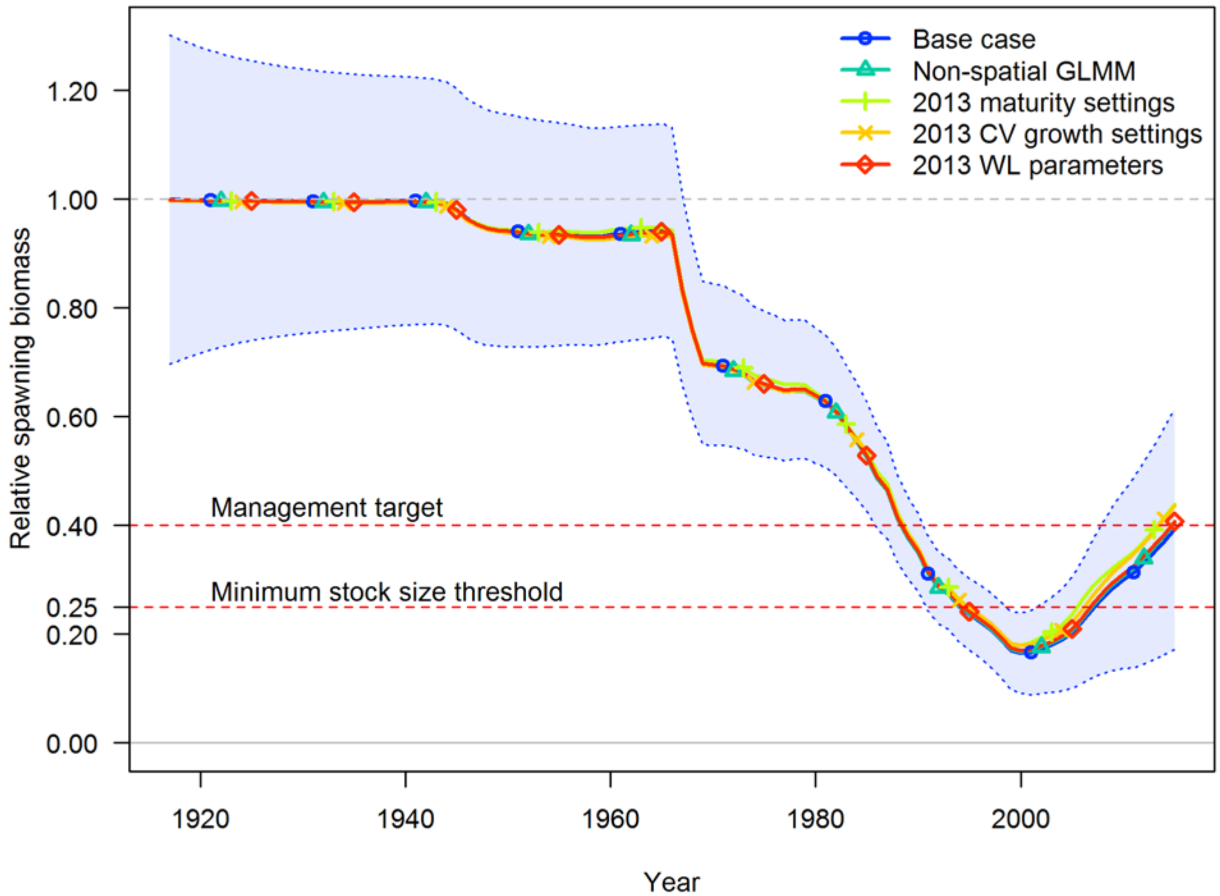

Figure 112: Sensitivity of darkblotched rockfish spawning depletion to selected changes made from 2013 assessment. Spawning depletion time series of this assessment base model are provided with ~ 95% interval.

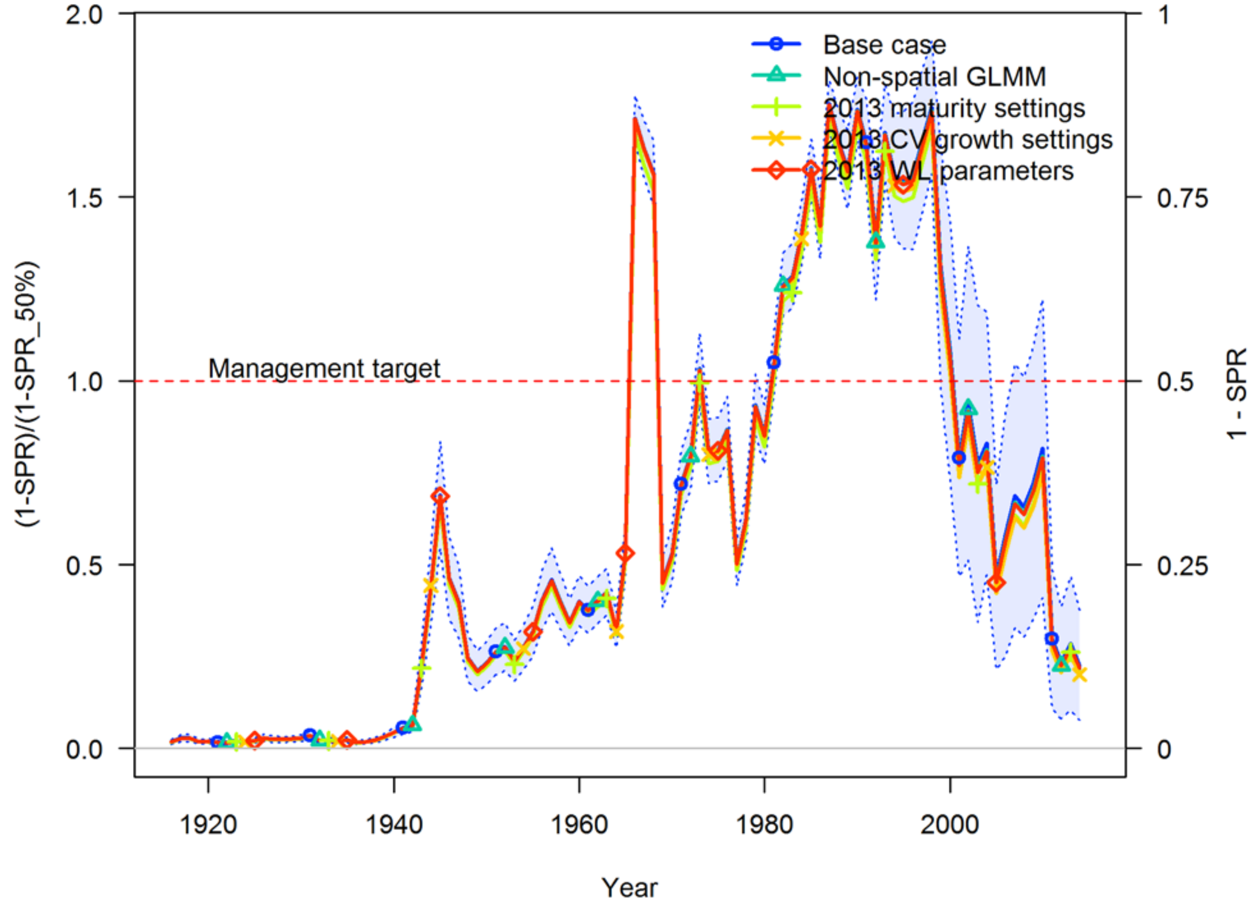

Figure 113: Sensitivity of darkblotched rockfish rockfish relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) to selected changes made from 2013 assessment. Time series of this assessment base model are provided with ~ 95% interval.

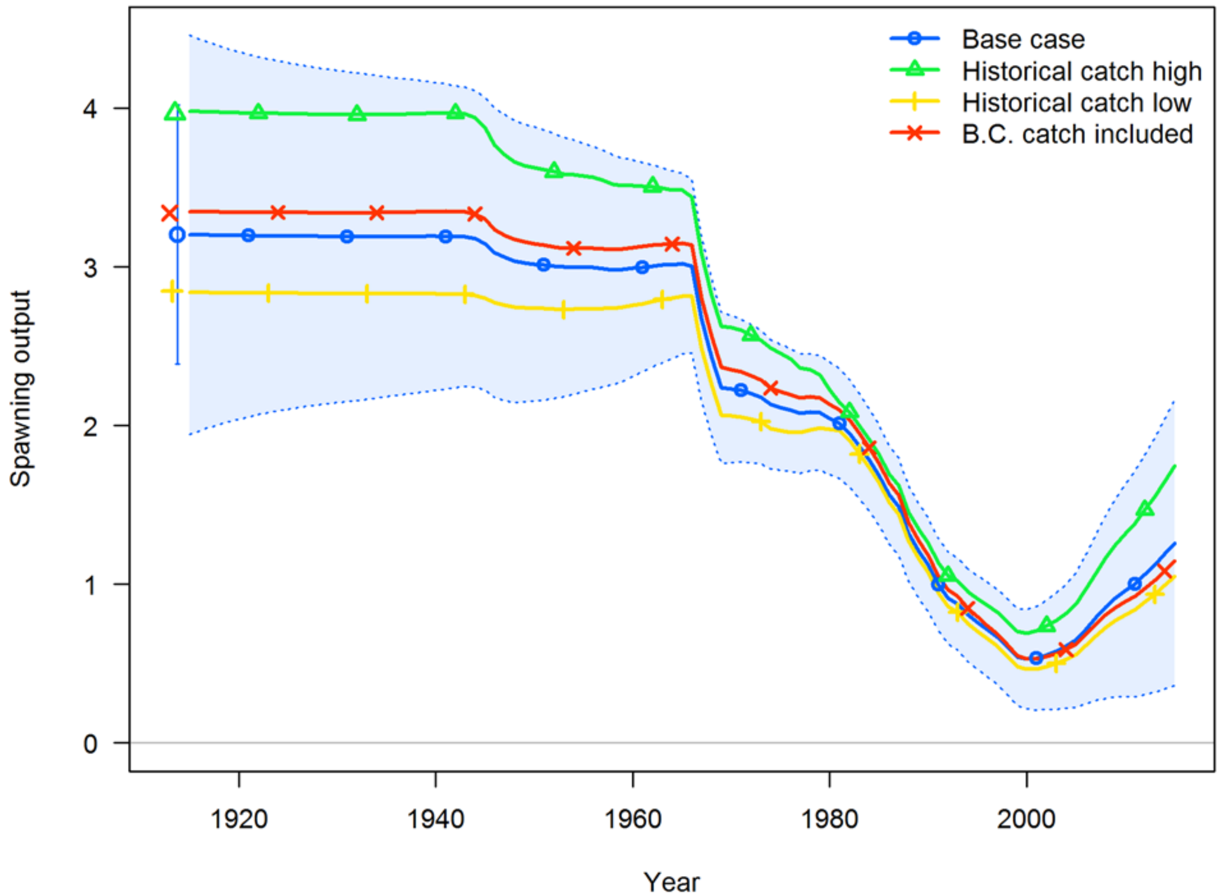

Figure 114: Sensitivity of darkblotched rockfish spawning output to alternative assumptions about historical shoreside fishery removals. Spawning output time series of this assessment base model are provided with ~ 95% interval.

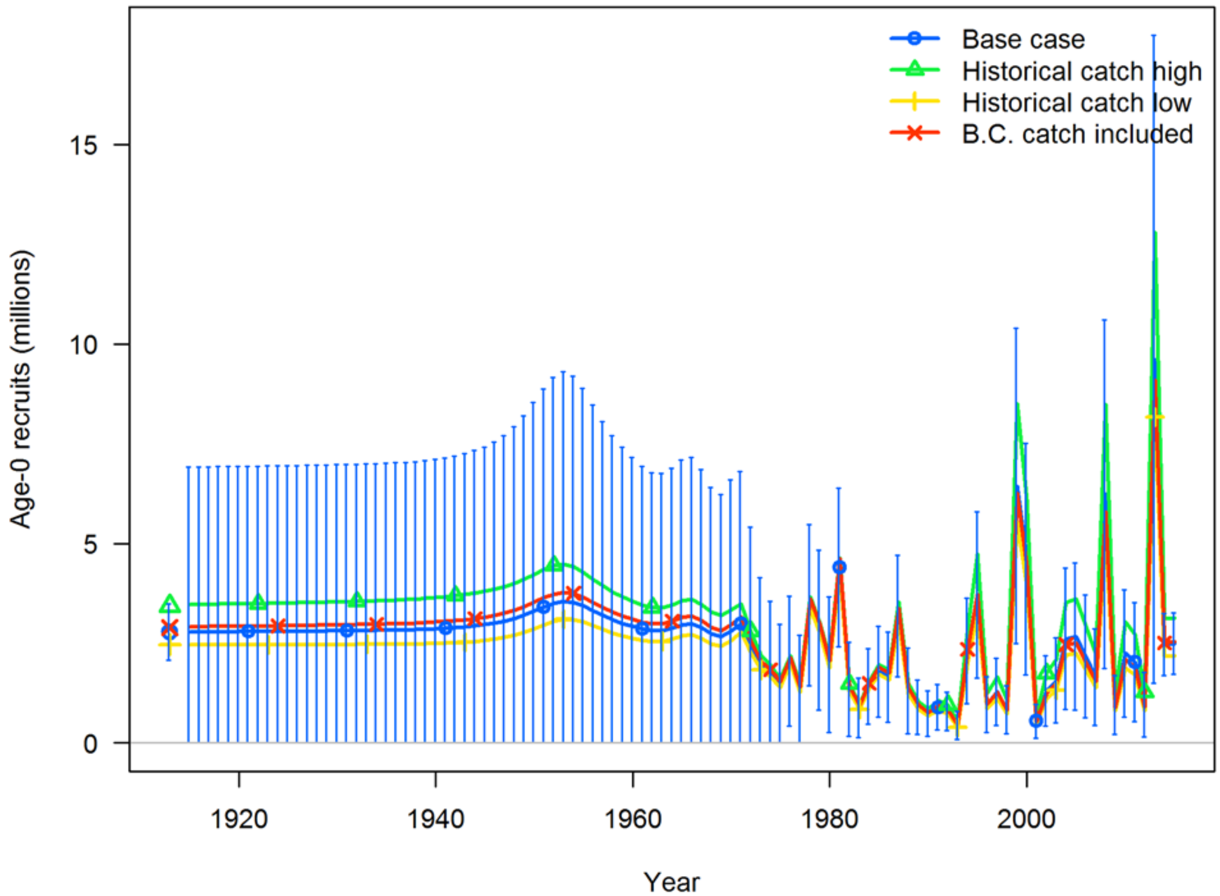

Figure 115: Sensitivity of darkblotched rockfish recruitment to alternative assumptions about historical shoreside fishery removals. Recruitment time series of this assessment base model are provided with ~ 95% interval.

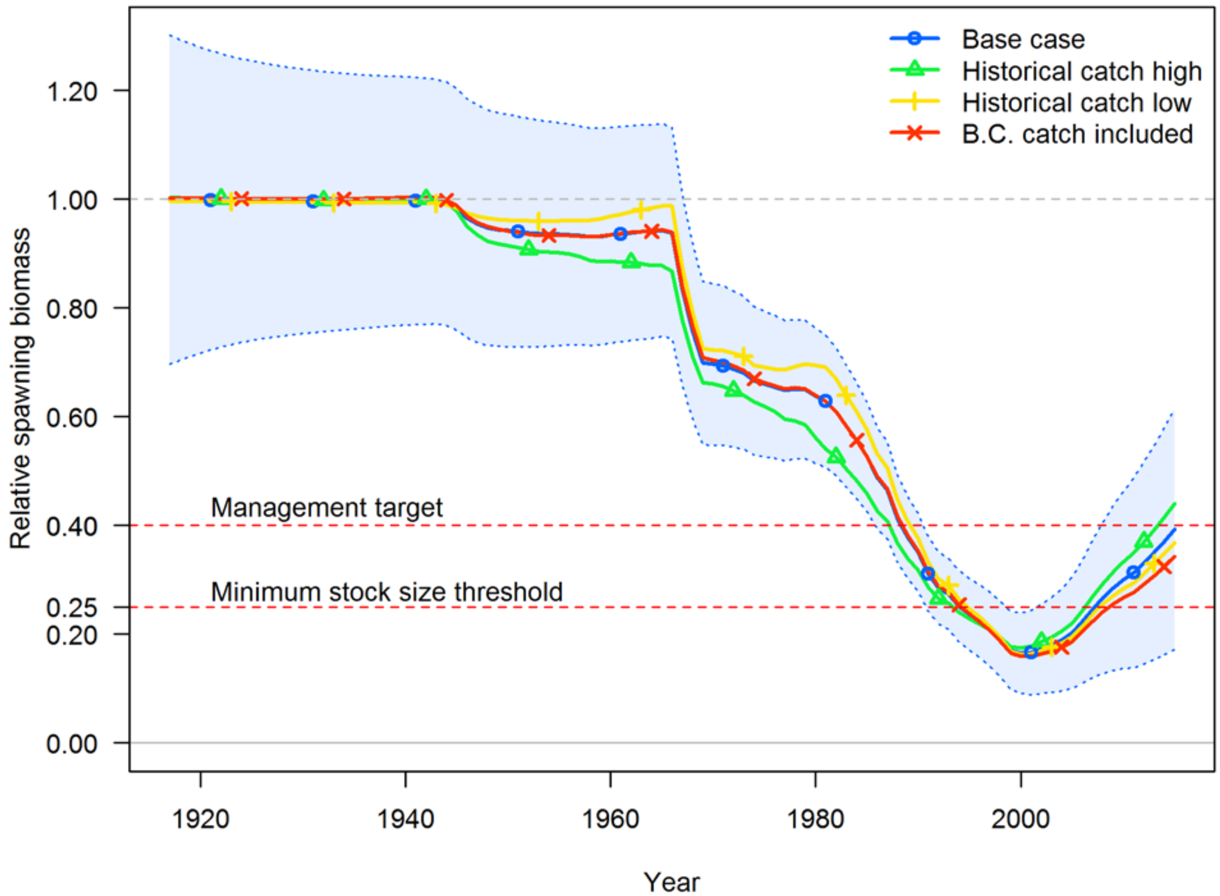

Figure 116: Sensitivity of darkblotched rockfish spawning depletion to alternative assumptions about historical shoreside fishery removals. Depletion time series of this assessment base model are provided with ~ 95% interval.

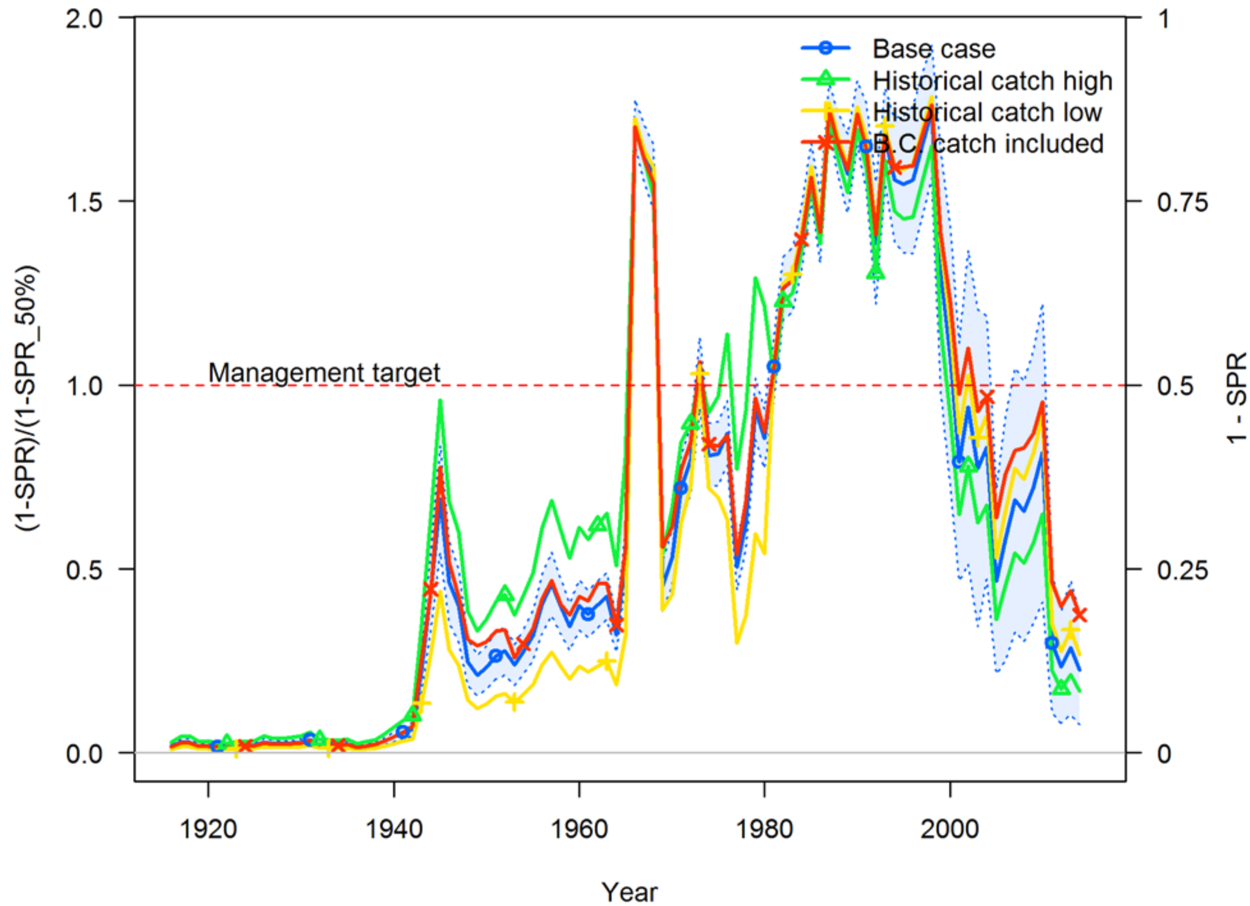

Figure 117: Sensitivity of darkblotched rockfish relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) to alternative assumptions about historical shoreside fishery removals. Relative SPR ratio time series of this assessment base model are provided with ~ 95% interval.

