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Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009

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EXECUTIVE SUMMARY

Stock

This assessment reports the status of the bocaccio rockfish (*Sebastes paucispinis*) off of the west coast of the United States, from the U.S.-Mexico border to Cape Blanco, Oregon (representing the Conception, Monterey and Eureka INPFC areas). Although the range extends considerably further north, there is some evidence that there are two demographic clusters of bocaccio, centered around southern/central California and the west coast of British Columbia, with a relative rarity of bocaccio (particularly smaller fish) in the region between Cape Mendocino and the Columbia rivermouth. This is supported by apparent differences in growth, maturity and longevity, although genetic evidence seems to indicate a single west coast population. Within the stock area, there is also evidence of limited demographic separation, which is treated through some separation of fleets and data. These and other issues related to stock identification and relative levels of demographic mixing and isolation remain important research questions for future assessments.

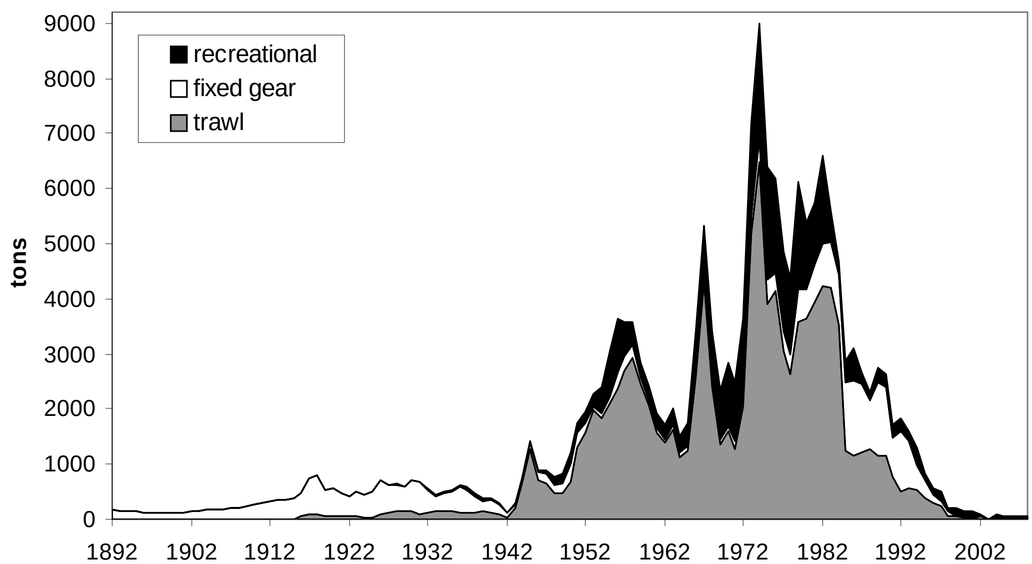


Figure E1: Catch history of bocaccio rockfish (in metric tons) in the assessment area from 1892-present

Catches

Bocaccio rockfish have long been one of the most important targets of both commercial and recreational fisheries in California waters, accounting for between 25 and 30% of the commercial rockfish (*Sebastes*) historical catch over the past century. However, this percentage has declined in recent years as a result of stock declines, management actions and the development of alternative fisheries (particularly the widow rockfish fishery in the early 1980s). The catch history for this assessment begins in 1892, a major shift from recent assessments which began in 1951, and relies heavily on the catch reconstruction efforts and products recently developed for historical California groundfish landings. Although the recent (post-1950) catch history has changed only modestly, the revised catch history prior to 1950 has a substantial impact on the perception of stock status.

Table E1. Recent catches (in metric tons) of bocaccio rockfish south of Cape Blanco

	Trawl south of 38° N	Trawl north of 38° N	Hook and line	Setnet	Rec south of 34.5° N	Rec north of 34.5° N
1999	19.0	26.0	20.7	7.2	80.1	60.2
2000	13.2	6,6	7,0	0,7	58.2	74.4
2001	9.2	4.4	7.8	0.8	62.7	53.8
2002	28.0	20.7	0.1	0.0	35.9	4.9
2003	5.1	0.3	0.0	0.0	5.5	1.9
2004	13.9	3.5	1.8	0.2	63.4	2.3
2005	24.6	0.4	1.5	0.2	69.9	10.7
2006	16.1	0.3	2.3	0.3	29.0	11.8
2007	4.1	1.6	3.4	0.4	44.2	8.9
2008	28.7	1.6	13.4	0.5	30.3	3.6

Data and Assessment

The last full assessment of bocaccio rockfish was done in 2003 in Stock Synthesis 1, and subsequently updated (with the same software) in 2005 and 2007. This assessment uses the Stock Synthesis 3 (version 3.03a), expands the area modeled from Cape Mendocino, CA to Cape Blanco, OR, and begins the model at 1892 rather than 1950. This model includes catch and length-frequency from six fisheries, two trawl fisheries (north and south of 38° N), a hook and line fishery, a set net (gillnet) fishery and recreational fisheries south and north of Point Conception, CA. No age data are used in this model. Fisheries dependent relative abundance (CPUE) indices, unchanged from the last assessment, are used for the trawl fishery and the two recreational fisheries; a recruitment (age-0) index based on recreational pier fishing is also included, revised since its removal from the 2003 assessment. Fisheries independent data used in the last assessment and continued here include the CalCOFI larval abundance time series and the triennial trawl survey index; new fisheries independent indices include a GLMM index based on the NWFSC combined survey index, the new NWFSC Southern California Bight hook and line survey, and the revised (coastwide) pelagic juvenile index. A recruitment index based on power plant impingement data is described but not included in the base model, as are point estimates of spawning and total biomass in the Southern California Bight based on larval production. The most significant parameter change includes the estimation of a steepness value of 0.57 in the base model; the natural mortality rate is unchanged from recent assessments (0.15). Growth is estimated within the model and results are consistent with past assessments.

Stock spawning output

The spawning output was estimated to be very slightly below the estimated unfished levels in the beginning of the modeled period, due to very moderate fishing pressure that began no later than the 1850s. The spawning output trajectory continues a very moderate decline until about 1950, but is estimated to have declined steeply from the early 1950s through the early 1960s as catches rose from several hundred to several thousand tons. The biomass increased sharply thereafter, as a result of one or several very strong recruitment events in the early 1960s, exceeding the mean unfished biomass level through the early 70s, when catches again began to climb rapidly to their peak levels, associated with high fishing mortality rates and a rapid drop in spawning output. Fishing mortality remained high throughout the 1980s and 1990s, even as catches, biomass and spawning output declined rapidly. Fishing mortality declined towards the end of the 1990s, in response to severe management restrictions, and coincident with a series of several strong year classes (following a decade of very poor recruitment) that began in 1999. Since the early 2000s, spawning output has been increasing steadily. The base model estimates a current (2009) depletion level of 28%, a 2008 SPR of 0.950, with the forecast under constant harvest rates indicating a continued increase in spawning output.

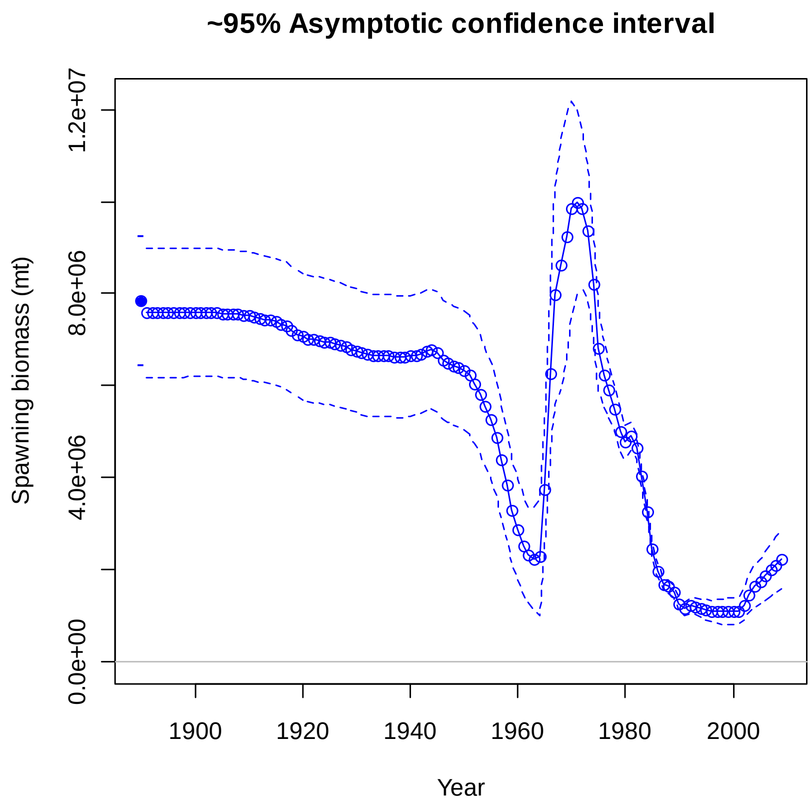


Figure E2. Estimated spawning output time series (1892-2008) for the base case model with approximate asymptotic 95% confidence interval.

Table E2. Recent trends in estimated spawning output and relative depletion level

Year	Spawning Output	Confidence interval (~95%)	Depletion	Confidence interval (~95%)
1999	1091300	(803600 - 1379000)	13.88%	(0.09 - 0.17)
2000	1087600	(792900 - 1382300)	13.84%	(0.09 - 0.17)
2001	1094600	(792340 - 1396860)	13.93%	(0.09 - 0.18)
2002	1225700	(884940 - 1566460)	15.59%	(0.10 - 0.20)
2003	1453900	(1046540 - 1861260)	18.50%	(0.12 - 0.24)
2004	1628200	(1169340 - 2087060)	20.72%	(0.14 - 0.27)
2005	1733900	(1239080 - 2228720)	22.06%	(0.15 - 0.28)
2006	1848700	(1313540 - 2383860)	23.52%	(0.16 - 0.3)
2007	1980000	(1400300 - 2559700)	25.19%	(0.17 - 0.33)
2008	2103200	(1480260 - 2726140)	26.76%	(0.18 - 0.35)
2009	2209900	(1546440 - 2873360)	28.12%	(0.18 - 0.37)

Recruitment

Recruitment for bocaccio is highly variable, with a small number of year classes tending to dominate the catch in any given fishery or region. Recruitment appears to have been at very low levels throughout most of the 1990s, but several recent year classes (1999, 2003, 2005) have been relatively strong given the decline in spawner abundance, and have resulted in an increase in abundance and spawning output. The juvenile cruise index suggests low recruitment in 2007 and 2008, years in which length composition data are not indicative of above average recruitment. Estimated recruitments and confidence intervals for those values are shown in Table E3 and Figure E3.

Table E3. Estimated recruitment with 95% confidence interval, 1999-2009

Year	Recruits (x1000)	Confidence interval (~95%)
1999	8067	(5647 - 10487)
2000	268	(22 - 514)
2001	318	(74 - 562)
2002	1250	(714 - 1786)
2003	3952	(2660 - 5244)
2004	566	(232 - 900)
2005	3642	(2368 - 4916)
2006	433	(129 - 737)
2007	838	(308 - 1368)
2008	850	(0 - 1742)
2009	3428	(0 - 10336)

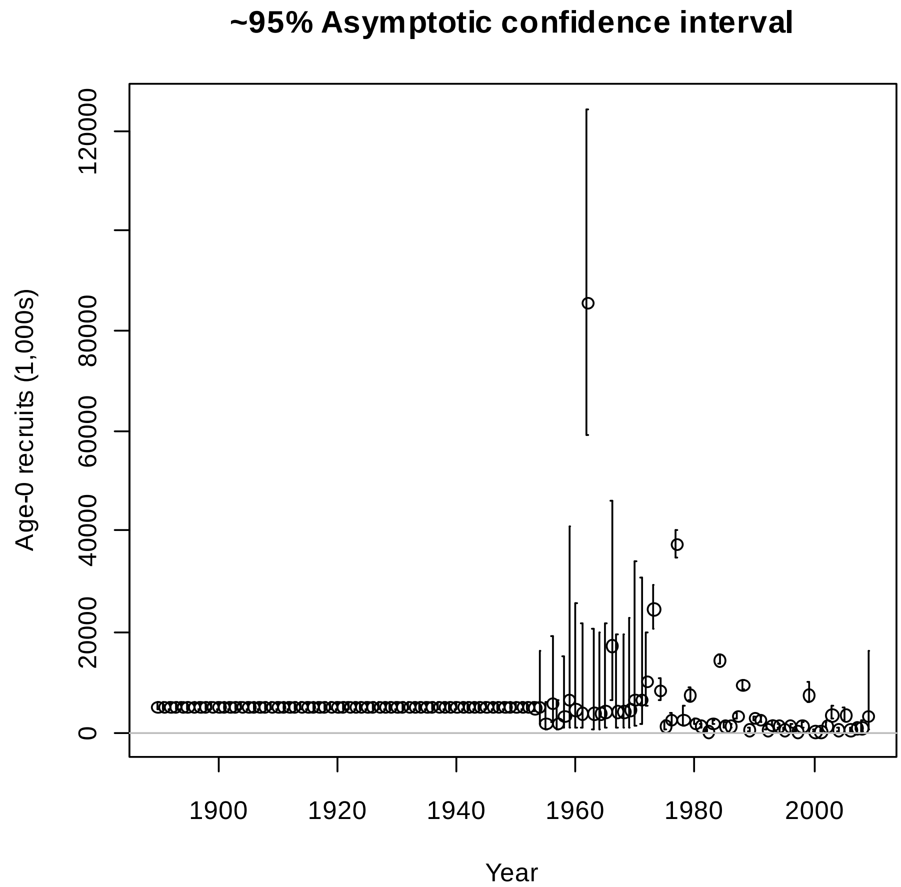


Figure E3. Estimated recruitment of bocaccio rockfish with 95% asymptotic confidence intervals, from 1892-2009 (freely estimated only from 1954-2008).

Reference Points

Reference points are presented in Table E4, which presents the unfished summary biomass, unfished spawning output, mean unfished recruitment and the proxy estimates for MSY based on the $SPR_{50\%}$ rate, the fishing mortality rate associated with a spawning stock output of 40% of the unfished level, and MSY estimated based on the spawner/recruit relationship. The corresponding yields for these three estimates vary by a relatively minor amount, ranging from 1250 tons based on the spawning output proxy and 1270 tons based on the MSY estimate. However, the relative impact of the higher harvest rate on spawner abundance is results in a significantly lower equilibrium spawning output and summary biomass with both the SPR proxy and the estimated MSY rate, relative to the spawning output reference point. Additionally, estimates of the different MSY proxies are based on the relative proportion of total catches by fishery in 2008 (which in no way are intended to imply a de facto sector allocation), and will change modestly depending upon allocation among fisheries with differing selectivity curves.

Table E4. Summary of reference points for bocaccio rockfish from the base model

Unfished Stock	Estimate	95% Confidence Limits Lower	Upper
Summary (1+) Biomass	44070	36029	52111
Spawning Output	7860000	6426040	9293960
Equilibrium recruitment	5060	4129	5991

	Yield reference Points		
	$SSB_{40\%}$	SPR proxy	MSY est.
SPR	0.512	0.500	0.461
Exploitation rate	0.066	0.069	0.078
Yield	1250	1258	1270
Spawning output	3140000	3031020	2651890
SSB/SSB_0	0.40	0.39	0.34

Exploitation Status

The 2009 spawning output is estimated to be at 28.3% of the unfished spawning output, significantly lower than the target levels, but slightly above the minimum stock size threshold (Figure E5). The draft base model indicates that the exploitation rates for bocaccio rockfish has remained at low levels since the turn of the millennia, and the population has been increasing accordingly (Table E5, Figures E5-E6).

Table E5. Base model estimated exploitation rate and spawning potential ratio (SPR)

Year	Exploitation rate	SPR rate
1999	0.034	0.754
2000	0.023	0.825
2001	0.018	0.912
2002	0.010	0.988
2003	0.001	0.922
2004	0.008	0.906
2005	0.010	0.949
2006	0.005	0.949
2007	0.005	0.941
2008	0.006	0.950

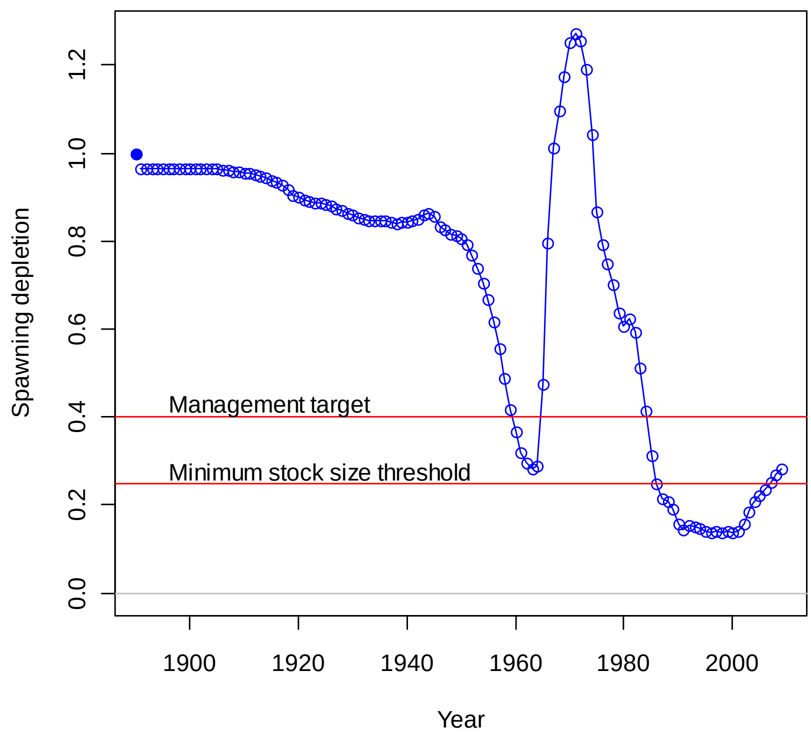
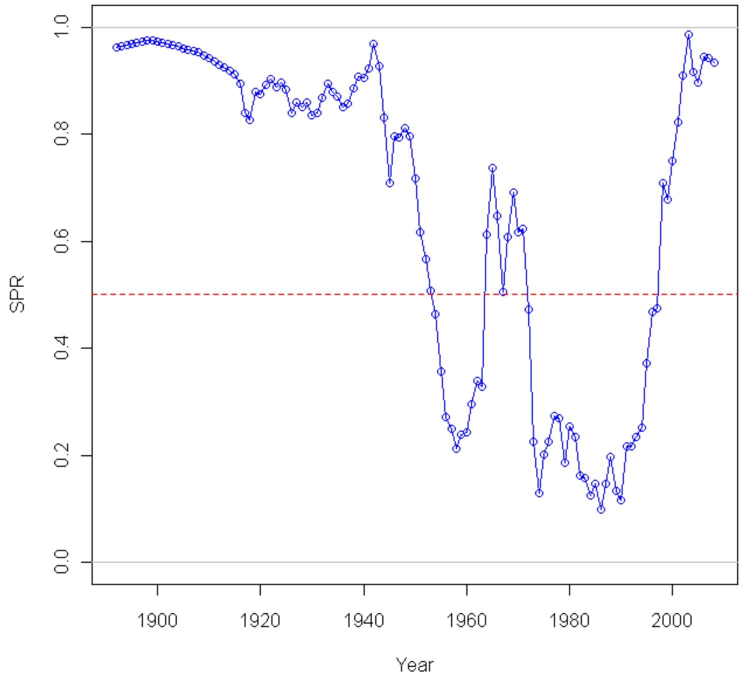
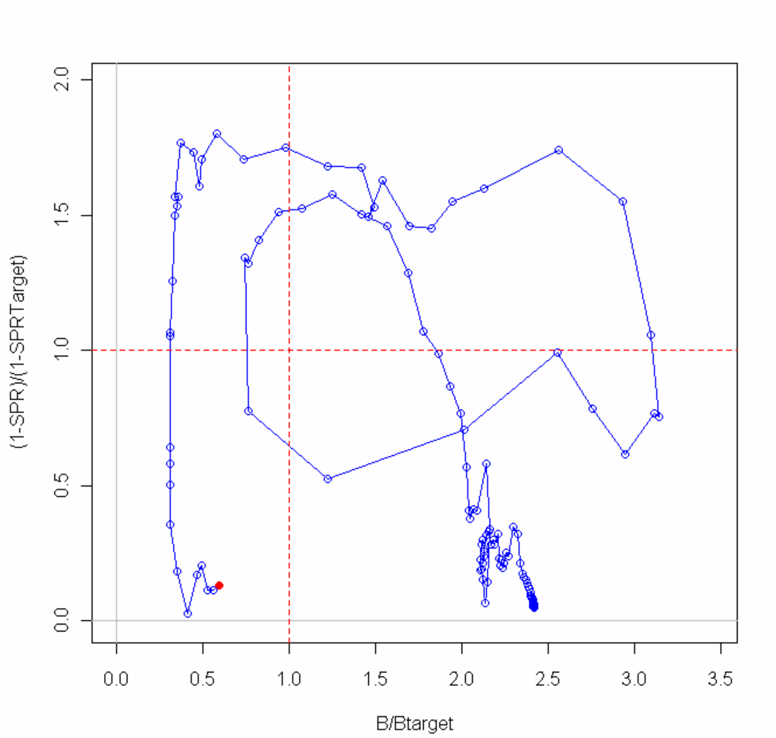


Figure E4. Time series of estimated depletion level of bocaccio from the base model

Management Performance

Bocaccio rockfish were formally designated as overfished in March of 1999, after the groundfish FMP was amended to incorporate the mandates of the Sustainable Fisheries Act reauthorization to the MSFCMA. The rebuilding policy adopted by the PFMC held the rebuilding OY constant at 100 MT for the years 2000-2002, with the intention of switching to a constant fishing rate policy beginning in 2003. However, due to an extremely pessimistic 2002 assessment, the 2003 OY was set to 20 tons. A more optimistic assessment in 2003 led to a 2004 OY of 199 tons. The OY has been set at a range of values between 218 and 307 tons since then (Table E6), with actual catches (including discards) estimated to be less than half of that amount in most years since 2003.





Figures E5- E6. Spawner potential ratio (SPR) over time (top), with reference proxy for *Sebastes* (0.5) and phase plot of SPR rate plotted against SSB, against target levels (bottom).

Table E6. Management performance

	Commercial catches	Recreational catches	ABC	OY
1999	73	124	230	230
2000	28	112	164	100
2001	22	109	122	100
2002	49	41	122	100
2003	5	7	244	20
2004	19	66	400	199
2005	27	81	566	307
2006	19	41	549	306
2007	9	53	602	218
2008	44	34	618	218

Unresolved problems and major uncertainties

Although much of the parameter uncertainty is reported, natural mortality (M) is treated as fixed, as are several important selectivity parameters. Consequently, the reported asymptotic confidence intervals underestimate the true parameter uncertainty. While the data seem to be relatively informative with respect to steepness, the lack of age data lead to a potentially misleading interpretation of the sensitivity to alternative values of natural mortality. There is clear tension in the model between several key indices, particularly the CalCOFI index and the southern recreational CPUE index, which tend to reflect a more optimistic view of stock status, and the trawl cpue and triennial survey index, which tend to reflect a more pessimistic view of stock status. This tension is explored further in the decision table. The manner in which selectivity is estimated for the triennial trawl survey continues to be problematic, as it has for past assessments, although the application of a GLMM index seems to result in a more plausible index. Despite other sources of parameter and model uncertainty, and the potentially confounding impacts of management actions in both reducing the availability of data in recent years, there appears to be clear signs that the stock is rebuilding at a relatively rapid rate. Data from relative recent, short term surveys do not yet appear to be informative with respect to trends in abundance trends, although they are informative with respect to cohort strength.

Table E7. Forecast of bocaccio ABC, OY, spawning biomass and depletion, based on the SPR= 0.777 fishing mortality target (OY) and $F_{50\%}$ overfishing limit (ABC)

Year	ABC (mt)	OY (mt)	Age 1+ biomass (mt)	Spawning output	Depletion
2009	831	267	12,808	2,209,950	28.11%
2010	744	251	12,618	2,228,890	28.35%
2011	714	246	12,671	2,206,150	28.06%
2012	753	265	13,018	2,199,380	27.98%
2013	824	299	13,605	2,252,490	28.65%
2014	894	339	14,340	2,352,740	29.93%
2015	950	377	15,151	2,481,040	31.56%
2016	992	413	15,991	2,625,210	33.39%
2017	1025	445	16,833	2,777,630	35.33%
2018	1051	474	17,663	2,933,000	37.31%
2019	1074	500	18,472	3,087,910	39.28%
2020	1094	517	19,256	3,239,680	41.21%

Decision Table

Both the STAT and the STAR Panel identified the major sources of uncertainty in the model as relating to the tension between two generally pessimistic indices (both derived primarily from north of Point Conception, California) and two optimistic indices (both derived primarily from south of Point Conception). Consequently, the two alternative states of nature sequentially increased the emphasis on each of these groups to bracket uncertainty (Table E8). The low abundance scenario (State 1) was obtained by upweighting ($\lambda = 10$) the triennial and southern trawl CPUE indices, while the high biomass scenario (State 2) was obtained by upweighting the southern recreational CPUE index and the CalCOFI indices. Thus, these scenarios also provided useful contrast between an apparent, but poorly understood, spatial dimension to relative abundance trends, as the data suggest that recovery may be taking place more rapidly in the south, and recovery in the central/northern California region may be dependent on an influx of fish from the southern area.

Table E8: Decision Table for the bocaccio assessment, where State 1 has the triennial and trawl CPUE indices emphasized, and State 2 emphasizes southern rec CPUE and the CalCOFI indices.

		State1 (low biomass)		Base Model		State2(high biomass)	
catch with 2008 F		larvae	depletion	larvae	depletion	larvae	depletion
2009	65	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	62	1056130	**0.15**	2259880	**0.29**	2715680	**0.39**
2011	62	1059020	**0.15**	2267600	**0.29**	2720120	**0.39**
2012	68	1076100	**0.15**	2289230	**0.29**	2736480	**0.40**
2013	78	1133840	**0.16**	2371870	**0.30**	2819550	**0.41**
2014	90	1224880	**0.18**	2506410	**0.32**	2959720	**0.43**
2015	102	1337490	**0.19**	2675120	**0.34**	3137450	**0.45**
2016	113	1464190	**0.21**	2865660	**0.36**	3338590	**0.48**
2017	123	1600700	**0.23**	3069460	**0.39**	3552450	**0.51**
2018	129	1744400	**0.25**	3280130	**0.42**	3770470	**0.55**
2019	136	1893960	**0.27**	3493470	**0.44**	3986640	**0.58**
2020	142	2048240	**0.29**	3706040	**0.47**	4196180	**0.61**
SPR 0.77 (base)		larvae	depletion	larvae	depletion	larvae	depletion
2009	267	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	251	1025030	**0.15**	2228890	**0.28**	2684700	**0.39**
2011	246	997328	**0.14**	2206150	**0.28**	2658730	**0.38**
2012	265	986019	**0.14**	2199380	**0.28**	2646800	**0.38**
2013	299	1013570	**0.14**	2252490	**0.29**	2700770	**0.39**
2014	339	1068090	**0.15**	2352740	**0.30**	2807790	**0.41**
2015	377	1136160	**0.16**	2481040	**0.32**	2947220	**0.43**
2016	413	1210440	**0.17**	2625210	**0.33**	3105210	**0.45**
2017	445	1287560	**0.18**	2777630	**0.35**	3272010	**0.47**
2018	474	1365920	**0.20**	2933000	**0.37**	3440210	**0.50**
2019	500	1444790	**0.21**	3087910	**0.39**	3604600	**0.52**
2020	517	1523620	**0.22**	3239680	**0.41**	3761180	**0.54**
SPR 0.77(State 2)		larvae	depletion	larvae	depletion	larvae	depletion
2009	353	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	326	1009690	**0.14**	2213630	**0.28**	2669450	**0.39**
2011	314	967342	**0.14**	2176350	**0.28**	2628970	**0.38**
2012	328	942839	**0.13**	2156410	**0.27**	2603940	**0.38**
2013	360	956879	**0.14**	2196410	**0.28**	2645010	**0.38**
2014	395	995845	**0.14**	2282340	**0.29**	2738290	**0.40**
2015	429	1045960	**0.15**	2394880	**0.30**	2863010	**0.41**
2016	459	1100950	**0.16**	2522930	**0.32**	3006440	**0.43**
2017	479	1158410	**0.17**	2659810	**0.34**	3159810	**0.46**
2018	497	1217370	**0.17**	2800930	**0.36**	3316360	**0.48**
2019	512	1277570	**0.18**	2943370	**0.37**	3471380	**0.50**
2020	527	1338790	**0.19**	3084810	**0.39**	3621160	**0.52**

Research and Data Needs

Stock structure for bocaccio rockfish on the West Coast remains an important issue to consider with respect to both future assessments and future management actions. Although a reanalysis of the genetic evidence done for this assessment suggests no significant differentiation among the major oceanographic provinces in the California Current, the apparent differences in growth, maturity, and longevity, are indicative of moderate demographic isolation. Although an area model could be a worthy approach for addressing some of these questions, the lack of mixing or movement data would make such an effort challenging, and questions regarding the appropriate scale of such models remain largely unresolved.

The potential to develop defensible aging criteria for bocaccio in the southern area should be evaluated further, particularly if such criteria could be developed in a coordinated effort among workers along the west coast. Although production aging is likely to remain a challenge, future aging efforts would likely improve the ability to adequately inform natural mortality rates, growth and variability of size at age, and possibly contribute to an improved understanding of differences in life history parameters and rates in different regions of the West Coast.

With respect to both time varying growth and a more comprehensive evaluation of the interaction between climate and fecundity, additional research into the consequences of poor environmental conditions in affecting bioenergetic allocation patterns should be explored in greater detail. Efforts underway to investigate these questions, which should ultimately improve the interpretation of the CalCOFI larval abundance data as well as better inform efforts to model time-varying growth.

Since large scale area closures and other management actions were initiated in 2001, the spatial distribution of fishing mortality has changed over both large and small spatial scales. Not only has this effectively truncated several abundance indices (recreational CPUE indices), this confounds the interpretation of survey indices as well as fishery dependent and independent length frequency data. This is a problem for virtually all west coast groundfish, and should be addressed accordingly.

The application of juvenile indices to inform future recruitment remains an area ripe for additional investigations. Such indices have successfully captured the magnitude of some large recruitment events in the past, although they have missed others. Given the high recruitment variability observed in bocaccio, even indices with high uncertainty are likely to be an improvement over recruitment predicted from the spawner-recruit relationship. However, a better appreciation of the strengths and weaknesses of these indices is an important research priority.

C. INTRODUCTION

The name bocaccio is derived from the Italian for "bigmouth," bocaccio were also often called "bocacc" by early Italian fishermen, "merou" by Portuguese fishermen, "jack" by some American fishermen, "andygumps" by some British Columbia fishermen, "tomcod" for young bocaccio caught around wharfs, salmon grouper, and longjaw and many others (Love et al. 2002). The genus, *Sebastes*, is Latin for magnificent of course, and the species name, *paucispinis*, is a reference to the paucity of head spines relative to most other species of *Sebastes*. The body shape is best described as an elongate, laterally compressed fish with a very large mouth (thus the name) and a protruding lower jaw with a prominent knob at the end of their lower jaw. The upper jaw (maxillary) also extends to beyond the eye, distinguishing bocaccio from the often co-occurring chilipepper rockfish (Miller and Lea 1972). Underwater, subadult and adult bocaccio appear pink, pink-brown, gray or red; upon capture most appear a brighter reddish or salmon color mixed with brown, however considerable variation in colors and mottled patterns have been reported (Love et al. 2002). Both juvenile and adult stages grow rapidly, although growth slows considerably in mature adults; maximum reported sizes are 91 cm and to approximately 8 kg. In an extensive review of phylogenetic relationships among *Sebastes*, Hyde and Vetter (2007) found that bocaccio were most closely related to both chilipepper (*S. goodei*) and shortbelly (*S. jordani*) rockfish, although that lineage dated back approximately 6 million years. Adult systematics are described in more detail in Phillips (1957; 1964) and Love et al. (2002); larval distribution and descriptions are provided by Moser (1967; 1996) and pelagic juvenile life history stages and growth are described in Woodbury and Ralston (1991).

C.1 Management History

As the management history is closely linked to the history of many of the past assessments, highlights from previous modeling approaches are included in this section, and the assessment history section focuses on the transition from the 2003 assessment (and subsequent updates) to this assessment. Together with chilipepper rockfish (*Sebastes goodei*), bocaccio have long been one of the most important rockfish species in California commercial fisheries, particularly off of central and southern California (development of fisheries and trends in landings in the historical period are discussed in great detail in the catch reconstruction section). Throughout most of this period, domestic groundfish fisheries were managed by state management agencies, and in California waters there were few restrictions on harvest other than prohibitions on trawl fishing in state waters (within 3 miles of shore) and minimum mesh size requirements. Foreign fisheries caught significant volumes of some groundfish (Rogers 2003; also discussed in the landings section) in offshore waters of the west coast from 1966 through 1976, at which point harvest was limited by passage of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), which extended U.S. control over living marine resources within 200 miles of the coastline. The Pacific Fishery Management Council (PFMC) assumed management responsibility for west coast groundfish when the Groundfish Fishery Management Plan (FMP) became effective in September 1982.

From 1983 through 1990 the PFMC routinely adopted an acceptable biological catch (ABC) for bocaccio of 4,100 metric tons (mt) for the Monterey INPFC area and 2,000 mt for the Conception area. Landings in the other INPFC areas (Eureka, Columbia and U.S. Vancouver) were considered too small to warrant a separate ABC. Initially, these ABCs were based solely on historical (domestic) landings during selected periods; however actual landings were observed to be a declining fraction of the allowable landings throughout this period. In response to concerns about bocaccio stock conditions, an assessment was conducted in 1990 (Bence and Hightower 1990). The assessment results initially resulted in a recommendation for an 800 mt ABC for the combined Conception-Monterey-Eureka INPFC areas (for both commercial and recreational fisheries) for 1991; however, a harvest guideline of 1,100 mt was ultimately adopted for both 1991 and 1992. During those two years, actual harvest exceeded the harvest guideline by 300-500 mt (Figure 1; Table 1). Management measures used to constrain catches were primarily effort controls, with trip limits for commercial fisheries (trawl and fixed gear) and daily bag limits of rockfish in recreational fisheries. Trip limits were implemented for all rockfish species as a complex through 1990, generally limited to 40,000 lbs per trip. Species-specific trip limits began to be implemented in 1991, when trip limits were constrained to 25,000 lbs per trip of which no more than 5,000 lbs could be bocaccio. However, these limits were relaxed to 50,000 lbs per trip of which no more than 10,000 lbs could be bocaccio in 1992.

In 1992 the PFMC reviewed a new assessment for bocaccio (Bence and Rogers 1992). The ABC estimated from that assessment, based on strict adherence to the target fishing mortality rate at that time ($F_{35\%}$), was 1,540 mt. The assessment also projected that spawning and total biomass were expected to continue to decline under status quo harvest rates, and recommended that the 1,100 mt ABC be maintained. However, the PFMC adopted the 1,540 ton ABC (with the harvest guideline the same) for 1993 and 1994. The new assessment had also accommodated some expected discard in the trawl and set net fisheries that often fished to the trip limits. In 1994 the Council determined that few trips were being impacted by trip limits, such that the discard-based reduction was unnecessary and the ABC and harvest guideline was adjusted to 1,700 mt for 1995 and 1996. During this period, trip limits were replaced by monthly catch limits, which fluctuated in values throughout the year in response to efforts to achieve, but not exceed, harvest guidelines. Actual catches of bocaccio during this period were far below harvest guidelines, presumably in response to declining availability associated with continued harvest and ocean conditions that led to a long period of very poor recruitment.

A stock assessment conducted in 1996 (Ralston et al. 1996) indicated that the stock was in severe decline, and the PFMC drastically reduced the ABC to 265 mt in 1997, and to 230 mt with adoption of an $F_{40\%}$ policy in 1998 and 1999. In March of 1999 the stock was formally designated as overfished, after the groundfish FMP was amended to incorporate the mandates of the Sustainable Fisheries Act reauthorization to the MSFCMA. Later that year, an assessment by MacCall et al. (1999) estimated that the southern stock was only 2.1 percent of the unfished spawning output. Perhaps ironically, both the management regime and the climate regime shifted almost simultaneously; the decade-long string of poor recruitments ended in 1999 with early indications of a strong 1999 year class. The rebuilding policy adopted by the PFMC held the rebuilding OY constant at 100 mt for the years 2000-2002, with the intention of switching to a constant fishing rate policy beginning in 2003. Trip limits for trawl and fixed gear fisheries were reduced substantially during this period, in recreational fisheries a two-fish daily bag limit was imposed for bocaccio, and additional time-area closures were implemented in 2002 to reduce the recreational catch of bocaccio.

The 2002 assessment (MacCall 2002) utilized more information, particularly recreational fisheries CPUE indices and recruitment indices, and examined both a California-wide model as well as individual models for the areas north and south of Point Conception. The regional models provided a more optimistic perspective of stock status in the southern region, and a more pessimistic perspective of the central/northern California region, due to the absence of evidence for the strong 1999 year class in fisheries data from the northern area. However, the review panel recommended that a single, coastwide model be used to provide management advice. This model recognized the importance of the 1999 year class, but estimated that the stock spawning output was at only 4.8% of the unfished level, and the subsequent rebuilding analysis estimated that the stock would take nearly 100 years to rebuild to target levels (40% of the unfished output). The results of this assessment, combined with pessimistic assessments of other rockfish species coastwide, contributed to severe management constraints in 2003, including significant area closures and a near total cessation of recreational and commercial fisheries in shelf and shelf break waters. The estimated total catch of bocaccio declined to approximately 11 mt in 2003, roughly 10% of the total catch in 2002 and less than 1% of the catch ten years prior. Total mortality in 2003 fisheries was restricted to a 20 mt OY as a means of conserving the stock while minimizing adverse socioeconomic impacts to communities.

The 2003 bocaccio assessment differed greatly from the 2002 assessment. Both the CalCOFI time series and the recreational CPUE indices showed increasing trends as a result of the strong 1999 year class. However, the recreational CPUE indices were adjusted to account for regulatory changes (principally bag limit changes), and all of these indices were in conflict with the triennial trawl survey time series. The most recent triennial survey data was from 2001 and showed little evidence of an increase in abundance (although the length frequency data was indicative of a strong 1999 cohort). The STAR Panel recommended the use of two assessment models, each of which excluded the conflicting data, as a means of bracketing uncertainty from the very different signals between the recreational CPUE data and the triennial survey. However, the STAT Team was not in full agreement with this approach, and for the purposes of management decisions developed and presented a third "hybrid" model (STATc) that incorporated the data from all of the indices to the PFMC SSC. The SSC recommended and the Council approved the use of this third modeling approach. This resulted in modest improvement in estimated stock size, but had very significant impacts on the estimated productivity of the stock and rebuilding scenarios. These results were more optimistic with respect to the rebuilding outlook for bocaccio, suggesting the stock could rebuild to B_{MSY} within 25 years while sustaining an OY of approximately 300 mt in 2004. The 2004 OY was set at 199 mt.

The 2003 assessment was updated in 2005 (MacCall 2006). The assessment used the original Stock Synthesis model (SS1), and did not develop an equivalent new Stock Synthesis 2 (SS2) version of the assessment. In addition to new length frequency data, new data points were included from both the triennial survey and the CalCOFI larval abundance index, both of which suggested an increasing upwards trajectory for the stock. Importantly, the updated triennial trawl survey index (updated with a 2004 data point, now the last point in that time series) was now consistent with the increase in abundance suggested in the 2003 model with the recreational CPUE and CalCOFI indices. The updated base-case (STATc) model continued to forecast a slow increase in biomass (spawning output), with depletion (current spawning output divided by unfished spawning output) increasing from a current value of 10.7 percent to approximately 20 percent over the coming decade. The 2006 OY was ultimately set at 218 mt. The 2003 assessment was updated again in 2007 (MacCall 2008) without a major change in the perception of stock status. The only significant differences in the 2007 model were slight revisions to historical catches and updates of catch, length frequency, and the CalCOFI time series; the latter was the only time series of relative abundance that continued from the 2003 assessment. Adopted OY values have been maintained at 218 mt since 2007, with actual catches (including discards) estimated to be less than half of that amount.

C.2 Stock Distribution and Life History

The distribution of bocaccio has been described as ranging from Stepovak Bay on the Alaskan Peninsula (as well as Kodiak Island, Alaska) to Punta Blanca, Baja California (Miller and Lea 1972; Eschmeyer 1983; Love et al. 2002). It is abundant off southern and central California, uncommon between Cape Mendocino and the Oregon/Washington border, and moderately abundant from the Oregon-Washington border into Queen Charlotte Sound and Hecata Strait, British Columbia. The southern U.S. stock (the stock evaluated in past assessments) was petitioned for listing under the U.S. Endangered Species Act (ESA) in 2002. Although this petition was denied, bocaccio have been listed as a "Species of Concern" by the NMFS since 2002, and a more recent petition has proposed listing the population of bocaccio in the Georgia Basin Ecosystem under the ESA.

The U.S. stock assessment has traditionally assessed bocaccio from the U.S./Mexico border to either Cape Mendocino (MacCall 2002; MacCall 2003 and recent updates), or through the Eureka INPFC area (Ralston et al. 1996; MacCall et al. 1999). This has been based on a conceptual model of two centers of population density, one around southern and central California and another from Queen Charlotte Sound through the northwest coast of Washington State. Both historical and recent catch statistic and surveys suggest low relative abundance levels of bocaccio between approximately Cape Mendocino and the Columbia River mouth (essentially, the Eureka and Columbia INPFC areas; Figure 2). Moreover, most of the bocaccio observed in this region tend to be very large (Figure 3a), suggesting the possibility that there is little or no localized recruitment in this region and the animals that are observed are likely to be slowly dispersing or diffusing adults. Similarly, a summary of bocaccio catches in Russian trawl surveys conducted off of the U.S. west coast from 1963 to 1978, prior to what has been estimated to be the greatest period of depletion of this stock or stocks, is consistent with a pattern of low abundance from north of Cape Mendocino through Oregon, with higher catches in southern and northern regions (Figure 4).

There is a fair amount of data and information on the status of bocaccio in Canadian waters, where landings have ranged from several hundred to over 1000 mt per year in recent decades. In 2002, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed bocaccio as threatened (COSEWIC 2002) based on an apparent population decline of more than 95% over a two decade period, and the stock is under consideration for listing under the Canadian Species at Risk Act (SARA). A stock assessment was performed on this stock in 2004 (Stanley and Starr 2004), in which most evidence suggested that bocaccio had been widespread over their habitat and stable in abundance since the mid-1990s, a period in which total catches (primarily from bottom trawl) ranged from 300 to 330 mt. However, the magnitude of the decline over the preceding decades was unclear. That assessment was based on observed trends in spatial distribution, and irregular catch rates from bottom trawl surveys. Interestingly, one of these surveys was described as suggesting a peak relative abundance in the 1980s, noting that the abundance levels observed in that period might not be appropriate rebuilding targets (Stanley and Starr 2004).

More recent work in Canada includes the preparation of a stock assessment (Stanley et al. in prep.; pers. com.) and a recovery potential assessment (DFO Canada, Canadian Science Advisory Secretariat, in press) to provide scientific advice for the recovery strategy in Canadian waters. The recovery potential assessment (DFO Canada, Canadian Science Advisory Secretariat, in press) is based on the results of a Bayesian surplus production model fitted to one fishery-dependent and six fishery-independent abundance indices and a reconstructed catch history that stretched back to 1935. In their reference case model, the biomass was estimated to demonstrate a monotonic decline from the 1930s through the early 2000s, with the steepest decline taking place from the mid-1980s through the mid-1990s and some suggestion of a flattening of the biomass trend since the late 1990s. The model estimated a posterior median for the estimated 2008 biomass of 2,324 mt (posterior mean of 3,022 mt), with the posterior median relative stock size (B_{08}/B_{MSY}) of 0.111 (posterior mean 0.155). In general, the recovery potential assessment indicates that contemporary Canadian catches of approximately 150 mt per year will not place the population in short-term jeopardy, but that reductions in harvest will be necessary to implement the probability of future population increases.

There is also what is currently described as a discrete population segment (DSP) of bocaccio rockfish in the Georgia Basin ecosystem (Puget Sound plus the Strait of Georgia), spanning the inland waters of the U.S. (Washington State) and Canada (Southwestern British Columbia). The National Marine Fisheries Service (NMFS) recently issued a proposed rule (and request for comment) to list this DSP of bocaccio as endangered (at high risk of extinction) under the Endangered Species Act (ESA).[1] This proposed rule came about as a result of a petition to enlist this and several other population units of rockfish in this region (the other four species were canary, yelloweye, greenstriped and redstriped rockfish). Of these five only bocaccio is proposed to be listed as endangered, while yelloweye and canary are proposed to be listed as threatened and greenstriped and redstriped were found not to be at risk of extinction. This petition follows an earlier petition to list three other species of rockfish (among other species), although the initial petition was ultimately denied (Stout et al. 2001).

The proposed rule is based on the evaluation of abundance trends, spatial structure of the populations, and the suite of somewhat unique threats in these ecosystem. Among the factors related directly to bocaccio are the rapid decline and current total absence of bocaccio in recreational rockfish catches within the Georgia Basin (consistent with a substantial overall decline in the catch rates of all rockfish, but of a greater magnitude), the highly variable nature of bocaccio recruitment, and the observation that historical length composition data were indicative of multiple strong cohorts (interpreted as evidence that fish present in the ecosystem were unlikely to be infrequent strays from the coastal population). Specifically, from 1975-1979

[1] Proposed rule published in the U.S. Federal Register, Vol. 74, No. 77, Thursday April 23, 2009. Proposed rule and supporting background documents, including the Biological Review Team (BRT) report are available at http://www.nwr.noaa.gov/Other-Marine-Species/Puget-Sound-Marine-Fishes/esa-PS-rockfish.cfm.

bocaccio accounted for an average of 4.6% of the total catch, from 1980-1990 they represented 0.24% of the catch, and no bocaccio have been observed from 1996 through 2007. The total absence of bocaccio from observed catches or surveys since 1996 was noted as being of particular concern, indicative of at least some possibility that the population has already been extirpated. Among the more general observations that support the conclusion that the bocaccio DPS may be at high risk is the unique and relatively isolated nature of the Georgia Basin ecosystem, the cumulative impact of various anthropogenic threats to habitat in this ecosystem (including contamination from pollutants, declines in oxygen levels, habitat impacts, and impacts of harvest) and the observations that multiple studies have found evidence that rockfish (and several other finfish species) inhabiting geographically isolated areas have been demonstrated to have genetic differentiation from coastal populations (Stout et al. 2001).

Although the southern/central California "stock" and the British Columbia "stock," as well as the more recently described Puget Sound/Georgia Basin stock, are treated independently by their respective management entities, an accurate understanding of stock structure both among and within these regions remains unclear. Wishard et al. (1980) described electrophoretic patterns in a series of samples collected between the Southern California Bight and Cape Mendocino. Although the PGI-1 and ADH loci were polymorphic and heterozygosity was high, there was no genetic differentiation among the samples at these or three other loci. However, no samples were collected and evaluated north of Cape Mendocino. Results of genetic research conducted in conjunction with the 1999 assessment (MacCall et al. 1999) suggested genetic differentiation between bocaccio collected off southern California and fish from Washington, but that fish from southern California and Monterey Bay do intermix genetically (MacCall et al. 1999). In that study, a lack of samples from intermediate locations did not allow geographic identification of genetic stock boundaries or possible areas of limited mixing.

Matala et al. (2004) used likelihood tests of homogeneity of allele frequencies at seven highly polymorphic microsatellite loci to evaluate population connectivity along the west coast. Samples were divided into eight regions: Queen Charlotte Island and Vancouver Island in British Columbia, Monterey Bay in Central California, four locations in the Southern California Bight (Point Conception, Tanner Banks, Santa Barbara Channel, and Santa Monica Bay), and Punta Colnett, Mexico. Unfortunately, there were no samples evaluated from Northern California, Oregon or Washington, nor from the Puget Sound/Georgia Basin region. Analysis based on fixation index (F_{ST}) values revealed no statistically significant geographic divergence, or evidence for isolation-by-distance (Matala et al. 2004). However, an ad hoc method for partitioning the samples based on genetic and geographic homogeneity could not reject the possibility of some population structure related to geographic location. These patterns appeared to be related to oceanographic features, possibly suggesting limited gene flow between British Columbia and California, as well as limited flow around Point Conception, California. However, a re-analysis of the same data (D.E. Pearse, FED/SWFSC, pers. comm.) using the Bayesian partitioning program STRUCTURE 2.0 (Pritchard et al. 2000), found no support for the presence of population genetic structure among the samples of bocaccio analyzed by Matala et al. (2004; Figure 5). This most recent analysis suggests that from a population genetic perspective, all bocaccio from British Colombia, Canada to Baja, Mexico, should probably be considered to be a single, panmictic unit.

As Waples et al. (2008) and Berntson and Moran (2009) suggest, demographic independence does not necessarily require strong evidence of genetic isolation. As pointed out by Waples et al. (2008), population genetic analyses typically have considerable power to identify separate populations connected only by low levels of migration, but struggle to identify differentiation at the level of connectivity that would indicate demographically coupled stocks. Similarly, Berntson and Moran (2009) suggest that while relatively few migrants per generation will typically result in low F_{ST} values, indicative of a single evolutionary genetic population, such low levels of migration would likely not be sufficient to result in rebuilding stocks in regions where there might be a wide disparity in abundance. Thus, although the failure to identify clear evidence of population genetic structure among bocaccio populations in the Canadian/Northern U.S. region and the southern/central California region suggests that some migratory connectivity exists, the apparent differences in growth rates, size (and presumably age) at maturity, and longevity suggest that some level of demographic independence is likely.

We maintain the tradition of distinguishing the southern bocaccio population unit from the northern unit in this assessment. However, in evaluating commercial length frequency data and landings trends (described later), we suggest that the fish in the Eureka INPFC area are likely to be most closely linked with the southern subpopulation, and we include this region in this assessment. Consequently, the geographic range of the southern bocaccio stock is assumed to correspond to the waters south of Cape Blanco, Oregon (the northern boundary of the Eureka INPFC area). This is consistent with the suggestion of a break in population distribution based on both historical and recent abundance data, the paucity of data in the northern part of the range, and a long history of previous assessments.

Even less is known about the abundance and distribution of bocaccio at the southern end of their range. MacCall (2003) used the CalCOFI larval abundance data from the 1950s and 1960s (CalCOFI cruises ceased to sample Mexican waters in the 1970s) to estimate that the historical distribution of spawning abundance over the assessment range. He found that approximately 4.6 percent of larvae were encountered in Mexican waters, 46 percent in southern California waters, and 50 percent in central/northern California waters (from Pt. Conception to Bodega Bay). No information is available on catches or stock status and trends of bocaccio in waters off northern Baja California; and although there is presumably population connectivity between the Southern California Bight and Baja California, we are constrained to treating the stock as distinct north of the U.S./Mexico border. As Mexican oceanographers have begun occupying the historical CalCOFI stations off of the Baja Penninsula in recent monitoring efforts, the potential to include or analyze data from these efforts should be revisited in the future.

Genetics and effective population size

Narum (2007) evaluated the evidence for reduced effective population sizes for eighteen species of rockfish, most at multiple sites, using microsatellite data from the published literature. Although such analyses are sensitive to the estimates of mutation rate and life history characteristics, most species identified as having low effective population sizes were those that have been heavily exploited by marine fisheries, including bocaccio, copper (S. *caurinus*) and quillback (*S. maliger*). For bocaccio, Narum (2007) interpreted the results as indicative of recent bottlenecks (dramatic reductions in population size) across all locations. However, bottlenecks of sufficient magnitude to result in such low effective population sizes are in all likelihood much more extreme events than the past assessments might suggest. The most recent assessment (MacCall 2007) estimated that at its lowest point the mature female population was represented by a population on the order of five million mature and spawning females. Nonetheless, as highlighted by Berntson and Moran (2009), there are several examples in which effective population sizes have been demonstrated to be several orders of magnitude lower than actual abundance (e.g. red drum, Turner et al. 2002; darkblotched rockfish, Gomez-Uchida and Banks 2006).

C.3 Life history, habitat preferences and movement patterns

Like all *Sebastes*, bocaccio are primitively viviparous and bear live young at parturition. They copulate during September-October, although fertilization is often delayed, and embryonic development takes at least a month to complete, with larvae hatching internally (Moser 1967). Parturition occurs during the winter months (Wyllie Echeverria, 1987) and larvae eventually metamorphose into pelagic juveniles (Moser and Boehlert, 1991). The combined larval and juvenile pelagic phase typically lasts about 150 days, consequently the spatial dispersal of larvae and juveniles likely links populations among fairly broad regions. This might be particularly true as bocaccio appear to orient higher in the water column than juveniles of most other winter-spawning rockfish species (Ross and Larson 2003), and propagule dispersal tends to be greater at shallower depths (Peterson et al., in press). The rapid growth of bocaccio is initiated at the juvenile stage; Woodbury and Ralston (1991) describe linear species-specific growth rates (and interannual variability in the same) for juvenile rockfish in approximately the first 50 to 150 days of life, in which those for bocaccio ranged from 0.56 to 0.97 mm/day, the highest rate amongst the species evaluated. Settlement to littoral and demersal habitats begins in late spring and extends throughout the summer months.

Pelagic bocaccio young-of-year typically recruit to shallow habitats, and subadult bocaccio are more common in shallower water than adults, with average size becoming notably larger at greater depths (Figure 3b). Strong year classes frequently lead to high densities and high catches of young bocaccio from piers and other shore structures from the early summer through winter of the first year of life; data describing such events are discussed in greater detail in the section on the pier fishery survey data. Adult bocaccio are typically described as occurring in a broad range of habitats and depths, including developing large midwater aggregations, high densities tend to be more associated with more complex substrates. As with many other shelf species of rockfish, there is a clear trend towards larger fish at greater depths as well as towards higher latitudes (Figures 3a-b).

In southern California, juveniles often recruit to oil platforms, often in large numbers during strong recruitment years. For example, in 2003 Love et al. (2006) estimated a minimum of 430,000 juvenile (age ~0.75 yrs.) bocaccio recruiting to just 8 oil platforms in the Santa Barbara Channel. They estimated that this represented approximately 20% of the average number of juveniles in any given year, and estimated further that densities of juveniles around oil platforms that year tended to be greater than the density of juveniles over nearby shallow habitat areas more typically considered juvenile habitat. Their results also suggested very high patchiness in the distribution of juvenile bocaccio; over 80% of the total estimated number of juveniles recruited to just one platform (Grace), two other platforms in the immediate vicinity accounted for another 10% of the total numbers of recruits, but at widely disparate densities. Although they acknowledge that considerable uncertainty exists with respect to the potential role of platforms in providing recruitment habitat, Love et al. (2006) suggest that bocaccio and other rockfish that recruit to these structures likely represent production that would have been lost to the population in the absence of these structures. Love et al. (2005) also estimated higher densities of adult bocaccio at platform habitat relative to the densities on nearby natural reefs, suggesting that platforms could represent a source of subadults to neighboring natural habitats

In considering habitat preferences more generally, we obtained data on over 2800 bocaccio observations from 14 years of submersible surveys of southern California habitats from M. Love (University California at Santa Barbara) and colleagues. These surveys have been used to assess the abundance of rockfish and other species on oil platforms (as described in the preceding paragraph), to develop absolute abundance indices for other species of rockfish (e.g., Yoklavich et al. 2007) and to characterize assemblages of rockfish communities (Love et al. 2009). Details of the survey methods and results can be found in those publications and others. We evaluated rockfish densities by size and habitat, although rather than use complex habitat types, we simply described habitat as low, moderate, or high relief (for each dive, this rating is given to a primary habitat type, as habitats often vary within dives, a secondary habitat type is also ascribed). We grouped fish size data at 5 cm increments and looked at mean densities of fishes by size and by year over different habitat types (Figure 6). In general, there was a clear trend towards greater densities of fish of all sizes over high relief habitats, such that 30-40 cm fish over high relief habitats were found at roughly 2-3 times the abundance levels at moderate relief habitats, and roughly 9 times the abundance at low relief habitats. For larger fish (50 cm and greater) this discrepancy was even greater; virtually no large fish were seen in low relief habitats and 4-5 times as many large bocaccio were seen in high relief habitats relative to those with moderate relief. Interestingly, when the mean densities by habitat type are compared by year, it is seen that the greatest number of fish were seen in low relief habitat in the year 2000, following the strong 1999 year class, a year in which densities in all habitats were notably greater. This could reflect either, or both, a tendency for smaller, younger fish to occupy less optimal habitat particularly in years of high abundance due to strong recruitment pulses. Moreover, if there are density-related habitat preferences, such that less suitable habitat is occupied only during periods of relatively high abundance (over either short- e.g., recruitment pulses, or long, e.g., low frequency trends in abundance), then traditional trawl surveys may be less likely to provide unbiased estimates of stock abundance.

With respect to movement patterns, the evidence for most rockfish suggests that the bulk of the adults are highly sedentary, with some ontogenetic movement to greater depths common for most shelf and slope species. However, some rockfish have shown fairly extensive movements, usually of late juvenile and early adult stages. For example, Hartmann (1987) reported the results of tagging studies of nearly 25 species of rockfish from over 10,000 fish tagged in the Southern California Bight (olive, blue, widow, bocaccio, kelp and copper rockfish comprised over 90% of both the fish tagged and recaptured). The total number of recaptures was 696, of which 606 were recaptured at or very near to the site of tagging. Of the remaining 90 only 12 (of four species) moved greater than 10 km. Most of these were juvenile bocaccio, which moved as far as 150 km. By contrast no movement was observed in adult bocaccio, although relatively few were tagged. Lea et al. (1999) found no movement for bocaccio rockfish, although they only had three tags returned (out of 56 deployed). However, in a movement study using fish captured and surgically implanted with acoustic transmitters, most spent only a small fraction of their time in the 12 square kilometer study area, with frequent small scale movements in both horizontal and vertical planes (Starr et al. 2001). By contrast, six greenspotted rockfish tagged in the same study exhibited substantially lower movement rates.

Although there are no quantitative food habits studies of this species, they have long been described as primarily piscivorous, consistent with their name. Phillips (1964) stated that even before completing their first year of life, young bocaccio (which, as previously mentioned, tend to recruit to shallow, nearshore waters late in their first year of life) prey on other young-of-year rockfish, surfperch, jack mackerel and other small inshore species. Adults in deeper waters feed on small rockfish and sablefish, anchovies, mesopelagic fishes, and squids such as the California market squids. Pelagic juveniles feed primarily on copepods, juvenile (and other stages) of euphausiids, and other fish larvae; while their diet was found to be highly similar to other pelagic juveniles of winter-spawning species, there is some suggestion that that bocaccio fed on larger prey than the other species (Reilly et al. 1992). Pelagic juveniles are preyed upon by a wide range of predators, including seabirds, salmon, lingcod, and marine mammals (Merkle 1957; Sydeman et al. 2001). Predators of larger adults are likely limited to larger piscivorous fishes and marine mammals, although few studies have identified rockfish prey to the species level.

C.4 Growth, Maturity, Fecundity and Natural Mortality

Growth

The stock synthesis approach uses the Schnute (1981) parameterization of the von Bertalanffy growth equation (Methot 2009). Bocaccio have long been described as having very rapid growth during the early years of life, more so than most other *Sebastes*, which can be tracked by the progression of strong cohorts in fisheries length frequency data. Due to the problems associated with ageing of bocaccio rockfish (described in greater detail below, in the section on natural mortality), past assessments have typically estimated the growth coefficient (K) internally, while fixing L_{min} and L_{max} based on the length frequency data (MacCall et al. 2002; MacCall 2003). The 2003 assessment (and subsequent updates) fixed values for L_{min} at 27 cm (for an age of 1.5 years) and L_{max} at 65.6 and 75.9 cm for males and females, respectively, with K estimated as 0.184 and 0.210 for females and males, respectively. The forthcoming Canadian bocaccio assessment estimated a L_{inf} of 78.32 and 69.98 for females and males, with corresponding von-Bertalanffy growth parameters (K values) of 0.163 and 0.108 respectively. This suggests that bocaccio in Canada tend to grow larger and slower than fish in the southern/central California region; consistent with observations regarding apparent greater longevity and age at maturity, as discussed later in this section.

We explored several options for modeling growth, including the approach used in the last assessment, freeing all of the growth parameters, and fixing L_{min} at 0.16 at an age (A_{min}) of 0.75 yrs. The latter was based on the observed length frequencies from recreational pier and shore fisheries, which show the modal progression of recently settled age 0 juveniles (Figure 7; length data pooled among all available years). However, this parameterization, as well as freely estimating all of the primary growth parameters, often led to problems in which growth was unrealistically slow (essentially shifting the strong recruitment years to the left) or in which male and female L_{min} values were dramatically different. Consequently, we maintained an approach by which L_{min} was treated as a fixed value for age 1.5.

To confirm that a reasonable value could be derived, we examined wave-specific length frequency data from recreational fisheries in which age-1 fish were caught in high abundance. Modal progression of strong year classes was easily discernable in many such datasets, particularly in the southern California recreational fisheries. As the 1970s CPFV observer program collected the greatest number of length frequency observations (over 77,000 in four years of collections), and the 1977 year class was among the strongest observed historically, we evaluated the size frequency of the 1978 length frequency data from this fishery to confirm a plausible size at age 1.5. Figure 8a shows the length frequencies from this fishery by wave in 1978 with a bin resolution of 1 cm (where waves are the 2-month intervals used in RecFIN statistics; although note that calendar dates for each observation are available for this dataset), with the maximum size of the 1977 cohort estimated visually from the data and larger sizes removed from the dataset. When these larger sizes are removed, the wave 3 and 4 data (May-August) have a mean of 25.98 cm, a median of 25.95 cm, and a standard deviation of 2.73 cm, leading to a CV of 0.105 (n = 1330). Over all waves, the same data have a mean of 27.87 cm, a median of 27.39 cm, a standard deviation of 37.14 and a CV of 0.136 (n = 3908).

Although few other years included comparable numbers of measured fish during the summer period (as rockfish tend to be a more important recreational target during the winter months, when more desirable warm-water species are unavailable), these results are consistent with RecFIN data for the size distribution of other strong cohorts at age 1.5, such as the 1984, 1988, and 1999 cohorts. Consequently, we fixed L_{min} for both sexes at 26 cm at age 1.5. The CV for L_{min} was set at 0.10, based on the described analysis and an evaluation of changes in the model likelihood with different combinations of CVs; there was a clear improvement in fit when the CV of L_{min} was raised from 0.08 to 0.1, and an equally significant improvement when the CV of older fish was decreased from 0.1 or 0.12 to 0.08 (the fit began to degrade again at lower values). More evaluation of this issue is included in the section on model sensitivity. Similarly, as past assessments have noted, periods of consistent variability in expected length at age, which may be attributed to climate-modulated variability in growth rates, leads to an exploration of time-varying growth in this assessment (see the model-sensitivity section).

The length-weight relationship was re-estimated using a total of 5,050 weight and length observations from the triennial trawl survey, the NWFSC combined trawl survey, the SWFSC groundfish ecology cruise dataset and the NWFSC hook-and-line survey in the Southern California Bight (Figure 9). Estimates were based on bias-corrected data from a log linear regression between fork length (cm) and weight (kg). The estimated values for a and b were a = 7.355 E-06, b = 3.11359, which are very similar to the values carried over from the 1996 assessment (then based solely on several hundred fish from the triennial survey) of 6.19 E-06 and 3.1712 for a and b, respectively.

Maturity

We compare results from four previous studies that describe the proportion of female bocaccio that are mature as a function of body length. To facilitate comparison, we standardized all lengths to centimeters fork length using the equations from Echeverria and Lenarz (1984). Phillips (1964) found that 50% of females from statewide samples in California were mature by 40.4 cm, and indicated a few were mature by 34.9 cm. Gunderson et al. (1980) examined 84 female bocaccio from 34°08' to 40°26' N latitude (central California), finding that 50% were mature by 48.2 cm. Wyllie Echeverria (1987) estimated length at 50% maturity as 46.5 cm based on samples from central and northern California. Wyllie Echeverria reports interannual differences in size at maturity, although the reported lengths at 50% maturity differ by only 1 cm for bocaccio. No significant regional differences (north and south of Point Arena) were detected in the latter study. Thus, the estimated proportion of mature females at length differs among studies (Figure 10a). As Phillips only reported the length of 50% maturity, the curve based on his results uses the slope equal to that of Love et al. (1990). The curve shown for Love et al. (1990) is fitted to a fork length of 35.3 cm at 50% maturity and 43 cm at 99% maturity.

Differences in maturity at length among these studies may be due to spatial or temporal variation (including density dependence) in length at maturity, or changes in methodology such as determination of maturity stages. Love et al. (1990) report a larger proportion of fish maturing at smaller sizes relative to the other studies, based on samples from the Southern California Bight (SCB). Phillips (1964) combined statewide samples from CA, reporting a higher proportion of mature females at a given length relative to Love et al (1990). Wyllie Echeverria (1987) and Gunderson (1980) based their maturity estimates on fish captured north of Point Conception, and both studies estimated larger lengths at 50% maturity than were reported for the studies that included SCB data. However, temporal changes in maturity at length may have caused the observed differences among studies, and there is insufficient overlap in the timing of the surveys to eliminate either possibility. Regarding definitions of maturity stages, it is important to recognize the difficulty in distinguishing ovaries of immature rockfish (those that have never spawned) from ovaries of mature individuals in early stages of vitellogenesis or resting periods (Wyllie Echeverria, 1987). Errors in assignment of rockfish maturity stages are most likely to occur during non-spawning seasons (Wyllie Echeverria 1987).

We obtained maturity data for female bocaccio from four studies conducted off the west coast of North America: 1) CalCOM, 2) the NMFS Southwest Fisheries Science Center Groundfish Ecology cruise conducted by the Fisheries Ecology Division, 3) the west coast triennial trawl survey, and 4) the Department of Fisheries and Oceans, Canada (R. Stanley, DFO, pers. com.).

CalCOM maturity data are collected by port samplers in California, who have recorded maturity stages of female bocaccio landed by commercial vessels since 1993. Sample sizes vary considerably over time (1993-2008) and by port complex. Central California port complexes have the highest number of observations, and sample sizes decrease in the more northern California ports. Very few samples are available from ports south of Pt. Conception (25 fish), and all of these southern specimens were mature; moreover, 90% were caught during the non-reproductive season for bocaccio (July – September). Consequently, we excluded CalCOM samples taken south of Pt. Conception or during the months of July through September from our analysis.

The SWFSC Fisheries Ecology Division collected rockfish maturity data from 2001-2007 in central California (Monterey area). We removed samples from the non-reproductive season (61 out of 343 observations). The majority of samples were collected during peak spawning season for bocaccio (January-April). Maturity samples from the west coast triennial survey were available for 1977, 1986, 1989, 1992, 1995, and 1998. We excluded samples from the non-reproductive season for bocaccio (July-September), leaving data from 1995 and 1998 only. Maturity data from Washington and Oregon were collected during non-reproductive months for bocaccio, so these data are excluded from our analysis. Most survey years exclusively contained samples during the non-reproductive period, so the triennial data in our final analysis are samples from central California in 1995 and 1998. Starting latitudes for each trawl tow were used to assign fish to regions roughly consistent with the CalCOM port complexes. Data from Canadian waters were provided by DFO, Canada (R. Stanley, pers. comm.) and used to evaluate evidence of latitudinal changes in size at maturity and seasonality of reproduction for bocaccio, as such trends have been reported for many rockfish species (Haldorson and Love 1991). The DFO data were collected from 1967-1971, 1978-1980, 1988-1991, and 2002-2007.

The number of maturity stage observations among port complexes is not consistent over time (Table 2). Analysis of interannual changes in maturity at size were therefore limited to regional subsets of the data (e.g., Morro Bay from 1993-1998 and Monterey in 1993 and 2000-2004). Our evaluation of regional differences in size at maturity does not account for temporal trends due to minimal overlap among regions with larger sample sizes.

We considered all observations taken in U.S. waters during the reproductive season for the final analysis, classifying individual fish as either immature (0) or mature (1) using the maturity stage data supplied with each study. All fish assigned to the early vitellogenic maturity stage (stage 2) were excluded to minimize the number of classification errors. We define all stage 1 ovaries as immature. Fish with ovaries in late vitellogenic stages, with fertilized eggs or eyed larvae, or spent and recovering stages were classified as mature. We model the proportion of individuals that are mature at a given length using generalized linear models (GLM) with binomial error structures and logit link functions. The response variable is binary (immature=0, mature=1), and covariates examined include fork length, port complex, and year. The simplest model for maturity at length pools all data across years and areas (Figure 10b). The combined model estimated lengths at 50% and 95% maturity as 39.9 and 48.1 cm fork length, respectively (corresponding slope parameter is -0.359). These estimates were used in the draft assessment.

Interannual differences in maturity are confounded with differences in spatial coverage among studies. We restricted our analysis of temporal effects to individual regions and studies with adequate sample sizes. Models fit to Groundfish Ecology data from Monterey suggest that a larger fraction of females were mature at larger lengths in 2004 (ogive shifted to the right) relative to other years. No interannual differences were detected in the CalCOM data for Morro Bay. Regional difference in length at maturity have been reported in previous studies (Haldorson and Love 1991). No consistent latitudinal trend in length at maturity is evident among the data sets we examined; however, the data suggest that differences in maturity exist among regions (Table 3). Fish from Canadian waters appear to mature at larger sizes, based on the DFO data (pooled across areas and years). Lengths at 50% and 95% maturity for the bocaccio from Canadian waters were estimated at 49.2 cm and 57.3 cm, respectively, consistent with published accounts of increasing size at maturity in northern latitudes. Proportions of fish that are mature at length also appear to vary by data source (CalCOM, triennial survey, or Groundfish Ecology survey), even after accounting for variability among regions (Table 3).

Although the length compositions of mature fish do not vary considerably among studies, there are differences in the distribution of lengths for immature fish, which may provide evidence of differences in gear selectivity (Figure 11a). Selectivity differences are expected between the samples from scientific surveys and commercial landings, but smaller differences were also detected between the triennial and Groundfish Ecology surveys. If fish landed by the commercial fisheries are generally larger than the survey fish, then it is possible that a bias may be introduced into maturity estimates based on commercial samples because smaller (possibly mature) fish are not caught in the fishery. Methodological differences among studies may also introduce variability in maturity estimates. Given the effect of data source on maturity estimates, we examined an alternative data set that did not include the samples from the commercial fishery. A binomial GLM fit to these data indicates that fish from Morro Bay differ significantly from those in Monterey, San Francisco, and Bodega. However, we chose to group the data among regions because a number of strata lack observations (unbalanced data), and all regions are within central California. Estimated lengths at 50% and 95% maturity from the combined survey model are 37.7 and 44.4 cm fork length, respectively (Figure 11b), approximately 2.2 and 3.7 cm less (respectively) than the combined model. This estimate, as well as the values used in previous models, was evaluated in a sensitivity analysis.

Fecundity

Bocaccio stock assessments since 1996 have used a linear model for relative fecundity as a function of weight developed by Ralston (1996) from data reported by Phillips (1964). Dick (2009) estimated relative fecundity as function of weight for 40 species of *Sebastes* using a hierarchical linear model for relative fecundity. His results for bocaccio are similar to that of Ralston, with a slightly steeper slope (Figure 12). The relationship used in this assessment is that of Dick (2009):

$$\frac{E}{W} = 192.5 + 49.3W \qquad (1)$$

where E is number of eggs and W is weight in kilograms.

Natural Mortality

Although age determinations of bocaccio are known to be imprecise, Ralston and Ianelli (1996) reported that the maximum known age of bocaccio is 45 years. Piner et al. (2006) used radiocarbon levels measured in otoliths from fish taken off the coast of Washington state to confirm that bocaccio can live up to at least 37 years. Andrews et al. (2005)used lead-radium dating in an attempt to independently age bocaccio otoliths, but found that measured levels of lead and radium were among the lowest in the literature, resulting in poor age resolution. Their results were consistent with a longevity of 30-40 years. The Canadian assessment (Stanley et al., in prep, pers. comm.) documents age frequencies for over 900 aged bocaccio, in which the maximum ages were 57 for males and 52 for females (99% ages were 52 and 46 for males and females respectively). Based on those ages they used the Hoenig (1983) relationship with the bias correction suggested by MacCall (2003) to derive estimates of total mortality of 0.097 and 0.086 for females and males respectively. The difficulties encountered in ageing bocaccio, which may be greater in the southern part of the range, are discussed in greater detail in the section on age data.

In 1996, Ralston and Ianelli (1996) reviewed the information relating to the natural mortality rate of bocaccio and used a natural mortality rate of 0.15 in their model. Due to computational problems in the then-current SS1 program (subsequently fixed), MacCall (1999) was unable to develop a model with the 0.15 mortality rate and developed a model with M set to 0.2, which was adopted as the base model. In the 2002 assessment, MacCall examined both M=0.15 and M=0.25, but retained M=0.2 as the base model because it was consistent with the previous assessment and rebuilding analysis. During discussions following the 2002 STAR Panel, it was generally agreed that M=0.2 was probably too high, and lower values of natural mortality rate should be considered. MacCall (2003) used the Hoenig (1983) method to estimate a total mortality rate of 0.092 for the maximum age of 45, but noted that this estimate is a geometric mean, and estimated that a bias-corrected total mortality rate should be approximately 0.1. However, the 2003 STAR Panel recommended a natural mortality rate of 0.15, and this value has been used in subsequent updates (MacCall 2005; MacCall 2007).

It might be noted that the maximum age of 45 was from fish in the northern part of the range, for which the maximum age has more recently been estimated as 57 (as above). Of the more than 1300 fish aged using break-and-burn methods for the 1996 assessment (fishery-dependent samples from 1988, 1991 and 1994), the oldest was 37 years. This would correspond to a total mortality (Z) of approximately 0.121 (with the bias adjustment), still quite below the rate of 0.15 used in past assessments (particularly given the high fishing mortality rates known to have been taking place in the decades preceding sample collection). Despite this, in the absence of convincing evidence for a different value, we maintain this estimate; and sensitivity to this estimate is evaluated and discussed in the section on model sensitivity.

D. ASSESSMENT

D.1 DATA

D.1.a. Catch History

One of the most significant changes to this assessment is consideration of the catch history of bocaccio. Together with chilipepper rockfish (*Sebastes goodei*), bocaccio have long been described as one of the dominant rockfish species for both commercial and recreational fisheries throughout California. Although landings of many California groundfish are typically reported in single species market categories, group market categories have been the most common approach for sorting rockfish catches in California, with a trend towards single species categories in recent years due to regulatory constraints.

Commercial Catches

In order to obtain reliable estimates of species-specific landings, a sampling program for commercial fisheries, the California Cooperative Groundfish survey (CCGS) was implemented in 1978 by the California Department of Fish and Game, the Pacific States Marine Fisheries Commission and the National Marine Fisheries Service. The primary objective is to collect species composition data for rockfish landed under various market categories, as well as biological information and samples (sex, maturity, length, weight, and ageing structures) to help manage commercial fisheries. Detailed descriptions of the sampling framework and program are provided in Sen (1984), Pearson and Erwin (1997), and Pearson et al. (2008). Commercial landings of bocaccio from 1978 through 2008 are based on this program, and landings from 1969 to 1977 are based on applying the species composition of market categories in the sampled period to the reported catches by market category in that period.

The most recent catch estimates for bocaccio for the period from 1968 to the present have changed modestly from those used in the 2007 assessment in response to slight revisions to the estimation procedures (correcting minor errors such as mis-specified port or gear codes and invalid market categories) reported in Pearson et al. (2008). The recent commercial and recreational catch estimates relative to those used in the 2007 assessment are reported in Figures 13a-e and are discussed in more detail below. Pearson et al. (2008) also developed an index (largely subjective) of the reliability of landings estimates by species, based on the potential for misidentification, sorting requirements, the percentage of landings based on port samples, and other criteria. Landings estimates for bocaccio from 1969 to the present are considered to be very reliable, as this is one of the most commonly caught species of rockfish, landings are usually reported into the bocaccio market category (required since 1991), and problems associated with misidentification are minimal as bocaccio are likely to be confused only with relatively uncommon species such as silvergrey (*S. brevispinis*) and Mexican (*S. macdonaldi*) rockfish (Pearson et al. 2008).

For the 2007 model, estimates of historical catches from 1950 through 1968 had been largely unchanged since the 1996 assessment (although the 2002 assessment used the methodology developed in the 1996 assessment to apportion catches north and south of Point Conception in separate area models). The 1996 assessment had apportioned the total California rockfish catch based on total rockfish catches (as reported in CDFG Bulletins) and the percentage of total rockfish catch estimated to be bocaccio by region based on early species composition samples reported by Nitsos (1965) and other sources. Following the PFMC recommendation to evaluate historical catches as part of the "off-year" science activities, concerted efforts were undertaken to develop a comprehensive estimation of the historical catches of west coast groundfish, with the species composition of historical rockfish catches in California representing a major focus of those efforts. At that time, the SWFSC was in the process of several efforts that have and will continue to aid in this effort, including a major effort to digitize spatially explicit (monthly summaries of catches by 10-minute CDFG geographic blocks) catch records extending from 1931 through the CalCOM (1969) period. Additionally, efforts are underway to digitize vessel-specific historical fish ticket information; both of these projects are currently funded by the NESDIS Climate Database Modernization Program (CDMP). These efforts were folded into the historical catch reconstruction efforts described below for commercial and recreational species, respectively. For both commercial and recreational catch histories, it should be recognized that reconstruction efforts are ongoing and the exercise is likely to be an iterative and multistage process. Consequently, catch estimates may change again in the future, although we expect that the magnitude of such changes should be minimal.

The methodology for reconstructing historical commercial catches for bocaccio and other groundfish is reported in detail in Ralston et al. (in prep). The recovered block summary data were decomposed into "trawl" and "non-trawl" landings based on the observed differences between trawl summary block data and total catch by block data, after accounting for irregularities, missing years and assuming a constant ratio for years for which no trawl summary data exist. Next, market category catches (by area and gear) were converted into species-specific catches by applying stratum-specific species compositions of the highly mixed market categories from port samples collected during the 1978-1984 time period. This assumes that the proportional representation of a given species in a given market category was static over time, an unavoidable consequence given the paucity of more detailed information, but validated to a considerable extent by comparing these reconstructed species-specific catches to the species composition of trawl-caught rockfish reported by Nitsos (1965) (see Figure 6 in Ralston et al., in prep).

Figures 14 a-c show the historical commercial catches (1916-2000) for all rockfish throughout the entire state as well as north and south of Point Conception, based on the catch reconstruction of the three most important (by volume) rockfish species over the last century: bocaccio, chilipepper, and widow rockfish (with all other species lumped together). The percentage of the total rockfish catch estimated to be bocaccio rockfish is also shown. Total rockfish landings were reported to be approximately 2000 to 3500 mt statewide from the early part of the 20th century, dipping slightly in the late 1930s and into the beginning of the war years in the 1940s. During this period, slightly more than half of the total California catch was taken south of Point Conception, with the majority of the remainder coming from central California ports (particularly San Francisco and Monterey). Although paranzella trawling (and later otter-board trawling) have been an important source of marine fisheries landings in central California since 1876, most of the trawl catch in early years was composed of flatfish (petrale and English sole) fished over soft bottom (Clark 1935), and rockfish catches were primarily from hook-and-line fisheries (Wolford 1930; Phillips 1949).

Based on the catch reconstruction efforts, bocaccio represented approximately 20% of the total catch (by volume) in both regions (19% in southern California and 22% in central/northern California) during this period (1916- early 1940s), although in both regions this percentage fluctuates somewhat. Phillips (1939) reported on the species composition of rockfish from the Monterey wholesale fish markets between April 1937 and March 1938, in which 39.4% of the fish in the market were bocaccio, compared to 30.8% chilipepper rockfish and 7.9% yellowtail rockfish. Catch reconstruction estimates are consistent with Phillip's observation, as they estimate that bocaccio represented 35.9% and 32.8% of the rockfish catch (by weight) in the Monterey region for 1937 and 1938, respectively. Phillips also noted that catches (and presumably local abundance and/or availability) of bocaccio and chilipepper seemed to be negatively correlated and, when both of these species were uncommon, catches were bolstered by yellowtail, vermilion, and canary rockfish. The 1937-38 catches examined by Phillips may have been during a peak in the relative abundance of bocaccio, as the reconstruction estimates that the percentage of bocaccio estimated in Southern California catches increased to peak (pre-1950) values in the 1936-1938 period, to 27-29% in southern California and 24-26% in central/ northern California (above the 1916-1940 averages of 19% and 22%, respectively), presumably as more fish were landed in the bocaccio market categories that are the foundation of the reconstruction.

As stated earlier, total California rockfish catches declined through the 1930s and into the early war years, although most of this decline was observed in southern California, while central California landings were relatively constant. Although paranzella trawling was an important fishery during this period, ranging up and down the coast, over 70% of trawl catches during the mid-1930s were English, rex, or petrale sole, while only about 5% of the catch was rockfish (Clark 1935). Consequently, most rockfish catches were from hook-and-line gear throughout the state. However, in 1943 the balloon trawl was introduced to northern California waters from Oregon, in association with a strong market for frozen rockfish by the military to support the war effort. Trawl gear rapidly surpassed hook-and-line gear in accounting for the majority of California rockfish landings, particularly in the northern ports of Eureka and Fort Bragg (Scofield 1948; Phillips 1949). Although the initial pulse of landings was north of Cape Mendocino, where bocaccio represented a fairly modest fraction of the catch, the fishing gear and methods found their way to central California fisheries rapidly and resulted in a rapid increase in rockfish landings from the late 1940s through the early 1950s. The percentage of the total catch estimated to be bocaccio in the catch reconstruction increased as well throughout this period; in the early 1950s bocaccio represented 45% of the total rockfish catch in the San Francisco and Monterey regions, 38% of the southern California rockfish catch, and 34% of the total statewide catch (for which northern California continued to represent a significant fraction of total landings).

This is consistent with reports from CDFG biologists at the time; Phillips (1955) had described bocaccio as the dominant species "at present" in the statewide commercial catch, followed by chilipepper, canary, vermilion, yellowtail, and black rockfish. Heimann and Miller (1960) described the species composition of trawl fisheries in the Morro Bay region, based on 64 drags observed over a one year period from 1957-1958. Bocaccio were the most frequently encountered species, caught in every haul and representing 65.6% of the total catch (followed by 31.8% chilipepper and less than 1% stripetail, widow, shortbelly, vermilion, and several other species). The authors reported that most bocaccio (and other desirable species) were retained, with discards representing 0.43% of the total catch (by contrast nearly all stripetail, shortbelly, and greenstriped rockfish were discarded). Their samples suggested an average total length of 48.3 cm for bocaccio (based on over 1,200 measurements), with the discarded bocaccio averaging 30.7 cm (14 measurements). Heimann (1963) also reported the species composition of trawl catches in the Monterey Bay area from a 1960 study, in which bocaccio were the most important rockfish species in the shallow water (targeting largely flatfish; less than 10% of the catches in this sector were rockfish) fishery; accounting for 53.3% of the rockfish landed in that sector, and were the second most important rockfish species in the intermediate depth fishery (which targeted rockfish, which were nearly 90% of the catch) at 34.9% of the rockfish caught, following chilipepper at 49.5%. Retention of both species was high for both sectors; only 0.7% of bocaccio were discarded in the shallow (flatfish-oriented) fishery, and only 0.1% of bocaccio were discarded in the intermediate depth (rockfish-oriented) fishery. Consequently, we have assumed discards to be negligible in the historical era of the fishery.

Bocaccio remained the most significant species in California rockfish fisheries throughout the 1960s and 1970s, representing approximately 33% to 35% of the statewide catch throughout that era. As with earlier eras, bocaccio represented a modest (generally 5-10%) fraction of the rockfish catch in northern California, and a greater (often greater than 50%) fraction of the catch in central California. Again, catch reconstruction estimates of the species composition of the catch are consistent with other reports throughout that period (e.g., Nitsos 1965 and Gunderson et al. 1974). Landings in both the hook-and-line and the trawl fisheries throughout this period are reported for the regions north and south of both 38^{o} N latitude (used as a break point for the trawl fishery as described later) and Point Conception from 1916 through 1968 in Table 4. Landings for the 1969-2008 period are presented in Table 5 for the three major gear types, with the same latitudinal break points, and including estimates of catches in the Eureka INPFC area of Oregon (all are assumed to be trawl). Oregon landings from 1969-1980 were taken from Douglas (1998), landings from 1981-2002 were taken from PacFIN (query March 2009). Landings of bocaccio are assumed to be negligible in Oregon waters prior to 1969.

Rockfish, including bocaccio, were observed in California fish markets as early as the 1850s, and even David Starr Jordan described bocaccio as "rather more abundant southward than about San Francisco. It is, however, a common market fish, and its flesh is considered excellent" (Jordan 1884). Eigenmann (1894) also described bocaccio as abundant from San Diego to British Columbia. To estimate catches of bocaccio prior to 1916, we used rockfish landings reported by Sette and Fiedler (1928), who report landings irregularly from 1892 through 1926 (1892, 1895, 1899, 1904, 1908, and 1915). Landings are interpolated between unreported years, and an equilibrium catch was implemented prior to 1892 based on the average of the first two estimates of catches (for 1892 and 1895). To estimate the fraction of these catches that were bocaccio, we applied the proportion of catches north and south of the major Points (Point Conception and Cape Mendocino) as estimated in the historical catch reconstruction (average of 1916-1920 values, although the ratios were nearly constant through this period), in which 52.4% of landings were from south of Conception, and 47.6% were north of Conception (the percentage of landings north of Mendocino were minimal, less than 0.1%). Next we applied the fraction of the catch by region assumed to be bocaccio (again averaging 1916-1920 values), which was 18.9% south of Conception and 21.5% from Conception to Cape Mendocino. Table 6 provides the total California rockfish catch estimates based on Sette and Fiedler from 1892 to 1915, and the estimated catches of bocaccio by region based on these ratios. We assumed that all catches prior to 1916 were hook-and-line caught, based on the observation by Clark (1935) that the use of gasoline powered paranzella trawlers (the predecessors of diesel powered trawlers) peaked in the 1917-1922 period, at which time they began to replace earlier steam trawlers that fished shallow fishing grounds just outside of the entrance to San Francisco Bay, targeting primarily small flatfish.

Landings from north of the assessment area (Cape Blanco, Oregon) are reported for the remaining Oregon catches, Washington catches, and British Columbia catches, in Table 7. For Oregon and Washington these numbers represent PacFIN estimates (query March 2009) for 1981-present, and Douglas (1998) for 1969-1980 (the latter are likely an underestimate, as the species composition of the catch was not sampled in earlier landings). In general, bocaccio represent a modest proportion of the rockfish caught north of Cape Mendocino, where widow, canary, yellowtail and Pacific ocean perch dominate the catches. From 1981-2000, bocaccio represented less than 3% of the annual *Sebastes* catch. However, given that the total catch was considerably greater in this region, this still represents a significant fraction of the total coastwide catch of bocaccio. From 1969-2008, the total landings of bocaccio are estimated to be just over 85,700 mt, with 15,400 mt (18%) coming from the region north of Mendocino (by contrast, total commercial landings south of Point Conception were 12,300 mt in the same period, although total recreational landings were an additional 14,600 mt). As this assessment maintains the spatial structure of past assessments, and does not extend north of Cape Blanco, these landings are reported for informational purposes only.

From 1965 through 1976, foreign fishing fleets, primarily Russian and Japanese, fished for Pacific hake, rockfish and other species along the U.S. west coast. In recognition of the inconsistent manner in which estimated catches in these fisheries were (or were not) included in stock assessments, Rogers (2003) developed a method of allocating these catches to all *Sebastes* and *Sebastolobus* species by year and INPFC area. The estimated catches for bocaccio for this period are reported in Table 8, and catches from the Monterey INPFC are pooled with the "southern" trawl fishery, while those from the Eureka INPFC are pooled with the "northern" trawl fishery.

As described in the section on management measures, since 2002 both commercial and recreational fisheries have been subject to very restrictive management measures. Regulatory discards consequently represent a significant fraction of the catch, thus recent catches and discards, for the 2002-2007 period, are based on the total mortality reports produced by the Pacific States Marine Fisheries Commission and the Northwest Fisheries Science Center, based on a combination of landings data and observer reported discarding (Bellman et al. 2008; provided by E. Heery). The 2008 estimates are based on the PFMC's Groundfish Management Team scorecard (J. DeVore, PFMC) and recreational estimates from California Department of Fish and Game (J. Budrick, CDFG). For the purposes of the model, catches by the various open access fleets and research catches (the latter of which are principally trawl-caught) are pooled with the southern trawl fishery (note that due to reporting constraints the northern trawl landings in this period only reflect those north of 40°10' N latitude). Discards represented approximately 75% of total trawl landings during this period, and for commercial fisheries have been centered around the central California (Monterey Bay to San Francisco) region (Figures 15a-b). Table 9 reports these data by the fisheries used in the model. The length frequency data for these discards is consistent with being regulatory discards, as discarded fish tended to be larger on average than those in the retained catch in earlier years. This is likely a consequence of a shift in most fishing effort that encounters bocaccio to waters seaward of the Rockfish Conservation Areas (RCAs). It is likely that an offset or blocked selectivity pattern for the post 2002 period would be a more appropriate way to model recent catches; however, as these landings were modest overall, and as incidental landings for other fisheries as well as research surveys are included in trawl catches (and indeed are comparable or exceed total trawl catches in magnitude for many recent years), this was not determined to be a high priority for this model. Similarly, we did not attempt to estimate a discard rate for the period following substantial management restrictions, but prior to the implementation of the RCAs and the bycatch monitoring program, although this may well be an unrealistic assumption. Greater consideration of these factors is recommended for future efforts.

Figure 16 summarizes the total catches in the assessment area (Cape Blanco through the U.S./Mexico border), from 1892-2008, by the fleet definitions used in the model, while Figure 17 shows the total estimated catches of bocaccio by INPFC area in the region north of Cape Blanco from 1969 through the present.

Commercial Length Frequency Compositions

The length composition of commercial landings (here broken out into trawl, hook-and-line, and set net fisheries) were obtained from the CalCOM database, and cover the years 1978-2008. Figure 18 shows the length compositions for bocaccio by year caught in the trawl fisheries; Figure 19 shows the length information for the hook-and-line fishery, and Figure 20 shows this information for the set net fishery. Figures 21a-c show the length frequency distributions for the three major gear types for both sexes and all years combined, in order to evaluate possible differences in the vulnerability (or fishing methods) of fish of different sizes in different regions. Although there appeared to be some differences in the size composition of fish landed in all gear types along the coast, with a general trend towards catching fewer smaller fish and more larger fish in more northern regions. The apparent shift to the right in trawl fishery length frequencies between the Monterey/San Francisco region and the Bodega Bay/Fort Bragg region was the primary rationale in separating the trawl fishery north and south of 38° N.

After careful evaluation of the raw (individual fish) versus expanded (based on fish ticket and port information) length frequency data, we compiled length frequencies using raw length observations. This is consistent with past assessments (MacCall 2003, MacCall 2007) for which length frequency data were "sharpened," essentially adjusted using the Von Bertalanffy growth curve to grow (or shrink) observed length data to reflect the length at the middle of the year (the time at which the predicted length frequencies are estimated by the model). As length composition data is based on expansion methods that typically borrow over time (months, seasons) and space (ports), sharpening was not possible with the expanded length data.

Although we did not continue with the sharpening approach, based on what we considered to be reasonable model performance with the unadjusted length frequency data, concerns over borrowing across both seasons and ports led us to evaluate more closely the differences among raw versus expanded length composition data. This evaluation suggested that while the differences between raw and expanded length frequencies were typically negligible, where there were differences they tended to result in an apparent coarsening of the length frequency data, which would presumably add noise to the model. The initial effective sample sizes (input N) for commercial, recreational and fishery independent length frequency data were calculated using the approach developed by Stewart (2008) in which:

$N_{eff} = N_{trips} + 0.138N_{fish}$ if $N_{fish}/N_{trips} < 44$
$N_{eff} = 7.06N_{trips}$ if $N_{fish}/N_{trips} \geq 44$

In this method, trips are considered equivalent to sampling clusters in CalCOM or hauls in the triennial or NWFSC combined survey, and the maximum input N_{eff} is capped at 400. This approach tended to result in N_{eff} values for most fisheries and surveys that were more precise than the model-estimated effective sample sizes, but not to the magnitude at which trips (for CPFV trips) or clusters (which are subsamples of trips for sampling commercial landings) alone tended to result in lower effective sample sizes than those estimated by the model. The number of subsamples taken, fish measured, and the initial effective multinomial sample sizes for the commercial fisheries are provided in Tables 10-11.

Recreational catches

Until this assessment, estimates of recreational catches for the pre-RecFIN (pre-1980) era had changed little since the 1996 assessment, when they were estimated as a constant fraction of CPFV-reported rockfish catches for southern and central/northern California as reported in CDFG Fish Bulletins (e.g., Young 1969; Best 1963). As with the commercial catch reconstruction, the methodology for reconstructing historical (pre-1980) recreational catches for bocaccio (and other rockfish) are reported in Ralston et al. (in prep) and summarized only briefly here. The reconstruction was based primarily on linking historical CPFV logbook-reported catches of rockfish (where CDFG blocks are reported with the catch) with the species composition of rockfish catches for those blocks from more recent CPFV observer data and other sources. Skiff and private vessel estimates are considerably more uncertain, and the approach developed used estimates of private boat catch from studies in the 1960s and interpolated catches to the RecFIN era. The interpolation was developed to match early 1980s RecFIN catches, although we excluded 1980, which was only a partially sampled year and has been considered highly uncertain in retrospect due to anomalously high catch estimates of several species. Species composition information for skiff and shore modes is very limited, despite the apparently great significance of this component of the recreational fishery even in the pre-1980 era, and consequently estimations are much more uncertain. These early catch estimates are presented in Table 12.

