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Status of the widow rockfish resource in 2009

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Table of Contents

Executive summary

Stock

This assessment applies to widow rockfish (*Sebastes entomelas*) located in the territorial waters of the U.S., including the Vancouver, Columbia, Eureka, Monterey, and Conception areas designated by the International North Pacific Fishery Commission (INPFC). The stock is assumed to be a single mixed stock and subject to four major fisheries.

Catches

The earliest records of landings of widow rockfish were in 1916. Major U.S. commercial catches of widow rockfish began in the late 1970s, peaking in 1981 (Figure ES1). Since the 1981 peak there has been a steady decline in the landings of widow rockfish to 52 mt in 2003 and to 254 mt in 2006 (Table ES1). Catches were mostly from commercial fisheries. Catches from recreational fisheries ranged from less than 2 mt in 2003 to 375 mt in 1982. The dominant gear type historically has been the midwater trawl. During the early 1990s, bottom trawl catches nearly matched the midwater trawl catches.

Table ES1. Recent catches (mt) of widow rockfish by four fisheries from 1999 to 2008.

Year	Vancouver, Columbia	Oregon Midwater Trawl	Oregon Bottom Trawl	Eureka, Monterey, and Conception	Total
1999	777	2016	923	1053	4768
2000	639	2665	18	1341	4664
2001	424	1220	45	590	2279
2002	65	310	7	50	432
2003	14	22	2	5	43
2004	32	34	10	26	101
2005	43	139	6	12	199
2006	45	155	3	13	215
2007	37	192	10	19	259
2008	97	106	2	38	243

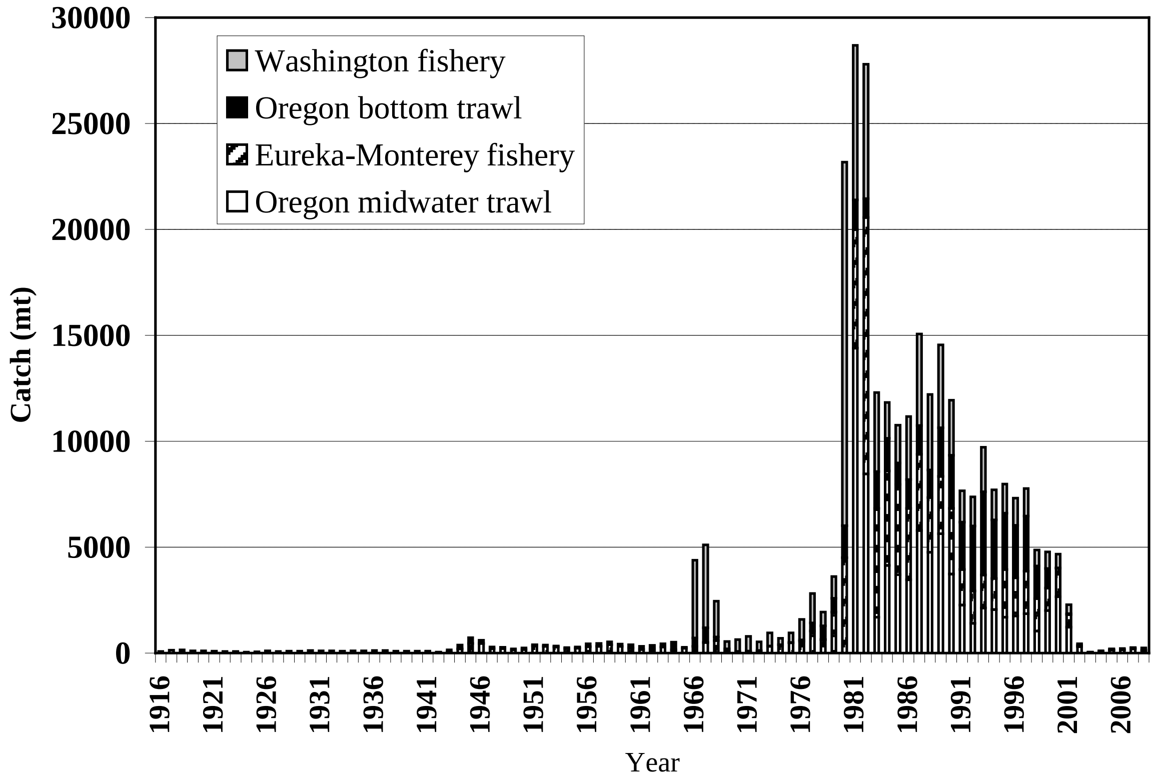

Figure ES1. Total catches of widow rockfish from 1916 to 2008.

Data and assessment

The last full assessment of widow rockfish was conducted in 2005 and was updated in 2007 using an age-based population model (written in AD Model Builder (ADMB), He et al. 2007a). The Stock Synthesis program (SS3) was used in this assessment. All fishery data, including landings, age composition, and logbook catch rates, were recently downloaded from the PacFIN, CALCOM, and NORPAC databases, or provided by state and federal agencies. Survey data, including the triennial survey and the Northwest Fisheries Science Center (NWFSC) combo survey, were also used in the assessment. Bycatch data from at-sea processing vessels were also included in the assessment.

Stock spawning output

Stock spawning output has shown a steady decline between 1980 and 2003, soon after major commercial fisheries for widow rockfish began. Since 2003, stock spawning output has shown an increasing trend. Table ES2 and Figure ES2 show time series of estimated spawning outputs, depletion, and their 95% confidence intervals from the base assessment model.

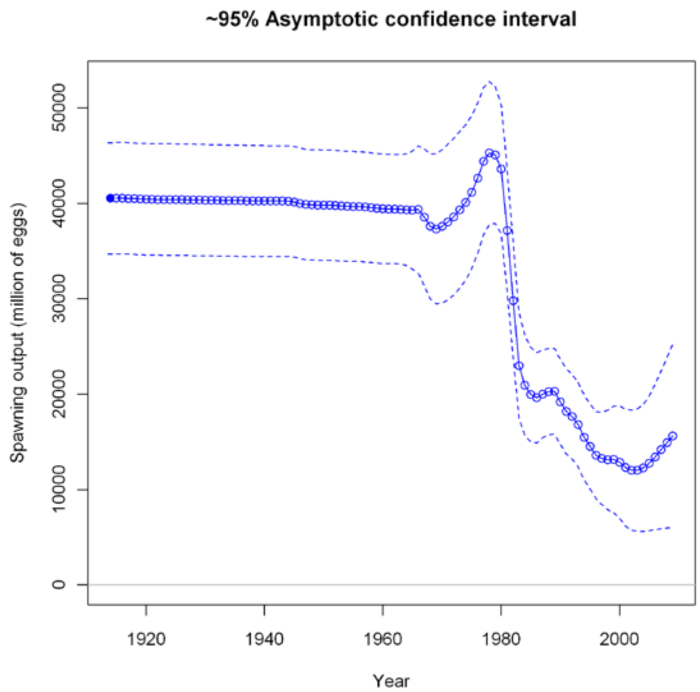

Figure ES2. Estimated spawning outputs of widow rockfish from 1916 to 2009 with 95% confidence intervals.

Table ES2. Estimated spawning outputs (million of eggs) and depletion levels of widow rockfish from 2000 to 2009. The 95% confidence intervals are also shown.

Year	Spawning output	Confidence interval (95%)	Depletion (%)	Confidence interval (95%)
2000	12852	6949-18755	31.7	17.8-45.6
2001	12294	6164-18425	30.3	15.7-44.9
2002	12000	5709-18290	29.6	14.5-44.7
2003	12024	5597-18452	29.7	14.1-45.2
2004	12259	5604-18914	30.2	14.0-46.5
2005	12735	5677-19794	31.4	14.0-48.8
2006	13403	2784-21021	33.1	14.1-52.0
2007	14171	5897-22445	34.9	14.3-55.6
2008	14908	5960-23856	36.8	14.2-59.3
2009	15625	5984-25266	38.5	14.2-62.9

Recruitment

The model estimated time series of recruitment of age-0 fish from 1958 to 2008. The highest recruitment occurred in 1970 (Figure ES3). Recruitments remained generally low in the early 1990s as well as since 2001 as compared to the long-term average (Figure ES3 and Table ES3). The 2007 assessment update indicated that the 2000 recruitment was strong, but this assessment does not confirm this is the case. As in the last assessments, uncertainties in estimation of recruitment remain high.

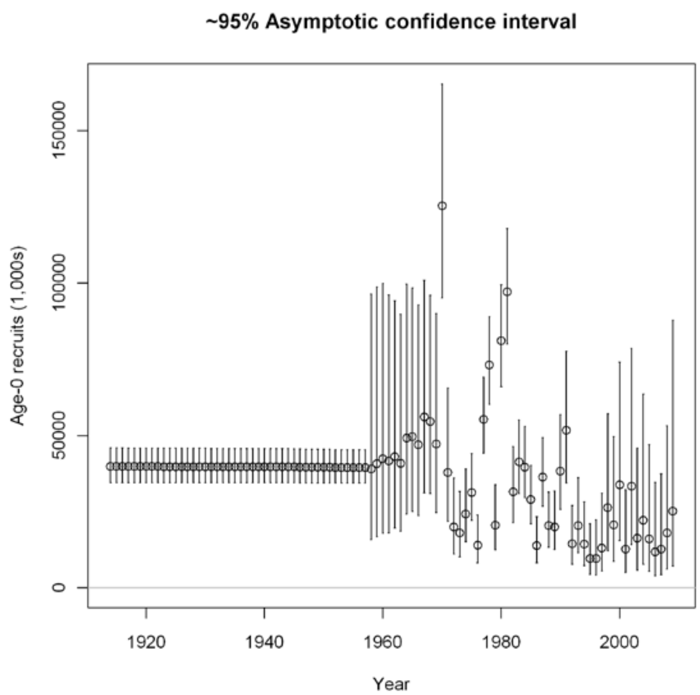

Figure ES3. Estimated recruitment of widow rockfish and 95% of asymptotic confidence intervals from 1916 to 2009.

Table ES3. Estimated recruitment with 95% confidence intervals from 2000 to 2009.

Year	Recruitment (*1000)	Confidence interval (95%)
2000	33828	15457-74031
2001	12686	5008-32140
2002	33395	14202-78523
2003	16309	5805-45818
2004	22192	7750-63549
2005	16046	5490-46901
2006	11746	3991-34575
2007	12698	4310-37408
2008	18038	6124-53125
2009	25135	7201-87732

Reference points

The spawning output in 2009 as a percentage of unfished spawning output is the population status (depletion). Depletion below 25% indicates an overfished stock, and depletion between 25% and 40% indicates a stock in the precautionary zone[1]. Depletion over 40% indicates a healthy stock. The estimated depletion in 2009 is 38.5% with 95% of confidence intervals of 14.2% and 62.9% (Table ES2 and Figure ES4). The management target for widow rockfish is 40% of unfished spawning output. The assessment estimates the unfished spawning output to be 40,547 million eggs, and 40% of the target to be 16,218 million eggs. A summary of reference points is listed in Table ES4.

[1] A stock that has declined to less than 25% of its unfished spawning output is considered "overfished" until it rebuilds to 40% of its unfished spawning output. Such a stock is managed under the rebuilding plan while it is in the precautionary zone and not under the normal control rules specified for a stock in the precautionary zone (i.e., the 40-10 rule).

Table ES4. Summary of reference points for widow rockfish from the base case model.

Reference term	Estimated value	Confidence interval (95%)
Unfished spawning output ($SB_{0,}$ millions of eggs)	40547	35108-46828
Unfished recruitment (*1000)	39790	34523-45860
Reference points based on $SB_{40\%}$		
MSY Proxy Spawning output ($SB_{40\%}$)	16218	14043-18731
SPR resulting in $B_{40\%}$ ($SPR_{SB40\%}$)	0.6193	0.4157-0.9227
Exploitation rate resulting in $SB_{40\%}$	0.0337	NA
Yield with $SPR_{SB40\%}$ at $SB_{40\%}$ (mt)	3518	1379-8972
Reference points based on SPR proxy for MSY		
Spawning output at SPR (SB_{SPR}) (millions of eggs)	8589	1335-55244
$SPR_{MSY\text{-}proxy}$	0.5	0.0479-0.0530
Exploitation rate corresponding to SPR	0.0504	NA
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)	3031	472-19469
Reference points based on estimated MSY values		
Spawning output at *MSY* (SB_{MSY}) (millions of eggs)	15272	9698-23635
SPR_{MSY}	0.6045	0.3463-1.055
Exploitation Rate corresponding to SPR_{MSY}	0.0256	NA
MSY (mt)	3526	1353-9189

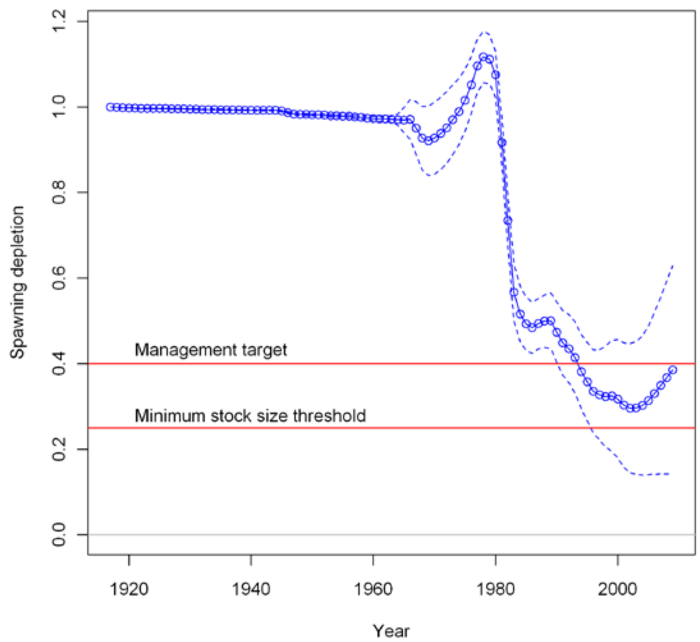

Figure ES4. Time series of depletion from 1916 to 2009 with 95% asymptotic intervals. Levels of management target and minimum stock size threshold are also shown.

Exploitation status

This assessment indicates that the widow rockfish population is at 38.5% of virgin spawning output in 2009 with an exploitation rate below 1% (Table ES5) and an equilibrium SPR of 95.7% (Figure ES5). However, the population is still below its target level of spawning output and is therefore still considered overfished (Figure ES6).

Table ES5. Time series of SPR (spawning potential ratio) and total exploitation rate of widow rockfish from 1999 to 2008.

Year	Spawning potential ratio (SPR)	Exploitation rate
1999	0.4881	0.0590
2000	0.4773	0.0602
2001	0.6536	0.0301
2002	0.9128	0.0057
2003	0.9905	0.0005
2004	0.9799	0.0012
2005	0.9648	0.0023
2006	0.9663	0.0024
2007	0.9627	0.0028
2008	0.9651	0.0026

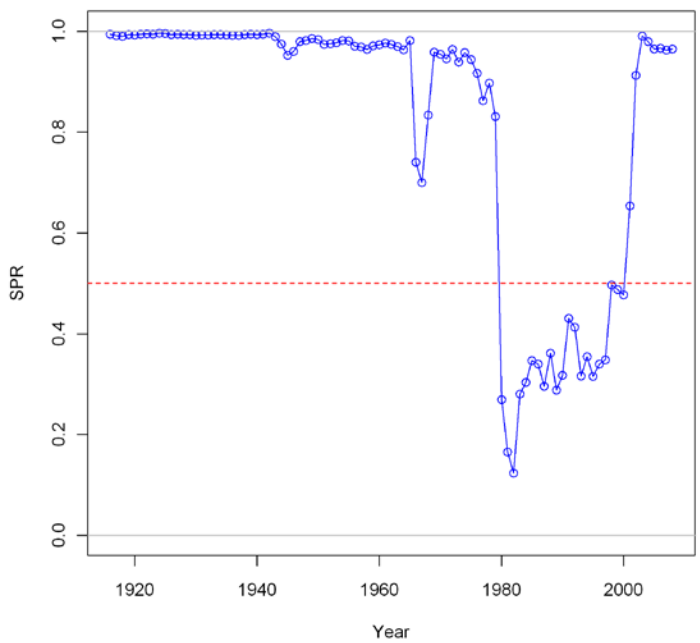

Figure ES5. Time series of estimated equilibrium spawning potential ratios (SPR) from 1916 to 2009. The target SPR level of 0.5 is also shown. Values below the target level indicate that overfishing occurred.

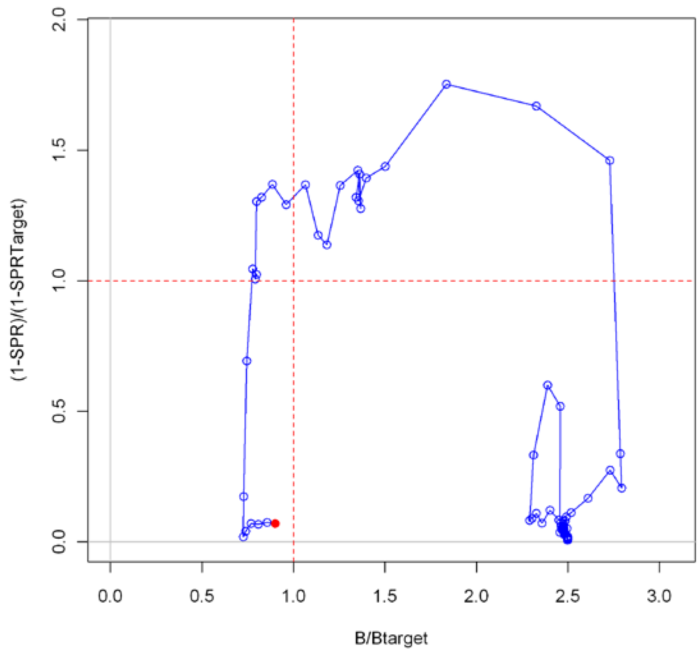

Figure ES6. Phase plot of estimated annual spawning potential ratios to the target of 0.5 and estimated spawning output relative to the target of SB40%. The last point on the lower-left quadrant corresponds to the estimated value in 2009.

Management performance

Widow rockfish was declared overfished in 2001. Optimal yield (OY), allowable biological catch (ABC), and catches of recent years are listed in Table ES6.

Table ES6. Management performance in obtaining the harvest guideline for widow rockfish. Harvest guideline and allowable biological catch (ABC) are taken from Council documents.

Year	Harvest Guideline or OY (mt)	Allowable Biological Catch (mt)	Catches (mt)
1999	5,090	5,750	4,136
2000	5,090	5,750	4,049
2001	2,300	3,727	1,989
2002	856	3,727	432
2003	832	3,871	43
2004	284	3,460	101
2005	285	3,218	199
2006	289	3,059	215
2007	368	5,334	258
2008	368	5,144	243
2009	522	7,728	
2010	509	6,937	

Unresolved problems and major uncertainties

1. The primary source of information on trends in abundance of widow rockfish is the Oregon bottom trawl logbook data, which is a questionable source of information for widow rockfish. In addition, no information after 1999 in the Oregon bottom trawl logbook data can be used in the assessment because the catch rates were very low due to trip limits and other management regulations. Based on a recommendation by the 2003 STAR panel, triennial survey indices have been used since 2005, but catches in the survey were low and the survey was discontinued in 2004. The NWFSC survey provided abundance indices in recent years, but the time series is short. Also, it is a bottom trawl survey, and does not adequately sample midwater habitat of widow rockfish.
2. Estimates of recruitment in recent years are highly uncertain and are key factors in determining how quickly the population will rebuild (He *et al*. 2003a, 2006b, 2007b). Age and length composition data from fisheries and surveys from the most recent years (2007 and 2008) suggest weak recruitment in 2002. This result contradicts the results in the 2007 assessment, which estimated the recruitment in 2002 to be a strong year class. More age and length data should be collected in 2009 and 2010 to resolve this issue.
3. As in the past assessments, there exist uncertainties in estimating the stock-recruitment relationship. These lead to greater uncertainties in the rebuilding analysis because it largely depends on how future recruitments are generated.
4. Stock structure issues, in particular the relationship to the Canadian stock, remain a source of uncertainty.

Forecasts
Widow rockfish was declared to be overfished in 2001. Forecasts will be provided as part of a forthcoming rebuilding analysis.

Decision table
As in the past assessments, there exist great uncertainties in estimating the stock-recruitment relationship. This is especially true for estimating recruitments in recent years, which are key factors in determining how quickly the population will rebuild. During the STAR Panel review, it was determined that a range of the steepness parameter (h) be used to bracket the recruitment uncertainties. Two alternative states of nature of h=0.25 and h=0.55 (versus h=0.406 in the base model) were chosen after a series of trial runs during the review. Future catch scenarios at F95% and F50% between 2011 and 2020 were used as alternative management decisions (Table ES7).

Table ES7. Decision table of 12-year projections for widow rockfish. Alternate states of nature and management options begin in 2011.

			State of nature					
			h = 0.25		Base case (h=0.4061)		*h* = 0.55	
Management decision	Year	Catch (mt)	Depletion(%)	Spawning output (mil eggs)	Depletion(%)	Spawning output (mil eggs)	Depletion(%)	Spawning output (mil eggs)
F95%	2009	522	25.2%	10949	38.5%	15625	48.6%	19238
	2010	509	25.4%	11029	39.9%	16178	50.9%	20118
	2011	359	25.4%	11006	40.9%	16580	52.6%	20812
	2012	342	25.1%	10887	41.4%	16801	53.7%	21259
	2013	324	24.6%	10672	41.5%	16838	54.2%	21453
	2014	317	24.0%	10421	41.4%	16797	54.4%	21530
	2015	327	23.6%	10239	41.6%	16863	54.9%	21720
	2016	346	23.4%	10175	42.2%	17120	55.9%	22118
	2017	366	23.5%	10205	43.2%	17533	57.3%	22682
	2018	383	23.7%	10286	44.5%	18032	59.0%	23329
	2019	399	23.9%	10387	45.8%	18570	60.7%	24012
	2020	411	24.2%	10494	47.2%	19123	62.5%	24705
F50%	2009	522	25.2%	10949	38.5%	15625	48.6%	19238
	2010	509	25.4%	11029	39.9%	16178	50.9%	20118
	2011	5210	25.4%	11006	40.9%	16580	52.6%	20812
	2012	4556	22.7%	9836	38.9%	15764	51.1%	20225
	2013	3963	20.0%	8680	36.7%	14865	49.3%	19484
	2014	3632	17.6%	7653	34.6%	14042	47.5%	18775
	2015	3598	15.8%	6841	33.2%	13462	46.3%	18311
	2016	3718	14.4%	6244	32.5%	13159	45.9%	18138
	2017	3854	13.3%	5778	32.2%	13046	45.9%	18164
	2018	3960	12.3%	5359	32.1%	13024	46.2%	18288
	2019	4016	11.4%	4932	32.1%	13027	46.6%	18450
	2020	4028	10.3%	4469	32.1%	13021	47.1%	18623

Research and data needs

1. There are increasingly fewer reliable abundance indices for widow rockfish. Recent management measures have undermined the ability to continue a fishery-dependent time series of relative abundance from the Oregon bottom trawl fishery and the Pacific whiting fishery since 1999. The constant flux of the management regime suggests that there is little likelihood that meaningful CPUE indices can be developed from these fisheries in the future. The NWFSC combo survey provides some useful information on abundance of widow rockfish, but catches from the survey have been generally very low in recent years. It is desirable that a trawl survey (including midwater trawls) that targets widow-like rockfish be initiated. A long-term hydroacoustic survey would also be very useful.
2. The long-term recruitment index is a key time series in the stock assessment. Continuation of the NMFS/PWCC midwater juvenile trawl survey should provide key information on the recruitment strength of widow rockfish.
3. Sample sizes for existing age-collection programs as well as length measurements (by fishery and survey) should be increased substantially.
4. Effort on ageing of widow rockfish should include collecting information on length-age keys and growth rates for both the northern and southern areas.
5. A single-area assessment model should be considered in the next assessment.
6. Conduct an interagency ageing comparison and comparative analysis of break and burn and surface ageing methods.
7. Develop methods to incorporate uncertainty in natural mortality and/or steepness in model configurations in which these parameters are fixed. The delta method for propagating uncertainty (MacCall in prep.) is a promising approach that warrants further evaluation.

1. Introduction

Widow rockfish (*Sebastes entomelas*) is an important commercial groundfish species belonging to the scorpionfish family (Scorpaenidae). It ranges from southeastern Alaska to northern Baja California, where it frequents rocky banks at depths of 25-370m (Eschemeyer *et al*. 1983, Wilkins 1986). In those habitats it feeds on small pelagic crustaceans and fishes, including especially *Sergestes similis*, myctophids, and euphausiids (Adams 1987). There is no evidence that separate genetic stocks of widow rockfish occur along the Pacific coast and the species has been treated as one stock with four separate fisheries (Hightower and Lenarz 1990; Rogers and Lenarz 1993; Ralston and Pearson 1997, Williams *et al*. 2002, Field and Ralston 2005).

A midwater trawl fishery for widow rockfish developed rapidly in the late 1970s and increased rapidly in 1980-82 (Gunderson 1984, Quirollo 1987, Figure 1). Large concentrations of widow rockfish had evidently gone undetected because aggregations of this species form at night and disperse at dawn, an atypical pattern for rockfish. Since the fishery first developed, substantial landings of widow rockfish have been made in all three west-coast states.

Management of the fishery began in 1982 when 75,000 lbs trip limits were introduced in an effort to curb the rapid expansion of the fishery (Appendix A). These were reduced to 30,000 lbs in 1983 and the fishery was managed by alteration of trip limits within the fishing season. A 10,500 mt/yr Allowable Biological Catch (ABC) for widow rockfish was instituted in 1983, but no harvest guideline was established. This form of management continued with alterations in ABC and trip limits until 1989 when a 12,100 mt/yr harvest guideline was implemented (Appendix A). From 1994 to 1997 the harvest guideline was changed to 6,500 mt and then reduced to 5,090 mt for 1998 to 2000. Based on the 2000 stock assessment, the population was declared overfished (Williams *et al*. 2000), and a series of management actions were taken by the Pacific Fisheries Management Council to protect the stock (Appendix A). As consequence, stock assessments for the population were conducted in 2002, 2004, and in 2006 along with rebuilding analyses of the stock (He *et al*. 2003a, 2003b, 2006, 2006b, 2007, and 2007a). Table 1 shows the management performance and harvest guidelines for widow rockfish from 1989 to 2010.

This assessment used an age-based population model similar to those used in previous assessments (Ralston and Pearson 1997, Williams *et al*. 2000, He *et al*. 2003b, He *et al*. 2006a, He et al. 2007a). Like the previous assessments, this assessment used a two-area model, delineated by 43^{o} N latitude (Figure 2). Unlike the previous assessments, which used ADMB software, this assessment used the Stock Synthesis program developed by Richard Methot (Version 3.03a, Methot 2009).

2. Assessment

2.1 Biological data

Growth in length for widow rockfish has been described using von Bertalanffy growth equations in two papers by Lenarz (1987) and Pearson and Hightower (1991). In their analyses it was determined that females attain a larger size than males and fish from the northern part of the range tend to be larger at age in comparison with those in the south. For these reasons we chose to use the sex-specific and area-specific estimates of length-at-age. Furthermore, we chose to use the estimates listed in Pearson and Hightower (1991). The growth parameters were then transformed in the format of Schnute parameters, expressed as *L1*, *L2*, and *K*, and shown below and in Figure 3, because they are from a more recent and comprehensive analysis of widow rockfish growth compared to the analysis by Lenarz (1987). In order to match the fisheries, we used the Columbia-Eureka INPFC area border (43^o N latitude) to delineate north from south.

Parameter	Females (north)	Males (north)	Females (south)	Males (south)
L1 (age=3)	22.7	28.5	22.3	23.2
L2 (age=18)	47.7	42.9	46.2	41.0
K	0.14	0.18	0.2	0.25

Sex-specific weight-at-age estimates were computed using the length-at-age estimates above in combination with sex-specific length-weight regressions for widow rockfish that were developed by Barss and Echeverria (1987). The length-weight regression equation is $W = \alpha L^{\beta}$, where *W* is the weight (g) and *L* is the length (cm). The sex-specific parameter values used in this assessment are listed below:

Parameter	Females	Males
α	0.00545	0.01188
β	3.28781	3.06631

Estimates of maturity and fecundity of female widow rockfish were obtained from Barss and Echeverria (1987) and Boehlert *et al*. (1982), respectively. Age-specific maturity estimates were taken directly from the literature instead of fitting a parametric model (Figure 4), while age-specific fecundity was computed using the weight-fecundity regression:

$$F = 605.71W - 261830.7$$

where *F* is fecundity (number of eggs) and *W* is weight (g). The weight-fecundity regression applied to the southern weight-at-age estimates resulted in negative values for ages 3 and 4. The weight-fecundity regression developed by Boehlert et al. (1982) was based on fish captured from Oregon and apparently does not apply to widow rockfish in the south. Recent work indicates that there is no significant relationship between body weight and weight specific fecundity in widow rockfish (Dick 2009). The maturity estimates indicate a substantial difference in maturity-at-age between the north and south, with the northern fish maturing at an older age. Lacking any other estimate of fecundity for the south, we applied the weight-fecundity regression from the north and modified the estimates for ages 3-5 to approximate an asymptote to 0.

2.2 Fishery-dependent data

2.2.1 Landings

All landings were summarized into four fisheries: (1) Vancouver-Columbia in Washington State (WAFishery1); (2) Oregon mid-water trawl (ORMWTraw); (3) Oregon bottom trawl (ORBTraw); and (4) Eureka, Monterey, and Conception (EMFishery) (Figure 1). Landings statistics used in this assessment were derived from six sources:

1. All commercial landings from 1981 were extracted from the PacFIN database. Landings from at-sea-processing (ASP) were not included in the assessment. They were replaced by the bycatch estimates (see #6 below).
2. The very small annual recreational take of widow rockfish from 1980 to 2008 was extracted from the Marine Recreational Fishing Statistics Survey (MRFSS) database. Because there were no estimates in the database between 1990 and 1992, catches for these three years were linearly interpolated.
3. All landings from 1966 to 1972, and some landings from 1973 to 1976 were directly taken from a summary table in Rogers (2003), who compiled summaries of foreign catches in the period.
4. Some landings from 1973 to 1976 and all landings from 1977 to 1979 were directly copied from the 2000 assessment (Williams *et al*. 2000).
5. Historical California catch data from 1916 to 1968 recently reconstructed by Ralston *et al*. (2009).
6. Historical Oregon bottom trawl catch data from 1938 to 1975 estimated from catch reports.
7. Bycatch estimates from 1991 to 2001 were provided by the NWFSC (Jim Hastie and Eliza Heery, personal communication).
8. Total catch (total mortality) between 2002 and 2007 were reconstructed from West Coast Groundfish Observer Program.

Summarized catches by year and fishery are presented in Table 2 and Figure 1. As in the past assessments of widow rockfish, the data were pooled over states into INPFC area blocks. These in turn were collapsed into northern and southern areas, representing the U.S. Vancouver and Columbia areas (WAFishery1, ORMWTraw, and ORBTraw) and the Eureka, Monterey, and Conception areas (EMFishery), respectively. The northern and southern areas are conveniently delineated by the 43^{o} N. latitude line. Within the southern area, widow rockfish landings were further condensed by summing over gears (i.e., trawl, other commercial, and recreational), providing annual estimates of landings from the southern area fishery. In the northern area, however, landings were partitioned into three separate fisheries: the Oregon midwater trawl fishery, the Oregon bottom trawl fishery, and the remaining catch of widow rockfish, referred to as the WAFishery1 (Vancouver-Columbia fishery). Because identification of gear types in Oregon (midwater or bottom trawl) did not begin until 1983, all landings in the northern area prior to that time were assigned to the Vancouver-Columbia "trawl" fishery. These fishery definitions are consistent with all previous widow rockfish stock assessments.

A revised approach for estimating historical catches of widow rockfish in Oregon and Washington fisheries was developed. Widow rockfish catches for the period from 1963 through 1975 are based on a dataset compiled by Jack Taggart (WDFW; unpublished manuscript 1975) from data reported in Barss and Niska (1978), DiDonato and Pattie (1968), Pattie (1973) and Tagart and Kimura (1982). We queried the total estimated catches of widow rockfish in this database for PMFC areas 2A through 3B (CA/OR border to the U.S./Canada border), and compared that to the total estimated catch of all rockfish in this region. We also compared the Tagart database estimates to those reported by Douglas (1998) for Oregon trawl fisheries, and found the results consistent with the Tagart estimated catches. These estimates suggest that widow made up a small fraction (35-370 mt per year, generally less than 5% of the total rockfish catch), although there seems to have been a large pulse of widow rockfish landings in 1967. For the period from 1938 through 1962, we compiled total rockfish catches from the "red book"

(Bureau of Commercial Fisheries) reports for 1938 through 1955, and from the Historical Annotated Database (Lynde 1984) for the period from 1956 through 1962. We then applied a ratio estimator based on the average fraction of total rockfish catch estimated to be widow rockfish from the Tagart database between 1963 and 1965 (2.4%) to these total landings. The resulting estimate was then used as the Oregon bottom trawl historical catches. As total rockfish catches were very modest prior to World War II (when balloon trawl fisheries developed), and most catches tended to be from fixed gear, we assume zero catches in Oregon and Washington prior to 1938. This method is intended to be a placeholder, until estimated historical catches by species are available from ongoing catch reconstruction efforts.

Recently estimated bycatch from at-sea processing (ASP) on widow rockfish from 1991 to 2001 were provided by the Northwest Fisheries Science Center and are included in the total landing estimates (Table 3) (Jim Hastie and Eliza Heery, NMFS Northwest Fisheries Science Center, personal communications). These landings were grouped into either the Vancouver-Columbia fishery or the Oregon mid-water trawl fishery, proportioned by number of hauls observed north or south of 43^{o}N latitude. Widow rockfish total catches between 2002 and 2007 were reconstructed from West Coast Groundfish Observer Program total mortality estimates and at-sea whiting fishery bycatch estimates, provided by the Northwest Fisheries Science Center. All Washington catches from the Groundfish Observer Program were assigned to the Washington fishery. Oregon midwater trawl catches were assigned to the Oregon midwater trawl fishery, and Oregon non-midwater trawl catches were assigned to the Oregon bottom trawl fishery. All California catches were assigned to the California fishery. Widow bycatch in the at-sea whiting fishery was added to the Oregon midwater trawl fishery. For 2008, landings data from PacFIN and the widow bycatch estimate in the at-sea whiting fishery were used, and no additional discard was added. The only 2008 discard information for widow rockfish available at the time of STAR Panel was the discard estimate from the PacFIN quota-species monitoring report, and this value was minimal.

2.2.2 Age composition data

Widow rockfish otolith samples collected coastwide since 1989 have been aged at the NMFS SWFSC Fisheries Ecology Division in Santa Cruz (formerly the Tiburon Laboratory) using the break-and-burn aging method (Pearson and Hightower 1991). Most fish were aged by Fisheries Ecology Division staff (Don Pearson) using the break-and-burn ageing technique. Prior to 1989, the ages of all Vancouver-Columbia fish were obtained by researchers in the State of Washington, who used surface readings. Prior to 1982, Oregon widow rockfish were aged by investigators in Oregon, who used the break-and-burn ageing method.

Age validation of widow rockfish was conducted by marginal increment analysis (Lenarz 1987). Hyaline-zone formation, the measure of annual growth, appears to occur between December and April (Pearson 1996). For convenience all widow rockfish are assumed to be born on January 1. Variation in the timing of hyaline-zone formation occurs between fish from Washington and California, which could affect age determination. Knowledge of this timing variation can be used to avoid mis-ageing and ultimately, variation in hyaline-zone formation is unlikely to result in major age discrepancies (Pearson 1996).

Washington provided ageing data from samples collected during commercial market sampling. The data were then expanded using relative catches from US Vancouver and Columbia areas. Oregon provided raw sample data which were expanded using methods described in Sampson and Crone (1997). California age data were extracted and expanded from the CALCOM database (Pearson and Erwin 1997). Summaries of age samples for four fisheries from 1978 to 2008 were presented in Table 4. Complete age compositions (proportion-at-age) of both sexes for the four fisheries from 1978 to 2008 are presented in Figures 5 to 8.

2.2.3 Oregon bottom trawl logbook

Oregon logbook data from 1984 to 1986 were provided by the Oregon Department of Fish and Wildlife, and data from 1987 to 2002 were extracted from the PacFIN database. Catch per unit effort (CPUE) was computed as pounds of fish caught per hour trawled. The data were filtered before the analysis. Only records meeting the following criteria were used in the analysis: (1) the fishing gear code corresponded to bottom trawl or roller gear, (2) hauls were conducted during the months of January, February, or March, and (3) the location of the reported haul fell in the range of 42°30' N to 46°30' N latitude and 124°36' W to 124°54' W longitude. In addition, records associated with any vessel code or spatial unit that had less than 1000 pounds of widow catch over the entire period (1984 to 2002) were also deleted. Data from 2000 to 2002 were not used in the analysis because widow catches in those three years were very low due to trip limits and other management regulations that had been implemented.

Annual CPUE indices were derived using the Delta-GLM (Generalized Linear Model) method with an additional factor (vessel) included:

$$\log(CPUE) = \mu + Y_i + V_j + L_k + \varepsilon_{ijkl}$$

where μ is the average $\log(CPUE)$, Y_i is a year effect, V_j is a vessel effect, L_k is a spatial (latitude and longitude) effect, and ε_{ijkl} is a normal error term with mean zero and variance σ_ε^2. The back-transformed year-specific CPUE, with bias-correction, was then calculated as:

$$CPUE_i = \exp\left(\mu + Y_i + \overline{V} + \overline{L} + \frac{\sigma_\varepsilon^2}{2}\right)\pi_i$$

where $\overline{V}$ and $\overline{L}$ are the mean effects of vessel and spatial unit, respectively, and π_i is a binomial coefficient:

$$\pi_i = \frac{\exp(\mu^' + y_i^' + \overline{V}^' + \overline{L})}{1 + \exp(\mu^' + y_i^' + \overline{V}^' + \overline{L})}$$

where $\mu^'$ is the average, $y^'$ is year effect, $\overline{V}^'$ is average vessel effect, and $\overline{L}$ is average spatial effect. Derived annual CPUE indices are presented in Table 5, which are identical to those used in the past assessments.

2.2.4. Pacific whiting bycatch indices

As in the previous assessments (Rogers and Lenarz 1993, Ralston and Pearson 1997, Williams et al. 2000), CPUE indices were computed that measured the incidental catch rate of widow rockfish in the at-sea Pacific whiting fishery. Data from the foreign fishery, joint-venture fishery and recent domestic fishery were extracted from the NORPAC database.

Full descriptions of how the CPUE indices were derived are in Appendix A of the 2005 Assessment (He *et al*. 2006a). An approach similar to the Delta-GLM analysis of Oregon bottom trawl logbook was used for estimation of the bycatch indices. Annual CPUE indices for bycatch in the foreign fishery, joint-venture fishery, and domestic fisheries are presented in Table 6. As recommended by the 2003 STAR Panel, annual CPUE indices from the domestic fishery after 1998 were excluded from the analysis because changes in management measures are expected to have more influence on the CPUE statistic than changes in stock size.

2.3 Fishery-independent data

2.3.1 Midwater trawl pelagic juvenile survey

Every year since 1983 the Groundfish Analysis Branch at NMFS Fisheries Ecology Division in Santa Cruz/Tiburon Laboratory has conducted a midwater trawl survey, which is designed to assess the reproductive success of rockfish spawning, including widow rockfish. Since 2001, the survey was expanded to a coastwide, combined industry and NMFS survey (PWCC/NWFSC: Pacific Whiting Conservation Cooperative and Northwest Fisheries Science Center) (Sakuma et al. 2006). An ANOVA analysis was used to fit all data from the combined survey (Steve Ralston, personal communication). Annual indices along with CVs from 2001 to 2008 are presented in Table 7. The index shows relatively high age-0 abundance in 2002.

2.3.2 Triennial trawl survey index

The AFSC/NWFSC triennial trawl survey index was not used in the 2003 assessment because of very limited widow catches by the survey and very poor fit of the index in the assessment model (He *et al*. 2003b). The 2003 STAR panel recommended the index be analyzed further and be considered for inclusion in the assessment. In the 2005 and 2007 assessments, the analysis of the triennial survey data uses the same Delta-GLM method as for the Pacific whiting bycatch indices. Detailed description of the analysis is in Appendix B of the 2005 assessment (He et al. 2006a). For this assessment, separate and distinct indices were developed for northern and southern areas, delineated by 43^{o} N latitude. The analysis was conducted using a GLMM method developed by staff at the NWFSC (John Wallace and Beth Horness, personal communication). The CVs were generated from MCMC sampling of 15 million runs. Derived index values and associated CVs are presented in Table 8.

Length frequency data from the triennial survey were also compiled and used in this assessment. The numbers of fish measured in length from 1980 to 2004 are presented in Table 9. Length composition (proportion-at-length) data of both sexes for the northern and southern areas are presented in Figures 9 and 10. Although the mean dates of the triennial survey changed from middle August between 1980 to 1992 to middle July between 1995 to 2004, this assessment assumes that it has no effect on the index and all data from 1980 to 2004 were treated as one continuous time series. This is because there is no evidence that indicates seasonal migration of widow rockfish. In addition, too few data, both in catches and length compositions, would be available if the time series were broken into two times series.

2.3.3 NWFSC trawl survey

Since 2003 NWFSC has conducted an annual shelf and slope trawl survey. This is the first time these trawl survey data are used in a widow rockfish assessment, since the survey now has a six-year time series. The survey is based on a stratified random-grid design, covering the coastal waters from a depth of 55 m to 1,280 m from Washington to California. Detailed survey information can be found in Keller *et al*. (2007).

As in the triennial survey, separate indices were developed for both the northern and southern areas, delineated by 43^{o} N latitude. The analysis was conducted using a GLMM method developed by the NWFSC staff (John Wallace and Beth Horness, personal communication). The CVs were generated from MCMC sampling of 15 million runs. Derived index values and associated CVs are presented in Table 10.

Age and length composition data were also compiled from the survey and were used in this assessment (Figures 11 to 14). Numbers of fish measured for length compositions and numbers of fish aged for age compositions from the survey are presented in Table 11. Note that sample sizes, in terms of numbers of fish measured, are very small in comparison to the commercial fisheries data.

2.4 History of modeling approaches

Previous assessments of widow rockfish were performed in 1989, 1990, 1993, 1997, 2000, 2003, 2005, and 2007 (Hightower and Lenarz 1989, 1990; Rogers and Lenarz 1993; Ralston and Pearson 1997, Williams *et al.* 2000, He *et al*. 2003b, He *et al*. 2006a, He *et al*. 2007). In 1989 the assessment involved the use of both cohort analysis and the Stock Synthesis program (Methot 1998). In 1993 and 1997, the age-based version of the stock synthesis program was used to assess the status of widow rockfish. In 2000, 2003, and 2005, the assessment of widow rockfish was implemented in ADMB software (Otter Research, Ltd. 2001), and applied an age-based analysis of the population with methods very similar to those used in the Stock Synthesis program. A full description of the ADMB model can be found in the previous assessment documents (He *et al*. 2003b and He *et al*. 2006a). In 2007, an update of the 2005 assessment was conducted (He *et al*. 2007a). The current assessment uses the Stock Synthesis program (SS3) (Version 3.03a, Methot 2009). A comparison between the ADMB-based assessment and an SS2-based model was conducted in November 2007, and it showed that the results between two programming approaches were very similar (He and Methot, Appendix B).

In the 2000 assessment, a starting year of 1968 was chosen based on the assumption that the 1965 year class was the earliest recruitment which could be reasonably estimated given a starting year of 1980 for the age composition information. The model tracked numbers and catches of male and female widow rockfish in age classes 3-20 (age 20 is an age-plus group). In the 2003 assessment, the starting year was extended backward to 1958 because the new landing data from 1966 to 1972 were added. Recruitment estimates prior to 1958 are assumed equal to the 1958 estimate in the model, so that the model is estimating recruitment at age 3 for the years 1958-1999. The same time frame was used in the 2005 and 2007 assessments.

2.4.1 Response to the 2002 STAR Panel recommendations

The last full assessment was reviewed by the STAR Panel in August 2005 (STAR Panel Report 2005). Generic recommendations and recommendations for future research are outlined below.

1. Find alternative indices. The recent trawl survey conducted by the NWFSC has been included in the assessment. Although it is not most suitable for widow rockfish, the survey has provided useful information on status of the population. The Panel also recommended hydro-acoustic surveys to be considered, but the technology and survey have not been fully developed.
2. Juvenile survey. As recommended by the STAR Panel and various workshops, the assessment uses the coast-wide surveys conducted by the SWFSC and PWCC/NWFSC vessels.

3. Increase age sample sizes. Sample sizes for widow rockfish ageing have been increased in the most recent years, most notably from the Oregon bottom trawl fishery.
4. Two-area assessment models. Given that there is no evidence that recruitments of widow rockfish between two areas were independent, this assessment still uses a two-area assessment model with linkage of recruitment.
5. Using and comparing the ADMB-based assessment with one done using the Stock Synthesis program. This assessment uses SS3 and comparisons between this assessment and the previous assessment are included in this report.
6. Priors for steepness. This assessment uses general priors developed by Martin Dorn for west coast rockfish. The steepness prior functions developed by He et al. (He *et al*. 2006) were used in the previous assessment. But it was not used in this assessment because it was not implemented in the current SS3 program.

2.4.2 Assessment update in 2007

An update assessment was conducted in 2007 and reviewed by the SCC. Depletion of the widow rockfish population was estimated to be 35.5% (He *et al*. 2007).

2.5 Model description

2.5.1 General

In this assessment, the population model begins in 1916 since the historical catch data from 1916 were provided by the California Reconstruction Project (Ralston *et al*., in review). The data used in this assessment that are also used in the previous assessments include four fishery catch-at-age compositions, landings in weight for each fishery, a midwater juvenile survey index, an Oregon bottom trawl logbook CPUE index, three whiting bycatch indices, and triennial survey indices. The new data sets, those not used in the previous assessments, include a NWFSC trawl survey index, length composition data from the triennial survey, and length and age composition data from the NWFSC survey.

Double-logistic selectivity functions by age were used to estimate female selectivities of each fishery. Selectivities for males were modeled as offsets of female selectivities. Double-normal selectivity was considered for age selectivity, but it was dropped from further consideration because no male offset function has been implemented in the current SS3 program. Experimental runs with no male offsets between double-logistic and double-normal selectivities indicated that the results were similar. Double-normal selectivity functions for length data were used to estimate female selectivities for both surveys along with male offsets.

A constant CV of 0.05 is assumed for catch estimates. Year-specific fishing mortalities are computed for each fishery for those years in which there are landings estimates available. In this assessment, a hybrid fishing mortality estimate was used for all fisheries (SS3 documentation, Methot 2009). Catchabilities for all indices, including fishery-dependent and -independent indices, were estimated in the model.

2.5.2 Natural mortality

Natural mortality (*M*) is assumed to be constant for all ages and in all years. In the 2003 assessment, the initial model estimated a slightly higher natural mortality for males than females based on the observation that there were more old females than males in the age data. The model was presented to the 2003 STAR Panel. It was noted that greater proportions of males at younger ages could be due to differences in selectivity by gender. The 2005 STAR Panel requested that natural mortality be estimated in the model. After a series of model runs, it was decided natural mortality should be fixed at 0.125 for the assessment model. In this assessment, the same natural mortality rate (0.125) was used.

2.5.3 Age compositions

The age data are modeled as multinomial random variables, with the year-specific sample sizes set equal to the number of samples collected, rather than the number of fish which often overstates the confidence of the data (Quinn and Deriso 1999). However, this assessment also examined an iterative reweighting method (model tuning) to determine the effective sample size in the likelihood functions (details in the model turning section).

The only information available for determination of ageing error was based on two point estimates of percent ageing agreement from the last two assessments (Rogers and Lenarz 1993; Ralston and Pearson 1997). From the previous assessments an estimate of 75% agreement for age 5 fish and 66% agreement for age 20 fish was modeled by assuming a linear relationship of percent agreement with age. These estimates of percent agreement at age were then fit to a set of age-specific normal distributions, which approximated the level of ageing agreement. The resulting matrix of true age versus reader age was then modeled in the past assessments:

$$A_t = EA_r$$

where A_t and A_r are n*n matrices for true age and reader age, respectively, n is number of age classes, and E is a n*n matrix for ageing error with the sum across each column equal to one.

Because the SS3 program does not accept ageing error matrices as inputs, standard deviations of ageing error for each age were computed from the ageing error matrix.

2.5.4 Proportion of recruitment to northern area

Since area-specific (north and south) growth and maturity is evident in widow rockfish, the population has been assessed using two-area models since 1989. The key component for the two-area model is how to allocate recruits of each year to each area. In all previous assessments, the proportions of recruitments to each area were determined by using averaged proportions of domestic landings by each area. Specifically, we used the sum of the domestic landings in the Vancouver-Columbia and both Oregon trawl fisheries relative to the total landings as an estimate of the proportion of recruitments to the northern area (He *et al*. 2006a). Figure 15 shows the proportions and moving averages of landings to the northern area that were used in the 2007 assessment.

In this assessment, the proportion of recruitment to the northern areas was estimated in the model. Annual deviations of the estimated proportion were also analyzed between 1978 and 2003 as a sensitivity analysis since age-composition data were available during that time period.

2.5.5 Discards and bycatch

The discards of widow rockfish are virtually unknown in most years. Age compositions of discards and landings can be very different (typically smaller fish are discarded) and can be important in determining discard rates (Williams *et al*. 1999). In the past assessments, a value of 6% of total weight was assumed for the years 1958-1982 and 16% of total weight for the years 1983-2006 (Hightower and Lenarz 1990, Williams *et al*. 2000, He *et al*. 2003b). The 16% estimate of discards is based on a dated study by Pikitch *et al*. (1988), which indicated most of the discards of widow rockfish were induced by regulations. The earlier 6% estimated is based on an ad hoc adjustment of the 16% estimate by previous assessment authors (Hightower and Lenarz 1990). The 16% assumed discard rate has likely become more uncertain in recent years due to changes in regulations.

Since the last assessment update in 2007, estimates of bycatch for the at-sea processing vessels (ASP) have been provided by the NWFSC (Table 3). Since no age or length composition data are available from these sources of bycatch, estimates of selectivities for these catches cannot be made. These bycatch amounts were added to the total catches of the two northern fleets (Vancouver-Columbia fishery and Oregon mid-water trawl).

2.5.6 Logbook and bycatch indices

The Oregon bottom trawl logbook indices and whiting bycatch indices are treated as biomass indices and are estimated in the model with a catchability parameter estimated for each index. Because there were no new data since the 2003 assessment, the same Oregon bottom trawl logbook indices from the 2002 assessment are used in this assessment. The whiting bycatch indices are recalculated according to the 2003 STAR panel recommendation. Details regarding the calculations of the whiting bycatch indices using Delta-GLM methods are in Appendix A of the 2005 Assessment.

2.5.7 Survey indices

Three survey indices are used in the assessment: the midwater juvenile trawl survey, the triennial trawl survey, and the NWFSC trawl survey. The CV for the midwater juvenile trawl survey was fixed during the tuning process and was set to equal to σ_R since the time period of the survey is short and it is the only data series that measures recruitment strength in recent years. The CVs for the other two surveys were set to equal to root mean squared errors (RMSEs) during the tuning process (see below). Time series of all indices (scaled to the mean of each index) were plotted in Figures 16 and 17.

2.5.8 Model tuning

An iterative weighting method was used in this assessment for model tuning. In addition, a downweighting of composition data developed by Francis was applied in this assessment (Appendix C). The initial sample sizes for age and length composition data were from actual sample sizes or numbers of fish measured, and the initial CVs for each index were derived externally to the model. The first step was to replace sample sizes of length and age composition data with effective sample sizes that include both sample trips and number of fished measured or aged. This method was developed by Ian Stewart of the NWFSC and has been used in other stock assessments. The second step repeated these same procedures. The last step involved applying Francis' method of down-weighting composition data (Appendix C).

Comparisons of time series of spawning outputs, recruitments and key parameters and model outputs are presented in Table 12 and Figures 18 and 19.

2.6 Model selection and evaluation

The initial model used untuned CVs for indices and the original sample sizes of age and length composition data. Many steps were taken during the model selection and evaluation process. These included selection of starting models that had few parameters, e.g. assuming the same selectivities for fisheries and surveys, and no male offsets in selectivities. Alternative definitions of periods of early recruitment and late recruitment were evaluated during the process. Different selectivity functions (such as double-logistic and/or double-normal functions) were also evaluated along with fixing some of the terminal selectivity parameters.

2.7 Responses to STAR panel requests

- Date Requests 1, 2, and 3: These requests include splitting Oregon catches prior to 1983 out of the Washington fishery, providing new estimates for Vancouver-Columbia for 1916 to 1976, and providing discard rates by state and gears from the West Coast observer program for 2002 to 2008 and using total mortality estimates from the same program for 2007 to 2008. These requests were implemented during the Panel review with little effects on the modeling results.
- Date Request 4: Providing a graph of the abundance indices scaled to their own average for a common time period so that they are on a similar scale. The request was implemented in Figures 15 and 16.
- Modeling Request 5: Reset all effective Ns using Stewart's method with number of trips and number of fish for fisheries; for the surveys, use Stewart's method with the number of positive hauls. Do the re-tuning with effective N multipliers for the composition data sets, rather than adjusting each individual year. This request was implemented during the Panel review and used in the setup of the base model for this assessment.
- Modeling Request 6: Provide a run with one asymptotic length-based selectivity for all surveys, genders and areas combined. Also provide a run with separate asymptotic length-based selectivity curves for each survey, but combining genders and areas. The first part of this request deteriorated the model fit and resulted in unreasonable selectivities. The second part of the request (one selectivity for each survey) resulted in more stable model and was used in the base model.
- Modeling Request 7: Provide a run with the abundance index for juveniles up-weighted and the age and length compositions down-weighted. This run resulted in a close fit to the juvenile abundance index. The down-weighting of the age and length composition data were later incorporated in the base model.
- Modeling Request 8: Provide a new base case using the Francis multipliers applied to the N-multipliers from the last re-weighted run. This request was implemented in the base model (also see Appendix C).
- Modeling Requests 9 to 11: These requests include using h=0.25 and h=0.55 to bracket the uncertainties, providing runs with the proportion of recruits to the northern area at 0.68 and 0.80, and providing a likelihood profile on steepness. These requests were conducted during the Panel review and included in this report.
- Modeling Request 12: Examine the contribution of age 1 male of Oregon mid-water trawl in 2007 to the total likelihood. Examining the model fit indicated relatively large likelihood value from this datum point (=0.71). This is because the Pearson residual tends to be large when expected values are near zero even with small observed values. In this case, one fish of age 1 was observed.
- Modeling Request 13: The original report presented to the STAR Panel shows stacked fishing mortalities by area. Provide different graphs for northern and southern areas. A new graph that shows fishing mortalities by area is included in this report.

- Provide a run with single area model re-combining the Triennial and NWFSC surveys into one series and the age compositions. If results are significantly different, try to explain the differences. This request will be examined in the next assessment.

2.8 Base case model results

Results from the base model run are presented in Tables 13 to 15 and Figures 20 to 52. Overall, time series patterns of biomass, spawning output, recruitment, and depletion are similar to those in the 2007 assessment. The trends were also very similar between the northern and southern areas (Figure 20). Spawning outputs showed steep decline in the early 1980s and almost continuous decline until the early 2000s (Figure 21). However, spawning outputs have shown an increasing trend in recent years. Depletion in recent years has been in the precautionary zone, with the lowest depletion of 27.39% in 2003 (Figure 22). The 95% confidence intervals of depletion for the most recent years were wide and ranged from below the overfished level to above the target biomass level of 40% of initial biomass (Figure 22). This suggests that there is high uncertainty in estimates of recent year depletion levels.

The stock-recruit relationship and recruitment deviations are presented in Table 14 and Figures 23 to 26. The input value of the standard deviation of log recruitment (σ_R) is 0.6, which is about 10% higher than the estimated RMSE value of 0.485 in the base model. Like many other rockfish species, recruitment of widow rockfish has been highly variable. The estimated steepness is 0.4061, suggesting this species is not very productive at low abundance. This value is low compared to the prior expected value of 0.721 compiled by Martin Dorn for west coast groundfish species (Martin Dorn, personal communication). It is also important to point out that recruitment of widow rockfish has been very low in recent years. The 2007 assessment indicated that there was a strong recruitment in 2000 (He *et al*. 2007a), which is not the case in this assessment. More discussion regarding estimation of recent year recruitments is in the section describing sensitivity analyses.

A time series of fishing mortalities is presented in Figure 27. Fishing mortalities were very high between 1980 and the early 2000s, and have been very low in recent years due to management regulations.

Model fits to indices are presented in Figures 28 to 36. The fits to these indices were generally good. The CVs for both the triennial and NWFSC surveys were large, mainly because few widow rockfish were caught in these surveys.

Estimated selectivity curves for four fisheries and all surveys are presented in Figures 37 to 42, and residuals from model fits to age and length compositions are presented in Figures 43 to 52. Patterns of age selectivity curves for four fisheries (Figures 37 to 40) were very similar to those in the past assessments, even though selectivities of male offsets were applied in this assessment. Residuals of the model fits to age composition data for these four fisheries showed no strong evidence of lack of fit to the data (Figures 43 to 48). Some residuals were large (e.g. male age 1 fit in 2007 of the Oregon mid-water trawl fishery in Figure 44). This is because the Pearson residual tends to be large when expected values are near zero even with small observed values. In this case, one fish of age 1 was observed. Estimated length selectivity curves for the triennial surveys in both northern and southern areas are plotted in Figures 41 to 42. Residuals of the model fits to the age and length composition data for all surveys fit relatively well (Figures 47 to 52). Model fits for all age and length composition data are provided as Appendix C.

2.9 Uncertainty and sensitivity analyses

2.9.1 Sensitivity analyses

A set of sensitivity analyses were performed to test model assumptions and to explore uncertainty in estimations of key model parameters (see also the likelihood profile section). During the model set up and the STAR review, the following three parameters to be included in sensitivity analyses: (1) recruitment distribution parameters to be estimated annually between 1978 to 2003, as compared to one parameter to be estimated in the base model; (2) using no *h* prior; and (3) CV for juvenile survey to be fixed at 0.2. Results of these sensitivity analyses are presented in Table 16 and Figures 53 and 54. Overall, model outputs from these runs were similar.

A detailed comparisons of key parameters and model outputs between the base model and two fixed proportions of recruitments to the northern area (0.6875 and 0.75) were presented in Table 17 and Figures 55 and 56. It showed the importance of the recruitment distribution. With the range between 0.6875 and 0.75, the stock was less depleted if less recruits were distributed to the northern area. More results of the recruitment distribution are presented in the profile run section.

2.9.2 Retrospective analysis

Retrospective analysis of the base model was performed by using the data only through 2007, 2006, and 2004 (Table 18 and Figures 57 to 58). The results indicated that data from the most recent years (2007 and 2008) had moderate effects on the model outputs. If data from the last two years (2007 and 2008) were not used, the model would show that the population is less depleted (depletion equals to 40.6% in 2007) with the steepness value of 0.535 (Table 18 and Figure 57). It also showed that recruitment in 2002 was higher than that estimated in the base model (Figure 58).

2.9.3 Likelihood profiles

Likelihood profiles for the proportion of recruitment to the northern area, steepness, and natural mortality were provided to investigate their effects on model outputs. These are important population parameters and, more importantly, these parameter estimates are highly uncertain in the assessment given the fact that no reliable abundance data exists in recent years for widow rockfish. Figures 59 to 61 show the likelihood profiles as well as effects of those parameters on the estimated depletion in 2009.

Figure 59 shows that when the proportion of recruitment to the northern area (PRNA) was at 0.75, the stock was most depleted. It is interesting to point out that the estimated PRNA value of 0.717 is very close to the proportions of landings in the northern area during the 1990s (Figure 15), which was used as the proportions of recruitments to the northern area in the previous assessments.

The profile on steepness showed that the stock was more depleted as steepness decreased (Figure 60). All previous stock assessments had shown that steepness of widow rockfish was low even with relatively high priors of steepness applied in the assessments (He *et al*. 2006a). This suggests that widow rockfish might be less productive than other rockfish species in west coast waters.

Figure 61 shows the profile of natural mortality (*M*) and related depletion of the stock in 2009. The likelihood profile indicates that natural mortality of widow rockfish, with current data and model settings, is most likely to be around 0.125, which was the assumed *M* in the assessment model. The stock was more depleted when *M* was assumed to be higher than 0.125 (most depleted at $M \approx 0.15$). This is because virgin biomass is estimated to be lower with higher *M* values. Consequently, virgin biomass is estimated to be higher with low *M* values.

2.9.4 Comparisons between this assessment and the past assessments

Comparisons of spawning outputs and recruitments between this assessment and the past assessments (2000, 2003, 2005, and 2009) are presented in Figures 62 and 63. Comparisons of key parameters between this assessment and the 2007 assessment are presented in Table 19. Overall, the patterns of time series of spawning outputs were similar among all assessments, which show steep declines in the early 1980s, and steady declines from the middle 1980s to early 2000s. Comparisons of the time series of recruitments estimated by all assessments also showed similar trends (Figure 63).

However, there some differences between this assessment and the 2007 assessment. For example, the 2007 assessment indicated much higher virgin spawning output than the current assessment (Figure 62). The higher virgin biomass in the 2007 assessment could have been the result of a relatively short catch history or that no recruitment bias-adjustment was applied in the assessment, or both. The 2007 assessment also indicated much higher recruitment in 2000 (Figure 63), which resulted in a projection of stock recovery within two years (see the rebuilding analysis, He *et al*. 2007b).

3 Rebuilding parameters

A separate rebuilding analysis will be conducted since the widow rockfish has been overfished**.**

4 Reference points

Virgin spawning output for widow rockfish is estimated to be 40,547 million eggs. The current depletion is 38.5% of the virgin spawning output. The management target for widow rockfish is 40% of virgin spawning output (16,218 million of eggs). The time series of estimated equilibrium spawning potential ratio (SPR) is shown in Figure 64. A phase plot of annual equilibrium SPR relative to its target and estimated spawning output relative its target is shown in Figure 65. An equilibrium yield curve is plotted in Figure 66.

5 Decision table

Decision table of 12-year projections with two alternate states of nature is presented in Table 20.

6 Management Recommendations

The stock has declined since fishing began in the late 1970s. The 2000 assessment showed that the spawning output in 1999 was just below 25% of unfished spawning output. This assessment shows that the spawning output in 2009 is within the precautionary zone and is yet to be rebuilt. Therefore, it is necessary to conduct a rebuilding analysis to determine harvest levels and related risks of not successfully rebuilding the stock by the target year in the rebuilding plan under alternative harvest levels.

7 Research needs

1. There are increasingly fewer reliable abundance indices for widow rockfish. Recent management measures have undermined the ability to continue a fishery-dependent time series of relative abundance from the Oregon bottom trawl fishery and the Pacific whiting fishery since 1999. The constant flux of the management regime suggests that there is little likelihood that meaningful CPUE indices can be developed from these fisheries in the future. The NWFSC combo survey provides some useful information on abundance of widow rockfish, but catches from the survey have been generally very low in recent years. It is desirable that a trawl survey (including midwater trawls) that targets widow like rockfish be initiated. A long-term hydroacoustic survey will also be very useful.
2. The long-term recruitment index is a key time series in the stock assessment. Continuation of the NMFS/PWCC midwater juvenile trawl survey should provide key information on the recruitment strength of widow rockfish.
3. Sample sizes for existing age-collection programs as well as length measurements (by fishery and survey) should be increased substantially.
4. Effort on ageing of widow rockfish should include collecting information on length-age keys and growth rates for both the northern and southern areas.
5. One area assessment model should be considered in the next assessment.
6. Conduct an interagency ageing comparison and comparative analysis of break and burn and surface ageing methods.
7. Develop methods to incorporate uncertainty in natural mortality and/or steepness in model configurations in which these parameters are fixed. The delta method for propagating uncertainty (MacCall in prep.) is promising approach that warrants further evaluation.

