Stock Assessment Update: Status of Widow Rockfish (*Sebastes entomelas*) Along the U.S. West Coast in 2019

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Executive Summary

Stock

This is an update assessment of Widow Rockfish (*Sebastes entomelas*) that reside in the waters off California, Oregon, and Washington from the U.S.-Canadian border in the north to the U.S.-Mexico border in the south. This is an update of the 2015 benchmark assessment (Hicks and Wetzel, 2015). Widow Rockfish inhabit water depths of 25–370 m from northern Baja California, Mexico to Southeastern Alaska. Although catches north of the U.S.-Canada border and south of the U.S.-Mexico border were not included in this assessment, it is not certain if those populations contribute to the biomass of Widow Rockfish off of the U.S. West Coast, possibly through adult migration and/or larval dispersion.

There is little evidence of genetically separate stocks along the U.S. coast and the previous benchmark assessment used a single area, coastwide model with multiple fisheries (Hicks and Wetzel, 2015). There is some evidence of biological differences between areas. For example, Widow Rockfish collected off California tend to mature at a smaller length than do Widow Rockfish collected off of Oregon (Barss and Echeverria 1987). This may be due to environmental or anthropogenic effects rather than genetic differences. The 2015 benchmark assessment decided to continue with a single area model for this assessment rather than lose prediction power by splitting the model and data into two separate areas.

Landings

The historical reconstruction of landings for Widow Rockfish suggests that hook-and-line and bottom trawl fisheries have caught Widow Rockfish since the turn of the 20th century. Landings in the trawl fishery are estimated to have increased into the 1940s and remained relatively constant and small (below 1,000 mt per year) throughout the 1950s and into the 1960s before the foreign trawl fleet increased catches into the 1970s, with a peak at almost 5,000 mt in 1967. In the late 1970s a midwater trawl fishery developed for Widow Rockfish and catches increased rapidly with the discovery of large aggregations that form at night.

Total landings of Widow Rockfish peaked in the early 1980s, increasing from approximately 1,000 metric tons (mt) in 1978 to over 25,000 mt in 1981. After this sudden increase in catch, Widow Rockfish were given their own market category and often identified to species in the landings. However, species composition sampling of market categories occurred before the mid-1980s when Widow Rockfish was not specifically identified. The uncertainty in species composition is greater in past years, thus landings of Widow Rockfish are not well known further back in history.

The large landings in the early 1980s were curtailed with trip limits beginning in 1982, which resulted in a decline in landings throughout the 1980s and 1990s following sequential reductions in the trip limits. From 2000 to 2003, landings of Widow Rockfish dropped from over 4,000 mt to about 40 mt and have been slowly increasing in recent years as the population has rebuilt from early exploitation, with a more rapid relative increase after 2015 to above 10,000 mt in 2018. Midwater trawl gears in groundfish and Pacific Whiting (hake) fisheries account for the majority of the recent catch.

Widow Rockfish are a desirable market species and it is believed that discarding was low historically. However, management restrictions (e.g., trip limits) resulted in a substantial amount of discarding beginning in 1982. Trawl rationalization was introduced in 2011, and since then very little discarding of Widow Rockfish has occurred. Discards were estimated in the model with the assistance of data from the West Coast Observer Program (WCGOP), and total catches (discards plus landings) are reported in addition to landings.

Table a: Recent landings for the bottom trawl, midwater trawl, at-sea hake, net, and hook-and-line fisheries and the total landings across fisheries and the total mortality (discards + landings) (mt). 100% mortality is assumed for discards and catch sources are described below.

Year	Trawl	Midwater Trawl	At-Sea Hake	Net	Hook-and-line	Total Landings	Total Mortality
2009	8.06	42.16	135.35	0.21	0.43	176.6	186.21
2010	9.1	63.23	106.35	0	0.16	165.9	178.84
2011	18.53	44.32	149.65	0	0.13	212.0	212.63
2012	41.65	47.84	181.43	0	0.35	270.4	271.27
2013	51.79	243.53	176.41	0	1.03	469.8	472.75
2014	72	309.72	342.16	0.03	1.86	721.9	725.77
2015	12.3	484.04	386.2	0	2.25	879.6	884.79
2016	9.72	593.94	440.8	0	0.92	1039.2	1,045.38
2017	36.29	4,901.11	1,455.20	0	2.8	6345.9	6,395.41
2018	36.29	9,468.99	1,081.30	0	1.55	10496.0	10,588.14

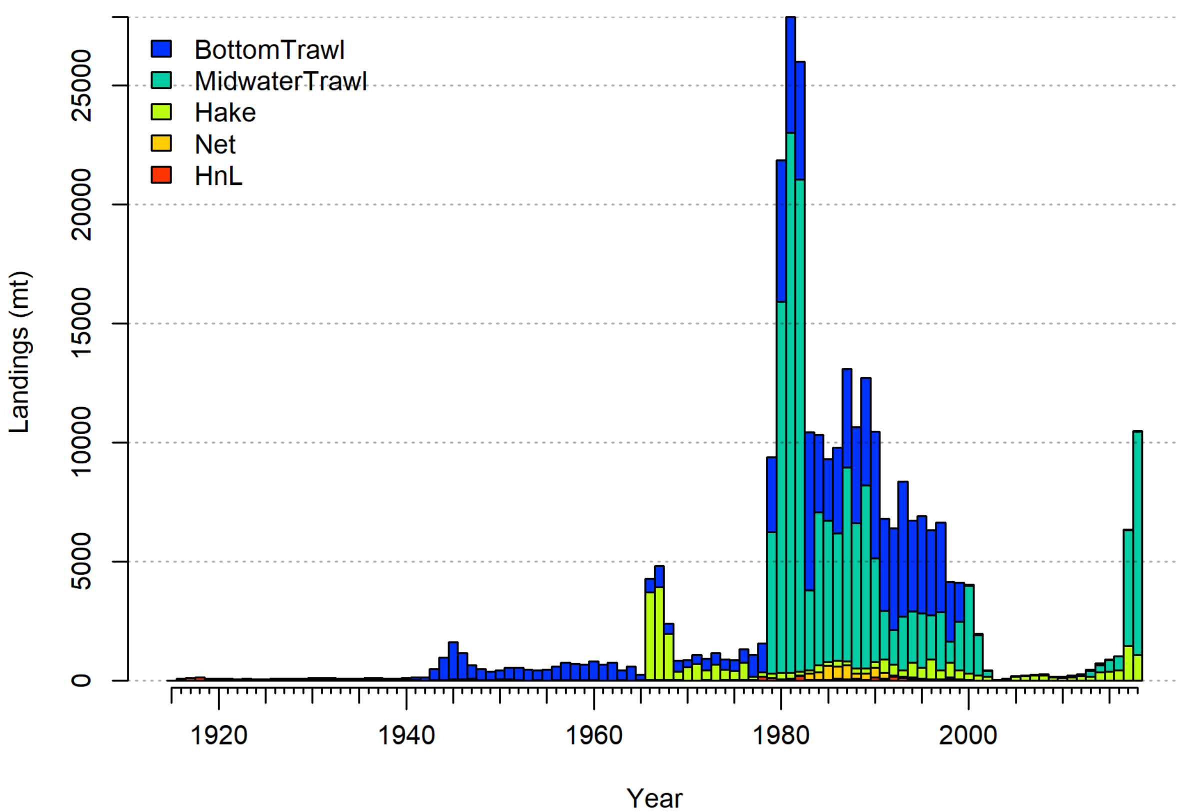

Figure a: Landings of Widow Rockfish from 1916 to 2018 for bottom trawl, midwater trawl, net, and hook-and-line fisheries, and catches of Widow Rockfish for the foreign (1966–1976) and Pacific Whiting (hake) fisheries (green).

Data and assessment

This is an update assessment of the 2015 full assessment of Widow Rockfish (Hicks and Wetzel, 2015). In this assessment, aspects of the model including catches, data, and modelling assumptions were generally consistent with the 2015 assessment. However, the assessment used the updated version of the length- and age-structured modeling software Stock Synthesis (version 3.30.13), while the benchmark assessment used version 3.24U. The coastwide population was modeled assuming separate growth and mortality parameters for each sex (a two-sex model) from 1916 to 2019, and forecasted beyond 2019.

The definitions of fishing fleets have not been changed from those in the 2015 assessment. Five fishing fleets were specified within the model: 1) a shorebased bottom trawl fleet with coastwide catches from 1916–2018 (bottomtrawl in Figure a), 2) a shorebased midwater trawl fleet with coastwide catches from 1979–2018 (midwater in Figure a), 3) a mostly midwater trawl fleet that targets Pacific Hake/Whiting (*Merluccius productus*) and includes a foreign and at-sea fleet with catches from 1975–2018, a domestic shorebased fleet that targeted Pacific Hake with catches from 1991–2018, and foreign vessels that targeted Pacific Hake and rockfish between 1966–1976 (hake in Figure a), 4) a net fishery consisting of catches mostly from California from 1981–2018 (net in Figure a), and 5) a hook-and-line fishery (predominantly longline) with coastwide catches from 1916–2018 (HnL in Figure a).

Data from three fishery-independent surveys were also included in the model: 1) the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) and Northwest Fisheries Science Center (NWFSC)/Pacific Whiting Conservation Cooperative (PWCC) Midwater Trawl Survey that provides pre-recruit indices of abundance, 2) the NMFS Triennial Shelf Survey which was conducted from 1977–2004 in depths less than 500 meters, and 3) the NWFSC West Coast Groundfish Bottom Trawl Survey (WCGBTS) which has been surveying the entire U.S. West Coast in depths between 55 and 1,280 meters since 2003.

The data used in the assessment model consisted of survey abundance indices, length compositions, discard data, and age compositions. Model-based biomass indices and length compositions were determined for the NMFS Triennial Shelf and NWFSC West Coast Groundfish Bottom Trawl Surveys. Length and age compositions were also available from the five fisheries. Age data for all years of the WCGBTS were input as age-at-length compositions. Discard data for the bottom trawl, midwater trawl, and hook-and-line fisheries were available in various years in the form of discarded biomass and length compositions. A small amount of data was available to inform discarding practices of Widow Rockfish prior to 2002. The variances and sample sizes on all of the data were tuned to the expected variability in the model predictions.

The base model estimated parameters for length-based selectivity for all fleets and surveys, retention curves based on length for the bottom trawl, midwater trawl, and hook-and-line fishing fleets, a length-at-age relationship, natural mortality for males and females assuming lognormal priors, and recruitment deviations starting in 1900. A Beverton-Holt stock-recruitment function was used to model productivity and the steepness parameter was fixed at 0.72 based on a steepness meta-analysis for west coast rockfishes.

Uncertainty for the parameter estimates and derived quantities was determined in three ways. First, estimation uncertainty in the base model was determined using approximate asymptotic 95% confidence intervals based on maximum likelihood theory. Second, model uncertainty was investigated with various sensitivity runs where alternative model structures were implemented. Finally, the major axis of uncertainty was determined to define a range of states of nature and results are presented in a decision table.

Although there are many types of data available for Widow Rockfish since the late 1970s, which were used in this assessment, there is little information about steepness and natural mortality, and recent recruitment. Estimates of steepness are uncertain partly because of variable recruitment. Uncertainty in natural mortality is common in many fish stock assessments even when length and age data are available. Finally, there is little information about the strength of recent recruitment because the young fish are seen with a lower probability in the fisheries and surveys. These uncertainties were characterized as best as possible in the predictions and projections from this assessment.

Stock biomass

The predicted spawning biomass from the base model generally showed a slight decline over the time series until 1966 when the foreign fleet began. A short, but sharp decline occurred, followed by a steep increase due to strong recruitment. The spawning biomass declined rapidly with the developing domestic midwater fishery in the late 1970s and early 1980s. The stock continued to decline until 2000, when a combination of strong recruitment and low catches resulted in a steady increase. The 2019 spawning biomass relative to unfished equilibrium spawning biomass is 91.9%, well above the target of 40% of unfished spawning biomass and the minimum value of 36.3% which occurred in 1998, 2000, and 2001.

Approximate confidence intervals based on the asymptotic variance estimates show that the uncertainty in the estimated spawning biomass is high, especially in the early years. Spawning biomass is estimated to be at 80,910 mt in 2019, with an asymptotic 95% confidence interval of 49,484–112,335.

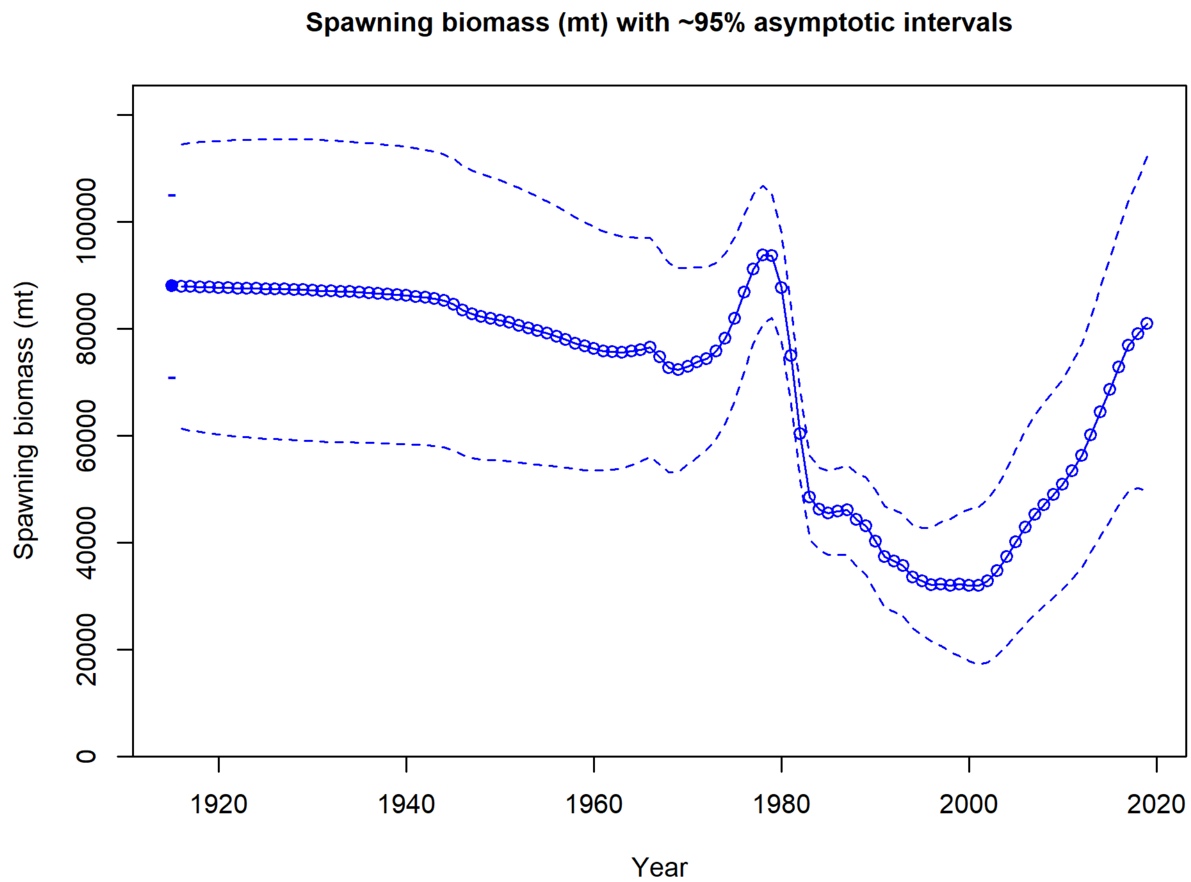

Figure b: Estimated female spawning biomass time-series from the base model (solid line) with an approximate asymptotic 95% confidence interval (dashed lines).

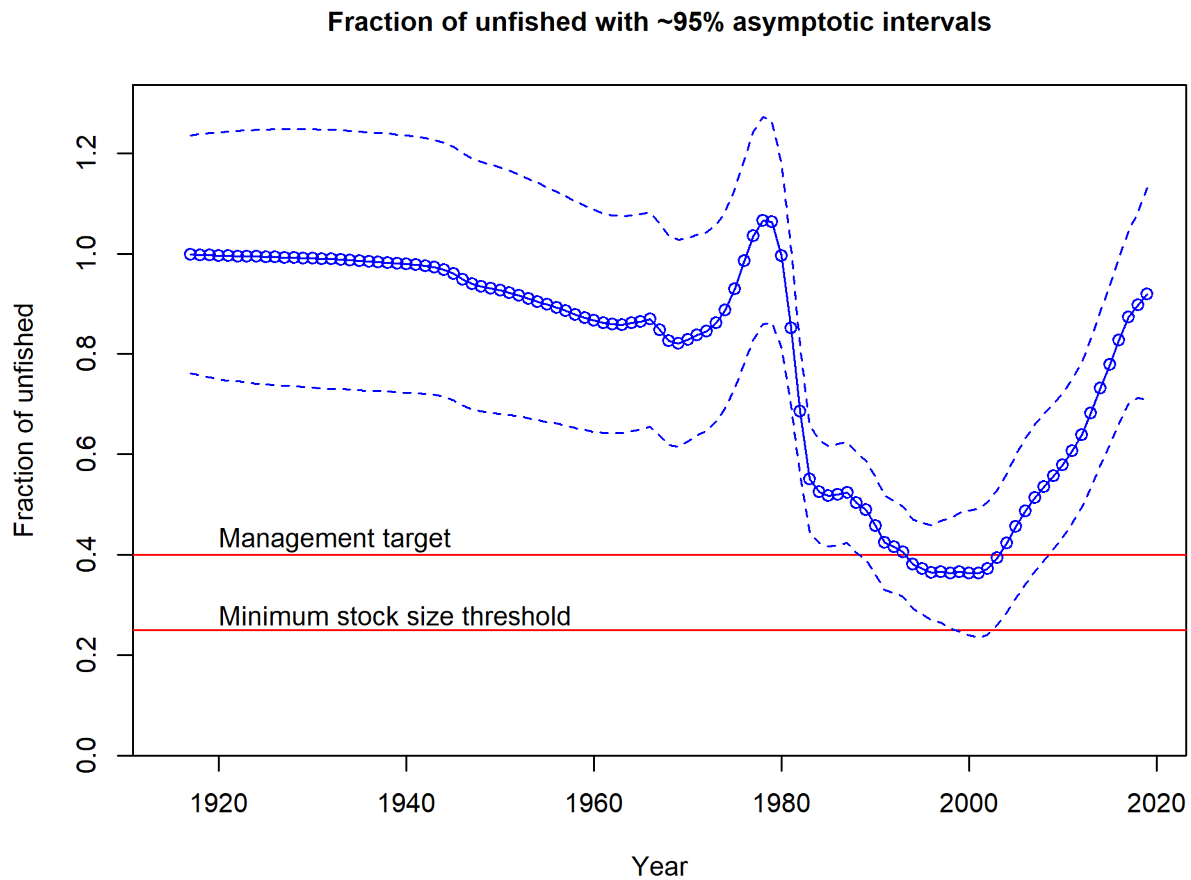

Figure c. Estimated relative spawning biomass (depletion) with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model.

Table b: Recent trend in estimated female spawning biomass (mt) and relative spawning biomass (depletion).

Year	Spawning Biomass	~95% Confidence Interval	Estimated Depletion (%)	~95% Confidence Interval
2010	50,864	31,199–70,529	57.8	43.4–72.2
2011	53,403	33,186–73,620	60.7	46.3–75.1
2012	56,192	35,332–77,051	63.9	49.4–78.3
2013	60,047	38,128–81,965	68.2	53.4–83.0
2014	64,421	41,214–87,627	73.2	57.9–88.5
2015	68,547	44,090–93,003	77.9	62.0–93.8
2016	72,782	46,970–98,594	82.7	66.2–99.2
2017	76,824	49,668–103,979	87.3	70.1–104.5
2018	79,032	50,137–107,927	89.8	71.2–108.4
2019	80,910	49,484–112,335	91.9	70.8–113.1

Recruitment

Recruitment deviations were estimated for the entire time series modeled. There is little information regarding recruitment prior to 1965, and the uncertainty in these estimates is expressed in the model. There are very large, but uncertain, estimates of recruitment in 2013, 1970, 2008, and 1971. Other large recruitment events (in descending order of magnitude) occurred in 1978, 2014, 1981, 2010, and 1991. The five lowest recruitments (in ascending order) occurred in 2012, 2011, 1976, 2007, and 1973. Estimates of recruitment appear to be episodic and characterized by periods of low recruitment. Two of the four largest estimated recruitments happened in the last 11 years.

Figure d: Time-series of estimated recruitments (medians as open circles) for the base case model with approximate asymptotic 95% confidence interval (vertical bars). Estimated mean unfished equilibrium recruitment (*R_0*) is shown as the closed circle with a 95% confidence interval at the beginning of the time series.

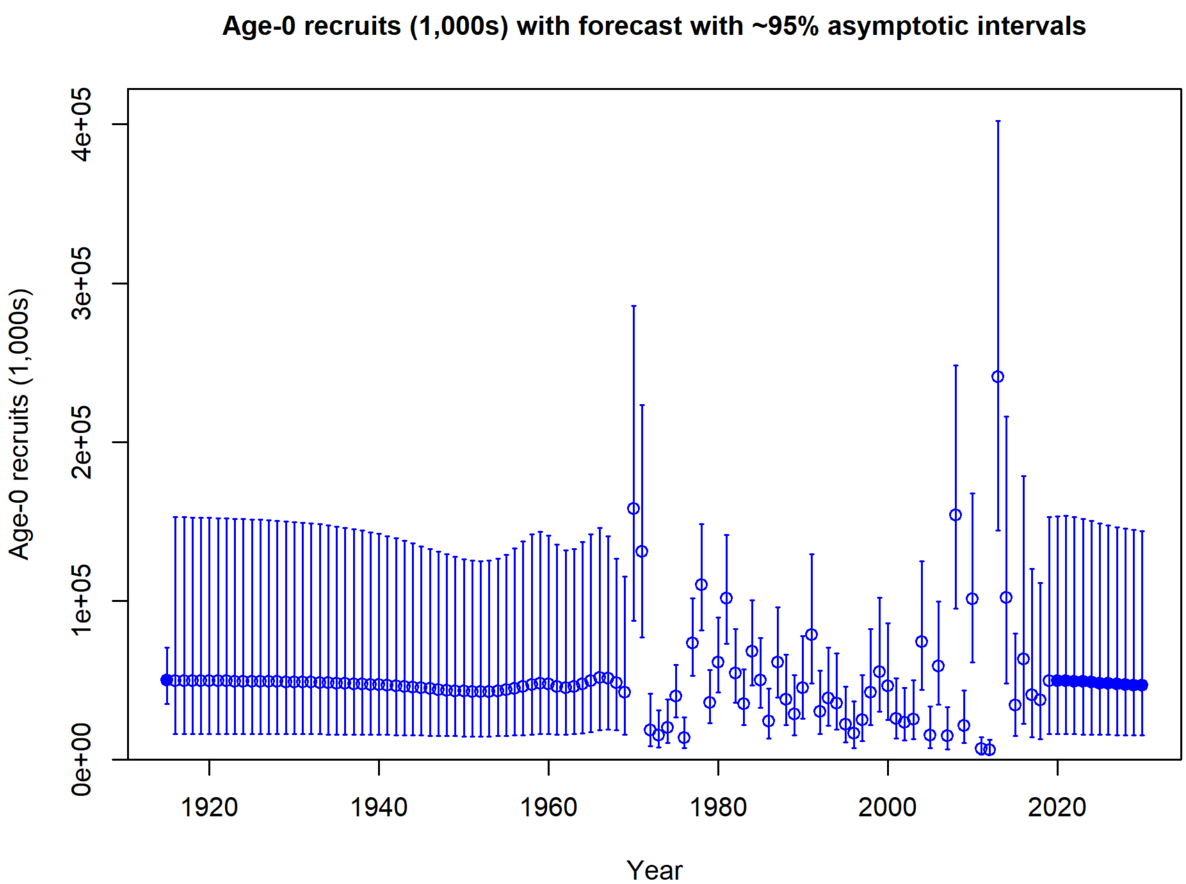

Table c: Recent estimated trend in Widow Rockfish recruitment with approximate 95% confidence intervals determined from the base model. Recruitment deviations were fixed at zero in 2019 in the base model.

Year	Estimated Recruitment (number in thousands)	~95% Confidence Interval	Estimated Recruitment Deviation	~95% Confidence Interval
2010	101,007	60,929–167,448	0.931	0.630–1.232
2011	6,740	3,220–14,107	-1.783	-2.424–-1.143
2012	6,074	3,040–12,134	-1.895	-2.493–-1.297
2013	240,825	144,209–402,171	1.776	1.418–2.133
2014	101,692	47,924–215,784	0.904	0.243–1.566
2015	34,200	14,729–79,408	-0.244	-1.047–0.559
2016	63,177	22,368–178,435	0.312	-0.739–1.362
2017	40,750	13,832–120,048	-0.184	-1.288–0.920
2018	37,521	12,654–111,256	-0.27	-1.382–0.843
2019	49,257	15,883–152,756	0	–

Exploitation status

The spawning biomass of Widow Rockfish reached a low in 2001 before increasing due to low catch levels. The lower 95% confidence interval of the estimated depletion dipped below the overfished threshold in the very late 1990s and early 2000s, but has remained above that level otherwise, and currently the depletion estimate is significantly greater than the spawning biomass target. Throughout the 1980s and 1990s the exploitation rate and (1-*SPR*) were mostly above target levels. Recent exploitation rates on Widow Rockfish are estimated to have been substantially below target levels.

Table d. Recent trend in spawning potential ratio and summary exploitation rate. Harvest rate is defined as catch divided by age 4+ biomass.

Year	Estimated (1-SPR)/(1-SPR$_{50\%}$)	~95% confidence interval	Harvest rate (proportion)	~95% confidence interval
2009	3.83	2.02-5.64	0.002	0.001-0.003
2010	3.53	1.90-5.15	0.002	0.001-0.002
2011	3.99	2.20-5.79	0.002	0.001-0.003
2012	4.9	2.75-7.04	0.002	0.001-0.003
2013	7.67	4.46-10.88	0.004	0.002-0.005
2014	10.8	6.41-15.19	0.005	0.003-0.007
2015	11.83	7.12-16.54	0.006	0.004-0.008
2016	13.04	7.93-18.14	0.007	0.005-0.010
2017	60.67	42.03-79.31	0.037	0.024-0.051
2018	85.46	62.27-108.65	0.058	0.036-0.080

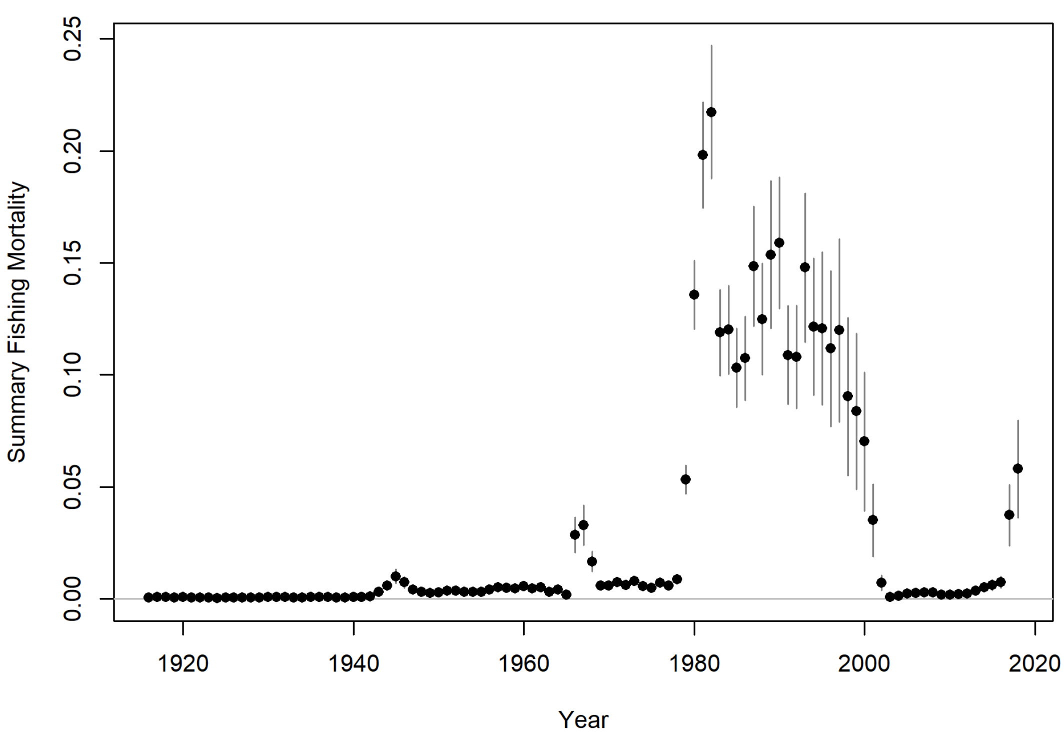

Figure e. Time-series of estimated summary harvest rate (catch divided by age 4+ biomass) for the base case model (round points) with approximate 95% asymptotic confidence intervals (gray lines).

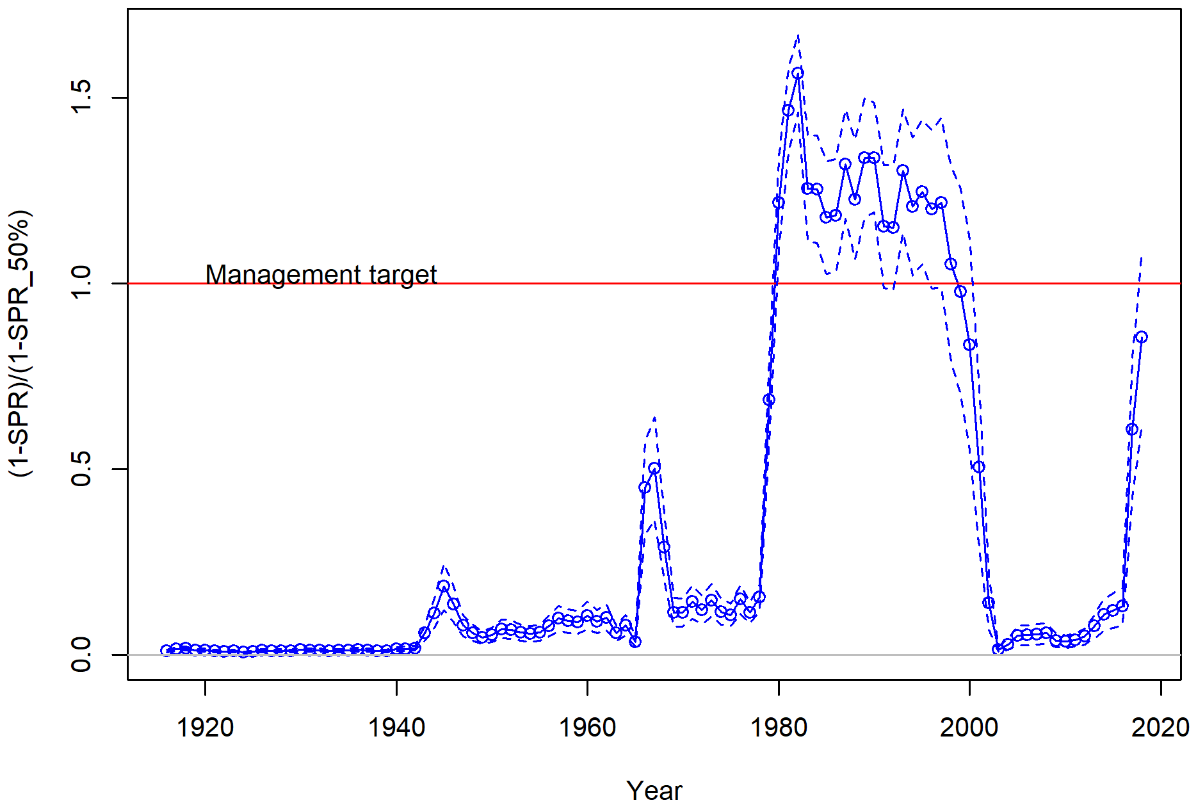

Figure f. Trend in estimated fishing intensity (relative to the SPR management target) through 2018 with 95% asymptotic confidence intervals. One minus SPR is used so that higher exploitation rates occur on the upper portion of the y-axis. The relative management target is plotted as a horizontal line and values above this reflect harvests in excess of the overfishing proxy based on $SPR_{50\%}$.

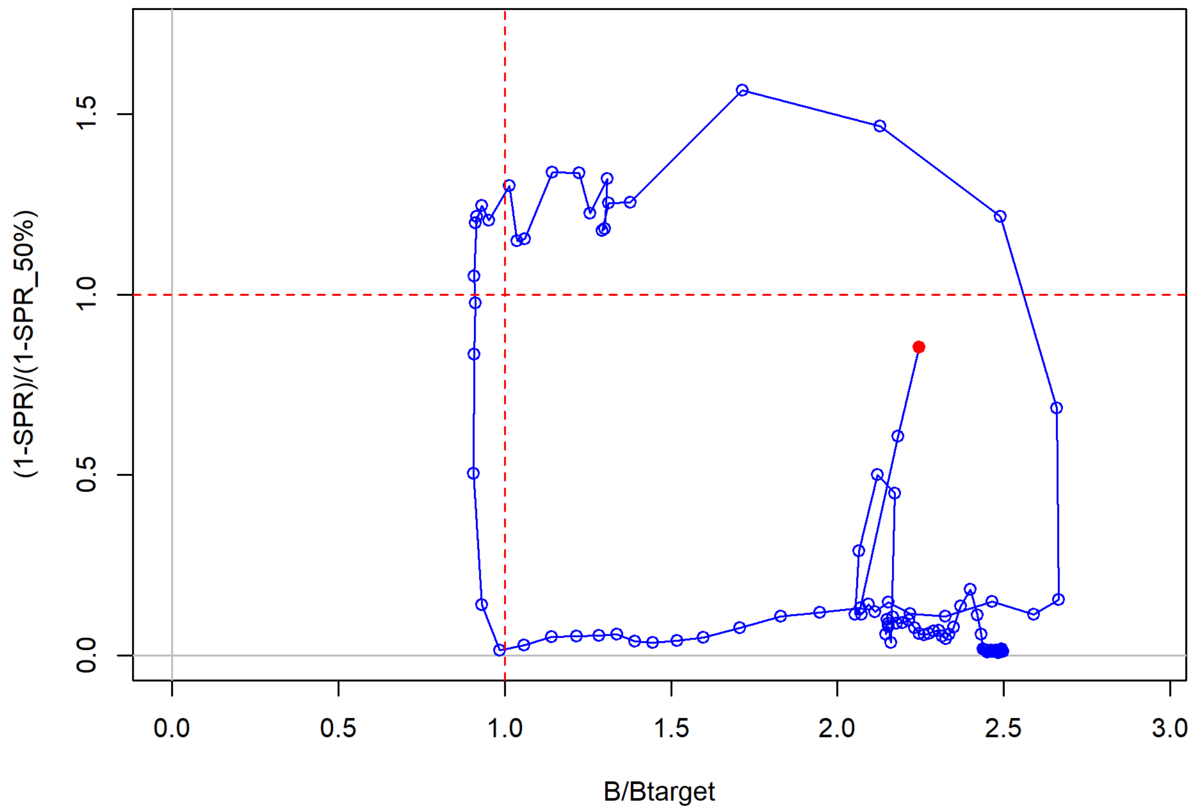

Figure g. Phase plot of estimated relative (1-SPR) vs. relative biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 0.5 (one minus the SPR target). 2018 is noted a red circle.

Ecosystem considerations

Rockfish are an important component of the California Current ecosystem along the U.S. West Coast, with its more than sixty-five species filling various niches in both soft and hard bottom habitats from the nearshore to the continental slope, as well as near bottom and pelagic zones. Widow Rockfish frequently aggregate in the pelagic zone.

Recruitment is one mechanism by which the ecosystem may directly impact the population dynamics of Widow Rockfish. The specific pathways through which environmental conditions exert influence on Widow Rockfish dynamics are unclear; however, changes in water temperature and currents, distribution of prey and predators, and the amount and timing of upwelling are all possible linkages. Changes in the environment may also result in changes in age-at-maturity, fecundity, growth, and survival which can affect how the status of the stock and its susceptibility to fishing are determined. Unfortunately, there are few data available for Widow Rockfish that provide insights into these effects.

Fishing has effects on both the age structure of a population as well as the habitat with which the target species is associated. Fishing often targets larger, older fish, and years of fishing mortality results in a truncated age-structure when compared to unfished conditions. Rockfish are often associated with habitats containing living structure such as sponges and corals, and fishing may alter that habitat to a less desirable state. This assessment provides a look at the effects of fishing on age structure, and recent studies on essential fish habitat are beginning to characterize important locations for rockfish throughout their life history; however there is little current information available to evaluate the specific effects of fishing on the ecosystem issues specific to Widow Rockfish.

Reference points

Reference points were calculated using the estimated selectivities and catch distribution among fleets in the most recent year of the model (2018). Sustainable total yields (landings plus discards) were 7,240 mt when using an $SPR_{50\%}$ reference harvest rate and with a 95% confidence interval of 5,447 to 9,033 mt based on estimates of uncertainty. The spawning biomass equivalent to 40% of the unfished spawning output ($SB_{40\%}$) was 35,198 mt. Prior to 2018, the most recent catches (landings plus discards) have been below the point estimate of potential long-term yields calculated using an $SPR_{50\%}$ reference point and the population has been increasing over the last decade. However, catches in 2018 were above the point estimate of potential long-term yields calculated using an SPR_{50} reference point.

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

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning Biomass (mt)	87,995	70,867–105,123
Unfished age 4+ biomass (mt)	171,336	137,799–204,873
Unfished recruitment (R_0)	49,662	36,639-70,665
Spawning Biomass (2019)	80,910	49,484–112,335
Depletion (2019)	91.95	70.78–113.11
Reference points based on SB40%		
Spawning biomass ($SB_{40\%}$, mt)	35,198	28,347–42,049
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.458	0.458–0.458
Exploitation rate resulting in $B_{40\%}$	0.096	0.087–0.105
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	7,606	5,717–9,494
Reference points based on SPR proxy for MSY		
Spawning Biomass ($SB_{SPR50\%}$, mt)	39,259	31,618–46,901
$SPR_{50\%}$	0.5	NA
Exploitation rate corresponding to $SPR_{50\%}$	0.084	0.075–0.092
Yield with $SPR_{50\%}$ at $SB_{SPR50\%}$ (mt)	7,240	5,447–9,033
Reference points based on estimated MSY values		
Spawning biomass at *MSY* (SB_{MSY}, mt)	23,063	18,611–27,516
SPR_{MSY}	0.334	0.330–0.337
Exploitation rate corresponding to SPR_{MSY}	0.145	0.130–0.159
MSY (mt)	8,169	6,123–10,215

Management performance

Exploitation rates on Widow Rockfish exceeded *MSY* proxy target harvest rates during the 1980s and 1990s and spawning biomass is predicted to have fallen below the proxy management target of 40%. Exploitation rates decreased in the late 1990s due to management restrictions, and have increased in recent years. Predicted catches in the last decade have not exceeded the annual catch limit (ACL) set by management.

Table f. Recent trend in total catch and commercial landings (mt) relative to the management guidelines. Estimated total catch reflects the commercial landings plus the model estimated dead discarded biomass.

Year	OFL (mt) (termed ABC prior to 2011)	ABC (mt)	ACL (mt) (termed OY prior to 2011)	Estimated Total Catch (mt)
2008	5,144	NA	368	272.16
2009	7,728	NA	522	186.21
2010	6,937	NA	509	178.84
2011	5,097	4,872	600	212.63
2012	4,923	4,705	600	271.27
2013	4,841	4,598	1,500	472.75
2014	4,435	4,212	1,500	725.77
2015	4,137	3,929	2,000	884.79
2016	3,990	3,790	2,000	1,045.38
2017	14,130	13,508	13,508	6,395.41
2018	13,237	12,655	12,655	10,588.14
2019	12,375	11,831	11,831	NA

Unresolved problems and major uncertainties

This is a reconfiguration of a long line of stock assessments for Widow Rockfish on the U.S. West Coast and although scientifically credible advice is provided by synthesizing many sources of data, there remain data and structural assumptions that contribute to uncertainty in the estimates. Major sources of uncertainty include landings, discards, natural mortality, and recruitment, which are discussed below.

Discards of Widow Rockfish are even more uncertain than landings, but because Widow Rockfish is a marketable species, historical discard rates were likely lower than less desirable or smaller species. In this assessment, we assumed that discarding was nearly negligible before management restrictions began in 1982. Once trip limits were introduced, discarding tended to be an all or none event, and detecting large, but rare, discard events with far less than 100% observer coverage has a low probability. For the years 2002–2010, the WCGOP has provided data on discards from vessels that were randomly selected for observer coverage, thus some uncertainty is present in the total amount discarded. The implementation of trawl rationalization in 2011 resulted in almost 100% observer coverage for the trawl fleet and very little incentive to discard Widow Rockfish. However, the open access fixed-gear fleet is not monitored by the full observer coverage required under trawl rationalization and data show that discarding of Widow Rockfish has occurred on fixed gear vessels in recent years (limited entry vessel fishing with fixed gear are subject to 100% observer coverage). Uncertainty in recent discards is greatly reduced because of observer coverage, but it is unknown what historical discarding may have been. The model assumes a discard rate of 1% pre-1982, which is arbitrary, but reasonable. Discard mortality is assumed to be 100%, which may overestimate actual mortality (Jarvis & Lowe, 2007), but given the low number of discards, will have minimal effect on assessment results.

There may also be uncertainty in the ability of bottom trawl surveys to be a reliable measure of widow abundance, which spend a significant portion of their time in mid-water (Wilkins 1986). Multiple surveys are used in the assessment, but further consideration of additional surveys is reasonable.

Widow Rockfish is a relatively long-lived fish, and natural mortality is likely to be lower than many species of fish, such as gadoids. Ages above 50 years have been observed and it is expected that natural mortality could be less than 0.10 yr^{-1}. However, even with length and age data available back to the late 1970s, natural mortality was estimated above 0.14 yr^{-1} with a small amount of uncertainty (7% coefficient of variation). This assessment attempts to capture that uncertainty by estimating natural mortality (*M*) and integrating that uncertainty into the derived biomass estimates, as well as additional uncertainty by including levels outside of the predicted interval in a decision table.

Model sensitivities and profiles over *M* showed that current stock status was highly sensitive to the assumption about natural mortality. The estimates of *M* varied slightly depending on the weight given to age and length data, or removing recent years of data, but *M* was always estimated above 0.123 yr^{-1}. Profiles over natural mortality provide support for values above 0.14 yr^{-1}.

Steepness was fixed at 0.720 in the base model, but a likelihood profile showed that it would be estimated at a value less than that. Estimates of *M* increased with lower steepness, while unfished equilibrium spawning biomass increased and current spawning biomass decreased. Equilibrium yield ranged from approximately 3,600 to 7,500 mt depending on the value of steepness.

Scientific uncertainty

Spawning biomass is estimated to be at 80,910 mt in 2019, with a sigma of 0.1962. OFL is estimated to be 14,669.9 mt in 2019 with a sigma of 0.2230.

Decision table

Model uncertainty has been described by the estimated uncertainty within the base model and by the sensitivities to different model structure. The estimated parameter that resulted in the most variability of predicted status and yield advice was natural mortality (*M*), which was estimated with much more certainty than the prior distribution implied. In fact, the 95% confidence interval for estimated *M* was entirely greater than and did not include the point estimate from the prior distribution. There is the possibility that the base model and the approximate uncertainty intervals based on maximum likelihood theory may not entirely convey the actual uncertainty of this assessment

Three categories of parameters that greatly contribute to uncertainty in the results were natural mortality (an important estimated parameter), steepness (not estimated in the model), and the strength of recent year classes (influential on projections). A combination of these three factors was used as the axis of uncertainty to define low and high states of nature, consistent with the 2015 assessment. The 12.5% and 87.5% quantiles for female and male natural mortality (independently) were chosen as low and high values (0.133 yr^{-1} and 0.155 yr^{-1} for females; 0.144 yr^{-1} and 0.166 yr^{-1} for males). The 12.5% and 87.5% quantiles of the 2013 recruitment deviation were also used (1.5781 and 1.9985). Steepness is probably the most important factor since it was fixed in the base model and is not incorporated in the estimation uncertainty. The 12.5% and 87.5% quantiles from the steepness prior (without Widow Rockfish data) were used to define the low and high values of steepness (0.536 and 0.904). The low combination of these three factors defined the low state of nature and the high combination of these three factors defined the high state of nature. The predictions of spawning biomass in 2019 from the low and high states of nature are close to the 12.5% and 87.5% lognormal quantiles from the base model.

This assessment synthesizes many sources of data and estimates recruitment variability, thus it is classified as a Category 1 stock assessment. Therefore, the sigma for P* to determine the catch reduction to account for scientific uncertainty is 0.50.

Table g. Projection of potential OFL, landings, and catch, summary biomass (age-4 and older), spawning biomass, and depletion for the base case model projected with total catch equal to the predicted ABC. The predicted OFL is the calculated total catch determined by $F_{SPR=50\%}$.

Year	Predicted OFL (mt)	Projected ABC/ Catch (mt)	Age 4+ Biomass (mt)	Spawning Biomass (mt)	Depletion (%)	Assumed dead removals
2019	12,375*	10,868	180,855	80,910	92%	10,868
2020	11,714*	10,868	179,750	83,054	94%	10,868
2021	15,749	14,725	173,890	83,673	95%	14,725
2022	14,826	13,788	161,799	80,275	91%	13,788
2023	13,633	12,625	151,136	75,720	86%	12,625
2024	12,453	11,481	141,680	70,914	81%	11,481
2025	11,487	10,533	133,763	66,509	76%	10,533
2026	10,769	9,832	127,304	62,790	71%	9,832
2027	10,240	9,308	122,045	59,739	68%	9,308
2028	9,842	8,897	117,739	57,242	65%	8,897
2029	9,534	8,580	114,196	55,185	63%	8,580
2030	9,288	8,322	111,249	53,473	61%	8,322

* Value determined prior to the 2019 assessment as part of the harvest specifications

Table h. Summary table of 12-year projections beginning in 2021 for alternate states of nature based on the axis of uncertainty (a combination of *M*, *h*, and 2013 recruitment strength). Columns range over low, mid, and high state of nature, and rows range over different assumptions of total catch levels (discards + retained). Catches in 2019 and 2020 are allocated using the percentage of landings for each fleet in 2018.

				State of nature					
				Low		Base case		High	
Relative probability of ln(SB_2013)				0.25		0.5		0.25	
Management decision	Year	OFL	Catch (mt)	Spawning biomass (mt)	Depletion (%)	Spawning biomass (mt)	Depletion (%)	Spawning biomass (mt)	Depletion (%)
9,000 K	2021	15,749	9,000	60,785	66%	83,673	95%	95,098	107%
	2022	15,378	9,000	60,237	66%	83,145	94%	94,188	106%
	2023	14,608	9,000	58,583	64%	80,975	92%	91,415	103%
	2024	13,686	9,000	56,291	61%	77,825	88%	87,555	99%
	2025	12,828	9,000	53,815	59%	74,318	84%	83,321	94%
	2026	12,106	9,000	51,443	56%	70,866	81%	79,179	89%
	2027	11,505	9,000	49,264	54%	67,638	77%	75,325	85%
	2028	10,995	9,000	47,262	51%	64,664	73%	71,805	81%
	2029	10,553	9,000	45,397	49%	61,935	70%	68,615	77%
	2030	10,164	9,000	43,636	48%	59,432	68%	65,737	74%
ACLp* = 0.45 sigma = 0.50	2021	15,749	14,725	60,785	66%	83,673	95%	95,098	107%
	2022	14,826	13,788	57,355	62%	80,275	91%	91,324	103%
	2023	13,633	12,625	53,270	58%	75,720	86%	86,203	97%
	2024	12,453	11,481	49,250	54%	70,914	81%	80,742	91%
	2025	11,487	10,533	45,784	50%	66,509	76%	75,676	85%
	2026	10,769	9,832	43,043	47%	62,790	71%	71,336	81%
	2027	10,240	9,308	40,927	45%	59,739	68%	67,731	76%
	2028	9,842	8,897	39,262	43%	57,242	65%	64,757	73%
	2029	9,534	8,580	37,905	41%	55,185	63%	62,310	70%
	2030	9,288	8,322	36,744	40%	53,473	61%	60,294	68%
ACLp* = 0.25 sigma = 0.50	2021	15,749	10,961	60,785	66%	83,673	95%	95,098	107%
	2022	15,188	10,313	59,254	65%	82,166	93%	93,211	105%
	2023	14,304	9,470	56,935	62%	79,347	90%	89,801	101%
	2024	13,364	8,620	54,445	59%	76,020	86%	85,781	97%
	2025	12,575	7,910	52,246	57%	72,813	83%	81,863	92%
	2026	11,984	7,346	50,530	55%	70,035	80%	78,406	88%
	2027	11,553	6,908	49,278	54%	67,743	77%	75,492	85%
	2028	11,235	6,550	48,381	53%	65,875	75%	73,073	82%
	2029	10,998	6,247	47,742	52%	64,362	73%	71,084	80%
	2030	10,819	5,994	47,288	52%	63,143	72%	69,463	78%

Research and data needs

There are many areas of research that could be improved to benefit the understanding and assessment of Widow Rockfish. Below, we specifically identify five topics that we believe are most important (order does not indicate importance).

- **Historical landings and discards:** The historical landings and discards are uncertain for Widow Rockfish and improvements would increase the certainty that fishing removals are applied appropriately. Because landings are assumed to be known exactly in the assessment model, uncertainty in the predictions does not include uncertainty in the landings. A thorough look at historical landings, species compositions, and discarding practices would potentially account for and possibly reduce the uncertainty. More importantly, though, a measure of uncertainty on the estimated historical landings would allow for reasonable sensitivities to be investigated.

- **Natural mortality:** Uncertainty in natural mortality translates into uncertain estimates of status and sustainable fishing levels for Widow Rockfish. The collection of additional age data, re-reading of older age samples, reading old age samples that are unread, and improved understanding of the life-history of Widow Rockfish may reduce that uncertainty.

- **Maturity and fecundity:** There are few studies on the maturity of Widow Rockfish and even less recent information. There have been no studies that reported results of a histological analysis. Further research on the maturity and fecundity of Widow Rockfish, the potential differences between areas, the possibility of changes over time would greatly improve the assessment of these species.

- **Age data and error:** There is a considerable amount of error in the age data and potential for bias. Investigating the ageing error and bias would help to understand the influences that the age data have on this assessment.

- **Basin-wide understanding of stock structure, biology, connectivity, and distribution:** This is a stock assessment for Widow Rockfish off of the west coast of the U.S. and does not consider data from British Columbia or Alaska. Further investigating and comparing the data and predictions from British Columbia and Alaska to determine if there are similarities with the U.S. West Coast observations would help to define the connectivity between Widow Rockfish north and south of the U.S.-Canada border.

Table i. Summary table of results for the assessment of Widow Rockfish.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total catch (mt)	188.93	212.09	270.41	472.3	722.04	885.19	1,038.85	6,347.48	10,517.80	NA
OFL (mt)	6,937	5,097	4,923	4,841	4,435	4,137	3,990	14,130	13,237	12,375
ACL (mt)	509	600	600	1,500	1,500	2,000	2,000	13,508	12,655	11,831
(1-SPR)/(1-$SPR_{50\%}$)	0.04	0.04	0.05	0.08	0.11	0.12	0.13	0.61	0.85	NA
Exploitation rate (catch/ age 4+ biomass)	0	0	0	0	0.01	0.01	0.01	0.04	0.06	NA
Age 4+ biomass (mt)	106,867	107,098	126,117	130,681	144,306	145,255	142,506	171,160	182,799	180,855
Spawning Biomass	50,864	53,403	56,192	60,047	64,421	68,547	72,782	76,824	79,032	80,910
~95% Confidence Interval	31,199–70,529	33,186–73,620	35,332–77,051	38,128–81,965	41,214–87,627	44,090–93,003	46,970–98,594	49,668–103,979	50,137–107,927	49,484–112,335
Recruitment	101,007	6,740	6,074	240,825	101,692	34,200	63,177	40,750	37,521	49,257
~95% Confidence Interval	60,929–167,448	3,220–14,107	3,040–12,134	144,209–402,171	47,924–215,784	14,729–79,408	22,368–178,435	13,832–120,048	12,654–111,256	15,883–152,756
Depletion (%)	57.8	60.7	63.9	68.2	73.2	77.9	82.7	87.3	89.8	91.9
~95% Confidence Interval	43.4–72.2	46.3–75.1	49.4–78.3	53.4–83.0	57.9–88.5	62.0–93.8	66.2–99.2	70.1–104.5	71.2–108.4	70.8–113.1

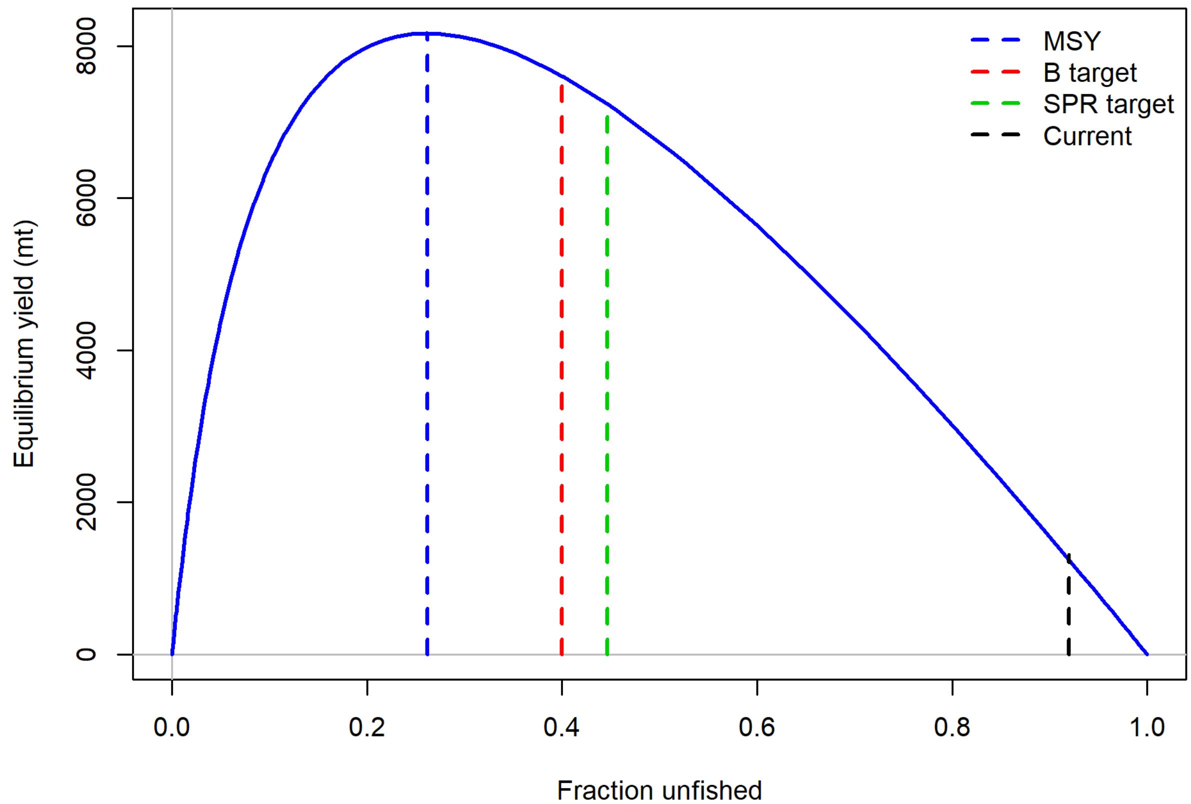

Figure h. Equilibrium yield curve for the base case model and associated target and limit reference points. Values are based on 2019 fishery selectivity and distribution with steepness fixed at 0.720. The %unfished is relative to unfished spawning biomass.

1 Introduction

Sebastes entomelas (Widow Rockfish) is named after its black-lined gut cavity (*ento* meaning within and *melas* meaning black). It has been referred to as buda, beccafico (Italian bird), and viuva (widow) prior to the 1930s. More recently, the Widow Rockfish is also called brownie, belinda bass, brown bomber, and soft brown.

This is an update assessment of Widow Rockfish that inhabit the waters off California, Oregon, and Washington from the U.S.-Canadian border in the north to the U.S.-Mexico border in the south, and does not include Puget Sound waters (Table 1). This is an update assessment of the 2015 full assessment of Widow Rockfish assessment (Hicks and Wetzel, 2015). In this assessment, aspects of the model including catches, data, and modelling assumptions were generally consistent with the 2015 assessment.

1.1 Distribution and stock structure

Widow Rockfish inhabit water depths of 25–370 m from northern Baja California, Mexico to Southeastern Alaska, and are most abundant from British Columbia to Northern California. Although catches north of the U.S.-Canada border or south of the U.S.-Mexico border were not included in this assessment, it is possible that these populations contribute to the biomass of Widow Rockfish off of the U.S. West Coast through adult migration and/or larval dispersion.

There is little evidence of genetically separate stocks along the U.S. coast and past assessments have used a single area, coastwide model with multiple fisheries (He et al. 2011). In 2011, a two-area assessment model was brought forward for review, and was found to be similar to a coastwide model (He et al. 2011). There is some evidence of biological differences between areas. For example, Widow Rockfish collected off California tend to mature at a smaller length than Widow Rockfish collected off Oregon (Barss & Echevarria 1984). This may be due to environmental or anthropogenic effects rather than genetic differences. The connectivity of Widow Rockfish populations throughout its range is unknown and it was decided to continue with a single area model for this assessment instead of potentially losing prediction power by splitting the data into two separate areas.

1.2 Life History and ecosystem interactions

Widow Rockfish are atypical for West Coast rockfish species because they form dense midwater aggregations at night, which were largely undetected until the late 1970s. They are typically found over high relief strata and near cobblestone. The diet of Widow Rockfish is dominated by species that comprise the deep scattering layers, including salps, myctophids, *Sergestes similis* (a caridean shrimp), and euphausiids (Adams 1987).

Widow Rockfish are ovoviviparous with gestation lasting from 1 to 3 months. Parturition occurs earlier in southern latitudes (December-March off California) than in northern latitudes (April in British Columbia) and occurs once a year (Barss & Echeverria, 1987). Estimates of fecundity of Widow Rockfish range from 95,375 oocytes at 33 cm to 1,113,000 oocytes at 52 cm (Boehlert et al, 1982).

There is little information regarding the movement of Widow Rockfish. Past assessments have assumed a two-area model because of differences in growth and maturity (see He et al. 2011; Hicks and Wetzel, 2015). However, using recent observations from the NWFSC shelf/slope survey to follow two separate cohorts through time and space suggests that Widow Rockfish may recruit in the south and disperse northward as they age (Figure 2) Spatial recruitment and movement patterns of Widow Rockfish are uncertain and much more investigation and sampling is needed to fully understand them.

1.3 Historical and current fishery

Widow Rockfish were lightly exploited by bottom trawl and hook-and-line gears prior to the 1980s. After many attempts to start trawl fisheries off the west coast of the United States in the late 1800s, the availability of otter trawl nets and the diesel engine in the mid-1920s helped trawl fisheries expand (Douglas 1998). The trawl fisheries really became established during World War II when demand increased for shark livers and bottomfish. A mink food fishery also developed during World War II (Jones and Harry 1960). Foreign fleets began fishing for rockfish in the mid-1960s until the EEZ was implemented in 1977 (Rogers 2003). Longline catches of Widow Rockfish are present from the turn of the century and continue in recent years, mainly from fisheries targeting sablefish and halibut.

In the late 1960s and early 1970s, it is reported that foreign fishing vessels caught large numbers of Widow Rockfish (Rogers 2003). In the late 1970s a domestic midwater trawl fishery began developing off of Oregon when it was realized that Widow Rockfish form dense aggregations at night (Gunderson 1984). The fishery expanded very quickly, with landings from trawl, net, and hook-and-line gears increasing more than 20 times by the early 1980s (Table 1). Time series of hake fishery are given in Table 2. As early as 1982, trip limits were imposed to keep catches below recommended annual levels (Table 3). Trip limits became more restrictive over the years until Widow Rockfish was declared overfished in 2001. In 2002, harvest guidelines were greatly reduced and remained low, though increasing, until 2017. Catches have increased greatly over the past couple of years to over 10,000 mt in 2018.

Historical discarding practices are not well known, but it is believed that little discarding occurred prior to management restrictions. With the introduction of trip limits, limited data from the mid-1980s show occasional very high discard rates of Widow Rockfish from tows that occurred near the end of a trip.

More detailed information of the fisheries in each state is given in Section 2.2.1 where the reconstructed landings are discussed.

1.4 Management history and performance

Widow Rockfish has been a component of groundfish fisheries since the late 1970s. The landings of Widow Rockfish have been historically governed by harvest guidelines and trip limits, while recently management is imposed with total catch harvest limits in the form of overfishing limits (OFLs), acceptable biological catches (ABCs), and annual catch limits (ACLs). A trawl rationalization program, consisting of an individual fishing quota (IFQ) or catch shares system, was implemented in 2011 for the limited entry trawl fleet targeting non-whiting groundfish, including Widow Rockfish, and the trawl fleet targeting and delivering whiting to shore-based processors. The limited entry at-sea trawl sectors (motherships and catch-processors) that target whiting and process at sea are managed in a system of harvest cooperatives.

Limits on Widow Rockfish were first established in 1982 (Table 3). These were implemented as trip limits and cumulative landing limits that were first imposed by trip, then week, then every 2 weeks, month, 2 months, and eventually into periods. In many years, the trip limits on Widow Rockfish were significantly reduced at the end of the year to avoid exceeding the harvest recommendations. Some important years were 1985 when trip limits were reduced to 30,000 pounds once per week or 60,000 pounds once every 2 weeks, 1990 when trip limits were reduced to 15,000 or 25,000 pounds every one or two weeks, respectively, 1998 when a 25,000 pound cumulative limit per two-month period was implemented, and 2011 when catch shares were implemented.

A requirement to sort landings of Widow Rockfish from other species was implemented in the early 1980s with California beginning in 1982, Oregon in 1984, and Washington in 1988. Some important events that could affect fishery selectivity are the gear restrictions implemented in 2000, implementation of Rockfish Conservation Areas (RCAs) in 2002, seasonal changes to the RCAs in 2007, and the beginning of catch shares in 2011.

Table 1 shows that recent landings have been below recommended catch levels. Landings are a considerable amount below the ACL, and it is unlikely that total mortality has exceeded the ACL in the last 10 years.

1.5 Fisheries and assessments in Canada and Alaska

Widow Rockfish are distributed throughout Canada and Southeast Alaska and are commonly caught in trawl and hook-and-line fisheries. However, the landings from the fisheries in these areas are estimated to harvest Widow Rockfish at a much smaller rate than has been observed off California, Oregon, and Washington mostly due to lower abundance of Widow Rockfish, but also partly due to precautionary behavior of Canadian managers after the large catches followed by management restrictions and concerns of the U.S. fishery in the early 1980s.

Alaska formed the “Other Rockfish” complex in 2012 from the combination of Other Slope Rockfish and the Widow and Yellowtail Rockfishes from the Pelagic Shelf Rockfish category. This new complex includes 18 species and Widow Rockfish are a small proportion of the catch (less than 5%). Total biomass estimates are provided by the Gulf of Alaska (GOA) triennial/biennial trawl survey. ABCs and OFLs were set for the Other Rockfish Complex and component species in 2013 with a recommended OFL in 2014 of 5,347 mt for the complex. Widow Rockfish comprise a small part of this complex in Alaska.

The fishery for Widow Rockfish in British Columbia, Canada started in 1986 although some very small landings occurred in the mid-1970s. Landings peaked at about 4,500 mt in 1990 and were around 2,000 mt throughout the 1990s (DFO 1999). Most landings occurred in a midwater trawl fishery, but there have also been reports of “nuisance catches in the salmon troll fishery”. An assessment of Widow Rockfish in Canada was completed in 1998 (Stanley 1999) as part of a shelf rockfish complex. Additional research has since been done on the estimation of biomass of particular aggregations of Widow Rockfish (Stanley et al. 2000), but no formal assessment has been done since.

2 Data

Many sources of data were available for this assessment, including indices of abundance (Table 5), length observations, and age observations from fishery-dependent and fishery-independent sources.

2.1 Fishery-independent data

Data from three fishery-independent surveys were used in this assessment: 1) the SWFSC and NWFSC/PWCC Midwater Trawl Survey (hereafter, “juvenile survey”); 2) the Alaska Fisheries Science Center (AFSC)/NWFSC Triennial Shelf Trawl Survey (hereafter, “triennial survey”); and 3) the NWFSC West Coast Groundfish Bottom Trawl Survey (hereafter, “WCGBTS”). These surveys employed different designs and sampling methodologies, were conducted during different years and time periods within years, and included coverage over different areas of the coast. In some instances, the survey frequency, depths, and geographic areas covered were not internally consistent within surveys. A brief description of each survey is provided below.

Strata were defined by latitude and depth to analyze the catch-rates, length compositions, and age compositions using stratified random sampling theory (Table 6 & Table 7). The latitude and depth breaks were chosen based on the design of the survey as well as by looking at biological patterns in relation to latitude and depth. Indices of abundance for all of the surveys were derived using model based approaches described below.

2.1.1 Juvenile survey

An update of the coastwide pre-recruit indices of abundance was obtained from John Field (SWFSC, pers. comm.). These indices of abundance were estimated using data from three separate midwater trawl surveys for young-of-the-year (YOY) pelagic juvenile rockfish. Identical gear was used by each survey, and combining the data provides the best opportunity to create coastwide indices. Only years that covered waters from 36°N latitude to the U.S./Canada border were used. The indices were constructed using vector-autoregressive spatiotemporal models (Thorson, 2019; Thorson and Barnett, 2017) available within the VAST R package. This method represents an update from the 2015 assessment, which used Delta-GLMM, but both indices provide similar estimates of trend.

The index shows a very large number of age-0 fish in 2013, followed by a large number in 2014, and a moderate value in 2004 (Table 8).

2.1.2 AFSC/NWFSC triennial bottom trawl survey

The triennial survey was first conducted by the AFSC in 1977 and spanned the timeframe from 1977–2004. The survey's design and sampling methods are most recently described in Weinberg et al. (2002). Its basic design was a series of equally-spaced east-west transects from which searches for tows in a specific depth range were initiated (Figure 5). The survey design changed slightly over time (Table 6 and Figure 6). In general, all of the surveys were conducted in the mid-summer through early fall: the 1977 survey was conducted from early July through late September; the surveys from 1980 through 1989 ran from mid-July to late September; the 1992 survey spanned from mid-July through early October; the 1995 survey was conducted from early June to late August; the 1998 survey ran from early June through early August; and the 2001 and 2004 surveys were conducted in May-July (Figure 6).

Haul depths ranged from 91–457 m during the 1977 survey with no hauls shallower than 91 m. The surveys in 1980, 1983, and 1986 covered the West Coast south to 36.8°N latitude and a depth range of 55–366 meters. The surveys in 1989 and 1992 covered the same depth range but extended the southern range to 34.5°N (near Point Conception). From 1995 through 2004, the surveys covered the depth range 55–500 meters and surveyed south to 34.5°N latitude. In the final year of the triennial series (2004), the NWFSC's Fishery Resource and Monitoring division (FRAM) conducted the survey and followed very similar protocols as the AFSC.

Given the different depths surveyed during 1977, the data from that year were not included in this assessment. Water hauls (Zimmermann et al. 2003) and tows located in Canadian waters were also excluded from the analysis of this survey. The survey was analyzed as an early series (1980–1992) and a late series (1995–2004), as has been done in other West Coast rockfish assessments.

The triennial index was estimated using a delta-generalized linear mixed model (GLMM) following the methods of Thorson and Ward (2013). The survey were stratified by latitude and depth, with the stratifications shown in Table 7. Vessel-specific differences in catchability (via inclusion of random effects) were estimated. The Delta-GLMM approach explicitly models both the zero and non-zero catches and allows for skewness in the distribution of catch rates. Lognormal and gamma errors structures were considered for the positive tows, including the option to model extreme catch events (ECEs), defined as hauls with extraordinarily large catches, as a mixture distribution (Thorson et al. 2011). There were therefore four total positive tow error structures considered: gamma or lognormal with or without ECEs mixture distributions. Model convergence was evaluated using the effective sample size of all estimated parameters (typically >500 of more than 1000 kept samples would indicate convergence), while model goodness-of-fit was evaluated using Bayesian Q-Q plots and deviance. The resultant coefficient of variations (CVs) of each model were also considered when determining viable indices (i.e., CVs consistently >2 in each year were deemed uninformative and not used). Boxplots of the deviance for triennial survey series are shown in Figure 7 and show that the gamma and the lognormal distributions with random strata-year effects including an extreme catch event mixture distribution (ECE) have the lowest median deviance values. Random or fixed strata-year effects without extreme catch events produced a similar deviance to each other, and the deviance was greatly reduced when ECEs were accounted for. Deviance Information Criterion (DIC) values were also compared among models. DIC values favored the gamma distribution with ECEs over the lognormal distribution with ECEs. The Q-Q plot for the gamma distribution with random strata-year effects and ECEs did not show a departure from the normality assumption (Figure 8). Therefore, based on the deviance and the DIC criteria the gamma distribution with random strata-year effects accounting for ECEs was used to estimate the indices given in Table 8. The time series suggests a possible slightly increasing trend in biomass from 1980 - 1983, although is relatively flat until the end of the period in 2001 and 2004 when the index declines significantly. The design-based estimates (average density expanded to the stratum area then summed over strata) are compared to the model-based estimates in Figure 9. The trends generally vary between the design-based and the Delta-GLMM based model, with the highest estimates based on the design-based occurring in 1989 and 1992. However, the design-based abundance estimates result in the lowest abundances in 2001 and 2004, similar to the Delta-GLMM model.

Length frequencies for each year were expanded using the same stratification as the GLMM, and weighted by strata estimated numbers from the GLMM when combining them into a coastwide length composition (Figure 10). Unsexed fish were apportioned to males and females according to the estimated sex ratio for lengths greater than 28 cm. The sex ratio of lengths less than 28 cm was assumed to be 0.5. There was considerable variability in length frequencies in the triennial survey data. Smaller fish (less than 15 cm) were observed in small proportions from 1992 onwards. There is no clear difference in length composition pre- and post-1995 that would support the split into early and late periods.

2.1.3 NWFSC West Coast Groundfish Bottom Trawl Survey (WCGBTS)

The WCGBTS is based on a random-grid design, covering the coastal waters from a depth of 55 m to 1,280 m (Keller et al. 2007). This design uses four chartered industry vessels in most years, assigned to a roughly equal number of randomly selected grid cells. The survey, which has been conducted from late-May to early-October each year, is divided into two 2-vessel passes of the coast, which are executed from north to south. This design therefore incorporates both vessel-to-vessel differences in catchability as well as variance associated with selecting a relatively small number (~700) of cells from a very large population of possible cells (greater than 11,000) distributed from the Mexican to the Canadian border. Much effort has been expended on appropriate analysis methods for this type of data, culminating in the West Coast trawl survey workshop held in Seattle in November 2006.

Widow Rockfish are not commonly caught in the WCGBTS. Higher catch rates occur north of 40° N latitude and catches are rare south of 36° N latitude (Figure 11). Few large fish are found shallower than 100 m and few small fish are found in the deeper water of the slope. There is no clear trend in length with latitude other than smaller fish tend to occur south of approximately 36° N latitude, and there appears to be some very small fish found near 39° N latitude.

An index was created using vector-autoregressive spatiotemporal models (Thorson, 2019; Thorson and Barnett, 2017) available within the VAST R package. VAST allows for the estimation of the variation in density for multiple locations across time and categories (e.g., species or age classes) and has been reviewed, endorsed, and recommended by the Pacific Fishery Management Council's Scientific and Statistical Committee for estimating abundance indices. Spatial and spatiotemporal variation is specifically included in both model components, i.e., encounter probabilities and positive catch rates, which are modeled using logit- and log-links, respectively. Gamma and lognormal error structures were investigated for the positive catch-rate component of the model to allow for skewness in the estimated distribution (Maunder and Punt, 2004). Vessel-year effects were included for each unique combination of vessel and year to account for the random selection of commercial vessels from those that were available

(Helser et al., 2004; Thorson and Ward, 2014). In summary, the survey biomass density (weight per area swept) was a function of year, latitude, longitude, and vessel-year. Spatial variation was approximated using 50 knots and the results were corrected for transformation bias (Thorson and Kristensen, 2016) using an algorithm in Template Model Builder (Kristensen et al., 2016). Further details regarding the structure of the spatiotemporal model available in VAST are available in the user manual. Specific details of how VAST was configured to estimate an index of abundance from WCGBT surveydata are available in VASTWestCoast (https://github.com/nwfsc-assess/VASTWestCoast), which contains scripts specific to fitting VAST to data from surveys operating off of the U.S. West Coast. For example, a covariate was included for survey pass (i.e., 'first' or 'second') to account for the incomplete sampling during the second pass of the 2013 WCGBT survey when the survey was cut short and no stations south of 37_N were sampled. Model convergence and fit were evaluated using the matrix of second-order partial derivatives ('Hessian matrix') and quantile-quantile ('Q-Q') plots of the predicted distribution versus the expectation under a null model (i.e., uniform distribution). Positive definite Hessian matrices were indicative of a model that had reached a local minimum and, thus, converged. Q-Q plots that largely followed a 1:1 relationship suggested that the distributional form used to fit the positive catch-rate data captured the shape of the dispersion present in the data. Histograms of the quantiles were also used to inspect for over- and under-estimated probability of encounter rates, which can suggest a lack of fit. Finally, plots of Pearson residuals across space and time were investigated for spatial and spatiotemporal patterns suggesting model misspecification.

The estimated index shows a relatively precise and stable trend from 2003-2015, a sharp increase in 2016, and a decline to values like 2011 for 2017 and 2018 (Figure 11). Comparison with design-based estimates and the delta-glmm index used in the 2015 assessment are shown in Figure 11. The mean index value used in the 2015 assessment is 2701.12 and the mean VAST index used in the current update assessment is 3,301.765. AIC scores and Q-Q plots suggested that the lognormal distribution (Appendix G Figures E1 and E2) fit the data better than a gamma distribution or gamma distribution with poisson-link for the encounter rate (results not shown). Although quantile histogram of predicted quantiles binned by encounter probability for the NWFSC WCGBT survey show some overdispersion present in the encounter residuals (Appendix G Figure E2). The lognormal distribution also presented greater consistency with the previous assessments' index of abundance for this survey. No persistent spatial or spatiotemporal patterns were found in the Pearson residuals (Appendix G Figures E3 - 7).

Length, age, and conditional age-at-length compositions were created by expanding to the tow and summing to give a strata specific composition (Table 9). The strata compositions were combined to a coastwide composition using a design-based index of abundance from each strata. The design based index is constructed by taking the average catch per unit effort (CPUE) defined as catch per area swept across tows in each stratum and year. The sum of strata specific composition data was then calculated, weighting by the average CPUE per stratum multiplied by the area of each stratum. The 2015 assessment weighted composition data by a Delta-GLMM. Unsexed fish were apportioned to males and females according to the estimated sex ratio for lengths greater than 28 cm. The sex ratio of lengths less than 28 cm was assumed to be 0.5. The design based weighting was selected because a Delta-GLMM based index was not constructed for this assessment and VAST based weighting providing results inconsistent with the previous assessment.

Expanded length frequencies from this survey show intermittent years of small fish (Figure 13). In 2003 and 2004, a high proportion of fish were seen around 35–40 cm, but in later years, it was uncommon to see fish in that range. Age compositions (Figure 14) show a high proportion of a single age in 2003 and 2004. Strong cohorts are not immediately apparent and it seems that ageing error may result in some variability between years. In 2012, there was a high proportion of 4 year old fish, which appears in successive years as a strong 2008 year class. Conditional age-at-length proportions (Figure 15) show relatively consistent length-at-age with few outliers.

2.1.4 Fishery-independent surveys not used in this analysis

2.1.4.1 AFSC slope survey

The AFSC slope survey operated during autumn (October-November) aboard the R/V *Miller Freeman*. Partial survey coverage of the U.S. west coast occurred during 1988–96 and complete coverage (north of 34° 30' S latitude) during 1997, 1999, 2000, and 2001, which observed Widow Rockfish in 10, 17, 5 and 8 tows, respectively. Length data are available in each year, with 89 samples in 1999, but less than 20 combined between 2000 and 2001.

2.1.4.2 NWFSC slope survey

The NWFSC slope survey covered waters throughout the summer from 183 m to 1280 m north of 34° 30' S latitude, which is near Point Conception. The survey took place from 1998–2002. In 1999, Widow Rockfish were caught in 18 hauls, the most seen for this survey. In 1998, rockfish were not recorded. This survey was not used because it occurred over a short time period, surveyed slope waters (>183 m) that exclude some of the Widow Rockfish habitat, observed few Widow Rockfish, and did not record any lengths of Widow Rockfish.

2.1.4.3 IPHC longline survey

The International Pacific Halibut Commission (IPHC) has conducted an annual longline survey for Pacific halibut off the coast of Oregon and Washington (IPHC area "2A") since 1999 with a fixed station design. Approximately 1,800 hooks are deployed at 84 locations each year (Figure 16). Rockfish bycatch is routinely recorded during this survey, and originally estimates of rockfish bycatch in area 2A were based on subsampling the first 20 hooks of each 100-hook skate. Recently, all rockfish are tagged and recorded for later sampling by WDFW and ODFW biologists (see http://www.iphc.int/publications/rara/2012/rara2012503_ssa_survey.pdf). Some variability in exact sampling location is practically unavoidable, and leeway is given in the IPHC methods to center the set on the target coordinates but to allow wind and currents to dictate the actual direction in which the gear is deployed. This can result in different habitats accessed at each fixed location among years.

The IPHC longline survey fishes in suitable habitat for Widow Rockfish, but the majority of the rockfish catch is yelloweye rockfish (*S. ruberrimus*). From 2002 to 2012, only one observation of Widow Rockfish was recorded, which was at station 1064 off of Westport.

2.2 Fishery-dependent data

Widow Rockfish have been caught in trawl and hook-and-line fisheries since the early part of the 20th century. Widow Rockfish are a desirable rockfish and are not likely to be discarded for market reasons. However, smaller Widow Rockfish are found at shallower depths and discarding practices in the early 1900s are uncertain. Few Widow Rockfish have been observed (relative to other gear types) in recreational, commercial pot, and commercial shrimp fisheries, thus only trawl, net, and hook-and-line landings were used in this assessment.

In data from the early 1980s, Widow Rockfish have had their own landing category. California began in 1982, Oregon in 1984, and Washington in 1988. Estimates of historical landings of Widow Rockfish rely upon species-composition sampling data from each period. The uncertainty in species composition is greater in past years, with less systematic and extensive sampling occurring prior to 1980. Consequently, the precision with which landings of Widow Rockfish can be estimated likely decreases for earlier years. A description of the methods used to determine the historical and current landings is provided below.

2.2.1 Commercial catch reconstruction

PacFIN serves as a clearinghouse for commercial landings data since the early 1980s, and before that, landings for each state were reconstructed using the assumptions described below. The domestic at-sea trawl fleet catches are calculated from observer data stored in the NORPAC database, maintained by the AFSC. For a full description of the catch reconstruction see the previous assessment (Hicks and Wetzel 2015).

2.2.2 Fishery catch-per-unit-effort

Changes in management during the years with the largest catches of Widow Rockfish and restrictive limits, including the cessation of the target fishery beginning in 2002 after the Widow Rockfish stock was declared overfished, make it difficult to create a catch-per-unit-effort (index of abundance from fishery-dependent information) that adequately reflect the population trend. In the 2011and 2015 assessments for Widow Rockfish, four fishery-dependent CPUE indices were used. These were derived from the following fisheries: 1) Oregon bottom trawl, 2) Pacific Whiting at-sea foreign fleet, and 3) Pacific Whiting at-sea domestic fleet.

We do not present new fishery CPUE indices, but use the same three series that were included in the 2011 and 2015 assessments. These three indices are shown in Figure 4.

2.2.3 Fishery length and age data

Biological data from commercial fisheries that caught Widow Rockfish were extracted from PacFIN (PSMFC) on July 3, 2019, from CALCOM on July 3, 2019 and from the NORPAC database on July 3, 2019. Lengths taken during port sampling in California, Oregon, and Washington were used to calculate length and age compositions. The data were classified into bottom trawl, midwater trawl, hake trawl, net, and hook-and-line fleets

Table 10 shows the number of landings sampled and Table 11 shows the number of lengths taken for each year, gear, and fleet from the three states. Table 12 shows these numbers for the at-sea fleet.

Consistent with the 2015 assessment, length and age samples from PacFIN and CALCOM were expanded up to the total landing then combined into state-specific frequencies (Table 13). Expansion factors were calculated in a way such that large expansions would not occur and based on ideas first presented by Owen Hamel (pers. comm., NWFSC). First the expansion factor (E_k) was the total catch weight (W_k) divided by the sample weight (w_k), and raised to 0.9 to account for non-homogeneity within a trip. Then, expansion factors greater than 300 were capped (100 for net fisheries) to reduce the influence of small samples (i.e., a few fish representing a large catch). The predicted total numbers at length or age weighted by landings for each state were added to create a coast-wide length frequency. The effective sample sizes of the state combined length frequencies were determined from the following formula, which has been used in previous Widow Rockfish assessments as well as other west coast groundfish assessments.

Fishery Samples		Survey Samples	
$N_{eff} = N_{sample} + 0.138N_{fish}$	$\frac{N_{fish}}{N_{sample}} < 44$	$N_{eff} = N_{sample} + 0.0707N_{fish}$	$\frac{N_{fish}}{N_{sample}} < 55$
$N_{eff} = 7.06N_{sample}$	$\frac{N_{fish}}{N_{sample}} \geq 44$	$N_{eff} = 4.89N_{sample}$	$\frac{N_{fish}}{N_{sample}} \geq 55$

This is slightly different than the sample size of 2.43 per haul for rockfish that Stewart & Hamel (2014) report.

Observed lengths were expanded to the tow from At-Sea Hake Observer Program samples (NORPAC). Tows are typically well sampled, thus expansion factors were not modified from what was calculated. Hake fishery length compositions were created by combining shoreside and at-sea length compositions, weighting by the catch from each sector. The effective sample sizes for hake fishery length and age comps were calculated using the above equations for the shoreside fleet and added to the number of tows sampled from the at-sea fleet.

Expanded length compositions for bottom trawl, midwater trawl, hake fisheries, net, and hook-and-line are shown in Figure 17 to Figure 21. It is quickly apparent that all of these fisheries rarely land fish less than 26 cm. All of the non-hake fleets show a strong cohort coming though in the late 1970s and early 1980s, and then another cohort coming through in the late 1980s. Sample sizes typically dropped off after 2000, except in the hake fishery where nearly every tow is sampled.

Age compositions for the five fleets are shown in Figure 22 and Figure 26. Occasional cohorts appear to move through the population, indicating that Widow Rockfish population dynamics may be characterized by episodic recruitment events.

2.2.4 Discards

Treatment and source of discard data was consistent with the 2015 assessment. Data on discards on Widow Rockfish are available from three different sources. The earliest source is called the Pikitch data and comes from a study organized by Ellen Pikitch that collected data on trawl discards from 1985–1987 (John Wallace, pers. comm and a manuscript in prep). The second source is called EDCP data, which stands for Enhanced groundfish Data Collection Project. These data were collected from late 1995 to early 1999 by at-sea observers on vessels that voluntarily participated in the project. These data were obtained from John Wallace (NWFSC, pers. comm.) and a report to the Oregon Trawl Commission written by David Sampson describes the data. The third data source is from the WCGOP. This program is part of the NWFSC and has been recording discard observations since 2003.

Results of the Pikitch data were obtained from John Wallace (NWFSC, pers. comm.) in the form of ratios of discard weight to retained weight of Widow Rockfish and sex-specific length frequencies. Although results were extended to additional years using data from a mesh study, it was decided to use only the results from the specific years of the study since there were many observations from those years (1985–1987). Discard estimates are shown in Table 16 and range from 463 to 1,847 mt. Length compositions for discards show a wide range of sizes being discarded, with a peak around 40 cm (Figure 27).

Observations of discards from the EDCP dataset were provided as total discards and total landings per trip (i.e., fish ticket). For each year, the discards were summed and divided by the total observed landings to provide a ratio of discarded to retained catch. This was then applied to the total landings of that fleet to estimate to total discards in that year (Table 16). Variability was estimated from individual trip discard ratios. Length data were not available.

The WCGOP has been collecting on-vessel data since 2002 to mainly record discard information, and are current through 2017. A proportion of the fleet for various gear types has been observed in each year and the data collected are used to estimate the total mortality for various species. Since 2011, under trawl rationalization, 100% observer coverage is required for the limited entry trawl sectors, which resulted in a large increase in data and ability to determine discard behavior. However, given the change in management, it is likely that there has been a change in discarding behavior.
Table 18 shows the number of vessels, trips, hauls with Widow Rockfish and the number of Widow Rockfish observed by the WCGOP in the years 2002–2013 for each fleet. One year of data from midwater trawl had to be removed due to confidentiality (at least three vessels need to be observed within a year, regardless of species caught, for the strata defined). Sample sizes are largest for bottom trawl and least for hook-and-line. Midwater trawl and shoreside hake were sampled in few years, mostly since 2011. Since 2011, when the trawl rationalization program was implemented, observer coverage rates increased to nearly 100% for all the limited entry trawl vessels in the program. Open access and non-sablefish fixed gear fisheries have continued with observer rates less than 13% of all groundfish landings

(WCGOP report, http://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/sector_products.cfm).

Table 16 shows discard totals in metric tons for each year since the WCGOP has been collecting data. Prior to 1982, we assumed a discard rate of 1%, which is arbitrary, but reasonable. Total discards by fleet were calculated by summarizing the observed discards (d) and observed retention (r) by fleet on a coastwide basis. Using the observed landings (R), the total discards were calculated as

$$D_{y,f} = \frac{d_{y,f}}{r_{y,f}} R_{y,f}$$

where y and f indicate year and fleet, respectively. The groundfish mortality reports written by WCGOP personnel were not used because they did not contain the exact fleet structure needed and did not have uncertainty associated with the estimates. Coefficients of variation (CV) were calculated by bootstrapping vessels within ports because the observer program randomly chooses vessels within ports to be observed in the non-catch shares sectors.

Total discards were estimated in many years for some fleets and few for others (Table 16). Discards in the bottom trawl fleet were estimated for all available years (2002–2017), and discard rates (d/[d+r]) were typically greater than 50% prior to implementation of the trawl rationalization program in 2011, but less than 5% thereafter. The hook-and-line fleet had a paucity of data in 2002, 2003, and 2009 (see Table 18), but other years (2004–2008 and 2010–2017) produced estimates with discard rates ranging from 10.71% to 71.7%. Observations of the midwater trawl fleet were available in only one year prior to catch-shares (2002), and every year post-catch shares (2012-2017). The discard ratio was 42.5% in 2002, and virtually zero after catch shares was implemented. The shoreside hake fleet was only observed post-trawl rationalization, and even though they do not typically sort the catch at-sea, 2011 showed a discard rate of 9.6%. This was mainly the result of a single very large discard event recorded in the observer database, and because it was not indicative of more recent years and the shoreside hake fishery is managed under a maximum retention regulation, discard estimates were simply added into landings and not modeled separately for this fleet. No observations of the net fleet were available even though a very small amount of Widow Rockfish was landed by this gear between 2002 and 2017. Overall, this period of time (2002–2017) is a period with highly regulated fisheries, and discarding could have been a result of trip limits being reached. Therefore, these numbers may not be indicative of previous years when the fishery was not as tightly regulated. Variability from bootstrapping the discard data often had a long tail or was characterized by small discards or large discards, indicating that tow-specific discard rates were sometimes zero and sometimes near 100% (Figure 28).

Length compositions of the discards for the bottom trawl are in Figure 29.

These discards were fitted to in the model. Estimated total catches, the sum of estimated discards and fixed landings, are reported where necessary.

2.3 Biological data

2.3.1 Weight-length relationship

Weight-at-length data, which are the same used in the 2015 assessment, were collected from fisheries sampling and by the Triennial and NWFSC WCGBT Surveys, and were used to estimate a weight-length relationship for Widow Rockfish (Figure 30). Weight-at-length was similar between sources with the fishery samples showing a slightly smaller weight at large sizes when compared to the survey data (Figure 31). WCGOP data were not used because only small fish were sampled, the weight of these small fish were typically less than from other sources (Figure 30), and the curves fitted to only WCGOP data were unable to estimate the slope. There were only 81 observations from the WCGOP data, which is a small amount of data compared to everything available. However, these observations may be useful to understand discards.

The weight-length relationship used in the 2011 assessment was similar for males but predicted slightly heavier females at larger sizes than the 2015 assessment (Figure 31). The following relationships between weight and length for females and males were estimated for the 2015 assessment from all of the data combined and were used in the current assessment:

Females $\quad \text{weight} = 1.7355 \times 10^{-5} \cdot \text{Length}^{2.9617}$

Males $\quad \text{weight} = 1.4824 \times 10^{-5} \cdot \text{Length}^{3.0047}$

where weight is measured in kilograms and length in cm. These relationships were used in the assessment as fixed relationships.

2.3.2 Maturity schedule

Estimates of maturity used in this update were the same as the 2015 assessment. Estimates of maturity at length have been presented by Barss & Echeverria (1987), Echeverria (1987), and Love et al (1990). Barss & Echeverria (1987) supplied data collected from Oregon and California commercial and recreational samples, which allowed us to estimate the proportion mature-at-length and proportion mature-at-age for samples from each state (Figure 32). As noted by Barss & Echeverria (1987), the samples from Oregon matured at older age and larger length. Estimates of maturity-at-length from California reported by Barss & Echeverria (1987) are similar to estimates of length-at-50%-mature from samples collected in California reported by Echeverria (1987) and Love et al (1990), although Barss & Echeverria show the smallest length-at-50%-mature.

To maintain some consistency with the 2011 assessment and to avoid any potential growth issues by area, the 2015 assessment used maturity-at-age data from the 2011 assessment, but used the data provided by Barss & Echeverria (1987) to estimate a new maturity curve following a logistic function with the data from California and Oregon equally weighted to avoid California dominating the estimated relationship. This maturity-at-age curve falls between the estimated California and Oregon maturity-at-age curves (Figure 32, right), with the age-at-50%-mature estimated at 5.47 and with a slope of -0.7747 (as specified in SS). This logistic maturity-at-age curve was used in the 2015 and 2019 update assessment except that maturity-at-age for ages 2 and lower were set equal to zero (Table 19).

2.3.3 Fecundity

Fecundity in rockfish is often not a linear function of weight, but increases faster at larger weights (Dick 2009). Therefore, this relationship is often accounted for in rockfish assessments by using spawning output (numbers of eggs) to determine current status. Dick (2009) did not find a significant relationship between the number of eggs per gram of body weight and body weight for Widow Rockfish. Therefore, spawning output was assumed to be proportional to weight, which is the same as spawning biomass, and is reported here.

2.3.4 Natural mortality

Natural mortality used in this update differed from the 2015 assessment. Natural mortality (*M*) is a parameter that is often highly uncertain in fish stocks. Past assessments of Widow Rockfish assumed constant natural mortality of 0.125 yr^{-1} or 0.15 yr^{-1}. The 2011 assessment estimated *M* with a prior developed by Owen Hamel (NWFSC, pers. comm.) using methods described in Hamel (2014). This prior was based on a maximum age of 44 and 40 for females and males, respectively, a mean temperature of 8 degrees Celsius (about 150m deep off of Oregon), and a gonadosomatic index of 9.99% and 1.86% for females and males, respectively (Love et al 1990). The sex-specific lognormal priors for *M* have medians of 0.124 yr^{-1} and 0.129 yr^{-1} for females and males, respectively, and a coefficient of variation (CV) of 30.7% for each sex. In 2015, discussions with Owen Hamel (NWFSC) led to the development of a new prior based solely on maximum age to use when estimating M. Using all of the available age data, a maximum age of 54 was determined for both females and males, although it has been rare to observe Widow Rockfish older than about 45 years old (Figure 33). This resulted in a prior with a much smaller median (0.0810 or -2.513284 in log space) and a larger standard deviation in log space (0.523694). For the update assessment, an updated meta-anaysis resulted in a prior with a slightly smaller median than the 2015 assessment (0.10 or -2.30 in log space) and a smaller standard deviation in log space (0.438). Figure 34 shows that these prior distributions are wide and not highly informative.

2.3.5 Length-at-age

Estimates of length-at-age used in this update were the same as the 2015 assessment. Two different labs have aged the majority of processed otoliths for Widow Rockfish. The SWFSC has been aging Widow Rockfish otoliths for many years, including all of the fishery data prior to 2011 and otoliths collected from the NWFSC WCGBT survey in 2009 and 2010. The Cooperative Ageing Project (CAP) in Newport, Oregon aged 1,100 otoliths from the NWFSC WCGBT survey, 2,026 otoliths provided by ASHOP, and 3,467 otoliths collected by port samplers. All of the commercial fishery samples were collected in the years 2011–2014. In total, there are 105,814 paired age and length observations ranging from 1978 to 2014.

Figure 35 shows the lengths and ages for all years and all data as well as predicted von Bertalanffy fits to the data. Females grow larger than males and sex specific growth parameters were estimated at the following values:

Females	$L_\infty = 50.34,\ k = 0.15,\ t_0 = -2.22$
Males	$L_\infty = 44.19,\ k = 0.21,\ t_0 = -1.78$

The data from each source (ASHOP, port sampling/BDS, Triennial survey, and NWFSC survey) are shown in Figure 36 with fitted von Bertalanffy lines. All of these sources are quite similar, especially observations from ASHOP and the NWFSC survey.

The standard deviation (SD) and coefficient of variation (CV) of length-at-age are shown in Figure 37. Modelling the CV as a function of predicted length-at-age appears to be somewhat linear from a value just over 0.1 at small lengths and slightly less than 0.045 at larger lengths. However, variance in length-at-age was estimated separately in stock-synthesis.

2.3.6 Sex ratios

Females tend to grow larger than males and it is expected that the proportion of females approaches one at large lengths and is less than 0.5 at intermediate lengths. Figure 38 shows that the proportion of females at length from survey data is approximately 50% until approximately 34 cm, when the proportion of females drops below 50%. At lengths larger than 46 cm, the proportion of females increases rapidly to one, suggesting that few males grow larger than 50 cm.

2.3.7 Ageing bias and imprecision

Uncertainty surrounding the ageing-error process for widow rockfish used in the 2015 assessment was incorporated by estimating ageing error by age. No changes were made from the 2015 assessment for the update. Age-composition data used in the model were from break-and-burn and surface reads and were aged by the Cooperative Ageing Project (CAP) in Newport, Oregon and the SWFSC in Santa Cruz, California.

Break-and-burn double reads of 1788 otoliths were performed by both the CAP and the SWFSC lab combined. Additionally, 100 otoliths were read both by surface and break-and-burn methods. An ageing error estimate was made based on these double reads using a computational tool specifically developed for estimating ageing error (Punt et al. 2008), and using release 1.0.0 of the R package *nwfscAgeingError* (Thorson et al. 2012) for input and output diagnostics, publicly available at: https://github.com/nwfsc-assess/nwfscAgeingError. The maximum aged fish read by the surface reading method was 10 years and the cross otolith reads between the surface and break-and-burn ageing methods showed limited variation. Therefore, a unique ageing error was not created for surface read otoliths. A non-linear standard error was estimated by age where there is more variability in the estimated age of older fish was estimated for each reading lab (Table 20 and Figure 39).

