Status of Kelp Greenling (*Hexagrammos decagrammus*) along the Oregon Coast in 2015

Aaron M. Berger[1]

Linsey Arnold[2]

Brett T. Rodomsky[3]

[1]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2032 SE OSU Drive, Newport, OR 97365

[2]Oregon State University, Department of Fish and Wildlife, 104 Nash Hall, 2820 SW Campus Way, Corvallis, OR 97331

[3]Oregon Department of Fish and Wildlife, 2040 SE Marine Science Drive, Newport, OR 97365

November 17, 2015

Table of Contents

Executive Summary

Stock

This is the second stock assessment of the population status of Kelp Greenling (*Hexagrammos decagrammus* [Pallas, 1810]) along the Oregon coast (Figure 1). Kelp Greenling is endemic to nearshore rocky reef, kelp forest, and eelgrass habitats of the Northeast Pacific Ocean and ranges from southern California, north to the Alaskan Aleutian Islands, but is rarely found south of Point Conception, California. The first stock assessment of Kelp Greenling (Cope and MacCall, 2005) modeled a separate substock off the coast of California. However, there was insufficient population information (e.g., age, growth, natural mortality, abundance index) at the time for the California assessment results to be used for management advice. Subsequently, a data-poor assessment for waters off California was conducted and used for specifying an overfishing-level (OFL) contribution to the 'Other Fish' complex. In Washington nearshore waters, there is no commercial fishery for Kelp Greenling nor are there substantial recreational removals of Kelp Greenling. The spatial extent of this assessment includes the waters off the coast of Oregon.

Catches

Kelp Greenling is predominantly caught using hook-and-line gear by recreational fishermen and by hook-and-line or longline gear by commercial fishermen. Several other gear types harvest incidental amounts of Kelp Greenling (including fish pots, crab pots, troll gear, and trawl gear). Their preferred habitat is often easily accessible from shore or with a small vessel, making Kelp Greenling a frequent target for recreational fishermen. The onset of a readily available market for live fish, along with attractive ex-vessel prices, was a main driving force for the development of a Kelp Greenling commercial fishery in the late 1990s. Total landings have generally increased through time with a major peak occurring in 2002, resulting primarily from an exceptionally large commercial harvest in that year (Figure E1). Since the implementation of management limits (fleet size limit, annual landing caps, and daily and period landing limits) for the commercial fishery in 2004, landings have been generally stable. Landings were episodic from 1980 through the late 1990s, primarily driven by frequent fluctuations in shore and estuary-boat removals over the course of several years. Recent landings have been dominated by the commercial sector (Table E1).

The most significant change in the harvest trend for Kelp Greenling has resulted from the development of a live-fish market. This fishery started in northern California in the late 1980s and spread northward during the late 1990s to Oregon in order to supply the live-fish market in San Francisco, CA. Commercial landings of Kelp Greenling were available from the Pacific Fisheries Information Network (PacFIN; 1988 – 2014). Landings prior to 1988 are believed to be negligible, because only minor removals (0.3% on average compared to later years), were recorded on fish tickets from 1988 – 1995, prior to the advent of the live-fish market. More than 95% of commercial landings occur along the southern Oregon coastline at the ports of Gold Beach and Port Orford. Kelp Greenling is one of several nearshore species targeted for the live-fish market.

Historically, a significant portion of Oregon's Kelp Greenling landings came from the recreational fishery (particularly through shore and estuary-boat fishing modes). However, the magnitude of Oregon's recreational Kelp Greenling harvest prior to the early 1970s was not well documented, and there have been spans of years since that time with little information from the shore-based and estuary-boat fishing modes. The ocean-boat recreational fleet rarely targets Kelp

Greenling, instead landings are often incidental when targeting other species such as Lingcod and Black Rockfish. Catch data begin in 1973 for the ocean-boat fishing mode and in 1981 for the estuary boat and shore fishing modes. For years prior to 1980 and for recent years (2005 – 2014), no direct information was available to estimate catch from estuary-boat and shore-based fishing modes, so a catch reconstruction was completed for these periods. Nonetheless, there remains significant uncertainty around total landings for estuary-boat and shore-based fishing modes, particularly during periods where catch information was extrapolated from fishing license sales (pre-1980) or from recent years (2005-2014) when no data were collected for these fishing modes.

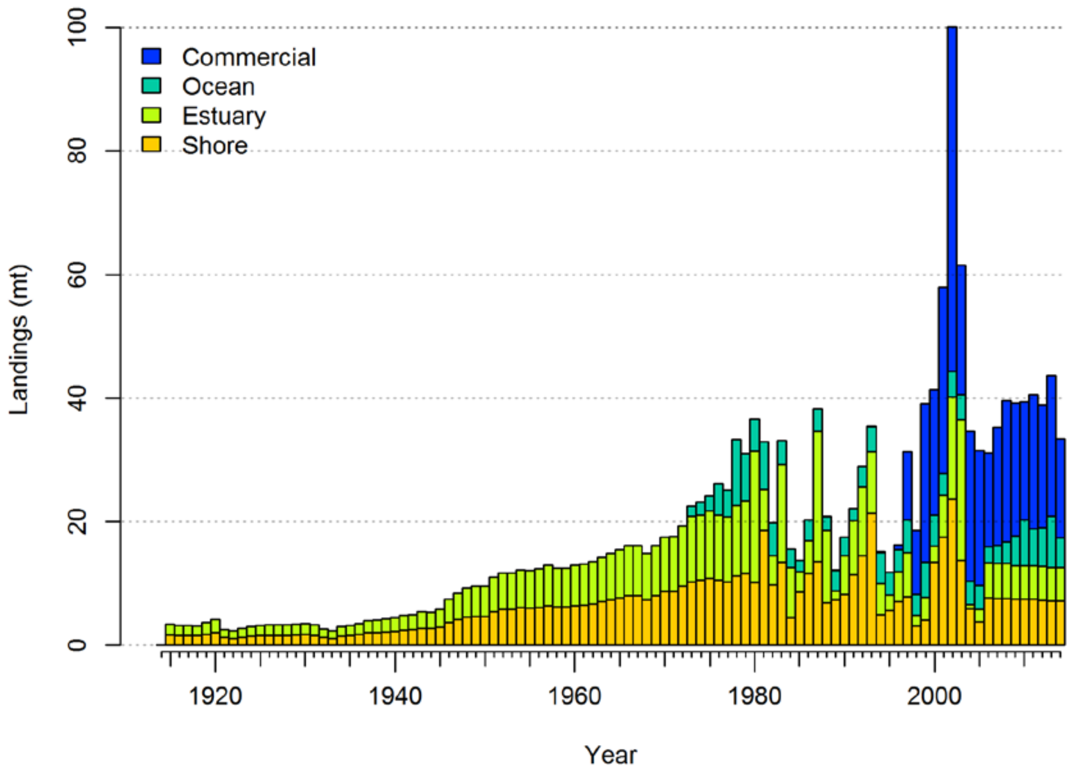


Figure E1. **Stacked time series of Kelp Greenling landings (mt) by fleet for Oregon waters.**

Table E1. Recent landings (mt) for Kelp Greenling by fleet.

Year	Commercial	Recreational Ocean Boat	Recreational Estuary Boat	Recreational Shore	Total Landings
2005	21.38	3.90	2.00	3.70	30.98
2006	14.83	2.67	5.60	7.50	30.60
2007	18.72	2.90	5.60	7.40	34.63
2008	22.43	3.48	5.60	7.40	38.91
2009	21.05	4.77	5.40	7.30	38.52
2010	18.73	7.37	5.40	7.30	38.80
2011	21.25	5.91	5.40	7.30	39.86
2012	19.44	6.22	5.40	7.20	38.27
2013	22.35	8.26	5.30	7.10	43.02
2014	15.72	4.75	5.30	7.10	32.87

Data and assessment

Kelp Greenling were assessed previously in 2005 (Cope and MacCall 2005). For Oregon, management advice regarding the status of the stock was determined to be acceptable (spawning biomass depletion of 49% of unfished levels). However, it was decided that an OFL could not be determined because of substantial uncertainties associated with overall catch levels, particularly from shore-based fishing modes. It is important to note that under current PFMC guidelines an OFL could have been determined for this assessment by applying the overfishing probability P* tier categories to establish a suitable buffer given the level of uncertainty in recent estimates of spawning biomass.

This assessment uses the most recent version of Stock Synthesis (version 3.24u) available. The assessment is structured as a single, sex-disaggregated, unit population, spanning Oregon coastal waters, and operates on an annual time step covering the period 1915 to 2014. The input files used for the stock assessment can be found in the appendices (pp. 151, 189, 194, and 195). Fleets were specified for recreational and commercial sectors. The recreational sector was split into three main fleets according to fishing mode, a proxy for the location of fishing. These include ocean-boat, estuary-boat, and fishing from shore fleets. The commercial sector was represented by one fleet, which included a combination of hook-and-line and longline gear types. Data used in the assessment includes time-series of commercial and recreational landings, three abundance indices (catch per unit effort or CPUE), length compositions for each fleet, and age compositions from the recreational ocean-boat fleet and the commercial fleet. Discard mortality rates were also used for each fleet to expand total landings to total catch.

Stock biomass

Kelp Greenling spawning biomass was estimated to be 316 mt in 2015 (~95% asymptotic intervals: 116-516 mt), which when compared to unfished spawning biomass equates to a depletion level of 80% (~95% asymptotic intervals: 0.59-1.00; Table E2) in 2015. Depletion is a ratio of the estimated spawning biomass in a particular year relative to estimated unfished, equilibrium spawning biomass. In general, spawning biomass has been trending slightly downwards until the early to mid-2000s and has since been trending slightly upwards (Figure E2). Considerable variation in stock sizes occurs during this time frame when the model allows for interannual deviations from the stock-recruitment relationship. Stock size is estimated to be at the lowest level throughout the historic time series in 1998, but has since increased as a result of strong recruitment in 2000 and 2009. Throughout the time series, the stock is estimated to be above the management target of $B_{40\%}$ (Figure E3).

Table E2. Recent trends in the beginning of the year biomass and depletion for Kelp Greenling in Oregon waters.

Year	Spawning Biomass (mt)	~ 95% confidence intervals	Estimated depletion	~ 95% confidence intervals
2006	346.17	(162-531)	0.87	(0.74-1.00)
2007	318.88	(146-492)	0.80	(0.68-0.93)
2008	277.73	(123-432)	0.70	(0.59-0.81)
2009	265.76	(113-419)	0.67	(0.55-0.79)
2010	282.47	(115-450)	0.71	(0.57-0.85)
2011	362.24	(144-581)	0.91	(0.72-1.10)
2012	415.18	(163-667)	1.05	(0.82-1.27)
2013	403.17	(157-650)	1.02	(0.79-1.25)
2014	354.51	(134-575)	0.89	(0.68-1.10)
2015	315.98	(116-516)	0.80	(0.59-1.00)

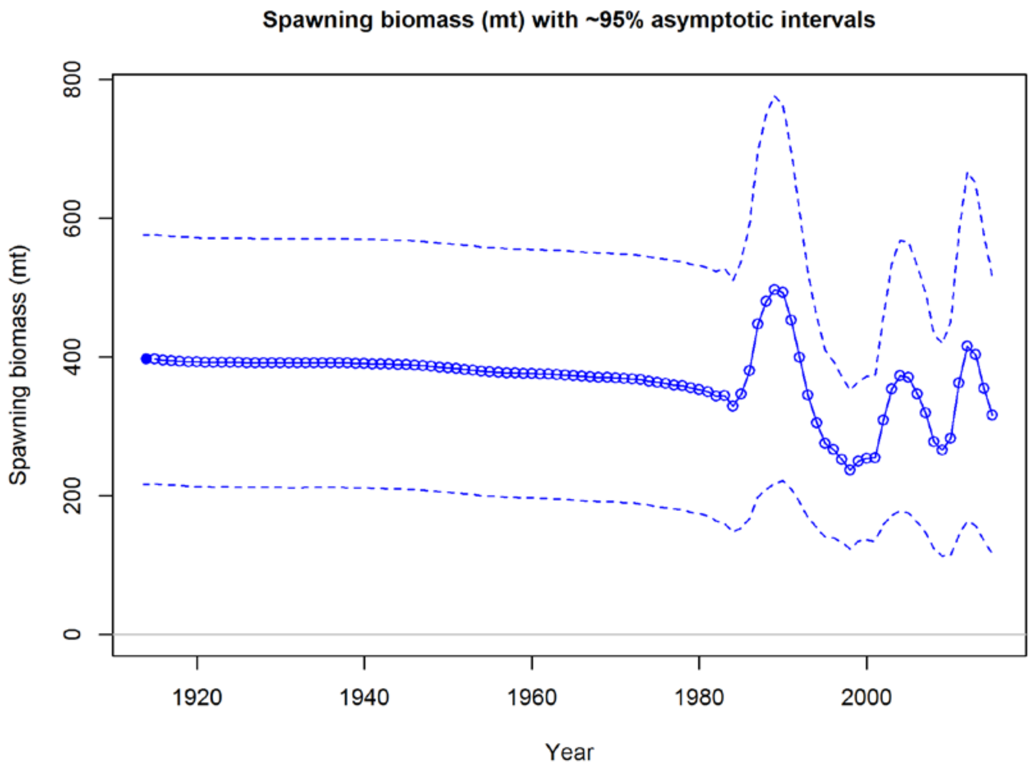


Figure E2. Time series of spawning biomass for Kelp Greenling in Oregon waters.

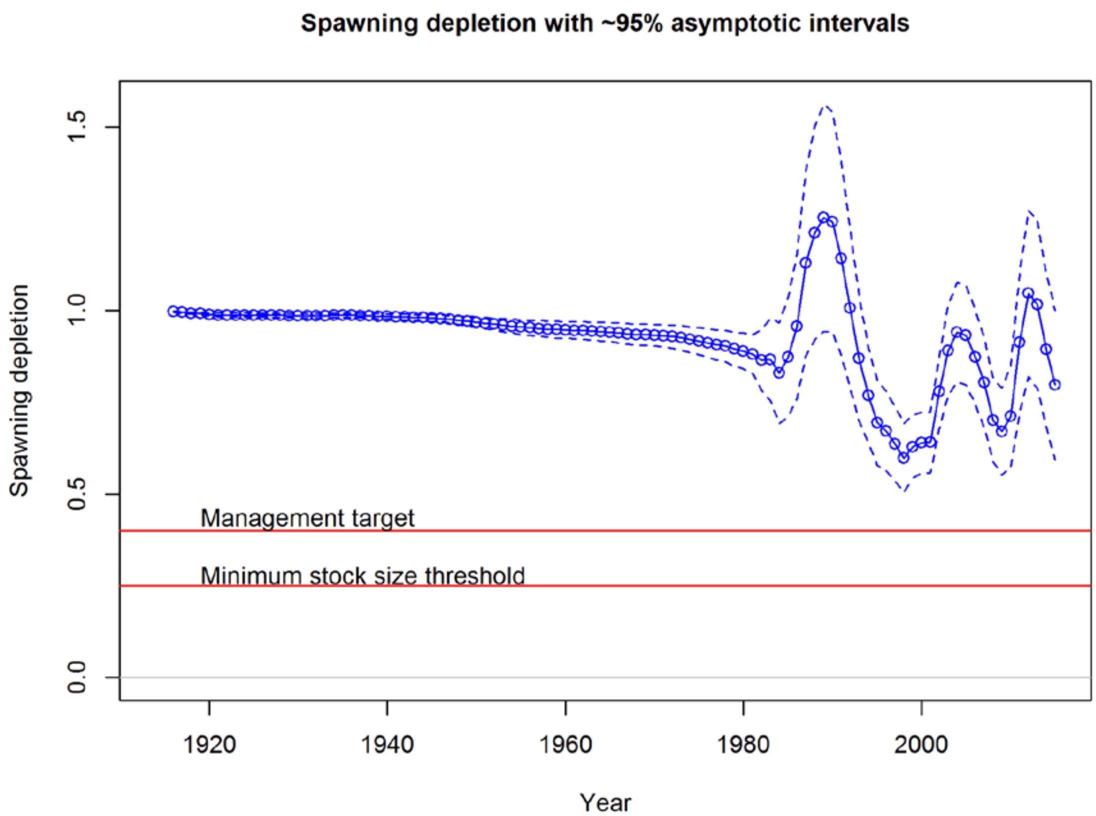


Figure E3. Estimated relative depletion in relation to management reference points for Kelp Greenling in Oregon waters.

Recruitment

Recruitment variability was notably dynamic for Kelp Greenling (Table E3, Figure E4) and indicated well above average recruitment in 2009. Other years with relatively high estimates of recruitment were 1985 and 2000. In recent years (2012-2014), the model had difficulty estimating recruitment levels because of a lack of cohort information contained in the most recent data.

Table E3. Recent trend in estimated recruitment for Kelp Greenling in Oregon waters.

Year	Estimated Recruitment (1,000s)	~ 95% confidence intervals
2006	432	(148-715)
2007	1,495	(674-2,315)
2008	1,827	(799-2,856)
2009	3,524	(1,559-5,489)
2010	1,855	(736-2,973)
2011	487	(86-889)
2012	447	(0-916)
2013	996	(0-2,141)
2014	1,433	(0-3,365)
2015	1,413	(0-3,318)

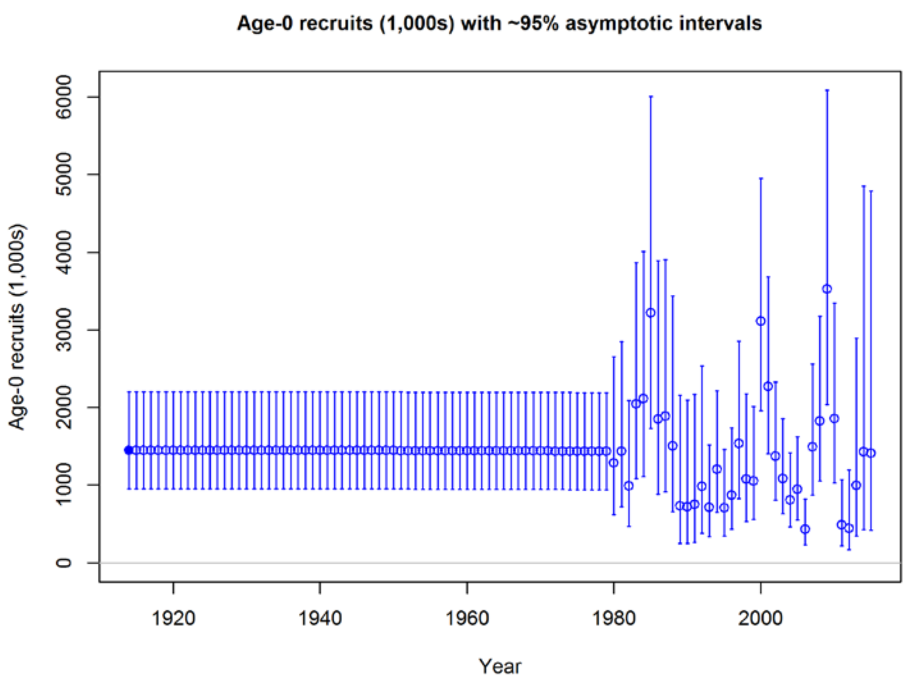


Figure E4. Time series of estimated recruitments with approximate 95% asymptotic intervals for Kelp Greenling in Oregon waters.

Exploitation status

Harvest rates have been generally increasing through time, reaching a maximum in 2002 (0.51, or 51% of the target level) before declining again to 0.21 in 2014 (Table E4, Figure E5). Fishing intensity is estimated to have been below the target throughout the time series [(1-SPR) / (1-$SPR_{45\%}$) < 1]. In 2014, Kelp Greenling biomass is estimated to have been 2.24 times higher than the target biomass level, while experiencing fishing intensity 4.76 times lower than the SPR fishing intensity target (Figure E6).

Table E4. Recent trend in spawning potential ratio (entered as 1-SPR / 1-$SPR_{45\%}$) and exploitation for Kelp Greenling in Oregon waters.

Year	Estimated (1-SPR) / (1-$SPR_{45\%}$)	~ 95% confidence intervals	Harvest rate (ratio)	~ 95% confidence intervals
2005	0.18	(0.09-0.26)	0.14	(0.07-0.21)
2006	0.20	(0.11-0.30)	0.15	(0.07-0.22)
2007	0.25	(0.13-0.36)	0.19	(0.09-0.30)
2008	0.27	(0.14-0.39)	0.21	(0.10-0.33)
2009	0.26	(0.13-0.39)	0.19	(0.09-0.30)
2010	0.23	(0.11-0.35)	0.14	(0.06-0.23)
2011	0.22	(0.11-0.34)	0.14	(0.06-0.22)
2012	0.21	(0.10-0.33)	0.15	(0.06-0.24)
2013	0.24	(0.12-0.37)	0.19	(0.08-0.31)
2014	0.21	(0.09-0.33)	0.16	(0.06-0.26)

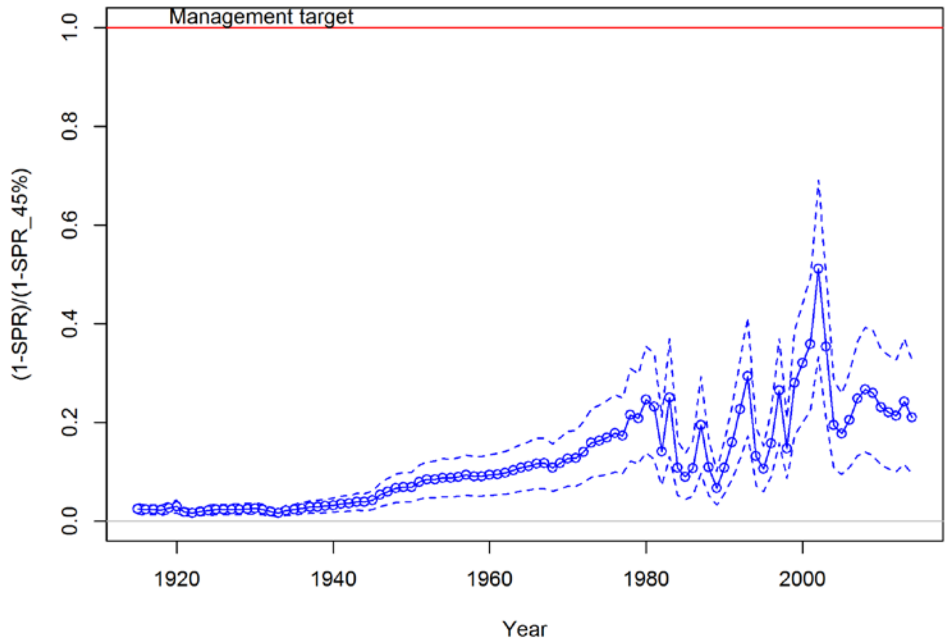


Figure E5. Estimated spawning potential ratio (SPR) for the base case model with approximate 95% asymptotic confidence intervals. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as the red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{45\%}$. The last year of the time series is 2014.

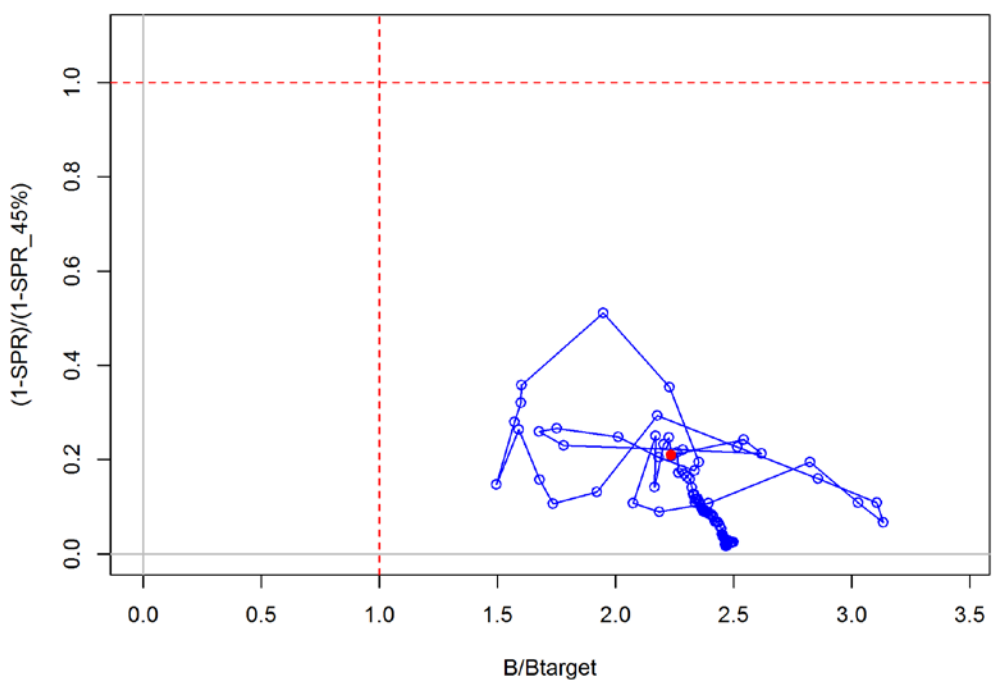


Figure E6. Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 45% (the SPR target). Relative depletion is the annual spawning biomass divided by the spawning biomass corresponding to 40% of the unfished spawning biomass. The red point indicates the year 2014.

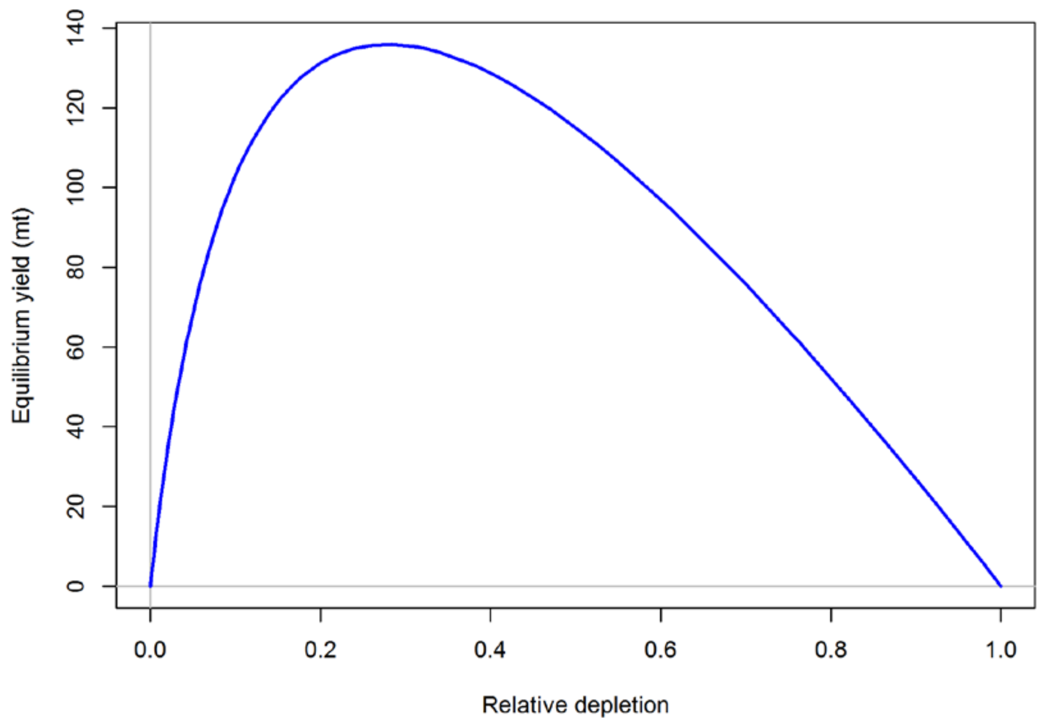


Figure E7. Equilibrium yield curve for the Kelp Greenling base case model. Values are based on 2014 fishery selectivity and with steepness fixed at 0.7.

Ecosystem considerations

Kelp Greenling is ubiquitous in suitable habitat including subtidal and intertidal nearshore and estuarine rocky habitats, both natural and man-made, and biogenic substrates. Important Kelp Greenling habitat associations include bedrock, large boulder, and small boulder habitats. Environmental factors altering nearshore habitat may have a direct or indirect impact on the Oregon Kelp Greenling stock. No research was uncovered that quantified ecosystem level effects on Kelp Greenling; therefore, considerations such as environmental correlations and food web interactions were not explicitly included in the assessment.

Reference points

Reference points and management quantities for the Oregon Kelp Greenling base case model are listed in (Table E5). The Kelp Greenling stock is estimated to be above the biomass target. In general, there has been a declining (though variable) trend in spawning biomass from the beginning of the time series through the early 2000s. Spawning biomass has since increased (though variable) as a result of large recruitment events in 2000 and 2009. The estimated relative depletion level in 2015 is 80% (~95% asymptotic interval: 59% - 100%), corresponding to 316 mt (~95% asymptotic interval: 116 - 516 mt) of spawning biomass in the base model. Unfished spawning stock biomass was estimated to be 397 mt in the base case model. The target stock size based on the spawning biomass target ($B_{40\%}$) is 159 mt, with the corresponding SPR giving an MSY of 129 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{45\%}$ is 130 mt.

Table E5. Summary of reference points and management quantities for the Kelp Greenling base case model.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning biomass (mt)	397	(217-576)
Unfished recruitment (R0, thousands)	1,451	(838-2,064)
Spawning Biomass (2015)	316	(116-516)
Depletion (2015)	0.80	(0.59-1.00)
Reference points based on SB $_{40\%}$		
Proxy spawning biomass ($B_{40\%}$)	159	(87-230)
SPR resulting in $B_{40\%}$	0.46	(0.46-0.46)
Exploitation rate resulting in $B_{40\%}$	0.18	(0.17-0.18)
Yield at $B_{40\%}$ (mt)	129	(73-184)
Reference points based on SPR proxy for MSY		
Spawning biomass	152	(83-221)
SPR_{proxy}	0.45	
Exploitation rate corresponding to SPR_{proxy}	0.18	(0.18-0.19)
Yield with SPR_{proxy} at SB_{SPR} (mt)	130	(74-187)
Reference points based on estimated MSY values		
Spawning biomass at MSY (SB_{MSY})	111	(60-161)
SPR_{MSY}	0.36	(0.35-0.36)
Exploitation rate corresponding to SPR_{MSY}	0.24	(0.23-0.25)
MSY (mt)	136	(77-194)

Management performance

The status of Kelp Greenling was last determined in 2004 (Cope and MacCall 2005) to be above the default target management level (40% spawning biomass depletion) at 49%. An OFL or ACL was not determined from the results of that assessment, leaving little formal guidance for setting annual fishing limits and harvest guidelines. Without a federal OFL, Oregon has regulated Kelp Greenling harvest through the implementation of annual state-specified harvest limits for the greenling complex (Table E6). In 2003, these harvest levels were set at the 2000 landings level for both recreational (5.2 mt) and commercial (19.5 mt) fisheries through the state public process. In 2004, the commercial fishery state-specified harvest limit was increased 20% to 23.4 mt to allow for higher harvest levels of a perceived healthy stock. In the recreational fishery, these annual harvest limits were breached from 2009 - 2013, but in other years landings did not exceed limits. Commercial landings from the greenling complex are monitored and regulated by state-specified two-month cumulative trip limits. In the commercial fishery, state harvest limits have never been breached. Even though the recreational fishery has exceeded the state limit for that fleet in some years, it is important to note that total estimated fishing mortality has been well below what the current assessment estimates were the largest sustainable removals possible in those years.

Table E6. Recent trend in total commercial and recreational ocean-boat removals of Kelp Greenling relative to state instructed harvest limits for a greenling species complex. Removals were calculated as total landings plus the estimated number of dead discards.

Year	Management Guideline	Commercial Limit (mt)	Estimated Commercial Catch (mt)	Recreational Limit (mt)	Estimated Recreational Catch (mt)	Combined Limit (mt)
2005	State harvest limit	23.4	21.8	5.2	4.0	28.6
2006	State harvest limit	23.4	15.1	5.2	2.7	28.6
2007	State harvest limit	23.4	19.1	5.2	2.9	28.6
2008	State harvest limit	23.4	22.9	5.2	3.5	28.6
2009	State harvest limit	23.4	21.5	5.2	4.9	28.6
2010	State harvest limit	23.4	19.1	5.2	7.5	28.6
2011	State harvest limit	23.4	21.7	5.2	6.0	28.6
2012	State harvest limit	23.4	19.9	5.2	6.3	28.6
2013	State harvest limit	23.4	22.8	5.2	8.4	28.6
2014	State harvest limit	23.4	16.1	5.2	4.8	28.6
2015	OFL ('Other Fish')	14				
2016	OFL ('Other Fish')	16.6				

Unresolved problems and major uncertainties

The data for this assessment provided little contrast and significant noise throughout the time series, resulting in significant uncertainties about Kelp Greenling population dynamics. The major sources of uncertainty in this assessment were the values for natural mortality, growth, population scale (i.e., virgin recruitment level), and the catch history for recreational estuary-boat and shore fishing modes. Natural mortality could not be reliably estimated within the assessment model, and thus was fixed for males and females at the median of the prior distribution developed through meta-analytic approaches (Hamel 2015, Then et al. 2015) based on maximum age. The specification of maximum age itself is uncertain, and this uncertainty will propagate to the assumed values for natural mortality. With no ageing error available for Kelp Greenling (Cabezon was used as a proxy to provide ageing error information), it is difficult to translate such estimation error to maximum age. Further, natural mortality estimates were based on observed values for maximum age, which could be underestimated if the number of age samples is small or older fish are less vulnerable to being caught.

There was very little ageing information for age-0 and age-1 Kelp Greenling, yet by age-1 these fish can grow to 60-70% of their maximum length. This feature of the data, coupled with this species very rapid growth, resulted in significant uncertainty in the form of the von Bertalanffy growth function at young ages. The combination of growth and natural mortality uncertainty leads to significant uncertainty about population scale. The range of natural mortality values examined as a decision table major axis of uncertainty resulted in population scales that approached extrapolated density estimates from reef-level research survey transects in the territorial sea (see Appendix H for further details, pp. 206).

The catch history for estuary-boat and shore recreational fishing modes in recent years (2006-2014) is unknown. The main catch, effort, and biological sampling that were in place for these modes ceased in 2005. In this assessment, these catches were extrapolated from information available in the time series, and do not capture the range of variability that is often seen with recreational fisheries from one year to the next.

During the course of the STAR panel, it was determined that there were unresolved problems associated with the MRFSS (Marine Recreational Fisheries Statistics Survey) database, and these data are important because they cover the longest time period (1980 – 2005). In particular, the MRFSS database includes multiple columns for length information, some values entered as integers and some entered with many decimal places; the assumption being that integers are real measurements and values with decimals (>> hundredths place) were estimated from weights. However, different length columns contain integers for different years, making it challenging to infer real length measurements, and column labels have changed over time. The MRFSS database needs to have clearly documented metadata associated with it.

Other unresolved problems identified at the STAR panel include a) lack of ageing error for Kelp Greenling and b) lack of clarity on a best method for weighting (tuning) compositional data. The best way to approach this weighting remains unresolved for all stocks. This assessment used the harmonic mean approach of McAllister and Ianelli (1997), applied only to length composition data.

Forecast

A projection of the Kelp Greenling population up to year 2026 was examined that would result in reaching the biomass target (SB ratio = 0.40) by the final year (2026; Table E7). Fleet specific catches during the first two years (2015 – 2016) were set to their average over the most recent three years (2012 – 2014; i.e., status quo levels). In order to reach the biomass target, total catch would need to more than triple that of current status quo levels. Several other forecasts were conducted to populate the decision table as described in the next section.

Table E7. Projection of Kelp Greenling spawning biomass and depletion using the base case model for the scenario of achieving the biomass target (*SB*40%) in 10 years. Total catch in 2015 and 2016 were set to the average over the most recent three years (2012 – 2014).

Year	Total Catch (mt)	Age 1+ Biomass (mt)	Spawning Biomass (mt)	Depletion
2015	38.7	1,131	316	0.80
2016	38.7	1,141	300	0.76
2017	239.1	1,156	299	0.75
2018	201.0	1,007	246	0.62
2019	177.5	912	214	0.54
2020	162.5	851	194	0.49
2021	152.7	810	181	0.46
2022	146.1	782	173	0.44
2023	141.7	763	167	0.42
2024	138.5	749	163	0.41
2025	136.3	739	160	0.40
2026	134.5	732	158	0.40

Decision table

The main axis of uncertainty that was identified for this assessment was alternative states of nature for male and female natural mortality (Table E8). The specification of natural mortality for the base model was done by fixing the parameter at the median of a prior distribution, which was proportional to maximum age (observed female maximum age = 15; male = 17). Alternative states were developed by using the same maximum age formulation as in the base model, but applying maximum age values of ±2 years from that observed for females and males. These high and low levels of natural mortality resulted in bounds on estimated spawning stock biomass that were similar to bounds when extrapolating density estimates from research survey transects (see Appendix H for further details, pp. 206).

Four alternative forecast catch scenarios were examined: high, low, and following the ABC/ACL according to the 40:10 harvest control rules when a buffer of 4.4% or 5.4% was applied (Table E8). For all scenarios, catch by fleet during 2015 and 2016 was set to the fleet-specific average over the most recent three years (2012-2014). The low catch scenario applied 2014 levels of catch to each fleet from 2017 – 2026 (total catch = 33.5 mt). The high catch scenario applied 2002 levels of catch to each fleet from 2017 – 2026 (total catch = 100.2 mt). Catch in 2002 was significantly higher than any other year during the time series, and this level of catch occurred prior to the 2004 implementation of state imposed commercial and recreational harvest limits. The first ABC/ACL scenario applied a level of catch consistent with the 40:10 harvest control rules, where a buffer of 4.4% was used to calculate ABC from the OFL based on $SPR_{45\%}$. This buffer was calculated using the minimum sigma of 0.36 for a category 1 stock and a P* of 0.45 (the sigma for the estimated spawning biomass in 2015 was 0.322). The second ABC/ACL scenario applied a level of catch consistent with the 40:10 harvest control rules, where a buffer of 5.4% was used to calculate ABC from the OFL based on $SPR_{45\%}$. This buffer was calculated following an alternative approach for setting the sigma value that was discussed at the SSC meeting in Sacramento, CA (September 11, 2015). This approach was meant to directly take into account the uncertainty associated with Kelp Greenling (male and female) natural mortality and the resulting influence these parameters had on overall population scale. Sigma was calculated by taking the log of the ratio of the base model spawning biomass in 2015 to the assumed low values for natural mortality model spawning biomass in 2015 and dividing by 1.15 (the z-score equivalent to a probability of 0.125; see equation E1). This calculation resulted in a sigma of 0.441 using a P* of 0.45, and thus a buffer of 5.4%. The base case level of natural mortality was the only state of nature used to forecast the second ABC/ACL scenario (Table E8), because the calculation of the buffer in this case was itself dependent on an alternative state of nature (low assumed levels of natural mortality).

$$sigma = \frac{ln\left[\frac{base\ model_{SB2015}}{low\ M\ model_{SB2015}}\right]}{1.15} \qquad \text{Eq. E1}$$

Table E8. Decision table summarizing 12-year projections (2015 – 2026) under three different scenarios for male and female natural mortality and four alternative catch scenarios. The state of nature for natural mortality was based on maximum age calculations using ± 2 years from the base case for males and females.

		State of nature								
		Low			Base case			High		
		$M_f = 0.318$			$M_f = 0.360$			$M_f = 0.415$		
		$M_m = 0.285$			$M_m = 0.318$			$M_m = 0.360$		
Relative prob. of ln(SB_2015):		0.25			0.5			0.25		
Management decision	Year	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion
High Observed Catch (Based on 2002 Landings)	2017	100.2	177	0.67	100.2	299	0.75	100.2	1,127	0.82
	2018	100.2	160	0.61	100.2	286	0.72	100.2	1,145	0.83
	2019	100.2	147	0.56	100.2	277	0.70	100.2	1,167	0.85
	2020	100.2	136	0.52	100.2	270	0.68	100.2	1,186	0.86
	2021	100.2	126	0.48	100.2	265	0.67	100.2	1,202	0.87
	2022	100.2	118	0.45	100.2	260	0.66	100.2	1,214	0.88
	2023	100.2	111	0.42	100.2	257	0.65	100.2	1,223	0.89
	2024	100.2	105	0.40	100.2	254	0.64	100.2	1,231	0.89
	2025	100.2	99	0.38	100.2	251	0.63	100.2	1,236	0.90
	2026	100.2	94	0.36	100.2	249	0.63	100.2	1,240	0.90
Low Observed Catch (Based on 2014 Landings)	2017	33.5	177	0.67	33.5	299	0.75	33.5	1,127	0.82
	2018	33.5	179	0.68	33.5	305	0.77	33.5	1,163	0.84
	2019	33.5	183	0.70	33.5	312	0.79	33.5	1,200	0.87
	2020	33.5	187	0.71	33.5	319	0.80	33.5	1,232	0.89
	2021	33.5	190	0.72	33.5	325	0.82	33.5	1,257	0.91
	2022	33.5	193	0.73	33.5	330	0.83	33.5	1,276	0.93
	2023	33.5	195	0.74	33.5	333	0.84	33.5	1,291	0.94
	2024	33.5	197	0.75	33.5	336	0.85	33.5	1,303	0.95
	2025	33.5	199	0.76	33.5	339	0.85	33.5	1,311	0.95
	2026	33.5	200	0.76	33.5	341	0.86	33.5	1,318	0.96
ABC/ACL (sigma: 0.360, P*: 0.45, buffer: 4.4%)	2017	121.8	177	0.67	229.8	299	0.75	996.9	1,127	0.82
	2018	107.0	154	0.58	194.9	249	0.63	817.5	901	0.65
	2019	97.4	139	0.53	173.2	218	0.55	712.2	770	0.56
	2020	91.0	129	0.49	159.2	199	0.50	647.9	692	0.50
	2021	86.5	122	0.46	150.0	186	0.47	607.5	645	0.47
	2022	83.5	117	0.45	143.8	178	0.45	581.6	614	0.45
	2023	81.3	114	0.43	139.6	172	0.43	564.5	594	0.43
	2024	79.7	112	0.42	136.6	168	0.42	552.8	581	0.42
	2025	78.5	110	0.42	134.5	165	0.42	544.8	571	0.41
	2026	77.7	108	0.41	133.0	163	0.41	539.2	565	0.41
ABC/ACL (sigma: 0.441, P*: 0.45, buffer: 5.4%)	2017	-	-	-	227.6	299	0.75	-	-	-
	2018	-	-	-	193.4	250	0.63	-	-	-
	2019	-	-	-	172.1	219	0.55	-	-	-
	2020	-	-	-	158.4	200	0.50	-	-	-
	2021	-	-	-	149.4	188	0.47	-	-	-
	2022	-	-	-	143.3	179	0.45	-	-	-
	2023	-	-	-	139.1	174	0.44	-	-	-
	2024	-	-	-	136.2	170	0.43	-	-	-
	2025	-	-	-	134.1	167	0.42	-	-	-
	2026	-	-	-	132.6	165	0.42	-	-	-

Research and data needs

There are several areas of further research or data acquisition that would have a high probability of improving the estimation of population parameters for Kelp Greenling in Oregon waters. These include, but are not limited to, the following:

1. Fishery-independent surveys of abundance for nearshore species, including Kelp Greenling, would provide information about population trends that don't rely on data collected directly from the fishery and the inherent complexities that those data entail. Surveys that result in a time series of information covering a representative spatial extent of the population would be most advantageous.

2. Improved data collection relevant to basic fishery statistics (catch/effort) for recreational shore and estuary-boat fleets, including biological sampling where possible, to monitor changes in these highly dynamic fishing modes.

3. The collection of gender-specific information is generally straightforward given the visual ease (color and markings) of identifying adult Kelp Greenling by gender and the collection of this information should be implemented for Ocean Recreational Boat Samplers (ORBS).

4. The double reading of Kelp Greenling otoliths would provide some indication into error and bias for this influential source of information.

5. Kelp Greenling stock structure needs to be studied and the results accounted for in future assessments. In particular, ontogenetic and gender-related movement according to offshore depth and spawning seems plausible for Kelp Greenling, and data to support that hypothesis would be beneficial for future assessments.

6. Research into the implications and complexities of managing a stock where both genders contribute to spawning potential (e.g., through a Management Strategy Evaluation) would help guide future assessments and management for species such as Kelp Greenling (males exhibit nest-guarding behavior).

Table E9. Summary of base case model results for Kelp Greenling in Oregon waters.

Quantity	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total landings (mt)	30.98	30.60	34.63	38.91	38.52	38.80	39.86	38.27	43.02	32.87	
Total removals (mt)	31.59	31.17	35.28	39.65	39.26	39.52	40.61	38.98	43.83	33.49	
1-SPR	0.10	0.11	0.14	0.15	0.14	0.13	0.12	0.12	0.13	0.12	
Exploitation rate	0.14	0.15	0.19	0.21	0.19	0.14	0.14	0.15	0.19	0.16	
Age 1+ biomass (mt)	1,327	1,308	1,283	1,274	1,279	1,297	1,302	1,305	1,288	1,305	
Spawning Output	370	346	319	278	266	282	362	415	403	355	316
~95% CI	(175-566)	(162-531)	(146-492)	(123-432)	(113-419)	(115-450)	(144-581)	(163-667)	(157-650)	(134-575)	(116-516)
Recruitment (1,000s)	945	432	1,495	1,827	3,524	1,855	487	447	996	1,433	1,413
~95% CI	(422-1,468)	(148-715)	(674-2,315)	(799-2,856)	(1,559-5,489)	(736-2,973)	(86-889)	(0-916)	(0-2,141)	(0-3,365)	(0-3,318)
Depletion (%)	0.93	0.87	0.80	0.70	0.67	0.71	0.91	1.05	1.02	0.89	0.80
~95% CI	(0.80-1.07)	(0.74-1.00)	(0.68-0.93)	(0.59-0.81)	(0.55-0.79)	(0.57-0.85)	(0.72-1.10)	(0.82-1.27)	(0.79-1.25)	(0.68-1.10)	(0.59-1.00)

1 Introduction

1.1 Basic Information

Kelp Greenling (*Hexagrammos decagrammus* [Pallas 1810]) is demersal, solitary finfish in the family Hexagrammidae, which also includes lingcod. Kelp Greenling is endemic to nearshore rocky reef, kelp forest, and eelgrass habitats of the Northeast Pacific Ocean (Bodkin 1986, Pacunski and Palsson 2001). This species ranges from southern California, north to the Aleutian Islands, Alaska (Miller and Lea 1972; Eschmeyer et al. 1983), but are rarely found south of Point Conception, California (Feder *et al.* 1974, Fitch 1953). The main population range and fisheries activities are from central California (including the Channel Islands) north through Oregon. Kelp Greenling is primarily a nearshore species found intertidally and among rocks and kelp, usually down to depths of <50m, though they can be found out to depths >150m (Miller and Lea 1972; Love et al. 1996). Kelp Greenling tend to remain within three meters of benthic substrates and are often observed resting on the bottom (Rosenthal 1980). These fish tolerate salinities ranging from 5 ppt to 45 ppt (Zahr 1984), an adaptation allowing this species to occupy estuarine habitats. Evidence suggests Kelp Greenling may display ontogenetic movement, with smaller fish in shallower waters (DeMartini 1986, ODFW 2002).

In Oregon's nearshore, Kelp Greenling is found in association with finfish species including Hexagrammids, Scorpaenids, and Cottids among others (Easton et al. 2015). Black Rockfish (*Sebastes melanops*), Lingcod (*Ophiodon elongatus*), China rockfish (*S. nebulosus*), Canary Rockfish (*S. pinniger*), Quillback Rockfish (*S. maliger*), Copper Rockfish (*S. caurinus*), Yellowtail Rockfish (*S. flavidus),* Yelloweye Rockfish (*S. ruberrimus*), Rock Greenling (*Hexagrammos lagocephalus*), Irish Lords (*Hemilepidotus* spp.), and surfperches are species commonly co-occurring with Kelp Greenling. Many of these species are also exploited in Oregon's nearshore fishery.

There is little direct information on the stock structure of Kelp Greenling off the U.S. west coast. Little is also known of Kelp Greenling movement patterns, but given their nearshore distribution and the territorial behavior of adults (Barker 1979; Bryant 1978; DeMartini 1986), they are not believed to migrate great distances. Once settled, Kelp Greenling in California waters are thought to establish home ranges at least 500 – 3,000 m^2 (Love 2011). Typical of nearshore reef fishes, Kelp Greenling subpopulations are often spatially discrete, suggesting the possibility of increasing genetic differentiation as distance along the coast increases (Palumbi 2003). Spatially discrete population distributions, regardless of the extent of genetic differentiation, can be susceptible to serial depletion. The spatial extent of this assessment is limited by the available data.

The population status of Kelp Greenling was assessed in 2005, and at that time was determined to have a spawning biomass depletion of 49%. The 2005 assessment delineated two sub-stocks at the Oregon-California border. This substock distinction was made because of available data, fisheries history, fishing behavior, and management vary between these states. However, there was insufficient population information (e.g., age, growth, natural mortality, abundance index) at the time for the California assessment results to be used for management advice. This assessment characterizes Kelp Greenling population dynamics in Oregon waters.

1.2 Map

A map showing the scope of the assessment and depicting boundaries for fisheries or data collection strata is provided in Figure 1.

1.3 Life History

Kelp Greenling is sexually dimorphic at maturity with notable chromatic differences between the sexes. Adult females are generally light gray with yellow fins and speckled orange-brown spots across the entire body. Adult males are commonly olive-brown with blue tinged fins. Males have blue spots surrounded by rings of reddish-brown spots on the anterior portion of the body. Considerable variation in coloration exists by season, geographic location and among individuals of the same sex.

Kelp Greenling spawns sub-tidally in shallow rocky areas. Female Kelp Greenling batch spawn (Kurita et al. 1995) producing at least three clutches of eggs (Crow et al. 1997) during the primary reproductive season of September through December (Rodomsky et al. 2015). Golf ball to tennis ball sized egg clutches are deposited sub-tidally, adhering to shallow benthic substrates of rock, kelp or biological composition in nests established by males (DeMartini 1986). It is apparent that females lay multiple batches in different nests, but whether these eggs are temporally distinct enough to qualify for separate spawning events has not been determined (Crow 1995; Crow et al. 1997; Rothrock 1983). Clutches collected from Washington waters averaged 4,340 eggs each (SE = 311) with egg diameters ranging from 2.2 to 2.5 mm (mean = 2.3 mm) and egg weights from 6.8 to 8.7 mg (mean = 7.6 mg, DeMartini 1986). The role of female Kelp Greenling in reproduction ends with egg deposition.

Male Kelp Greenling has a significant paternal role in reproduction. Territorial during the reproductive season, males establish nests, fertilize eggs, fan eggs to increase oxygenation, and guard nests from predation. Sneak spawning by non-territorial males has been observed (Crow et al. 1997). Nests are 0.001 m^2 to 7 m^2 in size and may hold one to 11 clutches (Crow 1995; Crow et al. 1997; DeMartini 1986; Howard and Silberberg 2001). Clutches in a single nest are often in various stages of development and are contributed to by multiple females, indicating a polygamous mating system (Crow et al. 1997). Embryos require 30 days to develop when held in 10°C water in a laboratory (DeMartini 1986). Laid eggs are sticky and adhere to the surface where deposited. After hatching, the young of the year spend several months as epipelagic larvae and juveniles (Gorbunova 1970). Settlement takes place in the nearshore after a planktonic phase when the young fish have attained 5-7 cm in length (Burge and Schultz 1973; ODFW 2002, Matarese et al 1989; Robinson et al. 1968a, b). Growth is rapid in the first three years for both sexes, thereafter slowing dramatically (ODFW 2002, Rodomsky et al. 2015). Adult Kelp Greenling reaches a maximum size of 63 cm (total length) and 2.1 kg (Love 2011). In Oregon marine waters, Kelp Greenling rarely grow over 50 cm and live at least 17 years (Rodomsky et al. 2015).

1.4 Ecosystem Considerations

Kelp Greenling is a diurnal generalist mesopredator of Northeast Pacific nearshore ecosystems (Frid et al. 2012). This species uses both ram and suction feeding (Nemeth 1997) to prey on crustaceans, polychaete worms, echinoderms, mollusks, fish eggs (including Kelp Greenling), small fishes and algae (Bryant 1978). In turn, Kelp Greenling is preyed upon by a wide variety of organisms including Black Rockfish, Pacific Halibut (*Hippoglossus stenolepis*), Lingcod, Cabezon (*Scorpaenichthys marmoratus*), salmonids, seabirds, pinnipeds, and mink (*Mustela vison*) among others.

Kelp Greenling is ubiquitous in suitable nearshore habitat stretching from the northern California Current north and west through the Eastern Bering Sea Large Marine Ecosystem. In Oregon, Kelp Greenling occupy subtidal and intertidal nearshore and estuarine rocky habitats, both natural and man-made (Matthews 1985), and biogenic substrates. Significant Kelp Greenling habitat associations include bedrock, large boulder, and small boulder habitats (Easton et al. 2015). Environmental factors threatening these habitats in Oregon potentially impact the Kelp Greenling stock negatively. No studies were located that quantified ecosystem level effects on Kelp Greenling; therefore, considerations such as environmental correlations and food web interactions were not explicitly included in the assessment.

1.5 Fishery Information

Oregon's Kelp Greenling fishery is centuries old. Exploitation of Kelp Greenling on the Oregon coast dates back to prehistoric subsistence harvest by Native American tribes. Excavation of shell middens at both Seal Rock and Neptune, OR, confirm Kelp Greenling were a dietary component of the Alsea and Siuslaw tribes of the Oregon coast during late spring and early summer months (Zontek 1982).

In the twentieth century, a significant portion of Oregon's Kelp Greenling removals came from the recreational fishery, particularly through shore and estuary modes. This species is caught by fishermen fishing natural and man-made rocky habitats such as reefs and jetties. The ocean-boat recreational fleet rarely targets Kelp Greenling. Rather, take is often incidental when targeting other species such as Lingcod and Black Rockfish. Prior to the early 1970s, the magnitude of Oregon's recreational Kelp Greenling harvest is not well documented. Ocean-boat estimates of Kelp Greenling catch began in 1973, and shore and estuary catch estimates began in 1981. Before these surveys, annual harvest was thought minimal due to the small size of and technology available to the ocean-boat recreational fleet. Kelp Greenling was managed as part of the "Other Fish" category that included other greenlings, Cabezon, Lingcod, rockfishes, and Pacific Halibut. Kelp Greenling is also known bait for targeting Lingcod. The amount of mortality attributed to bait usage is difficult to quantify but thought minimal. Because of the numerous charter fishing businesses and the proximity to population centers such as Portland, northern Oregon coast ports from Newport north are where most recreationally-caught Kelp Greenling is landed.

The most significant change in the fishery for Kelp Greenling has been the development of the live-fish commercial fishery that, in addition to Kelp Greenling, targets several other nearshore fishes (CDFG 2002). This fishery started in northern California in the late 1980s and spread northward during the late 1990s to Oregon in order to supply the live-fish market in San Francisco, CA (Starr *et al.* 2002). Kelp Greenlings are not subject to barotrauma because they lack a swim bladder and are usually found in shallow nearshore waters accessible to many fishermen. These traits make Kelp Greenling an ideal target for both the live-fish and recreational fisheries.

Oregon's southern ports from Brookings to Port Orford, have been the epicenter of the live-fish commercial fishery. Vessels targeting this species are small, averaging 25 ft., and make day trips to fishing grounds. Prior to the live-fish fishery, Kelp Greenling were not targeted commercially because fillets produce an inferior fresh product with short shelf life. By 1997, the live-fish fishery began expanding rapidly because fishermen found delivering live, healthy Kelp Greenling, able to survive days at California markets, brought premium ex-vessel prices upwards of $5.00/lb or more. Relative to state-managed species in Oregon's commercial nearshore fishery, Kelp Greenling is second in total ex-vessel value to only Black Rockfish. Greater than 95% of commercially landed Kelp Greenling comes from the ports of Port Orford and Gold Beach and greater than 99.5% of those landings go to supply the live-fish market.

1.6 Summary of Management History

State of Oregon management of the recreational Kelp Greenling fishery began in 1976. That year a daily limit for Kelp Greenling harvest was implemented under Oregon's 'Other Fish' complex aggregate daily bag limit of 25 fish per day. In 1978, that bag limit was changed to 15 fish per day, and in 1994 the Kelp Greenling bag limit was again raised to 25 fish per day. In 2003, the first state recreational fishery landing cap of 5.2 mt for the Greenling complex was implemented, and the Kelp Greenling bag limit was lowered to 10 fish per day. The recreational landing cap has since varied (Table 1). In 2004, Oregon implemented a minimum size limit of 10 inches for retaining recreationally caught Kelp Greenling, which is still in effect. In 2005, the bag limit was lowered to 8 per day, and again lowered to 6 fish per day in 2006 before being raised to the current limit of 7 per day in 2010.

The push for formal state management of Oregon's commercial Kelp Greenling fishery arose in the late 1990s. At that time, fishery participants became concerned about the resource because of the rapid expansion of the commercial live-fish fishery. Initial efforts to cap fishery participation failed in 1997 due to a lack of industry support. However, that year the Oregon Department of Fish and Wildlife (ODFW) began sampling the species composition of commercial Greenling complex landings. A minimum length limit of 12 inches was implemented in 2000 for the commercial fishery. Landings from open-access participation continued to rise, peaking in 2002. That year, due to industry pressure to limit fishery participation, the Oregon Fish and Wildlife Commission adopted a "Nearshore Permit" and placed the commercial nearshore fishery into the state developmental fisheries program. Consequently, ODFW implemented Oregon's Interim commercial harvest management plan for Nearshore Permit holders (ODFW 2002) designed to reduce effort in the fishery by at least 50%. Under the Nearshore Permit, 73 vessels with commercial nearshore landings history were permitted access to harvest 21 nearshore species including Kelp Greenling

Oregon's limited entry commercial nearshore fishery program became law in 2003 when the State legislature approved House Bill 3108. This bill established two types of nearshore permits, Black and Blue Rockfish Permits with or without Nearshore Endorsements. One of these two permits is required to land more than incidental amounts of nearshore species. Under HB 3108, the original 73 "Nearshore Permits" were converted to Oregon Black and Blue Rockfish Permits with a Nearshore Endorsement. A nearshore-endorsed permit is required to land maximum state bimonthly period limits of Kelp Greenling while permits without an endorsement are only permitted incidental daily landings of 15 lbs. of Kelp Greenling per day. Bimonthly period limits have varied over time from 2003 – 2015 (Table 2). Currently, there are 71 nearshore-endorsed permits. A conservative State landing cap for Kelp Greenling of 19.5 mt was also first implemented in 2003 (Table 1). This landing cap was raised to 23.4 mt in 2004 where it has since remained because of uncertainty about population size.

Current management of Kelp Greenling falls under both federal and state authority. The Pacific Fishery Management Council and NOAA Fisheries manage Kelp Greenling under the federal Groundfish Fishery Management Plan (FMP). This FMP guides federal jurisdiction over all groundfish, including Kelp Greenling, throughout the 200 mile Exclusive Economic Zone. Kelp Greenling is currently managed within the federal "Other Fish" complex which includes Cabezon off Washington and Leopard Sharks (*Triakis semifasciata).* Federal harvest limits for Kelp

Greenling were not based from the first and only full stock assessment (Cope and MacCall 2005) given the Council's Scientific and Statistical Committee's (SSC's) caution that "yield estimates from the model are very uncertain" (see Agenda Item F.8.b, Supplemental SSC Report, September 2005). Ultimately, the assessment was used to determine a healthy status for the stock but was not used for determining harvest specifications. Kelp Greenling occupies depths within Oregon's three mile territorial sea so management of this species is under the jurisdiction of the Oregon Fish and Wildlife Commission. State management is guided by both Oregon's Marine Fisheries Management Plan Framework (2015) and Interim Management Plan for Oregon's Nearshore Commercial Fisheries (2002). At the State level, Kelp Greenling is currently managed as part of a "Greenling complex". Species composition sampling of the Greenling complex by ODFW biologists indicates Kelp Greenling compose greater than 99% of landings from the "Greenling" complex (ODFW unpublished data). Other species within this state management complex include Rock Greenling (*Hexagrammos lagocephalus*), White-spotted Greenling (*H. steleri*), and Painted Greenling (*Oxyledius pictus*).

1.7 Management Performance

The status of Kelp Greenling was last determined in 2005 (Cope and MacCall 2005) to be above the default target management level (40% spawning biomass depletion) at 49%. An OFL or ACL was not determined from the results of that assessment, leaving little formal guidance for setting annual fishing limits and harvest guidelines until 2015 when a depletion-based stock reduction analysis (DB-SRA) estimate of OFL was specified to inform the contribution of Oregon Kelp Greenling to the 'Other Fish' complex OFL.

Without a stock-specific federal OFL (only OFLs at the complex level are specified in regulations), Oregon has regulated Kelp Greenling harvest through the implementation of annual state-specified harvest limits for the greenling complex (Table 2). In 2003, these harvest levels were set at 2000 landings level for both recreational (5.2 mt) and commercial (19.5 mt) fisheries through the state public process. In 2004, the commercial fishery state-specified harvest limit for the commercial fishery was increased 20% to 23.4 mt to allow for higher harvest levels of a perceived healthy stock (Table 1). Commercial landings from the greenling complex are monitored and regulated by state-specified two-month cumulative period limits (Table 2). In the commercial fishery, harvest limits have never been breached. A summary of recent (2011-2014) public input relevant to Kelp Greenling that was presented at annual (Oregon Department of Fish and Wildlife Marine Resources Program sponsored) stakeholder meetings for the commercial nearshore fishery can be found in Appendix G (pp.205). Recent public meetings for recreational fisheries have not mentioned Kelp Greenling specifically.

2 Assessment

2.1 Data

Data used in the Kelp Greenling assessment are summarized in Figure 2. A description of each data source is below. All catch was assumed to be taken in the middle of the year and converted from pounds to mt for the purposes of the stock assessment. All data extractions were deemed final on 30 March, 2015 or as near to that date as was feasible.

2.1.1 Fishery-Dependent Data: Commercial Landings and Discards

Commercial landings of Kelp Greenling were obtained from PacFIN (Table 3, Figure 3, and Figure 4). Since 1988, commercial landings of Kelp Greenling have been tracked by the Oregon Department of Fish and Wildlife (ODFW) under the "Greenling complex" fish ticket code. Prior to 1988, no commercial landing records existed for Kelp Greenling in Oregon. Landings prior to 1988 from the commercial sector are believed to be negligible because only minor landings were recorded on fish tickets from 1988 – 1995 (0.3% on average compared to later years), prior to the advent of the live-fish market in the late 1990s. The onset of a readily available market for live fish, along with attractive ex-vessel prices, has been the main driving force for the Kelp Greenling commercial fishery. More than 99% of commercial landings occur along the southern Oregon coastline (95% of that are associated with the ports of Gold Beach and Port Orford; Figure 5), with only minor contributions from eight other ports. Total landings rapidly increased from approximately 1 mt in 1996 to 53 mt in 2002. From 2003 to 2014, total landings have remained fairly stable at around 20 mt. This stability is mostly a result of State regulations (e.g., fleet size limit, trip and period landing limits, and minimum fish size limit) implemented by ODFW in 2004 to limit overall commercial harvest (Rodomsky et. al. 2014; Appendix F, pp. 199).

There is relatively high confidence in the total landing estimates from the commercial fishery since the initiation of the greenling complex fish ticket code in 1988. Although Kelp Greenling landings come from fish tickets that aggregate all greenling species under one fish ticket code, Kelp Greenling consistently make up more than 99% of the greenling complex as reported from landing species composition data. Therefore, typical uncertainties associated with spatial and temporal variation in species compositions from aggregated fish ticket codes are not an issue. Other greenling species reported in the species composition data include Whitespotted Greenling (*Hexagrammos stelleri*) and Rock Greenling (*Hexagrammos lagocephalus*).

Commercial fishermen use two main gear types to target Kelp Greenling in Oregon waters: hook-and-line gear and longline gear. Since 1997, hook-and-line gear (jig, dingle bar, cable) has been used to take 93% (on average) of the overall Kelp Greenling harvest by weight. Bottom longline gear was used to take nearly all of the remaining (7%) total harvest by weight. Several other gear types harvest incidental amounts of Kelp Greenling (including fish pots, crab pots, troll gear, and trawl gear). Landings from these gear types were negligible and were not included in this assessment.

The previous assessment for Kelp Greenling (Cope and MacCall 2005) reconstructed commercial landings for the period 1981 – 1987 to match the available recreational catch time period. For this assessment, recreational landings (estuary and shore modes) were reconstructed back to 1915 (refer to Section 2.1.2 for details), a time period well before the start of a Kelp Greenling commercial fishery. In addition, the low total commercial landings from 1988 to 1995 indicated a basis for assuming in this assessment that the commercial fishery began in 1988.

The amount of discarded Kelp Greenling relative to retained Kelp Greenling was estimated by the West Coast Groundfish Observer Program (WCGOP). Discard ratios were available from 2003 to 2013 for the nearshore fixed-gear fishery (in waters < 50 fathoms). Mortality associated with discarded Kelp Greenling is assumed to be low (7% as provided by the Groundfish Management Team; Somers et al. 2014), because these fish do not have swim bladders (and thus do not experience barotrauma) and tend to recover quickly post-release from fixed gears. The average dead discard rate for Kelp Greenling was 2.2%. This value was used to calculate total catch as 1.022 times total landings for all years (1988 – 2014).

2.1.2 Fishery-Dependent Data: Recreational Landings and Discards

Three recreational fishing modes are recognized for Oregon: 1) ocean-boats (Private Boat and Rental (PBR) and Commercial Passenger Fishing Vessel (CPFV) boat types), 2) estuary-boats (PBR boat types), and 3) fishing from shore (beach/bank and man-made structure types). These modes were distinguished for this assessment because of differences in length composition of the sampled catch and potential differences in selectivity. For example, estuary-boat and shore fishing modes generally catch smaller individuals than ocean-boats, and there is differential access to Kelp Greenling habitat that naturally occurs for each mode.

Total Kelp Greenling landings for Oregon recreational fishing modes are provided in Table 4, Table 5, Table 6, and Figure 3. For the ocean-boat fishing mode, total landings were obtained from ODFW and informed by the Oregon Recreational Boat Survey (ORBS). For estuary and shore fishing modes, total landings were obtained from ODFW and informed by the Marine Recreational Fisheries Statistics Survey (MRFSS). To address survey biases, spatial and temporal under-coverage, and other known errors, ODFW reconstructed both the ORBS and MRFSS historic landings for Kelp Greenling (methods described below). Ocean-boat landings peaked in 1978 at over 10 mt before declining back down to levels early in the time series (1 to 2 mt) by 1985. Since that time, landings have been steadily increasing to around 7 mt in recent years. Estuary-boat and shore landings have been episodic, with catches from those modes nearly doubling or halving from one span of years to the next. There has been a downward overall trend in total landings for these fishing modes since the beginning of the time series in the early 1980s (three-year average = 23.5 mt combined) to the mid-2000s (three-year average = 16.1 mt combined).

Discard mortality for Kelp Greenling was estimated for each of the three recreational fishing modes. Dead discard rates were estimated for ocean and estuary-boat modes using information collected from ORBS dockside interviews. Retained Kelp Greenling was examined by dockside samplers while discarded fish were angler reported. The dead discard rate was calculated as the proportion of discarded to retained fish multiplied by the assumed discard mortality rate (7%). The estimated dead discard rate for ocean and estuary-boats was 1.6% and 1.7%, respectively. As with the commercial fishery, total catch was calculated by summing total dead discards and total retained landings for each fishing mode. For the ocean-boat mode, dead discard rates were also available from onboard (charter vessel) observers, and these were similar to those from dockside interviews. For the shore mode, dead discards were assumed to be negligible prior to the initiation of a 10-inch minimum size limit in 2004 and 1.5% thereafter. This value was calculated as the average proportion of catch in weight from fish less than 10-inches pre-2004 multiplied by the assumed 7% discard mortality rate.

The Oregon sport fishery for Kelp Greenling is unusual in that the majority of landings have come from the estuary-boat and shore fishing modes. In contrast, landings of most other Pacific groundfish species have been dominated by the ocean-boat fishing mode. Further, for much of the time series, landings of Kelp Greenling from estuary-boat and shore fishing modes comprised a larger portion of overall landings than both the commercial sector and the recreational ocean-boat mode combined. This atypical prevalence of estuary and shore fishing mode landings is attributed to targeting. These fishing modes are used to target Kelp Greenling by fishing small hooks directly above rocks. In contrast, ocean-boat fishermen mostly target suspended schools of semi-pelagic rockfish species by fishing above the rocks with larger hooks where Kelp Greenling is caught less frequently and often times incidentally.

Ocean-boat Landings Reconstruction (1973 – 2014)

Total landings of Kelp Greenling from ocean-boats were obtained from estimates produced by ORBS. ORBS applies catch rates from a subsample of vessels (from dockside interviews) to total effort counts at fine levels of stratification (i.e., by week, port, fishery, and type of boat) to estimate total landed catch. Effort is computed by using visual counts to estimate private boat trips (i.e., number of vessels crossing the ocean bar or trailer counts) and through a census of charter boat logbooks. Since 2001, ORBS has produced comprehensive year-round estimates of catch and effort for all developed Oregon ports (and these estimates are available in RecFIN). However, prior to 2001, ORBS sampling was typically conducted at only major ports during peak months of sport fishing activity, and no estimates of catch were made for unsampled ports and during certain times of day. Therefore, ODFW reconstructed historic ORBS estimates for Kelp Greenling to account for these known biases and errors (not yet available on RecFIN).

The ocean-boat reconstruction addressed four spatial and temporal coverage biases identified during an external review of ORBS by the RecFIN Statistical Subcommittee (Van Vorhees et al. 2000): (1) "major ports" that were sampled each year were not sampled during the winter months; (2) "minor ports" were not sampled at all during some years; (3) effort counts for private boats excluded afternoon and night trips; and (4) undeveloped launch sites (e.g., beaches) were never sampled. The ocean-boat reconstruction utilized ratio estimators, based on years with complete sampling, to expand catches from years with partial sampling. For instance, the contribution of winter catch to total catch during years with complete sampling was used to expand catches for years with missing winter catch. Similarly, the contribution of catch from a minor port to that of the major ports during years with complete sampling was used to expand catches to years for which the minor port was not sampled. Given these corrections and the relatively minor incidence of discard mortality for Kelp Greenling, total landings from ocean-boats are considered to be reasonably certain.

Estuary-boat and Shore Landings Reconstruction (1915 – 2014)

ODFW conducted a landed catch reconstruction for estuary-boat and shore fishing modes using two approaches. The first was to correct for known biases in the MRFSS dataset, and the second was to estimate landings for years not covered by MRFSS. Estimates of Kelp Greenling landings from estuary-boat and shore fishing modes were obtained from MRFSS (1980 – 1989; 1993 - 2005). Like ORBS, MRFSS also utilized a dockside angler intercept survey component to obtain catch rates; however, MRFSS used a random-digit phone survey of residents in coastal and adjacent counties to estimate total effort. Although MRFSS had comprehensive spatial and temporal coverage, MRFSS estimates were determined to contain bias (Van Vorhees et al. 2000). The first bias was the inclusion of freshwater fishing trips in effort counts for marine fisheries that caused boat (and presumably shore-based) estimates to be overestimated by 17%. Specifically, trips conducted in zip codes that were not adjacent to the ocean were being recorded as marine trips in the phone survey. Therefore, the reconstruction applied a scaling factor to both the shore and estuary-boat estimates to remove this freshwater bias.

The second identified bias in MRFSS was a result of sampling area. Ocean-boat landings were deemed to be overestimated by 23% at the expense (underestimation) of estuary-boats. Although MRFSS estimates boat catch (by boat type), they were not stratified by area. The total (coastwide) estimates were partitioned to inland (estuary) and ocean areas based on ratios observed in the dockside survey. In order for the area partitioned estimates to be correct, the MRFSS dockside samples would have to have been representative. However, it was determined that MRFSS had oversampled the central and southern parts of Oregon that tend to have a larger proportion of ocean trips than in the north, where there is a larger proportion of estuary trips.

Therefore, another scaling factor was applied to the estuary-boat estimates to account for this boat area bias. This scaling factor did not affect the shore fishing mode.

In addition to using scaling factors to account for MRFSS biases, this reconstruction also corrected for errors in weights of individual fish that were used to convert numbers of fish (measure produced by MRFSS) to metric tons. The magnitude of these errors was not inconsequential.

A reconstruction of landings outside the temporal scope of MRFSS (1915-1980; 2005-2014) was conducted through extrapolation (Figure 4). For years prior to 1980, no direct information was available to estimate catch from estuary-boat and shore fishing modes. Therefore, historic sales of fishing licenses were obtained from ODFW and used as an indirect measure of fishing pressure to scale landings from 1915 to 1980. Using Oregon license sales resulted in a similar catch history pattern to that observed for the California sport fishery reconstruction for the shore and skiff fisheries (Ralston et al. 2010). There is also missing catch information in recent years (2005-2014) for shore and estuary-boat fishing modes. Since the end of the MRFSS (and ODFW sponsored equivalent program; SEBS) programs in 2005, there has been no catch or effort information collected from these nearshore fishing modes. For these recent missing years, an extrapolation from a simple linear regression of the landings from 1980-2005 was used, which also followed the same general trajectory as seen with recent license sales. Although the regression captured the general trend well, this approach was unable to predict the high level of inter-annual variability often seen from these two fishing modes. Nonetheless, there remains significant uncertainty around total landings for estuary-boat and shore fishing modes, particularly from periods outside the temporal scope of MRFSS.