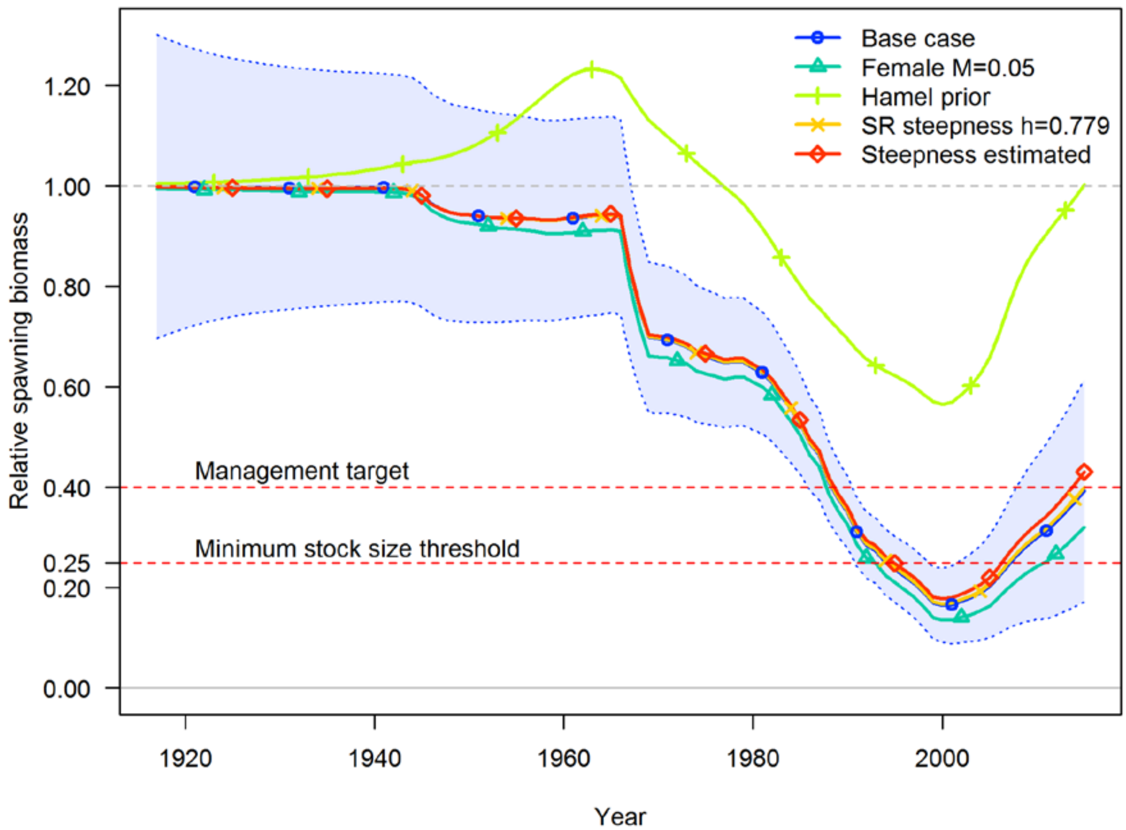

Figure 118: Sensitivity of darkblotched rockfish spawning depletion to alternative value of natural mortality and stock-recruit steepness. Spawning depletion time series of this assessment base model are provided with ~ 95% interval.

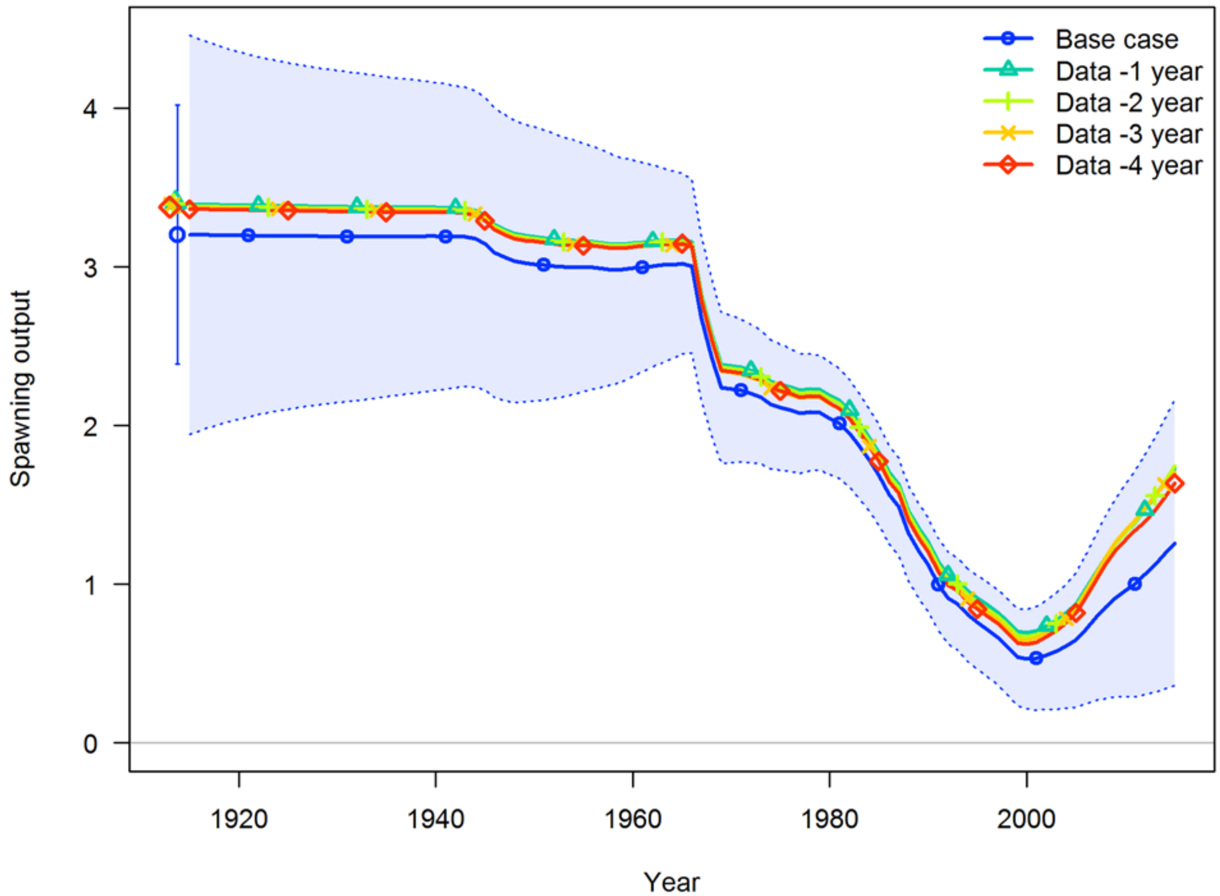

Figure 119: Results of retrospective analysis. Spawning output time series of this assessment base model are provided with ~ 95% interval.

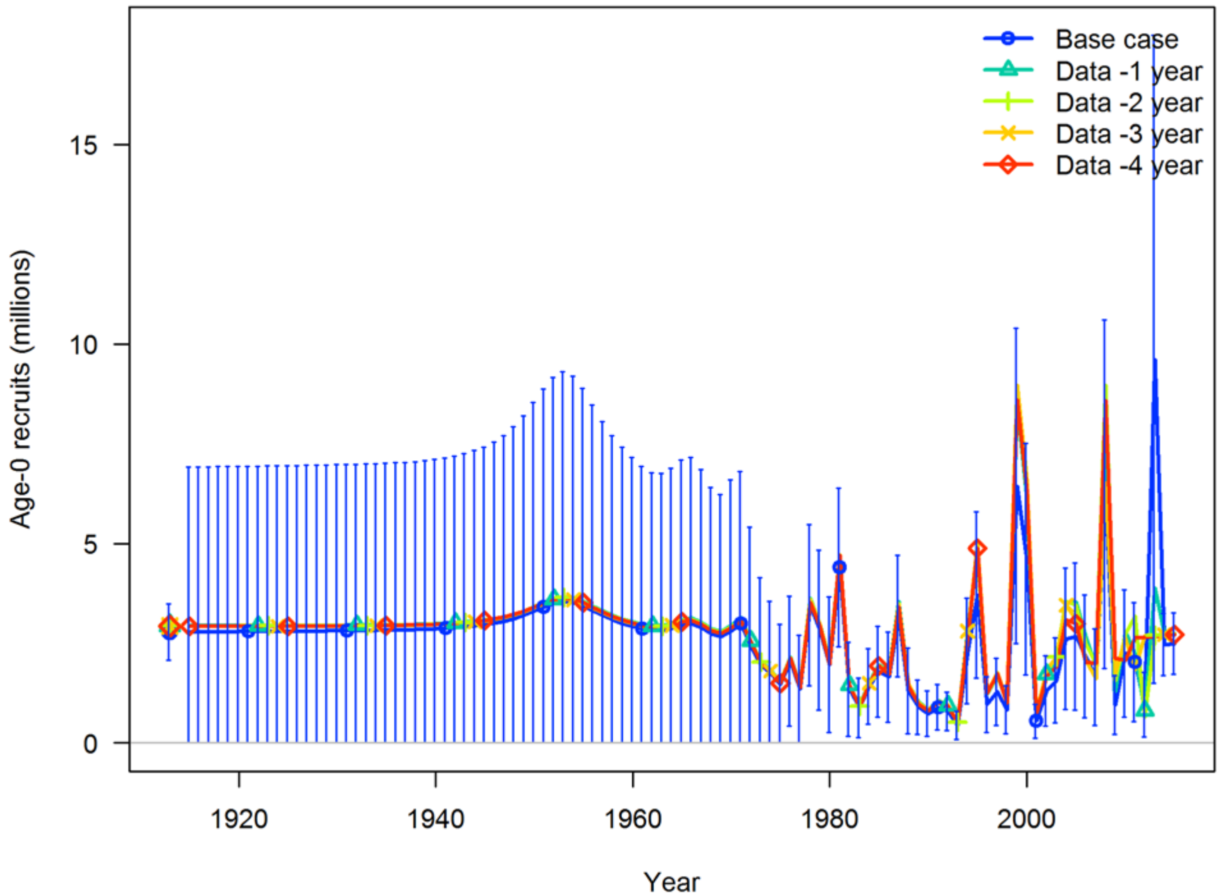

Figure 120: Results of retrospective analysis. Recruitment time series of this assessment base model are provided with ~ 95% interval.

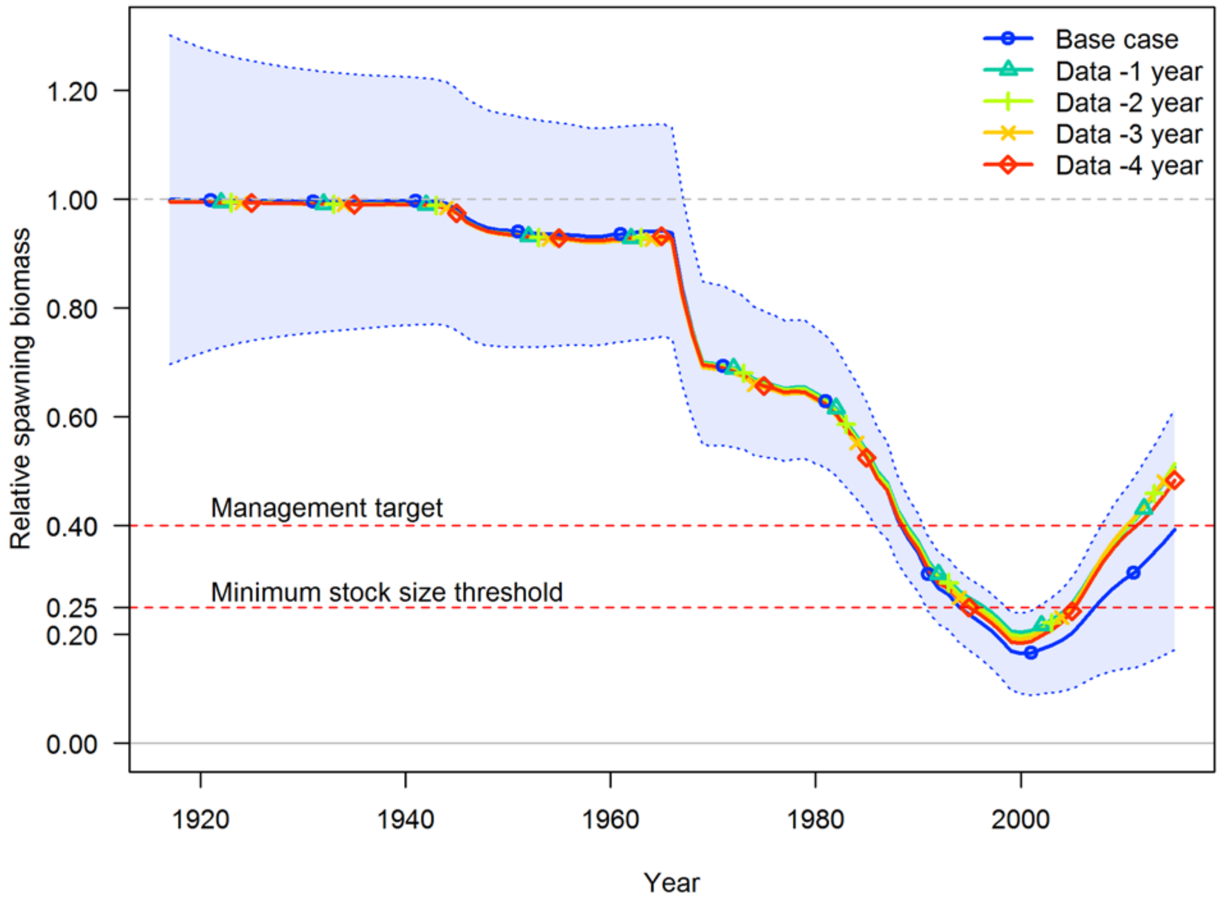

Figure 121: Results of retrospective analysis. Spawning depletion time series of this assessment base model are provided with ~ 95% interval.

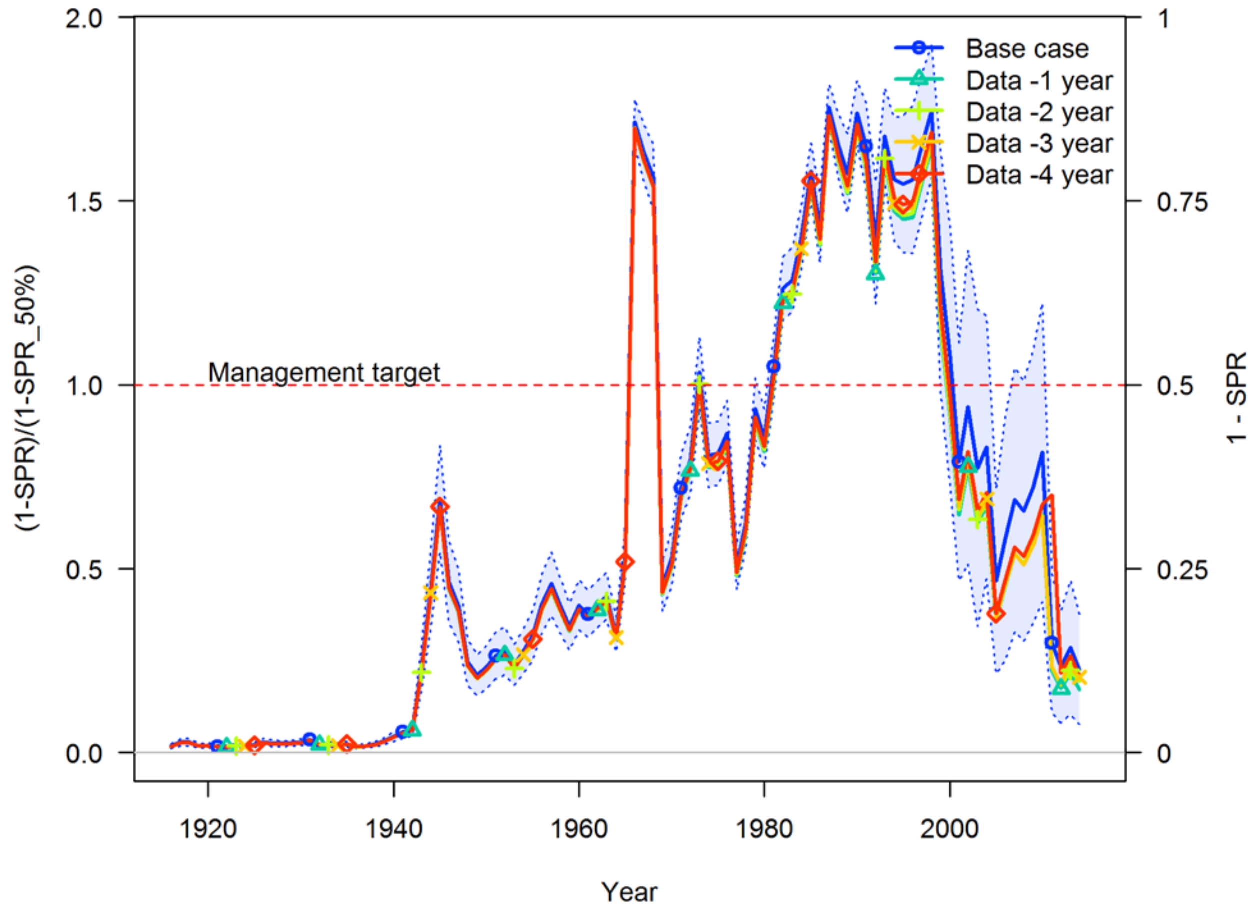

Figure 122: Results of retrospective analysis. Relative SPR ratio (1-SPR/1-$SPR_{Target=0.50}$) time series of this assessment base model are provided with ~ 95% interval.

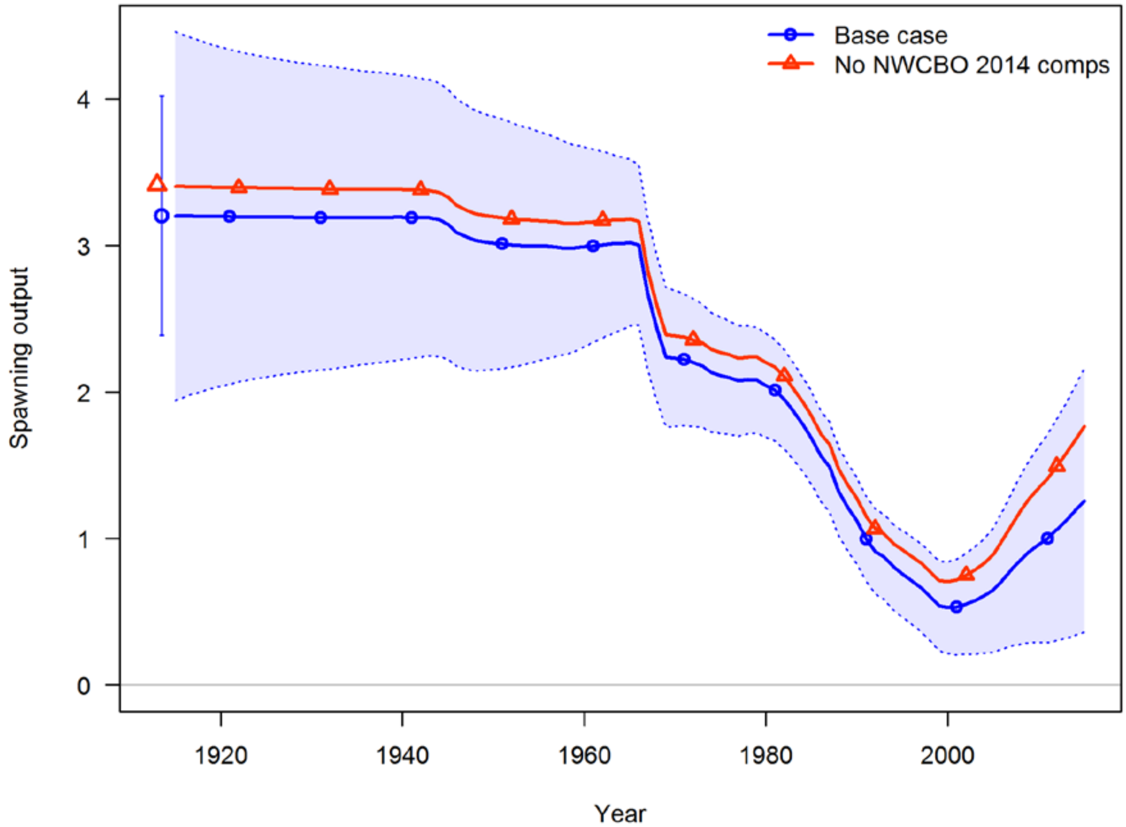

Figure 123: Comparison of spawning output time series between the base model and a run when 2014 NWFSC shelf-slope (NWCBO) composition data were excluded.