A combination of RecFIN and California Recreational Fisheries Survey (CRFS) data provides ready access to catch and discard estimates to the species level for the recent period (1980-

present). RecFIN data are based on Marine Recreational Fisheries Statistics Survey (MRFSS) catch estimates, which are based on a combination of angler field surveys and randomized telephone surveys from 1980 through 2008 (with a hiatus from 1990 through 1992), with four primary fishing modes: CPFV, private vessel, pier, and shore (only the first two catch notable quantities of bocaccio in most years, although, as discussed earlier, catches are high during years of exceptional recruitment). For 1980 through 2003, catches in both numbers of fish and weight of fish were obtained from the RecFIN database. Spatial resolution of these catch estimates is generally limited to north and south of Point Conception, although some data can be retrieved at the county level. As RecFIN records include a significant fraction of "unknown" rockfish catches, the proportion of bocaccio observed in the "known" catches was applied to the reported catches of "unknown" rockfish and the total bocaccio catch was adjusted accordingly (Table 13). This is recognized to be a problem that, similar to the historical catch reconstruction, will require a more sophisticated evaluation and analysis for future assessment cycles.

Recreational Length Frequency Data

Recreational length frequency data were collected in CPFV fisheries during onboard observer programs for different periods in northern and southern California fisheries. In southern California, observers monitored CPFV catches during 1975-1978 and 1986-1989; collecting a total of nearly 78,000 fish in over 1000 trips during the 70s program, and another 14,000 fish in over 400 trips in the 1980s program. The central/northern California CPFV observer program collected nearly 12,000 length frequency observations from a total of just over 1300 trips (that encountered bocaccio). As all of these observer program measured fish in total length and other data series are in fork length, lengths were converted by the equation: Fork_length = a+b*total_length; where a=0.93 and b= 0.956. Table 14 and Figure 22-23 show the length frequencies and associated sample sizes, including the initial effective N estimated in the same manner as the commercial effective sample sizes.

The central/northern California observer program was also the source of the recreational CPUE index developed in prior assessments to which these length frequencies are linked. In past assessments, the length frequencies were pooled directly with the RecFIN length frequencies. We differ from the past in linking the length frequency information from the observer program directly to the index itself (which is treated as a survey), rather than pooling the length frequencies together. In past assessments the independence of these observations has been questioned and evaluated, although it does appear that there is some contamination of RecFIN length information with data from these observer programs for years in which the two overlapped. This overlap is generally minimal and the southern California CPFV observer length frequency information was not used in the model for the brief period of overlap between this program and RecFIN data collections as a result of these concerns (the data have little influence when included, this decision could be revisited).

Two other sources of length information were considered as well; one is length frequency information for the years 1959-1961 and 1966 from the Miller and Gotshall (1965) and Miller and Odemar (1968; and additional unpublished CDFG data). These data were collected as part of an exhaustive effort to evaluate recreational fisheries in the central and northern California region by CDFG, from which the recreational catch reconstruction effort in Ralston et al. (in prep) drew from considerably. Beyond the summaries reported in the publications, the raw length frequency and species composition data for Monterey Bay area recreational skiff and CPFV fisheries were recovered from paper forms by Jan Mason (ERD, SWFSC; pers. com.) with some of the results reported in Mason (1995) and Mason (1998).

Although the currently available data are limited to this region, this region was responsible for slightly more than 1/3rd of the recreational rockfish catch in central/northern California fisheries during this period. Additional paper records exist for Half Moon Bay, San Francisco, and Bodega Bay recreational fisheries, and efforts to digitize and utilize these data are also being implemented. While the early 1960s data suggest a consistent size mode without particular evidence of extremely strong recent year classes, the 1966 length frequency data is consistent with both a strong year class several years earlier (approximately 1962-63) as well as a strong year class that year (1966) based on the high frequency of 20-30 cm fish (Figure 24). Moreover, the percentage of the total rockfish catch represented by bocaccio also shifts during this period, from a range of 2-5% of the total recreational catch in from 1959-1964, to a range of 5-9% of the total rockfish catch from 1966 through 1972. This is consistent with the perceived increase in the relative abundance of bocaccio in the mid-1960s as evidenced from the CalCOFI data and recent assessments. However, as it seems likely that the recreational fishery had a more limited spatial distribution (across both latitude and depth) and it is not clear how compatible these data are with later length data, this information is not currently included in the model. Further evaluation of these data, as well as the spatial patterns of development of the recreational fisheries more generally, would be beneficial to future assessment efforts.

Most of the recreational length frequency data are from the 1980-2008 period (exclusive of the MRFSS hiatus of 1990-1992) and, as in past assessments, the length frequencies and catches are divided into southern and northern components (Figures 25-26). Oregon and Washington length frequency data (outside of the modeled area) are also presented (Figure 27), but as pooled 5 year intervals due to the paucity of data. Sexes are pooled in all RecFIN rockfish data. As in prior assessments, strong year classes tend to show up earlier in southern California fisheries than in northern California fisheries, with northern California fisheries tending to catch larger individuals. The 1999 and 2003 year classes are particularly prominent in these data in the southern fisheries, with a suggestion of a strong 2005 year class as well. Sampling is generally comprehensive in southern and northern California, where bocaccio represent a significant fraction of the total recreational rockfish catch. The total number of clusters, fish sampled, and initial effective sample sizes are presented as Table 15.

Ageing Uncertainties and Age Data

The 1996 bocaccio assessment (Ralston et al. 1996; Ralston and Ianelli 1998) attempted to utilize age-frequency information from otoliths aged using break-and-burn methods from trawl fishery samples collected in 1988, 1991, and 1994. Just over 1,300 otoliths were aged, and approximately one of every four was subsequently reexamined by a second age reader to determine the precision of the break-and-burn age data. They found that the percent agreement between readers declined from ~90% for age 1 fish to ~10% agreement at age 20. The pattern of decline appeared to reflect an exponential decay in the precision of age estimates with increasing age. In their evaluation of the diverse sources of data, the assessment authors concluded that the age composition data were in fundamental disagreement with all of the other data sources. This was primarily due to the bias and imprecision in the ageing results, which resulted in an uninformative age composition data that were wholly inconsistent with the highly variable recruitment patterns clearly informed by the length frequency data. Since that assessment, age data have not been utilized in any of the subsequent southern bocaccio stock assessments, although STAR Panels have frequently recommended re-examination of age information and the potential for developing ageing criteria that could be used to guide production ageing efforts.

Ralston and Ianelli (1998) also noted that the rapid growth of young bocaccio and the relatively brief seasonality of spawning likely exacerbated the interpretation of bocaccio otoliths, as they resulted in a proliferation of false annuli and accessory check marks that were difficult to interpret, resolve, and validate through the application of marginal increment analysis. These results are consistent with the later age validation efforts of Andrews et al. (2005) and Piner et al. (2006), both of whom validated the longevity ranges described in earlier break-and-burn estimates of age structure, and both of whom found a high degree of ageing imprecision. Piner et al. (2006) used otoliths from twenty four adult fish captured near the U.S./Canada border (~47°-49° N latitude), for which initial age estimates were available from the collecting agency. Second and third independent age determinations were made from experienced readers in two separate laboratories to provide an estimate of ageing precision and possible age bias. Their results indicated that ageing precision was low for most samples, although they found no evidence of bias in this imprecision. The number of samples in this effort was inadequate to evaluate whether and how ageing error changed as a function of age. In contrast to their results, Andrews et al. (2005), using otoliths collected from central California, did report a bias towards under-ageing of bocaccio, which they also found to be very difficult to age using break-and-burn methods. However, the otoliths that they evaluated had not been aged based on established ageing criteria.

The inconsistencies with respect to possible bias in ageing are to some extent consistent with expectations; although bocaccio have long been known to be among the most difficult fish to age by experienced readers, age readers in northern regions have tended to report less difficulty and smaller inter-reader errors than those in southern regions. To evaluate this issue more rigorously, the one experienced reader contributing to this assessment (Pearson) aged a number of similarly sized fish from the same or similar years, from three regions of the coast; southern California (south of Point Conception), central California (Monterey Bay) and the west coast of Washington. To facilitate the evaluation, otoliths were cut using a Isomet low speed precision saw with a diamond encrusted blade, and then burnt, rather than the break-and-burn method typically used in production ageing.

In general, we found a trend towards easier readability with more northerly latitudes, which would be consistent with the more rapid growth and smaller age at maturity in southern animals, as well as the more variable ocean conditions in southern waters. Moreover, Parrish (1981) noted that upwelling winds, which drive much of coastal ocean productivity, were strongly seasonal in northern waters (north of Cape Mendocino), with upwelling favorable winds in spring and summer seasons, and downwelling during fall and winter. Upwelling winds demonstrate a somewhat more extended and slightly weaker seasonality in northern and central California, where onshore transport during winter tends to have more frequent interruptions.

Seasonal patterns become weaker still south of Point Conception and into Baja California, where a more continuous but less intense level of offshore transport occurs year round.

Figure 28 shows examples of cut and aged otoliths from fish that were approximately 600 cm long and taken from similar time periods from each of the three regions of coast. For future research efforts it may be possible to develop more rigorous ageing criteria for the ageing of southern bocaccio based on the more resolved patterns observed in fish from the north; an effort that might merit collaboration among age readers from California, the Pacific Northwest and British Columbia. In the foreseeable future, it is unlikely that production ages will play a meaningful role in future assessment efforts, and we have maintained the approach of previous assessments of excluding the sparse, and highly uncertain, age data from this assessment.

D.1.b Fishery-Dependent Indices

Trawl Catch per Unit Effort

Ralston (1999) developed a CPUE index of bocaccio abundance based on California trawl logbooks that was initially used in the assessment (Figure 29). Because the logbooks do not identify most individual species such as bocaccio, Ralston applied species compositions from local port sampling to the overall catch rates of rockfish from the trawl logbooks. This assessment uses Ralston's "area-weighted" index of bocaccio CPUE, and the associated standard errors (average CV is 32%).

Recreational CPUE Indices

Recreational CPUE indices were developed for the 2003 assessment (MacCall 2003) using catch and effort data were from two sources, the RecFIN database (Wade Van Buskirk, Pers. Comm.) and the Northern California partyboat monitoring conducted by CDFG (Deb Wilson-Vandenberg, Pers. Comm.). These two sources contain different kind of information and were treated differently in the 2003 assessment, although for the RecFIN data only the partyboat catch and effort data were used, as bocaccio catch rates from private boats appeared to be less consistent than those from partyboats.

MacCall (2003) developed indices based on the RecFIN data using a multispecies discriminant function analysis (Stephens and MacCall 2004) to identify which fishing trips are appropriate to include in calculation of a CPUE index of abundance. The concept behind the method is that the species mix in the catch of a fisherman or a fishing trip is indicative of the habitat where fishing occurred, allowing discrimination between those trips where the target species (bocaccio in this case) could have been caught and trips where bocaccio were unlikely to have been caught. Essentially, given the various fishing strategies of CPFV operators across many different habitats, seasons, and target species, the latter trips are not informative, and should be excluded from the CPUE analysis. The approach involves identifying the general list of species commonly caught on fishing trips in the region under consideration, and then converting trip records to a vector of presences (1) and absences (0) of those species.

For each trip record, the probability of the target species (bocaccio) being present was fit by maximum likelihood using a logit function based on an indicator consisting of the sum of estimated species-specific coefficients, such that these coefficients include large positive values for species that consistently co-occur with bocaccio (e.g., chilipepper and bank rockfish), and large negative values for species that occur in habitats where bocaccio are unlikely to be encountered (e.g., oceanic species such as albacore, and nearshore species such as barracuda). Figure 30 shows an example of these coefficients for the southern California recreational index. Next, each trip record is assigned an estimated probability that bocaccio could have been encountered. The trip records are sorted by descending probability, and a threshold probability is chosen for exclusion of trips from the CPUE calculation. After additional refinements to account for discards and other factors (See MacCall 2003, or Stephens and MacCall 2004 for a greater detailed description of the analysis), a delta-GLM model is applied to the retention-corrected records to arrive at a relative abundance index, with year and wave effects estimated as factors.

The resulting indices were also corrected to account for the expected impact of bag limits and for intentional avoidance of bocaccio in the post-2000 period, although the behavioral changes associated with increased regulatory activity from 2000 onward are difficult to fully understand. Consequently, the post-2000 data points should be interpreted as being more uncertain than previous points, and following the 2003 assessment the index was not updated due to the expectation of even greater bias as a result of management activities. Consequently, the indices included in this assessment are unchanged from those developed in the 2003 assessment (and subsequent updates), and additional details (including additional analyses conducted for past STAR Panels) should be referred to from those documents or from the publication that originated from this analysis by Stephens and MacCall (2004). It is also worth noting that the approach has subsequently been applied in many other west coast groundfish stock assessments for which recreational catches and effort represent a significant fraction of the fishery, including those for gopher rockfish (Key et al. 2006), yelloweye rockfish (Wallace et al. 2006), blue rockfish (Key et al. 2008), and black rockfish (Sampson et al. 2008).

In addition to the indices derived from the MRFSS data, the California Department of Fish and Game conducted on-board monitoring of partyboat catches in central and northern California from 1988 to 1998. Presence of location and depth information associated with catch and effort at individual fishing sites (Deb Wilson-Vandenberg, Pers. Comm.) allowed a more direct identification of appropriate records for use in a CPUE calculation. The analysis used only those fishing sites with at least seven occupations and at least five positive occurrences of bocaccio catch in the data set. Initial exploration allowed collapse of monthly effects into a seasonal winter (January, February and March) and nonwinter effect; and the few records from depths greater than 80 fm were combined to form an 80+ fm depth effect. The final delta-lognormal GLM included year (12), season (2), site (100) and depth (8) effects. As with the other recreational CPUE indices, this index was not revisited for this assessment. However, the index was treated as an independent survey in this assessment, with the length frequency information (which was pooled with the RecFIN length frequency information in the 2003 assessment and subsequent updates) treated as independent observations from the RecFIN data. The independence was somewhat artificial, in that the selectivity curves for the RecFIN length frequency data and this survey were linked (mirrored selectivity), consistent with the notion that the two data sources are related. Sensitivity analysis suggests that the two curves were highly similar when estimated independently, however, this allowed for these data to be evaluated and weighted (tuned) independently. All three of these recreational CPUE indices developed for the 2003 assessment are shown in Figures 31a-b.

D.1.c. Fishery-Independent Data

CalCOFI larval abundance data

The historical ichthyoplankton abundance data from the California Cooperative Oceanic and Fisheries Investigations (CalCOFI) surveys was first used in the bocaccio stock assessment in 1996, although it was not included in the 1999 assessment due to the re-analysis of the CalCOFI dataset during that period (it was used again in the 2002 and subsequent assessments). Egg or larval abundance data from these surveys have also been used in stock assessments for other important west coast species, including northern anchovy (Jacobson and Lo 1994), Pacific sardine (Hill et al. 2007), shortbelly rockfish (Field et al. 2007) and California sheephead (Alonzo et al. 2004). Although a larval abundance index was developed in the first stock assessment for cowcod (*S. levis*, Butler et al. 1999), this index was not included in the most recent assessment (Piner et al. 2006, Dick et al. 2008) out of concerns for the rarity of cowcod in sampled tows. Similarly, these data were explored for an a recent assessment of the closely related and often co-occurring chilipepper rockfish (*Sebastes goodei*), the index was ultimately not included in the final model as most of the data were from the southern periphery of that stock's range, and the near total absence of larvae in the southern region between the early 70s and 2000 (Field 2008).

Bocaccio rockfish are one of only several *Sebastes* species for which larvae are readily identifiable using morphometric methods (Moser et al. 1977). Most of these larvae were not identified to the species level in initial plankton sorting efforts; rather the core area dataset was reanalyzed following the development of morphological criteria that allowed for conclusive identification to the species level. Consequently, data for the northern regions are only available for a subset of years, although historical samples are currently being enumerated from 1968 back to 1951 (W. Watson, SWFSC, pers. comm.). Table 16 shows the number of total tows, positive tows, and the mean CPUE of positive tows for the southern and northern stations, for years in which adequate sampling took place during the winter (November-May) spawning period (sampling was generally triennial from 1969-1984). The mean catch rates by station and decade are also shown as Figures 32a-f, note that for the central Californian stations, sampling effort is typically far lower than the south (as shown in Table 16). Although contemporary sampling effort in the central California region is not as intensive as that in the southern region, the time series for central California will continue to grow both forwards and backwards in time.

We developed the CalCOFI index consistent with the approach from past assessments, in which we used tow specific information and a delta-GLM approach to derive an index of spawning output. Fixed effects in the model included year (fixed to spawning season, such that data from November and December are used to estimate the year effect for the following year, along with the January-April data from that year), month and line-station effects. We also explored alternatives to the line.station factor approach, including combinations of line, distance from shore, and depth. Although these approaches used a lesser number of parameters, they also resulted in models that had significant interactions among the different factors, and when such factors were accounted for using interaction terms the effective number of parameters varied little from the line.station model. As the resulting indices were all comparable, and AIC additionally indicated that the line.station model explained more of the variance in the model, we continued with the use of line.station effects for this index. However, we did evaluate alternative link terms in the binomial component of the model, and found that a complementary log log (cloglog) link function performed better (AIC of 20 likelihood units) than the logit link term used in the past. This link term was consequently used to develop the relative abundance index.

These estimates and the associated standard errors estimated from a jackknife routine were used in the model as a relative index of population spawning output (Figures 33a-b). The trends suggested by both the raw data (percent positive tows and catch rates of positive tows) suggest that relative abundance was declining through the 1950s, but increased sharply in the 1960s through the early 70s, after which the index declines similar to the decline observed in other indices. Throughout the time series, there is considerable high frequency year-to-year variability in larval distribution and abundance that may be related to variability in climate, oceanographic features and circulation patterns, or variable reproductive output (MacGregor 1986, Moser et al. 2000; Lenarz et al. 1995).

Larval production estimates

In addition to the relative abundance estimates based on the delta-GLM model, we consider estimates of absolute biomass developed by Ralston and MacFarlane (in review), for the Southern California Bight (U.S. waters south of Point Conception). These estimates are developed from an estimation of the spawning output necessary to produce observed daily rates of larval production, using a methodology developed first by Ralston et al. (2003) for shortbelly rockfish (*Sebastes jordani*) and subsequently used in an assessment of that unfished population (Field et al. 2007). Ralston and MacFarlane used expanded the daily rates of larval production observed in the CalCOFI Ichthyoplankton surveys during 2002-2003, a year in which sampling in the Southern California Bight was enhanced within the region currently encompassed by the Cowcod Conservation Areas (CCAs) as part of an effort to improve the assessment of that stock. Their results indicate that in 2002 and 2003 there were approximately 3470 and 5921 mt, respectively, of female spawning biomass in the Southern California Bight, corresponding to 6953 and 10,656 mt of total biomass. Interestingly, their results also indicate that the concentration of bocaccio in the years of their survey was strongly centered around the Cowcod Conservation Areas (CCAs), which have been closed to fishing since 2001, and which was not typical of the long-term average distribution of larval abundance through the duration of the time-series (Figures 34a-b). While the causes of this shift in distribution are unclear (certainly it is not reasonable to think that it was the result of a 1-2 year closure), the consequence does have implications for the interpretation of data from those indices that sample in the Conception area, but avoid sampling within the Cowcod Conservation Areas themselves.

Additional visual and acoustic methods of abundance estimation

Several additional non-lethal methodologies for the assessment and monitoring of rockfish stocks off Southern California are currently under development and may provide useful data for future assessments. For example, data from multifrequency echosounders and underwater cameras have been used jointly by the Advanced Survey Technology (AST) and In-Situ Survey groups at the Fisheries Resources Division (SWFSC) in La Jolla to map the dispersions and estimate the abundances of rockfish at a suite of historical fishing sites within this region. The techniques were developed in 2003/04 from the Commercial Passenger Fishing Vessel (CPFV) Outer Limits; applied throughout the SCB in 2004/05 and 2007 (COAST07), largely from NOAA Ship David Starr Jordan. The frequency dependence of sound-scatter intensity is commonly exploited to classify fish, zooplankton and seabed observed in acoustic surveys.

Although less utilized, techniques based on scattering statistics of echo amplitudes can also be used to extract information, and workers have developed a hybrid, statistical-spectral method for target identification (SSID), which incorporates information contained in both the signal amplitudes and phases (Demer et al. 2009). This approach should ultimately provide the means to separate scatter from demersal fish and the seabed, as well as estimate seabed depth, within-beam slope, hardness and roughness, and the height of the dynamic acoustic dead zone. Additionally, preliminary success has been made in investigating sound production in rockfishes, including the identification of sounds made by bocaccio and several other species (Širović and Demer 2009). From August to October 2007, the acoustic and visual surveys described above were augmented with two passive-acoustic seabed recorders, which were subsequently analyzed for the presence of rockfish sounds. A repetitive pulsing from bocaccio was the most commonly recorded sound and it occurred predominately at night. The daily calling rates at each site were quantitatively compared with the rockfish abundance estimates obtained from the active-acoustic survey, and they were positively correlated (Širović et al. 2009). These results suggest it may be feasible to use passive acoustic tools to efficiently monitor changes in rockfish populations, possibly in conjunction with acoustic and/or visual survey methodologies. However, as all of these approaches show some promise for potentially useful survey methodologies, none was sufficiently developed to be used as an index in this assessment.

Triennial Trawl Survey

A primary source of fishery independent information for most managed and assessed groundfish species in the California Current is the West Coast triennial trawl survey conducted between 1977 and 2004 (e.g., Weinberg et al. 2002). As the general consensus from recent data workshops has been to exclude 1977 data, we have not used these data in either the area-swept or GLMM indices, but continue to report the data here. We obtained both stratum-specific area swept biomass estimates and haul-specific survey data from 1980 to 2004 (M. Wilkins, AFSC; B. Horness, NWFSC), both of which were generated after excluding bad performance tows and "water hauls," in which few benthic organisms were noted (Zimmermann et al. 2001). Catch rates pooled over all years are shown relative to the latitude and longitude in Figure 35, while the log of tow specific CPUEs from this survey by year, relative to both latitude and depth (but excluding depth contours to better capture the depth distribution) are shown in Figures 36a-j, which also illustrate the variation in the latitudinal range of this survey over time. The number of hauls, number of positive hauls, number of hauls in which lengths were measured, and total number of lengths measured by year are presented as Table 17. Biomass estimates, and their associated coefficients of variation based on area-swept indices are presented by depth and INPFC strata in Table 18.

The area-swept index of abundance has been criticized in the past due to the infrequent occurrence of very large hauls, which leads to noisy abundance estimates in the time series. This is a consequence primarily of the aggregating behavior and habitat associations of many semi-pelagic rockfish species, which tend to be characterized by patchy distributions and often highly specific habitat associations. Consequently, survey workshop recommendations and trends in stock assessment applications have been to developed survey indices an index of abundance using the Generalized Linear Mixed Model (GLMM) approach described in Helser et al. (2007); this method is also used for the Northwest Fisheries Science Center combined survey data described later. The model uses depth strata and latitude (or INPFC latitude proxies) as fixed effects, and vessel as a random effect, to develop stratum-specific estimates of catch rates (kg/ha), which are then expanded to the total area of a given stratum to arrive at an abundance estimate. The model assumes a log-normal error variance assumption for the positive observations, which is consistent with observations of observed catch rates (Figure 37a). Models with gamma or inverse Gaussian error distributions generally failed to converge, likely due to low sample sizes in many strata. Point estimates of biomass and the associated CVs are based on the median of the marginal posterior density from MCMC (although standard errors and CVs are reported in the tables, the starting value for the indices in the assessments were based on the square root of the CV+1).

The STAT considered the standard depth and area stratification structure used for the GLMM to be potentially problematic for bocaccio. The traditional stratification is based on the INPFC areas (essentially, proxies for latitude effects) and depth bins from 55-183 meters, 183-300 meters, and 300-550 meters (deeper strata are not used for rockfish). However, the northern region of the Conception INPFC area was sampled only occasionally (and was never sampled south of Point Conception), such that there are essentially no Conception area data for the 1980-1986 period. Consequently, we evaluated an alternative stratification in which the northern Conception area (34.5-36° N) was grouped with the southern Monterey area (36-38° N), and the remaining Monterey INPFC area (38- 40.5° N) was considered a distinct region. We also had concerns regarding the design of the depth strata, which essentially bisect the depths of greatest abundance for bocaccio. Figures 38a-c show depth effects (as factors) with the standard depth strata, and with alternative 50 and 25 meter depth bins, illustrating that the greatest catch rates of bocaccio tend to occur between 150 and 250 meters, with low catches in both shallower and deeper depths. Consequently, we also explored alternative depth stratification, in which strata were redesigned into 100 meter depth bins (55-150, 150-250, 250-350). Revised estimates of the total areas of these new strata were provided by Beth Horness (NWFSC, pers. com.).

As seen in Figures 39a-c, there is a significant difference between the design-based estimate and the GLMM estimates. This is a consequence of the down-weighted significance a small number of tows with very large positive catches. The influence of these tows is reduced in the GLMM under the assumption of a log-normal error distribution, and consequently the index has a smoother (temporally autocorrelated) trend, as opposed to the relatively noisy trend of the area-swept index. However, the difference among the indices with the standard versus the alternative area stratifications was relatively modest (note that the standard stratification in this example excludes the Conception area data entirely due to the lack of data in many years). Similarly, a coastwide GLMM that incorporates the (relatively modest volume) data from the Columbia and

Vancouver INPFC areas (using the standard, rather than alternative stratification, and thus excluding the Conception area data) was nearly identical to the index based on the assessment area alone, not surprising due to the paucity of positive tows in the northern INPFC areas (Table 19). Similarly, there was little difference when the alternative depth strata were used, suggesting that the model does not require informative depth factors to arrive at consistent results. Due to the apparent habitat preferences of bocaccio, which tend to prefer untrawlable habitat, as well as the fact that the triennial survey did not survey the Conception INPFC area in many years (and never extended to the core of that area, south of Point Conception), this index is treated as an index of relative, rather than absolute biomass, such that q is treated as a nuisance parameter.

Length frequencies for the triennial survey were calculated based on standard estimation methods (Dark and Wilkins 1994). However, it was noted that in the early years of the trawl survey, length measurements were not taken from every haul, and in fact most hauls with only a small number of bocaccio (less than 10 fish) in the catch did not report length frequency information (Figures 37b-c). This may have led to a bias in which larger fish were disproportionately excluded from the length frequency data, as the mean weight of fish in the hauls with no length frequency data tended to be greater than the mean weight of fish in hauls that did include length frequency data. Length frequency data are shown in Figure 40.

Northwest Center Trawl Survey

The Northwest Fishery Science Center has conducted combined shelf and slope trawl surveys since 2003, based on a random-grid design from depths 0of 55 to 1280 meters. Additional details on this survey and design are available in the abundance and distribution reports by Keller et al. (2008). Geographic locations of catches and negative tows pooled over all years are shown as Figure 41, while tow-specific log CPUE estimates from this survey by latitude, depth and year are shown as Figures 42a-f. Additional data on the number of tows, number of positive tows, number of length measurements and mean CPUE rates by depth and INPFC area are provided in Tables 20. The design-based area-swept biomass estimates for the West Coast are provided by INPFC area in Table 21, which range from 1235 mt in 2003 to 9184 mt in 2004, with a (very general) declining trend suggested from 2005 through 2008 (3644 to 1784 mt). The vast majority of the estimated biomass is found in the assessment area (Conception, Monterey and Eureka INPFC areas), and in the shallower depth strata.

As with the triennial survey, an alternative index GLMM methods described above for the triennial survey index (the error distribution was assumed to be lognormal). We explored both the standard stratification (INPFC area and 55-183, 183-300, 300-549 meter depth bins) and the revised depth stratification used for the triennial survey as described in the previous section (Figure 38a-b); we maintained the standard INPFC area stratification due to the consistency in sampling the entire Conception INPFC area throughout the survey. However, it should be noted that sampling density in the Conception area is relatively modest, and does not include the habitat in the Cowcod Conservation Areas (CCAs). As with the triennial survey, the results varied little among the two models, similarly there was little difference between the assessment area estimate and the coastwide model estimate (Figure 43). For consistency with the area-swept biomass estimates and the expanded length-frequency estimates, which were derived using the standard depth stratification, we used the index from the model with the standard depth stratification. As the indices vary little among the alternative stratifications, we do not consider this to be a major concern.

Length frequency data were based on the expanded length frequencies provided by Beth Horness (NWFSC), shown in Figure 44. The length frequency data in most of these years are dominated by the 1999 year class, with signs of the incoming 2003 and 2005 year classes in later survey years.

NWFSC Southern California Bight hook-and-line survey

Since 2004 the NWFSC has conducted a hook-and-line survey for rockfish in the region south of Point Conception, using essentially recreational gear types, surveying locations that are either likely or known sites where recreational fishing occurs, and chartering recreational (CPFV) vessels to conduct the survey (Harms et al. 2008; Harms et al. in prep). Importantly, this survey does not include fishing sites within the Cowcod Conservation Areas, a large region closed to commercial and recreational fishing in order to rebuild the cowcod rockfish (*S. levis*). Consequently, the trends inferred from this index should be interpreted with some caution.

Bocaccio rockfish are among the most frequently encountered species in the survey, representing approximately 25% of all fishes encountered. Harms et al. (in prep; included in supplementary materials) standardized catch rates of bocaccio rockfish from 2004 – 2007 using a Bayesian Generalized Linear Model to account for site, fishing time, survey vessel, angler, and other statistically significant effects. Their results are moderately indicative of a slight downward trend in the biomass vulnerable to this survey (Figure 45a), which like the southern California recreational fishery, is likely to show dome-shaped selectivity. As with the NWFSC combined survey and the southern recreational fishery length frequency data, the length-frequency distributions are dominated by the 1999 year class from 2004-2006, with signs of the incoming 2003 year class, which together with an apparent strong 2005 year class tends to dominate the length frequencies of the later years of survey data (Figure 45b).

Recruitment Indices

Two recruitment indices were used in the 2002 bocaccio assessment: the Midwater Trawl Survey of juvenile rockfish in Central California, and an index based on impingement rates at Southern California electrical generating stations (Power Plant Index). The 2003 assessment added a third recruitment index, the Pier CPUE Index based on recreational catches of young-of-the-year bocaccio from piers. However, the 2003 STAR Panel recommended that all three recruitment indexes be removed from the model, so the 2003 assessment, as well as the 2005 and 2007 update assessments did not include any recruitment indexes. All three recruitment indexes are reconsidered in the 2009 assessment. The Power Plant Index data end in 2000 and have not been updated due to changes in plant ownership, but the index has been re-estimated here. The Midwater Trawl Survey and Pier CPUE Index have been substantially revised and extended. Although all of these indexes are imprecise, they potentially provide improved stability to the pre-1970 abundance and recruitment estimates when length composition information is otherwise lacking.

Power Plant Index (Southern California)

Annual impingement rates (number of bocaccio per volume of intake water) at five Southern California electrical generating stations from 1972 to 2000 form the basis of a recruitment index (data supplied by Kevin Herbinson, Southern California Edison). The five power plants (sites) are El Segundo (ES), Huntington Beach (HB), Ormond Beach (OB), Redondo Beach (RB), and San Onofre (SO). San Onofre consists of three time series for three separate intakes; the first extends from 1972 to 1993, and the other two extend from ca. 1982 to 2000. A preliminary delta-GLM produced overlapping jackknife confidence intervals for the three San Onofre "effects" which supported using a combined average value for San Onofre (this avoids need for complicated weighting to preserve equal weighting among power plant sites). A gamma model of the positives was marginally better than a lognormal model, deltaAIC = 2.48, and was used in this analysis. The shape parameter of the gamma distribution was 0.87, indicating an approximately exponential distribution of the positive values.

Jackknife estimates of standard error were possible for most years. The three years 1982, 1993 and 1994 contained only one positive site; index values were estimable and approximate standard errors were based on an assumed CV of 1.5, derived from the trend of CV vs. index value. El Nino years 1983 and 1998 contained no positive sites, but an index value of zero cannot be used by Synthesis. These two years were represented by an index value somewhat smaller than the minimum observed positive values, and with an assumed CV of 2. The time series of log(index) values is shown in Figure 46a, and shows a general trend of declining recruitment over the duration of the observations.

Pier CPUE Index

Young-of-the-year bocaccio have long been known to be occasional targets of recreational fishermen from fishing piers, where high catch rates appear to be associated with strong year classes. MacCall (2003) developed an index of bocaccio recruitment along the California coast based on bocaccio catches and associated effort from piers during the May-October period. Based on these data, San Luis Obispo County was described as the apparent center of historical bocaccio recruitment, with Santa Barbara (34° 24' N) to Santa Cruz (36° 58' N) being the typical geographic range of large recruitment events. Juveniles were rarely observed at piers in or south of Ventura and Los Angeles Counties, and MacCall concluded that there was no evidence of separate southern California recruitment events from this analysis. This analysis demonstrated that 1980, 1984, 1988 and 1993 were years of strong bocaccio recruitment; most other years in the time series showed weak or no catches of bocaccio.

Miller and Gotschall (1965) reported on one such event in 1956 and 1957, during which large numbers of young bocaccio occurred at all piers from Avila Beach, CA (35° 11" N) to Princeton, CA (39° 24' N; four coastal counties). They reported that the greatest concentrations appeared in mid-1956; by 1957 larger fish had moved to deeper waters and by 1958 they were not observed from piers or near shore. This event was also observed by Dr. Milton Love (USCB, pers. Com), who as a young fisherman witnessed very high catch rates of bocaccio at the Cayucos Pier (just north of Morro Bay) during a family vacation in August of 1956. Sadly, Love lost half of his fishing pole through the slats in the Cayucos Pier during this experience, and did not manage to land any of these fish himself. Large numbers of bocaccio were also observed in pier fisheries in the Central California region during the fall of 1966, accounting for 26.4% of the 1.3 million fish estimated to have been caught in pier fisheries in three different central California counties (San Mateo, Santa Cruz and Monterey) during that year (Miller and Odemar 1968).

The bulk of the pier data were obtained from the RecFIN database covering most of the years from 1980 to 2008. RecFIN records of bocaccio catch per angler hour were summarized by years (26), 2-month waves (3), and counties (6), each combination constituting a single record. Records with bocaccio mean length larger than 175mm FL were dropped (9 positive records). Also, the seasonal frame was restricted to May-October, which removed two more positive records, leaving 42 positive records out of a total of 438. No pier-caught bocaccio were seen in 13 of the years, and bocaccio were very rare in some locations such as Los Angeles and Ventura Counties.

Analysis of an initial GLM including year, wave and county effects indicated that the three wave effects were indistinguishable, allowing the model to be simplified to just year and county effects. Individual wave records were treated as replicates. AIC values showed no significant difference between gamma and lognormal models (deltaAIC = 0.06) , and the estimated gamma shape parameter of 86.7 indicated a non-zero mode for the positive observations. Consequently the lognormal model was chosen for the pier CPUE data. Values for the 13 zero-index years were replaced by minimum values of 0.01, which is about one-half the smallest non-zero estimate, and associated CVs were set at 1.5. All of the CVs were subsequently converted to standard errors in log space (sigma) by the transformation, sigma = sqrt(ln(CV^2+1)). These data were merged with the RecFIN data to produce the final index values. Miller and Gotshall (1965) anecdotally observed that bocaccio catch rates had been much higher in 1954 and 1956, so nominal index values for those years were set at 0.1 (1955 and 1957 were set at the default minimum of 0.01), and all were assigned large CVs. The final time series is shown in Figure 46b. The value for 1966 is quite high, but is strongly supported by observed data.

Midwater juvenile rockfish survey

The Fishery Ecology Division of the Southwest Fishery Science Center has conducted a standardized midwater trawl survey during May-June aboard the NOAA R/V David Starr Jordan every year since 1983. The primary purpose of the survey is to estimate the abundance of pelagic juvenile rockfishes (*Sebastes spp.*) and to develop indices of year-class strength for use in groundfish stock assessments on the U. S. west coast. This is possible because the survey samples young-of-the-year rockfish when they are ~100 days old, an ontogenetic stage that occurs after year-class strength is established, but well before cohorts recruit to commercial and recreational fisheries. This survey has encountered tremendous interannual variability in the abundance of the ten species that are routinely indexed, as well as high apparent synchrony in abundance among the ten most frequently encountered species. Past assessments have used this survey as an index of year-class strength, including assessments for widow rockfish (He et al. 2005), Pacific hake (Helser et al. 2006), shortbelly rockfish (Field et al. 2007) and chilipepper rockfish (Field 2008).

Historically, the survey was conducted between 36°30' to 38°20' N latitude (approximately Carmel to just north of Point Reyes, CA), but starting in 2004 the spatial coverage expanded to effectively cover the entire range of shortbelly rockfish indexed in this model, from Cape Mendocino in the north to the U.S./Mexico border (Sakuma et al. 2006). Additionally, since 2001 juvenile rockfish data are available from a comparable survey conducted by the Pacific Whiting Conservation Cooperative and the Northwest Fisheries Science Center (spanning from just south of Monterey Bay to Westport, WA; see Sakuma et al. 2007). Comparison of the coastwide data have revealed two types of shifts in the distribution of most pelagic species, in which species characterized by a more southerly geographic range (e.g., bocaccio, shortbelly, and squarespot rockfish) were caught in relatively large numbers south of Point Conception, while species with more northerly distributions (widow, canary, and yellowtail rockfish) were caught in moderate numbers north of Cape Mendocino. Thus the near absence of fish in the core survey area during the 2005-2007 period, which saw two of the lowest abundance levels of juvenile rockfish ever observed in the core area time series, was associated with an apparent redistribution of fish, both to the north and the south.

The survey index is calculated after the raw catch data are adjusted to a common age of 100 days to account for interannual differences in age structure. For this assessment cycle, a number of survey indices were developed by S. Ralston (SWFSC) as a combined index that uses both SWFSC and NWFSC/PWCC survey data (report in supporting materials). As the core area index seems to have failed to capture the magnitude of the 1999 year class for most stocks, the recommendations from the juvenile rockfish survey workshop held in 2005 were to exclude the core juvenile indices unless a convincing case could be made otherwise. The coastwide juvenile bocaccio index (Figure 47) was developed by integrating the results of both surveys in an ANOVA model with year, latitude, vessel, period, and depth effects, was used to inform the relative year class strength for the years 2001-2006. Past assessments have used a power coefficient to transform the index (He et al. 2006), based on the assumption of a compensatory relationship between pelagic juvenile abundance and subsequent recruitment to the adult population following settlement (Adams and Howard 1996). However, due to the short duration of the time series, a power transformation was not estimated for the coastwide index in this assessment.

D.2 History of modeling approaches and transition to new modeling platform

D.2.a Pre-STAR Panel Consultations

Due to time and budget constraints, a pre-assessment data workshop was not held for the bocaccio stock assessment. Email communications were exchanged between the STAT team and the GAP, GMT and PFMC representatives regarding major changes to the model and the new data sources being considered. In particular, a draft of the historical catch reconstruction was circulated to these members, as this was among the more significant changes with an effect on the ultimate model outcome.

D.2.b Responses to previous STAR Panel recommendations

The 2003 STAR Panel report and subsequent STAR Panel reports from the 2005 and 2007 updates highlighted a number of recommendations for future research activities. All of these recommendations were addressed to the greatest extent practicable in this assessment. The primary research recommendations from the 2003 STAR Panel report, and a narrative on how these recommendations were addressed, follows. Most of the 2005 and 2007 STAR Panel recommendations were similar in nature, those that are not addressed in the discussion below are summarized and responded to in the paragraph that follows the response to the 2003 recommendations.

- *Due to the extensive fishery closures and regulations prohibiting retention of catch in excess of the legal limits, fishery CPUE indices in the future will be biased indices of abundance. The Council and NMFS need to consider to how to monitor bocaccio status in the future. The CPFV data set consisting of reef-specific indices of abundance from partyboats is extremely valuable for evaluating of local fishing effects and as an index of overall abundance. Reef-specific CPUE is not as subject to the typical limitations of fishery CPUE data. A program of exempted fishing permits for partyboats with observers to monitor stock status should be considered.*

The Southern California Bight hook-and-line survey discussed earlier was developed in part as a result of that recommendation (Harms et al. 2007; Harms et al. in prep), and is incorporated into this assessment. The performance of this index is discussed in the model evaluation section. The STAT Team also points out that the CalCOFI larval abundance index, which represents the longest (largely) continuous time series of relative abundance for any west coast groundfish, seems to be working well for bocaccio over long time periods, and it is doubtful that exempted CPFV fishing would provide information of greater utility. This is particularly true given the uncertain effects of the area closures (CCAs and RCAs), particularly in southern California, which are likely to be biased with respect to relative abundance trends which are currently limited to those regions open to fishing and do not sample in regions where fishing has been excluded (now for nearly 8 years). The diagnostics of the relative shift in the spatial distribution of spawning output inferred from the larval production paper (Ralston and MacFarlane, in review) provide substantive evidence of this problem.

- *More attention needs to be given to how growth is modeled in the assessment. A model with time varying growth or cohort-specific growth may improve the fit to the length frequency data. Alternative ways to model variation in length with age should also be considered. Also, the Panel recommends that ageing of bocaccio be re-visited. A modest ageing sample could be used to evaluate whether the linear trend in the coefficient of variation (CV) of length with age in Stock Synthesis is a reasonable assumption, as well as confirming the model estimates of growth.*

In this assessment, growth is revisited and continues to be estimated internally. Although improvements in the fits to the length composition seem to reduce the necessity of exploring time-varying growth, there are still patterns in the residuals that suggest either time- or cohort-specific growth patterns that contribute to poor fits to some data. Initial efforts to incorporate time-varying growth did result in an improvement in the fit to the data and indicate that this process is important to incorporate into the modeling framework. However, the initial results also suggest that the results of the base model change only marginally with incorporation of time varying growth, thus for the purposes of this assessment, time-varying growth is not adopted. The CV of length at age was explored to the extent it could be with available data as well as through the relative change in fit with varying values, and profiles of the CV of length at age were used to inform the final values. Although several age validation manuscripts have been published since the 2003 assessment, all recognize the difficulty in ageing bocaccio. We have initiated an effort to better understand if, and why, bocaccio from the southern region of the California Current appear to be more difficult to age than those from the north, which likely is a combination of factors relating to the differences in the seasonality of secondary production among these regions. This may also act in concert with the very rapid and likely variable growth typical of bocaccio in the southern region.

- *The Stock Synthesis model apparently does not perform well with the diverse data sets used to assess bocaccio. Consideration should be given to moving the bocaccio assessment to a new modeling environment, ideally one with optimization routines using automatic differentiation rather than numerical differentiation as in Stock Synthesis.*

Movement of the model to the SS3 modeling platform addressed this need in a highly satisfactory way, with an apparent improvement in model performance, improvements in fit related to more plausible model parameters (e.g., steepness), and greatly improved run times (for example, the draft base model run time is approximately seven minutes without inverting the Hessian matrix, versus over two hours for the 2003 SS1 model).

- *Early catch history of bocaccio is a significant source of assessment uncertainty. Focused research on historical catch is needed. A comprehensive approach should be taken where historical catches of all West Coast groundfish species are investigated at the same time. Assessing historical effort in West Coast groundfish fisheries may be more successful as a collaborative undertaking between an expert in historical research and a stock assessment scientist.*

As discussed in the comparison to the most recent assessments, this assessment uses a greatly revised catch history based on a major effort to reconstruct historical landings for groundfish throughout California waters. The authors of this assessment were deeply involved in this effort.

- *Work needs to be done to figure how to the start the model with appropriate initial conditions and with sensible initial depletion which is consistent with the data.*

The revised catch history and time period of the model (which now starts in 1892 rather than 1950) addresses these concerns.

- *The relationship between the CalCOFI index and climate should be evaluated. Two analyses are suggested. The first is to compare the residual patterns in model fits to an environmental index such as the Scripps Pier water temperatures. Adding an environmental covariate to the CalCOFI index catchability coefficient may improve the model fit to the index if annual egg production is influenced by environment conditions. A second analysis would be to compare biomass trends to indices associated with regime-*

scale environmental variability to see if significant correlations exist that would help explain long-term abundance trends.

We have not had sufficient time to evaluate this in great detail. However, initial evaluation of the residuals of the CalCOFI index to environmental indices (such as the multivariate ENSO index or the Pacific Decadal Oscillation index) do not show great promise for explaining much of the variability; interestingly the fit to climate indices tends to be better with the raw data than with the residuals to the fitted index (although neither would be considered a good fit in any meaningful sense). This suggests that climate conditions relate to fecundity (larval production) patterns as well as growth, and these interactions will be investigated in greater detail in the interim period between this assessment and the next assessment cycle, in concert with the research efforts related to time varying growth (discussed above).

The recommendations of the 2005 and 2007 STAR Panels (for the two assessment updates) varied little from those in the 2003 STAR Panel report, and the vast majority are consequently addressed in the above discussions. Among the topics not explicitly addressed in the above responses from the 2005 STAR Panel were the observation that an exploratory delta-GLM analysis of the triennial survey appeared to offer a more promising approach to evaluating the information from that time series (implemented in this assessment for both the triennial and the NWFSC combined survey); that the multiple spawning of bocaccio should be investigated with respect to the significance of this on larval counts or juvenile indices (addressed to some extent in the Ralston and MacFarlane, in review, manuscript described in this document); and that consideration should be given to the development of a more spatially-disaggregated model for bocaccio, similar to the approach developed but rejected in the 2002 model. Among the topics not explicitly addressed in the above responses from the 2007 STAR Panel report were to evaluate assumptions about stock structure and boundaries in light of information on catches of bocaccio rockfish taken off Mexico, Oregon, and Washington (addressed to the extent practicable in the discussion on genetics, stock structure and differences in growth and maturity patterns between the southern region modeled here and the northern/Canadian regional center of bocaccio abundance); and that length data be modeled seasonally (not addressed in this model).

D.2.c Transition to SS3 modeling platform and comparison to most recent assessment

In the last full assessment (MacCall 2003), contrasting information from a low 2001 triennial trawl survey data point with high recreational CPUE indices was difficult to reconcile, and the STAR Panel consequently adopted two “equally likely” but separate models. The first omitted the triennial trawl survey data (STARb1) and the second omitted the recreational CPUE data (STARb2). The STAT Team preferred a single, intermediate model (STATc) which included all of the data despite their inconsistencies, and the PFMC’s SSC subsequently agreed that all three models could be considered by the Council as bracketing the full range of uncertainty. The STATc model was subsequently the focus of the two updates to the 2003 model (in 2005 and 2007), with updated data sources confirming the strength of the 1999 year class (which had been observed to be strong in the 2003 assessment) and a relatively high 2004 triennial survey data point reducing (albeit not eliminating) the tension between the triennial survey and the recreational CPUE indices. Consequently we focused our attention on developing an SS3 model comparable to the most recent update of the STATc model in 2007.

To replicate the 2007 STATc model (herein called the 2007 model), an SS3 model was developed with an identical time frame and fisheries (trawl, hook-and-line, set net, recreational south and recreational central) as well as three surveys (CalCOFI larval abundance, triennial trawl survey, and the CPFV observer survey referred to as the Wilson-Vandenberg survey in the 2007 model). The 2007 model, as with earlier models, was a length-based model, the 2007 model began in the year 1951 with equilibrium catches estimated at 2000 mt/year and significant initial depletion. Landings were unchanged, as were the years in which recruitment deviations were estimated. Survey and length frequency data from the SS1 model were imported into the SS3 file structure with the associated tuned CVs and effective sample sizes from the tuned 2007 model. As with the 2007 model, the lambda (emphasis) on the stock/recruitment relationship was downweighted to 0.1, all other likelihood components were set at 1.

As the selectivity curves in the 2007 model were double logistic, the curves were duplicated as closely as possible using the double logistic parameterization in SS3 and "fitting" the curves visually with the slider bars in the selex24 spreadsheet provided by Rick Methot. The parameters from these "fits" were used as fixed values in the SS3 model. While not absolutely identical, the selectivity curves were replicated with a high degree of accuracy and we expect that their performance was effectively identical to the 2007 model parameterization (spreadsheet and parameters to compare the selectivity curves available upon request). As in the 2007 model, the selectivity of the CPFV observer time series was set equal to that of the central recreational fishery. The growth parameters in the SS3 model were estimated with a T_{min} of 1.6 and a T_{max} of 25 with starting values taken from the 2007 assessment (noting that the growth parameters were freely estimated in the 2007 model as well). All other biological parameters (natural mortality, weight/length, maturity, fecundity) were set to the 2007 model, as was sigma-R (set to 1). As R0 was to some extent a nuisance parameter in the 2007 model (model estimated h was approximately 0.2), this parameter was freely estimated in the SS3 model, and a range of steepness values was explored.

The trends observed in the SS1 model could be simulated reasonably well in SS3, however could not be perfectly replicated. There have been tremendous changes between the SS1 and SS3 modeling framework, including the use of ADMB and changes in the parameterization of the spawner-recruit relationship and the recruitment deviation values. The current model (SS3) fits vector of recruitment deviation parameters, by contrast, SS1 would fit individual log recruitments and then estimated the spawner recruit relationship with a component of goodness of fit to that relationship. The high recruitment variability observed in all previous bocaccio models led to very poor estimates of productivity (steepness) in the spawner-recruit relationship, and the emphasis on this relationship was downweighted in the final model. The earlier (SS1) model did not have as sophisticated a translation between pre-dev and post-dev bias adjustments to the spawner-recruit relationship, which is also likely responsible for some of the discrepancies between the models run with identical data and similar parameterizations. Other changes in the model structure that may have led to discrepancies between SS1 and SS2 (and would therefore be equally true for transitioning to SS3) were reported in the 2004 modeling workshop. For example, the likelihood components associated with length-frequency data often differed among the two modeling approaches, likely due to a simpler structure implemented for the emphasis coefficients in SS2. Another modest change was that small constants (which can be user defined) are added to composition data in SS2 (an option not available in SS1), mean weight at age is calculated from weight at length internally (rather than input directly) and SS1 had no adjustment for growth of individuals in the accumulator age within the population (Summary Report from the Stock Assessment Modeling Workshop, October 25-29, 2004, Northwest Fisheries Science Center).

Despite these discrepancies, the SS3 model replicated general trends in biomass, spawning output and recruitment with a high degree of consistency (Figures 48a-c). As early runs clearly indicated that the low steepness (h=0.21) scenario was not as comparable as runs with higher steepness values, we explored a range of steepness values, including the h=0.44 estimate (based on the posterior median estimated in the 2007 model), and scenarios in which h was fixed at the 2007 Dorn prior (based on updating the rockfish steepness meta-analysis of Dorn 2002) of 0.61, as well as the mean plus one standard deviation (h=0.79). Interestingly, the trends from the SS1 model were best replicated with a considerably higher (0.79) steepness value; the SS3 model with steepness set to the SS1 estimated value of 0.21 diverged notably in the early part of the model (particularly the 1960s through the early 1970s, during which CalCOFI larval abundance was essentially the only source of information). Additionally, the Hessian does not converge when steepness is fixed at 0.21, suggesting that the low steepness configuration was inconsistent with the data and results. In general, the model run with steepness set at 0.44 and 0.61 resulted in trends and depletion-based reference points similar to the h=0.75 run, and a likelihood profile demonstrated that this version was close to the best-fitting estimate of steepness for this SS3 model configuration. Likelihood values were quite different between the SS1 model results and the SS3 models, further evidence that the substantial changes in the modeling framework have made exact replication of the results nearly impossible.

All of the SS3 models estimate a slightly lower total biomass and spawning output (relative to the SS1 model) during the period from the mid-1970s through the early 1990s, the cause of this discrepancy is unclear. There are some interesting differences in the distribution of recruitment pulse in the early 1960s that is driven by the fits to CalCOFI data, with the “high steepness” SS3 model “smearing” the unusually strong 1962 year across several years, while the low steepness models reflect a single year pulse of strong recruitment. As these recruitments are driven by trends in the (somewhat noisy) CalCOFI data rather than informed by length information on recruitment, this presumed artifact of the manner by which recruitment deviations are estimated is of little concern, particularly as later recruitments (which are informed by very strong signals in length frequency data) are nearly identical during most of the modeled period. Similarly, all three models produce nearly identical estimates of the total and spawning output from the late 1990s to the end of the modeled period (2006), such that the range of difference in ending (2006) spawning output among these three models is less than 27 mt. However, the resulting depletion levels in 2006 differ more significantly, from 12.7% of SSB_0 in the SS1 model to 16.9% of SSB_0 in the SS3 model with low steepness (h=0.21) model and 20.7% of SSB_0 in the h= 0.79 model, due to the substantial differences in the estimated unfished spawning output levels among the models. Table 22 provides the estimated mean unfished recruitment, SPR, SSB_0 and relative (2006) depletion for the 2007 SS1 model relative to the 2009 SS3 model that is most similar to the SS1 biomass and spawning output trajectories (the h=0.79 version). Although the percent change was not trivial for all of these metrics, it was relatively modest (within 10%) for all.

To compare the influence of the new catch data, which together with the transition to the SS3 modeling platform are the most significant and influential changes in this assessment, we next compared the SS3 version most compatible with the 2007 SS1 model (the h=0.79 version) with the same model after the revised catch history and start year were revised from the 2007 model. As with the comparison between SS1 and SS3, the two models track each other closely in the recent historical period (~1970-present), however the revised catch history leads to a major change in the perception of starting (unfished) biomass and the relative abundance of bocaccio immediately prior to the 1950s when the 2007 model was initiated. The greatly revised catch history is largely responsible for this shift; whereas the SS3 best fit to the 2007 model had a initial (1950) equilibrium depletion level estimated to be at 43% of the equilibrium unfished level, the same model with the revised catch history and start year of 1892 had a 1950 depletion level of 87% of the unfished spawning output (Figures 49a-c).

This is due to the fact that the model beginning in 1951 had an estimated equilibrium catch of 2000 mt, comparable to the total estimated catch of bocaccio in the 1950s in the catch reconstruction developed for earlier assessments (Ralston 1996). In contrast, while the results of the catch reconstruction effort (Ralston et al., in prep) are consistent with that level of landings in the 1950s, catches of bocaccio in the 1940s appeared to be at relatively low levels, despite the fact that total catches of rockfish in California waters increased rapidly during this period. Much of this increase was in northern California waters, particularly north of Cape Mendocino, where bocaccio appear to have historically represented a much smaller fraction of total rockfish catches. As described in the catch reconstruction document, as well as the abridged discussion of the catch reconstruction in this document, bocaccio trawl catches rose rapidly from several hundred to nearly 3000 mt per year during the 1950s as the balloon trawl fleet expanded from Oregon and northern California waters to central California waters (declining again in the late 1950s and early 1960s). Bocaccio catches in central California until that period had rarely been greater than 500 to 600 mt, caught primarily with hook-and-line gear. Overall, this revision is the primary cause of one of the most significant changes in our perception of the relative stock status of bocaccio in California waters. Remaining revisions are numerous, and are discussed in the description of the base model, the intent here was to capture the history of modeling approaches used in the last several assessments (including updates) and provide documentation of the major aspects of the transition from the last assessment.

D.3 Model Description

Modeling software

This assessment used the Stock Synthesis 3 modeling framework developed by Dr. Richard Methot (Methot 2009a; Methot 2009b). For the comparison to the SS1 assessment, we used the most recent (at the time) version, (SS-V3.02B). The final model used the most recent version at the time (May 2009), SS-V3.03A.

Model Priors

This model used uninformative priors on many of the selectivity parameters in early modeling efforts, which contribute trivially to the total likelihood function. The Dorn (2002 and updated, pers. comm..) beta prior distribution for steepness was used to steepness in both the early modeling to compare the SS1 bocaccio model to the SS3 model, and in the final base model. The final base model steepness was estimated with the updated Dorn prior following the reanalysis of past stock assessments, which for bocaccio was 0.736 with a standard deviation of 0.186, considerably higher than the 2007 bocaccio point estimate of 0.612 with a standard deviation of 0.18. The resulting model posterior was 0.573 (nearly one standard deviation below the point estimate), which was consistent with the results of a likelihood profile across the fixed values of steepness.

D.3.a Base model selection, evaluation and description

From the SS3 model developed to evaluate the transition from SS1 and the impact of the revised catch history (describe in detail in the previous section), a number of alternative models were explored, for which comparable sensitivity analysis similar to that provided to document the transition to SS3 and the revised catch reconstruction would be overwhelming. New or revised survey indices, length frequency information, growth and maturity parameters, and other explorations were done based in part on the availability of new information and time, through over 100 versions of the control and data files (including a transition from the earlier version of SS3 and the May 2009 release of SS3.03). For example, in evaluating the utility of modeling northern and southern trawl fisheries independently, we implemented an incremental approach in which we visually evaluated the length frequency data by port group, compared the results of pooling all length frequencies, of pooling length frequencies north and south of Cape Mendocino, and of pooling length frequencies north and south of 38° N. In all cases the two fleet models had selectivity curves estimated independently and jointly ("mirrored"), and the relative improvement in fit with independently estimated curves, as well as visual analysis of the residual patterns, was used to divide the data from this fleet north and south of 38° N. Additionally, while the F estimation method in the early comparison models was based on estimating fishing mortalities as year and fleet specific parameters (comparable to the SS1 model), the new model uses the "hybrid" method (Methot 2009b), which reduced the run time from ~40 minutes to ~7. While the data, control and many of the output files are archived from this transition, including an annotated log of the significant change in each model version, the number of model versions and minor changes (many of which were reversed or later superseded by other changes) is too lengthy to present in a clear and concise manner in this document. Consequently, the impacts of the most significant of those changes are evaluated in the model sensitivity section.

As mentioned earlier, these changes include an expansion of the modeled assessment area, such that the northern boundary is now Cape Blanco, OR rather than Cape Mendocino, WA. In part due to this change, and in part due to patterns observed in the trawl length frequency data by port group, the trawl fishery was subsequently split into a northern and southern trawl fishery. The remaining fleets (hook-and-line, set net, southern recreational and northern recreational) are consistent with earlier modeling approaches. In the base model we include most of the survey indices, which include the trawl CPUE time series (linked here to the southern trawl fishery), the three recreational CPUE time series, the triennial trawl survey index (based on the GLMM index), the new NWFSC combined survey index, the new NWFSC Southern California Bight hook-and-line survey, the revised pier index and the revised (coastwide) pelagic juvenile index.

The power plant impingement data is not included, as it has not been updated to reflect recent years, and recruitment for the years for which the data do exist are well informed by length frequency data. The larval abundance biomass estimates were not included in the base model due to the mismatch in the spatial distribution of the estimates. Many of the selectivity and other parameters are estimated with diffuse, normal priors that are close to their final estimated value, which seemed to be helpful in stabilizing the model early in the development (particularly for growth parameters).

Although the base model is not spatially disaggregated, most of the data sources have some regional bias within the assessment area, thus the spatial nature of the various fisheries and indices is captured to the extent practicable by the separation of fisheries and indices. As described earlier, the trawl fishery was broken up into southern (south of 38° N) and northern fleets, as described above, the geographic pattern of other fisheries was held constant relative to earlier model configurations. In other words, both hook and line and setnet catches and length frequency data were pooled across all areas (although catches are very low north of Cape Mendocino, and there were no data for the small amount of the assessment area north of the California/Oregon border for these fisheries), and the recreational fisheries were treated independently north and south of Point Conception, CA (34.5° N). The three recreational fisheries indices are in turn based on data exclusively from southern or central/northern California respectively, similarly the trawl fishery CPUE index is derived from data derived from central California logbooks (this time series is linked to the trawl fishery south of 38° N), and the triennial trawl survey reflects data N of 34.5° N (with inconsistent coverage between 34.5° N and 36.5° N). The NWFSC combined trawl survey covers the entire assessment area, although trawl density is relatively sparse south of Point Conception, and the survey does not sample within the Cowcod Conservation Area (CCA) closures. The NWFSC hook-and-line survey is exclusive of the southern California Bight (south of Point Conception), although this too excludes the CCAs. The CalCOFI indices, while inclusive of data from the central California for many years, primarily reflect the "core" CalCOFI survey area (south of 35° N), the pier index reflect primary central (south of 37° N) and southern California, as juveniles are rarely caught in pier fisheries north of Half Moon Bay, while the coastwide juvenile survey includes data from the entire assessment area, although most data is from north of Point Conception (34.5° N).

In the base model, the size at age 1.5 is fixed at 26 cm for both males and females (as discussed in the growth section), although values for sex-specific L_{max} and K are freely estimated for each sex (estimation is as independent parameters, rather than the option in which male growth parameters are estimated as exponential offsets from females). Growth is time-invariant in the base model. Other growth and maturity parameters are fixed as discussed in the section on growth and maturity. Length bins start at 16 cm (versus 26 in the 2007 model) and are incremented at 2 cm intervals to the largest sizes (68, 72 and 76 cm), at which point bins are in 4 cm increments due to the relative rarity of larger fish (as in the 2007 model). Ages 0-20 are individually tracked, with 21 representing the accumulator age. R_0 (mean unfished recruitment) is freely estimated, steepness is estimated with an informative prior as described above, and sigma-R is fixed at 1. Recruitment deviations are freely estimated from 1954 through 2008; early deviation parameters are influenced only by the CalCOFI and pier index data, while year class strengths from about 1970 through 2006 are well informed by length data. The most recent years (2007-2008) are influenced primarily from the juvenile trawl index. All catchability coefficients (q parameters) in the base model were freely estimated as nuisance parameters. Recruitment deviations were estimated from 1954 through 2008, a slight shift from the 2007 model which began estimating recruitment deviations in 1960. This shift was done to allow the incorporation of some information from the pier survey index, but the difference between a start of 1954 and 1960 was negligible.

As with earlier models, and as noted in earlier STAR panels, the parameterization of the selectivity pattern for the triennial survey is notoriously unstable. In both early and quasi-final versions of this assessment, it was noted that when the model was "jittered" or when some starting (initial) values were altered, the selectivity pattern for this survey would vacillate between a strongly dome-shaped pattern (in which selectivity was greatest for age 1-2 fish, and declined sharply for larger, older fish) and a nearly asymptotic pattern (in which selectivity rose sharply for young, small fish but stayed high into larger, older fish, declining very modestly at sizes greater than approximately 70 cm). This seemed to be the result of two local minima in the negative log likelihood. Although the dome-shaped selectivity pattern resulted in an improved fit to the data, the model seemed to be unable to achieve that minimum in many model runs in which initial values were "jittered." This same phenomenon took place with both the NWFSC combined survey selectivity pattern, and the selectivity pattern for the southern trawl fishery; in the case of the latter, an approximately 100 likelihood point difference took place when the jittered run found the local minimum associated with the "asymptotic" selectivity relative to the dome-shaped.

Consequently, the selectivity patterns for the triennial survey were fixed at values arrived at from the best fitting jittered run, the selectivity pattern for the NWFSC combined survey was fitted as asymptotic, and the latter five (of six) selectivity parameters for the southern trawl fishery were fixed at the values that resulted in the best fit to the data upon multiple jittered runs (parameter 1, the peak of the ascending inflection, remained freely estimated). The selectivity pattern for the southern fishery is best fitted as a double-normal selectivity option, while the northern fishery is best fitted as an asymptotic selectivity option. Selectivity patterns for the hook-and-line, set net, and southern recreational fishery are also modeled as double-normal, while the selectivity for the central/northern recreational fishery is modeled as asymptotic. Selectivity patterns for the triennial survey and the NWFSC Southern California Bight hook-and-line survey are modeled as double-normal, while the selectivity for the NWFSC combined trawl survey is modeled as asymptotic (see below). Selectivity for the CalCOFI larval abundance time series is set to mirror population fecundity, while selectivity for the age 0 recruitment indices is strictly age-based, such that age-0 fish are fully vulnerable and all other ages are fully invulnerable. Upon fixing these parameters, model results were generally stable when jittered, although slight excursions (of 0.5 to 1.5 likelihood units) did take place in a small fraction (approximately 30%) of the jittered runs. This likely reflects an irregular likelihood surface, and similar results have been seen in many other relatively "data rich" models in which there are conflicting signals from various data sources. Although a cause for some concern, the effects of this did not seem to be severe with respect to the model results.

As so many of the survey variances were derived from different approaches (jackknife routines, MCMC routines, ANOVA routines), iterative re-weighting was applied to these indices by adding a constant to the variance adjustment in the control file such that the model estimated

RMSE was approximately equivalent to the mean input RMSE plus the adjustment (within ~5%). Table 23 reports the model observed RMSE values, along with the mean input values and the input variance adjustments. Similarly, effective sample sizes for the length frequency data were iteratively reweighted using the multiplicative scalar to adjust the input sample sizes for each fleet. Table 24 reports the mean input sample sizes, the mean effective sample sizes, and the corresponding multiplicative scalars used to reweight the length frequency data in the base model.

Table 25 shows values for the key fixed parameters, and all estimated parameters, along with the model estimated standard deviations for estimated parameters (although steepness was fixed, the standard deviation from the run where steepness was estimated with the Dorn prior is also reported, in parentheses). The model estimated growth curve is also shown as Figure 50, all of the estimated selectivity curves are shown as Figures 51a-j. The southern trawl fishery, hook-and-line, set net, and southern recreational fisheries all had greatly improved fits to length data with dome-shaped (double logistic) selectivity, while the central/northern recreational fishery and the northern (north of 38˚) trawl fishery fits to length data did not improve with double-logistic selectivity, and were fit using logistic selectivity curves. As discussed above, the triennial survey selectivity was fixed to avoid local minima in the negative log likelihood surface, as were all but the peak selectivity parameter for the southern trawl fishery. Although it seems illogical that the NWFSC combined survey would have a selectivity pattern dramatically different from the triennial trawl survey, the fit to the length frequency data degraded substantially when dome-shaped selectivity was either "fixed" for this survey, or when selectivity was explicitly linked ("mirrored") to triennial selectivity. The best fitting selectivity curve using the double-logistic parameterization was "virtually logistic," thus a logistic curve was used for this survey. The CPFV observer index and associated length frequency data from the central/northern California recreational fishery were explicitly linked to the central/northern CPUE time series based on the RecFIN dataset (and associated length frequency data) by mirroring those selectivity curves. and Figures 52a-b show the estimated recruitment deviation parameter values and the associated asymptotic standard error.

STAR Panel Requests and Response by the STAT Team

1. Eliminate the central CA rec. CPUE (MRFSS) index. Rationale: These data could be misleading because they may be more indicative of changes in the spatial pattern of the fishery than in the fish stock.

Elimination of the central recreational cpue index resulted in a drop in 2009 depletion from 25 to 22%. The index was ultimately included in the final model (see request #11).

2. Iteratively up-weight each informative index to determine the major conflicts in the model and to bracket more of the model uncertainty (adjust lambdas) and determine the estimates of current biomass and depletion under each scenario. Rationale: To identify major conflicts amongst the biomass indices and determine which indices were optimistic and which were pessimistic.

Due to growing run times, this request was not fully completed, and results that were completed were merged with request number 3.

3. Iteratively re-weight "optimistic" indices and "pessimistic" indices Rationale: To provide a useful pair of runs to bracket uncertainty.

Response: Based on both past assessments and various sensitivity analyses in the draft assessment, the STAT and STAR had identified the fundamental tensions in this model as being primarily between two pessimistic indices, the triennial trawl survey index and trawl fishery CPUE and two optimistic indices, the southern recreational CPUE index and the CalCOFI larval abundance index. The two pessimistic indices both indicate a steep decline in the 1980s, a decline also observed in the optimistic indices (albeit of lesser severity), while the two optimistic indices both suggest stronger rebuilding in the early 2000s. Upweighting the pessimistic indices resulted in a better fit to the 1980s decline and changed depletion to 16% (from the then "base" level of 22%). Upweighting the optimistic indices produced a better fit to the 2000s rebuild and indicated considerably less depletion (39% when recSO was upweighted; 36% when CalCOFI was upweighted).

4. Evaluate the effect of the relative weighting of the biomass indices and the compositional data by down-weighting the compositional data. Rationale: To determine whether there are any conflicts between the biomass and compositional data.

Response: All length frequency lambdas were scaled by 0.5 and 0.25 in two separate runs, and by fishery-specific scalars provided by the STAR Panel based on a methodology developed by Dr. Chris Francis (see STAR Panel report). The overall effect relative to the base model was fairly modest, the fit to survey indices improved by less than 2 likelihood points with lambdas of 0.5, another 3 with lambdas of 0.25. Fits to the trawl CPUE and triennial index improved more, resulting in a slightly more pessimistic perception of stock status (depletion in 2009 changed from 0.22 to 0.21 with lambda of 0.5, and to 0.20 with lambdas of 0.25). The result was similar when the lambdas were scaled by the values provided by the STAR Panel, with a consequent dip in depletion from 0.22 to 0.19.

5. Do a model run as a sensitivity analysis that incorporates all coastwide catches and mirrors selectivity of the northern trawl fishery. Rationale: To evaluate the effect of uncertainty about the northern boundary of the stock.

Response: The primary consequence of including OR and WA catches (when the compositional data were not included) was simply to scale up the biomass trajectory. In this scenario, the catches were simply combined with the "northern trawl" fishery catches, and the estimated current status was slightly more pessimistic (23% depletion, from 22%).

6. Do an additional model run as a sensitivity analysis that incorporates all coastwide catches and compositional data. Rationale: To evaluate the effect of uncertainty about the northern boundary of the stock.

Inclusion of the compositional data required the creation of a 7th "fishery" for Oregon and Washington landings and length frequency information. As length comps, which were based on relatively sparse data, were comprised almost exclusively of very large fish, an asymptotic selectivity curve was used, adding two parameters to the model. No relative abundance indices were available for this region. In this scenario, the assessment became more optimistic (28% depletion), although the exact reason was unclear. Growth parameters changed slightly in this scenario, with L_{max} increasing by several cm for both males and females, and the growth coefficient (K) decreasing, resulting in a degraded fit to many of the length compositional data. One problem noted with this approach is that the size bin structure developed for the base model is not optimal for the large sizes of the fish observed in northern catches.

7. Fix M for older fish at 0.1 and allow M to be estimated for younger fish. Rationale: Based on the Hoenig method, an M of 0.1 is more consistent with the longevity data than the current value of 0.15. There are also indications that mortality of younger fish (before settlement to demersal habitat) may be higher that that of older fish.

Response: The result is highly sensitive to the (assumed) fixed ages of "young" and "old" mortality rates (rates are interpolated between the two). If "young"=3 and "old"=5, M_{young} is estimated ~0.06, a counterintuitive result. However, if "old" age is 8 or 10, M_{young} estimated at 0.17 and 0.21 respectively. Depletion changes from 0.22 in base, to 0.20 and 0.19 in the latter two cases. Overall fit degrades 25 and 20 units respectively, with improvement to the pessimistic indices and degradation to the optimistic indices. Although the STAT and STAR were in agreement that the assumed value for natural mortality is not entirely consistent with estimates of longevity for this species, it was agreed not to change the value of M used in the base model, given the sensitivity to the definition of "old" fish age and inadequate data for estimation of M for "young" fish.

8. Include in the assessment report reference to the proposed listing of bocaccio in Georgia basin as endangered (under the terms of the Endangered Species Act). Rationale: A proposed listing of a distinct population segment of bocaccio rockfish is important background information that managers may want to consider when developing management measures for rebuilding the southern bocaccio stock.

Response: A new section has been drafted for the assessment report.

9. Assess the effect of the maturity curve by doing alternative runs using the maturity curves of Love et al. (1990) and Wyllie Echeverria (1987). Rationale: To evaluate the sensitivity of the assessment to previously published maturity curves.

Response: Although trajectories of biomass, spawning output and recruitment changed slightly, the effect on 2009 depletion was negligible (all 3 runs estimated 2009 depletion at 25%; note that this request was filled after implementing request 11). The Wyllie Echeverria (1987) curve resulted in a slightly poorer fit, the Love et al. (1990) maturity curve resulted in a modestly improved fit.

10. Specify the area covered by the assessment in the title of the assessment report. Rationale: To improved clarity since the entire US west coast was not assessed.

Response: The report title was amended to include the area assessed.

11. Include recCEN index back in the base model. Rationale: It seemed more reasonable that this index be downweighted, rather than removed, and the tuning procedure already does this downeighting.

Response: Reintroducing the recCEN index changed the depletion from 22% to 25%.

12. Conduct two runs to bracket the uncertainty in the assessment: one upweighting the triennial and trawlsou indices, and the other upweighting the recSO and CalCOFI indices. Rationale: To bracket the uncertainty.

Response: Upweighting an index was done by setting the associated $\lambda = 10$. The depletion changed from 25% to 14% when the triennial & trawlsou indices were upweighted, and to 38% when recSO and CalCOFI were upweighted. The standard deviation for 2009 depletion (based on the estimation of the hessian) was 0.033 (range 22-28%) but this only accounts for variance in estimated parameters.

13. Provide confidence intervals for model outputs, with and without delta method (McCall, in prep.) contributions for uncertainty in steepness, h, and natural mortality, M. Rationale: For models in which h and M are fixed, the usual confidence intervals (based on the inverse Hessian) may substantially underestimate uncertainty.

Response: When uncertainty in both M and h was included in the calculation of standard errors, this made the changes caused by the two bracketing runs (see request 12) approximately equivalent to ± 1 s.e. in depletion as estimated by the base model.

14. For the base model use the revised CalCOFI index (presented to the Panel) that utilizes a complementary log log link in the binomial part of the GLM (instead of the usual logit link). Rationale: An alternative GLM, using a complementary log log link in the binomial model, rather than the previously used logit link, fitted the CALCOFI data better (AIC decreased by 20 in the index GLM).

Response: This change had only a slight effect on the biomass trajectory, changing the depletion from 25% to 26%.

15. Conduct run in which catches north of 40° 10´ N were removed. Rationale: To evaluate the consequences of using the assessment to manage bocaccio fisheries south of 40° 10´.

Response: This change had only a slight effect on the biomass trajectory, changing the depletion from 26% to 27%. The catch north of 40° 10´ throughout the assessment period was approximately 6.7% of the total catch. The 2009 spawning biomass for the model excluding the catch north of 40° 10´ is 5.4% lower, while the summary biomass is 5.0% lower.

D.3.b Base model results

The base model results for summary biomass, spawning output, depletion and age-0 recruitment are shown as Figures 53-54, and in Tables 26. The initial unfished summary (age 1+) biomass is estimated to be 44,070 mt, with a spawning output (SSB_0) of 7,861 x 10^9 larvae and mean age 0 recruitment (R_0) of 5,060,000 recruits. The estimated steepness (h) for the base model was 0.573, approximately one standard deviation lower than the prior point estimate of 0.73. The initial (fixed) value for sigma-R was 1, the effective (output) sigma-R is 1.10; when the early years of estimated recruitments (1954-1969) are excluded the effective sigma-R remains high (1.16) indicating that the recruitment estimates for the early (poorly informed) part of the time series are not having an undue influence on the effective sigma-R. Sensitivity tests suggested little change in model fit or results when slightly higher fixed values for sigma-R were used. As the error around early recruitments is essentially as great or greater as sigma-R for most early years, these recruitments should be considered relatively poorly estimated from the data, and do not necessarily represent the nature of episodic recruitment in this early period that likely existed. The spawner-recruit curve, and the observed recruitments are shown as Figure 55. The total catches, fishing mortality rates (by fishery), estimated SPR rates and a phase plot of the SPR rates against depletion, are shown as Figures 56-57. Table 27 and 28 provide the numbers at age (female and male, respectively) estimated by the base model.

The summary biomass, spawning output and recruitment in 1892 (when the catch history begins) are slightly below the estimated unfished levels (96.8, 96.4 and 99.3% of unfished estimates respectively), due to the assumed existence of a very moderate fishery beginning in the 1850s. The population trajectory exhibits a very moderate decline until about 1950, when summary biomass, spawning output and recruitment are estimated to be at 82.6 80.7 and 95.7% of the unfished levels respectively. From 1950 through the 1960s the biomass is estimated to have declined steeply, as catches rose from several hundred to several thousand mt, reaching a local minimum in 1963 of 28.4% of the unfished spawning output, associated with harvest rates significantly above the (current) target levels. The biomass increased sharply thereafter, as a result of one or several very strong recruitment events in the early 1960s (informed primarily by the CalCOFI time series, with some support by irregular years of pier fishery data), exceeding the mean unfished biomass level through the early 70s, when catches again began to climb rapidly to their peak levels, associated with high (SPR of less than 0.2) fishing mortality rates and a rapid drop in biomass. By the mid 1980s depletion was at approximately 20% of the unfished level, and by the early 1990s depletion was at about 15%. Fishing mortality remained high throughout this period, even as catches declined rapidly, and recruitment during the 1990s was at very low levels. Fishing mortality declined only at the very end of the 1990s, in response to severe management restrictions. By 2002 SPR was generally close to or above 0.9, and in concert with a strong 1999 year, and relatively strong year classes in 2003 and 2005, spawning output has been increasing steadily. The base model estimates a current (2009) depletion level of 28.1%, a 2008 SPR of 0.947, with the forecast under constant harvest rates indicating a continued increase in spawning output.

Fits to the relative abundance indices, in both arithmetic and log space, and including plots of the observed vs. predicted values, are shown as Figures 58-67 for all of the indices used in the model. Fits to the length frequency data are shown as Figures 68-78. Fits to the CPUE indices were generally reasonable, the model was able to replicate the trends of both the trawl fishery and southern recreational fishery fairly well, although the model fits to the central/northern recreational fishery were poor, particularly in the last several years of the index, and the fit to the CPFV CPUE index completely missed the rapid rise and fall in catch rates from 1989 through 1992 that appears to have resulted from a strong 1988 year class. It is possible that a disproportionate influence of larger fish in the catches in some later years, when the fishery may have explored fishing grounds not widely exploited by recreational fleets earlier in the fishery, resulted in a selectivity curve that failed to predict higher catches of smaller fish from strong cohorts. Alternatively, strong year classes may result in large numbers of fish available in atypical habitat types (e.g., soft bottom) prior to dispersal, or fisheries may target abundant year classes resulting in higher catch rates and relatively greater catches of smaller individuals. Some greater exploration of this would be worthwhile. Fits to survey indices were also reasonable.

Although the relative lack of conflicting information facilitates the fit to the early years of the CalCOFI index, this index also captures the rapid decline in the 1970s through the 1990s and the increase in abundance in the post 1999 era that are observed in other indices and consequently predicted by the model. The use of the GLMM for the triennial trawl survey index also results in a relative improvement to the model fit to the data, although there is some suggestion of autocorrelation in the residuals in that the model underestimates the index in early years and overestimates the index in several years towards the end of the time series. As described earlier, there is considerable evidence that both past and present trawl survey methods are ill-suited for sampling bocaccio. The NWFSC trawl survey index and the index developed from the NWFSC hook-and-line survey in the southern California Bight are neither consistent with nor influential to the model estimated trends in abundance in recent years; both predict relatively flat or slightly declining trends while the model is estimating a relative increase in abundance. Although the pier survey index has little conflicting information for the early years, the data do conflict with the model biomass and recruitment estimates as informed by the CalCOFI data. This index does capture many of the strong recruitments in the period informed by length composition data (e.g., 1984, 1988, 1999, 2005), although it often underestimates the magnitude of these events, and also indicated strong year classes for several years in which strong cohorts did not later appear from the length composition data. The juvenile index seems to have overestimated the relative strength of the 2001 and 2002 year classes while underestimating the magnitude of the 2003 year class; the index may have captured the 2005 year class to a reasonable extent. The effectiveness of this index has yet to be determined, although the relatively low values observed are consistent with the generally unusual and low productivity ocean conditions observed in recent years (e.g., Goericke et al. 2007).

For the most part, the length composition data fit reasonably well in most fleets, particularly the southern recreational fishery and south/central trawl fishery, both of which clearly demonstrating the modal progression of strong year classes. There are some patterns of autocorrelation in the residuals to the length composition data that suggest an inability to perfectly fit the strong year class modes. This could be a consequence of slight differences in the timing of landings for some fisheries (as growth during the first several years is sufficiently rapid that data early or late in the year may not match expected length frequencies in the middle of the year), the geographic areas of given fleets (which may tend to capture slightly smaller or larger fish depending on the region), or variability in growth rates with differences in oceanographic conditions. The likelihood values associated with the base model are presented with values in the sensitivity analysis (below).

D.3.c Uncertainty and sensitivity analysis

Several diagnostics were developed to assess the sensitivity of the model to different values for key parameters, particularly steepness (h) and natural mortality (M). Profiles for those two values are shown in Figures 79a-b and differences in key reference points and relative likelihood values (by survey and/or fleet) are presented as Tables 29 and 30. The profile of steepness shows that the best fit occurs within a range of 0.4 to 0.6, consistent with the model estimated value of 0.573 when steepness was estimated with the Dorn prior. Although the fit is still reasonable at most higher levels of steepness, low levels of steepness appear less plausible based on the likelihood profile. However, as seen in Table 29, different data components have different responses in fit to the range of steepness values. In general, the trawl CPUE index (and trawl fishery length frequency data) and the triennial survey have better fits with lower values of h, while the recreational CPUE indices and associated length frequencies, as well as the CalCOFI time series, have a better fit with high values of h.

Similarly, a profile of natural mortality (M) suggests that the model has a better fit with higher values of M, with the best likelihood values in the range of 0.16 to 0.22. The trawl fishery CPUE and length frequency data, and triennial trawl survey, had better fits with lower M, while recreational fishery CPUE and CalCOFI indices fit had the best fit with higher M. Given the lack of age data in the model, improvements in fit alone were not deemed adequately informative to alter the estimated natural mortality rate, which remains one of the most significant unknowns in the model. The potential effect of migration of strong cohorts from the south to the north is an added complication. The relative influence of alternative values for steepness and natural mortality are shown as Figures 80-81, the results of which are generally intuitive. With higher assumed steepness values (and natural mortality rates), the estimated historical unfished biomass declines, leading to a more optimistic perception of stock productivity and relative abundance, the opposite is of course observed with lower assumptions of steepness and natural mortality.

In addition to the sensitivity to these life history parameters, we evaluated the sensitivity to changes in the data included in the model, to changes in model structure (developing essentially independent models north and south of Point Conception) and the influence of incorporating time-varying growth. These explorations were explored and discussed during the STAR Panel review, and the STAR Panel and STAT Team ultimately agreed that alternatively weighting a suite of indices for which the greatest source of model tension existed would capture the major axes of uncertainty in the model. Consequently, two models were developed to reflect the primary sources of uncertainty in the model, and thus bracket the plausible states of nature. State one is the scenario in which the two pessimistic indices (the triennial trawl survey and the trawl fishery CPUE index) were upweighted by setting the associated lambdas equal to ten. State two is the scenario in which the two optimistic indices (CalCOFI larval abundance and the southern California recreational fishery index) were upweighted, also with lambdas of ten. Figures 82a-c show the results of these two scenarios. The estimated depletion changed from 25% to 14% when the triennial and trawl fishery CPUE indices were upweighted, and to 38% when recSO and CalCOFI were upweighted. The corresponding point estimates of steepness in each of these scenarios was 0.539 for state one (the pessimistic scenario) and 0.724 for state two (the optimistic scenario), relative to 0.573 for the base model.

The retrospective analysis (Figures 83a-c) do not seem to demonstrate a major shift in perception of stock status when data from the last 2, 4 or 6 years are removed (only 2 and 6 are shown, as 4 is essentially no different). It is likely that a retrospective analysis that went back more years would reflect greater uncertainty with respect to stock status, trends and productivity, as it is clear that the 1999 year class was among the most defining events in altering the perception of the status and productivity of this stock. This is illustrated further in Figures 84a-b, which show the results of this base model relative to past assessments, from 1996 to the most recent (2007) update of the 2003 model (2005 varied little from 2007, so is excluded to improve readability). Again, prior to the clear recognition of the magnitude of the 1999 year class, assessments were highly pessimistic.

E. Reference Points

Reference points are presented in Table 31, which provides the unfished summary biomass, unfished spawning output, mean unfished recruitment and the proxy estimates for MSY based on the $SPR_{50\%}$ rate as well as the fishing mortality rate associated with a spawning stock output of 40% of the unfished level and with MSY estimated based on the spawner/recruit relationship and yield curve. The corresponding yields for these three estimates vary by a relatively minor amount, ranging from 1250 tons based on the spawning output proxy and 1270 tons based on the MSY estimate. However, the relative impact of the higher harvest rate on spawner abundance is results in a significantly lower equilibrium spawning output and summary biomass with both the SPR proxy and the estimated MSY rate, relative to the spawning output reference point.

Harvest projections and decision tables

The base model indicates that larval production, as a function of spawning output, has been increasing since the 1999 recruitment event and several subsequent year classes of moderate magnitude. The spawning output trajectory indicates that the stock is likely to continue to increase in coming years under current harvest rates, although the form of this trajectory is highly dependent on the magnitude of several year classes currently thought to be of moderate magnitude, as well as future recruitment events, which are highly uncertain. The results of the base model, coupled with a (largely unrealistic) assumption of mean recruitment into the future, would indicate that this stock should approach 40% of the unfished spawning output in approximately 2018, if current (2008) harvest rates are maintained. However, as bocaccio are a rebuilding species, tradeoffs among future harvest projections and population trajectories will be evaluated in greater detail in the rebuilding analysis.

The alternative states of nature used in the decision table (Table 32) were developed in conjunction with the STAR Panel. As both the STAT and the STAR Panel identified the major sources of uncertainty in the model as relating to the tension between two generally pessimistic indices (both derived primarily from north of Point Conception, California) and two optimistic indices (both derived primarily from south of Point Conception), the two alternative states of nature sequentially increased the emphasis on each of these groups to bracket uncertainty. The low abundance scenario was obtained by upweighting ($\lambda = 10$) the triennial and southern trawl CPUE indices, while the high biomass scenario was obtained by upweighting the southern recreational CPUE index and the CalCOFI indices. Thus, these scenarios also provided useful contrast between an apparent, but poorly understood, spatial dimension to relative abundance trends, as the data suggest that recovery may be taking place more rapidly in the south, and recovery in the central/northern California region may be dependent on an influx of fish from the southern area.

Catch trajectories for the three scenarios were developed in coordination with the Pacific Fishery Management Council (PFMC), Groundfish Management Team (GMT) and Groundfish Advisory Subpanel (GAP) representatives to the STAR Panel, and were based on three possibilities. The first catch stream was based on the fishing mortality rates associated with status quo (2008) catches projected into the future. In this scenario, catches then track changes in biomass, including a very slight dip in 2010 due to anticipated poor recruitment in 2007 and 2008. As recent catches have been less than half of the adopted OY values, this scenario is considered the low catch scenario; the 2009 catch in this scenario would be 65 tons. The second scenario projected catches that are associated with the SPR rate adopted in the Council's rebuilding plan of 0.77 in the base model, which results in a 2009 OY of 267 tons. Finally, the third catch stream was based on the Council-adopted SPR rate applied to the "optimistic" state of nature. Although the ABC (based on the 40:10 rule) would have been greater than this catch stream, the likelihood of management adopting an OY equal to the ABC for this rebuilding species was considered unlikely.

Regional management considerations

As described throughout the document, the stock structure for bocaccio is poorly understood. The decision to extend the boundaries of what we consider to be the southern subpopulation from Cape Mendocino to Cape Blanco was based on the observation that catches (both fishery and survey-derived) do not end abruptly at Cape Mendocino, but rather tend to taper off to the north. As such the fish in this region were more likely to originate from the southern subpopulation than the subpopulation distributed to the north. However, either boundary is imperfect. More significantly for management, it is worth noting that as the vast majority of the catches, and virtually all of the data used to inform the indices, are derived from the region south of Cape Mendocino, it may be reasonable to apply the results of this assessment to management measures applied to bocaccio solely in this region. Correspondingly, it would likely not be appropriate to set catch targets and limits for a small part of the northern range based on a downscaling of model results (for example, the small area of Oregon south of Cape Blanco ostensibly covered by this assessment). Practical considerations relating to the complexities associated with implementing catch monitoring or catch sharing agreements could preclude the application of these results in this region. There is clearly a need to devote additional effort into understanding population structure and connectivity, and to evaluating trends in abundance in the waters of the Pacific Northwest, as discussed in the research needs section below.

Future Research Needs

Stock structure for bocaccio rockfish on the West Coast remains an important issue to consider in future assessments as well as management. Although reanalysis of the genetic evidence suggests no genetic differentiation among the major oceanographic provinces in the California Current, both recent and historical data on the distribution of bocaccio rockfish, and the apparent differences in growth, maturity, and longevity, are indicative of moderate demographic isolation. This assessment does not address population abundance levels or trends in the Columbia or U.S. Vancouver INPFC areas, which might be considered more likely to be comparable to those observed in Canadian waters than waters south of Cape Blanco. However, this issue has yet to be resolved. It is possible that more refined genetic analysis, trace elements analysis of archived otoliths (Elsdon et al. 2008) or parasitology studies, could potentially shed some light on population structure, connectivity and/or movement patterns throughout their range. Ideally, such efforts would be conducted in coordination with Canadian and Mexican researchers. Similarly, several of the indices developed for this assessment could be improved by greater evaluation and consideration of the spatial distribution of fishing effort and fish size, particularly in the context of possible ontogenetic movement patterns.

Closely related to this issue is the question of whether a separate area model could be developed for bocaccio. There could be clear advantages with regard to the ability to more appropriately link the various indices to their appropriate spatial scale. However, possible diffusion or migration patterns and rates are completely unknown for this stock, and would likely prove to be a source of significant uncertainty.

Currently the CalCOFI index is the longest time series of relative abundance in the model, and may be the longest time series currently used for any west coast groundfish. However, for most of the time series the data are only available for the southern region of the range of bocaccio. Current CalCOFI surveys have surveyed the central California region for most of the past decade, additionally, ongoing efforts are retrospectively analyzing samples from the northern stations collected in the 1950s and 1960s. Both of these efforts will increase the data available for both monitoring trends and possibly for better understanding differences in relative abundance trends among these regions. As such these efforts are of high importance for future assessment.

The potential to develop defensible ageing criteria for bocaccio in the southern area should be evaluated further, and such criteria could possibly be developed in a coordinated effort among workers throughout the West Coast. Although production ageing is likely to remain a challenge given the expectation of high ageing error and uncertainty, as well as the high information content of the length frequency data in assessing growth and year class strength from animals of younger ages, future ageing efforts would likely improve the ability to adequately inform natural mortality rates, variability of size at age, and possibly contribute to an improved understanding of differences in life history parameters and rates in different regions of the West Coast.

Time varying growth has been shown to be an important factor in a number of stock assessments of west coast groundfish, and a more focused exploration of time-varying growth has also been strongly encouraged in past models and STAR Panel reviews of bocaccio. Although time constraints limited the extent of exploration that could be done in this assessment, some exploration of time-varying growth was developed in the draft assessment, by estimating offsets to the von Bertalanffy growth parameter (K) as free parameters in various types of time blocks. As these preliminary explorations did not have a tremendous influence on the outcome in the current assessment, the final model did not include a time-varying growth component. However, the STAT Team intends to expand on process studies relating environmental conditions to growth and fecundity, using those results to modify existing bioenergetics models, and further investigating mechanisms by which climate may drive changes in energy budgets. Our hope is that the results of that effort can improve upon the manner by which time-varying growth (and potentially fecundity) have can subsequently be incorporated into future stock assessments.

The trawl survey indices (triennial and NWFSC combined shelf-slope survey) are not well suited to species that largely associate with highly structured habitat. Research to develop or improve upon alternative survey methodologies would benefit this assessment.

Currently, most of the fishing mortality on bocaccio rockfish takes place in the southern California recreational fishery, where a broad area of habitat is closed to fishing in the cowcod conservation areas (CCAs) and rockfish conservation areas (RCAs). Although the entire coast has significant RCA closures, with consequent impacts on the distribution of fishing effort and likely consequences on selectivity, the Cowcod Conservation Areas have been treated as closed to most monitoring efforts as well (the NWFSC SCB hook-and-line survey, the NWFSC combined trawl survey), unlike the RCAs. Consequently, the time series derived from these indices in this region are likely to be biased, and the inability to develop time series of abundance, as well as to assess potential differences in demographic structure, could eventually compromise the ability to assess the status of this stocks. This is by no means a problem limited to bocaccio (Field et al. 2006), however the problem may be particularly acute in the Southern California Bight, as suggested by the difference in trends observed from the CalCOFI data relative to the hook-and-line survey, and the apparent concentration of spawning output in the area now protected by the CCAs.

Although the influence of alternative maturity curves was relatively modest in this assessment, there have been few historical, and no recent, histology studies to confirm macroscopic staging for confirming the maturity relationship. Additionally, there is very little data available in the southern area (south of Conception) for smaller fish, somewhat complicating efforts to detect differences in maturity across space.

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Table 1. Total catches (metric tons) and PFMC adopted ABC/OY values for bocaccio rockfish.

	Commercial	Recreational	ABC	OY
1980	4177	1057		
1981	4610	1071		
1982	5001	1516		
1983	5021	566	6100	6100
1984	4427	244	6100	6100
1985	2471	387	6100	6100
1986	2511	599	6100	6100
1987	2451	193	6100	6100
1988	2153	151	6100	6100
1989	2492	257	6100	6100
1990	2396	324	6100	6100
1991	1486	292	1100	1100
1992	1604	259	1100	1100
1993	1409	128	1540	1540
1994	982	220	1540	1540
1995	716	47	1700	1700
1996	447	93	1700	1700
1997	318	156	265	265
1998	152	52	230	230
1999	73	124	230	230
2000	28	112	164	100
2001	22	109	122	100
2002	49	41	122	100
2003	5	7	244	20
2004	19	66	400	199
2005	27	81	566	307
2006	19	41	549	306
2007	9	53	602	218
2008	43	34	618	218

Table 2. Sample sizes of maturity data by year and port complex. Combined data from CALCOM, West Coast triennial survey, and Groundfish Ecology survey.

year	Morro Bay	Monterey	San Fran.	Bodega	Bragg	Eureka	Crescent City
1993	180	201	73		38	10	
1994	137	14	10	1	42	9	
1995	216	5	1	14	8	11	2
1996	130		3				
1997	173		31	12	1		5
1998	110	32	26	20			21
1999	19		20	5	5		
2000		52	2	11			
2001		190		4			
2002	1	104	8	9	5	1	
2003		68					
2004	1	129	3				
2005		25					
2006		29		7			
2007		28		3		1	
2008			1	10		10	

Table 3. AIC values associated with alternative model structures, data pooled across years. Data source included maturity estimates from commercial landings (CALCOM).

model	covariates	parameters	AIC	AIC-min(AIC)
1	FL	2	770.5	105.3
2	FL + port	8	697	31.8
3	FL + port + source	10	672.8	7.6
4	FL + port + source + FL:port	16	665.4	0.2
5	FL + port + source + FL:port + FL:source	18	665.2	0

Table 4. Estimated catches of bocaccio rockfish (metric tons) in California by region and gear type from the historical catch reconstruction, 1916-1968.