2.1.3 Fishery-Dependent Data: Oregon Commercial Logbook

The Oregon Department of Fish and Wildlife has required nearshore commercial fishermen (both permitted vessels and open access vessels) to submit fishing logbooks since 2004. Compliance is generally high, averaging around 80%, but has varied through time ranging from 65% in 2007 to 95% in recent years. Although required to provide all requested information in the logbook per fishing gear set, there has been substantial variation in the completeness and quality of information reported in logbooks. Responses from submitted logbooks were entered into a central database and span the years 2004 through 2013. At the time of this assessment, 2014 logbook submissions were not fully processed and thus were not available.

Logbook information went through several data quality filters to create the most consistent and representative set of catch and effort data with which to estimate a relative abundance trend over this period. Results from the filtration algorithm are summarized in Table 7. Of note, only logbook submissions from Black and Blue Rockfish permitted vessels with a nearshore endorsement (refer to section 1.6 for vessel permitting details) were included in the analysis, because these vessels consistently fish in areas where Kelp Greenling is encountered, target this species, and are permitted to land more than incidental amounts. Vessel operators may have changed through time. To balance consistency in reporting and the amount of logbook data available for analysis, the STAR panel recommended using vessels that submitted logbooks in at least 3 years (not necessarily contiguous from 2004 – 2013). Individual observations of catch (kg) and effort (hook hour) were at the trip level, where multi-set trips were aggregated to the trip level. The final subset of logbook data included 9,715 compliant trips (37% of the full set of submitted logbook data), which represented 80% of the total recorded landings for Kelp Greenling from 71 vessels (Figure 5).

Preliminary data analyses identified levels or limits of filtering variables in order to preserve adequate sample sizes and representative trips for Kelp Greenling. For example, gear type was restricted to hook-and-line (excluding longline gear) because this method accounted for 85% of all sets. The three main southernmost Oregon ports (Port Orford, Gold Beach, and Brookings) were the only locations that included a sufficient number of vessels and sets throughout the time series. Thus, this abundance index is most representative of the nearshore in southern Oregon waters (Figure 6). Fishing depth at the start of a set was restricted to within 30 fathoms (54.9 m), which included more than 99% of all sets by nearshore endorsed vessels, to ensure the evaluation of catch-per-unit-effort (CPUE) only in areas where Kelp Greenling is targeted was evaluated.

Covariates considered in the full model included *month*, *vessel*, *port*, *depth*, and *people* (Figure 7). All covariates were specified as categorical variables, except *depth* was a continuous variable. *Depth* was included to account for general differences in bathymetry and fishing depth restrictions associated primarily with limiting catch of Yelloweye Rockfish. *People* were included in an attempt to control for the potential oversaturation of hooks at a given fishing location and the interaction that multi-crew trips (# fishermen onboard) may have on fishing efficiency. The selection of covariates included in final models were evaluated using standard information criterion for relative goodness of fit (Akaike Information Criterion (AICc) and Bayesian Information Criterion (BIC)) in a backwards stepwise fashion, where a covariate remained in the model if model fit was improved relative to an otherwise identical model without the covariate.

CPUE was modeled using a delta-Generalized Linear Model (GLM) approach, where the catch-occurrence (binomial) component was modeled using a logit link function and the positive catch component was modeled according to a gamma distribution with a log link function. CPUE was calculated for each trip, where total catch was defined as the sum total of all reported retained catch (in weight) and released catch (numbers converted to weight by applying a median catch weight) and total effort was defined by hook-hours (number of hooks used multiplied by the number of hours fished). A lognormal distribution for the positive catch component was also evaluated, but graphical summary diagnostics of model adequacy favored the gamma distribution. A delta-GLMM (generalized linear mixed model) was also attempted to specify vessel-year interaction effects as stemming from a distribution (random effect) and to account for this added source of variation. However, the delta-GLM approach was preferred because runtime for the delta-GLMM jackknife procedure to estimate standard errors was restrictive; an alternative normal approximation to the delta-GLMM index standard error estimates resulted in overinflated coefficient of variations (CVs); and the resulting index time-series between the two approaches was very similar.

Model selection procedures identified the covariates *month*, *vessel*, *port*, and *people* as important, and along with the categorical *year* factor of interest for the index were the variables included in both the catch occurrence and positive catch component models. Extracted, back-transformed and bias-corrected estimates of the *year* effect were used for the abundance index (Table 8, Figure 8). A jackknife resampling routine was conducted to estimate the standard error (and CV) of the *year* effects. The relative effects of each covariate are shown in Figure 9 for the catch occurrence component and Figure 10 for the positive catch component. Standard model diagnostics show adequate fit and general consistency with GLM model assumptions for the positive-catch component (Figure 11).

2.1.4 Fishery-Dependent Data: Recreational Dockside Survey

Oregon Dockside Charter Boat Index (ORBS)

The Oregon Department of Fish and Wildlife provided recreational dockside fisheries data from the ORBS program from 2001 to 2014. Within this dataset, the charter boat trips are those likely to be consistent over the time-series, and provide a representative relative index of abundance when standardized. A Stephens-MacCall (2004) data filter was applied to the 37,749 ocean-boat trip records from this period. Species that occurred in at least 1% of the trips with Kelp Greenling were used as a filter in the Stephens-MacCall analysis to select trips representing effort in areas where Kelp Greenling would likely be encountered (Figure 12). This resulted in 9,599 trips available for the CPUE standardization.

Catch of Kelp Greenling per angler hour was the response variable for the delta-GLM, where the catch occurrence (binomial) component was modeled using a logit link function and the positive catch component was modeled using either lognormal or gamma distributions. Covariates chosen for the full model included *Year, Month, Port, and Boat Type*. Boat type distinguishes between charter and private boats.

Model selection based on AIC was used to choose the model with the most support for each model component. AIC was not used to choose between error distributions for the positive catch model component. Instead, this was done by evaluating model diagnostic plots (e.g., quantile-quantile plots; Figure 13). The full model with lognormal distribution was chosen for inference, and a bootstrap analysis (N=500) was used to estimate the standard errors and CVs for the year effects (Table 9; Figure 14).

Oregon Dockside Charter Boat Index (MRFSS)
Methods similar to that used for the ORBS index were applied to the MRFSS dataset. However, at the STAR panel it was determined that the catch and effort data available for this analysis were likely to be incorrectly aggregated at the trip level. As a result, this index was removed from the assessment.

2.1.5 Fishery-Dependent Data: Recreational Onboard Observer Surveys

The goal of the Oregon Observer Program is to collect data including charter boat fishing locations, catch and discard of observed fish by species, and lengths of discarded fish. The ODFW initiated an onboard observer program in 2001, which became a yearly sampling program in 2003 (Monk et al. 2013), and has continued through 2014. ODFW samples the commercial passenger fishing vessel (CPFV), i.e., charter boat or for-hire fleet. The onboard observer programs collect drift-specific information at each fishing stop on an observed trip. At each fishing stop recorded information includes start and end times, start and end location (latitude/longitude), start and end depth, number of observed anglers (a subset of the total anglers), and the catch (retained and discarded) by species of the observed anglers.

An index of abundance was generated using a subset of drifts that occurred on potential reef habitat for Kelp Greenling (details provided in Appendix E, pp.197). All indices were standardized using a delta-GLM modeling approach (Lo et al. 1992). Data were analyzed at the drift level and catch was taken to be the sum of observed retained and discarded fish, i.e., number of fish encountered per angler hour. Prior to the index standardization, preliminary data filters were applied. Trips or drifts meeting the following criteria were excluded from analyses:

1. Halibut-targeted trips
2. Trips encountering <50% groundfish species
3. Drifts deeper than 30 fathoms (due to depth regulations)

4. Drifts within the current Stonewall Bank Yelloweye Rockfish Conservation
5. Drifts missing a starting location (latitude/longitude)
6. Drifts identified as having possible erroneous location or time data
7. Drifts missing both starting and ending depths
8. Drifts occurring farther than 83m from a reef
9. Drifts occurring on a reef with <3 positive encounters of Kelp Greenling
10. Drifts occurring on a reef in which Kelp Greenling was observed in <25% of the years the reef was visited
11. Drifts where species encounters comprised of >95% Black, Blue and Yellowtail Rockfishes (see below)

At the March 2015 Nearshore Stock Assessments Workshop the issue of hook saturation by Black Rockfish in Oregon was raised (Agenda Item D.8 Attachment 10, June 2015). The recreational fishery in Oregon specifically targets Black Rockfish. While Black Rockfish associate with rocky habitat, they are a schooling, mid-water species. Fishermen specifically targeting Black Rockfish may not drop their lines to the seafloor, or may encounter Black Rockfish and other mid-water species before their lines can reach the seafloor. To address this issue in the onboard observer data, drifts for which the catch (retained plus discarded) consisted of at least 95% Black, Blue, and Yellowtail Rockfishes, the most commonly occurring mid-water rockfish species, were filtered out. This resulted in a decrease in the number of drifts by 4,092, only eleven of which observed Kelp Greenling.

The filtered dataset included 6,038 drifts, of which 259 (4%) drifts had positive encounters (Figure 15). The majority of drifts sampled (75%) were from north of Florence, although Kelp Greenling were present in 8% of drifts in southern Oregon and 10% of drifts in the north. Covariates considered in the full model included *year, depth, month or 2-month wave*, and *region* (Figure 16). Depths greater than 20 m were combined due to low samples sizes in the 40-59 m depth bin. The final selected data contained categorical variables for *year* (13 levels), *wave* (4 levels), and two *depth* bins (10-19m and 20-59m).

Model selection procedures initially suggested a model with a depth and a year/depth interaction for the binomial-model component. By removing 2003, AIC selected a model without the interaction. There were no apparent outliers or indicators in the raw data for the selection of the interaction in a model including 2003. The binary model used a logit transformation which performed equivalently to alternative transformations. For the positive-catch model component, a lognormal distribution was used because model diagnostics suggested it satisfied the underlying model assumptions more so than a gamma distribution (Figure 17). For both the binomial and positive-catch model components, stepwise BIC removed all interaction terms. The final positive model retained *year*, and the binomial portion retained *year* and *depth*. The year effects were used as the index of abundance (Table 10; Figure 18).

A comparison of the relative abundance trends from the three catch rate indices (commercial logbook, ORBS dockside, and onboard observer) is shown in Figure 19.

2.1.6 Fishery-Independent Data: sources considered, but not used in assessment

Northwest Fisheries Science Center (NWFSC) slope survey
This survey was conducted from 1999 through 2002 and samples water depths generally between 100 and 700 fm. This depth range is outside the normal habitat range for Kelp Greenling, and was thus not used in this assessment.

Northwest Fisheries Science Center (NWFSC) shelf-slope survey
This survey was conducted from 2003 through 2014 and samples water depths generally between 55 and 1280 fm. This depth range is outside the normal habitat range for Kelp Greenling, and was thus not used in this assessment.

Alaska Fisheries Science Center (AFSC) shelf survey
This survey has been conducted every third year since 1977 and samples water depths generally between 30 and 275 fm. This depth range is outside the normal habitat range for Kelp Greenling, and was thus not used in this assessment.

Oregon Department of Fish and Wildlife visual surveys
Since 1995, ODFW has conducted surveys used to enumerate fish densities at sampled reefs (or reef complexes). These surveys have limited spatial and temporal coverage, but do provide some information on Kelp Greenling density (Appendix H, pp.206).

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)
SCUBA transects and hook-and-line sampling (2010 – 2013) was conducted at reef sites in Oregon nearshore coastal waters. Hook-and-line sampling has resulted in the capture of 250 Kelp Greenling, most of which include sex, length and weight information from in or around marine reserves in California and southern Oregon.

2.1.7 Fishery-Dependent Data: sources considered, but not used in assessment

Pikitch study
The primary goal of the Pikitch study (Pikitch et al. 1988) was to collect retained and discarded catch information from trawl fleets (bottom, midwater, and shrimp trawl gears) operating near the Columbia INPFC area (1985 – 1987). Kelp Greenling is not targeted using trawl gear and have been rarely encountered by the trawl fleet historically, thus this data set was not used in this assessment.

Enhanced Data Collection Project (EDCP)
ODFW collected bycatch and discard information for groundfish species caught using trawl gear off the coast of Oregon (1995 – 1999). Kelp Greenling is not targeted using trawl gear and have been rarely encountered by the trawl fleet historically, thus this data set was not used in this assessment.

2.1.8 Biological Data: Length and age compositions

Biological data for Kelp Greenling was available from ODFW from both recreational and commercial sectors and from ODFW special projects. Length compositions were compiled from data collected by the ORBS and MRFSS programs for recreational ocean-boat (1980 – 2014), estuary-boat (1980 – 2013), and shore (1980 – 2005) fishing modes. Population length bins were set every 2 cm between 0 and 60 cm, and data length bins were set every 2 cm between 6 and 60 cm. Spatial differences in recreational length-composition data were not distinguishable (Figure 20) and contained no gender information (compositions were gender-aggregated). The initial sample sizes used in the assessment for each year and recreational fishing mode were the number of sampled fish (Table 11).

During the STAR panel, it was determined that the MRFSS database in RecFIN had undergone column labeling changes through time, in particular those associated with measured and/or estimated length information. In some cases, it appears as though length was estimated from weights (i.e., columns referring to length are entered with >> 4 decimal places), and in other cases it is entered as an integer value. For the purposes of this assessment, recreational length compositions were calculated using data in columns labeled "T_LEN" or "LNGTH" in the MRFSS database depending on which contained an integer value. This resulted in using "T_LEN" from 1980 – 1989 and "LNGTH" from 1994 – 2003. Data from 1993 were omitted because both columns contained integer values, and they were not equal. No MRFSS sampling occurred between the years 1990 and 1992. It was discovered that the column labels in MRFSS have changed over time, complicating repeatability and consistency through time. For example, the previous assessment conducted in 2005 used MRFSS length information from 1993 – 2003 (under a different column heading altogether), because at that time there was only one column with integer values (no data entered for previous years; J. Cope, NWFSC; pers. comm.).

Age compositions were available for the recreational ocean-boat fishing mode from 2005 – 2013, the commercial fishery from 2003 – 2013, and from ODFW research projects from 2013 - 2014. A total of 1,070 males and 823 females were aged for developing compositional data. Age data from ODFW research projects (4 males and 9 females) were included to provide information on the growth of age-1 fish. The initial sample sizes used in the assessment for each year and recreational fishing mode were the number of aged fish by gender (Table 12). Conditional age-at-length compositions were created from the age-composition data as an alternative model input to facilitate internal estimation of growth parameters and to account for the lack of independence between age- and length-compositional data.

Commercial length compositions for hook-and-line fisheries were extracted from PacFIN for each gender (1988 - 2014) on June 2, 2015. These data are collected by port biologists following a stratified, multistage sampling design. Raw compositions were expanded to the sample level (individual port sample) to account for unmeasured fish and then to the trip level to account for inter-trip variation in landing size. Some inter-annual variation in mean length was observed in the commercial length composition data (Figure 21). The initial annual sample sizes used in the assessment for the commercial fishery length-composition data were the number of trips (Table 12).

2.1.9 Biological Data: Age structures

Kelp Greenling otoliths were collected from charter ocean-boats (CPFV; Table 11) and from the commercial fishery (Table 12). Otoliths were aged using the break and burn method, a more precise method of aging than surface reads (Beamish 1979, Kimura et al. 1979), by the ODFW aging lab. A total of 1,547 fish were aged from the ocean boat fishery (2005 – 2013) and 349 from the commercial fishery (2003 – 2013) for use in this assessment. Very few fish under 30 cm (and none under 24 cm) were collected from these fisheries for ageing, making it difficult to reliably estimate growth (namely the length at age-0, length at age-1, and growth coefficient, K, parameters). In response to this knowledge gap, ODFW aged an additional set of smaller-sized Kelp Greenling using collections from fishery-independent 'special projects' and produced an externally estimated growth curve (Rodomsky et al. 2015). This growth curve was used to inform the starting parameter values for the Schnute parameterized version of the von Bertalanffy growth equation (Bertalanffy 1938; Schnute 1981) used in stock synthesis. Upon further discussion at the STAR panel, the 'special projects' age data for age-1 fish were incorporated into the assessment to inform the growth curve.

There was an additional set of aged Kelp Greenling data available from ODFW, totaling around 600 fish from 2005 – 2007, that were ultimately determined to be unusable due to the potential for inaccuracies and biased ages (Nearshore Stock Assessments Workshop, June 2015). Therefore, these ages were not used in this assessment.

Very few studies have examined the age and growth of Kelp Greenling. Moulton (1977) and Barker (1979) provided von Bertalanffy growth function (VBGF) parameter estimates for Kelp Greenling in Puget Sound, Washington, but those may not be applicable to Oregon waters. Kelp Greenling growth was also discussed in Burge and Schultz (1973) and Rothrock (1983), but no estimates were provided. Initial explorations of growth for this assessment suggested that there were only modest differences in growth by gender (female: L_{inf} = 38.30, k = 0.56, t_0 = -0.65; male: L_{inf} = 37.17, k = 0.55, t_0 = -0.69), and these parameter values were similar to those recently presented in Rodomsky et al. 2015. There was no evidence of a difference in growth between the north and south coasts of Oregon as estimated using 391 aged fish from southern Oregon and 1,205 aged fish from northern Oregon. Despite the growth similarity between sexes, the assessment model maintained gender-specific population dynamics because of potential differences in exploitation between genders. Males are nest guarders and remain in shallower depths for a longer period of time where they are potentially more vulnerable to fishing. As nest guarders, males are likely to play an important role in determining egg survival and thus recruitment potential.

2.1.10 Biological Data: Ageing precision and bias

For the purposes of this assessment, age information is assumed to have observation error. However, available Kelp Greenling otoliths were read once by a single ODFW aging specialist, thus the necessary double (or multiple) reads that are used to inform ageing precision and bias were unavailable at the time of this assessment. Thus, an ageing error matrix was assumed from another recently assessed species, Cabezon (Cope and Key 2009), which has some similarities in life history and the overall ease of ageing the otolith. For Kelp Greenling, ageing error was set to zero for age-0 and age-1 fish; set to that estimated for Cabezon from age-3 to age-15; and set to the midpoint between zero and that estimated for age-3 Cabezon for age-2 Kelp Greenling. A sensitivity analysis was conducted that assumed no ageing error.

2.1.11 Biological Data: Weight-Length

Weight-length relationships have previously been specified for Kelp Greenling (Moulton 1977: total length, combined genders; Barker 1979: standard length, combined genders in Puget Sound, WA; and Rothrock 1983: standard length, gender specific for individuals >24 cm in central California). The Puget Sound studies were not considered further because of potential intraspecific biological differences in Puget Sound versus coastal populations of fishes (Buonaccorsi et al. 2002). A more recent study conducted in Oregon coastal waters estimated gender-specific weight-length relationships based on fork length (Rodomsky et al. 2015). Given the direct applicability to the population of interest, estimates using data presented in the Rodomsky et al. study were used in this assessment (Figure 22). The weight-length parameters for females were $\alpha = 6.81x10^{-6}$ and $\beta = 3.211$ and for males were $\alpha = 9.76x10^{-6}$ and $\beta = 3.116$, following the standard power function formulation $W = \alpha(L^{\beta})$ where weight is in kilograms and length is in centimeters.

2.1.12 Biological Data: Maturity and Fecundity

Histological examination of 615 ovaries from Oregon waters indicated that female Kelp Greenling are 50% mature at 29.3 cm (SD = 0.5 cm; Rodomsky et al. 2015; Figure 23). Males are thought to mature at a similar size (Crow 1995, ODFW 2002), but this has not been confirmed with histology. Using information from the Rodomsky et al. 2015 study, the proportions of mature females in each assessment length bin (every 2 cm from 0 to 60 cm) were entered into the assessment model as fixed quantities.

The relationship between age/size and number of eggs spawned is uncertain because of the possibility of multiple spawning events per year. Total egg production was estimated at 28,500 to 125,000 per year (Love 2011), however no formal study on Kelp Greenling fecundity has been located. Therefore, reproductive output has, for the purposes of this assessment, been defined to be proportional to the product of maturity-at-age and body weight for females at the start of the year.

2.1.13 Biological Data: Natural Mortality

Little is known about the natural mortality rate of Kelp Greenling, so empirical models using life history traits (e.g., growth rate (*k*), maximum length (*Linf*), maximum weight (*Winf*), and maximum age (ω)) were used to estimate gender-specific natural mortality rates. Gender-specific differences in natural mortality rates were expected because of differences in the observed maximum age for females and males (Figure 24) and because of (albeit minor) differences in growth. A series of methods for estimating *M* (Then et al. 2015; Mccoy and Gillooly 2008; Hoenig 1983; and Pauly 1980) were explored. Following the methods presented in Hamel (2015), a prior distribution for natural mortality was developed (Figure 24) by using the three approaches described in the Then et al. 2015 study (all based on alternative formulations using maximum age). Base models for this assessment fix natural mortality at the median of the constructed prior distribution, which was 0.360 for females and 0.318 for males. The final relationship that was selected was 5.4/maxage, where maximum age was 15 for females and 17 for males. The previous Kelp Greenling assessment set natural mortality at 0.26 for both genders, and this value was used for a sensitivity model run.

Given uncertainties associated with maximum age observations and due to the fact that ageing error was not explicitly available for Kelp Greenling, two alternative sets of natural mortality parameters were developed during the STAR panel for sensitivity runs and to provide bounds for natural mortality as a major axis of uncertainty. Using the 5.4/maxage formulation, natural mortality was specified for males and females by increasing or decreasing the maximum age by 2 years. Thus, low values of natural mortality were 0.284 and 0.318 (age-19 male and age-17 female, respectively), and high values were 0.360 and 0.415 (age-15 male and age-13 female, respectively).

2.1.14 Biological Data: Sex ratios

Sex ratios were available from fishery dependent biological sampling of the commercial sector and from aged fish collected from the recreational ocean-boat fishing sector. Data in both cases indicated that females consisted of 44% and 43% of the sampled catch, respectively. This suggests that males may be more vulnerable to hook-and-line fishing than females.

2.2 History of Modeling Approaches Used for this Stock

2.2.1 Previous assessments

The previous, and only, formal stock assessment for Kelp Greenling in Oregon waters was conducted in 2005 (Cope and MacCall 2005). This full assessment included two separate populations, one in Oregon waters and one in California waters, and was modeled as an age/size structured population model under version 2 of Stock Synthesis (SS2). It was determined that there was insufficient population information (e.g., age, growth, natural mortality, and an abundance index) at the time for the California population to proceed with providing management advice. For the Oregon population, management advice regarding the status of the stock was determined to be acceptable (spawning biomass depletion of 49% of unfished levels). However, it was decided that an OFL could not be determined because of substantial uncertainties associated with overall catch levels, particularly from estuary and shore fishing modes. It is important to note that under current PFMC guidelines an OFL could have been determined for this assessment by applying the overfishing probability P* tier categories to establish a suitable buffer given the level of uncertainty in the recent estimate of spawning biomass.

2.3 Response to the 2005 STAR Panel Recommendations

The STAR panel report for the most recent (2004) and only Kelp Greenling assessment relative to Oregon waters suggested several recommendations for further consideration. Those applicable to Kelp Greenling are listed below along with how this assessment addressed each recommendation.

1. More sampling of the recreational catch, particularly the shore-based sector, is required to provide catch-at-length information and ageing structures. This will require a modification to the current program which does not collect ageing structures for Kelp Greenling. Sex for Kelp Greenling is relatively easy to determine externally, and efforts should be made to include information on sex when collecting length frequency data.
   Response: Sampling of the estuary-boat and shore fishing modes ceased in 2005 and no comprehensive surveys from these recreational sectors are available since that time. As a result, recent catch from these sectors is highly uncertain. The collection of gender information should become common practice for Ocean Recreational Boat Samplers (ORBS).

2. Given data at appropriate spatial resolution, efforts should be made to conduct assessments based on sub-stocks separated biogeographically. Evidence reviewed by the STAR Panel indicated biological similarity between Kelp Greenling in Oregon and northern California, which suggests that there is value in attempting an assessment in which the data for these two areas are analyzed together.
   Response: This assessment is for Kelp Greenling in Oregon waters only.

3. Tagging studies, either traditional or archival, should be evaluated in relation to their ability to provide information on movement, sub-stock structure, age validation, and exploitation rates.
   Response: Although potentially very important for Kelp Greenling (e.g., ontogenetic movement and sub-stock structure), such data has not been collected. Tagging simulation studies for Kelp Greenling have not been conducted.

4. There is need to consider alternative techniques for monitoring the abundance of Kelp Greenling such as industry cooperative surveys.
   Response: Comprehensive cooperative surveys for Kelp Greenling have not been initiated.

5. Several of the 2005 assessments have conducted historical catch reconstructions. An effort needs to be made to develop a consistent approach to reconstructing catch histories. The ideal outcome would be a single document outlining the best reconstructed catch histories for each species (c.f. Rogers (2003) that lists foreign catches).

Response: The Oregon Department of Fish and Wildlife conducted a historical catch reconstruction for Kelp Greenling (unpublished data but methods described in this assessment; section 2.1.2) from estuary-boat and shore fishing modes. A commercial catch reconstruction was recently completed (Karnowski et al. 2014), but unfortunately it did not include Kelp Greenling.

6. Improvements to these assessments are dependent on increased availability of sex-specific age-length data. Even just one additional year of data may reduce uncertainty substantially.
   Response: Age and sex-specific information has been collected since the last assessment and are incorporated into this assessment (see sections 2.1.8 – 2.1.10).

2.4 Model Description

2.4.1 Transition from 2005 to 2015 stock assessment

It has been a decade since the last assessment has been conducted for Kelp Greenling along the Oregon coastline, and much has changed during that time in terms of updates to modeling software, data availability, parameterization, and the best available estimates for recreational catch history. The accumulation of these changes made it difficult, and in some cases impractical, to create a set of 'bridge' or transition models from the 2005 assessment to the 2015 assessment. Below is a list of the major changes that occurred since the previous assessment and rationale for making those changes.

1. The 2005 assessment used Stock Synthesis 2 (Methot, 2005), while this assessment was conducted using Stock Synthesis 3. Several improvements to the Stock Synthesis modeling framework have occurred since that time, many of which are not straightforward for examining 'bridge' models and impractical to evaluate step by step.
   Rationale: straightforward improvements made to modeling software.

2. The catch history for Kelp Greenling was reexamined in 2013, and it was determined that there were significant changes in the historical recreational catch time series (J. Cope, NWFSC; pers. comm.). The previous assessment in 2005 extracted recreational catch data directly from the RecFIN database (managed by the Pacific States Marine Fisheries Commission; PSMFC). However, Kelp Greenling catch estimates from RecFIN were not consistent with what Oregon believed to be the best available estimates. This inconsistency between RecFIN and individual state estimates has occurred across other species as well. This assessment used ODFWs corrected catch estimates (section 2.1.2). Differences between recreational catch data used in the 2005 and 2015 assessments are shown in Figure 26. This assessment also used ODFWs reconstructed catch time series for estuary-boat and shore fleets (1915-1979 and 2006- 2014).
   Rationale: State data stewards conducted the reconstructions and they represent the best available estimates for recreational catch.

3. A new fleet structure was developed for this assessment. Previously, recreational fleets were encapsulated by RecFIN fishing modes (party and charter boats, private and rental boats, beach/bank, and man-made structure), and the commercial fleet was separated by live-fish and non-live fish components. For this assessment, recreational fleets were described by fishing type (ocean-boats, estuary-boats, and shore methods), and a single aggregated (live and non-live combined) commercial fishery.

Rationale: the assessment team, along with state biologists, agreed that the location of fishing was more likely to be the primary factor affecting fishing mortality (including selectivity) for recreational fisheries, as opposed to the type of boat (party/charter, private/rental) or shore fishing method (beach/bank, man-made). Length compositions were clearly different among ocean-boat, estuary-boat, and shore recreational fisheries (Figure 23). The vast majority of the commercial fishery catch comes from the live-fish fishery (> 95%), and the non-live component for Kelp Greenling is believed to be more a function of the prevailing market and mortality from live-fish dead-loss. There were no major differences in length compositions between the live-fish and non-live fish components.

4. Updated estimates of gender specific natural mortality rates (females = 0.360; males = 0.318).
   Rationale: these values were the medians of the prior distributions estimated for Kelp Greenling (O. Hamel, NWFSC; pers. comm.).

5. A new CPUE index of abundance was created for the recreational ocean-boat fishery based on the MRFSS program (1981-1989, 1993-2002), but was not used in the base model.
   Rationale: the only available abundance index from the early part of the time-series for the ocean-boat fishery

6. A new CPUE index of abundance was created for the recreational ocean-boat fishery based on the ORBS program (2001 – 2014).
   Rationale: an adequate time series available to evaluate trends in abundance for the ocean-boat fishery.

7. A new CPUE index of abundance was created for the recreational ocean-boat fishery based on selected drifts occurring on Kelp Greenling reef habitat using data collected from onboard observers (CPFV).
   Rationale: an adequate time series available to evaluate trends in abundance for the ocean-boat fishery that is informed by onboard observer reports and available habitat.

8. A new CPUE index of abundance was created for the commercial fishery based on logbook submissions. Logbook information was available beginning in 2004 and thus was unavailable as an index time series for the 2005 assessment. The two largest years of harvest occurred before the start of the logbook program.
   Rationale: the expansion of the live-fish fishery has resulted in increased commercial catch of Kelp Greenling and previously there was no index for this fishing sector.

9. New age data spanning 2003 – 2013 were available. Recreational ocean boat age data included in the previous assessment (2003 – 2004) were excluded.
   Rationale: the ODFW aging laboratory has low confidence in the ages from those years and is working to reanalyze those samples, but they were unavailable for this assessment.

10. Time-invariant dead discard estimates were applied to the total landings to calculate total catch for each fishing mode.
    Rationale: dead discard estimates for Kelp Greenling were minor, but were included in the overall catch to nonetheless account for this source of mortality.

2.4.2 Definition of fleets and areas

This assessment considers the population of Kelp Greenling in Oregon waters to be a single, one area closed population. There is little information available on Kelp Greenling movement rates within Oregon or among adjacent states. There is somewhat of a natural spatial component to the recreational and commercial sectors, with >99% of commercial landings occurring in southern Oregon waters (Table 3; Figure 6) and 57% of recreational landings occurring in northern Oregon waters (Table 4, Table 5, and Table 6).

Fleets were specified for recreational and commercial sectors. The recreational sector was split into three main fleets according to fishing type, a proxy for the location of fishing. These include ocean-boat, estuary-boat, and shore fleets. The commercial sector was represented by one fleet, which included a combination of hook-and-line and longline gear types.

2.4.3 Summary of data for fleets and areas

The time-series of data used in this assessment is summarized in Figure 3. Sample sizes for length composition, age composition, and mean body weights are also summarized (Table 11, Table 12).

2.4.4 Modeling software

The most recent version of Stock Synthesis 3 (version 3.24u) was provided by Rick Methot (NWFSC) and used for this assessment.

2.4.5 Data weighting

For yearly length-composition data, initial sample sizes for recreational fleets were set at the number of sampled fish. For the commercial fleet, the initial sample size was set to the number of hauls. Length composition sample sizes were then tuned in all base assessment models to the harmonic mean effective sample size (McAllister and Ianelli 1997) by using tuning scalars that are generated using the r4ss package in program R (https://github.com/r4ss/r4ss). The harmonic mean approach resulted in a down-weighting of recreational fleet sample sizes and only minor adjustments to the commercial fleet sample size. An alternative approach to weighting length-composition data ("Francis method", Francis 2011) was explored through sensitivity evaluations.

Conditional age-at-length data were used in the assessment model to inform estimation of growth and to alleviate the potential lack of independence among dual age and length-composition information for the same sample. Age-at-length composition sample sizes were set at the number of aged fish in each population bin. These data were not re-weighted because there was little age-at-length information available for this assessment; it is informative information for estimating growth; and there is no clear research directive on how best to re-weight conditional age-at-length data.

Weights can also be specified among data sources ("lambdas" in Stock Synthesis). In this assessment, there was no clear reason to down-weight (up-weight) particular data sources, so all were assumed to have equal weight.

2.4.6 Priors

Diffuse, uninformative priors were used for the estimates of the Brody growth coefficient (*k*), the length at minimum age for each gender, and the length at maximum age for each gender. Informative priors were used during particular sensitivity runs. A lognormal prior for natural mortality was applied when attempting to estimate female (-1.02, 0.437) and male (-1.15, 0.438) natural mortality (Figure 25). A normal prior was applied when attempting to estimate steepness of the stock recruitment curve (0.70, 0.09).

2.4.7 General model specifications

The assessment is structured as a single, sex-disaggregated, unit population, spanning Oregon marine waters. It operates on an annual time step covering the period 1915 to 2015, assumes negligible catch prior to that time, and thus assumes a stable equilibrium population prior to 1915. Population dynamics are modeled for ages 0 through 12, with age-12 being the accumulator age (i.e., includes 12+ year old fish). The maximum observed age was 17 for males and 15 for females. Population bins were set every 2 cm from 0 to 60 cm, and data bins were set every 2 cm from 6 to 60 cm. The model tracks catch across two sectors (commercial and recreational) and four fleets, and is informed by 3 separate abundance indices. Recruitment was related to spawning biomass using the Beverton-Holt stock recruitment relationship with log-normally distributed, bias corrected process error. Growth was modeled across a range of ages from 1 through 11. Selectivity was assumed to be asymptotic for the recreational ocean fleet, and dome shaped for the commercial and recreational estuary and shore fleets. Sensitivity to these selectivity assumptions were explored during model development and relative to the base model. All catch was assumed to be known without error. Model sensitivity to alternative catch histories was explored.

Likelihood components that were minimized in the overall fitting procedure include fleet-specific catch, length composition, and conditional age-at-length composition and also survey, recruitment deviate, parameter prior, and parameter soft-bound components. Initial model explorations utilized individual and combined likelihood values to assist in model development.

The basic population dynamic equations used in Stock Synthesis 3 can be found in Methot and Wetzel (2013). The relevant input files (starter.ss, data.ss, ctl.ss, and forecast.ss) necessary to run the stock assessment can be found in Appendices A (pp. 151), B (pp. 189), C (pp. 194) and D (pp. 195), respectively.

2.4.8 Estimated and fixed parameters

The population dynamics model has many parameters, some estimated using the available data in the assessment and some fixed at values either external to the assessment or informed by the available data. A summary of all estimated and fixed parameter values, including associated properties, are listed in Table 13.

A total of 68 parameters were estimated in the base model. Time-invariant growth parameters (Brody growth coefficient, length at minimum age, and CV old/young) using the Schnute parameterization of the von Bertalanffy growth function were estimated as gender invariant. Length at maximum age was estimated separately by gender. Selectivity was assumed to be asymptotic and related to length by a logistic function for the recreational ocean fleet, and dome-shaped for the commercial and recreational estuary and shore fleets. All selectivity parameters were assumed to be time-invariant, except a time block was used to capture changes in selectivity as a result of the implementation of a minimum size limit for Kelp Greenling in 2004. Recruitment deviates were estimated in the base model from 1980 – 2012. Initial (equilibrium) recruitment was also estimated. Coefficients of variation about the abundance indices derived from bootstrapping or jackknifing techniques may greatly underestimate the true uncertainty regarding the relationship between these indices and biomass. Thus, extra standard deviation parameters were estimated for each abundance index.

The base model assumed a stock-recruitment steepness of 0.7; the same as in the previous Kelp Greenling assessment and similar to the value used in other recent assessments for similar species (Cope and Key 2009; Hamel et al. 2009; Jagielo et al. 2004). Recruitment variation about the stock recruitment curve was fixed at 0.65, a value tuned to the estimated recruitment deviation RMSE plus a slight adjustment upward to account for unmeasured process error. Natural mortality was fixed at the median of the prior distribution (females = 0.360; males = 0.318) generated following methods in Hamel 2015 and Then et al. 2015. Estimates from the Rodomsky et al. (2015) study were used to parameterize gender specific weight-length relationships and the maturity curve (L_{50} = 29.34 cm). This study specifically sought to collect and include smaller sized Kelp Greenling that is typically outside the range of landed (and thus sampled) fish. Parameters for fecundity were fixed such that it was proportional to spawning biomass.

Several of the parameterization decisions were further examined through sensitivity analysis (section 2.7.1).

No research was uncovered that quantified ecosystem level effects on Kelp Greenling; therefore, considerations such as environmental correlations and food web interactions were not explicitly included in the assessment model.

2.5 Model Selection and Evaluation

2.5.1 Key assumptions and structural choices

Many of the key assumptions and structural choices made in this assessment were evaluated through sensitivity analysis (2.7.1). For consistency, model structural choices were made that were likely to result in the most parsimonious treatment of the available data, either *a priori* determined or through the evaluation of model goodness of fit. Major structural choices in this assessment included the use of a single closed area (Oregon marine waters) to adequately describe gender-specific population dynamics of Kelp Greenling. The age structure, including maximum age, for Kelp Greenling was determined from what was decided to be the current best available data. This differs significantly from what was available for the previous assessment (e.g., observed maximum age was 25 years compared to 17 for this assessment) as a result of removing age data that are now believed to be inaccurate. It was determined that there was enough information in the length composition and mean-weight data to estimate recruitment deviations from the deterministic stock recruitment relationship.

Major assumptions included fixing the steepness stock recruitment parameter and gender-specific natural mortality parameters. The median of the calculated prior distribution was used for natural mortality in this assessment (female = 0.360; male = 0.318), which is reasonably different from that used in the last assessment (0.26 for both genders). Selectivity was assumed to be asymptotic following a logistic function for the ocean-boat fleet, and was assumed to be dome-shaped for the commercial, estuary-boat, and shore fleets. There was sufficient information in the data to produce reasonable estimates for selectivity. However, under some model configurations estuary-boat and shore selectivity was less stable. As expected, the base model was sensitive to the shape of the selectivity curves. A time block was used to capture changes in selectivity as a result of the implementation of a minimum size limit for Kelp Greenling in 2004. The reconstruction of the historical (pre-1980, when data did not exist) catch time series for estuary-boat and shore-based fishing modes was based on the assumption that the catch of these fleets was proportional to Oregon fishing license sales (see section 2.1.2).

2.5.2 Alternative models explored

Initial development and exploration of 'bridge' models to link the 2005 and 2015 assessment were undertaken. However, due to difficulties in transparently stepping from a Stock Synthesis 2 model to a Stock Synthesis 3 model, data changes (updated catch time series), and fleet restructuring (recreational fleets), conducting a set of 'bridge' models from a decade old assessment was determined to be uninformative. A comparison between spawning biomass estimates from the previous assessment (2005) and the 2015 base model is shown in Figure 27. Data for a two-area model (northern and southern Oregon waters; divided at 44° 18' N latitude, corresponding to the boundary between PFMC areas 2B and 2C and to a large area of unstructured, sand-bottom habitat where Kelp Greenling is rarely encountered) were accumulated to explore region-specific population dynamics. The main impetus for a spatially structured model would be due to exploitation history (in particular, the onset of the commercial fishery in southern waters) as the available data did not readily support spatial differences in sex-ratio, growth or length compositions. Sample sizes were inadequate to justify separating recreational abundance indices by region. Due to the natural spatial separation of the commercial fishery (occurring almost exclusively in southern waters), information on relative exploitation among fleets (and thus regions) was still available using a single area model, which could be used to inform regional management. A gender-aggregated model was also explored.

Many other model parameterizations were explored (e.g., shape of selectivity curve and the estimation of growth and natural mortality parameters) during the development of the base case and for sensitivity analysis relative to the base model (section 2.7.1). In general, model sensitivity to the parameterization and estimation of growth, natural mortality, steepness, selectivity, recruitment deviates and variance, abundance indices, composition weighting, and the historical catch time series were explored.

2.5.3 Convergence

Model convergence was checked for all models during development of a base model by ensuring that the final gradient of the likelihood surface was less than 0.0001. All estimated parameter values were also checked to ensure they were not hitting a minimum or maximum bound. To reduce the chance that the parameter estimation process (i.e., setting initial parameter values and the sequence of parameter estimation through phasing) resulted in a converged gradient at a local (rather than the desired global) minima on the likelihood surface, multiple model runs were conducted with alternative parameter initial starting values. The 'jitter' option in Stock Synthesis adds a random normal deviate to parameter initial starting values in logistic space to ensure the starting value is within the parameter's established range. One hundred separate base model runs were evaluated, each with different initial parameter values. The base model resulted in 36% of those runs returning to the base case results and 0% resulting in a smaller negative log likelihood value (Figure 28).

2.6 Response to STAR Panel Recommendations

During the course of the STAR panel, several recommendations were made that were specific to this assessment. The following is a list of those recommendations and the author's response.

1. Explain the change in MRFSS length filtering relative to the last assessment and the specific methods used to generate the data sets being currently used.
   Response: Following this recommendation, additional text has been added to 2.1.8 and in the executive summary (Unresolved problems and major uncertainties).

2. Table the sample sizes of number of trips/interviews in addition to the number of individual fish.
   Response: Table 11 for the recreational fishery and Table 12 for the commercial fishery were extended to include this information.

3. Add a histogram of male and female age data to evaluate the maximum age and evidence for differences in natural mortality.
   Response: Figure 24 was developed in response to this recommendation.

4. Include a retrospective over assessments (in this case just a comparison to the results from the 2005 assessment).
   Response: Figure 27 was developed that, along with Figure 26, provide a retrospective comparison among the current base case model and that from the 2005 assessment.

5. Correct the CVs reported in the document tables to correspond to those used for indices in the assessment model.
   Response: The CVs reported in the document tables for the three abundance indices are now the input (log(SD)) values that are directly used in the assessment model. Previous jackknife CVs and approximate 95% confidence intervals were removed to minimize confusion.

6. Explain the choice of maximum age as an axis of uncertainty and compare with density-based scale estimates.
   Response: Text has been added to 2.1.13, 4, and the executive summary (Unresolved problems and major uncertainties and Decision table) to incorporate this recommendation.

7. Consider a larger jitter setting for the final fit with a lower convergence rate, therefore ensuring that a more robust test of convergence to the global minimum is applied.
   Response: The jitter setting was increased to 0.1 with a convergence rate equal to 0.0001.

Several other recommendations were made by the STAR panel for consideration in future assessments. Those can be found in the Stock Assessment Review (STAR) Panel Report for Kelp Greenling (http://www.pcouncil.org/groundfish/stock-assessments/by-species/kelp-greenling/).

A new base case model was developed during the STAR panel, which included several changes to the pre-STAR panel base case model. Results from the new base case model are presented in this document. These changes include:

- Population bin structure was set to start at age-0.
- Include age-1 ages from ODFW special projects as conditional age-at-length information using a fully age-selected ghost fishery (inform growth).
- Mean weight data were removed.
- The MRFSS dockside index was removed.

- Length composition data from MRFSS was recompiled to include only lengths believed (at this time) to be actual measurements (i.e., 'T_Len' database column for 1980 – 1989, 'LNGTH' column for 1994 – 2002, and drop 1993).
- Estimate male to be equal to female parameters for the CV young, CV old, length Amin, and k. Length at Amax to remain gender specific.
- Use Cabezon as a proxy for estimating Kelp Greenling ageing error by 1) assuming age-0 and age-1 fish have no ageing error, 2) use Cabezon ageing error matrix for age-3 and older, and 3) ramp ageing error from 0 to that specified for age-3 for age-2.
- The commercial logbook abundance index filtering criteria for participation in the fishery was relaxed to 3 years (instead of 10).

2.7 Base-Model(s) Results

The Kelp Greenling base case model was capable of estimating reasonable growth parameters (*k*, length at minimum and maximum age, and CV young/old) for ages 1 and older fish. Growth was estimated beginning at age-1, because there was no information in the conditional age-at-length data to predict growth for smaller size class fish. Further, there was conflict in the model when estimating the growth curve for small fish and the selectivity for shore and estuary fleets (that harvest smaller sized fish) that resulted in significant changes to population scale (unfished recruitment, R_0). Asymptotic length was estimated at 36.4 cm for females and 35.75 cm for males (Table 14, Figure 29). The fit to the abundance indices was reasonable for the recreational onboard observer index (Figure 31) and the ORBS index (Figure 32). Both indices track ocean-boats and indicated relative increases in abundance from 2001 – 2003 and from 2009 – 2010. The fit to the commercial logbook index was also reasonable but less consistent than the recreational indices (Figure 30). The model estimated an additional standard deviation for each index (0.02, 0.09, and 0.02 for logbook, onboard observer, and ORBS based indices, respectively).

The base model produced reasonable fits in general to length and age composition data. Across all years, the fit to length composition information was best for the gender-specific commercial fleet (Figure 33) and for the gender-aggregated recreational ocean-boat fleet (Figure 34). The model was slightly less able to fit smaller sized fish as well as larger sized fish for the estuary-boat and shore fleets (Figure 35, Figure 36). In general, annual fits to length composition information were adequate (Figure 37), with poorer fitting years (i.e., the largest residuals) mainly associated with low sample sizes or from smaller sized fish in the shore fleet early in the time series (Figure 38, Figure 39, Figure 40, and Figure 41). The model was able to track mean length well for the commercial fleet and for the recreational ocean and estuary-boat fleet, especially for years with adequate sample sizes (Figure 42, Figure 43, and Figure 44). There were very few length samples from estuary-boats available after the end of the MRFSS program in 2005. The model had relatively more difficulty tracking mean length for the shore fleet (Figure 45).

Age compositions that resulted from fitting conditional age-at-length data matched reasonably well with the observed age compositions from the recreational ocean-boat fleet (Figure 46) and from the commercial fleet (Figure 47) during years with reasonable amounts of observations (2009 – 2013). Fits to the recreational ocean boat conditional age composition data shows generally good agreement between observed and expected ages at length (Figure 48). Fits to commercial conditional age composition data were less desirable (Figure 49). The model was able to track mean age for the ocean-boat fleet moderately well, except for in 2007 when the sample size was only 6 fish (Figure 50). Mean age for the commercial fleet tracked reasonable well during years with adequate sample sizes (2009 – 2013; Figure 51). No pathological patterns were apparent in the residuals for the recreational ocean boat conditional age-at-length fits (Figure 52). Significant residual patterns were persistent in the commercial fleet age data, particularly for females (Figure 53). This could be a result of sampling bias arising from the collection of otoliths from only dead loss fish (i.e., live-fish are too valuable to sacrifice for bone extraction). The fit to the research special project age data was expected (Figure 54) given that selectivity was age-based and fixed at one.

Selectivity curves were estimated for all four fleets (Figure 55, Figure 56), whereas survey abundance index selectivity was mirrored to the relevant fleet. An asymptotic curve following the logistic function was used for the recreational ocean fleet. Selectivity following a double normal function was estimated for the commercial, estuary and shore fleets. The commercial fleet often targets 'plate-sized' fish for the live-fish market. Estuary and shore fleets have a propensity to catch smaller fish nearer to shore. The peak and ascending width parameters for the ocean-boat fleet indicated that recreational fishermen catch larger Kelp Greenling (estimated peak was 40 cm). The ascending limb of the selectivity curve for the ocean fleet shifted to larger-sized fish during the time block that coincided with the installation of a Kelp Greenling minimum size catch limit. The estimated commercial dome-shaped selectivity showed a preference for fish between 35 and 45 cm. Estuary and shore fleet selectivity patterns were consistent with fisheries that tend to catch smaller fish in areas where larger fish are generally less available for capture.

2.8 Uncertainty and Sensitivity Analyses

2.8.1 Sensitivity analyses

Sensitivity to the main sources of uncertainty was structured as 'one-off' (remove one data source or change one structural assumption relative to the base model) analyses to clearly identify the impact of a single piece of information or structural assumption. Several model sensitivities were evaluated. In general, these fell under four categories: removal of an index of abundance time series, removal of length or age composition data, evaluation of structural (parameterization) assumptions, and alternative assumptions about estuary and shore catch time series. A complete list of sensitivity runs and resulting output are presented in Table 16.

In terms of population scale, the base model was most sensitive to the case when length composition data for the shore fishery were removed (Figure 64), recruitment was deterministic according to the stock recruitment curve (Figure 66), and to alternative assumptions for natural mortality (Figure 66). In terms of depletion, the base model was the most sensitive to the case when natural mortality was fixed to values used in the previous assessment, the use of Francis weights, and deterministic recruitment (Figure 67). Current depletion levels (SB ratio 2015) predominantly ranged from 70% to 90% across sensitivity scenarios. However, current depletion was 63% when natural mortality was set at the level used in the previous assessment (0.26 for both genders) and 108% when recruitment deviates were estimated throughout the entire time series (1915 - 2014). When natural mortality was set to a high relative value (females = 0.415; males = 0.360), population scale increased by 350% from 397 mt (base model) to 1,378 mt unfished spawning biomass, while relative depletion was fairly stable (84% compared to 80% for the base model). Assuming recruitment is deterministic according to the stock-recruitment curve resulted in a larger overall population scale, but similar depletion estimate.

In addition to length compositions, other likelihood components also had an influence on results relative the base model. Dropping commercial age compositions resulted in the stock estimated to be at 89% of the equilibrium unfished level, while dropping recreational age compositions resulted in 74% (Figure 65). The approach to weighting length composition data (harmonic mean as in the base case model or 'Francis' methods) was influential for the most recent estimates of depletion and the overall population scale. The harmonic mean weighting approach resulted in less optimistic, though still well above the target, levels of depletion compared to the Francis weighting approach (80% and 116%, respectively in 2015). For the abundance indices, the commercial logbook index had the most influence on relative depletion (71% compared to 80% for the base model).

Significant uncertainty exists regarding historical (1915 – 1980) and recent (2006 – 2014) catch levels from the estuary-boat and shore-based fishing modes. Doubling recent catch from these fishing modes resulted in an 18% and 19% increase in unfished and current (2015) spawning biomass, respectively, relative to the base model catch history (Figure 68). Relative depletion was robust to this alternative catch history (Figure 69). Beginning the estuary-boat and shore catch time series in 1940 compared to 1915 had little influence on the base case model, producing very similar current (2015) biomass and depletion estimates.

2.8.2 Retrospective analysis

Retrospective analysis was conducted by sequentially removing 1 through 5 years of data from the base model starting with 2014. The base model was generally more optimistic than models with sequentially less data (Figure 70, Figure 71). In particular, removing the most recent 5 years of data (i.e., 2009 is model end year) resulted in the largest difference in population scale, mainly because of a lack of information on spawning biomass at that time from the otherwise large predicted recruitment event in 2009. The overall population trend remained robust to the inclusion/omission of recent data.

2.8.3 Likelihood profiles

Likelihood profiles were performed across three major sources of uncertainty: natural mortality *M*), steepness (*h*), and initial recruitment (R_0). An individual profile was completed for each data source and parameter combination to derive the relative importance of each data set to parameter estimation. The profile over the initial scale of the population (R_0) indicated a well determined estimate for the base model (Figure 72), bounded on the lower end mainly by recruitment, age composition and abundance index data sources, and on the upper end by length composition data (Figure 73). The influence of R_0 on derived quantities for absolute levels of biomass was nonlinear, with large changes in biomass predicted from small changes in R_0 (Figure 72).

Profiles over the steepness parameter (*h*) indicated that steepness was difficult to determine given the available data, and was primarily driven by specified prior information (Figure 74). Steepness was fixed at 0.7 in the base model, which was similar to the estimated value for steepness when it was freely estimated given the prior.

A bivariate profile over natural mortality (*M*) by gender was conducted across a range of values while maintaining a similar ratio of male natural mortality to female natural mortality as that used in the base model. Additional scenarios were examined where the ratio between male and female natural mortality was lower and higher than that used in the base model. Results indicated a minimum at 0.420 (median of the prior = 0.360) for female natural mortality and 0.365 for male natural mortality (median of the prior = 0.318) (Figure 75). These values were most informed by recruitment data (Figure 76).

3 Reference Points

Spawning output demonstrated a moderate decline (though variable) over most of the time series up until the large predicted recruitment event in 2009, which increased spawning biomass in 2011 – 2012 (Figure 57). Stock status has remained well above the biomass target reference point (40%), though was trending towards it prior to the 2009 recruitment event, and is estimated to be at 80% (~95% asymptotic intervals = 59%-100%) in 2015 (Figure 58). Unfished spawning biomass was estimated at 397 mt (~95% asymptotic intervals = 217-576 mt; Table 17), and spawning biomass at the beginning of 2015 was estimated to be 316 mt (~95% asymptotic intervals = 116-516 mt). Kelp Greenling recruitment has fluctuated over the last 35 years, with the largest recruitments occurring in 1985, 2000, and 2009 (Figure 59, Figure 60). Fishing intensity has been above the SPR45% rate throughout the time series (Figure 61), with the highest fishing intensity occurring in 2002 (SPR72%). The phase plot shows the interaction of fishing intensity and biomass targets (Figure 62), and shows that spawning biomass in 2014 is estimated to have been 2.24 times higher than the target biomass level, while experiencing fishing intensity 4.76 times lower than the SPR fishing intensity target. The equilibrium curve is shifted left, as expected from the high fixed steepness, showing a more productive stock than the SPR45% reference point would suggest (Figure 63). The target stock size based on the biomass target (*SB*40%) is 159 mt, which corresponds to a catch of 129 mt. Equilibrium yield at the proxy *FMSY* harvest rate corresponding to *SPR45*% is 130 mt.

4 Harvest Projections and Decision Tables

A projection of the Kelp Greenling population up to year 2026 was examined that would result in reaching the biomass target (SB ratio = 0.40) by the final year (2026; Table 18). Fleet specific catches during the first two years (2015 – 2016) were set to their average over the most recent three years (2012 – 2014; i.e., status quo levels). In order to reach the biomass target, total catch would need to more than triple current status quo levels.

The main decision table axis of uncertainty that was identified for this assessment was alternative states of nature for male and female natural mortality (Table 19). The specification of natural mortality for the base model was done by fixing the parameter at the median of a prior distribution, which was proportional to maximum age (observed female maximum age = 15; male = 17). Alternative states were developed by using the same maximum age formulation as in the base model, but applying maximum age values of ±2 years from that observed for females and males. These high and low levels of natural mortality resulted in bounds on estimated spawning stock biomass that were similar to bounds when extrapolating density estimates from research survey transects (see Appendix H for further details, pp. 206).

Four alternative forecast catch scenarios were examined: high, low, and following the ABC/ACL according to the 40:10 harvest control rules when a buffer of 4.4% or 5.4% was applied (Table 19). For all scenarios, catch by fleet during 2015 and 2016 was set to the fleet-specific average over the most recent three years (2012-2014). The low catch scenario applied 2014 levels of catch to each fleet from 2017 – 2026 (total catch = 33.5 mt). The high catch scenario applied 2002 levels of catch to each fleet from 2017 – 2026 (total catch = 100.2 mt). Catch in 2002 was significantly higher than any other year during the time series, and this level of catch occurred prior to the 2004 implementation of state imposed commercial and recreational harvest limits. The first ABC/ACL scenario applied a level of catch consistent with the 40:10 harvest control rules, where a buffer of 4.4% was used to calculate ABC from the OFL based on $SPR_{45\%}$. This buffer was calculated using the minimum sigma of 0.36 for a category 1 stock and a P* of 0.45

(the sigma for the estimated spawning biomass in 2015 was 0.322). The second ABC/ACL scenario applied a level of catch consistent with the 40:10 harvest control rules, where a buffer of 5.4% was used to calculate ABC from the OFL based on $SPR_{45\%}$. This buffer was calculated following an alternative approach for setting the sigma value that was discussed at the SSC meeting in Sacramento, CA (September 11, 2015). This approach was meant to directly take into account the uncertainty associated with Kelp Greenling (male and female) natural mortality and the resulting influence these parameters had on overall population scale. Sigma was calculated by taking the log of the ratio of the base model spawning biomass in 2015 to the assumed low values for natural mortality model spawning biomass in 2015 and dividing by 1.15 (the z-score equivalent to a probability of 0.125; see equation 1). This calculation resulted in a sigma of 0.441 using a P* of 0.45, and thus a buffer of 5.4%. The base case level of natural mortality was the only state of nature used to forecast the second ABC/ACL scenario (Table 19), because the calculation of the buffer in this case was itself dependent on an alternative state of nature (low assumed levels of natural mortality).

$$sigma = \frac{ln\left[\frac{base\ model_{SB2015}}{low\ M\ model_{SB2015}}\right]}{1.15} \qquad \text{Eq. 1}$$

5 Regional Management Considerations

Little is known of Kelp Greenling movement patterns, but given their nearshore distribution and the territorial behavior of adults, they are not believed to migrate great distances. This population feature implies that Kelp Greenling could be a candidate for regional management, and may become important given the spatial differences in exploitation history between the recreational and commercial fisheries. Currently, the fishing intensity on the Kelp Greenling population in Oregon waters is believed to be well below (SPR88%) the target rate (SPR45%). If fishing intensity significantly increases in one or more fishing sectors, the potential for local depletion increases, which could warrant regional management.

The rise of the southern Oregon commercial fishery in the mid to late-1990s as a result of the, predominantly California based, live-fish market, suggests that Kelp Greenling populations in northern California may also be experiencing an increase in exploitation. Given the proximity of the main Oregon commercial ports to the California border and the similarities between habitat and environmental conditions between southern Oregon and northern California, future assessments should consider incorporating northern California waters into the assessment if data is available. There may or may not be biological consistencies between northern California and Oregon populations, which could have implications for regional management.

6 Research Needs

There are several areas for further research that were identified while conducting this assessment or that continue to carry forward since the last assessment in 2005. Those listed below are believed to represent strategic pieces of information that would likely help to resolve key uncertainties associated with assessing Kelp Greenling in Oregon waters. Many would provide the necessary information to evaluate finer scale population and fleet dynamics, thereby enabling finer scale management, as necessary, for this growing fishery.

1. <u>Accurate accounting of removals for recreational estuary-boat and shore fishing modes.</u> Fisheries exploited by the recreational sector are traditionally hard to monitor. Since

2005, there has been no comprehensive information collected about catch or effort from estuary-boat and shore fishing modes. These modes have historically accounted for a significant portion of overall total landings and are likely to continue to be a consequential source of data and fishing mortality. A monitoring program to track catch and effort would have an impact on reducing uncertainties associated with this assessment.

2. Biological sampling from estuary and shore-based fishing modes. In addition to catch and effort, biological sampling (length, age, and gender) would help to reduce uncertainty about the selectivity of these fishing modes and help to better track the population through time. Available data ends in 2005 and suggests that these modes land substantially smaller fish than in the commercial fishery or from the recreational ocean-boat fishing mode.

3. Ageing bias, precision, and sample sizes. Age information was available for the recreational ocean-boat fleet and the commercial fleet. More aged fish, especially for age-0 and age-1, would improve the ability to estimate growth. In particular, aged fish from the estuary-boat and shore fishing modes would provide information about smaller sized fish that could be used to better estimate the intercept and ascending limb of the growth curve and provide information about ontogenetic or size-based movement. No information is currently available about aging error or bias and this should be a priority (even in lieu of more aged fish if constraints apply). Multiple read experiments are recommended to better account for this traditionally important source of uncertainty.

4. Collection of gender-specific data. Gender-specific information should be collected for Kelp Greenling given that adults are generally easy to outwardly sexual identify. This is especially the case for recreational fisheries. Although gender-specific data are available for the commercial sector, it is difficult to translate that information to the recreational sector because discrepancies in selectivity and regional fishing grounds.

5. A study of the stock structure of Kelp Greenling. Kelp Greenling stock structure needs to be studied and the results accounted for in future assessments. In particular, ontogenetic and gender-related movement according to offshore depth and spawning seems plausible, and data to support that hypothesis would be beneficial for future assessments. Alternative sub-stock boundaries, those that do not lie on political borders, should also be explored. Nine polymorphic microsatellite loci were developed and characterized by Freiwald et al. (2009) for Kelp Greenling, which can inform studies of stock structure as well as reproductive and mating strategies.

6. Alternative procedures at the assessment-management interface. The nest-guarding behavior of males indicates that for Kelp Greenling (and other similar species) males are likely to play a critical role in determining reproductive output and thus spawning potential. Given that the sex-ratio from biologically sampled fish favored males, there is evidence to suggest that males may be more vulnerable to fishing than females. As a result, it is recommended that a combination of male and female biomass should be considered when developing reference points related to depletion rates, especially when considering the population state for which reproductive capacity is severely impeded (e.g., limit reference point).

7 Acknowledgments

The Kelp Greenling STAT team gratefully acknowledge myriad of people who collected, collated, analyzed, and reviewed data or aspects of this document. Members of ODFW were particularly vital to the completion of this assessment. Troy Buell, Patrick Mirick, and Alison Dauble worked extra hard to ensure datasets were accurate and up to date for use in the assessment. They answered many, many questions and responded promptly to many email inquiries. Lisa Kautzi provided age information for a species where very little previously existed, and offered her expertise on the otolith ageing process for Kelp Greenling.

We gratefully acknowledge Andi Stephens (NWFSC) and Melissa Monk (SWFSC) for providing recreational dockside and onboard observer indices of abundance. Jason Cope (NWFSC), Ian Taylor (NWFSC), and Allan Hicks (NWFSC) provided countless insights, guidance, and code that significantly aided the completion of this assessment and improved it. We thank Owen Hamel (NWFSC), Jim Hastie (NWFSC), and John Devore (PFMC) for providing insightful comments and suggestions that improved early drafts.

The reviewers of the STAR panel (Paul Medley, Neil Klaer, and Ian Stewart) and the STAR chair (David Sampson) provided numerous constructive comments, advice and insights that ultimately improved the assessment. The STAR panel GAP representative (Heather Mann) and GMT representative (Lynn Mattes) provided necessary perspective from an industry and management standpoint. And, finally, thanks to Selina Heppell for allowing her doctoral student to diverge from her normal tasks to work on this assessment.

8 Literature Cited

Beamish, R. 1979. New information on the longevity of Pacific ocean perch (*Sebastes alutus*).Journal of the Fisheries Board of Canada 36, 1395–1400.

Barker, M.W. 1979. Population and fishery dynamics of recreationally exploited marine bottomfishes of northern Puget Sound. Ph.D. Thesis, University of Washington. 135 p.

Bodkin, J. L. 1986. Fish assemblages in *Macrocystis* and *Nerocystis* kelp forests off central California. Fish. Bull. 84, 799-808

Bryant, M. 1978. Ecological studies of the striped perch *Embiotoca lateralis* and the Kelp Greenling *Hexagrammos decagrammus* in Carmel Bay, California. M. A. Thesis, California State University Fresno. 77 p.

Buonaccorsi, V.P., C.A. Kimbrell, E.A. Lynn, and R.D. Vetter. 2002. Population structure of copper rockfish (*Sebastes caurinus*) reflects postglacial colonization and contemporary patterns of larval dispersal. *Can. J. Fish. Aquat. Sci*. 59: 1374-1384.

Burge, R.T. and S.A. Schultz. 1973. The marine environment in the vicinity of Diablo Cove with special reference to abalones and bony fishes. California Department of Fish and Game, Marine Research Technical Report No. 19, 433 p.

California Department of Fish and Game (CDFG). 2002. Nearshore Fishery Management Plan. California Fish and Game Commission. 20 Lower Ragsdale Drive, Suite 100. Monterey, CA 93940.

Cope, J. and A. MacCall. 2005. Status of Kelp Greenling (*Hexagrammos decagrammus*) in Oregon and California waters as assessed in 2005. Pacific Fisheries Management Council, Portland, OR.

Cope, J.M. and M. Key. 2009. Status of Cabezon (*Scorpaenichthys marmoratus*) in California and Oregon Waters as Assessed in 2009. Pacific Fisheries Management Council, Portland, OR.

Crow, K. D. 1995. The reproductive biology of Kelp Greenling *Hexagrammos decagrammus*. M. S. Thesis. San Francisco State University. 32 p.

Crow, K. D., A. Dennis, and G. Bernardi. 1997. Evidence for multiple contributors in nests of Kelp Greenling (Hexagrammos decagrammus, Hexagrammidae). Copeia 1, 9-15.

DeMartini, E. E. 1986. Reproductive colorations, paternal behavior and egg masses of Kelp Greenling, *Hexagrammos decagrammus*, and Whitespotted Greenling, *H. stelleri*. Northwest Sci. 60, 32-35.

Easton, R. R., S. S. Heppell, and R. W. Hannah. 2015. Quantification of habitat and community relationships among nearshore temperate fishes through analysis of drop camera video. Marine and Coastal Fisheries 7, 87-102.

Eschmeyer, W.N., E.S. Herald, and H. Hammann. 1983. A field guide to Pacific coast fishes North America. Houghton Mifflin CO., Boston, MA. 336 p.

Feder, H.M., C.H. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. Calif. Dept. Fish Game, Fish Bull. 160. 144p.

Fitch, J. E. 1953. Extensions to known geographical distributions of some marine fishes on the Pacific Coast. Calif. Fish and Game 39(4). 539-552.

Francis, R. 2011. Data weighting in statistical fisheries stock assessment models. Canadian 2487 Journal of Fisheries and Aquatic Sciences 68: 1124–1138.

Freiwald, J., N.L. Stewart, D.C. Yates, and G. Bernardi. 2009. Isolation and characterization of nine polymorphic microsatellite loci of the Kelp Greenling, *Hexagrammos decagrammus*, a temperate reef fish. Molecular Ecology Resources 9, 563-565.

Frid, A., J. Marliave, and M. R. Heithaus. 2012. Interspecific variation in life history relates to antipredator decisions by marine mesopredators on temperate reefs. PloS one, 7(6), e40083.

Fox, D., A. Merems, J. Golden, and M. Amend. 1996. 1996 Kelp / Reef Assessment. Oregon Department of Fish and Wildlife. Newport, OR. 61 p.

Fox, D., A. Merems, M. Amend, H. Weeks, C. Romsos, M. Appy. 2004. Comparative characterization of two nearshore rocky reef areas: a high-use recreational fishing reef vs. and unfished reef. Oregon Department of Fish and Wildlife. Newport, OR. 66 p.

Goldfinger C, S.K. Henkel, C. Romsos, A. Havron, and B. Black. 2014. Benthic Habitat Characterization Offshore the Pacific Northwest Volume 1: Evaluation of Continental Shelf Geology. US Dept. of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region. OCS Study BOEM 2014-662. 161 pp.

Gorbunova, N.N. 1970. Spawning and development of greenlings (Family Hexagrammidae). *In*: T.S. Rass (Editor), Greenlings: Taxonomy, Biology, Interoceanic Transplantation, p. 121-185. Academy of Sciences of the USSR, Transactions of the Institute of Oceanology, Volume 59. Translated from Russian by the Israel Program for Scientific Translations, Jerusalem.

Greene, H.G., M.M. Yoklavich, R.M. Starr, V.M. O'Connell, W.W. Wakefield, D.E. Sullivan, J.E. McRea, G.M. Cailliet. 1999. A classification scheme for deep seafloor habitats. Oceanologica Acta. Volume 22, Issue 6. Pp 663-678.

Hamel, O.S. 2015. A method for calculating a meta-analytical prior for the natural mortality rate using multiple life history correlates. ICES Journal of Marine Science 72(1), 62-69.

Hamel, O. S. 2015. A method for calculating a meta-analytical prior for the natural mortality rate using multiple life-history correlates. ICES Journal of Marine Science 72(1): 62-69.

Hannah, R. W. and M. T. O. Blume. 2014. The influence of bait and stereo video on the performance of a video lander as a survey tool for marine demersal reef fishes in Oregon waters. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science 6:181-189.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82: 898-902.

Howard, D. and K.R. Silberberg. 2001. Kelp Greenling. *In*: California's Living Resources. *In*: W.S. Leet, C.M. Dewees, R. Klingbeil, and R.J. Larson. California's Living Marine Resources. A Status Report. Sacramento. California Department of Fish and Game. UC DANR Pub. SG01-11. p. 183-184.

Jagielo, T.H., F.R. Wallace and Y.W. Cheng. 2004. Assessment of lingcod (*Ophiodon elongatus*) for the Pacific Fishery Management Council in 2003. *In* Status of the Pacific coast Groundfish fishery through 2004. Stock assessment and fishery evaluation: stock assessments and rebuilding plans. Vol. I. Pacific Fishery Management Council, Portland, Oregon.

Karnowski, M., V. Gertseva, and A. Stephens. 2014. Historical reconstruction of Oregon's commercial fisheries landings. Oregon Department of Fish and Wildlife, Info. Rep. No. 2014-02.

Kimura, D., R. Mandapat, and S. Oxford. 1979. Method, validity, and variability in the age determination of yellowtail rockfish (Sebastes flavidus), using otoliths. Journal of the Fisheries Research Board of Canada 35, 377–383.

Kurita, Y., M. Sano, and M Shimizu. 1995. Reproductive cycle and body size and age at maturity of the Hexagrammid fish *Hexagrammos agrammus* in central Japan. Fish. Sci. 61:1-6.

Lo, N.C.H., L.D. Jackobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Love, M. S, L. Thorsteinson, C. W. Mecklenburg and T. A. Mecklenburg. 1996. A checklist of marine and estuarine fishes of the Northeast Pacific, from Alaska to Baja California. National Biological Service. Located at website http://id-www.ucsb.edu/lovelab/list.html.

Love, M. S. 2011. Certainly more than you want to know about the fishes of the Pacific coast: A postmodern experience. Really Big Press. Santa Barbara, CA. 650 p.

Matarese, A.C., A.W. Kendall, Jr., D.M. Blood, and B.M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. NOAA Technical Report No. 80. 652 p.

McAllister, M.K. and J.N. Ianelli 1997. Bayesian stock assessment using catch-age data and the sampling-importance resampling algorithm. *Can. J. Fish. Aquatic Sci.* 54: 284-300.

Miller, B., D. Fox, A. Merems, and M. Amend. 1997. 1997 Kelp / Reef Habitat Assessment. Oregon Department of Fish and Wildlife. Newport, OR. 40 p.

Miller, D.J., and R.J. Lea. 1972. Guide to the coastal marine fishes of California. Dept Fish Game Fish Bull. 157, 249 p.

Matthews, K. R. 1985. Species similarity and movement of fishes on natural and artificial reefs in Monterey Bay, California. Bull. Marine Sci. 37(1), 252-270.

McCoy, W.M., and J.F. Gillooly. 2008. Predicting natural mortality rates of plants and animals. Ecol. Lett. 11, 710-716.

Methot, R. 2005. User Manual for the Assessment Program Stock Synthesis 2 (SS2). Model Version 1.19. April. 47 p.

Methot, R.D., and C.R. Wetzel. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fish. Res. 142:86-99.

Monk, M., E. Dick, T. Buell, L. ZumBrunnen, A. Dauble, and D. Pearson. 2013. Documentation of a relational database for the Oregon Sport Groundfish Onboard Sampling Program. U.S. Department of Commerce. NOAA-TM-NMFS-SWFSC-519.

Moulton, L.L. 1977. An ecological analysis of fishes inhabiting the rocky nearshore regions of northern Puget Sound, Washington. Ph.D. Thesis. University of Washington. 182 p.

Nemeth, D. H. 1997. Modulation of attack behavior and its effect on feeding performance in a trophic generalist fish, *Hexagrammos decagrammus*. Journal of Exper. Bio. 200:2155-2164.

Oregon Department of Fish and Wildlife (ODFW). 2002. An Interim Management Plan for Oregon's Nearshore Commercial Fisheries. Marine Resources Program. Newport, OR. 109 p. http://www.dfw.state.or.us/MRP/publications/docs/northshore_comm_fisheries.pdf

Oregon Department of Fish and Wildlife (ODFW). 2015. Marine Fisheries Management Plan Framework. Marine Resources Program. Newport, OR. 50 p. http://www.dfw.state.or.us/MRP/publications/docs/MFMP%20Framework_01-09-15.pdf

Pacunski, R. E. and W. A. Palsson. 2001. Macro- and micro-habitat relationships of adult and sub-adult rockfish, lingcod, and Kelp Greenling in Puget Sound. Puget Sound Research. (http://archives.eopugetsound.org/conf/2001PS_ResearchConference/sessions/oral/6a_pacun.pdf)

Palumbi, S.R. 2003. Populations genetics, demographic connectivity, and the design of marine reserves. Ecol. App. 13(1): S146-S158.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. de Conseil International pour l'Exploration de la Mer, 39, 175-192.

Pikitch, E.K., D.L. Erikson, and J.R. Wallace. 1988. An evaluation of the effectiveness of trip limits as a management tool. NOAA, NMFS, NWAFC Processed Report 88-27. 33 p.

Potts, G. W. 1984. Paternal behavior in temperate marine teleosts with special reference to the development of nest structures. Fish reproduction strategies and tactics 223-244.

Ralston, S., D.E. Pearson, J. Field, and M. Key. 2010. Documentation of the California Catch NOAA Technical Memorandum NMFS-SWFSC 461.