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9 Literature Cited

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10 Tables

Table 1. Management performance in obtaining the harvest guideline for widow rockfish. Harvest guideline and allowable biological catch (ABC) are taken from Council documents.

Year	Harvest Guideline or OY (mt)	Allowable Biological Catch (mt)	Catches (mt)
1989	12,100	12,400	12,543
1990	12,400	8,900	10,293
1991	7,000	7,000	6,638
1992	7,000	7,000	6,400
1993	7,000	7,000	8,388
1994	6,500	6,500	6,679
1995	6,500	7,700	6,903
1996	6,500	7,700	6,327
1997	6,500	7,700	6,715
1998	5,090	5,750	4,230
1999	5,090	5,750	4,136
2000	5,090	5,750	4,049
2001	2,300	3,727	1,989
2002	856	3,727	432
2003	832	3,871	43
2004	284	3,460	101
2005	285	3,218	199
2006	289	3,059	215
2007	368	5,334	258
2008	368	5,144	243
2009	522	7,728	
2010	509	6,937	

Table 2. U.S. total catches (mt) of widow rockfish by four fisheries from 1916 to 2008.

Year	Vancouver, Columbia	Oregon Midwater Trawl	Oregon Bottom Trawl	Eureka, Monterey, and Conception	Total
1916	0	0	0	83	83
1917	0	0	0	129	129
1918	0	0	0	148	148
1919	0	0	0	102	102
1920	0	0	0	105	105
1921	0	0	0	87	87
1922	0	0	0	75	75
1923	0	0	0	83	83
1924	0	0	0	53	53
1925	0	0	0	66	66
1926	0	0	0	100	100
1927	0	0	0	83	83
1928	0	0	0	95	95
1929	0	0	0	93	93
1930	0	0	0	120	120
1931	0	0	0	108	108
1932	0	0	0	109	109
1933	0	0	0	95	95
1934	0	0	0	101	101
1935	0	0	0	109	109
1936	0	0	0	121	121
1937	0	0	0	114	114
1938	0	0	2	95	97
1939	0	0	2	85	86
1940	0	0	9	89	98
1941	0	0	16	72	88
1932	0	0	30	22	51
1943	0	0	99	54	153
1944	0	0	170	202	372
1945	0	0	271	451	721
1946	0	0	152	457	609
1947	0	0	86	209	294
1948	0	0	62	205	267
1949	0	0	57	146	203
1950	0	0	70	167	237
1951	0	0	48	344	392
1952	0	0	53	318	371
1953	0	0	39	293	333
1954	0	0	47	216	263
1955	0	0	48	232	280
1956	0	0	136	295	431

Table 2 (continued). U.S. total catches (mt) of widow rockfish by four fisheries from 1916 to 2008.

Year	Vancouver, Columbia	Oregon Midwater Trawl	Oregon Bottom Trawl	Eureka, Monterey, and Conception	Total
1957	0	0	130	324	454
1958	0	0	136	394	529
1959	0	0	104	320	424
1960	0	0	138	249	387
1961	0	0	152	171	323
1962	0	0	191	175	367
1963	0	0	150	289	438
1964	0	0	355	155	510
1965	0	0	36	230	266
1966	3670	0	391	318	4379
1967	3900	0	705	495	5100
1968	1693	0	169	586	2447
1969	356	0	115	80	550
1970	554	0	0	75	629
1971	701	0	22	62	785
1972	410	0	25	89	524
1973	621	0	14	314	949
1974	295	0	5	394	693
1975	465	0	10	483	958
1976	971	0	65	555	1591
1977	1397	0	367	1047	2811
1978	641	0	657	633	1931
1979	1024	0	646	1938	3608
1980	17161	0	1502	4505	23167
1981	7289	14390	1408	5592	28678
1982	6354	8453	885	12107	27799
1983	3739	1684	1726	5148	12296
1984	1686	4138	1548	4450	11821
1985	1786	3695	1010	4272	10763
1986	2969	3453	1358	3379	11159
1987	4318	5784	1353	3601	15056
1988	3572	4758	1300	2581	12211
1989	3920	5634	2289	2707	14550
1990	2599	3728	2514	3099	11940
1991	1474	2267	2245	1670	7657
1992	1378	1401	3053	1536	7368
1993	2089	2123	3928	1567	9706
1994	1421	2060	2764	1456	7701
1995	1376	1698	2663	2240	7977
1996	1274	1757	2479	1795	7305
1997	1289	1865	2604	1999	7757

Table 2 (continued). U.S. total catches (mt) of widow rockfish by four fisheries from 1916 to 2008.

Year	Vancouver, Columbia	Oregon Midwater Trawl	Oregon Bottom Trawl	Eureka, Monterey, and Conception	Total
1998	751	1045	1543	1527	4866
1999	777	2016	923	1053	4768
2000	639	2665	18	1341	4664
2001	424	1220	45	590	2279
2002	65	310	7	50	432
2003	14	22	2	5	43
2004	32	34	10	26	101
2005	43	139	6	12	199
2006	45	155	3	13	215
2007	37	192	10	19	259
2008	97	106	2	38	243

Table 3. Comparisons of annual catches (mt) from at-sea processing (ASP) retrieved from the PacFIN database and bycatch estimates (mt) provided by the Northwest Fisheries Science Center for widow rockfish from 1991 to 2001. Only bycatch estimates were included in the assessment.

Year	ASP Catch	Bycatch estimate
1991	150	272
1992	5	348
1993	4	151
1994	27	288
1995	33	195
1996	4	212
1997	3	205
1998	66	259
1999	33	186
2000	77	207
2001	50	173

Table 4. Number of samples collected for each year and fishery of age composition data used in the widow rockfish assessment.

	Vancouver-Columbia	Oregon midwater trawl	Oregon bottom trawl	Eureka-Conception
1978				7
1979				11
1980	18			26
1981	31			44
1982	40			149
1983	25			189
1984	22	32	27	169
1985	16	53	23	175
1986	27	56	22	154
1987	36	68	34	135
1988	20	39	33	127
1989	30	65	45	170
1990	41	61	49	155
1991	35	59	78	95
1992	31	43	82	55
1993	36	50	61	22
1994	28	22	63	28
1995	33	30	43	11
1996	27	32	27	35
1997	30	47	40	61
1998	22	41	30	37
1999	29	62	26	31
2000	21	55		17
2001	10	40		7
2002	12	17		14
2003	5			3
2004	20	4		7
2005	11			
2006	10	13		
2007	16	9	12	
2008	14	25	15	8

Table 5. Oregon bottom trawl logbook catch-per-unit-effort index from 1984 to 1999.

Year	CPUE (lbs./hr.)	CV
1984	331.47	0.2121
1985	100.88	0.1875
1986	227.08	0.2928
1987	169.08	0.2730
1988	93.97	0.2897
1989	164.10	0.1749
1990	78.49	0.1348
1991	73.59	0.1275
1992	83.16	0.1179
1993	53.58	0.1314
1994	100.34	0.1128
1995	109.96	0.1387
1996	94.81	0.1357
1997	97.23	0.1502
1998	56.56	0.1718
1999	84.46	0.1684

Table 6. Scaled indices of widow rockfish catches derived from bycatch in three sectors of the Pacific whiting fishery. Note that index values after 1998 were not used in this assessment.

Year	Index	CV
Foreign		
1977	0.770	0.115
1978	1.205	0.112
1979	0.703	0.119
1980	1.993	0.131
1981	0.728	0.126
1982	0.243	0.247
1984	2.937	0.125
1985	0.407	0.107
1986	1.111	0.103
1987	0.390	0.088
1988	0.513	0.124
Joint venture		
1983	2.889	0.120
1985	0.776	0.117
1986	0.823	0.081
1987	0.320	0.087
1988	0.659	0.077
1989	0.824	0.064
1990	0.710	0.074
Domestic		
1991	1.264	0.125
1992	0.781	0.125
1993	0.801	0.104
1994	1.465	0.068
1995	0.455	0.106
1996	1.018	0.082
1997	0.886	0.077
1998	1.330	0.079

Table 7. Yearly index estimates from the pelagic juvenile trawl survey, 2001 to 2008.

Year	Index value	CV
2001	3.79	0.06
2002	10.07	0.08
2003	4.57	0.06
2004	8.43	0.07
2005	3.52	0.06
2006	1.63	0.05
2007	1.69	0.05
2008	3.09	0.06

Table 8. Indices of widow rockfish catches derived from triennial surveys from 1980 to 2004 for northern and southern areas.

Year	Index	CV
Northern area		
1980	222.7	0.5728
1983	292.9	0.4399
1986	110.7	0.4980
1989	136.9	0.6483
1992	236.0	0.4800
1995	56.6	1.0350
1998	500.3	0.4280
2001	57.2	0.9266
2004	14.2	0.7726
Southern area		
1980	208.7	0.7360
1983	334.0	0.7464
1986	433.4	1.2778
1989	154.4	0.8178
1992	104.6	0.6392
1995	198.8	0.7360
1998	221.2	0.6677
2001	27.1	0.8978
2004	204.4	1.0286

Table 9. Number of fish measured for length compositions from the tri-annual survey that were used in the widow assessment model.

	Northern area	Southern area
1980	83	
1983	169	88
1986	67	82
1989	110	201
1992	48	281
1995	148	139
1998	203	245
2001	21	58
2004	7	116

Table 10. Indices of widow rockfish catches derived from the NWFSC surveys from 2003 to 2008 for northern and southern areas.

Year	Index	CV
Northern area		
2003	793.6	0.9087
2004	55.1	1.6844
2005	118.2	1.0357
2006	135.3	0.7991
2007	159.5	0.7115
2008	82.1	0.9918
Southern area		
2003	193.4	0.6723
2004	186.4	1.4798
2005	203.6	0.6365
2006	243.4	0.5484
2007	314.8	0.6416
2008	113.0	0.6931

Table 11. Number of fish measured for length compositions and number of fish aged for age compositions from the NWFSC survey that were used in the widow assessment model.

	Northern area length	Southern area length	Northern area age	Southern area age
2003	110	102	4	6
2004	8	172	8	50
2005	35	161	22	59
2006	98	74	29	60
2007	46	45	37	45
2008	10	16	10	10

Table 12 Comparisons of key parameters and model outputs between the reweighted post-STAR model (PostSTARRewet2), the final base model (PostSTARBase), and the pre-STAR base model (PreSTARBase).

Description	PostSTARRewet2	PostSTARBase	PreSTARBase
Management quantities			
B_0 (million of eggs)	38426	40547	39425
2007 depletion (%)	32.0	34.9	31.5
2009 depletion (%)	34.7	38.5	33.2
No. of parameters	115	115	127
Steepness (*h*)	0.3059	0.4061	0.3103
Proportion of recruits to north	0.7220	0.7170	0.7258

Table 13. Fixed and estimated parameter values with standard deviations for the base model.

Parameter	Estimated (yes/no).	value	Standard deviation	Note
Natural mortality all ages, all sexes, all area	No	0.125	NA	
L_at_Amin female north	No	27.72	NA	
L_at_Amax female north	No	47.74	NA	
K female north	No	0.14	NA	
L_at_Amin female south	No	22.32	NA	
L_at_Amax female south	No	46.29	NA	
K female south	No	0.2	NA	
L_at_Amin male north	No	28.54	NA	
L_at_Amax male north	No	42.96	NA	
L male north	No	0.18	NA	
L_at_Amin male south	No	23.22	NA	
L_at_Amax male south	No	41.07	NA	
L male south	No	0.25	NA	
Age growth CV, all ages, all sexes, all areas	No	0.1	NA	
Weight-length relationship parameter 1 female	No	5.45E-06	NA	
Weight-length relationship parameter 2 female	No	3.2878	NA	
Weight-length relationship parameter 1 male	No	1.19E-05	NA	
Weight-length relationship parameter 2 male	No	3.0663	NA	
Proportion of recruitment to northern area	Yes	-0.3612	0.0934	
R0	Yes	10.5914	0.0725	
Steepness	Yes	0.4061	0.1400	
Sigma R	No	0.6	NA	
Early_RecrDev_1958	Yes	-0.0103	0.4635	
Early_RecrDev_1959	Yes	0.0322	0.4596	
Early_RecrDev_1960	Yes	0.0719	0.4455	
Early_RecrDev_1961	Yes	0.0561	0.4325	
Early_RecrDev_1962	Yes	0.0878	0.4058	
Early_RecrDev_1963	Yes	0.0360	0.4058	
Early_RecrDev_1964	Yes	0.2229	0.3640	
Early_RecrDev_1965	Yes	0.2315	0.3533	

Table 13 (continued). Fixed and estimated parameter values with standard deviations for the base model.

Parameter	Estimated (yes/no).	value	Standard deviation	Note
Early_RecrDev_1966	Yes	0.1751	0.3516	
Early_RecrDev_1967	Yes	0.3621	0.3034	
Early_RecrDev_1968	Yes	0.3430	0.2958	
Early_RecrDev_1969	Yes	0.2016	0.3298	
Early_RecrDev_1970	Yes	1.1760	0.1583	
Early_RecrDev_1971	Yes	-0.0271	0.2828	
Early_RecrDev_1972	Yes	-0.6690	0.3071	
Early_RecrDev_1973	Yes	-0.7844	0.2950	
Early_RecrDev_1974	Yes	-0.4906	0.2509	
Early_RecrDev_1975	Yes	-0.2458	0.1904	
Early_RecrDev_1976	Yes	-1.0642	0.2736	
Early_RecrDev_1977	Yes	0.2953	0.1324	
RecrDev_1978	Yes	0.5700	0.1241	
RecrDev_1979	Yes	-0.6991	0.2653	
RecrDev_1980	Yes	0.6853	0.1256	
RecrDev_1981	Yes	0.9476	0.1053	
RecrDev_1982	Yes	-0.0660	0.1950	
RecrDev_1983	Yes	0.3501	0.1501	
RecrDev_1984	Yes	0.3793	0.1495	
RecrDev_1985	Yes	0.1161	0.1668	
RecrDev_1986	Yes	-0.5922	0.2587	
RecrDev_1987	Yes	0.3852	0.1472	
RecrDev_1988	Yes	-0.1748	0.1986	
RecrDev_1989	Yes	-0.1992	0.2095	
RecrDev_1990	Yes	0.4823	0.1522	
RecrDev_1991	Yes	0.8130	0.1301	
RecrDev_1992	Yes	-0.4431	0.2552	
RecrDev_1993	Yes	-0.0691	0.2006	
RecrDev_1994	Yes	-0.3728	0.2469	
RecrDev_1995	Yes	-0.7389	0.3053	

Table 13 (continued). Fixed and estimated parameter values with standard deviations for the base model.

Parameter	Estimated (yes/no).	value	Standard deviation	Note
RecrDev_1996	Yes	-0.6928	0.3260	
RecrDev_1997	Yes	-0.3716	0.3278	
RecrDev_1998	Yes	0.3369	0.2474	
RecrDev_1999	Yes	0.0915	0.3218	
RecrDev_2000	Yes	0.5986	0.2398	
RecrDev_2001	Yes	-0.3533	0.3312	
RecrDev_2002	Yes	0.6305	0.2766	
RecrDev_2003	Yes	-0.0875	0.3864	
RecrDev_2004	Yes	0.1718	0.3979	
RecrDev_2005	Yes	-0.2133	0.4143	
RecrDev_2006	Yes	-0.5940	0.4228	
RecrDev_2007	Yes	-0.5872	0.4276	
RecrDev_2008	Yes	-0.3034	0.4310	
Q juvenile survey north	Yes	-7.0729	0.5012	
Q Oregon bottom trawl CPUE	Yes	-5.8940	0.1852	
Q triennial survey	Yes	-5.6973	0.3619	
Q whiting bycatch foreign	Yes	-10.9010	0.2393	
Q whiting bycatch joint venture	Yes	-10.6780	0.3166	
Q whiting bycatch domestic	Yes	-10.1087	0.2180	
Q NWFSC survey north	Yes	-5.3063	0.8116	
Q NWFSC survey south	Yes	-3.9441	0.7936	
Q triennial survey south	Yes	-4.3767	0.3399	
SizeSel_7P_1_TriAnSurvey	Yes	52.9070	2.7939	Double-normal
SizeSel_7P_2_TriAnSurvey	Yes	-0.9080	107.4270	Double-normal
SizeSel_7P_3_TriAnSurvey	Yes	5.3739	0.3486	Double-normal
SizeSel_7P_4_TriAnSurvey	Yes	3.4957	123.2440	Double-normal
SizeSel_7P_5_TriAnSurvey	Yes	-3.4304	0.8262	Double-normal
SizeSel_7P_6_TriAnSurvey	Yes	0.6863	5.7837	Double-normal

Table 13 (continued). Fixed and estimated parameter values with standard deviations for the base model.

Parameter	Estimated (yes/no).	value	Standard deviation	Note
SizeSel_11P_1_NWFSCSvy	Yes	51.6943	20.1715	Double-normal
SizeSel_11P_2_NWFSCSvy	Yes	-1.0546	108.6770	Double-normal
SizeSel_11P_3_NWFSCSvy	Yes	5.1566	2.3827	Double-normal
SizeSel_11P_4_NWFSCSvy	Yes	3.4999	122.9960	Double-normal
SizeSel_11P_5_NWFSCSvy	Yes	-2.3625	1.6734	Double-normal
SizeSel_11P_6_NWFSCSvy	Yes	-4.5640	11.5979	Double-normal
AgeSel_1P_1_WAFishery1	Yes	5.6972	0.0854	Double-logistic
AgeSel_1P_2_WAFishery1	Yes	2.9282	0.3031	Double-logistic
AgeSel_1P_3_WAFishery1	Yes	0.0036	0.1168	Double-logistic
AgeSel_1P_4_WAFishery1	Yes	0.1574	0.0137	Double-logistic
AgeSel_1P_5_WAFishery1	No	2	NA	Double-logistic
AgeSel_1P_6_WAFishery1	No	0	NA	Double-logistic
AgeSelMale_1P_1_WAFishery1	No	2	NA	Double-logistic
AgeSelMale_1P_2_WAFishery1	Yes	-3.6748	173.8930	Double-logistic
AgeSelMale_1P_3_WAFishery1	Yes	-0.3823	0.1073	Double-logistic
AgeSelMale_1P_4_WAFishery1	Yes	1.5949	0.3029	Double-logistic

Table 13 (continued). Fixed and estimated parameter values with standard deviations for the base model.

Parameter	Estimated (yes/no).	value	Standard deviation	Note
AgeSel_2P_1_ORMWTraw	Yes	6.2801	0.1256	Double-logistic
AgeSel_2P_2_ORMWTraw	Yes	2.5797	0.3434	Double-logistic
AgeSel_2P_3_ORMWTraw	Yes	0.0285	0.8988	Double-logistic
AgeSel_2P_4_ORMWTraw	Yes	0.2455	0.0252	Double-logistic
AgeSel_2P_5_ORMWTraw	No	2	NA	Double-logistic
AgeSel_2P_6_ORMWTraw	No	0	NA	Double-logistic
AgeSelMale_2P_1_ORMWTraw	No	2	NA	Double-logistic
AgeSelMale_2P_2_ORMWTraw	Yes	0.0582	98.0188	Double-logistic
AgeSelMale_2P_3_ORMWTraw	Yes	-0.5704	0.1979	Double-logistic
AgeSelMale_2P_4_ORMWTraw	Yes	1.5755	0.6392	Double-logistic
AgeSel_3P_1_ORBTraw	Yes	5.9804	0.1557	Double-logistic
AgeSel_3P_2_ORBTraw	Yes	2.7635	0.4676	Double-logistic
AgeSel_3P_3_ORBTraw	Yes	6.9875	4.5277	Double-logistic
AgeSel_3P_4_ORBTraw	Yes	0.2172	0.0369	Double-logistic
AgeSel_3P_5_ORBTraw	No	2	NA	Double-logistic
AgeSel_3P_6_ORBTraw	No	0	NA	Double-logistic
AgeSelMale_3P_1_ORBTraw	No	2	NA	Double-logistic
AgeSelMale_3P_2_ORBTraw	Yes	-2.4644	195.3500	Double-logistic
AgeSelMale_3P_3_ORBTraw	Yes	-0.6698	0.1880	Double-logistic
AgeSelMale_3P_4_ORBTraw	Yes	2.2718	0.5286	Double-logistic
AgeSel_4P_1_EMFishery	Yes	5.6605	0.1327	Double-logistic
AgeSel_4P_2_EMFishery	Yes	2.6696	0.4486	Double-logistic
AgeSel_4P_3_EMFishery	Yes	28.4631	1.8110	Double-logistic
AgeSel_4P_4_EMFishery	Yes	0.7104	0.7538	Double-logistic
AgeSel_4P_5_EMFishery	No	2	NA	Double-logistic
AgeSel_4P_6_EMFishery	No	0	NA	Double-logistic
AgeSelMale_4P_1_EMFishery	No	2	NA	Double-logistic
AgeSelMale_4P_2_EMFishery	Yes	-2.9528	189.4150	Double-logistic
AgeSelMale_4P_3_EMFishery	Yes	0.1024	0.1806	Double-logistic
AgeSelMale_4P_4_EMFishery	Yes	-0.7016	0.5760	Double-logistic

Table 14 Estimated age 1+ biomass, spawning outputs, recruits, total catch, depletion, SPR and relative exploitation rate of widow rockfish from 1916 to 2008 from the base model.

Year	Total biomass (mt)	Spawning output (mil eggs)	Recruit (*1000)	Total catch (mt)	Depletion (%)	SPR	Relative exploitation rate
1916	220930	40547	39791	83	100.0	0.9946	0.0004
1917	220850	40528	39784	129	100.0	0.9916	0.0006
1918	220731	40498	39773	148	99.9	0.9904	0.0007
1919	220601	40465	39761	102	99.8	0.9933	0.0005
1920	220524	40445	39754	105	99.7	0.9931	0.0005
1921	220449	40426	39747	87	99.7	0.9943	0.0004
1922	220397	40413	39743	75	99.7	0.9950	0.0003
1923	220358	40404	39739	83	99.6	0.9945	0.0004
1924	220314	40394	39736	53	99.6	0.9965	0.0002
1925	220301	40392	39735	66	99.6	0.9956	0.0003
1926	220275	40387	39733	100	99.6	0.9934	0.0005
1927	220218	40375	39729	83	99.6	0.9945	0.0004
1928	220179	40366	39726	95	99.6	0.9937	0.0004
1929	220130	40355	39722	93	99.5	0.9939	0.0004
1930	220086	40345	39718	120	99.5	0.9921	0.0005
1931	220019	40329	39712	108	99.5	0.9928	0.0005
1932	219966	40316	39708	109	99.4	0.9928	0.0005
1933	219915	40304	39703	95	99.4	0.9937	0.0004
1934	219881	40296	39700	101	99.4	0.9933	0.0005
1935	219842	40287	39697	109	99.4	0.9928	0.0005
1936	219797	40277	39694	121	99.3	0.9920	0.0006
1937	219744	40265	39689	114	99.3	0.9924	0.0005
1938	219700	40255	39685	97	99.3	0.9935	0.0004
1939	219675	40249	39683	86	99.3	0.9942	0.0004
1940	219662	40246	39682	98	99.3	0.9934	0.0004
1941	219637	40241	39681	88	99.2	0.9940	0.0004
1942	219622	40239	39680	51	99.2	0.9964	0.0002
1943	219645	40245	39682	153	99.3	0.9891	0.0007
1944	219565	40226	39675	372	99.2	0.9745	0.0017
1945	219277	40156	39650	721	99.0	0.9522	0.0033
1946	218666	40006	39595	609	98.7	0.9601	0.0028
1947	218202	39886	39551	294	98.4	0.9799	0.0014
1948	218073	39849	39538	267	98.3	0.9819	0.0012
1949	217977	39824	39528	203	98.2	0.9860	0.0009
1950	217948	39818	39526	237	98.2	0.9837	0.0011

Table 14 (continued). Estimated age 1+ biomass, spawning outputs, recruits, total catch, depletion, SPR and relative exploitation rate of widow rockfish from 1916 to 2008 from the base assessment model.

Year	Total biomass (mt)	Spawning output (mil eggs)	Recruit (*1000)	Total catch (mt)	Depletion (%)	SPR	Relative exploitation rate
1951	217885	39807	39522	392	98.2	0.9742	0.0018
1952	217673	39761	39505	371	98.1	0.9754	0.0017
1953	217493	39721	39491	333	98.0	0.9778	0.0015
1954	217357	39691	39479	263	97.9	0.9821	0.0012
1955	217297	39678	39475	280	97.9	0.9810	0.0013
1956	217222	39662	39469	431	97.8	0.9706	0.0020
1957	217003	39612	39450	454	97.7	0.9692	0.0021
1958	216766	39557	39027	529	97.6	0.9644	0.0024
1959	216486	39487	40695	424	97.4	0.9712	0.0020
1960	216377	39446	42326	387	97.3	0.9731	0.0018
1961	216415	39415	41649	323	97.2	0.9772	0.0015
1962	216759	39402	42986	367	97.2	0.9741	0.0017
1963	217244	39380	40807	438	97.1	0.9698	0.0020
1964	217895	39342	49174	510	97.0	0.9637	0.0023
1965	218789	39303	49584	266	96.9	0.9819	0.0012
1966	220314	39364	46890	4379	97.1	0.7403	0.0199
1967	218660	38547	56088	5100	95.1	0.7000	0.0234
1968	216998	37604	54512	2447	92.7	0.8341	0.0113
1969	218628	37325	47187	550	92.1	0.9590	0.0025
1970	224145	37598	125384	629	92.7	0.9546	0.0028
1971	230232	38033	37811	785	93.8	0.9454	0.0034
1972	237641	38588	20010	524	95.2	0.9642	0.0022
1973	246299	39327	17956	949	97.0	0.9393	0.0039
1974	248909	40102	24264	693	98.9	0.9579	0.0028
1975	248657	41162	31291	958	101.5	0.9440	0.0039
1976	245744	42648	13980	1591	105.2	0.9168	0.0065
1977	241201	44432	55224	2811	109.6	0.8624	0.0117
1978	235198	45292	73166	1931	111.7	0.8971	0.0083
1979	230150	45073	20530	3608	111.2	0.8312	0.0157
1980	226845	43610	81040	23167	107.6	0.2697	0.1027
1981	206611	37174	97131	28678	91.7	0.1654	0.1399
1982	182878	29778	31453	27799	73.4	0.1236	0.1524
1983	165858	22991	41267	12296	56.7	0.2807	0.0744
1984	165473	20929	39579	11821	51.6	0.3033	0.0717
1985	162968	19978	29014	10763	49.3	0.3467	0.0662

Table 14 (continued). Estimated age 1+ biomass, spawning outputs, recruits, total catch, depletion, SPR and relative exploitation rate of widow rockfish from 1916 to 2008 from the base assessment model.

Year	Total biomass (mt)	Spawning output (mil eggs)	Recruit (*1000)	Total catch (mt)	Depletion (%)	SPR	Relative exploitation rate
1986	160753	19618	13833	11159	48.4	0.3398	0.0695
1987	156678	20019	36340	15056	49.4	0.2957	0.0965
1988	146582	20248	20421	12211	49.9	0.3614	0.0835
1989	137943	20288	19949	14550	50.0	0.2882	0.1057
1990	127119	19194	38273	11940	47.3	0.3174	0.0944
1991	118507	18185	51695	7657	44.8	0.4308	0.0651
1992	114655	17627	14465	7368	43.5	0.4128	0.0644
1993	112392	16799	20448	9706	41.4	0.3158	0.0866
1994	107715	15458	14368	7701	38.1	0.3545	0.0717
1995	103211	14507	9586	7977	35.8	0.3155	0.0774
1996	97841	13597	9639	7305	33.5	0.3402	0.0748
1997	92080	13266	13084	7757	32.7	0.3481	0.0844
1998	85244	13104	26364	4866	32.3	0.4968	0.0574
1999	81200	13149	20674	4768	32.4	0.4881	0.0590
2000	78036	12852	33828	4664	31.7	0.4773	0.0602
2001	75845	12294	12686	2279	30.3	0.6536	0.0301
2002	76752	12000	33395	432	29.6	0.9128	0.0057
2003	79983	12024	16309	43	29.7	0.9905	0.0005
2004	83281	12259	22192	101	30.2	0.9799	0.0012
2005	86937	12735	16046	199	31.4	0.9648	0.0023
2006	89536	13403	11746	215	33.1	0.9663	0.0024
2007	91678	14171	12698	259	34.9	0.9627	0.0028
2008	92871	14908	18038	243	36.8	0.9651	0.0026
2009	93509	15625	25135		38.5		

Table 15 Asymptotic standard deviations of estimated spawning output (million of eggs) and recruitment (*1000).

Year	Std dev Spawning output	Std dev Age 0 recruits	Year	Std dev Spawning output	Std dev Age 0 recruits	Year	Std dev Spawning output	Std dev Age 0 recruits
1916	2983	2886	1951	2952	2804	1986	2420	3754
1917	2983	2884	1952	2950	2799	1987	2343	5665
1918	2983	2881	1953	2947	2795	1988	2308	4542
1919	2983	2878	1954	2944	2791	1989	2291	4780
1920	2983	2876	1955	2941	2789	1990	2279	7827
1921	2982	2874	1956	2937	2786	1991	2274	10848
1922	2982	2872	1957	2934	2781	1992	2271	4716
1923	2982	2871	1958	2931	19002	1993	2263	6047
1924	2982	2870	1959	2927	19381	1994	2264	5083
1925	2982	2870	1960	2923	19465	1995	2280	3990
1926	2981	2869	1961	2920	18590	1996	2332	4313
1927	2981	2868	1962	2917	17938	1997	2463	6045
1928	2980	2867	1963	2927	17074	1998	2663	10823
1929	2979	2865	1964	2991	18296	1999	2857	9712
1930	2978	2864	1965	3162	17862	2000	3012	14075
1931	2977	2862	1966	3400	16836	2001	3128	6372
1932	2976	2861	1967	3657	17199	2002	3209	15289
1933	2975	2859	1968	3867	16067	2003	3279	9228
1934	2974	2858	1969	4011	15975	2004	3396	12824
1935	2973	2857	1970	4103	17755	2005	3601	9481
1936	2971	2855	1971	4162	10807	2006	3887	6993
1937	2970	2854	1972	4189	6130	2007	4222	7567
1938	2969	2852	1973	4185	5278	2008	4565	10746
1939	2968	2851	1974	4154	5975	2009	4919	17807
1940	2967	2851	1975	4097	5512			
1941	2965	2850	1976	4022	3881			
1942	2964	2849	1977	3937	6339			
1943	2963	2849	1978	3820	7313			
1944	2962	2847	1979	3662	5308			
1945	2961	2840	1980	3463	8494			
1946	2960	2826	1981	3263	9598			
1947	2958	2814	1982	3060	6274			
1948	2957	2810	1983	2850	6098			
1949	2955	2807	1984	2677	5918			
1950	2953	2806	1985	2538	4819			

Table 16 Comparisons of key parameters and model outputs between the base model and sensitivity model runs. All runs were converged and had maximum gradient component less than 0.001.

Description	Base case	Recruit distribution estimated (1978-2003)	No *h* prior	Juvenile survey CV=0.2
Management quantities				
B_0 (million of eggs)	40547	39102	41473	40671
2007 depletion (%)	34.9	32.0	30.2	32.3
2009 depletion (%)	38.5	35.4	32.7	38.0
No. of parameters estimated	115	140	115	115
Negative log-likelihoods				
Total	650.068	588.143	649.072	643.935
Catch	3.3E-10	3.3E-10	3.3E-10	3.3E-10
Indices	-5.080	-3.410	-5.403	-14.593
Length composition	84.483	79.486	84.049	84.403
Age composition	564.524	504.245	546.820	564.745
Recruitment	5.290	4.822	5.571	8.379
Priors	0.816	0.784	NA	0.966
Parameter soft bound	0.0394	0.0334	0.0341	0.0341
Other parameter values				
Steepness (*h*)	0.4061	0.4135	0.3360	0.3738
Proportion of recruits to north	0.7170	Variable	0.7226	0.7175

Table 17 Comparisons of key parameters and model outputs between the base model and two fix proportions of recruitment to the northern area (0.6875 and 0.7500). All runs were converged and had maximum gradient component less than 0.001.

Description	Proportion of recruitment to northern area = 0.6875	Base case (PropN=0.7170)	Proportion of recruitment to northern area = 0.7500
Management quantities			
B_0 (million of eggs)	38709	40547	44226
2007 depletion (%)	43.3	34.9	32.4
2009 depletion (%)	48.7	38.5	34.9
No. of parameters estimated	114	115	114
Negative log-likelihoods			
Total	651.097	650.068	651.801
Catch	3.3E-10	3.3E-10	3.3E-10
Indices	-4.466	-5.080	-5.521
Length composition	82.298	84.483	82.890
Age composition	563.499	564.524	567.935
Recruitment	5.395	5.290	5.170
Priors	0.333	0.816	1.292
Parameter soft bound	0.0372	0.0394	0.0331
Other parameter values			
Steepness (*h*)	0.5560	0.4061	0.3204
Proportion of recruits to north	0.6875	0.7170	0.7500

Table 18 Comparisons of key parameters and model outputs between the base model and retrospective analysis runs. All runs were converged and had maximum gradient component less than 0.001.

Description	Base case	Retrospective 1 year	Retrospective 2 year	Retrospective 4 year
Management quantities				
B_0 (million of eggs)	40547	40141	40401	40096
2007 depletion (%)	34.9	40.6	41.1	38.0
2009 depletion (%)	38.5	47.0	48.5	41.1
Other parameter values				
Steepness (*h*)	0.4061	0.5354	0.5374	0.4951
Proportion of recruits to north	0.7170	0.7159	0.7156	0.7128

Table 19. Comparisons of key parameters between this assessment (2009 base model) and the base model of the 2007 assessment (2007 base model).

Parameter and estimate	2007 base model	2009 model
Unfished spawning output (B_0) (millions of eggs)	50746	40547
Steepness (*h*)	0.2904	0.4061
2007 spawning output (B_t) (millions of eggs)	17999	14170
2009 spawning output (B_t) (millions of eggs)	NA	15625
2007 depletion ($100*B_t/B_0$)	35.47	34.9
2009 depletion ($100*B_t/B_0$)	Na	38.5
2007 standard deviation of depletion	6.32	10.55
2009 standard deviation of depletion	NA	12.43

Table 20. Decision table of 12-year projections for widow rockfish. Alternate states of nature and management options begin in 2011.

			State of nature					
			h = 0.25		Base case (h=0.4061)		*h* = 0.55	
Management decision	Year	Catch (mt)	Depletion(%)	Spawning output (mil eggs)	Depletion(%)	Spawning output (mil eggs)	Depletion(%)	Spawning output (mil eggs)
F95%	2009	522	25.2%	10949	38.5%	15625	48.6%	19238
	2010	509	25.4%	11029	39.9%	16178	50.9%	20118
	2011	359	25.4%	11006	40.9%	16580	52.6%	20812
	2012	342	25.1%	10887	41.4%	16801	53.7%	21259
	2013	324	24.6%	10672	41.5%	16838	54.2%	21453
	2014	317	24.0%	10421	41.4%	16797	54.4%	21530
	2015	327	23.6%	10239	41.6%	16863	54.9%	21720
	2016	346	23.4%	10175	42.2%	17120	55.9%	22118
	2017	366	23.5%	10205	43.2%	17533	57.3%	22682
	2018	383	23.7%	10286	44.5%	18032	59.0%	23329
	2019	399	23.9%	10387	45.8%	18570	60.7%	24012
	2020	411	24.2%	10494	47.2%	19123	62.5%	24705
F50%	2009	522	25.2%	10949	38.5%	15625	48.6%	19238
	2010	509	25.4%	11029	39.9%	16178	50.9%	20118
	2011	5210	25.4%	11006	40.9%	16580	52.6%	20812
	2012	4556	22.7%	9836	38.9%	15764	51.1%	20225
	2013	3963	20.0%	8680	36.7%	14865	49.3%	19484
	2014	3632	17.6%	7653	34.6%	14042	47.5%	18775
	2015	3598	15.8%	6841	33.2%	13462	46.3%	18311
	2016	3718	14.4%	6244	32.5%	13159	45.9%	18138
	2017	3854	13.3%	5778	32.2%	13046	45.9%	18164
	2018	3960	12.3%	5359	32.1%	13024	46.2%	18288
	2019	4016	11.4%	4932	32.1%	13027	46.6%	18450
	2020	4028	10.3%	4469	32.1%	13021	47.1%	18623

11 Figures

Figure 1. U.S. catches of widow rockfish by four fisheries from 1916 to 2008. Four fisheries are defined by area and gear type. Bycatches are included. Detail numbers are presented in Table 1.

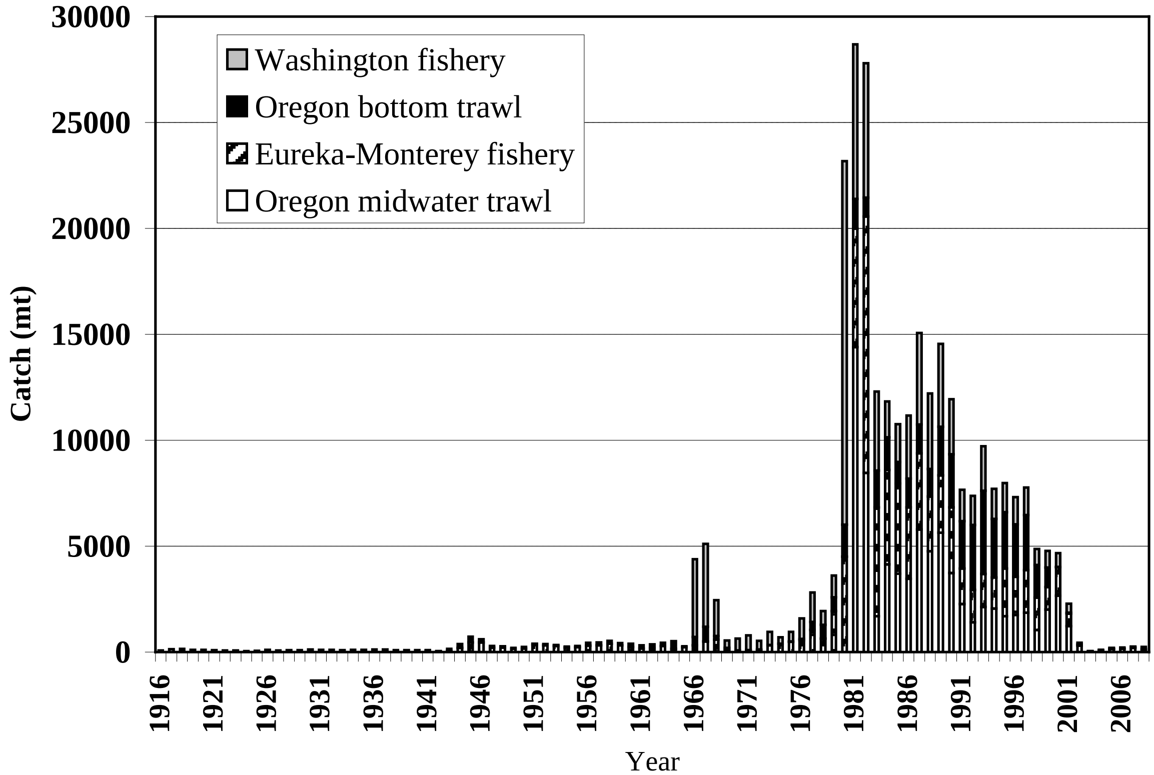


Figure 2. Area map that shows the northern and southern areas delineated by 43° N latitude.

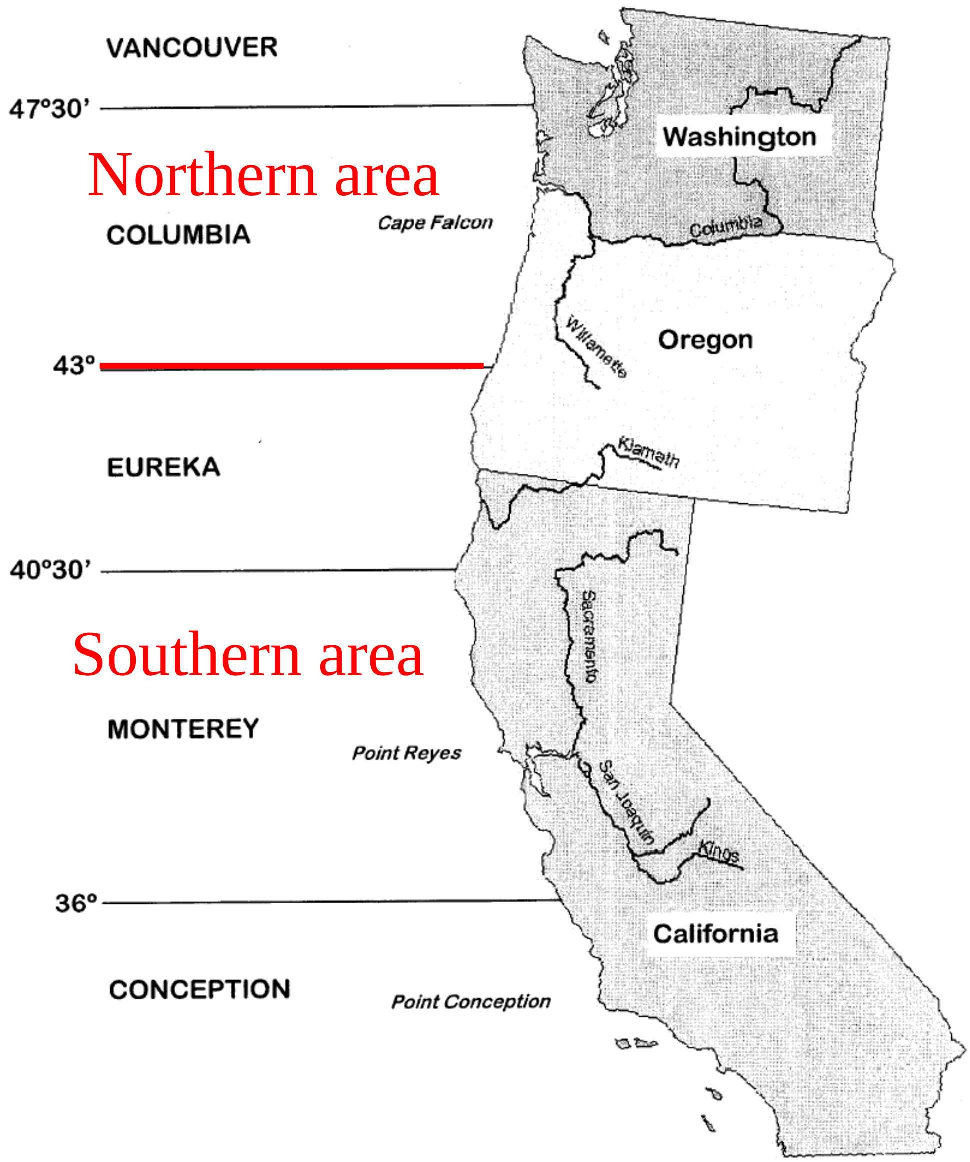
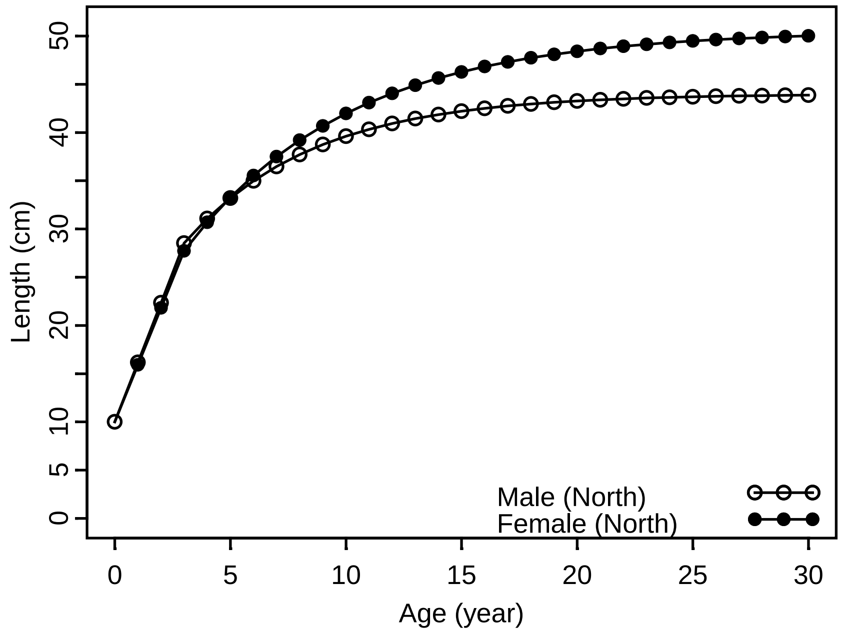


Figure 3. Growth functions for both sexes of widow rockfish for northern and southern areas.



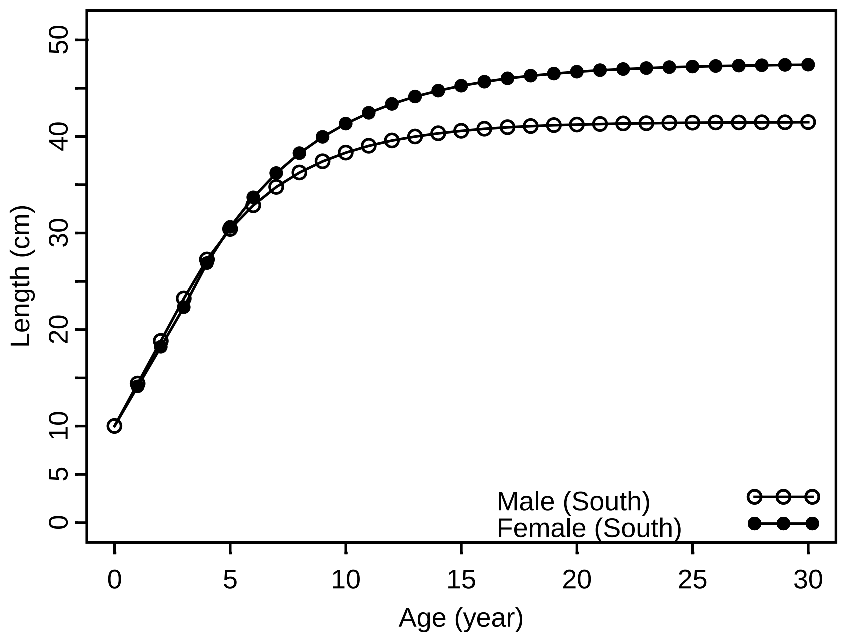


Figure 4. Fecundity of widow rockfish for northern and southern areas.

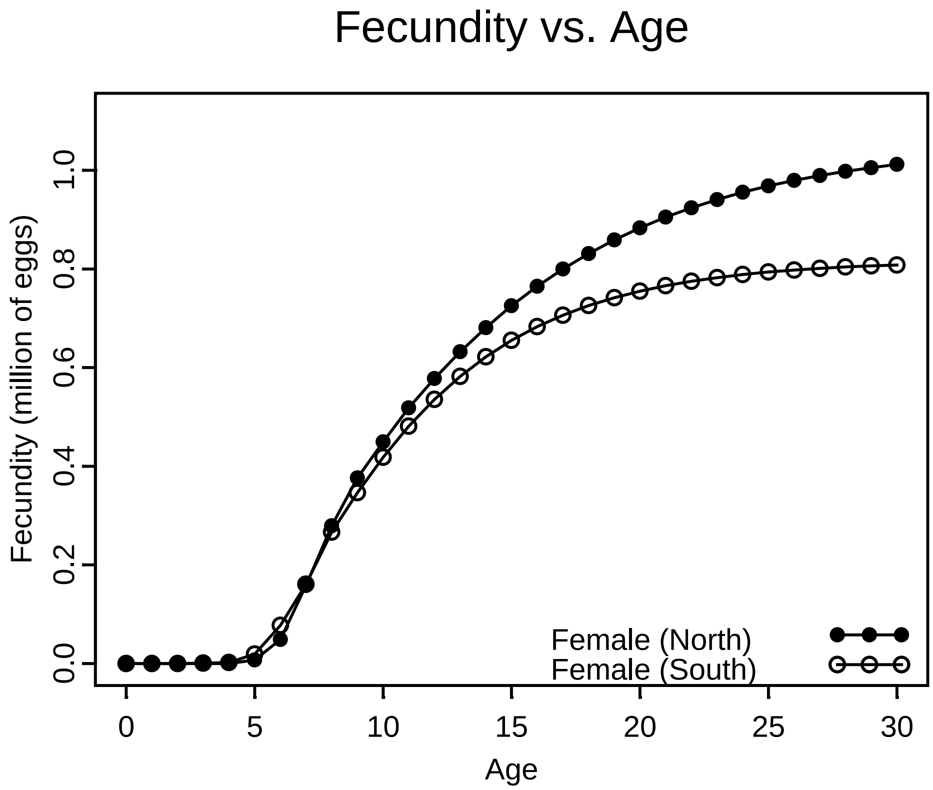


Figure 5. Age composition data from the Vancouver-Columbia fishery from 1980 to 2008.

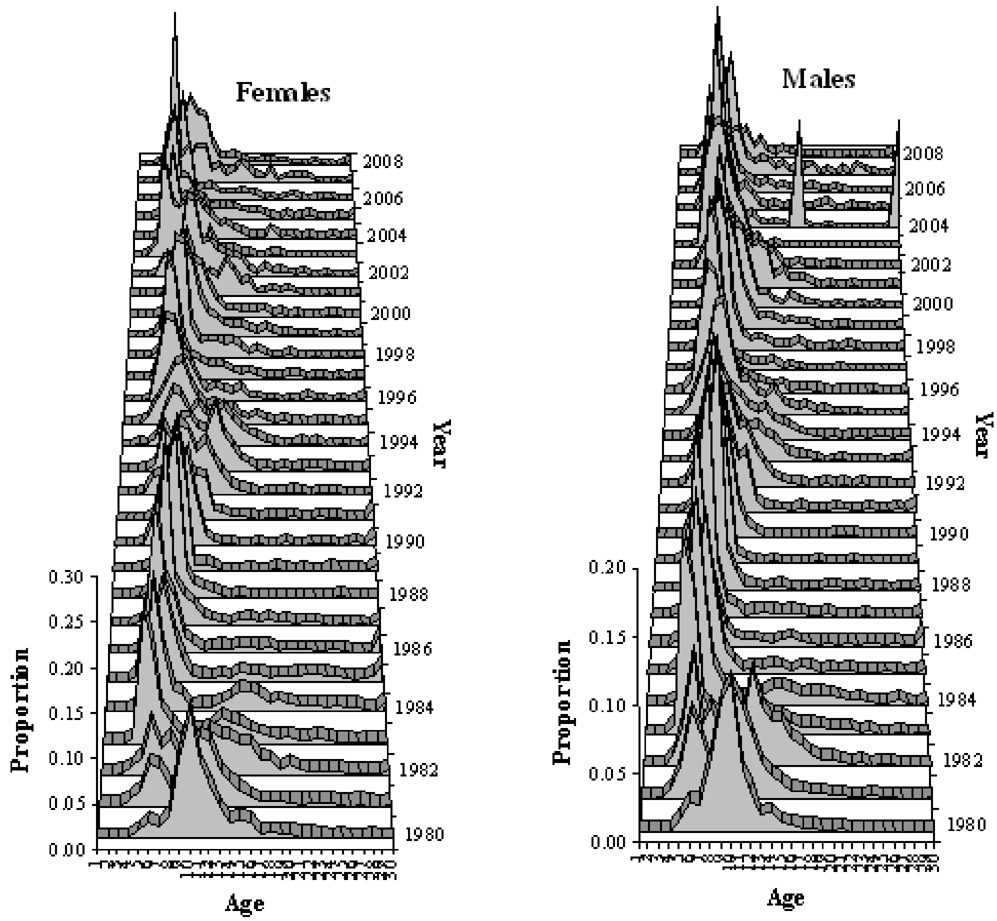


Figure 6. Age composition data from the Oregon mid-water trawl fishery from 1984 to 2008.

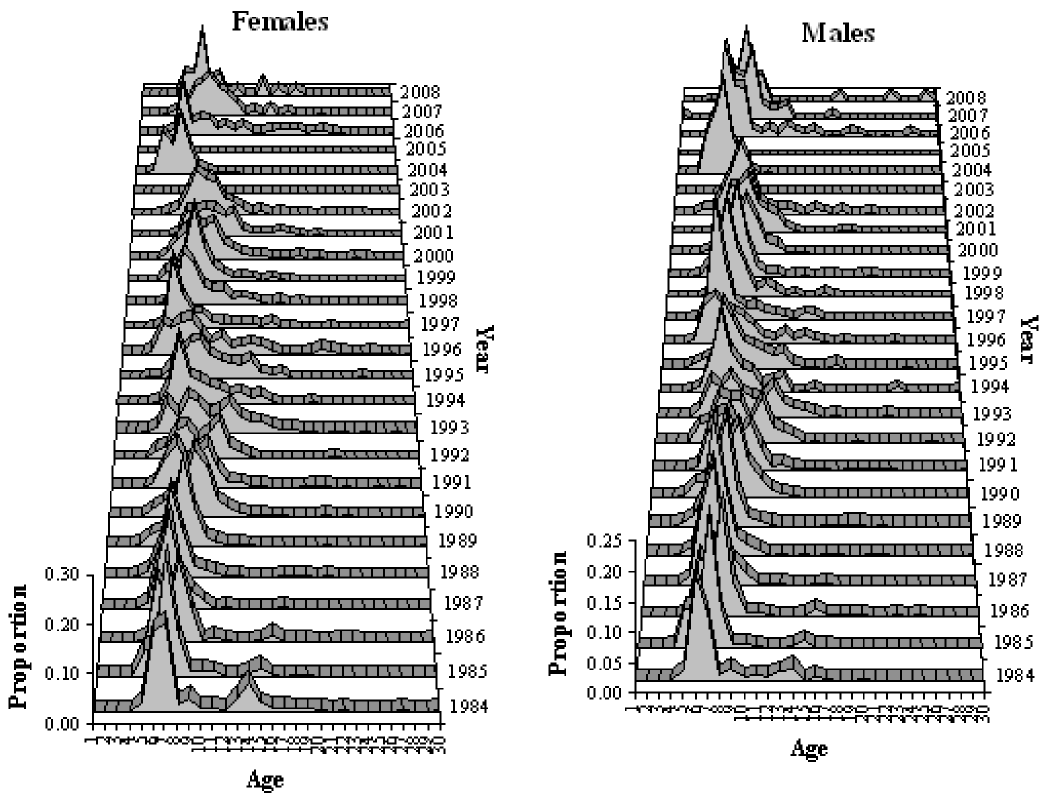


Figure 7. Female age composition data from the Oregon bottom trawl fishery from 1984 to 2008.

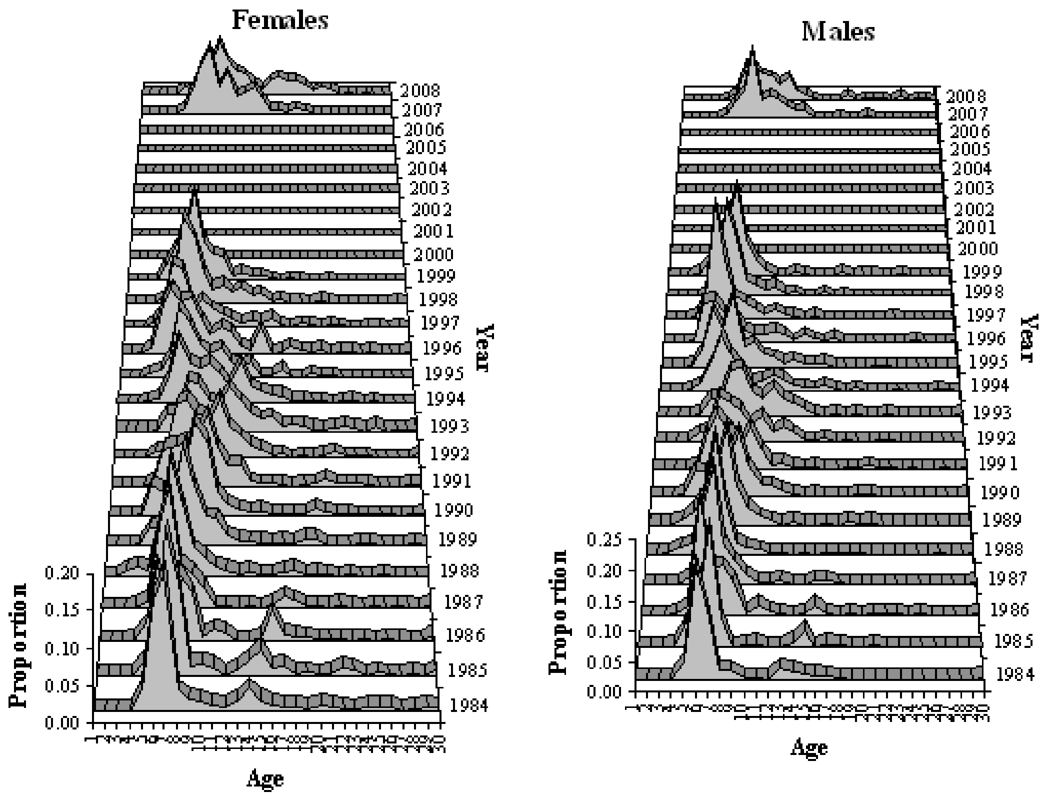


Figure 8. Age composition data from the Eureka-Conception fishery from 1978 to 2008.

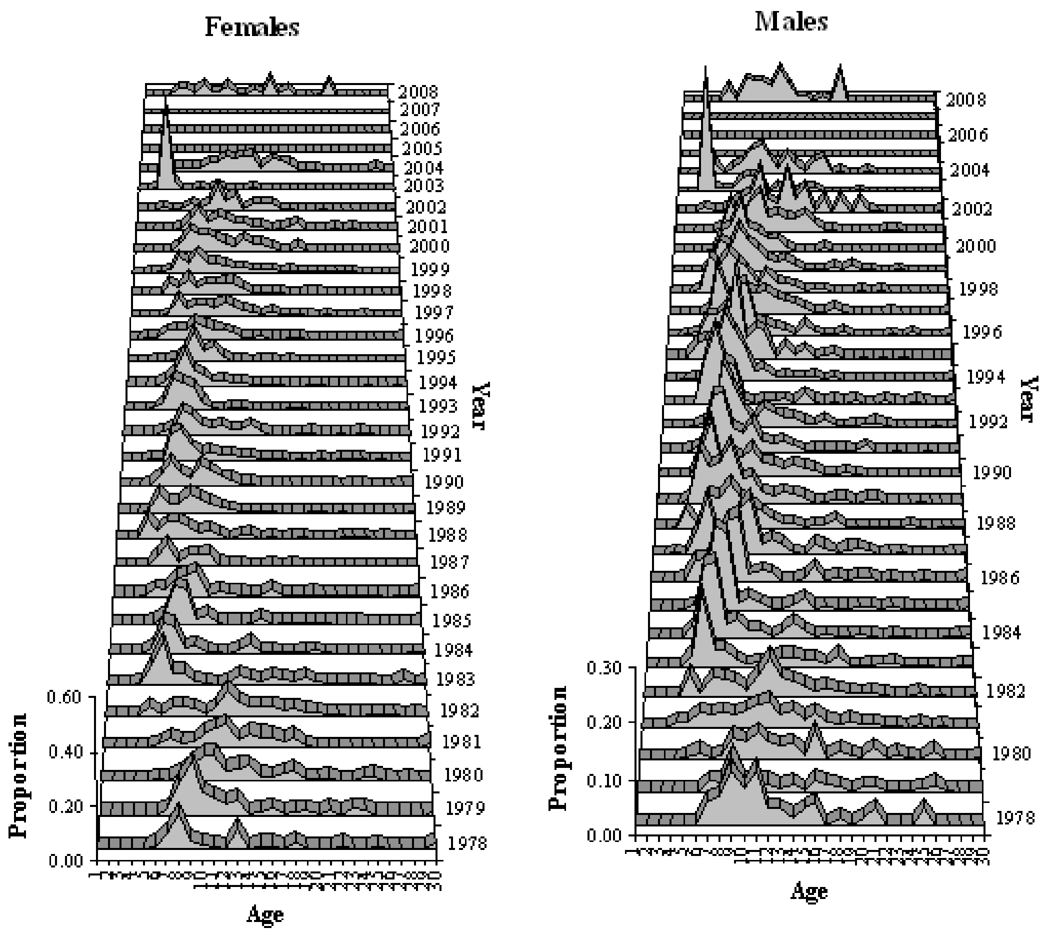


Figure 9. Length composition data from the northern area triennial suvery from 1980 to 2004.

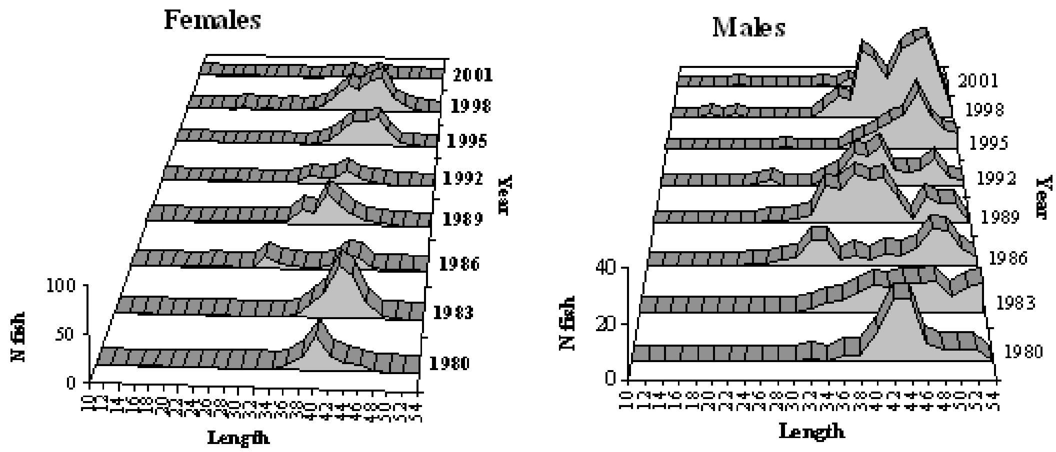


Figure 10. Length composition data for the southern area triennial survey from 1980 to 2004.

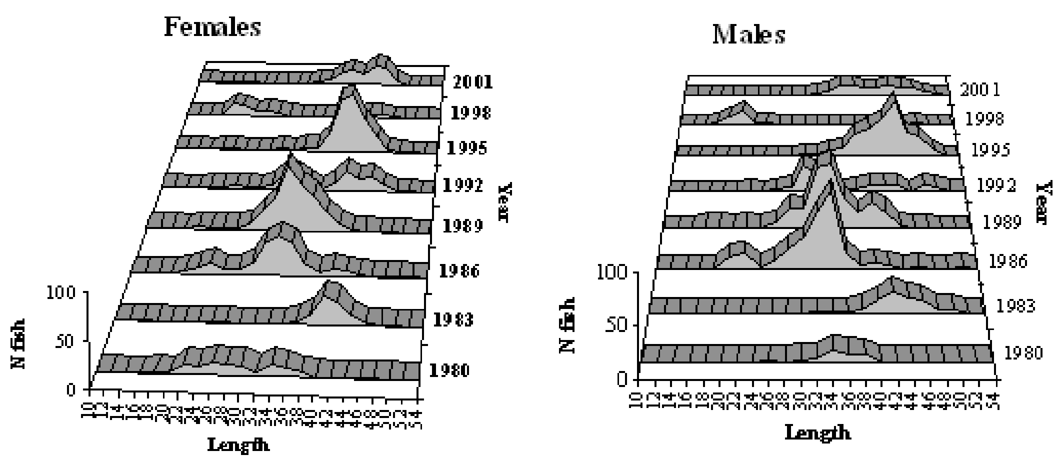


Figure 11. Age composition data from the NWFSC northern area survey from 2003 to 2008.