	North 38	South of 38		South of Conception	
year	trawl	trawl	h&line	trawl	h&line
1916	0	55	377	0.0	42
1917	0	86	593	0.0	69
1918	1	97	641	0.0	60
1919	0	66	428	0.0	35
1920	0	68	443	0.0	39
1921	0	56	372	0.0	34
1922	0	49	333	0.0	34
1923	0	55	387	0.0	47
1924	0	37	331	0.0	74
1925	1	30	395	0.0	80
1926	1	83	534	0.0	93
1927	2	111	422	0.0	75
1928	1	151	423	0.0	60
1929	28	119	380	0.0	62
1930	17	136	490	0.0	61
1931	50	46	490	0.0	88
1932	37	69	386	0.0	44
1933	59	90	215	0.0	42
1934	41	109	289	0.1	28
1935	43	91	341	0.0	28
1936	18	108	449	0.0	25
1937	41	92	391	0.0	17
1938	48	76	284	0.0	12
1939	86	50	184	0.0	16
1940	60	46	220	0.0	18
1941	53	32	168	0.0	20
1942	26	8	63	0.0	8.8
1943	196	8	65	0.0	5.4
1944	635	3	82	0.0	2.1
1945	1211	54	123	0.8	3.7
1946	612	111	116	0.1	6.6
1947	632	6	193	0.0	5.5
1948	397	82	141	0.3	9.4
1949	380	93	163	1.2	13
1950	375	303	313	0.3	15
1951	532	765	249	0.6	13
1952	268	1308	172	3.3	8.8
1953	305	1676	63	2.1	7.5
1954	246	1583	79	15	10
1955	335	1586	111	179	12
1956	350	1897	285	109	15
1957	469	2074	257	145	15
1958	482	2323	198	137	16
1959	379	2001	110	61	15
1960	345	1603	77	128	16
1961	266	1193	63	105	18
1962	230	1054	54	93	14
1963	326	1197	64	117	21
1964	190	869	52	74	18
1965	273	896	59	70	22
1966	196	1237	103	72	26
1967	294	1065	91	115	27
1968	325	1036	61	118	20

Table 5. Estimated domestic commercial landings of bocaccio rockfish South of Cape Blanco, OR by region and gear type, 1969-2008 (metric tons).

	North of 38			Conception to 38			South of Conception			Total		
year	CA trawl	CA H&L	OR Erk	trawl	H&L	set net	trawl	H&L	set net	trawl	H&L	set net
1969	223	6	9	806	40	7	279	34	10	1317	80	17
1970	250	4		1126	53	9	215	27	5.8	1591	83	15
1971	324	9	4	766	44	54	195	30	4.6	1289	83	59
1972	371	18		1278	64	67	332	44	3.6	1980	126	71
1973	335	9		2484	101	156	379	43	11	3198	153	167
1974	489	28		1705	102	222	381	39	40	2575	170	262
1975	556	11		1870	97	248	399	54	37	2825	162	285
1976	691	26		1932	133	82	486	65	41	3109	225	123
1977	674	19		1880	124	109	501	53	49	3055	197	158
1978	745	39		1507	152	24	372	80	101	2624	270	125
1979	286	46	207	2950	194	10	349	131	226	3793	371	235
1980	586	20	45	2797	220	34	258	96	182	3686	335	216
1981	2165	0	18	1580	196	89	200	116	264	3962	312	353
1982	1897	2	62	2087	218	182	237	173	205	4284	393	387
1983	2280	2	121	1663	160	479	251	78	109	4315	239	588
1984	1621	17	70	1808	273	247	84	77	300	3584	367	547
1985	654	21	81	555	71	687	27	62	404	1318	154	1092
1986	377	104	12	696	71	695	94	97	391	1179	272	1086
1987	555	128	9	564	120	673	86	56	295	1214	304	968
1988	695	185	14	533	207	268	57	125	104	1299	518	371
1989	553	90	16	532	202	744	62	95	238	1163	386	982
1990	463	125	25	618	160	554	64	212	239	1170	497	793
1991	263	37	13	455	110	266	44	124	192	774	271	458
1992	133	61	9	322	134	418	40	284	222	504	479	640
1993	203	104	15	334	101	228	25	241	202	577	446	430
1994	150	24	12	300	56	179	77	126	84	538	206	263
1995	162	18	20	191	26	206	24	24	76	398	69	281
1996	63	36	2	212	21	53	14	36	38	290	93	92
1997	94	19	4	128	14	25	8.8	24	10	234	58	35
1998	32	15	1	36	13	34	4.7	14	4.8	74	42	39
1999	26	10	0.2	18	8	5.5	1.2	3.5	1.7	45	21	7.2
2000	7	2.5	4.0	13	3	0.7	0.1	1.9	0.0	24	7	0.7
2001	4	2.7	0.2	9	3	0.5	0.1	2.6	0.3	14	8	0.9
2002	6	0.7	0.1	12	0	0.1	0.1	2.0	0.1	18	3	0.2
2003	0.0	0.0	0.1	0	0	0.0	0.0	0.4		0	0	0.0
2004	0.3	0.3	0.0	6	1	0.3	0.1	4.4	0.0	6	5	0.3
2005	0.2	0.5	0.0	4	1	0.0	0.1	3.1	0.0	4	4	0.1
2006	0.4	0.8	0.0	0	1	0.2	0.2	4.7	0.1	1	7	0.2
2007	0.2	0.8	0.0	1	1	0.2	0.0	3.2	0.0	2	5	0.2
2008	1.6	1.0	0.0	0	1	0.2	0.0	2.9	0.0	2	5	0.2

Table 6. Total rockfish catch and estimated catch of bocaccio rockfish (metric tons) by region from 1892 to 1915 (all catch is assumed to be hook and line gear for this period).

	Total CA rockfish	Estimated catches of bocaccio South of Men.	South of Conc.	Conc. to Mendocino
equil	764	153	76	77
1892	**834**	167	83	84
1893	*788*	157	78	80
1894	*741*	148	73	75
1895	**694**	139	69	70
1896	*655*	131	65	66
1897	*616*	123	61	62
1898	*578*	115	57	58
1899	**539**	108	53	54
1900	*596*	119	59	60
1901	*654*	131	65	66
1902	*711*	142	70	72
1903	*768*	154	76	78
1904	**826**	165	82	83
1905	*882*	176	87	89
1906	*939*	188	93	95
1907	*996*	199	98	101
1908	**1052**	210	104	106
1909	*1184*	237	117	120
1910	*1316*	263	130	133
1911	*1447*	289	143	146
1912	*1579*	316	156	159
1913	*1711*	342	169	173
1914	*1843*	368	182	186
1915	**1975**	395	195	199

Table 7. Total reported catches of bocaccio rockfish outside the assessment area (north of Cape Blanco, Oregon), 1969-2008.

	Northern U.S.		Canada		Total	
	OR	WA	VN INPFC	CH INPFC	U.S.	Canada
1969	57		90	725	57	815
1970	62		208	98	62	306
1971	112		32	140	112	172
1972	50		72	151	50	223
1973	36		98	648	36	746
1974	31		39	669	31	708
1975	56		37	467	56	504
1976	18		210	285	18	495
1977	39		44	326	39	370
1978	143		28	221	143	249
1979	510		84	394	510	478
1980	294		15	163	294	177
1981	630	45	11	79	675	90
1982	619	46	11	89	665	101
1983	785	136	46	102	921	148
1984	244	152	65	104	396	169
1985	483	123	164	243	606	407
1986	274	80	304	396	354	700
1987	247	110	206	504	357	710
1988	192	96	594	728	288	1323
1989	254	247	336	449	501	785
1990	182	267	270	763	448	1032
1991	213	363	321	742	577	1063
1992	152	205	361	588	358	949
1993	153	132	458	671	285	1129
1994	107	50	281	327	158	607
1995	99	47	170	340	146	510
1996	71	43	117	185	114	302
1997	102	54	89	159	156	248
1998	45	37	67	151	82	217
1999	25	10	97	130	35	228
2000	0.3	1.9	96	178	2	275
2001	5.1	7.6	92	165	13	257
2002	0.0	5.4	68	204	5	272
2003	0.3	6.4	62	155	7	217
2004	0.2	3.8	42	104	4	146
2005	0.4	0.9	56	84	1.3	140
2006	0.7	0.0	42	67	0.7	110
2007	0.1	0.7			0.9	
2008	0.0	0.0			0.0	

Table 8. Total foreign catches of bocaccio rockfish by INPFC area, 1966-1976, from Rogers (2003).

	INPFC Area				
	U.S. VAN	COL	EUR	MON	CON
1966	23	188	0	1101	0
1967	20	90	1	2856	0
1968	9	30	67	842	0
1969	2	29	0	48	0
1970	3	37	0	0	0
1971	5	17	0	0	0
1972	5	28	9	39	0
1973	4	49	313	1375	299
1974	2	11	37	3835	35
1975	0	16	23	1047	0
1976	0	13	14	1007	0

Table 9. Total mortality (landed plus discarded catch) for the 2002-2008 period Based on NWFSC total mortality reports (2002-2007) and the GMT scorecard (2008).

	trawl south of 38° N	trawl north of 38° N	hook and line	setnet	rec south of 34.5° N	rec north of 34.5° N
1999	19	53	26	20.7	7.2	71
2000	13.5	60	6.6	7	0.7	52
2001	9.2	49	4.4	7.8	0.9	60
2002	28.04	20.67	0.13	0.01	35.88	4.93
2003	5.07	0.31	0	0	5.53	1.87
2004	13.86	3.52	1.84	0.21	63.43	2.27
2005	24.64	0.43	1.5	0.17	69.9	10.7
2006	16.09	0.31	2.25	0.25	29	11.8
2007	4.06	1.58	3.39	0.38	44.2	8.92
2008	28.73	1.58	13.4	0.5	30.3	3.59

Table 10. Number of subsamples (clusters), length observations and initial effective sample sizes (Neff) for the southern and northern commercial trawl fisheries.

	Trawl South			Trawl North		
year	Nsamp	Nfish	Neff	Nsamp	Nfish	Neff
1978	64	963	197	99	584	180
1979	62	1085	212	44	170	67
1980	108	992	245	129	666	221
1981	78	631	165	96	719	195
1982	133	1515	342	119	905	244
1983	134	1558	349	202	1187	366
1984	189	1801	438	122	897	246
1985	182	1151	341	114	595	196
1986	108	1892	369	92	545	167
1987	99	1768	343	111	1048	256
1988	93	1198	258	87	662	178
1989	90	721	189	70	429	129
1990	108	1496	314	84	552	160
1991	98	1911	362	44	580	124
1992	71	1370	260	17	210	46
1993	73	1063	220	12	230	44
1994	51	313	94	16	272	54
1995	43	240	76	19	154	40
1996	34	349	82	10	59	18
1997	53	368	104	8	70	18
1998	21	281	60	7	106	22
1999	21	417	79	5	21	8
2000	11	103	25	5	65	14
2001	30	451	92	5	16	7
2002	16	160	38	9	107	24
2003	1	2	1			
2004	17	118	33			
2005	1	4	2	1	2	1
2007	4	10	5	2	2	2
2008	2	2	2	7	21	10

Table 11. Number of subsamples (clusters), length observations and initial effective sample sizes (Neff) for the commercial hook-line and setnet fisheries.

	Hook and line			Setnet		
#Yr	Nsamp	Nfish	Neff	Nsamp	Nfish	Neff
1978				9	73	19
1979	3	17	5	1	20	4
1980	12	50	19			
1982	15	20	18	1	9	2
1983	11	55	19	33	60	41
1984	16	47	22	82	46	88
1985	22	94	35	231	852	349
1986	37	259	73	165	1260	339
1987	25	227	56	119	1049	264
1988	12	82	23	93	960	225
1989	29	112	44	130	1401	323
1990	14	68	23	106	916	232
1991	33	122	50	37	384	90
1992	66	329	111	71	1186	235
1993	77	239	110	50	447	112
1994	57	212	86	53	196	80
1995	27	90	39	42	204	70
1996	62	318	106	27	121	44
1997	40	265	77	13	84	25
1998	32	191	58	16	127	34
1999	10	98	24	1	26	5
2000	10	44	16			
2001	20	152	41			
2002	5	14	7	1	25	4
2004				2	17	4

Table 12. Total estimated recreational catch of bocaccio rockfish 1928-1980 from the California historical catch reconstruction effort (metric tons).

year	south	north	year	south	north
1928	2.0	2.4	1955	761	69
1929	4.0	4.8	1956	917	77
1930	6.0	5.5	1957	530	77
1931	8.0	7.3	1958	301	123
1932	10	9.2	1959	178	103
1933	12	11	1960	185	81
1934	14	13	1961	212	69
1935	16	15	1962	204	80
1936	16	17	1963	194	89
1937	28	20	1964	244	75
1938	22	19	1965	319	107
1939	20	17	1966	564	118
1940	14	24	1967	770	111
1941	13	22	1968	832	104
1942	7	12	1969	785	111
1943	7	11	1970	1039	118
1944	5	9	1971	967	104
1945	7	12	1972	1309	123
1946	12	21	1973	1511	186
1947	37	17	1974	1893	201
1948	102	34	1975	1865	200
1949	133	44	1976	1489	216
1950	157	54	1977	1265	194
1951	136	63	1978	1174	196
1952	152	55	1979	1714	230
1953	171	47	1980	943	264
1954	411	58			

Table 13. Total RecFIN recreational landings (metric tons), 1980-2003, with four year bracketing average values used for missing years (1990-92 in south, 1990-95 in north) and corrected for "unknown" rockfish.

	All RecFIN rock		unknown rockfish		bocaccio		bocaccio+unk	
	south	north	south	north	south	north	south	North
1980	5236	2770	4	603	1755	178	1756	227
1981	2544	2956	204	64	841	230	914	235
1982	3589	4038	209	155	1158	358	1230	372
1983	1562	2757	7	85	265	301	266	311
1984	1906	2035	53	7	177	67	182	67
1985	2284	2033	24	70	321	66	325	68
1986	2238	2021	30	55	428	171	434	176
1987	932	1710	22	60	90	103	92	106
1988	900	1961	0	14	107	44	107	44
1989	971	1683	19	89	179	78	182	82
1990	*798*	*1572*	*42*	*106*	*152*	*64*	161	68
1991	*798*	*1572*	*42*	*106*	*152*	*64*	161	68
1992	*798*	*1572*	*42*	*106*	*152*	*64*	161	68
1993	410	*1572*	24	*106*	109	*64*	116	68
1994	910	*1572*	124	*106*	215	*64*	249	68
1995	458	*1572*	56	*106*	30	*64*	35	68
1996	600	1083	11	264	67	26	68	34
1997	283	1562	112	56	49	107	82	111
1998	288	938	51	124	29	23	35	26
1999	596	1245	75	169	71	53	81	61
2000	325	1278	42	300	52	60	59	79
2001	232	1099	10	113	60	49	63	54
2002	269	824	26	80	76	8	84	9
2003	249	1488	29	14	11	0	12	0

Table 14. Number of subsamples (clusters), length observations and initial effective sample sizes (Neff) for southern and central/northern CPFV observer programs conducted by CDFG.

	South CPFV Observer			Central/North CPFV Observer		
	Nsamp	Nfish	Neff	Nsamp	Nfish	Neff
1975	290	21866	2030			
1976	326	25900	2282			
1977	222	11431	1554			
1978	238	18579	1666			
1986	111	4110	678			
1987	93	2949	500	71	917	198
1988	83	1870	341	131	1227	300
1989	137	5025	830	163	1435	361
1990				58	976	193
1991				59	871	179
1992				161	1702	396
1993				137	1159	297
1994				111	721	210
1995				121	750	225
1996				105	580	185
1997				122	982	258
1998				65	433	125

Table 15.Number of subsamples (clusters), length observations and initial effective sample sizes (Neff) for southern and central/northern recreational fisheries from RecFIN. Note that effective starting samples greater than 400 were set to 400.

	South RecFIN			Central/North RecFIN		
	Nsamp	Nfish	Neff	Nsamp	Nfish	Neff
1980	176	2606	536	70	252	105
1981	148	2233	456	34	252	69
1982	135	1819	386	50	311	93
1983	99	706	196	46	359	96
1984	181	594	263	69	187	95
1985	147	1331	331	99	554	175
1986	119	1299	298	105	942	235
1987	32	132	50	37	225	68
1988	39	79	50	36	48	43
1989	50	489	117	36	119	52
1993	17	53	24	30	56	38
1994	23	86	35	26	50	33
1995	17	35	22	29	68	38
1996	35	116	51	78	229	110
1997	15	53	22	108	787	217
1998	39	105	53	83	504	153
1999	118	460	181	127	623	213
2000	95	526	168	47	277	85
2001	57	380	109	38	326	83
2002	102	720	201	18	180	43
2003	20	122	37			
2004	200	912	326	49	80	60
2005	200	1449	400	103	259	139
2006	200	1860	457	124	279	163
2007	200	2139	495	138	262	174
2008	200	1811	450	87	162	109

Table 16. Total number of bongo plankton tows, positive (for bocaccio) tows, and the mean cpue of positive tows for years with adequate sampling, 1951-2008.

	Northern area (lines<77)			Southern area (lines>=77)		
	total tows	positive	ave cpue	total tows	positives	ave cpue
1951				128	32	2.4
1952				190	42	1.6
1953				240	59	3.7
1954				259	92	5.7
1955				180	56	3.1
1956				210	31	2.2
1957				205	44	3.6
1958				251	54	3.1
1959				291	37	1.1
1960				307	57	2.2
1961				100	23	2.8
1962				94	26	1.9
1963				118	28	2.1
1964				136	29	3.5
1965				119	34	2.8
1966				193	62	3.0
1967				52	12	1.7
1968				50	26	15.6
1969	120	38	6.7	205	71	8.1
1970				51	7	0.9
1972	120	47	10.5	161	66	9.8
1975	99	23	4.0	306	65	5.0
1976				64	13	4.0
1978	116	15	2.0	284	27	2.2
1981	130	16	2.0	270	25	4.7
1983	44	2	0.5	83	6	1.5
1984	107	17	2.7	165	31	2.5
1985				86	5	0.7
1986				131	6	0.4
1987				135	9	1.0
1988				142	19	1.3
1989				96	13	3.5
1990				135	9	0.5
1991				135	21	2.6
1992				91	17	1.9
1993				96	4	0.6
1994				146	13	0.6
1995				89	2	0.2
1996				92	19	3.6
1997				97	9	0.6
1998				120	5	0.2
1999				118	8	0.6
2000				96	8	0.8
2001				93	6	0.5
2002				118	10	1.0
2003	46	4	0.6	143	14	1.0
2004	46	3	1.3	99	11	4.9
2005				146	16	1.6
2006	28	4	1.6	149	13	0.7
2007	10	4	5.6	108	11	1.2
2008				134	13	1.8

Table 17. Summary of survey information for Triennial trawl survey, 1977-2004.

Total number of hauls, 50 to 350 m

lat	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
34	388				626	201	93	39	57	75
36	415	264	129	106	730	231	77	65	53	123
38	347	249	363	124	90	57	79	60	65	84
40.5	24	61	101	72	49	54	48	54	54	49
43	290	336	579	430	325	346	249	262	233	168

Number of positive tows

lat	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
34	350				616	189	77	19	35	59
36	392	258	112	100	697	189	49	29	15	94
38	320	241	339	108	51	16	37	10	18	61
40.5	1	50	64	45	7	5	3		3	4
43	101	111	257	81	43	51	9	21	10	

Percent positive

lat	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
34	0.90				0.98	0.94	0.83	0.49	0.61	0.79
36	0.94	0.98	0.87	0.94	0.95	0.82	0.64	0.45	0.28	0.76
38	0.92	0.97	0.93	0.87	0.57	0.28	0.47	0.17	0.28	0.73
40.5	0.04	0.82	0.63	0.63	0.14	0.09	0.06	0.00	0.06	0.08
43	0.35	0.33	0.44	0.19	0.13	0.15	0.04	0.08	0.04	0.00

Number of length measurements

lat	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
34	317				613	189	77	19	35	59
36	382	247	102	81	695	186	49	29	15	94
38	278	224	327	87	49	15	37	10	18	61
40.5		38	49	42	2	4	3		3	4
43	62	70	193	56	28	49	9	21	10	

Table 18. Triennial survey area-swept biomass estimates and coefficient of variation (CV).

Depth Stratum		Biomass (mt)									
US Vancouver		1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
	55-183 m	1568	130	313	108	101	16	1	99	1	0
	184-366 m	49	28	19	8	20	181	10	44	26	0
	367-475 m	0						0	0	0	0
	all depths	1617	159	332	116	121	198	11	143	27	0
Columbia											
	55-183 m	566	475	462	214	33	0	32	0	51	0
	184-366 m	340	41	128	325	41	74	0	0	16	0
	367-475 m	6						0	0	0	0
	all depths	912	516	590	539	74	74	32	0	67	0
Eureka											
	55-183 m	13	668	142	1840	19	0	7	0	12	0
	184-366 m	10	93	176	217	30	23	4	0	16	20
	367-475 m	0						0	0	0	0
	all depths	22	761	318	2057	49	23	11	0	27	20
Monterey											
	55-183 m	2393	2956	892	4268	478	473	192	97	77	1760
	184-366 m	3691	546	5294	322	601	64	294	33	33	329
	367-475 m	1						7	0	0	12
	all depths	6085	3502	6187	4591	1078	537	494	130	110	2101
Conception											
	55-183 m	623				8450	1010	31	4	38	148
	184-366 m	181				196	58	27	6	14	66
	367-475 m	0						0	2	0	0
	all depths	804				8646	1068	58	11	52	215
Total US Area											
	55-183 m	5163	4230	1809	6430	9080	1500	263	200	179	1908
	184-366 m	4271	708	5617	873	888	401	335	84	105	415
	367-475 m	7						7	2	0	12
	all depths	9441	4938	7427	7303	9968	1900	606	285	284	2335

		Coefficient of Variation									
Depth Stratum		1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
US Vancouver											
	55-183 m	0.91	0.70	0.48	0.37	0.34	0.34	0.58	0.48	1.00	
	184-366 m	0.54	1.00	0.52	1.00	0.43	0.43	0.71	0.47	1.00	
	367-475 m	-						-	-	-	
	all depths	0.89	0.61	0.46	0.35	0.29	0.29	0.63	0.36	0.96	
Columbia											
	55-183 m	0.54	0.35	0.39	0.40	0.70	0.70	0.81		0.61	
	184-366 m	0.30	0.36	0.24	0.86	0.82	0.82	-		0.69	
	367-475 m	1.00						-		-	
	all depths	0.35	0.33	0.31	0.54	0.55	0.55	0.81		0.49	
Eureka											
	55-183 m	1.00	0.43	0.45	0.84	0.78	0.78	0.92		1.00	1.00
	184-366 m	1.00	0.52	0.65	0.53	0.52	0.52	1.00		0.69	1.00
	367-475 m	-						-		-	-
	all depths	0.71	0.38	0.41	0.75	0.44	0.44	0.69		0.58	1.00
Monterey											
	55-183 m	0.43	0.40	0.33	0.84	0.36	0.36	0.37	0.48	0.43	0.62
	184-366 m	0.62	0.48	0.74	0.59	0.60	0.60	0.81	0.51	0.70	0.41
	367-475 m	0.75						1.00	-	-	1.00
	all depths	0.41	0.35	0.64	0.78	0.37	0.37	0.50	0.38	0.37	0.52
Conception											
	55-183 m	0.63				0.90	0.90	0.92	0.41	0.51	0.69
	184-366 m	0.24				0.97	0.97	0.60	0.46	0.94	0.51
	367-475 m	1.00						-	1.00	-	-
	all depths	0.49				0.88	0.88	0.56	0.31	0.45	0.51
Total US Area											
	55-183 m	0.35	0.29	0.21	0.80	0.84	0.84	0.31	0.33	0.28	0.59
	184-366 m	0.54	0.38	0.70	0.49	0.62	0.62	0.71	0.33	0.38	0.35
	367-475 m	0.85						1.00	1.00	-	1.00
	all depths	0.31	0.26	0.53	0.70	0.77	0.77	0.42	0.25	0.23	0.48

Table 19. Summary of key GLMM results for the Triennial trawl survey.

	GLMM, Mont, Erk only, trad. depth		GLMM, coast, no Con traditional depth		GLMM, revise depth, and INPFC strata	
Year	Index	CV	Index	CV	Index	CV
1980	1882	0.29	2262	0.19	2228	0.15
1983	1423	0.33	1891	0.18	1849	0.18
1986	632	0.90	924	0.21	724	0.16
1989	302	0.40	450	0.25	530	0.14
1992	181	0.41	252	0.38	319	0.23
1995	165	0.38	167	0.43	193	0.20
1998	47	0.53	79	0.46	57	0.31
2001	74	0.43	131	0.38	121	0.27
2004	379	0.42	341	0.30	439	0.22

Table 20. Summary of survey information for NWFSC survey, by latitude and inside of 350 meters depth, 2003-2008.

Total number of hauls, 50 to 350 m

lat	2003	2004	2005	2006	2007	2008
32	44	46	63	54	63	51
34.5	22	21	18	16	24	24
36	25	29	41	31	30	41
38	34	39	52	45	33	43
40.5	56	28	50	34	41	36
43	132	139	169	173	196	165

Number of positive tows

lat	2003	2004	2005	2006	2007	2008
32	11	11	21	13	12	2
34.5	8	4	3	2	6	3
36	6	9	14	9	6	8
38	8	10	8	12	1	8
40.5	4	0	3	1	2	1
43	5	0	2	3	3	4

Percent positive

lat	2003	2004	2005	2006	2007	2008
32	0.25	0.24	0.33	0.24	0.19	0.04
34.5	0.36	0.19	0.17	0.13	0.25	0.13
36	0.24	0.31	0.34	0.29	0.20	0.20
38	0.24	0.26	0.15	0.27	0.03	0.19
40.5	0.07	0	0.06	0.03	0.05	0.03
43	0.04	0	0.01	0.02	0.02	0.02

Mean cpue (kg/ha) of positives

lat	2003	2004	2005	2006	2007	2008
32	1.6	2.4	1.3	1.6	6.1	2.3
34.5	1.0	5.8	1.1	29.0	3.7	1.7
36	2.1	51.8	13.5	2.1	4.7	11.4
38	3.5	4.0	3.2	3.4	1.9	4.8
40.5	2.7		2.7	0.3	2.7	0.0
43	5.0		1.4	27.1	6.8	5.1

Number of length measurements

lat	2003	2004	2005	2006	2007	2008
32	37	54	111	95	98	7
34.5	15	29	4	81	25	10
36	11	378	165	16	21	63
38	25	32	22	22	1	21
40.5	9		15	1	4	1
43	16		2	50	8	9

Table 21. Design-based (area-swept) biomass estimates for bocaccio rockfish by year, depth strata and INPFC area.

	Biomass Estimates (tons)						
	depth (m)	2003	2004	2005	2006	2007	2008
CONCEPTION	55-182	177	566	362	1173	1049	64
	183-550	402	425	61	32	284	89
	total	579	991	423	1206	1334	152
MONTEREY	55-182	407	7370	829	484	443	1325
	183-550	249	824	2391	306	55	307
	total	657	8194	3220	790	498	1632
EUREKA	55-182	76	0	11	0	76	0
	183-550	28	0	75	4	0	0
	total	104	0	85	4	76	0
COLUMBIA	55-182	469	0	38	0	0	0
	183-550	0	0	0	0	30	34
	total	469	0	38	0	30	34
VANCOUVER	55-182	83	0	0	1152	252	252
	183-550	0	0	0	65	0	49
	total	83	0	0	1218	252	300
Assessment Area Total		1235	9184	3644	1995	1832	1784
Coastwide Total		1891	9184	3767	3217	2190	2119

	Coefficient of Variation						
	depth (m)	2003	2004	2005	2006	2007	2008
CONCEPTION	55-182	0.58	0.58	0.51	0.75	0.80	0.57
	183-550	0.61	0.48	0.75	0.78	0.60	0.72
	total	0.46	0.39	0.45	0.73	0.65	0.48
MONTEREY	55-182	0.60	0.51	0.40	0.30	0.73	0.61
	183-550	0.39	0.77	0.69	0.48	0.73	0.57
	total	0.40	0.46	0.53	0.26	0.65	0.51
EUREKA	55-182	0.84		1.00		0.92	1.00
	183-550	0.84		0.72	1.00		
	total	0.65		0.65	1.00	0.92	1.00
COLUMBIA	55-182	1.00		0.98			1.00
	183-550					1.00	1.00
	total	1.00		0.98		1.00	0.99
VANCOUVER	55-182	0.50			0.91	0.71	1.00
	183-550				1.00		1.00
	total	0.50			0.86	0.71	0.85
Assessment Area CV		0.30	0.42	0.47	0.45	0.50	0.47
Coastwide CV		0.32	0.42	0.45	0.43	0.43	0.41

Table 22. Basic reference points and likelihood estimates from the 2007 SS1 model relative to a comparable model in SS3.

	2007	2009 comp	% change
aveR 51-86 (07), 50-85 (09)	5449	6257	0.13
SPR(f=0) (age 1 recruits)	2.49	2.30	0.08
SSB_0	13572	12391	-0.10
$40\%SSB_0$	5429	4956	-0.10
SSB_{2006}	1727	1681	-0.03
SSB_{2006}/Sunf	12.7%	13.6%	0.06

Table 23. Input (index) RSME values (formula), additive variance adjustment, combined average input plus adjusted variance, model RSME and ratio of input/model RSME.

Fleet	years	mean input rsme	variance adjustment	input+ adjustment	model rsme	input+ adj/model
trawlsouth	15	0.32	0.38	0.38	0.38	1.00
recSO	20	0.17	0.76	0.76	0.76	1.01
recCEN	20	0.15	0.75	0.75	0.74	1.01
CalCOFI	51	0.31	0.59	0.60	0.58	1.04
Triennial trawl survey	9	0.20	0.70	0.70	0.70	1.00
CPFV CPUE	12	0.15	0.37	0.37	0.38	0.98
NWFSChook&line	5	0.22	0.16	0.16	0.15	1.05
NWFSC trawl survey	6	0.24	0.49	0.49	0.48	1.02
juvenile trawl survey	8	0.02	0.98	0.98	0.97	1.01
pier_juv	32	0.89	0.89	0.89	0.88	1.01

Table 24. Input mean sample sizes, effective mean sample sizes, and variance adjustment values used for tuning the length frequency data in the base model.

Fleet	years	mean start effN	mean model effN	Var_Adj	Harmonic mean (effN)	model effN/ input*var.adj
trawlsouth	26	202	154	0.76	92	1.00
hook and line	23	46	52	1.00	31	1.13
setnet	17	151	122	0.81	59	1.00
recSO	26	205	121	0.63	62	0.94
recCEN	32	107	91	0.83	57	1.02
trawlnorth	25	121	59	0.49	36	1.00
Triennial trawl survey	9	96	31	0.32	26	1.00
South CPFV observer	8	393	235	0.63	152	0.95
Central CPFV observer	12	244	292	1.00	141	1.20
NWFSChook&line	5	72	103	1.00	92	1.44
NWFSC trawl survey	6	66	67	1.00	52	1.02

Table 25. Fixed and estimated parameter values with standard deviations for the base model.

Parameter	est.	value	st. dev	Parameter	est.	value	st. dev
Natural mortality, both sexes	no	0.15		RecrDev_1954	yes	0.13	0.68
Length@Amin, both sexes	no	26		RecrDev_1955	yes	-1.03	0.76
Length@Amax, females	yes	67.75	0.37	RecrDev_1956	yes	0.26	0.71
VonBert K females	yes	0.22	0	RecrDev_1957	yes	-0.96	0.78
Length@Amax, males	yes	58.89	0.33	RecrDev_1958	yes	-0.31	0.94
VonBert K males	yes	0.27	0.01	RecrDev_1959	yes	0.36	1.2
CV of size at Amin, both sexes	no	0.1		RecrDev_1960	yes	0.07	1.08
CV of size at Amax, both sexes	no	0.08		RecrDev_1961	yes	0	1.05
log R0	yes	8.53	0.09	RecrDev_1962	yes	3.18	0.3
Steepness (h)	yes	0.57	0.08	RecrDev_1963	yes	0.04	1.08
Sigma-R	no	1		RecrDev_1964	yes	0.03	1.07
Initial F, hook and line fleet	yes	0.0060	0.0006	RecrDev_1965	yes	0	1.05
length@peak_trawlsou	yes	43.42	0.18	RecrDev_1966	yes	1.42	0.58
Width of top_trawlsou	no	-4.82		RecrDev_1967	yes	-0.14	0.97
Ascending width_trawlsou	no	4.3		RecrDev_1968	yes	-0.13	0.97
Decending width_trawlsou	no	4.76		RecrDev_1969	yes	0.02	1.02
Initial sel_trawlsou	no	-10.5		RecrDev_1970	yes	0.42	1.14
final sel_trawlsou	no	-0.77		RecrDev_1971	yes	0.52	0.99
length@peak_hook and line	yes	50.24	0.78	RecrDev_1972	yes	1.02	0.38
Width of top_hook and line	yes	-4.09	2.46	RecrDev_1973	yes	1.96	0.13
Ascending width_hook and line	yes	4.33	0.13	RecrDev_1974	yes	0.95	0.16
Decending width_hook and line	yes	3.98	0.53	RecrDev_1975	yes	-0.87	0.37
Initial sel_hook and line	yes	-9.41	4.07	RecrDev_1976	yes	-0.15	0.23
final sel_hook and line	yes	-0.67	0.32	RecrDev_1977	yes	2.57	0.07
length@peak_setnet	yes	48.57	0.36	RecrDev_1978	yes	-0.14	0.41
Width of top_setnet	yes	-7.41	5.36	RecrDev_1979	yes	1.01	0.1
Ascending width_setnet	yes	3.45	0.1	RecrDev_1980	yes	-0.32	0.19
Decending width_setnet	yes	4.15	0.18	RecrDev_1981	yes	-0.97	0.2
Initial sel_setnet	yes	-6.07	0.32	RecrDev_1982	yes	-2.66	0.38
final sel_setnet	yes	-1.59	0.21	RecrDev_1983	yes	-0.22	0.11
length@peak_southern rec	yes	38.37	0.56	RecrDev_1984	yes	1.77	0.06
Width of top_southern rec	yes	-7.64	5.19	RecrDev_1985	yes	-0.58	0.17
Ascending width_southern rec	yes	4.66	0.12	RecrDev_1986	yes	-0.65	0.16
Decending width_southern rec	yes	5.47	0.11	RecrDev_1987	yes	0.6	0.13
Initial sel_southern rec	yes	-4.47	0.28	RecrDev_1988	yes	1.67	0.12
final sel_southern rec	yes	-3.23	0.5	RecrDev_1989	yes	-1.31	0.33
logistic, size infl_central rec	yes	34.44	0.48	RecrDev_1990	yes	0.56	0.17
logistic, width 95%_central rec	yes	11.7	0.57	RecrDev_1991	yes	0.5	0.18
logistic, size infl_northern trawl	yes	40.34	0.39	RecrDev_1992	yes	-0.81	0.33
logistic, width 95%_northern trawl	yes	6.35	0.52	RecrDev_1993	yes	0.04	0.19
length@peak_triennial	no	24		RecrDev_1994	yes	-0.25	0.2
Width of top_triennial	no	-9.79		RecrDev_1995	yes	-0.86	0.25
Ascending width_triennial	no	6.11		RecrDev_1996	yes	-0.27	0.2
Decending width_triennial	no	5.56		RecrDev_1997	yes	-1.84	0.38
Initial sel_triennial	no	-2.86		RecrDev_1998	yes	-0.13	0.22
final sel_triennial	no	-1.25		RecrDev_1999	yes	1.73	0.16
length@peak_SCB hook line	yes	55.07	1.97	RecrDev_2000	yes	-1.67	0.45
Width of top_SCB hook line	yes	-5.73	7.45	RecrDev_2001	yes	-1.5	0.38
Ascending width_SCB hook line	yes	6	0.24	RecrDev_2002	yes	-0.2	0.21
Decending width_SCB hook line	yes	2.92	1.16	RecrDev_2003	yes	0.85	0.14
Initial sel_SCB hook line	yes	-7.76	4.84	RecrDev_2004	yes	-1.15	0.27
final sel_SCB hook line	yes	-1.12	0.56	RecrDev_2005	yes	0.68	0.14
logistic, size inflection_NWFSC combo	yes	22.56	1.95	RecrDev_2006	yes	-1.48	0.33
logistic, width 95% inflect_NWFSC combo	yes	15.19	3.93	RecrDev_2007	yes	-0.86	0.29
				RecrDev_2008	yes	-0.87	0.5

Table 26. Total and summary biomass, spawning output, age 0 recruitment, total catch, exploitation rate (catch/summary biomass) and SPR mortality rate.

Year	Total biomass	Summary biomass	Spawning output	CV spawning	Depletion	Recruits (x 10^3)	CV recruits	Total catch	Exploit. rate	SPR rate
Unfished	44136	44070	7861300	0.091	1.000	5060	0.092	0	0	1
1892	42722	42656	7580000	0.095	0.964	5026	0.091	167	0.004	0.966
1893	42706	42640	7580000	0.095	0.964	5025	0.091	157	0.004	0.968
1894	42695	42629	7580000	0.095	0.964	5025	0.091	148	0.003	0.97
1895	42688	42623	7580000	0.095	0.964	5025	0.091	139	0.003	0.971
1896	42687	42621	7580000	0.095	0.964	5025	0.091	131	0.003	0.973
1897	42689	42623	7580000	0.094	0.964	5026	0.091	123	0.003	0.975
1898	42696	42630	7580000	0.094	0.964	5026	0.091	115	0.003	0.976
1899	42708	42643	7590000	0.094	0.965	5026	0.091	108	0.003	0.974
1900	42726	42661	7590000	0.094	0.965	5026	0.091	119	0.003	0.971
1901	42731	42665	7590000	0.094	0.965	5027	0.091	131	0.003	0.969
1902	42723	42657	7590000	0.094	0.965	5026	0.091	142	0.003	0.966
1903	42703	42637	7590000	0.094	0.965	5026	0.091	154	0.004	0.964
1904	42672	42607	7580000	0.094	0.964	5025	0.091	165	0.004	0.961
1905	42632	42567	7570000	0.094	0.963	5024	0.091	176	0.004	0.959
1906	42584	42518	7560000	0.094	0.962	5023	0.091	188	0.004	0.956
1907	42527	42462	7550000	0.094	0.960	5022	0.091	199	0.005	0.954
1908	42464	42398	7540000	0.094	0.959	5021	0.091	210	0.005	0.948
1909	42394	42328	7530000	0.094	0.958	5019	0.091	237	0.006	0.943
1910	42303	42237	7510000	0.094	0.955	5017	0.090	263	0.006	0.937
1911	42193	42127	7490000	0.094	0.953	5014	0.090	289	0.007	0.931
1912	42064	41999	7470000	0.094	0.950	5011	0.090	316	0.008	0.926
1913	41920	41854	7440000	0.095	0.946	5008	0.090	342	0.008	0.92
1914	41760	41694	7410000	0.095	0.943	5004	0.090	368	0.009	0.914
1915	41586	41521	7380000	0.095	0.939	4999	0.090	395	0.010	0.897
1916	41400	41334	7350000	0.096	0.935	4995	0.090	474	0.011	0.842
1917	41147	41082	7300000	0.096	0.929	4989	0.090	747	0.018	0.831
1918	40637	40572	7210000	0.097	0.917	4976	0.089	799	0.020	0.882
1919	40108	40043	7110000	0.099	0.904	4963	0.089	529	0.013	0.877
1920	39886	39821	7070000	0.099	0.899	4957	0.089	550	0.014	0.895
1921	39667	39602	7020000	0.100	0.893	4950	0.089	463	0.012	0.905
1922	39557	39492	7000000	0.100	0.890	4946	0.089	417	0.011	0.889
1923	39507	39442	6980000	0.100	0.888	4944	0.088	489	0.012	0.899
1924	39392	39328	6960000	0.100	0.885	4941	0.088	442	0.011	0.886
1925	39335	39271	6950000	0.100	0.884	4939	0.088	505	0.013	0.843
1926	39222	39157	6920000	0.100	0.880	4935	0.088	711	0.018	0.862
1927	38909	38845	6870000	0.101	0.874	4927	0.088	610	0.016	0.854
1928	38716	38651	6830000	0.101	0.869	4922	0.088	639	0.017	0.863
1929	38505	38441	6790000	0.101	0.864	4916	0.088	597	0.016	0.838
1930	38351	38287	6760000	0.102	0.860	4911	0.087	715	0.019	0.844
1931	38092	38028	6710000	0.102	0.854	4904	0.087	689	0.018	0.87
1932	37879	37815	6670000	0.103	0.848	4897	0.087	556	0.015	0.896
1933	37817	37753	6650000	0.103	0.846	4894	0.087	429	0.011	0.882
1934	37891	37827	6660000	0.102	0.847	4896	0.087	494	0.013	0.874

Table 26 (continued)

Year	Total biomass	Summary biomass	Spawning output	CV spawning	Depletion	Recruits (x 10^3)	CV recruits	Total catch	Exploit. rate	SPR rate
1935	37898	37834	6660000	0.102	0.847	4895	0.087	534	0.014	0.853
1936	37865	37801	6650000	0.102	0.846	4894	0.087	632	0.017	0.861
1937	37732	37668	6630000	0.102	0.843	4891	0.087	589	0.016	0.889
1938	37649	37585	6610000	0.102	0.841	4888	0.087	461	0.012	0.909
1939	37700	37636	6620000	0.102	0.842	4889	0.086	373	0.010	0.907
1940	37841	37777	6640000	0.101	0.845	4892	0.086	382	0.010	0.924
1941	37967	37903	6660000	0.100	0.847	4895	0.087	308	0.008	0.969
1942	38160	38096	6690000	0.100	0.851	4900	0.087	124	0.003	0.929
1943	38526	38462	6750000	0.099	0.859	4910	0.087	292	0.008	0.835
1944	38710	38646	6780000	0.098	0.862	4915	0.087	737	0.019	0.714
1945	38455	38391	6730000	0.099	0.856	4907	0.087	1413	0.037	0.801
1946	37559	37495	6550000	0.101	0.833	4879	0.086	880	0.023	0.798
1947	37223	37160	6490000	0.102	0.826	4868	0.086	890	0.024	0.816
1948	36904	36840	6420000	0.103	0.817	4857	0.086	766	0.021	0.801
1949	36714	36650	6390000	0.103	0.813	4851	0.085	828	0.023	0.723
1950	36464	36401	6340000	0.104	0.806	4844	0.085	1216	0.033	0.625
1951	35822	35759	6240000	0.106	0.794	4826	0.085	1759	0.049	0.576
1952	34654	34592	6040000	0.109	0.768	4791	0.084	1966	0.057	0.517
1953	33294	33232	5810000	0.113	0.739	4749	0.084	2271	0.068	0.475
1954	31676	31606	5540000	0.118	0.705	5334	0.652	2402	0.076	0.37
1955	29963	29942	5250000	0.125	0.668	1648	0.757	3053	0.102	0.283
1956	27526	27449	4860000	0.134	0.618	5872	0.688	3650	0.133	0.262
1957	24340	24318	4370000	0.144	0.556	1679	0.780	3566	0.147	0.224
1958	21287	21246	3840000	0.158	0.488	3099	0.945	3580	0.169	0.251
1959	18198	18123	3290000	0.176	0.419	5779	1.202	2847	0.157	0.257
1960	16078	16025	2870000	0.195	0.365	4091	1.095	2436	0.152	0.305
1961	14748	14701	2510000	0.220	0.319	3617	1.076	1924	0.131	0.344
1962	15233	14140	2310000	0.231	0.294	83792	0.215	1731	0.122	0.329
1963	20471	20424	2230000	0.257	0.284	3584	1.112	2008	0.098	0.614
1964	31740	31693	2270000	0.286	0.289	3587	1.104	1523	0.048	0.744
1965	43555	43500	3740000	0.179	0.476	4200	1.053	1746	0.040	0.658
1966	53013	52766	6260000	0.145	0.796	18923	0.552	3418	0.065	0.52
1967	58213	58161	7960000	0.152	1.013	3997	0.964	5331	0.092	0.622
1968	59341	59290	8610000	0.161	1.095	3904	0.964	3405	0.057	0.703
1969	60097	60041	9230000	0.147	1.174	4327	1.017	2347	0.039	0.63
1970	60022	59942	9850000	0.121	1.253	6203	1.129	2846	0.047	0.636
1971	58025	57939	9990000	0.103	1.271	6595	0.991	2497	0.043	0.488
1972	55715	55581	9860000	0.090	1.254	10277	0.366	3653	0.066	0.24
1973	52373	52049	9360000	0.078	1.191	24770	0.091	7201	0.138	0.143
1974	46760	46651	8190000	0.071	1.042	8370	0.139	9001	0.193	0.22
1975	41054	41037	6810000	0.068	0.866	1256	0.365	6404	0.156	0.233
1976	38031	37998	6240000	0.060	0.794	2508	0.221	6177	0.163	0.27
1977	34550	34059	5890000	0.051	0.749	37567	0.036	4861	0.143	0.255
1978	33142	33109	5500000	0.046	0.700	2473	0.409	4367	0.132	0.159
1979	34256	34156	4990000	0.044	0.635	7629	0.084	6116	0.179	0.217

Table 26 (continued)

Year	Total biomass	Summary biomass	Spawning output	CV spawning	Depletion	Recruits (x 10^3)	CV recruits	Total catch	Exploit. rate	SPR rate
1980	33324	33298	4760000	0.039	0.605	1994	0.181	5384	0.162	0.207
1981	32051	32038	4900000	0.032	0.623	1041	0.189	5752	0.180	0.154
1982	28829	28826	4660000	0.028	0.593	190	0.376	6599	0.229	0.164
1983	23258	23230	4030000	0.027	0.513	2092	0.103	5598	0.241	0.143
1984	18002	17816	3250000	0.029	0.413	14196	0.029	4676	0.262	0.165
1985	14083	14067	2460000	0.033	0.313	1215	0.164	2864	0.204	0.1
1986	12972	12959	1960000	0.038	0.249	1032	0.141	3121	0.241	0.123
1987	11690	11647	1680000	0.041	0.214	3318	0.078	2649	0.227	0.177
1988	10837	10713	1620000	0.041	0.206	9495	0.051	2304	0.215	0.132
1989	10417	10411	1500000	0.044	0.191	464	0.318	2756	0.265	0.128
1990	9779	9743	1250000	0.053	0.159	2708	0.108	2624	0.269	0.242
1991	9057	9026	1130000	0.063	0.144	2395	0.128	1714	0.190	0.244
1992	8999	8990	1220000	0.067	0.155	678	0.317	1832	0.204	0.258
1993	8466	8446	1190000	0.077	0.151	1565	0.151	1593	0.189	0.26
1994	7796	7781	1150000	0.090	0.146	1147	0.170	1294	0.166	0.364
1995	7168	7160	1110000	0.102	0.141	608	0.232	818	0.114	0.44
1996	6841	6827	1090000	0.113	0.139	1080	0.173	547	0.080	0.452
1997	6636	6633	1090000	0.121	0.139	227	0.379	498	0.075	0.701
1998	6374	6358	1080000	0.128	0.137	1237	0.213	211	0.033	0.684
1999	6409	6304	1090000	0.132	0.139	8067	0.150	213	0.034	0.754
2000	6821	6817	1090000	0.135	0.139	268	0.459	160	0.023	0.825
2001	7802	7798	1090000	0.139	0.139	318	0.384	139	0.018	0.912
2002	8735	8718	1230000	0.139	0.156	1250	0.214	90	0.010	0.988
2003	9532	9480	1450000	0.140	0.184	3952	0.164	13	0.001	0.922
2004	10326	10319	1630000	0.141	0.207	566	0.295	85	0.008	0.906
2005	11055	11008	1730000	0.143	0.220	3642	0.175	107	0.010	0.949
2006	11683	11677	1850000	0.145	0.235	433	0.351	60	0.005	0.949
2007	12320	12309	1980000	0.146	0.252	838	0.316	63	0.005	0.941
2008	12703	12692	2100000	0.148	0.267	850	0.525	77	0.006	0.95
2009	*12853*	*12808*	*2210000*	*0.150*	*0.281*	*3428*	*1.008*	*62*	*0.005*	*0.949*
2010	*12662*	*12618*	*2210000*	*0.155*	*0.281*	*3430*	*1.008*	*60*	*0.005*	*0.949*
2011	*12716*	*12671*	*2180000*	*0.160*	*0.277*	*3404*	*1.008*	*59*	*0.005*	*0.949*
2012	*13063*	*13018*	*2160000*	*0.166*	*0.275*	*3390*	*1.009*	*65*	*0.005*	*0.948*
2013	*13649*	*13605*	*2200000*	*0.185*	*0.280*	*3418*	*1.010*	*74*	*0.005*	*0.946*
2014	*14386*	*14340*	*2280000*	*0.218*	*0.290*	*3477*	*1.011*	*84*	*0.006*	*0.945*
2015	*15197*	*15151*	*2390000*	*0.252*	*0.304*	*3551*	*1.011*	*95*	*0.006*	*0.943*
2016	*16038*	*15991*	*2520000*	*0.282*	*0.321*	*3630*	*1.012*	*105*	*0.007*	*0.942*
2017	*16882*	*16833*	*2660000*	*0.307*	*0.338*	*3709*	*1.013*	*115*	*0.007*	*0.94*
2018	*17712*	*17663*	*2800000*	*0.328*	*0.356*	*3786*	*1.013*	*124*	*0.007*	*0.94*
2019	*18522*	*18472*	*2940000*	*0.345*	*0.374*	*3859*	*1.013*	*131*	*0.007*	*0.94*

Table 27. Female numbers at age over time from the base model.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
VIRG	2.53	2.18	1.87	1.61	1.39	1.20	1.03	0.89	0.76	0.66	0.56	0.49	0.42	0.36	0.31	0.27	0.23	0.20	0.17	0.15	0.13	0.78
INIT	2.53	2.18	1.87	1.61	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1892	2.51	2.18	1.87	1.61	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1893	2.51	2.16	1.87	1.61	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1894	2.51	2.16	1.86	1.61	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1895	2.51	2.16	1.86	1.60	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1896	2.51	2.16	1.86	1.60	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1897	2.51	2.16	1.86	1.60	1.38	1.18	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1898	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1899	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.75	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1900	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1901	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1902	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1903	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1904	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1905	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.86	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1906	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.86	0.74	0.63	0.55	0.47	0.40	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.72
1907	2.51	2.16	1.86	1.60	1.37	1.18	1.01	0.86	0.74	0.63	0.54	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1908	2.51	2.16	1.86	1.60	1.37	1.18	1.01	0.86	0.74	0.63	0.54	0.47	0.40	0.34	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1909	2.51	2.16	1.86	1.60	1.37	1.18	1.01	0.86	0.74	0.63	0.54	0.47	0.40	0.34	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1910	2.51	2.16	1.86	1.60	1.37	1.17	1.00	0.86	0.73	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1911	2.51	2.16	1.86	1.60	1.37	1.17	1.00	0.86	0.73	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1912	2.51	2.16	1.86	1.60	1.37	1.17	1.00	0.85	0.73	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.72
1913	2.50	2.16	1.86	1.60	1.37	1.17	1.00	0.85	0.73	0.62	0.53	0.46	0.39	0.34	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.72
1914	2.50	2.16	1.86	1.60	1.37	1.17	0.99	0.85	0.72	0.62	0.53	0.46	0.39	0.34	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.71
1915	2.50	2.15	1.85	1.60	1.37	1.17	0.99	0.84	0.72	0.62	0.53	0.45	0.39	0.34	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.71
1916	2.50	2.15	1.85	1.59	1.37	1.16	0.99	0.84	0.72	0.61	0.53	0.45	0.39	0.33	0.29	0.25	0.21	0.18	0.16	0.13	0.12	0.71
1917	2.49	2.15	1.85	1.59	1.36	1.16	0.98	0.84	0.71	0.61	0.52	0.45	0.38	0.33	0.28	0.24	0.21	0.18	0.16	0.13	0.11	0.70
1918	2.49	2.15	1.85	1.59	1.35	1.14	0.97	0.83	0.70	0.60	0.52	0.44	0.38	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11	0.70
1919	2.48	2.14	1.85	1.59	1.35	1.13	0.96	0.81	0.69	0.59	0.51	0.44	0.37	0.32	0.28	0.24	0.20	0.18	0.15	0.13	0.11	0.69
1920	2.48	2.14	1.84	1.59	1.35	1.14	0.96	0.81	0.69	0.59	0.50	0.43	0.37	0.32	0.27	0.24	0.20	0.17	0.15	0.13	0.11	0.68
1921	2.48	2.13	1.84	1.58	1.35	1.14	0.96	0.81	0.68	0.58	0.50	0.43	0.37	0.32	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.68
1922	2.47	2.13	1.84	1.58	1.35	1.15	0.97	0.81	0.69	0.58	0.50	0.42	0.36	0.31	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.67
1923	2.47	2.13	1.83	1.58	1.35	1.15	0.97	0.82	0.69	0.58	0.49	0.42	0.36	0.31	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.67
1924	2.47	2.13	1.83	1.57	1.35	1.14	0.97	0.82	0.70	0.59	0.50	0.42	0.36	0.31	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.66
1925	2.47	2.13	1.83	1.57	1.34	1.14	0.97	0.82	0.70	0.59	0.50	0.42	0.36	0.31	0.26	0.23	0.19	0.17	0.14	0.12	0.11	0.66
1926	2.47	2.13	1.83	1.57	1.34	1.14	0.96	0.82	0.70	0.59	0.50	0.43	0.36	0.31	0.26	0.22	0.19	0.17	0.14	0.12	0.11	0.65
1927	2.46	2.12	1.83	1.57	1.34	1.13	0.95	0.81	0.69	0.59	0.50	0.43	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.64
1928	2.46	2.12	1.83	1.57	1.33	1.13	0.95	0.80	0.68	0.58	0.50	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.64
1929	2.46	2.12	1.82	1.57	1.33	1.12	0.95	0.80	0.68	0.58	0.49	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.63
1930	2.46	2.12	1.82	1.56	1.33	1.12	0.95	0.80	0.67	0.57	0.49	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.62
1931	2.45	2.11	1.82	1.56	1.33	1.12	0.94	0.79	0.67	0.57	0.48	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.62
1932	2.45	2.11	1.82	1.56	1.33	1.12	0.94	0.79	0.67	0.57	0.48	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.61
1933	2.45	2.11	1.82	1.56	1.33	1.12	0.94	0.79	0.67	0.57	0.48	0.41	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.60
1934	2.45	2.11	1.81	1.56	1.33	1.13	0.95	0.80	0.67	0.57	0.48	0.41	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.10	0.60
1935	2.45	2.11	1.81	1.55	1.33	1.13	0.95	0.80	0.68	0.57	0.48	0.41	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.10	0.59
1936	2.45	2.11	1.81	1.55	1.32	1.12	0.95	0.80	0.68	0.57	0.48	0.41	0.35	0.30	0.25	0.22	0.18	0.16	0.14	0.12	0.10	0.59
1937	2.45	2.11	1.81	1.55	1.32	1.11	0.94	0.80	0.68	0.57	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.12	0.10	0.59
1938	2.44	2.10	1.81	1.55	1.32	1.11	0.94	0.79	0.67	0.57	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.11	0.10	0.58
1939	2.44	2.10	1.81	1.55	1.32	1.12	0.94	0.79	0.67	0.57	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.11	0.10	0.58
1940	2.45	2.10	1.81	1.55	1.33	1.12	0.95	0.80	0.68	0.57	0.49	0.42	0.35	0.30	0.25	0.22	0.18	0.16	0.13	0.11	0.10	0.58
1941	2.45	2.11	1.81	1.55	1.33	1.13	0.95	0.81	0.68	0.57	0.49	0.42	0.36	0.30	0.26	0.22	0.18	0.16	0.13	0.11	0.10	0.58
1942	2.45	2.11	1.81	1.55	1.33	1.13	0.96	0.81	0.69	0.58	0.49	0.42	0.36	0.30	0.26	0.22	0.19	0.16	0.13	0.11	0.10	0.58
1943	2.46	2.11	1.81	1.56	1.33	1.14	0.97	0.82	0.70	0.59	0.50	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.13	0.11	0.10	0.58
1944	2.46	2.11	1.81	1.56	1.33	1.14	0.97	0.83	0.70	0.59	0.50	0.43	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.58
1945	2.45	2.12	1.82	1.56	1.33	1.13	0.96	0.82	0.70	0.59	0.50	0.42	0.36	0.30	0.26	0.22	0.19	0.16	0.14	0.11	0.10	0.57
1946	2.44	2.11	1.82	1.56	1.31	1.10	0.93	0.79	0.68	0.58	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.11	0.09	0.55
1947	2.43	2.10	1.82	1.56	1.32	1.10	0.92	0.78	0.66	0.57	0.48	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.55
1948	2.43	2.09	1.81	1.56	1.32	1.10	0.92	0.77	0.65	0.56	0.48	0.41	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.54
1949	2.43	2.09	1.80	1.54	1.31	1.11	0.93	0.77	0.65	0.55	0.47	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.53

Table 27 (continued). Female numbers at age over time from the base model

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1950	2.42	2.09	1.79	1.53	1.30	1.10	0.93	0.78	0.65	0.54	0.46	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.53
1951	2.41	2.08	1.79	1.52	1.27	1.07	0.90	0.76	0.64	0.54	0.45	0.39	0.33	0.28	0.24	0.21	0.17	0.15	0.13	0.11	0.09	0.52
1952	2.40	2.08	1.79	1.50	1.24	1.02	0.86	0.73	0.62	0.53	0.44	0.37	0.32	0.27	0.23	0.20	0.17	0.14	0.12	0.10	0.09	0.51
1953	2.37	2.06	1.78	1.48	1.20	0.97	0.81	0.69	0.59	0.51	0.43	0.36	0.31	0.26	0.23	0.19	0.17	0.14	0.12	0.10	0.09	0.49
1954	2.67	2.04	1.76	1.46	1.16	0.92	0.76	0.64	0.55	0.48	0.41	0.35	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.10	0.08	0.47
1955	0.82	2.29	1.74	1.43	1.12	0.88	0.71	0.59	0.51	0.44	0.38	0.33	0.28	0.24	0.20	0.18	0.15	0.13	0.11	0.09	0.08	0.46
1956	2.94	0.71	1.94	1.36	1.04	0.81	0.65	0.54	0.46	0.40	0.35	0.30	0.26	0.23	0.19	0.16	0.14	0.12	0.10	0.09	0.08	0.43
1957	0.84	2.52	0.59	1.47	0.95	0.71	0.57	0.47	0.40	0.34	0.30	0.27	0.24	0.21	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.40
1958	1.55	0.72	2.13	0.45	1.01	0.64	0.49	0.40	0.34	0.29	0.26	0.23	0.20	0.18	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.37
1959	2.89	1.33	0.61	1.62	0.30	0.66	0.42	0.33	0.28	0.25	0.22	0.19	0.17	0.15	0.14	0.12	0.10	0.09	0.08	0.06	0.06	0.33
1960	2.05	2.49	1.13	0.47	1.11	0.20	0.44	0.29	0.24	0.21	0.18	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.29
1961	1.81	1.76	2.11	0.87	0.32	0.74	0.14	0.31	0.21	0.18	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.26
1962	41.9	1.56	1.49	1.65	0.62	0.23	0.52	0.10	0.23	0.16	0.13	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.05	0.05	0.04	0.24
1963	1.79	36.0	1.32	1.18	1.21	0.44	0.16	0.39	0.08	0.18	0.12	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.22
1964	1.79	1.54	30.7	1.05	0.86	0.85	0.32	0.12	0.29	0.06	0.14	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.20
1965	2.10	1.54	1.32	25.7	0.85	0.69	0.69	0.26	0.10	0.24	0.05	0.11	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.20
1966	9.46	1.81	1.32	1.12	21.3	0.70	0.57	0.57	0.22	0.08	0.20	0.04	0.09	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.19
1967	2.00	8.14	1.55	1.10	0.90	17.1	0.57	0.47	0.47	0.18	0.07	0.17	0.03	0.08	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.18
1968	1.95	1.72	6.95	1.26	0.86	0.70	13.3	0.45	0.37	0.38	0.14	0.06	0.14	0.03	0.06	0.05	0.04	0.03	0.03	0.03	0.03	0.17
1969	2.16	1.68	1.47	5.74	1.01	0.68	0.56	10.8	0.37	0.31	0.31	0.12	0.05	0.11	0.02	0.05	0.04	0.03	0.03	0.03	0.02	0.17
1970	3.10	1.86	1.43	1.22	4.68	0.82	0.56	0.46	9.00	0.31	0.26	0.26	0.10	0.04	0.09	0.02	0.05	0.03	0.03	0.02	0.02	0.16
1971	3.30	2.67	1.58	1.18	0.98	3.74	0.66	0.46	0.38	7.44	0.26	0.21	0.22	0.08	0.03	0.08	0.02	0.04	0.03	0.02	0.02	0.15
1972	5.14	2.84	2.27	1.30	0.95	0.78	3.02	0.54	0.38	0.31	6.19	0.21	0.18	0.18	0.07	0.03	0.07	0.01	0.03	0.02	0.02	0.15
1973	12.39	4.42	2.40	1.81	1.00	0.72	0.61	2.39	0.43	0.30	0.26	5.07	0.17	0.15	0.15	0.06	0.02	0.06	0.01	0.03	0.02	0.14
1974	4.19	10.65	3.70	1.80	1.22	0.66	0.49	0.43	1.74	0.32	0.23	0.20	3.89	0.13	0.11	0.12	0.05	0.02	0.04	0.01	0.02	0.12
1975	0.63	3.60	8.81	2.60	1.08	0.71	0.40	0.32	0.29	1.21	0.23	0.17	0.14	2.86	0.10	0.08	0.09	0.03	0.01	0.03	0.01	0.11
1976	1.25	0.54	3.00	6.52	1.73	0.70	0.48	0.28	0.23	0.21	0.90	0.17	0.13	0.11	2.20	0.08	0.07	0.07	0.03	0.01	0.02	0.09
1977	18.78	1.08	0.45	2.26	4.45	1.16	0.48	0.34	0.20	0.17	0.16	0.69	0.13	0.10	0.08	1.70	0.06	0.05	0.05	0.02	0.01	0.09
1978	1.24	16.15	0.91	0.35	1.60	3.10	0.82	0.35	0.25	0.15	0.13	0.12	0.53	0.10	0.08	0.07	1.34	0.05	0.04	0.04	0.02	0.08
1979	3.81	1.06	13.55	0.70	0.25	1.12	2.20	0.60	0.26	0.19	0.12	0.10	0.10	0.42	0.08	0.06	0.05	1.05	0.04	0.03	0.03	0.07
1980	1.00	3.28	0.89	10.02	0.46	0.16	0.73	1.50	0.42	0.19	0.14	0.09	0.08	0.07	0.32	0.06	0.05	0.04	0.81	0.03	0.02	0.08
1981	0.52	0.86	2.77	0.69	7.08	0.31	0.11	0.52	1.10	0.32	0.14	0.11	0.07	0.06	0.06	0.25	0.05	0.04	0.03	0.63	0.02	0.08
1982	0.09	0.45	0.73	2.19	0.49	4.86	0.22	0.08	0.37	0.80	0.23	0.11	0.08	0.05	0.04	0.04	0.18	0.04	0.03	0.02	0.47	0.08
1983	1.05	0.08	0.37	0.54	1.45	0.31	3.10	0.14	0.05	0.26	0.56	0.16	0.08	0.06	0.04	0.03	0.03	0.13	0.03	0.02	0.02	0.40
1984	7.10	0.90	0.07	0.29	0.37	0.91	0.19	1.98	0.09	0.03	0.18	0.38	0.11	0.05	0.04	0.03	0.02	0.02	0.09	0.02	0.01	0.29
1985	0.61	6.11	0.76	0.05	0.19	0.22	0.53	0.12	1.24	0.06	0.02	0.12	0.26	0.08	0.04	0.03	0.02	0.01	0.01	0.06	0.01	0.21
1986	0.52	0.52	5.14	0.59	0.04	0.11	0.13	0.33	0.08	0.83	0.04	0.02	0.08	0.18	0.06	0.03	0.02	0.01	0.01	0.01	0.05	0.16
1987	1.66	0.44	0.44	3.90	0.37	0.02	0.06	0.07	0.19	0.05	0.53	0.03	0.01	0.06	0.13	0.04	0.02	0.01	0.01	0.01	0.01	0.15
1988	4.75	1.43	0.38	0.35	2.71	0.22	0.01	0.04	0.04	0.12	0.03	0.36	0.02	0.01	0.04	0.09	0.03	0.01	0.01	0.01	0.01	0.11
1989	0.23	4.08	1.22	0.31	0.25	1.77	0.14	0.01	0.02	0.03	0.09	0.02	0.26	0.01	0.01	0.03	0.06	0.02	0.01	0.01	0.00	0.08
1990	1.35	0.20	3.47	0.96	0.21	0.15	1.01	0.08	0.00	0.02	0.02	0.06	0.02	0.18	0.01	0.00	0.02	0.05	0.01	0.01	0.01	0.06
1991	1.20	1.16	0.17	2.72	0.63	0.12	0.08	0.57	0.05	0.00	0.01	0.01	0.04	0.01	0.12	0.01	0.00	0.01	0.03	0.01	0.00	0.05
1992	0.34	1.03	0.99	0.14	1.98	0.42	0.08	0.05	0.39	0.04	0.00	0.01	0.01	0.03	0.01	0.09	0.00	0.00	0.01	0.02	0.01	0.04
1993	0.78	0.29	0.88	0.80	0.10	1.31	0.27	0.05	0.04	0.28	0.03	0.00	0.01	0.01	0.02	0.01	0.07	0.00	0.00	0.01	0.02	0.04
1994	0.57	0.67	0.25	0.71	0.59	0.07	0.88	0.19	0.04	0.03	0.20	0.02	0.00	0.00	0.01	0.02	0.00	0.05	0.00	0.00	0.01	0.04
1995	0.30	0.49	0.57	0.20	0.52	0.41	0.05	0.62	0.14	0.03	0.02	0.16	0.01	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.04
1996	0.54	0.26	0.42	0.47	0.15	0.39	0.30	0.04	0.47	0.10	0.02	0.02	0.12	0.01	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.03
1997	0.11	0.46	0.22	0.35	0.37	0.12	0.30	0.24	0.03	0.38	0.08	0.02	0.01	0.10	0.01	0.00	0.00	0.00	0.01	0.00	0.03	0.03
1998	0.62	0.10	0.40	0.18	0.28	0.29	0.09	0.23	0.19	0.02	0.30	0.07	0.01	0.01	0.08	0.01	0.00	0.00	0.00	0.01	0.00	0.04
1999	4.03	0.53	0.08	0.34	0.15	0.23	0.24	0.08	0.19	0.16	0.02	0.25	0.06	0.01	0.01	0.07	0.01	0.00	0.00	0.00	0.01	0.04
2000	0.13	3.47	0.45	0.07	0.28	0.13	0.19	0.20	0.06	0.16	0.13	0.02	0.21	0.05	0.01	0.01	0.06	0.01	0.00	0.00	0.00	0.04
2001	0.16	0.12	2.97	0.38	0.06	0.23	0.10	0.16	0.17	0.05	0.14	0.11	0.01	0.18	0.04	0.01	0.01	0.05	0.00	0.00	0.00	0.03
2002	0.63	0.14	0.10	2.51	0.32	0.05	0.19	0.09	0.13	0.14	0.05	0.12	0.09	0.01	0.15	0.03	0.01	0.01	0.04	0.00	0.00	0.03
2003	1.98	0.54	0.12	0.08	2.14	0.27	0.04	0.16	0.08	0.11	0.12	0.04	0.10	0.08	0.01	0.13	0.03	0.01	0.00	0.04	0.00	0.02
2004	0.28	1.70	0.46	0.10	0.07	1.83	0.23	0.04	0.14	0.06	0.10	0.10	0.03	0.09	0.07	0.01	0.11	0.03	0.00	0.00	0.03	0.02
2005	1.82	0.24	1.46	0.39	0.09	0.06	1.56	0.20	0.03	0.12	0.06	0.08	0.09	0.03	0.07	0.06	0.01	0.10	0.02	0.00	0.00	0.05
2006	0.22	1.57	0.21	1.24	0.33	0.07	0.05	1.33	0.17	0.03	0.10	0.05	0.07	0.08	0.02	0.06	0.05	0.01	0.08	0.02	0.00	0.04
2007	0.42	0.19	1.35	0.18	1.06	0.29	0.06	0.04	1.14	0.15	0.02	0.09	0.04	0.06	0.07	0.02	0.05	0.04	0.01	0.07	0.02	0.04
2008	0.42	0.36	0.16	1.15	0.15	0.90	0.24	0.05	0.04	0.98	0.13	0.02	0.08	0.04	0.05	0.06	0.02	0.05	0.04	0.00	0.06	0.05

Table 28. Male numbers at age over time from the base model

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
VIRG	2.53	2.18	1.87	1.61	1.39	1.20	1.03	0.89	0.76	0.66	0.56	0.49	0.42	0.36	0.31	0.27	0.23	0.20	0.17	0.15	0.13	0.78
INIT	2.53	2.18	1.87	1.61	1.39	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1892	2.51	2.18	1.87	1.61	1.39	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1893	2.51	2.16	1.87	1.61	1.39	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1894	2.51	2.16	1.86	1.61	1.39	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1895	2.51	2.16	1.86	1.60	1.39	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1896	2.51	2.16	1.86	1.60	1.38	1.19	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1897	2.51	2.16	1.86	1.60	1.38	1.18	1.02	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1898	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1899	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.75	0.64	0.55	0.47	0.40	0.34	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1900	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1901	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1902	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1903	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1904	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1905	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.87	0.74	0.64	0.55	0.47	0.40	0.34	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1906	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.86	0.74	0.63	0.54	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1907	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.86	0.74	0.63	0.54	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1908	2.51	2.16	1.86	1.60	1.38	1.18	1.01	0.86	0.74	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.12	0.70
1909	2.51	2.16	1.86	1.60	1.37	1.18	1.01	0.86	0.74	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.22	0.18	0.16	0.14	0.12	0.70
1910	2.51	2.16	1.86	1.60	1.37	1.18	1.01	0.86	0.74	0.63	0.54	0.46	0.40	0.34	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.70
1911	2.51	2.16	1.86	1.60	1.37	1.18	1.00	0.86	0.73	0.63	0.54	0.46	0.39	0.34	0.29	0.25	0.21	0.18	0.16	0.13	0.12	0.70
1912	2.51	2.16	1.86	1.60	1.37	1.17	1.00	0.86	0.73	0.63	0.53	0.46	0.39	0.34	0.29	0.25	0.21	0.18	0.16	0.13	0.12	0.70
1913	2.50	2.16	1.86	1.60	1.37	1.17	1.00	0.85	0.73	0.62	0.53	0.46	0.39	0.33	0.29	0.25	0.21	0.18	0.16	0.13	0.11	0.69
1914	2.50	2.16	1.86	1.60	1.37	1.17	1.00	0.85	0.73	0.62	0.53	0.45	0.39	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11	0.69
1915	2.50	2.15	1.85	1.60	1.37	1.17	1.00	0.85	0.72	0.62	0.53	0.45	0.39	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11	0.68
1916	2.50	2.15	1.85	1.60	1.37	1.17	0.99	0.85	0.72	0.61	0.52	0.45	0.38	0.33	0.28	0.24	0.21	0.18	0.15	0.13	0.11	0.68
1917	2.49	2.15	1.85	1.59	1.36	1.16	0.99	0.84	0.72	0.61	0.52	0.44	0.38	0.32	0.28	0.24	0.20	0.18	0.15	0.13	0.11	0.67
1918	2.49	2.15	1.85	1.59	1.36	1.15	0.98	0.83	0.70	0.60	0.51	0.44	0.37	0.32	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.66
1919	2.48	2.14	1.85	1.59	1.35	1.14	0.96	0.82	0.69	0.59	0.50	0.43	0.37	0.31	0.27	0.23	0.20	0.17	0.14	0.12	0.11	0.65
1920	2.48	2.14	1.84	1.59	1.36	1.15	0.97	0.81	0.69	0.58	0.50	0.42	0.36	0.31	0.27	0.23	0.19	0.17	0.14	0.12	0.11	0.64
1921	2.48	2.13	1.84	1.58	1.36	1.15	0.97	0.81	0.69	0.58	0.49	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.63
1922	2.47	2.13	1.84	1.58	1.35	1.15	0.97	0.82	0.69	0.58	0.49	0.42	0.36	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.62
1923	2.47	2.13	1.83	1.58	1.35	1.15	0.98	0.83	0.69	0.58	0.49	0.42	0.36	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.62
1924	2.47	2.13	1.83	1.58	1.35	1.15	0.97	0.83	0.70	0.59	0.49	0.42	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.61
1925	2.47	2.13	1.83	1.57	1.35	1.15	0.97	0.83	0.70	0.59	0.50	0.42	0.35	0.30	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.61
1926	2.47	2.13	1.83	1.57	1.35	1.14	0.97	0.82	0.70	0.59	0.50	0.42	0.35	0.30	0.25	0.22	0.18	0.16	0.14	0.12	0.10	0.60
1927	2.46	2.12	1.83	1.57	1.34	1.14	0.96	0.81	0.69	0.58	0.50	0.42	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.11	0.10	0.59
1928	2.46	2.12	1.83	1.57	1.34	1.13	0.96	0.81	0.68	0.58	0.49	0.42	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.10	0.58
1929	2.46	2.12	1.82	1.57	1.34	1.13	0.95	0.80	0.68	0.57	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.10	0.57
1930	2.46	2.12	1.82	1.57	1.34	1.13	0.95	0.80	0.68	0.57	0.48	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.56
1931	2.45	2.11	1.82	1.56	1.33	1.13	0.95	0.80	0.67	0.57	0.48	0.41	0.35	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.56
1932	2.45	2.11	1.82	1.56	1.33	1.12	0.95	0.79	0.67	0.56	0.48	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.55
1933	2.45	2.11	1.82	1.56	1.33	1.13	0.95	0.80	0.67	0.56	0.48	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.54
1934	2.45	2.11	1.81	1.56	1.33	1.13	0.96	0.80	0.68	0.57	0.48	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.54
1935	2.45	2.11	1.81	1.56	1.33	1.13	0.96	0.81	0.68	0.57	0.48	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.53
1936	2.45	2.11	1.81	1.55	1.33	1.13	0.95	0.81	0.68	0.57	0.48	0.41	0.34	0.29	0.24	0.21	0.18	0.15	0.13	0.11	0.09	0.53
1937	2.45	2.11	1.81	1.55	1.32	1.12	0.95	0.80	0.68	0.57	0.48	0.41	0.34	0.29	0.24	0.21	0.18	0.15	0.13	0.11	0.09	0.53
1938	2.44	2.10	1.81	1.55	1.32	1.12	0.94	0.80	0.67	0.57	0.48	0.41	0.34	0.29	0.24	0.21	0.17	0.15	0.13	0.11	0.09	0.52
1939	2.44	2.10	1.81	1.55	1.33	1.12	0.95	0.80	0.67	0.57	0.48	0.41	0.35	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.52
1940	2.45	2.10	1.81	1.55	1.33	1.13	0.95	0.80	0.68	0.57	0.49	0.41	0.35	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.52
1941	2.45	2.11	1.81	1.55	1.33	1.13	0.96	0.81	0.68	0.58	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.52
1942	2.45	2.11	1.81	1.55	1.33	1.13	0.96	0.82	0.69	0.58	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.52
1943	2.46	2.11	1.81	1.56	1.34	1.14	0.97	0.83	0.70	0.59	0.50	0.42	0.36	0.30	0.26	0.22	0.18	0.15	0.13	0.11	0.09	0.53
1944	2.46	2.11	1.81	1.56	1.34	1.14	0.97	0.83	0.70	0.60	0.50	0.42	0.36	0.30	0.26	0.22	0.18	0.16	0.13	0.11	0.09	0.53
1945	2.45	2.12	1.82	1.56	1.33	1.13	0.96	0.82	0.70	0.59	0.50	0.42	0.36	0.30	0.26	0.22	0.18	0.16	0.13	0.11	0.09	0.53
1946	2.44	2.11	1.82	1.56	1.32	1.11	0.94	0.80	0.68	0.58	0.49	0.41	0.35	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.51
1947	2.43	2.10	1.82	1.56	1.32	1.11	0.93	0.78	0.67	0.57	0.48	0.41	0.35	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.51
1948	2.43	2.09	1.81	1.56	1.32	1.11	0.93	0.78	0.65	0.56	0.47	0.40	0.34	0.29	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.50
1949	2.43	2.09	1.80	1.54	1.32	1.11	0.93	0.78	0.65	0.55	0.47	0.40	0.34	0.29	0.24	0.21	0.17	0.15	0.12	0.11	0.09	0.50

Table 28 (continued). Male numbers at age over time from the base model

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1950	2.42	2.09	1.79	1.53	1.30	1.10	0.93	0.78	0.65	0.54	0.46	0.39	0.33	0.29	0.24	0.21	0.17	0.15	0.12	0.11	0.09	0.49
1951	2.41	2.08	1.79	1.52	1.28	1.07	0.91	0.76	0.64	0.54	0.45	0.38	0.33	0.28	0.24	0.20	0.17	0.14	0.12	0.10	0.09	0.48
1952	2.40	2.08	1.79	1.51	1.24	1.03	0.86	0.73	0.62	0.52	0.44	0.37	0.31	0.27	0.23	0.19	0.16	0.14	0.12	0.10	0.08	0.47
1953	2.37	2.06	1.78	1.49	1.21	0.98	0.81	0.68	0.58	0.49	0.42	0.35	0.30	0.25	0.21	0.18	0.16	0.13	0.11	0.10	0.08	0.45
1954	2.67	2.04	1.76	1.47	1.17	0.93	0.76	0.63	0.53	0.46	0.39	0.33	0.28	0.24	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.43
1955	0.82	2.29	1.74	1.43	1.13	0.89	0.71	0.58	0.49	0.42	0.36	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.10	0.09	0.07	0.40
1956	2.94	0.71	1.94	1.37	1.06	0.82	0.64	0.52	0.43	0.37	0.32	0.28	0.24	0.20	0.17	0.15	0.12	0.11	0.09	0.08	0.07	0.37
1957	0.84	2.52	0.59	1.48	0.97	0.72	0.56	0.45	0.37	0.31	0.27	0.23	0.20	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.33
1958	1.55	0.72	2.13	0.46	1.04	0.65	0.49	0.38	0.31	0.26	0.22	0.19	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.29
1959	2.89	1.33	0.61	1.64	0.31	0.68	0.42	0.32	0.26	0.21	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.25
1960	2.05	2.49	1.13	0.48	1.15	0.21	0.45	0.28	0.22	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.21
1961	1.81	1.76	2.11	0.88	0.33	0.77	0.14	0.30	0.20	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.18
1962	41.90	1.56	1.49	1.67	0.64	0.23	0.54	0.10	0.22	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.16
1963	1.79	36.05	1.32	1.19	1.23	0.46	0.17	0.39	0.07	0.16	0.11	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.14
1964	1.79	1.54	30.72	1.06	0.88	0.88	0.32	0.12	0.28	0.05	0.12	0.08	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.13
1965	2.10	1.54	1.32	25.75	0.86	0.71	0.70	0.26	0.10	0.23	0.04	0.10	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.12
1966	9.46	1.81	1.32	1.12	21.43	0.71	0.58	0.58	0.22	0.08	0.19	0.04	0.08	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.12
1967	2.00	8.14	1.55	1.11	0.91	17.24	0.57	0.47	0.47	0.18	0.07	0.15	0.03	0.07	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.11
1968	1.95	1.72	6.95	1.27	0.87	0.70	13.29	0.45	0.37	0.37	0.14	0.05	0.12	0.02	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.11
1969	2.16	1.68	1.47	5.76	1.02	0.69	0.56	10.67	0.36	0.30	0.30	0.11	0.04	0.10	0.02	0.04	0.03	0.02	0.02	0.02	0.01	0.10
1970	3.10	1.86	1.43	1.22	4.71	0.83	0.56	0.46	8.77	0.30	0.25	0.25	0.09	0.04	0.08	0.02	0.04	0.02	0.02	0.02	0.01	0.10
1971	3.30	2.67	1.58	1.18	0.98	3.76	0.67	0.45	0.37	7.15	0.24	0.20	0.21	0.08	0.03	0.07	0.01	0.03	0.02	0.02	0.01	0.09
1972	5.14	2.84	2.27	1.31	0.95	0.79	3.02	0.54	0.37	0.30	5.86	0.20	0.17	0.17	0.06	0.02	0.06	0.01	0.02	0.02	0.01	0.09
1973	12.39	4.42	2.40	1.82	1.01	0.73	0.60	2.34	0.42	0.29	0.24	4.67	0.16	0.13	0.14	0.05	0.02	0.05	0.01	0.02	0.01	0.08
1974	4.19	10.65	3.70	1.82	1.25	0.67	0.48	0.41	1.62	0.30	0.21	0.17	3.40	0.12	0.10	0.10	0.04	0.01	0.03	0.01	0.01	0.07
1975	0.63	3.60	8.81	2.64	1.12	0.73	0.39	0.29	0.26	1.04	0.19	0.14	0.12	2.30	0.08	0.07	0.07	0.03	0.01	0.02	0.00	0.06
1976	1.25	0.54	3.00	6.60	1.79	0.73	0.47	0.26	0.20	0.18	0.73	0.14	0.10	0.08	1.67	0.06	0.05	0.05	0.02	0.01	0.02	0.05
1977	18.78	1.08	0.45	2.29	4.58	1.19	0.49	0.32	0.18	0.14	0.13	0.53	0.10	0.07	0.06	1.23	0.04	0.04	0.04	0.01	0.01	0.05
1978	1.24	16.15	0.91	0.35	1.64	3.19	0.83	0.34	0.23	0.13	0.10	0.09	0.39	0.07	0.05	0.05	0.93	0.03	0.03	0.03	0.01	0.04
1979	3.81	1.06	13.55	0.70	0.25	1.14	2.22	0.59	0.25	0.17	0.10	0.08	0.07	0.29	0.06	0.04	0.03	0.70	0.02	0.02	0.02	0.04
1980	1.00	3.28	0.89	10.14	0.47	0.16	0.73	1.45	0.39	0.17	0.12	0.07	0.05	0.05	0.21	0.04	0.03	0.03	0.51	0.02	0.02	0.04
1981	0.52	0.86	2.77	0.70	7.29	0.32	0.11	0.51	1.02	0.28	0.12	0.08	0.05	0.04	0.04	0.16	0.03	0.02	0.02	0.38	0.01	0.04
1982	0.09	0.45	0.73	2.20	0.51	5.05	0.22	0.08	0.35	0.71	0.20	0.09	0.06	0.04	0.03	0.03	0.11	0.02	0.02	0.01	0.27	0.04
1983	1.05	0.08	0.37	0.55	1.49	0.32	3.18	0.14	0.05	0.23	0.48	0.13	0.06	0.04	0.02	0.02	0.02	0.08	0.01	0.01	0.01	0.22
1984	7.10	0.90	0.07	0.30	0.38	0.95	0.20	1.98	0.09	0.03	0.15	0.31	0.09	0.04	0.03	0.02	0.01	0.01	0.05	0.01	0.01	0.15
1985	0.61	6.11	0.76	0.05	0.20	0.23	0.55	0.12	1.17	0.05	0.02	0.09	0.19	0.05	0.02	0.02	0.01	0.01	0.01	0.03	0.01	0.10
1986	0.52	0.52	5.14	0.60	0.04	0.12	0.14	0.33	0.07	0.72	0.03	0.01	0.06	0.13	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.07
1987	1.66	0.44	0.44	3.95	0.40	0.02	0.07	0.07	0.18	0.04	0.41	0.02	0.01	0.04	0.08	0.02	0.01	0.01	0.00	0.00	0.00	0.06
1988	4.75	1.43	0.38	0.36	2.85	0.25	0.01	0.04	0.04	0.10	0.02	0.25	0.01	0.00	0.02	0.05	0.01	0.01	0.00	0.00	0.00	0.04
1989	0.23	4.08	1.22	0.31	0.26	1.93	0.16	0.01	0.02	0.03	0.07	0.02	0.17	0.01	0.00	0.02	0.03	0.01	0.00	0.00	0.00	0.03
1990	1.35	0.20	3.47	0.97	0.22	0.16	1.11	0.09	0.00	0.01	0.02	0.04	0.01	0.10	0.01	0.00	0.01	0.02	0.01	0.00	0.00	0.02
1991	1.20	1.16	0.17	2.75	0.67	0.13	0.09	0.60	0.05	0.00	0.01	0.01	0.02	0.01	0.06	0.00	0.00	0.01	0.01	0.00	0.00	0.01
1992	0.34	1.03	0.99	0.14	2.05	0.46	0.08	0.06	0.39	0.03	0.00	0.01	0.01	0.02	0.00	0.04	0.00	0.00	0.00	0.01	0.00	0.01
1993	0.78	0.29	0.88	0.81	0.10	1.41	0.30	0.05	0.04	0.26	0.02	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.01	0.01
1994	0.57	0.67	0.25	0.72	0.61	0.07	0.94	0.20	0.04	0.03	0.18	0.02	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.01
1995	0.30	0.49	0.57	0.20	0.53	0.43	0.05	0.65	0.14	0.03	0.02	0.13	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.01
1996	0.54	0.26	0.42	0.47	0.16	0.40	0.32	0.04	0.48	0.10	0.02	0.01	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
1997	0.11	0.46	0.22	0.35	0.38	0.12	0.31	0.24	0.03	0.38	0.08	0.02	0.01	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
1998	0.62	0.10	0.40	0.18	0.28	0.30	0.09	0.24	0.19	0.02	0.30	0.06	0.01	0.01	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.01
1999	4.03	0.53	0.08	0.34	0.15	0.23	0.24	0.08	0.20	0.16	0.02	0.25	0.05	0.01	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.01
2000	0.13	3.47	0.45	0.07	0.28	0.13	0.19	0.20	0.06	0.16	0.13	0.02	0.21	0.04	0.01	0.01	0.04	0.00	0.00	0.00	0.00	0.01
2001	0.16	0.12	2.97	0.38	0.06	0.23	0.11	0.16	0.17	0.05	0.14	0.11	0.01	0.17	0.04	0.01	0.01	0.04	0.00	0.00	0.00	0.01
2002	0.63	0.14	0.10	2.51	0.32	0.05	0.19	0.09	0.13	0.14	0.05	0.12	0.09	0.01	0.15	0.03	0.01	0.00	0.03	0.00	0.00	0.01
2003	1.98	0.54	0.12	0.08	2.14	0.27	0.04	0.16	0.08	0.11	0.12	0.04	0.10	0.08	0.01	0.12	0.03	0.01	0.00	0.03	0.00	0.01
2004	0.28	1.70	0.46	0.10	0.07	1.84	0.23	0.04	0.14	0.06	0.10	0.10	0.03	0.09	0.07	0.01	0.11	0.02	0.00	0.00	0.02	0.01
2005	1.82	0.24	1.46	0.39	0.09	0.06	1.56	0.20	0.03	0.12	0.06	0.08	0.09	0.03	0.07	0.06	0.01	0.09	0.02	0.00	0.00	0.03
2006	0.22	1.57	0.21	1.24	0.33	0.07	0.05	1.33	0.17	0.03	0.10	0.05	0.07	0.08	0.02	0.06	0.05	0.01	0.08	0.02	0.00	0.03
2007	0.42	0.19	1.35	0.18	1.06	0.29	0.06	0.04	1.14	0.15	0.02	0.09	0.04	0.06	0.06	0.02	0.05	0.04	0.01	0.07	0.01	0.02
2008	0.42	0.36	0.16	1.15	0.15	0.90	0.24	0.05	0.04	0.97	0.12	0.02	0.08	0.03	0.05	0.06	0.02	0.05	0.04	0.00	0.06	0.03

Table 29. Sensitivity of model outputs and likelihood estimates under scenarios with alternative assumed values for the steepness of the spawner-recruit relationship (h).

	h=0.21	h=0.3	h=0.4	h=0.5	h=0.57	h=0.6	h=0.7	h=0.8	h=0.9	h=0.99
R0	8607	6653	5968	5325	5060	4958	4600	4412	4238	4117
Larval output	1.3E+07	1.0E+07	9.2E+06	8.2E+06	7.9E+06	7.7E+06	7.2E+06	6.9E+06	6.6E+06	6.4E+06
Unfished biomass	73614	57298	51718	46273	44070	43199	40120	38514	37006	35951
S2009/SSB0	0.146	0.188	0.223	0.252	0.281	0.302	0.338	0.357	0.386	0.410
B2009/B0	0.146	0.191	0.229	0.259	0.291	0.339	0.383	0.370	0.402	0.427
Total like	3133.9	3113.6	3104.0	3102.3	3102.1	3101.9	3103.0	3104.3	3105.7	3106.9
Survey	94.5	88.2	87.4	85.2	85.4	85.2	84.3	85.2	85.7	86.2
Length_comp	2984.1	2981.3	2980.9	2982.0	2982.4	2982.6	2983.4	2983.5	2983.7	2983.7
Recruitment	54.1	42.9	34.6	34.0	32.9	33.0	34.2	34.5	35.3	35.9
Parm_priors	1.2	1.1	1.1	1.1	1.4	1.1	1.1	1.1	1.1	1.1
Surveys										
Trawl_south	7.6	7.2	7.4	7.2	7.6	7.6	7.7	8.3	8.6	8.9
RecSouth	8.1	8.0	7.9	7.9	7.7	7.7	7.7	7.6	7.6	7.6
RecCentral	10.9	10.9	10.5	10.5	10.1	10.0	9.9	9.4	9.2	9.0
CalCOFI	28.6	24.3	23.8	21.6	21.3	21.0	19.8	19.8	19.7	19.6
Triennial	3.9	3.8	3.9	3.9	4.1	4.1	4.2	4.4	4.6	4.7
CPFV_index	5.6	5.6	5.8	5.8	6.0	6.1	6.1	6.4	6.6	6.7
SCB_hook	1.8	2.0	2.2	2.3	2.4	2.4	2.4	2.5	2.5	2.5
Combo	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Juv_trawl	4.6	4.3	4.1	4.0	3.9	3.9	3.9	3.9	3.9	3.8
Pier_index	20.7	19.3	19.0	19.2	19.4	19.5	19.7	20.0	20.2	20.4
Length comps										
Trawl_south	465.0	465.6	466.9	467.4	468.1	468.2	468.4	468.9	469.1	469.2
hook-line	362.9	362.9	363.0	362.9	363.0	363.0	363.0	363.2	363.3	363.3
setnet	352.7	354.0	355.2	355.7	356.2	356.3	356.5	356.7	356.8	356.9
RecSouth	373.0	373.7	374.5	375.1	375.4	375.5	375.8	376.0	376.0	376.1
RecCentral	368.2	366.8	365.8	365.4	365.2	365.2	365.0	364.9	364.9	364.9
Trawl_north	371.9	369.0	366.8	366.2	365.4	365.3	365.2	364.8	364.6	364.6
Triennial	148.1	149.1	150.2	150.7	151.0	151.1	151.2	151.4	151.4	151.4
CPFV CenCal	212.5	212.7	212.9	213.1	213.1	213.1	213.2	213.0	212.9	212.8
SCB_hook	62.4	61.8	61.3	61.1	60.9	60.9	60.8	60.8	60.8	60.8
Combo	137.6	137.3	137.3	137.3	137.3	137.3	137.3	137.3	137.3	137.3
delete	179.4	181.5	183.6	184.6	185.4	185.6	186.0	186.3	186.4	186.4
CPFV SouCal	129.9	128.4	127.1	127.2	126.6	126.6	126.8	126.5	126.5	126.4

Table 30. Sensitivity of model outputs and likelihood estimates under scenarios with alternative assumed values for the natural mortality rate (M), with steepness estimated.