Robinson, D.G., W.E. Barraclough, and J.D. Fulton. 1968a. Data Record. Number, size composition, weight and food of larval and juvenile fish caught with a two-boat surface trawl in the Strait of Georgia May 1-4, 1967. Fisheries Research Board of Canada Manuscript Report Series No. 964, 105 p.

Robinson, D.G., W.E. Barraclough, and J.D. Fulton. 1968b. Data Record. Number, size composition, weight and food of larval and juvenile fish caught with a two-boat surface trawl in the Strait of Georgia June 5-9, 1967. Fisheries Research Board of Canada Manuscript Report Series No. 972, 109 p.

Rodomsky, B., G. Krutzikowsky, R. Ireland, and R. Calavan. 2014. The 2013 Oregon commercial nearshore fishery summary. Oregon Dept. of Fish & Wildlife. Marine Program Data Series Report.

Rodomsky, B. T., L. A. Kautzi, R. H. Hannah, and C. D. Good. 2015. Kelp Greenling (*Hexagrammos decagrammus*) growth, spawning seasonality, and female length at maturity based on histological evaluation of ovaries from Oregon waters. Oregon Dept. Fish Wildl., Information Rept. Ser., Fish No. 2015-02. 26 p.

Rogers, J.B. 2003. Species allocation of Sebastes and Sebastolobus sp. Caught by foreign countries of Washington, Oregon, and California, U.S.A. in 1965-1976. NMFS, Northwest Science Center.

Rosenthal, R. J. 1980. Shallow water fish assemblages in the northeastern Gulf of Alaska: habitat evaluation, species composition, abundance, spatial distribution and trophic interaction. *In* Outer continental shelf environmental assessment program. Final Reports of Principle Investigators (Vol. 17, pp. 451-540).

Rothrock, G.C. 1983. Age-length, weight, fecundity, and meristics of the Kelp Greenling (Hexagrammos decagrammus) off California. M.S. Thesis, University of California, Davis. 95 p.

Schnute, J., 1981. A versatile growth model with statistically stable parameters, Can. J. Fish Aquat. Sci. 38, 1128-1140

Siegle, M. R., L. Clifford, K. Robinson, and J. Yakimishyn. 2014. The effect of region, body size, and sample size on the weight-length relationships of small-bodied fishes found in eelgrass meadows. Northwest Sci. 88 (2), 140-154.

Somers, K.A., M. Bellman, J. Jannot, N. Riley, and J. McVeigh. 2014. Estimated discard and catch of groundfish species in the 2013 US west coast fisheries. NOAA Fisheries, NWFSC Observer Program, 2725 Montlake Blvd E., Seattle, WA 98112.

Starr, R.M., J.M. Cope and L.A. Kerr. 2002. Trends in Fisheries and Fishery Resources Associated with the Monterey Bay National Marine Sanctuary From 1981-2000. La Jolla, California, California Sea Grant College Program.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data 2573 for purposes of estimating CPUE. Fisheries Research 70: 299–310.

Then, A.Y., J.M. Hoenig, N.G. Hall, and D.A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES J. of Mar. Sci. 72, 82-92.

Van Voorhees, D., Hoffman, A., Lowther, A., Van Buskirk, W., Weinstein, J., and White, J. 2000. An evaluation of alternative estimators of ocean-boat fish effort and catch in Oregon. The Pacific RecFIN Statistics Subcommittee, http://old.recfin.org/lib/RecFIN_ORBS_ MRFSS_Comparison.PDF.

von Bertalanffy, L. 1938. A quantitative theory of organic growth (inquiries on growth laws. II). Human Biology 10(2): 181-213.

Zahr, C. R. 1984. Effects of salinity on the tolerance, growth, food conversion and oxygen consumption of Kelp Greenling (Hexagrammos decagrammus). M. S. Thesis. Oregon State University.

Zontek, T. 1982. Aboriginal Fishing at Seal Rock (35-LC-14) and Neptune (35-LA-3): Late Archaeological Sites on the Central Oregon Coast. M. S. Thesis. Oregon State University. 121p.

9 Tables

Table 1. State of Oregon recreational and commercial annual landing caps for the Greenling complex, 2003-2015.

	Landing Cap (mt)	
Year	**Recreational**	**Commercial**
2003	5.2	19.5
2004	5.2	23.4
2005	5.2	23.4
2006	5.2	23.4
2007	5.2	23.4
2008	5.2	23.4
2009	5.2	23.4
2010	5.2	23.4
2011	5.2	23.4
2012	5.2	23.4
2013	5.2	23.4
2014	5.2	23.4
2015	5.2	23.4

Table 2. Oregon commercial bimonthly trip limits for the greenling complex, 2003-2015.

Year	Bimonthly Trip Limit (lbs)
2003	350
2004	350
July 27th	*600*
Sept. 28th	*closed*
2005	350
May 1st	*225*
August 4th	*175*
Dec. 1st	*275*
2006*	100
July 1st	*200*
August 11th	*400*
Oct 1st	*600*
2007	400
Sept. 1st	*800*
Nov. 28th	*closed*
2008	450
2009	450
May 1st	*250*
July 1st	*150*
2010	250
Oct. 15th	*300*
2011	250
2012	250
Sept. 1st	*400*
2013	300
2014	300
Oct. 13th	*350*
2015	300

Inseason changes in *italics*
* - In 2006 one-month trip limits were implemented

Table 3. Commercial removals (mt) from northern and southern regions of Oregon. The regional boundary was set at the PFMC management line of 44° 18' N latitude (near Florence, OR).

Year	North Landings	North Discards	North Removals	South Landings	South Discards	South Removals	Total Landings	Total Discards	Total Removals	Landings Source	Discards Source
1915	0	0	0	0	0	0	0	0	0	-	-
1916	0	0	0	0	0	0	0	0	0	-	-
1917	0	0	0	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	0	0	0	0	0	0	0	0	0	-	-
1986	0	0	0	0	0	0	0	0	0	-	-
1987	0	0	0	0	0	0	0	0	0	-	-
1988	0.02	0.00	0.03	0.06	0.00	0.06	0.08	0.00	0.08	PacFIN	WCGOP
1989	0.08	0.00	0.08	0.00	0.00	0.00	0.08	0.00	0.08	PacFIN	WCGOP
1990	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	PacFIN	WCGOP
1991	0.01	0.00	0.02	0.01	0.00	0.01	0.02	0.00	0.02	PacFIN	WCGOP
1992	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.02	PacFIN	WCGOP
1993	0.06	0.00	0.06	0.02	0.00	0.02	0.08	0.00	0.09	PacFIN	WCGOP
1994	0.15	0.00	0.16	0.03	0.00	0.03	0.18	0.00	0.19	PacFIN	WCGOP
1995	0.00	0.00	0.00	0.04	0.00	0.04	0.04	0.00	0.04	PacFIN	WCGOP
1996	0.00	0.00	0.00	0.67	0.01	0.69	0.68	0.01	0.69	PacFIN	WCGOP
1997	0.00	0.00	0.00	10.80	0.23	11.03	10.80	0.23	11.03	PacFIN	WCGOP
1998	0.00	0.00	0.00	10.04	0.22	10.26	10.04	0.22	10.26	PacFIN	WCGOP
1999	0.00	0.00	0.00	25.15	0.54	25.69	25.15	0.54	25.69	PacFIN	WCGOP
2000	0.00	0.00	0.00	19.83	0.43	20.26	19.83	0.43	20.26	PacFIN	WCGOP
2001	0.01	0.00	0.01	29.53	0.64	30.17	29.54	0.64	30.17	PacFIN	WCGOP
2002	0.00	0.00	0.00	54.64	1.18	55.82	54.64	1.18	55.82	PacFIN	WCGOP
2003	0.00	0.00	0.00	20.52	0.44	20.97	20.52	0.44	20.97	PacFIN	WCGOP
2004	0.00	0.00	0.00	23.78	0.51	24.29	23.78	0.51	24.29	PacFIN	WCGOP
2005	0.00	0.00	0.00	21.38	0.46	21.84	21.38	0.46	21.84	PacFIN	WCGOP
2006	0.00	0.00	0.00	14.83	0.32	15.14	14.83	0.32	15.14	PacFIN	WCGOP
2007	0.00	0.00	0.00	18.72	0.40	19.13	18.72	0.40	19.13	PacFIN	WCGOP
2008	0.00	0.00	0.00	22.43	0.48	22.91	22.43	0.48	22.91	PacFIN	WCGOP
2009	0.00	0.00	0.00	21.05	0.45	21.50	21.05	0.45	21.50	PacFIN	WCGOP
2010	0.00	0.00	0.00	18.73	0.40	19.13	18.73	0.40	19.13	PacFIN	WCGOP
2011	0.00	0.00	0.00	21.25	0.46	21.70	21.25	0.46	21.70	PacFIN	WCGOP
2012	0.01	0.00	0.01	19.43	0.42	19.85	19.44	0.42	19.86	PacFIN	WCGOP
2013	0.01	0.00	0.01	22.35	0.48	22.83	22.35	0.48	22.83	PacFIN	WCGOP
2014	0.00	0.00	0.00	15.72	0.34	16.06	15.72	0.34	16.06	PacFIN	WCGOP

Table 4. Recreational removals (mt) for the ocean-boat fishing mode from northern and southern regions of Oregon. The regional boundary was set at the PFMC management line of 44° 18' N latitude (near Florence, OR).

Year	North Landings	North Discards	North Removals	South Landings	South Discard	South Removals	Total Landings	Total Discard	Total Removals	Source
1915	0	0	0	0	0	0	0	0	0	-
1916	0	0	0	0	0	0	0	0	0	-
1917	0	0	0	0	0	0	0	0	0	-
…	0	0	0	0	0	0	0	0	0	-
…	0	0	0	0	0	0	0	0	0	-
1970	0	0	0	0	0	0	0	0	0	-
1971	0	0	0	0	0	0	0	0	0	-
1972	0	0	0	0	0	0	0	0	0	-
1973	1.04	0.02	1.06	0.56	0.01	0.57	1.61	0.03	1.63	ODFW Reconstruction
1974	1.40	0.02	1.42	0.75	0.01	0.77	2.15	0.03	2.18	ODFW Reconstruction
1975	1.54	0.02	1.57	0.83	0.01	0.84	2.37	0.04	2.41	ODFW Reconstruction
1976	3.32	0.05	3.37	1.79	0.03	1.82	5.11	0.08	5.19	ODFW Reconstruction
1977	2.79	0.04	2.84	1.51	0.02	1.53	4.30	0.07	4.37	ODFW Reconstruction
1978	6.97	0.11	7.08	3.76	0.06	3.82	10.72	0.17	10.89	ODFW Reconstruction
1979	5.58	0.09	5.67	2.06	0.03	2.09	7.64	0.12	7.76	ODFW Reconstruction
1980	3.85	0.06	3.91	1.38	0.02	1.41	5.23	0.08	5.32	ODFW Reconstruction
1981	4.44	0.07	4.51	3.30	0.05	3.36	7.75	0.12	7.87	ODFW Reconstruction
1982	2.74	0.04	2.78	2.56	0.04	2.61	5.30	0.08	5.39	ODFW Reconstruction
1983	2.72	0.04	2.76	1.14	0.02	1.16	3.86	0.06	3.92	ODFW Reconstruction
1984	2.08	0.03	2.11	0.96	0.02	0.97	3.04	0.05	3.09	ODFW Reconstruction
1985	1.01	0.02	1.02	0.82	0.01	0.84	1.83	0.03	1.86	ODFW Reconstruction
1986	2.20	0.04	2.23	1.23	0.02	1.25	3.43	0.05	3.48	ODFW Reconstruction
1987	2.48	0.04	2.52	1.09	0.02	1.11	3.58	0.06	3.63	ODFW Reconstruction
1988	1.42	0.02	1.44	0.79	0.01	0.80	2.21	0.04	2.25	ODFW Reconstruction
1989	2.00	0.03	2.03	1.27	0.02	1.29	3.26	0.05	3.31	ODFW Reconstruction
1990	1.76	0.03	1.79	1.18	0.02	1.20	2.94	0.05	2.99	ODFW Reconstruction
1991	1.41	0.02	1.43	0.58	0.01	0.59	1.99	0.03	2.02	ODFW Reconstruction
1992	2.17	0.03	2.20	1.24	0.02	1.26	3.41	0.05	3.46	ODFW Reconstruction
1993	2.90	0.05	2.94	1.13	0.02	1.15	4.03	0.06	4.09	ODFW Reconstruction
1994	3.11	0.05	3.16	1.89	0.03	1.92	5.00	0.08	5.08	ODFW Reconstruction
1995	1.85	0.03	1.88	1.80	0.03	1.83	3.65	0.06	3.71	ODFW Reconstruction
1996	2.14	0.03	2.18	1.48	0.02	1.51	3.63	0.06	3.68	ODFW Reconstruction
1997	3.47	0.06	3.52	1.81	0.03	1.84	5.27	0.08	5.36	ODFW Reconstruction
1998	2.32	0.04	2.35	1.12	0.02	1.14	3.44	0.05	3.49	ODFW Reconstruction
1999	3.12	0.05	3.17	2.52	0.04	2.56	5.64	0.09	5.73	ODFW Reconstruction
2000	3.55	0.06	3.61	1.47	0.02	1.49	5.02	0.08	5.10	ODFW Reconstruction
2001	0.88	0.01	0.89	2.71	0.04	2.75	3.59	0.06	3.64	RecFIN
2002	0.98	0.02	1.00	3.13	0.05	3.18	4.11	0.07	4.18	RecFIN
2003	1.16	0.02	1.18	2.92	0.05	2.97	4.08	0.07	4.15	RecFIN
2004	1.50	0.02	1.53	2.26	0.04	2.30	3.77	0.06	3.83	RecFIN
2005	1.53	0.02	1.56	2.37	0.04	2.40	3.90	0.06	3.96	RecFIN
2006	0.70	0.01	0.72	1.97	0.03	2.00	2.67	0.04	2.71	RecFIN
2007	0.89	0.01	0.91	2.01	0.03	2.04	2.90	0.05	2.95	RecFIN
2008	1.33	0.02	1.35	2.15	0.03	2.18	3.48	0.06	3.54	RecFIN
2009	1.72	0.03	1.75	3.06	0.05	3.10	4.77	0.08	4.85	RecFIN
2010	3.19	0.05	3.24	4.18	0.07	4.25	7.37	0.12	7.49	RecFIN
2011	2.66	0.04	2.70	3.25	0.05	3.31	5.91	0.09	6.01	RecFIN
2012	2.98	0.05	3.02	3.25	0.05	3.30	6.22	0.10	6.32	RecFIN
2013	3.68	0.06	3.74	4.58	0.07	4.65	8.26	0.13	8.39	RecFIN
2014	1.93	0.03	1.96	2.82	0.05	2.86	4.75	0.08	4.83	RecFIN

Table 5. **Recreational removals (mt) for the estuary-boat fishing mode from northern and southern regions of Oregon. The regional boundary was set at the PFMC management line of 44° 18' N latitude (near Florence, OR).**

Year	North Landings	North Discards	North Removals	South Landings	South Discards	South Removals	Total Landings	Total Discards	Total Removals	Source
1915	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1916	0.70	0.01	0.71	0.90	0.02	0.92	1.60	0.03	1.63	ODFW Reconstruction
1917	0.70	0.01	0.71	0.90	0.02	0.92	1.60	0.03	1.63	ODFW Reconstruction
1918	0.60	0.01	0.61	0.90	0.02	0.92	1.50	0.03	1.53	ODFW Reconstruction
1919	0.80	0.01	0.81	1.10	0.02	1.12	1.90	0.03	1.93	ODFW Reconstruction
1920	0.90	0.02	0.92	1.20	0.02	1.22	2.10	0.04	2.14	ODFW Reconstruction
1921	0.50	0.01	0.51	0.70	0.01	0.71	1.20	0.02	1.22	ODFW Reconstruction
1922	0.50	0.01	0.51	0.70	0.01	0.71	1.20	0.02	1.22	ODFW Reconstruction
1923	0.60	0.01	0.61	0.80	0.01	0.81	1.40	0.02	1.42	ODFW Reconstruction
1924	0.60	0.01	0.61	0.90	0.02	0.92	1.50	0.03	1.53	ODFW Reconstruction
1925	0.70	0.01	0.71	0.90	0.02	0.92	1.60	0.03	1.63	ODFW Reconstruction
1926	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1927	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1928	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1929	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1930	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1931	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1932	0.50	0.01	0.51	0.80	0.01	0.81	1.30	0.02	1.32	ODFW Reconstruction
1933	0.50	0.01	0.51	0.70	0.01	0.71	1.20	0.02	1.22	ODFW Reconstruction
1934	0.60	0.01	0.61	0.90	0.02	0.92	1.50	0.03	1.53	ODFW Reconstruction
1935	0.70	0.01	0.71	0.90	0.02	0.92	1.60	0.03	1.63	ODFW Reconstruction
1936	0.70	0.01	0.71	1.00	0.02	1.02	1.70	0.03	1.73	ODFW Reconstruction
1937	0.80	0.01	0.81	1.10	0.02	1.12	1.90	0.03	1.93	ODFW Reconstruction
1938	0.80	0.01	0.81	1.20	0.02	1.22	2.00	0.03	2.03	ODFW Reconstruction
1939	0.90	0.02	0.92	1.20	0.02	1.22	2.10	0.04	2.14	ODFW Reconstruction
1940	0.90	0.02	0.92	1.30	0.02	1.32	2.20	0.04	2.24	ODFW Reconstruction
1941	1.00	0.02	1.02	1.40	0.02	1.42	2.40	0.04	2.44	ODFW Reconstruction
1942	1.00	0.02	1.02	1.40	0.02	1.42	2.40	0.04	2.44	ODFW Reconstruction
1943	1.10	0.02	1.12	1.60	0.03	1.63	2.70	0.05	2.75	ODFW Reconstruction
1944	1.10	0.02	1.12	1.50	0.03	1.53	2.60	0.05	2.65	ODFW Reconstruction
1945	1.20	0.02	1.22	1.70	0.03	1.73	2.90	0.05	2.95	ODFW Reconstruction
1946	1.50	0.03	1.53	2.20	0.04	2.24	3.70	0.06	3.76	ODFW Reconstruction
1947	1.70	0.03	1.73	2.40	0.04	2.44	4.10	0.07	4.17	ODFW Reconstruction
1948	1.90	0.03	1.93	2.70	0.05	2.75	4.60	0.08	4.68	ODFW Reconstruction
1949	2.00	0.03	2.03	2.80	0.05	2.85	4.80	0.08	4.88	ODFW Reconstruction
1950	2.00	0.03	2.03	2.80	0.05	2.85	4.80	0.08	4.88	ODFW Reconstruction
1951	2.30	0.04	2.34	3.20	0.06	3.26	5.50	0.10	5.60	ODFW Reconstruction
1952	2.40	0.04	2.44	3.40	0.06	3.46	5.80	0.10	5.90	ODFW Reconstruction
1953	2.40	0.04	2.44	3.40	0.06	3.46	5.80	0.10	5.90	ODFW Reconstruction
1954	2.50	0.04	2.54	3.50	0.06	3.56	6.00	0.10	6.10	ODFW Reconstruction
1955	2.50	0.04	2.54	3.50	0.06	3.56	6.00	0.10	6.10	ODFW Reconstruction
1956	2.60	0.05	2.65	3.60	0.06	3.66	6.20	0.11	6.31	ODFW Reconstruction
1957	2.70	0.05	2.75	3.70	0.06	3.76	6.40	0.11	6.51	ODFW Reconstruction
1958	2.60	0.05	2.65	3.60	0.06	3.66	6.20	0.11	6.31	ODFW Reconstruction
1959	2.60	0.05	2.65	3.60	0.06	3.66	6.20	0.11	6.31	ODFW Reconstruction
1960	2.70	0.05	2.75	3.70	0.06	3.76	6.40	0.11	6.51	ODFW Reconstruction
1961	2.70	0.05	2.75	3.80	0.07	3.87	6.50	0.11	6.61	ODFW Reconstruction
1962	2.80	0.05	2.85	3.90	0.07	3.97	6.70	0.12	6.82	ODFW Reconstruction
1963	2.90	0.05	2.95	4.10	0.07	4.17	7.00	0.12	7.12	ODFW Reconstruction
1964	3.10	0.05	3.15	4.30	0.07	4.37	7.40	0.13	7.53	ODFW Reconstruction
1965	3.20	0.06	3.26	4.50	0.08	4.58	7.70	0.13	7.83	ODFW Reconstruction
1966	3.30	0.06	3.36	4.70	0.08	4.78	8.00	0.14	8.14	ODFW Reconstruction
1967	3.30	0.06	3.36	4.70	0.08	4.78	8.00	0.14	8.14	ODFW Reconstruction
1968	3.10	0.05	3.15	4.30	0.07	4.37	7.40	0.13	7.53	ODFW Reconstruction
1969	3.30	0.06	3.36	4.70	0.08	4.78	8.00	0.14	8.14	ODFW Reconstruction
1970	3.60	0.06	3.66	5.00	0.09	5.09	8.60	0.15	8.75	ODFW Reconstruction

Table 5 continued.

Year	North Landings	North Discards	North Removals	South Landings	South Discards	South Removals	Total Landings	Total Discards	Total Removals	Source
1971	3.60	0.06	3.66	5.10	0.09	5.19	8.70	0.15	8.85	ODFW Reconstruction
1972	4.00	0.07	4.07	5.60	0.10	5.70	9.60	0.17	9.77	ODFW Reconstruction
1973	4.30	0.07	4.37	6.10	0.11	6.21	10.40	0.18	10.58	ODFW Reconstruction
1974	4.30	0.07	4.37	6.10	0.11	6.21	10.40	0.18	10.58	ODFW Reconstruction
1975	4.50	0.08	4.58	6.30	0.11	6.41	10.80	0.19	10.99	ODFW Reconstruction
1976	4.30	0.07	4.37	6.10	0.11	6.21	10.40	0.18	10.58	ODFW Reconstruction
1977	4.30	0.07	4.37	6.00	0.10	6.10	10.30	0.18	10.48	ODFW Reconstruction
1978	4.70	0.08	4.78	6.50	0.11	6.61	11.20	0.19	11.39	ODFW Reconstruction
1979	4.80	0.08	4.88	6.80	0.12	6.92	11.60	0.20	11.80	ODFW Reconstruction
1980	6.20	0.11	6.31	14.60	0.25	14.85	20.80	0.36	21.16	MRFSS - corrected
1981	2.30	0.04	2.34	4.20	0.07	4.27	6.50	0.11	6.61	MRFSS - corrected
1982	1.60	0.03	1.63	3.00	0.05	3.05	4.60	0.08	4.68	MRFSS - corrected
1983	4.50	0.08	4.58	11.10	0.19	11.29	15.60	0.27	15.87	MRFSS - corrected
1984	5.10	0.09	5.19	2.80	0.05	2.85	7.90	0.14	8.04	MRFSS - corrected
1985	1.60	0.03	1.63	1.60	0.03	1.63	3.20	0.06	3.26	MRFSS - corrected
1986	2.20	0.04	2.24	3.00	0.05	3.05	5.20	0.09	5.29	MRFSS - corrected
1987	12.10	0.21	12.31	8.70	0.15	8.85	20.80	0.36	21.16	MRFSS - corrected
1988	4.00	0.07	4.07	7.50	0.13	7.63	11.50	0.20	11.70	MRFSS - corrected
1989	0.30	0.01	0.31	1.10	0.02	1.12	1.40	0.02	1.42	MRFSS - corrected
1990	2.40	0.04	2.44	3.80	0.07	3.87	6.20	0.11	6.31	ODFW Reconstruction
1991	4.80	0.08	4.88	3.80	0.07	3.87	8.60	0.15	8.75	ODFW Reconstruction
1992	7.90	0.14	8.04	3.00	0.05	3.05	10.90	0.19	11.09	ODFW Reconstruction
1993	8.70	0.15	8.85	1.10	0.02	1.12	9.80	0.17	9.97	MRFSS - corrected
1994	3.60	0.06	3.66	1.40	0.02	1.42	5.00	0.09	5.09	MRFSS - corrected
1995	1.70	0.03	1.73	0.80	0.01	0.81	2.50	0.04	2.54	MRFSS - corrected
1996	1.80	0.03	1.83	2.90	0.05	2.95	4.70	0.08	4.78	MRFSS - corrected
1997	4.10	0.07	4.17	3.00	0.05	3.05	7.10	0.12	7.22	MRFSS - corrected
1998	0.30	0.01	0.31	1.40	0.02	1.42	1.70	0.03	1.73	MRFSS - corrected
1999	1.30	0.02	1.32	2.30	0.04	2.34	3.60	0.06	3.66	MRFSS - corrected
2000	1.80	0.03	1.83	0.80	0.01	0.81	2.60	0.05	2.65	MRFSS - corrected
2001	3.10	0.05	3.15	3.50	0.06	3.56	6.60	0.11	6.71	MRFSS - corrected
2002	5.40	0.09	5.49	10.80	0.19	10.99	16.20	0.28	16.48	MRFSS - corrected
2003	14.10	0.24	14.34	8.30	0.14	8.44	22.40	0.39	22.79	MRFSS - corrected
2004	0.40	0.01	0.41	0.30	0.01	0.31	0.70	0.01	0.71	MRFSS - corrected
2005	1.20	0.02	1.22	0.80	0.01	0.81	2.00	0.03	2.03	MRFSS - corrected
2006	2.30	0.04	2.34	3.30	0.06	3.36	5.60	0.10	5.70	ODFW Reconstruction
2007	2.30	0.04	2.34	3.30	0.06	3.36	5.60	0.10	5.70	ODFW Reconstruction
2008	2.30	0.04	2.34	3.30	0.06	3.36	5.60	0.10	5.70	ODFW Reconstruction
2009	2.20	0.04	2.24	3.20	0.06	3.26	5.40	0.09	5.49	ODFW Reconstruction
2010	2.20	0.04	2.24	3.20	0.06	3.26	5.40	0.09	5.49	ODFW Reconstruction
2011	2.20	0.04	2.24	3.20	0.06	3.26	5.40	0.09	5.49	ODFW Reconstruction
2012	2.20	0.04	2.24	3.20	0.06	3.26	5.40	0.09	5.49	ODFW Reconstruction
2013	2.20	0.04	2.24	3.10	0.05	3.15	5.30	0.09	5.39	ODFW Reconstruction
2014	2.20	0.04	2.24	3.10	0.05	3.15	5.30	0.09	5.39	ODFW Reconstruction

Table 6. **Recreational removals (mt) for the shore fishing mode from northern and southern regions of Oregon. The regional boundary was set at the PFMC management line of 44° 18' N latitude (near Florence, OR).**

Year	North Landings	North Discards	North Total	South Landings	South Discards	South Total	Total Landings	Total Discards	Total Removals	Source
1915	0.80	-	0.80	0.90	-	0.90	1.70	0.00	1.70	ODFW Reconstruction
1916	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1917	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1918	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1919	0.80	-	0.80	1.00	-	1.00	1.80	0.00	1.80	ODFW Reconstruction
1920	0.90	-	0.90	1.10	-	1.10	2.00	0.00	2.00	ODFW Reconstruction
1921	0.60	-	0.60	0.70	-	0.70	1.30	0.00	1.30	ODFW Reconstruction
1922	0.50	-	0.50	0.60	-	0.60	1.10	0.00	1.10	ODFW Reconstruction
1923	0.60	-	0.60	0.70	-	0.70	1.30	0.00	1.30	ODFW Reconstruction
1924	0.70	-	0.70	0.80	-	0.80	1.50	0.00	1.50	ODFW Reconstruction
1925	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1926	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1927	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1928	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1929	0.80	-	0.80	0.90	-	0.90	1.70	0.00	1.70	ODFW Reconstruction
1930	0.80	-	0.80	1.00	-	1.00	1.80	0.00	1.80	ODFW Reconstruction
1931	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1932	0.60	-	0.60	0.70	-	0.70	1.30	0.00	1.30	ODFW Reconstruction
1933	0.50	-	0.50	0.60	-	0.60	1.10	0.00	1.10	ODFW Reconstruction
1934	0.70	-	0.70	0.80	-	0.80	1.50	0.00	1.50	ODFW Reconstruction
1935	0.70	-	0.70	0.90	-	0.90	1.60	0.00	1.60	ODFW Reconstruction
1936	0.80	-	0.80	1.00	-	1.00	1.80	0.00	1.80	ODFW Reconstruction
1937	0.90	-	0.90	1.10	-	1.10	2.00	0.00	2.00	ODFW Reconstruction
1938	0.90	-	0.90	1.10	-	1.10	2.00	0.00	2.00	ODFW Reconstruction
1939	0.90	-	0.90	1.20	-	1.20	2.10	0.00	2.10	ODFW Reconstruction
1940	1.00	-	1.00	1.20	-	1.20	2.20	0.00	2.20	ODFW Reconstruction
1941	1.10	-	1.10	1.30	-	1.30	2.40	0.00	2.40	ODFW Reconstruction
1942	1.10	-	1.10	1.40	-	1.40	2.50	0.00	2.50	ODFW Reconstruction
1943	1.20	-	1.20	1.50	-	1.50	2.70	0.00	2.70	ODFW Reconstruction
1944	1.20	-	1.20	1.50	-	1.50	2.70	0.00	2.70	ODFW Reconstruction
1945	1.30	-	1.30	1.60	-	1.60	2.90	0.00	2.90	ODFW Reconstruction
1946	1.70	-	1.70	2.00	-	2.00	3.70	0.00	3.70	ODFW Reconstruction
1947	1.90	-	1.90	2.30	-	2.30	4.20	0.00	4.20	ODFW Reconstruction
1948	2.10	-	2.10	2.50	-	2.50	4.60	0.00	4.60	ODFW Reconstruction
1949	2.10	-	2.10	2.60	-	2.60	4.70	0.00	4.70	ODFW Reconstruction
1950	2.10	-	2.10	2.60	-	2.60	4.70	0.00	4.70	ODFW Reconstruction
1951	2.40	-	2.40	3.00	-	3.00	5.40	0.00	5.40	ODFW Reconstruction
1952	2.60	-	2.60	3.20	-	3.20	5.80	0.00	5.80	ODFW Reconstruction
1953	2.60	-	2.60	3.20	-	3.20	5.80	0.00	5.80	ODFW Reconstruction
1954	2.70	-	2.70	3.40	-	3.40	6.10	0.00	6.10	ODFW Reconstruction
1955	2.70	-	2.70	3.30	-	3.30	6.00	0.00	6.00	ODFW Reconstruction
1956	2.70	-	2.70	3.40	-	3.40	6.10	0.00	6.10	ODFW Reconstruction
1957	2.90	-	2.90	3.50	-	3.50	6.40	0.00	6.40	ODFW Reconstruction
1958	2.80	-	2.80	3.40	-	3.40	6.20	0.00	6.20	ODFW Reconstruction
1959	2.80	-	2.80	3.40	-	3.40	6.20	0.00	6.20	ODFW Reconstruction
1960	2.90	-	2.90	3.50	-	3.50	6.40	0.00	6.40	ODFW Reconstruction
1961	2.90	-	2.90	3.60	-	3.60	6.50	0.00	6.50	ODFW Reconstruction
1962	3.00	-	3.00	3.70	-	3.70	6.70	0.00	6.70	ODFW Reconstruction
1963	3.20	-	3.20	3.90	-	3.90	7.10	0.00	7.10	ODFW Reconstruction
1964	3.30	-	3.30	4.10	-	4.10	7.40	0.00	7.40	ODFW Reconstruction
1965	3.40	-	3.40	4.20	-	4.20	7.60	0.00	7.60	ODFW Reconstruction
1966	3.60	-	3.60	4.40	-	4.40	8.00	0.00	8.00	ODFW Reconstruction
1967	3.60	-	3.60	4.40	-	4.40	8.00	0.00	8.00	ODFW Reconstruction
1968	3.30	-	3.30	4.10	-	4.10	7.40	0.00	7.40	ODFW Reconstruction
1969	3.60	-	3.60	4.40	-	4.40	8.00	0.00	8.00	ODFW Reconstruction
1970	3.90	-	3.90	4.80	-	4.80	8.70	0.00	8.70	ODFW Reconstruction

Table 6 continued.

Year	North Landings	North Discards	North Total	South Landings	South Discards	South Total	Total Landings	Total Discards	Total Removals	Source
1971	3.90	-	3.90	4.80	-	4.80	8.70	0.00	8.70	ODFW Reconstruction
1972	4.30	-	4.30	5.30	-	5.30	9.60	0.00	9.60	ODFW Reconstruction
1973	4.60	-	4.60	5.70	-	5.70	10.30	0.00	10.30	ODFW Reconstruction
1974	4.70	-	4.70	5.80	-	5.80	10.50	0.00	10.50	ODFW Reconstruction
1975	4.80	-	4.80	6.00	-	6.00	10.80	0.00	10.80	ODFW Reconstruction
1976	4.70	-	4.70	5.80	-	5.80	10.50	0.00	10.50	ODFW Reconstruction
1977	4.60	-	4.60	5.70	-	5.70	10.30	0.00	10.30	ODFW Reconstruction
1978	5.00	-	5.00	6.20	-	6.20	11.20	0.00	11.20	ODFW Reconstruction
1979	5.20	-	5.20	6.40	-	6.40	11.60	0.00	11.60	ODFW Reconstruction
1980	8.30	-	8.30	1.90	-	1.90	10.20	0.00	10.20	MRFSS - corrected
1981	16.80	-	16.80	1.80	-	1.80	18.60	0.00	18.60	MRFSS - corrected
1982	7.80	-	7.80	2.00	-	2.00	9.80	0.00	9.80	MRFSS - corrected
1983	9.40	-	9.40	4.00	-	4.00	13.40	0.00	13.40	MRFSS - corrected
1984	3.90	-	3.90	0.60	-	0.60	4.50	0.00	4.50	MRFSS - corrected
1985	5.90	-	5.90	2.70	-	2.70	8.60	0.00	8.60	MRFSS - corrected
1986	8.70	-	8.70	2.90	-	2.90	11.60	0.00	11.60	MRFSS - corrected
1987	8.20	-	8.20	5.30	-	5.30	13.50	0.00	13.50	MRFSS - corrected
1988	2.80	-	2.80	4.10	-	4.10	6.90	0.00	6.90	MRFSS - corrected
1989	5.10	-	5.10	2.30	-	2.30	7.40	0.00	7.40	MRFSS - corrected
1990	5.50	-	5.50	2.70	-	2.70	8.20	0.00	8.20	ODFW Reconstruction
1991	7.40	-	7.40	4.00	-	4.00	11.40	0.00	11.40	ODFW Reconstruction
1992	9.10	-	9.10	5.40	-	5.40	14.50	0.00	14.50	ODFW Reconstruction
1993	12.90	-	12.90	8.40	-	8.40	21.30	0.00	21.30	MRFSS - corrected
1994	2.50	-	2.50	2.40	-	2.40	4.90	0.00	4.90	MRFSS - corrected
1995	3.00	-	3.00	2.60	-	2.60	5.60	0.00	5.60	MRFSS - corrected
1996	4.30	-	4.30	2.80	-	2.80	7.10	0.00	7.10	MRFSS - corrected
1997	4.70	-	4.70	3.10	-	3.10	7.80	0.00	7.80	MRFSS - corrected
1998	1.40	-	1.40	1.70	-	1.70	3.10	0.00	3.10	MRFSS - corrected
1999	3.30	-	3.30	0.80	-	0.80	4.10	0.00	4.10	MRFSS - corrected
2000	7.80	-	7.80	5.60	-	5.60	13.40	0.00	13.40	MRFSS - corrected
2001	11.00	-	11.00	6.50	-	6.50	17.50	0.00	17.50	MRFSS - corrected
2002	11.70	-	11.70	12.00	-	12.00	23.70	0.00	23.70	MRFSS - corrected
2003	7.30	-	7.30	6.40	-	6.40	13.70	0.00	13.70	MRFSS - corrected
2004	3.90	0.06	3.96	1.90	0.03	1.93	5.80	0.09	5.89	MRFSS - corrected
2005	2.00	0.03	2.03	1.70	0.03	1.73	3.70	0.05	3.75	MRFSS - corrected
2006	4.40	0.07	4.47	3.10	0.05	3.15	7.50	0.11	7.61	ODFW Reconstruction
2007	4.40	0.07	4.47	3.00	0.04	3.04	7.40	0.11	7.51	ODFW Reconstruction
2008	4.40	0.07	4.47	3.00	0.04	3.04	7.40	0.11	7.51	ODFW Reconstruction
2009	4.30	0.06	4.36	3.00	0.04	3.04	7.30	0.11	7.41	ODFW Reconstruction
2010	4.30	0.06	4.36	3.00	0.04	3.04	7.30	0.11	7.41	ODFW Reconstruction
2011	4.30	0.06	4.36	3.00	0.04	3.04	7.30	0.11	7.41	ODFW Reconstruction
2012	4.30	0.06	4.36	2.90	0.04	2.94	7.20	0.11	7.31	ODFW Reconstruction
2013	4.20	0.06	4.26	2.90	0.04	2.94	7.10	0.11	7.21	ODFW Reconstruction
2014	4.20	0.06	4.26	2.90	0.04	2.94	7.10	0.11	7.21	ODFW Reconstruction

Table 7. Logbook filtering criteria and resulting sample sizes used for Kelp Greenling. Bold value indicates the final trip-level sample size used for delta-GLM analysis.

Filter	Criteria	Sample size	Level
Full Data Set	All data	26,592	Set
Gear type	Hook-and-line only	22,735	Set
Port	Port Orford, Gold Beach, and Brookings	17,100	Set
Depth	Valid set starting depth (<= 30 fm; 54.9 m)	15,663	Set
Hooks	Valid hook count (1 - 100)	15,552	Set
Hours	Valid hours fishing (0.1 - 20)	15,180	Set
People	Valid number of fishermen onboard (>=1)	14,976	Set
Nearshore Endorsed	Nearshore endorsed vessel only	13,262	Set
Vessel	Completed at least one set in at least three years (2004 – 2013)	11,931	Set
Period Limit	Set occurred prior to breaching Kelp Greenling trip limit	11,839	Set
Trip	Aggregate multi-set trip to trip level	**9,715**	Trip

Table 8. Abundance indices for Kelp Greenling based on least square means from the delta-GLM model and associated log-scale standard deviation estimates from the final subset of Oregon commercial nearshore logbook submissions.

Year	Index	Log(sd)
2004	0.229	0.199
2005	0.223	0.195
2006	0.181	0.196
2007	0.202	0.196
2008	0.260	0.194
2009	0.219	0.197
2010	0.284	0.194
2011	0.348	0.188
2012	0.304	0.191
2013	0.294	0.192

Table 9. Abundance indices for Kelp Greenling based on least square means from the delta-GLM model and associated jackknife estimates of standard errors from ORBS program.

Year	Index	Log(sd)
2001	0.0433	0.2824
2002	0.0542	0.2387
2003	0.0662	0.2189
2004	0.0584	0.2351
2005	0.0434	0.2987
2006	0.0346	0.3500
2007	0.0404	0.3309
2008	0.0389	0.3017
2009	0.0411	0.2473
2010	0.0665	0.1877
2011	0.0795	0.1671
2012	0.0598	0.1942
2013	0.0597	0.1871
2014	0.0286	0.3817

Table 10. Least square means of the delta-GLM for Kelp Greenling from the ODFW onboard observer program.

Year	Index	Log(sd)
2001	0.0796	0.237
2004	0.1210	0.134
2005	0.1071	0.159
2006	0.0777	0.158
2007	0.0702	0.184
2008	0.0746	0.197
2009	0.0990	0.162
2010	0.1647	0.171
2011	0.1139	0.144
2012	0.0870	0.164
2013	0.0950	0.173
2014	0.0979	0.172

Table 11. Sample sizes for the number of fish sampled by ODFW from the recreational fishery for lengths and ages.

Year	N fish Lengths Ocean	N interviews Lengths Ocean	N fish Lengths Estuary	N interviews Lengths Estuary	N fish Lengths Shore	N interviews Lengths Shore	N fish Ages Ocean
1980	46	31	71	32	529	175	-
1981	46	20	46	19	274	115	-
1982	72	40	52	19	239	125	-
1983	16	11	47	15	211	80	-
1984	71	48	144	35	240	118	-
1985	71	63	84	32	470	256	-
1986	55	47	122	48	353	207	-
1987	58	36	253	55	332	147	-
1988	83	65	139	38	232	89	-
1989	60	40	22	10	155	63	-
1990	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-
1993	135	71	72	20	530	222	-
1994	162	101	60	27	299	138	-
1995	75	49	59	17	246	122	-
1996	87	62	109	27	309	146	-
1997	163	112	85	25	316	134	-
1998	156	104	61	14	93	49	-
1999	298	199	83	27	138	76	-
2000	165	101	31	9	262	97	-
2001	498	302	106	30	153	65	-
2002	1264	655	109	26	300	108	-
2003	1338	729	137	35	308	109	-
2004	1079	574	89	26	211	90	-
2005	1533	905	94	27	107	47	146
2006	1320	763	32	7	-	-	85
2007	1305	718	7	4	-	-	6
2008	1781	956	50	15	-	-	86
2009	1807	1032	13	9	-	-	257
2010	2523	1287	49	15	-	-	271
2011	2423	1104	67	16	-	-	289
2012	2411	1114	18	10	-	-	220
2013	2302	1117	3	1	-	-	184
2014	1045	619	-	-	-	-	-

Table 12. Sample sizes for the number of port samples taken for Kelp Greenling length compositions and the number of individual fish sampled for length and age from the commercial fishery in Oregon.

Year	N port samples with lengths	N fish length samples	N fish aged
1998	5	165	-
1999	8	192	-
2000	90	1442	-
2001	143	2898	-
2002	185	3870	-
2003	77	1696	28
2004	128	2561	2
2005	86	1639	-
2006	129	1993	-
2007	150	2068	12
2008	112	1539	4
2009	113	1146	23
2010	169	1829	34
2011	217	2551	77
2012	138	1597	100
2013	177	2382	69
2014	185	1904	-

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

Parameter	Number Estimated	Bounds (low, high)	Prior (Mean, SD) - Type	Estimate
Biology				
Natural mortality (M) -*female*	0		-	0.360
Natural mortality (M) -*male*	0		-	0.318
L (R_0)	1	(5,15)	-	7.28
Steepness (h)	0		-	0.70
Growth				
Length at age 1 - *female*	1	(-10,30)	(20, 10) - Normal	25.07
Length at age 11 - *female*	1	(20,60)	(38.51, 10) - Normal	36.44
von Bertalnaffy k - f*emale*	1	(0.1,1)	(0.3, 0.5) - Normal	0.26
CV of length at age 0 - *female*	1	(0.05-0.15)	-	0.105
CV of length at age 17 - *female (offset)*	0		-	0.000
Length at age 1 - *male (offset)*	0		-	0.00
Length at age 11 - *male (offset)*	1	(-0.5,0.5)	(0, 0.5) - Normal	-0.019
von Bertalnaffy k - *male (offset)*	0		-	0.00
CV of length at age 0 - *male (offset)*	0		-	0.000
CV of length at age 17 - *male (offset)*	0		-	0.000
Indices				
Extra SD - commercial: logbook	1	(0,1)	-	0.02
Extra SD - ocean: onboard observer	1	(0,1)	-	0.09
Extra SD - ocean: ORBS dockside	1	(0,1)	-	0.02
Selectivity				
<u>Commercial fleet</u>				
Length at peak	1	(24,45)	-	39.20
Top	0	(-10,5)	-	-8.00
Ascending width	1	(0,9)	-	3.20
Decending width	1	(-9,9)	-	0.93
Initial	0	(-9,9)	-	-8.00
Final	1	(-9,9)	-	-1.35
<u>Recreation - ocean fleet</u>				
Length at peak	1	(24,45)	-	39.89
Top	0	(-10,5)	-	-5.00
Ascending width	1	(0,9)	-	3.62
Decending width	0	(0,9)	-	8.00
Initial	0	(-9,9)	-	-8.00
Final	0	(-9,9)	-	8.00
Ascending width (additive time block 1)	1	(-3,0)	-	-0.25
<u>Recreation - estuary fleet</u>				
Length at peak	1	(10,45)	-	12.28
Top	1	(-10,5)	-	-5.16
Ascending width	1	(0,9)	-	4.50
Decending width	1	(-9,9)	-	3.58
Initial	0	(-9,9)	-	-8.00
Final	1	(-9,9)	-	-1.59
<u>Recreation - shore fleet</u>				
Length at peak	0	(6,20)	-	6.00
Top	0	(-10,9)	-	-9.00
Ascending width	0	(0,9)	-	5.00
Decending width	1	(-9,9)	-	3.97
Initial	0	(-9,9)	-	8.00
Final	1	(-9,9)		-5.28

Table 14. Growth parameters estimated in the base model for Kelp Greenling.

Parameter	Female Estimate	Female Standard Error	Male Estimate	Male Standard Error
Length at minimum age	25.07	0.25	25.07	0.25
Length at maximum age	36.44	0.29	35.75	0.19
k (min length to max length)	0.26	0.02	0.26	0.02
CV young	0.105	0.002	0.105	0.002
CV old	0.105	0.002	0.105	0.002

Table 15. Time-series of population estimates for Kelp Greenling from the base case model.

Year	Total Biomass (mt)	Spawning Biomass (mt)	Depletion	Age-0 Recruits	Total Catch (mt)	Relative Exploitation Rate	SPR
1915	1,412	397	1.00	1,451	3.4	0.02	0.99
1916	1,412	396	1.00	1,451	3.2	0.02	0.99
1917	1,412	395	1.00	1,450	3.2	0.02	0.99
1918	1,413	394	0.99	1,450	3.1	0.03	0.99
1919	1,410	393	0.99	1,450	3.7	0.03	0.99
1920	1,408	393	0.99	1,450	4.1	0.02	0.98
1921	1,415	392	0.99	1,449	2.5	0.02	0.99
1922	1,416	392	0.99	1,449	2.3	0.02	0.99
1923	1,414	392	0.99	1,449	2.7	0.02	0.99
1924	1,413	392	0.99	1,449	3.0	0.02	0.99
1925	1,412	392	0.99	1,449	3.2	0.02	0.99
1926	1,412	392	0.99	1,449	3.3	0.02	0.99
1927	1,412	391	0.99	1,449	3.3	0.02	0.99
1928	1,412	391	0.99	1,449	3.3	0.02	0.99
1929	1,411	391	0.99	1,449	3.4	0.03	0.99
1930	1,411	391	0.99	1,449	3.5	0.02	0.99
1931	1,412	391	0.99	1,449	3.3	0.02	0.99
1932	1,415	391	0.99	1,449	2.6	0.02	0.99
1933	1,416	391	0.99	1,449	2.3	0.02	0.99
1934	1,413	391	0.99	1,449	3.0	0.02	0.99
1935	1,412	391	0.99	1,449	3.2	0.03	0.99
1936	1,411	391	0.99	1,449	3.5	0.03	0.99
1937	1,409	391	0.99	1,449	3.9	0.03	0.98
1938	1,409	391	0.99	1,449	4.0	0.03	0.98
1939	1,408	391	0.98	1,449	4.2	0.03	0.98
1940	1,407	390	0.98	1,449	4.4	0.03	0.98
1941	1,405	390	0.98	1,449	4.8	0.04	0.98
1942	1,405	390	0.98	1,448	4.9	0.04	0.98
1943	1,403	389	0.98	1,448	5.4	0.04	0.98
1944	1,403	389	0.98	1,448	5.3	0.04	0.98
1945	1,401	388	0.98	1,448	5.8	0.05	0.98
1946	1,394	388	0.98	1,448	7.4	0.06	0.97
1947	1,390	387	0.98	1,447	8.3	0.07	0.97
1948	1,386	386	0.97	1,447	9.2	0.07	0.96
1949	1,385	385	0.97	1,447	9.5	0.07	0.96
1950	1,385	384	0.97	1,446	9.5	0.08	0.96
1951	1,379	383	0.97	1,446	10.9	0.08	0.96
1952	1,376	382	0.96	1,445	11.6	0.08	0.95
1953	1,375	381	0.96	1,445	11.6	0.09	0.95
1954	1,373	380	0.96	1,444	12.1	0.09	0.95
1955	1,374	379	0.95	1,444	12.0	0.09	0.95
1956	1,372	378	0.95	1,444	12.3	0.09	0.95
1957	1,370	377	0.95	1,443	12.8	0.09	0.95
1958	1,372	377	0.95	1,443	12.4	0.09	0.95
1959	1,372	376	0.95	1,443	12.4	0.09	0.95
1960	1,370	376	0.95	1,443	12.8	0.09	0.95
1961	1,369	375	0.95	1,442	13.0	0.10	0.95
1962	1,367	375	0.95	1,442	13.4	0.10	0.95
1963	1,364	374	0.94	1,442	14.1	0.11	0.94
1964	1,361	374	0.94	1,442	14.8	0.11	0.94
1965	1,359	373	0.94	1,441	15.3	0.10	0.94

Table 15 continued.

Year	Total Biomass (mt)	Spawning Biomass (mt)	Depletion	Age-0 Recruits	Total Catch (mt)	Relative Exploitation Rate	SPR
1966	1,356	372	0.94	1,441	16.0	0.12	0.94
1967	1,356	371	0.94	1,441	16.0	0.12	0.94
1968	1,361	371	0.93	1,440	14.8	0.11	0.94
1969	1,356	371	0.93	1,440	16.0	0.12	0.94
1970	1,350	370	0.93	1,440	17.3	0.13	0.93
1971	1,349	369	0.93	1,440	17.4	0.13	0.93
1972	1,342	368	0.93	1,439	19.2	0.14	0.92
1973	1,331	367	0.93	1,439	22.3	0.16	0.91
1974	1,328	365	0.92	1,438	23.1	0.16	0.91
1975	1,325	363	0.92	1,437	24.0	0.17	0.91
1976	1,320	362	0.91	1,436	26.0	0.18	0.90
1977	1,323	360	0.91	1,435	24.9	0.17	0.90
1978	1,299	358	0.90	1,435	33.1	0.22	0.88
1979	1,303	355	0.90	1,433	30.8	0.21	0.89
1980	1,279	353	0.89	1,286	36.2	0.25	0.86
1981	1,288	350	0.88	1,435	32.8	0.23	0.87
1982	1,342	343	0.87	991	19.7	0.14	0.92
1983	1,276	344	0.87	2,046	32.9	0.25	0.86
1984	1,362	329	0.83	2,111	15.4	0.11	0.94
1985	1,372	346	0.87	3,221	13.6	0.09	0.95
1986	1,362	380	0.96	1,854	20.2	0.11	0.94
1987	1,310	448	1.13	1,890	37.9	0.19	0.89
1988	1,361	480	1.21	1,506	20.7	0.11	0.94
1989	1,387	497	1.25	731	12.1	0.07	0.96
1990	1,361	493	1.24	722	17.3	0.11	0.94
1991	1,330	453	1.14	754	22.0	0.16	0.91
1992	1,290	399	1.01	984	28.8	0.23	0.88
1993	1,249	345	0.87	715	35.2	0.29	0.84
1994	1,348	305	0.77	1,204	15.1	0.13	0.93
1995	1,363	275	0.69	707	11.8	0.11	0.94
1996	1,333	266	0.67	869	16.1	0.16	0.91
1997	1,272	252	0.64	1,536	31.0	0.26	0.85
1998	1,343	237	0.60	1,078	18.3	0.15	0.92
1999	1,270	249	0.63	1,056	38.5	0.28	0.85
2000	1,242	254	0.64	3,113	40.9	0.32	0.82
2001	1,221	254	0.64	2,274	57.2	0.36	0.80
2002	1,134	309	0.78	1,372	98.6	0.51	0.72
2003	1,220	353	0.89	1,086	60.7	0.35	0.81
2004	1,317	373	0.94	809	34.0	0.19	0.89
2005	1,327	370	0.93	945	31.0	0.18	0.90
2006	1,308	346	0.87	432	30.6	0.20	0.89
2007	1,283	319	0.80	1,495	34.6	0.25	0.86
2008	1,274	278	0.70	1,827	38.9	0.27	0.85
2009	1,279	266	0.67	3,524	38.5	0.26	0.86
2010	1,297	282	0.71	1,855	38.8	0.23	0.87
2011	1,302	362	0.91	487	39.9	0.22	0.88
2012	1,305	415	1.05	447	38.3	0.21	0.88
2013	1,288	403	1.02	996	43.0	0.24	0.87
2014	1,305	355	0.89	1,433	32.9	0.21	0.88
2015	835	316	0.80	1,413			

Table 16. Sensitivity of the Kelp Greenling base case model to alternative data source configurations and model structural assumptions.

Label	Base (harmonic mean)	Fixed M (previous assessment)	Fixe M (high)	Fixed M (low)	Estimate M	Estimate Steepness	Francis Weights Length Comps	Rec-devs Not Estimated	Rec-devs All Years Estimated	No ageing error	Drop Logbook Index	Drop Onboard Index	Drop ORBS Index
Total Likelihood	1,305	1,350	1,298	1,315	1,294	1,305	1,287	1,553	1,295	1,305	1,315	1,316	1,316
Likelihood Components													
Catch	0.013	0.002	0.000	0.024	0.000	0.013	0.008	0.004	0.020	0.070	0.016	0.013	0.015
Survey	-32.59	-31.90	-31.72	-32.34	-31.23	-32.60	-34.39	-33.04	-33.35	-32.34	-21.03	-21.01	-19.97
Length comps	377	403	372	382	369	377	356	421	364	381	374	376	374
Age comps	951	968	948	955	948	951	956	1,157	952	948	952	952	953
Parameter priors	7.85	8.14	7.90	7.89	7.96	7.89	7.87	7.86	7.84	7.85	7.84	7.84	7.84
SSB_Unfished (mt)	397	225	1378	263	590,970	395	3127	535	385	353	343	374	353
Total Biomass Unfished (mt)	1,426	675	5,316	898	2,432,390	1,421	10,648	1,869	1,369	1,319	1,231	1,347	1,268
Virgin Recruitment, R0 (thousands mt)	1,451	477	6,572	776	3,268,600	1,446	10,259	1,848	1,389	1,381	1,253	1,374	1,294
SSB (Btarget) (mt)	159	90	551	105	236,388	158	1,251	214	154	141	137	150	141
SPR (Btarget)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Fstd (Btarget)	0.18	0.15	0.19	0.17	0.20	0.18	0.17	0.18	0.18	0.18	0.18	0.18	0.18
Total Yield (Btarget) (mt)	129	50	525	75	250,423	132	937	171	125	122	112	122	115
SSB (SPRtarget) (mt)	152	86	529	101	226,932	155	1,201	206	148	136	132	144	135
Fstd (SPRtarget)	0.18	0.15	0.20	0.17	0.20	0.18	0.18	0.19	0.19	0.19	0.18	0.18	0.18
Total Yield (SPRtarget) (mt)	130	51	532	76	253,699	133	948	173	126	123	113	123	116
SSB (MSY) (mt)	152	86	529	101	226,932	155	1,201	206	148	136	132	144	135
SPR (MSY)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Fstd (MSY)	0.18	0.15	0.20	0.17	0.20	0.18	0.18	0.19	0.19	0.19	0.18	0.18	0.18
Total Yield (MSY) (mt)	130	51	532	76	253,699	133	948	173	126	123	113	123	116
SSB_2015 (mt)	316	141	1,152	190	497,033	316	3,631	448	417	274	243	291	259
SBratio_2015	0.80	0.63	0.84	0.72	0.84	0.80	1.16	0.84	1.08	0.78	0.71	0.78	0.73
F_2015	1.21	1.15	1.23	1.18	1.25	1.21	1.21	1.16	1.24	1.22	1.19	1.21	1.20
Recruitment_2015 (thousands mt)	1,413	449	6,437	745	3,203,730	1,413	10,414	1,810	1,401	1,340	1,200	1,333	1,246
M (female|male)	0.36|-0.13	0.26|0.00	0.42|-0.14	0.32|-0.11	0.45|-0.19	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13
Steepness (h)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
L at Amin Female	25	25	25	25	25	25	26	25	25	25	25	25	25
L at Amax Female	36	36	37	36	37	36	37	36	37	36	36	36	36
VonBert K Female	0.26	0.26	0.26	0.26	0.26	0.26	0.30	0.29	0.27	0.24	0.27	0.26	0.26
L at Amin Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L at Amax Male	-0.02	0.00	-0.02	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
VonBert K Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16 continued.

Label	Base (harmonic mean)	Drop Comm. Length Comps	Drop Rec. Ocean Length Comps	Drop Rec. Estuary Length Comps	Drop Rec. Shore Length Comps	Drop Comm. Age Comps	Drop Rec. Ocean Age Comps	Drop Spec. Proj. Age Comps	Recent Shore/Estuary catch doubled	Shore/Estuary Catch Ramp Starts 1940	Shore/Estuary Catch High Early/Low Recent	Shore/Estuary Catch Low Early/High Recent
Total Likelihood	1,305	1,209	1,224	1,210	1,150	904	684	1,305	1,307	1,304	1,303	1,307
Likelihood Components												
Catch	0.013	0.006	0.000	0.016	0.000	0.040	0.000	0.013	0.009	0.009	0.017	0.009
Survey	-32.59	-36.22	-44.32	-33.10	-34.56	-32.09	-30.06	-32.59	-32.59	-32.33	-32.28	-32.92
Length comps	377	286	308	283	233	384	370	377	379	377	375	380
Age comps	951	949	951	951	943	542	338	951	951	950	951	951
Parameter priors	7.85	7.85	7.84	7.86	7.89	7.86	8.08	7.85	7.85	7.84	7.84	7.85
SSB_Unfished (mt)	397	401	410	345	623	473	792,032	397	468	404	341	461
Total Biomass Unfished (mt)	1,426	1,422	1,458	1,284	2,051	1,675	2,836,400	1,426	1,680	1,438	1,229	1,652
Virgin Recruitment, R0 (thousands mt)	1,451	1,443	1,486	1,335	1,892	1,673	3,268,900	1,451	1,704	1,452	1,254	1,675
SSB (Btarget) (mt)	159	160	164	138	249	189	316,813	159	187	161	136	184
SPR (Btarget)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Fstd (Btarget)	0.18	0.17	0.17	0.18	0.19	0.17	0.22	0.18	0.17	0.17	0.19	0.17
Total Yield (Btarget) (mt)	129	126	125	123	196	145	306,671	129	142	129	120	143
SSB (SPRtarget) (mt)	152	154	157	132	239	182	304,140	152	180	155	131	177
Fstd (SPRtarget)	0.18	0.18	0.17	0.19	0.20	0.18	0.23	0.18	0.17	0.18	0.20	0.18
Total Yield (SPRtarget) (mt)	130	128	126	125	198	147	310,261	130	144	131	121	145
SSB (MSY) (mt)	152	154	157	132	239	182	304,140	152	180	155	131	177
SPR (MSY)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Fstd (MSY)	0.18	0.18	0.17	0.19	0.20	0.18	0.23	0.18	0.17	0.18	0.20	0.18
Total Yield (MSY) (mt)	130	128	126	125	198	147	310,261	130	144	131	121	145
SSB_2015 (mt)	316	315	321	297	583	423	583,914	316	377	317	267	374
SBratio_2015	0.80	0.78	0.78	0.86	0.94	0.89	0.74	0.80	0.80	0.79	0.78	0.81
F_2015	1.21	1.14	1.12	1.47	1.24	1.22	1.09	1.21	1.11	1.20	1.31	1.15
Recruitment_2015 (thousands mt)	1,413	1,402	1,443	1,312	1,879	1,652	3,148,660	1,413	1,661	1,411	1,218	1,635
M (female|male)	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13	0.36|-0.13
Steepness (h)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
L at Amin Female	25	25	25	25	26	25	21	25	25	25	25	25
L at Amax Female	36	37	38	36	37	37	33	36	36	37	36	36
VonBert K Female	0.26	0.26	0.19	0.24	0.28	0.21	0.65	0.26	0.26	0.26	0.26	0.26
L at Amin Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L at Amax Male	-0.02	-0.02	-0.03	-0.02	-0.02	-0.03	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02
VonBert K Male	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 17. Summary of reference points for Kelp Greenling base case model in Oregon waters.

Quantity	Estimate	~95% Confidence Interval
Unfished Spawning biomass (mt)	397	(217-576)
Unfished recruitment (R0, thousands)	1,451	(838-2,064)
Spawning Biomass (2015)	316	(116-516)
Depletion (2015)	0.80	(0.59-1.00)
Reference points based on $SB_{40\%}$		
Proxy spawning biomass ($B_{40\%}$)	159	(87-230)
SPR resulting in $B_{40\%}$	0.46	(0.46-0.46)
Exploitation rate resulting in $B_{40\%}$	0.18	(0.17-0.18)
Yield at $B_{40\%}$ (mt)	129	(73-184)
Reference points based on SPR proxy for MSY		
Spawning biomass	152	(83-221)
SPR_{proxy}	0.45	
Exploitation rate corresponding to SPR_{proxy}	0.18	(0.18-0.19)
Yield with SPR_{proxy} at SB_{SPR} (mt)	130	(74-187)
Reference points based on estimated MSY values		
Spawning biomass at MSY (SB_{MSY})	111	(60-161)
SPR_{MSY}	0.36	(0.35-0.36)
Exploitation rate corresponding to SPR_{MSY}	0.24	(0.23-0.25)
MSY (mt)	136	(77-194)

Table 18. Projection of Kelp Greenling spawning biomass and depletion using the base case model for the scenario of achieving the biomass target (*SB*40%) in 10 years. Total catch in 2015 and 2016 were set to the average over the most recent three years (2012 – 2014).

Year	Total Catch (mt)	Age 1+ Biomass (mt)	Spawning Biomass (mt)	Depletion
2015	38.7	1,131	316	0.80
2016	38.7	1,141	300	0.76
2017	239.1	1,156	299	0.75
2018	201.0	1,007	246	0.62
2019	177.5	912	214	0.54
2020	162.5	851	194	0.49
2021	152.7	810	181	0.46
2022	146.1	782	173	0.44
2023	141.7	763	167	0.42
2024	138.5	749	163	0.41
2025	136.3	739	160	0.40
2026	134.5	732	158	0.40

Table 19. Decision table summarizing 12-year projections (2015 – 2026) under three different scenarios for male and female natural mortality and four alternative static catch scenarios. The state of nature for natural mortality was based on maximum age calculations using ± 2 years from the base case for males and females.

		State of nature								
		Low			Base case			High		
		$M_f = 0.318$			$M_f = 0.360$			$M_f = 0.415$		
		$M_m = 0.285$			$M_m = 0.318$			$M_m = 0.360$		
Relative prob. of ln(SB_2015):		0.25			0.5			0.25		
Management decision	Year	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion
High Observed Catch (Based on 2002 Landings)	2017	100.2	177	0.67	100.2	299	0.75	100.2	1,127	0.82
	2018	100.2	160	0.61	100.2	286	0.72	100.2	1,145	0.83
	2019	100.2	147	0.56	100.2	277	0.70	100.2	1,167	0.85
	2020	100.2	136	0.52	100.2	270	0.68	100.2	1,186	0.86
	2021	100.2	126	0.48	100.2	265	0.67	100.2	1,202	0.87
	2022	100.2	118	0.45	100.2	260	0.66	100.2	1,214	0.88
	2023	100.2	111	0.42	100.2	257	0.65	100.2	1,223	0.89
	2024	100.2	105	0.40	100.2	254	0.64	100.2	1,231	0.89
	2025	100.2	99	0.38	100.2	251	0.63	100.2	1,236	0.90
	2026	100.2	94	0.36	100.2	249	0.63	100.2	1,240	0.90
Low Observed Catch (Based on 2014 Landings)	2017	33.5	177	0.67	33.5	299	0.75	33.5	1,127	0.82
	2018	33.5	179	0.68	33.5	305	0.77	33.5	1,163	0.84
	2019	33.5	183	0.70	33.5	312	0.79	33.5	1,200	0.87
	2020	33.5	187	0.71	33.5	319	0.80	33.5	1,232	0.89
	2021	33.5	190	0.72	33.5	325	0.82	33.5	1,257	0.91
	2022	33.5	193	0.73	33.5	330	0.83	33.5	1,276	0.93
	2023	33.5	195	0.74	33.5	333	0.84	33.5	1,291	0.94
	2024	33.5	197	0.75	33.5	336	0.85	33.5	1,303	0.95
	2025	33.5	199	0.76	33.5	339	0.85	33.5	1,311	0.95
	2026	33.5	200	0.76	33.5	341	0.86	33.5	1,318	0.96
ABC/ACL (sigma: 0.360, P*: 0.45, buffer: 4.4%)	2017	121.8	177	0.67	229.8	299	0.75	996.9	1,127	0.82
	2018	107.0	154	0.58	194.9	249	0.63	817.5	901	0.65
	2019	97.4	139	0.53	173.2	218	0.55	712.2	770	0.56
	2020	91.0	129	0.49	159.2	199	0.50	647.9	692	0.50
	2021	86.5	122	0.46	150.0	186	0.47	607.5	645	0.47
	2022	83.5	117	0.45	143.8	178	0.45	581.6	614	0.45
	2023	81.3	114	0.43	139.6	172	0.43	564.5	594	0.43
	2024	79.7	112	0.42	136.6	168	0.42	552.8	581	0.42
	2025	78.5	110	0.42	134.5	165	0.42	544.8	571	0.41
	2026	77.7	108	0.41	133.0	163	0.41	539.2	565	0.41
ABC/ACL (sigma: 0.441, P*: 0.45, buffer: 5.4%)	2017	-	-	-	227.6	299	0.75	-	-	-
	2018	-	-	-	193.4	250	0.63	-	-	-
	2019	-	-	-	172.1	219	0.55	-	-	-
	2020	-	-	-	158.4	200	0.50	-	-	-
	2021	-	-	-	149.4	188	0.47	-	-	-
	2022	-	-	-	143.3	179	0.45	-	-	-
	2023	-	-	-	139.1	174	0.44	-	-	-
	2024	-	-	-	136.2	170	0.43	-	-	-
	2025	-	-	-	134.1	167	0.42	-	-	-
	2026	-	-	-	132.6	165	0.42	-	-	-

10 Figures

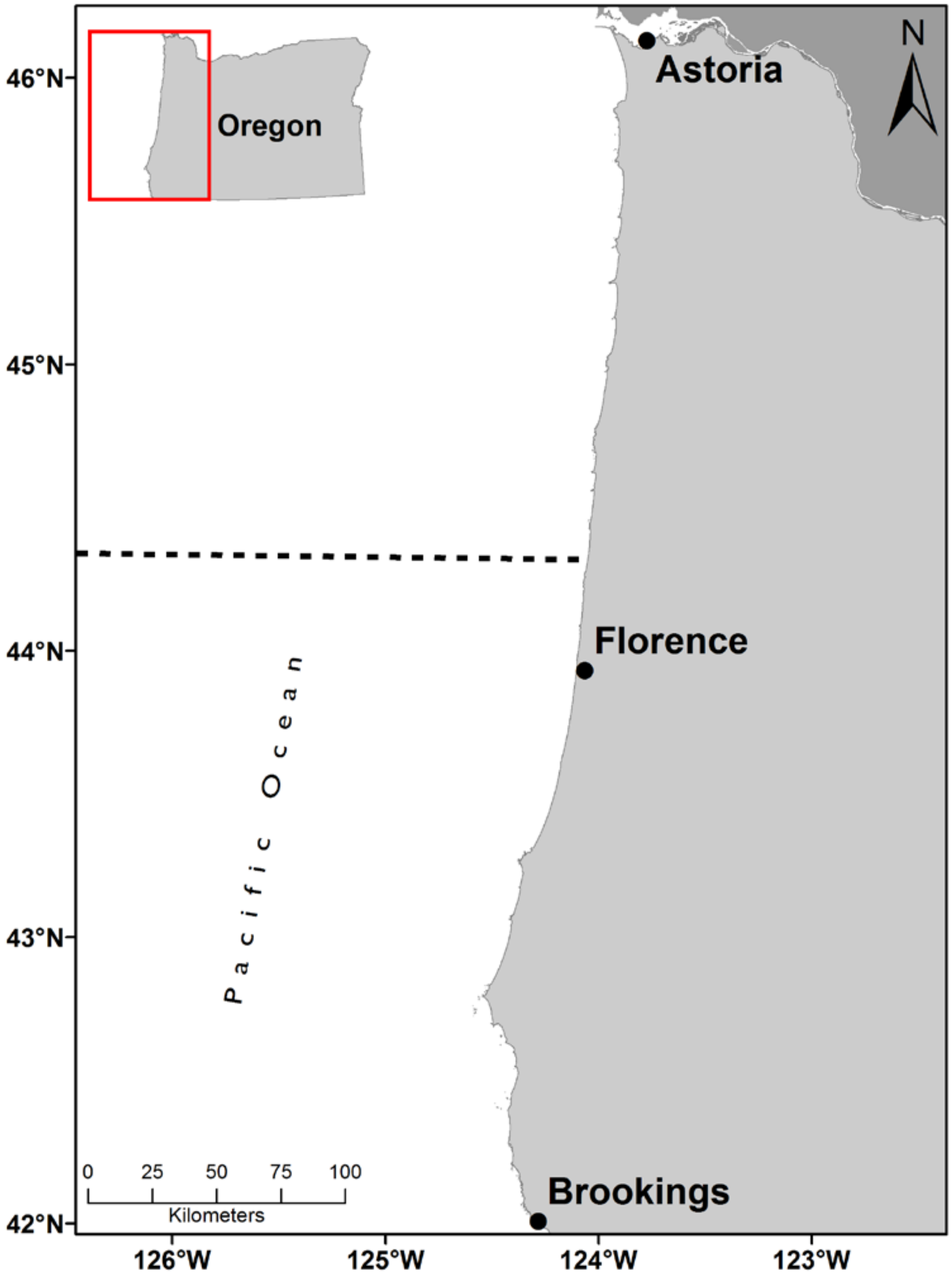


Figure 1. Map showing the Oregon coast with the dashed line north of Florence delineating the boundary between PSMFC areas 2B and 2C, which was used for exploring northern and southern coast catch histories and available biological data.

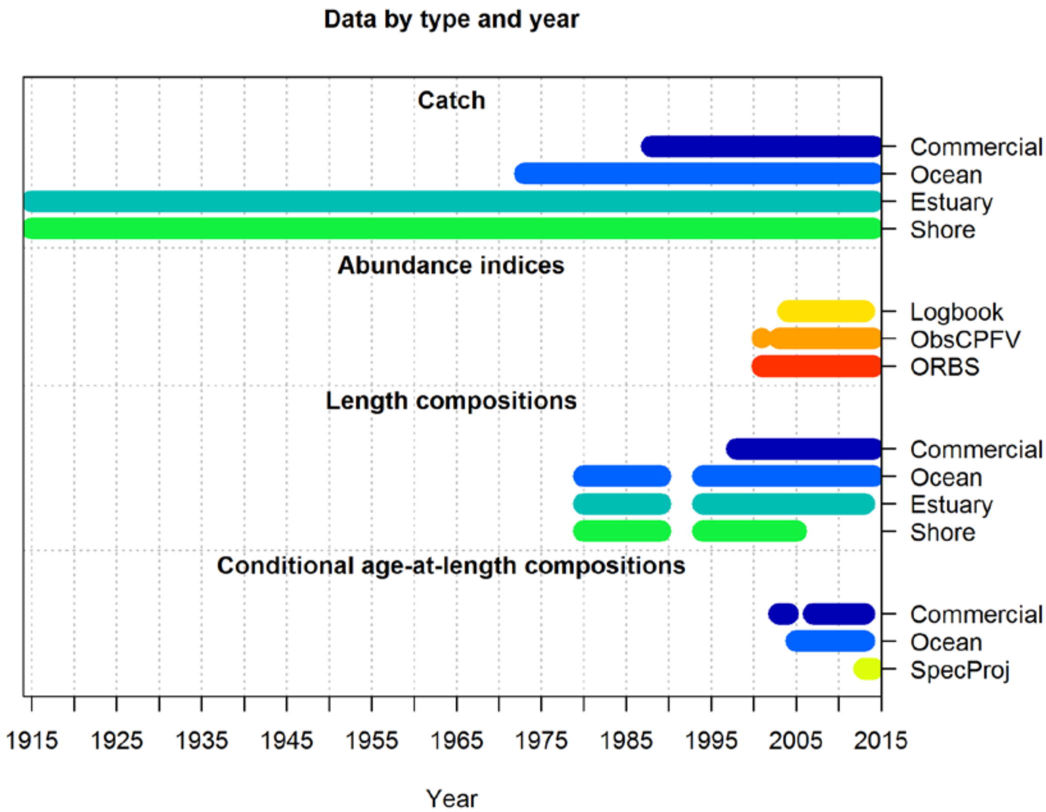


Figure 2. Summary of the data types and the duration of available time series that were used in the Kelp Greenling stock assessment.

