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Stock assessments, STAR Panel reports, and rebuilding analyses

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Status of the Chilipepper rockfish, *Sebastes goodei*, in 2007

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EXECUTIVE SUMMARY

Stock Structure: This assessment applies to the chilipepper rockfish (*Sebastes goodei*) in the waters off of California and Oregon, in the region bounded by the U.S./Mexico border in the south through the Columbia River in the north. Although the distribution is described in the literature as ranging from Queen Charlotte Sound (British Columbia) to Bahia Magdalena (Baja California Sur), the region of greatest abundance is found between Point Conception and Cape Mendocino, California.

Catch History: Chilipepper rockfish have been one of the most important commercial target species in California waters since the 1880s, as well as an important recreational target in Southern California waters historically, and an important recreational target in central and northern California more recently (following the movement of recreational fishing effort to deeper waters in the 1970s and 1980s). Catches were estimated to have begun in 1892, and are estimated to have ranged from several hundred to nearly 1000 tons throughout the first half of the 20th century. Gear types are grouped into four general categories; trawl, hook and line, setnet, and recreational; since World War II a majority has been taken with trawl gear, although hook and line, setnet, and recreational gear have accounted for between 20 and 40% of landings for most of the last three decades. As early rockfish landings were only reported at the genus level, a combination of historical data and publications, as well as anecdotal accounts of early line, trawl, and recreational fisheries, were used to reconstruct the fraction of catch by gear and sector assumed to be chilipepper. Estimated landings from foreign fisheries from the mid-1960s through the mid-1970s were included as part of the trawl fishery. Throughout most of the past three decades, domestic landings have ranged between approximately 2000 and 3000 tons, however since 2002 landings have averaged less than 100 tons per year (Table E1, Figure E1), primarily a consequence of area closures implemented to rebuild depleted co-occurring species such as bocaccio (*S. paucispinis*) and canary (*S. pinniger*) rockfish. Discards are assumed to be negligible in the historical period, however regulatory discards have been substantial in recent years, more than doubling the total catch relative to landings since 2002.

Table E1: Recent commercial and recreational landings (mt, excludes discards)

Year	Trawl	Hook/line	Setnet	Recreation
1995	1595	325	94	7
1996	1528	254	58	30
1997	1614	339	83	73
1998	1138	209	78	5
1999	839	104	10	24
2000	403	51	6	39
2001	436	25	5	52
2002	162	3	0.2	12
2003	18	0.2	0.1	0
2004	61	3	1	6
2005	60	3	0.1	4
2006	37	6	0.2	1

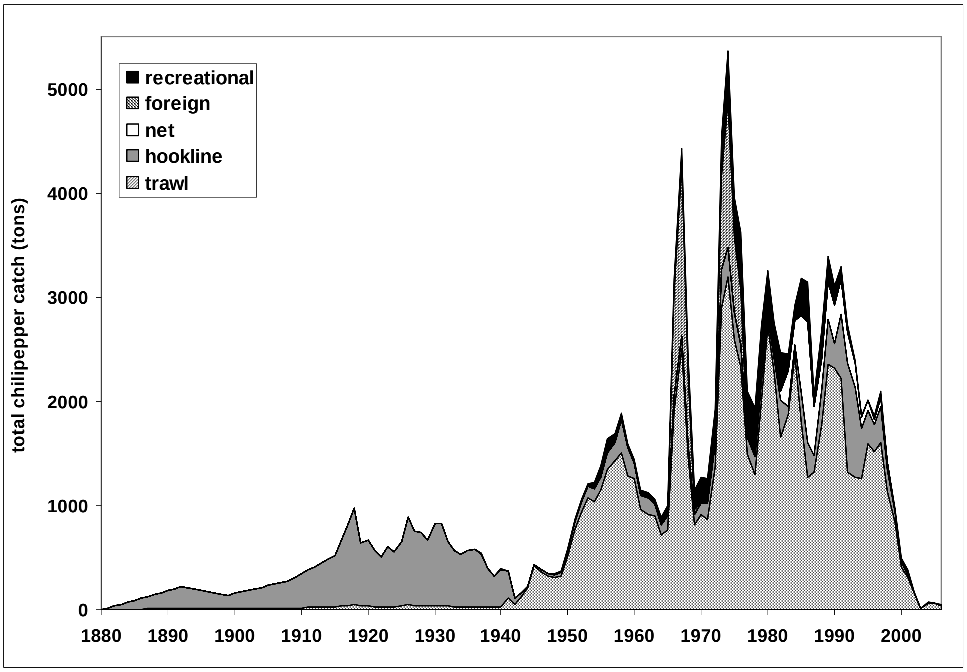

Figure E1: Estimated catches of chilipepper rockfish by major fishery

Data and Assessment: Chilipepper rockfish were last assessed in 1998 (Ralston et al. 1998), at which time they were considered to be above target levels of abundance. From 1978 through 2006, commercial catches and demographic (age and length composition) data for California were obtained from the CalCOM database, those from Oregon were obtained from the PacFIN database, and recreational catches and length composition data were obtained from the RecFIN database beginning in 1981 (with interpolation of landings in missing years). Indices of relative abundance used in the assessment model included a catch per unit effort index from commercial trawl logbooks (from 1980 to 1996, developed and used in the 1998 assessment), an index of relative abundance from a recreational observer program (1987-1998), an index of relative abundance based on the triennial trawl survey (1980-2004), an index of relative abundance based on the Northwest Fishery Science Center Combined Survey (2003-2006), and a coastwide index of pelagic age-0 juvenile abundance developed by combining data from both the SWFSC and NWFSC/PWCC juvenile survey data. Several other potential sources of information were evaluated in earlier models and are discussed in the assessment documentation, although they were not used in the final model. The population was modeled using an age and size structured statistical model, Stock Synthesis II (SS2), version 2.00c, the modeling framework used for most West Coast groundfish assessments.

Unresolved Problems and Major Uncertainties

The length composition data were down-weighted when associated age-composition data were available, however the approach was acknowledged to be ad-hoc. A more appropriate approach is to use conditional age-at-length compositions, which should be explored in more detail in future modeling efforts.

The results from the convergence tests with randomly jittered starting parameter values indicated that the likelihood surface is very irregular. In general, biomass trajectories and other critical results do not appear to be sensitive to these differences.

The application of a combined age- and length- based selectivity curve for the recreational CPFV data is somewhat non-traditional and would benefit by either more detailed investigation or an alternative selectivity configuration (an age-based, sex-specific selection curve showed considerable promise).

Future (post-1999) year class strength is highly uncertain; although this model includes highly influential projections through 2006 based on juvenile abundance indices, the failure of the historical (core area) juvenile index to capture much of the year class variability that has been observed is cause for some concern.

The current approach for implementing time-varying growth would benefit by additional data (particularly fishery-independent size at age data), the use of conditional age-at-length data, and more comprehensive efforts to link variability in growth to climate conditions.

Stock Status: This assessment estimates that the spawning biomass of chilipepper rockfish (*Sebastes goodei*) has increased substantially in recent years, due to a strong 1999 year class as well as greatly reduced harvest rates in commercial and recreational fisheries. The base model result suggests a spawning biomass of 23,889 tons in 2006, corresponding to approximately 70% of the unfished spawning biomass of 33,390 tons and representing a near tripling of spawning biomass from the estimated low of 8696 tons (26% of unfished) in 1999 (Figure ES-1). As both commercial and recreational fisheries for chilipepper rockfish have been greatly reduced in recent years due to management measures implemented to rebuild depleted rockfish, it is likely that the stock will continue to increase modestly in the longer term under assumptions of equilibrium recruitment.

Table E2: Recent trends in chilipepper rockfish spawning biomass and relative depletion

year		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	*2007*
Summary biomass		17008	16453	15865	14578	13635	13573	18556	23175	27023	30022	31509	32405	*32401*
Spawning biomass		9812	9589	9489	8968	8666	9029	9536	12671	17040	20229	22146	23224	*23827*
~95 confidence limits on spawning biomass														
	lower	8418	8033	7743	7046	6608	6734	7044	9281	12336	14616	15984	16773	
	upper	11259	11202	11296	10953	10785	11379	12080	16125	21830	25948	28424	29797	
depletion		0.29	0.29	0.28	0.27	0.26	0.27	0.29	0.38	0.51	0.61	0.66	0.70	*0.71*
~95 confidence limits on depletion														
	lower	0.25	0.24	0.23	0.21	0.2	0.2	0.21	0.28	0.37	0.44	0.48	0.5	
	upper	0.34	0.34	0.34	0.33	0.32	0.34	0.36	0.48	0.65	0.78	0.85	0.89	

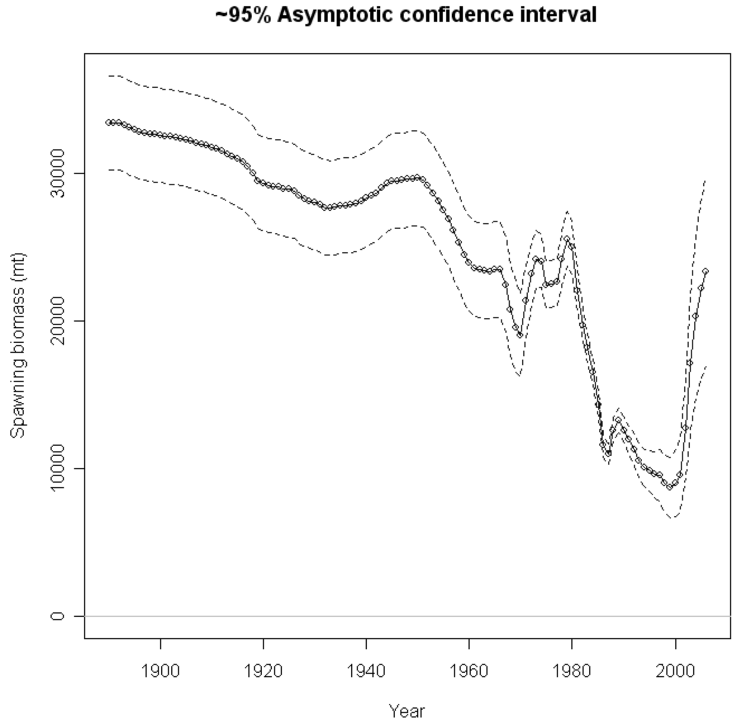

Figure E2: Estimated trajectory of spawning stock biomass over the modeled period.

Recruitment

An extremely strong 1999 year class represents the largest estimated historical recruitment, and is the primary cause for the current population trajectory. A year class of comparable strength was also observed in 1984, and the model suggests a series of strong year classes in the late 1960s and early 1970s as well. There are no obvious signs of strong year classes since 1999, and coastwide pelagic juvenile surveys suggest average to low recruitment in recent years, suggesting that the stock may dip slightly in the near term. The projected low recruitments in 2005 and 2006 are based exclusively on the coastwide pelagic juvenile rockfish survey index, which is of short duration and has yet to be validated.

Table E3: Estimated recruitment (1000s) for the recent (1995-2006) period

year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	*2007*
recruits	15080	6555	7584	12569	153415	3708	15148	23831	14082	25895	7647	6645	*32063*
~95 confidence limits on recruitment													
lower	8031	1399	2723	4260	104994	0	9036	14220	8380	15385	4546	3959	
upper	22095	11691	12465	20936	202966	8023	21322	33540	19842	36511	10779	9358	

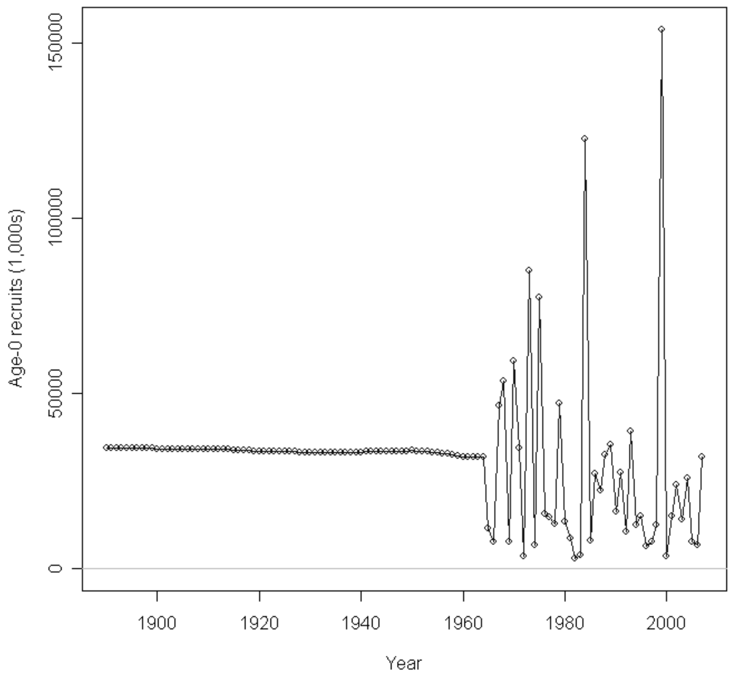

Figure E3: Estimated recruitment over the modeled time period

Exploitation Status: Although chilipepper rockfish have been a commercially important species in California waters since well before the second World War, the exploitation rate has rarely exceeded the current target exploitation rate (SPR 50%). The highest exploitation rates occurred from the late 1980s through the mid 1990s, when they were above target levels and the stock was approaching it's lowest estimated historical levels. From the late 1990s through the present, exploitation rates have been declining significantly, as a result of management measures implemented to rebuild other depleted rockfish species.

Table E4: Estimated exploitation rate (catch/sum bio) for the recent historical period

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Expl. Rate	0.119	0.113	0.133	0.098	0.071	0.037	0.028	0.014	0.001	0.008	0.006	0.004

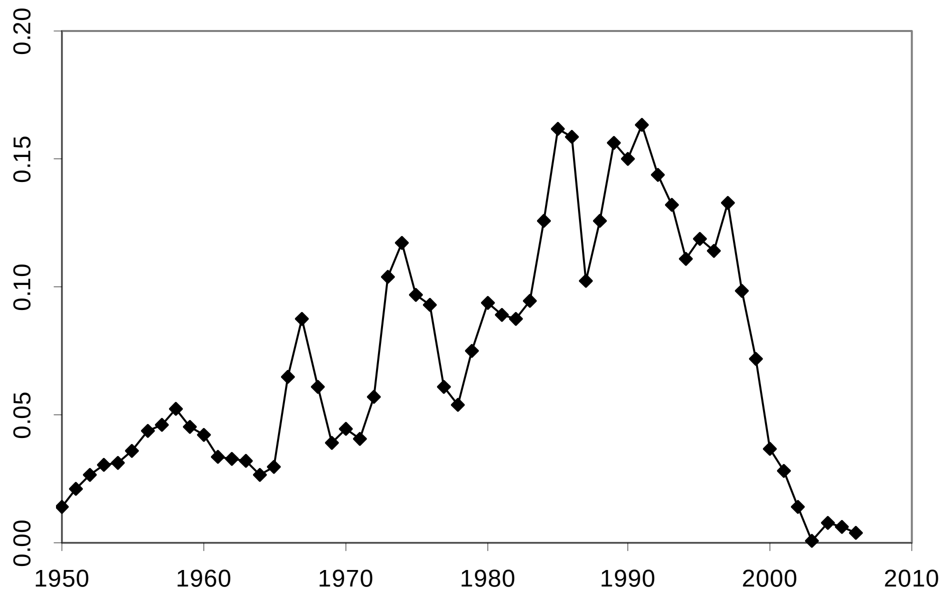

Figure E4: Estimated exploitation rate over the post-World War II period.

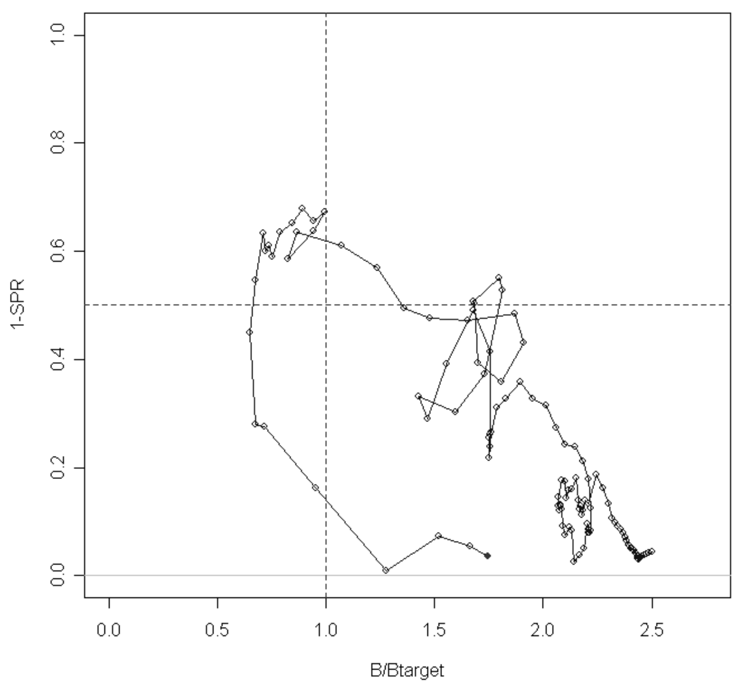

Figure E5: SPR relative to stock status through the modeled period

Reference Points

For rockfish of the genus *Sebastes*, the proxy for B_{MSY} is estimated to be 40% of the unfished spawning stock biomass (SSB_0), and the stock is considered to be overfished if the SSB drops below 25% of SSB_0. The proxy for MSY is estimated to be the harvest rate associated with a spawning potential ratio (%SPR) of 50%, which is a measure of the expected spawning biomass per recruit at the current population level relative to that at the stock's unfished condition (allowing for direct comparison of fishing mortality rates among fisheries with different selectivity patterns). The estimated MSY proxy (harvest associated with an SPR of 50%) for this assessment is 2099 tons, based on the relative proportion of total catches by fishery assumed in the last year for which data were available (2006), however this in no way intended to imply a de facto sector allocation. The estimated MSY value will change modestly depending upon allocation among fisheries with differing selectivity curves. With a greater proportion of catch allocated to fisheries that are selective at younger ages (trawl and recreational fisheries) the total yield would increase slightly, while if a greater fraction were allocated to hook and line or setnet fisheries, the total equilibrium yield would decrease slightly. Estimates of maximum sustainable yield based on a target equilibrium spawning biomass of 40% of the unfished spawning biomass, or on the model-estimated MSY, were very modestly greater than the $F_{50\%}$ SPR proxy for MSY.

Table E5: Summary of reference points for chilipepper rockfish

		~95% Confidence Limits	
Unfished Stock	Estimate	Lower	Upper
Summary (1+) Biomass	45057		
Spawning Biomass (SSB)	33390	30138	36642
Equilibrium recruitment	34490	31131	37849

	SPR proxy MSY	$SB_{40\%}$	Estimated MSY
SPR	0.50	0.45	0.43
Fmult (2006)	25.2	29.9	33.0
Exploitation rate	0.088	0.102	0.112
Yield	2099	2155	2164
SSB at Equilibrium	15482	21034	12126
SSB/SSB_0	0.46	0.40	0.36

Forecasts

Projections of future biomass were made for two possible catch stream scenarios; status quo (2006) catches and the catch associated with $F_{50\%}$ fishing mortality. Under all projections, selection curves were unchanged and the relative proportion of the catch by fishery was assumed to be at the 2006 value for ease of computation. In the $F_{50\%}$ projections, the 2007 and 2008 catches were assumed to be at status quo (2006 levels), as it is unlikely that catches could be significantly increased prior to the 2009-2010 management cycle, and as the spawning biomass was greater than 40% of the unfished level the OY was assumed to be equal to the ABC, and assumed to be fully achieved.

Table E6: Two alternative forecasts of Catch, Spawning Biomass and Depletion

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
status quo catch	127	127	127	127	127	127	127	127	127	127	127	127
SSB	23827	23285	22379	21574	21199	21226	21531	22011	22587	23211	23846	24473
Depletion	0.71	0.70	0.67	0.65	0.63	0.64	0.64	0.66	0.68	0.70	0.71	0.73
F50% catch	127	127	3037	2576	2229	2013	1901	1852	1831	1822	1814	1804
SSB	23827	23285	22379	19139	16940	15629	14911	14530	14312	14164	14041	13928
Depletion	0.71	0.70	0.67	0.57	0.51	0.47	0.45	0.44	0.43	0.42	0.42	0.42

Decision Table

The alternative states of nature used in the decision table were developed in conjunction with the STAR Panel, which considered a variety of potentially appropriate sources of uncertainty. As steepness was thought to be poorly specified for this model (perhaps more so than the natural mortality rate), the lower and upper 25% of the prior probability distribution for steepness based on the informative prior developed (but not used) in the assessment represented a reasonable means of bracketing uncertainty. As steepness was fixed at the mean value of the prior probability (0.57) in the base model, the alternative states of nature were consequently 0.34 (low productivity) and 0.81 (high productivity). The three catch streams used in the decision table were developed in coordination with the Groundfish Management Team (GMT) and Groundfish Advisory Subpanel (GAP) representatives to the STAR Panel, and represented "status quo" catches (based on estimates of the 2006 catch, including estimates of discards), equilibrium MSY catches (based on the SPR 0.50 harvest strategy), and ABC catches (based on the 40:10 harvest control rule). In all cases, the 2006 total catch estimates were used to apportion theoretical future catches among gear types, importantly this was done to facilitate comparable evaluation of plausible stock trajectories under different states of nature, and in no way implies a recommended or de facto sector allocation.

Rebuilding Projections

The chilipepper rockfish stock is estimated to be well above the overfished level, such that no rebuilding is required.

Table E7: Decision Table

					Low Productivity h=0.34		BASE MODEL h=0.57		High Productivity h=0.81	
	"Status quo" (2006) catches				SSB0	40568	SSB0	33390	SSB0	30489
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18542	0.46	23827	0.71	26482	0.87
2008	105	18	0.5	4	17887	0.44	23285	0.70	25949	0.85
2009	105	18	0.5	4	16995	0.42	22379	0.67	24991	0.82
2010	105	18	0.5	4	16255	0.40	21574	0.65	24072	0.79
2011	105	18	0.5	4	15929	0.39	21199	0.63	23526	0.77
2012	105	18	0.5	4	15966	0.39	21226	0.64	23347	0.77
2013	105	18	0.5	4	16239	0.40	21531	0.64	23436	0.77
2014	105	18	0.5	4	16645	0.41	22011	0.66	23704	0.78
2015	105	18	0.5	4	17118	0.42	22587	0.68	24082	0.79
2016	105	18	0.5	4	17624	0.43	23211	0.70	24522	0.80
2017	105	18	0.5	4	18141	0.45	23846	0.71	24986	0.82
2018	105	18	0.5	4	18661	0.46	24473	0.73	25451	0.83
	"MSY" catches (base model)									
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18542	0.46	23827	0.71	26485	0.87
2008	105	18	0.5	4	18325	0.45	23917	0.72	26652	0.87
2009	1735	292	7	64	17684	0.44	23385	0.70	26111	0.86
2010	1735	292	7	64	15560	0.38	21270	0.64	23899	0.78
2011	1735	292	7	64	14111	0.35	19814	0.59	22259	0.73
2012	1735	292	7	64	13216	0.33	18934	0.57	21149	0.69
2013	1735	292	7	64	12644	0.31	18440	0.55	20424	0.67
2014	1735	292	7	64	12199	0.30	18171	0.54	19956	0.65
2015	1735	292	7	64	11776	0.29	18019	0.54	19650	0.64
2016	1735	292	7	64	11333	0.28	17921	0.54	19446	0.64
2017	1735	292	7	64	10863	0.27	17845	0.53	19302	0.63
2018	1735	292	7	64	10369	0.26	17779	0.53	19194	0.63
	40:10 Catches									
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18652	0.46	23827	0.71	26366	0.86
2008	105	18	0.5	4	17994	0.44	23285	0.70	25836	0.85
2009	2507	429	12	89	17099	0.42	22379	0.67	24882	0.82
2010	2127	364	11	75	13923	0.34	19139	0.57	21533	0.71
2011	1847	308	9	65	11785	0.29	16940	0.51	19164	0.63
2012	1679	266	8	60	10501	0.26	15629	0.47	17650	0.58
2013	1594	241	7	59	9739	0.24	14911	0.45	16734	0.55
2014	1558	228	6	60	9204	0.23	14530	0.44	16194	0.53
2015	1543	223	6	61	8719	0.21	14312	0.43	15874	0.52
2016	1535	220	5	62	8208	0.20	14164	0.42	15681	0.51
2017	1528	219	5	62	7654	0.19	14041	0.42	15561	0.51
2018	1520	218	5	62	7068	0.17	13928	0.42	15486	0.51

Table E8: Summary Table for chilipepper rockfish

year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	*2007*
Summary biomass	17008	16453	15865	14578	13635	13573	18556	23175	27023	30022	31509	32405	*32401*
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depletion	0.29	0.29	0.28	0.27	0.26	0.27	0.29	0.38	0.51	0.61	0.66	0.70	*0.71*
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lower	0.25	0.24	0.23	0.21	0.2	0.2	0.21	0.28	0.37	0.44	0.48	0.5	
upper	0.34	0.34	0.34	0.33	0.32	0.34	0.36	0.48	0.65	0.78	0.85	0.89	
recruits	15080	6555	7584	12569	153415	3708	15148	23831	14082	25895	7647	6645	*32063*
~95 confidence limits on recruitment													
lower	8031	1399	2723	4260	104994	0	9036	14220	8380	15385	4546	3959	
upper	22095	11691	12465	20936	202966	8023	21322	33540	19842	36511	10779	9358	
ABC	4000	4000	4000	3400	3724	3681	2700	2700	2700	2700	2700	2700	*2700*
OY					3724	2000	2000	2000	2000	2000	2000	2000	*2000*
total catch	2021	1870	2110	1430	977	499	517	329	21	236	192	127	*n/a*
expl. rate	0.119	0.114	0.133	0.098	0.072	0.037	0.028	0.014	0.001	0.008	0.006	0.004	*n/a*
SPR	0.40	0.37	0.45	0.55	0.72	0.72	0.84	0.99	0.93	0.95	0.96	0.97	0.97

Research and Data Needs

Additional investigations into the catch history should be made, ideally as a part of a greater reconstruction of historical rockfish landings done comprehensively across all species.

Greater exploration of methods for modeling time-varying growth as influenced by environmental factors should be a key research area for future assessments, and would benefit greatly from data from historical (triennial trawl) and recent (NWC combined) surveys.

The effects of spatial management measures on patterns of vulnerability and selectivity over time have not been evaluated, and would benefit from generic simulation studies of the consequences of spatially explicit management measures to the basic assumptions of stock assessment models.

Regional Management Concerns

There are insufficient data to consider spatial structure in the model. Although the CalCOFI time series (which was not used in the final model) might suggest greater relative depletion south of Point Conception, this time series has some unusual characteristics that undermine its utility as an index of abundance. As there is only very limited fisheries dependent information in this region, and only a very short (four years) time series of fishery independent information (with low sampling density), there is insufficient information to assess regional concerns. However, as abundance appears to drop sharply towards the U.S./Mexico border, transboundary issues are minimal for this stock.

Status of the Chilipepper rockfish, *Sebastes goodei*, in 2007

Introduction and distribution

Chilipepper rockfish (*Sebastes goodei*) are described as an elongate fish with reduced head spines similar in appearance to both shortbelly rockfish (at smaller sizes, although shortbelly tend to be slimmer) and bocaccio rockfish (bocaccio tend to have larger mouths). The latin name honors that 19^{th} century ichthyologist and fisheries biologist David Brown Goode (Love et al. 2002), while the common name was derived from the observation that long strings of these bright red fish resemble a string of drying chilis (Davis 1978). They have been one of the most important commercial target species in California waters since the 1880s, particularly in this core region, and were historically an important recreational target in Southern California waters. Their importance in recreational fisheries in northern waters followed the movement of recreational fishing effort to deeper waters in the 1970s and 1980s, prior to which catches were apparently minimal.

The distribution is described in the literature as ranging from Queen Charlotte Sound (British Columbia) to Bahia Magdalena (Baja California Sur)(Westrheim 1965; Eschmeyer 1983; Love et al. 2002), however they are uncommon north of Cape Blanco (Oregon) and south of Punta Colnett (Baja California Norte). The region of greatest abundance is found between Point Conception and Cape Mendocino, California. Alverson et al. (1964) reported only trace catches of chilipepper rockfish in resource surveys conducted in the 1960s off of Oregon and Washington, all of which was noted between 100 and 150 fathoms. Adult fish tend to be most abundant in large schools between 100 and 300 meters, often in midwater. Settled juveniles tend to be found in shallow water, and move to greater depths with size and age. Love et al. (2002) describe the habitat of adult schools as including boulder fields and other high relief substrata, and occasionally low-relief cobblestones.

Like all rockfish, chilipepper are primitively viviparous and bear live young at parturition. They copulate during September-October and extrude their larvae from December-February (Wyllie Echeverria 1987). Larvae and juveniles have an extended pelagic phase of about 150 days, consequently the spatial dispersal of larvae likely links recruitment among areas. Field and Ralston (2005) evaluated spatial patterns in recruitment variability based on regional catch at age data and concluded that recruitment is largely synchronous throughout most of the range of chilipepper in the California Current between Cape Blanco and Point Conception, although there were insufficient data to evaluate chilipepper south of Point Conception. Wishard et al. (1980) conducted the only known study of stock structure, from samples collected between 34 and 40 N, and they concluded that chilipepper was unusual in its very low levels of allozyme variability, with no suggestion of population substructure. In an extensive review of phylogenetic relationships among *Sebastes*, Hyde and Vetter (2007) found that chilipepper rockfish were most closely related to both shortbelly (*S. jordani*) and bocaccio (*S. paucispinis*) rockfish, with a lineage that dated back approximately 6 million years.

Although there are no quantitative food habits studies of this species, they are described as midwater foragers, with euphausiids, forage fishes (such as anchovies, Pacific hake, and mesopelagic fishes), and small squids among key prey items (Love et al. 2002). Pelagic juveniles are preyed upon by a wide range of predators, including seabirds, salmon, lingcod and marine mammals. Larger piscivorous fishes, marine mammals, and in recent years jumbo squid are among the predators of larger adults.

Growth and Maturity

The most recent assessment (Ralston et al. 1998) provides a summary of previous estimates of chilipepper growth parameters, dating back to Phillips (1964). Age and length data were available for over 16,000 males and 30,000 females, however most of these data were fisheries derived. The external fits are shown (Figures 1a and 1b), comparable parameter values estimated internally from an early draft of the model that included conditional catch-at-age information were used in the base model as fixed parameters. As the previous assessment reported significant variation in size at age, potentially confounded with changes in selectivity over time, time varying growth was explored in some detail for this assessment. Figures 2a and 2b shows the average size at age from the commercial trawl fishery over time, as both annual averages and a 3-year running mean for fish ages 3, 6 and 9. These data suggest a gradual decline in size at age from the late 1970s and early 1980s, with a slight bump in the late 1980s, followed by low values in the 1990s and increasing values since 1999. Consequently, changes in the size at age were explored in this model.

Weight at length was estimated separately for males and females, based on data from 233 females and 220 males for which this information was collected during triennial trawl surveys (Figures 3a and 3b). Although maturity could vary both as a function of length and age, for the purposes of this model, maturity was fit with a logistic regression model as a function of length (Figure 4).

Natural Mortality

In the last chilipepper stock assessment, Ralston et al. (1998) estimated sex-specific values of natural mortality internally; for females the model estimated a natural mortality rate of 0.223/yr and for males the model estimated M = 0.253. Prior to that assessment, Rogers and Bence (1993) assumed a natural mortality rate of 0.15 - 0.20, and Henry (1986) had used a value of 0.20. In earlier assessments, the maximum observed age of chilipepper was 35 years, which corresponds to an estimate of Z = 0.12 from Hoenig's (1983) equation. However, Ralston et al. (1998) also note that application of the Jensen (1997) equation to the estimated K values obtained for the two sexes yielded M values in the range of 0.28 - 0.34. In order to evaluate Beverton's (1992) approach relating the age at 50% maturity to the natural mortality rate, we compiled data on age at maturity and estimated natural mortality for all West Coast groundfish stocks as well as four Gulf of Alaska rockfish stocks (Figure 5). The resulting relationships were used to develop point estimates of natural mortality for chilipepper rockfish, based on an estimated age at 50% maturity of 2.5 yr. These provided point estimates of M of 0.17 based on all West Coast and Gulf of Alaska *Sebastes* (n=15), and 0.24 based on all West Coast groundfish (n=22). Despite the fact that each relationship had an R^2 of ~0.75, no attempt was made to develop confidence intervals or informative priors based on any of these estimates, in keeping with the guidance developed in the Harvest Policy workshop. This report emphasized the significant limitations associated with deriving a relationship between M and life history characteristics, and stressed that in the absence of a genuine scientific advance in estimating natural mortality rates, continuity in assumptions regarding natural mortality has a greater priority than any preferences developed by assessment authors.

Despite this, the natural mortality rate used in the last assessment was considered to be too high by the STAT team and the STAR Panel during the review of this stock assessment. Part of the rationale for this likely includes the age data for 1978-1981 that were used or considered in this model, which suggested a greater proportion of older fish in the early years of the fishery. Based on model estimates and model profiles of alternative natural mortality rates conducted prior to and during the stock assessment review, M was fixed at 0.16 for females, and 0.202 for males. The higher natural mortality rate estimated for male chilipepper is somewhat unusual given the assumptions of a higher natural mortality rate for older females estimated or assumed in assessments of canary, black and yellowtail rockfish.

Aging Precision

As surface ageing often underestimates ages of older individuals, the 1980 and 1981 age data (which were originally surface read) were not included in the 1998 model. These samples were re-aged using break and burn methods, and samples from 1978 and 1979 were also aged using break and burn methods, these data are now included in the model. The ages available for four years of the triennial trawl survey were all surface read and are no longer available (to re-read and evaluate for a potential bias correction), and consequently these too are not used in this model. The precision of the age determination process was measured by both comparing the independent readings of two age readers of samples collected in 2004 (n=95), as well as comparing independent readings by the same reader (n=97), as reported in the 1998 assessment). The standard deviation by age for each double read was estimated, and as there was no evidence of bias or of an increasing CV with age, a constant CV based on pooling the two samples was used to project the standard deviation by age in the aging error matrix. However, the precision could be overestimated as the high agreement at older ages could also be due to the small sample sizes, as most fish with two reads were less than ~7 years of age.

Regulatory History

Chilipepper have long been an important element of California fisheries, however with the exception of excluding foreign fishing effort from the U.S. EEZ in the late 1970s, management actions were modest (and usually general to all rockfish and other groundfish) prior to the implementation of the Groundfish Fishery Management Plan in 1982. When the Groundfish FMP was implemented, management for the groundfish trawl fishery was based on individual vessel trip limits, which were set at 40,000 lbs per trip on the Sebastes (all rockfish species) complex. These limits were maintained until 1991, when they were reduced to 25,000; in 1993 the trip limit system was revised from daily to biweekly trip limits, which were set at 50,000 lbs (south of Cape Mendocino). The trip limit regime continued to evolve in their absolute amounts and temporal duration (monthly, bimonthly) throughout the 1990s, with a general trend towards lower limits as conservation concerns arose for other rockfish species (particularly bocaccio rockfish in the region south of Mendocino). Consequently, landings for chilipepper rockfish declined significantly during this period, falling well below the ABCs and OYs implemented by the PFMC. Figure 6 summarizes the major management actions for chilipepper (and rockfish regulations more generally), Table 1 summarizes the ABC and OY values adopted by the Council and the subsequent estimates of total catches (including discards), while Appendix A provides an extensive summary of the management actions relevant to chilipepper rockfish since the implementation of the FMP.

For the current management cycle, the Pacific Fishery Management Council has specified status quo alternatives for chilipepper rockfish south of Cape Mendocino for 2007 and 2008 (ABC 2,700; OY 2,000). Chilipepper rockfish within the Eureka INPFC region are managed within the minor rockfish North category (an assumption that they account for approximately 32 tons of that OY has been made). Recent catches are well below these levels due to the constraints imposed by the rockfish conservation areas, and low trip limits in open areas implemented to ensure low bycatch rates of rebuilding species that co-occur with chilipepper (particularly bocaccio, but including canary, widow, cowcod and yelloweye). Although proposals have been repeatedly developed that would facilitate accessing the existing chilipepper OY, a paucity of bycatch data in southern areas for many gear types as well as coastwide bycatch constraints have repeatedly prevented liberalization of trip limits or approval of Experimental Fishing Permits (EFPs) in recent years.

Commercial Fisheries Landings

Chilipepper have historically been one of the most important rockfish species in California fisheries. Commercial landings from 1978 to the present were obtained directly from the California Cooperative Survey (CALCOM) database using expansion procedures from sampling commercial market categories (Pearson and Erwin 1997). Chilipepper have been landed primarily in chilipepper, bocaccio and mixed rockfish market categories. In a recent evaluation of market categories of the commercial fishery, chilipepper rockfish scored high on an index of reliability (D. Pearson, NMFS/SWFSC, pers. comm.), and landings from 1978 to the present are consequently considered to be accurate.

Landings of rockfish (all species combined) in California were recorded in CDFG Fisheries Bulletins from 1928 through 1978 by region (Del Norte/Eureka, San Francisco, Monterey, Santa Barbara, Los Angeles, and San Diego), shown as Figure 7a and 7b (digitized summaries of these catches can be queried online http://las.pfeg.noaa.gov:8080/las_fish1/servlets/dataset). We used these landings to derive catch estimates for the early time period. For the period prior to 1928, we used rockfish landings reported by Sette and Fiedler (1928), who report landings irregularly from 1892 through 1926. Landings are interpolated between unreported years, and assumed to be zero prior to 1892. Although paranzella trawling (and later otter-board trawling) have been an important source of marine fisheries landings in California since 1876, most of the trawl catch in early years was composed of flatfish (petrale and English sole) fished over soft bottom (Clark 1936). Wolford (1930) describes hook and line, set lines, long lines, and hand lines as being the primary gears used in rockfish fisheries prior to World War II, and Phillips (1949) estimates that only about 5% of the early rockfish landings were from trawl-caught fish. Thus, we assume 95% of all rockfish landings prior to 1943 to be hook and line caught, and 5% to be trawl caught. Table 2 provides estimates based on Sette and Fiedler from 1880 to 1927. Table 3 provides the

CDF&G Fisheries Bulletin summaries of total rockfish catch by region, and the assumed proportion of these catches by gear type, and the assumed proportion of each catch estimated to be chilipepper rockfish by region based on the following analysis.

There is little in the way of species composition information for these early fisheries, however Phillips (1939) reported on the species composition of rockfish from the Monterey wholesale fish markets between April 1937 and March 1938, in which 30.8% of the landings by weight were chilipepper rockfish (with 39.4% bocaccio and 7.9% yellowtail rockfish). Monterey Bay ports were the most productive along the coast during that period, accounting for 51% of all landings between 1936 and 1940, with San Francisco accounting for another 20%. Consequently, as landings of rockfish in the Eureka area were minimal until the introduction of the trawl fishery in the 1940s, we assume that 30.8% of California rockfish landings from Santa Barbara north to the Del Norte/Eureka area were chilipepper rockfish until the introduction of the balloon trawl fishery in 1943. Based on the earliest estimate of species composition in the Del Norte/Eureka area (see below), we assume that 5.7% of rockfish landed in this region were chilipepper (note that landings in this region were minimal until 1943). The species composition of southern California rockfish fisheries is not quantified in historical accounts, however chilipepper are cited by Wolford (1930) as being the "second most important rockfish in southern California rockfish fisheries (vermillion are described as the "most important" and bocaccio as "important"). Similarly, Roedel (1948) described chilipepper as "one of three leading Southern California species" (along with vermillion and bocaccio). Even earlier, Jordan and Evermann (1898) had described chilipepper as being "taken in abundance about the Coronados Islands, Santa Catalina, and the Cortez Banks." The 1930s was a period in which landings in Los Angeles and San Diego regions dominated southern California landings, as the Santa Barbara region, including Morro Bay, accounts for only 12% of Southern California landings during this period. Consequently, chilipepper seem to have been historically a significant component of hook and line fisheries throughout Los Angeles and San Diego regions, and we assume that chilipepper accounted for 20% of all Los Angeles and San Diego region rockfish landings from 1928 through 1963.

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). Thus, through 1940 we assume that 95% of chilipepper were hook and line caught, and we assume that by 1944 some 90% of the total rockfish (and subsequently, chilipepper) catch was trawl (based on the percentage trawl in later years, see below). Between 1940 and 1944 we assume that rockfish catches were 25, 50 and 75% trawl in 1941, 1942 and 1943 respectively. Trawl caught rockfish continued to comprise approximately 85 to 90% of all rockfish landings throughout the 1960s and early 1970s, and we used the ratio of trawl caught rockfish reported by Nitsos (1965), Orcutt (1969) and Gunderson et al. (1974) to total rockfish landings from CDFG bulletin to apportion the chilipepper catch by gear from 1953 through 1977 based on these observed fractions and interpolation between unobserved periods (Table 4).

To assess the fraction of trawl caught rockfish that were chilipepper, we relied on the very sparse species composition reports included in Nitsos (1965) and Gunderson et al. (1974). Nitsos reported the 1962-1963 species composition by port complex for most California ports (as trawling was then prohibited in nearshore waters south of Santa Barbara, no species composition was reported for that region), these are reported in bold font in Table 4, and these values were used for both trawl and hook-line fisheries from 1942 through 1963 (during the period in which trawl landings dominated). Gunderson et al. (1974) also reported trawl species composition for the year 1973. For all intervening years between 1963 and 1978, the fraction of the catch that was chilipepper rockfish was interpolated between these observed catch compositions and the CalCOM estimates for 1978-1979. Accounting for the catch composition in the Los Angeles and San Diego regions since 1963 is tricky, as most landings were hook and line in this region and no hook and line data for this period are available. However Gunderson et al. (1974) described chilipepper as accounting for 26.4% of the Conception area trawl catch in 1973, and chilipepper continued to be described as important to Santa Barbara hook and line fisheries during this period, although they were not as valuable as the more brightly colored vermillion and other species (Love 1991; Kronman 1999). Consequently we assume the Gunderson et al. (1974) catch proportion for all fisheries throughout Santa Barbara, Los Angeles and San Diego; and interpolate catch proportions from 20% in 1963 to 26.4% in 1973. From 1974 to 1977 we interpolate the 26.4% in Southern California fisheries reported by Gunderson to the CalCOM estimates of 2% of Santa Barbara, 8.1% of Los Angeles, and 2.2% of San Diego rockfish catches. There is clearly a great deal of uncertainty over whether this decline is an artifact of the means by which catches were reconstructed, or reflects changes in abundance or target fisheries, and we acknowledge that the relative importance of chilipepper in Southern California fisheries throughout this period is highly uncertain. For Oregon landings, PacFIN estimates were used for landings from 1981-present, and for 1963-1980 estimated are based on Douglas (1998), who report minimal (and sporadic) chilipepper landings on the Pacific Ocean perch and other rockfish market categories. We assume landings were negligible in Oregon waters prior to 1963. The resulting estimates of chilipepper catch are reported in Tables 5-6 and Figures 8a and 8b.

An alternative catch stream for the period between 1953-1977 was also developed, based on retroactively applying market category species compositions from the 1978-1984 period to CDFG landings data by market category extending back to 1953 (D. Pearson, pers. com.). Based on recently digitized CDFG landings information by block and market category, and applying the species composition for market categories from the 1978-1983 period, the catch of chilipepper rockfish was reconstructed from the period 1953-1968, and CalCOM reconstructions from 1969-1977 were used based on Pearson (in prep). The corresponding total catch estimate is compared to the earlier reconstruction in Figure 9. As these values differed only modestly, the first catch stream was used in the base model, to maintain consistency with the approach used to estimate landings prior to 1953.

Prior to the STAR Panel meeting, but following the distribution of the draft assessment, the STAR Panel Chair (Dr. David Sampson) pointed out that records of rockfish catches (at the genus, not species level) by gear and by region were also available for much of the historical period, as published in Bureau of Commercial Fisheries Reports. A subset of the relative proportion of catch by gear and by region was developed from these records, which reflect strong geographical differences in historical gear type use, with a shift to primarily trawl-caught rockfish in the north to almost exclusively hook and line caught rockfish in the south. Figures 10a-10e show the relative rockfish catch by gear type and district for select years in this period, however there was insufficient time to re-define the initial catch statistics in a timely fashion for consideration in the final model. Modest changes between the proportion of catch by gear type are not anticipated to have a major influence on the model results. A number of STAR Panel reviews have lamented the lack of a comprehensive reconstruction of historical rockfish catches by species for California waters, similar to that of Rogers (2003) for foreign fishery catches, and this remains a key stock assessment need. Currently, California fish ticket information with associated market category and CDF&G block number is in the process of being digitized for the period 1928-1977, and a comprehensive rockfish historical catch reconstruction will benefit greatly from the results of this effort. Finally, comparison of the catch estimates used in this model to those used in Ralston et al (1998) are presented as Figures 11a through 11d, which show that although some catch estimates have varied modestly over time, the time series track each other very closely.

Commercial Discards

Heimann and Miller (1960) reported a bycatch rate of approximately 0.8% for chilipepper rockfish taken in 64 bottom trawls off of Morro Bay, California between August 1957 and July 1958. Similarly, Heimann (1963) reported extremely low discard rates for chilipepper rockfish, of approximately 0.4% for a series of 19 intermediate depth tows made between Pigeon Point and Point Sur, California in 1960. Aside from these observations, there is essentially no data available on potential discard rates for any but the most recent years for chilipepper rockfish. As chilipepper are a desirable market category, discards have been assumed to be negligible in past assessments (Ralston 1998), and with the exception of the recent years in which regulatory changes have resulted in high discard rates, we will continue with that assumption.
The estimated commercial discard rates for chilipepper and bocaccio in the Monterey and Conception INPFC areas, derived primarily from observations of the trawl fleet, were 46%, 11%, 70%, and 65% from 2002 through 2005 respectively (as a % of discard+landed). Catches for all gear types for these four years were adjusted proportionately, with the 65% discard rate from 2005 carried over into 2006 (based on Hastie and Bellman 2006, and comparable reports). As the total landings have been minor relative to historical landings in this period, adjustments to this rate for recent years would not be expected to have major consequences to the model results.

Recreational Fishery Landings

Recreational fishing effort in California for fishes other than big game fish such as tunas and salmon was relatively modest in California until about 1928, when Commercial Passenger Fishing Vessels (CPFVs) popularized recreational fishing (Scofield 1928; Croker 1940; Young 1969). Initially, most effort was in the waters of the Southern California Bight, however party boat fisheries soon became popular in Monterey, and although these fisheries were suspended during World War II, effort increased rapidly shortly after the war ended. CPFV captains have been required to submit logbooks detailing catches since 1936, in which species resolution is typically low (typically only “rockfish” is recorded, although some rockfish targets such as cowcod were usually identified to species). Reported CPFV catches in numbers of fish for most years between 1936 and 2000 were available from the CPFV database (Hill and Schneider 1999), with missing years and region-specific information filled in from Young (1969) and Best (1963). Although this database has no estimate of private vessel catches or other fishing modes (shore, pier, neither of which catch chilipepper), and compliance rates have typically been less than 100%, this is the only source of recreational catches prior to 1980, and catch estimates are based on this information as tuned to more recent estimates.

For 1980 through 2006, catches in both numbers of fish and weight of fish were obtained from the RecFIN database. 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 2006 (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 chilipepper). Spatial resolution of these catch estimates is limited to northern and southern California (north and south of Point Conception). Table 7 provides RecFIN catch information for chilipepper rockfish in northern and southern (south of Conception) recreational fisheries in numbers, total weight, and average weight from 1980-2006 (with the years 1990-1992 interpolated) by mode (CPFV and private/rental only). Figure 12 also shows the percentage of all rockfish that were estimated to be chilipepper rockfish by region and mode from RecFIN data as well as CDFG observer program data collected from 1975-1978 and 1986-1989 in the south, and 1987-1998 in the north. These percentages were critical to reconstructing historical estimates of chilipepper catches in recreational fisheries.

The reconstruction of recreational catches prior to 1980 is highly dependent on assumptions about the spatial development of this fishery to deeper water over time, particularly in the north, (reconstructions were made separately both north and south of Point Conception). North of Point Conception, it is widely held that CPFV fisheries moved from nearshore habitat and target species to deeper and deeper waters over time. Miller and Gotshall (1965) report on the landings, weights, and species composition of northern California recreational fisheries from 1957 through 1961, in which blue, yellowtail, olive, and bocaccio rockfish were among the most important (together accounting for ~65% of the total catch by number). Chilipepper were reported in only trace amounts, accounting for 0.321% of the total observed CPFV rockfish catch (2165 out of 674,678 rockfish reported), and were even more scarce in the private/rental boat (skiff) fishery, where they accounted for 0.004% of observed rockfish (7 out of 157,257 rockfish reported). Similarly, Heimann and Miller (1960) described chilipepper as being a very minor species in Morro Bay party boat fisheries in the late 1950s; this fleet too was clearly targeting nearshore assemblages (blue, olive, yellowtail, and vermillion rockfish comprised over 80% of the catch). However, chilipepper appear to have been sporadically important, at least in the Monterey Bay area recreational fisheries, in the years between this report and the RecFIN time period; Mason (1995) describes wide fluctuations in the CPFV catches of deepwater rockfish, with chilipepper being a key recreational species in 1962, 1964 and 1977-1978. As no species composition data are available, nor is it clear whether this reflected local or coastwide shifts in fishing spots and methods, we interpolated the percentage of rockfish landings (in numbers of fish) thought to be chilipepper from the 1957-1961 point estimate (0.321%) to the 1980-1982 RecFIN average (3.84%). This in turn was scaled upwards by the ratio of RecFIN estimated CPFV catches over logbook CPFV catches from 1980-1982 to develop an expansion factor for the historic CPFV fishery (1.87), which provided an estimate of the historical CPFV (and other fishery modes) total rockfish catches in numbers (Table 8; Figure 13). Finally, as the average weight of chilipepper reported in Miller and Gotshall (1.2 kg) was significantly greater than the average weight of fish reported by RecFIN in the 1980-1982 period (0.72 kg), we interpolated the average weight between these periods to arrive at the tonnage of total catch. To account for the presumably modest CPFV chilipepper catches in the north prior to 1957, we assume that chilipepper catches were 0% of the total rockfish catch at the initiation of the fishery in 1928, and interpolate from 0 to 0.331% in 1957. As the private boat fishery represented a trivial source of mortality in both the 1957-61 period and the 1980-82 period, we do not account for possible private vessel landings in the north prior to 1980.

For southern recreational fisheries, we used RecFIN data from 1980 through 2006, an expansion factor for historical CPFV logbook data as was done in the north (estimated at 1.98), and supplemented with observations of the percentage of the CPFV catch listed as chilipepper from the 1975-1979 onboard observer program. As this program tended to record a higher (and less variable) percentage of chilipepper rockfish relative to the total rockfish catch, we used the average proportion of the total rockfish catch observed to be chilipepper from the 1975-1979 observer data and the 1980-1982 RecFIN data to interpolate the fraction of historical catches that were chilipepper, assuming a ramp up from 0% chilipepper in 1928 (when CPFV fishing began, presumably with a focus on shallow water targets) to 11.3% in 1974. As chilipepper have long been described as an important recreational fish in Southern California (Wolford 1930; Roedel 1948; Davis 1977; Love 1991), and tend to be more important over deeper reefs, this is a reasonable approximation of recreational fisheries development. As private vessel landings of chilipepper estimated by RecFIN were significant in the early 1980s (estimated at 38,000 fish per year between 1980-1982), we assumed that private vessels began catching chilipepper in the post-world war II era, and interpolated landings from 0 in 1947 to 38,000 fish per year in 1979. As the average weights of chilipepper in the early 1980s were comparable in the north and south in the RecFIN database, we used the same average weight estimated for central California fisheries (above) for southern California fisheries.

The total estimated catches in the recreational fishery are shown as Figure 14, the total catches by all fisheries are shown in Figure 15, and these catches by fishery are also shown relative to catches estimated in the 1998 assessment in Figure 10 (referred to earlier). The number of subsamples and length measurements in the RecFIN database are included as Table 9.

Trawl Logbook CPUE Data

A catch per unit effort index was developed in the last assessment by Ralston et al. (1998), and was included in this assessment in the same form, as management constraints have likely biased the assumptions that would be necessary to update this index. Ralston (1999) further developed the trawl CPUE time series using alternative weighting regimes; these two time series as well as the time series from the 1998 model are presented as Table 10 and Figure 16. The 1998 estimates were assumed to have a CV of 0.10 in the 1998 model, however this CV was largely arbitrary. As the indices developed in 1999 had CVs on the order of 0.25 to 0.35, and model runs consistently estimated an effective RSME of ~0.25-0.28 when the initial CV was set at 0.1, we used 0.25 as the assumed CV.

Commercial age and length composition data

Expanded length composition data for the three commercial fisheries were extracted from the CalCOM database (Pearson and Erwin 1997) for all years from 1978 through 2006. Length data were pooled into 2 cm groups with accumulator groups representing sizes less than 16 cm and greater than 52 cm. Age data were aggregated into 21 age groups, comprised of ages 1-20 and an accumulator age of 21 and older fish. Age composition data by commercial gear type are shown in Figures 17-19, and length composition data are shown as Figures 20-22. Although earlier years of the fishery had significant proportions of older fish, less than 1% of all (expanded) fish were older than age 20 (although this fraction was somewhat higher for earlier years in which catch at age data were available). Starting values for multinomial sample for both age and length composition data were based on the number of port samples taken that included chilipepper age structures or lengths, respectively. Table 11 provides the sample sizes and total number of fish by year and gear type used in the expansions.

A comparison of raw (unexpanded) catch-at-length data from port samples that included age information and those that did not suggested some potential discrepancies between the length composition of aged versus un-aged fish, which may have been a (minor) contributing factor to the complications encountered with the conditional catch-at-age data. A more likely complicating factor may have been the approach used to generate the effective sample sizes as well as for tuning the effective sample sizes of the conditional age-at-length data. Recommendations for future efforts to incorporate conditional age-at-length information, as well as innovative approaches that could be used to link the likelihood components between length frequency and age-length data, are included in the STAR Panel report as well as the recommendations section of this document. As a result of potential biases in the age composition subsampling, the effective sample sizes were set to negative numbers (resulting in a zero emphasis for those combinations in the likelihood function) for the following gear/year combinations; trawl (1978-1979, 1998-2000), hook and line (1998-2002), and setnet (1983, 1992). These data should be revisited for potential bias (by evaluating the expanded, rather than raw, catch at length for both aged and un-aged fish) prior to the next assessment. Additionally, the length frequency data for the 1992 setnet fishery suggested catches of a large number of very large males, which were sufficiently suspect to warrant exclusion of these data from the model.

Recreational length composition data and CPUE time series

Recreational length data from the RecFIN database were based on a query of coastwide length composition data from March of 2007, and are presented as Figure 23 (northern and southern separate) and Figure 24 (combined). As these data were not associated with sex information, they were included in the model as combined sex length composition data associated with the recreational fishery. In evaluating the potential for developing a CPUE time series for chilipepper rockfish using RecFIN observer data, we found that chilipepper were only recorded in 52 of the thousands of observed trips. Attempting to identify appropriate trips using the approach of Stephens and MacCall (2004) resulted in a subset of nearly 250 trips that could be identified as those in which chilipepper catches were likely, however there were unusual species co-occurrences that lead to this approach being suspect. As chilipepper rockfish tend to only be encountered in deeper water recreational trips, and the depth distribution of recreational effort has changed markedly over time, RecFIN catch rate data were not evaluated further in this assessment.

The California Department of Fish and Game conducted on-board monitoring of partyboat catches in Northern California from 1987 to 1998, which includes catch, angler effort, size composition of catches, location information and, more importantly, depth information (Deb Wilson-Vandenberg, CDFG, pers. comm.). Between 1987 and 1998 some 2267 recreational fishing trips were observed from Morro Bay (649) to Eureka and Crescent City (12), however the majority of observed trips originated from Monterey (821), San Francisco (444), and Bodega Bay (269) area ports. CDFG block information, as well as fishing site (457 sites) and the maximum and minimum observed depth information (ranging from 2 to 150 fathoms), was also available for all trips. Locations represented 68 separate CDF&G blocks, but 90% of the trips took place in just 27 of these blocks. Between 1987 and 1998 most of the trips were in the 20 to 60 fathom range, however there was a slight increase in the percentage of trips in the 0 to 20 fathom range and a slight decrease in the percentage of trips in the 60 to 100 fathom range. Overall, the latter represented less than 15% of all trips observed.

The total number of observed trips, binned by the average depth for the trip, for each year are given in Table 12. Chilipepper were ranked third in terms of the total number of rockfish caught in observed trips (27,690 out of 313,752), after blue and yellowtail rockfish, however they were ranked 21st in terms of the most frequently occurring species. This seems to be a consequence of fishing location. Chilipepper were frequently encountered in trips that fished at greater depths, occurring in only 1% of trips that fished less than 40 fathoms, but in 68% of trips that fished in 60 to 80 fathoms and 92% of trips that fished greater than 80 fathoms. The number of chilipepper caught per year and depth bin are included as Table 13. Clearly, depth is an important variable in the GLM, although when site-specific location information was explored as a variable, the variance explained by depth decreased substantially. This reinforced the decision to exclude RecFIN data. Consequently, due to concerns discussed during the STAR Panel review regarding possible impacts of changing depth strategies over time, all trips at depths greater than 80 fathoms were excluded from the final model. We used the average depth per location, binned into 20 fathom depth intervals for the GLM. Ultimately, trips taken at less than 20 fathoms average depth were also excluded due to the very low frequency of positives for chilipepper. For location information, we considered site specific information, CDF&G block information, and port-group information as possible factors in exploratory models. All explained a moderate fraction of the variance, and all resulted in very similar results with respect to year effects, however using site as a variable resulted in the loss of a substantial number of records.

The logistic regression method of Stephens and MacCall (2004) was also evaluated to obtain a subset of the trip data that would be appropriate for calculating chilipepper CPUE from the observer data. This method uses the species composition from each trip to determine whether chilipepper rockfish were likely to have been encountered on that trip, however this method is more commonly used for datasets in which location information is unavailable or unreliable (such as sampling and interviews conducted at the end of a fishing trip, used for MRFSS dataseries). One reason for this was to evaluate whether this approach resulted in different inferences with respect to trend, and to evaluate whether the resulting species coefficients from this approach were consistent with those obtained from a similar effort using the MRFSS data.