	M=0.08	M=0.1	M=0.12	M=0.14	M=0.15	M=0.16	M=0.18	M=0.20	M=0.22	M=0.24
R0	2040	2726	3543	4495	5060	5566	5566	8817	11369	15243
Larval output	9.1E+06	8.6E+06	8.2E+06	7.9E+06	7.9E+06	7.6E+06	7.6E+06	7.7E+06	8.1E+06	8.9E+06
Unfished biomass	46361	45053	44353	43911	44070	43442	43442	46333	50047	56849
S2009/SSB0	0.292	0.293	0.295	0.286	0.281	0.276	0.268	0.244	0.225	0.206
B2009/B0	0.331	0.325	0.318	0.300	0.291	0.281	0.273	0.235	0.211	0.187
steepness	0.95	0.84	0.73	0.62	0.57	0.54	0.44	0.37	0.31	0.25
Total like	3134.5	3121.7	3112.8	3104.9	3102.1	3099.8	3096.3	3093.9	3092.5	3092.4
Survey	92.7	89.6	87.9	85.8	85.4	84.2	85.0	83.9	84.9	86.7
Length_comp	3000.5	2994.5	2989.2	2984.5	2982.4	2980.7	2976.9	2974.3	2971.5	2969.2
Recruitment	39.4	36.3	34.7	33.3	32.9	33.3	32.1	32.7	32.5	32.1
Parm_priors	1.8	1.3	1.1	1.3	1.4	1.6	2.3	3.0	3.7	4.4
Survey										
Trawl_south	5.3	5.9	6.6	7.2	7.6	7.8	8.7	9.2	10.0	11.2
RecSouth	7.6	7.6	7.6	7.7	7.7	7.8	7.9	8.1	8.3	8.4
RecCentral	10.1	10.0	9.9	10.0	10.1	10.3	10.3	10.8	11.0	11.1
CalCOFI	26.3	24.2	23.6	21.7	21.3	20.3	20.8	19.8	20.0	20.3
Triennial	3.6	3.7	3.9	4.0	4.1	4.1	4.3	4.3	4.5	4.8
CPFV_index	5.3	5.5	5.8	5.9	6.0	6.0	6.3	6.2	6.4	6.6
SCB_hook	5.5	4.4	3.5	2.7	2.4	2.0	1.5	1.0	0.7	0.6
Combo	3.3	3.2	3.1	2.9	2.9	2.9	2.8	2.7	2.7	2.7
Juv_trawl	4.3	4.2	4.1	4.0	3.9	3.9	3.8	3.7	3.6	3.6
Pier_index	21.4	20.8	19.8	19.7	19.4	19.1	18.6	18.0	17.6	17.4
Length										
Trawl_south	469.0	468.6	468.5	468.2	468.1	467.9	468.0	467.8	468.0	468.6
hook-line	361.5	361.9	362.5	362.8	363.0	363.2	363.7	363.9	364.3	364.7
setnet	356.3	356.1	356.2	356.1	356.2	356.2	356.5	356.5	356.8	357.3
RecSouth	377.4	376.8	376.2	375.7	375.4	375.2	374.7	374.2	373.7	373.2
RecCentral	369.2	368.0	366.9	365.7	365.2	364.7	363.8	362.9	362.0	361.2
Trawl_north	375.6	372.6	369.5	366.8	365.4	364.3	361.7	359.8	357.5	355.3
Triennial	149.7	150.0	150.4	150.8	151.0	151.3	151.8	152.5	153.2	154.2
CPFV CenCal	215.4	214.7	214.0	213.4	213.1	212.9	212.2	211.8	211.2	210.5
SCB_hook	61.8	61.6	61.4	61.1	60.9	60.8	60.5	60.3	60.0	59.7
Combo	137.2	137.2	137.2	137.2	137.3	137.3	137.4	137.6	137.7	137.9
delete	180.5	181.9	183.3	184.7	185.4	186.1	187.5	188.8	190.3	192.0
CPFV SouCal	127.5	127.1	126.5	126.7	126.6	126.9	126.6	127.2	127.1	126.8

Table 31. Summary of Reference Points for bocaccio rockfish.

		95% Confidence Limits	
Unfished Stock	Estimate	Lower	Upper
Summary (1+) Biomass	44070	36029	52111
Spawning Output	7860000	6426040	9293960
Equilibrium recruitment	5060	4129	5991

	Yield reference Points		
	$SSB_{40\%}$	SPR proxy	MSY est.
SPR	0.512	0.5	0.461
Exploitation rate	0.066	0.068	0.078
Yield	1250	1258	1270
Spawning output	3140000	3031020	2651890
SSB/SSB_0	0.40	0.39	0.34

Table 32: Decision Table for the bocaccio assessment, where State 1 has the triennial and trawl CPUE indices emphasized, and State 2 emphasizes southern rec CPUE and the CalCOFI indices.

		State1		**Base Model**		**State2**	
catch with 2008 F		larvae	depletion	larvae	depletion	larvae	depletion
2009	65	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	62	1056130	**0.15**	2259880	**0.29**	2715680	**0.39**
2011	62	1059020	**0.15**	2267600	**0.29**	2720120	**0.39**
2012	68	1076100	**0.15**	2289230	**0.29**	2736480	**0.40**
2013	78	1133840	**0.16**	2371870	**0.30**	2819550	**0.41**
2014	90	1224880	**0.18**	2506410	**0.32**	2959720	**0.43**
2015	102	1337490	**0.19**	2675120	**0.34**	3137450	**0.45**
2016	113	1464190	**0.21**	2865660	**0.36**	3338590	**0.48**
2017	123	1600700	**0.23**	3069460	**0.39**	3552450	**0.51**
2018	129	1744400	**0.25**	3280130	**0.42**	3770470	**0.55**
2019	136	1893960	**0.27**	3493470	**0.44**	3986640	**0.58**
2020	142	2048240	**0.29**	3706040	**0.47**	4196180	**0.61**
SPR of 0.77 (base)		larvae	depletion	larvae	depletion	larvae	depletion
2009	267	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	251	1025030	**0.15**	2228890	**0.28**	2684700	**0.39**
2011	246	997328	**0.14**	2206150	**0.28**	2658730	**0.38**
2012	265	986019	**0.14**	2199380	**0.28**	2646800	**0.38**
2013	299	1013570	**0.14**	2252490	**0.29**	2700770	**0.39**
2014	339	1068090	**0.15**	2352740	**0.30**	2807790	**0.41**
2015	377	1136160	**0.16**	2481040	**0.32**	2947220	**0.43**
2016	413	1210440	**0.17**	2625210	**0.33**	3105210	**0.45**
2017	445	1287560	**0.18**	2777630	**0.35**	3272010	**0.47**
2018	474	1365920	**0.20**	2933000	**0.37**	3440210	**0.50**
2019	500	1444790	**0.21**	3087910	**0.39**	3604600	**0.52**
2020	517	1523620	**0.22**	3239680	**0.41**	3761180	**0.54**
SPR of 0.77(State 2)		larvae	depletion	larvae	depletion	larvae	depletion
2009	353	1034540	**0.15**	2209950	**0.28**	2658620	**0.38**
2010	326	1009690	**0.14**	2213630	**0.28**	2669450	**0.39**
2011	314	967342	**0.14**	2176350	**0.28**	2628970	**0.38**
2012	328	942839	**0.13**	2156410	**0.27**	2603940	**0.38**
2013	360	956879	**0.14**	2196410	**0.28**	2645010	**0.38**
2014	395	995845	**0.14**	2282340	**0.29**	2738290	**0.40**
2015	429	1045960	**0.15**	2394880	**0.30**	2863010	**0.41**
2016	459	1100950	**0.16**	2522930	**0.32**	3006440	**0.43**
2017	479	1158410	**0.17**	2659810	**0.34**	3159810	**0.46**
2018	497	1217370	**0.17**	2800930	**0.36**	3316360	**0.48**
2019	512	1277570	**0.18**	2943370	**0.37**	3471380	**0.50**
2020	527	1338790	**0.19**	3084810	**0.39**	3621160	**0.52**

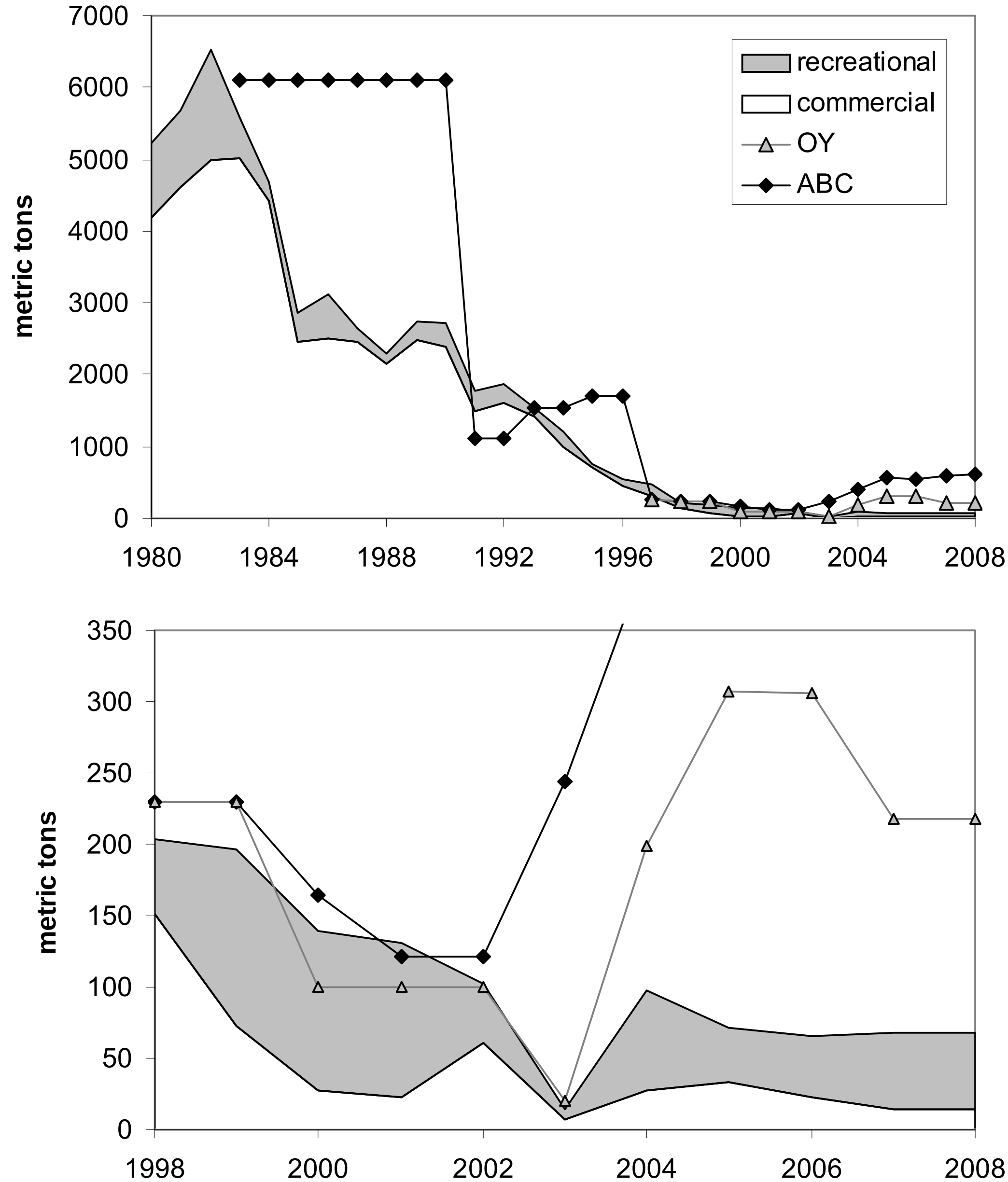


Figure 1: Management performance with PFMC adopted ABC and OY values relative to estimated landings (1980-2002) and landings + discards (2002-2007; 2008 is set to 2007 until final numbers provided). Lower graph provided for scale in recent years.

Figure 2: Map of the West Coast INPFC management areas. This assessment covers the bocaccio stock in the Eureka, Monterey and Conception management areas.

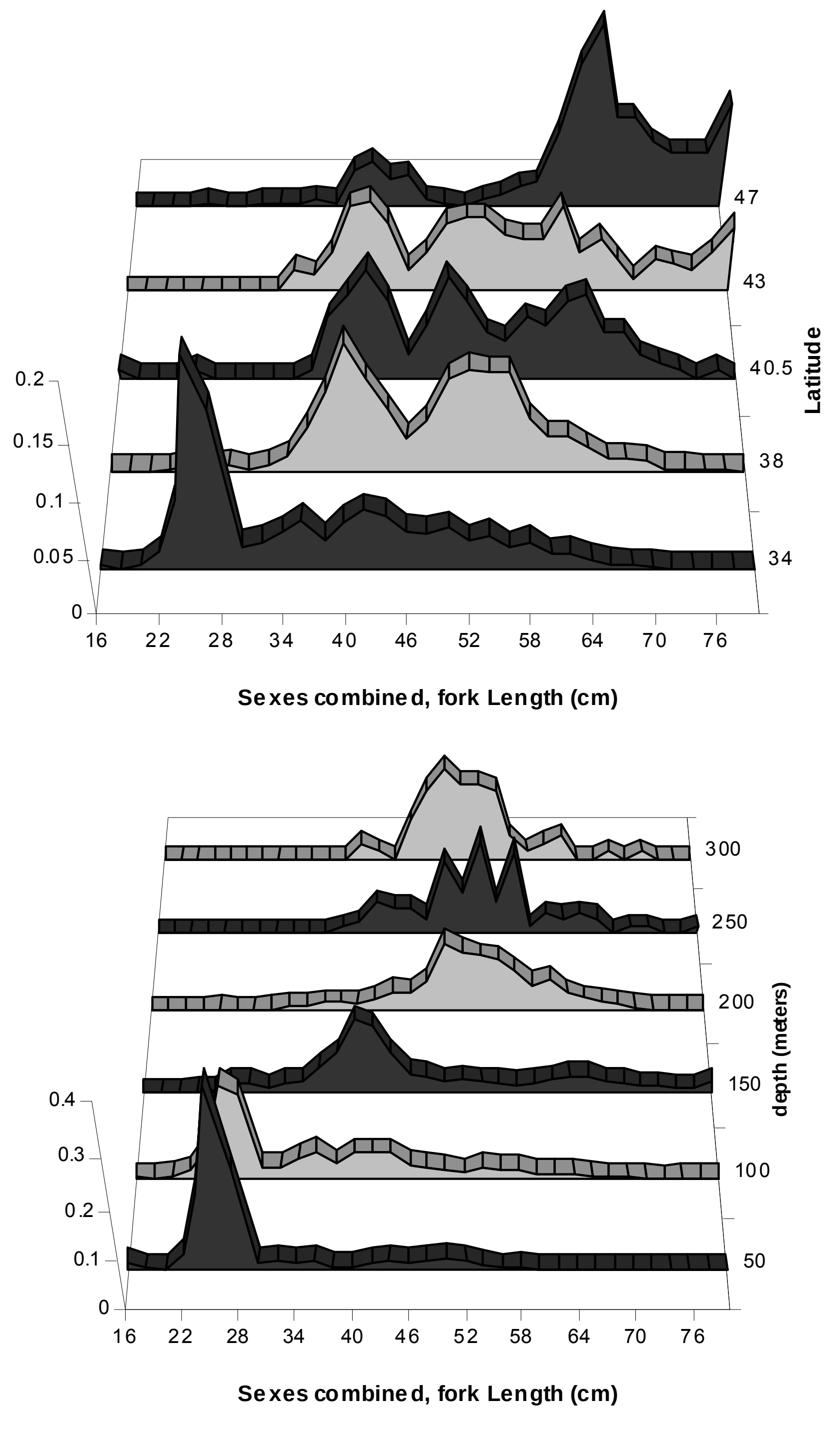


Figure 3a-b. 3a (top) Length frequency information from the triennial trawl survey by region; all years aggregated, demonstrating the shift in size distribution in the northern areas; 3b (bottom) length frequency information by depth bin, illustrating ontogenetic movement to deeper water with size.

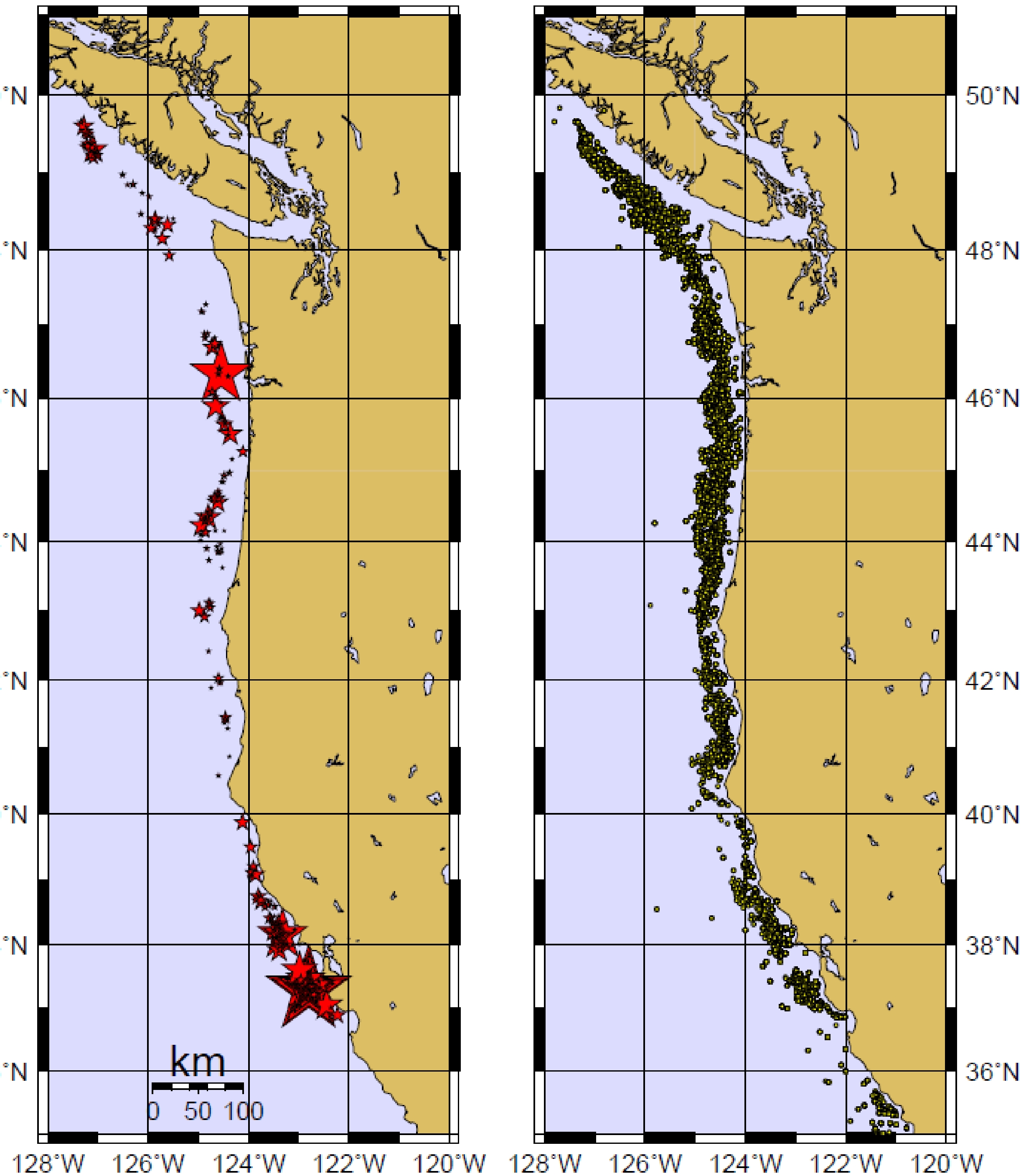


Figure 4. Locations of Russian trawls where bocaccio were caught (left panel) versus tow locations where no bocaccio were found (right panel) from trawls taken between 1963-1978. Stars are sized proportional to the square root of the total number caught per tow.

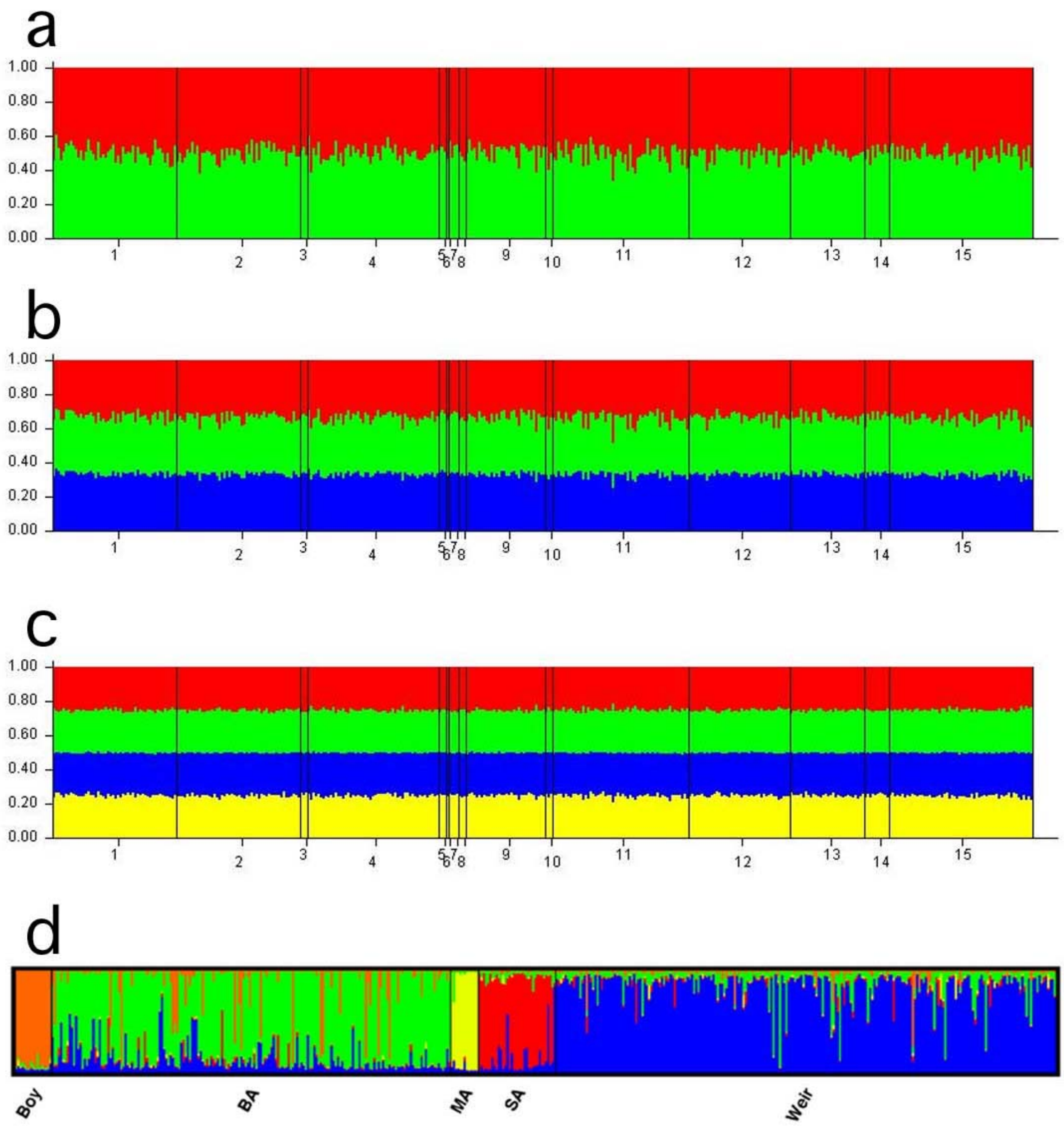


Figure 5a-d. Results of analysis of data from seven microsatellite loci in 386 *S. paucispinis* using the program STRUCTURE (Pritchard et al. 2000; data from Matala et al. 2004; analysis by D. E. Pearse, FED/SWFSC/NMFS). Each vertical line represents an individual, and color indicates membership in a specified number of distinct genetic groups. Panels a, b, and c show results for two, three, and four groups, respectively. For comparison, analysis of five genetically-differentiated populations of steelhead/rainbow trout is shown in 5d (*from* Pearse et al. *In Press*).

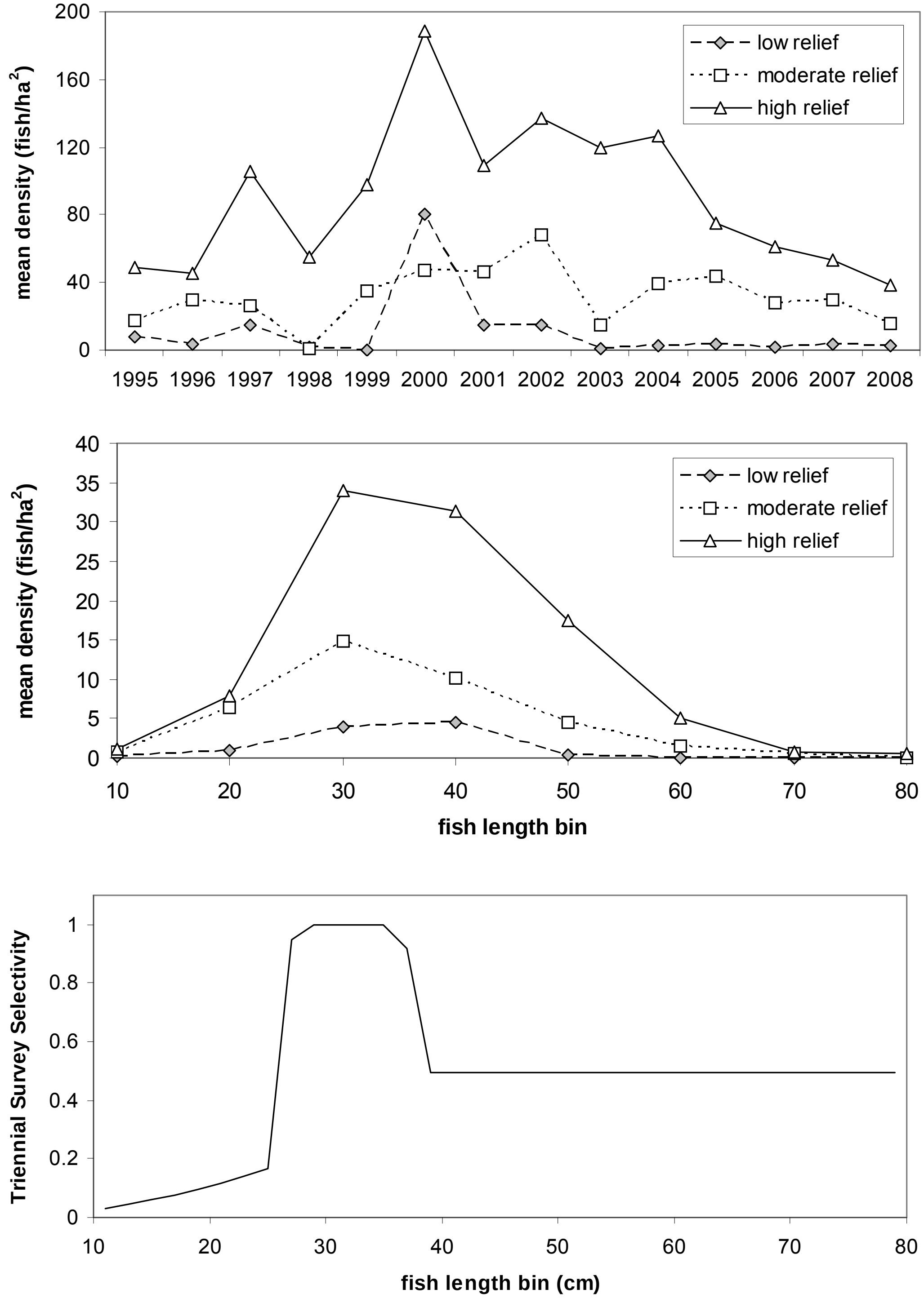


Figure 6. Habitat associations of bocaccio based on submersible observation data from Love (pers. com). Top panel shows the mean density (in numbers of fish observed per hectare) by year (pooled over all sizes), middle figure shows the mean density by habitat type and fish size, bottom figure shows the estimated selectivity of trawl survey from the 2007 model.

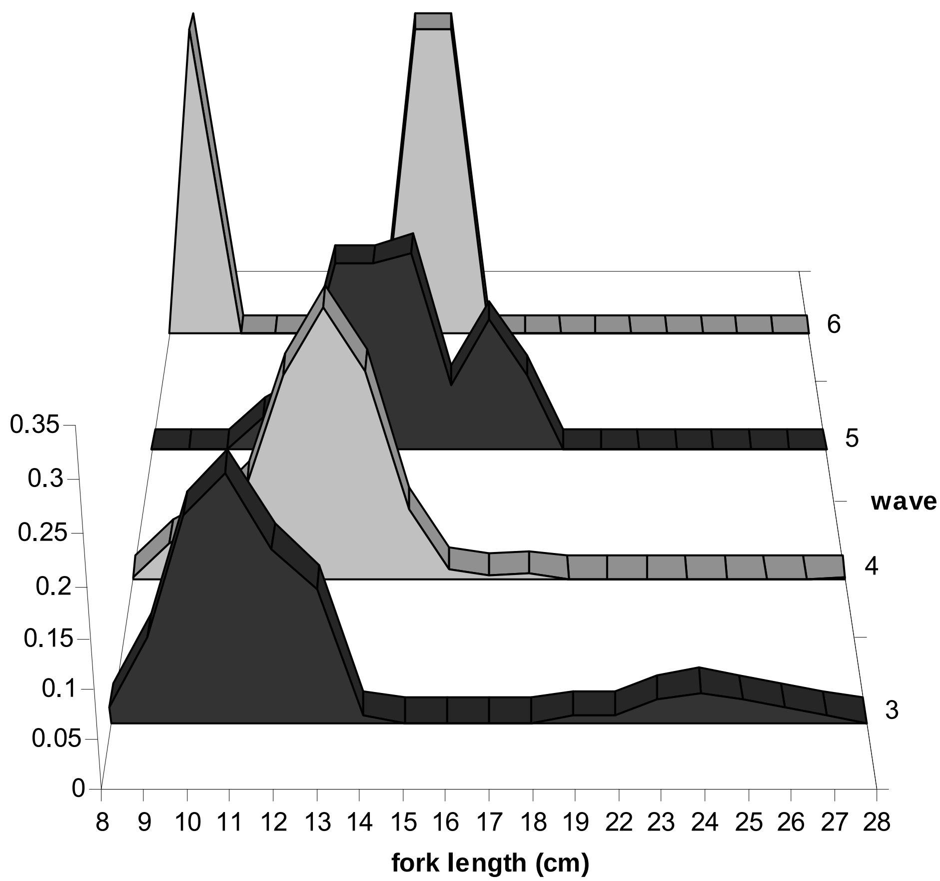


Figure 7. Length frequency data from recreational pier and shore fisheries in California (all years combined) showing the modal progression of age-0 size at age. Waves correspond to bimonthly sampling periods (such that wave 3 is May-June, wave 4 is July-August, etc).

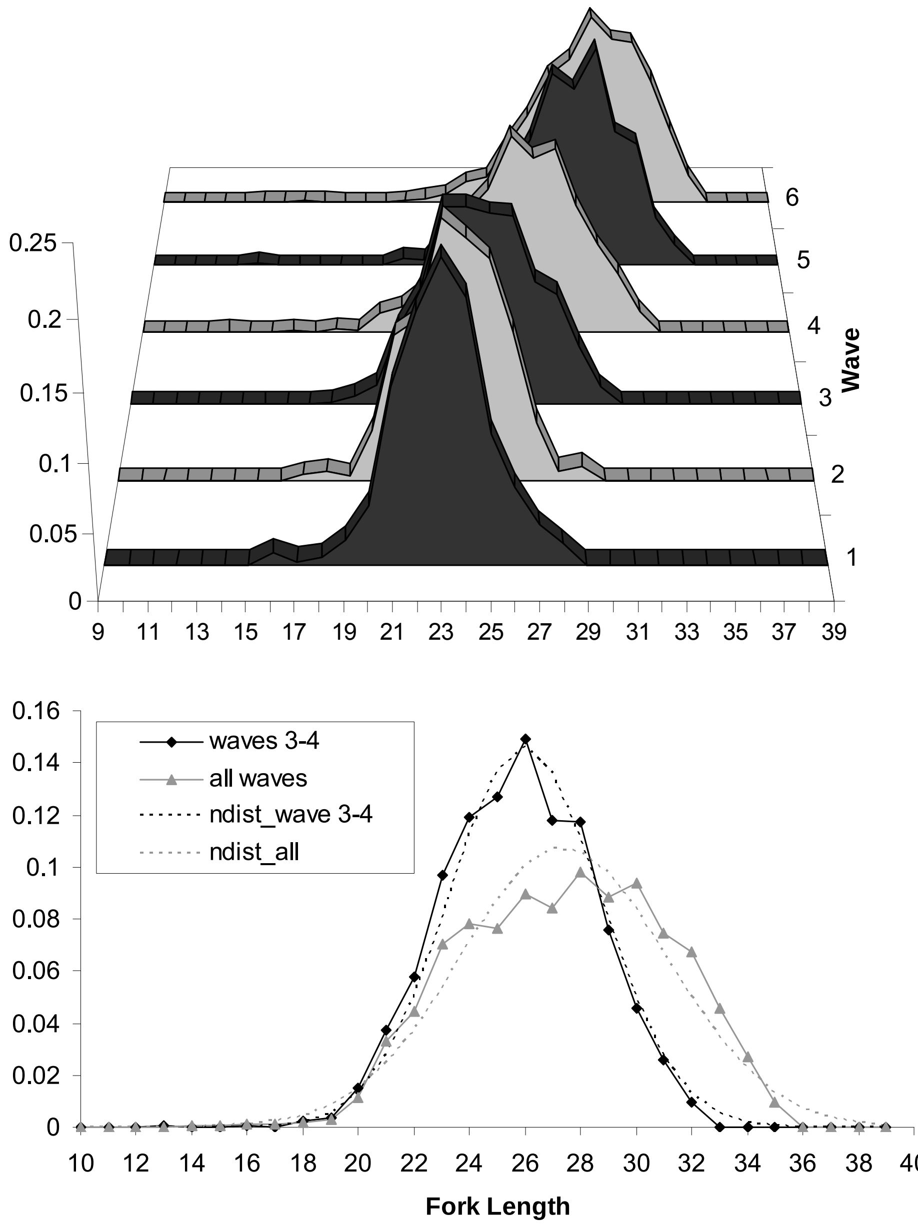


Figure 8a and 8b. Length frequency data from the Southern California CPFV fishery in 1978, with sizes data truncated above a wave-specific maximum to illustrate the modal progression of the 1977 year class by wave. Bottom figure shows the same data with a fitted normal distribution for all waves versus waves 3-4 (May-August).

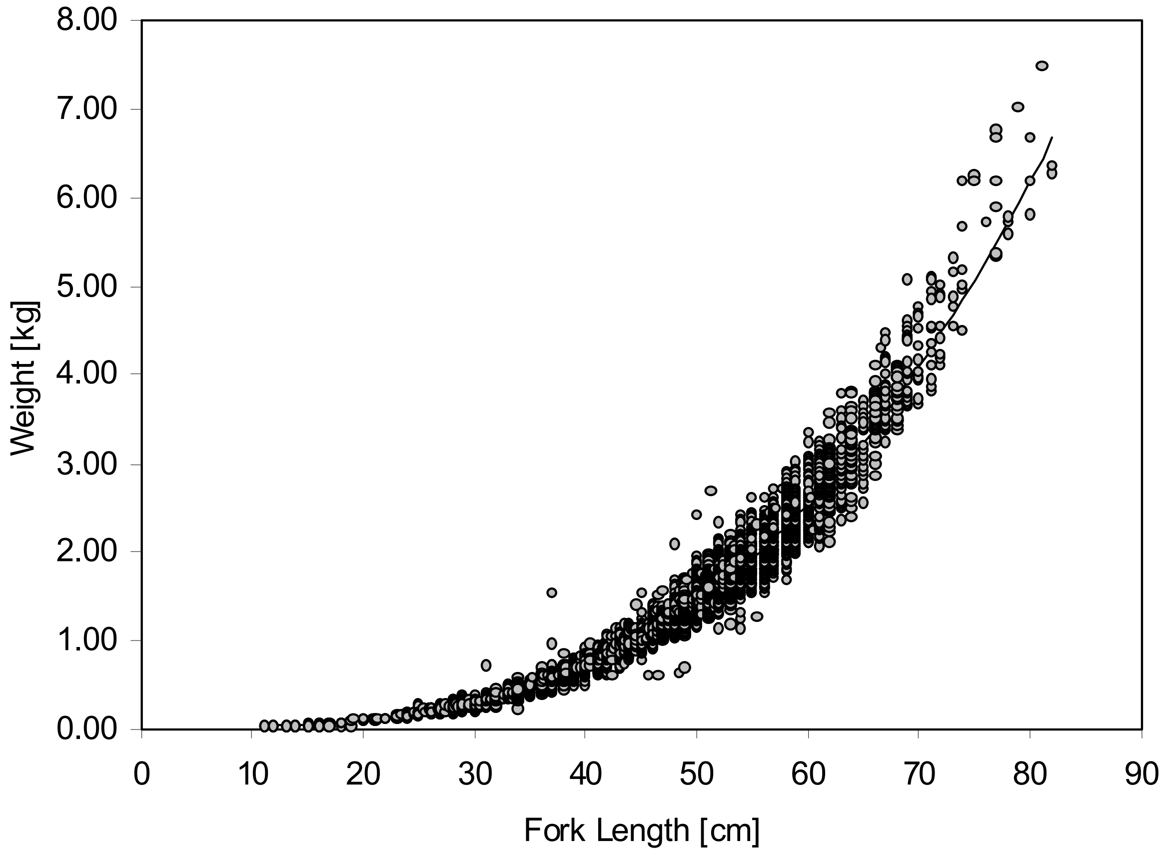
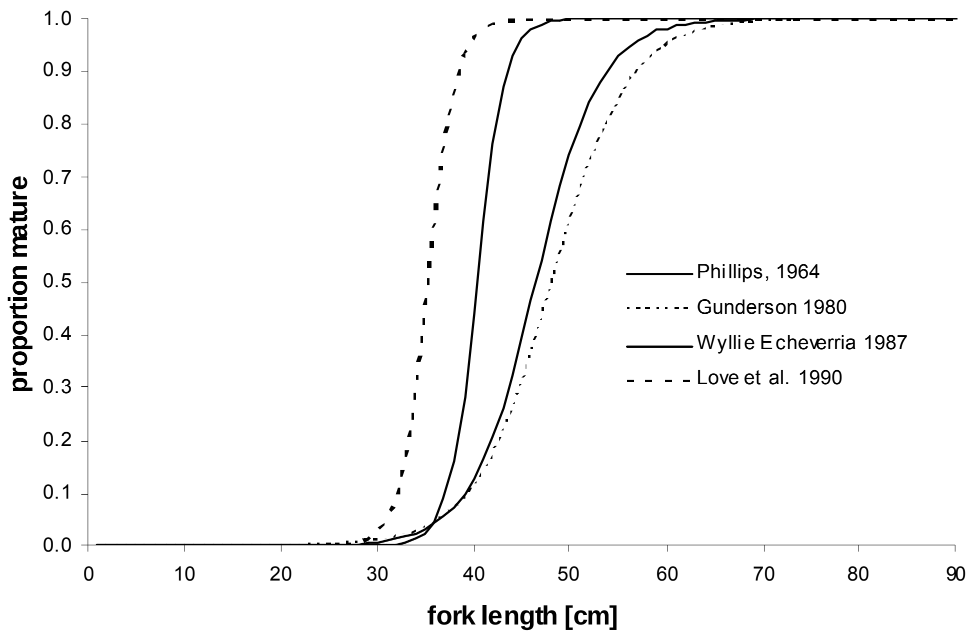


Figure 9. Weight-length relationship for bocaccio rockfish.



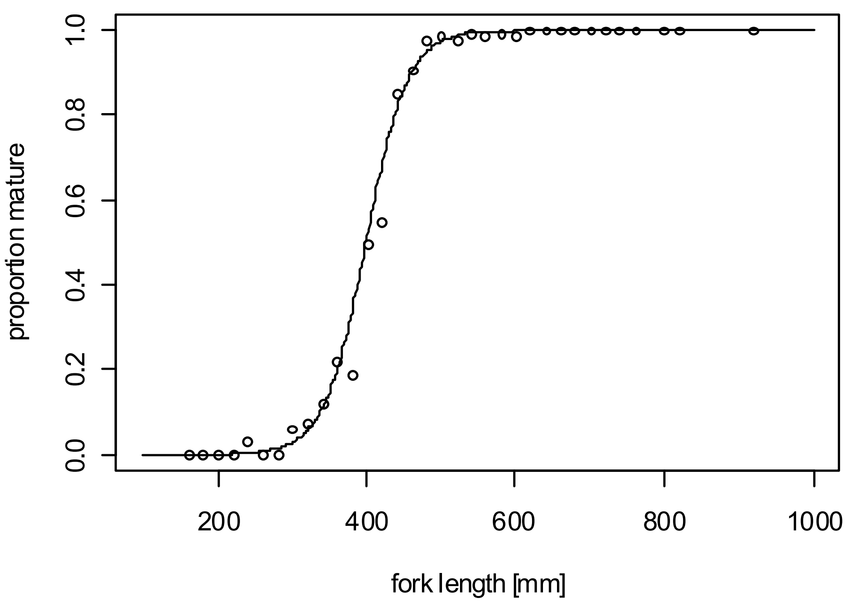
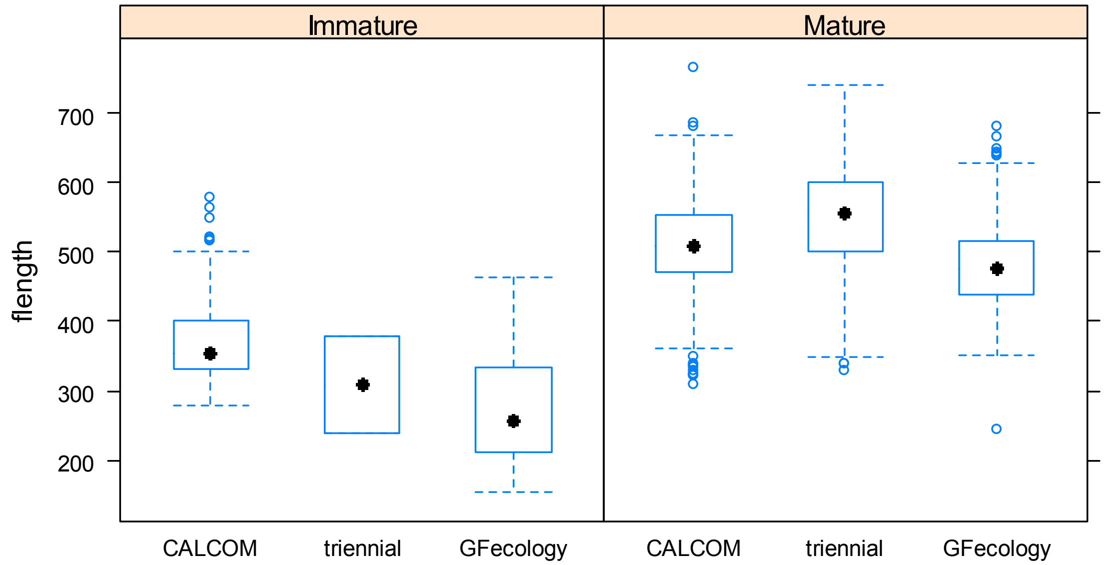


Figure 10a-b. 10a (top) Logistic curves representing the proportion of female bocaccio that are mature as a function of body length, as reported in four published studies. Figure 10b (bottom) observed proportion of mature female bocaccio at length (solid circles, 2-cm length bins) and binomial GLM predictions (solid line) for central and northern California, all years and regions combined.



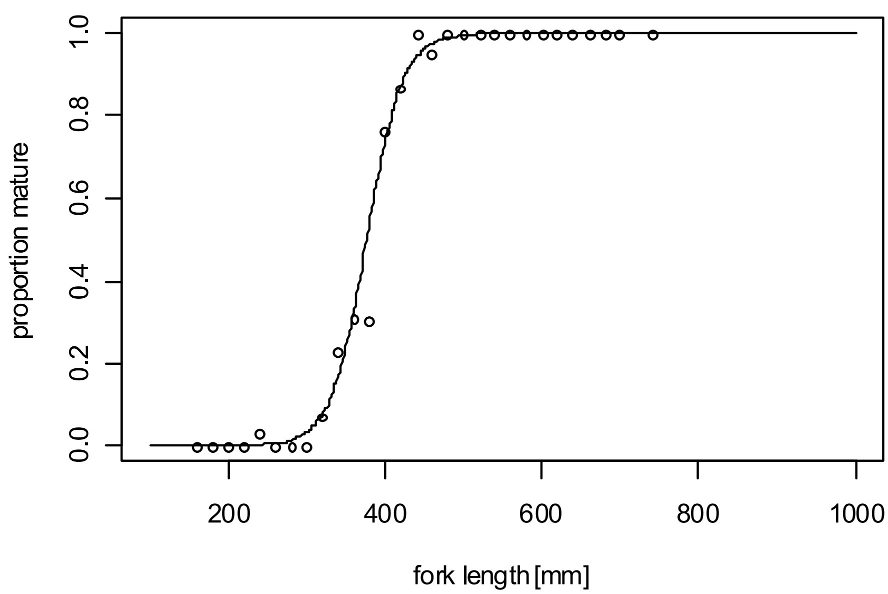


Figure 11a-b. 11a (top) Length distributions of female bocaccio taken in the Monterey (MNT) area, by maturity status and data source. Immature fish from commercial fishery (CALCOM data) are larger on average than samples from surveys (triennial and Groundfish Ecology), likely due to differences in gear selectivity. 11b (bottom) Maturity at length based on the combined survey model. Solid circles are observed proportion of mature female bocaccio at length (2-cm length bins) and the solid line is the prediction from a binomial GLM for central California, all years and regions combined.

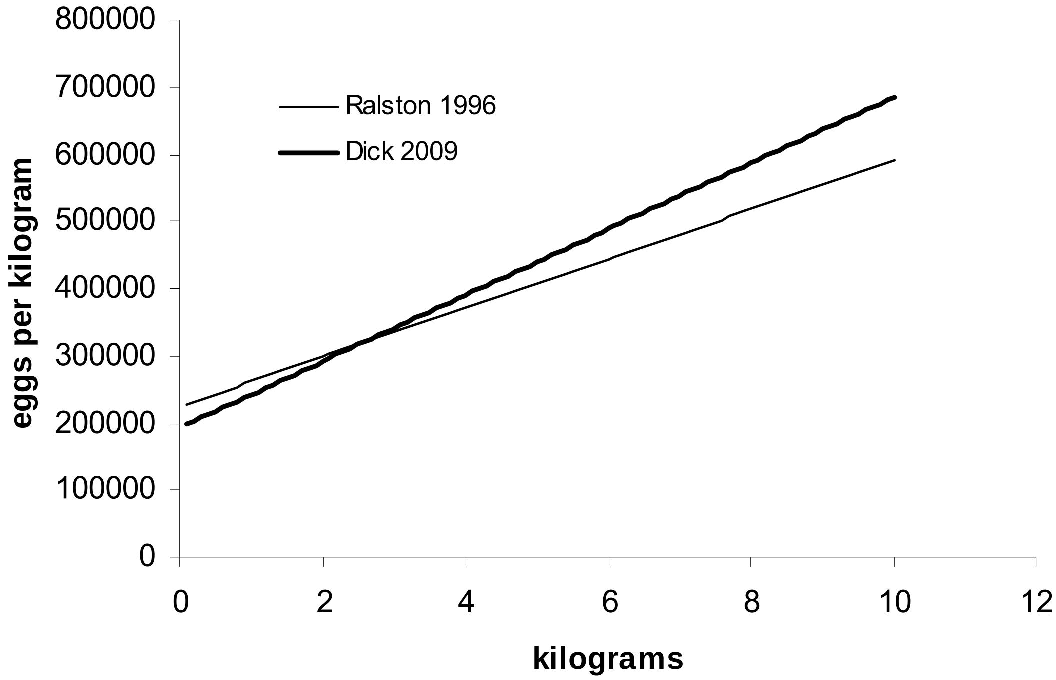
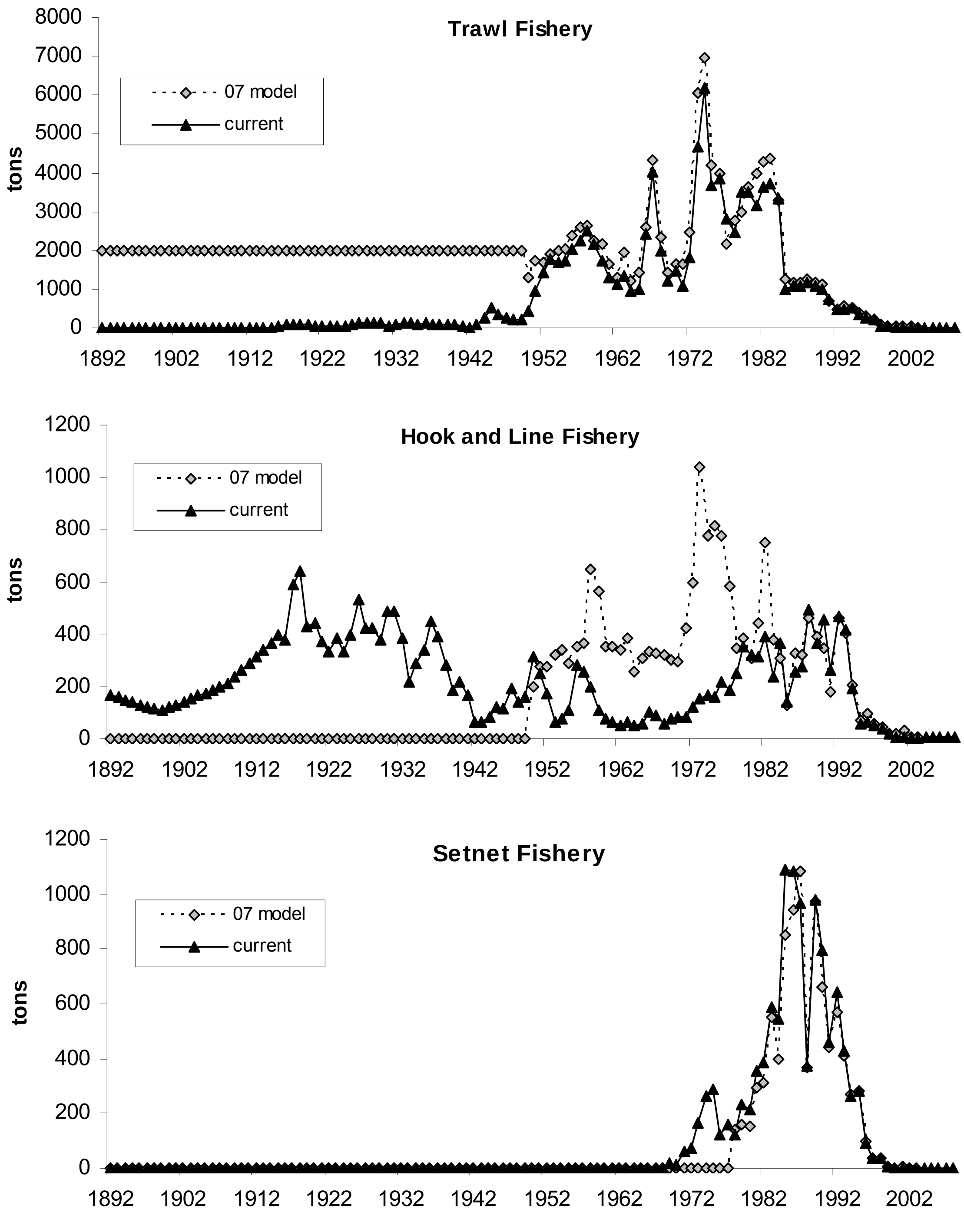
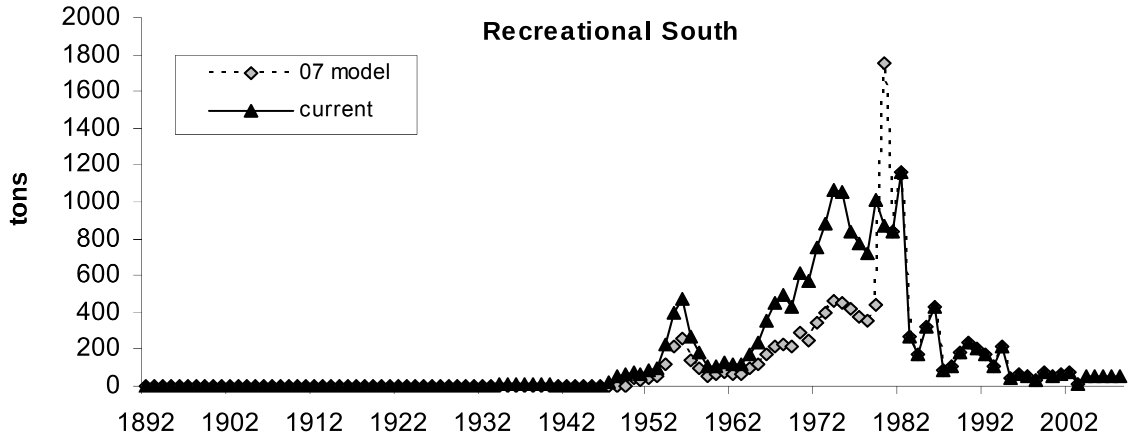
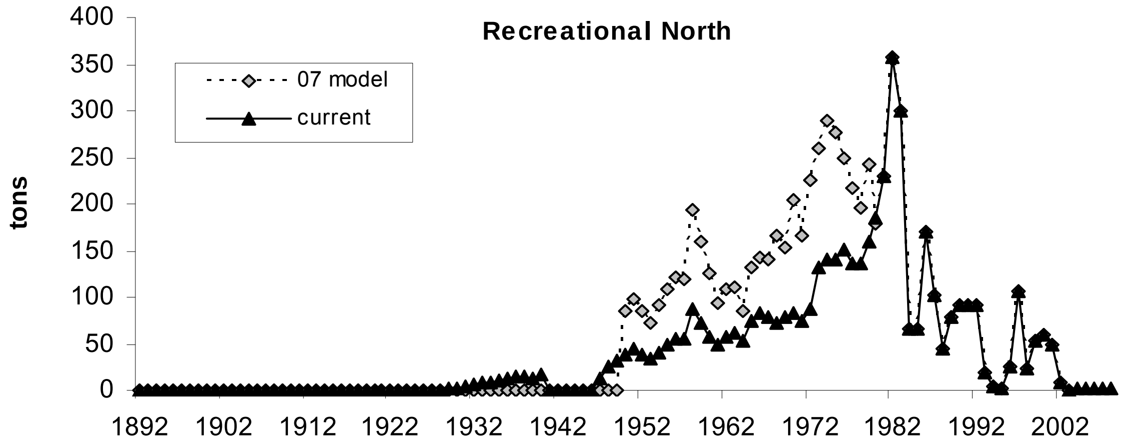


Figure 12. Linear models for relative fecundity (eggs per kilogram) of female bocaccio as a function of weight.

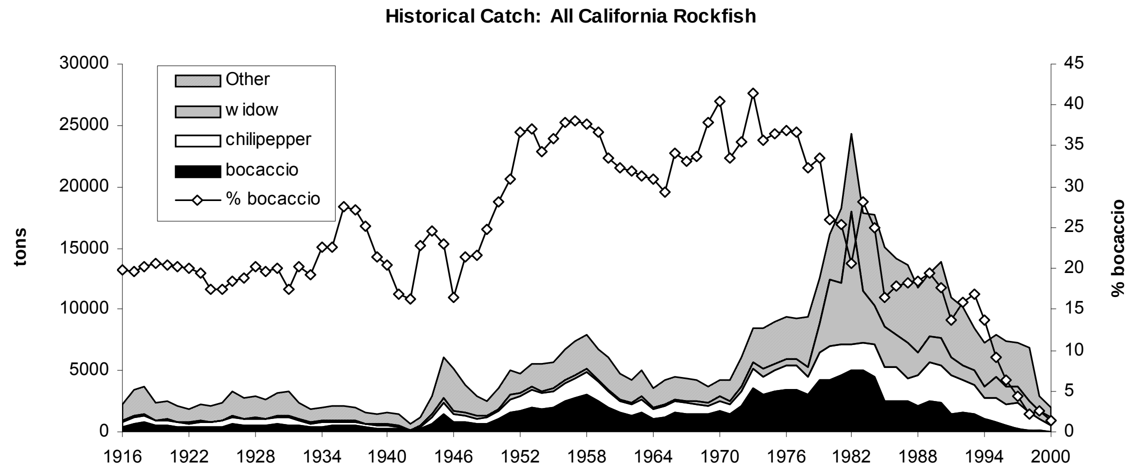


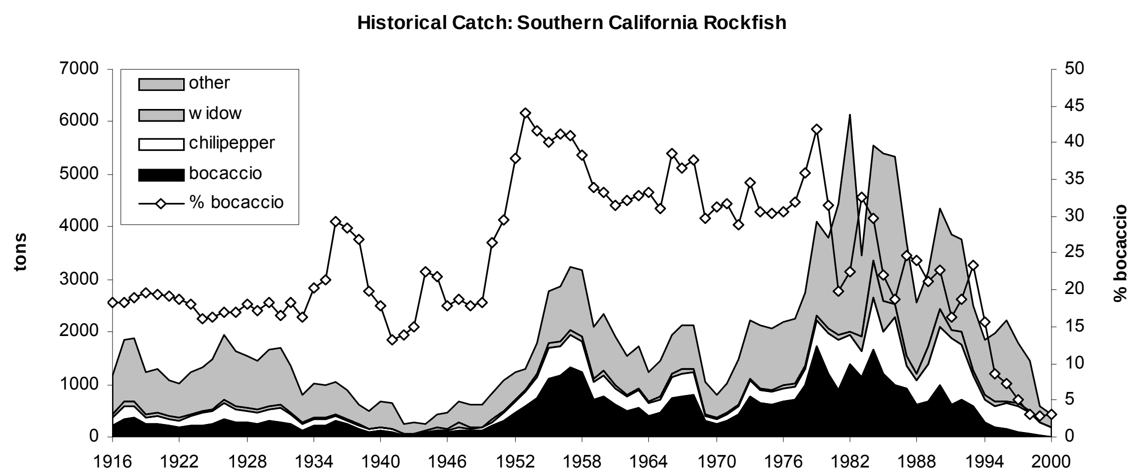
Figures 13a-c. Comparison of 2007 and current model catch estimates commercial gears; trawl (top), hook and line (middle) and set net (bottom)

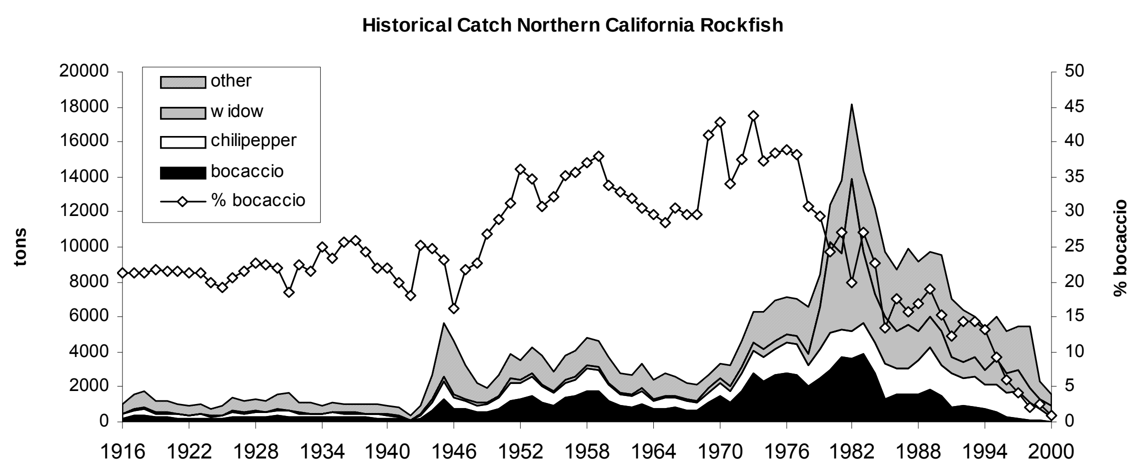




Figures 13d-e. Comparison of 2007 and current model catch estimates for the two recreational fisheries, south (top) and north (bottom) of Point Conception.







Figures 14a-c. Reconstructed commercial catches of California rockfish for bocaccio, chilipepper, widow and all other rockfish species, including the percentage of the total catch estimated to be comprised of bocaccio rockfish, for all of California (top), south of Point Conception (middle) and north of Point Conception (bottom).

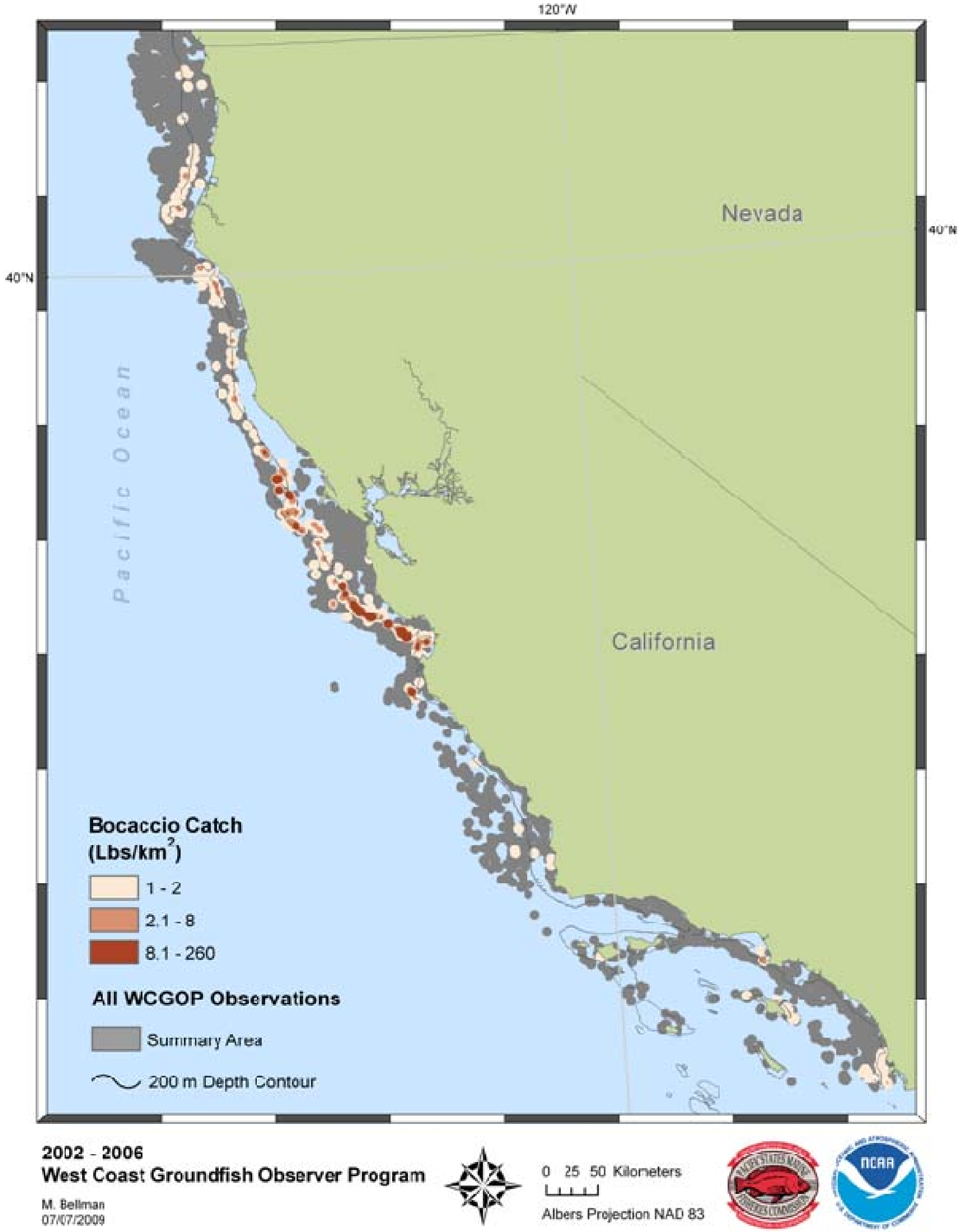
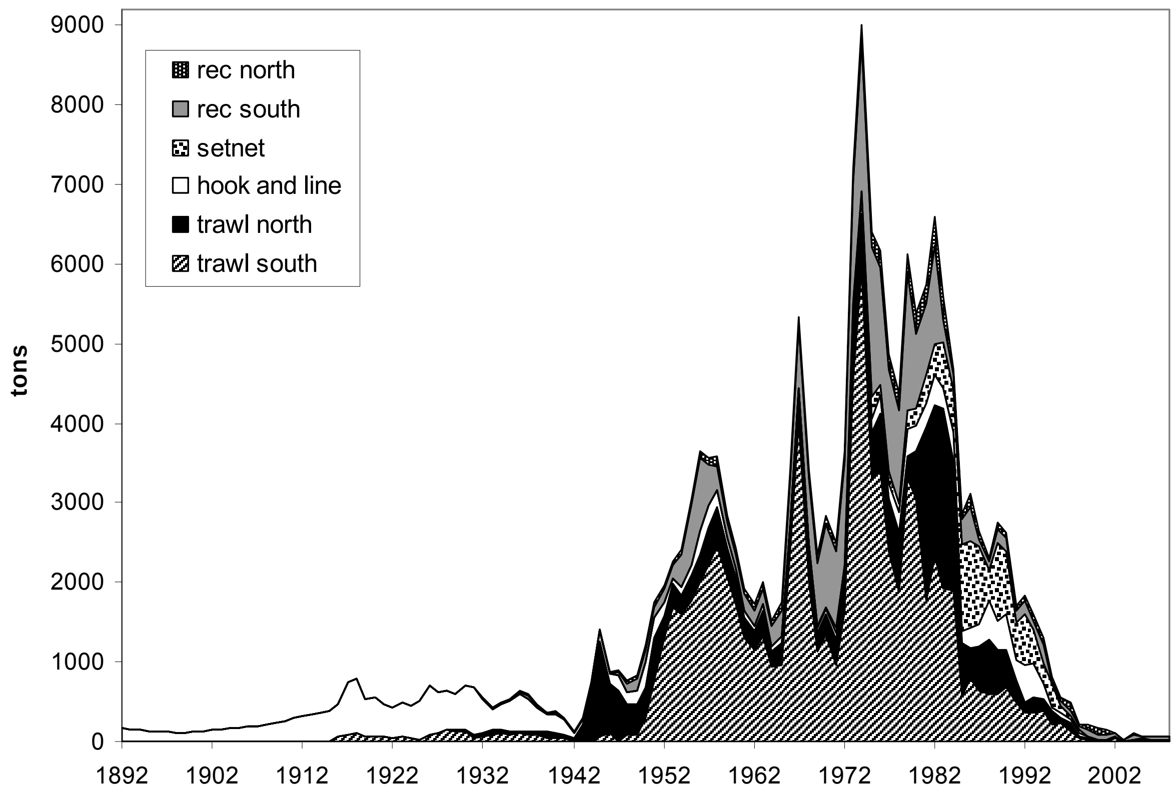


Figure 15: Bocaccio bycatch rates for California waters, from the West Coast Groundfish Observer Program (WCGOP).



Figures 16. Assessment area (U.S. waters south of Cape Blanco) catch estimates for the six fisheries used in the model.

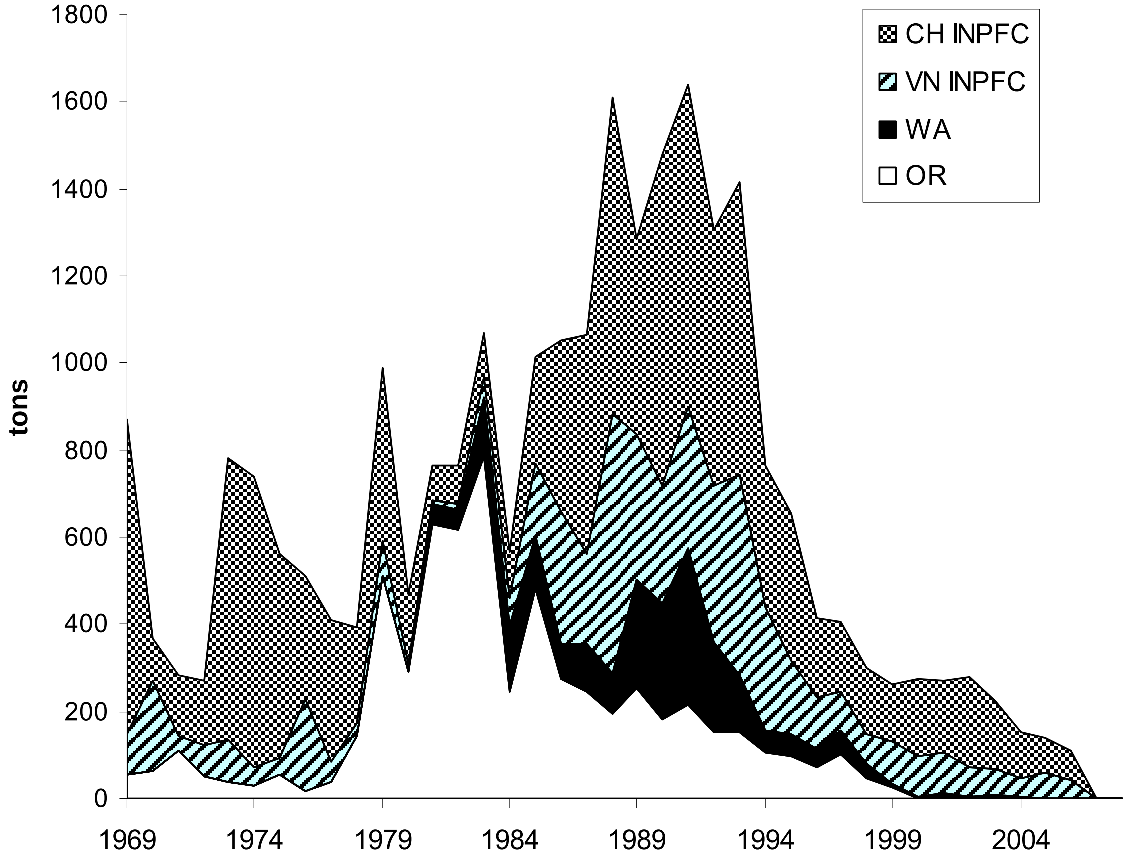


Figure 17. Catch estimates for the recent (1969-2006) period for areas north of Cape Blanco, Oregon, not included in the assessment model.

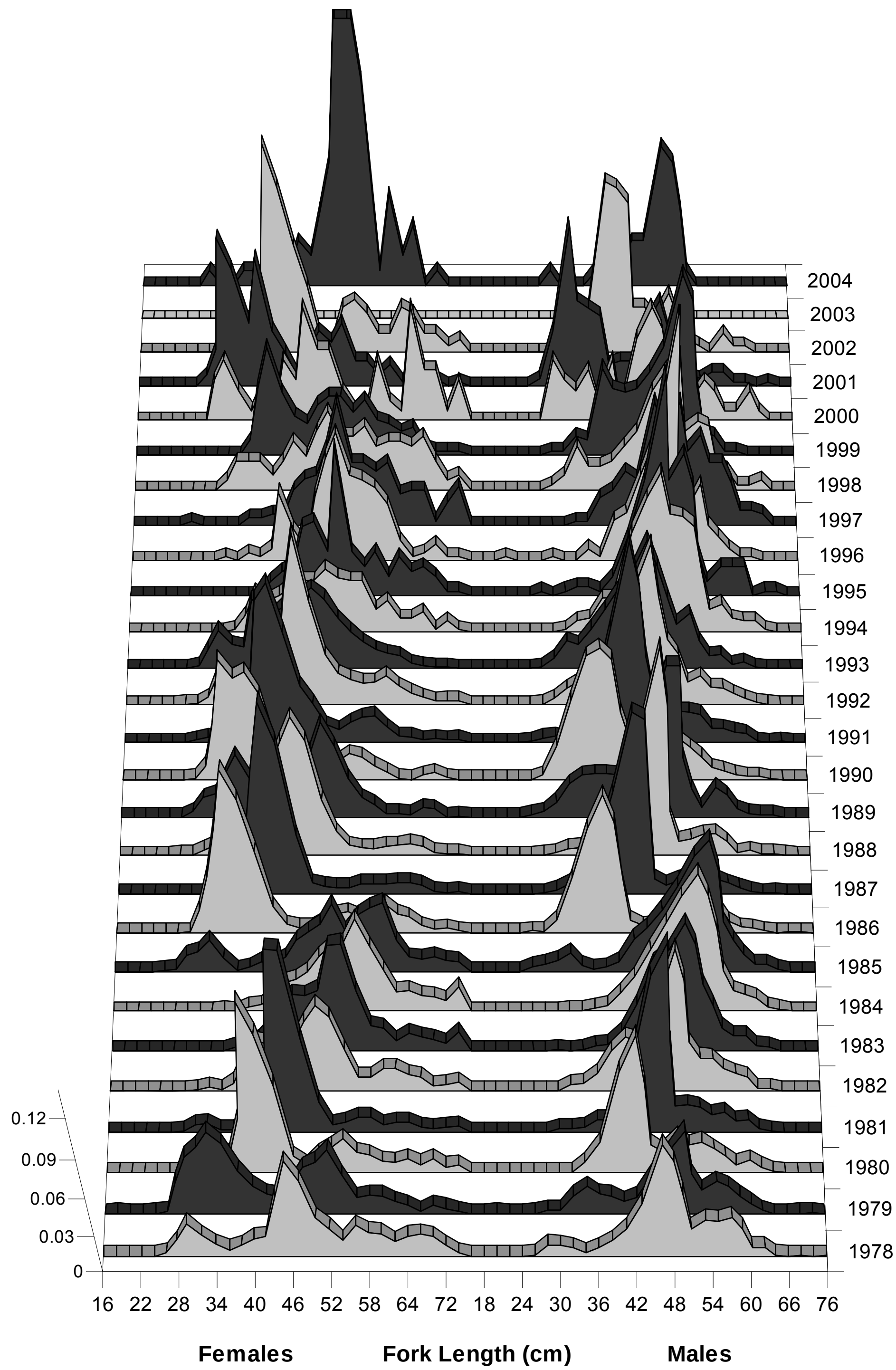


Figure 18. Length frequencies for all California trawl catches, 1978-2004.

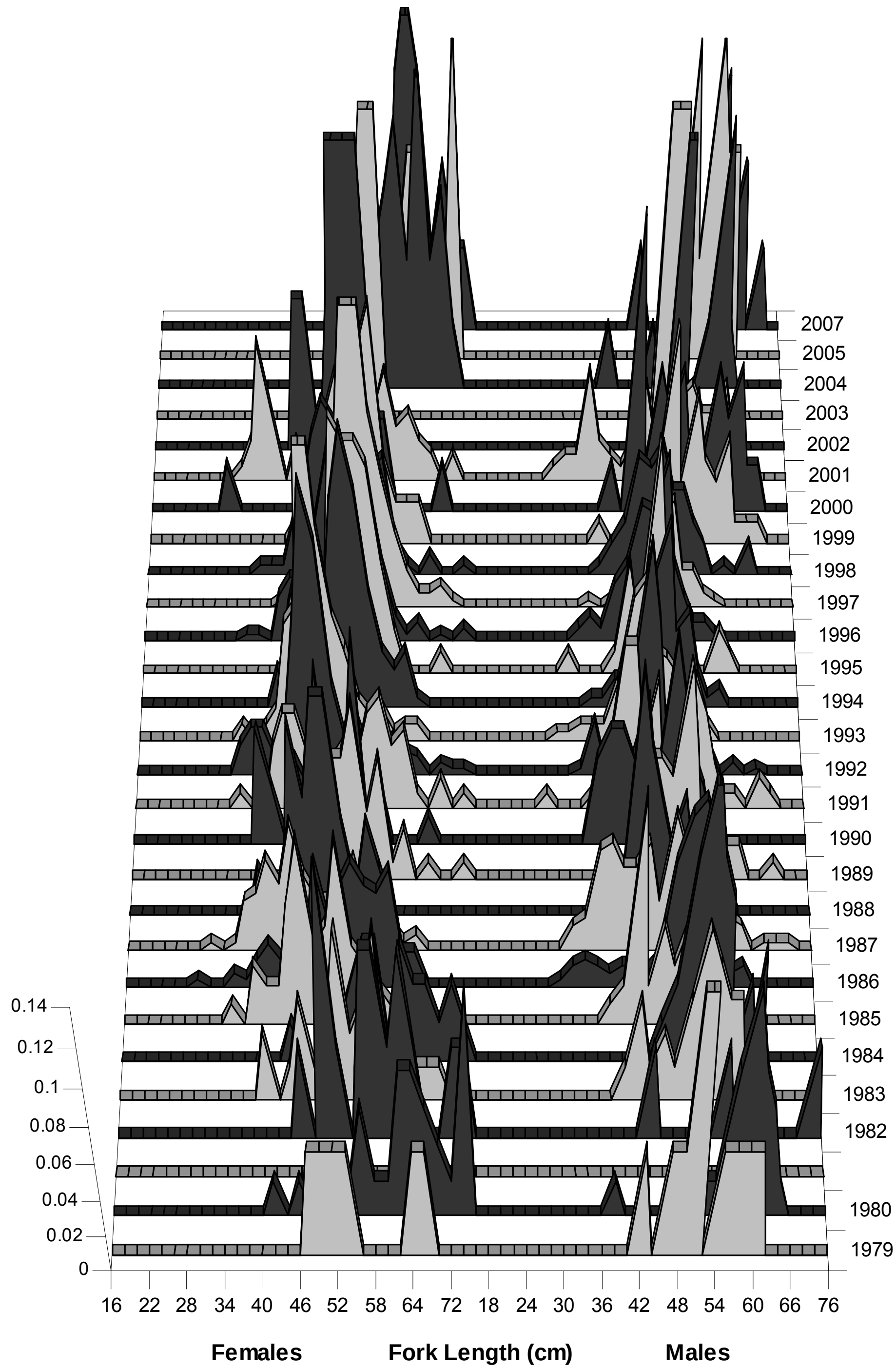


Figure 19. Length frequencies for all California hook-and-line catches, 1978-2004.

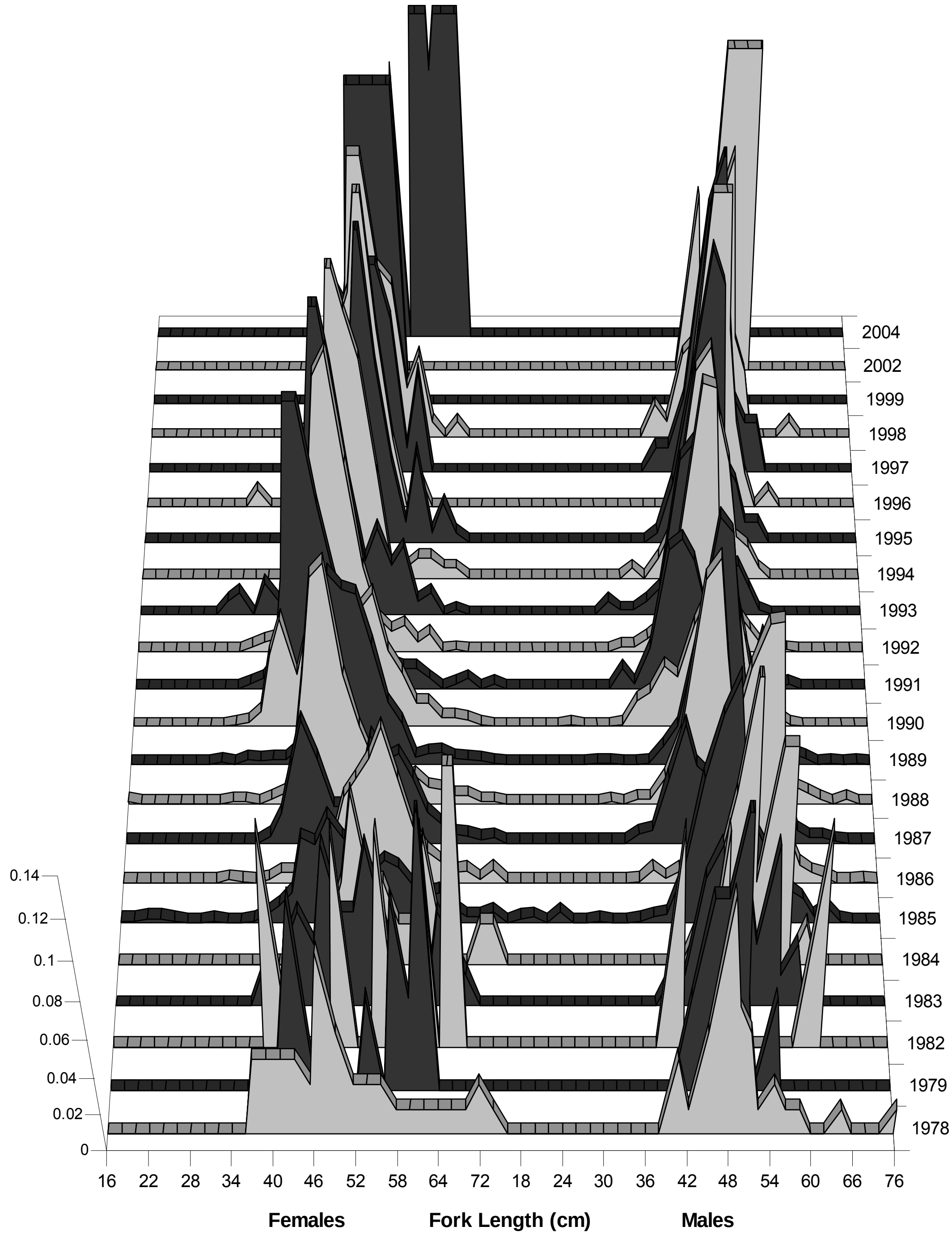
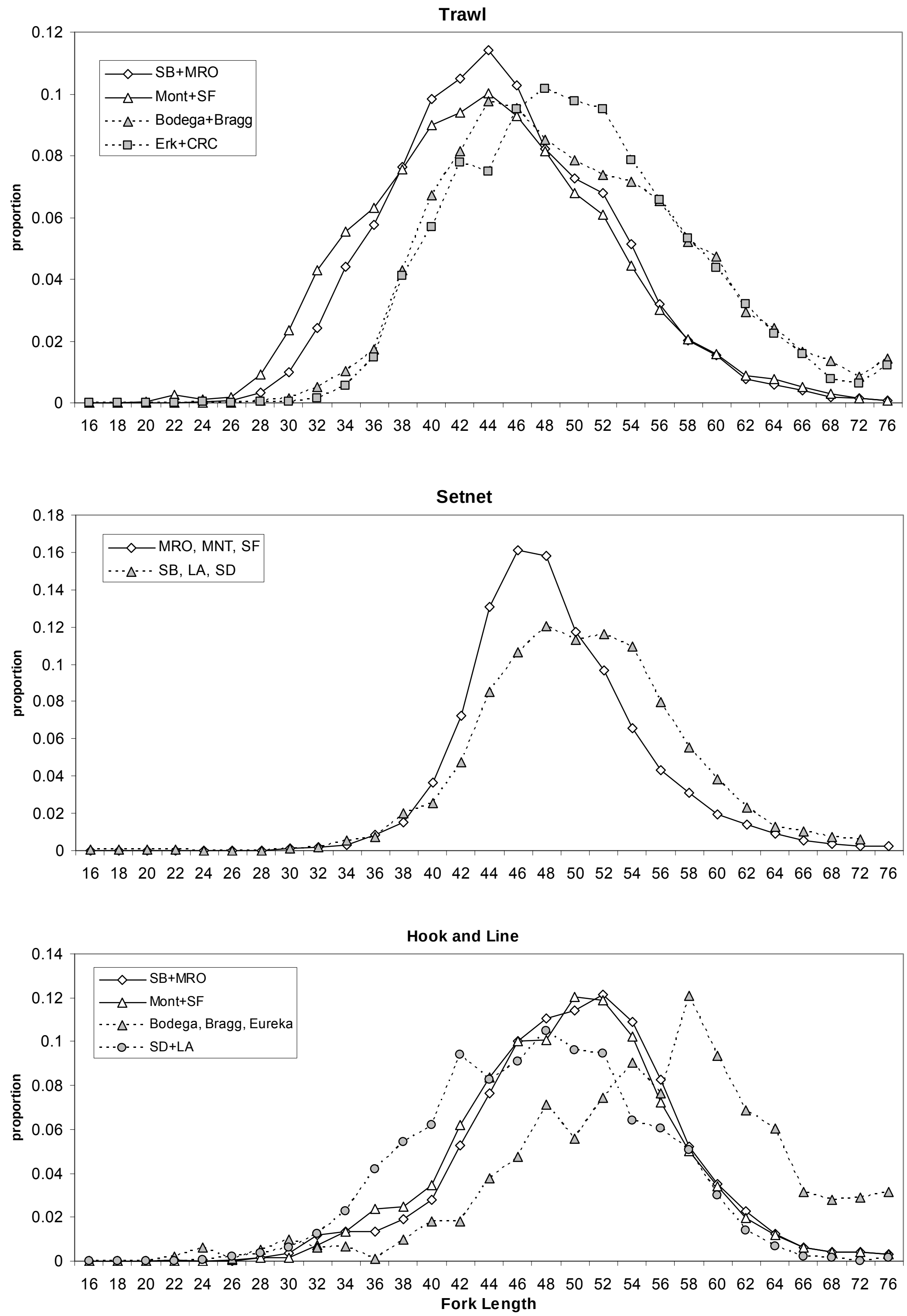


Figure 20. Length frequencies for all California set net catches, 1978-2004.



Figures 21a-c. Length frequency composition data for the trawl, hook-and-line and set net fisheries by port groups and regions. From south to north, port groups (essentially regions) are SD (San Diego), LA (Los Angeles), SB (Santa Barbara), MRO (Morro Bay), MNT (Monterey Bay), SF (San Francisco Bay), Bodega (Bodega Bay), Bragg (Fort Bragg), Erk (Eureka) and CRC (Crescent City).

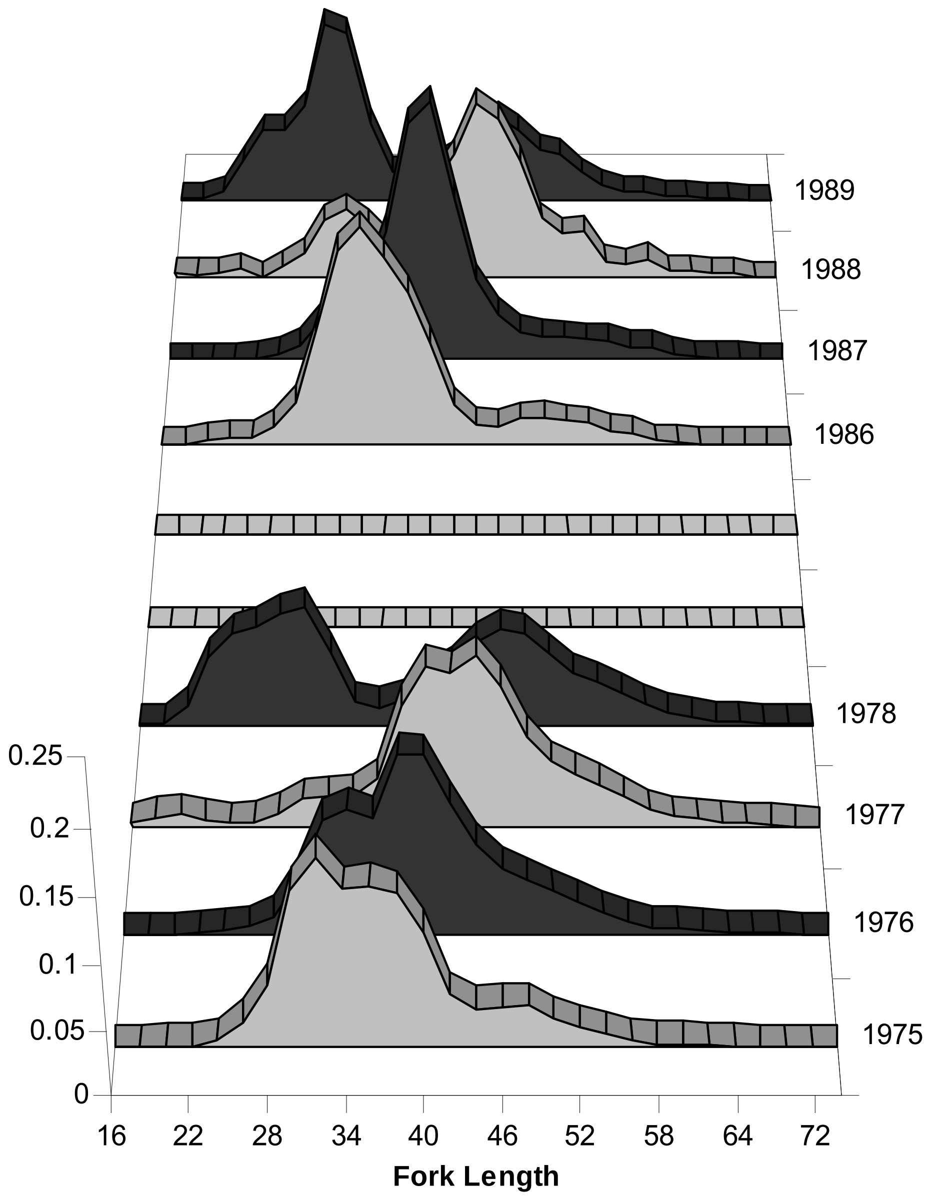


Figure 22. Length frequency distribution for Southern California CPFV observer program1975-1978 and 1986-1989.

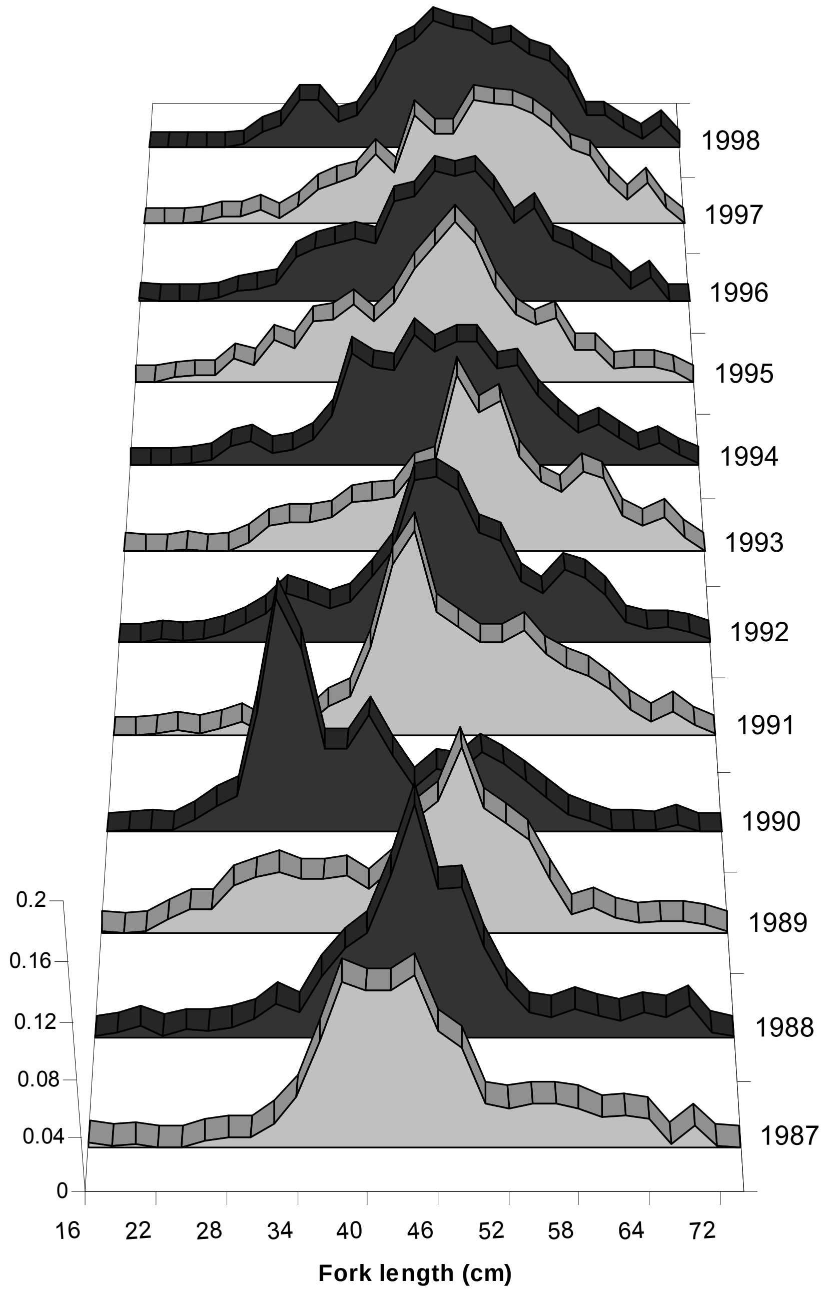


Figure 23. Length frequency distribution of sampled bocaccio from the central California CPFV observer program, 1987-1998.