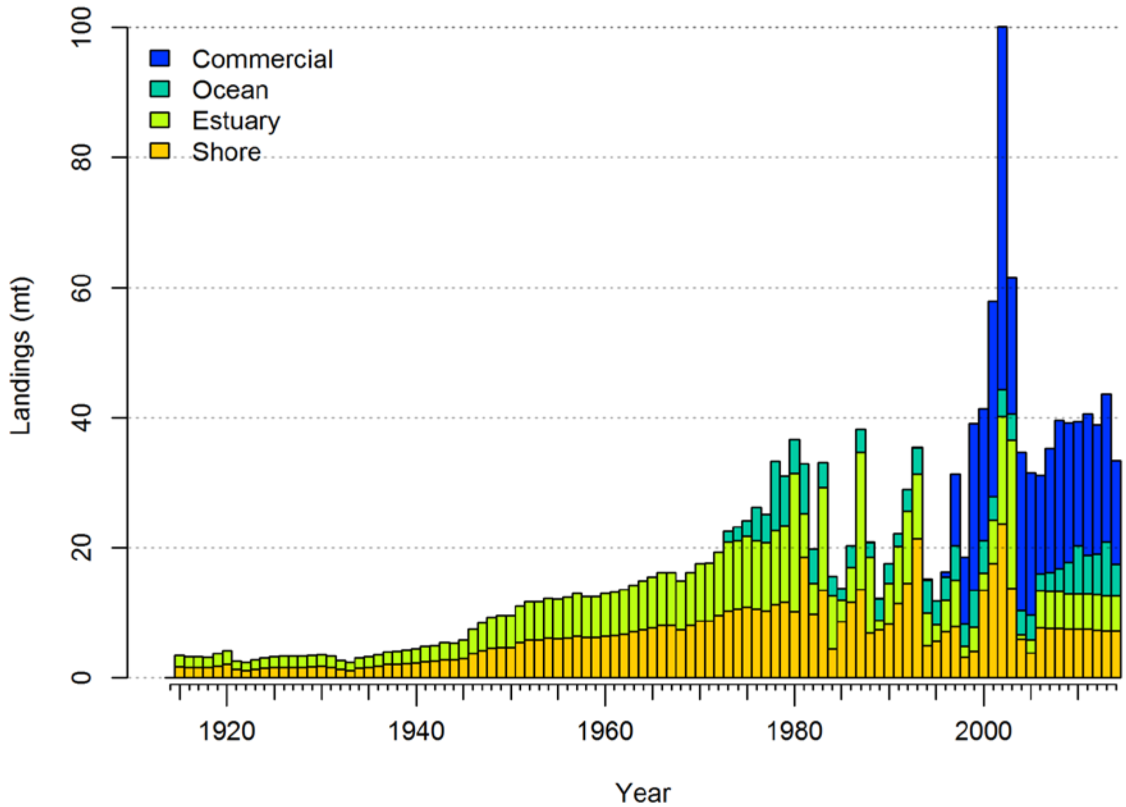


Figure 3. Stacked time series of Kelp Greenling landings (mt) by fleet for Oregon waters.

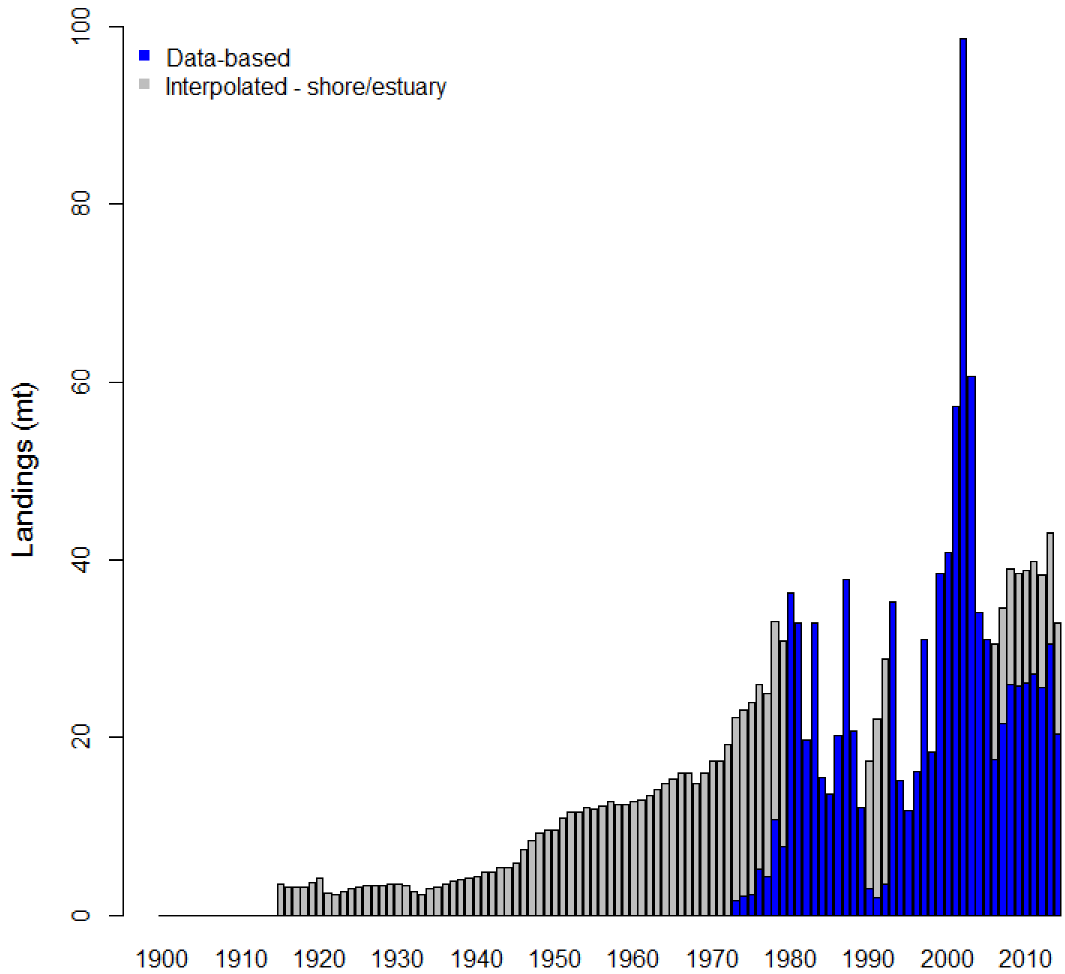


Figure 4. Stacked time series of Kelp Greenling landings (mt) for time periods when landings were directly informed by data and when shore and estuary fleet landings were interpolated.

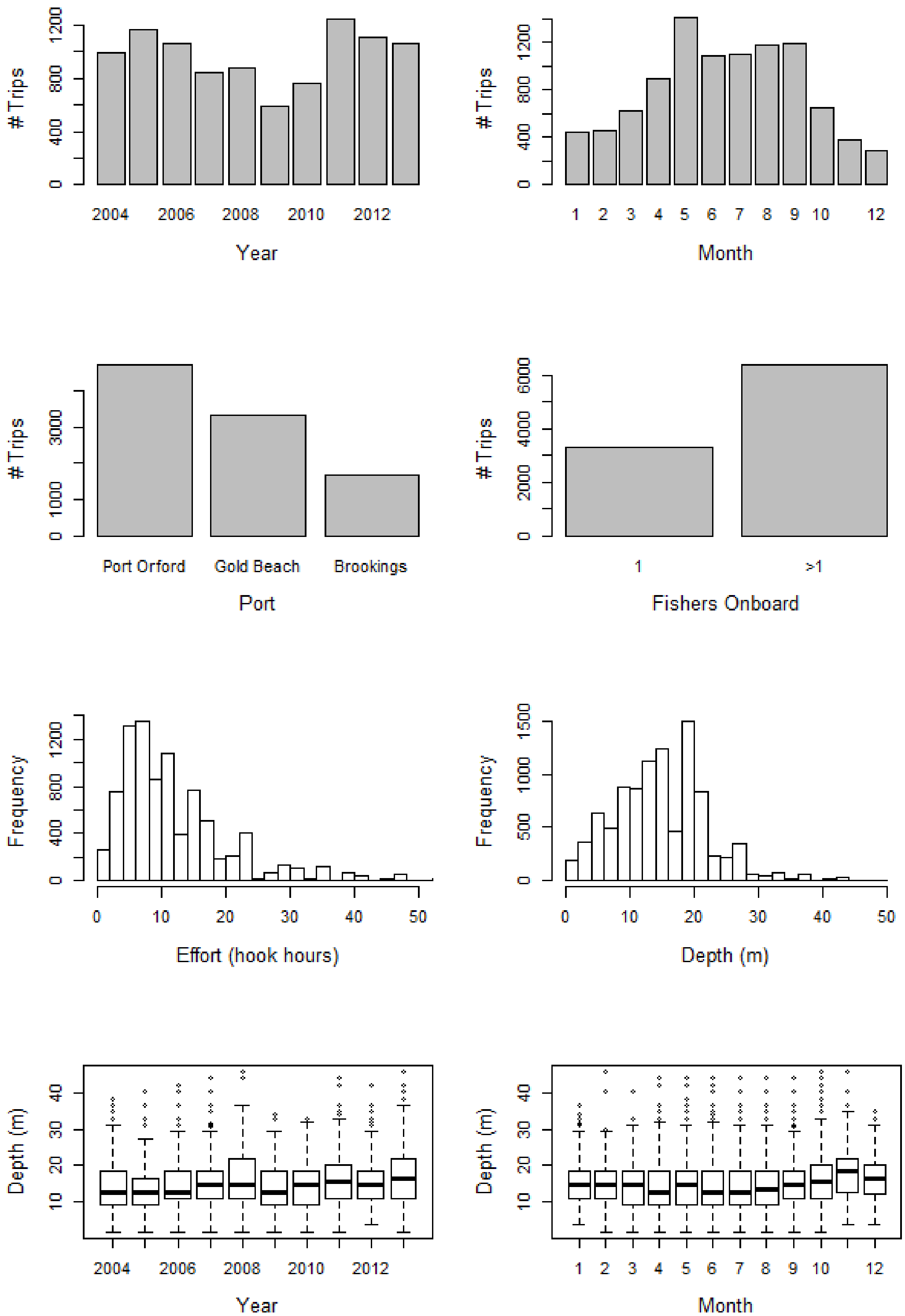


Figure 5. Characterization of the final subset of logbook data used in delta-GLM analyses for Kelp Greenling.

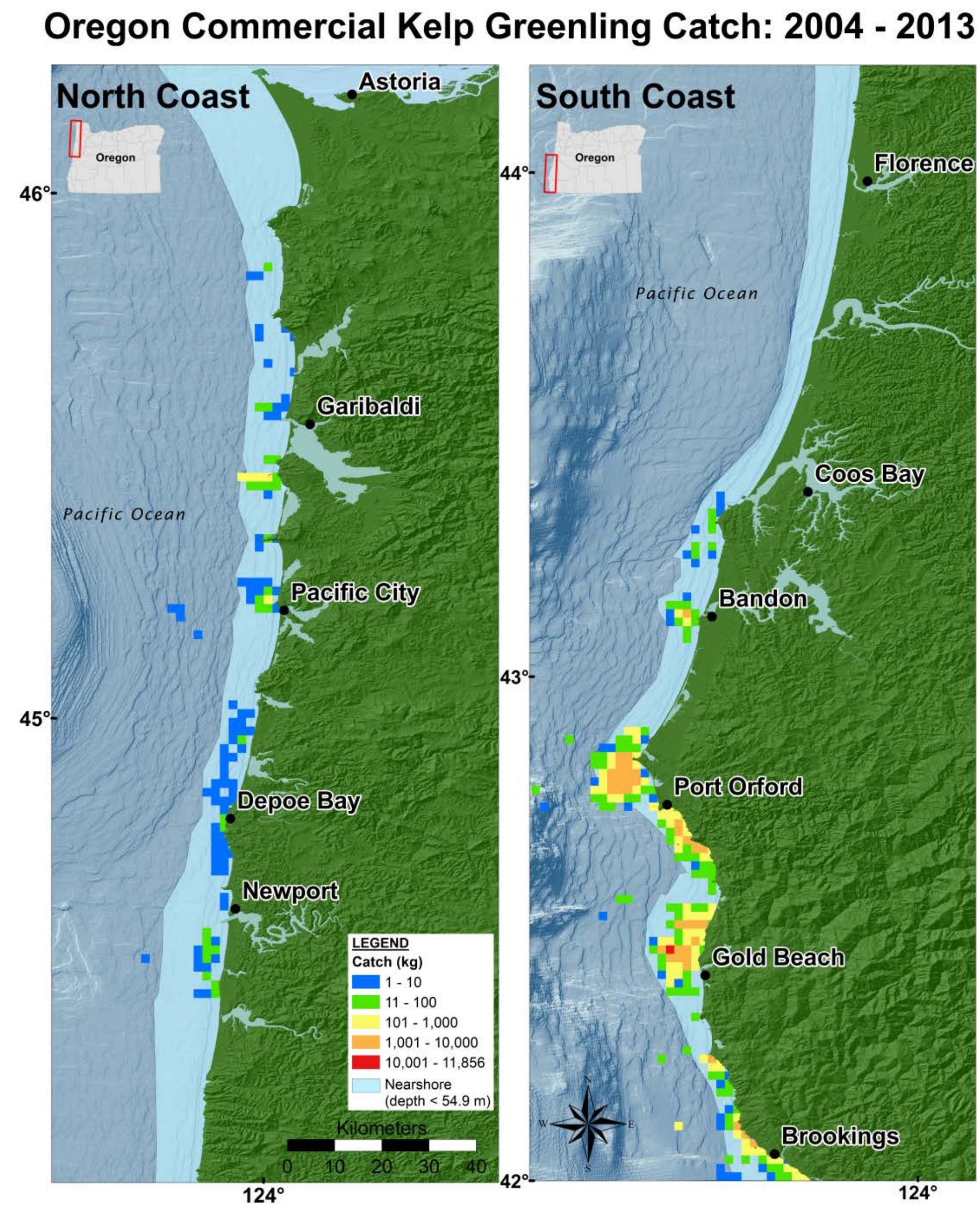


Figure 6. Distribution of Kelp Greenling catch from all logbook reported sets. For confidentiality, these data have been filtered to include only areas where three or more vessels have recorded catch.

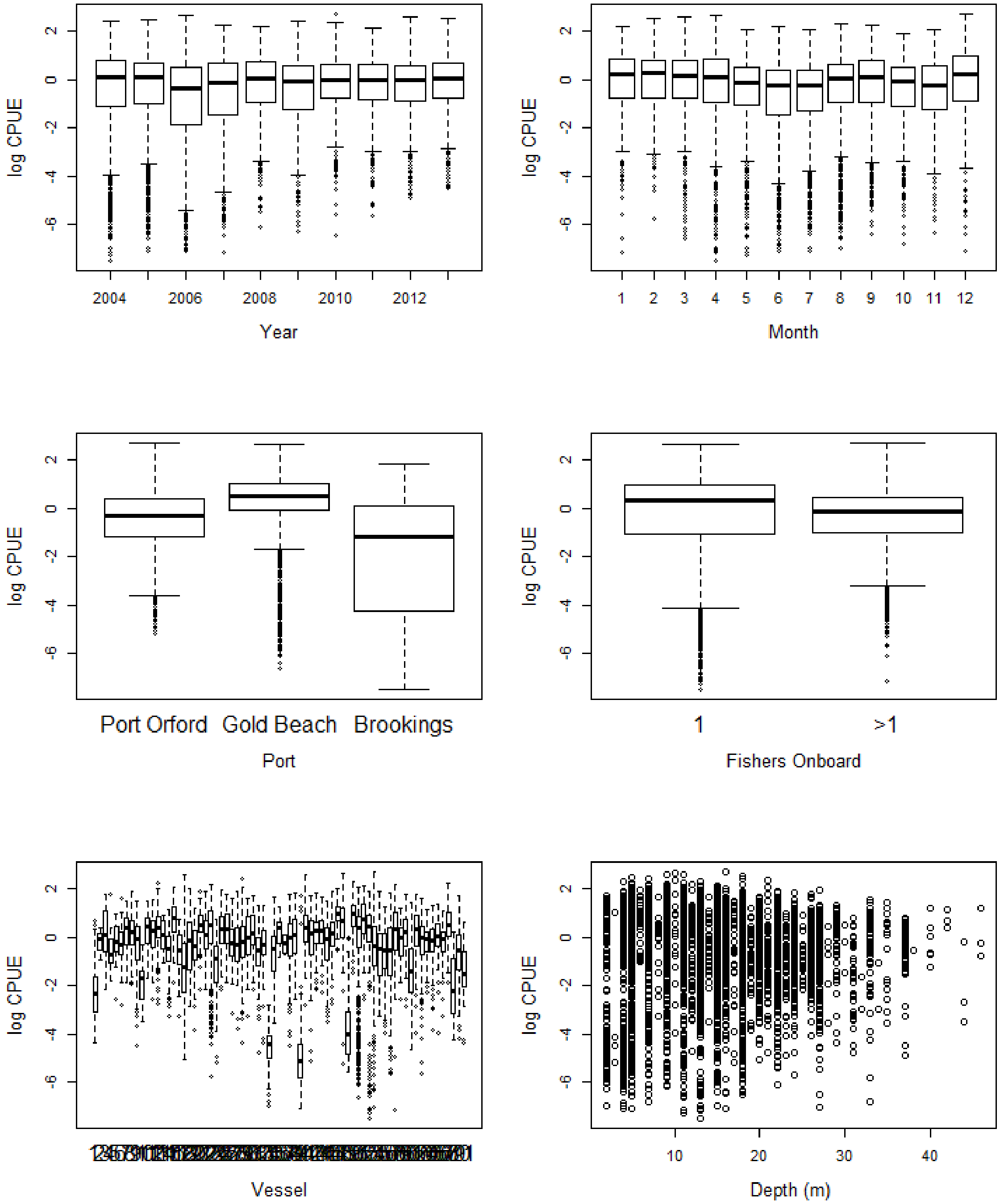


Figure 7. The distribution of set-level raw positive catch CPUE data for the commercial logbook data relative to potential covariates evaluated in the Kelp Greenling delta-GLM analysis.

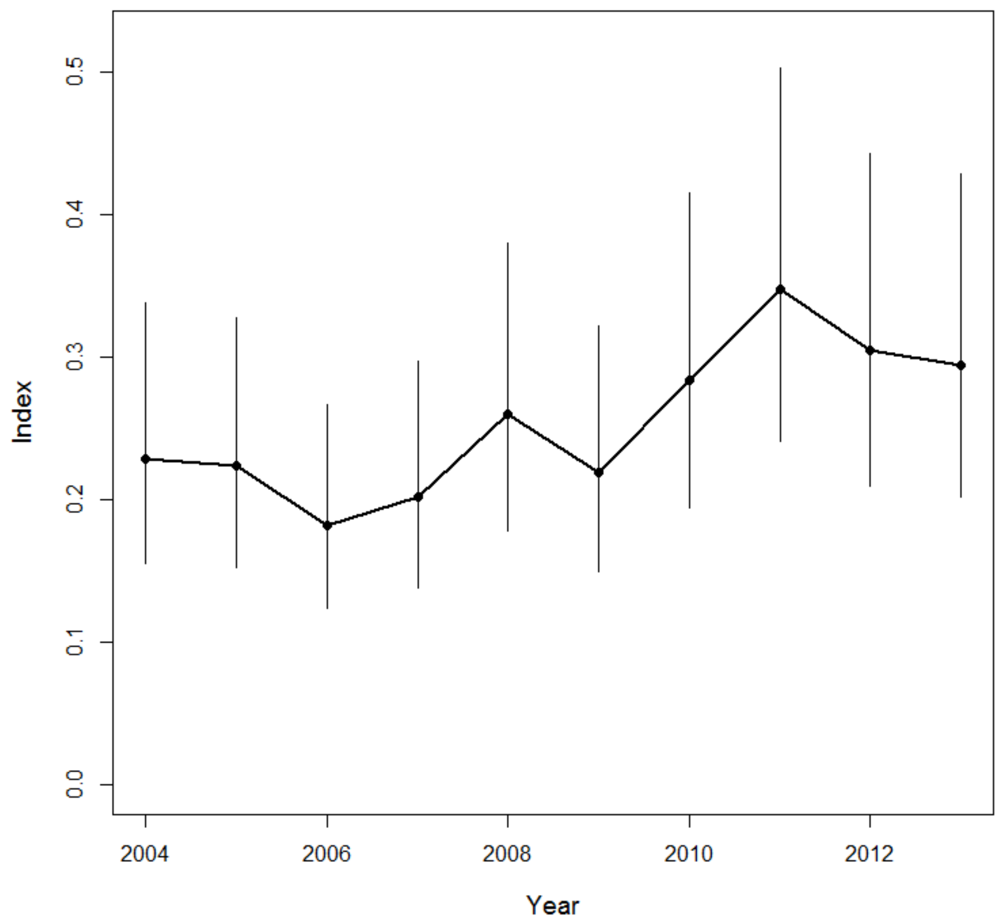


Figure 8. Oregon nearshore commercial logbook abundance index for Kelp Greenling 2004 – 2013.

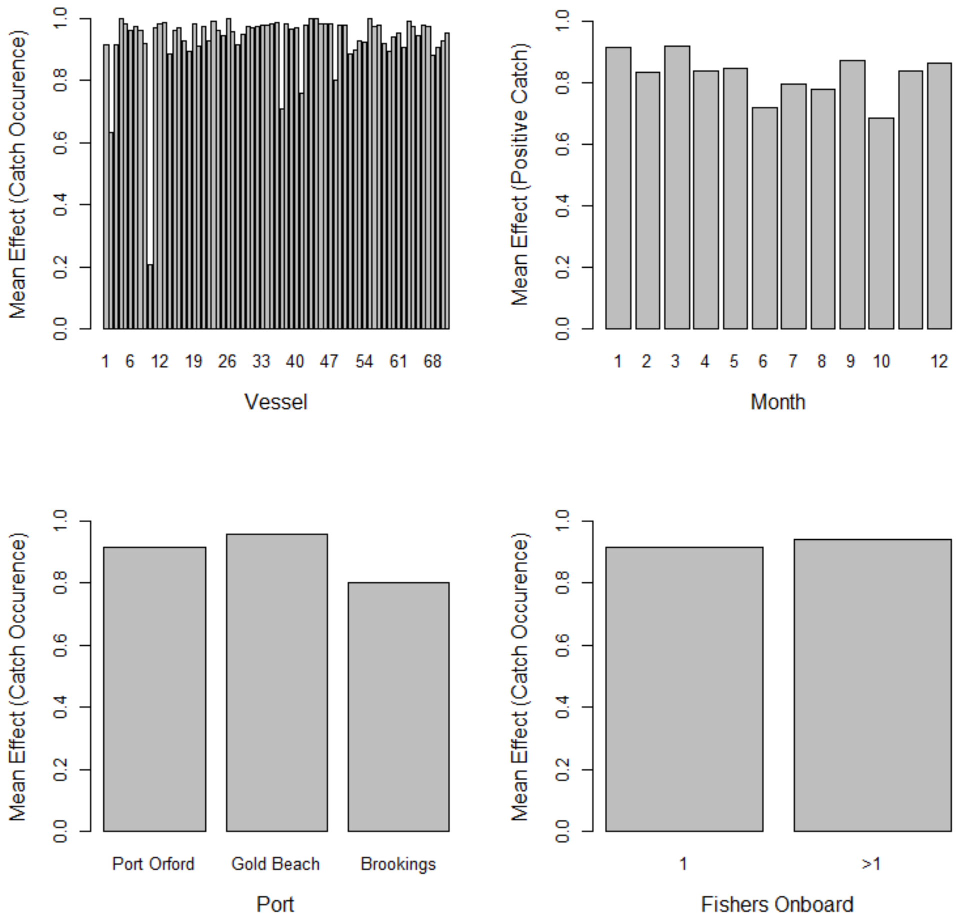


Figure 9. Summary of the relative effects of each covariate in the catch occurrence model component for Kelp Greenling commercial logbook index.

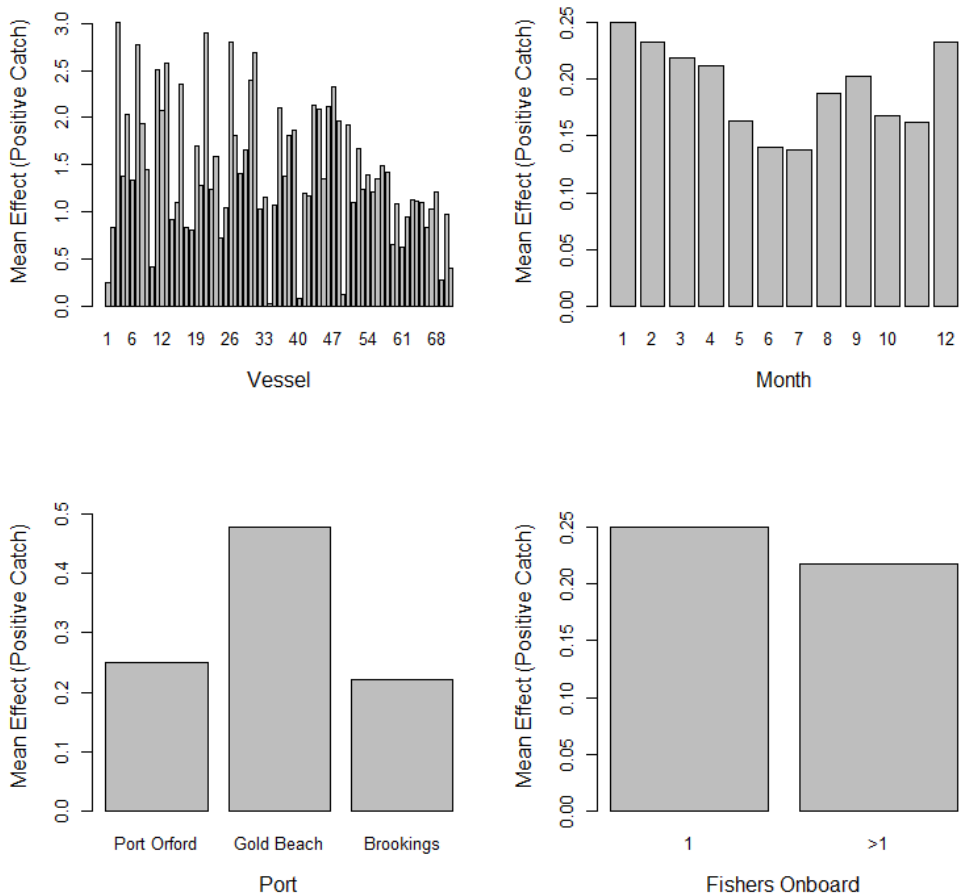


Figure 10. Summary of the relative effects of each covariate in the positive catch model component for Kelp Greenling commercial logbook index.

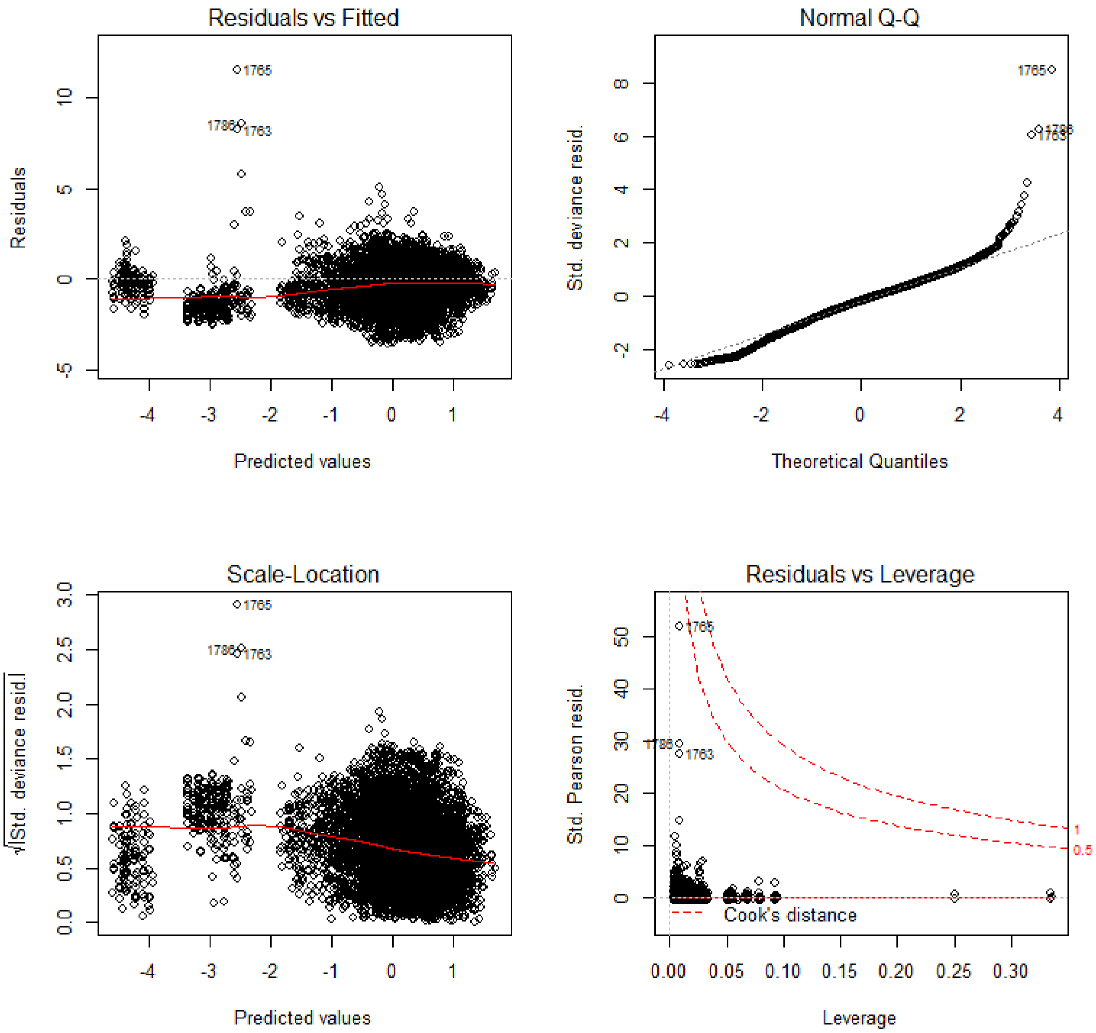


Figure 11. Diagnostic plots for the Kelp Greenling commercial logbook positive catch component delta-GLM model. These are used to evaluate model fit (top left), assumptions of normality (top right), assumptions of constant variance (bottom left), and the presence of outliers (bottom right).

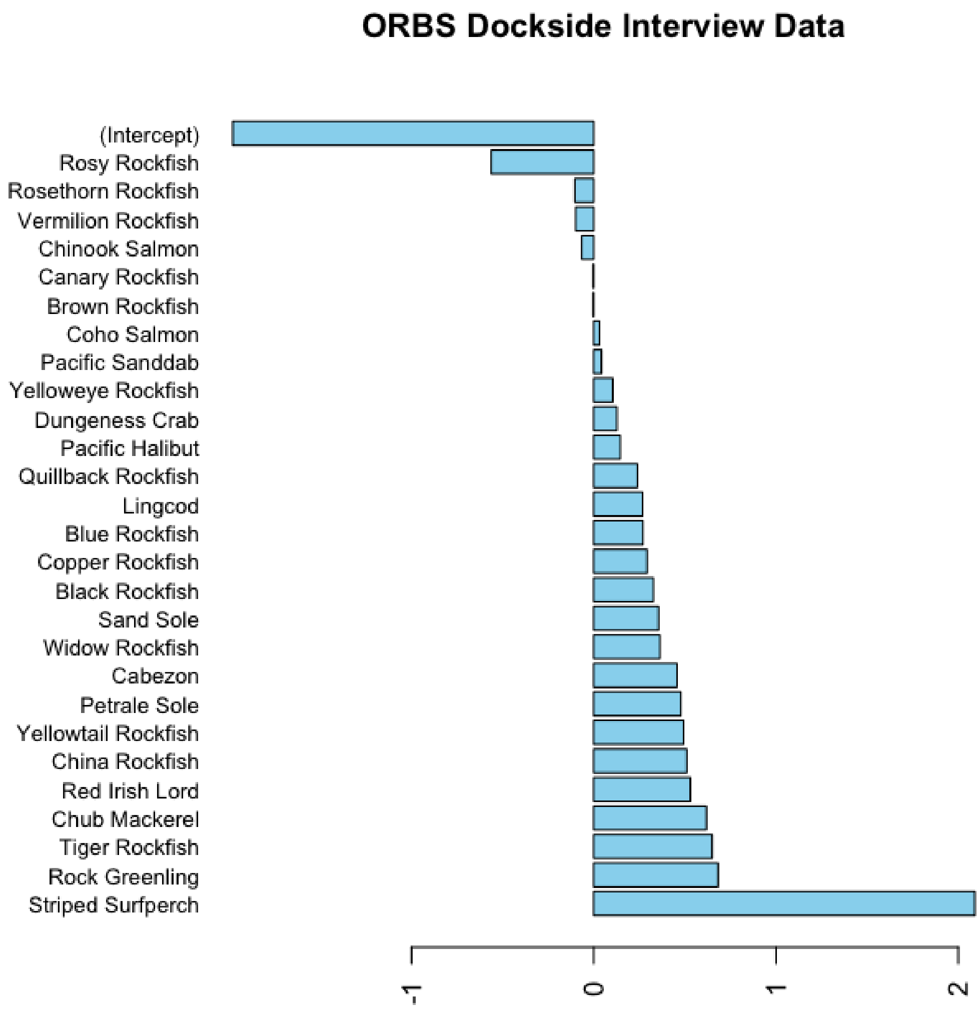


Figure 12. Species coefficients for the Stephens-MacCall filter of the ORBS ocean-boat data.

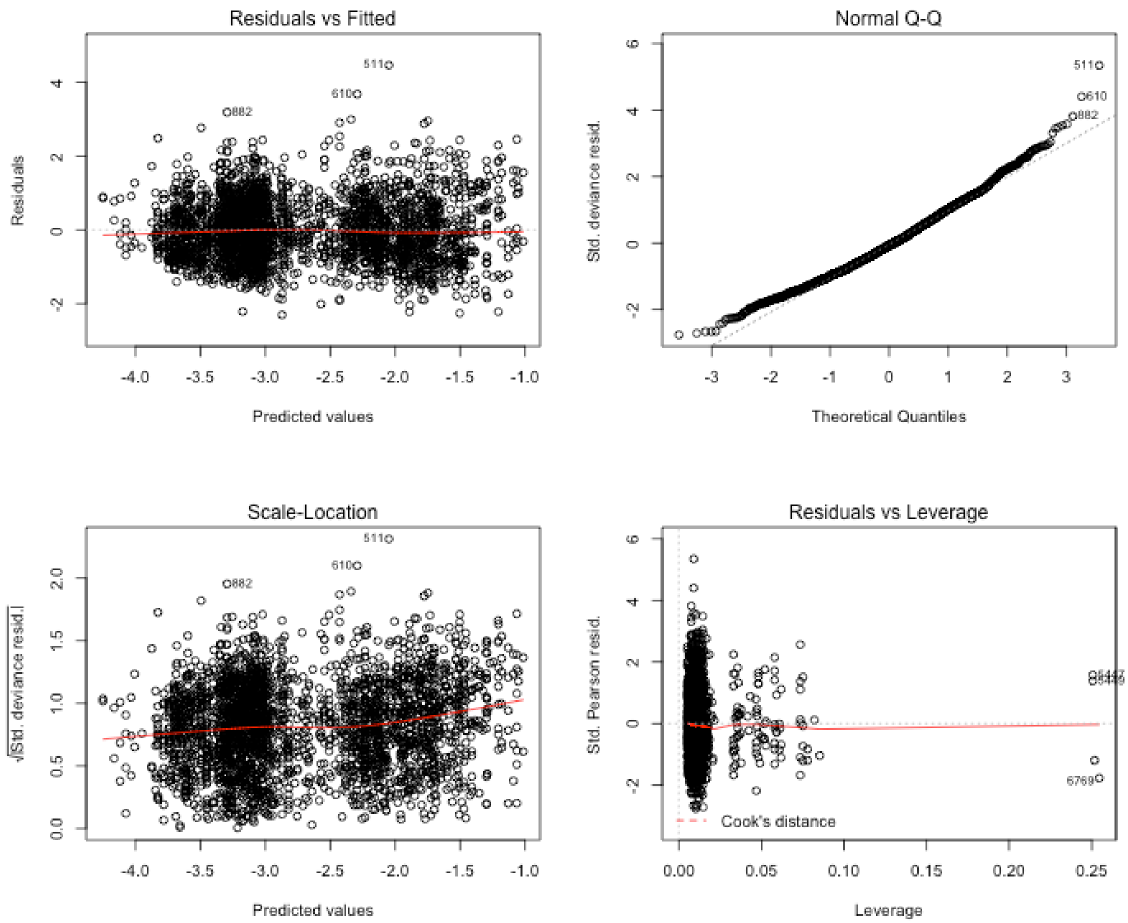


Figure 13. Diagnostic plots for the ORBS ocean-boat positive catch component delta-GLM model. These are used to evaluate model fit (top left), assumptions of normality (top right), assumptions of constant variance (bottom left), and the presence of outliers (bottom right).

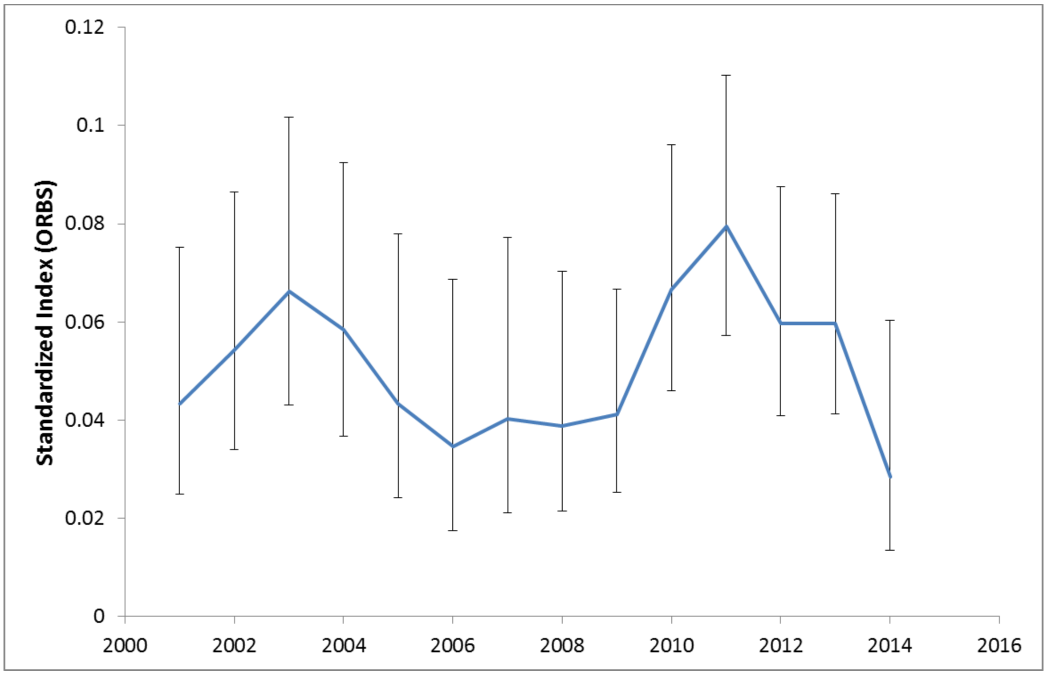


Figure 14. Index of Kelp Greenling relative abundance with lognormal 95% confidence intervals from ORBS ocean-boats.

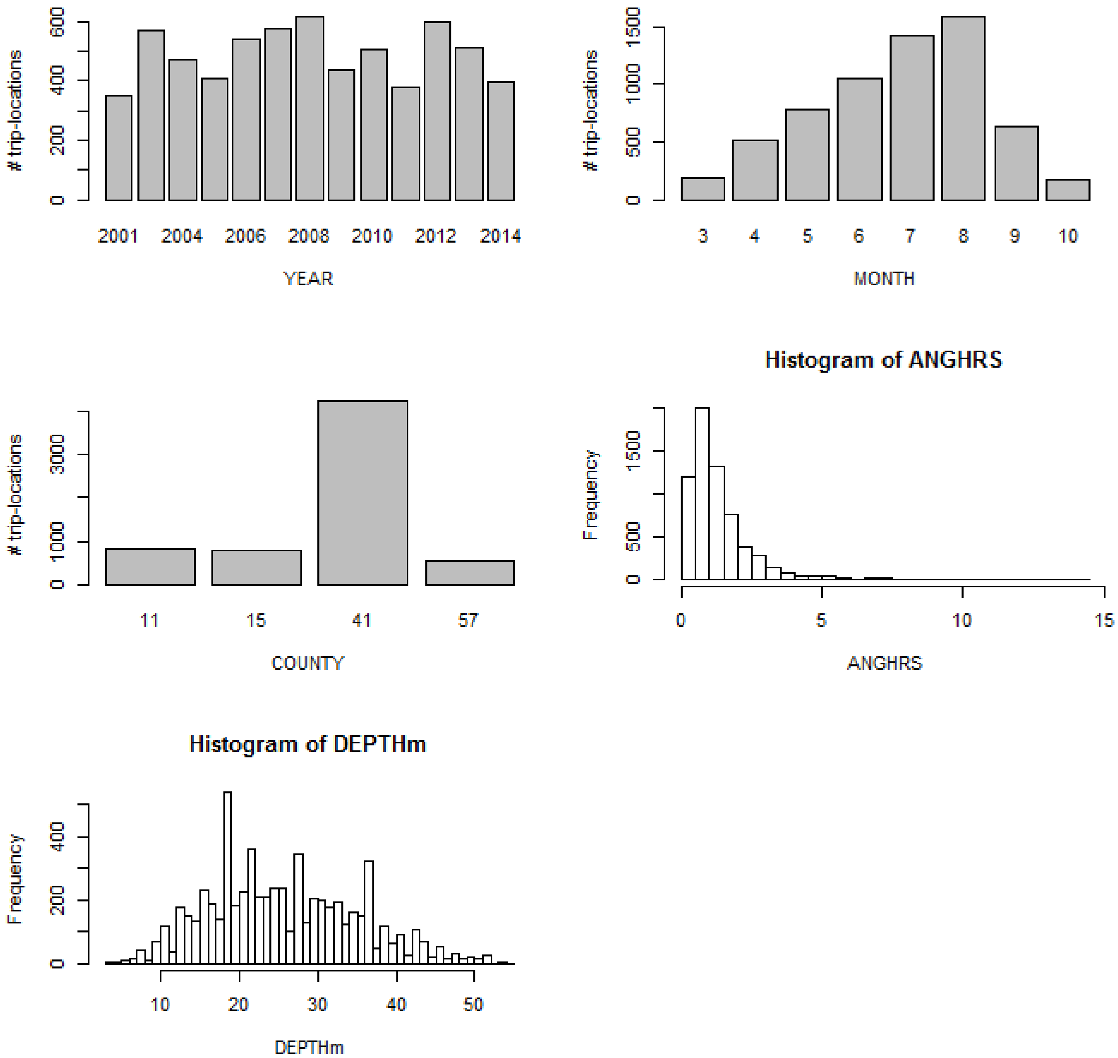


Figure 15. Characterization of the final subset of Oregon onboard observer data used in delta-GLM analyses for Kelp Greenling.

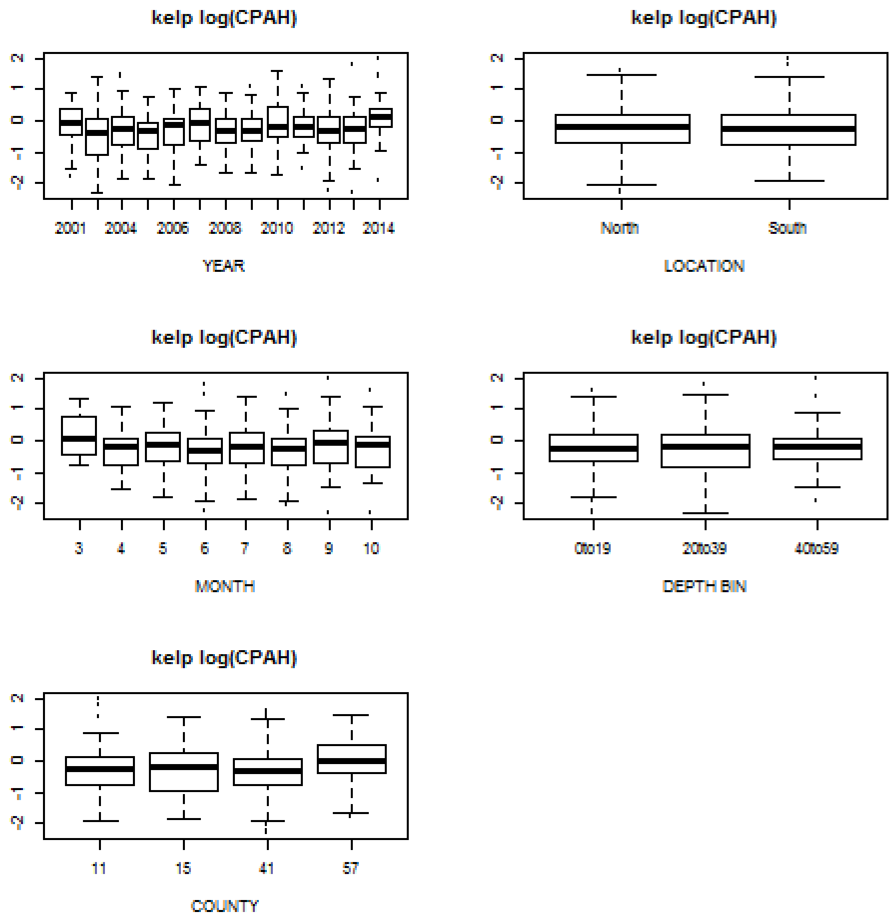


Figure 16. The distribution of drift-level CPUE data relative to potential covariates evaluated in the Kelp Greenling onboard observer delta-GLM analysis.

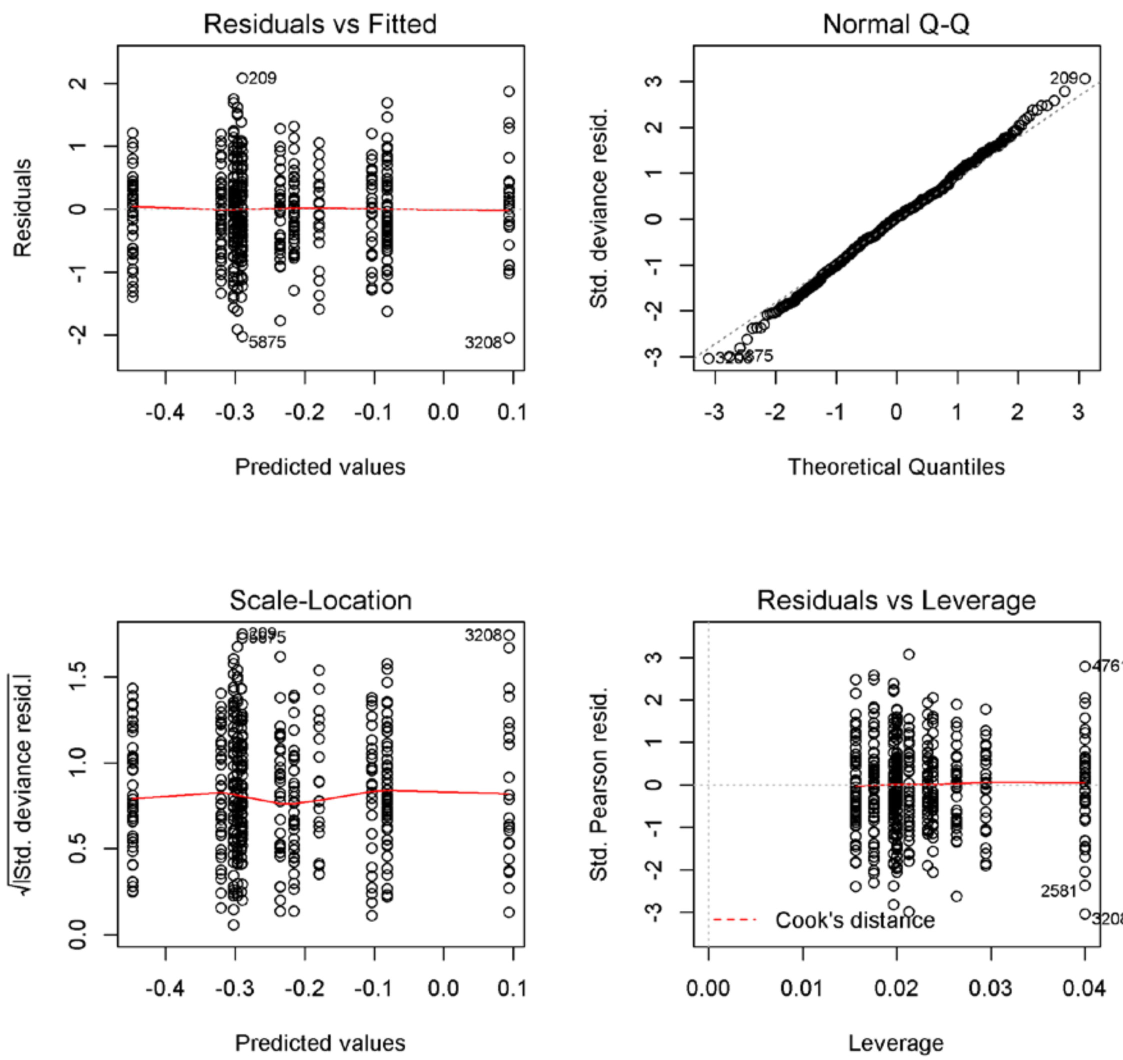


Figure 17. **Diagnostic plots for the Kelp Greenling positive catch component lognormal delta-GLM model for the Oregon onboard observer index. These are used to evaluate model fit (top left), assumptions of normality (top right), assumptions of constant variance (bottom left), and the presence of outliers (bottom right).**

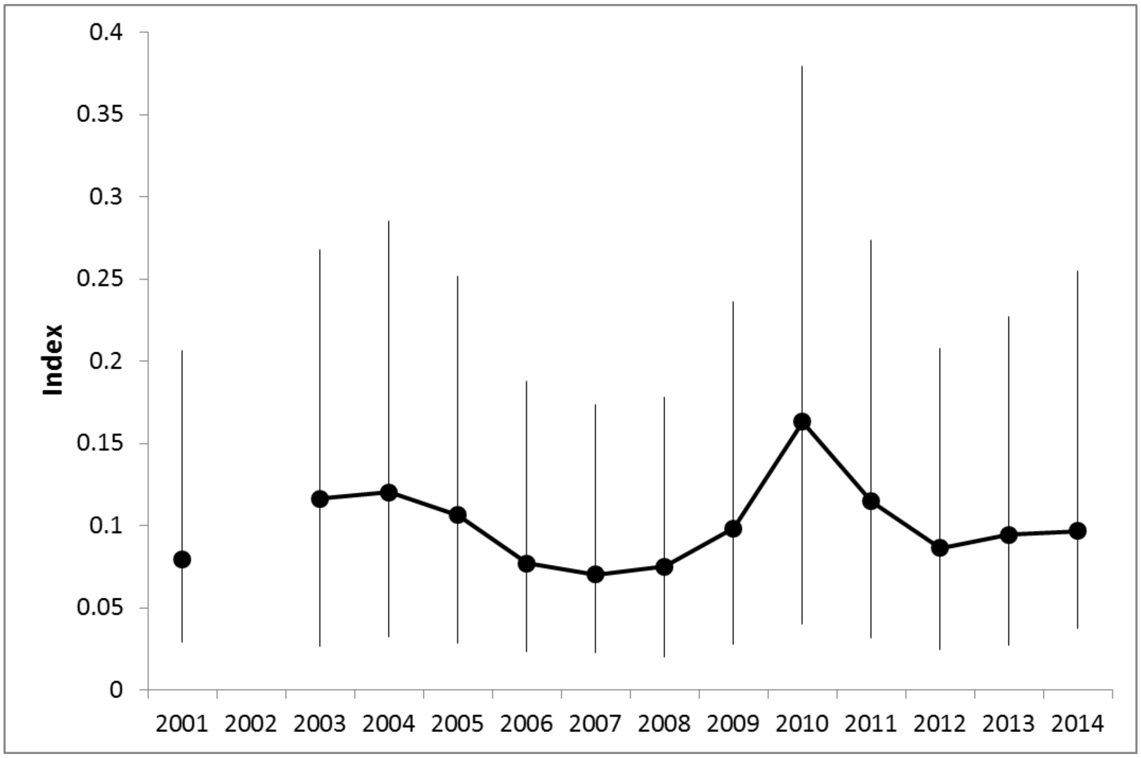


Figure 18. Index for the Oregon onboard observer program for Kelp Greenling, with lognormal 95% confidence intervals.

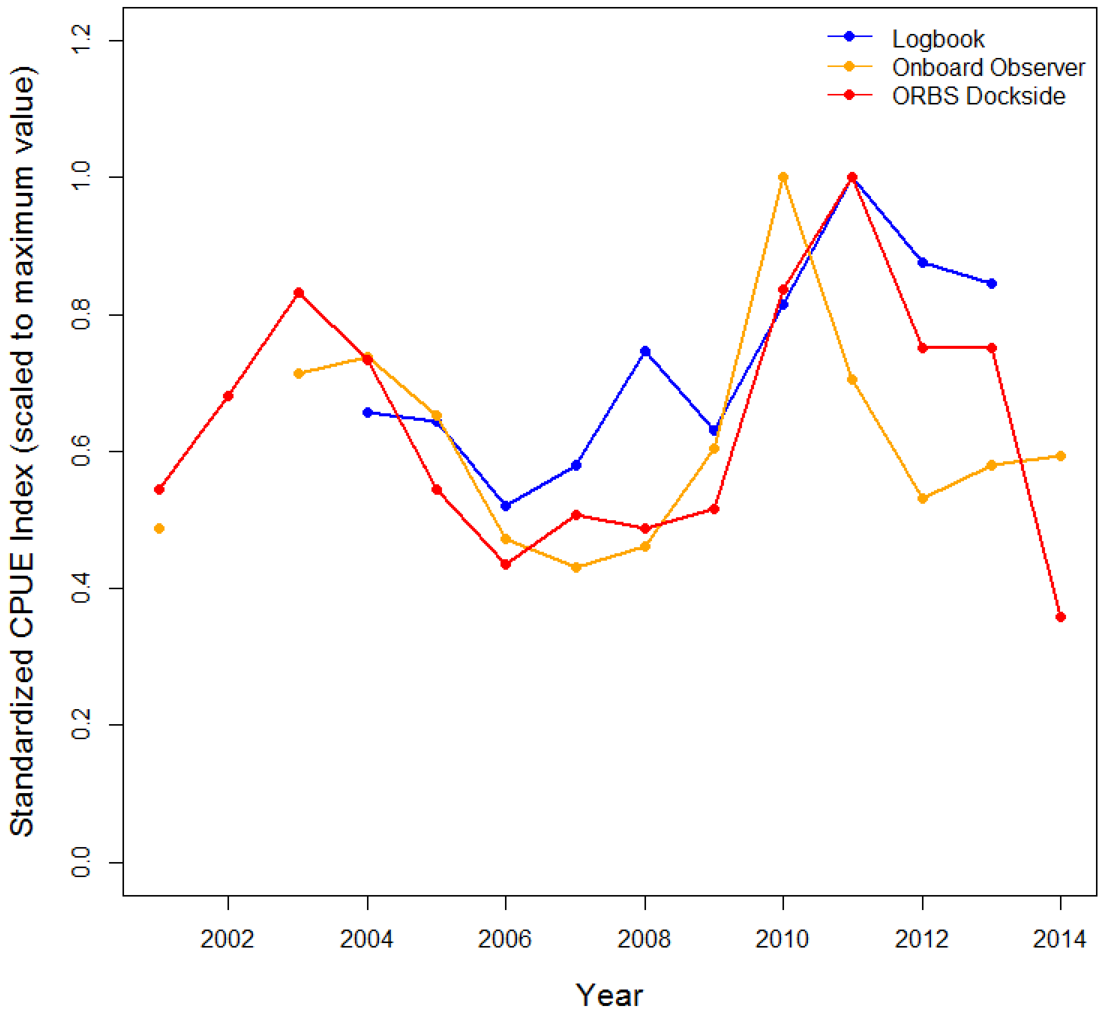


Figure 19. A summary comparison of the abundance indices explored in this assessment. Each index has been scaled to its maximum value.

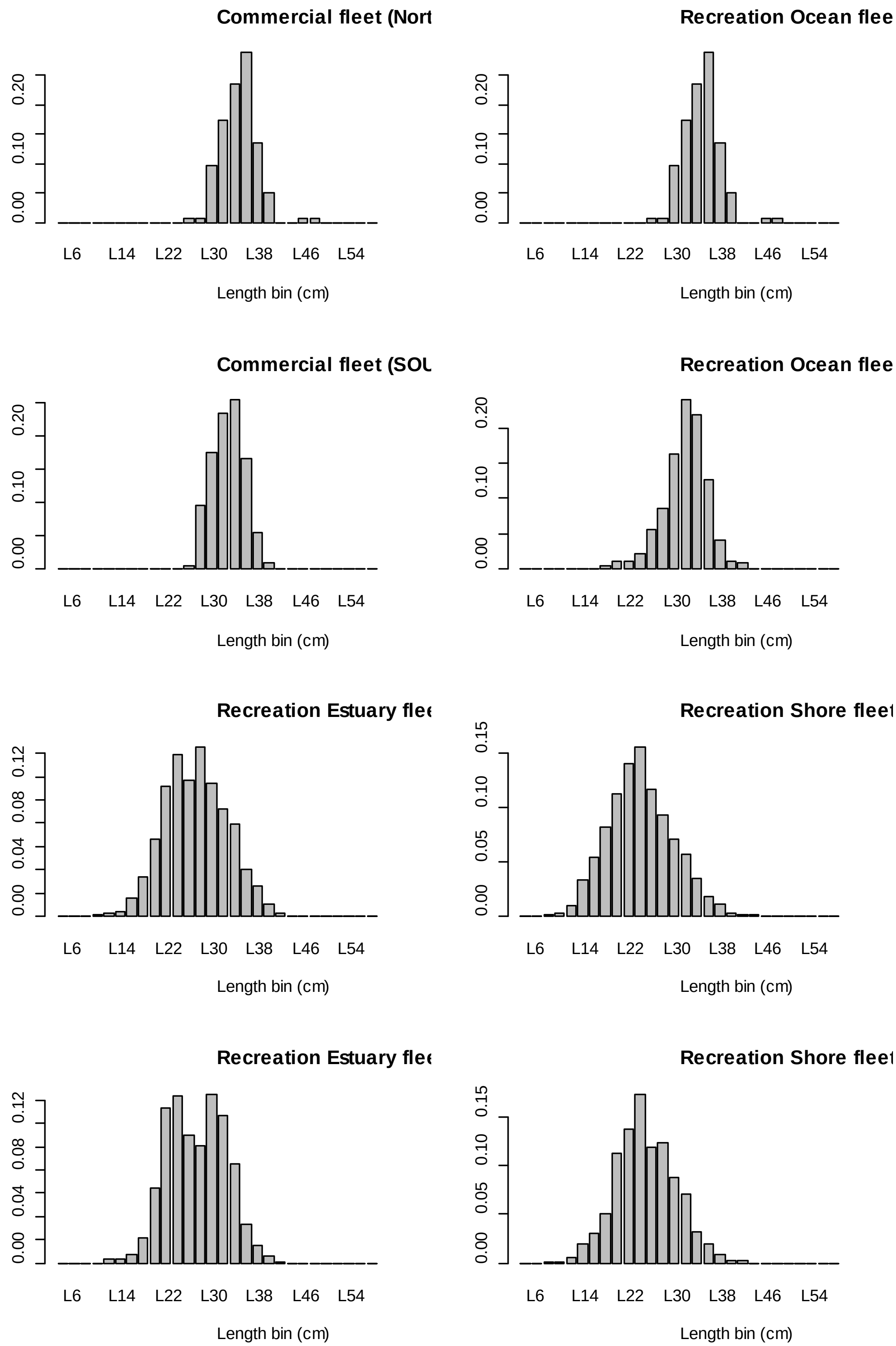


Figure 20. Length compositions from recreational and commercial fleets by region (see Figure 1 for the north/south coast delineation).

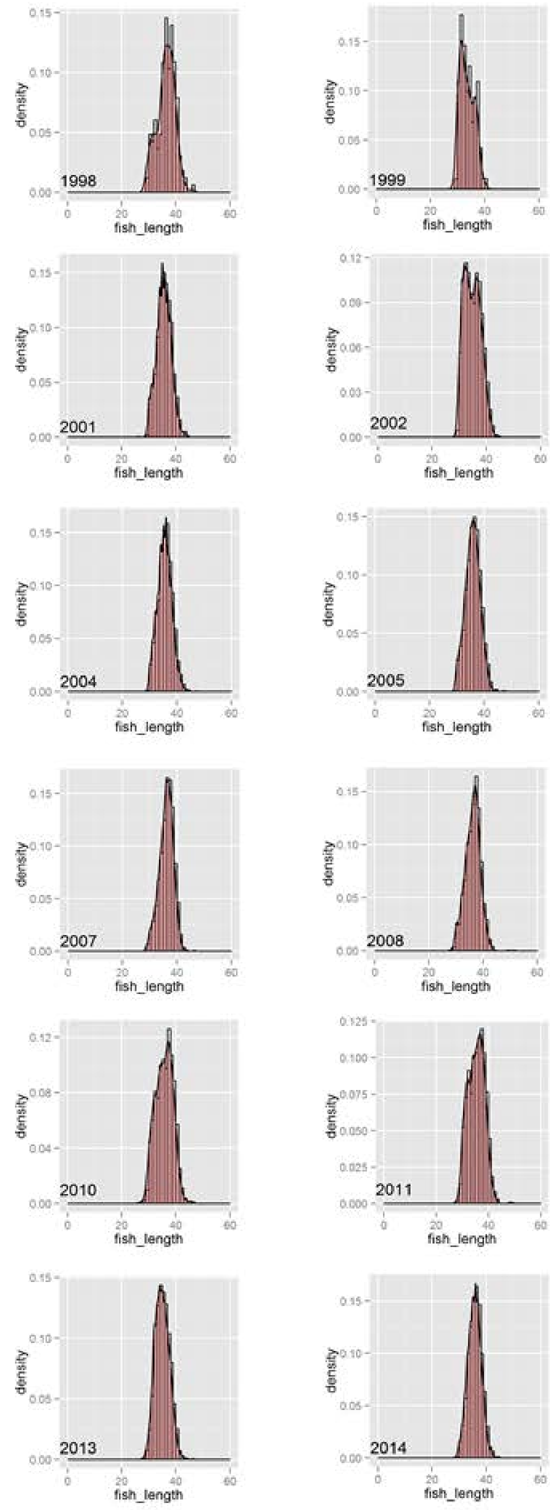


Figure 21. Observed length compositions from the commercial fleet from 1998 to 2014.

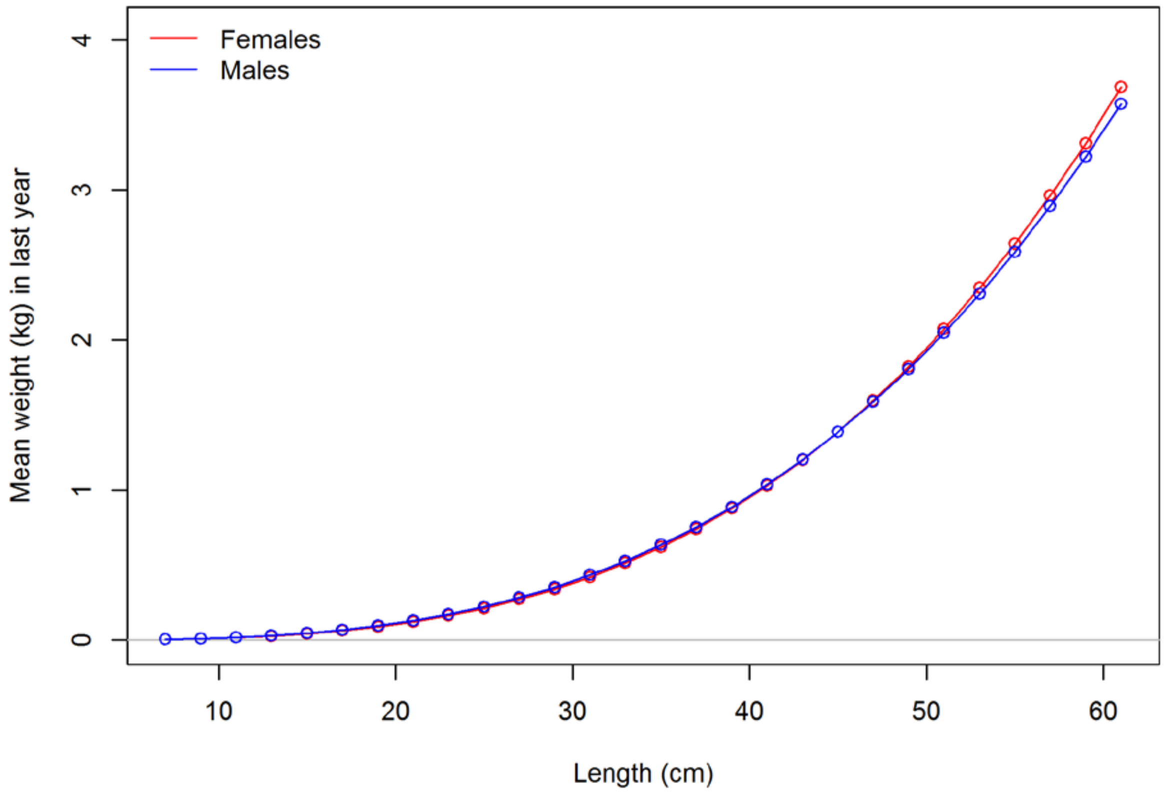


Figure 22. Weight-length relation for Kelp Greenling in Oregon waters by gender.

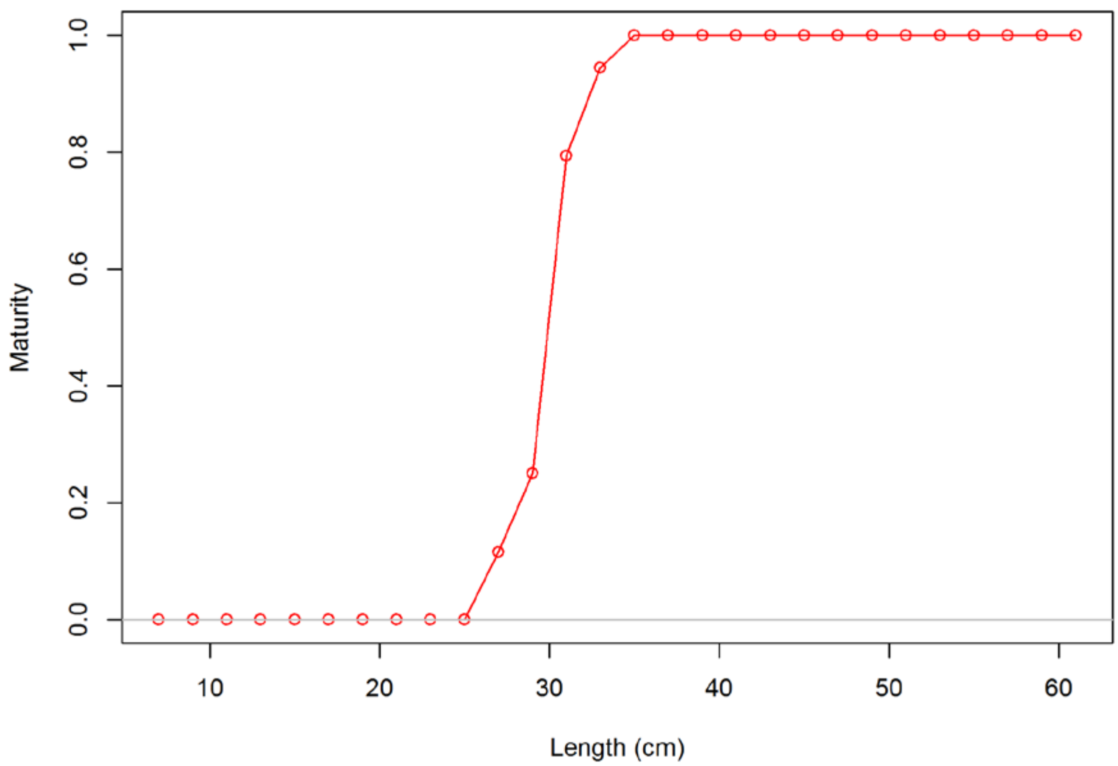


Figure 23. Maturity ogive used in the assessment for Kelp Greenling in Oregon waters.

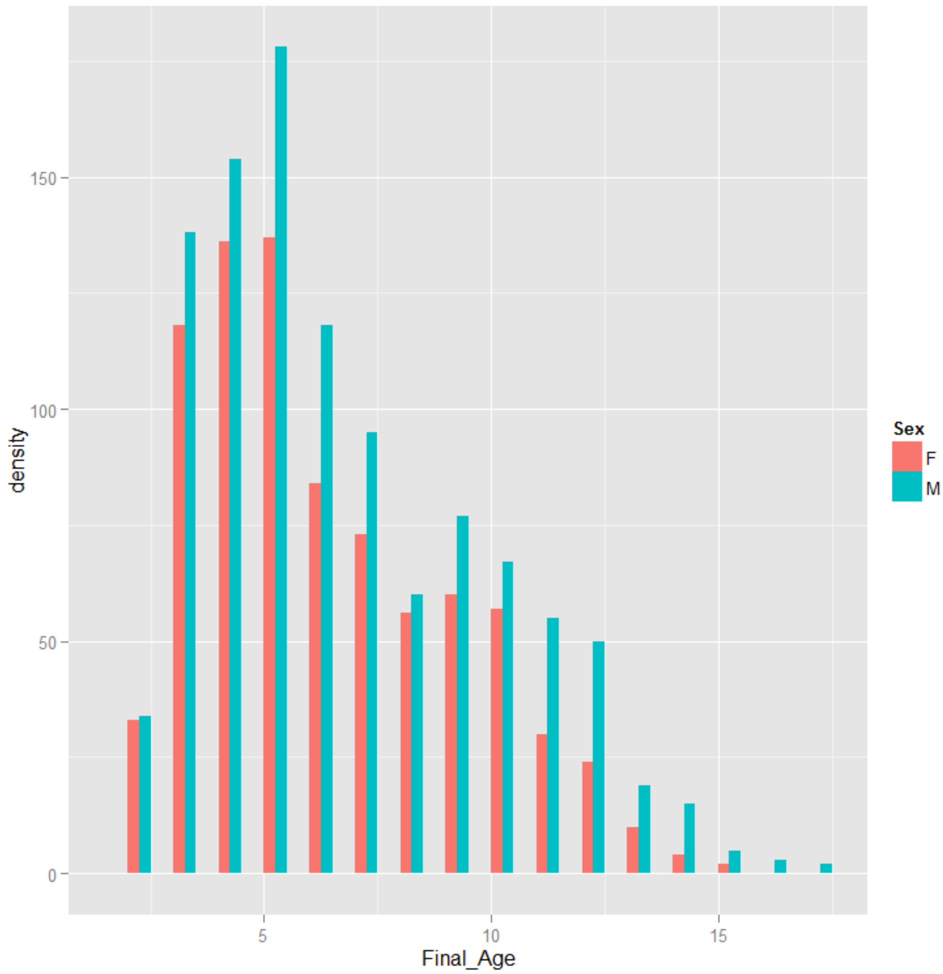


Figure 24. Histogram of age data available for male and female Kelp Greenling.

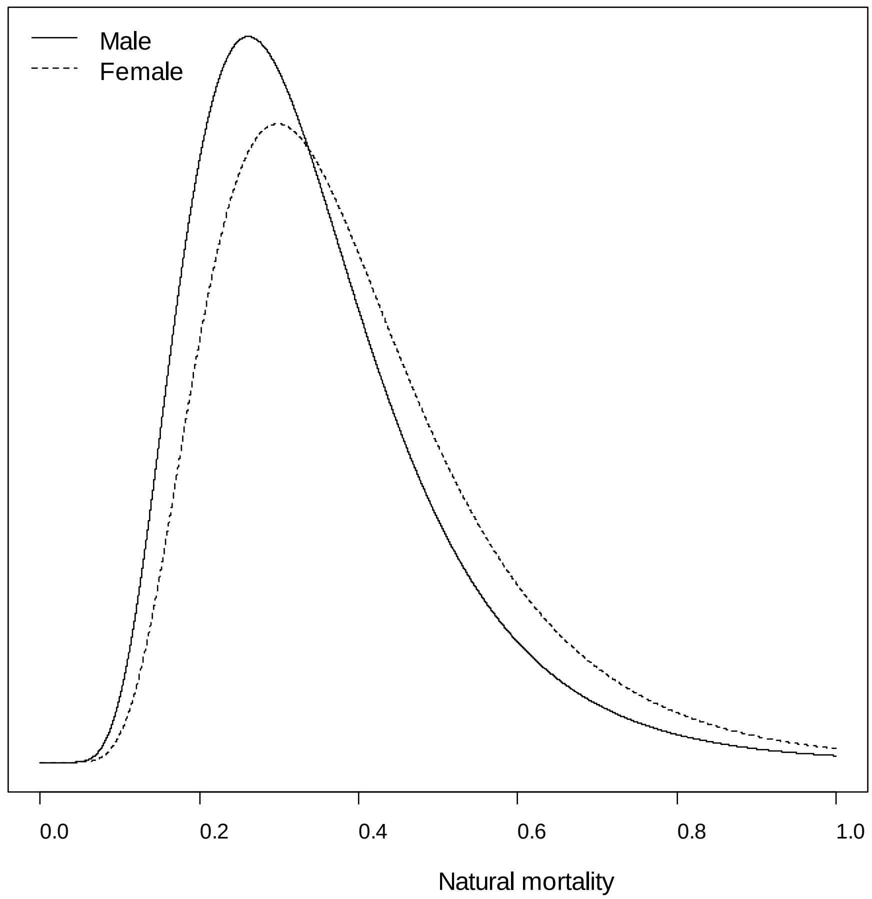


Figure 25. Prior distribution for natural mortality of male and female Kelp Greenling in Oregon waters.