The top 50 species in frequency of occurrence were extracted, chilipepper were separated as being the target species, and species that co-occurred with chilipepper less than two times were excluded (four species). The remaining 45 species served as potential explanatory variables. Logistic regression of chilipepper presence/absence on categorical presence/absence of these explanatory species provided predicted probabilities that chilipepper would be taken on a trip, given the other species that were taken on that trip. The resulting species associations (coefficients from the logistic regressions) are shown in Figure 25. The threshold probability for inclusion in the selected set was set at 0.35 as this was the probability that resulted in the lowest average CV of the annual indexes. However, the results of using the filtered dataset relative to the entire dataset were nearly identical (discussed below), as the logic behind the filter was to provide proxy information for habitat (area, depth) in datasets without data on these factors. When location and depth information are included, the filter is essentially unnecessary.

Consequently, the final model used all of the available trip information, the year effects are the relative CPUE index (Figure 26), with precision estimated using a jackknife procedure. The other fixed effects were block information (11 blocks with sufficient data, Figure 27) and depth (three bins, 20 to 39, 40 to 59, and 60 to 79 fathoms, Figure 28). A large number of sensitivity runs suggested highly similar, if not virtually identical, results when either higher resolution (site-specific) or lower resolution (port group) location information was used, as well as month or season, or other changes in the resolution of these bins was altered. The AIC values for a suite of models are reported in Table 14, which demonstrates that year, depth, block and season information contributed to an improved model fit. Although the results varied only modestly, the AIC also suggested that a gamma error distribution fit the data better than a lognormal distribution for the base models. Furthermore, the resulting trend when the Stephens/MacCall filter was developed and used to filter trips was nearly identical to the trend without this filter when all trips positive for chilipepper or with a threshold of 0.35 or above were used. The coefficient of variation (CV) estimated in the jackknife routine was also very similar with all of these runs, and between the gamma and lognormal error distribution, although the CV was considerably greater when depth information was excluded.

Length frequency information from chilipepper measured in the observer program was converted from total length to fork length, using the conversions provided by D. Pearson (pers. com.), where

$Fl = 0.977*TL-0.977$

The resulting length compositions by year, for fish caught within the depth ranges used to develop the relative abundance index, are shown in Figure 29. The number of trips in which chilipepper were caught was used as the sample size in the length composition data. As sex information was not included, the resulting length frequencies were used in the model with the unknown gender code. These data suggest that the high value in the index during 1987-1988 represented the abundance of the 1984 year class, which is identifiable in other age and length time series. As this age class grew, it likely moved into deeper water, consistent with the shift to greater depths with size observed in the triennial length composition data and consistent with similar ontogenetic movement for many other rockfish and groundfish. Similarly, the increase in abundance in 1992 may have been a function of a relatively strong 1988 or 1989 year class. This also suggests that a dome-shaped selectivity curve is likely to be appropriate for these length data, given the changing spatial distribution of animals with size.

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 (Weinberg et al. 2002). As the general consensus from recent data workshops has been to exclude 1977 data, we obtained both stratum-specific area swept biomass estimates and haul-specific survey data from 1980 to 2004 (M. Wilkins, AFSC, pers. com; B. Horness, NWFSC, pers. com), both of which were generated after excluding bad performance tows and "waterhauls," in which few benthic organisms were noted (Zimmermann et al. 2001). Tow specific CPUEs from this survey by year are shown in Figure 30, which also illustrates the variation in the latitudinal range of this survey over time (These Figures include a "cap" on the relative size of the largest tows, to maintain a constant scale across all of the Figures). Area-swept biomass indices by INPFC area and depth strata are presented as Table 15. To develop a consistent area-swept biomass index that represented all years, we compiled biomass estimates for all stratum between 36˚ 48' N and 43˚ 00 N (55m-366 m depth)(Figure 31).

Another comparable index was developed by T. Helser (NWFSC, pers. com.) using the Generalized Linear Mixed Model (GLMM) approach described in Helser (2003) and Helser et al. (2005). This model uses depth strata and latitude (or INPFC latitude proxies) as fixed effects, and vessel as a random effect. This index more explicitly accounts for the area of the given strata, as well as integrates uncertainty across both the proportion positive and the positive catch rate indices (such that both the variance due to vessel and residual variances are estimated, with the assumption of a log-normal error variance assumption for the positive observations). Point estimates of biomass and the associated CVs are based on the median of the marginal posterior density from MCMC, however to develop these estimates the model needs a high density of positive tows per strata (at least 2, preferably 3 for each year, depth, latitude combination). The strata used for this index were from 34.5˚ N to 38˚ N, and from 38˚ to 41˚ N. The region north of 41 was excluded due to the rarity of positive tows in that area, inclusion of this area could result in a bias by extrapolating the larger CPUEs observed south of this region. Depth strata were 50 to 155 m, and 156 to 366 m.

As seen in Table 16 and Figures 31 and 32, there is a relatively large difference between the design-based estimate and the GLMM estimates, due primarily to the fact that the mean from the standard approach is heavily influenced by 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. This is a common challenge in developing indices of abundance from trawl surveys for semi-pelagic rockfish species with very patchy distributions and often highly specific habitat associations. By contrast, modeling of absolute abundance using design-based versus GLMM approaches tends to produce very similar trends for most flatfish species. Consequently, survey biomass indices are often more appropriately treated as indices of relative, rather than absolute biomass, and both the triennial trawl survey index and the combined survey index are treated in this matter in this assessment.

Length frequencies for the triennial survey were calculated based on standard estimation methods (Dark and Wilkins, 1994), and are presented as Figure 33. Additionally, these data are pooled over all years and shown aggregated into depth bins to demonstrate a clear movement to deeper water with size, as shown for many other *Sebastes* species (Figure 34). Otoliths collected in 1977, 1980, 1992 and 1995 were surfaced aged, and the samples have since been lost or destroyed; there are no available data with which to bias-correct these estimates and they were consequently not used in the model. The number of hauls was used for the initial effective multinomial sample size in the length compositional data.

Northwest Center Trawl Survey

Data were provided for area-swept biomass estimates from 2003 to 2006, and associated length frequency compositions, were provided by Beth Horness (NWFSC). A summary of methods used to derive these data is available from O. Hamel (Calculation of summary statistics for the Pacific West Coast upper continental slope trawl survey of groundfish resources off Washington, Oregon and California, in prep, available on request). Catch per unit effort estimates from this survey by latitude and depth are shown as Figure 35. The total area swept biomass estimates ranged from a high of 129,000 tons in 2003 to a low of 69,200 tons in 2006, with the vast majority of the biomass in the shallow stratum of the Monterey INPFC area (Table 17). However, there is no obvious overall trend in the results, particularly given the high uncertainty in the estimates, although there may be a possible suggestion of a decline in recent years. As with the triennial survey index, another comparable index was developed by T. Helser (NWFSC, pers. com.) using the GLMM methods described above for the triennial survey index. The stratification for this index differed, as there was greater spatial coverage in the southern area, and consequently this index estimated biomass for three latitudinal strata, from 32-36 N, 36-40 N, and 40-43 N, with depth strata 50-155, and 156-400. The resulting index is provided in Table 18, which also includes the comparable design-based estimates. As shown in Figure 36, the two indices both appear to be somewhat noisy, with substantial interannual variability from which no obvious trends can be detected; although the GLMM index does seem somewhat better behaved, and may be indicative of a modest population decline over the (short) duration of that time series. The length data for all years, and the age data for 2004, all suggest that the biomass vulnerable to this survey in this period was very strongly dominated by the 1999 year class (Figure 46). Approximately 700 to 1000 chilipepper otoliths have been collected in each year of this survey, however only 850 ages for 2004 were available for this model. These were expanded by the NWFSC and entered into the model as catch at age data.

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. Chilipepper rockfish are the second most frequently encountered species in the survey, accounting for ~4.3% of the total number of rockfish caught from 1983-2006 (shortbelly accounting for just over 85% of the rockfish identified to species since 1983, excluding shortbelly, chilipepper account for nearly 31% of the remaining rockfish). 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. 2005), shortbelly rockfish (Field et al. 2007) and past assessments of chilipepper rockfish (Ralston et al. 1998).

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. 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. The near absence of fish in the core survey area was associated with an apparent redistribution of fish, both to the north and the south, as well as overall lower abundances.

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) using both the historical (core) survey area and a combined index that uses both SWFSC and NWFSC/PWCC survey data. The indices prepared for chilipepper are presented in Table 19 and shown in Figure 37, and the methods are described in the 2007 stock assessment cycle background materials. One shortcoming of the core index that has been noticed in past assessments has been the failure of the core area survey to capture the magnitude of the 1999 year class for most stocks, the strength of which has since been demonstrated for most recently assessed species. Based on the strong evidence for a very strong 1999 year class, and the recommendations from the juvenile rockfish survey workshop, the core juvenile index was not included in the final model. However, the coastwide juvenile index 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 survey.

CalCOFI larval abundance data

Egg or larval abundance data from the California Cooperative Oceanic and Fisheries Investigations (CalCOFI) surveys have been used in stock assessments for a number of commercially important west coast species, including northern anchovy (Jacobson and Lo 1994), Pacific sardine (Conser et al. 2002), bocaccio rockfish (MacCall 2003), shortbelly rockfish (Field et al. 2007) and 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) out of concerns for the rarity of cowcod in sampled tows. Only a small number of *Sebastes* larvae can readily be identified to species, including bocaccio, shortbelly, cowcod, splitnose, and chilipepper. Chilipepper rockfish larvae were not identified to the species level in initial plankton sorting efforts. However, morphological characteristics were developed in recent years that allowed for identification, and they were consequently identified in all samples in the CalCOFI core area, and are currently in the process of being enumerated in CalCOFI tows taken in northern stations (W. Watson, SWFSC, pers. comm.). The distribution of chilipepper larvae catches between 1951 and 1969 demonstrates higher catches in northern transects, with catches generally greatest within 75 miles of the mainland (Figures 38 and 39).

As with other indices, we used tow specific information and a delta-GLM approach to derive an index of spawning biomass. Fixed effects in the model included year (fixed to spawning season, such that a year is the October-April spawning period), latitude (30' bins), month (October-April), and distance from shore (25 mile bins). These estimates and the associated standard errors estimated from a jackknife routine were used in the model as an index of population fecundity (spawning biomass). Figures 40-42 show the resulting latitude, distance from shore, and month effects; Figure 43 shows the year effects (with standard error) for the resulting model. In general, high levels of abundance were observed throughout most of the 1950s and 1960s, sporadic catches were observed through the 1970s and 1980s (recall that the survey was triennial between 1971 and 1984), and very few larvae were observed in the 1990s. Larvae have been more frequently encountered between 2002-2006. Although the CalCOFI time series is not inconsistent with other data series, the fact that these data are taken from the southern periphery of the stock's range indicates that this may not be an appropriate index of abundance for a coastwide model. Additionally, the lack of estimates throughout most of the period between the early 70s and 2000 (associated with few or no catches of larvae) are troublesome. Consequently, these data were not used in the final model.

History of Modeling Approaches

Chilipepper rockfish were last assessed by Ralston et al. (1998) using the stock synthesis age-structured model (Methot 2000) for the combined Eureka, Monterey, and Conception areas. The 1998 model began in 1970, but assumed a starting biomass below the unfished equilibrium (based on using the estimated landings from 1960-69 to generate an initial equilibrium population in 1970). The 1998 model also made no assumptions regarding a stock-recruit relationship; recruitment strengths were estimated based on free parameters. Natural mortality rates were estimated internally at 0.22 for females and 0.25 for males. The structure of the data in this assessment is consistent with that assessment, as both assumed four distinct fisheries (trawl, hook-and-line, setnet and recreational). Landings, age, length, and length-at-age data from these four fisheries were included in the model based on similar expansion routines, age data were limited to 1982-1996 but length data were available from 1980-1996. Estimates of landings changed little between the 1998 and current assessments (Figures 11a-11d, discussed in the catch reconstruction). Similarly, the 1998 model included survey indices from a catch-per-unit-effort index derived from the California commercial trawl logbook data base (which remains unchanged in this assessment), an index of abundance from the triennial trawl survey (which has an extended time series and was been modeled using a different GLM approach than that used in this assessment), and a time series of pelagic juvenile abundance, although the current time series is considerably shorter (2001-2006) than the core index used in the 1998 assessment (1983-1997). However, the 1998 assessment explicitly described significant changes in mean size at age, which were raised as an important research question, but ultimately applied an approach utilizing time-varying selectivity to fit the length composition data. New indices used in this assessment include the recreational CPUE time series based on CDF&G monitoring data, and the 2003-2006 NWFSC combined survey index (also modeled using a GLMM approach).

The results of the 1998 assessment suggested that chilipepper were at a moderate level of biomass and were not estimated to be overfished. The 1998 model estimated that spawning biomass had declined from ~48,000 tons during the 1970's to a low of 22,000 tons in 1987, before increasing as a result of the 1984 year class (which was apparent in both the 1998 and 2006 models). The unfished spawning biomass in the 1998 model was estimated at 58,500 mt. The 1998 model estimated that the total exploitation rate ranged from a low of 4.2% in 1970 to a peak of 19.8% in 1989, although the exploitation rate had been below the target fishing mortality rate since 1993. Primary sources of uncertainty in the 1998 assessment included the statistical uncertainty associated with the fit of the various data sources to the base model, the conflict between the two principle sources of information (logbook and triennial trawl survey indices), the difficulty in projecting future recruitment for a stock characterized by high recruitment variability, and the difficulty in distinguishing potential changes in selectivity from apparently substantial declines in the mean size at age for fish collected in the post-1993 period.

Prior to the 1998 assessment, Rogers and Bence (1993) conducted a similar length-based assessment (using the length-based version of stock synthesis, Methot 1990) for which the modeled time period began in 1980. Their model included a triennial trawl survey index and a recreational CPUE index, but did not include either a trawl logbook CPUE or a pelagic juvenile survey index. The 1993 assessment also included age and length data from commercial fisheries (modeled as the same four fisheries as in Ralston et al. 1998 and this assessment), including data from fish that had their otoliths surface aged (rather than break-and-burn), and used estimates of natural mortality rate that ranged from 0.15 to 0.20. Rather than present the results of a single base model, the authors presented the results of a suite of three models, in which the 1992 biomass ranged from 40,000 to 87,000 mt, and the equilibrium yield (based on the then proxy for FMSY of F35%) ranged from 3,941 to 6,729 mt. Their general conclusions were that the existing ABC of 3600 mt was sufficient to protect the fishery at the F35% level, and that raising the ABC above this level could be "somewhat optimistic."

Prior to the 1993 assessment, a stock assessment had been developed by Henry (1986), who used the age composition data in a cohort analysis model to estimate upper and lower bounds on fishing mortality rates and population abundance (Deriso et al. 1985). The author then applied an age-structured deterministic population model (GENMOD; Hightower and Lenarz 1989) to estimate MSY and equilibrium yields with two alternative models. The data used in that model included total catch (modeled as a single fishery), catch at age (1978-1982, surface read ages), catch at length (1978-1985), and triennial survey abundance point estimates from 1977, 1980 and 1983. The results indicated that the stock was moderately exploited, with "good recent recruitment and the absence of apparent biological stress," and the author recommended an ABC level set at the midpoint of two alternative MSY estimates, which was 3563 mt (the ABC was ultimately set at 3,600 mt). A precursor to the 1986 assessment was performed in 1985 (Henry 1985) using a cohort analysis, however this assessment did not result in a clear picture of stock status and did not recommend changes in the ABC levels.

Previous STAR Panel Suggestions

The prioritized STAR Panel recommendations from the 1998 assessment included:

- Aging otoliths collected from research surveys (the triennial trawl survey)
- Investigating differences between the trawl logbook and the shelf trawl survey index
- Continuation of the midwater trawl survey for pelagic juveniles
- Continuing to monitor the age and length composition of the fishery catch
- Reporting of logbook catches of rockfish by species rather than unspecified rockfish.

For the first priority, only a very limited number of otoliths were aged in time to incorporate in this assessment, these from the 2004 NWFSC combined survey. Ageing of both historical and recent otoliths from resource surveys remains a key priority, unfortunately most of the historically collected otoliths from the triennial survey (4 survey years) were surface aged and their whereabouts are no longer known. As a result, these samples are not available to re-age using break-and-burn methods. For the second priority, the triennial survey index was developed using a somewhat different means in for this assessment, however the major data conflicts in this assessment were among the recreational CPUE survey (which tended to be in agreement with the trawl survey) and the trawl fishery catch at age data (and to a lesser extent the trawl CPUE index).

The third recommendation was to maintain the midwater trawl survey for pelagic juveniles; this survey has been maintained and in fact expanded spatially (including a second survey that is used to develop a combined coastwide index). Additional details, analysis and recommendations related to the application of juvenile indices were the subject of a Council-sponsored workshop, and recommendations in the report to the PFMC (Hastie and Ralston 2007) should be consulted for details. One recommendation was to exclude the historical (core area) index unless a strong relationship between the index and subsequent year class strength could be demonstrated. Consequently, as the core area index failed to capture the magnitude of the 1999 year class, this index was not used in the final model.

With respect to the fourth recommendation, continued data collection of age and length data from fisheries has been well maintained, and otoliths aged in a timely fashion. With respect to the reporting of logbook catches by species, it is generally agreed that the substantial impact of management measures implemented to rebuild depleted rockfish in the post-1998 era have undermined the assumptions that would allow for continuation of a trawl logbook CPUE index. Finally, while not explicitly stated in the list of prioritized research recommendations, the recognition and consideration of time-varying growth was a key uncertainty in the 1998 assessment, and remains a key research priority in this most recent review.

Consultations with the Groundfish Advisory Subpanel (GAP) and with Fishers

Due to time and budget constraints, a pre-assessment data workshop was not held for the chilipepper and bocaccio stock assessments. Consultations with members of the GAP representatives did not suggest major concerns regarding the data available or considered for the chilipepper assessment, as there was a general sense that this stock would be shown to be above target levels. One issue raised was the question of historical discard rates, which were described as negligible by fishers prior to the implementation of highly restrictive management measures beginning in the late 1990s due to the desirability of chilipepper by processors. Consequently, discards were assumed to be zero prior to the collection of observer data in 2002.

Model

The population was modeled using an age and size structured statistical model, Stock Synthesis II (SS2), version 2.00c, the modeling framework used for most West Coast groundfish assessments. This modeling framework was developed with the intent of allowing the complexity of the model to be consistent with the quantity and quality of the data commonly available for West Coast groundfish. The model treats a cohort as a collection of fish whose size-at-age is characterized by a mean and a variance, such that the numbers at age are distributed across defined length bins- similar to a length-age transition matrix, although with the potential to account for the effects of size-specific survivorship. The model also allows for growth, mortality, selectivity and other functions to be time varying, and time varying growth is explored in this model. A full description of the population dynamics, selectivity and catch equations, and associated likelihood functions are given in Methot (2005), while a more practical guide to using this modeling framework is provided in Methot (2006).

The base model developed here is based on equal emphasis factors (lambdas=1.0) for most likelihood components, with the exception that lambda's are set at 0.1 for length composition data where age composition data are used (trawl, hook and line, and setnet fisheries, as well as the NWFSC Combined survey). This downweighting is acknowledged to be an ad-hoc approach, to lessen the possible effects of double-use of data from the same fish. This was considered to be a reasonable interim approach based on the STAR Panel recommendations. A more appropriate approach would be to use conditional age-at-length compositions, which would also facilitate the estimation of growth (including time-varying growth) internally, however early efforts to apply conditional age-at-length information were unsuccessful and were postponed for future work. The approach used for iteratively re-weighting standard errors (for indices) and sample sizes (for catch at age, catch at length information) was based on the recommendations of

R. Methot (OST/NMFS). For standard errors, the model estimated root mean squared error (RSME) was compared to the input error, and where the model RSME was greater (lower), a scalar was added to the CVs in the data file. However, in cases where the model fits to surveys had very large input CVs (considerably larger than the model estimated RSMEs), the input CVs were reduced externally using multiplicative scalars, as the subtraction of a scalar to the input CV could result in a negative CV for some index/year combinations.

An additional problem noted during the assessment review is that the model tuning process that adjusted for inconsistencies between the "input" and "effective" sample sizes for length and age compositions treated the age- and length-compositions as independent even though length/age data for some fish were included in both length- and age-compositions.

Prior Probabilities

Based on the recommendations from the Groundfish Harvest Policy Evaluation Workshop, a prior probability for steepness was developed by M. Dorn (AFSC, pers. comm.) for consideration in the stock assessment model. This resulted from an updated meta-analysis comparable to that developed in Dorn (2002), but excluding the contribution of chilipepper rockfish to avoid double use of stock information. The prior developed for chilipepper rockfish had a mean value of 0.573 with a standard deviation of 0.183, very comparable to the prior probability for previously unassessed rockfish with a mean value of 0.58 and a standard deviation of 0.181. Ultimately, steepness was fixed at this point estimate, and no other prior probabilities were used in the model, however the standard deviation of the prior probability was used to bracket uncertainty in the decision table.

Major changes since last assessment

- Change in modeling platform to Stock Synthesis 2 v2.00c

- Catch reconstruction revised, with catch history extended back to 1892 rather than starting at an initial equilibrium in 1970 (fleet structure is unchanged).

- Length composition data extended back to 1978 (and forward to 2006), new age data include years 1978-1981 and 1998-2005. Some of these years were not used in final model.

- Relative abundance indices developed using CPFV observer data (1987-1998) and CalCOFI larval abundance data (1951-2006), although the latter were not used in the final model.

- Juvenile survey indices revised from index used in 1998 model; but excluded from the final model due to the failure of the index to capture the magnitude of the 1999 year class. A new coastwide index, based on the expanded SWFSC survey and a new NWFSC/PWCC survey, was used for the last six years of the model (2001-2006).

- Steepness fixed at 0.57 (there was no explicit spawner-recruit relationship in the 1998 model), natural mortality fixed at 0.16 for females, 0.20 for males (values in 1998 were 0.22 and 0.25 for females and males respectively).

- Selectivity curves are modeled using a double-normal selectivity curve for recreational fisheries and CPUE index.

- Time varying growth estimated internally in the model, implemented with a time-varying growth coefficient, K, using five time period blocks that were informed by major shifts in the signal for the Pacific Decadal Oscillation.

Base Model Selection

The initial (draft) base model was developed under the assumption that a reasonable starting point would be to include all of the relevant sources of information and examine their influence on the model in the sensitivity analysis by sequentially removing time series. The model assumed a single stock, with two sexes, which had differential growth and natural mortality. Several of the time series, including the CalCOFI larval abundance index and the core juvenile rockfish survey index, were excluded from the final base model during this examination. Similarly, early exploration of alternative values for steepness, natural mortality and other parameters led to these parameters being estimated in the draft model, and fixed in the final model. Sigma-R was fixed at 1, a value consistent with the effective Sigma-R in the results, and recruitment deviations were estimated for 1965-2006. Age frequency data in this assessment were initially treated as conditional age-at-length data, an approach recommended by the developers of SS2 in order to improve the ability to fit growth curves internally and avoid problems associated with weighting of the length and age likelihood components. However, efforts to model conditional age-at-length data, and in particular efforts to tune the effective sample sizes for these data, led to a decision to use traditional catch-at-age data along with catch-at-length information.

As time-varying growth was described as a key uncertainty in the last (1998) assessment, there were numerous efforts to develop a reasonable approach to estimating time-varying growth (primarily by allowing the growth coefficients K to vary), including exploration of annual deviations, offsets staggered in three year time blocks, linking growth directly to climate indices, and allowing time-varying blocks of years that are informed by major shifts in climate indices. All improved the model fit by dozens to several hundred likelihood units, most of which was accounted for in length frequency information.

Due to both the tremendous discrepancy between design-based and GLMM-based estimates of biomass from the trawl surveys, the inconsistencies in the relative values for each survey using each estimation approach, and the observed patchiness of the data, the trawl survey indices were treated as relative abundance indices with no estimated catchability coefficients. There was general agreement that the index should provide a meaningful index of relative abundance, and consequently this index was evaluated carefully with respect to the raw data used to develop the index as well as the model fit to the index. Initial fits were quite poor, and reflected another unusual characteristic of the early versions of the model, the failure of the model to capture an increase in relative abundance in the late 1980s as a result of the strong 1984 year class, a phenomena that was puzzling given the widespread evidence for an increase in stock abundance in most of the data.

Logistic and dome-shaped selectivity were explored for all fleets and surveys. For most fleets there was little or no improvement in fit by using dome-shaped selectivity, however the fits to the recreational fishery and CPUE data both improved significantly with dome-shaped selectivity. In the draft model and the model evaluated early in the STAR process, the setnet fishery showed strong signs of dome-shaped selectivity, within a relatively narrow size band. However, changes made during the end of the STAR week led to a selectivity curve with a double-normal parameterization that seemed to be "truncated" prior to reaching the ascending asymptote.

Developing an appropriate means of modeling selectivity to the recreational CPUE time series was widely acknowledged to be key to incorporating the index into the model, and upon exploration of various combinations of sex- and age-specific selectivity curves, a combination of size and age-based selectivity (non sex-specific) was ultimately used for this index. The ability of the model to capture the increase and subsequent stock decline associated with the strong 1984 year class, including the bimodality present in the observed length data (indicative of the dimorphic growth rates by sex of that year class), contributed to the decision to use this somewhat nontraditional approach to modeling selectivity. The model predicted length-compositions using length-based selectivity alone, including sex-specific length-based selectivity, failed to replicate the length composition data. However, exploration of sex-specific age selectivity curves during the STAR Panel review suggested that such an approach held promise for replacing the age- and length-based, sex-specific selectivity curve; although successful implementation would have required additional (unavailable) time.

Base model results

For the final base model, the total number of parameters estimated in this model was 80, including R_0, time-varying growth (K offsets, 5), parameters for logistic selectivity curves for trawl and hook and line fisheries and the two trawl surveys (8), parameters for the double-normal selectivity curves for the setnet fishery, recreational fishery, and recreational CPUE index (18), parameters for double-normal age selectivity for the recreational CPUE index (6), and recruitment deviation values for the years 1965-2006 (42). Table 20 provides the estimates for all of these parameters, as well as the model estimated standard deviation values for most of these parameters. However, in order for the model to be able to invert the Hessian matrix, selectivity for the triennial trawl survey as well as the age selectivity for the recreational CPUE index were fixed at their estimated values and the model was re-run.

The final base model used five offsets for K that were based on intervals informed by major shifts in the Pacific Decadal Oscillation (PDO) index, with the years grouped according to a five-block pattern based on major changes in the PDO index (1970-1979, 1980-1988, 1989-1991, 1992-1998, and 1999-2006). The PDO has been widely described as the dominant low frequency signal in Northeast Pacific Ocean, and is essentially the leading principal component of North Pacific Ocean temperatures above 20° N latitude. This climate signal has been linked to zooplankton abundance and productivity, salmon smolt survival, halibut recruitment, and other indices of marine productivity (Mantua et al. 1997; Francis et al. 2001; Clark and Hare 2002; Peterson and Schwing 2003; Logerwell et al. 2003). Consequently this approach was considered to be preferable to arbitrary multi-year bins and provided a comparable improvement in the fit to the data (on the order of 90 likelihood units at the cost of five parameters, and noting that the length frequency data were downweighted for many data sources). Other growth parameters were estimated externally.

The base model estimates of total biomass, spawning biomass, depletion, recruitment, total catch, exploitation rate, spawning biomass per recruit (SPR) are provided in Tables 21a and 21b. The model estimated an unfished spawning biomass (SSB_0) of 33,390 metric tons, an unfished summary biomass of 45,057, and a 2007 spawning biomass of 23,827, which results in a relative spawning biomass estimate of 0.71. Figures 44-47 show the total biomass, spawning biomass, depletion (with reference 25% and 40% of unfished biomass references), and depletion with a ten year forecast (based on 2006 status quo catches). The depletion level at its lowest point (1999) was estimated to be 8,666 tons, or 26% of SSB_0. Thus, based on the base model result, the spawning biomass has nearly tripled in a relatively short (8 year) time period, due primarily to a very strong 1999 year class (the strongest year class estimated by the model) and greatly reduced harvest levels in recent years. Figures 48 and 49 show estimated annual recruitment values over the time period with 95% asymptotic confidence limits, and Figures 50-51 show the recruitment deviations and deviation variance checks. Figure 52 shows the estimated harvest rate by year and fishery, and Figure 53 shows the model estimated spawner recruit relationship.

The SPR was well above (current) target levels throughout most of the historical period, but was below (current) target levels between 1983 and 1997, with a low of 0.32 in 1990. The SPR has ranged between 0.72 and 0.99 since 1999, reflecting the lack of fishing mortality and fishing opportunities for chilipepper rockfish (Figures 54-55). The model estimated proxy MSY based on an $F_{50\%}$ SPR, the current (1999-2006) growth conditions, and an allocation regime consistent with the catch composition of the final year (2006) of the fishery, was estimated to be 2099 metric tons. This value was associated with an exploitation rate (catch over summary biomass) of 0.088, and an equilibrium spawning biomass of 15,482, which corresponds to 46% of the unfished biomass. Based on the fishing mortality rate that would cause the spawning biomass to maintain an equilibrium value of 40% of the unfished level ($B_{40\%}$), the MSY proxy would be slightly greater, at 2155 metric tons, corresponding to an exploitation rate of 0.102 and an SPR of 0.45. When the model estimated MSY internally the estimated value was very slightly greater, at 2164 metric tons (corresponding to an exploitation rate of 0.112 and an SPR of 0.43). Table 22 provides a more comprehensive summary of all of the relevant MSY proxy reference points.

The selectivity curves for the six fisheries are shown in Figures 56-63. Model estimated numbers at age over time, and the average age of fish in the population are shown separately for both females and males (Figures 64-67). Fits to each of the relative abundance indices (in both arithmetic and log scale) as well as scatterplots of observed versus predicted indices are shown as Figures 68-87. Figures 88 and 89 show time varying growth and Figure 90 shows model estimates of the von Bertalanffy growth coefficient (K) over time, with the mean annual winter PDO and a running three year mean of the winter PDO, which were used to inform the designation of the time blocks. Fits to catch at length data by fleet are shown as Figures 91 through 128, including Pearson residual plots and observed versus effective sample sizes. Fits to catch at age data by fleet are shown as Figures 129 through 150, including Pearson residual plots and observed versus effective sample sizes.

Time-varying growth was included in the base model as offsets from the base K parameter for five time blocks that were structured around major changes in the Pacific Decadal Oscillation (PDO). Inclusion of time varying growth in this manner improved the overall model fit by nearly 100 likelihood units, primarily in the trawl and recreational CPUE length composition data as well as the recreational CPUE index. There were modest degradation of fits to survey length composition data and fishery age composition data. Inclusion of time-varying growth also captured a significant amount of the observed variability in the size at age of fish from commercial fisheries (Figures 151-152). However, the approach used to model time-varying growth would benefit by additional data and analyses, as discussed in greater detail in the sections that follow.

Forecasts and decision table

The alternative states of nature used in the decision table (Table 23) were developed in conjunction with the STAR Panel, which considered a variety of potentially appropriate sources of uncertainty. As steepness was generally thought to be poorly specified for this model, the lower and upper 25% of the prior probability distribution for steepness based on the informative prior probability developed (but not used) for the assessment represented a reasonable means of bracketing uncertainty. As steepness was fixed at the mean value of the prior probability (0.57) in the base model, the alternative states of nature were consequently 0.34 (low productivity) and 0.81 (high productivity). The three catch streams used in the decision table were developed in coordination with the Groundfish Management Team (GMT) and Groundfish Advisory Subpanel (GAP) representatives to the STAR Panel, and represented "status quo" catches (based on estimates of the 2006 catch), equilibrium MSY catches (based on the SPR 0.50 harvest strategy), and ABC catches (based on the 40:10 harvest control rule). In all cases, the 2006 total catch estimates were used to apportion theoretical future catches among gear types. This was done to facilitate comparable evaluation of plausible stock trajectories under different states of nature, and in no way implies a recommended or de facto sector allocation.

The forecast scenarios included in the decision table provide a sense of the likely population trajectories under alternative fishing regimes. In all examples, it seems likely that the sharp increase in spawning biomass associated with the 1999 year class will taper off, with the stock taking a slight (under status quo fishing effort) or moderate (under equilibrium MSY or higher catches) dip in abundance in the near term. Under status quo catches, none of the states of nature suggest the possibility of the stock declining below target biomass levels (40% of unfished) within the next ten years. Only the low productivity scenario coupled with MSY catches or 40:10 catches (fishing down to MSY) show any risk of dipping below target levels, and even under this low productivity scenario only the very high catch stream might cause the stock to fall below the overfished limit within the next ten years. In general, the stock is above target levels and expected to remain so within the foreseeable future.

Sensitivity Analysis

To evaluate model convergence during the model review, starting values were randomly adjusted ("jittered") between a range of starting values. During the assessment review, convergence problems were evident as indicated by irregular profile plots and other analyses. This seems to reflect an irregular likelihood surface related to 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. To evaluate the effect, twelve simulations were done with "jittered" initial values, and the resulting equilibrium recruitment estimates and likelihood estimates were plotted against each other (Figure 151). These results suggest two relatively localized minima in the likelihood surface, one very close to the minimum likelihood of the base model, the other associated with a slightly lower equilibrium recruitment value, but a considerably higher total likelihood value. The latter seemed to be associated with very poor fits to the recreational CPUE index and associated length composition data (Table 24), and may reflect the difficulty in achieving convergence with combined age and length-based selectivity for that index. However, the effects did not appear too severe for most other indices, and the model results varied only slightly even among the simulations with considerably higher likelihood values.

The sensitivity analyses reported here provided an opportunity to compare the results from the base model in terms of measures of the model fit (in likelihood units) when key parameters that were fixed at assumed values in the model were varied, as well as the changes in model results. Table 25 presents the likelihood values by data type for the two states of nature, the high steepness (h=0.81) and low steepness (h=0.34) scenarios, as well as very high (h=0.99) and very low (h=0.21) scenarios. Similarly, the Table includes likelihood estimates when female natural mortality is varied from 0.12 to 0.2. In all examples, the male offset is 1.26*Female_M, as in the base model. Likelihood profiles for steepness (h) and natural mortality (M) are presented as Figures 154 and 155, and a likelihood surface is presented as Figure 156. For all of these values, each run was "jittered" no less than ten times, and the model run with the lowest likelihood of the ten was reported for the likelihood values and profiles. The results of the sensitivity and the profiling on steepness suggests that estimates of steepness lower than the base case (0.57) are increasingly unlikely, while higher values of steepness are increasingly (but very modestly) more likely.

Overall, these results suggest that steepness is likely to be greater than approximately 0.4, but that the model is otherwise relatively uninformative with respect to steepness. The improvement in likelihood with higher steepness values is found primarily in the trawl fishery length and age frequency data, as well as in the trawl CPUE index. By contrast the triennial survey index and the recreational CPUE index are more consistent with lower steepness values. This tension characterizes the strongest inconsistencies among the various sources of data used in this model. Consequently, the steepness value assumed for the base model is reasonable, as high steepness values for *Sebastes* are generally considered to be less consistent with their long-lived, slow growing life history characteristics (although chilipepper rockfish are among the faster growing species with relatively higher turnover rates), and lower levels are not consistent with the likelihood profile. Figures 157 and 158 show the resulting estimates of spawning biomass and recruitment over time with the high and low productivity scenarios, with the intuitive result that the historical biomass is scaled upwards in the low productivity scenario, with current abundance at a slightly lower level than in the base model, while historical abundance is slightly lower in the high productivity model, and current abundance is even closer to the unfished level.

As with the previous assessment, the choice (or estimation) of M has a strong impact on the model results, and as with the previous assessment, lower natural mortality rates are associated with less severe declines in biomass over time (with a smaller overall stock size), while higher natural mortality rates are associated with greater declines in spawning biomass and higher overall stock sizes. Consequently, natural mortality is a key uncertainty in the model. Figures 159 and 160 show the estimated spawning biomass and recruitment over time with the lower (0.12) and higher (0.20) assumed values for female natural mortality; although the historical estimates of abundance change little, recent estimates are (intuitively) far more dynamic for the higher natural mortality assumption relative to the lower natural mortality assumption. The likelihood profile for M suggests that the fixed (assumed) value is close to the local minima for M (Figure 153), suggesting that the assumed value is reasonable. Similarly, the likelihood surface (Figure 154) demonstrates that the gradient in likelihood is consistent across all assumed values of h, implying that the model is relatively more informative for natural mortality.

Another means of evaluating the sensitivity of the model is to sequentially remove datasets from the base model. Table 26 provides the likelihood values and point estimates of unfished spawning biomass and recruitment, while Figures 161-172 show the estimated trends in spawning biomass and recruitment for a suite of runs in which individual data sources are excluded or model structure otherwise altered. For most data, the consequence of removal was relatively modest, for example there were only very modest changes in estimates of B_0, biomass trend and end-year depletion with removal of the trawl CPUE time series, the NWC combined survey time series, the setnet fishery length and age composition data, and the assumption of asymptotic versus dome-shaped selectivity for the setnet fishery (which in retrospect would have been a more reasonable assumption given the shape of the final selectivity curve, however the effect on the model estimates is virtually nonexistent). With the exclusion of other sources of data, there were often more noteworthy effects on model estimates of the unfished spawning biomass and the depletion trend, although none of these had a major impact on the general population trend or depletion level. For example, exclusion of the recreational CPUE index resulted in a slight scaling upwards of the unfished spawning biomass level (from ~33,400 to ~35,300), a flattening of the population trend during the 1990s relative to the base model (Figure 162) which suggests continued population declines in this period, and a greater population increase during the early 2000s to end at a final (2006) depletion level of 84% of the unfished level (rather than 70% in the base model). By contrast, when the trawl fishery length and age frequency data are excluded (Figure 163), the recreational CPUE data are more influential in the 1990s, such that depletion is lower in both the late 1990s (16% rather than 26% of unfished biomass in 1998) and 2006 (53% rather than 70%). A similar, but less significant, result occurred when the hook and line length and age frequency data were excluded, although this result was also associated with a general scaling downward of the total spawning biomass throughout the duration of the time series.

In general, this reflects the greatest sources of tension in the model, both the trawl CPUE and length/age frequency data, as well as the hook and line length frequency and age frequency data, were generally in conflict with the recreational CPUE data and (to a lesser extent) the triennial survey data. The latter two sources suggested greater population declines during the 1990s, while the former sources were more consistent with a relatively level biomass trend throughout the 1990s. The major effect of not including time-varying growth was a general scaling upward of the historical biomass (Figure 167), consistent with the lower productivity that this would have assumed as the growth deviations were generally all in the positive direction during the period in which they were estimated. Reconciliation of the most appropriate approach for modeling time varying growth is a key research and modeling priority for future assessments.

For the coastwide juvenile survey time series, Figure 164 shows only the estimates of SSB and recruitment from 1990 but includes a ten year forecast (assuming status quo catches), as the primary effect of this survey is to invert the recruitment estimates for 2002-2004, which are very weakly informed by the NWC combined survey length composition data, and reduce the estimates of the 2005 and 2006 year classes, which have very little data that might inform the model otherwise. As this dataset is of short duration, has not necessarily been validated, and the previous (core area, longer time series) failed to capture the magnitude of the 1999 year class (the index is moderately well correlated with year class strength estimates for other years), the inferences resulting from inclusion of the coastwide survey index should be treated with some apprehension. However, the overall effect of including this dataset is negligible with respect to estimates of reference points and biomass trend through the present period, and is relatively modest with respect to the forecast of future biomass trends. Importantly however, all of the data sources seemed to be consistent with a population increase in the early 2000s, as in none of these sensitivity runs did the end year depletion fall below 50% of the unfished population level.

A final sensitivity test evaluated the consequences of either doubling or halving the estimates of historical (pre-1978) landings of chilipepper rockfish (Figures 171-172). As described in the section on catch reconstructions, the estimated proportion of historical catches that are likely to have been chilipepper are highly uncertain for most of the pre-1978 period, including the period of foreign fisheries through the mid-1960s to the early 1970s. Doubling or halving these estimates is an ad-hoc approach to evaluating the sensitivity of the model to the exploitation history, but provides reasonable bounds on the plausible impacts. The results are consistent with the base model, with a general scaling upwards (for the doubling) and downwards (for the halving) of the historical trend, however the trend over the past 25 years and the ending depletion levels are virtually unchanged.

Summary of Responses to STAR Panel requests

The draft assessment distributed to the STAR Panel included conditional age-at-length compositions rather than age-compositions, however problems with tuning this model resulted in a model revision that was based on both length- and age-compositions without conditional age-at-length compositions. The STAT also proposed that the core area juvenile survey index be removed from the SS2 analysis, largely as a result of the failure of that index to capture the magnitude of the extremely strong 1999 year class. In discussing the significant limitations of the CalCOFI index, both the STAT and the STAR Panel agreed that this index too was not suitable for chilipepper rockfish, primarily as the survey misses much of the spatial range of the stock. The STAR Panel accepted these initial revisions to the base model, and proposed downweighting those length-compositions for which there were also age-compositions. The STAR Panel also suggested fixing, rather than estimating, both steepness and natural mortality in the revised model. The mean value of steepness based on the Dorn prior probability was used for steepness, while 0.16 was used for female natural mortality (based on profiles of M in the draft model).

Among the first requests made by the Panel was the review of the length composition data for both aged and unaged fish, which uncovered some potentially imbalanced age composition subsampling and resulted in removing selected years of data from the model (although the overall influence of these data on the model was minimal). The STAR Panel and STAT also spent considerable time reviewing the data that contributed to the CPFV index, ultimately arriving at a new approach for estimating the index based on excluding the deeper depths (which had limited sampling) and considering a suite of alternative approaches for modeling selectivity, including age-based, sex-based and length-based dome-shaped selectivity curves. Considerable effort was also expended on evaluating an appropriate means of modeling time-varying growth. For both of these issues, the current approaches should be considered placeholders until more appropriate means of modeling selectivity to the recreational index and time-varying growth can be developed. The STAR Panel also provided additional guidance for future modeling efforts with respect to tuning the effective sample sizes in a model in which sampled fish contribute to both length- and age-compositions (see the STAR Panel report). This summary highlights the key issues that were raised and considered during the model review, a more detailed accounting of the requests and responses is included as Appendix C.

Comparison with the last assessment

The major differences between the 1998 assessment and the current assessment were summarized earlier, and Figures 173 and 174 show the major differences in the results of the base models for each assessment. There is a substantial difference in the scale of the total biomass between the two models, with the 1998 model estimating a considerably larger (approximately double) spawning biomass than the current model in the early period (the 1998 model was initiated in 1970). However, the “low natural mortality rate” model run as a sensitivity test in the 1998 assessment (in which M was set to 0.16, which is the base model M for this assessment) predicted an early 1970s total biomass of approximately 35,000 mt, much closer to 30,000 mt total biomass estimated in the base model for this assessment (Ralston et al. 1998, Figure 38). The 1998 model also suggested a greater relative decline throughout the early 1980s, and a proportionately greater (but slightly lagged) response in the spawning biomass through the late 1980s into the 1990s. These results are also consistent with the sensitivity tests that assumed a higher natural mortality rate in this assessment (Figure 160). Estimates of recruitment in the two models were nearly identical throughout the overlapping time period (Figure 174), demonstrating consistency in both the estimation of recruitment strengths and variability. Estimates of exploitation rates and harvest projections were also similar, although estimates of both were slightly higher in the 1998 assessment.

Retrospective analysis

A retrospective analysis was conducted by sequentially removing the most recent two years of data, such that models included data through 2004 only (Figure 175), through 2002 only (Figure 176), through 2000 only (Figure 177) and through 1998 only (Figure 178). As with other sensitivity runs, the runs were "jittered" at least 8-10 times, and the model with the lowest likelihood was presented in the comparison. The historical spawning biomass and recruitment trajectories changed very little with each analysis, which is not a terribly surprising result in a model for which steepness and natural mortality were fixed, and catches in the past 5-8 years have been minimal. Interestingly, the strength of the 1999 year class was very evident in the data by as early as 2002, and the 2000 retrospective may have mistakenly attributed an apparent abundance of small fish associated with the 1999 recruitment year (these fish were just beginning to appear in trawl catches) to a strong 1998 year class.

Technical Deficiencies

During the STAR Panel review, the length composition data were down-weighted when associated age-composition data were available, however the approach (a lambda of 0.1 for length data where age data also exist, and 1 for the associated age data) was acknowledged to be ad-hoc and lacking a solid theoretical basis. A more appropriate approach is to use conditional age-at-length compositions, which was attempted in early runs but led to a suite of problems in model tuning.

In evaluating possible causes of these problems, the raw length composition data by fishery for years with both aged and non-aged fish was evaluated on a year-by-year basis, and where the length compositions seemed inconsistent, the emphasis on the data was effectively set to zero. For some years, there seems to be evidence that there was some geographic bias in the sampling of aged versus un-aged fish that could have been internally inconsistent, and there was at least one example of samples that had large numbers of male chilipepper that were of unreasonably large size and must have represented identification errors of some sort. However, as this evaluation was based on unexpanded length compositions, it is possible that good length-composition data may have been excluded from the model. A re-evaluation of these length composition data, improved efforts to incorporate conditional age-at-length information, and approaches to model tuning that account for joint tuning of co-dependent age and length frequencies are all priorities for future assessments.

The model tuning process that adjusted for inconsistencies between the model fits to surveys (RMSE) and the input CVs took an ad hoc approach with surveys that had very large CVs for some index values. The input CVs were reduced proportionally, which was somewhat inconsistent with the normal process of adding a constant to account for process error.

The estimated growth curves had kinks that could probably be eliminated by reducing the lower bound of the smallest length bin. This would also improve estimation of the selectivity curves for the two fisheries independent trawl surveys, for which the smallest (<16 cm) fish appear to be fully, or near fully, selected. This in turn would negate the need to fix the parameters for the triennial survey selectivity, which was necessary to invert the Hessian matrix.

The results from the convergence tests with randomly jittered starting parameter values indicated that the likelihood surface is very irregular. The final runs, as well as sensitivity runs, were "jittered" 10 to 12 times in order to better ensure convergence, however the conflicting signals of some data sources is a source of some concern. In general, biomass trajectories and other critical results do not appear to be sensitive to these differences.

Although there is a clear progression from shallow to deeper water with age and size, the application of a combined age- and length- based selectivity curve for the recreational CPFV data is somewhat non-traditional and would benefit by either more detailed investigation or an alternative selectivity configuration (an age-based, sex-specific selection curve showed considerable promise).

Although the setnet fishery was modeled with dome-shaped (double logistic) selecitivity, which indicated declining selectivity at the very largest size classes for early model configurations, the ultimate shape of the selectivity curve suggested a more monotonic increase in selectivity with largest sizes. Consequently, a logistic selectivity curve may have been more appropriate for modeling the selectivity of this fishery, although a sensitivity analysis suggest that the significance of such a change would be negligible.

Key Uncertainties

This stock has increased substantially in recent years due to the strength of the 1999 year class, which is strongly visible in age and length composition data from both fisheries and resource surveys. Future (post-1999) year class strength is highly uncertain; although this model includes highly informative projections through 2006 based on juvenile abundance indices, the failure of the historical (core area) juvenile index to capture much of the year class variability that has been observed is troublesome.

Early catch histories are fairly uncertain. Although it is common knowledge that chilipepper have been historically important, and reasonable estimates of the total rockfish catch estimates exist, estimates of the percentage of historical catches that were chilipepper, and how that percentage may have changed over time, are based primarily on anecdotal information.

Lack of fishery-independent age data is problematic; as the four years of triennial age data were surface read, they were not used in the model (the ages up to age 8 were used in estimating the external growth curves, based on the common assumption that surface ages tend to be consistent with break and burn ages up to approximately age 10). Such data would be particularly useful in estimating time-varying growth, which seems to be an important factor for chilipepper rockfish. As the 1970-1979 estimated K is quite high (approximately 0.32), alternative approaches for estimating growth prior to the period in which most data are available should be explored. Additionally, the estimates of yield and productivity will be based in part on future assumptions regarding growth. Similarly, while there is a paucity of smaller fish in the commercial fisheries, there are indications of smaller individuals in the surveys, and including a broader range of length bins (smaller than 16 cm) or exploring a younger minimum age (A_{min}) for the Schnute growth curve formulation could lead to improvements in how growth is estimated.

There are insufficient data to consider spatial structure in the model; although the CalCOFI time series might suggest greater relative depletion south of Point Conception, this time series has some unusual characteristics that undermine its utility as an index of abundance. As there is only very limited fisheries dependent information in this region, and only a very short (four years) time series of fishery independent information (with low sampling density), spatial features have been ignored in this model.

Discards are assumed to be negligible until 2002, when catches were scaled upwards to account for the discard rates estimated by the West Coast groundfish observer program. This assumption may be incorrect, as regulatory impacts may have resulted in an increase in discarding as management measures evolved from the mid to late 1990s to 2002 to rebuild overfished and depleted stocks. In the earlier historical period, even negligible to modest estimates of discarding in some fisheries could potentially be developed based on observed discard rates in other fisheries for earlier time periods. Average size data from the observer program have not been developed or integrated into the model, and could be evaluated in the future.

There is considerable uncertainty associated with the coastwide juvenile index as this dataset is of short duration, has not necessarily been validated, and the previous (core area survey) failed to capture the magnitude of the 1999 year class. Although the current influence of the survey is modest, and there is currently little information in the model to counter the influence of this index, it is also likely that the CVs in the coastwide index may be constraining (currently the average CV is approximately 0.037) as the time series lengthens and begins to overlap temporally with length and age data from fisheries and surveys. Re-evaluation of the coastwide juvenile index should be an important element of both future research and future assessments.

Since 2003, the Rockfish Conservation Areas (RCAs) have been the primary management tool implemented to protect rebuilding species that co-occur with chilipepper, such as bocaccio, widow, and canary rockfish. As a result of these management measures and reductions in trip limits, catches of chilipepper rockfish have declined significantly, limiting the amount of fishery-dependent information (age and length frequency information) available to the assessment model. However, such measures have also likely resulted in a bias in those age and length frequency information that do exist, as such data are derived from fish that were caught either shoreward or seaward of the RCAs, while the areas of greatest chilipepper abundance are within the RCAs. As a result, and further complicated by the clear ontogenetic shift to deeper water with size (and presumably age), these age and length frequency information are not likely to be reflective of the true age and length structure of the population (e.g., Punt and Methot 2004; Field et al. 2006). Such considerations could potentially be addressed by a more rigorous evaluation of the sources of the data, and possibly by including alternative selectivity curves for the post-RCA period, however such approaches were not evaluated in detail in this assessment and should be considered in future assessments.

Regional Management Concerns

There are insufficient data to consider spatial structure in the model, consequently the resource is modeled as a single stock. Although the stock extends north of Cape Blanco, Oregon, the abundance and catches are minimal and have no significance in the model. Catches and biomass between Cape Mendocino and Cape Blanco are modest, but noteable and historically accounted for in landings and surveys. By contrast, catches and biomass trends south of Point Conception are poorly quantified and highly uncertain, but anecdotal accounts suggest that chilipepper were historically a relatively important stock in this region. Although the CalCOFI time series (which was not used in the final model) is suggestive of greater relative depletion in this region, this time series has some unusual characteristics that undermine its utility as an index of abundance. As there is only very limited fisheries dependent information in this region, and only a very short (four years) time series of fishery independent information (with low sampling density), there is insufficient information to assess potential regional concerns in this area. Increased sampling of both fisheries data and by resource surveys are critical to any attempts to develop a greater understanding of potential spatial differences in stock status and trends in this region. However, as the Southern California Bight appears to be a region of sharply declining abundance, and abundance appears to drop even more sharply towards the U.S./Mexico border, transboundary issues are minimal for this stock.

Research and Data Needs

Additional investigations into the catch history should be made, including greater evaluation of detailed historical landings data from fish tickets (ongoing) which should inform catch history reconstructions. As has been recommended previously by both STAT teams and STAR panels, the reconstruction of historical rockfish landings should be done comprehensively across all rockfish species to ensure efficiency and consistency (priority medium, medium to long term).

Information on maturity and fecundity is available, but limited. Additional information should be compiled and carefully evaluated for accuracy, potential changes over time, and potential maternal effects (priority medium, long term).

There is a paucity of length at age information for smaller fish, particularly those collected in fishery independent surveys. Otoliths that are available from past years of the triennial survey, and those available from the combined survey, should be aged to provide better data on the early stages of growth and possible time-variations in growth. Additionally, aging error is poorly estimated, as only a modest number of otoliths were read by two readers, and most of these were relatively young fish. Additional double-reads of break and burn otoliths should be conducted to better estimate ageing error (priority high, short term).

Greater exploration of methods for modeling time-varying growth as influenced by environmental factors should be a key research area for future assessments. Such exploration will benefit substantially from both an increased availability of data from research catches (both historical and recent) as well as a renewed attempt to model age and length data using conditional length-at-age approaches (priority high, short to medium term).

The consequences of the Rockfish Conservation Areas to vulnerability, selectivity patterns and other stock attributes could be significant, and would benefit from greater analysis as well as more generic simulation studies that might inform assessment authors of the consequences of spatially explicit management measures to the basic assumptions of stock assessment models (priority medium, medium to long term).

Additional fisheries dependent and fisheries independent data for the region south of Point Conception (including additional evaluation of historical landings in this region) is essential in evaluating whether the relative stock status may be different in this region relative to the coastwide trend, as might be suggested by a superficial evaluation of the CalCOFI data. Further evaluation of the CalCOFI data, to determine the extent to which these data may or may not inform relative trends at a more spatially explicit level, should also be a research priority (priority medium, medium to long term).

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Table 1: Management performance in obtaining the ABC and OY for chilipepper rockfish (catch includes all catches in all areas, commercial and recreational, as well as estimated discards from 2002-2006; discards prior to 2002 are assumed to be negligible, although some regulatory discarding was likely).

Year	ABC	OY	Catch	%ABC	%OY
1982	-		2492		
1983	2300		2465	107	
1984	2300		2923	127	
1985	2300		3182	138	
1986	2300		3147	137	
1987	2300		2059	90	
1988	3600		2691	75	
1989	3600		3395	94	
1990	3600		3110	86	
1991	3600		3311	92	
1992	3600		2753	76	
1993	3600		2393	66	
1994	4000		1877	47	
1995	4000		2021	51	
1996	4000		1870	47	
1997	4000		2110	53	
1998	3400		1430	42	
1999	3724	3724	977	26	26
2000	3681	2000	499	14	25
2001	2700	2000	517	19	26
2002	2700	2000	329	12	16
2003	2700	2000	21	1	1
2004	2700	2000	236	9	12
2005	2700	2000	192	7	10
2006	2700	2000	127	5	6
2007	2700	2000	-		

Table 2: Estimated chilipepper rockfish landings by gear type for the early period (1892-1927), based on reported estimates of total rockfish landings by Sette and Fiedler (1928, bold under "all rockfish"), interpolated estimates for intervening years, the estimated ratio of chilipepper to all rockfish in 1928 based on the regional landings data, and the assumption that 95% of rockfish landings were hook and line until 1943.

	trawl	hookline	total
1892	11	206	**217**
1893	10	195	205
1894	10	183	193
1895	9	171	**180**
1896	9	162	170
1897	8	152	160
1898	8	143	150
1899	7	133	**140**
1900	8	147	155
1901	8	161	170
1902	9	176	185
1903	10	190	200
1904	11	204	**215**
1905	11	218	229
1906	12	232	244
1907	13	246	259
1908	14	260	**274**
1909	15	292	308
1910	17	325	342
1911	19	358	376
1912	21	390	411
1913	22	423	445
1914	24	455	479
1915	26	488	**513**
1916	33	633	**666**
1917	41	778	**819**
1918	49	924	**972**
1919	32	605	**637**
1920	33	631	**665**
1921	28	534	**562**
1922	25	483	**509**
1923	30	571	**601**
1924	28	532	**560**
1925	32	615	**648**
1926	44	845	**890**
1927	38	716	**754**

Table 3: Total California rockfish catches by region (based on CDF&G Fisheries Bulletin reports) and as estimated by gear type.

Year	Trawl	% trawl	% hook-line	**Eureka**	**San Francisco**	**Monterey**	**Santa Barbara**	**Los Angeles**	**San Diego**	**CA Total**
1928		0.050	0.950	49	453	1037	47	770	555	2911
1929		0.050	0.950	117	487	745	45	687	642	2723
1930		0.050	0.950	114	466	1282	21	906	478	3268
1931		0.050	0.950	48	473	1162	31	1183	400	3298
1932		0.050	0.950	40	451	930	35	798	299	2552
1933		0.050	0.950	14	516	734	47	588	253	2152
1934		0.050	0.950	58	414	762	128	511	130	2001
1935		0.050	0.950	73	402	976	178	374	78	2080
1936		0.050	0.950	85	391	1189	182	123	70	2039
1937		0.050	0.950	61	470	955	166	157	65	1875
1938		0.050	0.950	248	254	839	73	126	34	1573
1939		0.050	0.950	342	176	603	91	141	92	1445
1940		0.050	0.950	264	206	753	136	153	67	1579
1941		0.250	0.750	206	205	662	132	203	42	1451
1942		0.500	0.500	123	32	298	38	74	10	576
1943		0.750	0.250	624	92	311	39	89	5	1160
1944		0.900	0.100	2506	31	332	22	10	5	2907
1945		0.900	0.100	5315	84	534	45	27	5	6009
1946		0.900	0.100	4007	100	508	49	80	9	4752
1947		0.900	0.100	2497	96	690	27	132	9	3450
1948		0.900	0.100	1595	123	748	36	200	24	2726
1949		0.900	0.100	1275	236	611	62	259	37	2481
1950		0.900	0.100	1556	449	1107	86	294	34	3525
1951		0.900	0.100	2052	1000	1441	122	329	15	4958
1952		0.900	0.100	1090	1625	1677	108	219	9	4728
1953		0.900	0.100	1336	1892	1954	89	179	15	5466
1954	4899	**0.892**	0.108	1263	1354	2349	263	247	14	5491
1955	5035	**0.899**	0.101	1225	709	1887	1533	199	48	5601
1956	5897	**0.887**	0.113	1305	1335	2548	1169	258	35	6650
1957	6396	**0.886**	0.114	1676	1279	2482	1523	228	32	7220
1958	6486	**0.814**	0.186	1610	1903	2657	1426	229	141	7967
1959	5534	**0.818**	0.182	1366	2233	2132	671	265	95	6761
1960	5352	**0.889**	0.111	1300	1493	1617	1281	239	90	6019
1961	4037	**0.862**	0.138	885	1008	1465	1053	175	99	4684
1962	3538	**0.849**	0.151	808	903	1295	917	172	70	4166
1963	4445	**0.883**	0.117	1332	1070	1119	1181	221	112	5034
1964	3078	**0.864**	0.136	768	794	987	719	208	87	3562
1965	3481	**0.838**	0.162	1082	715	1188	786	249	133	4153
1966	3856	**0.861**	0.139	822	732	1536	1027	226	136	4480
1967		0.860	0.140	1075	389	1156	1313	251	167	4351
1968		0.860	0.140	1272	265	1087	1188	243	126	4180
1969	3434	**0.860**	0.140	1340	276	932	1133	227	86	3994
1970	4109	**0.866**	0.134	1694	350	1305	1115	172	108	4744
1971	4018	**0.809**	0.191	2098	565	1088	869	197	150	4968
1972	5969	**0.829**	0.171	2734	736	1669	1493	301	267	7200
1973	7958	**0.823**	0.177	2371	1391	3528	1759	277	344	9671
1974		0.832	0.168	3277	984	2723	1809	224	584	9602
1975		0.841	0.159	3679	1014	2732	2168	369	445	10407
1976		0.851	0.149	4410	1105	2193	2652	328	460	11147
1977		0.860	0.140	3183	826	2292	2514	214	407	9435

Table 4: Fraction of rockfish landings by region assumed to be chilipepper, based on analysis in text (where bold early years represent fractions supported by literature estimates, and 1978-1979 fractions are based on CalCOM estimates).