2.4 History of modeling approaches used for this stock

Interest in assessing Widow Rockfish began with a workshop on Widow Rockfish that was held at the NMFS SWFSC lab on December 11–12, 1980 (Lenarz & Gunderson 1987). This workshop was in response to the increase in catches that began in 1979. Descriptions of the fisheries in different states were given along with the biological research that was being done.

A 1984 assessment of Widow Rockfish (Lenarz 1984) summarizes a 1983 report provided to the groundfish management team, and then reports the results of a full assessment. Changes included reducing M from 0.25 yr^{-1} to 0.15 yr^{-1}, modeling sexes combined, and making improvements to the cohort analysis. The assessment reported that the population had declined considerably since 1980 (more than 50%) and that 1977 and 1978 were potentially strong cohorts. Assessments though 1988 suggested an equilibrium yield around 10,000 mt and strong cohorts in the late 1970s or early 1980s.

In 1989 (Hightower & Lenarz1989), stock synthesis was introduced as an assessment tool and $F_{0.1}$ was used to determine sustainable yield for M values of 0.15 yr^{-1} and 0.2 yr^{-1}. Equilibrium yield estimates were slightly less than 10,000 mt. In 1990 (Hightower & Lenarz1990) $F_{SPR=35\%}$was used to determine ABC, which was 11% less than the ABC from the previous assessment. This assessment also reported results of an area-stratified model where northern and southern areas were treated as separate fisheries, with different selectivities.

An assessment in 1993 (Rogers & Lenarz 1993) produced similar results as the 1990 assessment, but made some notable observations. They found that the 1980 and 1981 year classes were stronger than the 1978, 1979, and 1984 year classes. They also reported different selectivities between bottom trawl and midwater trawl gears and suggested separating the landings by gear type.

The 1997 assessment (Ralston & Pearson 1997) defined the fleet structure that would pretty much remain until 2011. They define a mixed gear fishery in Eureka and Conception INPFC areas, an Oregon bottom trawl fishery, an Oregon midwater trawl fishery, and a Vancouver-Columbia trawl fishery. They reported that the fishery had been supported by a small number of strong cohorts: 1977, 1978, 1980, 1981, and especially 1970. They cautioned against using a constant harvest rate policy of $F_{35\%}$ or $F_{40\%}$ because of the low stock size.

An age-based model similar to Stock Synthesis was coded in ADMB (Fournier et al. 2012) for the 2000 assessment (Williams et al. 2000). The differences between SS and the new ADMB model were minor. This assessment predicted that the Widow Rockfish stock was below the B25% minimum stock size threshold and the NMFS formally declared the stock to be overfished, but that the population was likely to increase with reasonable catches. Natural mortality was fixed at 0.15 yr^{-1} in this model and a starting year of 1968 was chosen based on the assumption that the 1965 year class was the earliest recruitment that could be estimated given the available data. The assessment model remained the same through 2007 with the exception of starting in year 1958 and reducing the fixed value of M to 0.125 yr^{-1}. In 2009, a full assessment was completed with a two-area model for a coastwide stock that estimated the proportion of recruitment in each area and started with reconstructed landings back to 1916 (He et al. 2009).

The stock was not declared rebuilt until the 2011 assessment (He et al. 2011). This assessment was a one-area model with fisheries stratified by areas as in previous assessments. This was the result of an investigation that found little difference between a one-area model and a two-area model. The model used Stock Synthesis, started in 1916, estimated recruitment, estimated M with a prior distribution, used length-based selectivity, and assumed a time-varying, but flat discard rate for all fisheries before 2007.

3 Assessment

An age-structured stock assessment model was used to predict the biomass trajectory of Widow Rockfish with an approach of balancing parsimony with complexity. This allowed for the determination of general trends in the biomass over time without introducing extraneous data partitions that explain little additional variation. The assessment followed the same model structure as the 2015 base assessment.

3.1 General model specifications and assumptions

For the update assessment, new versions of the previously used software were used. Stock Synthesis v3.24U was used to estimate the parameters in the 2015 model. R4SS, revision 1.23.4, along with R version 3.2.0 were used to investigate and plot the 2015 model fits. For the update, Stock Synthesis v3.30.13 and R4SS, revision 1.35.3, along with R version 3.5.3 were used. Bridging from Stock Synthesis v3.24U to v3.30.13 is illustrated in Figure 41. A summary of the data sources used in the model (details discussed above) is shown in Figure 40.

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

3.1.1 Summary of fleets and areas

Widow Rockfish are observed along the entire U.S. West Coast in survey and fishery observations. Past assessments have attempted modelling Widow Rockfish in two separate areas split by latitude 43° N. However, in 2011, investigations found that a single area model produced similar results. A multi-area model was not attempted in 2015 for that reason plus others listed here. The authors concluded that: 1) splitting the data into two areas reduces the amount of data in each area, and should be done only when there are obvious differences that may bias the results (as in stratified sampling); 2) there is little information to inform the life-history assumptions of each area, such as maturity and movement; and 3) following two cohorts that were seen by the NWFSC bottom trawl survey indicated that they may recruit to Central and Southern California and move north as they age (Figure 2).

Multiple fisheries encounter Widow Rockfish. Bottom and midwater trawl fisheries account for the majority of the Widow Rockfish landings both historically and currently. Five fishing fleets were specified within the model: 1) a shorebased bottom trawl fleet with coastwide catches from 1916–2018, 2) a shorebased midwater trawl fleet with coastwide catches from 1979–2018, 3) a fleet that targets Pacific Hake/Whiting (*Merluccius productus*) and includes a foreign and at-sea fleet with catches from 1975–2018, a domestic shorebased fleet with catches from 1991–2018, and foreign vessels that targeted Pacific Hake and rockfish between 1966–1976, 4) a net fishery consisting of catches mostly from California from 1981–2018, and 5) a hook-and-line fishery (mostly longline) with coastwide catches from 1916–2018.

3.1.2 Other specifications

The specifications of the assessment are listed in Table 21 and are not changed from the 2015 assessment except for updated data, natural mortality priors, and steepness. The model is a two-sex, age-structured model starting in 1916 with an accumulated age group at 40 years. Growth and natural mortality were estimated. The lengths in the population were tracked by 1 cm intervals and the length data were binned into 2 cm intervals. A curvilinear ageing imprecision relationship was estimated and used to model ageing error. Fecundity was assumed to be proportional to body weight, thus spawning biomass was used as the measure of spawning output.

The Triennial Shelf Survey was kept as a single series. Assessment of other groundfish have split this survey into an early and a late series, based mostly on the shift to deeper depths and the timing of the survey (see section 2.1.2), by estimating different catchability parameters and selectivity parameters for each period. Age data were not available for the Triennial survey, but were available for the NWFSC WCGBT survey and were entered into the model as conditional age-at-length. Length-frequencies were calculated for the Triennial and the NWFSC WCGBT surveys within each stratum, and then combined across strata using the biomass in each stratum as the weighting factor. This reduced the influence of a few fish observed in a large area.

The specification of when to estimate recruitment deviations is an assumption that likely affects model uncertainty. It was decided to estimate recruitment deviations from 1900–2018 to appropriately quantify uncertainty. The earliest length-composition data occur in 1976 and the earliest age data were in 1978. The most informed years for estimating recruitment deviations were from about the mid-1970s to about 2014. The period from 1900-1970 was fit using an early series with little or no bias adjustment, the main period of recruitment deviates occurred from 1971–2017 with an upward and downward ramping of bias adjustment, and 2018 onward was fit using forecast recruitment deviates with little bias adjustment. Methot and Taylor (2011) summarize the reasoning behind varying levels of bias adjustment based on the information available to estimate the deviates. The standard deviation of recruitment variability (sigma-R) was assumed to be 0.85, based on iteratively tuning to a value slightly less than the observed variability of recruitment deviations in the period 1976–2014 in 2015 (Figure 49).

Selectivity and retention time blocks for the bottom trawl, midwater trawl, and hook-and-line fishery are provided in Table 21. The following distributions were assumed for data fitting. Survey indices were lognormal, total discards were lognormal.

3.1.3 Priors

A prior distribution was developed for the natural mortality parameter from an analysis of a maximum age of 54 years. The analysis was performed by Owen Hamel (pers comm, NWFSC, NOAA; Hamel, 2015) and used data from Then et al. (2015) to provide a lognormal distribution for natural mortality. The median of the lognormal prior was updated from 0.081 to 0.10 and has an updated standard deviation in log space of 0.438 from 0.52. The distribution is shown in Figure 34.

Hamel (2015) developed a method for combining meta-analytic approaches to relating the natural mortality rate (M) to other life-history parameters such as longevity, size, growth rate and reproductive effort, to provide a prior on M. In that same issue of ICESJMS, Then et al. (2015), provided an updated data set of estimates of M and related life history parameters across a large number of fish species, from which to develop an M estimator for fish species in general. They concluded by recommending M estimates be based on maximum age (Amax) alone, based on an updated Hoenig non-linear least squares (nls) estimator $M = 4.899 * Amax^{-0.916}$. The approach of basing M priors on maximum age alone was one that was already being used for west coast rockfish assessments. However, in fitting the alternative model forms relating M to Amax, Then et al. (2015) did not consistently apply their transformation. In particular, in real space, one would expect substantial heteroscedasticity in both the observation and process error associated with the observed relationship of M to Amax. Therefore, it would be reasonable to fit all models under a log transformation. This was not done for the 2015 assessment. For the 2019 update, we revaluated the data used in Then et al. (2015) by fitting the one-parameter Amax model under a log-log transformation (such that the slope is forced to be -1 in the transformed space (as in Hamel (2015)), the point estimate for M is:

M = 5.4/ Amax

The above is also the median of the prior. The prior is defined as a lognormal with mean (=median) = ln(5.4/Amax) and SE = 0.4384343 (Owen Hamel, personal communication, NMFS). Using a maximum age of 54 the point estimate and median of the prior is 0.10, which is used as the median of the prior for in the assessment model and as a fixed quantity in the base model.

The prior for steepness (*h*) assumes a beta distribution with parameters based on an update of the Dorn rockfish prior (commonly used in past West Coast rockfish assessments) conducted by J. Thorson (pers. comm, NWFSC, NOAA) which was reviewed and endorsed by the SSC in 2015. During the stock assessment review, it was decided that the steepness prior should be developed without the past Widow Rockfish data, because that would be essentially using data twice if the 2011 assessment results were included in the prior. Without Widow Rockfish, the prior used for the 2015 assessment was a beta distribution with μ=0.798 and σ=0.132. The update assessments used the current West Coast rockfish steepness prior with μ=0.72 and σ=0.16 which has been approved for use in all rockfish stock assessments for 2019.

3.1.4 Sample weights

Following the 2015 assessment, the base case model was iteratively reweighted following McCallister & Ianelli (1997) such that the various data sources were mostly consistent with each other in terms of the relationship between input and effective sample sizes. Length and age-at-length compositions from the NWFSC WCGBT survey were fit along with length and marginal age compositions from the fishery fleets. Length data started with a sample size determined from the equation listed in Section 2.2.3. Age-at-length data assumed that each age was a random sample within the length bin and started with a sample size equal to the number of fish in that length bin . One extra variability parameter that was added to the input variance was estimated for each survey index series. Vessels present in the WCGOP data were bootstrapped to provide uncertainty of the total discard.

An alternative method to determine weightings for the different data sources is called the Francis method, which was based on equation TA1.8 in Francis (2011). This formulation looks at the mean length or age and the variance of the mean to determine if across years, the variability is explained by the model. If the variability around the mean does not encompass the model predictions, then that data source should be down-weighted. This method does account for correlation in the data (i.e., the multinomial distribution) as opposed to the McAllister and Ianelli (1997) method of looking at the difference between individual observations and predictions. The Francis weighting method is presented as a sensitivity, as is the method that estimates data weights using a Dirichlet multinomial formulation.

The method to weight the compositions datasets in SS was to use the lambdas as the weighting factor. The fleet and data-type (length or age) factor was entered as lambdas until the harmonic mean of the effective sample sizes matched the mean of the adjusted input sample sizes. Once the weighting was determined, lambda factors for all fleets with both marginal length and marginal age compositions were down-weighted by 0.5 to account for the potential double use of data since length and age are observed from the same fish.

3.1.5 Estimated and fixed parameters

There were 207 estimated parameters in the base case model. These included one parameter for R_0, 10 parameters for growth, two sex-specific natural mortality parameters, 4 parameters for extra variability on the survey indices (survey indices were fixed at zero), 3 parameters for the catchability of the hake series and the Triennial Shelf survey (the catchabilities for other surveys were calculated analytically), 47 parameters for selectivity, retention, and time blocking of the fleets, 8 parameters for survey selectivity, 119 recruitment deviations, and 12 forecast recruitment deviations.

Fixed parameters in the model were as follows. Steepness was fixed at 0.72, which is the mean of the current rockfish prior as described above. A sensitivity analysis and a likelihood profile were done for steepness. The standard deviation of recruitment deviates was fixed at 0.60. Maturity at age was fixed as described in Section 2.3.2. Length-weight parameters were fixed at estimates using all length-weight observations (Figure 31 and Table 22).

Dome-shaped selectivity was explored for both the fishery and the surveys in the 2015 assessment. Older Widow Rockfish are often found in deeper waters and may move into areas that limit their availability to fishing gear, especially trawl gear. Little evidence was found for domed shape selectivity in all but the midwater trawl fleet. The final base model assumed asymptotic selectivity (double-normal selectivity curve) for each fishery, except for the midwater trawl fishery. The NWFSC and Triennial surveys both used spline curves. All selectivity curves were length-based and are the same shape as in the 2015 benchmark. Time blocks were used for the bottom trawl, midwater trawl and hook-and-line fisheries as indicated in Table 21.

3.2 Model selection and evaluation

The base case assessment model for Widow Rockfish in 2019 follows the structure of the 2015 base case, which was developed to balance parsimony and realism, and the goal was to estimate a biomass trajectory for the population of Widow Rockfish on the west coast of the United States. The model contains many assumptions to achieve parsimony and uses many different sources of data to estimate reality. A series of investigative model runs were done to achieve the final base case model for the update assessment.

3.2.1 Key assumptions and structural choices

The key assumptions in the model were that the assessed population is a single stock with biological parameters characterizing the entire coast, maturity at age has remained constant over the period modeled, weight-at-length has remained constant over the period modeled, the standard deviation in recruitment deviation is 0.60, and steepness is 0.72. These are simplifying assumptions that unfortunately cannot be verified or disproven. Sensitivity analyses were conducted for most of these assumptions to determine their effect on the results.

Structurally, the model assumed that the catches from each fleet were representative of the coastwide population, instead of specific areas, and fishing mortality prior to 1916 was negligible. It also assumed that discards were low prior to 1982 and after 2010.

3.2.2 Alternate models explored

The exploration of models began by bridging from the 2015 assessment to SS version 3.30.13, which produced no discernable difference (Figure 41). The updated catch series with discards added per the 2015 assessment produced small differences, such as lower biomass in the late 1990’s and early 2000’s (Figure 42). However, when updating the catch composition data, the biomass increased throughout the time period. Updating the survey indices produced varying differences as well (Figure 43). Updating survey composition data led to higher estimates of biomass throughout the time period. Updating composition weighting and updating the composition data expansion method led to lower biomass estimates.

The 2015 assessment attempted to estimate discards in the model, wherein the authors investigated time blocks for changes in selectivity and retention to match the limited discard data as best as possible. Using major changes in management (mainly in trip limits, Table 3) and observed changes in landings, a set of blocks was found for the bottom trawl, midwater trawl, and hook-and-line fleets. In the spirit of parsimony, they used as few blocks as possible, allowed blocks only for time periods with data, and added new blocks when we felt they were justified by changes in management and they improved the fit to the data. The same structure was followed for the update.

Natural mortality was also investigated as part of this update assessment and a new prior was developed assuming a maximum age of 54 years for females and males. The new prior showed a median natural mortality that was less than the prior for natural mortality used in the 2015 assessment. Therefore, even though *M* was estimated using the new prior, sensitivities were done fixing M at the medians of the sex-specific updated priors and priors from the 2015 assessment.

3.2.3 Convergence status

Adding the additional years of survey composition data required increasing the initial value of log R0 from that in the 2015 assessment by 0.5 to limit population crashes. Model convergence was determined by starting the minimization process from dispersed values of the maximum likelihood estimates to determine if the model found a better minimum. Jittering was repeated 100 times with a jitter coefficient of 0.10 and a better minimum was not found. 36% of the jittered models achieved the minimum negative log-likelihood. The model did not experience convergence issues when provided reasonable starting values. Through the jittering done as explained above and likelihood profiles, we are confident that the base case as presented represents the best fit to the data given the assumptions made. There were no difficulties in inverting the Hessian to obtain estimates of variability. Jittering was necessary for some of the likelihood profiles and retrospective models to converge. Convergence was defined as the lowest negative log-likelihood achieved with jittering where the hessian matrix was invertible.

3.3 Base-model results

The base model parameter estimates along with approximate asymptotic standard errors are shown in Table 23 and the likelihood components are shown in Table 25. Estimates of key derived parameters and approximate 95% asymptotic confidence intervals are shown in Table 26.

3.3.1 Parameter estimates

The estimates of natural mortality (0.1444 yr^{-1} and 0.1549 yr^{-1} for females and males, respectively) were higher than suggested by the medians of the prior distributions used in this assessment and the 2015 assessment. Fixing *M* at lower values than those estimates resulted in a pattern of reduced recruitment immediately before the fishery started. This suggests that the model is doing what it can to reduce the number of observations of older fish in the data. The estimates of *M* fall within the 95% confidence interval of the prior distribution (0.0425–0.237), and are shown in Figure 44.

Estimating *M* is difficult in stock assessments, and the estimated values may represent model misspecification instead of the actual life-history trait. However, in alternative models to the base case model, the estimates of M were rarely less than 0.14 yr^{-1} (Table 29). Uncertainty in the estimated *M* was also much less than the range of the prior (Figure 44). The assumption that appeared to have the largest effect on *M* was introducing dome-shaped selectivity in the midwater trawl fleet, which made *M* smaller (Table 29).

Selectivity curves were estimated for commercial and survey fleets and parameter estimates are provided in Table 24. The final base model assumed asymptotic selectivity (double-normal selectivity curve) for each fishery, except for the midwater trawl fishery. The NWFSC and Triennial surveys both used spline curves. All selectivity curves were length-based and are the same shape as in the 2015 benchmark. Time blocks were used for the bottom trawl, midwater trawl and hook-and-line fisheries as indicated in Table 21. The estimated selectivity, retention, and keep (the product of selectivity and retention) curves for the trawl and hook-and-line fleets are shown in Figure 45. The selectivity curves showed a shift to larger fish in 2002 for the bottom trawl fishery and a shift to smaller fish in 2003 for the hook-and-line fishery. The bottom trawl shift is consistent with the introduction of the RCA and gear restrictions (shoreward of the

RCA) that virtually eliminated fishing in shelf habitats where smaller Widow Rockfish would more likely be encountered. Around this same time, the fixed-gear RCA specifications began preventing fishing between 30 and 100 fm.

The retention curves showed a shift to retaining a lower percentage of fish since trip limits were introduced, but increases in recent years. The asymptote of the retention curve for the bottom trawl fishery sequentially decreased as more management restrictions were introduced to about 50% retention of larger fish in the 1998-2010 period. Midwater trawl and hook-and-line fisheries estimated an asymptote to retention just above 80% for the period 1983-2010.

Both the selectivity for the hake fleet and the selectivity of the net fleet did not support dome-shaped selectivity (Figure 46). The estimated selectivity curves for the Triennial and NWFSC WCGBT surveys were similar to each other except that the triennial survey selected larger fish (Figure 46). The NWFSC WCGBT survey was no longer minimally dome-shaped as in the 2015 assessment.

In 2015, additional survey variability (process error added directly to each year's input variability) for the triennial and NWFSC WCGBT surveys was not estimated in the model because the estimate was zero. To avoid bound issues in estimation of the Hessian, the authors fixed these at zero because the model-based results provided reasonable estimates of variance. We retained the same modelling approach for the update assessment. The additional standard deviation added to the fishery-dependent indices was quite large, ranging from 0.16 for the bottom trawl index and 0.58 for the foreign at-sea hake fleet. The additional variability on the juvenile survey was the highest, at 0.83, giving the index very little weight in the model.

The estimates of maximum size for both females and males (Table 23) were not unexpected given the data in Figure 35. Estimates of *k* were slightly different in the model, but that is expected when accounting for selectivity. Estimated growth curves are shown in (Figure 47).

Estimates of recruitment suggest that the Widow Rockfish population is characterized by variable recruitment with occasional strong recruitments and periods of low recruitment (Figure 48). There is little information regarding recruitment prior to 1965, and the uncertainty in these estimates is expressed in the model. There are very large, but uncertain, estimates of recruitment in 2013, 1970, 2008, and 1971. Other large recruitment events (in descending order of magnitude) occurred in 1978, 2014, 1981, 2010, and 1991. The five lowest recruitments (in ascending order) occurred in 2012, 2011, 1976, 2007, and 1973. Estimates of recruitment appear to be episodic and characterized by periods of low recruitment. Two of the four largest estimated recruitments occurred in the last 11 years.

3.3.2 Fits to the data

There are numerous types of data for which the fits are discussed: survey abundance indices, discard data (biomass and length compositions), length composition data for the fisheries and surveys, marginal age compositions for the fisheries, and conditional age-at-length observations for the NWFSC WCGBT survey.

The fits to the five survey series are shown in Figure 51. Extra standard error was estimated for all of the series except for the two survey series (Table 23). None of the series showed patterns in residuals, and with the large amount of error, none of the series showed serious lack of fit. The recent NWFSC WCGBTsurvey showed a general increase over the time period, which was also estimated in the base model (Figure 51, lower left), although the low estimate of abundance in 2015 was not fit very well.

Fitting the total observed discard amounts required time blocks (Figure 52). Fits to the trawl discards from the Pikitch data in 1985–1987 in the time block 1982–1989 were quite good. The EDCP data (1995–1999) were not fit as well. In the time block 1990–1997, the EDCP discard observations showed a high error, and the fits were within the confidence limits, but below the point estimate in two of the three years. The 2015 assessment introduced a time block in 1998 because a serious reduction in trip limits occurred in that year (Table 3) and continued to 2010. The EDCP data showed a very small amount of discarding, which was consistent with the WCGOP data from that time period, but in 1998 and 1999, landings from the bottom trawl fleet were very large compared to 2000–2010. Therefore, a large amount of discards were predicted for 1998 and 1999, which do not match the observations. It is believed that the EDCP observations in 1998 and 1999 are not indicative of the actual discards because the sample sizes from the EDCP data were small in those years, and 1999 had a few samples from early in the year and at the beginning of the two-month trip limit period. The predicted discards for the years 2002–2010 were small (ranging from 1.98 to 15.92 mt), and the WCGOP points estimates showed more interannual variation than the predictions (ranging from 0.03 to 26.57 mt). There were not specific patterns in residuals other than when the observation was high, the prediction was less, and vice versa. Since catch shares was introduced in 2011, the predicted discards were 0.5 mt or less (with a fixed discard rate of 1%). Observed discards in 2013, with nearly 100% observer coverage, were 2.43 mt.

The midwater trawl fishery had four time blocks, two with estimated constant discard rates across length, and two with a fixed constant discard rate of 1% across length (see Figure 45). The first time block with discard data was 1983 to 2001. Predicted discards for all three years of the Pikitch data (1985–1987) were underfit, but within the confidence limits (Figure 52). The fits to the EDCP data in 1997 and 1998 were overfit. The second time block was 2002 to 2010, which contained only one observation in 2002 (and was fit exactly, as expected). The last time block (2011 onward) assumed a 1% discard rate (as did 1916–1982). The two observations were nearly zero, and the model predicted 2.4 mt of discards in 2013.

The hook-and-line fleet had one period when retention was estimated (1983 onward). Fits to the discard data were variable, but reasonable (Figure 52).

Fits to the length-composition data are displayed in two different ways: the Pearson residuals-at-length are shown for each year for all types of length compositions, and also compared across fleets. More detailed plots of fitted lines drawn over the plotted proportions at length are shown in Appendix A. Pearson residuals for the fisheries (Figure 53 to Figure 54) do not show consistent patterns, but they do show that some fleets are not fitting some cohorts. Each fleet also shows that there are periods where older fish are underfit, and periods when older fish are overfit. With a peaked length frequency distribution, it is common for these patterns to appear given shifts in the expected distribution due to sampling error, and time-varying parameters that are assumed time-invariant. The net fishery observed some very large fish in the first two years of data, but did not observe those fish in later years. This pattern was not seen in any other fishery. There were also years where females showed positive residuals (filled circle, observed > expected) and males showed negative residuals (e.g., Figure 53, early years of bottom trawl and midwater trawl). It is uncertain if this pattern is related to growth, sexing error, or to sex-specific selectivity (e.g., when Widow Rockfish aggregate, sexes possibly may be aggregating separately). Overall, the fits to commercial fishery length compositions showed some patterns that the 2015 assessment deemed to require complicated modelling assumptions to alleviate. However, the residuals were mostly less than 2 in absolute value, especially for fleets with a lot of sampling and catch.

Looking at the fits to length compositions aggregated for all years shows that the general shape of the length distributions are captured (Figure 55).

The discard length frequencies for the bottom trawl and hook-and-line fleets showed a few patterns and some large residuals in a few years (Figure 56). The fits to bottom trawl discard length frequencies were generally good except in the years since catch shares began. These recent years observed small fish, which the estimated selectivity of the trawl fleet did not allow for. There were no other years that showed small fish being caught by the trawl fleet. Attempting to explain these small fish with additional time blocks on selectivity and retention did not help because explaining the small fish in the discards worsened the fits to the landed and larger fish. Discards are extremely small in this time period, so it is unlikely that a misfit here will have a lot of effect on the model. Combining the discard length frequencies over years may not be appropriate for the bottom trawl fishery due to the likely changes in discarding practices, but Figure 56 shows the prediction of discarding smaller females than observed and a more peaked observed distribution of discarded males than predicted.

Hook-and-line discard length frequencies showed a pattern of observed mall fish that the model did not fit. These residuals were large, but given the small amount of catch from the hook and line fishery, likely have a small effect on the model results. Combining the discard length frequencies over years showed that to capture the pattern of many small fish and a few large fish in the hook-and-line fleet would require observations of fish of sizes in the 30-40 cm range (Figure 55). Modeling discards with a simple retention function may not capture the actual all-or-none discarding pattern observed in the Widow Rockfish fishery.

The Triennial Shelf and NWFSC WCGBT surveys length frequencies showed underfitting of older fish in some years and underfitting of younger fish in others (Figure 57). The combined length frequencies across years were bimodal with a valley around 37 cm, and the model showed an indication of a bimodal distribution but was unable to adequately capture both peaks (Figure 55). The nonparametric selectivity pattern helped to reduce this pattern, but selectivity may be even more complicated for the surveys.

Age data were fitted as marginal age compositions for the fishing fleets and as conditional age-at-length for the NWFSC WCGBT survey, which were expanded by tow and then by strata. Raw observations of age-at-length, which assumes that within each length bin the observed ages are a random sample of fish, were not used because they are inconsistent with the length compositions which are expanded. Using expanded age-at-length ensures that as the length bin size is increased, it approaches the expanded marginal age composition. Pearson residuals for the commercial fleets are shown in Figure 53 and Figure 54. For the trawl fisheries in Figure 53, there are diagonal patterns that mostly correspond to cohorts ageing through the years. However, there are instances where the diagonal seems to shift, such as the filled circles of the midwater trawl fishery on the lower left of the plot (years 1981–1991). The patterns match the length compositions residuals in some cases. The bottom trawl fishery shows the largest residuals in the most recent years, which could indicate a change in selectivity. The net and hook-and-line fits to age compositions (Figure 54) showed larger residuals than the trawl fisheries. As with the fits to the length compositions, the net fishery showed the inability to match the large number of older fish observed in the early years. There appears to be a strong shift in residuals in 1988 when a lack of fit to potentially a cohort appears. The residuals were typically less than 2 for fits to the age data. However, the female age compositions occasionally produced some large residuals that were not consistently seen in the male age compositions. Aggregating across years shows that the fit to age comps was good for the trawl fleets and less so for the net and hook-and-line fleets, which had smaller sample sizes (Figure 58). The aggregated data also showed that the predictions were often unable to fit the peak in the data.

The observed and expected age-at-length are shown in Figure 59 for the twelve years of the NWFSC WCGBT survey observations. The fits generally match the observations with some misfit at larger lengths. The standard deviation of age-at-length was variable and often the expectation was higher than the observations at larger lengths. Plots with the residuals for individual observations showed reasonably good fits to the conditional age-at-length data from the NWFSC shelf/combo survey (Figure 60). Some outliers are apparent, with large residuals mostly at smaller lengths for a given age.

3.3.3 Population trajectory

The predicted spawning biomass (in metric tons) is given in Table 27 and plotted in Figure 61. The predicted spawning biomass from the base model generally showed a slight decline over the time series until 1966 when the foreign fleet began. A short, but sharp decline occurred, followed by a steep increase due to strong recruitment. The spawning biomass declined rapidly with the developing domestic midwater fishery in the late 1970s and early 1980s. The stock continued to decline until 2000 when a combination of strong recruitment and low catches resulted in a quick increase at the end of the time series. The recent increase is even faster for summary biomass (Figure 62) because not all age 4 fish are mature (Figure 32). The 2019 spawning biomass relative to unfished equilibrium spawning biomass is above the target of 40% of unfished spawning biomass (91.9%), with a low of 36.3% in 1998, 2000, and 2001 (Figure 63). This suggests that Widow Rockfish was not overfished, as was inferred from previous assessments (Williams et al. 2000). Approximate confidence intervals based on the asymptotic variance estimates show that the uncertainty in the estimated spawning biomass is high, especially in the early years.

Recruitment deviations were estimated for the entire time series that was modeled (Figure 48 and discussed in Section 3.3.1) and provide a more realistic portrayal of uncertainty. There are very large, but uncertain, estimates of recruitment in 2013, 1970, 2008, and 1971 (in descending order of magnitude). Other large recruitment events (in descending order of magnitude) occurred in 1978, 2014, 1981, 2010, and 1991. The five lowest recruitments (in ascending order) occurred in 2012, 2011, 1976, 2007, and 1973. Many other stock assessments of rockfish along the west coast of the U.S. have estimated a large recruitment event in 1999 and 2013 (e.g., greenstriped rockfish (Hicks et al. 2009), chilipepper rockfish (Field 2007), darkblotched rockfish (Gertseva and Thorson 2013)), and the 1999 cohort is predicted to be slightly above average for Widow Rockfish. The 2008 and 2013 year classes were estimated as 2 of the 4 strongest year classes. It may be worthwhile to investigate the periods of strong and weak year classes further to see if it is an artifact of the data, a consistent autocorrelation, or a result of the environment. The input bias adjustment ramp matched the estimated (Figure 49).

The stock-recruit curve resulting from a fixed value of steepness is shown in Figure 64 with estimated recruitments also shown. The stock is predicted to have never fallen to low enough levels that the steepness is obvious. However, the lowest levels of predicted spawning biomass showed some of the smallest recruitments and very few above average recruitments. Steepness was not estimated in this model, but sensitivities to alternative values of steepness are discussed below.

The population numbers-at-age for each year are shown in Appendix B.

3.4 Response to STAR panel review and recommendations

3.4.1 STAR panel in 2011

1. *A thorough review of model structure and available data should be conducted, including but not limited to evaluation of one-area vs two areas models, the use of age- or length-based selectivities, evaluation of fixed model parameters (i.e. natural mortality), the use of dome-shaped or asymptotic selectivity curves, and the spatial definition of fisheries. Some of these items are discussed in detail below.*

   Response: All data used in the assessment model presented here, except for the fisheries indices of abundance, were obtained from appropriate sources and completely re-analyzed. This includes discards, lengths, ages, maturity, and catches. A single area assessment model was thorough investigated. A two-area model is not presented because time was better spent investigating spatial differences in the data.

2. *Provide data and/or maps on spatial patterns of fishing harvest and/or effort, particularly as it relates to the split between the northern and southern areas, in order to assess whether the division at 43° N corresponds to a natural break in the fishery or whether it divides a continuous pattern.*

Response: Specific spatial patterns have not been fully investigated, but it was assumed that specific fishery practices have more influence on the dynamics of the population that dividing fisheries by space. Catches in California have historically been large, and may have had an effect on local abundance. However, following two recent cohorts with the NWFSC shelf/slope bottom trawl survey data show that as the cohort ages, it appears farther north, suggesting potential coastwide movement of Widow Rockfish. Spatial differences in the fisheries, the distribution of Widow Rockfish recruitment, and movement of Widow Rockfish are concepts that should be investigated further.

3. *Consider the theoretical basis of selectivity with regard to whether the mechanistic process is age-based or size-based, and the types of data which would provide information on this topic.*

   Response: A thorough investigation of age and length data was done and all available data were compiled. A specific theoretical investigation of selectivity was not done, but all possible sources of data were included in this model to inform selectivity. Selectivity was modeled as length-based because it was obvious in the fishery data that larger fish were selected. An upper dome-shape on age-based selectivity was not investigated.

4. *Obtain all length composition from the fisheries and surveys, and evaluate whether the inclusion of these data in the model improves model performance.*

   Response: A thorough investigation of available age and length data was done, and much more data were included in this model. It is difficult to say if model performance has improved since the authors of this assessment do not have a lot of experience with the 2011 assessment, but the model was stable and uncertainty was much smaller than for many groundfish assessments.

5. *Consider multiple model-independent estimates of natural mortality in order to assess potential variation, with the possibility of developing a prior distribution for M.*

   Response: A discussion with Owen Hamel (NWFSC) led to the development of a new prior distribution based on a maximum age of 54. This prior showed a lower median than previous prior distributions, and we feel that this is the lower range of natural mortality, although the assessment of Widow Rockfish in Alaska assumes a natural mortality of 0.05 (which would indicate that fish grow to 100 years old). Owen Hamel believes that accounting for other life-history components would increase *M* for Widow Rockfish. The prior for *M* is broad and covers a wide range of possibilities.

6. *Future estimates of steepness should be accompanied by comparisons to other west coast rockfish stocks, with proposed biological explanations for any large discrepancies from other rockfish stocks.*

   Response: A new prior distribution for steepness was developed for West Coast rockfish, but was not much different than previous prior distributions. This model does not seem to be as sensitive to steepness as previous models, but that may be because *M* was estimated. Sensitivities exploring different values of steepness in combination with *M* were done.

7. *Apply other assessment methodologies, potentially including catch curves, surplus production models, stock reduction analysis, etc., to evaluate whether the information obtained on stock status, vital rates, and productivity are consistent with the assessment model.*

Response: A proxy to a surplus production model was done in SS by fixing recruitment deviations at zero. The general trend in spawning biomass was similar, except that spawning biomass started at a higher value. Estimates of natural mortality were nearly identical to the base model. The end of the time series increased faster than the base model to nearly unfished equilibrium levels.

3.4.2 SSC recommendations in 2011

The SSC recommends that the next assessment of this stock should be

1. *a full assessment to incorporate reconstructed historical landings data for Washington,*

   Response: This is a full assessment and although a formal reconstruction of Washington landings is not complete, the assessment authors worked closely with WDFW to reconstruct the landings of Widow Rockfish in Washington.

2. *resolve potential inconsistencies in the age-reading data,*

   Response: The ages have been historically read at the SWFSC, but with many different readers. A small number of ages were surface reads, and a comparison of surface to break-and-burn (100 double reds ranging in age from 4–10) showed little bias and similar standard error. In addition, 618 otoliths were re-read by CAP that were originally read by the SWFSC. The ageing error used in this assessment accounts for the bias and error of these two sources, although it has to assume that the CAP readings are unbiased. Further investigation, and possibly re-ageing, of older otoliths should be done.

3. *evaluate the strength of incoming year-classes,*

   Response: One of the main goals of this assessment was to enumerate past and recent recruitment in the best way possible. This included eliminating spurious trends in early recruitment, but also using up-to-date data to estimate recent recruitments. The main sources of information were the NWFSC shelf/slope survey and the juvenile survey. Strong 2008 and 2010 cohorts were predicted.

4. *explore the utility of several legacy data sets, such as the Oregon bottom trawl catch per unit of effort (CPUE) index, for which complete documentation is lacking.*

   Response: Initial investigations of logbook data were done before it was realized that a proper investigation would require more time than is available to complete this assessment. This would be a useful non-assessment year research topic.

3.4.3 STAR panel in 2015

The stock assessment review (STAR) panel for this assessment was held at the NWFSC satellite lab in Newport, OR from July 27–31, 2015. David Sampson was the chair, while Paul Medley, Neil Klaer, and Ian Stewart were invited reviewers. It was a productive and busy review that thoroughly reviewed many facets of the assessments. As mentioned above, slight changes were made to the survey length and age-at-length compositions, the steepness prior without Widow Rockfish was used, and the data weighting method was slightly modified. The changes made during the STAR panel made very little difference to the model results.

The STAR panel had many recommendations, of which a great proportion applied to stock assessments in general. Only the recommendations specific to Widow Rockfish are listed here with a specific response.

3.4.3.1 Specific recommendations for the 2015 full assessment

1. Produce diagnostics (residual plots, sample size estimates) based on a model run with sample size multipliers used for length and age compositions, rather than the lambda adjustment. This will make diagnostics and residual plots more straightforward to interpret.
2. The description of the W-L relationship on page 16 of the draft document describes the relationship in grams to cm; this should be kilograms.
3. Include a sensitivity run using logistic selectivity for the NWFSC survey.
4. Include a retrospective over historical assessments.
5. Include the summary table of indices used in the assessment with relative rankings.

3.4.3.2 Specific recommendations for the next widow rockfish assessment

6. The next iteration of this assessment should be an update assessment.

   Response: We agree.

7. Minor anomalies in the weight-length data from the BDS system should be excluded or reconciled.

   Response: We agree, although these anomalies had minimal effect on the assessment results.

8. A reanalysis of the foreign at-sea index that best overlaps the period of largest stock decline could be conducted before the next assessment. Other fishery indices are unlikely to have an appreciable impact on the results and may not be worth reanalyzing. In particular, an analysis should consider effort measures that include search as well as towing time, given the schooling nature of this species.

   Response: This could potentially provide better information to the period of time when the population was declining fastest. The analysis done for previous assessments, and used here, is defensible and sound. A reanalysis of these data may provide minimal return for the time invested.

9. Widow rockfish should be considered in any future discussions about trans-national stocks. Although a joint assessment with Canada may be difficult to arrange, it should be explored. It is possible that lack of information from Canada affects estimates of productivity and, in particular, steepness. Until such time as a joint assessment can be conducted, evaluation of relative catches and trend information on abundance in Canadian waters would also be helpful. Potential exchange also clouds the clear interpretation of what represents steepness for this stock.

   Response: Data on the Widow Rockfish fishery in Canada are sparse. Recent catches are well determined, but there is little additional information. To fully understand the Widow Rockfish population in Canada and its connectivity to the west coast of the United States would likely require additional sampling. However, this would result in a more complete assessment.

10. Updated maturity data representing the current stock distribution should be collected and analyzed, preferably using histological methods.

    Response: We agree completely.

11. Since there was so little information in the data on steepness, the informative prior might be strong enough to allow for estimation in future assessments. This should be explored.

    Response: Sensitivities are provided that estimate steepness with the prior. However, we are concerned that using two independent priors for natural mortality and steepness is not completely correct, and a joint prior would be the correct method. In addition, the likelihood profiles for steepness show little information about steepness, thus it was fixed and included as an axis of uncertainty.

12. Based on the variability estimated for the juvenile index, it should be removed from future analyses unless it can be improved and validated. Specifically, the estimated variance is greater than the RMSE of the recruitments, so it will add more noise than signal at the end of the time-series when there are no other data to inform recruitment. This decreases the predictive ability of the model.

    Response: We feel that this should be investigated further.

13. The recreational catch is higher than might be expected for this species. Although recreational removals are still likely to be low in relation to other removals for this stock, these should at least be reported in a table for comparison in future documents.

    Response: We agree, and have not included those catches in this document because they are difficult to compile and subject to great uncertainty.

14. It may be improve the model if the H&L and NET fisheries are combined with other fleets, as these represent very little removals and noisy data. Removals of these data did not appreciably change the results for this assessment and their selectivity showed similar patterns to other fleets. Removing these as separate fleets would likely to make the modelling simpler with no loss of signal.

    Response: This assessment included a major overhaul of the fleet structure compared to previous assessments. It is likely that future assessments can improve the assessment by learning from this and past assessments about what the important fleet structure may be.

15. Select one or more fleets (as run-time allows) and create conditional age at length data in order to inform growth and selectivity from more than just the most recent years where survey data is available.

    Response: We agree that this will be a useful investigation. Based on the advice from reviewers for this assessment, the conditional age-at-length compositions should be expanded by sample (trip or tow). Doing this for this assessment was too time consuming during the review week, so the original structure of marginal age compositions for the fishing fleets was retained.

3.5 Response to Groundfish Subcommittee recommendations

The GFSC reviewed the draft assessment document in August, 2019 and did not provide any formal recommendations.

3.6 Uncertainty and sensitivity analyses

Three types of uncertainty are presented for the assessment of Widow Rockfish. First, uncertainty in the parameter estimates was determined using approximate asymptotic estimates of the standard error. These estimates were based on the maximum likelihood theory that the inverse of the Hessian matrix (the second derivative of the log-likelihood function with respect to the parameter vector) approaches the true uncertainty of the parameter estimates as the sample size approaches infinity. This approach takes into account the uncertainty in the data and supplies correlation estimates between parameters, but does not capture possible skewness in the error distribution of the parameters and may not accurately estimate the standard error in some cases (see Stewart et al. 2013).

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

Lastly, a major axis of uncertainty was determined from a parameter or structural assumption that results in the greatest change in stock status and advice, and projections were made for different states of nature based upon that parameter or structural assumption.

3.6.1 Parameter uncertainty

Parameter estimates are shown in Table 22, Table 23, and Table 28 along with approximate asymptotic standard errors. The only parameters with an absolute value of correlation greater than 0.95 were the female and male natural mortality parameters, which is expected. Estimates of key derived quantities are given in Table 26 along with approximate 95% asymptotic confidence intervals. There is a reasonable amount of uncertainty in the estimates of biomass. The confidence interval of the 2019 estimate of depletion is 70.78%–113.11% and above the management target of 40% of the unfished spawning biomass.

3.6.2 Sensitivity analysis

Sensitivity analysis was performed to determine the model behavior under different assumptions than those of the base case model. Seven sensitivity analyses were conducted to explore the potential differences in model structure and assumptions, including:

1. Steepness fixed at 0.40
2. Steepness fixed at 0.60
3. Steepness fixed at 0.798 (used in the 2015 assessment).
4. Fixed natural mortality at 0.1 for both sexes
5. Fixed natural mortality at 0.124 yr^{-1} for females and 0.129 yr^{-1} for males
6. Forcing asymptotic selectivity on the midwater trawl fleet
7. Weighting the composition data using the Francis method
8. Weighting the composition data using the Dirichlet method
9. Fitting logistic curves for survey selectivities
10. Removing the Triennial survey data

Likelihood values and estimates of key parameters are shown in Table 29. Predicted spawning biomass trajectories and estimated recruitments are shown in in Figure 65. The estimates of current stock depletion ranged from 50.0%–102.5% across the sensitivity runs, with fixing natural mortality at 0.1 resulting in the lowest estimate and forcing asymptotic selectivity on the midwater trawl fleet resulting in the highest estimate.

Fixing M at values lower than the base case estimate resulted in the largest changes to spawning biomass (Figure 65). Due to the changes in spawning biomass, the relative spawning biomass in 2018 changed to 76.4% with an M of 0.124 yr^{-1} and 0.129 yr^{-1} for females and males, respectively, and then to 50.0% with an M of 0.1 yr^{-1}. The total likelihood for both sensitivities is beyond the significance level for a two-parameter likelihood profile and is significantly less likely than our base model.

The value of steepness also had a large effect on the end of the time series with smaller values of steepness resulting in a more depleted stock in 2018. Fixing steepness at a value of 0.4 resulted in a large reduction in spawning biomass from 89.8% in the base to 52.5% (Figure 65), which is comparable to the natural mortality sensitivity where M = 0.1. Equilibrium yield at a $SPR_{50\%}$ reference harvest rate also decreased significantly, as expected, to a low of 3,602 mt with a steepness of 0.40. Fixing steepness at 0.6 also decreased the relative spawning biomass to 81.2%. The total likelihood when h is set to 0.6 is within the significance level of a one-parameter likelihood profile. On the other hand, fixing steepness at a greater value than the assessment (h = .798) resulted in a higher relative spawning biomass, with a relative spawning biomass of 94.0% in 2018. The total likelihood when h is set to 0.798 is equivalent to the base model.

Fitting logistic curves for survey selectivities resulted in estimates of relative spawning biomass which were comparable to the base. However, forcing asymptotic selectivity on the midwater fleet resulted in the highest estimates of M (M = 0.17 females and M = 0.177 males) and the highest relative spawning biomass in 2018 (102.5%). Similar to the 2015 assessment, estimating double-normal selectivity for the midwater fleet did not result in a significant improvement to the likelihood. It is important to note that for this sensitivity, the optimizer had difficulty finding the minimum and was sensitive to starting values.

Parameter estimates of alternative data weighting methods are presented in Table 34.

The Dirichlet-Multinomial parameters for data weighting of the length- and age- composition for all fleets were estimated. Thirteen parameters were estimated, as one parameter was estimated for each fleet and composition combination. The parameters for the NWFSC length composition data, net fishery length composition data, midwater trawl age composition data, net fishery age composition data, hook and line age composition data, and NWFSC age composition data went to bounds. Those parameters that went to bounds (Theta/(1+Theta) ≥ .999), implying full weight should be given to the data set, were fixed at 7. This weighting estimated the lowest initial spawning biomass (62,271 mt) and lowest 2018 spawning biomass (36,201 mt). Growth parameters, initial recruitment, equilibrium yield, and 2018 relative spawning biomass were also estimated lower than the base model (Table 29).

Two iterations of Francis weighting were completed. After two iterations, the composition fits appeared to worsen, so no further iterations were completed. The likelihood for this sensitivity is much lower than the base model, with the bulk of the change occurring in the fits to the length compositions. This weighting method estimated a higher relative spawning biomass (93.3%) than the base model. We think this is because of a higher estimated recruitment in 2013 which led to a higher depletion estimate. Lastly, the removal of the Triennial survey data estimated spawning biomass, relative spawning biomass, equilibrium yield, and growth parameters higher than the base model. These estimates are comparable to the Francis weighting sensitivity.

Overall, the base model appears the most sensitive to natural mortality and steepness. Lower mortality and lower steepness resulted in a lower relative spawning biomass in 2019 (i.e., more depleted) and lower equilibrium yield (Figure 48 and Figure 50). None of the sensitivities would suggest the stock is currently overfished.

3.6.3 Retrospective analysis

A 8-year retrospective analysis was conducted by running the model using data only through 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017 progressively (Table 30 and Figure 66). The initial scale of the spawning population was basically unchanged for all of these retrospectives. The size of the population for the last 15 years generally increased as data were removed, although slightly. The estimate of natural mortality increased slightly when 2 to 3 years of data were removed. No alarming trends were present in the retrospective analysis.

A look at past assessments shows that the prediction of spawning biomass has generally increased with each assessment (Figure 67). This assessment (2019) predicts the largest spawning biomass. All assessments show similar trends.

3.6.4 Likelihood profiles over key parameters

Likelihood profiles were conducted for R_0, steepness (even though it was not estimated in the base case) and over male and female natural mortality values simultaneously. These likelihood profiles were conducted by fixing the parameter at specific values and removing the prior on the parameter being profiled. Without the original prior distribution the MLE estimates from the base case will likely be different than the MLE in the likelihood profile, but this displays what information the data have. There was some difficulty in achieving model convergence for many parameterizations in the likelihood profile. In some cases jittering was required.

As R_0 increased, natural mortality also increased and the relative spawning biomass in 2015 was less depleted (Table 31). There was variable support for each likelihood component across the range of R_0 evaluated. The total likelihood supported the estimated value (Table 31). Profiles are illustrated in Figure 68.

For steepness, the negative log-likelihood was minimized at a steepness of 0.736 and 0.791, but the 95% confidence interval extends over the entire range of possible steepness values (Table 32). Profiles are illustrated in Figure 69.

For profiles of natural mortality, where natural mortality for females and males were set to the same value, the negative log-likelihood was minimized 0.156 (Table 33). Profiles are illustrated in Figure 70.

3.6.5 Overall assessment uncertainty

Model uncertainty has been described by the estimated uncertainty within the base model and by the sensitivities to different model structure. The parameters that resulted in the most variability of predicted status and yield advice were natural mortality (M) and steepness (h). The 95% confidence interval for M was greater than and did not include the median of the prior distribution with a maximum age of 54, nor did it include the medians of the prior distributions used in the 2015 assessment (which were lower than the estimates from that assessment). There is the possibility that the base model and its approximate uncertainty intervals based on maximum likelihood theory may not entirely convey the actual uncertainty of this assessment.

The estimates of natural mortality in this assessment are lower than the values estimated in the 2015 assessment. This assessment included much more length and age data, but the same index data with updates to the juvenile survey and the NWFSC WCGBT survey. It is likely that the additional length and age data suggest that more fish are reaching old ages and large lengths than suggested by the larger values of natural mortality estimated in the previous assessment. In addition, this assessment does not show as strong of a pattern in the estimated recruitment deviations immediately before fishing began (Figure 48 and Figure 50). The pattern of below average recruitment deviations before data were available is a way for the model to explain fewer old and fewer large fish in the years when data were available.

Recent recruitment is estimated with low precision because there are few observations to inform those year classes. However, the cohorts are very important to projections because they will be an important component of the fishery in future years.

Three major sources of uncertainty used in the 2015 full assessment and in this update were natural mortality, steepness, and the strength of recent year classes. Therefore, the axis of uncertainty to define low and high states of nature was a combination of these three factors. The 12.5% and 87.5% quantiles for female and male natural mortality (independently) were chosen as low and high values (0.133 yr^{-1} and 0.155 yr^{-1} for females; 0.144 yr^{-1} and 0.166 yr^{-1} for males). The 12.5% and 87.5% quantile of the 2013 recruitment deviation were also used (1.5781 and 1.9985). Steepness is probably the most important factor since it was fixed in the base model and is not incorporated in the estimation uncertainty. The 12.5% and 87.5% quantiles from the steepness prior (without Widow Rockfish data) were used to define the low and high values of steepness (0.536 and 0.904). The low combination of these three factors defined the low state of nature and the high combination of these three factors defined the high state of nature. The predictions of spawning biomass in 2019 from the low and high states of nature are close to the 12.5% and 87.5% lognormal quantiles from the base model.

4 Reference points

Reference points (see Table e in the Executive Summary) were calculated using the estimated selectivities and catch distribution among fleets in the most recent year of the model (2018). Sustainable total yields (landings plus discards) were 7,240 mt when using an $SPR_{50\%}$ reference harvest rate and with a 95% confidence interval of 5,447 to 9,033 mt based on estimates of uncertainty. The spawning biomass equivalent to 40% of the unfished spawning output ($SB_{40\%}$) was 35,198 mt. Prior to 2018, the most recent catches (landings plus discards) have been below the point estimate of potential long-term yields calculated using an $SPR_{50\%}$ reference point and the population has been increasing over the last decade. However, catches in 2018 were above the point estimate of potential long-term yields calculated using an SPR_{50} reference point.

The predicted spawning biomass from the base model generally showed a slight decline until the late 1970s, steep increase above unfished equilibrium levels, then a steep decline until the mid-1980s followed by less of a decline until 2001 (Figure 61). Since 2001, the spawning biomass has been increasing due to small catches, and recently, above average recruitment. The 2018 spawning biomass relative to unfished equilibrium spawning biomass is above the target of 40% of unfished spawning biomass (Figure 63). The fishing intensity (relative 1-*SPR*) exceeded the current estimates of the harvest rate limit ($SPR_{50\%}$) throughout the 1980s and early 1990s, as seen in Figure 73. Recent exploitation rates on Widow Rockfish were predicted to be much less than target levels. In recent years, the stock has experienced exploitation rates that have been below the target level while the biomass level has remained above the target level (Figure 74).

The equilibrium yield plot is shown in Figure 75, based on a steepness value fixed at 0.720. The predicted maximum sustainable yield under the assumptions of this assessment occurs near 25% of equilibrium unfished spawning biomass.

5 Unresolved problems and major uncertainties

This is a reconfiguration of a long line of stock assessments for Widow Rockfish on the U.S. West Coast and although scientifically credible advice is provided by synthesizing many sources of data, there remain data and structural assumptions that contribute to uncertainty in the estimates. Major sources of uncertainty include landings, discards, natural mortality, and recruitment, which are discussed below.

Discards of Widow Rockfish are even more uncertain than landings, but because Widow Rockfish is a marketable species, historical discard rates were likely lower than less desirable or smaller species. In this assessment, we assumed that discarding was nearly negligible before management restrictions began in 1982. Once trip limits were introduced, discarding tended to be an all or none event, and detecting large, but rare, discard events with far less than 100% observer coverage has a low probability. For the years 2002–2010, the WCGOP has provided data on discards from vessels that were randomly selected for observer coverage, thus some uncertainty is present in the total amount discarded. The implementation of trawl rationalization in 2011 resulted in almost 100% observer coverage for the trawl fleet and very little incentive to discard Widow Rockfish. However, the open access fixed-gear fleet is not monitored by the full observer coverage required under trawl rationalization and data show that discarding of Widow Rockfish has occurred on fixed gear vessels in recent years (limited entry vessel fishing with fixed gear are subject to 100% observer coverage). Uncertainty in recent discards is greatly reduced because of observer coverage, but it is unknown what historical discarding may have been. The model assumes a discard rate of 1% pre-1982, which is arbitrary, but reasonable. Discard mortality is assumed to be 100%, which may overestimate actual mortality (Jarvis & Lowe, 2007), but given the low number of discards, will have minimal effect on assessment results.

There may also be uncertainty in the ability of bottom trawl surveys to be a reliable measure of widow abundance, which spend a significant portion of their time in mid-water (Wilkins 1986). Multiple surveys are used in the assessment, but further consideration of additional surveys is reasonable.

Widow Rockfish is a relatively long-lived fish, and natural mortality is likely to be lower than many species of fish, such as gadoids. Ages above 50 years have been observed and it is expected that natural mortality could be less than 0.10 yr^{-1}. However, even with length and age data available back to the late 1970s, natural mortality was estimated above 0.14 yr^{-1} with a small amount of uncertainty (7% coefficient of variation). This assessment attempts to capture that uncertainty by estimating natural mortality (M) and integrating that uncertainty into the derived biomass estimates, as well as additional uncertainty by including levels outside of the predicted interval in a decision table.

Model sensitivities and profiles over M showed that current stock status was highly sensitive to the assumption about natural mortality. The estimates of M varied slightly depending on the weight given to age and length data, or removing recent years of data, but M was always estimated above 0.123 yr^{-1}. Profiles over natural mortality provide support for values above 0.14 yr^{-1}.

Steepness was fixed at 0.720 in the base model, but a likelihood profile showed that it would be estimated at a value less than that. Estimates of M increased with lower steepness, while unfished equilibrium spawning biomass increased and current spawning biomass decreased. Equilibrium yield ranged from approximately 3,600 to 7,500 mt depending on the value of steepness.

6 Scientific uncertainty

Spawning biomass is estimated to be at 80,910 mt in 2019, with a sigma of 0.1962. OFL is estimated to be 14,669.9 mt in 2019 with a sigma of 0.2230.

7 Harvest projections and decision tables

A twelve year projection of the base model with catches equal to the current ACL in 2019 and 2020 (10,868 mt) and catches of 9,000 mt for all later years and a catch allocation equal to the percentages for each fleet in 2018 predicts spawning biomass will decrease over the projection period for all states of nature (Table 36).

Projections with catches based on the predicted annual catch limit (ACL) using the SPR rate of 50%, the 40:10 control rule, and a 0.45 P* adjustment using a sigma of 0.50 from 2021 onward suggest that the spawning biomass will decrease over the projection period for all states of nature (Table 36). Predicted ACL catches range from 14,725 mt in 2021 to 8,322 mt in 2030.

Projections with catches based on the predicted annual catch limit (ACL) using the SPR rate of 50%, the 40:10 control rule, and a 0.25 P* adjustment using a sigma of 0.50 from 2021 onward suggest that the spawning biomass will decrease over the projection period for all states of nature. Predicted ACL catches range from 10,961 mt in 2021 to 5,944 mt in 2030.

8 Regional management considerations

Widow Rockfish have shown latitudinal differences in life-history parameters, which has led past assessment authors to pursue a two-area model. Modelling a stock with two areas is difficult because it requires many assumptions about recruitment distribution, movement, and connectivity, while also splitting data into two areas that reduces sample sizes when compared to a coastwide model. The upside is that it can result in a better model that more accurately predicts regional status. This assessment is a coastwide model because not enough is known about the assumptions that would have to be made for a two-area model.

It is still important to consider regional differences when making management decisions. Following recent cohorts through time with survey data showed that older fish showed up in the north after younger fish were observed in the south (Figure 2). This may indicate connectivity between the north and the south and that this is truly one stock. However, more investigation is needed.

Widow Rockfish are managed on a coastwide basis and observed more often in the NWFSC WCGBT bottom trawl survey north of latitude 40° 10′ N. Bottom trawl catches in California have historically been as large as in Oregon and larger than in Washington, but recently catches in California have been small. Rockfish Conservation Areas (RCAs) cover a significant proportion of Widow Rockfish habitat, but a midwater trawl fishery is beginning to re-develop that can fish in these areas. Future assessments and management of Widow Rockfish may want to monitor where catches are being taken to make sure that specific areas are not being overexploited. In addition, research on the connectivity along the coast as well as regional differences would help to inform the potential for overfishing specific areas.

9 Research and data needs

There are many areas of research that could be improved to benefit the understanding and assessment of Widow Rockfish. Below, we specifically identify five topics that we believe are most important (order does not indicate importance).

- **Historical landings and discards:** The historical landings and discards are uncertain for Widow Rockfish and improvements would increase the certainty that fishing removals are applied appropriately. Because landings are assumed to be known exactly in the assessment model, uncertainty in the predictions does not include uncertainty in the landings. A thorough look at historical landings, species compositions, and discarding practices would reduce the potential uncertainty that is not entirely accounted for.

- **Natural mortality:** Uncertainty in natural mortality translates into uncertain estimates of status and sustainable fishing levels for Widow Rockfish. The collection of additional age data, re-reading of older age samples, reading old age samples that are unread, and improved understanding of the life-history of Widow Rockfish may reduce that uncertainty.

- **Maturity and fecundity:** There are few studies on the maturity of Widow Rockfish and even less recent information. There have been no studies that reported results of a histological analysis. Further research on the maturity and fecundity of Widow Rockfish, the potential differences between areas, the possibility of changes over time would greatly improve the assessment of these species.

- **Age data and error:** There is a considerable amount of error in the age data and potential for bias. Investigating the ageing error and bias would help to understand the influences that the age data have on this assessment. Disagreement between surface reads of age versus break-and-burn reads is worth more investigation.

- **Basin-wide understanding of stock structure, biology, connectivity, and distribution:** This is a stock assessment for Widow Rockfish off of the west coast of the U.S. and does not consider data from British Columbia or Alaska. Further investigating and comparing the data and predictions from British Columbia and Alaska to determine if there are similarities with the U.S. West Coast observations would help to define the connectivity between Widow Rockfish north and south of the U.S.-Canada border.

10 Progress on research and data needs identified in the most recent previous assessment

Research is ongoing into the items that were identified for research from the last full assessment in 2015 and will be addressed in depth at the time of the next full assessment. For example, we have collected >300 maturity samples from widow rockfish from various fisheries and surveys since the 2015 assessment for use in developing a new maturity curve.

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13 Tables

Table 1: Landings for bottom trawl, midwater trawl, net, and hook-and-line (mt) fisheries from Washington, Oregon, and California.

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1916	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.8	0.3	0.0
1917	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.9	0.3	0.0
1918	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	128.5	0.3	0.0
1919	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.6	0.3	0.0
1920	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90.7	0.4	0.0
1921	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.1	0.4	0.0
1922	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.2	0.4	0.0
1923	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.7	0.4	0.0
1924	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.2	0.4	0.0
1925	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.7	0.4	0.0
1926	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	85.5	0.4	0.0
1927	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.4	0.5	0.0
1928	16.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.0	0.8	0.0
1929	23.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.1	1.3	0.0
1930	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90.4	1.2	0.0
1931	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.6	0.9	0.0
1932	21.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	77.7	0.3	0.0
1933	34.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	50.9	0.5	0.0
1934	30.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.7	0.5	0.0
1935	28.9	0.2	0.7	0.0	0.0	0.0	0.0	0.0	67.9	0.5	0.0
1936	23.4	0.7	1.1	0.0	0.0	0.0	0.0	0.0	84.3	1.2	0.0
1937	33.6	1.3	0.9	0.0	0.0	0.0	0.0	0.0	66.3	1.3	0.0
1938	32.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	49.6	1.0	0.0
1939	38.8	1.9	1.0	0.0	0.0	0.0	0.0	0.0	34.2	0.7	0.0
1940	30.6	43.7	1.0	0.0	0.0	0.0	0.0	0.0	43.9	1.5	0.0
1941	24.8	67.3	1.4	0.0	0.0	0.0	0.0	0.0	34.1	1.9	0.0
1942	5.4	126.1	1.8	0.0	0.0	0.0	0.0	0.0	10.2	3.1	0.0
1943	28.3	439.2	1.2	0.0	0.0	0.0	0.0	0.0	18.0	3.9	0.0
1944	148.6	770.7	2.0	0.0	0.0	0.0	0.0	0.0	38.0	1.4	0.0
1945	353.4	1,196.6	3.4	0.0	0.0	0.0	0.0	0.0	66.8	1.1	0.0
1946	353.2	735.0	0.8	0.0	0.0	0.0	0.0	0.0	69.7	1.3	0.0
1947	98.1	452.8	0.2	0.0	0.0	0.0	0.0	0.0	91.3	0.7	0.0
1948	139.4	297.3	0.1	0.0	0.0	0.0	0.0	0.0	39.6	1.2	0.0
1949	75.1	254.7	0.0	0.0	0.0	0.0	0.0	0.0	43.9	0.6	0.0
1950	70.9	286.8	1.8	0.0	0.0	0.0	0.0	0.0	63.4	0.8	0.0
1951	249.4	252.9	2.0	0.0	0.0	0.0	0.0	0.0	49.1	0.6	0.0

Table 1 continued

Year	Bottom Trawl CA	OR	WA	Midwater Trawl CA	OR	WA	Net CA	WA	Hook-and-line CA	OR	WA
1952	236.6	264.2	0.2	0.0	0.0	0.0	0.0	0.0	39.9	0.6	0.0
1953	242.6	211.5	1.2	0.0	0.0	0.0	0.0	0.0	13.7	0.3	0.0
1954	155.8	267.3	3.1	0.0	0.0	0.0	0.0	0.0	21.3	0.4	0.0
1955	166.3	277.5	2.5	0.0	0.0	0.0	0.0	0.0	18.2	0.4	0.0
1956	196.8	361.3	0.7	0.0	0.0	0.0	0.0	0.0	41.8	0.3	0.0
1957	233.1	489.5	0.1	0.0	0.0	0.0	0.0	0.0	37.4	0.6	0.0
1958	284.3	380.4	0.2	0.0	0.0	0.0	0.0	0.0	36.6	0.1	0.0
1959	229.9	412.8	0.1	0.0	0.0	0.0	0.0	0.0	28.6	0.2	0.0
1960	180.0	608.6	0.2	0.0	0.0	0.0	0.0	0.0	21.9	0.2	0.0
1961	118.4	543.1	0.2	0.0	0.0	0.0	0.0	0.0	15.0	0.5	0.0
1962	115.9	623.8	2.0	0.0	0.0	0.0	0.0	0.0	15.4	0.4	0.0
1963	221.2	190.2	2.1	0.0	0.0	0.0	0.0	0.0	19.6	0.4	0.0
1964	104.1	480.9	3.2	0.0	0.0	0.0	0.0	0.0	13.0	0.1	0.0
1965	155.9	80.6	2.2	0.0	0.0	0.0	0.0	0.0	20.2	0.6	0.0
1966	123.0	455.8	0.6	0.0	0.0	0.0	0.0	0.0	37.4	0.4	0.0
1967	141.9	743.9	0.6	0.0	0.0	0.0	0.0	0.0	31.9	1.1	0.0
1968	155.0	240.6	16.7	0.0	0.0	0.0	0.0	0.0	19.0	1.0	0.0
1969	223.5	229.3	16.7	0.0	0.0	0.0	0.0	0.0	17.6	2.3	0.0
1970	257.3	27.7	3.0	0.0	0.0	0.0	0.0	0.0	9.0	0.9	0.0
1971	316.2	50.6	11.7	0.0	0.0	0.0	0.0	0.0	10.2	1.8	0.0
1972	411.9	51.8	14.1	0.0	0.0	0.0	0.0	0.0	17.8	2.3	0.0
1973	428.1	20.9	32.4	0.0	0.0	0.0	0.0	0.0	15.8	2.5	0.0
1974	426.4	7.3	6.5	0.0	0.0	0.0	0.0	0.0	41.3	3.1	0.0
1975	429.9	9.0	12.0	0.0	0.0	0.0	0.0	0.0	28.4	1.6	0.0
1976	467.3	56.0	36.2	0.0	0.0	0.0	0.0	0.0	39.5	2.2	0.0
1977	459.0	340.0	125.8	0.0	0.0	0.0	0.0	0.0	38.1	2.6	0.0
1978	538.9	340.1	336.7	0.0	0.0	0.0	0.0	0.0	157.4	3.8	0.0
1979	2,315.4	519.4	305.0	0.0	3,746.0	2,199.8	0.0	0.0	97.1	6.4	0.0
1980	5,175.6	410.8	338.4	150.8	8,460.7	6,969.4	0.0	3.4	55.9	3.7	0.0
1981	2,660.2	1,527.1	681.2	2,627.4	13,861.9	6,183.5	15.5	3.2	67.5	4.0	0.0
1982	3,656.7	782.8	522.0	7,008.1	8,184.4	5,458.0	38.1	37.1	180.6	5.9	0.0
1983	3,667.1	1,403.6	1,554.6	205.1	1,495.6	1,656.5	280.0	14.5	23.5	10.2	0.0
1984	1,434.6	1,428.5	381.8	1,378.6	3,982.8	1,064.6	324.8	26.6	22.8	3.8	0.0
1985	1,363.0	895.1	317.6	1,281.6	3,423.4	1,214.6	585.8	40.2	26.1	1.1	0.0
1986	1,640.4	1,230.1	716.1	362.2	3,150.5	1,834.1	500.8	0.0	81.5	1.9	0.0
1987	2,261.1	1,185.5	698.4	0.0	5,114.5	3,013.1	584.6	0.0	52.4	2.7	0.0
1988	1,585.3	1,152.8	1,290.3	0.0	4,305.6	1,785.0	220.7	0.0	72.3	1.0	0.2
1989	1,838.3	2,027.5	647.7	0.0	4,957.7	2,726.9	253.6	0.1	44.7	0.4	0.0
1990	1,812.7	2,289.3	1,210.4	0.0	3,352.8	1,021.1	411.2	0.0	126.9	7.3	0.2

Table 1 continued

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1991	996.4	1,989.2	878.9	0.0	1,779.9	260.2	234.8	0.0	89.7	5.2	0.3
1992	917.4	2,709.5	646.5	0.0	1,183.8	282.5	45.4	0.0	165.8	9.2	0.5
1993	1,088.3	3,457.0	1,109.8	1.2	1,706.8	547.9	51.6	0.0	63.7	44.7	0.5
1994	557.9	2,600.7	644.1	210.0	1,564.4	387.5	58.4	0.0	71.7	9.6	0.4
1995	1,361.1	2,386.7	339.0	292.7	1,283.4	700.7	57.6	0.0	19.0	7.2	0.1
1996	1,056.8	2,292.1	237.9	238.8	998.2	609.4	16.1	0.0	21.6	11.0	0.1
1997	1,032.5	2,502.8	241.7	253.6	1,453.1	735.8	16.4	0.0	22.4	15.6	0.0
1998	686.2	1,641.1	188.4	81.6	493.4	307.8	48.7	0.0	62.4	24.1	0.0
1999	485.0	945.0	182.7	100.1	1,634.2	315.9	10.0	0.0	29.0	14.7	0.1
2000	34.2	19.6	2.9	680.8	2,604.8	379.4	6.8	0.0	11.9	2.5	0.0
2001	9.3	28.8	1.0	310.3	1,092.4	287.1	7.0	0.0	6.4	0.7	0.0
2002	8.7	6.0	2.4	40.0	151.7	59.8	0.0	0.0	0.4	0.1	0.0
2003	3.1	0.3	0.2	0.4	0.0	9.3	0.4	0.0	0.3	0.6	0.0
2004	5.9	2.4	0.1	7.5	0.0	21.3	0.0	0.0	0.2	0.1	0.0
2005	2.7	0.2	0.2	5.2	0.0	27.6	0.1	0.0	0.4	0.8	0.1
2006	3.8	2.0	0.3	3.6	0.0	9.3	0.0	0.0	0.8	0.0	0.0
2007	2.7	1.8	0.3	1.0	0.0	0.5	2.9	0.0	1.6	0.3	0.0
2008	0.2	1.7	0.2	29.2	0.0	12.9	0.0	0.0	1.2	0.0	0.0
2009	1.9	2.1	0.2	2.3	0.0	34.1	0.2	0.0	0.4	0.0	0.0
2010	1.2	2.9	0.7	9.0	0.0	45.7	0.0	0.0	0.0	0.1	0.0
2011	1.1	10.0	7.2	0.0	12.4	31.5	0.0	0.0	0.0	0.0	0.0
2012	2.3	27.0	12.0	0.0	5.9	41.5	0.0	0.0	0.2	0.1	0.0
2013	4.8	44.0	2.4	0.0	204.5	36.6	0.0	0.0	0.9	0.1	0.0
2014	2.7	46.1	22.5	0.0	259.7	46.9	0.0	0.0	1.7	0.1	0.0
2015	1.8	9.8	0.0	0.0	409.4	96.9	0.0	0.0	0.5	0.2	1.3
2016	0.4	5.9	0.0	0.0	587.3	13.7	0.0	0.0	0.7	0.1	0.0
2017	2.4	473.0	1.9	44.8	4341.5	27.8	0.0	0.0	2.3	0.3	0.1
2018	21.1	14.1	0.4	214.2	7593.8	1564.2	0.0	0.0	1.5	0.0	0.1

Table 2: Landings (mt) from the foreign & domestic at-sea fleet and the domestic shoreside hake fleet. Catches (mt) from the Pacific whiting at-sea fishery as determined by onboard observers.

Year	Foreign & Domestic At-sea	Shoreside hake CA	Shoreside hake OR	Shoreside hake WA	Year	Foreign & Domestic At-sea	Shoreside hake CA	Shoreside hake OR	Shoreside hake WA
1966	3,670.0	0.0	0.0	0.0	1991	471.3	42.7	39.0	9.3
1967	3,902.0	0.0	0.0	0.0	1992	389.6	13.5	42.1	6.2
1968	1,956.0	0.0	0.0	0.0	1993	173.2	0.4	91.2	11.0
1969	358.0	0.0	0.0	0.0	1994	370.7	2.1	210.8	28.6
1970	554.0	0.0	0.0	0.0	1995	228.6	7.2	192.1	36.8
1971	701.0	0.0	0.0	0.0	1996	252.2	5.7	475.1	104.7
1972	421.0	0.0	0.0	0.0	1997	215.5	7.2	133.9	22.1
1973	656.0	0.0	0.0	0.0	1998	268.5	40.4	278.0	28.1
1974	418.0	0.0	0.0	0.0	1999	191.8	12.7	166.4	15.2
1975	391.2	0.0	0.0	0.0	2000	205.4	7.7	70.9	4.7
1976	718.5	0.0	0.0	0.0	2001	174.0	9.2	26.4	9.0
1977	119.3	0.0	0.0	0.0	2002	154.9	1.2	2.6	1.4
1978	191.9	0.0	0.0	0.0	2003	14.5	0.4	7.6	4.6
1979	197.9	0.0	0.0	0.0	2004	21.2	7.4	12.4	8.5
1980	272.0	0.0	0.0	0.0	2005	80.1	5.2	59.1	13.6
1981	227.9	0.0	0.0	0.0	2006	143.0	3.6	11.3	35.3
1982	157.5	0.0	0.0	0.0	2007	146.0	1.0	46.1	35.3
1983	131.5	0.0	0.0	0.0	2008	115.2	29.2	36.1	37.5
1984	294.7	0.0	0.0	0.0	2009	26.6	2.3	46.6	59.8
1985	182.6	0.0	0.0	0.0	2010	44.6	9.0	35.3	17.5
1986	256.8	0.0	0.0	0.0	2011	38.4	0.0	79.9	19.5
1987	181.3	0.0	0.0	0.0	2012	79.2	0.0	85.1	17.1
1988	231.6	0.0	0.0	0.0	2013	31.2	0.0	115.1	29.2
1989	212.0	0.0	0.0	0.0	2014	56.2	0.0	250.1	35.9
1990	230.2	0.0	0.0	0.0					

Table 3: A subset of management actions of importance to fisheries that caught Widow Rockfish.

Year	Management action
1982	Establishment of a 75,000 pound trip limit on Widow Rockfish in October
1983	Per-trip and per-week limits implemented for *Sebastes* complex coastwide (north and south of 40° N) 30,000 pound Widow Rockfish trip limit at the start of the year adjusted to 1,000 pound trip limit in September
1984	50,000 pound Widow Rockfish trip limit limited to once per week Trip limit lowered to 40,000 pounds once per week in May Directed fishery for Widow Rockfish closed in August and a full fishery closure in November
1985	30,000 pound trip limit once per week, or 60,000 pounds once every 2 weeks. Every 2 week option was rescinded in April Landings of *Sebastes* complex and Widow Rockfish smaller than 3,000 pounds unrestricted Widow Rockfish trip limit reduced to 3,000 pounds per trip without a trip frequency in July
1986	30,000 pound coastwide Widow Rockfish trip limit with no biweekly option Landings of *Sebastes* complex and Widow Rockfish smaller than 3,000 pounds unrestricted 3,000 pound coastwide trip limited implemented in September when Widow Rockfish ABC reached
1987	30,000 pound coastwide Widow Rockfish trip limit with no biweekly option. Only one landing per week above 3,000 pounds. Reduced Widow Rockfish trip limit to 5,000 pounds in October Closed the Widow Rockfish fishery in November
1988	30,000 pound coastwide Widow Rockfish trip limit with no biweekly option. Only one landing per week above 3,000 pounds. Reduced Widow Rockfish trip limit to 3,000 pounds in October
1989	30,000 pound coastwide Widow Rockfish trip limit with no biweekly option. Only one landing per week above 3,000 pounds. Reduced Widow Rockfish trip limit to 10,000 pounds in April Reduced Widow Rockfish trip limit to 3,000 pounds in October
1990	15,000 pound trip limit once per week, or 25,000 pounds once every 2 weeks. Only one landing per week above 3,000 pounds. Closed the Widow Rockfish fishery in December
1991	10,000 pound trip limit once per week, or 20,000 pounds once every 2 weeks. Only one landing per period above 3,000 pounds. Reduced Widow Rockfish trip limit to 3,000 pounds on my birthday in September
1992	30,000 pound coastwide Widow Rockfish trip limit per 4-week period. All landings apply to the 30,000 pounds. Reduced Widow Rockfish trip limit to 3,000 pounds in August Re-established the 30,000 pound cumulative landing limit for December
1993	30,000 pound coastwide Widow Rockfish trip limit per 4-week period. All landings apply to the 30,000 pounds. Reduced Widow Rockfish trip limit to 3,000 pounds in December
1994	Divided the commercial groundfish fishery in limited entry and open access fisheries. 30,000 pound cumulative Widow Rockfish limit per calendar month. Reduced Widow Rockfish trip limit to 3,000 pounds in December Rockfish limit of 10,000 per vessel per trip in open access fisheries, not to exceed 30,000 pounds of Widow Rockfish (as in limited entry fisheries) cumulative per month.
1995	30,000 pound cumulative Widow Rockfish limit per calendar month. Monthly cumulative trip limit increased to 45,000 pounds for Widow Rockfish
1996	70,000 pound cumulative Widow Rockfish limit per two-month period. Reduced cumulative two-month period Widow Rockfish limit to 50,000 pounds in September. 25,000 pound monthly cumulative limit implemented in November.
1997	70,000 pound cumulative Widow Rockfish limit per two-month period. Reduced cumulative two-month period Widow Rockfish limit to 60,000 pounds in May.

1998	25,000 pound cumulative Widow Rockfish limit per two-month period. Increased cumulative two-month period Widow Rockfish limit to 30,000 pounds in May. Open access monthly cumulative trip limits reduced to 3,000 pounds in July. Limited entry monthly trip limits for Widow Rockfish increased to 19,000 pounds. Prohibited landings of Widow Rockfish in open access fisheries.
1999	Dividing line between north and south management areas moved to 40º 10' N. Three-phase cumulative limit period system introduced. Phase 1: 70,000 pounds cumulative limit from January through March for Widow Rockfish. Phase 2: 16,000 pounds per 2-month period April through September for Widow Rockfish. Phase 3: 30,000 pounds per month October through December for Widow Rockfish. Open access limit to 2,000 pounds per month of Widow Rockfish. Phase 2 two-month limits reduced to 11,000 pounds for Widow Rockfish starting in June. Open access month cumulative trip limit increased to 8,000 pounds of Widow Rockfish. WA and OR restrict landings applied to 30,000 monthly limit to have midwater gear. State imposed cumulative trip limits per month applied otherwise.
2000	Sorting of Widow Rockfish required before weighing in limited entry and open access fisheries. New limited entry trawl gear restrictions implemented for large footrope trawl gear, small footrope trawl gear, and midwater trawl gear. Cumulative trip limits allowed for Widow Rockfish only if small footrope or midwater trawl gear were used. Higher cumulative trip limits available to midwater gear. 30,000 pound two-month cumulative trip limit for Widow Rockfish caught with mid-water gear. 1,000 pound monthly trip limit allowed for small footrope trawl. 3,000 pound monthly trip limits for Widow Rockfish caught with limited entry fixed gear, open access gear, and exempted trawl gear. Some closures south of 40°10' N latitude in January through April.
2001	Similar actions as in 2000 with the following changes: 20,000 pound two-month cumulative trip limit for Widow Rockfish caught with mid-water gear in January through April and September through October. 10,000 pound two-month cumulative trip limit in other periods. Widow Rockfish limits reduced to 1,000 pounds per month in July-September unless landed with Pacific Whiting, which is 2,000 pounds per month with a 500 pound trip limit. Retention of Widow Rockfish prohibited beginning in October. For gears other than midwater trawl.
2002	Rockfish Conservation Areas (RCA) established. Large footrope gear prohibited inside 275 m. Widow fishery closed most of the year except for a small amount of bycatch and small monthly limits in some months.
2003	Widow fishery closed most of the year except for a small amount of bycatch and small monthly limits in some months.
2004	Widow fishery closed most of the year except for a small amount of bycatch and small monthly limits in some months.
2005	Widow fishery closed most of the year except for a small amount of bycatch and small monthly limits in some months.
2006	Amendment 19 established essential fish habitat (EFH) boundaries and conservation areas. Widow bycatch cap in the non-tribal limited entry whiting trawl fishery increased from 200 mt to 220 mt in October
2007	Seasonal changes of trawl RCA boundaries and periodic closures within certain latitude boundaries (e.g., north of Cape Alava at 48°10' N. latitude to the U.S. - Canada border) started in 2007. Small monthly limits for Widow Rockfish (less than 1,500 pounds per month) Widow bycatch cap in the non-tribal limited entry whiting trawl fishery increased from 200 mt to 220 mt in May. Limited entry whiting trawl fishery closed due to attainment of 220 mt widow bycatch in July Limited entry whiting trawl fishery re-opened with 275 mt widow bycatch cap in October
2008	Widow bycatch cap of 275 mt adopted for limited entry whiting trawl fishery. Limited entry whiting trawl fishery closed due to attainment of canary bycatch in August Limited entry whiting trawl fishery re-opened with 284 mt widow bycatch cap in October Small monthly limits for Widow Rockfish (less than 1,500 pounds per month)

Table 3 (continued)

2009	Sector specific bycatch caps for Widow Rockfish in the limited entry whiting trawl fishery:105 mt for shoreside fleet, 85 mt to catcher-processors, 60 mt to motherships Small monthly limits for Widow Rockfish (less than 1,500 pounds per month)
2010	
2011	Trawl rationalization began, establishing the IFQ fishery.

Table 4: Management guidelines for Widow Rockfish from 2004 to 2015. Total landings (mt) are also shown.

Year	OFL (mt) (termed ABC prior to 2011)	ABC (mt)	ACL (mt) (termed OY prior to 2011)	Commercial Landings (mt)	Estimated Total Catch (mt)
2004	3,460	NA	284	87	99
2005	3,218	NA	285	195	204
2006	3,059	NA	289	213	221
2007	5,334	NA	368	240	245
2008	5,144	NA	368	264	272
2009	7,728	NA	522	177	186
2010	6,937	NA	509	166	179
2011	5,097	4,872	600	212	213
2012	4,923	4,705	600	270	271
2013	4,841	4,598	1,500	470	473
2014	4,435	4,212	1,500	722	726
2015	4,137	3,929	2,000	880	885
2016	3,990	3,790	2,000	1,039	1,045
2017	14,130	13,508	13,508	6,346	6,395
2018	13,237	12,655	12,655	10,493	10,588
2019	12,375	11,831	11,831	NA	NA

Table 5: Description of indices of abundance with a ranking of the author's belief of the usefulness of each index.

Name	**Region**	**Years**	**Fishery independent**	**Filtering**	**Method**	**Rank**	**Method endorsed**
NWFSC WCGBT survey	Coastwide	2003–2014	No	South of 34.5 removed	VAST	1	SSC
Oregon Bottom Trawl	OR	1984–1999	No	Jan–Mar 42.5–46.5 & 124.6-124.9 >1000 lbs	Delta-GLM	2	Past assessments
Domestic at-sea	OR/WA	1991–1998	No		Delta-GLM	3	Past assessments
Triennial trawl survey	Coastwide	1980–2004 (triennially)	Yes	None	GLMM, Gaussian, ECEs	4	SSC
JV at-sea bycatch	OR/WA	1983, 1985–1990	No		Delta-GLM	5	Past assessments
Foreign at-sea bycatch	Coastwide	1977-82, 1984-88	No		Delta-GLM	6	Past assessments
Juvenile Survey	Coastwide	2004, 2005–09, 2011 2013-14	No	Included years with coastwide coverage	VAST	7	SSC

Table 6: Depth ranges and limits of the southern latitude in the Triennial survey for the different years.

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

Table 7. Stratifications used for the two surveys.

Triennial					
Strata	**Area (km2)**	**Depth1**	**Depth2**	**Latitude1**	**Latitude2**
A	33,730.25	55	183	34.5	49
B	11,062.63	183	400	34.5	49
NWFSC WCGBT					
Strata	**Area (km2)**	**Depth1**	**Depth2**	**Latitude1**	**Latitude2**
A	10,687.86	55	183	34.5	40.5
B	3,394.82	183	400	34.5	40.5
C	23,042.39	55	183	40.5	49
D	7,667.81	183	400	40.5	49

Table 8: Survey indices of abundance used in the base case model.

	Juvenile		Triennial		NWFSC WCGBT	
Year	Estimate (N)	SE(logN)	Estimate (B)	SE(logB)	Estimate (B)	SE(logB)
1980			7255.87	0.732		
1981						
1982						
1983			10838.68	0.690		
1984						
1985						
1986			5847.21	0.774		
1987						
1988						
1989			3884.95	0.702		
1990						
1991						
1992			7441.37	0.707		
1993						
1994						
1995			5885.03	0.712		
1996						
1997						
1998			9717.84	0.696		
1999						
2000						
2001			1980.62	0.742		
2002						
2003					7,582,600.07	0.56
2004	44,210	0.337	1069.11	0.853	372,305.62	0.48
2005	5,462	0.277			1,218,323.20	0.55
2006	64	1.279			1,190,902.05	0.41
2007	546	0.651			773,443.18	0.31
2008	16,863	0.456			217,903.22	0.28
2009	13,956	0.466			1,107,685.67	0.30
2010					1,772,645.70	0.43
2011	3,250	0.591			4,784,591.43	0.54
2012					2,221,772.21	0.64
2013	259,118	0.275			11,880,869.81	0.62
2014	97,231	0.360			3,341,071.53	0.52
2015	22,368	0.271			2,743,758.46	0.80
2016	63,369	0.300			31,090,855.11	0.48
2017	4,425	0.649			10,610,744.94	0.69
2018	2,562	0.622			7,738,473.17	0.50

Table 9: Number of positive tows, lengths, and ages in each year from the Triennial survey (Tri) and the NWFSC WCGBT survey (NW).

	Number of positive tows		Number of tows with lengths		Number of lengths		Number of tows with ages		Number of ages	
Year	Tri	NW	Tri	NW	Tri	NW	Tri	NW	Tri	NW
1980	38		3		166		1		22	
1981										
1982										
1983	70		5		385		0		0	
1984										
1985										
1986	46		8		317		0		0	
1987										
1988										
1989	38		20		713		0		0	
1990										
1991										
1992	50		10		708		0		0	
1993										
1994										
1995	43		43		500		0		0	
1996										
1997										
1998	59		58		738		0		0	
1999										
2000										
2001	28		28		130		0		0	
2002										
2003		20		18		216		6		10
2004	36	12	33	12	219	84	0	12	0	43
2005		20		20		78		18		65
2006		26		26		172		26		89
2007		27		27		92		27		83
2008		17		17		26		15		20
2009		32		32		142		32		124
2010		28		28		240		28		116
2011		31		31		313		31		152
2012		32		32		181		32		91
2013		18		18		364		18		246
2014		29		28		349		28		264
2015		21		21		149		21		93
2016		40		40		888		40		556
2017		30		30		310		30		213
2018		34		34		410		34		353

Table 10: Number of landings sampled for length data by gear and state for non-whiting fisheries.

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1976	0	2	0	0	0	0	0	0	0	0	0
1977	22	0	0	0	0	0	0	0	0	0	0
1978	50	0	0	0	0	0	10	0	0	0	0
1979	32	9	0	0	8	0	8	0	3	0	0
1980	106	3	0	1	32	19	0	0	1	0	1
1981	76	13	0	56	40	31	0	0	7	0	0
1982	96	16	0	81	53	40	1	0	11	0	0
1983	157	22	0	46	20	25	27	0	9	0	0
1984	146	28	0	29	34	22	40	0	4	0	0
1985	149	25	0	25	58	16	81	0	5	0	0
1986	108	21	0	25	58	27	59	0	16	0	0
1987	88	34	0	49	69	36	37	0	3	0	0
1988	79	32	7	37	41	14	43	0	2	0	0
1989	81	49	14	30	68	16	79	0	7	0	0
1990	80	57	11	39	63	30	74	0	8	0	0
1991	74	76	19	13	59	15	23	0	12	0	0
1992	55	96	22	5	44	9	31	0	53	1	0
1993	60	70	28	5	46	8	19	0	40	0	0
1994	54	67	13	2	21	16	34	0	38	0	0
1995	53	47	17	11	14	16	14	0	7	0	0
1996	48	33	17	11	12	13	4	0	10	0	0
1997	54	49	16	10	21	18	2	0	20	0	0
1998	41	43	26	3	11	8	5	0	15	0	0
1999	37	29	21	5	17	11	1	0	3	1	0
2000	14	0	3	16	44	19	0	0	8	1	0
2001	12	6	2	10	38	11	0	0	2	3	0
2002	22	8	7	1	15	10	1	0	2	0	0
2003	7	0	1	0	0	5	0	0	0	0	0
2004	5	1	1	0	0	9	0	0	0	0	0
2005	4	2	0	0	0	7	0	0	1	0	0
2006	7	3	2	0	0	5	0	0	4	1	0
2007	7	16	4	0	0	1	0	0	4	1	0
2008	5	18	5	0	0	10	0	0	2	0	0
2009	19	28	0	0	1	13	0	0	0	0	0
2010	18	23	1	0	0	9	0	0	0	3	0
2011	6	14	9	0	1	6	0	0	1	0	0
2012	14	18	3	0	4	7	0	0	3	2	0
2013	20	21	1	0	6	6	0	0	9	4	0
2014	18	20	3	0	5	7	0	0	12	8	0
2015	36	0	0	0	0	4	0	0	9	0	2
2016	27	6	0	0	3	1	0	0	2	1	2
2017	22	41	0	3	35	3	0	0	5	2	3
2018	31	25	7	10	120	4	0	0	3	4	7

Table 11: Number of lengths of Widow Rockfish by gear and state for non-whiting fisheries.

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1976	0	150	0	0	0	0	0	0	0	0	0
1977	66	0	0	0	0	0	0	0	0	0	0
1978	303	0	0	0	0	0	66	0	0	0	0
1979	436	452	0	0	230	0	68	0	7	0	0
1980	736	302	0	3	1,021	1,900	0	0	1	0	2
1981	474	1,122	0	1,320	3,392	3,100	0	0	23	0	0
1982	988	1,819	0	3,088	6,187	4,000	1	0	84	0	0
1983	1,346	658	0	1,406	640	2,500	138	0	31	0	0
1984	1,722	3,247	0	1,278	4,334	2,199	167	0	11	0	0
1985	1,853	2,716	0	1,176	6,954	1,600	557	0	8	0	0
1986	1,740	1,886	0	1,032	6,245	2,650	321	0	120	0	0
1987	997	1,015	0	1,744	2,048	1,942	262	0	11	0	0
1988	763	976	350	1,230	1,209	700	334	0	3	0	0
1989	1,005	1,099	700	1,325	1,842	799	432	0	20	0	0
1990	1,202	1,294	550	1,510	1,479	1,500	612	0	37	0	0
1991	1,596	1,569	947	566	1,357	750	268	0	75	0	0
1992	1,470	1,947	1,100	222	1,778	450	231	0	689	2	0
1993	1,682	1,436	1,400	231	1,091	400	275	0	274	0	0
1994	1,359	1,464	650	112	557	842	410	0	554	0	0
1995	1,539	1,066	850	519	296	800	175	0	22	0	0
1996	1,329	845	704	437	316	650	132	0	80	0	0
1997	2,063	1,231	557	382	620	900	80	0	212	0	0
1998	1,368	1,013	865	125	291	400	179	0	318	0	0
1999	1,385	752	952	240	459	550	1	0	104	20	0
2000	263	0	101	641	1,147	950	0	0	64	1	0
2001	139	98	2	349	960	550	0	0	4	20	0
2002	318	185	136	39	319	500	2	0	74	0	0
2003	234	0	46	0	0	208	0	0	0	0	0
2004	26	18	3	0	0	477	0	0	0	0	0
2005	27	48	0	0	0	313	0	0	4	0	0
2006	79	58	7	0	0	337	0	0	36	1	0
2007	12	302	104	0	0	100	0	0	64	1	0
2008	8	274	76	0	0	986	0	0	27	0	0
2009	170	304	0	0	6	1,029	0	0	0	0	0
2010	204	238	100	0	0	753	0	0	0	16	0
2011	32	246	93	0	30	550	0	0	17	0	0
2012	136	352	91	0	95	688	0	0	9	8	0
2013	153	365	39	0	215	486	0	0	102	6	0
2014	134	324	106	0	150	700	0	0	242	16	0
2015	207	0	0	0	0	400	0	0	45	0	2
2016	143	72	0	0	80	100	0	0	38	1	24
2017	316	864	0	158	1,010	125	0	0	73	3	23
2018	645	161	12	507	2,585	350	0	0	32	7	10

Table 12: Number of landings and number of lengths sampled from the at-sea hake and shoreside hake fisheries.

Year	Number of hauls (at-sea) or landings (shoreside)		Number of lengths	
	Domestic at-sea	Shoreside	Domestic at-sea	Shoreside
1991	0	8	0	280
1992	161	1	1,962	17
1993	220	2	2,124	39
1994	315	3	4,566	78
1995	297	20	2,936	600
1996	312	19	3,444	575
1997	371	30	3,994	869
1998	461	34	3,142	1,034
1999	593	54	3,822	1,616
2000	570	34	3,541	1,034
2001	522	1	2,185	36
2002	365	1	1,452	16
2003	290	2	805	26
2004	507	7	2,223	89
2005	1,226	0	7,175	0
2006	1,290	0	7,733	0
2007	1,491	1	14,367	30
2008	1,135	8	9,988	161
2009	398	22	2,506	789
2010	979	44	7,188	1,234
2011	980	42	4,539	1,236
2012	911	41	6,432	1,058
2013	900	36	4,726	960
2014	771	44	5,496	1,152
2015	523	35	5,038	1,263
2016	801	38	5,175	1,180
2017	997	53	7,493	1,265
2018	461	4	3,028	140

Table 13: Number of landings sampled for ages by gear and state for non-whiting fisheries.

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	7	0	0	0	0	0	0	0	0	0	0
1979	11	8	0	0	8	0	0	0	0	0	0
1980	27	3	0	0	31	0	0	0	0	0	0
1981	14	13	0	30	39	0	0	0	0	0	0
1982	87	15	0	71	53	0	1	0	4	0	0
1983	150	21	0	45	20	0	5	0	2	0	0
1984	144	28	0	29	34	0	11	0	2	0	0
1985	137	25	0	24	56	0	40	0	2	0	0
1986	106	21	0	22	58	0	53	0	3	0	0
1987	84	27	0	49	62	0	27	0	0	0	0
1988	67	31	0	34	40	0	39	0	2	0	0
1989	75	49	0	30	67	0	75	0	3	0	0
1990	70	57	0	32	63	0	65	0	2	0	0
1991	65	76	0	13	59	0	19	0	9	0	0
1992	45	91	0	4	27	0	21	0	15	0	0
1993	28	68	0	0	46	0	6	0	3	0	0
1994	28	67	0	2	21	0	7	0	1	0	0
1995	8	45	0	3	13	0	0	0	0	0	0
1996	35	32	0	6	11	0	2	0	1	0	0
1997	42	46	0	10	20	0	0	0	9	0	0
1998	27	42	0	2	11	0	2	0	3	0	0
1999	28	28	0	3	16	0	0	0	0	0	0
2000	8	0	2	9	42	19	0	0	3	0	0
2001	2	6	0	4	35	10	0	0	0	0	0
2002	17	8	2	1	15	10	1	0	0	0	0
2003	3	0	0	0	0	5	0	0	0	0	0
2004	3	0	1	0	0	9	0	0	0	0	0
2005	0	2	0	0	0	7	0	0	0	0	0
2006	6	3	1	0	0	5	0	0	2	1	0
2007	6	16	4	0	0	1	0	0	3	1	0
2008	5	18	5	0	0	10	0	0	0	0	0
2009	8	27	0	0	1	12	0	0	0	0	0
2010	7	21	1	0	0	9	0	0	0	3	0
2011	0	5	7	0	1	5	0	0	0	0	0
2012	0	7	3	0	0	7	0	0	0	2	0
2013	0	7	1	0	3	5	0	0	0	0	0
2014	0	4	2	0	1	7	0	0	0	0	0
2015	0	0	0	0	0	4	0	0	0	0	1
2016	0	6	0	0	0	1	0	0	0	0	2
2017	0	36	0	0	11	3	0	0	0	0	3
2018	0	24	7	0	54	4	0	0	0	0	7

Table 14: Number of ages of Widow Rockfish by gear and state for non-whiting fisheries.