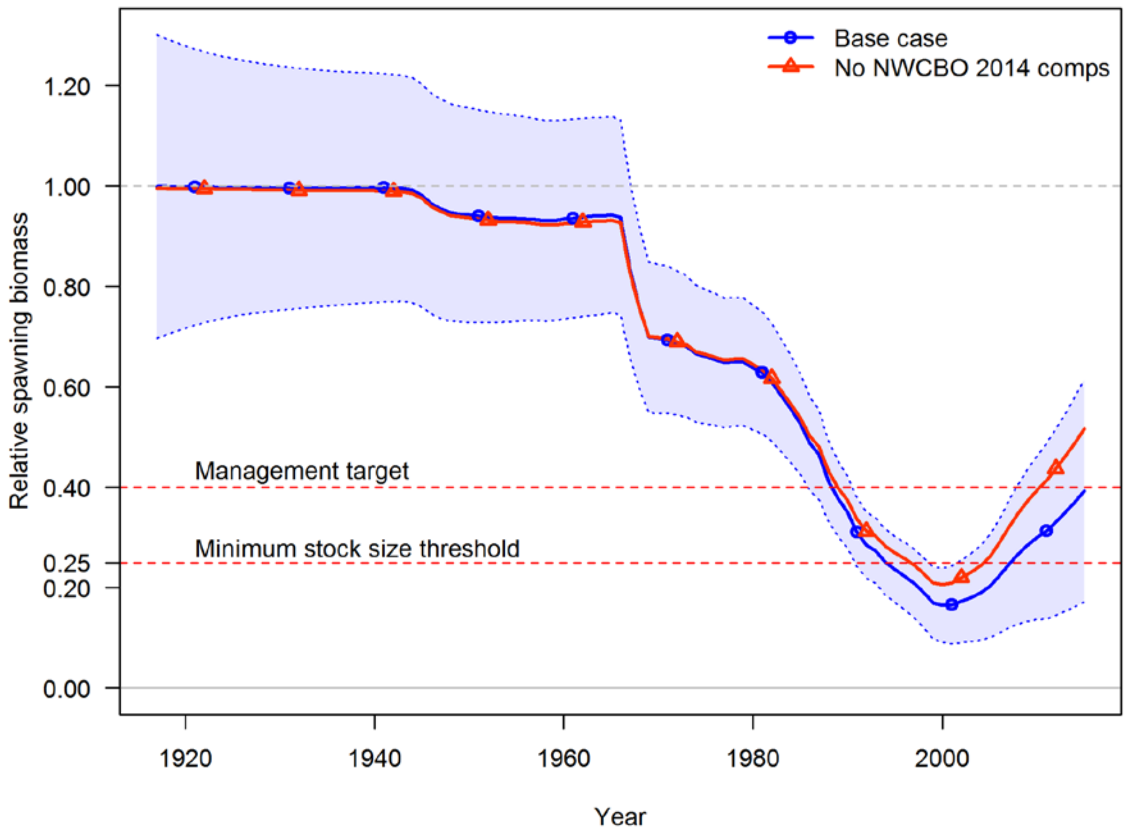

Figure 124: Comparison of spawning depletion time series between the base model and a run when 2014 NWFSC shelf-slope (NWCBO) composition data were excluded.

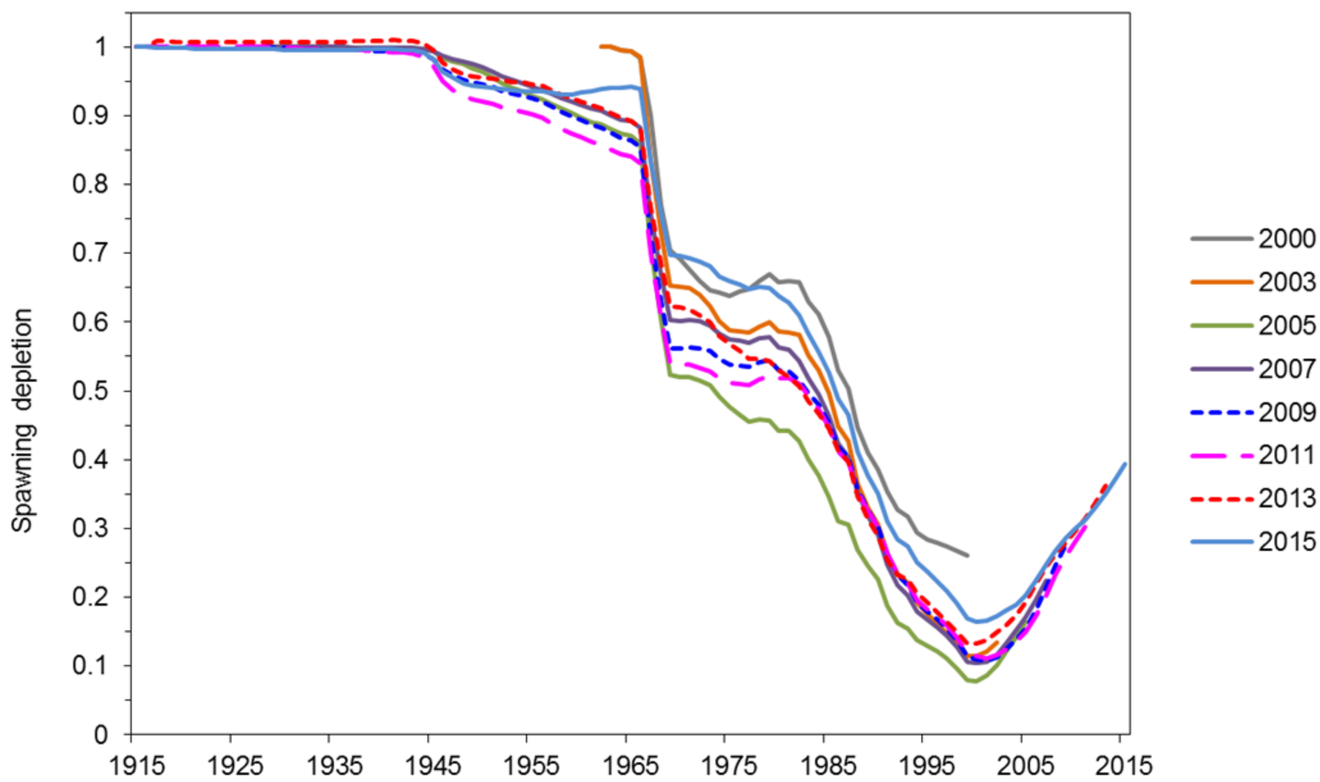

Figure 125: Comparison of spawning depletion time series among darkblotched rockfish assessments.

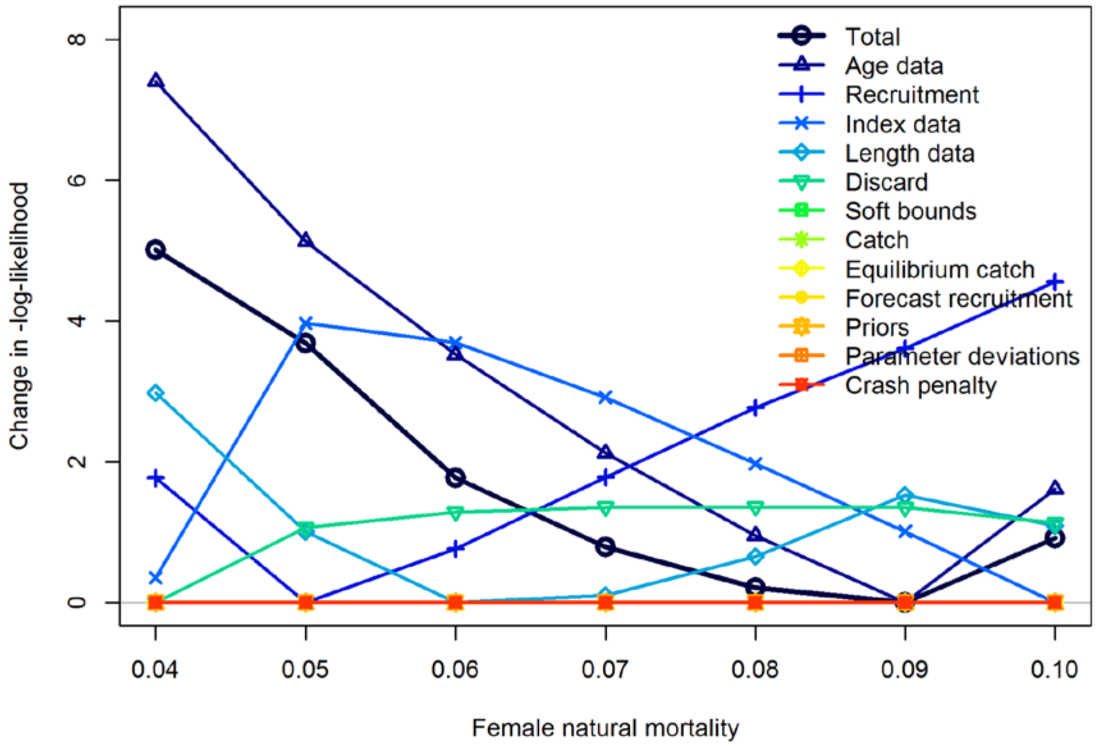

Figure 126: Negative log-likelihood profile for each data component and in total given different values of natural mortality ranging from 0.04 to 0.1 by increments of 0.01.

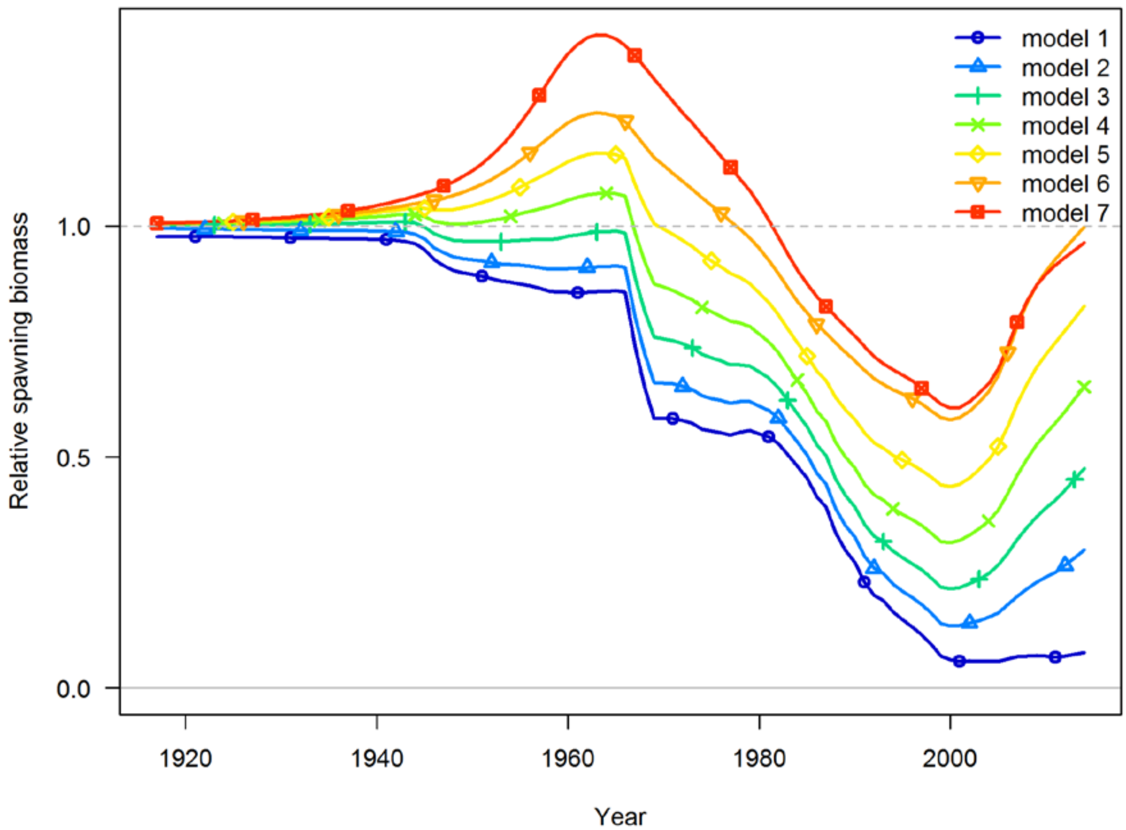

Figure 127: Time series of spawning depletion associated with different values of natural mortality ranging from 0.04 (Model 1) to 0.1 (Model 7) by increments of 0.01.

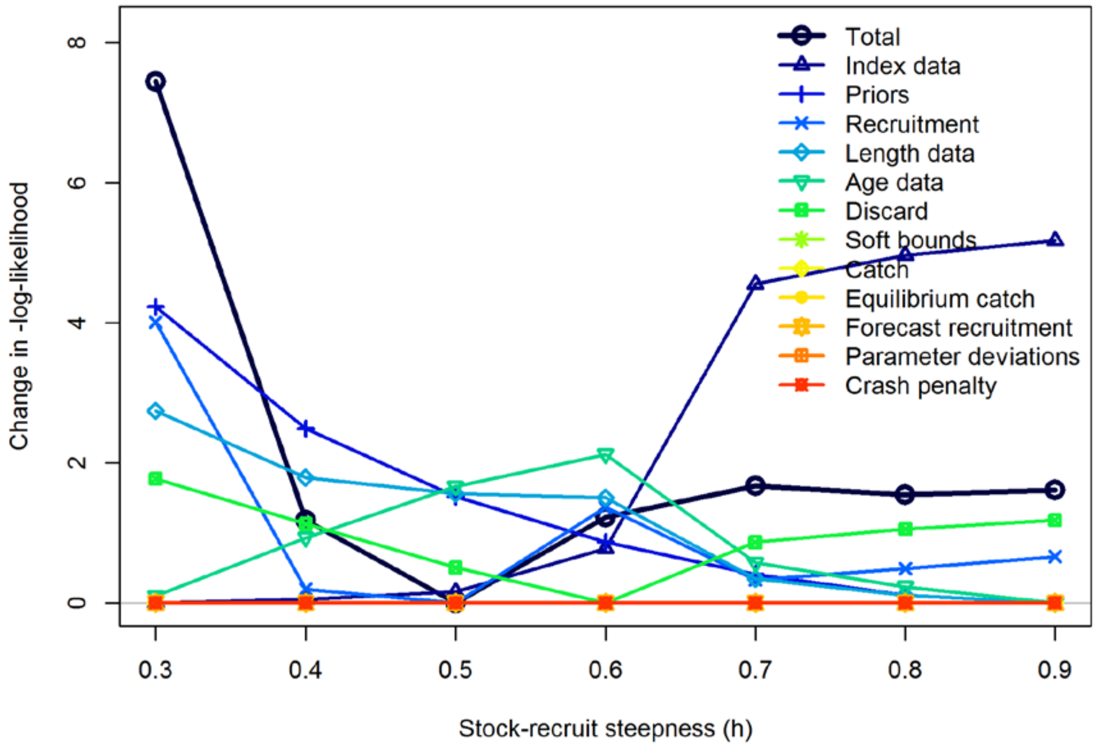

Figure 128: Negative log-likelihood profile for each data component and in total given different values of stock-recruit steepness ranging from 0.3 to 0.9 by increments of 0.1.

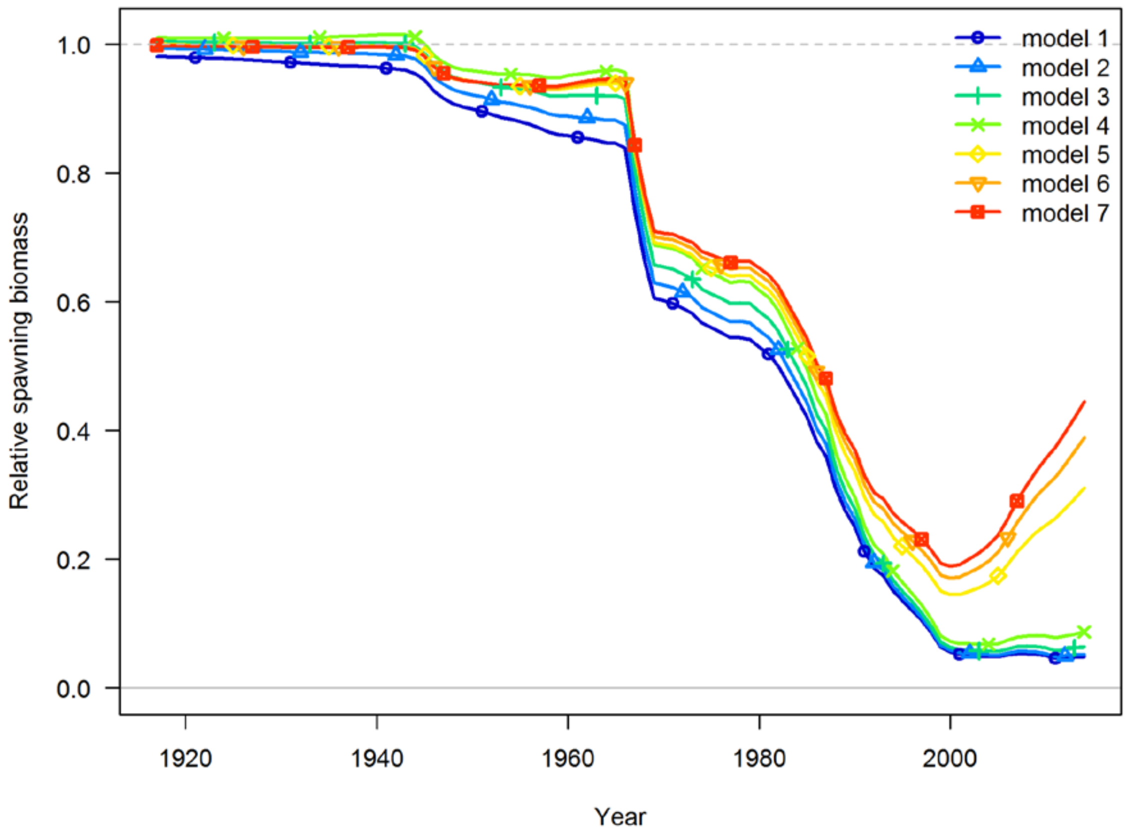

Figure 129: Time series of spawning depletion associated with different values of steepness ranging from 0.3 (Model 1) to 0.9 (Model 7) by increments of 0.1.

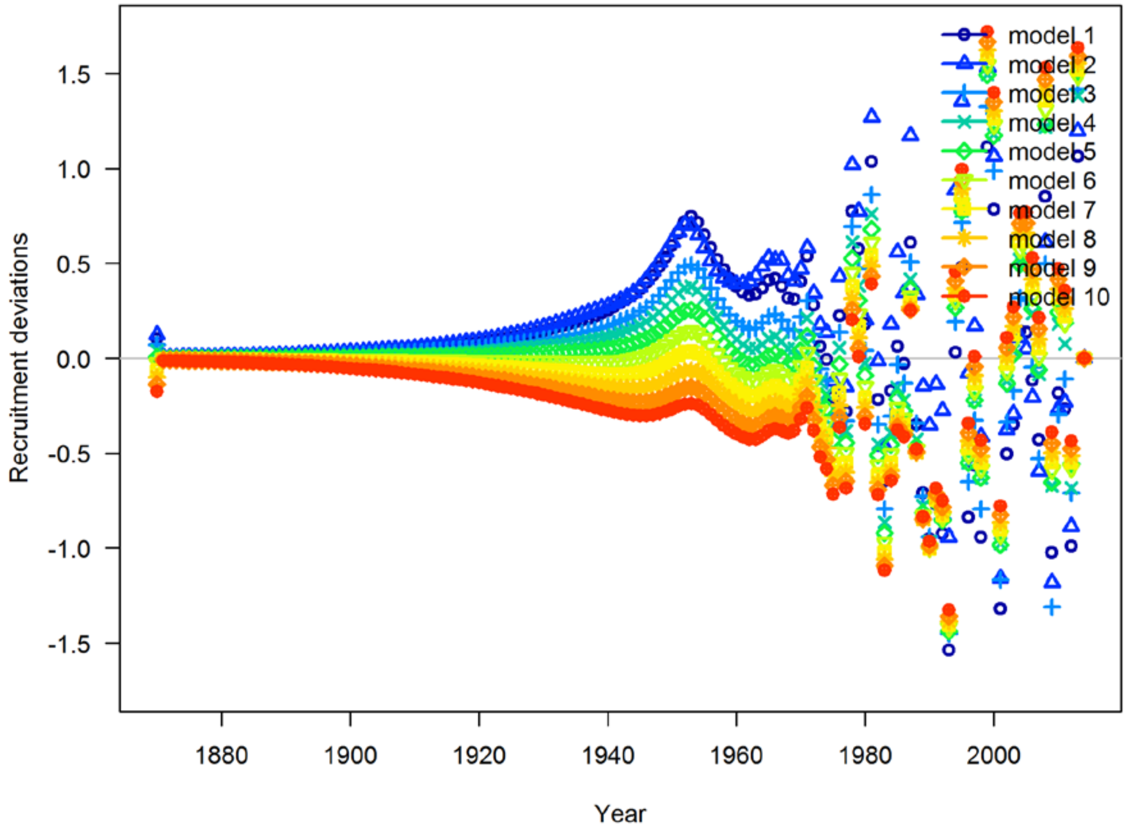

Figure 130: Values of recruitment deviations given different values of $\ln(R_0)$ ranging from 7.5 to 8.4 by increments of 0.1.