	Eureka	**San Francisco**	**Monterey**	**Santa Barbara**	**Los Angeles**	**San Diego**
1928	0.057	0.308	0.308	0.308	0.200	0.200
1929	0.057	0.308	0.308	0.308	0.200	0.200
1930	0.057	0.308	0.308	0.308	0.200	0.200
1931	0.057	0.308	0.308	0.308	0.200	0.200
1932	0.057	0.308	0.308	0.308	0.200	0.200
1933	0.057	0.308	0.308	0.308	0.200	0.200
1934	0.057	0.308	0.308	0.308	0.200	0.200
1935	0.057	0.308	0.308	0.308	0.200	0.200
1936	0.057	0.308	0.308	0.308	0.200	0.200
1937	0.057	0.308	0.308	0.308	0.200	0.200
1938	0.057	0.308	**0.308**	0.308	0.200	0.200
1939	0.057	0.308	0.308	0.308	0.200	0.200
1940	0.057	0.308	0.308	0.308	0.200	0.200
1941	0.057	0.308	0.308	0.308	0.200	0.200
1942	0.057	0.331	0.213	0.341	0.200	0.200
1943	0.057	0.331	0.213	0.341	0.200	0.200
1944	0.057	0.331	0.213	0.341	0.200	0.200
1945	0.057	0.331	0.213	0.341	0.200	0.200
1946	0.057	0.331	0.213	0.341	0.200	0.200
1947	0.057	0.331	0.213	0.341	0.200	0.200
1948	0.057	0.331	0.213	0.341	0.200	0.200
1949	0.057	0.331	0.213	0.341	0.200	0.200
1950	0.057	0.331	0.213	0.341	0.200	0.200
1951	0.057	0.331	0.213	0.341	0.200	0.200
1952	0.057	0.331	0.213	0.341	0.200	0.200
1953	0.057	0.331	0.213	0.341	0.200	0.200
1954	0.057	0.331	0.213	0.341	0.200	0.200
1955	0.057	0.331	0.213	0.341	0.200	0.200
1956	0.057	0.331	0.213	0.341	0.200	0.200
1957	0.057	0.331	0.213	0.341	0.200	0.200
1958	0.057	0.331	0.213	0.341	0.200	0.200
1959	0.057	0.331	0.213	0.341	0.200	0.200
1960	0.057	0.331	0.213	0.341	0.200	0.200
1961	0.057	0.331	0.213	0.341	0.200	0.200
1962	**0.059**	**0.365**	**0.230**	**0.389**	0.200	0.200
1963	**0.054**	**0.297**	**0.196**	**0.293**	0.200	0.200
1964	0.057	0.331	0.213	0.341	0.206	0.206
1965	0.066	0.327	0.224	0.332	0.213	0.213
1966	0.076	0.323	0.234	0.322	0.219	0.219
1967	0.086	0.319	0.245	0.312	0.225	0.225
1968	0.095	0.315	0.256	0.302	0.232	0.232
1969	0.105	0.311	0.266	0.293	0.238	0.238
1970	0.114	0.307	0.277	0.283	0.245	0.245
1971	0.124	0.303	0.288	0.273	0.251	0.251
1972	0.134	0.299	0.299	0.264	0.257	0.257
1973	**0.134**	**0.299**	**0.299**	**0.264**	**0.264**	**0.264**
1974	0.143	0.283	0.308	0.215	0.227	0.215
1975	0.152	0.268	0.317	0.166	0.190	0.167
1976	0.162	0.252	0.326	0.117	0.154	0.119
1977	0.171	0.237	0.335	0.069	0.117	0.071
1978	**0.181**	**0.222**	**0.344**	**0.020**	**0.081**	**0.022**
1979	**0.209**	**0.194**	**0.337**	**0.019**	**0.080**	**0.021**

Table 5: Estimated landings of chilipepper rockfish by California region, 1928-1979, including Oregon and Foreign Fishery landings, and by gear type.

Year	Eureka	San Francisco	Monterey	Santa Barbara	Los Angeles	San Diego	Oregon	Foreign Fisheries	Trawl	Hook-line
1928	3	140	320	14	154	111			37	701
1929	7	150	229	14	137	128			33	626
1930	6	144	395	7	181	96			41	781
1931	3	146	358	10	237	80			42	788
1932	2	139	286	11	160	60			33	623
1933	1	159	226	14	118	51			28	539
1934	3	127	235	39	102	26			27	503
1935	4	124	301	55	75	16			29	541
1936	5	120	366	56	25	14			29	552
1937	3	145	294	51	31	13			27	508
1938	14	78	258	22	25	7			20	371
1939	19	54	186	28	28	18			17	299
1940	15	64	232	42	31	13			20	362
1941	12	63	204	41	41	8			92	268
1942	7	11	63	13	15	2			55	52
1943	35	30	66	13	18	1			123	32
1944	142	10	71	8	2	1			210	9
1945	301	28	114	15	5	1			418	16
1946	227	33	108	17	16	2			362	18
1947	141	32	147	9	26	2			322	22
1948	90	41	159	12	40	5			313	26
1949	72	78	130	21	52	7			325	29
1950	88	149	235	29	59	7			510	48
1951	116	331	307	42	66	3			778	75
1952	62	538	357	37	44	2			935	98
1953	76	627	416	30	36	3			1069	111
1954	72	448	500	90	49	3			1037	118
1955	69	235	402	523	40	10			1149	122
1956	74	442	542	399	52	7			1344	163
1957	95	423	528	520	46	6			1434	174
1958	91	630	565	487	46	28			1504	326
1959	77	740	454	229	53	19			1286	271
1960	74	494	344	437	48	18			1258	149
1961	50	334	312	359	35	20			956	146
1962	48	330	297	357	34	14			917	156
1963	72	318	219	346	44	22	14.9		917	111
1964	43	263	210	245	43	18	0.1		711	106
1965	72	234	266	261	53	28	0		765	136
1966	62	236	360	331	50	30	0	985	1905	140
1967	92	124	283	410	57	38	0.3	1634	2498	127
1968	121	83	278	359	56	29	0	671	1468	113
1969	140	86	248	332	54	20	0	53	810	104
1970	194	107	362	316	42	27	0	1	908	114
1971	260	171	313	238	50	38	0	2	867	155
1972	365	220	498	394	77	69	0	26	1372	215
1973	317	416	1054	464	73	91	0	907	2893	371
1974	469	279	838	389	51	126	0.2	1403	3193	282
1975	561	272	865	360	70	74	1.5	734	2588	260
1976	713	279	714	311	50	55	0	529	2335	210
1977	545	196	767	172	25	29	0		1491	167
1978	618	284	500	45	33	9	0		1293	169
1979	1005	417	694	51	56	12	0		2004	177

Table 6: Estimates of chilipepper landings by region and gear type in California area (based on CalCOM), including Oregon (based on PacFIN), 1978-2006. Excludes 2002-2006 discards.

year	Eureka	San Francisco	Monterey	Santa Barbara	Los Angeles	San Diego	Oregon	Trawl	Hook-line	Net
1978	618	284	500	45	33	9	0	1293	169	169
1979	1005	417	694	51	56	12	0	2004	177	177
1980	783	835	1157	31	52	5	0	2721	96	45
1981	713	874	772	32	68	23	23.4	2295	139	71
1982	369	508	1087	37	75	23	23.2	1681	356	85
1983	558	950	717	11	38	22	9.8	1879	80	345
1984	573	1141	908	43	81	29	2.1	2448	98	231
1985	421	872	1386	19	91	35	2.1	1807	279	739
1986	404	1353	940	29	28	6	1.1	1269	331	1161
1987	506	522	827	59	21	11	0.5	1314	173	461
1988	741	689	889	65	11	5	0.2	1778	333	289
1989	721	989	1210	193	30	3	4.5	2363	426	361
1990	926	1174	722	95	1	2	2.3	2317	232	373
1991	814	1411	774	155	10	1	14	2229	618	332
1992	377	1489	717	63	15	6	13.1	1330	1053	297
1993	595	963	761	41	3	7	6.1	1282	861	233
1994	498	608	723	13	1	3	13.9	1267	485	108
1995	606	564	819	8	3	4	9.5	1595	325	94
1996	451	606	748	19	2	4	9.3	1528	254	58
1997	486	840	681	17	4	2	7.3	1614	339	83
1998	319	644	449	2	3	1	5.8	1138	209	78
1999	411	358	175	2	1	3	3.3	839	104	10
2000	177	213	68	1	0	0	0.7	403	51	6
2001	116	144	72	0	1	0	132.7	436	25	5
2002	67	61	37	0	0	0	0.3	162	3	0
2003	10	2	5	0	0	0	0.7	18	0	0
2004	38	18	9	0	0	0	0.2	61	3	1
2005	43	11	8	0	0	0	0.7	60	3	0
2006	19	14	10	0	0	0	0.1	37	6	0

Table 7: RecFIN catch information for chilipepper rockfish, 1980-2006.

	Private/Rental 1000s		CPFV 1000s		Total metric tons		Mean weight (kg)	
	North	South	North	South	North	South	North	South
1980	0	50	50	385	30	362	0.60	0.83
1981	0	27	105	252	61	210	0.58	0.75
1982	0	36	181	246	178	192	0.98	0.68
1983	1	6	110	100	100	60	0.90	0.57
1984	0	3	201	28	127	19	0.63	0.60
1985	2	3	218	253	156	202	0.70	0.79
1986	21	6	342	183	276	110	0.76	0.58
1987	12	6	146	6	109	3	0.69	0.23
1988	14	25	679	51	264	26	0.38	0.35
1989	15	21	289	195	150	95	0.49	0.44
1990	*15*	*23*	*261*	*159*	*114*	*74*		
1991	*8*	*25*	*232*	*122*	*79*	*52*		
1992	*5*	*28*	*203*	*86*	*43*	*31*		
1993	15	30	174	50	7	10	0.50	0.32
1994	0	37	146	14	0	17	0.09	0.34
1995	3	26	117	2	2	5	0.62	0.21
1996	1	20	88	1	21	10	0.48	0.45
1997	0	1	1	1	73	1	0.82	0.40
1998	0	6	24	9	1	4	0.75	0.61
1999	0	12	49	9	18	6	0.75	0.28
2000	1	9	50	7	31	8	0.63	0.44
2001	1	6	28	11	51	1	1.01	0.16
2002	0	3	5	14	6	6	0.97	0.37
2003	0	0	0	0	0	0	0.37	
2004	0	0	0	15	0	6		0.38
2005	0	0	0	8	0	4	0.07	0.43
2006	0	0	0	4	0	1	0.07	0.34

Table 8: Reconstructed catches of all rockfish based on CPFV logs and estimated catches of chilipepper rockfish (1000s fish, tons), 1928-1979, based on interpolated species composition and average weight information.

	All rockfish Reported CPFV		All rockfish Expanded CPFV		Chilipepper Private (1000s)		Chilipepper CPFV (1000s)		Chilipepper Total Tons	
	North	South	North	South	North	South	North	South	North	South
1928	0	0	0	0	0	0	0	0	0	0
1929	*18*	*8*	34	15	0	0	0	0	0	0
1930	*36*	*15*	67	30	0	0	0	0	0	0
1931	*54*	*23*	101	45	0	0	0	0	0	0
1932	*72*	*30*	135	60	0	0	0	1	0	0
1933	*90*	*38*	168	75	0	0	0	1	0	1
1934	*108*	*46*	202	90	0	0	0	1	0	1
1935	*126*	*53*	236	105	0	0	0	2	0	1
1936	*144*	*61*	270	120	0	0	0	2	0	2
1937	*171*	*72*	320	143	0	0	0	3	0	2
1938	*168*	*71*	314	140	0	0	0	3	0	2
1939	*147*	*62*	275	123	0	0	0	3	0	2
1940	*211*	*90*	396	177	0	0	1	5	0	4
1941	0	0	0	0	0	0	0	0	0	0
1942	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0
1947	148	46	277	91	0	0	1	4	0	3
1948	295	116	553	228	0	1	1	11	1	8
1949	383	188	716	372	0	2	2	18	1	14
1950	467	213	873	420	0	3	2	21	2	16
1951	533	189	997	374	0	4	3	20	2	15
1952	464	242	868	479	0	4	2	26	2	20
1953	395	301	739	595	0	5	2	34	1	26
1954	491	658	919	1301	0	6	3	78	2	59
1955	585	1153	1095	2278	0	7	3	142	2	107
1956	653	1384	1223	2734	0	7	4	176	3	133
1957	645	767	1207	1516	0	8	4	101	3	77
1958	1052	517	1968	1021	0	9	6	71	5	53
1959	879	300	1645	593	0	10	5	42	4	32
1960	679	307	1271	606	0	10	4	45	3	34
1961	514	348	961	689	0	11	5	52	3	40
1962	589	339	1102	670	0	12	7	52	5	40
1963	609	346	1141	684	0	13	10	55	7	42
1964	462	488	864	964	0	13	9	80	6	60
1965	718	631	1345	1246	0	14	16	106	12	80
1966	773	940	1447	1858	0	15	20	163	14	123
1967	760	1158	1423	2288	0	16	22	205	16	155
1968	800	1274	1497	2517	0	16	26	232	19	175
1969	843	1097	1578	2167	0	17	30	205	22	155
1970	1047	1532	1960	3027	0	18	41	293	29	221
1971	803	1399	1504	2764	0	19	34	274	24	207
1972	1098	1827	2054	3609	0	19	50	366	36	276
1973	1391	2137	2603	4223	0	20	68	438	49	331
1974	1466	2552	2745	5042	0	21	76	569	55	430
1975	1396	2516	2613	4971	0	22	77	428	56	323
1976	1580	1978	2957	3909	0	22	93	635	67	480
1977	1384	1792	2590	3541	0	23	86	492	62	372
1978	1199	1674	2245	3307	0	24	78	514	57	389
1979	1321	2319	2472	4583	0	38	91	562	65	425

Table 9: Number of subsamples (trips) and fish measured for RecFIN length composition data

	Number of subsamples			Number of fish measured		
	N.Cal	S.Cal	Coastwide	N.Cal	S.Cal	Coastwide
1980	18	32	50	88	303	391
1981	6	41	47	90	697	787
1982	10	49	59	204	414	618
1983	12	33	45	213	433	646
1984	41	49	90	675	111	786
1985	86	52	138	1475	537	2012
1986	78	37	115	1715	383	2098
1987	21	1	22	384	10	394
1988	67	5	72	875	53	928
1989	20	9	29	658	254	912
1994		5	5		31	31
1995	5		5	149		149
1996	18	2	20	550	6	556
1997	15		15	590		590
1998	6		6	263		263
1999	28	19	47	528	53	581
2000	9	22	31	194	82	276
2001	9	7	16	210	89	299
2002	11	7	18	140	85	225
2004		41	41		233	233
2005		16	16		53	53

Table 10: Trawl logbook CPUE time series developed by Ralston et al. (1998) and Ralston (1999)

year	Ralston et al. 1998	cv (assumed)	catch weighted	SE	CV	area weighted	SE
1980	249	0.1					
1981	150	0.1					
1982	121	0.1	132	49.8	0.38	95	32.6
1983	116	0.1	35	13.1	0.38	35	11.4
1984	91	0.1	90	27	0.30	57	16.4
1985	88	0.1	101	31.3	0.31	51	13.1
1986	76	0.1	57	17.7	0.31	35	10
1987	116	0.1	103	30.3	0.30	55	14.2
1988	158	0.1	175	59.2	0.34	77	18.6
1989	172	0.1	92	28.4	0.31	66	18
1990	149	0.1	103	31.8	0.31	74	20
1991	146	0.1	131	41.3	0.32	70	17
1992	109	0.1	120	45.8	0.38	45	11.5
1993	80	0.1	69	19	0.27	45	11
1994	112	0.1	103	32.6	0.32	51	13.6
1995	126	0.1	119	34.5	0.29	59	15.6
1996	96	0.1	95	28.1	0.29	45	11.7

Table 11: Number of subsamples for length comp data, and numbers of length and age observations by fishery

	Subsamples (length)			Length measurements			Age measurements		
	Trawl	Hk-line	Net	Trawl	Hk-line	Net	trawl	Hk-line	net
1978	147			1560	4		559		
1979	110			1860	307		330		
1980	191	1		1590	85		841	2	
1981	125			955	109		701		
1982	195	20		1856	227		1220		
1983	275	8	24	2701	79	211	2305	8	68
1984	305	9	68	5186	94	660	3574		42
1985	338	14	155	7153	356	1090	3269	100	266
1986	219	8	113	4076	213	824	2008	173	414
1987	211	9	92	4433	135	700	2529	36	367
1988	199		70	4669	122	551	2428	5	220
1989	183	16	82	4582	284	650	2524	9	311
1990	204	16	99	5026	80	953	1692	15	443
1991	208	41	35	7632	1801	483	1600	424	96
1992	132	84	68	4208	2570	946	2081	745	406
1993	126	87	35	4630	3584	966	2001	434	188
1994	117	86	47	3898	3615	931	742	251	253
1995	114	23	32	3747	841	742	1306	249	60
1996	116	41	21	3327	1138	342	803	189	37
1997	136	38	14	4537	1367	439	1718	209	63
1998	123	38	11	3109	886	269	2135	322	93
1999	84	11		3030	435		2091	165	
2000	50	9		1706	364		998	161	
2001	58	12		1996	401		767	128	
2002	54	3		1832	64		1029	38	1
2003	18			533	6		309	3	
2004	54			1743			949		
2005	20			452			349		
2006	31	3		650	70				

Table 12: Number of trips by year and average depth bin for the CPFV observer dataset.

YEAR	0-19	20-39	40-59	60-79	80-99	>100
1987	1	14	36	21	17	1
1988	23	75	62	25	21	4
1989	16	77	83	26	25	4
1990	3	25	33	8	4	1
1991	9	34	32	9		1
1992	28	64	110	22	6	
1993	33	93	81	35	5	1
1994	35	89	85	25	3	
1995	32	89	86	8	3	
1996	46	94	76	11	2	
1997	54	77	88	20	5	
1998	40	72	46	13		

Table 13: Total number of chilipepper caught (by mean depth bin)

	0-19	20-39	40-59	60-79	80-99	>100
1987		1	557	1770	3573	295
1988	3		493	3267	2973	556
1989			355	2351	3004	388
1990			150	193	442	218
1991		1	60	173	6	8
1992		0	454	852	56	
1993			181	1504	457	161
1994		3	186	1069	111	
1995	15	12	45	320	82	
1996		3	33	413	216	
1997			18	376	91	
1998		3	3	189		

Table 14: AIC scores for the different fixed effect models considered in the recreational observer database CPUE series

Model	Binomial	Gamma
Year	1038	442
Depth	704	470
Block	846	436
Year+depth	696	417
Year+block	834	395
Year+depth+block	656	373
Year+depth+block+depth:block	672	379
Null deviance	1059	561

Table 15: Triennial trawl survey area-swept biomass estimates by depth and INPFC area. Dashes denote area-strata combinations in which no chilipepper were encountered, zeros denote area-strata combinations in which the total biomass was estimated at less than 0.5 ton, and empty cells denote strata that did not have any survey effort.

			Columbia		**Eureka**		**Monterey**		**Conception**		**Total**
Year	Depth (m)	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
1977	91-183	-	-	-	-	4755	0.38	94	0.76	4850	0.37
	184-366	-	-	-	-	4942	0.35	148	0.49	5090	0.34
	367-475	-	-	-	-	0	0.72	1	1.00	1	0.81
	91-475	-	-	-	-	9697	0.26	243	0.42	9940	0.25
1980	55-183	129	0.62	901	1.00	12740	0.63			13770	0.59
	184-366	0	-	0	-	904	0.43			904	0.43
	55-366	129	0.62	901	1.00	13644	0.59			14674	0.55
1983	55-183	0	-	9	1.00	7113	0.62			7123	0.61
	184-366	26	0.81	19	0.07	2379	0.39			2423	0.38
	55-366	26	0.81	28	0.34	9492	0.47			9546	0.47
1986	55-183	0	-	2857	0.33	6596	0.32			9453	0.33
	184-366	30	1.00	228	0.63	385	0.64			643	0.61
	55-366	30	1.00	3175	0.30	7135	0.30			10340	0.30
1989	55-183	0	1.00	221	0.98	14563	0.34	1862	0.36	16646	0.30
	184-366	219	0.97	67	1.00	2540	0.48	643	0.42	3470	0.37
	55-366	220	0.97	288	0.79	17102	0.30	2505	0.29	20116	0.26
1992	55-183	0	-	5	0.94	6661	0.51	1284	0.48	7949	0.44
	184-366	0	-	18	0.37	657	0.80	258	0.13	933	0.57
	55-366	0	-	22	0.35	7318	0.47	1542	0.40	8882	0.40
1995	55-183	0	-	69	0.98	9640	0.31	299	0.38	10009	0.30
	184-366	0	1.00	33	0.61	2321	0.38	1326	0.73	3681	0.37
	367-500	0	-	0	-	2	0.81	2	0.66	4	0.55
	55-500	0	1.00	102	0.69	11963	0.26	1627	0.60	13693	0.24
1998	55-183	0	1.00	3	0.83	10991	0.47	576	0.57	11570	0.45
	184-366	12	0.79	235	0.83	5177	0.73	126	0.32	5550	0.69
	367-500	0	-	1	1.00	0	-	0	-	1	1.00
	55-500	12	0.78	239	0.82	16168	0.40	702	0.47	17121	0.38
2001	55-183	0	-	15	0.72	9270	0.38	13550	0.93	22835	0.58
	184-366	1	0.62	60	0.99	4838	0.90	107	0.50	5006	0.87
	367-500	0	-	0	-	1	1.00	1	1.00	3	0.71
	55-500	1	0.62	76	0.80	14109	0.40	13658	0.93	27844	0.50
2004	55-183	0	-	67	0.52	31716	0.40	305	0.41	32088	0.39
	184-366	4	0.88	22	0.38	6916	0.44	1896	0.62	8838	0.37
	367-500	0	-	0	-	0	-	0	-	0	-
	55-500	4	0.88	88	0.40	38632	0.34	2202	0.54	40927	0.32

Table 16: Comparison of triennial trawl survey indices generated by and core-area swept biomass and GLMM, with associated coefficients of variation.

	Core area-swept			GLMM
	Biomass	CV	Index	CV
1980	14674	0.55	4093	1.73
1983	9546	0.47	1884	2.11
1986	8704	0.32	1685	2.81
1989	17274	0.29	3313	0.86
1992	6774	0.5	27	1.73
1995	11307	0.27	2034	0.98
1998	16007	0.4	1004	0.92
2001	14103	0.4	964	0.79
2004	38444	0.34	3644	1.41

Table 17: NWFSC combined survey estimates of area-swept biomass and associated CVs by INPFC area and depth strata, 2003-2006.

		Conception		Monterey		Eureka		Columbia		Total Biomass	
Year	Depth (m)	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
2003	55-183	1577	0.93	106395	0.54	1741	0.68	0		109713	
	184-548	12751	0.92	6510	0.46	58	0.75	4	1.00	19323	
	55-548	14329	0.82	112905	0.51	1799	0.66	4	1.00	129037	0.46
2004	55-183	238	0.39	49594	0.49	4087	0.67	1747	1.00	55666	
	184-548	2915	0.50	24704	0.57	0		87	0.94	27705	
	55-548	3153	0.47	74298	0.38	4087	0.67	1834	0.95	83371	0.34
2005	55-183	1386	0.64	71694	0.73	3682	0.69	216	0.78	76978	
	184-548	4211	0.96	29388	0.40	2129	0.96	0		35728	
	55-548	5597	0.74	101082	0.53	5810	0.56	216	0.78	112706	0.48
2006	55-183	1282	0.89	54131	0.55	1543	0.74	13	1.00	56970	
	184-548	356	0.54	11133	0.45	56	0.92	693	0.71	12239	
	55-548	1638	0.70	65264	0.46	1600	0.71	706	0.69	69209	0.43

Table 18: Comparison of area-swept and GLMM biomass estimates for the Northwest Fisheries Science Center combined survey

	Area-Swept			GLMM
	Bio	CV	Bio	CV
2003	129037	0.46	3932	1.06
2004	83371	0.34	24559	2.06
2005	112706	0.48	9540	0.77
2006	69209	0.44	7384	0.69

Table 19: Indices of pelagic juvenile (age 0) rockfish abundance

	core		design		deltaGLM		anova	
	index	jack.cv	Index	CV	index	CV	Index	CV
1983								
1984	7.33	0.37						
1985	8.12	0.46						
1986	0.72	0.33						
1987	13.22	0.35						
1988	16.38	0.39						
1989	0.39	0.48						
1990	0.31	0.41						
1991	0.98	0.34						
1992	0.17	0.52						
1993	10.33	0.30						
1994	0.02	0.81						
1995	0.25	0.61						
1996	0.09	0.52						
1997	0.13	0.74						
1998								
1999	0.21	0.43						
2000	0.09	0.52						
2001	0.85	0.34	1.51	0.21	0.24	0.39	1.72	0.04
2002	2.29	0.32	5.61	0.25	0.76	0.38	2.76	0.05
2003	1.01	0.41	2.06	0.32	0.35	0.40	1.57	0.04
2004	1.33	0.39	5.80	0.21	0.63	0.34	2.94	0.04
2005			0.21	0.44	0.03	0.60	0.87	0.03
2006			0.02	0.44	0.01	0.59	0.75	0.03

Table 20: Parameter point estimates and standard deviations for the base model (note that both the triennial length selectivity and the recreational CPUE age-selectivity curve parameters were fixed to enable estimation of the Hessian matrix).

Parameter	value	std	parameter	value	std
ln R0	10.45	0.05	1965 rec dev	-0.50	0.72
K (1970-1979)	0.32	0.06	1966 rec dev	-0.93	0.74
K (1980-1988)	0.25	0.02	1967 rec dev	0.89	0.47
K (1989-1991)	0.23	0.04	1968 rec dev	1.05	0.39
K (1992-1998)	0.20	0.04	1969 rec dev	-0.89	0.76
K (1999-2006)	0.26	0.04	1970 rec dev	1.17	0.22
Trawl sel inflection	32.65	0.35	1971 rec dev	0.60	0.26
Trawl sel width 95% inflection	8.46	0.36	1972 rec dev	-1.66	0.62
Hook sel inflection	37.27	0.67	1973 rec dev	1.47	0.08
Hook sel width 95% inflection	7.20	0.60	1974 rec dev	-1.04	0.48
Setnet sel peak	59.43	3.46	1975 rec dev	1.40	0.07
Setnet sel top	-2.19	37616	1976 rec dev	-0.20	0.18
Setnet sel asc-width	4.99	0.18	1977 rec dev	-0.27	0.13
Setnet sel desc-width	1.98	9359	1978 rec dev	-0.42	0.14
Setnet sel init	-44.77	51789	1979 rec dev	0.87	0.06
Setnet sel final	-13.05	150010	1980 rec dev	-0.38	0.12
Rec sel peak	41.25	0.85	1981 rec dev	-0.78	0.12
Rec sel top	-15.76	1149.3	1982 rec dev	-1.78	0.23
Rec sel asc-width	4.92	0.12	1983 rec dev	-1.54	0.24
Rec sel desc-width	2.59	1.01	1984 rec dev	1.95	0.04
Rec sel init	-8.25	3.05	1985 rec dev	-0.74	0.20
Rec sel final	-0.64	0.75	1986 rec dev	0.57	0.08
Triennial sel size inflect	15.70	*fixed*	1987 rec dev	0.39	0.10
width 95% inflect	0.00	*fixed*	1988 rec dev	0.71	0.09
Combo sel size inflect	13.34	12.74	1989 rec dev	0.78	0.09
Combo sel width 95% inflect	12.88	22.76	1990 rec dev	0.02	0.14
Rec CPUE sel peak	39.34	0.61	1991 rec dev	0.57	0.12
Rec CPUE sel top	-6.00	0.10	1992 rec dev	-0.37	0.21
Rec CPUE sel asc-width	3.76	0.09	1993 rec dev	0.97	0.12
Rec CPUE sel desc-width	3.45	1.50	1994 rec dev	-0.15	0.21
Rec CPUEsel init	-7.66	0.63	1995 rec dev	0.04	0.22
Rec CPUE sel final	-1.32	2.32	1996 rec dev	-0.78	0.38
Rec CPUE age sel peak	1.11	*fixed*	1997 rec dev	-0.63	0.31
Rec CPUE age sel top	-60.00	*fixed*	1998 rec dev	-0.09	0.32
Rec CPUE age sel asc-width	-24.80	*fixed*	1999 rec dev	2.42	0.12
Rec CPUE age sel desc-width	-0.12	*fixed*	2000 rec dev	-1.32	0.57
Rec CPUE age sel init	-33.55	*fixed*	2001 rec dev	0.06	0.18
Rec CPUE age sel final	-4.11	*fixed*	2002 rec dev	0.40	0.18
			2003 rec dev	-0.23	0.17
			2004 rec dev	0.33	0.17
			2005 rec dev	-0.91	0.17
			2006 rec dev	-1.07	0.17

Table 21a: Base model output 1892-1949.

year	bio-all	bio-smry	SSB	depletion	recruits	total catch	expl. rate
Unfished	47214	45057	33390	1.00	34490	0	0.000
1892	47214	45057	33391	1.00	34490	217	0.005
1893	47013	44857	33200	0.99	34453	205	0.005
1894	46841	44688	33038	0.99	34421	193	0.004
1895	46699	44547	32904	0.99	34394	180	0.004
1896	46582	44432	32795	0.98	34373	171	0.004
1897	46486	44337	32706	0.98	34355	160	0.004
1898	46409	44261	32636	0.98	34341	151	0.003
1899	46348	44201	32582	0.98	34330	140	0.003
1900	46303	44156	32543	0.97	34322	155	0.004
1901	46247	44101	32494	0.97	34312	169	0.004
1902	46184	44039	32437	0.97	34300	185	0.004
1903	46112	43967	32372	0.97	34287	200	0.005
1904	46032	43889	32300	0.97	34272	215	0.005
1905	45946	43803	32222	0.97	34256	229	0.005
1906	45855	43713	32139	0.96	34239	244	0.006
1907	45759	43618	32051	0.96	34221	259	0.006
1908	45658	43518	31959	0.96	34201	274	0.006
1909	45552	43414	31862	0.95	34181	307	0.007
1910	45426	43289	31747	0.95	34157	342	0.008
1911	45279	43144	31611	0.95	34128	377	0.009
1912	45113	42980	31459	0.94	34095	411	0.010
1913	44931	42800	31292	0.94	34059	445	0.010
1914	44735	42606	31111	0.93	34020	479	0.011
1915	44525	42399	30919	0.93	33978	514	0.012
1916	44303	42180	30715	0.92	33933	666	0.016
1917	43960	41840	30397	0.91	33861	819	0.020
1918	43506	41391	29977	0.90	33765	973	0.024
1919	42950	40843	29462	0.88	33644	637	0.016
1920	42758	40656	29292	0.88	33604	664	0.016
1921	42560	40460	29118	0.87	33562	562	0.014
1922	42474	40376	29051	0.87	33545	508	0.013
1923	42445	40347	29037	0.87	33542	601	0.015
1924	42330	40233	28942	0.87	33519	560	0.014
1925	42260	40165	28888	0.87	33505	647	0.016
1926	42115	40021	28762	0.86	33474	889	0.022
1927	41757	39666	28434	0.85	33393	754	0.019
1928	41555	39468	28254	0.85	33347	739	0.019
1929	41386	39302	28105	0.84	33309	659	0.017
1930	41306	39223	28040	0.84	33292	822	0.021
1931	41081	39001	27839	0.83	33240	830	0.021
1932	40867	38790	27648	0.83	33190	656	0.017
1933	40834	38758	27627	0.83	33185	568	0.015
1934	40885	38809	27685	0.83	33200	531	0.014
1935	40965	38888	27770	0.83	33222	571	0.015
1936	40999	38921	27810	0.83	33233	583	0.015
1937	41017	38939	27833	0.83	33239	537	0.014
1938	41076	38997	27893	0.84	33254	394	0.010
1939	41262	39181	28071	0.84	33300	318	0.008
1940	41502	39418	28300	0.85	33359	386	0.010
1941	41658	39570	28447	0.85	33396	360	0.009
1942	41822	39732	28604	0.86	33435	107	0.003
1943	42206	40112	28965	0.87	33524	155	0.004
1944	42511	40412	29254	0.88	33594	219	0.005
1945	42725	40623	29460	0.88	33644	434	0.011
1946	42715	40611	29464	0.88	33645	380	0.009
1947	42754	40650	29506	0.88	33655	347	0.009
1948	42822	40716	29569	0.89	33670	347	0.009
1949	42883	40777	29627	0.89	33683	368	0.009

Table 21b: Base model output 1950-2007.

Year	bio-all	bio-smry	SSB	depletion	rec	total catch	expl. rate
1950	42920	40813	29662	0.89	33691	576	0.014
1951	42758	40652	29519	0.88	33658	870	0.021
1952	42330	40228	29141	0.87	33567	1055	0.026
1953	41761	39666	28637	0.86	33443	1207	0.030
1954	41096	39010	28048	0.84	33294	1215	0.031
1955	40479	38401	27505	0.82	33152	1381	0.036
1956	39756	37688	26875	0.80	32982	1643	0.044
1957	38842	36787	26079	0.78	32758	1687	0.046
1958	37961	35920	25314	0.76	32533	1889	0.053
1959	36963	34937	24442	0.73	32263	1593	0.046
1960	36325	34313	23892	0.72	32085	1443	0.042
1961	35879	33876	23524	0.70	31962	1146	0.034
1962	35748	33750	23431	0.70	31931	1118	0.033
1963	35652	33656	23370	0.70	31910	1077	0.032
1964	35596	33601	23347	0.70	31902	884	0.026
1965	35086	33727	23478	0.70	11737	993	0.029
1966	34339	33735	23473	0.70	7623	2182	0.065
1967	33633	31923	22447	0.67	46692	2796	0.088
1968	32115	28980	20755	0.62	53478	1775	0.061
1969	29870	27973	19569	0.59	7602	1090	0.039
1970	30621	28520	19029	0.57	59113	1273	0.045
1971	33863	30943	21323	0.64	34502	1253	0.040
1972	34608	33423	23118	0.69	3682	1899	0.057
1973	37977	35174	24162	0.72	85193	3644	0.104
1974	36701	33844	24005	0.72	6905	3960	0.117
1975	35964	33305	22406	0.67	77489	3228	0.097
1976	36092	33196	22459	0.67	15714	3092	0.093
1977	35209	34259	22631	0.68	14693	2091	0.061
1978	36770	35912	24114	0.72	12750	1934	0.054
1979	38241	36360	25500	0.76	47094	2725	0.075
1980	36490	34605	24919	0.75	13496	3255	0.094
1981	31887	31194	22019	0.66	8719	2776	0.089
1982	28876	28508	19682	0.59	3130	2492	0.087
1983	26269	26051	18125	0.54	3862	2465	0.095
1984	27234	23240	16495	0.49	122750	2923	0.126
1985	23721	19667	14284	0.43	7999	3182	0.162
1986	20941	19835	11548	0.35	27210	3147	0.159
1987	21602	20057	10969	0.33	22256	2059	0.103
1988	23163	21448	12593	0.38	32477	2691	0.125
1989	23808	21682	13242	0.40	35464	3395	0.157
1990	22382	20771	12573	0.38	16270	3110	0.150
1991	21653	20279	11919	0.36	27574	3311	0.163
1992	20340	19153	11258	0.34	10565	2753	0.144
1993	19649	18087	10540	0.32	39139	2393	0.132
1994	18583	16975	10036	0.30	12526	1877	0.111
1995	17872	17008	9812	0.29	15080	2021	0.119
1996	17127	16453	9589	0.29	6555	1870	0.114
1997	16307	15865	9489	0.28	7584	2110	0.133
1998	15209	14578	8968	0.27	12569	1430	0.098
1999	18866	13635	8666	0.26	153415	977	0.072
2000	18442	13573	9029	0.27	3708	499	0.037
2001	19149	18556	9536	0.29	15148	517	0.028
2002	24397	23175	12671	0.38	23831	329	0.014
2003	28205	27023	17040	0.51	14082	21	0.001
2004	31275	30022	20229	0.61	25895	236	0.008
2005	32553	31509	22146	0.66	7647	192	0.006
2006	32852	32405	23224	0.70	6645	127	0.004
2007	*33619*	*32401*	*23827*	*0.71*	*32063*	n/a	n/a

Table 22: Reference Points

Unfished Stock	Estimate	~95% Confidence Limits Lower	Upper
Summary (1+) Biomass	45057		
Spawning Biomass (SSB)	33390	30138	36642
Equilibrium recruitment	34490	31131	37849

	SPR proxy MSY	$SB_{40\%}$	Estimated MSY
SPR	0.50	0.45	0.43
Fmult (2006)	25.2	29.9	33.0
Exploitation rate	0.088	0.102	0.112
Yield	2099	2155	2164
SSB at Equilibrium	15482	21034	12126
SSB/SSB_0	0.46	0.40	0.36

Table 23: Decision table with 10 year forecast

					Low Productivity		**BASE MODEL**		**High Productivity**	
					h=0.34		**h=0.57**		**h=0.81**	
	"Status quo" (2006) catches				SSB0	40568	SSB0	33390	SSB0	30489
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18542	0.46	23827	0.71	26482	0.87
2008	105	18	0.5	4	17887	0.44	23285	0.70	25949	0.85
2009	105	18	0.5	4	16995	0.42	22379	0.67	24991	0.82
2010	105	18	0.5	4	16255	0.40	21574	0.65	24072	0.79
2011	105	18	0.5	4	15929	0.39	21199	0.63	23526	0.77
2012	105	18	0.5	4	15966	0.39	21226	0.64	23347	0.77
2013	105	18	0.5	4	16239	0.40	21531	0.64	23436	0.77
2014	105	18	0.5	4	16645	0.41	22011	0.66	23704	0.78
2015	105	18	0.5	4	17118	0.42	22587	0.68	24082	0.79
2016	105	18	0.5	4	17624	0.43	23211	0.70	24522	0.80
2017	105	18	0.5	4	18141	0.45	23846	0.71	24986	0.82
2018	105	18	0.5	4	18661	0.46	24473	0.73	25451	0.83
	"MSY" catches (base model)									
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18542	0.46	23827	0.71	26485	0.87
2008	105	18	0.5	4	18325	0.45	23917	0.72	26652	0.87
2009	1735	292	7	64	17684	0.44	23385	0.70	26111	0.86
2010	1735	292	7	64	15560	0.38	21270	0.64	23899	0.78
2011	1735	292	7	64	14111	0.35	19814	0.59	22259	0.73
2012	1735	292	7	64	13216	0.33	18934	0.57	21149	0.69
2013	1735	292	7	64	12644	0.31	18440	0.55	20424	0.67
2014	1735	292	7	64	12199	0.30	18171	0.54	19956	0.65
2015	1735	292	7	64	11776	0.29	18019	0.54	19650	0.64
2016	1735	292	7	64	11333	0.28	17921	0.54	19446	0.64
2017	1735	292	7	64	10863	0.27	17845	0.53	19302	0.63
2018	1735	292	7	64	10369	0.26	17779	0.53	19194	0.63
	40:10 Catches									
year	Trawl	Hook/line	Net	Rec	SpawnBio	depletion	SpawnBio	depletion	SpawnBio	depletion
2007	105	18	0.5	4	18652	0.46	23827	0.71	26366	0.86
2008	105	18	0.5	4	17994	0.44	23285	0.70	25836	0.85
2009	2507	429	12	89	17099	0.42	22379	0.67	24882	0.82
2010	2127	364	11	75	13923	0.34	19139	0.57	21533	0.71
2011	1847	308	9	65	11785	0.29	16940	0.51	19164	0.63
2012	1679	266	8	60	10501	0.26	15629	0.47	17650	0.58
2013	1594	241	7	59	9739	0.24	14911	0.45	16734	0.55
2014	1558	228	6	60	9204	0.23	14530	0.44	16194	0.53
2015	1543	223	6	61	8719	0.21	14312	0.43	15874	0.52
2016	1535	220	5	62	8208	0.20	14164	0.42	15681	0.51
2017	1528	219	5	62	7654	0.19	14041	0.42	15561	0.51
2018	1520	218	5	62	7068	0.17	13928	0.42	15486	0.51

Table 24: Likelihood values and reference points for the base model and 13 “jittered” base models

		BASE	Jittered models->											
SSB0		33390	33576	33756	31924	33483	32076	33390	33427	33776	32543	33845	32221	32268	33416
R0		34490	34682	34868	32975	34586	33133	34490	34528	34888	33615	34960	33282	33331	34516
Maximum gradient		0.00057	0.00072	0.00006	0.00072	0.00062	0.00055	0.00085	0.00098	0.00037	0.00052	0.00050	0.00084	0.00079	0.00090
Total Likelihood		1972.2	1973.8	1978.5	2010.5	1978.2	2006.6	1972.2	1974.7	1974.3	2014.8	1975.8	2008.0	2013.7	1972.4
Likelihood components															
indices		43.6	43.8	44.1	67.6	43.4	65.5	43.6	43.4	43.7	67.8	43.8	65.5	67.8	43.6
length_comps		430.1	431.0	436.2	453.6	435.5	450.6	430.1	432.3	428.2	457.1	433.0	451.8	457.8	430.2
age_comps		1479.0	1479.5	1478.8	1470.2	1479.7	1471.6	1479.0	1479.4	1482.7	1470.9	1479.6	1471.8	1468.9	1479.0
Recruitment		19.5	19.5	19.3	19.1	19.6	19.0	19.5	19.6	19.7	19.0	19.4	19.0	19.2	19.5
Indices															
Fleet	lambda		surv_like												
trawl	1	9.9	9.8	9.8	9.9	9.9	9.9	9.9	10.0	10.1	9.9	9.8	9.9	9.9	9.9
triennial	1	8.7	8.7	8.7	8.2	8.9	7.9	8.7	8.7	8.6	8.2	8.8	8.0	8.3	8.7
combined	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
coast juvenile	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
recreational CPUE	1	23.8	24.0	24.4	48.2	23.4	46.3	23.8	23.5	23.7	48.4	24.0	46.4	48.3	23.8
Length composition	lambda		length_like												
trawl	0.1	468.9	469.4	471.7	470.7	468.9	472.4	468.9	468.3	473.7	472.4	471.4	472.7	471.1	468.9
hook	0.1	171.9	171.9	173.1	189.2	170.1	188.5	171.9	170.7	169.1	188.8	171.8	188.4	189.3	171.9
setnet	0.1	228.7	228.6	225.7	235.9	228.0	235.3	228.7	229.6	188.1	230.6	225.8	233.4	234.8	228.6
recreational	1	126.1	126.8	127.9	126.2	126.5	126.0	126.1	125.8	126.5	129.1	128.1	127.1	126.4	126.1
triennial	1	146.4	146.3	147.4	146.9	146.6	146.8	146.4	146.3	146.9	147.4	147.1	146.8	146.8	146.4
combined	0.1	33.6	33.6	33.6	35.6	35.0	33.7	33.6	33.6	33.9	33.7	33.6	33.7	33.6	33.6
recreational CPUE	1	67.4	67.5	70.5	87.3	72.2	84.8	67.4	70.0	68.3	88.1	67.6	85.1	91.6	67.4
Age composition	lambda		age_like												
trawl	1	672.7	673.3	672.9	664.6	673.4	666.3	672.7	672.9	671.6	665.7	673.6	666.7	663.9	672.7
hook	1	266.1	266.4	266.4	261.1	267.0	261.2	266.1	266.5	265.5	261.5	266.7	261.4	261.3	266.2
setnet	1	531.9	531.6	531.4	536.6	531.1	536.3	531.9	531.8	537.3	535.8	531.1	535.9	535.8	531.9
combined	1	8.2	8.2	8.2	7.9	8.2	7.9	8.2	8.2	8.3	7.9	8.2	7.9	7.9	8.2

Table 25: Select run results and likelihood components from profiles on alternative steepness and natural mortality values.

Parameter Value (h and M)			h=0.21	h=0.34	h=0.57	h=0.81	h=0.99	M=0.12	M=0.14	M=0.16	M=0.18	M=0.2
SSB0	SSB0		54233	40274	33390	30718	29667	34235	33933	33390	32606	32182
R0	R0		56019	41600	34490	31730	30645	20621	27096	34490	42718	52617
Total Likelihood			2009.5	1980.0	1972.2	1971.1	1970.9	2018.6	1983.8	1972.2	1977.8	1994.1
Likelihood components												
indices			40.4	41.3	43.6	44.9	45.4	44.1	44.0	43.6	43.1	42.7
length_comps			442.9	434.1	430.1	428.8	428.5	444.0	434.7	430.1	428.1	429.1
age_comps			1481.3	1478.9	1479.0	1479.1	1479.0	1500.9	1482.3	1479.0	1488.3	1503.9
Recruitment			44.9	25.6	19.5	18.4	18.1	29.7	22.9	19.5	18.3	18.4
Fleet	lambda		surv_like									
trawl		1	10.6	10.4	9.9	9.6	9.5	8.7	9.3	9.9	10.6	11.6
triennial		1	7.2	7.5	8.7	9.3	9.6	9.2	9.0	8.7	8.3	7.9
combined		1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
coast juvenile		1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
recreational CPUE		1	21.3	22.1	23.8	24.7	25.1	24.9	24.5	23.8	23.0	21.9
Length composition	lambda		length_like									
trawl		0.1	474.5	470.7	468.9	468.0	467.7	476.7	469.2	468.9	474.6	489.4
hook		0.1	176.2	173.8	171.9	171.1	170.9	181.1	176.0	171.9	168.4	165.1
setnet		0.1	227.0	228.2	228.7	228.8	229.0	233.7	231.3	228.7	219.2	190.9
recreational		1	131.0	127.5	126.1	125.6	125.6	132.1	128.2	126.1	124.5	124.5
Triennial		1	152.5	148.0	146.4	146.0	145.8	151.9	148.3	146.4	146.2	147.3
combined		0.1	28.8	31.9	33.6	34.0	34.1	29.2	31.8	33.6	35.2	36.9
recreational CPUE		1	68.8	68.1	67.4	67.0	66.9	67.9	67.4	67.4	67.7	69.1
Age composition	lambda		age_like									
Trawl		1	669.1	670.7	672.7	673.3	673.6	695.4	677.8	672.7	676.8	686.4
Hook		1	265.8	266.2	266.1	265.9	265.8	273.5	269.2	266.1	263.7	262.3
Setnet		1	535.2	533.2	531.9	531.7	531.5	521.5	526.3	531.9	540.1	547.6
combined		1	11.1	8.7	8.2	8.2	8.2	10.5	9.0	8.2	7.8	7.6

Table 26: Model sensitivity runs, sequentially remove data or alter total catches.

		BASE	no trawl cpue	no triennial index, LFs	no combo index, LFs, AF	no juv survey	no rec cpue, LF's	no trawl cpue, LFs, Afs	no hook LFs, AFs	no net LFs, AFs	net sel. asymp.	K time-invariant	2x pre-1970 catches	0.5x pre-1970 catches
SSB0		33390	32958	32919	32273	33698	35285	33886	31160	35126	33510	39879	48079	25097
R0		34490	34044	34003	33336	34808	36447	35003	32186	36284	34614	41193	49662	25924
Maximum gradient		0.00057	0.00046	0.00073	0.00059	0.00054	0.00080	0.00074	0.00093	0.00071	0.00095	0.00060	0.00079	0.00081
Total Likelihood		1972.2	1964.4	1851.6	2001.6	1961.9	1863.9	1179.7	1718.4	1394.8	1989.2	2067.1	2023.6	1981.1
Likelihood components														
indices		43.6	31.7	58.3	66.3	43.1	21.4	17.3	61.1	45.5	45.9	54.2	75.5	41.2
length_comps		430.1	433.1	311.6	456.7	420.0	365.2	362.1	432.7	400.7	437.8	509.8	454.5	433.3
age_comps		1479.0	1480.2	1463.1	1459.8	1479.7	1456.8	782.0	1205.4	930.6	1486.2	1484.4	1475.8	1483.2
Recruitment		19.5	19.4	18.7	18.9	19.0	20.5	18.2	19.2	18.1	19.4	18.7	17.8	23.4
Indices														
Fleet	lambda	surv_like												
trawl	1	9.9	0.0	9.1	9.7	10.0	8.9	0.0	12.0	9.9	10.2	9.2	8.7	10.8
triennial	1	8.7	8.3	0.0	8.1	8.5	11.2	7.2	7.0	8.9	8.5	8.7	11.1	7.5
combined	1	1.0	1.0	1.1	0.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1
coast juvenile	1	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
recreational CPUE	1	23.8	22.1	48.1	48.3	23.5	0.0	8.9	41.0	25.5	25.9	35.1	54.5	21.7
Length composition	lambda	length_like												
trawl	0.1	468.9	467.7	482.6	470.9	468.8	485.3	0.0	473.4	453.4	470.3	679.5	467.1	472.9
hook	0.1	171.9	170.0	193.8	189.1	171.9	187.4	166.1	0.0	177.5	173.2	170.4	186.4	173.1
setnet	0.1	228.7	229.5	223.8	234.6	228.8	213.3	211.3	230.6	0.0	198.9	173.8	236.6	225.2
recreational	1	126.1	127.1	118.8	125.9	126.3	122.5	116.2	125.3	125.9	130.7	111.9	126.3	125.9
triennial	1	146.4	145.7	0.0	148.1	135.8	150.7	141.5	142.4	143.0	146.3	186.2	144.8	148.5
combined	0.1	33.6	33.5	42.9	0.0	35.5	33.9	32.1	34.0	33.9	33.6	59.2	35.6	32.7
recreational CPUE	1	67.4	70.2	98.4	93.2	67.4	0.0	63.4	91.2	65.2	73.1	103.4	90.9	68.6
Age composition	lambda	age_like												
trawl	1	672.7	673.9	660.1	662.4	672.3	656.0	0.0	663.6	658.9	670.9	677.0	676.7	669.9
hook	1	266.1	266.3	259.5	261.2	266.2	259.0	276.8	0.0	263.6	265.8	272.6	260.4	266.5
setnet	1	531.9	531.9	534.9	536.2	532.0	533.6	498.6	534.2	0.0	541.2	526.1	530.9	538.1
combined	1	8.2	8.2	8.6	0.0	9.2	8.2	6.7	7.5	8.1	8.2	8.7	7.8	8.6

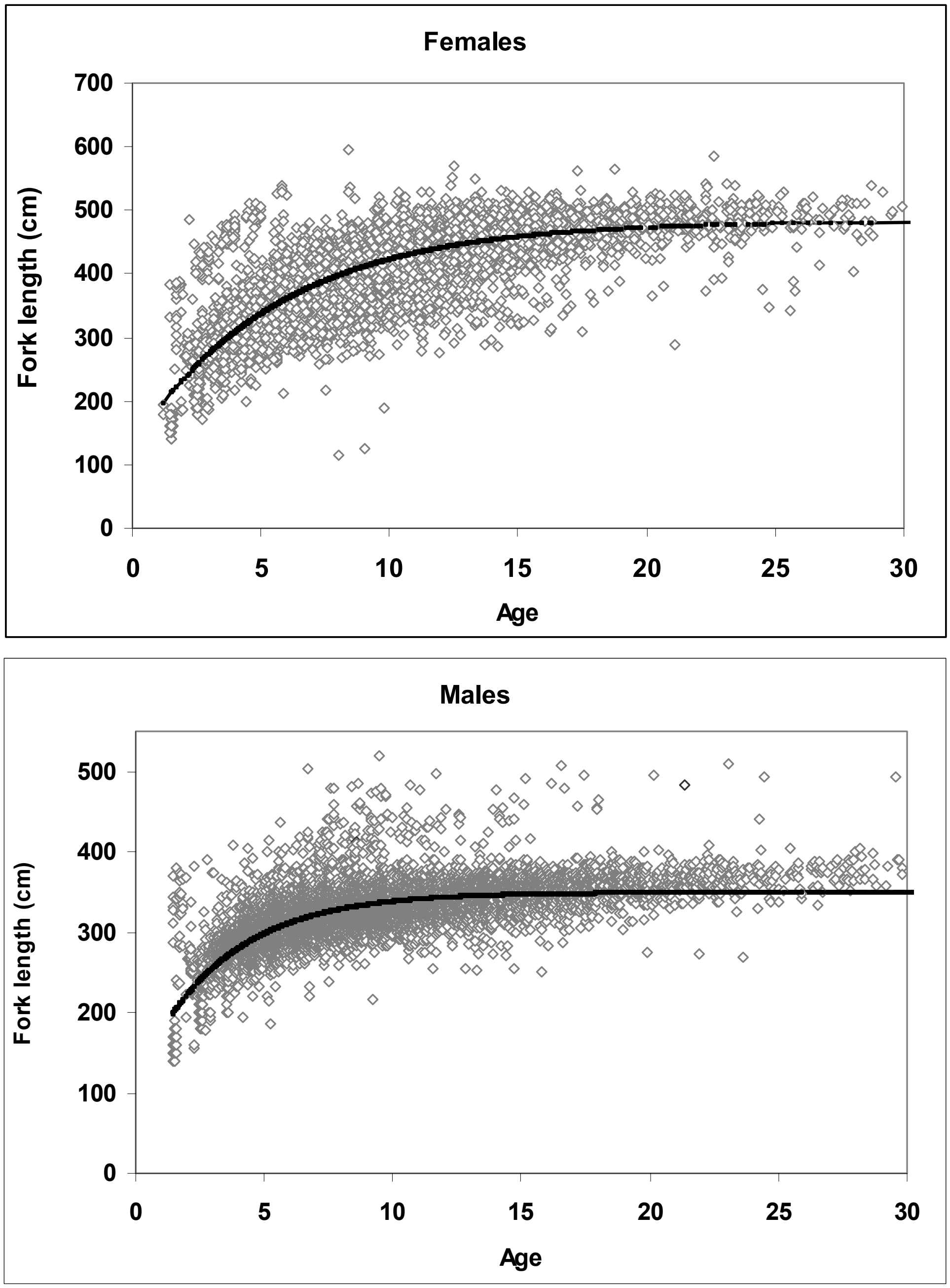


Figure 1a (top) and 1b (bottom): Externally fitted growth curves and size at age data for female and male chilipepper rockfish.

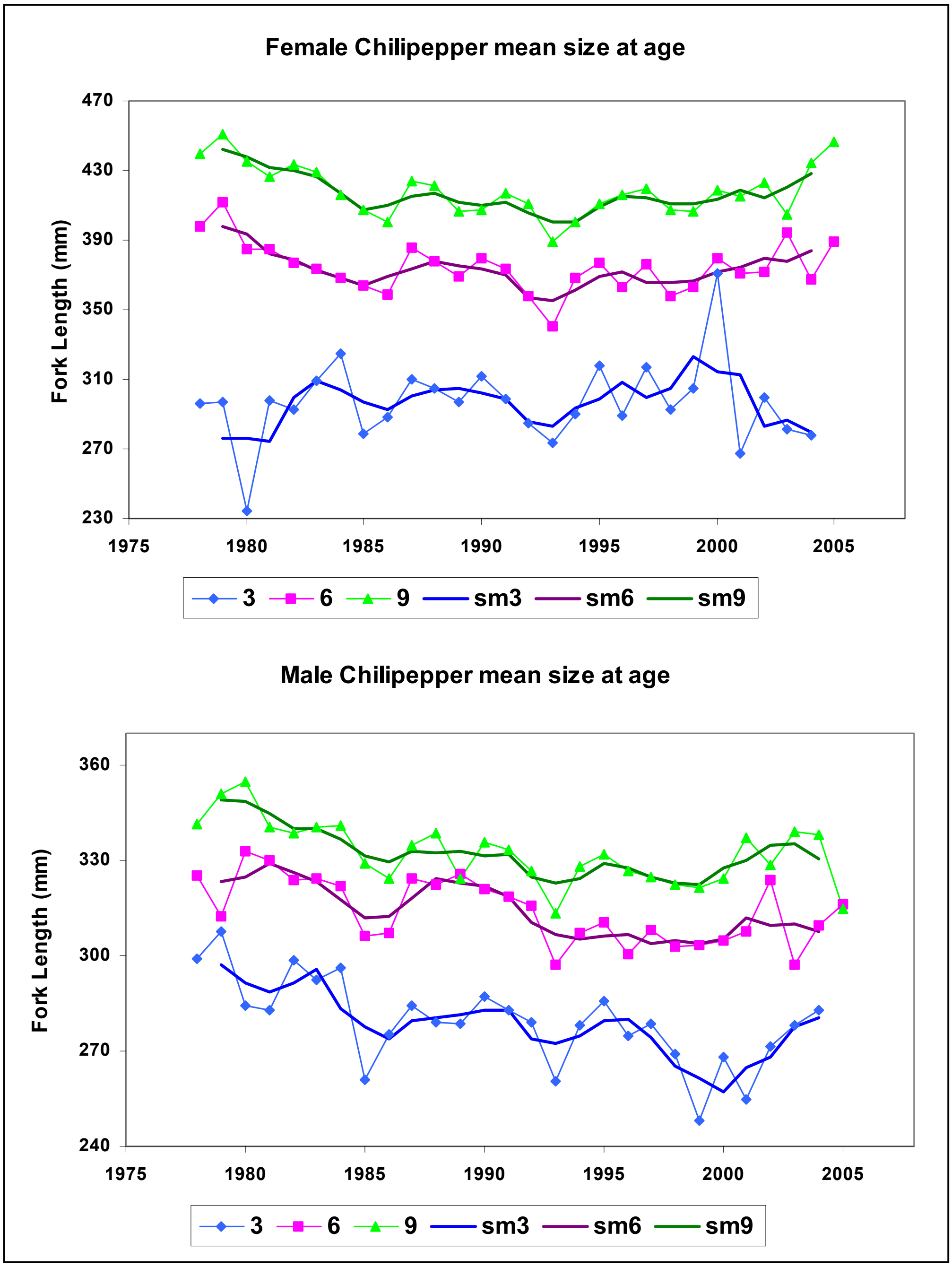


Figure 2a (top) and 2b (bottom): Average size at age over time for three representative ages of chilipepper rockfish (trawl fishery only).