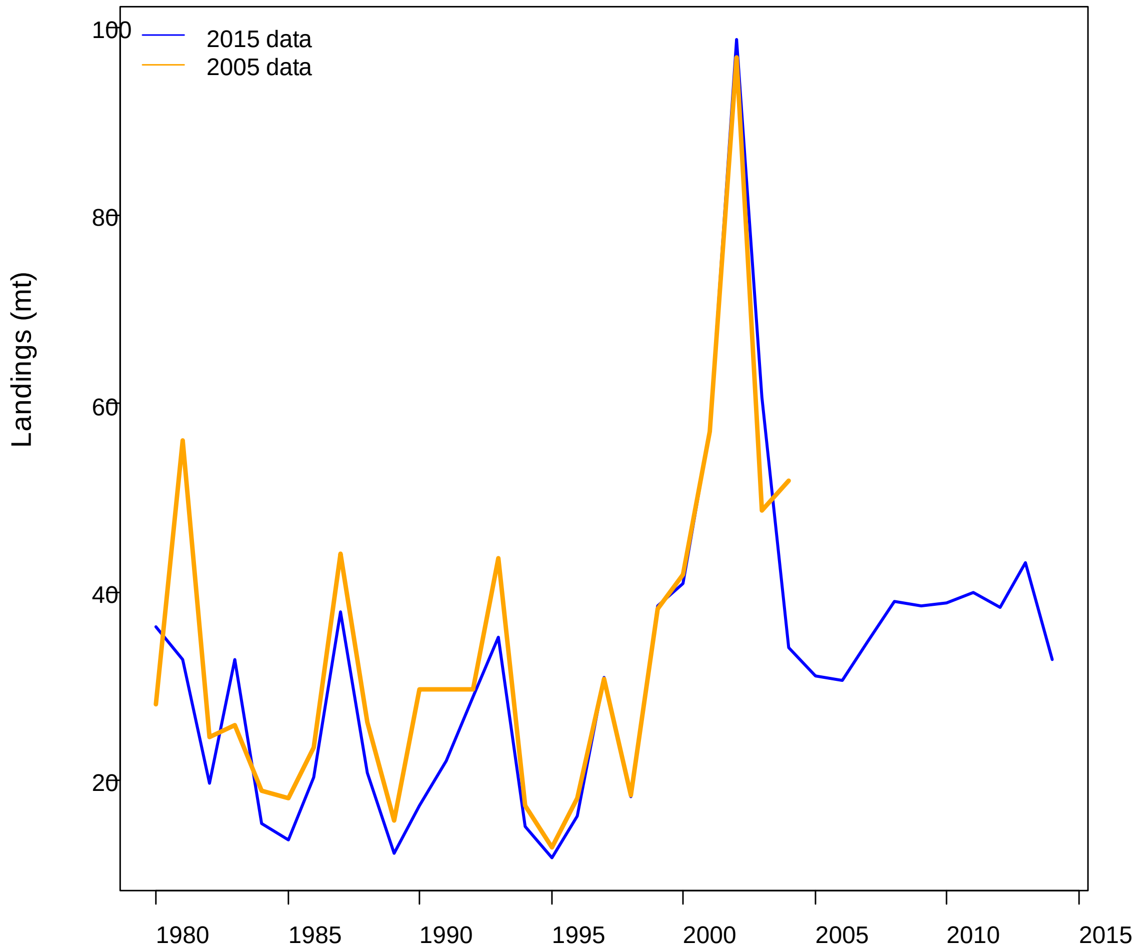


Figure 26. Total landings time series used in the 2005 assessment and the 2015 assessment for Kelp Greenling in Oregon waters.

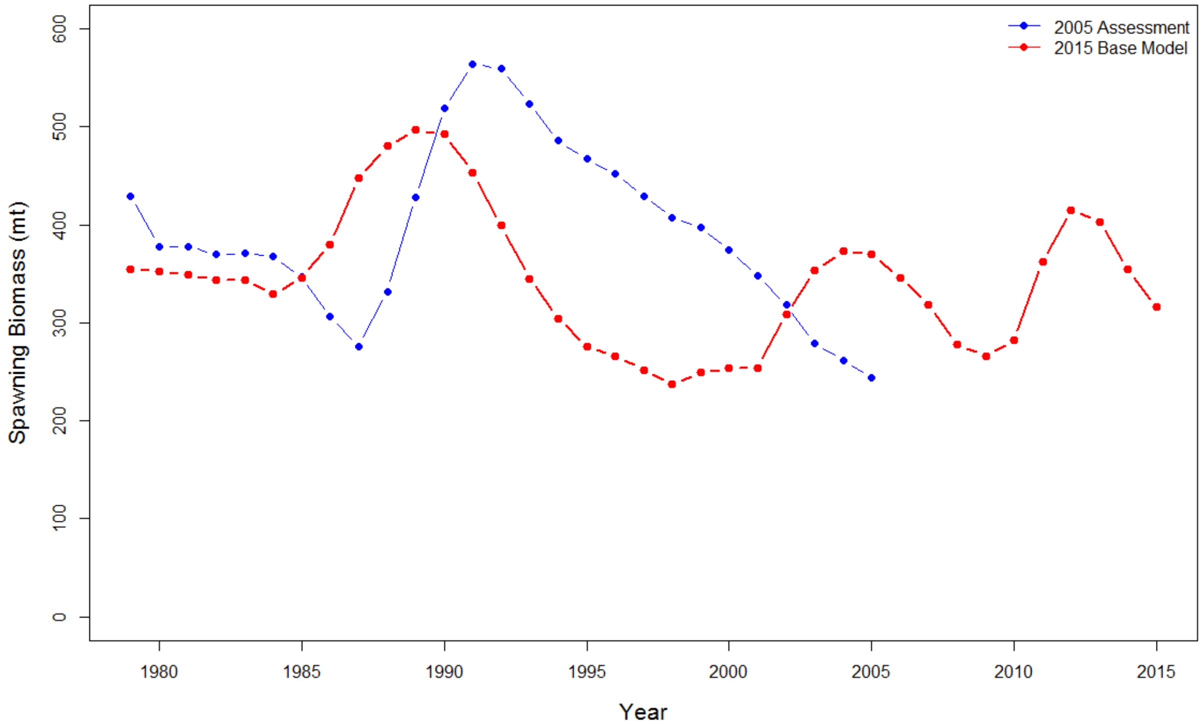


Figure 27. Comparison of the estimated spawning biomass trends from the previous (2005) assessment and the 2015 base model.

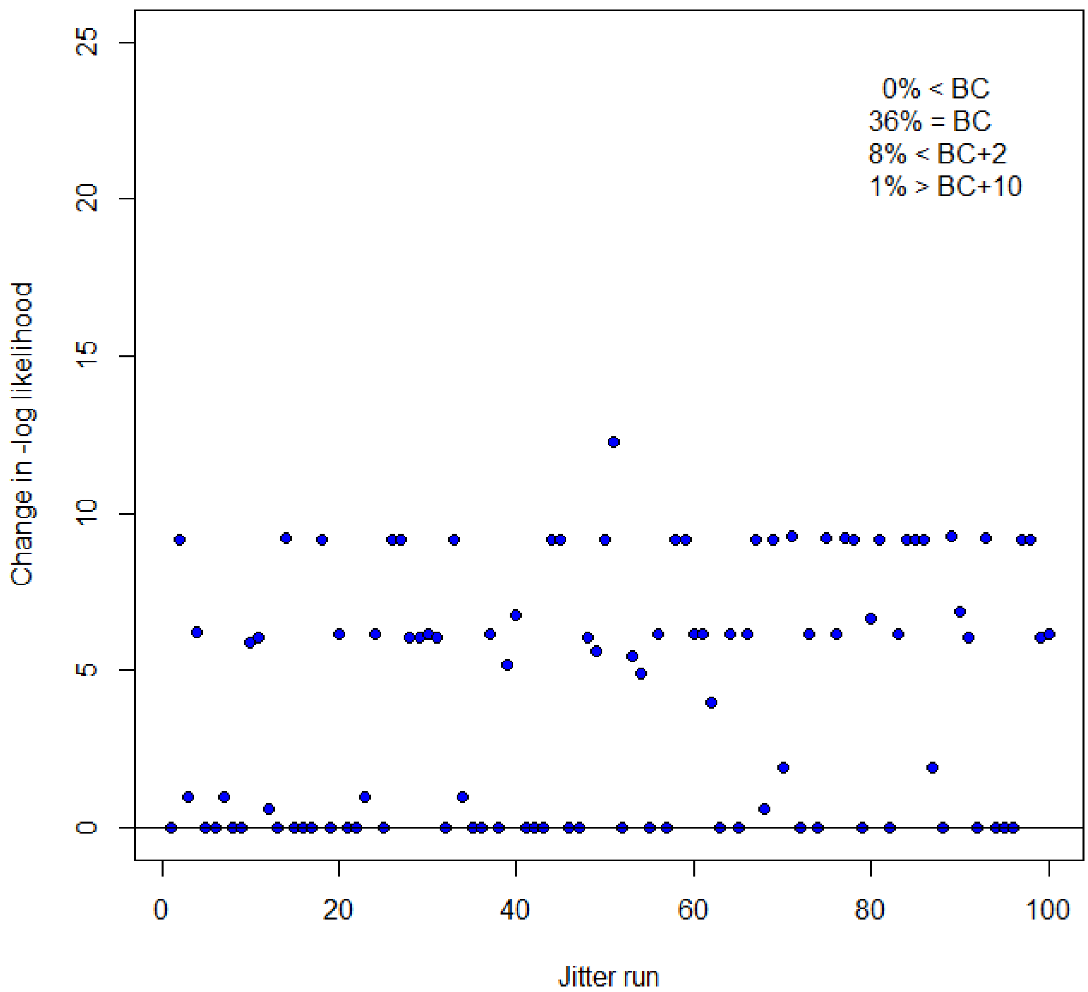


Figure 28. Results from 100 base case model runs when starting values were jittered (0.1).

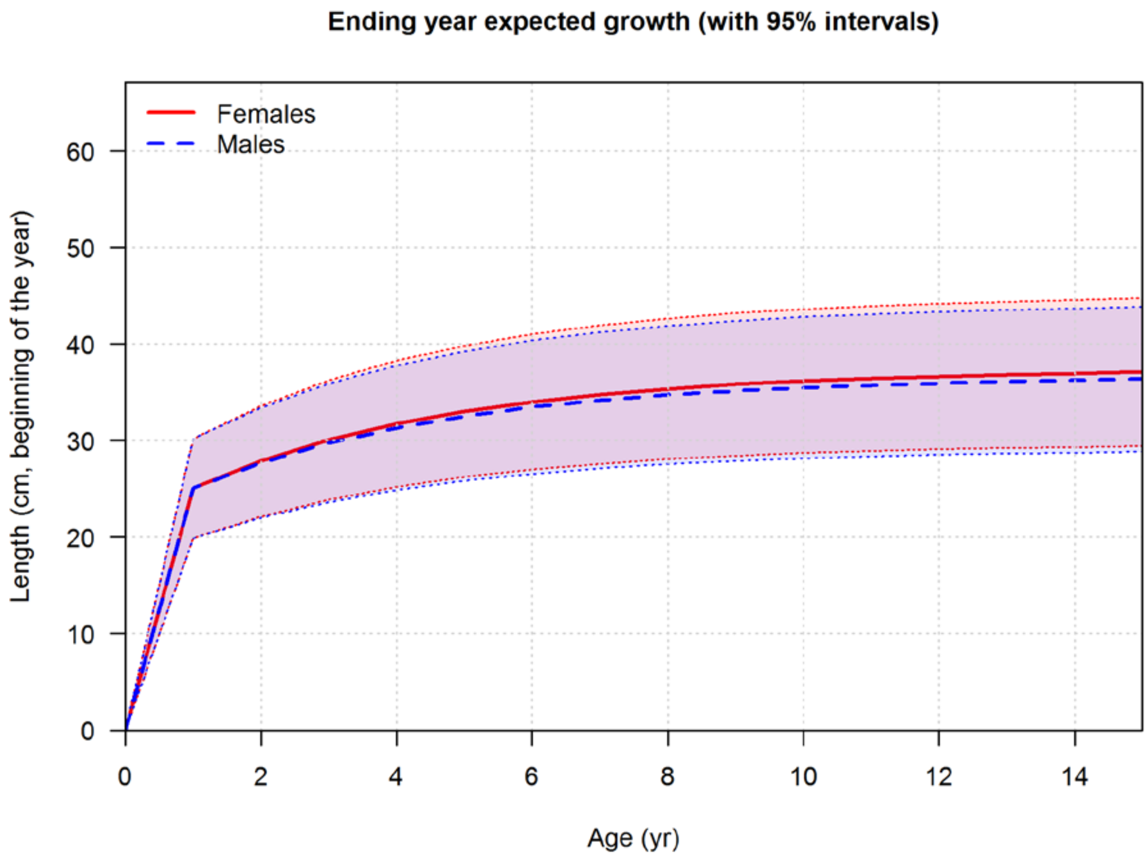


Figure 29. Growth curve for male and female Kelp Greenling with age-1 set as the minimum age for growth estimation.

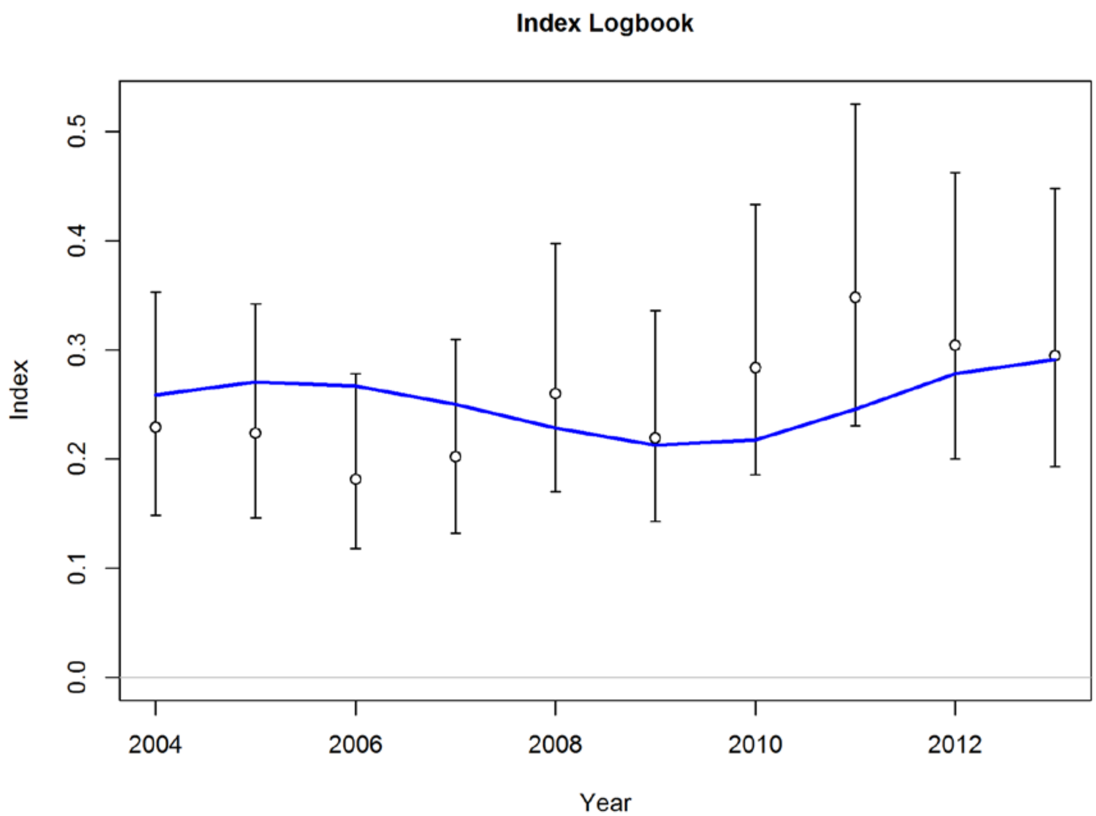


Figure 30. Fit to the commercial logbook abundance index for the Kelp Greenling base case model.

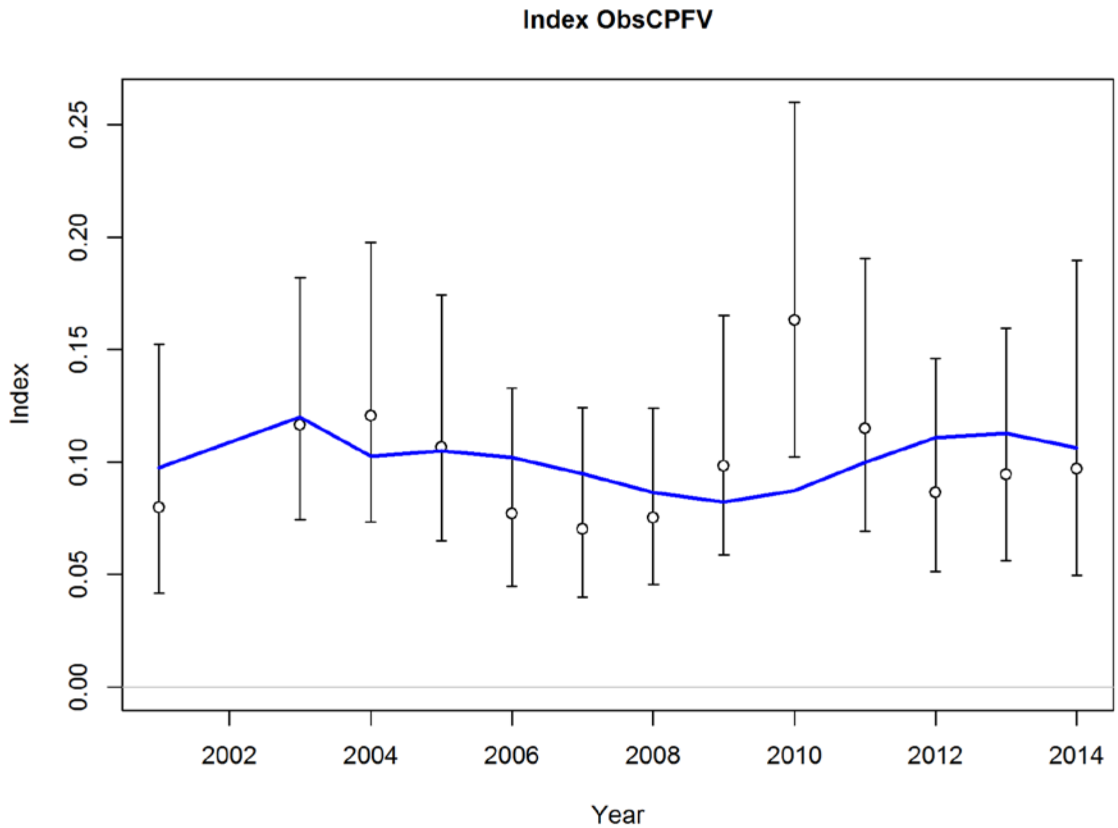


Figure 31. Fit to the recreational onboard observer abundance index for the Kelp Greenling base case model.

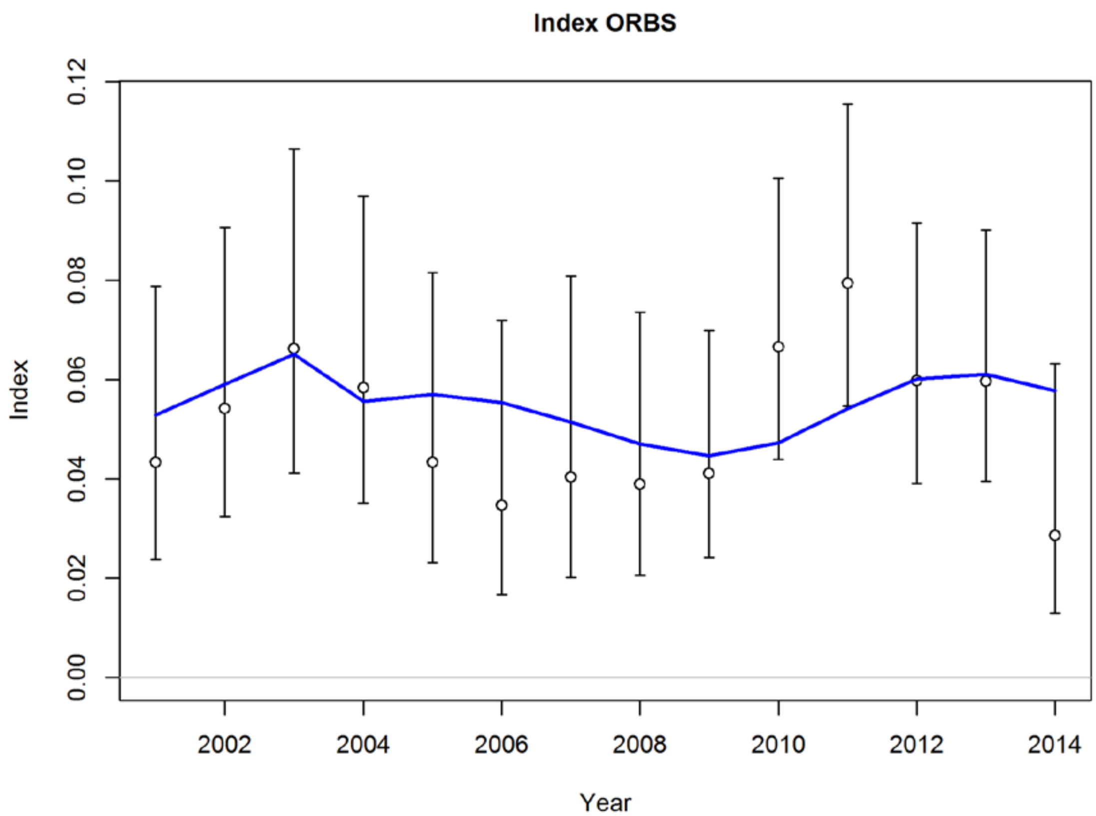


Figure 32. Fit to the recreational ORBS abundance index for the Kelp Greenling base case model.

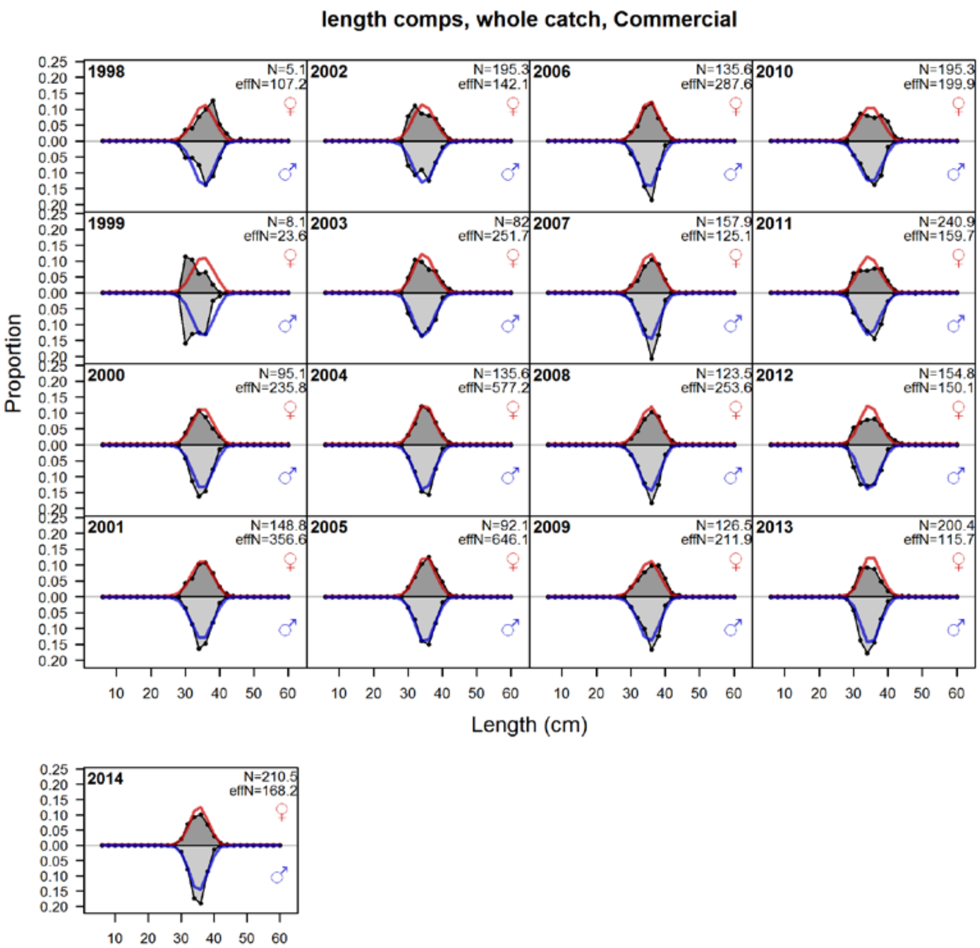
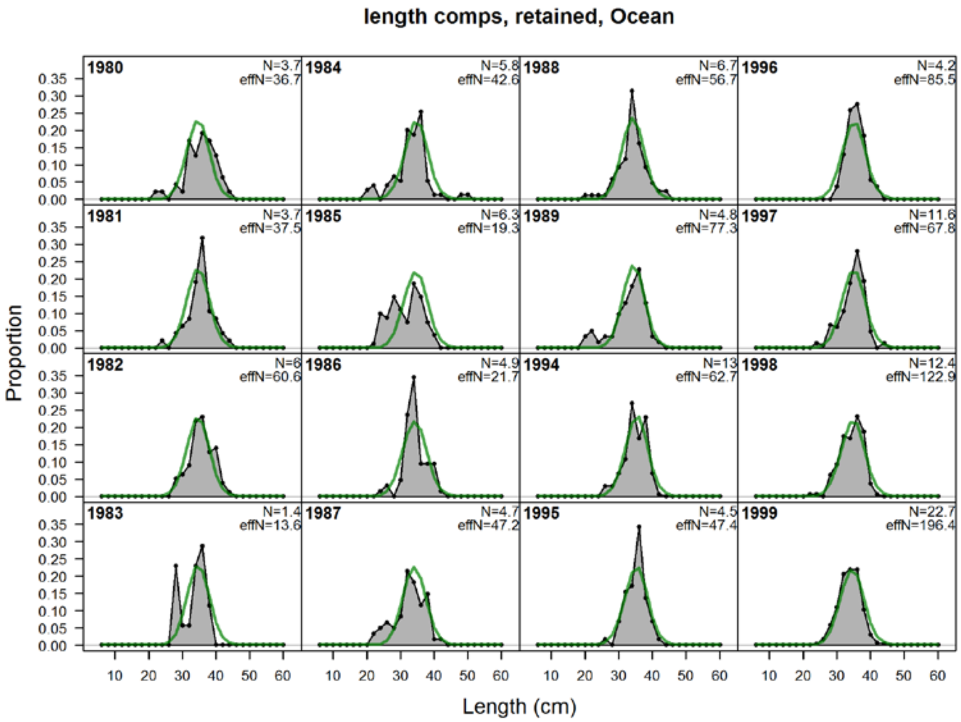


Figure 33. Base fit to gender-specific Kelp Greenling length compositions for the commercial fleet.



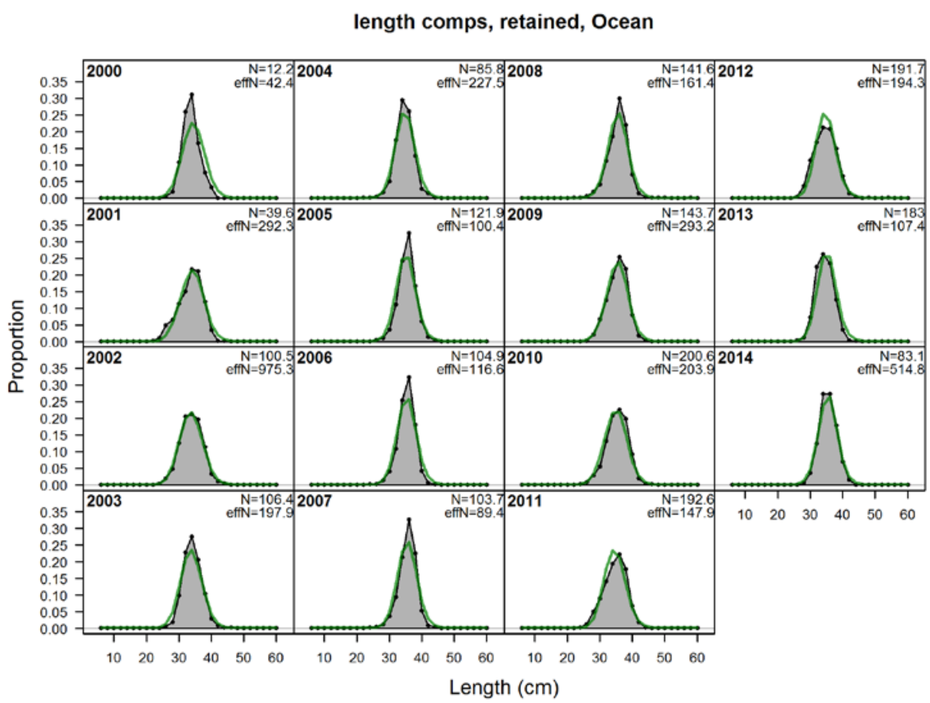


Figure 34. Base fit to gender-aggregated Kelp Greenling length compositions for the recreational ocean fleet.

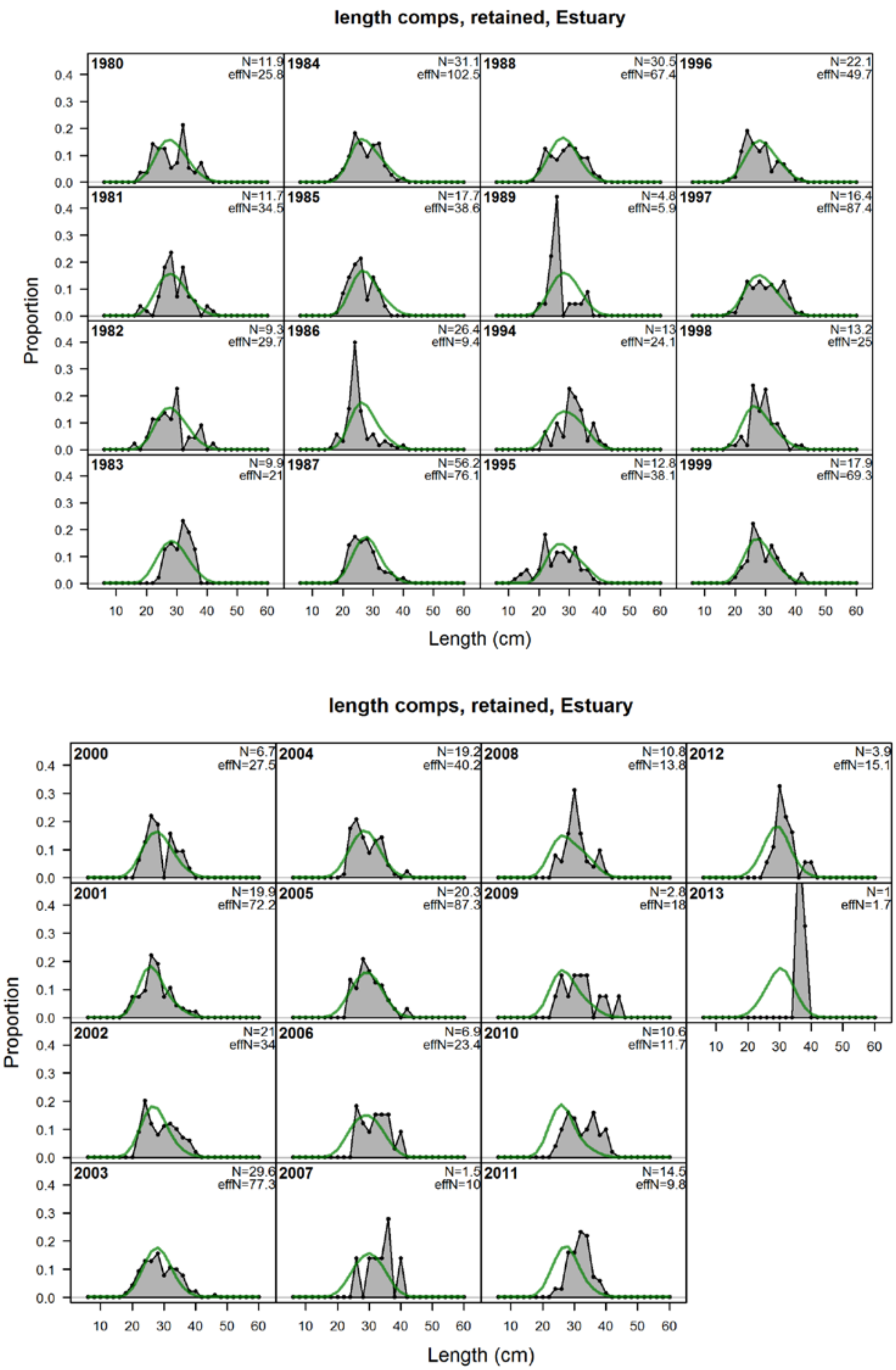


Figure 35. Base fit to gender-aggregated Kelp Greenling length compositions for the recreational estuary fleet.

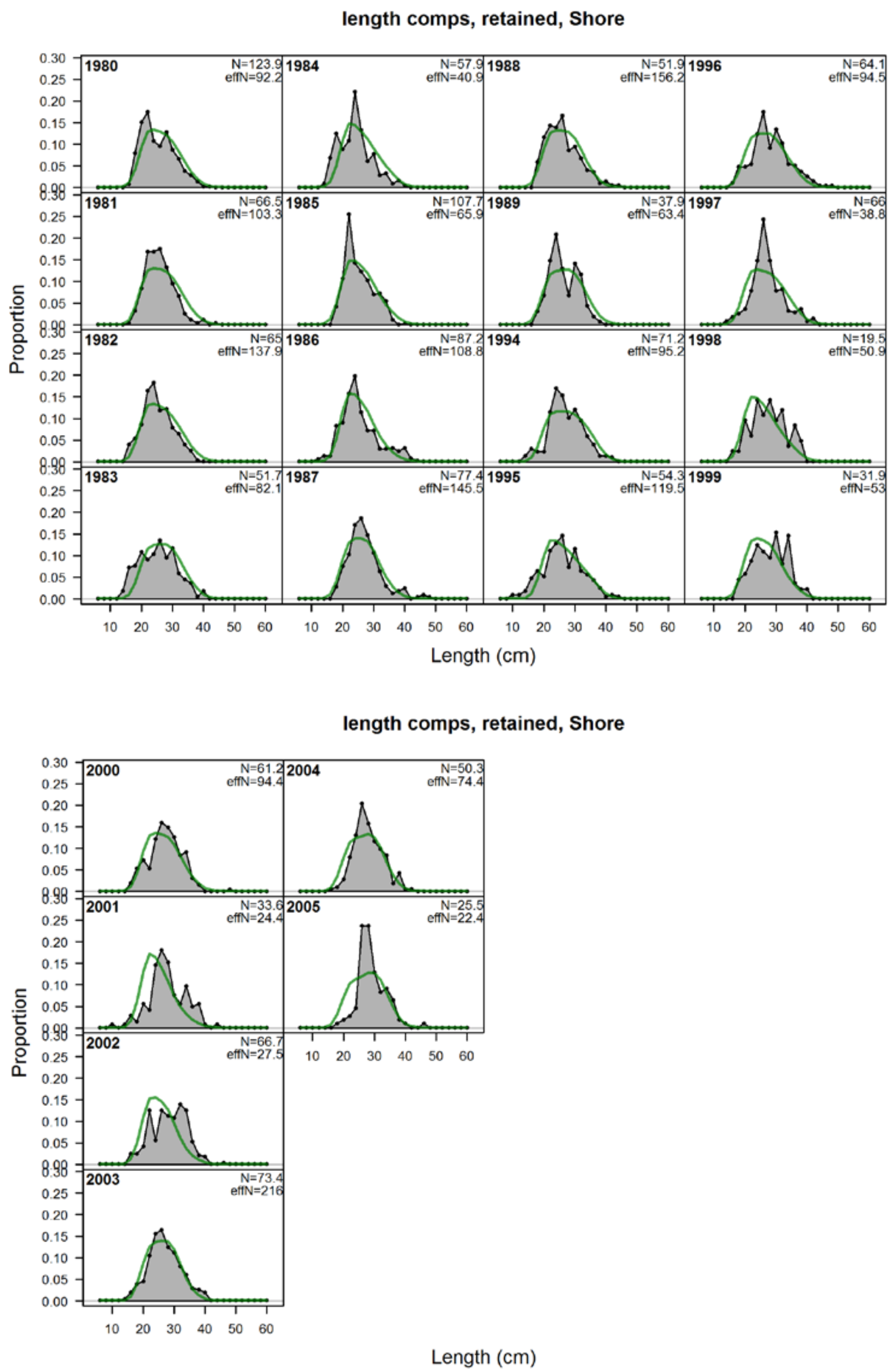


Figure 36. Base fit to gender-aggregated Kelp Greenling length compositions for the recreational shore fleet.

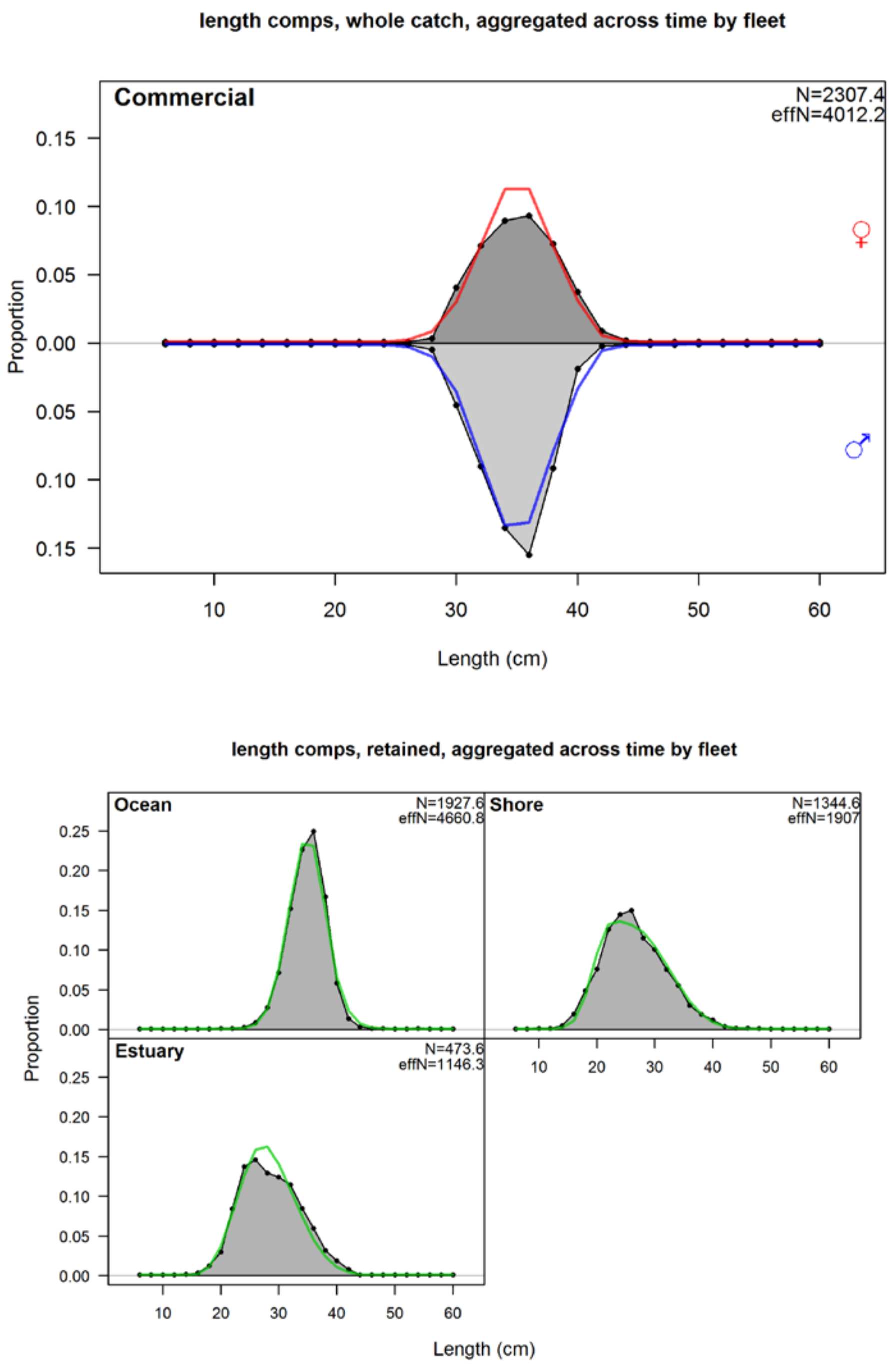


Figure 37. Base fit to time-aggregated Kelp Greenling length compositions for all fleets.

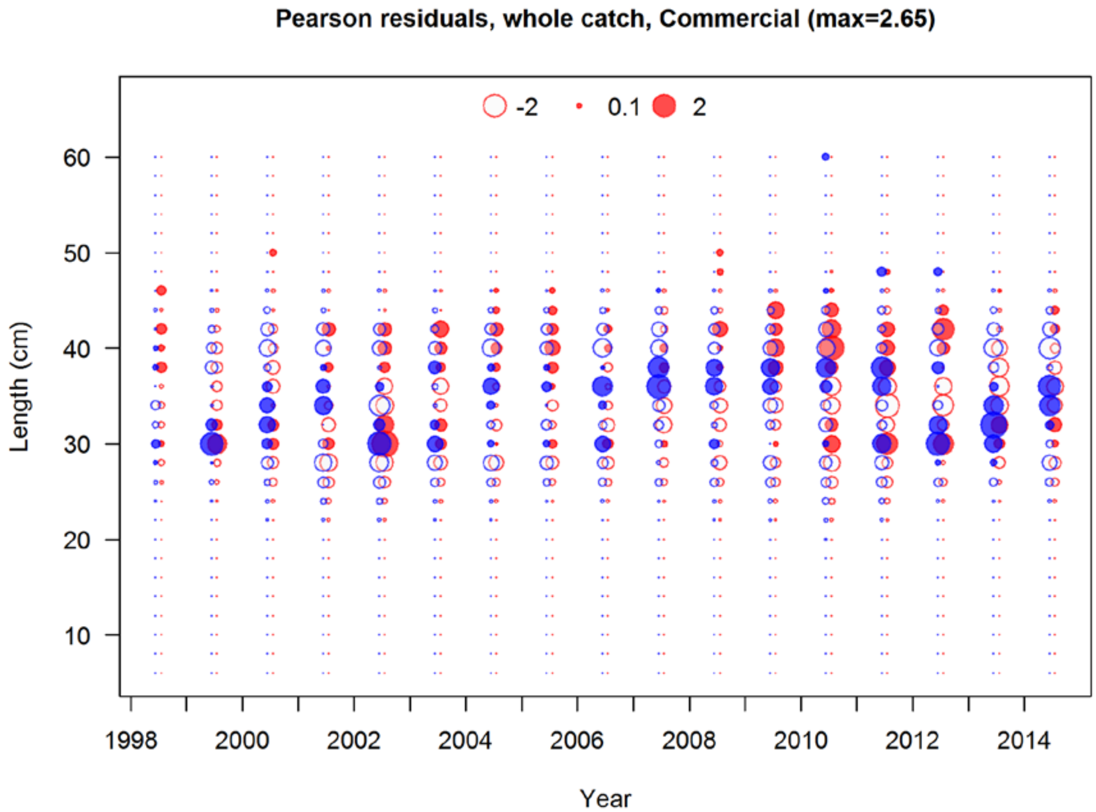


Figure 38. Pearson residuals for the fit to length composition data for the commercial fleet.

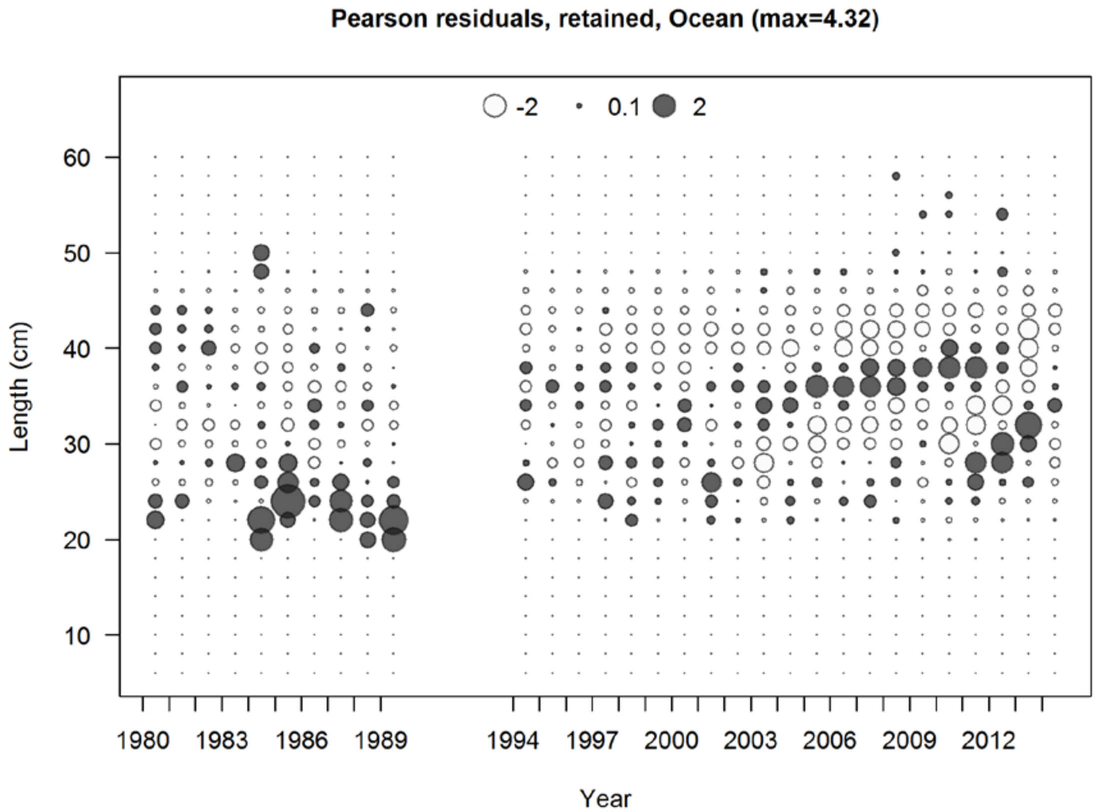


Figure 39. Pearson residuals for the fit to length composition data for the recreational ocean fleet.

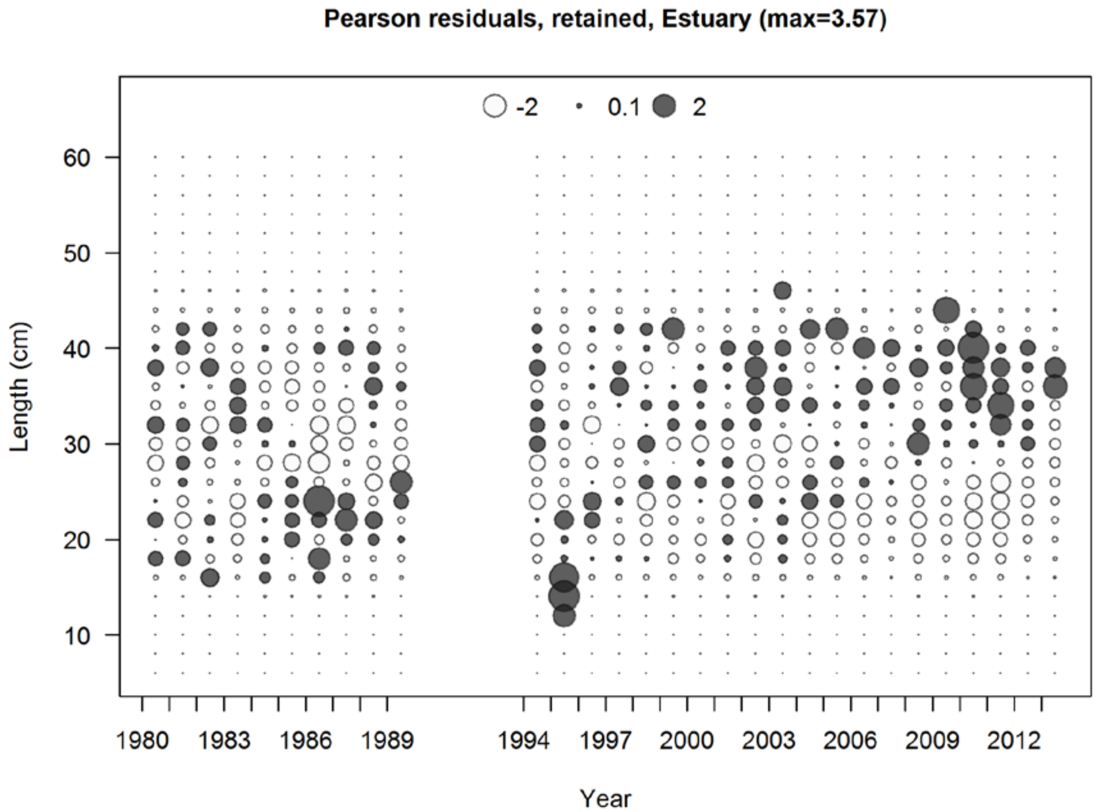


Figure 40. Pearson residuals for the fit to length composition data for the recreational estuary fleet.

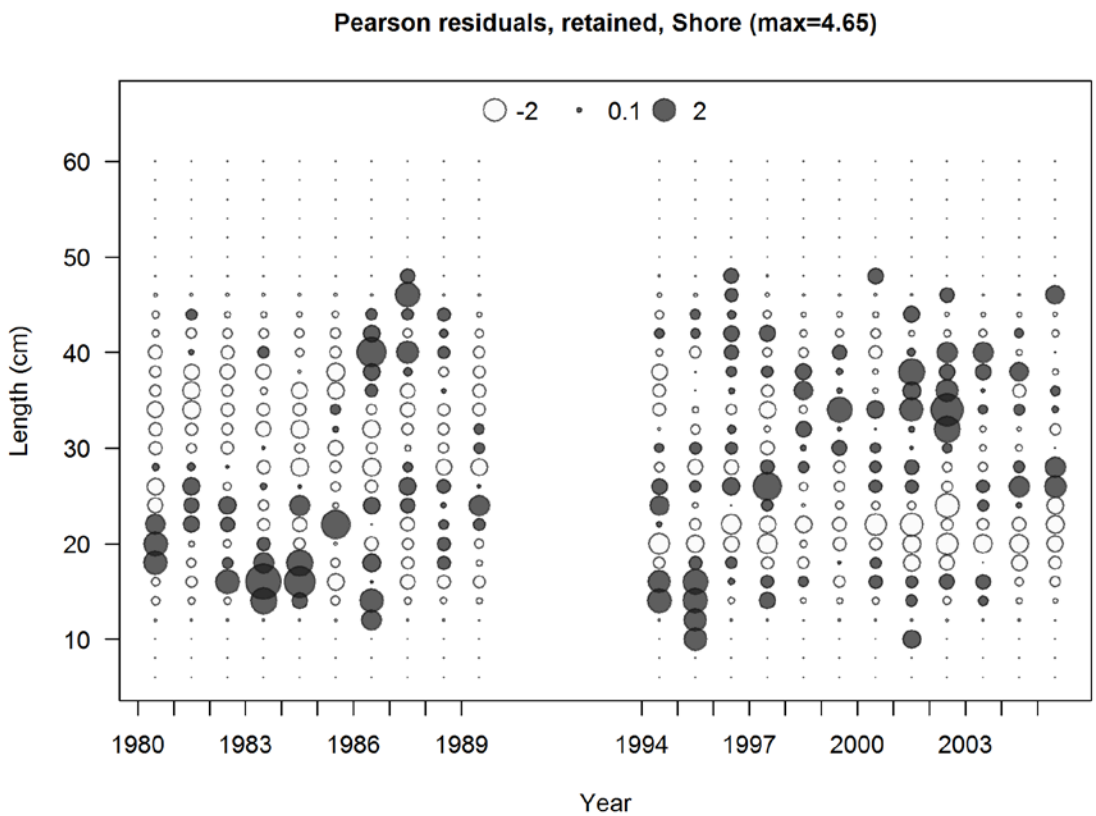


Figure 41. Pearson residuals for the fit to length composition data for the recreational shore fleet.

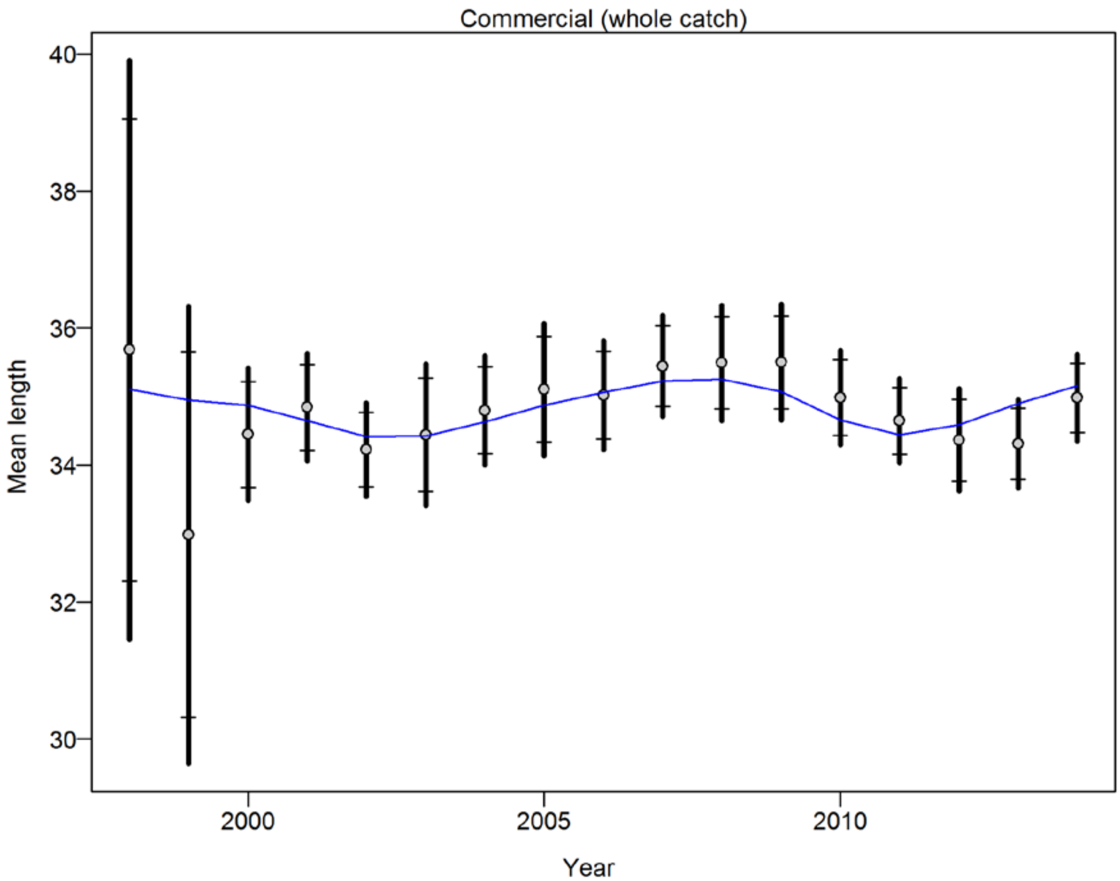


Figure 42. Base fit to mean Kelp Greenling lengths for the commercial fleet.

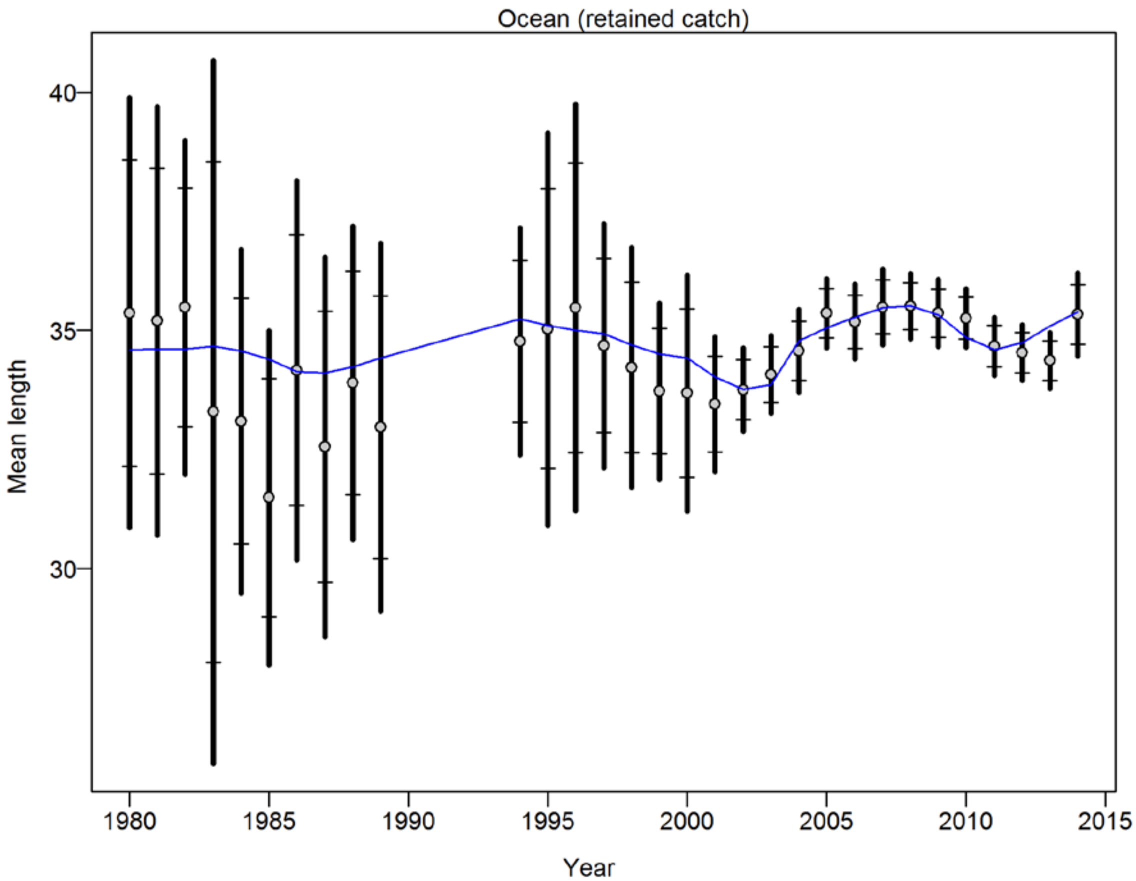


Figure 43. Base fit to mean Kelp Greenling lengths for the recreational ocean fleet.

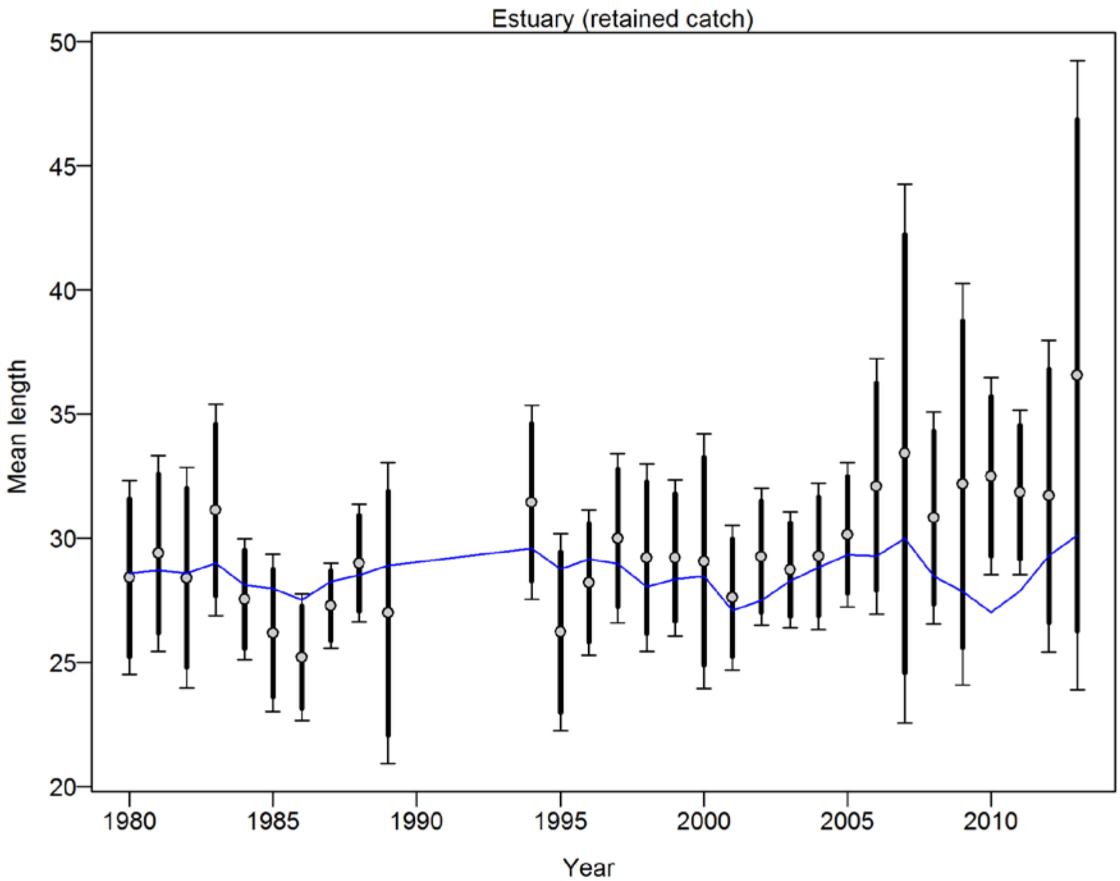


Figure 44. Base fit to mean Kelp Greenling lengths for the recreational estuary fleet.

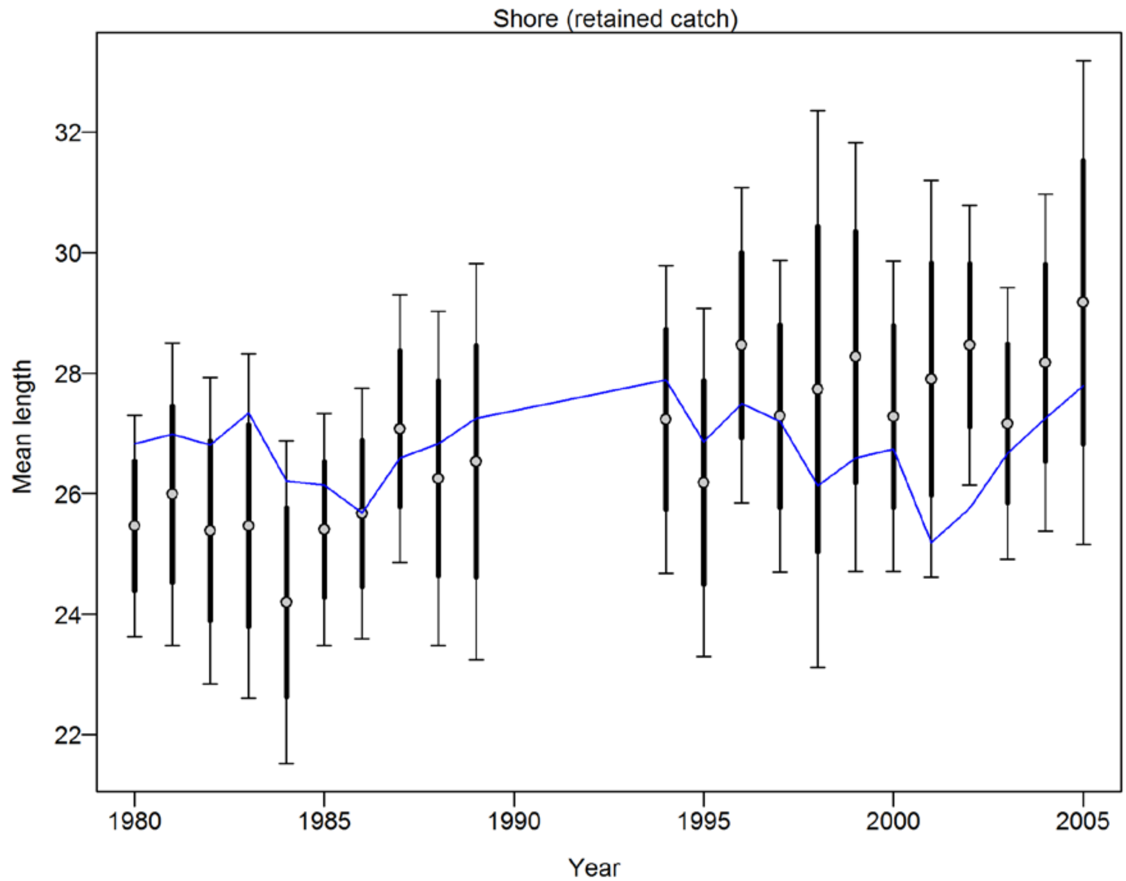


Figure 45. Base fit to mean Kelp Greenling lengths for the recreational shore fleet.

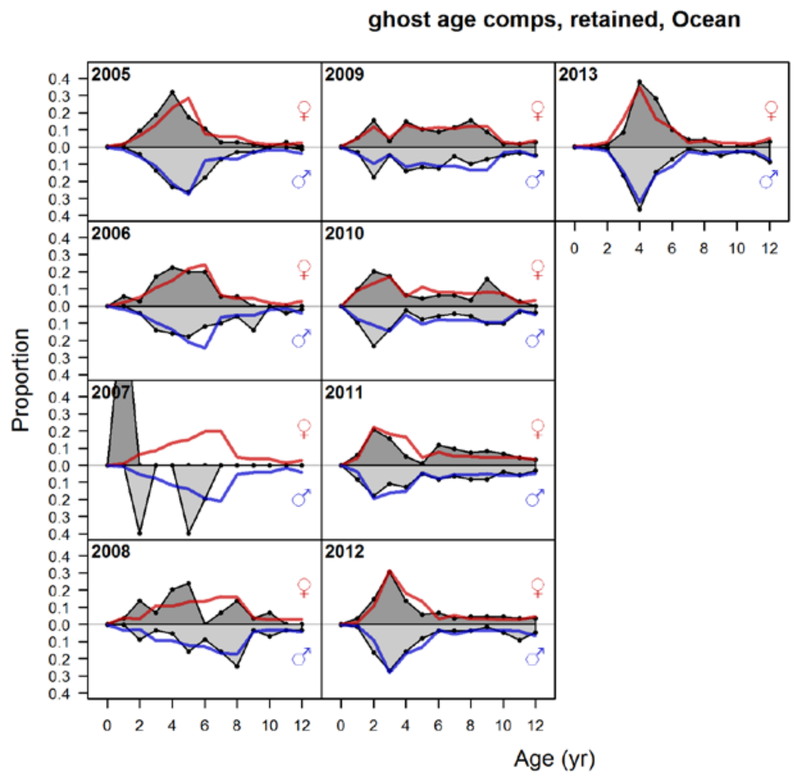


Figure 46. Resulting deviations in age composition patterns from fitting conditional age-at-length data for the recreational ocean fleet.

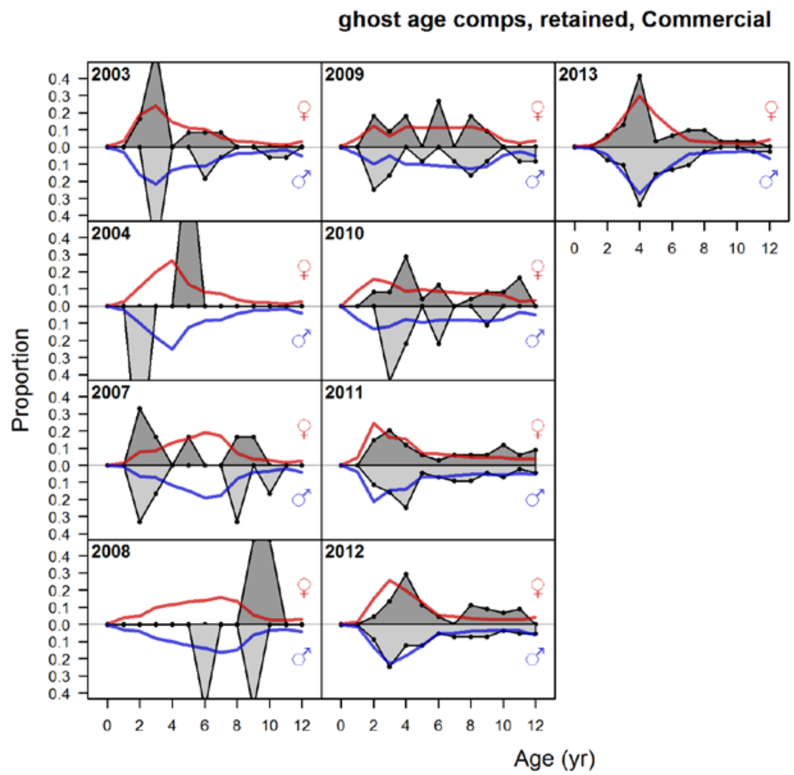


Figure 47. Resulting deviations in age composition patterns from fitting conditional age-at-length data for the commercial fleet.

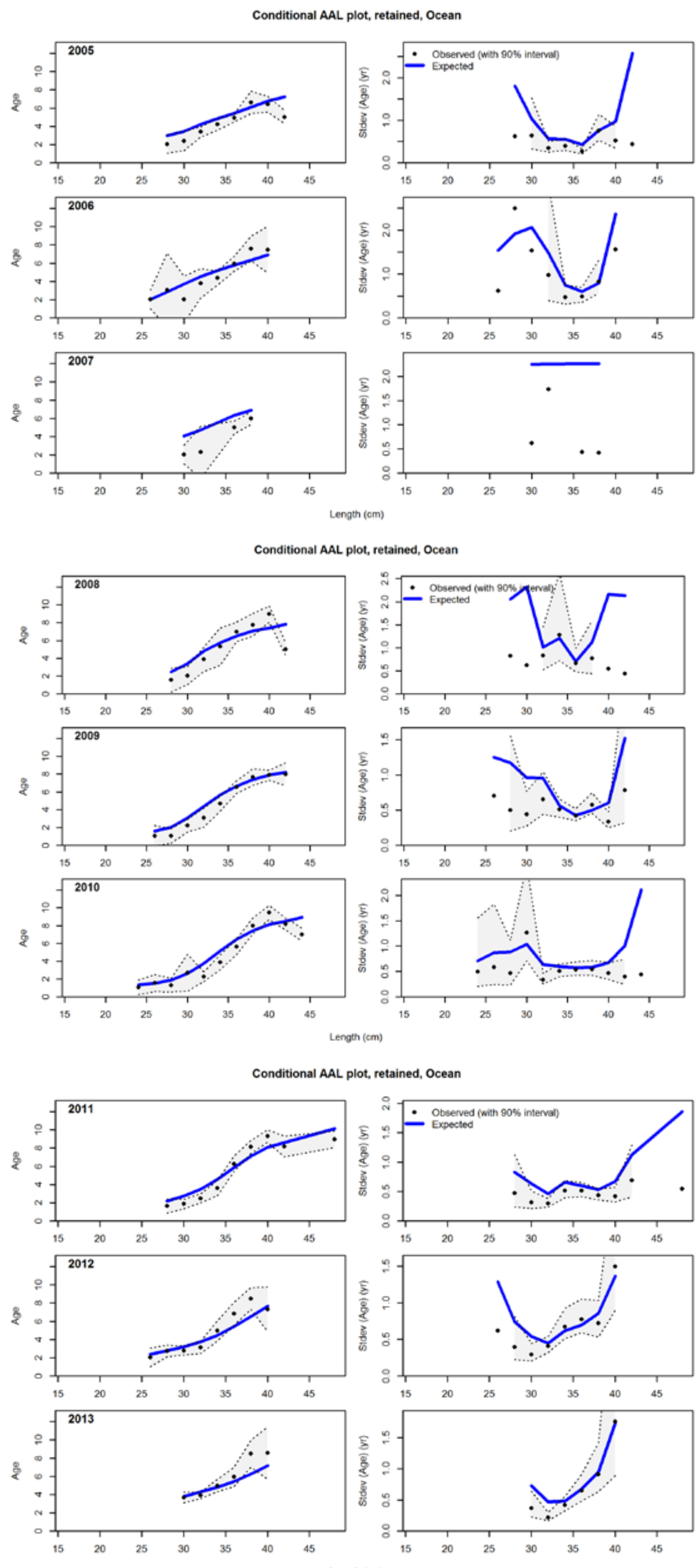


Figure 48. Base model fits to conditional age-at-length data for the recreational ocean fleet.