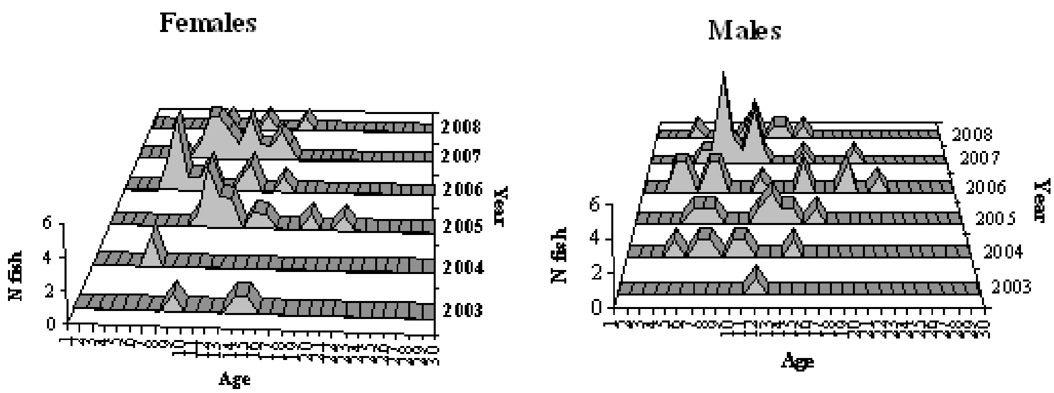


Figure 12. Age composition data from the NWFSC southern area survey from 2003 to 2008.

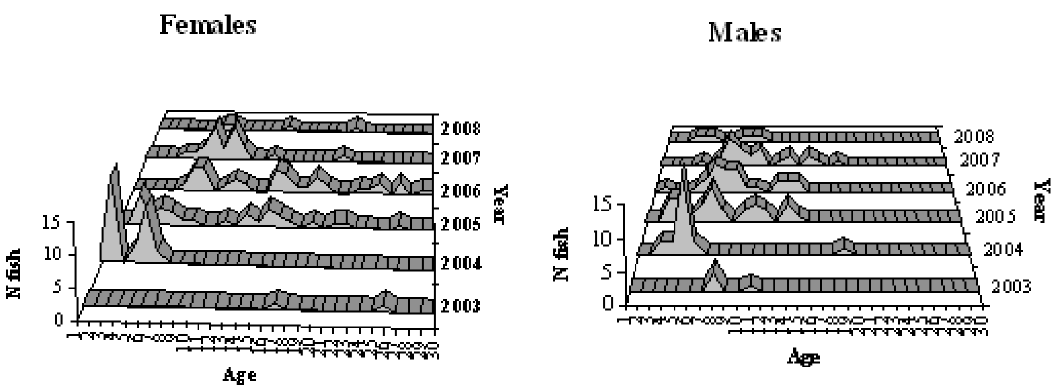


Figure 13. Length composition data from the NWFSC northern area survey from 2003 to 2008.

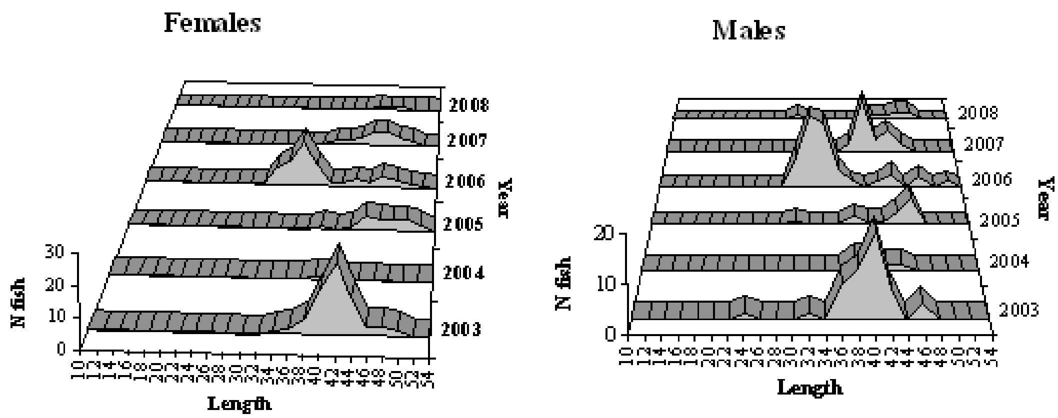


Figure 14. Length composition data from the NWFSC southern area survey from 2003 to 2008.

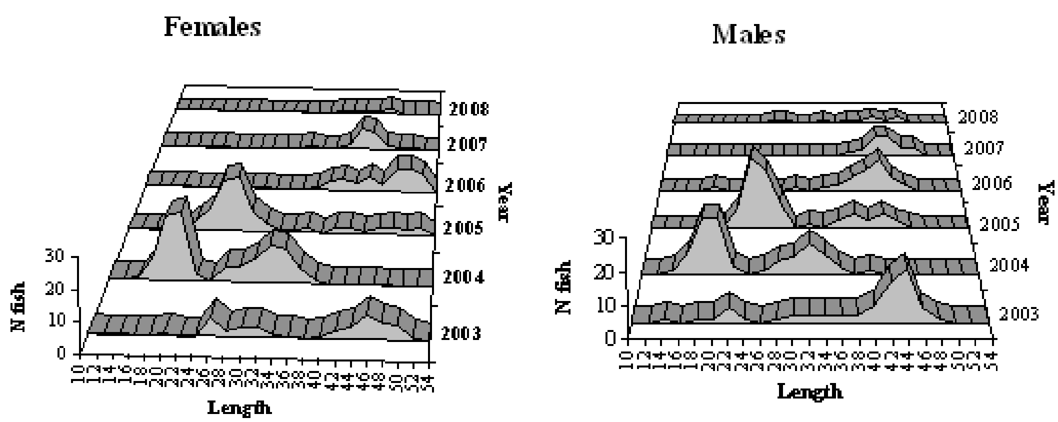


Figure 15. Fraction of landings in the north area, defined as the Vancouver-Columbia and Oregon trawl fisheries, with a 7-year moving average. Note that the fractions before 1977 were fixed at the value computed before the foreign landings (Rogers 2003) were added. This time series of fraction was used in the previous assessments as proportion recruits to the northern area.

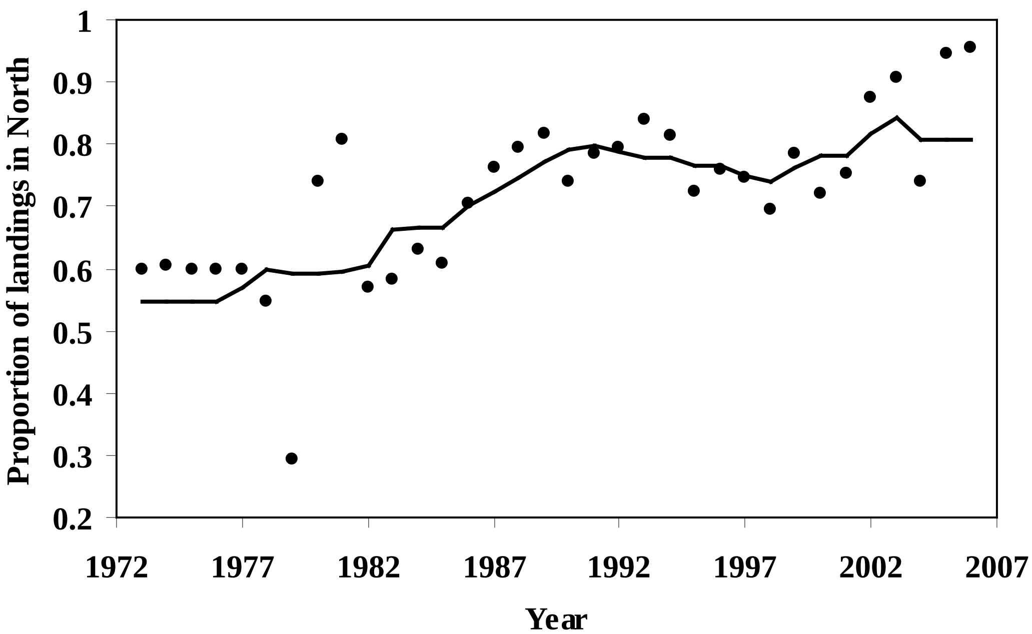


Figure 16. Time series of scaled abundance indices of the Oregon bottom trawl logbook and triennial survey for the northern and southern areas.

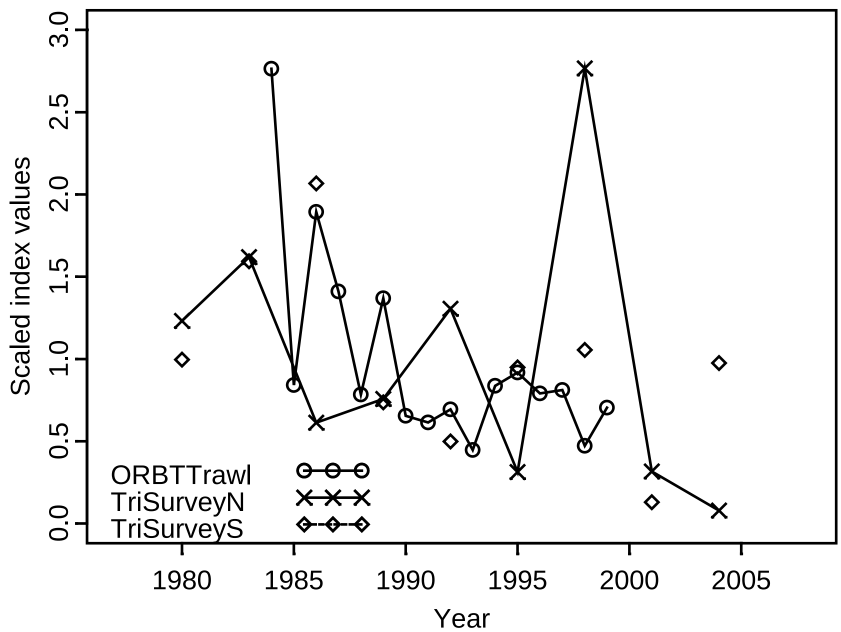


Figure 17. Time series of scaled abundance indices of three whiting bycatch fisheries (foreign, joint venture, and domestic), and the NWFSC survey for the northern and southern areas.

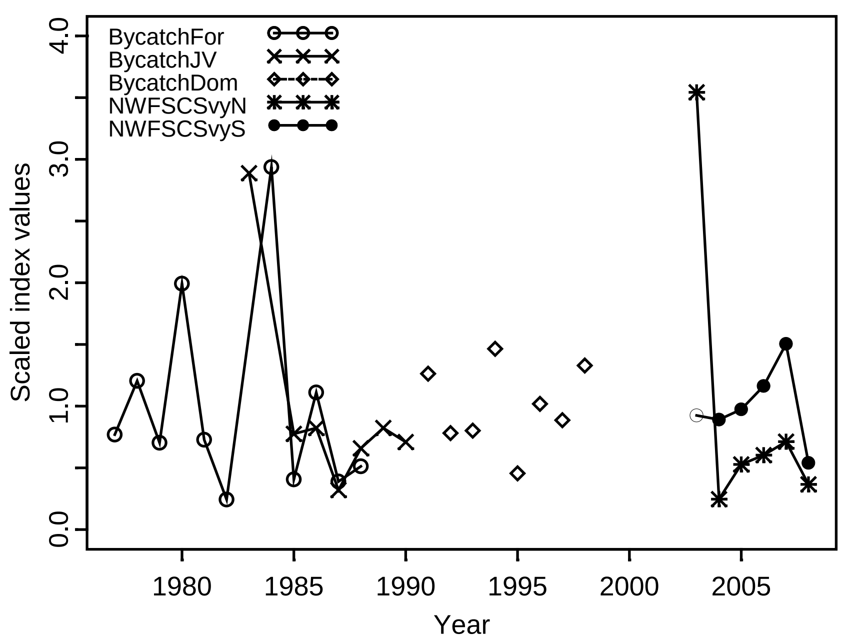


Figure 18. Comparisons of time series of spawning outputs between the reweighted post-STAR model (PostSTARRewet2), the final base model (PostSTARBase), and the pre-STAR base model (PreSTARBase).

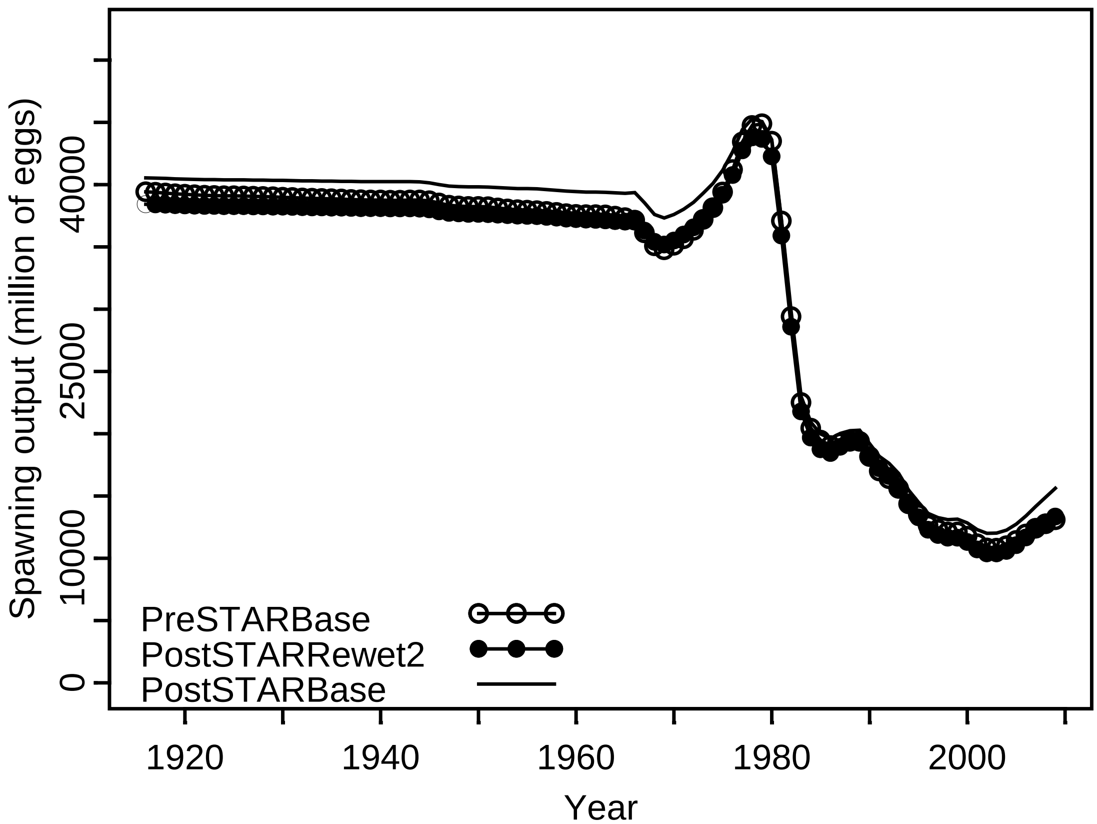


Figure 19. Comparisons of time series of recruitments between the reweighted post-STAR model (PostSTARRewet2), the final base model (PostSTARBase), and the pre-STAR base model (PreSTARBase).

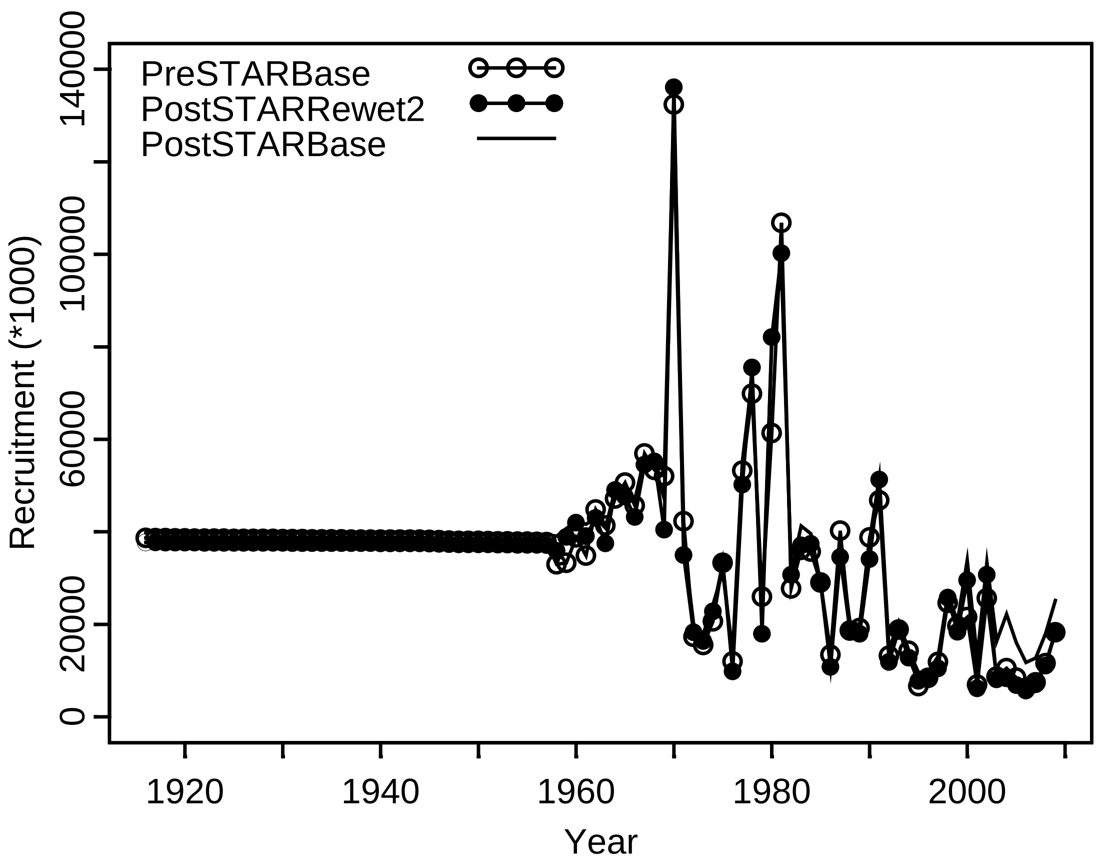


Figure 20. Time series of age spawning output from 1916 to 2009 estimated from the base model for two areas (area1 = northern area, area2 = southern area).

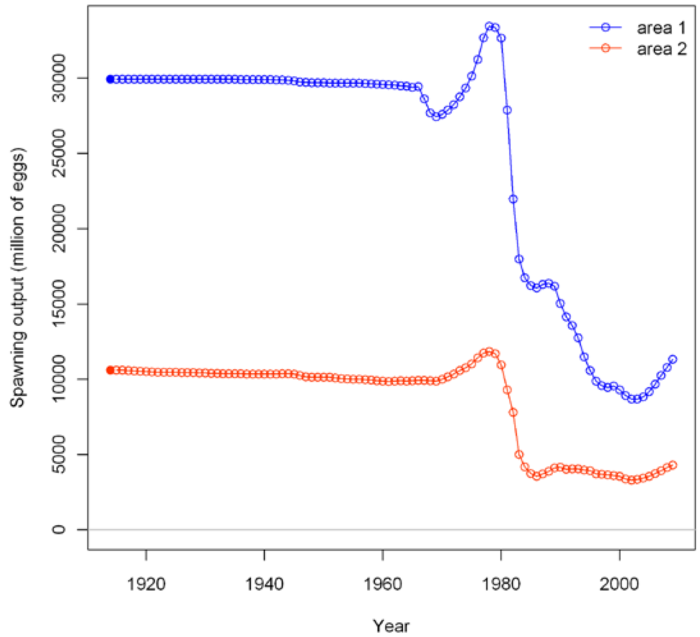


Figure 21. Time series of spawning outputs of the population from 1916 to 2009 with 95% asymptotic intervals estimated from the base model.

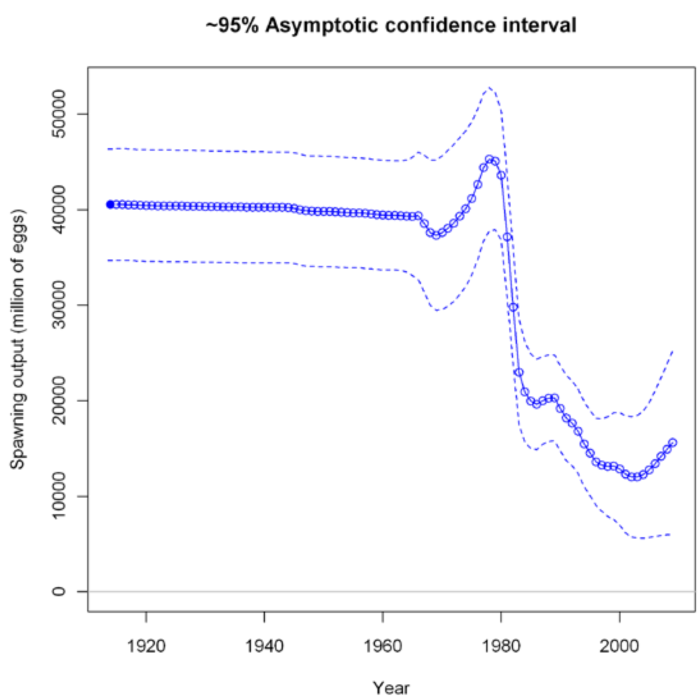


Figure 22. Time series of depletion from 1916 to 2009 with 95% asymptotic intervals estimated from the base model. Levels of management target and minimum stock size threshold are also shown.

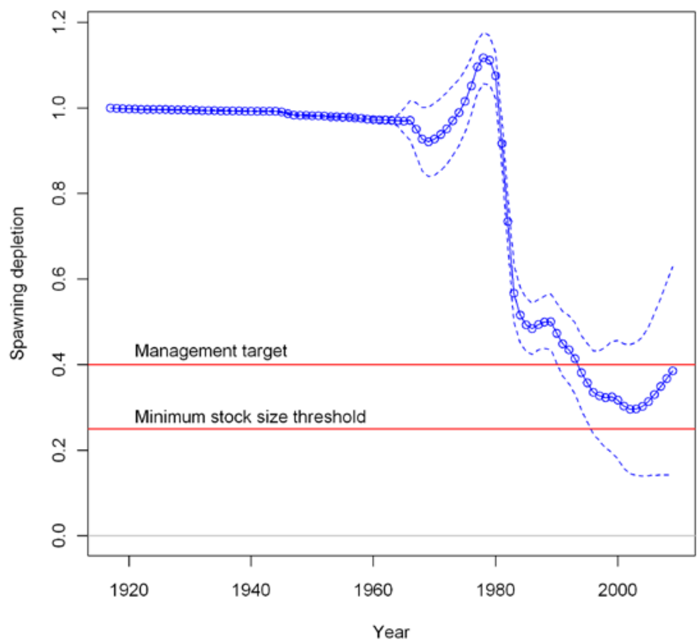


Figure 23. Estimated stock-recruit relationships from the base model (dark line). The expected recruits are bias-adjusted (green line). Open circles are actual recruitment.

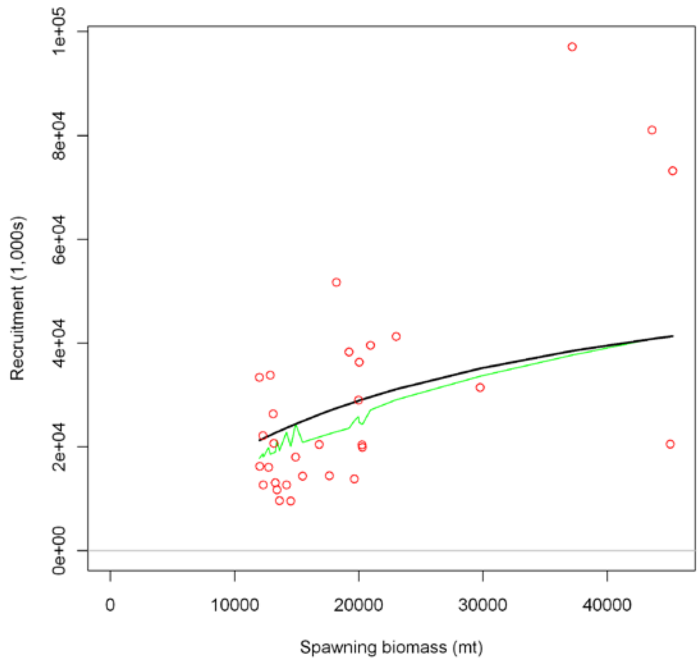


Figure 24. Estimated total recruitment and their 95% of asymptotic confidence intervals from 1916 to 2009 from the base model.

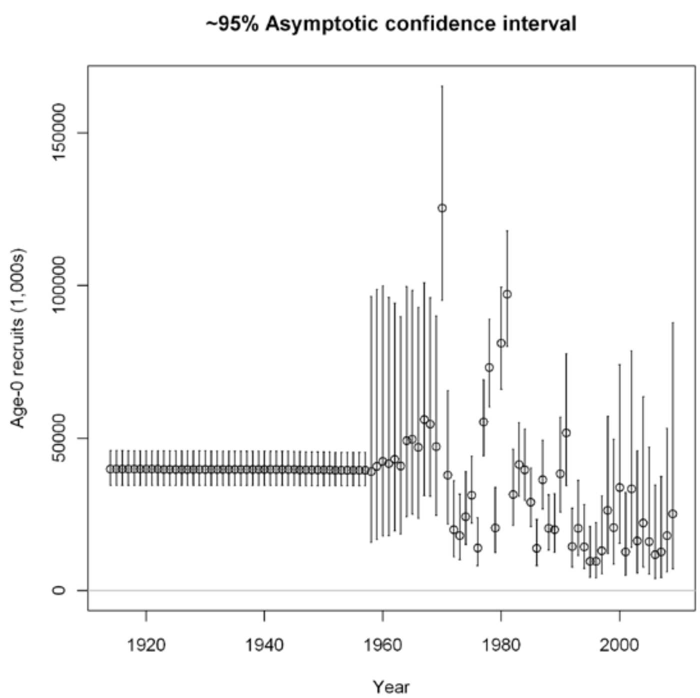


Figure 25. Time series of recruitment estimated from the base model from 1916 to 2009 along with virgin and initial recruitment and bias-adjusted values. Note that the y-axis is in log-scale.

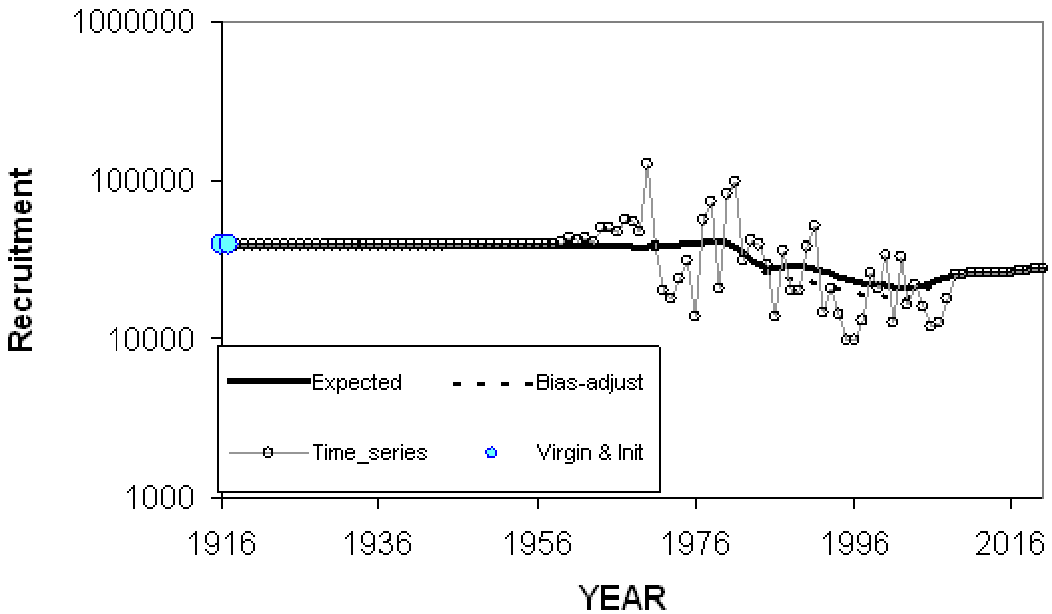


Figure 25. Time series of recruitment deviations estimated from the base model from 1958 to 2008.

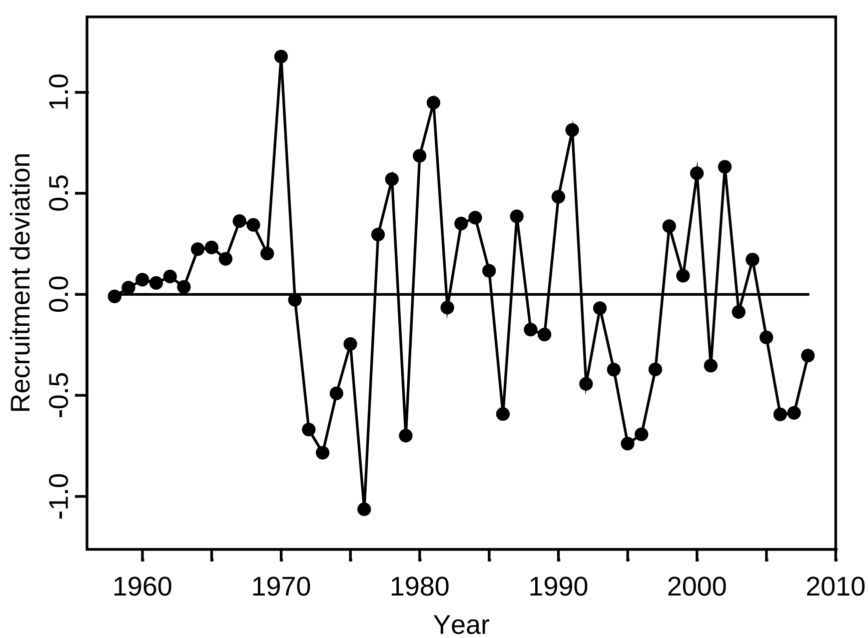
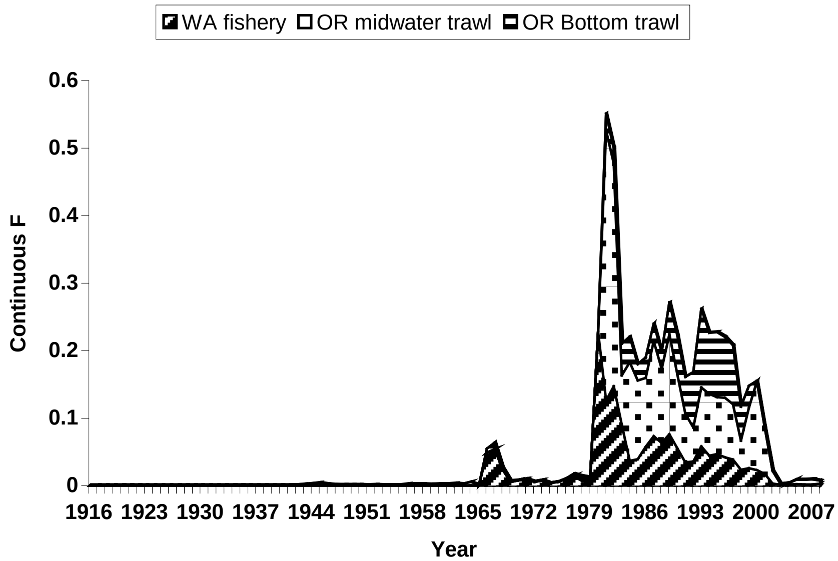


Figure 27. Time series of fishing mortalities for four fisheries in the northern area (top) and in the southern area (bottom) from 1916 to 2008.



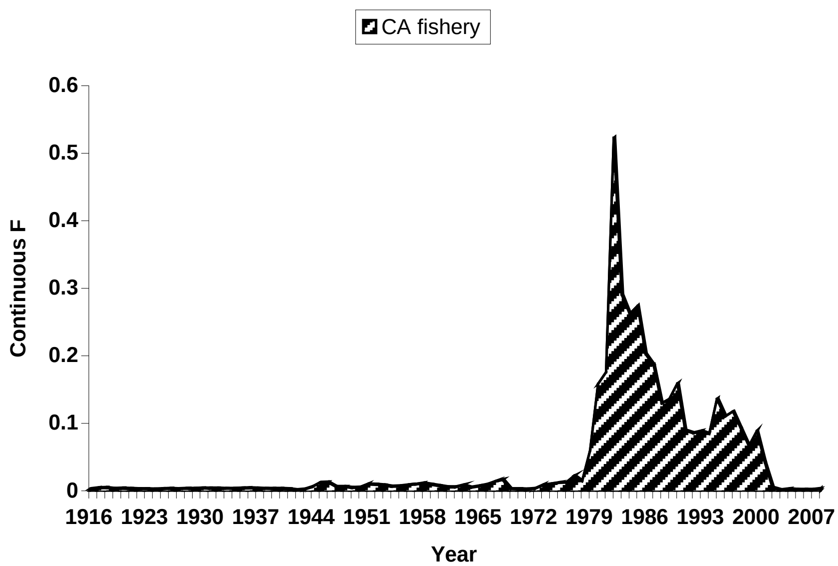


Figure 28. Model fit to the index of the juvenile fish survey from 2001 to 2008.

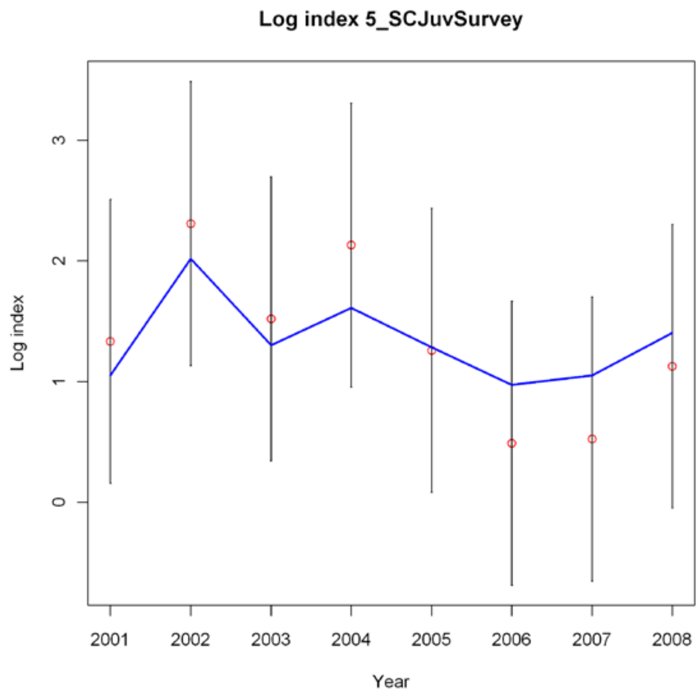


Figure 29. Model fits to the Oregon bottom trawl logbook index.

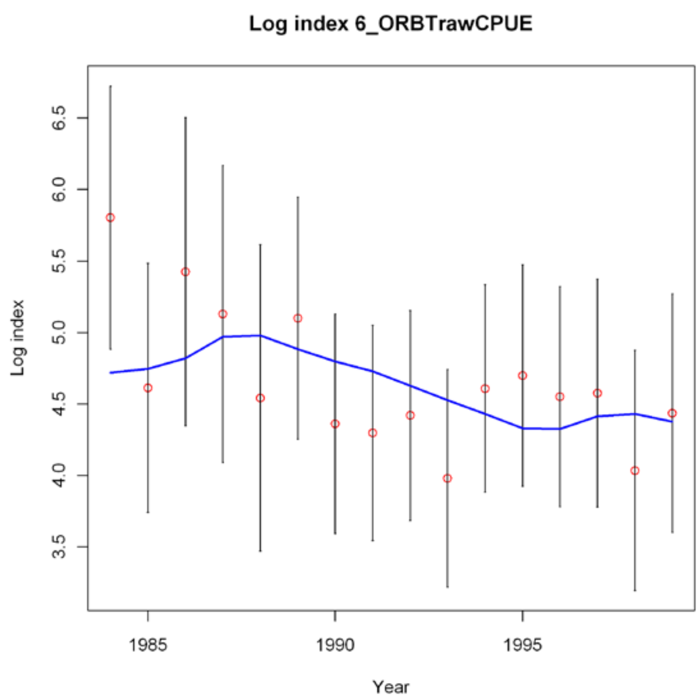


Figure 30. Model fits to the northern area triennial survey index

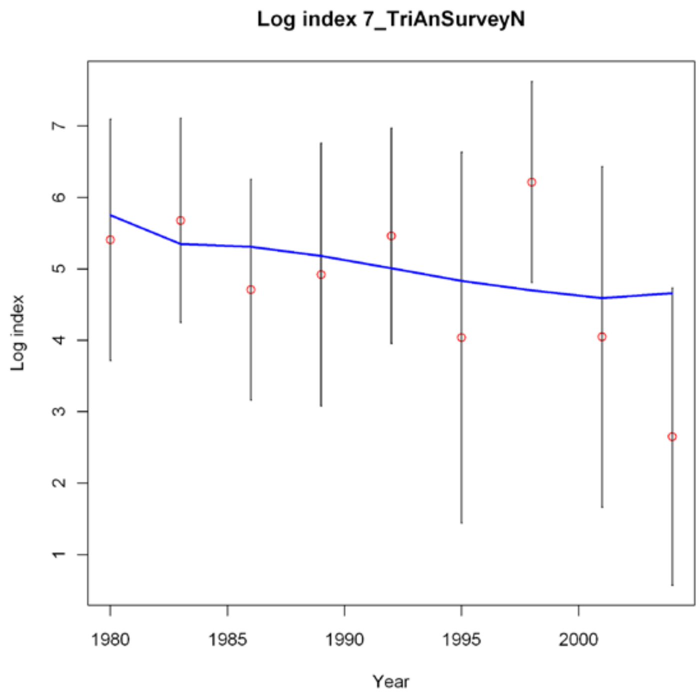


Figure 31. Model fits to the southern area triennial survey index.

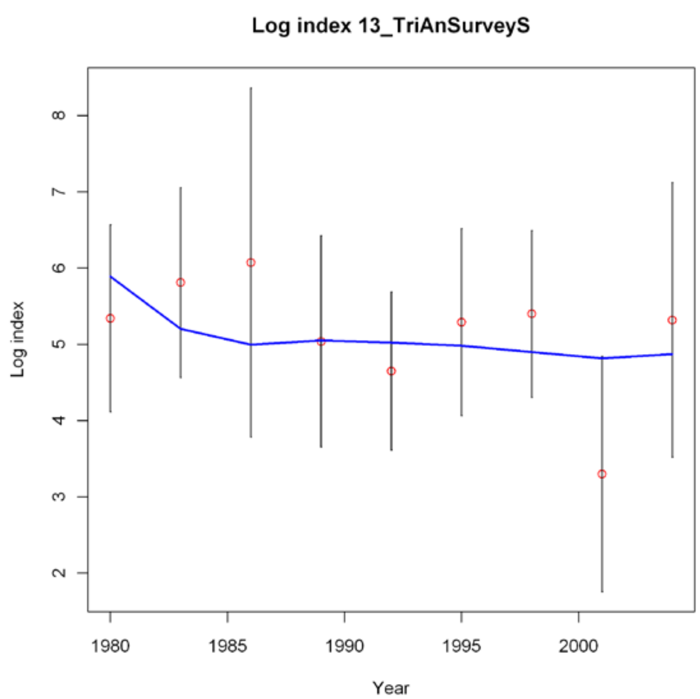


Figure 32. Model fits to the Pacific whiting foreign fishery bycatch index.

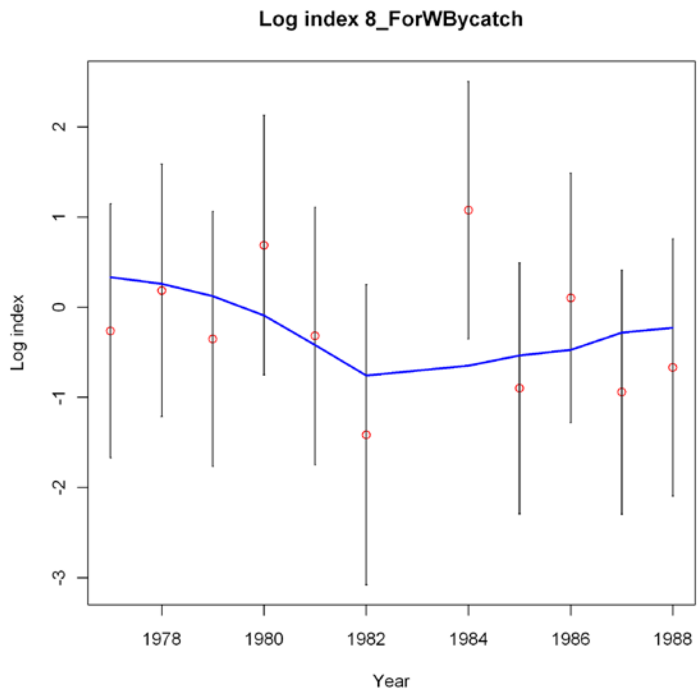


Figure 33. Model fits to the Pacific whiting joint venture fishery bycatch index.

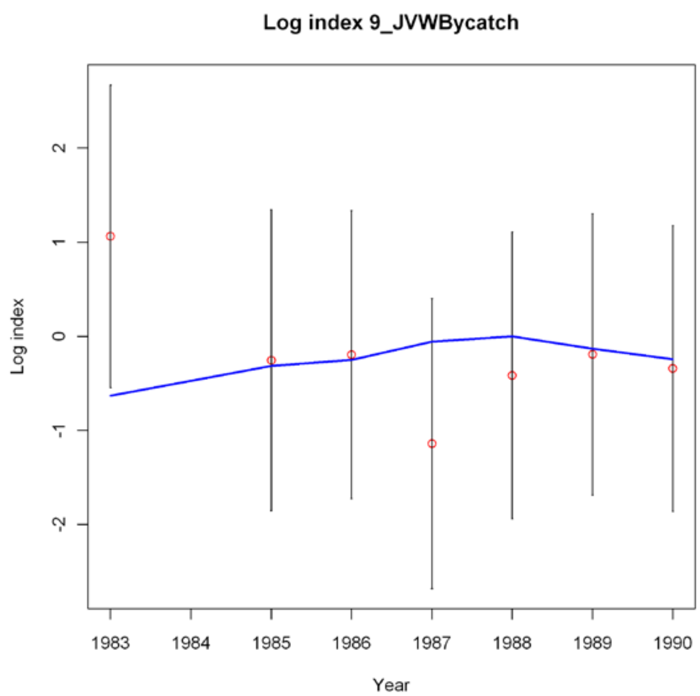


Figure 34. Model fits to the Pacific whiting domestic fishery bycatch index.

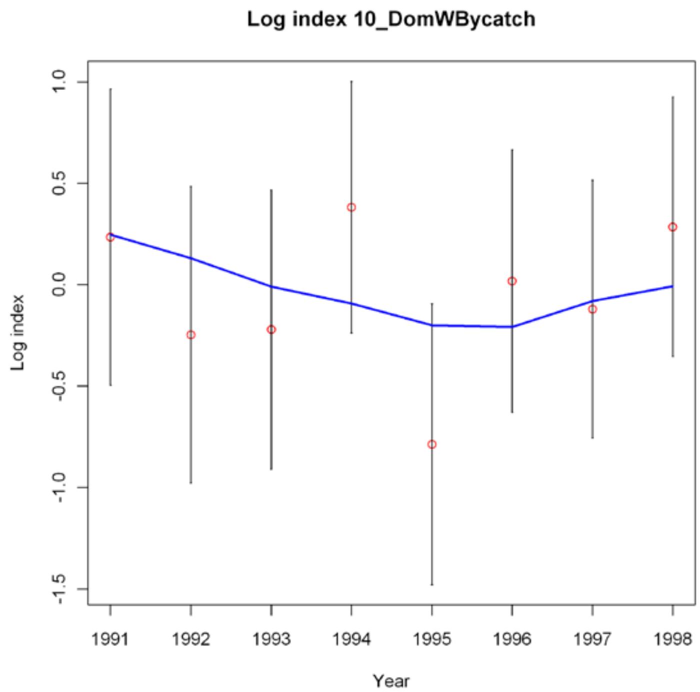


Figure 35. Model fits to the NWFSC northern area survey index.

Figure 36. Model fits to the NWFSC southern area survey index.

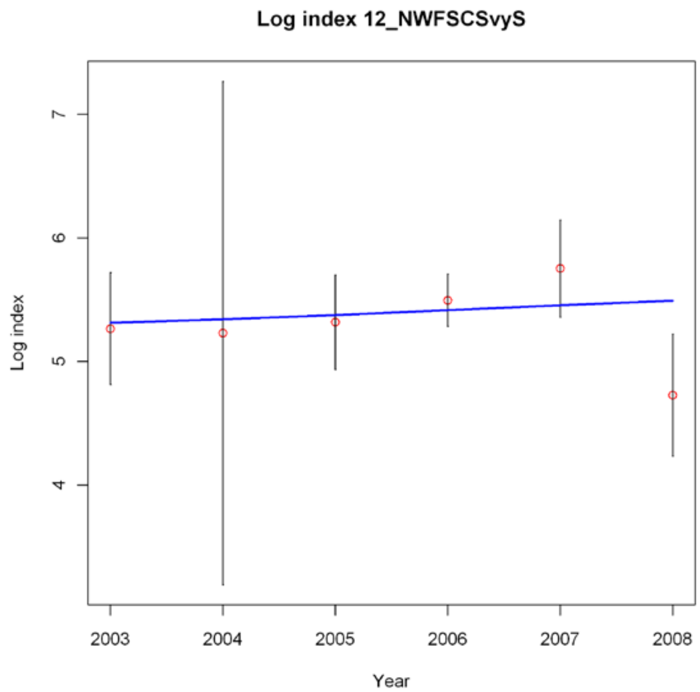


Figure 37. Estimated age selectivity curves for the Washington fishery for females (top) and males (bottom).

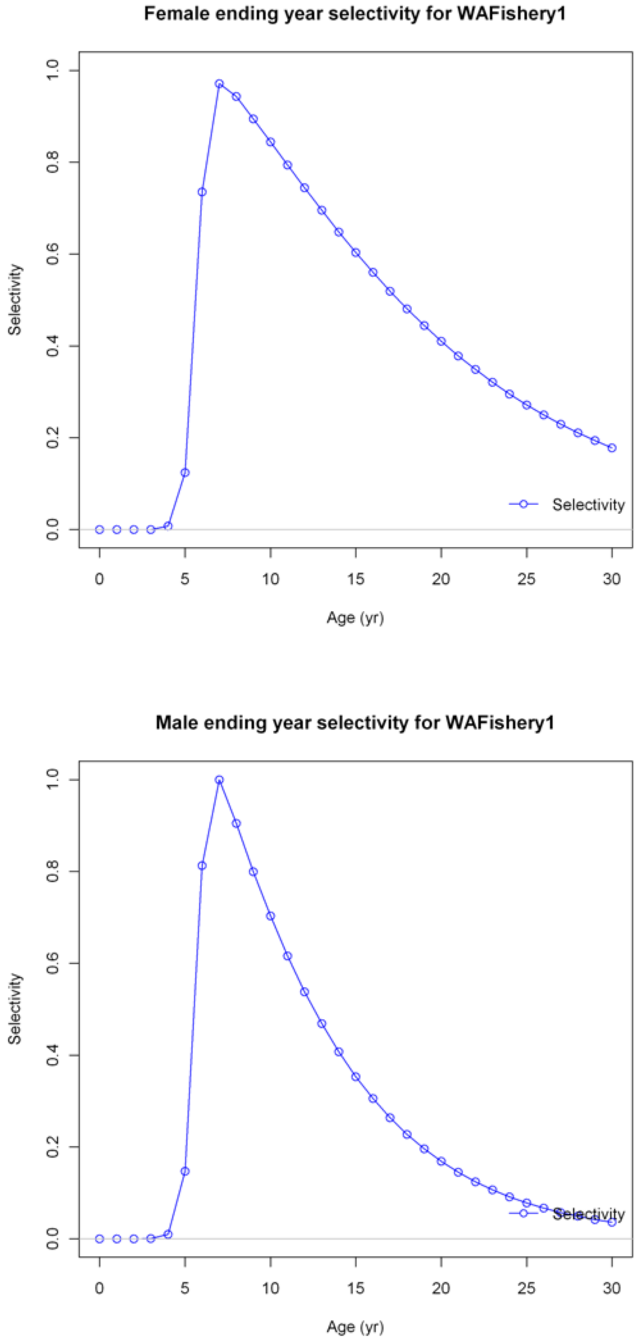


Figure 38. Estimated age selectivity curves for the Oregon mid-water trawl fisheries for females (top) and males (bottom).

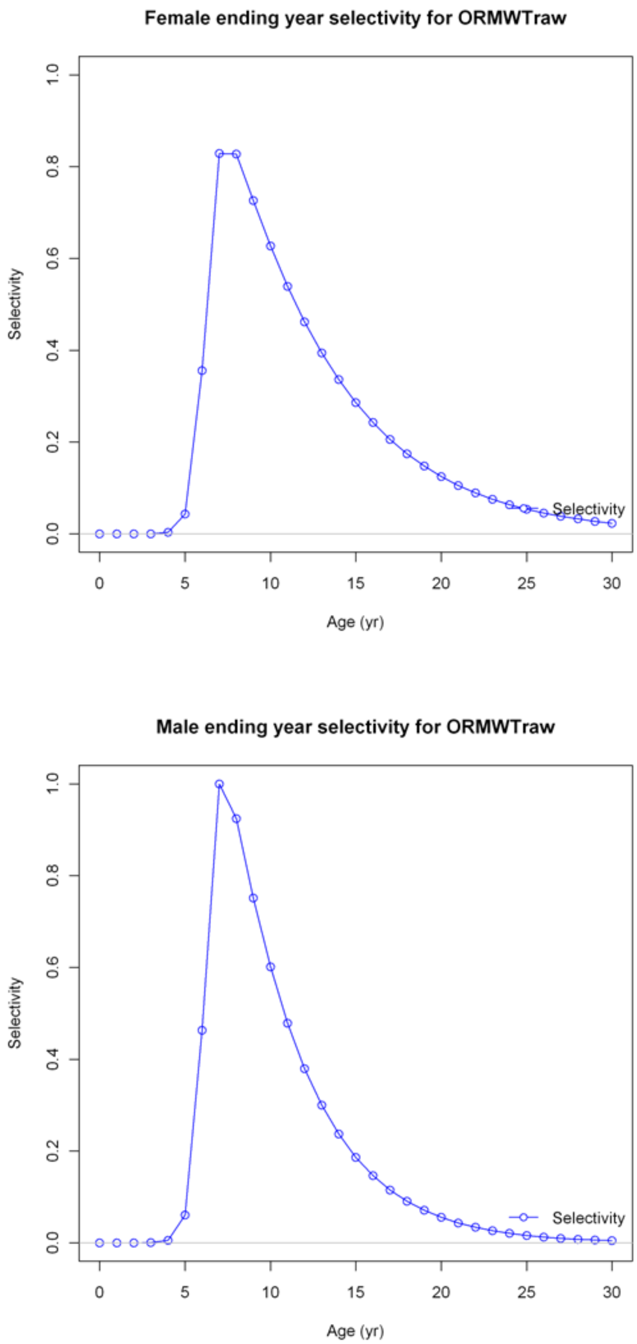
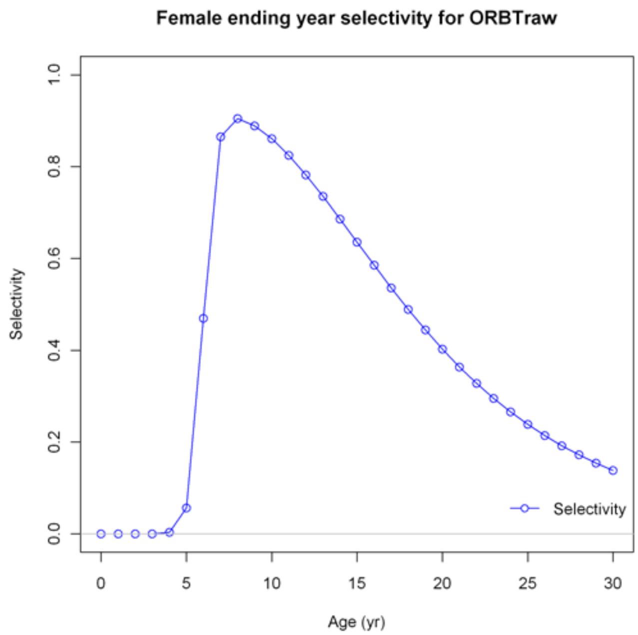


Figure 39. Estimated age selectivity curves for the Oregon bottom trawl fishery for females (top) and males (bottom).



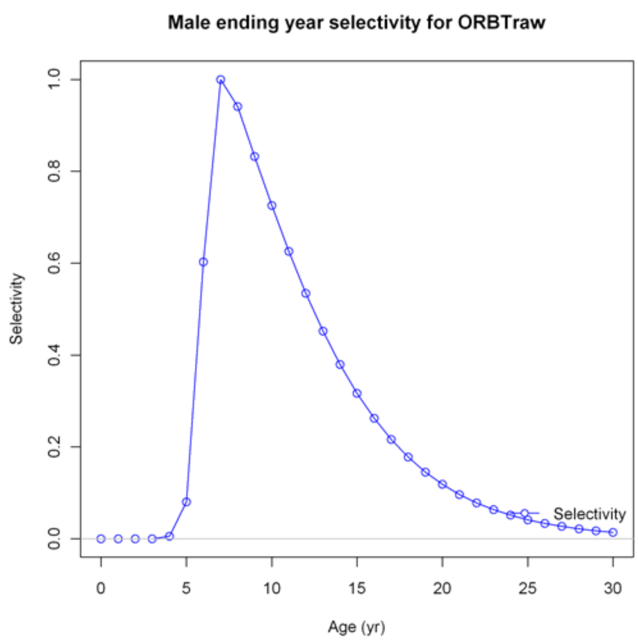


Figure 40. Estimated age selectivity curves for the Eureka-Conception fisheries for females (top) and males (bottom).

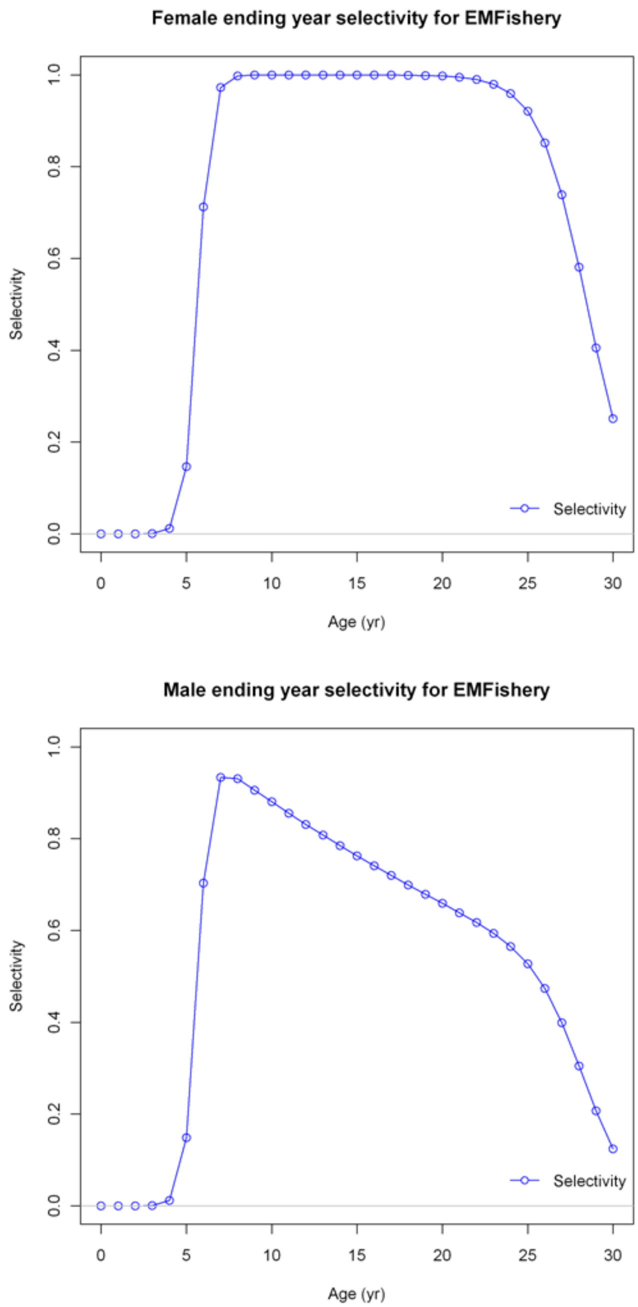


Figure 41. Estimated length selectivity curves for the triennial survey.

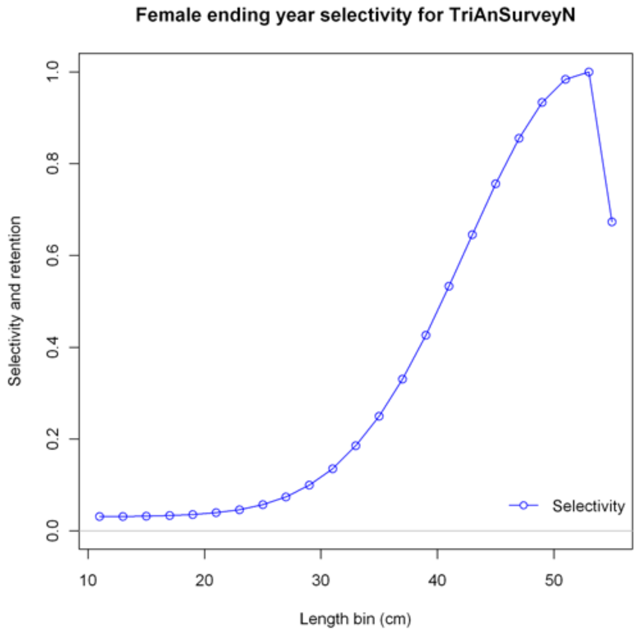


Figure 42. Estimated length selectivity curves for the NWFSC survey.