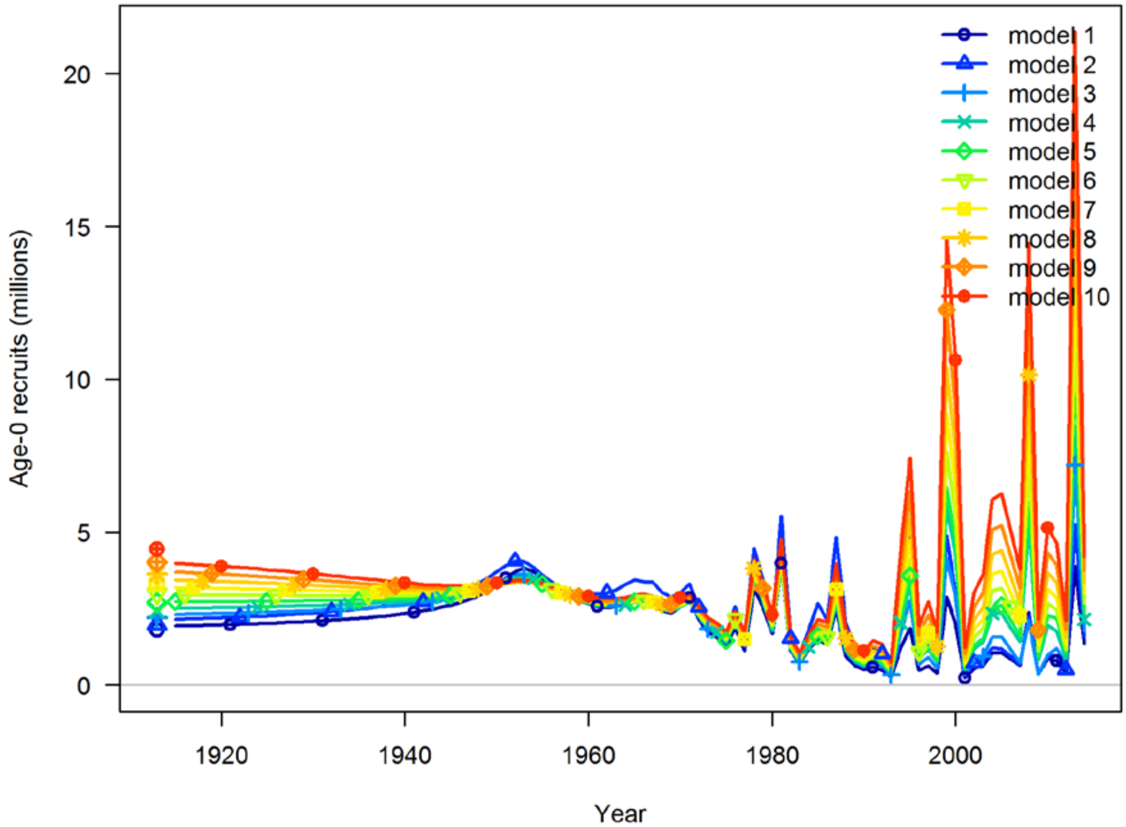

Figure 131: Values of estimated recruitment given different values of ln(R_0) ranging from 7.5 to 8.4 by increments of 0.1.

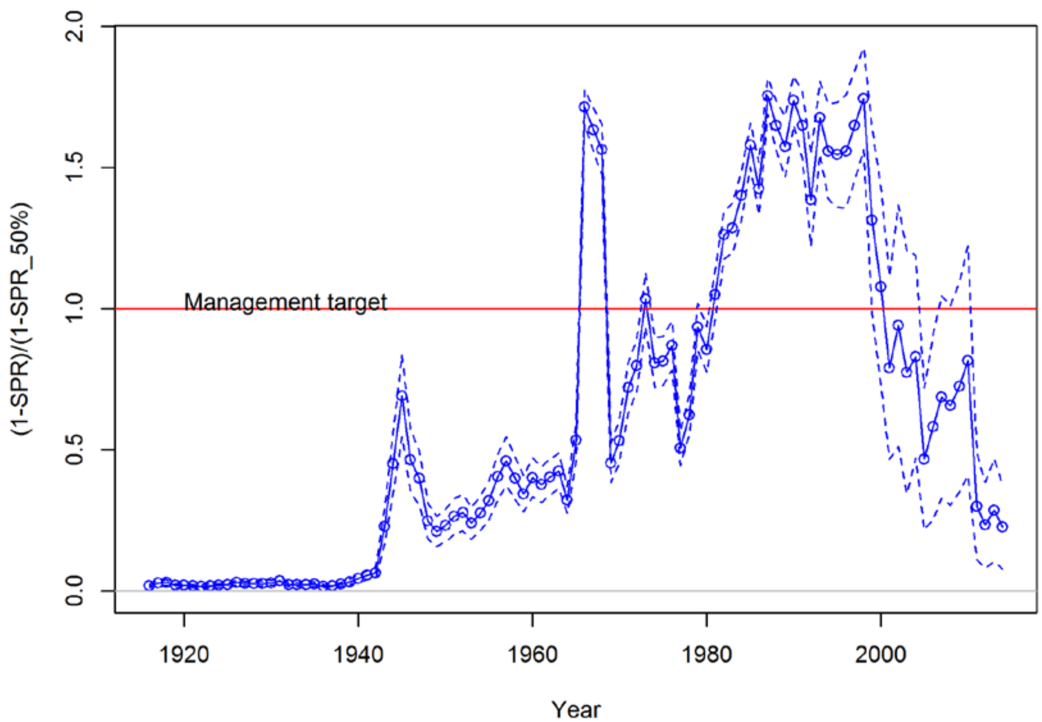

Figure 132: Time series of estimated relative spawning potential ratio (1-SPR/1-SPR$_{Target=0.5}$) for the base model (round points) with ~95% intervals (dashed lines). Values of relative SPR above 1.0 reflect harvests in excess of the current overfishing.

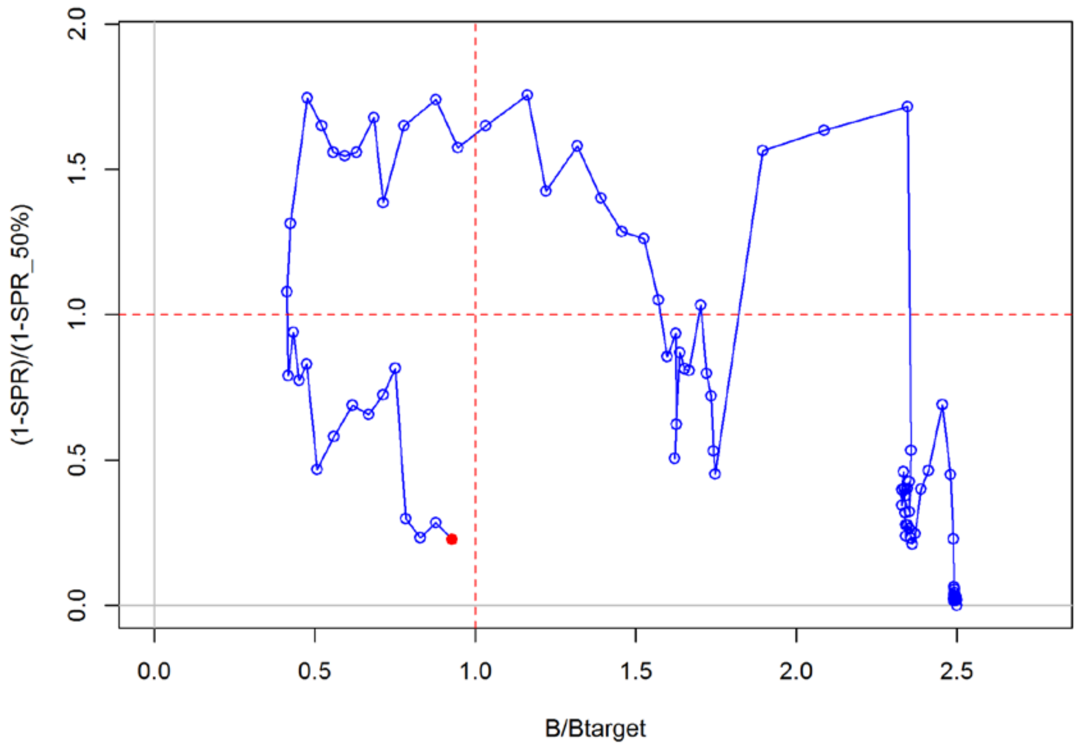

Figure 133: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base model. The relative (1-SPR) is (1-SPR) divided by 0.649 (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 40% of the unfished spawning biomass. The red point indicates the year 2014.

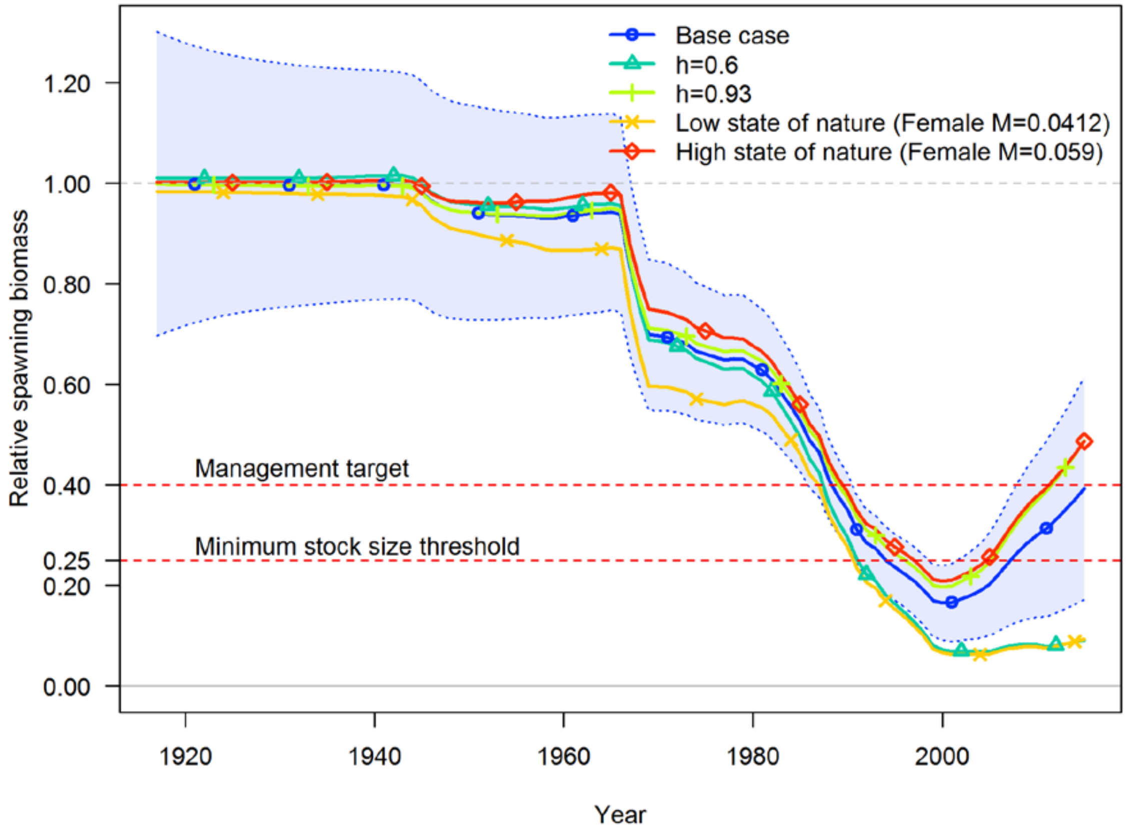

Figure 134: Comparison of depletion time series for base case, runs with alternative steepness values and female natural mortality values used to construct Decision Table.

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, 1983
- Established first coastwide trip limits on Sebastes complex

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, 1997
- Established first Dover sole, thornyheads, and trawl-caught sablefish (DTS) complex cumulative limits

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° 10’.

Appendix B. Assessment model files

Appendix B.1. SS data file

```
#Global specifications
1915 # Start year
2014 # End year
1 # N seasons per year
12 # Months per season
1 # Spawning Season
3 # N fishing fleets
4 # N surveys
1 # Number of areas
Shoreside%ForeignPOP%AtSeaHake%AKSHLF%AKSLP%NWSLP%NWCBO #Names divided
by "%"
0.5 0.5 0.5 0.5 0.5 0.5 0.5 #Timing of each fishery/survey
1 1 1 1 1 1 1 # Area of each fleet
1 1 1 # Units for catch by fishing fleet:
1=Biomass(mt),2=Numbers(1000s)
0.01 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 0 # Initial equilibrium catch (landings + discard) by fishing fleet
100 # Number of lines catch data
# Landed catch (only) time series by fleet
# Catch(by fleet) Year Season
0 0 0 1915 1
13.009 0 0 1916 1
20.633 0 0 1917 1
21.345 0 0 1918 1
13.733 0 0 1919 1
14.439 0 0 1920 1
12.312 0 0 1921 1
11.311 0 0 1922 1
13.643 0 0 1923 1
13.863 0 0 1924 1
15.798 0 0 1925 1
21.328 0 0 1926 1
18.319 0 0 1927 1
18.159 0 0 1928 1
19.318 0 0 1929 1
21.079 0 0 1930 1
26.002 0 0 1931 1
16.433 0 0 1932 1
16.044 0 0 1933 1
15.249 0 0 1934 1
17.499 0 0 1935 1
11.881 0 0 1936 1
13.537 0 0 1937 1
16.741 0 0 1938 1
23.738 0 0 1939 1
32.725 0 0 1940 1
41.860 0 0 1941 1
48.165 0 0 1942 1
```

183.614 0 0 1943 1
397.657 0 0 1944 1
678.760 0 0 1945 1
401.009 0 0 1946 1
331.568 0 0 1947 1
191.102 0 0 1948 1
160.203 0 0 1949 1
177.770 0 0 1950 1
205.861 0 0 1951 1
216.837 0 0 1952 1
184.548 0 0 1953 1
216.901 0 0 1954 1
256.018 0 0 1955 1
339.045 0 0 1956 1
396.068 0 0 1957 1
335.049 0 0 1958 1
283.182 0 0 1959 1
342.106 0 0 1960 1
318.933 0 0 1961 1
345.280 0 0 1962 1
368.227 0 0 1963 1
264.989 0 0 1964 1
482.897 0 0 1965 1
413.119 3807 0 1966 1
370.119 2706 0 1967 1
133.875 2288 0 1968 1
133.554 153 0 1969 1
202.068 149 0 1970 1
250.117 278 0 1971 1
237.284 374 0 1972 1
146.314 768 0 1973 1
263.084 346 0 1974 1
318.595 293 0 1975 1
541.032 118 10.759 1976 1
315.707 0 2.396 1977 1
415.123 0 1.075 1978 1
732.379 0 3.716 1979 1
598.373 0 21.430 1980 1
824.186 0 11.848 1981 1
1134.167 0 1.653 1982 1
1114.261 0 11.559 1983 1
1302.935 0 19.582 1984 1
1760.725 0 12.769 1985 1
1252.661 0 5.720 1986 1
2394.355 0 13.985 1987 1
1646.823 0 9.519 1988 1
1269.285 0 5.289 1989 1
1651.773 0 28.252 1990 1
1161.048 0 44.969 1991 1
657.876 0 29.453 1992 1
1185.767 0 8.026 1993 1
851.378 0 14.734 1994 1
737.049 0 49.066 1995 1
736.793 0 5.993 1996 1
816.422 0 3.879 1997 1
912.558 0 14.058 1998 1
350.348 0 11.114 1999 1

```
250.741 0 8.145 2000 1
162.871 0 12.357 2001 1
109.061 0 3.217 2002 1
75.486 0 4.371 2003 1
181.779 0 7.274 2004 1
86.647 0 11.059 2005 1
95.978 0 11.148 2006 1
131.538 0 12.052 2007 1
111.054 0 6.317 2008 1
138.071 0 0.353 2009 1
176.131 0 8.176 2010 1
104.643 0 12.197 2011 1
91.528 0 2.698 2012 1
117.712 0 6.329 2013 1
92.253 0 10.672 2014 1
#Survey Indices section
29 # 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) # Shoreside
2 1 0 # fleet (fishery or survey) # ForeighPOP
3 1 0 # fleet (fishery or survey) # AtSeaHake
4 1 0 # fleet (fishery or survey) # AKSHLF
5 1 0 # fleet (fishery or survey) # AKSLP
6 1 0 # fleet (fishery or survey) # NWSLP
7 1 0 # fleet (fishery or survey) # NWCBO
#Year Seas Flt/Svy Value se(log)
#AKSHLF triennial early (N=5)
1980 1 4 4329.510695 0.328855581
1983 1 4 11307.197 0.188300112
1986 1 4 5626.360727 0.2519586
1989 1 4 7000.510252 0.316365157
1992 1 4 6185.453803 0.289054054
#AKSHLF triennial late (N=4)
1995 1 4 3574.325258 0.295860335
1998 1 4 4152.80707 0.345400667
2001 1 4 3408.702865 0.325285022
2004 1 4 7329.157077 0.31872779
#AKSLP survey (N=4)
1997 1 5 1655.059106 0.558034217
1999 1 5 1917.966195 0.612989277
2000 1 5 1633.165459 0.56262013
2001 1 5 2180.37366 0.87740395
#NWSLP survey (N=4)
1999 1 6 3467.103363 0.550010623
2000 1 6 5715.048007 0.419764141
2001 1 6 2917.12162 0.454480825
2002 1 6 2341.556201 0.450368493
#NWCBO survey (N=12)
2003 1 7 10930.392 0.200477888
2004 1 7 8084.521577 0.214218431
2005 1 7 7629.426546 0.19324383
2006 1 7 7692.710983 0.180479193
2007 1 7 7520.231366 0.179195116
2008 1 7 5026.280996 0.192391668
2009 1 7 9065.893271 0.182071936
```

```
2010 1 7 6972.419485 0.187887322
2011 1 7 7133.199872 0.192604277
2012 1 7 8077.772137 0.199176192
2013 1 7 6907.602955 0.211365551
2014 1 7 5410.189388 0.189871869

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 # Shoreside

15 # Discards N observations
# Year seas fleet obs err
#Shoreside from Pikitch study
1985 1 1 0.1053 0.242
1986 1 1 0.1195 0.2581
1987 1 1 0.0908 0.2259
#Shoreside from WCGOP, from 2013 assessment
2002 1 1 0.56 0.09
2003 1 1 0.60 0.10
2004 1 1 0.18 0.04
2005 1 1 0.24 0.05
2006 1 1 0.48 0.09
2007 1 1 0.49 0.07
2008 1 1 0.54 0.06
2009 1 1 0.55 0.05
2010 1 1 0.49 0.06
2011 1 1 0.027 0.01
2012 1 1 0.037 0.01
2013 1 1 0.024 0.01
# Mean Body Weight
0 # Number of mean body weight observations
30 # Degrees of freedom for mean body weight for T-distribution
# 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

90 # Length Composition Observations
#Shoreside (N=38)
#Year Seas Fleet Gender Partition Nsamp
```