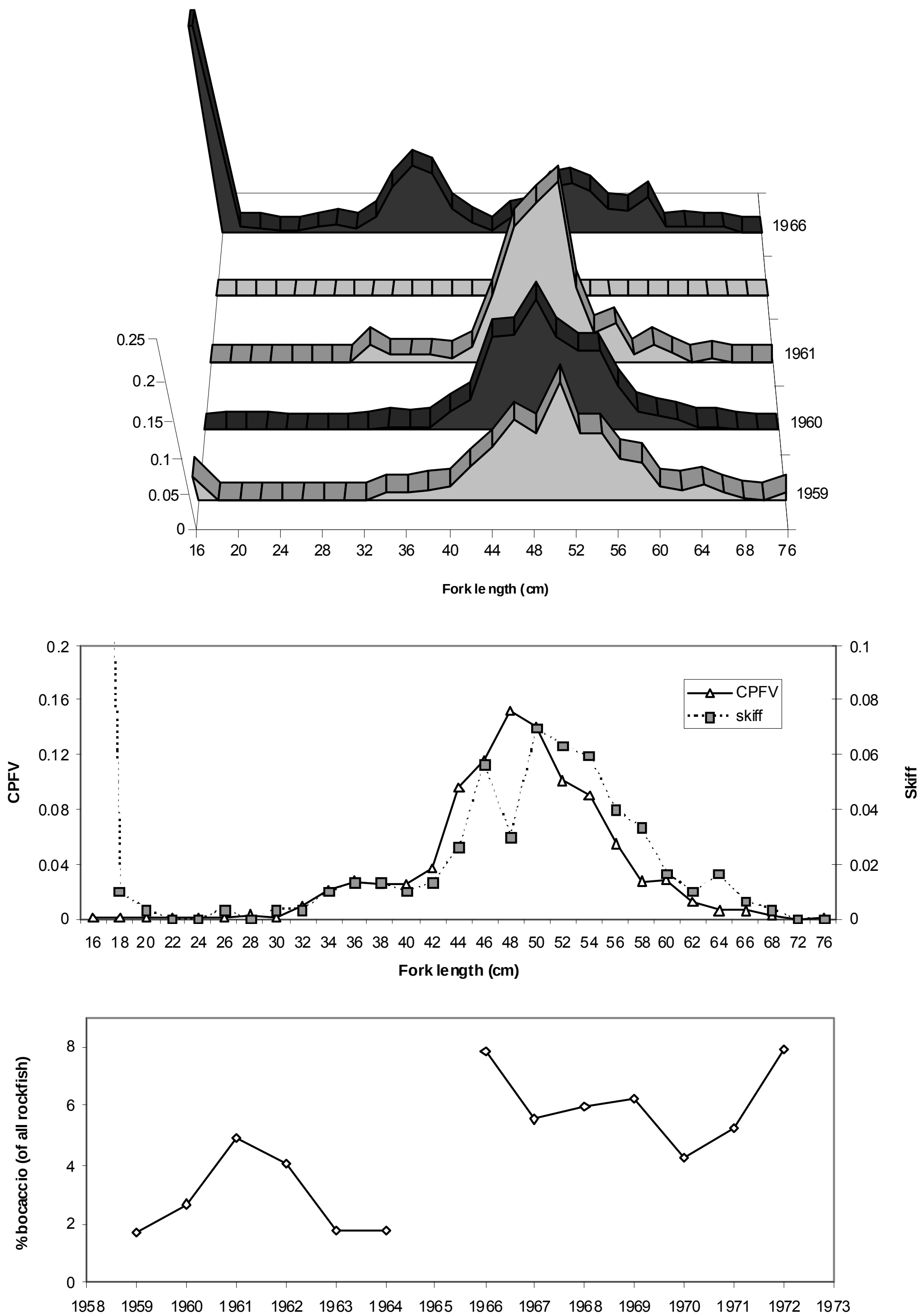


Figure 24a-c. 24a, Length frequency distribution for Monterey Bay CPFV and skiff recreational fisheries from the Miller and Gotshall monitoring efforts, 24b, pooled length frequencies showing difference between skiff and CPFV lengths, and 24c the percentage of the total recreational rockfish catch observed to be bocaccio in Monterey Bay, 1959-1972.

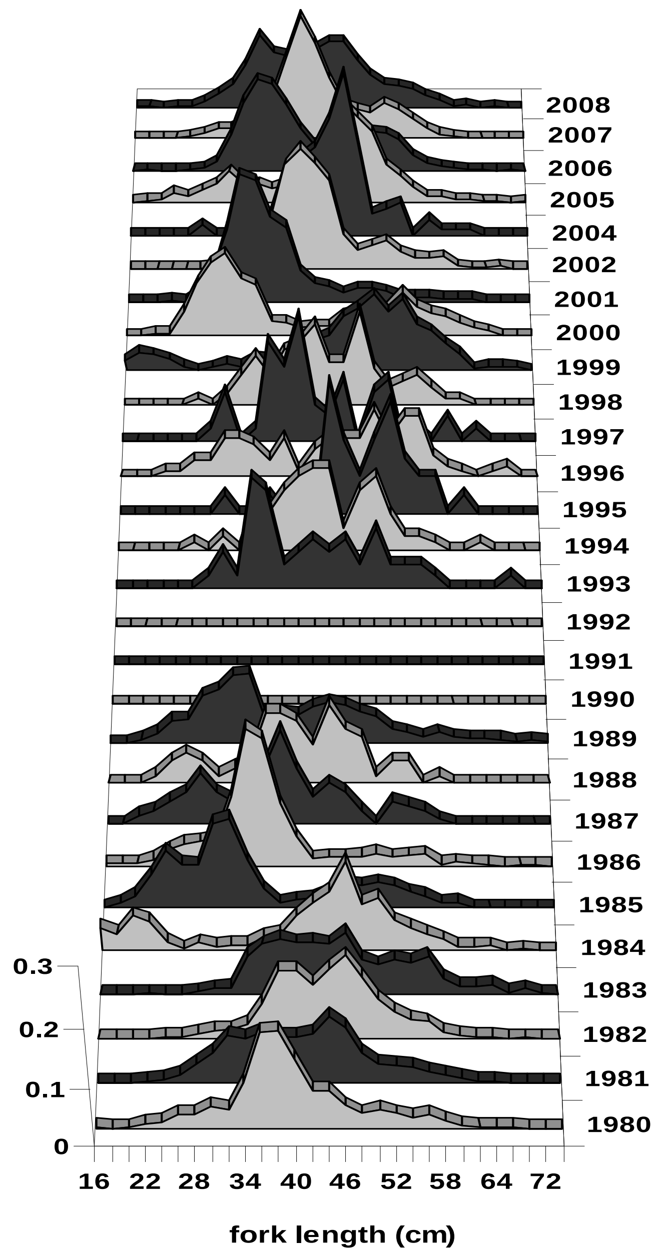


Figure 25. Length frequency composition of bocaccio for Southern California recreational fisheries (excluding shore modes) from the RecFIN database, 1980-2008. Note that no sex information is available, no data were collected from 1990-1992, and 1980-1989 data are derived from weight-frequency information.

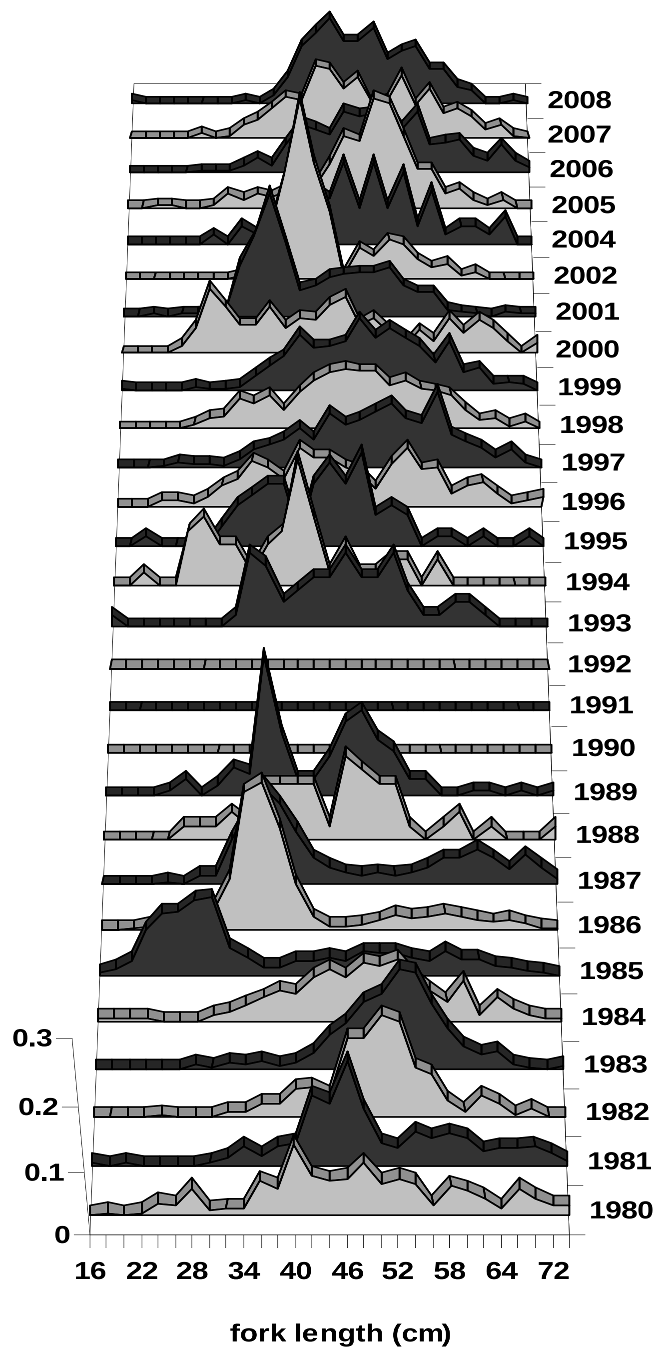


Figure 26. Length frequency composition of bocaccio sampled in central and northern California recreational fisheries (excluding shore modes) from the RecFIN database, 1980-2008. Note that no sex information is available, no data were collected from 1990-1992, and 1980-1989 data are derived from weight-frequency information.

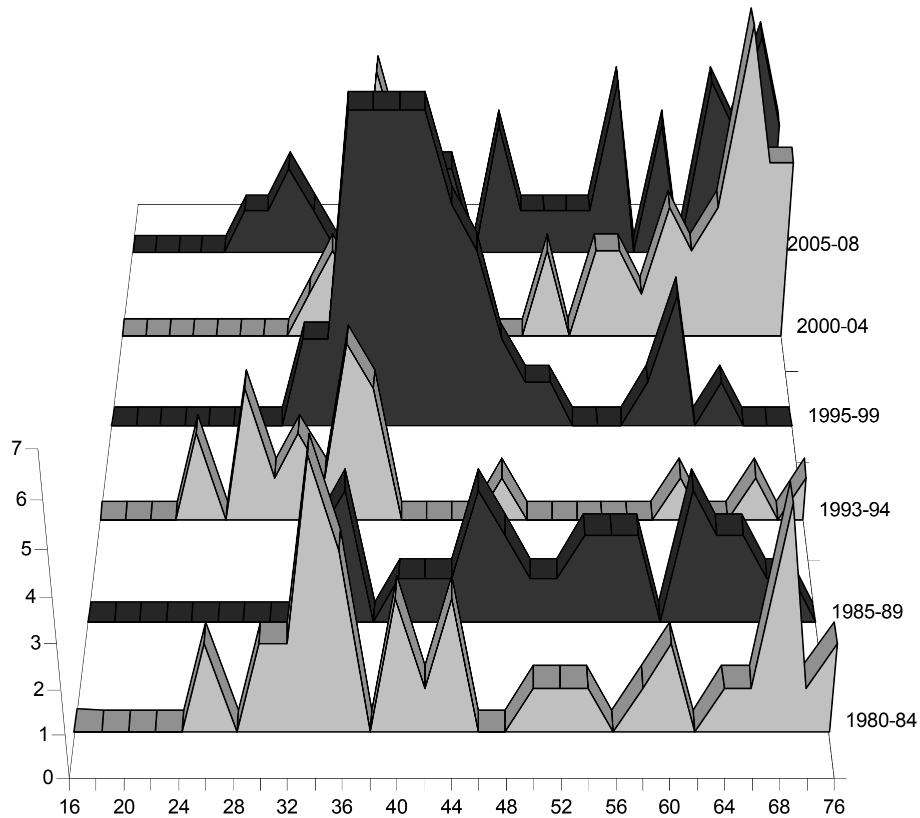


Figure 27. Length frequency composition of bocaccio sampled in Oregon and Washington recreational fisheries (excluding shore modes) from the RecFIN database, 1980-2008. As very limited information is available and many years had either no observations or only observations in single digits, data are pooled into 5-year intervals.

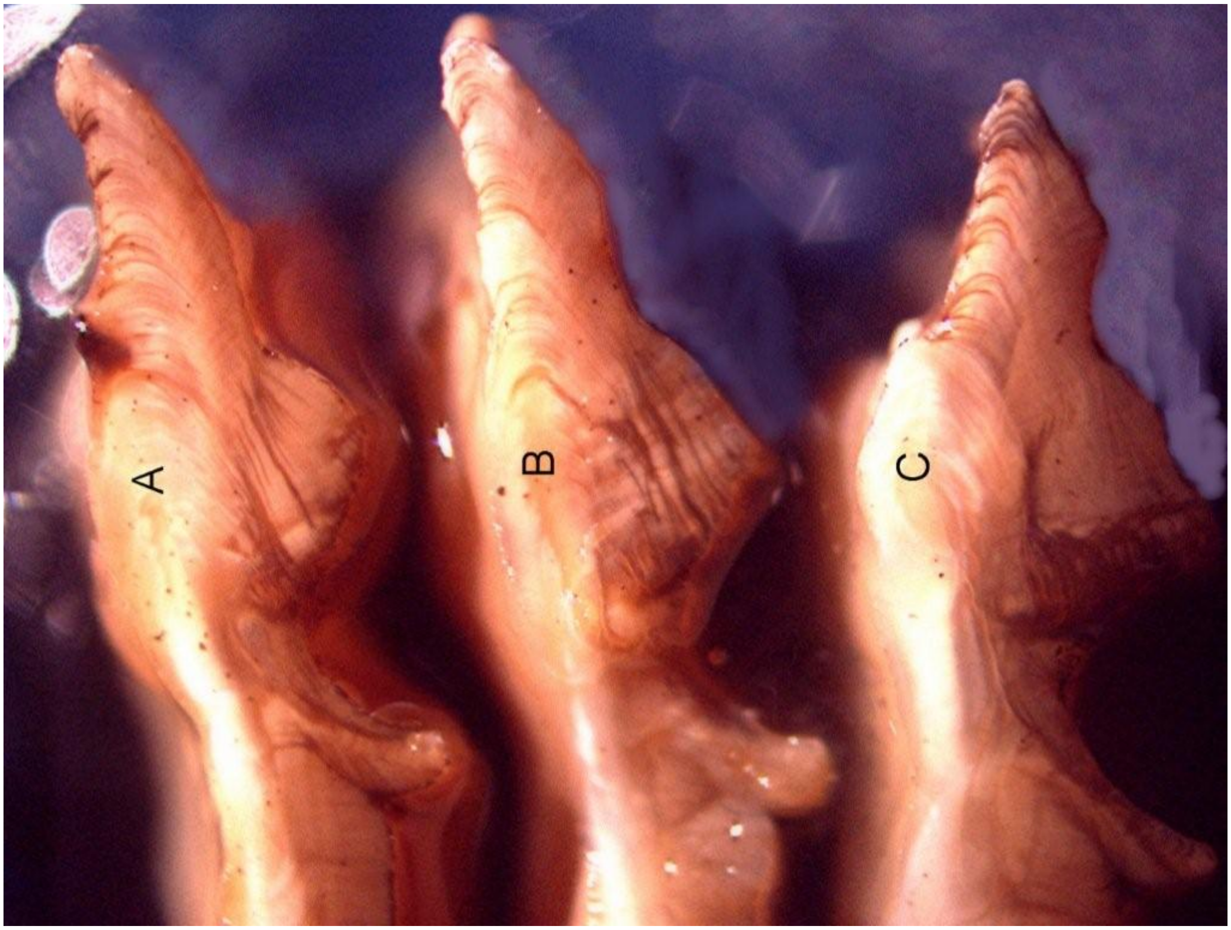


Figure 28. Three otoliths from similarly sized bocaccio along different regions of the west coast; otolith A: Washington, September 23, 2003: 55cm male, otolith B: Monterey, December 3, 1992: 57cm male, otolith C: Los Angeles, May 7, 1987: 56 cm male.

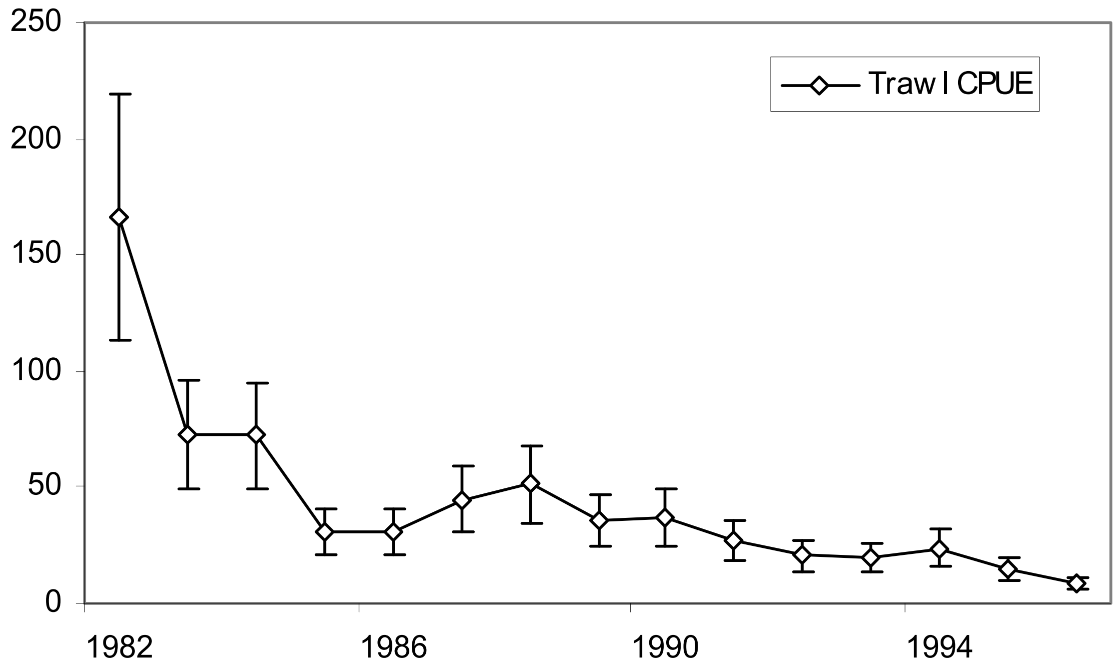


Figure 29. Trawl fishery CPUE index of bocaccio abundance developed in Ralston (1998)

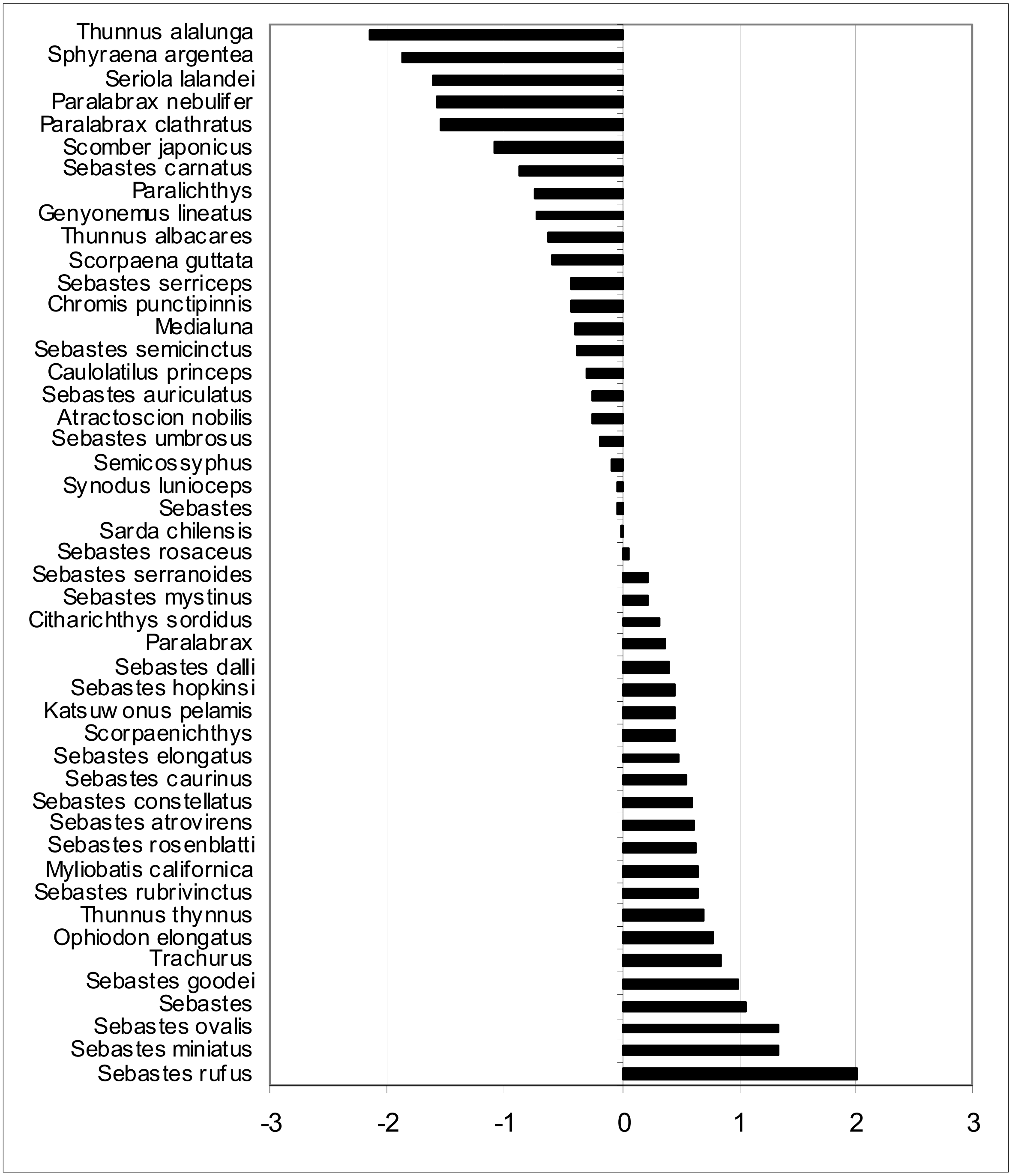


Figure 30. Species-specific catch coefficients developed to filter appropriate trips for the southern recreational fishery CPUE index of bocaccio abundance.

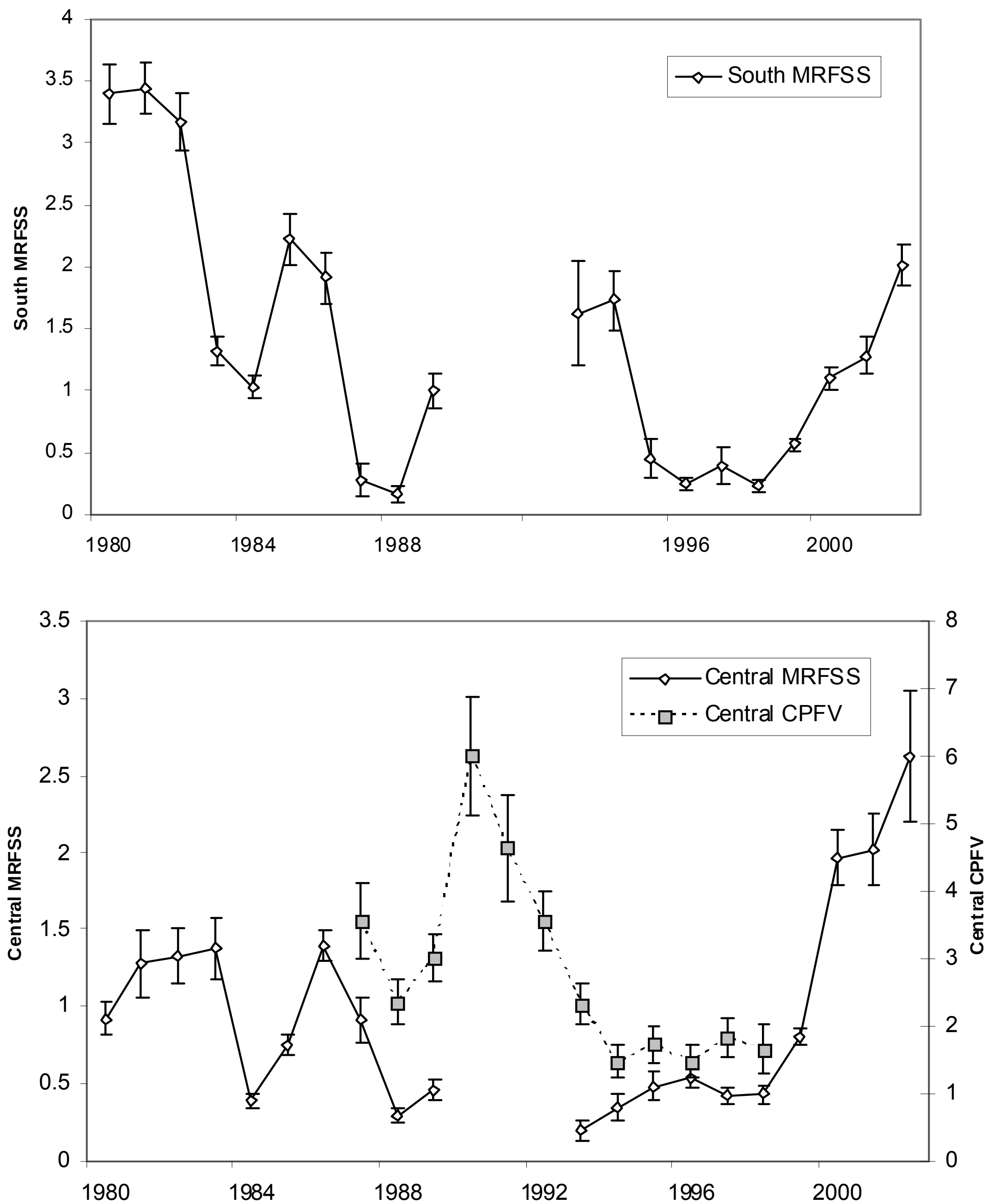
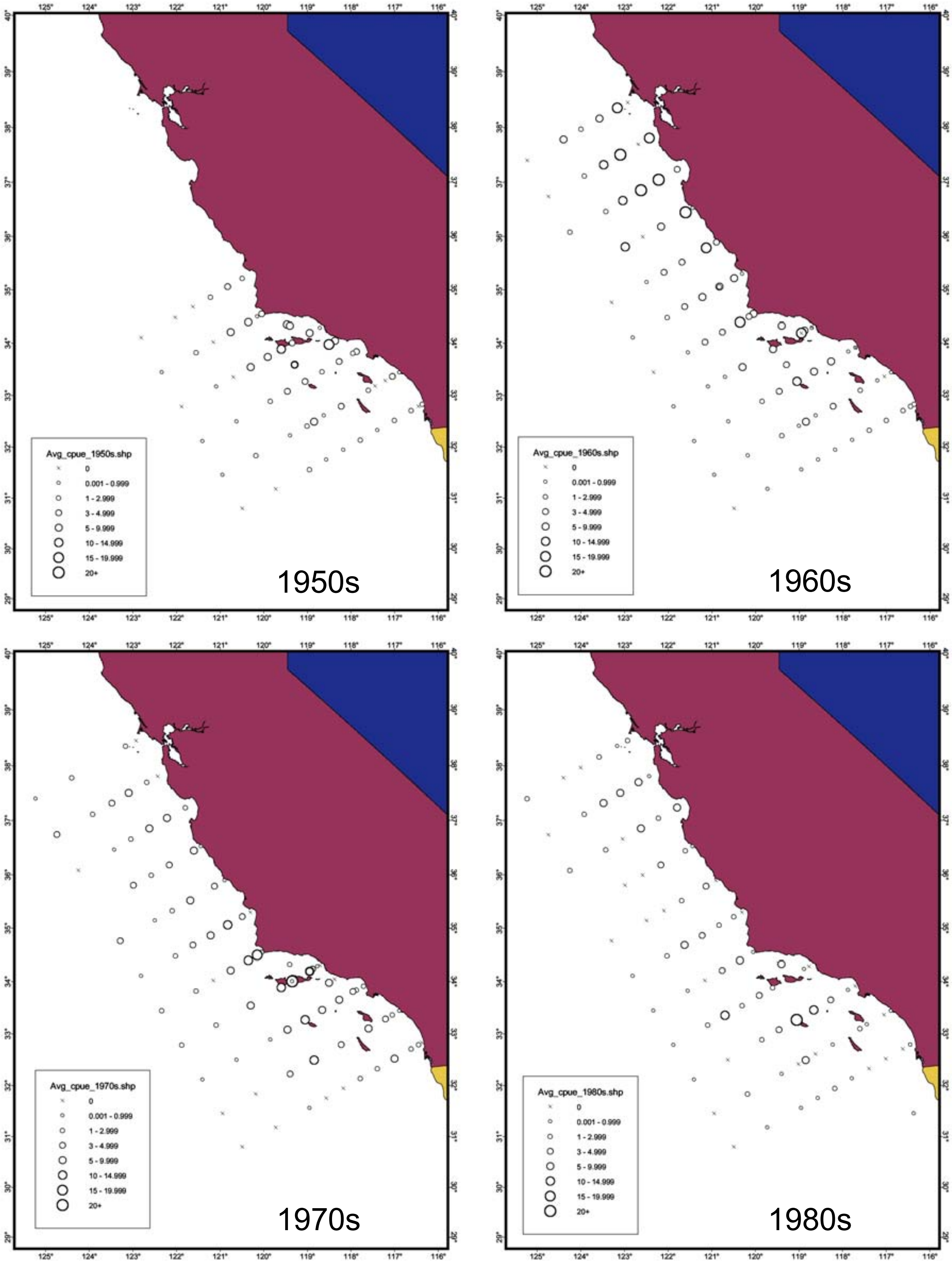
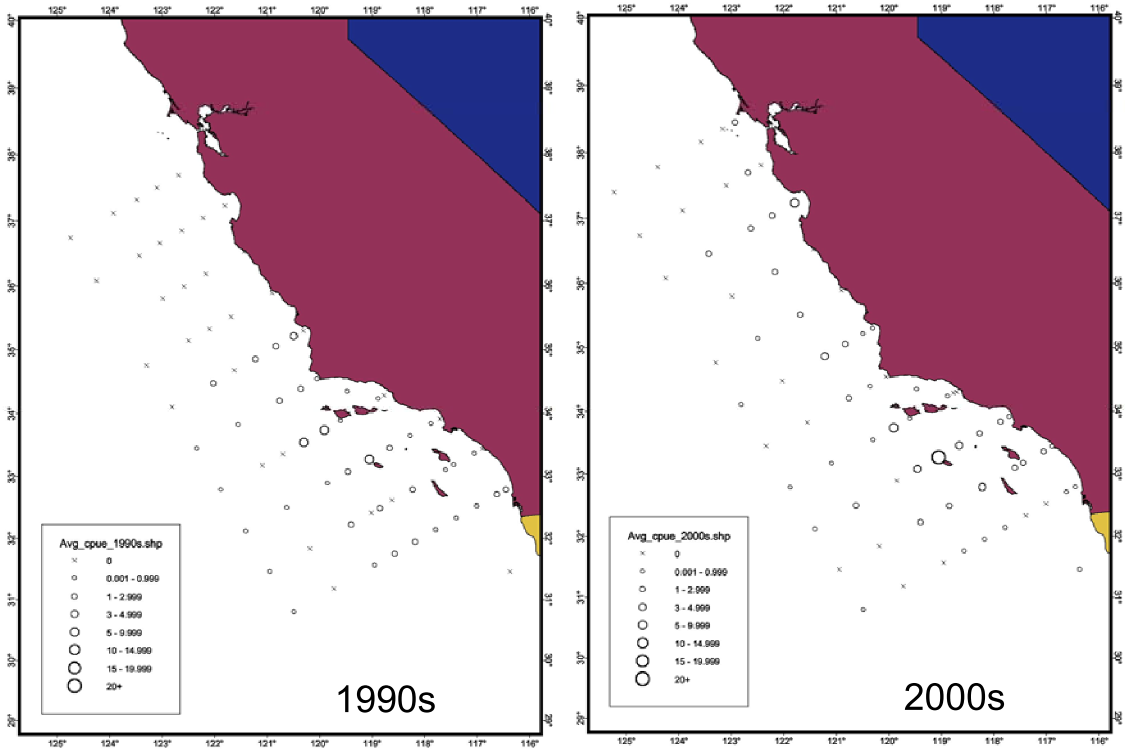


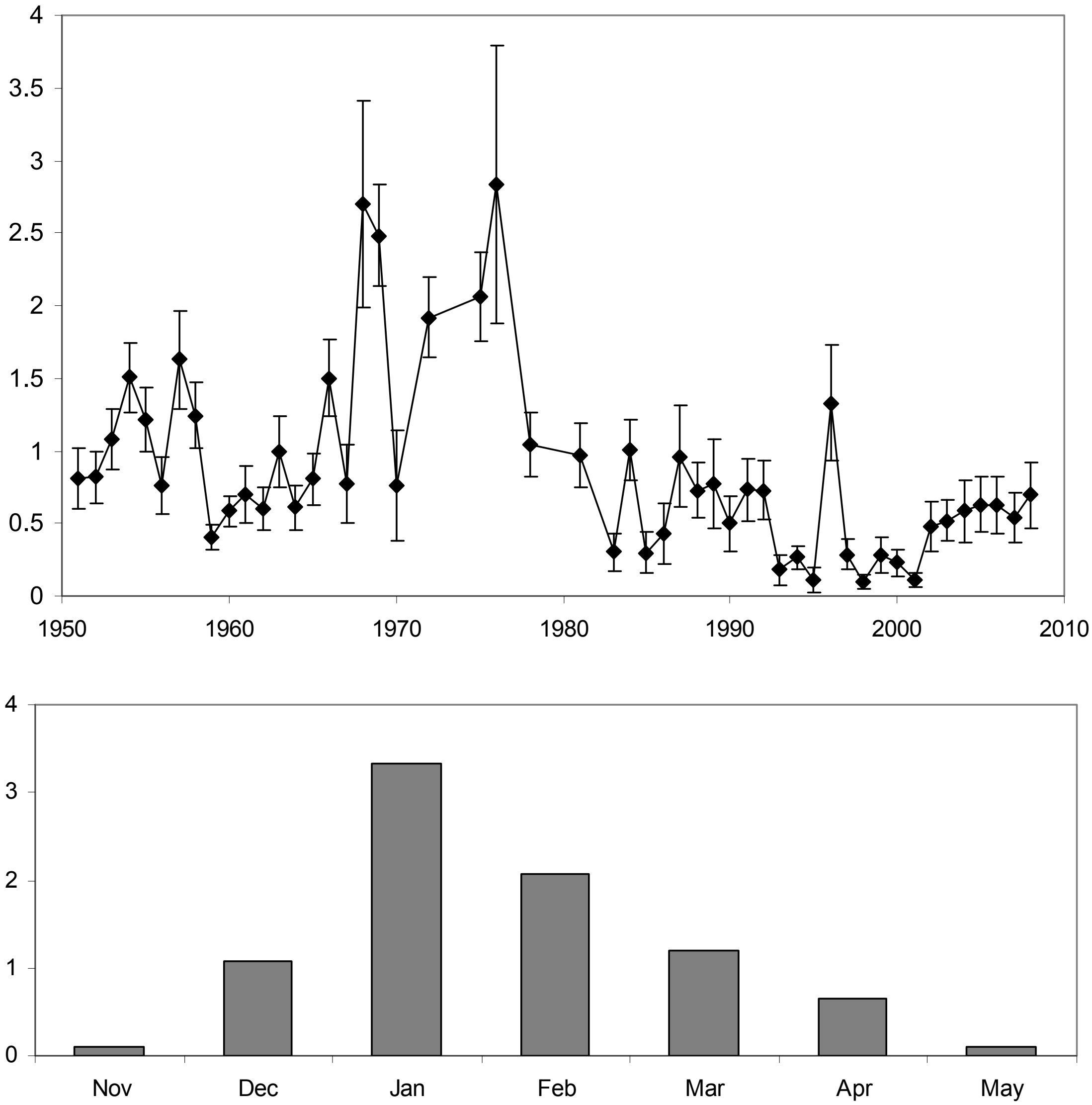
Figure 31a-b. Southern California recreational fishery CPUE index (top) and the two central/northern California recreational CPUE indices (bottom) of bocaccio abundance.



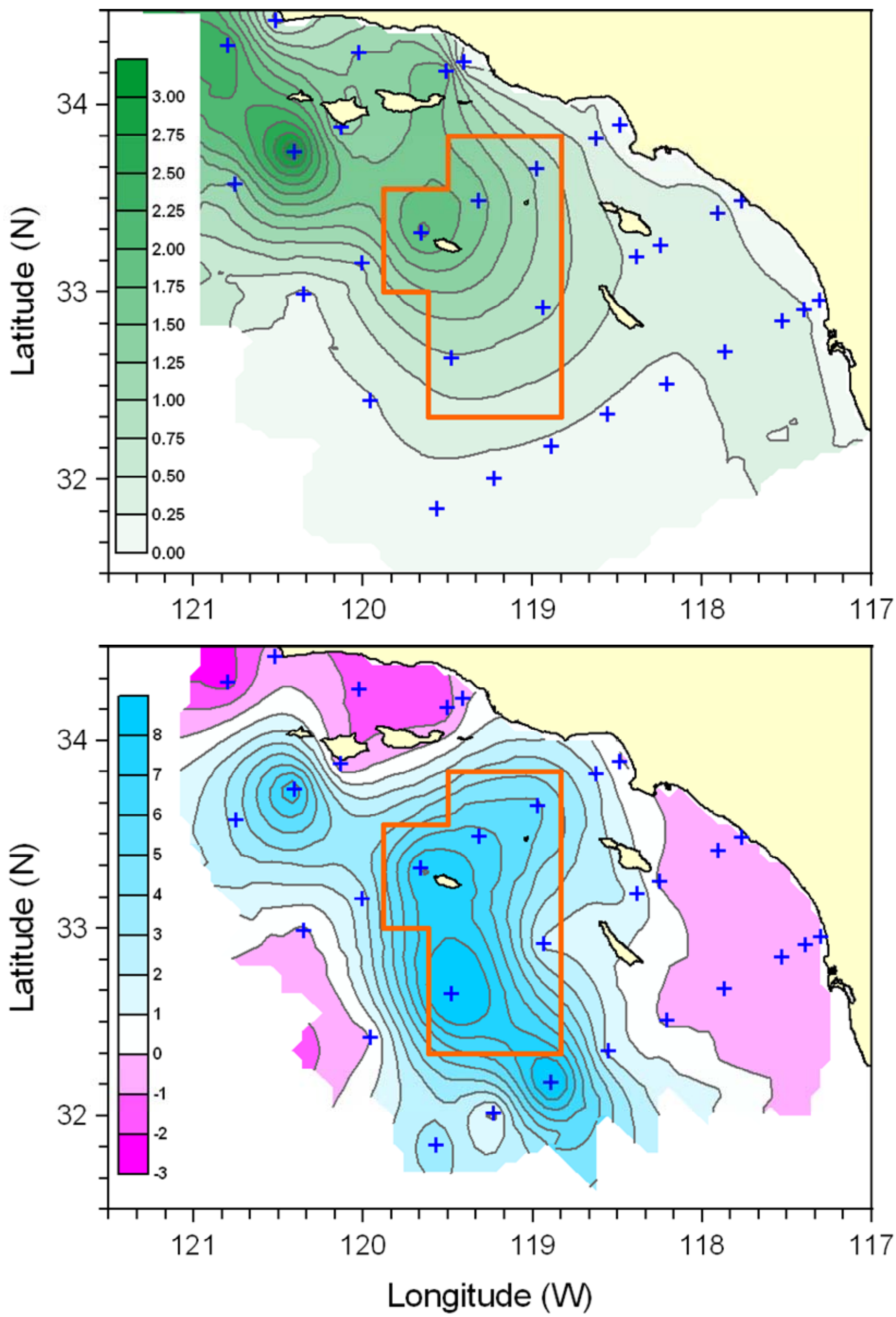
Figures 32a-d. CalCOFI mean CPUE rate of larval bocaccios by station and decade



Figures 32e-f. CalCOFI mean CPUE rate of larval bocaccios by station and decade



Figures 33a-b. CalCOFI larval abundance indices (top) for the coastwide bocaccio model, with asymptotic standard errors based on a jackknife routine; (bottom) month effects for the delta-GLM model.



Figures 34a-b. Spatial distribution of bocaccio larvae in the Southern California Bight (top) based on estimated station effects [#/10 m^2] from a delta-GLM analysis of the entire CalCOFI time series (1951-2005). Bottom figure reflects the spatial distribution of bocaccio larvae in 2002-03 represented as anomalies from the long-term mean distribution. From Ralston and MacFarlane (in review).

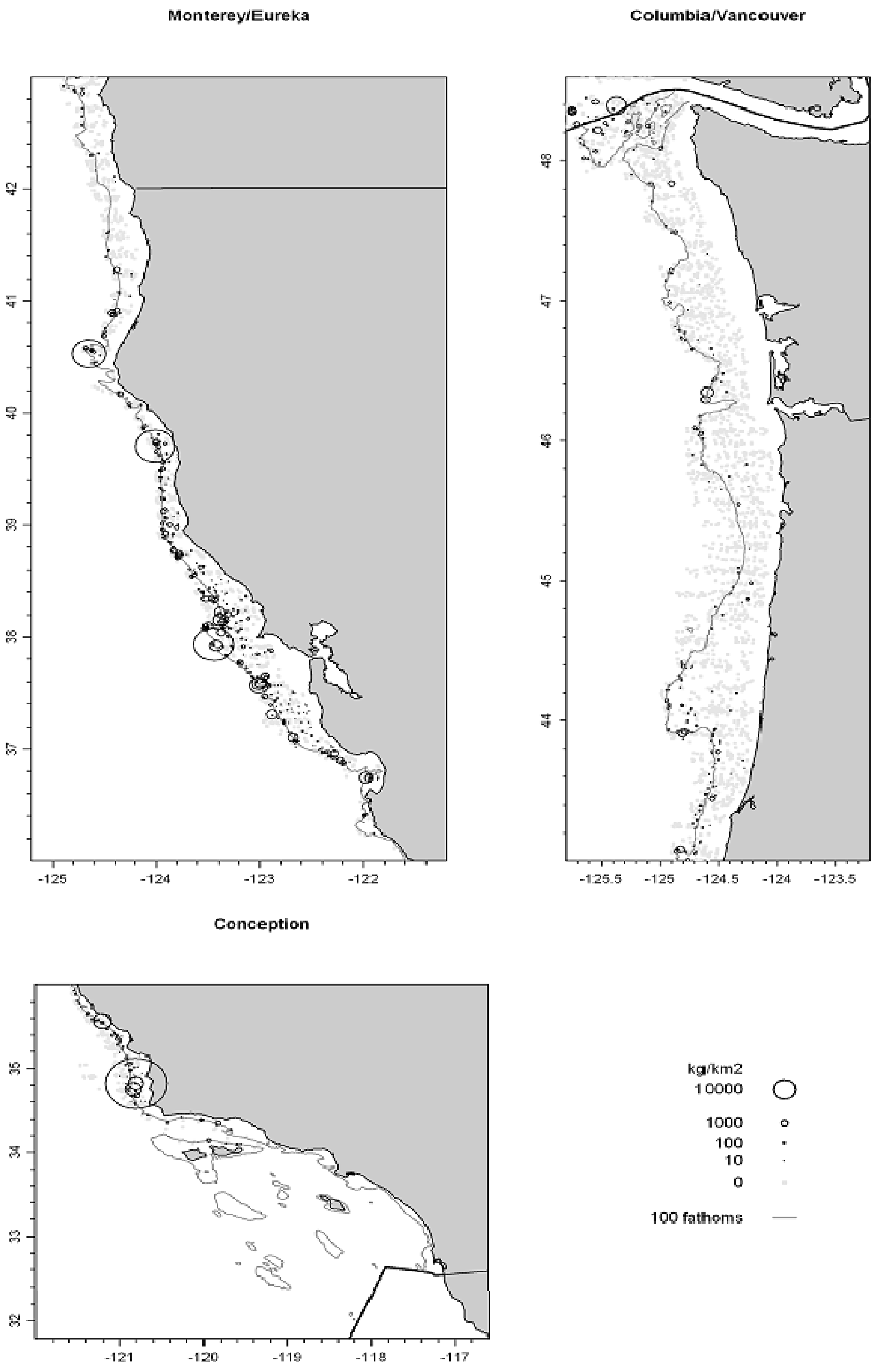
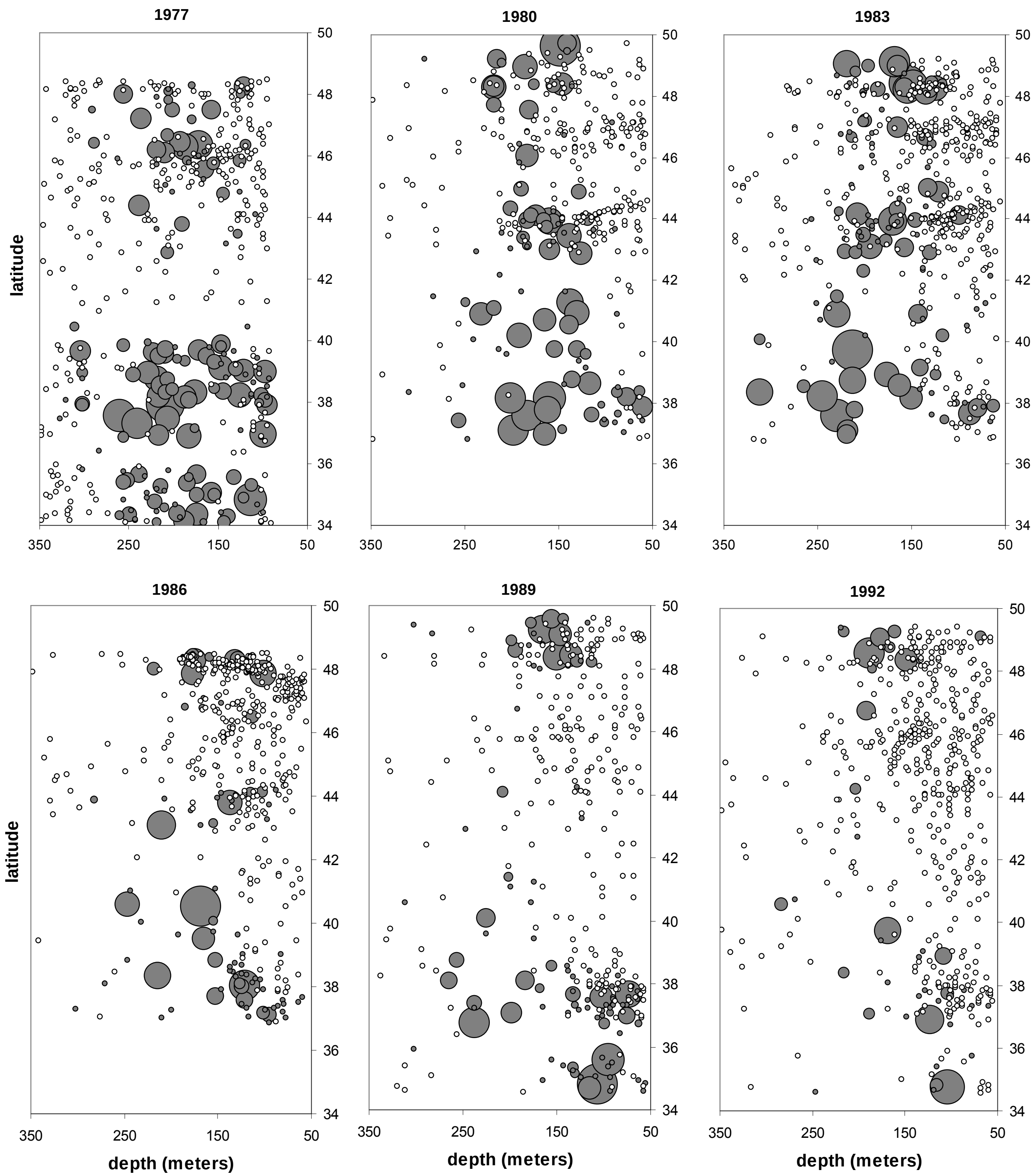
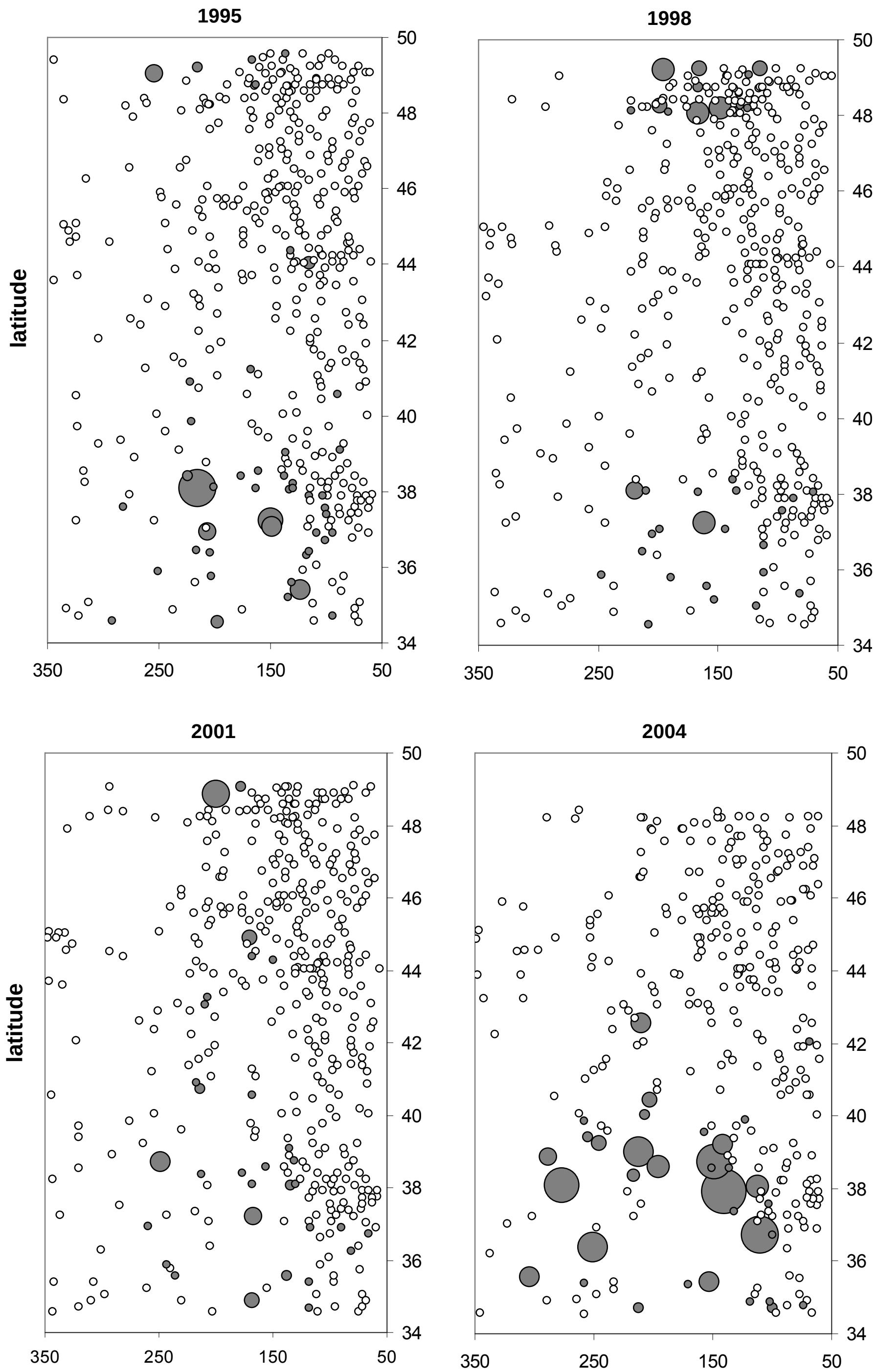


Figure 35: Triennial trawl survey CPUE over space, all years (1980-2004) combined.



Figures 36a-f. Triennial trawl survey catches of bocaccio rockfish, 1977-1992, plotted as the log of the catch (with a minimum size threshold) by year, depth and latitude (note that longitude is absent). Empty circles represent non-positive hauls.



Figures 36g-j. Triennial trawl survey catches of bocaccio rockfish, 1977-1992, plotted as the log of the catch (with a minimum size threshold) by year, depth, and latitude (note that longitude is absent). Empty circles represent non-positive hauls.

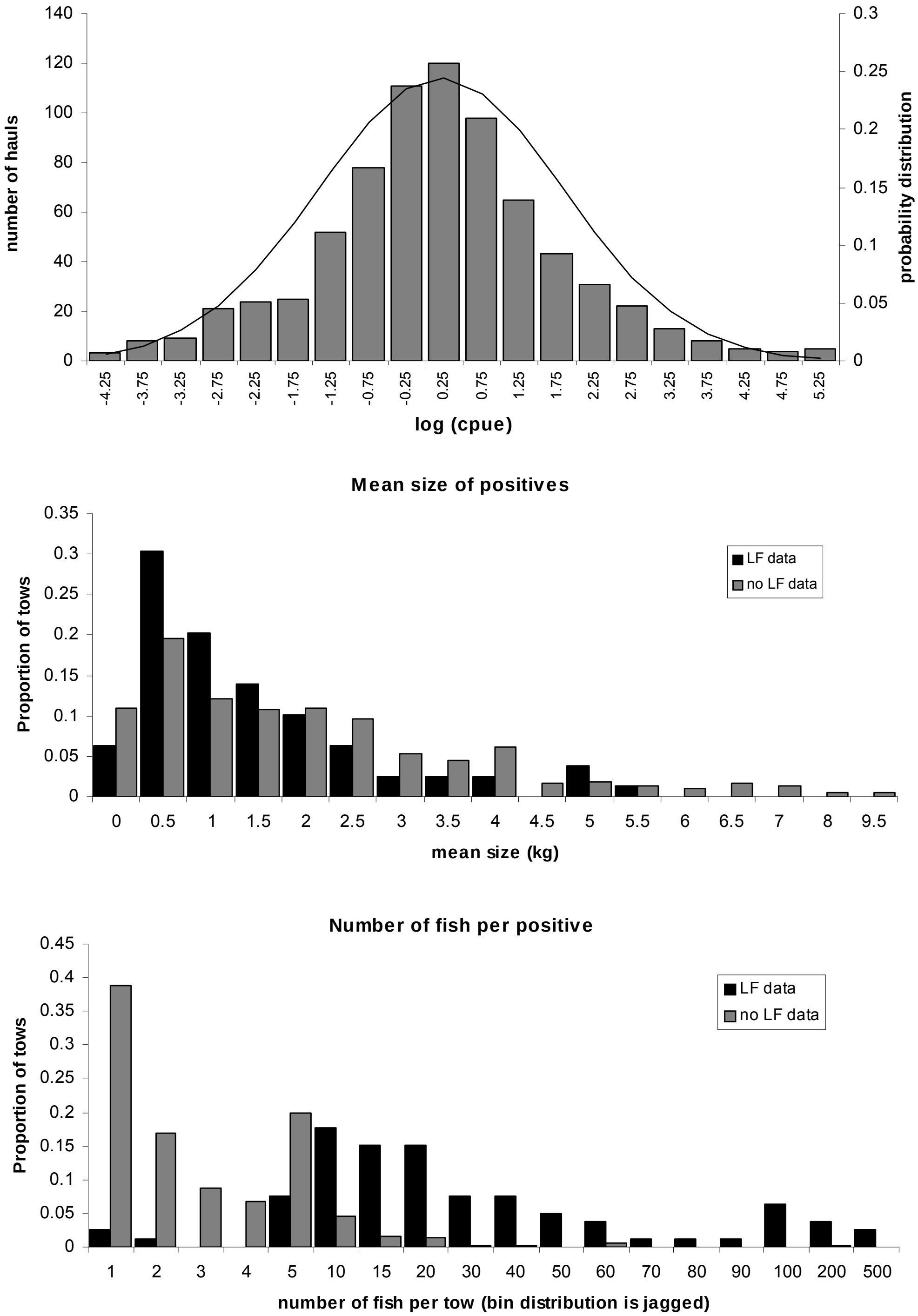
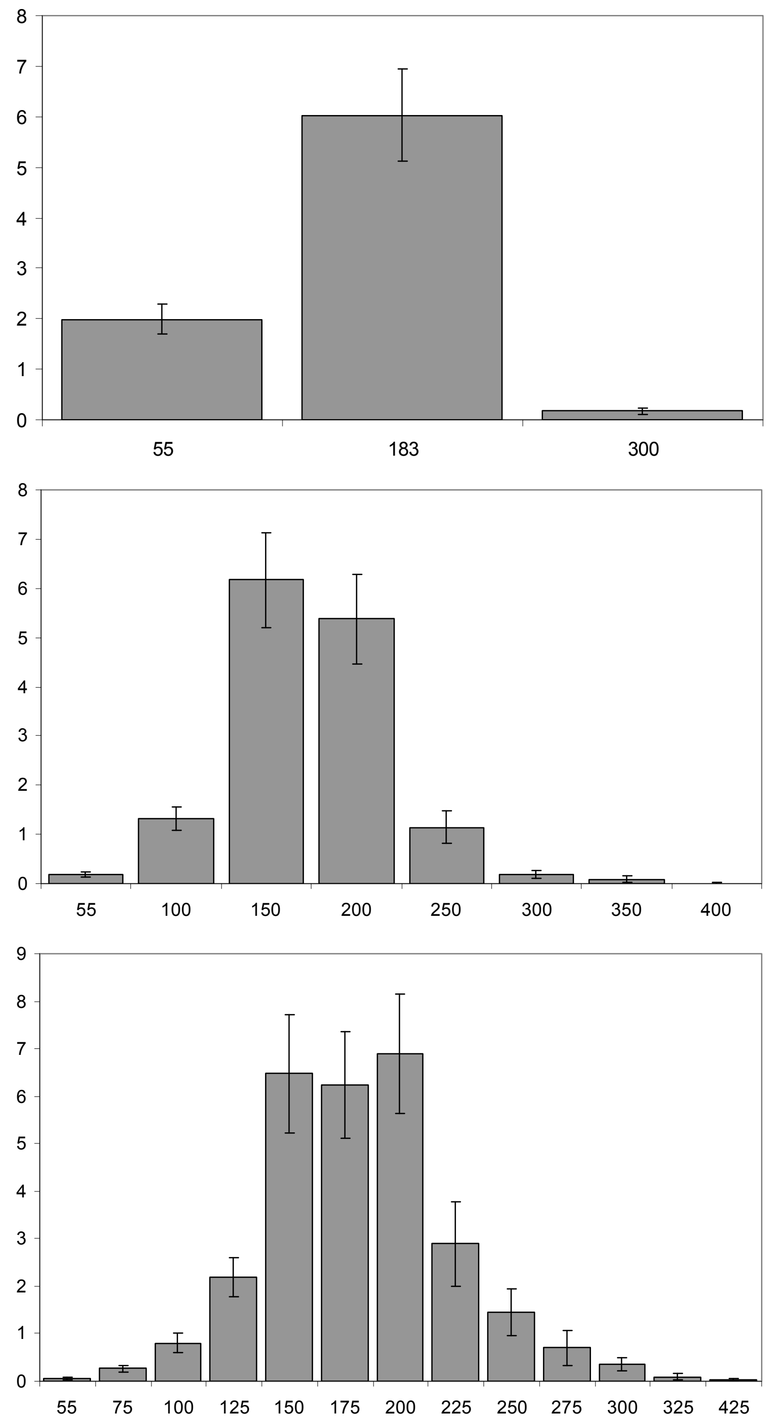


Figure 37a-c. Distribution of bocaccio CPUE for the triennial survey in log scale (top), distribution of average weight (center) and of the count (bottom) of bocaccio per haul for hauls in which length frequencies were taken versus hauls in which they were not.



Figures 38a-c. Depth factor coefficients across a range of depth bins from GLM of triennial CPUE data (in all cases, year effects, and INPFC area effects also estimated). Standard errors based on a jackknife routine.

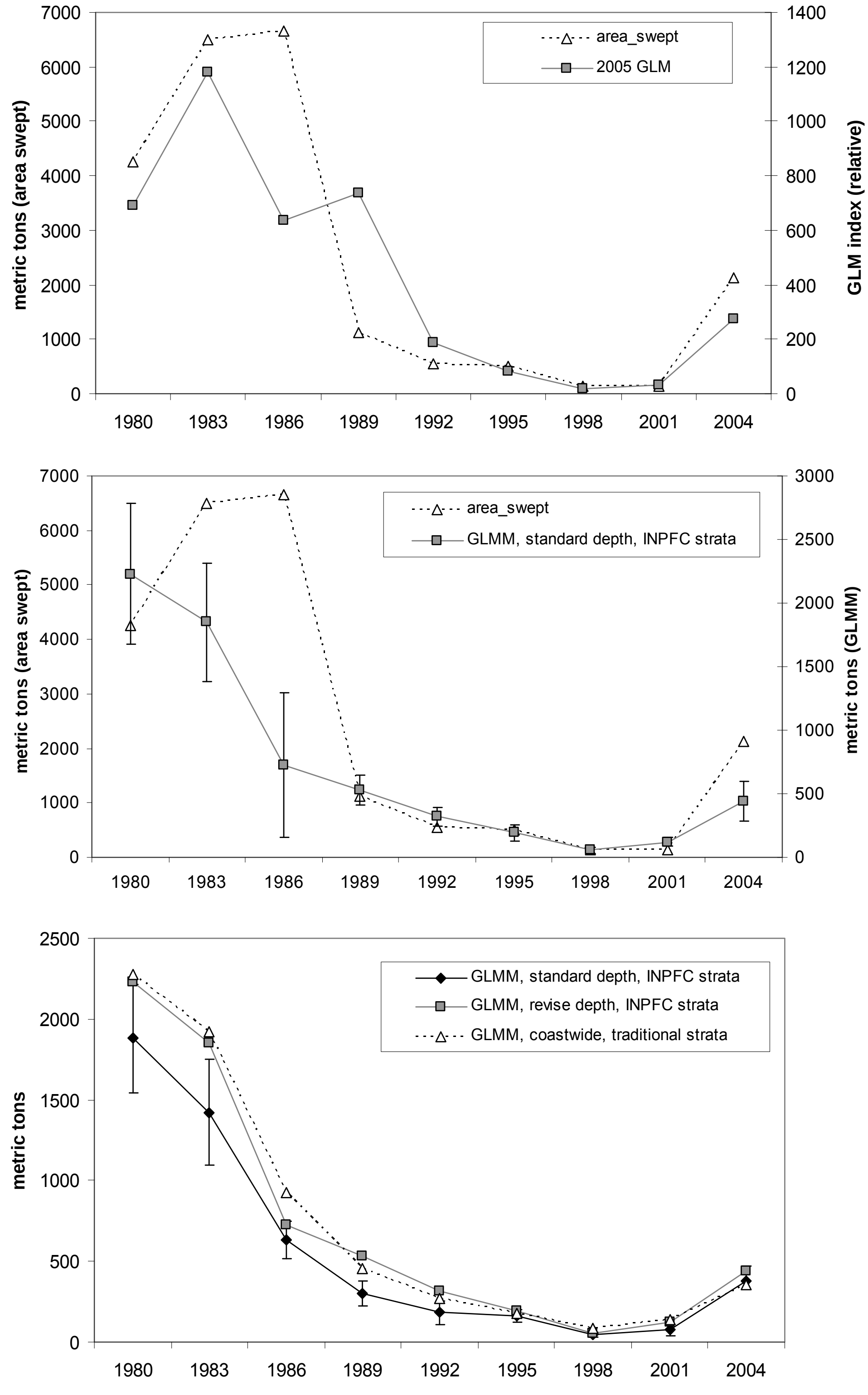


Figure 39a-c. Area swept (Monterey and Eureka INPFC areas only), 2005 assessment GLM (includes Conception INPFC observed and predicted) and GLMM estimates of relative abundance of bocaccio based on the 1980-2004 triennial survey data for this assessment. Error bars not shown for all indices to minimize confusion (CVs are also reported in Tables).

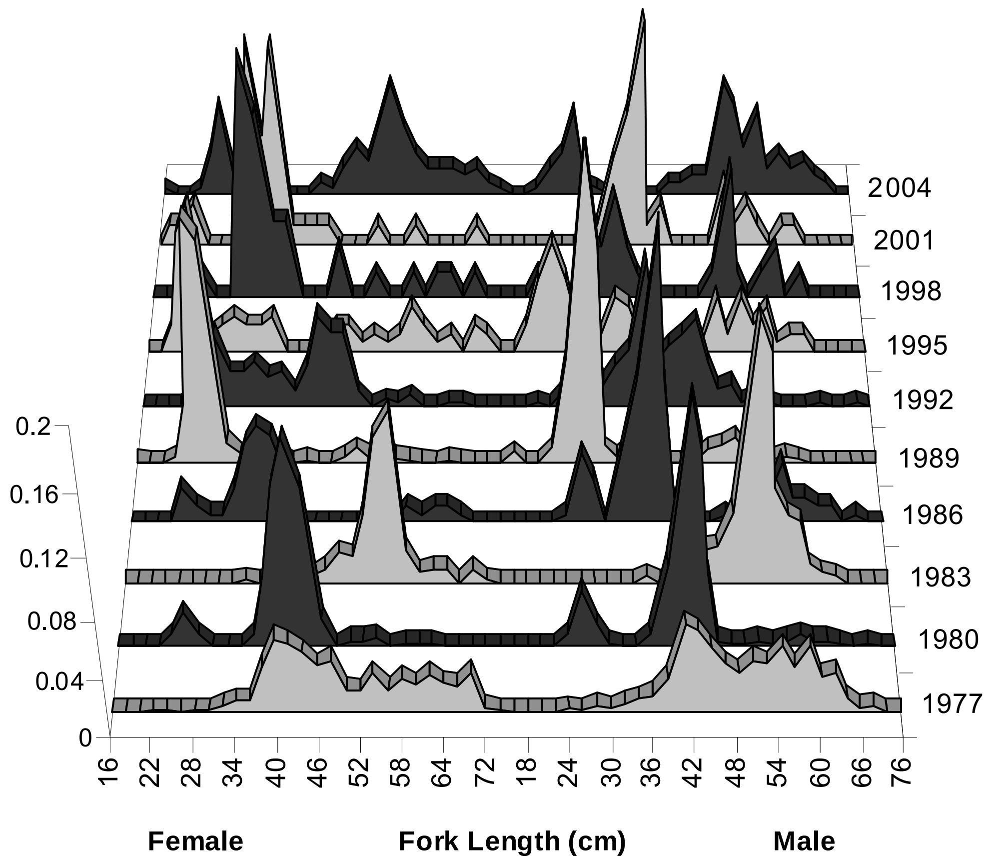


Figure 40. Length frequency information for bocaccio from the triennial trawl survey by year for the assessment area (south of Cape Blanco).

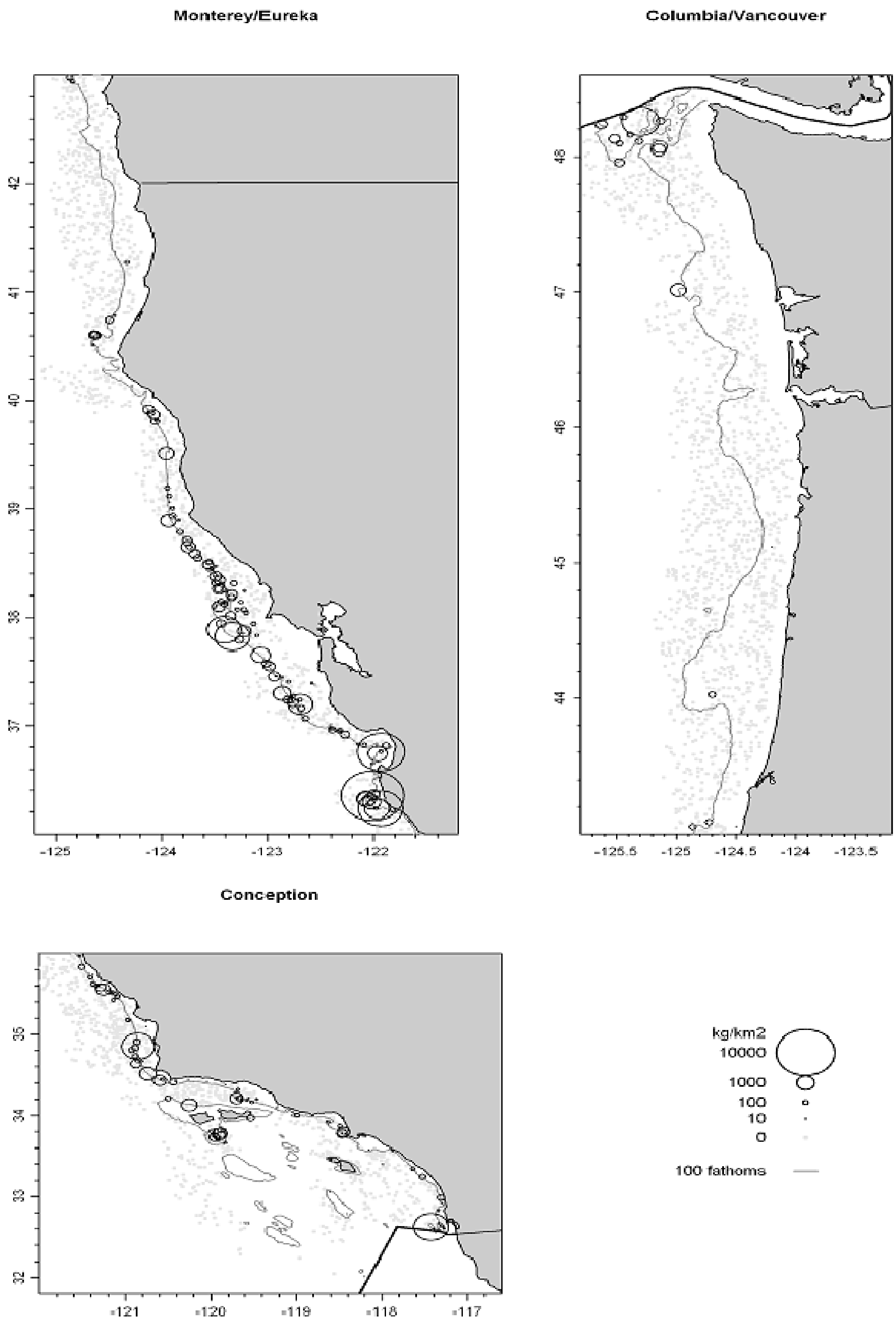
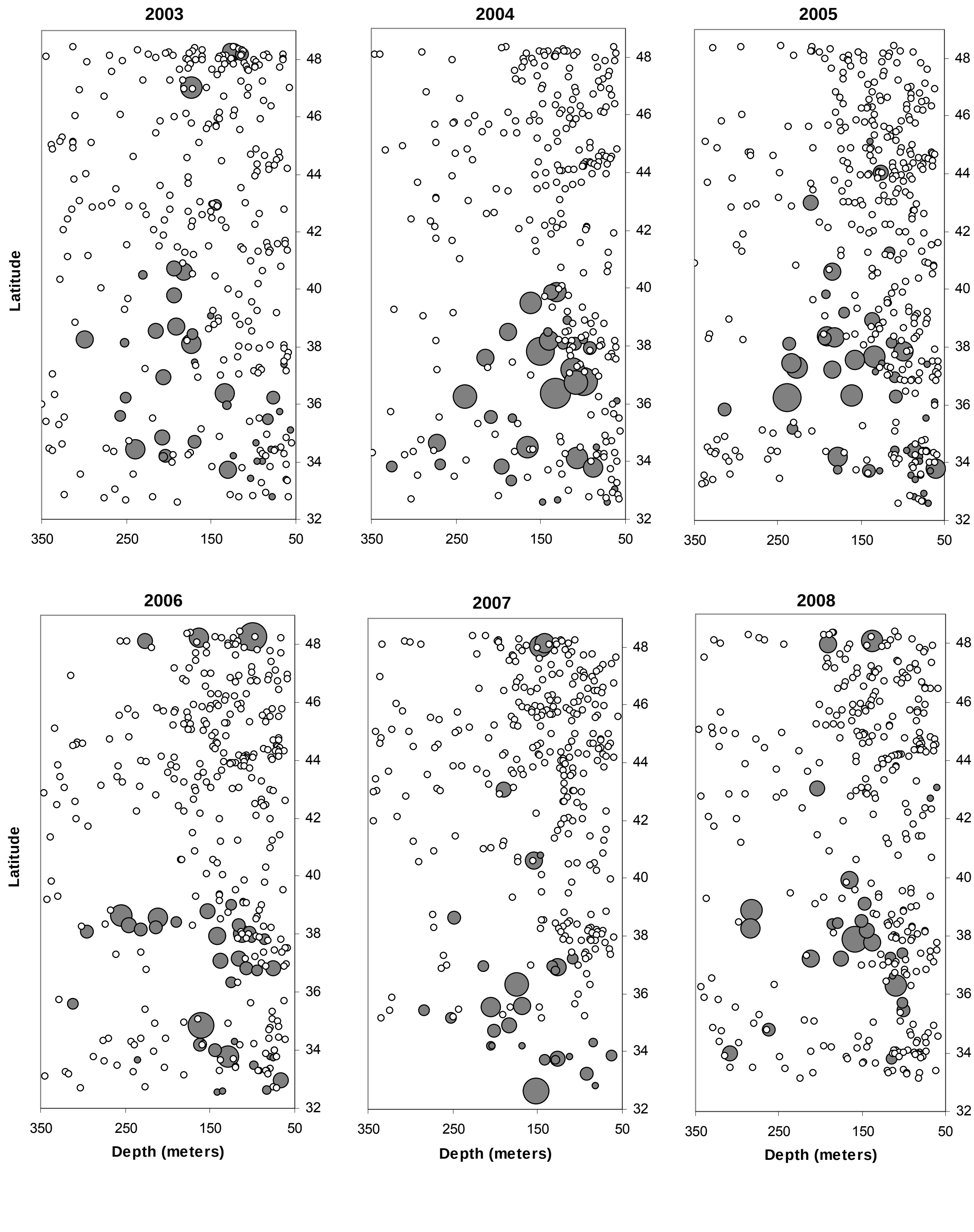
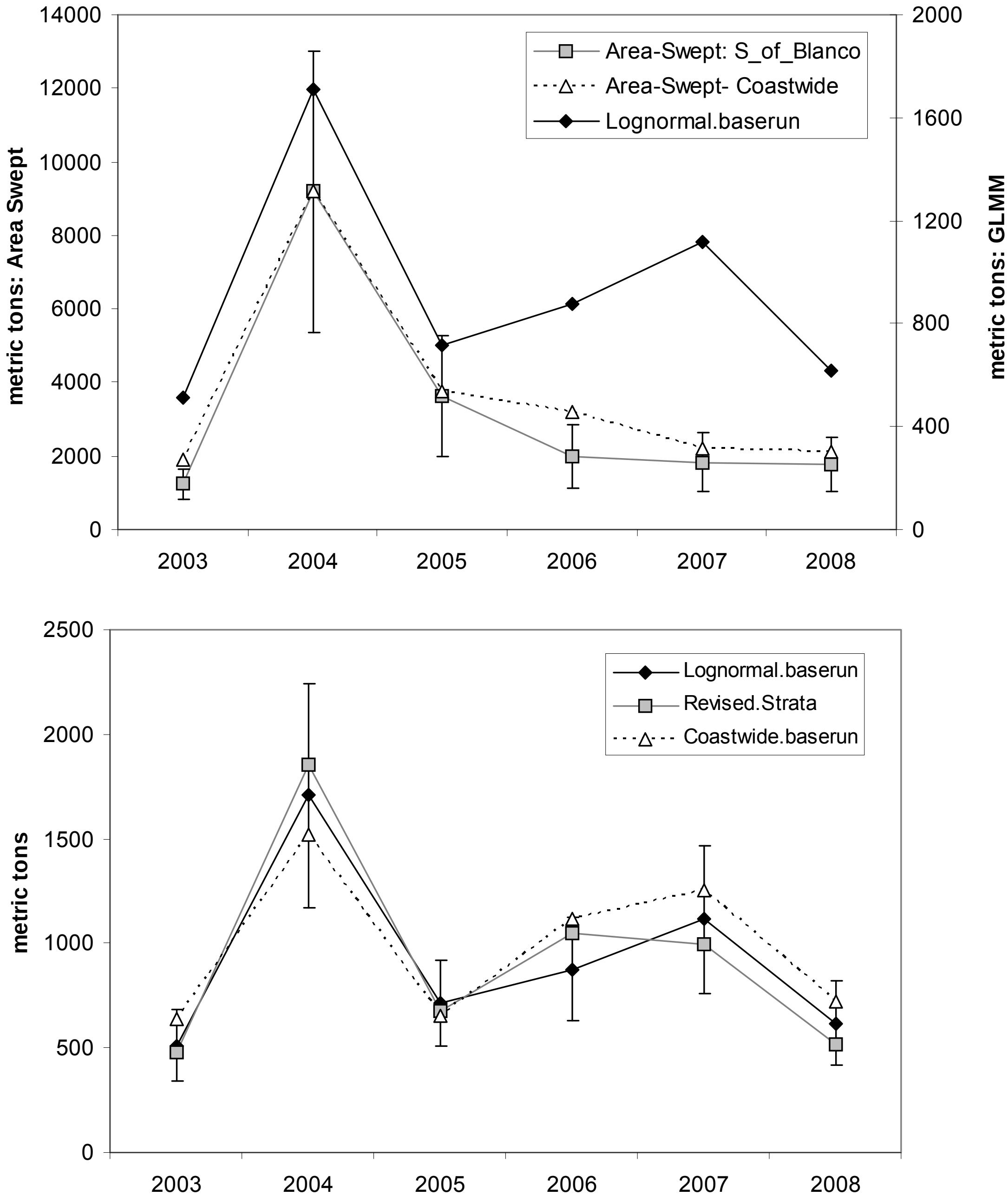


Figure 41: NWFSC Combined shelf-slope survey CPUE for bocaccio rockfish, all years (2003-2008) combined.



Figures 42a-f. Northwest Fisheries Science Center survey catches of bocaccio rockfish, plotted as the log of the catch (with a minimum size threshold) by year, depth and latitude (note that longitude is absent). Empty circles represent non-positive hauls.



Figures 43a-b. Comparison of area-swept versus GLMM abundance estimates for bocaccio rockfish from the NWFSC Combined survey (note different axes for different surveys).

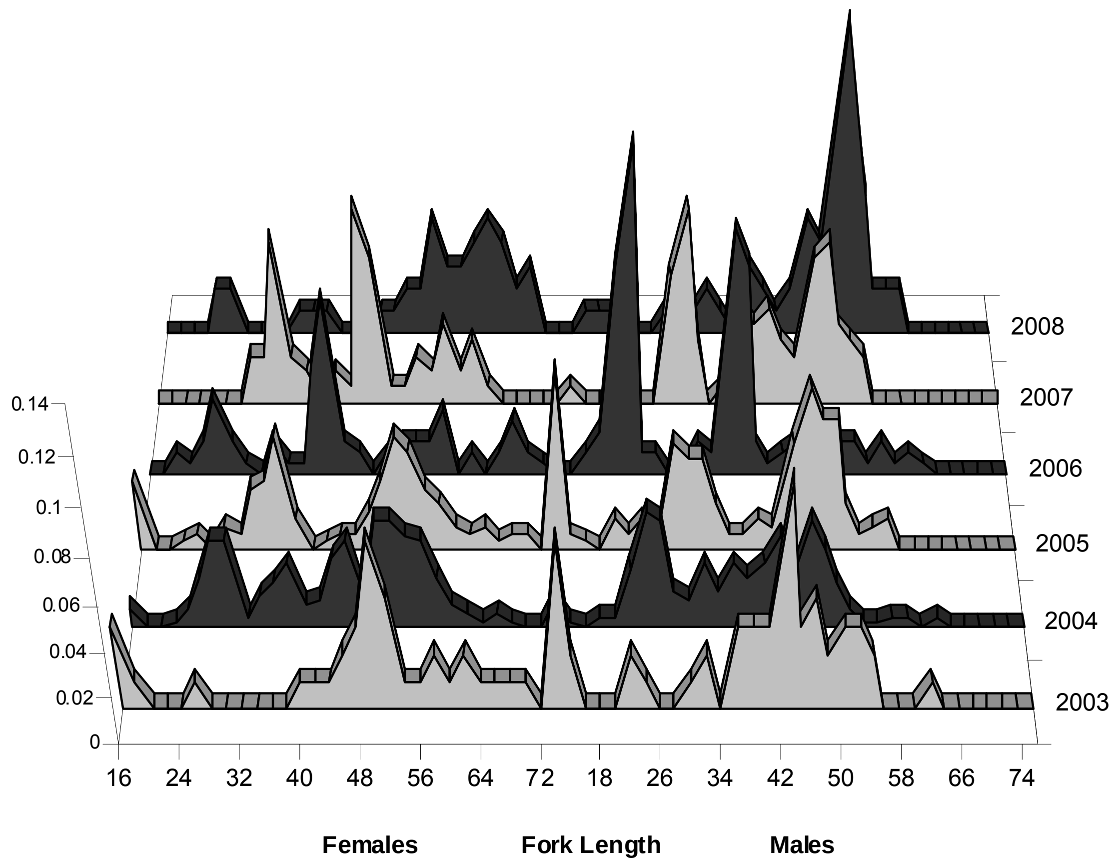
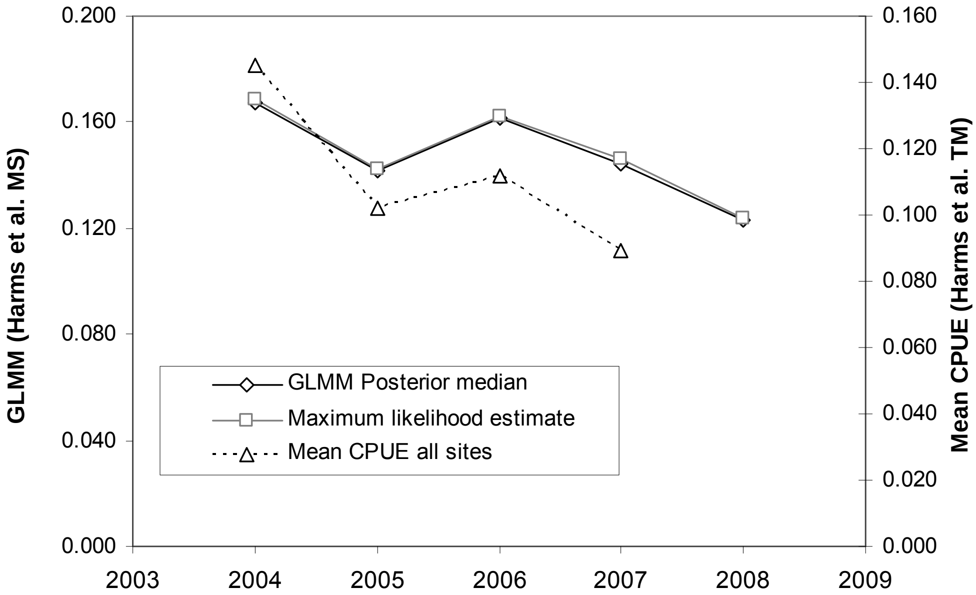


Figure 44. Length frequency information for bocaccio from the NWFSC combined survey (assessment area only).



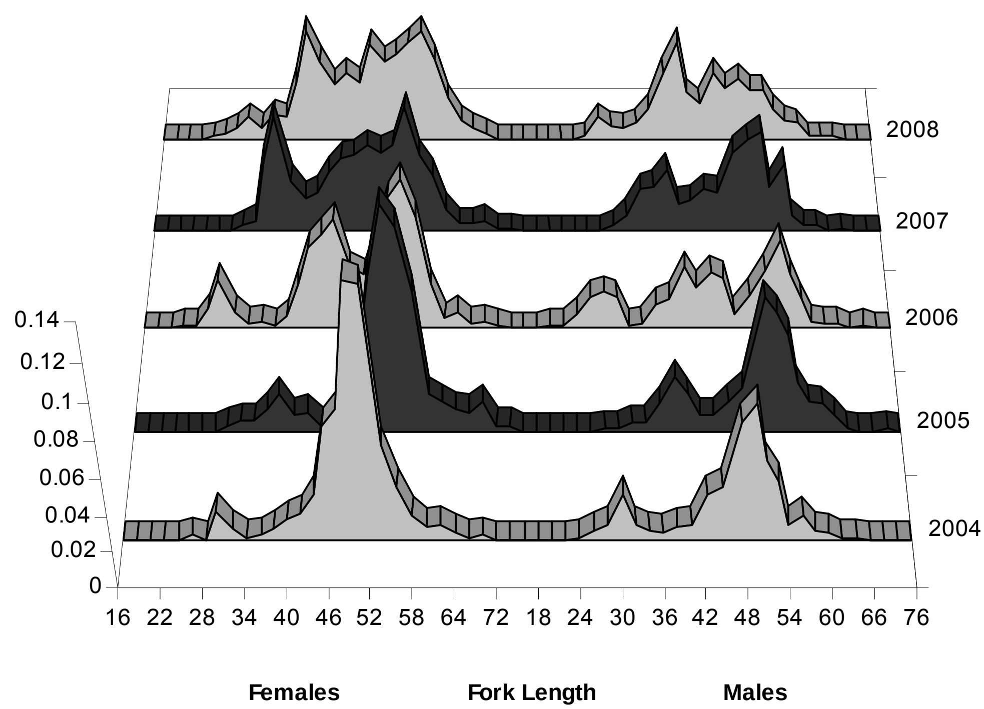
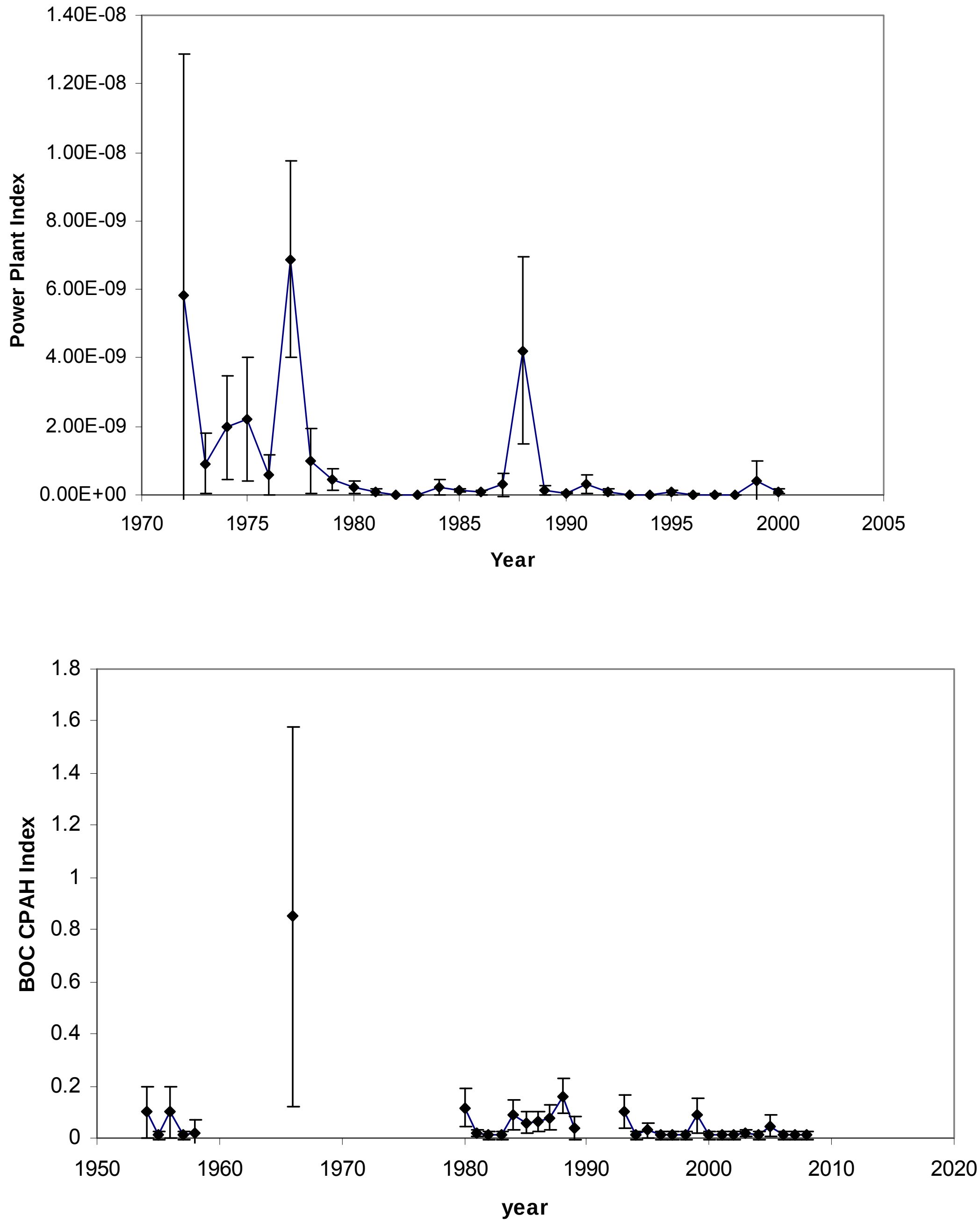
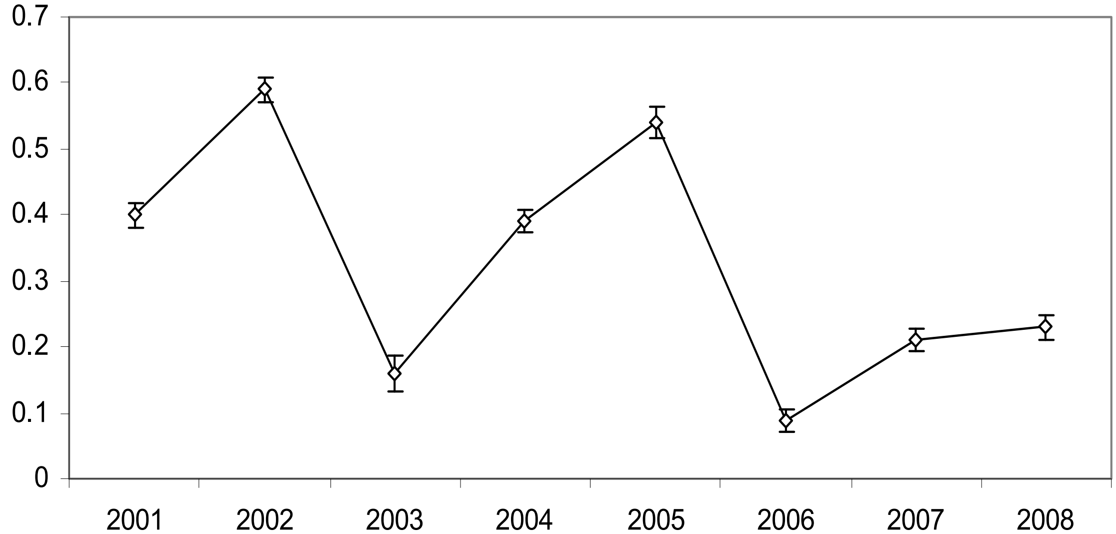


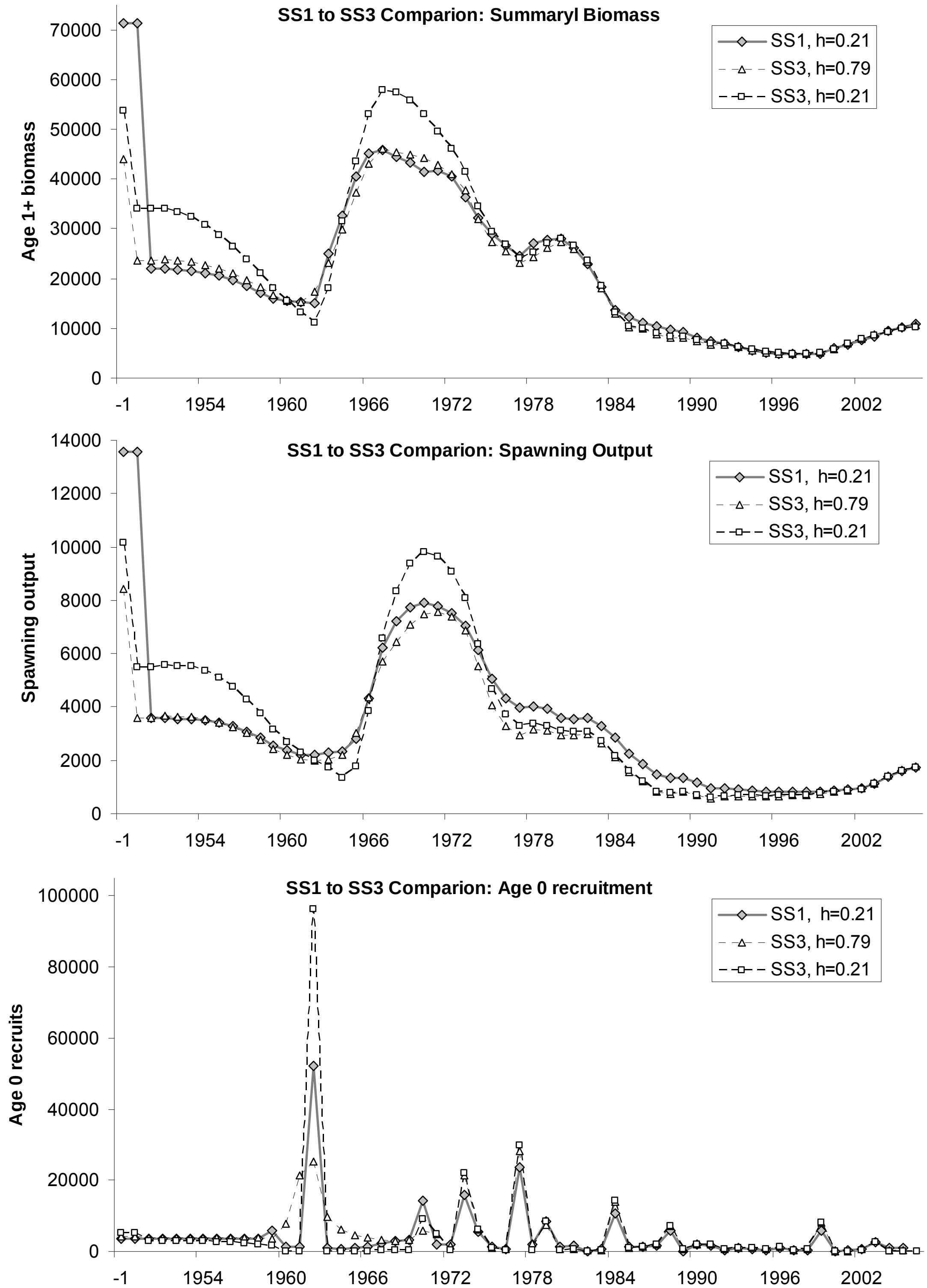
Figure 45a-b. Figure 45a (top) Catch rate indices of bocaccio abundance for the NWFSC hook-and-line survey in the Southern California Bight, 2004-2008 and Figure 45b (bottom), length frequency distribution for all bocaccio rockfish measured in the same survey.