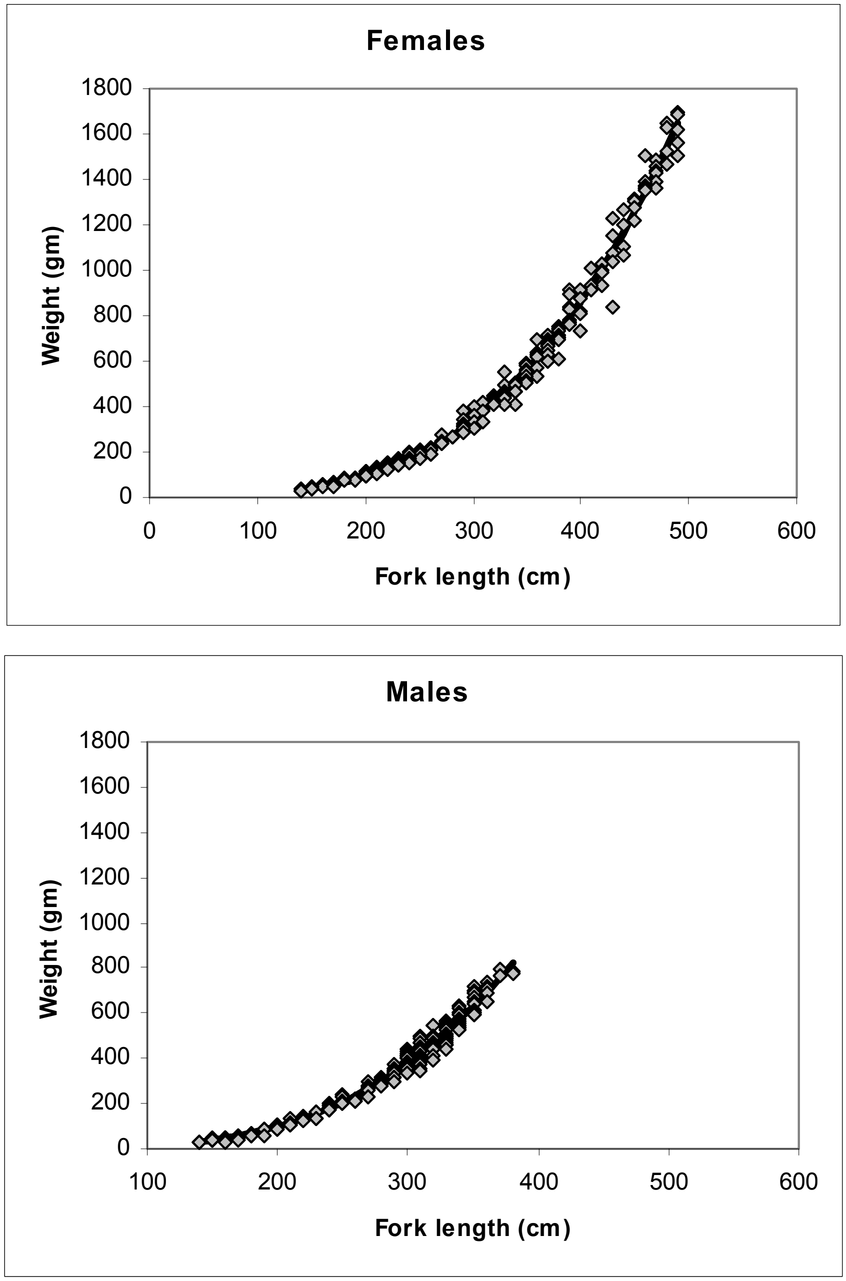


Figure 3a (top) and 3b (bottom): Female and male weight/length relationship.

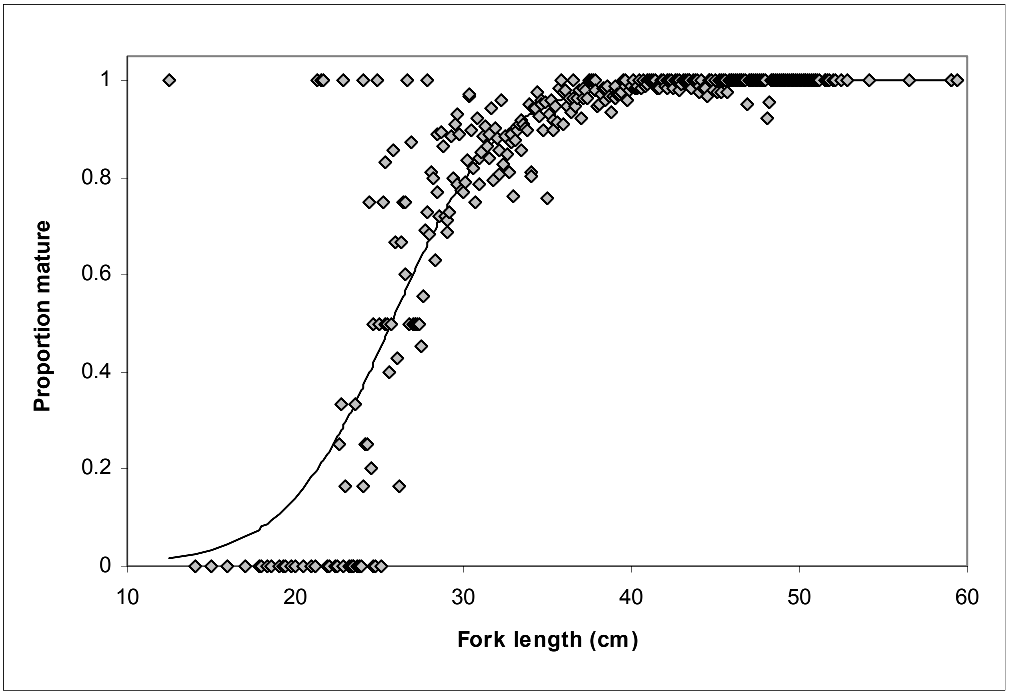


Figure 4: Maturity curve for chilipepper rockfish

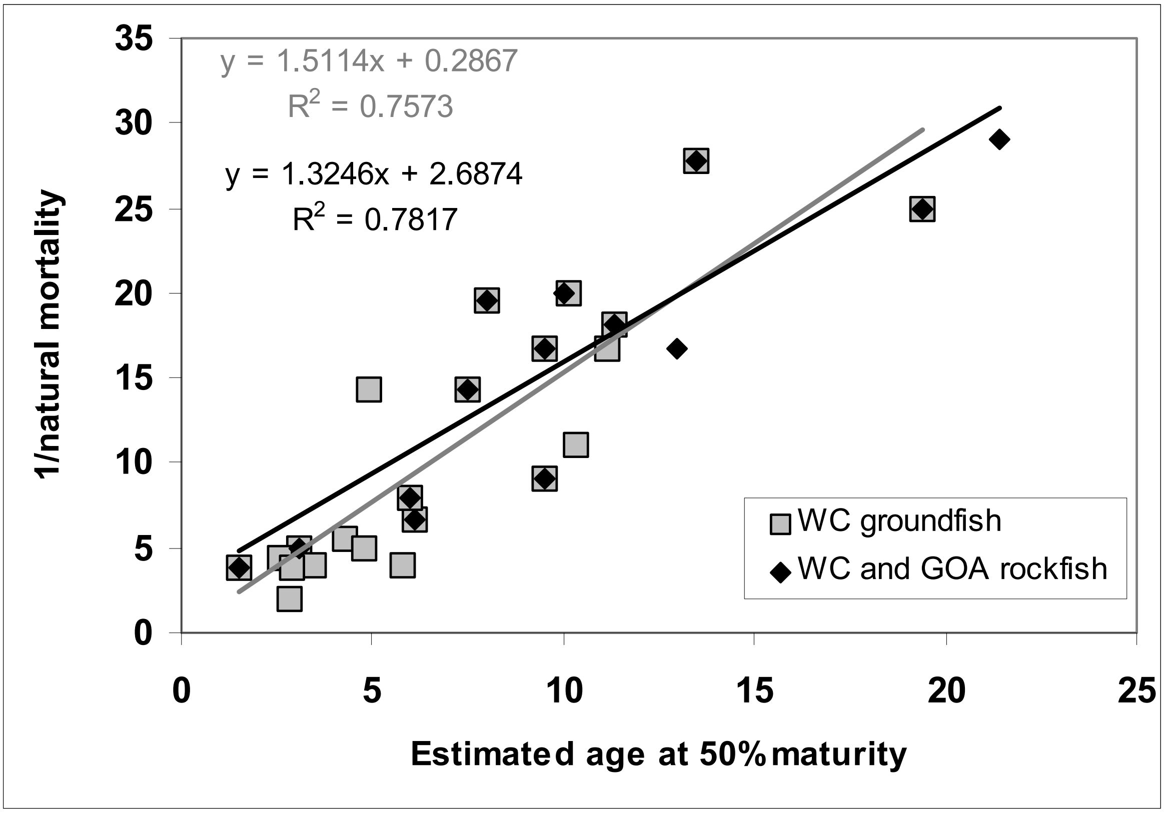


Figure 5: Observed and predicted natural mortality rates (1/M) based on age at 50% maturity for West Coast groundfish and Gulf of Alaska rockfish.

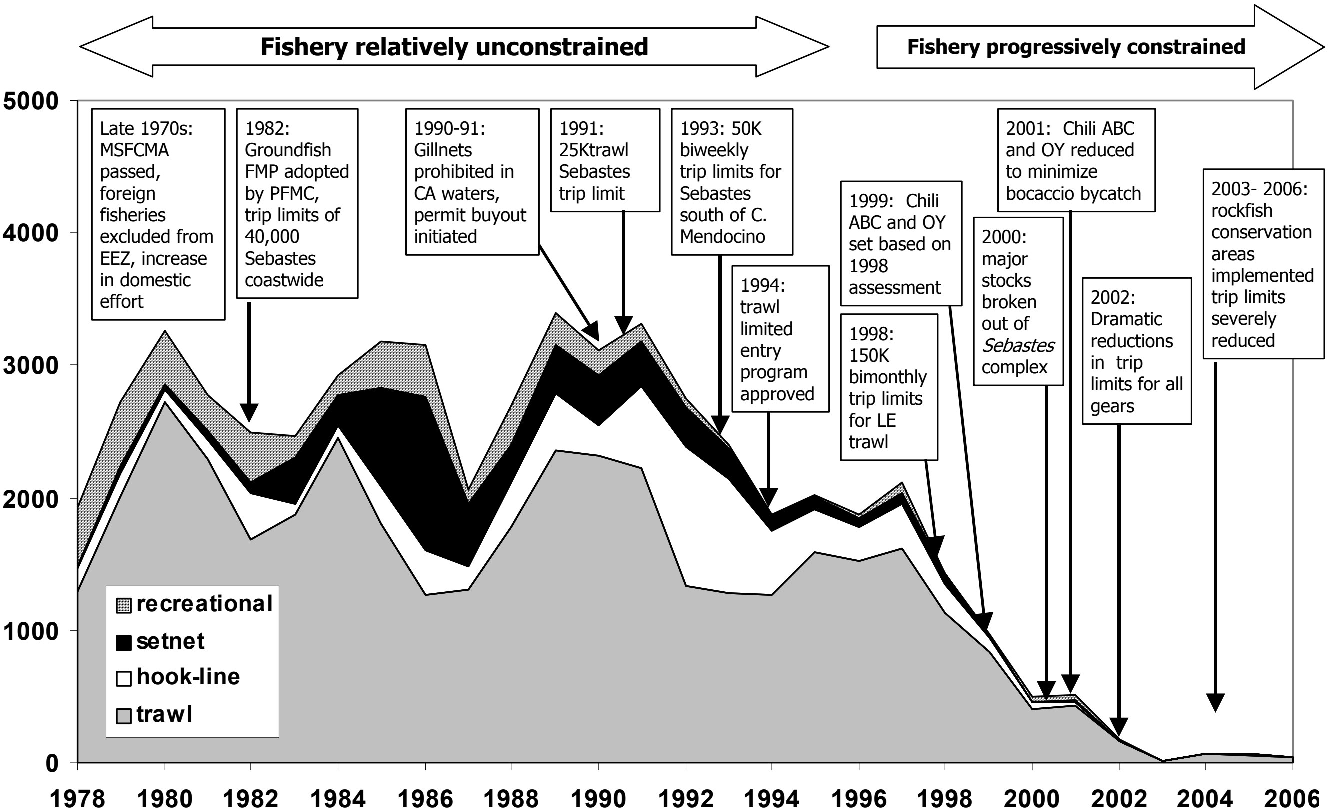
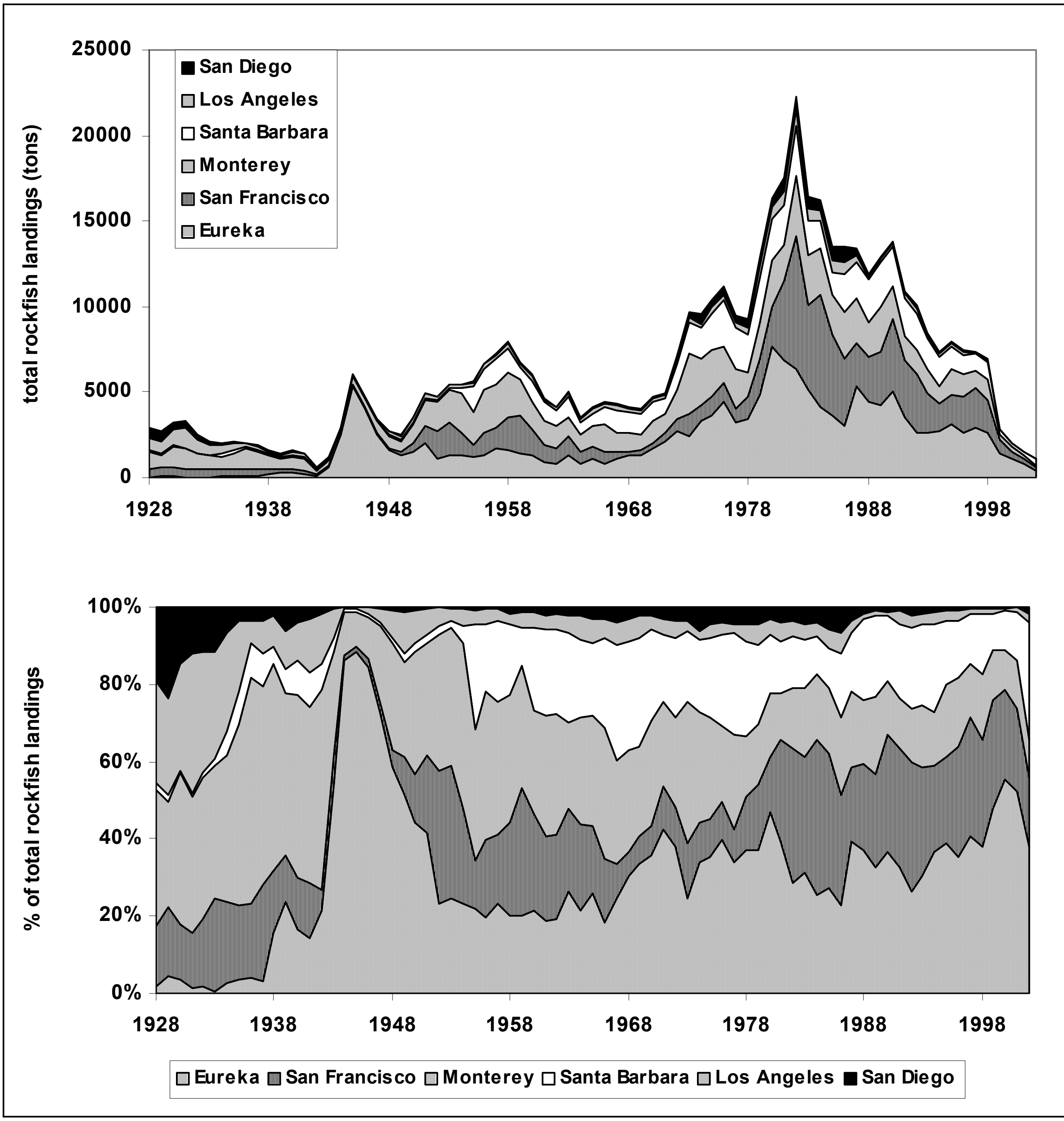


Figure 6: Observed and predicted natural mortality rates (1/M) based on age at 50% maturity for West Coast groundfish and Gulf of Alaska rockfish.



Figures 7a (top) and 7b (bottom): Total California rockfish landings by CDF&G region, 1928-2002.

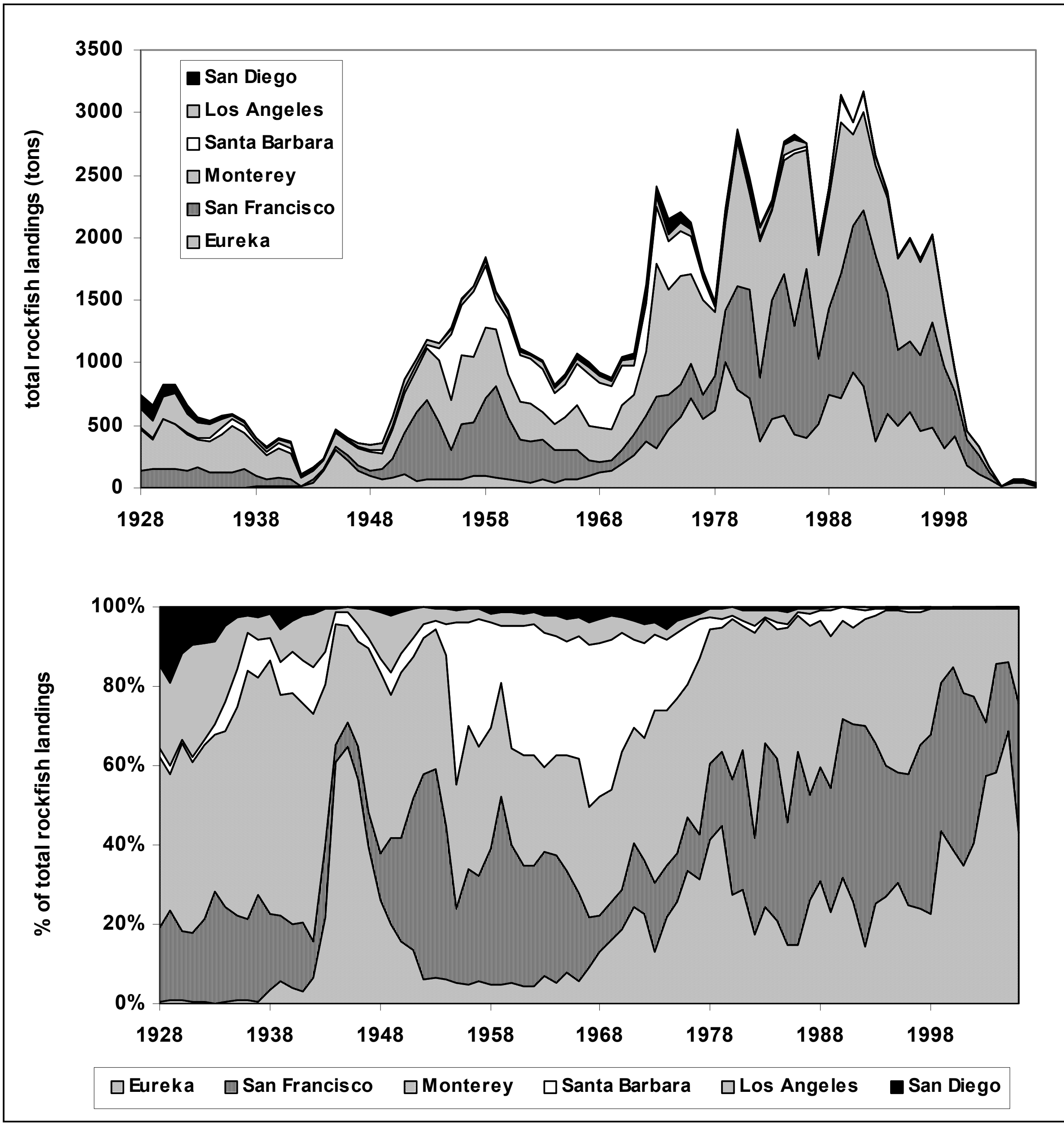


Figure 8a and 8b: Total estimated commercial chilipepper rockfish landings by CDF&G region, 1928-2002.

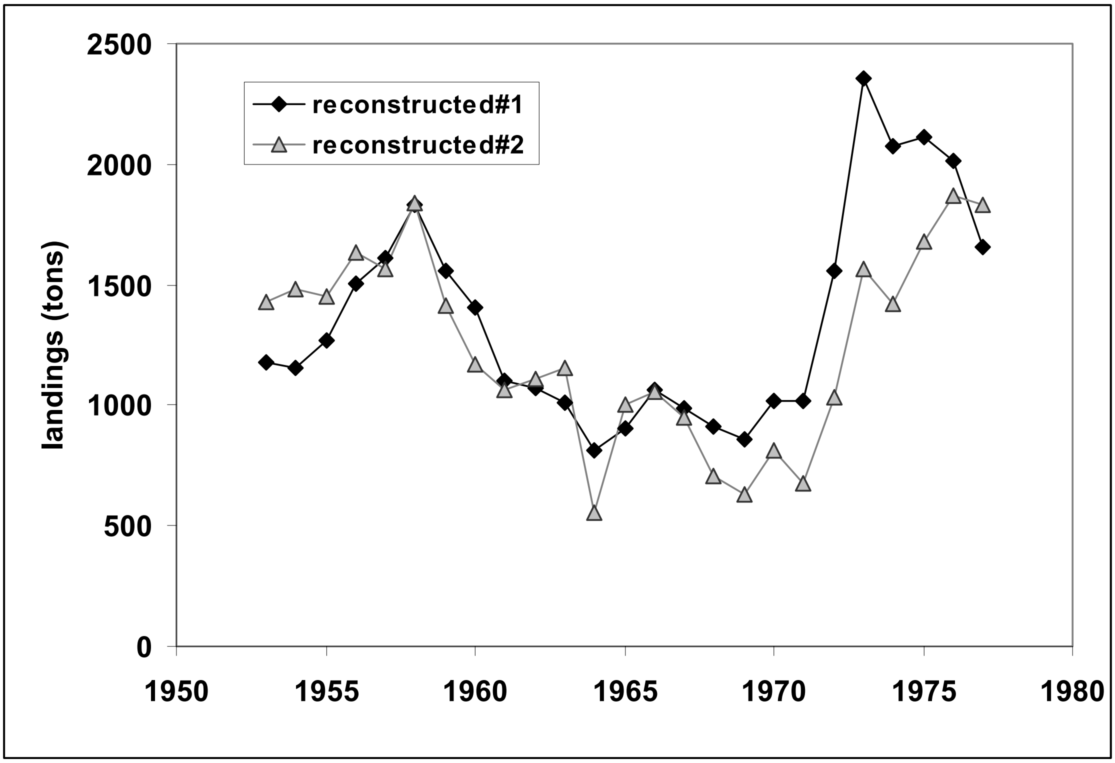
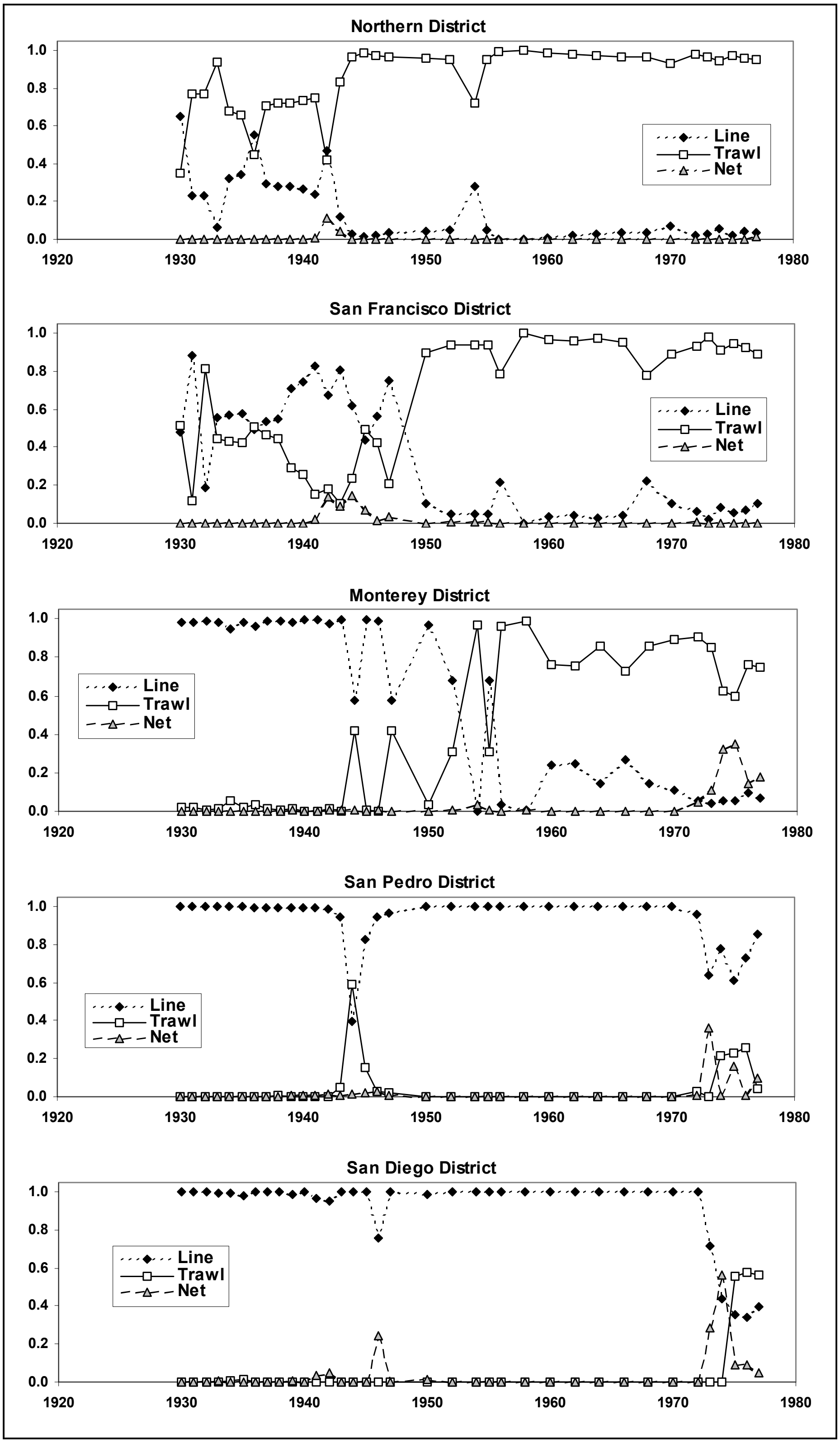


Figure 9: Comparison of base (reconstructed #1) versus an alternative (reconstructed #2) catch history for the period between 1953 and 1977.



Figures 10a-10e: Records of the fraction of landings by gear type from 1930-1978 reported by district.

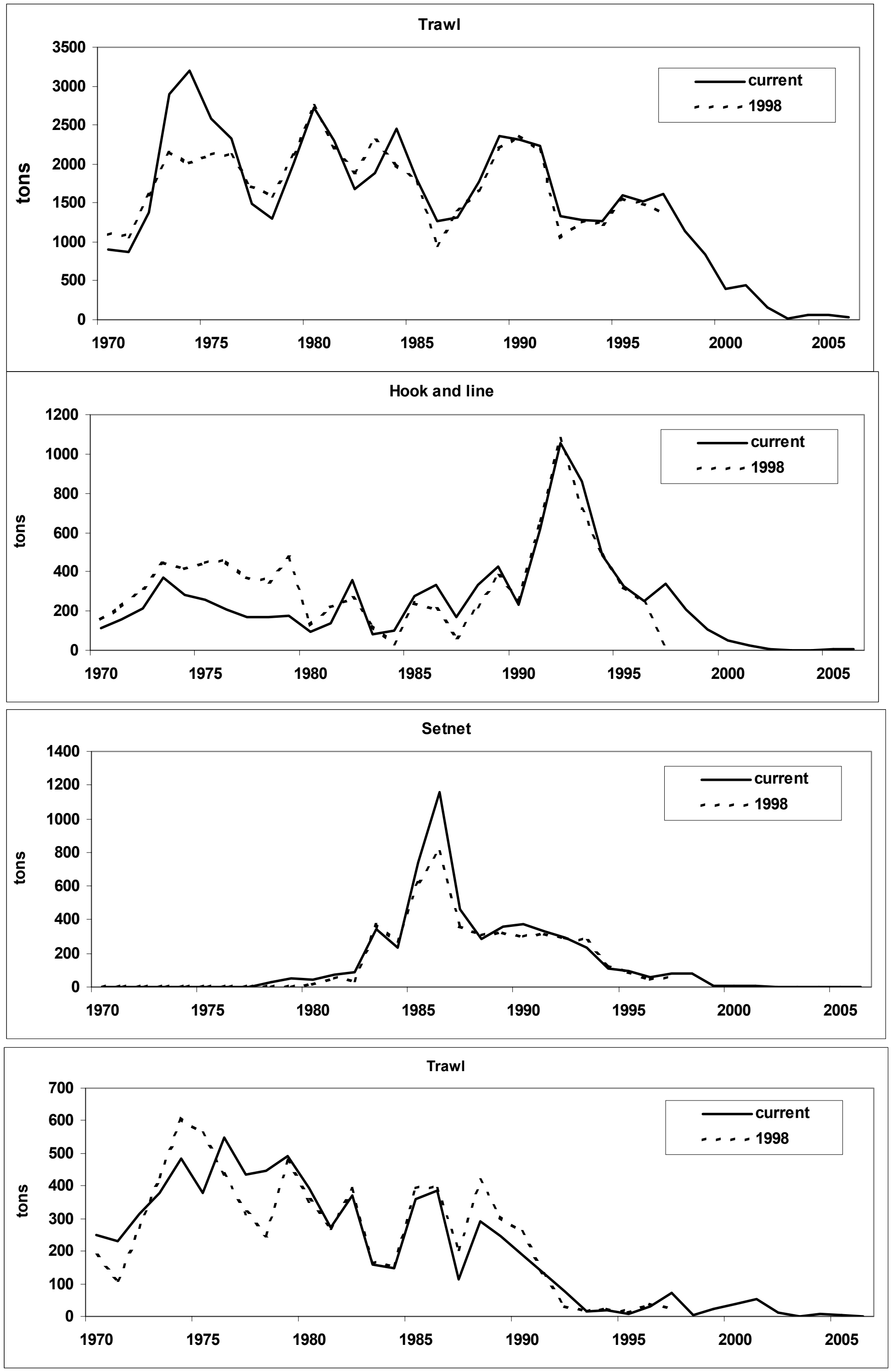


Figure 11a-11d: Comparison of catch estimates from Ralston 1998 with catch estimates used in this model.

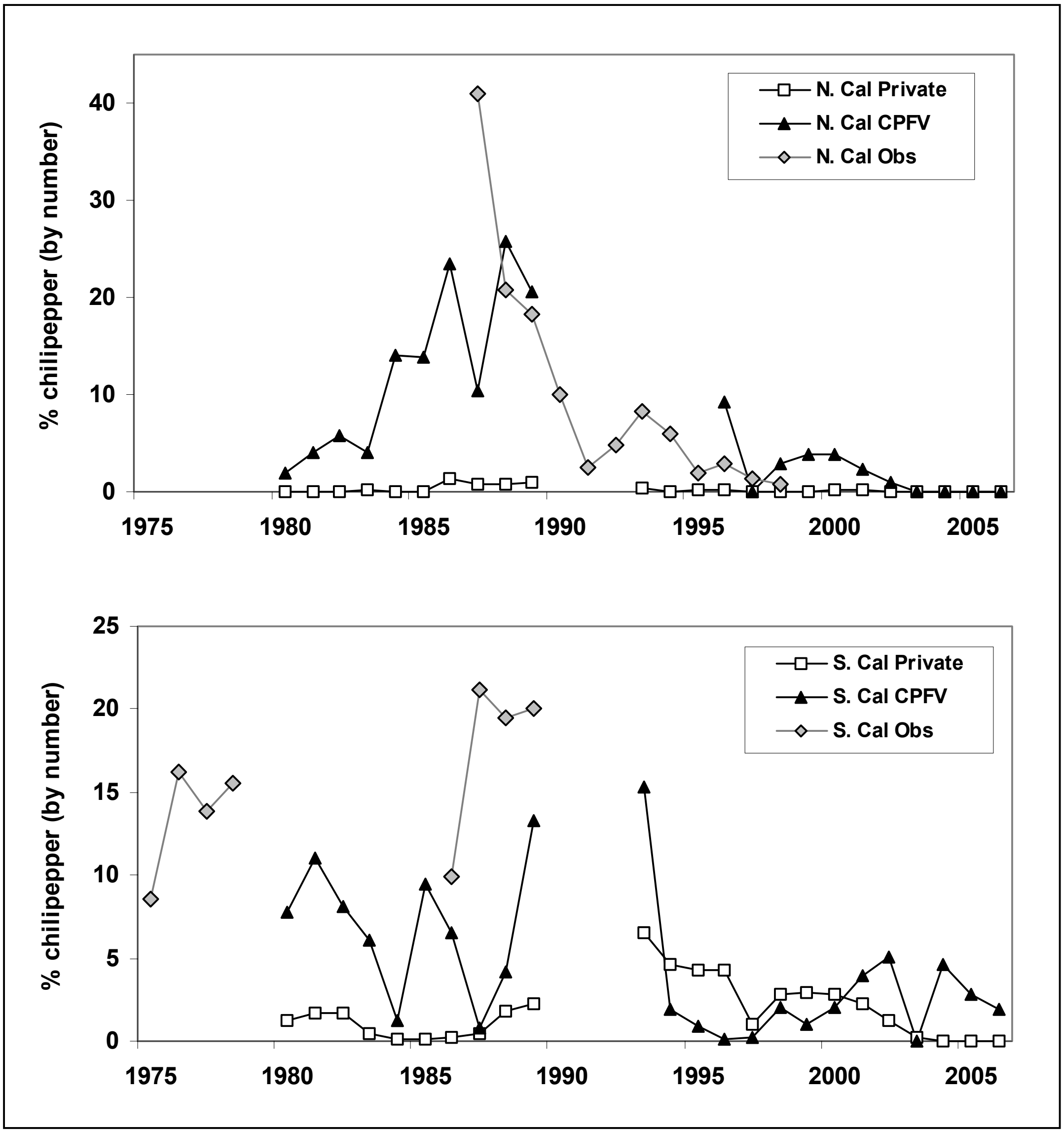


Figure 12: Percentage of total rockfish catch (in 1000s) estimated to be chilipepper by RecFIN (modes CPFV and private only) and from CPFV observer data.

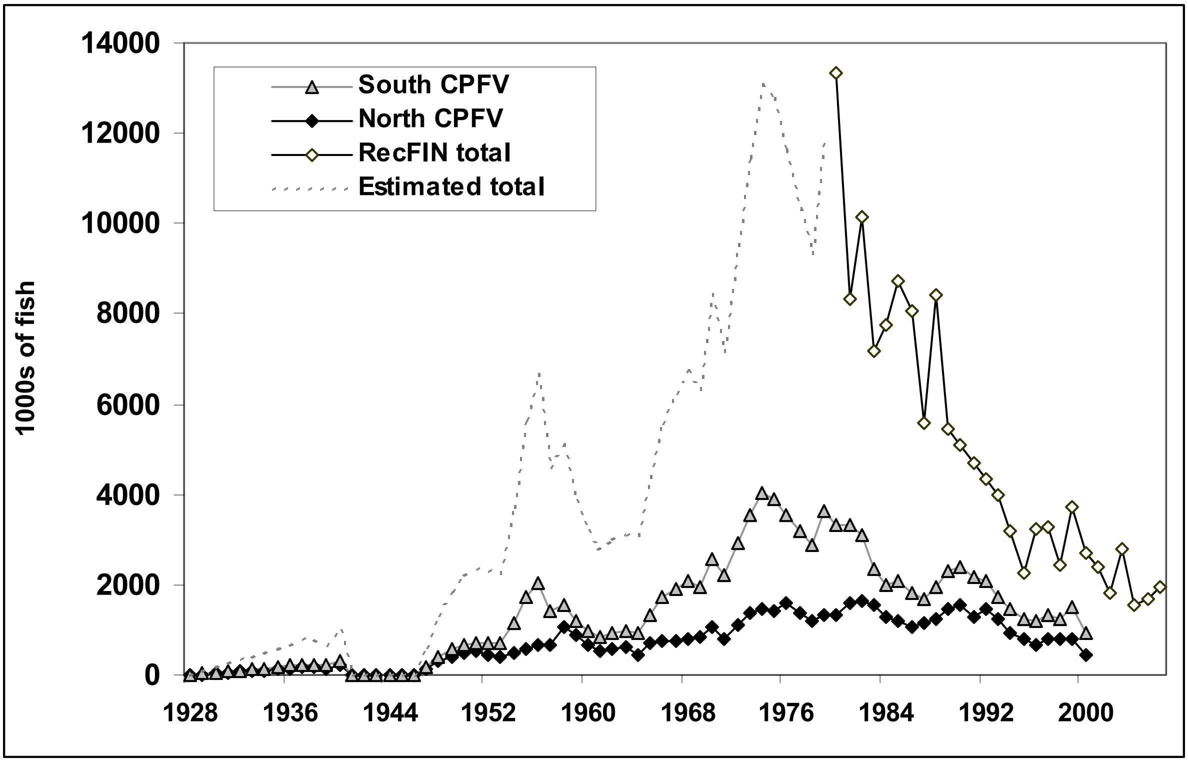


Figure 13: Total estimated recreational rockfish catches in northern and southern California as reported by RecFIN and CPFV logbook data, with reconstructed catches (in numbers) to 1928.

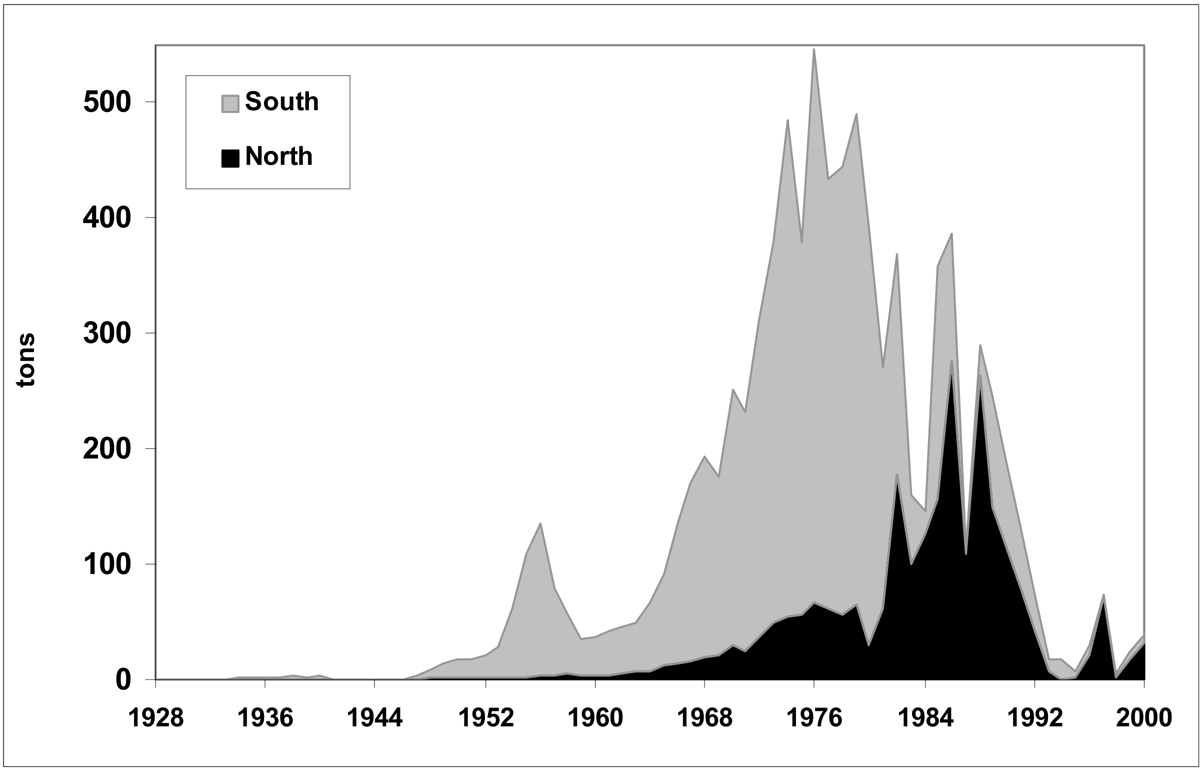


Figure 14: Estimated historical recreational catches of chilipepper rockfish in northern and southern California (tons) based on RecFIN data (1980-2006) and reconstructions based on historical sampling and CPFV logbook data (1928-1979).

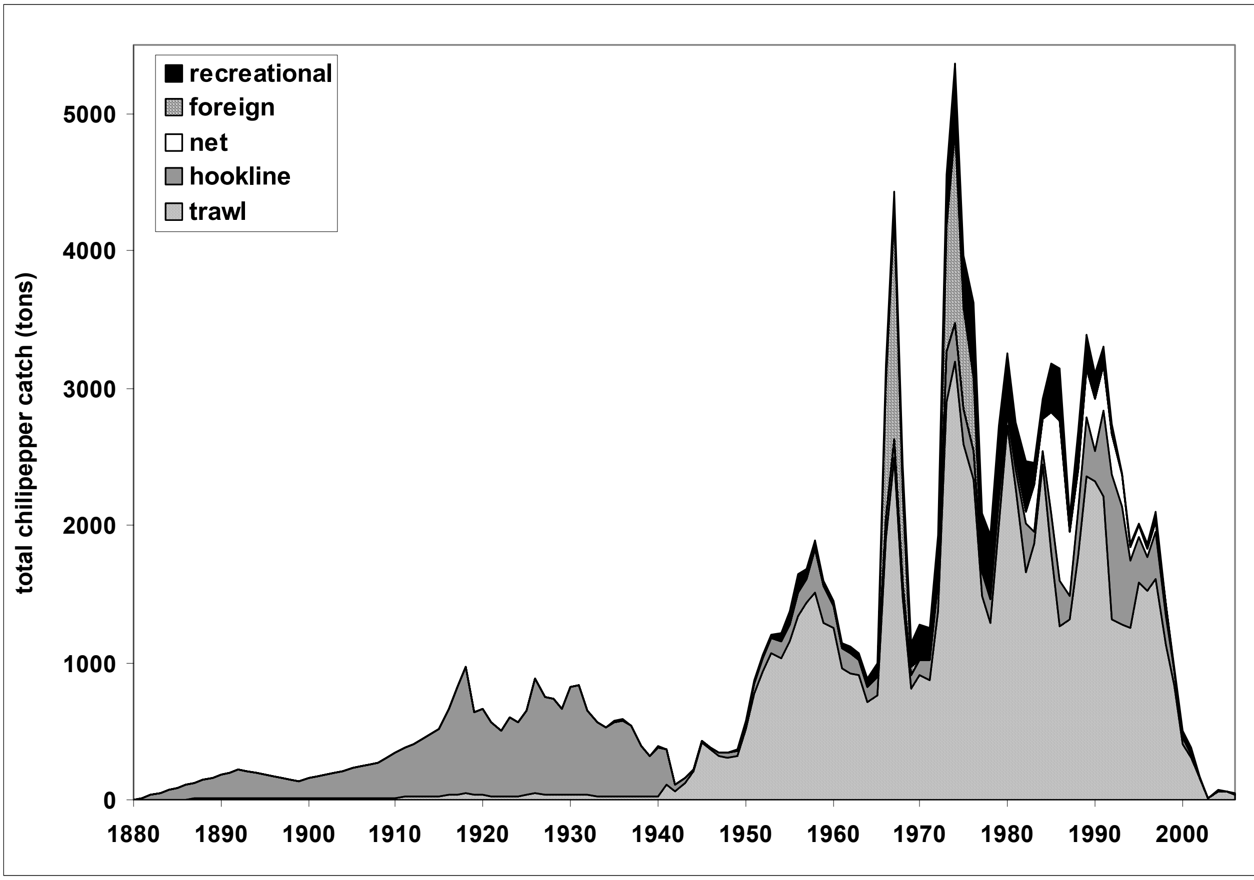


Figure 15: Total estimated chilipepper rockfish landings by fishery, 1880-2006.

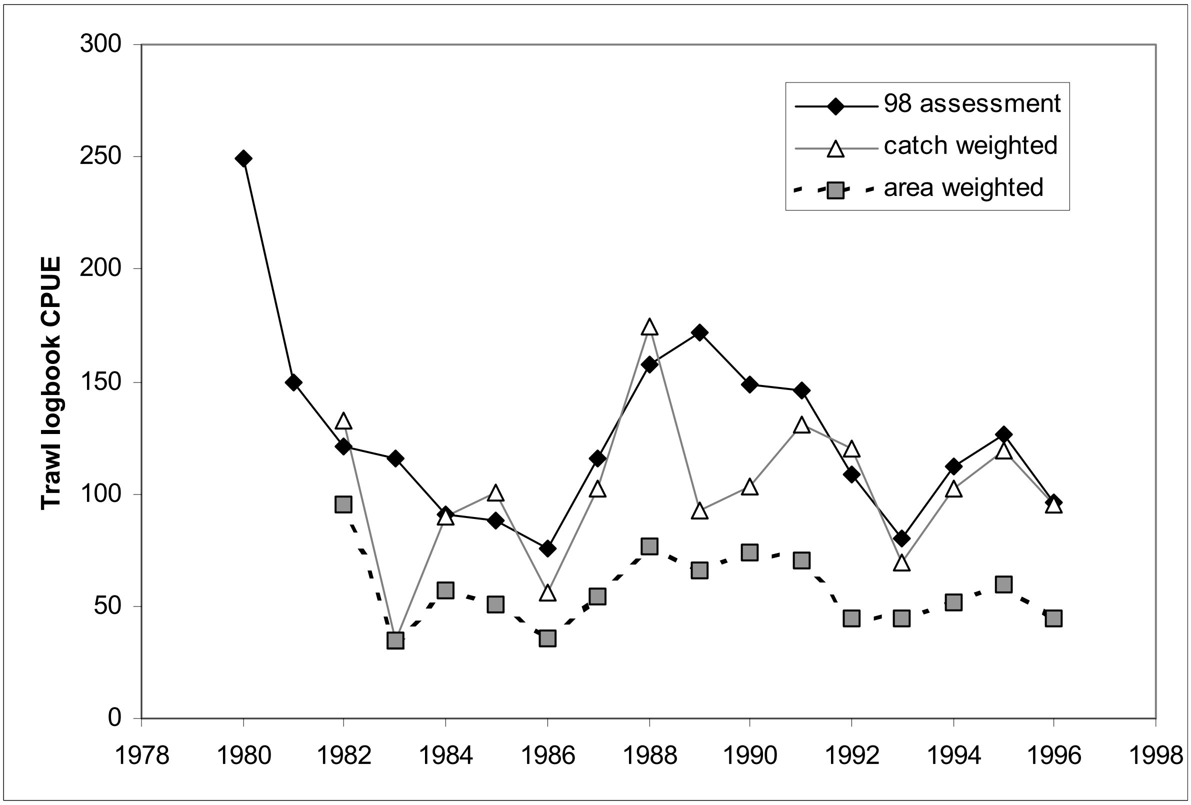


Figure 16: Trawl logbook CPUE time series developed in the last assessment by Ralston et al. (1998) and Ralston (1999).

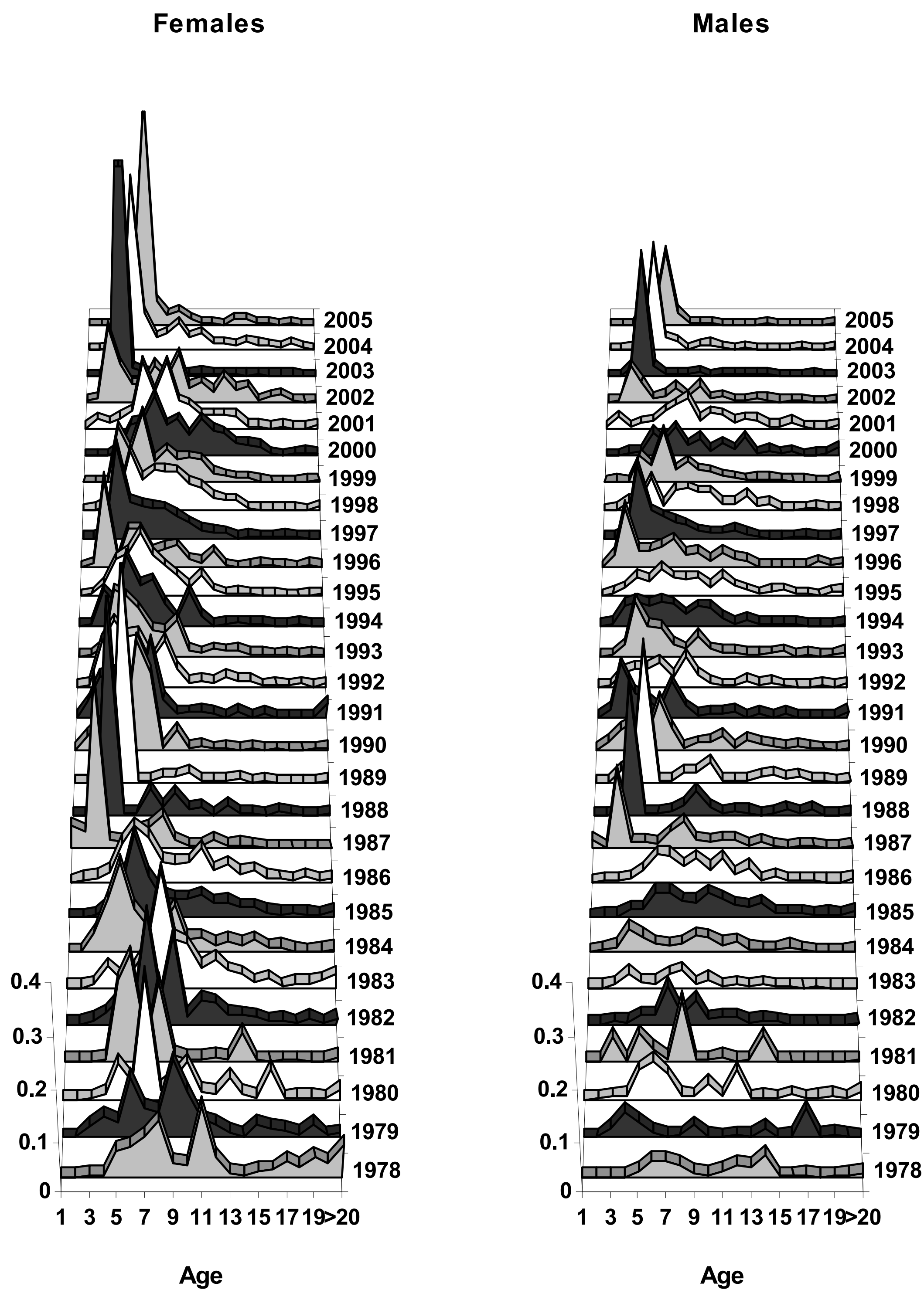


Figure 17: Age composition data from trawl fisheries, 1978-2005

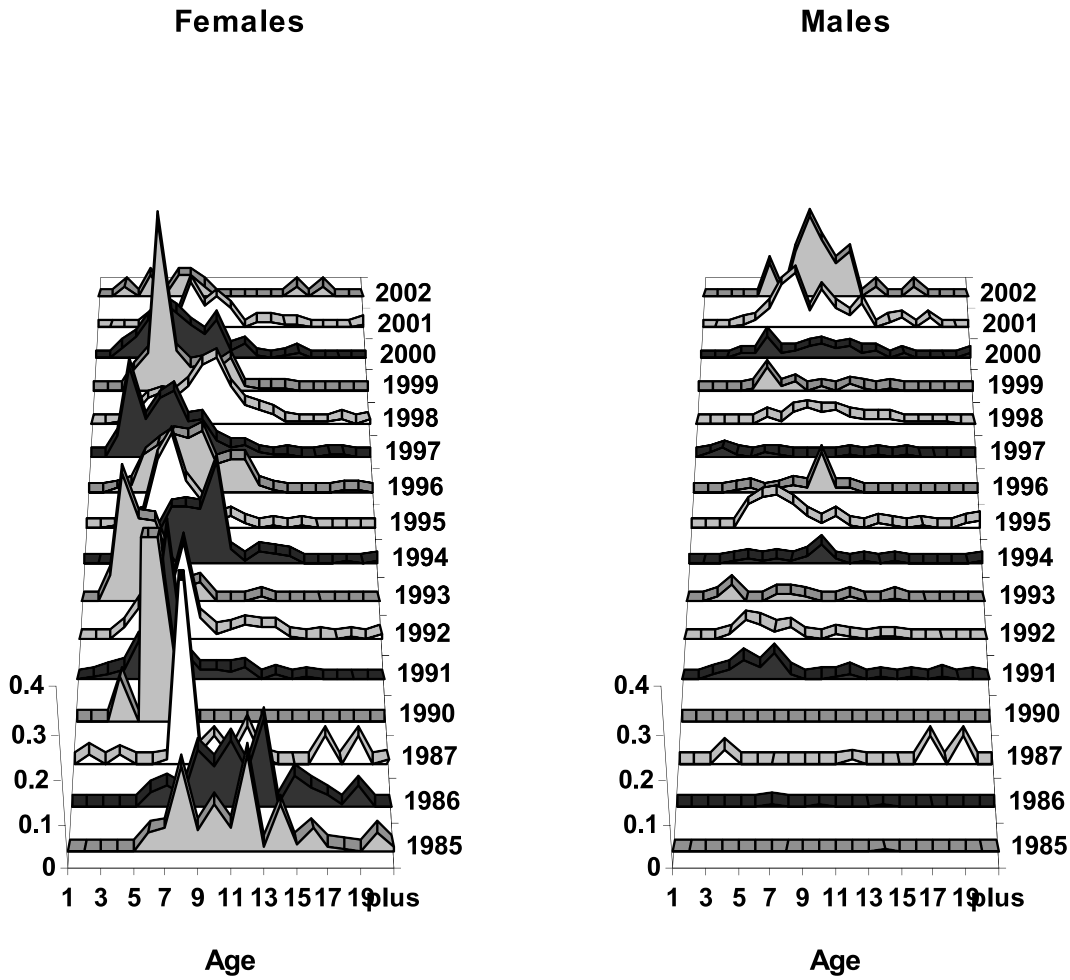


Figure 18: Age composition data from hook and line fisheries, 1985-2002 with no data for some years

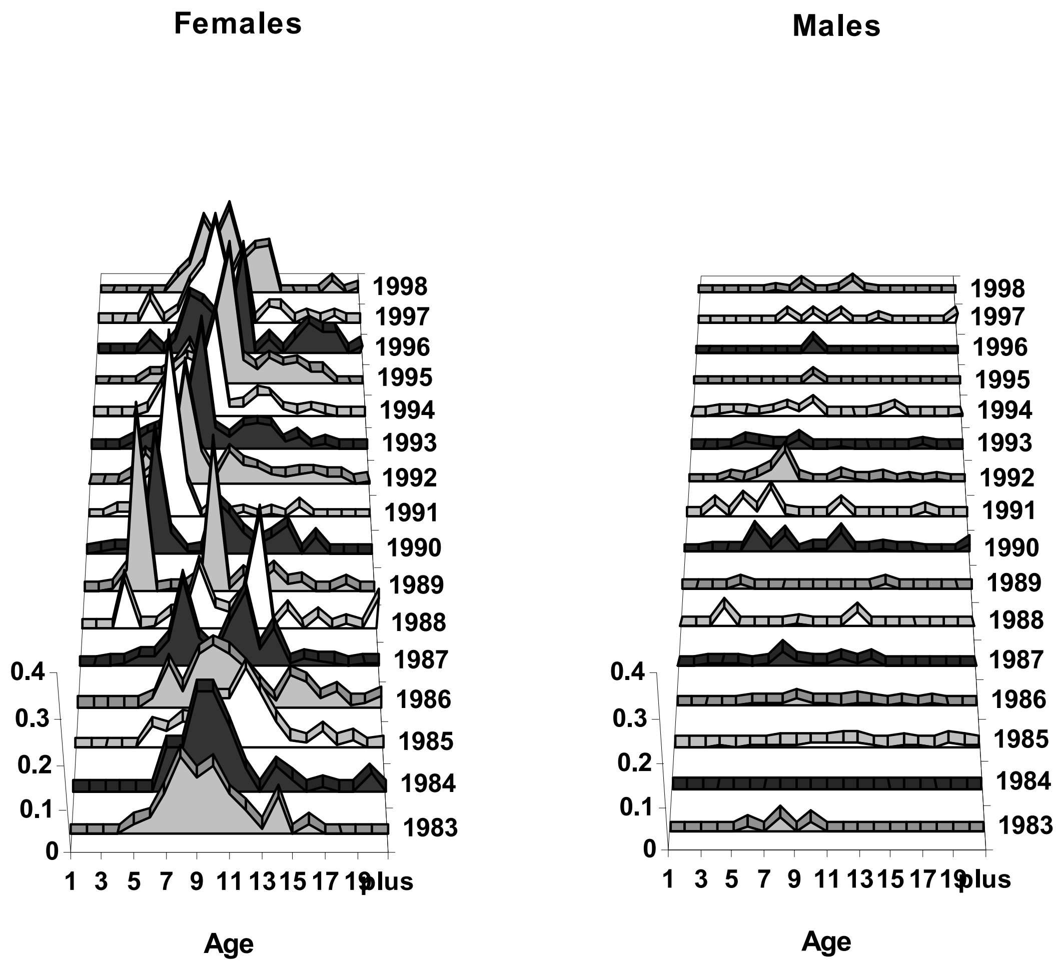


Figure 19: Age composition data from net fisheries, 1983-1998.