	Bottom Trawl			Midwater Trawl			Net		Hook-and-line		
Year	CA	OR	WA	CA	OR	WA	CA	WA	CA	OR	WA
1976	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0
1978	107	0	0	0	0	0	0	0	0	0	0
1979	269	363	0	0	230	0	0	0	0	0	0
1980	404	302	0	0	986	0	0	0	0	0	0
1981	205	407	0	598	1,258	0	0	0	0	0	0
1982	834	510	0	2,382	1,620	0	1	0	18	0	0
1983	1,277	624	0	1,360	640	0	55	0	3	0	0
1984	1,678	839	0	1,278	1,019	0	94	0	5	0	0
1985	1,762	735	0	1,174	1,628	0	415	0	2	0	0
1986	1,704	798	0	913	2,033	0	188	0	5	0	0
1987	967	805	0	1,742	1,837	0	186	0	0	0	0
1988	692	946	0	1,132	1,179	0	290	0	3	0	0
1989	919	1,099	0	1,323	1,793	0	403	0	6	0	0
1990	1,051	1,284	0	1,309	1,472	0	533	0	8	0	0
1991	1,308	1,566	0	566	1,328	0	164	0	23	0	0
1992	676	1,854	0	82	592	0	87	0	91	0	0
1993	472	1,387	0	0	1,090	0	57	0	3	0	0
1994	516	1,463	0	54	556	0	58	0	1	0	0
1995	167	1,027	0	68	276	0	0	0	0	0	0
1996	838	827	0	158	292	0	88	0	7	0	0
1997	892	1,164	0	187	593	0	0	0	55	0	0
1998	1,019	987	0	82	291	0	84	0	46	0	0
1999	1,008	731	0	133	424	0	0	0	0	0	0
2000	157	0	100	353	1,067	948	0	0	12	0	0
2001	43	98	0	132	858	485	0	0	0	0	0
2002	294	179	99	21	319	488	2	0	0	0	0
2003	87	0	0	0	0	208	0	0	0	0	0
2004	7	0	3	0	0	475	0	0	0	0	0
2005	0	48	0	0	0	313	0	0	0	0	0
2006	74	58	6	0	0	237	0	0	5	1	0
2007	11	302	54	0	0	50	0	0	23	1	0
2008	8	274	75	0	0	500	0	0	0	0	0
2009	81	303	0	0	6	639	0	0	0	0	0
2010	54	231	50	0	0	439	0	0	0	15	0
2011	0	63	84	0	30	250	0	0	0	0	0
2012	0	79	41	0	0	163	0	0	0	8	0
2013	0	190	26	0	90	153	0	0	0	0	0
2014	0	91	25	0	30	178	0	0	0	0	0
2015	0	0	0	0	0	195	0	0	0	0	1
2016	0	47	0	0	0	28	0	0	0	0	24
2017	0	209	0	0	83	100	0	0	0	0	23
2018	0	160	12	0	495	200	0	0	0	0	10

Table 15: Number of landings and number of ages sampled from the at-sea hake and shoreside hake fisheries.

	Number of hauls (at-sea) or landings (shoreside)		Number of ages	
Year	Domestic at-sea	Shoreside	Domestic at-sea	Shoreside
1991	0	8	0	8
1992	0	1	0	1
1993	0	2	0	2
1994	0	3	0	3
1995	0	20	0	20
1996	0	19	0	19
1997	0	25	0	25
1998	0	34	0	34
1999	0	49	0	49
2000	0	29	0	29
2001	0	1	0	1
2002	0	1	0	1
2003	0	0	0	0
2004	0	7	0	7
2005	0	0	0	0
2006	0	0	0	0
2007	0	1	0	1
2008	617	8	1,215	1,840
2009	377	20	643	1,040
2010	218	39	380	637
2011	467	22	510	999
2012	412	14	501	927
2013	455	10	509	974
2014	443	15	502	960
2015	474	7	628	309
2016	0	9	0	445
2017	0	43	0	761
2018	0	4	0	139

Table 16: Discard totals (mt) for four fleets derived from Pikitch data, EDCP data, and WCGOP data. Italics indicate years that were not fitted to because they were simply added to the landings (Shoreside hake) or omitted because they were outside of the main study period.

	Year	Source	Discards	CV
Bottom Trawl	*1981*	*Pikitch*	*900.19*	*54.26%*
	1982	*Pikitch*	*1450.74*	*44.12%*
	1983	*Pikitch*	*1847.15*	*43.91%*
	1984	*Pikitch*	*586.36*	*55.78%*
	1985	Pikitch	462.9	49.53%
	1986	Pikitch	534.8	53.11%
	1987	Pikitch	1035.5	42.57%
	1988	*Pikitch*	*1177.09*	*43.38%*
	1989	*Pikitch*	*1217.74*	*44.70%*
	1990	*Pikitch*	*1010.95*	*51.53%*
	1991	*Pikitch*	*1219.25*	*42.20%*
	1992	*Pikitch*	*1217.51*	*44.62%*
	1993	*Pikitch*	*1430.18*	*46.57%*
	1994	*Pikitch*	*1177.71*	*43.11%*
	1995	EDCP	924.8	83.18%
	1996	EDCP	3084.5	67.07%
	1997	EDCP	3353.3	75.06%
	1998	EDCP	42.6	48.80%
	1999	EDCP	4.8	68.78%
	2002	WCGOP	13.22	43.07%
	2003	WCGOP	1.21	81.96%
	2004	WCGOP	5.13	75.89%
	2005	WCGOP	10.17	44.61%
	2006	WCGOP	0.03	135.56%
	2007	WCGOP	13.86	61.57%
	2008	WCGOP	3.9	44.54%
	2009	WCGOP	26.57	33.77%
	2010	WCGOP	22.74	54.32%
	2011	WCGOP	0.08	5.00%
	2012	WCGOP	0.01	5.00%
	2013	WCGOP	2.43	5.00%
	2014	WCGOP	0.09	5.00%
	2015	WCGOP	0.03	5.00%
	2016	WCGOP	0.02	5.00%
	2017	WCGOP	0.26	5.00%

Table 17 continued

	Year	Source	Discards	CV
Midwater Trawl	*1981*	*Pikitch*	*6479.88*	*23.24%*
	1982	*Pikitch*	*5722.25*	*22.84%*
	1984	*Pikitch*	*1737.57*	*23.33%*
	1985	Pikitch	1502	24.09%
	1986	Pikitch	1321.2	23.64%
	1987	Pikitch	1798.4	26.20%
	1988	*Pikitch*	*1615.83*	*24.82%*
	1989	*Pikitch*	*1981.86*	*25.26%*
	1990	*Pikitch*	*1205.44*	*24.51%*
	1991	*Pikitch*	*565.94*	*24.33%*
	1992	*Pikitch*	*356.00*	*25.00%*
	1993	*Pikitch*	*569.86*	*25.34%*
	1994	*Pikitch*	*536.80*	*25.43%*
	1995	*Pikitch*	*663.24*	*23.81%*
	1996	*Pikitch*	*465.66*	*24.84%*
	1997	*Pikitch*	*663.14*	*24.10%*
	1998	*Pikitch*	*217.15*	*25.53%*
	1997	EDCP	1	83.26%
	1998	EDCP	18.7	80.00%
	2002	WCGOP	39.4	40.71%
	2012	WCGOP	0.01	5.00%
	2013	WCGOP	0.01	5.00%
	2014	WCGOP	0.01	5.00%
	2015	WCGOP	0.01	5.00%
	2016	WCGOP	0.01	5.00%
	2017	WCGOP	0.01	5.00%
Hook-and-line	2004	WCGOP	0.02	113.92%
	2005	WCGOP	0.21	60.59%
	2006	WCGOP	0.74	68.93%
	2007	WCGOP	0.61	106.22%
	2008	WCGOP	0.64	90.93%
	2010	WCGOP	0.29	75.64%
	2011	WCGOP	0.02	84.94%
	2012	WCGOP	0.04	106.28%
	2013	WCGOP	0.11	40.96%
	2014	WCGOP	0.01	16.87%
	2015	WCGOP	0.06	57.65%
	2016	WCGOP	0.19	15.96%
	2017	WCGOP	0.05	37.65%

Table 18: Number of observed vessels, trips, and hauls in the WCGOP with Widow Rockfish for the years 2002–2013 and four fleets: Bottom Trawl, Hook-and-line, Midwater Trawl, and Shoreside Hake. Italics indicate that those observations were not used. The letter "C" indicates that the data are confidential, due to less than 3 vessels observed, and were not used.

	Bottom Trawl			Hook-and-line		
Year	Vessels	Trips	Hauls	Vessels	Trips	Hauls
2002	41	68	173	*1*	*1*	*1*
2003 Ss	12	15	36	*1*	*1*	*1*
2004	27	34	82	5	7	7
2005	25	40	122	3	6	6
2006	18	32	163	4	8	8
2007	31	53	189	9	17	18
2008	33	54	243	6	6	6
2009	52	97	387	*2*	*2*	*2*
2010	37	58	297	5	5	6
2011	43	193	924	6	8	9
2012	45	238	1154	5	11	11
2013	44	235	1867	4	6	6
2014	64	1033	8322	148	514	1261
2015	60	904	7480	146	565	1295
2016	53	802	6623	136	490	1178
2017	54	839	6398	160	527	1280

	Midwater Trawl			Shoreside Hake		
Year	Vessels	Trips	Hauls	Vessels	Trips	Hauls
2002	8	8	18	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	*C*	*C*	*C*	26	673	1257
2012	4	8	23	24	680	1474
2013	4	10	28	25	861	1566
2014	9	34	133	25	996	1726
2015	10	172	437	0	0	0
2016	7	116	257	0	0	0
2017	13	275	522	0	0	0

Table 19: Estimated logistic maturity-at-age using data from Barss & Echeverria (1987) for data collected in California and Oregon. The estimated maturity-at-age using data from both states equally weighted is in the column called "All", and was used in the assessment model with maturity-at-age at ages 2 and lower set equal to zero. The logistic parameter estimates (as would be input into SS3) are shown at the top.

	CA	**OR**	**All**
$A_{50\%}$	4.25	6.68	5.47
Slope	-0.6647	-1.1173	-0.7747

Age	**CA**	**OR**	**All**
0	0.0560	0.0006	*0*
1	0.1034	0.0017	*0*
2	0.1830	0.0053	*0*
3	0.3034	0.0161	0.1283
4	0.4585	0.0476	0.2420
5	0.6220	0.1326	0.4093
6	0.7618	0.3184	0.6006
7	0.8615	0.5881	0.7654
8	0.9236	0.8136	0.8763
9	0.9592	0.9303	0.9389
10	0.9786	0.9761	0.9709
11	0.9889	0.9920	0.9864
12	0.9942	0.9974	0.9937
13	0.9970	0.9991	0.9971
14	0.9985	0.9997	0.9986
15	0.9992	0.9999	0.9994
16	0.9996	1.0000	0.9997
17	0.9998	1.0000	0.9999
18	0.9999	1.0000	0.9999
19	0.9999	1.0000	1.0000
20	1.0000	1.0000	1.0000

Table 20: Ageing error for two labs that was used in the assessment model.

True Age	Standard Deviation CAP	Standard Deviation SWFSC
0.5	0.145	0.111
1.5	0.145	0.111
2.5	0.187	0.147
3.5	0.233	0.187
4.5	0.283	0.233
5.5	0.338	0.284
6.5	0.398	0.341
7.5	0.463	0.406
8.5	0.534	0.478
9.5	0.612	0.560
10.5	0.697	0.651
11.5	0.790	0.755
12.5	0.892	0.871
13.5	1.003	1.001
14.5	1.124	1.148
15.5	1.256	1.313
16.5	1.401	1.499
17.5	1.558	1.708
18.5	1.731	1.943
19.5	1.919	2.207
20.5	2.124	2.504
21.5	2.349	2.839
22.5	2.594	3.215
23.5	2.861	3.638
24.5	3.154	4.113
25.5	3.473	4.649
26.5	3.821	5.250
27.5	4.202	5.927
28.5	4.618	6.689
29.5	5.072	7.545
30.5	5.568	8.508
31.5	6.109	9.592
32.5	6.700	10.810
33.5	7.346	12.181
34.5	8.052	13.723
35.5	8.822	15.456
36.5	9.663	17.407
37.5	10.582	19.600
38.5	11.585	22.067
39.5	12.680	24.842
40.5	13.877	27.964

Table 21: Specifications of the base assessment model for Widow Rockfish.

Starting year	1916
Population characteristics	
Maximum age	40
Genders	2
Population lengths	6-60 cm by 1 cm bins
Summary biomass (mt)	Age 4+
Data characteristics	
Data lengths	8-56 cm by 2 cm bins
Data ages	1-40
Minimum age for growth calcs	3
Maximum age for growth calcs	40
First mature age	3
Starting year of estimated recruitment	1900
Fishery characteristics	
Fishery timing	0.5
Triennial survey timing	0.55
NWFSC WCGBT survey timing	0.65
Fishing mortality method	Discrete
Maximum F	0.9
Catchability	Analytical estimate
Fishery Selectivity (not midwater trawl)	Asymptotic Double Normal
Midwater Trawl Fishery Selectivity	Dome-shaped Double Normal
Triennial Survey Selectivity	Double Normal
Triennial Survey Selectivity	Cubic spline with 3 nodes
NWFSC WCGBT Survey Selectivity	Cubic spline with 3 nodes
Fishery time blocks	
Bottom Trawl Selectivity	1916–2001, 2002-
Bottom Trawl Retention	1916–1981 and 2011 onward, 1982–1989, 1990–2010
Midwater Trawl Selectivity	1916–1982, 1983–2001, 2002–2010, 2011–
Midwater Trawl retention	1916–1982, 1983–2001, 2002–2010, 2011–
Hook-and-line Selectivity	1916–2002, 2003–
Hook-and-line Retention	1916–1982, 1983–

Table 22: Description of biological parameters in the base case assessment model. The lognormal (LN) prior distribution is specified with the median of the parameter and the standard deviation of the log of the parameter.

Parameter	Initial value	Number estimated	Bounds (low, high)	Prior distribution
Biological				
Females:				
Natural mortality (M) yr^{-1}	0.1	1	(0.01–0.30)	LN(0. 1, 0.438)
Length at age 3	27.5	1	(10-40)	
Length at age 40	50	1	(35-60)	
von Bertalanffy K	0.15	1	(0.01-0.40)	
ln(SD) of length at age 3	0.07	1	(0.01-0.40)	
ln(SD) of length at age 40	0.04	1	(0.01-0.40)	
Maturity-at-age inflection	5.47	0	—	
Maturity-at-age slope	-0.7747	0	—	
Fecundity intercept	1	0	—	
Fecundity slope	0	0	—	
Length-weight intercept	1.736E-5	0	—	
Length-weight slope	2.962	0	—	
Males:				
Natural mortality (M) yr^{-1}	0.1	1	(0.01-0.30)	LN(0.1, 0.438)
Length at age 3	26	1	(10-40)	
Length at age 40	44	1	(35–60)	
von Bertalanffy K	0.21	1	(0.01-0.40)	
ln(SD) of length at age 3	0.07	1	(0.01-0.40)	
ln(SD) of length at age 40	0.04	1	(0.01-0.40)	
Fecundity intercept	1	0	—	
Fecundity slope	0	0	—	
Length-weight intercept	1.484E-5	0	—	
Length-weight slope	3.005	0	—	

Table 23: Parameter estimates and approximate asymptotic standard deviations for the base case model.

Parameter	Estimate	SD	Estimate	SD
Stock and recruitment				
Ln(R0)	10.813	0.179952		
Surveys	*Catchability (q)*		*Extra SE*	
Bottom trawl	0.002336199		0.157603	0.059407
JV at-sea hake				
Domestic at-sea hake	1.42764E-05		0.366788	0.085535
Juvenile	0.358265839		0.83169	0.31116
Foreign at-sea hake	1.03399E-05		0.579698	0.152174
Triennial	0.113264442		0	
NWFSC WCGBT	0.042213298		0	

	Females			
Biological	**Estimate**	**SD**	**Estimate**	**SD**
Natural mortality (M)	0.144401	0.009525	0.154867	0.009607
Length at age 3	20.8325	0.420408	21.1828	0.377994
Length at age 40	50.3914	0.306445	44.1793	0.27788
Von Bertalanffy K	0.171903	0.006095	0.236074	0.009574
SD (log) at age 3	0.10617	0.008565	0.086163	0.006405
SD (log) at age 40	0.0440323	0.003257	0.054212	0.003183

Table 24: Parameter estimates and approximate asymptotic standard deviations for the base case model selectivity parameters.

Selectivity_Parameter	Value	StdDev	Fleet	Time Block
Size_DblN_peak_BottomTrawl	45.8061	3.33339	BottomTrawl	NA
Size_DblN_top_logit_BottomTrawl	2.49993	167.801	BottomTrawl	NA
Size_DblN_ascend_se_BottomTrawl	4.63698	0.439335	BottomTrawl	NA
Size_DblN_peak_MidwaterTrawl	37.4551	1.26401	MidwaterTrawl	NA
Size_DblN_top_logit_MidwaterTrawl	-9.30925	16.9076	MidwaterTrawl	NA
Size_DblN_ascend_se_MidwaterTrawl	2.90637	0.43419	MidwaterTrawl	NA
Size_DblN_descend_se_MidwaterTrawl	4.51658	3.45592	MidwaterTrawl	NA
Size_DblN_end_logit_MidwaterTrawl	-0.61429	4.78531	MidwaterTrawl	NA
Size_DblN_peak_Hake	43.2065	0.64911	Hake	NA
Size_DblN_top_logit_Hake	2.50295	167.65	Hake	NA
Size_DblN_ascend_se_Hake	3.72893	0.125286	Hake	NA
Size_DblN_peak_Net	42.7767	0.936115	Net	NA
Size_DblN_top_logit_Net	2.50691	167.756	Net	NA
Size_DblN_ascend_se_Net	3.58755	0.214835	Net	NA
Size_DblN_peak_HnL	17.5003	0.495536	Hook and Line	NA
Size_DblN_top_logit_HnL	-1.7446	63.6694	Hook and Line	NA
Size_DblN_ascend_se_HnL	-2.48616	16.2837	Hook and Line	NA
SizeSpline_GradLo_Triennial	0.124088	0.035877	Triennial	NA
SizeSpline_GradHi_Triennial	0.022316	0.097692	Triennial	NA
SizeSpline_Val_1_Triennial	-1.87994	0.313113	Triennial	NA
SizeSpline_Val_3_Triennial	0.449634	0.265326	Triennial	NA
SizeSpline_GradLo_NWFSC	0.493265	0.129427	NWFSC	NA
SizeSpline_GradHi_NWFSC	-0.0164	0.06455	NWFSC	NA
SizeSpline_Val_1_NWFSC	-2.75945	0.277515	NWFSC	NA
SizeSpline_Val_3_NWFSC	-0.0378	0.175617	NWFSC	NA
Size_DblN_peak_BottomTrawl_BLK4repl_1916	39.3021	0.801054	BottomTrawl	1916
Size_DblN_ascend_se_BottomTrawl_BLK4repl_1916	3.46297	0.238438	BottomTrawl	1916
Size_DblN_peak_MidwaterTrawl_BLK7repl_1916	38.7217	0.984183	MidwaterTrawl	1916
Size_DblN_peak_MidwaterTrawl_BLK7repl_1983	38.0921	0.452876	MidwaterTrawl	1983
Size_DblN_peak_MidwaterTrawl_BLK7repl_2002	37.5949	2.72387	MidwaterTrawl	2002
Size_DblN_ascend_se_MidwaterTrawl_BLK7repl_1916	3.35403	0.282452	MidwaterTrawl	1916
Size_DblN_ascend_se_MidwaterTrawl_BLK7repl_1983	3.07871	0.14112	MidwaterTrawl	1983
Size_DblN_ascend_se_MidwaterTrawl_BLK7repl_2002	2.83281	0.873079	MidwaterTrawl	2002
Size_DblN_descend_se_MidwaterTrawl_BLK7repl_1916	4.30674	0.982095	MidwaterTrawl	1916
Size_DblN_descend_se_MidwaterTrawl_BLK7repl_1983	3.15164	0.658332	MidwaterTrawl	1983
Size_DblN_descend_se_MidwaterTrawl_BLK7repl_2002	-1.63262	8.77051	MidwaterTrawl	2002
Size_DblN_end_logit_MidwaterTrawl_BLK7repl_1916	-2.32627	4.39999	MidwaterTrawl	1916
Size_DblN_end_logit_MidwaterTrawl_BLK7repl_1983	-0.45474	0.37774	MidwaterTrawl	1983
Size_DblN_end_logit_MidwaterTrawl_BLK7repl_2002	1.74863	2.69016	MidwaterTrawl	2002
Size_DblN_peak_HnL_BLK5repl_1916	37.9869	2.32195	Hook and Line	1916
Size_DblN_ascend_se_HnL_BLK5repl_1916	3.86062	0.532098	Hook and Line	1916

Table 25: Likelihood components and other quantities related to the minimization of the base case model.

Description	Values
Nparameters	207
Negative log-likelihoods	
Total	52921
Indices	-2.39259
Length-frequency data	51164.9
Age-frequency data	718.302
Discard biomass	1019.45
Recruitment	19.2447
Priors	0.365573
Parameter Softbound	1.11577

Table 26: Estimates of key derived parameters and reference points with approximate 95% asymptotic confidence intervals.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning Biomass (mt)	87,995	70,867–105,123
Unfished age 4+ biomass (mt)	171,336	137,799–204,873
Unfished recruitment (R0)	49,662	36,639-70,665
Spawning Biomass (2019)	80,910	49,484–112,335
Depletion (2019)	91.95	70.78–113.11
Reference points based on SB40%		
Spawning biomass (S$B_{40\%}$, mt)	35,198	28,347–42,049
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.458	0.458–0.458
Exploitation rate resulting in $B_{40\%}$	0.096	0.087–0.105
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	7,606	5,717–9,494
Reference points based on SPR proxy for MSY		
Spawning Biomass (S$B_{SPR50\%}$, mt)	39,259	31,618–46,901
$SPR_{50\%}$	0.5	NA
Exploitation rate corresponding to $SPR_{50\%}$	0.084	0.075–0.092
Yield with $SPR_{50\%}$ at $SB_{SPR50\%}$ (mt)	7,240	5,447–9,033
Reference points based on estimated MSY values		
Spawning biomass at MSY (SB_{MSY}, mt)	23,063	18,611–27,516
SPR_{MSY}	0.334	0.330–0.337
Exploitation rate corresponding to SPR_{MSY}	0.145	0.130–0.159
MSY (mt)	8,169	6,123–10,215

Table 27: Time series of population estimates from the base case model.

Year	Total biomass (mt)	Spawning Biomass (mt)	Age 4+ biomass (mt)	Spawning Depletion (%)	Age-0 recruits	Estimated Total Catch (mt)	1- SPR (%)	Relative exploitation rate (%)
1916	179,236	87,915	171,145	99.9	49,462	79.10383	0.009	0.05%
1917	179,130	87,861	171,041	99.8	49,435	123.0853	0.015	0.07%
1918	178,984	87,783	170,900	99.8	49,404	141.4904	0.017	0.08%
1919	178,827	87,699	170,747	99.7	49,369	97.68029	0.012	0.06%
1920	178,718	87,641	170,643	99.6	49,333	99.9733	0.012	0.06%
1921	178,610	87,585	170,539	99.5	49,293	82.89186	0.01	0.05%
1922	178,519	87,540	170,454	99.5	49,249	71.96217	0.009	0.04%
1923	178,437	87,502	170,379	99.4	49,201	79.03312	0.009	0.05%
1924	178,346	87,460	170,295	99.4	49,147	50.76957	0.006	0.03%
1925	178,277	87,432	170,234	99.4	49,089	62.86091	0.008	0.04%
1926	178,191	87,395	170,155	99.3	49,023	95.59938	0.011	0.06%
1927	178,065	87,338	170,039	99.3	48,950	79.3461	0.009	0.05%
1928	177,949	87,288	169,933	99.2	48,868	90.3059	0.011	0.05%
1929	177,813	87,229	169,809	99.1	48,778	87.6389	0.01	0.05%
1930	177,672	87,168	169,680	99.1	48,677	113.4986	0.014	0.07%
1931	177,494	87,089	169,517	99	48,566	100.9224	0.012	0.06%
1932	177,318	87,014	169,357	98.9	48,442	101.1041	0.012	0.06%
1933	177,128	86,934	169,185	98.8	48,305	86.7394	0.01	0.05%
1934	176,937	86,855	169,013	98.7	48,155	91.8408	0.011	0.05%
1935	176,722	86,767	168,819	98.6	47,987	99.1138	0.012	0.06%
1936	176,479	86,668	168,600	98.5	47,801	111.771	0.013	0.07%
1937	176,201	86,553	168,349	98.4	47,592	104.5683	0.013	0.06%
1938	175,905	86,432	168,082	98.2	47,359	84.6788	0.01	0.05%
1939	175,600	86,310	167,809	98.1	47,098	77.3549	0.009	0.05%
1940	175,267	86,180	167,513	97.9	46,806	121.8604	0.015	0.07%
1941	174,854	86,011	167,141	97.7	46,481	130.8298	0.016	0.08%
1942	174,393	85,822	166,725	97.5	46,121	148.1216	0.018	0.09%
1943	173,871	85,607	166,255	97.3	45,730	495.5872	0.058	0.30%
1944	172,974	85,184	165,414	96.8	45,312	970.3952	0.111	0.59%
1945	171,603	84,495	164,105	96	44,867	1637.749	0.183	1.00%
1946	169,611	83,451	162,180	94.8	44,396	1171.78	0.136	0.72%
1947	168,115	82,691	160,754	94	43,951	649.711	0.078	0.40%
1948	167,122	82,231	159,835	93.4	43,532	482.4863	0.059	0.30%
1949	166,251	81,854	159,038	93	43,143	378.1335	0.047	0.24%
1950	165,422	81,513	158,279	92.6	42,808	427.8915	0.053	0.27%
1951	164,483	81,115	157,405	92.2	42,565	559.5369	0.069	0.36%
1952	163,366	80,614	156,346	91.6	42,458	546.9509	0.068	0.35%
1953	162,232	80,092	155,256	91	42,554	474.0413	0.059	0.31%
1954	161,157	79,586	154,205	90.4	42,916	452.4552	0.057	0.29%
1955	160,116	79,073	153,160	89.9	43,604	469.6871	0.059	0.31%
1956	159,113	78,539	152,113	89.3	44,637	606.9513	0.077	0.40%
1957	158,087	77,935	150,997	88.6	45,909	768.416	0.097	0.51%
1958	157,089	77,271	149,857	87.8	47,085	708.7186	0.091	0.47%
1959	156,401	76,700	148,988	87.2	47,643	678.3644	0.088	0.46%
1960	156,032	76,235	148,436	86.6	47,254	819.0619	0.105	0.55%
1961	155,823	75,817	148,103	86.2	45,932	683.9296	0.089	0.46%
1962	155,998	75,627	148,273	85.9	45,180	765.2022	0.1	0.52%
1963	156,258	75,552	148,643	85.9	45,771	437.7883	0.058	0.29%
1964	156,904	75,796	149,430	86.1	47,398	607.3639	0.079	0.41%
1965	157,395	76,034	149,925	86.4	49,287	262.0814	0.035	0.17%
1966	158,251	76,490	150,604	86.9	51,456	4293.496	0.449	2.85%
1967	155,446	74,661	147,519	84.8	51,207	4830.628	0.501	3.27%
1968	152,634	72,689	144,445	82.6	48,147	2392.85	0.29	1.66%
1969	152,598	72,300	144,302	82.2	42,175	852.4246	0.114	0.59%
1970	154,657	72,951	146,133	82.9	158,009	854.859	0.114	0.58%

Year	Total biomass (mt)	Spawning Biomass (mt)	Age 4+ biomass (mt)	Spawning Depletion (%)	Age-0 recruits	Estimated Total Catch (mt)	1- SPR (%)	Relative exploitation rate (%)
1971	158,008	73,713	148,062	83.8	130,853	1095.576	0.142	0.74%
1972	163,318	74,392	149,361	84.5	18,345	923.9503	0.12	0.62%
1973	171,152	75,818	149,803	86.2	15,007	1160.718	0.147	0.77%
1974	179,937	78,118	166,543	88.8	19,832	907.5272	0.115	0.54%
1975	187,331	81,831	184,372	93	39,651	876.9492	0.107	0.48%
1976	191,034	86,737	187,907	98.6	13,575	1325.835	0.149	0.71%
1977	190,848	91,136	186,537	103.6	73,238	1094.665	0.113	0.59%
1978	188,693	93,795	182,544	106.6	109,898	1582.775	0.155	0.87%
1979	185,471	93,593	178,540	106.4	35,687	9480.009	0.686	5.31%
1980	175,389	87,636	162,400	99.6	61,236	22055.79	1.217	13.58%
1981	155,495	74,937	142,016	85.2	101,496	28136.04	1.466	19.81%
1982	133,027	60,313	124,691	68.5	54,190	27103.75	1.566	21.74%
1983	114,904	48,493	103,210	55.1	35,009	12269.96	1.255	11.89%
1984	113,950	46,209	100,990	52.5	68,162	12134.45	1.253	12.02%
1985	113,771	45,491	105,599	51.7	49,892	10890.61	1.177	10.31%
1986	114,177	45,786	106,643	52	24,218	11447.14	1.183	10.73%
1987	113,163	46,077	103,732	52.4	61,156	15398.84	1.321	14.84%
1988	107,482	44,253	100,407	50.3	37,801	12539.22	1.226	12.49%
1989	103,606	43,056	97,612	48.9	28,308	14995.69	1.338	15.36%
1990	96,535	40,222	88,331	45.7	44,840	14028.36	1.338	15.88%
1991	90,300	37,331	84,270	42.4	78,632	9172.991	1.154	10.89%
1992	88,726	36,516	82,383	41.5	29,883	8888.731	1.149	10.79%
1993	87,662	35,689	79,014	40.6	38,524	11683.99	1.302	14.79%
1994	84,319	33,545	74,726	38.1	35,349	9084.473	1.206	12.16%
1995	83,656	32,743	78,293	37.2	22,039	9450.842	1.247	12.07%
1996	81,984	32,105	76,238	36.5	16,204	8519.519	1.199	11.17%
1997	80,318	32,225	75,575	36.6	24,744	9062.783	1.217	11.99%
1998	77,022	31,931	73,562	36.3	42,271	6639.939	1.052	9.03%
1999	75,201	32,118	71,498	36.5	55,220	5983.032	0.977	8.37%
2000	73,757	31,986	68,225	36.3	46,043	4785.146	0.834	7.01%
2001	73,874	31,920	66,349	36.3	25,820	2321.161	0.504	3.50%
2002	77,065	32,772	69,157	37.2	23,040	484.4773	0.14	0.70%
2003	82,271	34,697	76,226	39.4	25,286	46.43892	0.014	0.06%
2004	87,546	37,273	83,259	42.4	73,953	99.17315	0.027	0.12%
2005	92,126	40,129	87,360	45.6	15,163	203.3644	0.052	0.23%
2006	96,327	42,798	89,901	48.6	58,529	220.5608	0.053	0.25%
2007	100,408	45,185	91,682	51.3	14,554	244.3833	0.055	0.27%
2008	104,952	47,064	99,800	53.5	153,674	272.1586	0.058	0.27%
2009	109,903	48,959	100,876	55.6	21,292	186.2058	0.038	0.18%
2010	116,416	50,864	106,867	57.8	101,007	178.8444	0.035	0.17%
2011	124,262	53,403	107,098	60.7	6,740	212.629	0.04	0.20%
2012	133,086	56,192	126,117	63.9	6,074	271.2665	0.049	0.22%
2013	141,550	60,047	130,681	68.2	240,825	472.7484	0.077	0.36%
2014	150,057	64,421	144,306	73.2	101,692	725.7676	0.108	0.50%
2015	159,367	68,547	145,255	77.9	34,200	884.7927	0.118	0.61%
2016	170,649	72,782	142,506	82.7	63,177	1045.38	0.13	0.73%
2017	183,575	76,824	171,160	87.3	40,750	6395.405	0.607	3.74%
2018	189,911	79,032	182,799	89.8	37,521	10588.14	0.855	5.79%
2019	189,576	80,910	180,855	91.9	49,257	NA	NA	NA

Table 28: Time series of log-normal recruitment deviation estimates from the base case model.

Year	Recruitment deviate	St. Dev	Year	Recruitment deviate	St. Dev
1916	-0.00424	0.59879	1968	0.06550	0.50385
1917	-0.00472	0.59865	1969	-0.05675	0.52967
1918	-0.00527	0.59850	1970	1.27260	0.28892
1919	-0.00587	0.59833	1971	1.09240	0.26798
1920	-0.00654	0.59814	1972	-0.86378	0.40988
1921	-0.00730	0.59792	1973	-1.05723	0.36102
1922	-0.00813	0.59769	1974	-0.77213	0.32086
1923	-0.00907	0.59742	1975	-0.07467	0.20280
1924	-0.01011	0.59713	1976	-1.14289	0.32706
1925	-0.01127	0.59680	1977	0.53783	0.14358
1926	-0.01256	0.59644	1978	0.94100	0.12176
1927	-0.01400	0.59603	1979	-0.18358	0.20504
1928	-0.01561	0.59558	1980	0.36260	0.15977
1929	-0.01740	0.59508	1981	0.88429	0.12829
1930	-0.01939	0.59452	1982	0.28363	0.17532
1931	-0.02160	0.59391	1983	-0.12071	0.20875
1932	-0.02406	0.59322	1984	0.55362	0.13498
1933	-0.02680	0.59245	1985	0.24428	0.15670
1934	-0.02983	0.59161	1986	-0.47961	0.26864
1935	-0.03322	0.59066	1987	0.44565	0.15934
1936	-0.03700	0.58961	1988	-0.02842	0.22348
1937	-0.04123	0.58844	1989	-0.31273	0.26437
1938	-0.04601	0.58713	1990	0.15986	0.20219
1939	-0.05141	0.58565	1991	0.73620	0.13484
1940	-0.05746	0.58400	1992	-0.22679	0.23247
1941	-0.06423	0.58216	1993	0.03195	0.20149
1942	-0.07180	0.58013	1994	-0.04074	0.21842
1943	-0.08006	0.57794	1995	-0.50779	0.28754
1944	-0.08874	0.57566	1996	-0.81092	0.34603
1945	-0.09781	0.57329	1997	-0.38844	0.30425
1946	-0.10710	0.57089	1998	0.14918	0.23115
1947	-0.11624	0.56855	1999	0.41508	0.19059
1948	-0.12523	0.56625	2000	0.23427	0.20099
1949	-0.13375	0.56406	2001	-0.34368	0.25410
1950	-0.14110	0.56213	2002	-0.46358	0.25260
1951	-0.14627	0.56065	2003	-0.38308	0.26414
1952	-0.14814	0.55984	2004	0.67515	0.13720
1953	-0.14521	0.55995	2005	-0.92396	0.34649
1954	-0.13606	0.56123	2006	0.41474	0.15851
1955	-0.11946	0.56384	2007	-0.98655	0.37015
1956	-0.09533	0.56768	2008	1.36348	0.12171
1957	-0.06639	0.57209	2009	-0.61952	0.30545
1958	-0.04016	0.57542	2010	0.93123	0.15365
1959	-0.02757	0.57544	2011	-1.78344	0.32698
1960	-0.03511	0.57085	2012	-1.89500	0.30531
1961	-0.05331	0.56377	2013	1.77580	0.18239
1962	-0.05997	0.55768	2014	0.90438	0.33758
1963	-0.03730	0.55516	2015	-0.24410	0.40979
1964	0.00682	0.55561	2016	0.31153	0.53596
1965	0.05512	0.55465	2017	-0.18403	0.56352
1966	0.10710	0.54703	2018	-0.26965	0.56768
1967	0.11451	0.53090			

Table 29: Quantities of interest from the sensitivity analyses. ‘RSB2018’ refers to depletion in 2018 (SB_{2015}/SB_0).

	Base model	h = 0.4	h = 0.6	h = 0.798	M = 0.1 both sexes	M = 0.124 (f) & 0.129 (m)	Asymptotic selectivity midwater trawl	Francis weighting	Dirichlet weighting	Logistic survey selectivity	No triennial survey data
M (females)	0.1444	0.1464	0.1453	0.1442	0.1	0.124	0.17	0.1474	0.1225	0.1404	0.1462
Lmin (females)	20.8325	20.7418	20.8326	20.8325	20.8358	20.8606	21.3384	21.0087	19.5602	20.601	20.7204
Lmax (females)	50.3914	50.2968	50.3899	50.3924	50.0228	50.2541	50.616	50.3838	49.9561	50.2968	50.3353
k (females)	0.1719	0.1739	0.1719	0.1719	0.179	0.1746	0.1637	0.1651	0.1881	0.1753	0.1731
CV young (females)	0.1062	0.1074	0.1062	0.1062	0.1055	0.1056	0.0986	0.1137	0.1307	0.1104	0.1076
CV old (females)	0.044	0.0439	0.044	0.044	0.0451	0.0446	0.0464	0.0398	0.0472	0.0434	0.0438
M (males)	0.1549	0.157	0.1557	0.1547	0.1	0.129	0.1769	0.1596	0.1328	0.1519	0.1575
Lmin (males)	21.1828	21.0996	21.1831	21.1829	21.1415	21.2093	21.1622	20.6039	20.7741	21.2138	21.2028
Lmax (males)	44.1793	44.1698	44.1807	44.1788	43.9065	44.0761	43.6889	44.1832	43.748	44.3783	44.2106
k (males)	0.2361	0.2375	0.236	0.2361	0.242	0.2367	0.2443	0.2438	0.2545	0.2322	0.2343
CV young (males)	0.0862	0.087	0.0862	0.0861	0.0842	0.0852	0.0845	0.0988	0.0903	0.0874	0.0859
CV old (males)	0.0542	0.054	0.0542	0.0542	0.0562	0.0552	0.0553	0.0471	0.0577	0.0531	0.0546
lnR0	10.8133	10.9313	10.8478	10.8006	9.9582	10.4399	11.1798	10.9367	10.1238	10.7521	10.8794
SB2018	79032	50465.2	72989.1	81891.6	38822.7	63495.1	90072.1	87240.5	36201.3	74445.4	85079.9
SB0	87995	96119.5	89900	87165.3	77576	83160.9	87887	93539.7	62270.8	87991.7	91437
RSB2018	89.81%	52.50%	81.19%	93.95%	50.04%	76.35%	102.49%	93.27%	0.5814	84.60%	93.05%
Yield SPR50	7239.78	3602.19	6676	7480.99	4635.24	5986.62	8735.98	7968.37	4375.51	7003.31	7597.34
Likelihood				Difference from base model							
Total	52921	11.7	0.4	0	43.5	5.7	33.2	-718.1	5140.4	10.6	-94.5
Survey	-2.39259	1.04055	0.08957	-0.02296	3.69196	0.79486	0.89152	0.84821	3.58795	0.18941	-1.35432
Discard	51164.9	1.1	0.1	0	1.5	0.2	-4.2	-2	36.4	2.4	0.2
Length	718.302	4.995	-0.16	0.074	11.626	-1.738	7.508	-516.912	2289.058	10.721	-92.087
Age	1019.45	3.32	0.18	-0.09	16.5	9214.05	28.19	-208.647	2794.28	-2.65	-0.51
Recruitment	19.2447	-0.183	-0.18	0.1103	11.2277	3.1728	-0.1261	-3.9162	17.5695	0.0271	-0.4561

Table 30: Results from retrospective runs, sequentially removing data over the last five years using the base case assumptions.

Retrospective	Base	Retro-1	Retro-2	Retro-3	Retro-4	Retro-5	Retro-6	Retro-7	Retro-8
M (females)	0.14	0.14	0.15	0.15	0.14	0.15	0.15	0.15	0.14
Lmin (females)	20.83	20.17	20.48	19.80	18.71	16.21	15.49	15.35	15.39
Lmax (females)	50.39	50.40	50.68	50.61	50.23	49.96	50.00	49.91	49.80
k (females)	0.17	0.18	0.17	0.18	0.19	0.20	0.21	0.21	0.21
CV young (females)	0.11	0.12	0.11	0.12	0.14	0.20	0.20	0.20	0.19
CV old (females)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
M (males)	0.15	0.15	0.16	0.16	0.15	0.17	0.17	0.16	0.16
Lmin (males)	21.18	20.56	20.95	20.82	20.28	19.23	20.01	20.05	19.10
Lmax (males)	44.18	44.37	44.50	44.56	44.64	44.57	44.79	44.78	44.29
k (males)	0.24	0.24	0.24	0.24	0.24	0.25	0.24	0.24	0.27
CV young (males)	0.09	0.09	0.09	0.09	0.10	0.11	0.09	0.09	0.07
CV old (males)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
lnR0	10.81	10.64	10.86	10.81	10.76	10.88	10.86	10.77	10.81
SB0	79,032	71,122	72,812	75,937	83,690	76,574	62,354	51,767	55,266
SB Final Year	87,995	82,580	84,570	84,058	85,689	84,427	83,670	82,515	88,091
Depletion Final Year (%)	89.81%	86.13%	86.10%	90.34%	97.67%	90.70%	74.52%	62.74%	62.74%
Yield SPR50	7,240	6,448	7,323	7,220	7,041	7,459	7,294	7,041	6,666

Table 31: Quantities of interest when profiling over R_0.

log(R0)	10	10.364	10.727	11.091	11.455	11.818	12.182	12.545	12.909	13.273	13.636	14
M (females)	0.12	0.14	0.16	0.17	0.19	0.20	0.21	0.21	0.22	0.23	0.23	0.12
Lmin (females)	20.38	20.83	20.85	20.87	20.90	20.93	21.01	21.02	21.05	21.10	21.14	20.38
Lmax (females)	50.11	50.37	50.46	50.53	50.58	50.60	50.63	50.62	50.62	50.64	50.65	50.11
k (females)	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.18
CV young (females)	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.12
CV old (females)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
M (males)	0.13	0.15	0.17	0.18	0.20	0.21	0.22	0.22	0.23	0.24	0.24	0.13
Lmin (males)	21.04	21.18	21.19	21.19	21.19	21.19	21.22	21.22	21.21	21.21	21.21	21.04
Lmax (males)	44.24	44.18	44.17	44.15	44.13	44.11	44.11	44.10	44.08	44.05	44.02	44.24
k (males)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
CV young (males)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
CV old (males)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
lnR0	10.36	10.73	11.09	11.46	11.82	12.18	12.55	12.91	13.27	13.64	14.00	10.36
SB2018	50,569	73,680	97,228	123,915	155,845	197,403	254,664	336,540	447,914	598,674	807,121	50,569
SB0	77,327	85,468	97,264	113,055	135,225	167,845	215,186	286,320	382,825	512,833	692,259	77,327
RSB2018	0.65	0.86	1.00	1.10	1.15	1.18	1.18	1.18	1.17	1.17	1.17	0.65
Likelihood						**difference from base model likelihood**						
Total	51.70	0.20	1.10	5.30	11.20	17.60	23.40	28.20	32.20	36.40	41.00	51.70
Survey	2.63	0.10	0.11	1.14	2.86	4.75	6.35	7.72	8.84	10.29	12.23	2.63
Discard	34.60	0.30	-0.60	-1.10	-1.30	-1.40	-0.70	-0.70	-0.90	-1.20	-1.70	34.60
Length	12.32	-0.14	0.47	1.03	1.44	1.78	1.76	2.06	2.49	3.25	4.29	12.32
Age	1.92	-0.47	1.72	4.37	7.21	9.83	12.08	13.81	15.39	16.86	18.23	1.92
Recruitment	1.15	0.54	-1.09	-1.37	-0.77	0.29	1.22	2.29	3.09	3.68	4.14	1.15
Forecast Rec	-0.23	0.00	0.00	0.01	0.03	0.06	0.06	0.08	0.11	0.13	0.15	-0.23
Parameter Priors	-0.65	-0.15	0.52	1.18	1.75	2.24	2.65	2.94	3.19	3.43	3.65	-0.65

Table 32: Quantities of interest when profiling over steepness values

Steepness (h)	0.3	0.355	0.409	0.464	0.518	0.573	0.627	0.682	0.736	0.791	0.845	0.9
M (females)	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14
Lmin (females)	20.84	20.84	20.83	20.83	20.83	20.83	20.83	20.83	20.83	20.83	20.83	20.83
Lmax (females)	50.40	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39
k (females)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
CV young (females)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
CV old (females)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
M (males)	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15
Lmin (males)	21.19	21.19	21.19	21.18	21.18	21.18	21.18	21.18	21.18	21.18	21.18	21.18
Lmax (males)	44.20	44.19	44.19	44.18	44.18	44.18	44.18	44.18	44.18	44.18	44.18	44.18
k (males)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
CV young (males)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
CV old (males)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
lnR0	11.25	11.09	11.00	10.93	10.89	10.86	10.84	10.82	10.81	10.80	10.80	10.79
SB0	42,384	49,734	56,437	62,339	67,181	71,257	74,565	77,369	79,675	81,661	83,323	84,779
SB2015	108,043	100,995	96,764	93,924	91,963	90,488	89,381	88,498	87,805	87,231	86,766	86,371
Depl2015	0.39	0.49	0.58	0.66	0.73	0.79	0.83	0.87	0.91	0.94	0.96	0.98
Yield SPR50	-	1,675	4,052	5,287	6,008	6,493	6,833	7,094	7,295	7,462	7,598	7,717
Likelihood					**difference from minimum likelihood at h=0.720**							
Total	5.60	3.40	2.20	1.40	0.90	0.50	0.30	0.10	0.00	0.00	0.00	0.20
Survey	1.66	1.03	0.64	0.39	0.23	0.13	0.06	0.02	-0.01	-0.02	-0.03	-0.03
Discard	0.50	0.50	0.40	0.30	0.20	0.20	0.10	0.10	0.00	0.00	0.00	0.00
Length	-0.75	-0.67	-0.56	-0.43	-0.31	-0.21	-0.12	-0.04	0.02	0.07	0.11	0.15
Age	0.89	0.68	0.55	0.43	0.33	0.22	0.13	0.05	-0.02	-0.09	-0.14	-0.19
Recruitment	0.09	-0.24	-0.34	-0.34	-0.29	-0.22	-0.14	-0.06	0.02	0.10	0.17	0.24
Forecast Rec	0.11	0.10	0.08	0.06	0.04	0.03	0.02	0.01	0.00	-0.01	-0.01	-0.02
Parameter Priors	3.09	2.08	1.45	0.99	0.65	0.40	0.21	0.07	-0.02	-0.06	-0.04	0.08

Table 33: Quantities of interest when profiling over natural mortality values

Natural mortality (M)	0.08	0.091	0.102	0.113	0.124	0.135	0.145	0.156	0.167	0.178	0.189	0.2
M (females)	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.20
Lmin (females)	20.85	20.84	20.85	20.87	20.89	20.91	20.93	20.96	20.98	21.01	21.09	21.13
Lmax (females)	49.91	50.02	50.11	50.18	50.25	50.32	50.38	50.45	50.51	50.57	50.66	50.72
k (females)	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17
CV young (females)	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10
CV old (females)	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
M (males)	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.20
Lmin (males)	21.19	21.20	21.21	21.22	21.23	21.24	21.24	21.25	21.25	21.25	21.27	21.28
Lmax (males)	43.93	43.95	43.96	43.96	43.96	43.96	43.96	43.95	43.95	43.94	43.93	43.93
k (males)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.23	0.23
CV young (males)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09
CV old (males)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
lnR0	9.63	9.82	10.02	10.21	10.40	10.58	10.74	10.91	11.09	11.27	11.46	11.65
SB0	24,262	33,024	42,625	52,091	60,754	68,354	74,401	80,342	85,870	91,344	97,642	104,442
SB2015	82,383	80,175	79,514	79,563	79,944	80,558	81,375	82,690	84,618	87,374	91,196	96,458
Depl2015	0.29	0.41	0.54	0.65	0.76	0.85	0.91	0.97	1.01	1.05	1.07	1.08
Yield SPR50	3,982	4,375	4,840	5,350	5,893	6,467	7,026	7,701	8,465	9,357	10,430	11,746
Likelihood						**difference from minimum likelihood**						
Total	45.30	32.70	23.80	17.30	12.80	10.10	8.90	8.80	9.80	11.90	14.80	18.50
Survey	5.62	4.48	3.22	2.04	1.09	0.44	0.11	0.00	0.14	0.49	0.98	1.69
Discard	2.90	1.90	1.10	0.30	-0.40	-1.00	-1.60	-2.20	-2.70	-3.10	-2.90	-3.10
Length	1.40	0.48	-0.22	-0.72	-1.11	-1.42	-1.64	-1.81	-1.92	-1.96	-2.25	-2.21
Age	12.90	10.93	10.16	9.94	10.11	10.63	11.40	12.57	14.05	15.81	17.81	20.02
Recruitment	23.24	15.94	10.58	6.70	3.92	1.99	0.80	0.00	-0.38	-0.40	-0.36	0.10
Forecast Rec	0.05	0.02	0.01	0.00	-0.01	-0.01	-0.01	0.00	0.01	0.03	0.03	0.05
Parameter Priors	-0.74	-1.00	-1.06	-0.97	-0.77	-0.49	-0.18	0.20	0.61	1.05	1.51	1.97

Table 34: Estimated Dirichlet-multinomial parameters and the corresponding data weights derived using the McAllister-Ianelli and Francis methods. The Dirichlet-multinomial ln(EffN_mult) parameter was bounded between -7 and 7.

Fleet	Composition data type	ln(EffN_mult)	Theta/(1+Theta)	McAllister-Ianelli weighting	Francis weighting
Bottom Trawl	Length	1.33702	0.7919995	0.035	0.053614
Midwater Trawl	Length	0.546577	0.6333411	0.13	0.039485
Hake	Length	-0.297882	0.4260753	0.06	0.026282
Net	Length	6.88681	0.9989799	0.23	0.116726
Hook and Line	Length	5.54885	0.9961232	0.2	0.007122
Triennial	Length	0.926885	0.7164429	0.38	0.087836
NWFSC	Length	7	0.9990889	0.73	0.098688
Bottom Trawl	Age	3.69165	0.9756756	0.08	0.186184
Midwater Trawl	Age	7	0.9990889	0.16	0.13557
Hake	Age	3.48578	0.9702804	0.11	0.225704
Net	Age	7	0.9990889	0.23	0.159333
Juvenile Survey	Age	7	0.9990889	0.31	0.426377
NWFSC	Age	7	0.9990889	0.33	0.161881

Table 35: Projection of potential OFL, landings, and catch, summary biomass (age-4 and older), spawning biomass, and depletion for the base case model projected with total catch equal to the predicted ABC. The predicted OFL is the calculated total catch determined by $F_{SPR=50\%}$.

Year	Predicted OFL (mt)	Projected ABC/ Catch (mt)	Age 4+ Biomass (mt)	Spawning Biomass (mt)	Depletion (%)	Assumed dead removals
2019	12,375*	10,868	180,855	80,910	92%	10,868
2020	11,714*	10,868	179,750	83,054	94%	10,868
2021	15,749	14,725	173,890	83,673	95%	14,725
2022	14,826	13,788	161,799	80,275	91%	13,788
2023	13,633	12,625	151,136	75,720	86%	12,625
2024	12,453	11,481	141,680	70,914	81%	11,481
2025	11,487	10,533	133,763	66,509	76%	10,533
2026	10,769	9,832	127,304	62,790	71%	9,832
2027	10,240	9,308	122,045	59,739	68%	9,308
2028	9,842	8,897	117,739	57,242	65%	8,897
2029	9,534	8,580	114,196	55,185	63%	8,580
2030	9,288	8,322	111,249	53,473	61%	8,322

* Value determined prior to the 2019 assessment as part of the harvest specifications

Table 36: Summary table of 12-year projections beginning in 2021 for alternate states of nature based on the axis of uncertainty (a combination of *M*, *h*, and 2013 recruitment strength). Columns range over low, mid, and high state of nature, and rows range over different assumptions of total catch levels (discards + retained). Catches in 2019 and 2020 are allocated using the percentage of landings for each fleet in 2018.

				State of nature					
				Low		Base case		High	
Relative probability of ln(SB_2013)				0.25		0.5		0.25	
Management decision	Year	OFL	Catch (mt)	Spawning biomass (mt)	Depletion (%)	Spawning biomass (mt)	Depletion (%)	Spawning biomass (mt)	Depletion (%)
9,000 K	2021	15,749	9,000	60,785	66%	83,673	95%	95,098	107%
	2022	15,378	9,000	60,237	66%	83,145	94%	94,188	106%
	2023	14,608	9,000	58,583	64%	80,975	92%	91,415	103%
	2024	13,686	9,000	56,291	61%	77,825	88%	87,555	99%
	2025	12,828	9,000	53,815	59%	74,318	84%	83,321	94%
	2026	12,106	9,000	51,443	56%	70,866	81%	79,179	89%
	2027	11,505	9,000	49,264	54%	67,638	77%	75,325	85%
	2028	10,995	9,000	47,262	51%	64,664	73%	71,805	81%
	2029	10,553	9,000	45,397	49%	61,935	70%	68,615	77%
	2030	10,164	9,000	43,636	48%	59,432	68%	65,737	74%
ACLp* = 0.45 sigma = 0.50	2021	15,749	14,725	60,785	66%	83,673	95%	95,098	107%
	2022	14,826	13,788	57,355	62%	80,275	91%	91,324	103%
	2023	13,633	12,625	53,270	58%	75,720	86%	86,203	97%
	2024	12,453	11,481	49,250	54%	70,914	81%	80,742	91%
	2025	11,487	10,533	45,784	50%	66,509	76%	75,676	85%
	2026	10,769	9,832	43,043	47%	62,790	71%	71,336	81%
	2027	10,240	9,308	40,927	45%	59,739	68%	67,731	76%
	2028	9,842	8,897	39,262	43%	57,242	65%	64,757	73%
	2029	9,534	8,580	37,905	41%	55,185	63%	62,310	70%
	2030	9,288	8,322	36,744	40%	53,473	61%	60,294	68%
ACLp* = 0.25 sigma = 0.50	2021	15,749	10,961	60,785	66%	83,673	95%	95,098	107%
	2022	15,188	10,313	59,254	65%	82,166	93%	93,211	105%
	2023	14,304	9,470	56,935	62%	79,347	90%	89,801	101%
	2024	13,364	8,620	54,445	59%	76,020	86%	85,781	97%
	2025	12,575	7,910	52,246	57%	72,813	83%	81,863	92%
	2026	11,984	7,346	50,530	55%	70,035	80%	78,406	88%
	2027	11,553	6,908	49,278	54%	67,743	77%	75,492	85%
	2028	11,235	6,550	48,381	53%	65,875	75%	73,073	82%
	2029	10,998	6,247	47,742	52%	64,362	73%	71,084	80%
	2030	10,819	5,994	47,288	52%	63,143	72%	69,463	78%

14 Figures

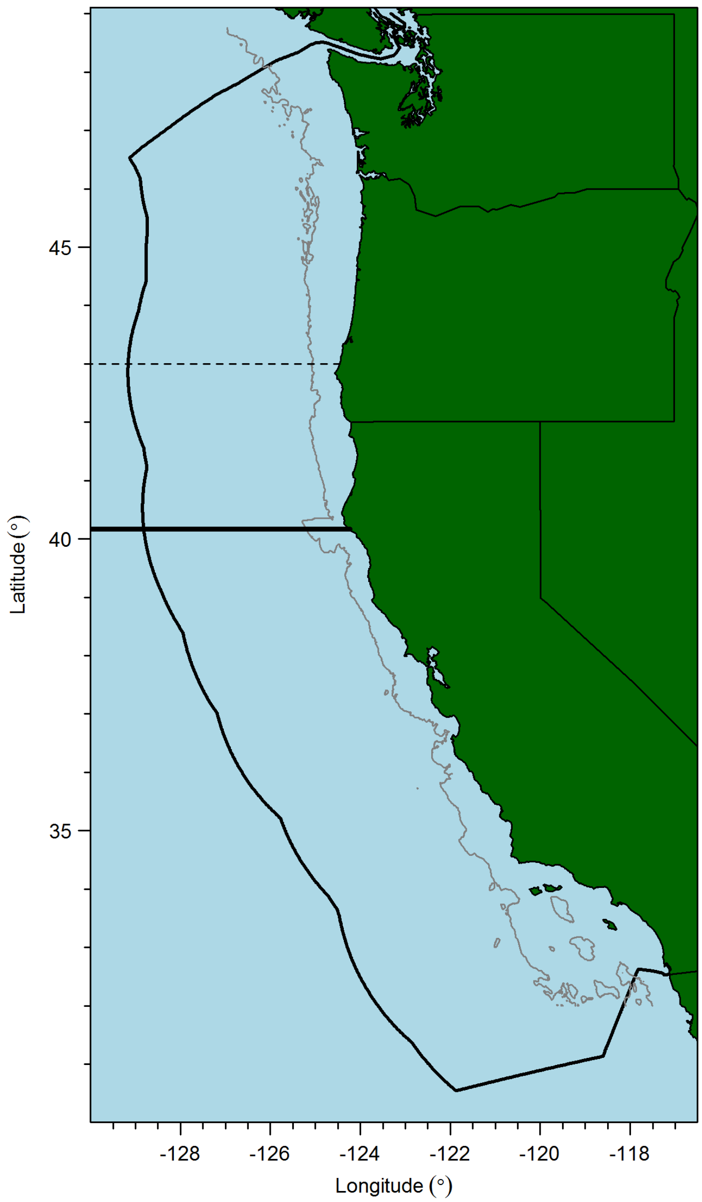


Figure 1: A map of the west coast of the U.S. with the EEZ and the 40° 10' line that divides management into northern and southern regions for some species (although not Widow Rockfish). The line at latitude 43° N latitude is where past assessment models have been stratified into two areas.

Figure 2: Observations of two cohorts (2008, top and 2010, bottom) from the NWFSC WCGBT survey data. Darker circles indicate more observations (possibly within the same tow).

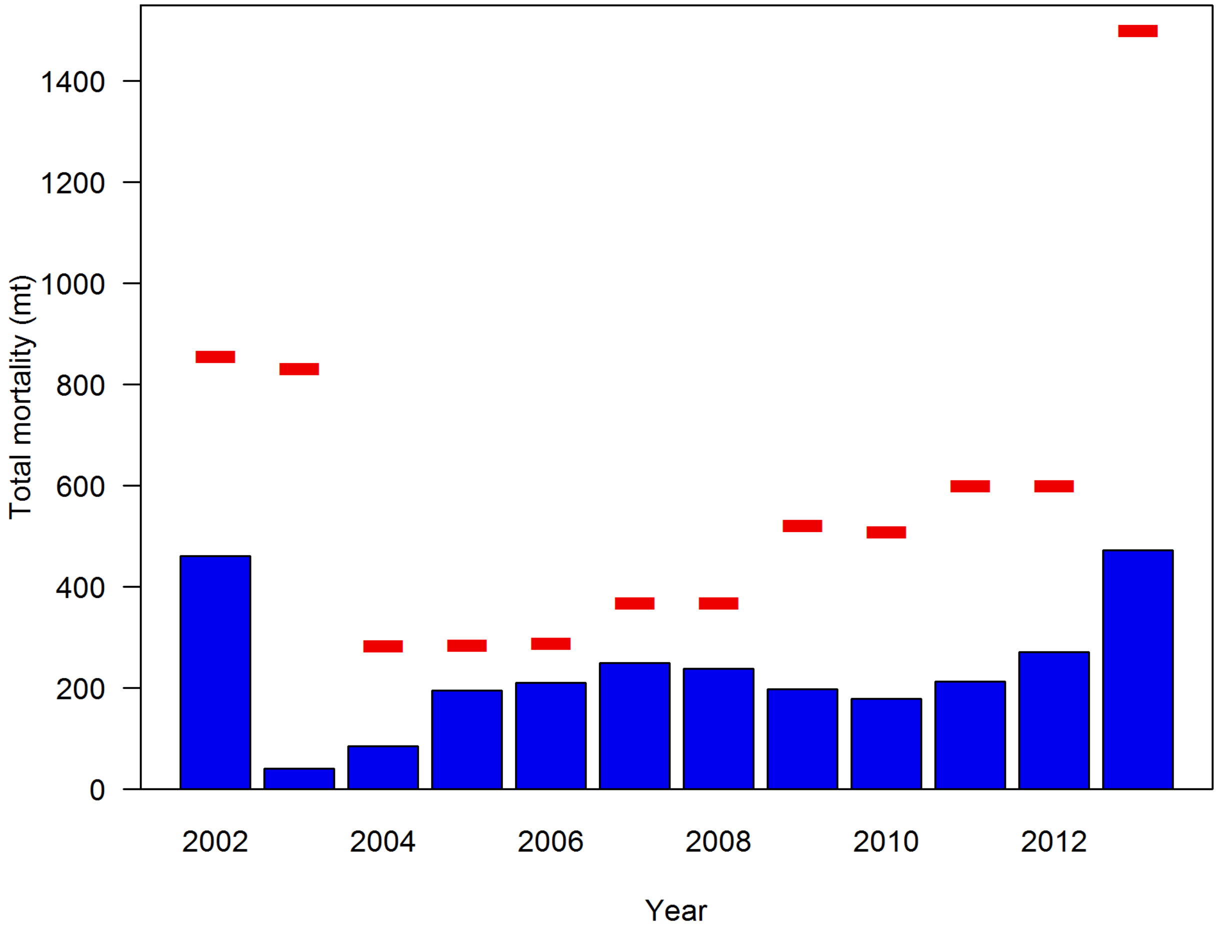


Figure 3: Total removals as estimated in the groundfish mortality report (pers. comm., Kayleigh Somers, WCGOP, NWFSC) for 2002 to 2013. The horizontal red lines represent the Widow Rockfish specific ACL for each year.

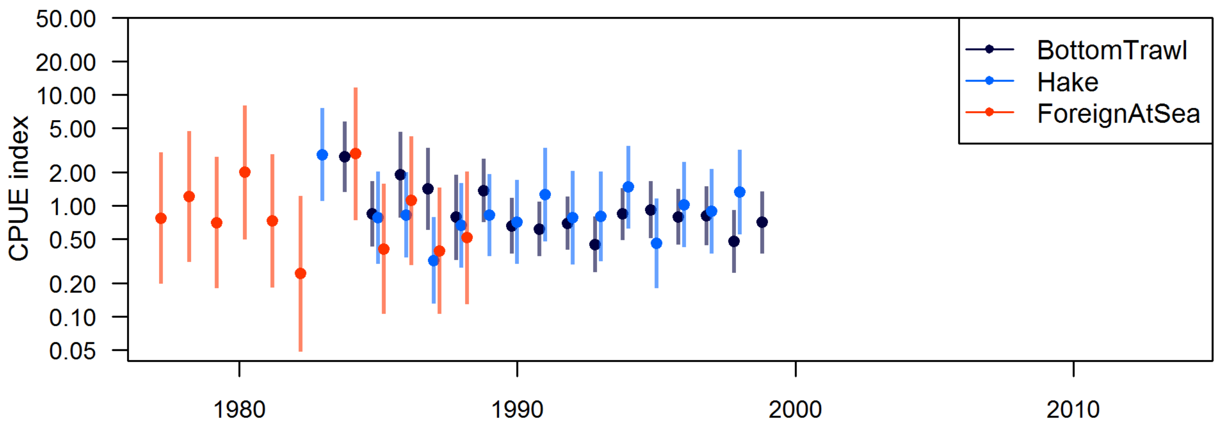


Figure 4: Fishery-dependent indices of abundance from the 2011 assessment scaled to the mean of their own series.

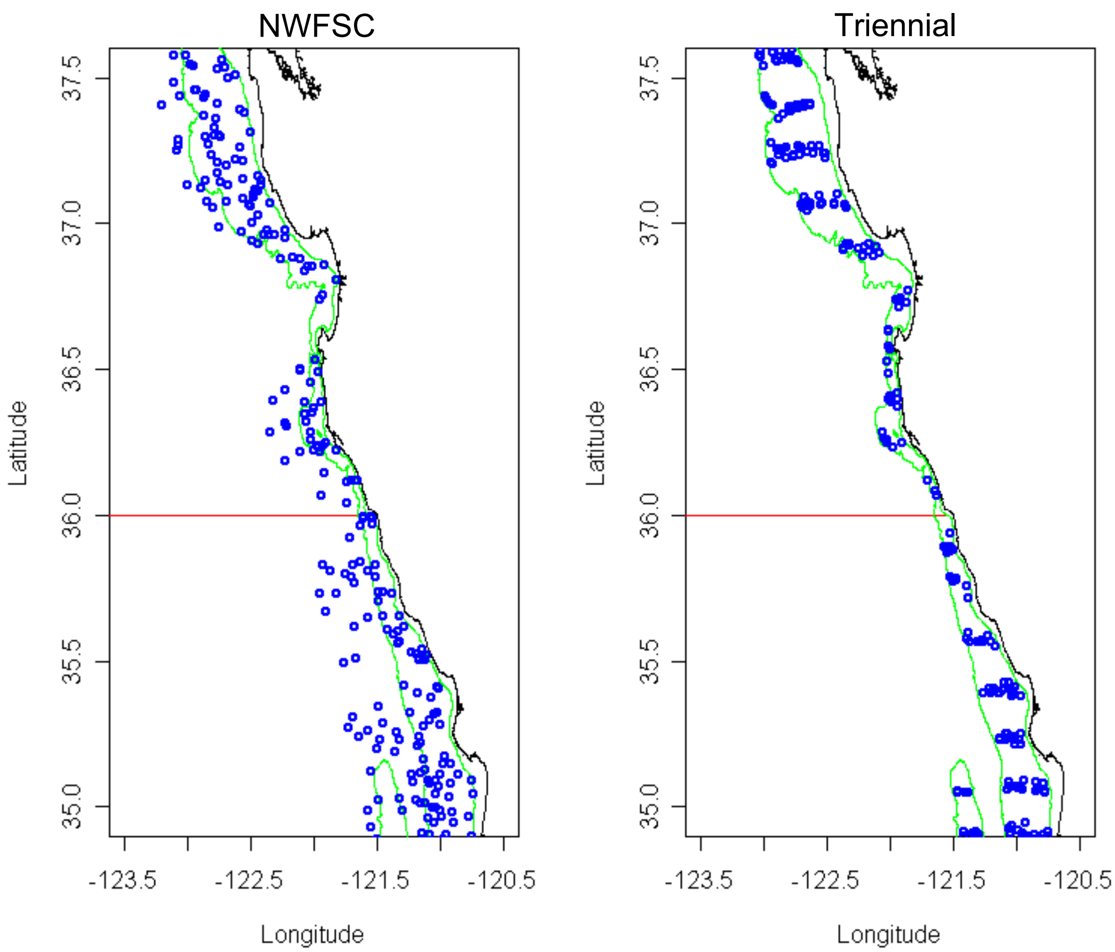


Figure 5: Survey tow locations in 2004, showing the difference in station design for the NWFSC WCBTS survey relative to the Triennial trawl survey (Figure from Stewart (2007)).

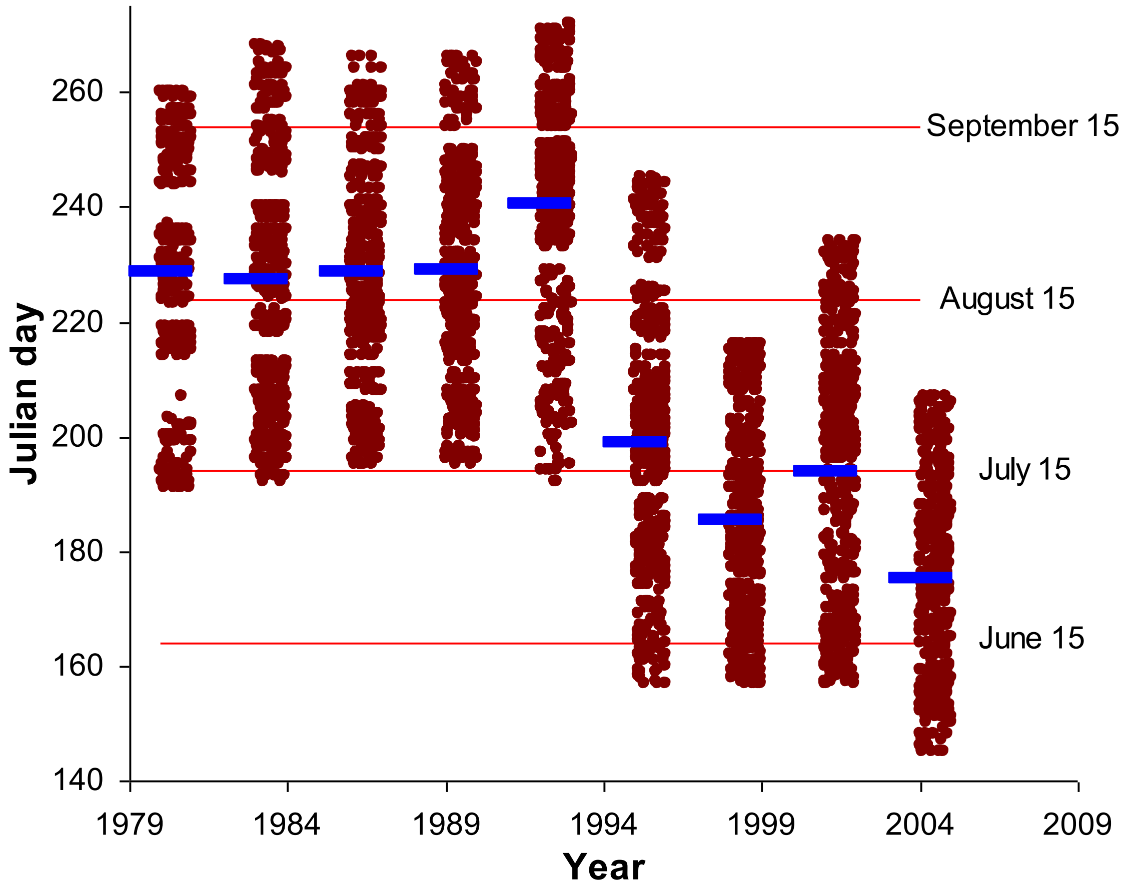


Figure 6: Distribution of dates of operation for the triennial survey (1980-2004). Solid bars show the mean date for each survey year, points represent individual hauls dates, but are jittered to allow better delineation of the distribution of individual points (Figure from (Stewart 2007)).

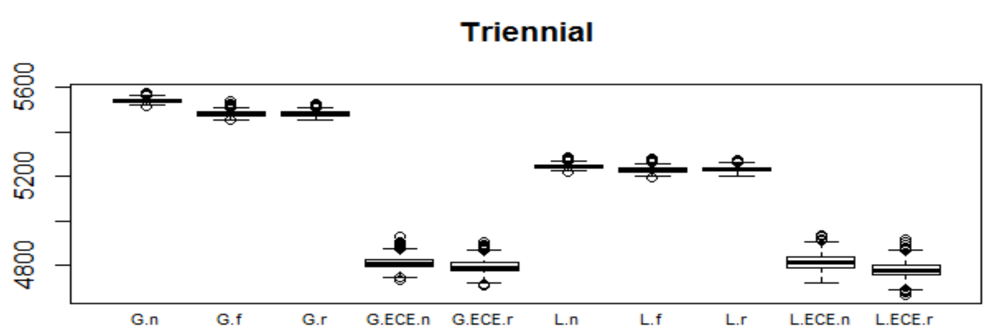


Figure 7: Deviance from six assumptions in the GLMM model for the five surveys. "G" refers to the gamma distribution and "L" refers to the lognormal distribution. No stratum effects, and random stratum effects are notated with "n" and "r", respectively.

Triennial survey \

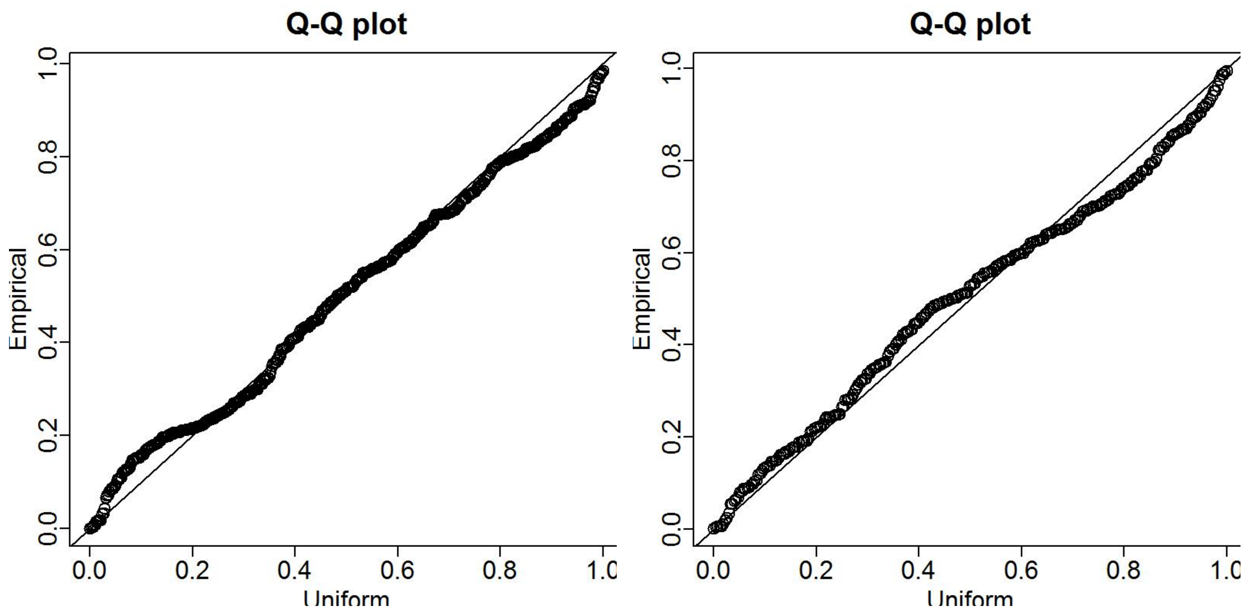


Figure 8: Q-Q plots for models with an extreme catch event (ECE) mixture distribution for the Triennial survey.

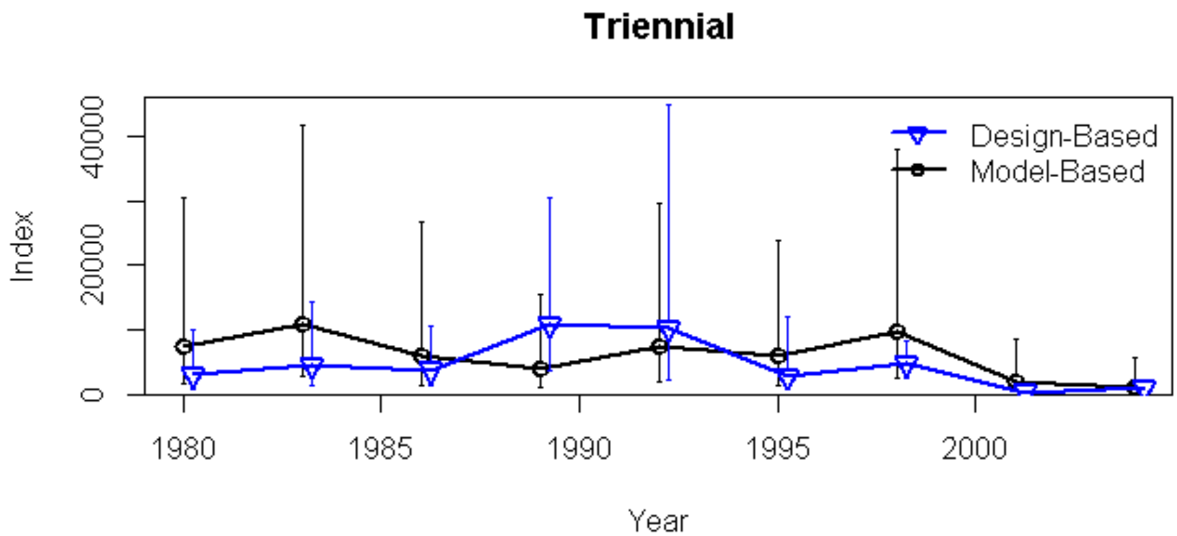


Figure 9: Model-based survey estimates for the Triennial with estimated 95% confidence intervals. Design-based estimates and 95% confidence intervals are shown in blue for comparison.

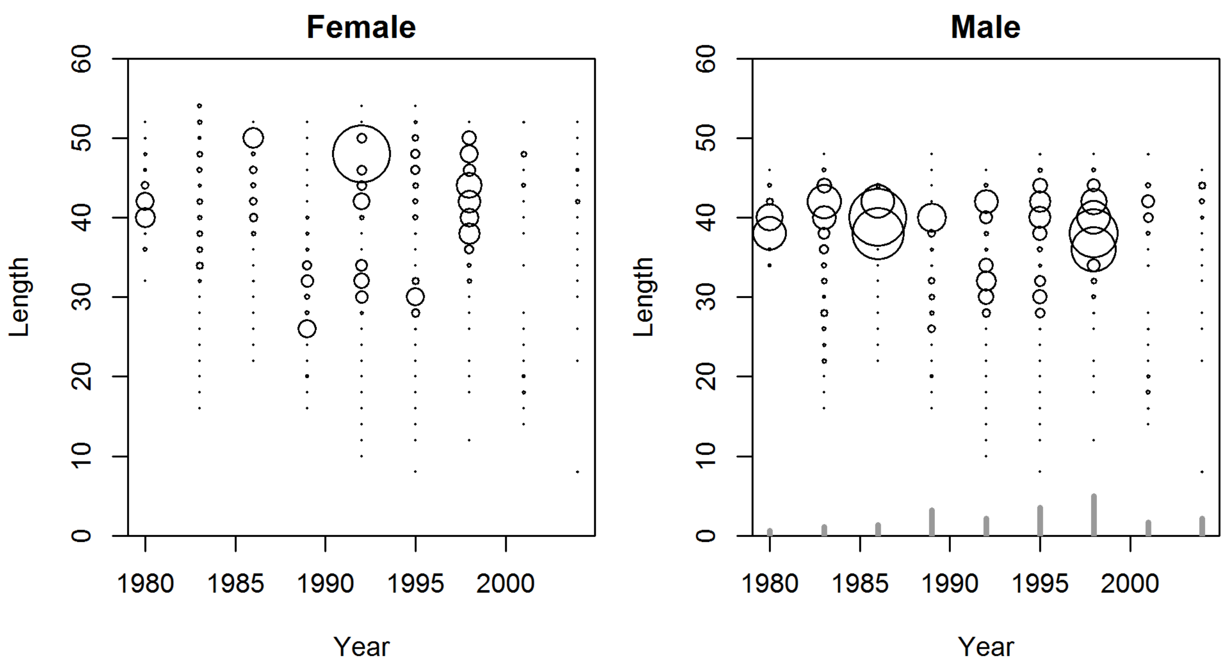


Figure 10: Expanded length compositions weighted by estimated numbers from the GLMM in each strata for the Triennial survey.

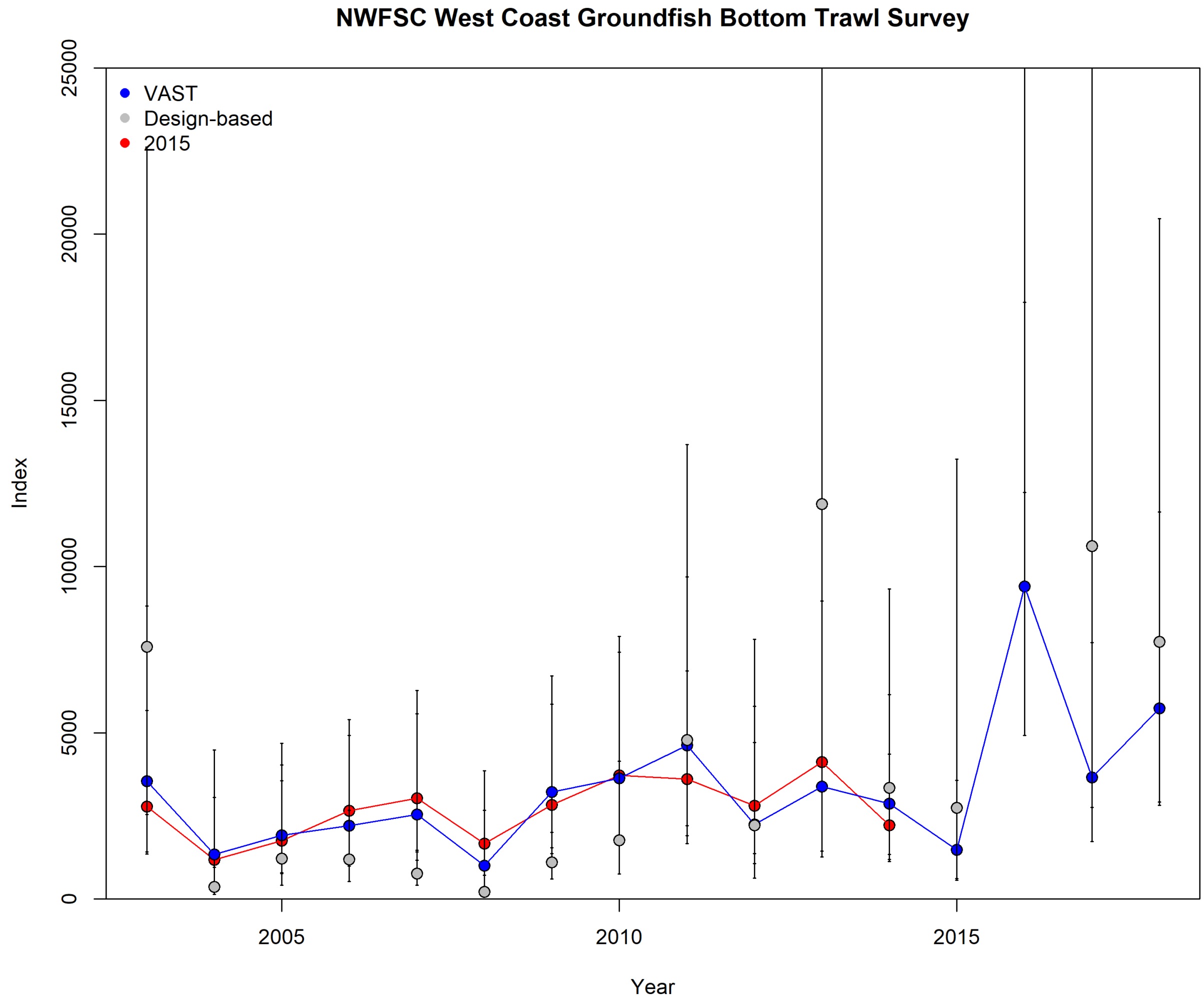


Figure 11: Estimated index of relative abundance for the West Coast Groundfish Bottom Trawl Survey using VAST, swept area biomass estimates (design-based), and the swept area biomass estimate from the 2015 assessment with 5 and 95% intervals.

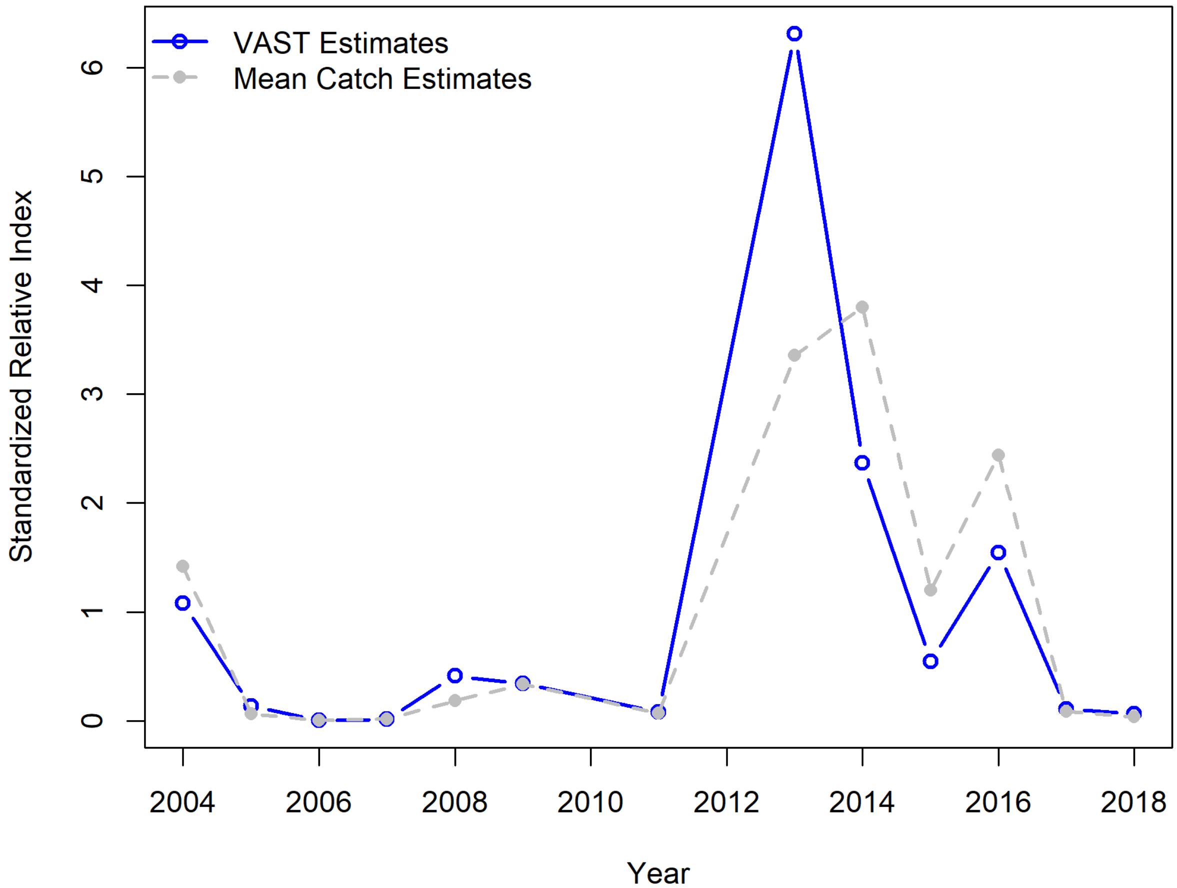


Figure 12: Estimated index of relative abundance for the West Coast Groundfish Bottom Trawl Survey using VAST, swept area biomass estimates (design-based), and the swept area biomass estimate from the 2015 assessment with 5 and 95% intervals.

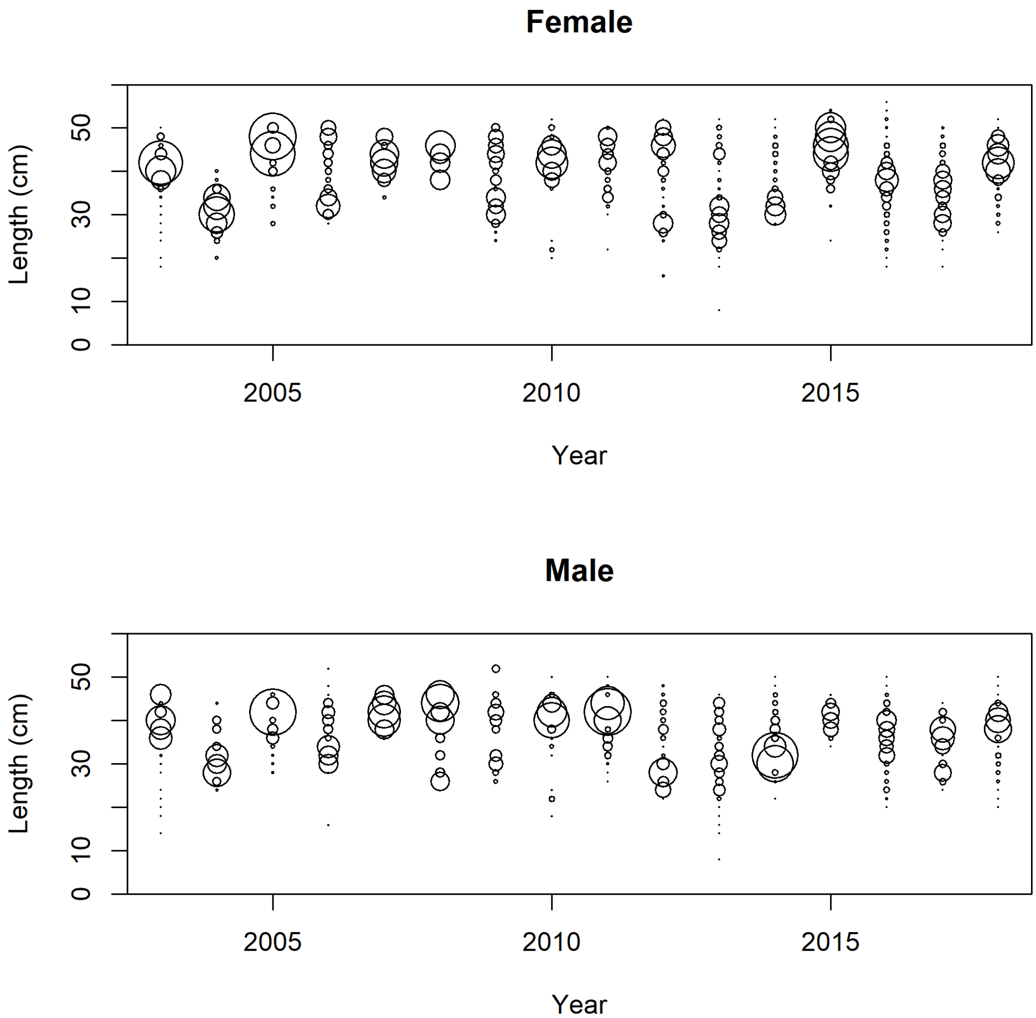


Figure 13: Expanded length compositions for the WCGBTS

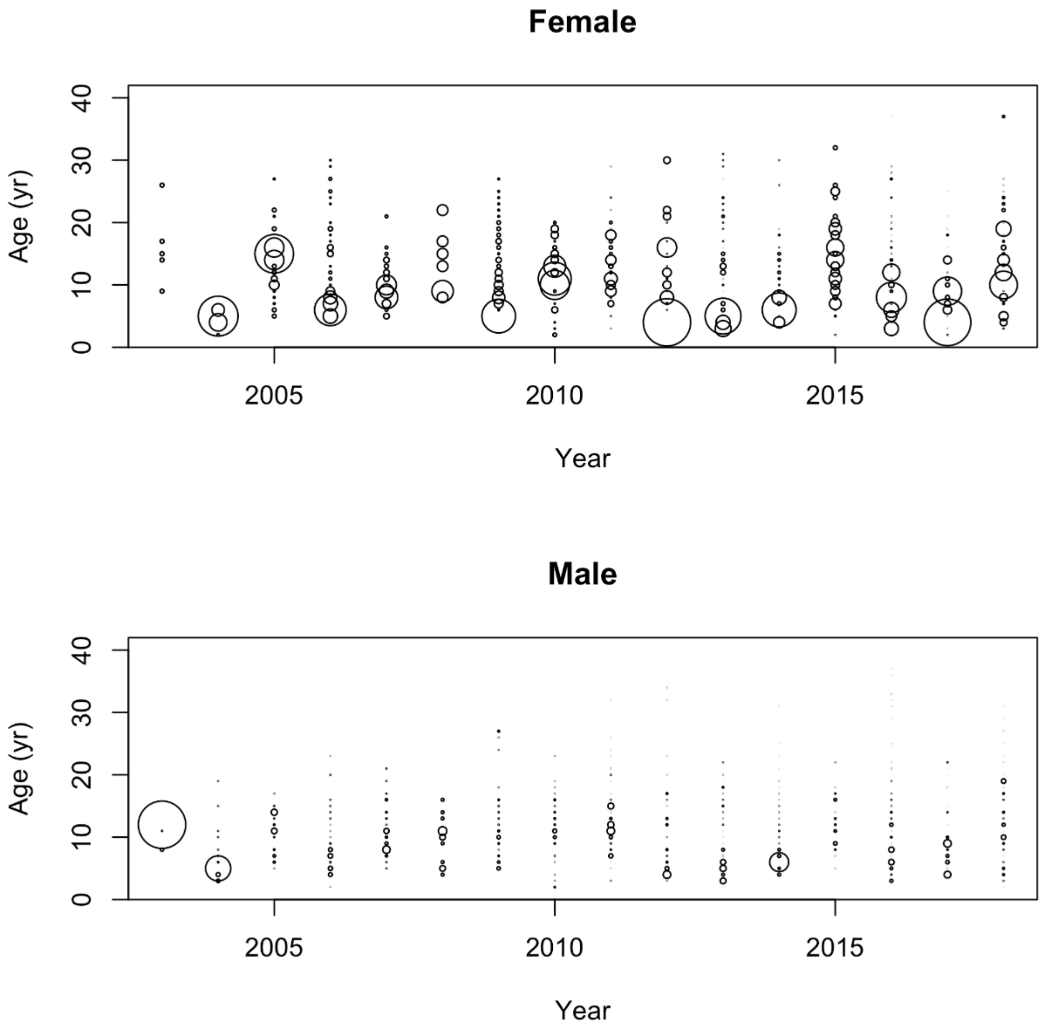


Figure 14: Expanded marginal age compositions from the WCGBTS.