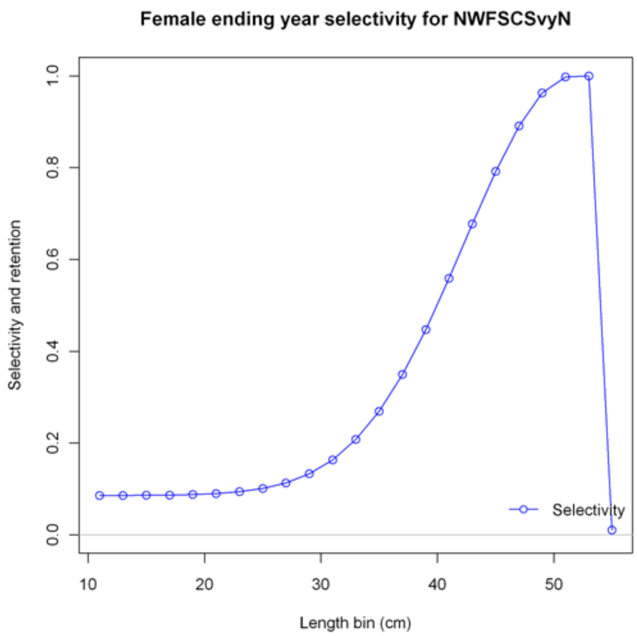
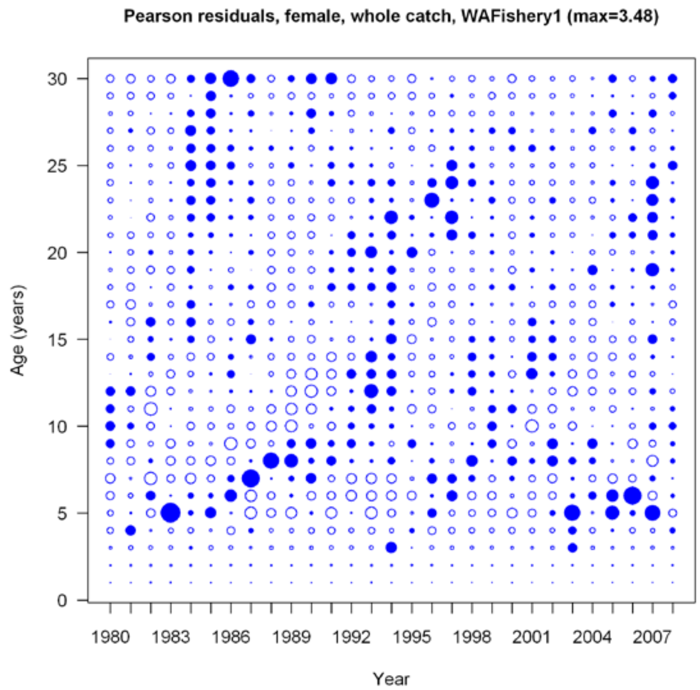


Figure 43. Age composition residuals of females (top) and male (bottom) for the Vancouver-Columbia fishery from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



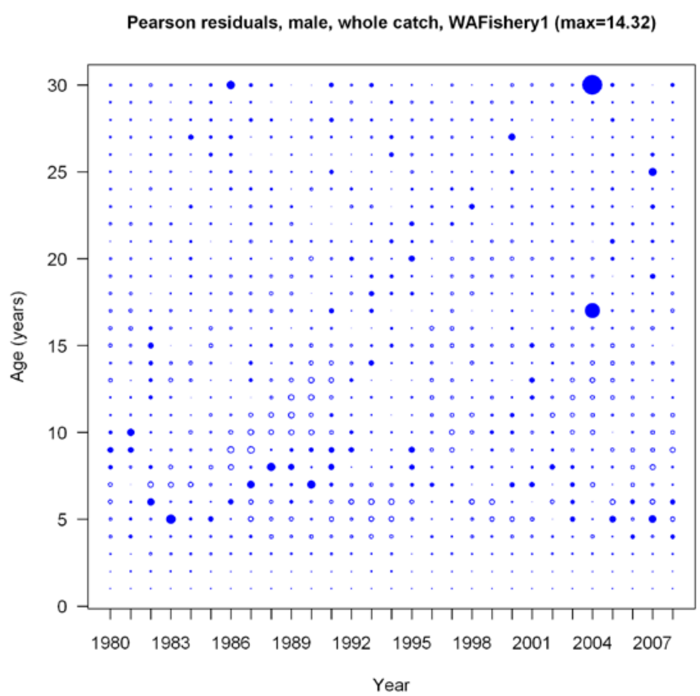
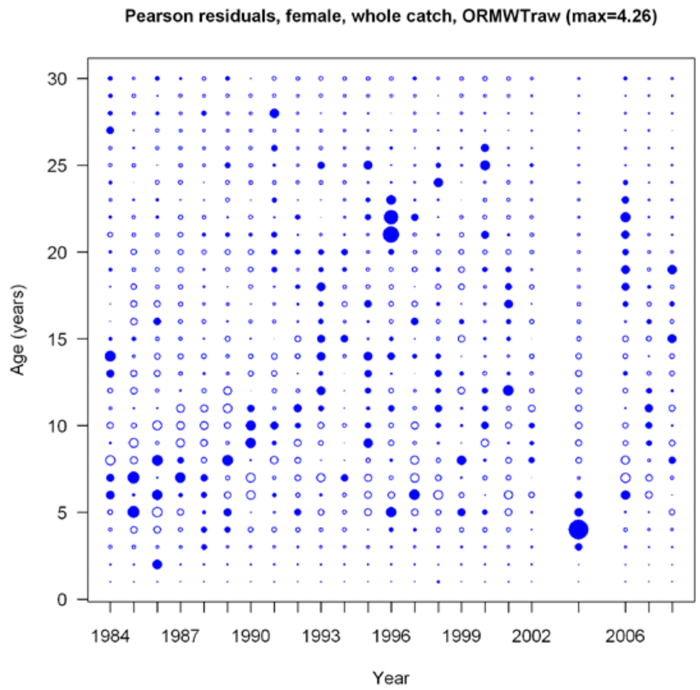


Figure 44. Age composition residuals of females (top) and male (bottom) for the Oregon mid-water trawl fishery from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



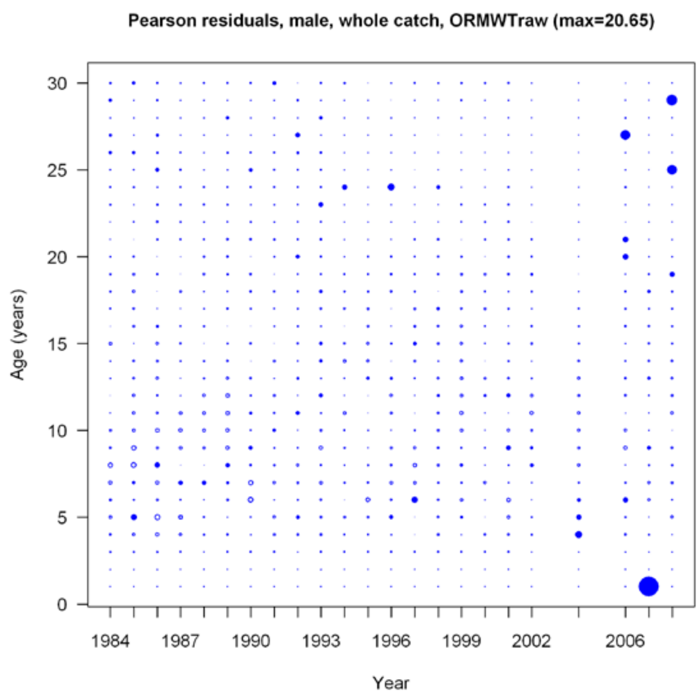
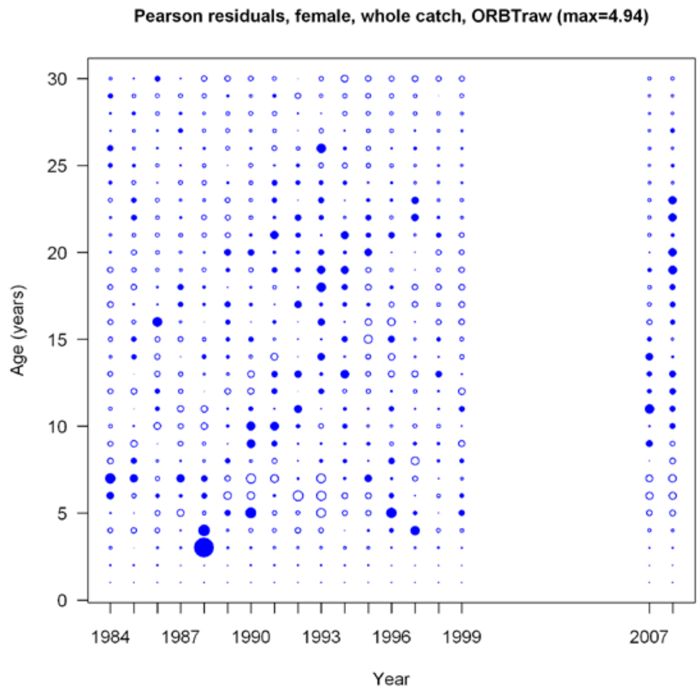


Figure 45. Age composition residuals of females (top) and males (bottom) for the Oregon bottom trawl fishery from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



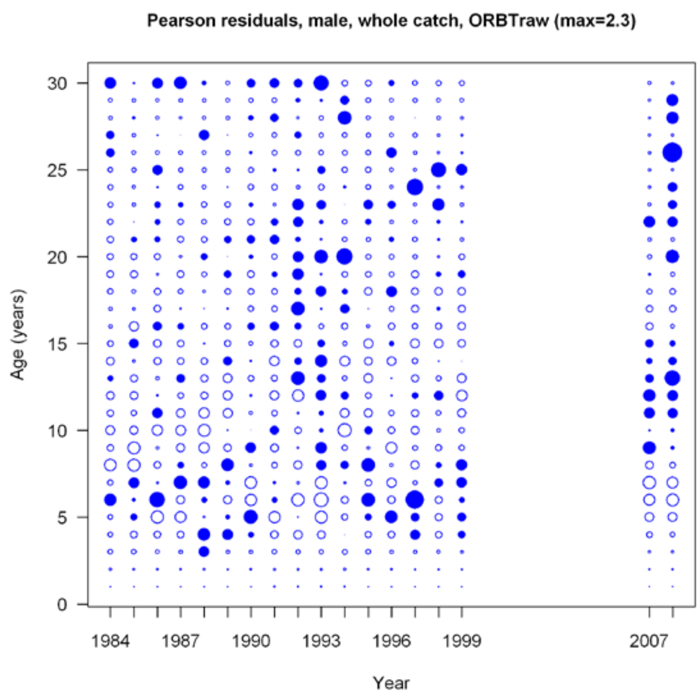
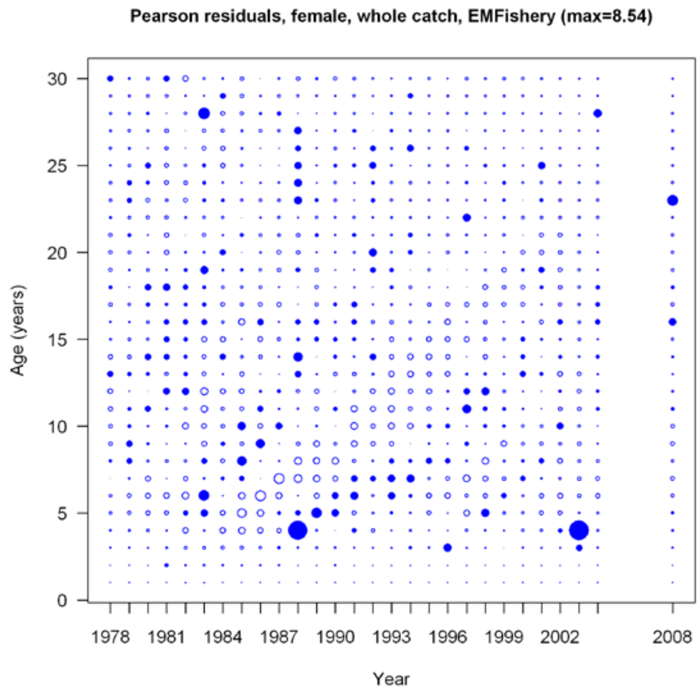


Figure 46. Age composition residuals of females (top) and males (bottom) for the Eureka-Conception fishery from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



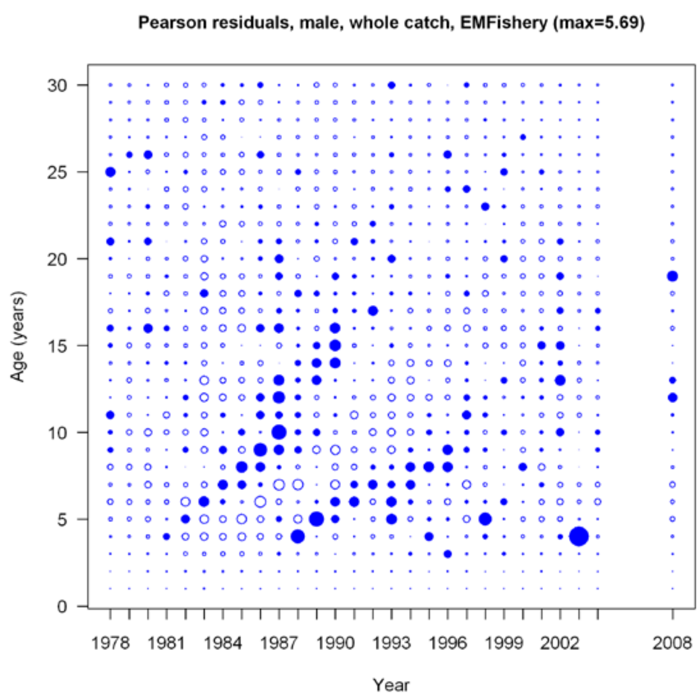


Figure 47. Age composition residuals of females (top) and males (bottom) for the NWFSC northern area survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.

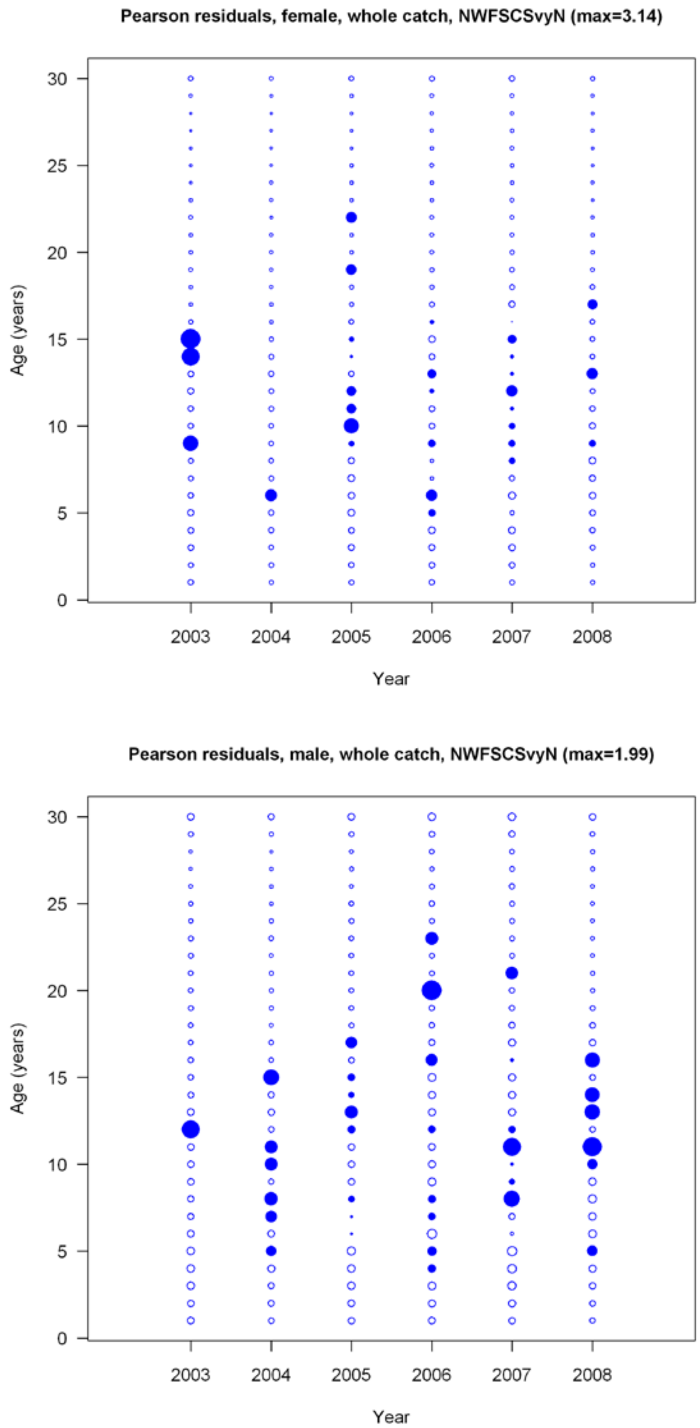


Figure 48. Age composition residuals of females (top) and males (bottom) for the NWFSC southern area survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.

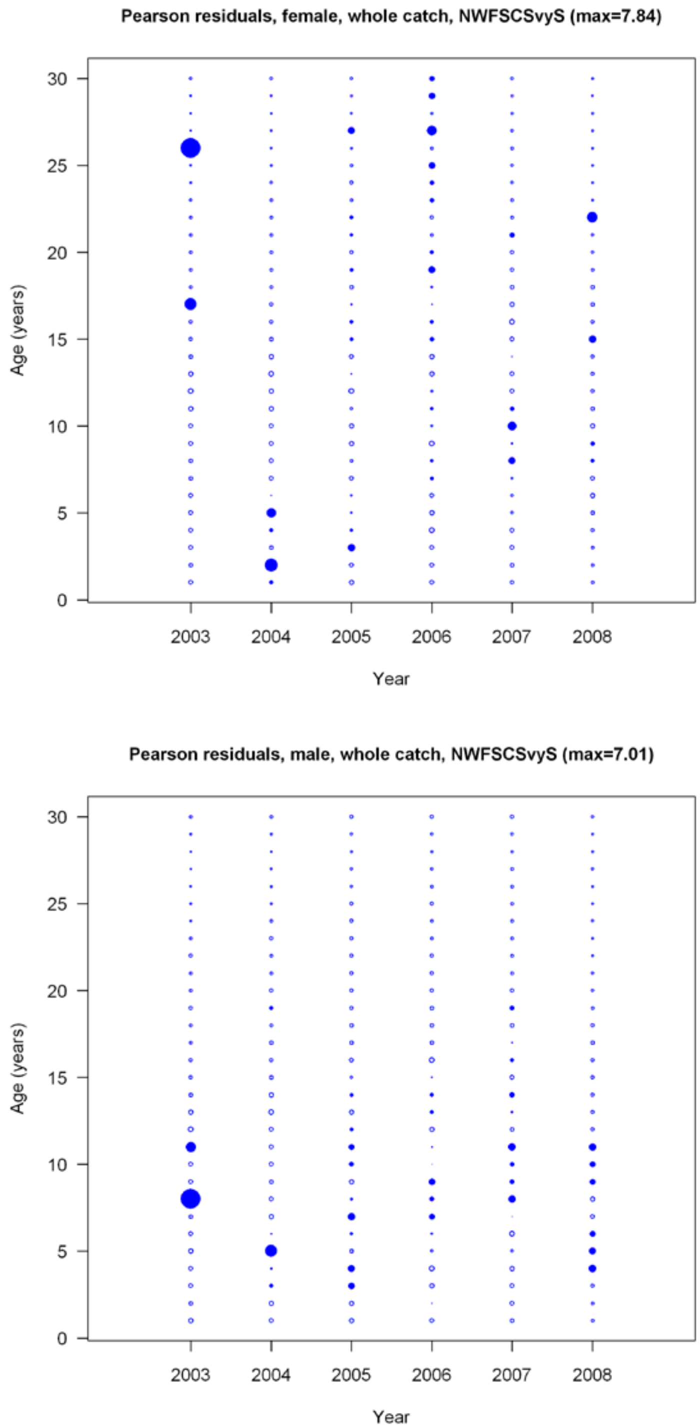
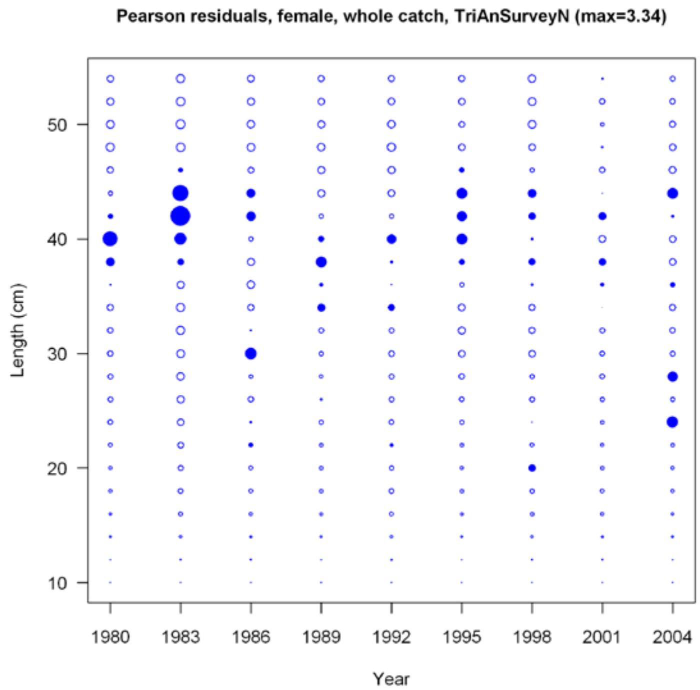


Figure 49. Length composition residuals of females (top) and males (bottom) for the northern area triennial survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



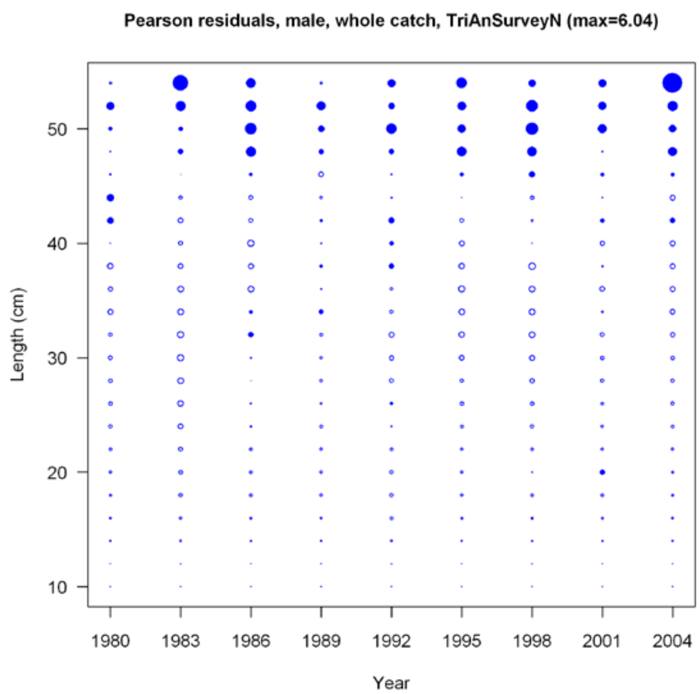
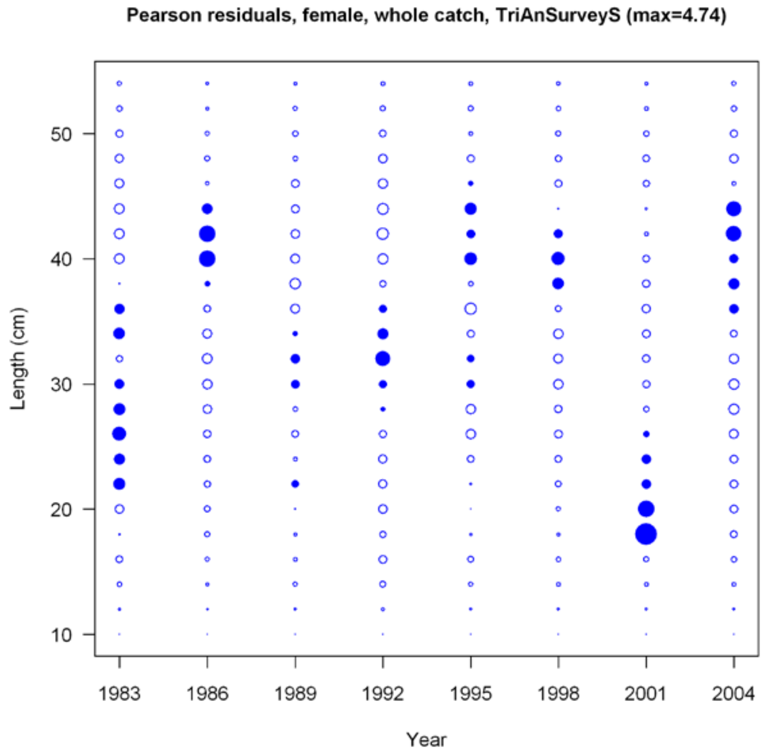


Figure 50. Length composition residuals of females (top) and males (bottom) for the southern area triennial survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



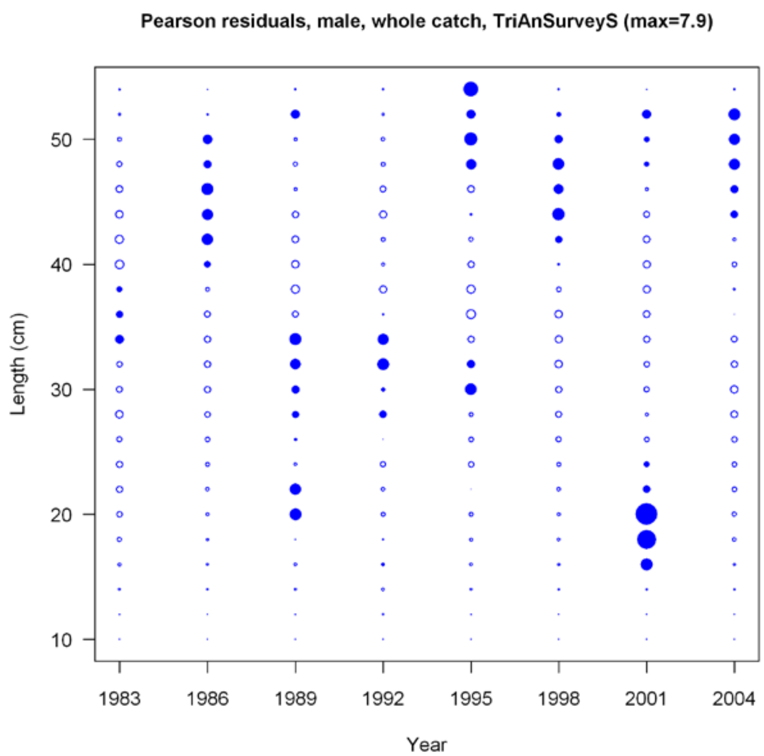


Figure 51. Length composition residuals of females (top) and males (bottom) for the NWFSC northern area survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.

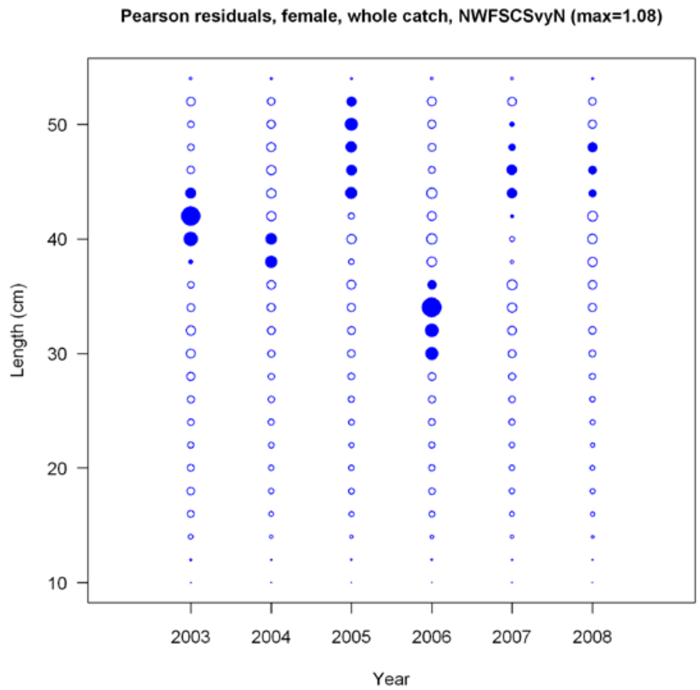
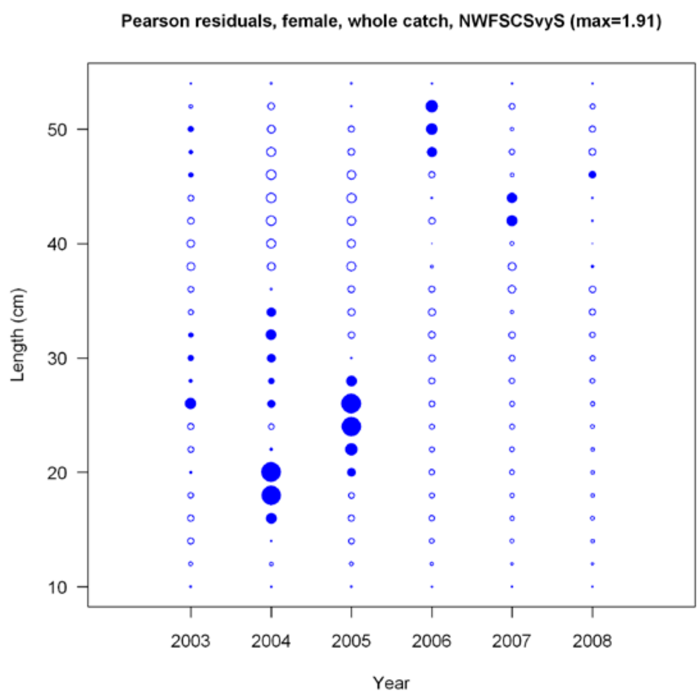


Figure 52. Length composition residuals of females (top)and males (bottom) for the NWFSC southern area survey from the base model. Residuals are standardized differences (observed – estimated). Dark circles are positive residuals and open circles are negative residuals.



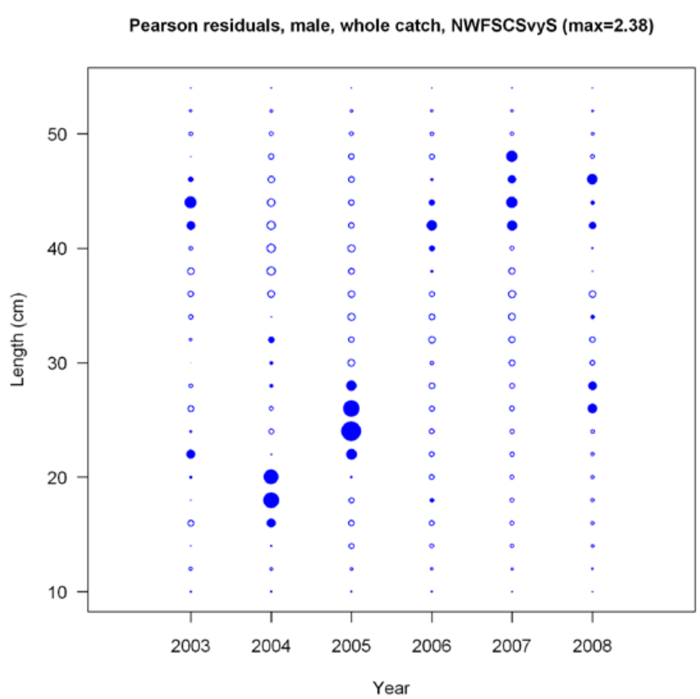


Figure 53. Comparisons of time series of spawning outputs between the base model and sensitivity runs.

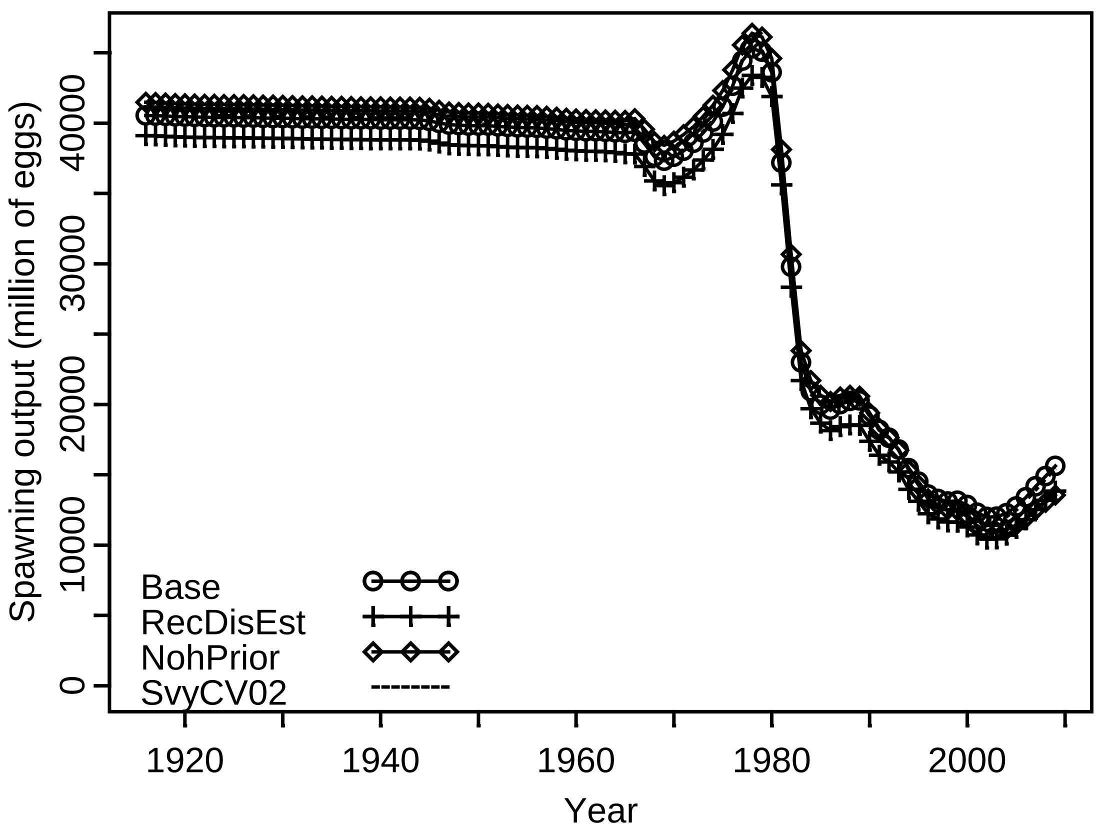


Figure 54. Comparisons of time series of recruitments between the base model and sensitivity runs.

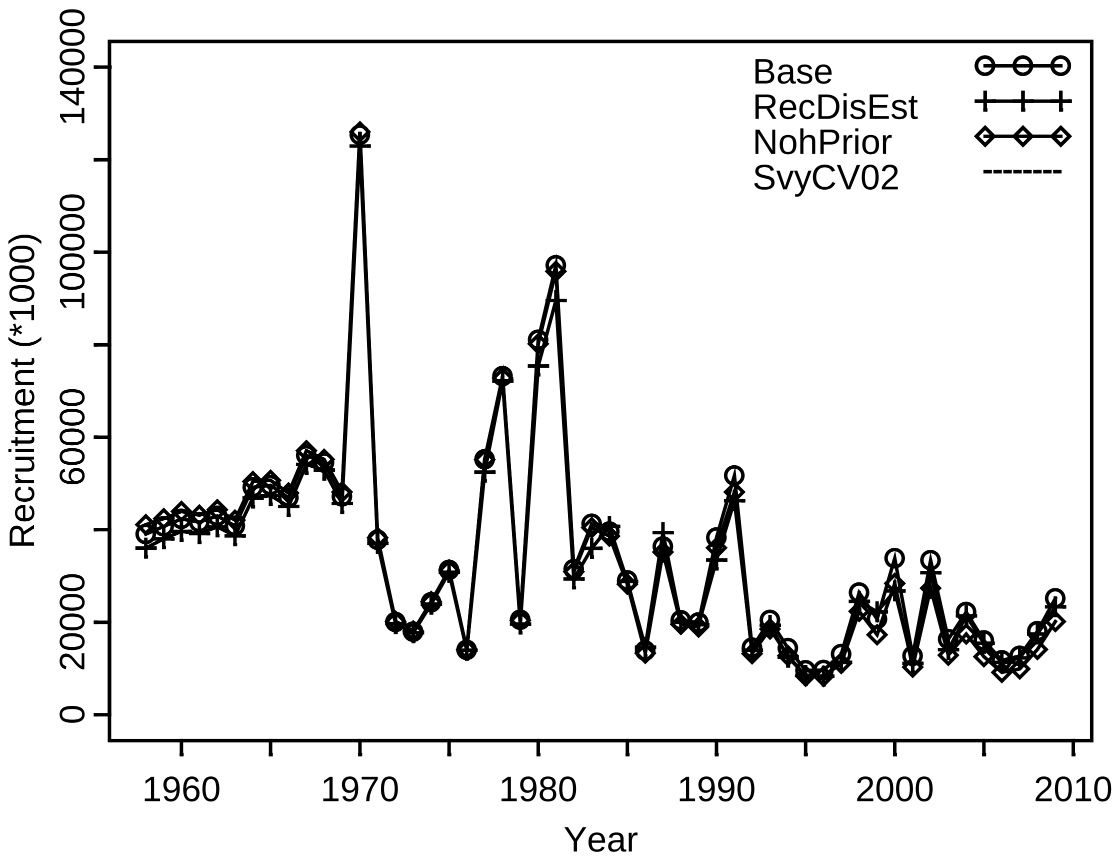


Figure 55. Comparisons of time series of spawning outputs between the base model and two fix proportions of recruitment to the northern area (0.6875 and 0.7500).

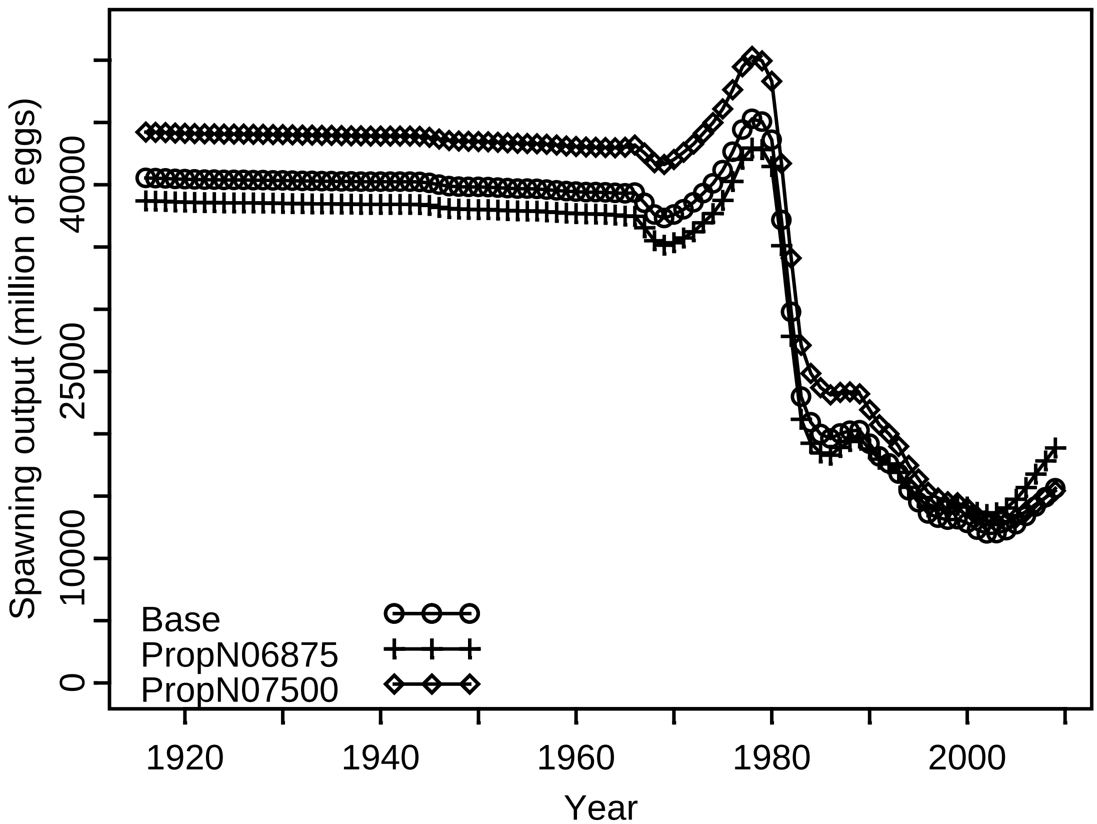


Figure 56. Comparisons of time series of recruitments between the base model and two fix proportions of recruitment to the northern area (0.6875 and 0.7500).

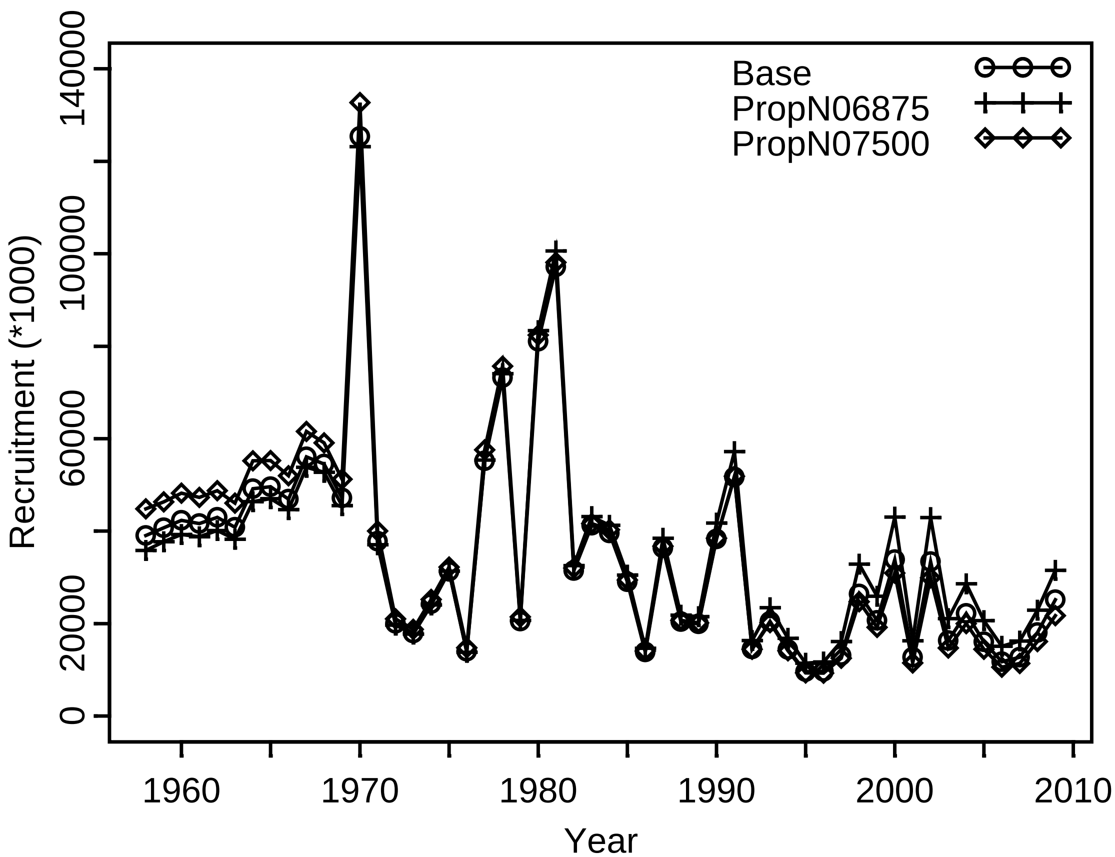


Figure 57. Comparisons of time series of spawning outputs between the base model and retrospective analysis runs.

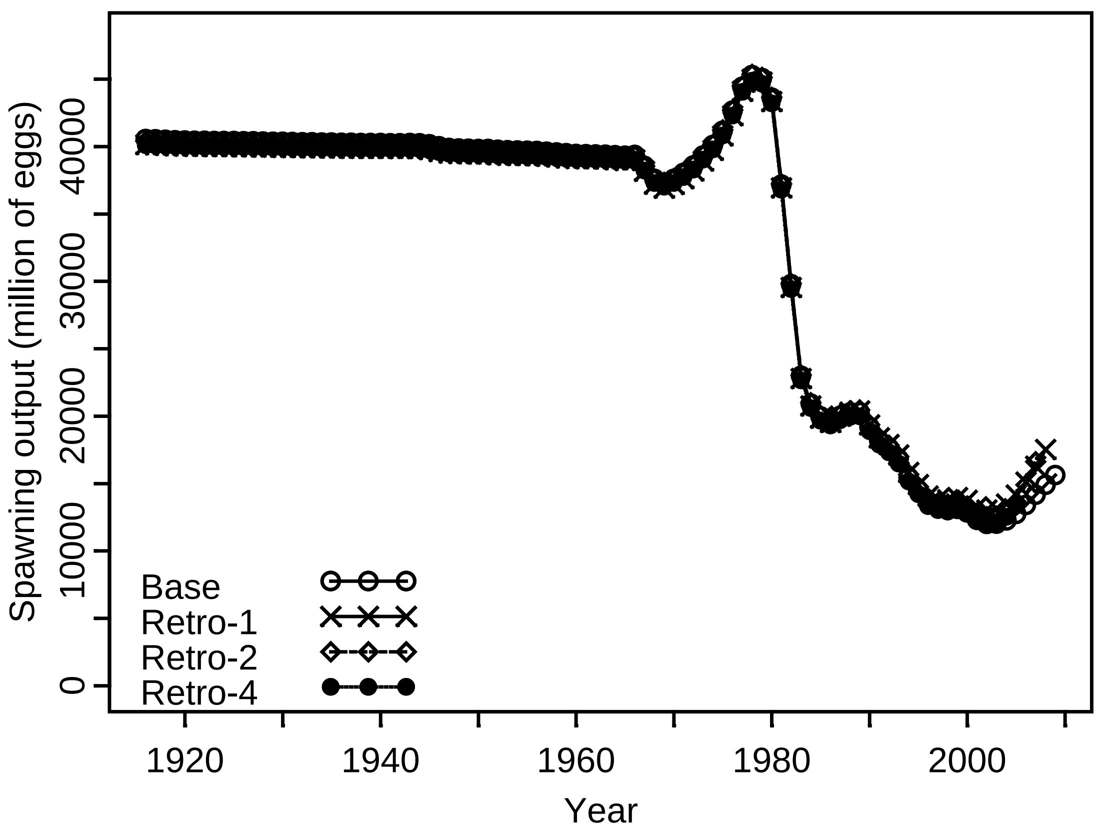


Figure 58. Comparisons of time series of recruitments between the base model and retrospective analysis runs.

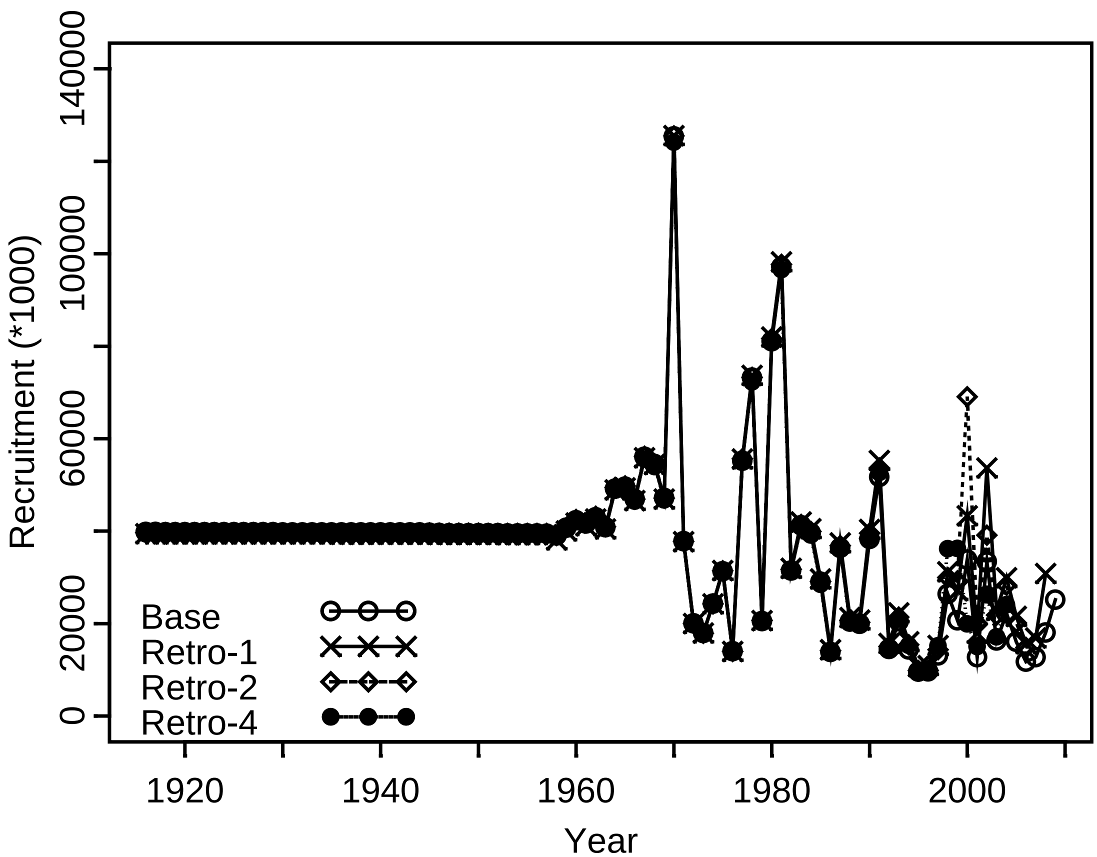


Figure 59. Likelihood profiles for the proportion of recruitment to northern area and associated depletion in 2009.

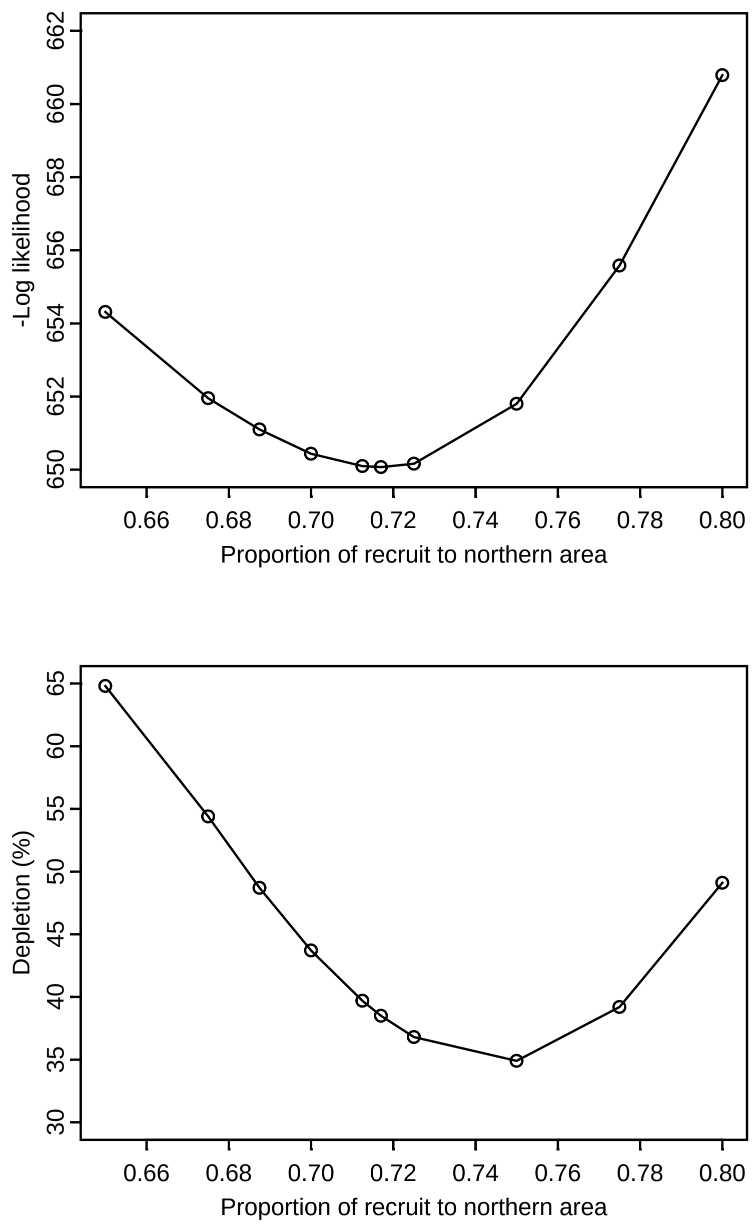


Figure 60. Likelihood profiles for steepness (*h*) and associated depletion in 2009.

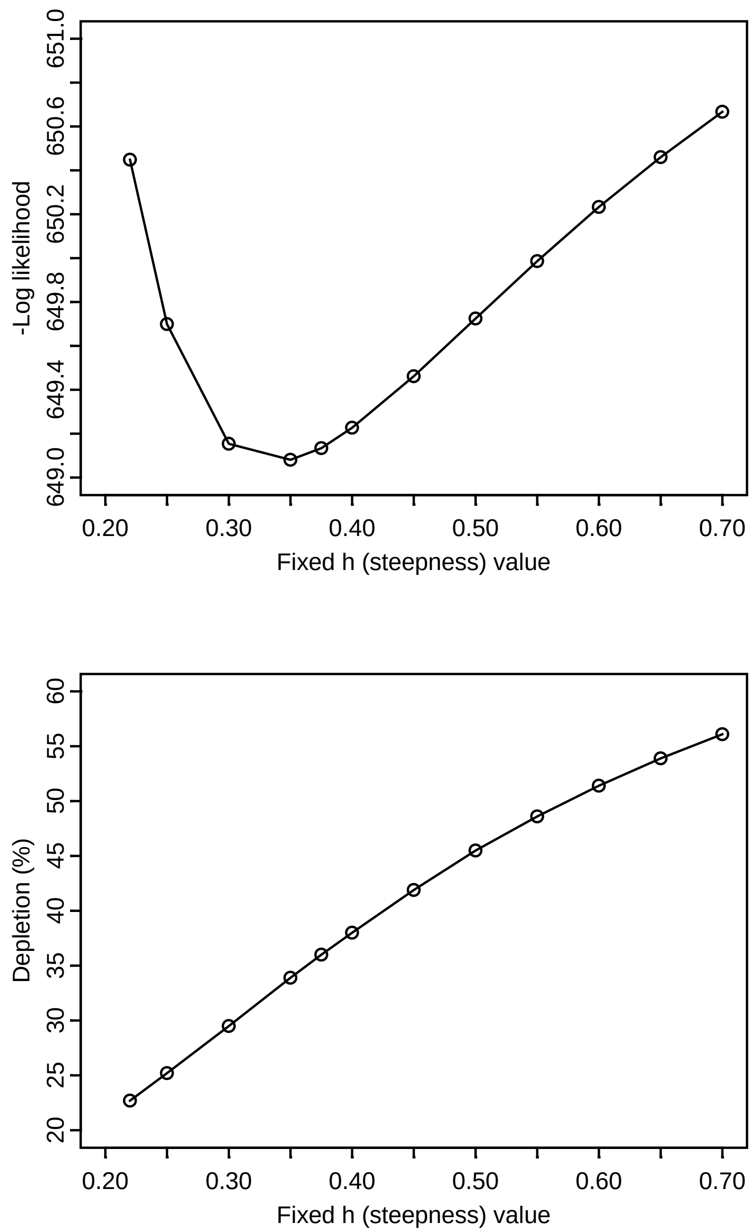
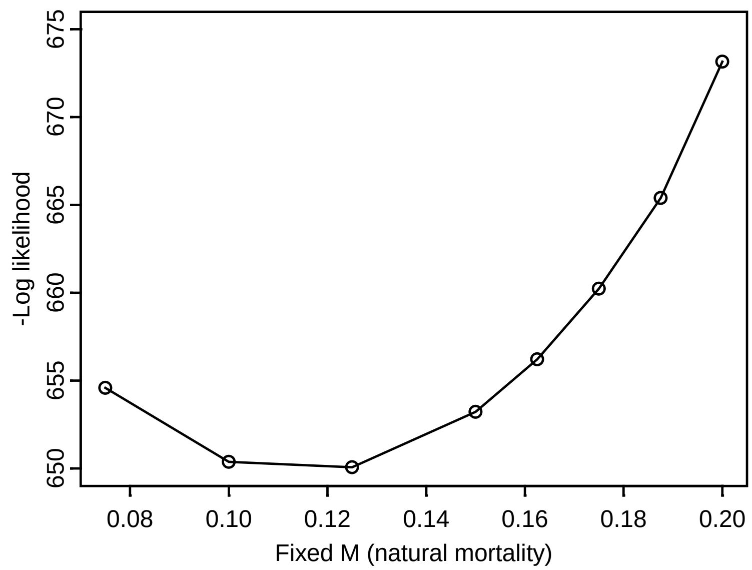


Figure 61. Likelihood profiles for natural mortality (*M*) and associated depletion in 2009.



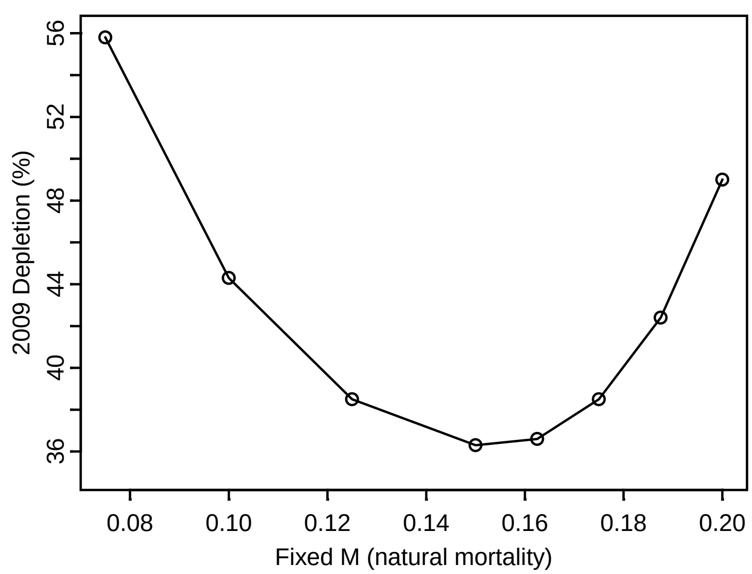


Figure 62. Comparisons of time series of spawning (*SO*) outputs between the 2009 base model and four previous assessments (2000, 2003, 2005, and 2007).

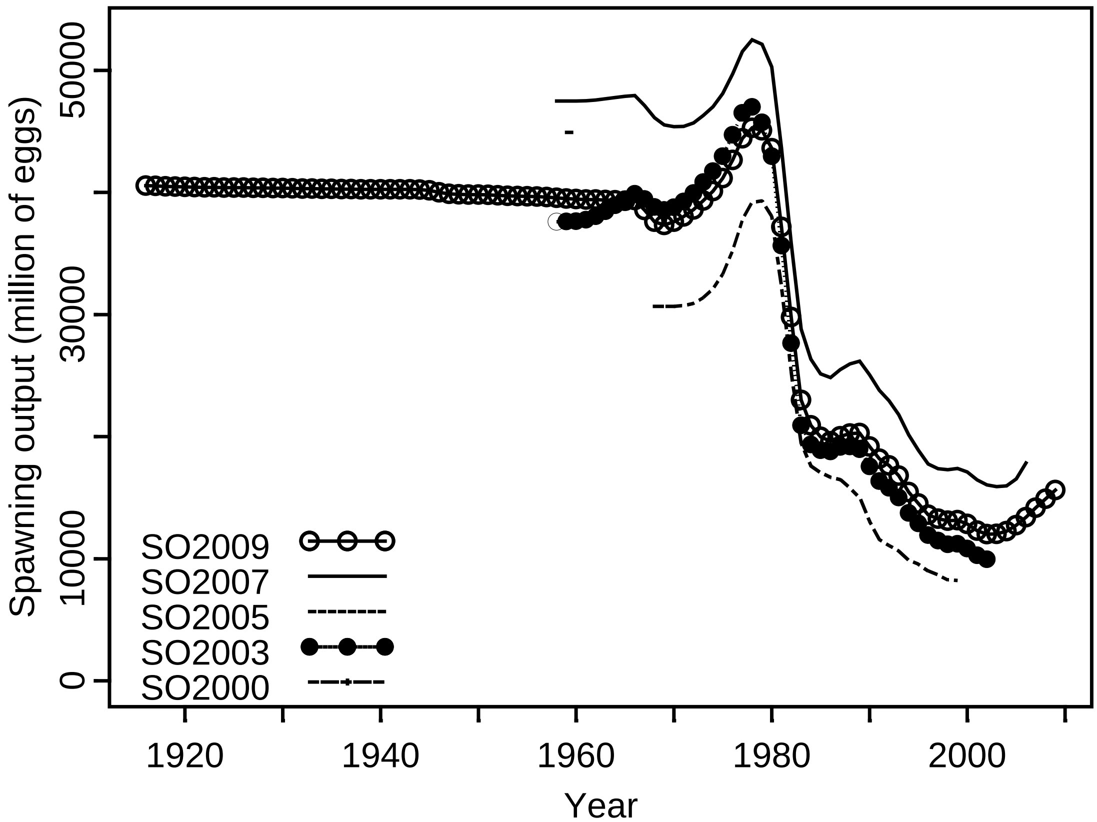


Figure 63. Comparisons of time series of recruitments between the 2009 base model and four previous assessments (2000, 2003, 2005, and 2007).

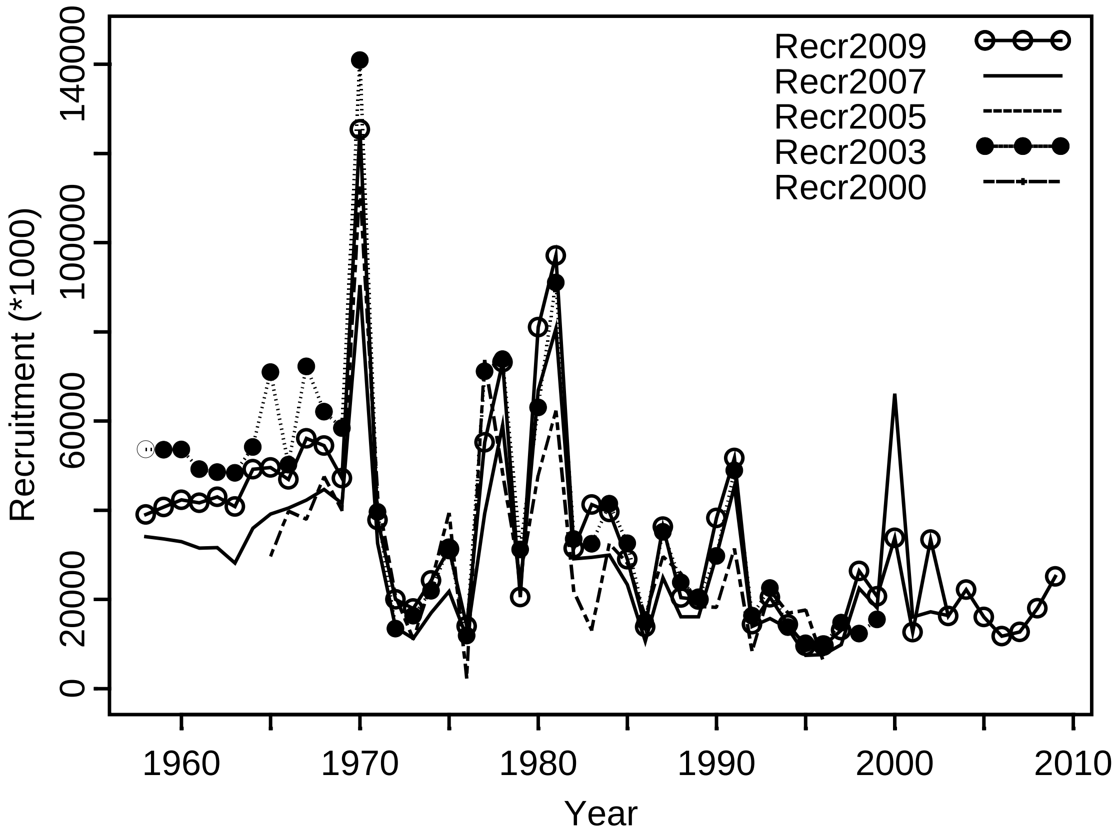


Figure 64. Estimated spawning potential ratio (SPR). The target SPR level of 0.4 (alternatively, the value could be 0.5) is also shown. Values below the target level indicates that overfishing occurred.

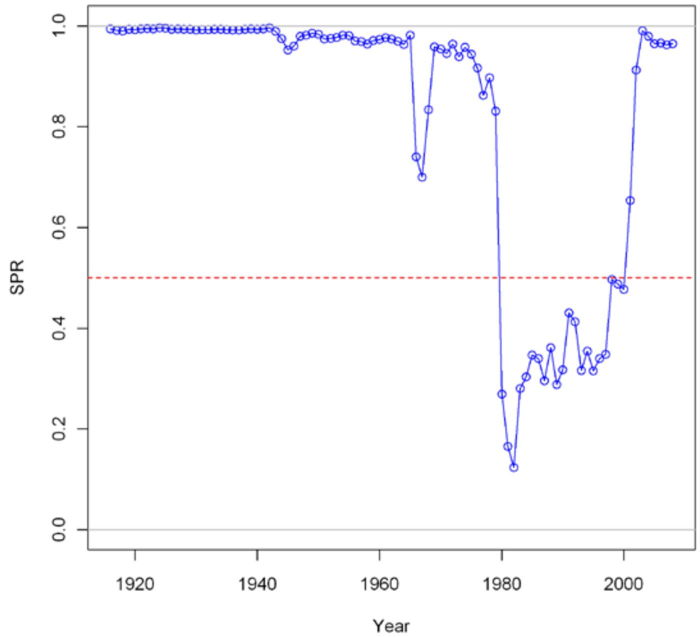


Figure 65. Phase plots of estimated spawning potential ratio to its target of 0.4 and estimated spawning output relative to its target of SB40%. The last point on the lower-left quarter corresponds to estimated value of 2009.

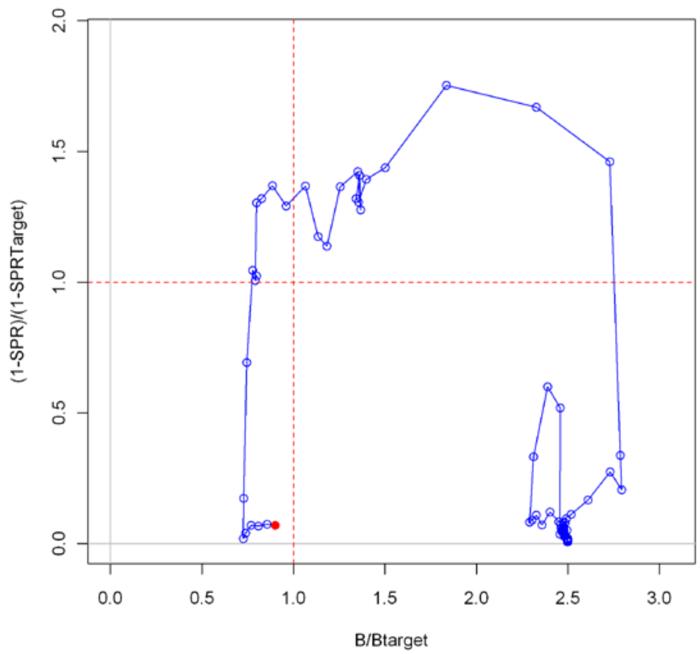
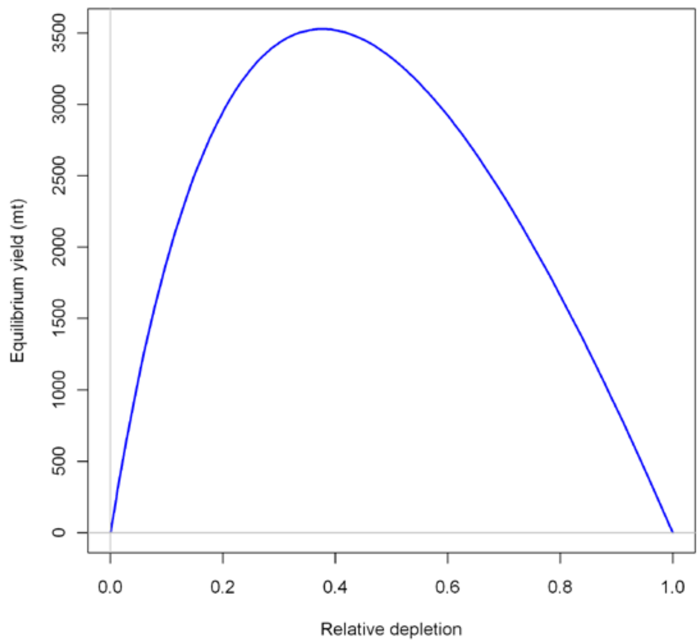


Figure 66. Equilibrium yield curve for the base model.