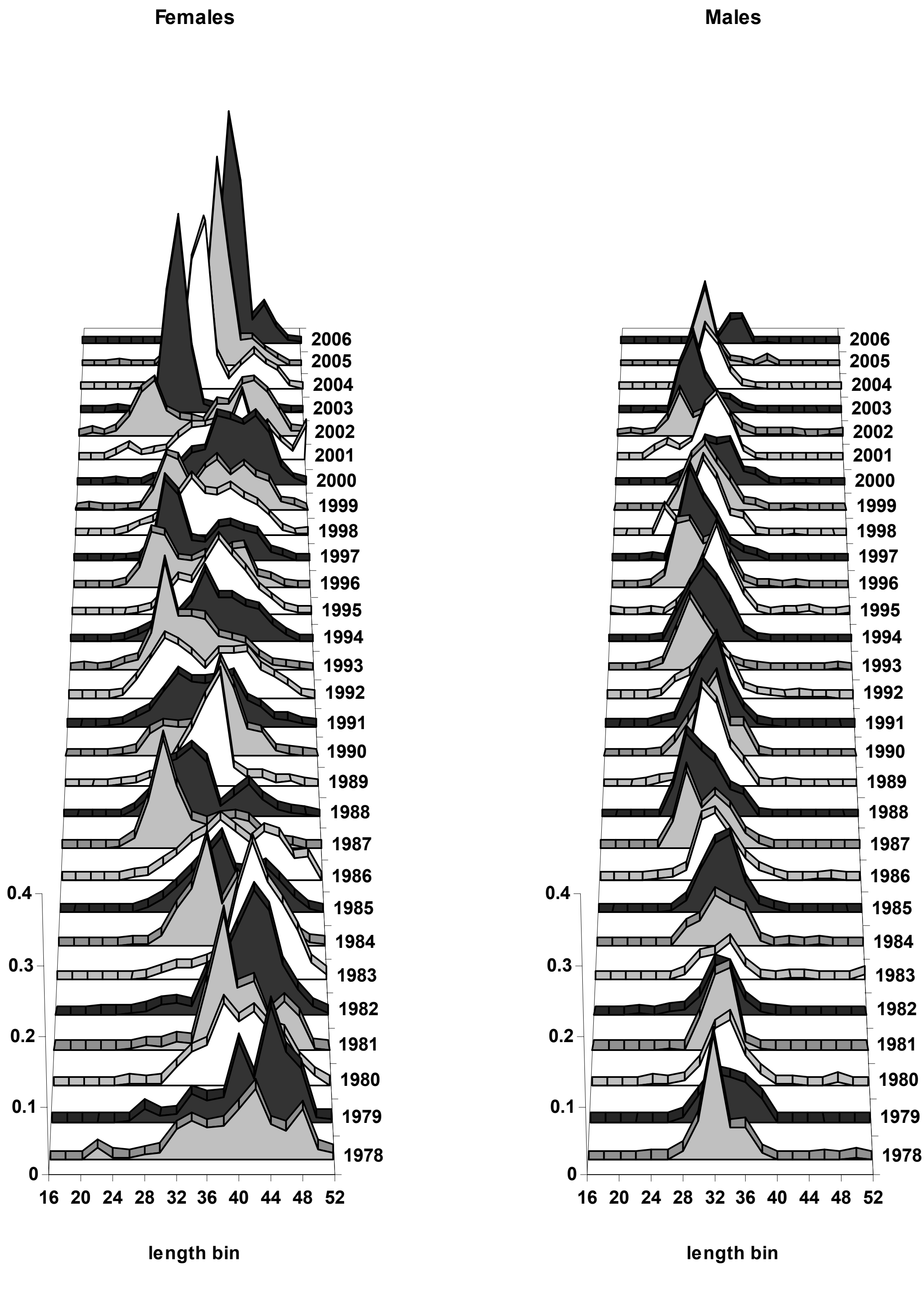


Figure 20: Length composition data from trawl fisheries, 1978-2006

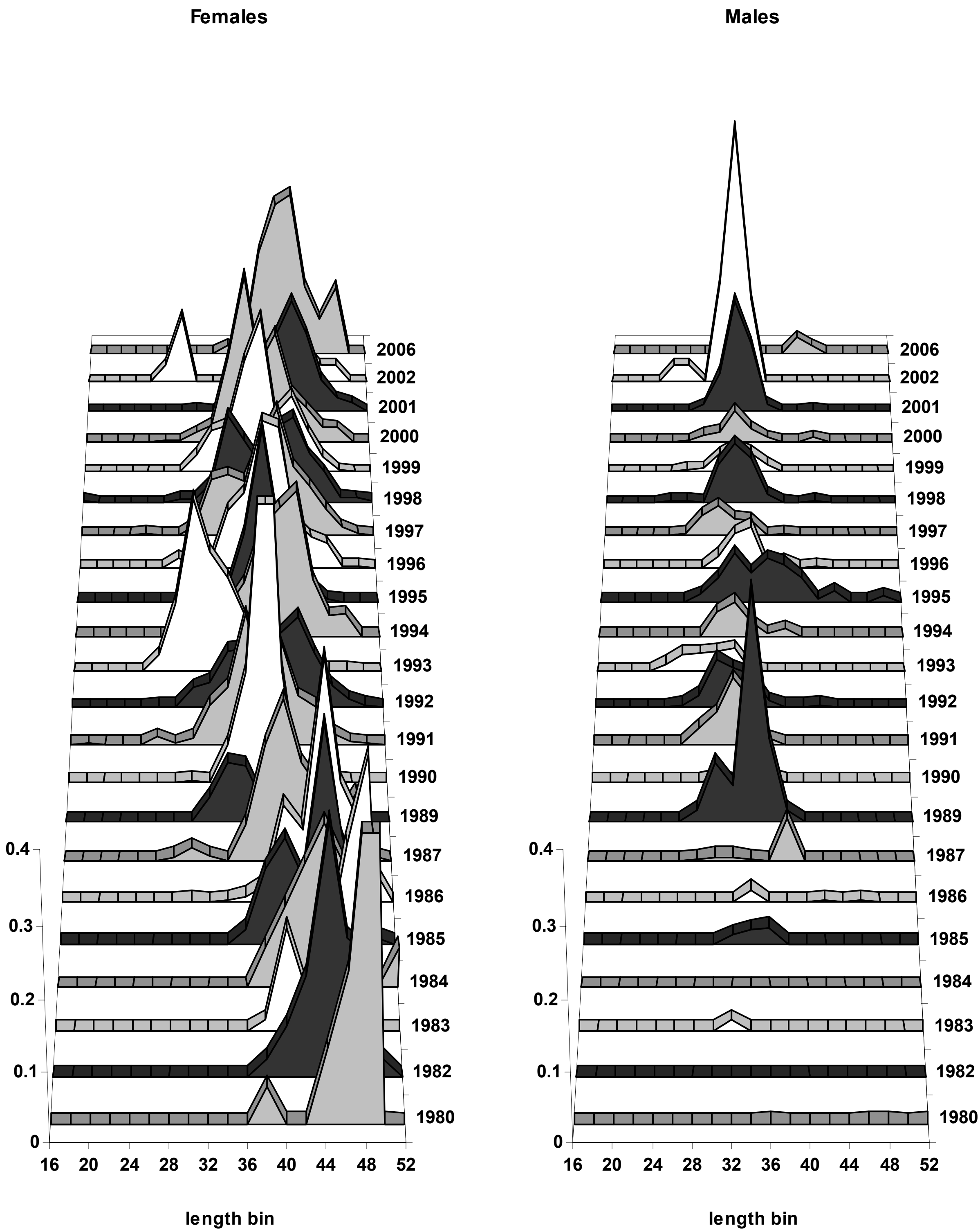


Figure 21: Length composition data from hook and line fisheries, 1980-2006 (with many years with no data)

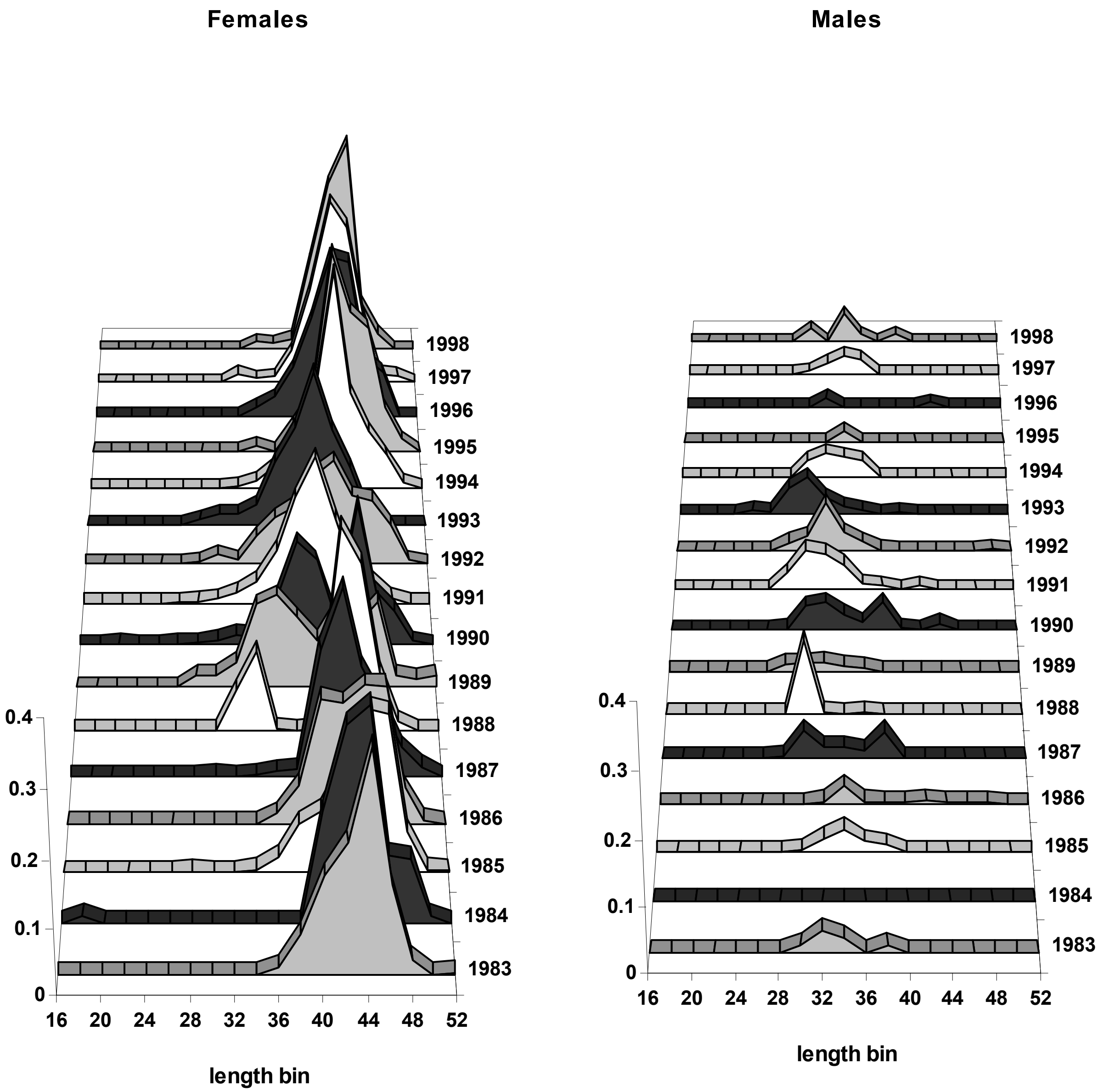


Figure 22: Length composition data from net fisheries, 1983-1998

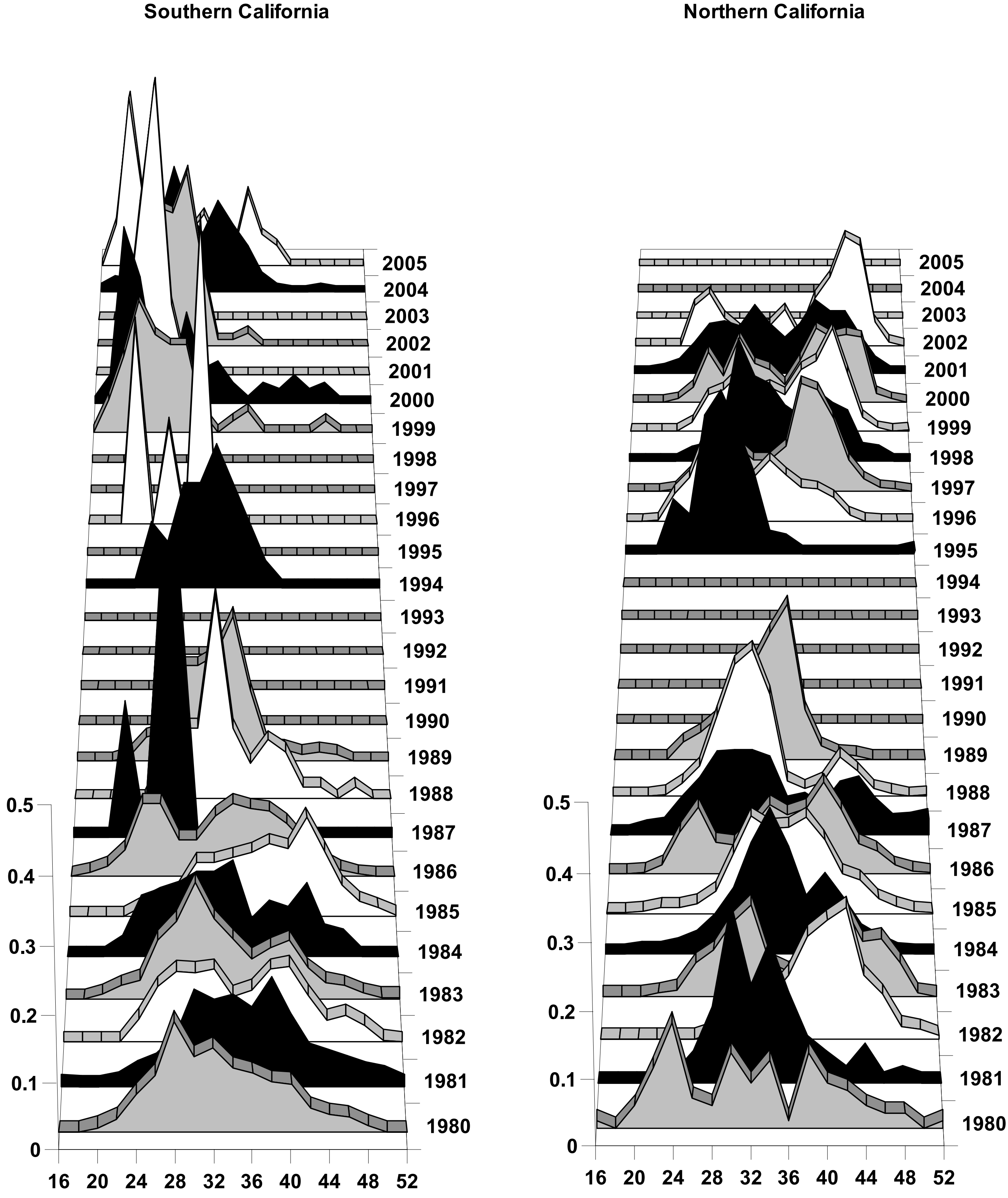


Figure 23: Length composition data for Southern and Northern California from RecFIN database

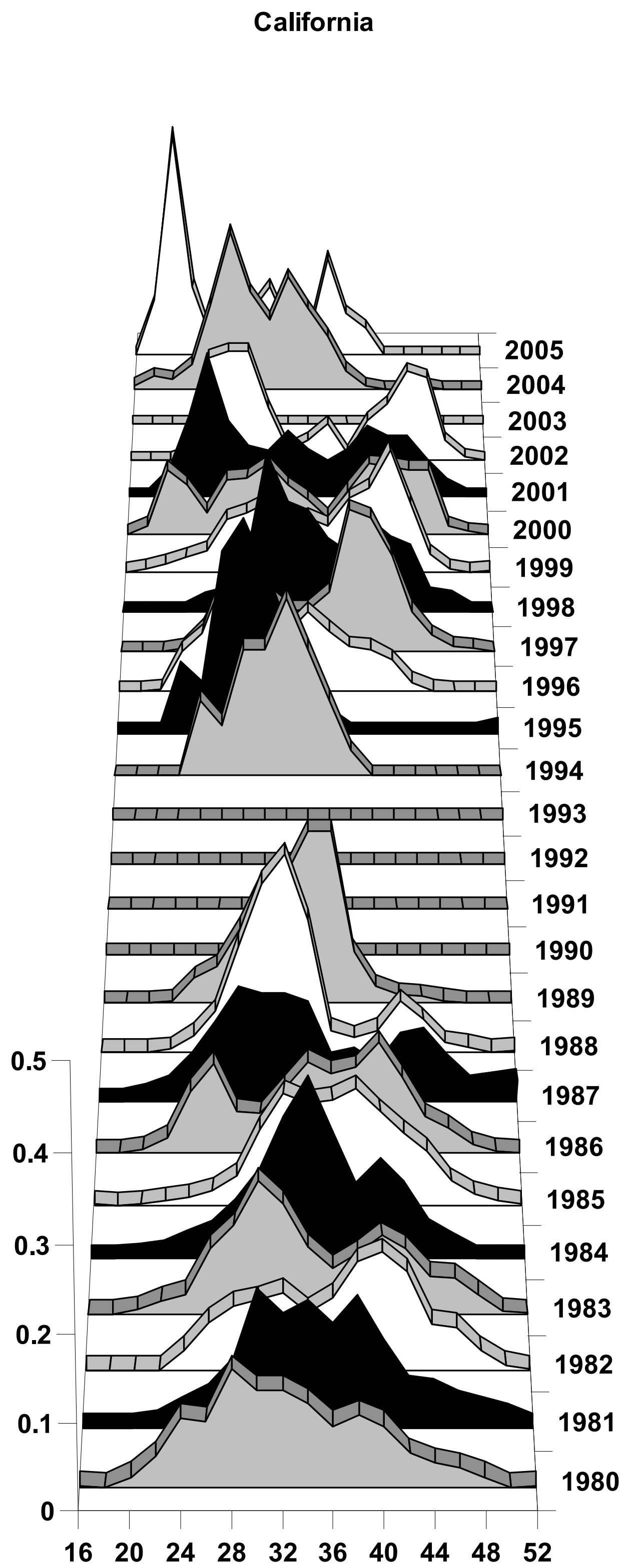


Figure 24: Coastwide length composition data from RecFIN database

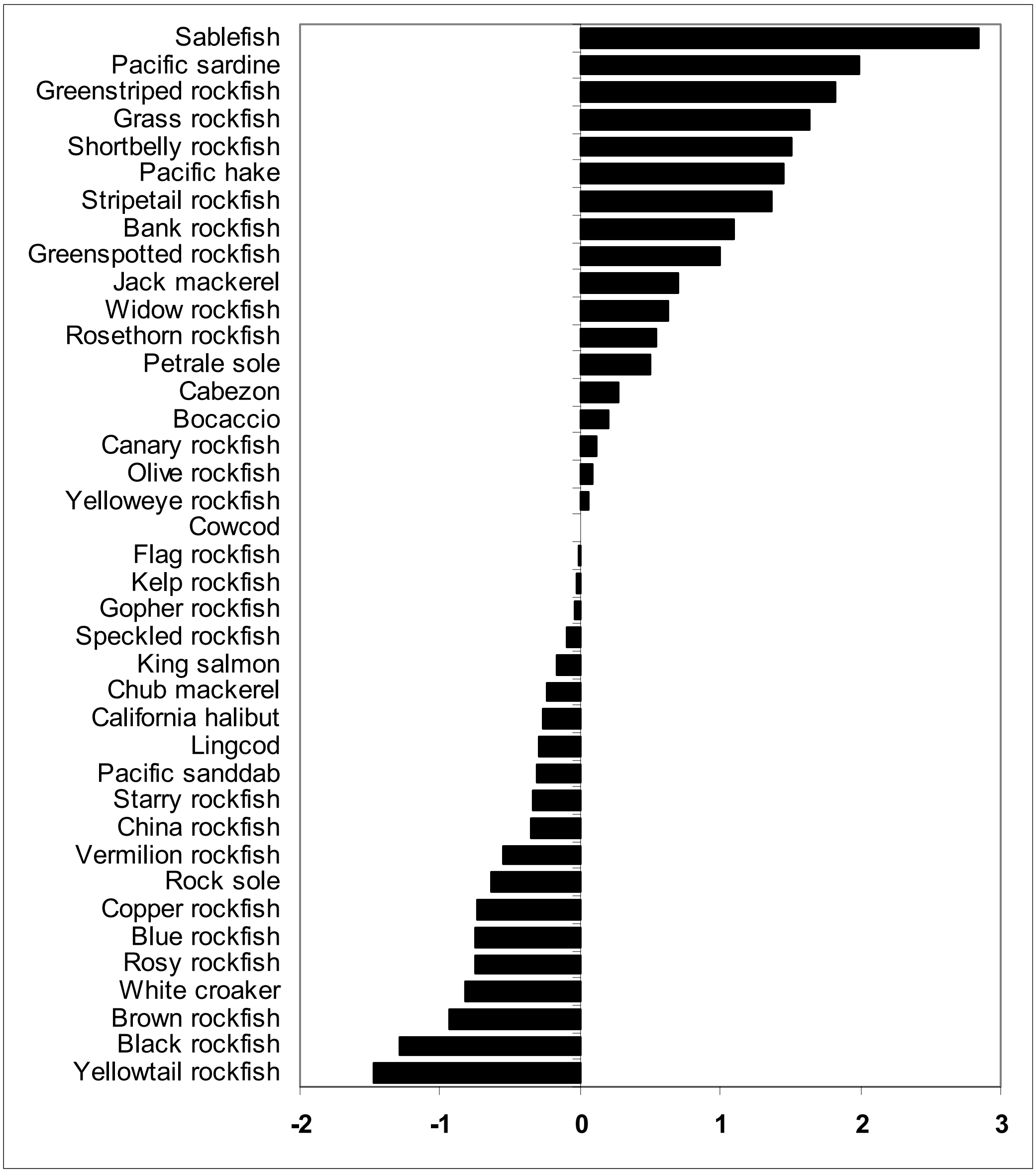
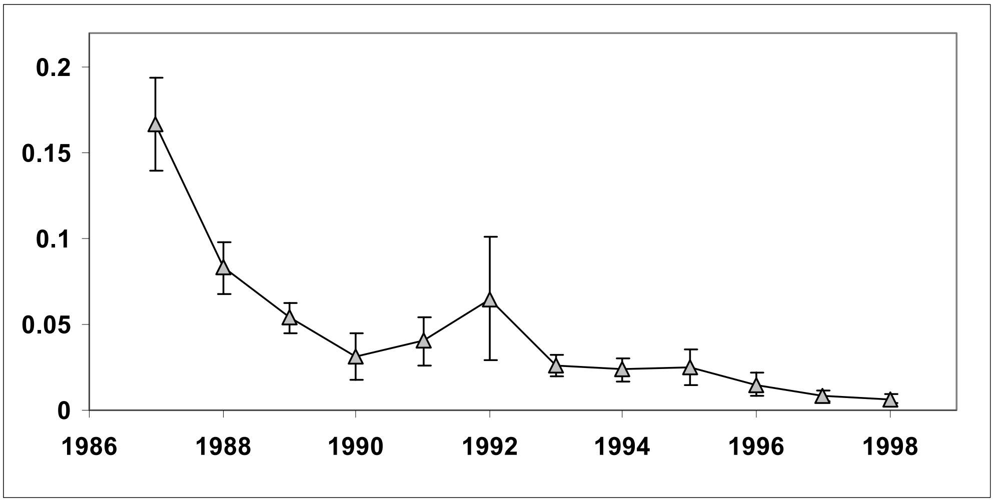
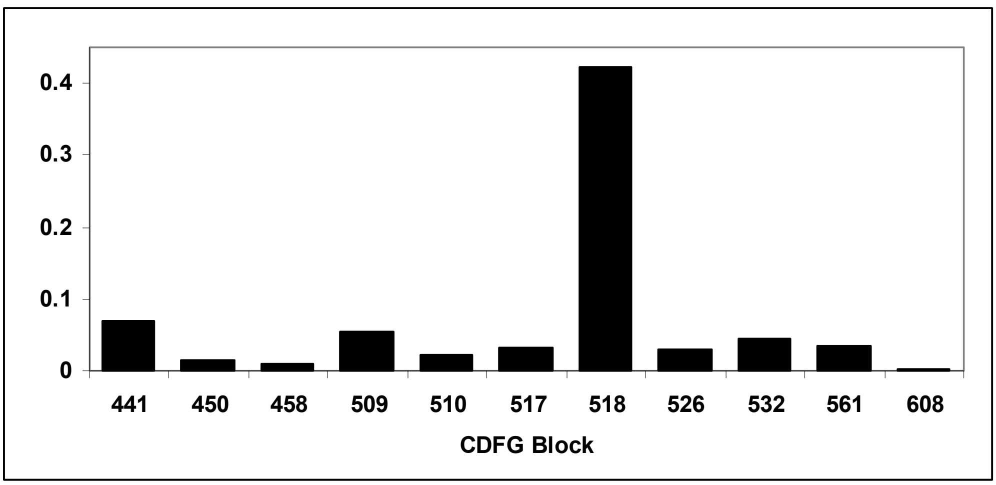


Figure 25: Species coefficients for CDFG observer data using the Stephens/MacCall method.





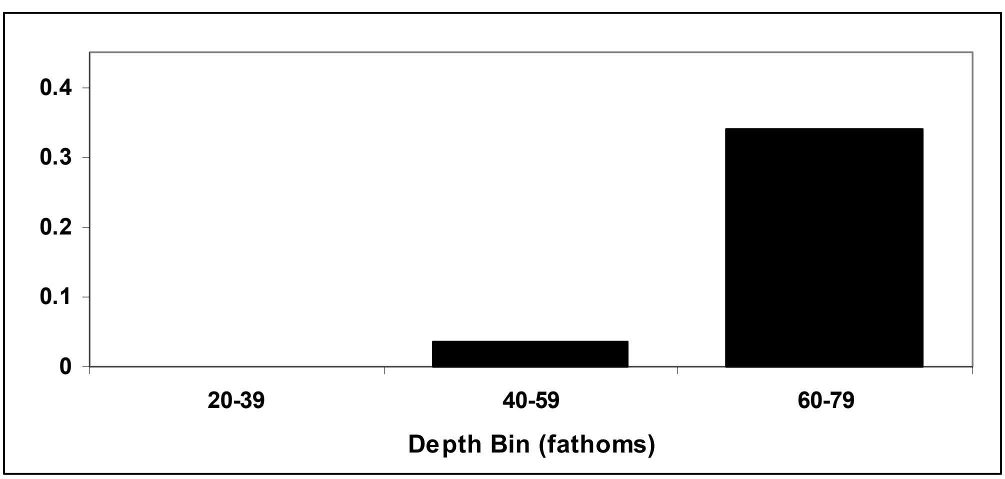


Figure 26 (top): CPUE time series from the CDF&G recreational observer data, with error estimated with a jackknife routine. Figure 27 (center) is block effects for the Rec CPUE model, Figure 28 (bottom) shows the depth bin effects.

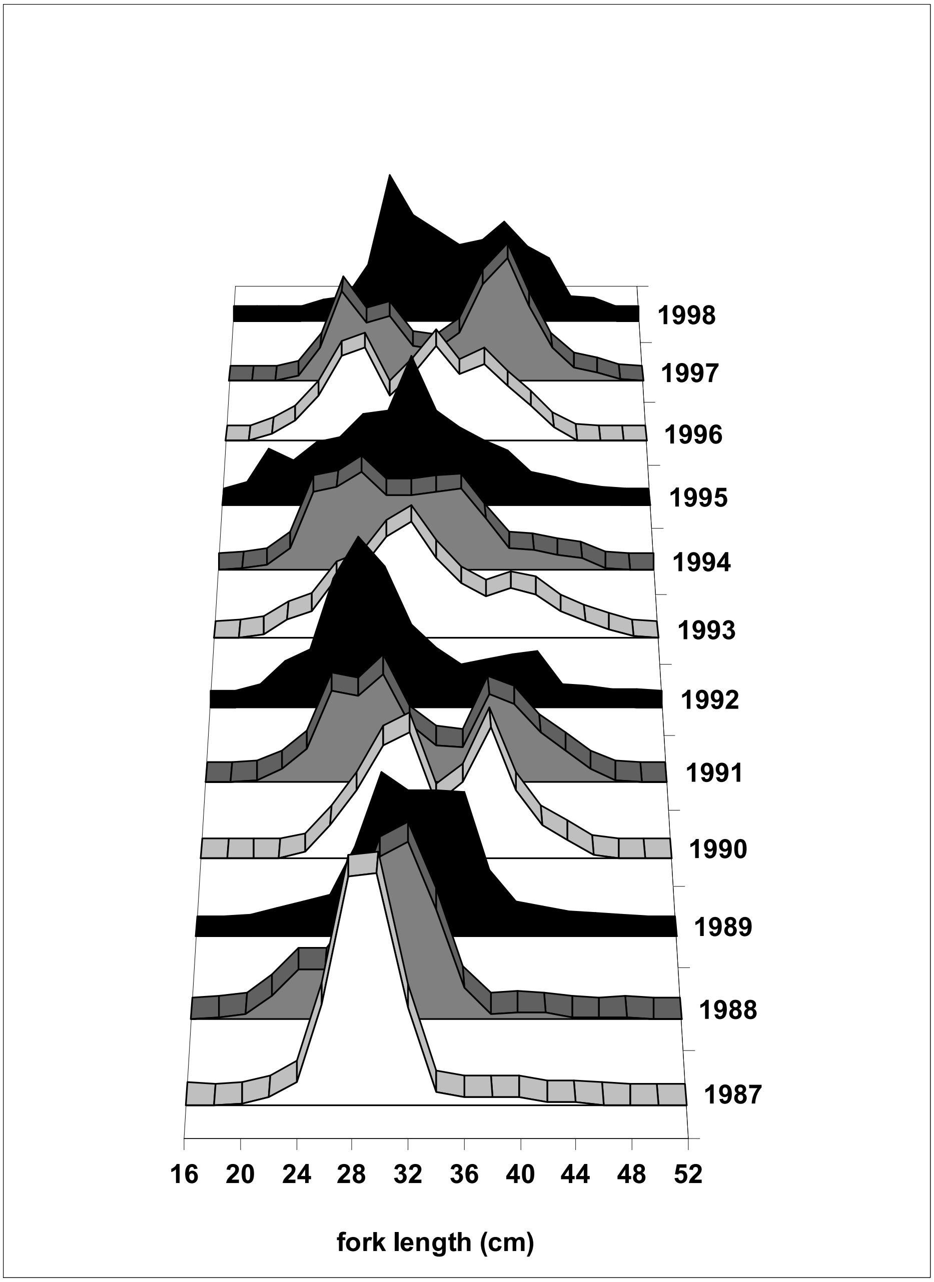


Figure 29: Length frequency information (sex unknown) for the CDF&G observer program recreational CPUE time series.

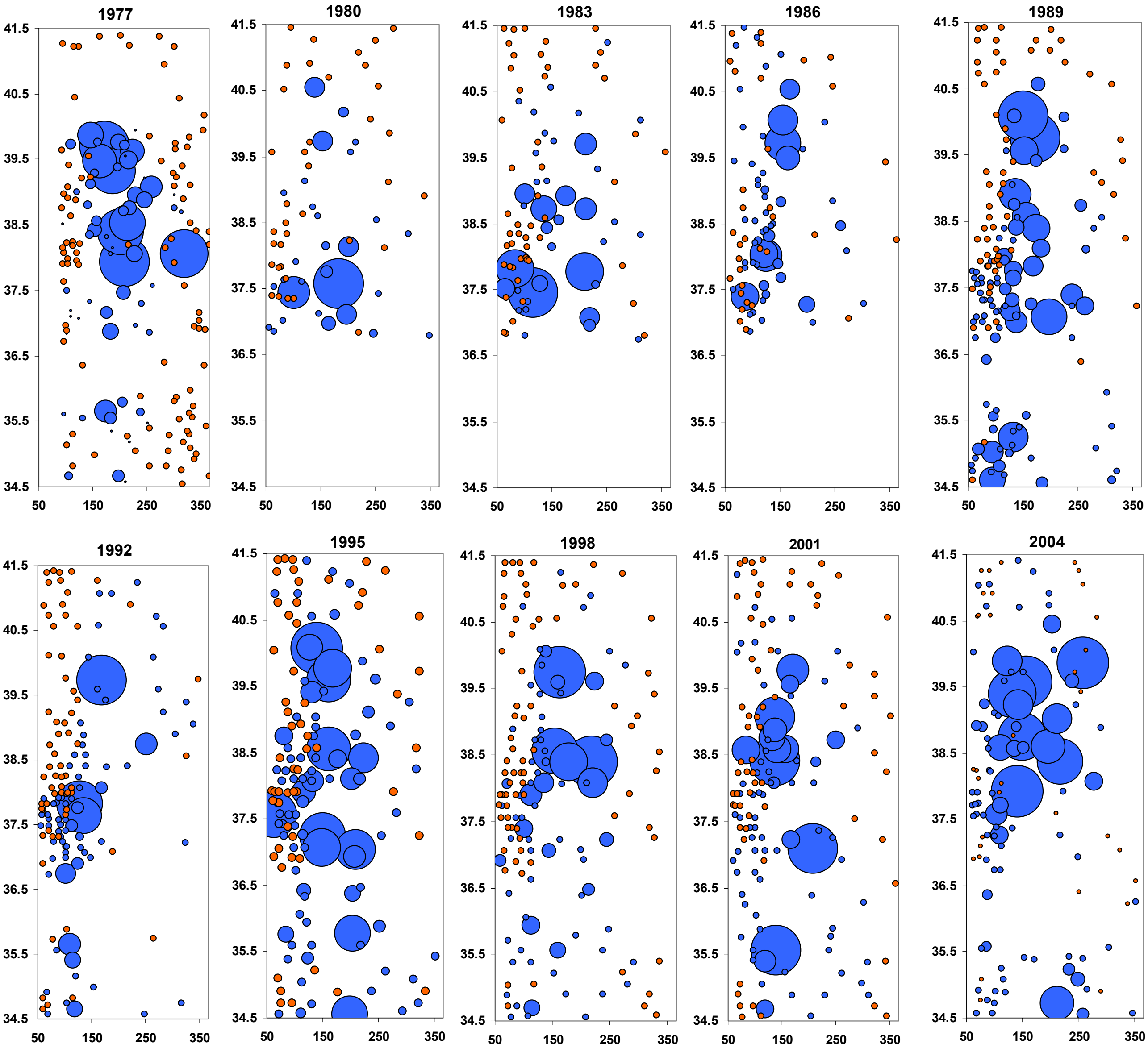
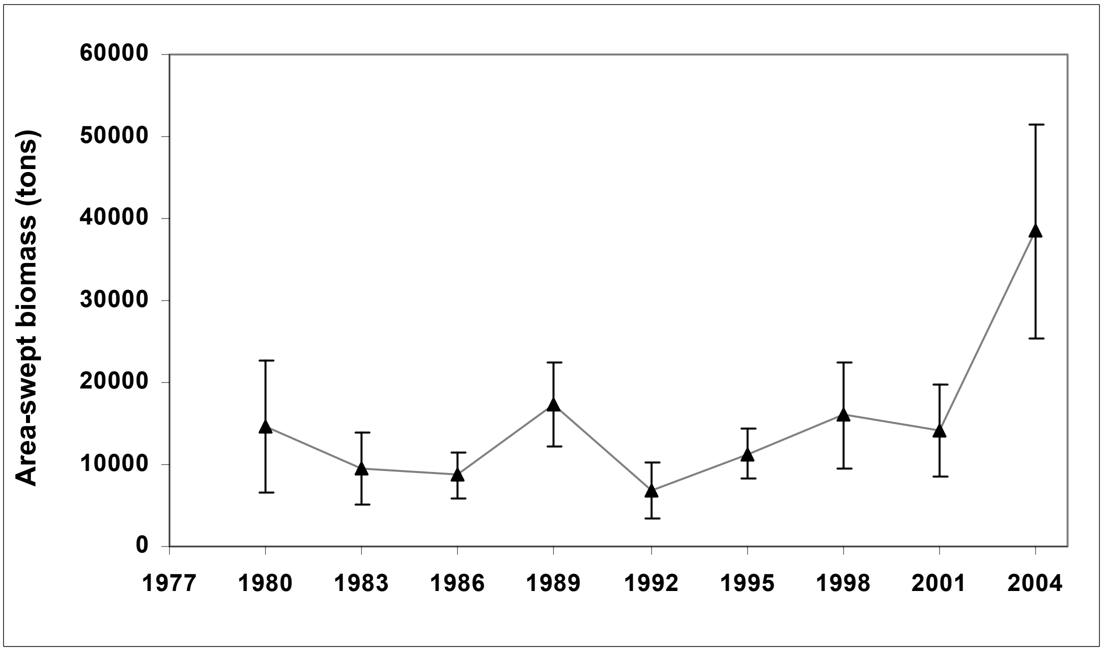


Figure 30: Chilipepper CPUE from triennial trawl survey across latitude and depth, 1977-2004; orange dots represent hauls in which no chilipepper were caught.



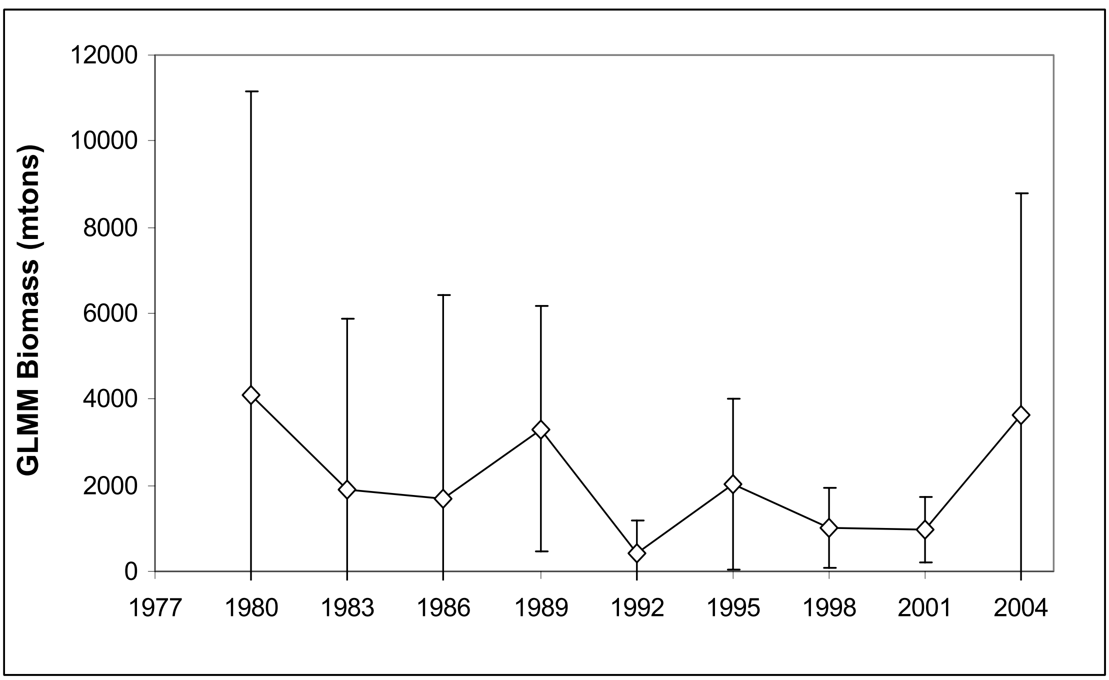


Figure 31 (top): Triennial survey core area-swept biomass index with estimated CV, and 32 (bottom) GLMM biomass point estimates with standard error.

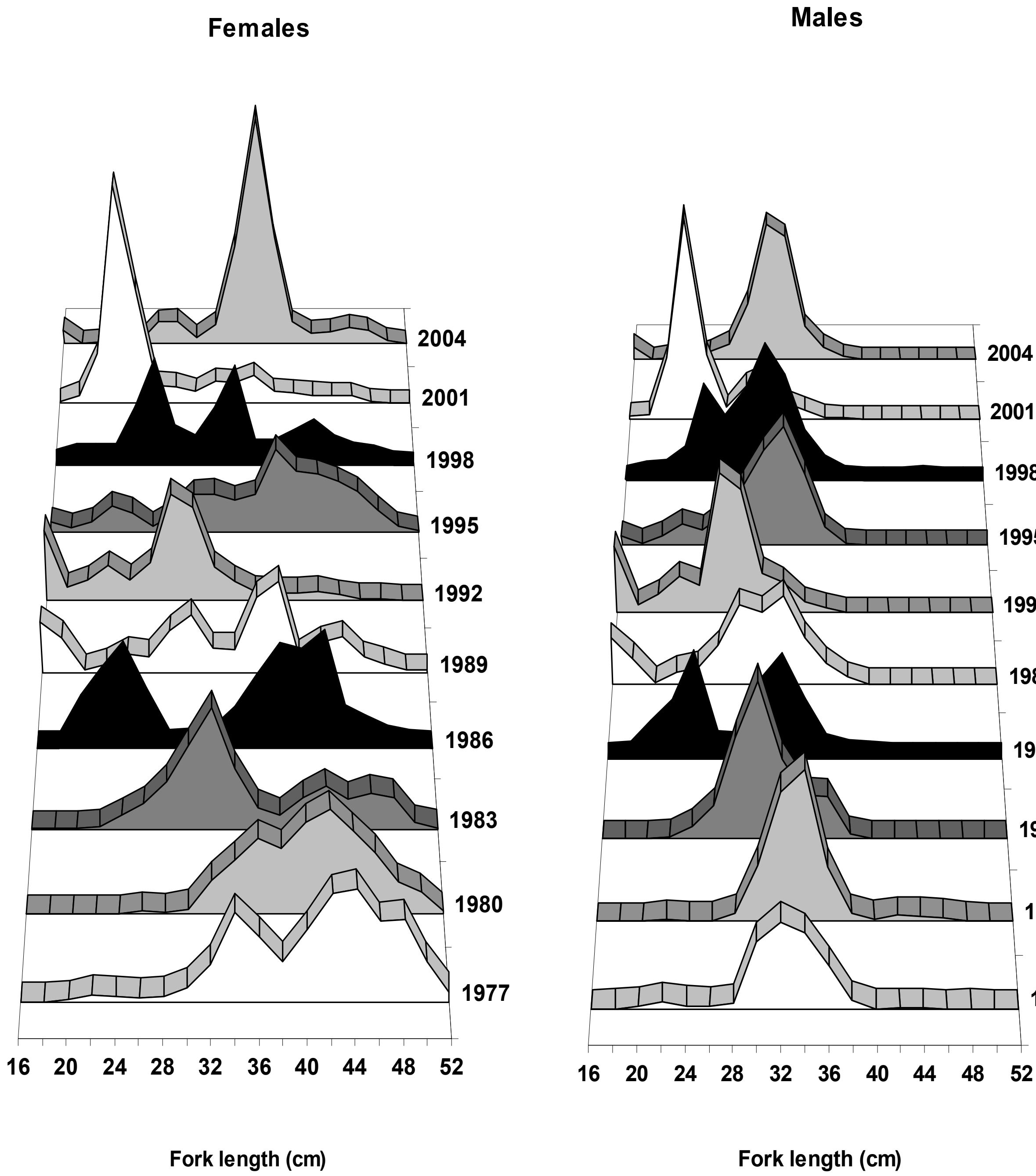


Figure 33: Size composition of chilipepper rockfish from the triennial trawl survey.

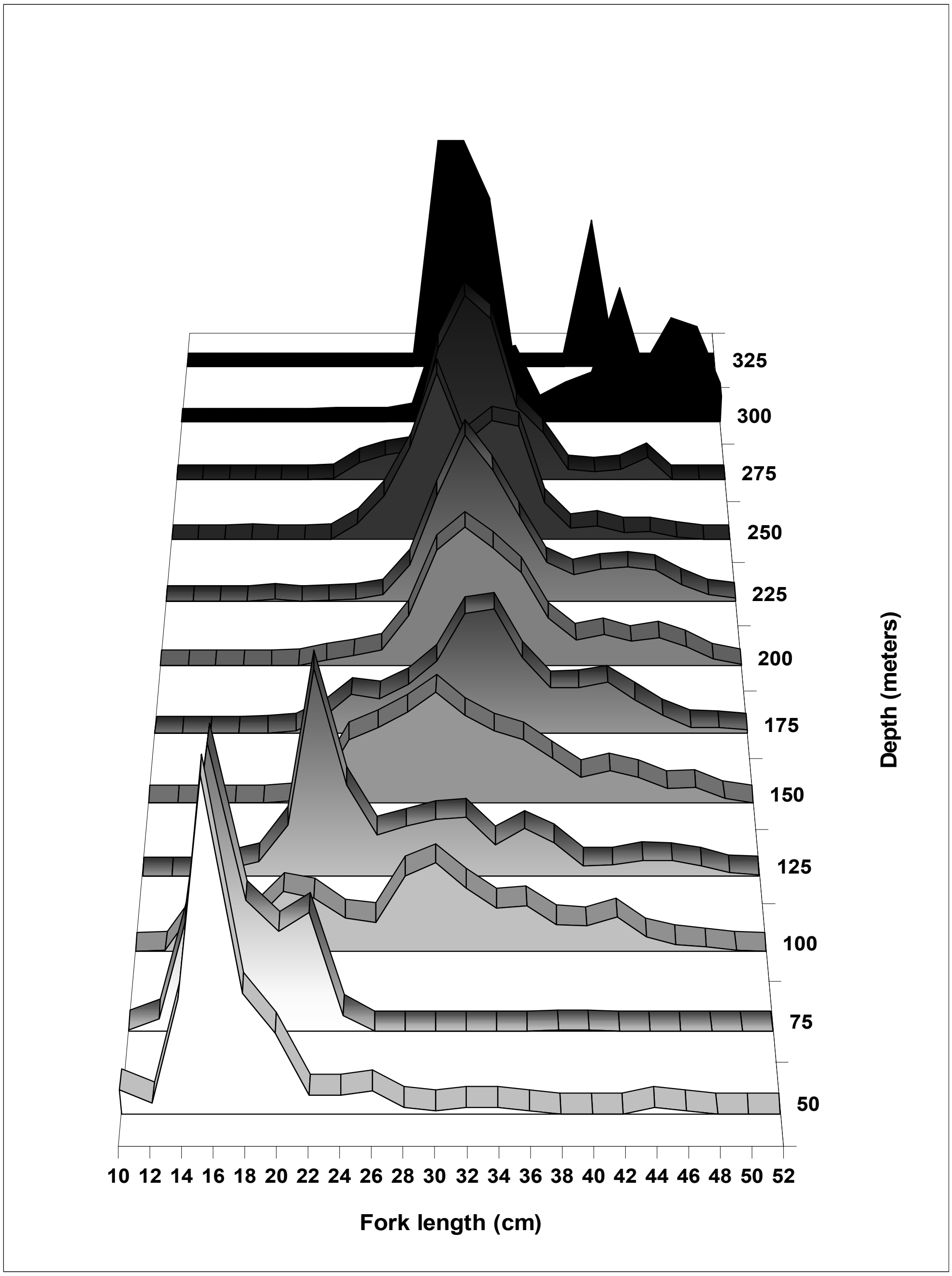


Figure 34: Shift in size composition of chilipepper rockfish by depth (from raw triennial trawl survey catches, all years).

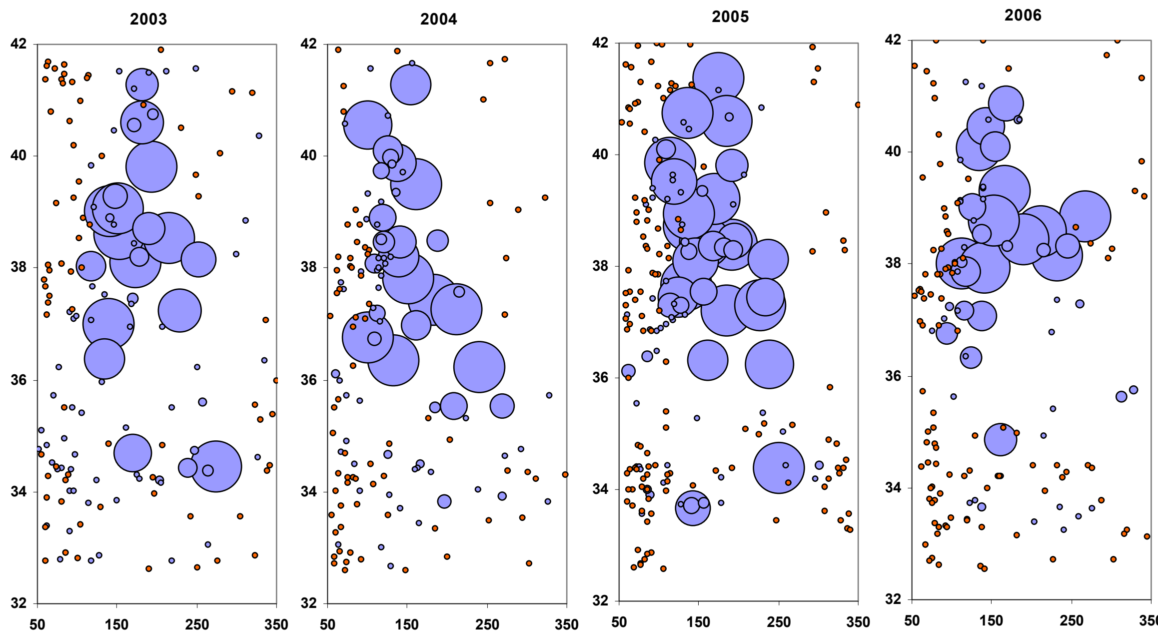


Figure 35: Chilipepper CPUE from NWFSC Combined survey, 2003-2006; orange dots reflect hauls in which no chilipepper were encoutnered.

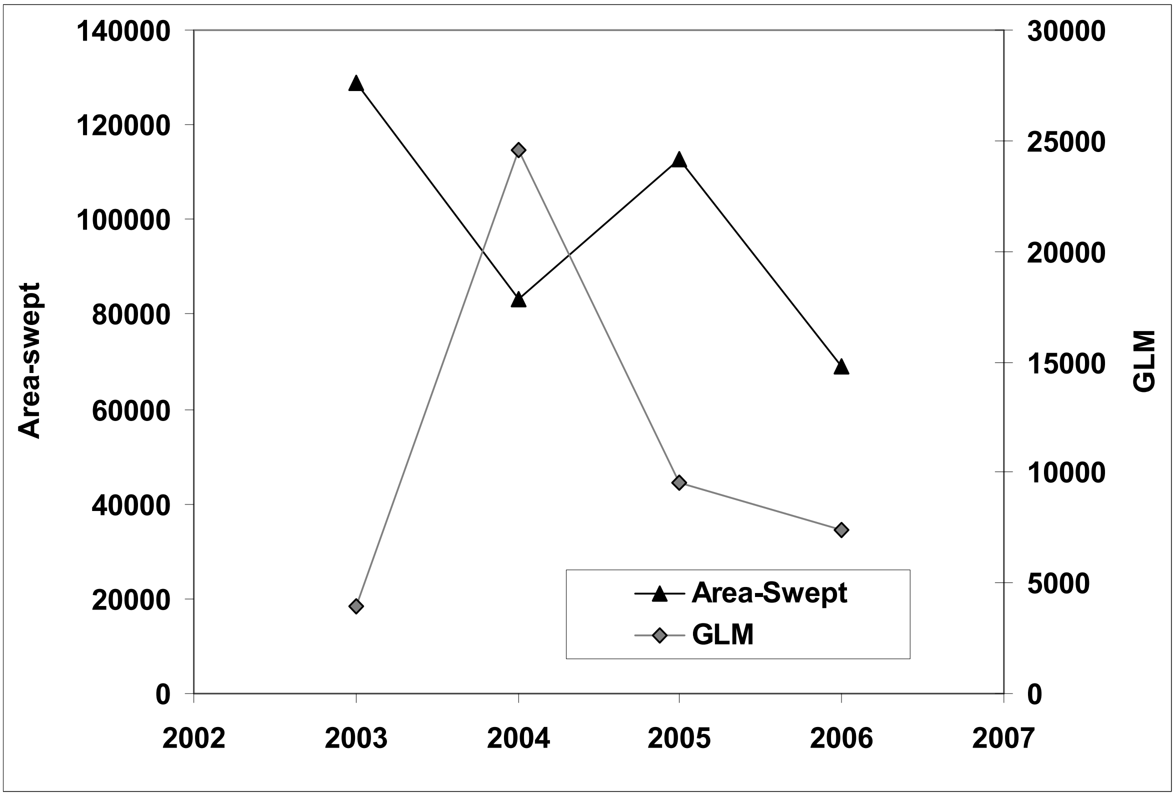


Figure 36: NWFSC Combined survey abundance indices for Chilipepper rockfish

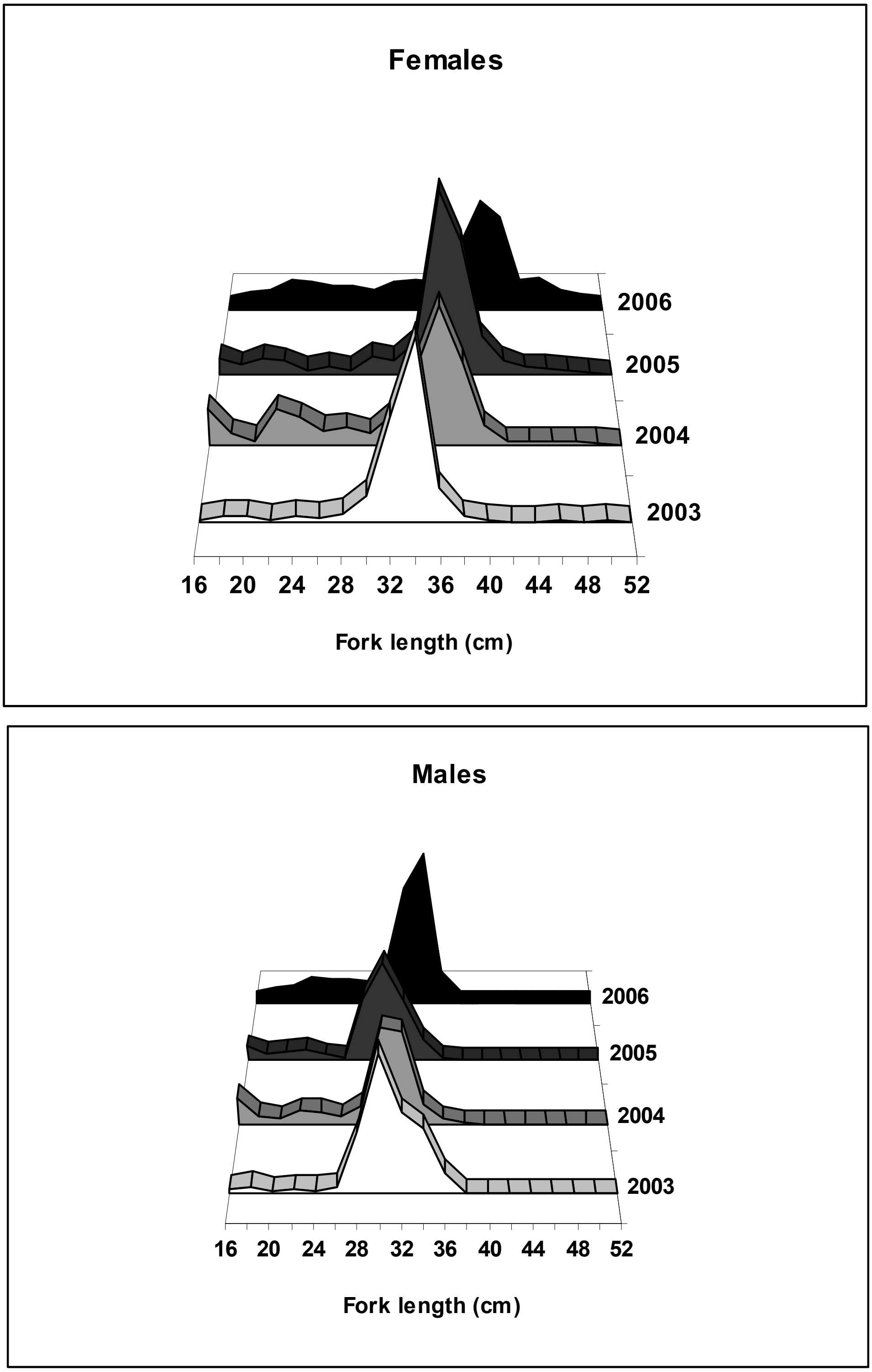


Figure 37: NWC Combined survey length compositions.