1977 1 -1 3 2 35 0 0 0 0 0 0 0 0 0 0 1791.845251 8363.171008 21793.21813
38799.07023 37129.35414 25809.51217 8697.766411 689.4982778 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2462.933228 4134.271699 15879.66499
52406.00417 32515.38904 15949.36039 1567.010602 0 25.87916958 0 0 0 0
207.2355376 0 0 0 0 0 0 0
1978 1 -1 3 2 92 0 0 0 0 0 0 0 0 0 0 2656.014214 11356.42569
25052.00262 37573.82069 47145.47426 20718.82222 3710.384222 3523.468147
6328.160714 5250.207125 3057.807005 1052.189595 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 209.8130854 16371.42275 38632.03009 62263.96527 26087.79839
13527.82939 8195.678739 13278.83992 4958.34389 1241.447558 11.83547655
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 0 205.0806259 1082.230207
3659.904511 12908.78586 9609.731783 6920.522962 3982.462771 4170.445092
4011.969357 3996.351877 1082.230207 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 3408.285275 6620.418966 5087.365301 13851.00267 3263.186236
14286.25427 22260.7639 11627.63025 0 6017.954036 0 0 0 0 0 0 0 0
1980 1 1 3 2 59 0 0 0 0 0 0 0 14.82808254 0 358.5975063 488.338185
846.9356913 4838.562205 5597.676835 5220.144397 10026.70262 13493.89087
17083.69403 29294.09584 16119.20346 7457.739098 889.103459 0
1358.443691 1358.443691 0 0 0 0 0 0 0 0 0 0 0 0 0 0 630.9822358 0
1073.424236 2296.375716 7992.678676 12718.30618 21361.20357 27296.63266
5042.125227 1202.229502 608.8236243 0 0 0 0 0 0 0 0 0 0
1981 1 1 3 2 56 0 0 0 0 0 0 0 0 0 0 4229.269956 3917.219148 0
12767.05821 2215.36872 4205.283581 14127.64479 78537.51016 74668.46451
57357.2888 27438.13371 7083.413646 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 584.841428 0 2648.584592 15337.05749 97546.73346 42934.6651
4446.848125 0 0 0 0 0 0 0 0 0 0 0
1982 1 1 3 2 160 0 0 0 0 0 0 0 0 0 0 140.9397594 391.2967158 3328.343499
5760.601452 22196.27933 30203.6145 47020.98676 149384.6987 163750.4206
196918.3866 110057.2195 47460.95567 13852.32733 4312.232692 2899.963037
1264.114359 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 841.5737507 3004.03014
1452.490267 8187.389735 17140.43919 58781.94694 111737.0575 131955.5803
40444.74033 9174.751632 1219.761206 899.0506124 185.8671596 371.7343193
130.9919078 0 0 0 0 0 0
1983 1 1 3 2 224 0 0 0 0 0 0 0 0 0 0 1036.378394 2296.389306
2464.213031 5064.708252 9489.466406 12265.32239 52048.4749 46382.79928
77414.35834 44515.45585 19755.6351 5321.741222 2466.843472 1118.370212
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 238.1188693 306.9346135 532.9962052
4306.174284 4867.08206 21636.85092 42146.56191 48843.43295 44765.0534
8623.407771 2159.07782 645.3355397 458.1516801 0 883.6989358
883.6989358 0 0 0 0 0
1984 1 1 3 2 437 0 0 0 0 0 0 77.75349014 0 0 77.75349014 389.6816841
1476.24377 14921.97121 15497.28883 18391.08525 39757.69169 111038.5944
182331.17 120128.2693 165126.6419 111869.2465 29543.65028 16671.09382
1759.908315 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2894.896551 1144.281032
8753.861976 12138.16969 37433.8025 88837.53713 69925.16031 58017.36718
13327.48435 8964.806179 803.6273643 0 0 127.185813 0 0 0 0 0 0
1985 1 1 3 2 618 0 0 0 0 47.80443317 0 0 0 357.429943 1392.526749
814.6306435 6993.14464 13709.82286 36392.36071 46407.7168 38059.19711
56666.08701 75719.8746 69846.55074 45135.92164 28665.4715 6365.558433
199.2500458 110.1643913 0 0 0 0 0 0 0 0 0 0 0 0 0 0 27.91124314
673.0605438 2566.866333 8357.826569 18769.26667 41501.55246 53782.3586
92846.26834 82080.08194 43052.50945 18256.81161 1119.26731 2674.180392
0 0 0 0 0 0 0 0 0
1986 1 1 3 2 481 0 0 0 0 0 0 0 0 0 0 1076.843557 115.9564734 1408.289863
5966.371826 21235.57129 46228.90434 54419.56171 40622.52731 42613.11285
32754.01491 22458.97529 7780.822263 2180.155309 451.6616402 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1076.843557 58.43049225 740.4460429 2114.569821
7105.285848 25611.64633 38808.11764 46441.97804 36700.21329 23630.56383
3542.396411 692.9237354 0 0 0 0 0 0 0 0 0 0
1987 1 1 3 2 484 0 0 0 0 0 0 0 0 0 0 749.5615182 1644.853131 1103.637222
5457.081326 26516.5819 104751.7924 193579.0148 269186.4632 169226.6674
108432.6612 32824.56179 8659.481293 1527.97981 178.3432929 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 505.2559434 671.9239863 4139.908002 12557.48103
74173.11947 236216.3199 324178.0894 236049.8623 57055.79653 9740.822125
2768.742155 1445.415494 2037.057695 0 0 320.9088461 0 0 0 0 0
1988 1 1 3 2 278 0 0 0 0 0 0 0 0 0 0 535.6060301 277.8336956 3494.135985
4095.696334 5209.422727 61673.85811 98328.11927 100649.7014 97290.51563
65379.31446 18025.49056 5229.059929 2137.132467 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 490.0622987 2948.874991 4314.609086 19578.61814 92493.27226
110277.4194 117378.8297 40979.74786 5781.485596 0 209.9414917 0 0 0 0 0
0 0 0 0
1989 1 1 3 2 243 0 0 0 0 0 0 0 0 0 0 1597.829608 6721.708761
10764.75126 14526.45577 33178.37777 61675.35007 55086.08905 34343.49709
28932.19745 13502.3074 9397.371325 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
167.1377096 421.0708707 9369.782493 9726.789136 19360.91919 61391.16492
84631.47816 41328.44229 18392.03387 3834.065163 237.1229117 0
50.51742324 0 0 0 0 0 0 0 0
1990 1 1 3 2 223 0 0 0 0 0 0 0 0 0 0 1632.167191 16908.3099 44381.23282
61619.62671 121390.852 139897.2191 176789.2359 145549.9827 94113.16407
69041.94371 84875.91987 34213.29063 4274.943883 8509.176359 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 2095.730971 2863.517187 48240.35812 113069.7969
141342.5428 210141.9565 162009.8841 73035.96029 25933.17873 5191.382522
0 0 0 0 0 0 0 0 0 0
1991 1 1 3 2 206 0 0 0 0 0 0 0 0 0 1068.102249 2772.199778 8293.887483
5302.345174 11224.55759 15347.62067 19495.09498 61171.60033 107924.204
143228.357 93795.6558 81736.37797 68689.95126 52997.25265 13561.51759 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 119.1690483 0 435.5132177 2476.586057
3879.918179 9871.554569 6916.605894 9969.815945 71946.24699 99884.62857
100906.9896 39808.14002 14936.94523 3625.318592 0 0 0 0 0 0 0 0 0 0
1992 1 1 3 2 103 0 0 0 0 0 0 0 0 0 0 495.1204563 1520.352565
2133.827206 6703.725781 9901.354047 13139.0219 15729.31725 21647.14333
18164.08996 13526.8727 5497.088832 261.4071658 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 302.0381404 1846.831534 4873.784092 5278.246218 5739.180677
22984.86236 23442.10729 10488.84199 2563.75624 909.35842 0 456.115456 0
0 0 0 0 0 0 0
1993 1 1 3 2 112 0 0 0 0 0 0 0 0 807.9120851 145.5759649 186.3779734
1607.190453 1796.187654 6321.965508 13743.76909 14357.83962 16978.87072
31568.24722 20899.65557 13331.85982 6500.255877 2093.843717 807.9120851
403.9560425 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 988.0815704 0 601.654578
3376.100045 8916.567955 18746.25132 40108.01169 45405.29 38106.28999
11668.92886 4369.825093 1829.215786 0 0 0 0 0 0 0 0 0 0
1994 1 1 3 2 129 0 0 0 0 0 0 0 0 0 0 605.8716907 853.8256793 894.0851158
3897.896716 13335.83321 36065.26885 45392.9576 88083.73734 137758.2451
61847.09967 72604.21374 30144.88994 15538.81782 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 546.6234441 2629.879849 30535.79591 93309.2193
118977.9478 97488.21177 54300.25477 19094.42881 3202.082323 0
1155.591292 0 0 0 0 0 0 0 0
1995 1 1 3 2 176 0 0 0 0 0 0 0 0 0 0 428.8776955 804.3127764 545.5797094
3857.500231 16162.57772 47618.2285 75817.34625 74574.52994 63233.43108
63335.24345 49475.85576 18074.2741 8768.560739 395.3654171 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 203.4671469 168.4115333 926.1966425 8050.24965
46309.30703 68636.09741 101575.6144 61495.62763 20212.15699 3023.399008
37.45893956 0 0 0 0 0 0 0 0 0 0

1996 1 1 3 2 348 0 0 0 0 0 0 0 0 0 100.1406971 2137.963109 4635.920732
8709.96733 15035.68487 34224.24037 53654.47912 62205.54653 67402.88263
62421.11047 36863.18845 16779.74532 6460.079445 1354.005338 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 684.6954547 2895.757052 5388.603376 13031.62081
52986.39611 116784.7847 146845.9915 63525.60155 27400.18293 4555.661169
829.3711155 395.5398024 319.9371971 0 0 0 0 0 0 0 0
1997 1 1 3 2 310 0 0 0 0 0 0 0 0 76.45953993 1325.709393 6669.466145
9194.038881 17438.01557 22193.72813 56925.33682 66127.65201 67884.60375
83988.10616 58850.15944 46194.55201 26156.08348 14237.63103 3722.701006
75.41766695 0 0 0 0 0 0 0 0 0 0 0 0 0 0 211.4771268 677.9226921
3546.568298 8095.861359 18301.21392 55098.4003 106241.0935 93792.10794
77378.14522 34778.38232 9191.479842 2953.92796 148.3027287 0 0 0 0 0 0
0 0 0
1998 1 1 3 2 395 0 0 0 0 0 0 0 0 1029.418742 3524.419447 7330.375512
14348.55249 26429.0765 32505.74676 40674.77638 73785.50658 107018.1245
78134.52817 73620.38757 66252.78057 36100.54234 7340.230867 624.7394307
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1798.200664 3271.703366 19937.10349
22345.97796 33751.49435 29491.10951 102923.5241 119933.8496 72582.05036
36858.0745 9149.31972 4596.444961 0 1883.203814 998.7573554 0 0 0 0 0 0
0
1999 1 1 3 2 273 0 0 0 0 0 0 0 0 328.2281636 3487.594448 15935.23752
33271.69745 27789.73675 25093.82188 14454.13169 30994.66778 51488.19615
30254.65139 24263.718 14671.42209 4660.026416 4869.509098 1270.024048 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 404.7037091 4040.201469 14568.5094
31220.24699 30433.61034 26115.57541 30718.26293 42110.95581 19953.77329
12095.21003 6384.834946 50.71379474 63.74096329 0 12.46295541 0 0 0 0 0
0 0
2000 1 1 3 2 318 0 0 0 0 0 0 0 0 0 226.21951 2581.556055 9975.370862
22980.27862 17422.05656 16040.75371 8640.274838 26176.37125 24396.04609
28187.87338 10974.74258 6188.802184 1419.159946 339.5491326 0 0 0 0 0 0
0 0 0 0 0 14.31017503 14.31017503 14.31017503 0 0 1742.655232
4082.868159 14001.5594 25125.59298 14337.03277 15952.46827 20964.99796
22595.69201 7972.683873 2822.623079 247.382551 128.7268714 320.6338338
8.771692732 0 0 0 0 0 0 0
2001 1 1 3 2 414 0 0 0 0 0 0 0 98.45342128 229.515619 256.8086066
939.6116697 3868.880871 8571.562457 28698.37361 23331.90127 12215.19313
5769.840956 6677.442777 4649.257723 2805.594601 3182.262006 1633.655822
45.5817802 11.68381545 0 0 0 0 0 0 0 0 0 0 0 0 0 900.3010216
24.0847712 515.3800473 5430.710939 14289.3297 27570.50737 19732.35877
9154.347072 7886.444737 2883.275938 935.2624458 265.1750717 0 0
239.5784223 0 0 0 0 0 0 0
2002 1 1 3 2 465 0 0 0 0 0 0 0 0 73.10877137 888.1160194 780.9517586
1168.403139 1371.476616 3912.487961 11477.38816 13368.70389 6756.38843
7107.882631 7720.386404 8438.388323 4660.849212 1414.137979 180.7423876
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 119.1807953 1931.908724 742.1814415
1029.805559 2899.937055 8504.48582 14710.2639 15595.04878 7281.867592
3750.924314 1026.863202 174.1151593 16.30908527 0 6.886015324 0 0 0 0 0
0 0
2003 1 1 3 2 447 0 0 0 0 0 0 0 55.47202386 61.3153053 497.579823
777.4645804 420.3972089 304.2232987 1472.739932 3892.599266 10846.30559
10591.94437 5825.811646 5163.220115 3788.259728 3250.97205 791.1524111
310.6463079 77.22223713 2.453951259 0 0 0 0 0 0 0 0 0 0 0 7.380137284
50.03366363 273.7357506 857.9396586 253.2137808 583.8481162 1102.674829
2301.607431 8877.69235 10270.18083 6993.85228 2367.392663 1026.857383
254.1683441 105.5843277 93.16719109 0 0 0 0 35.51234376 0 0 0
2004 1 1 3 2 442 0 0 0 0 0 0 0 0 0 7.820057555 13.95604918 1671.473513
1201.21513 4129.984301 5967.002692 14212.7303 19490.70047 17465.925

17545.37742 9638.770314 5771.516339 4156.487504 777.9788119 205.299332
0 0 0 0 0 0 0 0 0 0 4.361265369 0 0 0 0 0 1323.509781 1180.072934
4390.745747 6283.950158 16097.78185 27771.73029 20267.50165 8084.037989
2385.897065 129.2195218 328.5869928 8.966319607 0 0 0 0 0 0 0 0
2005 1 1 3 2 366 0 0 0 0 0 0 0 0 0 0 13.83312229 419.29725 1374.197774
3811.05922 7566.426316 8019.771671 7363.17275 9242.667527 9167.340427
5955.395213 2975.191049 1164.207436 952.5947721 297.6569745 12.17605144
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 134.958047 390.691454 1743.819494
3989.326886 10984.71012 8759.482055 11567.27129 9501.665034 4069.809681
1017.414724 260.2380605 33.53544675 9.183343872 0 0 0 0 0 0 0 0
2006 1 1 3 2 546 0 0 0 0 0 0 0 0 0 2.535724212 12.67862106 367.8437747
1477.261761 5672.102616 14401.82392 9808.797021 8034.218767 6797.77114
4772.038367 2656.635891 2336.471471 408.2970917 92.10145849 33.27751318
0 0 0 0 0 2.356609392 0 0 0 0 0 0 0 0 0 3.571273065 19.29238269
315.9327471 2553.20895 11973.46777 14342.08643 12876.86173 9712.093036
3234.499669 949.6875876 112.8540224 34.01571644 0 0 0 0 0 0 0 0 0
2007 1 1 3 2 755 0 0 0 0 0 0 0 0 0 0 16.20022078 84.20798731
924.7681442 5025.685071 16250.79128 17509.43215 12682.80421 10468.6259
7502.163569 5115.738911 4347.217389 1710.521423 767.0686912 100.1967878
27.77162104 0 0 0 0 0 0 0 0 0 0 0 0 3.555099688 0 0 155.1423317
1918.227203 8081.31455 17910.78017 15432.47164 11569.29542 5648.211665
2662.020369 1189.477874 12.0102565 19.35107122 0 0 0 0 0 0 0 0
2008 1 1 3 2 862 0 0 0 0 0 0 0 0 0 45.00993237 144.1612213 221.6201213
216.5234063 703.8634581 3790.365112 14605.68468 17654.61118 9922.796516
7933.01702 6649.269802 4436.618348 2649.191243 1583.465007 303.6195616
0 113.9071865 0 0 0 0 0 0 0 0 0 0 0 0 7.288667321 10.51568009
56.52812198 172.6595669 219.0552117 845.9550215 8125.555005 17692.0499
16007.08773 10333.20927 3667.709569 851.5336051 76.3822032 81.63804814
29.17354427 0 0 0 0 0 0 0 0
2009 1 1 3 2 805 0 0 0 0 0 0 0 0 0 5.63600829 0 15.04178102 343.2334731
1293.729679 4033.523774 11532.84432 29230.42614 18341.44942 10747.08287
11108.63709 9030.42607 4780.539062 1743.526889 602.7859769 8.876713057
43.43483722 0 0 0 0 0 0 0 0 0 0 0 0 0 0 94.18415293 88.54814464
1122.143637 1313.657488 7160.482642 20772.37349 25458.41761 17011.84047
5416.139593 2264.288446 762.8336623 40.07770926 0 285.0731189
43.43483722 0 0 0 0 0 0
2010 1 1 3 2 710 0 0 0 0 0 0 0 0 0 0 0 0 2.938559556 871.4868402
2349.919546 7737.851044 23340.35825 33043.60796 14938.52084 9550.157533
7730.829271 4803.614526 2923.024511 518.2779033 131.8088024 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 13.67701791 72.02619285 1262.634685 4172.940086
12779.8238 27926.54768 20229.5049 8177.606419 2168.877381 281.4688059
22.88020712 48.26182238 36.14291093 0 0 0 0 0 0 0
2011 1 1 3 2 770 0 0 0 0 0 0 0 0 0 124.8975817 183.4978396 127.5033334
224.8808942 706.5029049 3786.970811 7550.829697 11290.08093 14042.60676
10050.52776 4472.705726 3852.842776 2745.929209 1211.398998 67.73443565
63.19403468 0 24.34807515 0 0 0 0 0 0 0 0 0 0 0 0 114.2171507
99.25731101 233.377395 254.8927127 1564.967135 6997.342681 12122.97039
15642.1529 17457.09178 5496.853786 1517.507651 346.6821701 34.06068313
188.7718207 0 0 0 0 0 0 0 0 0
2012 1 1 3 2 713 0 0 0 0 0 0 5.68055158 0 5.68055158 63.45263041
253.4642348 766.2041045 2403.912426 6521.496097 13026.22642 11442.8661
6517.144365 5613.273006 5036.736004 3871.127235 2111.535271 943.2362276
159.8531643 4.265925111 0 0 0 0 0 0 0 0 0 0 0 0 5.68055158 0 0
20.14714134 177.2450199 791.6601281 3691.681814 12245.239 12421.13267
12542.2884 9565.71784 3744.539384 1021.965278 149.102855 13.15661265 0
0 0 0 0 0 0 0 0

2013 1 1 3 2 643 0 0 0 0 0 0 5.23615074 44.72821744 34.22596042
45.80265783 105.4981556 652.0650521 2967.35351 5305.540766 13380.16397
18492.10702 9648.102628 6234.406074 3039.597167 1267.346704 1015.696542
282.7244038 576.9867847 0 0 0 0 0 0 0 0 0 0 20.81007809 0 0 13.09037685
24.20265231 19.81174523 60.13518029 66.78306194 1683.139206 6444.500385
11337.81835 26554.36362 26091.69564 16896.42513 5176.810386 722.5956886
23.24208184 9.373636039 0 41.62015618 0 0 0 0 0 0 0
2014 1 1 3 2 456 0 0 0 0 27.68209061 115.7692998 124.2411029
5.197630222 55.59986522 169.3606284 994.3239549 948.5302265 2505.43379
7973.451798 11167.77223 8741.241464 6552.678286 4869.956121 3740.2736
2096.513239 2821.375944 588.8562528 111.0604088 164.9340638 0 0 0 0 0 0
0 0 0 0 17.08300153 158.2058695 5.197630222 0 0 104.5744238 785.2862514
693.5389749 4252.260269 11635.2918 15456.14195 15955.21218 8277.182698
3644.655449 1049.312887 78.77008893 22.45662458 19.84088675 0 0
86.69966172 0 0 0 0 0
#Shoreside discard from Pikitch study (N=3)
#year season fleet gender partition Nsamp
1986 1 1 0 1 15 0 0 0 0 0 0 0 0 0.00356613 0.10821618 0.143878405
0.158533106 0.160475842 0.38610291 0.035661298 0.00356613 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00356613 0.10821618 0.143878405
0.158533106 0.160475842 0.38610291 0.035661298 0.00356613 0 0 0 0 0 0 0
0 0 0 0 0 0 0
#Shoreside discard from WCGOP (N=11)
2003 1 1 0 1 35 0 0 0 0 0 0 0 0 0 0 0 18125.71547 43693.3428
37933.97894 141540.985 144180.586 91656.22165 26662.17594 25275.03648
4061.375892 1296.318555 798.8584201 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 18125.71547 43693.3428 37933.97894 141540.985 144180.586 91656.22165
26662.17594 25275.03648 4061.375892 1296.318555 798.8584201 0 0 0 0 0 0
0 0
2004 1 1 0 1 588 492.2865079 11583.32098 785.1511195 4256.190468
4185.581958 801.0305665 3710.636995 4873.655025 1235.047373 1795.173626
4871.369573 4941.037795 5119.066828 9149.682972 24705.07507 37967.54885
34948.67289 15737.58489 21643.94234 8088.331648 3139.469501 1585.852456
21.24464156 0 0 0 0 0 0 0 492.2865079 11583.32098 785.1511195
4256.190468 4185.581958 801.0305665 3710.636995 4873.655025 1235.047373
1795.173626 4871.369573 4941.037795 5119.066828 9149.682972 24705.07507
37967.54885 34948.67289 15737.58489 21643.94234 8088.331648 3139.469501
1585.852456 21.24464156 0 0 0 0 0 0 0
2005 1 1 0 1 467 191.2955394 973.3083282 6771.132401 3736.2099
5907.301748 3417.180497 4063.571004 3509.434352 1156.007417 1203.160481
602.2472449 3442.073048 6436.194532 15615.2667 25878.34742 20303.8494
23352.66283 11969.48713 416.7526041 257.1150884 124.7472788 320.8178646
91.77428845 0 0 0 2.88562936 0 0 0 191.2955394 973.3083282 6771.132401
3736.2099 5907.301748 3417.180497 4063.571004 3509.434352 1156.007417
1203.160481 602.2472449 3442.073048 6436.194532 15615.2667 25878.34742
20303.8494 23352.66283 11969.48713 416.7526041 257.1150884 124.7472788
320.8178646 91.77428845 0 0 0 2.88562936 0 0 0
2006 1 1 0 1 297 0 0 721.5172066 5387.198081 16884.5303 18879.48349
13157.10105 26365.87896 21830.49601 15525.22967 5493.11252 5503.044497
9381.344454 83217.4412 107878.8052 140143.6355 73504.90077 46765.54047
12754.03451 37231.14998 8387.644461 1845.628348 0 2.851676101 0 0
2083.92126 0 0 0 0 0 721.5172066 5387.198081 16884.5303 18879.48349
13157.10105 26365.87896 21830.49601 15525.22967 5493.11252 5503.044497
9381.344454 83217.4412 107878.8052 140143.6355 73504.90077 46765.54047
12754.03451 37231.14998 8387.644461 1845.628348 0 2.851676101 0 0
2083.92126 0 0 0