12 Appendix A. Chronology of the regulatory history of widow rockfish by the Pacific Fishery Management Council.

Date	Regulation
10/13/82	75,000 lb trip limit.
1/30/83	30,000 lb trip limit.
9/10/83	1,000 lb trip limit.
1/1/84	50,000 lb trip limit once per week.
5/6/84	40,000 lb trip limit once per week.
8/1/84	Closed fishery with 1,000 trip limit for incidental catch.
9/9/84	Closed fishery.
1/10/85	30,000 lb trip limit once a week or 60,000 lb trip limit once per two weeks, unlimited trips of less than 3,000 lbs.
4/28/85	Dropped 60,000 lb biweekly option.
7/21/85	3,000 lb trip limit, unlimited number of trips.
1/1/86	30,000 lb trip limit, only one weekly landing greater than 3,000 lbs.
9/28/86	3,000 lb trip limit, unlimited number of trips.
1/1/87	30,000 lb trip limit, only one weekly landing greater than 3000 lbs.
11/25/87	Closed fishery.
1/1/88	30,000 lb trip limit, only one weekly landing greater than 3000 lbs, unlimited number of trips less than 3,000 lbs.
9/21/88	3,000 lb trip limit, unlimited number of trips.
1/1/89	30,000 lb trip limit, only one weekly landing greater than 3,000 lbs.
4/26/89	10,000 lb trip limit once per week.
10/11/89	3,000 lb trip limit with unlimited number of trips.
1/1/90	15,000 lb trip limit once per week or 25,000 lb trip limit once per two weeks with only one landing greater than 3,000 lbs each week.
12/12/90	Closed fishery.
1/1/91	10,000 lb trip limit per week or 20,000 lb trip limit every two weeks with only one landing greater than 3,000 lbs per week.
9/25/91	3,000 lb trip limit with unlimited number of trips.
1/1/92	30,000 lbs cumulative landings every 4 weeks
5/9/92	Change from 3" mesh to 4.5" mesh in codend for roller gear north of Point Arena.
8/12/92	3,000 lb trip limit with unlimited number of trips.
12/2/92	30,000 lb cumulative trip limit per 4 weeks.
12/1/93	3,000 lb trip limit with unlimited number of trips.
1/1/94	30,000 lb cumulative limit per calendar month.
12/1/94	3,000 lb trip limit with unlimited number of trips.
1/1/95	30,000 lb cumulative limit per calendar month.

4/14/95	45,000 lb cumulative limit per calendar month.
9/8/95	4.5" mesh applies to entire net and bottom trawl.
1/1/96	70,000 lb cumulative limit per two months.
9/1/96	50,000 lb cumulative limit per two months.
11/1/96	25,000 lb cumulative limit per two months.
1/1/97	70,000 lb cumulative limit per two months.
5/1/97	60,000 lb cumulative limit per two months.
1/1/98	Limited entry: 25,000 lb cumulative per two month period. Open access: 12,500 lb cumulative per two month period.
5/1/98	Limited entry: 30,000 lb cumulative per two month period
7/1/98	Open access: 3,000 lb cumulative per month
10/1/98	Limited entry: 19,000 lb cumulative per month
1/1/99	Limited entry: cumulative limits: phase 1 - 70,000 lbs per period, phase 2 - 16,000 lbs per period, phase 3 - 30,000 lbs per period. Open access: 2,000 lbs per month.
5/1/99	Limited entry: decrease phase 2 and phase 3 limits to 11,000 lbs.
7/2/99	Open access: 8,000 lb cumulative limit per month.
10/1/99	Limited entry: vessels in Oregon and Washington using 30,000 lb cumulative monthly limit must have midwater trawl gear aboard or a state cumulative limit will be imposed.
1/1/00	Widow rockfish classified as a shelf species for regulatory purposes. Limited entry trawl: 30,000 lbs/2 months. Limited entry fixed gear: 3,000 lbs/month. Open access: 3,000 lbs/month.
1/1/01	Limited entry trawl: 20,000 lbs/2 months for months of Jan-Apr and Sep-Oct; otherwise 10,000 lbs/2 months for midwater trawls; 1,000 lbs/months for small footrope trawls. Limited entry fixed gear: 3,000 lbs/month. Open access: north - 3,000 lbs/month; south - 3,000 lbs per month with some monthly closures in some areas.
7/1/01	Limited entry midwater trawl in the north: 1,000 lbs/month.
10/1/01	Closed fishery for all except midwater, which may land 2,000 lbs/month in north for October, then 25,000 lbs/2 months.
1/1/02	Limited entry trawl in the north: closed through November to midwater trawl except for small bycatch in whiting fishery, in November 13,000 lbs/2 month with no more than 2 trips, small footrope trawl 1000 lbs/month through September, then closed Sept-Oct, then 500 lbs/month Nov-Dec. Limited entry trawl in the south: midwater closed year round except for a small bycatch in the whiting fishery; small footrope trawl 1,000 lbs/month through July, then closed.
1/1/03	Limited entry trawl RCA in the north: 75-200 fm during Jan-Aug, 50-200 fm during Sep-Oct, and shoreline to 200 fm (petrale areas open) during Nov-Dec. Limited entry trawl RCA in the south: between 34□27’ N. lat. and 40□10’ N. lat. - 60-

	200 fm during Jan-Oct, and shoreline to 200 fm (petrale areas open) during Nov-Dec; south of 34°27’ N. lat. - 100-200 fm during Jan-Oct, and shoreline to 200 fm (petrale areas open) during Nov-Dec.
	Limited entry and open access fixed gear RCA established as follows (seaward boundaries held static until Jan 2009; shoreward boundaries south of the OR-WA border vary): shoreline to 100 fm north of the OR-WA border (46°16' N. lat.) to the U.S.-Canada border; seaward boundary of 100 fm north of 40°10’ N. lat.; seaward boundary of 150 fm south of 40°10' N. lat.
	Limited entry trawl in the north: midwater trawl closed through November except for small amount of bycatch in whiting fishery, 12,000 lbs/2 months for Nov-Dec; small footrope trawl - 300 lbs/month Jan-Apr and Nov-Dec, 1000 lbs/month May-Oct.
	Limited entry fixed gear in the north: 200 lbs/month.
	Open access in the north: 200 lbs/month.
	Limited entry trawl in the south: same as north for midwater and small footrope trawl.
	Limited entry fixed gear in the south: closed Mar-Apr, then variable 100 lbs/2 months to 250 lbs/2 months.
	Open access in the south: same as limited entry fixed gear.
1/1/04	Limited entry trawl RCA in the north: 75-200 fm during Jan-Feb (petrale areas open), 60-200 fm during Mar-Apr, 60-150 fm during May-Jun, 75-150 fm during Jul-Sep, and shoreline to 250 fm during Oct-Dec.
	Limited entry trawl RCA in the south: 75-150 fm during Jan-Apr and Sep, and 100-150 fm May-Aug; between 38° N. lat. and 40°10’ N. lat. - shoreline to 250 fm during Oct-Dec; between 36° N. lat. and 38° N. lat. - shoreline to 200 fm during Oct-Dec; south of 36° N. lat. - shoreline to 150 fm during Oct-Dec.
	Limited entry trawl in the north: midwater trawl closed through November except for small amount of bycatch in whiting fishery (500 lbs/month during primary whiting season; combined widow and yellowtail trip limit of 500 lbs/trip with trips of at least 10,000 lbs of whiting), 12,000 lbs/2 months for Nov-Dec; small footrope trawl - 300 lbs/month Jan-Apr and Nov-Dec, 1000 lbs/month May-Oct.
	Limited entry fixed gear in the north: 200 lbs/month.
	Open access in the north: 200 lbs/month.
	Limited entry trawl in the south: closed.
	Limited entry fixed gear in the south: between 40°10’ and 34°27’ N lat. - 300 lbs/2 months Jan-Feb and Sep-Dec, closed Mar-Apr, 200 lbs/2 months May-Aug; south of 34°27’ N lat.: closed Jan-Feb, 2,000 lbs/2 months Mar-Dec.
	Open access in the south: between 40°10’ and 34°27’ N lat. - same as limited entry fixed gear; south of 34°27’ N lat. - closed Jan-Feb, 500 lbs/2 months Mar-Dec.
1/1/05 (regs. for 2005 and 2006)	Limited entry trawl RCA in the north: 75-200 fm during Jan-Feb and Nov-Dec (petrale areas open), and 100-200 fm during Mar-Oct.
	Selective flatfish trawls required shoreward of the RCA in the north (new permanent reg. implemented from 2005 to present).
	Limited entry trawl in the north: large and small footrope trawl- 300 lbs/2 months; midwater trawl- closed except for small amount of bycatch in whiting fishery (500

	lbs/month during primary whiting season; combined widow and yellowtail trip limit of 500 lbs/trip with trips of at least 10,000 lbs of whiting); selective flatfish trawl - 300 lbs/month Jan-Apr and Nov-Dec, 1,000 lbs/month May-Oct.
	Limited entry fixed gear in the north: 200 lbs/month.
	Open access in the north: 200 lbs/month.
	Limited entry trawl in the south: large footrope and midwater trawl- closed; small footrope trawl- 300 lbs/month.
	Limited entry fixed gear in the south: between 40°10’ and 34°27’ N lat. - 300 lbs/2 months Jan-Feb and Sep-Dec, closed Mar-Apr, 200 lbs/2 months May-Aug; south of 34°27’ N lat.: 2,000 lbs/2 months Jan-Feb and May-Dec, closed Mar-Apr.
	Open access in the south: between 40°10’ and 34°27’ N lat. - same as limited entry fixed gear; south of 34°27’ N lat. - 500 lbs/2 months Jan-Feb and May-Dec, closed Mar-Apr.
7/1/05	Limited entry fixed gear south of 34°27’ N lat.: 3,000 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish/2 months Jul-Dec.
	Open access south of 34°27’ N lat.: 750 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish /2 months Jul-Dec.
10/1/05	Limited entry trawl RCA north of 38° N lat. extended from shoreline to 250 fm; 36° N lat. to 38° N lat.: limited entry trawl RCA extended from shoreline to 200 fm; south of 36° N lat.: limited entry trawl RCA extended from 50 fm to 200 fm.
1/1/06	Limited entry fixed gear south of 34°27’ N lat.: 3,000 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish /2 months Jan-Feb.
	Open access south of 34°27’ N lat.: 750 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish /2 months Jan-Feb.
3/1/06	Limited entry fixed gear south of 34°27’ N lat.: 3,000 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish /2 months Mar.-Dec.
	Open access south of 34°27’ N lat.: 750 lbs of shelf rockfish, shortbelly rockfish, and widow rockfish /2 months Mar.-Dec.
10/1/06	Widow bycatch cap in the non-tribal limited entry whiting trawl fishery increased from 200 mt to 220 mt.
1/1/07 (regs. for 2007 and 2008)	Widow bycatch cap of 200 mt adopted for the limited entry whiting trawl fishery.
	Limited entry trawl RCA: 75-250 fm in Jan-Apr and Nov-Dec; 75-200 fm in May-Jun and Sep-Oct; 100-200 fm in Jul-Aug.
	Limited entry trawl in the north: large and small footrope trawl- 300 lbs/2 months; midwater trawl- closed except for small amount of bycatch in whiting fishery (500 lbs/month during primary whiting season; combined widow and yellowtail trip limit of 500 lbs/trip with trips of at least 10,000 lbs of whiting; cumulative widow limit of 1,500 lbs/month); selective flatfish trawl - 300 lbs/month Jan-Apr and Nov-Dec, 1,000 lbs/month May-Oct.
	Limited entry fixed gear in the north: 200 lbs/month.
	Open access in the north: 200 lbs/month.
	Limited entry trawl in the south: large footrope and midwater trawl- closed; small footrope trawl- 300 lbs/month.
	Limited entry fixed gear in the south: between 40°10’ and 34°27’ N lat. - 300 lbs/2

	months Jan-Feb and Sep-Dec, closed Mar-Apr, 200 lbs/2 months May-Aug; south of 34°27’ N lat.: 3,000 lbs/2 months Jan-Feb and May-Dec, closed Mar-Apr.
	Open access in the south: between 40°10’ and 34°27’ N lat. - same as limited entry fixed gear; south of 34°27’ N lat. - 750 lbs/2 months Jan-Feb and May-Dec, closed Mar-Apr.
5/1/07	Widow bycatch cap in the limited entry whiting trawl fishery increased from 200 mt to 220 mt.
	Limited entry trawl in the north: RCA extended to the shore from Cape Alava (48°10’ N lat.) to U.S.-Canada border and from Cape Arago (43°20.83' N. lat.) to Humbug Mountain (42°40.50' N. lat.); the shoreward boundary of the trawl RCA is shifted shoreward to 60 fm from April 17 through October 31, 2007 between Leadbetter Point (46°38.17' N. lat.) and the Oregon/Washington border (46°16’ N. lat.); shoreward boundary of the trawl RCA shifted shoreward to 75 fm in all other areas through Dec.; the seaward boundary of the trawl RCA is shifted shoreward to 150 fm from the U.S.-Canada Border to Cascade Head (45°03.83’ N. lat.) from April 17 through August 31, 2007; the seaward boundary of the trawl RCA is shifted shoreward to 200 fm between Cascade Head (45°03.83’ N. lat.) and 40°10 N. lat. from April 17 through April 30, 2007.
7/26/07	Limited entry whiting trawl fishery closed due to attainment of 220 mt widow bycatch cap.
9/1/07	Limited entry fixed gear in the south between 40°10' N. lat. and 34°27' N. lat.: combined the trip limit for bocaccio and the trip limit for minor shelf rockfish, shortbelly rockfish, and widow rockfish into a single cumulative trip limit of 500 lb/2 months from Sep-Dec.
10/1/07	Limited entry trawl RCA north of Cape Alava (48°10’ N lat.) to U.S.-Canada border and from Cape Arago (43°20.83' N. lat.) to Humbug Mountain (42°40.50' N. lat.): shoreward boundary moved to the 75 fm line.
10/7/07	Limited entry whiting trawl fishery re-opened after widow bycatch cap is increased to 275 mt; shoreside whiting sector required to fish seaward of the 150 fm line; at-sea sectors voluntarily fish seaward of the 150 fm line.
1/1/08	Limited entry trawl RCA in the north: the seaward boundary north of 40□10’ N. lat. to the U.S.-Canada border is shifted to the modified petrale 200 fm line in Jan-Feb and Nov-Dec; the seaward boundary from the OR-WA border (46□16' N. lat.) to the U.S.-Canada border is shifted to 150 fm from May-Oct; all other areas and times will have a seaward boundary of 200 fm; the shoreward boundary is shifted to the shoreline from north of Cape Alava (48°10’ N lat.) to the U.S.-Canada border and from Cape Arago (43°20.83' N. lat.) to Humbug Mountain (42°40.50' N. lat.) for the entire year; the shoreward boundary from the OR-WA border (46□16' N. lat.) to Cape Alava shifted to 60 fm in Mar-Oct; all other times and areas will have a shoreward boundary of 75 fm for the year.
	Limited entry trawl RCA in the south: 100-150 fm for the year.
	Limited entry fixed gear in the south between 40°10' N. lat. and 34°27' N. lat.: modify the chilipepper rockfish limit of 2,000 lb/2 months by recombining it into a single combined cumulative limit with minor shelf rockfish, shortbelly, widow rockfish and bocaccio, and increase the trip limit from 500 lb/2 months to 2,500 lb/2 months of which no more than 500 lb/2 months may be any species other than chilipepper rockfish.
3/08	Widow bycatch cap of 275 mt adopted for the limited entry whiting trawl fishery.

5/1/08	Limited entry trawl RCA in the north: the seaward boundary is shifted to the 200 fm line from the OR-WA border (46□16' N. lat.) to Leadbetter Pt. (46°38.17’ N. lat.) from May-Jun; the seaward boundary is shifted to the 150 fm line from Cape Falcon (45°46’ N. lat.) to the OR-WA border from May-Aug; the shoreward boundary is shifted to the 60 fm line from north of Cape Alava (48°10’ N lat.) to the U.S.-Canada border and from Cape Arago (43°20.83' N. lat.) to Humbug Mountain (42°40.50' N. lat.) from May-Oct; no other changes to the trawl RCA for all other times and areas.
	Darkblotched rockfish bycatch cap in the limited entry whiting trawl fishery increased to 40 mt to decrease impacts on widow rockfish.
8/19/08	Limited entry whiting trawl fishery closed due to attainment of 4.7 mt canary bycatch cap.
10/10/08	Limited entry trawl RCA in the north: the shoreward boundary of the is shifted from 60 fm to 75 fm, with the exception of the areas north of Cape Alava (48°10’N. lat.) and between Cape Arago (43°20.83’ N. lat.) and Humbug Mountain (42°40.50’N. lat.).
10/12/08	Limited entry whiting trawl fishery reopened after the canary bycatch cap is increased from 4.7 mt to 6.4 mt and the widow bycatch cap is increased from 275 mt to 284 mt.
10/26/08	Canary bycatch cap in the limited entry whiting trawl fishery is increased from 6.4 mt to 6.7 mt.
11/1/08	Open access south of 34□27’ N. lat.: shelf rockfish trip limit increased from 750 lb/2 months to 1,000 lb/2 months in period 6 (Nov-Dec).
1/1/09 (regs. for 2009 and 2010)	Sector-specific bycatch caps adopted for the limited entry whiting trawl fishery for canary, darkblotched, and widow rockfish distributed on a pro rata basis in relation to the sectors' whiting allocation. Additionally, NMFS has the authority to restrict fishing depths by sector of the limited entry whiting trawl fishery if a bycatch cap is attained inseason.
	Limited entry trawl RCA: north of Cape Alava (48°10’N. lat.) - shoreline to 200 fm during Jan-Mar (petrale areas open) and Sep-Dec (petrale areas open Nov-Dec), and shoreline to 150 fm during Apr-Aug; north of Cape Falcon (45□46’ N. lat.) to Cape Alava - 75-200 fm during Jan-Apr (petrale areas open Jan-Mar) and Sep-Dec (petrale areas open Nov-Dec), and 75-150 fm during May-Aug; north of 40□10’ N. lat. to Cape Falcon - 75-200 fm year-round (petrale areas open during Jan-Mar and Nov-Dec); south of 40□10' N. lat. - 100-150 fm year-round.
	Limited entry and open access fixed gear RCA: seaward boundary shifted from 100 fm to 125 fm between Cascade Head (45°03.83’ N. lat.) and Cape Blanco (43□ N. lat.), except on days when the directed fishery for Pacific halibut is open; otherwise, seaward boundary of 100 fm north of 40□10’ N. lat. and 150 fm south of 40□10’ N. lat.
	Limited entry trawl in the north (combined limits of widow, yelloweye, shortbelly, and minor shelf rockfish): large and small footrope trawl- 300 lbs/2 months; midwater trawl- closed except for small amount of bycatch in whiting fishery (500 lbs/month during primary whiting season; combined widow and yellowtail trip limit of 500 lbs/trip with trips of at least 10,000 lbs of whiting; cumulative widow limit of 1,500 lbs/month); selective flatfish trawl - 300 lbs/month Jan-Apr and Nov-Dec, 1,000 lbs/month of which no more than 200 lbs/month can be yelloweye during May-Oct.; multiple bottom trawl gear - 300 lbs/ month Jan-Apr and Nov-Dec, 300 lbs/2 months of which no more than

	200/lbs/month can be yelloweye during May-Oct.
	Limited entry trawl in the south: large footrope and midwater trawl - closed; small footrope trawl for minor shelf rockfish, shortbelly, widow, and yelloweye - 300 lbs/ month year-round.
	Limited entry and open access fixed gear in the north: 200 lbs/ month (combined limit for minor shelf rockfish, shortbelly, widow, and yellowtail) year-round.
	Limited entry fixed gear in the south: between 34□27’ N. lat. and 40□10’ N. lat. - 2,500 lbs/2 months (combined limit for minor shelf rockfish, shortbelly, widow, bocaccio, and chilipepper) of which no more than 500 lb/2 months may be any species but chilipepper; south of 34□27' N. lat. (combined limit for minor shelf rockfish, shortbelly, widow, and bocaccio) - 3,000 lbs/2 months during Jan-Feb and May-Dec, and closed during Mar-Apr.
	Open access in the south (combined limit for minor shelf rockfish, shortbelly, widow, and chilipepper):: between 34□27’ N. lat. and 40□10’ N. lat. - 300 lbs/2 months during Jan-Feb and Sep-Dec, closed during Mar-Apr, and 200 lbs/2 months during May-Aug; south of 34□27’ N. lat. - 750 lbs/2 months during Jan-Feb and May-Dec, and closed during Mar-Apr.
3/09	Widow bycatch caps for sectors of the limited entry whiting trawl fishery are adopted as follows: 105 mt to shoreside whiting, 85 mt to catcher-processors, and 60 mt to motherships.

13 Appendix B. Comparisons of widow rockfish stock assessment using direct ADMB code and SS2 interface software

Xi He and Richard Methot

November 2007

Important notice: Results shown in this report are solely for comparisons of widow rockfish assessments using ADMB software and Stock Synthesis (SS2) software. These results should NOT be used for management references or any other purposes.

Brief summary
This appendix compares the results of stock assessments for the widow rockfish population using two stock assessment programs. One uses programs written in ADMB code and another uses SS2 interface software. Both programs use the same data set. The results, including time series of spawning outputs and recruits as well as estimated key parameters, are very similar between two programs.

Introduction

The stock assessments for widow rockfish have been conducted using the ADMB software since 2000 (Williams et al. 2000, He et al. 2003, 2006, 2007). It is planned that for the next assessment for widow rockfish in 2009, the assessment will employ the stock synthesis program (SS2, developed by R. Methot, Methot 2007). This report compares the assessment results between these two programs. The same data set is used in both programs. A complete set of program codes and data used for both program are not printed on this report because they are too long (over 50 pages) to print but they are available upon request.

Models and methods

The ADMB program for the 2007 widow assessment was used in this exercise. To make it more comparable with SS2 software, one minor change was made in the ADMB program (wdw.tpl). In SS2, there is one parameter of fishing mortality each year for each fishery. In ADMB, there is an average fishing mortality for each fishery and then there is a deviation vector of fishing mortality for each fishery. The ADMB code was changed to have the same setup as in SS2. This change resulted in same numbers of estimated parameters in both programs, and had no effects on the ADMB outputs. The SS2 program version is 2.00j (dated August 25, 2007).

The same data set was in used in both programs. However, the data set was modified from the data set used in the 2007 widow assessment. The main reasons for this modification were that it simplified the SS2 program and it made possible for direct comparisons between two programs. The modifications of the data are listed below:

1. Change the widow assessment from two-area model to one-area model. That is, all widow are assumed to be in the northern area (Washington and Oregon). This is an easy change in the ADMB data by simply changing proportions of northern catches to 1.0.

Test runs showed that this change had very little effect (<2% of change in depletion rate) in the ADMB results.

2. Set both sexes to have the same length-weight relationship and the same growth function. This change makes conversions of growth in length and weigh by age much easier in the SS2 program because the SS2 program uses different methods in computing weight by age as in the ADMB program. The SS2 requires inputs of length bins, growth parameters, and length-weight relations to compute weight for each age, while the ADMB program directly computes weight for each age from given growth functions and length-weight relationships. Test run showed that this modification had very little effect (<1% of change in depletion rate) in the results.
3. No implicit priors were used in both programs. In the SS2 program, the lambda value for prior was set to zero. In the ADMB program, a prior function for the steepness parameter was removed. This modification had no effect on the results since the estimated steepness values in both program were much higher than those specified in the prior function used in the 2007 widow assessment.
4. Changes in ageing error inputs. In the ADMB, an ageing error matrix was used. In the SS2 program, a standard deviation is defined for each age group. To make it more comparable, it was assumed that there be no ageing error in the input data. The change in fact had the largest effects on the results. The depletion rate estimated by the ADMB program increased by about 5% as compared to the 2007 widow assessment. The main reason is that the assessment program estimates much stronger recruits in 2000 than those in the 2007 widow assessment.

All other estimation procedures for both programs were same, including uses of effective sample sizes for age samples and root mean square errors (RMSE) for each CPUE time series.

Results and discussions

Comparisons of main assessment results between two programs are presented in Table A1 and Figures A1 and A2. Plots of length at age and weight at age for both programs are presented in Figures A3 and A4.

Overall, the results are very similar between two programs. Time series of spawning outputs and recruits match each other very well. Both programs estimate a strong recruitment in 2000, which resulted in increasing trend of spawning outputs in recent years. The overall patterns of spawning output and recruitment are also very similar to those in the 2007 widow assessment (He et al. 2007). However, the depletion rates estimated by both programs are higher than that estimated in the 2007 widow assessment. As stated previously, this is mainly due to the assumption that there be no ageing errors in the current programs.

References

He, X., S.V. Ralston, A.D. MacCall, D.E. Pearson, and E.J. Dick. 2003. Status of the widow rockfish resource in 2003. Status of the Pacific coast groundfish fishery through 2003, stock assessment and fishery evaluation, Volume I. Pacific Fisheries Management Council, August 2003.

He, X., D.E. Person, E.J. Dick, J.C. Field, S.V. Ralston, and A.D. MacCall. 2006. Status of the widow rockfish resource in 2005. Status of the Pacific coast groundfish fishery through 2003, stock assessment and fishery evaluation, Volume III. Pacific Fisheries Management Council, April 2006.

He, X., A. Punt, A.D. MacCall, and S. Ralston. 2006b. Rebuilding analysis for widow rockfish in 2005. Status of the Pacific Coast Groundfish Fishery through 2005, Stock Assessment and Fishery Evaluation: Stock Assessments and Rebuilding Analyses (Volumes III). Pacific Fisheries Management Council, April 2006.

He, X., M. Mangel, and A.D. MacCall. 2006c. A prior for steepness in stock-recruitment relationships, based on an evolutionary persistence principle. Fishery Bulletin 104(3):428-433.

He, X., D.E. Person, E.J. Dick, J.C. Field, S.V. Ralston, and A.D. MacCall. 2007. Status of the widow rockfish resource in 2007, An update. Document submitted to the Pacific Fisheries Management Council, July 2007.

Methot, R. 2007. User manual for the integrated analysis program stock synthesis (SS2). Model Version 2.00c. NOAA Fisheries Service, Seattle, WA.

Williams, E.H., A.D. MacCall, S. Ralston, and D.E. Pearson. 2000. Status of the widow rockfish resource in Y2K. *In*: Appendix to the status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001, stock assessment and fishery evaluation. Pacific Fishery Management Council, Portland, OR.

Table A1. Comparisons of key parameters between ADMB and SS2 models.

Parameter and estimate	ADMB	SS2
Number of parameters	203	203
Steepness (h)	0.6247	0.5743
Log(R_0)	10.2677	10.6497
Spawning output in 1958 (million of eggs)	43411	43674
Spawning output in 2006 (million of eggs)	19029	17626
Depletion (100*(SO in 1958)/*(SO in 2006))	43.84	40.38
Standard deviation of depletion	10.72	---

Figure A1. Time series of spawning outputs from 1958 to 2006 from ADMB and SS2.

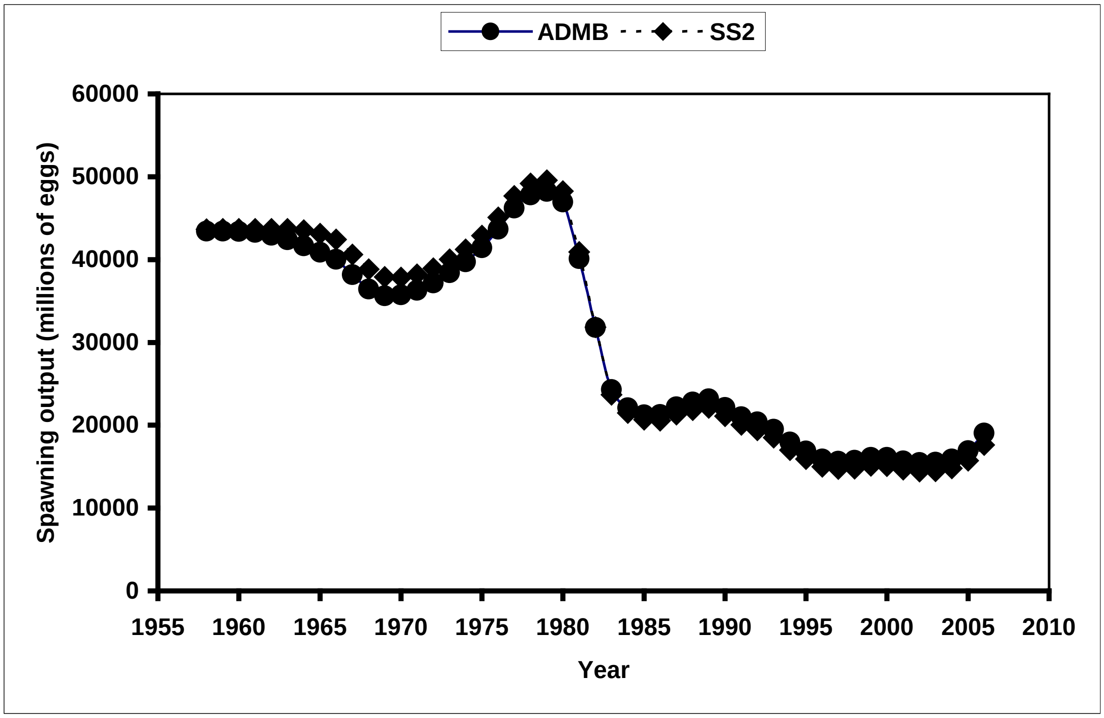


Figure A2. Time series of recruits from 1958 to 2006 from ADMB and SS2.

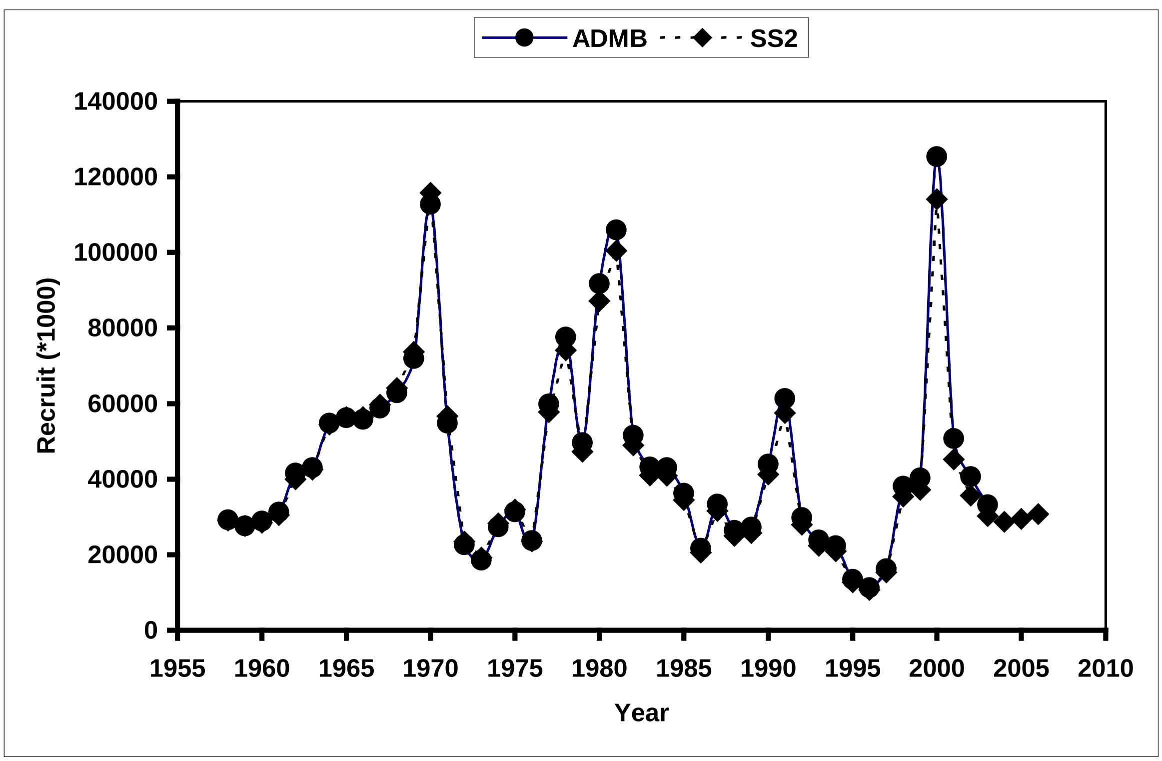


Figure A3. Age-length relationships used in ADMB and SS2.

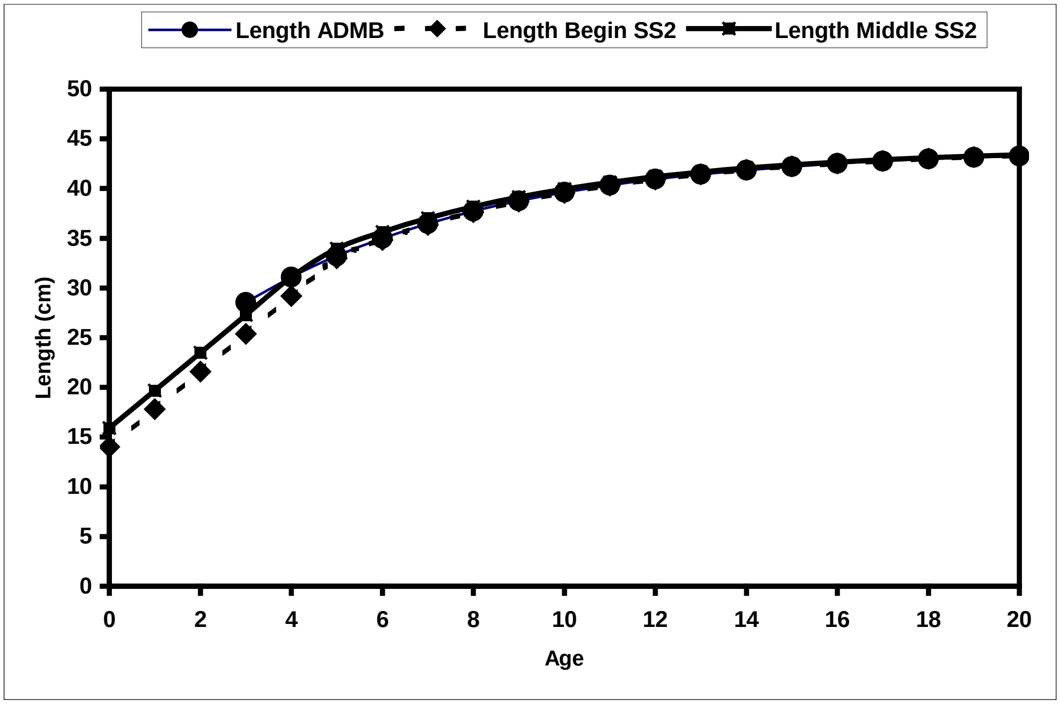
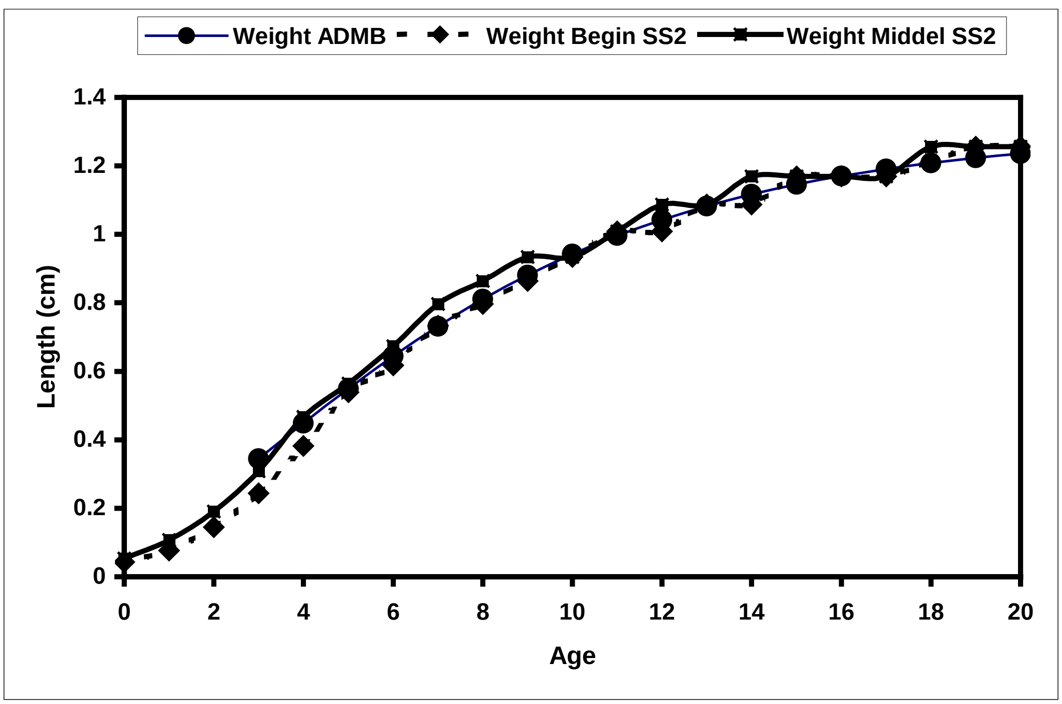


Figure A4. Age-weight relationships used in ADMB and SS2.



14 Appendix C. Multinomial sample sizes

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This Appendix describes the method that was used to correct the multinomial sample sizes for compositional data in the Widow assessment, shows the results of its application to these data, and provides a brief rationale for the use of thes method. The description that follows concerns age data, but the approach is exactly the same for lengths. Also, for simplicity, the following description ignores sex, but the extension to include sex is straightforward.

Suppose $p_{ay,\text{obs}}$ is the observed proportion at age a in year y in a set of age composition data that is assumed to have a multinomial error structure, and let $N_{\text{init},y}$ denote the initial sample sizes. We run our assessment model using these sample sizes and obtain, from the modwl fit, estimates of the expected proportions at age, $p_{ay,\text{exp}}$. Our aim is to use the $p_{ay,\text{obs}}$, $p_{ay,\text{exp}}$, and $N_{\text{init},y}$ to calculate a correction factor f so that the size of the model residuals is consistent with the corrected sample sizes, $N_{\text{corr},y} = fN_{\text{init},y}$.

This aim is the same as for the method currently used in SS3 to correct multinomial sample sizes. Where the two methods differ is that the SS3 method is based on the residuals for individual proportions, $r_{ay} = p_{ay,\text{obs}} - p_{ay,\text{exp}}$, whereas the present method is based on residuals for mean age, $r_y = (m_{y,\text{obs}} - m_{y,\text{exp}})$, where $m_{y,\text{obs}} = \Sigma_a(a\, p_{ay,\text{obs}})$, and $m_{y,\text{exp}} = \Sigma_a(a\, p_{ay,\text{exp}})$. The reason for using mean-age residuals is discussed below.

For the multinomial distribution, the expected variance of the mean age, $m_{y,\text{obs}}$, and thus of the residual r_y, is $v_y/(fN_{\text{init},y})$ [i.e., $v_y/N_{\text{corr},y}$], where v_y is the variance of the age frequency in year y, given by $v_y = \Sigma_a(a^2\, p_{ay,\text{obs}}) - m_{y,\text{obs}}^2$. Therefore, the expected variance of $r_y(N_{\text{init},y}/v_y)^{0.5}$ is $1/f$, and we estimate f as $1/\text{Var}(r_y(N_{\text{init},y}/v_y)^{0.5})$.

Figure 1 shows the application of this method to the Widow age and length composition data. In this application, the sample sizes, $N_{\text{init},y}$, were those obtained after correction (or tuning) using the SS3 method. That is to say, the residuals for individual proportions, r_{ay}, should be consistent with the size expected given these sample sizes. What Figure 1 shows is that the mean-age residuals are still too large (note that many of the confidence intervals for the observed values do not overlap the expected values). Thus, according to the present method, the sample sizes are too large, and so the estimated f is less than 1 for all data sets (range 0.04 to 0.45).

The reason the mean-age residuals, r_y, can be too large, while the individual proportion residuals, r_{ay}, are not, is that there is substantial correlation between the individual residuals. This is shown in Figure 2, in which the observed age frequency flips from one side of the expected frequency to the other from one year to the next. Sideways movement of this magnitude would not be possible if the individual residuals were uncorrelated. This correlation could be caused by either observation or process error (or a combination of both). One explanation of how this could occur derives from the fact that size (and thus age) distribution of fish often varies spatially. We would get between-year sideways movements of age frequencies if the spatial distribution of fishing changed substantially from year to year. In a model like that for Widow, in which selectivities are assumed to be time-invariant, this would movement would add process error to the observations. If the spatial distribution of catch sampling varied from year to year, in a way that did not reflect the movement of fishing activity, this would produce observation error, with a correlation between individual proportions. More information on the generation of correlations in composition data are given by Hrafnkelsson & Stefánsson (2004) and section 3 of Francis (2006).

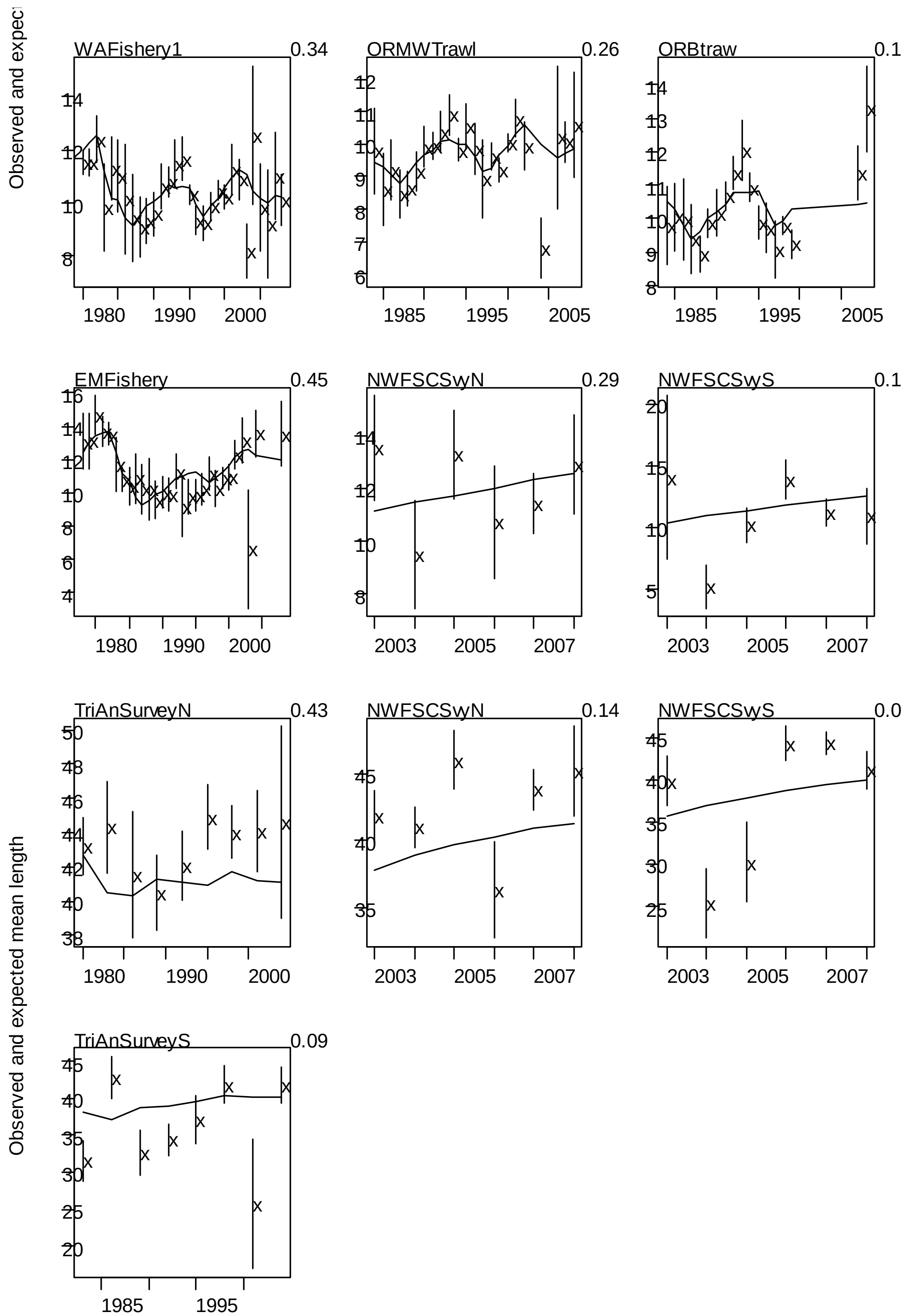


Figure 1: Observed & expected mean ages (upper panels) and lengths (lower panel) for the Widow comps in the (former) base case model. Vertical bars are approximate 95% confidence intervals based on the multinomial sample sizes used in that model. The number printed above each panel is the correction factor *f*, calculated as described above.

Note that there is no intention to suggest that mean age (or length) is a quantity of particular interest in stock assessments. The only reason mean age (or length) is used in calculating the correction factor is that it is sensitive to the sort of correlations shown in Figures 1 and 2. Because of these correlations the composition data are less informative than is suggested by the multinomial sample size correction method used in SS3 (which assumes no correlation). Ideally, we should include these correlations in the likelihood function for composition data. However, that is not straightforward to do. The method proposed here is a simpler pragmatic alternative approach which adjusts sample sizes to compensate for the correlations.

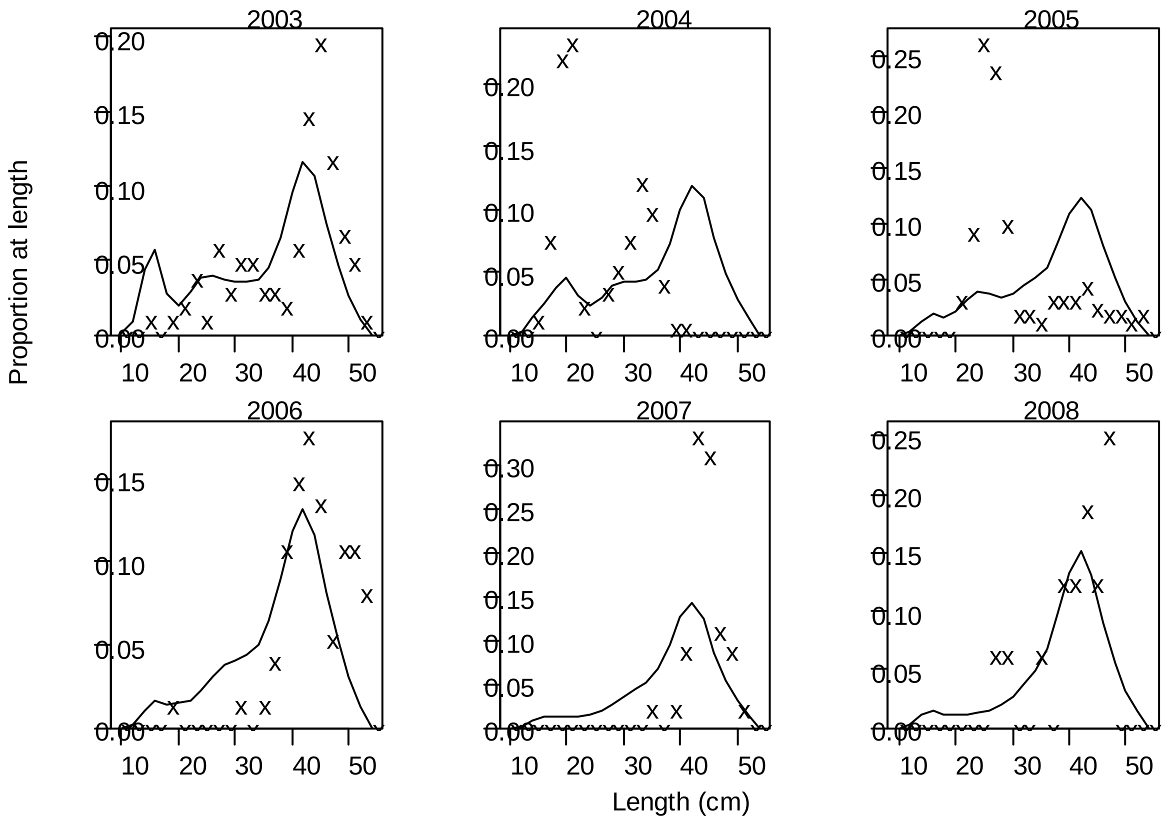


Figure 2: Observed ('x') and expected (line) proportions at length (sexes combined) for data set NWFSCSvyS.

References

Hrafnkelsson, B.; Stefánsson, G. (2004). A model for categorical length data from groundfish surveys. *Canadian Journal of Fisheries & Aquatic Sciences* 61: 1135-1142.

Francis, R.I.C.C. (2006). Some recent problems in New Zealand orange roughy assessments. *New Zealand Fisheries Assessment Report 2006/43.* 64 p.

15 Appendix D. Model fits to age and length composition data.

Figure D1. Model fits to the Washington fishery female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

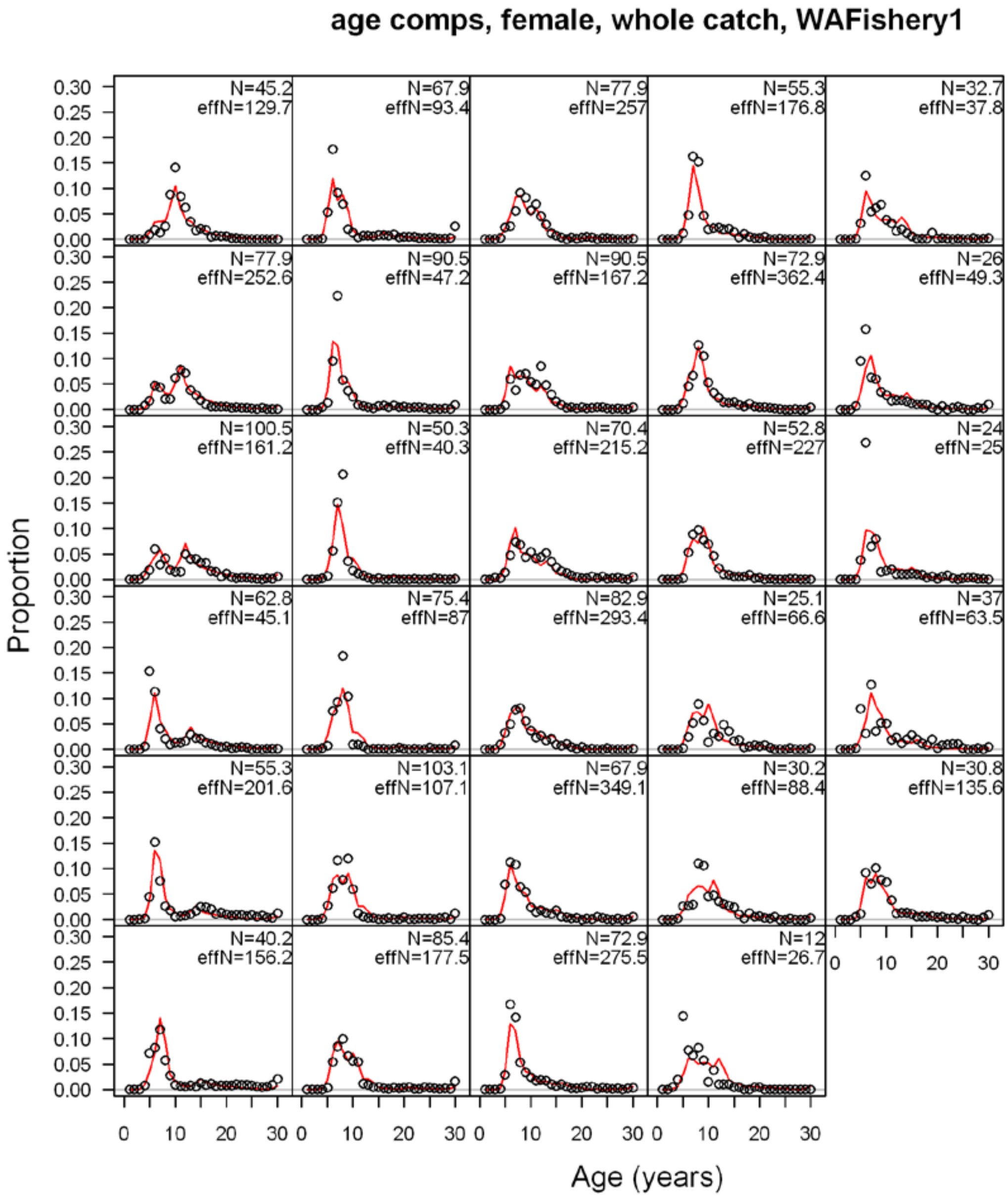


Figure D2. Model fits to the Washington fishery male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

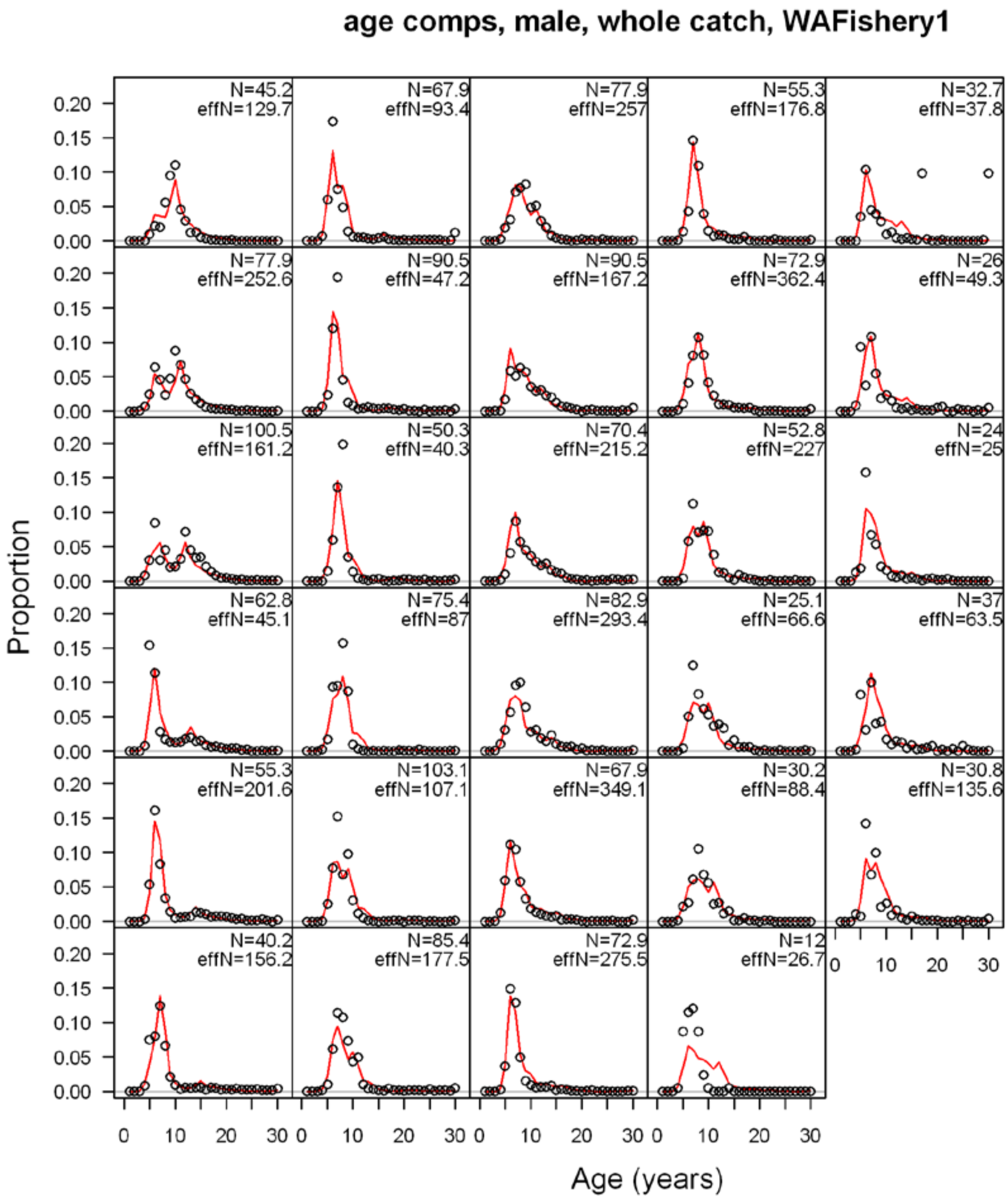


Figure D3. Model fits to the Oregon mid-water trawl fishery female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

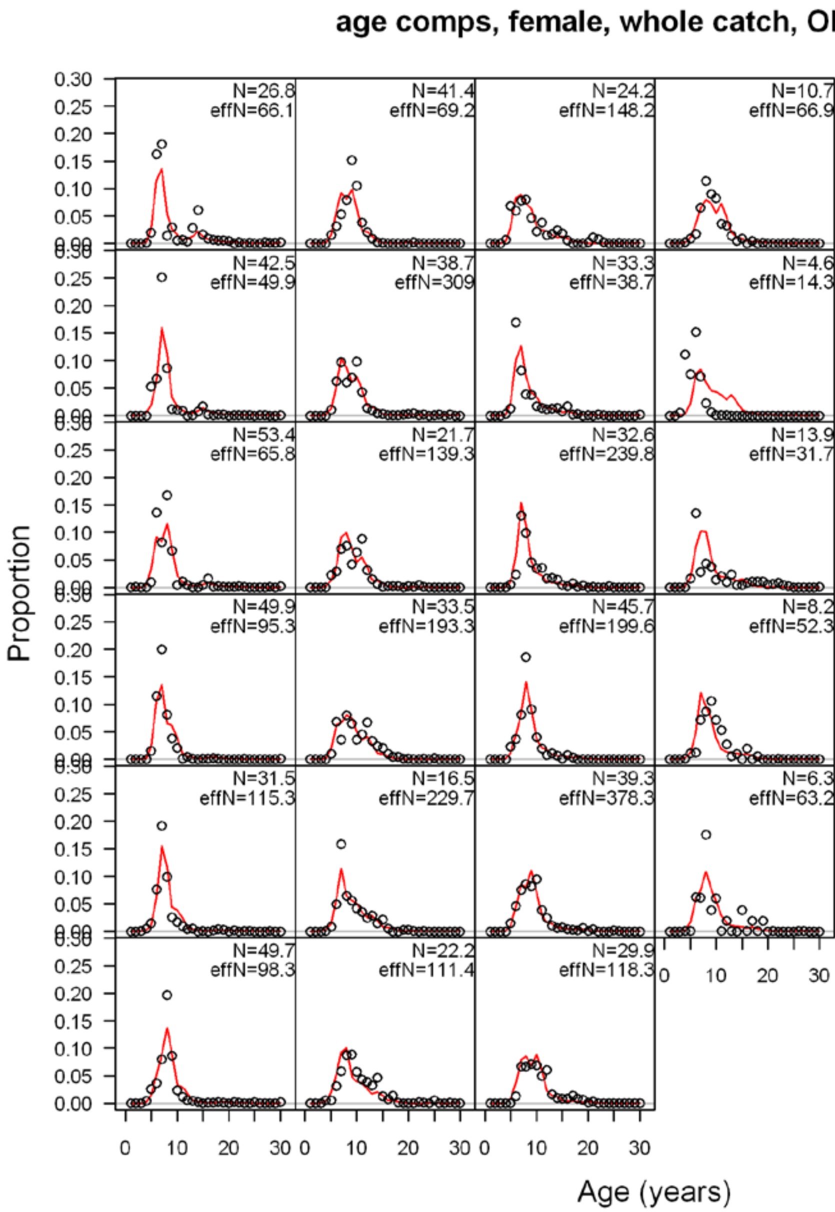


Figure D4. Model fits to the Oregon mid-water trawl fishery male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

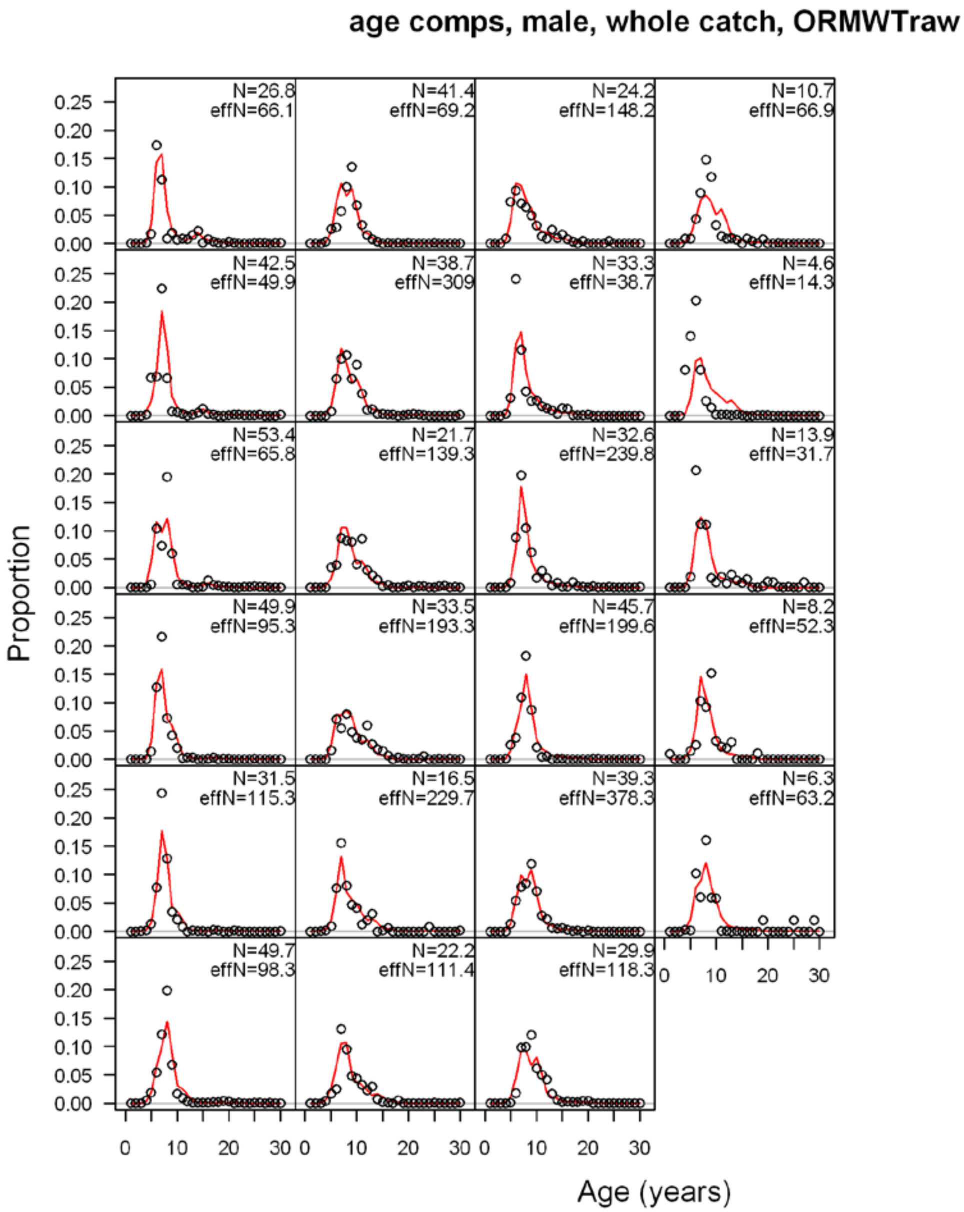


Figure D5. Model fits to the Oregon bottom trawl fishery female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

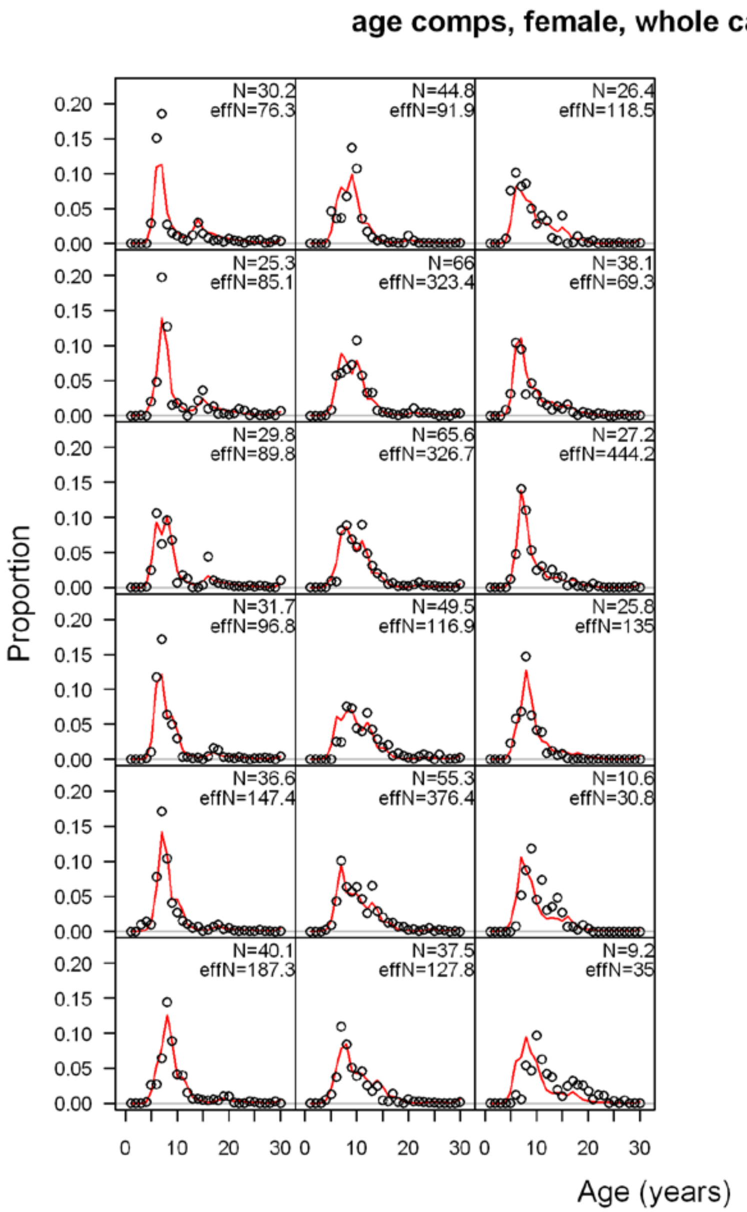


Figure D6. Model fits to the Oregon bottom trawl fishery male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