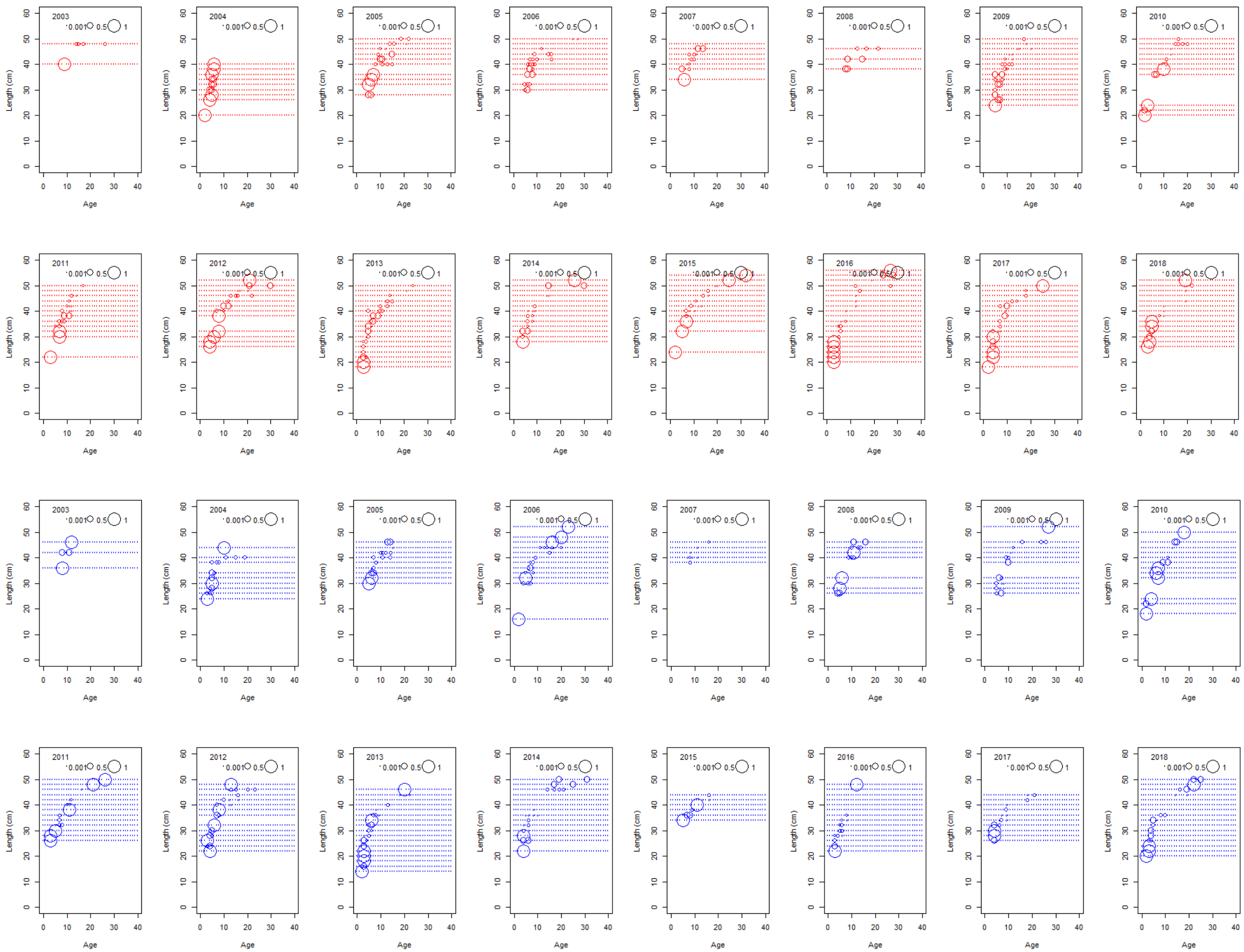


Figure 15: Conditional age-at-length from WCGBTS observations for females (red) and males (blue).

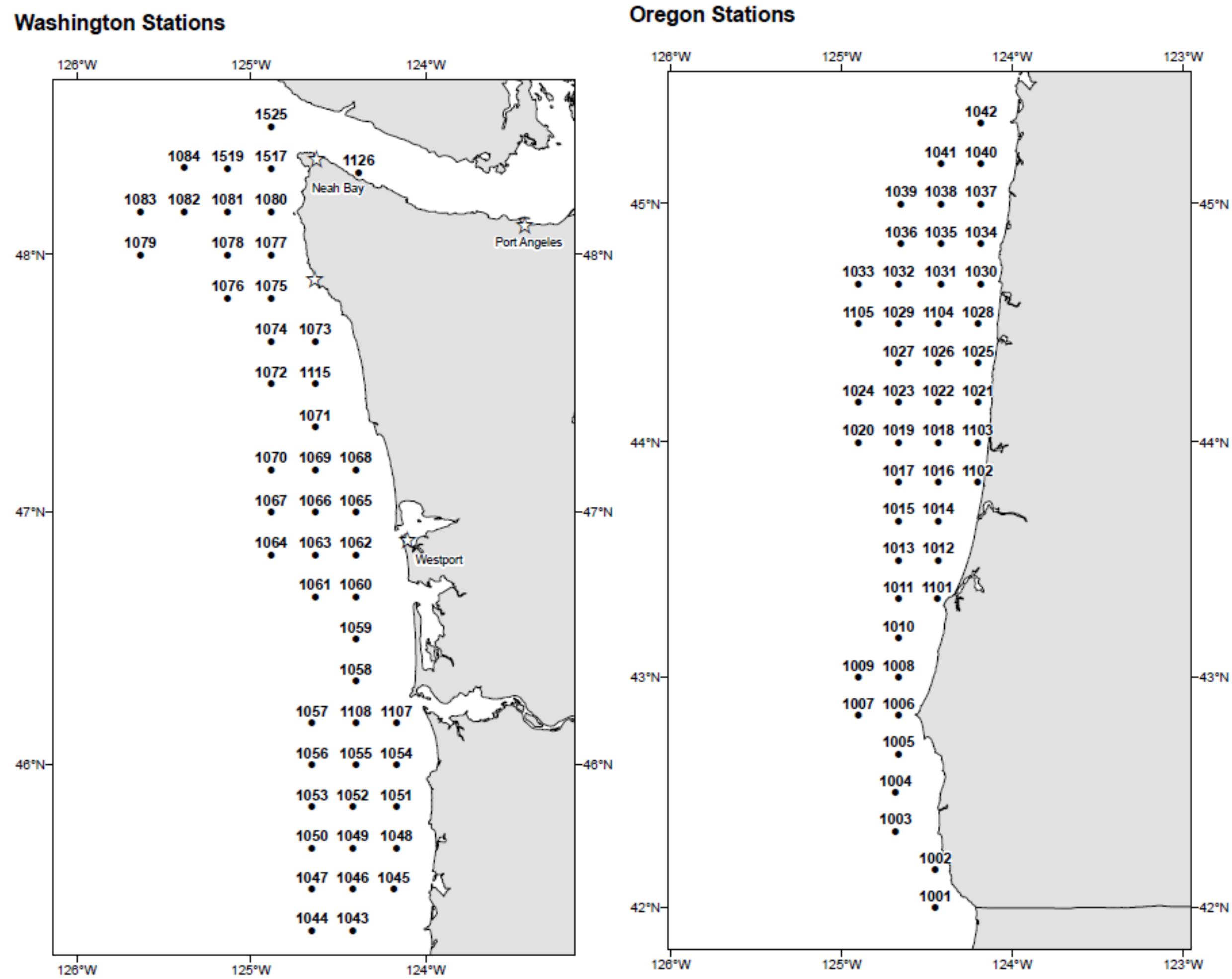


Figure 16: Station locations for the International Pacific Halibut Commission longline survey in Washington (left) and Oregon (right). Maps supplied by IPHC. See also http://www.iphc.int/research/37-survey-data.html.

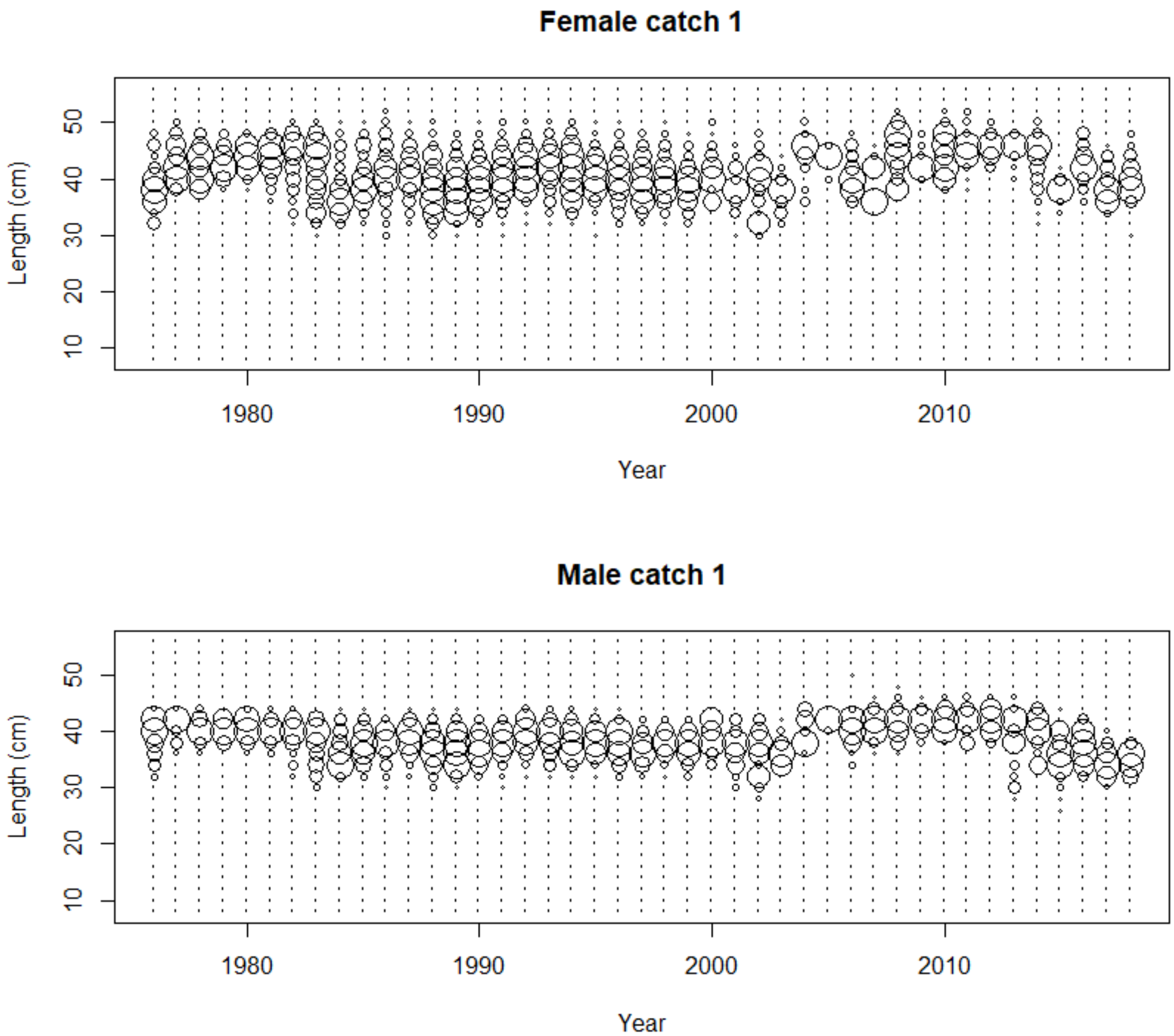
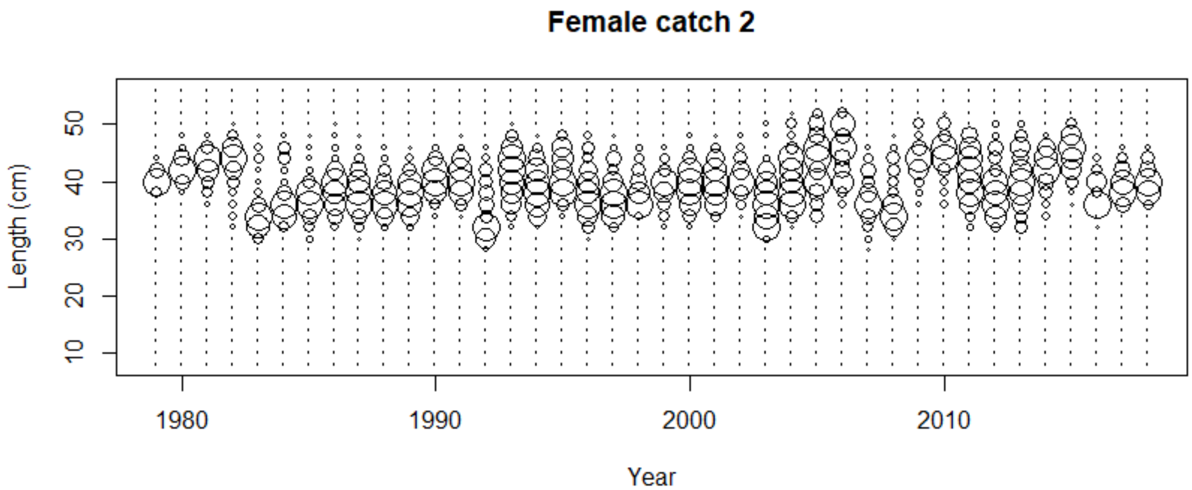


Figure 17: Expanded length compositions for the bottom trawl fishery. The area of the circle is proportional to the proportion-at-length.



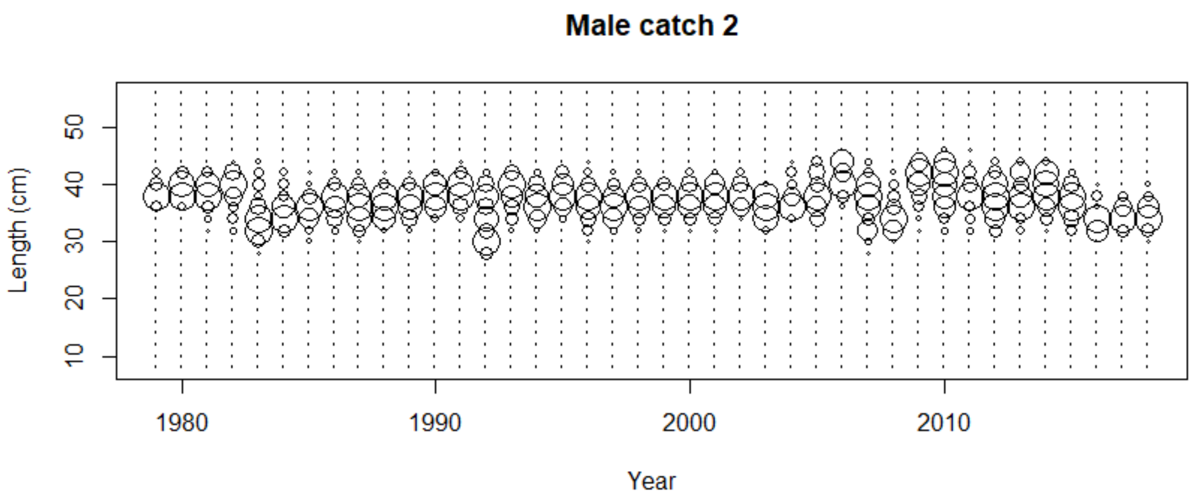


Figure 18: Expanded length compositions for the midwater trawl fishery. The area of the circle is proportional to the proportion-at-length.

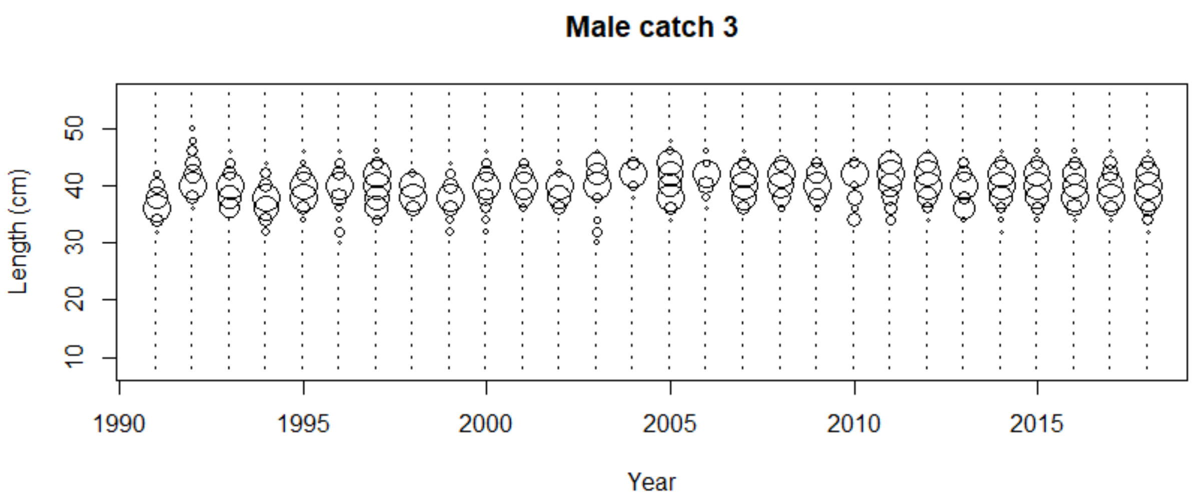


Figure 19: Expanded length compositions for the hake fishery. The area of the circle is proportional to the proportion-at-length.

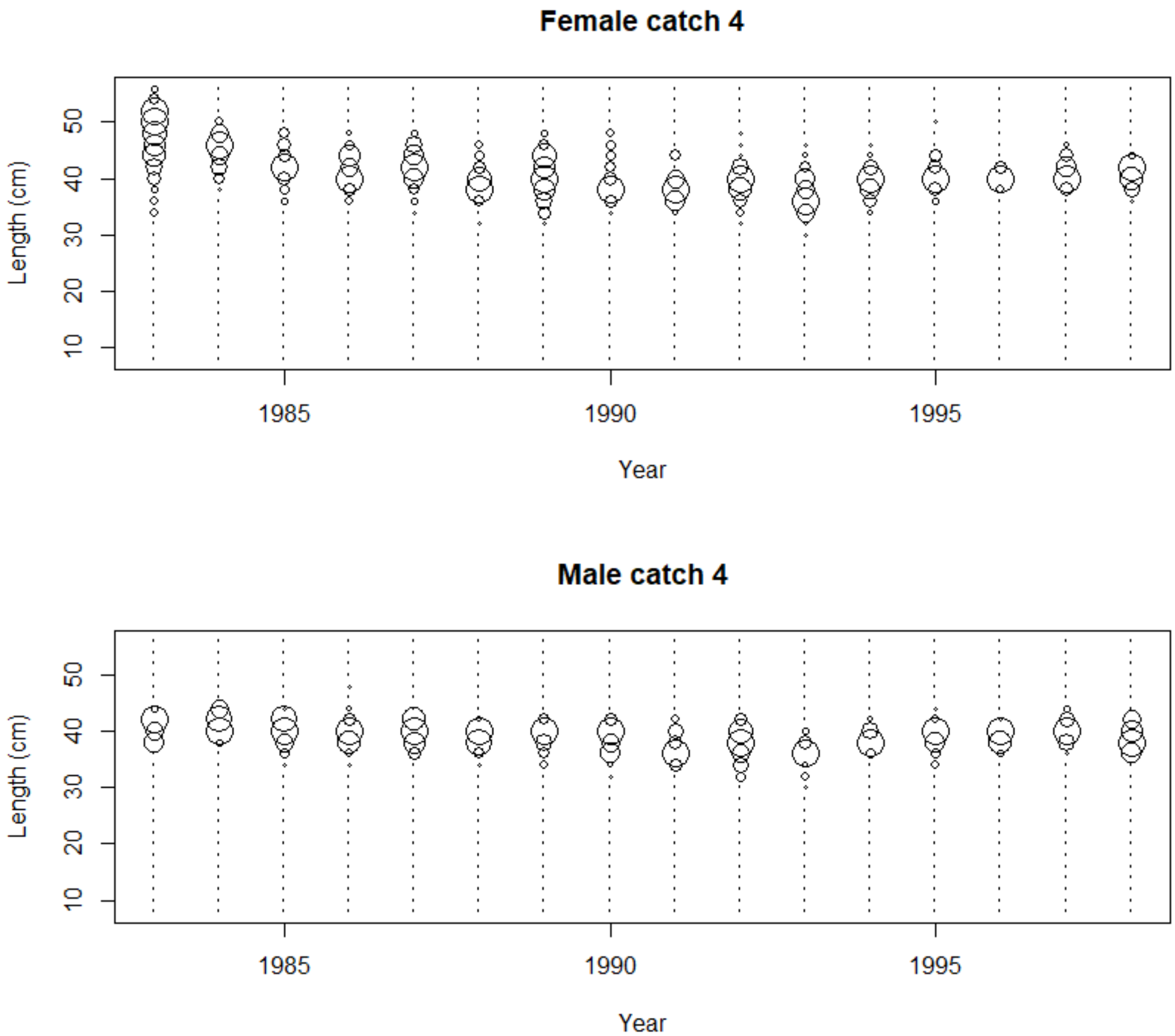


Figure 20: Expanded length compositions for the net fishery. The area of the circle is proportional to the proportion-at-length.

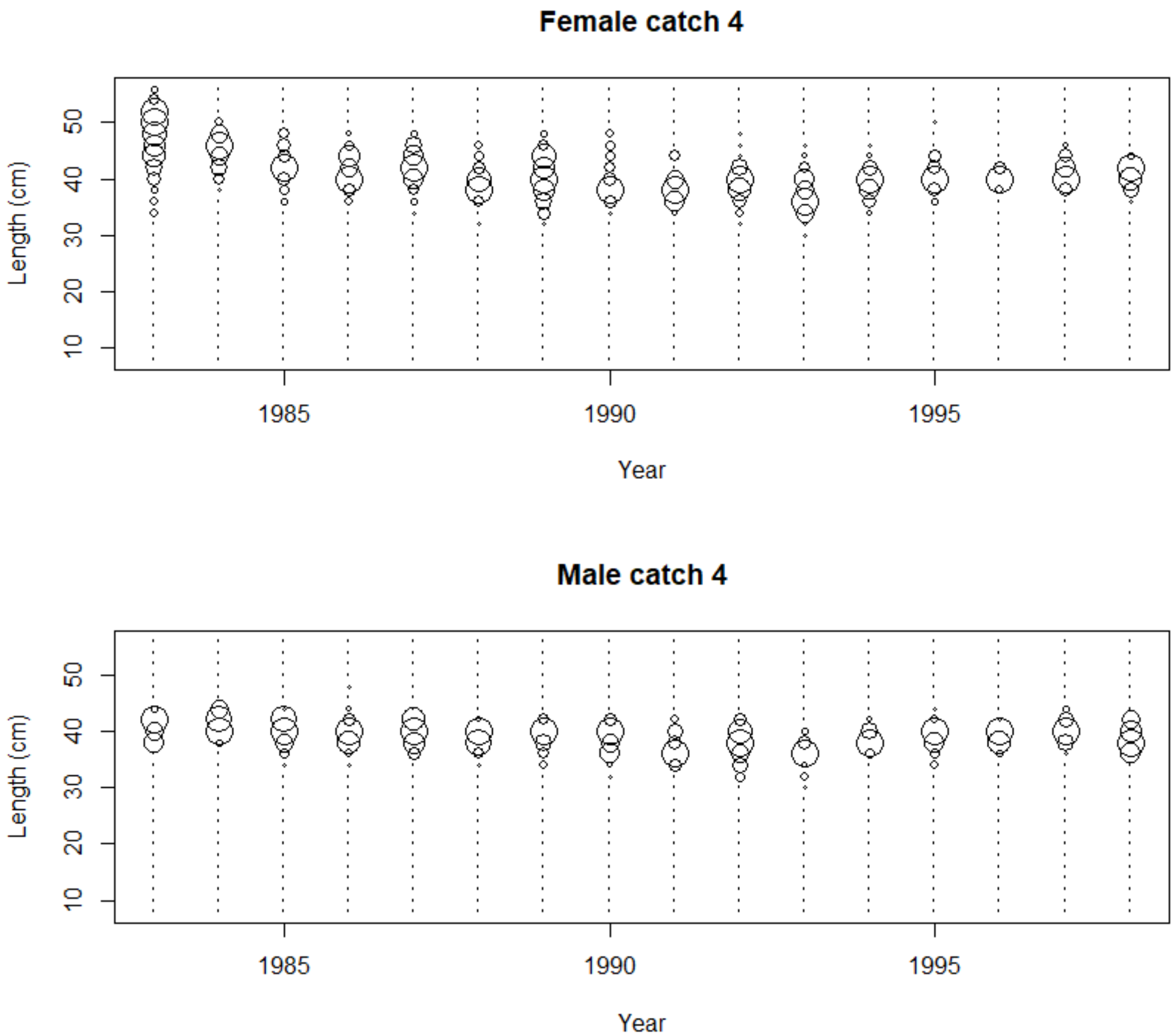


Figure 21: Expanded length compositions for the hook-and-line fishery. The area of the circle is proportional to the proportion-at-length.

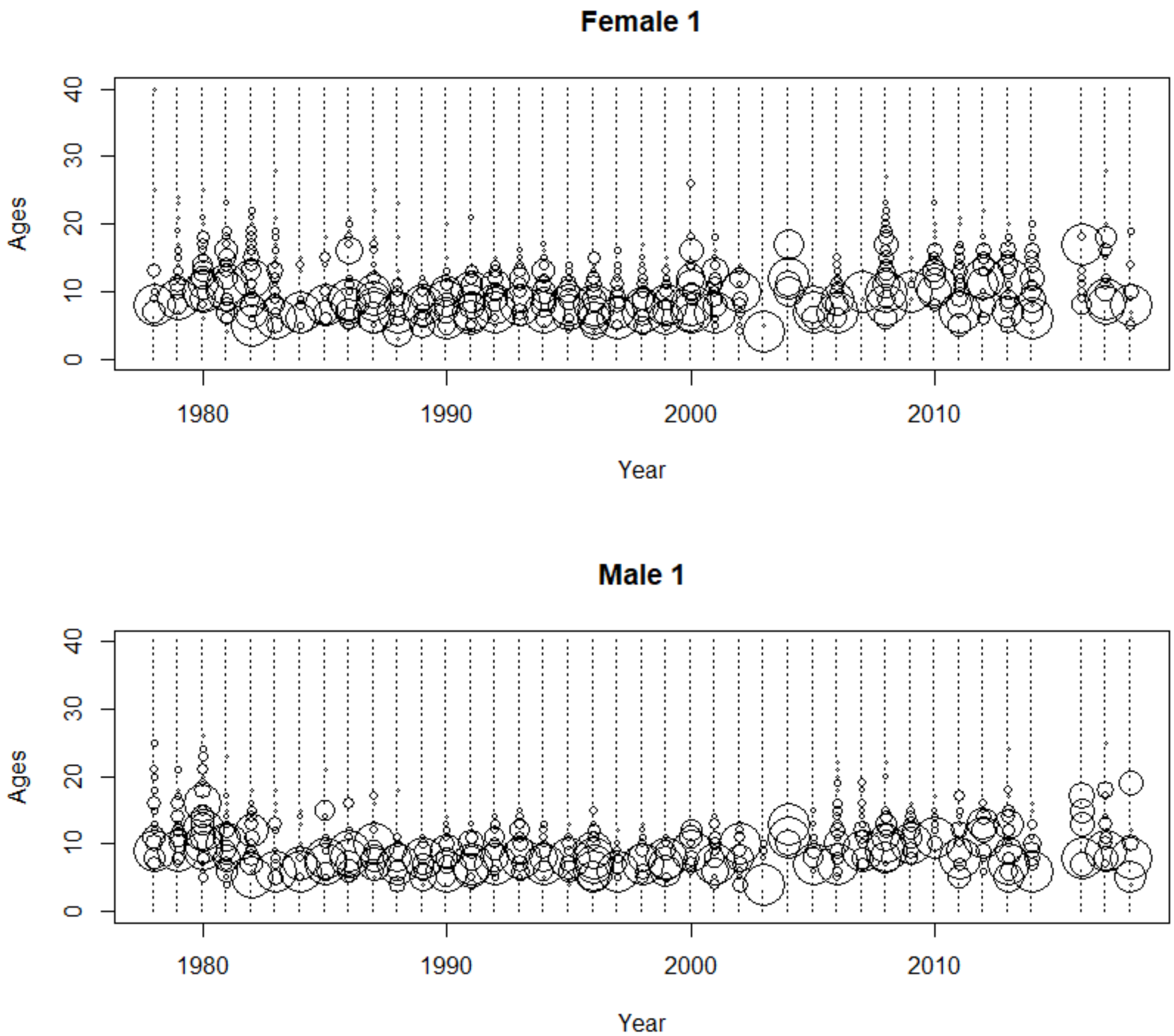
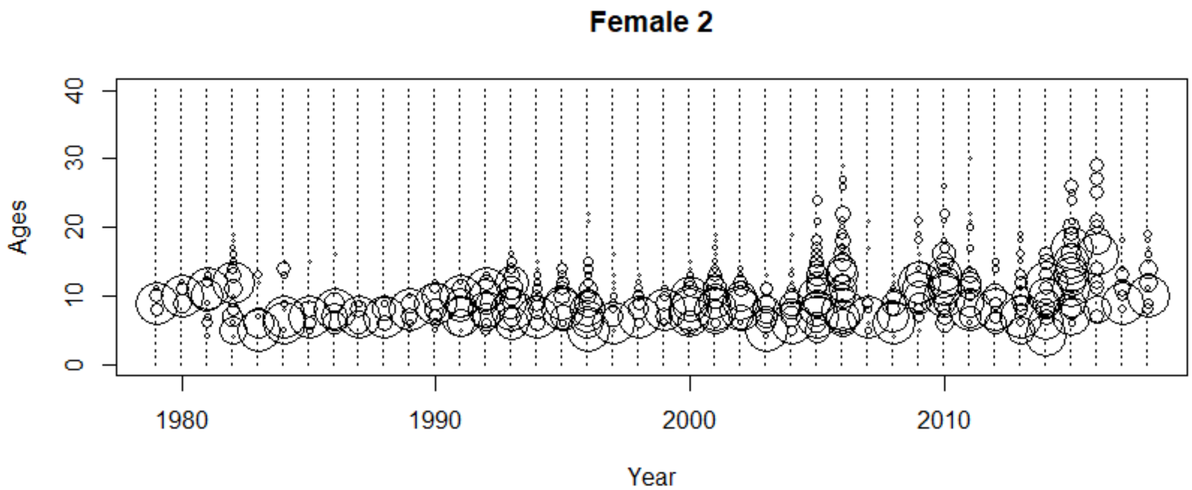


Figure 22: Expanded age compositions for the bottom trawl fishery. The area of the circle is proportional to the proportion-at-age.



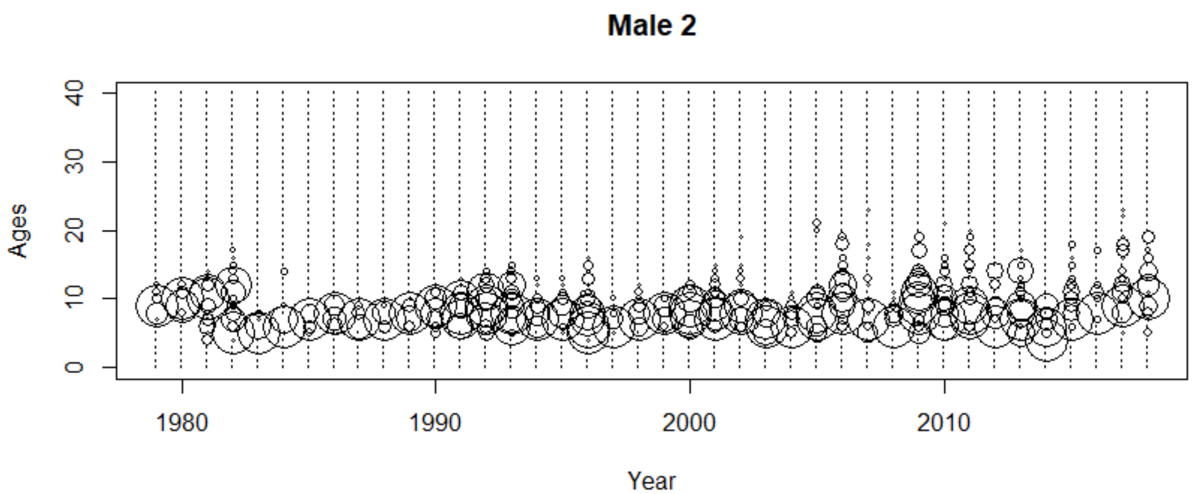


Figure 23: Expanded age compositions for the midwater trawl fishery. The area of the circles is proportional to the proportion-at-age.

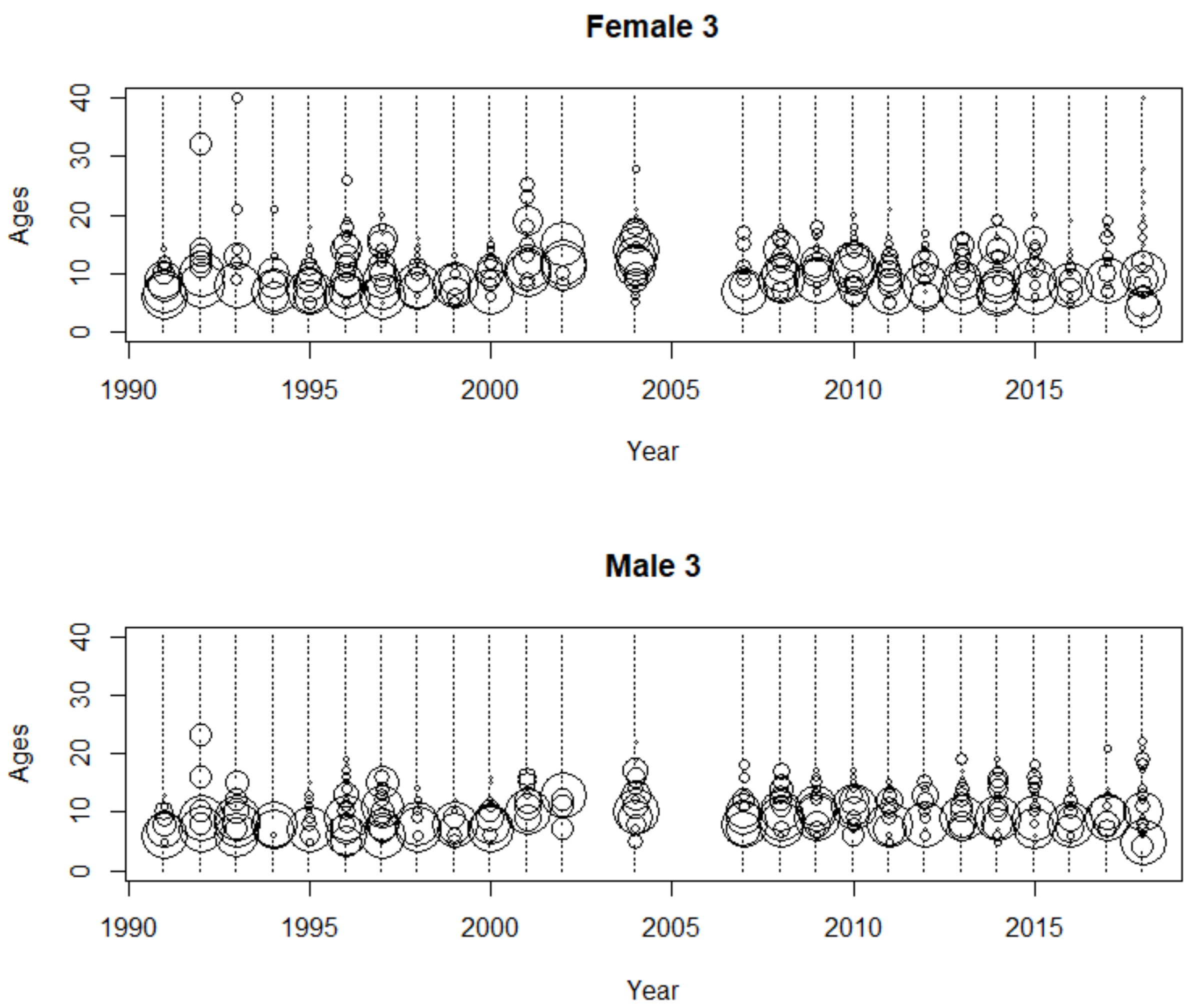


Figure 24: Expanded age compositions for the hake fishery. The area of the circles is proportional to the proportion-at-age.

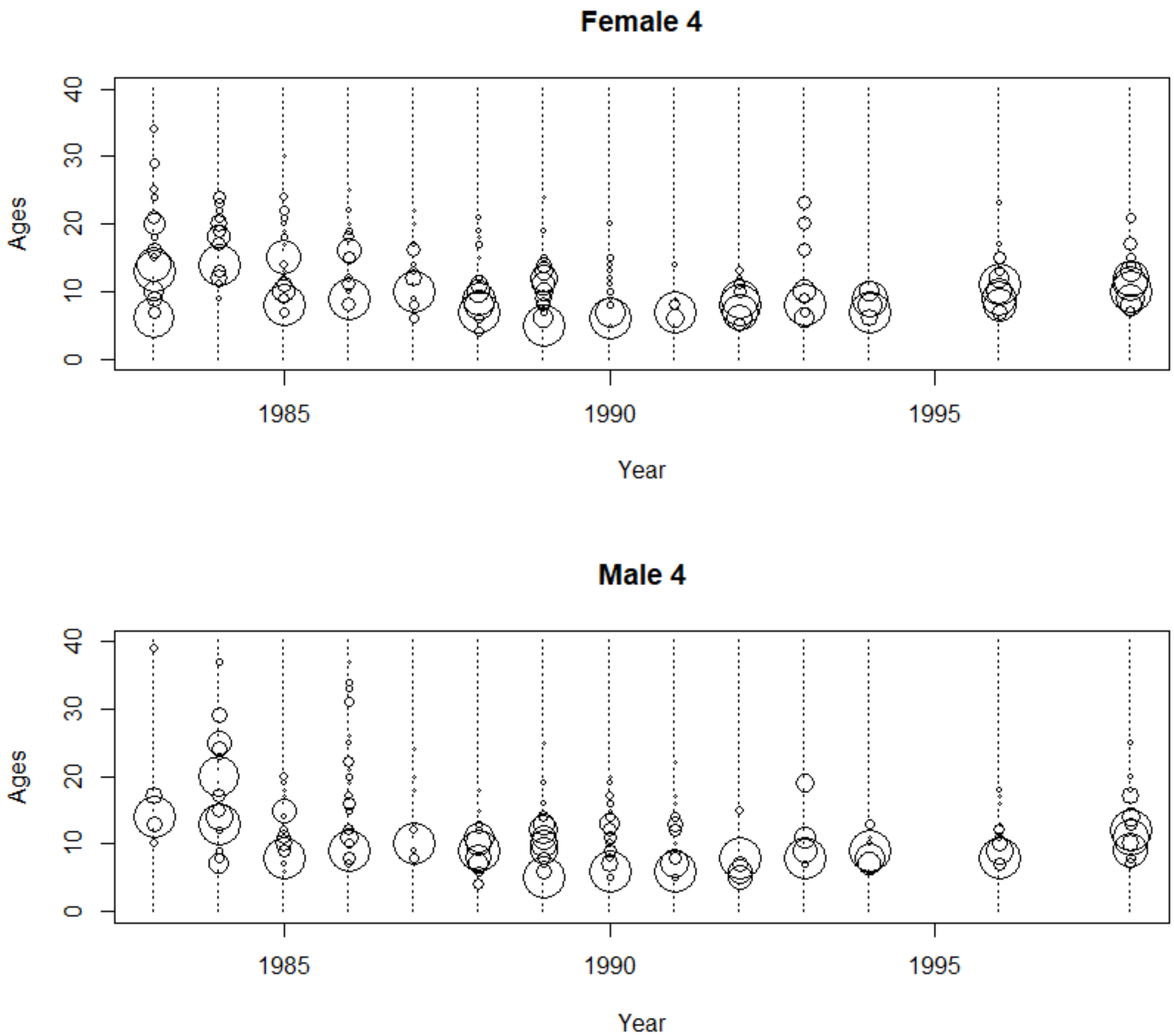


Figure 25: Expanded age compositions for the net fishery. The area of the circles is proportional to the proportion-at-age.

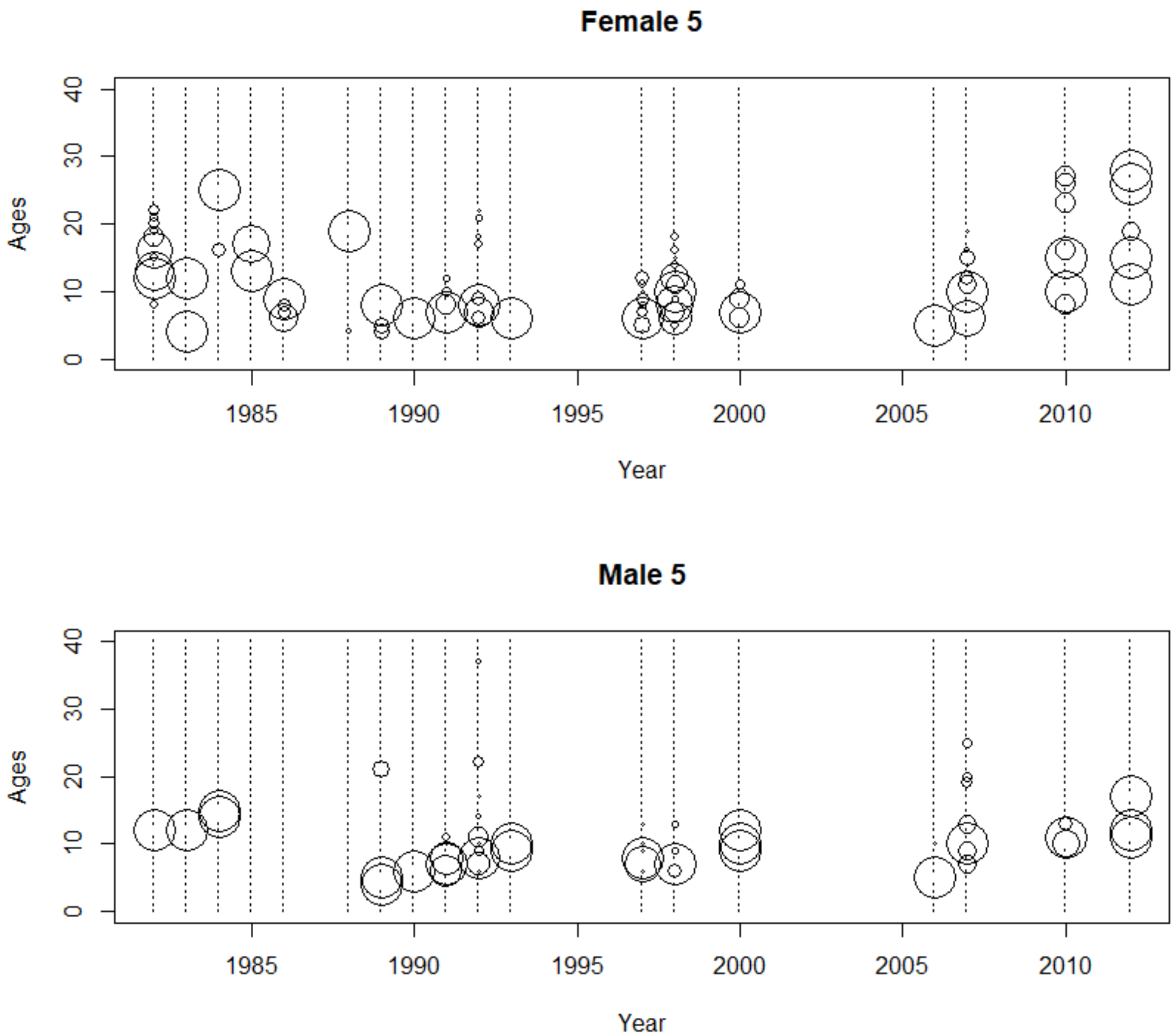


Figure 26: Expanded age compositions for the hook-and-line fishery. The area of the circles is proportional to the proportion-at-age.

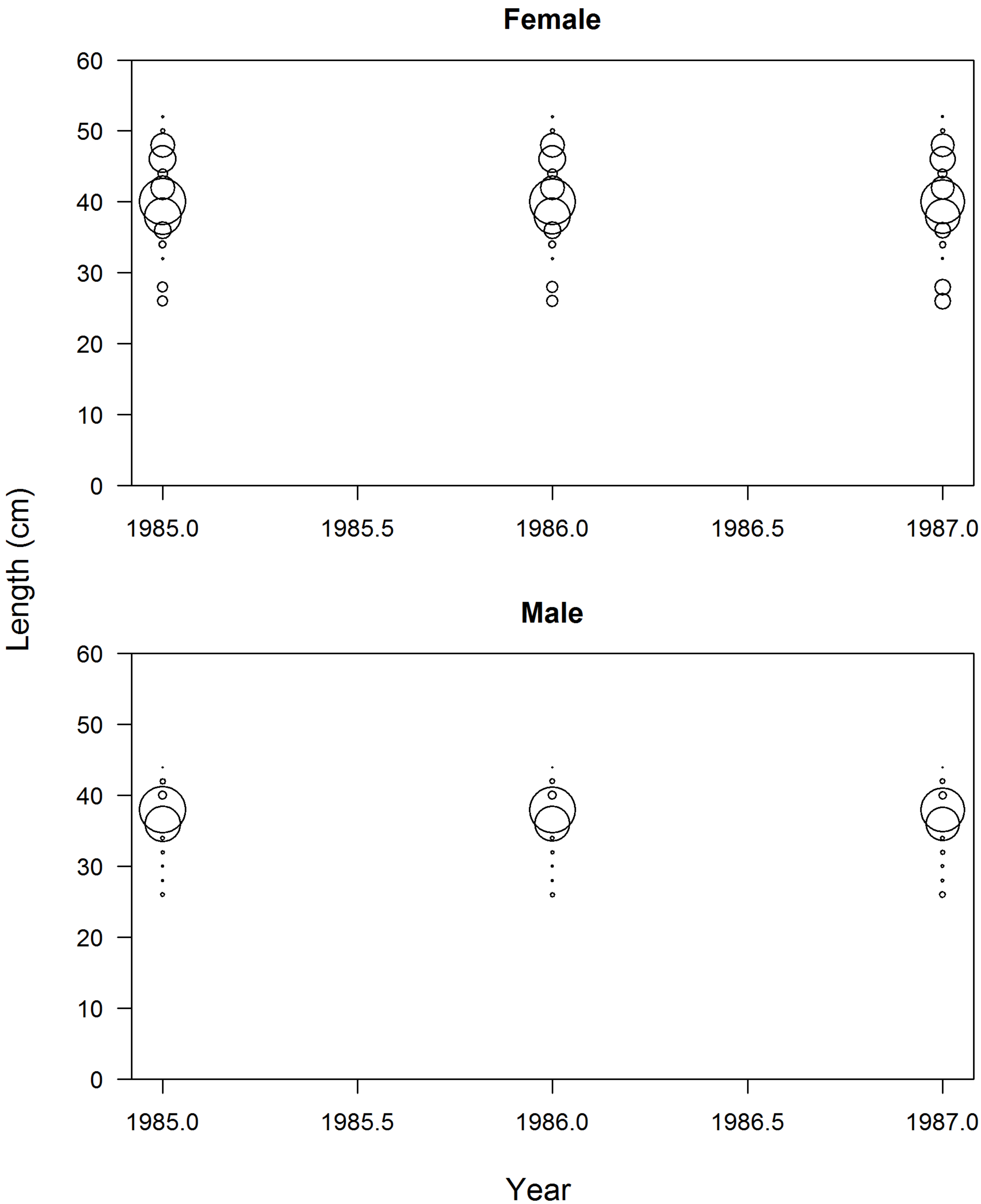


Figure 27: Length compositions for discards from the Pikitch study. The discard length comps were fit to in the model.

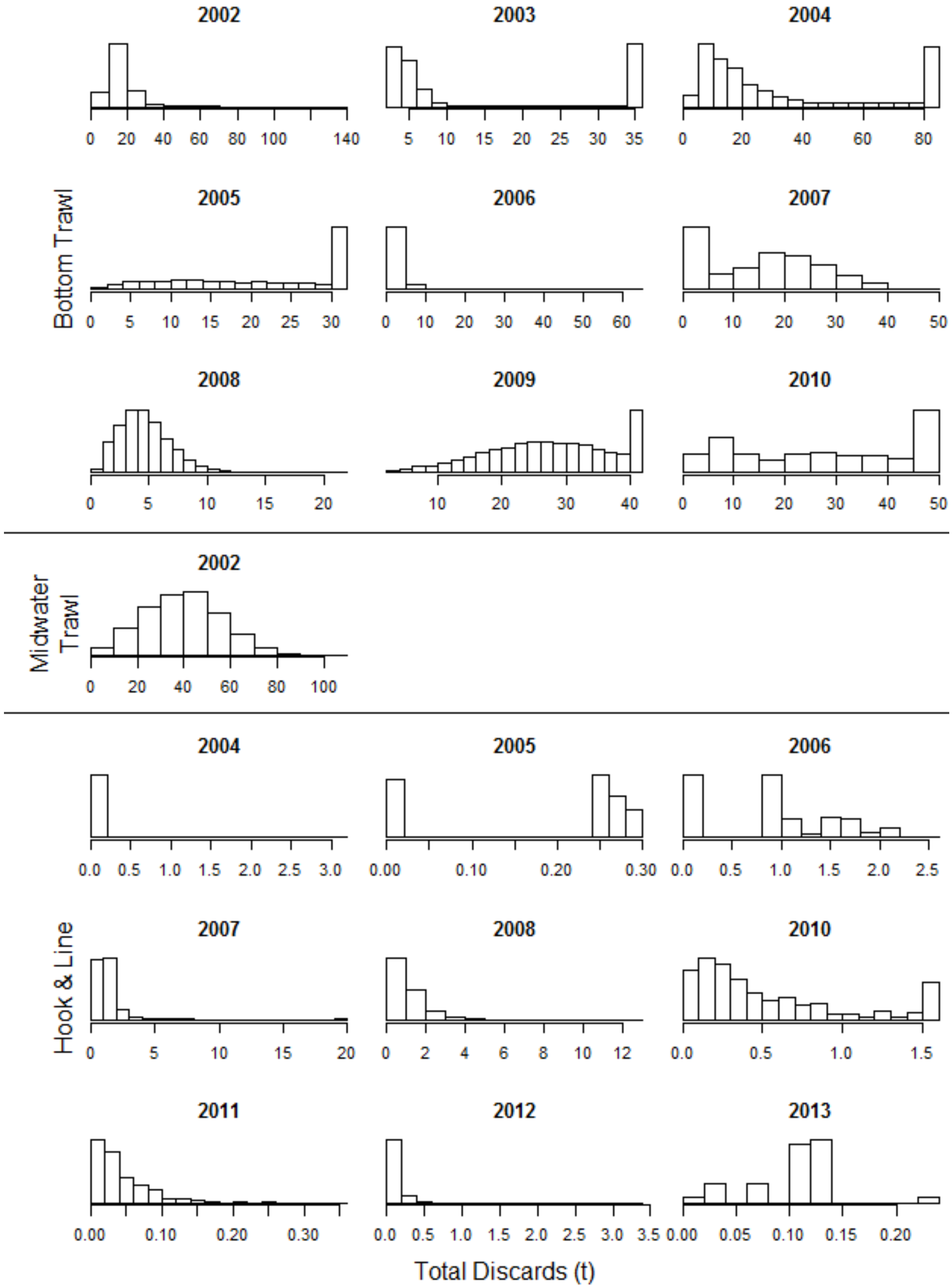


Figure 28: Histograms of bootstrap samples for WCGOP estimates of total discards (mt) for bottom trawl (top), midwater trawl (middle), and hook-and-line (bottom) gears.

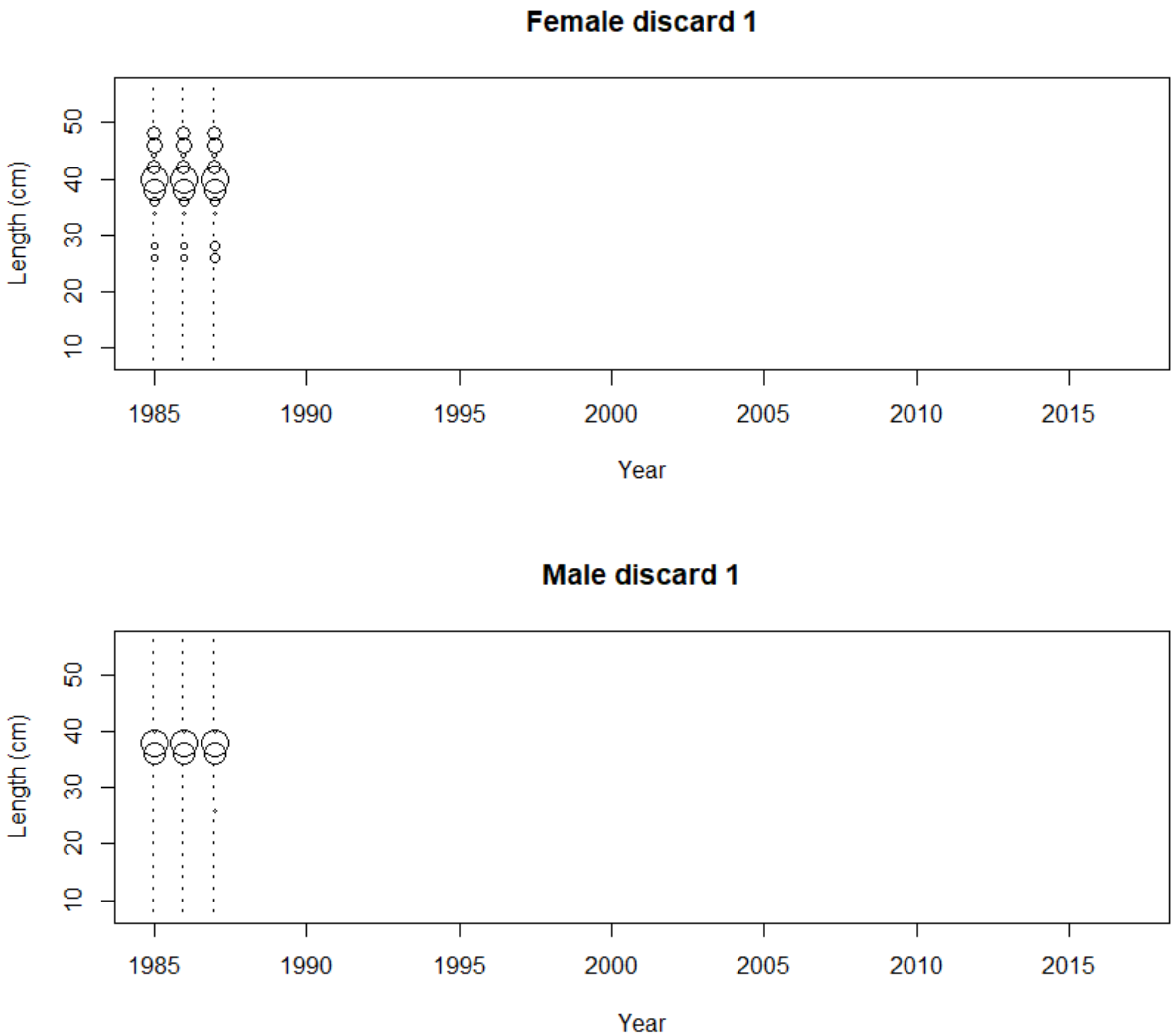


Figure 29: Length compositions of the discards for the bottom trawl.

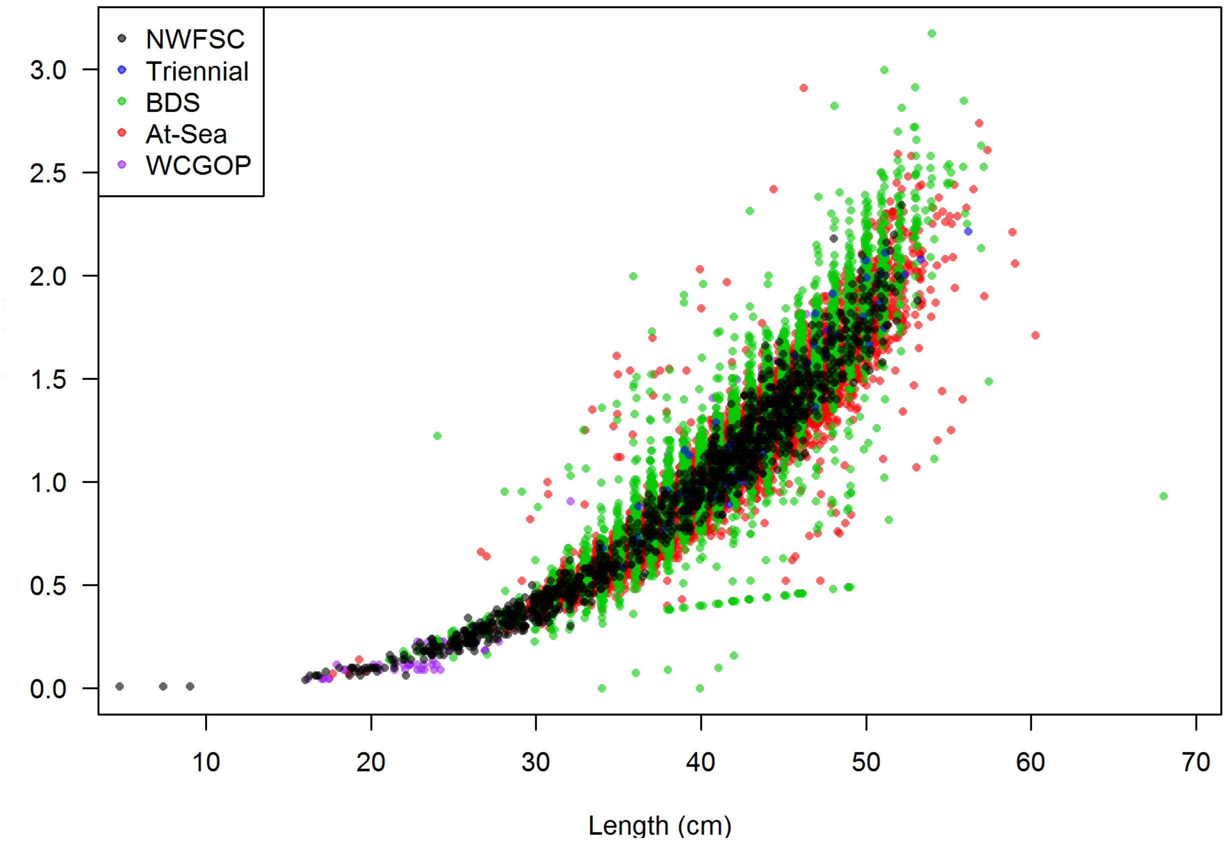


Figure 30: Weight-at-length observations of Widow Rockfish from different data sources.

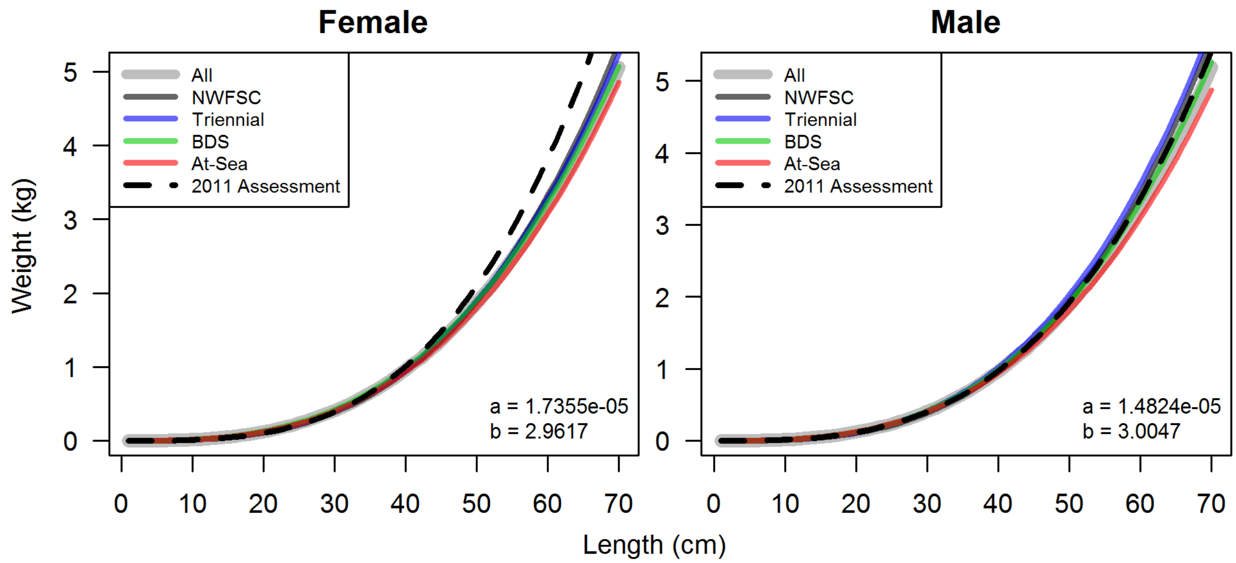


Figure 31: Fits to weight-at-length observations for females (left) and males (right) using observations from different data sources. The weight-at-length curve used in the 2011 assessment is shown as a dashed line. Estimates of the intercept (a) and slope (b) are show in the lower left for each sex. Observations from the WCGOP were not used due to potential biases and lack of older fish resulting in a lack of fit compared to other sources (81 observations) and length observations greater than 60 cm were removed.

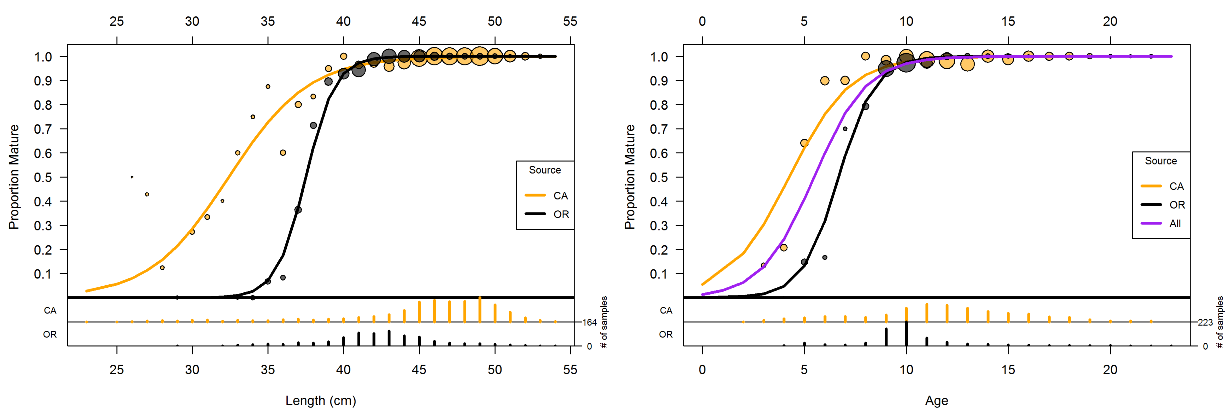


Figure 32: Maturity-at-length (left) and maturity-at-age (right) from data reported by Barss & Echeverria (1987). Circles are proportional to the number of observations at that length or age. Lines are estimated logistic curves fitted to the data. The bars at the bottom are the number of samples by each state. The purple line is the estimated maturity-at-age using all data with each state equally weighted, and is used in the assessment model with maturity-at-age for ages 2 and lower set equal to zero.

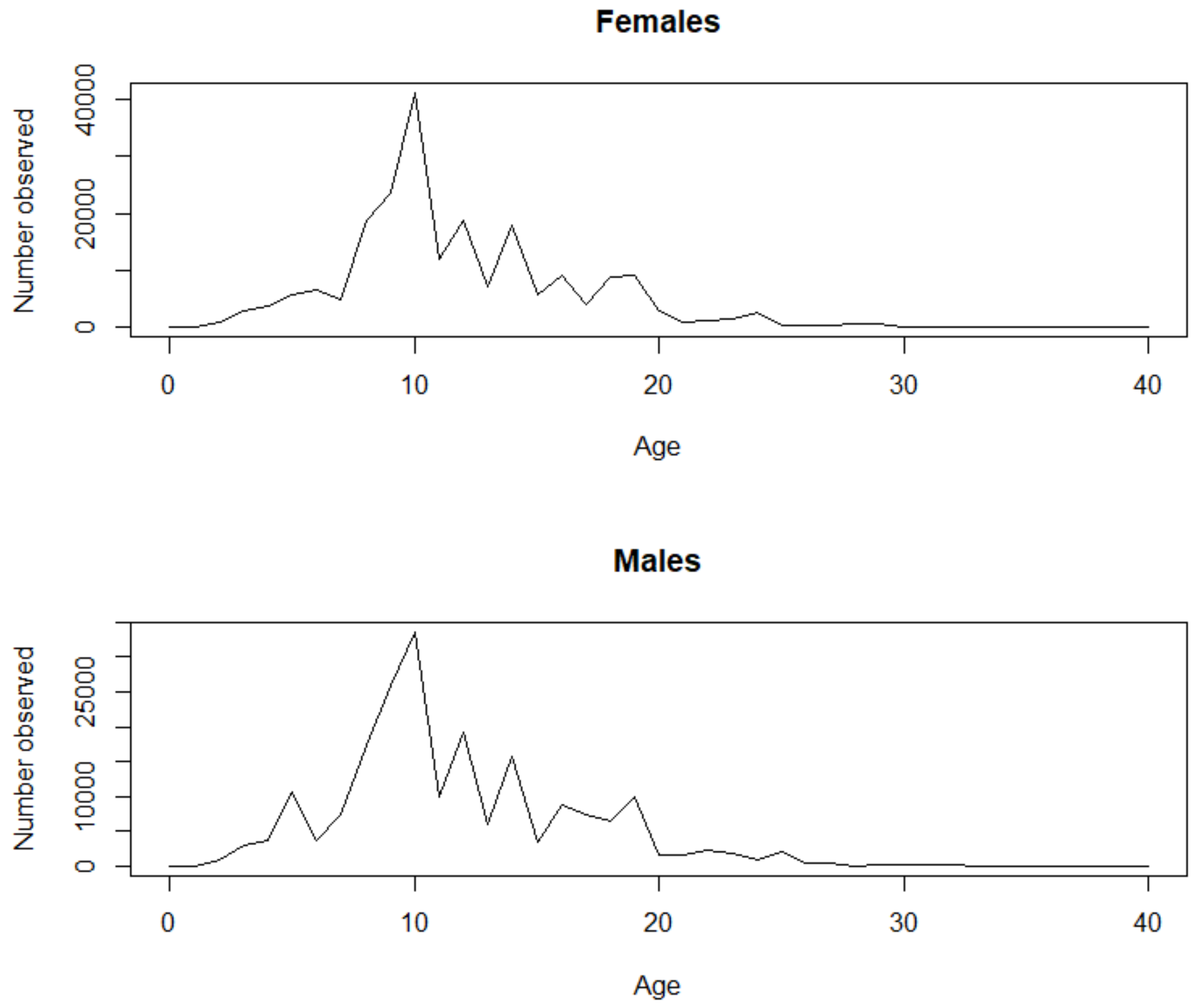


Figure 33: Number at age observed from all data for female and male Widow Rockfish.

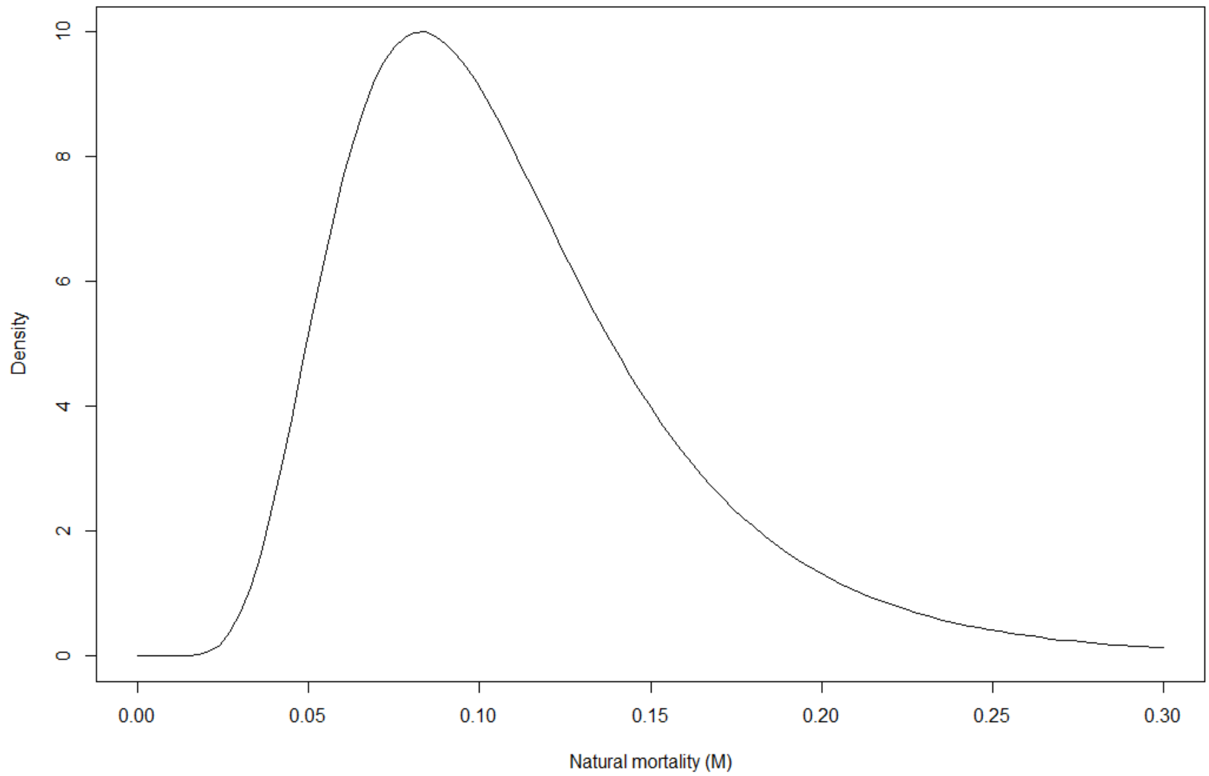


Figure 34: Prior distributions for natural mortality (*M*).

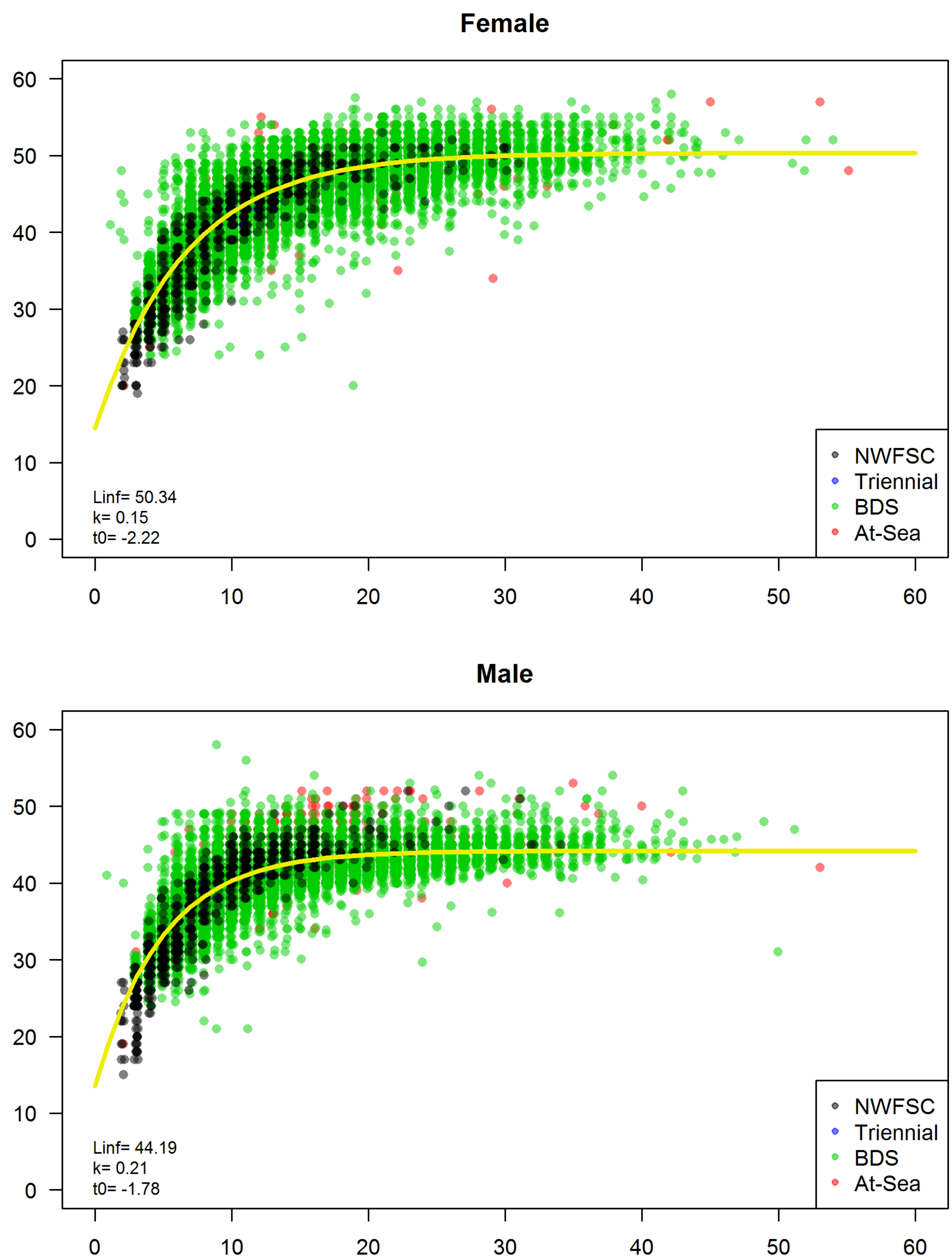


Figure 35: Length-at-age observations (points, slightly jittered) and predicted length-at-age von Bertalanffy curves for female (top) and male (bottom) Widow Rockfish collected from all fishery (BDS and At-Sea) and survey (Triennial and NWFSC) data.

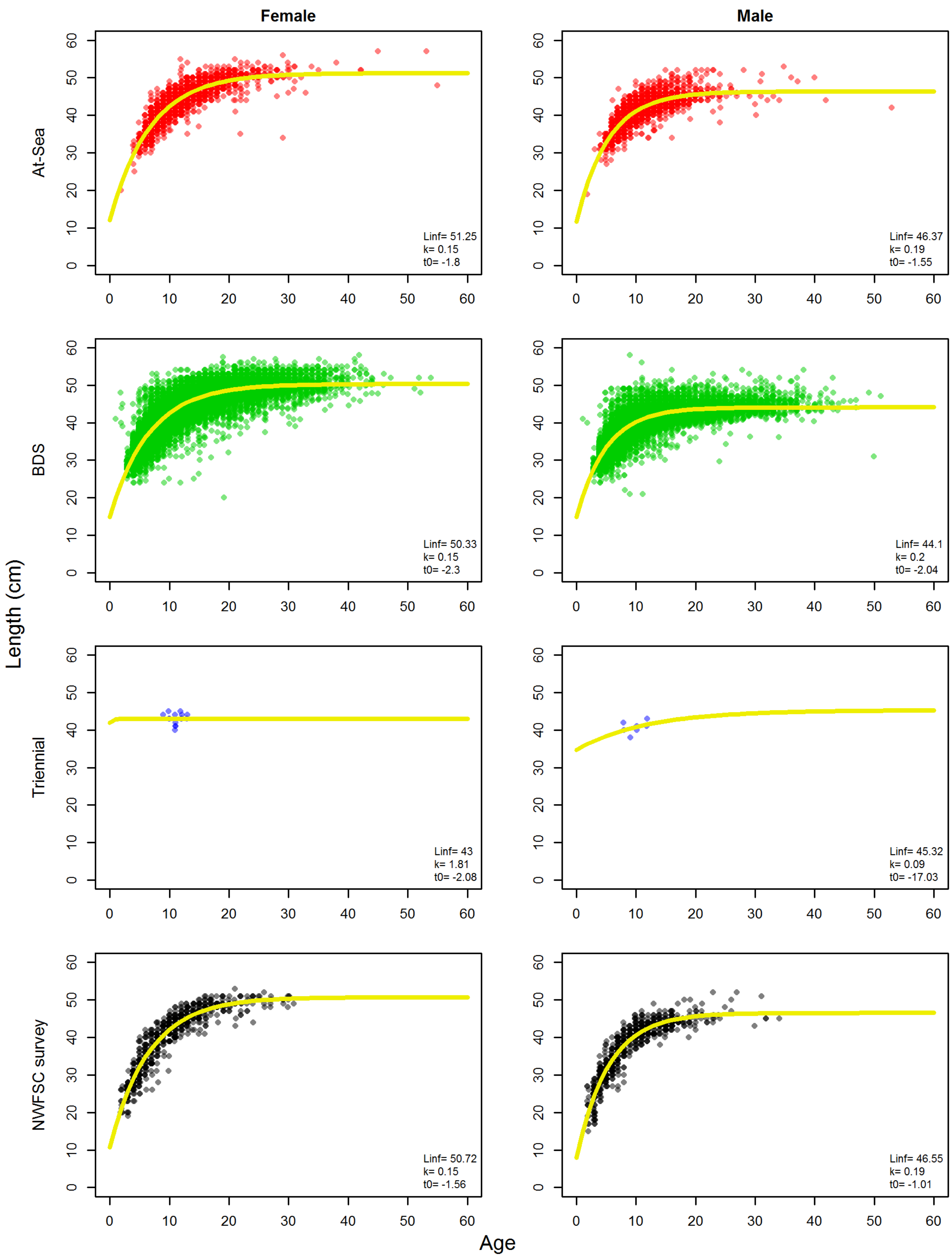


Figure 36: Length-at-age observations (points) and predicted length-at-age von Bertalanffy curves for female (left) and male (right) Widow Rockfish for each source.

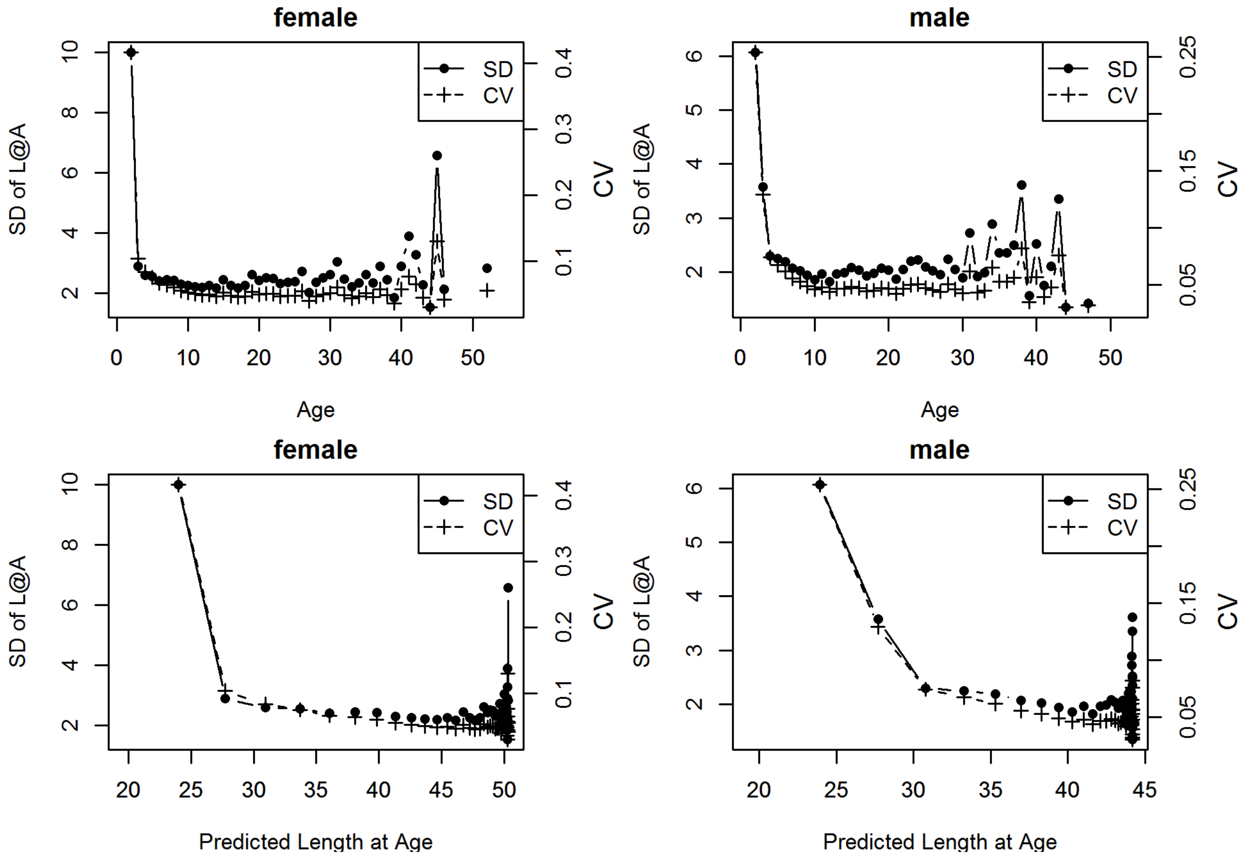


Figure 37: Standard deviation (SD) and coefficient of variation (CV) of length at age from all data sources as a function of age (top) and predicted length-at-age (bottom).

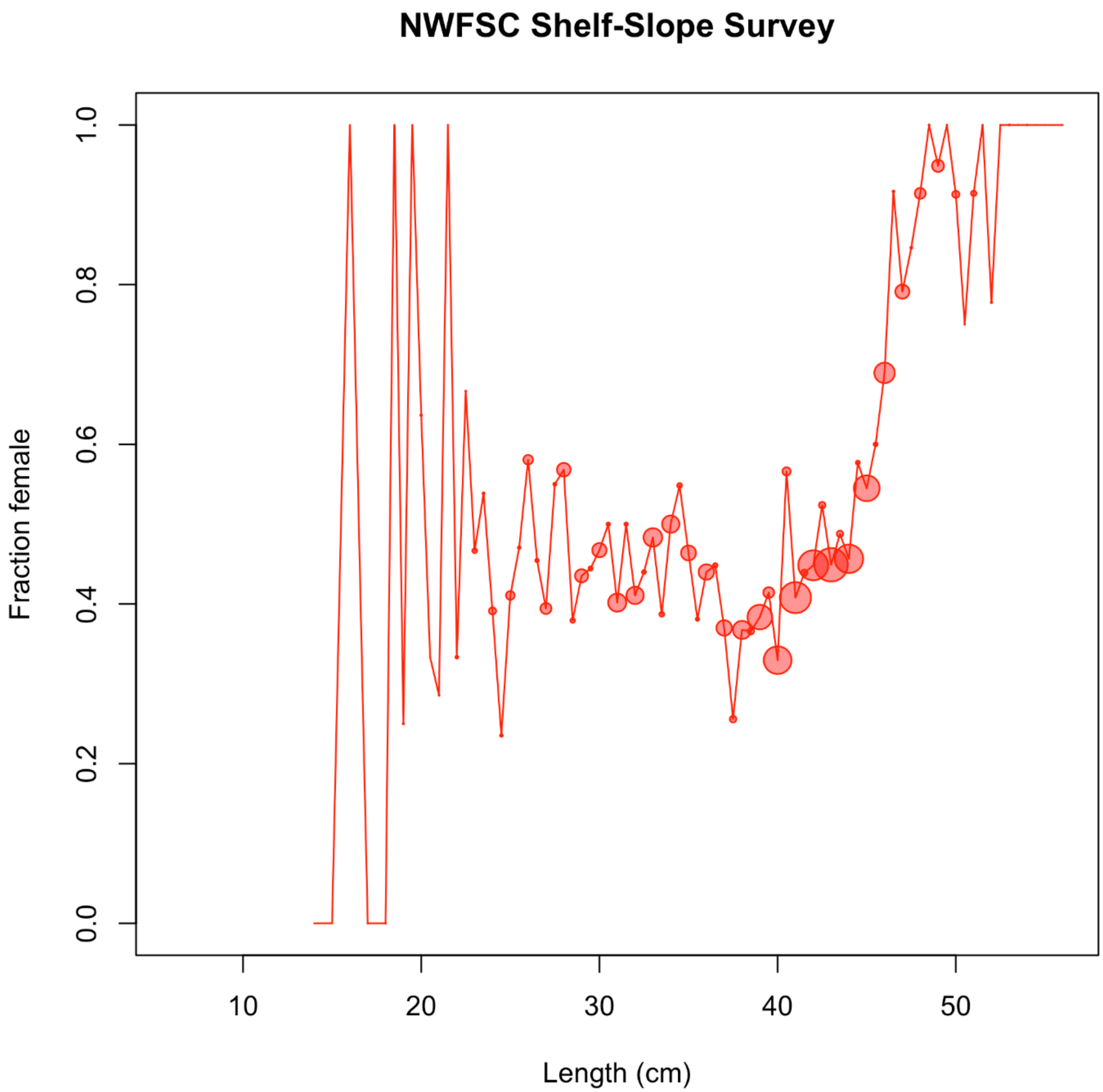


Figure 38: Proportion of females plotted against fish length (cm) from data collected on the NWFSC WCGBT survey from 2003–2018. The area of the circle corresponds to the number of observations in that bin.

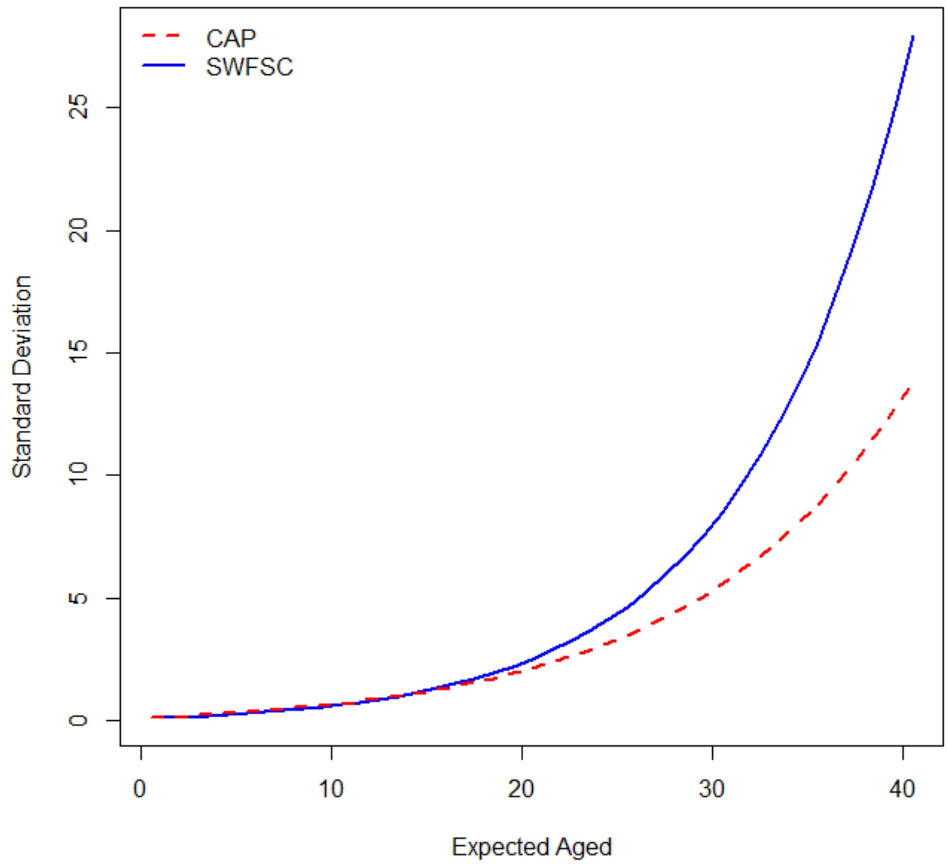


Figure 39: Estimated ageing error for the Cooperative Ageing Project lab and the SWFSC.

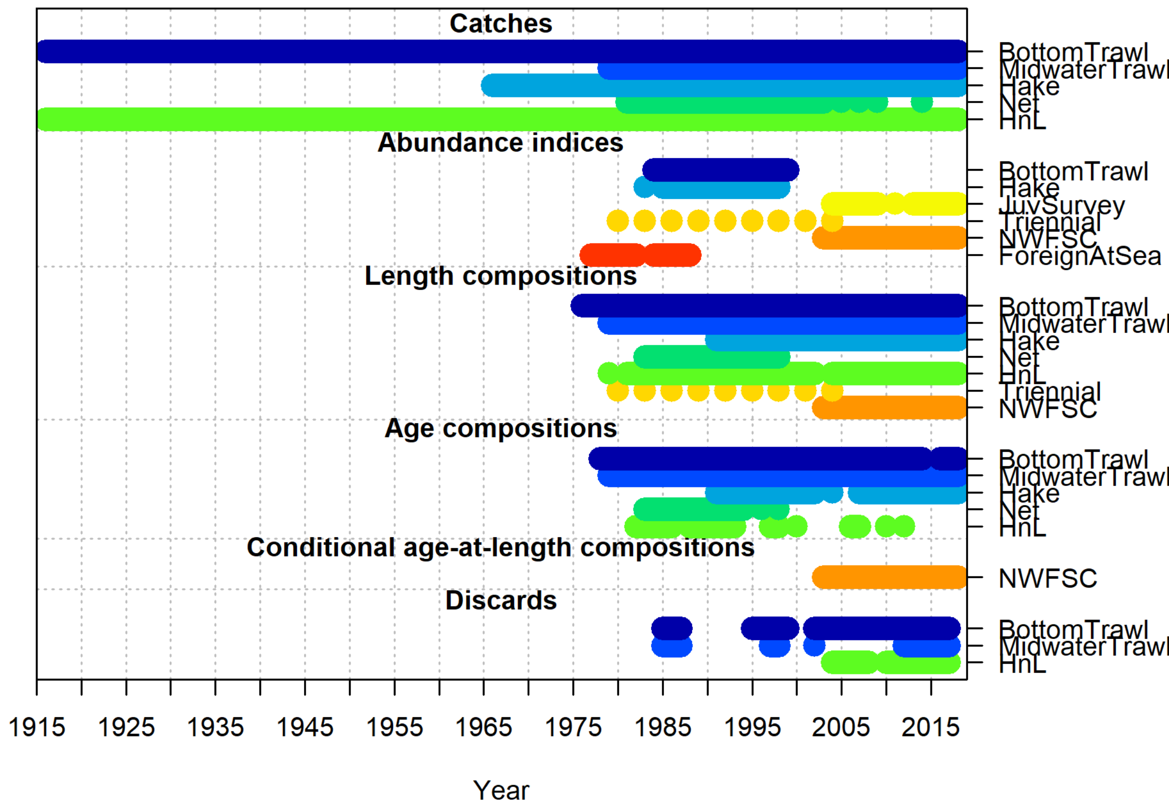


Figure 40: Data sources by type and year that were used in the base model.

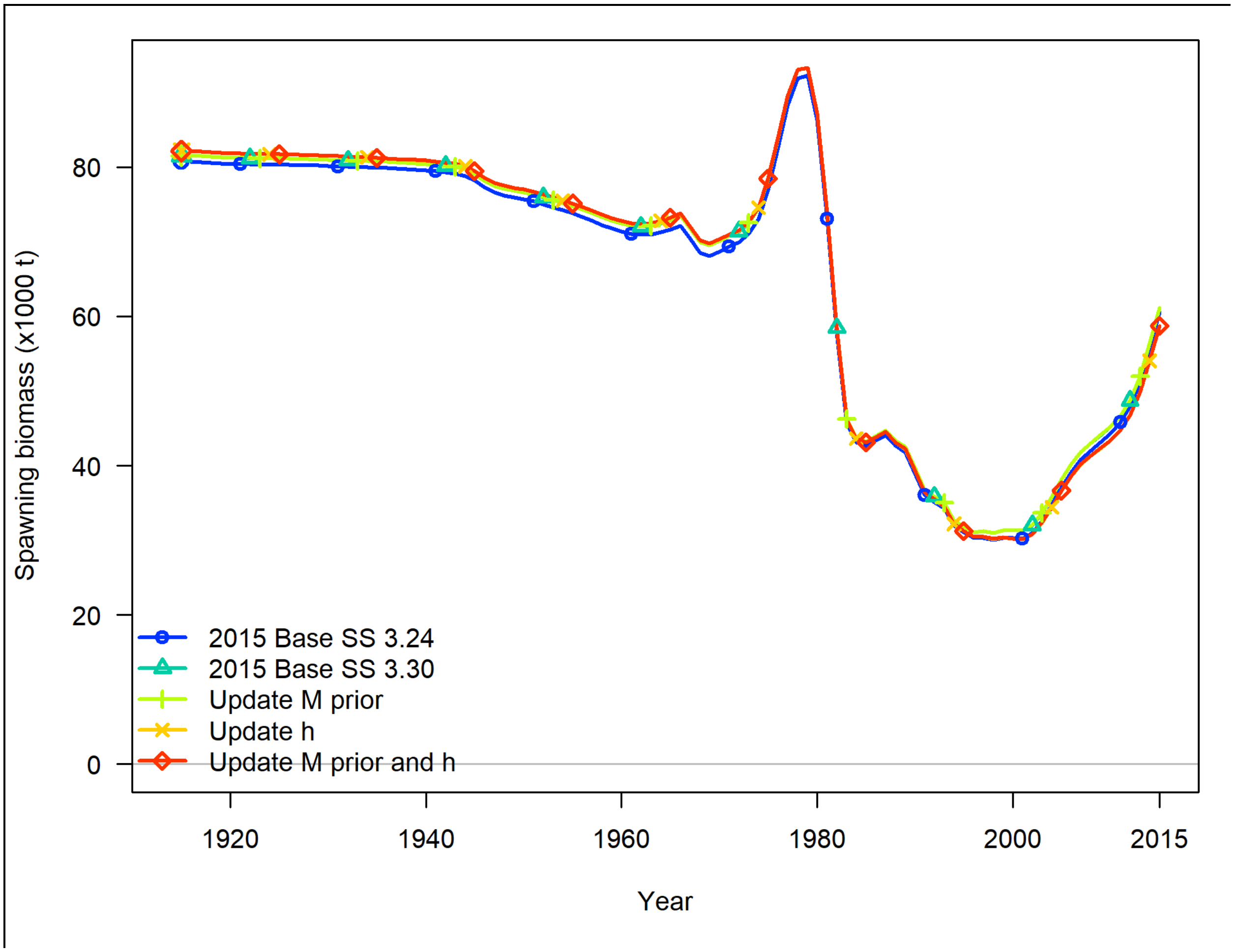


Figure 41: Bridging from the 2015 assessment models with updated priors.

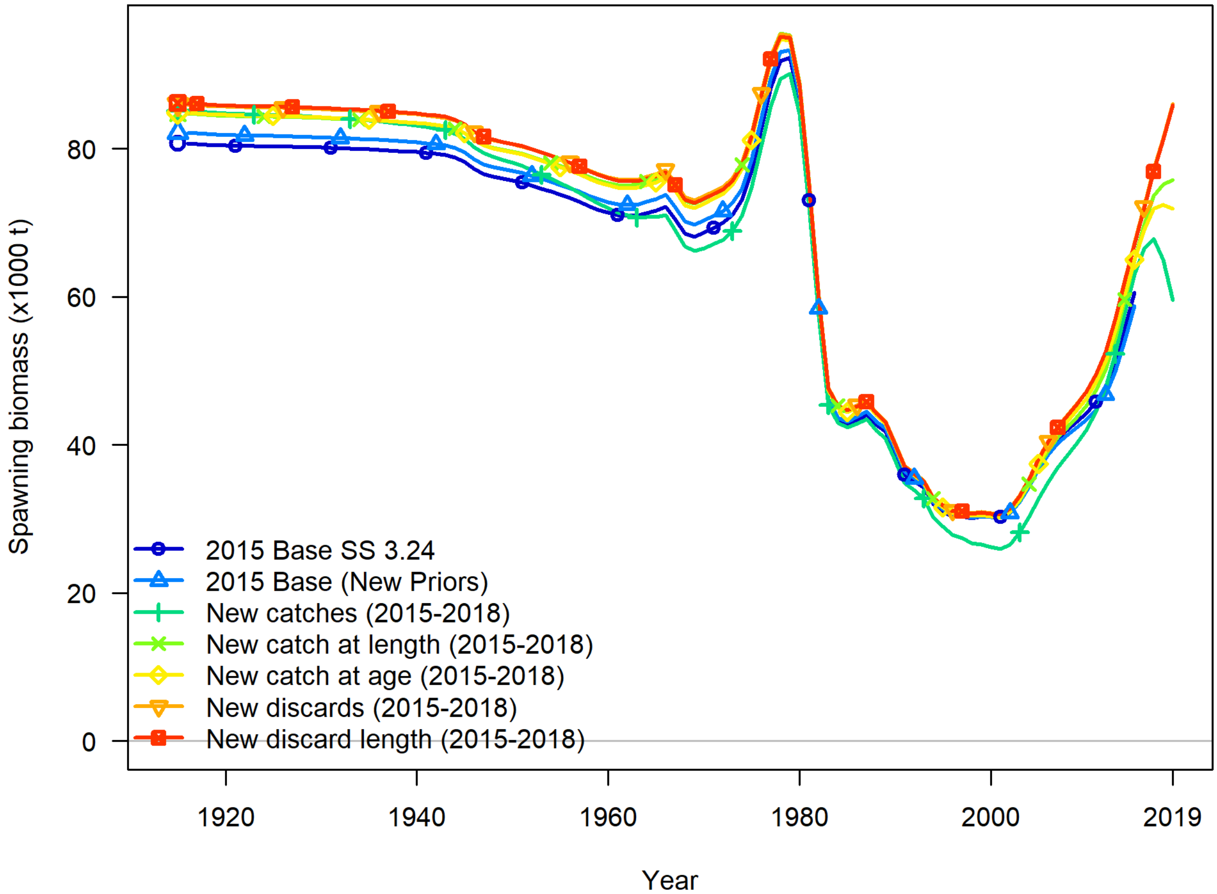


Figure 42: Bridging from the 2015 assessment models with updated priors and fishery data. Catch-at-length and catach-at-age indicate updated years of catch composition data. All models except 2015 Base SS 3.24 were fit in SS 3.30.