2007 1 1 0 1 351 1711.464489 14065.68507 10492.63785 26240.77309
30948.59295 22881.52345 28305.3371 18889.65063 13960.05379 6582.851085
4297.367641 10716.32386 7356.193552 28766.12038 68921.25543 177158.0357
89297.07946 82594.58824 19168.48552 28445.46659 9776.548416 39.92306157
0 16.75488041 0 0 0 0 0 0 1711.464489 14065.68507 10492.63785
26240.77309 30948.59295 22881.52345 28305.3371 18889.65063 13960.05379
6582.851085 4297.367641 10716.32386 7356.193552 28766.12038 68921.25543
177158.0357 89297.07946 82594.58824 19168.48552 28445.46659 9776.548416
39.92306157 0 16.75488041 0 0 0 0 0 0
2008 1 1 0 1 403 1229.015972 38271.09937 33079.10746 13257.30465
11435.33745 10815.16853 10173.81903 7162.941323 6951.79248 3105.28079
3373.504639 13839.04442 29593.40794 37689.29807 151194.3213 180807.5514
90919.33697 92602.3674 55337.39912 16467.7628 13192.09413 22953.74798
535.4291992 0 0 0 0 0 0 0 1229.015972 38271.09937 33079.10746
13257.30465 11435.33745 10815.16853 10173.81903 7162.941323 6951.79248
3105.28079 3373.504639 13839.04442 29593.40794 37689.29807 151194.3213
180807.5514 90919.33697 92602.3674 55337.39912 16467.7628 13192.09413
22953.74798 535.4291992 0 0 0 0 0 0 0
2009 1 1 0 1 528 0 17496.25267 20007.28026 46396.89454 105456.6639
55915.66476 22299.64622 14687.54041 25138.78663 19353.73395 21502.29334
14157.6506 10885.26704 26213.45841 93860.70172 259368.4409 122479.6073
29165.06252 8666.149873 20825.80354 2807.108918 20034.35491 46.88595468
0 0 0 0 0 0 0 0 17496.25267 20007.28026 46396.89454 105456.6639
55915.66476 22299.64622 14687.54041 25138.78663 19353.73395 21502.29334
14157.6506 10885.26704 26213.45841 93860.70172 259368.4409 122479.6073
29165.06252 8666.149873 20825.80354 2807.108918 20034.35491 46.88595468
0 0 0 0 0 0 0
2010 1 1 0 1 432 265.1502678 14522.25019 11270.46272 16872.47356
15124.59697 17871.71501 34892.02619 35428.09221 13266.89317 4363.486512
2108.926053 8418.14998 19212.87228 163217.1012 173970.1929 141012.3375
85615.56357 50239.74089 11352.67941 34802.01657 636.8145826 1072.340436
1946.999332 430.7480145 126.428528 0 0 0 0 0 265.1502678 14522.25019
11270.46272 16872.47356 15124.59697 17871.71501 34892.02619 35428.09221
13266.89317 4363.486512 2108.926053 8418.14998 19212.87228 163217.1012
173970.1929 141012.3375 85615.56357 50239.74089 11352.67941 34802.01657
636.8145826 1072.340436 1946.999332 430.7480145 126.428528 0 0 0 0 0
2011 1 1 0 1 713 4475.222052 13505.05362 4700.455931 7484.427016
18282.67289 8682.339938 3901.159389 3389.839855 2678.65781 5255.439001
1577.402031 704.6185124 309.2855351 281.3620085 140.5220748 113.6021052
133.0278439 219.9149925 12.6408788 8.532265816 5.552726563 9.527116914
0.910283043 0 0.455141522 0 0.910283043 0 0 0 4475.222052 13505.05362
4700.455931 7484.427016 18282.67289 8682.339938 3901.159389 3389.839855
2678.65781 5255.439001 1577.402031 704.6185124 309.2855351 281.3620085
140.5220748 113.6021052 133.0278439 219.9149925 12.6408788 8.532265816
5.552726563 9.527116914 0.910283043 0 0.455141522 0 0.910283043 0 0 0
2012 1 1 0 1 702 589.2659296 8264.209948 19236.57201 42654.36039
38529.65248 14795.28885 12804.45481 8803.743267 4675.699175 3361.761251
3473.152237 3189.632466 2331.491247 1131.666292 349.0090361 411.9314556
297.6992118 65.54536521 201.8034174 58.7194112 61.06497922 19.09805152
6.820732687 4.934303085 0 0 0 0 0 0 589.2659296 8264.209948 19236.57201
42654.36039 38529.65248 14795.28885 12804.45481 8803.743267 4675.699175
3361.761251 3473.152237 3189.632466 2331.491247 1131.666292 349.0090361
411.9314556 297.6992118 65.54536521 201.8034174 58.7194112 61.06497922
19.09805152 6.820732687 4.934303085 0 0 0 0 0 0
2013 1 1 0 1 587 3642.187875 97558.60703 42169.89532 12334.65296
18555.01198 7129.074919 5359.112783 9231.576449 5561.244619 8848.482673
5089.134241 4526.431325 5519.855294 750.7353682 178.8423452 217.3211635

263.2365595 156.8849432 1.137100698 0.591218345 0 0 0 0 0 0 0 0 0 0
3642.187875 97558.60703 42169.89532 12334.65296 18555.01198 7129.074919
5359.112783 9231.576449 5561.244619 8848.482673 5089.134241 4526.431325
5519.855294 750.7353682 178.8423452 217.3211635 263.2365595 156.8849432
1.137100698 0.591218345 0 0 0 0 0 0 0 0 0 0
#AtSeaHake (N=12)
#year season fleet gender partition Nsamp
2003 1 3 3 0 255 0 0 0 0 0 0 0 0 72 375 241 596 459 219 41 124 115 80
32 110 103 54 0 98 0 0 49 0 0 0 0 0 0 0 4 3 0 3 85 316 314 527 492 140
134 115 95 77 67 52 0 0 0 0 0 0 0 0 0 0
2004 1 3 3 0 386 0 0 0 0 0 0 0 0 0 12 109 522 601 723 591 222 167 166
152 152 47 16 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 23 166 452 606 802 564
287 277 237 93 33 13 6 0 0 0 0 0 0 0 0
2005 1 3 3 0 815 0 0 0 0 0 0 0 0 0 0 508 127 578 1392 1374 587 379 249
331 261 174 27 16 1 2 0 0 0 0 0 0 0 0 0 0 0 0 3 0 12 27 715 654 848 781
518 421 315 103 15 13 0 7 0 0 0 0 0 0 0
2006 1 3 3 0 811 0 0 0 0 0 0 0 0 0 0 23 35 148 579 1056 1079 732 391
328 266 163 39 29 0 1 2 1 0 0 0 0 0 0 0 0 0 0 0 1 1 13 24 184 750 983
922 810 506 233 33 19 9 6 5 0 0 0 0 0 0
2007 1 3 3 0 734 0 0 0 0 0 0 0 0 3 1 12 68 146 829 1522 1088 483 374
202 177 161 18 14 4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 5 20 57 261 896 1431
806 615 331 75 46 3 5 0 0 6 0 5 0 0 0
2008 1 3 3 0 500 0 0 0 0 0 0 0 0 0 0 25 4 30 47 235 567 245 343 167 139
100 41 9 2 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 6 22 24 93 353 552 262 181
131 36 15 10 0 3 0 0 0 0 0 0
2009 1 3 3 0 59 0 0 0 0 0 0 0 0 0 0 0 0 3 0 4 4 15 17 14 14 25 20 10 6 2
2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 14 32 6 25 4 5 0 0 0 0 0 0 0 0
0 0
2010 1 3 3 0 496 0 0 0 0 0 0 0 0 0 2 13 8 37 111 151 229 357 262 307
681 143 77 10 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 94 120 175 347 625
383 229 28 15 2 2 0 0 0 0 0 0 0
2011 1 3 3 0 511 0 0 0 0 0 0 0 0 0 0 0 7 55 252 744 1083 1180 514 532
272 132 38 6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 7 5 117 747 1032 1474
1930 924 182 8 3 0 0 0 0 0 0 1 0 0
2012 1 3 3 0 310 0 0 0 0 0 0 0 0 0 4 97 170 134 83 92 87 48 68 76 108
86 40 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 106 178 162 89 71 72 49 28
31 13 0 0 0 0 0 0 0 0 0 0
2013 1 3 3 0 429 0 0 0 0 0 0 0 0 2 0 6 198 474 474 312 292 199 194 176
161 139 91 24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16 210 522 467 380 209
317 288 54 12 35 4 2 0 0 0 0 0 0 0 0
2014 1 3 3 0 643 0 0 0 0 0 0 0 0 0 7 11 16 159 744 1177 1100 349 614
265 163 171 64 24 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 11 43 173 967 749
305 626 225 155 29 11 8 4 0 1 0 0 0 0 0 0
#AKSHLF (N=9)
#year season fleet gender partition Nsamp
1980 1 4 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 4 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 4 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 4 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 4 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 0.108972336
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 4 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 4 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 4 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 4 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
1997 1 5 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
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 5 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 5 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 5 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
2000 1 6 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 6 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 6 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=12)
#year season fleet gender partition Nsamp
2003 1 7 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 7 3 0 165 0 0 0.02051891 0.228399848 0.364505231 0.584743225
1.0269105 1.535332522 2.546528787 2.283901975 8.960084879 13.90709251
6.581359129 3.836843176 1.565445546 0.757853752 0.530830297 0.255805798
0.39359231 0.085270292 0.116333078 0 0 0 0 0 0 0 0 0 0 0 0.073964576
0.165217857 0.571629407 0.955322867 0.386720507 1.886017963 1.11142403
4.286847252 11.56687527 16.66380807 8.118042648 3.48163748 1.310670773
1.438786987 1.242750133 0.83797908 0.198693138 0.122260199 0 0 0 0 0 0
0 0 0 0
2005 1 7 3 0 250 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 7 3 0 266 0 0.023436132 0.064525302 0.077540183 1.189453787
1.128141315 2.094356016 4.772734362 6.340162952 6.331961475 2.693426072
2.116004647 2.601305484 6.67795986 4.73818184 3.66330924 2.043225293
2.502140037 0.93557599 0.850698872 0.19041565 0.047444731 0 0 0 0 0 0 0
0 0 0.023436132 0.064531144 0.203477263 1.160129415 1.493469252
1.375219597 4.830769748 5.324856214 6.589017053 2.373241312 2.374199319
4.097572818 6.492123953 5.208616038 4.409924115 1.83525591 0.983937838
0.078223639 0 0 0 0 0 0 0 0 0 0 0
2007 1 7 3 0 279 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 7 3 0 227 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 7 3 0 288 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 7 3 0 275 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 7 3 0 237 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 7 3 0 258 0 0 0.008307491 0.008307491 0.188935532 0.113834052
0.604845826 2.374385447 1.491594811 4.171217508 15.72282417 9.462616292
4.557474851 3.098684542 2.799220936 1.787950987 0.937195875 0.866812268
0.538414265 0.341335123 0.348296901 0.151655825 0.144845322 0 0 0 0 0 0
0 0 0 0.008307491 0.008307491 0.215210019 0.105485591 0.653660212
2.964138492 1.960466934 5.250850919 15.08043706 9.68348965 3.944857298
3.655094168 2.850682626 1.336670827 1.464056551 0.774818471 0.236032322
0.088678365 0 0 0 0 0 0 0 0 0 0
2013 1 7 3 0 198 0 0 0.043304949 0.045665406 0.222147659 0.15247381
0.493420632 1.947170026 4.623905041 5.469994001 2.255716668 1.091679629
1.775480486 2.134166631 5.192896175 3.769823738 5.037352875 3.591627237
4.21630001 3.370336702 1.803545684 0.526704861 0.207311787 0 0 0 0 0 0
0 0 0 0.043309437 0 0.318365423 0.235215432 0.377188353 1.861165948
3.535389141 5.867757814 2.573682698 2.082689836 2.024091284 2.456454181
6.866894991 8.164598478 8.991278742 4.954979232 1.617639555 0 0
0.058275448 0 0 0 0 0 0 0 0
2014 1 7 3 0 221 0 0 0 0.108417551 3.12842498 4.383911155 2.039572563
1.82705606 2.122707144 2.944636267 2.246060631 1.339871703 3.174842049
4.352624893 5.014501877 5.758576801 4.07636664 2.000365729 0.848067013
0.356664637 0.317935552 0.26733818 0.046806812 0 0 0 0 0 0 0 0 0 0
0.069707324 2.91055266 6.137739636 4.003861971 1.990559306 2.123706644
2.700418615 2.510287158 1.754331375 4.705209807 10.72917608 8.688528578
3.366796495 1.344900638 0.495620395 0.113855087 0 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
#1-Betty, 2-everyone else
# Ageing error for "bkamikawa" in the ageing error "Late" 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
0.101891 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 "jmenkel" from the DoubleReader column in the ageing
error "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

858 # Number of age comp observations
3 # Age-Length Bin Option (1=poplenbins; 2=datalenbins; 3=lengths)
0 # Combine Males & Females Below this Bin
#Shoreside marginal ages (N=32)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
1980 1 1 3 2 2 -1 -1 54 0 0 0 0 0 396.7091604 2994.065271 5433.404842
5163.456997 8143.022515 598.4784523 2808.304344 5659.23706 2119.311429
2137.870281 2944.812271 0 3969.379238 6013.318569 3679.166747 0
4613.490771 3300.664851 2773.806072 0 273.4001246 2952.721346
2180.639394 0 0 11459.37094 0 1502.818749 2132.520972 2520.358577
24187.93344 0 0 0 0 0 1324.20756 0 16772.91061 7321.022546 9033.56595
4105.298696 6909.960335 4278.012008 2181.144644 2181.144644 201.769292
7312.435354 0 185.206536 820.2003738 2376.084512 1700.158203 2806.05022
820.2003738 0 0 0 2132.520972 820.2003738 211.2434432 0 396.7091604 0
820.2003738 0 6074.041497
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2006 1 1 3 2 1 -1 -1 392 0 0 0 31.31496261 42.61868223 389.4484632
7447.392171 16712.14455 9345.5593 4563.276977 4565.393944 3129.326055
3007.953161 864.9566509 839.6354115 1371.602745 419.8448463 1042.306111
941.5154198 1166.045673 620.2718639 342.3733098 565.2759309 598.4905331
565.1002224 821.8384077 358.0125354 93.02559968 387.4397183 515.0706174
282.6134748 278.6103643 68.89327536 18.41146271 32.78998043 1357.051207
0 0 0 9.745126887 23.12540009 1408.477085 8168.129564 13185.34069
9596.101059 4050.815891 5242.040283 4320.34318 1073.545637 1071.386942

292.2771558 1895.262882 922.203307 494.8875567 1030.762019 769.6100326
594.8262531 454.1769169 572.2246205 590.7291381 376.1505025 991.9006717
691.6660338 204.7993249 201.7087021 88.36908511 413.5736159 312.2533231
19.42292533 21.55205368 227.2141943 390.2446904
2007 1 1 3 2 1 -1 -1 472 0 0 0 0 9.626799418 890.4159927 7143.250539
16679.78243 13814.37497 7676.771605 4717.097251 5628.100871 2743.348388
2591.960172 2136.302774 838.6277688 860.1900612 2151.232814 1679.310471
766.3664221 2132.011108 2386.135832 538.3614694 1062.825741 1190.681801
1880.380019 1087.179519 875.6575699 1408.889965 1287.547818 81.54221317
705.0035272 598.6773485 682.5573139 177.446581 1676.982224 0 0 0 0
9.626799418 699.8775553 5312.367135 13582.84203 8736.433267 5753.723556
4237.370568 4067.085733 2994.319213 1522.66902 1214.177044 565.4537256
478.1550144 1628.473425 852.1792936 889.7322747 1219.340342 777.1265301
787.7093208 1450.6883 360.9379839 1053.754715 249.0208509 271.5962644
291.1788955 229.9160584 104.9701284 24.46896449 442.6691156 102.5233983
820.4107618 2763.471321
2008 1 1 3 2 1 -1 -1 487 0 0 0 61.82995593 414.8149926 231.9712341
1677.029285 8348.669977 13411.23275 9460.82007 4819.915903 2853.81991
2874.283174 2952.1925 1721.546916 1055.659307 838.9525867 1058.78576
1231.661012 962.3809863 987.4335482 1790.115244 1097.01155 948.2166831
703.7823621 1040.331517 816.0198361 765.1513021 1060.999471 650.763878
274.4379433 517.8416241 163.0185405 225.4357192 392.7195887 2099.013592
0 0 0 23.76924483 275.2355918 438.1525165 3374.46378 9840.269716
13236.9716 7213.425825 3522.425387 2459.00829 3521.87718 1846.440671
909.0559651 798.9460292 3845.669467 732.2197537 655.3387898 617.8139903
960.6460694 278.6902707 405.8311605 679.8004598 892.4986851 101.7165653
386.8449245 366.8175732 234.9471743 329.6230624 302.9545213 152.4147745
40.71887296 2611.321065 78.64079744 713.533424
2009 1 1 3 2 1 -1 -1 499 0 0 0 6.134307606 30.35072283 216.6744251
686.5187226 1373.807368 5893.879601 7591.454542 12312.81458 4597.004105
2943.295262 2127.741655 2244.658159 1625.947085 1424.446791 1244.147967
1096.169433 1076.309352 1020.695171 1040.56111 773.2028959 833.827079
940.4316549 672.9401809 1580.586498 620.9429942 600.6641517 403.9170818
410.1203344 246.971319 164.6037482 329.4040632 109.4089772 2436.693679
0 0 0 4.827242284 18.23408866 162.5961027 429.2716033 979.8316477
5076.21196 6017.461096 9248.118534 4010.09549 2994.014057 1929.106402
2300.522471 1918.990613 1165.069921 362.5397414 569.6181507 738.9531323
699.3969812 699.7551883 1165.182494 195.2751386 1086.278353 657.9033106
350.3913302 228.5421287 591.1881778 501.7200086 354.916522 208.1082218
158.1695195 100.1809686 190.6642845 1091.336515
2010 1 1 3 2 1 -1 -1 357 0 0 0 0 0 312.938336 3708.863824 3225.208191
4161.638474 9505.71407 18057.62908 16812.09793 6689.169086 5538.46748
6057.257301 1674.036999 2768.211346 2540.932523 1840.962661 1502.990866
2360.885871 1222.847657 949.5724524 546.1673398 1297.09486 1075.655352
1599.988432 1026.20513 475.1819898 1248.987175 671.850667 244.0125652
664.9362501 708.4035707 178.8049718 5754.788007 0 0 0 9.550455742
16.59143899 295.4403893 1980.517325 3536.883325 5521.383943 6611.962051
9908.992578 11308.23925 5489.993511 4135.170866 3960.659428 3681.100822
2131.774082 1398.124207 1088.313658 1285.458127 489.6442781 1073.941281
1445.729533 509.5717909 1015.205382 638.3172148 719.7353917 372.4265073
726.2419682 758.5818082 1040.826216 782.1350401 393.4789394 119.6368555
138.1453522 1641.762574
2011 1 1 3 2 1 -1 -1 392 0 0 0 314.3468001 59.55958889 612.8166458
2662.648073 6490.263053 7173.331061 4043.187049 3532.770696 6539.03018
8620.027031 2707.254925 1633.71887 1434.84827 1597.856118 1010.450518
571.197286 517.1082676 770.7821552 181.3262242 437.2456186 709.5727684
417.8220909 658.6059842 196.2343285 399.9640643 364.6572892 286.2264889