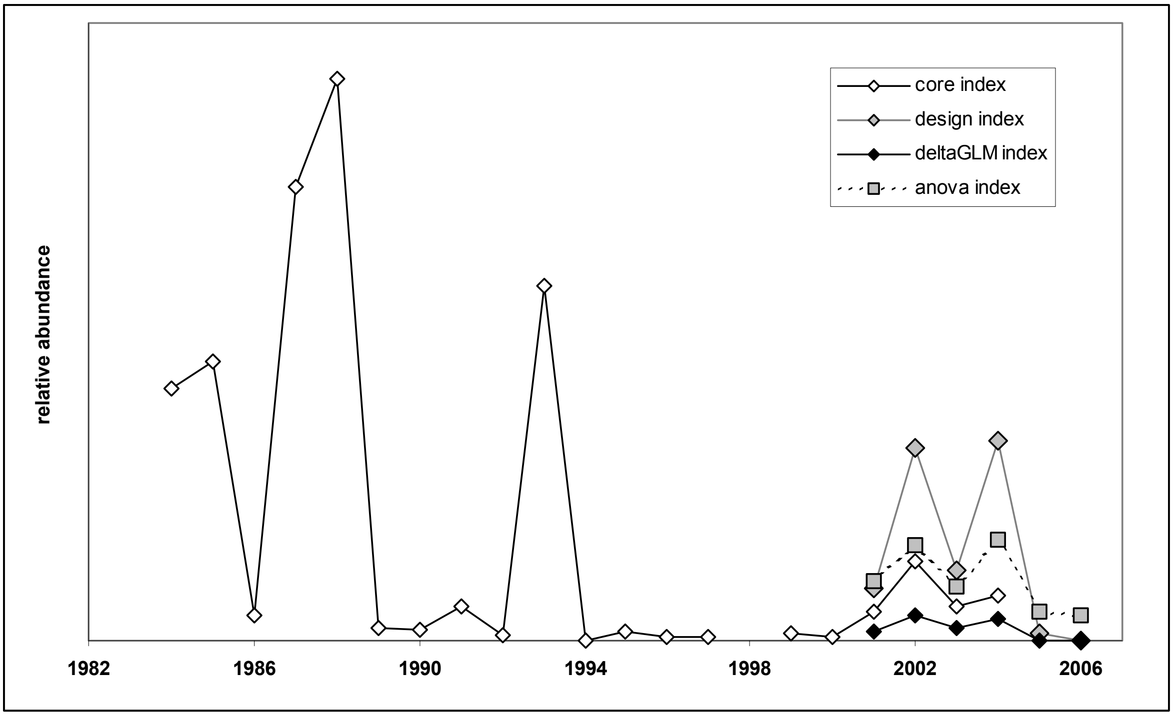
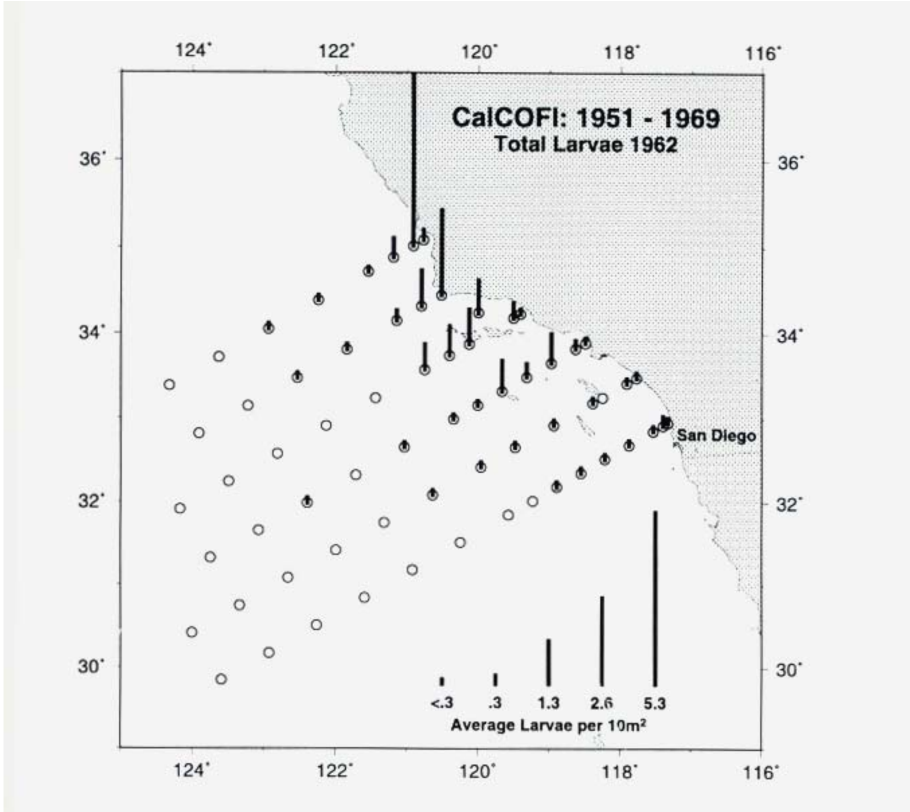


Figure 38: Juvenile (age 0) indices for core area (1984-2004) and coastwide (2001-2006) juvenile rockfish surveys



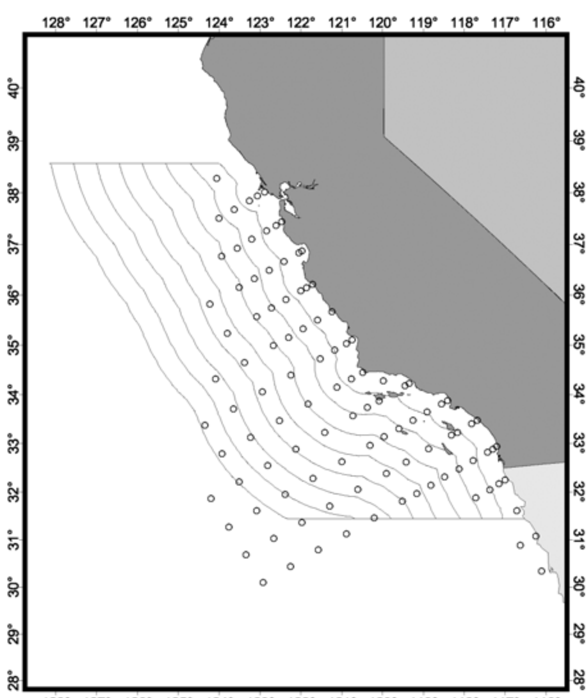
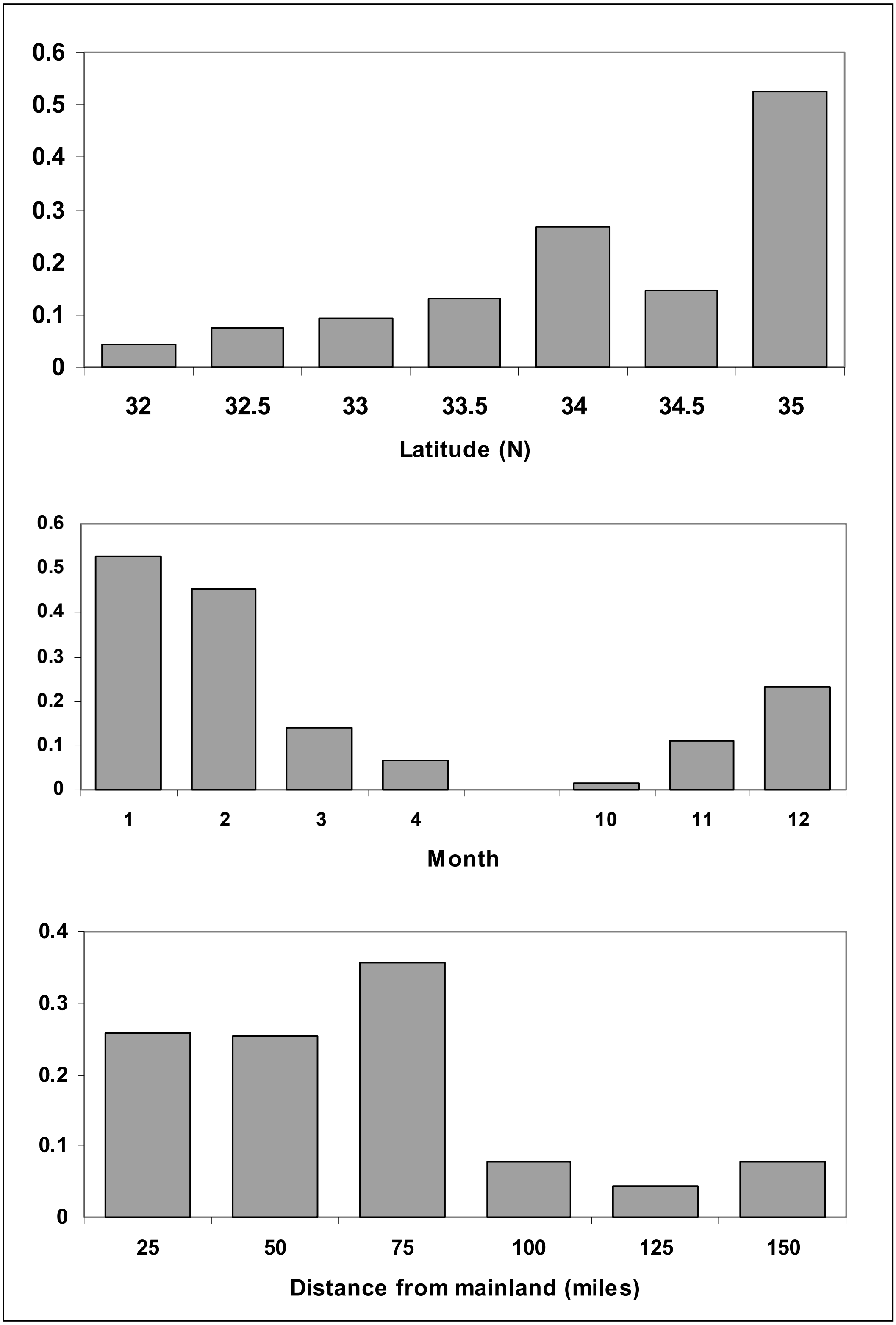


Figure 39 (top): Catches of chilipepper rockfish larvae from CalCOFI surveys, 1951-1969. Figure 40 (bottom), zones for estimating distance from shore in 25 km bins.



Figures 41a-c: Latitude (top), month (middle), and distance from shore (bottom) effects for the CalCOFI larval abundance index.

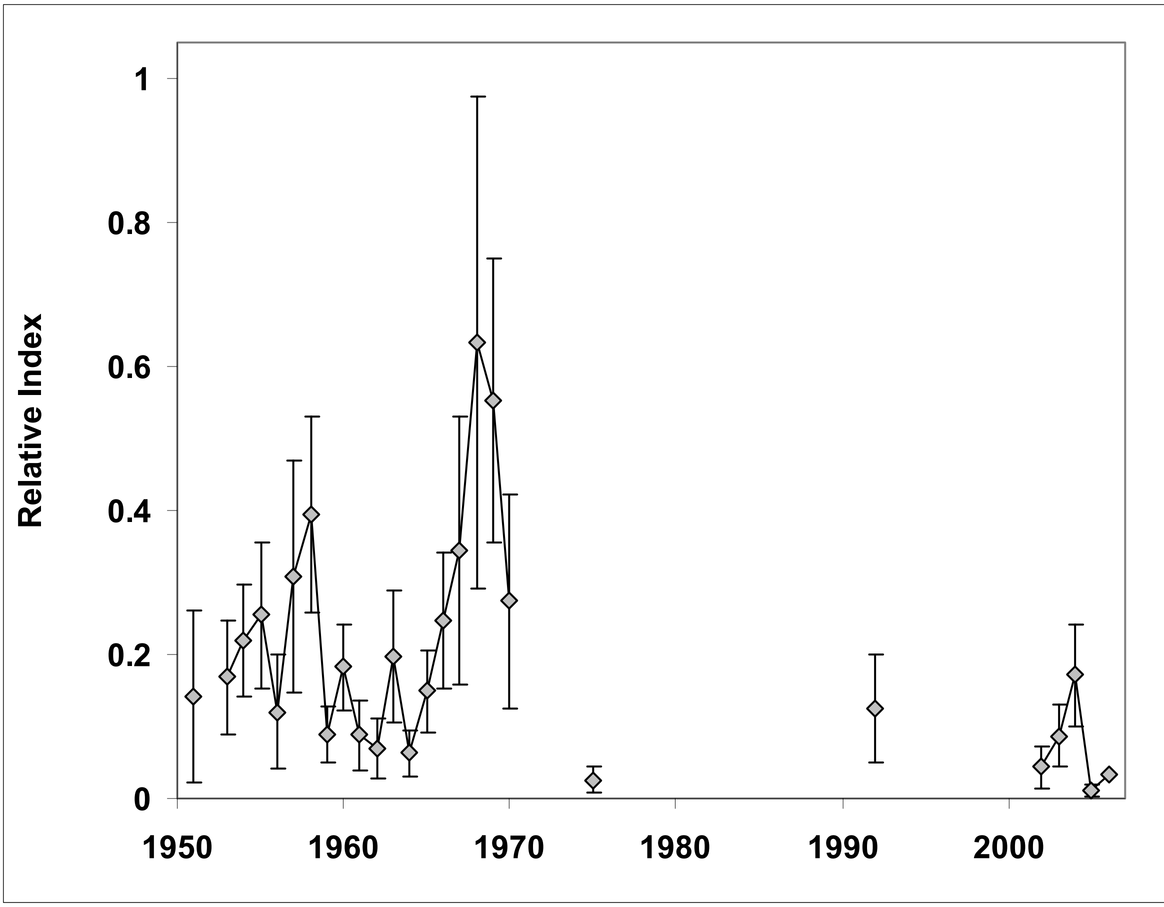
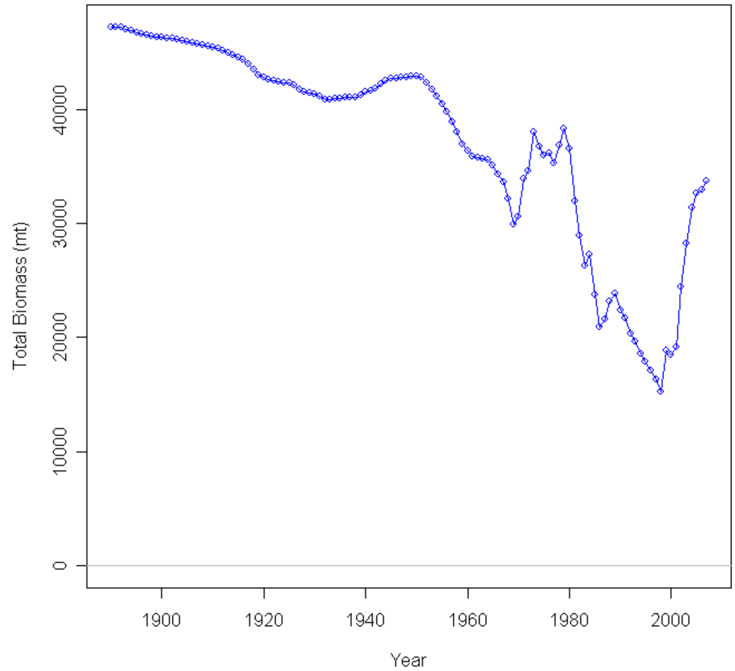


Figure 43: CalCOFI index point estimates, with error estimated from a jackknife. As two positive tows are necessary to run the jackknife, many years with a single positive tow (1984, 1985, 1991, 2000) are not included.



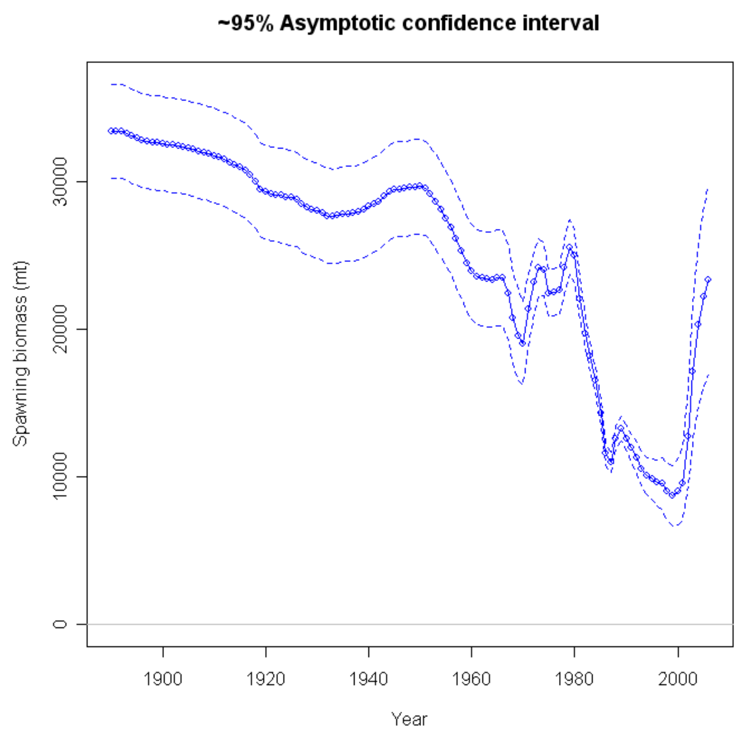


Figure 44-45: Base model output estimates of total biomass (top) and of spawning biomass with ~95% asymptotic confidence intervals (bottom).

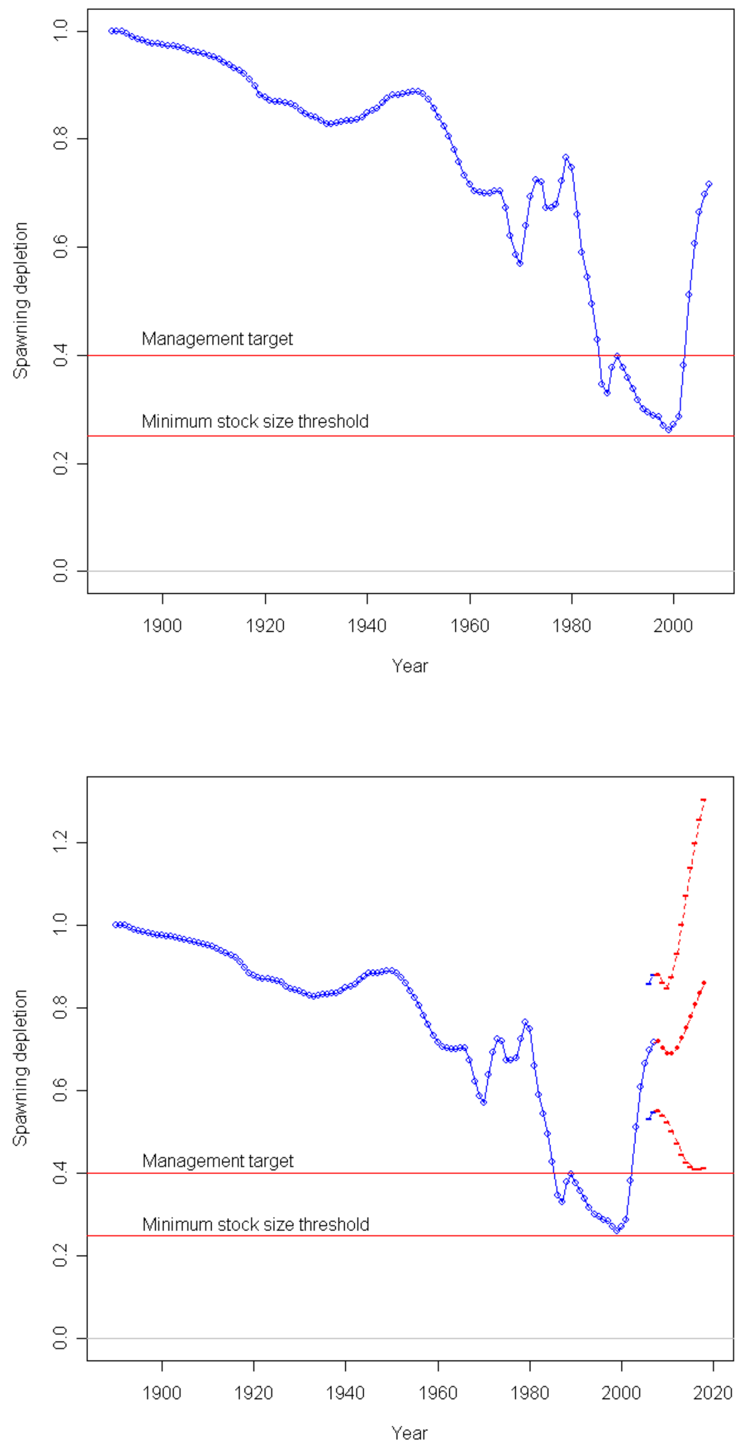
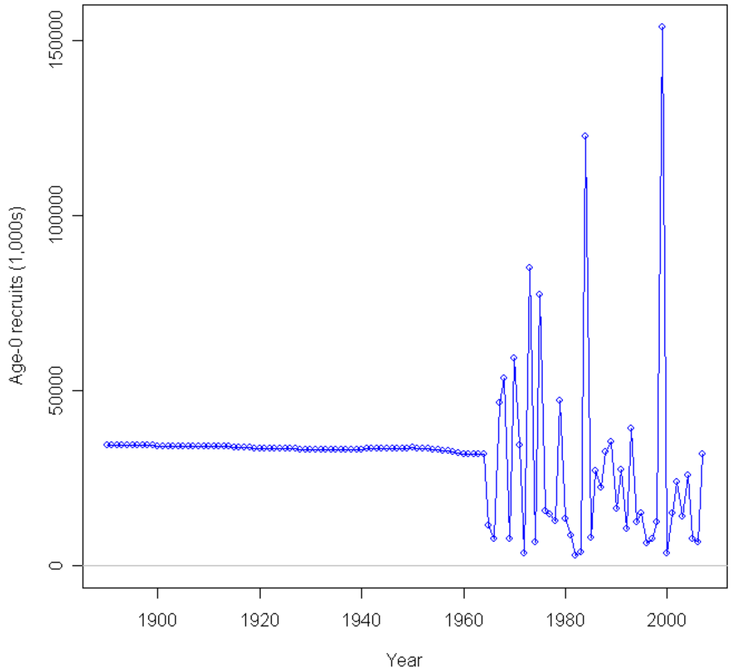


Figure 46-47: Base model output estimates of relative depletion (top) and projections of estimated depletion through 2018 with ~95% asymptotic confidence intervals (bottom).



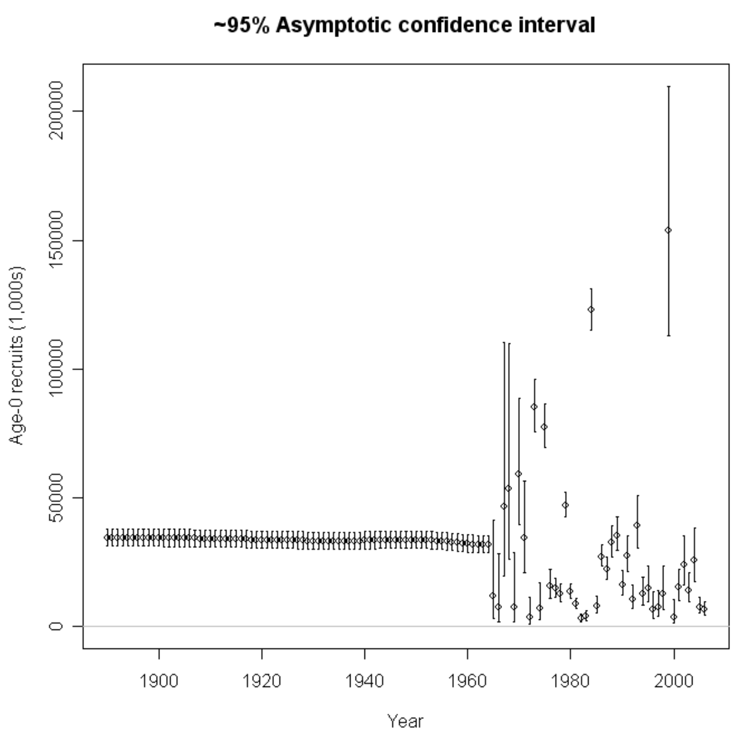
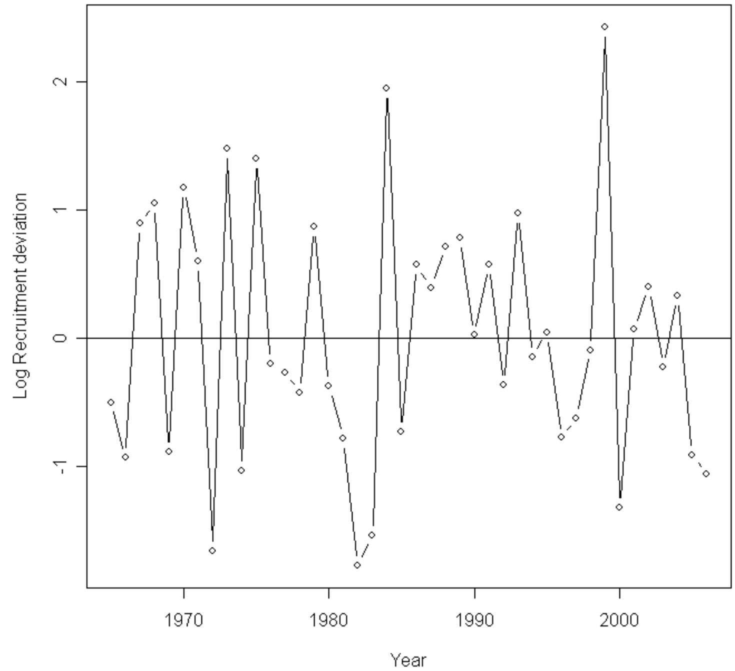


Figure 48-49: Model estimate recruitments (top) and observed recruitments with ~95% asymptotic confidence intervals (bottom).



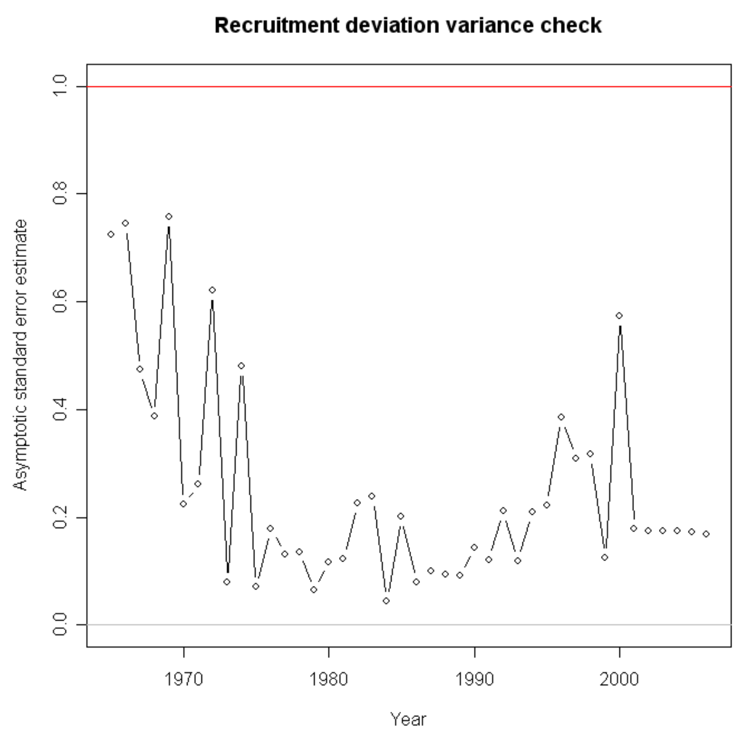
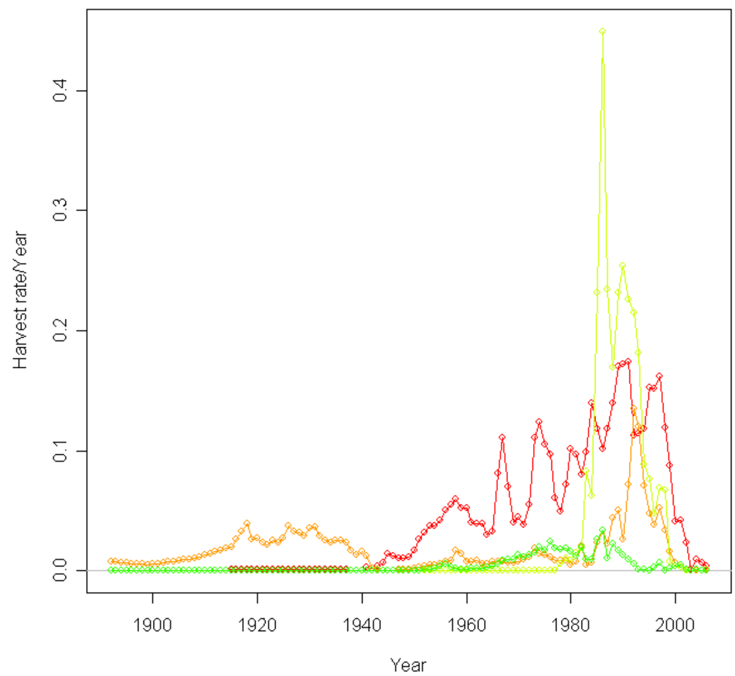


Figure 50-51: Model estimated recruitment deviation parameters (top) and recruitment deviance variance check (bottom).



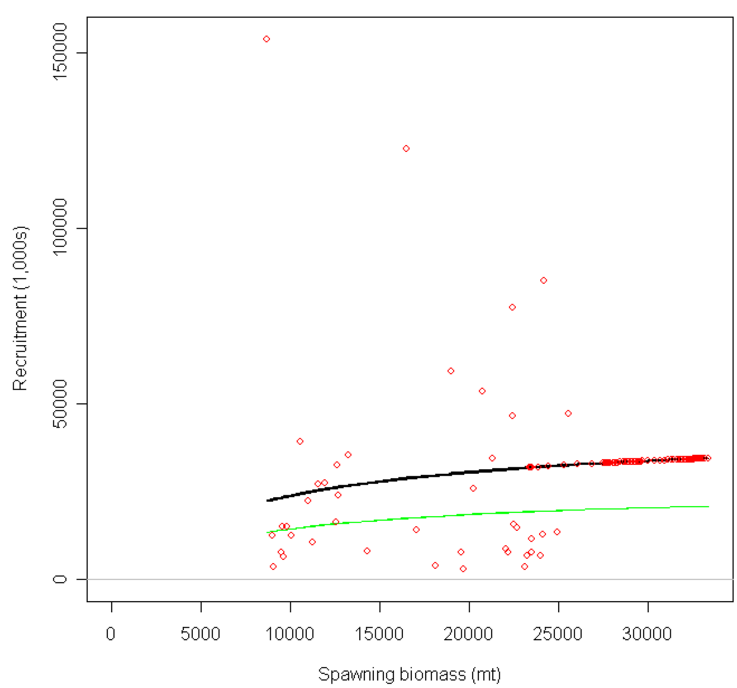
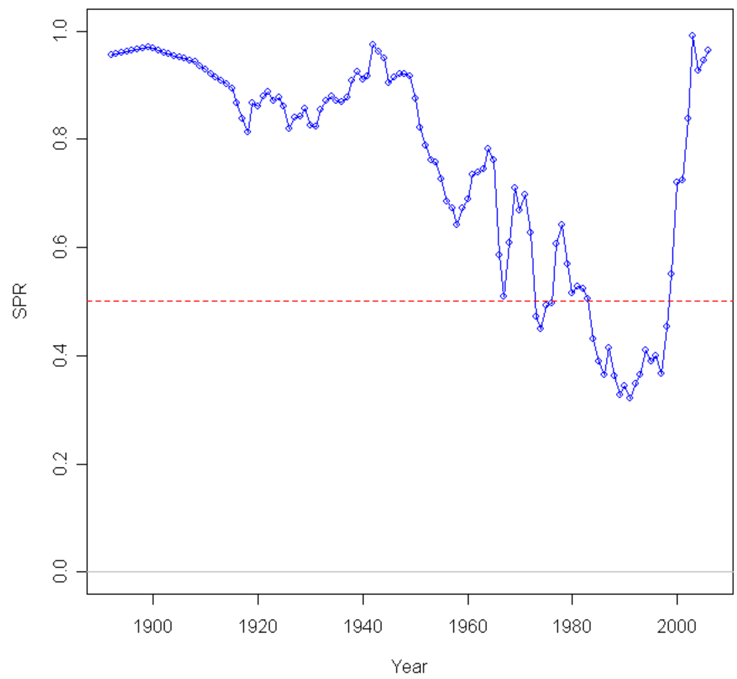


Figure 52-53: Harvest rates for each of the four fisheries (top) and model estimated spawner recruit relationship (bottom).



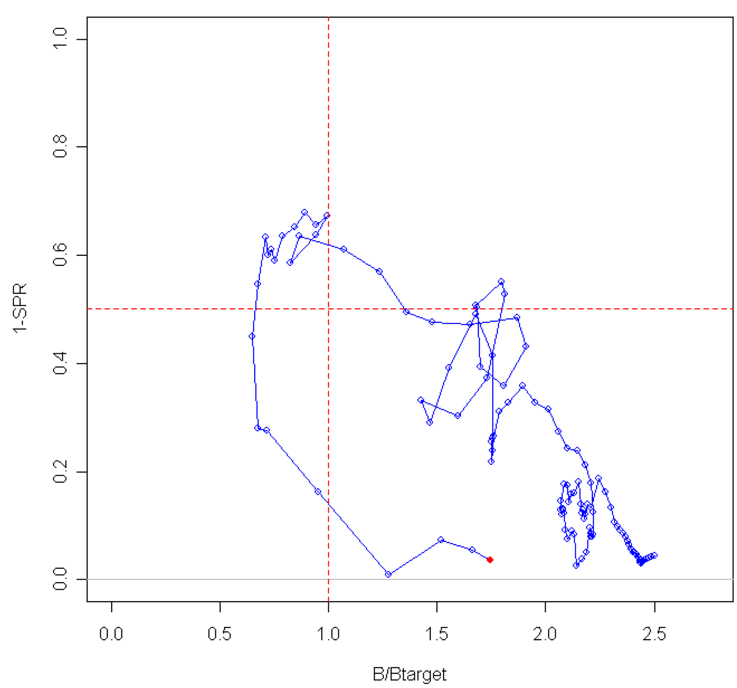
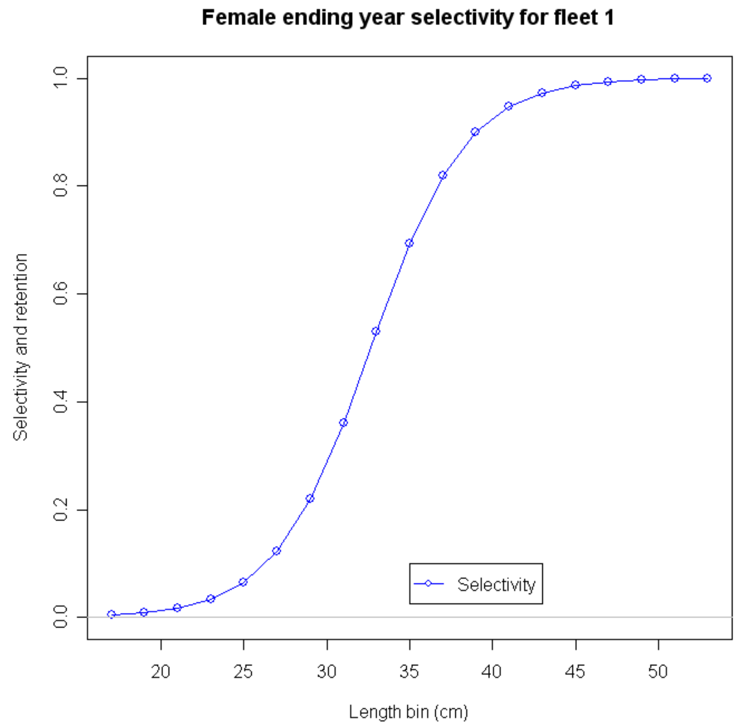


Figure 54-55: Base model output estimates of Spawning potential ratio (SPR) relative to the 50% level (top) and phase plot of the same information relative to SPR and SSB targets (bottom).



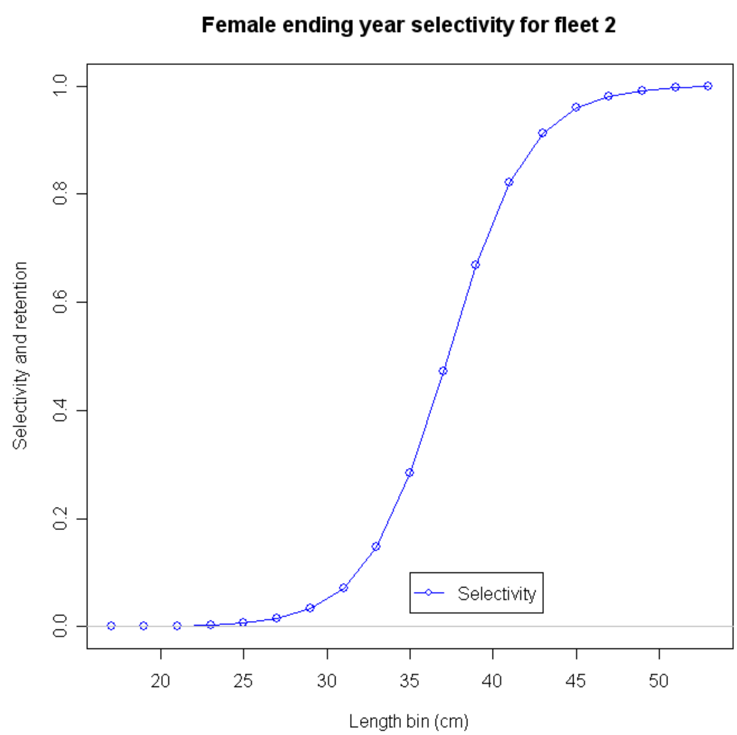
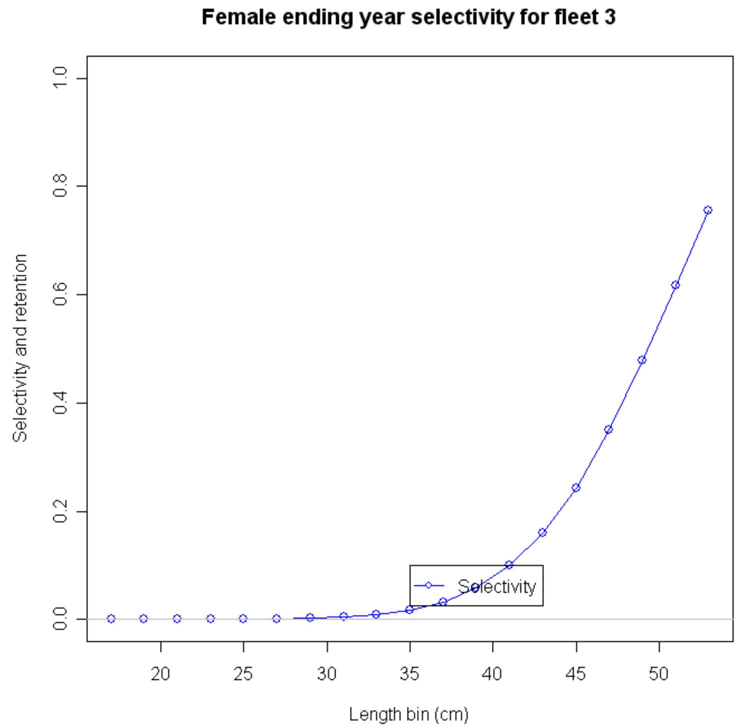


Figure 56-57: Selectivity curves (double-normal form) for trawl (top) and hook and line (bottom) fisheries.



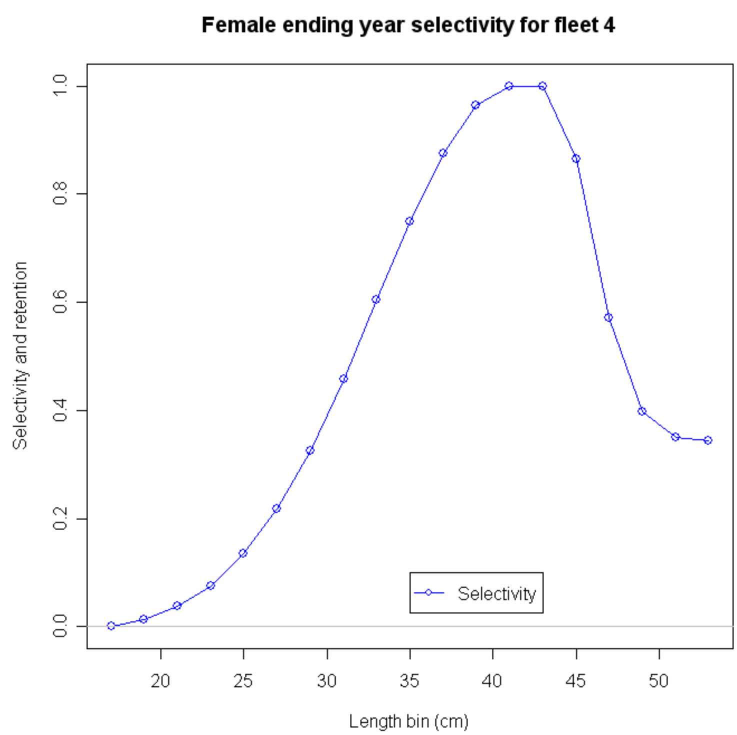
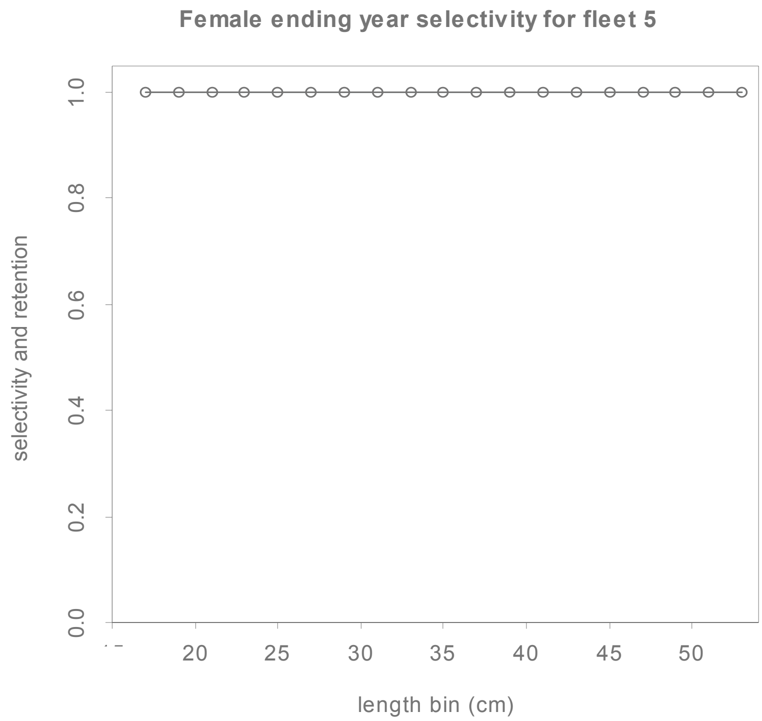


Figure 58-59: Selectivity curves (double-normal form) for setnet (top) and recreational (bottom) fisheries.



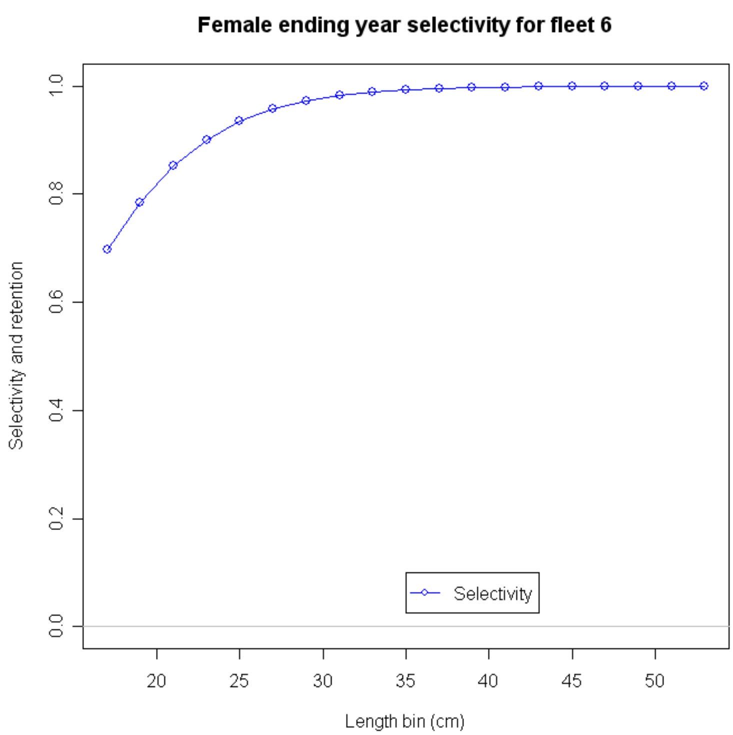
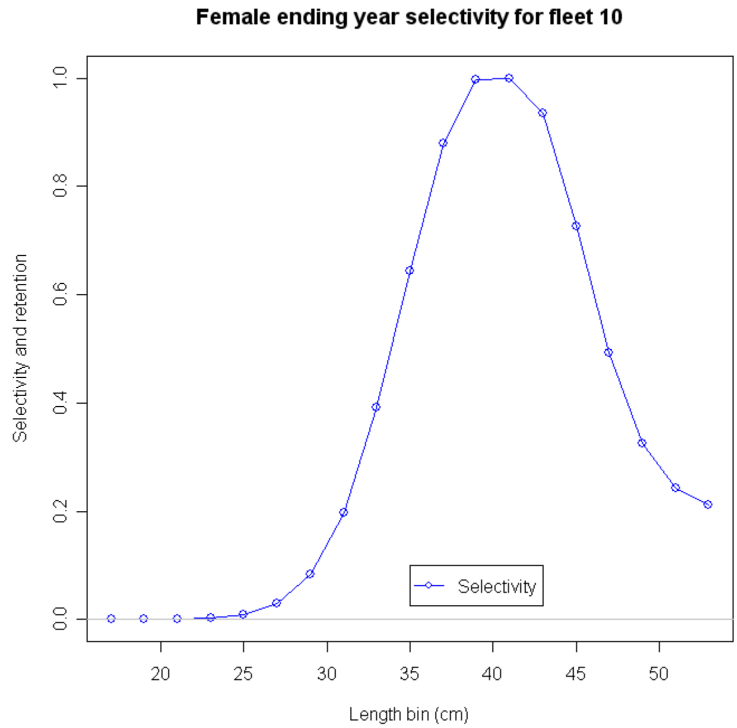


Figure 60-61: Selectivity curves (logistic form) for triennial bottom trawl survey (top) and NWC combined survey (bottom).



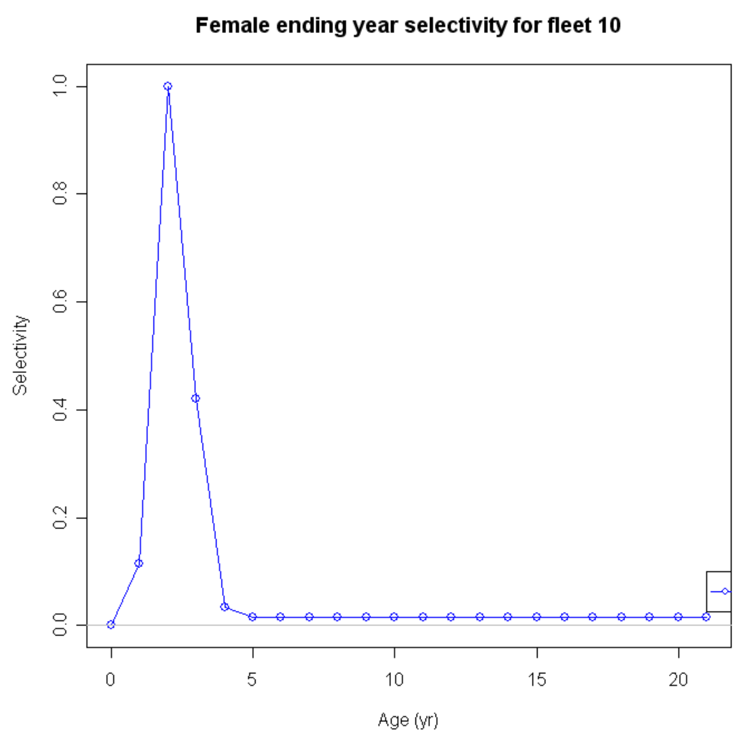
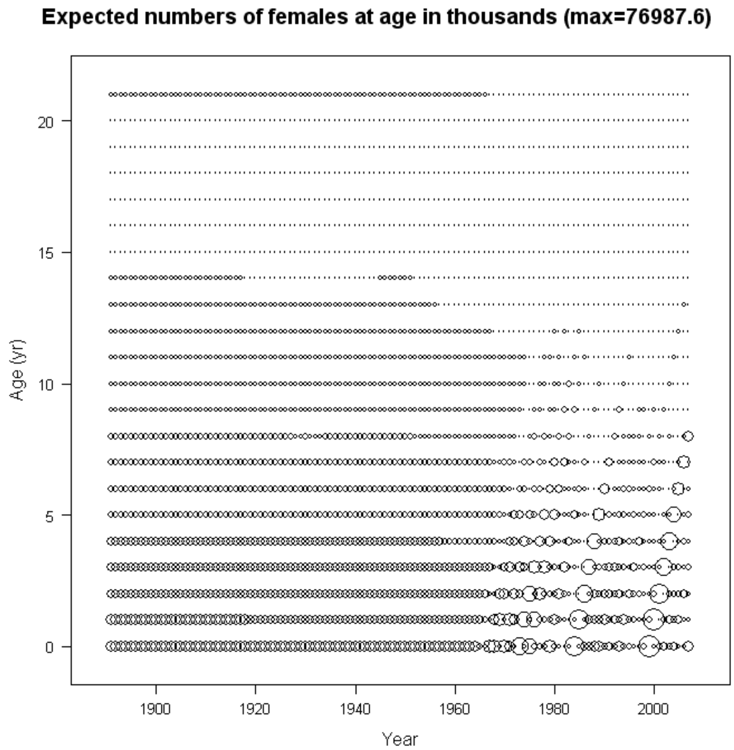


Figure 62-63: Selectivity curves (logistic form) for triennial bottom trawl survey (top) and NWC combined survey (bottom).



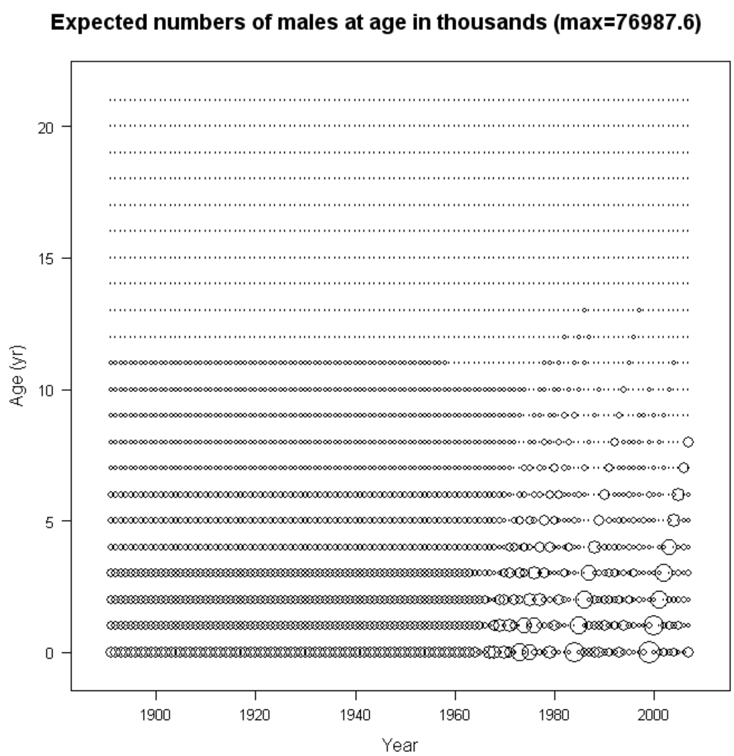
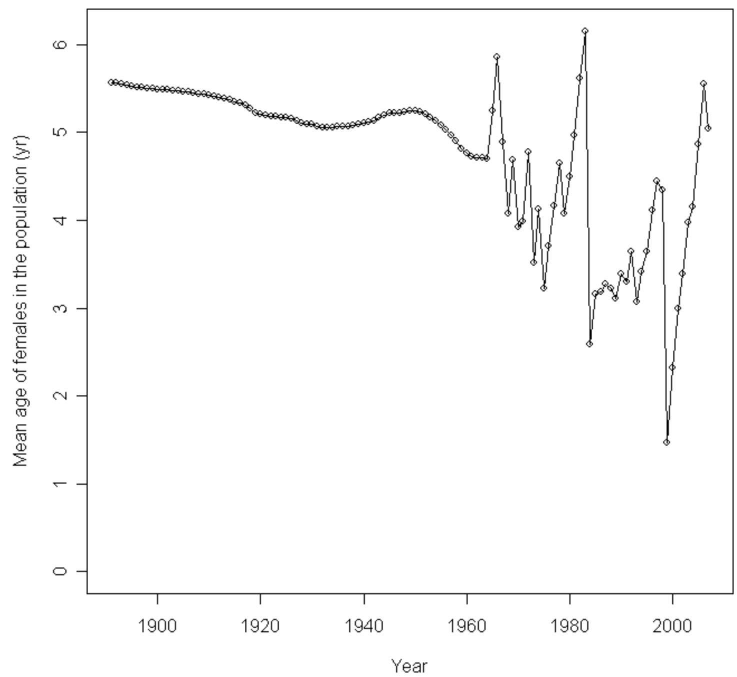


Figure 64-65: Model estimated numbers at age over time for females (top) and males (bottom).



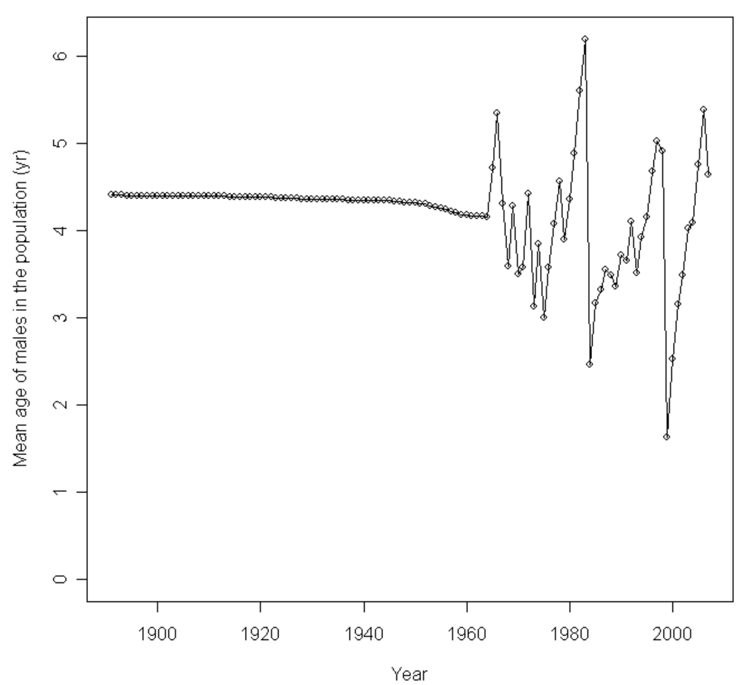


Figure 66-67: Mean age of females (top) and males (bottom) in the population over time.

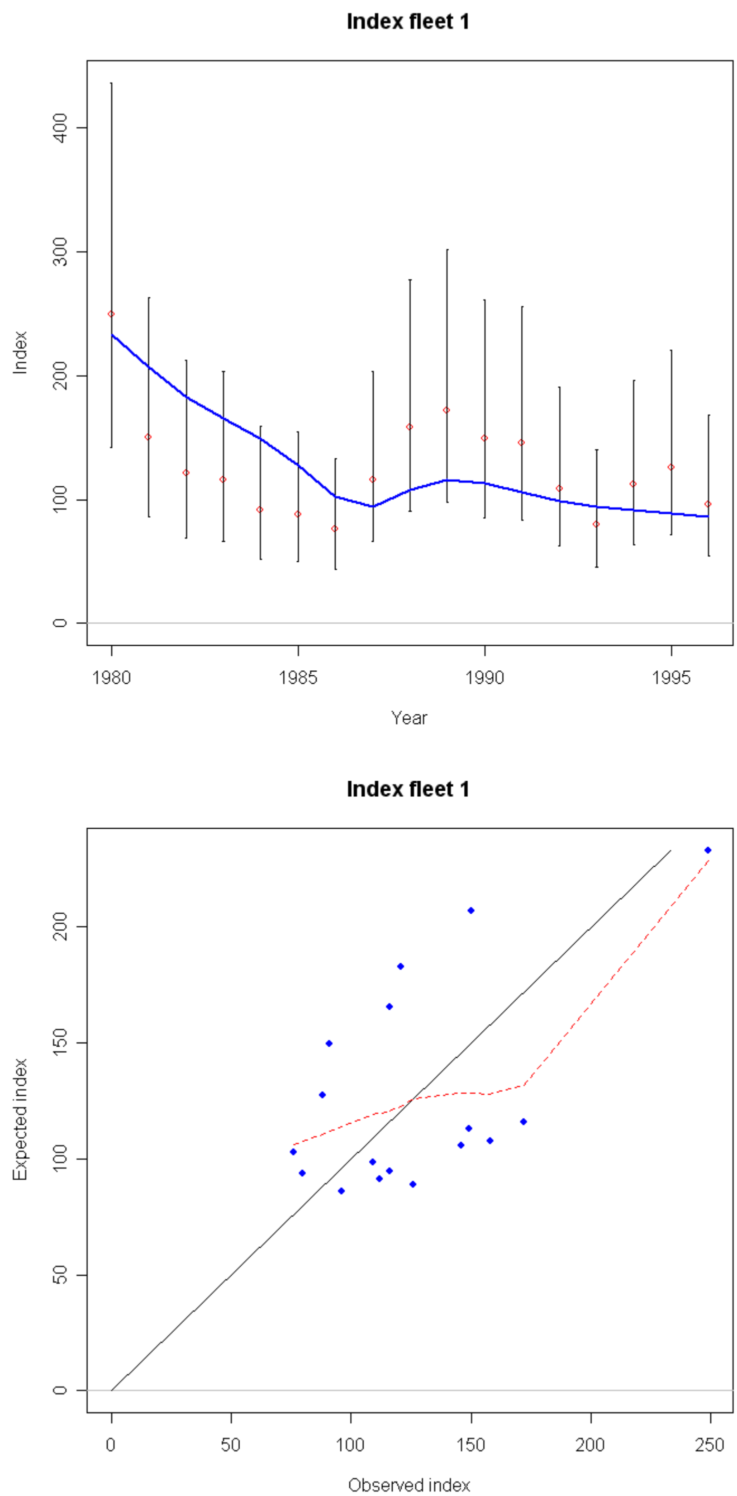


Figure 68-69: Fits to the trawl CPUE time series

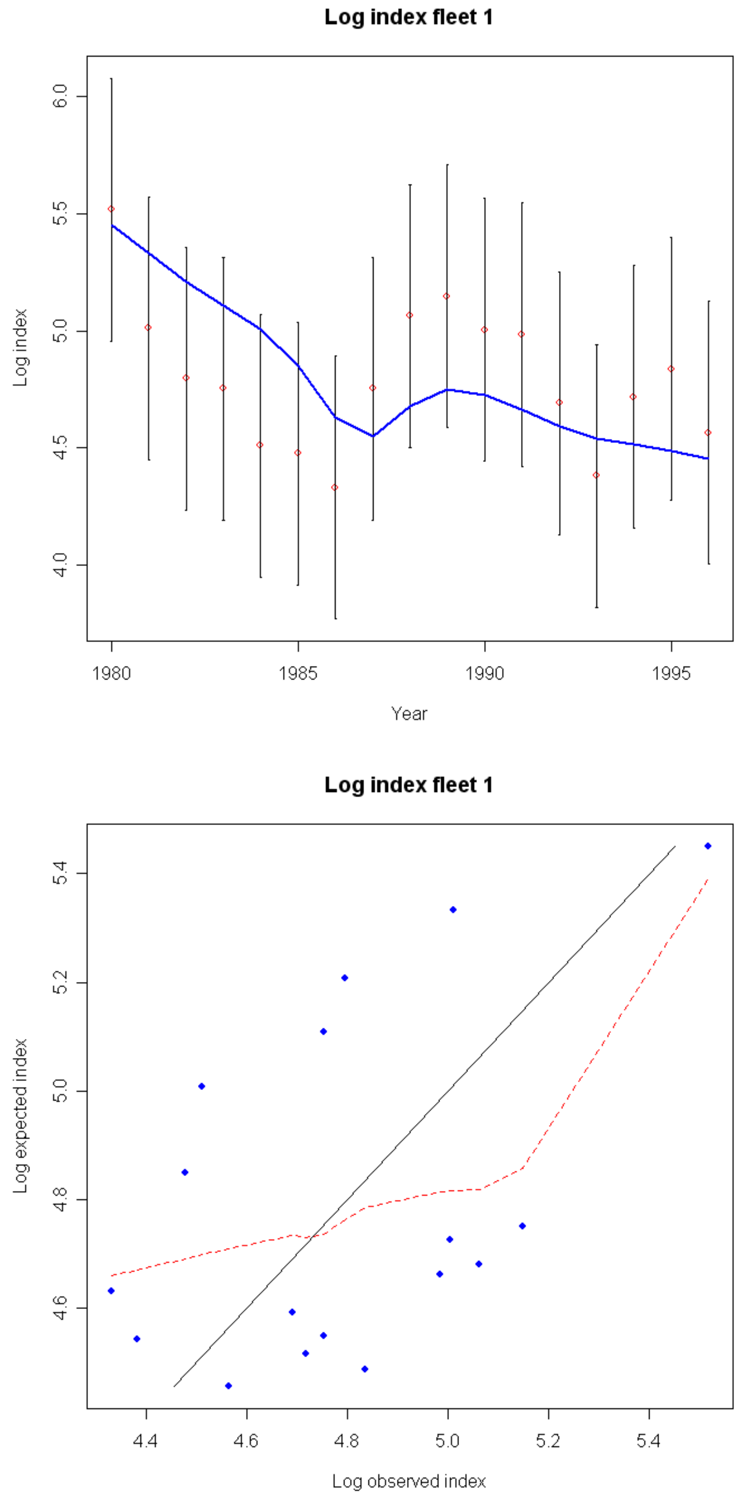


Figure 70-71: Fits to the trawl CPUE time series in log space

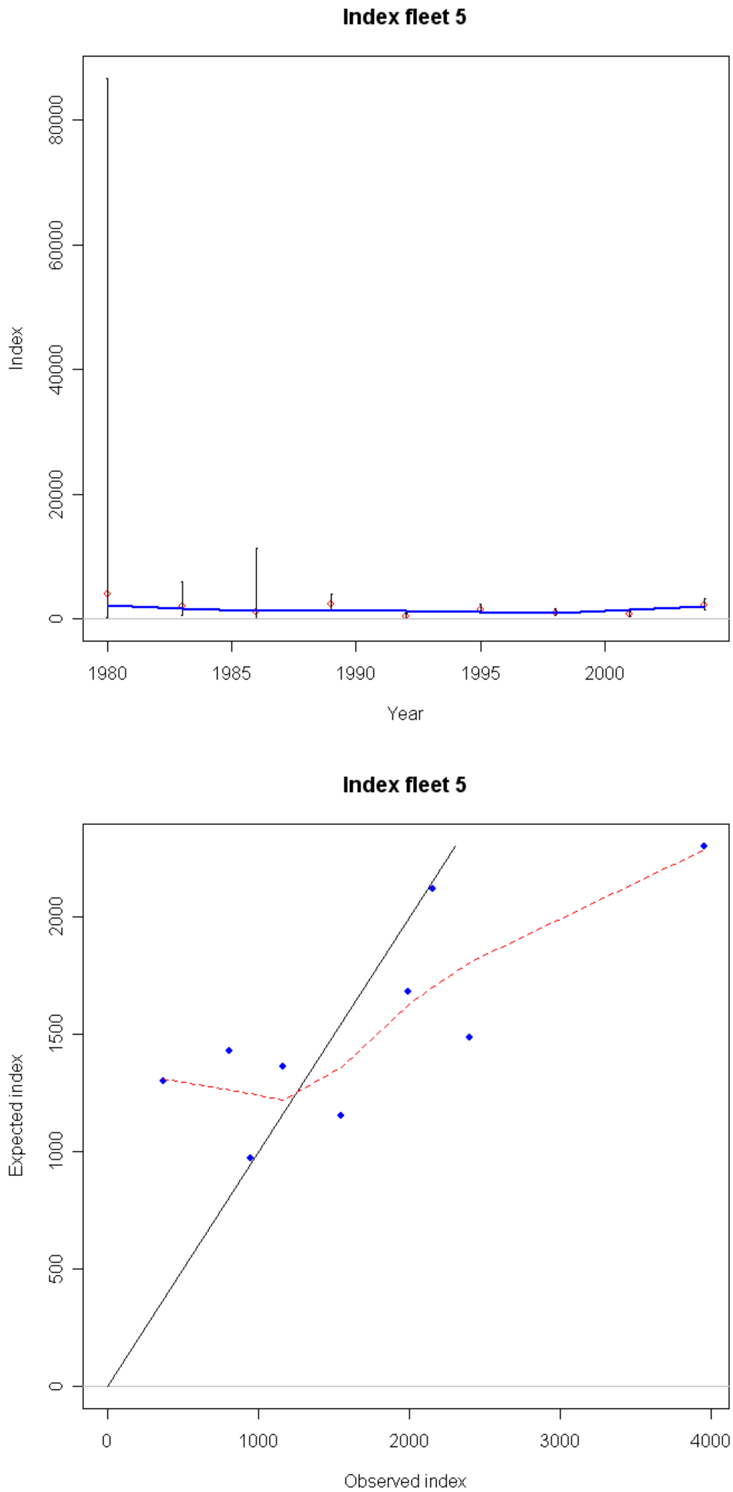


Figure 72-73: Fits to the triennial survey core area swept index.