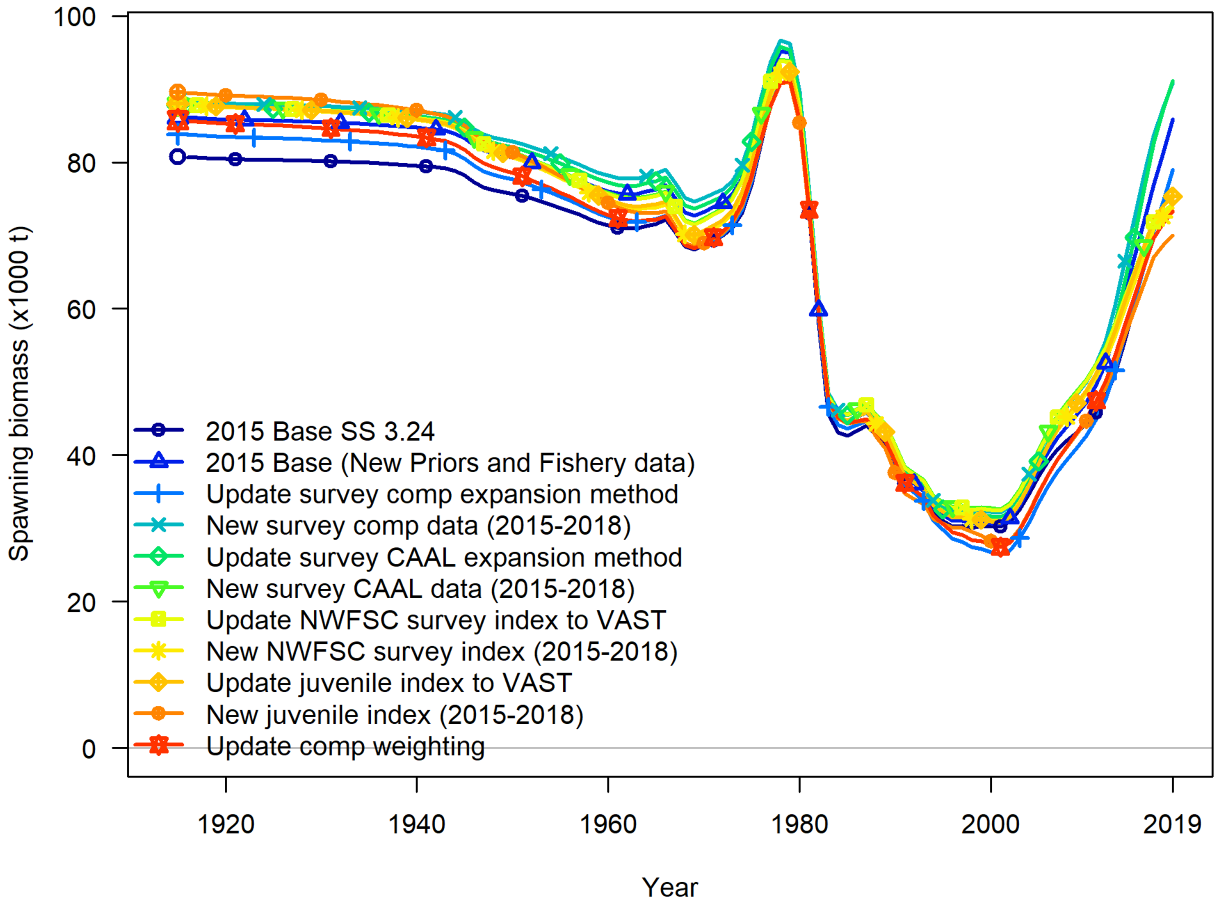


Figure 43: Bridging from the 2015 assessment models with updated priors, fishery data, and survey data. All models except 2015 Base SS 3.24 were fit in SS 3.30.

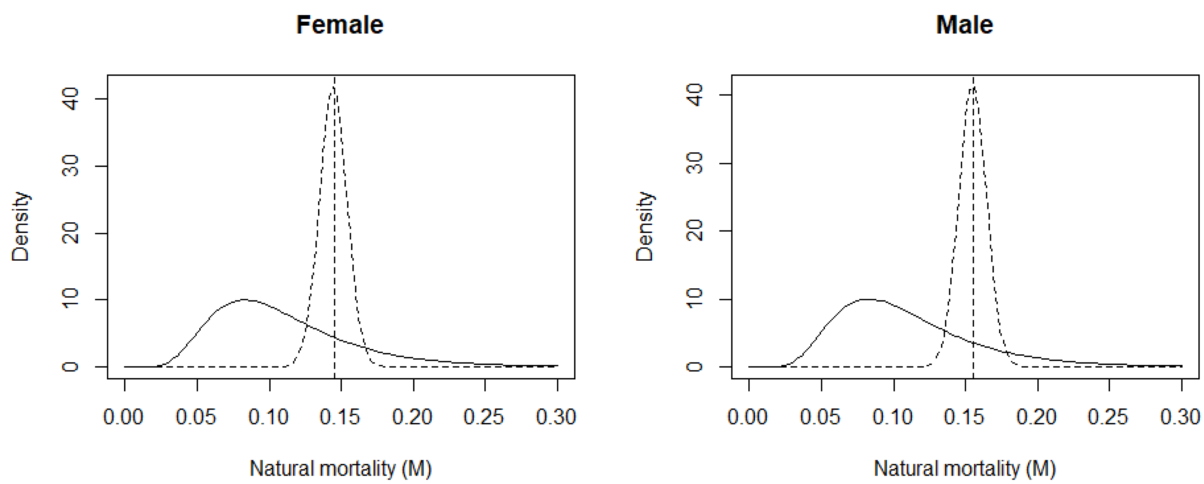


Figure 44: The prior for natural mortality (*M*, yr^{-1}) and the estimated *M* for females (left) and males (right) with asymptotic uncertainty based on maximum likelihood theory. The median of the prior is shown by the red triangle and the maximum likelihood estimate is shown by the vertical blue line.

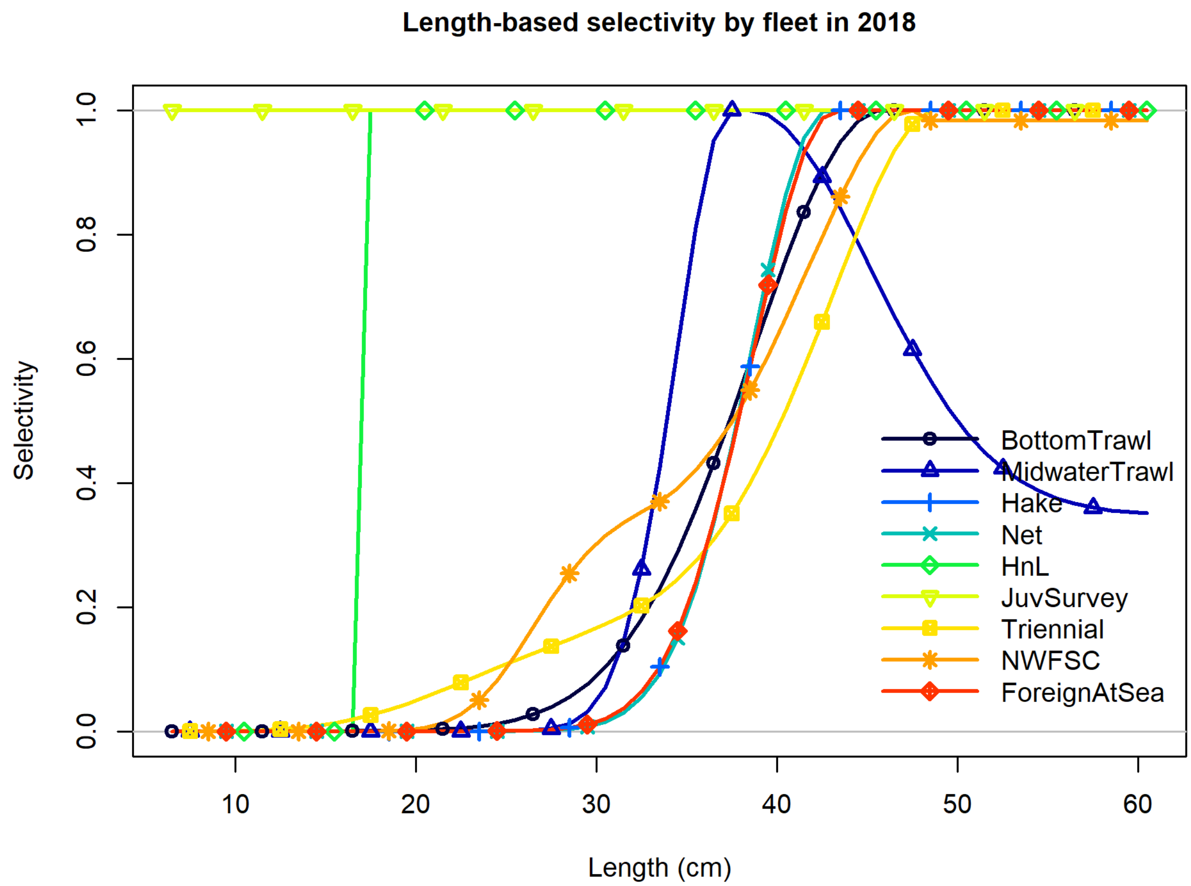


Figure 45: Estimated selectivity for different fleets and surveys.

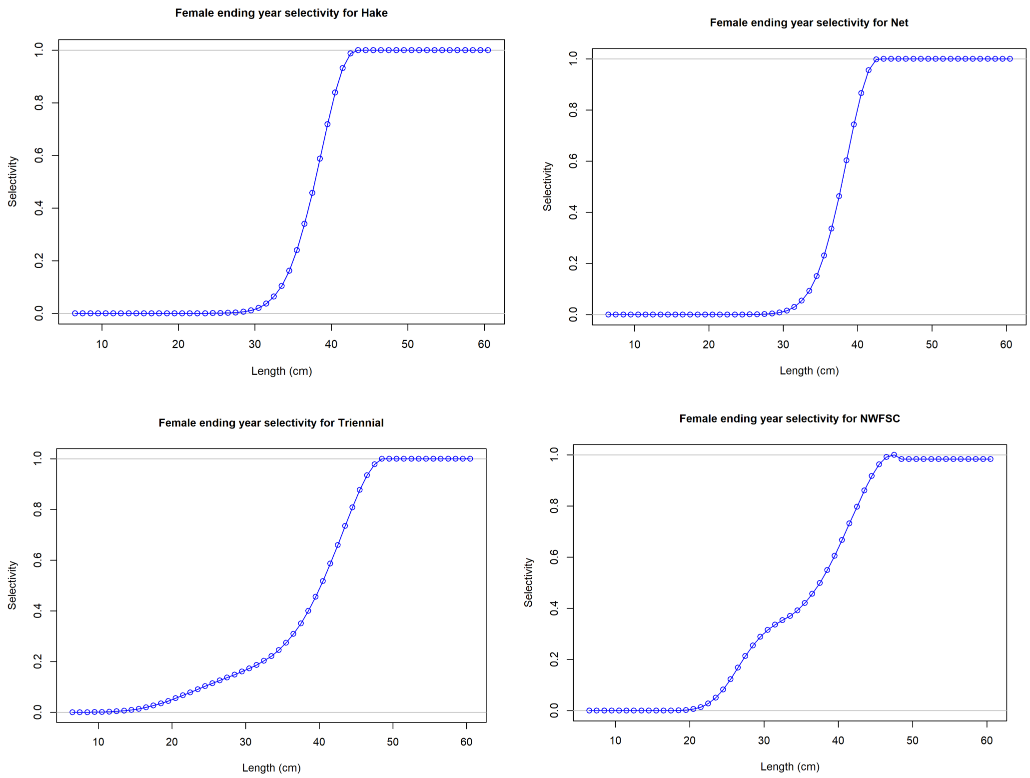


Figure 46: Estimated selectivity curves for 2018 of the hake fleet (topleft), net fishing fleets (topright), the triennial survey (bottomleft), and the NWFSC survey (bottomright).

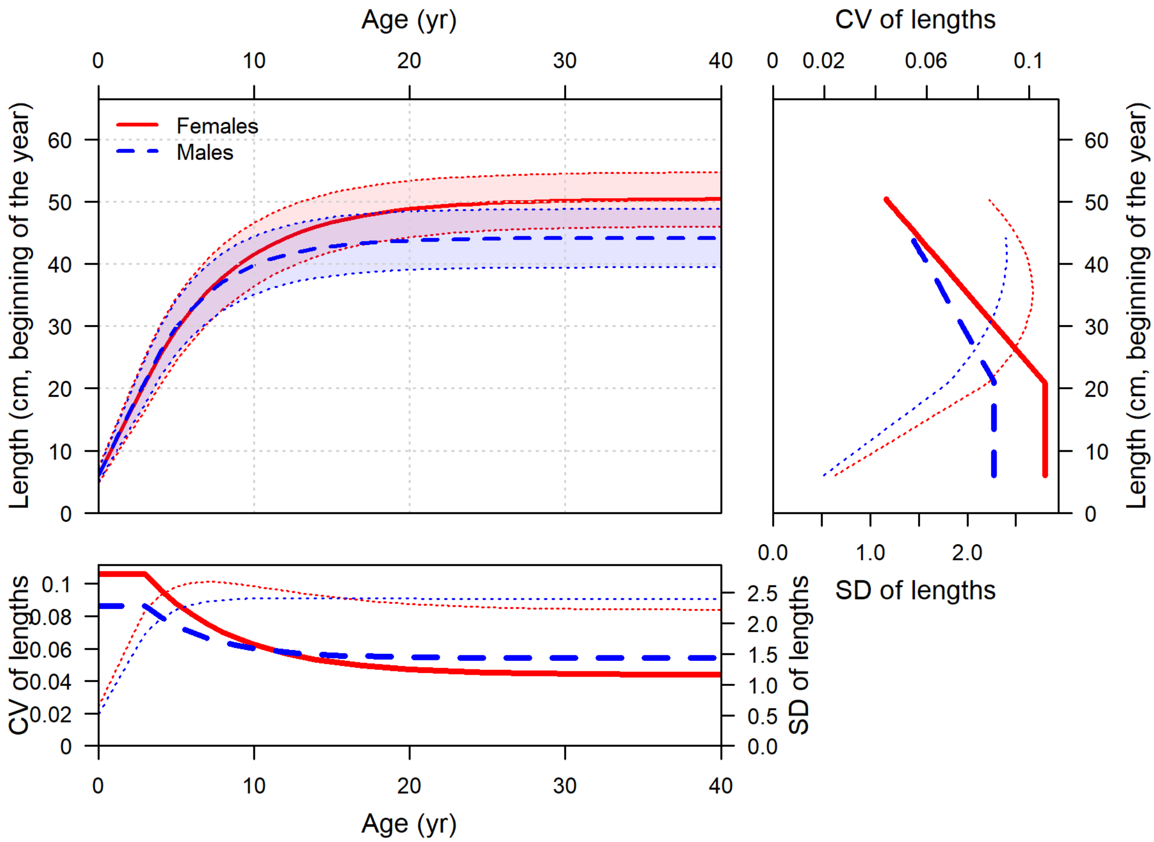
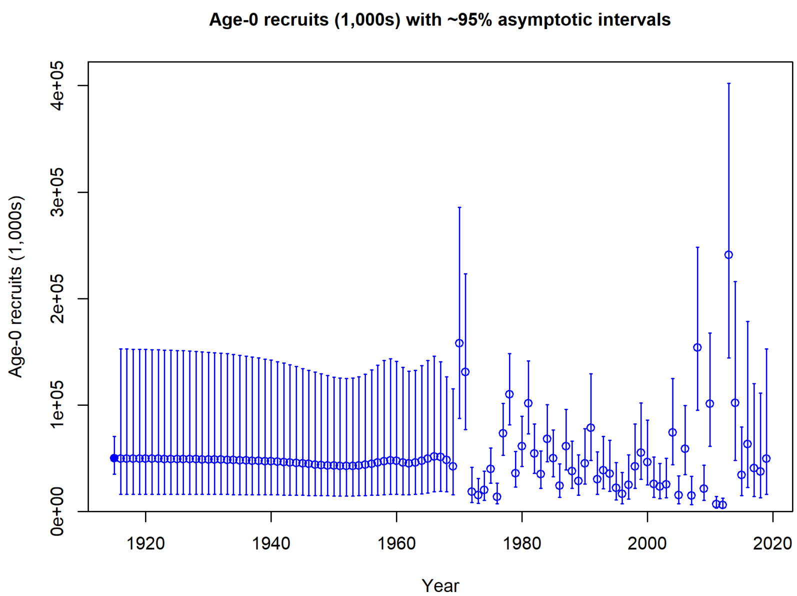


Figure 47: Length at age (top-left panel) with estimated coefficient of variation (CV, thick line) and calculated standard deviation (SD, thin line) versus length at age in the top-right panel and versus age in the lower-left panel.



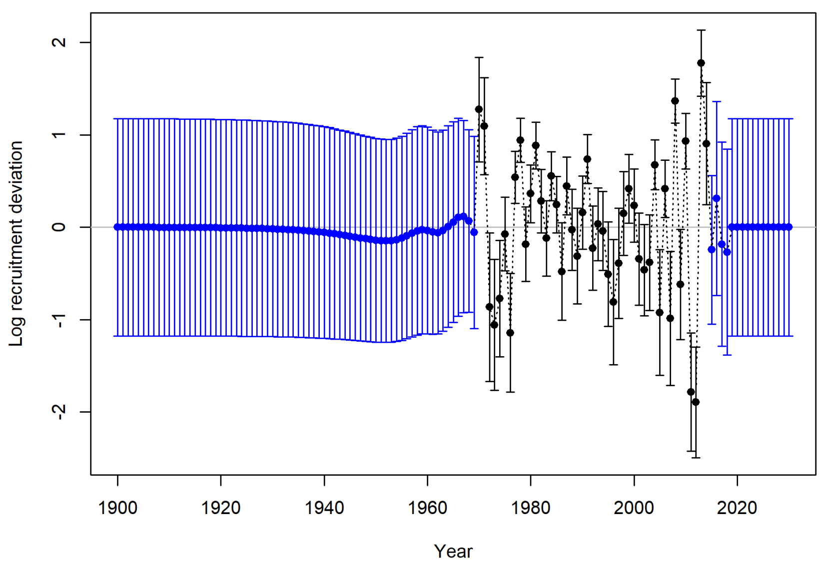


Figure 48: Estimates of recruitment (upper) and recruitment deviates (lower) with approximate asymptotic 95% confidence intervals (vertical lines) from the MLE estimates.

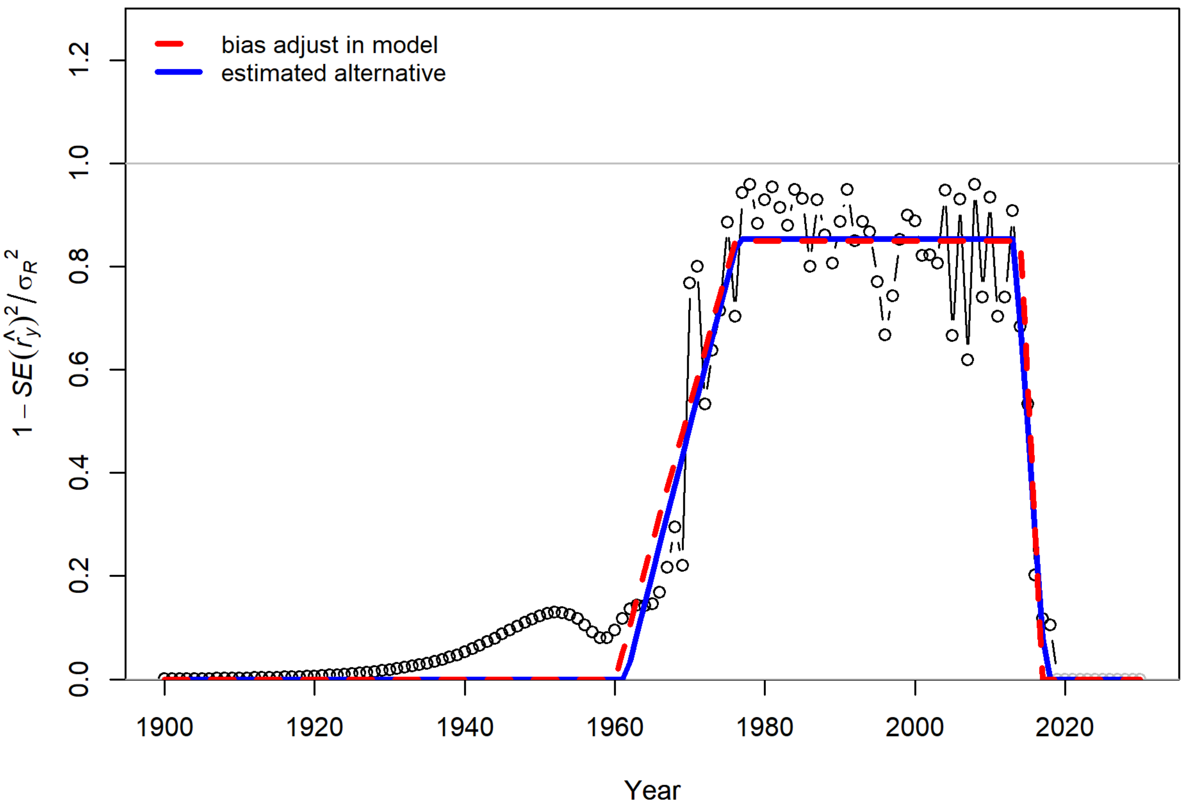


Figure 49: Estimated and input recruitment bias adjustment ramp. Red line shows current settings for bias adjustment specified the model. Blue line shows least squares estimate of alternative bias adjustment relationship for recruitment deviations.

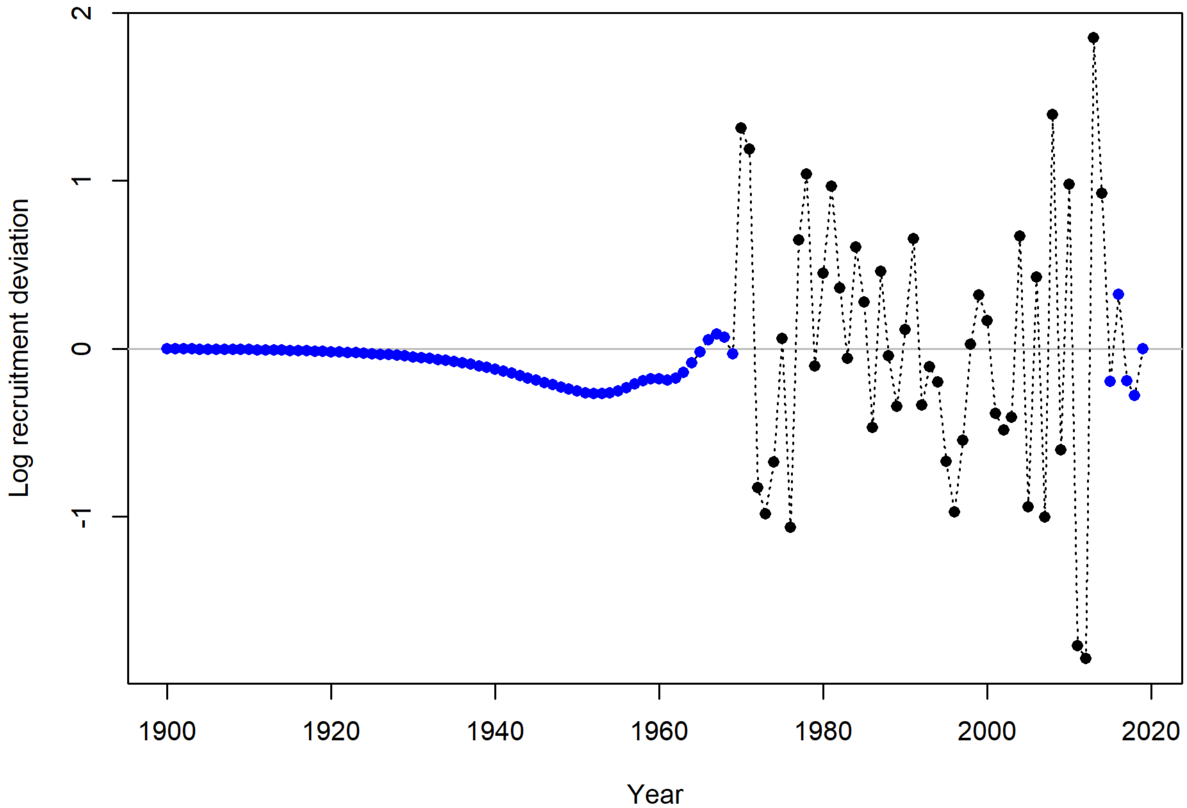


Figure 50: Estimates of recruitment deviations for a sensitivity model with natural mortality fixed at 0.124 and 0.129 for females and males, respectively.

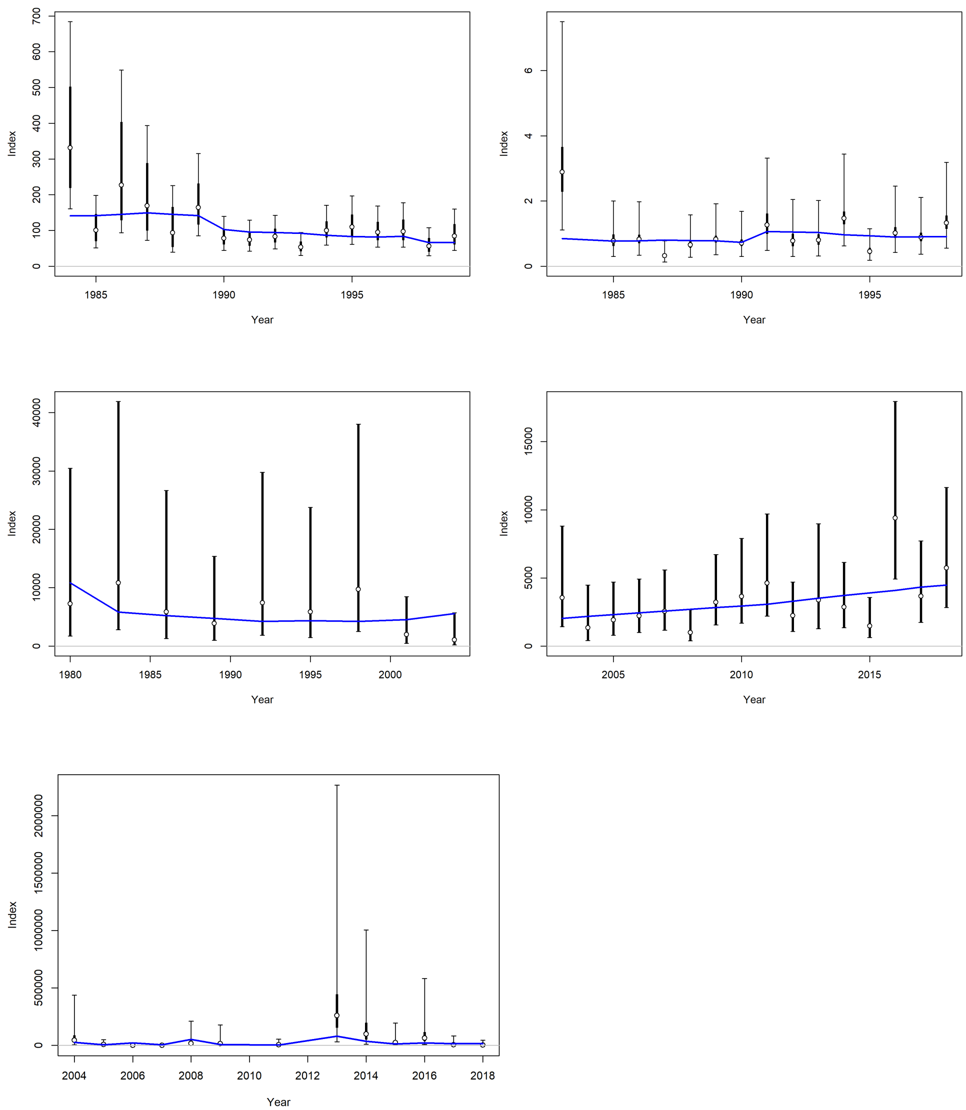


Figure 51: Fits (lines) to the abundance estimates (points) for the base model. Bottom trawl is in the top left, hake indices are in the top right (a separate *q* is estimated for the Hake series starting in 1991), the triennial trawl survey index is on the middle left, the NWFSC survey index is on the middle right, and the juvenile survey index (in numbers) is on the bottom. 95% confidence intervals are shown input the input standard errors. Thicker lines (if present) indicate input uncertainty before addition of estimated additional uncertainty parameter.

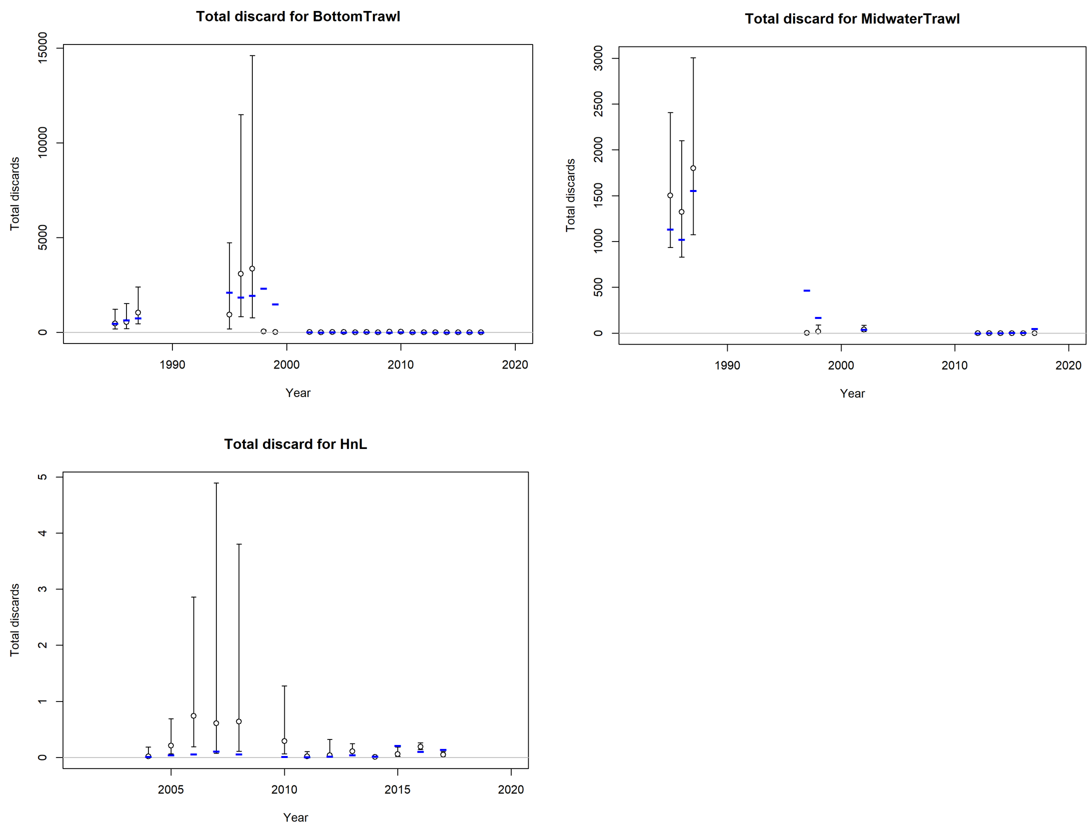


Figure 52: Predicted (blue line) and observed (open circles) discards for the bottom trawl (top left), midwater trawl (top right), and hook-and-line (bottom left) fleets from the base model. 95% confidence intervals are shown for the observations.

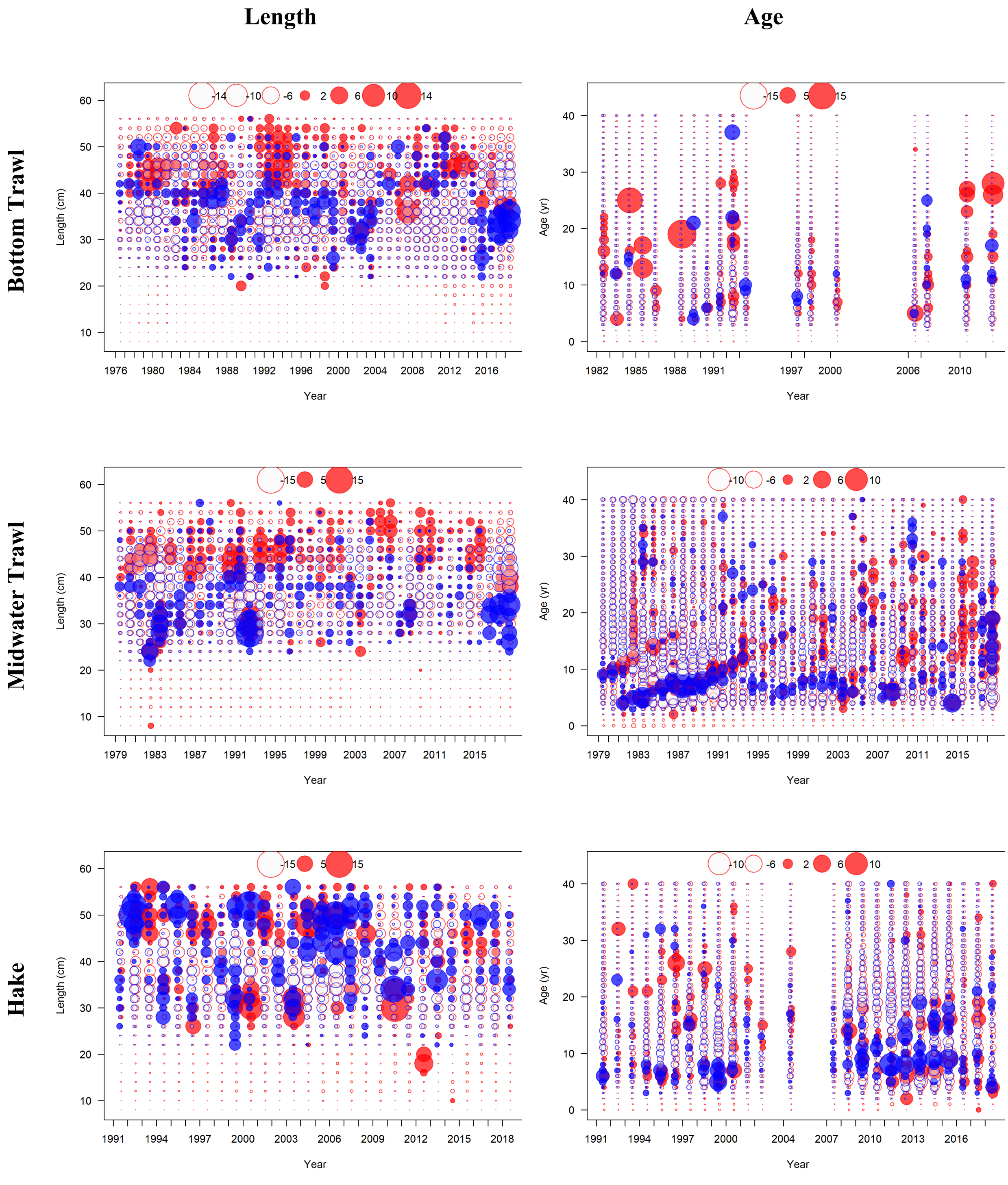


Figure 53: Pearson residuals for fits to length frequency data (left) and age frequency data (right) for landings from the trawl commercial fleets (rows). Filled circles indicate that the fitted proportion was less than the observed proportion. Red indicates females, blue males, and gray unsexed.

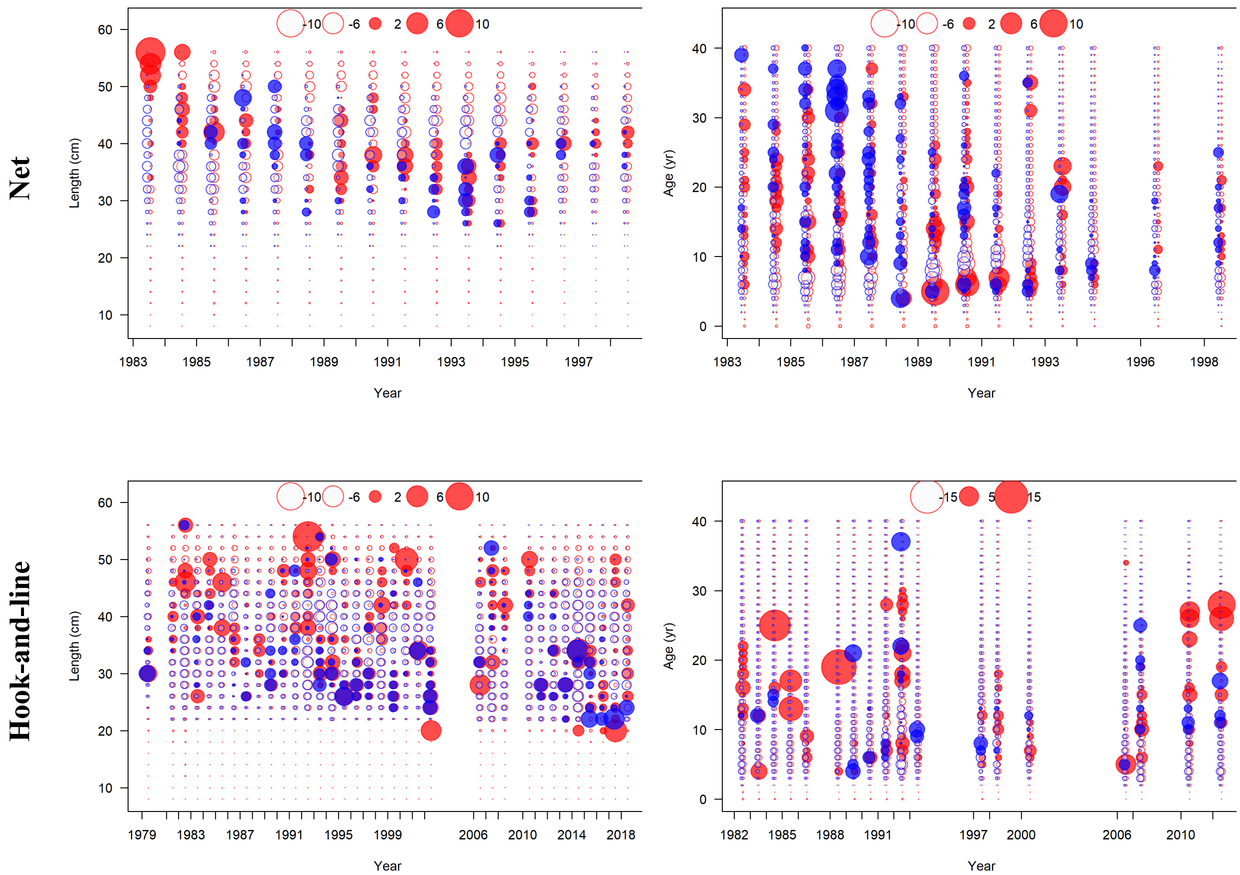


Figure 54: Pearson residuals for fits to length frequency data (left) and age frequency data (right) for landings from the net and hook-and-line commercial fleets (rows). Filled circles indicate that the fitted proportion was less than the observed proportion. Red indicates females, blue males, and gray unsexed.

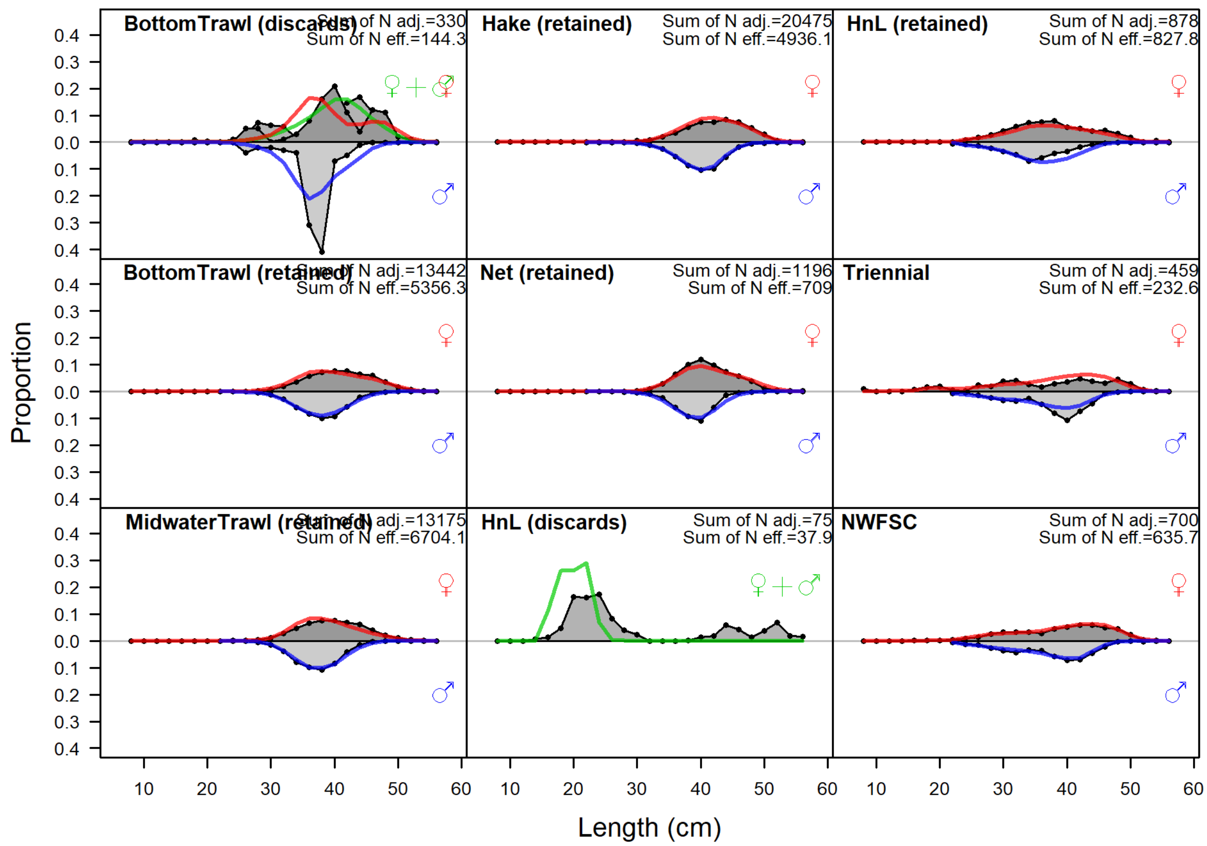


Figure 55: Combined length frequencies for all years from fishery (retained catch) and survey length frequency data (points). Fits are shown by the red line (females) and blue line (males).

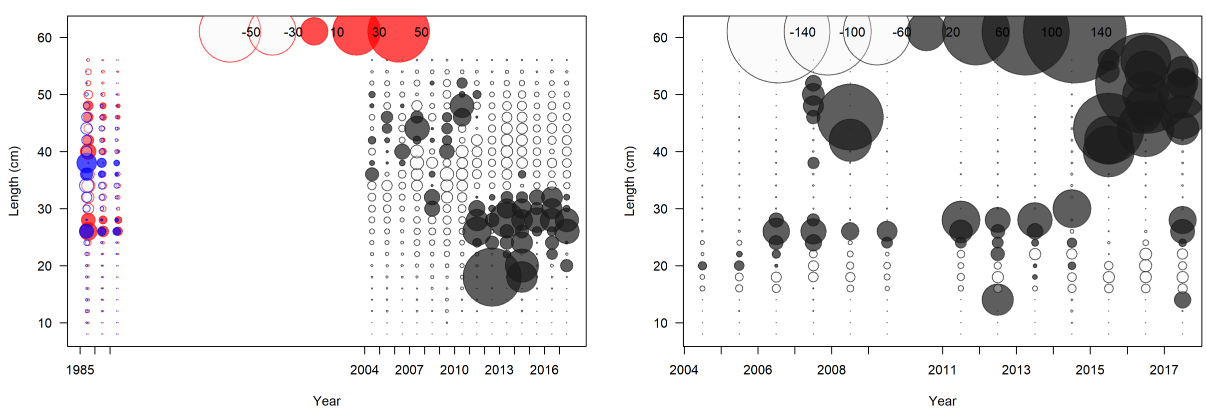


Figure 56: Pearson residuals for fits to the discard length frequencies from the bottom trawl (left) and hook-and-line (right) fleets. Filled circles indicate that the fitted proportion was less than the observed proportion. Red indicates females, blue males, and gray unsexed.

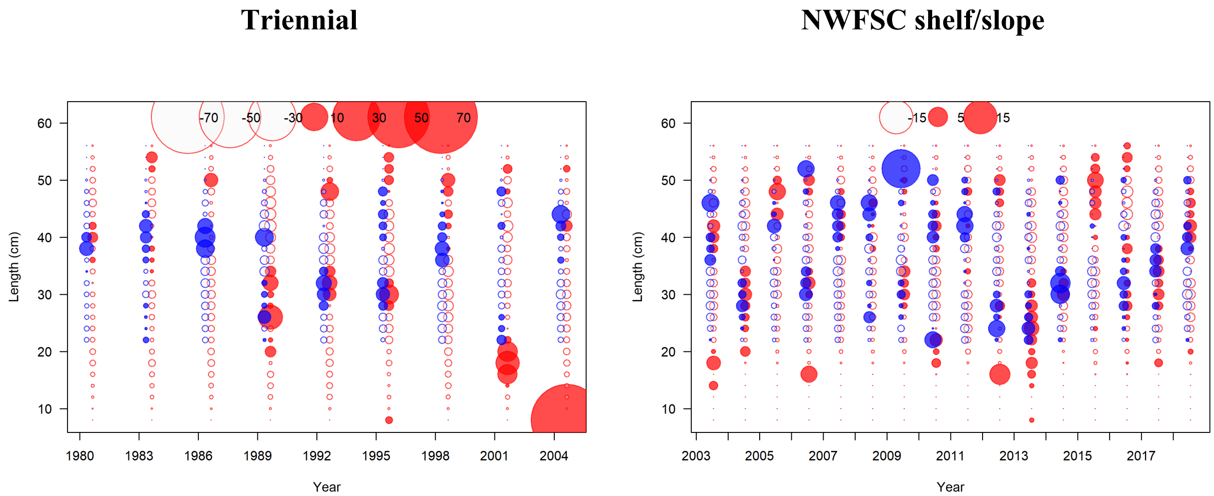


Figure 57: Pearson residuals for fits to the triennial survey length frequency data (left) and NWFSC WCGBT (shelf/slope) survey length frequency data (right). Filled circles indicate that the fitted proportion was less than the observed proportion. Red indicates females, blue males, and gray unsexed.

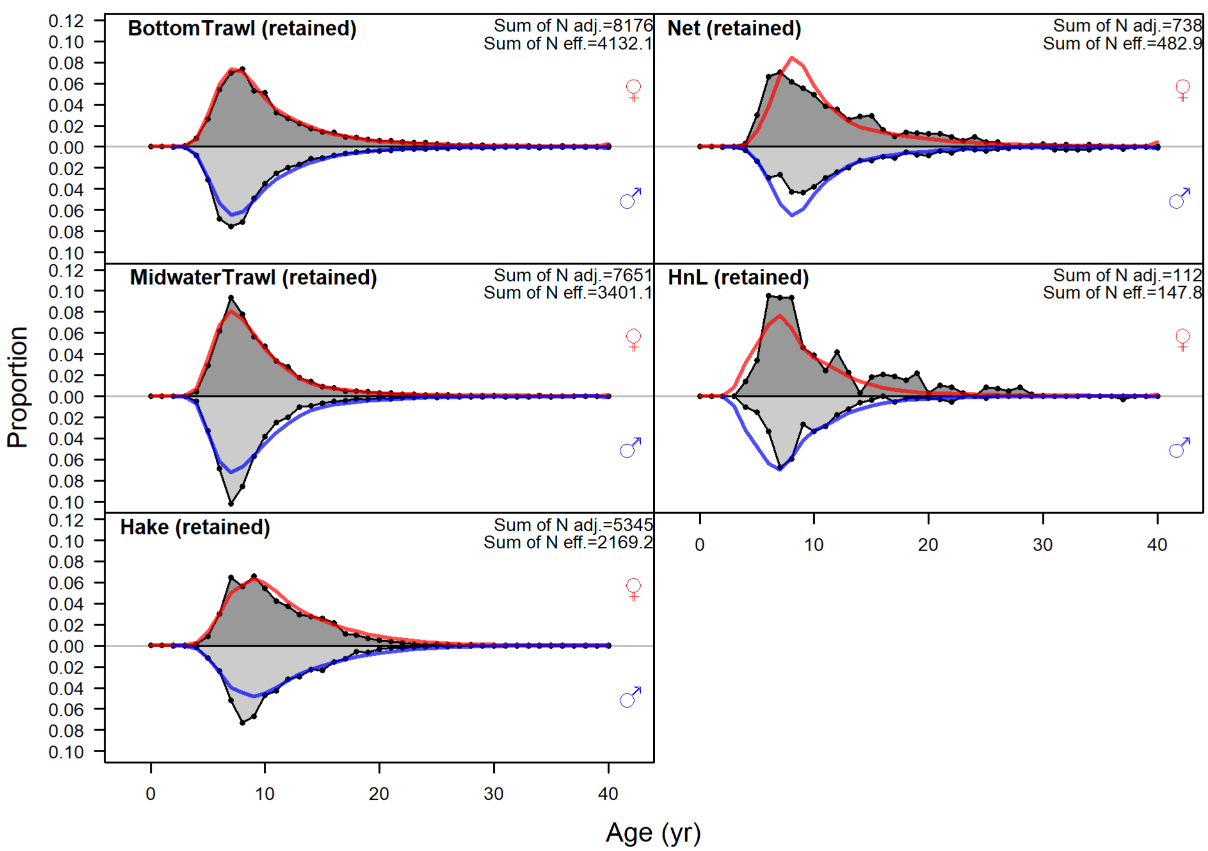


Figure 58: Combined age frequencies for all years from fishery (retained catch) and survey length frequency data (points). Fits are shown by the red line (females) and blue line (males).

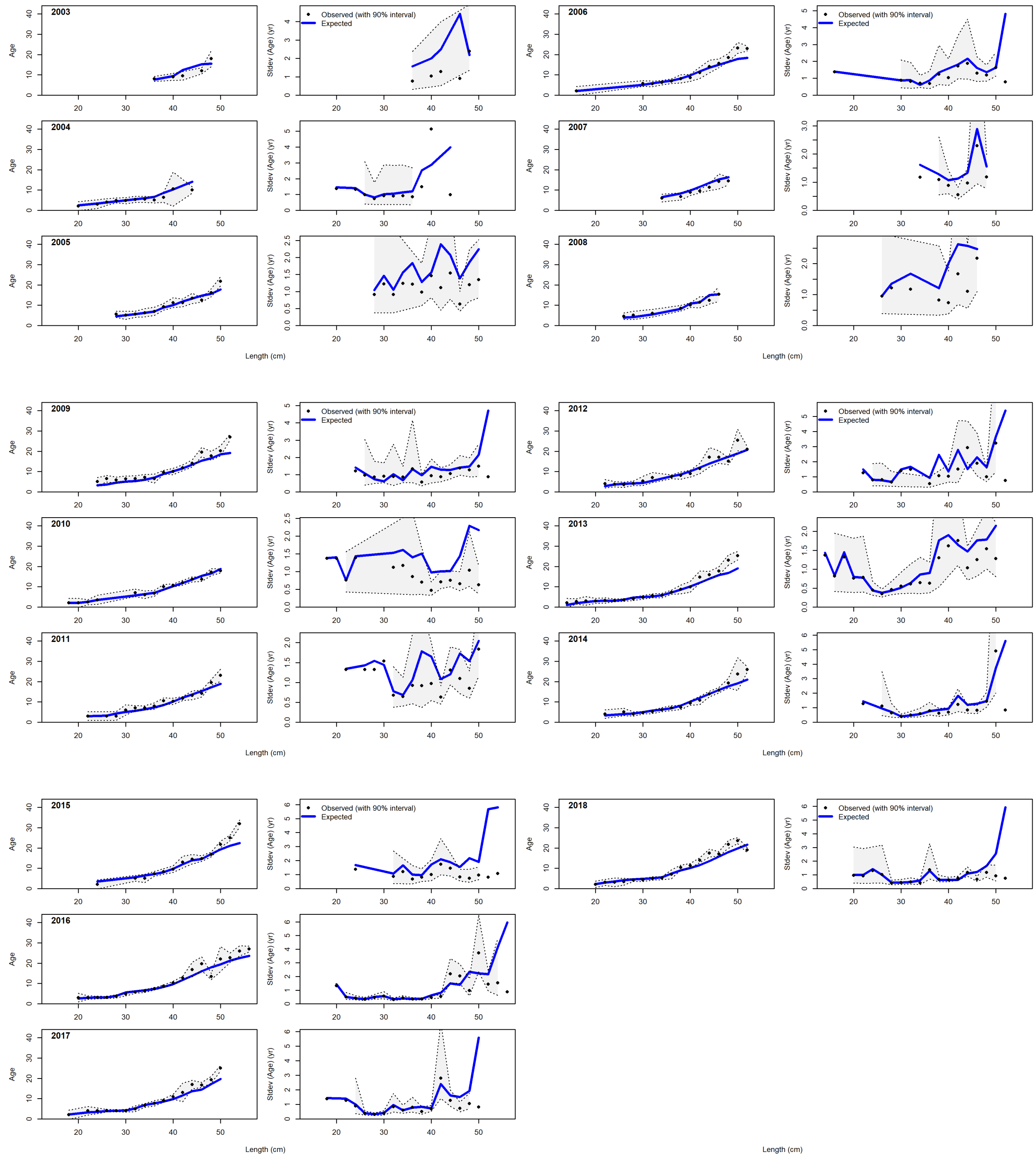


Figure 59: Observed and expected age-at-length with 95% confidence intervals (left) and observed and expected standard deviation of age-at-length with 95% confidence intervals (right) for the NWFSC WCGBT survey data.

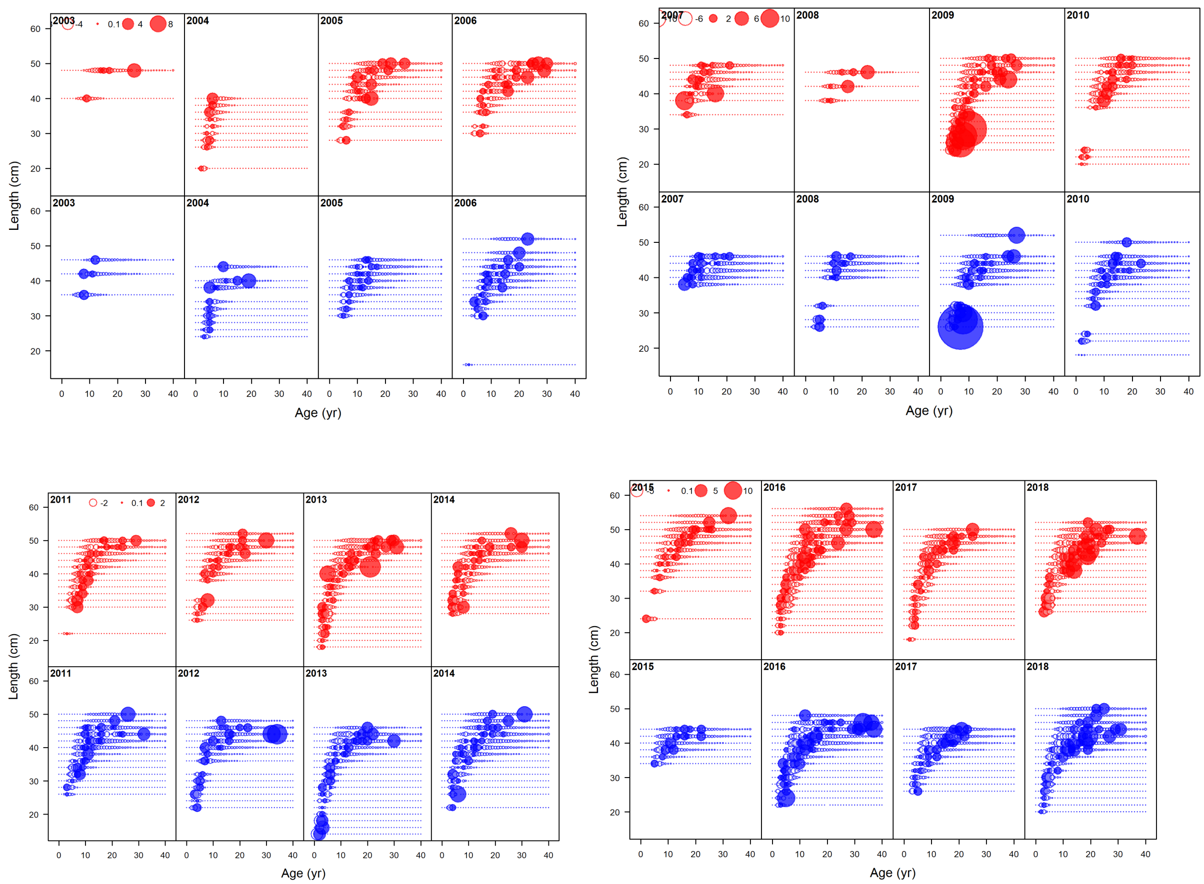


Figure 60: Pearson residuals for fits to age-at-length data for the NWFSC WCGBT survey. Filled circles indicate that the fitted proportion was less than the observed proportion.

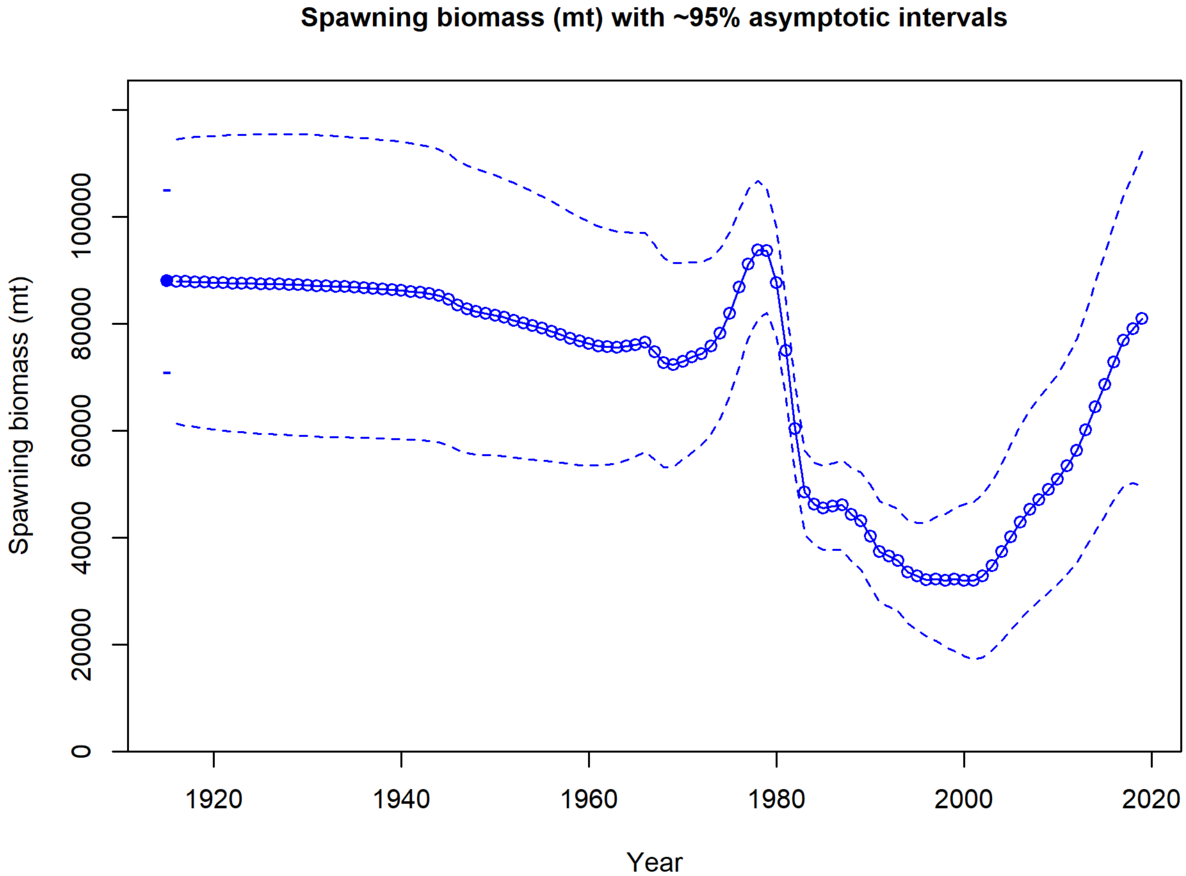


Figure 61: Predicted spawning biomass (thousand mt) for Widow Rockfish using the base assessment. The solid line is the MLE estimate and the dashed lines depicts the approximate asymptotic 95% confidence intervals.

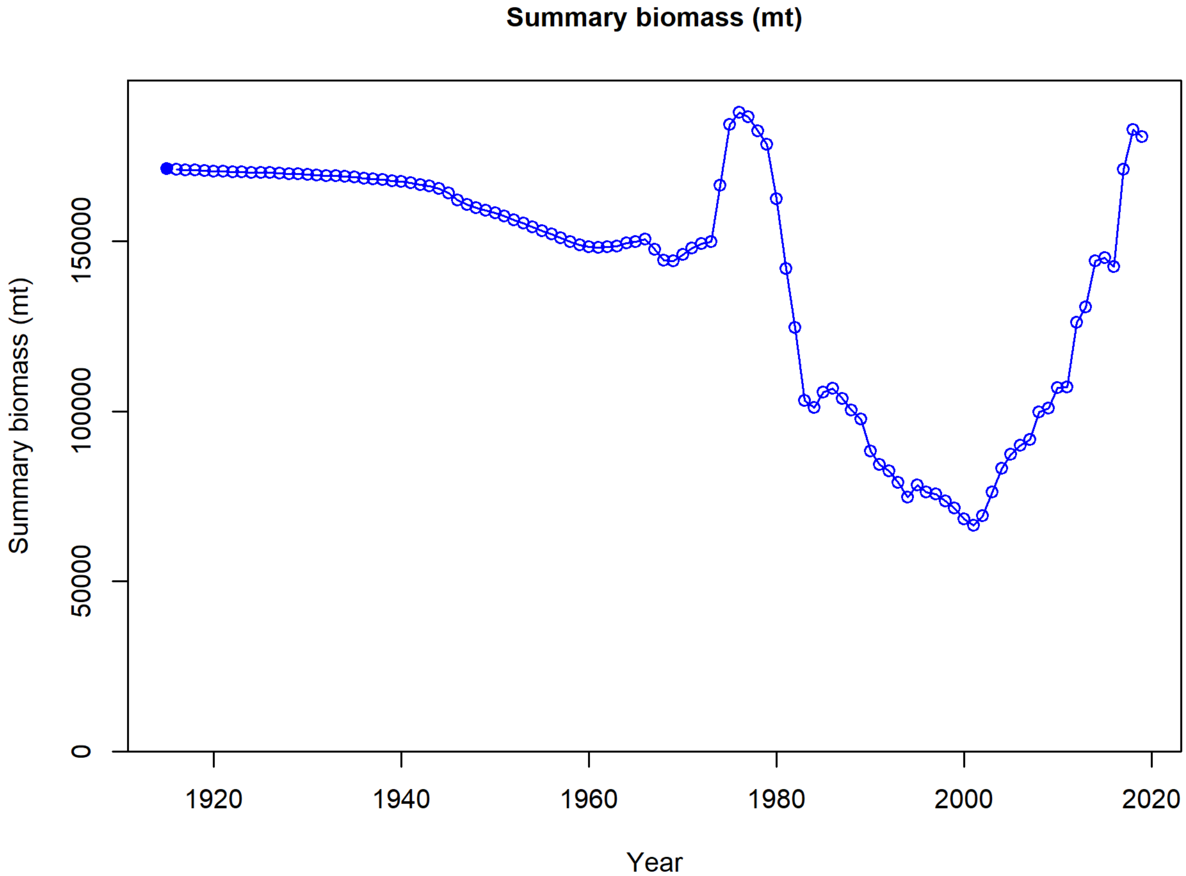


Figure 62: Predicted summary biomass (age 4+) from the base model.

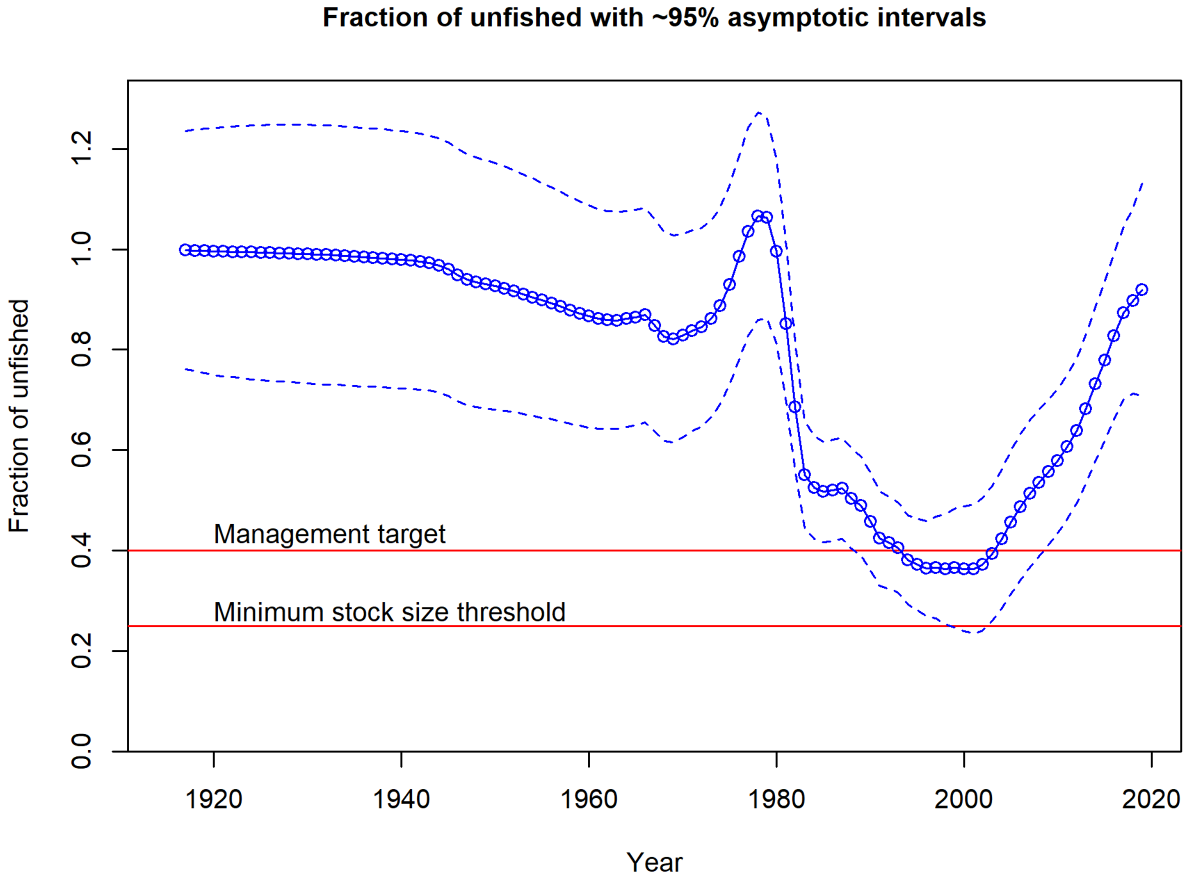


Figure 63: Predicted relative spawning biomass from the Widow Rockfish base case assessment. The solid line is the MLE estimate and the dashed lines depicts the approximate asymptotic 95% confidence intervals. The dashed lines show the equilibrium level (100%), the management target of 40% of unfished biomass, and the minimum stock size threshold of 25% of unfished biomass.

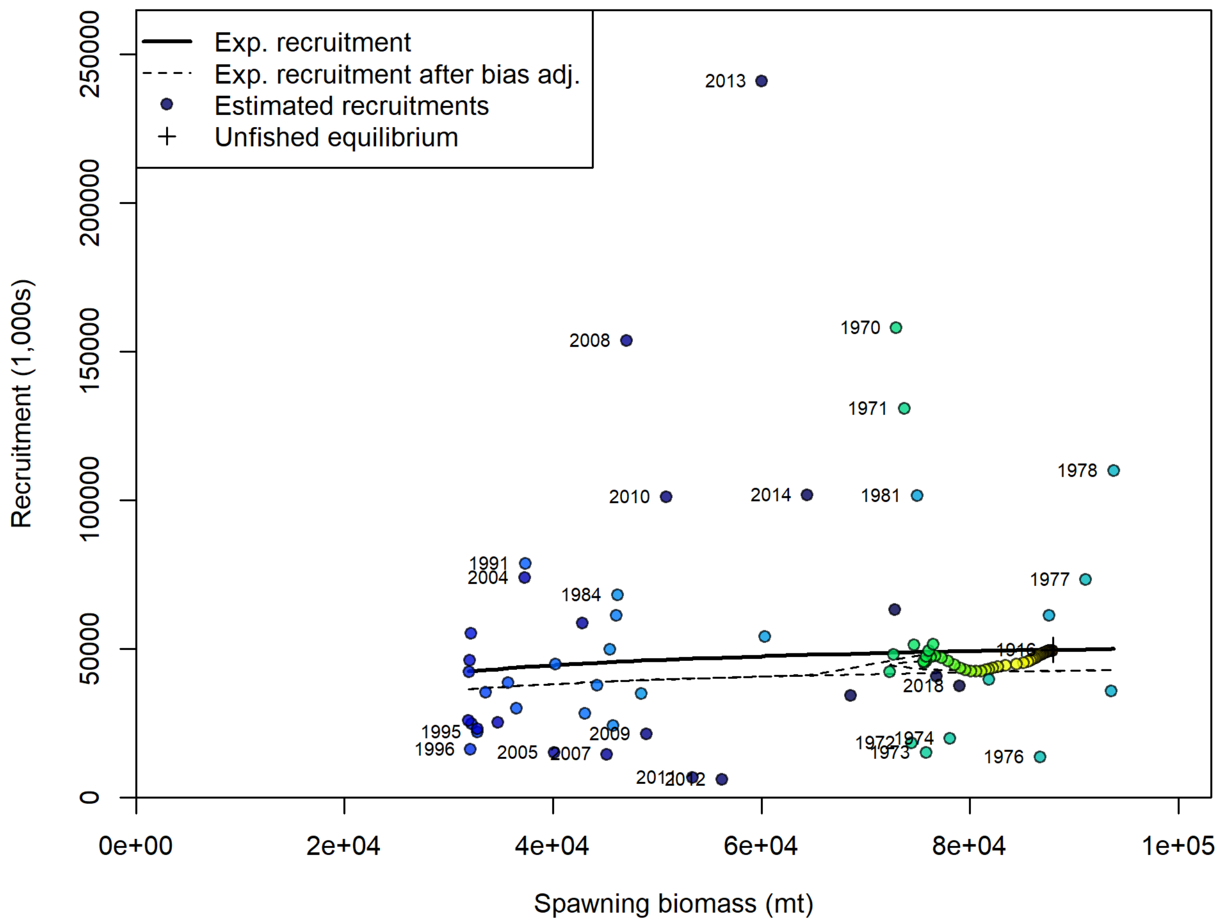


Figure 64: Estimated recruitment (red circles) and the assumed stock-recruit relationship (black line). The dashed line shows the effect of the bias correction for the lognormal distribution.

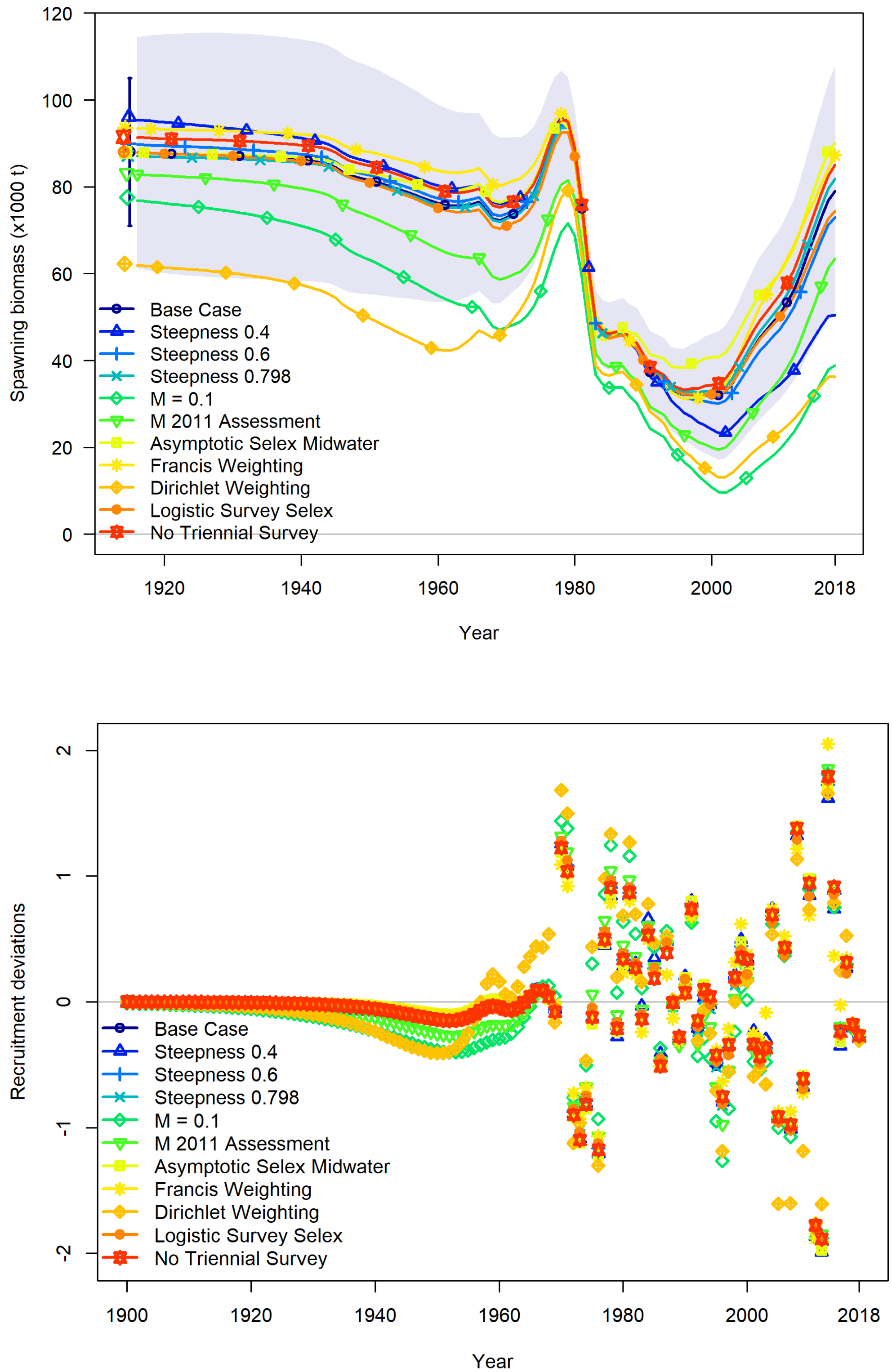
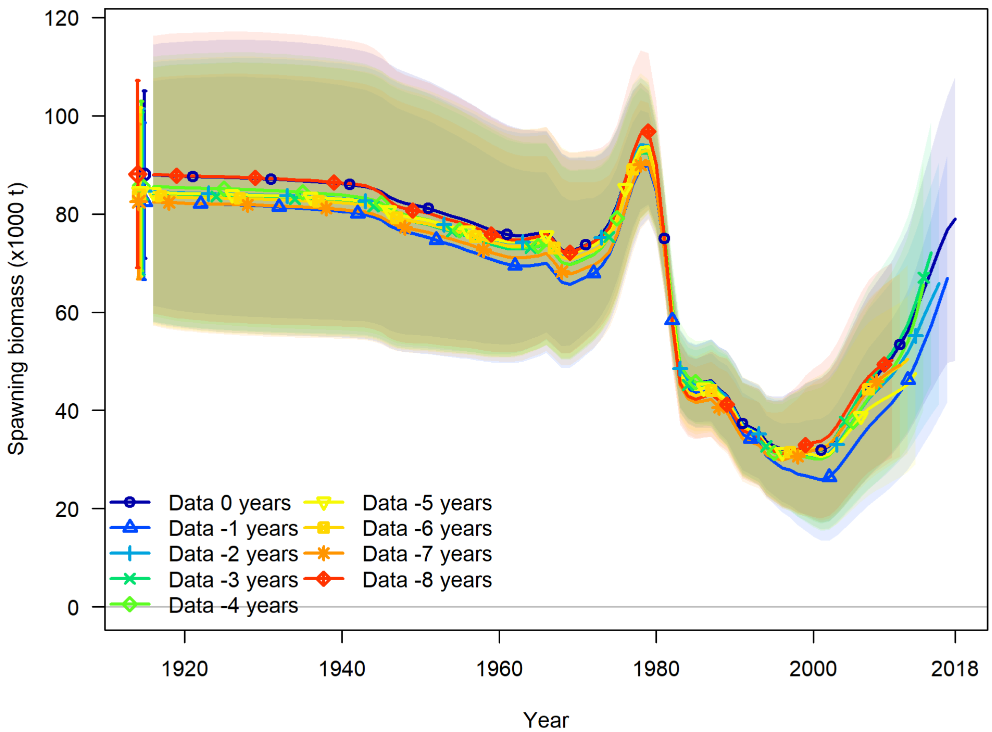


Figure 65: Spawning biomass (with 95% confidence interval around the base model) and recruitment deviations for the base model and sensitivity runs.



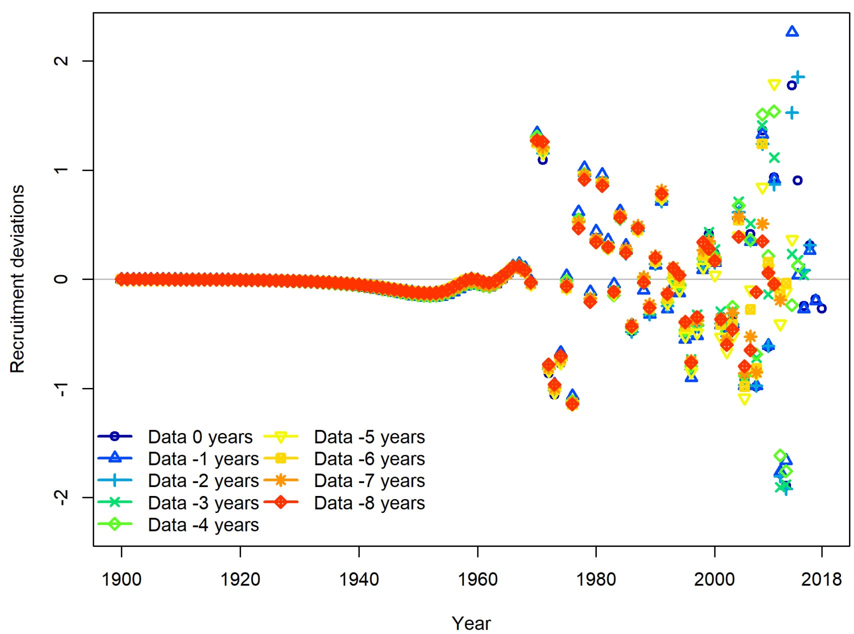


Figure 66: Eight-year retrospective estimates of spawning biomass (top) and recruitment deviations (bottom).

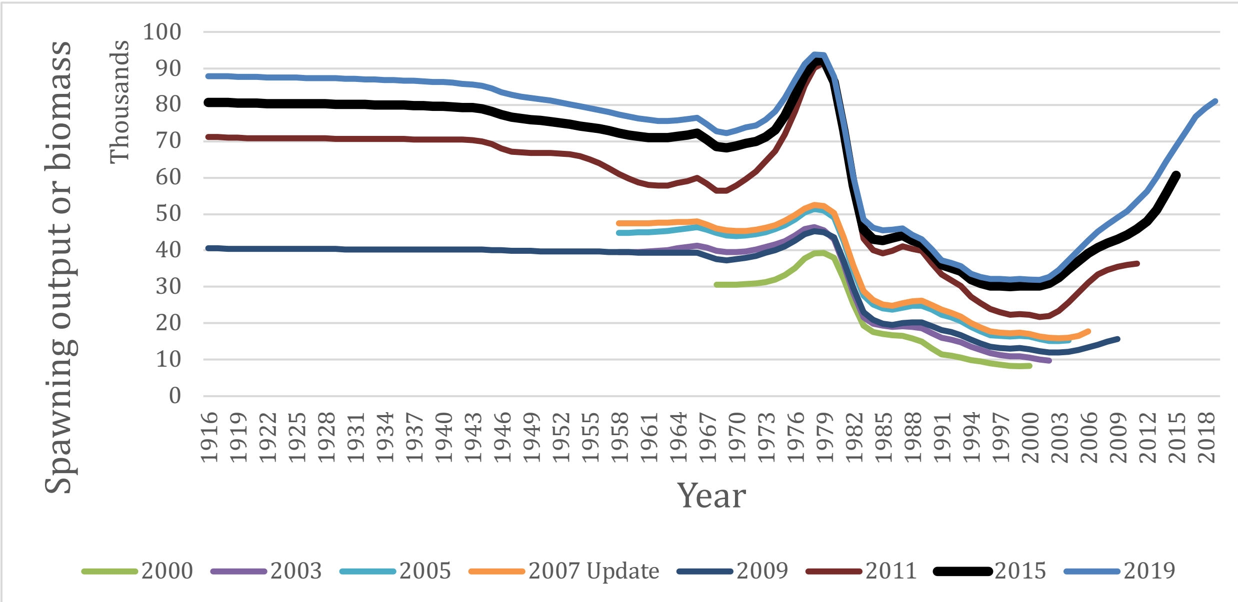


Figure 67: Predicted spawning biomass (2011, 2015, and 2019) or spawning output (2000-2009) from past assessments.

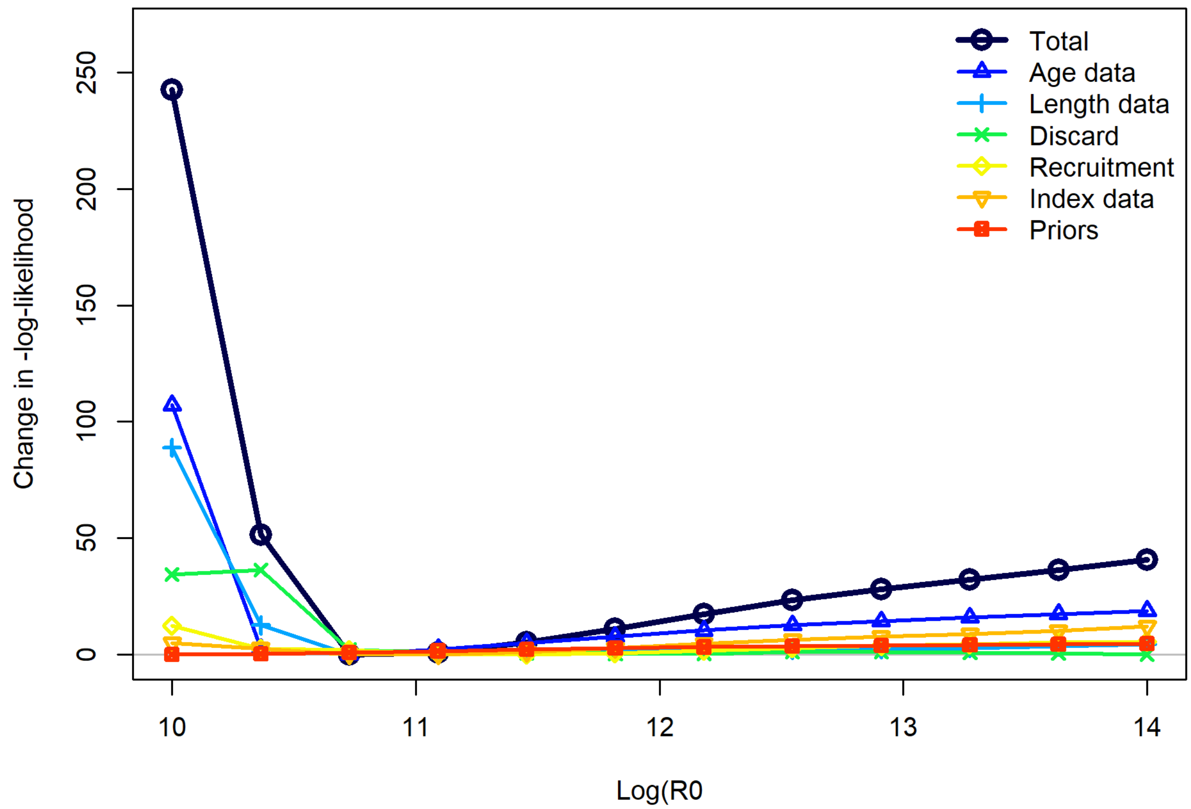


Figure 68: Likelihood components in the likelihood profile for unfished equilibrium recruitment (*R_0*).

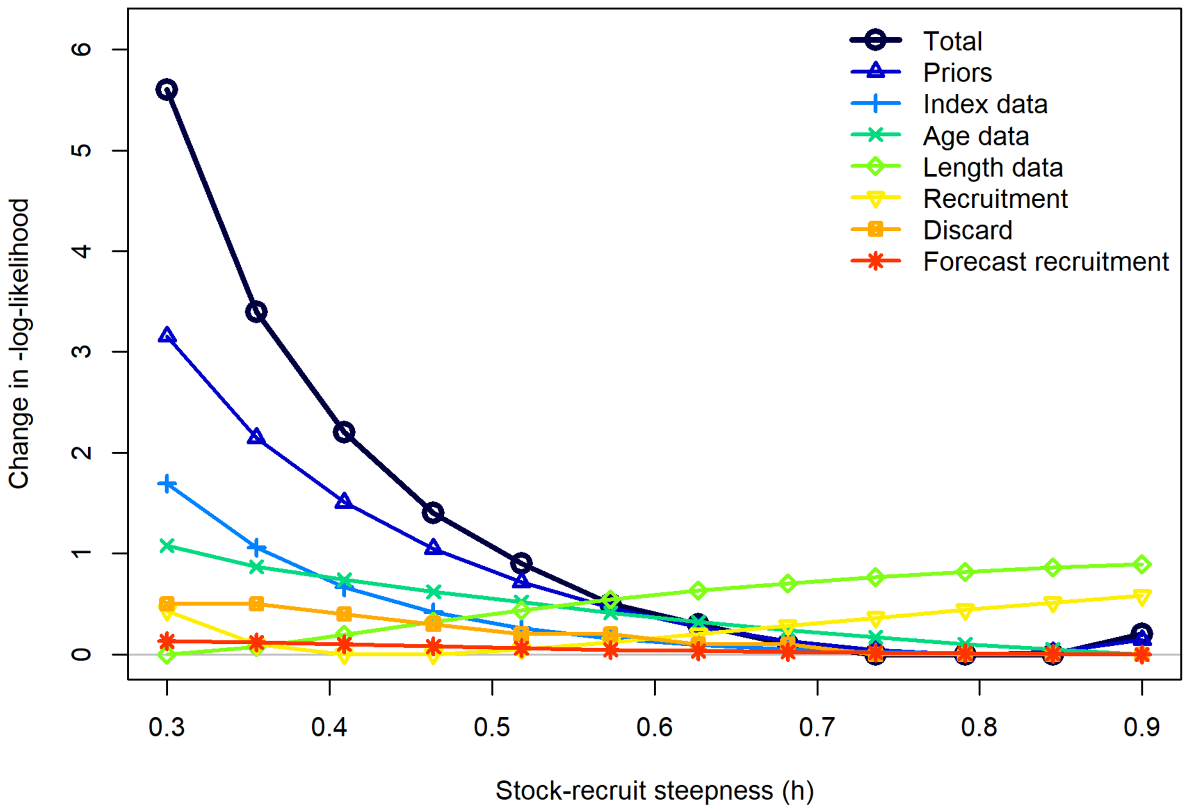


Figure 69: Likelihood components in the likelihood profile for steepness (*h*).

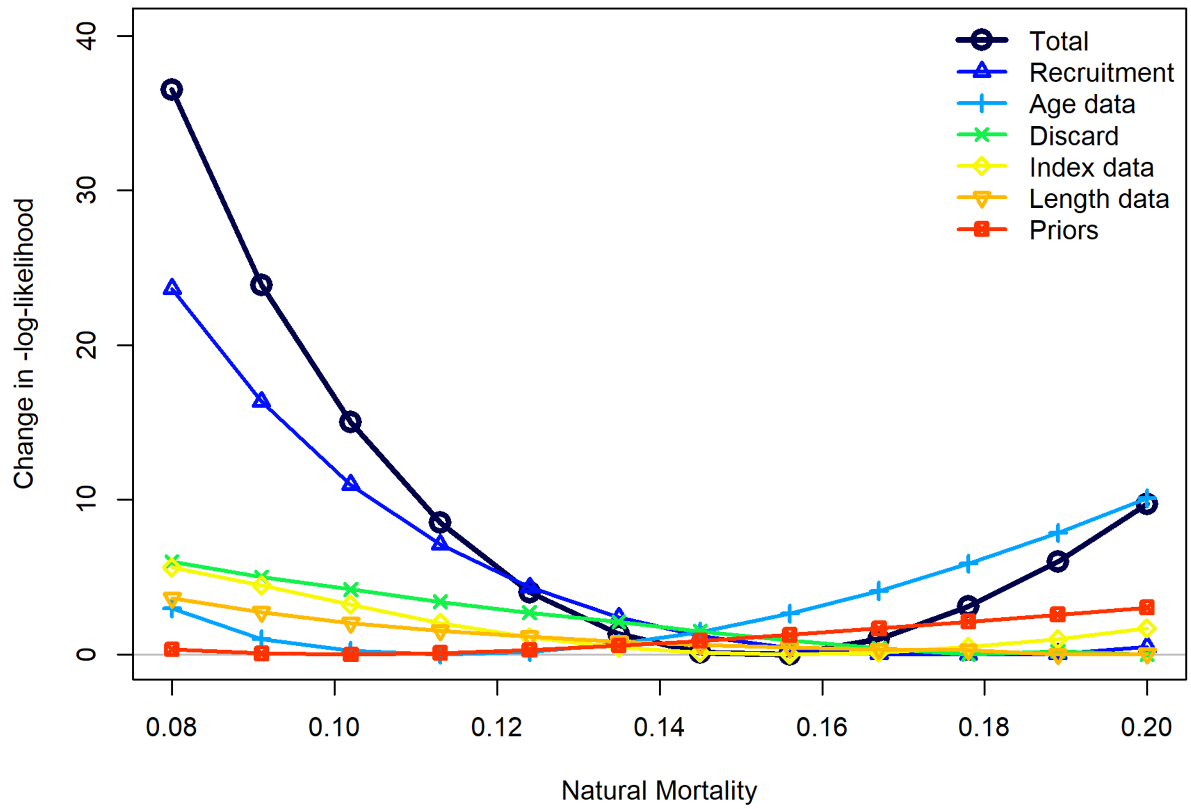


Figure 70: Likelihood components in the likelihood profile for natural mortality (*M*). Note: male and female natural mortality are set to the same value.