414.3759396 795.7677022 287.0817558 341.0020694 531.2748129 2217.7114 0
0 0 335.7536353 174.2974666 912.0797093 2753.116837 6199.210543
4005.783539 6425.116773 2838.728482 4530.31761 9846.311802 2431.523637
1297.988929 2249.0219 2856.362456 2526.091815 913.6595155 682.6564858
1089.703781 709.0491929 927.2936723 981.2843648 657.0979424 682.659318
656.5743038 235.7467168 211.2361979 163.8513676 672.3379351 343.6014315
174.9257691 49.57841341 35.23703667 1729.765173
2012 1 1 3 2 1 -1 -1 401 0 0 6.289766517 87.89441022 611.5446266
1618.86124 7369.263199 11239.42256 8275.607803 4642.933444 2252.8703
1289.174638 2000.065398 2865.040647 676.8652992 1179.408497 1138.005498
842.6808805 924.2547388 50.2821319 247.6008895 440.36082 253.6090906
261.5166938 1126.531155 627.9342015 396.3012369 438.2971375 218.7862643
275.5539218 248.2176575 60.58350844 319.6358164 95.82719296 387.1387512
2126.534682 0 0 6.289766517 3.705138033 494.515969 1127.95312
9255.84604 12370.72019 7521.038749 3427.793727 2243.806182 2052.315965
2983.081391 3114.113014 779.0489953 1113.308988 999.80428 918.7551575
862.0175609 369.5978672 590.2985347 328.5125821 318.5104379 1033.677655
263.4657341 373.8076379 231.9467089 34.99330187 65.03264538 170.1353477
409.830026 241.0045866 400.0735707 58.64356253 200.8818269 1095.995359
2013 1 1 3 2 1 -1 -1 212 0 0 74.77659457 0 302.3249986 2121.43293
7541.109545 14404.11256 15366.35304 7621.644992 4019.120691 772.1316685
1216.989857 1537.228744 3937.696738 578.9343703 356.4085867 336.4334303
312.1933413 31.72122464 19.99476027 56.48679602 26.91021686 66.51952369
91.7203488 0 25.20082511 46.67820557 0 39.60930684 0 0 0 0 26.91021686
276.4412088 0 0 0 0 1141.127339 8035.623983 7682.357401 20072.79506
15694.4742 13477.2316 4762.48792 4447.040319 3674.61375 5743.373745
7160.894532 1648.178584 2173.313182 538.048702 773.547376 143.9927207
160.1243433 161.5120786 1143.421577 657.2992592 461.6415038 142.7307542
1232.607281 12.85967686 174.5649077 6.520399534 80.44267266 55.94066967
6.966238818 809.0126003 0 443.8521602
2014 1 1 3 2 1 -1 -1 148 0 0 10.72407565 10.51784343 332.0597391
1203.741274 780.9065976 1987.139194 1006.160575 1523.431231 153.9393933
40.46696838 22.74060032 38.64753674 88.32221387 45.48378558 67.61557577
29.66786961 148.6575298 471.8717399 19.00370925 294.5414201 184.9733633
95.53743992 7.086490253 10.11310882 0 28.03467612 0 69.9352438
73.10991641 70.53090505 0 0 200.5139751 218.7233535 0 0 21.4481513 0
144.6285644 816.1391085 1057.687533 969.8895871 1875.31454 393.5227017
992.6678156 111.2042425 582.5620408 14.07027161 129.953751 583.1111241
377.7403751 212.6671119 47.64290721 0 182.2752732 29.86493416
69.57597344 0 29.60934047 10.32372216 18.77167649 11.48500144 0 0 0 0 0
76.89434644 65.2844967 11.08154484
#Shoreside WCGOP discard marginal ages (N=2)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2004 1 1 0 1 1 -1 -1 119 40.53333333 118.5083333 86.08333333
47.50454545 264.6490385 235.5920611 69.37884184 186.8956317 109.6045821
22.05515763 1 30.5 124.0417898 0 113.3417898 20.95 2 7.25 6 14.8 1 1 0
1 0 4.25 13.8 1 0 106.3417898 0 0 0 0 0 9 40.53333333 118.5083333
86.08333333 47.50454545 264.6490385 235.5920611 69.37884184 186.8956317
109.6045821 22.05515763 1 30.5 124.0417898 0 113.3417898 20.95 2 7.25 6
14.8 1 1 0 1 0 4.25 13.8 1 0 106.3417898 0 0 0 0 0 9
2005 1 1 0 1 1 -1 -1 199 26.27659574 97.83333333 273.9172368
90.56079787 146.8397655 800.3860846 447.6208075 446.5661499 507.7537767
145.9142857 207.95 25.66687321 239.3327273 44.88695652 7.665714286 8
6.95 126.2 3 3.013003096 4 0 0 4 1 2 6.732727273 0 0 0 0 1 0 11 0 5
26.27659574 97.83333333 273.9172368 90.56079787 146.8397655 800.3860846
447.6208075 446.5661499 507.7537767 145.9142857 207.95 25.66687321

```
239.3327273 44.88695652 7.665714286 8 6.95 126.2 3 3.013003096 4 0 0 4
1 2 6.732727273 0 0 0 0 1 0 11 0 5
#AtSeaHake marginal ages (N=9)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2003 1 3 3 0 1 -1 -1 195 0 0 0 654.1458109 1598.764825 659.6128328
122.0581864 67.23228649 143.6748583 12.90112818 293.446569 2.935981159
0 305.1520287 6.321645121 299.0772512 6.194657398 26.35035175 0 0
3.051586445 3.051586445 5.630682247 0 0 0 1.04236795 0 0 4.042146877 0
0 0 0 0 8.682268692 0 0 93.04204614 697.3660439 1373.081067 310.2603019
64.66565268 18.02543052 29.90898566 58.4205221 0 3.351615636 0
60.88069016 0 6.077493093 0 9.569728084 0 0.91997054 14.30326035 0 0 0
9.569728084 6.942397133 18.3288821 0 0 0 0 0 0 0 0 0
2004 1 3 3 0 1 -1 -1 302 0 0 0 0 1449.361565 2256.567344 1042.436236
307.7395505 88.61769728 112.2007505 11.21685398 129.808722 0
13.42648922 19.8160453 35.06490633 28.83935668 40.02153794 3.229884956
2.399846359 21.25004648 0 7.977604573 3.510176213 0 24.7602227
23.95438118 3.096566972 0 3.510176213 0 0 0 0 3.175910645 9.521778684 0
0 0 2.832916734 1282.781874 1885.59874 1084.254532 252.8504246
26.81676854 232.4986306 53.4663576 24.57226768 74.19271057 14.6471907
10.2169859 17.57580517 18.92375097 20.05527286 31.40738671 2.900585013
0 24.16218873 59.53347034 21.46630285 56.94379836 34.96441544
5.010306067 2.819893979 20.37863305 0 2.741001064 0 3.22091282 0 0
11.33183462
2005 1 3 3 0 1 -1 -1 493 0 0 0 0 5.228314597 335.4067372 442.5386344
131.1618296 33.17184054 345.9263618 68.99820137 316.3721234 0
15.45372402 23.41160693 318.6070611 40.49882928 7.199583708 347.00255
65.67870781 1.863688491 2.427931128 5.988518063 36.90428046 22.87219776
10.74747438 1.864905237 0 0 0 0 0 0 311.9794346 2.490721257 0 0 0 0 0
242.9973039 273.5442178 89.62842637 48.59805979 37.77582273 81.028552
87.38214597 1.905613488 0 4.411263011 2.610429435 7.591474109
4.576111822 0 61.41689865 7.131268006 0 28.35717493 1.864452515
85.46071408 0 0 0 2.488280797 0 3.995026711 0 0 0 0 5.850079706
2007 1 3 3 0 1 -1 -1 429 0 0 0 0 5.807154075 2.244856881 65.60407014
857.3988226 534.7341212 218.9850632 71.9032814 0 21.38526676
2.034960972 2.121053354 0 12.07462381 0 0 0 52.01454828 17.53518922 0
10.09206058 0 3.896947778 0 0 0 0 0 0 0 0 0 0 0 0 0 0 15.17385949
103.1188817 448.9731162 117.2825547 81.73164593 20.57568485 41.25748988
24.55114526 70.13857598 0 0 0 0 0 0 6.607992929 0 0 21.21782192 0
7.425751257 1.658875313 3.888554232 3.888554232 3.194622973 0
14.67296129 0 0 0 0
2008 1 3 3 0 1 -1 -1 58 0 0 0 0 0.076801313 0.670576669 0.366247423
20.60934741 26.37541057 9.782200243 8.998118116 5.498016459 4.300396789
4.793146059 2.373042854 3.751252644 1.743393874 3.040567423 4.069476455
2.591709929 0.135216101 7.383114398 1.281133403 0.786478204 1.359566124
0.157304631 1.701756967 2.180804298 1.689567007 0.196155905 1.482336374
0.182489318 1.086932937 0 0 0.767702483 0 0 0 0 1.015068317 0.056933228
4.276110098 17.41485023 23.39004164 18.24387414 2.616471281 5.720932681
3.751029221 1.923605583 2.997488074 0.541493607 2.440006243 0.539672815
1.253095826 2.555500479 1.932406585 0 6.483529664 0.273008344
0.039612299 0.289326375 0.153402193 0 0.239461191 0 0.090453248 0
0.61561889 0 0 0.496863405
2009 1 3 3 0 1 -1 -1 13 0 0 0 0 0 3.371923377 0.101990787 0.142662046 0
1.784367051 0 0.617605174 1.136229325 0.241078078 0.488561138
0.447889878 1.621161235 0.454436877 0.2068118 0.142662046 0.593524169
0.139087291 0 0.040671259 0 0.142662046 0 0.474980647 0.081342519 0 0
0.593524169 0 0 0 1.007147769 0 0 0 0 0 0 0.207163487 0 0.805046145
0.281694059 0.919533764 0.71575642 0 0 0.557185234 0.139107963 0 0 0
```

0.139107963 0 0 0 0 0.101888672 0 0 0 0 0.040697424 0 0.040697424
0.240996635 0 0 0
2011 1 3 3 0 1 -1 -1 55 0 0 0 0 1.189225426 0.275699837 4.755219726
3.050124173 11.66561154 3.526441164 6.270065114 15.19017707 12.08362729
1.448458169 0.55379572 0.267156679 1.385785459 8.061740607 1.541968852
1.278082113 0 0 1.456789301 1.236888764 1.189225426 2.404274955
3.217121544 0.117425259 2.467307539 1.504452639 0.538165602 0.05871263
0.047663339 0 0.045537376 3.926537107 0 0 0 0 0 1.00804855 6.748757243
5.280788409 9.522401932 0.596902607 4.924120847 5.614611987 22.57050454
12.30016944 3.363666741 6.233368943 10.82238825 9.760803537 8.770446709
0.171192129 0.045397989 7.408946105 7.249652766 6.284118391 1.819573017
2.796336175 1.189628247 0.166465642 0.805642065 0.868178856 0
4.099592113 1.514120295 0.111355017 0.058630832 3.249852377
2012 1 3 3 0 1 -1 -1 47 0 0 0 0 0.853502391 2.643938284 0.769293197
1.971783621 1.386107472 0.535743725 0.532307654 0.031288529 0.258349787
0.584959068 0.498359025 0.199406227 0.468237835 0.193116815 0.21448665
0.11586547 1.243958379 0.16453527 0 0.320425324 0.297956654 0.324539587
0.378804014 0.034025616 0.069810537 0.144888367 0.088916952 0.352706721
0.644067794 0.146047062 0.522377635 1.120941286 0 0 0 0 3.967649395
3.802084861 2.071013751 1.269630229 0.45492691 0.474056136 0.232032059
0.108497045 1.184869428 0.231080846 0.088916952 0.034025616 0.080153054
0.187007396 0.318362177 0 0 0.12358652 0.088916952 0.051653951
0.244761165 0.06221929 0.072911334 0 0.088916952 0 0 0 0 0 0
0.151909592
2013 1 3 3 0 1 -1 -1 52 0 0 0 0 0.58680161 2.948513593 0.522309215
0.517377746 0.903157132 0.627814339 0.245650763 2.021736353 0.307701427
0.107405078 0.465336146 0.132837722 0.103222699 0.05123823 0.584161428
0.087665941 0.0300832 0.124229773 0 0.112494063 0.694393635 0.68520051
0.07721729 0.608029127 0 0.104813971 0 0.072671321 0.239164497
0.083291979 0.040937794 0.670923033 0 0 0 0.326424516 0 2.852683009
3.465113678 2.66702249 0.674314422 0.406679646 0.015027632 0.140053754
0.216900789 0.111515431 0.696355891 0.086250048 0.172885674 0
0.381678769 0.081961357 0.056166848 0 0.076767785 0.0300832 0.320435815
0.065359973 0.232294172 0.080639651 0.0300832 0.119188738 0 0
0.035276773 0 0.039701857 0.409182014
#AKSHLF CAAL (N=203)
#AKSHLF females
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
1980 1 4 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 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
1980 1 4 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 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
1980 1 4 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 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 4 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 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
1980 1 4 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 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 4 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 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 4 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 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 4 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
1980 1 4 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
1980 1 4 1 0 2 40 40 5 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 4 1 0 2 42 42 2 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 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 4 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
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1983 1 4 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
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2004 1 4 1 0 2 20 20 16 0 0 62.38378524 32.20799165 5.408223116 0 0 0 0
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32.20799165 5.408223116 0 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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62.28332214 33.23009581 0 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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#AKSHLF males
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
1980 1 4 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
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1983 1 4 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 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

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1983 1 4 2 0 2 34 34 12 0 0 0 0 0 0 0 0 0 16.66666667 16.66666667 0 33.33333333 8.333333333 8.333333333 0 8.333333333 0 0 0 8.333333333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.66666667 16.66666667 0 33.33333333 8.333333333 8.333333333 0 8.333333333 0 0 0 8.333333333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

1983 1 4 2 0 2 36 36 14 0 0 0 0 0 0 0 0 0 0 0 0 7.142857143 0 7.142857143 14.28571429 0 0 7.142857143 14.28571429 14.28571429 0 14.28571429 0 7.142857143 7.142857143 0 0 7.142857143 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.142857143 0 7.142857143 14.28571429 0 0 7.142857143 14.28571429 14.28571429 0 14.28571429 0 7.142857143 7.142857143 0 0 7.142857143 0 0 0 0 0 0 0 0

1983 1 4 2 0 2 38 38 17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.882352941 0 5.882352941 11.76470588 11.76470588 5.882352941 0 0 0 11.76470588 5.882352941 0 0 0 5.882352941 0 0 11.76470588 0 0 23.52941176 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.882352941 0 5.882352941 11.76470588 11.76470588 5.882352941 0 0 0 11.76470588 5.882352941 0 0 0 5.882352941 0 0 11.76470588 0 0 23.52941176

1983 1 4 2 0 2 40 40 6 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 0 0 0 0 16.66666667 0 0 0 0 16.66666667 0 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.66666667 0 0 0 0 16.66666667 0 0 0 0 16.66666667 0 0 0 50

1983 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 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100

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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1995 1 4 2 0 2 36 36 6 0 0 0 0 0 0 0 0 0 19.72696572 0 0 0 19.72696572
0 0 0 39.45393144 0 0 19.72696572 1.365171401 0 0 0 0 0 0 0 0 0 0 0 0 0
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19.72696572 1.365171401 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 49.40322936 0 0 0 1.193541278 0 0 49.40322936 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
1998 1 4 2 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 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
1998 1 4 2 0 2 14 14 2 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0
1998 1 4 2 0 2 16 16 9 0 67.50517789 32.49482211 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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29.14586672 39.16406354 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1998 1 4 2 0 2 20 20 17 0 4.290951818 45.1729004 50.53614778 0 0 0 0 0
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45.1729004 50.53614778 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1998 1 4 2 0 2 22 22 39 0 0 31.58248281 67.62794796 0.789569229 0 0 0 0
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67.62794796 0.789569229 0 0 0 0 0 0 0 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
1998 1 4 2 0 2 26 26 17 0 0 5.002742177 19.7631097 71.65273673
1.491560334 2.089851054 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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2.089851054 0 0 0 0 0 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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40.15728702 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 3.721992091 9.515874823 46.60484607 40.15728702 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1998 1 4 2 0 2 30 30 9 0 0 0 16.89059525 7.272425643 15.27573806
60.56124104 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 16.89059525 7.272425643 15.27573806 60.56124104 0 0 0 0 0 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 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 4 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
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0
1998 1 4 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 0 100
2001 1 4 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 0 100 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 2 0 2 14 14 44 0 94.48203416 5.517965842 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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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 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
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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 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
2001 1 4 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 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 4 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 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 4 2 0 2 26 26 35 0 0 0 5.084223772 46.74657177 43.47154206
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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
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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 0 0
2001 1 4 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 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 4 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
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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
2001 1 4 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 0 100 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
2001 1 4 2 0 2 38 38 1 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
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2001 1 4 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 0
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0 0 0 0 0 0 0 0 0 0 20.53252618 0 0 0 0 0 0 0 0 0 0 0 0 0 79.46747382
2004 1 4 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 4 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 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
2004 1 4 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 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
2004 1 4 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 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 0 0
2004 1 4 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 4 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 4 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
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2004 1 4 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

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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 4 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
2004 1 4 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 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 4 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
2004 1 4 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 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
2004 1 4 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 4 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 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 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
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
1980 1 -4 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 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 -4 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 -4 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 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 -4 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 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 -4 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 -4 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 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 -4 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
#AHSLP CAAL (N=49)
```