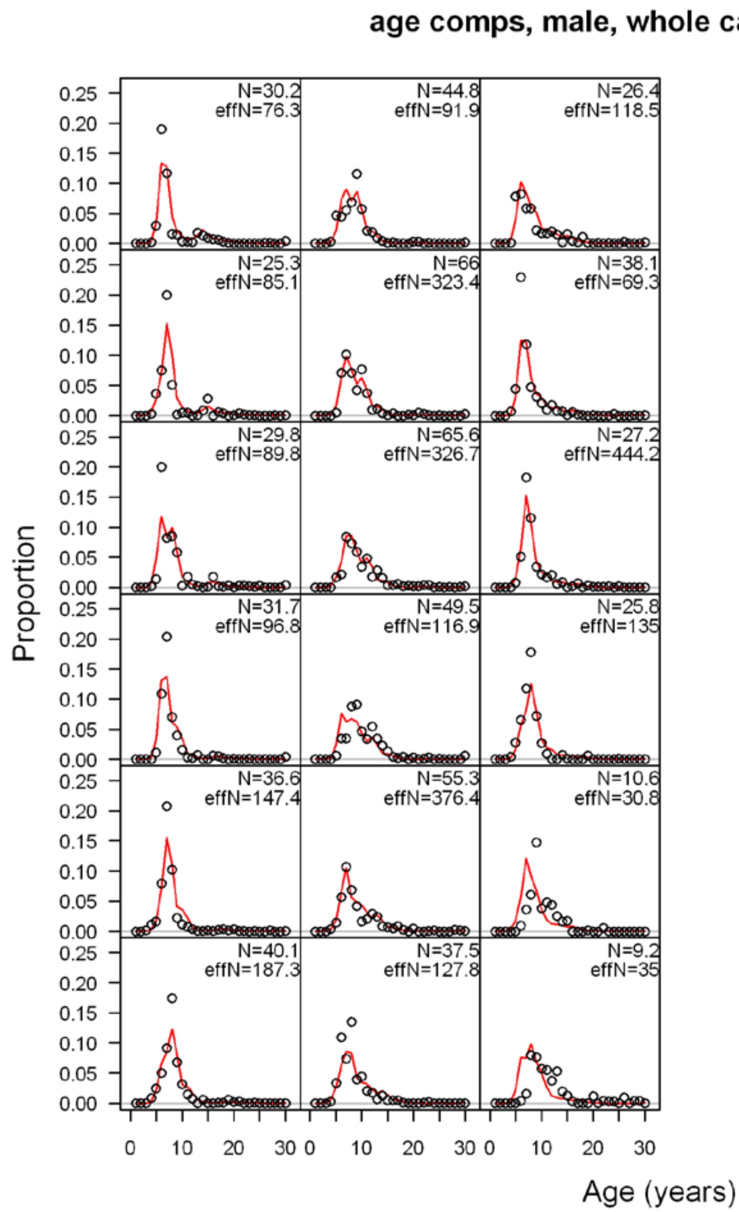


Figure D7. Model fits to the Eureka-Conception fishery female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

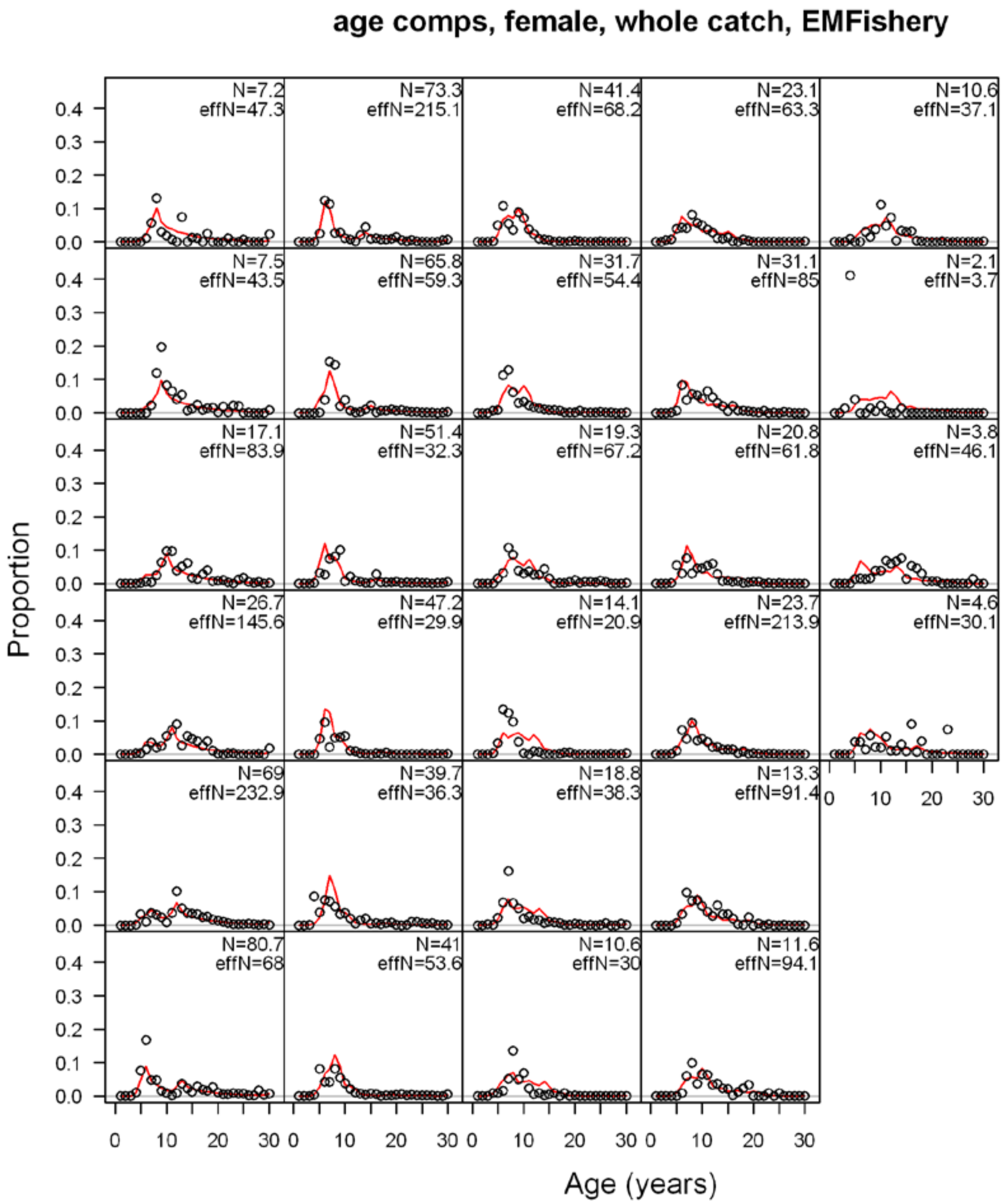


Figure D8. Model fits to the Eureka-Conception fishery male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

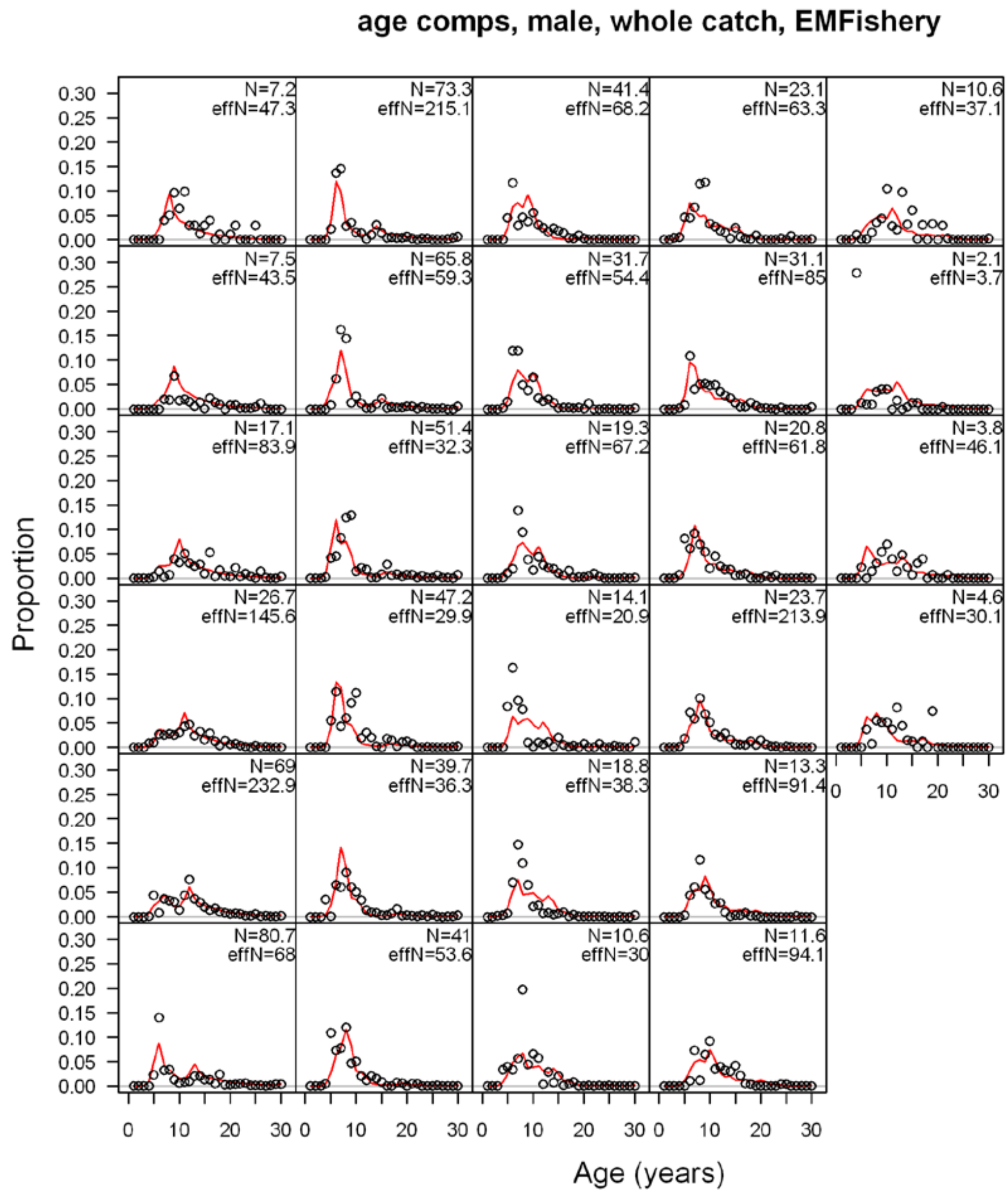


Figure D9. Model fits to the NWFSC northern area survey female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

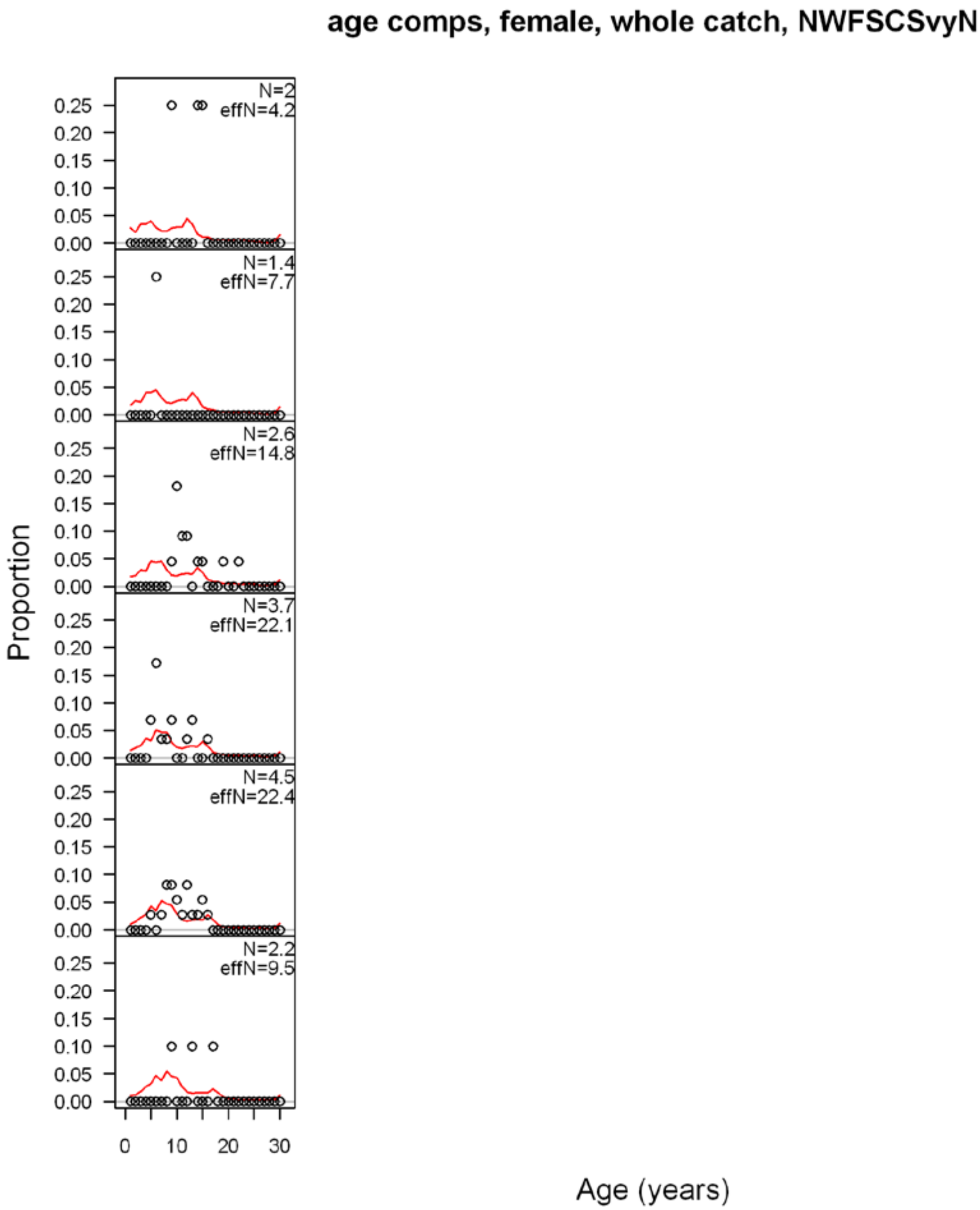


Figure D10. Model fits to the NWFSC northern area male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

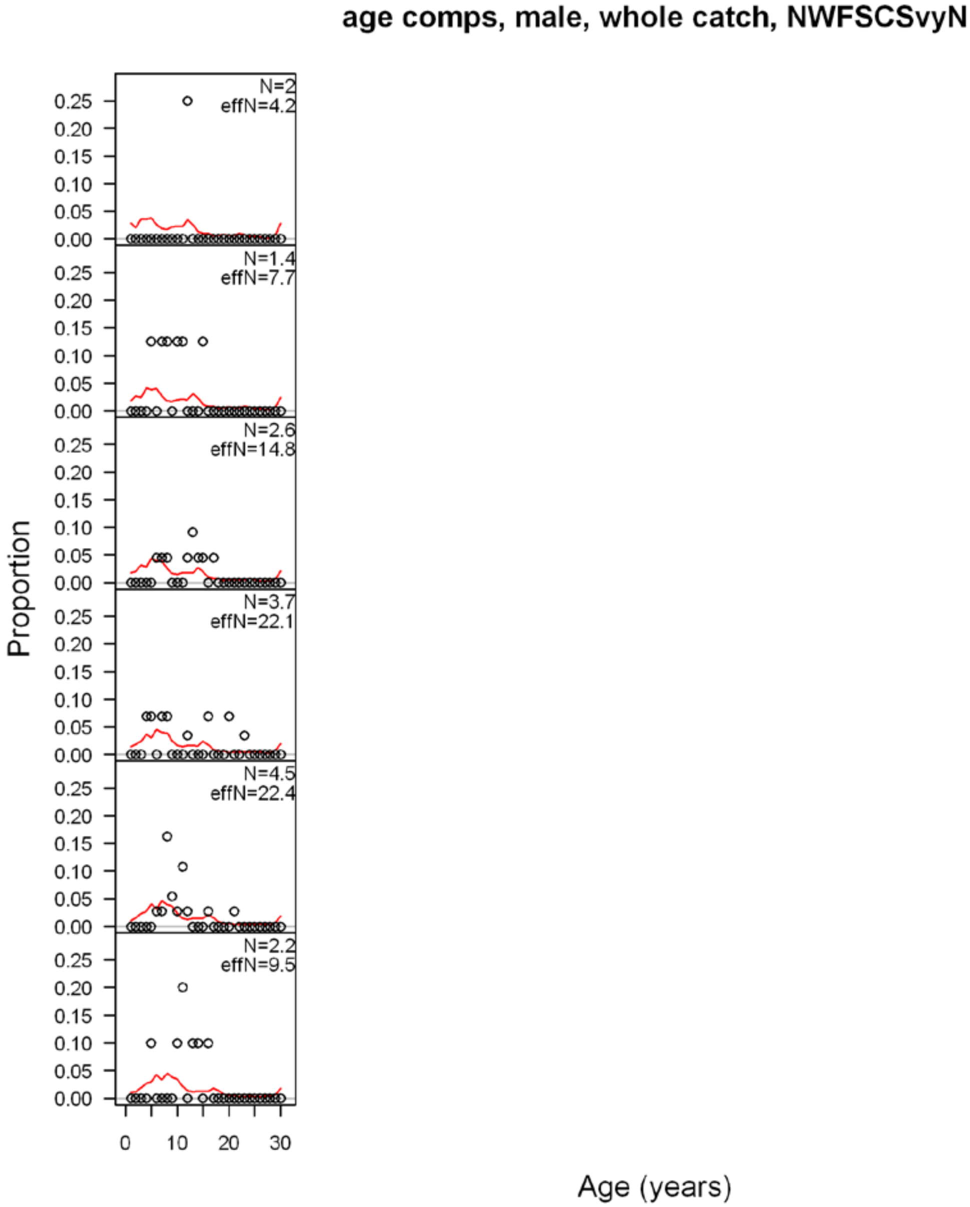


Figure D11. Model fits to the NWFSC southern area female age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

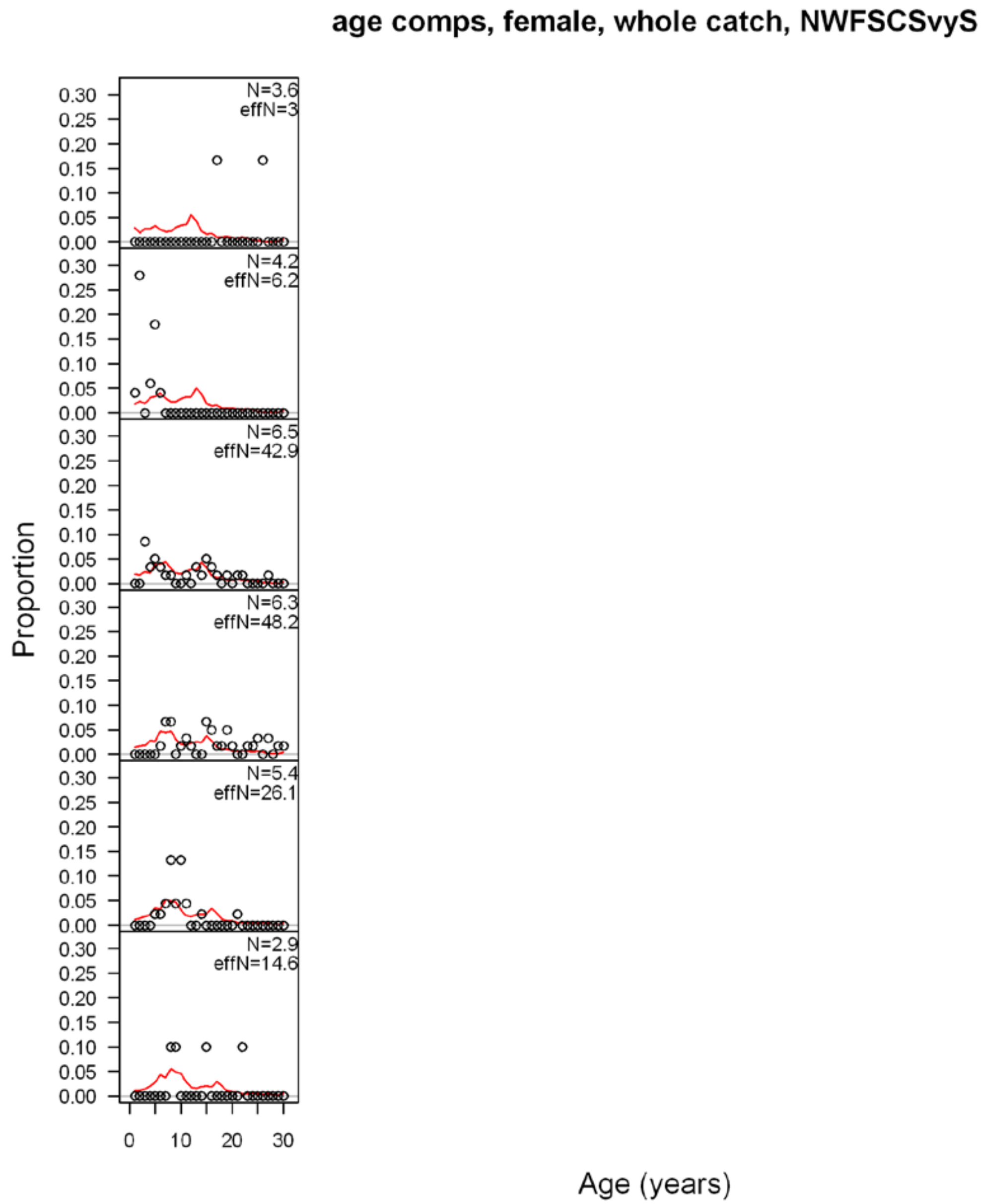


Figure D12. Model fits to the NWFSC southern area male age composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

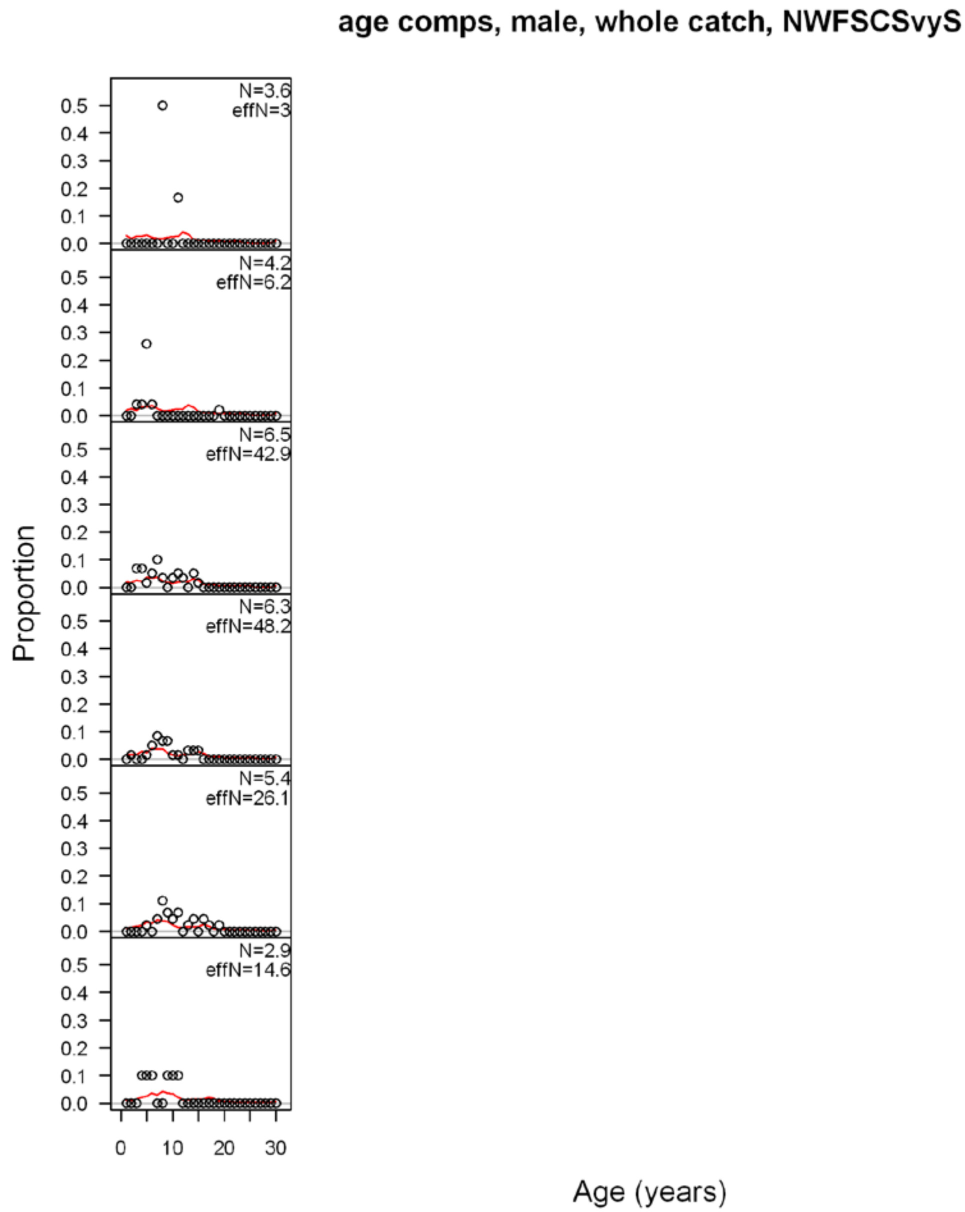


Figure D13. Model fits to the northern area triennial survey female length composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

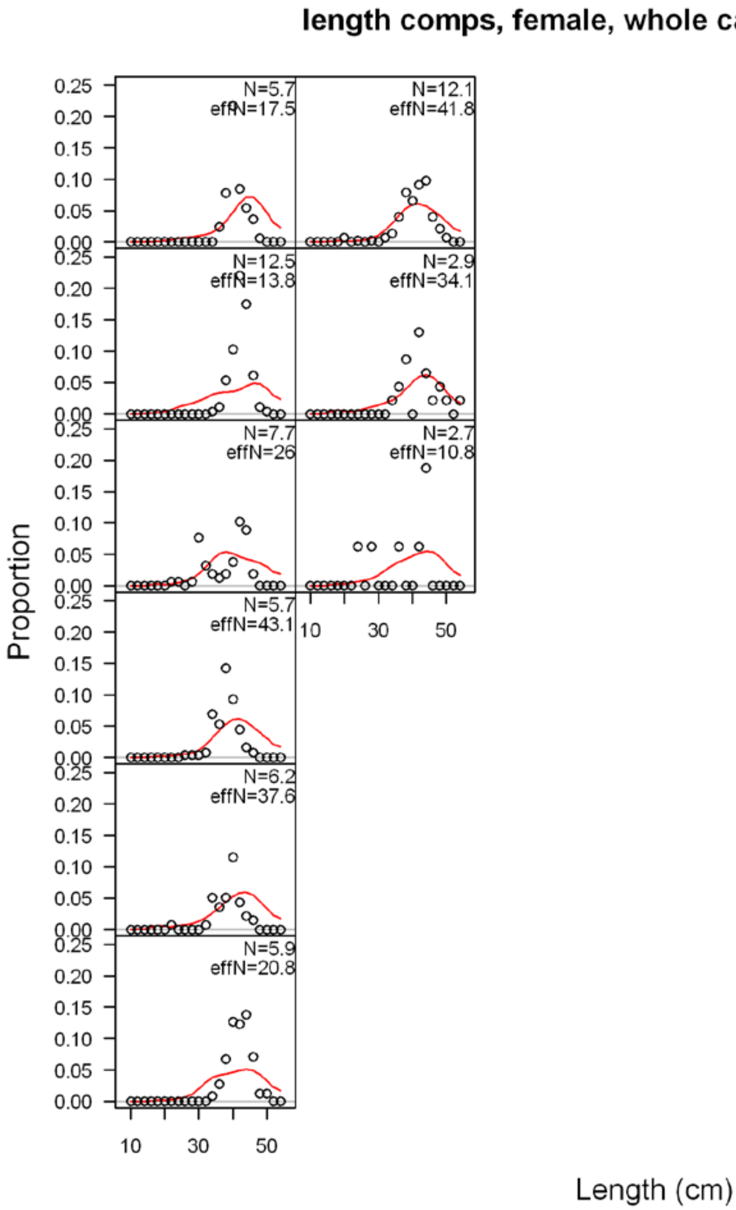


Figure D14. Model fits to the northern area triennial survey male length composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

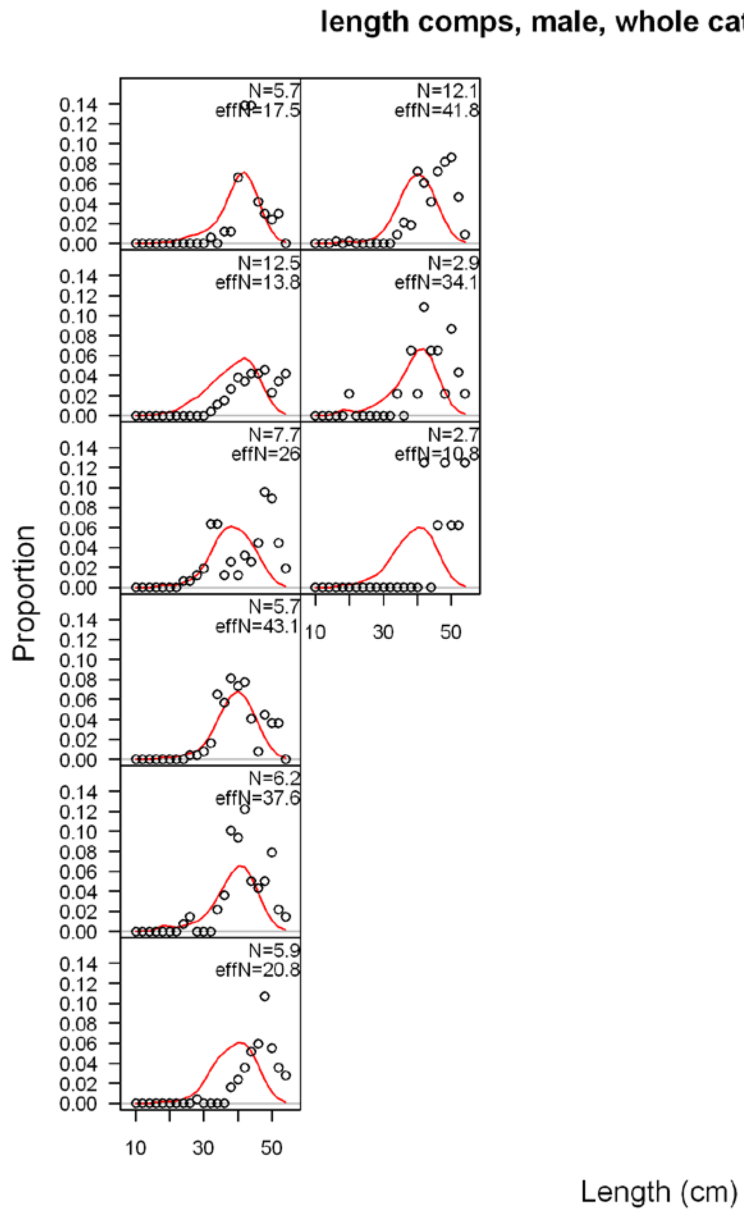


Figure D15. Model fits to the southern area triennial survey female length composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

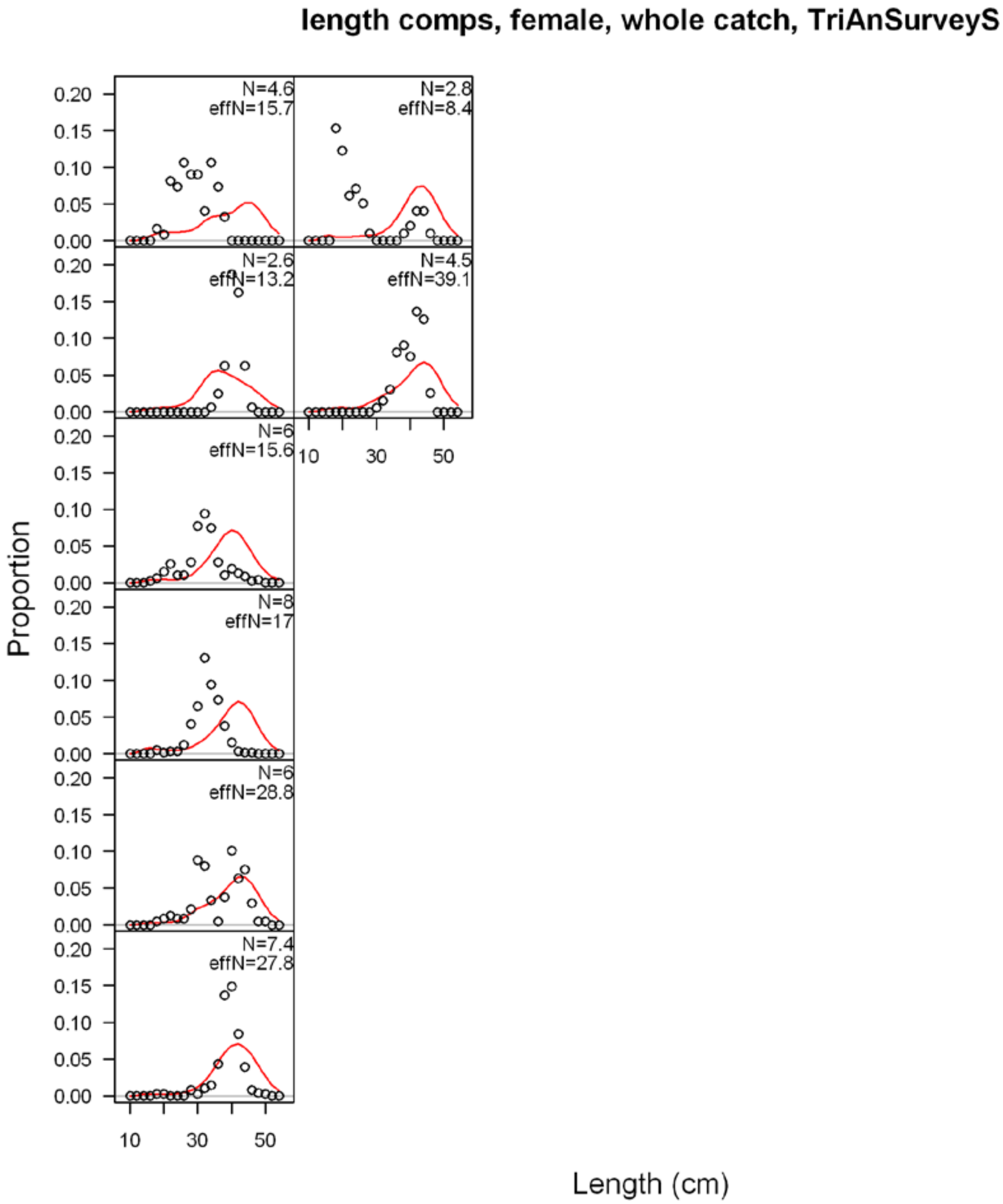


Figure D16. Model fits to the southern area triennial survey male length composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

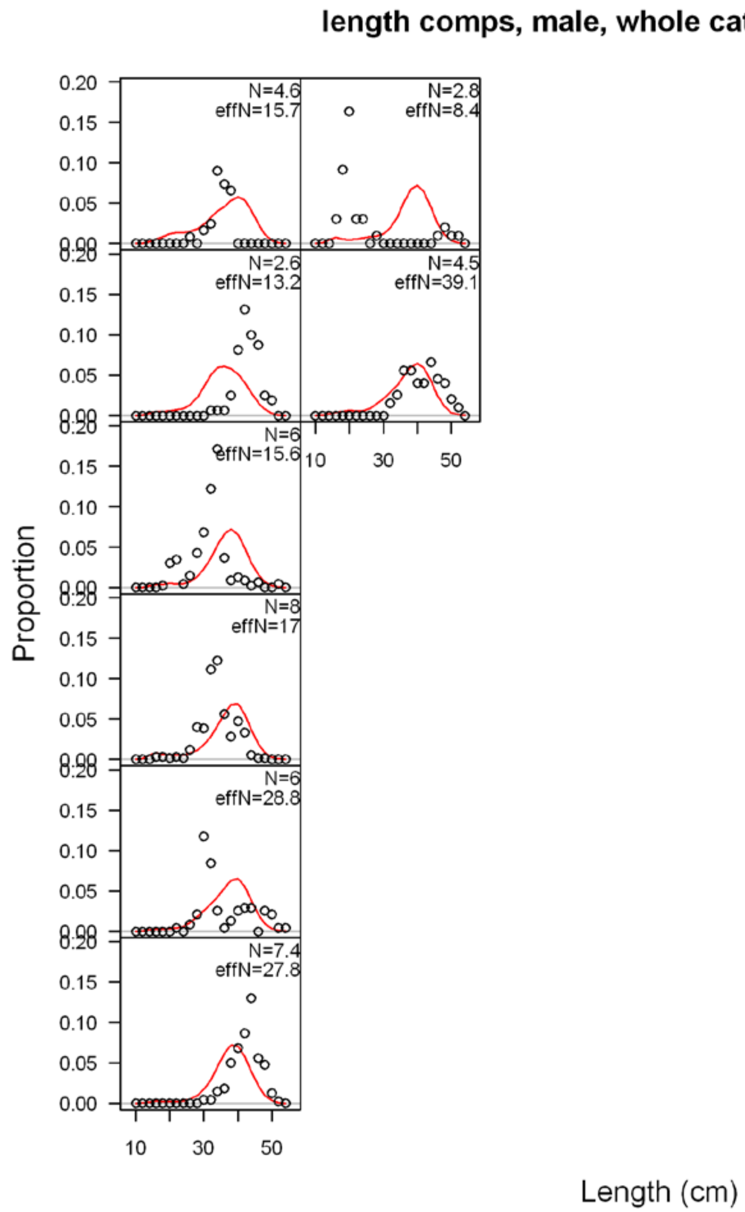


Figure D17. Model fits to the NWFSC northern area length female composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

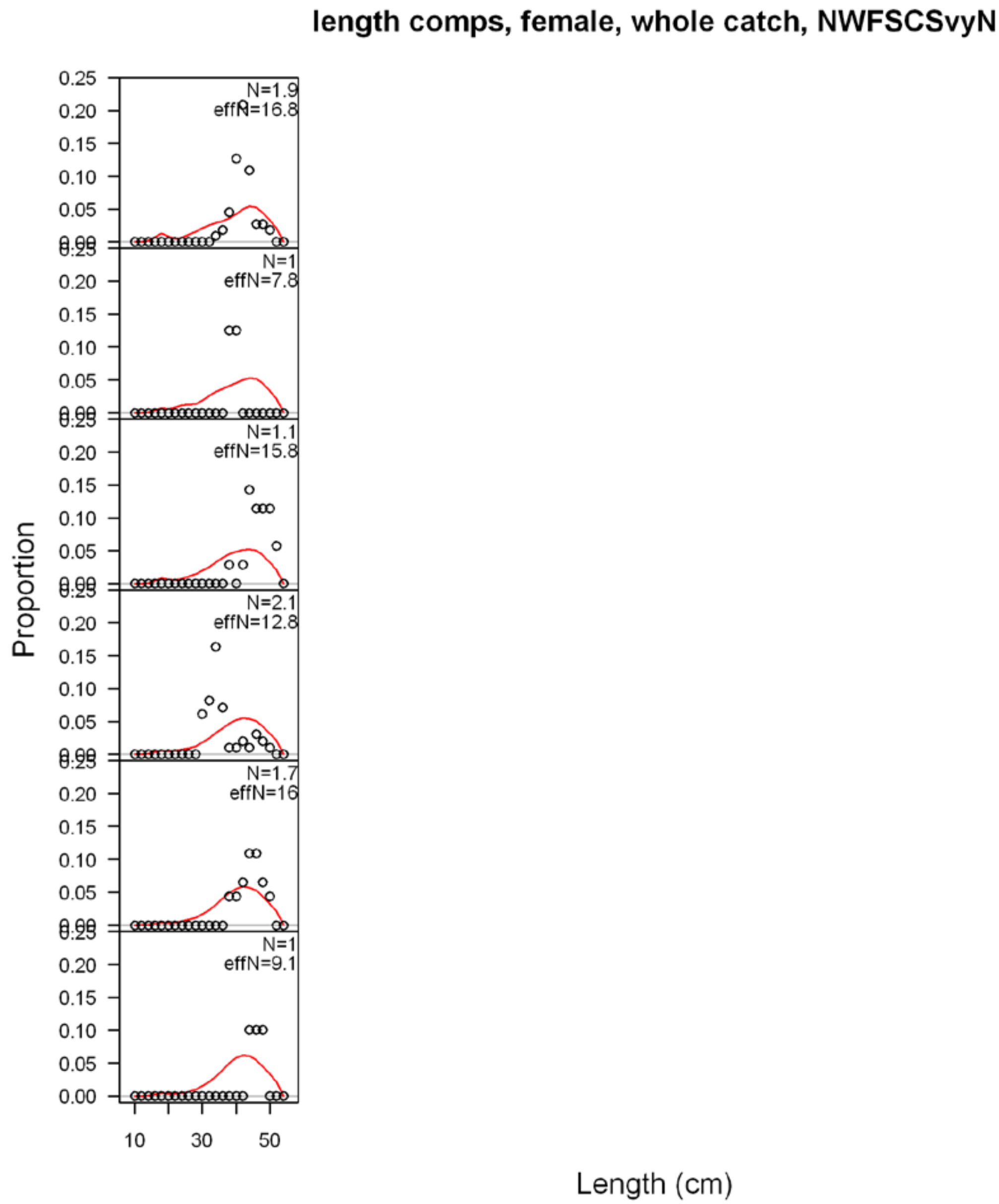


Figure D18. Model fits to the NWFSC northern area survey male composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

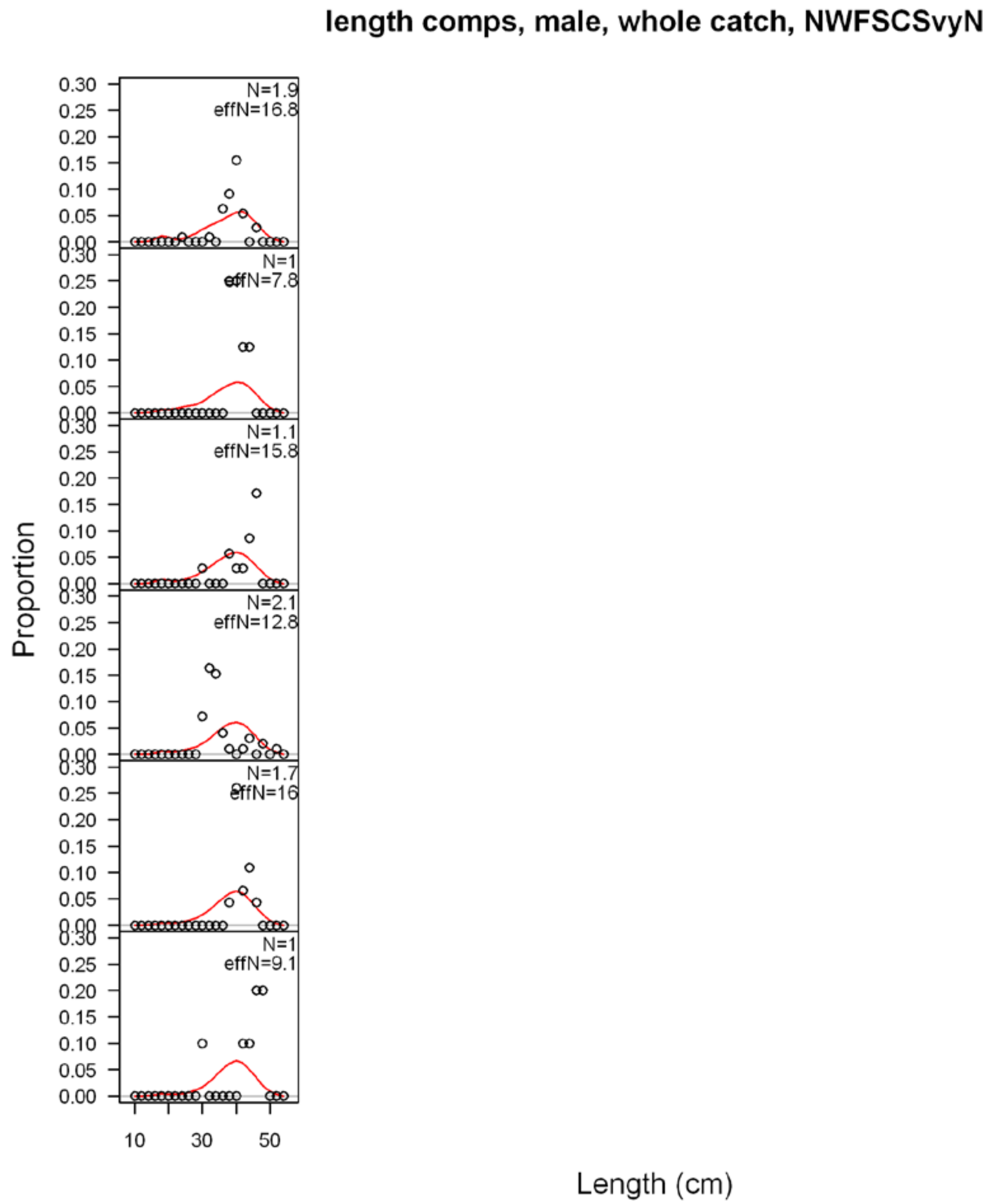


Figure D19. Model fits to the NWFSC southern area survey female composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.

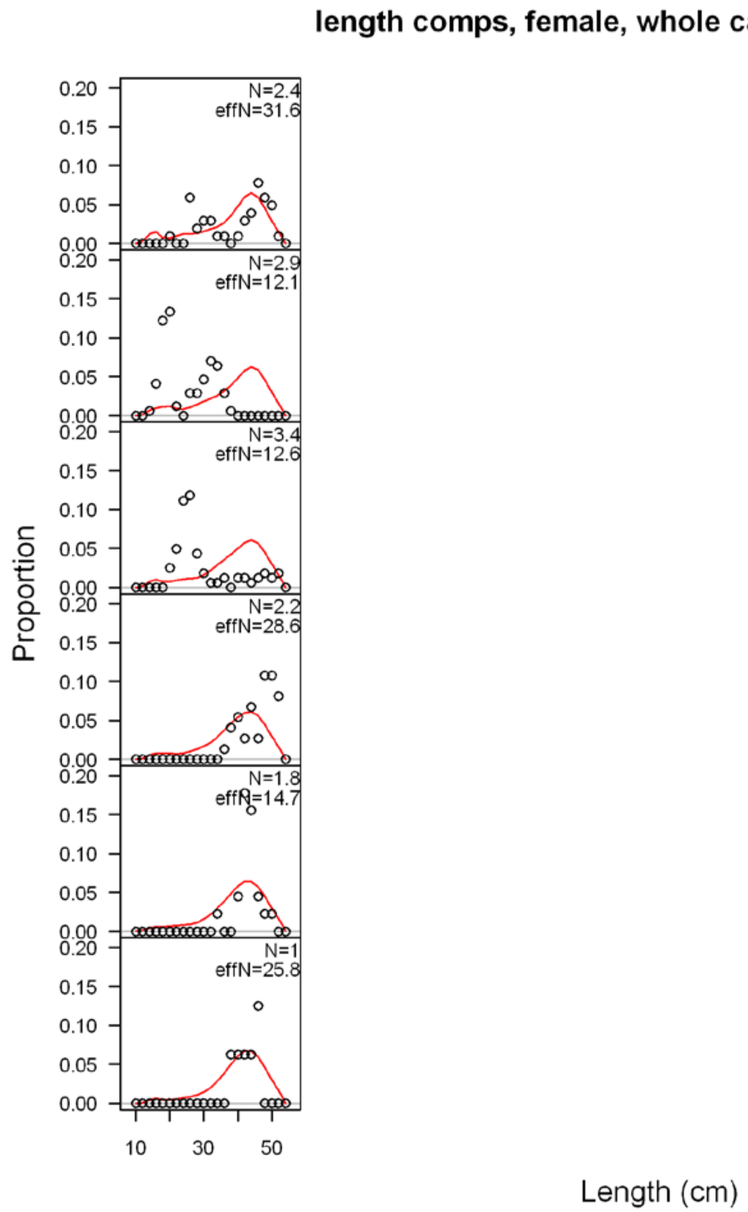
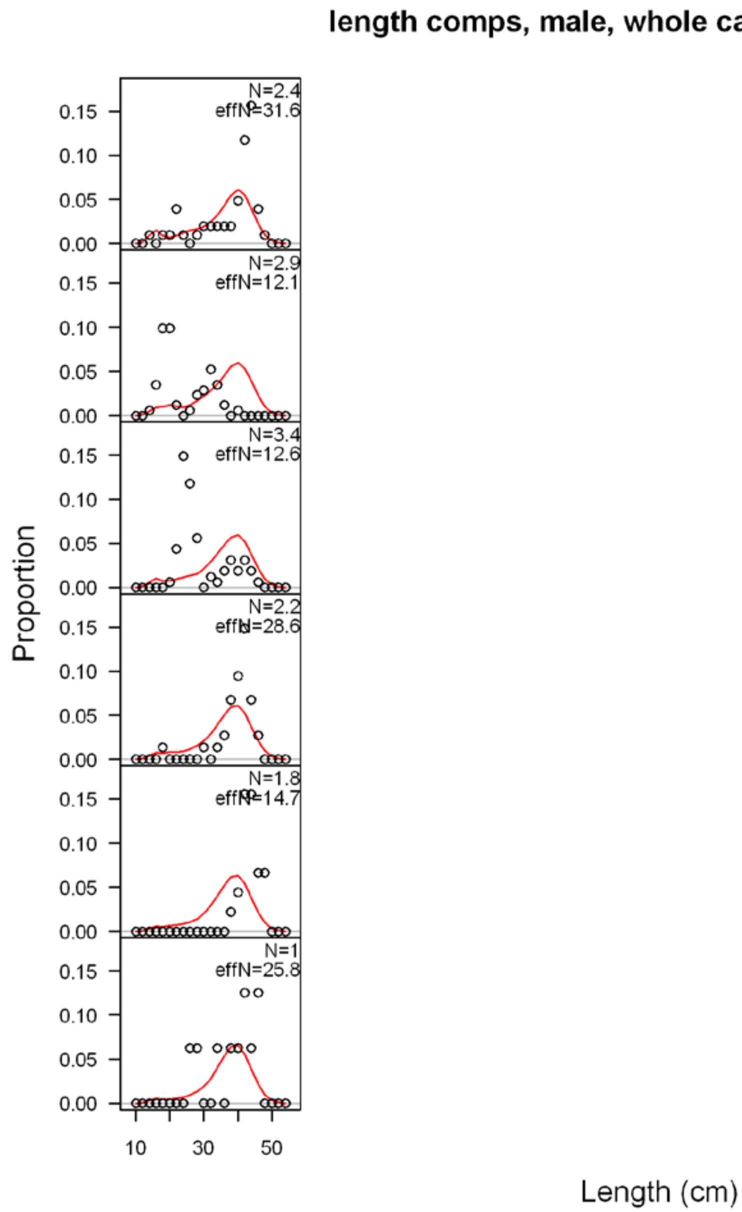


Figure D20. Model fits to the NWFSC southern area survey male composition data. Note that N is not the actual sample size, but the effective sample size from the previous iteration.



16 Appendix E. Input SS3 starter file (Starter.ss) for widow rockfish stock assessment base model.

```
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#_SS-V3.03a-opt;_05/11/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);
_using_ADMB_7.0.1

wdw1.dat
wdw1.ctl

0             # 0=use init values in control file; 1=use ss2.par
1             # run display detail (0,1,2)
1             # detailed age-structured reports in SS2.rep (0,1)
0             # write detailed checkup.sso file (0,1)
1             # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all;
3=every_iter,all_parms)
2             # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
0             # Include prior_like for non-estimated parameters (0,1)
1             # Use Soft Boundaries to aid convergence (0,1) (recommended)
1             # Number of bootstrap datafiles to produce
9             # Turn off estimation for parameters entering after this phase
10            # MCMC burn interval
2             # MCMC thin interval
0.0001 # jitter initial parm value by this fraction
-1            # begin annual SD report in start year
-2            # end annual SD report in end year (-2=end of annual SD report in last
forecast year
0             # N individual STD years (0=none)

#vector of year values

0.0001 # final convergence criteria (e.g. 1.0e-04)
0             # retrospective year relative to end year (e.g. -4)
1             # min age for calc of summary biomass
1             # Depletion basis:  denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel
X*B_styr
1             # Fraction (X) for Depletion denominator (e.g. 0.4)
4             # (1-SPR)_reporting:  0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-
SPR_Btarget); 4=no denominator (report actural 1-SPR values)
1             # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)
0             # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt

999           # check value for end of file
```

17 Appendix F. Input SS3 forecast file (forecast.ss) for widow rockfish stock assessment base model.

```
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#_SS-V3.03a-opt;_05/11/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_ADMB_7.0.1

1            # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=F(endyr); 5=Ave F
(enter yrs); 6=read Fmult
# -4  # first year for recent ave F for option 5 (not yet implemented)
# -1  # last year for recent ave F for option 5 (not yet implemented)
# 0.74  # F multiplier for option 6 (not yet implemented

2007   # first year to use for averaging selex to use in forecast (e.g. 2004; or use -
x to be rel endyr)
2008   # last year to use for averaging selex to use in forecast

1            # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2            # MSY: 0=none; 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set
to F(endyr)
0.5          # SPR target (e.g. 0.40)
0.4          # Biomass target (e.g. 0.40)

12           # N forecast years with standard deviations

1            # read 10 advanced options
1            # Do West Coast gfish rebuilder output (0/1)

2000   # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to
endyear+1)
2001   # Rebuilder:  year for current age structure (Yinit) (-1 to set to endyear+1)
1            # Control rule method (1=west coast adjust catch; 2=adjust F)
0.4          # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.1          # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
1            # Control rule fraction of Flimit (e.g. 0.75)
-1           # maximum annual catch during forecast (not coded yet)
0            # 0= no implementation error; 1=use implementation error in forecast (not
coded yet)
0.1          # stddev of log(realized F/target F) in forecast (not coded yet)
# end of advanced options

1 # fleet allocation (in terms of F) (1=use endyr pattern, no read; 2=read below)
# rows are seasons, columns are fleets
#  0 0 0 0

48           # Number of forecast catch levels to input (rest calc catch from forecast
F
1            # basis for input forecatch:  1=retained catch; 2=total dead catch

#_Assuming 2009 and 2010 OYs are: 522mt and 509mt (John's email, May 13, 2009) see
Excel file: "Catch2009_2010 for forecast.xls"
#_Year Sea Fleet Catch
2009   1     1       97.1
2009   1     2      268.8
2009   1     3       36.9
2009   1     4      119.2
2010   1     1       94.7
2010   1     2      262.1
2010   1     3       36.0
2010   1     4      116.2
2011   1     1       94.7
2011   1     2      262.1
```

```
2011   1      3        36.0
2011   1      4       116.2
2012   1      1        94.7
2012   1      2       262.1
2012   1      3        36.0
2012   1      4       116.2
2013   1      1        94.7
2013   1      2       262.1
2013   1      3        36.0
2013   1      4       116.2
2014   1      1        94.7
2014   1      2       262.1
2014   1      3        36.0
2014   1      4       116.2
2015   1      1        94.7
2015   1      2       262.1
2015   1      3        36.0
2015   1      4       116.2
2016   1      1        94.7
2016   1      2       262.1
2016   1      3        36.0
2016   1      4       116.2
2017   1      1        94.7
2017   1      2       262.1
2017   1      3        36.0
2017   1      4       116.2
2018   1      1        94.7
2018   1      2       262.1
2018   1      3        36.0
2018   1      4       116.2
2019   1      1        94.7
2019   1      2       262.1
2019   1      3        36.0
2019   1      4       116.2
2020   1      1        94.7
2020   1      2       262.1
2020   1      3        36.0
2020   1      4       116.2

999 # verify end of input
```