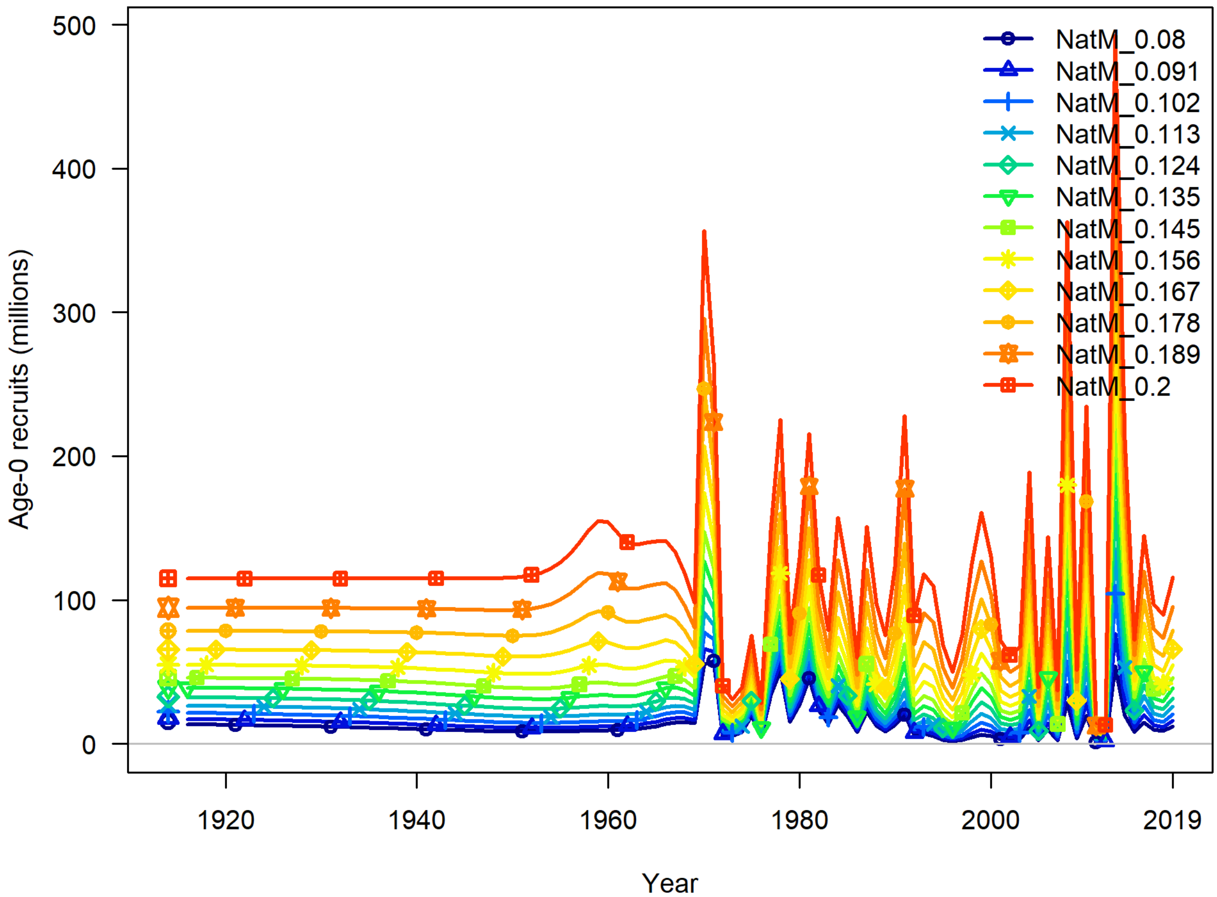


Figure 71: Time series of recruitment estimates for models with different fixed values of natural mortality (*M*)

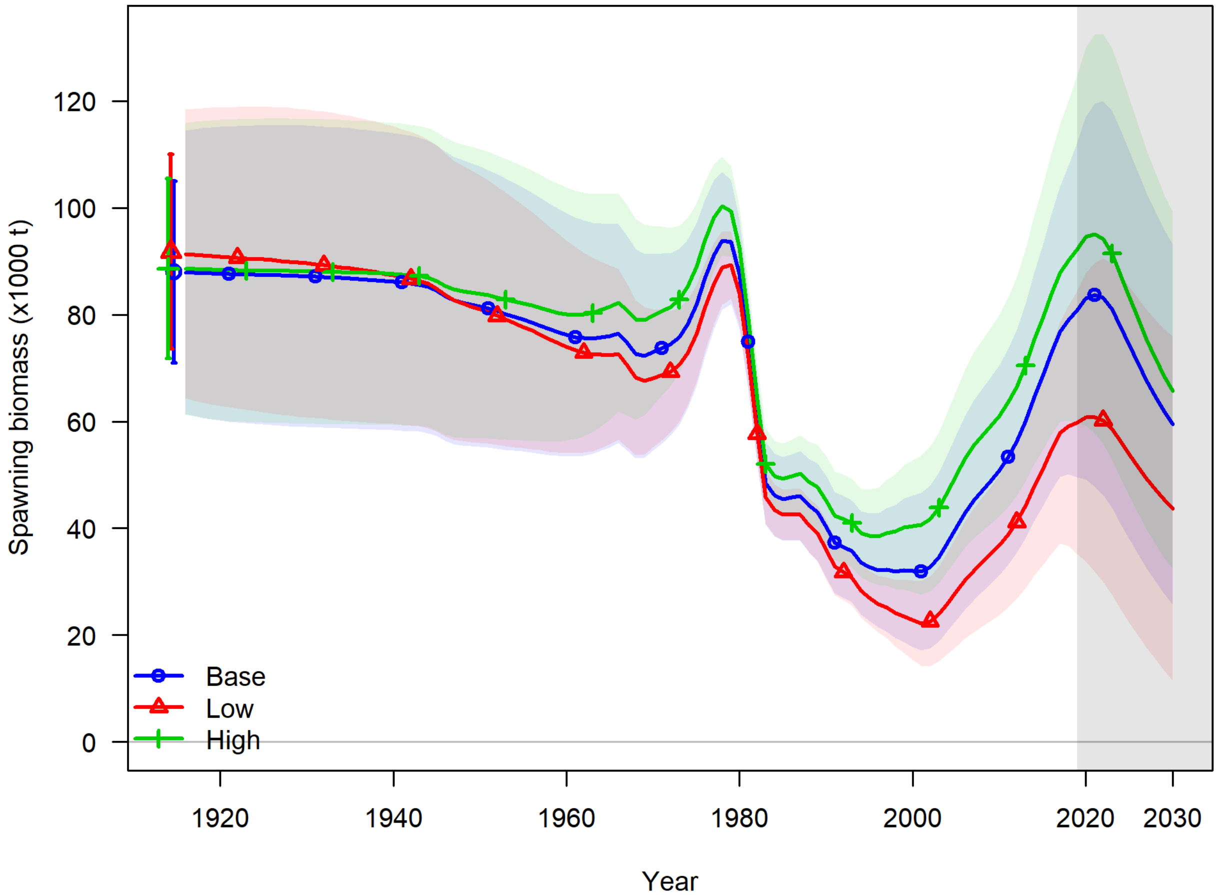


Figure 72: Base model, low state of nature, and high state of nature spawning biomass trajectories assuming a catch of 9,000 metric tons for 2019 to 2030. The shaded areas indicate the 12.5% and 87.5% lognormal quantiles of spawning biomass.

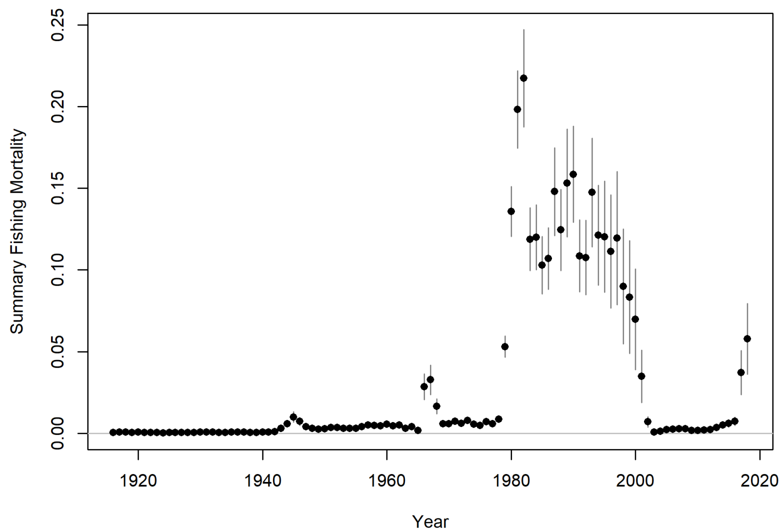


Figure 73: Plot of the predicted (1-SPR) for each year of the model with 95% confidence intervals.

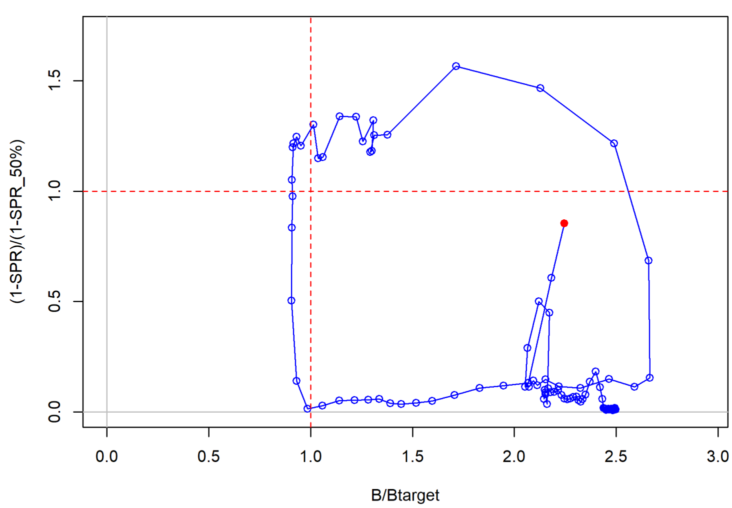


Figure 74: Phase plot of relative (1-SPR) (y-axis) and depletion (x-axis) for Widow Rockfish. The red point represents the year 2018.

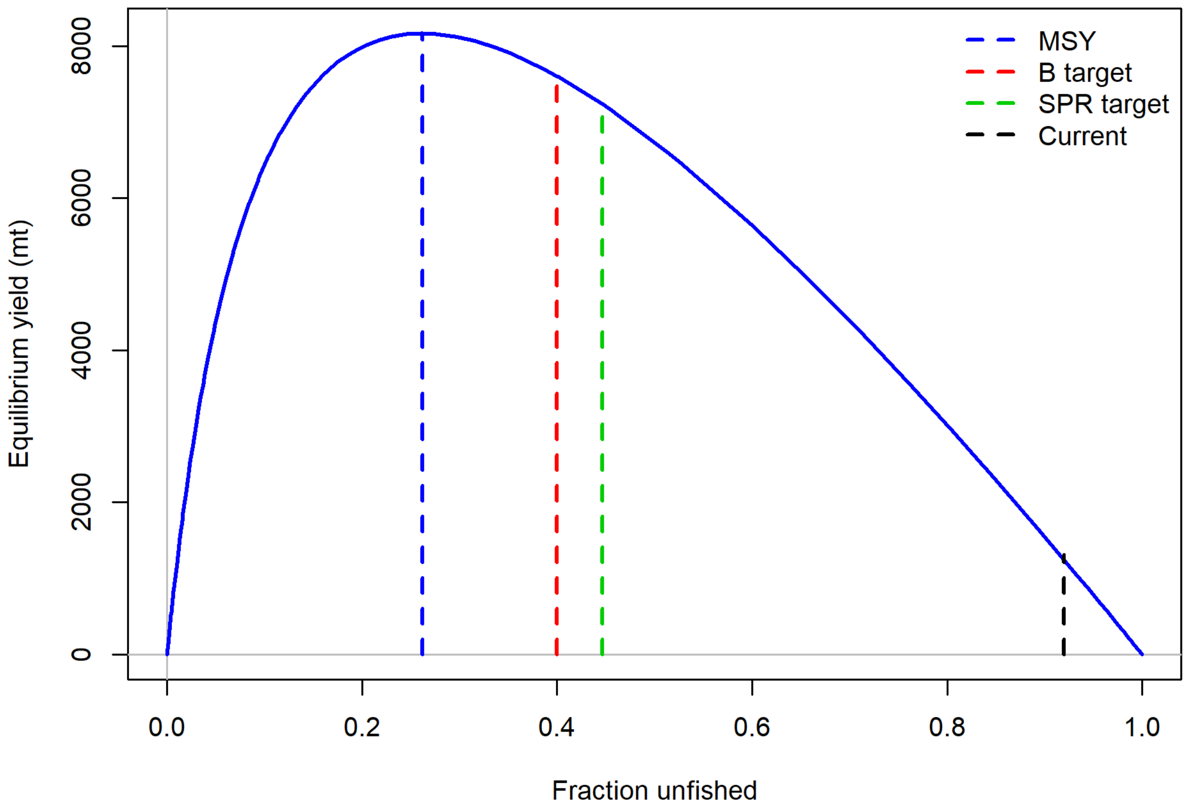


Figure 75: Estimated plot of equilibrium yield vs relative spawning biomass (*B/B₀*).

Appendix A. **Year-specific fits to the length compositions**

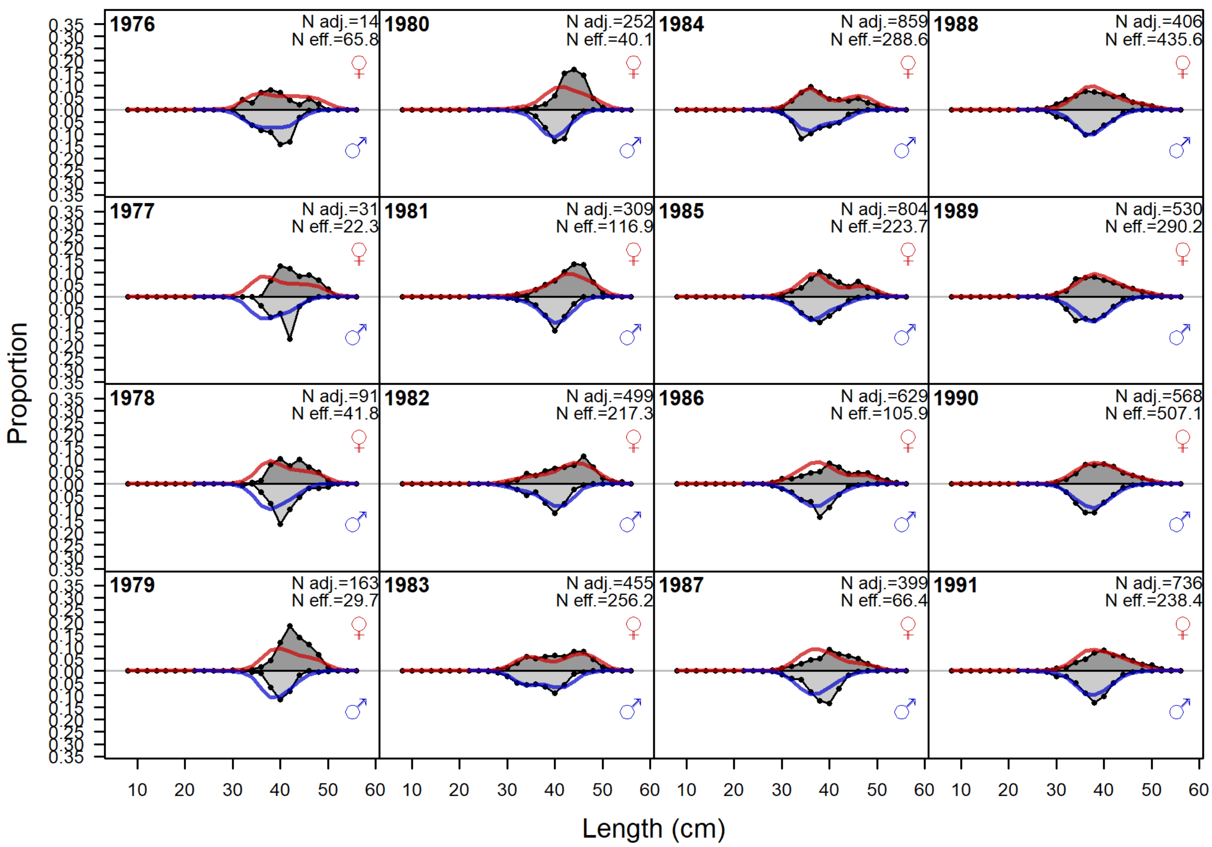


Figure A1: Fits to the retained length compositions for the bottom trawl fleet.

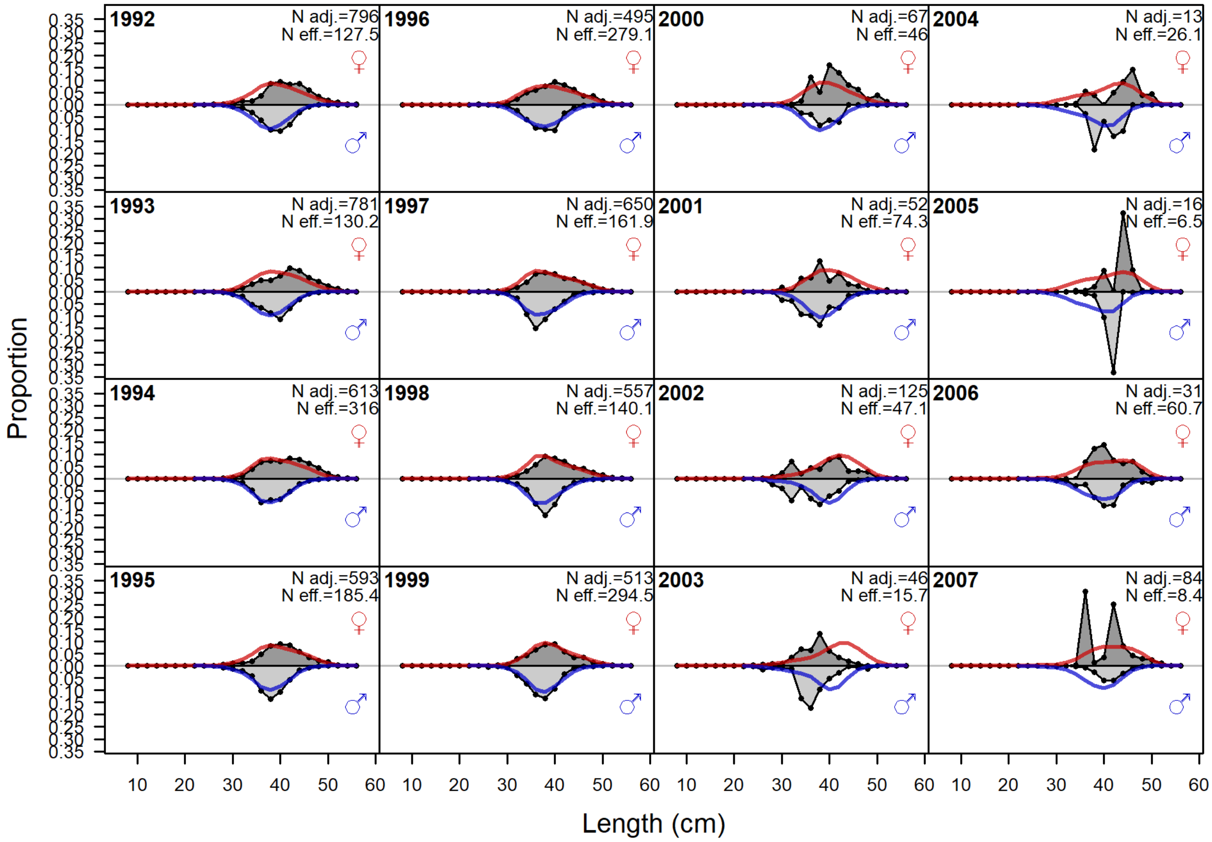


Figure A1: (continued) Fits to the retained length compositions for the bottom trawl fleet.

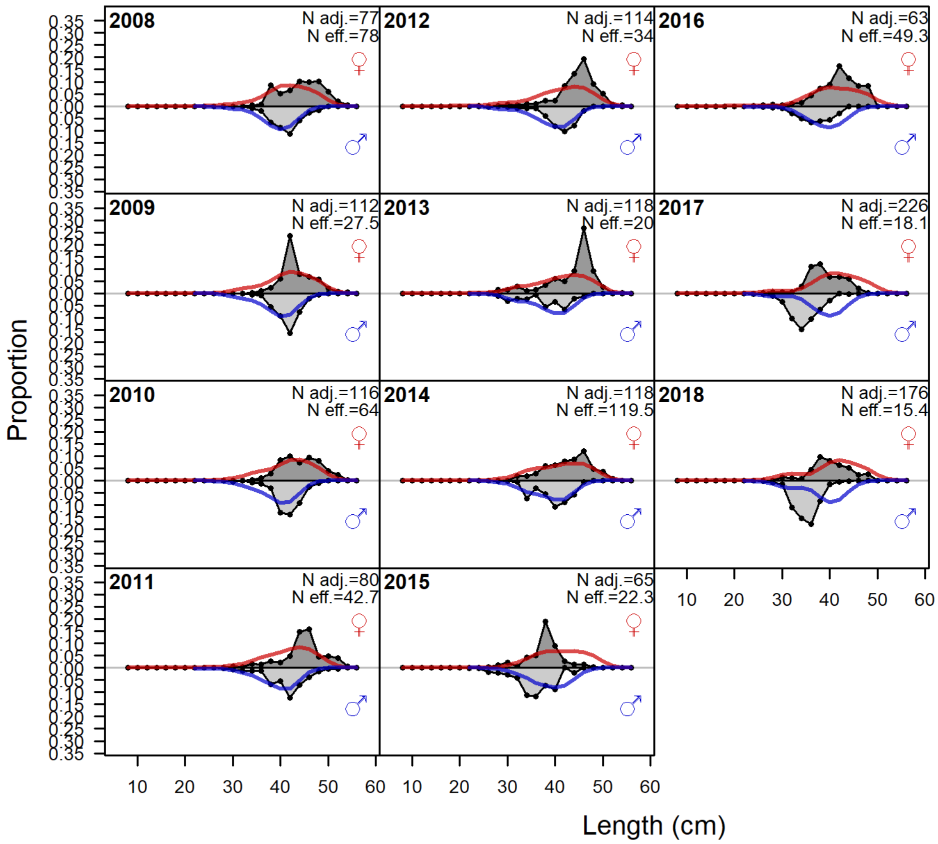
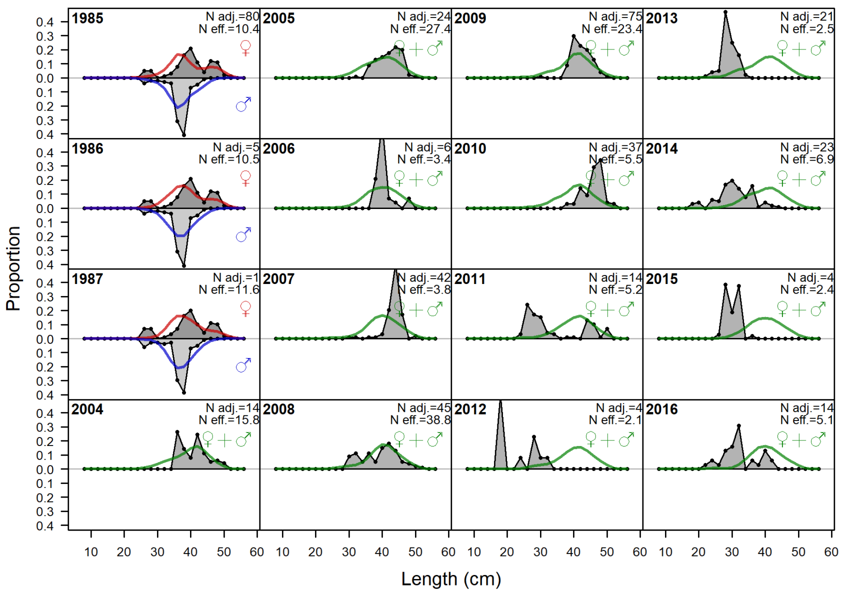


Figure A1: (continued) Fits to the retained length compositions for the bottom trawl fleet.



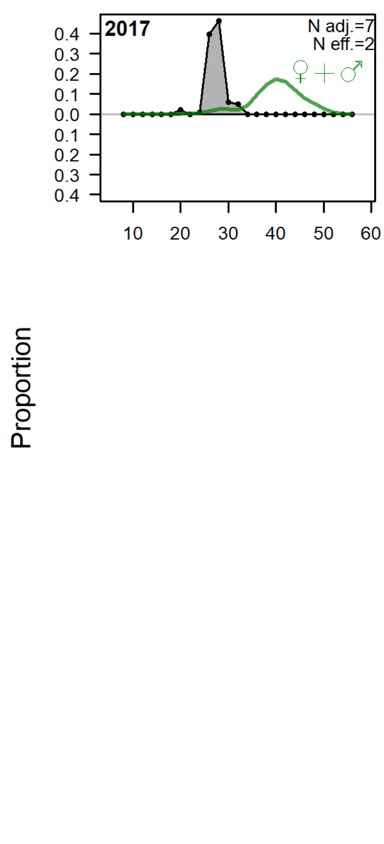


Figure A2: Fits to the discarded length compositions for the bottom trawl fleet.

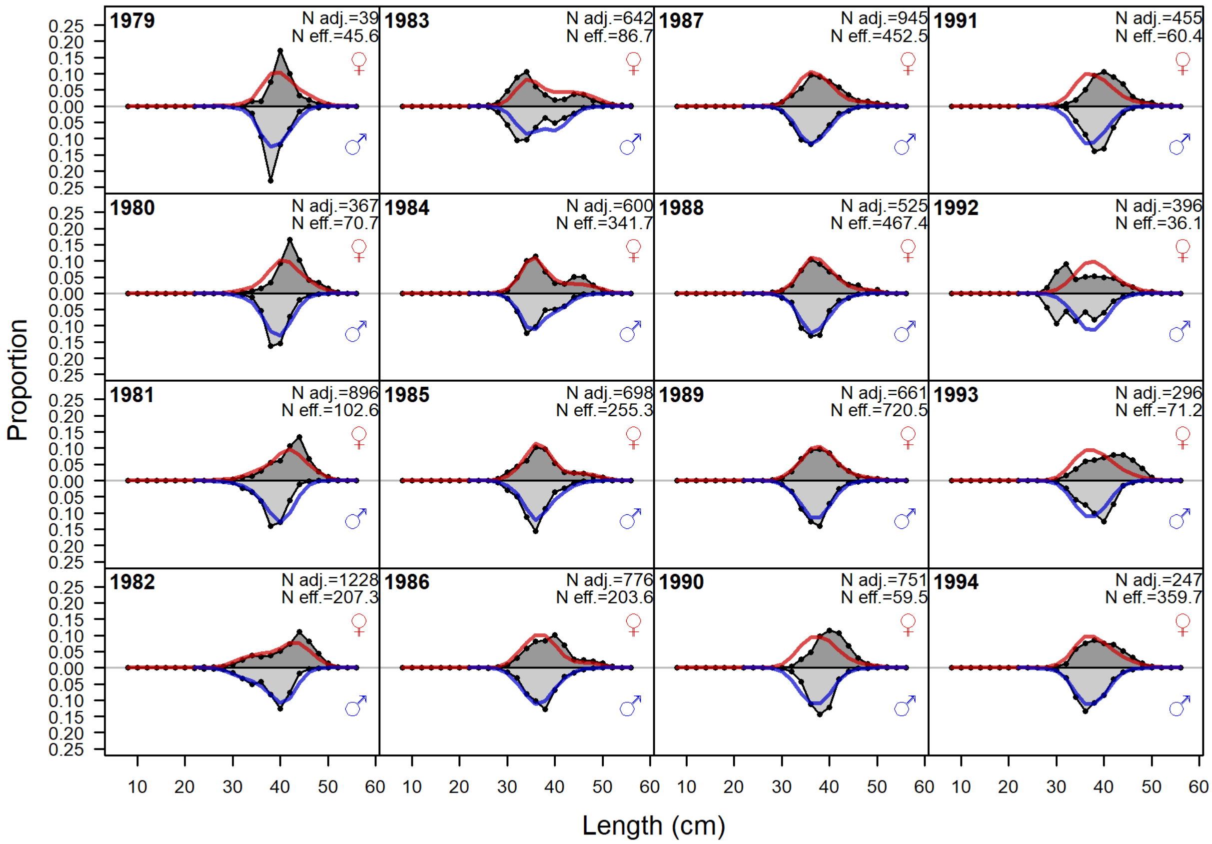


Figure A3: Fits to the retained length compositions for the midwater trawl fleet.

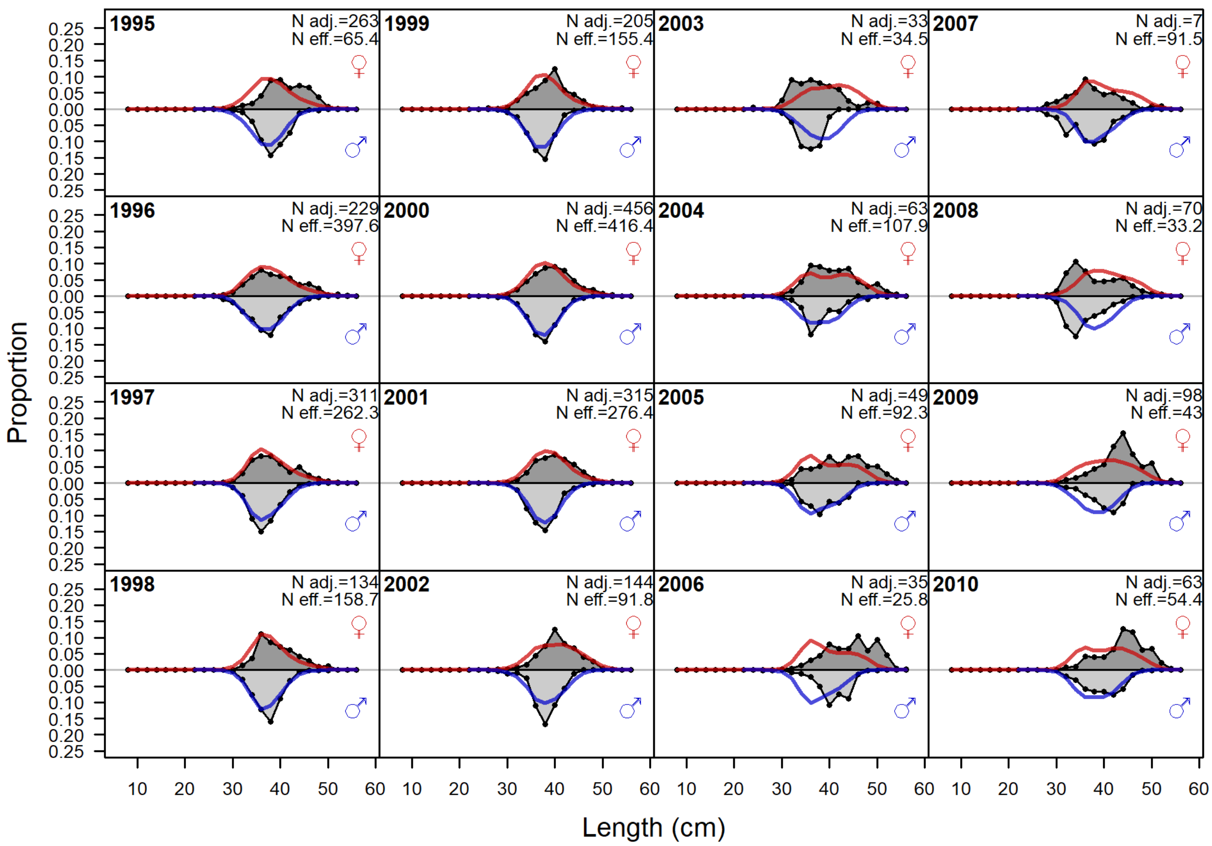


Figure A3: (continued) Fits to the retained length compositions for the midwater trawl fleet.

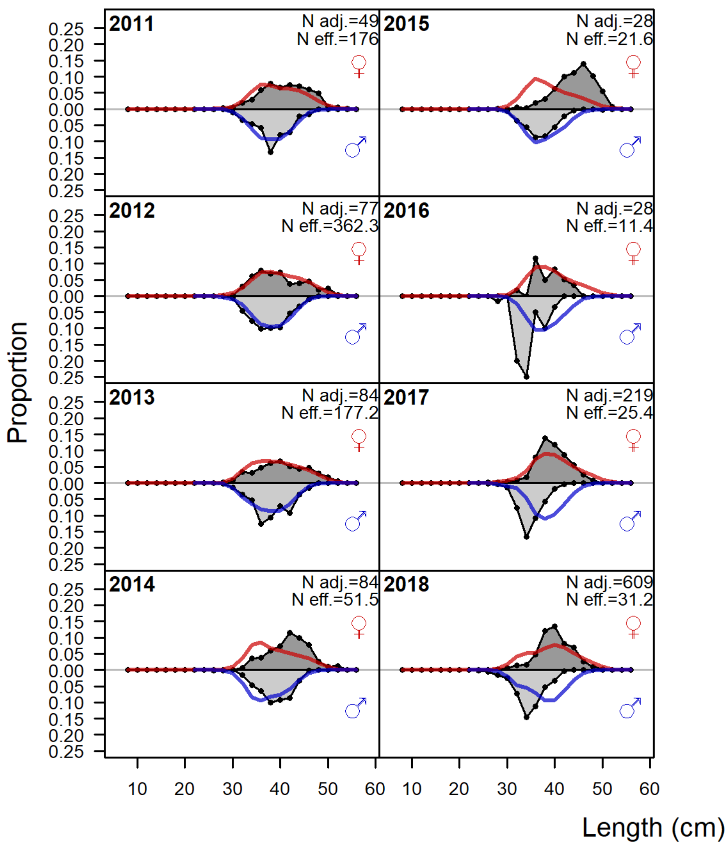


Figure A3: (continued) Fits to the retained length compositions for the midwater trawl fleet.

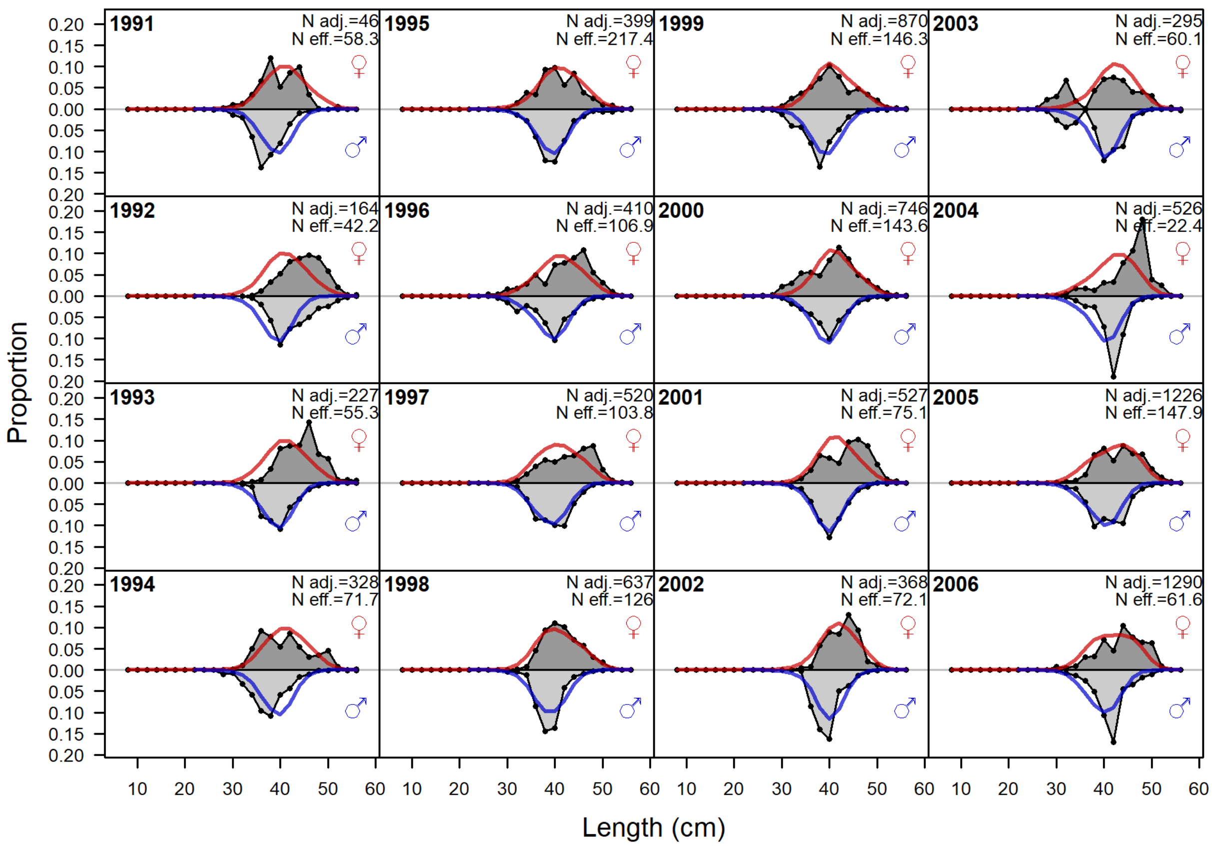


Figure A4: Fits to the retained length compositions for the hake fleet.

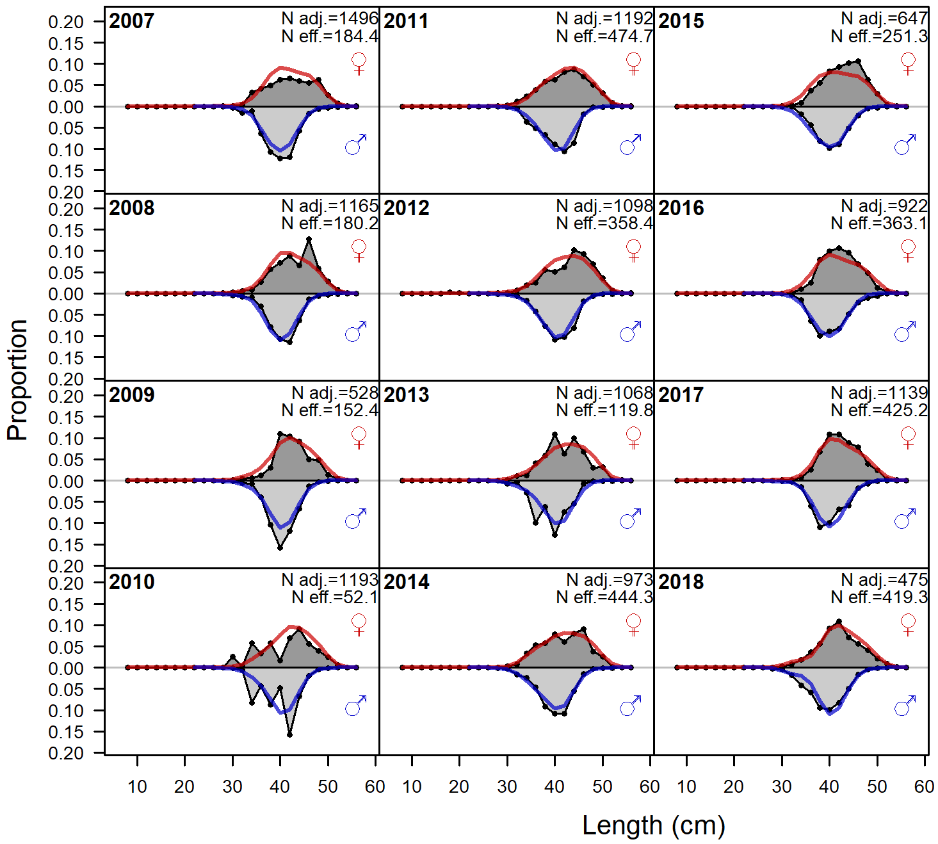


Figure A4: (continued) Fits to the retained length compositions for the hake fleet.

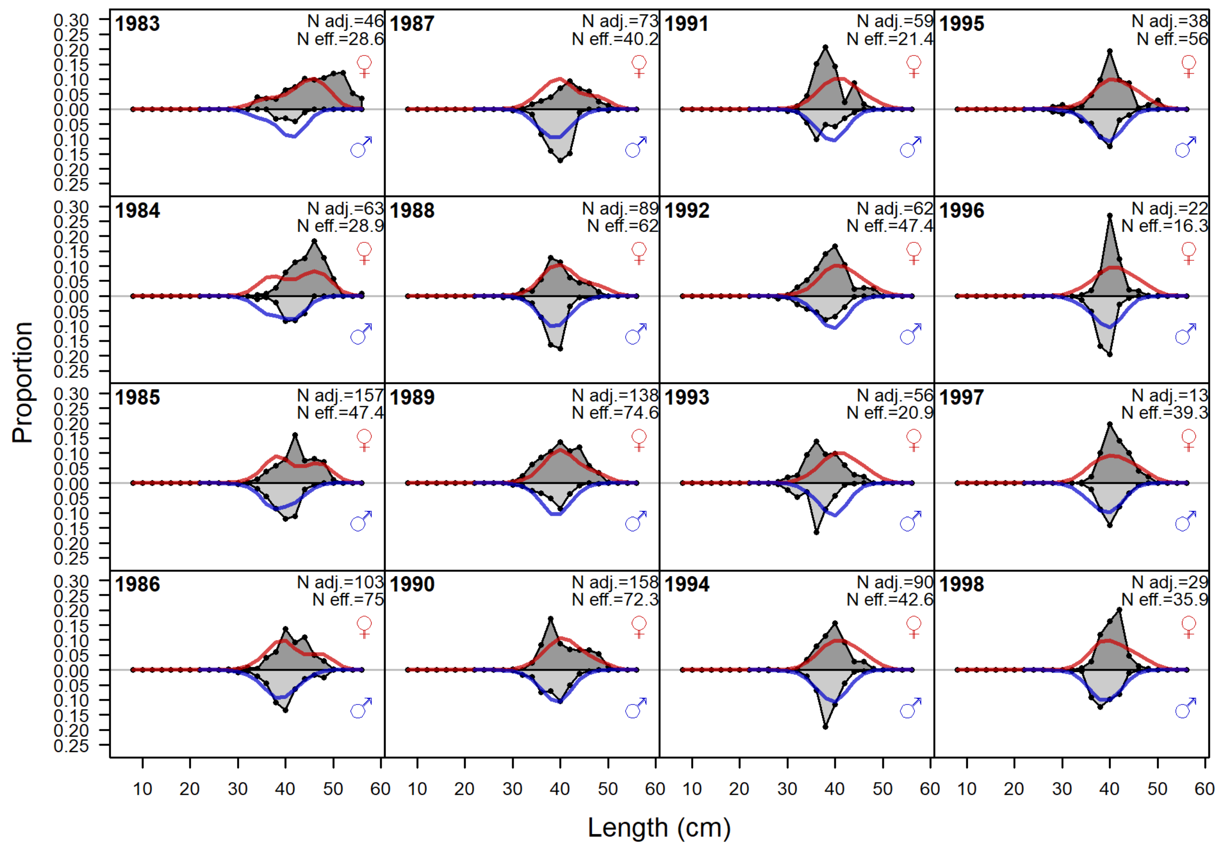


Figure A5: (continued) Fits to the retained length compositions for the net fleet.

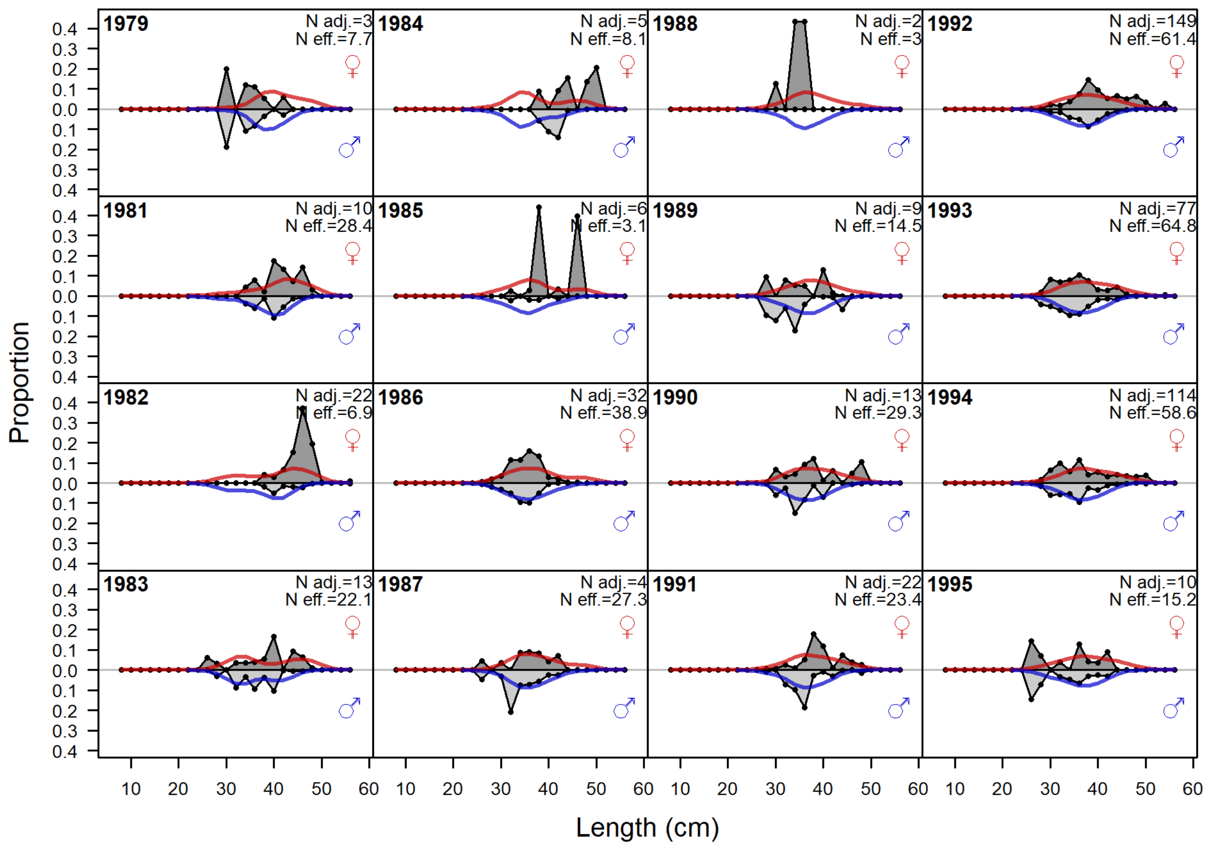


Figure A6: Fits to the retained length compositions for the hook-and-line fleet.

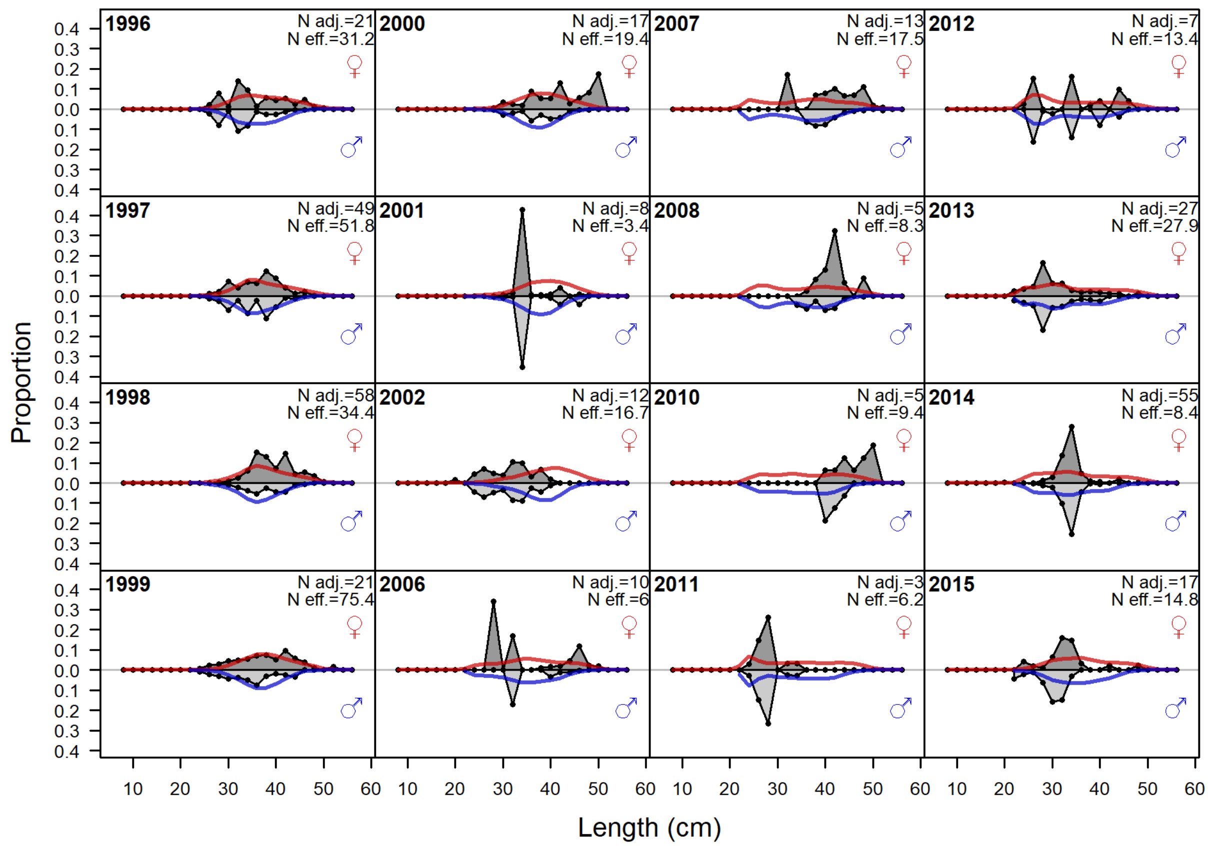


Figure A6: (continued) Fits to the retained length compositions for the hook-and-line fleet.

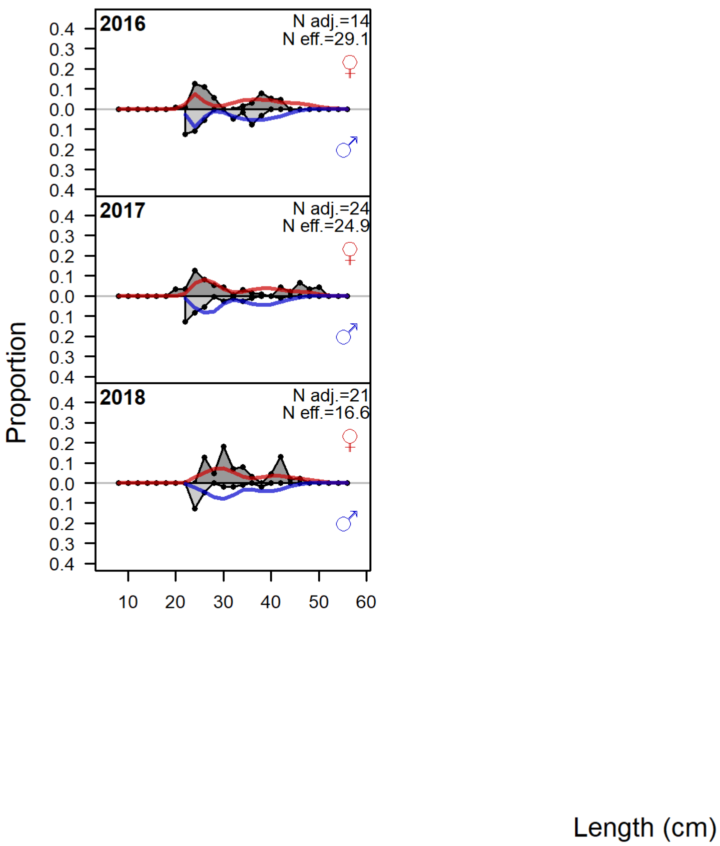


Figure A6: (continued) Fits to the retained length compositions for the hook-and-line fleet.

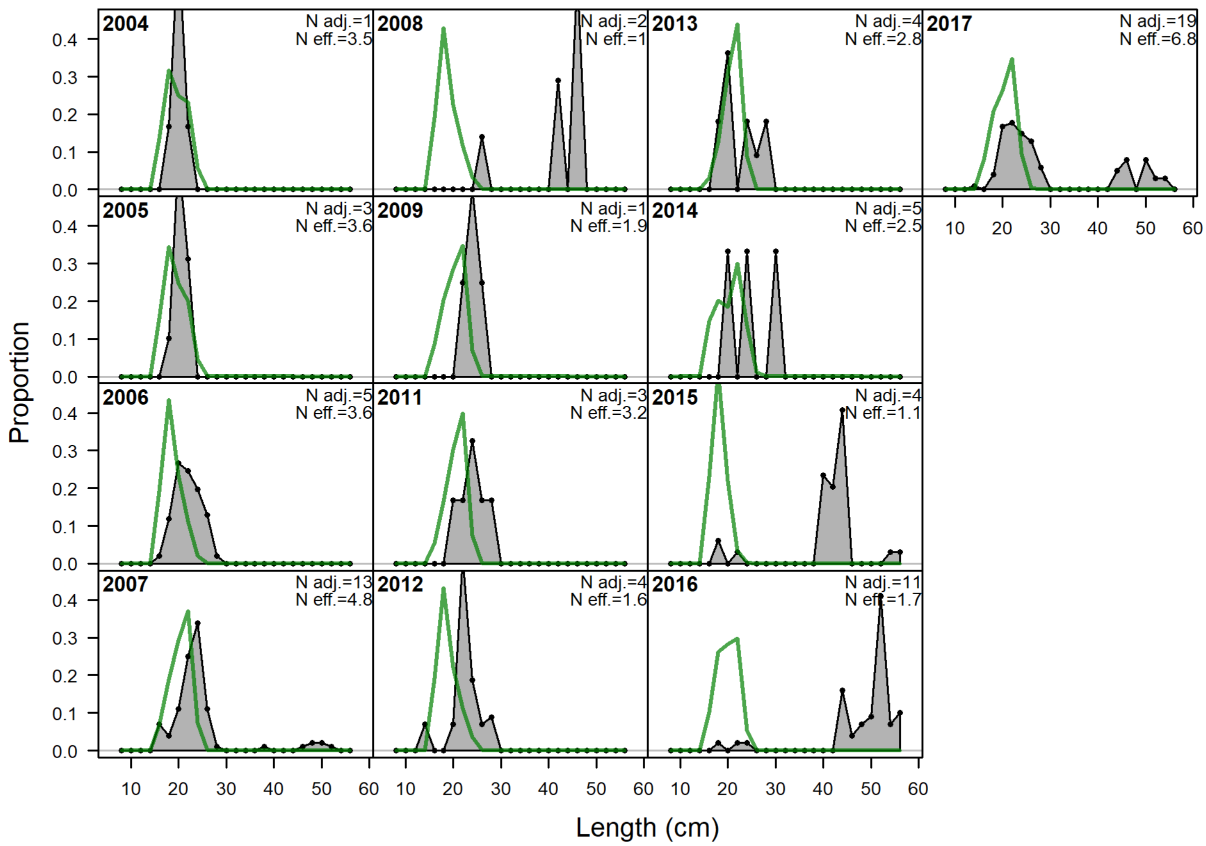


Figure A7: Fits to the discarded length compositions for the hook-and-line fleet.

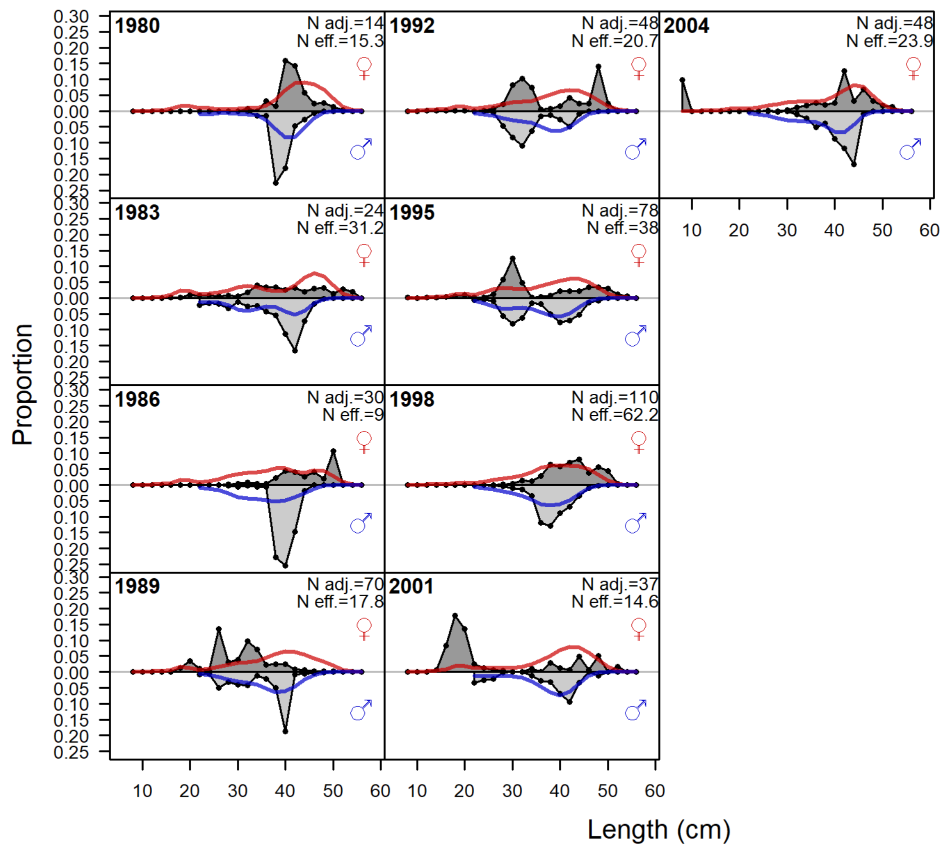


Figure A8: Fits to the length compositions for the triennial survey.

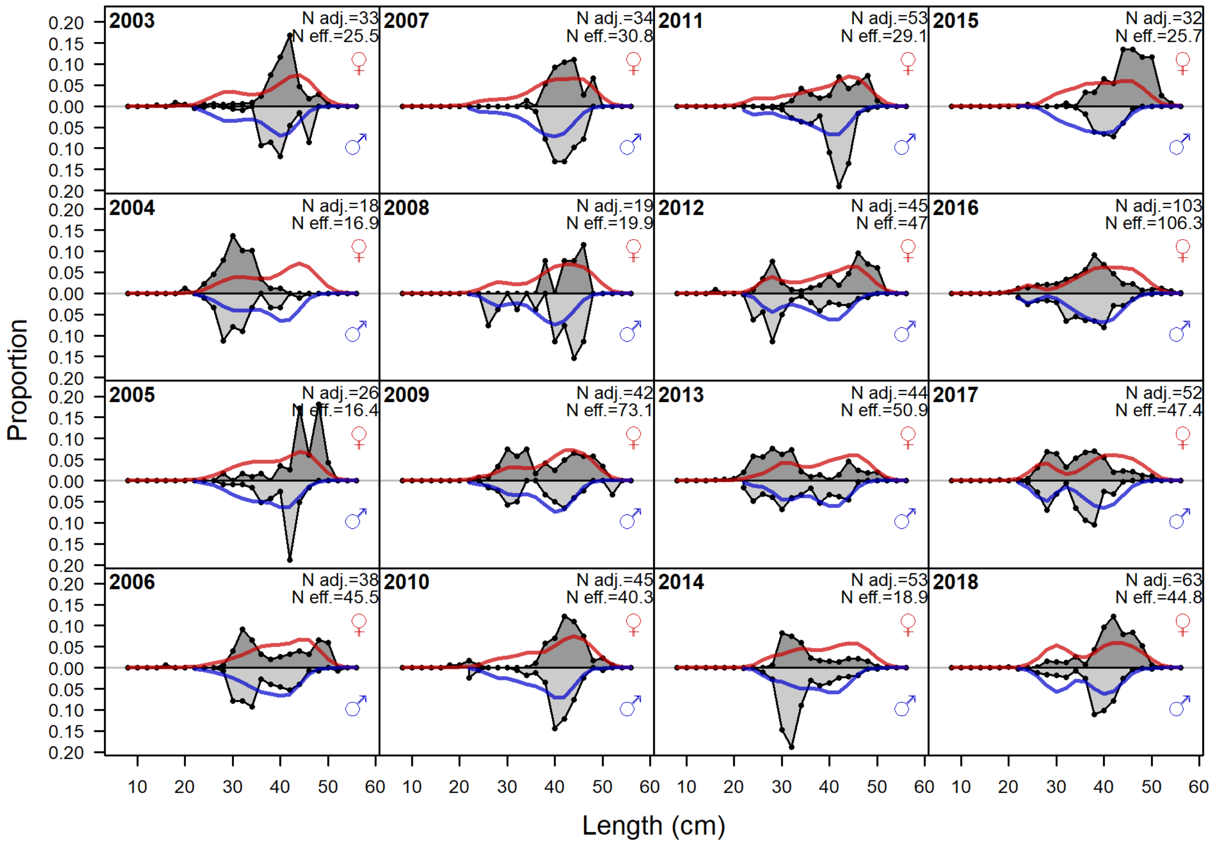


Figure A9: Fits to the length compositions for the NWFSC WCGBT survey.

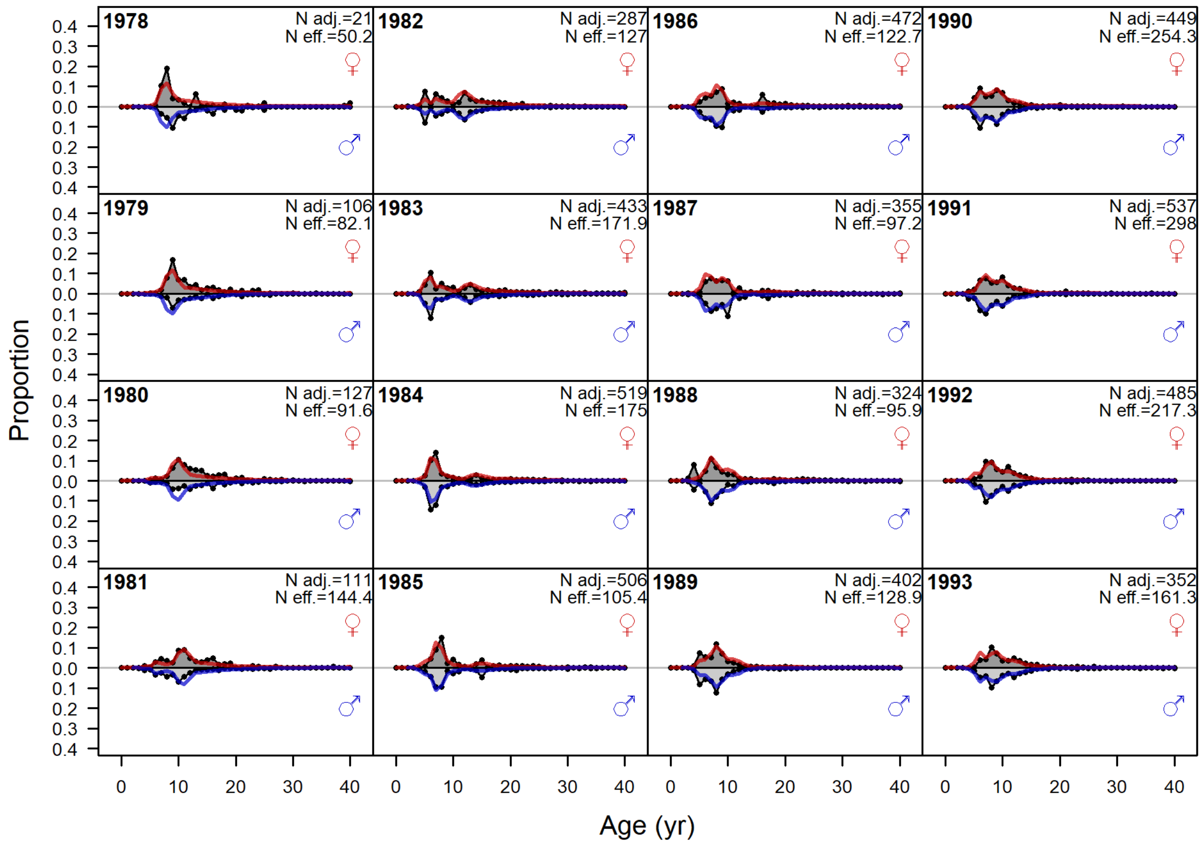


Figure A10: Fits to the retained age compositions for the bottom trawl fleet.

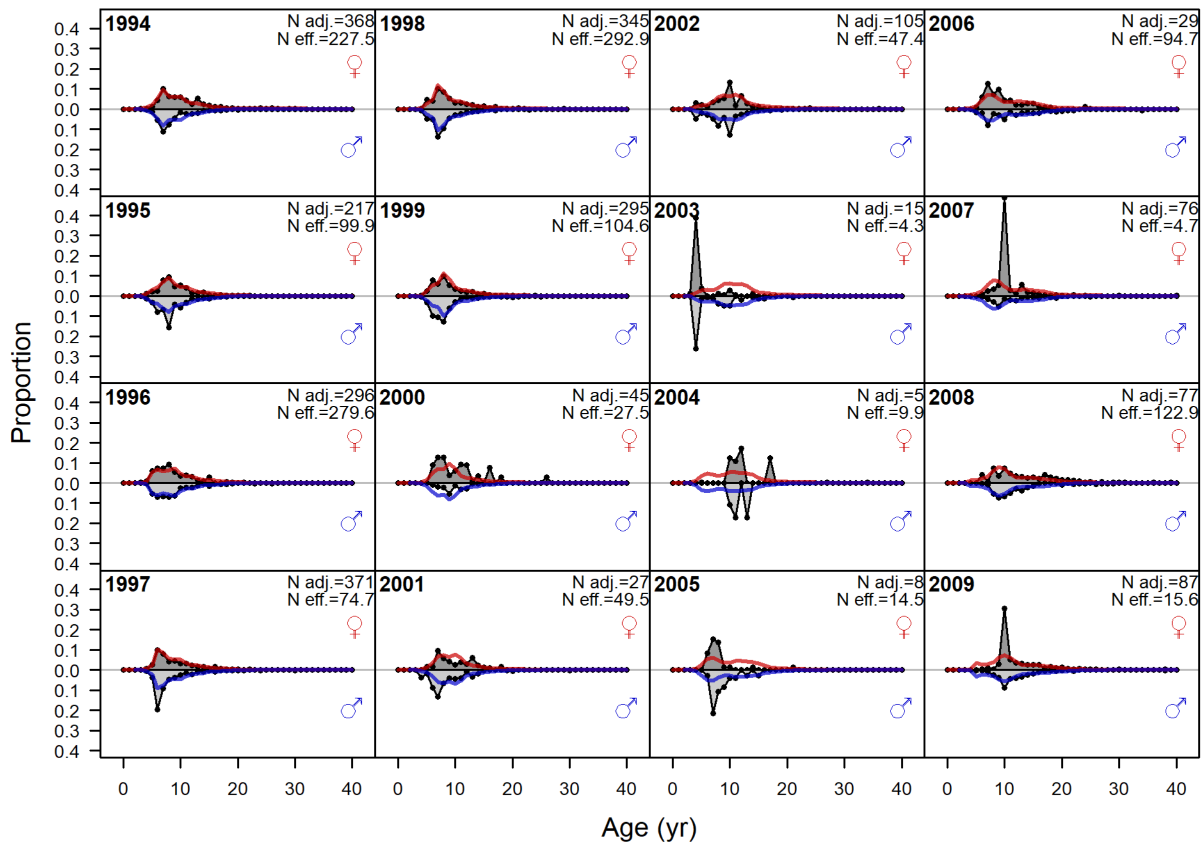


Figure A10: (continued) Fits to the retained age compositions for the bottom trawl fleet.

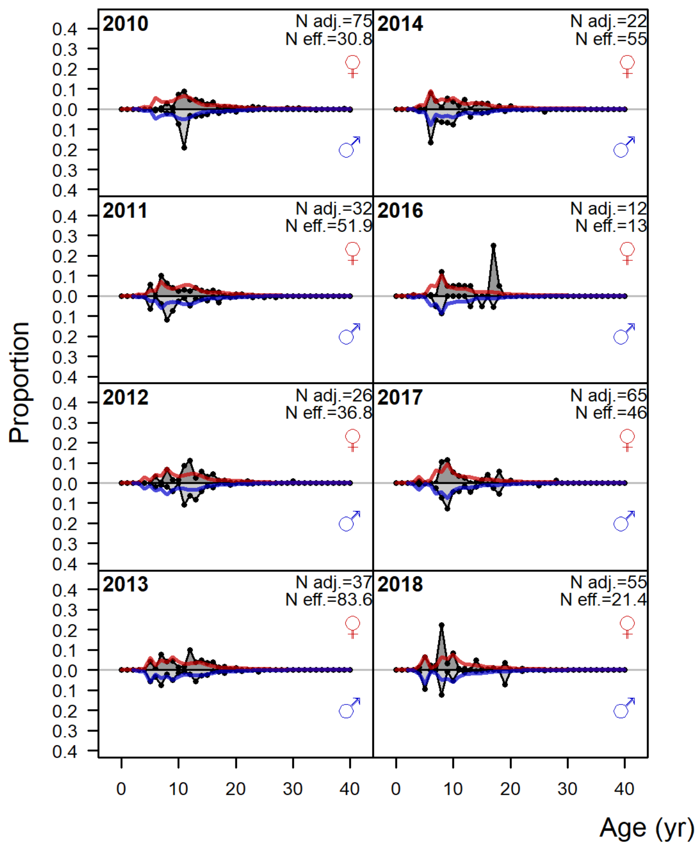


Figure A10: (continued) Fits to the retained age compositions for the bottom trawl fleet.

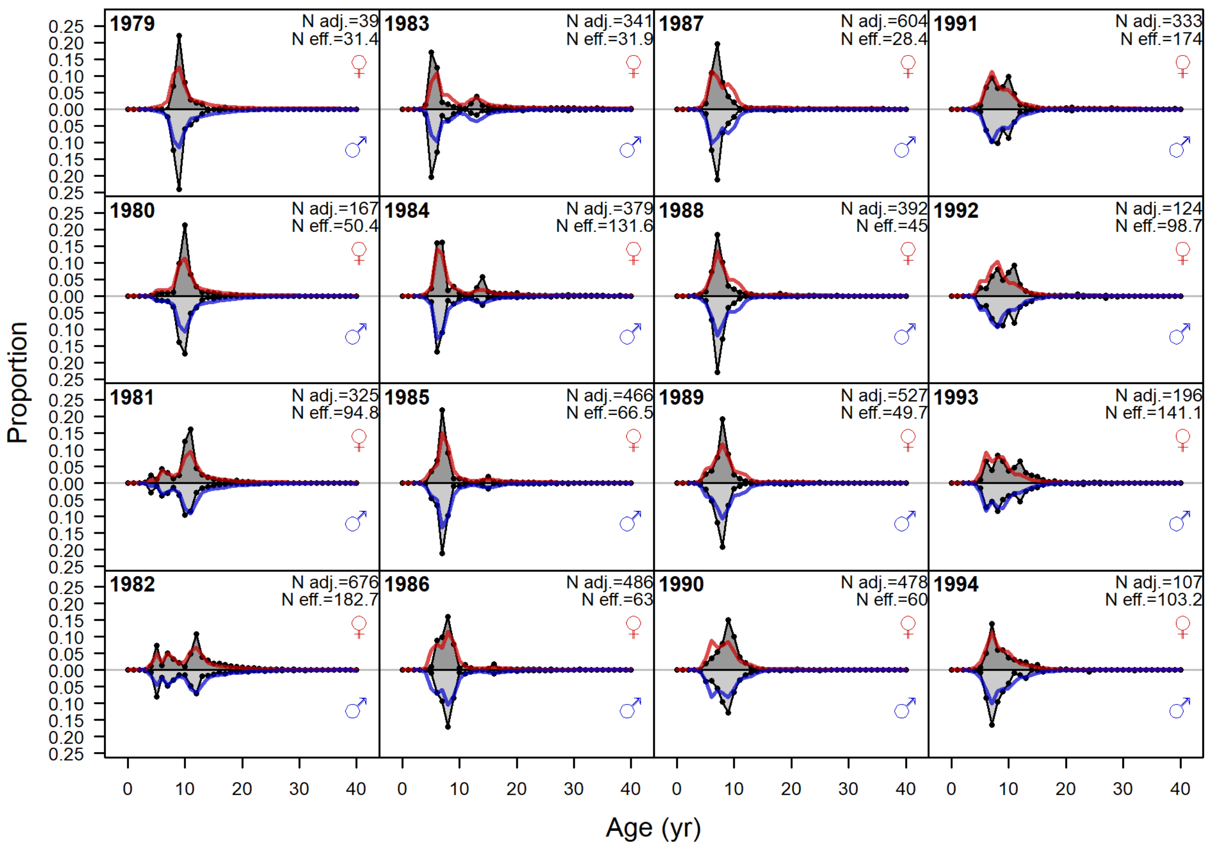


Figure A11: Fits to the retained age compositions for the midwater trawl fleet.

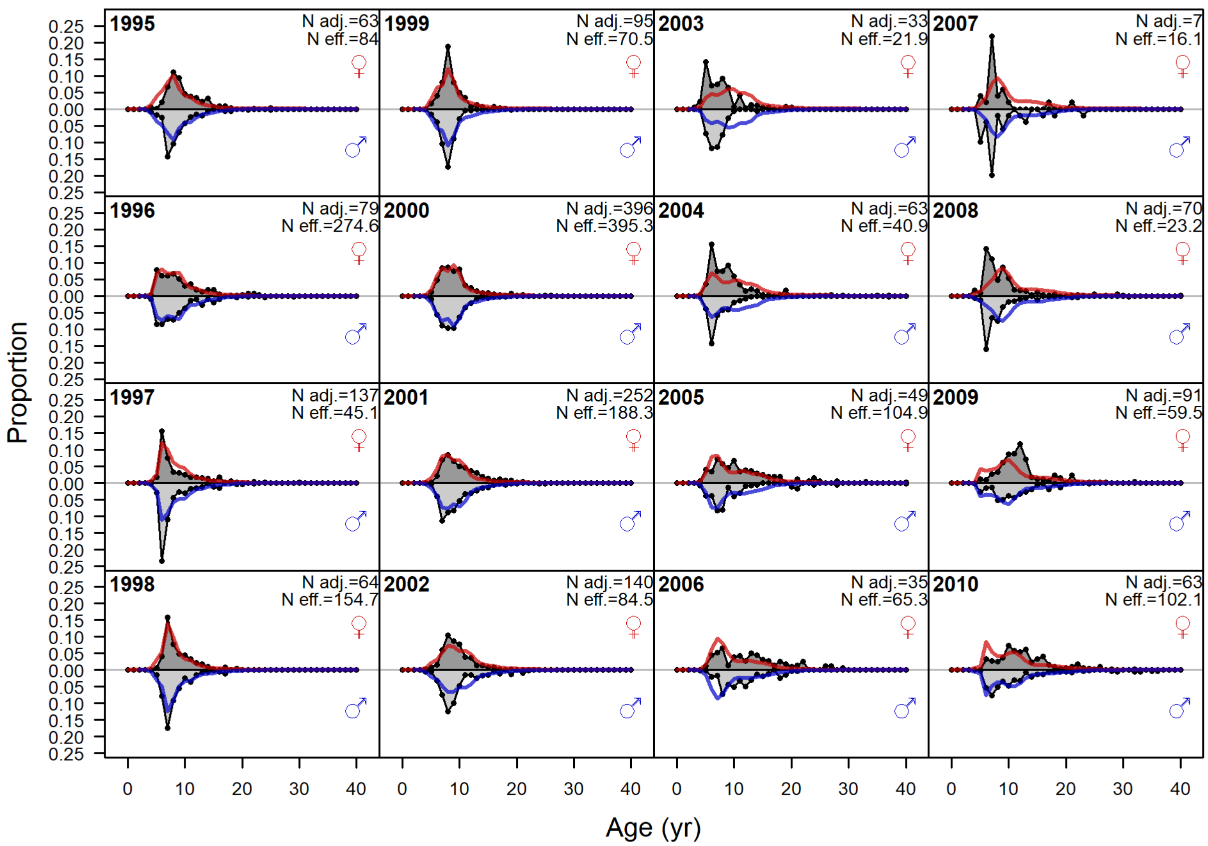


Figure A11: (continued) Fits to the retained age compositions for the midwater trawl fleet.

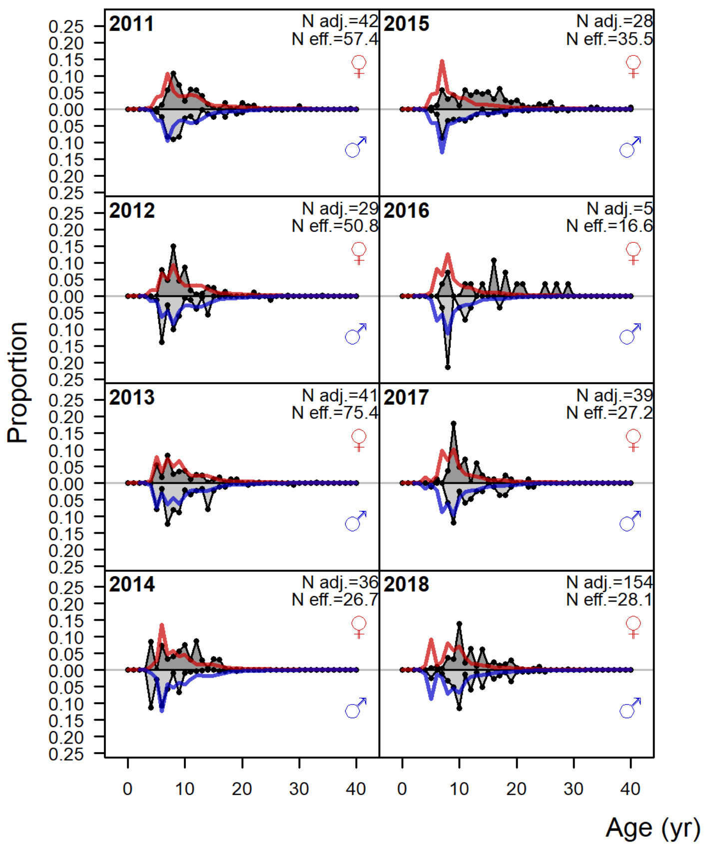


Figure A11: (continued) Fits to the retained age compositions for the midwater trawl fleet.

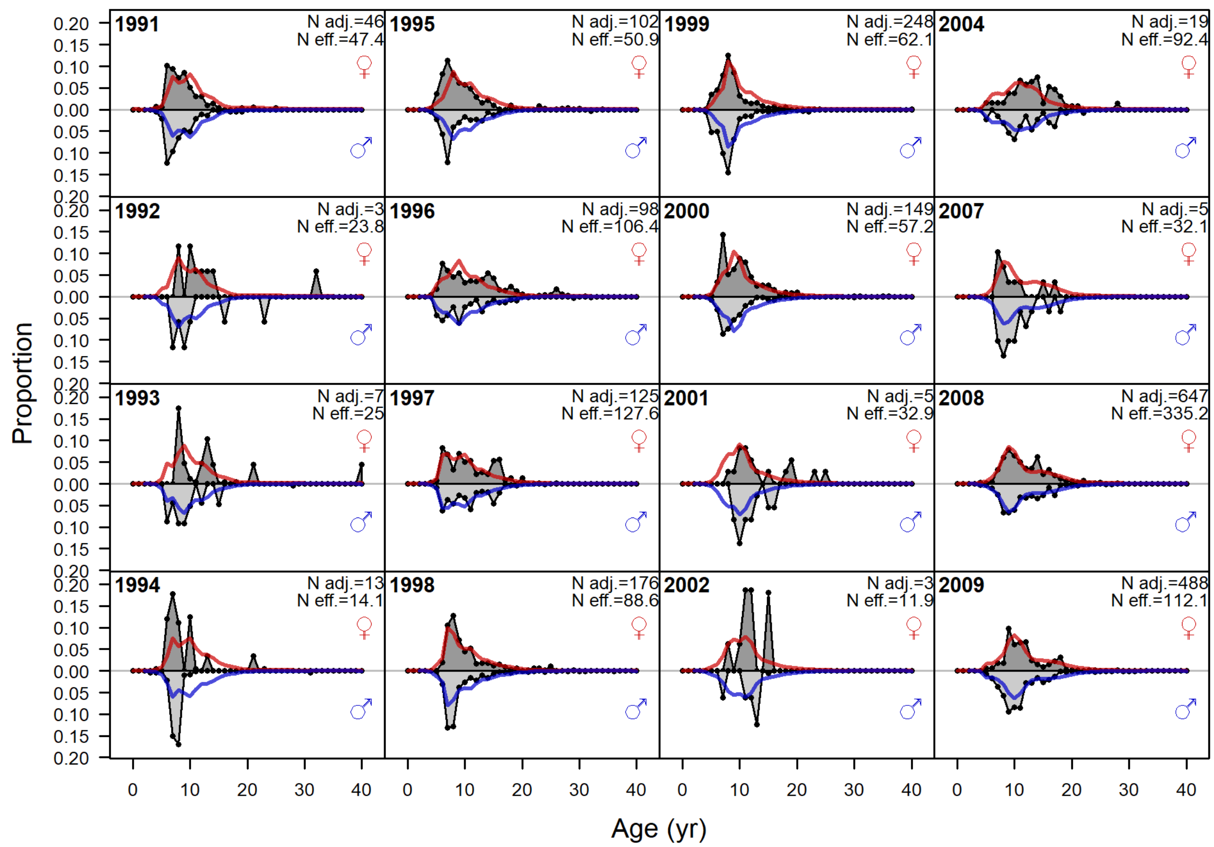


Figure A12: Fits to the retained age compositions for the hake fleet.

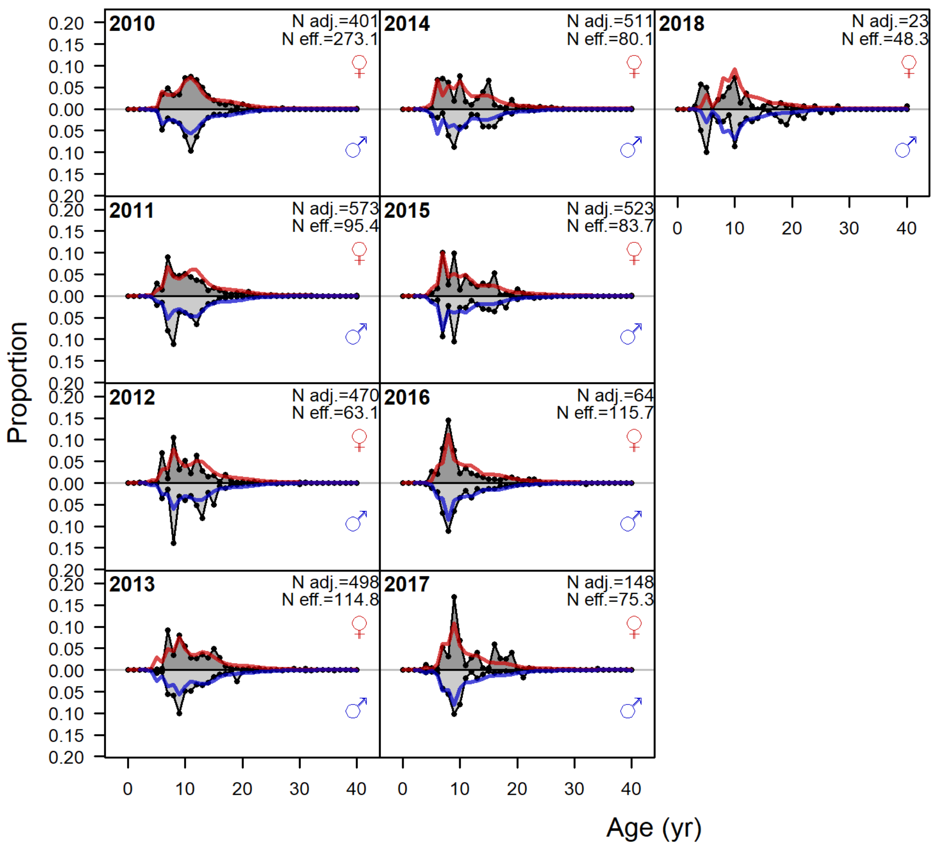


Figure A12: (continued) Fits to the retained age compositions for the hake fleet.

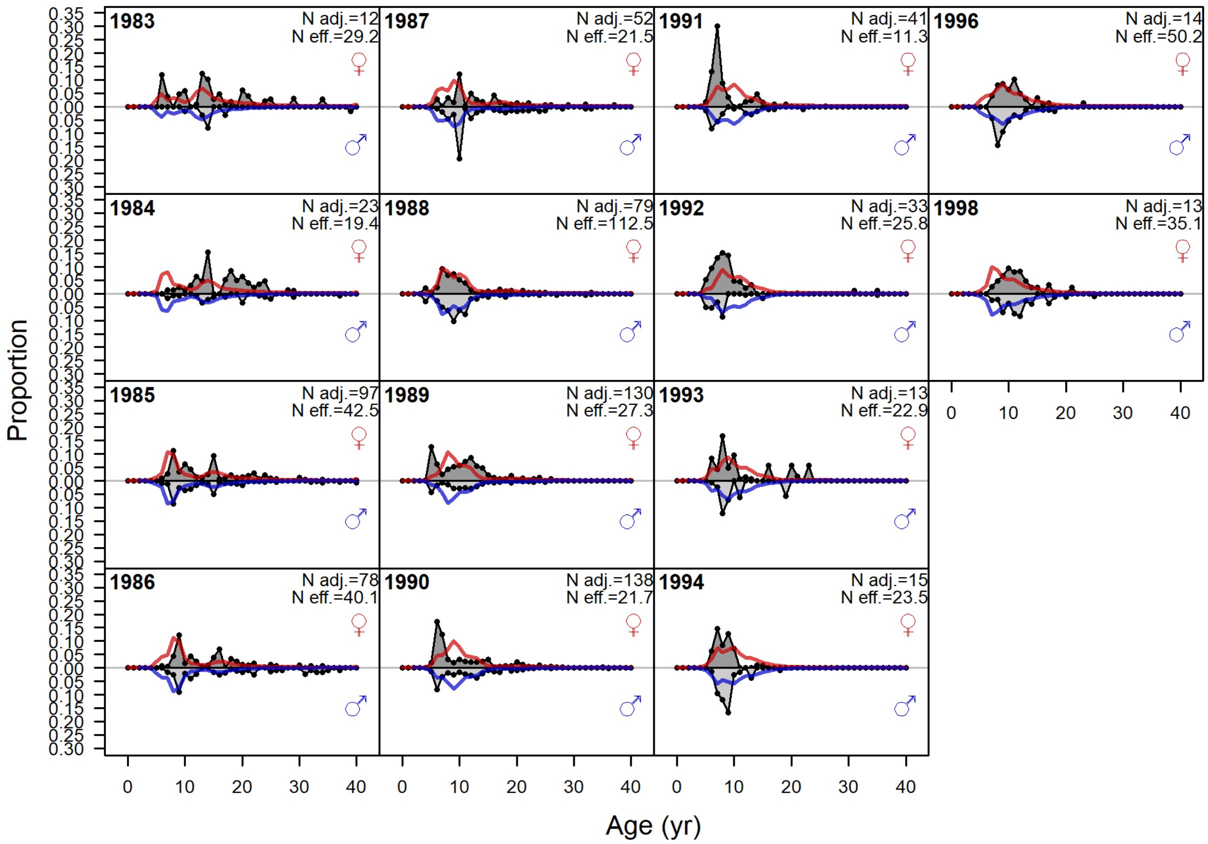


Figure A13: Fits to the retained age compositions for the net fleet.

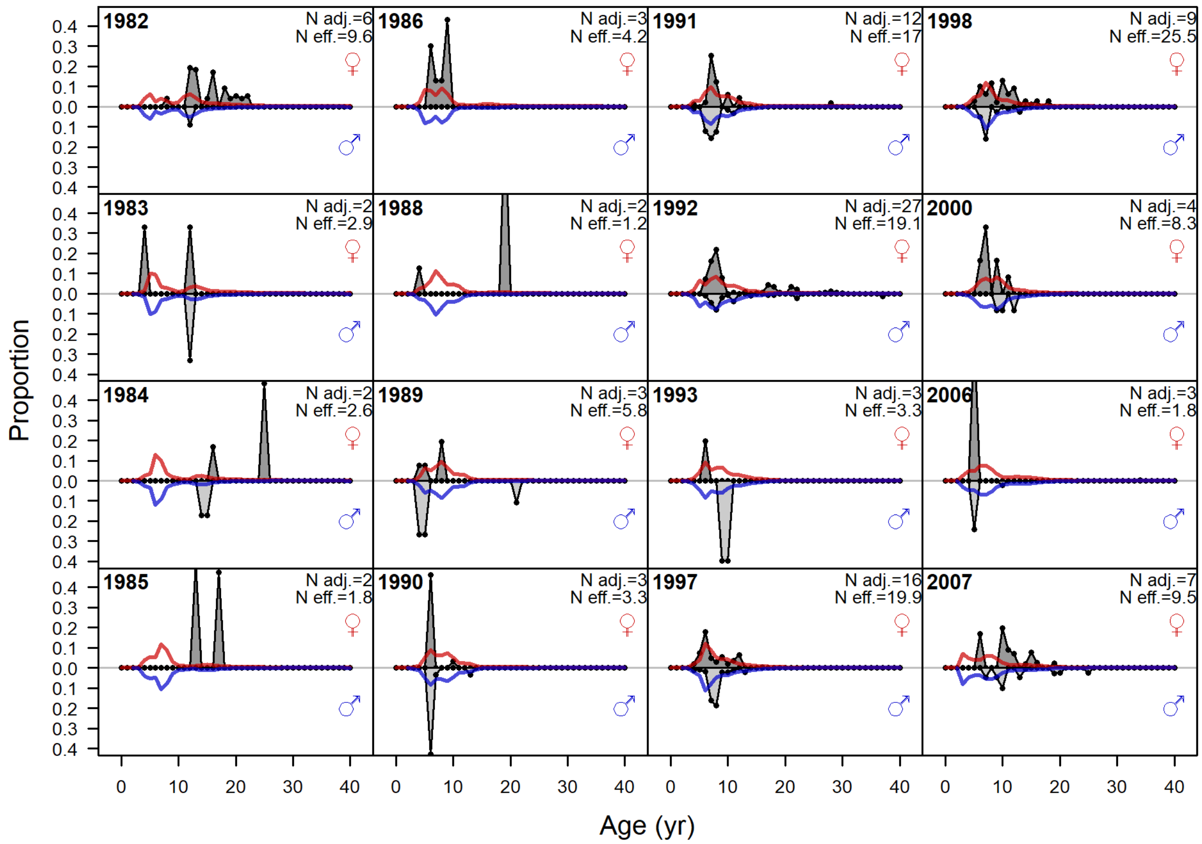


Figure A14: Fits to the retained age compositions for the hook-and-line fleet.

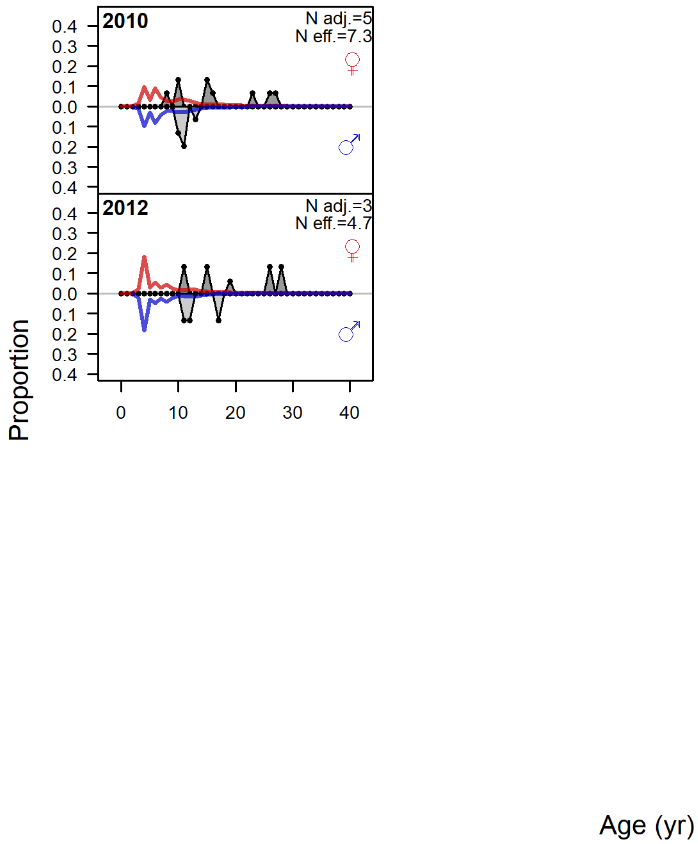


Figure A14: (continued) Fits to the retained age compositions for the hook-and-line fleet.

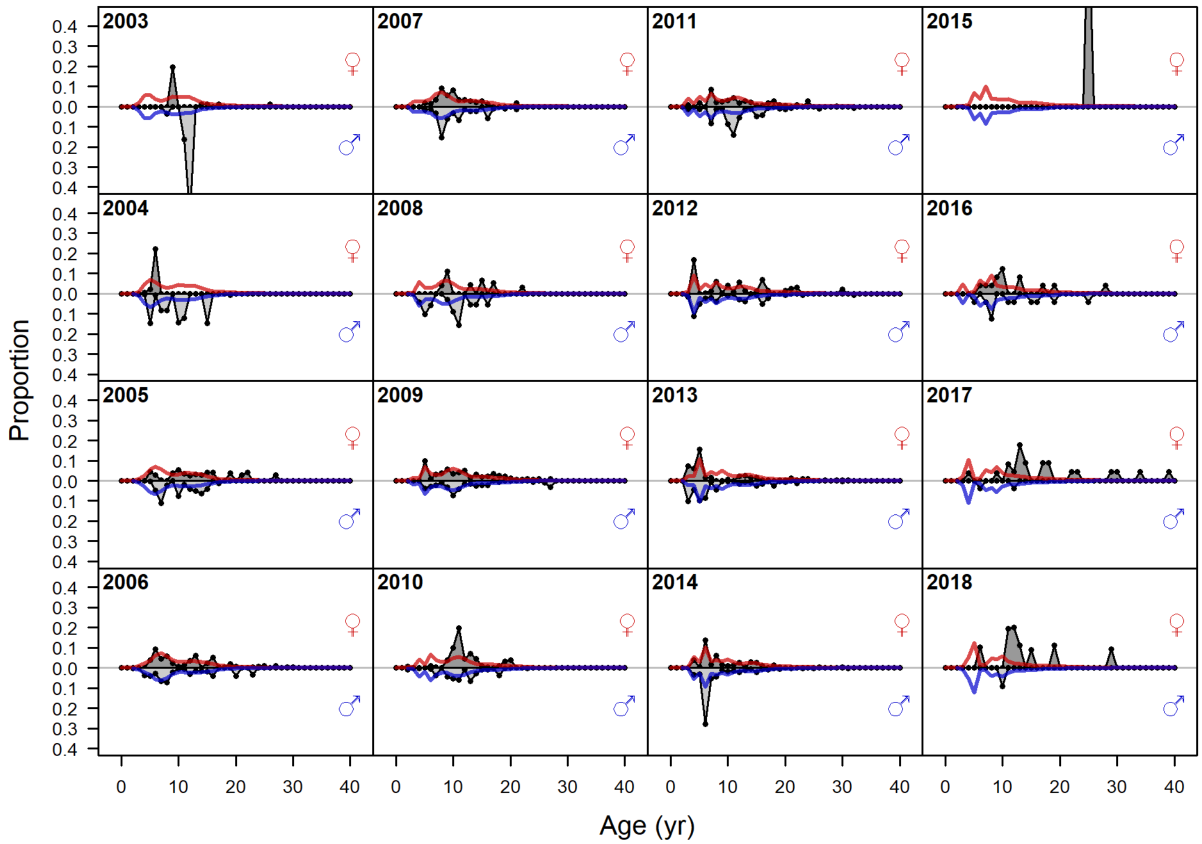


Figure A15: Implied fits to the age compositions for the NWFSC WCGBT survey.