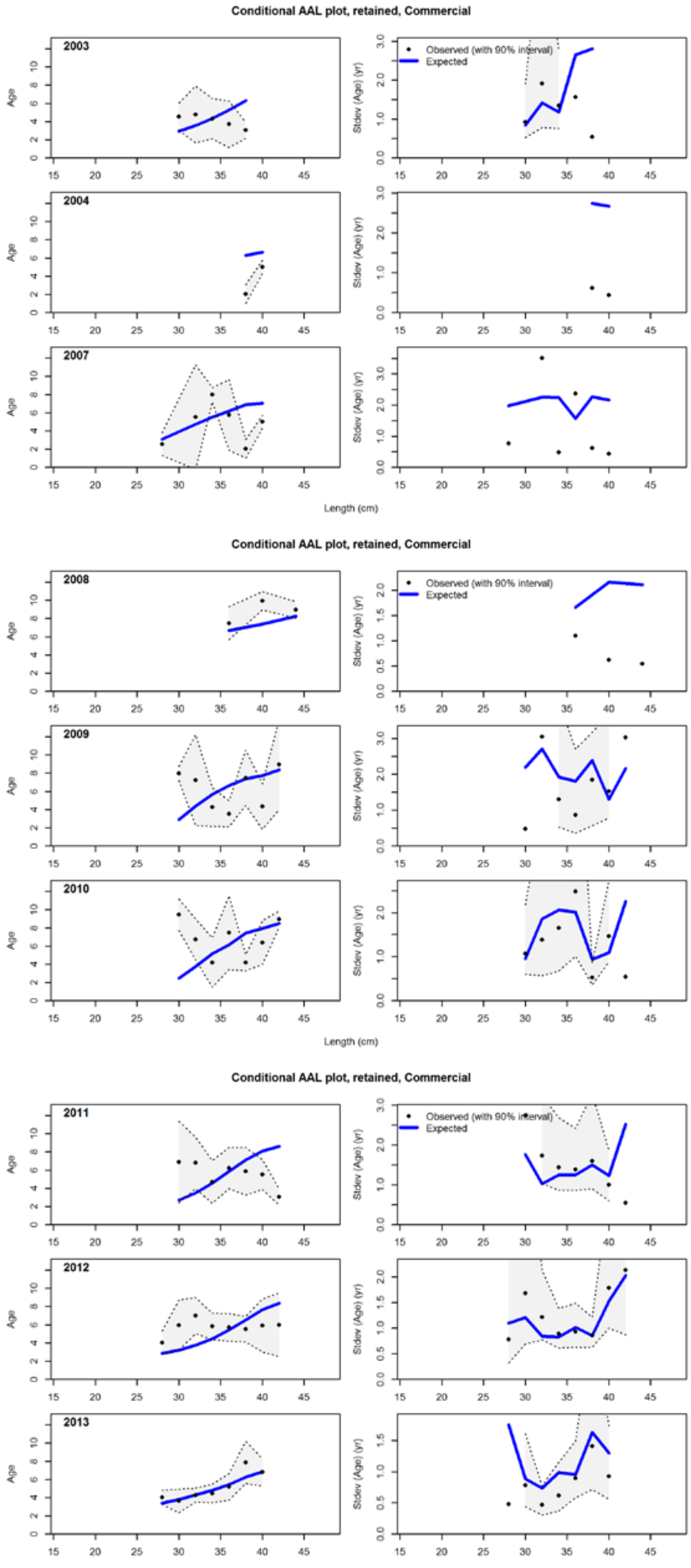


Figure 49. Base model fits to conditional age-at-length data for the commercial fleet.

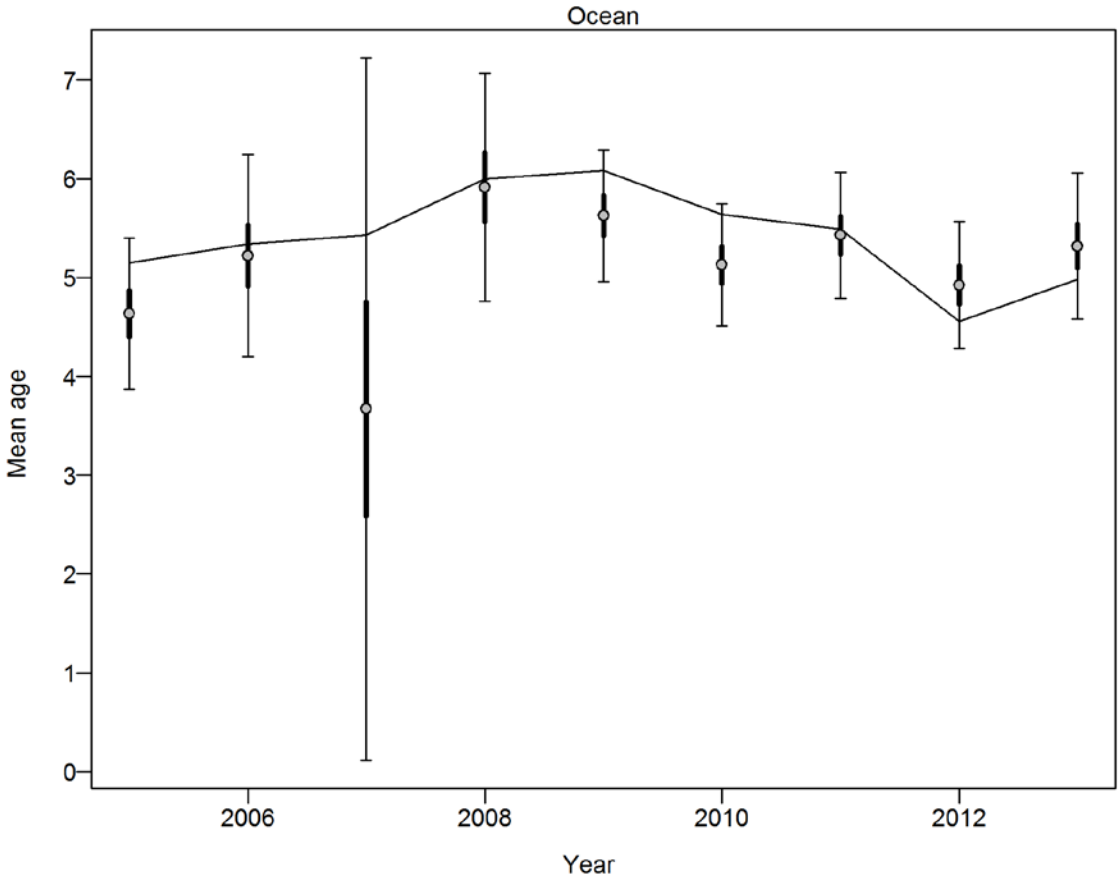


Figure 50. Base model fit to Kelp Greenling mean age for the recreational ocean fleet.

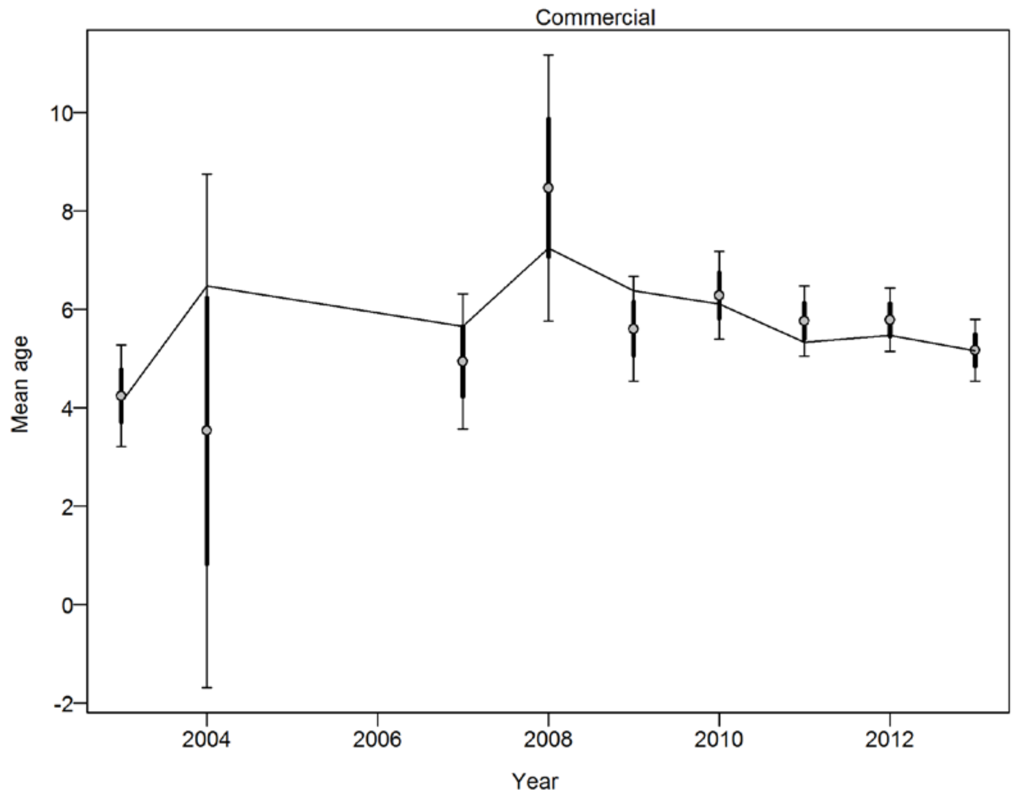


Figure 51. Base model fit to Kelp Greenling mean age for the commercial fleet.

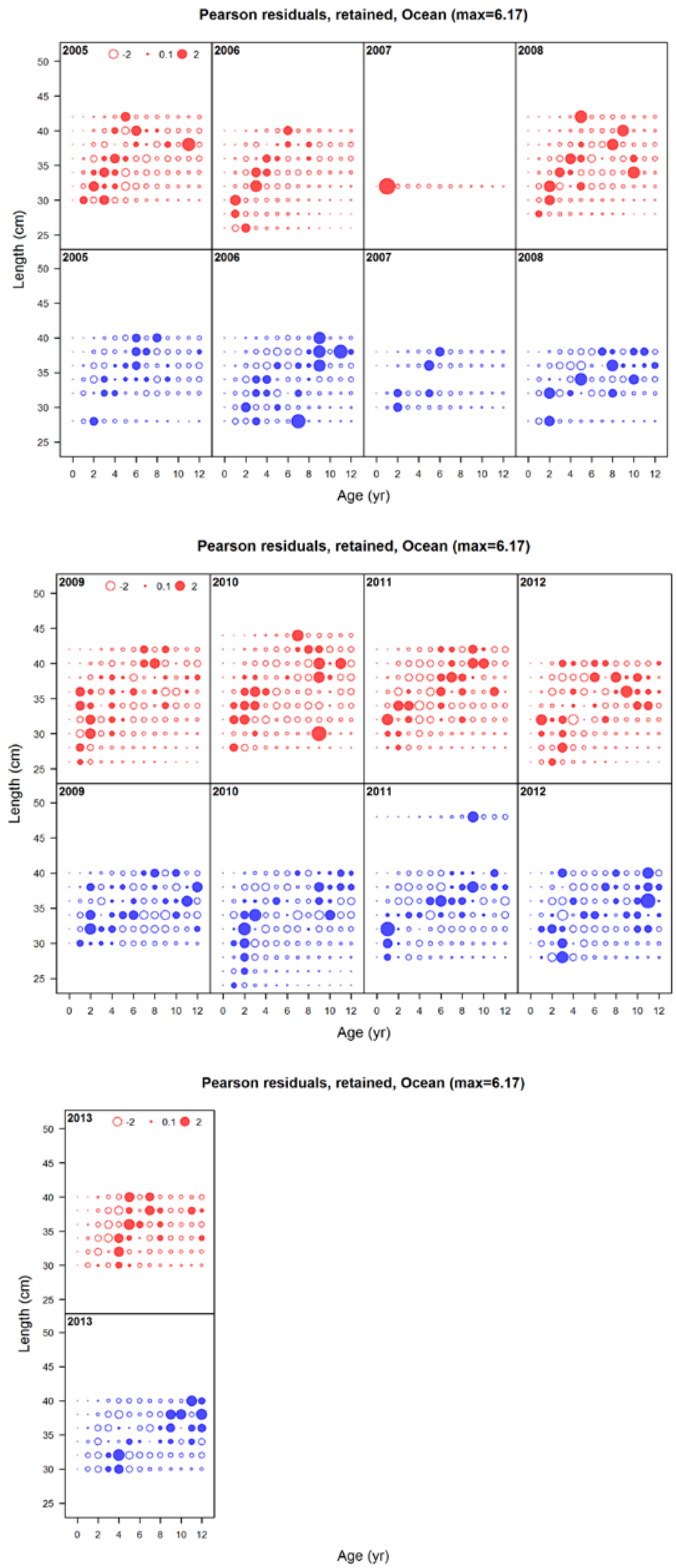


Figure 52. Pearson residuals from the base model fit to conditional age-at-length data in the recreational ocean fleet.

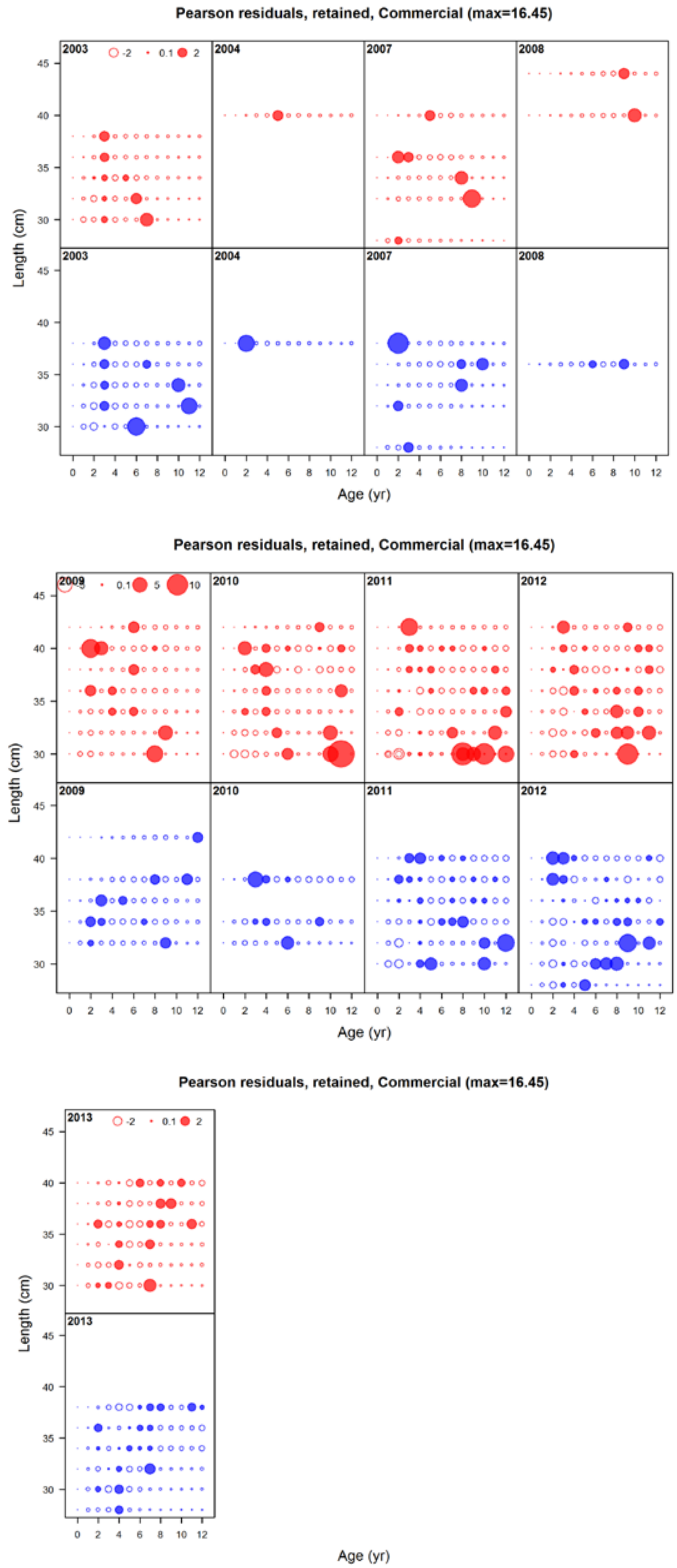


Figure 53. Pearson residuals from the base model fit to conditional age-at-length data in the commercial fleet.

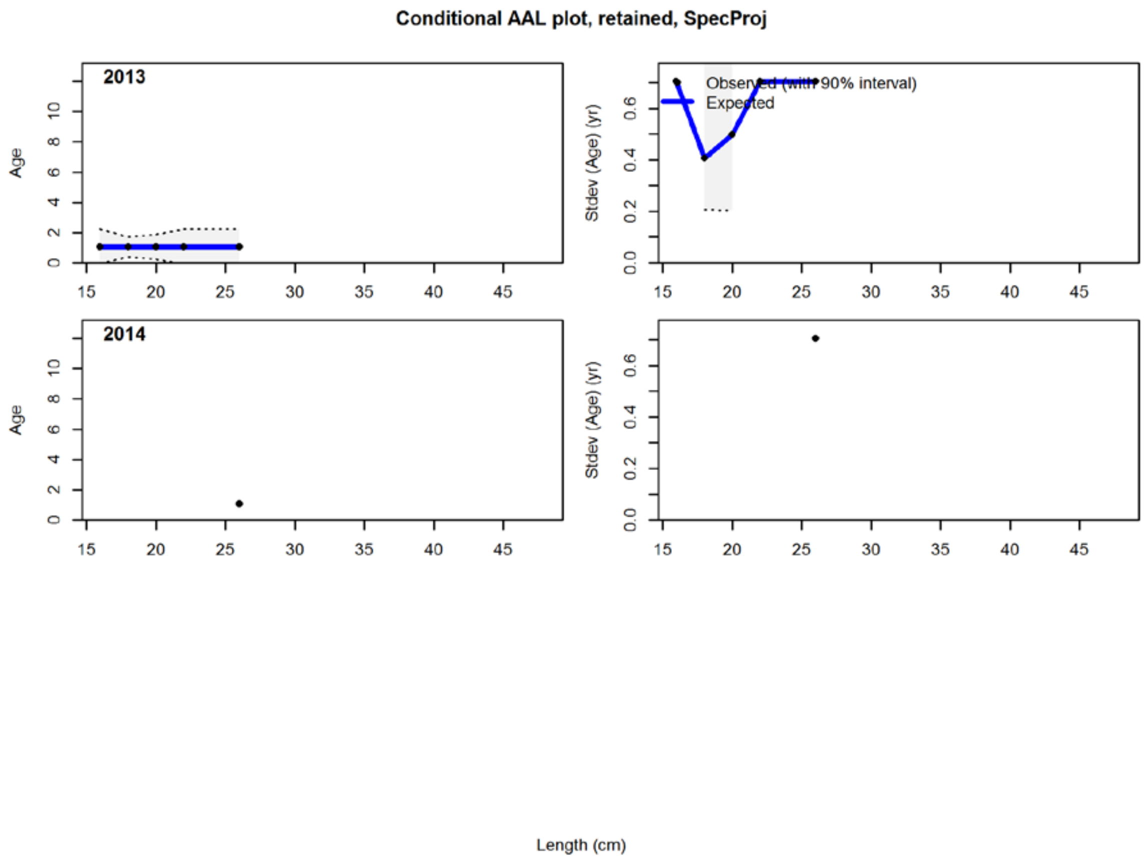


Figure 54. Base model fits to conditional age-at-length data for the ODFW special projects survey data.

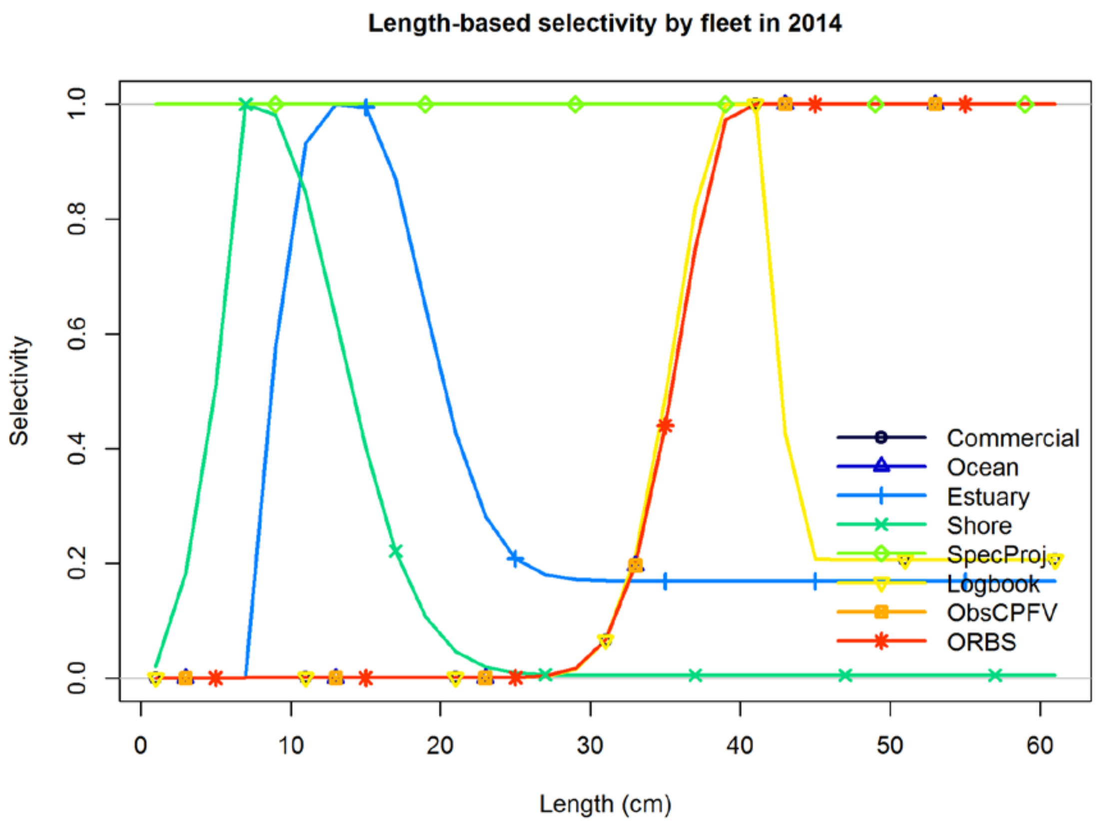


Figure 55. Selectivity curves for fisheries and surveys structured in the base case Kelp Greenling model.

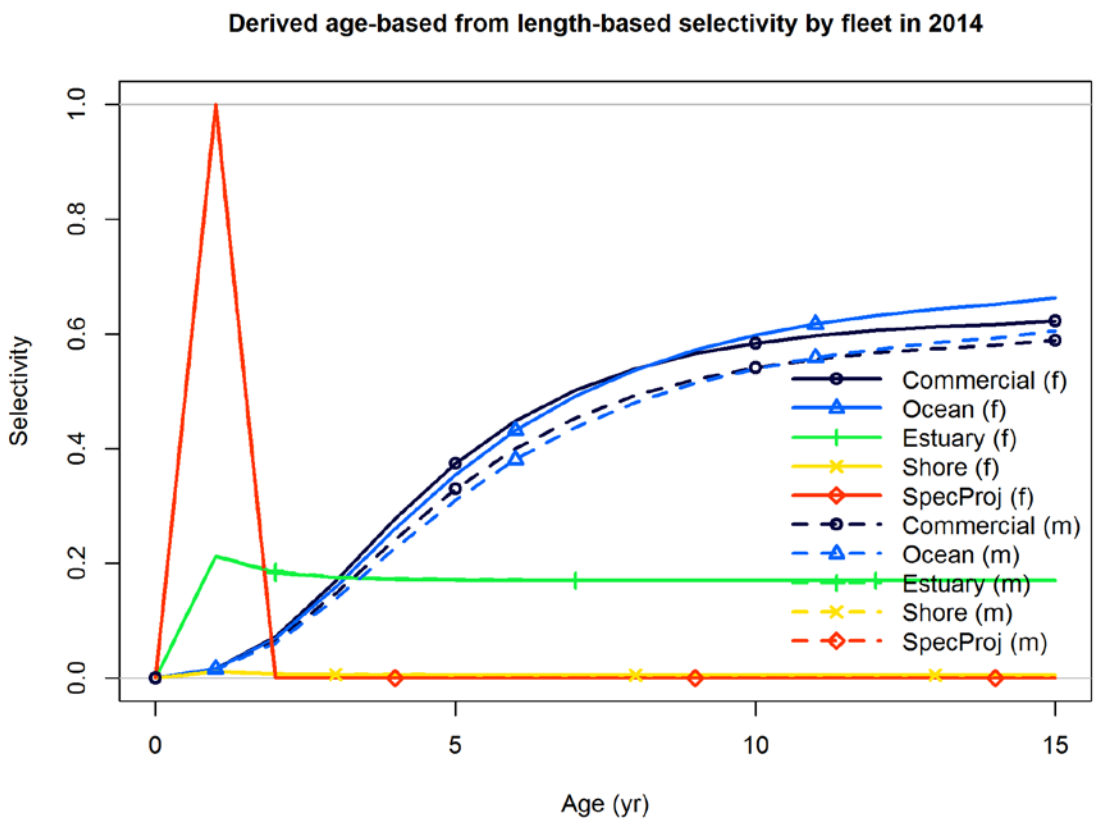


Figure 56. Derived age-based selectivity from length-based selectivity for the fisheries and surveys structured in the base case Kelp Greenling model.

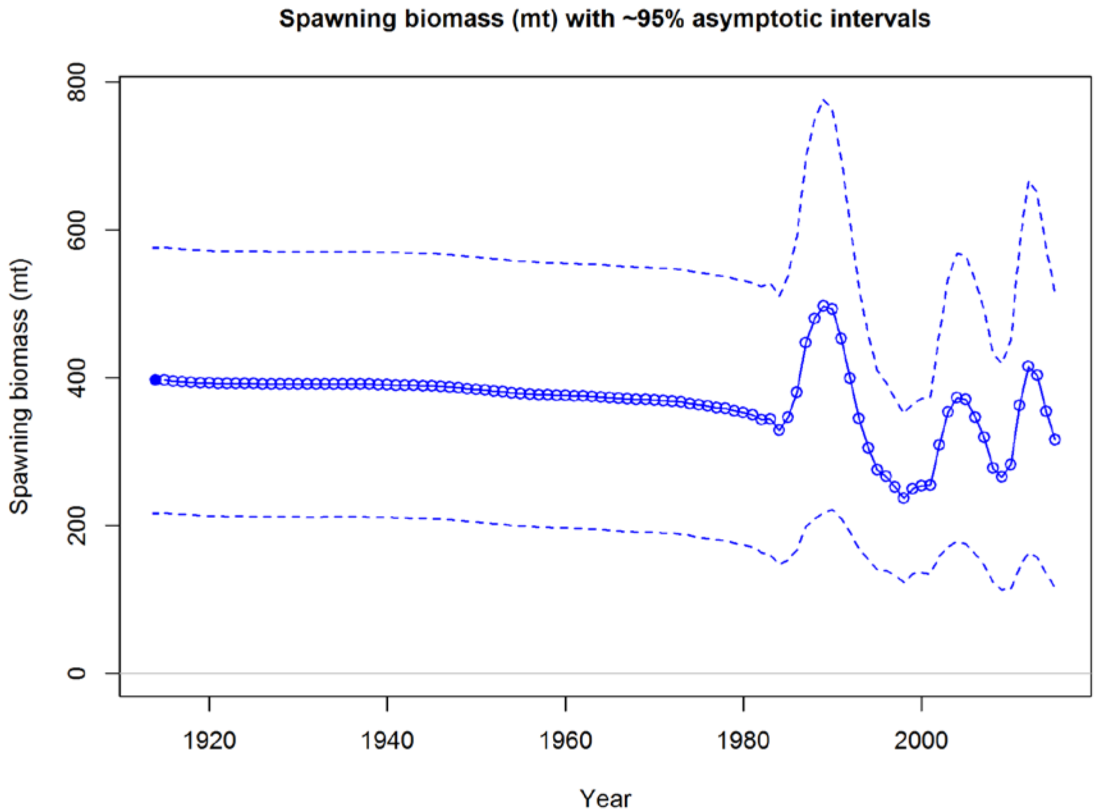


Figure 57. Estimated spawning biomass time series from the base case Kelp Greenling model with ~95% confidence intervals.

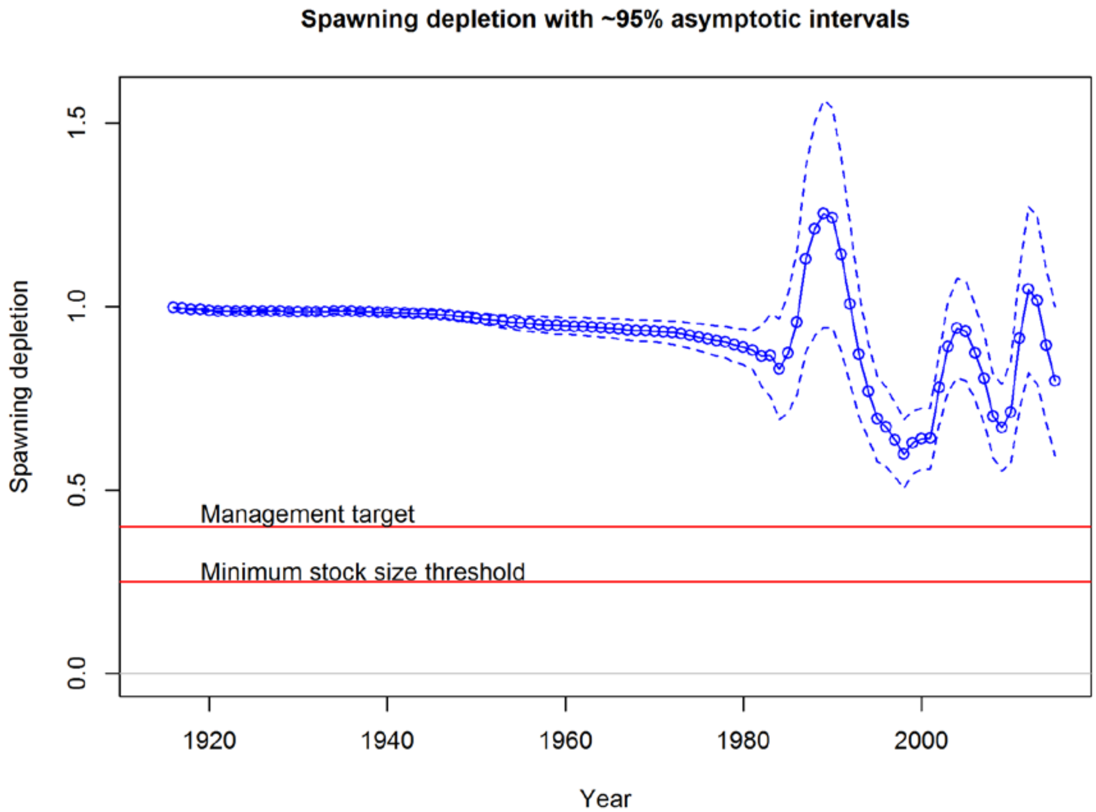


Figure 58. Estimated spawning biomass depletion relative to unfished levels for the base case model with ~95% confidence intervals.

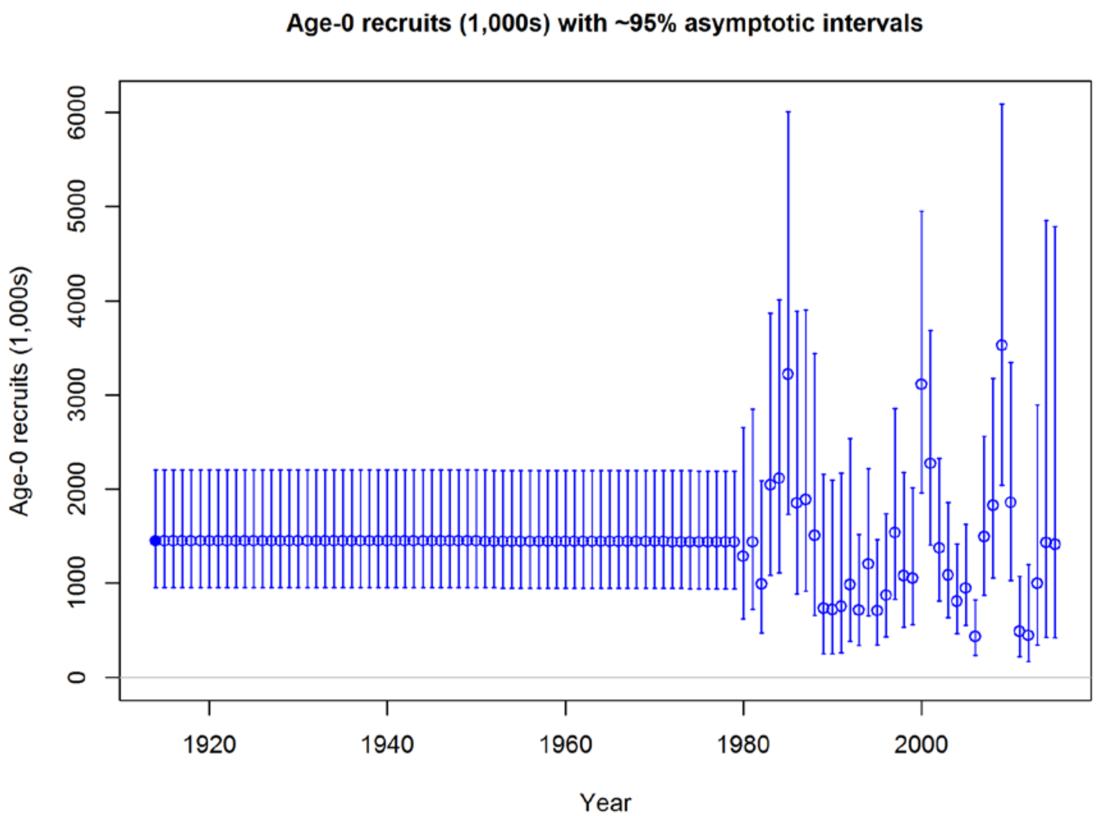


Figure 59. Base model estimates of age-0 recruitment with ~95% confidence intervals.

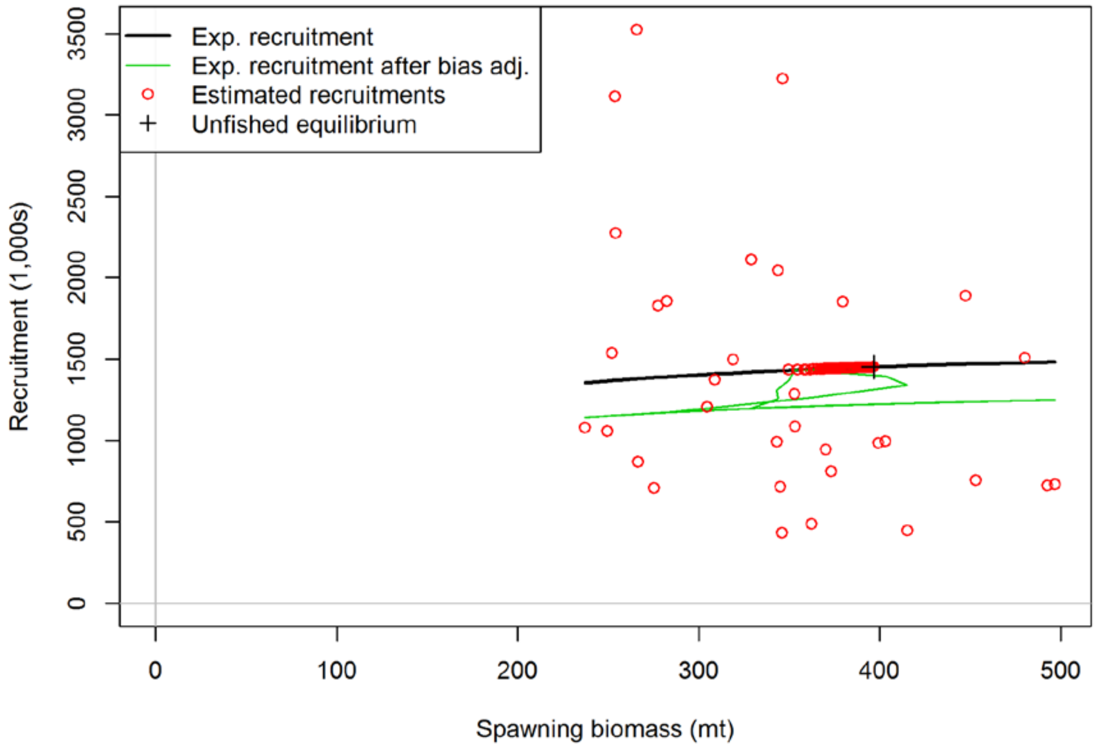


Figure 60. Beverton-Holt stock recruitment relationship for the Kelp Greenling base case model.

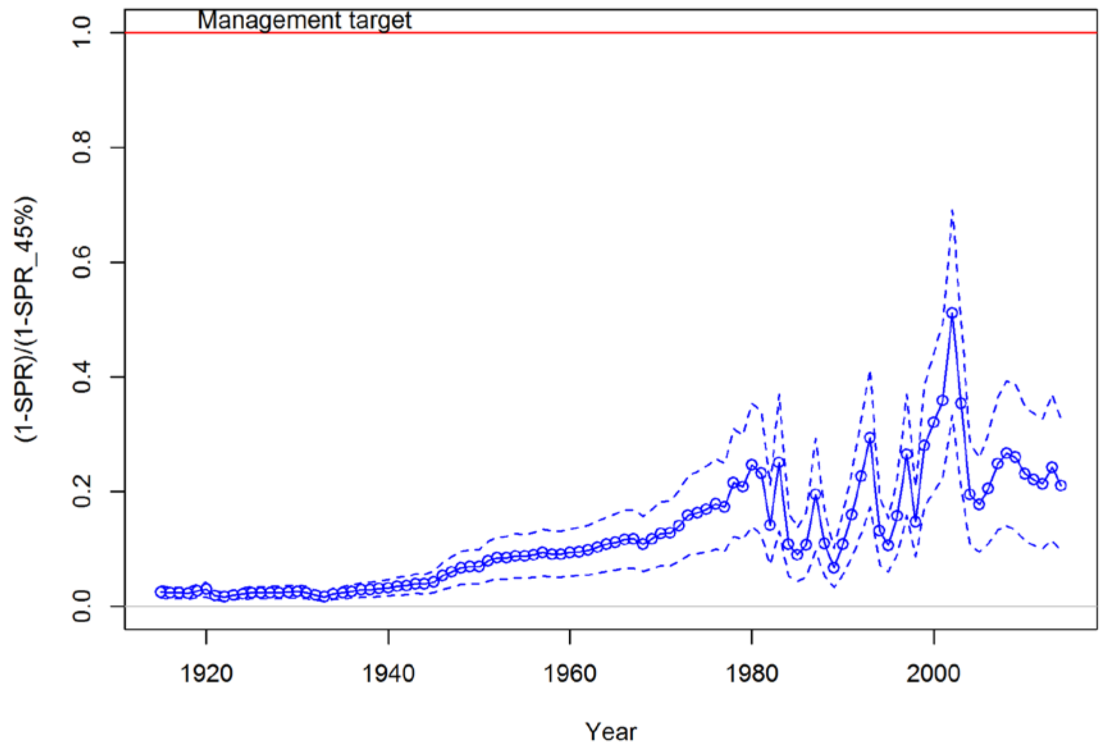


Figure 61. Estimated spawning potential ratio (SPR) for the Kelp Greenling base case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the SPR45% harvest rate. The last year in the time series is 2014.

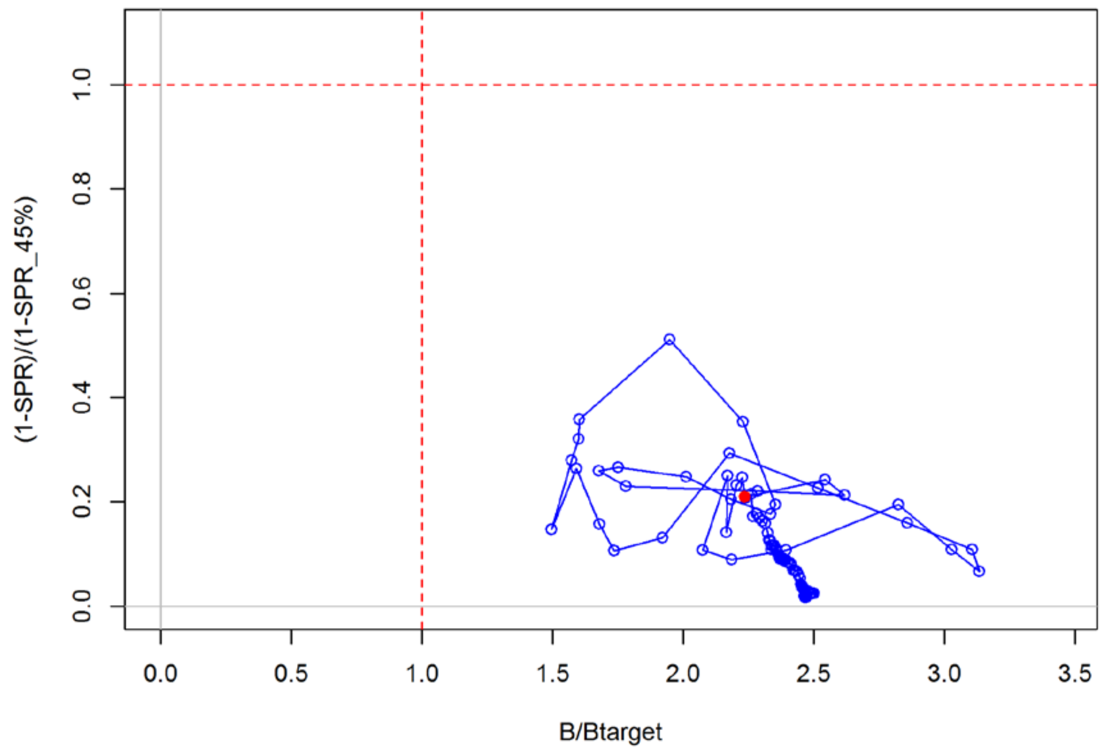


Figure 62. Phase plot of relative spawning output vs fishing intensity for the Kelp Greenling base case model. The relative fishing intensity is (1-SPR) divided by 45% (the SPR target). The vertical red line is the relative spawning output target defined as the annual spawning output divided by the spawning output corresponding to 40% of the unfished spawning output.

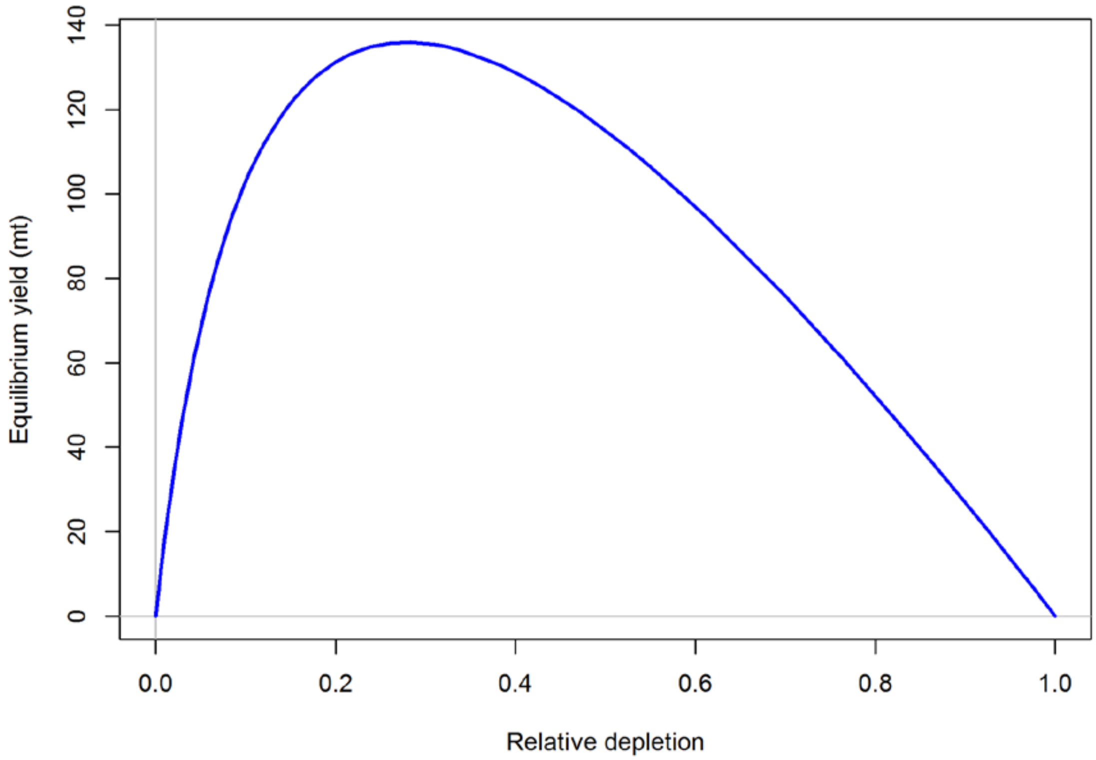
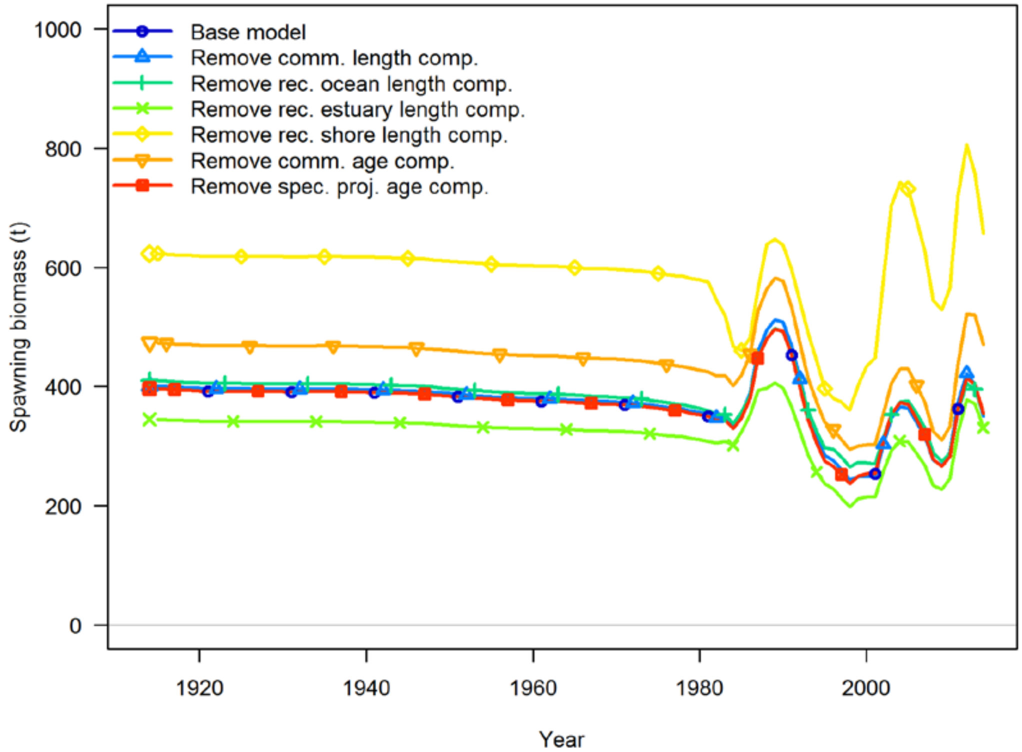


Figure 63. Equilibrium yield curve for the Kelp Greenling base case model. Values are based on 2014 fishery selectivity and distribution with steepness fixed at 0.70. The depletion is relative to unfished spawning biomass.



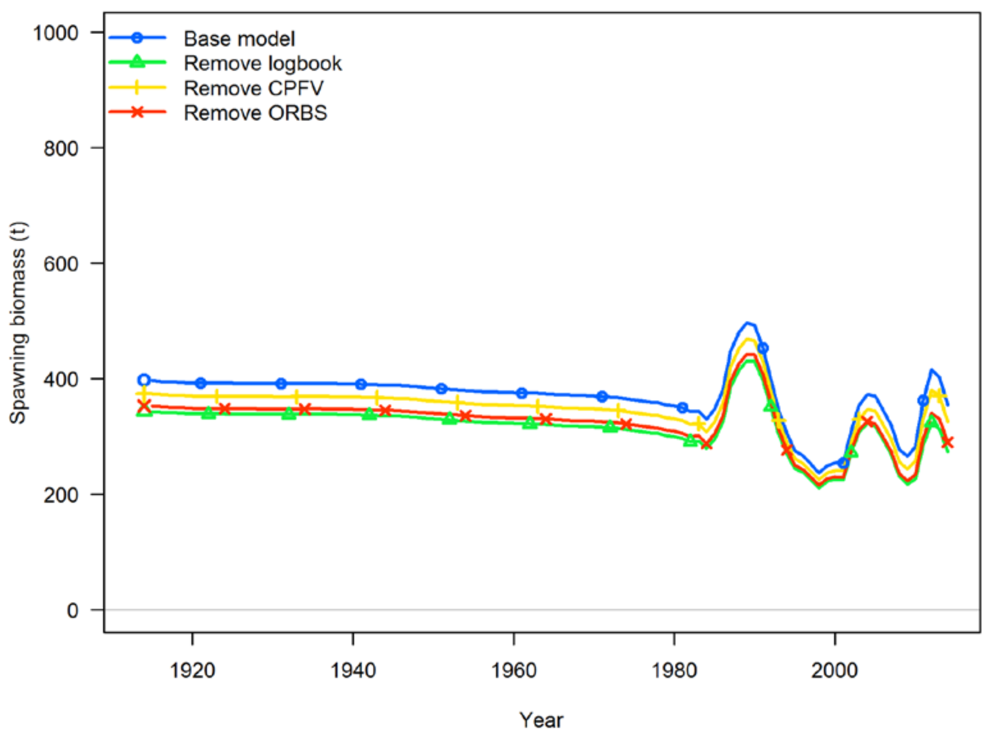


Figure 64. Comparison of spawning biomass for the base model and alternative data source sensitivity runs (top and bottom). The final year in the time series is 2014.

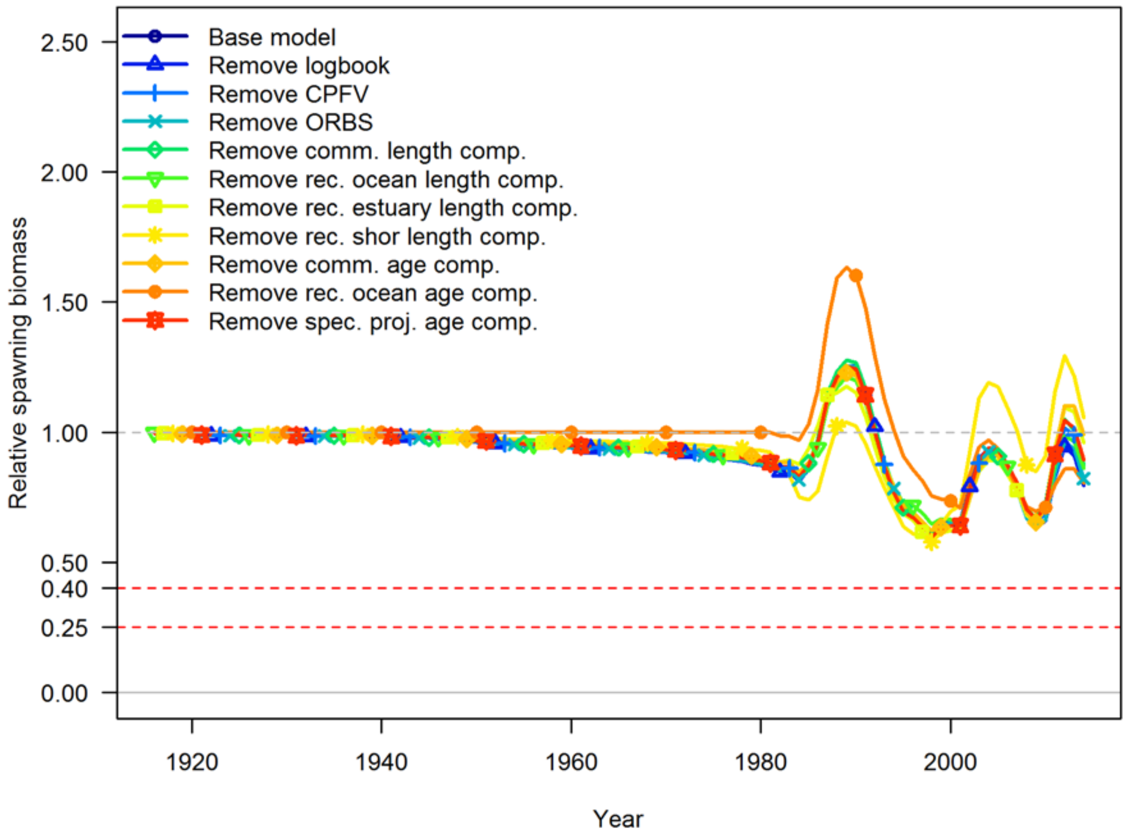
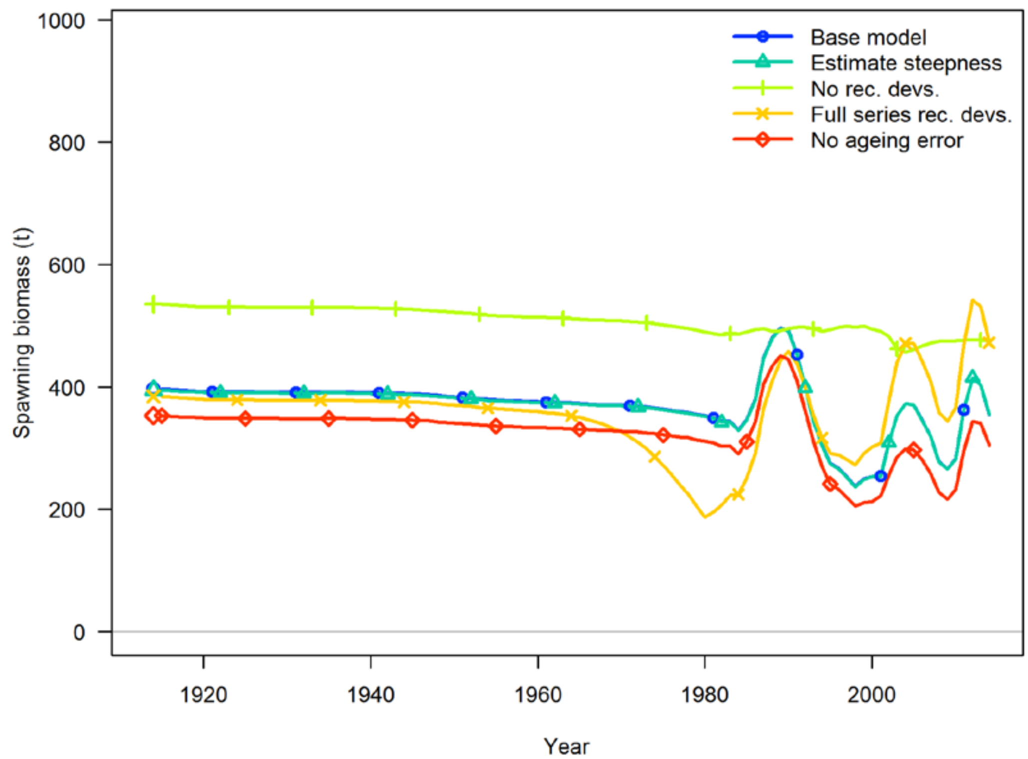


Figure 65. Comparison of relative depletion for the base model and alternative data source sensitivity runs. The final year in the time series is 2014.



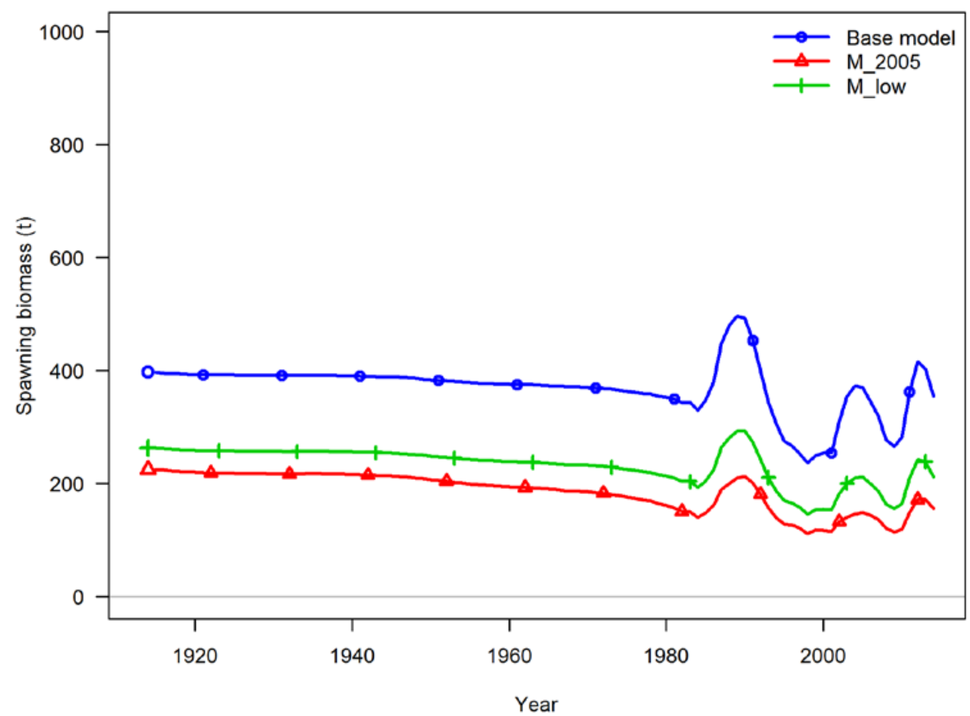
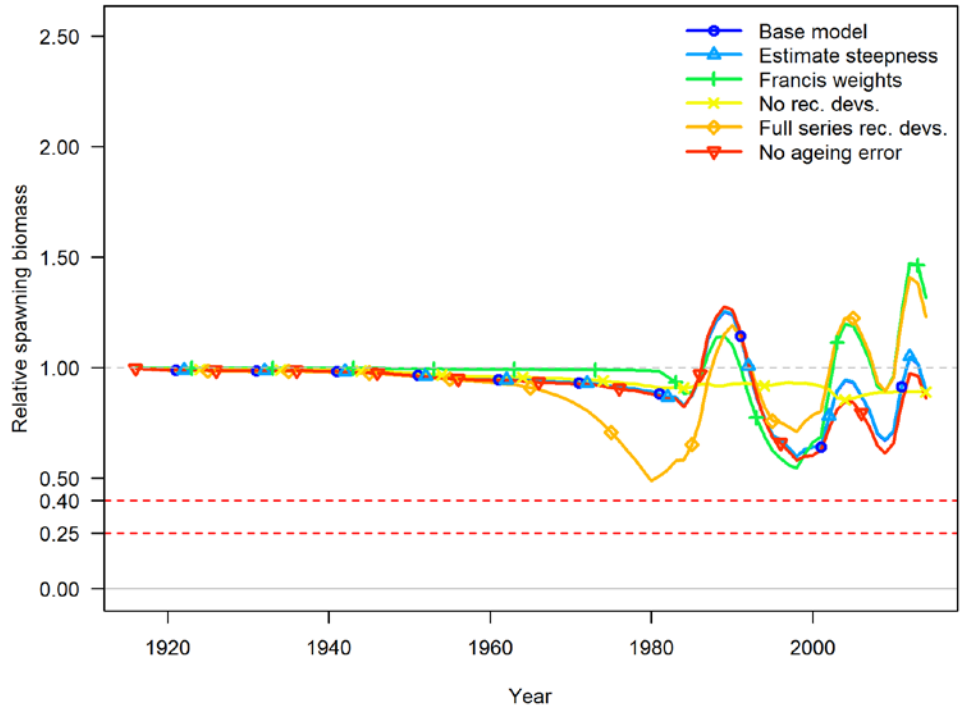


Figure 66. Comparison of spawning biomass for the base model and alternative structural assumption (top and bottom) sensitivity runs. The final year in the time series is 2014.



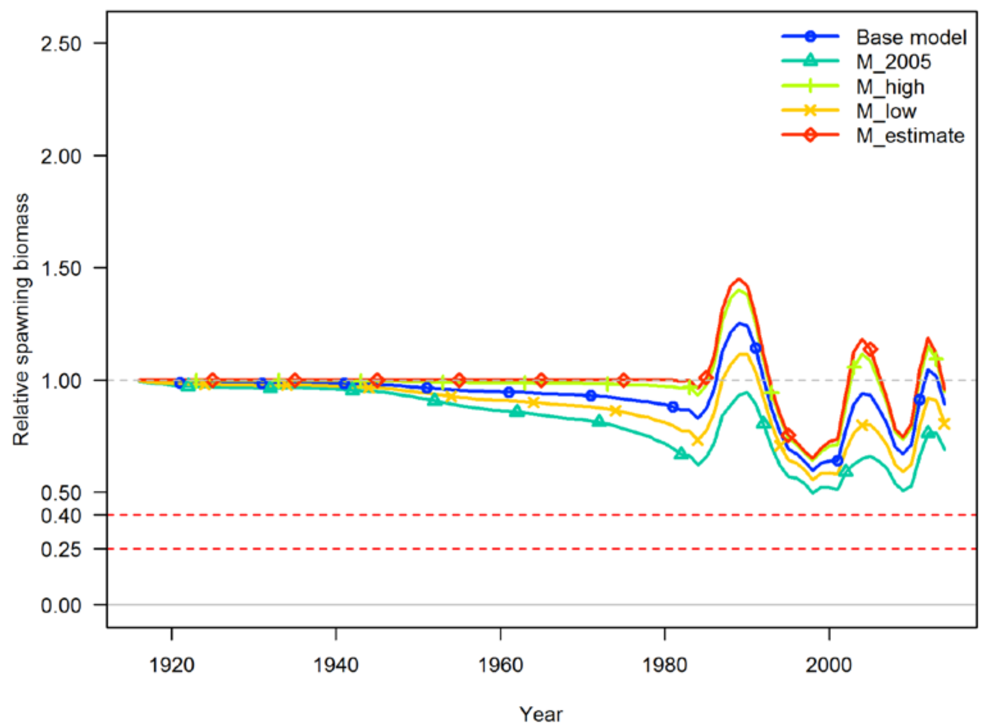


Figure 67. Comparison of relative depletion for the base model and alternative structural assumption (top and bottom) sensitivity runs. The final year in the time series is 2014.

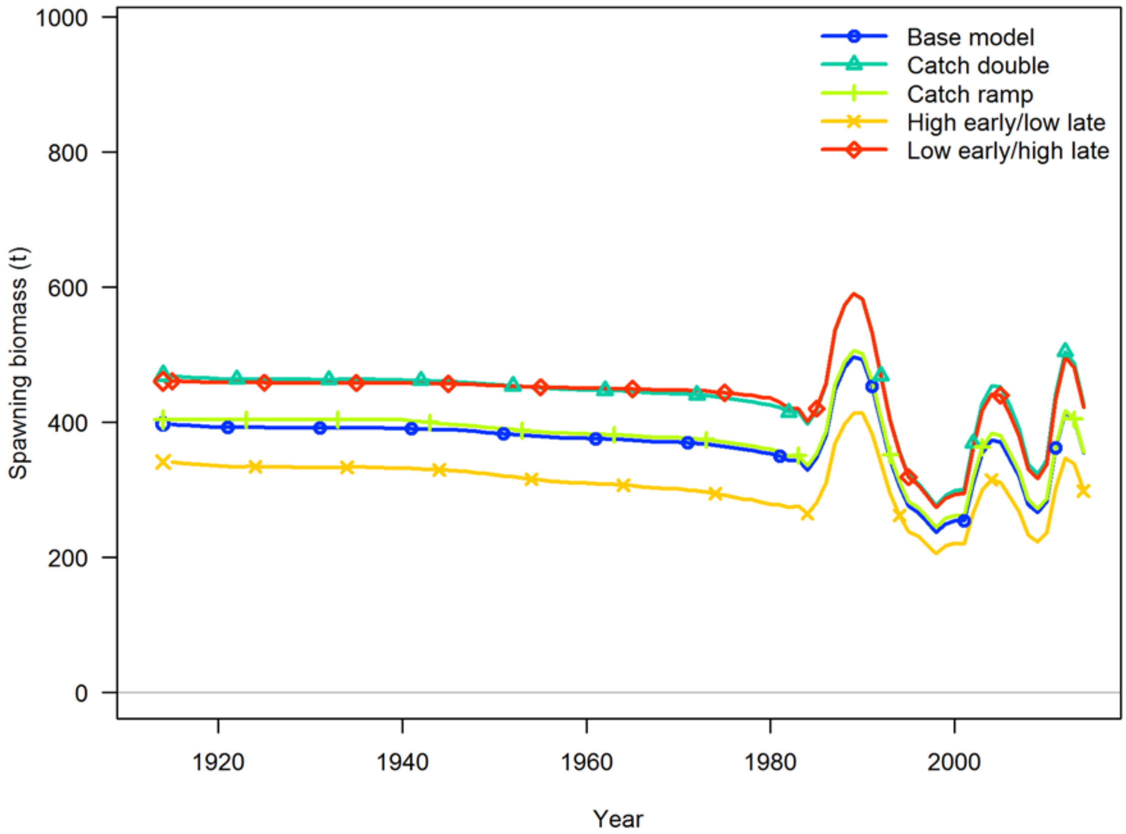


Figure 68. Comparison of spawning biomass for the base model and alternative catch time series sensitivity runs. The final year in the time series is 2014.

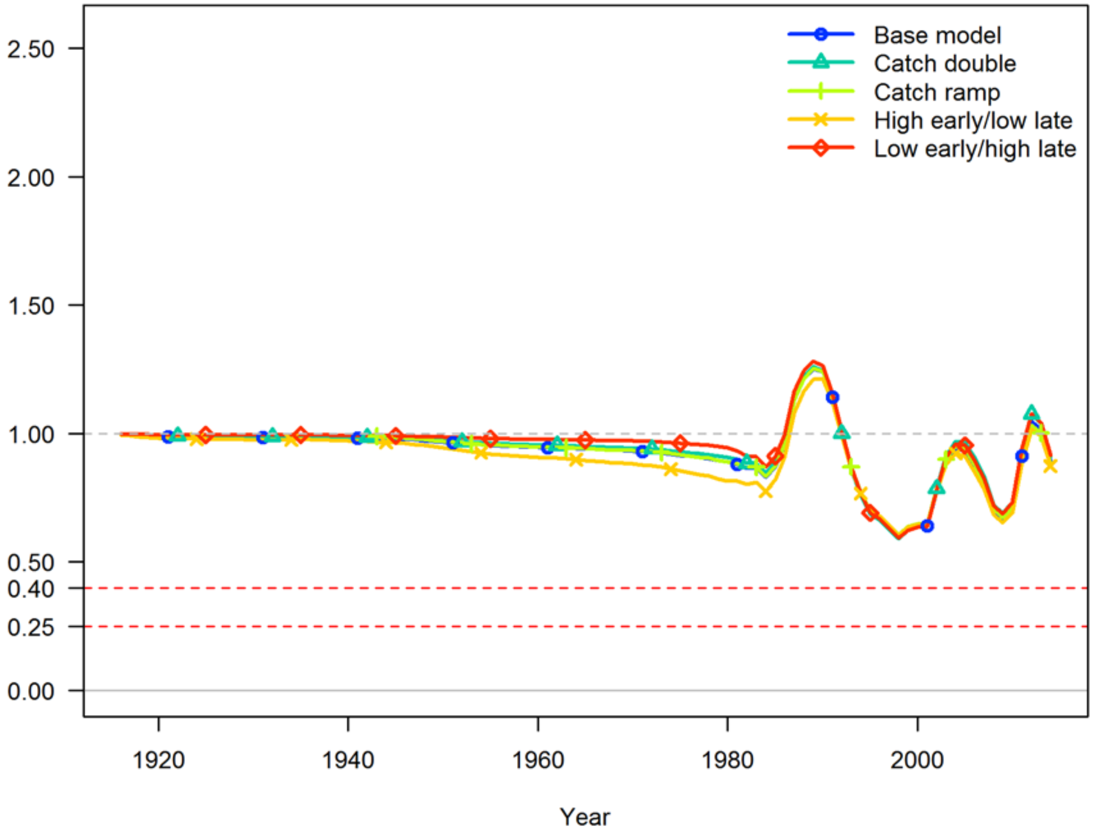


Figure 69. Comparison of relative depletion for the base model and alternative catch time series sensitivity runs. The final year in the time series is 2014.

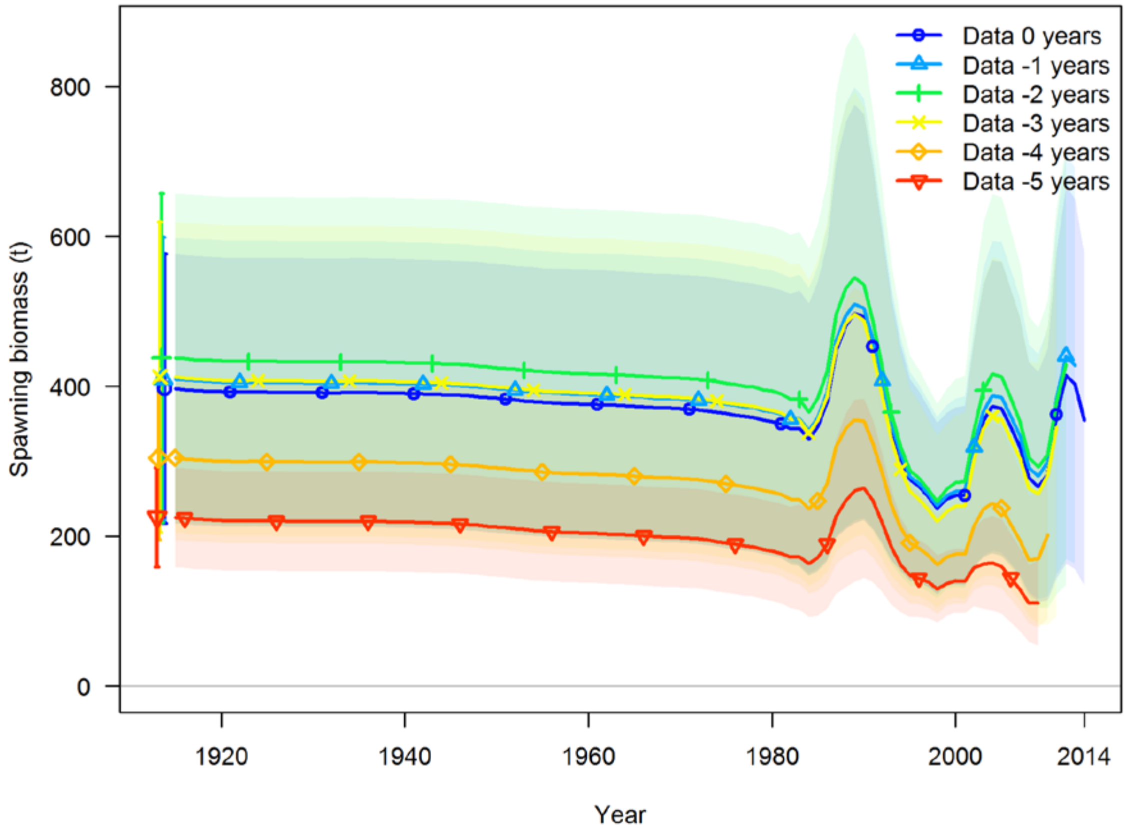


Figure 70. Retrospective model runs (present to -5 years) for the base case model relative to Kelp Greenling spawning output. Shaded regions are approximate 95% confidence intervals.