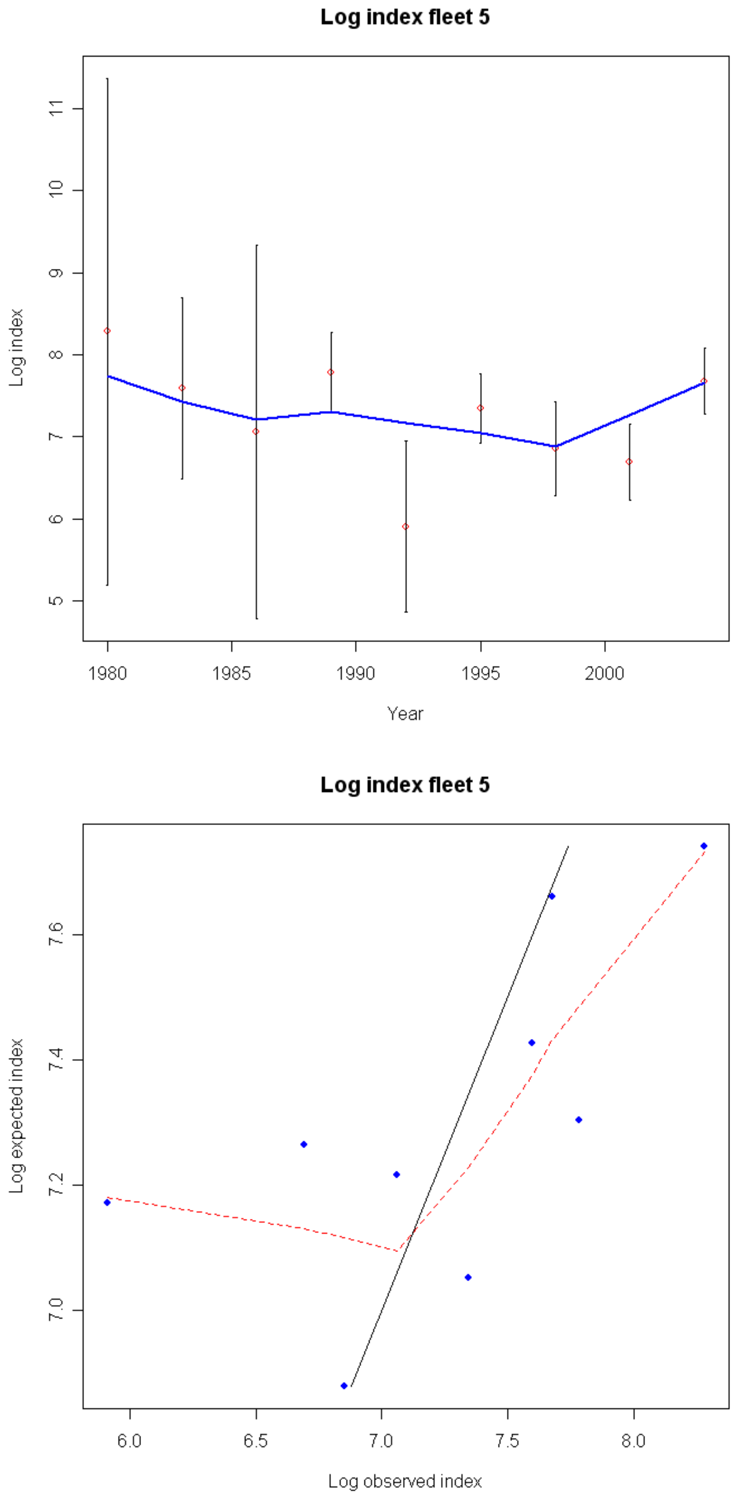
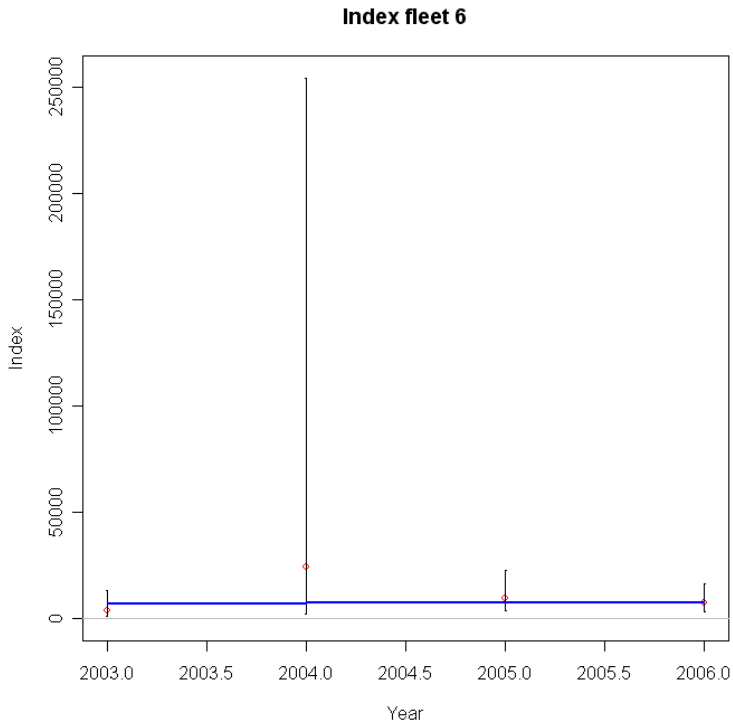


Figure 74-75: Fits to the triennial survey core area swept index in log space.



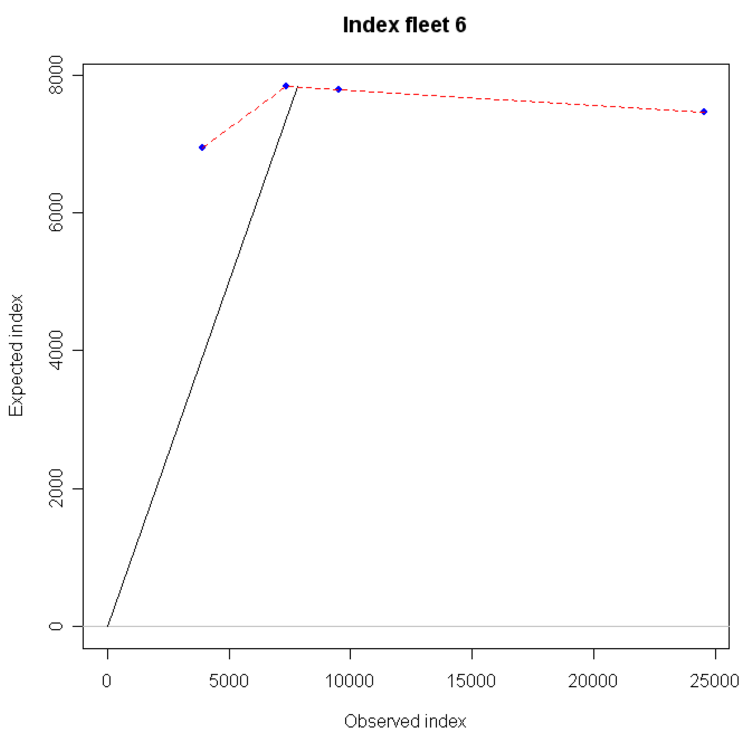


Figure 76-77: Fits to the NWC Combined survey.

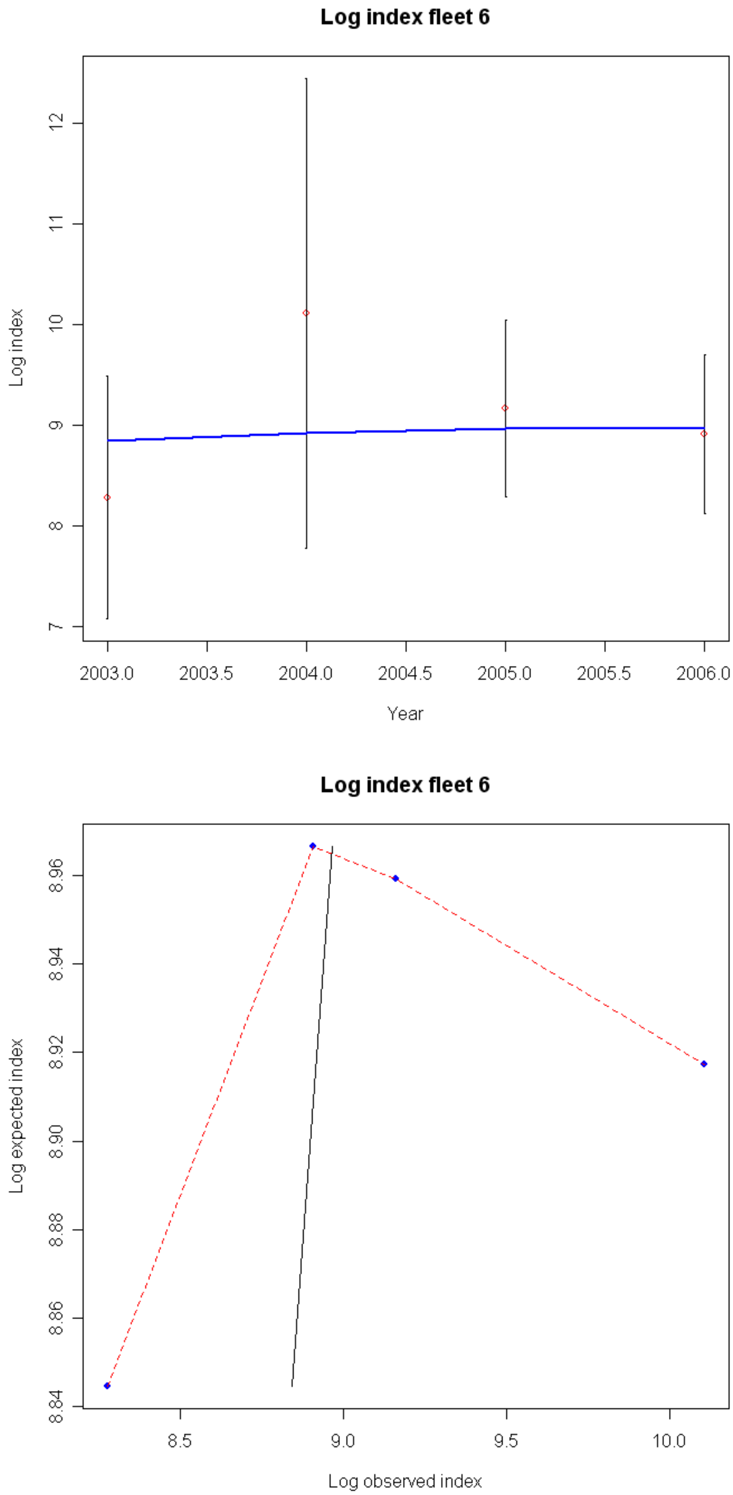


Figure 78-79: Fits to the NWC Combined survey in log space.

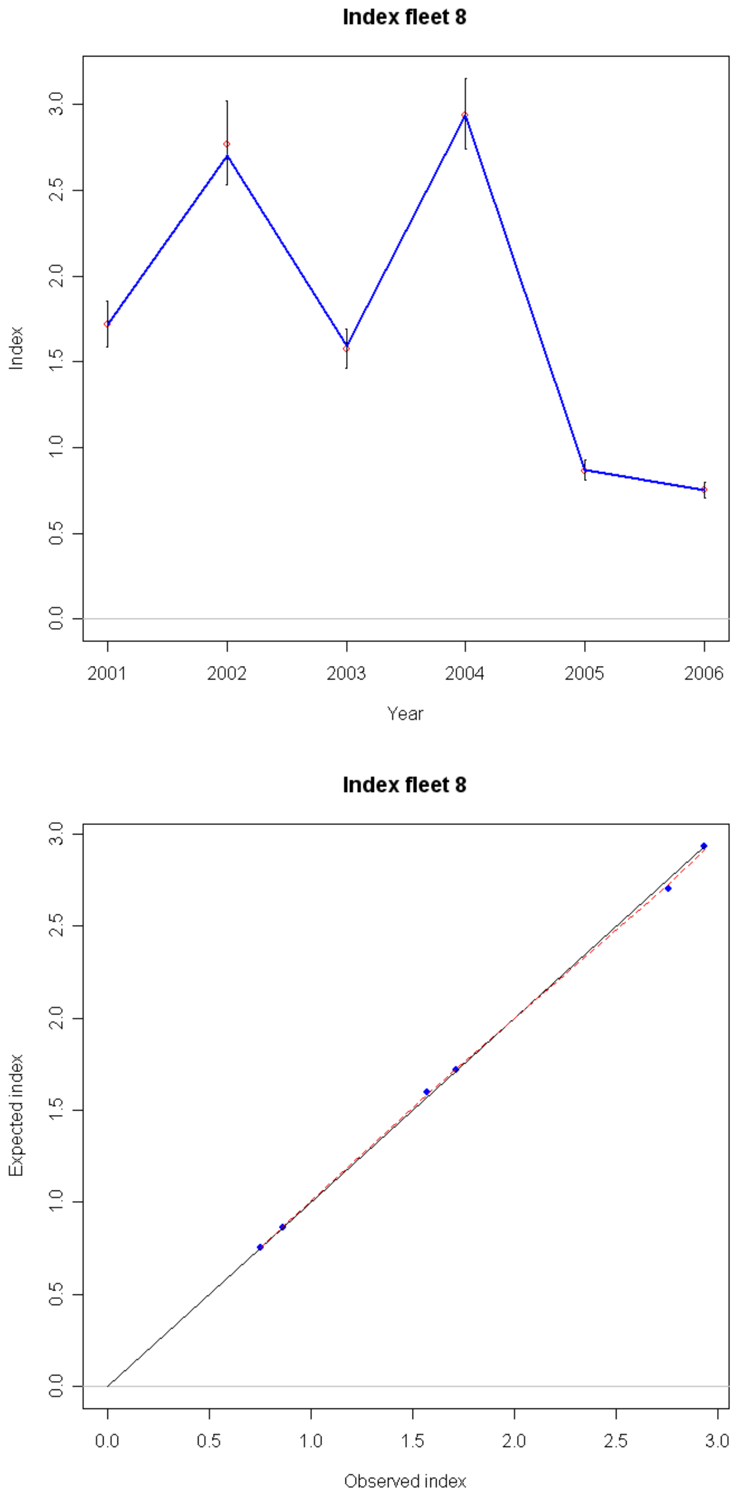


Figure 80-81: Fits to the Coastwide juvenile survey.

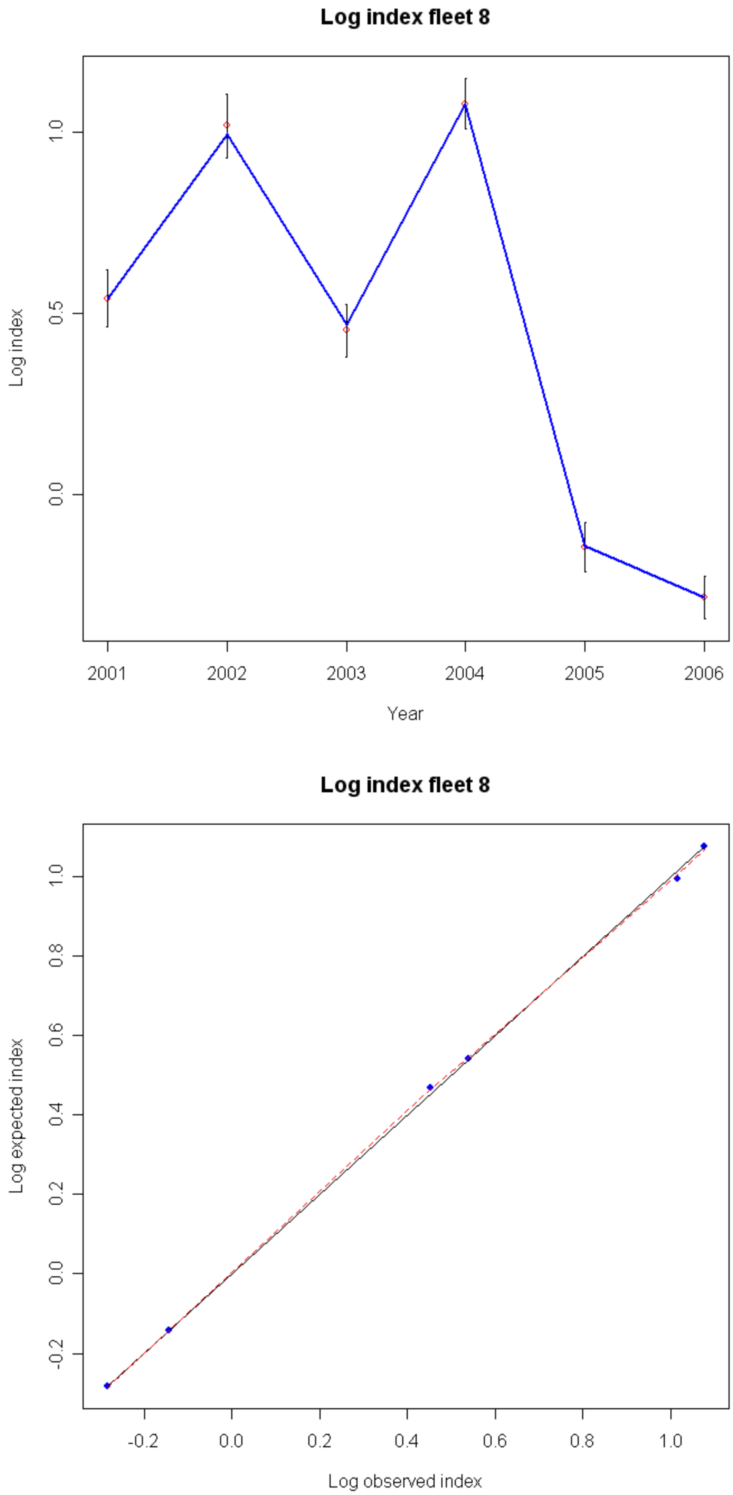
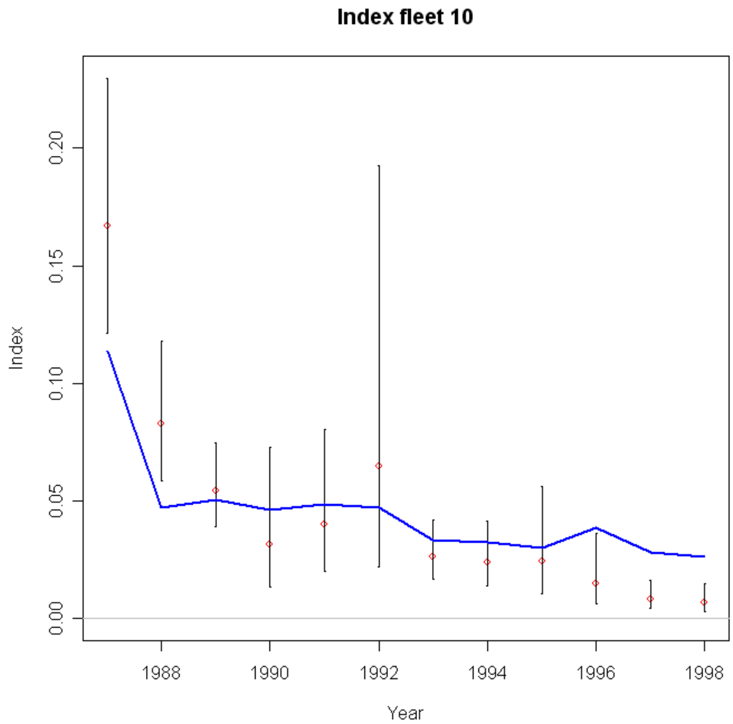


Figure 82-83: Fits to the Coastwide juvenile survey in log space.



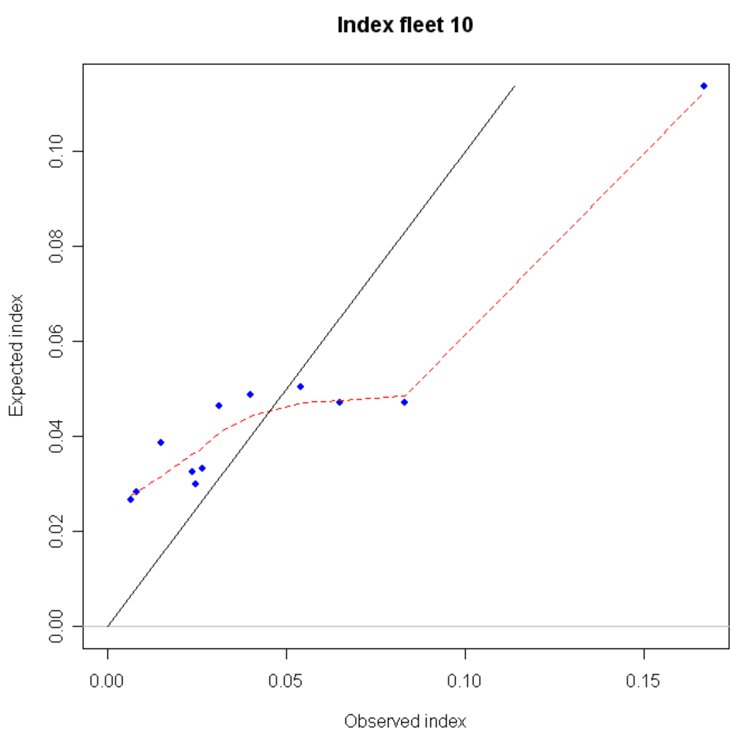
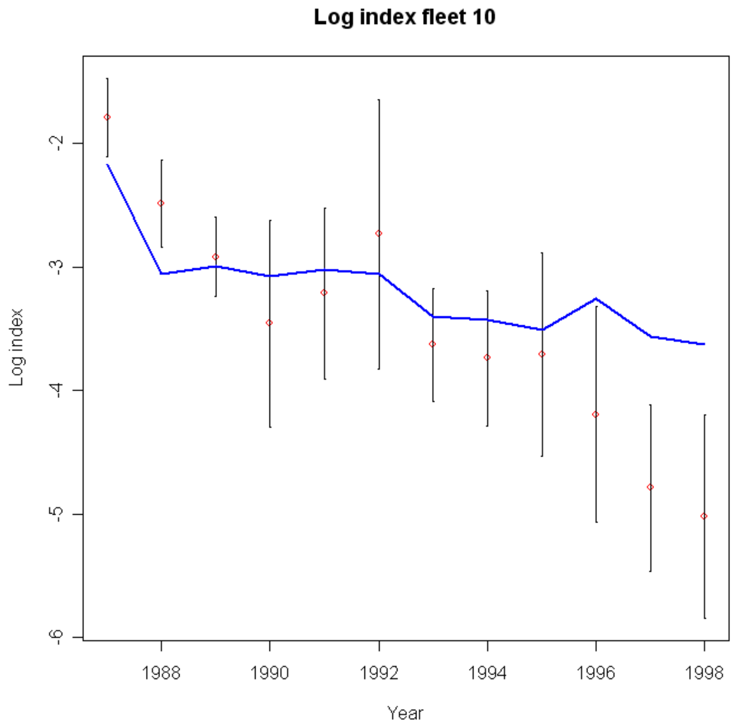


Figure 84-85: Fits to the Recreational CPUE index.



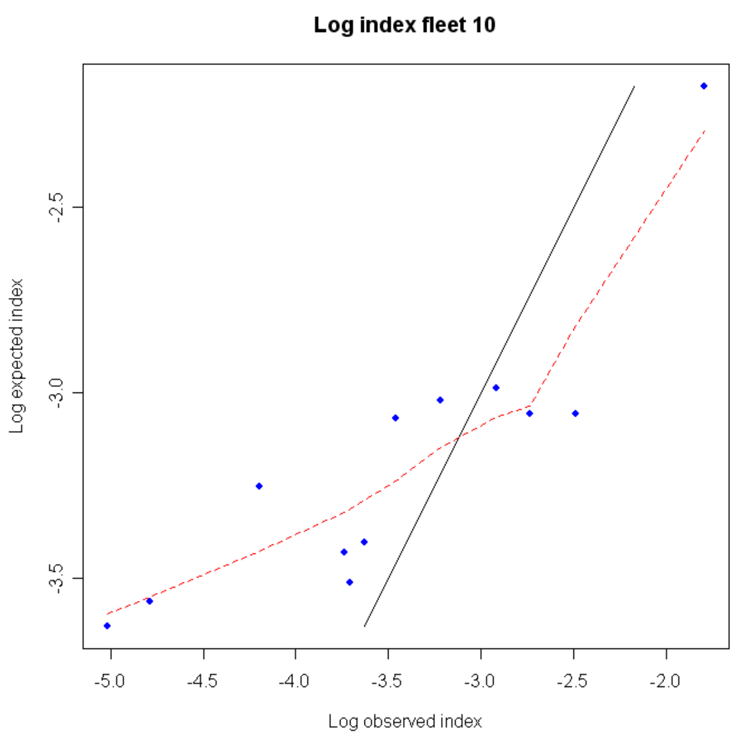
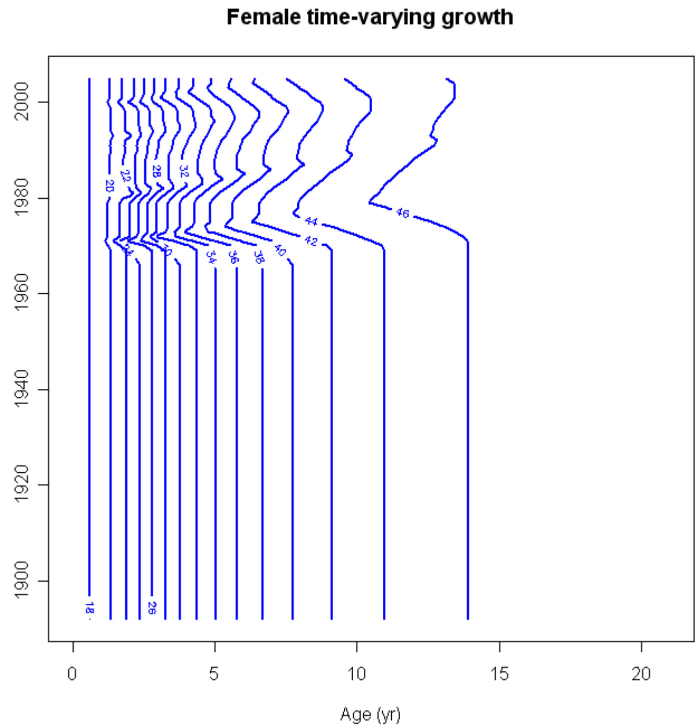
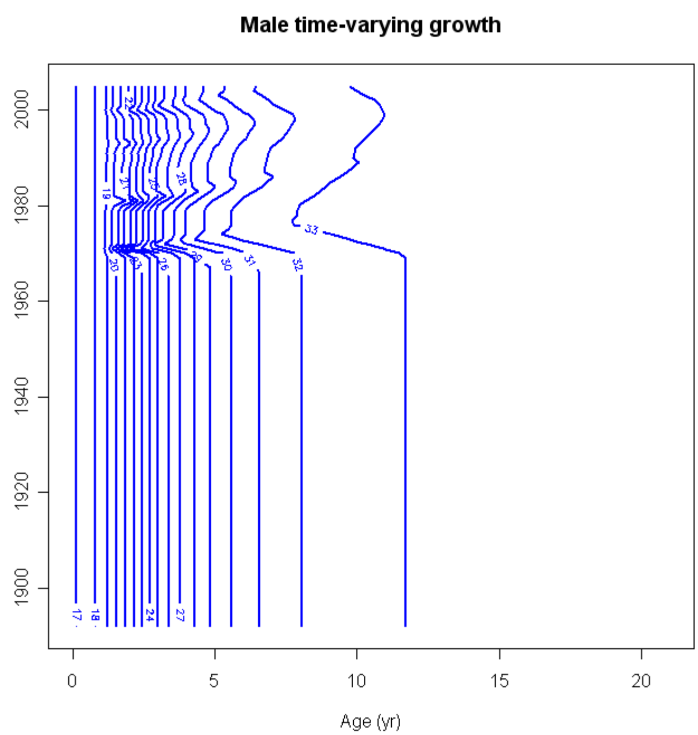


Figure 86-87: Fits to the recreational CPUE index in log space.





Figures 88-89: Size at age contours for female (top) and male (bottom) chilipepper rockfish over time under time-varying growth assumptions.

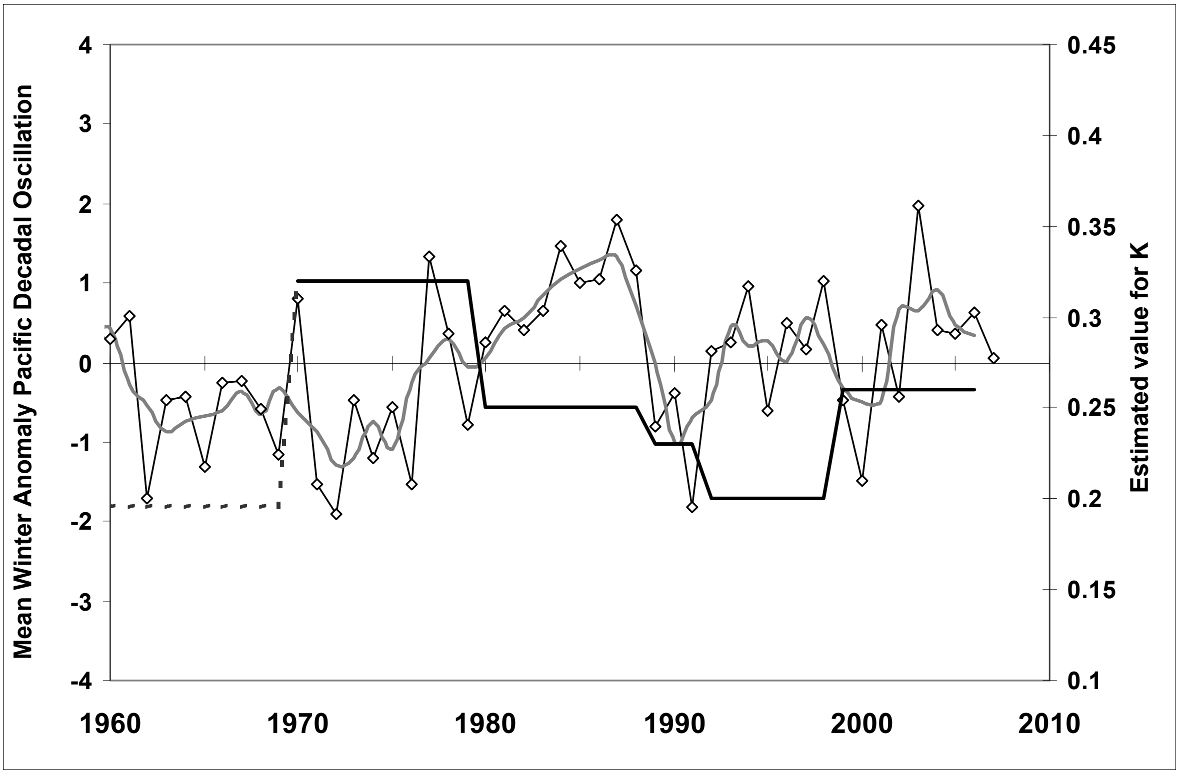


Figure 90: Estimates of time-varying growth coefficient (K), with mean annual winter PDO and a running three year mean of the winter PDO.

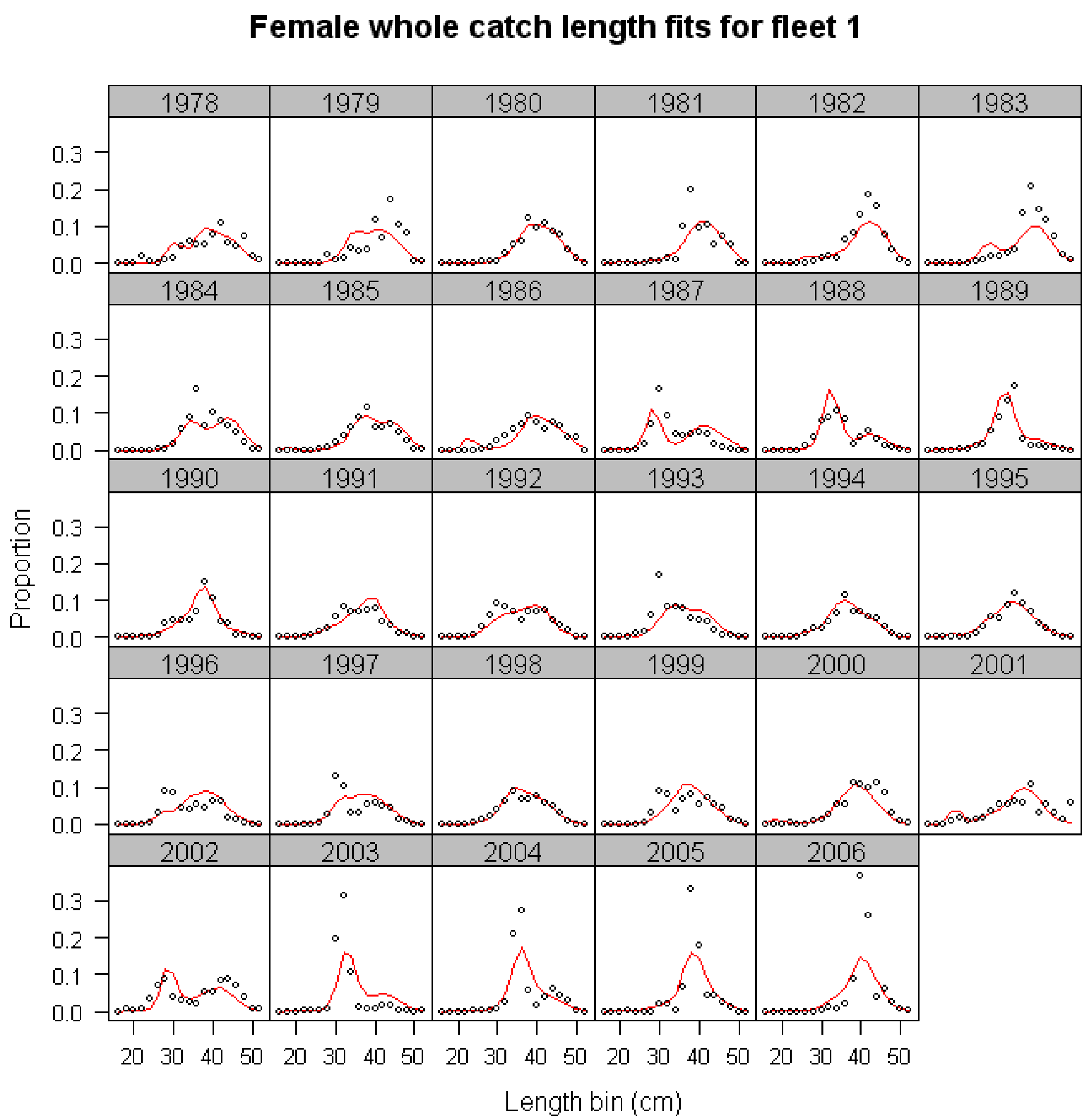


Figure 91: Observed and predicted catch at length for female chilipepper in the trawl fishery.

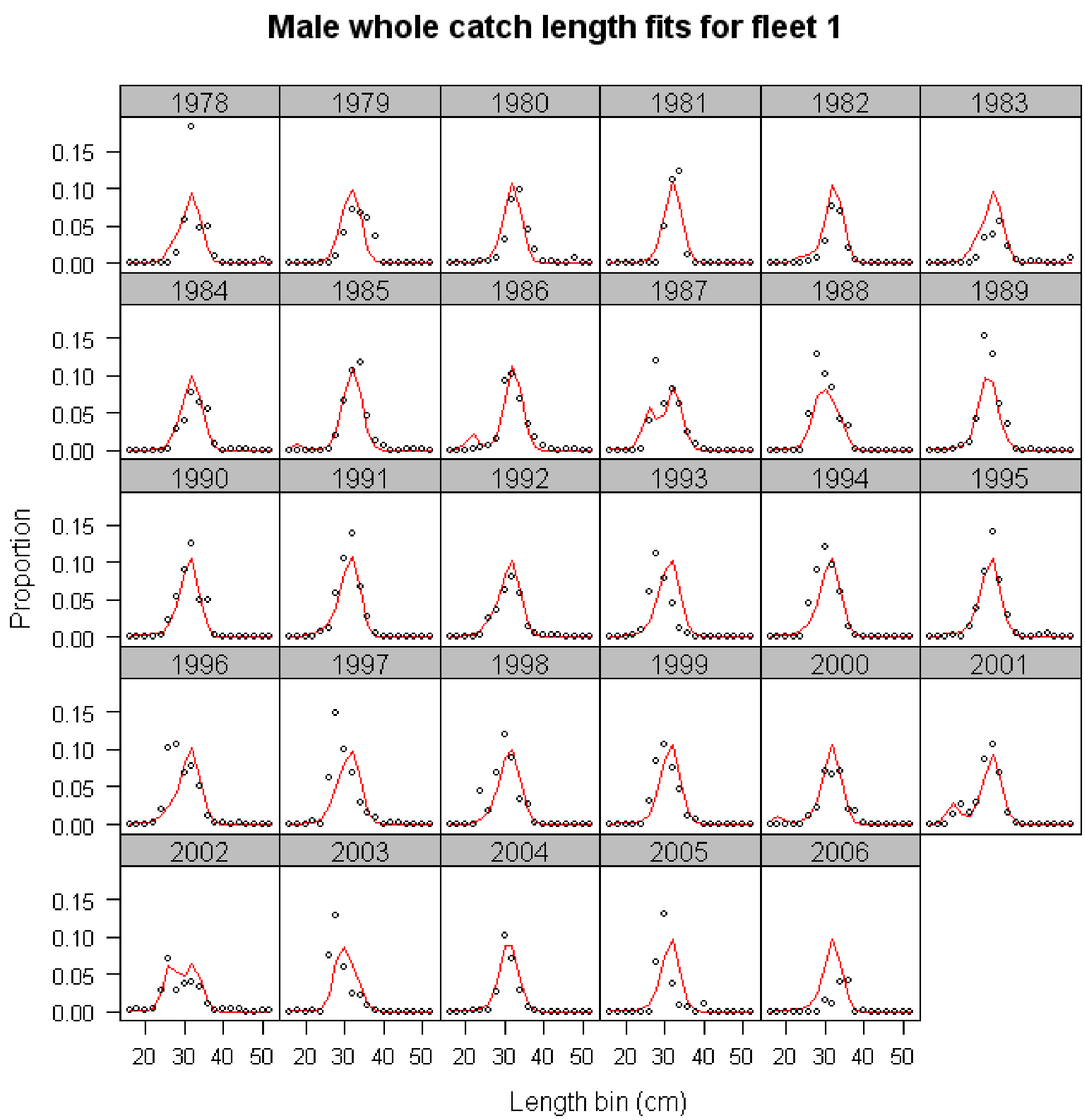
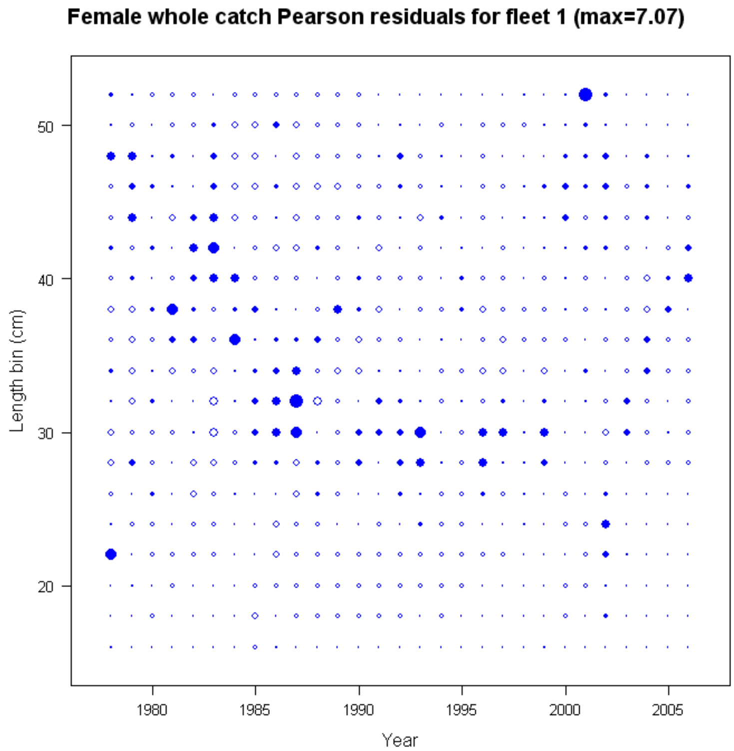


Figure 92: Observed and predicted catch at length for male chilipepper in the trawl fishery.



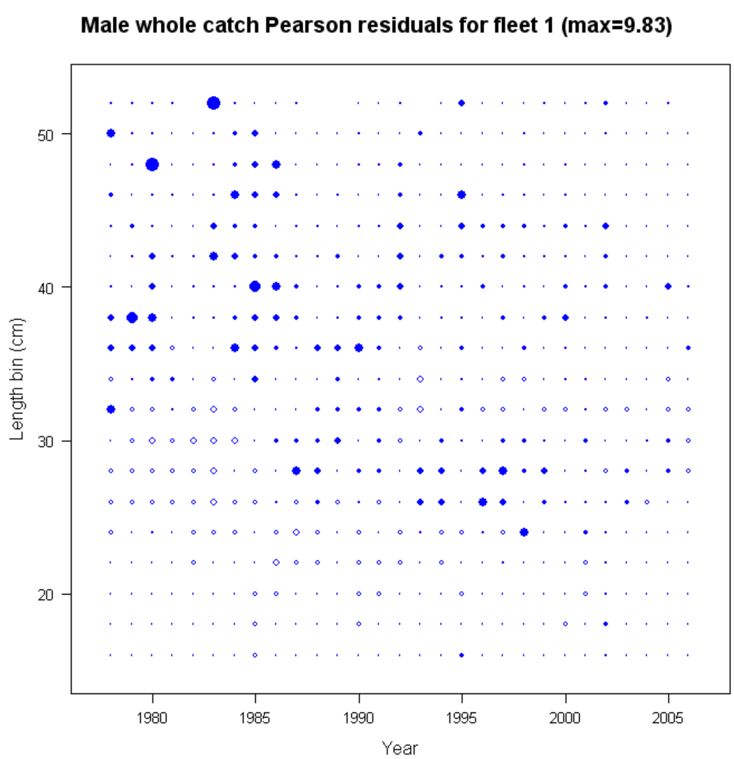
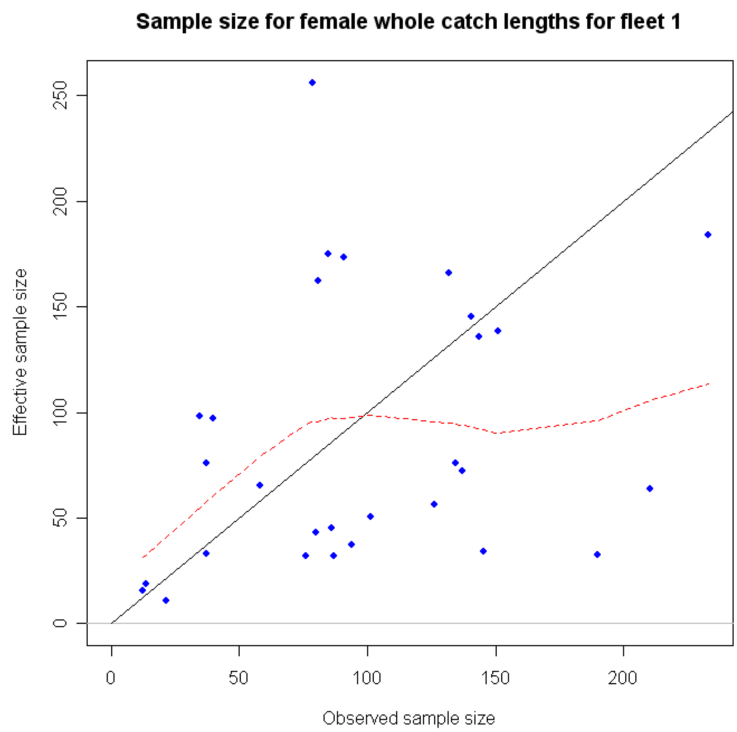


Figure 93-94: Residuals to the length composition data in the trawl fishery



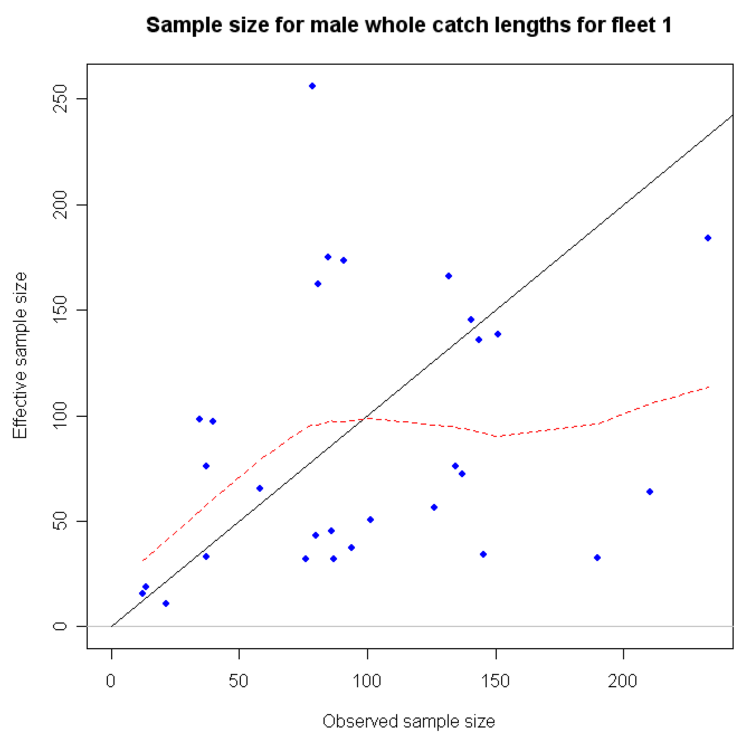


Figure 95-96: Observed and effective sample sizes for length composition data from the bottom trawl fishery.

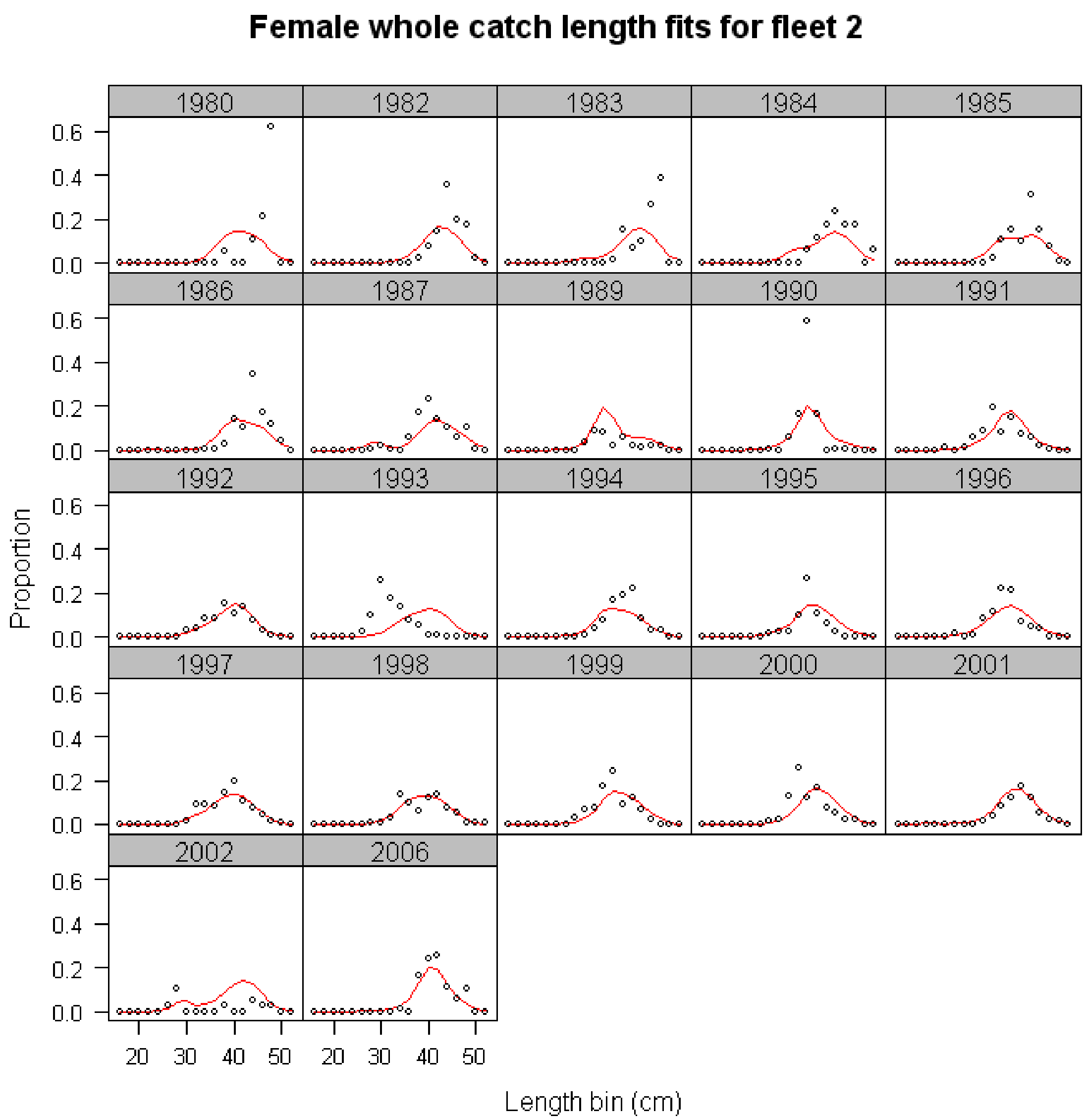


Figure 97-98: Observed and predicted length composition data for females in the hook and line fishery.

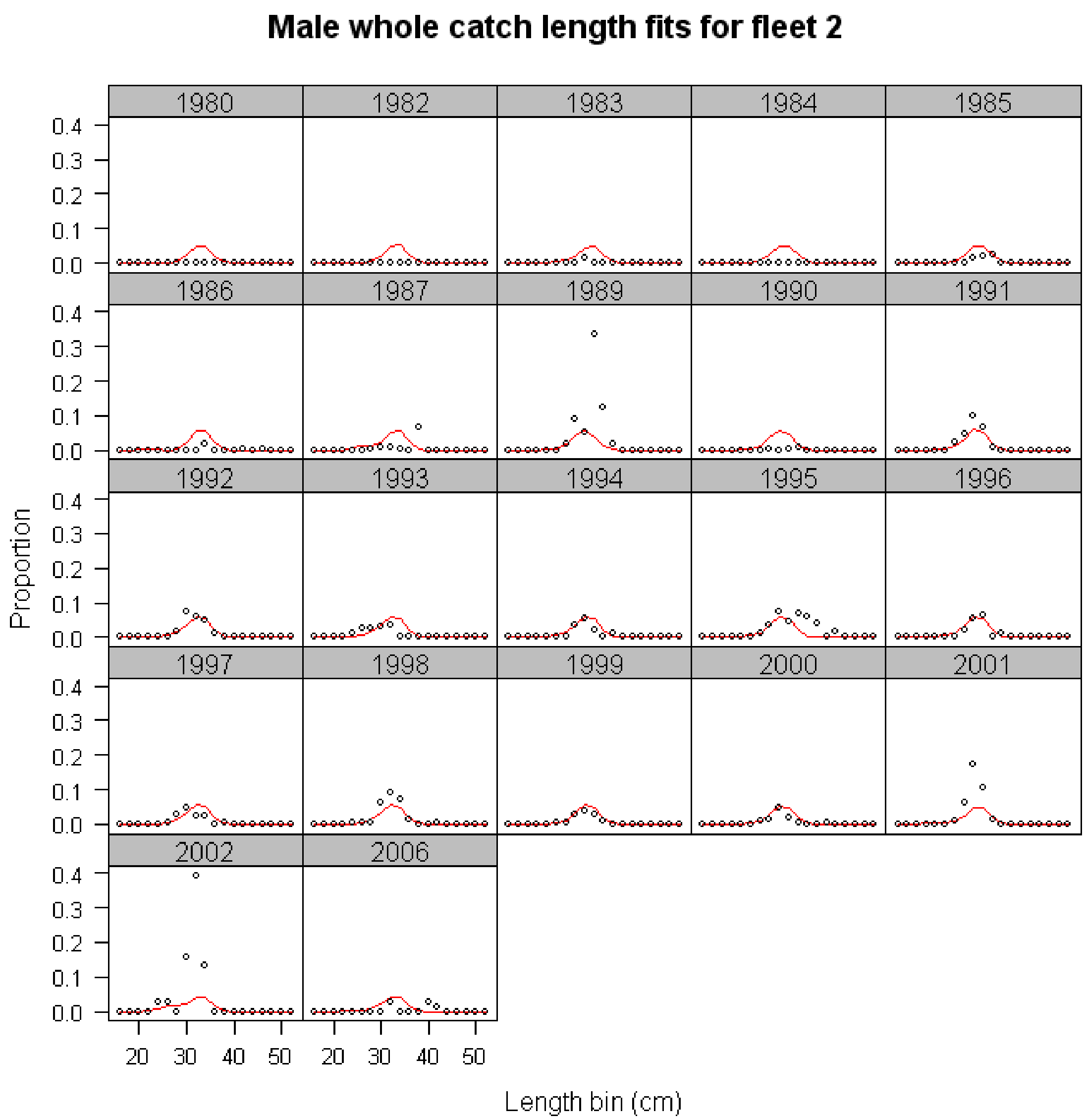


Figure 99: Observed and predicted length composition data for males in the hook and line fishery.