Appendix B. **Predicted numbers-at-age**

Female numbers-at-age

Year	0	1	2	3	4	5	Age 6	7	8	9	10-19	20-29	30-39	40+
1916	24,731	21,417	18,544	16,057	13,902	12,036	10,421	9,022	7,810	6,761	33,277	7,859	1,855	573
1917	24,717	21,406	18,537	16,051	13,898	12,032	10,416	9,016	7,805	6,757	33,254	7,855	1,854	573
1918	24,702	21,394	18,527	16,045	13,893	12,028	10,411	9,010	7,798	6,750	33,222	7,849	1,852	572
1919	24,685	21,380	18,517	16,036	13,887	12,023	10,406	9,005	7,792	6,744	33,185	7,841	1,850	572
1920	24,666	21,366	18,506	16,027	13,880	12,019	10,404	9,003	7,790	6,740	33,159	7,835	1,849	571
1921	24,646	21,350	18,493	16,017	13,872	12,012	10,400	9,001	7,788	6,738	33,134	7,829	1,848	571
1922	24,624	21,332	18,479	16,006	13,864	12,006	10,395	8,998	7,787	6,737	33,116	7,824	1,847	570
1923	24,600	21,313	18,464	15,994	13,854	11,999	10,390	8,994	7,785	6,737	33,102	7,819	1,846	570
1924	24,574	21,293	18,448	15,981	13,844	11,990	10,383	8,990	7,781	6,735	33,089	7,814	1,845	570
1925	24,544	21,270	18,430	15,967	13,832	11,982	10,377	8,985	7,778	6,733	33,084	7,811	1,844	570
1926	24,512	21,244	18,410	15,952	13,820	11,972	10,369	8,979	7,774	6,730	33,076	7,806	1,844	569
1927	24,475	21,216	18,388	15,934	13,807	11,961	10,360	8,971	7,767	6,725	33,059	7,800	1,842	569
1928	24,434	21,184	18,363	15,915	13,792	11,949	10,351	8,963	7,761	6,719	33,045	7,795	1,842	569
1929	24,389	21,149	18,336	15,894	13,775	11,936	10,340	8,955	7,754	6,714	33,027	7,789	1,840	568
1930	24,339	21,110	18,305	15,870	13,757	11,922	10,329	8,947	7,747	6,708	33,007	7,783	1,839	568
1931	24,283	21,066	18,271	15,844	13,736	11,906	10,316	8,936	7,739	6,701	32,981	7,776	1,837	568
1932	24,221	21,018	18,234	15,814	13,713	11,888	10,303	8,925	7,730	6,694	32,954	7,771	1,836	567
1933	24,153	20,964	18,192	15,782	13,688	11,868	10,287	8,913	7,720	6,686	32,926	7,766	1,835	567
1934	24,077	20,905	18,145	15,746	13,660	11,847	10,271	8,901	7,711	6,679	32,898	7,763	1,833	567
1935	23,994	20,840	18,094	15,706	13,628	11,822	10,252	8,886	7,700	6,670	32,867	7,759	1,832	566
1936	23,900	20,767	18,038	15,661	13,594	11,795	10,230	8,869	7,687	6,660	32,833	7,755	1,830	566
1937	23,796	20,687	17,975	15,612	13,555	11,765	10,206	8,850	7,672	6,649	32,792	7,750	1,829	565
1938	23,680	20,597	17,905	15,558	13,513	11,732	10,180	8,830	7,656	6,636	32,749	7,746	1,827	565
1939	23,549	20,496	17,827	15,498	13,466	11,695	10,152	8,808	7,639	6,623	32,707	7,742	1,826	565
1940	23,403	20,383	17,740	15,430	13,414	11,655	10,121	8,785	7,621	6,609	32,662	7,738	1,824	564
1941	23,241	20,256	17,642	15,355	13,355	11,609	10,085	8,756	7,598	6,591	32,601	7,731	1,823	564
1942	23,060	20,116	17,533	15,270	13,290	11,559	10,046	8,725	7,573	6,571	32,533	7,723	1,821	563
1943	22,865	19,960	17,411	15,175	13,217	11,502	10,002	8,691	7,546	6,549	32,454	7,713	1,819	563
1944	22,656	19,791	17,276	15,070	13,135	11,438	9,948	8,642	7,502	6,510	32,288	7,683	1,813	560
1945	22,433	19,610	17,130	14,953	13,043	11,365	9,885	8,581	7,441	6,452	32,006	7,627	1,801	556
1946	22,198	19,417	16,973	14,826	12,942	11,284	9,813	8,506	7,361	6,371	31,567	7,533	1,779	550
1947	21,975	19,213	16,806	14,691	12,832	11,197	9,749	8,457	7,315	6,322	31,244	7,464	1,764	545
1948	21,766	19,021	16,630	14,546	12,715	11,104	9,681	8,417	7,293	6,304	31,055	7,424	1,756	542
1949	21,571	18,840	16,463	14,394	12,590	11,004	9,604	8,364	7,266	6,292	30,922	7,391	1,750	540
1950	21,404	18,671	16,306	14,250	12,458	10,896	9,518	8,300	7,224	6,273	30,827	7,364	1,745	539
1951	21,283	18,526	16,160	14,114	12,333	10,781	9,424	8,225	7,167	6,235	30,723	7,333	1,739	537
1952	21,229	18,421	16,035	13,987	12,216	10,673	9,323	8,140	7,096	6,179	30,576	7,294	1,731	535
1953	21,277	18,375	15,944	13,879	12,107	10,571	9,229	8,053	7,023	6,119	30,411	7,253	1,724	532
1954	21,458	18,416	15,904	13,800	12,013	10,477	9,143	7,974	6,951	6,059	30,241	7,216	1,717	530
1955	21,802	18,573	15,940	13,766	11,945	10,396	9,062	7,900	6,884	5,997	30,054	7,178	1,710	529
1956	22,319	18,871	16,075	13,797	11,915	10,337	8,991	7,829	6,819	5,939	29,841	7,139	1,704	527
1957	22,954	19,318	16,333	13,914	11,941	10,310	8,938	7,764	6,752	5,877	29,581	7,094	1,695	524
1958	23,543	19,868	16,720	14,137	12,043	10,333	8,913	7,713	6,689	5,812	29,269	7,042	1,683	521
1959	23,822	20,377	17,197	14,472	12,236	10,421	8,933	7,693	6,648	5,760	28,963	6,997	1,673	518
1960	23,627	20,619	17,637	14,884	12,526	10,588	9,010	7,711	6,631	5,726	28,666	6,957	1,662	515
1961	22,966	20,450	17,846	15,266	12,883	10,839	9,152	7,773	6,641	5,705	28,353	6,910	1,649	512
1962	22,590	19,878	17,700	15,447	13,213	11,148	9,371	7,900	6,700	5,719	28,108	6,867	1,638	509
1963	22,885	19,553	17,205	15,320	13,369	11,433	9,637	8,086	6,806	5,766	27,903	6,816	1,626	506
1964	23,699	19,808	16,924	14,892	13,260	11,570	9,889	8,326	6,980	5,872	27,856	6,778	1,617	504
1965	24,643	20,512	17,145	14,648	12,889	11,475	10,004	8,539	7,180	6,015	27,879	6,727	1,607	501
1966	25,728	21,330	17,754	14,840	12,678	11,155	9,927	8,650	7,379	6,203	28,115	6,690	1,600	500
1967	25,604	22,269	18,462	15,367	12,844	10,967	9,623	8,511	7,352	6,220	27,491	6,400	1,535	480
1968	24,074	22,161	19,274	15,979	13,300	11,109	9,455	8,235	7,211	6,170	26,883	6,084	1,464	458
1969	21,087	20,837	19,181	16,683	13,830	11,508	9,596	8,137	7,051	6,145	26,967	5,915	1,429	447
1970	79,004	18,252	18,035	16,602	14,439	11,968	9,949	8,283	7,010	6,066	27,434	5,841	1,418	444
1971	65,426	68,381	15,798	15,610	14,370	12,496	10,350	8,592	7,139	6,033	27,773	5,769	1,406	440

	Age													
Year	0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40+
1972	9,173	56,629	59,187	13,674	13,511	12,435	10,804	8,932	7,397	6,135	27,983	5,694	1,391	435
1973	7,503	7,939	49,015	51,229	11,835	11,692	10,751	9,324	7,694	6,362	28,301	5,642	1,378	431
1974	9,916	6,494	6,872	42,424	44,340	10,241	10,107	9,275	8,025	6,609	28,704	5,595	1,361	426
1975	19,826	8,583	5,621	5,948	36,719	38,369	8,854	8,724	7,991	6,904	29,318	5,586	1,347	422
1976	6,787	17,160	7,429	4,865	5,148	31,776	33,177	7,644	7,519	6,878	30,091	5,610	1,332	418
1977	36,619	5,875	14,853	6,430	4,211	4,455	27,467	28,619	6,578	6,457	30,604	5,650	1,313	413
1978	54,949	31,695	5,085	12,856	5,565	3,644	3,850	23,696	24,645	5,658	30,739	5,739	1,298	410
1979	17,843	47,561	27,433	4,401	11,127	4,815	3,148	3,317	20,364	21,144	30,056	5,830	1,278	405
1980	30,618	15,444	41,165	23,745	3,809	9,603	4,107	2,630	2,720	16,531	40,637	5,738	1,225	390
1981	50,748	26,501	13,367	35,629	20,543	3,272	7,990	3,227	1,959	1,968	40,985	5,288	1,112	356
1982	27,095	43,924	22,937	11,569	30,818	17,561	2,652	5,873	2,157	1,243	27,771	4,619	970	312
1983	17,504	23,452	38,017	19,852	10,005	26,258	13,990	1,862	3,633	1,242	17,452	3,821	808	261
1984	34,081	15,151	20,298	32,904	17,176	8,600	21,866	10,979	1,381	2,612	13,031	3,290	690	223
1985	24,946	29,498	13,113	17,568	28,471	14,766	7,146	17,034	8,054	984	11,061	2,917	609	195
1986	12,109	21,592	25,531	11,350	15,202	24,499	12,340	5,650	12,789	5,897	8,647	2,629	549	174
1987	30,578	10,481	18,688	22,098	9,821	13,080	20,480	9,769	4,250	9,375	10,437	2,322	492	154
1988	18,901	26,466	9,071	16,175	19,120	8,435	10,812	15,732	7,003	2,945	13,671	1,951	431	132
1989	14,154	16,359	22,907	7,851	13,996	16,440	7,026	8,481	11,671	5,055	11,964	1,630	387	115
1990	22,420	12,251	14,159	19,827	6,793	12,016	13,565	5,372	6,038	8,024	11,328	1,796	337	98
1991	39,316	19,406	10,603	12,255	17,153	5,832	9,938	10,455	3,867	4,186	13,013	1,650	282	81
1992	14,941	34,030	16,796	9,177	10,604	14,764	4,897	7,969	8,016	2,888	12,719	1,245	247	70
1993	19,262	12,932	29,454	14,537	7,941	9,125	12,397	3,931	6,124	6,004	11,573	929	215	61
1994	17,674	16,672	11,193	25,493	12,577	6,820	7,577	9,668	2,884	4,337	12,336	673	179	50
1995	11,020	15,298	14,430	9,688	22,057	10,818	5,706	6,020	7,304	2,116	12,109	556	155	43
1996	8,102	9,538	13,241	12,489	8,382	18,964	9,024	4,498	4,492	5,282	10,244	415	133	37
1997	12,372	7,013	8,255	11,460	10,807	7,212	15,887	7,191	3,412	3,308	11,186	466	113	32
1998	21,136	10,708	6,069	7,145	9,916	9,294	6,026	12,577	5,405	2,491	10,314	606	95	28
1999	27,610	18,294	9,268	5,253	6,183	8,543	7,852	4,911	9,893	4,159	9,671	545	80	25
2000	23,022	23,898	15,834	8,022	4,546	5,329	7,226	6,413	3,882	7,683	10,608	563	94	23
2001	12,910	19,926	20,684	13,705	6,943	3,922	4,517	5,927	5,111	3,057	14,311	749	100	22
2002	11,520	11,174	17,247	17,903	11,861	5,999	3,360	3,809	4,928	4,225	14,269	824	84	21
2003	12,643	9,971	9,672	14,928	15,496	10,264	5,185	2,896	3,276	4,232	15,709	858	72	21
2004	36,976	10,943	8,630	8,371	12,921	13,412	8,883	4,486	2,506	2,833	16,880	1,104	63	22
2005	7,581	32,005	9,472	7,470	7,246	11,183	11,606	7,684	3,879	2,166	16,713	1,264	60	22
2006	29,265	6,562	27,701	8,198	6,465	6,271	9,676	10,035	6,639	3,349	16,102	1,269	53	22
2007	7,277	25,330	5,680	23,976	7,096	5,596	5,426	8,368	8,672	5,732	16,236	1,608	69	22
2008	76,837	6,298	21,924	4,916	20,752	6,141	4,842	4,693	7,230	7,487	18,551	1,733	105	21
2009	10,646	66,506	5,452	18,976	4,255	17,960	5,313	4,186	4,054	6,241	22,104	1,826	106	20
2010	50,503	9,215	57,563	4,719	16,424	3,683	15,541	4,596	3,619	3,502	23,822	2,192	119	25
2011	3,370	43,713	7,976	49,823	4,084	14,215	3,187	13,441	3,972	3,127	22,270	3,151	167	27
2012	3,037	2,917	37,835	6,903	43,124	3,535	12,300	2,756	11,617	3,431	21,348	3,252	188	24
2013	120,413	2,628	2,525	32,748	5,975	37,323	3,058	10,636	2,381	10,031	20,547	3,602	197	21
2014	50,846	104,222	2,275	2,185	28,344	5,171	32,276	2,641	9,173	2,052	25,501	3,857	252	19
2015	17,100	44,009	90,208	1,969	1,891	24,528	4,470	27,854	2,275	7,891	23,122	3,800	288	19
2016	31,588	14,801	38,092	78,078	1,704	1,637	21,201	3,856	23,973	1,955	26,213	3,649	288	17
2017	20,375	27,341	12,811	32,970	67,579	1,475	1,414	18,277	3,316	20,586	23,522	3,665	363	21
2018	18,761	17,635	23,665	11,088	28,535	58,393	1,262	1,190	15,143	2,726	35,217	4,040	378	27

Male numbers-at-age

Year	Age												
	0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40+
1916	24,731	21,194	18,160	15,560	13,332	11,423	9,786	8,384	7,183	6,154	28,949	6,158	1,309	353
1917	24,717	21,183	18,153	15,555	13,328	11,418	9,782	8,379	7,178	6,149	28,930	6,155	1,308	353
1918	24,702	21,171	18,144	15,549	13,323	11,414	9,777	8,374	7,172	6,144	28,901	6,150	1,307	353
1919	24,685	21,158	18,134	15,541	13,318	11,410	9,773	8,369	7,166	6,138	28,870	6,144	1,306	352
1920	24,666	21,143	18,122	15,532	13,311	11,406	9,770	8,367	7,164	6,135	28,847	6,139	1,305	352
1921	24,646	21,127	18,110	15,522	13,303	11,400	9,767	8,365	7,162	6,132	28,826	6,134	1,304	352
1922	24,624	21,110	18,096	15,511	13,295	11,394	9,762	8,362	7,161	6,132	28,810	6,130	1,303	352
1923	24,600	21,092	18,082	15,500	13,286	11,387	9,757	8,359	7,160	6,131	28,799	6,127	1,303	352
1924	24,574	21,071	18,066	15,487	13,276	11,379	9,751	8,354	7,156	6,129	28,788	6,123	1,302	351
1925	24,544	21,048	18,048	15,474	13,265	11,371	9,745	8,350	7,154	6,128	28,783	6,120	1,302	351
1926	24,512	21,023	18,028	15,459	13,254	11,361	9,738	8,344	7,150	6,125	28,776	6,116	1,301	351
1927	24,475	20,995	18,007	15,442	13,241	11,351	9,729	8,337	7,143	6,120	28,761	6,111	1,300	351
1928	24,434	20,963	17,983	15,423	13,226	11,340	9,720	8,330	7,138	6,115	28,749	6,107	1,299	351
1929	24,389	20,929	17,956	15,403	13,210	11,328	9,711	8,322	7,131	6,110	28,733	6,103	1,299	350
1930	24,339	20,890	17,926	15,380	13,193	11,314	9,700	8,314	7,125	6,105	28,716	6,098	1,298	350
1931	24,283	20,847	17,893	15,354	13,173	11,299	9,688	8,304	7,117	6,098	28,693	6,093	1,297	350
1932	24,221	20,799	17,856	15,326	13,151	11,282	9,675	8,294	7,109	6,092	28,670	6,089	1,296	350
1933	24,153	20,746	17,815	15,294	13,127	11,263	9,661	8,283	7,100	6,085	28,645	6,085	1,295	350
1934	24,077	20,688	17,770	15,259	13,100	11,243	9,645	8,272	7,092	6,078	28,621	6,082	1,294	349
1935	23,994	20,623	17,719	15,220	13,070	11,219	9,627	8,258	7,081	6,071	28,594	6,080	1,293	349
1936	23,900	20,551	17,664	15,177	13,036	11,194	9,607	8,243	7,070	6,062	28,564	6,077	1,292	349
1937	23,796	20,471	17,603	15,130	13,000	11,165	9,585	8,225	7,056	6,051	28,528	6,073	1,290	349
1938	23,680	20,382	17,534	15,077	12,959	11,134	9,561	8,206	7,041	6,039	28,491	6,069	1,289	348
1939	23,549	20,282	17,458	15,019	12,914	11,099	9,534	8,186	7,025	6,028	28,454	6,066	1,288	348
1940	23,403	20,170	17,372	14,953	12,864	11,061	9,505	8,164	7,009	6,015	28,414	6,063	1,287	348
1941	23,241	20,046	17,276	14,880	12,808	11,017	9,471	8,138	6,988	5,999	28,362	6,057	1,286	348
1942	23,060	19,906	17,170	14,798	12,745	10,969	9,434	8,109	6,965	5,981	28,302	6,051	1,285	347
1943	22,865	19,752	17,050	14,706	12,675	10,916	9,393	8,077	6,940	5,961	28,233	6,043	1,284	347
1944	22,656	19,585	16,918	14,604	12,596	10,854	9,343	8,032	6,901	5,926	28,090	6,020	1,279	346
1945	22,433	19,406	16,775	14,491	12,509	10,786	9,283	7,976	6,846	5,875	27,848	5,976	1,271	343
1946	22,198	19,215	16,622	14,368	12,411	10,708	9,215	7,907	6,774	5,804	27,473	5,902	1,256	339
1947	21,975	19,013	16,458	14,237	12,306	10,626	9,155	7,860	6,731	5,759	27,198	5,848	1,245	336
1948	21,766	18,823	16,285	14,097	12,194	10,538	9,091	7,823	6,709	5,741	27,038	5,817	1,239	334
1949	21,571	18,643	16,122	13,949	12,074	10,443	9,019	7,774	6,683	5,729	26,925	5,792	1,235	333
1950	21,404	18,476	15,969	13,809	11,947	10,340	8,939	7,714	6,645	5,710	26,843	5,771	1,231	332
1951	21,283	18,333	15,826	13,678	11,828	10,231	8,850	7,644	6,592	5,676	26,752	5,746	1,227	331
1952	21,229	18,229	15,703	13,555	11,715	10,129	8,755	7,565	6,527	5,626	26,623	5,715	1,222	330
1953	21,277	18,183	15,614	13,450	11,610	10,032	8,667	7,484	6,460	5,571	26,478	5,684	1,216	328
1954	21,458	18,224	15,575	13,374	11,520	9,943	8,586	7,411	6,394	5,516	26,328	5,655	1,212	327
1955	21,802	18,379	15,610	13,340	11,455	9,866	8,510	7,342	6,332	5,460	26,163	5,626	1,207	326
1956	22,319	18,674	15,742	13,370	11,426	9,810	8,444	7,276	6,273	5,407	25,975	5,597	1,202	325
1957	22,954	19,116	15,995	13,484	11,452	9,784	8,394	7,216	6,211	5,351	25,745	5,562	1,196	323
1958	23,543	19,661	16,374	13,700	11,549	9,806	8,370	7,169	6,154	5,293	25,473	5,522	1,188	321
1959	23,822	20,165	16,840	14,025	11,734	9,889	8,389	7,150	6,116	5,246	25,207	5,488	1,180	320
1960	23,627	20,404	17,272	14,424	12,012	10,048	8,461	7,167	6,100	5,214	24,949	5,457	1,173	318
1961	22,966	20,237	17,477	14,794	12,355	10,286	8,595	7,224	6,110	5,196	24,679	5,420	1,164	316
1962	22,590	19,671	17,334	14,969	12,671	10,579	8,800	7,342	6,164	5,208	24,469	5,386	1,156	314
1963	22,885	19,349	16,849	14,847	12,821	10,850	9,050	7,515	6,261	5,251	24,295	5,346	1,147	312
1964	23,699	19,602	16,573	14,431	12,717	10,980	9,287	7,738	6,421	5,347	24,258	5,316	1,142	311
1965	24,643	20,299	16,790	14,195	12,361	10,890	9,395	7,936	6,605	5,477	24,285	5,275	1,134	309
1966	25,728	21,108	17,386	14,381	12,159	10,586	9,323	8,039	6,787	5,647	24,498	5,245	1,130	308
1967	25,604	22,037	18,079	14,892	12,317	10,408	9,038	7,915	6,777	5,684	24,052	5,024	1,085	296
1968	24,074	21,930	18,875	15,485	12,755	10,542	8,880	7,660	6,653	5,653	23,630	4,783	1,036	283
1969	21,087	20,620	18,784	16,167	13,263	10,921	9,012	7,565	6,499	5,623	23,756	4,654	1,012	277
1970	79,004	18,062	17,661	16,089	13,847	11,358	9,344	7,699	6,453	5,536	24,162	4,598	1,004	274
1971	65,426	67,670	15,471	15,127	13,781	11,859	9,720	7,986	6,570	5,499	24,441	4,544	996	272

						Age								
Year	0	1	2	3	4	5	6	7	8	9	10-19	20-29	30-39	40+
1972	9,173	56,040	57,961	13,251	12,957	11,801	10,146	8,302	6,808	5,591	24,602	4,488	986	269
1973	7,503	7,857	47,999	49,645	11,350	11,095	10,096	8,667	7,080	5,798	24,854	4,451	977	267
1974	9,916	6,427	6,729	41,113	42,522	9,719	9,492	8,621	7,386	6,023	25,192	4,420	965	264
1975	19,826	8,493	5,505	5,764	35,214	36,412	8,315	8,109	7,353	6,292	25,713	4,419	955	261
1976	6,787	16,981	7,275	4,715	4,937	30,155	31,157	7,105	6,918	6,267	26,375	4,446	945	259
1977	36,619	5,814	14,545	6,231	4,038	4,227	25,795	26,602	6,054	5,885	26,814	4,485	931	256
1978	54,949	31,365	4,980	12,458	5,337	3,458	3,616	22,025	22,676	5,155	26,899	4,563	921	254
1979	17,843	47,065	26,865	4,265	10,670	4,569	2,956	3,083	18,738	19,264	26,257	4,638	907	251
1980	30,618	15,283	40,313	23,011	3,653	9,112	3,855	2,446	2,509	15,093	35,627	4,473	850	237
1981	50,748	26,225	13,090	34,528	19,702	3,104	7,497	3,007	1,817	1,810	35,415	3,863	720	201
1982	27,095	43,467	22,462	11,212	29,556	16,659	2,487	5,480	2,017	1,156	22,707	2,973	547	153
1983	17,504	23,208	37,229	19,238	9,595	24,906	13,112	1,739	3,418	1,170	13,154	2,095	382	107
1984	34,081	14,993	19,878	31,887	16,473	8,161	20,514	10,214	1,286	2,451	9,807	1,781	320	89
1985	24,946	29,191	12,842	17,025	27,305	14,012	6,708	15,862	7,473	912	8,410	1,537	274	76
1986	12,109	21,367	25,003	10,999	14,579	23,249	11,584	5,261	11,867	5,441	6,531	1,359	240	65
1987	30,578	10,372	18,301	21,415	9,419	12,412	19,225	9,100	3,945	8,658	8,461	1,185	210	56
1988	18,901	26,191	8,883	15,675	18,337	8,004	10,147	14,666	6,515	2,723	11,548	972	178	46
1989	14,154	16,189	22,433	7,609	13,422	15,601	6,594	7,900	10,848	4,679	10,048	802	155	39
1990	22,420	12,123	13,866	19,214	6,515	11,402	12,730	5,008	5,619	7,430	9,638	908	130	32
1991	39,316	19,204	10,384	11,876	16,451	5,533	9,326	9,746	3,604	3,892	11,370	850	107	26
1992	14,941	33,675	16,448	8,894	10,169	14,009	4,596	7,420	7,447	2,684	11,152	637	93	22
1993	19,262	12,798	28,843	14,088	7,615	8,658	11,635	3,660	5,682	5,562	10,138	476	81	19
1994	17,674	16,498	10,961	24,705	12,062	6,471	7,110	9,010	2,682	4,022	10,863	346	67	15
1995	11,020	15,139	14,131	9,388	21,154	10,265	5,355	5,606	6,789	1,964	10,662	296	58	13
1996	8,102	9,439	12,966	12,103	8,039	17,994	8,470	4,190	4,175	4,902	8,933	223	49	11
1997	12,372	6,939	8,084	11,106	10,364	6,843	14,912	6,698	3,170	3,070	9,866	276	42	9
1998	21,136	10,597	5,944	6,924	9,509	8,819	5,655	11,715	5,021	2,309	9,088	386	35	8
1999	27,610	18,103	9,076	5,091	5,929	8,106	7,371	4,571	9,173	3,851	8,531	353	30	7
2000	23,022	23,649	15,506	7,774	4,360	5,057	6,783	5,968	3,592	7,082	9,363	380	37	7
2001	12,910	19,719	20,256	13,281	6,658	3,722	4,241	5,514	4,723	2,803	12,614	520	40	6
2002	11,520	11,058	16,890	17,350	11,375	5,693	3,155	3,541	4,545	3,866	12,477	573	34	6
2003	12,643	9,867	9,471	14,466	14,860	9,741	4,869	2,692	3,015	3,864	13,762	601	29	6
2004	36,976	10,829	8,452	8,112	12,391	12,728	8,342	4,170	2,305	2,581	14,807	791	26	6
2005	7,581	31,671	9,275	7,239	6,948	10,613	10,899	7,141	3,568	1,972	14,622	919	26	6
2006	29,265	6,494	27,127	7,945	6,200	5,951	9,087	9,327	6,107	3,049	14,025	925	24	6
2007	7,277	25,066	5,562	23,235	6,805	5,310	5,096	7,777	7,977	5,220	14,150	1,202	35	6
2008	76,837	6,233	21,470	4,764	19,901	5,828	4,547	4,361	6,652	6,819	16,221	1,314	57	6
2009	10,646	65,813	5,339	18,389	4,080	17,045	4,990	3,891	3,729	5,684	19,386	1,392	59	6
2010	50,503	9,119	56,371	4,573	15,751	3,495	14,595	4,271	3,329	3,189	20,896	1,696	70	8
2011	3,370	43,258	7,810	48,283	3,917	13,490	2,993	12,492	3,654	2,847	19,504	2,486	103	9
2012	3,037	2,886	37,051	6,690	41,356	3,355	11,552	2,561	10,686	3,124	18,626	2,565	118	8
2013	120,413	2,601	2,472	31,735	5,730	35,420	2,872	9,885	2,190	9,134	17,894	2,845	124	7
2014	50,846	103,137	2,228	2,118	27,182	4,907	30,311	2,455	8,438	1,868	22,356	3,049	163	7
2015	17,100	43,551	88,340	1,908	1,814	23,277	4,198	25,889	2,093	7,188	20,151	2,994	188	7
2016	31,588	14,647	37,303	75,664	1,634	1,553	19,910	3,584	22,058	1,781	22,890	2,859	188	6
2017	20,375	27,056	12,545	31,951	64,808	1,400	1,328	16,988	3,051	18,754	20,418	2,869	244	8
2018	18,761	17,452	23,174	10,745	27,365	55,417	1,185	1,107	13,957	2,487	30,945	3,135	254	12

Appendix C. SS data file

```
#V3.30.12.00-trans;_2018_08_01;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11.6
#Stock Synthesis (SS) is a work of the U.S. Government and is not subject to copyright protection in the United States.
#Foreign copyrights may apply. See copyright.txt for more information.
#_user_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_user_info_available_at:https://vlab.ncep.noaa.gov/group/stock-synthesis
#_Start_time: Fri Aug 10 14:29:09 2018
#_Number_of_datafiles: 1
#C 2019 Widow Rockfish Update Assessment
#Grant Adams, Maia Kapur, Stephanie Thurner, Kristin Cochran, Owen Hamel, Chantel Wetzel
# SAFS, University of Washinton, Seattle, WA
# NWFSC, NOAA, Seattle, WA
#_observed data:
#V3.30.12.00-trans;_2018_08_01;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11.6
#Stock Synthesis (SS) is a work of the U.S. Government and is not subject to copyright protection in the United States.
#Foreign copyrights may apply. See copyright.txt for more information.
1916 #_StartYr
2018 #_EndYr
1 #_Nseas
 12 #_months/season
2 #_Nsubseasons (even number, minimum is 2)
1 #_spawn_month
2 #_Ngenders
40 #_Nages=accumulator age
1 #_Nareas
9 #_Nfleets (including surveys)
#_fleet_type: 1=catch fleet; 2=bycatch only fleet; 3=survey; 4=ignore
#_survey_timing: -1 for fishing fleet to midseason catch-at-age for observations, or 1 to use observation month; (always 1 for surveys)
#_fleet_area: area the fleet/survey operates in
#_units of catch: 1=bio; 2=num (ignored for surveys; their units read later)
#_catch_mult: 0=no; 1=yes
#_rows are fleets
#_fleet_type fishery_timing area catch_units need_catch_mult fleetname
 1 -1 1 1 0 BottomTrawl # 1
 1 -1 1 1 0 MidwaterTrawl # 2
 1 -1 1 1 0 Hake # 3
 1 -1 1 1 0 Net # 4
 1 -1 1 1 0 HnL # 5
 3 1 1 2 0 JuvSurvey # 6
 3 1 1 2 0 Triennial # 7
 3 1 1 2 0 NWFSC # 8
 3 1 1 2 0 ForeignAtSea # 9
#Bycatch_fleet_input_goes_next
#a: fleet index
#b: 1=include dead bycatch in total dead catch for F0.1 and MSY optimizations and forecast ABC; 2=omit from total catch for these purposes
(but still include the mortality)
#c: 1=Fmult scales with other fleets; 2=bycatch F constant at input value; 3=bycatch F from range of years
#d: F or first year of range
```

```
#e: last year of range
#f: not used
# a  b  c  d  e  f
#_Catch data: yr, seas, fleet, catch, catch_se
#_catch_se: standard error of log(catch)
#_NOTE: catch data is ignored for survey fleets
-999 1 1 0 0.01
1916 1 1 6.2 0.01
1917 1 1 9.63 0.01
1918 1 1 11.23 0.01
1919 1 1 7.8 0.01
1920 1 1 7.96 0.01
1921 1 1 6.58 0.01
1922 1 1 5.66 0.01
1923 1 1 6.14 0.01
1924 1 1 3.62 0.01
1925 1 1 3.06 0.01
1926 1 1 8.68 0.01
1927 1 1 11.74 0.01
1928 1 1 16.6 0.01
1929 1 1 23.36 0.01
1930 1 1 20.8 0.01
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1953 1 1 455.27 0.01
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1958 1 1 664.89 0.01
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2013 1 5 0.98 0.01
2014 1 5 1.84 0.01
2015 1 5 2.04 0.01
2016 1 5 0.82 0.01
2017 1 5 2.66 0.01
2018 1 5 1.50 0.01
-9999 0 0 0 0
#
 #_CPUE_and_surveyabundance_observations
#_Units: 0=numbers; 1=biomass; 2=F; >=30 for special types
#_Errtype: -1=normal; 0=lognormal; >0=T
#_SD_Report: 0=no sdreport; 1=enable sdreport
#_Fleet Units Errtype SD_Report
1 1 0 0 # BottomTrawl
2 1 0 0 # MidwaterTrawl
3 1 0 0 # Hake
4 1 0 0 # Net
5 1 0 0 # HnL
6 0 0 0 # JuvSurvey
7 1 0 0 # Triennial
8 1 0 0 # NWFSC
9 1 0 0 # ForeignAtSea
#_yr month fleet obs stderr
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1986 7 1 227.08 0.2928 #_ BottomTrawl
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-2011 7 6 7.3891 0.624 #_ JuvSurvey
-2013 7 6 1032.77 0.98 #_ JuvSurvey
-2014 7 6 204.384 0.934 #_ JuvSurvey
2004 7 6 44210 0.337 #_ Updated_VAST_JuvSurvey
2005 7 6 5462 0.277 #_ Updated_VAST_JuvSurvey
2006 7 6 64 1.279 #_ Updated_VAST_JuvSurvey
2007 7 6 546 0.651 #_ Updated_VAST_JuvSurvey
2008 7 6 16863 0.456 #_ Updated_VAST_JuvSurvey
2009 7 6 13956 0.466  #_ Updated_VAST_JuvSurvey
2011 7 6 3250 0.591  #_ Updated_VAST_JuvSurvey
2013 7 6 259118 0.275 #_ Updated_VAST_JuvSurvey
2014 7 6 97231 0.36 #_ Updated_VAST_JuvSurvey
2015 7 6 22368 0.271 #_ Updated_VAST_JuvSurvey
2016 7 6 63369 0.3 #_ Updated_VAST_JuvSurvey
2017 7 6 4425 0.649 #_ Updated_VAST_JuvSurvey
2018 7 6 2562 0.622 #_ Updated_VAST_JuvSurvey
1980 7.6 7 7255.87 0.732 #_ Triennial
1983 7.6 7 10838.7 0.69 #_ Triennial
1986 7.6 7 5847.21 0.774 #_ Triennial
1989 7.6 7 3884.95 0.702 #_ Triennial
1992 7.6 7 7441.37 0.707 #_ Triennial
1995 7.6 7 5885.03 0.712 #_ Triennial
1998 7.6 7 9717.84 0.696 #_ Triennial
2001 7.6 7 1980.62 0.742 #_ Triennial
2004 7.6 7 1069.11 0.853 #_ Triennial
-2003 8.8 8 2779.54 0.364 #_ GLMM_NWFSC
-2004 8.8 8 1182.17 0.485 #_ GLMM_NWFSC
-2005 8.8 8 1760.56 0.423 #_ GLMM_NWFSC
-2006 8.8 8 2656.9 0.362 #_ GLMM_NWFSC
-2007 8.8 8 3035.76 0.37 #_ GLMM_NWFSC
-2008 8.8 8 1668.12 0.428 #_ GLMM_NWFSC
-2009 8.8 8 2836.5 0.37 #_ GLMM_NWFSC
```

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-2010 8.8 8 3720.15 0.353 #_ GLMM_NWFSC
-2011 8.8 8 3613.07 0.327 #_ GLMM_NWFSC
-2012 8.8 8 2814.3 0.369 #_ GLMM_NWFSC
-2013 8.8 8 4121.93 0.534 #_ GLMM_NWFSC
-2014 8.8 8 2224.45 0.344 #_ GLMM_NWFSC
2003 8.8 8 3542.07 0.465 #_ VAST_NWFSC
2004 8.8 8 1340.39 0.616 #_ VAST_NWFSC
2005 8.8 8 1925.60 0.454 #_ VAST_NWFSC
2006 8.8 8 2210.92 0.409 #_ VAST_NWFSC
2007 8.8 8 2551.43 0.399 #_ VAST_NWFSC
2008 8.8 8 1002.74 0.499 #_ VAST_NWFSC
2009 8.8 8 3223.93 0.374 #_ VAST_NWFSC
2010 8.8 8 3638.48 0.396 #_ VAST_NWFSC
2011 8.8 8 4620.03 0.378 #_ VAST_NWFSC
2012 8.8 8 2242.98 0.378 #_ VAST_NWFSC
2013 8.8 8 3378.96 0.498 #_ VAST_NWFSC
2014 8.8 8 2874.12 0.388 #_ VAST_NWFSC
2015 8.8 8 1484.97 0.447 #_ VAST_NWFSC
2016 8.8 8 9400.51 0.330 #_ VAST_NWFSC
2017 8.8 8 3654.26 0.381 #_ VAST_NWFSC
2018 8.8 8 5736.85 0.361 #_ VAST_NWFSC
1977 7 9 0.77 0.1153 #_ ForeignAtSea
1978 7 9 1.205 0.1118 #_ ForeignAtSea
1979 7 9 0.703 0.1186 #_ ForeignAtSea
1980 7 9 1.993 0.1311 #_ ForeignAtSea
1981 7 9 0.728 0.1257 #_ ForeignAtSea
1982 7 9 0.243 0.2467 #_ ForeignAtSea
1984 7 9 2.937 0.1254 #_ ForeignAtSea
1985 7 9 0.407 0.1074 #_ ForeignAtSea
1986 7 9 1.111 0.1027 #_ ForeignAtSea
1987 7 9 0.39 0.0881 #_ ForeignAtSea
1988 7 9 0.513 0.1243 #_ ForeignAtSea
-9999 1 1 1 1 # terminator for survey observations
#
3 #_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; -3 for trunc normal with
CV
# note, only have units and errtype for fleets with discard
#_Fleet units errtype
1 1 -2 # BottomTrawl
2 1 -2 # MidwaterTrawl
5 1 -2 # HnL
#_yr month fleet obs stderr
1985 7 1 462.9 0.4953 #_ BottomTrawl
1986 7 1 534.8 0.5311 #_ BottomTrawl
1987 7 1 1035.5 0.4257 #_ BottomTrawl
1995 7 1 924.8 0.8318 #_ BottomTrawl
1996 7 1 3084.5 0.6707 #_ BottomTrawl
1997 7 1 3353.3 0.7506 #_ BottomTrawl
1998 7 1 42.6 0.488 #_ BottomTrawl
```

```
1999 7 1 4.8 0.6878 #_ BottomTrawl
2002 7 1 13.22 0.4307 #_ BottomTrawl
2003 7 1 1.21 0.8196 #_ BottomTrawl
2004 7 1 5.13 0.7589 #_ BottomTrawl
2005 7 1 10.17 0.4461 #_ BottomTrawl
2006 7 1 0.03 1.3556 #_ BottomTrawl
2007 7 1 13.86 0.6157 #_ BottomTrawl
2008 7 1 3.9 0.4454 #_ BottomTrawl
2009 7 1 26.57 0.3377 #_ BottomTrawl
2010 7 1 22.74 0.5432 #_ BottomTrawl
2011 7 1 0.08 0.05 #_ BottomTrawl
2012 7 1 0.01 0.05 #_ BottomTrawl
2013 7 1 2.43 0.05 #_ BottomTrawl
2014 7 1 0.09 0.05 #_ BottomTrawl
2015 7 1 0.03 0.05 #_ BottomTrawl
2016 7 1 0.02 0.05 #_ BottomTrawl
2017 7 1 0.26 0.05 #_ BottomTrawl
1985 7 2 1502 0.2409 #_ MidwaterTrawl
1986 7 2 1321.2 0.2364 #_ MidwaterTrawl
1987 7 2 1798.4 0.262 #_ MidwaterTrawl
1997 7 2 1 0.8326 #_ MidwaterTrawl
1998 7 2 18.7 0.8 #_ MidwaterTrawl
2002 7 2 39.4 0.4071 #_ MidwaterTrawl
2012 7 2 0.01 0.05 #_ MidwaterTrawl
2013 7 2 0.01 0.05 #_ MidwaterTrawl
2014 7 2 0.01 0.05 #_ MidwaterTrawl
2015 7 2 0.01 0.05 #_ MidwaterTrawl
2016 7 2 0.01 0.05 #_ MidwaterTrawl
2017 7 2 0.01 0.05 #_ MidwaterTrawl
2004 7 5 0.02 1.1392 #_ HnL
2005 7 5 0.21 0.6059 #_ HnL
2006 7 5 0.74 0.6893 #_ HnL
2007 7 5 0.61 1.0622 #_ HnL
2008 7 5 0.64 0.9093 #_ HnL
2010 7 5 0.29 0.7564 #_ HnL
2011 7 5 0.02 0.8494 #_ HnL
2012 7 5 0.04 1.0628 #_ HnL
2013 7 5 0.11 0.4096 #_ HnL
2014 7 5 0.01 0.1687 #_ HnL
2015 7 5 0.06 0.5765 #_ HnL
2016 7 5 0.19 0.1596 #_ HnL
2017 7 5 0.05 0.3765 #_ HnL
-9999 0 0 0.0 0.0 # terminator for discard data
#
0 #_use meanbodysize_data (0/1)
#_COND_30 #_DF_for_meanbodysize_T-distribution_like
# note: type=1 for mean length; type=2 for mean body weight
#_yr month fleet part type obs stderr
# -9999 0 0 0 0 0 # terminator for mean body size data
#
# set up population length bin structure (note - irrelevant if not using size data and using empirical wtatage
```

```
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
1 # binwidth for population size comp
6 # minimum size in the population (lower edge of first bin and size at age 0.00)
60 # maximum size in the population (lower edge of last bin)
1 # use length composition data (0/1)
#_mintailcomp: upper and lower distribution for females and males separately are accumulated until exceeding this level.
#_addtocomp: after accumulation of tails; this value added to all bins
#_males and females treated as combined gender below this bin number
#_compressbins: accumulate upper tail by this number of bins; acts simultaneous with mintailcomp; set=0 for no forced accumulation
#_Comp_Error: 0=multinomial, 1=dirichlet
#_Comp_Error2: parm number for dirichlet
#_minsamplesize: minimum sample size; set to 1 to match 3.24, minimum value is 0.001
#_mintailcomp addtocomp combM+F CompressBins CompError ParmSelect minsamplesize
-1 0.0001 7 0 0 0 1 #_fleet:1_BottomTrawl
-1 0.0001 7 0 0 0 1 #_fleet:2_MidwaterTrawl
-1 0.0001 7 0 0 0 1 #_fleet:3_Hake
-1 0.0001 7 0 0 0 1 #_fleet:4_Net
-1 0.0001 7 0 0 0 1 #_fleet:5_HnL
-1 0.0001 7 0 0 0 1 #_fleet:6_JuvSurvey
-1 0.0001 7 0 0 0 1 #_fleet:7_Triennial
-1 0.0001 7 0 0 0 1 #_fleet:8_NWFSC
-1 0.0001 7 0 0 0 1 #_fleet:9_ForeignAtSea
# sex codes: 0=combined; 1=use female only; 2=use male only; 3=use both as joint sexxlength distribution
# partition codes: (0=combined; 1=discard; 2=retained
25 #_N_LengthBins; then enter lower edge of each length bin
 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
#_yr month fleet sex part Nsamp datavector(female-male)
 1976 7 1 3 2 14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.08 2.72 7.04 8.08 6.96 3.92 1.92 4.32 2.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.36 6.32 8.4 9.44 14.24
13.28 3.28 0.32 0 0 0 0 0
 1977 7 1 3 2 31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.62 12.64 11.61 8.26 8.96 6.82 3.14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.83 8.45 6.9 17.47 3.97
1.34 0 0 0 0 0
 1978 7 1 3 2 91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.64 1.32 7.78 10.36 7.4 9.99 6.8 4.86 1.32 0.05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.64 0.05 3.41 8.07
16.72 10.46 5.41 1.74 1.8 1.22 0 0 0
 1979 7 1 3 2 163 0 0 0 0 0 0 0 0 0 0 0 0 0 0.26 0.08 0.45 1.57 4.16 11.6 18.52 13.87 10.98 6.53 1.36 0 0.02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.34 0.9
6.8 11.69 8.33 1.84 0.02 0.44 0.25 0 0 0
 1980 7 1 3 2 252 0 0 0 0 0 0 0 0 0 0 0 0 0 0.24 0.37 0.9 2.29 5.57 14.85 16.43 14.11 4.76 0.82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.04 0.1 0.57 2.71
7.41 13 12 3.09 0.57 0.02 0.17 0 0 0
 1981 7 1 3 2 309 0 0 0 0 0 0 0 0 0 0 0 0 0.17 0.9 0.47 2.9 4.85 6.5 10.19 13.32 13.09 6.09 1.65 0.11 0 0 0 0 0 0 0 0 0 0 0 0 0.12 0.5 1.35 1.29
3.54 7.65 14.07 8.32 2.83 0.04 0.05 0 0 0 0
 1982 7 1 3 2 499 0 0 0 0 0 0 0 0 0 0 0 0.1 0.65 1.62 4.09 3.31 5.18 6.21 6.98 7.76 11.21 6.84 2.39 1.1 0.9 0.01 0 0 0 0 0 0 0 0 0 0 0.08 0.46
2.35 4.64 3.41 7.8 12.03 8.14 2.23 0.4 0.1 0 0 0 0
 1983 7 1 3 2 455 0 0 0 0 0 0 0 0 0 0.04 0.15 0.55 1.25 3.34 5.79 5.09 5.85 6.33 5.85 7.88 7.88 4.83 1.55 0.7 0.38 0.01 0 0 0 0 0 0 0 0 0 0.04
0.13 0.62 2.42 4.97 5.7 5.43 6.53 9.22 5.82 1.18 0.43 0.03 0 0 0.01 0
 1984 7 1 3 2 859 0 0 0 0 0 0 0 0 0 0 0.09 0.88 3.62 7.08 9.51 6.89 4.47 4.09 3.6 4.7 2.87 1.62 0.37 0.02 0 0 0 0 0 0 0 0 0 0 0.01 0.32 1.5
4.49 11.95 9.93 7.36 6.63 5.37 1.9 0.58 0.06 0.08 0 0 0
 1985 7 1 3 2 804 0 0 0 0 0 0 0 0 0 0.01 0.16 0.75 2.25 3.64 7.31 10.22 8.28 5.98 4.27 6.35 3.55 1.71 0.37 0.03 0 0 0 0 0 0 0 0 0 0 0.09 0.29
1.21 2.68 6.52 9.04 10.69 7.88 4.8 1.5 0.41 0.01 0 0 0 0
 1986 7 1 3 2 629 0 0 0 0 0 0 0 0 0 0.12 0.56 2.1 2.14 3.13 4.46 5.08 8.42 6.84 4.26 4.61 4.57 2.6 1.59 0.41 0 0 0 0 0 0 0 0 0 0.04 0.09 0.7
1.97 3.28 6.47 7.38 13.57 9.68 4.5 0.98 0.4 0.02 0 0 0 0
 1987 7 1 3 2 399 0 0 0 0 0 0 0 0 0 0.06 0.43 1.04 1.98 3.04 4.49 5.15 8.81 6.86 6.07 5.12 2.85 1.44 0.25 0.01 0 0 0 0 0 0 0 0 0 0.01 0.16
0.27 1.52 2.98 3.52 8.72 12.31 13.3 7.42 1.84 0.29 0.03 0 0 0 0
```

1988 7 1 3 2 406 0 0 0 0 0 0 0 0 0 0 0.12 0.68 2.38 4.03 5.82 7.66 7.25 6.49 5.31 5.59 2.97 2.38 1.57 0.42 0.02 0.01 0 0 0 0 0 0 0 0.04 0 0.04
0.58 2.93 3.86 6.92 10.34 9.57 6.53 4.39 1.46 0.41 0.14 0 0.09 0 0
1989 7 1 3 2 530 0 0 0 0 0 0 0 0 0 0 0.09 0.13 1.2 2.22 7.38 7.9 7.99 6.75 5.84 4.35 3.49 2 0.99 0.57 0.01 0.05 0 0 0 0 0 0 0.09 0 0 0.08 0.19
1.47 5.02 9.72 9.03 9.89 7.57 3.92 1.47 0.5 0.09 0.02 0 0 0
1990 7 1 3 2 568 0 0 0 0 0 0 0 0.04 0.01 0.02 0.04 0.7 1.97 4.15 7.98 7.77 8.07 7.18 4.59 3.44 2.25 1.09 0.3 0.06 0.05 0 0 0 0 0 0 0 0.04 0
0.02 0.17 0.87 3.5 7.78 11.73 11.76 7.71 4.44 1.52 0.54 0.16 0.05 0 0 0.02
1991 7 1 3 2 736 0 0 0 0 0 0 0 0 0.02 0.02 0.41 1.14 1.44 3.42 4.74 7.5 8.44 6.39 6.23 4.19 2.8 2.3 0.8 0.22 0.01 0 0 0 0 0 0 0 0 0 0 0.56
2.27 2.4 4.92 9.24 13.07 10.42 4.87 1.55 0.56 0.06 0 0.01 0 0
1992 7 1 3 2 796 0 0 0 0 0 0 0 0 0 0.03 0.16 0.4 1.36 1.59 3.61 8.57 9.27 8.27 8.5 5.9 3.36 1.73 0.82 0.28 0.09 0 0 0 0 0 0 0 0 0.07 0.07
0.07 0.81 1.49 3.31 6.48 10.47 10.89 8.15 3.15 0.97 0.04 0.04 0.03 0 0
1993 7 1 3 2 781 0 0 0 0 0 0 0 0 0.02 0.05 0.16 0.51 1.58 3.13 4.68 4.81 6.56 9.81 8.68 5.76 4.23 2.21 1.23 0.17 0 0 0 0 0 0 0 0 0 0.02 0.03
0.21 1.19 1.85 5.27 6.62 8.73 11.47 6.84 3.16 0.7 0.26 0.05 0 0 0
1994 7 1 3 2 613 0 0 0 0 0 0 0 0 0.02 0.11 0.25 0.54 1.27 3.94 6.75 7.35 7.04 8.53 7.86 6.34 4.54 2.13 0.86 0.16 0 0 0 0 0 0 0 0 0 0 0 0.11
0.21 0.56 1.69 4.61 9.78 8.63 8.33 5.24 2.17 0.64 0.34 0 0 0 0
1995 7 1 3 2 593 0 0 0 0 0 0 0 0.01 0.01 0.17 0.62 1.18 1.16 1.98 4.7 8.2 8.98 8.5 5.93 3.54 2.1 1.6 0.25 0.08 0 0 0 0 0 0 0 0 0.01 0 0.03
0.61 1.14 2.01 4.06 10.33 13.59 10.84 5.63 1.85 0.75 0.07 0 0.06 0 0
1996 7 1 3 2 495 0 0 0 0 0 0 0 0 0.11 0.02 0.22 0.71 2.3 4.84 5.92 7.55 9.45 8.06 6.23 3.47 3.46 1.38 0.39 0.23 0 0 0 0 0 0 0 0 0 0 0.03 0.31
0.68 2.55 6.12 9.53 10.18 10.52 3.64 1.44 0.36 0.28 0 0 0 0
1997 7 1 3 2 650 0 0 0 0 0 0 0 0 0 0.15 0.12 0.52 1.76 4.03 7.2 7.93 7.37 5.59 5.35 3.74 2.38 0.97 0.46 0.01 0 0 0 0 0 0 0 0 0 0 0.02 0.43
0.71 2.79 9.28 15.05 11.47 7.24 4.09 0.96 0.19 0.18 0 0 0 0
1998 7 1 3 2 557 0 0 0 0 0 0 0.02 0.08 0.02 0 0.19 0.52 1.29 3.2 5.69 9.24 8.46 6.99 4.72 4.2 2.64 1.61 0.56 0.23 0 0 0 0 0 0 0 0.03 0 0 0.06
0.28 0.91 2.19 4.4 10.22 15.11 10.59 4.03 1.64 0.56 0.19 0.12 0 0 0
1999 7 1 3 2 513 0 0 0 0 0 0 0 0.08 0.01 0.37 0.64 3.05 4.14 6.62 8.74 9.13 5.72 3.41 3.54 1.25 0.8 0.2 0.04 0.01 0 0 0 0 0 0 0 0 0 0.06 0.35
0.31 0.83 3.89 7.36 11.78 13.5 9.32 3.45 1.02 0.28 0.11 0 0 0 0
2000 7 1 3 2 67 0 0 0 0 0 0 0 0 0 0 0 0 0.04 0.28 1.58 11.31 5.09 16.28 13.13 8.19 6.11 2.36 3.9 1.17 0 0 0 0 0 0 0 0 0 0 0 0 0 0.15 0.39 3.6
4.03 8.54 6.4 7.23 0.15 0 0 0.06 0 0 0
2001 7 1 3 2 52 0 0 0 0 0 0 0 0 0 0 0 0 1.76 0 5.54 5.71 12.69 4.5 7.52 3.1 2.36 0.52 0.13 0.67 0 0 0 0 0 0 0 0 0 0 0 0 0 3.52 3.63 9.3 9.89
13.64 6.25 6.53 1.72 0.88 0.1 0.03 0 0 0
2002 7 1 3 2 125 0 0 0 0 0 0 0 0 0 0.31 0.88 2.32 7.2 2.02 4.54 4.01 7.89 8.91 3.24 3.15 2.77 0.48 0.33 0.39 0 0 0 0 0 0 0 0 0 0 0.23 2.38
3.99 8.96 3.3 8.25 10.57 7.22 4.94 0.96 0.58 0.18 0 0 0 0
2003 7 1 3 2 46 0 0 0 0 0 0 0 0.15 0.41 0.61 0.78 0.73 3.49 6.95 6.48 13.3 6.17 3.51 1.86 0.75 0.04 0 0 0 0 0 0 0 0 0 0 0 0.15 0.2 1.42 0.68
0.73 1.29 13.31 17.39 9.61 5.14 2.91 0.12 0.61 1.23 0 0 0 0
2004 7 1 3 2 13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.32 5.56 3.84 0 4.9 9.49 14.31 3.84 4.49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.84 18.54 7.01 13
10.85 0 0 0 0 0 0
2005 7 1 3 2 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.37 0.37 2.04 8.53 0.24 32.25 9.01 0.39 0.37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.86 1.55 10.48
33.16 0 0.37 0 0 0 0 0
2006 7 1 3 2 31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.74 12.47 13.9 7.67 6.31 7.17 2.82 0.67 0.3 0 0 0 0 0 0 0 0 0 0 0 0 0 0.67 0.9 2.94 2.27 7.55
10.97 10.72 2.58 0.63 1.25 1.46 0 0 0
2007 7 1 3 2 84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.27 30.53 1.39 3.6 25.35 8.34 4.38 2.83 2.5 1.01 0.06 0 0 0 0 0 0 0 0 0 0 0 0 0.13 0 0.21 0.8 2.56
5.97 5.94 3.08 0.86 0.19 0 0 0 0
2008 7 1 3 2 77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.37 0.64 8.52 5.29 6.43 10.3 9.88 10.19 5.99 1.96 0.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.94 1.93 6.61
8.9 11.31 5.99 2.79 1.61 0 0 0 0
2009 7 1 3 2 112 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.15 1.13 2.35 5.9 23.71 7.86 6.76 5.76 2.12 0.66 0.54 0 0 0 0 0 0 0 0 0 0 0 0 0 0.48 0.75 5.47
9.35 16.42 7.78 2.27 0.43 0 0 0.11 0
2010 7 1 3 2 116 0 0 0 0 0 0 0 0 0 0 0 0 0 0.04 0.36 0.96 2.84 8.46 10.04 7.47 9.46 8.17 3.91 2.27 0.15 0 0 0 0 0 0 0 0 0 0 0 0 0.49 0.05 0.79
1.19 3.12 13.24 14.08 9.29 2.66 0.94 0.01 0.01 0 0
2011 7 1 3 2 80 0 0 0 0 0 0 0 0 0 0.03 0 0.08 0.55 0.19 1.75 1.38 2.58 2.23 4.71 14.8 15.99 4.66 4.74 3.95 0.59 0 0 0 0 0 0 0 0 0 0 0 0 0.08 0.59
1.14 1.24 1.15 6.84 5.38 12.32 6.98 3.85 1.48 0.36 0.36 0 0
2012 7 1 3 2 114 0 0 0 0 0 0 0 0 0.03 0 0.2 0.65 0.35 0.93 0.86 2.25 2.31 8.3 13.42 19.42 9.1 5.27 0.58 0.53 0.01 0 0 0 0 0 0 0 0 0 0.22 0.11
0.28 0.95 0.79 0.86 3.91 8.23 10.25 8.09 1.98 0.11 0 0 0 0

2013 7 1 3 2 118 0 0 0 0 0 0 0 0 0 0 0 1.52 1.41 2.84 1.08 1.66 3.43 6.05 4.98 9.24 26.85 9.18 2.47 0.34 0.13 0 0 0 0 0 0 0 0 0 0.01 0 0 0.98 3.17 2.2 2.42 0.69 5.54 3.51 6.55 2.12 1.39 0.12 0.12 0 0 0
2014 7 1 3 2 118 0 0 0 0 0 0 0 0 0 0 0.02 0.05 0.1 1.82 1.74 2.96 6.13 6.39 7.8 8.82 12.01 4.85 3.71 0.92 0 0 0 0 0 0 0 0 0 0 0 0 0 0.13 0.29 0.4 7.28 3.22 5.44 10.66 8.92 5.74 0.6 0 0 0 0 0
2015 7 1 3 2 65 0 0 0 0 0 0 0 0 0 0 1 4 7.75 2.63 16.14 18.77 70.86 33.54 10.43 5 5.3 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 7 7.25 10.42 14.92 42.2 43.56 26.84 32.88 0 7.3 0 0 0 0 0 0
2016 7 1 3 2 63 0 0 0 0 0 0 0 0 0 1 4.92 9.02 5.05 10.94 18.02 56.17 92.47 114.04 209.89 145.72 105.63 105.73 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5.9 7.87 11.12 36.66 66.51 86.28 79.03 70.99 37.09 0 0 0 0 0 0 0
2017 7 1 3 2 226 0 0 0 0 0 0 0 32.53 66.06 212.5 754.95 638.05 718.5 4821.75 18682.03 20513.2 11827.54 11798.66 10123.4 3466.45 311.23 61.55 0 0 0 0 0 0 0 0 0 13.8 2 415.25 571.56 1954.6 5806.77 17845.16 25310.43 18098.4 11444.45 5126.34 205.19 595.39 1.86 0 0 0 0 0
2018 7 1 3 2 176 0 0 0 0 0 0 0 0 0 0 0 3.05 40.63 32.44 21.03 125.76 281.26 234.62 183.79 147.93 66.77 74.69 2 0 1 0 0 0 0 0 0 0 0 0 0 3 9.05 21.05 42.66 316.1 443.42 514.39 243.35 47.06 11.63 6.63 1 0 0 0 0 0
1985 7 1 1 1 85 0 0 0 0 0 0 0 0 0 0 0.05 0.05 0 0.01 0.03 0.08 0.16 0.21 0.11 0.04 0.12 0.11 0.02 0.01 0 0 0 0 0 0 0 0 0 0 0 0 0.05 0.05 0 0.01 0.03 0.08 0.16 0.21 0.11 0.04 0.12 0.11 0.02 0.01 0 0
1985 7 1 2 1 80 0 0 0 0 0 0 0 0 0 0 0.04 0.02 0.02 0.03 0.04 0.31 0.41 0.07 0.05 0.01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.04 0.02 0.02 0.03 0.04 0.31 0.41 0.07 0.05 0.01 0 0 0 0 0 0
1986 7 1 1 1 7 0 0 0 0 0 0 0 0 0 0 0.05 0.05 0 0.01 0.03 0.08 0.16 0.21 0.11 0.04 0.12 0.11 0.02 0.01 0 0 0 0 0 0 0 0 0 0 0 0 0.05 0.05 0 0.01 0.03 0.08 0.16 0.21 0.11 0.04 0.12 0.11 0.02 0.01 0 0
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0 0 0 0.03 0.03
 2016 7 5 0 1 11 0 0 0 0 0 0.02 0 0.02 0.02 0 0 0 0 0 0 0 0 0.16 0.04 0.07 0.09 0.41 0.07 0.10 0 0 0 0 0 0.02 0 0.02 0.02 0 0 0 0 0 0 0 0 0
0.16 0.04 0.07 0.09 0.41 0.07 0.10
 2017 7 5 0 1 19 0 0 0 0.01 0 0.04 0.17 0.18 0.15 0.13 0.06 0 0 0 0 0 0 0 0.05 0.08 0 0.08 0.03 0.03 0 0 0 0 0.01 0 0.04 0.17 0.18 0.15 0.13
0.06 0 0 0 0 0 0 0 0.05 0.08 0 0.08 0.03 0.03 0
 -2018 7 5 0 1 999 0 0 0 0 0 0.18 0.36 0 0.18 0.09 0.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.18 0.36 0 0.18 0.09 0.18 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
 1980 7.6 7 3 0 14 0 0 0 0 0 0 0 0 0 0 0 0.77 0 3.07 1.53 16.02 14.4 5.89 2.3 2.47 1.41 0.23 0 0 0 0 0 0 0 0 0 0 0 0 0 1.53 1.53 22.71
18.02 4.69 2.71 0.7 0 0 0 0 0
 1983 7.6 7 3 0 24 0 0 0 0 0.06 0.06 0.24 0.73 0.73 0.61 0.79 0.49 1.72 3.95 3.47 3.34 2.64 3.16 1.91 2.9 3.2 1.41 2.77 2.07 0 0 0 0 0 0.18
0.18 0.73 2.19 1.7 1.82 3.34 1.21 2.69 2.44 4.28 5.5 11.47 16.61 7.23 1.92 0.25 0 0 0 0
 1986 7.6 7 3 0 30 0 0 0 0 0 0 0 0.01 0.04 0.03 0.12 0.38 0.84 0.36 0.34 2.25 4.36 4.12 2.58 4.12 2.05 10.73 0.4 0 0 0 0 0 0 0 0 0 0.03 0.04
0.01 0.18 0.59 0.17 0.62 0.68 22.86 25.49 14.75 1.84 0 0 0 0 0 0
 1989 7.6 7 3 0 70 0 0 0 0 0.03 0.6 1.86 1.02 0.5 13.71 3.12 3.95 9.83 7.05 2.32 2.42 2.39 0.78 0.74 0.27 0.29 0.19 0.02 0 0 0 0 0 0 0.08 0.71
1.64 0.75 0.46 5.08 3.17 3.97 4.17 1.1 2.27 5.04 18.79 0.78 0.52 0.3 0.05 0 0 0 0
 1992 7.6 7 3 0 48 0 0 0.01 0.01 0.02 0.02 0.01 0.01 0.05 0.67 2.05 8.18 10.16 7.42 0.6 0.79 1.52 4.22 2.43 2.39 14.05 2.42 0.04 0.01 0 0 0
0.01 0.01 0.02 0.01 0.02 0.02 0.04 0.46 4.69 8.47 11.04 6.43 1.76 1.32 2.78 4.97 0.82 0.03 0 0 0 0 0
 1995 7.6 7 3 0 78 0.04 0 0.04 0.13 0.09 0.22 0.43 0.13 0.23 1.18 5.89 12.43 4.92 0.18 0.42 0.82 2.24 2.28 2.22 3.34 3.38 2.99 1.27 0.51 0
0.04 0 0.04 0.13 0.28 0.42 0.5 0.61 0.43 1.08 5.66 8.22 6.3 1.7 1.9 5.02 7.63 7.19 5.26 1.43 0.79 0 0 0 0
 1998 7.6 7 3 0 110 0 0 0.02 0 0 0.02 0.02 0.02 0 0.05 0.14 0.37 1.37 1.21 2.81 6.56 5.81 7.1 8.09 3.85 5.59 4.38 0.35 0 0 0 0 0.02 0 0 0.07
0.07 0.07 0 0.14 0.43 1.08 1.48 3.39 11.98 12.95 8.82 6.91 3.47 1.09 0.26 0 0 0 0
 2001 7.6 7 3 0 37 0 0 0 0.48 3.69 9.29 6.7 2.42 1.29 0.7 0.48 0 0 0.97 0 2.92 1.29 0.63 4.87 0.63 5.16 0 1.72 0 0 0 0 0 0.16 4.65 8.66 6.96
3.39 2.59 2.11 0.16 0 0 1.19 2.87 3.25 6.75 9.37 3.44 0 1.18 0 0 0 0
 2004 7.6 7 3 0 48 4.88 0 0 0 0 0 0 0.05 0 0.05 0 0.25 1.18 1.66 2.61 1.99 2.47 12.61 3.1 6.8 3.23 1.82 1.29 0 0 4.88 0 0 0 0 0 0 0.16 0 0.16
0.25 0 1.11 2.28 5.05 3.9 8.68 11.79 16.91 0.82 0 0 0 0 0
 -2003 8.8 8 3 0 33 0 0 0 0 0 0.08 0 0 0.25 0.34 0.17 0.25 1.75 0.79 2.16 6.85 14.03 15.83 4.22 1.69 2.78 0.33 0 0 0 0 0 0 0.11 0 0.24 0.08
0.34 0.17 0 0.08 0.34 0.85 0 10.12 9.45 11.06 5.87 1.72 8.05 0 0 0 0 0 # Old_length_composition_data
 -2004 8.8 8 3 0 17 0 0 0 0 0 0 0.05 0 0.13 0.26 0.48 0.81 0.62 0.62 1.37 8.23 14.08 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.05 0.2 3.92 0.49 0.57
1.37 0 24.69 27.63 0 14.43 0 0 0 0 0 0 # Old_length_composition_data
 -2005 8.8 8 3 0 25 0 0 0 0 0 0 0 0 0 0 1.1 0 3.62 2.75 0.91 0 1.27 2.96 7.42 9.26 10.68 10.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0.63 0.17 0.17 0.34
10.27 4.55 3.79 11.54 13.37 4.53 0 0 0 0 0 # Old_length_composition_data
 -2006 8.8 8 3 0 38 0 0 0 0 0 0 0 0 0 0 0.34 2.41 5.51 4.14 4.35 1.08 2.23 3.16 2.71 5.54 13.14 3.72 0 0 0 0 0 0 0 0.31 0 0 0 0 0 0.34 5.66
4.82 6.48 2.24 7.39 4.32 7 8.98 0.37 0.37 0 3.4 0 0 # Old_length_composition_data
 -2007 8.8 8 3 0 33 0 0 0 0 0 0 0 0 0 0 0 0 0 1.38 0 3.24 6.6 10.41 9.89 3.4 8.85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.77 9.27 12.79 14.84
8.29 10.28 0 0 0 0 0 # Old_length_composition_data
 -2008 8.8 8 3 0 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.22 0 7.55 4.61 12.84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.74 4.47 0 2.69 0 2.18 0 11.11 7.26
19.34 13.97 0 0 0 0 0 # Old_length_composition_data
```

```
 -2009 8.8 8 3 0 42 0 0 0 0 0 0 0 0 0.46 0.95 2.09 4.61 3.56 4.71 1.06 4.04 2.94 5.9 9.04 7.95 8.01 4.6 0 0 0 0 0 0 0 0 0 0 0 0 1.38 1.9 3.62
3.35 0 0 3.94 6.42 9.15 4.91 2.29 0 0 3.13 0 0 # Old_length_composition_data
 -2010 8.8 8 3 0 44 0 0 0 0 0 0 0.2 0.79 0.2 0 0 0 0 0 0.38 4.1 11.53 15.54 15.56 7.58 0.65 5.48 0.13 0 0 0 0 0 0 0 0.2 0 0.98 0.2 0 0 0 2.52
0.83 0.38 3.57 9.86 4.74 8.97 3.1 0 2.52 0 0 0 # Old_length_composition_data
 -2011 8.8 8 3 0 53 0 0 0 0 0 0 0 0 0.98 0 0 0 0.63 2.76 7.7 3.62 0.83 2.34 4.78 5.11 2.97 7.52 2.91 0 0 0 0 0 0 0 0 0 0 0 0 1.08 0.21 1.64 3.06
5.07 2.06 1.64 7.54 9.88 17.03 7.38 0.31 0.98 0 0 0 # Old_length_composition_data
 -2012 8.8 8 3 0 44 0 0 0 0 0.63 0 0 0 0.63 2.51 5.64 2.06 1.9 0.5 1.01 1.51 4.44 2.78 6.18 8.72 8.77 4.53 0.26 0 0 0 0 0 0 0 0 0 0.23 7.11
3.36 8.4 3.76 1.13 0.5 2.64 3.96 2.66 5.8 4.24 2.71 1.44 0 0 0 0 # Old_length_composition_data
 -2013 8.8 8 3 0 43 0 0 0 0 0 0.06 0.18 1.89 5.46 5.39 7.12 5.73 6.61 2.19 0.83 1.3 0.4 1.49 5.01 2.85 2.43 2.29 0.33 0 0 0 0 0 0.06 0.18 0.42
0.42 1.6 4.95 3.01 3.86 6.24 3.86 3.31 1.85 5.37 3.23 4.5 5.25 0.33 0 0 0 0 0 # Old_length_composition_data
 -2014 8.8 8 3 0 52 0 0 0 0 0 0 0 0 0 0 0 0.44 6.61 6.03 4.85 1.95 1.76 2.63 2.61 5.14 4.71 2.56 0.43 0.13 0 0 0 0 0 0 0 0 0 0.1 0 0.77 1.97
11.87 15.49 7.43 2.76 4.55 5 4.75 3.26 1.54 0.43 0.22 0 0 0 # Old_length_composition_data
 2003 8.8 8 3 0 33 0 0 0 0 0 0.3454 0.0864 0 0.4318 0.5181 0.3454 0.5181 0.5181 0.8636 2.4180 7.4266 11.7444 16.9257 4.6632 1.7271 2.7634
0.3454 0 0 0 0 0 0 0.1727 0 0.5181 0.2591 0.5181 0.2591 0 0.1727 0.6908 1.0363 0 9.3264 8.6356 11.9171 4.6632 1.5544 8.6356 0 0 0 0 0
 2004 8.8 8 3 0 18 0 0 0 0 0 0 0 1.1364 0 2.2727 4.5455 7.9545 13.6364 10.2273 10.2273 3.4091 1.1364 1.1364 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1.1364 3.4091 11.3636 7.9545 9.0909 3.4091 0 3.4091 3.4091 0 1.1364 0 0 0 0 0 0
 2005 8.8 8 3 0 26 0 0 0 0 0 0 0 0 0 0 0 1.7241 0 1.7241 0.8621 1.7241 0 3.4483 2.5862 17.2414 6.0345 18.1034 4.3103 0 0 0 0 0 0 0 0 0 0 0 0 0
0.8621 0.8621 0.8621 1.7241 5.1724 4.3103 2.5862 18.9655 5.1724 1.7241 0 0 0 0 0
 2006 8.8 8 3 0 38 0 0 0 0 0 0 0 0 0 0 0 0.6579 3.9474 9.2105 6.5789 3.2895 1.9737 2.6316 3.2895 3.9474 3.2895 6.5789 5.9211 0 0 0 0 0 0 0
0.6579 0 0 0 0 0 0.6579 7.8947 7.8947 9.2105 2.6316 3.9474 4.6053 5.2632 3.9474 0.6579 0.6579 0 0.6579 0 0
 2007 8.8 8 3 0 34 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.3158 0 5.2632 9.2105 10.5263 11.1583 2.6316 6.5789 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.3158
7.8947 13.1579 13.1579 9.8943 7.8947 0 0 0 0 0
 2008 8.8 8 3 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.6923 0 7.6923 7.6923 11.5385 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.6923 3.8462 0 3.8462 0 3.8462 0
11.5385 7.6923 15.3846 11.5385 0 0 0 0 0
 2009 8.8 8 3 0 42 0 0 0 0 0 0 0 0 0.8264 0.8264 3.3058 7.4380 5.7851 7.4380 1.6529 4.1322 2.4793 4.9587 6.6116 5.7851 5.7851 3.3058 0 0 0 0 0
0 0 0 0 0 0 0 1.6529 2.4793 5.7851 4.9587 0 0 3.3058 4.9587 6.6116 4.1322 2.4793 0 0 3.3058 0 0
 2010 8.8 8 3 0 45 0 0 0 0 0 0 0.5814 1.7442 0.5814 0 0 0 0 0 1.1628 5.8140 6.9767 12.2093 11.0465 7.5581 1.7442 2.3256 0.5814 0 0 0 0 0 0 0
0.5814 0 2.3256 0.5814 0 0 0 0.5814 1.7442 1.1628 3.4884 14.5349 12.2093 7.5581 2.3256 0 0.5814 0 0 0
 2011 8.8 8 3 0 53 0 0 0 0 0 0 0 0.1980 0 0 0 0.1980 1.3861 4.1584 2.7723 1.9802 2.5743 6.9307 4.1584 5.5446 7.3267 1.3861 0 0 0 0 0 0 0 0 0 0
0 0 0.3960 0.3960 0.7921 2.7723 3.7624 4.1584 2.3762 11.0891 19.2079 13.6634 1.7822 0.7921 0.1980 0 0 0
 2012 8.8 8 3 0 45 0 0 0 0 0.9524 0 0 0 0.9524 3.4921 7.6190 2.5397 0.9524 0.6349 1.2698 1.9048 4.1270 1.9048 4.7619 9.5238 6.9841 6.0317
0.3175 0 0 0 0 0 0 0 0 0 0.3175 6.3492 4.4444 11.4286 5.0794 1.5873 0.6349 2.2222 4.1270 2.2222 2.5397 2.8571 1.2698 0.9524 0 0 0 0
 2013 8.8 8 3 0 44 0.0233 0 0 0 0 0.0465 0.1395 2.0465 5.8140 5.5814 7.6744 6.1860 7.3488 2.1395 0.8837 1.3953 0.1395 1.3488 4.5581 2.3721
1.8605 2.0465 0.2791 0 0 0.0233 0 0 0.0465 0.1395 0.3256 0.3256 1.6279 4.9302 3.1163 3.9535 6.8837 4.1395 3.3953 1.8605 5.3488 3.3488 3.7674
4.6047 0.2791 0 0 0 0 0
 2014 8.8 8 3 0 53 0 0 0 0 0 0 0 0 0 0 0 0.6667 8.3333 7.5000 6.0000 2.3333 1.6667 1.5000 1.3333 2.1667 2.1667 1.5000 0.3333 0.1667 0 0 0 0 0 0
0 0 0 0.1667 0 1.0000 2.6667 14.8333 18.8333 9.0000 3.0000 4.1667 3.6667 2.3333 2.1667 1.8333 0.3333 0.3333 0 0 0
 2015 8.8 8 3 0 32 0 0 0 0 0 0 0 0 0.3636 0 0 0 0.7273 0 3.2727 3.2727 6.5455 5.4545 13.4545 13.4545 11.6364 11.6364 2.5455 0.7273 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.3636 1.8182 6.1818 6.5455 7.2727 4.0000 0.7273 0 0 0 0 0
 2016 8.8 8 3 0 103 0 0 0 0 0 0.0744 0.1488 1.1654 1.3637 1.9340 2.0332 2.1820 3.2730 4.0169 5.6534 9.1495 6.8435 4.6615 2.2316 2.2068 0.6943
0.8926 1.1902 0.6447 0.0992 0 0 0 0 0 0 0.0744 0.8678 2.6283 1.7109 1.6613 2.0828 6.5212 5.5294 6.3724 6.5708 8.0833 2.9259 2.8515 1.4133
0.1240 0.1240 0 0 0
 2017 8.8 8 3 0 52 0 0 0 0 0 0.2092 0 0.2092 0.4184 3.0858 6.8515 6.3808 3.1904 5.3347 6.6946 7.0084 5.4916 1.9874 2.3536 2.1444 1.2029 0.9937
0 0 0 0 0 0 0 0 0 0 0 0.4184 2.7720 6.9561 3.1904 0.5230 6.4854 9.5188 10.5126 2.5105 3.2427 0.3138 0 0 0 0 0 0
 2018 8.8 8 3 0 63 0 0 0 0 0 0 0 0 0 0 0.2427 1.5777 1.4563 1.2136 2.6699 0.7282 4.2476 9.7087 12.2573 8.0097 8.4951 5.2184 0.6068 0.1214 0 0 0
0 0 0 0 0 0.2427 0.2427 0.1214 1.2136 1.6990 1.8204 2.3058 0.7282 2.5485 11.1650 10.1942 7.8883 2.5485 0.3641 0.1214 0.2427 0 0 0
-9999 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
41 #_N_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 36 37 38 39 40
2 #_N_ageerror_definitions
```

```
 0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5 11.5 12.5 13.5 14.5 15.5 16.5 17.5 18.5 19.5 20.5 21.5 22.5 23.5 24.5 25.5 26.5 27.5 28.5 29.5
30.5 31.5 32.5 33.5 34.5 35.5 36.5 37.5 38.5 39.5 40.5
 0.144685 0.144685 0.186767 0.232724 0.282913 0.337724 0.397582 0.462953 0.534344 0.612309 0.697454 0.79044 0.891989 1.00289 1.124 1.25627
1.40072 1.55847 1.73074 1.91888 2.12435 2.34874 2.59379 2.86141 3.15368 3.47285 3.82143 4.2021 4.61783 5.07184 5.56766 6.10914 6.70049 7.34629
8.05157 8.8218 9.66295 10.5816 11.5848 12.6804 13.8769
 0.515025 1.54508 2.57513 3.60518 4.63523 5.66528 6.69533 7.72538 8.75543 9.78548 10.8155 11.8456 12.8756 13.9057 14.9357 15.9658 16.9958
18.0259 19.0559 20.086 21.116 22.1461 23.1761 24.2062 25.2362 26.2663 27.2963 28.3264 29.3564 30.3865 31.4165 32.4466 33.4766 34.5067 35.5367
36.5668 37.5968 38.6269 39.6569 40.687 41.717
 0.111336 0.111336 0.147152 0.187437 0.232748 0.283712 0.341034 0.405507 0.478023 0.559587 0.651326 0.75451 0.870568 1.0011 1.14793 1.31306
1.49881 1.70772 1.9427 2.20699 2.50425 2.8386 3.21467 3.63764 4.11339 4.6485 5.25036 5.9273 6.6887 7.54509 8.50833 9.59173 10.8103 12.1809
13.7225 15.4564 17.4066 19.6001 22.0673 24.8423 27.9635
#_mintailcomp: upper and lower distribution for females and males separately are accumulated until exceeding this level.
#_addtocomp: after accumulation of tails; this value added to all bins
#_males and females treated as combined gender below this bin number
#_compressbins: accumulate upper tail by this number of bins; acts simultaneous with mintailcomp; set=0 for no forced accumulation
#_Comp_Error: 0=multinomial, 1=dirichlet
#_Comp_Error2: parm number for dirichlet
#_minsamplesize: minimum sample size; set to 1 to match 3.24, minimum value is 0.001
#_mintailcomp addtocomp combM+F CompressBins CompError ParmSelect minsamplesize
-1 0.0001 2 0 0 0 1 #_fleet:1_BottomTrawl
-1 0.0001 2 0 0 0 1 #_fleet:2_MidwaterTrawl
-1 0.0001 2 0 0 0 1 #_fleet:3_Hake
-1 0.0001 2 0 0 0 1 #_fleet:4_Net
-1 0.0001 2 0 0 0 1 #_fleet:5_HnL
-1 0.0001 2 0 0 0 1 #_fleet:6_JuvSurvey
-1 0.0001 2 0 0 0 1 #_fleet:7_Triennial
-1 0.0001 2 0 0 0 1 #_fleet:8_NWFSC
-1 0.0001 2 0 0 0 1 #_fleet:9_ForeignAtSea
3 #_Lbin_method_for_Age_Data: 1=poplenbins; 2=datalenbins; 3=lengths
# sex codes: 0=combined; 1=use female only; 2=use male only; 3=use both as joint sexxlength distribution
# partition codes: (0=combined; 1=discard; 2=retained
#_yr month fleet sex part ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
 -2003 8.8 8 1 0 1 40 40 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 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 # Old_conditional_AAL_data
 -2003 8.8 8 1 0 1 48 48 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 26.13 26.13 0 23.87 0 0 0 0 0 0 0 0 23.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 26.13 26.13 0 23.87 0 0 0 0 0 0 0 0 23.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 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 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 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 26 26 2 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 28 28 3 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 30 30 2 0 0 0 0 77.68 22.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 77.68 22.32 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 32 32 2 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 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 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 34 34 2 0 0 0 0 0 77.68 22.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 77.68 22.32 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 36 36 2 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
```

```
 -2004 8.8 8 1 0 1 38 38 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 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 # Old_conditional_AAL_data
 -2004 8.8 8 1 0 1 40 40 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 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 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 28 28 2 0 0 0 0 0 35.49 64.51 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 35.49 64.51 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 32 32 2 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 34 34 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 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 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 36 36 1 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 40 40 4 0 0 0 0 0 0 0 0 19.66 0 0 35.49 0 17.17 0 27.68 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
19.66 0 0 35.49 0 17.17 0 27.68 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 42 42 2 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 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 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 44 44 3 0 0 0 0 0 0 0 0 0 84.05 0 0 0 0 0 15.95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 84.05 0
0 0 0 0 15.95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 46 46 8 0 0 0 0 0 0 0 0 0 0 12.96 4.32 8.64 70.96 0 3.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 12.96 4.32 8.64 70.96 0 3.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 48 48 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 31.53 0 37.2 0 0 0 0 31.27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 31.53 0 37.2 0 0 0 0 31.27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 1 0 1 50 50 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 35.83 0 0 40.52 0 0 0 0 23.65 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 35.83 0 0 40.52 0 0 0 0 23.65 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 30 30 3 0 0 0 0 0 33.33 66.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.33 66.67 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 32 32 3 0 0 0 0 0 33.33 33.33 33.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.33 33.33
33.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 36 36 4 0 0 0 0 0 0 77.52 0 22.48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 77.52 0 22.48
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 38 38 3 0 0 0 0 0 0 0 65.95 34.05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 65.95 34.05
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 40 40 4 0 0 0 0 0 0 19.96 28.99 35.19 15.86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 19.96
28.99 35.19 15.86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 42 42 4 0 0 0 0 0 0 0 17.59 50.41 0 14.4 0 0 0 0 0 17.59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
17.59 50.41 0 14.4 0 0 0 0 0 17.59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 44 44 3 0 0 0 0 0 0 0 0 0 57.26 0 0 0 0 0 31.08 11.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
57.26 0 0 0 0 0 31.08 11.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 46 46 6 0 0 0 0 0 0 0 0 0 0 0 16.71 52.84 0 0 4.82 0 0 0 22.14 0 0 0 3.48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 16.71 52.84 0 0 4.82 0 0 0 22.14 0 0 0 3.48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 48 48 10 0 0 0 0 0 0 0 0 0 0 0 22.14 0 18.95 0 1.7 9.83 1.52 1.7 42.48 0 0 0 0 0 0 0 0 0 1.7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 22.14 0 18.95 0 1.7 9.83 1.52 1.7 42.48 0 0 0 0 0 0 0 0 0 1.7 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 1 0 1 50 50 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.77 20.77 0 0 0 20.77 0 0 0 20.77 6.77 0 6.77 0 0 3.38 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 20.77 20.77 0 0 0 20.77 0 0 0 20.77 6.77 0 6.77 0 0 3.38 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 1 0 1 34 34 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 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 # Old_conditional_AAL_data
 -2007 8.8 8 1 0 1 38 38 3 0 0 0 0 0 57.85 0 0 42.15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 57.85 0 0 42.15
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 1 0 1 40 40 8 0 0 0 0 0 0 0 19.73 53.44 7.71 7.02 0 0 0 0 0 12.09 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
19.73 53.44 7.71 7.02 0 0 0 0 0 12.09 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
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-2007 8.8 8 1 0 1 42 42 11 0 0 0 0 0 0 0 11.39 20.19 42.31 26.1 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
11.39 20.19 42.31 26.1 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 # Old_conditional_AAL_data
-2007 8.8 8 1 0 1 44 44 9.54013 0 0 0 0 0 0 0 0 27.1 0 35.09 16.61 9.37 11.82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 27.1 0 35.09 16.61 9.37 11.82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2007 8.8 8 1 0 1 46 46 2 0 0 0 0 0 0 0 0 0 0 0 0 53.18 0 46.82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
53.18 0 46.82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2007 8.8 8 1 0 1 48 48 7 0 0 0 0 0 0 0 0 0 0 0 9.99 25.71 7.87 27.42 17.71 0 0 0 0 0 11.3 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 9.99 25.71 7.87 27.42 17.71 0 0 0 0 0 11.3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2008 8.8 8 1 0 1 38 38 2 0 0 0 0 0 0 0 0 52.61 47.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 52.61
47.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2008 8.8 8 1 0 1 42 42 2 0 0 0 0 0 0 0 0 0 52.61 0 0 0 0 0 47.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 52.61 0
0 0 0 0 47.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2008 8.8 8 1 0 1 46 46 3 0 0 0 0 0 0 0 0 0 0 0 0 0 37.53 0 0 0 43.15 0 0 0 0 19.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 37.53 0 0 0 43.15 0 0 0 0 19.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 24 24 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 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 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 26 26 2 0 0 0 0 0 0 48.23 51.77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 48.23 51.77 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 28 28 4 0 0 0 0 0 53.63 0 0 46.37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 53.63 0 0 46.37
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 30 30 5 0 0 0 0 0 53.63 0 23.19 0 0 23.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 53.63 0
23.19 0 0 23.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 32 32 2 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 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 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 34 34 6 0 0 0 0 0 24.06 0 12.03 17.53 0 46.37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 24.06 0
12.03 17.53 0 46.37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 36 36 2 0 0 0 0 0 50 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 50 0 0 50 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 38 38 6 0 0 0 0 0 0 0 12.96 0 65.47 21.57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12.96 0
65.47 21.57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 40 40 4 0 0 0 0 0 0 0 0 11.75 29.92 0 26.88 31.45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
11.75 29.92 0 26.88 31.45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 42 42 8 0 0 0 0 0 0 0 0 0 37.45 21.81 18.86 17.18 0 0 0 4.7 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 0 0 0 0
0 37.45 21.81 18.86 17.18 0 0 0 4.7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 44 44 11 0 0 0 0 0 0 0 0 0 0 8.24 25.17 23.38 12.19 6.9 0 0 0 0 0 0 13.39 0 0 10.73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 8.24 25.17 23.38 12.19 6.9 0 0 0 0 0 0 13.39 0 0 10.73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 46 46 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.03 25.45 12.28 10.97 0 6.87 13.73 0 10.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 20.03 25.45 12.28 10.97 0 6.87 13.73 0 10.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 48 48 9 0 0 0 0 0 0 0 0 0 0 0 0 0 9.24 9.24 0 8.27 9.74 45.95 8.3 0 0 0 0 0 0 9.24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 9.24 9.24 0 8.27 9.74 45.95 8.3 0 0 0 0 0 0 9.24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2009 8.8 8 1 0 2 50 50 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 41.39 0 18.17 0 0 0 20.22 0 20.22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 41.39 0 18.17 0 0 0 20.22 0 20.22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2010 8.8 8 1 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 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 # Old_conditional_AAL_data
-2010 8.8 8 1 0 2 22 22 4 0 0 75.03 0 24.97 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 75.03 0 24.97 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2010 8.8 8 1 0 2 24 24 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
-2010 8.8 8 1 0 2 36 36 2 0 0 0 0 0 0 76.81 23.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 76.81 23.19 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data

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 -2010 8.8 8 1 0 2 38 38 3 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 40 40 10 0 0 0 0 0 0 0 0 0 46.46 28.23 25.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
46.46 28.23 25.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 42 42 13 0 0 0 0 0 0 0 0 0 0 10.59 76.15 0.95 12.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 10.59 76.15 0.95 12.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 44 44 17 0 0 0 0 0 0 0 0 0 0 6.07 3.42 26.19 31.2 24.27 4.42 0 0 4.42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 6.07 3.42 26.19 31.2 24.27 4.42 0 0 4.42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 46 46 10 0 0 0 0 0 0 0 0 0 0 7.91 10.14 12.02 17.57 26.18 0 0 0 0 26.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 7.91 10.14 12.02 17.57 26.18 0 0 0 0 26.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 48 48 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 32.57 18.18 0 32.57 0 16.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 32.57 18.18 0 32.57 0 16.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 1 0 2 50 50 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 19.3 7.88 0 29.7 43.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 19.3 7.88 0 29.7 43.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 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 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 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 30 30 1 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 32 32 4 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 34 34 6 0 0 0 0 0 29.7 0 58.98 0 11.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 29.7 0 58.98
0 11.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 36 36 3 0 0 0 0 0 0 33.93 54.75 11.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.93
54.75 11.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 38 38 2 0 0 0 0 0 0 0 0 0 96.02 0 3.98 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 96.02 0
3.98 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 40 40 4 0 0 0 0 0 0 0 0 62.57 0 0 29.81 7.62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 62.57
0 0 29.81 7.62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 42 42 12 0 0 0 0 0 0 0 0.66 0 0 17.45 23.71 42.5 0 15.69 0 0 0 0 0 0 0 0 0 0 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 0 0 17.45 23.71 42.5 0 15.69 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 44 44 12 0 0 0 0 0 0 0 0 0 1.05 27.47 46.55 0.85 24.08 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1.05 27.47 46.55 0.85 24.08 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 46 46 7 0 0 0 0 0 0 0 0 0 0 0 0 10.33 28.61 32.46 0 28.61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 10.33 28.61 32.46 0 28.61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 48 48 10 0 0 0 0 0 0 0 0 0 0 0 0 0 19.38 0 5.56 0.75 14.14 21.28 13.4 5.56 0 13.4 0 6.54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 19.38 0 5.56 0.75 14.14 21.28 13.4 5.56 0 13.4 0 6.54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2011 8.8 8 1 0 1 50 50 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.06 45.13 23.98 0 0 0 0 0 23.98 0 0 0 0 3.84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 3.06 45.13 23.98 0 0 0 0 0 23.98 0 0 0 0 3.84 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 26 26 3 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 28 28 4 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 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 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 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 32 32 1 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 38 38 1 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 40 40 6 0 0 0 0 0 0 0 19.9 33.61 0 46.49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 19.9
33.61 0 46.49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
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 -2012 8.8 8 1 0 1 42 42 2 0 0 0 0 0 0 0 0 0 0 46.96 0 53.04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 46.96
0 53.04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 44 44 8 0 0 0 0 0 0 0 0 0 0 5.6 5.91 11.94 70.9 5.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
5.6 5.91 11.94 70.9 5.66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 46 46 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.48 0 7.73 74.24 0 0 0 0 0 8.55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 9.48 0 7.73 74.24 0 0 0 0 0 8.55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 48 48 9 0 0 0 0 0 0 0 0 0 0 0 0 0 4.52 0 0 3.92 49.49 8.46 0 0 8.85 0 24.75 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 4.52 0 0 3.92 49.49 8.46 0 0 8.85 0 24.75 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 50 50 2 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
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 # Old_conditional_AAL_data
 -2012 8.8 8 1 0 1 52 52 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 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 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 8 8 0.5 100 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 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 18 18 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 20 20 3 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 0 100 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 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 22 22 3 0 0 0 86.57 13.43 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 86.57 13.43 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 24 24 10 0 0 0 95.22 2.85 1.93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 95.22 2.85 1.93
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 26 26 17 0 0 0 10.77 58.17 31.06 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 10.77 58.17
31.06 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 28 28 11 0 0 0 6.43 64.72 28.86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.43 64.72
28.86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 30 30 7 0 0 0 3.08 6.16 90.75 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 0 0 0 3.08 6.16 90.75 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 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 32 32 5 0 0 0 0 0 0 80 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 80 0 20 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 34 34 4 0 0 0 0 0 0 87.1 12.9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 87.1 12.9 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 36 36 5 0 0 0 0 0 0 0 87.17 12.83 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 87.17 12.83 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 38 38 2 0 0 0 0 0 0 0 0 13.43 0 86.57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 13.43 0
86.57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 40 40 3 0 0 0 0 0 0 23.36 0 0 0 0 38.32 38.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 23.36 0 0 0
0 38.32 38.32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 42 42 6 0 0 0 0 0 0 0 0 0 0 73.3 0 0 15.93 5.39 0 0 0 0 0 0 5.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
73.3 0 0 15.93 5.39 0 0 0 0 0 0 5.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 44 44 9 0 0 0 0 0 0 0 0 0 0 0 0 0 40.52 44.39 0 11.63 3.47 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 40.52 44.39 0 11.63 3.47 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 46 46 7 0 0 0 0 0 0 0 0 0 0 0 0 0 14.51 0 43.52 14.51 0 14.51 0 0 0 0 0 12.97 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 14.51 0 43.52 14.51 0 14.51 0 0 0 0 0 12.97 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 48 48 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 17.41 17.41 34.81 0 6.48 0 0 0 6.48 0 0 0 17.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 17.41 17.41 34.81 0 6.48 0 0 0 6.48 0 0 0 17.41 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 1 0 1 50 50 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.67 16.67 33.33 0 0 0 0 16.67 16.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16.67 16.67 33.33 0 0 0 0 16.67 16.67 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 28 28 4 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 0 100 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 # Old_conditional_AAL_data
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 -2014 8.8 8 1 0 1 30 30 16 0 0 0 0 33.83 0 44.12 0 22.06 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.83 0
44.12 0 22.06 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 32 32 10 0 0 0 0 9.38 0 90.62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.38 0 90.62 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 34 34 7 0 0 0 0 8.96 4.49 51.93 17.31 17.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.96
4.49 51.93 17.31 17.31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 36 36 6 0 0 0 0 0 6.47 60.5 0 33.04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.47 60.5 0
33.04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 38 38 9 0 0 0 0 0 0.69 2.77 29.73 66.8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 2.77
29.73 66.8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 40 40 13 0 0 0 0 0 0 6.95 17.64 9.74 54.38 5.22 6.08 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
6.95 17.64 9.74 54.38 5.22 6.08 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 42 42 5 0 0 0 0 0 0 3.47 0 0 55.95 25.72 0 14.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.47 0
0 55.95 25.72 0 14.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 44 44 14 0 0 0 0 0 0 0 0 0 1.97 22.5 24.29 8.65 28.17 8.65 2.88 2.88 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1.97 22.5 24.29 8.65 28.17 8.65 2.88 2.88 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 46 46 14 0 0 0 0 0 0 0 0 0 0 0 17.15 18.24 24.05 24.62 12.75 0 0 3.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 17.15 18.24 24.05 24.62 12.75 0 0 3.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 48 48 12 0 0 0 0 0 0 0 0 0 0 0 0 6.52 20.15 8.46 7.76 6.52 0 24.18 4.7 0 0 0 0 0 0 9.31 0 0 0 12.39 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 6.52 20.15 8.46 7.76 6.52 0 24.18 4.7 0 0 0 0 0 0 9.31 0 0 0 12.39 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 50 50 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 30.8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 69.2 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 30.8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 69.2 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 1 0 1 52 52 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2003 8.8 8 2 0 1 36 36 2 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2003 8.8 8 2 0 1 42 42 2 0 0 0 0 0 0 0 0 89.448 0 0 10.552 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 89.448
0 0 10.552 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2003 8.8 8 2 0 1 46 46 1 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 0 100 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 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 24 24 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 26 26 3 0 0 0 33.333 33.333 33.333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.333
33.333 33.333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 28 28 3 0 0 0 0 9.095 90.905 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.095 90.905 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 30 30 3 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 32 32 6 0 0 0 0 0 90.877 9.123 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 90.877 9.123 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 34 34 3 0 0 0 0 0 70.377 29.623 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 70.377 29.623
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 38 38 3 0 0 0 0 0 33.333 0 33.333 33.333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.333 0
33.333 33.333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 40 40 3 0 0 0 0 0 0 0 0 0 0 0 42.651 0 0 0 50.144 0 0 0 7.205 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 42.651 0 0 0 50.144 0 0 0 7.205 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2004 8.8 8 2 0 1 44 44 1 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 30 30 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 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 # Old_conditional_AAL_data
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 -2005 8.8 8 2 0 1 32 32 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 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 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 34 34 2 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 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 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 36 36 7 0 0 0 0 0 0 40.98 51.69 7.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40.98
51.69 7.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 38 38 5 0 0 0 0 0 0 0 62.541 25.594 0 0 6.017 5.848 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
62.541 25.594 0 0 6.017 5.848 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 40 40 3 0 0 0 0 0 0 0 77.275 0 0 14.66 0 0 8.065 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 77.275
0 0 14.66 0 0 8.065 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 42 42 4 0 0 0 0 0 0 0 0 0 0 51.542 7.973 32.512 0 7.973 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 51.542 7.973 32.512 0 7.973 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 44 44 7 0 0 0 0 0 0 0 0 0 0 25.037 0 7.26 7.26 24.055 29.129 0 7.26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 25.037 0 7.26 7.26 24.055 29.129 0 7.26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2005 8.8 8 2 0 1 46 46 2 0 0 0 0 0 0 0 0 0 0 0 0 0 70.961 29.039 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 70.961 29.039 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 16 16 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 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 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 30 30 3 0 0 0 0 55.861 0 35.186 8.952 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 55.861 0
35.186 8.952 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 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 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 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 34 34 7 0 0 0 0 15.438 18.5 17.593 15.438 33.031 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
15.438 18.5 17.593 15.438 33.031 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 36 36 3 0 0 0 0 0 0 32.407 67.593 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 32.407
67.593 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 38 38 6 0 0 0 0 0 0 0 19.997 70.958 0 0 0 0 0 9.045 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
19.997 70.958 0 0 0 0 0 9.045 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 40 40 6 0 0 0 0 0 0 0 28.629 0 27.2 28.629 0 0 15.542 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
28.629 0 27.2 28.629 0 0 15.542 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 42 42 5 0 0 0 0 0 0 0 0 40.781 8.303 0 0 28.776 0 0 22.139 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 40.781 8.303 0 0 28.776 0 0 22.139 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 44 44 5 0 0 0 0 0 0 0 0 0 0 0 26.189 0 26.189 10.664 0 18.479 0 0 0 18.479 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 26.189 0 26.189 10.664 0 18.479 0 0 0 18.479 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 46 46 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 48 48 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 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 # Old_conditional_AAL_data
 -2006 8.8 8 2 0 1 52 52 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 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 # Old_conditional_AAL_data
 -2007 8.8 8 2 0 1 38 38 7 0 0 0 0 0 12.831 0 11.345 58.112 17.711 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
12.831 0 11.345 58.112 17.711 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 2 0 1 40 40 10 0 0 0 0 0 0 12.704 15.292 26.144 18.499 0 27.361 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 12.704 15.292 26.144 18.499 0 27.361 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 2 0 1 42 42 11 0 0 0 0 0 0 0 0 18.086 39.952 14.063 12.999 9.609 0 5.292 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 18.086 39.952 14.063 12.999 9.609 0 5.292 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 2 0 1 44 44 7.45987 0 0 0 0 0 0 0 0 16.331 0 0 24.62 0 23.402 9.078 0 17.492 9.078 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 16.331 0 0 24.62 0 23.402 9.078 0 17.492 9.078 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2007 8.8 8 2 0 1 46 46 6 0 0 0 0 0 0 0 0 0 0 38.345 6.052 0 0 0 0 15.728 0 0 6.052 0 33.822 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 38.345 6.052 0 0 0 0 15.728 0 0 6.052 0 33.822 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
```