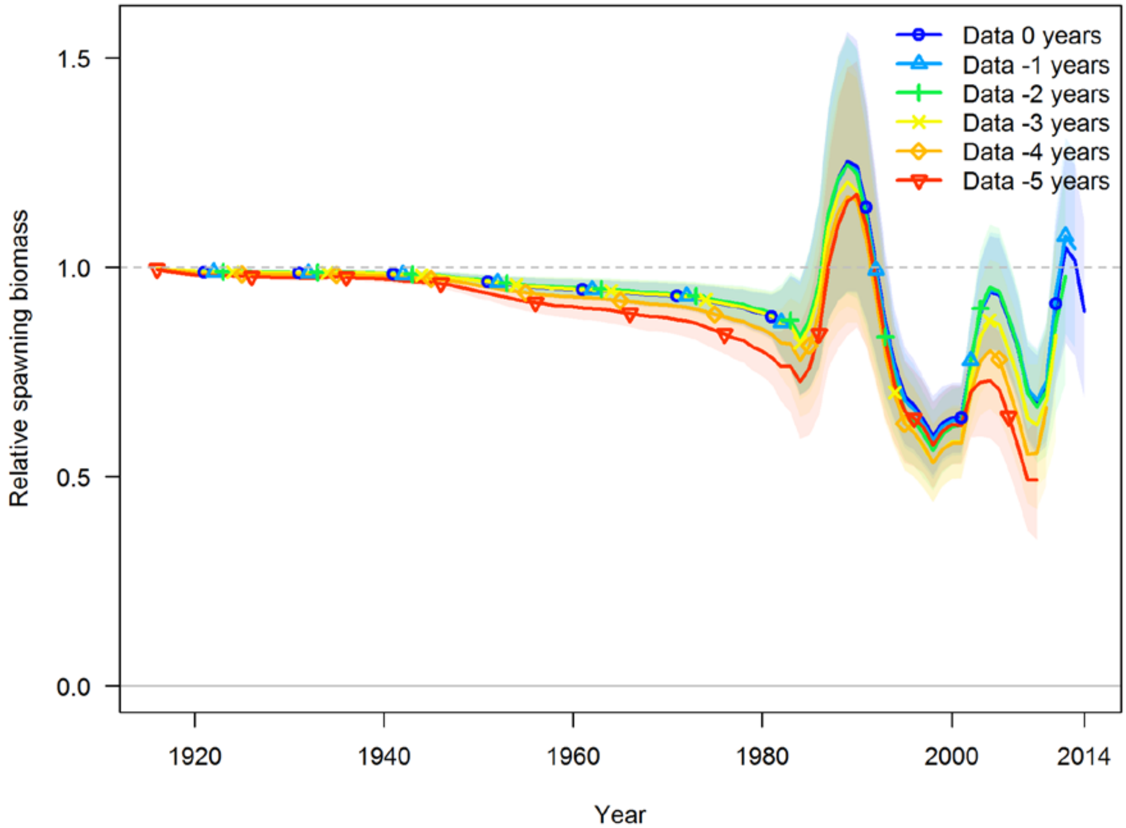


Figure 71. Retrospective model runs (present to -5 years) for the base case model relative to Kelp Greenling depletion. Shaded regions are approximate 95% confidence intervals.

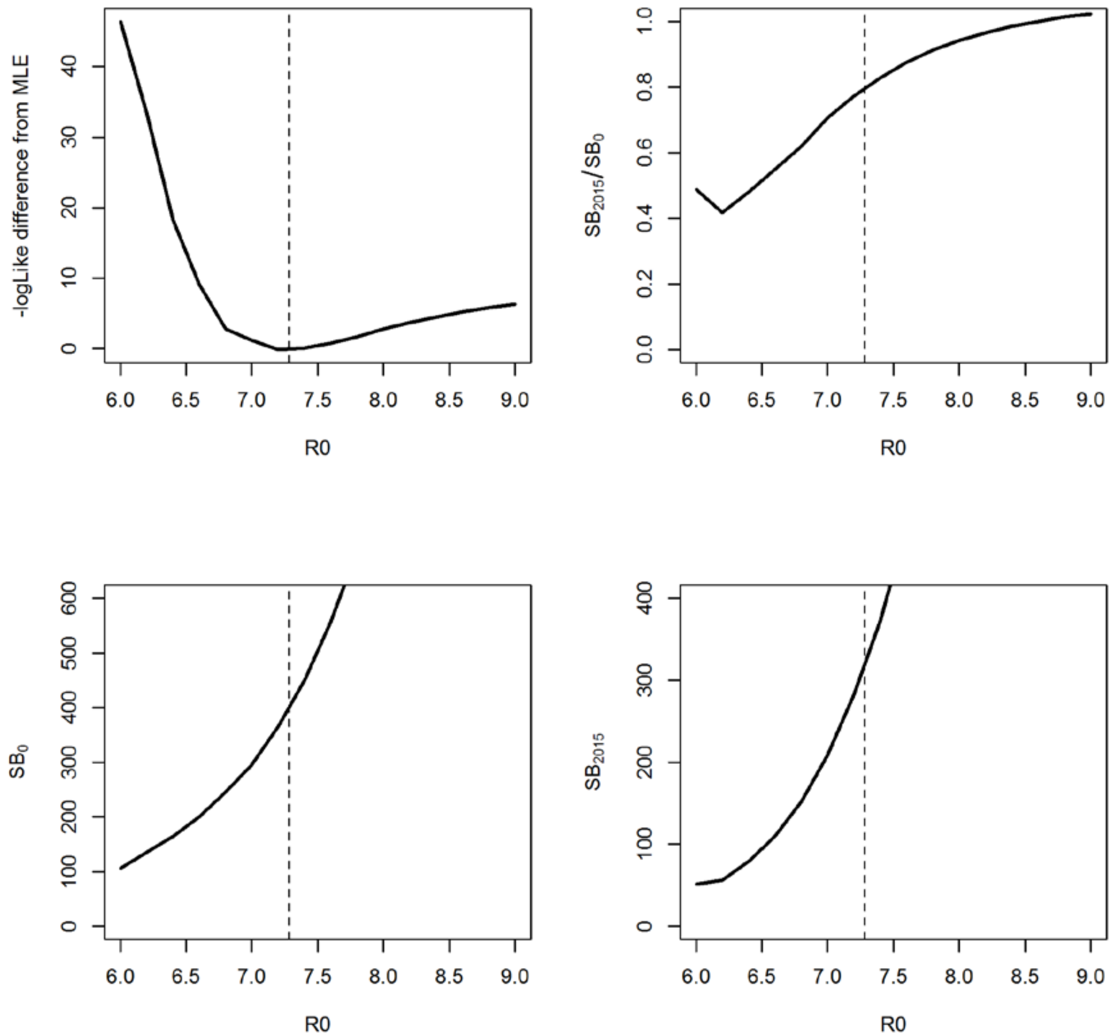


Figure 72. Likelihood profile for initial equilibrium recruitment ($\ln R_O$) and resultant derived quantities for the base case model.

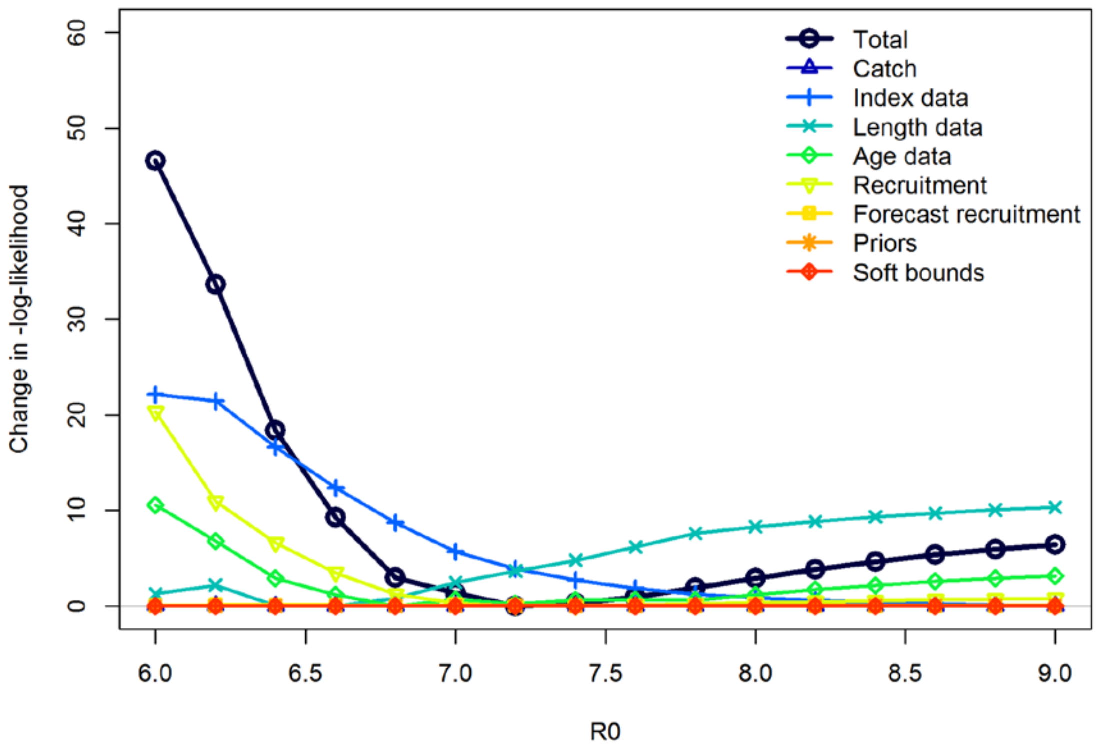


Figure 73. Likelihood profile across data sources for initial equilibrium recruitment (lnR_O) for the base case model.

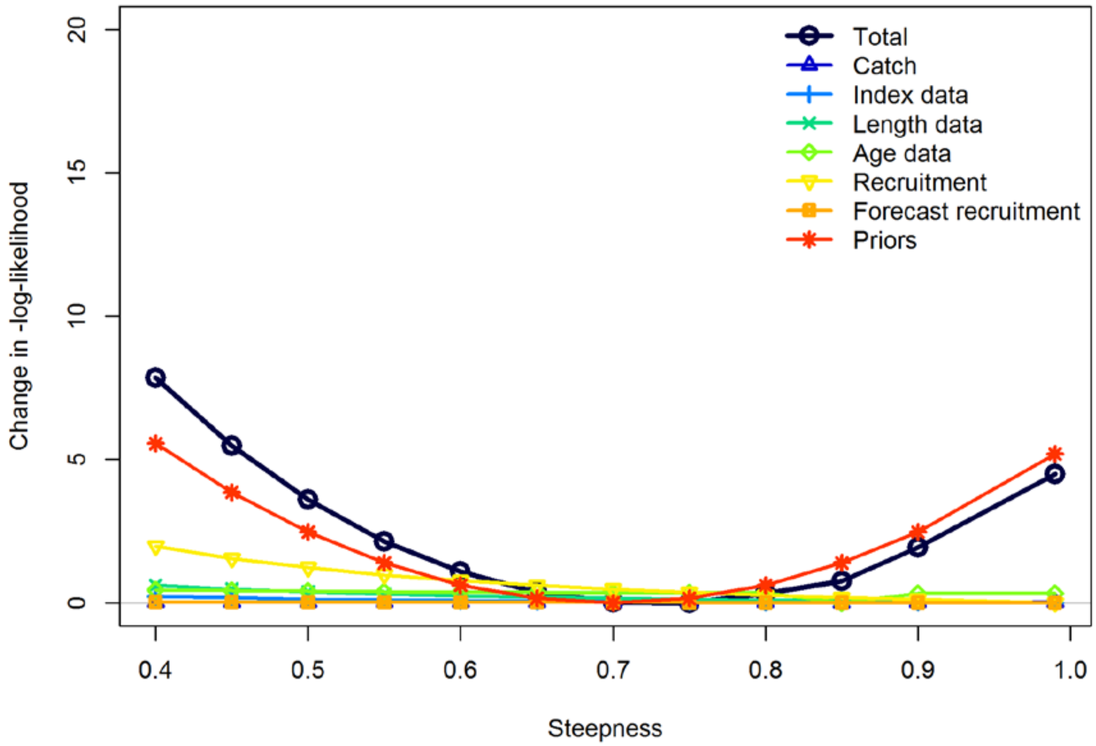


Figure 74. Likelihood profile across data sources for steepness (h) and resultant derived quantities for the base case model.

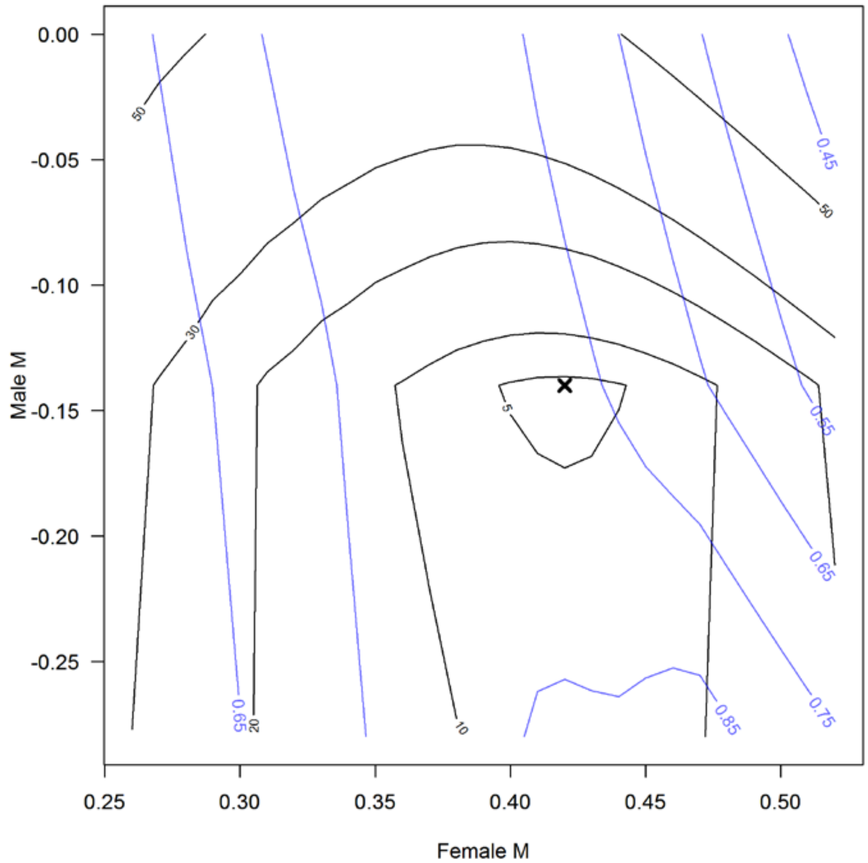


Figure 75. Bivariate likelihood profile (contours) across alternative values for male and female natural mortality (M) for the base case model.

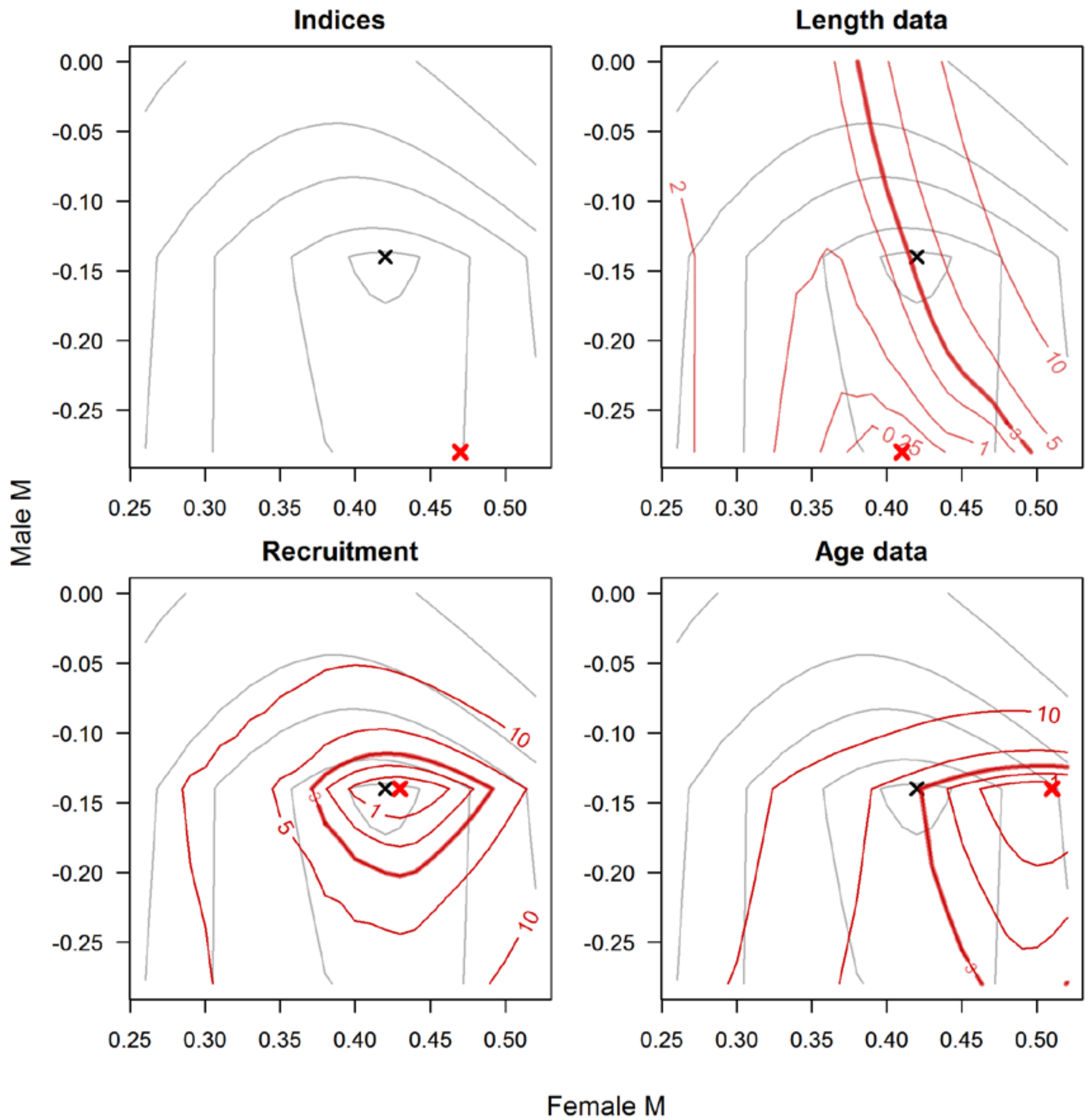


Figure 76. Bivariate likelihood profile (contours) across alternative data sources for male and female natural mortality (M) for the base case model.

Appendix A. SS data file

#C 2015 Assessent of Kelp Greenling (Berger, Arnold, Randomsky) run with SSv3.24u
#Data: One area, sex seperated
#year is from Jan-Dec
1915 #_styr
2014 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
5 #_Nfleet: Commercial,Rec_ocean,Rec_estuary,Rec_shore,SPECPROJ
3 #_Nsurveys
1 #_N_areas
Commercial%Ocean%Estuary%Shore%SpecProj%Logbook%ObsCPFV%ORBS
0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 # fleet/survey timing_in_season
1 1 1 1 1 1 1 1#_area_assignments_for_each_fishery_and_survey
1 1 1 1 1 #_units of catch: 1=biomass(mt); 2=numbers (1000s)
0.01 0.01 0.01 0.01 0.01 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
15 #_Nages
0 0 0 0 0 #_init_equil_catch_for_each_fishery
115 #_N_lines_of_catch_to_read
#Commercial, Ocean, Estuary, Shore, Year, Season (values are landings + discard)

0	0	0	0	0	1900	1
0	0	0	0	0	1901	1
0	0	0	0	0	1902	1
0	0	0	0	0	1903	1
0	0	0	0	0	1904	1
0	0	0	0	0	1905	1
0	0	0	0	0	1906	1
0	0	0	0	0	1907	1
0	0	0	0	0	1908	1
0	0	0	0	0	1909	1
0	0	0	0	0	1910	1
0	0	0	0	0	1911	1
0	0	0	0	0	1912	1
0	0	0	0	0	1913	1
0	0	0	0	0	1914	1
0	0	1.729441593	1.7	0	1915	1
0	0	1.627709735	1.6	0	1916	1
0	0	1.627709735	1.6	0	1917	1
0	0	1.525977876	1.6	0	1918	1
0	0	1.93290531	1.8	0	1919	1
0	0	2.136369027	2	0	1920	1
0	0	1.220782301	1.3	0	1921	1
0	0	1.220782301	1.1	0	1922	1
0	0	1.424246018	1.3	0	1923	1
0	0	1.525977876	1.5	0	1924	1
0	0	1.627709735	1.6	0	1925	1
0	0	1.729441593	1.6	0	1926	1
0	0	1.729441593	1.6	0	1927	1
0	0	1.729441593	1.6	0	1928	1
0	0	1.729441593	1.7	0	1929	1
0	0	1.729441593	1.8	0	1930	1

0	0	1.729441593	1.6	0	1931	1
0	0	1.322514159	1.3	0	1932	1
0	0	1.220782301	1.1	0	1933	1
0	0	1.525977876	1.5	0	1934	1
0	0	1.627709735	1.6	0	1935	1
0	0	1.729441593	1.8	0	1936	1
0	0	1.93290531	2	0	1937	1
0	0	2.034637168	2	0	1938	1
0	0	2.136369027	2.1	0	1939	1
0	0	2.238100885	2.2	0	1940	1
0	0	2.441564602	2.4	0	1941	1
0	0	2.441564602	2.5	0	1942	1
0	0	2.746760177	2.7	0	1943	1
0	0	2.645028319	2.7	0	1944	1
0	0	2.950223894	2.9	0	1945	1
0	0	3.764078761	3.7	0	1946	1
0	0	4.171006195	4.2	0	1947	1
0	0	4.679665487	4.6	0	1948	1
0	0	4.883129204	4.7	0	1949	1
0	0	4.883129204	4.7	0	1950	1
0	0	5.595252212	5.4	0	1951	1
0	0	5.900447788	5.8	0	1952	1
0	0	5.900447788	5.8	0	1953	1
0	0	6.103911504	6.1	0	1954	1
0	0	6.103911504	6	0	1955	1
0	0	6.307375221	6.1	0	1956	1
0	0	6.510838938	6.4	0	1957	1
0	0	6.307375221	6.2	0	1958	1
0	0	6.307375221	6.2	0	1959	1
0	0	6.510838938	6.4	0	1960	1
0	0	6.612570796	6.5	0	1961	1
0	0	6.816034513	6.7	0	1962	1
0	0	7.121230088	7.1	0	1963	1
0	0	7.528157522	7.4	0	1964	1
0	0	7.833353097	7.6	0	1965	1
0	0	8.138548673	8	0	1966	1
0	0	8.138548673	8	0	1967	1
0	0	7.528157522	7.4	0	1968	1
0	0	8.138548673	8	0	1969	1
0	0	8.748939823	8.7	0	1970	1
0	0	8.850671681	8.7	0	1971	1
0	0	9.766258407	9.6	0	1972	1
0	1.606074183	10.58011327	10.3	0	1973	1
0	2.150266536	10.58011327	10.5	0	1974	1
0	2.374068586	10.98704071	10.8	0	1975	1
0	5.107398356	10.58011327	10.5	0	1976	1
0	4.299355166	10.47838142	10.3	0	1977	1
0	10.72247399	11.39396814	11.2	0	1978	1
0	7.640550974	11.80089558	11.6	0	1979	1
0	5.231914602	21.16022655	10.2	0	1980	1
0	7.746961965	6.612570796	18.6	0	1981	1
0	5.303309666	4.679665487	9.8	0	1982	1
0	3.860322712	15.87016991	13.4	0	1983	1
0	3.039541377	8.036816814	4.5	0	1984	1
0	1.829628791	3.255419469	8.6	0	1985	1
0	3.429557158	5.290056637	11.6	0	1986	1

0	3.577427573	21.16022655	13.5	0	1987	1
0.083775987	2.211037575	11.69916372	6.9	0	1988	1
0.079989502	3.26109639	1.424246018	7.4	0	1989	1
0.003313175	2.940240586	6.307375221	8.2	0	1990	1
0.023192222	1.991037988	8.748939823	11.4	0	1991	1
0.016565873	3.405550691	11.08877257	14.5	0	1992	1
0.086615851	4.025595443	9.969722124	21.3	0	1993	1
0.188850953	5.000967508	5.08659292	4.9	0	1994	1
0.038338163	3.654741332	2.54329646	5.6	0	1995	1
0.689613632	3.626740735	4.781397345	7.1	0	1996	1
11.03050494	5.273565505	7.222961947	7.8	0	1997	1
10.25995518	3.436560589	1.729441593	3.1	0	1998	1
25.69082933	5.641592727	3.662346903	4.1	0	1999	1
20.25816957	5.01952329	2.645028319	13.4	0	2000	1
30.17071473	3.586167561	6.714302655	17.5	0	2001	1
55.81515962	4.109743137	16.48056106	23.7	0	2002	1
20.96576901	4.084088164	22.78793628	13.7	0	2003	1
24.29030309	3.765223231	0.712123009	5.886072494	0	2004	1
21.83760725	3.898414707	2.034637168	3.754908315	0	2005	1
15.14404789	2.671680183	5.696984071	7.611300639	0	2006	1
19.12743041	2.902797022	5.696984071	7.509816631	0	2007	1
22.91202245	3.479860456	5.696984071	7.509816631	0	2008	1
21.50392323	4.773726047	5.493520354	7.408332622	0	2009	1
19.13216351	7.371824754	5.493520354	7.408332622	0	2010	1
21.70271371	5.913827367	5.493520354	7.408332622	0	2011	1
19.859642	6.224875674	5.493520354	7.306848614	0	2012	1
22.83392619	8.262514236	5.391788496	7.205364605	0	2013	1
16.06085064	4.751626986	5.391788496	7.205364605	0	2014	1

#
#Abundance indices
37 # Number of index observations
Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
Fleet Units Errortype
1 1 0 # fleet 1: Commercial
2 1 0 # fleet 2: Rec ocean
3 1 0 # fleet 3: Rec estuary
4 1 0 # fleet 4: Rec shore
5 1 0 # fleet 5: Special projects
6 1 0 # fleet/index 6: Commercial logbook
7 0 0 # fleet/index 7: Observer CPFV
8 0 0 # fleet/index 8: ORBS
#

#Year	Seas	Fleet	Value	SE(log(B))
2004	1	6	0.2287043	0.198689533
2005	1	6	0.2234879	0.194997679
2006	1	6	0.1813122	0.196244418
2007	1	6	0.2020644	0.195622952
2008	1	6	0.2597551	0.194198965
2009	1	6	0.219052	0.196523049
2010	1	6	0.2836423	0.193838184
2011	1	6	0.3477715	0.187917547
2012	1	6	0.3043261	0.1912098
2013	1	6	0.294281	0.191789258
2001	1	7	0.07970951	0.236956194
2003	1	7	0.11641911	0.134425631
2004	1	7	0.12051939	0.158962877

```
2005	1	7	0.10656498	0.157850004
2006	1	7	0.07708826	0.184036837
2007	1	7	0.07029032	0.197202337
2008	1	7	0.07523118	0.161667965
2009	1	7	0.09841169	0.171144788
2010	1	7	0.16317122	0.144038073
2011	1	7	0.11503259	0.163625762
2012	1	7	0.08661663	0.172969163
2013	1	7	0.09467076	0.171968616
2014	1	7	0.09695055	0.249150177
2001	1	8	0.04328875	0.28238379
2002	1	8	0.05420611	0.238680977
2003	1	8	0.06620316	0.218915884
2004	1	8	0.05836329	0.235146023
2005	1	8	0.04338391	0.298663099
2006	1	8	0.03458765	0.349979289
2007	1	8	0.04036153	0.330858152
2008	1	8	0.03887608	0.30169721
2009	1	8	0.04112152	0.247300412
2010	1	8	0.0665232	  0.187702311
2011	1	8	0.07949097	0.167110211
2012	1	8	0.05977387	0.194238725
2013	1	8	0.05968124	0.187133091
2014	1	8	0.02856071	0.381706903
#
#_Discards - note: small amount of discard mortality pre-processed into total catch
0 # N fleets with discard
0 #nobs_disc
#
#_Mean_BodyWt
0 #nobs_mnwt #N_observations
30 #Degrees of freedom for Students T distribution

#Population length bins
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
0 # 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)
#Length bins
-1 #min_tail #min_proportion_for_compressing_tails_of_observed_composition
0.001 #min_comp #constant_added_to_expected_frequencies
0 #_combine males into females at or below this bin number
#_Length_Composition_Data
28 #nlength #N_length_bins
#len_bins(1,nlength) #_lower_edge_of_length_bins
6 8 10 12 14 16    18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

#LENGTH_COMPOSITIONS
100 #nobs length
#lendata(1,nobsl,1,6+gender*nlength) #Sorted_by_year_fleet_mkt:_0:Survey_1:Discard_2:Fisheries
#year Season Fleet gender partition nSamps F6 F8 F10 F12 F14 F16 F18 F20 F22 F24 F26 F28 F30 F32
F34 F36 F38 F40 F42 F44 F46 F48 F50 F52 F54 F56 F58 F60 M6 M8 M10 M12 M14 M16 M18 M20
M22 M24 M26 M28 M30 M32 M34 M36 M38 M40 M42 M44 M46 M48 M50 M52 M54 M56 M58 M60
1998	1	1	3	0	5	0	0	0	0	0	0
	0	0	0	0	0	0	147.8402719	172.4803172
	320.3205891	418.8807703	542.0809969	221.7604078	98.56018126	0
```

	24.64004531		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	49.28009063	
	221.7604078		221.7604078		320.3205891		591.3610876		468.160861		
	221.7604078		24.64004531		0	0	0	0	0	0	0
	0	0									
1999	1	1	3	0	8	0	0	0	0	0	0
	0	0	0	0	0	0	566.7210422		517.4409516		
	295.6805438		320.3205891		123.2002266		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	49.28009063		788.4814501		
	640.6411782		616.0011329		640.6411782		123.2002266		49.28009063		0
	0	0	0	0	0	0	0	0	0		
2000	1	1	3	0	94	0	0	0	0	0	0
	0	0	0	0	0	83.65371636		1178.605262		2621.631869	
	3459.025699		2770.150019		1612.458187		801.573936		84.92119691		
	20.91342909		0	0	20.91342909		0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	20.91342909		83.65371636		1317.546033		3632.340096		5174.015161		
	4645.351257		2426.224839		450.3618596		0	0	0	0	0
	0	0	0	0	0						
2001	1	1	3	0	147	0	0	0	0	0	0
	0	0	0	0	0	14.28948478		1848.352375		2467.465029	
	4404.276485		4616.153002		3222.983113		1356.079194		380.7523912		
	28.94390366		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	14.30619674	
	56.33450802		1487.409479		3755.413447		7152.248718		6378.681853		
	3515.906036		792.4188636		41.96162166		13.98720722		0	0	0
	0	0	0	0	0						
2002	1	1	3	0	193	0	0	0	0	0	0
	0	0	0	0	0	214.791635		6266.832198		8885.783553	
	6914.653117		6443.100665		5544.773165		2781.881039		604.9203806		
	38.99199624		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	137.4563693		6181.296005		8591.060637		7322.531596		10092.41495		
	5475.644845		1511.669098		97.47999061		44.13604344		0	0	0
	0	0	0	0	0						
2003	1	1	3	0	81	0	0	0	0	0	0
	0	0	0	0	0	24.64004531		1562.228596		3479.170112	
	3289.884634		2436.818563		2298.418714		1131.349254		375.3692629		
	18.44852268		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	2138.594741		3648.457231		4518.35781		3801.155977		2777.745009		
	449.2409679		55.60663203		0	0	0	0	0	0	0
	0	0									
2004	1	1	3	0	134	0	0	0	0	0	0
	0	0	0	0	0	13.65876873		1127.30605		2497.761385	
	4515.141625		4075.578259		2615.319253		1195.710331		287.4322915		
	40.97630618		13.65876873		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	27.31753745		1433.517806		3166.554979		5489.447017		5830.566474		
	2759.454035		370.7617278		13.78407853		0	0	0	0	0
	0	0	0	0							
2005	1	1	3	0	91	0	0	0	0	0	0
	0	0	0	0	0	0	1009.21765		2153.071629		
	3553.501145		4338.965614		2977.479787		1573.273049		261.1211076		
	60.10329204		19.91415537		0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0
	19.91415537		1165.580509		2463.307675		4793.832012		5188.958052		
	2852.903768		584.3735506		20.09038683		0	0	0	0	0
	0	0	0	0							
2006	1	1	3	0	134	0	0	0	0	0	0
	0	0	0	0	0	26.79854972		556.3800395		970.9447638	
	2142.78886		2443.142577		1461.280155		757.0016021		135.7976337		
	17.05362255		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	51.50588313		827.2009356		1449.646978		2960.27065		3857.452366		
	1802.39469		262.8290327		18.76437299		0	0	0	0	0
	0	0	0	0							
2007	1	1	3	0	156	0	0	0	0	0	0
	0	0	0	0	0	62.14359456		558.4993606		1009.019912	
	2204.666664		2759.336436		2384.325914		1083.438887		109.6670746		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	122.2280666		
	575.7247284		1714.73292		3079.996403		5459.404841		3494.905733		
	571.7686631		9.624407463		0	9.624407463		0	0	0	0
	0	0	0								
2008	1	1	3	0	122	0	0	0	0	0	0
	0	0	0	0	0	0	505.2021562		1136.987457		
	2119.479408		2768.158417		2353.850796		1097.515845		339.4855783		13.4444
	0	13.4444	14.53448649		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	127.7850372	
	831.1207205		1777.531896		3243.017142		4894.802186		3361.733715		
	817.8273448		63.77928389		0	0	0	0	0	0	0
	0	0									
2009	1	1	3	0	125	0	0	0	0	0	0
	0	0	0	0	0	117.0143279		729.9267246		1327.515835	
	1951.197678		2524.152097		2519.504648		1469.118337		265.8179974		
	130.1765865		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	65.73475557		806.8546		1709.644445		2598.207414		4248.166159		
	3172.432229		679.1586401		86.4570496		0	0	0	0	0
	0	0	0	0							
2010	1	1	3	0	193	0	0	0	0	0	0
	0	0	0	0	0	74.91548301		1312.934442		2177.158653	
	1995.678418		1850.120678		2004.534825		1557.419558		327.7787732		
	77.16782371		9.791175901		0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	
	29.45580649		201.8283341		1114.21066		1783.59325		2897.299952		
	3488.602737		2756.980772		470.8047155		18.06572319		0	11.34006248	
	0	0	0	0	0	0	9.791175901				
2011	1	1	3	0	238	0	0	0	0	0	0
	0	0	0	0	0	251.5519812		2007.818206		2277.446892	
	2305.164862		2532.408631		2466.970945		1199.869967		265.4719943		0
	0	8.919189181		0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	22.44564165		
	227.8853826		2069.371064		2939.023294		3966.716207		4797.841973		
	3240.482105		822.5869889		104.4580814		0	0	23.0931678		0
	0	0	0	0	0						
2012	1	1	3	0	153	0	0	0	0	0	0
	0	0	0	0	0	181.4280652		1542.142373		2007.062175	
	2236.124934		2333.287194		1769.400955		936.1826787		388.6709931		
	55.09654003		0	0	0	0	0	0	0	0	0

0 0 0 0 0 0 0 0 0 0
265.8945199 2013.971478 3568.75412 3716.175108 3527.333133
2287.860772 390.0744797 24.64004531 0 0 19.70088172 0
0 0 0 0 0
2013 1 1 3 0 198 0 0 0 0 0 0
0 0 0 0 10.50479814 56.04150644 960.8393019
3148.710113 3269.810744 3049.294869 1656.211923 608.6293864
116.7055057 13.2692187 9.454318327 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 238.5047344 1493.701978 4836.196786 6304.596384
5086.599277 2445.186864 482.5046634 19.62668615 0 0 0
0 0 0 0 0 0
2014 1 1 3 0 208 0 0 0 0 0 0
0 0 0 0 0 28.11387591 463.1888632 1559.97237
2067.484796 2238.829094 1522.427421 658.3082073 148.8814571
30.98716772 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
7.977170994 482.738628 1760.233513 3888.079514 4283.602173
1905.214931 277.8400333 7.977170994 0 0 0 0 0
0 0 0 0
1980 1 2 0 2 46 0 0 0 0 0 0
0 0 0.02173913 0.02173913 0 0.043478261 0.02173913
0.173913043 0.130434783 0.195652174 0.173913043 0.130434783
0.065217391 0.02173913 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1981 1 2 0 2 46 0 0 0 0 0 0
0 0 0 0.02173913 0 0.043478261 0.065217391
0.086956522 0.195652174 0.326086957 0.108695652 0.086956522
0.043478261 0.02173913 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1982 1 2 0 2 76 0 0 0 0 0 0
0 0 0 0 0 0.052631579 0.065789474 0.092105263
0.223684211 0.236842105 0.131578947 0.144736842 0.039473684
0.013157895 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1983 1 2 0 2 17 0 0 0 0 0 0
0 0 0 0 0 0.235294118 0.058823529 0.058823529
0.235294118 0.294117647 0.117647059 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1984 1 2 0 2 73 0 0 0 0 0 0
0 0.02739726 0.04109589 0 0.04109589 0.068493151
0.054794521 0.205479452 0.191780822 0.260273973 0.054794521
0.01369863 0.01369863 0 0 0.01369863 0.01369863 0
0 0 0 0 0 0 0 0 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 1 2 0 2 79 0 0 0 0 0 0
0 0 0.012658228 0.101265823 0.088607595 0.151898734
0.113924051 0.075949367 0.189873418 0.151898734 0.075949367
0.037974684 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1986 1 2 0 2 62 0 0 0 0 0 0
0 0 0 0.016129032 0.032258065 0 0.048387097
0.241935484 0.35483871 0.096774194 0.096774194 0.096774194
0.016129032 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1987 1 2 0 2 59 0 0 0 0 0 0
0 0 0.033898305 0.050847458 0.06779661 0.050847458
0.084745763 0.220338983 0.186440678 0.118644068 0.152542373
0.016949153 0.016949153 0 0 0 0 0 0 0
0 0 0 0 0 0 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 1 2 0 2 84 0 0 0 0 0 0
0 0.011904762 0.011904762 0.011904762 0.011904762 0.05952381
0.095238095 0.119047619 0.321428571 0.166666667 0.095238095
0.047619048 0.023809524 0.023809524 0 0 0 0 0
0 0 0 0 0 0 0 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 1 2 0 2 60 0 0 0 0 0 0
0 0.033333333 0.05 0.016666667 0.033333333 0.033333333 0.1
0.133333333 0.183333333 0.233333333 0.133333333 0.033333333
0.016666667 0 0 0 0 0 0 0 0 0
0 0 0 0 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 2 0 2 164 0 0 0 0 0 0
0 0 0 0 0.030487805 0.030487805 0.067073171
0.109756098 0.274390244 0.170731707 0.231707317 0.067073171
0.006097561 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1995 1 2 0 2 57 0 0 0 0 0 0
0 0 0 0 0.01754386 0 0.070175439 0.157894737
0.175438596 0.350877193 0.140350877 0.070175439 0.01754386 0
0 0 0 0 0 0 0 0 0 0 0
0 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 2 0 2 53 0 0 0 0 0 0
0 0 0 0 0 0 0.037735849 0.132075472
0.264150943 0.283018868 0.188679245 0.056603774 0.037735849 0
0 0 0 0 0 0 0 0 0 0 0
0 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 1 2 0 2 146 0 0 0 0 0 0
0 0 0 0.01369863 0.006849315 0.068493151 0.061643836
0.109589041 0.191780822 0.287671233 0.198630137 0.047945205 0
0.01369863 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1998 1 2 0 2 156 0 0 0 0 0 0
0 0 0.006410256 0.006410256 0 0.064102564 0.096153846
0.179487179 0.173076923 0.237179487 0.192307692 0.038461538
0.006410256 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1999 1 2 0 2 285 0 0 0 0 0 0
0 0 0 0.003508772 0.01754386 0.059649123 0.112280702
0.210526316 0.224561404 0.224561404 0.105263158 0.031578947
0.007017544 0.003508772 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2000 1 2 0 2 154 0 0 0 0 0 0
0 0 0 0 0.006493506 0.019480519 0.11038961
0.266233766 0.318181818 0.168831169 0.077922078 0.032467532 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
2001 1 2 0 2 498 0 0 0 0 0 0
0 0 0.002008032 0.010040161 0.050200803 0.06626506
0.11646586 0.15461847 0.2228916 0.2168675 0.12249 0.03413655
0.002008032 0.002008032 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2002 1 2 0 2 1264 0 0 0 0 0 0
0 0 0.000791139 0.003164557 0.02056962 0.049050633
0.1289557 0.21123418 0.2175633 0.2017405 0.1170886
0.03401899 0.01028481 0.004746835 0.000791139 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2003 1 2 0 2 1338 0 0 0 0 0 0
0 0 0 0.000747384 0.005231689 0.019431988 0.10014948
0.23318386 0.2825112 0.2115097 0.1061286 0.02914798
0.007473842 0.002242152 0.001494768 0.000747384 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2004 1 2 0 2 1079 0 0 0 0 0 0
0 0 0.000926784 0.001853568 0.00463392 0.018535681
0.05189991 0.17886932 0.3021316 0.2669138 0.1297498
0.02780352 0.014828545 0.001853568 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

2005 1 2 0 2 1533 0 0 0 0 0 0
0 0 0 0 0.00456621 0.010437052 0.03587736
0.11350294 0.24788 0.334638 0.171559 0.06262231 0.01369863
0.003913894 0.000652316 0.000652316 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2006 1 2 0 2 1320 0 0 0 0 0 0
0 0 0 0.001515152 0.002272727 0.014393939 0.04166667
0.11060606 0.2598485 0.3318182 0.1856061 0.04242424
0.006818182 0.001515152 0.000757576 0.000757576 0 0 0
0 0 0 0 0 0 0 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 1 2 0 2 1305 0 0 0 0 0 0
0 0 0 0.002298851 0.003065134 0.011494253 0.03678161
0.09655172 0.2191571 0.3348659 0.2298851 0.05363985
0.007662835 0.003831418 0.000766284 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2008 1 2 0 2 1781 0 0 0 0 0 0
0 0 0.000561482 0.000561482 0.005053341 0.019651881
0.04211117 0.11510387 0.190904 0.3071308 0.2257159
0.07243122 0.01459854 0.002807412 0.001684447 0.000561482
0.000561482 0 0 0 0.000561482 0 0 0 0
0 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 1 2 0 2 1807 0 0 0 0 0 0
0 0 0 0.000553403 0.002213614 0.020475927 0.06751522
0.12672939 0.1959048 0.2595462 0.223575 0.0813503
0.01770891 0.003320421 0 0.000553403 0 0 0.000553403
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2010 1 2 0 2 2523 0 0 0 0 0 0
0 0 0 0.001981768 0.008323425 0.028933809 0.05667856
0.13476021 0.2136346 0.2318668 0.2025367 0.0947285
0.020610384 0.003963535 0.001189061 0 0 0 0.000396354
0.000396354 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2011 1 2 0 2 2423 0 0 0 0 0 0
0 0 0 0.001650846 0.011968634 0.051176228 0.09162196
0.14486174 0.1981015 0.2278168 0.1815931 0.06851011
0.019397441 0.001650846 0.001238135 0.000412712 0 0 0
0 0 0 0 0 0 0 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 1 2 0 2 2411 0 0 0 0 0 0
0 0 0 0 0.003732891 0.036914144 0.11613438
0.17212775 0.217752 0.2131895 0.1518042 0.06719204
0.014516798 0.004147657 0 0.001244297 0 0 0.001244297
0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2013 1 2 0 2 2302 0 0 0 0 0 0
0 0 0 0 0.003475239 0.011728931 0.07428323
0.22980017 0.269331 0.2406603 0.1290182 0.03692441
0.003475239 0.001303215 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2014 1 2 0 2 1045 0 0 0 0 0 0
0 0 0 0 0.000956938 0.006698565 0.03636364
0.12727273 0.2794258 0.2794258 0.1827751 0.0708134
0.015311005 0 0.000956938 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1980 1 3 0 2 55 0 0 0 0 0 0
0.036363636 0.036363636 0.145454545 0.127272727 0.127272727
0.054545455 0.072727273 0.218181818 0.054545455 0.036363636
0.072727273 0.018181818 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
1981 1 3 0 2 54 0 0 0 0 0 0
0.037037037 0.018518519 0 0.074074074 0.185185185 0.240740741
0.074074074 0.185185185 0.074074074 0.055555556 0 0.037037037
0.018518519 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1982 1 3 0 2 43 0 0 0 0 0
0.023255814 0 0.046511628 0.11627907 0.11627907 0.139534884
0.11627907 0.23255814 0 0.046511628 0.046511628 0.093023256
0 0.023255814 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1983 1 3 0 2 46 0 0 0 0 0 0
0 0 0 0.02173913 0.130434783 0.152173913 0.130434783
0.239130435 0.195652174 0.130434783 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0
1984 1 3 0 2 144 0 0 0 0 0
0.006944444 0.020833333 0.048611111 0.097222222 0.1875 0.145833333
0.097222222 0.138888889 0.145833333 0.0625 0.027777778 0.006944444
0.013888889 0 0 0 0 0 0 0 0 0
0 0 0 0 0 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 1 3 0 2 82 0 0 0 0 0 0
0.012195122 0.085365854 0.146341463 0.195121951 0.219512195
0.06097561 0.146341463 0.097560976 0.036585366 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0

```
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0
1986	1	3	0	2	122	0	0	0	0	0
        0.008196721	0.057377049	0.032786885	0.155737705	0.409836066
        0.147540984	0.040983607	0.057377049	0.016393443	0.032786885
        0.016393443	0.008196721	0.016393443	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
1987	1	3	0	2	260	0	0	0	0	0	0
        0.007692308	0.046153846	0.146153846	0.176923077	0.157692308
        0.169230769	0.119230769	0.057692308	0.042307692	0.038461538
        0.015384615	0.019230769	0.003846154	0	0	0	0	0
        0	0	0	0	0	0	0	0	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	1	3	0	2	141	0	0	0	0	0	0
        0.007092199	0.04964539	0.127659574	0.09929078	0.085106383
        0.120567376	0.141843972	0.127659574	0.092198582	0.092198582
        0.035460993	0.021276596	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	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	1	3	0	2	22	0	0	0	0	0	0
        0	0.045454545	0.045454545	0.227272727	0.454545455	0
        0.045454545	0.045454545	0.045454545	0.090909091	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0
1994	1	3	0	2	60	0	0	0	0	0	0
        0	0	0.066666667	0.016666667	0.1	0.05	0.233333333	0.2
        0.15	0.033333333	0.1	0.033333333	0.016666667	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	0
        0
1995	1	3	0	2	59	0	0	0	0.016949153
        0.033898305	0.050847458	0.016949153	0.050847458	0.186440678
        0.06779661	0.118644068	0.118644068	0.084745763	0.13559322
        0.050847458	0.050847458	0.016949153	0	0	0	0	0
        0	0	0	0	0	0	0	0	0	0	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	3	0	2	102	0	0	0	0	0	0
        0.009803922	0.019607843	0.117647059	0.196078431	0.147058824
        0.117647059	0.147058824	0.039215686	0.078431373	0.068627451
        0.039215686	0.009803922	0.009803922	0	0	0	0	0
        0	0	0	0	0	0	0	0	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	1	3	0	2	76	0	0	0	0	0	0
        0.013157895	0.013157895	0.065789474	0.131578947	0.105263158
        0.131578947	0.105263158	0.118421053	0.092105263	0.131578947
        0.065789474	0.013157895	0.013157895	0	0	0	0	0
```

0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
1998 1 3 0 2 61 0 0 0 0 0 0
0.016393443 0.016393443 0.049180328 0.016393443 0.245901639
0.147540984 0.229508197 0.098360656 0.098360656 0.049180328 0
0.016393443 0.016393443 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
1999 1 3 0 2 83 0 0 0 0 0 0
0 0.024096386 0.060240964 0.084337349 0.228915663 0.168674699
0.084337349 0.144578313 0.096385542 0.048192771 0.024096386 0
0.036144578 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2000 1 3 0 2 31 0 0 0 0 0 0
0 0 0.064516129 0.129032258 0.225806452 0.193548387 0
0.161290323 0.096774194 0.096774194 0.032258065 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0
2001 1 3 0 2 92 0 0 0 0 0 0
0.02173913 0.076086957 0.076086957 0.097826087 0.22826087
0.195652174 0.076086957 0.108695652 0.043478261 0.032608696
0.02173913 0.02173913 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2002 1 3 0 2 97 0 0 0 0 0 0
0 0 0.092783505 0.206185567 0.12371134 0.082474227
0.113402062 0.12371134 0.103092784 0.072164948 0.06185567
0.020618557 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2003 1 3 0 2 137 0 0 0 0 0 0
0.02247191 0.06741573 0.146067416 0.202247191 0.202247191
0.247191011 0.123595506 0.168539326 0.157303371 0.123595506
0.033707865 0.033707865 0 0 0.011235955 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2004 1 3 0 2 89 0 0 0 0 0 0
0 0 0.011235955 0.179775281 0.213483146 0.146067416
0.08988764 0.134831461 0.146067416 0.04494382 0.011235955 0
0.02247191 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
2005 1 3 0 2 94 0 0 0 0 0 0
0 0 0 0.138297872 0.106382979 0.212765957 0.170212766
0.127659574 0.117021277 0.063829787 0.031914894 0 0.031914894
0 0 0 0 0 0 0 0 0 0 0

	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0							
2006	1	3	0	2	32	0	0	0	0	0	0
	0	0	0	0	0.1875	0.125	0.09375	0.15625	0.15625	0.15625	0.03125
	0.09375	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	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	1	3	0	2	7	0	0	0	0	0	0
	0	0	0	0	0.14285714		0	0.14285714		0.14285714	
	0.14285714		0.28571429		0	0.14285714		0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0										
2008	1	3	0	2	50	0	0	0	0	0	0
	0	0	0	0.08	0.06	0.16	0.32	0.16	0.06	0.04	0.1
	0.02	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	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	1	3	0	2	13	0	0	0	0	0	0
	0	0	0	0.07692308		0.15384615		0.07692308		0.15384615	
	0.15384615		0.15384615		0	0.07692308		0.07692308		0	
	0.07692308		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0						
2010	1	3	0	2	49	0	0	0	0	0	0
	0	0	0	0.04081633		0.10204082		0.16326531		0.14285714	
	0.08163265		0.10204082		0.16326531		0.08163265		0.10204082		
	0.02040816		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0					
2011	1	3	0	2	67	0	0	0	0	0	0
	0	0	0	0.02985075		0.02985075		0.1641791		0.1641791	
	0.23880597		0.2238806		0.07462687		0.05970149		0.01492537		0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	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	1	3	0	2	18	0	0	0	0	0	0
	0	0	0	0	0.05555556		0.11111111		0.33333333		
	0.22222222		0.16666667		0	0.05555556		0.05555556		0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0								
2013	1	3	0	2	3	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.66666667	
	0.33333333		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0			

1980 1 4 0 2 520 0 0 0 0 0
0.007692308 0.080769231 0.153846154 0.178846154 0.109615385
0.098076923 0.130769231 0.088461538 0.067307692 0.038461538
0.028846154 0.013461538 0.001923077 0.001923077 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1981 1 4 0 2 279 0 0 0 0 0
0.003584229 0.032258065 0.086021505 0.172043011 0.172043011
0.17921147 0.136200717 0.096774194 0.068100358 0.025089606
0.010752688 0.003584229 0.010752688 0 0.003584229 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1982 1 4 0 2 273 0 0 0 0 0
0.04029304 0.054945055 0.087912088 0.168498168 0.186813187
0.120879121 0.124542125 0.080586081 0.065934066 0.04029304
0.025641026 0.003663004 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
1983 1 4 0 2 217 0 0 0 0 0.01843318
0.073732719 0.078341014 0.110599078 0.092165899 0.105990783
0.138248848 0.096774194 0.119815668 0.059907834 0.046082949
0.036866359 0.004608295 0.01843318 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1984 1 4 0 2 243 0 0 0 0 0.008230453
0.069958848 0.127572016 0.090534979 0.111111111 0.226337449
0.135802469 0.061728395 0.0781893 0.028806584 0.032921811
0.008230453 0.016460905 0.004115226 0 0 0 0 0
0 0 0 0 0 0 0 0 0 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 1 4 0 2 452 0 0 0 0 0 0
0.042035398 0.10840708 0.261061947 0.146017699 0.126106195
0.103982301 0.07079646 0.07300885 0.055309735 0.011061947 0
0.002212389 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1986 1 4 0 2 366 0 0 0 0.005464481
0.013661202 0.013661202 0.084699454 0.092896175 0.161202186
0.202185792 0.117486339 0.073770492 0.073770492 0.030054645
0.030054645 0.032786885 0.024590164 0.032786885 0.008196721
0.00273224 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0
1987 1 4 0 2 325 0 0 0 0 0 0
0.027692308 0.076923077 0.104615385 0.175384615 0.190769231
0.150769231 0.107692308 0.064615385 0.030769231 0.012307692
0.018461538 0.024615385 0 0.003076923 0.009230769 0.003076923

0 0 0 0 0 0 0 0 0 0 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 1 4 0 2 218 0 0 0 0 0 0
0.059633028 0.119266055 0.146788991 0.142201835 0.169724771
0.087155963 0.096330275 0.068807339 0.041284404 0.036697248
0.009174312 0.013761468 0.004587156 0.004587156 0 0 0
0 0 0 0 0 0 0 0 0 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 1 4 0 2 159 0 0 0 0 0 0
0.031446541 0.06918239 0.150943396 0.213836478 0.132075472
0.06918239 0.144654088 0.119496855 0.044025157 0.018867925
0.006289308 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 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 4 0 2 299 0 0 0 0 0.013377926
0.030100334 0.023411371 0.023411371 0.117056856 0.173913043
0.157190635 0.10367893 0.123745819 0.096989967 0.060200669
0.040133779 0.013377926 0.013377926 0.010033445 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1995 1 4 0 2 228 0 0 0.00877193 0.00877193
0.01754386 0.048245614 0.065789474 0.052631579 0.114035088
0.131578947 0.149122807 0.074561404 0.118421053 0.065789474
0.057017544 0.043859649 0.026315789 0.004385965 0.00877193
0.004385965 0 0 0 0 0 0 0 0 0
0 0 0 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 4 0 2 269 0 0 0 0 0
0.011152416 0.048327138 0.048327138 0.055762082 0.126394052
0.178438662 0.092936803 0.137546468 0.104089219 0.055762082
0.05204461 0.037174721 0.026022305 0.014869888 0.003717472
0.003717472 0.003717472 0 0 0 0 0 0 0
0 0 0 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 1 4 0 2 277 0 0 0 0 0.007220217
0.018050542 0.025270758 0.036101083 0.079422383 0.151624549
0.249097473 0.151624549 0.079422383 0.083032491 0.032490975
0.028880866 0.036101083 0.007220217 0.014440433 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
1998 1 4 0 2 82 0 0 0 0 0
0.024390244 0.024390244 0.097560976 0.06097561 0.146341463
0.109756098 0.146341463 0.097560976 0.12195122 0.036585366
0.085365854 0.048780488 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0

```
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
1999	1	4	0	2	134	0	0	0	0	0	0
	0.044776119	0.059701493	0.089552239	0.126865672	0.111940299
	0.097014925	0.156716418	0.082089552	0.149253731	0.037313433
	0.02238806	0.02238806	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
2000	1	4	0	2	257	0	0	0	0	0
	0.019455253	0.054474708	0.073929961	0.054474708	0.124513619
	0.163424125	0.151750973	0.128404669	0.085603113	0.093385214
	0.031128405	0.015564202	0	0	0	0	0.003891051	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
2001	1	4	0	2	141	0	0	0.007092199	0
	0.007092199	0.028368794	0.014184397	0.056737589	0.042553191
	0.14893617	0.184397163	0.156028369	0.078014184	0.056737589
	0.09929078	0.04964539	0.056737589	0.007092199	0	0.007092199
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0
2002	1	4	0	2	280	0	0	0	0	0	0.025
	0.025	0.042857143	0.128571429	0.057142857	0.128571429	0.114285714
	0.110714286	0.142857143	0.128571429	0.053571429	0.021428571
	0.017857143	0	0	0.003571429	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
2003	1	4	0	2	308	0	0	0	0	0.003246753
	0.019480519	0.038961039	0.045454545	0.107142857	0.159090909
	0.168831169	0.126623377	0.113636364	0.081168831	0.061688312
	0.029220779	0.025974026	0.019480519	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
2004	1	4	0	2	211	0	0	0	0	0
	0.004739336	0.009478673	0.028436019	0.08056872	0.132701422
	0.208530806	0.161137441	0.118483412	0.099526066	0.085308057
	0.018957346	0.042654028	0.004739336	0.004739336	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0
2005	1	4	0	2	107	0	0	0	0	0	0
	0.009345794	0.018691589	0.028037383	0.046728972	0.242990654
	0.242990654	0.130841121	0.08411215	0.093457944	0.065420561
	0.018691589	0.009345794	0	0	0.009345794	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

#_AGE_DATA
13 #n_abins #_N_agebins #(<=_#_of_age,_the_model_always_start_at_age_0)
```

#age_bins1(1,n_abins) #_lower_age_of_agebins
0 1 2 3 4 5 6 7 8 9 10 11 12

#_Age_error
2 #N_ageerr
#Ages: 0 1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
#Bins : 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
-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -
1
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001 0.001
#
0.5 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
0 0 0.239049 0.478098 0.48971 0.502373 0.516184
0.531244 0.547669 0.565581 0.585115 0.606417
0.629649 0.654984 0.682614 0.712746

#_AGE_COMPOSITIONS
253 #nobsa #ageerr: none
2 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
#year Season Fleet gender part. ageErr LbinLo LbinHi nSamps F0 F1 F2
F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 M0
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11
M12
#Ocean
2005 1 -2 1 2 1 -1 -1 74 0 0.01351351
0.09459459 0.18918919 0.32432432 0.175675676 0.10810811
0.02702703 0.02702703 0.01351351 0 0.02702703 0 0
0 0 0 0 0 0 0 0 0 0 0
0
2006 1 -2 1 2 1 -1 -1 35 0 0.05714286
0.02857143 0.17142857 0.22857143 0.2 0.2 0.05714286
0.05714286 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
2007 1 -2 1 2 1 -1 -1 1 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
2008 1 -2 1 2 1 -1 -1 29 0 0.03448276
0.13793103 0.06896552 0.20689655 0.24137931 0 0.06896552
0.13793103 0.03448276 0.06896552 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
2009 1 -2 1 2 1 -1 -1 115 0 0.05217391
0.15652174 0.03478261 0.14782609 0.104347826 0.08695652
0.11304348 0.15652174 0.08695652 0.0173913 0.0173913
0.026086956 0 0 0 0 0 0 0 0 0
0 0 0 0
2010 1 -2 1 2 1 -1 -1 113 0 0.09734513
0.20353982 0.17699115 0.0619469 0.044247788 0.0619469
0.0619469 0.03539823 0.15929204 0.07079646 0.02654867 0
0 0 0 0 0 0 0 0 0 0 0
0 0

2011 1 -2 1 2 1 -1 -1 134 0 0.05970149
0.20895522 0.15671642 0.05223881 0.007462687 0.11940299
0.09701493 0.07462687 0.08208955 0.06716418 0.04477612
0.029850746 0 0 0 0 0 0 0 0 0
0 0 0 0
2012 1 -2 1 2 1 -1 -1 87 0 0.03448276
0.14942529 0.31034483 0.13793103 0.057471264 0.06896552
0.03448276 0.04597701 0.04597701 0.04597701 0.03448276
0.034482759 0 0 0 0 0 0 0 0 0
0 0 0 0
2013 1 -2 1 2 1 -1 -1 70 0 0
0.01428571 0.08571429 0.38571429 0.285714286 0.1 0.04285714
0.04285714 0 0 0.01428571 0.028571428 0 0 0
0 0 0 0 0 0 0 0 0 0
2005 1 -2 2 2 1 -1 -1 72 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.04166667 0.13888889 0.23611111 0.26388889 0.18055556
0.06944444 0.02777778 0.02777778 0 0 0.013888889
2006 1 -2 2 2 1 -1 -1 50 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.04 0.14 0.16 0.18 0.12 0.1 0.06 0.14 0 0.04
0.02
2007 1 -2 2 2 1 -1 -1 5 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.4 0 0 0.4 0.2 0 0 0 0 0
0
2008 1 -2 2 2 1 -1 -1 57 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.0877193 0.03508772 0.05263158 0.15789474 0.0877193
0.15789474 0.24561404 0.03508772 0.07017544 0.03508772
0.035087719
2009 1 -2 2 2 1 -1 -1 142 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0.02816901 0.17605634 0.04929577 0.14084507 0.11971831
0.12676056 0.05633803 0.09859155 0.07042254 0.04929577
0.03521127 0.049295775
2010 1 -2 2 2 1 -1 -1 158 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0.09493671 0.23417722 0.13924051 0.02531646 0.07594937
0.05696203 0.0443038 0.05696203 0.10126582 0.10126582
0.03164557 0.037974684
2011 1 -2 2 2 1 -1 -1 155 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0.08387097 0.18064516 0.10967742 0.12903226 0.0516129
0.08387097 0.06451613 0.08387097 0.08387097 0.03870968
0.05806452 0.032258065
2012 1 -2 2 2 1 -1 -1 133 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0.01503759 0.16541353 0.27067669 0.15789474 0.08270677
0.03759398 0.03759398 0.03759398 0.01503759 0.04511278
0.09022556 0.045112782
2013 1 -2 2 2 1 -1 -1 114 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.00877193 0.16666667 0.36842105 0.14912281 0.07017544
0.00877193 0.02631579 0.05263158 0.02631579 0.03508772
0.087719298

#Commercial
#year Season Fleet gender part. ageErr LbinLo LbinHi nSamps F0 F1 F2
F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 M0
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11
M12
2003 1 -1 1 2 2 -1 -1 12 0 0
0.16666667 0.58333333 0 0.08333333 0.08333333 0.08333333
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2004 1 -1 1 2 2 -1 -1 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
2007 1 -1 1 2 2 -1 -1 6 0 0
0.33333333 0.16666667 0 0.16666667 0 0 0.16666667
0.16666667 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
2008 1 -1 1 2 2 -1 -1 2 0 0 0
0 0 0 0 0 0 0.5 0.5 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0
2009 1 -1 1 2 2 -1 -1 11 0 0
0.18181818 0.09090909 0.1818182 0 0.27272727 0
0.18181818 0.09090909 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
2010 1 -1 1 2 2 -1 -1 24 0 0
0.08333333 0.08333333 0.2916667 0.04166667 0.125 0
0.04166667 0.08333333 0.08333333 0.16666667 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2011 1 -1 1 2 2 -1 -1 34 0 0
0.14705882 0.20588235 0.1176471 0.05882353 0.02941176
0.05882353 0.05882353 0.05882353 0.11764706 0.05882353
0.08823529 0 0 0 0 0 0 0 0 0
0 0 0 0
2012 1 -1 1 2 2 -1 -1 44 0 0
0.04545455 0.13636364 0.2954545 0.11363636 0.04545455 0
0.11363636 0.09090909 0.06818182 0.09090909 0 0 0
0 0 0 0 0 0 0 0 0 0 0
2013 1 -1 1 2 2 -1 -1 31 0 0
0.06451613 0.12903226 0.4193548 0.03225806 0.06451613
0.09677419 0.09677419 0.03225806 0.03225806 0.03225806 0
0 0 0 0 0 0 0 0 0 0 0
0 0
2003 1 -1 2 2 2 -1 -1 16 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0.625 0 0 0.1875 0.0625 0 0 0.0625 0.0625
0
2004 1 -1 2 2 2 -1 -1 1 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
2007 1 -1 2 2 2 -1 -1 6 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0.33333333 0.1666667 0 0 0 0 0.33333333
0 0.16666667 0 0

```
2008	1	-1	2	2	2	-1	-1	2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.5	0	0	0.5	0	0
	0
2009	1	-1	2	2	2	-1	-1	12	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0.25	0.1666667	0	0.08333333	0	0.08333333
	0.16666667	0.08333333	0	0.08333333	0.08333333
2010	1	-1	2	2	2	-1	-1	9	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.4444444	0.2222222	0	0.22222222	0	0
	0.11111111	0	0	0
2011	1	-1	2	2	2	-1	-1	44	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0.11363636	0.1590909	0.25	0.04545455	0.06818182
	0.09090909	0.09090909	0.04545455	0.06818182	0.02272727
	0.04545455
2012	1	-1	2	2	2	-1	-1	56	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0.08928571	0.25	0.125	0.125	0.05357143	0.07142857
	0.07142857	0.07142857	0.03571429	0.05357143	0.05357143
2013	1	-1	2	2	2	-1	-1	38	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
	0	0.07894737	0.1052632	0.3421053	0.15789474	0.13157895
	0.10526316	0.02631579	0	0	0.02631579	0.02631579


# Conditional age-at-length
# female_Ocean


#year	Season	Fleet	gender	part.	ageErr	LbinLo	LbinHi	nSamps	F0	F1	F2
	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	M0
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
	M12
2005	1	2	1	2	2	13	13	3	0	0.3333333
	0	0.6666667	0	0	0	0	0	0	0	0
	0	0	0.3333333	0	0.6666667	0	0	0	0
	0	0	0	0	0
2005	1	2	1	2	2	14	14	12	0	0
	0.4166667	0.25	0.3333333	0	0	0	0	0	0
	0	0	0	0	0.4166667	0.25	0.3333333	0	0
	0	0	0	0	0	0
2005	1	2	1	2	2	15	15	14	0	0
	0.1428571	0.35714286	0.35714286	0.07142857	0.07142857	0
	0	0	0	0	0	0	0	0.1428571	0.35714286
	0.35714286	0.07142857	0.07142857	0	0	0	0	0
	0
2005	1	2	1	2	2	16	16	27	0	0	0
	0.14814815	0.4074074	0.33333333	0.07407407	0	0.03703704
	0	0	0	0	0	0	0	0.14814815	0.4074074
	0.33333333	0.07407407	0	0.03703704	0	0	0	0
2005	1	2	1	2	2	17	17	10	0	0	0
	0	0.2	0.2	0.2	0.1	0	0.1	0	0.2	0	0
	0	0	0	0.2	0.2	0.2	0.1	0	0.1	0	0.2
	0
```

2005 1 2 1 2 2 18 18 7 0 0 0
0 0.2857143 0 0.42857143 0.14285714 0.14285714 0
0 0 0 0 0 0 0 0.2857143 0
0.42857143 0.14285714 0.14285714 0 0 0 0
2005 1 2 1 2 2 19 19 1 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0
0
2006 1 2 1 2 2 11 11 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2006 1 2 1 2 2 12 12 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2006 1 2 1 2 2 13 13 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2006 1 2 1 2 2 14 14 2 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0
2006 1 2 1 2 2 15 15 8 0 0 0
0.375 0.375 0.125 0.125 0 0 0 0 0 0 0
0 0 0.375 0.375 0.125 0.125 0 0 0 0 0
0
2006 1 2 1 2 2 16 16 13 0 0 0
0.07692308 0.3076923 0.30769231 0.15384615 0.07692308
0.07692308 0 0 0 0 0 0 0 0.07692308
0.3076923 0.30769231 0.15384615 0.07692308 0.07692308 0
0 0 0
2006 1 2 1 2 2 17 17 8 0 0 0
0 0.125 0.25 0.375 0.125 0.125 0 0 0 0 0
0 0 0 0.125 0.25 0.375 0.125 0.125 0 0 0
0
2006 1 2 1 2 2 18 18 1 0 0 0
0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0
0
2007 1 2 1 2 2 14 14 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2008 1 2 1 2 2 12 12 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2008 1 2 1 2 2 13 13 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2008 1 2 1 2 2 14 14 6 0 0 0.5
0 0.1666667 0.33333333 0 0 0 0 0 0

0 0 0 0.5 0 0.1666667 0.33333333 0 0
0 0 0 0 0
2008 1 2 1 2 2 15 15 4 0 0 0
0.5 0.25 0 0 0 0 0 0.25 0 0 0
0 0 0.5 0.25 0 0 0 0 0 0.25 0
0
2008 1 2 1 2 2 16 16 11 0 0 0
0 0.3636364 0.27272727 0 0.18181818 0.09090909 0
0.09090909 0 0 0 0 0 0 0.3636364
0.27272727 0 0.18181818 0.09090909 0 0.09090909 0
0
2008 1 2 1 2 2 17 17 4 0 0 0
0 0 0.25 0 0 0.75 0 0 0 0 0
0 0 0 0 0.25 0 0 0.75 0 0 0
0
2008 1 2 1 2 2 18 18 1 0 0 0
0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0
0
2008 1 2 1 2 2 19 19 1 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0
0
2009 1 2 1 2 2 11 11 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2009 1 2 1 2 2 12 12 2 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2009 1 2 1 2 2 13 13 6 0 0
0.8333333 0 0.1666667 0 0 0 0 0 0
0 0 0 0 0.8333333 0 0.1666667 0 0
0 0 0 0 0 0
2009 1 2 1 2 2 14 14 8 0 0 0.625
0 0.25 0.125 0 0 0 0 0 0 0 0
0 0.625 0 0.25 0.125 0 0 0 0 0 0
0
2009 1 2 1 2 2 15 15 23 0 0.08695652
0.2173913 0.08695652 0.2173913 0.08695652 0.04347826
0.04347826 0.08695652 0.1304348 0 0 0 0
0.08695652 0.2173913 0.08695652 0.2173913 0.08695652
0.04347826 0.04347826 0.08695652 0.1304348 0 0 0
2009 1 2 1 2 2 16 16 36 0 0.02777778
0.08333333 0.02777778 0.1666667 0.13888889 0.19444444
0.11111111 0.16666667 0.02777778 0 0.02777778 0.02777778
0 0.02777778 0.08333333 0.02777778 0.1666667 0.13888889
0.19444444 0.11111111 0.16666667 0.02777778 0 0.02777778
0.02777778
2009 1 2 1 2 2 17 17 23 0 0 0
0.04347826 0.13043478 0.1304348 0.04347826 0.13043478
0.17391304 0.17391304 0.04347826 0.04347826 0.08695652 0
0 0 0.04347826 0.13043478 0.1304348 0.04347826
0.13043478 0.17391304 0.17391304 0.04347826 0.04347826
0.08695652

2009 1 2 1 2 2 18 18 14 0 0 0
0 0 0.07142857 0.07142857 0.28571429 0.42857143
0.07142857 0.07142857 0 0 0 0 0 0 0
0.07142857 0.07142857 0.28571429 0.42857143 0.07142857
0.07142857 0 0
2009 1 2 1 2 2 19 19 2 0 0 0
0 0 0 0 0.5 0 0.5 0 0 0 0
0 0 0 0 0 0 0.5 0 0.5 0 0
0
2010 1 2 1 2 2 12 12 3 0 1 0
0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0
2010 1 2 1 2 2 13 13 4 0 0.25 0.25
0.25 0 0 0 0 0 0.25 0 0 0 0
0.25 0.25 0.25 0 0 0 0 0 0.25 0 0
0
2010 1 2 1 2 2 14 14 17 0 0.2941176
0.5294118 0.1176471 0 0.05882353 0 0 0 0
0 0 0 0 0.2941176 0.5294118 0.1176471 0
0.05882353 0 0 0 0 0 0 0
2010 1 2 1 2 2 15 15 24 0 0.08333333
0.3333333 0.33333333 0.08333333 0.04166667 0.04166667
0.04166667 0 0 0.04166667 0 0 0 0.08333333
0.3333333 0.33333333 0.08333333 0.04166667 0.04166667
0.04166667 0 0 0.04166667 0 0
2010 1 2 1 2 2 16 16 25 0 0 0.16
0.28 0.16 0.04 0.08 0.08 0.04 0.08 0.08 0 0 0
0 0.16 0.28 0.16 0.04 0.08 0.08 0.04 0.08 0.08 0
0
2010 1 2 1 2 2 17 17 21 0 0
0.04761905 0.0952381 0.04761905 0.0952381 0.14285714
0.04761905 0.04761905 0.33333333 0.14285714 0 0 0
0 0.04761905 0.0952381 0.04761905 0.0952381 0.14285714
0.04761905 0.04761905 0.33333333 0.14285714 0 0
2010 1 2 1 2 2 18 18 13 0 0 0
0 0 0 0.07692308 0.07692308 0 0.46153846
0.15384615 0.23076923 0 0 0 0 0 0 0
0.07692308 0.07692308 0 0.46153846 0.15384615 0.23076923
0
2010 1 2 1 2 2 19 19 5 0 0 0
0 0 0 0 0.2 0.4 0.4 0 0 0 0
0 0 0 0 0 0 0.2 0.4 0.4 0 0
0
2010 1 2 1 2 2 20 20 1 0 0 0
0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 1 0 0 0 0
0
2011 1 2 1 2 2 12 12 3 0 0.3333333
0.6666667 0 0 0 0 0 0 0 0 0
0 0 0.3333333 0.6666667 0 0 0 0 0
0 0 0 0 0
2011 1 2 1 2 2 13 13 8 0 0.25 0.625
0.125 0 0 0 0 0 0 0 0 0 0
0.25 0.625 0.125 0 0 0 0 0 0 0 0
0