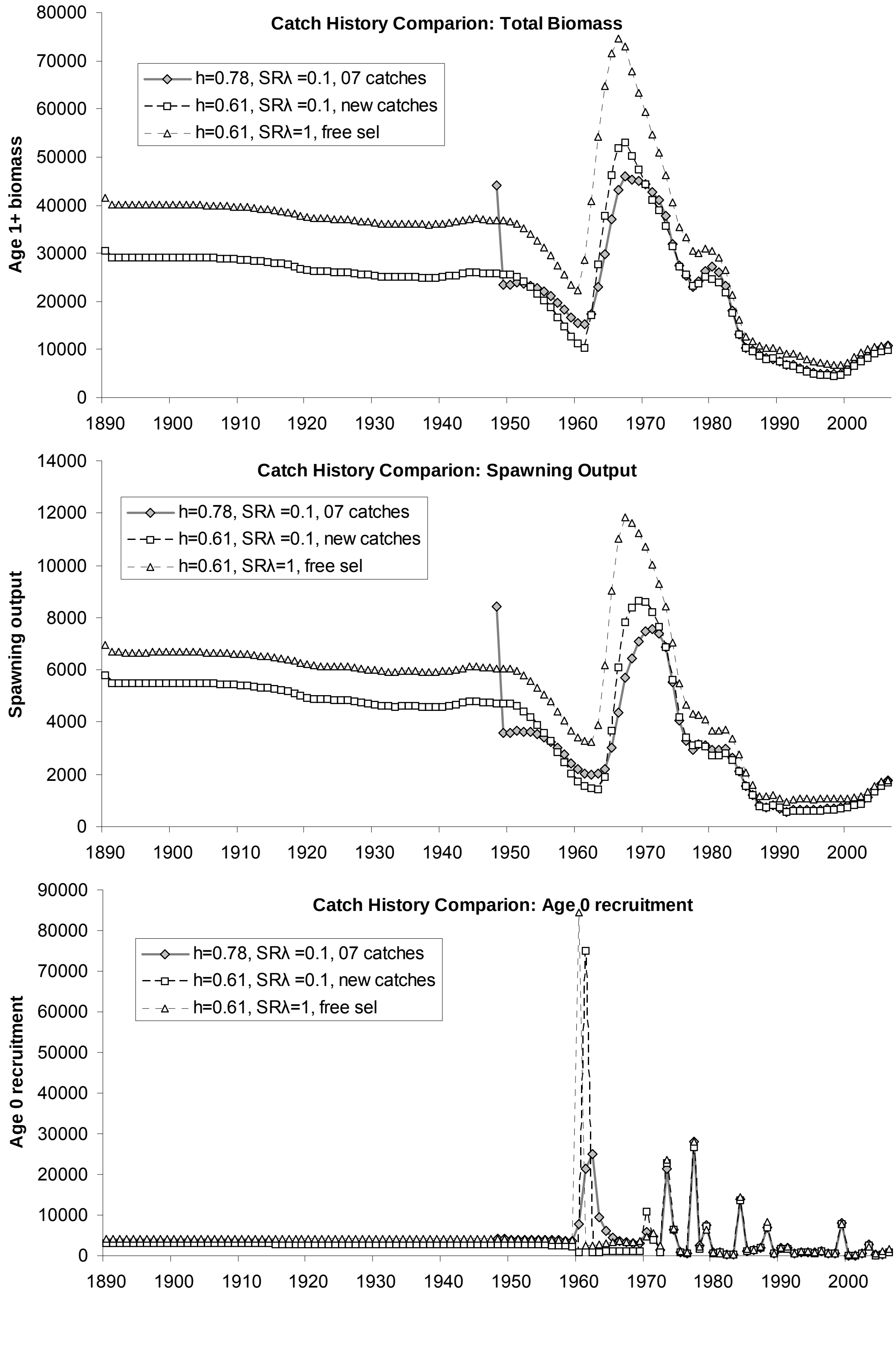
Figures 46a-b. Figure 46a (top) Juvenile indices of bocaccio recruitment for the power plant impingement index, and the pier survey index (Figure 46b, bottom).



Figures 47. The coastwide pelagic juvenile trawl survey index of bocaccio abundance.



Figures 48a-c. SS1 versus SS3 bocaccio model results (biomass, spawning biomass and recruitment) with alternative values of h for the SS3 model.



Figures 49a-c. The SS3 bocaccio model built to transition from the 2007 SS1 model (with h=0.78 and SR =0.1) with the 2007 catch history and start year, relative to the new catch history and start year developed for this assessment.

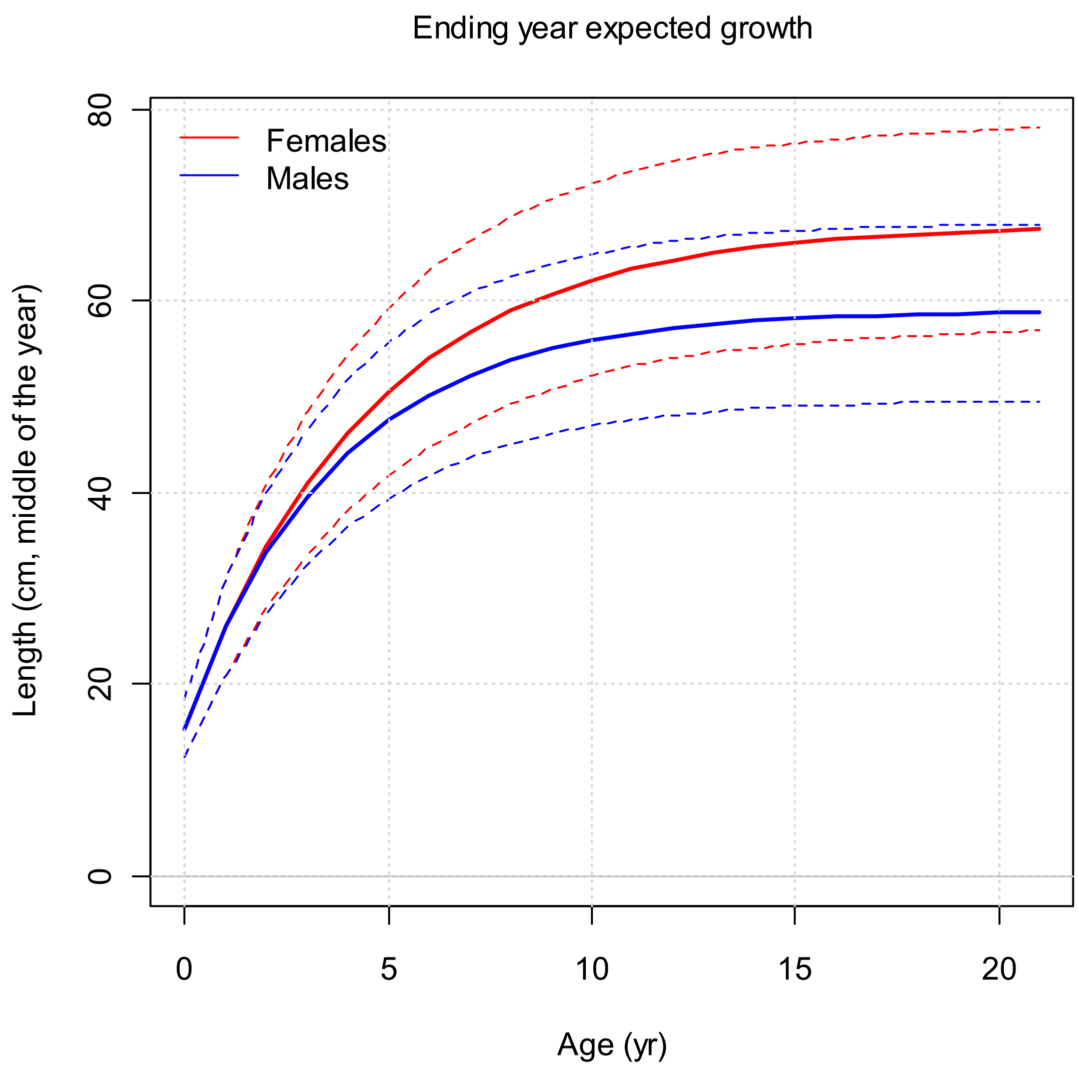
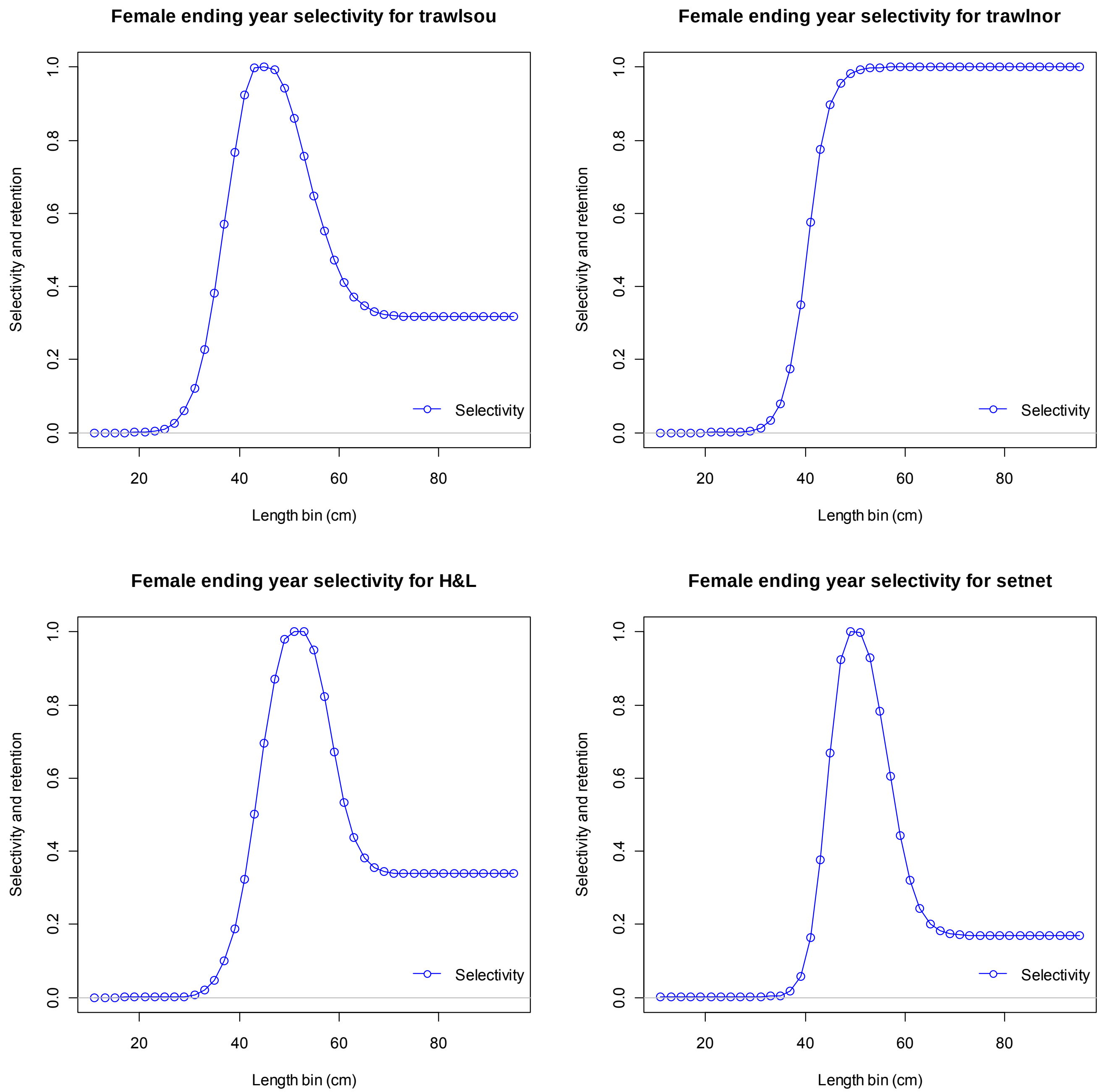
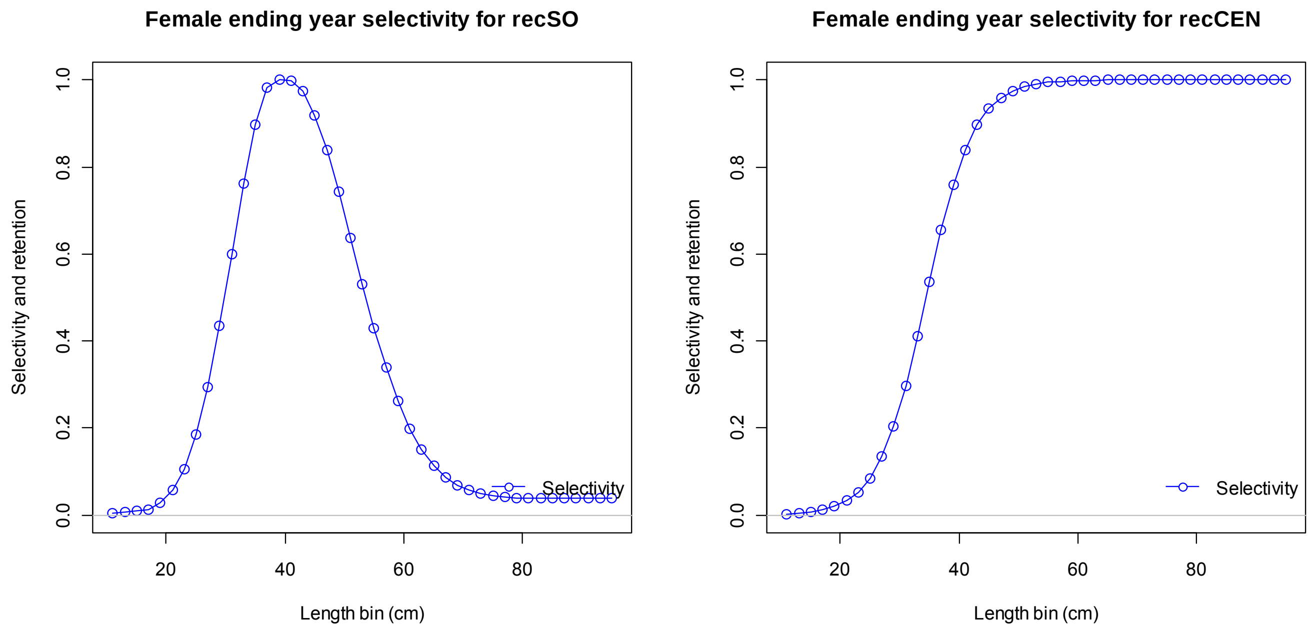


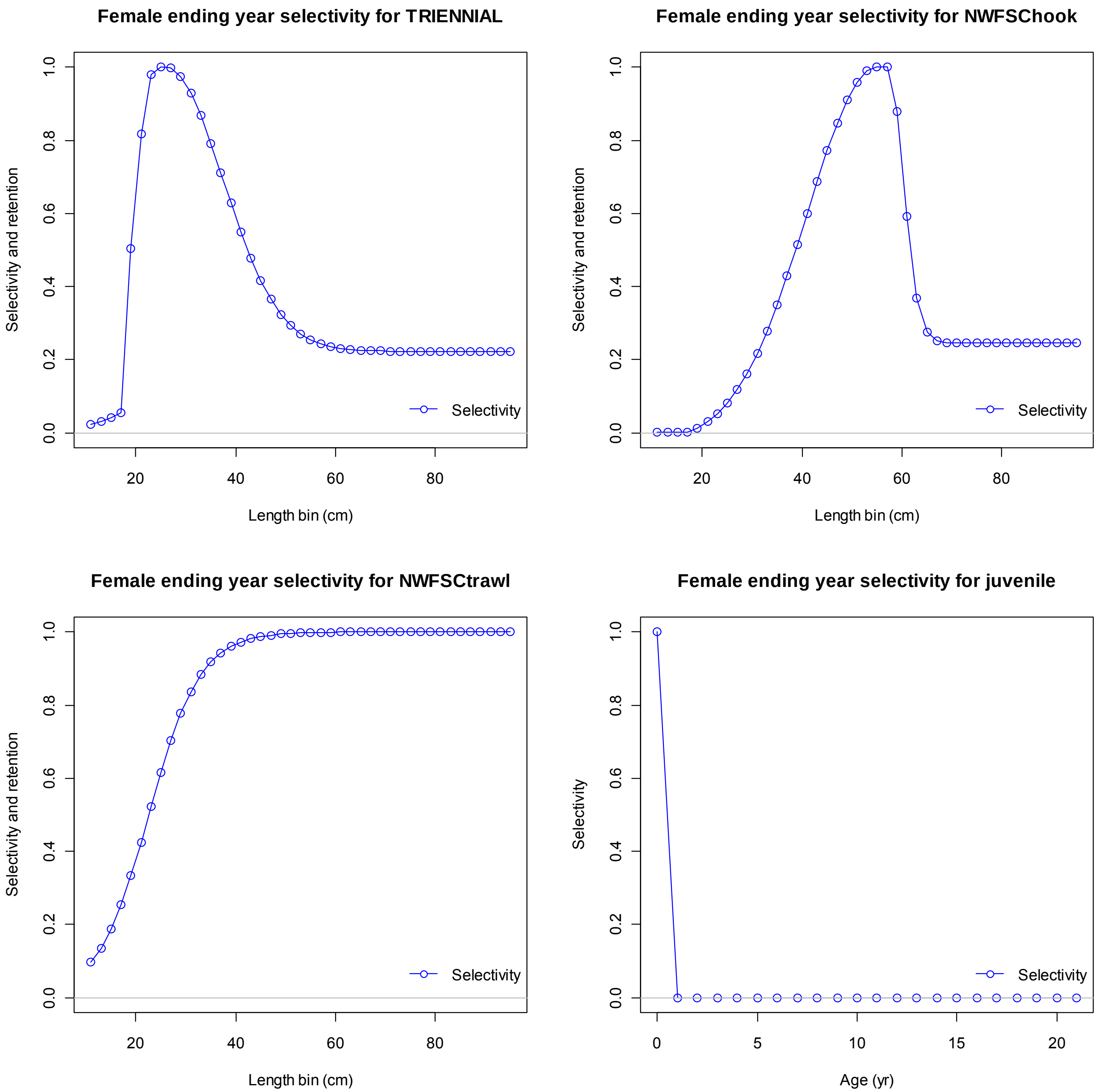
Figure 50. Model estimated growth curve for female and male bocaccio.



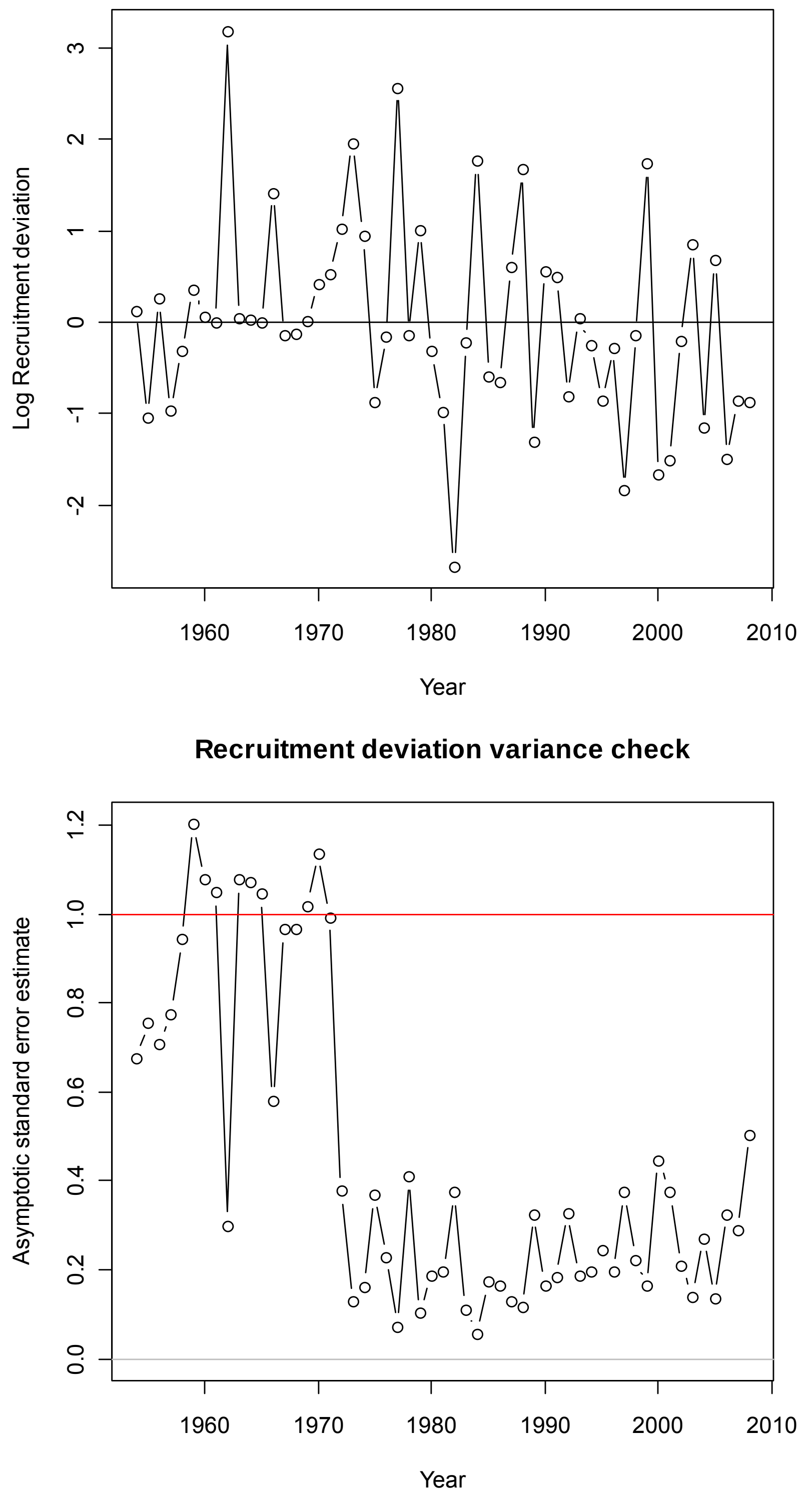
Figures 51a-d. Estimated selectivity curves for the bocaccio base model for commercial fisheries, trawl (north and south of 38˚ N latitude), hook-and-line, and set net.



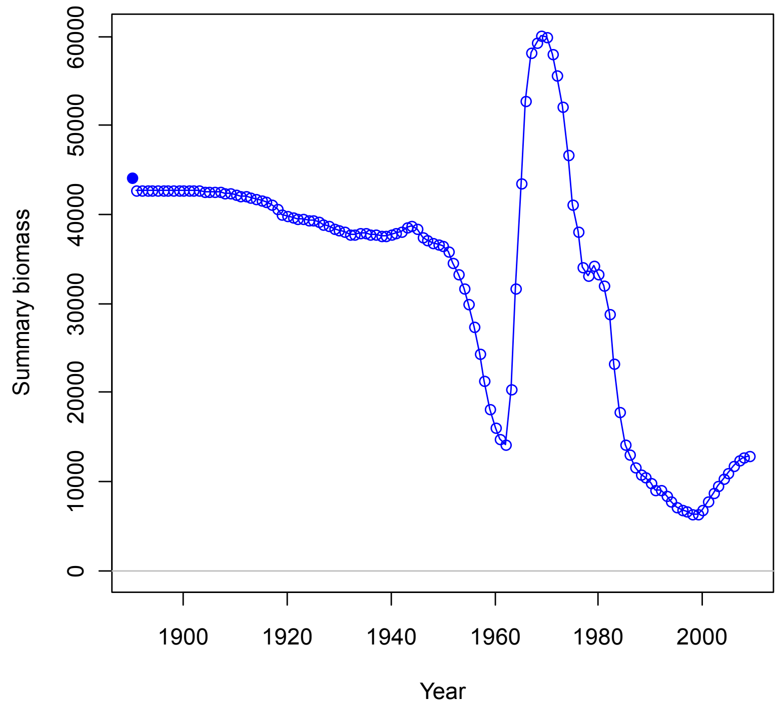
Figures 51e-f. Estimated selectivity curves for bocaccio in the southern and central California recreational fisheries.

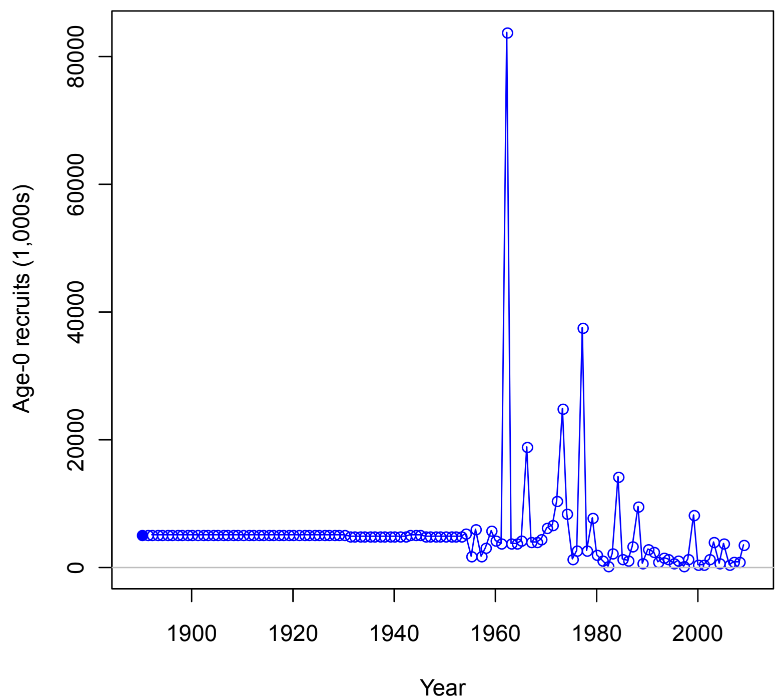


Figures 51g-j. Selectivity curves for bocaccio in the triennial survey (fixed), the NWFSC Southern California Bight hook-and-line survey, the NWFSC combined shelf and slope survey, and age selectivity for the pelagic juvenile age-0 survey.

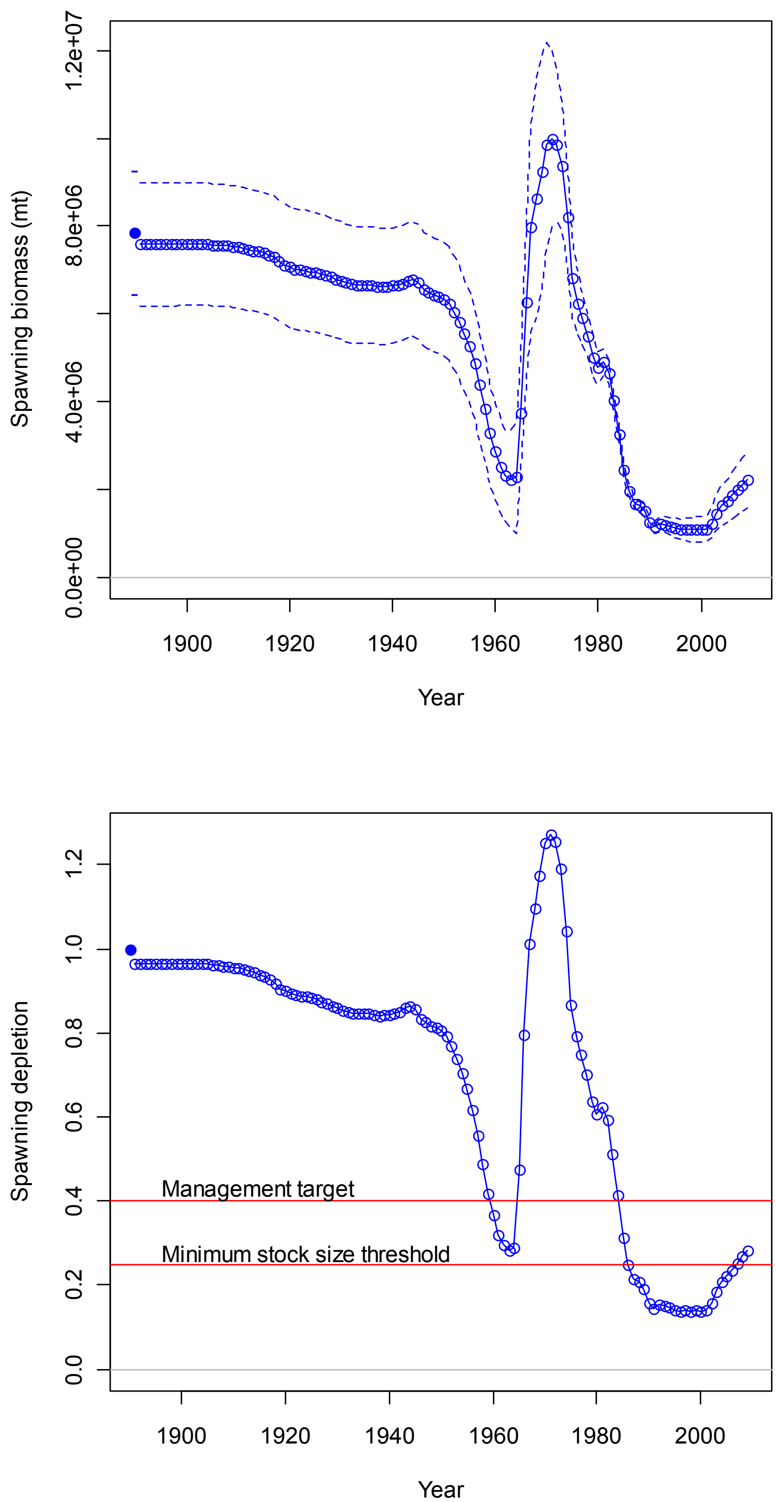


Figures 52a-b. Recruitment deviation parameter estimates for bocaccio (top) and asymptotic standard error estimates (bottom).





Figures 53a-b. Summary (age 1+) biomass and recruitment (age 0) of bocaccio for the base model.



Figures 54a-b. Spawning output (x10^{6}) estimated for bocaccio, with asymptotic confidence intervals (top) and relative depletion for the base model.

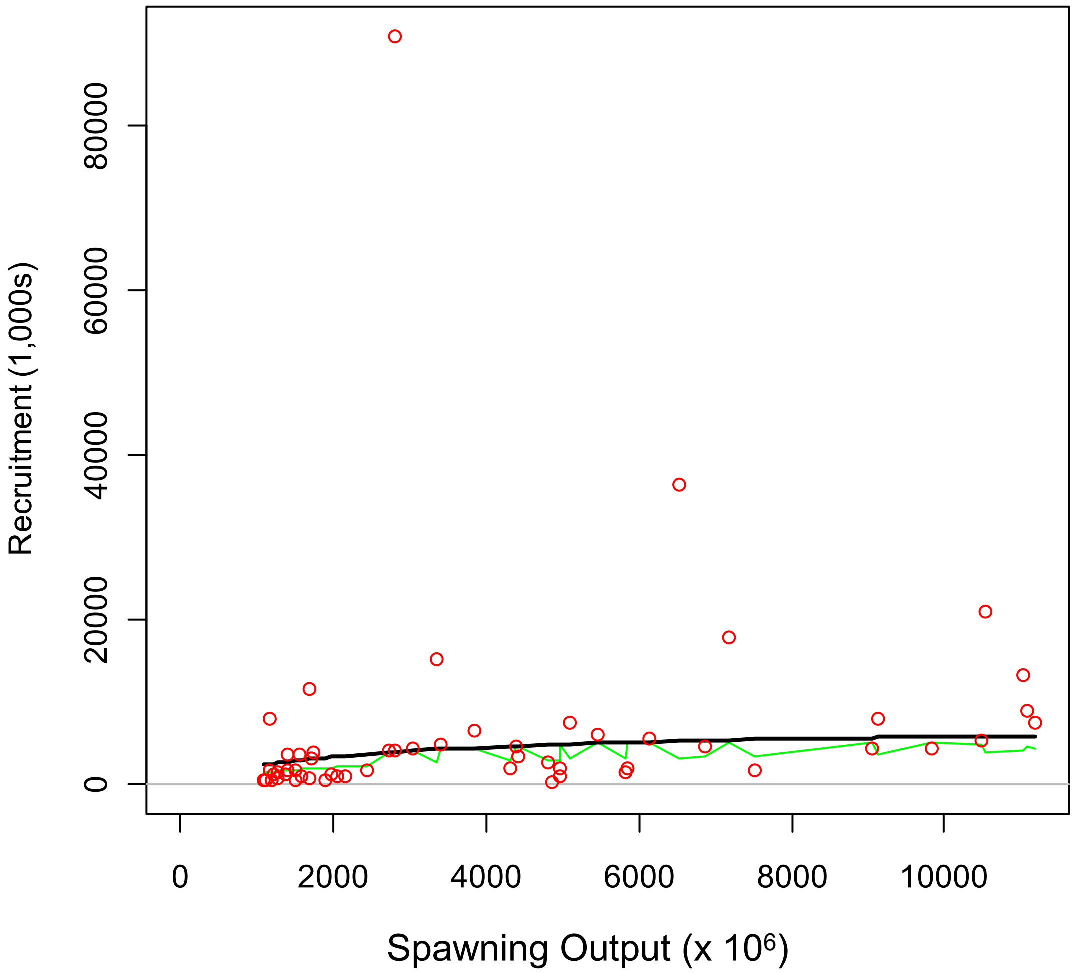
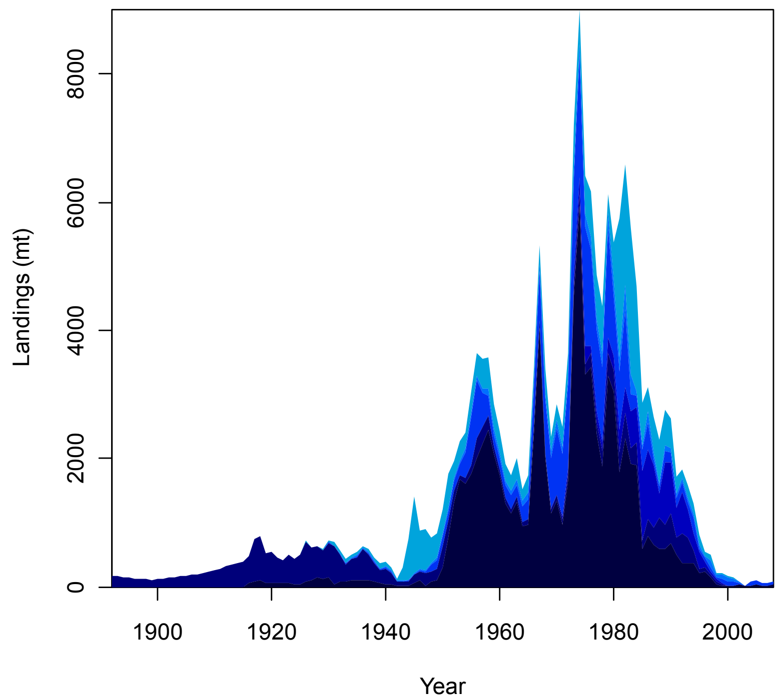
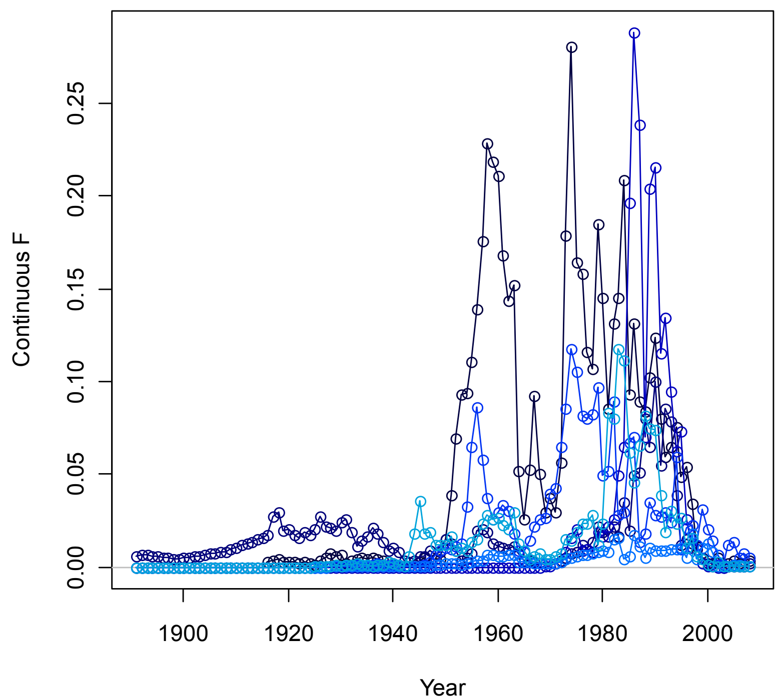
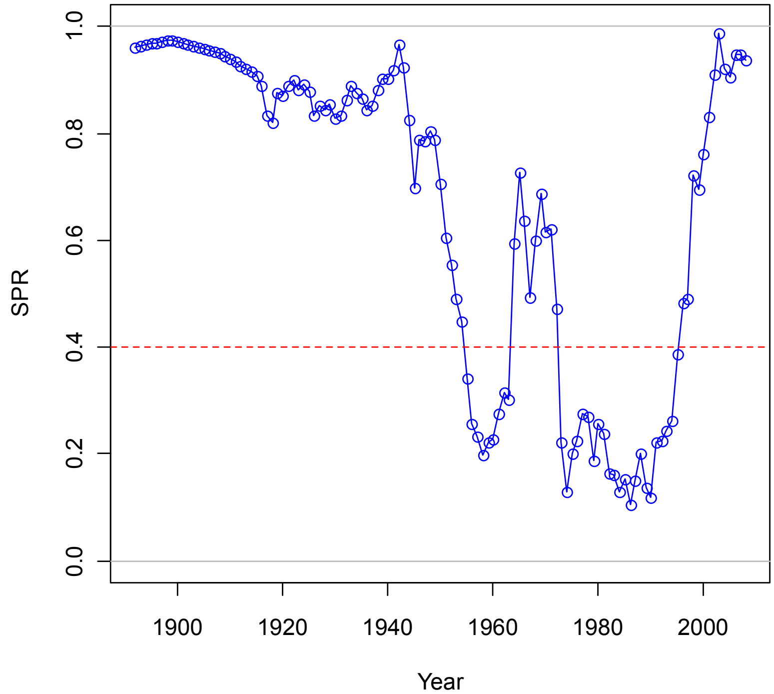


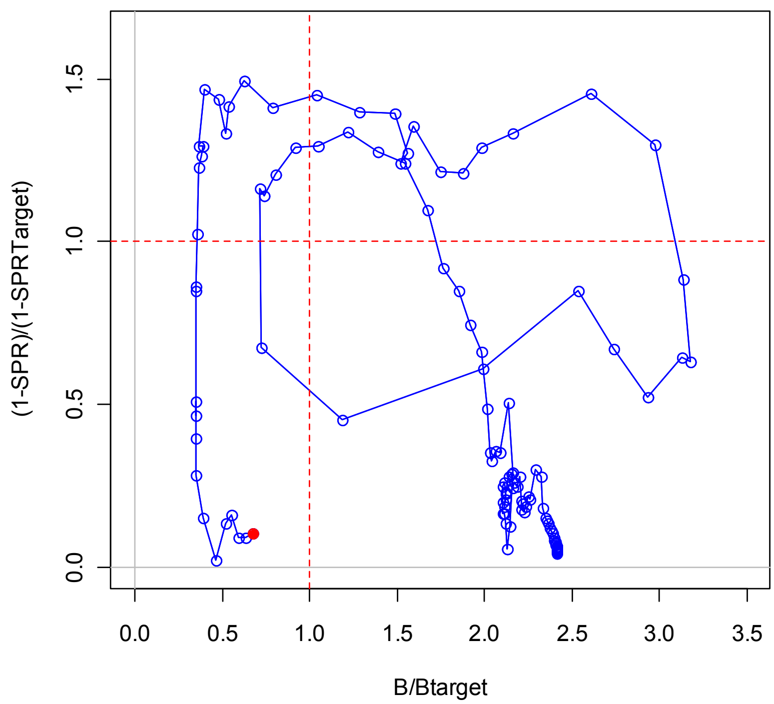
Figure 55. Spawner-recruit curve for bocaccio, based on the steepness value of 0.53.



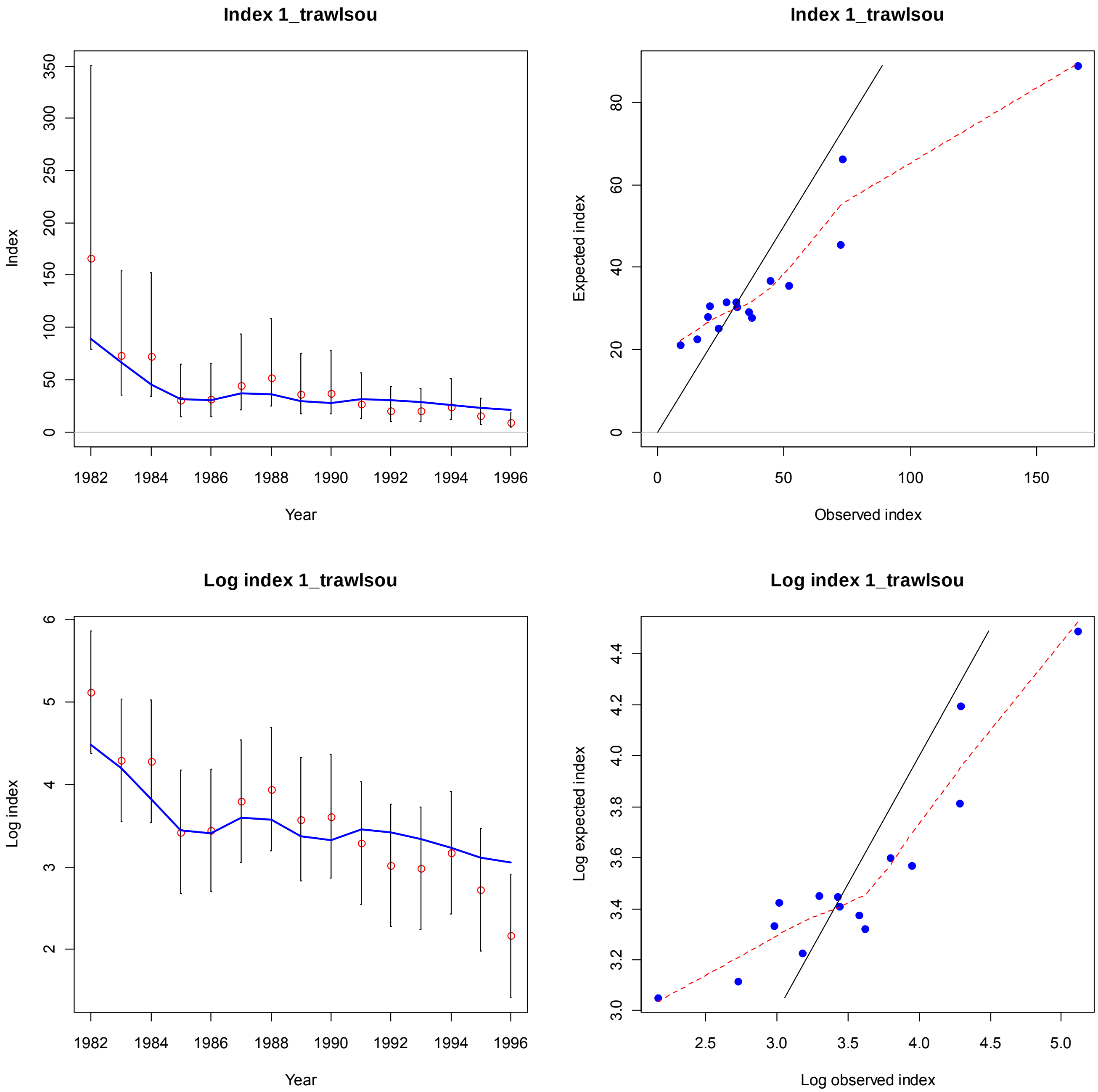


Figures 56a-b. Total catches of bocaccio and instantaneous fishing mortality rates for bocaccio by fishery.

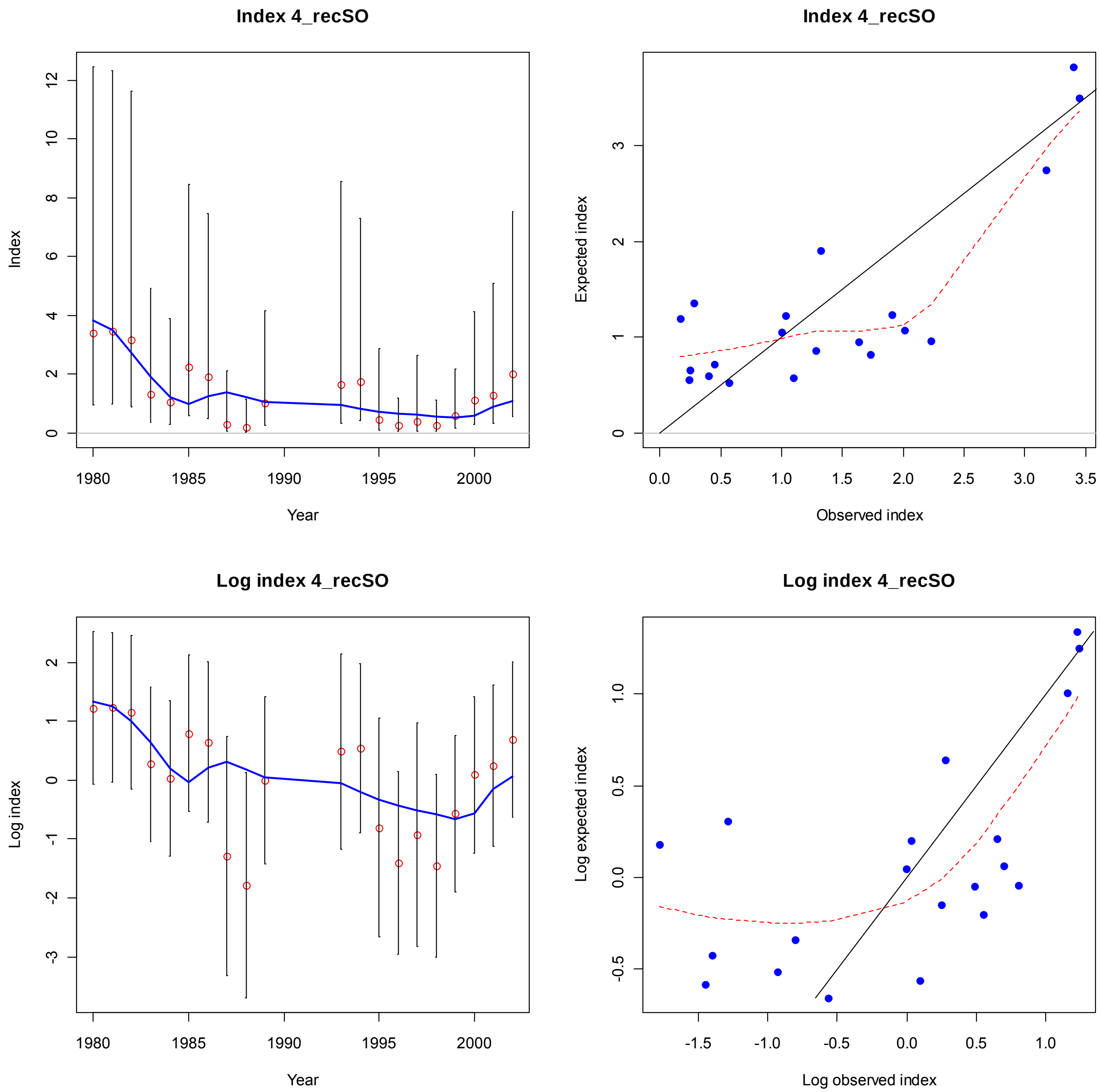




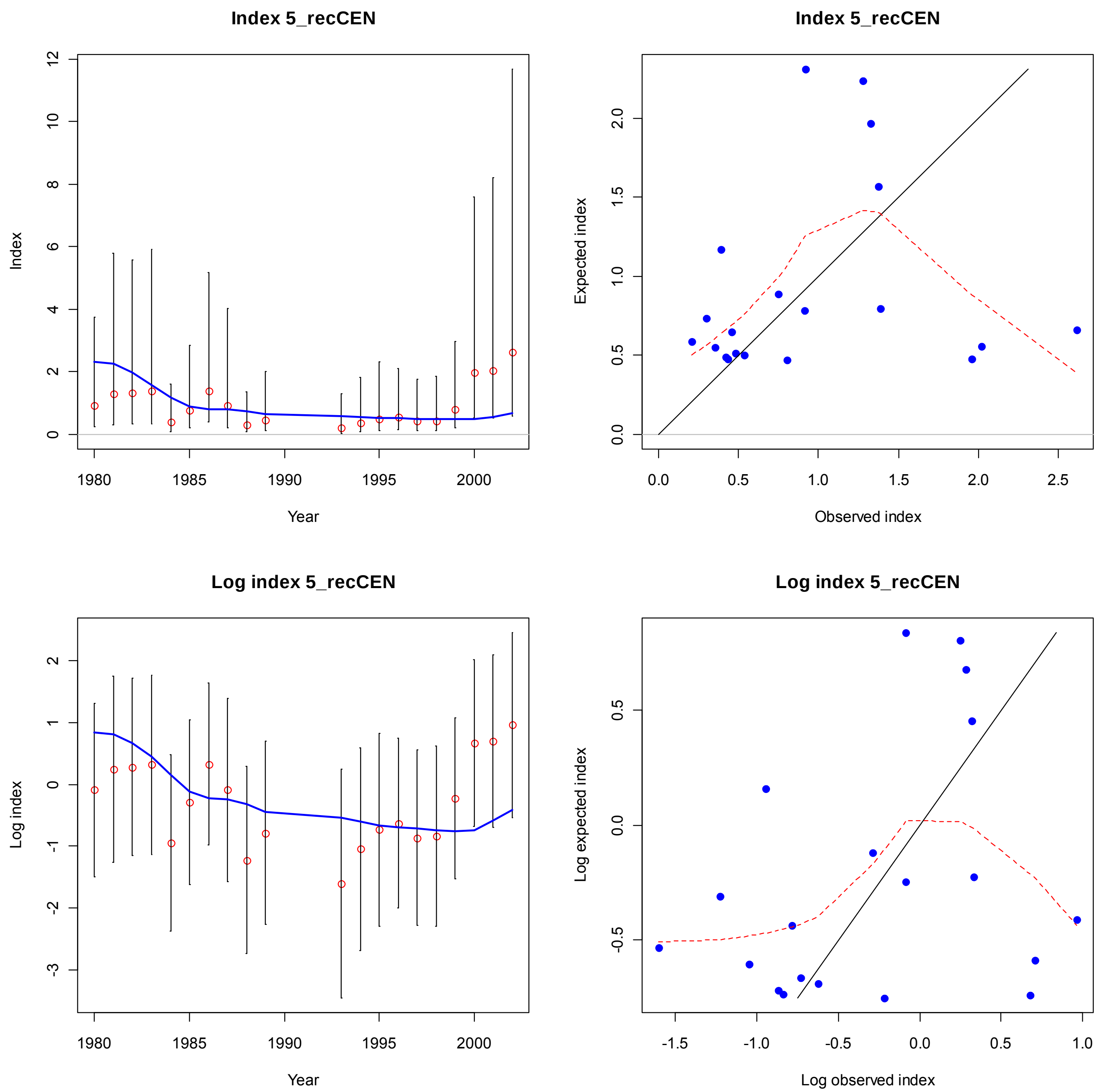
Figures 57a-b. 1-SPR rate (top) over time, with reference proxy for *Sebastes* and phase plot of SPR rate plotted against SSB target levels (bottom).



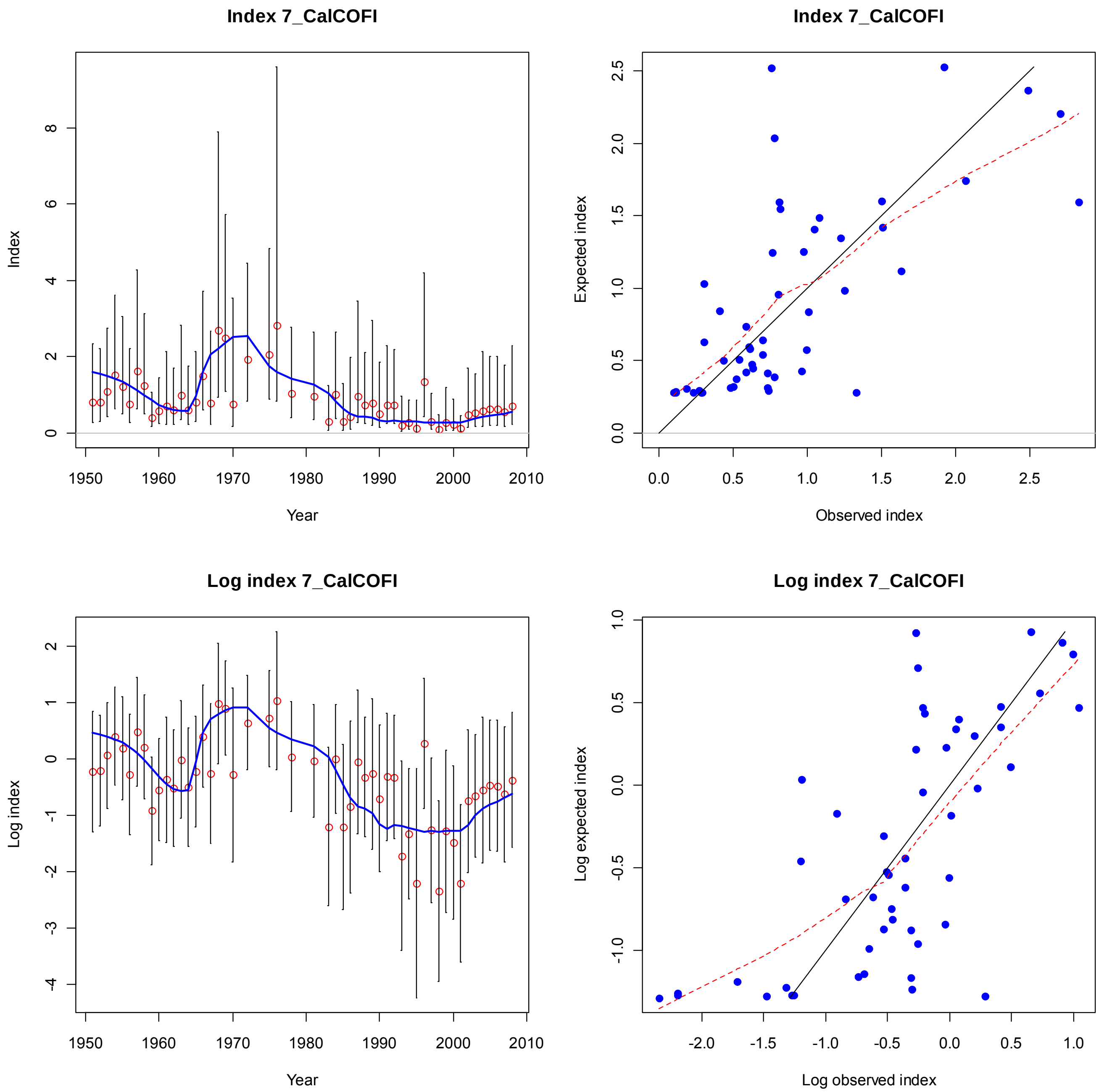
Figures 58a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the trawl fishery CPUE time series of bocaccio abundance.



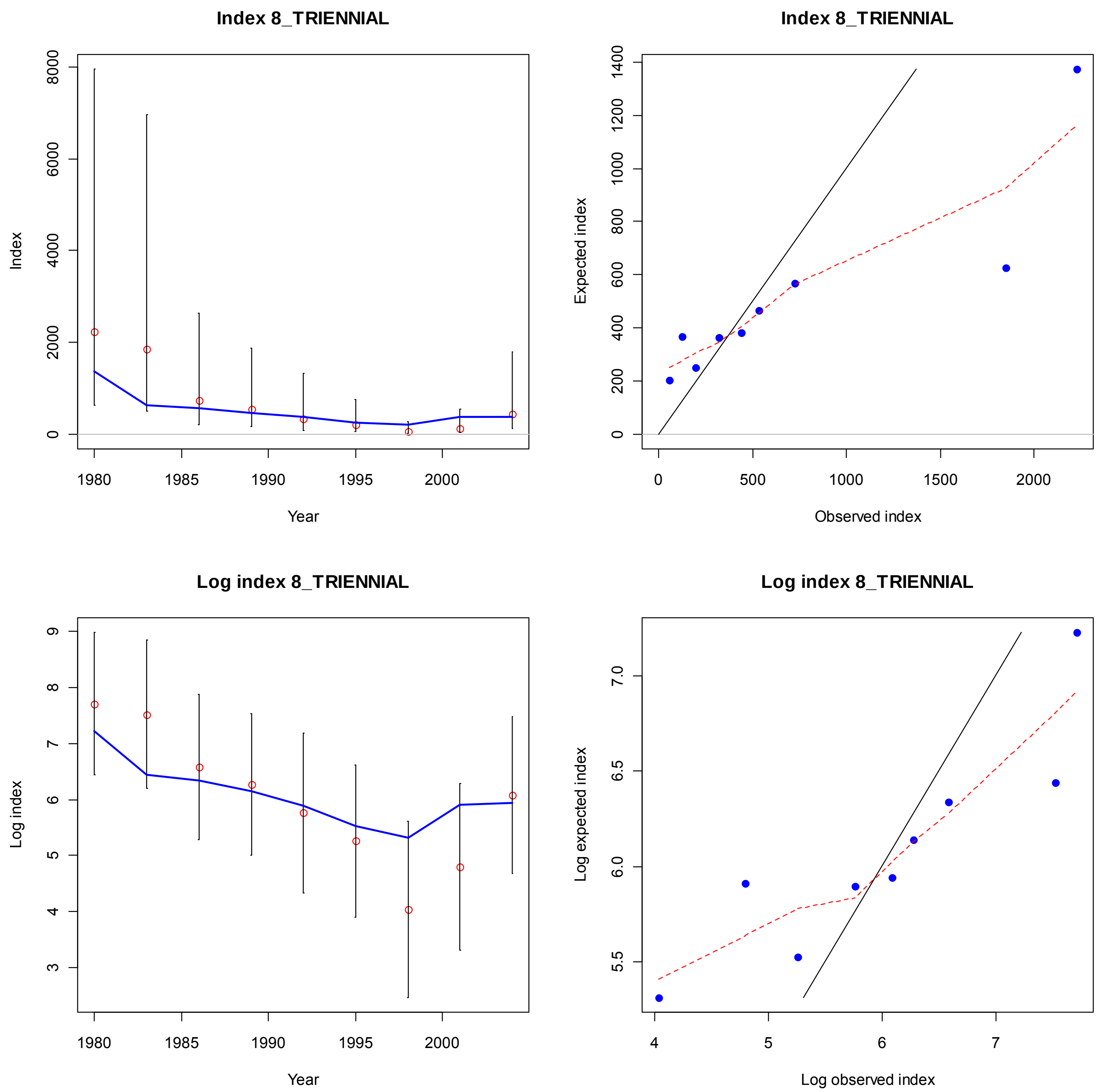
Figures 59a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the southern recreational fishery CPUE time series of bocaccio abundance.



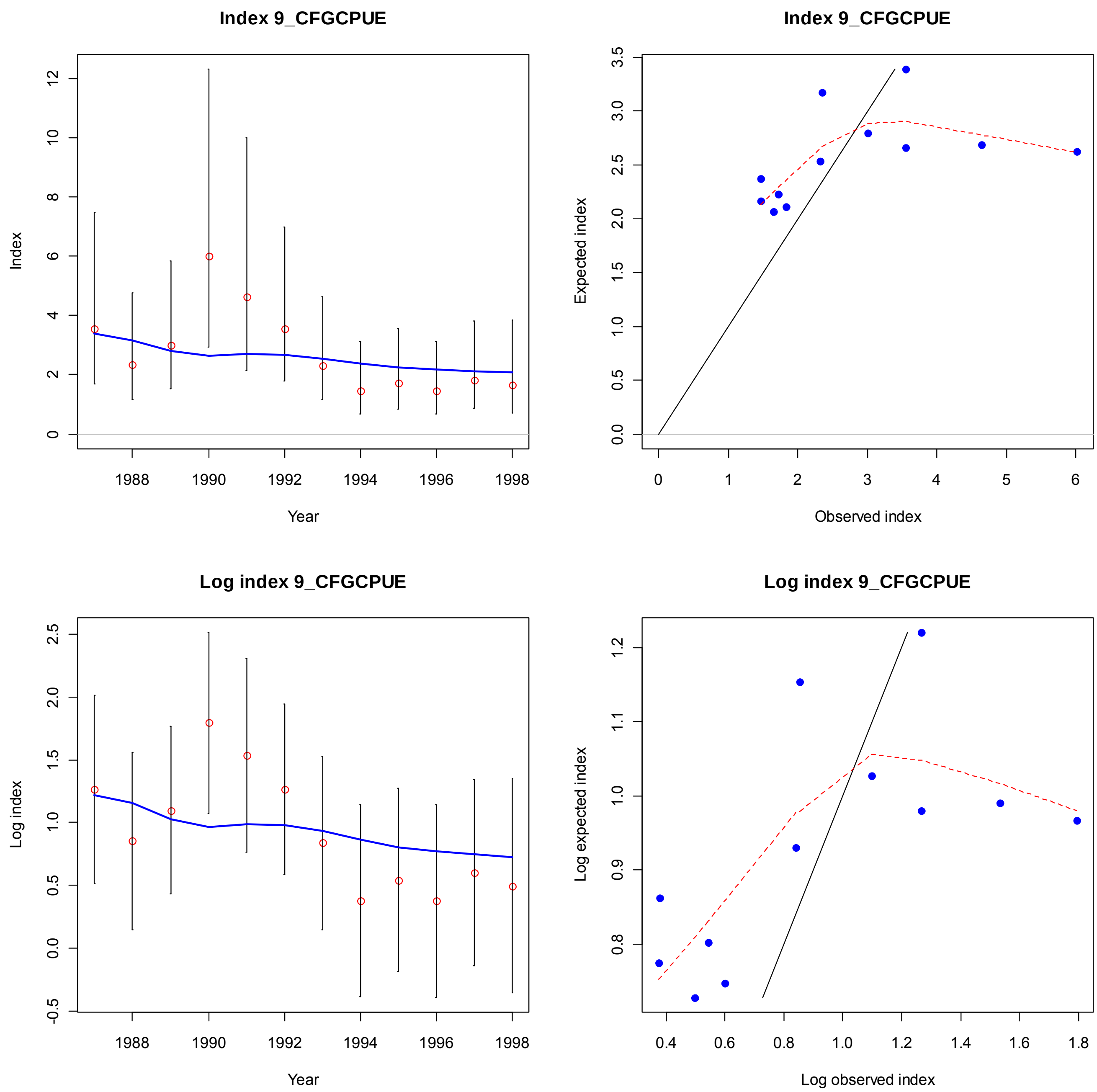
Figures 60a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the northern recreational fishery CPUE time series of bocaccio abundance.



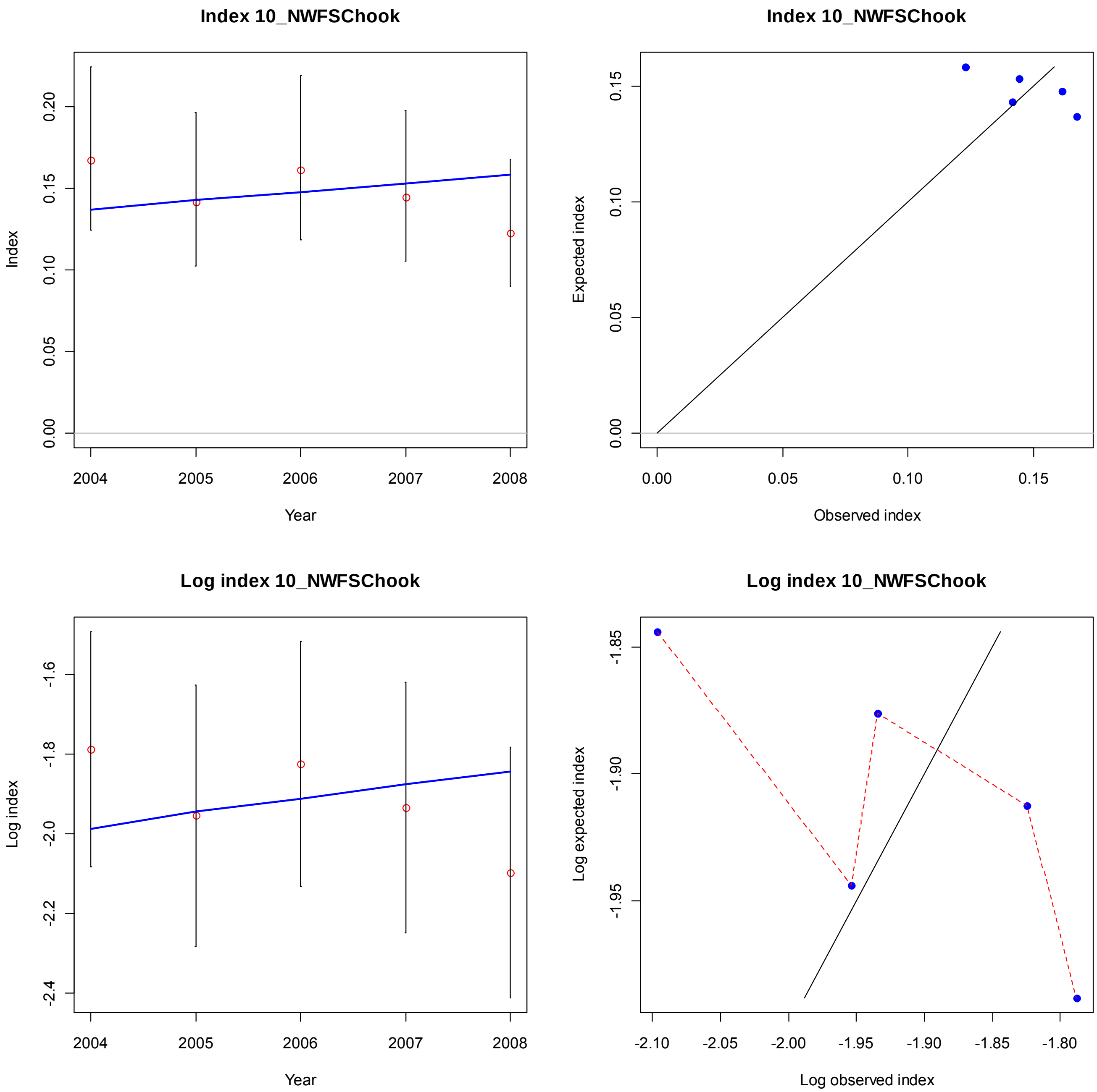
Figures 61a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the CalCOFI larval abundance time series of bocaccio abundance.



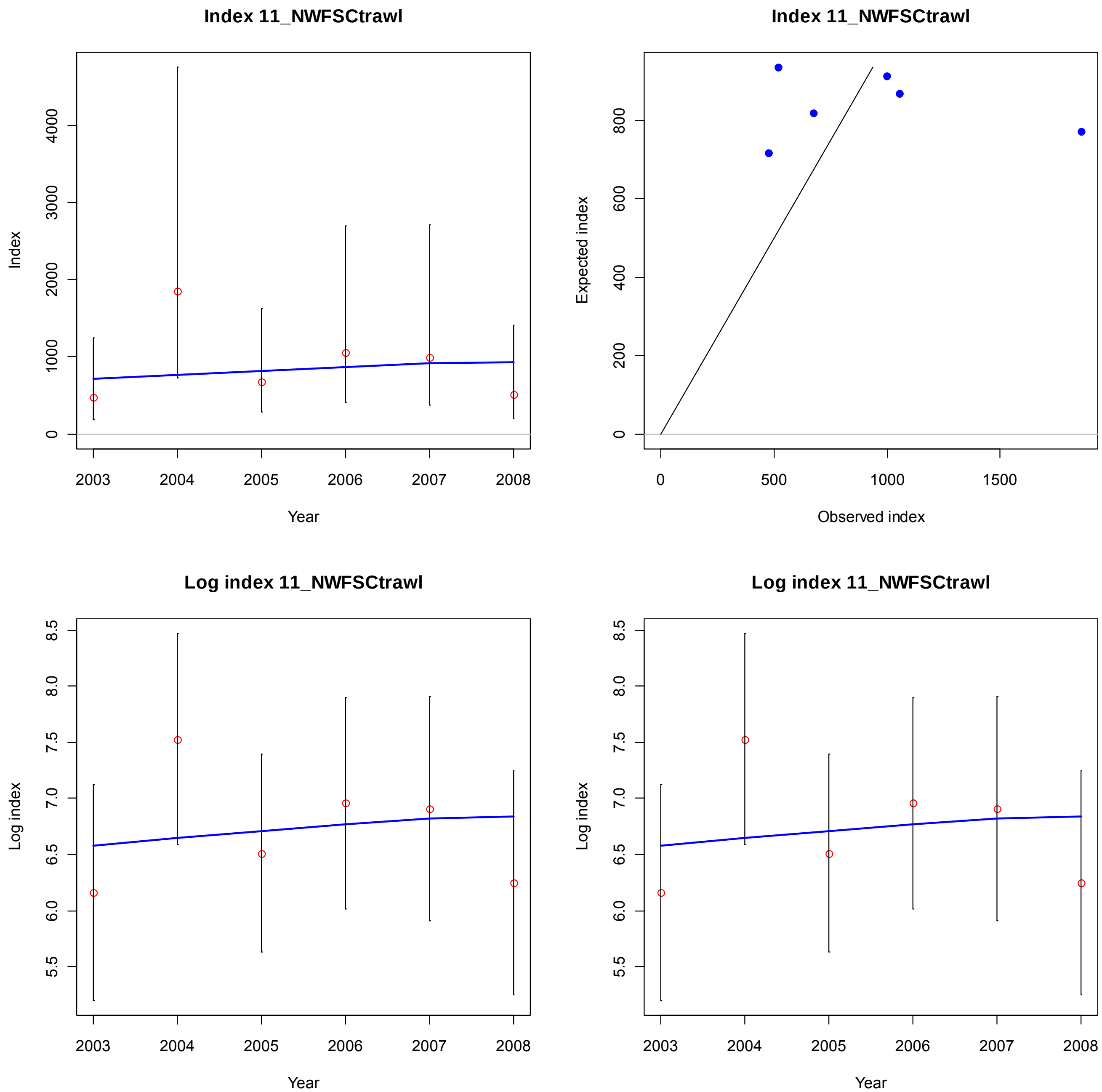
Figures 62a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the triennial trawl fishery GLMM index of bocaccio abundance.



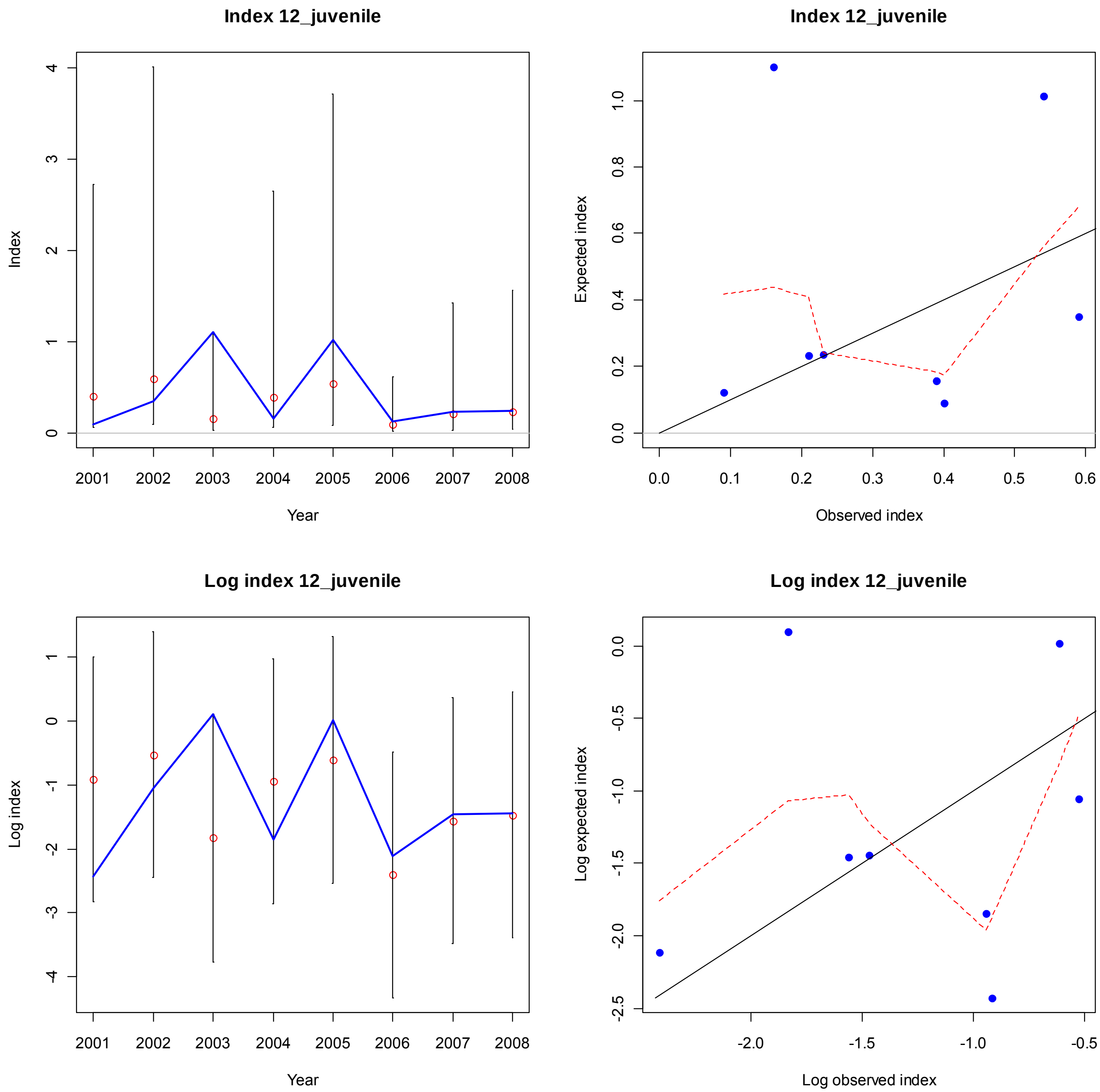
Figures 63a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the Northern California CPFV CPUE time series of bocaccio abundance.



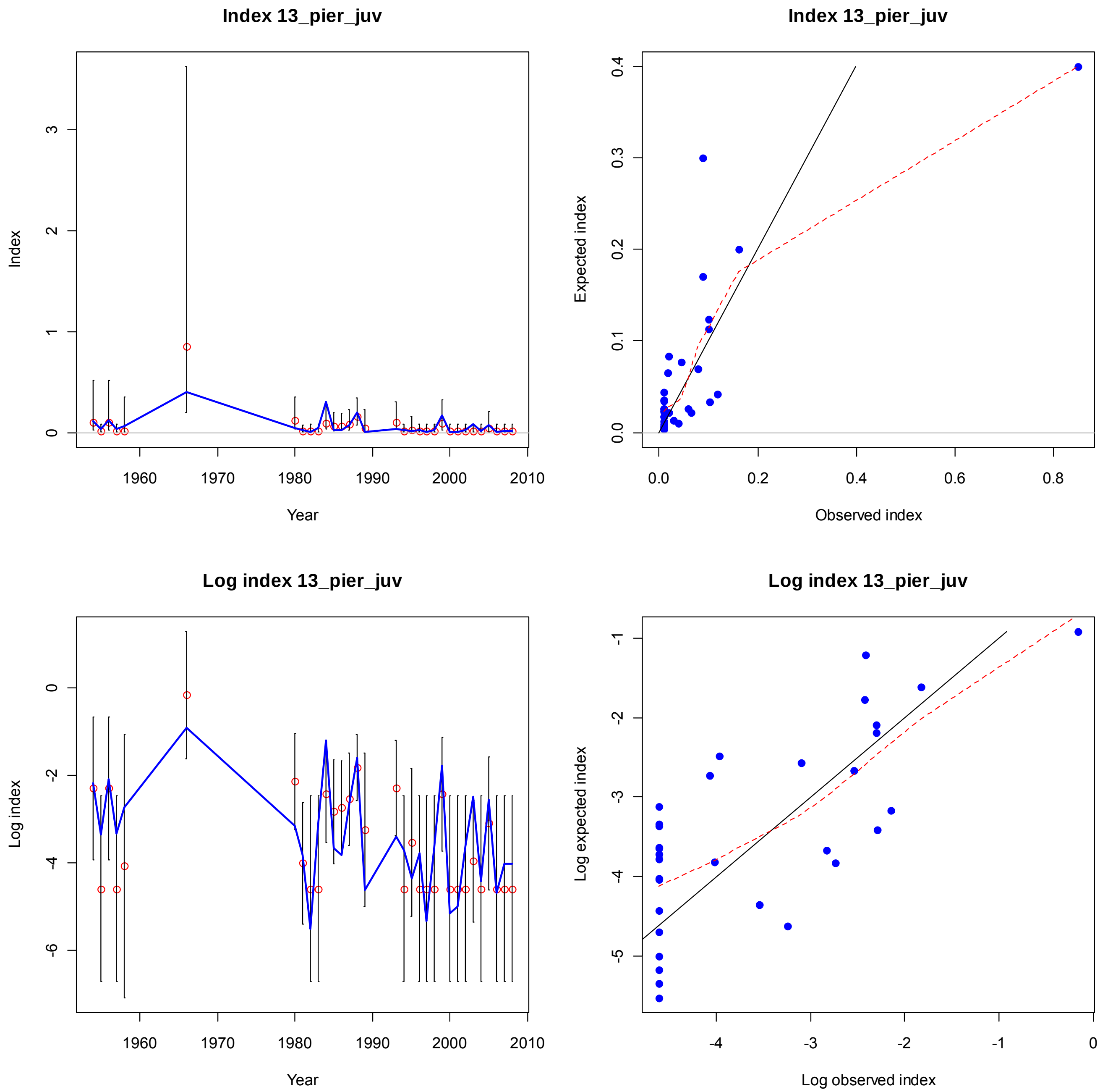
Figures 64a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the Northern California CPFV CPUE time series of bocaccio abundance.



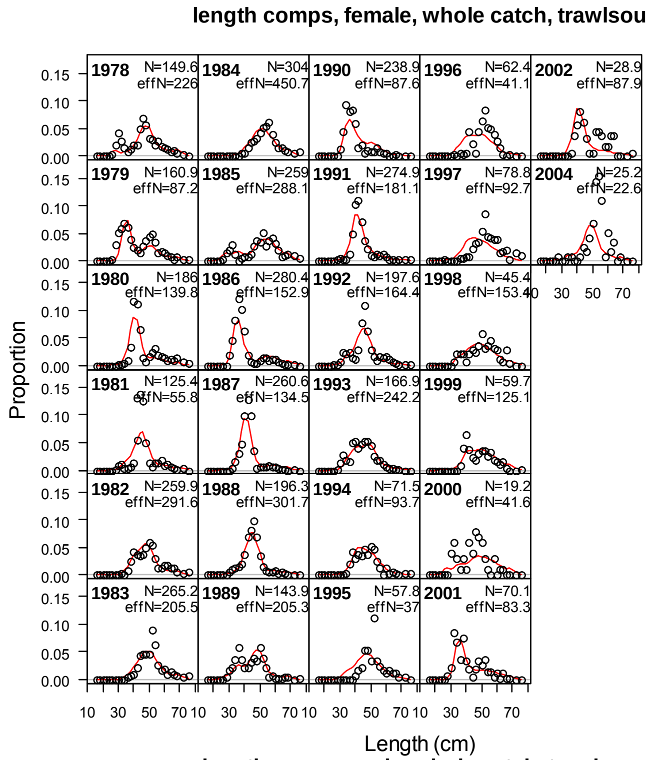
Figures 65a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the NWFSC combined trawl survey GLMM index of bocaccio abundance.



Figures 66a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the NWFSC combined trawl survey GLMM index of bocaccio abundance.



Figures 67a-d. Arithmetic and log fits, with corresponding observed and predicted values, to the pier fishery index of bocaccio abundance.



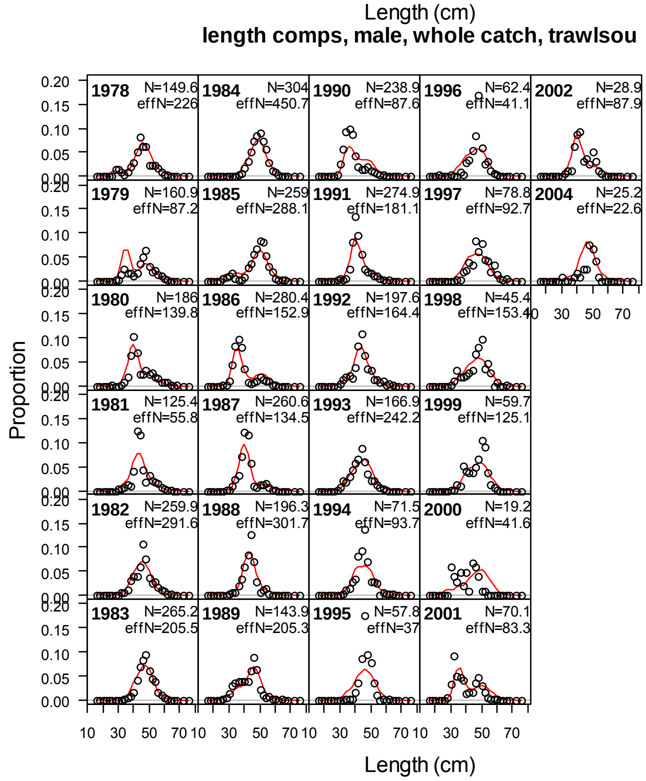


Figure 68a-b. Bocaccio model fits to female and male length frequency data for the trawl fishery south of 38˚ N latitude.

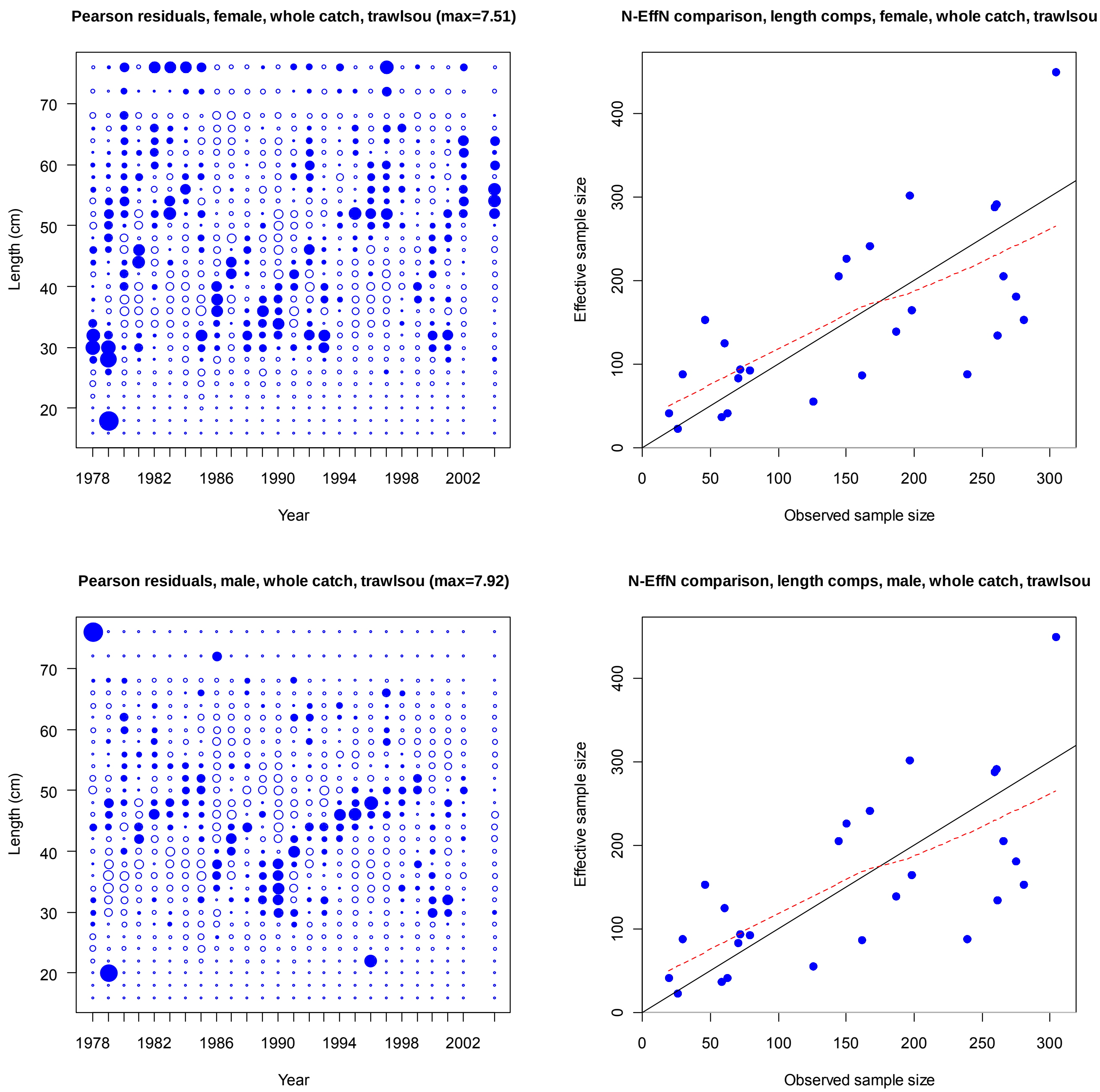
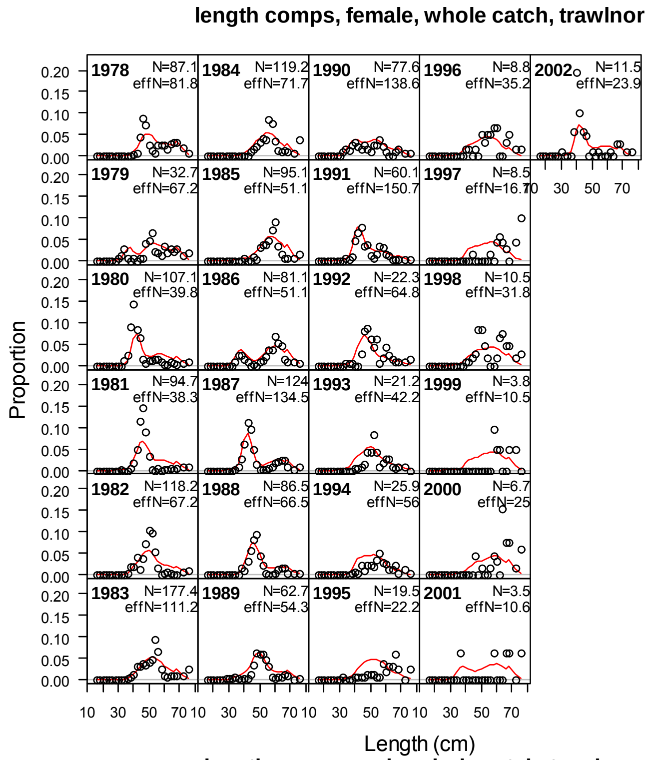
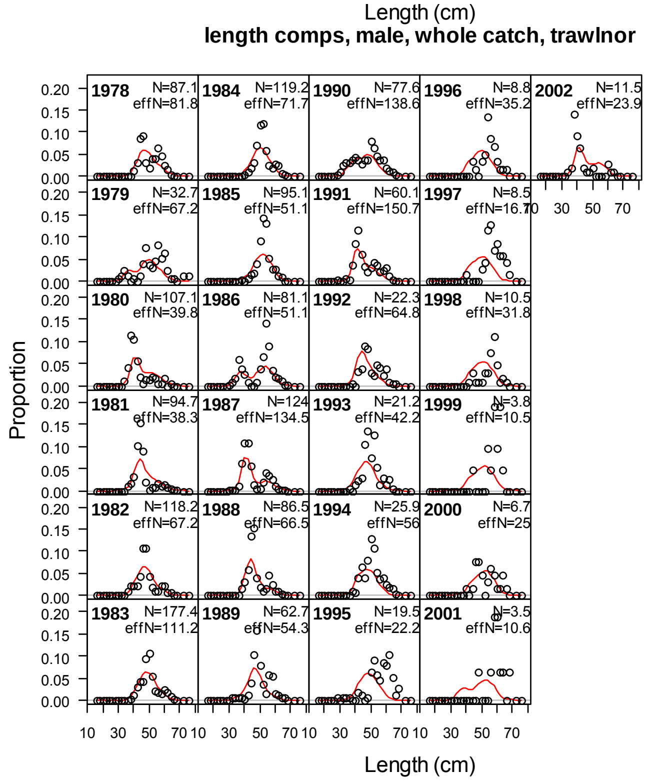
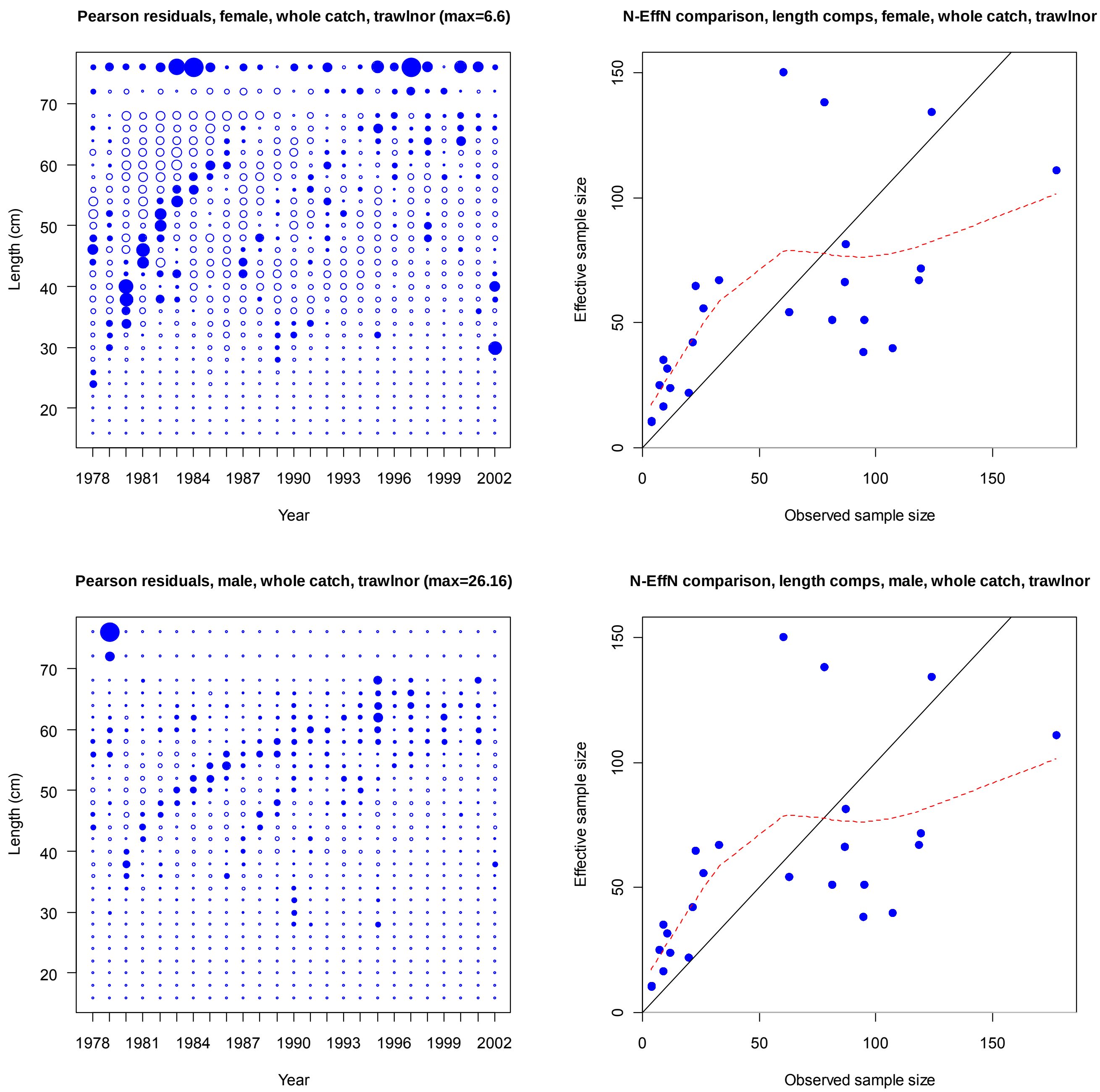


Figure 68c-f. Residuals and input versus effective sample sizes for the southern trawl fishery for the bocaccio base model.