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 -2008 8.8 8 2 0 1 26 26 2 0 0 0 0 52.607 47.393 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 52.607 47.393 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 28 28 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 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 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 32 32 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 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 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 40 40 3 0 0 0 0 0 0 0 0 0 9.657 9.657 80.686 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
9.657 9.657 80.686 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 42 42 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 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 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 44 44 3 0 0 0 0 0 0 0 0 0 0 34.213 0 0 32.893 32.893 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 34.213 0 0 32.893 32.893 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2008 8.8 8 2 0 1 46 46 2 0 0 0 0 0 0 0 0 0 0 0 42.615 0 0 0 0 57.385 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
42.615 0 0 0 0 57.385 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 26 26 3 0 0 0 0 0 33.333 0 66.667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.333 0
66.667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 28 28 4 0 0 0 0 0 69.084 15.458 0 15.458 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 69.084
15.458 0 15.458 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 30 30 4 0 0 0 0 0 53.626 0 23.187 23.187 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 53.626 0
23.187 23.187 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 32 32 3 0 0 0 0 0 0 53.626 46.374 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 53.626
46.374 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 38 38 5 0 0 0 0 0 0 0 0 0 0 84.749 15.251 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
84.749 15.251 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 40 40 8 0 0 0 0 0 0 0 0 0 61.326 29.278 0 0 0 9.396 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
61.326 29.278 0 0 0 9.396 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 42 42 12 0 0 0 0 0 0 0 0 0 0 18.84 51.061 0 2.974 17.907 6.243 2.974 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 18.84 51.061 0 2.974 17.907 6.243 2.974 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 44 44 6 0 0 0 0 0 0 0 0 0 0 0 0 29.326 20.964 0 21.04 20.964 0 7.706 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 29.326 20.964 0 21.04 20.964 0 7.706 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 46 46 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 27.468 0 0 0 0 0 0 34.538 0 37.994 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 27.468 0 0 0 0 0 0 34.538 0 37.994 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2009 8.8 8 2 0 2 52 52 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 2 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 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 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 22 22 5 0 0 80.013 19.987 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 80.013 19.987 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 24 24 1 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 32 32 1 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 34 34 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 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 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 36 36 1 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 38 38 2 0 0 0 0 0 0 0 0 0 72.819 0 27.181 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
72.819 0 27.181 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2010 8.8 8 2 0 2 40 40 11 0 0 0 0 0 0 0 0 0 1.396 44.153 50.611 1.783 0 2.057 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1.396 44.153 50.611 1.783 0 2.057 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
```

-2010 8.8 8 2 0 2 42 42 11 0 0 0 0 0 0 0 0 0 19.927 26.286 7.205 14.078 13.256 0 4.393 0 5.295 0 9.559 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 19.927 26.286 7.205 14.078 13.256 0 4.393 0 5.295 0 9.559 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #
Old_conditional_AAL_data
-2010 8.8 8 2 0 2 44 44 8 0 0 0 0 0 0 0 0 0 0 0 0 4.239 57.461 19.597 2.399 14.037 0 0 0 0 0 0 2.267 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 4.239 57.461 19.597 2.399 14.037 0 0 0 0 0 0 2.267 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2010 8.8 8 2 0 2 46 46 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 69.033 30.967 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 69.033 30.967 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2010 8.8 8 2 0 2 50 50 1 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 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 26 26 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 28 28 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 30 30 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 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 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 32 32 5 0 0 0 0 0 34.157 0 58.293 7.55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 34.157 0
58.293 7.55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 34 34 10 0 0 0 0 0 0 0 97.462 1.269 1.269 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
97.462 1.269 1.269 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 36 36 5 0 0 0 0 0 0 8.171 72.966 0 9.432 9.432 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
8.171 72.966 0 9.432 9.432 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 38 38 2 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 40 40 10 0 0 0 0 0 0 0 0 0 0.787 70.108 9.866 9.396 9.843 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0.787 70.108 9.866 9.396 9.843 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 42 42 15 0 0 0 0 0 0 0 0 0 0.27 0 58.282 12.182 0 0 11.367 17.899 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0.27 0 58.282 12.182 0 0 11.367 17.899 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 44 44 22 0 0 0 0 0 0 0 0 0 0 20.97 14.116 6.215 0.742 5.36 24.45 5.311 4.086 0 5.36 7.333 0 0 0.869 0.987 0 0 0 0 0 0 0
4.201 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 20.97 14.116 6.215 0.742 5.36 24.45 5.311 4.086 0 5.36 7.333 0 0 0.869 0.987 0 0 0 0 0 0 0 4.201 0 0
0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 46 46 10 0 0 0 0 0 0 0 0 0 0 8.697 17.396 0 0 17.64 17.816 23.742 0 0 0 8.697 6.012 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 8.697 17.396 0 0 17.64 17.816 23.742 0 0 0 8.697 6.012 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 48 48 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2011 8.8 8 2 0 1 50 50 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 22 22 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 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 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 24 24 3 0 0 0 2.828 97.172 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.828 97.172 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 26 26 1 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 28 28 3 0 0 0 0 95.012 4.988 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 95.012 4.988 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 30 30 3 0 0 0 0 33.333 66.667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.333 66.667 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 32 32 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 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 # Old_conditional_AAL_data
-2012 8.8 8 2 0 1 36 36 5 0 0 0 0 0 0 0 25.775 74.225 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 25.775
74.225 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data

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 -2012 8.8 8 2 0 1 38 38 1 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2012 8.8 8 2 0 1 40 40 4 0 0 0 0 0 0 0 18.974 0 0 0 0 68.147 12.879 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
18.974 0 0 0 0 68.147 12.879 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 2 0 1 42 42 4 0 0 0 0 0 0 0 0 0 0 83.16 0 13.568 0 0 0 3.272 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
83.16 0 13.568 0 0 0 3.272 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 2 0 1 44 44 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 18.901 69.128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.858 0 5.113 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 18.901 69.128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.858 0 5.113 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 2 0 1 46 46 4 0 0 0 0 0 0 0 0 0 0 0 0 0 74.241 0 8.454 0 0 0 0 9.322 0 0 7.983 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 74.241 0 8.454 0 0 0 0 9.322 0 0 7.983 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2012 8.8 8 2 0 1 48 48 1 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 8 8 0.5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 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 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 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 16 16 3 0 0 34.735 65.265 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 34.735 65.265 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 18 18 7 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 20 20 6 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 22 22 2 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 24 24 21 0 0 0 98.833 1.167 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 98.833 1.167 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 26 26 11 0 0 0 40.278 59.722 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40.278 59.722 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 28 28 14 0 0 0 4.699 23.991 69.713 1.596 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.699
23.991 69.713 1.596 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 30 30 10 0 0 0 0 7.999 54.901 37.1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.999 54.901
37.1 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 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 32 32 5 0 0 0 0 0 8.524 91.476 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.524 91.476 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 34 34 2 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 36 36 5 0 0 0 0 0 0 0 24.616 73.179 2.204 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
24.616 73.179 2.204 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 38 38 7 0 0 0 0 0 0 0 1.125 75.675 5.105 5.105 3.111 9.878 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1.125 75.675 5.105 5.105 3.111 9.878 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 40 40 5 0 0 0 0 0 0 0 0 67.91 0 0.927 0 10.312 20.85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
67.91 0 0.927 0 10.312 20.85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 42 42 17 0 0 0 0 0 0 0 0 0 0 0 5.105 6.012 0.324 2.844 68.537 4.918 0 3.168 0 8.053 0 0 0 0 0 0 0 0 0 1.037 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 5.105 6.012 0.324 2.844 68.537 4.918 0 3.168 0 8.053 0 0 0 0 0 0 0 0 0 1.037 0 0 0 0 0 0 0 0 0 0  #
Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 44 44 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.584 1.733 5.168 2.584 78.447 1.733 0 0 7.752 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 2.584 1.733 5.168 2.584 78.447 1.733 0 0 7.752 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  # Old_conditional_AAL_data
 -2013 8.8 8 2 0 1 46 46 1 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 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 22 22 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 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 # Old_conditional_AAL_data
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 -2014 8.8 8 2 0 1 26 26 2 0 0 0 0 9.383 0 90.617 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.383 0 90.617 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 28 28 5 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 30 30 27 0 0 0 0 8.796 8.824 74.141 8.238 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.796
8.824 74.141 8.238 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 32 32 23 0 0 0 0 6.686 5.927 82.104 5.283 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.686
5.927 82.104 5.283 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 34 34 9 0 0 0 0 0 6.469 63.792 14.869 14.869 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
6.469 63.792 14.869 14.869 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 36 36 10 0 0 0 0 0 2.467 8.493 7.26 66.028 7.26 8.493 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.467 8.493 7.26 66.028 7.26 8.493 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 38 38 14 0 0 0 0 0 1.156 1.156 22.05 54.99 1.156 11.783 0 7.711 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1.156 1.156 22.05 54.99 1.156 11.783 0 7.711 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 40 40 17 0 0 0 0 0 0 0 9.112 6.176 9.717 3.926 45.44 10.95 10.753 0 3.926 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 9.112 6.176 9.717 3.926 45.44 10.95 10.753 0 3.926 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 42 42 16 0 0 0 0 0 0 0 0 0 18.188 11.832 22.496 15.595 16.14 2.305 11.287 2.157 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 18.188 11.832 22.496 15.595 16.14 2.305 11.287 2.157 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #
Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 44 44 17 0 0 0 0 0 0 0 0 0 0 7.075 7.602 13.589 7.602 8.468 16.07 9.335 7.075 4.055 14.677 0 0 0 4.451 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.075 7.602 13.589 7.602 8.468 16.07 9.335 7.075 4.055 14.677 0 0 0 4.451 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
# Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 46 46 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 28.96 0 0 28.96 0 16.2 0 25.881 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 28.96 0 0 28.96 0 16.2 0 25.881 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 48 48 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 30.799 0 0 0 0 0 0 0 69.201 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 30.799 0 0 0 0 0 0 0 69.201 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 -2014 8.8 8 2 0 1 50 50 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 35.873 0 0 0 0 0 0 0 0 0 0 0 64.127 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 35.873 0 0 0 0 0 0 0 0 0 0 0 64.127 0 0 0 0 0 0 0 0 0 # Old_conditional_AAL_data
 2003 8.8 8 1 0 1 40 40 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 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
 2003 8.8 8 1 0 1 48 48 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 25.0000 25.0000 0 25.0000 0 0 0 0 0 0 0 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 25.0000 25.0000 0 25.0000 0 0 0 0 0 0 0 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2004 8.8 8 1 0 1 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 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
 2004 8.8 8 1 0 1 26 26 2 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2004 8.8 8 1 0 1 28 28 3 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2004 8.8 8 1 0 1 30 30 2 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 0
 2004 8.8 8 1 0 1 32 32 2 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 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
 2004 8.8 8 1 0 1 34 34 2 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 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
 2004 8.8 8 1 0 1 36 36 2 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
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 2004 8.8 8 1 0 1 38 38 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 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 8.8 8 1 0 1 40 40 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 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
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2005 8.8 8 1 0 1 28 28 2 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 0 0 0 0 50 50 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
2005 8.8 8 1 0 1 40 40 4 0 0 0 0 0 0 0 0 25.0000 0 0 25.0000 0 25.0000 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 25.0000 0 0 25.0000 0 25.0000 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 8.8 8 1 0 1 42 42 2 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 0 0 0 0 50 50 0 0 0
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2005 8.8 8 1 0 1 44 44 3 0 0 0 0 0 0 0 0 0 33.3333 0 0 0 0 66.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
33.3333 0 0 0 0 66.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 8.8 8 1 0 1 46 46 8 0 0 0 0 0 0 0 0 0 0 37.5000 12.5000 25.0000 12.5000 0 12.5000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 37.5000 12.5000 25.0000 12.5000 0 12.5000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 8.8 8 1 0 1 48 48 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40 0 40 0 0 0 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40
0 40 0 0 0 0 20 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 40 0 0 40 0 0 0 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 30 30 3 0 0 0 0 0 33.3333 66.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 33.3333
66.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 32 32 3 0 0 0 0 0 33.3333 33.3333 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
33.3333 33.3333 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 36 36 4 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 0 0 50 0 50 0 0 0 0 0 0
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2006 8.8 8 1 0 1 38 38 3 0 0 0 0 0 0 0 66.6667 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 66.6667
33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 40 40 4 0 0 0 0 0 0 25.0000 25.0000 25.0000 25.0000 0 0 0 0 0 0 0 0 0 0 0 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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2006 8.8 8 1 0 1 42 42 4 0 0 0 0 0 0 0 25.0000 25.0000 0 25.0000 0 0 0 0 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 25.0000 25.0000 0 25.0000 0 0 0 0 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 44 44 3 0 0 0 0 0 0 0 0 0 33.3333 0 0 0 0 0 33.3333 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 33.3333 0 0 0 0 0 33.3333 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 8.8 8 1 0 1 46 46 6 0 0 0 0 0 0 0 0 0 0 0 16.6667 33.3333 0 0 16.6667 0 0 0 16.6667 0 0 0 16.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2006 8.8 8 1 0 1 48 48 10 0 0 0 0 0 0 0 0 0 0 0 10 0 20 0 10 10 10 10 20 0 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 10
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2007 8.8 8 1 0 1 34 34 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 0 0 0 0 100 0 0 0 0 0 0 0 0 0
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2007 8.8 8 1 0 1 38 38 3 0 0 0 0 0 66.6667 0 0 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 66.6667 0 0
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2007 8.8 8 1 0 1 40 40 8 0 0 0 0 0 0 0 25.0000 37.5000 12.5000 12.5000 0 0 0 0 0 12.5000 0 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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2007 8.8 8 1 0 1 42 42 11 0 0 0 0 0 0 0 9.0909 18.1818 36.3636 36.3636 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 9.0909 18.1818 36.3636 36.3636 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2007 8.8 8 1 0 1 44 44 9 0 0 0 0 0 0 0 0 33.3333 0 33.3333 22.2222 11.1111 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 33.3333 0 33.3333 22.2222 11.1111 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

2007 8.8 8 1 0 1 46 46 2 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 0 0 0 50 0 50
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2007 8.8 8 1 0 1 48 48 7 0 0 0 0 0 0 0 0 0 0 0 14.2857 14.2857 14.2857 14.2857 28.5714 0 0 0 0 0 14.2857 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2008 8.8 8 1 0 1 42 42 2 0 0 0 0 0 0 0 0 0 50 0 0 0 0 0 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 50 0 0 0 0 0
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2008 8.8 8 1 0 1 46 46 3 0 0 0 0 0 0 0 0 0 0 0 0 0 33.3333 0 0 0 33.3333 0 0 0 0 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 33.3333 0 0 0 33.3333 0 0 0 0 33.3333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 8.8 8 1 0 1 24 24 1 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 8.8 8 1 0 1 26 26 2 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 0 0 0 0 50 50 0 0 0 0 0 0 0
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2009 8.8 8 1 0 1 28 28 4 0 0 0 0 0 75.0000 0 0 25.0000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 75.0000 0 0
25.0000 0 0 0 0 0 0 0 0 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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2009 8.8 8 1 0 1 34 34 6 0 0 0 0 0 33.3333 0 16.6667 33.3333 0 16.6667 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
33.3333 0 16.6667 33.3333 0 16.6667 0 0 0 0 0 0 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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2004 8.8 8 2 0 1 44 44 1 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 0 0 0 0
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2005 8.8 8 2 0 1 36 36 7 0 0 0 0 0 0 28.5714 57.1429 14.2857 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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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4511.24 7336.75 1691.46 346.09 117.88 1127.31 2252.62 0 0 0 1 572.05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 14.09 5864.69 4 2817.77 7941.39 12397.41
28183.82 3384.93 14256 1690.46 12624.89 2256.62 6619.67 3946.08 1693.46 8363.96 1128.31 1126.31 1111.91 909.24 695.59 1127.31 1 0 0 0 0 0 0 0
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 1991 7 3 3 2 2 -1 -1 46 0 0 0 0 0.68 0.57 10.23 9.42 7.35 8.57 5.08 3.07 3.09 0.95 1.45 0.42 0 0 0 0.34 0 0.54 0 0 0 0.42 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0.52 2.15 12.46 9.78 6.55 4.84 5.17 2.08 1.02 1.32 0 0.42 0 0.54 0.42 0.54 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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 1993 7 3 3 2 2 -1 -1 7 0 0 0 0 0 0 0 0 0 17.64 4.82 1.24 0.41 4.82 10.47 4.41 0 0.41 0 0.41 0 0 4.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.41 0
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0 0.45 0.45 0 2.26 15.12 17.17 1.01 0.9 0.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.45 0 0 0 0 0 0 0 0 0
 1995 7 3 3 2 2 -1 -1 102 0 0 0 0 0.3 3.6 8.31 11.47 8.18 6.27 5.82 4.84 2.87 1.6 2.18 1 0.09 0 1.01 0.16 0.03 0.01 0 0.89 0.17 0 0.02 0.18
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 1996 7 3 3 2 2 -1 -1 98 0 0 0 0 0.38 1.7 7.72 6.02 4.65 5.52 3.2 3.69 3.54 3.93 5.47 4.24 1.62 1.47 2.4 1.34 0.63 0.12 0.01 0.19 0.45 0.44
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 2010 7 3 3 2 2 -1 -1 401 0 0 0 0 0 0.11 3.37 4.82 3.17 3.4 7.17 7.61 6.8 5.01 3.03 1.96 1.35 0.96 1.39 0.36 1.07 0.61 0.09 0.03 0 0.11 0 0.19
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 2011 7 3 3 2 1 -1 -1 573 0 0 0 0 0 2.95 1.39 9.1 4.82 4.76 5.15 4.45 3.66 3.45 1.38 1.97 1.34 0.78 0.45 0.75 0.4 1 0.25 0.17 0.12 0.28 0.17
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1985 7 4 3 2 2 -1 -1 97 0 0 0 0 0 0 0.9 2.75 11.44 3.34 6.17 4.24 1.49 1.29 2.44 9.34 0.63 1.32 2.13 1.29 1.44 2.04 2.84 0.64 2.19 0.92 0.81 0 0 0 1.24 0.57 0.09 0 0.57 0 0 0 0 0 0.14 0 0 0 0 0 0 0.91 1.15 8.61 2.56 3.5 3.11 1.77 0.65 1.11 5.03 0.71 1.04 0.89 1.13 1.75 0.11 0.13 0.29 0.38 0 0.39 0 0 0 0 0 0.57 0.14 0.65 0 0 0.57 0 0 0.61
1986 7 4 3 2 2 -1 -1 78 0 0 0 0 0 0 0.78 0.64 4.41 12.46 1.74 4.37 2.56 0.41 1.01 3.89 7.14 0 3.53 2.34 1.24 1.06 1.7 0.16 0.23 1.2 0.78 0 0 0 0.97 0 0.78 0 0.78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.74 2.7 9.05 2.07 4.14 2.39 0 0 1.52 2.69 1.82 0.51 1.06 1.56 0.97 2.56 0 0 1.3 0.97 0.78 0 0 0 2.34 0.78 1.56 1.56 0.78 0 1.01 0 0 0
1987 7 4 3 2 2 -1 -1 52 0 0 0 0 0 0 2.83 0.22 3.16 1.53 12.32 0.22 4.96 2.56 1.77 0 4.25 1.52 0.71 0.92 1.42 0.71 1.42 0.11 0 0.71 0.71 0 0 0.71 0 0 0.82 0 0 0 0 0.71 0 0 0 0 0 0 0 0 0 0 0.71 2.12 4.6 3.05 19.68 0.71 4.36 2.13 1.42 0 1.17 1.42 2.23 1.42 1.88 1.42 1.42 0.71 1.77 1.42 0 0 0.71 0 0 0 0.71 0.71 0 0 0 0 0 0 0 0
1988 7 4 3 2 2 -1 -1 79 0 0 0 0 0 2.23 0.46 2.42 9.38 6.95 7.5 5.24 4.17 1.47 0 0.46 0.87 0.41 1.73 0.83 1.22 0 1.2 0.46 0.37 0.37 0.46 0 0 0 0 0 0 0 0.46 0 0 0 0 0 0 0 0 0 0 0 0 2.81 0.15 2.7 5.03 6.41 10.47 6.37 7.79 1.86 1.84 0.69 1.18 0 0.53 1.17 0 0 0.37 0.36 0 0.55 0 0 0.46 0 0 0 0 0.46 0.16 0 0 0 0 0 0 0
1989 7 4 3 2 2 -1 -1 130 0 0 0 0 0.35 12.81 6.29 2.43 4.43 5.35 5.76 7.29 8.6 5.61 4.85 2.16 1.11 0.82 0.81 1.92 0.15 0.99 0.17 0.68 1.27 0.1 0.7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.2 1.58 0.68 1.35 2.82 2.81 2.55 2.95 2.14 1.23 0.35 0.61 0.35 0 0.62 0 0.2 0.16 0.35 0 0.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

1990 7 4 3 2 2 -1 -1 138 0 0 0 0 0 1.98 17.5 12.64 3.11 1.94 3.19 2.53 2.13 2.27 2.52 3.24 0.3 0.45 0.75 0.66 2.23 1.19 0.51 0.21 0.96 0.37
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1991 7 4 3 2 2 -1 -1 41 0 0 0 0 0 1.72 13.18 30.32 8.76 3.57 0 0.13 1.92 2.28 4.66 1.67 0 0.79 0 0.93 0.05 0 0 0 0 0 0.05 0 0 0 0 0 0 0 0 0 0
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1982 7 5 3 2 2 -1 -1 6 0 0 0 0 0 0 0 0 0 4.04 0 0 0 19.52 18.44 0 4.04 17.22 0 9.15 4.04 5.18 4.04 5.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 9.15 0 0 0 0 0 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 7 5 3 2 2 -1 -1 2 0 0 0 0 33.33 0 0 0 0 0 0 0 33.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
33.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1984 7 5 3 2 2 -1 -1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 17.12 0 0 0 0 0 0 0 0 48.63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
17.12 17.12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1985 7 5 3 2 2 -1 -1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 52.11 0 0 0 47.89 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1986 7 5 3 2 2 -1 -1 3 0 0 0 0 0 0 0 30.33 13.11 13.11 43.44 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1988 7 5 3 2 2 -1 -1 2 0 0 0 0 12.61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 87.39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 7 5 3 2 2 -1 -1 3 0 0 0 0 7.77 7.77 0 0 19.61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 27 27 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 10.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 7 5 3 2 2 -1 -1 3 0 0 0 0 0 46.59 0 0 0 3.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 43.18 3.41 0 0 0
0 0 3.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1991 7 5 3 2 2 -1 -1 12 0 0 0 0 1 0 2 25.67 12.46 0 5.99 0 4.35 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.79 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 12.22
15.87 12.46 0 1.79 3.41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1992 7 5 3 2 2 -1 -1 27 0 0 0 0 0 0 7.34 16.32 22.11 8.06 0 0.7 0 0.95 0 0.36 0.7 4.34 3.31 0.44 0 3.48 2.28 0 0 0 0.36 0.71 1.14 0.7 0.36 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.88 4.4 8.08 2.1 0.8 3.91 0 0 1.14 0.17 0 0.71 0.7 0 0 0 2.25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.21 0 0 0
1993 7 5 3 2 2 -1 -1 3 0 0 0 0 0 0 19.87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40.07 40.07 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-1994 1 -5 3 2 2 -1 -1 1 0 0 0 0 0 0 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-1996 1 -5 3 2 2 -1 -1 1 0 0 0 0 0 0 0 0 0 14.29 0 28.57 0 0 0 14.29 0 0 0 0 14.29 14.29 0 0 0 14.29 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1997 7 5 3 2 2 -1 -1 16 0 0 0 0 1.95 7.35 18 4.83 3.04 5.38 2.01 3.69 6.42 0 0 0 0.24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1.28 0.98 1.92 16.41 18.73 2.06 2.26 1.28 0 2.16 0 0 0 0 0 0 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 7 5 3 2 2 -1 -1 9 0 0 0 0 0 0 2.62 10.24 6.38 11.73 2.27 13.08 6.13 9.21 1.14 2.62 1.14 2.73 0 2.73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 5.35 16.15 0 2.73 0 1.14 0 2.62 0 0 0 0 0 0 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 7 5 3 2 2 -1 -1 4 0 0 0 0 0 0 0 16.69 33.32 0 16.65 0 8.33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
8.34 8.33 0 8.34 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 7 5 3 2 2 -1 -1 3 0 0 0 0 0 0 73.18 0 0 0 0 0 0 0 0 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 0 0 0 0 0 0 0 0 0 0 0 0 24.39 0 0 0 0 2.12
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

```
 2007 7 5 3 2 2 -1 -1 7 0 0 0 0 0 0 17.03 0 0 0 19.85 9.17 7.13 0 1.89 7.61 2.54 0 0 2.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 4.59 0 4.59 10.21 0 0 4.59 0.65 0 0 0 0 2.88 2.54 0 0 0 0 2.54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2010 7 5 3 2 2 -1 -1 5 0 0 0 0 0 0 0 0 0 6.67 0 13.33 0 0 0 0 13.33 6.67 0 0 0 0 0 0 6.67 0 0 6.67 6.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 13.33 20 0 6.67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2012 7 5 3 2 1 -1 -1 3 0 0 0 0 0 0 0 0 0 0 0 0 13.42 0 0 0 13.42 0 0 0 6.09 0 0 0 0 0 0 13.42 0 13.42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 13.42 13.42 0 0 0 0 13.42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2003 8.8 -8 3 0 1 -1 -1 6 0 0 0 0 0 0 0 0 0 0 19.85 0 0 0 0 1.3 1.3 0 1.18 0 0 0 0 0 0 0 0 1.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
3.69 0 0 16.5 55 0 0 0 0 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 8.8 -8 3 0 1 -1 -1 15 0 0 0.05 0 0.46 2.29 22.49 0 0 0 0 0 0 0 0 0 0 0 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 0.41
14.66 0.74 8.23 8.23 0 14.43 12.13 0 0 0 14.86 0 0 0 0.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2005 8.8 -8 3 0 1 -1 -1 24 0 0 0 0 0 4.54 2.92 0.17 0.12 3.73 5.45 3.59 2.72 3.26 2.84 4.11 4.23 0 0 3.73 0 2.75 4.11 0 0 0 0 2.75 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.17 4.84 11.28 2.29 0 7.51 1.82 4.28 5.06 6.25 4.11 0 1.36 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2006 8.8 -8 3 0 1 -1 -1 32 0 0 0 0 0 3.86 9.42 4.42 5.91 2.23 0.55 1.36 3.65 6.15 0 2.45 5.13 0.41 0.46 1.99 0.55 0 0 0.33 0.55 0.92 0 0.92 0
0.46 0.46 0 0 0 0 0 0 0 0 0 0 0 0 0 0.31 0 3.86 4.24 2.75 6.59 7.39 2.26 0.55 0.55 3.1 1.53 1.43 1.96 3.94 0 0 0 3.94 0 0 3.4 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
 2007 8.8 -8 3 0 1 -1 -1 32 0 0 0 0 0 1.69 1.38 3.4 9.15 5.53 8.29 3.32 3.46 2.67 2.17 2.65 1.23 0 0 0 0 1.69 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1.69 1.41 3.28 15.43 6.21 3.23 6.84 1.23 2.43 2.25 0 5.84 1 0 1 0 1.51 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2008 8.8 -8 3 0 1 -1 -1 18 0 0 0 0 0 0 0 0 0 4.22 11.2 0 0 0 4.57 0 6.66 0 5.26 0 0 0 0 3.01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.05
10.43 5.96 0 0 3.01 8.88 15.82 0 5.64 5.64 0 5.64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2009 8.8 -8 3 0 2 -1 -1 40 0 0 0 0 0 10 0.92 3.17 4 5.83 3.58 4.1 5.02 1.51 3.35 1.8 2.26 3.66 2.57 2.38 1.41 0.71 0.75 0.93 0.57 0.93 0 0.93
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.92 2.87 2.08 0.92 3.17 7.41 3.99 1.55 1.5 2.58 2.14 2.21 0 0.58 0 0 0 0 0 0.75 0 0.83 3.13 0 0 0 0 0 0 0
0 0 0 0 0 0
 2010 8.8 -8 3 0 2 -1 -1 36 0 0 0.79 0.2 0.2 0 0.88 0.27 0 3.89 10.15 19.9 4.58 7.18 4.57 1.14 0.52 0.15 1.14 3.42 3.83 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.98 0.2 0.2 0 0.44 3.8 0 4.25 5.3 6.09 0.76 6.72 2.68 0.78 0.88 0.1 3.69 0.18 0 0 0 0.14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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 2011 8.8 -8 3 0 1 -1 -1 41 0 0 0 0.98 0 1.85 0 8.66 2.01 2.4 3.02 4.45 1.79 2.76 1.96 0.49 0.61 1.89 2.87 0.68 0.49 0 0.68 0 2.88 0 0 0 0
0.07 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.45 0 1.39 0.06 8.29 1.41 1.12 8.66 14.12 5.43 1.51 1.04 4.93 4.24 0.75 0 0.98 1.47 0.73 0 0.06 0.07 0 0.98
0 0 0 0 0 0.77 0 0 0 0 0 0 0 0
 2012 8.8 -8 3 0 1 -1 -1 38 0 0 0 0 16.87 0 0.18 1.2 5.96 0.22 4.07 0.95 5.65 1.45 0 1.38 6.84 1.56 0 0 1.63 2.54 3 0 0 0 0 0 0 0 2.28 0 0 0 0
0 0 0 0 0 0 0 0 0 1.59 11.23 5.07 2.28 2.01 3.78 0 0.85 0 3.08 3.95 0 0.72 5.02 2.28 0 0 0.8 0 0 0.68 0 0 0 0 0 0 0 0 0.68 0 0.17 0 0 0 0 0 0
 2013 8.8 -8 3 0 1 -1 -1 35 0.03 0 0 7.37 6.24 15.6 1.56 1.73 0 0.06 0.59 0.11 2.18 2.71 1.68 1.68 0.24 0.42 0 0.42 0.42 1.26 0.42 0.89 0.84 0
0 0.24 0 0.42 0.42 0.42 0 0 0 0 0 0 0 0 0 0.03 0 0.12 10.37 4.6 9.98 8.47 0.58 4.54 0.16 0.15 0.35 1.73 0.58 0.84 2.41 1.73 0.42 2.65 0.24
0.59 0 1.26 0 0 0 0 0 0 0 0.24 0 0 0 0 0 0 0 0 0 0
 2014 8.8 -8 3 0 1 -1 -1 46 0 0 0 0 3.85 0.37 13.89 1.72 6.02 1.56 1.06 1.49 2.78 0.46 2.87 2.62 0.9 0 1.46 0.32 0 0 0 0 0 0 0.23 0 0 0 0.26 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.57 3.14 27.96 5.24 4.25 1.2 1.84 1.58 2.29 1.22 0.63 2.08 0.59 0.89 0.26 0.69 0 0.13 0 0.28 0 0.13 0 0 0 0 0 0.15
0 0 0 0 0 0 0 0 0
 2015 8.8 -8 3 0 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 0 0 0 0 1.09 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2016 8.8 -8 3 0 1 -1 -1 5 0 0 0 0 0 0 1 1 1 2 3 0 0 2 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 3 0 0 1 1 0 0 1 1
0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2017 8.8 -8 3 0 1 -1 -1 6 0 0 0 0 1 0 0 0 0 1 0 2.14 1.14 4.55 2.27 0 0 2.27 2.27 0 0 0 1.14 1.14 0 0 0 0 0 1.14 1.14 0 0 0 1.14 0 0 0 0 1.14
0 0 0 0 0 0 0 1 0 0 0 0 0 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
 2018 8.8 -8 3 0 1 -1 -1 8 0 0 0 0 0 0 0 1.11 0 0 0 0 2.12 2.21 1.22 0 1 0 0 0 1.22 0 0 0 0 0 0 0 0 0 1.02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-9999 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
0 #_Use_MeanSize-at-Age_obs (0/1)
#
0 #_N_environ_variables
#Yr Variable Value
```

```
#
0 # N sizefreq methods to read
#
0 # do tags (0/1)
#
0 #  morphcomp data(0/1)
# Nobs, Nmorphs, mincomp
# yr, seas, type, partition, Nsamp, datavector_by_Nmorphs
#
0 # Do dataread for selectivity priors(0/1)
# Yr, Seas, Fleet, Age/Size, Bin, selex_prior, prior_sd
# feature not yet implemented
#
999

ENDDATA
```

Appendix D. **SS control file**

```
#V3.30.12.00-trans;_2018_08_01;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11.6
#Stock Synthesis (SS) is a work of the U.S. Government and is not subject to copyright protection in the United States.
#Foreign copyrights may apply. See copyright.txt for more information.
#_user_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_user_info_available_at:https://vlab.ncep.noaa.gov/group/stock-synthesis
#_data_and_control_files: 2015widow.dat // 2015widow.ctl
0  # 0 means do not read wtatage.ss; 1 means read and use wtatage.ss and also read and use growth parameters
1  #_N_Growth_Patterns
1 #_N_platoons_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond  1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)
#
2 # recr_dist_method for parameters:  2=main effects for GP, Settle timing, Area; 3=each Settle entity; 4=none, only when N_GP*Nsettle*pop==1
1 # not yet implemented; Future usage: Spawner-Recruitment: 1=global; 2=by area
1 #  number of recruitment settlement assignments
0 # unused option
#GPattern month  area  age (for each settlement assignment)
 1 1 1 0
#
#_Cond 0 # N_movement_definitions goes here if Nareas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10
#
10 #_Nblock_Patterns
 3 2 1 1 1 1 3 1 1 1#_blocks_per_pattern
# begin and end years of blocks
 1982 1989 1990 1997 1998 2010
 1982 1989 1990 2010
 1916 1982
 1916 2001
 1916 2002
 1995 2012
 1916 1982 1983 2001 2002 2010
 1915 1915
 1995 2004
 1991 1998
#
# controls for all timevary parameters
1 #_env/block/dev_adjust_method for all time-vary parms (1=warn relative to base parm bounds; 3=no bound check)
#  autogen
1 1 1 1 1 # autogen: 1st element for biology, 2nd for SR, 3rd for Q, 4th reserved, 5th for selex
# where: 0 = autogen all time-varying parms; 1 = read each time-varying parm line; 2 = read then autogen if parm min==-12345
#
#
#_Available timevary codes
#_Block types: 0: Pblock=Pbase*exp(TVP); 1: Pblock=Pbase+TVP; 2: Pblock=TVP; 3: Pblock=Pblock(-1) + TVP
```

```
#_Block_trends: -1: trend bounded by base parm min-max and parms in transformed units (beware); -2: endtrend and infl_year direct values; -3:
end and infl as fraction of base range
#_EnvLinks:  1: P(y)=Pbase*exp(TVP*env(y));  2: P(y)=Pbase+TVP*env(y);  3: null;  4: P(y)=2.0/(1.0+exp(-TVP1*env(y) - TVP2))
#_DevLinks:  1: P(y)*=exp(dev(y)*dev_se;  2: P(y)+=env(y)*dev_se;  3: random walk;  4: zero-reverting random walk with rho
#
#
# setup for M, growth, maturity, fecundity, recruitment distibution, movement
#
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
  #_no additional input for selected M option; read 1P per morph
#
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_specific_K_incr; 4=age_specific_K_decr; 5=age_specific_K_each; 6=not
implemented
3 #_Age(post-settlement)_for_L1;linear growth below this
40 #_Growth_Age_for_L2 (999 to use as Linf)
-999 #_exponential decay for growth above maxage (value should approx initial Z; -999 replicates 3.24; -998 to not allow growth above maxage)
0  #_placeholder for future growth feature
#
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 logSD=F(A)
#
2 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=disabled;
6=read length-maturity
3 #_First_Mature_Age
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=female-to-male age-specific fxn; -1=male-to-female age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
#
#_growth_parms
#_ LO HI INIT PRIOR PR_SD PR_type PHASE env_var&link dev_link dev_minyr dev_maxyr dev_PH Block Block_Fxn
 0.01 0.3 0.10 -2.30 0.438 3 5 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
 10 40 27.4948 27 99 0 3 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
 35 60 50.0042 50 99 0 2 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
 0.01 0.4 0.150077 0.15 99 0 2 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
 0.01 0.4 0.0705642 0.07 99 0 3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
 0.01 0.4 0.041775 0.04 99 0 3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
 -3 3 1.736e-05 0 99 0 -99 0 0 0 0 0 0 0 # Wtlen_1_Fem
 -3 10 2.962 2.962 99 0 -99 0 0 0 0 0 0 0 # Wtlen_2_Fem
 -3 50 5.47 7 99 0 -99 0 0 0 0 0 0 0 # Mat50%_Fem
 -3 3 -0.7747 -1 99 0 -99 0 0 0 0 0 0 0 # Mat_slope_Fem
 -1 1 1 1 99 0 -99 0 0 0 0 0 0 0 # Eggs/kg_inter_Fem
 0 1 0 0 99 0 -99 0 0 0 0 0 0 0 # Eggs/kg_slope_wt_Fem
 0.01 0.3 0.10 -2.30 0.438 3 5 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
 10 40 26.0012 27 99 0 3 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
 35 60 44.0029 45 99 0 2 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
 0.01 0.4 0.210064 0.19 99 0 2 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
 0.01 0.4 0.0701206 0.07 99 0 3 0 0 0 0 0 0 0 # CV_young_Mal_GP_1
 0.01 0.4 0.0401227 0.04 99 0 3 0 0 0 0 0 0 0 # CV_old_Mal_GP_1
 -3 3 1.484e-05 0 99 0 -99 0 0 0 0 0 0 0 # Wtlen_1_Mal
 -3 10 3.005 3.005 99 0 -99 0 0 0 0 0 0 0 # Wtlen_2_Mal
 0 2 1 1 99 0 -99 0 0 0 0 0 0 0 # RecrDist_GP_1
```

```
 0 2 1 1 99 0 -99 0 0 0 0 0 0 0 # RecrDist_Area_1
 0 2 1 1 99 0 -99 0 0 0 0 0 0 0 # RecrDist_timing_1
 0 2 1 1 99 0 -99 0 0 0 0 0 0 0 # CohortGrowDev
 0.000001 0.999999 0.5 0.5  0.5 0 -99 0 0 0 0 0 0 0 # FracFemale_GP_1
#
#_no timevary MG parameters
#
#_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
#_ LO HI INIT PRIOR PR_SD PR_type PHASE
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
3 #_Spawner-Recruitment; Options: 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop; 7=survival_3Parm; 8=Shepherd_3Parm;
9=RickerPower_3parm
0  # 0/1 to use steepness in initial equ recruitment calculation
0  #  future feature:  0/1 to make realized sigmaR a function of SR curvature
#_ LO   HI INITPRIORPR_SDPR_type  PHASEenv-varuse_dev   dev_mnyr   dev_mxyr dev_PH  BlockBlk_Fxn #  parm_name
1   2015.0006   10   990 2 0 0 0 0 0 0 0 0 # SR_LN(R0)
  0.210.7200.7200.1602-5 0 0 0 0 0 0 0 # SR_BH_steep
02  0.6 0.65   990 -50 0 0 0 0 0 0 0 # SR_sigmaR
   -550010 -99 0 0 0 0 0 0 0 # SR_regime
0  0.500   990 -99 0 0 0 0 0 0 0 # SR_autocorr
1 #do_recdev:  0=none; 1=devvector; 2=simple deviations
1970 # first year of main recr_devs; early devs can preceed this era
2014 # last year of main recr_devs; forecast devs start in following year
2 #_recdev phase
1 # (0/1) to read 13 advanced options
 1900 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
 4 #_recdev_early_phase
 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
 1 #_lambda for Fcast_recr_like occurring before endyr+1
 1960 #_last_yr_nobias_adj_in_MPD; begin of ramp
 1976 #_first_yr_fullbias_adj_in_MPD; begin of plateau
 2014 #_last_yr_fullbias_adj_in_MPD
 2017 #_end_yr_for_ramp_in_MPD (can be in forecast to shape ramp, but SS sets bias_adj to 0.0 for fcast yrs)
 0.85 #_max_bias_adj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated recdevs)
 0 #_period of cycles in recruitment (N parms read below)
 -5 #min rec_dev
 5 #max rec_dev
 0 #_read_recdevs
#_end of advanced SR options
#
#_placeholder for full parameter lines for recruitment cycles
# read specified recr devs
#_Yr Input_value
#
# all recruitment deviations
#  1900E 1901E 1902E 1903E 1904E 1905E 1906E 1907E 1908E 1909E 1910E 1911E 1912E 1913E 1914E 1915E 1916E 1917E 1918E 1919E 1920E 1921E 1922E
1923E 1924E 1925E 1926E 1927E 1928E 1929E 1930E 1931E 1932E 1933E 1934E 1935E 1936E 1937E 1938E 1939E 1940E 1941E 1942E 1943E 1944E 1945E
1946E 1947E 1948E 1949E 1950E 1951E 1952E 1953E 1954E 1955E 1956E 1957E 1958E 1959E 1960E 1961E 1962E 1963E 1964E 1965E 1966E 1967E 1968E
1969E 1970R 1971R 1972R 1973R 1974R 1975R 1976R 1977R 1978R 1979R 1980R 1981R 1982R 1983R 1984R 1985R 1986R 1987R 1988R 1989R 1990R 1991R
```

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1992R 1993R 1994R 1995R 1996R 1997R 1998R 1999R 2000R 2001R 2002R 2003R 2004R 2005R 2006R 2007R 2008R 2009R 2010R 2011F 2012F 2013F 2014F
2015F 2016F 2017F 2018F 2019F 2020F 2021F 2022F 2023F 2024F 2025F 2026F
#  -0.00197699 0.00024231 -0.000610518 0.0009343 -0.000710894 0.00178719 0.000914743 0.000705787 0.000642114 -0.00190445 -0.0013381 0.00161387
0.0004615 -0.00171831 -0.00189711 0.00108002 0.00120945 0.000248233 -0.0019523 0.00197832 -0.000518339 -0.000714241 -0.000581909 -0.000712476
-0.00141057 0.000480737 0.00127825 -0.000387643 0.000714036 -0.000736057 -0.000613424 0.000875004 -0.00126539 -0.00022268 -0.00108961 -
0.00190983 -0.000739032 0.00127379 4.57676e-05 -4.84407e-05 -0.000110513 0.00182372 -0.000181807 0.00174012 -2.80158e-05 -0.000848033
0.00094903 -0.00108725 -0.00152107 -0.00194648 -0.00166557 0.000493858 -0.000518935 0.0003545 0.000487365 -0.00062332 -0.00151522 0.000152153
-4.84485e-05 0.000156248 -5.67789e-05 -0.00157385 0.00114892 -0.000132076 0.00162723 -0.000888295 0.000817169 -0.000435262 0.000714717
0.000673137 0.00134954 6.75986e-05 -0.00162827 0.00133781 -0.00145496 -0.00137183 0.000665513 -0.000884725 -0.000407356 -0.00101511
0.000629278 -0.00159045 0.000781335 -0.00081777 0.00110797 -0.00161295 0.00192668 -0.000883153 0.000275409 -0.00111587 -0.00119724 0.000313546
-0.00107193 0.00076103 -0.000138742 -0.000308078 0.000684888 -0.00114981 1.97276e-05 -0.000342094 0.00143117 0.000541112 8.72455e-05 -
0.00141298 0.000583378 0.000300142 0.000227363 0.00227038 0.00215869 0.00154362 -0.000660116 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
# implementation error by year in forecast:  0 0 0 0 0 0 0 0 0 0 0 0
#
#Fishing Mortality info
0.05 # F ballpark
-1982 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # 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
#
#_initial_F_parms; count = 0
#_ LO HI INIT PRIOR PR_SD  PR_type  PHASE
#2026 2035
# F rates by fleet
# Yr:  1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942
1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970
1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026
# seas:  1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
# BottomTrawl 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.13771e-05 2.29696e-05 2.46785e-05 2.6512e-05 2.84786e-05 3.05862e-05
3.28416e-05 3.5251e-05 3.78206e-05 4.05568e-05 4.34658e-05 4.65533e-05
# MidwaterTrawl 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
# Hake 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
# Net 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
# HnL 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
#_Q_setup for fleets with cpue or survey data
#_1:  fleet number
#_2:  link type: (1=simple q, 1 parm; 2=mirror simple q, 1 mirrored parm; 3=q and power, 2 parm)
#_3:  extra input for link, i.e. mirror fleet# or dev index number
#_4:  0/1 to select extra sd parameter
#_5:  0/1 for biasadj or not
```

```
#_6:  0/1 to float
#_   fleet  link link_info  extra_se   biasadj float  #  fleetname
110101  #  BottomTrawl
310110  #  Hake
610101  #  JuvSurvey
710110  #  Triennial
810101  #  NWFSC
910101  #  ForeignAtSea
-9999 0 0 0 0 0
#
#_Q_parms(if_any);Qunits_are_ln(q)
#_ LO   HI INITPRIORPR_SDPR_type  PHASEenv-varuse_dev   dev_mnyr   dev_mxyr dev_PH  BlockBlk_Fxn  #  parm_name
  -25   25  -10.8418010-1 0 0 0 0 0 0 0  #  LnQ_base_BottomTrawl(1)
020.0020   990 2 0 0 0 0 0 0 0  #  Q_extraSD_BottomTrawl(1)
  -202  -10.00030   990 1 0 0 0 0 0101  #  LnQ_base_Hake(3)
020.0020   990 2 0 0 0 0 0 0 0  #  Q_extraSD_Hake(3)
  -25   25  -8.38193010-1 0 0 0 0 0 0 0  #  LnQ_base_JuvSurvey(6)
020.0020   990 2 0 0 0 0 0 0 0  #  Q_extraSD_JuvSurvey(6)
   -4400   990 2 0 0 0 0 0 9 1  #  LnQ_base_Triennial(7)
0200   990-2 0 0 0 0 0 0 0  #  Q_extraSD_Triennial(7)
  -25   25  -6.64111010-1 0 0 0 0 0 0 0  #  LnQ_base_NWFSC(8)
0200   990-2 0 0 0 0 0 0 0  #  Q_extraSD_NWFSC(8)
  -25   25  -15.9788010-1 0 0 0 0 0 0 0  #  LnQ_base_ForeignAtSea(9)
020.001670160   990 2 0 0 0 0 0 0 0  #  Q_extraSD_ForeignAtSea(9)
# timevary Q parameters
#_ LO   HI INITPRIORPR_SDPR_type PHASE  #  parm_name
 0.00012  0.5  0.5  0.563  # LnQ_base_Hake(3)_Block10_1991-1998
# 0.00012   99   99  0.56  -5  # LnQ_base_Hake(3)_dev_se
#-0.99 0.9900  0.56  -6  # LnQ_base_Hake(3)_dev_autocorr
 0.00012  0.5  0.5  0.563  # LnQ_base_Triennial(7)_Block9_1995-2004
# 0.00012   99   99  0.56  -5  # LnQ_base_Triennial(7)_dev_se
#-0.99 0.9900  0.56  -6  # LnQ_base_Triennial(7)_dev_autocorr
# info on dev vectors created for Q parms are reported with other devs after tag parameter section
#
#_size_selex_patterns
#Pattern:_0; parm=0; selex=1.0 for all sizes
#Pattern:_1; parm=2; logistic; with 95% width specification
#Pattern:_5; parm=2; mirror another size selex; PARMS pick the min-max bin to mirror
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_6; parm=2+special; non-parm len selex
#Pattern:_43; parm=2+special+2;  like 6, with 2 additional param for scaling (average over bin range)
#Pattern:_8; parm=8; New doublelogistic with smooth transitions and constant above Linf option
#Pattern:_9; parm=6; simple 4-parm double logistic with starting length; parm 5 is first length; parm 6=1 does desc as offset
#Pattern:_21; parm=2+special; non-parm len selex, read as pairs of size, then selex
#Pattern:_22; parm=4; double_normal as in CASAL
#Pattern:_23; parm=6; double_normal where final value is directly equal to sp(6) so can be >1.0
#Pattern:_24; parm=6; double_normal with sel(minL) and sel(maxL), using joiners
#Pattern:_25; parm=3; exponential-logistic in size
#Pattern:_27; parm=3+special; cubic spline
#Pattern:_42; parm=2+special+3; // like 27, with 2 additional param for scaling (average over bin range)
#_discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead;_4=define_dome-shaped_retention
```

```
#_Pattern Discard Male Special
 24 1 0 0 # 1 BottomTrawl
 24 1 0 0 # 2 MidwaterTrawl
 24 0 0 0 # 3 Hake
 24 0 0 0 # 4 Net
 24 1 0 0 # 5 HnL
 0 0 0 0 # 6 JuvSurvey
 27 0 0 3 # 7 Triennial
 27 0 0 3 # 8 NWFSC
 5 0 0 3 # 9 ForeignAtSea
#
#_age_selex_patterns
#Pattern:_0; parm=0; selex=1.0 for ages 0 to maxage
#Pattern:_10; parm=0; selex=1.0 for ages 1 to maxage
#Pattern:_11; parm=2; selex=1.0  for specified min-max age
#Pattern:_12; parm=2; age logistic
#Pattern:_13; parm=8; age double logistic
#Pattern:_14; parm=nages+1; age empirical
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_16; parm=2; Coleraine - Gaussian
#Pattern:_17; parm=nages+1; empirical as random walk  N parameters to read can be overridden by setting special to non-zero
#Pattern:_41; parm=2+nages+1; // like 17, with 2 additional param for scaling (average over bin range)
#Pattern:_18; parm=8; double logistic - smooth transition
#Pattern:_19; parm=6; simple 4-parm double logistic with starting age
#Pattern:_20; parm=6; double_normal,using joiners
#Pattern:_26; parm=3; exponential-logistic in age
#Pattern:_27; parm=3+special; cubic spline in age
#Pattern:_42; parm=2+nages+1; // cubic spline; with 2 additional param for scaling (average over bin range)
#_Pattern Discard Male Special
 10 0 0 0 # 1 BottomTrawl
 10 0 0 0 # 2 MidwaterTrawl
 10 0 0 0 # 3 Hake
 10 0 0 0 # 4 Net
 10 0 0 0 # 5 HnL
 11 0 0 0 # 6 JuvSurvey
 10 0 0 0 # 7 Triennial
 11 0 0 0 # 8 NWFSC
 10 0 0 0 # 9 ForeignAtSea
#
#_ LO   HI INITPRIORPR_SDPR_type  PHASEenv-varuse_dev   dev_mnyr   dev_mxyr dev_PH  BlockBlk_Fxn  #  parm_name
# 1   BottomTrawl LenSelex
   10   59 37.995   45 0.050 1 0 0 0 0 0.5 4 2  #  SizeSel_P1_BottomTrawl(1)
   -5   10 2.49875 0.050 3 0 0 0 0 0.5 0 0  #  SizeSel_P2_BottomTrawl(1)
   -4   123.998183 0.050 2 0 0 0 0 0.5 4 2  #  SizeSel_P3_BottomTrawl(1)
   -2   109   10 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P4_BottomTrawl(1)
   -9   10   -9  0.5 0.050-3 0 0 0 0 0.5 0 0  #  SizeSel_P5_BottomTrawl(1)
   -998  0.5 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P6_BottomTrawl(1)
   -5   60  -2.935250   990 4 0 0 0 0 0 2 2  #  Retain_P1_BottomTrawl(1)
 0.0181.201691   990 4 0 0 0 0 0 2 2  #  Retain_P2_BottomTrawl(1)
  -10   104.59512   10   990-2 0 0 0 0 0 1 2  #  Retain_P3_BottomTrawl(1)
  -10   1000   990 -99 0 0 0 0 0 0 0  #  Retain_P4_BottomTrawl(1)
```

```
# 2   MidwaterTrawl LenSelex
   10   5937.9964   45 0.050 1 0 0 0 0 0.5 7 2  #  SizeSel_P1_MidwaterTrawl(2)
  -10   100.003889965 0.050 3 0 0 0 0 0.5 0 0  #  SizeSel_P2_MidwaterTrawl(2)
   -4   122.999983 0.050 2 0 0 0 0 0.5 7 2  #  SizeSel_P3_MidwaterTrawl(2)
   -2   108.99092   10 0.050 4 0 0 0 0 0.5 7 2  #  SizeSel_P4_MidwaterTrawl(2)
   -9   10   -9  0.5 0.050-3 0 0 0 0 0.5 0 0  #  SizeSel_P5_MidwaterTrawl(2)
   -99 7.9441  0.5 0.050 4 0 0 0 0 0.5 7 2  #  SizeSel_P6_MidwaterTrawl(2)
   -5   60   -50   990-9 0 0 0 0 0 0 0 0  #  Retain_P1_MidwaterTrawl(2)
 0.018  1.21   990-9 0 0 0 0 0 0 0 0  #  Retain_P2_MidwaterTrawl(2)
  -10   104.59512   10   990-2 0 0 0 0 0 7 2  #  Retain_P3_MidwaterTrawl(2)
  -10   1000   990 -99 0 0 0 0 0 0 0 0  #  Retain_P4_MidwaterTrawl(2)
# 3   Hake LenSelex
   10   5939.9992   45 0.050 1 0 0 0 0 0.5 0 0  #  SizeSel_P1_Hake(3)
   -5   102.501265 0.050 3 0 0 0 0 0.5 0 0  #  SizeSel_P2_Hake(3)
   -4   124.002793 0.050 2 0 0 0 0 0.5 0 0  #  SizeSel_P3_Hake(3)
   -2   109   10 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P4_Hake(3)
   -9   10   -9  0.5 0.050-3 0 0 0 0 0.5 0 0  #  SizeSel_P5_Hake(3)
   -998  0.5 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P6_Hake(3)
# 4   Net LenSelex
   10   5940.0001   45 0.050 1 0 0 0 0 0.5 0 0  #  SizeSel_P1_Net(4)
   -5   102.498665 0.050 3 0 0 0 0 0.5 0 0  #  SizeSel_P2_Net(4)
   -4   124.001483 0.050 2 0 0 0 0 0.5 0 0  #  SizeSel_P3_Net(4)
   -2   109   10 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P4_Net(4)
   -9   10   -9  0.5 0.050-3 0 0 0 0 0.5 0 0  #  SizeSel_P5_Net(4)
   -998  0.5 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P6_Net(4)
# 5   HnL LenSelex
   10   5925   45 0.050 5 0 0 0 0 0.5 5 2  #  SizeSel_P1_HnL(5)
   -5   10 2.50055 0.050 3 0 0 0 0 0.5 0 0  #  SizeSel_P2_HnL(5)
   -5   124.000693 0.050 2 0 0 0 0 0.5 5 2  #  SizeSel_P3_HnL(5)
   -2   109   10 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P4_HnL(5)
   -9   10   -9  0.5 0.050-3 0 0 0 0 0.5 0 0  #  SizeSel_P5_HnL(5)
   -998  0.5 0.050-4 0 0 0 0 0.5 0 0  #  SizeSel_P6_HnL(5)
   -5   6025.00990   990 2 0 0 0 0 0 0 3 2  #  Retain_P1_HnL(5)
 0.018  0.9910061   990 3 0 0 0 0 0 0 3 2  #  Retain_P2_HnL(5)
  -10   102.19741   10   990 1 0 0 0 0 0 0 3 2  #  Retain_P3_HnL(5)
  -10   1000   990 -99 0 0 0 0 0 0 0 0  #  Retain_P4_HnL(5)
# 6   JuvSurvey LenSelex
# 7   Triennial LenSelex
020000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Code_Triennial(7)
 -0.0011  0.148975000 2 0 0 0 0 0.5 0 0  #  SizeSpline_GradLo_Triennial(7)
   -11-0.0300079000 2 0 0 0 0 0.5 0 0  #  SizeSpline_GradHi_Triennial(7)
8   56   24  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_1_Triennial(7)
8   56   34  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_2_Triennial(7)
8   56   48  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_3_Triennial(7)
  -10   10  -3.00454  -10   990 2 0 0 0 0 0.5 0 0  #  SizeSpline_Val_1_Triennial(7)
  -10   10   -1  -10   990 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Val_2_Triennial(7)
  -10   100.00205177  -10   990 2 0 0 0 0 0.5 0 0  #  SizeSpline_Val_3_Triennial(7)
# 8   NWFSC LenSelex
020000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Code_NWFSC(8)
 -0.0011  0.150832000 2 0 0 0 0 0.5 0 0  #  SizeSpline_GradLo_NWFSC(8)
   -11-0.0302647000 2 0 0 0 0 0.5 0 0  #  SizeSpline_GradHi_NWFSC(8)
```

```
8   56   24  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_1_NWFSC(8)
8   56   34  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_2_NWFSC(8)
8   56   48  -1000 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Knot_3_NWFSC(8)
  -10   10  -2.99769  -10   990 2 0 0 0 0 0.5 0 0  #  SizeSpline_Val_1_NWFSC(8)
  -10   10   -1  -10   990 -99 0 0 0 0 0.5 0 0  #  SizeSpline_Val_2_NWFSC(8)
  -10   100.00335515  -10   990 2 0 0 0 0 0.5 0 0  #  SizeSpline_Val_3_NWFSC(8)
# 9   ForeignAtSea LenSelex
   -2   6000  0.20 -99 0 0 0 0 0.5 0 0  #  SizeSel_P1_ForeignAtSea(9)
   -2   6000  0.20 -99 0 0 0 0 0.5 0 0  #  SizeSel_P2_ForeignAtSea(9)
# 1   BottomTrawl AgeSelex
# 2   MidwaterTrawl AgeSelex
# 3   Hake AgeSelex
# 4   Net AgeSelex
# 5   HnL AgeSelex
# 6   JuvSurvey AgeSelex
0100   990 -99 0 0 0 0 0.5 0 0  #  AgeSel_P1_JuvSurvey(6)
0100   990 -99 0 0 0 0 0.5 0 0  #  AgeSel_P2_JuvSurvey(6)
# 7   Triennial AgeSelex
# 8   NWFSC AgeSelex
0100   990 -99 0 0 0 0 0.5 0 0  #  AgeSel_P1_NWFSC(8)
0   50   400   990 -99 0 0 0 0 0.5 0 0  #  AgeSel_P2_NWFSC(8)
# 9   ForeignAtSea AgeSelex
# timevary selex parameters
#_ LO   HI INITPRIORPR_SDPR_typePHASE  #  parm_name
   10   5934.0094   45 0.050  1  # SizeSel_P1_BottomTrawl(1)_BLK4repl_1916
   -4   125.702893 0.050  2  # SizeSel_P3_BottomTrawl(1)_BLK4repl_1916
   -5   5034.9849   34   990  3  # Retain_P1_BottomTrawl(1)_BLK2repl_1982
   -5   5035.0169   34   990  3  # Retain_P1_BottomTrawl(1)_BLK2repl_1990
 0.0152.500051   990  3  # Retain_P2_BottomTrawl(1)_BLK2repl_1982
 0.0152.499351   990  3  # Retain_P2_BottomTrawl(1)_BLK2repl_1990
  -10           10      4.59512       10   990  2  # Retain_P3_BottomTrawl(1)_BLK1repl_1982
  -10           104.59512      10   990  2  # Retain_P3_BottomTrawl(1)_BLK1repl_1990
  -10           10      4.59512       10   990  2  # Retain_P3_BottomTrawl(1)_BLK1repl_1998
   10   5938.0042   45 0.050  1  # SizeSel_P1_MidwaterTrawl(2)_BLK7repl_1916
   10   5937.9976   45 0.050  1  # SizeSel_P1_MidwaterTrawl(2)_BLK7repl_1983
   10   5938.0034   45 0.050  1  # SizeSel_P1_MidwaterTrawl(2)_BLK7repl_2002
   -4   123.002423 0.050  2  # SizeSel_P3_MidwaterTrawl(2)_BLK7repl_1916
   -4   12 2.99873 0.050  2  # SizeSel_P3_MidwaterTrawl(2)_BLK7repl_1983
   -4   123.001113 0.050  2  # SizeSel_P3_MidwaterTrawl(2)_BLK7repl_2002
   -2   109.01133   10 0.050  4  # SizeSel_P4_MidwaterTrawl(2)_BLK7repl_1916
   -2   109.00781   10 0.050  4  # SizeSel_P4_MidwaterTrawl(2)_BLK7repl_1983
   -2   108.98781   10 0.050  4  # SizeSel_P4_MidwaterTrawl(2)_BLK7repl_2002
   -997.88418  0.5 0.050  4  # SizeSel_P6_MidwaterTrawl(2)_BLK7repl_1916
   -997.91362  0.5 0.050  4  # SizeSel_P6_MidwaterTrawl(2)_BLK7repl_1983
   -997.91958  0.5 0.050  4  # SizeSel_P6_MidwaterTrawl(2)_BLK7repl_2002
  -10           10      4.5912        10   990 -2  # Retain_P3_MidwaterTrawl(2)_BLK7repl_1916
  -10           10      4.59512       10   990  2  # Retain_P3_MidwaterTrawl(2)_BLK7repl_1983
  -10           10      4.59512       10   990  2  # Retain_P3_MidwaterTrawl(2)_BLK7repl_2002
   15   5948.0017   45 0.050  1  # SizeSel_P1_HnL(5)_BLK5repl_1916
   -4   122.801463 0.050  2  # SizeSel_P3_HnL(5)_BLK5repl_1916
   -5   50   -5   34   990 -2  # Retain_P1_HnL(5)_BLK3repl_1916
```

```
  0.18  1.21   990 -3  # Retain_P2_HnL(5)_BLK3repl_1916
  -10           10      4.5912        10   990 -3  # Retain_P3_HnL(5)_BLK3repl_1916
# info on dev vectors created for selex parms are reported with other devs after tag parameter section
#
0   #  use 2D_AR1 selectivity(0/1):  experimental feature
#_no 2D_AR1 selex offset used
#
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters
#
# deviation vectors for timevary parameters
#  base   base first block   block  env  env   dev   dev   dev   dev   dev
#  type  index  parm trend pattern link  var  vectr link _mnyr  mxyr phase  dev_vector
#  3 3 1 0 0 0 0 1 1  1983  1998 5 0.000181693 0.00180972 0.001629 -0.00147081 -0.00193688 -0.00190652 -0.00192409 0.00191806 -0.000961358 -
0.00177424 0.00153693 1.58565e-05 0.000139148 -0.00112142 0.000219548 -0.00152707
#  3 7 3 0 0 0 0 2 1  1980  2004 5 0.00104046 0.000577339 0.000989062 0.00156559 -0.000238446 -0.000608763 0.000150644 -0.000788755 0.00127865
-0.000634807 -0.00152794 -0.00122326 -0.00038408 0.000934731 0.000161483 -0.00150648 0.00177596 -0.000892146 0.000580528 0.00104247
0.000181536 -0.000538737 -0.000226183 0.000750919 -0.000152398
#  5 1 5 4 2 2 0 0 0 0 0 0
#  5 3 6 4 2 2 0 0 0 0 0 0
#  5 7 7 2 2 2 0 0 0 0 0 0
#  5 8 9 2 2 2 0 0 0 0 0 0
#  5 911 1 2 2 0 0 0 0 0 0
#  51114 7 2 2 0 0 0 0 0 0
#  51317 7 2 2 0 0 0 0 0 0
#  51420 7 2 2 0 0 0 0 0 0
#  51623 7 2 2 0 0 0 0 0 0
#  51926 7 2 2 0 0 0 0 0 0
#  53329 5 2 2 0 0 0 0 0 0
#  53530 5 2 2 0 0 0 0 0 0
#  53931 3 2 2 0 0 0 0 0 0
#  54032 3 2 2 0 0 0 0 0 0
#  54133 3 2 2 0 0 0 0 0 0
 #
# Input variance adjustments factors:
 #_1=add_to_survey_CV
 #_2=add_to_discard_stddev
 #_3=add_to_bodywt_CV
 #_4=mult_by_lencomp_N
 #_5=mult_by_agecomp_N
 #_6=mult_by_size-at-age_N
 #_7=mult_by_generalized_sizecomp
#_Factor  Fleet  Value
 -9999   10  # terminator
#
1 #_maxlambdaphase
1 #_sd_offset; must be 1 if any growthCV, sigmaR, or survey extraSD is an estimated parameter
# read 13 changes to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch; 9=init_equ_catch;
# 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin; 17=F_ballpark; 18=initEQregime
```

```
#like_comp fleet  phase  value  sizefreq_method
 4 1 1 0.030 1 # BottomTrawl_Length_Comp
 4 2 1 0.095 1 # MidwaterTrawl_Length_Comp
 4 3 1 0.065 1 # Hake_Length_Comp
 4 4 1 0.237 1 # Net_Length_Comp
 4 5 1 0.138 1 # HnL_Length_Comp
 4 7 1 0.375 1 # Triennial_Length_Comp
 4 8 1 0.699 1 # NWFSC_Length_Comp
 5 1 1 0.081 1 # BottomTrawl_Marginal_Age_Comp
 5 2 1 0.130 1 # MidwaterTrawl_Marginal_Age_Comp
 5 3 1 0.110 1 # Hake_Marginal_Age_Comp
 5 4 1 0.240 1 # Net_Marginal_Age_Comp
 5 5 1 0.312 1 # HnL_Marginal_Age_Comp
 5 8 1 0.279 1 # NWFSC_CAAL
-9999  1  1  1  1  #  terminator
#
# lambdas (for info only; columns are phases)
#  1 #_CPUE/survey:_1
#  0 #_CPUE/survey:_2
#  1 #_CPUE/survey:_3
#  0 #_CPUE/survey:_4
#  0 #_CPUE/survey:_5
#  1 #_CPUE/survey:_6
#  1 #_CPUE/survey:_7
#  1 #_CPUE/survey:_8
#  1 #_CPUE/survey:_9
#  1 #_discard:_1
#  1 #_discard:_2
#  0 #_discard:_3
#  0 #_discard:_4
#  1 #_discard:_5
#  0 #_discard:_6
#  0 #_discard:_7
#  0 #_discard:_8
#  0 #_discard:_9
#  0.035 #_lencomp:_1
#  0.13 #_lencomp:_2
#  0.06 #_lencomp:_3
#  0.23 #_lencomp:_4
#  0.2 #_lencomp:_5
#  0 #_lencomp:_6
#  0.38 #_lencomp:_7
#  0.73 #_lencomp:_8
#  0 #_lencomp:_9
#  0.08 #_agecomp:_1
#  0.16 #_agecomp:_2
#  0.11 #_agecomp:_3
#  0.23 #_agecomp:_4
#  0.31 #_agecomp:_5
#  0 #_agecomp:_6
#  0 #_agecomp:_7
```

```
#  0.33 #_agecomp:_8
#  0 #_agecomp:_9
#  1 #_init_equ_catch
#  1 #_recruitments
#  1 #_parameter-priors
#  1 #_parameter-dev-vectors
#  1 #_crashPenLambda
#  0 # F_ballpark_lambda
0 # (0/1) read specs for more stddev reporting
 # 0 0 0 0 0 0 0 0 0 # placeholder for # selex_fleet, 1=len/2=age/3=both, year, N selex bins, 0 or Growth pattern, N growth ages, 0 or
NatAge_area(-1 for all), NatAge_yr, N Natages
 # placeholder for vector of selex bins to be reported
 # placeholder for vector of growth ages to be reported
 # placeholder for vector of NatAges ages to be reported
999
```

Appendix E. **SS starter file**

```
#V3.30.12.00-trans;_2018_08_01;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11.6
#Stock Synthesis (SS) is a work of the U.S. Government and is not subject to copyright protection in the United
States.
#Foreign copyrights may apply. See copyright.txt for more information.
#_user_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_user_info_available_at:https://vlab.ncep.noaa.gov/group/stock-synthesis
2019widow.dat
2019widow.ctl
0 # 0=use init values in control file; 1=use ss.par
1 # run display detail (0,1,2)
1 # detailed output (0=minimal for data-limited, 1=high (w/ wtatage.ss_new), 2=brief)
0 # write 1st iteration details to echoinput.sso file (0,1)
0 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
0 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
0 # Number of datafiles to produce: 1st is input, 2nd is estimates, 3rd and higher are bootstrap
10 # Turn off estimation for parameters entering after this phase
1 # MCeval burn interval
1 # MCeval thin interval
0 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values

0.0001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
4 # min age for calc of summary biomass
1 # Depletion basis:  denom is: 0=skip; 1=rel X*SPB0; 2=rel SPBmsy; 3=rel X*SPB_styr; 4=rel X*SPB_endyr
1 # Fraction (X) for Depletion denominator (e.g. 0.4)
1 # SPR_report_basis:  0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
1 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates); 4=true F for range of ages;
5=unweighted avg. F for range of ages
#COND 10 15 #_min and max age over which average F will be calculated with F_reporting=4 or 5
0 # F_report_basis: 0=raw_F_report; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
```

```
0 # MCMC output detail: integer part (0=default; 1=adds obj func components); and decimal part (added to
SR_LN(R0) on first call to mcmc)
0 # ALK tolerance (example 0.0001)
3.30 # check value for end of file and for version control
```

Appendix F. **SS forecast file**

```
#V3.30.12.00-trans;_2018_08_01;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_11.6
#Stock Synthesis (SS) is a work of the U.S. Government and is not subject to copyright protection in the United States.
#Foreign copyrights may apply. See copyright.txt for more information.
# for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy; 2=calc F_spr,F0.1,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt) or F0.1; 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, beg_recr_dist, end_recr_dist, beg_SRparm,
end_SRparm (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0 1916 0 1916 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) or F0.1; 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
1 # F scalar (only used for Do_Forecast==5)
#_Fcast_years:  beg_selex, end_selex, beg_relF, end_relF, beg_mean recruits, end_recruits  (enter actual year, or values of 0
or -integer to be rel. endyr)
 0 0 0 0 -999 0
0 # Forecast selectivity (0=fcast selex is mean from year range; 1=fcast selectivity from annual time-vary parms)
3 # Control rule method (1: ramp does catch=f(SSB), buffer on F; 2: ramp does F=f(SSB), buffer on F; 3: ramp does
catch=f(SSB), buffer on catch; 4: ramp does F=f(SSB), buffer on catch)
0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40); (Must be > the no F level below)
0.1 # 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), negative value invokes list of [year, scalar] with filling from
year to YrMax
 2019 1
 2020 1
 2021 0.935
 2022 0.930
 2023 0.926
 2024 0.922
 2025 0.917
 2026 0.913
 2027 0.909
 2028 0.904
 2029 0.900
 2030 0.896
 -9999 0
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 recruitment:  0= spawn_recr; 1=value*spawn_recr_fxn; 2=value*VirginRecr; 3=recent mean from yr range above
```

```
1 # value is ignored
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2021  #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)
2015 # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2015 # Rebuilder:  year for current age structure (Yinit) (-1 to set to endyear+1)
2 # fleet relative F: 1=use first-last alloc year; 2=read seas, fleet, alloc list 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
# enter list of: season, fleet, relF; if used, terminate with season=-9999
1 1 0.003306009
1 2 0.862548985
1 3 0.133896572
1 4 0
1 5 0.000248434
 -9999 0 0
# enter list of: fleet number, max annual catch for fleets with a max; terminate with fleet=-9999
-9999 -1
# enter list of area ID and max annual catch; terminate with area=-9999
-9999 -1
# enter list of fleet number and allocation group assignment, if any; terminate with fleet=-9999
-9999 -1
#_if N allocation groups >0, list year, allocation fraction for each group
# list sequentially because read values fill to end of N forecast
# terminate with -9999 in year field
# no allocation groups
2 # basis for input Fcast catch: -1=read basis with each obs; 2=dead catch; 3=retained catch; 99=input Hrate(F)
#enter list of Fcast catches; terminate with line having year=-9999
#_Yr Seas Fleet Catch(or_F)
 2019 1 1 35.93
 2019 1 2 9374.26
 2019 1 3 1455.2
 2019 1 4 0
 2019 1 5 2.7
 2020 1 1 35.93
 2020 1 2 9374.26
 2020 1 3 1455.2
 2020 1 4 0
 2020 1 5 2.7
-9999 1 1 0
#
999 # verify end of input
```

Appendix G. **NWFSC WCGBT survey VAST model diagnostics**

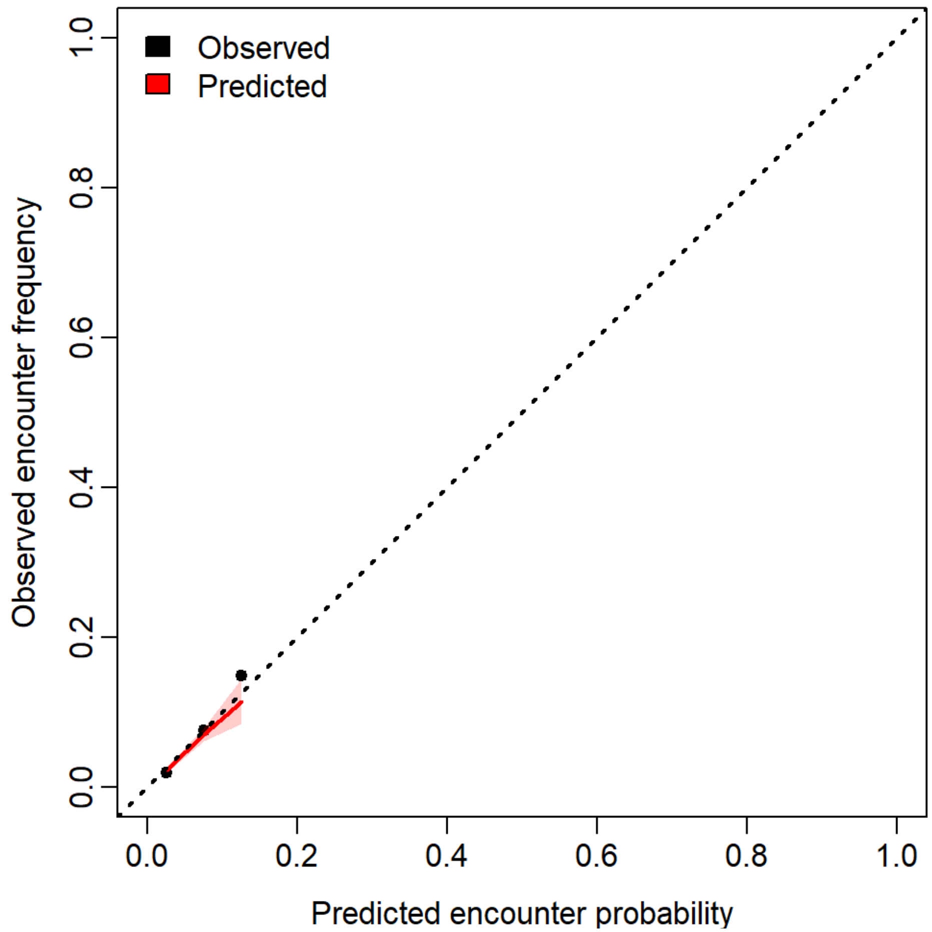

Figure E1. Predicted (red) versus observed (black) quantiles for encounter probabilities when estimating an index of relative abundance for the NWFSC WCGBT survey. The observed encounters are small and unlikely. This is typically true of a species that is infrequently sampled by the survey.

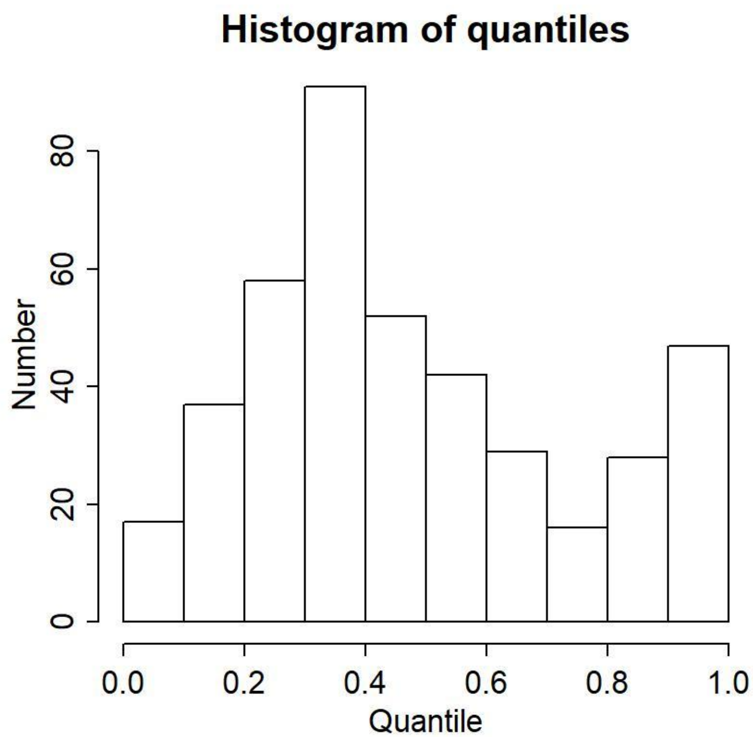

Figure E2. Predicted quantiles binned by encounter probability for the NWFSC WCGBT survey.

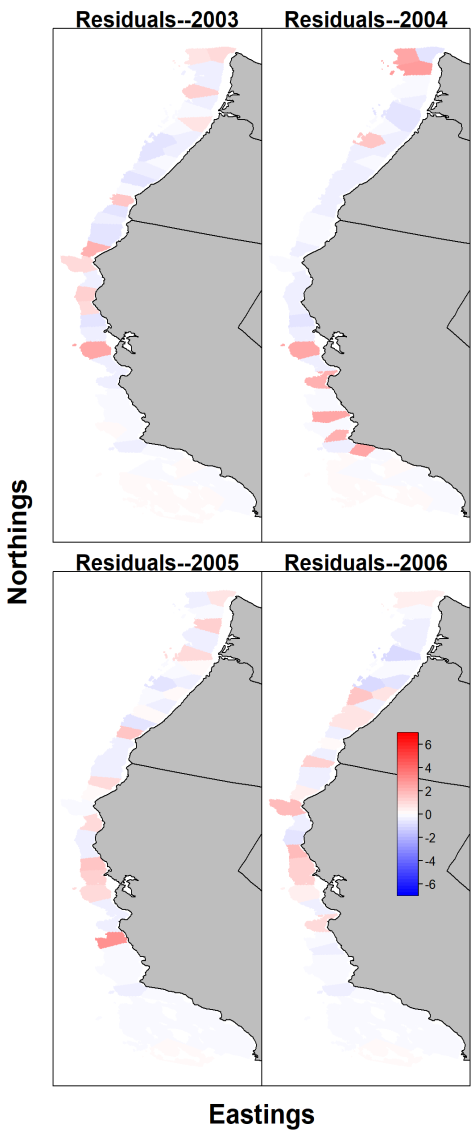

Figure E3. Pearson residuals across space and time (panels) for predicted encounter rates for the NWFSC WCGBT survey; panel 1 of 4

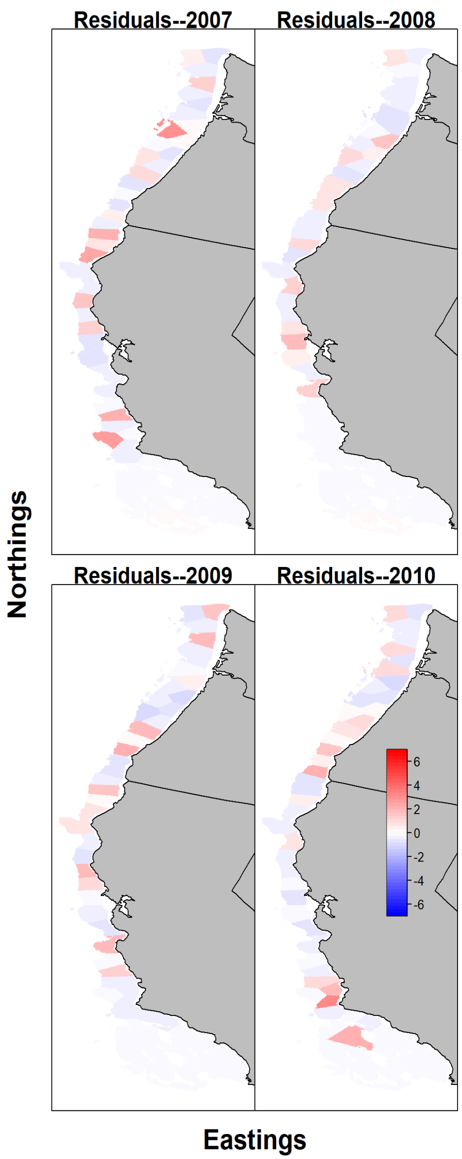

Figure E4. Pearson residuals across space and time (panels) for predicted encounter rates for the NWFSC WCGBT survey; panel 2 of 4

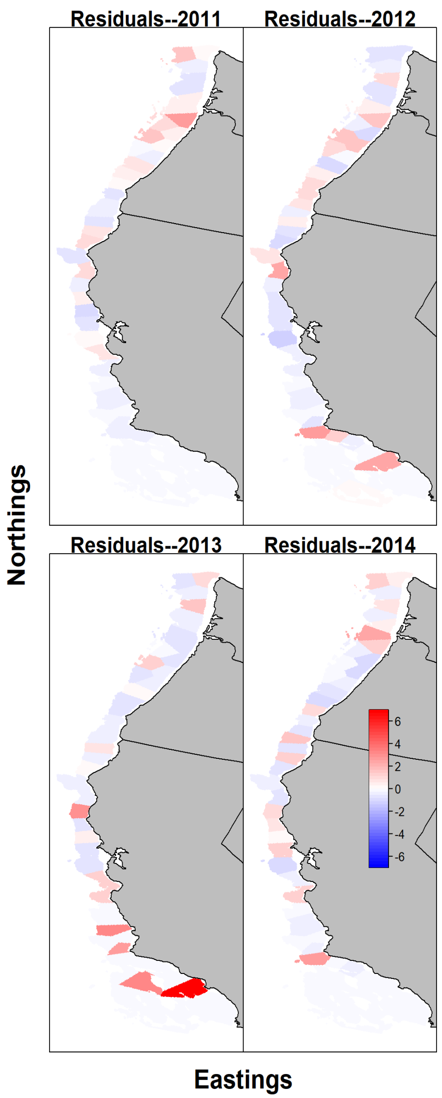

Figure E5. Pearson residuals across space and time (panels) for predicted encounter rates for the NWFSC WCGBT survey; panel 3 of 4

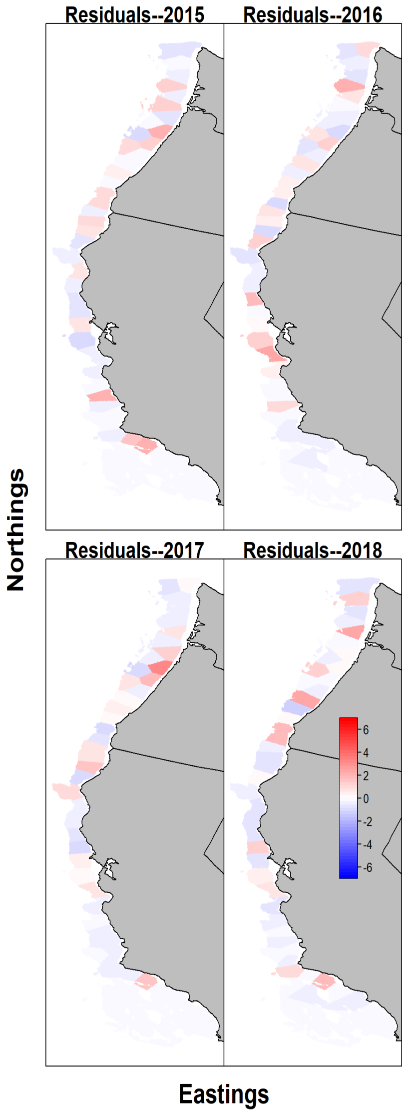

Figure E6. Pearson residuals across space and time (panels) for predicted encounter rates for the NWFSC WCGBTsurvey; panel 4 of 4

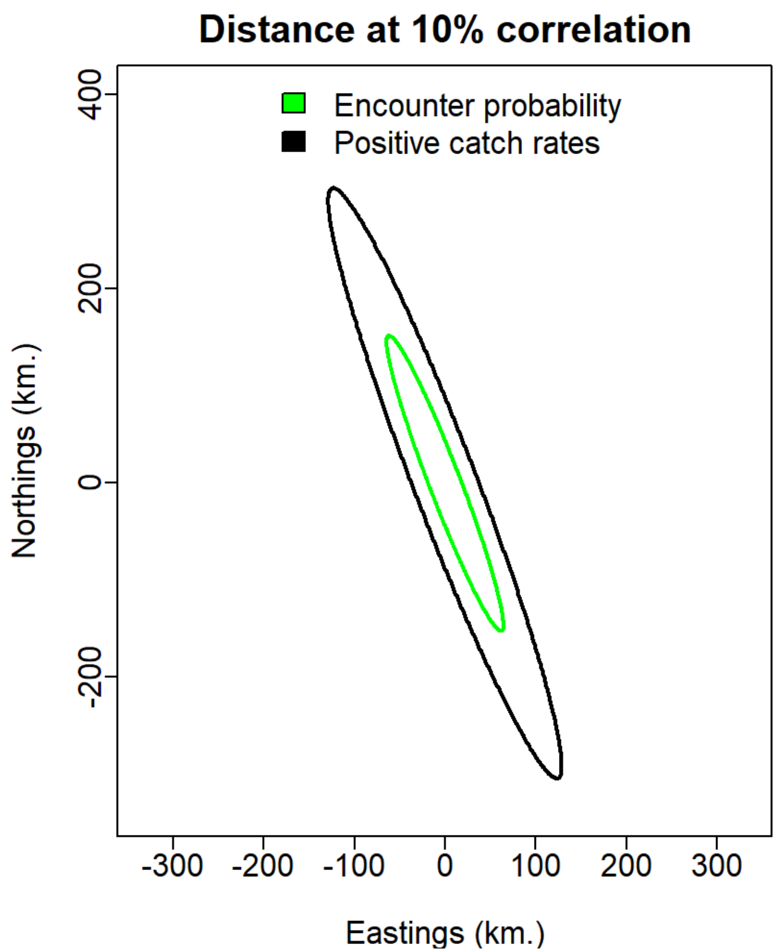

Figure E7. Aniosotropy for the NWFSC WCGBTsurvey.

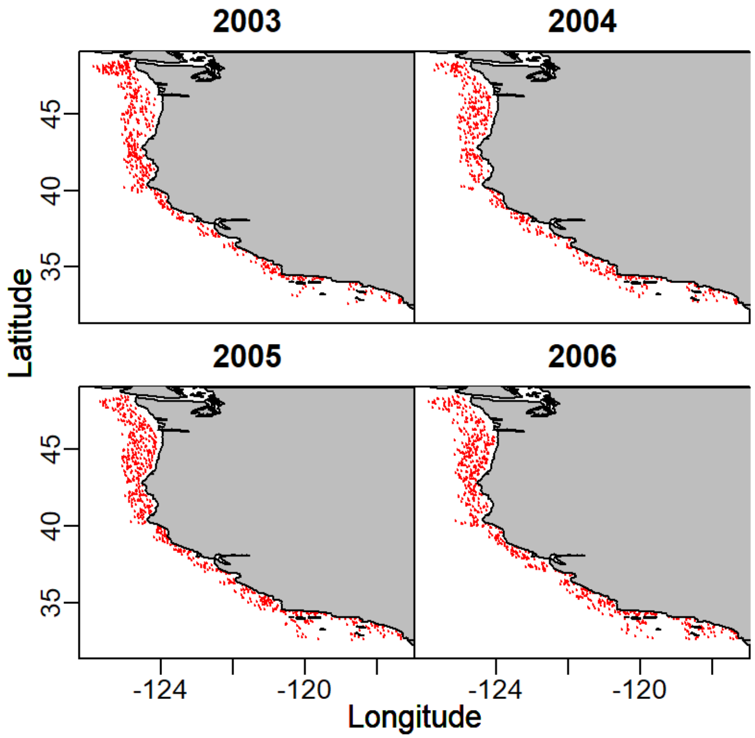

Figure E8. Sample locations by year for the NWFSC WCGBT survey; 1 of 4.

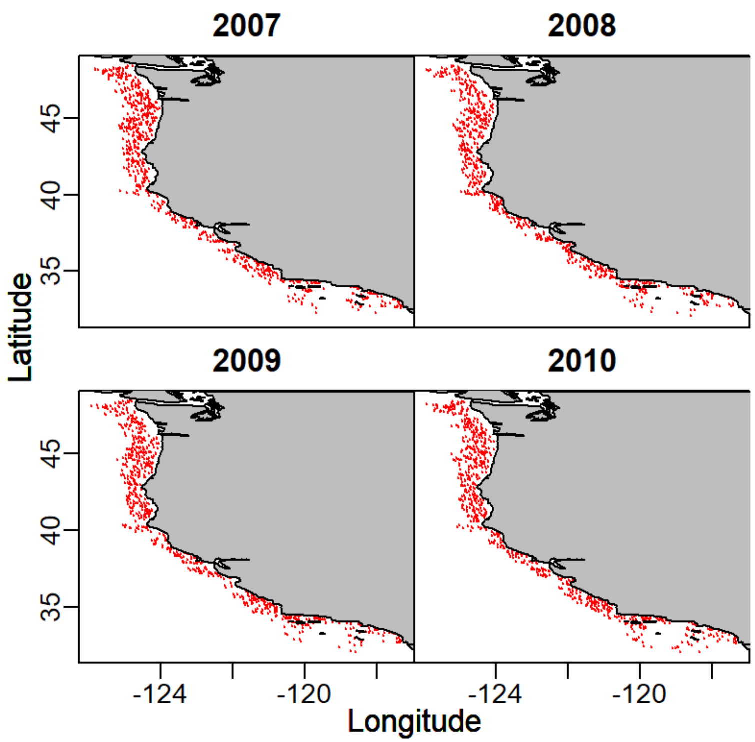

Figure E9. Sample locations by year for the NWFSC WCGBTsurvey; 2 of 4.

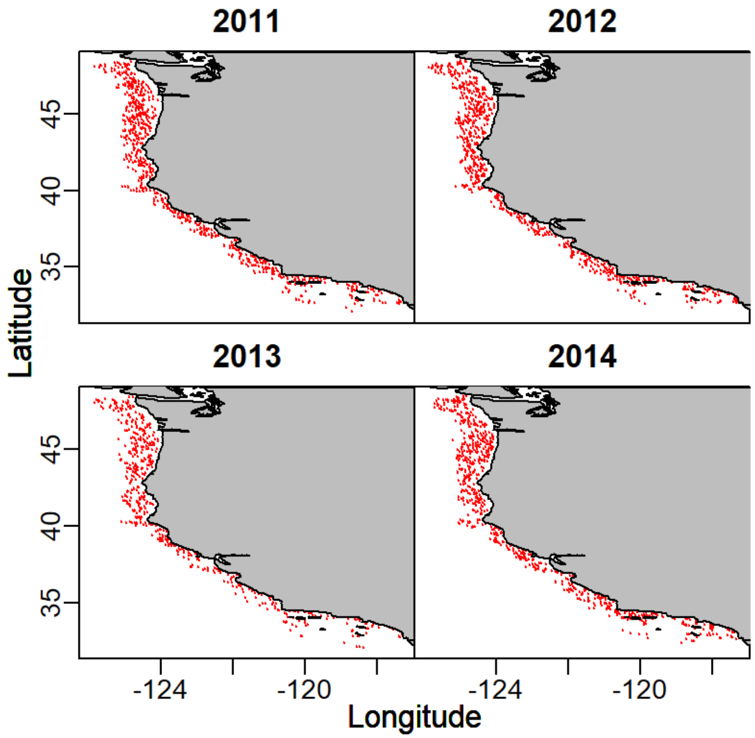

Figure E10. Sample locations by year for the NWFSC WCGBTsurvey; 3 of 4.

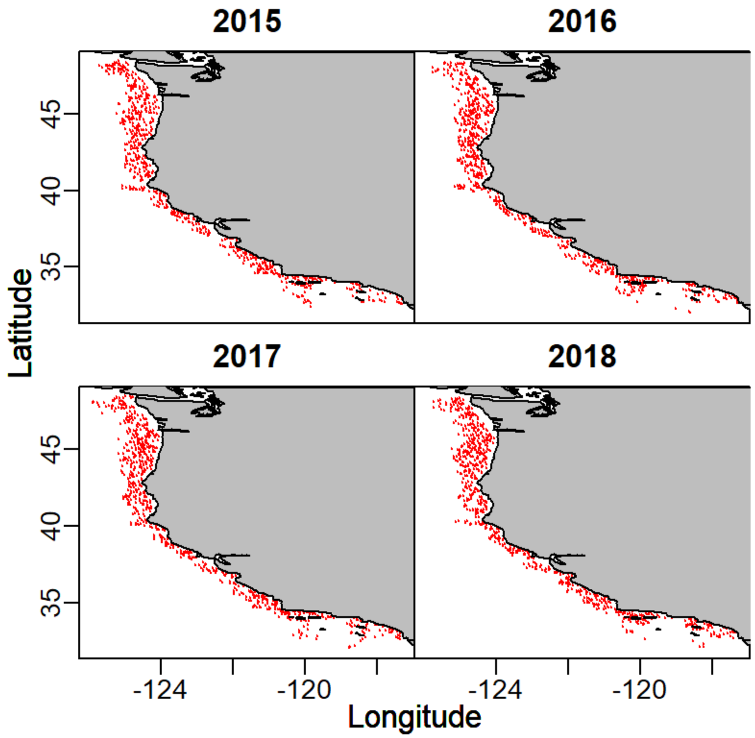

Figure E1l. Sample locations by year for the NWFSC WCGBTsurvey; 4 of 4.