```
#AKSLP females
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2000 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 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 5 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 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 5 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 5 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 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 5 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 0
2000 1 5 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
2000 1 5 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 5 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 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
2000 1 5 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 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 5 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 5 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
100 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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 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
2000 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 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
2001 1 5 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
2001 1 5 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
2001 1 5 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
```

2001 1 5 1 0 2 24 24 5 0 0 5.707612438 52.85380622 41.43858134 0 0 0 0
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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
2001 1 5 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
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0 0 0 0 0 0
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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 0 0 66.7570103 0 0 0 0 0 33.2429897 0 0 0 0 0 0
#AKSLP males
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2000 1 5 2 0 2 14 14 2 0 73.02329463 26.97670537 0 0 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2000 1 5 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
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2000 1 5 2 0 2 34 34 1 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 74.81060723 25.18939277
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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
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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
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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
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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 50 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0
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2001 1 5 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
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0 0 0 0 0 0 0 0 100 0 0 0 0

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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
# AKSLP ghost marginal ages (N=2)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2000 1 -5 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 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
2001 1 -5 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 1 0 0 0 1
#NWSLP CAAL (N=91)
#NWSLP females
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2000 1 6 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 0 100 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 6 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 0 100 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 6 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
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0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 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
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0
2000 1 6 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 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
2000 1 6 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 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
2000 1 6 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 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
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2000 1 6 1 0 2 34 34 1 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 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
2000 1 6 1 0 2 36 36 2 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 0 0 0 0 0 0 0 0 0 0
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2000 1 6 1 0 2 38 38 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.33333333 0
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0 0 0 0 0 0 0
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16.66669788 0 16.66669788 33.33320849 0 0 0 16.66669788 0 0 0 0 0 0 0 0
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2000 1 6 1 0 2 44 44 5 0 0 0 0 0 0 0 0 0 24.54034082 0 0 0 0 0 0 0 0 0 0
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0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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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 96.32390612
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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 6 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 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
2002 1 6 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 6 1 0 2 30 30 29 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 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
2002 1 6 1 0 2 32 32 17 0 0 0 0 5.613399463 10.46408011 71.0424801
12.88004033 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 5.613399463 10.46408011 71.0424801 12.88004033 0 0 0 0 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 6 1 0 2 34 34 10 0 0 0 0 12.7152308 0 3.644909081 58.2093985
25.43046161 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 12.7152308 0 3.644909081 58.2093985 25.43046161 0 0 0 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 6 1 0 2 36 36 3 0 0 0 0 0 0 0 54.93609928 0 0 0 0 45.06390072 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 54.93609928 0
0 0 0 45.06390072 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 6 1 0 2 40 40 4 0 0 0 0 0 0 0 0 0 42.27873102 0 0 0 0 0 0 0 0 0
29.81360326 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 27.90766572 0 0 0 0 0 0 0
0 42.27873102 0 0 0 0 0 0 0 0 29.81360326 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 27.90766572
2002 1 6 1 0 2 44 44 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 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
2002 1 6 1 0 2 46 46 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 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 0 33.33333333 0 66.66666667
2002 1 6 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 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
#NWSLP males
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2000 1 6 2 0 2 14 14 2.5 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 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 6 2 0 2 16 16 6.5 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 0 100 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
2000 1 6 2 0 2 20 20 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 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 6 2 0 2 22 22 3 0 0 0 61.31134433 38.68865567 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 61.31134433
38.68865567 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
2000 1 6 2 0 2 24 24 10.5 0 0 0 13.69298568 54.36697131 6.158395111
22.36220361 3.419444287 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 13.69298568 54.36697131 6.158395111 22.36220361
3.419444287 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 2 0 2 26 26 16 0 0 0 0 17.05095367 40.99820139 41.95084493 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
17.05095367 40.99820139 41.95084493 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 2 0 2 28 28 38 0 0 0 0.635279847 5.277527534 41.1226738
42.16771835 10.79680047 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0.635279847 5.277527534 41.1226738 42.16771835
10.79680047 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 2 0 2 30 30 20.5 0 0 0 0 16.87287958 78.01129402 2.23372838
1.706640979 1.175457043 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 16.87287958 78.01129402 2.23372838 1.706640979
1.175457043 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 2 0 2 32 32 7.5 0 0 0 0 0 0 18.34330748 1.283293999 0
26.79113284 0 0 0 0 0 26.79113284 0 0 0 26.79113284 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 18.34330748 1.283293999 0 26.79113284 0 0 0 0 0
26.79113284 0 0 0 26.79113284 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 6 2 0 2 34 34 16 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 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 6.974021578 0 6.974021578 0
0 0 0 0 0 0
2000 1 6 2 0 2 36 36 11 0 0 0 0 0 0 0 0 0 0 0 0 5.945332442 0
5.945332442 5.945332442 0 40.54674239 11.89059808 0 5.945332442
5.945332442 5.945332442 0 0 5.945332442 0 0 0 0 0 5.945332442 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 5.945332442 0 5.945332442 5.945332442 0
40.54674239 11.89059808 0 5.945332442 5.945332442 5.945332442 0 0
5.945332442 0 0 0 0 0 5.945332442 0 0 0 0
2000 1 6 2 0 2 38 38 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 0 100 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
2000 1 6 2 0 2 40 40 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 50 0 0 0 0 0 0 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 50 0 0 0 0 0 0 0 0 50
2000 1 6 2 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 0 100 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
2001 1 6 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 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 6 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 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 6 2 0 2 18 18 12 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 6 2 0 2 20 20 26 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 6 2 0 2 22 22 5 0 0 87.30963481 0 12.69036519 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 87.30963481 0
12.69036519 0 0 0 0 0 0 0 0 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 6 2 0 2 24 24 4 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 0 0 0 0 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
0
2001 1 6 2 0 2 26 26 21 0 0 0 36.8931235 25.75646603 32.23873182 0 0 0
0 0 0 0 5.111678651 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
36.8931235 25.75646603 32.23873182 0 0 0 0 0 0 0 5.111678651 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 6 2 0 2 28 28 9 0 0 0 13.4395729 55.96938834 22.19116249
8.39987627 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 13.4395729 55.96938834 22.19116249 8.39987627 0 0 0 0 0 0 0 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 6 2 0 2 30 30 24 0 0 0 0 25.50802282 26.85728874 38.69508724 0
8.939601203 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 25.50802282 26.85728874 38.69508724 0 8.939601203 0 0 0 0 0 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 6 2 0 2 32 32 27 0 0 0 0 13.17751462 44.55483474 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 0 0 0 0 0 13.17751462 44.55483474 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 6 2 0 2 34 34 25 0 0 0 0 0 3.643683032 16.89297173 9.242387554
7.101216781 12.5921666 1.58877656 0 0 7.101216781 11.11961983
16.51552757 7.101216781 0 0 0 0 0 0 7.101216781 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 3.643683032 16.89297173 9.242387554 7.101216781 12.5921666
1.58877656 0 0 7.101216781 11.11961983 16.51552757 7.101216781 0 0 0 0
0 0 7.101216781 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 6 2 0 2 36 36 23 0 0 0 0 0 0 0 0 10.28478292 12.16506663
10.28478292 2.737498209 0 1.880283708 12.16506663 3.760567417 0
8.404140994 0 0 13.15983665 0 0 0 8.349691933 0 0 0 0 8.404140994 0 0 0
0 0 8.404140994 0 0 0 0 0 0 0 0 10.28478292 12.16506663 10.28478292
2.737498209 0 1.880283708 12.16506663 3.760567417 0 8.404140994 0 0
13.15983665 0 0 0 8.349691933 0 0 0 0 8.404140994 0 0 0 0 0 8.404140994
2001 1 6 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
18.28282828 0 0 0 0 0 0 0 0 0 0 0 81.71717172 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 18.28282828 0 0 0 0 0 0 0 0 0 0 0 81.71717172
2001 1 6 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 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
2001 1 6 2 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 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
2002 1 6 2 0 2 14 14 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 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
2002 1 6 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 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
2002 1 6 2 0 2 18 18 25 0 0 92.11231566 7.887684338 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 92.11231566 7.887684338
0 0 0 0 0 0 0 0 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 6 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
2002 1 6 2 0 2 22 22 68 0 0 1.510654273 93.50413129 3.323476294
1.661738147 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1.510654273 93.50413129 3.323476294 1.661738147 0 0 0 0 0 0 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 6 2 0 2 24 24 127.5 0 0 1.592674218 86.88702397 10.73219321
0.788108597 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1.592674218 86.88702397 10.73219321 0.788108597 0 0 0 0 0 0 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 6 2 0 2 26 26 59.5 0 0 0 74.17570656 15.49666698 7.473859414
1.494838261 0 0 0 0 0 0 1.358928788 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 74.17570656 15.49666698 7.473859414 1.494838261 0 0 0 0 0
0 1.358928788 0 0 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 6 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 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
2002 1 6 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 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

2002 1 6 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 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
2002 1 6 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 0 0 0 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 0 0
2002 1 6 2 0 2 36 36 3 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 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 0 0
2002 1 6 2 0 2 38 38 5 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 14.82361543
2002 1 6 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
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 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
2000 1 -6 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 -6 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 0.769284802 0.1890131
0.198510749 0.29774139 0 0.198510749 0 0.778782451 0 0 0 0 0 0
0.198510749 0 0 0 0 0 0.198510749 0 0.647101511 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 -6 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 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 CAAL (N=448)
#NWCBO females
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2003 1 7 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 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 7 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 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 7 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 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
2003 1 7 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 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 7 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 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
2003 1 7 1 0 2 22 22 48.5 0 0 9.771834204 72.08511579 18.14305 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.771834204
72.08511579 18.14305 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2003 1 7 1 0 2 24 24 52 0 0 0 55.02762831 44.97237169 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 55.02762831
44.97237169 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
2003 1 7 1 0 2 26 26 32.5 0 0 0 5.609095774 62.541633 31.84927123 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.609095774
62.541633 31.84927123 0 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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#NWCBO males

#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2003 1 7 2 0 2 14 14 4 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 0 0 0 0 0 0
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2014 1 7 2 0 1 38 38 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.525162335 0 2.462684158 0 0 0 0 0 91.87487346 0 0 2.137280044 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.525162335 0 2.462684158 0 0 0 0 0 91.87487346 0 0 2.137280044 0 0 0 0 0 0 0 0 0 0 0
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#NWCBO ghost marginal ages (N=12)
#Year Seas Fleet Gender Partition AgeError LbinLo LbinHi Nsamp
2003 1 -7 3 0 2 -1 -1 748 0 0.067354237 0.431164156 3.591990083 8.806127788 1.312760371 4.104490986 11.83099869 8.347924897 7.724762523 8.121425875 0.8231769 0.05167833 2.807979938 0.024733567 0.008852457 0.076755179 1.674382106 0.907839072 0.026047244 0.057717409 0 0.065114274 0.466056186 0 0.009046153 0 0 0 0 0.798443333 0.438027879 0.826588624 0.413294312 0.413294312 3.007630086 0 0.151749838 0.451007392 9.43573581 7.610681656 2.416536774 4.045227849 4.444000756 1.309480972 0.24275218 0.165371806 0.112003915 0.466056186 0.024482338 0.082199747 0.01903777 0 0.008451642 0.173152226 0.105523747 0 0 0.057717409 0 0 0 0.057717409 0.413294312 0 0 0.057717409 0 0 0 0 0.914443895
2004 1 -7 3 0 2 -1 -1 594 0.02055708 1.374871728 2.47390205 2.958458874 26.70929445 6.643177998 0.773521179 0.510380384 0.344783949 0.35423817 0 0 0 0 0 0.123836051 0 0.148072033 0 0 0 0 0 0 0 0 0.148072033 0 0 0 0 0 0 0.123836051 0 0.419980118 0.020551991 2.027528474 2.946796294 4.437230357 30.26892578 11.12324239 2.675335987 0.49828529 0.290119418 0 0.348172814 0 0 0.123836051 0.123836051 0.179197691 0.337166635 0.395744135 0.054074278 0 0.052415464 0 0.05536164 0.049662648 0 0 0.271908084 0.148072033 0 0.054074278 0.123836051 0 0 0 0 0.267644017
2005 1 -7 3 0 1 -1 -1 804 0.189891813 1.169445316 3.282405716 2.219979801 0.715746865 8.121243202 5.891015756 3.190062468 10.94676693 5.341787057 2.820065257 7.976985488 0.065411534 0.136669948 0.05242078 0 0 0.026255473 0 0.087124058 0 0.026255473 0.026255473 0 0.087124058 2.843262042 0.026255473 0 0.026255473 0.084159003 0 0 0.113285897 0 0 0.074681231 0.061808386 2.509105579 5.262028819 2.093078928 3.408602605 13.79738439 7.31601064 2.173659057 0.205327437 0.262856434 0.523573173 0.31747933 2.8752881 0 0.135549816 0.052510945 0.04858875 0.178791064 0.052510945 0 0.087124058 2.669017394 0.087124058 0.022187626 0.022170286 0.044340572 0 0.113285897 0 0 0 0 0 0 0.026255473 0.11352865
2006 1 -7 3 0 1 -1 -1 940 0.049532917 2.128097991 7.897718616 13.24744316 4.963214679 4.685687751 8.348832824 4.416324755 2.254203563 1.041850932 1.084371167 0.937326893 0.677068696 0 0.141416596 0 0.037757454 0 0 0.590520501 0 0 0 0 0.046055795 0 0.590520501 0 0 0 0 0 0 0 0 0 0.094437464 2.331179446 6.675665108 8.861839802 3.647968458 3.929515991 9.135673384 3.18130947 3.403722554 0.968393078 0.5569765 1.370658105 0.75206934 0.146921552 0.636576296 0.113289893 0 0 0

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0 0 0 0.113289893 0 0
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0 0.107569698 0.134279811 0.075372871 0.100335106 0.042585701 0 0 0 0
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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
2013 1 -7 3 0 1 -1 -1 687 0.043304914 0.457214632 2.637605853
10.5879304 1.795515989 3.908405394 2.012363665 2.857379415 2.43503758
6.050962031 0.187911916 1.775137998 1.122194128 0.173888303 1.021901741
0.332581743 0.817170466 0 0.996134195 0.163023931 0.332581743 0
0.865070637 1.165193888 0.601247226 0.563946662 1.06497779 0.563946662
0.532488895 0 0.126611902 0 0.563946662 0 0 2.325976509 0.043309402
0.55436573 2.216628234 10.66802879 2.016200526 4.252632344 2.299989073
6.663791639 3.503022032 3.151597043 1.305820427 0 0.850521981
1.996217439 1.756599905 0.036483829 0.767538098 0.603926297 1.225493177
0.038063449 2.086879531 0.332581743 1.397061414 0.038238464 0.570727359
0.603926297 0.300136713 0.332581743 0.332581743 0.394541427 0.332581743
0.26916809 0 0 0.038063449 0.939047996
2014 1 -7 3 0 1 -1 -1 767 0.024214332 9.664818826 2.470767103
4.378582411 3.646614325 1.278512973 4.255310589 4.18751423 2.974641459
2.513582216 2.378442103 0.20330107 3.983408531 0 0.054023357
2.652047714 0.054023357 0 0.08326034 0 0 0 0 0 0.046806832 0 0 0 0 0
0 0 0 0 0.046806832 0.024208046 12.86007976 2.25328443 4.172766872
3.795967471 1.879885848 15.06057921 7.666583228 1.907431851 1.247937036
0.318413441 0.368432507 0.044719823 0.658771906 0.044719823 0.740731009
0 0 0 0 0 2.013020673 0 0 0.045788473 0 0 0 0 0 0 0 0 0 0 0
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

4 # Blocks
1 1 9 1 #1: blocks in each design
2011 2014 #1: Shoreside selectivity, to reflect IFQ
2011 2014 #2: Retention inflection and slope, to reflect IFQ
2002 2002 2003 2003 2004 2004 2005 2005 2006 2006 2007 2007 2008 2008
2009 2009 2010 2010 #3: Shoreside retention asymptote to fit changes in
discard ratios
1995 2004 #4: 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
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)
2 # CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
6 # Maturity option: 1=length logistic, 2=age logistic, 3=read age-
maturity matrix by growth_pattern
1.33E-06 2.11E-06 3.35E-06 5.32E-06 8.45E-06 1.34E-05 2.13E-05 3.38E-05
5.36E-05 8.51E-05 0.000135006 0.000214259 0.000340019 0.000539553
0.000856075 0.001358016 0.002153592 0.003413574 0.005406529 0.008552547
0.013503105 0.021254713 0.033298395 0.051786901 0.079651256 0.120502167
0.17803042 0.254616717 0.349288029 0.456148012 0.565068736 0.66513627
0.748669634 0.813000274 0.859534081 0.891690669 0.913216425 0.927320739
0.936433142 0.942266985 0.945980094 0.948334619 0.949824125 0.950765
0.951358759 0.951733241 0.951969336 0.952118149 0.952211933 0.952211933
0.952211933 0.952211933 0.952211933 0.952211933 0.952211933 0.952211933
0.952211933 0.952211933 0.952211933

2 # 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 0.054 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
```

```
 0.5 15 3 3 -1 99 5 0 0 0 0 0 0 0 # CV_young
 0.5 15 3 3 -1 99 5 0 0 0 0 0 0 0 # CV_old
# male growth as direct estimates (parameter offset approach = 1)
 0.01 0.15 0.054 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
 0.5 15 2.5 2.5 -1 99 5 0 0 0 0 0 0 0 # CV_old
# female weight and maturity
 0 1 1.148601e-05 1.148601e-05 -1 99 -3 0 0 0 0 0 0 0 # Wtlen coeff #
estimated from NWFSC shelf-slope survey data 2003-2014
 2 4 3.125356 3.125356 -1 99 -3 0 0 0 0 0 0 0 # Wtlen Exp # estimated
from NWFSC shelf-slope survey data 2003-2014
 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 1.223801e-05 1.223801e-05 -1 99 -3 0 0 0 0 0 0 0 # Wtlen coeff #
estimated from NWFSC shelf-slope survey data 2003-2014
 2 4 3.106474 3.106474 -1 99 -3 0 0 0 0 0 0 0 # Wtlen Exp # estimated
from NWFSC shelf-slope survey data 2003-2014
# 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 0.773 0.773 2 0.147 -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
2013 # 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
 1967.3 #_last_early_yr_nobias_adj_in_MPD
 1979.8 #_first_yr_fullbias_adj_in_MPD
 2012.9 #_last_yr_fullbias_adj_in_MPD
 2013.9 #_first_recent_yr_nobias_adj_in_MPD
 0.8166 #_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_1Shoreside
0 1 0 0.01 -1 99 -1 # InitF_2ForeignPOP
0 1 0 0.01 -1 99 -1 # InitF_3AtSeaHake

# 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 Shoreside
0 0 0 0 # 2 ForeignPOP
0 0 0 0 # 3 AtSeaHake
0 0 1 4 # 4 AKSHLF
0 0 0 2 # 5 AKSLP
0 0 0 2 # 6 NWSLP
0 0 1 2 # 7 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 Shoreside
15 0 0 1 # 2 ForeignPOP
24 0 0 0 # 3 AtSeaHake
24 0 0 0 # 4 AKSHLF
24 0 0 0 # 5 AKSLP
24 0 0 0 # 6 NWSLP
24 0 0 0 # 7 NWCBO
#_age_selex_types
#_Pattn Discard Male Special
11 0 0 0 # 1 Shoreside
11 0 0 0 # 2 ForeignPOP
11 0 0 0 # 3 AtSeaHake
11 0 0 0 # 4 AKSHLF
11 0 0 0 # 5 AKSLP
11 0 0 0 # 6 NWSLP
11 0 0 0 # 7 NWCBO

# Length-based selectivity, retention and discard mortality section
#Shoreside
#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 1 2 # PEAK
-6 4 -2 0 -1 99 3 0 0 0 0 0 1 2 # TOP:_width_of_plateau
-1 9 4 4 -1 99 2 0 0 0 0 0 1 2 # Asc_width
-1 9 0.6 5.5 -1 99 3 0 0 0 0 0 1 2 # Desc_width
-5 9 -5 -5 -1 99 2 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-5 9 9 5 -1 99 3 0 0 0 0 0 1 2 # FINAL:_selectivity_at_last_bin
#Shoreside 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 2 2 #Inflection
0.1 10 2 1 -1 99 2 0 0 0 0 0 2 2 #Slope # 1 means that parm’ = baseparm
+ blockparm
0.001 1 1 1 -1 99 -3 0 0 0 0 0 3 2 #Asymptotic retention # 2 means that
parm’ = blockparm
```

```
0 0 0 0 -1 99 -3 0 0 0 0 0 0 0 0 #Male offset To inflection
#AtSeaHake
#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 -5 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
#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 0 4 2 # Desc_width
-999 9 -999 -4 -1 99 -2 0 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 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 0 # PEAK
-6 4 -6 -1 -1 99 2 0 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 0 # Asc_width
-1 9 2 4 -1 99 3 0 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -4 -1 99 -4 0 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 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 0 # PEAK
-6 4 -6 1 -1 99 5 0 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 0 # Asc_width
-1 9 .1 4 -1 99 4 0 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -4 -1 99 -5 0 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 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 24.4731 20 -1 99 -2 0 0 0 0 0 0 0 0 # PEAK
-6 4 -6 -1 -1 99 -3 0 0 0 0 0 0 0 0 # TOP:_width_of_plateau
-1 9 4.13751 2 -1 99 -3 0 0 0 0 0 0 0 0 # Asc_width
-1 9 3 4 -1 99 -4 0 0 0 0 0 0 0 0 # Desc_width
-999 9 -999 -3 -1 99 -4 0 0 0 0 0 0 0 0 # INIT:_selectivity_at_fist_bin
-5 9 -0.841911 5 -1 99 -3 0 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
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
#Shoreside selex to fit length comps during IFQ
# Lo  Hi    Init  Prior P_type      SD    Phase
20 45 36 32 -1 99 2 # PEAK
-6 4 -5 0 -1 99 3 # TOP:_width_of_plateau
-1 9 4 4 -1 99 2 # Asc_width
-1 9 -1 5.5 -1 99 3 # Desc_width
-5 9 9 5 -1 99 3 # FINAL:_selectivity_at_last_bin
#Shoreside 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
#Shoreside Retention asymptote, to fit discard ratio
0 1 0.44 0.44 -1 99 3
0 1 0.4 0.4 -1 99 3
0 1 0.82 0.82 -1 99 3
0 1 0.76 0.76 -1 99 3
0 1 0.52 0.52 -1 99 3
0 1 0.51 0.51 -1 99 3
0 1 0.46 0.46 -1 99 3
0 1 0.45 0.45 -1 99 3
0 1 0.51 0.51 -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 0 # const added to survey CV
0 0 0 0 0 0 0 # const added to discard sd
0 0 0 0 0 0 0 # const added to body weight sd
0.133114337 1 0.120528164 0.297514455 0.572077928 0.485020519
0.281543227 # mult scalar for length comps
0.333242816 1 0.167388606 0.170827535 0.193359763 0.157214282
0.143451546 # mult scalar for age comps
1 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

4 # 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 #Shoreside length comps
 5 1 1 0.5 1 #Shoreside age comps
 4 3 1 0.5 1 #AtSeaHake length comps
 5 3 1 0.5 1 #AtSeaHake age comps

0 # extra SD pointer

999 # end of control file
```

Appendix B.3. SS starter file

```
darkblotched_data.SS    # Data file
darkblotched_control.SS # Control file

0      # Read initial values from .par file: 0=no,1=yes
1      # DOS display detail: 0,1,2
2      # Report file detail: 0,1,2
0      # Detailed checkup.sso file (0,1)
0      # Write parameter iteration trace file during minimization
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
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
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)
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
# max totalcatch by fleet (-1 to have no max) must enter value for each
fleet
-1    -1    -1
# max totalcatch by area (-1 to have no max); must enter value for each
fleet
-1
```

```
# fleet assignment to allocation group (enter group ID# for each fleet,
0 for not included in an alloc group)
0     0     0
#_Conditional on >1 allocation group
# allocation fraction for each of: 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
```