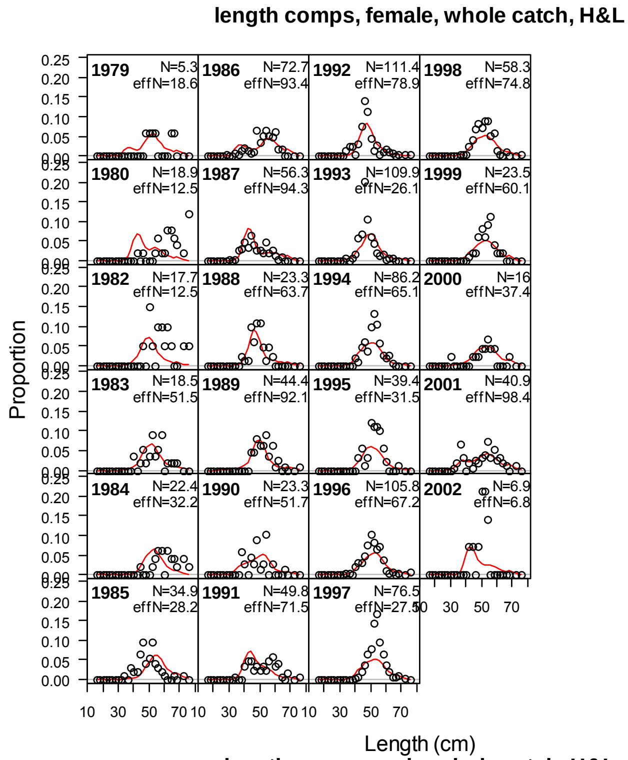


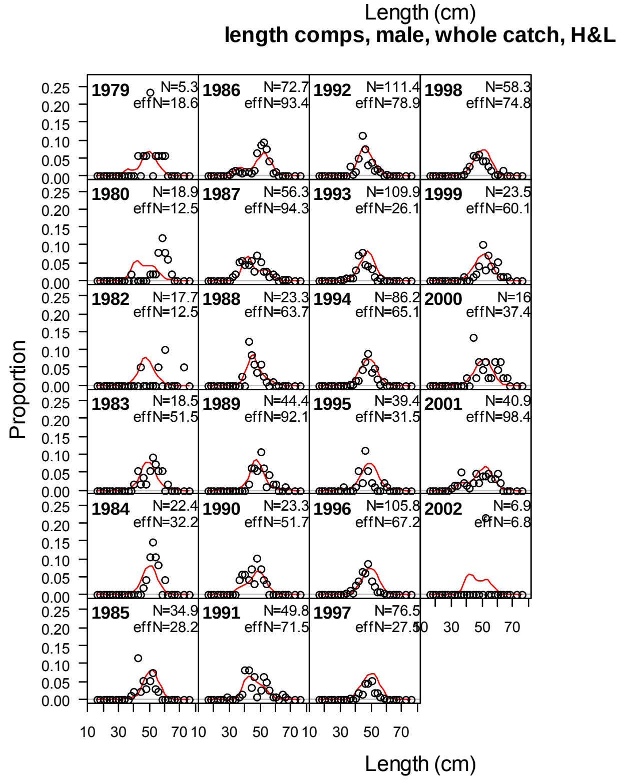


Figures 69a-b. Fits to female and male length frequency data for bocaccio for the trawl fishery north of 38˚ N latitude.

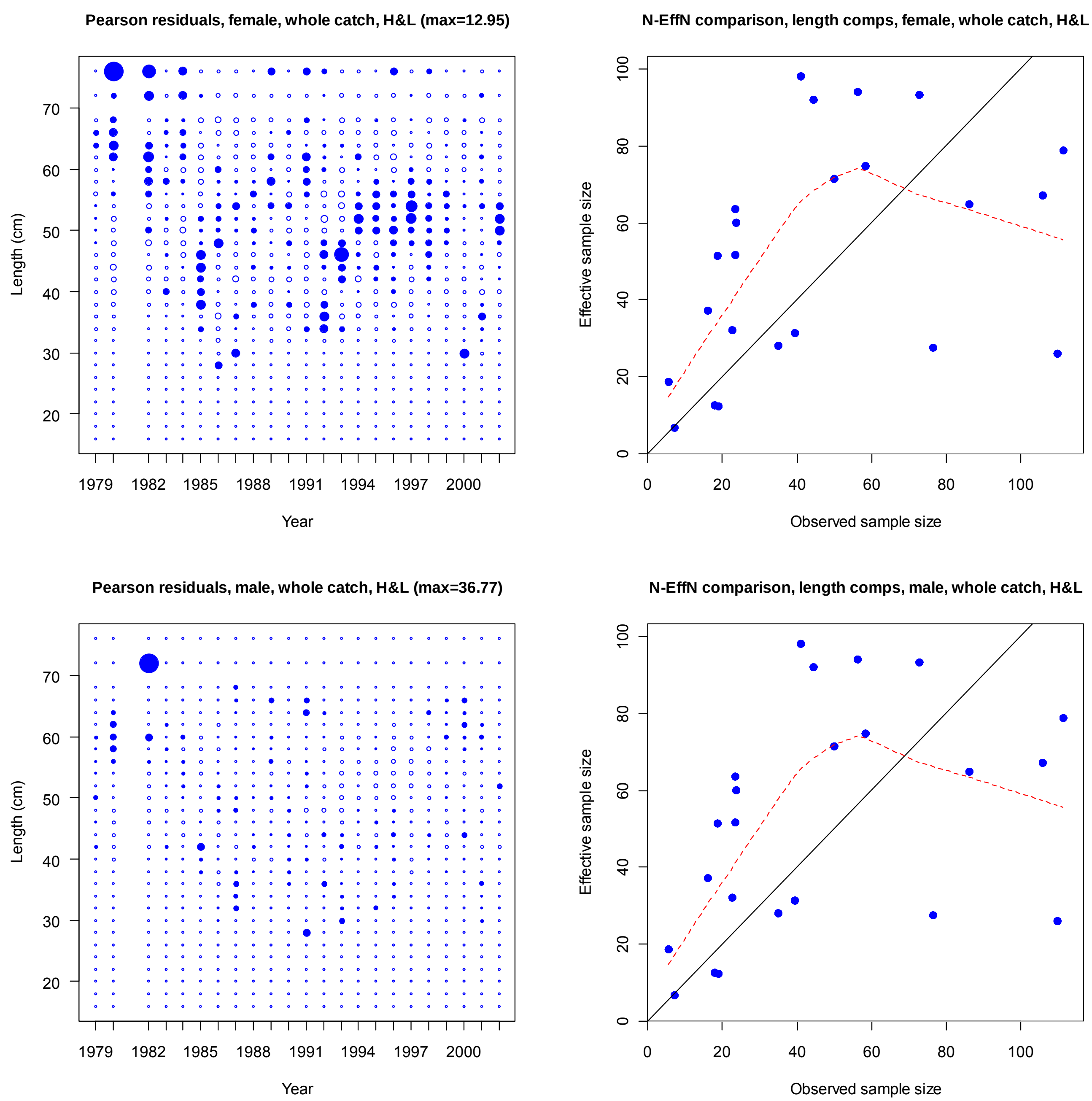


Figures 69c-f. Residuals and input versus effective sample sizes for the northern trawl fishery.

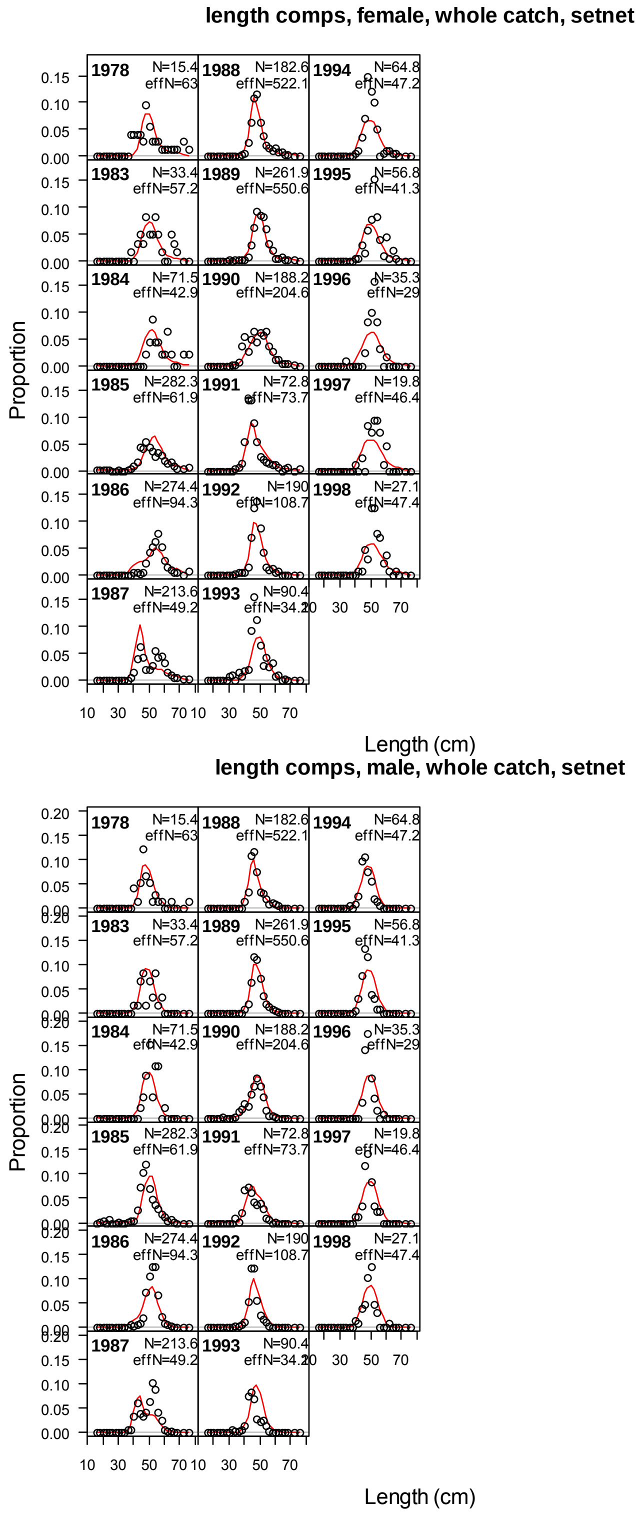




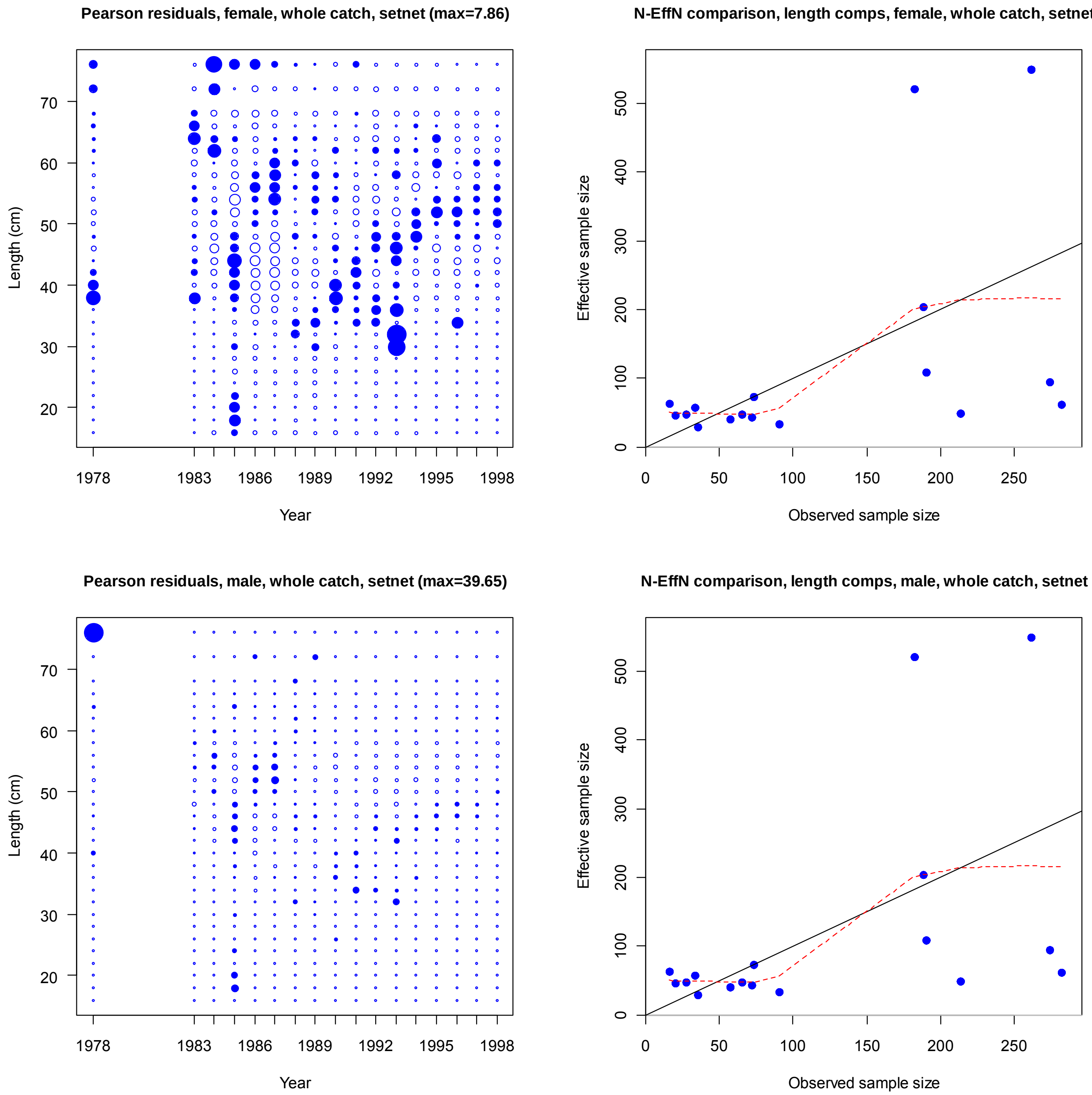
Figures 70a-b. Fits to female and male length frequency data for the hook-and-line fishery.



Figures 70c-f. Residuals and input versus effective sample sizes for the hook-and-line fishery.



Figures 71a-b. Fits to female and male length frequency data for the set net fishery.



Figures 71c-f. Residuals and input versus effective sample sizes for the set net fishery.

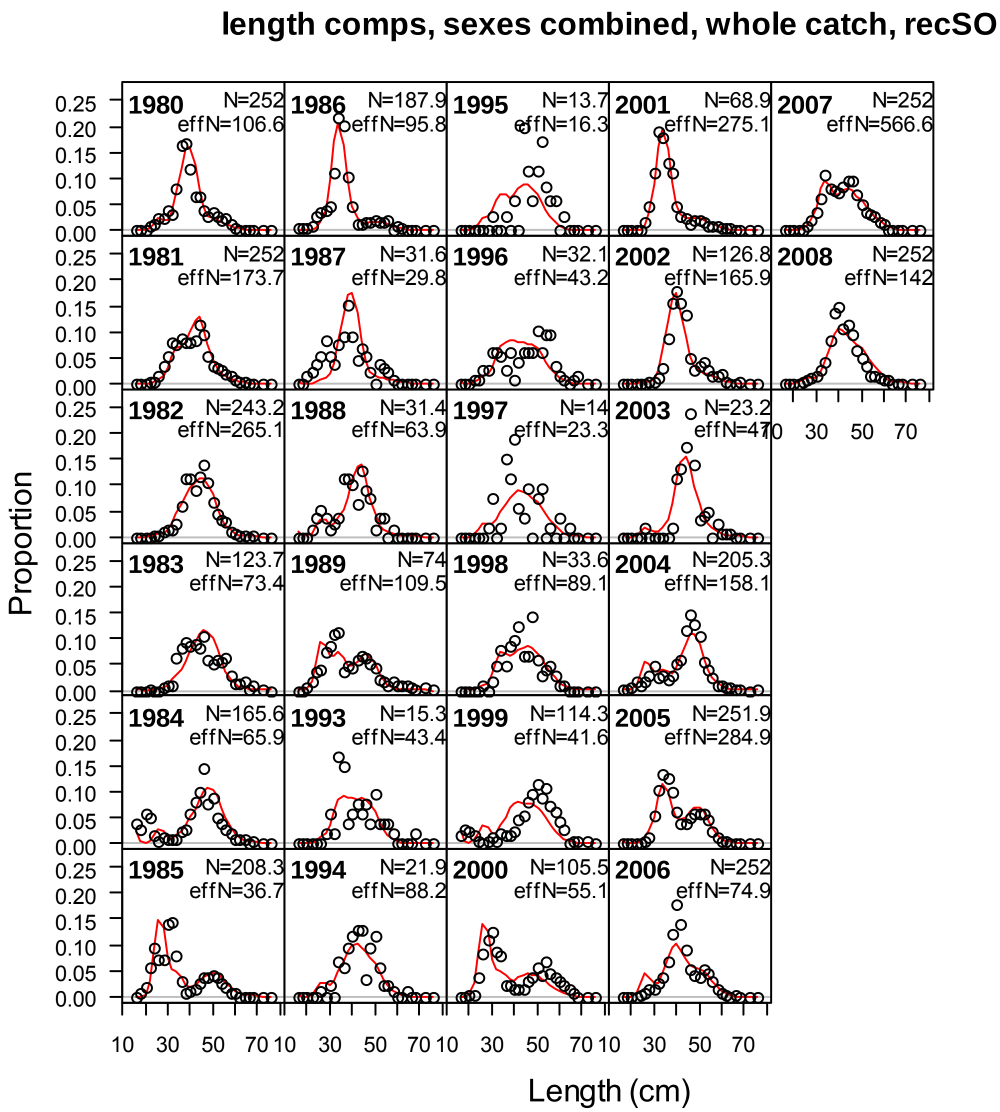
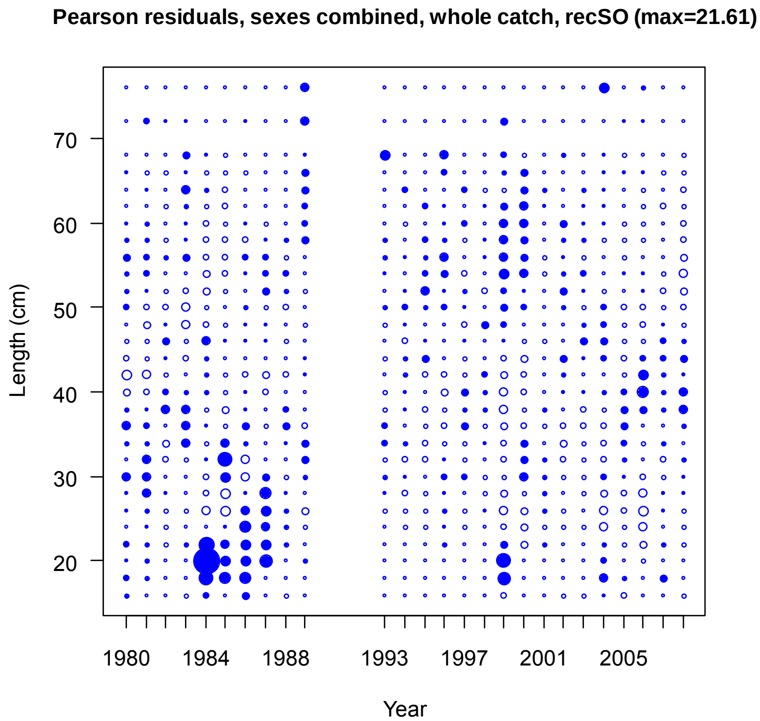
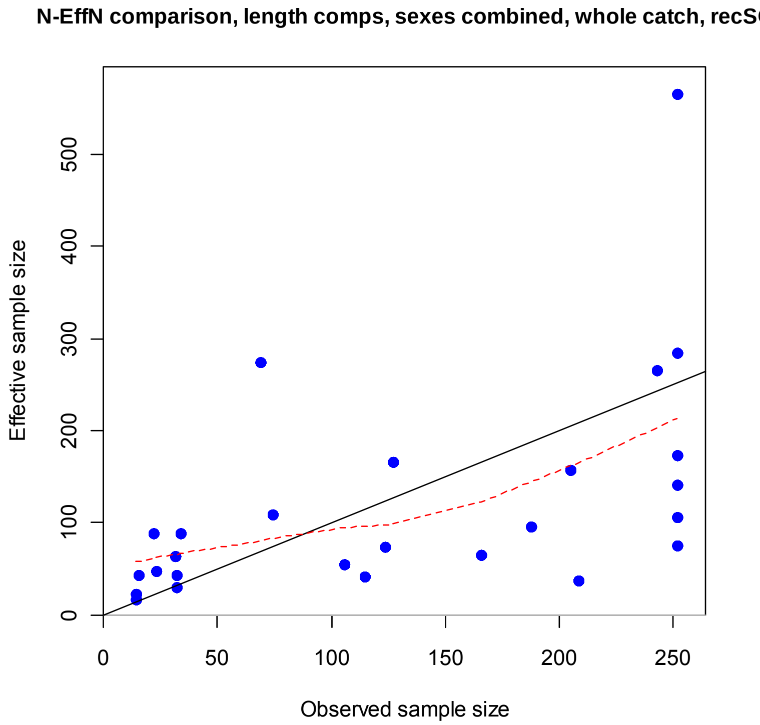


Figure 72a. Fits to combined sex length frequency data for the southern recreational fishery.





Figures 72b-c. Residuals and input versus effective sample sizes for the southern California recreational fishery.

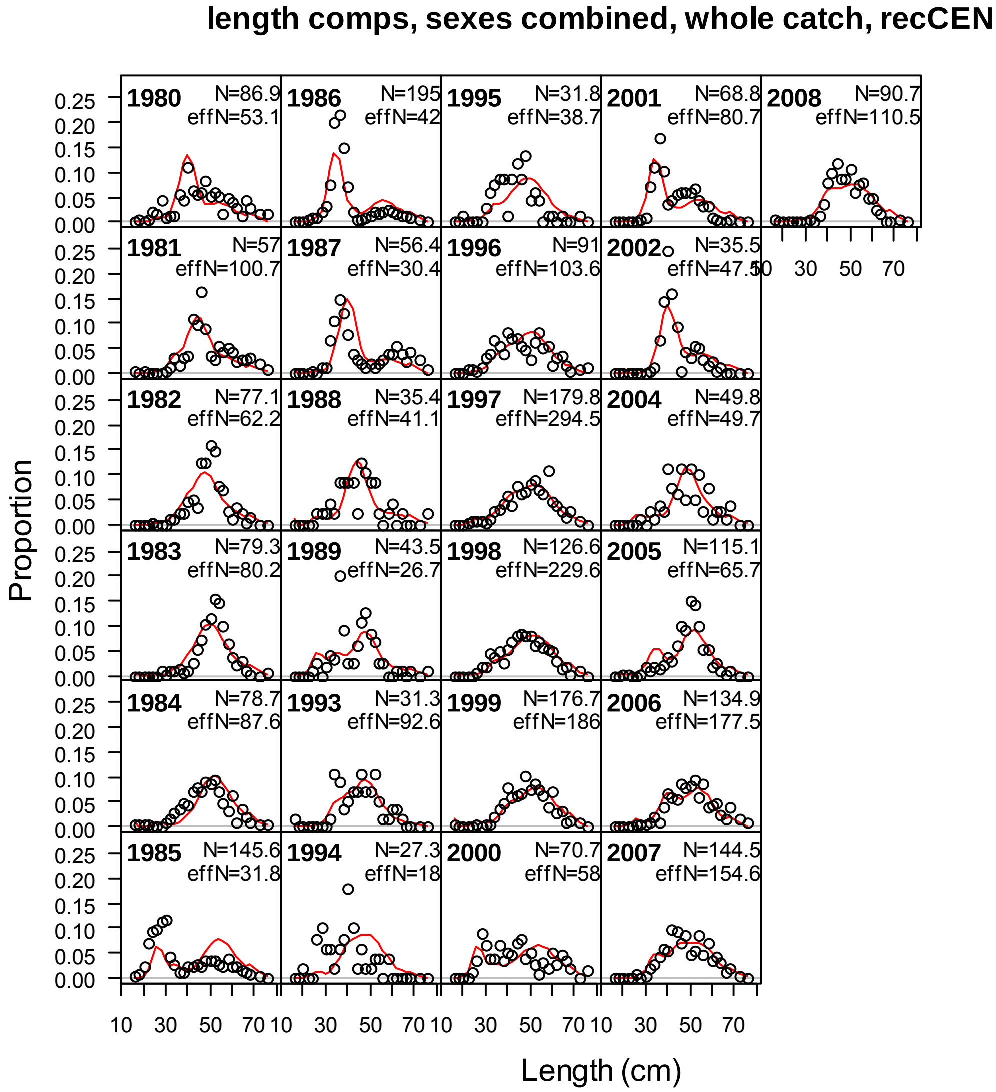
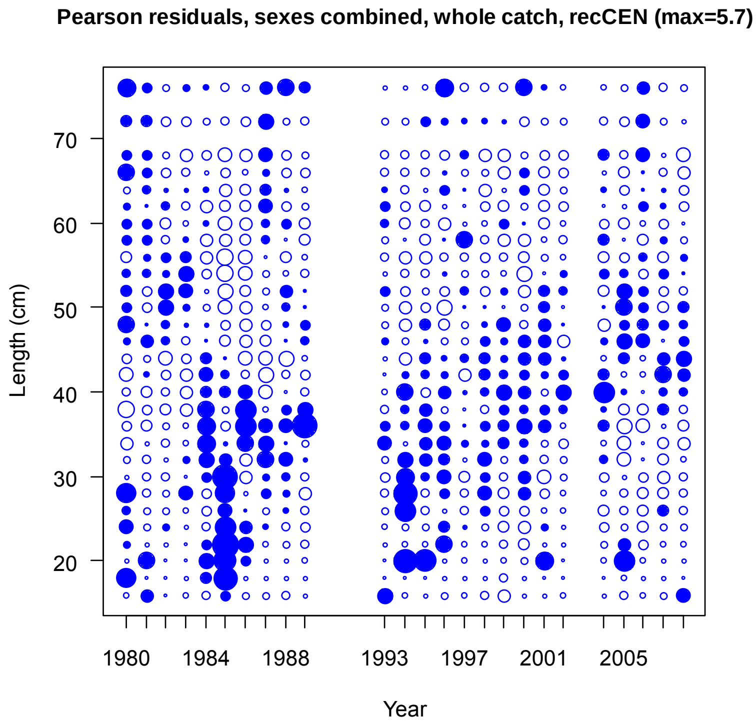
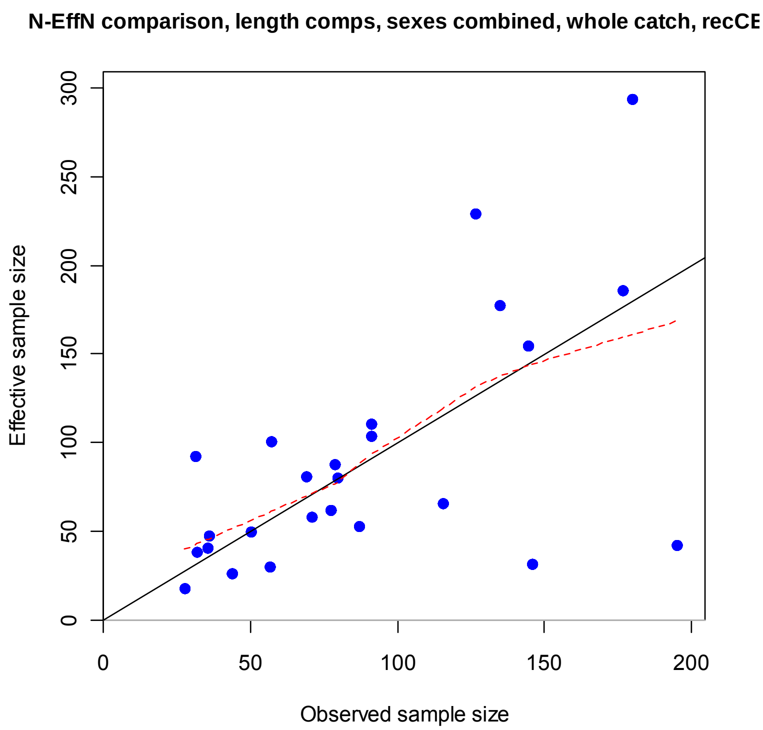
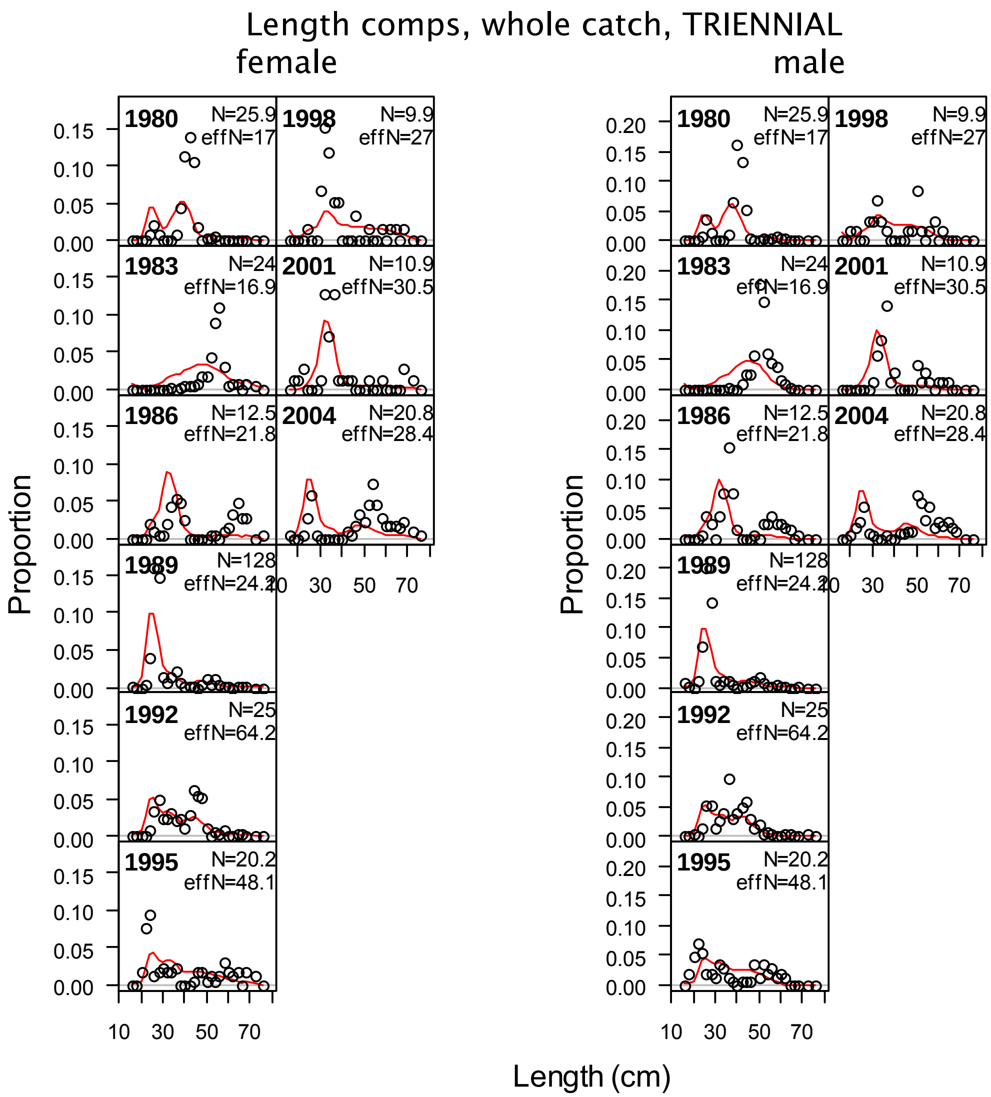


Figure 73a. Fits to combined sex length frequency data for the central California recreational fishery.

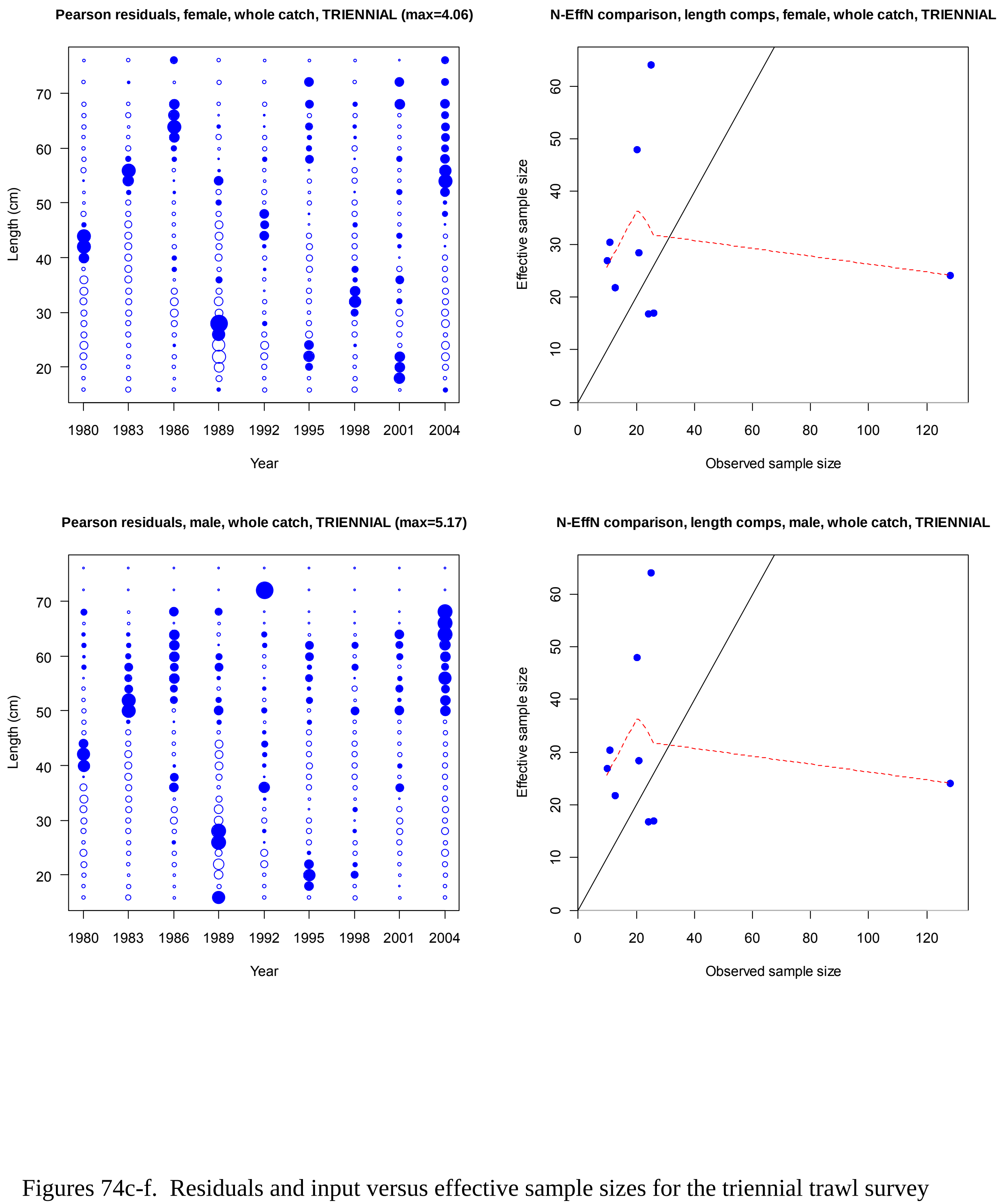




Figures 73b-c. Residuals and input versus effective sample sizes for the central California recreational fishery.



Figures 74a-b. Fits to female and male length frequency data for the triennial trawl survey.



Figures 74c-f. Residuals and input versus effective sample sizes for the triennial trawl survey length frequency data.

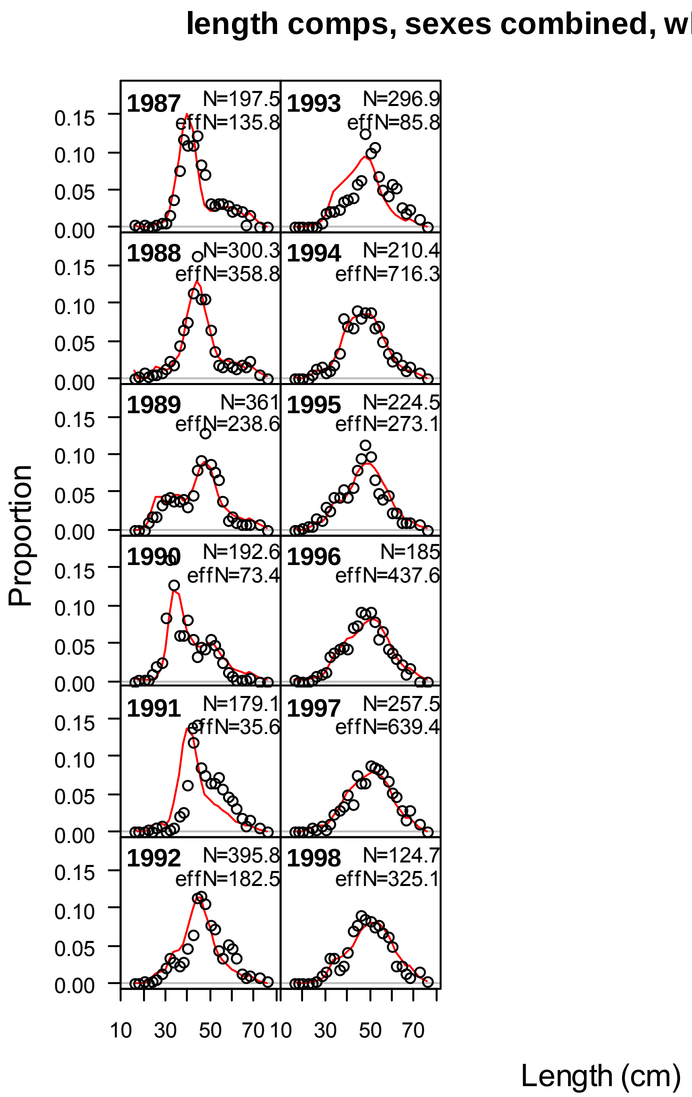


Figure 75a. Fits to combined sex length frequency data for the CDFG CPFV CPUE index.

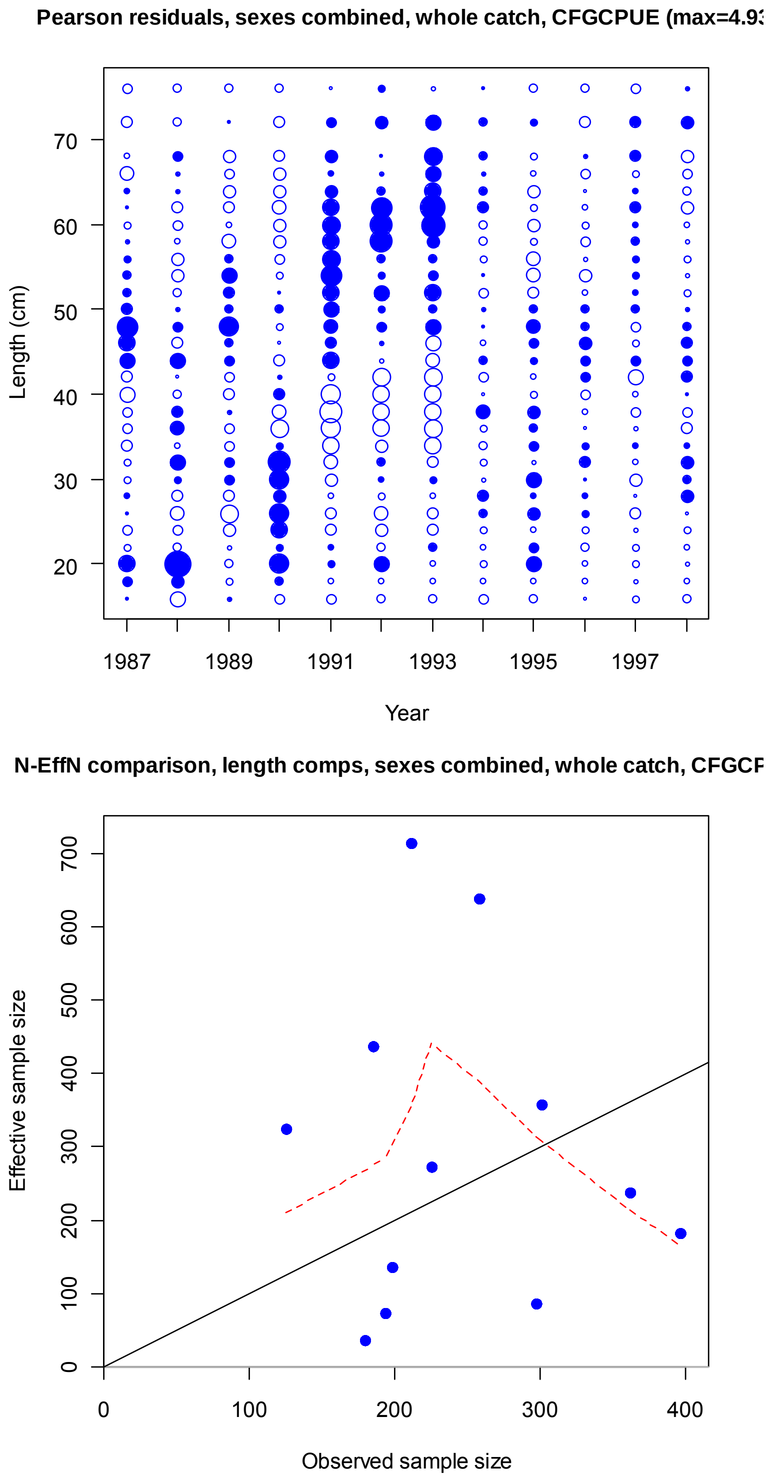
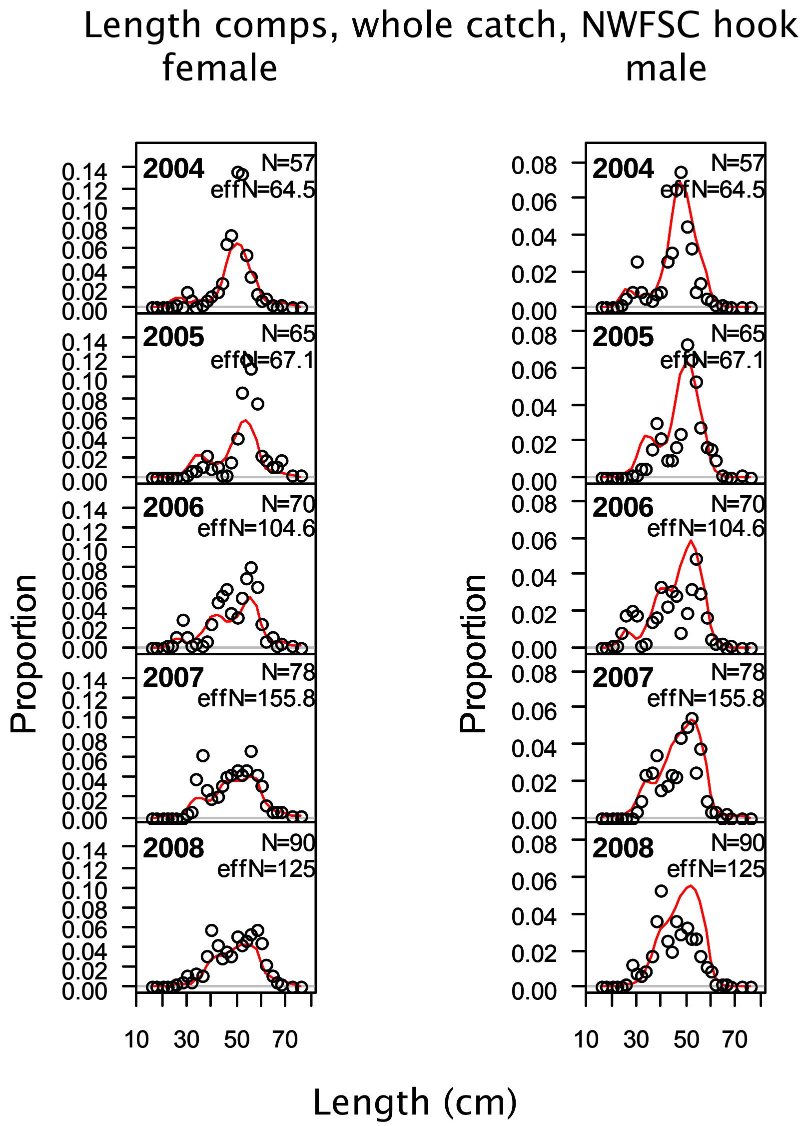
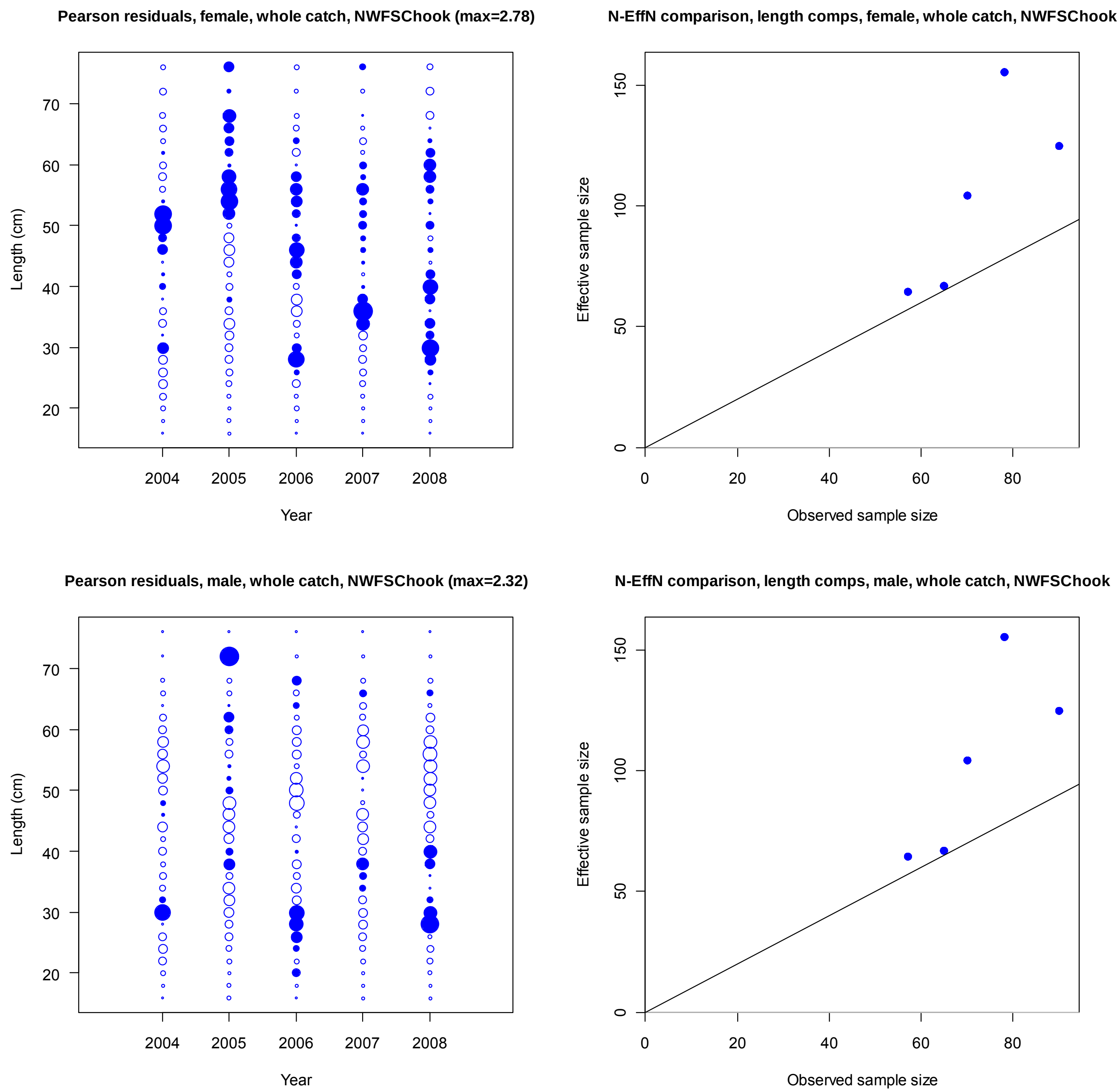


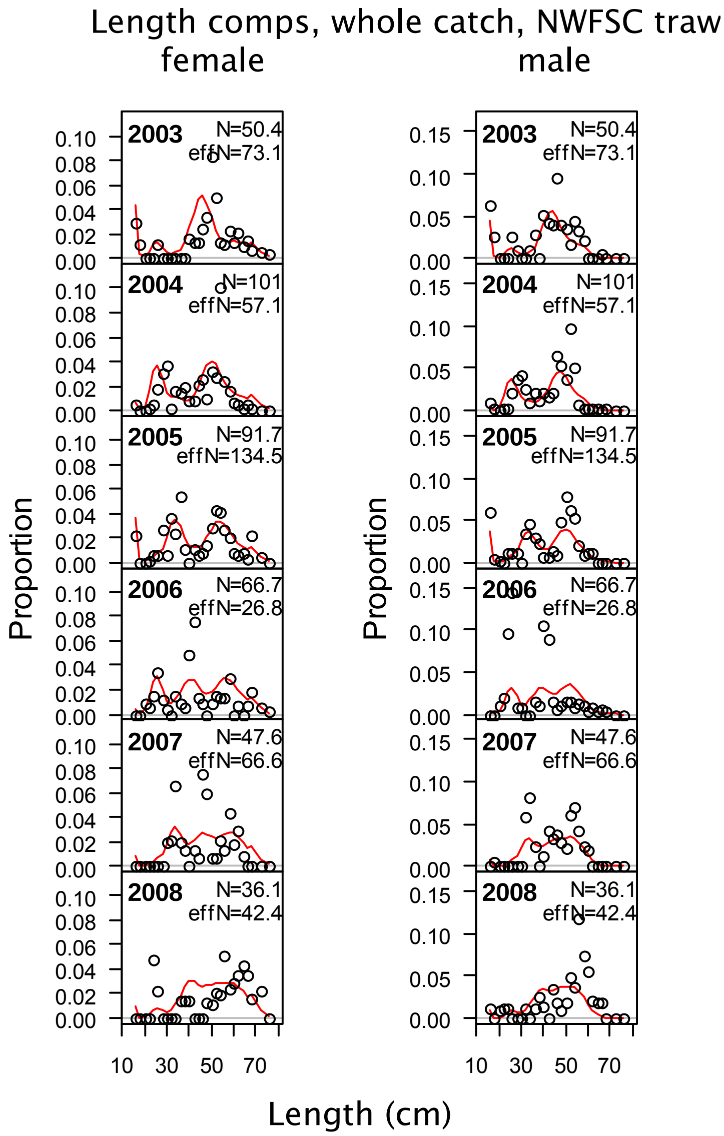
Figure 75b-c. Residuals and input versus effective sample sizes for CPFV survey.



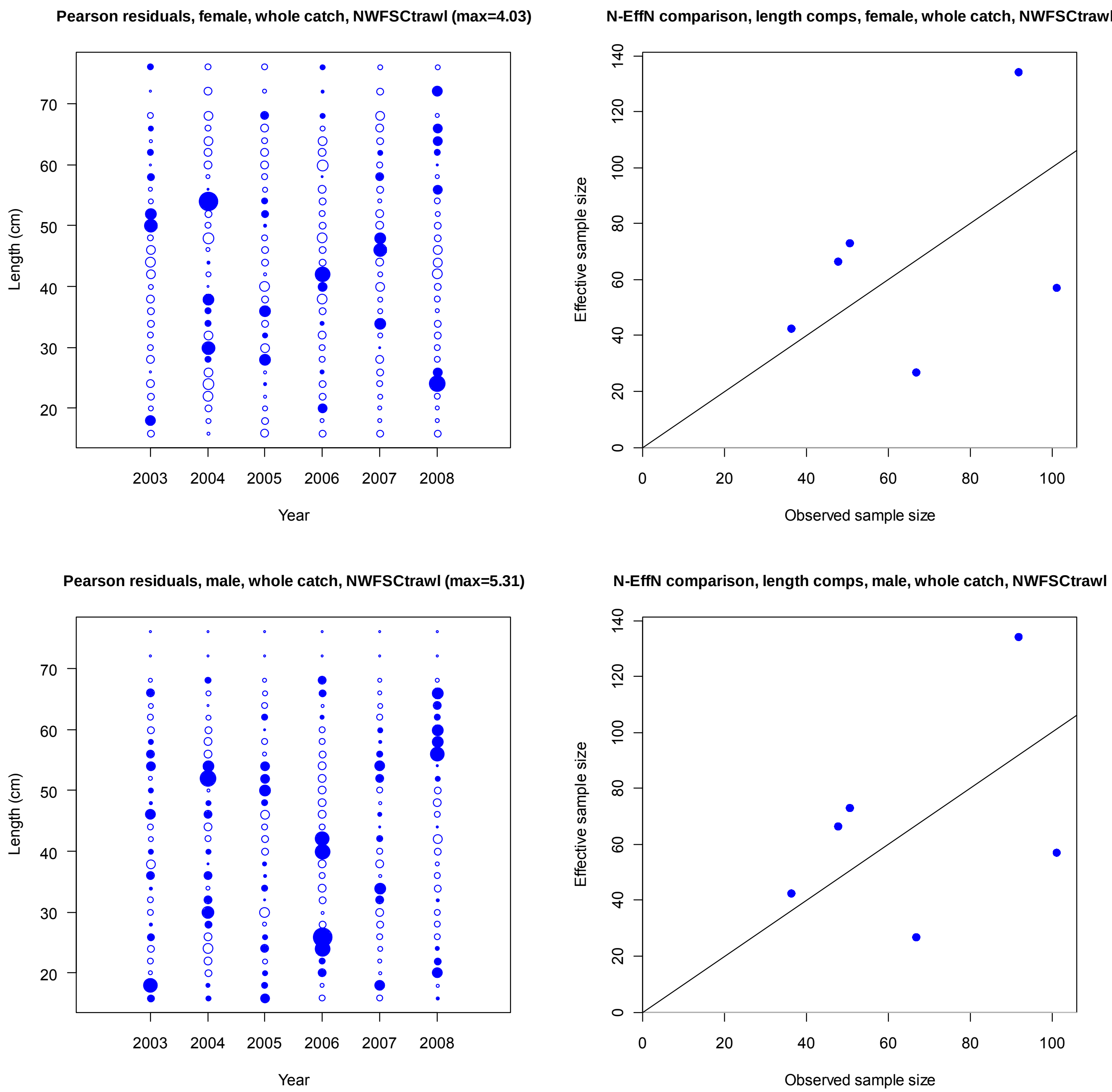
Figures 76a-b. Fits to sex-specific length frequency data for the CDFG CPFV CPUE index.



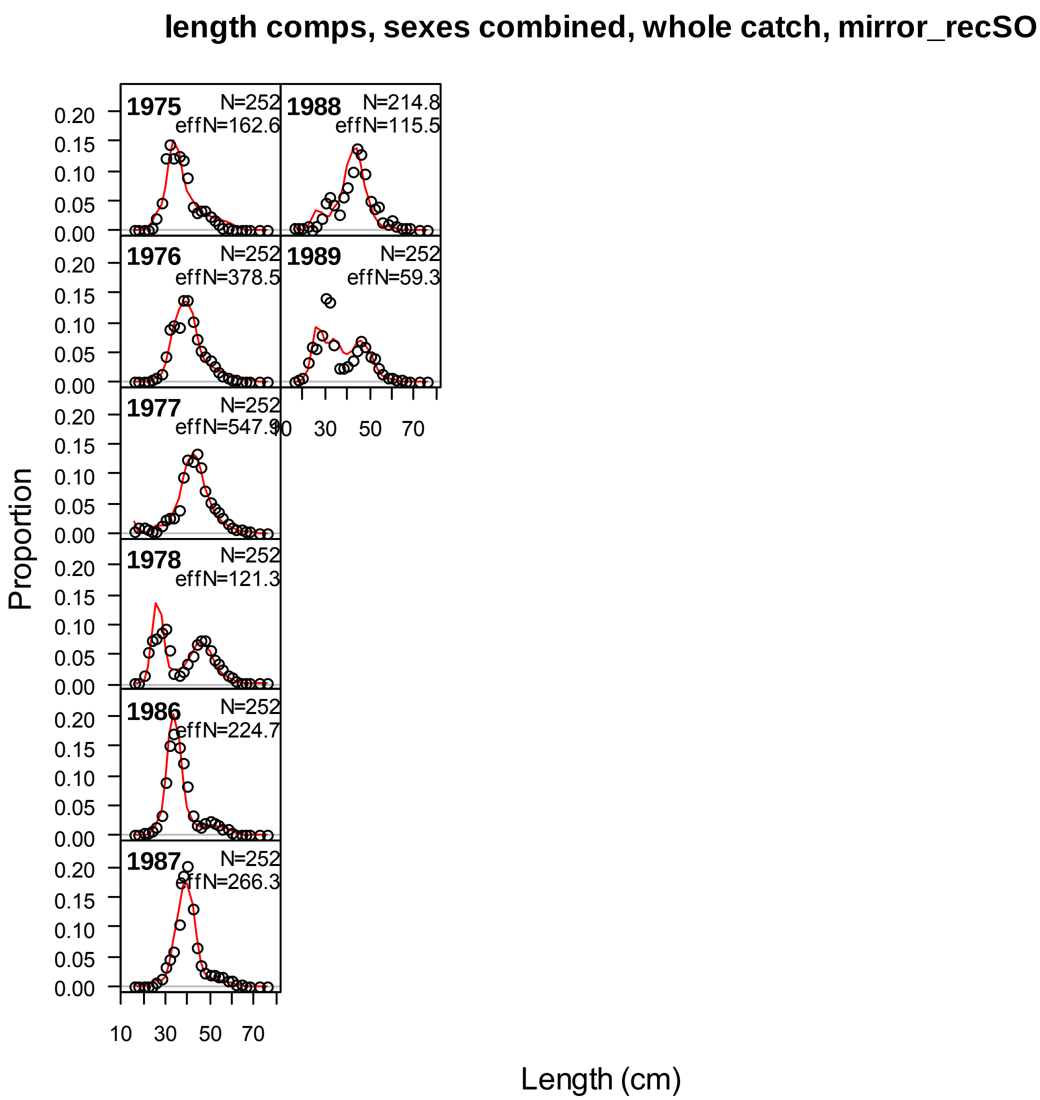
Figures 76c-f. Residuals and input versus effective sample sizes for the CPFV survey length frequency data.



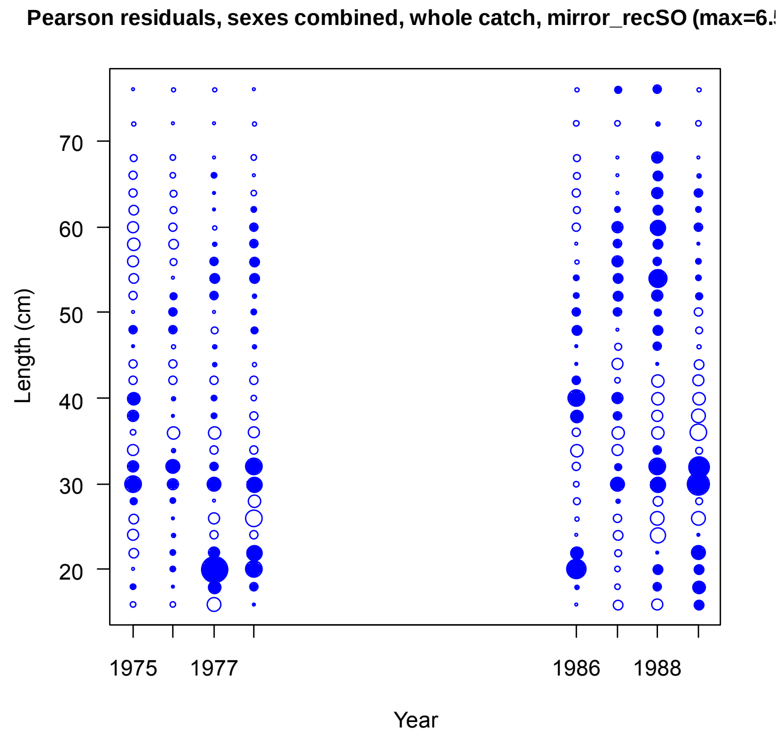
Figures 77a-b. Residuals and input versus effective sample sizes for the NWFSC combined trawl survey.

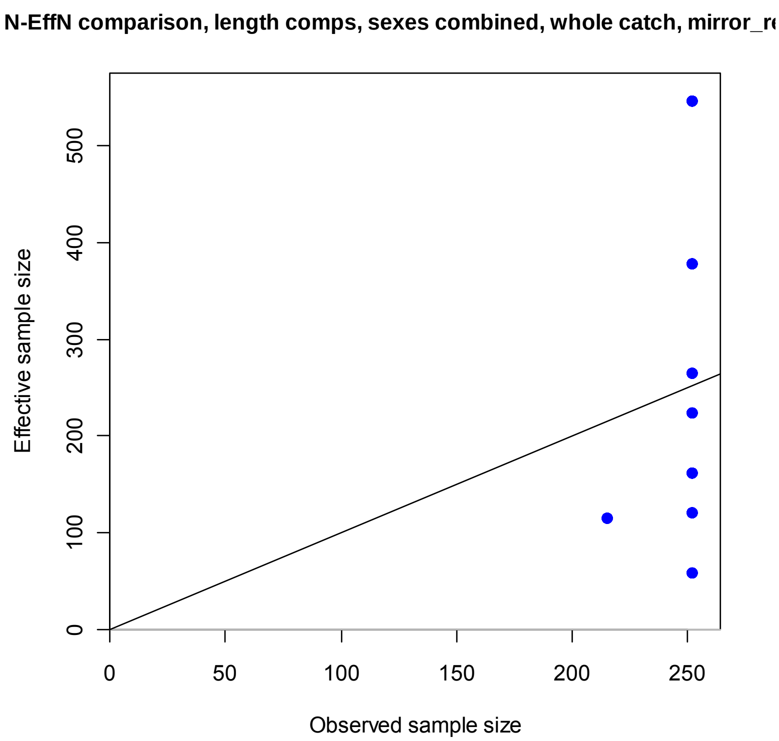


Figures 77c-f. Fits to sex-specific length frequency data for the NWFSC combined trawl survey.

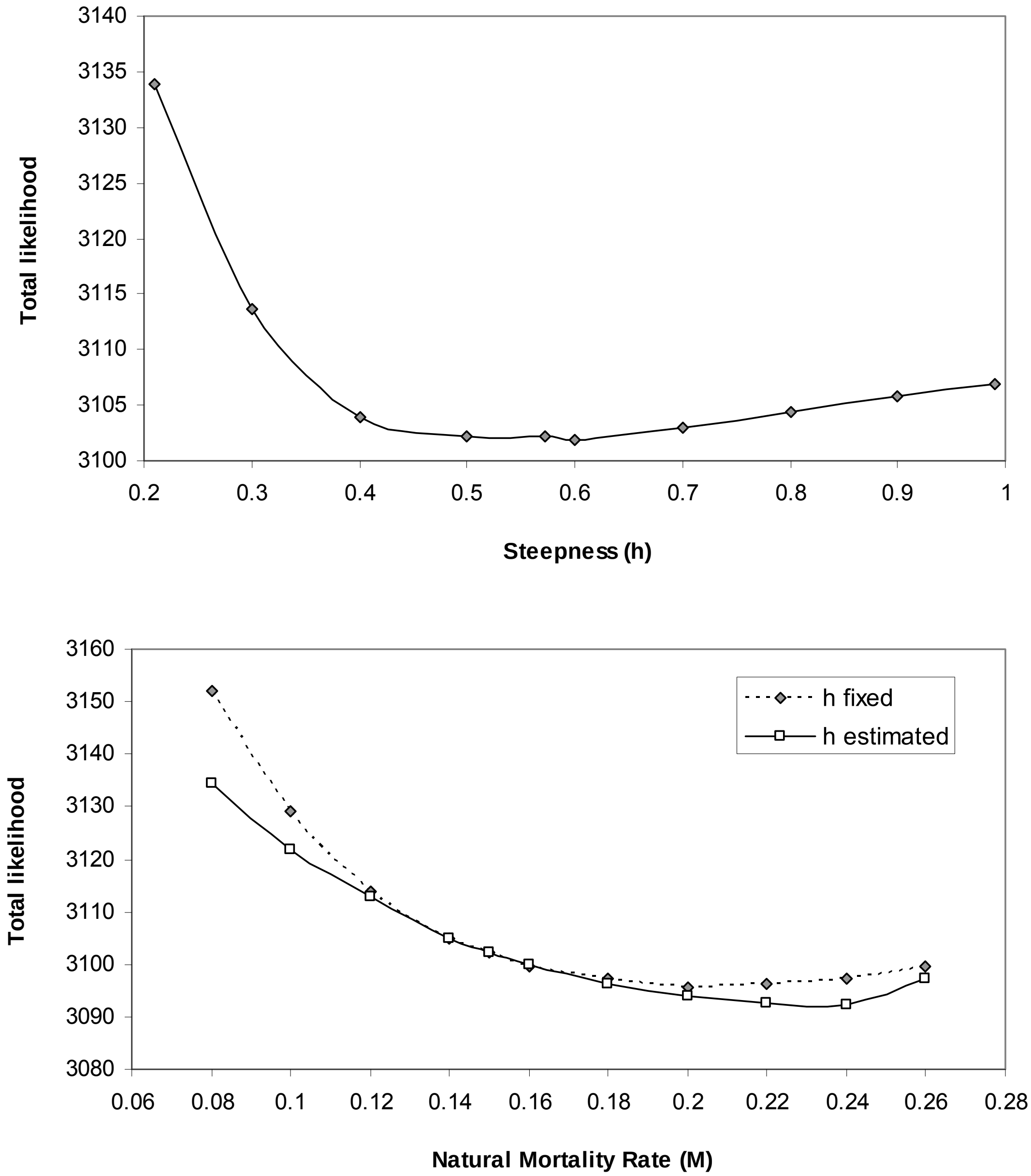


Figures 78a. Residuals and input versus effective sample sizes for the southern CPFV observer LF data

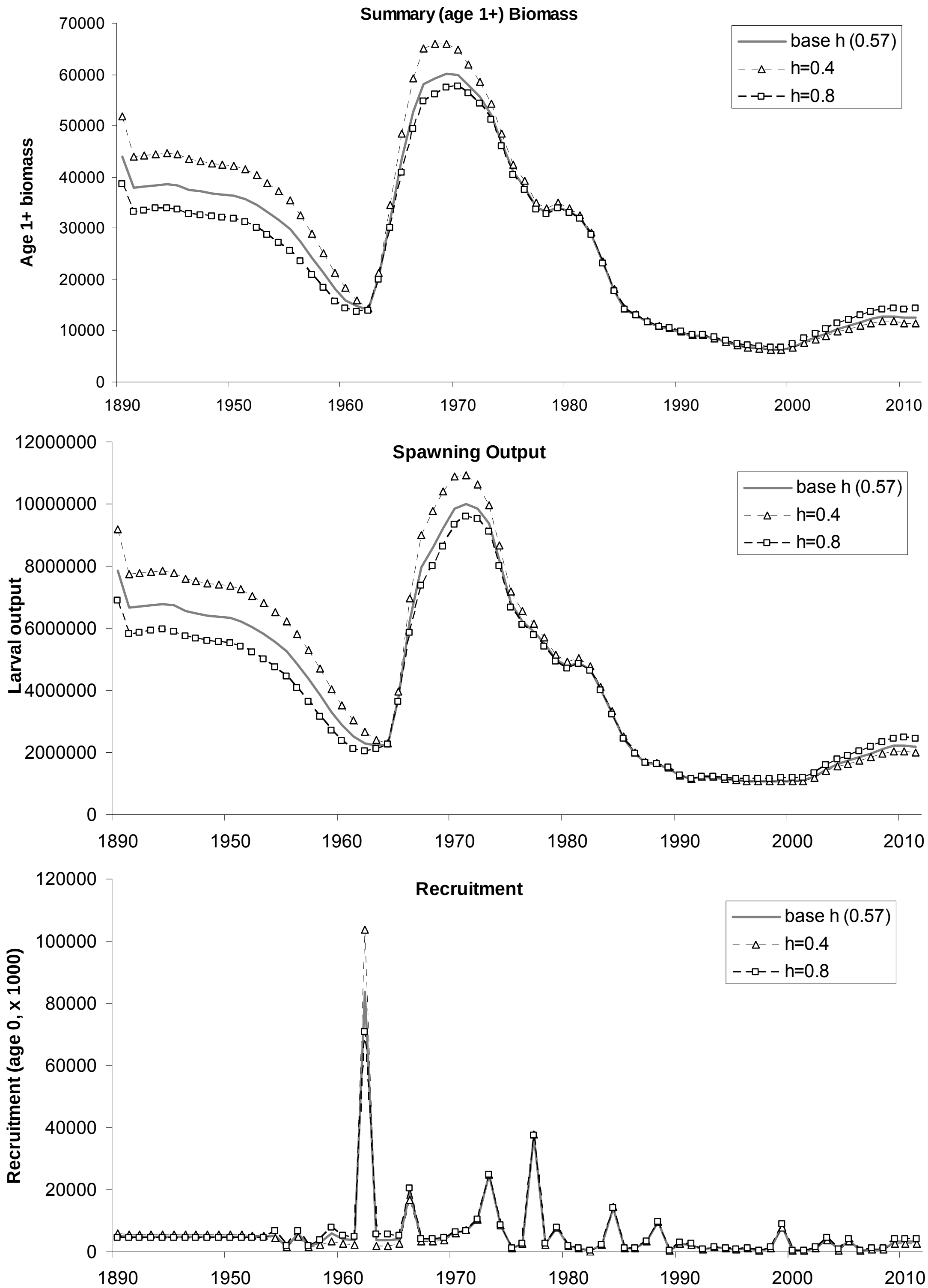




Figures 78b-c. Fits to sex-specific length frequency data for the Southern California CPFV observer LF data.



Figures 79a-b. Likelihood profiles over varying fixed values of steepness (h) and natural mortality (M).



Figures 80a-c. Model trajectories with varying values of steepness (h).

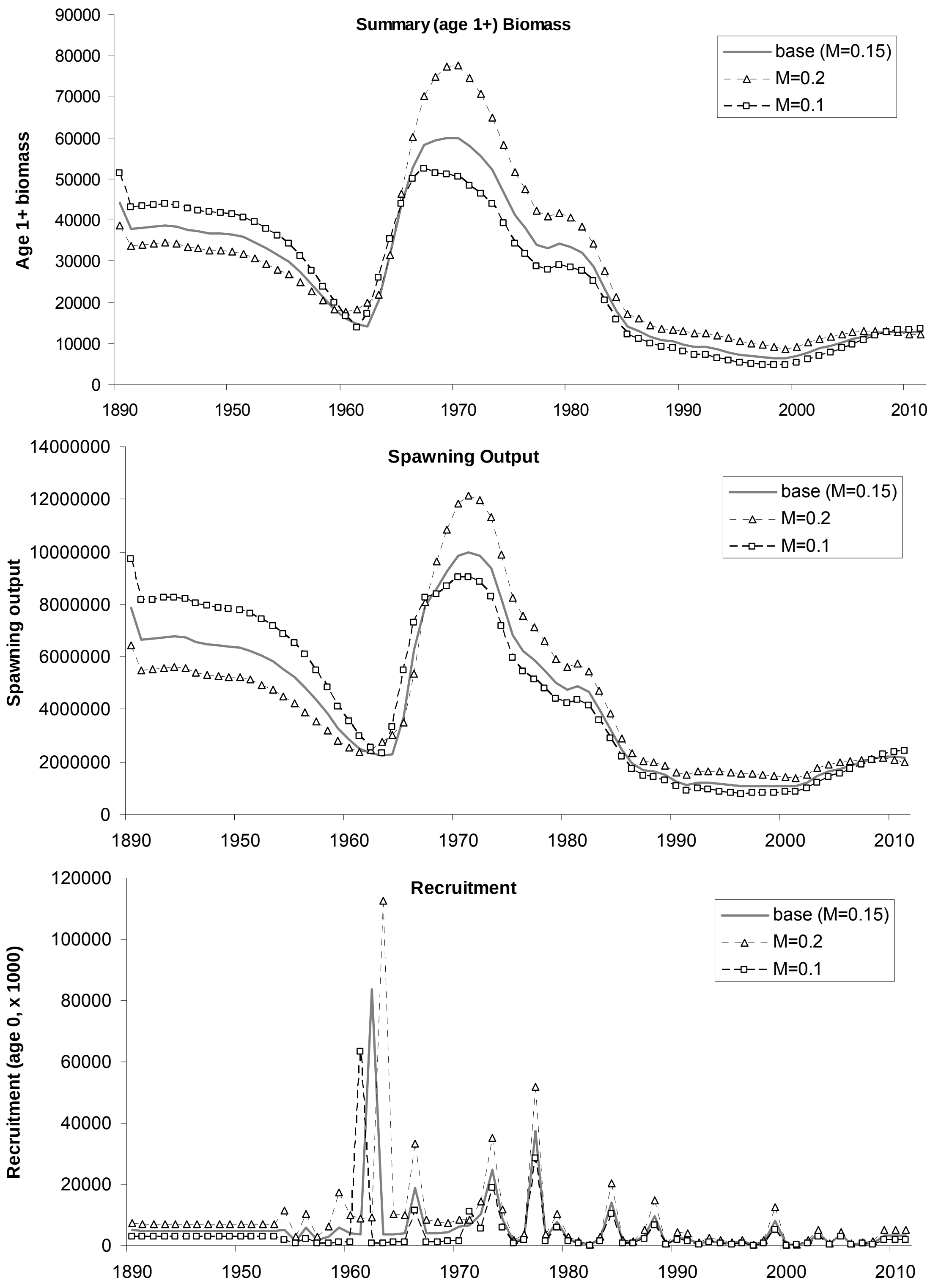
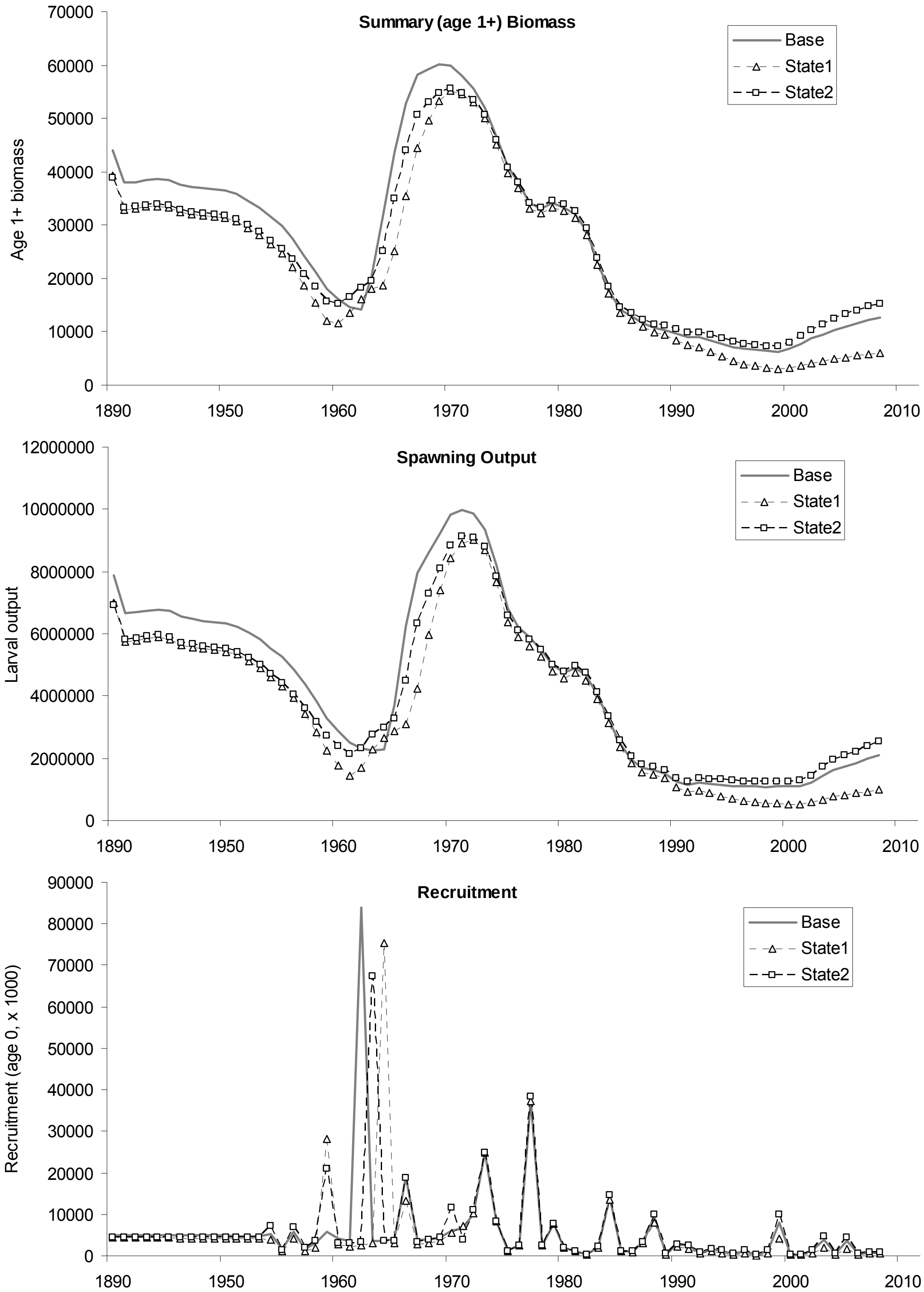
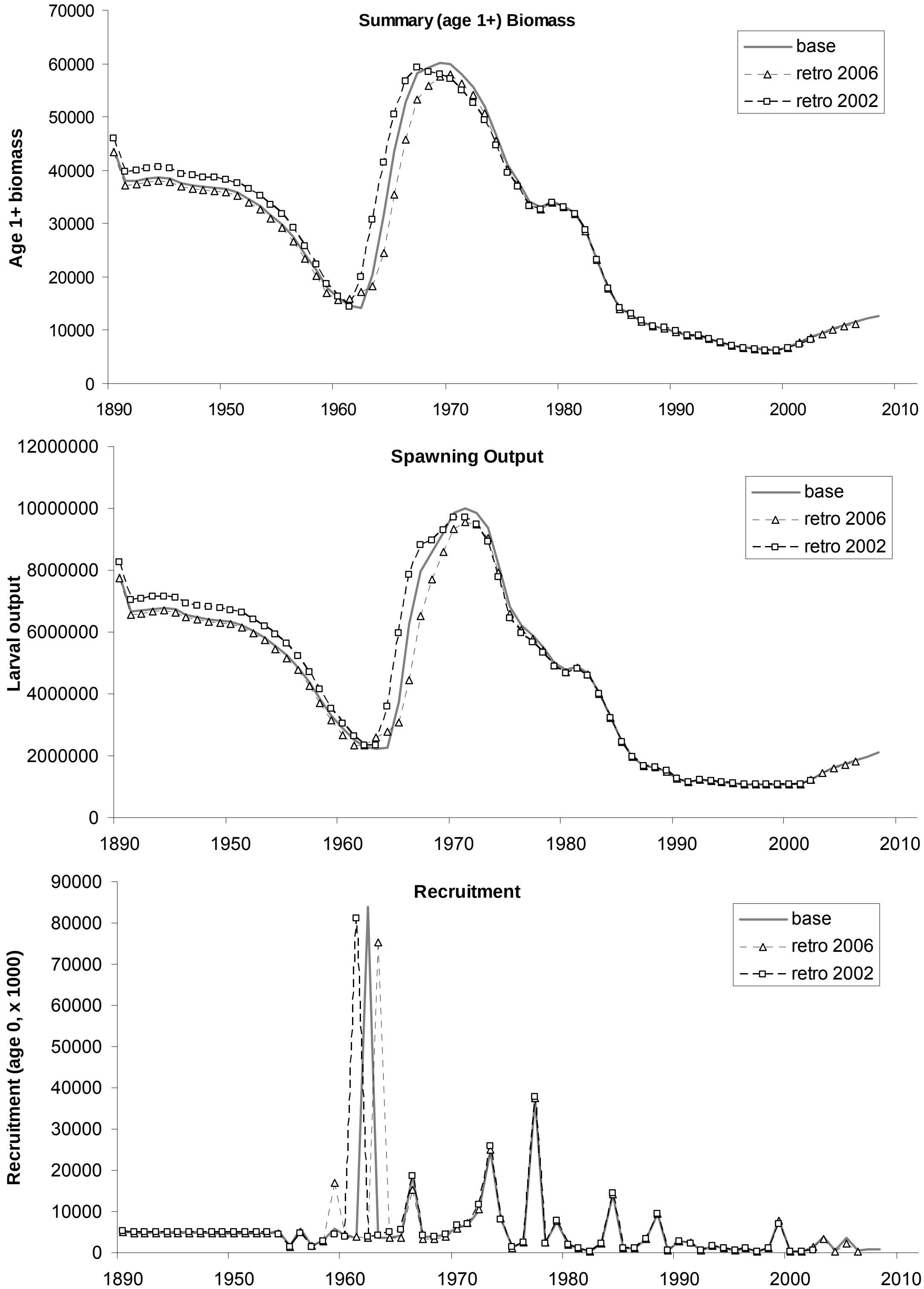


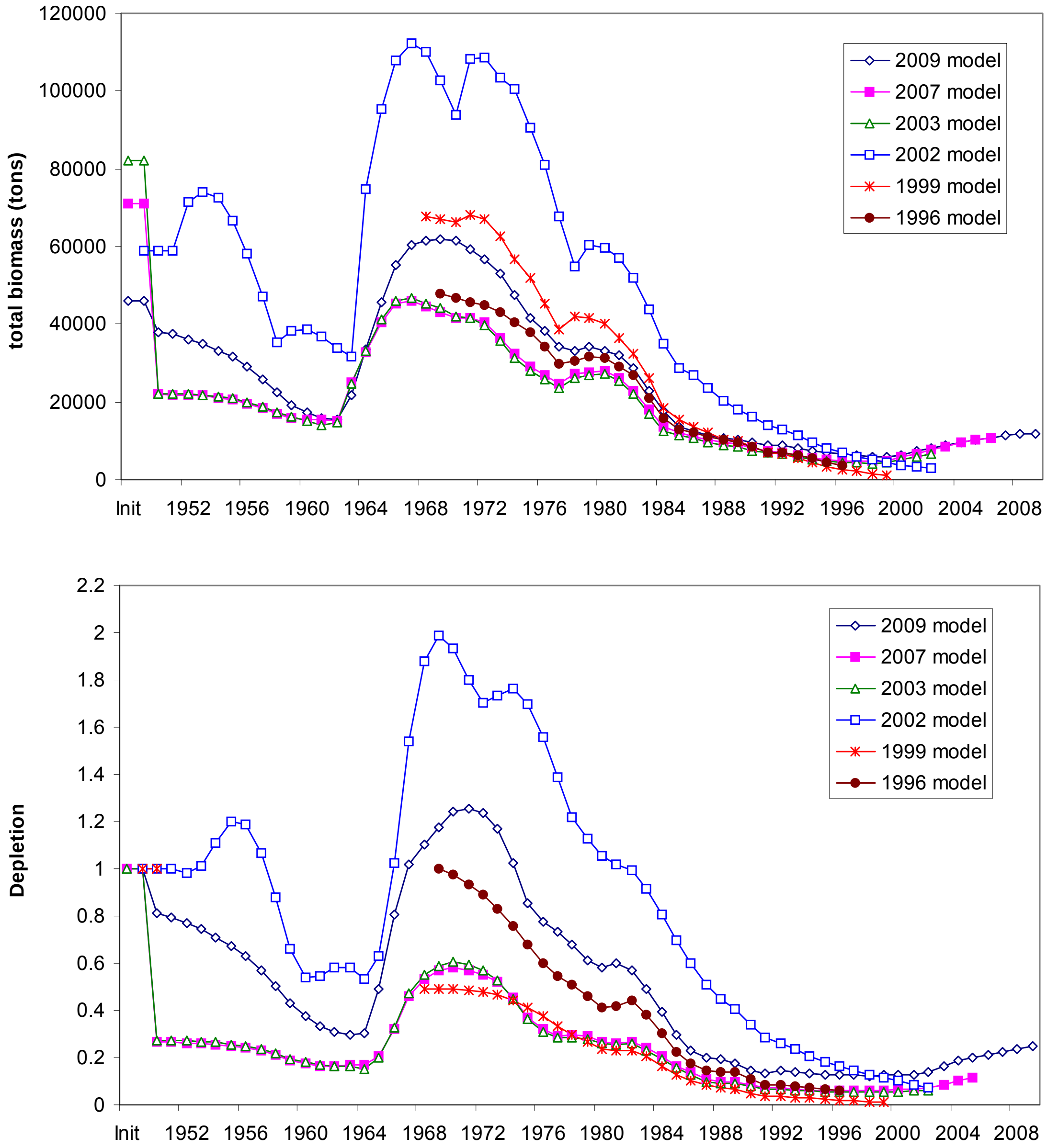
Figure 81a-c. Model trajectories with varying values of natural mortality (M).



Figures 82a-c. Model trajectories with the two possible states of nature



Figures 83a-c. Model trajectories with the restrospective analysis



Figures 84a-b. Comparison of the base model from this assessment with past assessments (note that the 1996 model did not estimate an "unfished" biomass, thus the resulting "depletion" for that model is not a fair comparison to more recent models).

Bocaccio Draft Assessment: Appendix A. SS3 files for the base model (all files in SS3 version 3.03 format).