18 Appendix G. Input SS3 control file (wdw1.ctl) for widow rockfish stock assessment base model.

```
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#_SS-V3.03a-opt;_05/11/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_ADMB_7.0.1

#_data_and_control_files: wdw1.dat wdw1.ctl

2      #_N_Growth_Patterns
1      #_N_Morphs_Within_GrowthPattern

#_Recruit_Setup
2      # N recruitment designs goes here if N_GP*nseas*pop>1
0      # placeholder for recruitment interaction request

# GP seas area for each recruitment assignment
1 1 1
2 1 2

# 1 1 1  # example recruitment design element for GP=1, seas=1, pop=1

# N_movement_definitions goes here if pop > 1
0

# 0 # N_movement_definitions goes here if pop > 1
# 1.0 # first age that moves (real age at begin of season, not integer)
# 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4,
age2=10

1      #_Nblock_Designs
3
1958 1977 1978 1995 1996 2008

0.5    #_fracfemale
1      #_natM_type:_0=1Parm;
1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
2      #_N_breakpoints
4 5    # age(real) at M breakpoints
1      # GrowthModel: 1=vonBert with L1&L2; 2=vonBert with A0&Linf; 3=Richards;
4=readvector
3      #_Growth_Age_for_L1
18     #_Growth_Age_for_L2 (999 to use as Linf)
0      #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
1      #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
4      #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity for
each femlae GP; 4=read age-fecundity for each female GP

#_Age_Maturity by growth pattern (Muturity by age for GP1 and GP2)
#_For max age = 30, see 5_12_2009 Excel file "AgeLengthWeight maturity fecundity.xls"
0.00000      0.00000      0.00000      0.00000      0.00000      0.00723
      0.04882      0.15808      0.27915      0.37660      0.44940      0.51860
      0.57802      0.63218      0.68119      0.72530      0.76479      0.80001
      0.83130      0.85902      0.88351      0.90511      0.92411      0.94080
      0.95544      0.96828      0.97951      0.98933      0.99791      1.00541
      1.01195
0.00000      0.00000      0.00000      0.00065      0.00210      0.01920
      0.07750      0.16088      0.26640      0.34664      0.41835      0.48129
      0.53574      0.58234      0.62188      0.65520      0.68312      0.70642
      0.72579      0.74184      0.75512      0.76609      0.77513      0.78257
```

```
       0.78869      0.79371      0.79784      0.80123      0.80401      0.80629
       0.80816

0      #_First_Mature_Age
1      #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b !!! No used
if maturity_option = 4
0      # no gender Change
1      #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1,
3=like SS2 V1.x)
2      #_env/block/dev_adjust_method (1=standard; 2=with logistic trans to keep within
base parm bounds)

#_growth_parms
#_LO   HI           INIT   PRIOR  PR_type      SD           PHASE  env    usdev  dminyr
       dmaxyr dev_std       Block  Block_Fxn
0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      # NatM_p_1_Fem_GP:1
0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      # NatM_p_2_Fem_GP:1
10            50           27.72  27.72  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amin_Fem_GP_1
25            70           47.74  47.74  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amax_Fem_GP_1
0.01   0.25   0.14  0.14   -1           0.8          -2           0      0
       0            0             0.5          0            0      #
VonBert_K_Fem_GP_1
0.01   0.2          0.10   0.10   -1           0.8          -1            0      0
       0            0             0.5          0            0      # CV_young_Fem_GP_1
0.01   0.2          0.10   0.10   -1           0.8          -1            0      0
       0            0             0.5          0            0      # CV_old_Fem_GP_1

0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      # NatM_p_1_Fem_GP:2
0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      # NatM_p_2_Fem_GP:2
10            50           22.32  22.32  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amin_Fem_GP_2
25            70           46.29  46.29  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amax_Fem_GP_2
0.01   0.25   0.20  0.20   -1           0.8          -2           0      0
       0            0             0.5          0            0      #
VonBert_K_Fem_GP_2
0.01   0.2          0.10   0.10   -1           0.8          -1            0      0
       0            0             0.5          0            0      # CV_young_Fem_GP_2
0.01   0.2          0.10   0.10   -1           0.8          -1            0      0
       0            0             0.5          0            0      # CV_old_Fem_GP_2

0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      #
NatM_p_1_Mal_GP:1_
0.01   0.3          0.125  0.125  -1           0.8          -1            0      0
       0            0             0.5          0            0      #
NatM_p_2_Mal_GP:1_
10            50           28.54  28.54  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amin_Mal_GP_1_
25            70           42.96  42.96  -1           10           -2            0
       0            0             0            0.5          0             0      #
L_at_Amax_Mal_GP_1_
```

```
0.01   0.25   0.18   0.18   -1          0.8          -2           0      0
       0             0             0.5          0            0      #
VonBert_K_Mal_GP_1_
0.01   0.2           0.10   0.10   -1           0.8          -1           0      0
       0             0             0.5          0            0      #
CV_young_Mal_GP_1_
0.01   0.2           0.10   0.10   -1           0.8          -1           0      0
       0             0             0.5          0            0      # CV_old_Mal_GP_1_

0.01   0.3           0.125  0.125  -1           0.8          -1           0      0
       0             0             0.5          0            0      # NatM_p_1_Mal_GP:2
0.01   0.3           0.125  0.125  -1           0.8          -1           0      0
       0             0             0.5          0            0      # NatM_p_2_Mal_GP:2
10            50            23.22  23.22  -1           10           -2           0
       0             0             0            0.5          0            0      #
L_at_Amin_Mal_GP_2
25            70            41.07  41.07  -1           10           -2           0
       0             0             0            0.5          0            0      #
L_at_Amax_Mal_GP_2
0.01   0.5           0.25   0.25   -1           0.8          -2           0      0
       0             0             0.5          0            0      #
VonBert_K_Mal_GP_2
0.01   0.2           0.10   0.10   -1           0.8          -1           0      0
       0             0             0.5          0            0      # CV_young_Mal_GP_2
0.01   0.2           0.10   0.10   -1           0.8          -1           0      0
       0             0             0.5          0            0      # CV_old_Mal_GP_2

-3            3 0.00000545 0.00000545    -1           0.8          -1           0
       0             0             0            0.5          0            0      #
Wtlen1_Fem
-3            10            3.28781 3.28781     -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Wtlen2_Fem
-3            50            7             7            -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Mat50_Fem          !! ignored if maturity option=4
-3            3             -1            -1           -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Mat_slope_Fem !! ignored if maturity option=4
0             1             1             1            -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Eggs1_Fem          !! ignored if maturity option=4
0             1             0             0            -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Eggs2_Fem          !! ignored if maturity option=4

-3            3 0.00001188 0.00001188    -1           0.8          -1           0
       0             0             0            0.5          0            0      #
Wtlen1_Mal
-3            10            3.06631 3.06631     -1           0.8          -1
       0      0             0             0            0.5          0            0
       # Wtlen2_Mal

-4      0    -0.32158  -0.32158 -1      99       6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
-4      0    -1.29098  -1.29098 -1      99      -6      0   0      0      0       0.5
0       0   # RecrDist_GP_2

-4      4       0       0       -1      99      -3      0   0       0       0
0.5     0       0   # RecrDist_Area_1
-4      4       0       0       -1      99      -3      0   0       0       0
0.5     0       0   # RecrDist_Area_2
```

```
-4      4       0       0       -1      99      -3      0   0       0       0
0.5     0       0   # RecrDist_Seas_1

1            1            1            1            -1           99           -3
      0     0            0            0            0.5          0            0
      # CohortGrowDev

##########################################################################################
######################################
# Prop to North = 0.6
# -4      0    -0.51083  -0.51083 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -0.91629  -0.91629 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.65
# -4      0    -0.43078  -0.43078 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.04982  -1.04982 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.675
# -4      0    -0.39034  -0.39034 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.12393  -1.12393 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.6875
# -4      0    -0.37469  -0.37469 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.16315  -1.16315 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.70
# -4      0    -0.35667  -0.35667 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.20397  -1.20397 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.7125
# -4      0    -0.33898  -0.33898 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.24653  -1.24653 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.725
# -4      0    -0.32158  -0.32158 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.29098  -1.29098 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.75
# -4      0    -0.28768  -0.28728 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.38629  -1.38629 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2

# Prop to North = 0.775
# -4      0    -0.25489  -0.25489 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.49165  -1.49165 -1      99      -6      0   0           0      0
0.5     0       0   # RecrDist_GP_2
```

```
# Prop to North = 0.80
# -4      0    -0.22314  -0.22314 -1      99      -6      0   0       0       0
0.5     0       0   # RecrDist_GP_1
# -4      0    -1.60944  -1.60944 -1      99      -6      0   0          0      0
0.5     0       0   # RecrDist_GP_2
######################################################################################
######################################

######################################################################################
######################################
# Next two blocks for setting different recruit distributions to each area
# Note: if use Rick's distri devs, need to set # placeholder for #_MGparm_Dev_Phase to
1
# next two lines: no annual devs
# -4   4      -0.32158     -0.32158            -1           99           -3
      0     0             0            0            0.5          0            0
      # RecrDist_GP_1
# -4   4      -1.29098     -1.29098            -1           99           -3
      0     0             0            0            0.5          0            0
      # RecrDist_GP_1

# next two lines: edited by Rick
# -4   4      -0.32158     -0.32158            -1           99           -3
      0     0             0            0            0.5          0            0
      # RecrDist_GP_1
# -4   4      -1.29098     -1.29098            -1           99           -1
      0     2             1978 2003          0.8          0            0      #
RecrDist_GP_2
######################################################################################
######################################

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

# 1  #custom_MG-block_setup (0/1)
# -2 2 0 0 -1 99 6 #_placeholder for no MG-block parameters
# -2 2 0 0 -1 99 6 #_placeholder for no MG-block parameters
# -2 2 0 0 -1 99 6 #_placeholder for no MG-block parameters

#_seasonal_effects_on_biology_parms
#_femwtlen1  femwtlen2    mat1  mat2  fec1  fec2  Malewtlen1   malewtlen2   L1
      K
0                   0                   0            0            0            0
      0                   0                   0      0

# -2 2 0 0 -1 99 -2 #_placeholder for no seasonal MG parameters
# -2 2 0 0 -1 99 -2 #_placeholder for no MG dev parameters
# if use Rick's recruit dist dev, active next line (phase for MGparm_dev)
#7  # placeholder for #_MGparm_Dev_Phase

#_Spawner-Recruitment
#_SR functions: 1=Beverton Holt with flat-top beyond Bzero; 2=Ricker; 3= Standard BH;
4=ingore steepness and no bias adjustment
3      #_SR_function

#_LO   HI     INIT   PRIOR  PR_type            SD           PHASE
1            20     10.0   10.0   -1                  0.8          1            #
SR_R0
0.2          1      0.721  0.721  2                   0.193  4            # SR_steep:
Martin's new prior (see email 6/2/2009)
0            2      0.6           0.6          -1                  100          -3
      # SR_sigmaR
```

```
-5          5     0           0           -1                1           -3
      # SR_envlink
-5          5     0           0           -1                1           -3
      # SR_R1_offset
0           0.5   0           0           -1                99          -2
      # 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
1978  # first year of main recr_devs; early devs can preceed this era
2008  # last year of main recr_devs; forecast devs start in following year
5           #_recdev phase

1           # (0/1) to read 11 advanced options: Mark all lines in next section if =
0

#_start of advanced SR options
-20         #_recdev_early_start (0=none; neg value makes relative to recdev_start)
6           #_recdev_early_phase
0           #_forecast_recruitment phase (incl. late recr) (0 value resets to
maxphase+1)
1           #_lambda for forecast recr dev occurring before endyr+1
1980  #_last_early_yr_nobias_adj_in_MPD
1988  #_first_yr_fullbias_adj_in_MPD
2003  #_last_yr_fullbias_adj_in_MPD
2008  #_first_recent_yr_nobias_adj_in_MPD
1.0         # Max bias adjustment
0           # future use
-5          #min rec_dev
5           #max rec_dev
0           #_read_recdevs
#_end of advanced SR options

#Fishing Mortality info
0.05  # F ballpark for tuning early phases
1982  # F ballpark year
3           # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
2.9         # 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
# read N iterations for tuning for Fmethod 3 (recommend 3 to 7)

# if F_Method=2 (instan.), active next line
# 0.01 1      0      # overall start F value; overall phase; N detailed inputs to read

# Number of tuning iterations in hybrid F: 4 or 5 may be good - check how catches data
match estimated catches
# if F_Method=3 (hybrid), active next line
5

#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           0.5   0           0           -1    1000   1           #
InitF_1WAFishery1
0           0.5   0           0           -1    1000   -1          #
InitF_2ORMWTraw
0           0.5   0           0           -1    1000   -1          #
InitF_3ORBTraw
```

```
0            0.5    0            0            -1     1000   1            #
InitF_4EMFishery

#_Q_setup
# A=do power, B=env-var, C=extra SD, D=devtype(<0=mirror, 0/1=none, 2=cons, 3=rand,
4=randwalk); E=0=num/1=bio, F=err_type
#A B C D E F
 0 0 0 0 1 0  # 1 WAFishery1
 0 0 0 0 1 0  # 2 ORMWTraw
 0 0 0 0 1 0  # 3 ORBTraw
 0 0 0 0 1 0  # 4 EMFishery
 0 0 0 2 0 0  # 5 SCJuvSurvey
 0 0 0 2 1 0  # 6 ORBTrawCPUE
 0 0 0 2 1 0  # 7 TriAnSurveyN
 0 0 0 2 1 0  # 8 ForWBycatch
 0 0 0 2 1 0  # 9 JVWBycatch
 0 0 0 2 1 0  # 10 DomWBycatch
 0 0 0 2 1 0  # 11 NWFSCSvyN
 0 0 0 2 1 0  # 12 NWFSCSvyS
 0 0 0 2 1 0  # 13 TriAnSurveyS

# To turn-on SOI effects on qs for surveys: 2nd column indicats which env var to use
# 0 1 0 2 1 0# 7  TriAnSurveyN
# 0 1 0 2 1 0# 13 TriAnSurveyS
# 0 2 0 2 1 0# 11 NWFSCSvyN
# 0 2 0 2 1 0# 12 NWFSCSvyS
# And activate the following lines for Q_envlink parameter setups
# -10  10     0.0          0.0          -1                  10           6
       # Q_envlink_7_TriAnSurveyN
# -10  10     0.0          0.0          -1                  10           6
       # Q_envlink_13_TriAnSurveyS
# -10  10     0.0          0.0          -1                  10           6
       # Q_envlink_11_NWFSCSvyN
# -10  10     0.0          0.0          -1                  10           6
       # Q_envlink_12_NWFSCSvyS

# 0 #_0=read one parm for each fleet with random q; 1=read a parm for each year of
index
#_Q_parms(if_any)
# LO   HI     INIT   PRIOR  PR_type             SD            PHASE
 -25   0      -10           -10          -1                  10           2
       # Q_base_5_SCJuvSurvey
 -25   0      -10           -10          -1                  10           2
       # Q_base_6_ORBTrawCPUE
 -25   0      -10           -10          -1                  10           4
       # Q_base_7_TriAnSurveyN
 -25   0      -10           -10          -1                  10           4
       # Q_base_8_ForWBycatch
 -25   0      -10           -10          -1                  10           4
       # Q_base_9_JVWBycatch
 -25   0      -10           -10          -1                  10           4
       # Q_base_10_DomWBycatch
 -25   0      -10           -10          -1                  10           4
       # Q_base_11_NWFSCSvyN
 -25   0      -10           -10          -1                  10           4
       # Q_base_12_NWFSCSvyS
 -25   0      -10           -10          -1                  10           4
       # Q_base_7_TriAnSurveyS

#_size_selex_Setup
#_SelPattern Do_retain    Do_male      Special
 0 0 0 0      # 1 WAFishery1
 0 0 0 0      # 2 ORMWTraw
```

```
 0 0 0 0     # 3 ORBTraw
 0 0 0 0     # 4 EMFishery
 0 0 0 0     # 5 SCJuvSurvey
 0 0 0 0     # 6 ORBTrawCPUE
24 0 0 0     # 7 TriAnSurveyN
 0 0 0 0     # 8 ForWBycatch
 0 0 0 0     # 9 JVWBycatch
 0 0 0 0     # 10 DomWBycatch
24 0 0 0     # 11 NWFSCSvyN
 5 0 0 11    # 12 NWFSCSvyS
 5 0 0 7     # 13 TriAnSurveyS

#_age_selex_Setup
#_SelPattern Do_retain    Do_male      Special
 19 0 2 0    # 1 WAFishery1
 19 0 2 0    # 2 ORMWTraw
 19 0 2 0    # 3 ORBTraw
 19 0 1 0    # 4 EMFishery
 11 0 0 0    # 5 SCJuvSurvey
 15 0 0 3    # 6 ORBTrawCPUE
 10 0 0 0    # 7 TriAnSurveyN
 15 0 0 2    # 8 ForWBycatch
 15 0 0 2    # 9 JVWBycatch
 15 0 0 2    # 10 DomWBycatch
 10 0 0 0    # 11 NWFSCSvyN
 10 0 0 0    # 12 NWFSCSvyS
 10 0 0 0    # 7 TriAnSurveyN

#LO    HI     INI    PRIOR  PR_ty  SD            PHA           envar  usdev dvminyr
       dvmaxyr       devstdv       Block  Block_Fxn

14     53     45     45            -1            10            1            0 0 0 0 0.5 0
0             # SizeSel_7P_1_TriAnSurveyN
-6     4      0      0             -1            10            1            0 0 0 0 0.5 0
0             # SizeSel_7P_2_TriAnSurveyN
-2     9      5      5             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_3_TriAnSurveyN
-2     9      5      5             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_4_TriAnSurveyN
-10    1  -5  -5            -1            10            2            0 0 0 0 0.5 0 0
       # SizeSel_7P_5_TriAnSurveyN
-5     9      2      2             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_6_TriAnSurveyN

14     53     45     45            -1            10            1            0 0 0 0 0.5 0
0             # SizeSel_7P_1_TriAnSurveyN
-6     4      0      0             -1            10            1            0 0 0 0 0.5 0
0             # SizeSel_7P_2_TriAnSurveyN
-2     9      5      5             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_3_TriAnSurveyN
-2     9      5      5             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_4_TriAnSurveyN
-10    1  -5  -5            -1            10            2            0 0 0 0 0.5 0 0
       # SizeSel_7P_5_TriAnSurveyN
-5     9      2      2             -1            10            2            0 0 0 0 0.5 0
0             # SizeSel_7P_6_TriAnSurveyN

-5     40     -1     -1            -1            10            -2           0 0 0 0 0.5 0
0             # SizeSel_12P_1_NWFSCSvyS
-5     40     -1     -1            -1            10            -2           0 0 0 0 0.5 0
0             # SizeSel_12P_2_NWFSCSvyS
```

```
-5     40     -1    -1           -1           10           -2           0 0 0 0 0.5 0
0             # SizeSel_12P_1_NWFSCSvyS
-5     40     -1    -1           -1           10           -2           0 0 0 0 0.5 0
0             # SizeSel_12P_2_NWFSCSvyS

#-----------------------------------------------------------------# 1 WAFishery1
0      40     10    10           -1           10           1            0 0 0 0 0.5 0
0             # AgeSel_1_P_1_Ascending inflection age
0      10     5     5            -1           10           1            0 0 0 0 0.5 0
0             # AgeSel_1_P_2_Ascending slope
0      40     15    15           -1           10           3            0 0 0 0 0.5 0
0             # AgeSel_1_P_3_Descending inflection age
0      5      2     2            -1           10           3            0 0 0 0 0.5 0
0             # AgeSel_1_P_4_Descending slope
1      3      2     2            -1           10           -2           0 0 0 0 0.5 0
0             # AgeSel_1_P_5_Bin number for first bin with non-zero sel(must be integer
bin number)
0      1      0     0            -1           10           -2           0 0 0 0 0.5 0
0             # AgeSel_1_P_6_(=0 if P3 is independent of P1, =1 if P3 is offset from
P1)
#
                    #_Male selectivity (if Do_male=1, they are offsets)
1      30     2     2            -1           5            -1           0 0   0 0
       0.5    0 0          #_Age at which dogleg occurs (integer at a bin bound -
DONOT estimate!)
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at age=0
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at dogleg
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at max age
#=================================================================# 1 WAFishery1

#-----------------------------------------------------------------# 2 ORMWTraw
0      40     10    10           -1           10           1            0 0 0 0 0.5 0
0             # AgeSel_2_P_1_AgeSel_1_P_1_Ascending inflection age
0      10     5     5            -1           10           1            0 0 0 0 0.5 0
0             # AgeSel_2_P_2_AgeSel_1_P_2_Ascending slope
0      40     15    15           -1           10           3            0 0 0 0 0.5 0
0             # AgeSel_2_P_3_AgeSel_1_P_3_Descending inflection age
0      5      2     2            -1           10           3            0 0 0 0 0.5 0
0             # AgeSel_2_P_4_AgeSel_1_P_4_Descending slope
1      3      2     2            -1           10           -2           0 0 0 0 0.5 0
0             # AgeSel_2_P_5_AgeSel_1_P_5_Bin number for first bin with non-zero
sel(must be integer bin number)
0      1      0     0            -1           10           -2           0 0 0 0 0.5 0
0             # AgeSel_2_P_6_AgeSel_1_P_6_(=0 if P3 is independent of P1, =1 if P3 is
offset from P1)
#
                    #_Male selectivity (if Do_male=1, they are offsets)
1      30     2     2            -1           5            -1           0 0   0 0
       0.5    0 0          #_Age at which dogleg occurs (integer at a bin bound -
DONOT estimate!)
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at age=0
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at dogleg
-15    15     0     0            -1           5            4            0 0   0 0
       0.5    0 0          #_log(relative male sel) at max age
#=================================================================# 2 ORMWTraw

#-----------------------------------------------------------------# 3 ORBTraw
```

```
0      40     10     10          -1          10          1           0 0 0 0 0.5 0
0             # AgeSel_3_P_1_AgeSel_1_P_1_Ascending inflection age
0      10     5      5           -1          10          1           0 0 0 0 0.5 0
0             # AgeSel_3_P_2_AgeSel_1_P_2_Ascending slope
0      40     15     15          -1          10          3           0 0 0 0 0.5 0
0             # AgeSel_3_P_3_AgeSel_1_P_3_Descending inflection age
0      5      2      2           -1          10          3           0 0 0 0 0.5 0
0             # AgeSel_3_P_4_AgeSel_1_P_4_Descending slope
1      3      2      2           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_3_P_5_AgeSel_1_P_5_Bin number for first bin with non-zero
sel(must be integer bin number)
0      1      0      0           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_3_P_6_AgeSel_1_P_6_(=0 if P3 is independent of P1, =1 if P3 is
offset from P1)
#
                    #_Male selectivity (if Do_male=1, they are offsets)
1      30     2      2           -1          5           -1          0 0   0 0
       0.5    0 0          #_Age at which dogleg occurs (integer at a bin bound -
DONOT estimate!)
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at age=0
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at dogleg
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at max age
#===============================================================# 3 ORBTraw

#---------------------------------------------------------------# 4 EMFishery
0      40     10     10          -1          10          1           0 0 0 0 0.5 0
0             # AgeSel_4_P_1_AgeSel_1_P_1_Ascending inflection age
0      10     5      5           -1          10          1           0 0 0 0 0.5 0
0             # AgeSel_4_P_2_AgeSel_1_P_2_Ascending slope
0      40     15     15          -1          10          3           0 0 0 0 0.5 0
0             # AgeSel_4_P_3_AgeSel_1_P_3_Descending inflection age
0.5    5      2      2           -1          10          3           0 0 0 0 0.5 0
0             # AgeSel_4_P_4_AgeSel_1_P_4_Descending slope
1      3      2      2           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_4_P_5_AgeSel_1_P_5_Bin number for first bin with non-zero
sel(must be integer bin number)
0      1      0      0           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_4_P_6_AgeSel_1_P_6_(=0 if P3 is independent of P1, =1 if P3 is
offset from P1)
#
                    #_Male selectivity (if Do_male=1, they are offsets)
1      30     2      2           -1          5           -1          0 0   0 0
       0.5    0 0          #_Age at which dogleg occurs (integer at a bin bound -
DONOT estimate!)
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at age=0
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at dogleg
-15    15     0      0           -1          5           4           0 0   0 0
       0.5    0 0          #_log(relative male sel) at max age
#===============================================================# 4 EMFishery

#---------------------------------------------------------------# 5 SCJuvSurvey
0      6      0      0           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_5_P_1_
0      6      0      0           -1          10          -2          0 0 0 0 0.5 0
0             # AgeSel_5_P_2_
#===============================================================# 5 SCJuvSurvey

# 0 #_custom_sel-env_setup (0/1)
```

```
# -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns

# 0 #_custom_sel-blk_setup (0/1)
# -2 2 0 0 -1 99 -2 #_placeholder when no block usage
# -2 2 0 0 -1 99 -2 #_placeholder when no selex devs
# -4 # placeholder for selparm_Dev_Phase
# 1 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm
bounds)

# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
# -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

#_1 2 3 4 5 6 7 8 9 10 11 12 13

#0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_survey_CV
#0 0 0 0 0  0.24402 0.326978     0.585253     0.663288     0.253102     -0.156397
      -0.45105     -0.120197
0 0   0 0   0  0.256812  0.290071     0.603116     0.699583     0.247671     -
0.151165     -0.44092     -0.110509


  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      #_add_to_discard_CV
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      #_add_to_bodywt_CV

#  1 1 1 1 1 1 1 1 1 1 1 1 1     #_mult_by_lencomp_N
#  1 1 1 1 1 1 0.6741 1 1 1 0.8382 0.9224 0.5033            #_mult_by_lencomp_N
#  1 1 1 1 1 1 0.6821 1 1 1 0.8281  0.9146  0.4840          #_mult_by_lencomp_N
   1 1 1 1 1 1 0.1705 1 1 1 0.08281 0.09146 0.1210          #_mult_by_lencomp_N

#  1 1 1 1 1 1 1 1 1 1 1 1 1     #_mult_by_agecomp_N
#  0.8580 0.71495 1.0113 0.8418 1 1 1 1 1 1 1.1596 1.4002 1 #_mult_by_agecomp_N
#  0.8900 0.7396 1.0920 0.8265 1 1 1 1 1 1 1.1690 1.4049 1  #_mult_by_agecomp_N
   0.3560 0.1627 0.2184 0.3306 1 1 1 1 1 1 0.2338 0.2809 1  #_mult_by_agecomp_N

  1 1 1 1 1 1 1 1 1 1 1 1 1      #_mult_by_size-at-age_N

30           #_DF_for_discard_like
30           #_DF_for_meanbodywt_like

1            #_maxlambdaphase
1            #_sd_offset

4            # 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=WtFreq; 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  wtfreq_method
4 11 1 0.5 1  #_NWFSC survey length comps
4 12 1 0.5 1  #_NWFSC survey length comps
5 11 1 0.5 1  #_NWFSC survey age comps
5 12 1 0.5 1  #_NWFSC survey age comps

# lambdas (for info only; columns are phases)
#  0 #_CPUE/survey:_1
#  0 #_CPUE/survey:_2
#  0 #_CPUE/survey:_3
#  0 #_CPUE/survey:_4
#  0.5 #_CPUE/survey:_5
#  1 #_CPUE/survey:_6
```

```
#  1 #_CPUE/survey:_7
#  1 #_CPUE/survey:_8
#  1 #_CPUE/survey:_9
#  1 #_CPUE/survey:_10
#  1 #_agecomp:_1
#  1 #_agecomp:_2
#  1 #_agecomp:_3
#  1 #_agecomp:_4
#  0 #_agecomp:_5
#  0 #_agecomp:_6
#  0 #_agecomp:_7
#  0 #_agecomp:_8
#  0 #_agecomp:_9
#  0 #_agecomp:_10
#  0 #_init_equ_catch
#  0.5 #_recruitments
#  0 #_parameter-priors
#  0 #_parameter-dev-vectors
#  100 #_crashPenLambda
0
999
```

19 Appendix H. Input SS3 data file (wdw1.dat) for widow rockfish stock assessment base model.

```
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#_SS-V3.03a-opt;_05/11/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_ADMB_7.0.1
#C 2009_Widow_rockfish_ stockassessment__Xi_He__NMFS_SWFSC__Santa_Cruz_CA
#_SS-V3.03a-opt;_05/11/09;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_ADMB_7.0.1

1916   #_styr
2008   #_endyr
1            #_nseas
12           #_months/season
1            #_spawn_seas
4            #_Nfleet
9            #_Nsurveys
2            #_N_areas

#_SCJuvSurvey: assigned to area 1 or 2?
WAFishery1%ORMWTraw%ORBTraw%EMFishery%SCJuvSurvey%ORBTrawCPUE%TriAnSurveyN%ForWBycatch
%JVWBycatch%DomWBycatch%NWFSCSvyN%NWFSCSvyS%TriAnSurveyS

#WA    ORMWT  ORBT   EM     SJSurv ORBTCPUE      TriAnsurv     ForBy  JVBy   DomBy
       NWFSCSvyN     NWFSCSvyS     TriAnSurveyS
0.5    0.5           0.5           0.5    0.5           0.5                  0.5
       0.5           0.5           0.5           0.5                  0.5
       0.5           #_surveytiming_in_season
1      1             1             2      2             1                    1
       1             1             1             1                    2
       2             #_area_assignments_for_each_fishery_and_survey

#_Fishery information (4 Fisheries)
#      WA            ORMWT  ORBT   EM
       1             1             1             1             #_units of catch:  1=bio;
2=num
       0.05   0.05   0.05   0.05   #_stderr of log(catch)

2                    #_Ngenders
30                   #_Nages
0 0 0 0              #_init_equil_catch_for_each_fishery

93                   #_N_lines_of_catch_to_read

# Note: Number F_Rate parameters estimated = number of yearly non-zero catches
#_catch_biomass(mt):_columns_are_fisheries,year,season
#  Fish1   Fish2   Fish3   Fish4    Year  Season
       0.0       0.0       0.0      82.7    1916  1
       0.0       0.0       0.0     128.8    1917  1
       0.0       0.0       0.0     148.1    1918  1
       0.0       0.0       0.0     102.1    1919  1
       0.0       0.0       0.0     104.5    1920  1
       0.0       0.0       0.0      86.6    1921  1
       0.0       0.0       0.0      75.1    1922  1
       0.0       0.0       0.0      82.5    1923  1
       0.0       0.0       0.0      52.8    1924  1
       0.0       0.0       0.0      65.5    1925  1
       0.0       0.0       0.0      99.9    1926  1
       0.0       0.0       0.0      82.8    1927  1
       0.0       0.0       0.0      95.0    1928  1
       0.0       0.0       0.0      92.6    1929  1
       0.0       0.0       0.0     120.2    1930  1
       0.0       0.0       0.0     108.1    1931  1
```

0.0	0.0	0.0	109.3	1932	1
0.0	0.0	0.0	95.0	1933	1
0.0	0.0	0.0	101.3	1934	1
0.0	0.0	0.0	108.9	1935	1
0.0	0.0	0.0	121.2	1936	1
0.0	0.0	0.0	114.3	1937	1
0.0	0.0	1.8	94.9	1938	1
0.0	0.0	1.8	84.5	1939	1
0.0	0.0	8.9	89.2	1940	1
0.0	0.0	16.3	71.9	1941	1
0.0	0.0	29.5	21.6	1942	1
0.0	0.0	99.4	54.0	1943	1
0.0	0.0	170.4	201.7	1944	1
0.0	0.0	270.6	450.8	1945	1
0.0	0.0	152.0	457.4	1946	1
0.0	0.0	85.6	208.6	1947	1
0.0	0.0	61.6	205.2	1948	1
0.0	0.0	57.3	145.9	1949	1
0.0	0.0	69.9	166.8	1950	1
0.0	0.0	47.8	343.7	1951	1
0.0	0.0	53.1	317.5	1952	1
0.0	0.0	39.3	293.4	1953	1
0.0	0.0	47.0	216.4	1954	1
0.0	0.0	48.0	232.4	1955	1
0.0	0.0	136.0	294.8	1956	1
0.0	0.0	129.9	324.2	1957	1
0.0	0.0	135.5	393.9	1958	1
0.0	0.0	103.9	319.7	1959	1
0.0	0.0	138.2	249.1	1960	1
0.0	0.0	152.2	171.0	1961	1
0.0	0.0	191.4	175.4	1962	1
0.0	0.0	149.5	288.6	1963	1
0.0	0.0	355.1	154.9	1964	1
0.0	0.0	36.0	230.1	1965	1
3670.0	0.0	391.1	317.9	1966	1
3900.0	0.0	704.9	495.0	1967	1
1693.0	0.0	168.5	585.5	1968	1
356.0	0.0	114.5	79.6	1969	1
554.0	0.0	0.0	74.8	1970	1
701.0	0.0	22.3	61.8	1971	1
410.0	0.0	25.4	88.6	1972	1
621.2	0.0	13.8	314.4	1973	1
294.6	0.0	5.3	393.5	1974	1
465.3	0.0	9.5	482.9	1975	1
970.6	0.0	65.0	555.1	1976	1
1397.1	0.0	367.3	1046.6	1977	1
641.3	0.0	657.2	632.7	1978	1
1024.0	0.0	646.0	1938.4	1979	1
17161.4	0.0	1502.0	4505.0	1980	1
7288.5	14389.8	1408.2	5591.9	1981	1
6353.9	8452.9	885.3	12106.6	1982	1
3738.6	1684.3	1725.6	5147.7	1983	1
1685.6	4138.4	1547.6	4449.7	1984	1
1786.0	3694.6	1010.2	4271.8	1985	1
2969.0	3453.2	1358.0	3378.8	1986	1
4317.9	5783.6	1352.8	3601.2	1987	1
3572.0	4757.8	1300.3	2580.6	1988	1
3919.5	5634.0	2289.4	2707.3	1989	1
2599.1	3728.1	2513.8	3099.1	1990	1
1474.4	2267.4	2245.0	1670.2	1991	1
1378.0	1401.4	3052.8	1536.1	1992	1
2089.1	2122.7	3928.0	1566.5	1993	1
1421.3	2060.0	2763.7	1456.4	1994	1

```
    1376.0    1697.8    2662.7    2240.0    1995  1
    1274.1    1757.3    2478.7    1794.6    1996  1
    1288.9    1864.7    2603.8    1999.4    1997  1
     751.0    1044.7    1542.5    1527.3    1998  1
     776.7    2016.1     923.1    1052.5    1999  1
     639.4    2665.1      17.8    1341.3    2000  1
     424.0    1219.8      45.1     590.1    2001  1

64.8   309.6  6.8           50.4   2002 1
14.4   22.1   1.7           4.8           2003 1
31.6   33.5   10.1   25.5   2004 1
42.8   139.1  5.6           11.9   2005 1
44.9   154.6  3.0           12.6   2006 1
37.1   192.3  9.7           19.4   2007 1

      96.5     106.4       1.6      38.3    2008  1

#      PacFin data replaced by Jim Hastis (John DeVore) data 7-16-2009 from 2002 to
2007 (no discard rates applied)
#      97.2     312.8       6.5      61.9    2002  1
#      20.8      21.2       0.3       7.3    2003  1
#      37.6      34.0       2.8      46.9    2004  1
#      81.0     118.0       0.7      13.4    2005  1
#      68.7     141.0       2.3      19.5    2006  1
#     109.4     121.3       1.8      20.2    2007  1
#      96.5     106.4       1.6      38.3    2008  1

80 #_N_cpue_and_surveyabundance_observations
#_NO BLANK LINE ALLOWED IN cpue DATA and DO NOT delete this line
#_year seas index obs se(log)
 2001 1  5    3.7900    0.6000
 2002 1  5   10.0700    0.6000
 2003 1  5    4.5700    0.6000
 2004 1  5    8.4300    0.6000
 2005 1  5    3.5200    0.6000
 2006 1  5    1.6300    0.6000
 2007 1  5    1.6900    0.6000
 2008 1  5    3.0900    0.6000

 1984 1  6  331.4700    0.2121
 1985 1  6  100.8800    0.1875
 1986 1  6  227.0800    0.2928
 1987 1  6  169.0800    0.2730
 1988 1  6   93.9700    0.2897
 1989 1  6  164.1000    0.1749
 1990 1  6   78.4900    0.1348
 1991 1  6   73.5900    0.1275
 1992 1  6   83.1600    0.1179
 1993 1  6   53.5800    0.1314
 1994 1  6  100.3400    0.1128
 1995 1  6  109.9600    0.1387
 1996 1  6   94.8100    0.1357
 1997 1  6   97.2300    0.1502
 1998 1  6   56.5600    0.1718
 1999 1  6   84.4600    0.1684

 1980 1  7 222.72125       0.57279
 1983 1  7 292.85691       0.43993
 1986 1  7 110.74147       0.49796
 1989 1  7 136.85329       0.64833
 1992 1  7 235.95895       0.48000
 1995 1  7 56.64875        1.03495
 1998 1  7 500.26525       0.42801
```

```
 2001 1  7 57.21004        0.92661
 2004 1  7 14.18196        0.77262

 1977 1  8    0.7700    0.1153
 1978 1  8    1.2050    0.1118
 1979 1  8    0.7030    0.1186
 1980 1  8    1.9930    0.1311
 1981 1  8    0.7280    0.1257
 1982 1  8    0.2430    0.2467
 1984 1  8    2.9370    0.1254
 1985 1  8    0.4070    0.1074
 1986 1  8    1.1110    0.1027
 1987 1  8    0.3900    0.0881
 1988 1  8    0.5130    0.1243

 1983 1  9    2.8890    0.1202
 1985 1  9    0.7760    0.1165
 1986 1  9    0.8230    0.0809
 1987 1  9    0.3200    0.0875
 1988 1  9    0.6590    0.0774
 1989 1  9    0.8240    0.0635
 1990 1  9    0.7100    0.0740

 1991 1 10    1.2640    0.1251
 1992 1 10    0.7810    0.1251
 1993 1 10    0.8010    0.1038
 1994 1 10    1.4650    0.0685
 1995 1 10    0.4550    0.1057
 1996 1 10    1.0180    0.0824
 1997 1 10    0.8860    0.0767
 1998 1 10    1.3300    0.0786

 2003 1 11 793.62277       0.90865
 2004 1 11 55.06312        1.68436
 2005 1 11 118.20781       1.03570
 2006 1 11 135.25025       0.79912
 2007 1 11 159.54437       0.71148
 2008 1 11 82.10579        0.99182

 2003 1 12 193.38997       0.67226
 2004 1 12 186.39198       1.47981
 2005 1 12 203.55717       0.63651
 2006 1 12 243.38742       0.54841
 2007 1 12 314.77433       0.64160
 2008 1 12 113.03983       0.69314

 1980 1 13 208.70591       0.73604
 1983 1 13 333.99521       0.74636
 1986 1 13 433.38732       1.27783
 1989 1 13 154.39509       0.81778
 1992 1 13 104.63796       0.63924
 1995 1 13 198.83814       0.73597
 1998 1 13 221.24944       0.66769
 2001 1 13 27.11028        0.89781
 2004 1 13 204.42516       1.02858

1      #_discard_type
0      #_N_discard_obs

0      #_N_meanbodywt_obs

1      # length bin method: 1=use databins; 2=generate from width, min,max below;
3=read nbins, then vector
```

```
# 2    # length bin method: 1=use databins; 2=generate from width, min,max below;
3=read nbins, then vector
# 1 6 52
# no additional lines to read

-1     #_comp_tail_compression
0.0000001    #_add_to_comp
0      #_combine males into females at or below this bin number

#43    #_N_LengthBins
#12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46 47 48 49 50 51 52 53 54


23     #_N_LengthBins
10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54

29     #_N_Length_obs

#Note: Nsamp = effective N from earlier outputs
#year sea  Flt Gend Part Nsamp   12 to 54cm
#2003    1   11    3    0  16.8   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    1    0    1    1    2    3    7    7
10   13    9    3    2    1    1    2    2    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    1    0    0    0    0    0    0    0    1
0    0    0    7    5    5    6   11    3    3    0    0    1    2    0    0    0    0
0    0    0    0
#2004    1   11    3    0  6.4    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    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    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    2    1    1    1    0    0    1    0    0    0    0    0    0    0
0    0    0
#2005    1   11    3    0  13.1   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0
0    1    3    2    0    4    4    0    3    1    2    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0    0
0    0    0    2    0    1    0    0    1    1    2    4    2    0    0    0    0    0
0    0    0
#2006    1   11    3    0  15.3   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    1    5    2    6   10    6    6    1    1    0    0    1
1    1    0    1    2    1    0    2    1    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    1    6    7    9    5
10    2    2    0    1    0    0    1    0    1    2    0    0    1    1    0    0
0    1    0    0
#2007    1   11    3    0  18.7   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    2    1    1
2    1    3    2    2    3    0    3    2    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    1    1    6    6    2    1    2    3    1    1    0    0    0    0    0
0    0    0
#2008    1   11    3    0  6.2    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    1    0    0    1    1    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0    0
0    0    0    0    0    0    0    1    0    0    1    2    0    2    0    0    0    0
0    0    0
#2003    1   12    3    0  20.4   0    0    0    0    0    0    0    1    0    0    0
0    0    3    3    1    1    1    2    1    2    0    1    0    1    0    0    0    1
1    2    3    1    5    3    0    6    3    2    1    0    0    0    0    0    1    0
0    0    1    1    0    1    3    1    0    0    0    0    1    0    2    2    0    2
```

```
0    0    2    1    1    2    3    6    6   11    5    4    0    1    0    0    0    0
0    0    0
#2004    1   12    3    0  13.8   0    0    1    5    2    3   18   16    7    2    0
0    0    2    3    1    4    3    5    7    5    5    6    3    2    1    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    3
3    5   12   13    4    1    1    0    0    1    0    3    1    4    1    6    3    5
1    2    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0    0
0    0    0
#2005    1   12    3    0  14.9   0    0    0    0    0    0    0    0    4    2    6
7   11    6   13    3    4    3    0    0    1    1    0    1    1    0    0    0    2
2    0    1    0    2    0    1    2    2    0    3    0    0    0    0    0    0    0
0    0    0    0    1    1    6   13   11   10    9    7    2    0    0    1    1    0
1    1    2    3    2    2    1    2    3    1    2    1    0    0    0    0    0    0
0    0    0
#2006    1   12    3    0  18.0   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    1    2    1    2    2
0    2    3    2    1    1    4    4    4    4    6    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
1    2    0    3    2    3    4    4    7    1    4    2    0    0    0    0    0    0
0    0    0
#2007    1   12    3    0  13.4   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    1    0    0    0    0    1    1
4    4    3    4    2    0    0    1    1    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    1    0    2    3    4    4    3    1    2    3    0    0    0    0
0    0    0
#2008    1   12    3    0  18.6   0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    1    0
0    1    0    1    1    1    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    1    1    0    0    0    0    0    1
0    0    0    1    0    0    1    1    1    1    0    1    1    0    0    0    0    0
0    0    0

#New length comp groups: grouped by 2cm interval and length range 10 -54cm
#Year        Seas     Flt    Gend    Part    NSmp      10      12      14      16
18      20      22      24      26      28      30      32      34      36      38
40      42      44      46      48      50      52      54      10              12
14      16      18      20      22      24      26      28      30      32      34
36      38      40      42      44      46      48      50      52      54
    1980       1       7       3       0   33.5        0       0       0       0
0       0       0       0       0       0       0       0       0       4      13
36      14       9       6       1       0       0       0       0       0       0
0       0       0       0       0       0       0       0       1       0       2
2      11      23      23       7       5       4       5       0
    1983       1       7       3       0   73.3        0       0       0       0
0       0       0       0       0       0       0       0       1       3      14
27      58      46      16       3       1       0       0       0       0       0
0       0       0       0       0       0       0       0       1       3       4
7      10       9      11      11      12       6       9      11
    1986       1       7       3       0   45.2        0       0       0       0
0       0       1       1       0       1      12       5       3       2       3
6      16      14       3       0       0       0       0       0       0       0
0       0       0       0       1       1       2       3      10      10       2
4       2       5       4       7      15      14       7       3
    1989       1       7       3       0   33.2        0       0       0       0
0       0       0       0       1       1       1       2      17      13      35
23      11       4       2       0       0       0       0       0       0       0
0       0       0       0       0       1       1       2       4      16      14
20      18      19      10       2      11       9       9       0
    1992       1       7       3       0   36.6        0       0       0       0
0       0       1       0       0       0       0       1       7       5       7
16       6       3       2       0       0       0       0       0       0       0
```

0	0	0	0	1	2	0	0	0	3	5
14	13	17	7	6	7	11	3	2		
1995	1	7	3	0	34.4	0	0	0	0	
0	0	0	0	0	0	0	0	2	7	17
32	31	35	18	3	3	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0
4	6	9	13	15	27	14	9	7		
1998	1	7	3	0	71.0	0	0	0	0	
0	3	0	1	0	1	0	3	6	17	34
28	39	42	17	9	3	0	0	0	0	0
1	0	1	0	0	0	0	0	0	4	9
8	31	26	18	31	35	37	20	4		
2001	1	7	3	0	16.9	0	0	0	0	
0	0	0	0	0	0	0	0	1	2	4
0	6	3	1	2	1	0	1	0	0	0
0	0	1	0	0	0	0	0	0	1	0
3	1	5	3	3	1	4	2	1		
2004	1	7	3	0	16.0	0	0	0	0	
0	0	0	1	0	1	0	0	0	1	0
0	1	3	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	2	0	1	2	1	1	2		
2003	1	11	3	0	23.2	0	0	0	0	
0	0	0	0	0	0	0	0	1	2	5
14	23	12	3	3	2	0	0	0	0	0
0	0	0	0	1	0	0	0	1	0	7
10	17	6	0	3	0	0	0	0		
2004	1	11	3	0	6.1	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
2	2	1	1	0	0	0	0	0		
2005	1	11	3	0	12.8	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	1
0	1	5	4	4	4	2	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
2	1	1	3	6	0	0	0	0		
2006	1	11	3	0	25.5	0	0	0	0	
0	0	0	0	0	0	6	8	16	7	1
1	2	1	3	2	1	0	0	0	0	0
0	0	0	0	0	0	0	7	16	15	4
1	0	1	3	0	2	0	1	0		
2007	1	11	3	0	20.3	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	2
2	3	5	5	3	2	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
2	12	3	5	2	0	0	0	0		
2008	1	11	3	0	9.4	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
0	0	1	1	2	2	0	0	0		
2003	1	12	3	0	26.1	0	0	0	0	
0	1	0	0	6	2	3	3	1	1	0
1	3	4	8	6	5	1	0	0	0	1
0	1	1	4	1	0	1	2	2	2	2
2	5	12	16	4	1	0	0	0		
2004	1	12	3	0	31.7	0	0	1	7	
21	23	2	0	5	5	8	12	11	5	1
0	0	0	0	0	0	0	0	0	0	1

6	17	17	2	0	1	4	5	9	6	2
0	1	0	0	0	0	0	0	0		
	2005	1	12	3	0	37.2	0	0	0	0
0	4	8	18	19	7	3	1	1	2	0
2	2	1	2	3	2	3	0	0	0	0
0	0	1	7	24	19	9	0	2	1	3
5	3	5	3	1	0	0	0	0		
	2006	1	12	3	0	24.2	0	0	0	0
0	0	0	0	0	0	0	0	0	1	3
4	2	5	2	8	8	6	0	0	0	0
0	1	0	0	0	0	0	1	0	1	2
5	7	11	5	2	0	0	0	0		
	2007	1	12	3	0	19.2	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0
2	8	7	2	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
1	2	7	7	3	3	0	0	0		
	2008	1	12	3	0	11.2	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
1	1	1	2	0	0	0	0	0	0	0
0	0	0	0	0	1	1	0	0	1	0
1	1	2	1	2	0	0	0	0		