2011 1 2 1 2 2 14 14 25 0 0.2 0.4
0.28 0.04 0 0.04 0 0.04 0 0 0 0 0
0.2 0.4 0.28 0.04 0 0.04 0 0.04 0 0 0
0
2011 1 2 1 2 2 15 15 18 0 0 0.5
0.38888889 0 0 0.11111111 0 0 0 0 0
0 0 0 0.5 0.38888889 0 0 0.11111111 0
0 0 0 0 0
2011 1 2 1 2 2 16 16 26 0 0
0.03846154 0.19230769 0.1538462 0 0.19230769 0.07692308
0.11538462 0.03846154 0.03846154 0.11538462 0.03846154 0
0 0.03846154 0.19230769 0.1538462 0 0.19230769
0.07692308 0.11538462 0.03846154 0.03846154 0.11538462
0.03846154
2011 1 2 1 2 2 17 17 32 0 0 0.03125
0.03125 0.0625 0.03125 0.1875 0.21875 0.15625 0.09375 0.0625 0.0625 0.0625 0
0 0.03125 0.03125 0.0625 0.03125 0.1875 0.21875 0.15625 0.09375 0.0625 0.0625
0.0625
2011 1 2 1 2 2 18 18 17 0 0 0
0 0 0 0.05882353 0.17647059 0.05882353 0.29411765
0.29411765 0.05882353 0.05882353 0 0 0 0 0
0 0.05882353 0.17647059 0.05882353 0.29411765 0.29411765
0.05882353 0.05882353
2011 1 2 1 2 2 19 19 5 0 0 0
0 0 0 0.2 0.2 0 0.4 0.2 0 0 0
0 0 0 0 0 0.2 0.2 0 0.4 0.2 0
0
2012 1 2 1 2 2 11 11 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2012 1 2 1 2 2 12 12 4 0 0 0.25
0.75 0 0 0 0 0 0 0 0 0 0
0 0.25 0.75 0 0 0 0 0 0 0 0
0
2012 1 2 1 2 2 13 13 10 0 0.1 0.3
0.5 0.1 0 0 0 0 0 0 0 0 0
0.1 0.3 0.5 0.1 0 0 0 0 0 0 0
0
2012 1 2 1 2 2 14 14 21 0 0.0952381
0.2857143 0.4761905 0 0.0952381 0 0.04761905 0
0 0 0 0 0 0.0952381 0.2857143 0.4761905
0 0.0952381 0 0.04761905 0 0 0 0 0
2012 1 2 1 2 2 15 15 16 0 0 0.125
0.3125 0.25 0.125 0.0625 0 0 0 0.0625 0.0625 0 0
0 0.125 0.3125 0.25 0.125 0.0625 0 0 0 0.0625 0.0625
0
2012 1 2 1 2 2 16 16 17 0 0 0
0.17647059 0.2941176 0.05882353 0.05882353 0 0.05882353
0.17647059 0.05882353 0.05882353 0.05882353 0 0 0
0.17647059 0.2941176 0.05882353 0.05882353 0 0.05882353
0.17647059 0.05882353 0.05882353 0.05882353
2012 1 2 1 2 2 17 17 13 0 0 0
0 0.07692308 0 0.23076923 0.07692308 0.23076923
0.07692308 0.15384615 0.07692308 0.07692308 0 0 0

0 0.07692308 0 0.23076923 0.07692308 0.23076923
0.07692308 0.15384615 0.07692308 0.07692308
2012 1 2 1 2 2 18 18 5 0 0 0
0.2 0.2 0 0.2 0.2 0 0 0 0 0.2 0
0 0 0.2 0.2 0 0.2 0.2 0 0 0 0
0.2
2013 1 2 1 2 2 13 13 6 0 0
0.1666667 0.1666667 0.5 0.1666667 0 0 0 0
0 0 0 0 0 0.1666667 0.1666667 0.5
0.1666667 0 0 0 0 0 0 0
2013 1 2 1 2 2 14 14 17 0 0 0
0.2352941 0.5882353 0.11764706 0.05882353 0 0 0
0 0 0 0 0 0 0.2352941 0.5882353
0.11764706 0.05882353 0 0 0 0 0 0
2013 1 2 1 2 2 15 15 21 0 0 0
0.04761905 0.52380952 0.23809524 0.0952381 0 0.04761905
0 0 0 0.04761905 0 0 0 0.04761905
0.52380952 0.23809524 0.0952381 0 0.04761905 0 0
0 0.04761905
2013 1 2 1 2 2 16 16 14 0 0 0
0 0.2142857 0.5 0.21428571 0 0.07142857 0 0
0 0 0 0 0 0 0.2142857 0.5 0.21428571
0 0.07142857 0 0 0 0
2013 1 2 1 2 2 17 17 9 0 0 0
0 0 0.3333333 0.11111111 0.22222222 0.11111111 0
0 0.11111111 0.11111111 0 0 0 0 0
0.3333333 0.11111111 0.22222222 0.11111111 0 0
0.11111111 0.11111111
2013 1 2 1 2 2 18 18 3 0 0 0
0 0 0.66666667 0 0.33333333 0 0 0 0
0 0 0 0 0 0 0.66666667 0 0.33333333
0 0 0 0 0

#male_Ocean

#year Season Fleet gender part. ageErr LbinLo LbinHi nSamps F0 F1 F2
F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 M0
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11
M12
2005 1 2 2 2 2 12 12 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2005 1 2 2 2 2 14 14 15 0 0
0.1333333 0.2666667 0.3333333 0.2 0.06666667 0 0
0 0 0 0 0 0 0.1333333 0.2666667
0.3333333 0.2 0.06666667 0 0 0 0 0 0
2005 1 2 2 2 2 15 15 24 0 0 0
0.20833333 0.25 0.29166667 0.125 0.08333333 0 0.04166667
0 0 0 0 0 0 0.20833333 0.25 0.29166667
0.125 0.08333333 0 0.04166667 0 0 0
2005 1 2 2 2 2 16 16 21 0 0 0
0.04761905 0.23809524 0.3333333 0.23809524 0.04761905
0.04761905 0.04761905 0 0 0 0 0 0

0.04761905 0.23809524 0.3333333 0.23809524 0.04761905
0.04761905 0.04761905 0 0 0
2005 1 2 2 2 2 17 17 9 0 0 0
0 0.11111111 0.22222222 0.33333333 0.22222222 0 0
0 0 0.11111111 0 0 0 0 0.11111111
0.22222222 0.33333333 0.22222222 0 0 0 0
0.11111111
2005 1 2 2 2 2 18 18 2 0 0 0
0 0 0 0.5 0 0.5 0 0 0 0 0
0 0 0 0 0 0.5 0 0.5 0 0 0
0
2006 1 2 2 2 2 12 12 2 0 0 0
0.5 0 0 0 0.5 0 0 0 0 0 0
0 0 0.5 0 0 0 0.5 0 0 0 0
0
2006 1 2 2 2 2 13 13 3 0 0
0.6666667 0 0 0.3333333 0 0 0 0 0
0 0 0 0 0.6666667 0 0 0.3333333 0
0 0 0 0 0 0
2006 1 2 2 2 2 14 14 6 0 0 0
0.3333333 0.3333333 0 0.16666667 0.1666667 0 0
0 0 0 0 0 0 0.3333333 0.3333333 0
0.16666667 0.1666667 0 0 0 0 0
2006 1 2 2 2 2 15 15 19 0 0 0
0.21052632 0.31578947 0.21052632 0.15789474 0.05263158
0.05263158 0 0 0 0 0 0 0 0.21052632
0.31578947 0.21052632 0.15789474 0.05263158 0.05263158 0
0 0 0
2006 1 2 2 2 2 16 16 11 0 0 0
0 0 0.3636364 0.09090909 0.18181818 0.09090909
0.27272727 0 0 0 0 0 0 0 0
0.3636364 0.09090909 0.18181818 0.09090909 0.27272727 0
0 0
2006 1 2 2 2 2 17 17 8 0 0 0
0 0 0 0.125 0 0.125 0.375 0 0.25 0.125 0
0 0 0 0 0 0.125 0 0.125 0.375 0 0.25
0.125
2006 1 2 2 2 2 18 18 1 0 0 0
0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0
0
2007 1 2 2 2 2 13 13 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2007 1 2 2 2 2 14 14 2 0 0 0.5
0 0 0.5 0 0 0 0 0 0 0 0
0 0.5 0 0 0.5 0 0 0 0 0 0
0
2007 1 2 2 2 2 16 16 1 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0
0
2007 1 2 2 2 2 17 17 1 0 0 0
0 0 0 1 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0
0
2008 1 2 2 2 2 12 12 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2008 1 2 2 2 2 14 14 8 0 0 0.375
0 0.25 0.125 0 0 0.25 0 0 0 0 0
0 0.375 0 0.25 0.125 0 0 0.25 0 0 0
0
2008 1 2 2 2 2 15 15 19 0 0
0.05263158 0.10526316 0.05263158 0.42105263 0.10526316
0.10526316 0.05263158 0 0.10526316 0 0 0 0
0.05263158 0.10526316 0.05263158 0.42105263 0.10526316
0.10526316 0.05263158 0 0.10526316 0 0
2008 1 2 2 2 2 16 16 22 0 0 0
0 0 0 0.13636364 0.18181818 0.40909091 0.09090909
0.04545455 0.04545455 0.09090909 0 0 0 0 0
0 0.13636364 0.18181818 0.40909091 0.09090909 0.04545455
0.04545455 0.09090909
2008 1 2 2 2 2 17 17 7 0 0 0
0 0 0 0 0.42857143 0.2857143 0 0.14285714
0.14285714 0 0 0 0 0 0 0 0
0.42857143 0.2857143 0 0.14285714 0.14285714 0
2009 1 2 2 2 2 13 13 8 0 0.375 0.375
0.125 0.125 0 0 0 0 0 0 0 0 0
0.375 0.375 0.125 0.125 0 0 0 0 0 0 0
0
2009 1 2 2 2 2 14 14 23 0 0.04347826
0.4782609 0.1304348 0.2173913 0.04347826 0.04347826 0
0 0 0 0 0.04347826 0 0.04347826 0.4782609
0.1304348 0.2173913 0.04347826 0.04347826 0 0 0
0 0 0.04347826
2009 1 2 2 2 2 15 15 42 0 0
0.21428571 0.07142857 0.16666667 0.19047619 0.21428571
0.02380952 0.04761905 0 0.07142857 0 0 0 0
0.21428571 0.07142857 0.16666667 0.19047619 0.21428571
0.02380952 0.04761905 0 0.07142857 0 0
2009 1 2 2 2 2 16 16 42 0 0
0.02380952 0 0.11904762 0.1190476 0.16666667 0.0952381
0.11904762 0.16666667 0.07142857 0.0952381 0.02380952 0
0 0.02380952 0 0.11904762 0.1190476 0.16666667
0.0952381 0.11904762 0.16666667 0.07142857 0.0952381
0.02380952
2009 1 2 2 2 2 17 17 23 0 0
0.04347826 0 0.08695652 0.13043478 0.04347826 0.08695652
0.2173913 0.1304348 0 0.04347826 0.2173913 0 0
0.04347826 0 0.08695652 0.13043478 0.04347826 0.08695652
0.2173913 0.1304348 0 0.04347826 0.2173913
2009 1 2 2 2 2 18 18 4 0 0 0
0 0 0 0 0.25 0.5 0 0.25 0 0 0
0 0 0 0 0 0 0.25 0.5 0 0.25 0
0
2010 1 2 2 2 2 10 10 2 0 1 0
0 0 0 0 0 0 0 0 0 0 0

1 0 0 0 0 0 0 0 0 0 0
0
2010 1 2 2 2 2 11 11 2 0 0.5 0.5
0 0 0 0 0 0 0 0 0 0 0
0.5 0.5 0 0 0 0 0 0 0 0 0
0
2010 1 2 2 2 2 12 12 8 0 0.5 0.5
0 0 0 0 0 0 0 0 0 0 0
0.5 0.5 0 0 0 0 0 0 0 0 0
0
2010 1 2 2 2 2 13 13 12 0 0.4166667
0.5833333 0 0 0 0 0 0 0 0 0
0 0 0.4166667 0.5833333 0 0 0 0 0
0 0 0 0 0
2010 1 2 2 2 2 14 14 22 0 0.13636364
0.5909091 0.1818182 0 0.04545455 0 0 0.04545455
0 0 0 0 0 0.13636364 0.5909091 0.1818182
0 0.04545455 0 0 0.04545455 0 0 0 0
2010 1 2 2 2 2 15 15 43 0 0
0.23255814 0.34883721 0.06976744 0.06976744 0.09302326 0
0.04651163 0 0.13953488 0 0 0 0 0.23255814
0.34883721 0.06976744 0.06976744 0.09302326 0 0.04651163
0 0.13953488 0 0
2010 1 2 2 2 2 16 16 26 0 0
0.07692308 0.11538462 0.03846154 0.1923077 0.11538462
0.07692308 0.07692308 0.19230769 0.11538462 0 0 0
0 0.07692308 0.11538462 0.03846154 0.1923077 0.11538462
0.07692308 0.07692308 0.19230769 0.11538462 0 0
2010 1 2 2 2 2 17 17 38 0 0 0
0 0 0.07894737 0.05263158 0.10526316 0.1052632
0.2631579 0.15789474 0.10526316 0.13157895 0 0 0
0 0 0.07894737 0.05263158 0.10526316 0.1052632
0.2631579 0.15789474 0.10526316 0.13157895
2010 1 2 2 2 2 18 18 5 0 0 0
0 0 0 0 0.2 0 0.2 0.2 0.2 0.2 0
0 0 0 0 0 0 0.2 0 0.2 0.2 0.2
0.2
2011 1 2 2 2 2 12 12 4 0 0.5 0.5
0 0 0 0 0 0 0 0 0 0 0
0.5 0.5 0 0 0 0 0 0 0 0 0
0
2011 1 2 2 2 2 13 13 8 0 0.375 0.5
0.125 0 0 0 0 0 0 0 0 0 0
0.375 0.5 0.125 0 0 0 0 0 0 0 0
0
2011 1 2 2 2 2 14 14 26 0 0.26923077
0.3846154 0.1538462 0.1538462 0.03846154 0 0 0
0 0 0 0 0 0.26923077 0.3846154 0.1538462
0.1538462 0.03846154 0 0 0 0 0 0 0
2011 1 2 2 2 2 15 15 42 0 0.02380952
0.23809524 0.23809524 0.21428571 0 0.0952381 0.02380952
0.07142857 0.02380952 0.04761905 0.02380952 0 0
0.02380952 0.23809524 0.23809524 0.21428571 0 0.0952381
0.02380952 0.07142857 0.02380952 0.04761905 0.02380952 0
2011 1 2 2 2 2 16 16 40 0 0 0.05
0.05 0.125 0.15 0.225 0.125 0.125 0.075 0.025 0.05 0 0

0 0.05 0.05 0.125 0.15 0.225 0.125 0.125 0.075 0.025 0.05
0
2011 1 2 2 2 2 17 17 27 0 0 0
0 0.07407407 0.03703704 0 0.11111111 0.1481481
0.2592593 0.07407407 0.14814815 0.14814815 0 0 0
0 0.07407407 0.03703704 0 0.11111111 0.1481481
0.2592593 0.07407407 0.14814815 0.14814815
2011 1 2 2 2 2 18 18 7 0 0 0
0 0 0 0 0.1428571 0.1428571 0.1428571
0.1428571 0.2857143 0.1428571 0 0 0 0 0
0 0 0.1428571 0.1428571 0.1428571 0.1428571
0.2857143 0.1428571
2011 1 2 2 2 2 22 22 1 0 0 0
0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0
0
2012 1 2 2 2 2 12 12 9 0 0.1111111
0.1111111 0.7777778 0 0 0 0 0 0 0
0 0 0 0.1111111 0.1111111 0.7777778 0 0
0 0 0 0 0 0 0
2012 1 2 2 2 2 13 13 18 0 0
0.2777778 0.5555556 0.1666667 0 0 0 0 0
0 0 0 0 0 0.2777778 0.5555556 0.1666667
0 0 0 0 0 0 0 0
2012 1 2 2 2 2 14 14 28 0 0.03571429
0.3571429 0.3928571 0.1071429 0.03571429 0 0 0
0 0.03571429 0.03571429 0 0 0.03571429 0.3571429
0.3928571 0.1071429 0.03571429 0 0 0 0
0.03571429 0.03571429 0
2012 1 2 2 2 2 15 15 40 0 0 0.15
0.1 0.2 0.2 0.1 0.05 0.025 0.05 0.05 0.025 0.05 0
0 0.15 0.1 0.2 0.2 0.1 0.05 0.025 0.05 0.05 0.025
0.05
2012 1 2 2 2 2 16 16 25 0 0 0
0.08 0.28 0.08 0.04 0.04 0.08 0 0.08 0.24 0.08 0
0 0 0.08 0.28 0.08 0.04 0.04 0.08 0 0.08 0.24
0.08
2012 1 2 2 2 2 17 17 9 0 0 0
0.1111111 0 0 0 0.22222222 0.1111111 0
0.11111111 0.22222222 0.22222222 0 0 0 0.1111111
0 0 0 0.22222222 0.1111111 0 0.11111111
0.22222222 0.22222222
2012 1 2 2 2 2 18 18 4 0 0 0
0.25 0 0 0 0 0.25 0 0 0.5 0 0
0 0 0.25 0 0 0 0 0.25 0 0 0.5
0
2013 1 2 2 2 2 13 13 8 0 0 0
0.375 0.625 0 0 0 0 0 0 0 0 0
0 0 0.375 0.625 0 0 0 0 0 0 0
0
2013 1 2 2 2 2 14 14 32 0 0 0.03125
0.28125 0.59375 0.0625 0.03125 0 0 0 0 0 0 0
0 0.03125 0.28125 0.59375 0.0625 0.03125 0 0 0 0 0
0
2013 1 2 2 2 2 15 15 27 0 0 0
0.18518519 0.2962963 0.25925926 0.11111111 0.03703704

0.03703704 0.03703704 0 0.03703704 0 0 0 0
0.18518519 0.2962963 0.25925926 0.11111111 0.03703704
0.03703704 0.03703704 0 0.03703704 0
2013 1 2 2 2 2 16 16 35 0 0 0
0.05714286 0.28571429 0.2 0.08571429 0 0.05714286
0.08571429 0.02857143 0.05714286 0.14285715 0 0 0
0.05714286 0.28571429 0.2 0.08571429 0 0.05714286
0.08571429 0.02857143 0.05714286 0.14285715
2013 1 2 2 2 2 17 17 10 0 0 0
0 0 0.1 0.1 0 0 0.2 0.2 0 0.4 0
0 0 0 0 0.1 0.1 0 0 0.2 0.2 0
0.4
2013 1 2 2 2 2 18 18 2 0 0 0
0 0 0 0 0 0 0 0 0.5 0.5 0
0 0 0 0 0 0 0 0 0 0 0.5
0.5

#female_commercial

#year Season Fleet gender part. ageErr LbinLo LbinHi nSamps F0 F1 F2
F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 M0
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11
M12
2003 1 1 1 2 2 13 13 4 0 0 0.25
0.5 0 0 0 0.25 0 0 0 0 0 0
0 0.25 0.5 0 0 0 0.25 0 0 0 0
0
2003 1 1 1 2 2 14 14 2 0 0 0
0.5 0 0 0.5 0 0 0 0 0 0 0
0 0 0.5 0 0 0.5 0 0 0 0 0
0
2003 1 1 1 2 2 15 15 4 0 0 0.25
0.5 0 0.25 0 0 0 0 0 0 0 0
0 0.25 0.5 0 0.25 0 0 0 0 0 0
0
2003 1 1 1 2 2 16 16 1 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0
2003 1 1 1 2 2 17 17 1 0 0 0
1 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0
2004 1 1 1 2 2 18 18 1 0 0 0
0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0 0
0
2007 1 1 1 2 2 12 12 1 0 0 1
0 0 0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0
2007 1 1 1 2 2 14 14 1 0 0 0
0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0
0

2007	1	1	1	2	2	15	15	1	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0										
2007	1	1	1	2	2	16	16	2	0	0	0.5
	0.5	0	0	0	0	0	0	0	0	0	0
	0	0.5	0.5	0	0	0	0	0	0	0	0
	0										
2007	1	1	1	2	2	18	18	1	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0
	0										
2008	1	1	1	2	2	18	18	1	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	1	0
	0										
2008	1	1	1	2	2	20	20	1	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0										
2009	1	1	1	2	2	13	13	1	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0										
2009	1	1	1	2	2	14	14	1	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0										
2009	1	1	1	2	2	15	15	2	0	0	0
	0	0.5	0	0.5	0	0	0	0	0	0	0
	0	0	0	0.5	0	0.5	0	0	0	0	0
	0										
2009	1	1	1	2	2	16	16	2	0	0	0.5
	0	0.5	0	0	0	0	0	0	0	0	0
	0	0.5	0	0.5	0	0	0	0	0	0	0
	0										
2009	1	1	1	2	2	17	17	1	0	0	0
	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0										
2009	1	1	1	2	2	18	18	3	0	0	
	0.3333333		0.3333333		0	0	0	0	0.3333333		0
	0	0	0	0	0	0.3333333		0.3333333		0	0
	0	0	0.3333333		0	0	0	0			
2009	1	1	1	2	2	19	19	1	0	0	0
	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0										
2010	1	1	1	2	2	13	13	4	0	0	0
	0	0	0	0.25	0	0	0	0.25	0.5	0	0
	0	0	0	0	0	0.25	0	0	0	0.25	0.5
	0										
2010	1	1	1	2	2	14	14	2	0	0	0
	0	0	0.5	0	0	0	0	0.5	0	0	0
	0	0	0	0	0.5	0	0	0	0	0.5	0
	0										

2010	1	1	1	2	2	15	15	2	0	0	0.5
	0	0.5	0	0	0	0	0	0	0	0	0
	0	0.5	0	0.5	0	0	0	0	0	0	0
	0										
2010	1	1	1	2	2	16	16	2	0	0	0
	0	0.5	0	0	0	0	0	0	0.5	0	0
	0	0	0	0.5	0	0	0	0	0	0	0.5
	0										
2010	1	1	1	2	2	17	17	8	0	0	0
	0.25	0.5	0	0.125	0	0.125	0	0	0	0	0
	0	0	0.25	0.5	0	0.125	0	0.125	0	0	0
	0										
2010	1	1	1	2	2	18	18	5	0	0	0.2
	0	0.2	0	0.2	0	0	0.2	0	0.2	0	0
	0	0.2	0	0.2	0	0.2	0	0	0.2	0	0.2
	0										
2010	1	1	1	2	2	19	19	1	0	0	0
	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0
	0										
2011	1	1	1	2	2	13	13	1	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0										
2011	1	1	1	2	2	13	13	7	0	0	0
	0.1428571		0.1428571		0	0	0	0.1428571		0.1428571	
	0.2857143		0	0.1428571		0	0	0	0.1428571		
	0.1428571		0	0	0	0.1428571		0.1428571		0.2857143	
	0	0.1428571									
2011	1	1	1	2	2	14	14	5	0	0	0.2
	0.2	0.2	0	0	0.2	0	0	0	0.2	0	0
	0	0.2	0.2	0.2	0	0	0.2	0	0	0	0.2
	0										
2011	1	1	1	2	2	15	15	5	0	0	0.6
	0.2	0	0	0	0	0	0	0	0	0.2	0
	0	0.6	0.2	0	0	0	0	0	0	0	0
	0.2										
2011	1	1	1	2	2	16	16	6	0	0	
	0.1666667		0.1666667		0	0.1666667		0	0	0	
	0.1666667		0.1666667		0	0.1666667		0	0	0.1666667	
	0.1666667		0	0.1666667		0	0	0	0.1666667		
	0.1666667		0	0.1666667							
2011	1	1	1	2	2	17	17	4	0	0	0
	0.25	0.25	0.25	0	0	0	0	0	0.25	0	0
	0	0	0.25	0.25	0.25	0	0	0	0	0	0.25
	0										
2011	1	1	1	2	2	18	18	5	0	0	0
	0.2	0.2	0	0.2	0.2	0	0	0.2	0	0	0
	0	0	0.2	0.2	0	0.2	0.2	0	0	0.2	0
	0										
2011	1	1	1	2	2	19	19	1	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0										
2012	1	1	1	2	2	13	13	2	0	0	0
	0	0.5	0	0	0	0	0.5	0	0	0	0

0 0 0 0.5 0 0 0 0 0.5 0 0
0
2012 1 1 1 2 2 14 14 6 0 0 0
0.1666667 0.1666667 0 0.1666667 0 0.1666667
0.1666667 0 0.1666667 0 0 0 0 0.1666667
0.1666667 0 0.1666667 0 0.1666667 0.1666667 0
0.1666667 0
2012 1 1 1 2 2 15 15 9 0 0
0.1111111 0.1111111 0.2222222 0.2222222 0 0
0.2222222 0 0.1111111 0 0 0 0 0.1111111
0.1111111 0.2222222 0.2222222 0 0 0.2222222 0
0.1111111 0 0
2012 1 1 1 2 2 16 16 8 0 0 0
0 0.5 0.125 0.125 0 0.125 0 0.125 0 0 0
0 0 0 0.5 0.125 0.125 0 0.125 0 0.125 0
0
2012 1 1 1 2 2 17 17 13 0 0
0.07692308 0.1538462 0.3846154 0.07692308 0 0
0.07692308 0.07692308 0 0.1538462 0 0 0
0.07692308 0.1538462 0.3846154 0.07692308 0 0
0.07692308 0.07692308 0 0.1538462 0
2012 1 1 1 2 2 18 18 4 0 0 0
0.25 0 0.25 0 0 0 0 0.25 0.25 0 0
0 0 0.25 0 0.25 0 0 0 0 0.25 0.25
0
2012 1 1 1 2 2 19 19 2 0 0 0
0.5 0 0 0 0 0 0.5 0 0 0 0
0 0 0.5 0 0 0 0 0 0.5 0 0
0
2013 1 1 1 2 2 13 13 4 0 0 0.25
0.5 0 0 0 0.25 0 0 0 0 0 0
0 0.25 0.5 0 0 0 0.25 0 0 0 0
0
2013 1 1 1 2 2 14 14 7 0 0 0
0.1428571 0.7142857 0.1428571 0 0 0 0 0
0 0 0 0 0 0.1428571 0.7142857 0.1428571
0 0 0 0 0 0 0
2013 1 1 1 2 2 15 15 5 0 0 0
0.2 0.6 0 0 0.2 0 0 0 0 0 0
0 0 0.2 0.6 0 0 0.2 0 0 0 0
0
2013 1 1 1 2 2 16 16 7 0 0
0.1428571 0 0.4285714 0 0 0.1428571 0.1428571
0 0 0.1428571 0 0 0 0.1428571 0
0.4285714 0 0 0.1428571 0.1428571 0 0
0.1428571 0
2013 1 1 1 2 2 17 17 3 0 0 0
0 0.3333333 0 0 0 0.33333333 0.33333333 0
0 0 0 0 0 0 0.3333333 0 0 0
0.33333333 0.33333333 0 0 0
2013 1 1 1 2 2 18 18 5 0 0 0
0 0.2 0 0.4 0 0.2 0 0.2 0 0 0
0 0 0 0.2 0 0.4 0 0.2 0 0.2 0
0

#male_commercial

#year	Season	Fleet	gender	part.	ageErr	LbinLo	LbinHi	nSamps	F0	F1	F2
	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	M0
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
	M12										
2003	1	1	2	2	2	13	13	4	0	0	0
	0.25	0	0	0.75	0	0	0	0	0	0	0
	0	0	0.25	0	0	0.75	0	0	0	0	0
	0										
2003	1	1	2	2	2	14	14	4	0	0	0
	0.75	0	0	0	0	0	0	0	0.25	0	0
	0	0	0.75	0	0	0	0	0	0	0	0.25
	0										
2003	1	1	2	2	2	15	15	3	0	0	0
	0.6666667		0	0	0	0	0	0	0.3333333		0
	0	0	0	0	0.6666667		0	0	0	0	0
	0	0.3333333		0	0						
2003	1	1	2	2	2	16	16	3	0	0	0
	0.6666667		0	0	0	0.33333333		0	0	0	0
	0	0	0	0	0.6666667		0	0	0	0.33333333	
	0	0	0	0	0						
2003	1	1	2	2	2	17	17	2	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0										
2004	1	1	2	2	2	17	17	1	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0
	0										
2007	1	1	2	2	2	12	12	1	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0
	0										
2007	1	1	2	2	2	14	14	1	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0
	0										
2007	1	1	2	2	2	15	15	1	0	0	0
	0	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0
	0										
2007	1	1	2	2	2	16	16	2	0	0	0
	0	0	0	0	0	0.5	0	0.5	0	0	0
	0	0	0	0	0	0	0	0.5	0	0.5	0
	0										
2007	1	1	2	2	2	17	17	1	0	0	1
	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0
	0										
2008	1	1	2	2	2	16	16	2	0	0	0
	0	0	0	0.5	0	0	0.5	0	0	0	0
	0	0	0	0	0	0.5	0	0	0.5	0	0
	0										

2009 1 1 2 2 2 14 14 2 0 0 0.5
0 0 0 0 0 0 0.5 0 0 0 0
0 0.5 0 0 0 0 0 0 0.5 0 0
0
2009 1 1 2 2 2 15 15 4 0 0 0.5
0.25 0 0 0 0.25 0 0 0 0 0 0
0 0.5 0.25 0 0 0 0.25 0 0 0 0
0
2009 1 1 2 2 2 16 16 2 0 0 0
0.5 0 0.5 0 0 0 0 0 0 0 0
0 0 0.5 0 0.5 0 0 0 0 0 0
0
2009 1 1 2 2 2 17 17 3 0 0 0
0 0 0 0 0 0.66666667 0 0 0.33333333
0 0 0 0 0 0 0 0 0 0.66666667
0 0 0.33333333 0
2009 1 1 2 2 2 19 19 1 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
1
2010 1 1 2 2 2 14 14 1 0 0 0
0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0
0
2010 1 1 2 2 2 15 15 3 0 0 0
0.3333333 0.3333333 0 0 0 0 0.3333333 0
0 0 0 0 0 0.3333333 0.3333333 0 0
0 0 0.3333333 0 0 0
2010 1 1 2 2 2 17 17 5 0 0 0
0.6 0.2 0 0.2 0 0 0 0 0 0 0
0 0 0.6 0.2 0 0.2 0 0 0 0 0
0
2011 1 1 2 2 2 13 13 7 0 0
0.1428571 0.1428571 0.2857143 0.2857143 0 0 0
0 0.1428571 0 0 0 0 0.1428571 0.1428571
0.2857143 0.2857143 0 0 0 0 0.1428571 0
0
2011 1 1 2 2 2 14 14 5 0 0 0
0.2 0.2 0 0 0 0 0 0.2 0 0.4 0
0 0 0.2 0.2 0 0 0 0 0 0.2 0
0.4
2011 1 1 2 2 2 15 15 14 0 0
0.14285714 0.1428571 0.2142857 0 0.1428571 0.14285714
0.2142857 0 0 0 0 0 0 0.14285714
0.1428571 0.2142857 0 0.1428571 0.14285714 0.2142857
0 0 0 0
2011 1 1 2 2 2 16 16 7 0 0
0.14285714 0.1428571 0.2857143 0 0 0.14285714 0
0.14285714 0.14285714 0 0 0 0 0.14285714
0.1428571 0.2857143 0 0 0.14285714 0 0.14285714
0.14285714 0 0
2011 1 1 2 2 2 17 17 6 0 0
0.1666667 0.1666667 0.16666667 0 0 0.1666667 0
0.1666667 0 0.16666667 0 0 0 0.1666667
0.1666667 0.16666667 0 0 0.1666667 0 0.1666667
0 0.16666667 0

2011 1 1 2 2 2 18 18 5 0 0 0
0.2 0.4 0 0.2 0 0.2 0 0 0 0 0
0 0 0.2 0.4 0 0.2 0 0.2 0 0 0
0
2012 1 1 2 2 2 12 12 2 0 0 0
0.5 0 0.5 0 0 0 0 0 0 0 0
0 0 0.5 0 0.5 0 0 0 0 0 0
0
2012 1 1 2 2 2 13 13 5 0 0 0
0.4 0 0 0.2 0.2 0.2 0 0 0 0 0
0 0 0.4 0 0 0.2 0.2 0.2 0 0 0
0
2012 1 1 2 2 2 14 14 5 0 0 0
0.2 0.2 0 0 0 0 0.4 0 0.2 0 0
0 0 0.2 0.2 0 0 0 0 0.4 0 0.2
0
2012 1 1 2 2 2 15 15 9 0 0 0
0.1111111 0.2222222 0.2222222 0.1111111 0 0.1111111
0.1111111 0 0 0.1111111 0 0 0 0.1111111
0.2222222 0.2222222 0.1111111 0 0.1111111 0.1111111
0 0 0.1111111
2012 1 1 2 2 2 16 16 13 0 0
0.07692308 0.2307692 0.1538462 0.1538462 0 0.07692308
0.07692308 0.07692308 0.07692308 0 0.07692308 0 0
0.07692308 0.2307692 0.1538462 0.1538462 0 0.07692308
0.07692308 0.07692308 0.07692308 0 0.07692308
2012 1 1 2 2 2 17 17 17 0 0
0.1764706 0.2352941 0.05882353 0.1176471 0.05882353
0.1176471 0.05882353 0 0.05882353 0.05882353 0.05882353
0 0 0.1764706 0.2352941 0.05882353 0.1176471
0.05882353 0.1176471 0.05882353 0 0.05882353 0.05882353
0.05882353
2012 1 1 2 2 2 18 18 5 0 0 0.2
0.4 0.2 0 0 0 0 0 0 0.2 0 0
0 0.2 0.4 0.2 0 0 0 0 0 0 0.2
0
2013 1 1 2 2 2 12 12 1 0 0 0
0 1 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0
0
2013 1 1 2 2 2 13 13 4 0 0 0.25
0 0.75 0 0 0 0 0 0 0 0 0
0 0.25 0 0.75 0 0 0 0 0 0 0
0
2013 1 1 2 2 2 14 14 4 0 0 0
0.25 0.5 0 0 0.25 0 0 0 0 0 0
0 0 0.25 0.5 0 0 0.25 0 0 0 0
0
2013 1 1 2 2 2 15 15 15 0 0
0.06666667 0.1333333 0.3333333 0.2666667 0.1333333
0.06666667 0 0 0 0 0 0 0 0.06666667
0.1333333 0.3333333 0.2666667 0.1333333 0.06666667 0
0 0 0 0
2013 1 1 2 2 2 16 16 9 0 0
0.11111111 0.1111111 0.2222222 0.2222222 0.2222222
0.11111111 0 0 0 0 0 0 0 0.11111111

	0.1111111		0.2222222		0.2222222		0.2222222		0.11111111		0
	0	0	0	0							
2013	1	1	2	2	2	17	17	5	0	0	0
	0	0	0	0.2	0.2	0.2	0	0	0.2	0.2	0
	0	0	0	0	0	0.2	0.2	0.2	0	0	0.2
	0.2										

#Special projects

#year	Season	Fleet	gender	part.	ageErr	LbinLo	LbinHi	nSamps	F0	F1	F2
	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F0.1
	F1.1	F2.1	F3.1	F4.1	F5.1	F6.1	F7.1	F8.1	F9.1	F10.1	F11.1
	F12.1										
2013	1	5	1	2	2	6	6	1	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	1	2	2	7	7	3	0	1	0
	0	0	0	0	0	0	0	0	0	0	0.25
	0.75	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	1	2	2	8	8	2	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	1	2	2	9	9	1	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	1	2	2	11	11	1	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2014	1	5	1	2	2	11	11	1	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	2	2	2	6	6	2	0	1	0
	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0										
2013	1	5	2	2	2	7	7	2	0	1	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 #N mean size-at-age obs
0 #N_envvar
0 #N_envdata
0 #N sizefreq methods to read
0 #Do_TagData(0/1)
0 #no morphcomp data
999
ENDDATA

Appendix B. SS control file

#C 2015 Assessent of Kelp Greenling (Berger, Arnold, Rodomsky) run with SSv3.24u
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
1#_Nblock_Patterns
1#_blocks_per_pattern
begin and end years of blocks
2004 2014 # For selectivities of all recreational fleets with comp data (ocean fishery only) due to 10 inch size limit in 2004-> 0 and 1 year olds only
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented
1 #_Growth_Age_for_L1 (minimum age for growth calcs)
11 #_Growth_Age_for_L2 (999 to use as Linf) (maximum age for growth calcs)
0.0 #_SD_add_to_LAA
0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
6 #_maturity_option: read an empirical length-maturity vector by population length bins
0 0 0 0 0 0 0 0 0 0 0 0 0 0.115 0.25 0.7933 0.944 1 1 1 1 1 1 1 1 1 1 1 1 1 1
#_placeholder for empirical age-maturity by growth pattern
2 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #hermaphrodite
3 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=with logistic trans to keep within base parm bounds)

#_growth_parms
#GP_1_Female
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0.1 0.60 0.360 -1.02 3 0.437 -2 0 0 0 0 0 0 0 #1 F_M
-10 30 20 20 0 10 3 0 0 0 0 0 0 0 #2 F_L@Amin (Amin is age entered above)
20 60 38.51 38.51 0 10 3 0 0 0 0 0 0 0 #3 F_L@Amax
0.1 1 0.3 0.3 0 0.5 3 0 0 0 0 0 0 0 #4 F_VBK
0.05 0.15 0.1 0.1 -1 0.8 3 0 0 0 0 0 0 0 #5 CV@LAAFIX
-0.3 0.3 0 0 -1 0.8 -3 0 0 0 0 0 0 0 # CV@LAAFIX2
#GP_1:::Male
-0.60 0.60 -0.12516 -1.15 -3 0.438 -2 0 0 0 0 0 0 0 #1 M_M
-10 30 0 12 0 10 -3 0 0 0 0 0 0 0 #2 M_L@Amin (Amin is age entered above)
-0.5 0.5 0 0 0 0.5 3 0 0 0 0 0 0 0 #3 M_L@Amax
-3 3 0 0 0 0.5 -3 0 0 0 0 0 0 0 #4 M_VBK
-0.3 0.3 0 0 -1 0.8 -3 0 0 0 0 0 0 0 #5 CV@LAAFIX
-0.3 0.3 0 0 -1 0.5 -3 0 0 0 0 0 0 0 # CV@LAAFIX2
#LW_female
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0 1 6.81E-06 6.81E-06 0 0.8 -3 0 0 0 0 0 0 0
#WL_intercept_female
1 5 3.2114 3.2114 0 0.8 -3 0 0 0 0 0 0 0 #WL_slope_female
#Female_maturity
1 60 29.34 29.34 0 0.8 -3 0 0 0 0 0 0 0 #mat_intercept #L50
-3 3 -1 -1 0 0.8 -3 0 0 0 0 0 0 0 #mat_slope

#Fecundity
-3 3 1 1 0 0.8 -3 0 0 0 0 0 0 0 #Eggs/kg_inter_Fem
-3 3 0 0 0 0.8 -3 0 0 0 0 0 0 0 #Eggs/kg_slope_wt_Fem
#LW_Male
0 1 9.76E-06 9.76E-06 0 0.8 -3 0 0 0 0 0 0 0
#WL_intercept_male
1 5 3.1164 3.1164 0 0.8 -3 0 0 0 0 0 0 0 #WL_slope_male
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#Allocate_R_by_areas_x_gmorphs
0 1 1 1 0 0.8 -3 0 0 0 0 0 0 0 #frac to GP 1 in area 1
#Allocate_R_by_areas
0 1 1 1 0 0.8 -3 0 0 0 0 0 0 0 #frac R in area 1
#Allocate_R_by_season
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0 1 1 1 0 0.8 -3 0 0 0 0 0 0 0 #frac R in season 1
#CohortGrowDev
#SS3 manual says it must be given a value of 1 and a negative phase
#LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0 1 1 1 -1 0 -4 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,L1,K,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#_Cond -4 #_MGparm_Dev_Phase

#_Spawner-Recruitment
3 #_SR_function
#_LO HI INIT PRIOR PR_type SD PHASE
5 15 7 7 -1 10 1 #Ln(R0)
0.2 1 0.70 0.70 0 0.09 -3 #steepness(h)
0 2 0.65 0.45 -1 0.2 -3 #sigmaR
-5 5 0 0 -1 1 -3 #Env_link_parameter
-5 5 0 0 -1 0.2 -3 # SR_R1_offset
0 0 0 0 -1 0 -3 # SR_autocorr
0 #_SR_env_link
0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
1 #do_recdev: 0=none; 1=devvector; 2=simple deviations
1980 # first year of main recr_devs; early devs can preceed this era
2012 # last year of main recr_devs; forecast devs start in following year
5 #_recdev phase
1 # (0/1) to read 13 advanced options
0 #_Cond 0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
-4 #_recdev_early_phase
0 #_Cond 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
1 #_Cond 1 #_lambda for prior_fore_recr occurring before endyr+1
1980 #_last_early_yr_nobias_adj_in_MPD
1984 #_first_yr_fullbias_adj_in_MPD
2010 #_last_yr_fullbias_adj_in_MPD
2014 #_first_recent_yr_nobias_adj_in_MPDadj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated recdevs)
0.81 #max bias
0 #period of cycles in recruitment
-5 #min rec_dev
5 #max rec_dev
0 #67 #_read_recdevs

#_end of advanced SR options

#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
4 # max F or harvest rate, depends on F_Method
no additional F input needed for Fmethod 1
read overall start F value; overall phase; N detailed inputs to read for Fmethod 2
NUM ITERATIONS, FOR CONDITION 3
5 # read N iterations for tuning for Fmethod 3 (recommend 3 to 7)
#Fleet Year Seas F_value se phase (for detailed setup of F_Method=2)
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
0   1 0   0.0001 0   99 -1 #Fleet1_Commercial
0   1 0   0.0001 0   99 -1 #Fleet2_Ocean
0   1 0   0.0001 0   99 -1 #Fleet3_Estuary
0   1 0   0.0001 0   99 -1 #Fleet4_Shore
0   1 0   0.0001 0   99 -1 #Fleet5_Special Projects

#_Q_setup
#do power, env-var, extra SD, dev type
#do power for commercial CPUE, estimating extra SD, estimating q
0 0 0 0 #Fleet1_Commercial
0 0 0 0 #Fleet2_Ocean
0 0 0 0 #Fleet3_Estuary
0 0 0 0 #Fleet4_Shore
0 0 0 0 #Fleet5_Special projects
0 0 1 0 #Fleet6 Logbook
0 0 1 0 #Fleet7 Onboard Observer
0 0 1 0 #Fleet8 ORBS
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#parameter lines for extra SD for fishery CPUE and surveys
#Prior type -1 = none, 0=normal, 1=symmetric beta, 2=full beta, 3=lognormal
#_LO   HI INIT PRIOR PR_type SD PHASE
0   2 0.5 1   -1   99 3 # Fleet6 Logbook
0   2 0.5 1   -1   99 3 # Fleet7 Onboard Observer
0   2 0.5 1   -1   99 3 # Fleet8 ORBS

#Seltype(1,2*Ntypes,1,4) #SELEX_&_RETENTION_PARAMETERS
#discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead
#_Pattern Discard Male Special
24 0 0 0 #Fleet1_Commercial
24 0 0 0 #Fleet2_Ocean
24 0 0 0 #Fleet3_Estuary
24 0 0 0 #Fleet4_Shore
0 0 0 0 #Fleet_Special Projects
15 0 0 1 #Fleet6 Logbook (includes commercial only so ok to mirror)
15 0 0 2 #Fleet7 Onboard Observer (includes ocean boat only so ok to mirror)
15 0 0 2 #Fleet8 ORBS (includes ocean boat only so ok to mirror)
#Age_selectivity #set_to_1
10 0 0 0 #Fleet1_Commercial
10 0 0 0 #Fleet2_Ocean
10 0 0 0 #Fleet3_Estuary
10 0 0 0 #Fleet4_Shore

```
11 0 0 0 #Fleet5_Special Projects
10 0 0 0 #Fleet6 Logbook
10 0 0 0 #Fleet7 Onboard Observer
10 0 0 0 #Fleet8 ORBS
#Selectivity parameters
# ALL DOUBLE-NORMALS, BUT FIXED AS ASYMPTOTIC
#_LO    HI    INIT    PRIOR    PR_type SD    PHASE    env-var use_dev dev_minyr    dev_maxyr  dev_SD
Block   Block_Fxn
# Fleet group 1: Commercial
24    45    36    36    -1    50    4    0    0    0    0    0    0    0 # PEAK
-10    5    -8    -8    -1    50    -5    0    0    0    0    0    0    0 # TOP (logistic)
0    9    3.3    3.3    -1    50    5    0    0    0    0    0    0    0 # Asc WIDTH exp
-9    9    2    2    -1    50    5    0    0    0    0    0    0    0 # Desc WIDTH exp
-9    9    -8    -8    -1    50    -5    0    0    0    0    0    0    0 # INIT (logistic)
-9    9    -8    -8    -1    50    5    0    0    0    0    0    0    0 # FINAL (logistic)
## Fleet group 2: Rec Ocean
24    45    36    36    -1    50    4    0    0    0    0    0    0    0 # PEAK
-10    5    -5    -5    -1    50    -9    0    0    0    0    0    0    0 # TOP (logistic)
0    9    4    4    -1    50    5    0    0    0    0    0    1    1 # Asc WIDTH exp
0    9    8    8    -1    50    -9    0    0    0    0    0    0    0 # Desc WIDTH exp
-9    9    -8    -8    -1    50    -9    0    0    0    0    0    0    0 # INIT (logistic)
-9    9    8    8    -1    50    -9    0    0    0    0    0    0    0 # FINAL (logistic)
## Fleet group 3: Rec Estuary
10    45    16    16    -1    50    4    0    0    0    0    0    0    0 # PEAK
-10    5    -5    -5    -1    50    5    0    0    0    0    0    0    0 # TOP (logistic)
0    9    5    5    -1    50    5    0    0    0    0    0    0    0 # Asc WIDTH exp
-9    9    4    4    -1    50   5    0    0    0    0    0    0    0 # Desc WIDTH exp
-9    9    -8    -8    -1    50    -5    0    0    0    0    0    0    0 # INIT (logistic)
-9    9    -2    -2    -1    50    5    0    0    0    0    0    0    0 # FINAL (logistic)

## Fleet group 4: Rec Shore-based
6    20    6    6    -1    50    -4    0    0    0    0    0    0    0 # PEAK
-10    9   -9    -9    -1    50    -5    0    0    0    0    0    0    0 # TOP (logistic)
0    9    5    5    -1    50    -5    0    0    0    0    0    0    0 # Asc WIDTH exp
-9    9    4    4    -1    50    5    0    0    0    0    0    0    0 # Desc WIDTH exp
-9    9    8    8    -1    50    -5    0    0    0    0    0    0    0 # INIT (logistic)
-9    9    0    0    -1    50    5    0    0    0    0    0    0    0 # FINAL (logistic)
## Fleet group 5: Special Projects
1   1    1    1    -1    50    -5    0    0    0    0    0    0    0 # PEAK
1    1    1    1    -1    50    -5    0    0    0    0    0    0    0 # TOP (logistic)
#
1 #_custom block setup (0/1)
#Ascending limb parameter for recreational ocean fishery due to regulation change (size limit set to 10
inches in 2004)
#LO   HI   INIT   PRIOR   PR_TYPE   SD   PHASE
-3   0   -1    -1    -1    99   5 #Asc WIDTH, 2004-2014 (additive: base param + block param)
#
1 #logistic bounding
# Tag loss and Tag reporting parameters go next
0 # TG_custom: 0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0 #_placeholder if no parameters
1 #_Variance_adjustments_to_input_values
#F1 F2 F3 F4 F5    F6   F7  F8
  0  0  0  0  0    0    0  0   #_add_to_survey_CV
  0  0  0  0  0    0    0  0   #_add_to_discard_stddev
  0  0  0  0  0    0    0  0  #_add_to_bodywt_CV
```

```
 1.012   0.0795   0.2162   0.2382  1 1       1   1 #_mult_by_lencomp_N
 1  1  1  1  1     1    1  1   #_mult_by_agecomp_N
 1  1  1  1  1     1    1  1   #_mult_by_size-at-age_N
#
4 #_maxlambdaphase
1 #_sd_offset
10 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes: 1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin
#like_comp   fleet/survey    phase    value    sizefreq_method
 1 6 1 1 1 # logbook
 1 7 1 1 1 # onboard CPFV
 1 8 1 1 1 # dockside ORBS
 4 1 1 1 1 #_lencomp: commercial
 4 2 1 1 1 #_lencomp: ocean boat
 4 3 1 1 1 #_lencomp: estuary boat
 4 4 1 1 1 #_lencomp: shore
 5 2 1 1 1 #_agecomp: ocean
 5 1 1 1 1 #_agecomp: commercial
 5 5 1 1 1 #_agecomp: special projects

#
0 # (0/1) read specs for more stddev reporting
999
```

Appendix C. SS starter file

```
#C starter file for 2015 Kelp Greenling base case work up
#C rerun model to get more complete formatting in starter.ss_new
#C should work with SS version: SSv3.10b_or_later
#C file write time: 2013-03-29 11:52:20
#
BC_dat.ss #_datfile
BC_ctl.ss #_ctlfile
0 #_init_values_src
1 #_run_display_detail
1 #_detailed_age_structure
0 #_checkup	#changed this from 0
0 #_parmtrace
1 #_cumreport
1 #_prior_like
1 #_soft_bounds
2 #_N_bootstraps
10 #_last_estimation_phase
0 #_MCMCburn
1 #_MCMCthin
0 #_jitter_fraction
-1 #_minyr_sdreport
-2 #_maxyr_sdreport
0 #_N_STD_yrs
0.0001 #_converge_criterion
0 #_retro_yr
0 #_min_age_summary_bio
1 #_depl_basis
1 #_depl_denom_frac
1 #_SPR_basis
1 #_F_report_units
1 #_F_report_basis
#
999
```

Appendix D. SS forecast file

```
#C  generic forecast file
#V3.24U
# 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
1 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.45 # SPR target (e.g. 0.40)
0.4 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values
of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
#  2010 2010 2010 2010 2010 2010 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual
F scalar
10 # N forecast years
1 # F scalar (only used for Do_Forecast==5)
#_Fcast_years:  beg_selex, end_selex, beg_relF, end_relF  (enter actual year, or values of 0 or -integer to be
rel. endyr)
 0 0 0 0
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
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)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2025  #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
-1 # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
-1 # Rebuilder:  year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F:  1=use first-last alloc year; 2=read seas(row) x fleet(col) below
# Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation  (2=deadbio; 3=retainbio;
5=deadnum; 6=retainnum)
# Conditional input if relative F choice = 2
# Fleet relative F:  rows are seasons, columns are fleets
#_Fleet:  FISHERY
#  1
# max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1   -1   -1   -1 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
 -1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0   0   0    0 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
```

0 # Number of forecast catch levels to input (else calc catch from forecast F)
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)

999 # verify end of input

Appendix E. Reef Delineation and Drift Selection Methodologies

Reef Delineation

We identified reefs as potential habitat for Kelp Greenling in Oregon using a lithology shapefile (AT&SML Oregon State University, 2014) that was based upon multiple seafloor mapping surveys including multi-beam and side-scan sonar, sediment grab and core samples, and images. Seafloor types were classified according to established classification schemes (Greene et al, 1999). We considered the following lithology types as 'reef habitat:' Boulder, cobble, cobble mix, hard, rock, and rock mix. All spatial data was projected to NAD 1983 UTM Zone 10 (Figure AE1).

Reef systems were grouped and stratified by depth at a spatial scale biologically meaningful to the more home-range limited species of rockfish. We considered two patches of rocky reef habitat great than ~200 m apart different reefs. If a reef system has contiguous habitat (no channels > 200m) it remained intact, no matter how large the reef. Reef area (m^2) was calculated using the zonal stats tool in ArcGIS, stratified by the depth bins 0-19m, 20-39 m, 40-59m, 60-79m, 80-99m and >100 m using the CSMP depth raster (2 m, 3m or 5m resolution). To get depths for those reefs outside the CSMP 'footprint' we used the NOAA Coastal Relief Model raster dataset (90m) for California, and 100m digital elevation model (DEM) bathymetry from the Active Tectonics and Seafloor Mapping Lab for Oregon.

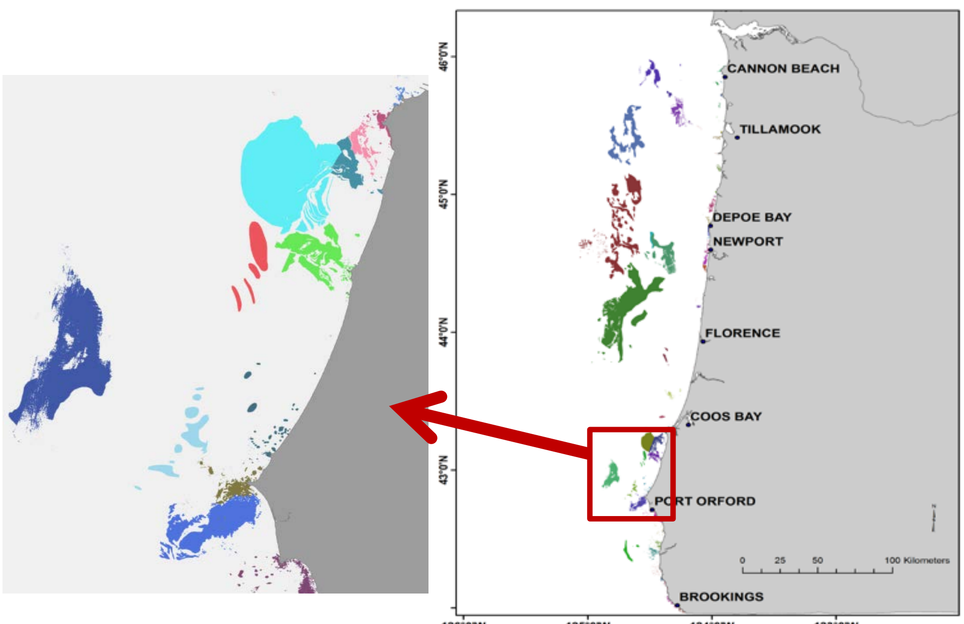


Figure AE1. Map of the reefs off the Oregon coast, showing an enhanced portion of the coast on the left. Individual reefs are color-coded.

CPFV drift selection

For each CPFV point we calculated depth, nearest reef, distance from reef, nearest MPA, distance from MPA using ArcGIS. Geoprocessing steps used were 'near' and 'extract values to points.' For consistency across databases, we used the starting location of the drift to determine if the drift was targeting fish associated with a reef. Drifts that had a distance of 0m, i.e., were fishing directly on the reef, were included in analyses. Recognizing that some drifts begin adjacent to a reef with the intention of drifting on to the reef, as well as the fact that the starting location may not be recorded at the very start of a drift, we devised a method for including drifts within a certain distance of a reef.

We compiled a list of rockfish species that are strictly reef associated (Black and Yellow Rockfish (*Sebastes chrysomelas*), Canary Rockfish (*Sebastes pinniger*), China Rockfish (*Sebastes nebulosus*), Cowcod *Sebastes levis*), Flag Rockfish (*Sebastes rubrivinctus*), Gopher Rockfish (*Sebastes carnatus*), Grass Rockfish (*Sebastes rastrelliger*), Greenblotched Rockfish *(Sebastes rosenblatti*), Kelp Rockfish (*Sebastes atrovirens*), Quillback Rockfish (*Sebastes maliger*), Rosy Rockfish (*Sebastes rosaceus*), Starry Rockfish (*Sebastes constellatus*), Treefish (*Sebastes serriceps*), Vermilion Rockfish (*Sebastes miniatus*), Yelloweye Rockfish (*Sebastes ruberrimus*)) (personal communication John Field and Tom Laidig, NMFS SWFSC). Using drifts that were greater than 0m from a reef and encountered one at least one of the fifteen species listed above, we calculated the depth for which 75% of the drifts were included. For Oregon this was 83m (Figure AE2). Any drift (with or without catch) greater than 83m from a reef was excluded from the analyses.

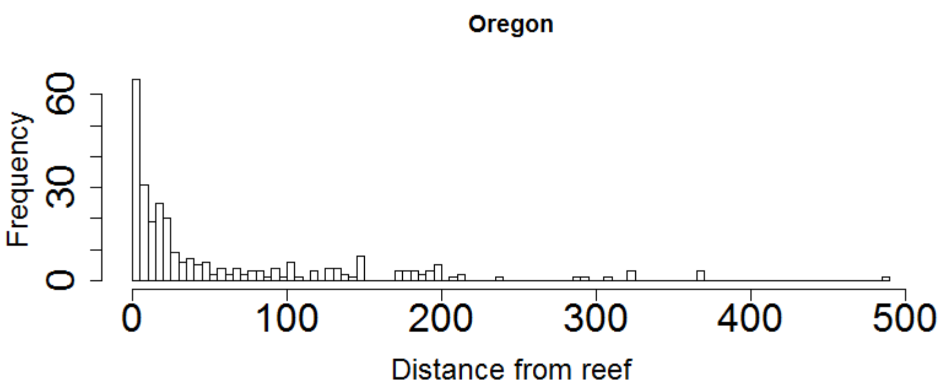


Figure AE2. Frequency distribution of the drifts with a distance greater than 0m from a reef that also encountered at least one of the fifteen rocky reef associated species described in the text.

Appendix F. History of Oregon Regulations

General Commercial Regulations and Definitions
Harvest cap: Total amount in regulation allowed to be impacted in a fishery (for a given season) including both discard mortality and landed catch mortality. Prior to 2007 this term was synonymous with "landing cap."

Landing cap: Total amount in regulation allowed to be landed in a fishery (for a given season). This includes only landed catch mortality (known as a harvest cap before 2007).

Bimonthly cumulative trip limit: The maximum amount of fish that may be and retained, possessed or landed per vessel in specified bi-monthly periods. There is no limit on the number of landings or trips in each period, and periods apply to calendar months. The specified periods are as follows:

Period 1: January - February
Period 2: March - April
Period 3: May - June
Period 4: July - August
Period 5: September - October
Period 6: November - December

Trip limits were first implemented July 16th, 2003

Incidental Catch Limits in Other Fisheries (established in 2004)
Non-permitted vessels: 15 lbs per day of black rockfish, blue rockfish, and nearshore fish, combined, for no more than one landing per day. These species must make-up 25% or less of landed poundage, and must be taken with gear legal in the permitted fishery.

Groundfish trawl fishery: Vessels may land no more than 1,000 lbs. of dead black rockfish, blue rockfish, and nearshore fish combined per calendar year if these species make-up 25% or less of landing.

Non-profit aquaria or vessels contracted by non-profit aquaria may land black rockfish, blue rockfish, and nearshore fish for purposes of display or for conducting research on these species.

Logbooks Requirement: All vessels landing Kelp Greenling need to maintain a logbook (as of 2004)

Minimum size limit measured from the tip of the snout to the extreme end of the tail=12 inches, established in 2000.

Legal Gear Types (from 2004 onward): Hook & line (including pole & line, troll, longline, and stick gear) and pot gear (max 35 pots) if a Developmental Fisheries permit for Nearshore species using pot gear was issued in 2003

Chronology of Oregon Recreational and Commercial Fisheries Regulations
2015
<u>Recreational</u>

- Bag limit = 7 rockfish, greenlings, Cabezon, skates, and other marine fish species not listed in the 2015 Oregon Recreational Fishing Regulations in the Marine Zone daily bag limit in aggregate, of which no more than three may be blue Rockfish and no more than

one maybe a Cabezon (when Cabezon is open), and no more than one may be a canary rockfish.
- 30-fathom curve: Seaward closed April 1-Sept. 30 for groundfish group.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 3 and thru 7/4 in period 4 = 300 lbs.
  Periods 4 – 6 from 7/5 onward = 400 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2014

Recreational
- same bag limit as 2010
- 30-fathom curve: Seaward closed April 1-Sept. 30 for groundfish group.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 4 and thru 10/12 in period 5 = 300 lbs.
  Periods 5 – 6 from 10/13 onward = 350 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2013

Recreational
- same bag limit as 2010
- 30-fathom curve: Seaward closed April 1-Sept. 30 for groundfish group.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 6 = 300 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2012

Recreational
- same bag limit as 2010
- 30-fathom curve: Seaward closed April 1-Sept. 30 for groundfish group.
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish and Pacific Cod are prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial

- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 4 = 250 lbs.
  Periods 5 – 6 = 400 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure :42º – 43º N = 20-100fm year-round; 43º-45º 03' 83N = 0 - 125 fm (125 line reduced to 100 fm during directed halibut days); 45º 03' 83N – 46º 16'N = 30-100fm year-round

2011
Recreational
- same bag limit as 2010
- 40-fm curve: Seaward closed April 1-Sept. 30
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish and Pacific Cod are prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 6 = 250 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure :42º – 43º N = 20-100fm year-round; 43º-45º 03' 83N = 0 - 125 fm (125 line reduced to 100 fm during directed halibut days); 45º 03' 83N – 46º 16'N = 30-100fm year-round

2010
Recreational
- Bag limit = 7 Rockfish, Cabezon (16" min.), greenling (10" min.), and other marine species not listed under Marine Zone in the Oregon Recreational Fishing Regulations daily in aggregate
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish and Pacific Cod are prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 3 and thru 8/1 in period 4 = 250 lbs.
  Periods 4 – 5 from 8/1 thru 10/4 = 300 lbs.
  Periods 5 – 6 from 10/4 thru 12/31 = 350 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round
- Rockfish Conservation Area closure :42º – 43º N = 20-100fm year-round; 43º-45º 03' 83N = 0 - 125 fm (125 line reduced to 100 fm during directed halibut days); 45º 03' 83N – 46º 16'N = 30-100fm year-round

2009
Recreational

- Same bag limit as 2006 through 4/30; increases to 7 fish bag limit on 5/1.
- 40-fm curve: Seaward closed April 1-Sept. 30
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish and Pacific Cod are prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 2 = 450 lbs.
  Periods 3 = 250 lbs.
  Periods 4 – 6 = 150 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure :42º – 43º N = 20-100fm year-round; 43º-45º 03' 83N = 0 - 125 fm (125 line reduced to 100 fm during directed halibut days); 45º 03' 83N – 46º 16'N = 30-100fm year-round

2008
Recreational
- same bag limit as 2006
- 40-fm curve: Seaward closed April 1-Sept. 30
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish is prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 6 = 700 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2007
Recreational
- same bag limit as 2006
- 40-fm curve: Seaward closed April 1-Sept. 30
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish is prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial
- Greenling landing cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 4 = 400 lbs.
  Periods 5 – 6 through 11/27 = 800 lbs.
  Periods 6 through 12/31 = closed (0 lbs.)
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2006

Recreational

- Bag limit = 6 Rockfish, Cabezon (16" min.), greenling (10" min.), flounder, sole and other marine species not listed bag limit
- 40-fm curve: Seaward closed June 1-Sept. 30
- North of Humbug Mt.: Retention of any groundfish species other than Sablefish is prohibited on all-depth P. Halibut days when P. Halibut is aboard vessel.
- Minimum size limit = 10 inches for Greenling

Commercial

- Greenling harvest cap: 23.4 mt
- 1-month Commercial cumulative trip limits
- Monthly cumulative trip limit: 1/1 through 8/10 = 100 lbs. per month
  8/11 through 9/30 = 400 lbs. per month
  10/1 through 12/31 = 600 lbs. per month
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2005

Recreational

- Bag limit = 8 Rockfish, Cabezon (16" min.), greenling (10" min.), flounder, sole and other marine species not listed
- 40-fm curve: Seaward closed June 1-Sept. 30.
- Minimum size limit = 10 inches for Greenling

Commercial

- Greenling harvest cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 2 = 350 lbs.
  Periods 3 – 4 through 8/3 = 225 lbs.
  Periods 4 – 6 through 12/1 = 175 lbs.
  12/1 – 12/31 = 275 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2004

Recreational

- Bag limit = 10 Rockfish, Cabezon (16" min.), greenling (10" min.), flounder, sole and other marine species not listed, no more than 1 P. Halibut
- 40-fm curve: Seaward closed June 1-Sept. 30.
- Minimum size limit first implemented = 10 inches for Greenling

Commercial

- Greenling harvest cap: 23.4 mt
- Bimonthly cumulative trip limit: Periods 1 – 4 through 7/26 = 350 lbs.
  Periods 4 – 5 through 9/27 = 600 lbs.
  9/27 through 12/31 = closed (0 lbs.)

- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 30-100fm year-round

2003

Recreational

- Bag limit = 10 Rockfish, Cabezon (15" min.), greenling (10" min.), flounder, sole and other marine species not listed, no more than 1 Canary RF, 1 Yelloweye RF and 1 P. Halibut

Commercial

- Greenling harvest cap: 19.5mt
- Bimonthly cumulative trip limit: All Periods = 350 lbs.
- Minimum size limit = 12 inches for Greenling
- Rockfish Conservation Area closure 27-100fm Jan. – Oct. and shore to 150fm Nov. and Dec.

1994 - 2002

Recreational

- Greenling part of Other fish bag limit
- Bag limit = 25 Other fish

Commercial

- 2002: In October, the Pacific Fishery Management Council adopted conservative harvest limits for 2003 equal to landings from 2000
- 2002: Oregon Fish and Wildlife Commission directs the Marine Resources Program to evaluate a harvest reduction equal to or greater than 20% of 2000
- Interim commercial harvest management plan implemented places a cap on fishery participants and reduced the nearshore fleet by 50%
- 2000 – 2002: Minimum size limit = 12 inches for Greenling
- Prior to 2000 no commercial regulations for Kelp Greenling

1978 - 1993

Recreational

- Bag limit = 15 Rockfish, Cabezon and greenling

Commercial

- 1988: First year Greenling complex recorded on commercial fish receiving tickets.

1976 - 1977

Recreational

- Greenling part of Other fish bag limit
- Bag limit = 25 Other fish

No regulations or bag limits relevant to Kelp Greenling prior to 1976.

Appendix G. Oregon Nearshore Commercial Fishery Public Input (2011-2014)

The Oregon Department of Fish and Wildlife Marine Resources Program (MRP) held a series of annual meetings with stakeholders to gather public input on the implementation of management measures for the Commercial Nearshore Fishery. Public input relevant to Kelp Greenling from 2011 – 2014 is summarized below.

<u>2014:</u> The discussion on greenling centered on the PFMC's reorganization of the roundfish stock complex, the 2015 scheduled full stock assessment, and trip limit increases for the remainder of 2014. The implications of this reorganization for Kelp Greenling harvest (status quo) appeared to be understood by fishermen. Many fishermen seemed happy with the 300 lbs. per trip limit for greenling, however, indicated that ODFW should consider bumping up the trip limit to 350 lbs. for the remainder of 2014 given the fishery is tracking low. Fishermen in Brookings indicated the Kelp Greenling bite slowed down with the big winds and strong upwelling in the summer. Most fishermen wanted the 2015 greenling trip limit to start low (300 lbs.) and raised in-season if the fishery is tracking low, while a minority of fishermen wanted the trip limit higher early in the season and then lowered in-season if the fishery is tracking too high. Fishermen in Pacific City had little input on the Greenling cumulative trip limit as few nearshore-endorsed permits are possessed by North Coast fishermen.

<u>2013:</u> Much of the discussion on greenling centered on the PFMC's reorganization of the roundfish stock complex. The implications of this reorganization for the greenling appeared to be generally understood by fishermen; however, they questioned how appropriate the chosen indicator species from Alternative 1 & 2 were for the whole complex. Fishermen seemed happy with this year's increase to 300 lbs. per trip limit for greenling, however, indicated there are a lot of greenling out there, and a fishermen can hit his limit in his first three days of fishing. Fishermen continued to express the need for a solid stock assessment for Kelp Greenling, stating this species should be a priority for assessment, and asked whether the state is capable of conducting its own assessment. ODFW explained how commercial nearshore logbook data has been submitted to a stock assessor, and how it may be used in a data moderate stock assessment outside the Council process. Gold Beach fishermen requested that if cuts are made to greenling trip limits in subsequent periods, that they not be drastic because large cuts hit hard on those who only have one permit. Fishermen in Pacific City had little input on the greenling cumulative trip limit as few nearshore-endorsed permits are possessed by north coast fishermen.

<u>2012:</u> Fishermen in Pacific City had little input on the greenling cumulative trip limit as few nearshore-endorsed permits are possessed by north coast fishermen. In Brookings and Port Orford the consensus among fishermen was the trip limit for greenling was too low. South coast fishermen requested an increase of 50 lbs., for a total of 300 lbs. of Kelp Greenling per period. Fishermen continued to express the need for a solid stock assessment for Kelp Greenling and stated that this species should be a priority for assessment.

<u>2011:</u> The other main cause for comments was regarding the Kelp Greenling landing cap and cumulative trip limits. Most fishermen suggested that the current cap and trip limits are much too conservative and reiterated the need for an improved assessment of Kelp Greenling in Oregon waters, considering its importance to the fleet. Additionally, some fishermen also felt that the prohibited Yelloweye and Canary Rockfish species are actively rebuilding, though some also noted the patchiness associated with encountering these species.

Appendix H. Oregon Department of Fish and Wildlife Visual Surveys

For two decades, ODFW has intermittently conducted visual benthic surveys across rocky reef complexes in waters off Oregon (Fox et al. 1996; Miller et al. 1997; Fox et al. 2004; Hannah and Blume 2014, ODFW 2000 – 2014 unpublished data). These surveys have documented Kelp Greenling densities in unfished and fished areas, before and after the rise of the commercial fishery. With an estimated 240 km^2 of subtidal rocky habitat in the Territorial Sea (excluding estuaries), another 465 km^2 between the Territorial Sea and the 100 m contour, and 100s of km^2 deeper (Goldfinger et al. 2014), these surveys have covered approximately one-third of Territorial Sea rocky habitat and a fraction of rock in deeper waters. All of these surveys are limited temporally. Nonetheless, these data may warrant consideration when evaluating the scale of the model.

From 1995 through 1997, Kelp Greenling density estimates from southern Oregon rocky reefs stretching from Blanco to Rogue Reefs were documented by Fox et al. 1996 and Miller et al. 1997. ODFW conducted surveys using SCUBA transects across rock, cobble and sand dominated habitats and counted fish by species. Surveys followed stratified random design using relative vertical relief of seafloor habitat as the strata. Kelp Greenling densities in these transects ranged from 0.3 (SE = 0.3) fish per 100 m^2 to 2.8 (SE = 0.8) fish per 100 m^2.

Beginning in 2000, ODFW conducted ROV transect surveys at reefs (or reef complexes) from Cannon Beach to Port Orford covering a range of habitat types. These surveys have included 8 rocky reef complexes which account for 64 km^2 of the total 240 km^2 of nearshore rocky reefs within the territorial sea. Surveys generally used stratified random designs with depth or relative seafloor relief forming the strata. The survey method was a video belt transect with belt width calculated using parallel lasers projected on the seafloor, and transect length based on navigation data from the ROV's TrackpointII acoustic positioning system (see Fox, et al. 2004 for methods summary). Methods for further refining sampling distance and correcting for field of view obstructions are currently being explored. Regardless, these ROV surveys suggest Kelp Greenling densities ranging from 0.6 (SD = 0.4) to 1.7(SD = 1.3) fish per 100 m^2 (Fox et al. 2004; ODFW unpublished data).

In 2013, a stereo-video lander survey conducted at Stonewall Bank sampled 160 sites and compared counts of fish species with and without bait as a fish attractant (Hannah and Blume 2014). Fourteen Kelp Greenling were encountered at the 80 baited stations while 16 were encountered at the 80 un-baited ones, resulting in a finding of no bait effect for this species (Hannah and Blume 2014). Research is nearly complete at ODFW this year on measurements of the effective range of the same stereo video lander as a function of variation in seafloor ambient light (µmol photons m^{-2} s^{-1}) and water clarity (attenuation of 650nm light $m^{-1}sr^{-1}$). For Stonewall Bank, this research has yielded estimates of the effective mean range of detection for the lander system (averaged across species) of 4.3 m (range 3.3-5.6 m, ODFW unpublished data). A model relating maximum effective range to the area viewed indicates that a range of detection of 4.3 m equals an area viewed of 12.7 m^2. With 30 Kelp Greenling detected at 160 stations, this yields an average density estimate for Kelp Greenling of:

$$30 / (160 \text{ X } 12.7 \text{ m}^2) = 0.01476 \text{ per m}^2 = 1.476 \text{ fish per } 100 \text{ m}^2$$

Although the prior study showed no bait effect, it is unknown whether Kelp Greenling is attracted to, or avoids the video lander. No behavior consistent with either attraction or avoidance has been observed.