Starter File

```
#C starter comment here
Bocstar85.dat
Bocstar85.ctl
0   # 0=use init values in control file; 1=use ss3.par (takes last run's estimates as starting- much faster!!!)
0 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
0 # write detailed checkup.sso file (0,1)
0 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
3 # Number of bootstrap datafiles to produce
7 # Turn off estimation for parameters entering after this phase
10 # MCMC burn interval
2 # MCMC thin interval
#0.001 # jitter initial parm value by this fraction
0  # jitter off
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values
# 1973 1976
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
0.25 # Fraction (X) for Depletion denominator (e.g. 0.4)
3 # (1-SPR)_reporting:  0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-SPR_Btarget); 4=notrel
1 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)
3 # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt
999 # check value for end of file
```

Data File

```
#_bootstrap file: 1
1892 #_styr
2008 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
6 #_Nfleet
10 #_Nsurveys
1 #_N_areas
trawlsou%H&L%setnet%recSO%recCEN%trawlnor%CalCOFI%TRIENNIAL%CFGCPUE%NWFSChook%NWFSCtrawl%juv
enile%pier_juv%60sLFs%free1%mirror_recSO
0.5 0.5 0.5 0.5 0.5 0.5 0.1 0.5 0.5 0.78 0.66 0.5 0.75 0.5 0.5 0.5 #_surveytiming_in_season
# SCB hook and line, and NWFSC combo based on Julian days
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 1 1 1 1 #_units of catch:  1=bio; 2=num
0.01 0.01 0.01 0.01 0.01 0.01 #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
2 #_Ngenders
21 #_Nages
0	152.72	0	0	0   0	#_init_equil_catch_for_each_fishery
117 #_N_lines_of_catch_to_read
#_catch_biomass(mtons):_columns_are_fisheries,year,season
```

#TWL	HKL	NET	RecSou	RecNor	ORWA_all	year	season
0	166.77	0	0	0	0	1892	1
0	157.4	0	0	0	0	1893	1
0	148.03	0	0	0	0	1894	1
0	138.66	0	0	0	0	1895	1
0	130.93	0	0	0	0	1896	1
0	123.2	0	0	0	0	1897	1
0	115.47	0	0	0	0	1898	1
0	107.73	0	0	0	0	1899	1
0	119.2	0	0	0	0	1900	1
0	130.66	0	0	0	0	1901	1
0	142.12	0	0	0	0	1902	1
0	153.59	0	0	0	0	1903	1
0	165.05	0	0	0	0	1904	1
0	176.36	0	0	0	0	1905	1
0	187.68	0	0	0	0	1906	1
0	198.99	0	0	0	0	1907	1
0	210.3	0	0	0	0	1908	1
0	236.64	0	0	0	0	1909	1
0	262.98	0	0	0	0	1910	1
0	289.32	0	0	0	0	1911	1
0	315.66	0	0	0	0	1912	1
0	342	0	0	0	0	1913	1
0	368.34	0	0	0	0	1914	1
0	394.68	0	0	0	0	1915	1
54.77	418.96	0	0	0	0.160	1916	1
85.57	661.43	0	0	0	0.320	1917	1
96.66	701.13	0	0	0	0.720	1918	1
66	463.1	0	0	0	0.160	1919	1
67.82	482.28	0	0	0	0.220	1920	1
56.38	406.03	0	0	0	0.330	1921	1
49.37	367.12	0	0	0	0.250	1922	1
55.07	434.14	0	0	0	0.080	1923	1
36.97	405.15	0	0	0	0.270	1924	1
29.85	474.63	0	0	0	0.870	1925	1
83.2	627.09	0	0	0	0.810	1926	1
111.29	497.26	0	0	0	1.500	1927	1
150.62	482.9	0	1.99	2.39	1.210	1928	1
119.43	441.16	0	3.99	4.79	28.040	1929	1

135.62	551	0	5.99	5.51	16.700	1930	1
45.59	578.08	0	7.99	7.34	49.580	1931	1
68.87	430.61	0	9.99	9.18	37.280	1932	1
89.53	257.34	0	11.98	11.02	59.260	1933	1
108.88	316.57	0	13.98	12.85	41.380	1934	1
90.51	369.17	0	15.98	14.69	43.190	1935	1
107.86	473.58	0	15.98	16.53	17.690	1936	1
91.98	408.44	0	27.51	19.59	41.130	1937	1
76.46	295.45	0	22.18	19.27	47.540	1938	1
49.95	200.11	0	19.63	16.85	86.170	1939	1
45.57	238.49	0	14.07	24.27	59.720	1940	1
32.44	187.35	0	13	22.43	53.070	1941	1
7.9	72.1	0	6.91	11.91	25.550	1942	1
7.56	70.44	0	6.6	11.39	196.130	1943	1
2.94	83.63	0	5.42	9.35	635.220	1944	1
55.17	127.08	0	7.23	12.47	1211.050	1945	1
111.53	122.33	0	12.45	21.47	611.940	1946	1
5.57	198.21	0	37.32	16.99	631.600	1947	1
81.94	150.23	0	102.08	33.9	397.440	1948	1
94	176.56	0	132.83	43.94	380.480	1949	1
303.66	327.61	0	156.82	53.55	374.730	1950	1
765.29	262.44	0	135.78	63.17	532.060	1951	1
1310.96	180.88	0	151.62	54.97	268.000	1952	1
1678.25	70.2	0	171.23	46.81	304.510	1953	1
1597.98	89.11	0	410.71	58.19	245.780	1954	1
1764.99	122.87	0	760.57	69.38	334.950	1955	1
2006.22	299.57	0	917.14	77.46	349.930	1956	1
2219.46	271.26	0	529.88	76.8	468.870	1957	1
2459.84	213.5	0	301.14	123.49	482.050	1958	1
2062.66	125.38	0	177.61	102.75	378.690	1959	1
1731.86	92.91	0	185.13	81.26	344.610	1960	1
1297.35	80.89	0	211.89	68.5	265.670	1961	1
1147.09	68.25	0	204.46	80.38	230.360	1962	1
1314.09	85.06	0	194.38	88.71	326.220	1963	1
942.79	70.17	0	244.36	74.98	190.470	1964	1
965.94	81.03	0	319.14	106.55	273.070	1965	1
2410.23	129.52	0	564.3	118.21	196.070	1966	1
4036.28	117.9	0	770.19	111.44	294.710	1967	1
1996.47	80.71	0	832.18	103.9	391.890	1968	1
1132.64	78.02	17.41	785	110.52	223.000	1969	1
1341.14	82.39	15.06	1039.41	117.87	250.090	1970	1
961.36	81.56	58.73	966.96	104.45	323.740	1971	1
1648.11	122.56	70.95	1308.7	123.08	379.600	1972	1
4537.05	151.53	167.3	1510.62	186.09	648.420	1973	1
5956.32	164.1	261.65	1892.59	200.89	525.550	1974	1
3316.02	158.13	285.36	1865.23	200.29	578.560	1975	1
3424.73	218.88	123.1	1489.03	215.7	705.480	1976	1
2381.4	188.75	158.08	1265.09	193.57	673.610	1977	1
1878.87	247.93	124.75	1174.03	195.63	745.440	1978	1
3299.31	351.15	235.32	1713.94	230.22	286.170	1979	1
3054.87	320.49	215.88	942.92	264.04	586.080	1980	1
1779.75	312.34	353.03	908.12	234.52	2164.520	1981	1
2323.84	392.92	387.01	1225.49	371.85	1897.440	1982	1
1914.02	238.56	588.49	265.96	310.65	2280.140	1983	1
1891.75	367.29	547.07	181.6	67.14	1621.380	1984	1
582.41	143.01	1091.66	324.48	67.93	654.150	1985	1
789.66	258.99	1085.78	433.75	175.84	376.540	1986	1
650.4	277.14	967.86	91.7	106.14	555.370	1987	1
590	496.55	371.48	106.54	44.32	695.430	1988	1
594.21	362.92	981.88	182.16	81.71	553.310	1989	1
681.56	458.67	793.27	160.27	68.02	462.620	1990	1
498.36	266.28	457.6	160.27	68.02	263.310	1991	1

362.09	468.03	640.31	160.27	68.02	133.250	1992	1
358.87	417.33	430.18	115.71	68.02	202.860	1993	1
377.01	193.06	262.64	243.9	68.02	149.530	1994	1
215.41	56.74	281.15	34.24	68.02	162.450	1995	1
225.84	66.23	91.83	68.36	32.22	62.910	1996	1
136.26	53.37	34.94	68.71	111.26	93.850	1997	1
41.16	39.38	39.21	33.53	25.87	31.970	1998	1
19.01	20.68	7.18	80.06	60.21	25.980	1999	1
13.48	7.01	0.73	58.24	74.42	6.570	2000	1
9.21	7.82	0.88	62.68	53.84	4.440	2001	1

total mortality reports- NWFSC total mort report for com fisheries 2002-2007
based on J. Budrick data for rec. fisheries 2004-2007, and scorecard estimates for all 2008 fisheries

#trl_s	hk_ln	setnet	Rec_S	Rec_N	trawl north		
28.04	0.13	0.01	35.88	4.93	20.67	2002	1
5.07	0	0	5.53	1.87	0.31	2003	1
13.86	1.84	0.21	63.43	2.27	3.52	2004	1
24.64	1.5	0.17	69.9	10.7	0.43	2005	1
16.09	2.25	0.25	29	11.8	0.31	2006	1
4.06	3.39	0.38	44.2	8.92	1.58	2007	1
28.73	13.4	0.5	30.3	3.59	1.58	2008	1

178 #_N_cpue_and_surveyabundance_observations
#_year seas index obs se(log)

1982	1	1	166.4	0.32	#areaweightedCPUEfromRalston
1983	1	1	73.1	0.32	#areaweightedCPUEfromRalston
1984	1	1	72.3	0.32	#areaweightedCPUEfromRalston
1985	1	1	30.7	0.32	#areaweightedCPUEfromRalston
1986	1	1	31.2	0.32	#areaweightedCPUEfromRalston
1987	1	1	44.4	0.32	#areaweightedCPUEfromRalston
1988	1	1	51.6	0.32	#areaweightedCPUEfromRalston
1989	1	1	35.8	0.32	#areaweightedCPUEfromRalston
1990	1	1	37.1	0.32	#areaweightedCPUEfromRalston
1991	1	1	26.9	0.32	#areaweightedCPUEfromRalston
1992	1	1	20.4	0.32	#areaweightedCPUEfromRalston
1993	1	1	19.7	0.32	#areaweightedCPUEfromRalston
1994	1	1	23.9	0.32	#areaweightedCPUEfromRalston
1995	1	1	15.2	0.32	#areaweightedCPUEfromRalston
1996	1	1	8.7	0.32	#areaweightedCPUEfromRalston

1980	1	4	3.401	0.071906949	#MRFsoCAL
1981	1	4	3.447	0.059646908	#MRFsoCAL
1982	1	4	3.173	0.073301426	#MRFsoCAL
1983	1	4	1.318	0.081365149	#MRFsoCAL
1984	1	4	1.034	0.084548676	#MRFsoCAL
1985	1	4	2.224	0.091706845	#MRFsoCAL
1986	1	4	1.91	0.105307369	#MRFsoCAL
1987	1	4	0.275	0.448819689	#MRFsoCAL
1988	1	4	0.169	0.387042386	#MRFsoCAL
1989	1	4	0.997	0.137842628	#MRFsoCAL
1993	1	4	1.631	0.255474245	#MRFsoCAL
1994	1	4	1.732	0.142670896	#MRFsoCAL
1995	1	4	0.448	0.358378941	#MRFsoCAL
1996	1	4	0.246	0.203184778	#MRFsoCAL
1997	1	4	0.395	0.38023361	#MRFsoCAL
1998	1	4	0.234	0.202021118	#MRFsoCAL
1999	1	4	0.566	0.091309348	#MRFsoCAL
2000	1	4	1.098	0.086438291	#MRFsoCAL
2001	1	4	1.28	0.113037949	#MRFsoCAL
2002	1	4	2.01	0.08355396	#MRFsoCAL

1980	1	5	0.917	0.118186092	#MRFnorth
1981	1	5	1.28	0.170552193	#MRFnorth
1982	1	5	1.326	0.131232941	#MRFnorth
1983	1	5	1.377	0.143163299	#MRFnorth
1984	1	5	0.388	0.126294711	#MRFnorth
1985	1	5	0.75	0.081166137	#MRFnorth
1986	1	5	1.39	0.07061189	#MRFnorth
1987	1	5	0.914	0.154768554	#MRFnorth
1988	1	5	0.294	0.1734864	#MRFnorth
1989	1	5	0.457	0.157321533	#MRFnorth
1993	1	5	0.202	0.345617372	#MRFnorth
1994	1	5	0.351	0.236456026	#MRFnorth
1995	1	5	0.482	0.197847986	#MRFnorth
1996	1	5	0.535	0.099354307	#MRFnorth
1997	1	5	0.42	0.125405334	#MRFnorth
1998	1	5	0.432	0.14513239	#MRFnorth
1999	1	5	0.802	0.066825326	#MRFnorth
2000	1	5	1.961	0.089420947	#MRFnorth
2001	1	5	2.022	0.115414586	#MRFnorth
2002	1	5	2.618	0.162618942	#MRFnorth

1951	1	7	0.80433779	0.2598427	#CalCOFIindex
1952	1	7	0.81633209	0.2195144	#CalCOFIindex
1953	1	7	1.07678184	0.1940405	#CalCOFIindex
1954	1	7	1.50849605	0.1584493	#CalCOFIindex
1955	1	7	1.21963136	0.1809103	#CalCOFIindex
1956	1	7	0.76244861	0.2581162	#CalCOFIindex
1957	1	7	1.62809823	0.2087456	#CalCOFIindex
1958	1	7	1.24526196	0.1865469	#CalCOFIindex
1959	1	7	0.40285729	0.2042333	#CalCOFIindex
1960	1	7	0.58397297	0.1791704	#CalCOFIindex
1961	1	7	0.69494994	0.2838339	#CalCOFIindex
1962	1	7	0.60138636	0.2459703	#CalCOFIindex
1963	1	7	0.99195987	0.2476998	#CalCOFIindex
1964	1	7	0.60958227	0.2540632	#CalCOFIindex
1965	1	7	0.80379947	0.2151925	#CalCOFIindex
1966	1	7	1.50196417	0.176161	#CalCOFIindex
1967	1	7	0.77217846	0.3476226	#CalCOFIindex
1968	1	7	2.70216315	0.2621446	#CalCOFIindex
1969	1	7	2.48439648	0.1406889	#CalCOFIindex
1970	1	7	0.75751541	0.4996026	#CalCOFIindex
1972	1	7	1.91939638	0.1446257	#CalCOFIindex
1975	1	7	2.06196014	0.1505552	#CalCOFIindex
1976	1	7	2.82888545	0.3382743	#CalCOFIindex
1978	1	7	1.04644442	0.212615	#CalCOFIindex
1981	1	7	0.96993804	0.2252523	#CalCOFIindex
1983	1	7	0.30179688	0.4327933	#CalCOFIindex
1984	1	7	1.00486872	0.2092068	#CalCOFIindex
1985	1	7	0.30053381	0.4627507	#CalCOFIindex
1986	1	7	0.42943603	0.4951728	#CalCOFIindex
1987	1	7	0.96144504	0.3670375	#CalCOFIindex
1988	1	7	0.72857066	0.2582412	#CalCOFIindex
1989	1	7	0.7744805	0.3958791	#CalCOFIindex
1990	1	7	0.49987268	0.3798154	#CalCOFIindex
1991	1	7	0.73391207	0.2941416	#CalCOFIindex
1992	1	7	0.7299093	0.2747813	#CalCOFIindex
1993	1	7	0.18050422	0.5705712	#CalCOFIindex
1994	1	7	0.26724335	0.3022706	#CalCOFIindex
1995	1	7	0.11122682	0.751706	#CalCOFIindex
1996	1	7	1.32795399	0.3012392	#CalCOFIindex
1997	1	7	0.28505355	0.3717163	#CalCOFIindex

1998	1	7	0.09616612	0.5342902	#CalCOFIindex
1999	1	7	0.27960981	0.451355 #CalCOFIindex	
2000	1	7	0.22851335	0.4078098	#CalCOFIindex
2001	1	7	0.11120509	0.4290012	#CalCOFIindex
2002	1	7	0.47653658	0.3639474	#CalCOFIindex
2003	1	7	0.52081887	0.2688129	#CalCOFIindex
2004	1	7	0.58379475	0.3752357	#CalCOFIindex
2005	1	7	0.63029617	0.3016986	#CalCOFIindex
2006	1	7	0.62487578	0.3083086	#CalCOFIindex
2007	1	7	0.53908393	0.3259584	#CalCOFIindex
2008	1	7	0.69476869	0.3225698	#CalCOFIindex

1980	1	8	2227.932433	0.149683111	#TRIENNIAL
1983	1	8	1849.416128	0.176692006	#TRIENNIAL
1986	1	8	723.6568073	0.159390796	#TRIENNIAL
1989	1	8	529.7149835	0.143672021	#TRIENNIAL
1992	1	8	319.1654707	0.228586262	#TRIENNIAL
1995	1	8	192.9998349	0.194757645	#TRIENNIAL
1998	1	8	56.92735471	0.301249017	#TRIENNIAL
2001	1	8	121.4857726	0.261983439	#TRIENNIAL
2004	1	8	439.3928644	0.214285691	#TRIENNIAL

1987	1	9	3.545	0.161148115	#VandenbergCPUE
1988	1	9	2.349	0.140405176	#VandenbergCPUE
1989	1	9	3.001	0.121154053	#VandenbergCPUE
1990	1	9	6.009	0.14611662	#VandenbergCPUE
1991	1	9	4.637	0.172508578	#VandenbergCPUE
1992	1	9	3.543	0.12570181	#VandenbergCPUE
1993	1	9	2.319	0.131726504	#VandenbergCPUE
1994	1	9	1.46	0.168399042	#VandenbergCPUE
1995	1	9	1.721	0.15083795	#VandenbergCPUE
1996	1	9	1.457	0.169280019	#VandenbergCPUE
1997	1	9	1.823	0.157419694	#VandenbergCPUE
1998	1	9	1.646	0.215088204	#VandenbergCPUE

2004	1	10	0.1673	0.210	#S_Cal_Hook_line
2005	1	10	0.1417	0.227	#S_Cal_Hook_line
2006	1	10	0.1613	0.217	#S_Cal_Hook_line
2007	1	10	0.1445	0.220	#S_Cal_Hook_line
2008	1	10	0.1229	0.2202	#S_Cal_Hook_line

2003	1	11	475	0.24	#	NWFSC Combo survey
2004	1	11	1857	0.23	#	NWFSC Combo survey
2005	1	11	673	0.20	#	NWFSC Combo survey
2006	1	11	1052	0.23	#	NWFSC Combo survey
2007	1	11	998	0.26	#	NWFSC Combo survey
2008	1	11	517	0.26	#	NWFSC Combo survey

2001	1	12	0.40	0.018	# Juvenile index
2002	1	12	0.59	0.018	# Juvenile index
2003	1	12	0.16	0.026	# Juvenile index
2004	1	12	0.39	0.017	# Juvenile index
2005	1	12	0.54	0.024	# Juvenile index
2006	1	12	0.09	0.017	# Juvenile index
2007	1	12	0.21	0.018	# Juvenile index
2008	1	12	0.23	0.018	# Juvenile index

# Pier Index		32	obs	
1954	1	13	0.1	0.832
1955	1	13	0.01	1.085
1956	1	13	0.1	0.832
1957	1	13	0.01	1.085
1958	1	13	0.017	1.539
1966	1	13	0.849	0.74
1980	1	13	0.117	0.564
1981	1	13	0.018	0.712
1982	1	13	0.01	1.085
1983	1	13	0.01	1.085
1984	1	13	0.089	0.566
1985	1	13	0.059	0.609
1986	1	13	0.065	0.547
1987	1	13	0.079	0.539
1988	1	13	0.161	0.384
1989	1	13	0.039	0.897
1993	1	13	0.101	0.557
1994	1	13	0.01	1.085
1995	1	13	0.029	0.86
1996	1	13	0.01	1.085
1997	1	13	0.01	1.085
1998	1	13	0.01	1.085
1999	1	13	0.088	0.667
2000	1	13	0.01	1.085
2001	1	13	0.01	1.085
2002	1	13	0.01	1.085
2003	1	13	0.019	0.71
2004	1	13	0.01	1.085
2005	1	13	0.045	0.775
2006	1	13	0.01	1.085
2007	1	13	0.01	1.085
2008	1	13	0.01	1.085

2 #_discard_type (1=bio or num; 2=fraction)
0 #_N_discard_obs

0 #_N_meanbodywt_obs

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
10 # minimum size in the population (lower edge of first bin and size at age 0.00)
94 # maximum size in the population (lower edge of last bin)

-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
29 #_N_LengthBins
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 72 76

200 #_N_Length_obs

# trawl fishery south of 38			26				currently#fish		Female			
												Male
#Yr	Seas	Flt/Svy	Gender	Part	Stewart, max400		16	18	20	22	24	26
	28	30	32	34	36	38	40	42	44	46	48	50
	52	54	56	58	60	62	64	66	68	72	76	16

	18	20	22	24	26	28	30	32	34	36	38	40
	42	44	46	48	50	52	54	56	58	60	62	64
	66	68	72	76								
1978	1	1	3	0	196.8	0	0	0	0	0	4	20
	40	26	15	8	13	19	20	47	67	54	32	30
	19	26	17	15	12	8	10	6	3	1	0	0
	0	0	0	2	14	13	10	4	10	19	27	48
	80	60	60	23	22	23	17	10	3	4	0	0
	1	0	1									
1979	1	1	3	0	211.7	0	1	0	0	0	3	31
	55	64	75	66	42	27	20	17	29	41	48	52
	36	15	18	15	11	7	3	7	4	2	0	0
	1	0	0	1	4	3	16	26	19	18	12	17
	39	55	70	33	21	24	16	13	5	2	0	0
	1	0	0									
1980	1	1	3	0	244.8	0	0	0	0	0	0	0
	3	2	5	10	33	115	111	65	14	6	16	24
	30	20	17	13	10	11	9	15	6	5	0	0
	0	0	0	1	0	0	1	7	20	63	101	68
	23	23	33	24	27	20	16	7	9	7	1	0
	1	0	0									
1981	1	1	3	0	165	0	0	0	0	0	0	1
	6	7	2	2	4	9	35	87	80	32	8	4
	8	9	12	5	7	4	2	1	2	0	0	0
	0	0	0	0	0	3	3	4	8	6	26	79
	73	27	11	20	14	11	10	5	2	1	1	0
	0	0	0									
1982	1	1	3	0	342	0	0	0	0	0	0	1
	2	6	2	11	37	62	56	52	55	75	91	83
	47	19	18	27	26	20	18	7	5	9	0	0
	0	0	0	0	1	1	8	10	20	49	59	62
	91	162	116	58	40	42	27	20	12	4	4	0
	0	0	0									
1983	1	1	3	0	349	0	0	0	0	0	0	0
	0	1	1	6	11	16	33	70	74	71	73	142
	100	41	25	29	14	22	16	10	6	11	0	0
	0	0	0	0	1	2	1	3	9	11	25	66
	111	132	148	94	68	60	25	16	9	3	2	0
	0	0	0									
1984	1	1	3	0	400	0	0	0	0	0	0	0
	0	0	1	0	8	11	26	45	48	60	78	93
	97	110	71	47	26	27	20	16	12	13	0	0
	0	0	0	0	0	0	1	1	5	10	31	57
	94	134	155	165	133	100	53	23	16	9	3	2
	0	0	0									
1985	1	1	3	0	340.8	0	0	0	0	1	3	18
	22	35	15	1	5	8	8	15	31	43	40	58
	31	43	49	37	22	9	11	15	10	7	0	0
	0	0	0	6	9	12	21	7	3	3	11	33
	43	63	77	96	94	62	35	24	7	2	3	3
	0	0	0									
1986	1	1	3	0	369	0	0	0	0	0	0	1
	36	88	157	231	191	120	37	13	7	9	18	26
	28	16	24	24	15	8	4	2	3	0	0	0
	0	0	0	3	2	19	82	155	184	150	69	16
	11	13	20	35	23	22	18	6	3	1	1	0
	0	1	0									
1987	1	1	3	0	342.9	0	0	0	0	0	0	0
	0	5	30	53	83	173	227	173	64	6	11	9
	9	16	11	9	7	3	2	0	1	0	0	0
	0	0	0	0	1	5	17	42	59	124	215	203

	101	15	10	22	20	28	10	2	2	0	0	0
	0	0	0									
1988	1	1	3	0	258.3	0	0	0	0	0	1	1
	7	13	15	19	24	46	82	97	117	82	41	18
	10	8	7	9	5	7	3	2	1	0	0	0
	0	0	0	0	1	3	8	9	25	40	72	102
	152	83	36	9	15	18	5	2	1	0	0	1
	1	0	0									
1989	1	1	3	0	189.4	0	0	0	0	0	0	4
	13	15	27	43	27	16	15	22	28	25	42	28
	15	4	6	2	2	2	4	3	0	1	0	0
	0	0	0	2	4	11	22	27	29	28	29	28
	45	64	47	17	9	4	6	3	1	0	1	0
	0	0	0									
1990	1	1	3	0	314.4	0	0	0	0	0	0	2
	18	65	141	121	124	90	22	32	10	17	11	11
	24	13	8	7	2	0	4	2	1	0	0	0
	0	0	0	0	4	38	87	138	147	131	65	29
	23	22	31	19	15	10	6	5	1	0	0	0
	0	0	0									
1991	1	1	3	0	361.7	0	0	0	0	0	0	4
	8	5	7	24	95	194	211	133	71	40	20	16
	23	21	25	15	3	7	2	4	3	3	0	0
	0	0	0	2	6	10	5	10	49	156	259	181
	106	51	35	33	24	24	10	8	0	6	1	0
	1	0	0									
1992	1	1	3	0	260	0	0	0	0	0	1	2
	8	32	28	33	18	15	39	107	150	85	39	24
	14	22	20	22	15	10	6	2	3	2	0	0
	0	0	0	0	1	7	17	25	29	21	54	113
	149	89	49	46	19	20	10	13	4	5	2	0
	0	0	0									
1993	1	1	3	0	219.6	0	0	0	0	0	0	2
	15	30	19	17	53	57	43	51	55	56	48	28
	20	20	12	7	4	3	2	1	0	0	0	0
	0	0	0	0	1	8	22	19	31	46	60	71
	93	63	36	21	22	14	7	5	1	0	0	0
	0	0	0									
1994	1	1	3	0	94.1	0	0	0	0	0	0	0
	0	0	1	6	13	9	12	11	15	12	16	15
	8	4	0	4	1	2	1	0	1	1	0	0
	0	0	0	0	0	0	1	4	5	9	11	26
	29	43	22	9	9	8	0	2	1	1	1	0
	0	0	0									
1995	1	1	3	0	76.1	0	0	0	0	0	0	0
	0	0	0	0	0	2	4	5	13	13	8	27
	8	6	4	3	4	3	3	1	1	0	0	0
	0	0	0	0	0	0	0	1	1	1	4	9
	21	42	23	19	9	3	0	1	0	1	0	0
	0	0	0									
1996	1	1	3	0	82.1	0	0	0	0	0	0	0
	0	1	0	2	1	2	16	8	2	16	22	29
	18	17	14	10	5	1	0	1	0	0	0	0
	0	1	0	0	0	1	0	0	3	1	10	12
	19	30	59	21	9	11	4	2	1	0	0	0
	0	0	0									
1997	1	1	3	0	103.7	0	0	0	0	0	1	0
	0	0	0	2	2	3	3	8	12	13	20	31
	16	15	14	14	5	6	7	1	5	4	0	0
	0	0	0	0	0	0	0	1	1	7	8	14
	12	31	23	29	16	15	7	12	5	2	1	2
	0	0	0									

1998	1	1	3	0	59.7	0	0	0	0	0	0	0
	0	2	6	6	6	2	6	8	7	10	16	9
	10	13	9	8	3	2	8	1	0	0	0	0
	0	0	0	0	0	1	3	9	5	5	6	8
	9	19	23	27	10	13	8	0	2	0	0	1
	0	0	0									
1999	1	1	3	0	78.5	0	0	0	0	0	0	0
	0	0	0	4	17	27	16	10	8	13	15	15
	11	14	8	7	5	7	2	0	0	1	0	0
	0	0	0	0	0	1	1	5	4	22	17	16
	16	21	27	44	38	16	5	3	1	0	0	0
	0	0	0									
2000	1	1	3	0	25.2	0	0	0	0	0	0	0
	4	6	3	1	3	1	6	4	8	7	6	3
	1	0	3	0	1	1	0	0	0	0	0	0
	0	0	0	0	0	6	4	3	5	2	5	1
	7	6	4	1	1	0	0	0	0	0	0	0
	0	0	0									
2001	1	1	3	0	92.2	0	0	0	0	0	0	3
	10	39	31	17	34	15	9	2	9	15	12	17
	7	7	2	6	1	5	1	1	0	0	0	0
	0	0	0	0	2	15	42	23	21	19	6	7
	7	17	22	14	7	3	1	1	1	0	0	0
	0	0	0									
2002	1	1	3	0	38	0	0	0	0	0	0	0
	0	0	0	1	6	9	13	10	5	1	1	7
	7	6	3	3	6	6	0	0	0	1	0	0
	0	0	0	0	0	0	1	2	2	10	14	15
	5	6	4	8	5	2	1	0	0	0	0	0
	0	0	0									
#2003	1	1	3	0	1.2	0	0	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2004	1	1	3	0	33.2	0	0	0	0	0	0	1
	0	0	1	1	0	0	1	3	2	5	8	17
	18	13	1	6	2	4	0	1	0	0	0	0
	0	0	0	0	0	1	0	0	0	1	2	1
	3	3	9	8	5	1	0	0	0	0	0	0
	0	0	0									
#2005	1	1	3	0	1.5	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	1	1	0	0	0	0	0	0	0
	0	0	0									
#2007	1	1	3	0	5.3	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	1	0	0
	1	0	2	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	2	1	0	0	0	0	0	0
	0	0	0									
#2008	1	1	3	0	2.2	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	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	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
#												

#Yr	Seas	Flt/Svy	Gender	Part	Stewart, max400	16	18	20	22	24	26
	28	30	32	34	36	38	40	42	44	46	48	50
	52	54	56	58	60	62	64	66	68	72	76	16
	18	20	22	24	26	28	30	32	34	36	38	40
	42	44	46	48	50	52	54	56	58	60	62	64
	66	68	72	76								
1979	1	2	3	0	5.3	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	1	1
	1	0	0	0	0	1	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
	0	1	1	4	0	1	1	1	1	0	0	0
	0	0	0									
1980	1	2	3	0	18.9	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	1	0	0	0
	1	3	1	1	4	4	3	2	1	6	0	0
	0	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	1	1	1	4	6	4	3	1	0
	0	0	0									
1982	1	2	3	0	17.7	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	3	1
	0	2	2	1	2	1	0	0	1	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	1	0	2	0	0	0
	0	1	0									
1983	1	2	3	0	18.5	0	0	0	0	0	0	0
	0	0	0	0	0	2	0	1	3	1	2	5
	2	3	5	0	1	1	1	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	3
	1	2	1	3	5	4	3	3	0	1	0	0
	0	0	0									
1984	1	2	3	0	22.4	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0	1
	2	3	3	0	3	2	2	1	2	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	2	5	7	5	4	0	2	0	0	0
	0	0	0									
1985	1	2	3	0	34.9	0	0	0	0	0	0	0
	0	0	1	0	3	2	2	6	9	4	5	9
	4	3	2	1	0	0	1	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	1	2	11
	2	5	3	5	7	3	2	0	0	0	0	0
	0	0	0									
1986	1	2	3	0	72.7	0	0	0	0	0	0	1
	0	0	2	1	4	6	4	2	3	17	9	14
	17	14	13	16	5	5	0	0	0	0	0	0
	0	0	0	0	0	1	3	4	3	2	3	3
	2	4	17	23	25	20	11	2	3	0	0	0
	0	0	0									
1987	1	2	3	0	56.3	0	0	0	0	0	0	0
	1	0	1	6	7	11	8	15	9	6	6	5
	11	5	6	3	1	2	0	0	0	0	0	0
	0	0	0	0	0	0	3	4	12	13	10	10
	13	6	16	12	6	6	3	4	3	0	1	1
	1	0	0									
1988	1	2	3	0	23.3	0	0	0	0	0	0	0
	0	0	0	0	2	1	1	8	5	9	9	4
	1	4	2	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	2	0	10

	7	5	3	5	2	1	0	1	0	0	0	0
	0	0	0									
1989	1	2	3	0	44.4	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	5	5	9	7	7
	10	4	7	1	3	0	1	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	2
	7	7	6	12	7	1	5	2	2	0	0	1
	0	0	0									
1990	1	2	3	0	23.3	0	0	0	0	0	0	0
	0	0	0	0	4	2	0	3	2	6	1	2
	7	0	2	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	3	4	4	3
	5	2	7	5	3	2	0	0	0	0	0	0
	0	0	0									
1991	1	2	3	0	49.8	0	0	0	0	0	0	0
	0	0	1	0	0	4	6	6	3	4	3	4
	3	6	7	4	5	1	0	2	0	1	0	0
	0	0	0	0	1	0	0	0	1	2	10	10
	4	8	1	3	8	6	3	1	1	0	2	1
	0	0	0									
1992	1	2	3	0	111.4	0	0	0	0	0	0	0
	0	0	5	8	8	2	10	25	46	37	15	5
	9	2	4	6	4	3	0	2	1	1	0	0
	0	0	0	0	0	0	0	1	9	2	4	16
	37	25	10	13	5	7	4	0	2	0	1	0
	0	0	0									
1993	1	2	3	0	109.9	0	0	0	0	0	0	0
	0	0	2	0	2	4	14	16	48	25	15	11
	5	3	4	1	2	2	0	0	0	0	0	0
	0	0	0	0	0	1	1	2	2	2	7	17
	19	11	10	8	3	0	2	0	0	0	0	0
	0	0	0									
1994	1	2	3	0	86.2	0	0	0	0	0	0	0
	0	0	0	0	0	4	2	10	13	8	21	28
	22	12	6	4	6	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	1	3	3
	9	14	19	8	10	4	1	2	0	0	0	0
	0	0	0									
1995	1	2	3	0	39.4	0	0	0	0	0	0	0
	0	0	0	0	0	0	3	5	1	3	11	10
	10	9	5	2	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	1	5
	2	10	5	2	1	0	0	2	1	0	0	0
	0	0	0									
1996	1	2	3	0	105.8	0	0	0	0	0	0	0
	0	0	1	1	0	7	10	10	15	24	33	26
	21	23	12	4	1	3	0	1	0	2	0	0
	0	0	0	0	0	0	0	2	4	2	9	12
	21	20	28	12	7	3	3	1	0	0	0	0
	0	0	0									
1997	1	2	3	0	76.5	0	0	0	0	0	0	0
	0	0	0	0	0	1	2	5	10	17	21	38
	44	25	17	10	5	2	2	3	1	0	0	0
	0	0	0	0	0	0	0	0	1	0	1	5
	4	12	12	14	5	5	2	1	0	0	0	0
	0	0	0									
1998	1	2	3	0	58.3	0	0	0	0	0	0	0
	0	0	0	1	1	1	5	8	13	16	14	17
	17	10	11	3	1	0	2	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	1	3	5
	11	10	12	8	8	5	3	0	1	0	3	0
	0	0	0									

1999	1	2	3	0	23.5	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	2	2	6	8	6
	9	11	4	2	2	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	0	0
	1	2	4	10	3	7	4	3	5	1	1	1
	0	0	0									
2000	1	2	3	0	16	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	1	1	1	2	2
	3	2	2	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	0
	6	1	3	2	3	1	1	3	2	3	1	1
	0	0	0									
2001	1	2	3	0	40.9	0	0	0	0	0	0	0
	0	1	3	10	5	0	3	1	4	3	5	6
	11	5	8	4	5	3	2	0	2	0	0	0
	0	0	0	0	0	1	2	2	8	3	2	1
	3	7	3	6	6	7	5	5	7	3	0	0
	0	0	0									
2002	1	2	3	0	6.9	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	1	0	1	3	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	3	0	0	0	0	0	0	0
	0	0	0									
#												

#Yr	Seas	Flt/Svy	Gender	Part	Stewart, max400		16	18	20	22	24	26
	28	30	32	34	36	38	40	42	44	46	48	50
	52	54	56	58	60	62	64	66	68	72	76	16
	18	20	22	24	26	28	30	32	34	36	38	40
	42	44	46	48	50	52	54	56	58	60	62	64
	66	68	72	76								
1978	1	3	3	0	19	0	0	0	0	0	0	0
	0	0	0	0	3	3	3	3	2	7	4	2
	2	2	1	1	1	1	1	1	2	1	0	0
	0	0	0	0	0	0	0	0	0	0	3	1
	4	9	5	4	1	2	1	1	0	0	1	0
	0	0	1									
#1979	1	3	3	0	3.7	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	2	0	0	0	0
	1	0	2	1	3	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
	2	2	3	1	0	1	0	0	0	0	0	0
	0	0	0									
#1982	1	3	3	0	2.2	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	1	0
	0	1	0	0	1	0	2	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	0
	0	1	0	0	0	0	0	0	1	0	0	0
	0	0	0									
1983	1	3	3	0	41.2	0	0	0	0	0	0	0
	0	0	0	0	1	0	2	3	2	5	3	3
	5	3	1	0	0	3	2	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	1
	4	5	1	4	2	5	1	2	0	0	0	0
	0	0	0									
1984	1	3	3	0	88.3	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	2	4
	2	2	1	1	3	1	0	0	1	1	0	0

	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	4	7	2	5	5	0	1	0	0	0
	0	0	0									
1985	1	3	3	0	348.5	1	1	2	2	1	0	0
	1	0	0	1	4	8	14	38	35	47	38	32
	22	28	25	17	12	14	7	3	3	5	0	2
	3	0	5	0	0	1	0	0	1	3	4	23
	63	88	103	60	42	32	24	15	11	3	7	1
	0	0	0									
1986	1	3	3	0	338.8	0	0	0	0	0	0	0
	0	2	1	0	2	7	7	4	8	28	56	67
	80	99	67	37	21	14	7	8	2	9	0	0
	0	0	0	0	0	0	0	0	1	9	3	8
	10	24	91	133	158	159	84	30	12	7	4	0
	0	1	0									
1987	1	3	3	0	263.7	0	0	0	0	0	0	0
	0	0	0	0	4	16	42	65	45	20	20	28
	57	44	48	35	17	11	5	4	2	3	0	0
	0	0	0	0	0	0	0	0	5	7	35	63
	42	36	45	67	107	93	43	26	7	3	3	1
	0	0	0									
1988	1	3	3	0	225.4	1	0	0	0	0	0	0
	0	1	1	0	2	5	24	61	105	111	62	38
	20	16	10	14	8	7	4	4	1	1	0	0
	0	0	0	0	0	0	1	0	2	2	13	34
	104	113	72	34	31	19	10	12	8	5	2	0
	2	0	0									
1989	1	3	3	0	323.3	0	0	0	0	0	0	0
	2	0	4	3	4	4	12	43	89	130	120	117
	84	45	30	6	8	9	5	4	3	1	0	0
	0	0	0	0	0	1	1	0	0	1	13	28
	90	165	155	100	50	26	21	12	8	5	0	1
	0	1	0									
1990	1	3	3	0	232.4	0	0	0	0	0	0	0
	0	1	2	7	33	49	24	45	60	41	58	53
	60	35	25	11	11	4	4	3	1	0	0	0
	0	0	0	1	0	0	0	1	12	16	28	23
	46	61	76	60	39	15	5	5	1	0	0	0
	0	0	0									
1991	1	3	3	0	89.9	0	0	0	0	0	0	0
	0	0	1	2	5	21	51	51	34	21	10	8
	6	5	4	4	2	0	1	2	0	1	0	0
	0	0	0	0	0	0	0	4	1	8	26	28
	24	16	14	15	11	4	3	0	1	0	0	0
	0	0	0									
1992	1	3	3	0	234.6	0	0	0	0	0	0	0
	0	0	3	6	8	7	20	83	151	164	106	50
	20	12	16	6	11	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	3	3	8	15	64
	147	145	66	29	22	13	4	2	1	0	0	0
	0	0	0									
1993	1	3	3	0	111.6	0	0	0	0	0	0	0
	3	5	0	7	3	8	9	41	69	51	29	12
	19	11	15	3	5	0	1	0	0	0	0	0
	0	0	0	0	0	0	3	1	1	3	6	33
	37	31	13	10	11	6	1	0	0	0	0	0
	0	0	0									
1994	1	3	3	0	80	0	0	0	0	0	0	0
	0	0	0	0	0	1	2	7	14	29	24	20
	10	0	1	2	2	1	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	2	5

	19	21	15	11	4	3	1	0	0	0	0	0
	0	0	0									
1995	1	3	3	0	70.1	0	0	0	0	0	0	0
	0	0	0	0	0	1	1	6	3	12	16	31
	17	8	2	9	1	4	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	6
	16	27	24	8	6	2	2	0	0	0	0	0
	0	0	0									
1996	1	3	3	0	43.6	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	3	10	12	19
	10	4	0	2	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	4	17	21	10	5	2	0	1	0	0	0	0
	0	0	0									
1997	1	3	3	0	24.5	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	2	0	7	6	8
	8	6	1	4	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	1
	3	10	12	7	3	2	2	0	0	0	0	0
	0	0	0									
1998	1	3	3	0	33.5	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	1	6	4	16	16
	10	9	3	5	1	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	2	1
	5	6	13	16	6	4	0	0	0	1	0	0
	0	0	0									
#1999	1	3	3	0	4.5	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	1	4	5
	7	5	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	0	0	0	0	0	0	0	0
	0	0	0									
#2002	1	3	3	0	4.4	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	2	0	7	11	4	0	0	0	0	0	0
	0	0	0									
#2004	1	3	3	0	4.3	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
	0	2	0	4	2	3	3	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	0
	0	0	0									
#Yr	Seas	Flt/Svy	Gender	Part	Neff	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
1980	1	4	0	0	400	4	2	3	20	30	63	64
	101	87	208	427	435	312	169	173	104	68	89	68
	52	64	33	15	5	4	5	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									
1981	1	4	0	0	400	1	1	2	7	13	31	74
	116	181	172	197	177	176	187	256	210	118	76	67
	60	45	31	18	6	6	1	1	3	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1982	1	4	0	0	386	0	0	0	0	3	5	16
	25	27	44	108	207	208	164	213	253	190	121	83
	59	51	18	11	4	5	1	2	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1983	1	4	0	0	196.4	0	0	0	1	0	0	3
	7	8	45	59	66	61	62	59	73	42	35	42
	38	45	19	10	9	12	2	7	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									
1984	1	4	0	0	262.9	23	17	35	29	9	2	8
	4	6	6	14	17	35	48	59	87	46	53	30
	23	17	11	4	4	5	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
	0	0	0									
1985	1	4	0	0	330.6	1	10	27	74	126	96	94
	185	194	104	42	11	17	22	35	53	49	57	49
	35	26	11	12	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									
1986	1	4	0	0	298.2	5	5	5	13	36	47	52
	60	145	284	264	133	63	16	18	19	20	27	19
	21	25	3	9	5	3	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									
1987	1	4	0	0	50.2	0	0	2	3	5	7	11
	7	5	10	12	20	12	6	9	7	3	0	5
	4	3	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									
1988	1	4	0	0	49.9	0	0	0	1	3	4	3
	1	2	3	9	9	8	5	10	7	6	1	3
	3	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									
1989	1	4	0	0	117.4	0	0	3	8	18	19	37
	42	53	54	18	24	22	29	32	30	25	21	11
	9	5	9	5	4	4	3	1	2	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1993	1	4	0	0	24.3	0	0	0	0	0	0	1
	3	1	9	8	2	3	4	3	4	2	5	2
	2	2	1	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1994	1	4	0	0	34.8	0	0	0	0	0	1	0
	2	0	6	5	8	10	11	11	3	8	10	5
	2	2	1	0	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									

1995	1	4	0	0	21.8	0	0	0	0	0	0	0
	1	0	0	1	0	2	0	7	4	2	4	6
	3	2	2	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									
1996	1	4	0	0	51	0	0	0	1	1	3	3
	7	7	6	3	7	1	5	7	7	7	12	7
	11	11	4	2	1	0	1	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									
1997	1	4	0	0	22.3	0	0	0	0	0	0	1
	4	0	1	8	6	10	3	2	5	0	4	5
	0	1	0	2	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									
1998	1	4	0	0	53.4	0	0	0	0	0	1	0
	2	5	8	5	9	10	13	7	7	15	6	3
	4	5	3	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
	0	0	0									
1999	1	4	0	0	181.4	7	13	11	8	3	0	2
	5	3	9	8	7	11	21	25	38	44	53	41
	50	33	28	19	12	1	3	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									
2000	1	4	0	0	167.5	0	0	2	2	20	43	58
	66	46	41	12	11	7	8	8	16	19	29	22
	35	24	19	16	11	7	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	0	0	0
	0	0	0									
2001	1	4	0	0	109.4	0	0	0	1	0	6	18
	42	72	69	49	43	18	11	9	5	8	8	6
	3	3	3	2	2	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2002	1	4	0	0	201.3	0	0	0	0	0	0	3
	3	7	23	62	112	129	113	95	37	20	25	31
	18	12	11	13	2	1	1	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									
2003	1	4	0	0	36.8	0	0	0	0	0	2	0
	0	0	0	0	2	14	16	21	29	17	4	5
	6	0	3	1	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2004	1	4	0	0	325.8	1	3	5	14	8	17	27
	44	24	27	20	25	48	55	105	135	116	97	52
	37	21	8	8	5	4	2	2	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	0									
2005	1	4	0	0	399.9	0	2	0	0	3	6	20
	77	148	195	185	143	91	54	58	74	86	84	83

	68	34	17	8	6	3	3	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									
2006	1	4	0	0	400	1	0	1	2	8	17	28
	29	46	69	128	224	334	263	169	96	80	72	98
	82	56	28	13	6	2	4	2	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									
2007	1	4	0	0	400	2	3	0	5	5	18	44
	74	133	228	173	167	158	184	208	209	148	107	74
	68	58	38	24	3	6	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
	0	0	0									
2008	1	4	0	0	400	0	0	0	0	7	15	23
	27	51	74	151	247	267	193	209	171	120	88	65
	31	25	20	12	11	2	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									
#												

#"year	Seas	Flt/Svy	Gender	Part	Stewart, max400		16	18	20	22	24	26
	28	30	32	34	36	38	40	42	44	46	48	50
	52	54	56	58	60	62	64	66	68	72	76	16
	18	20	22	24	26	28	30	32	34	36	38	40
	42	44	46	48	50	52	54	56	58	60	62	64
	66	68	72	76								
1978	1	5	3	0	-98	0	0	0	0	2	4	2
	4	0	3	5	8	7	9	28	32	15	14	7
	3	9	13	10	4	8	11	20	9	2	1	0
	0	0	0	3	1	1	3	1	5	5	11	7
	19	18	20	16	22	19	17	14	12	12	13	3
	0	1	1									
1979	1	5	3	0	-22	0	0	0	0	0	3	1
	7	25	44	26	7	0	4	7	20	14	11	11
	7	9	11	17	18	12	23	32	13	12	0	0
	0	0	0	0	2	4	2	4	4	3	7	4
	14	10	22	14	16	17	26	34	34	35	16	13
	4	3	1									
1980	1	5	3	0	-86.7	0	0	0	0	0	0	1
	0	1	4	2	15	33	23	9	5	4	4	3
	8	6	3	7	5	2	8	7	6	0	0	0
	0	0	0	2	1	0	1	0	12	15	20	6
	6	3	8	4	4	5	8	5	4	8	4	3
	2	0	0									
1981	1	5	3	0	-59.3	0	0	0	0	0	0	1
	0	11	13	2	1	4	8	9	15	19	5	4
	6	4	6	2	2	3	5	3	2	1	0	0
	0	0	0	0	2	0	6	8	5	3	4	6
	17	11	8	7	8	4	9	6	7	1	3	1
	2	0	0									
1982	1	5	3	0	-63	0	0	0	0	0	1	0
	0	0	1	5	3	3	8	7	5	14	16	15
	9	6	6	10	3	3	2	7	2	2	0	0
	0	0	0	2	0	0	0	0	0	2	4	3

	5	14	20	8	7	7	5	7	6	2	1	2
	1	0	0									
1983	1	5	3	0	-40.7	0	0	0	0	0	0	0
	0	0	0	0	1	3	6	3	10	4	3	10
	7	8	4	2	2	4	4	1	0	1	0	0
	0	0	0	0	1	0	2	0	1	0	4	5
	5	11	9	3	12	7	8	4	2	1	5	1
	0	0	0									
1984	1	5	3	0	-20.7	0	0	0	0	0	0	0
	0	0	0	1	0	1	2	4	0	1	7	2
	3	2	10	4	2	1	3	2	0	1	0	0
	0	0	0	0	0	0	0	3	0	0	4	4
	2	3	3	3	4	5	2	4	3	2	0	1
	0	0	0									

#YEAR

1980	1	5	0	0	104.7	0	1	0	1	5	4	11
	2	3	3	14	11	28	16	14	15	21	13	15
	13	4	12	10	7	3	11	7	4	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
	0	0	0									
1981	1	5	0	0	68.7	1	0	1	0	0	0	0
	1	3	8	4	8	9	28	25	41	23	9	7
	14	11	13	11	6	7	7	8	5	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									
1982	1	5	0	0	92.9	0	0	0	0	1	0	0
	0	3	3	7	7	14	15	11	38	38	49	46
	24	21	8	3	11	7	1	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	0	0
	0	0	0									
1983	1	5	0	0	95.5	0	0	0	0	0	0	3
	1	4	3	5	2	4	9	19	26	37	42	55
	53	36	23	13	8	10	3	1	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	0									
1984	1	5	0	0	94.8	1	1	1	1	0	0	0
	2	3	5	7	9	8	13	15	13	17	16	18
	13	9	6	12	2	7	4	2	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									
1985	1	5	0	0	175.4	2	5	12	38	52	53	63
	65	24	15	7	7	13	13	15	13	20	19	19
	15	13	21	14	14	8	7	4	3	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1986	1	5	0	0	234.9	0	0	1	5	8	8	18
	29	72	190	204	142	66	18	4	5	7	13	21
	17	19	24	19	15	11	14	8	3	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									
1987	1	5	0	0	68	0	0	0	0	1	0	3
	3	15	24	33	27	18	9	6	4	3	4	3
	4	6	9	9	12	9	5	10	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									
1988	1	5	0	0	42.6	0	0	0	0	0	1	1
	1	2	1	4	4	4	4	1	6	5	4	4
	1	0	1	2	0	1	0	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1989	1	5	0	0	52.4	0	0	0	0	1	3	0
	2	5	4	24	11	3	3	7	13	15	10	8
	3	3	0	0	1	1	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									
#YEAR	16	18	20	22	168	26	28	30	32	34	36	38
	40	42	44	46	48	50	52	54	56	58	60	62
	64	66	68	72	76	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76		
1993	1	5	0	0	37.7	1	0	0	0	0	0	0
	0	1	6	5	2	3	4	4	6	4	4	6
	3	1	1	2	2	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1994	1	5	0	0	32.9	0	0	1	0	0	4	5
	3	3	1	3	4	9	5	1	3	1	1	2
	2	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	0	0	0	0	0
	0	0	0									
1995	1	5	0	0	38.3	0	0	1	0	0	0	0
	2	4	5	6	6	1	6	8	6	9	3	4
	3	0	1	1	0	1	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1996	1	5	0	0	109.6	0	0	0	2	2	1	3
	7	9	15	13	9	19	16	16	13	11	6	14
	19	12	13	4	7	8	4	1	2	3	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1997	1	5	0	0	216.6	0	0	0	1	5	4	4
	2	10	21	25	32	44	31	60	48	53	63	71
	55	49	84	37	29	22	11	20	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	0
	0	0	0									
1998	1	5	0	0	152.5	0	0	0	0	0	3	8
	9	22	18	24	13	26	35	40	43	41	41	31
	35	29	27	24	14	6	8	2	5	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1999	1	5	0	0	212.9	2	0	0	0	0	3	1
	2	3	14	22	30	49	38	39	43	63	47	55
	47	40	25	44	17	20	6	7	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	0
	0	0	0									
2000	1	5	0	0	85.2	0	0	0	0	3	10	25
	18	11	11	18	10	14	13	19	22	11	14	8
	2	9	5	14	8	13	10	5	0	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
	0	0	0									
2001	1	5	0	0	82.9	0	0	1	0	1	1	2
	3	23	36	55	33	12	14	18	19	20	20	22
	14	11	11	3	2	1	0	2	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									
2002	1	5	0	0	42.8	0	0	0	0	0	0	0
	0	1	2	12	26	44	29	17	1	8	6	10
	9	5	3	4	1	2	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2004	1	5	0	0	60	0	0	0	0	0	0	1
	0	2	1	3	2	9	6	5	9	4	9	4
	8	2	6	1	2	2	1	3	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2005	1	5	0	0	138.7	0	0	1	1	0	0	1
	5	3	5	4	6	10	8	16	26	24	39	37
	26	14	14	5	7	3	1	3	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2006	1	5	0	0	162.5	0	0	0	0	0	1	1
	1	3	6	3	11	19	17	15	24	22	23	26
	17	24	11	12	13	7	5	11	5	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									
2007	1	5	0	0	174.1	0	0	0	0	0	2	0
	1	5	7	11	15	14	26	25	18	22	12	14
	23	12	18	9	11	8	3	5	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									
2008	1	5	0	0	109.3	1	0	0	0	0	0	0
	0	1	0	2	6	13	16	19	14	14	17	10
	12	13	8	8	4	3	0	0	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									

#

#year	Seas	Flt/Svy	Gender	Part	Stewart, max400		16	18	20	22	24	26
	28	30	32	34	36	38	40	42	44	46	48	50
	52	54	56	58	60	62	64	66	68	72	76	16
	18	20	22	24	26	28	30	32	34	36	38	40
	42	44	46	48	50	52	54	56	58	60	62	64
	66	68	72	76								
1978	1	6	3	0	179.5	0	0	0	0	1	1	0
	0	0	0	0	0	3	5	27	52	42	16	8
	4	15	15	16	9	17	18	19	12	5	0	0
	0	0	0	0	0	0	0	0	0	1	7	18
	51	53	19	12	24	23	37	27	14	9	3	1
	0	0	0									
1979	1	6	3	0	67.4	0	0	0	0	0	0	0
	1	2	5	1	0	1	0	1	1	7	8	11
	4	3	2	6	3	5	4	5	2	3	0	0
	0	0	0	0	0	1	2	4	2	0	1	0
	2	7	13	6	5	8	14	9	11	4	1	1
	0	2	2									
1980	1	6	3	0	220.9	0	0	0	0	0	0	0
	0	0	8	17	61	96	55	44	10	3	7	8
	11	10	6	2	2	6	4	1	4	5	0	0
	0	0	0	0	0	0	0	7	28	77	71	39
	14	4	9	9	13	12	4	4	12	0	3	0
	0	0	0									
1981	1	6	3	0	195.2	0	0	0	0	0	0	0
	0	1	0	0	4	12	35	83	104	65	24	2
	0	3	0	2	2	4	2	4	6	5	0	0
	0	0	0	0	0	0	0	0	7	12	24	73
	111	65	15	2	6	6	11	7	10	5	3	2
	2	0	0									
1982	1	6	3	0	243.8	0	0	0	0	0	0	0
	0	0	1	3	19	19	38	13	36	67	94	90
	49	15	2	4	6	4	1	2	5	9	0	0
	0	0	0	0	0	0	0	2	9	19	21	19
	38	98	97	39	18	8	8	19	20	6	5	2
	0	0	0									
1983	1	6	3	0	365.8	0	0	0	0	0	0	0
	0	0	0	2	9	16	39	36	46	41	50	54
	110	79	31	11	7	11	11	11	11	28	0	0
	0	0	0	0	0	0	1	0	1	4	16	36
	50	51	111	126	64	25	20	17	28	21	10	2
	1	0	0									
1984	1	6	3	0	245.7	0	0	0	0	0	0	0
	0	0	0	1	0	0	2	10	14	21	28	37
	34	78	68	33	13	9	12	10	6	36	0	0
	0	0	0	0	0	0	0	0	1	0	4	9
	16	28	64	105	108	54	23	16	26	22	6	3
	0	0	0									
1985	1	6	3	0	196.1	0	0	0	0	0	0	0
	0	0	0	1	0	3	0	1	6	2	18	23
	23	28	43	55	20	9	3	3	3	9	0	0
	0	0	0	0	0	0	0	0	0	2	0	3
	9	11	23	55	85	78	31	17	17	8	6	0
	0	0	0									
1986	1	6	3	0	167.2	0	0	0	0	0	0	0
	0	0	4	14	13	9	5	0	1	0	4	7
	11	20	20	38	29	26	9	4	4	3	0	0
	0	0	0	0	0	1	4	9	32	21	15	4
	0	0	5	22	36	78	50	19	11	9	6	1
	1	0	0									
1987	1	6	3	0	255.6	0	0	0	0	0	0	0
	0	0	2	7	27	64	118	101	50	16	2	2

	3	4	9	17	22	26	25	9	2	7	0	0
	0	0	0	0	0	1	1	1	12	65	113	112
	58	14	5	4	21	43	36	26	12	6	3	2
	0	0	0									
1988	1	6	3	0	178.3	0	0	0	0	0	0	0
	0	0	0	0	10	6	21	37	54	63	30	15
	3	1	1	3	8	10	10	3	3	3	0	0
	0	0	0	0	0	0	0	1	0	10	20	39
	89	101	26	13	6	11	31	17	6	7	3	1
	0	0	0									
1989	1	6	3	0	129.2	0	0	0	0	0	0	1
	1	2	3	1	0	1	1	6	15	27	26	25
	20	13	3	2	3	3	5	4	0	1	0	0
	0	0	0	0	0	0	2	3	2	3	1	5
	17	45	68	34	16	6	25	24	6	5	2	2
	0	0	0									
1990	1	6	3	0	160.1	0	0	0	0	0	0	0
	0	6	10	8	14	18	13	10	15	9	6	15
	14	21	13	5	1	1	5	10	4	4	0	0
	0	0	0	0	2	6	14	17	18	20	24	20
	16	21	20	44	36	26	21	20	10	8	5	2
	0	0	0									
1991	1	6	3	0	124	0	0	0	0	0	0	0
	0	0	4	1	5	28	39	45	21	22	8	4
	9	20	18	9	7	2	2	2	1	2	0	0
	0	0	0	0	1	0	0	3	2	22	49	68
	36	20	13	17	25	21	13	14	18	8	1	0
	0	0	0									
1992	1	6	3	0	45.9	0	0	0	0	0	0	0
	0	0	1	1	1	0	0	6	17	18	13	9
	13	1	4	9	5	3	2	2	2	3	0	0
	0	0	0	0	0	0	0	0	0	1	0	7
	8	19	18	6	5	10	9	5	8	2	1	1
	0	0	0									
1993	1	6	3	0	43.7	0	0	0	0	0	0	0
	0	0	0	0	0	1	1	2	3	10	10	19
	10	2	4	6	6	2	1	2	2	0	0	0
	0	0	0	0	0	0	0	0	1	0	3	5
	7	24	31	17	29	12	3	7	3	6	1	0
	0	0	0									
1994	1	6	3	0	53.5	0	0	0	0	0	0	0
	0	0	0	0	1	2	1	6	3	6	6	5
	10	14	8	7	4	4	6	1	4	1	0	0
	0	0	0	0	0	0	0	0	0	3	2	11
	18	11	22	35	29	14	10	11	7	5	4	1
	0	0	0									
1995	1	6	3	0	40.2	0	0	0	0	0	0	0
	0	1	0	0	0	1	1	1	1	2	2	2
	1	1	6	3	5	5	9	4	0	4	0	0
	0	0	0	0	1	0	1	1	1	0	0	3
	2	0	1	10	14	9	7	13	12	16	8	2
	4	0	0									
1996	1	6	3	0	18.1	0	0	0	0	0	0	0
	0	0	0	0	0	1	1	0	1	0	3	2
	3	3	4	4	0	0	2	3	1	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	2	1	0	2	3	8	5	4	2	1	1	1
	0	0	0									
1997	1	6	3	0	17.6	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0	0
	0	1	0	3	4	3	2	0	3	7	0	0
	0	0	0	0	0	0	0	0	0	0	1	0

	0	0	0	2	3	8	9	5	6	4	4	3
	1	0	0									
1998	1	6	3	0	21.6	0	0	0	0	0	0	0
	0	0	0	0	0	1	1	2	3	9	9	5
	2	0	0	2	7	8	5	5	2	3	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
	3	1	1	1	3	3	8	12	5	1	2	1
	0	0	0									
1999	1	6	3	0	7.8	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	2	1	1	0	0	1	1	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	2	1	4	2	4	1	0
	0	0	0									
2000	1	6	3	0	13.9	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	3	0	1	0
	0	1	3	2	0	10	5	5	1	4	0	0
	0	0	0	0	0	0	0	0	0	0	1	0
	1	5	5	3	0	2	4	3	1	1	3	1
	0	0	0									
2001	1	6	3	0	7.2	0	0	0	0	0	0	0
	0	0	0	1	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	1	1	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	1	3	3	1	1	0
	1	0	0									
2002	1	6	3	0	23.7	0	0	0	0	0	0	0
	1	0	0	0	6	21	11	6	5	0	1	0
	1	0	0	0	1	0	3	3	1	1	0	0
	0	0	0	0	0	0	0	1	2	15	10	7
	2	1	1	2	0	0	0	0	3	1	1	0
	0	0	0									
#2005	1	6	3	0	1.2	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	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									
#2007	1	6	3	0	2.2	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	0
	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
#2008	1	6	3	0	9.8	0	0	0	0	0	0	0
	0	0	0	0	0	0	2	3	4	1	0	0
	1	0	0	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1
	2	0	1	0	2	1	1	0	0	0	1	0
	0	0	0									

#Yr	Seas	Flt/Svy	Gender	Part	Nsamp	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
#1977	1	8	3	0	163	0	0	0	0.001	0.001	0	0.001
	0.001	0.004	0.0071	0.0071	0.0307	0.0501	0.047	0.0409	0.0317	0.0358	0.0153	0.0143
	0.0266	0.0153	0.0225	0.0184	0.0255	0.0194	0.0174	0.0276	0.003	0.001	0	0
	0	0	0.002	0.001	0.004	0.002	0.0051	0.0081	0.0112	0.0225	0.0603	0.0552

	0.044	0.0327	0.0276	0.0358	0.0327	0.045	0.0307	0.045	0.0245	0.0276	0.0092	0.003
	0.004	0	0									
1980	1	8	3	0	81	0	0	0	0	0.0078	0.0216	0.0078
	0	0	0	0.0078	0.0451	0.1119	0.1375	0.1041	0.0176	0	0.0039	0.0039
	0.0058	0	0.0019	0.0019	0.0019	0	0	0	0	0	0	0
	0	0	0.0078	0.0353	0.0137	0.0019	0	0	0.0098	0.0648	0.1611	0.1335
	0.053	0.0039	0.0019	0.0019	0.0039	0.0019	0.0039	0.0078	0.0039	0.0039	0.0019	0
	0.0019	0	0									
1983	1	8	3	0	75	0	0	0	0	0	0	0
	0	0	0.002	0	0.002	0.0041	0.0062	0.0062	0.0083	0.0188	0.0167	0.0439
	0.0899	0.1087	0.0313	0.0062	0.0083	0.0083	0	0.0083	0.0062	0	0	0
	0	0	0	0	0	0	0	0	0.0041	0	0	0.0083
	0.0271	0.0271	0.0585	0.1778	0.1485	0.0606	0.0439	0.0376	0.0167	0.0083	0.0041	0
	0	0	0									
1986	1	8	3	0	39	0	0	0	0	0.019	0.0095	0.0047
	0.0047	0.019	0.0428	0.0523	0.0476	0.0238	0	0	0	0	0	0.0047
	0.0047	0	0.0095	0.0142	0.0333	0.0476	0.0285	0.0285	0	0.0047	0	0
	0	0	0.0047	0.038	0.0238	0	0.038	0.0761	0.1523	0.0761	0.0142	0
	0	0	0.0047	0	0.0238	0.0238	0.038	0.0238	0.0238	0.019	0.0142	0
	0.0047	0	0									
1989	1	8	3	0	400	0.0014	0	0	0.0044	0.0404	0.1596	0.1456
	0.0147	0.0066	0.0132	0.0206	0.0066	0.0007	0.0022	0.0007	0	0.0044	0.0103	0.0036
	0.0117	0.0036	0.0022	0.0014	0	0.0022	0.0014	0.0014	0	0	0.008	0.0007
	0	0.0103	0.0699	0.2008	0.142	0.0117	0.0044	0.011	0.0125	0.0044	0	0.0007
	0.0014	0.0095	0.0125	0.0183	0.0073	0.0014	0.0029	0.0051	0.0029	0.0007	0	0
	0.0007	0	0									
1992	1	8	3	0	78	0	0	0	0	0.0076	0.0329	0.0482
	0.0228	0.0228	0.0304	0.0203	0.0228	0.0101	0.0279	0.0609	0.0532	0.0507	0.0101	0
	0.005	0.0025	0.0076	0	0	0.0025	0.0025	0	0	0	0	0
	0.0025	0	0.0126	0.0532	0.0507	0.0152	0.0279	0.038	0.0964	0.0304	0.0406	0.0482
	0.0583	0.0304	0.0126	0.0203	0.0025	0.0076	0.0025	0	0	0.0025	0.0025	0
	0	0.0025	0									
1995	1	8	3	0	63	0	0	0.0178	0.0773	0.0952	0.0119	0.0178
	0.0238	0.0178	0.0178	0.0238	0	0	0	0.0059	0.0178	0.0178	0.0059	0.0119
	0.0059	0.0119	0.0297	0.0178	0.0119	0.0178	0	0.0178	0.0119	0	0	0.0178
	0.0476	0.0714	0.0535	0.0178	0.0178	0.0119	0.0357	0.0297	0.0119	0.0059	0	0.0059
	0.0059	0.0059	0.0357	0.0119	0.0357	0.0178	0.0297	0.0119	0.0178	0.0119	0	0
	0	0	0									
1998	1	8	3	0	31	0	0	0	0	0.0169	0	0
	0.0677	0.1525	0.1186	0.0508	0.0508	0	0	0	0.0338	0	0	0.0169
	0	0	0.0169	0	0.0169	0.0169	0	0.0169	0	0	0	0
	0.0169	0.0169	0	0	0.0338	0.0338	0.0677	0.0338	0.0169	0	0	0
	0	0.0169	0.0169	0.0847	0.0169	0	0.0169	0.0338	0	0.0169	0	0
	0	0	0									
2001	1	8	3	0	34	0	0.014	0.014	0.0281	0	0	0
	0.014	0.1267	0.0704	0.1267	0.014	0.014	0.014	0.014	0	0	0	0.014
	0	0	0.014	0	0	0	0	0.0281	0.014	0	0	0
	0	0	0	0	0	0.014	0.0563	0.0845	0.1408	0.014	0.0281	0
	0	0	0	0.0422	0.014	0.0281	0.014	0	0.014	0.014	0.014	0
	0	0	0									
2004	1	8	3	0	65	0.0045	0	0	0.0045	0.0273	0.0593	0.0045
	0	0	0	0	0	0	0.0091	0.0045	0.0182	0.0319	0.0228	0.0456
	0.073	0.0456	0.0273	0.0182	0.0182	0.0182	0.0136	0.0228	0.0091	0.0045	0	0
	0.0045	0.0182	0.0273	0.0547	0.0091	0.0045	0	0	0.0045	0	0	0.0091
	0.0091	0.0136	0.0136	0.073	0.0593	0.0319	0.0547	0.0182	0.0273	0.0228	0.0273	0.0182
	0.0136	0	0									

#CPFV observer LFs

#Year	Seas	Flt/Svy	Gender	Part	NSamp	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42

	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
1987	1	9	0	0	197.5	3	1	2	0	0	4	6
	6	16	33	69	107	101	101	111	76	65	29	26
	29	29	26	20	21	19	2	14	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									
1988	1	9	0	0	300.3	1	4	10	2	7	6	9
	16	30	22	54	78	92	140	198	129	130	80	44
	22	18	26	20	15	22	18	28	5	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									
1989	1	9	0	0	361	1	0	1	13	24	24	49
	57	63	55	55	59	45	65	114	133	186	126	111
	95	55	19	26	15	10	12	12	9	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									
1990	1	9	0	0	192.6	0	1	2	1	8	18	25
	83	157	124	58	58	80	53	31	44	42	55	47
	36	24	12	7	2	2	1	5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1991	1	9	0	0	179.1	0	0	1	3	1	4	8
	1	3	6	18	24	54	103	123	75	66	57	57
	64	50	42	37	28	16	8	15	6	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									
1992	1	9	0	0	395.8	0	0	4	2	4	9	21
	34	59	50	41	49	78	109	191	196	181	132	122
	73	58	86	77	56	23	15	17	12	3	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1993	1	9	0	0	296.9	1	0	0	2	0	1	8
	21	25	25	28	41	43	45	66	72	143	113	122
	78	57	49	66	60	30	21	29	12	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									
1994	1	9	0	0	210.4	0	0	0	1	3	10	12
	6	8	13	25	57	50	48	66	58	63	63	49
	51	36	25	17	21	14	8	11	5	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									
1995	1	9	0	0	224.5	0	0	2	3	3	12	9
	22	18	32	33	41	32	42	60	72	84	73	50
	36	30	34	17	17	7	8	8	5	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1996	1	9	0	0	185	1	0	0	0	1	4	5
	7	18	22	24	26	24	41	43	53	51	53	45
	32	38	25	22	17	13	5	10	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									

1997	1	9	0	0	257.5	0	0	0	1	5	4	9
	3	12	24	29	33	49	35	75	63	63	86	83
	82	76	67	52	47	29	16	28	11	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1998	1	9	0	0	124.7	0	0	0	0	0	1	5
	7	15	15	8	10	18	30	33	39	37	36	32
	33	29	27	21	10	10	6	3	7	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									
#Year	Seas	Flt/Svy	Gender	Part	NSamp	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
2004	1	10	3	0	57	0	0	0	0	0	2	0
	13	5	1	2	5	9	12	20	50	57	108	106
	42	24	11	6	7	3	1	2	0	0	0	0
	0	0	1	4	7	20	7	4	3	6	7	20
	24	51	59	35	26	7	11	4	3	1	1	0
	0	0	0									
2005	1	10	3	0	65	0	0	0	0	0	0	0
	2	4	4	8	14	6	7	2	2	10	26	56
	79	72	50	14	11	8	7	11	2	2	0	0
	0	0	0	0	1	1	3	3	10	20	14	6
	6	11	16	48	43	35	18	11	10	6	1	0
	0	1	0									
2006	1	10	3	0	70	0	0	0	1	1	8	20
	7	2	3	1	5	18	33	38	44	25	22	37
	52	59	45	18	4	7	2	3	1	0	0	0
	1	1	6	13	15	13	1	2	10	12	25	17
	23	21	6	14	24	36	22	12	3	2	2	0
	1	0	0									
2007	1	10	3	0	78	0	0	0	0	0	0	0
	2	4	25	40	18	12	14	21	26	27	30	28
	30	43	27	20	8	3	3	4	1	1	0	0
	0	0	0	0	0	2	6	15	16	22	10	11
	15	14	28	32	35	16	24	6	2	2	0	1
	0	0	0									
2008	1	10	3	0	90	0	0	0	0	1	2	4
	8	4	9	8	21	39	28	20	24	21	34	28
	31	35	39	29	15	7	4	2	0	0	0	0
	0	0	0	1	8	5	4	6	11	24	35	17
	13	24	19	22	18	18	11	7	6	1	1	1
	0	0	0									
#year	Seas	Flt/Svy	Gender	Part	Nsamp	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
2003	1	11	3	0	50.386	27197	11383	0	0	0	11813	0
	0	0	0	0	0	15915	11915	12124	23276	32833	79821	48055
	11954	10989	21575	12509	20128	10050	14116	5828	4907	3832	60645	24947
	0	0	0	24446	10050	0	0	8614	26382	0	47745	40287
	37038	90203	37872	32505	15464	42155	32096	20064	0	0	0	5828
	0	0	0									

2004	1	11	3	0	101.034	40952	0	0	8393	42936	142187	242935
	284795	19247	128291	110985	154430	58923	66838	163055	200045	76111	249624	218763
	781530	189565	121889	53389	32236	10522	42466	11785	0	0	64788	12441
	0	21732	21795	164436	298166	322050	192814	68972	159780	86524	157021	126357
	158122	504012	422567	288074	762757	398354	49024	11306	10522	19952	20956	0
	18928	0	0									
2005	1	11	3	0	91.746	70603	0	0	5239	18024	19905	81266
	17306	114378	71886	167169	34903	0	34031	18501	21842	42470	89032	132638
	130974	83733	62020	25920	17441	26041	10022	69934	11926	0	182751	16181
	5239	0	37495	35278	34668	0	107986	145604	93804	72770	20401	18592
	41310	29922	146948	246914	190060	164801	60428	24711	32524	33144	0	0
	0	0	0									
2006	1	11	3	0	66.67	0	0	20589	10740	31866	76080	27333
	10422	0	32776	18325	11150	105043	165482	29012	20970	0	17655	32431
	31455	31455	64525	0	16465	0	16465	39661	13721	6462	0	0
	21480	42717	210063	316001	19216	20041	0	0	30842	21631	231122	196774
	32597	10485	20970	30818	32116	19442	25396	22068	7259	18957	5235	10342
	8442	0	0									
2007	1	11	3	0	47.562	0	0	0	0	0	0	0
	28511	30242	97493	28339	20631	0	20341	9901	110539	86822	10170	10170
	30313	20413	64968	27462	43878	11473	0	0	0	0	0	8918
	0	0	0	0	0	0	85902	119473	34810	0	18487	61023
	50119	54558	40681	30224	90747	104051	61897	35222	29778	0	0	0
	0	0	0									
2008	1	11	3	0	36.076	0	0	0	0	43321	20085	0
	0	0	0	12235	12235	12235	0	0	0	11455	9689	18989
	16558	46224	21916	26345	31822	38671	31710	14352	19467	0	9606	0
	7358	10043	10043	0	0	0	10043	0	10043	22278	12235	0
	31520	16949	7830	15660	44727	33702	106688	65828	49155	17977	15660	15660
	0	0	0									

this is the Gotshall and Miller LF data from Central California sampling programs

#year	Seas	Flt/Svy	Gender	Part	#_samp	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
1959	1	14	0	0	-10	9	0	0	0	0	0	0
	0	0	3	3	4	5	12	19	28	24	40	24
	24	15	14	5	4	6	3	1	0	3	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1960	1	14	0	0	-95	0	1	2	1	0	0	0
	0	1	5	4	5	25	42	121	123	166	122	103
	105	58	26	20	14	5	5	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									
1961	1	14	0	0	-25	0	0	0	0	0	0	0
	0	6	2	2	2	1	5	22	44	51	57	25
	10	13	2	6	3	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									
1966	1	14	0	0	-30	140	3	2	1	1	3	5
	2	10	28	40	35	14	6	1	10	12	28	30
	25	15	13	21	3	4	3	3	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									

this is the observer LF data

#Yr	Seas	Flt/Svy	Gender	Part	Neff	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
2002	1	15	0	0	24.38	0	0	0	0	0	0	0
	0	0	0	1	1	8	19	10	16	9	15	11
	11	7	7	3	3	1	0	3	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									
2003	1	15	0	0	8.83	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	3	5	6	4
	6	2	4	0	0	0	0	5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
2004	1	15	0	0	60.36	0	0	12	4	7	0	2
	0	0	0	0	0	2	3	7	9	24	28	45
	40	21	26	24	18	14	11	9	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									
2005	1	15	0	0	123.2	0	0	0	0	0	2	1
	0	0	2	6	8	5	8	21	34	49	66	85
	88	88	56	50	35	32	16	22	8	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									
2006	1	15	0	0	38.80	0	0	0	0	0	0	0
	0	0	0	1	2	5	11	20	19	13	10	14
	27	14	11	13	9	7	4	5	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									
2007	1	15	0	0	44.46	0	1	0	0	1	1	0
	1	0	1	2	1	1	0	3	2	8	23	13
	17	21	15	14	12	12	10	8	1	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									
2008	1	15	0	0	2.828	0	0	0	0	1	2	0
	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	1	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
#Yr	Seas	Flt/Svy	Gender	Part	Neff	16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52
	54	56	58	60	62	64	66	68	72	76	16	18
	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52	54	56	58	60	62	64	66
	68	72	76									
1975	1	16	0	0	400	3	8	18	22	124	435	1059
	2645	3183	2660	2729	2587	1969	910	662	705	717	495	354
	236	129	69	57	41	19	10	12	7	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									
1976	1	16	0	0	400	7	5	9	35	91	160	381
	1136	2293	2505	2364	3574	3567	2634	1841	1329	1140	895	687
	463	292	154	131	87	43	31	31	14	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									
1977	1	16	0	0	400	35	86	114	66	36	48	126
	252	276	290	438	1081	1428	1372	1514	1256	815	587	485
	389	279	162	96	77	49	41	25	8	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0									
1978	1	16	0	0	400	24	26	293	978	1346	1444	1622
	1729	1059	343	261	389	669	863	1218	1390	1348	1042	752
	625	464	295	189	106	41	34	21	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									
1986	1	16	0	0	400	3	1	17	23	25	60	139
	373	629	701	610	497	335	133	68	58	86	91	79
	72	47	38	13	8	2	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									
1987	1	16	0	0	400	1	0	0	1	3	15	36
	100	134	171	305	548	596	382	191	110	66	57	54
	48	45	31	29	13	6	3	3	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									
1988	1	16	0	0	341	7	6	7	14	1	17	38
	89	106	80	49	103	137	186	260	239	178	93	69
	73	26	22	30	12	11	7	8	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									
1989	1	16	0	0	400	9	11	33	167	289	286	390
	715	679	318	117	120	134	183	260	340	290	207	190
	113	65	33	33	16	16	7	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	0	0
	0	0	0									

21 #_N_age_bins
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
1 #_combine males into females at or below this bin number
#Yr Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)

0 #_N_MeanSize-at-Age_obs
#Yr Seas Flt/Svy Gender Part Ageerr Ignore datavector(female-male)

1 #_N_environ_variables
0 #_N_environ_obs
1 # N sizefreq methods to read

25 #Sizefreq N bins per method
1 #Sizetfreq units(bio/num) per method
1 #Sizefreq scale(kg/lbs/cm/inches) per method
1e-005 #Sizefreq mincomp per method
20 #Sizefreq N obs per method
#_Sizefreq bins

0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6
	2.8	3	3.2	3.4	3.6	3.8	4	4.5	5	5.5	6	6.5

#_Year season Fleet Partition Gender SampleSize <data>
southern California RecFIN

#	#Yr	Seas	Flt/Svy	Gender	Part	Nsamp	0.2	0.4	0.6	0.8	1	1.2
	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4	3.6
	3.8	4	4.5	5	5.5	6	6.5	0.2	0.4	0.6	0.8	1
	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4
	3.6	3.8	4	4.5	5	5.5	6	6.5				
1	1980	1	4	0	0	-176	253	258	821	536	209	121
	81	81	66	55	41	35	21	10	5	4	4	2
	0	3	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
1	1981	1	4	0	0	-148	211	395	367	302	316	240
	110	72	58	60	31	33	16	8	3	3	4	0
	0	0	2	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	1982	1	4	0	0	-135	40	82	313	320	268	306
	174	115	71	54	39	19	9	6	1	4	3	0
	1	2	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				
1	1983	1	4	0	0	-99	8	58	123	103	79	80
	41	39	36	42	33	17	7	12	3	9	8	0
	1	4	2	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
1	1984	1	4	0	0	-181	127	13	30	63	79	102
	47	45	30	19	8	14	4	3	2	3	3	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	0	0				
1	1985	1	4	0	0	-147	669	281	30	29	49	63
	55	50	42	26	21	8	13	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	0	0	0	0				
1	1986	1	4	0	0	-119	253	567	266	41	24	20
	32	16	18	20	21	2	7	2	5	2	1	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				
1	1987	1	4	0	0	-32	37	20	33	10	12	6
	1	4	1	5	2	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
1	1988	1	4	0	0	-39	12	12	13	11	12	8
	4	2	3	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				
1	1989	1	4	0	0	-50	139	105	42	41	49	28
	26	14	7	6	4	8	5	1	4	1	4	2

	0	1	0	2	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				

Northern California RecFIN

#use	YEAR	Seas	Flt/Svy	Gender	Part	Nsamp	0.2	0.4	0.6	0.8	1	1.2
	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4	3.6
	3.8	4	4.5	5	5.5	6	6.5	0.2	0.4	0.6	0.8	1
	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4
	3.6	3.8	4	4.5	5	5.5	6	6.5				
1	1980	1	5	0	0	-70	24	4	27	42	16	16
	22	14	11	14	3	6	9	6	3	3	5	1
	3	12	2	5	0	1	3	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
1	1981	1	5	0	0	-34	2	12	12	16	46	48
	21	6	6	13	10	12	6	8	5	3	4	6
	1	4	7	2	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	1982	1	5	0	0	-50	1	7	13	22	18	48
	44	50	31	26	15	7	4	5	7	4	4	1
	0	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	0	0	0	0				
1	1983	1	5	0	0	-46	3	9	6	11	21	33
	47	44	46	48	29	17	13	8	7	6	5	1
	2	1	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				
1	1984	1	5	0	0	-69	6	8	16	15	21	17
	18	17	16	9	8	5	6	9	1	5	2	1
	4	1	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				
1	1985	1	5	0	0	-99	301	37	13	21	21	20
	17	18	17	11	12	16	9	13	10	8	2	4
	1	3	3	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				
1	1986	1	5	0	0	-105	84	365	266	45	5	10
	12	14	16	18	14	19	16	17	6	6	10	7
	3	6	3	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				
1	1987	1	5	0	0	-37	9	55	50	19	8	5
	2	2	5	4	4	7	5	11	7	8	2	3
	5	6	4	2	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				
1	1988	1	5	0	0	-36	3	10	10	7	4	8
	5	3	1	1	0	1	2	0	0	1	0	0
	0	0	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				
1	1989	1	5	0	0	-36	8	17	27	3	11	14
	16	8	8	2	1	0	0	0	1	0	1	0
	0	1	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0				

0 # no tag data
0 # no morphcomp data

999

ENDDATA

Control File

```
#_data_and_control_files:
#_SS-V3.01-O-opt;_12/16/08;_Stock_Synthesis_by_Richard_Methot_(NOAA);_using_Otter_Research_ADMB_7.0.1
1  #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond  1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)

#_Cond 0  #  N recruitment designs goes here if N_GP*nseas*area>1
#_Cond 0  #  placeholder for recruitment interaction request
#_Cond 1 1 1  # example recruitment design element for GP=1, seas=1, area=1

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

3 #_Nblock_Patterns
11 6 18 #_blocks_per_pattern
# begin and end years of blocks
1975 1977
1978 1980
1981 1983
1984 1986
1987 1989
1990 1992
1993 1995
1996 1998
1999 2001
2002 2004
2005 2008

1970 1979
1980 1988
1989 1991
1992 1998
1999 2003
2004 2008

1973	1974
1975	1976
1977	1978
1979	1980
1981	1982
1983	1984
1985	1986
1987	1988
1989	1990
1991	1992
1993	1994
1995	1996
1997	1998
1999	2000
```

2001 2002
2003 2004
2005 2006
2007 2008

0.5 #_fracfemale
1 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
2 #_N_breakpoints
1 5 # age(real) at M breakpoints
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented
1.5 #_Growth_Age_for_L1
25 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
1 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity
#_placeholder for empirical age-maturity by growth pattern
1 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0
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-var	use_dev	dev_min	dev_max	dev_std	Block	Blk_Fxn		
0.05	0.25	0.15	0.16	0	0.8	-3	0	0	0	0	0.5	0	0	#	NatM_p_1_Fem_GP:1
0.05	0.25	0.15	0.16	0	0.8	-3	0	0	0	0	0.5	0	0	#	NatM_p_2_Fem_GP:1
1	45	26	27	0	10	-4	0	0	0	0	0.5	0	0	#	L_at_Amin_Fem_GP_1
60	80	67.738	69	0	10	3	0	0	0	0	0.5	0	0	#	L_at_Amax_Fem_GP_1
0.15	0.25	0.21958	0.21	0	0.8	3	0	0	1970	2008	0.5	3	1	#	VonBert_K_Fem_GP_1
0.05	0.25	0.1	0.1	0	0.8	-6	0	0	0	0	0.5	0	0	#	CV_young_Fem_GP_1
0.05	0.25	0.08	0.1	0	0.8	-3	0	0	0	0	0.5	0	0	#	CV_old_Fem_GP_1
0.05	0.25	0.15	0.16	0	0.8	-3	0	0	0	0	0.5	0	0	#	NatM_p_1_Mal_GP:1
0.05	0.25	0.15	0.16	0	0.8	-3	0	0	0	0	0.5	0	0	#	NatM_p_2_Mal_GP:1
1	45	26	27	0	10	-4	0	0	0	0	0.5	0	0	#	L_at_Amin_Mal_GP_1
50	70	58.9149	61	0	10	3	0	0	0	0	0.5	0	0	#	L_at_Amax_Mal_GP_1
0.2	0.3	0.26418	0.2	0	0.8	3	0	0	1970	2008	0.5	3	1	#	VonBert_K_Mal_GP_1
0.05	0.25	0.1	0.1	0	0.8	-6	0	0	0	0	0.5	0	0	#	CV_young_Mal_GP_1
0.05	0.25	0.08	0.1	0	0.8	-3	0	0	0	0	0.5	0	0	#	CV_old_Mal_GP_1
-3	3	7.355E-06	2.44E-06	0	0.8	-3	0	0	0	0	0.5	0	0	#	Wtlen_1_Mal
-3	4	3.11359	3.34694	0	0.8	-3	0	0	0	0	0.5	0	0	#	Wtlen_2_Mal
30	60	39.9	37.7	0	0.8	-3	0	0	0	0	0.5	0	0	#	Mat50%_Fem
-3	3	-0.359	-0.2876	0	0.8	-3	0	0	0	0	0.5	0	0	#	Mat_slope_Fem

```
#-3	3	0.22475	0.25	0	0.8	-3	0	0	0	0	0.5	0
	0	#	Eg/gm_inter_Fem
#-3	3	0.03657	0	0	0.8	-3	0	0	0	0	0.5	0
	0	#	Eg/gm_slope_wt_Fem
-3	3	192.5	190	0	0.8	-3	0	0	0	0	0.5	0
	0	#	Eg/gm_inter_Fem
-3	3	49.3	36.57	0	0.8	-3	0	0	0	0	0.5	0
	0	#	Eg/gm_slope_wt_Fem
-3	3	7.355E-06	2.44E-06	0	0.8	-3	0	0	0	0	0.5
	0	0	#	Wtlen_1_Mal
-3	4	3.11359	3.34694	0	0.8	-3	0	0	0	0	0.5	0
	0	#	Wtlen_2_Mal
0	0	0	0	-1	0	-4	0	0	0	0	0	0
	0	#	RecrDist_GP_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0
	0	#	RecrDist_Area_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0
	0	#	RecrDist_Seas_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0
	0	#	CohortGrowDev


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

1 #_Cond 0  #custom_MG-block_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters
#_LO	HI	INIT	PRIOR	PR_type SD	PHASE
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4
```

-5	5	0	0	0	-5	-4
-5	5	0	0	0	-5	-4

#_seasonal_effects_on_biology_parms
0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters

#_Cond -4 #_MGparm_Dev_Phase

#_Spawner-Recruitment
3 #_SR_function
#_LO HI INIT PRIOR PR_type SD PHASE
6 15 9.5 9 0 10 1 # SR_R0
0.2 1 0.736 0.73 0 0.186 5 # SR_steep
0 2 1 0.95 0 0.8 -4 # SR_sigmaR
-5 5 0 0 0 1 -3 # SR_envlink
-5 5 0 0 0 1 -4 # SR_R1_offset
0 0 0 0 -1 0 -99 # 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
1954 # 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
2 #_recdev phase

1 # (0/1) to read 11 advanced options
0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
-4 #_recdev_early_phase
0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
1 #_lambda for prior_fore_recr occurring before endyr+1
1965 #_last_early_yr_nobias_adj_in_MPD
1975 #_first_yr_fullbias_adj_in_MPD
2008 #_last_yr_fullbias_adj_in_MPD
2009 #_first_recent_yr_nobias_adj_in_MPD
1.
0
-5 #min rec_dev
5 #max rec_dev
0 #_read_recdevs
#_end of advanced SR options
read specified recr devs
#_Yr Input_value

#Fishing Mortality info
0.26 # F ballpark for tuning early phases
1980 # F ballpark year (neg value to disable)
3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
2.9 # max F or harvest rate, depends on F_Method

#need these three lines when doing option 2
#0.1 # start F
#1   # overall phase
#0   # N detailed inputs
#5 # need this for Fmethod 3, number if tuning iterations in hybrid F, 4 or 5 usually good
5

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)

```
#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 0.1 0 0.01 1 99 -2 # InitF_1FISHERY1
0.0001 0.05 0.007 0.007 0 99 2 # InitF_1FISHERY2
0 0.1 0 0.01 1 99 -2 # InitF_1FISHERY3
0 0.1 0 0.01 1 99 -2 # InitF_1FISHERY4
0 0.1 0 0.01 1 99 -2 # InitF_1FISHERY5
0 0.1 0 0.01 1 99 -2 # InitF_1FISHERY6


#_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 FISHERY1
0 0 0 0 1 0 # 1 FISHERY2
0 0 0 0 1 0 # 1 FISHERY3
0 0 0 0 1 0 # 1 FISHERY4
0 0 0 0 1 0 # 1 FISHERY5
0 0 0 0 1 0 # 1 FISHERY6
0 0 0 0 1 0 # 2 SURVEY1
0 0 0 0 1 0 # 3 SURVEY2
0 0 0 0 1 0 # 1 SURVEY3
0 0 0 0 1 0 # 1 SURVEY4
0 0 0 0 1 0 # 1 SURVEY5
0 0 0 0 1 0 # 1 SURVEY6
0 0 0 0 1 0 # 1 SURVEY7
0 0 0 0 1 0 # 1 SURVEY8
0 0 0 0 1 0 # 1 SURVEY9
0 0 0 0 1 0 # 1 SURVEY10

#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of
index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE

#_size_selex_types
#_Pattern Discard Male Special
24 0 0 0 #  FISHERY1 trawl
24 0 0 0 #  FISHERY2 hookline
24 0 0 0 #  FISHERY3 gillnet
24 0 0 0 #  FISHERY4 southrec
1 0 0 0  #  FISHERY5 cenrec
1 0 0 0  #  Fishery6 trawlnorth
30 0 0 0 #  SURVEY1 calcofi
24 0 0 0 #  SURVEY2 triennial
5 0 0 5  #  SURVEY3 deb w-v
24 0 0 0 #  SURVE4 hookline
1 0 0 0  #  SURVEY5 nwc combo
33 0 0 0 #  SURVEY6 juvenile survey
0 0 0 0  #  SURVEY7 pier index
5 0 0 5  #  SURVEY8 60s MBay rec LFs
5 0 0 1  #  SURVEY9 mirror southern trawl to look at LFs from observer fleet
5 0 0 4  #  SURVEY10 - mirror southern rec (for CPFV obs. LFs)


#_age_selex_types
#_Pattern ___ Male Special
11 0 0 0 # 1 FISHERY1
11 0 0 0 # 1 FISHERY2
```

```
11 0 0 0 # 1 FISHERY3
11 0 0 0 # 1 FISHERY4
11 0 0 0 # 1 FISHERY5
11 0 0 0 # 1 FISHERY6
11 0 0 0 # 2 SURVEY1
11 0 0 0 # 3 SURVEY2
11 0 0 0 # 3 SURVEY3
11 0 0 0 # 3 SURVEY4
11 0 0 0 # 3 SURVEY5
11 0 0 0 # 3 SURVEY6
11 0 0 0 # 3 SURVEY7
11 0 0 0 # 3 SURVEY8
11 0 0 0 # 3 SURVEY9
11 0 0 0 # 3 SURVEY10

#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#_size_sel: trawl - try logistic-

15     60     45.5     46     0     20     3     0     0     0     0     0.5     0
       0      #        PEAK   value
-10    10     -4.822   5      0     10     -4    0     0     0     0     0.5     0
       0      #        TOP    logistic
1      15     4.296    3.5    0     10     -4    0     0     0     0     0.5     0
       0      #        WIDTH  exp
-1     9      4.76     2      0     10     -4    0     0     0     0     0.5     0
       0      #        WIDTH  exp
-15    9      -10.5    -4.5   0     10     -4    0     0     0     0     0.5     0
       0      #        INIT   logistic
-5     9      -0.766   2      0     10     -4    0     0     0     0     0.5     0
       0      #        FINAL  logistic

# size_se1: 1- male offsets- 4 lines
#1     60     16       20     0     100    -5    0     0     0     0     0.5     0
       0      #        size@dogleg
#-10   0      0        0      0     10     -5    0     0     0     0     0.5     0
       0      #        log(relmalesel)at minL
#-10   0      0        0      0     10     -5    0     0     0     0     0.5     0
       0      #        log(relmalesel)at dogleg
#-10   0      0        0      0     10     -5    0     0     0     0     0.5     0
       0      #        log(relmalesel) at maxL
# size_se1: 1- male offsets- 4 lines
# fishery 2
15     60     52.459   55     0     20     3     0     0     0     0     0.5     0
       0      #        PEAK   value
-10    10     -10      5      0     10     3     0     0     0     0     0.5     0
       0      #        TOP    logistic
1      15     4.096    3.5    0     10     3     0     0     0     0     0.5     0
       0      #        WIDTH  exp
-1     9      4.744    2      0     10     3     0     0     0     0     0.5     0
       0      #        WIDTH  exp
-15    9      -11.22   -4.5   0     10     3     0     0     0     0     0.5     0
       0      #        INIT   logistic
-5     9      -1       2      0     10     3     0     0     0     0     0.5     0
       0      #        FINAL  logistic
# fishery 3
15     60     50.713   55     0     20     3     0     0     0     0     0.5     0
       0      #        PEAK   value
-10    10     -9.8     -5     0     10     3     0     0     0     0     0.5     0
       0      #        TOP    logistic
1      15     3.008    3.5    0     10     3     0     0     0     0     0.5     0
       0      #        WIDTH  exp
```

```
-1 9 4.408 2 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
-15 9 -11.22 -6 0 10 3 0 0 0 0 0.5 0 0 # INIT logistic
-5 9 -1.76 2 0 10 3 0 0 0 0 0.5 0 0 # FINAL logistic
#_size_sel: 4 double logistic-
15 60 36 40 0 20 3 0 0 0 0 0.5 0 0 # PEAK value
-10 10 -7 -5 0 10 3 0 0 0 0 0.5 0 0 # TOP logistic
1 15 4 3.5 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
-1 9 5.2 5 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
-15 9 -4 -4.5 0 10 3 0 0 0 0 0.5 0 0 # INIT logistic
-5 9 -3.28 -4 0 10 3 0 0 0 0 0.5 0 0 # FINAL logistic
# size_sel fishery 5 cenrec double logistic
#15 80 54.68 55 0 20 3 0 0 0 0 0.5 0 0 # PEAK value
#-10 10 5.1 5 0 10 3 0 0 0 0 0.5 0 0 # TOP logistic
#1 15 6.1 3.5 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
#-1 9 2.5 2 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
#-15 9 -2.86 -4.5 0 10 3 0 0 0 0 0.5 0 0 # INIT logistic
#-5 9 1.25 2 0 10 3 0 0 0 0 0.5 0 0 # FINAL logistic
#_size_sel: cenRec - try logistic-
5 50 40 35 0 50 3 0 0 0 0 0 0 0 #
0.0001 35 10 15 0 10 3 0 0 0 0 0 0 0 #

# size_sel fishery 6 trawlnorth double logistic
#13 80 54.68 55 0 20 3 0 0 0 0 0.5 0 0 # PEAK value
#-10 10 -9.792 5 0 10 3 0 0 0 0 0.5 0 0 # TOP logistic
#1 15 6.112 3.5 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
#-1 9 5.56 2 0 10 3 0 0 0 0 0.5 0 0 # WIDTH exp
#-15 9 -2.86 -4.5 0 10 3 0 0 0 0 0.5 0 0 # INIT logistic
#-5 9 -1.25 2 0 10 3 0 0 0 0 0.5 0 0 # FINAL logistic

# size sel for fishery 6- northern trawl
5 50 40 35 0 50 3 0 0 0 0 0 0 0 #
0.0001 35 10 5 0 10 3 0 0 0 0 0 0 0 #
#-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY3 - min and max bins
#-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY3 - min and max bins# sel survey 8 triennial
# size selectivity survey 8 - triennial
#5 50 40 20 0 50 3 0 0 0 0 0 0 0 #
```

#0.0001 35 10 5 0 10 3 0 0 0 0 0 0
0 #

sel survey 8 - triennial double logistic
15 80 24 25 0 20 -3 0 0 0 0 0.5 0
0 # PEAK value
-10 10 -9.792 5 0 10 -3 0 0 0 0 0.5 0
0 # TOP logistic3
1 15 6.112 3.5 0 10 -3 0 0 0 0 0.5 0
0 # WIDTH exp
-1 9 5.56 2 0 10 -3 0 0 0 0 0.5 0
0 # WIDTH exp
-15 9 -2.86 -4.5 0 10 -3 0 0 0 0 0.5 0
0 # INIT logistic
-5 9 -1.25 2 0 10 -3 0 0 0 0 0.5 0
0 # FINAL logistic
size sel 9 cpfv, set to mirror northrec
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY3 - min and max bins
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY3 - min and max bins# sel survey 8 triennial

#_size_sel: 10 SCB hook line double logistic-
15 60 54 55 0 20 3 0 0 0 0 0.5 0
0 # PEAK value
-10 10 -3.9 -5 0 10 3 0 0 0 0 0.5 0
0 # TOP logistic
1 15 12.2 3.5 0 10 3 0 0 0 0 0.5 0
0 # WIDTH exp
-1 9 5.2 2 0 10 3 0 0 0 0 0.5 0
0 # WIDTH exp
-15 9 -1.7 -4.5 0 10 3 0 0 0 0 0.5 0
0 # INIT logistic
-5 9 -3.3 2 0 10 3 0 0 0 0 0.5 0
0 # FINAL logistic

size sel. 11 - combo survey - mirror triennial
#-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY3 - min and max bins
#-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY3 - min and max bins# sel survey 8 triennial
5 50 30 25 0 50 3 0 0 0 0 0 0
0 #
0.0001 35 10 15 0 10 3 0 0 0 0 0 0
0 #
size selectivity survey 11 - NWFSC combo survey
#13 60 28.52 55 0 20 3 0 0 0 0 0.5 0
0 # PEAK value
#-10 10 -1.23 5 0 10 3 0 0 0 0 0.5 0
0 # TOP logistic
#1 15 4.43 3.5 0 10 3 0 0 0 0 0.5 0
0 # WIDTH exp
#-2 9 -1.5 2 0 10 3 0 0 0 0 0.5 0
0 # WIDTH exp
#-15 9 -0.58 -4.5 0 10 3 0 0 0 0 0.5 0
0 # INIT logistic
#-5 9 -0.03 2 0 10 3 0 0 0 0 0.5 0
0 # FINAL logistic

size selectivity survey 14 - 60s LFs from CenCal Rec fishery- mirror cen/north rec
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY
size sel. 15 bycatch LF data from observer program, link to southern trawl fishery
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY

```
# size sel. 16 mirror southern rec for LF data from CPFV observer program
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_1_SURVEY
-1 20 -1 -1 -1 99 -3 0 0 0 0 0.5 0 0 # SizeSel_1P_2_SURVEY


0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY1
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY1
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY2
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY2
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY3
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY3
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY4
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY4
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY5
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY5
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_1_FISHERY6
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_1P_2_FISHERY6
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_1_SURVEY1
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY1
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_1_SURVEY2
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY2
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY3
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY3
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY4
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY4
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY5
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY5
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY6
0 21 0 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_2_SURVEY6
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY7
0 21 0 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_2_SURVEY7
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY8
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY8
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY9
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY9
0 21 0 5 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_3P_1_SURVEY10
0 21 40 6 0 99 -1 0 0 0 0 0.5 0 0 # AgeSel_2P_2_SURVEY10




#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns


# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters

1 #_Variance_adjustments_to_input_values
#_1 2 3
  0.06 0 0 0.59 0.6 0 0.285 0.5 0.22 -0.06 0.25 0.96 0 0 0 0#_add_to_survey_CV
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_discard_stddev
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 #_add_to_bodywt_CV
  0.76 1 0.81 0.63 0.83 0.485 1 0.32 1 1 1 1 1 1 1 0.63 #_mult_by_lencomp_N
  1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 #_mult_by_agecomp_N
  1 1 1 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

4 #_maxlambdaphase
0 #_sd_offset
```

```
3 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin
#like_comp fleet/survey  phase  value  sizefreq_method

1 1 1 1 1
1 8 1 1 1
4 15 1 0.0001 1


# lambdas (for info only; columns are phases)
0 # (0/1) read specs for more stddev reporting
# runfaster using ss3 bat -nohess nox
# R output viewer commands- after loading routines
#myreplist <- SSv3_output(dir='c:\\SS3ver3\\bocstar\\', covar=F)
#SSv3_plots(replist=myreplist,plot=1:7)
#
999
```

Forecast File

```
4 # 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
2001 # first year to use for averaging selex to use in forecast (e.g. 2004; or use -x to be rel endyr)
2001 # 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: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.4 # SPR target (e.g. 0.40)
0.4 # Biomass target (e.g. 0.40)
12 # N forecast years
1 # read 10 advanced options
 0 # 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)
 2002 # 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 # basis for max forecast catch by seas and area (0=none; 1=deadbio; 2=retainbio; 3=deadnum; 4=retainnum)
 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
# max forecast catch
# rows are seasons, columns are areas
 -1000
1 # fleet allocation (in terms of F) (1=use endyr pattern, no read; 2=read below)
#  0.000897327 0.000385902 0 0.00692334 0.000251874 0.000148217
0 # 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
#Year Seas Fleet Catch


999 # verify end of input
```