	1983	1	13	3	0	38.1	0	0	0	0
2	1	10	9	13	11	11	5	13	9	4
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	2	3	11	9
8	0	0	0	0	0	0	0	0		
	1986	1	13	3	0	21.3	0	0	0	0
0	0	0	0	0	0	0	0	1	4	10
30	26	10	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1
4	13	21	16	14	4	3	0	0		
	1989	1	13	3	0	49.7	0	0	0	1
3	7	12	5	5	13	36	44	35	13	5
9	6	4	1	2	0	0	0	0	0	0
0	1	14	16	2	7	20	32	57	80	17
4	6	4	1	3	0	0	2	0		
	1992	1	13	3	0	65.8	0	0	0	0
3	1	2	2	7	23	37	75	54	42	22
9	2	1	1	0	0	0	0	0	0	0
2	2	1	2	1	7	23	22	64	70	32
16	27	19	3	1	1	0	0	0		
	1995	1	13	3	0	49.2	0	0	0	0
1	2	3	2	2	5	21	19	8	1	9
24	15	18	7	1	1	0	0	0	0	0
0	0	0	1	0	2	5	28	20	6	1
3	6	7	7	0	6	5	1	1		
	1998	1	13	3	0	60.8	0	0	0	0
1	1	0	0	0	4	1	5	7	21	66
72	41	19	4	2	1	0	0	0	0	0
0	0	0	0	0	0	0	2	2	7	9
24	33	42	63	27	23	6	1	0		
	2001	1	13	3	0	23.0	0	0	0	0
15	12	6	7	5	1	0	0	0	0	1
2	4	4	1	0	0	0	0	0	0	0
3	9	16	3	3	0	1	0	0	0	0
0	0	0	0	1	2	1	1	0		
	2004	1	13	3	0	37.0	0	0	0	0
0	0	0	0	0	0	1	3	6	16	18
15	27	25	5	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	3	5	11
11	8	8	13	9	8	4	2	0		

```
30     #_N_age_bins
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

1      #_N_ageerror_definitions
  0.5     1.5     2.5     3.5     4.5     5.5     6.5     7.5     8.5     9.5    10.5
11.5    12.5    13.5    14.5    15.5    16.5    17.5    18.5    19.5    20.5    21.5
22.5    23.5    24.5    25.5    26.5    27.5    28.5    29.5    30.5
0.515   0.519   0.523   0.527   0.531  0.5359  0.5408  0.5457  0.5506  0.5555  0.5604
0.5653  0.5702  0.5751    0.58  0.5849  0.5898  0.5947  0.5996  0.6045 0.61055  0.6166
0.62265  0.6287 0.63475  0.6408 0.64685  0.6529 0.65895   0.665   0.665


# 0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5 11.5 12.5 13.5 14.5 15.5 16.5 17.5 18.5
19.5 20.5 21.5 22.5 23.25 24.5 25.5 26.5 27.5 28.5 29.5 30.5
# 0.518      0.518  0.518  0.518  0.523  0.527  0.532  0.536  0.541  0.545  0.550  0.555
      0.560  0.565  0.570  0.575  0.580  0.585  0.590  0.595  0.600 0.600 0.600 0.600
0.600 0.600 0.600 0.600 0.600 0.600 0.600

# 0.518      0.518  0.518  0.518  0.523  0.527  0.532  0.536  0.541  0.545  0.550  0.555
      0.560  0.565  0.570  0.575  0.580  0.585  0.590  0.595  0.600
# 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35
0.35 0.35 0.35 0.35
# 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55
0.55 0.55 0.55 0.55
# 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006
1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006 1e-006
# 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05

110    #_N_Agecomp_obs
2      #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0      #_combine males into females at or below this bin number

#_NO BLANK LINE ALLOWED IN AGE COMP DATA and DO NOT delete this line
#Yr Seas Flt/Svy Gend Part Agerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
1980    1    1    3    0    1   -1   -1  127.1      0.00000   0.00000   0.00000
0.00000   0.00915   0.01848   0.01356   0.02572   0.08794   0.14181   0.08461
0.06275   0.03471   0.01774   0.02125   0.01851   0.00527   0.00702   0.00644
0.00585   0.00234   0.00253   0.00117   0.00019   0.00059   0.00000   0.00000
0.00059   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00936
0.02151   0.02034   0.05554   0.09555   0.11058   0.04602   0.02920   0.01189
0.01306   0.00585   0.00410   0.00234   0.00234   0.00117   0.00117   0.00176
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
1981    1    1    3    0    1   -1   -1  218.9      0.00000   0.00000   0.00000
0.00749   0.01721   0.04658   0.04392   0.02038   0.02043   0.06235   0.07845
0.07129   0.03738   0.02832   0.01854   0.01016   0.00539   0.00578   0.00517
0.00489   0.00272   0.00472   0.00367   0.00339   0.00234   0.00083   0.00272
0.00067   0.00033   0.00100   0.00000   0.00000   0.00044   0.00661   0.02443
0.06374   0.04552   0.02404   0.04774   0.08777   0.06757   0.04708   0.02576
0.01710   0.01166   0.00533   0.00428   0.00339   0.00289   0.00211   0.00200
0.00033   0.00100   0.00145   0.00050   0.00061   0.00000   0.00000   0.00000
0.00050
1982    1    1    3    0    1   -1   -1  282.4      0.00000   0.00000   0.00031
0.00756   0.01837   0.05959   0.02884   0.04157   0.01882   0.01498   0.01468
0.04925   0.03998   0.04034   0.03274   0.03228   0.01656   0.01511   0.00593
0.01120   0.00511   0.00218   0.00349   0.00291   0.00255   0.00130   0.00016
0.00187   0.00084   0.00548   0.00000   0.00000   0.00016   0.00849   0.03050
0.08438   0.03069   0.04496   0.02057   0.02149   0.03265   0.07169   0.04494
0.03431   0.03486   0.02110   0.01407   0.00881   0.00547   0.00526   0.00302
0.00146   0.00255   0.00042   0.00084   0.00167   0.00042   0.00042   0.00042
0.00042
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1983    1    1    3    0    1   -1   -1  176.5     0.00000   0.00000   0.00000
0.00557   0.15331   0.11397   0.04033   0.02055   0.00918   0.01352   0.01333
0.01629   0.02928   0.02280   0.02159   0.01315   0.01031   0.00688   0.00452
0.00639   0.00254   0.00361   0.00483   0.00380   0.00072   0.00163   0.00030
0.00193   0.00103   0.00103   0.00000   0.00000   0.00000   0.00757   0.15372
0.11349   0.02842   0.01747   0.01426   0.01310   0.01359   0.01836   0.02014
0.01478   0.01532   0.00881   0.00634   0.00669   0.00567   0.00361   0.00434
0.00434   0.00163   0.00247   0.00030   0.00030   0.00145   0.00000   0.00072
0.00072
1984    1    1    3    0    1   -1   -1  155.3      0.00000   0.00000   0.00106
0.00194   0.04400   0.15202   0.07538   0.02555   0.01816   0.00527   0.00650
0.00701   0.01138   0.01683   0.02513   0.02372   0.02010   0.01089   0.01354
0.01005   0.00742   0.00864   0.00901   0.00601   0.00850   0.00582   0.00707
0.00372   0.00282   0.01236   0.00000   0.00000   0.00000   0.00335   0.05370
0.16103   0.08334   0.03342   0.01385   0.00439   0.00560   0.00680   0.00752
0.01293   0.01279   0.01068   0.00680   0.00768   0.00768   0.00682   0.00474
0.00280   0.00386   0.00157   0.00104   0.00104   0.00317   0.00104   0.00000
0.00247
1985    1    1    3    0    1   -1   -1  113.0      0.00000   0.00000   0.00000
0.00830   0.07081   0.08146   0.11726   0.05756   0.02751   0.00857   0.00695
0.00532   0.00753   0.00546   0.01239   0.00959   0.01092   0.00722   0.00753
0.00796   0.00826   0.00988   0.00957   0.00884   0.00796   0.00589   0.00487
0.00589   0.00929   0.02093   0.00000   0.00000   0.00000   0.00830   0.07482
0.08042   0.12478   0.06645   0.02161   0.00947   0.00356   0.00591   0.00532
0.00605   0.00546   0.00266   0.00591   0.00472   0.00251   0.00325   0.00280
0.00384   0.00207   0.00207   0.00207   0.00295   0.00192   0.00133   0.00192
0.00413
1986    1    1    3    0    1   -1   -1  190.6     0.00000   0.00000   0.00000
0.00202   0.05331   0.17762   0.09124   0.06975   0.02015   0.01325   0.00395
0.00697   0.00765   0.00614   0.00888   0.00840   0.00772   0.00916   0.00350
0.00484   0.00494   0.00484   0.00322   0.00322   0.00449   0.00322   0.00161
0.00137   0.00247   0.02643   0.00000   0.00000   0.00000   0.00700   0.06018
0.17364   0.07517   0.04895   0.01438   0.00597   0.00529   0.00522   0.00346
0.00312   0.00463   0.00607   0.00322   0.00230   0.00154   0.00230   0.00161
0.00230   0.00171   0.00230   0.00213   0.00171   0.00189   0.00069   0.00086
0.01200
1987    1    1    3    0    1   -1   -1  254.2     0.00000   0.00000   0.00015
0.00447   0.01390   0.09509   0.22405   0.05680   0.03697   0.02557   0.00942
0.00674   0.00375   0.00196   0.00706   0.00754   0.00483   0.00752   0.00422
0.00527   0.00333   0.00407   0.00436   0.00272   0.00091   0.00183   0.00122
0.00196   0.00076   0.00894   0.00000   0.00000   0.00000   0.00626   0.02405
0.12001   0.19421   0.04619   0.01287   0.00853   0.00284   0.00419   0.00554
0.00421   0.00301   0.00405   0.00375   0.00211   0.00150   0.00314   0.00030
0.00061   0.00015   0.00194   0.00015   0.00046   0.00030   0.00105   0.00015
0.00299
1988    1    1    3    0    1   -1   -1  141.2     0.00000   0.00000   0.00000
0.00245   0.00735   0.05615   0.15087   0.20625   0.03527   0.01727   0.01207
0.00820   0.00296   0.00034   0.00262   0.00052   0.00034   0.00086   0.00017
0.00052   0.00017   0.00069   0.00000   0.00034   0.00052   0.00262   0.00103
0.00052   0.00034   0.00069   0.00000   0.00000   0.00000   0.00000   0.01486
0.06014   0.13687   0.19886   0.03497   0.01327   0.00455   0.00245   0.00086
0.00262   0.00314   0.00086   0.00017   0.00052   0.00069   0.00262   0.00279
0.00052   0.00052   0.00245   0.00017   0.00052   0.00000   0.00103   0.00052
0.00292
1989    1    1    3    0    1   -1   -1  211.8     0.00000   0.00000   0.00000
0.00256   0.00710   0.07590   0.09290   0.18362   0.10439   0.00897   0.00979
0.00582   0.00070   0.00105   0.00105   0.00151   0.00000   0.00093   0.00361
0.00128   0.00023   0.00151   0.00070   0.00023   0.00326   0.00198   0.00128
0.00151   0.00000   0.00802   0.00000   0.00000   0.00000   0.00256   0.01760
0.09336   0.09497   0.15702   0.08737   0.00920   0.00372   0.00116   0.00000
0.00128   0.00023   0.00093   0.00023   0.00046   0.00151   0.00093   0.00070
0.00000   0.00244   0.00093   0.00046   0.00023   0.00023   0.00046   0.00070
0.00139
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1990    1    1    3    0    1   -1   -1  289.5     0.00000   0.00000   0.00000
0.00144   0.02760   0.06205   0.11559   0.07780   0.11935   0.05906   0.01220
0.00551   0.00252   0.00293   0.00046   0.00103   0.00247   0.00098   0.00093
0.00407   0.00098   0.00051   0.00149   0.00149   0.00154   0.00051   0.00247
0.00355   0.00046   0.01225   0.00000   0.00000   0.00000   0.00046   0.02508
0.07734   0.15250   0.06807   0.09741   0.02997   0.01148   0.00453   0.00098
0.00046   0.00000   0.00046   0.00051   0.00098   0.00103   0.00000   0.00149
0.00144   0.00149   0.00000   0.00051   0.00051   0.00000   0.00000   0.00046
0.00154
1991    1    1    3    0    1   -1   -1  240.0      0.00000   0.00000   0.00000
0.00000   0.00381   0.05421   0.08411   0.09891   0.06548   0.05683   0.05378
0.01077   0.00936   0.00468   0.00417   0.00252   0.00063   0.00303   0.00240
0.00366   0.00429   0.00114   0.00114   0.00429   0.00354   0.00240   0.00126
0.00189   0.00126   0.01565   0.00000   0.00000   0.00000   0.00126   0.01012
0.06156   0.11387   0.10703   0.07369   0.04334   0.04963   0.01026   0.00393
0.00291   0.00165   0.00063   0.00405   0.00114   0.00114   0.00063   0.00189
0.00177   0.00126   0.00051   0.00315   0.00063   0.00126   0.00189   0.00063
0.00493
1992    1    1    3    0    1   -1   -1  218.9      0.00000   0.00000   0.00000
0.00303   0.02347   0.02534   0.05535   0.09135   0.08186   0.05667   0.06935
0.04588   0.02985   0.01169   0.00785   0.00442   0.00090   0.00360   0.00212
0.00360   0.00532   0.00343   0.00090   0.00311   0.00311   0.00221   0.00082
0.00000   0.00041   0.00131   0.00000   0.00000   0.00000   0.00262   0.01954
0.03090   0.07154   0.07726   0.08193   0.04874   0.05152   0.02944   0.01979
0.00793   0.00491   0.00270   0.00172   0.00000   0.00090   0.00270   0.00090
0.00221   0.00000   0.00270   0.00090   0.00090   0.00041   0.00000   0.00000
0.00090
1993    1    1    3    0    1   -1   -1  254.2      0.00000   0.00000   0.00000
0.00099   0.00824   0.05949   0.03773   0.06809   0.06964   0.05408   0.04986
0.08460   0.04758   0.02967   0.01536   0.00885   0.00291   0.00452   0.00192
0.00471   0.00155   0.00272   0.00452   0.00452   0.00235   0.00136   0.00155
0.00074   0.00099   0.00372   0.00000   0.00000   0.00019   0.00019   0.01642
0.05843   0.05075   0.06302   0.05670   0.03519   0.02906   0.03079   0.02292
0.02033   0.01221   0.00651   0.00533   0.00434   0.00198   0.00000   0.00118
0.00198   0.00037   0.00099   0.00056   0.00099   0.00000   0.00118   0.00099
0.00514
1994    1    1    3    0    1   -1   -1  197.7      0.00000   0.00000   0.00353
0.00266   0.01335   0.04676   0.07386   0.06785   0.04379   0.05439   0.04144
0.04327   0.05212   0.03475   0.02464   0.01604   0.01295   0.00759   0.00443
0.00176   0.00270   0.00626   0.00266   0.00579   0.00086   0.00180   0.00313
0.00133   0.00043   0.00403   0.00000   0.00000   0.00000   0.00133   0.01058
0.04137   0.08687   0.05705   0.04536   0.03712   0.02813   0.02280   0.02597
0.01647   0.01295   0.01115   0.00493   0.00360   0.00270   0.00090   0.00180
0.00000   0.00090   0.00180   0.00090   0.00313   0.00223   0.00090   0.00223
0.00270
1995    1    1    3    0    1   -1   -1  233.0      0.00000   0.00000   0.00069
0.00936   0.03205   0.05032   0.07765   0.08162   0.05547   0.03681   0.02349
0.02722   0.01720   0.02054   0.00968   0.00687   0.01075   0.00476   0.00157
0.00511   0.00069   0.00123   0.00035   0.00088   0.00246   0.00069   0.00000
0.00088   0.00000   0.00157   0.00000   0.00000   0.00069   0.01024   0.03093
0.05623   0.09619   0.09981   0.06392   0.02860   0.03060   0.01866   0.01498
0.02362   0.01041   0.00741   0.00614   0.00722   0.00246   0.00442   0.00123
0.00177   0.00088   0.00177   0.00000   0.00000   0.00000   0.00000   0.00000
0.00192
1996    1    1    3    0    1   -1   -1  190.6      0.00000   0.00000   0.00000
0.00158   0.06840   0.11204   0.10758   0.06432   0.05369   0.02393   0.01439
0.01827   0.01347   0.01113   0.01745   0.00477   0.00395   0.00158   0.00240
0.00000   0.00158   0.00079   0.00553   0.00237   0.00079   0.00000   0.00158
0.00000   0.00079   0.00560   0.00000   0.00000   0.00082   0.01211   0.05908
0.11182   0.10422   0.05758   0.03292   0.01834   0.01347   0.01037   0.00793
0.00635   0.00793   0.00237   0.00316   0.00319   0.00240   0.00082   0.00000
0.00079   0.00079   0.00079   0.00079   0.00158   0.00000   0.00000   0.00000
0.00237
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1997    1    1    3    0    1   -1   -1  204.7      0.00000   0.00000   0.00000
0.00066   0.02872   0.16724   0.14184   0.05282   0.03318   0.02357   0.01685
0.01800   0.01733   0.01004   0.00729   0.01061   0.00540   0.00199   0.00265
0.00274   0.00531   0.00531   0.00066   0.00332   0.00265   0.00133   0.00199
0.00000   0.00265   0.00332   0.00000   0.00000   0.00000   0.00283   0.03676
0.14894   0.12909   0.04963   0.01522   0.00955   0.00624   0.00681   0.00663
0.00814   0.00133   0.00332   0.00265   0.00066   0.00075   0.00000   0.00066
0.00133   0.00000   0.00066   0.00000   0.00000   0.00000   0.00000   0.00066
0.00066
1998    1    1    3    0    1   -1   -1  155.3      0.00000   0.00000   0.00000
0.00105   0.01201   0.04783   0.16346   0.15296   0.04678   0.02044   0.02276
0.02318   0.01981   0.02171   0.01433   0.00443   0.01138   0.00463   0.00253
0.00253   0.00548   0.00084   0.00084   0.00169   0.00084   0.00084   0.00105
0.00000   0.00105   0.00190   0.00000   0.00000   0.00000   0.00105   0.01433
0.04277   0.14603   0.10956   0.03982   0.01454   0.00716   0.00864   0.00780
0.00337   0.00253   0.00253   0.00675   0.00084   0.00000   0.00000   0.00084
0.00000   0.00253   0.00084   0.00000   0.00000   0.00000   0.00000   0.00000
0.00169
1999    1    1    3    0    1   -1   -1  204.7      0.00000   0.00000   0.00000
0.00123   0.01235   0.04592   0.06690   0.12636   0.10444   0.05266   0.03264
0.02281   0.01511   0.01327   0.01451   0.00865   0.00587   0.01143   0.00556
0.00401   0.00371   0.00278   0.00216   0.00093   0.00000   0.00000   0.00093
0.00000   0.00000   0.00401   0.00000   0.00000   0.00000   0.00185   0.01111
0.04101   0.08114   0.10695   0.08164   0.04128   0.02248   0.00985   0.00988
0.00927   0.00463   0.00524   0.00371   0.00463   0.00185   0.00000   0.00031
0.00093   0.00093   0.00031   0.00000   0.00000   0.00000   0.00000   0.00000
0.00278
2000    1    1    3    0    1   -1   -1  148.3      0.00000   0.00000   0.00000
0.00000   0.00176   0.05349   0.08833   0.09717   0.07705   0.06932   0.04611
0.02145   0.00985   0.00949   0.00633   0.00633   0.00633   0.00949   0.00211
0.00387   0.00000   0.00105   0.00000   0.00000   0.00000   0.00105   0.00105
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00458
0.05776   0.11266   0.07082   0.07327   0.07252   0.03838   0.01265   0.01232
0.00527   0.00211   0.00914   0.00633   0.00316   0.00211   0.00000   0.00000
0.00211   0.00000   0.00000   0.00105   0.00000   0.00211   0.00000   0.00000
0.00000
2001    1    1    3    0    1   -1   -1  70.6     0.00000   0.00000   0.00000
0.00000   0.00213   0.02436   0.05281   0.08862   0.05641   0.01406   0.03156
0.02534   0.04889   0.03597   0.01701   0.01913   0.00425   0.00621   0.00850
0.00621   0.00850   0.00425   0.00000   0.00000   0.00000   0.00213   0.00000
0.00000   0.00000   0.00213   0.00000   0.00000   0.00000   0.00000   0.00409
0.05101   0.12492   0.08322   0.06148   0.05347   0.03728   0.03990   0.03352
0.00850   0.01668   0.00638   0.00621   0.00638   0.00213   0.00000   0.00213
0.00000   0.00000   0.00213   0.00000   0.00000   0.00000   0.00000   0.00213
0.00000
2002    1    1    3    0    1   -1   -1  84.7     0.00000   0.00000   0.00000
0.00170   0.02555   0.02726   0.02896   0.11073   0.10562   0.04600   0.04770
0.03578   0.03066   0.02726   0.02385   0.01022   0.00170   0.01193   0.00511
0.00681   0.00341   0.00170   0.00511   0.00000   0.00000   0.00170   0.00000
0.00000   0.00000   0.00341   0.00000   0.00000   0.00000   0.00170   0.02215
0.02726   0.06133   0.10562   0.06814   0.05622   0.02555   0.02726   0.01193
0.01533   0.00170   0.00170   0.00511   0.00170   0.00170   0.00000   0.00170
0.00170   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2003    1    1    3    0    1   -1   -1  33.7     0.00000   0.00000   0.00481
0.01923   0.14423   0.07692   0.06731   0.08173   0.05769   0.01442   0.03846
0.00962   0.00962   0.00962   0.00481   0.00481   0.00000   0.00000   0.00481
0.00481   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00481   0.08654
0.11538   0.12019   0.08654   0.02404   0.00481   0.00000   0.00000   0.00000
0.00481   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
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2004    1    1    3    0    1   -1   -1  91.8     0.00000   0.00000   0.00000
0.00167   0.03168   0.12504   0.05502   0.06168   0.06835   0.03834   0.03168
0.01667   0.02001   0.01167   0.00667   0.00167   0.00167   0.00167   0.01334
0.00167   0.00333   0.00167   0.00000   0.00167   0.00000   0.00000   0.00333
0.00000   0.00167   0.00333   0.00000   0.00000   0.00000   0.00000   0.03501
0.10336   0.04501   0.04001   0.02834   0.01000   0.01334   0.00500   0.00333
0.00500   0.00333   0.00167   0.09822   0.00333   0.00000   0.00000   0.00167
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00167
0.09822
2005    1    1    3    0    1   -1   -1  73.0     0.00000   0.00000   0.00000
0.00678   0.09555   0.15796   0.06274   0.05935   0.03391   0.02882   0.01696
0.01865   0.01865   0.01526   0.01187   0.01017   0.01017   0.00848   0.00339
0.00000   0.00678   0.00000   0.00339   0.00509   0.00170   0.00000   0.00000
0.00339   0.00170   0.01017   0.00000   0.00000   0.00000   0.00848   0.09386
0.03730   0.10835   0.05426   0.01865   0.02374   0.01526   0.00509   0.00339
0.00509   0.00170   0.00339   0.00170   0.00170   0.00170   0.00509   0.00678
0.00000   0.00000   0.00339   0.00170   0.00170   0.00000   0.00170   0.00000
0.00509
2006    1    1    3    0    1   -1   -1  67.5     0.00000   0.00000   0.00000
0.00000   0.03829   0.26882   0.06514   0.07979   0.01465   0.01762   0.01961
0.00992   0.00992   0.00992   0.01167   0.01091   0.00893   0.00397   0.00595
0.00099   0.00595   0.00793   0.00198   0.00000   0.00198   0.00298   0.00298
0.00099   0.00099   0.00000   0.00000   0.00000   0.00000   0.01243   0.01915
0.15790   0.06713   0.05393   0.02136   0.01663   0.00793   0.00595   0.00893
0.00298   0.00496   0.00298   0.00099   0.00298   0.00397   0.00198   0.00198
0.00298   0.00099   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2007    1    1    3    0    1   -1   -1  103.9     0.00000   0.00000   0.00000
0.00264   0.08002   0.03182   0.12753   0.03613   0.05204   0.05144   0.01856
0.02385   0.01220   0.01958   0.02858   0.01958   0.01165   0.00793   0.01958
0.00264   0.00793   0.00900   0.01058   0.01058   0.00264   0.00000   0.00000
0.00264   0.00000   0.00529   0.00000   0.00000   0.00000   0.00264   0.08212
0.03131   0.09993   0.04047   0.04252   0.01753   0.00955   0.01433   0.01322
0.00426   0.00900   0.00264   0.00371   0.00529   0.00793   0.00000   0.00264
0.00000   0.00371   0.00000   0.00793   0.00264   0.00107   0.00000   0.00000
0.00107
2008    1    1    3    0    1   -1   -1  86.5      0.00000   0.00000   0.00000
0.00573   0.01142   0.09153   0.07003   0.10133   0.07753   0.07325   0.03756
0.01192   0.01287   0.01383   0.01050   0.00477   0.00477   0.00573   0.00619
0.00428   0.00477   0.00191   0.00286   0.00095   0.00523   0.00191   0.00095
0.00000   0.00382   0.00859   0.00000   0.00000   0.00000   0.01047   0.00714
0.14245   0.06762   0.09942   0.02097   0.02621   0.00859   0.01616   0.00477
0.00191   0.00714   0.00332   0.00095   0.00095   0.00095   0.00095   0.00000
0.00000   0.00000   0.00095   0.00000   0.00095   0.00000   0.00000   0.00000
0.00382

1984    1    2    3    0    1   -1   -1  164.5    0.00000   0.00000   0.00000
0.00151   0.01993   0.16245   0.18135   0.01481   0.03002   0.00630   0.00668
0.00375   0.02817   0.06093   0.01643   0.00893   0.00685   0.00580   0.00588
0.00433   0.00000   0.00267   0.00048   0.00178   0.00000   0.00000   0.00278
0.00113   0.00144   0.00304   0.00000   0.00000   0.00000   0.00132   0.01759
0.17377   0.11264   0.00877   0.01943   0.00685   0.00868   0.00759   0.01552
0.02262   0.00185   0.00778   0.00354   0.00188   0.00080   0.00334   0.00098
0.00080   0.00000   0.00000   0.00103   0.00171   0.00125   0.00000   0.00151
0.00130
1985    1    2    3    0    1   -1   -1  261.1    0.00000   0.00000   0.00000
0.00000   0.05308   0.06657   0.25172   0.08572   0.01114   0.01069   0.00865
0.00000   0.00053   0.00703   0.01717   0.00193   0.00073   0.00131   0.00192
0.00000   0.00095   0.00074   0.00080   0.00080   0.00000   0.00067   0.00047
0.00000   0.00000   0.00075   0.00000   0.00000   0.00000   0.00212   0.06673
0.06913   0.22390   0.06543   0.00744   0.00565   0.00289   0.00000   0.00165
0.00463   0.01273   0.00251   0.00220   0.00000   0.00000   0.00088   0.00130
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0.00179   0.00037   0.00125   0.00080   0.00127   0.00000   0.00000   0.00000
0.00194
1986    1    2    3    0    1   -1   -1  328.4    0.00000   0.00061   0.00000
0.00000   0.00963   0.13649   0.08220   0.16773   0.06712   0.00443   0.01070
0.00441   0.00000   0.00038   0.00392   0.01632   0.00137   0.00233   0.00157
0.00098   0.00080   0.00190   0.00144   0.00009   0.00051   0.00009   0.00000
0.00055   0.00051   0.00209   0.00000   0.00000   0.00000   0.00000   0.00548
0.10421   0.07353   0.19508   0.05964   0.00499   0.00509   0.00375   0.00000
0.00045   0.00114   0.01277   0.00398   0.00275   0.00140   0.00149   0.00045
0.00000   0.00144   0.00070   0.00202   0.00070   0.00079   0.00000   0.00000
0.00000
1987    1    2    3    0    1   -1   -1  306.9    0.00000   0.00000   0.00000
0.00070   0.01582   0.11461   0.19987   0.08121   0.03794   0.02040   0.00145
0.00487   0.00182   0.00000   0.00094   0.00154   0.00292   0.00140   0.00018
0.00000   0.00000   0.00000   0.00094   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00119   0.00000   0.00000   0.00000   0.00000   0.01390
0.12748   0.21611   0.07281   0.04196   0.02035   0.00255   0.00349   0.00292
0.00043   0.00024   0.00175   0.00356   0.00000   0.00140   0.00134   0.00043
0.00000   0.00000   0.00000   0.00097   0.00000   0.00000   0.00000   0.00000
0.00051
1988    1    2    3    0    1   -1   -1  193.6     0.00000   0.00000   0.00098
0.00468   0.01449   0.07673   0.19225   0.09945   0.02565   0.01698   0.00884
0.00425   0.00447   0.00000   0.00105   0.00000   0.00137   0.00405   0.00269
0.00000   0.00218   0.00000   0.00080   0.00052   0.00000   0.00000   0.00000
0.00089   0.00000   0.00000   0.00000   0.00000   0.00046   0.00112   0.01360
0.07695   0.24403   0.12888   0.03382   0.02019   0.00774   0.00000   0.00144
0.00044   0.00085   0.00000   0.00263   0.00204   0.00000   0.00000   0.00179
0.00098   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00072
1989    1    2    3    0    1   -1   -1  305.5     0.00000   0.00000   0.00000
0.00435   0.02625   0.03642   0.07946   0.19705   0.08638   0.02376   0.01144
0.00562   0.00447   0.00183   0.00000   0.00075   0.00051   0.00158   0.00132
0.00000   0.00222   0.00121   0.00000   0.00000   0.00156   0.00000   0.00000
0.00000   0.00000   0.00184   0.00000   0.00000   0.00000   0.00558   0.01863
0.05435   0.12120   0.19905   0.06833   0.01619   0.00961   0.00281   0.00078
0.00059   0.00050   0.00068   0.00217   0.00217   0.00353   0.00276   0.00000
0.00121   0.00000   0.00000   0.00048   0.00059   0.00000   0.00079   0.00000
0.00000
1990    1    2    3    0    1   -1   -1  254.2    0.00000   0.00000   0.00000
0.00000   0.01598   0.03209   0.05384   0.07940   0.15178   0.10523   0.03784
0.02153   0.00869   0.00227   0.00194   0.00058   0.00085   0.00000   0.00000
0.00000   0.00240   0.00000   0.00070   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00086   0.00000   0.00000   0.00000   0.00330   0.02563
0.02839   0.05750   0.10001   0.13517   0.06793   0.03283   0.01515   0.00748
0.00358   0.00000   0.00097   0.00000   0.00181   0.00000   0.00148   0.00000
0.00000   0.00092   0.00000   0.00186   0.00000   0.00000   0.00000   0.00000
0.00000
1991    1    2    3    0    1   -1   -1  238.0     0.00000   0.00000   0.00000
0.00000   0.01031   0.06236   0.09702   0.06024   0.06874   0.09754   0.04339
0.01378   0.00906   0.00453   0.00323   0.00079   0.00049   0.00049   0.00192
0.00313   0.00423   0.00087   0.00185   0.00000   0.00092   0.00173   0.00000
0.00237   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00743
0.06494   0.10032   0.10690   0.06420   0.08944   0.03859   0.00985   0.01149
0.00319   0.00249   0.00169   0.00135   0.00000   0.00056   0.00143   0.00263
0.00137   0.00100   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00216
1992    1    2    3    0    1   -1   -1  133.3     0.00000   0.00000   0.00000
0.00000   0.02308   0.02960   0.07022   0.07532   0.04225   0.06364   0.08880
0.03100   0.01530   0.00650   0.00119   0.00198   0.00203   0.00222   0.00000
0.00183   0.00122   0.00380   0.00109   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.03595
0.03972   0.08705   0.08303   0.08042   0.04121   0.08571   0.03005   0.02192
0.01350   0.00202   0.00416   0.00000   0.00000   0.00119   0.00323   0.00000
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0.00222   0.00161   0.00000   0.00000   0.00162   0.00292   0.00000   0.00109
0.00032
1993    1    2    3    0    1   -1   -1  206.0     0.00000   0.00000   0.00000
0.00062   0.01007   0.06822   0.03608   0.08030   0.06495   0.03604   0.04612
0.06751   0.03409   0.02409   0.02042   0.01022   0.00433   0.00506   0.00179
0.00155   0.00008   0.00069   0.00122   0.00000   0.00261   0.00000   0.00000
0.00033   0.00000   0.00008   0.00000   0.00000   0.00000   0.00000   0.01618
0.07024   0.05489   0.08040   0.04894   0.03813   0.03458   0.05978   0.02626
0.01808   0.01491   0.00645   0.00000   0.00305   0.00115   0.00000   0.00130
0.00109   0.00565   0.00000   0.00000   0.00117   0.00000   0.00124   0.00000
0.00000
1994    1    2    3    0    1   -1   -1  101.5     0.00000   0.00000   0.00000
0.00006   0.00835   0.04872   0.15787   0.06418   0.05596   0.04144   0.03490
0.02470   0.02857   0.01496   0.02072   0.00454   0.00000   0.00000   0.00233
0.00279   0.00058   0.00000   0.00006   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00006   0.00166   0.00880
0.07589   0.15556   0.07973   0.04685   0.04146   0.01169   0.01983   0.03131
0.00000   0.00160   0.00538   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00767   0.00000   0.00000   0.00000   0.00000   0.00000
0.00181
1995    1    2    3    0    1   -1   -1  136.5     0.00000   0.00000   0.00000
0.00477   0.00548   0.03066   0.05861   0.08756   0.08890   0.05684   0.04252
0.03874   0.03244   0.04617   0.01259   0.00744   0.01404   0.00123   0.00015
0.00003   0.00001   0.00144   0.00101   0.00016   0.00527   0.00002   0.00014
0.00046   0.00001   0.00020   0.00000   0.00000   0.00003   0.00406   0.01684
0.02462   0.13092   0.09484   0.04828   0.04344   0.03201   0.02257   0.02955
0.00697   0.00139   0.00058   0.00020   0.00533   0.00010   0.00001   0.00000
0.00002   0.00006   0.00002   0.00079   0.00002   0.00000   0.00000   0.00000
0.00047
1996    1    2    3    0    1   -1   -1  149.0     0.00000   0.00000   0.00000
0.00730   0.06907   0.05968   0.07861   0.08053   0.04715   0.02216   0.03858
0.01571   0.01774   0.02393   0.01873   0.00598   0.00072   0.00090   0.00059
0.00291   0.01164   0.00755   0.00248   0.00037   0.00042   0.00102   0.00048
0.00025   0.00000   0.00015   0.00000   0.00000   0.00000   0.00844   0.07369
0.09389   0.07017   0.06449   0.04944   0.03229   0.01275   0.00832   0.02455
0.00954   0.01645   0.00830   0.00326   0.00000   0.00461   0.00003   0.00017
0.00000   0.00000   0.00444   0.00002   0.00003   0.00000   0.00000   0.00026
0.00020
1997    1    2    3    0    1   -1   -1  204.6    0.00000   0.00000   0.00000
0.00258   0.01243   0.16982   0.08156   0.03842   0.03768   0.01700   0.01426
0.01155   0.01303   0.01320   0.00687   0.01652   0.00147   0.00243   0.00000
0.00032   0.00000   0.00173   0.00034   0.00001   0.00000   0.00026   0.00001
0.00001   0.00001   0.00197   0.00000   0.00000   0.00000   0.00247   0.03111
0.24025   0.11610   0.04277   0.02606   0.02670   0.01613   0.01326   0.00879
0.00303   0.01383   0.01276   0.00024   0.00032   0.00063   0.00186   0.00000
0.00002   0.00004   0.00000   0.00005   0.00000   0.00001   0.00004   0.00004
0.00001
1998    1    2    3    0    1   -1   -1  200.6     0.00002   0.00002   0.00000
0.00004   0.00509   0.02427   0.13112   0.09960   0.04506   0.03505   0.03619
0.01658   0.01688   0.01363   0.00439   0.00215   0.00751   0.00088   0.00305
0.00005   0.00055   0.00046   0.00032   0.00169   0.00044   0.00021   0.00022
0.00033   0.00042   0.00041   0.00000   0.00000   0.00000   0.00000   0.00873
0.08754   0.19782   0.10462   0.06132   0.01649   0.02881   0.01694   0.00346
0.00827   0.00066   0.00094   0.00978   0.00253   0.00058   0.00034   0.00210
0.00011   0.00008   0.00097   0.00000   0.00012   0.00006   0.00025   0.00008
0.00078
1999    1    2    3    0    1   -1   -1  280.6     0.00000   0.00000   0.00000
0.00017   0.02291   0.03677   0.08148   0.18652   0.09122   0.04026   0.01950
0.00789   0.01141   0.00682   0.00093   0.00741   0.00386   0.00052   0.00001
0.00003   0.00002   0.00024   0.00027   0.00012   0.00001   0.00000   0.00000
0.00000   0.00000   0.00023   0.00000   0.00000   0.00000   0.00132   0.02541
0.03829   0.10881   0.18261   0.08676   0.02163   0.00499   0.00556   0.00035
0.00091   0.00118   0.00013   0.00071   0.00052   0.00003   0.00008   0.00090
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0.00112   0.00000   0.00001   0.00000   0.00009   0.00001   0.00000   0.00000
0.00000
2000    1    2    3    0    1   -1   -1  241.6     0.00000   0.00000   0.00000
0.00000   0.01479   0.04592   0.07534   0.08610   0.08149   0.09496   0.03885
0.02438   0.01057   0.00597   0.00695   0.00427   0.00310   0.00185   0.00618
0.00081   0.00434   0.00002   0.00001   0.00001   0.00182   0.00099   0.00001
0.00000   0.00001   0.00001   0.00000   0.00000   0.00000   0.00000   0.01289
0.05382   0.07849   0.08417   0.11875   0.07071   0.02832   0.02125   0.00546
0.00522   0.00609   0.00290   0.00027   0.00126   0.00001   0.00164   0.00000
0.00000   0.00000   0.00001   0.00001   0.00000   0.00000   0.00000   0.00000
0.00000
2001    1    2    3    0    1   -1   -1  183.9     0.00000   0.00000   0.00000
0.00000   0.00000   0.01272   0.06694   0.06687   0.07108   0.06857   0.04924
0.06006   0.01639   0.00951   0.00836   0.00806   0.01374   0.00827   0.00578
0.00053   0.00286   0.00012   0.00014   0.00001   0.00035   0.00000   0.00009
0.00012   0.00000   0.00012   0.00000   0.00000   0.00000   0.00000   0.00124
0.01810   0.09827   0.09923   0.12010   0.06175   0.05010   0.04210   0.01684
0.00598   0.00201   0.00315   0.00151   0.00155   0.00404   0.00393   0.00006
0.00009   0.00001   0.00000   0.00000   0.00003   0.00000   0.00000   0.00000
0.00001
2002    1    2    3    0    1   -1   -1   65.6    0.00000   0.00000   0.00000
0.00282   0.00917   0.01795   0.06540   0.11427   0.09058   0.08212   0.03644
0.03317   0.01468   0.00468   0.00940   0.00004   0.00464   0.00004   0.00156
0.00004   0.00000   0.00007   0.00002   0.00004   0.00150   0.00002   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00872   0.00881
0.04389   0.08995   0.14800   0.11790   0.03322   0.01302   0.00892   0.00960
0.00672   0.00000   0.00884   0.00471   0.00000   0.00746   0.00002   0.00000
0.00150   0.00000   0.00000   0.00000   0.00002   0.00000   0.00002   0.00000
0.00000
2004    1    2    3    0    1   -1   -1   28.2    0.00000   0.00000   0.00542
0.11051   0.07520   0.15198   0.07073   0.02258   0.00587   0.00056   0.00056
0.00056   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.08001   0.14015
0.20279   0.08066   0.02610   0.01455   0.00168   0.00224   0.00168   0.00112
0.00168   0.00112   0.00000   0.00000   0.00056   0.00112   0.00056   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2006    1    2    3    0    1   -1   -1   85.5    0.00000   0.00000   0.00000
0.00000   0.01624   0.13520   0.02794   0.04297   0.03728   0.01421   0.02105
0.00944   0.02370   0.00465   0.00418   0.00823   0.01052   0.01104   0.01103
0.00492   0.00616   0.00847   0.00429   0.00187   0.00032   0.00000   0.00032
0.00000   0.00032   0.00155   0.00000   0.00000   0.00000   0.00000   0.01851
0.20614   0.11221   0.11128   0.01657   0.00907   0.01924   0.00728   0.02350
0.01296   0.00810   0.01434   0.00000   0.00047   0.00187   0.01056   0.00958
0.00069   0.00000   0.00116   0.00000   0.00000   0.00990   0.00035   0.00000
0.00035
2007    1    2    3    0    1   -1   -1   50.4    0.00000   0.00000   0.00000
0.00095   0.01155   0.01196   0.07210   0.08650   0.10573   0.07188   0.05367
0.02753   0.00518   0.01010   0.00017   0.02020   0.00061   0.00593   0.00000
0.00000   0.00000   0.00122   0.00000   0.00017   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.01010   0.00000   0.00000   0.00000   0.01541
0.02511   0.10327   0.09252   0.15198   0.03322   0.02196   0.02020   0.03031
0.00000   0.00000   0.00017   0.00000   0.01027   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2008    1    2    3    0    1   -1   -1   38.5    0.00000   0.00000   0.00000
0.00024   0.00037   0.06196   0.06063   0.17576   0.03881   0.06018   0.00024
0.01928   0.00053   0.00000   0.03857   0.00053   0.01928   0.00053   0.01928
0.00000   0.00053   0.00000   0.00000   0.00000   0.00000   0.00053   0.00031
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00217   0.00136
0.10172   0.05989   0.16055   0.05964   0.05785   0.00053   0.00053   0.00000
0.00034   0.00000   0.00000   0.00000   0.00000   0.01928   0.00000   0.00000
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0.00000   0.00000   0.00000   0.01928   0.00000   0.00000   0.00000   0.01928
0.00000

1984    1    3    3    0    1   -1   -1  138.5     0.00000   0.00000   0.00000
0.00000   0.02920   0.15022   0.18548   0.02763   0.01579   0.01139   0.00717
0.00461   0.01242   0.02993   0.01503   0.00810   0.00463   0.00525   0.00265
0.00678   0.00437   0.00356   0.00143   0.00479   0.00469   0.00552   0.00118
0.00181   0.00515   0.00410   0.00000   0.00000   0.00000   0.00200   0.03045
0.18955   0.11708   0.01603   0.01532   0.00311   0.00344   0.00195   0.01819
0.01325   0.00969   0.00780   0.00612   0.00293   0.00101   0.00088   0.00000
0.00021   0.00018   0.00000   0.00000   0.00177   0.00138   0.00000   0.00000
0.00478
1985    1    3    3    0    1   -1   -1  115.7     0.00000   0.00000   0.00044
0.00000   0.01981   0.04830   0.19771   0.12666   0.01481   0.01739   0.01142
0.00008   0.00764   0.02203   0.03641   0.01021   0.01343   0.00271   0.00332
0.00173   0.00314   0.00979   0.00769   0.00048   0.00373   0.00079   0.00044
0.00267   0.00043   0.00627   0.00000   0.00000   0.00000   0.00250   0.03601
0.07461   0.20014   0.05117   0.00187   0.00466   0.00495   0.00000   0.00104
0.00836   0.02849   0.00000   0.00533   0.00354   0.00014   0.00040   0.00380
0.00146   0.00044   0.00034   0.00000   0.00000   0.00000   0.00036   0.00000
0.00084
1986    1    3    3    0    1   -1   -1  136.3     0.00000   0.00000   0.00000
0.00106   0.02477   0.10638   0.06224   0.09563   0.06764   0.00690   0.01763
0.01306   0.00026   0.00000   0.00372   0.04390   0.00991   0.00698   0.00466
0.00303   0.00210   0.00181   0.00083   0.00281   0.00067   0.00214   0.00171
0.00000   0.00018   0.00982   0.00000   0.00000   0.00000   0.00245   0.01391
0.20013   0.08138   0.08466   0.05842   0.00288   0.01819   0.00539   0.00211
0.00000   0.00145   0.01761   0.00203   0.00102   0.00284   0.00038   0.00337
0.00253   0.00220   0.00077   0.00255   0.00000   0.00026   0.00000   0.00006
0.00358
1987    1    3    3    0    1   -1   -1  145.2     0.00000   0.00000   0.00000
0.00158   0.01023   0.11740   0.17187   0.06347   0.05034   0.02997   0.00358
0.00369   0.00152   0.00306   0.00027   0.00472   0.01657   0.01358   0.00334
0.00310   0.00165   0.00401   0.00152   0.00021   0.00218   0.00176   0.00246
0.00152   0.00000   0.00437   0.00000   0.00000   0.00000   0.00000   0.01112
0.10902   0.20352   0.07008   0.03947   0.01580   0.00286   0.00243   0.00685
0.00000   0.00000   0.00594   0.00529   0.00199   0.00000   0.00151   0.00000
0.00004   0.00149   0.00000   0.00000   0.00000   0.00019   0.00004   0.00000
0.00443
1988    1    3    3    0    1   -1   -1  167.6      0.00000   0.00000   0.00961
0.01433   0.00940   0.07733   0.17131   0.10380   0.04062   0.02667   0.01516
0.01027   0.00462   0.00599   0.00083   0.00248   0.00636   0.01015   0.00276
0.00450   0.00103   0.00029   0.00127   0.00004   0.00034   0.00185   0.00025
0.00034   0.00000   0.00011   0.00000   0.00000   0.00187   0.01103   0.01663
0.07952   0.20751   0.10242   0.02183   0.01134   0.00741   0.00305   0.00049
0.00011   0.00114   0.00018   0.00244   0.00351   0.00127   0.00343   0.00012
0.00025   0.00000   0.00016   0.00000   0.00000   0.00155   0.00000   0.00000
0.00102
1989    1    3    3    0    1   -1   -1  183.4      0.00000   0.00000   0.00000
0.00124   0.02582   0.02702   0.06466   0.14456   0.08892   0.04154   0.03995
0.01492   0.00673   0.00645   0.00508   0.00396   0.00538   0.00380   0.00966
0.01011   0.00037   0.00021   0.00019   0.00272   0.00178   0.00000   0.00000
0.00000   0.00246   0.00025   0.00000   0.00000   0.00000   0.00883   0.02465
0.05000   0.09206   0.17404   0.06781   0.03135   0.01489   0.00804   0.00000
0.00609   0.00020   0.00002   0.00127   0.00067   0.00609   0.00197   0.00304
0.00000   0.00000   0.00067   0.00008   0.00000   0.00024   0.00000   0.00000
0.00021
1990    1    3    3    0    1   -1   -1  205.1      0.00000   0.00000   0.00000
0.00035   0.04598   0.03582   0.03713   0.06784   0.13738   0.10725   0.03600
0.01722   0.00866   0.00488   0.00661   0.00226   0.00249   0.00117   0.00133
0.01120   0.00491   0.00126   0.00142   0.00086   0.00044   0.00102   0.00057
0.00000   0.00102   0.00154   0.00000   0.00000   0.00000   0.00358   0.04661
0.04482   0.05600   0.06843   0.11596   0.05795   0.02082   0.01954   0.00958
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0.00448   0.00131   0.00266   0.00000   0.00000   0.00000   0.00332   0.00375
0.00000   0.00133   0.00000   0.00000   0.00053   0.00000   0.00053   0.00000
0.00218
1991    1    3    3    0    1   -1   -1  302.1      0.00000   0.00000   0.00000
0.00028   0.00856   0.05737   0.06122   0.06597   0.07310   0.10781   0.05780
0.03271   0.03294   0.00701   0.00461   0.00437   0.00210   0.00053   0.00330
0.00356   0.01117   0.00394   0.00426   0.00429   0.00209   0.00012   0.00043
0.00000   0.00301   0.00301   0.00000   0.00000   0.00000   0.00015   0.00419
0.07028   0.10083   0.07052   0.04213   0.07631   0.03765   0.00948   0.01179
0.00321   0.00107   0.00358   0.00018   0.00000   0.00119   0.00047   0.00459
0.00243   0.00058   0.00000   0.00069   0.00000   0.00000   0.00085   0.00000
0.00228
1992    1    3    3    0    1   -1   -1  300.3      0.00000   0.00000   0.00000
0.00000   0.00975   0.00814   0.08154   0.08880   0.06877   0.05756   0.08995
0.04799   0.03177   0.01996   0.01444   0.00492   0.00645   0.00144   0.00251
0.00202   0.00433   0.00778   0.00275   0.00357   0.00280   0.00065   0.00119
0.00099   0.00000   0.00520   0.00000   0.00000   0.00000   0.00021   0.01710
0.02151   0.08374   0.07280   0.05904   0.03436   0.04817   0.01754   0.02880
0.01589   0.00421   0.00415   0.00598   0.00157   0.00267   0.00230   0.00163
0.00419   0.00407   0.00037   0.00066   0.00000   0.00082   0.00014   0.00063
0.00220
1993    1    3    3    0    1   -1   -1  226.7      0.00000   0.00000   0.00000
0.00000   0.00030   0.02528   0.02526   0.07564   0.07331   0.04433   0.04017
0.06633   0.04284   0.02874   0.01732   0.02064   0.00572   0.00884   0.00562
0.00279   0.00130   0.00406   0.00711   0.00413   0.00009   0.00724   0.00000
0.00123   0.00114   0.00279   0.00000   0.00000   0.00000   0.00000   0.00585
0.03525   0.03455   0.08824   0.09109   0.04652   0.03337   0.05433   0.03456
0.02281   0.01352   0.00429   0.00213   0.00394   0.00046   0.00342   0.00031
0.00115   0.00361   0.00000   0.00165   0.00000   0.00000   0.00000   0.00051
0.00622
1994    1    3    3    0    1   -1   -1  253.3      0.00000   0.00000   0.00000
0.00222   0.00882   0.04298   0.10046   0.06335   0.05690   0.06328   0.04604
0.02631   0.06474   0.02854   0.01985   0.01248   0.01245   0.00657   0.00601
0.00181   0.00339   0.00046   0.00184   0.00436   0.00008   0.00223   0.00114
0.00000   0.00062   0.00002   0.00000   0.00000   0.00000   0.00307   0.01428
0.05666   0.10709   0.06869   0.04228   0.01670   0.02076   0.02899   0.02374
0.00823   0.00620   0.00452   0.00874   0.00241   0.00000   0.00468   0.00000
0.00000   0.00058   0.00120   0.00000   0.00000   0.00000   0.00255   0.00158
0.00014
1995    1    3    3    0    1   -1   -1  171.6      0.00000   0.00000   0.00000
0.00485   0.01257   0.03707   0.10914   0.08421   0.05083   0.03891   0.04541
0.02556   0.01745   0.02488   0.00395   0.00200   0.01307   0.00161   0.00000
0.00553   0.00254   0.00231   0.00152   0.00105   0.00046   0.00000   0.00017
0.00000   0.00000   0.00117   0.00000   0.00000   0.00000   0.00298   0.03365
0.10893   0.07374   0.13537   0.03906   0.04434   0.02091   0.01793   0.00707
0.01226   0.00470   0.00500   0.00516   0.00034   0.00000   0.00000   0.00000
0.00072   0.00159   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
1996    1    3    3    0    1   -1   -1  121.0      0.00000   0.00000   0.00010
0.00727   0.07601   0.10163   0.08202   0.08610   0.05074   0.02826   0.04065
0.03227   0.00839   0.00432   0.03989   0.00000   0.00177   0.01013   0.00289
0.00172   0.00419   0.00000   0.00101   0.00095   0.00000   0.00221   0.00000
0.00000   0.00000   0.00095   0.00000   0.00000   0.00000   0.00155   0.07862
0.08223   0.05886   0.05838   0.02230   0.01735   0.01686   0.02035   0.01550
0.00211   0.01665   0.00469   0.00198   0.01089   0.00092   0.00000   0.00097
0.00000   0.00095   0.00000   0.00000   0.00313   0.00000   0.00000   0.00000
0.00223
1997    1    3    3    0    1   -1   -1  174.3     0.00000   0.00000   0.00000
0.00804   0.03084   0.10388   0.09444   0.03040   0.04672   0.03063   0.01910
0.01481   0.00814   0.01302   0.00974   0.01609   0.00470   0.00059   0.00504
0.00331   0.00063   0.00353   0.00255   0.00000   0.00000   0.00137   0.00163
0.00000   0.00059   0.00021   0.00000   0.00000   0.00000   0.00626   0.04409
0.22977   0.11812   0.04712   0.03146   0.02055   0.00928   0.01750   0.00734
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0.00633   0.00069   0.00568   0.00195   0.00021   0.00000   0.00069   0.00000
0.00000   0.00000   0.00253   0.00000   0.00000   0.00000   0.00021   0.00000
0.00021
1998    1    3    3    0    1   -1   -1  124.7      0.00000   0.00000   0.00000
0.00000   0.01161   0.04732   0.14057   0.11045   0.05376   0.02424   0.03026
0.01730   0.02568   0.01321   0.01573   0.00285   0.00801   0.00187   0.00137
0.00000   0.00555   0.00174   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00170   0.00000   0.00000   0.00000   0.00000   0.00000   0.00805
0.05130   0.18253   0.11576   0.03458   0.02184   0.01712   0.02033   0.00622
0.00903   0.00004   0.00181   0.00722   0.00000   0.00303   0.00128   0.00137
0.00070   0.00240   0.00000   0.00219   0.00000   0.00000   0.00000   0.00000
0.00000
1999    1    3    3    0    1   -1   -1  118.2      0.00000   0.00000   0.00000
0.00000   0.02336   0.05768   0.06775   0.14678   0.06262   0.04208   0.03937
0.00864   0.01188   0.00620   0.00762   0.00211   0.00000   0.00139   0.00114
0.00016   0.00000   0.00106   0.00000   0.00016   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00441   0.02819
0.06578   0.11762   0.17742   0.07207   0.02716   0.00866   0.00026   0.00000
0.00704   0.00139   0.00037   0.00014   0.00026   0.00666   0.00000   0.00058
0.00058   0.00000   0.00000   0.00139   0.00000   0.00000   0.00000   0.00000
0.00000
2007    1    3    3    0    1   -1   -1   48.6     0.00000   0.00000   0.00000
0.00000   0.00000   0.00687   0.05147   0.08682   0.11844   0.04536   0.07380
0.03038   0.03531   0.04767   0.02640   0.00645   0.00633   0.00185   0.00874
0.00405   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00905   0.03556   0.06093   0.14795   0.03797   0.04811   0.04347   0.02535
0.01636   0.01768   0.00000   0.00000   0.00000   0.00185   0.00000   0.00000
0.00579   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2008    1    3    3    0    1   -1   -1   41.9     0.00000   0.00000   0.00000
0.00000   0.00000   0.01184   0.00588   0.05438   0.04646   0.09646   0.06231
0.04266   0.03753   0.01965   0.01016   0.02420   0.03243   0.02626   0.02512
0.01765   0.00566   0.01202   0.01064   0.00000   0.00283   0.00000   0.00370
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00424   0.01547   0.07965   0.07685   0.05730   0.05481   0.03683   0.05281
0.01980   0.01272   0.00283   0.00000   0.00000   0.00000   0.01154   0.00000
0.00424   0.00283   0.00323   0.00000   0.00960   0.00000   0.00370   0.00370
0.00000

1978    1    4    3    0    1   -1   -1  21.8     0.00000   0.00000   0.00000
0.00000   0.00013   0.01219   0.05735   0.13228   0.03156   0.01912   0.00851
0.00000   0.07505   0.00025   0.01232   0.01219   0.00000   0.02463   0.00013
0.00000   0.00000   0.01219   0.00000   0.00007   0.00826   0.00013   0.00000
0.00000   0.00000   0.02317   0.00000   0.00000   0.00000   0.00000   0.00000
0.00007   0.03992   0.05103   0.09615   0.06438   0.09887   0.02944   0.02889
0.01232   0.02896   0.03975   0.00013   0.01086   0.00032   0.01086   0.02913
0.00000   0.00034   0.00000   0.02889   0.00000   0.00000   0.00000   0.00000
0.00017
1979    1    4    3    0    1   -1   -1  22.7     0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.02318   0.11903   0.19699   0.08239   0.06537
0.04040   0.05493   0.00722   0.01269   0.02365   0.00760   0.01283   0.01603
0.00179   0.01822   0.00089   0.02261   0.01988   0.00000   0.00075   0.00000
0.00000   0.00000   0.00905   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.01997   0.01856   0.06760   0.01788   0.02035   0.01557   0.00616
0.01382   0.00113   0.02206   0.01419   0.00867   0.00001   0.00753   0.00819
0.00225   0.00152   0.00165   0.00441   0.01205   0.00089   0.00000   0.00000
0.00002
1980    1    4    3    0    1   -1   -1  51.8     0.00000   0.00000   0.00000
0.00000   0.00096   0.00565   0.00370   0.02415   0.06337   0.09760   0.09741
0.03950   0.05137   0.06189   0.01753   0.01350   0.02912   0.04035   0.00678
0.00889   0.01104   0.00272   0.00005   0.01220   0.01756   0.00548   0.00128
0.00530   0.00000   0.00173   0.00000   0.00000   0.00000   0.00000   0.00182
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0.01406   0.00292   0.00664   0.03952   0.03231   0.05084   0.03128   0.02539
0.02879   0.00984   0.05279   0.00375   0.01624   0.00465   0.00323   0.02100
0.00303   0.00925   0.00393   0.00000   0.01429   0.00089   0.00050   0.00000
0.00390
1981    1    4    3    0    1   -1   -1  80.8      0.00000   0.00051   0.00000
0.00332   0.00486   0.01377   0.03572   0.01938   0.02490   0.05469   0.07273
0.09072   0.02676   0.05571   0.04581   0.03900   0.02538   0.03965   0.01080
0.00295   0.00108   0.00378   0.00378   0.00062   0.00000   0.00101   0.00007
0.00235   0.00098   0.01841   0.00000   0.00000   0.00080   0.00836   0.01000
0.02705   0.02502   0.02770   0.02556   0.03020   0.04292   0.04668   0.02382
0.03282   0.01591   0.02886   0.01230   0.00437   0.01354   0.00582   0.00692
0.00334   0.00200   0.00075   0.00434   0.00007   0.00144   0.00000   0.00000
0.00066
1982    1    4    3    0    1   -1   -1  208.7      0.00000   0.00000   0.00000
0.00030   0.03215   0.00908   0.03545   0.03110   0.02421   0.00784   0.03601
0.10164   0.05117   0.03645   0.03426   0.03231   0.02329   0.02493   0.01669
0.01265   0.00955   0.00668   0.00313   0.00320   0.00355   0.00443   0.00341
0.00161   0.00315   0.00096   0.00000   0.00000   0.00000   0.00011   0.04365
0.00734   0.03696   0.03348   0.03032   0.01354   0.04316   0.07627   0.03598
0.02955   0.01965   0.01377   0.01696   0.01042   0.00809   0.00534   0.00666
0.00490   0.00167   0.00141   0.00579   0.00059   0.00220   0.00006   0.00077
0.00216
1983    1    4    3    0    1   -1   -1  244.2     0.00000   0.00000   0.00000
0.00959   0.07535   0.16741   0.04727   0.04811   0.01505   0.00882   0.00231
0.00804   0.03732   0.02182   0.01205   0.02824   0.01969   0.01613   0.02575
0.01023   0.00488   0.00489   0.00783   0.00672   0.00616   0.00081   0.00114
0.01781   0.00389   0.00683   0.00000   0.00000   0.00000   0.00009   0.02289
0.14035   0.03192   0.03322   0.01280   0.00538   0.00774   0.00947   0.01969
0.02003   0.01247   0.01245   0.00471   0.02325   0.00212   0.00174   0.00290
0.00496   0.00573   0.00143   0.00148   0.00139   0.00022   0.00074   0.00373
0.00295
1984    1    4    3    0    1   -1   -1  221.7      0.00000   0.00000   0.00000
0.00000   0.02540   0.12438   0.11309   0.02675   0.02946   0.01160   0.00714
0.00334   0.01995   0.04521   0.00956   0.01060   0.00694   0.00713   0.01024
0.01505   0.00673   0.00332   0.00648   0.00278   0.00025   0.00008   0.00062
0.00000   0.00685   0.00798   0.00000   0.00000   0.00000   0.00000   0.02218
0.13687   0.14488   0.02753   0.03580   0.01445   0.01381   0.00172   0.01016
0.03036   0.01416   0.00413   0.00505   0.00381   0.00425   0.00635   0.00315
0.00052   0.00332   0.00294   0.00052   0.00109   0.00040   0.00174   0.00386
0.00601
1985    1    4    3    0    1   -1   -1  199.1     0.00000   0.00000   0.00000
0.00015   0.00156   0.03865   0.15256   0.14410   0.01994   0.03876   0.00648
0.00196   0.00298   0.01013   0.02275   0.00172   0.00637   0.00668   0.00945
0.00614   0.00813   0.00412   0.00230   0.00265   0.00139   0.00138   0.00095
0.00017   0.00044   0.00303   0.00000   0.00000   0.00000   0.00023   0.00862
0.06224   0.16279   0.14485   0.01274   0.02543   0.01133   0.00227   0.00257
0.01016   0.02167   0.00227   0.00480   0.00306   0.00326   0.00537   0.00515
0.00112   0.00453   0.00234   0.00033   0.00037   0.00170   0.00012   0.00000
0.00573
1986    1    4    3    0    1   -1   -1  155.6     0.00000   0.00000   0.00000
0.00109   0.03235   0.02704   0.07344   0.08185   0.10038   0.00709   0.02113
0.00935   0.00476   0.00177   0.00155   0.02771   0.00334   0.00377   0.00363
0.00510   0.00172   0.00383   0.00094   0.00288   0.00162   0.00129   0.00008
0.00171   0.00239   0.00476   0.00000   0.00000   0.00000   0.00267   0.04161
0.04581   0.08210   0.12392   0.12913   0.01376   0.02179   0.01739   0.00102
0.00089   0.00846   0.02910   0.00558   0.00866   0.00371   0.00734   0.00696
0.00155   0.00485   0.00059   0.00101   0.00584   0.00138   0.00076   0.00004
0.00754
1987    1    4    3    0    1   -1   -1  142.7     0.00000   0.00000   0.00118
0.00010   0.04721   0.09536   0.02129   0.05076   0.05089   0.05541   0.01145
0.01017   0.00402   0.00234   0.00079   0.00449   0.00282   0.00599   0.00087
0.00014   0.00109   0.00108   0.00059   0.00089   0.00145   0.00089   0.00012
0.00213   0.00016   0.00270   0.00000   0.00000   0.00118   0.00015   0.05500
```

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0.11420   0.04355   0.05967   0.09087   0.11202   0.01994   0.02995   0.02110
0.00284   0.00000   0.01867   0.01465   0.00281   0.01109   0.01229   0.00698
0.00047   0.00073   0.00174   0.00000   0.00020   0.00000   0.00016   0.00097
0.00238
1988    1    4    3    0    1   -1   -1  120.1     0.00000   0.00000   0.00014
0.08584   0.03747   0.07596   0.07187   0.05526   0.03250   0.03714   0.02121
0.00390   0.01422   0.01974   0.00423   0.00685   0.00358   0.00600   0.00881
0.00023   0.00006   0.00153   0.00988   0.00923   0.00665   0.00423   0.00565
0.00073   0.00019   0.00025   0.00000   0.00000   0.00004   0.03538   0.00033
0.06556   0.06058   0.09021   0.06070   0.05113   0.03440   0.01418   0.00884
0.00788   0.00343   0.00359   0.00649   0.01614   0.00150   0.00290   0.00133
0.00087   0.00283   0.00008   0.00423   0.00032   0.00000   0.00016   0.00032
0.00324
1989    1    4    3    0    1   -1   -1  124.0     0.00000   0.00000   0.00000
0.00341   0.08176   0.04260   0.04242   0.08150   0.05370   0.03781   0.02124
0.00970   0.00758   0.00380   0.00634   0.00554   0.00000   0.00065   0.00130
0.00385   0.00415   0.00078   0.00373   0.00169   0.00086   0.00062   0.00100
0.00048   0.00053   0.00480   0.00000   0.00000   0.00000   0.00492   0.10881
0.07299   0.07796   0.11901   0.04630   0.05007   0.01974   0.01168   0.02042
0.01573   0.00821   0.00000   0.00034   0.00720   0.00582   0.00001   0.00420
0.00420   0.00007   0.00000   0.00000   0.00047   0.00000   0.00000   0.00000
0.00000
1990    1    4    3    0    1   -1   -1  125.1     0.00000   0.00000   0.00001
0.00319   0.05082   0.10891   0.05629   0.03677   0.08872   0.07083   0.03706
0.02435   0.00983   0.00849   0.00622   0.00120   0.00335   0.00121   0.00217
0.00341   0.00219   0.00121   0.00020   0.00042   0.00261   0.00000   0.00019
0.00019   0.00063   0.00060   0.00000   0.00000   0.00020   0.00001   0.04523
0.11616   0.02949   0.04657   0.03773   0.05602   0.02994   0.02464   0.01628
0.02298   0.01900   0.01426   0.00372   0.00247   0.00838   0.00344   0.00000
0.00041   0.00124   0.00000   0.00019   0.00000   0.00000   0.00000   0.00000
0.00060
1991    1    4    3    0    1   -1   -1  95.9      0.00000   0.00000   0.00023
0.00712   0.00813   0.11290   0.12817   0.06071   0.03023   0.03311   0.02324
0.01698   0.01308   0.01096   0.00817   0.00817   0.00685   0.00073   0.00169
0.00099   0.00650   0.00070   0.00211   0.00198   0.00279   0.00048   0.00184
0.00000   0.00000   0.00066   0.00000   0.00000   0.00000   0.00244   0.01549
0.11903   0.11958   0.04945   0.03784   0.06509   0.02207   0.01639   0.02012
0.01238   0.00161   0.00354   0.00366   0.00259   0.00278   0.00142   0.01158
0.00000   0.00000   0.00117   0.00058   0.00000   0.00096   0.00000   0.00000
0.00172
1992    1    4    3    0    1   -1   -1  58.4      0.00000   0.00000   0.00000
0.00023   0.01534   0.03112   0.10817   0.08648   0.03906   0.03031   0.03740
0.02619   0.02578   0.04386   0.01502   0.00049   0.00145   0.00139   0.00589
0.01037   0.00105   0.00445   0.00554   0.00361   0.00841   0.00541   0.00075
0.00035   0.00042   0.00141   0.00000   0.00000   0.00000   0.00111   0.01130
0.01884   0.13832   0.09489   0.03772   0.01674   0.04400   0.02777   0.02134
0.01936   0.01110   0.00546   0.01602   0.00105   0.00185   0.00249   0.00519
0.01010   0.00323   0.00000   0.00000   0.00000   0.00000   0.00109   0.00000
0.00109
1993    1    4    3    0    1   -1   -1  42.8      0.00000   0.00000   0.00000
0.00421   0.03343   0.13516   0.12358   0.09695   0.03669   0.00444   0.00114
0.00952   0.00761   0.00133   0.00078   0.00097   0.00136   0.00516   0.00519
0.00014   0.00015   0.00010   0.00046   0.00000   0.00010   0.00000   0.00210
0.00000   0.00010   0.00368   0.00000   0.00000   0.00000   0.00000   0.08459
0.16331   0.09553   0.07773   0.00997   0.00173   0.00930   0.00688   0.01072
0.00092   0.02099   0.00471   0.00186   0.00406   0.00063   0.00774   0.00000
0.00000   0.00785   0.00040   0.00000   0.00406   0.00142   0.00015   0.00000
0.01106
1994    1    4    3    0    1   -1   -1  57.0      0.00000   0.00000   0.00188
0.00172   0.02248   0.06742   0.16134   0.06637   0.05077   0.01964   0.02589
0.01692   0.01507   0.00685   0.00937   0.00755   0.00629   0.00023   0.00172
0.00485   0.00342   0.00000   0.00012   0.00005   0.00157   0.00701   0.00003
0.00003   0.00481   0.00112   0.00000   0.00000   0.00188   0.00357   0.00711
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0.07028   0.14803   0.10959   0.06474   0.02123   0.02352   0.00682   0.00788
0.00474   0.00637   0.00851   0.00088   0.00481   0.00030   0.00062   0.00043
0.00023   0.00023   0.00012   0.00000   0.00000   0.00011   0.00000   0.00000
0.00350
1995    1    4    3    0    1   -1   -1  32.1     0.00000   0.00000   0.00000
0.00813   0.00909   0.01550   0.05015   0.13655   0.04976   0.06834   0.02326
0.00458   0.00773   0.00203   0.00506   0.00765   0.00000   0.00770   0.00000
0.00101   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.03349   0.03914
0.03379   0.05644   0.19687   0.04462   0.06603   0.05778   0.00316   0.02823
0.00677   0.02052   0.00101   0.00442   0.00809   0.00005   0.00000   0.00101
0.00000   0.00101   0.00000   0.00101   0.00000   0.00000   0.00000   0.00000
0.00000
1996    1    4    3    0    1   -1   -1  70.0     0.00000   0.00000   0.00532
0.00750   0.03965   0.04283   0.04183   0.08143   0.05803   0.04960   0.03762
0.02950   0.01078   0.00995   0.01224   0.00258   0.00143   0.00721   0.00489
0.00000   0.00000   0.00034   0.00009   0.00000   0.00000   0.00050   0.00000
0.00000   0.00000   0.00264   0.00000   0.00000   0.00354   0.00565   0.04606
0.04505   0.06664   0.11433   0.11778   0.03313   0.02666   0.01843   0.01539
0.00301   0.02493   0.00685   0.00239   0.00203   0.00882   0.00000   0.00022
0.00000   0.00000   0.00264   0.00000   0.00821   0.00000   0.00000   0.00022
0.00203
1997    1    4    3    0    1   -1   -1  94.0     0.00000   0.00000   0.00008
0.00101   0.00726   0.08297   0.03778   0.05579   0.05298   0.04154   0.06483
0.04776   0.03035   0.02026   0.00476   0.02109   0.00639   0.00695   0.00542
0.00255   0.00058   0.00669   0.00029   0.00108   0.00006   0.00237   0.00064
0.00005   0.00000   0.00009   0.00000   0.00000   0.00000   0.00163   0.00836
0.10829   0.04073   0.05108   0.05212   0.04842   0.04954   0.03587   0.02688
0.02293   0.01251   0.00503   0.00403   0.01243   0.00630   0.00257   0.00166
0.00035   0.00003   0.00299   0.00000   0.00000   0.00000   0.00000   0.00000
0.00461
1998    1    4    3    0    1   -1   -1  62.9     0.00000   0.00000   0.00000
0.00169   0.05395   0.02943   0.07570   0.02968   0.04599   0.04531   0.05263
0.06036   0.02818   0.00791   0.00962   0.00615   0.00661   0.00198   0.00334
0.00456   0.00466   0.00065   0.00145   0.00014   0.00136   0.00000   0.00000
0.00000   0.00000   0.00052   0.00000   0.00000   0.00000   0.00771   0.08175
0.06062   0.09268   0.06898   0.05385   0.02054   0.04544   0.02503   0.01826
0.01773   0.00546   0.00746   0.00945   0.00031   0.00000   0.00017   0.00428
0.00104   0.00539   0.00000   0.00052   0.00000   0.00000   0.00145   0.00000
0.00000
1999    1    4    3    0    1   -1   -1  71.8      0.00000   0.00000   0.00019
0.00161   0.01023   0.07363   0.04598   0.09364   0.04161   0.04705   0.03816
0.02215   0.02113   0.01529   0.01432   0.01416   0.00398   0.00861   0.00184
0.00429   0.00221   0.00116   0.00247   0.00195   0.00106   0.00010   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00079   0.00130   0.01854
0.07214   0.05925   0.10060   0.06900   0.05139   0.02678   0.02208   0.02956
0.01627   0.00603   0.00580   0.00562   0.01201   0.00498   0.01455   0.00605
0.00308   0.00233   0.00060   0.00308   0.00105   0.00000   0.00000   0.00028
0.00000
2000    1    4    3    0    1   -1   -1  40.2      0.00000   0.00000   0.00000
0.00000   0.00682   0.03281   0.09860   0.07333   0.07504   0.05679   0.03949
0.02742   0.05920   0.03256   0.03299   0.02113   0.00236   0.00056   0.02363
0.00000   0.00471   0.00000   0.00236   0.00000   0.00000   0.00022   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00353
0.04391   0.06088   0.11621   0.05522   0.04438   0.02728   0.02824   0.00939
0.00035   0.00287   0.00306   0.00824   0.00236   0.00215   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00194   0.00000   0.00000
0.00000
2001    1    4    3    0    1   -1   -1  35.0     0.00000   0.00000   0.00000
0.00000   0.00000   0.00819   0.06009   0.09860   0.03698   0.06524   0.06364
0.03241   0.03763   0.02260   0.02086   0.00094   0.01265   0.02253   0.03378
0.00000   0.00000   0.00000   0.00894   0.00000   0.00894   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00017   0.00000
```

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0.01041   0.07264   0.01207   0.06449   0.09240   0.03459   0.03962   0.03238
0.03008   0.04197   0.02113   0.00409   0.00326   0.00000   0.00000   0.00000
0.00000   0.00000   0.00326   0.00326   0.00000   0.00000   0.00000   0.00000
0.00017
2002    1    4    3    0    1   -1   -1  32.2     0.00000   0.00000   0.00000
0.01026   0.00160   0.00140   0.03111   0.01471   0.03821   0.11190   0.04871
0.07365   0.00409   0.03396   0.03075   0.03340   0.00377   0.00337   0.00000
0.00040   0.00040   0.00337   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00337   0.00000   0.00000   0.00000   0.01026   0.00160
0.00168   0.01528   0.03496   0.04386   0.10417   0.02863   0.02081   0.09759
0.03171   0.06070   0.00160   0.03019   0.00000   0.03256   0.00000   0.02879
0.00337   0.00040   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00337
2003    1    4    3    0    1   -1   -1  6.5    0.00000   0.00000   0.01327   0.41150
0.03982   0.00000   0.00000   0.01327   0.00442   0.02212   0.00442   0.00000
0.00000   0.01327   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.27876   0.01327   0.00885
0.00885   0.03540   0.03982   0.03982   0.00000   0.01770   0.00000   0.00442
0.01327   0.01327   0.00000   0.00000   0.00000   0.00000   0.00442   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
2004    1    4    3    0    1   -1   -1  11.4     0.00000   0.00000   0.00000
0.00000   0.01493   0.01580   0.01493   0.01580   0.03819   0.03819   0.06848
0.05970   0.06673   0.07550   0.01449   0.05268   0.04653   0.03073   0.00746
0.00746   0.00746   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.01449   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.02327
0.00000   0.01493   0.03073   0.05399   0.06980   0.03907   0.01493   0.04741
0.02327   0.00746   0.03161   0.03907   0.00000   0.00746   0.00000   0.00000
0.00746   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.00000
2008    1    4    3    0    1   -1   -1  13.9     0.00000   0.00000   0.00000
0.00000   0.03743   0.03751   0.01516   0.05785   0.02185   0.02063   0.05326
0.01065   0.01065   0.02972   0.00872   0.09010   0.00720   0.03920   0.00000
0.00008   0.00000   0.00185   0.07486   0.00000   0.00000   0.00000   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
0.03751   0.00712   0.05545   0.05212   0.05216   0.03802   0.08121   0.04408
0.01457   0.01280   0.00000   0.01271   0.00000   0.07486   0.00059   0.00000
0.00000   0.00000   0.00000   0.00000   0.00000   0.00008   0.00000   0.00000
0.00000

2003    1   11    3    0    1   -1   -1   8.6     0    0    0    0    0    0    0
0    1    0    0    0    0    1    1    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2004    1   11    3    0    1   -1   -1   6.1     0    0    0    0    0    2    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    1    0    1    1    0    1    1    0    0
0    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2005    1   11    3    0    1   -1   -1  11.0     0    0    0    0    0    0    0
0    1    4    2    2    0    1    1    0    0    0    1    0    0    1    0    0    0
0    0    0    0    0    0    0    0    0    0    1    1    1    0    0    0    1    2
1    1    0    1    0    0    0    0    0    0    0    0    0    0    0    0    0
2006    1   11    3    0    1   -1   -1  16.0    0    0    0    0    2    5    1    1
2    0    0    1    2    0    0    1    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    2    2    0    2    2    0    0    0    1    0    0
0    2    0    0    0    2    0    0    1    0    0    0    0    0    0    0
2007    1   11    3    0    1   -1   -1  19.1     0    0    0    0    1    0    1
3    3    2    1    3    1    1    2    1    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    1    1    6    2    1    4    1    0
0    0    1    0    0    0    0    1    0    0    0    0    0    0    0    0    0
2008    1   11    3    0    1   -1   -1   9.4    0    0    0    0    0    0    0    0
1    0    0    0    1    0    0    0    1    0    0    0    0    0    0    0    0    0
```

```
0    0    0    0    0    0    0    0    1    0    0    0    0    1    2    0    1    1
0    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0

2003    1   12    3    0    1   -1   -1   12.8    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    1    0    0    0    0    0    0    0    0
1    0    0    0    0    0    0    0    0    0    0    0    3    0    0    1    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2004    1   12    3    0    1   -1   -1   14.9    2   14    0    3    9    2    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    2    2   13    2    0    0    0    0    0    0    0
0    0    0    0    0    1    0    0    0    0    0    0    0    0    0    0    0
2005    1   12    3    0    1   -1   -1   23.1    0    0    5    2    3    2    1
1    0    0    1    0    2    1    3    2    1    0    1    0    1    1    0    0    0
0    1    0    0    0    0    0    4    4    1    3    6    2    0    2    3    2    0
3    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2006    1   12    3    0    1   -1   -1   22.3    0    0    0    0    0    1    4
4    0    1    2    1    0    0    4    3    1    1    3    1    0    0    1    1    2
0    2    0    1    1    0    1    0    0    1    3    5    4    4    1    1    0    2
2    2    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
2007    1   12    3    0    1   -1   -1   19.2    0    0    0    0    1    1    2
6    2    6    2    0    0    1    0    0    0    0    0    0    1    0    0    0    0
0    0    0    0    0    0    0    0    0    1    0    2    5    3    2    3    0    1
2    0    2    1    0    1    0    0    0    0    0    0    0    0    0    0    0
2008    1   12    3    0    1   -1   -1   10.4    0    0    0    0    0    0    0
1    1    0    0    0    0    0    1    0    0    0    0    0    0    1    0    0    0
0    0    0    0    0    0    0    0    1    1    1    0    0    1    1    1    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

-1            #_N_MeanSize-at-Age_obs

2             #_N_environ_variables
15            #_N_environ_obs

#_Year Variable      Value
 1980  1                  0.724518629
 1983  1                  1.236554728
 1986  1                  0.305533679
 1989  1                  -0.526410321
 1992  1                  1.078178166
 1995  1                  0.718825954
 1998  1                  0.529870997
 2001  1                  -0.260982852
 2004  1                  -0.126751988
 2003  2                  0.255464922
 2004  2                  -0.126751988
 2005  2                  0.112851373
 2006  2                  -0.118002192
 2007  2                  -0.576076484
 2008  2                  -0.362683828

0 # no wtfreq data

0 # no tag data

0 # no morphcomp data

999

ENDDATA
```

20 Appendix I. Spatial distribution of widow rockfish catch by the West Coast Groundfish Observer program. These figures were provided by Marlene Bellman of the NWFSC.

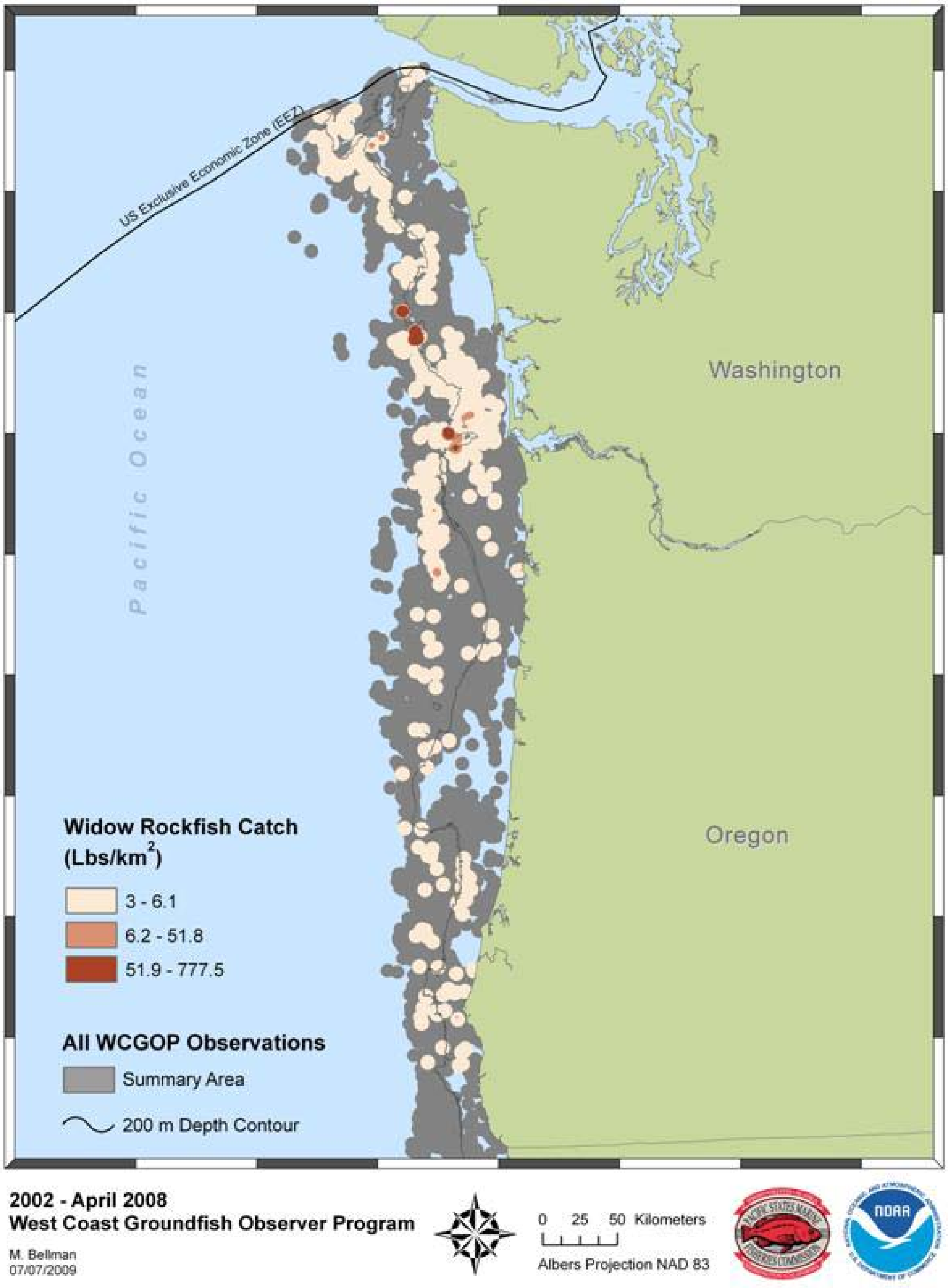

Figure I1. Spatial distribution of widow rockfish catch (lbs/km^2) observed by the West Coast Groundfish Observer Program from 2002 to April 2008 and the summary area of all observed fishing events off of Washington and Oregon. Note that this figure does not include midwater trawls from the at-sea whiting fishery.

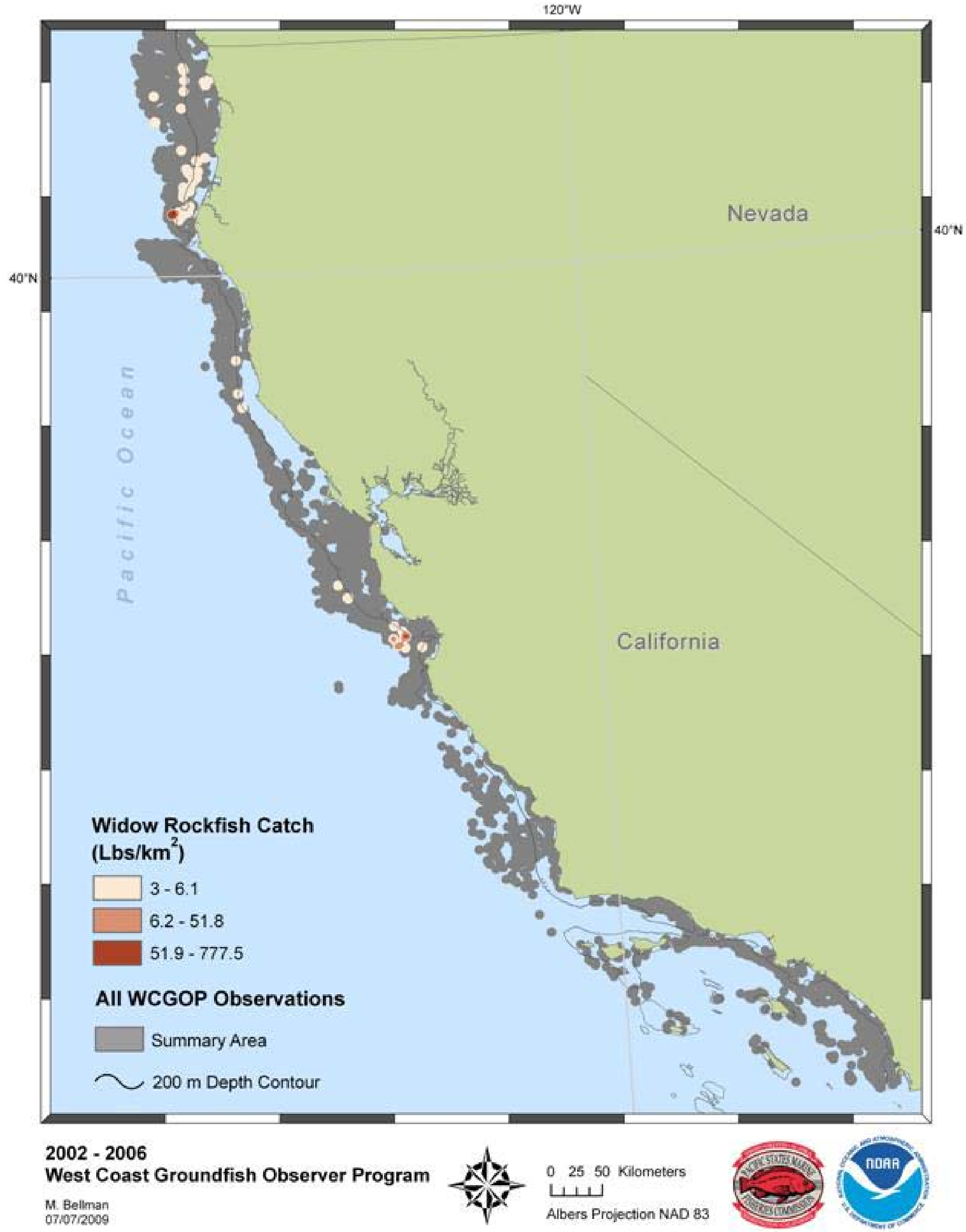

Figure I2. Spatial distribution of widow rockfish catch (lbs/km^2) observed by the West Coast Groundfish Observer Program from 2002 to April 2008 and the summary area of all observed fishing events off California. Note that this figure does not include midwater trawls from the at-sea whiting fishery.