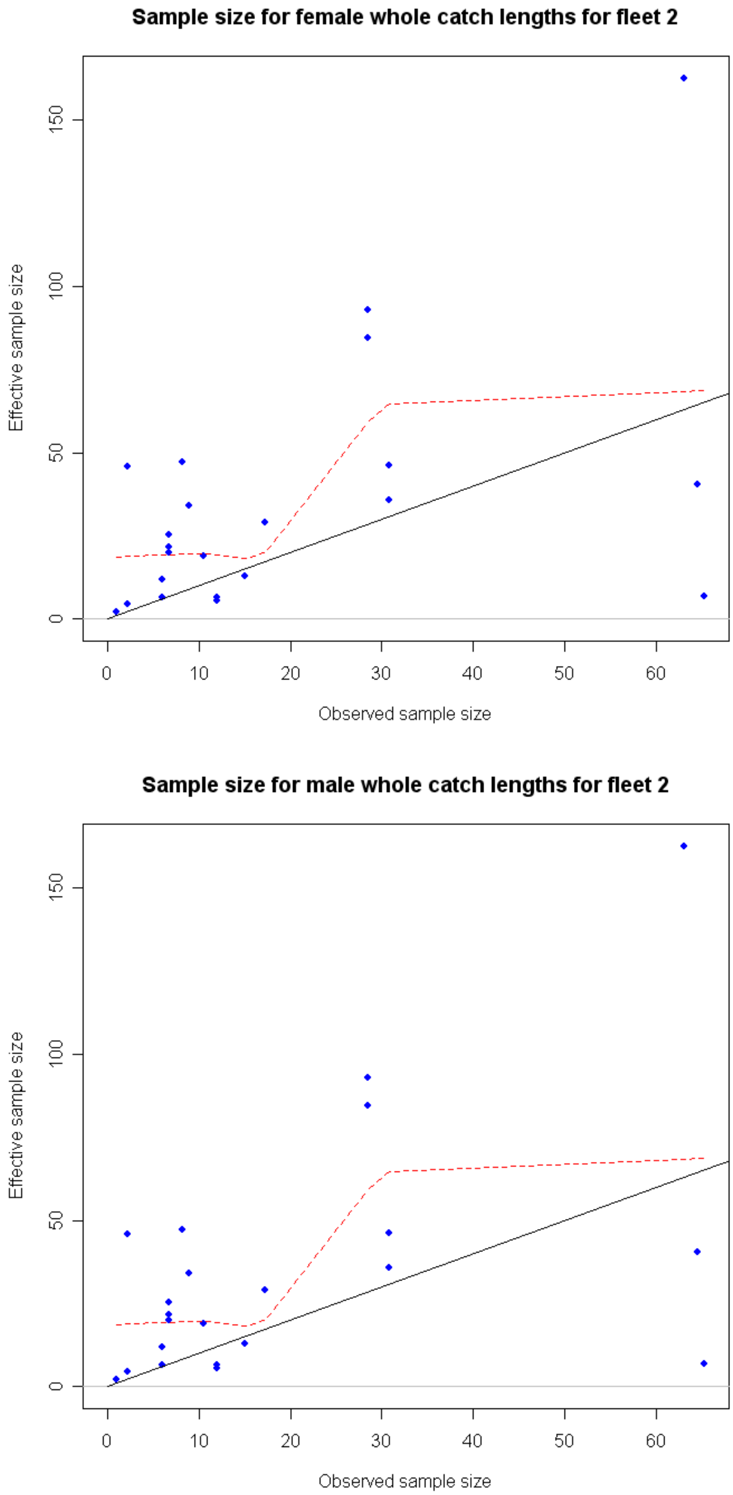
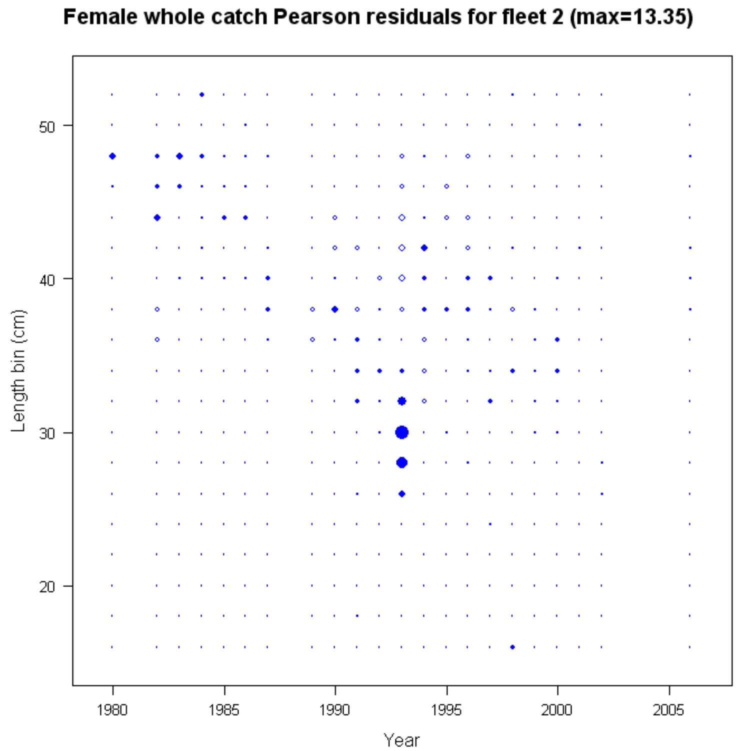


Figure 100-101: Observed and effective sample sizes for length composition data from the hook and line fishery.



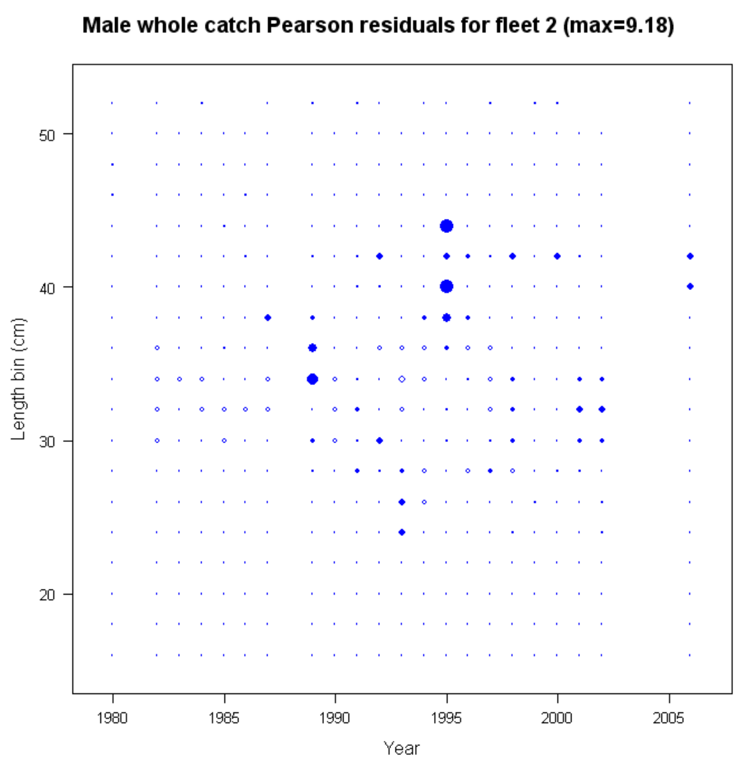
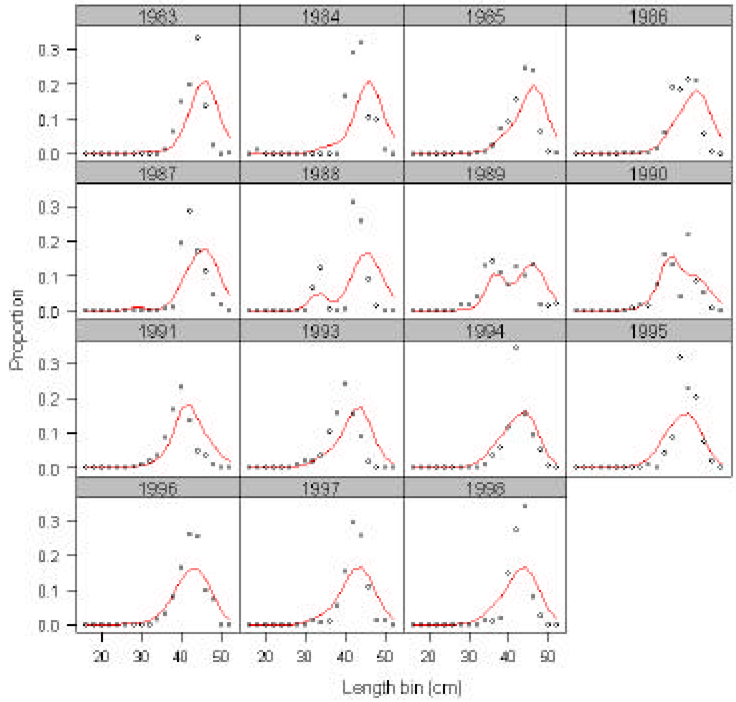


Figure 102-103: Residuals to the length composition data in the hook and line fishery

Female whole catch length fits for fleet 3



Male whole catch length fits for fleet 3

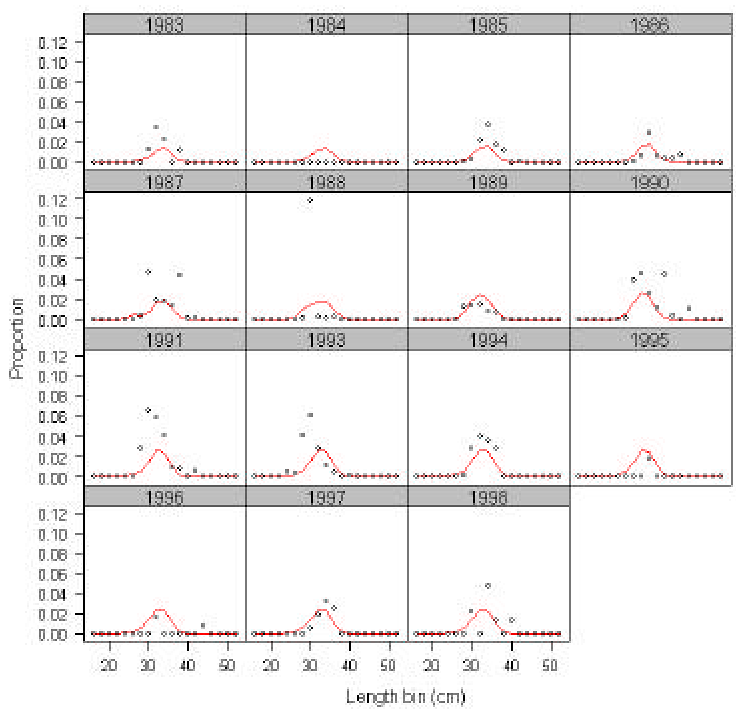
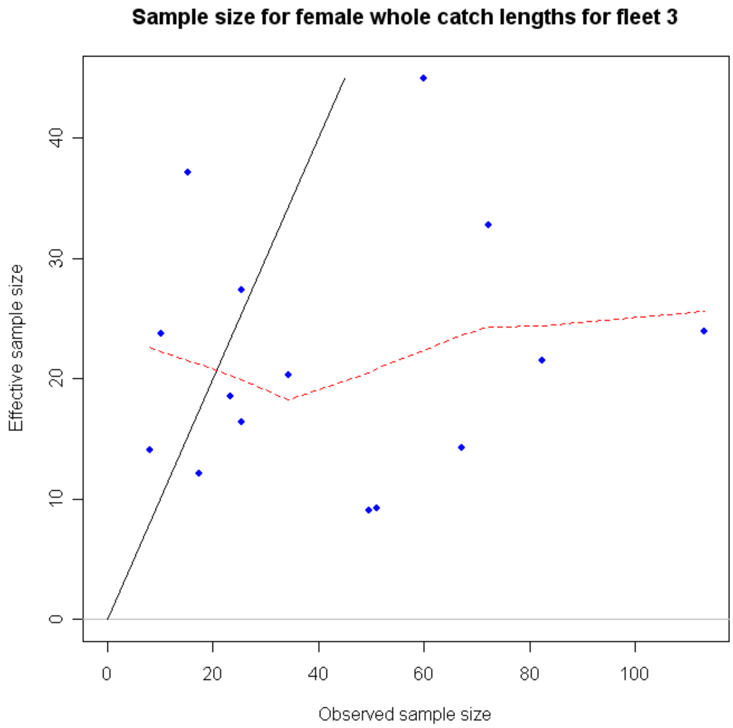


Figure 104-105: Observed and predicted length composition data for females (top) and males (bottom) in the setnet fishery.



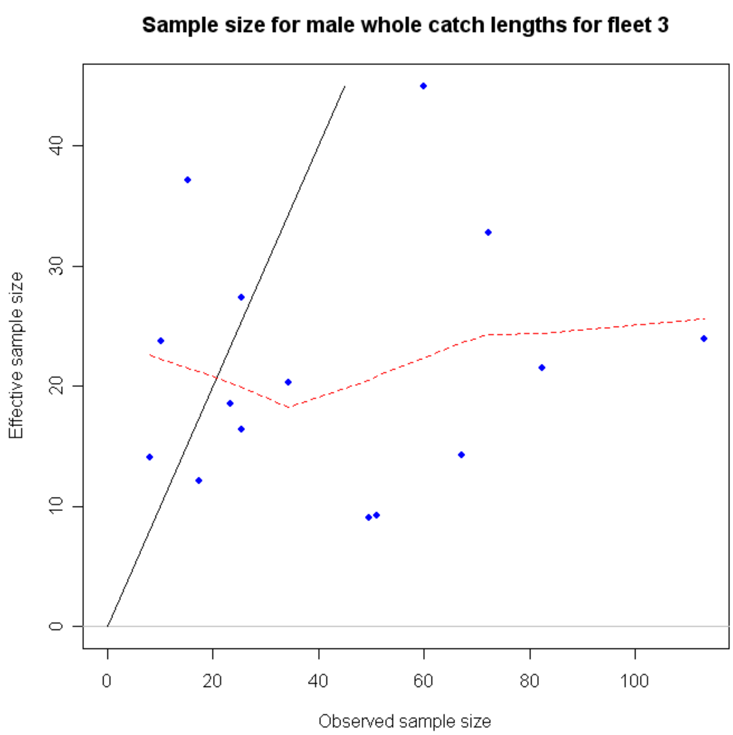
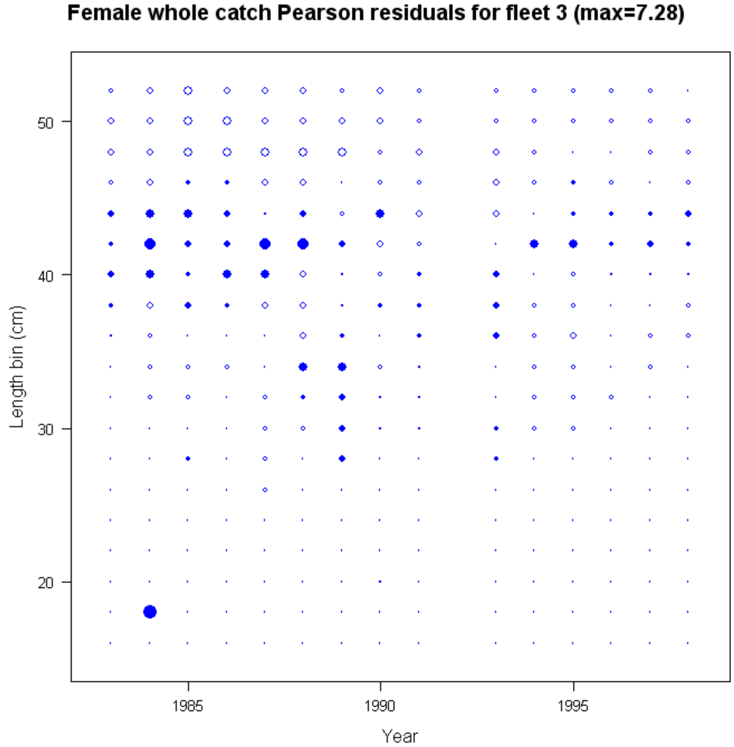


Figure 106-107: Observed and effective sample sizes for length composition data from the setnet fishery.



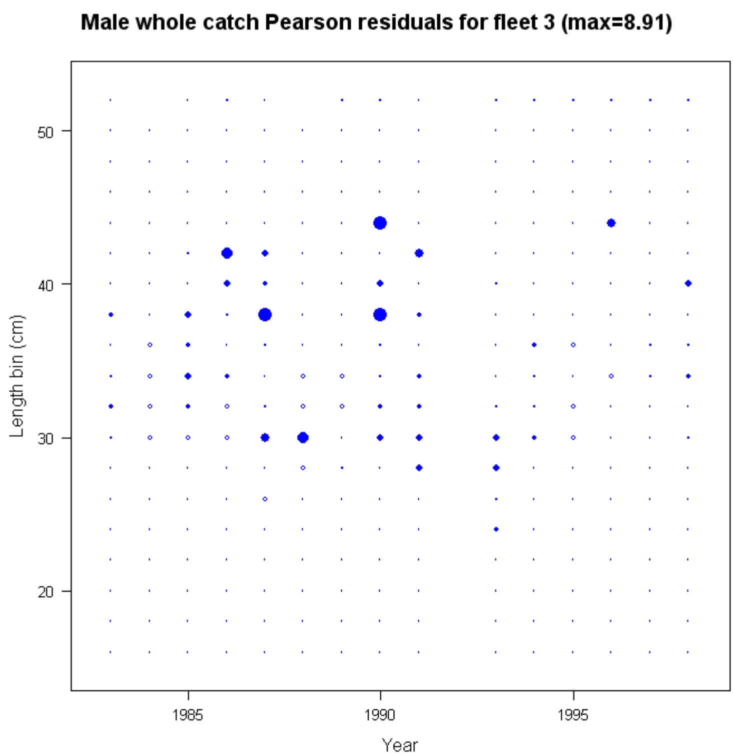


Figure 108-109: Residuals to the length composition data in the setnet fishery

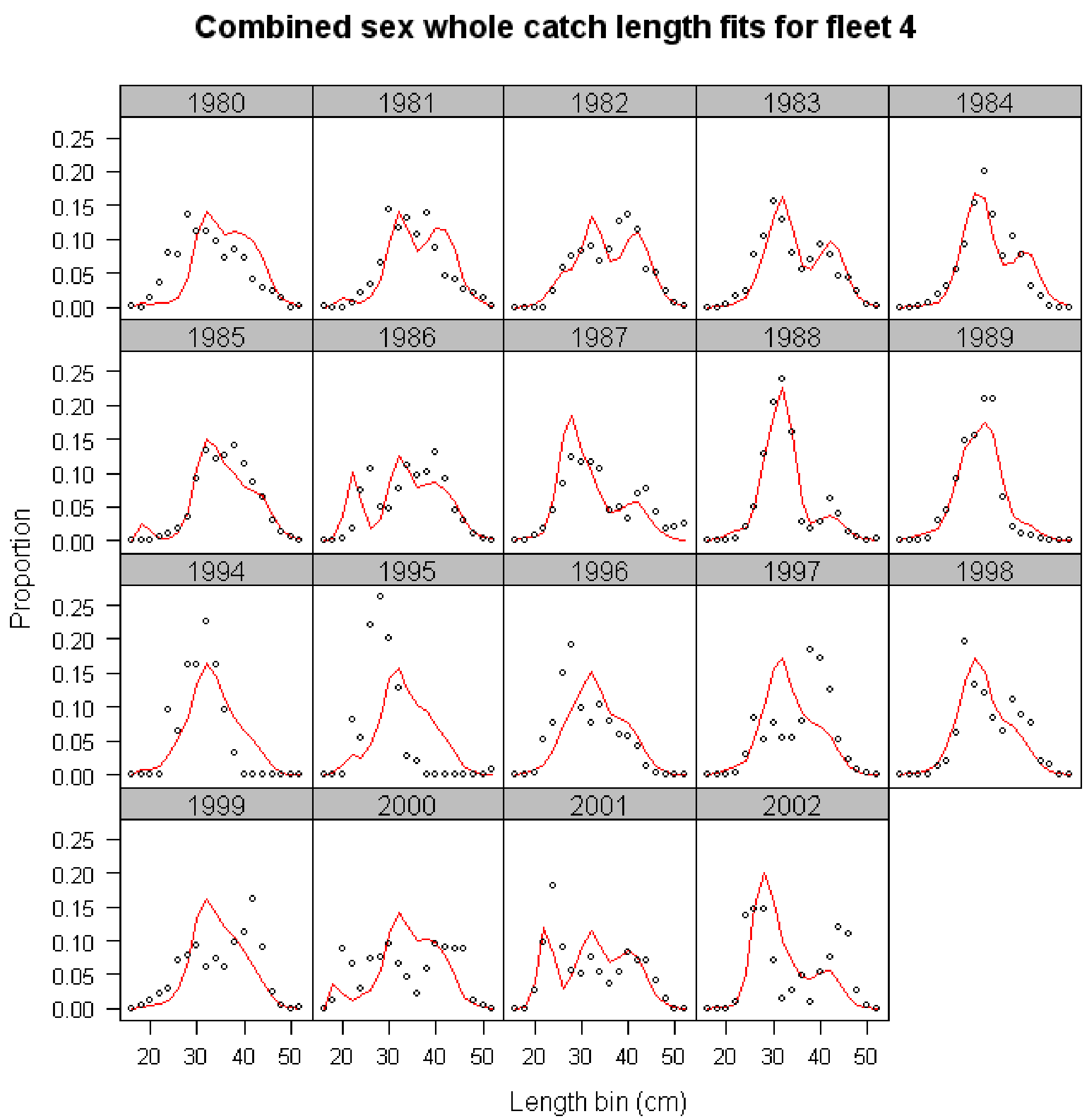
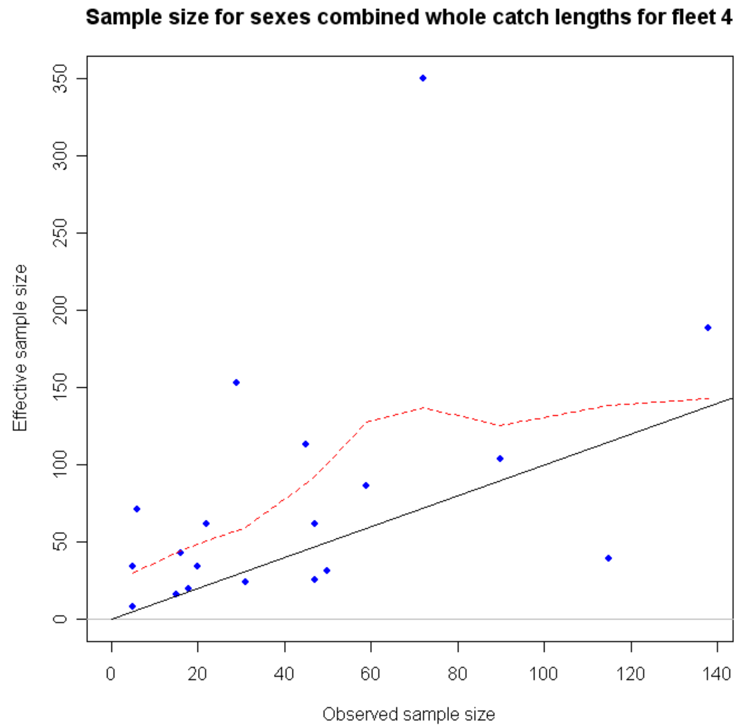


Figure 110-111: Observed and predicted length composition data for combined sexes in the recreational fishery.



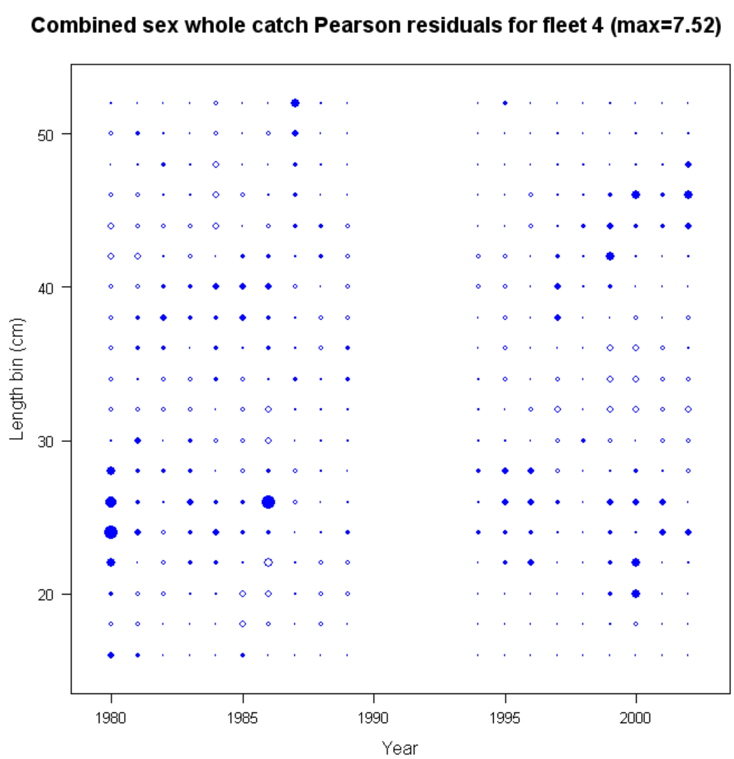
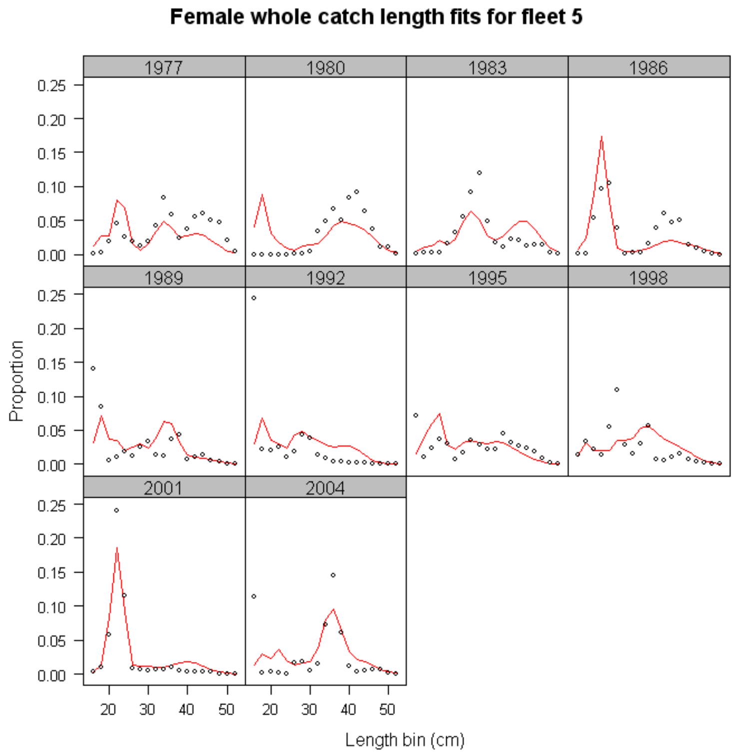


Figure 112-113: Residuals (top) to the length composition data in the recreational fishery and (bottom) observed and effective sample sizes.



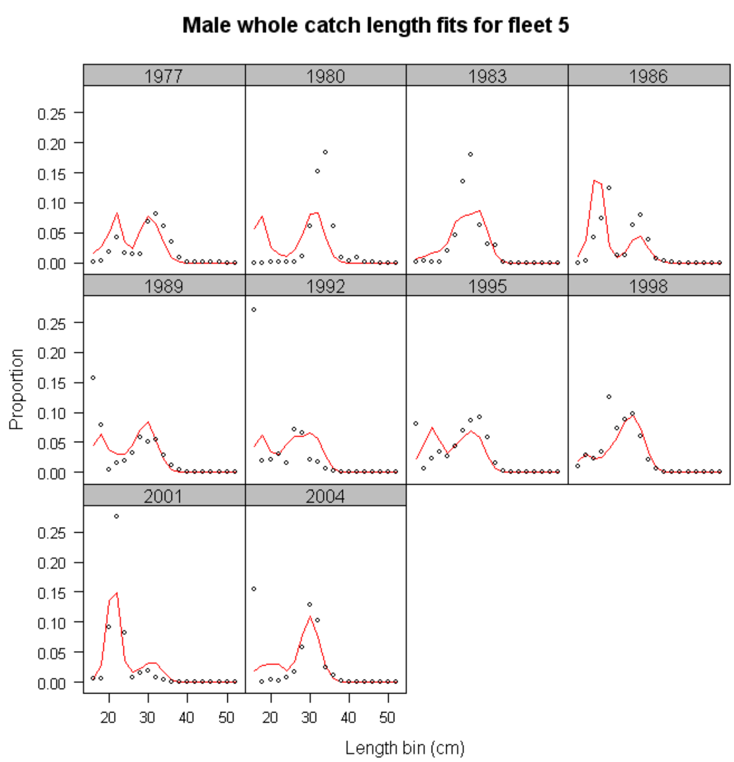
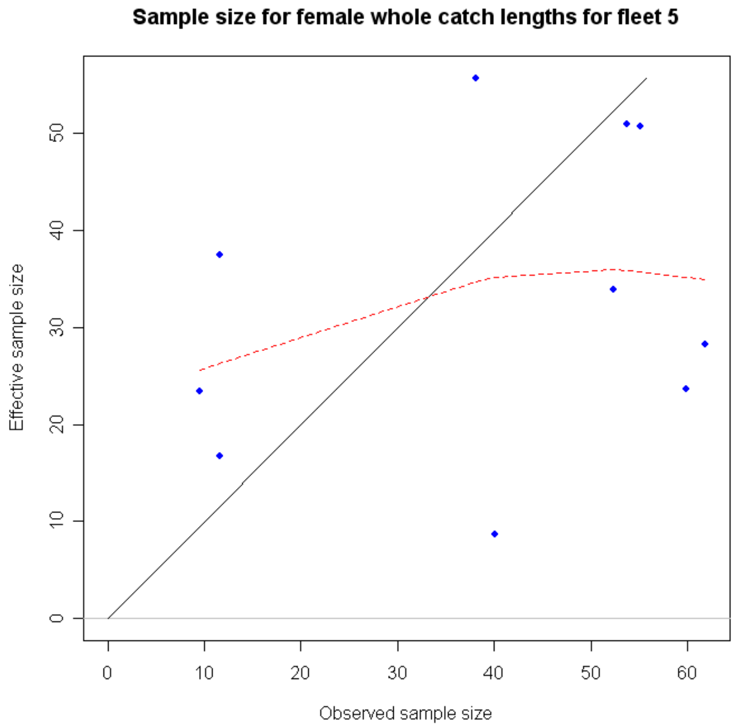


Figure 114-115: Observed and predicted length composition data for females (top) and males (bottom) in the triennial trawl survey.



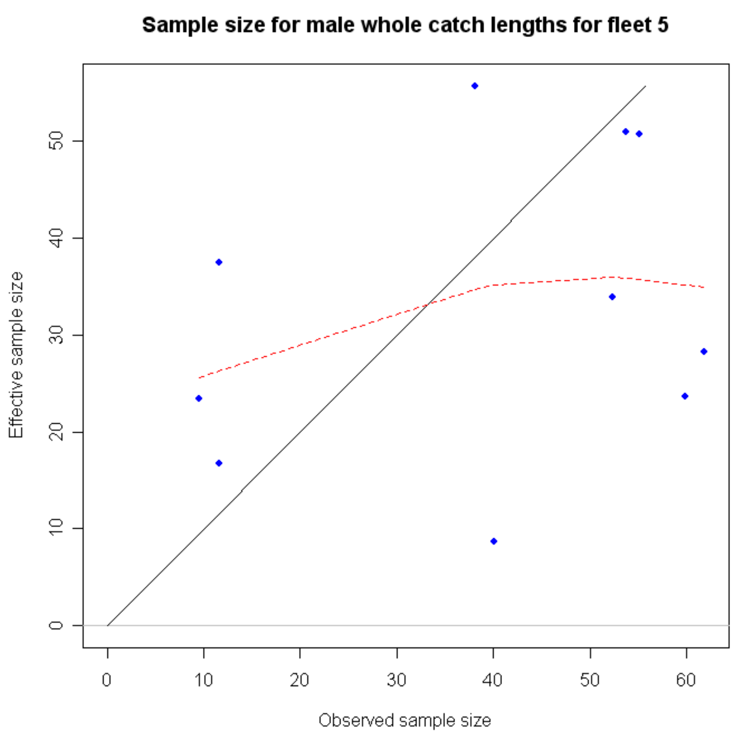


Figure 116-117: Observed and effective sample sizes for length composition data from the triennial trawl survey.

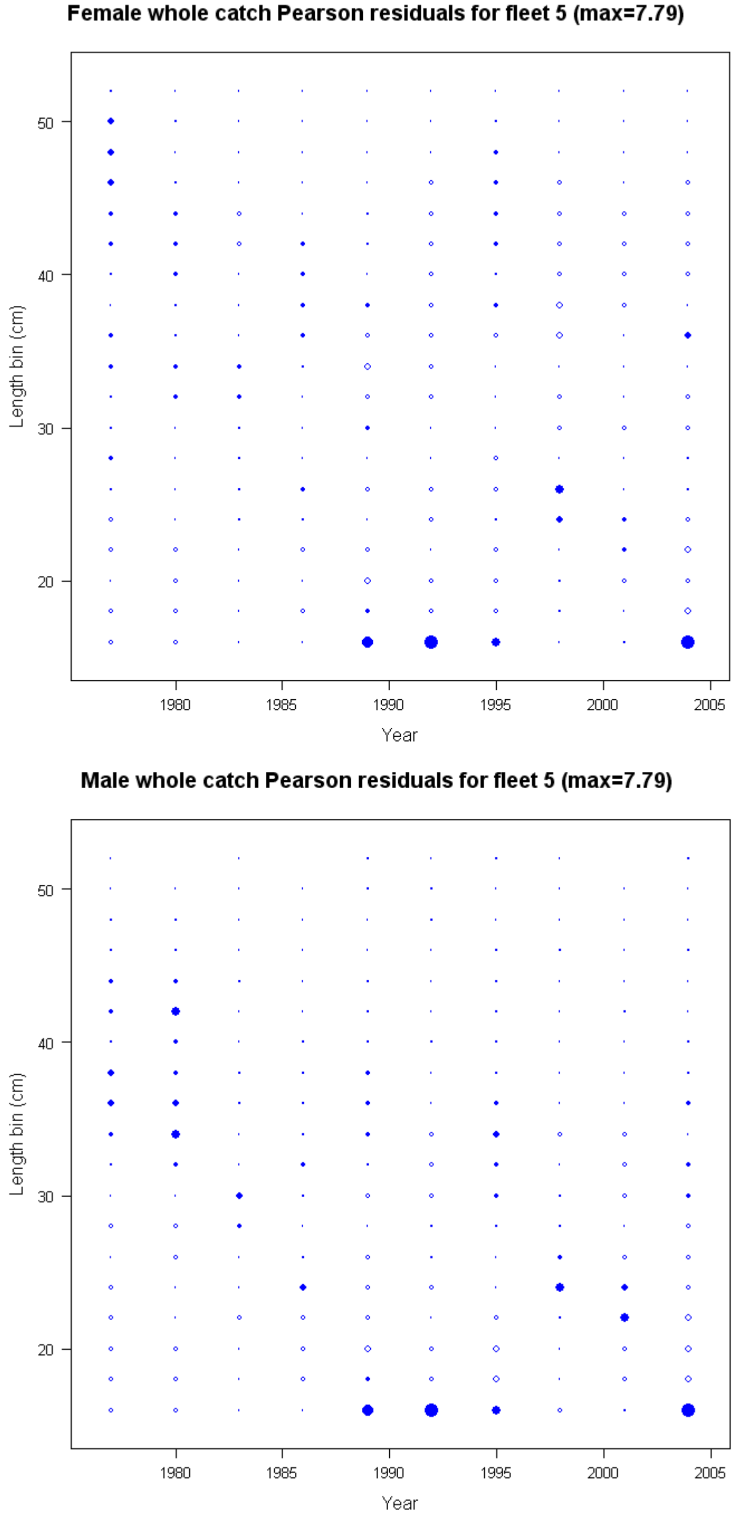
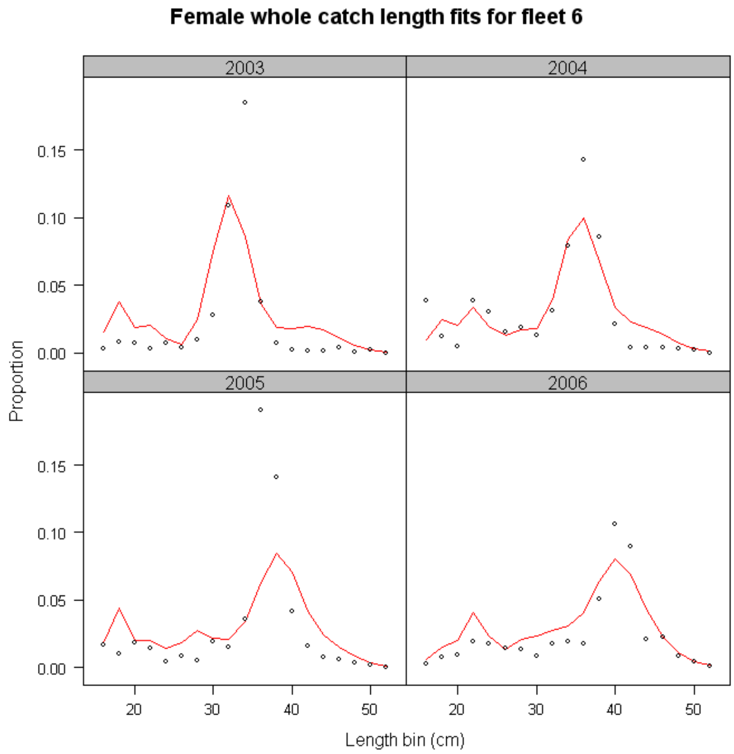


Figure 118-119: Residuals to the length composition data in the triennial trawl survey.



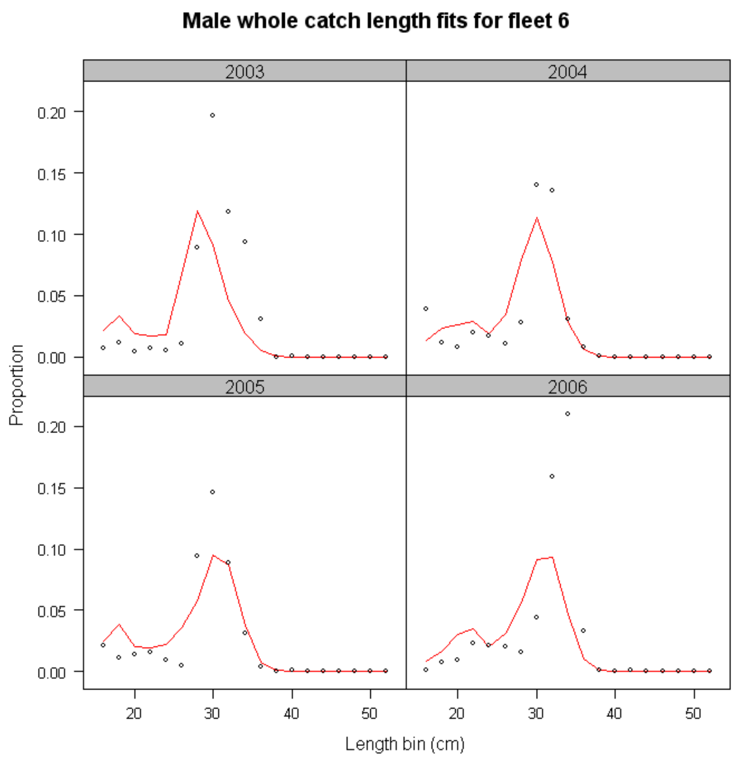
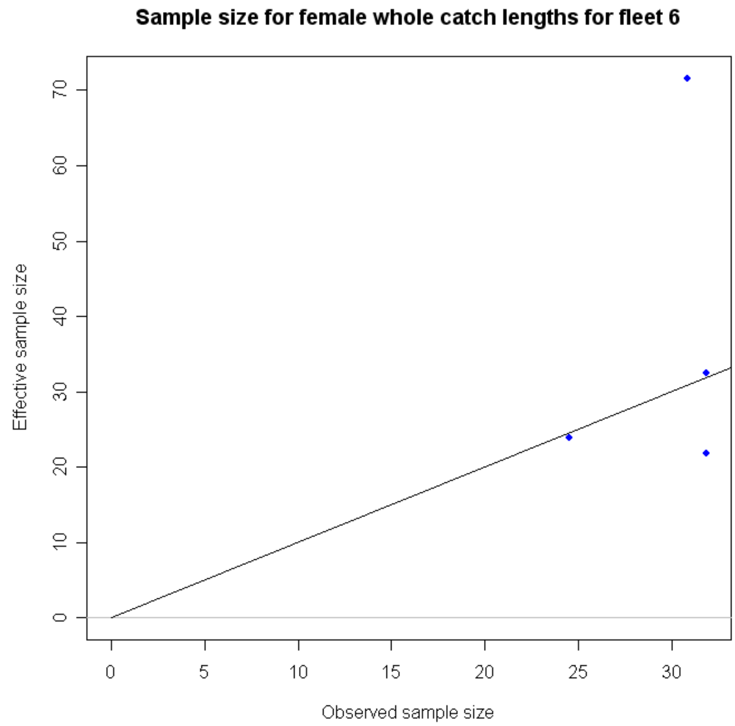


Figure 120-121: Observed and predicted length composition data for females (top) and males (bottom) in the NWC combined survey.



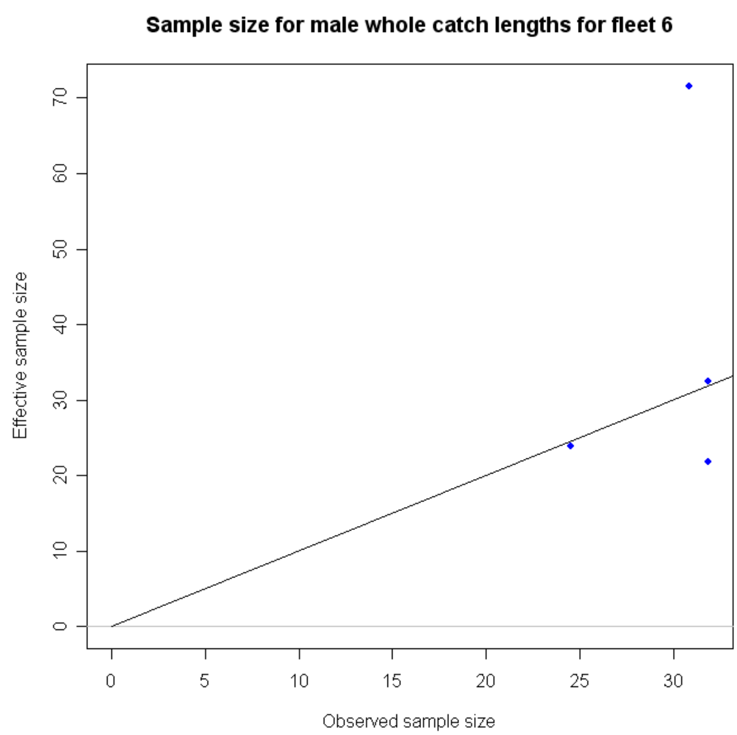
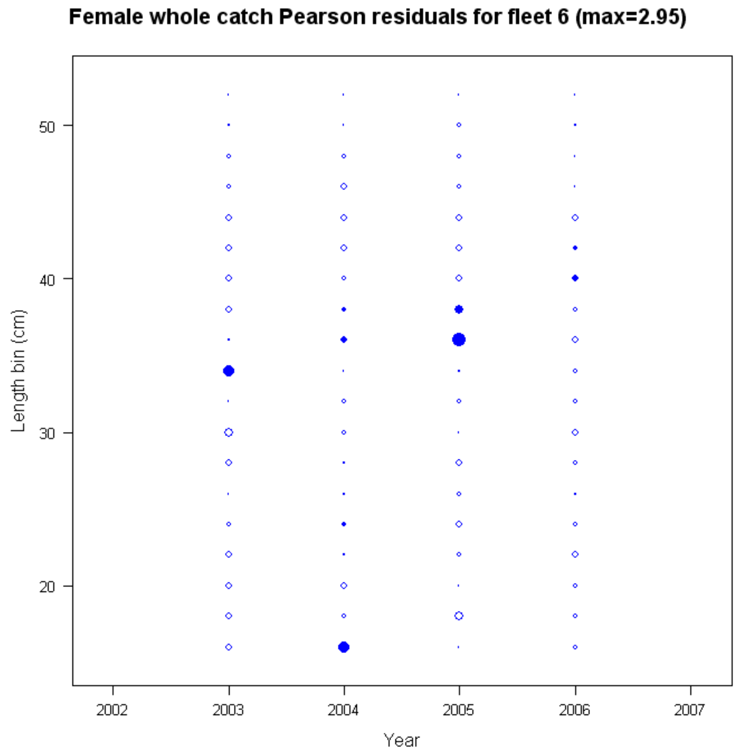


Figure 122-123: Observed and effective sample sizes for length composition data from the NWC combined survey.



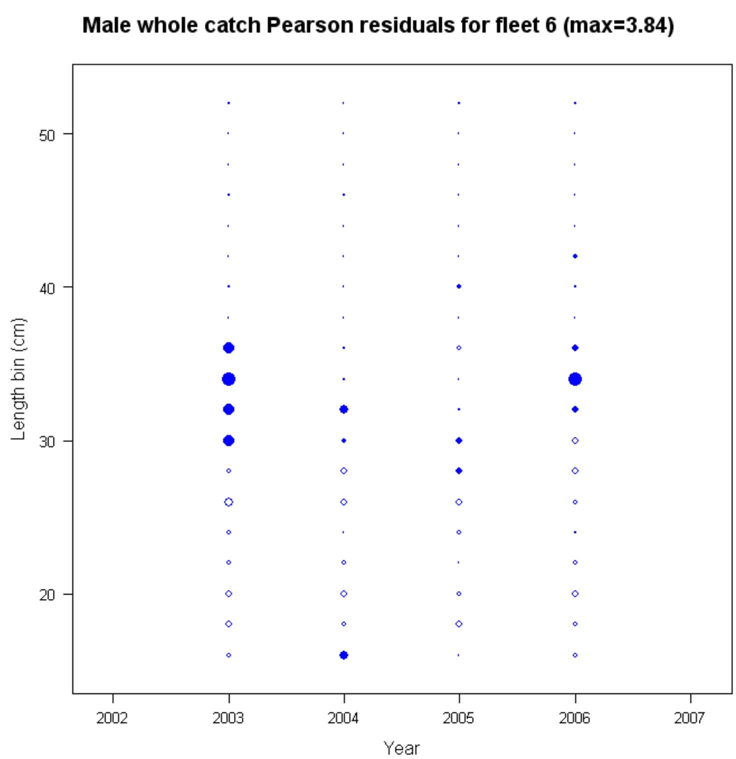


Figure 124-125: Residuals to the length composition data in the NWC combined survey

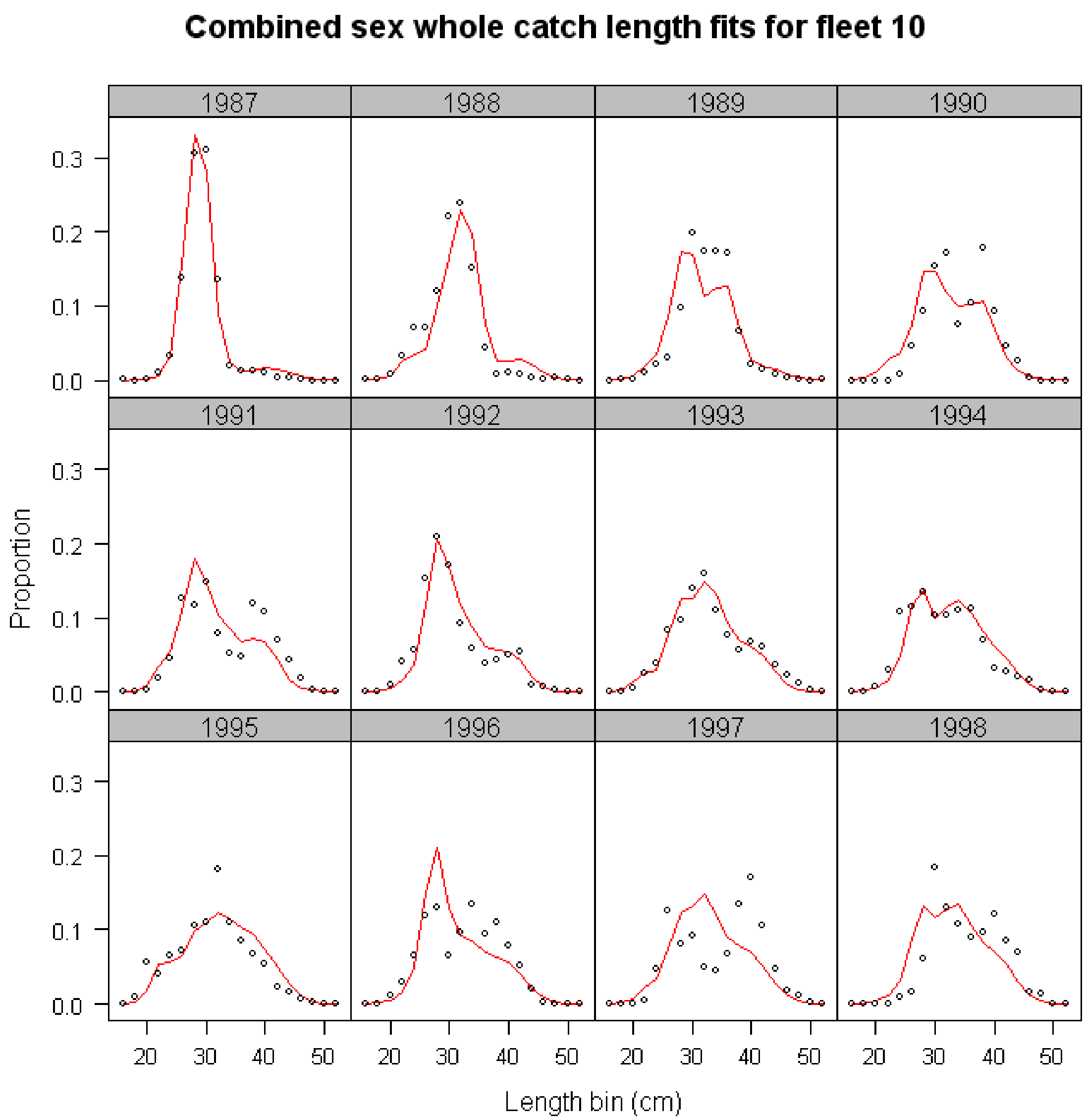
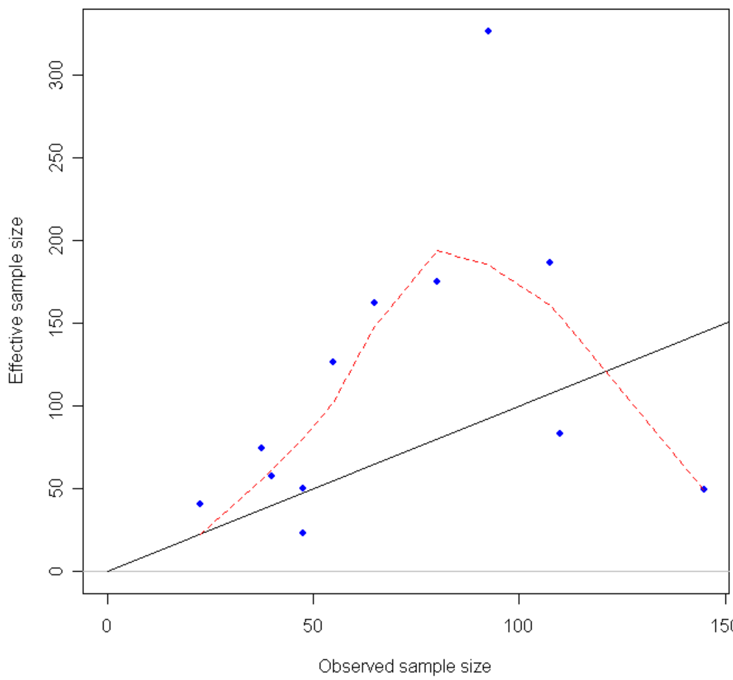


Figure 126: Observed and predicted length composition data for mixed sexes in the recreational observer data associated with the CPUE index.

Sample size for sexes combined whole catch lengths for fleet 10



Combined sex whole catch Pearson residuals for fleet 10 (max=2.74)

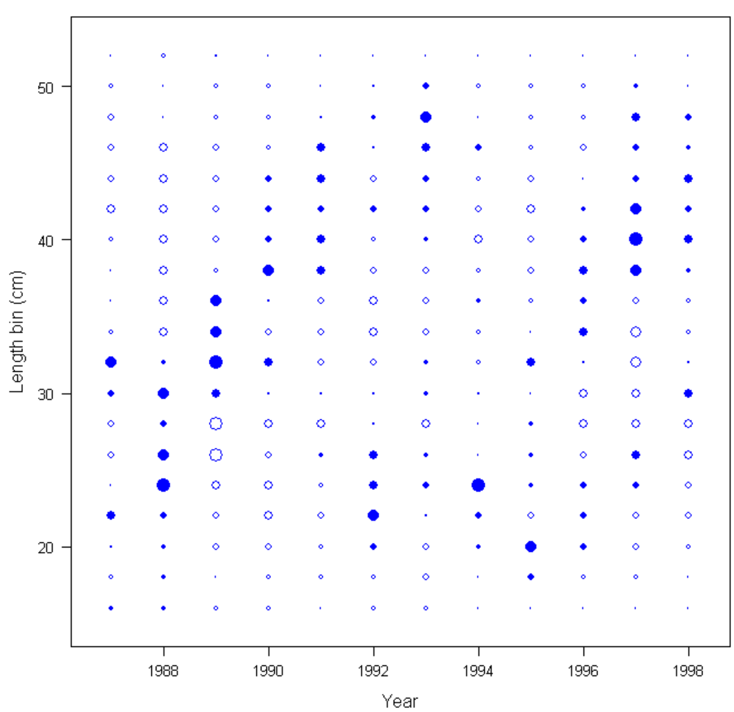


Figure 127 (top): Observed and effective sample sizes for length composition data from the recreational CPUE index, and Figure 128 (bottom): residuals to the length composition data in the recreational CPUE index.

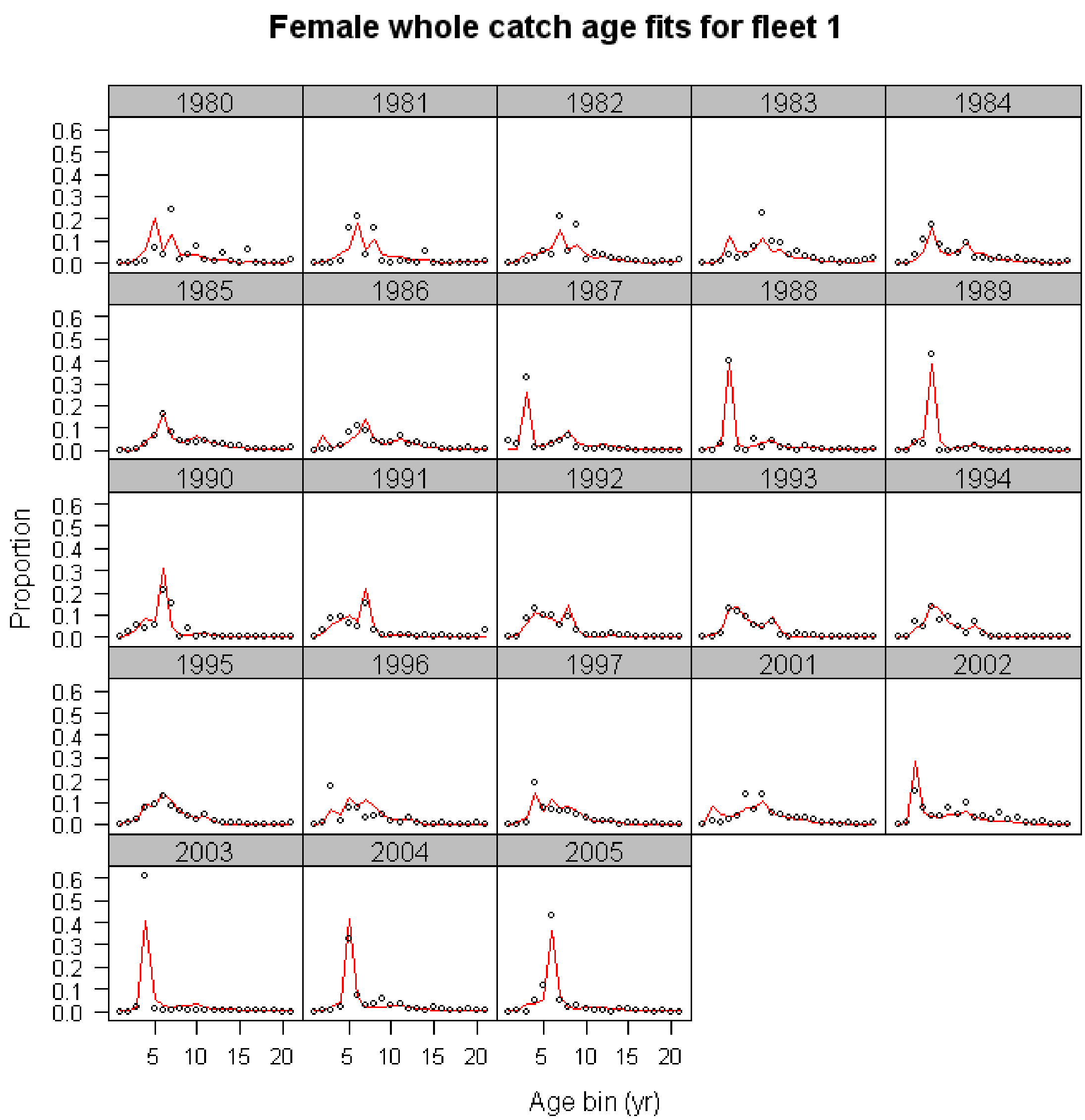


Figure 129: Observed and predicted catch at age data for females in the bottom trawl fishery.

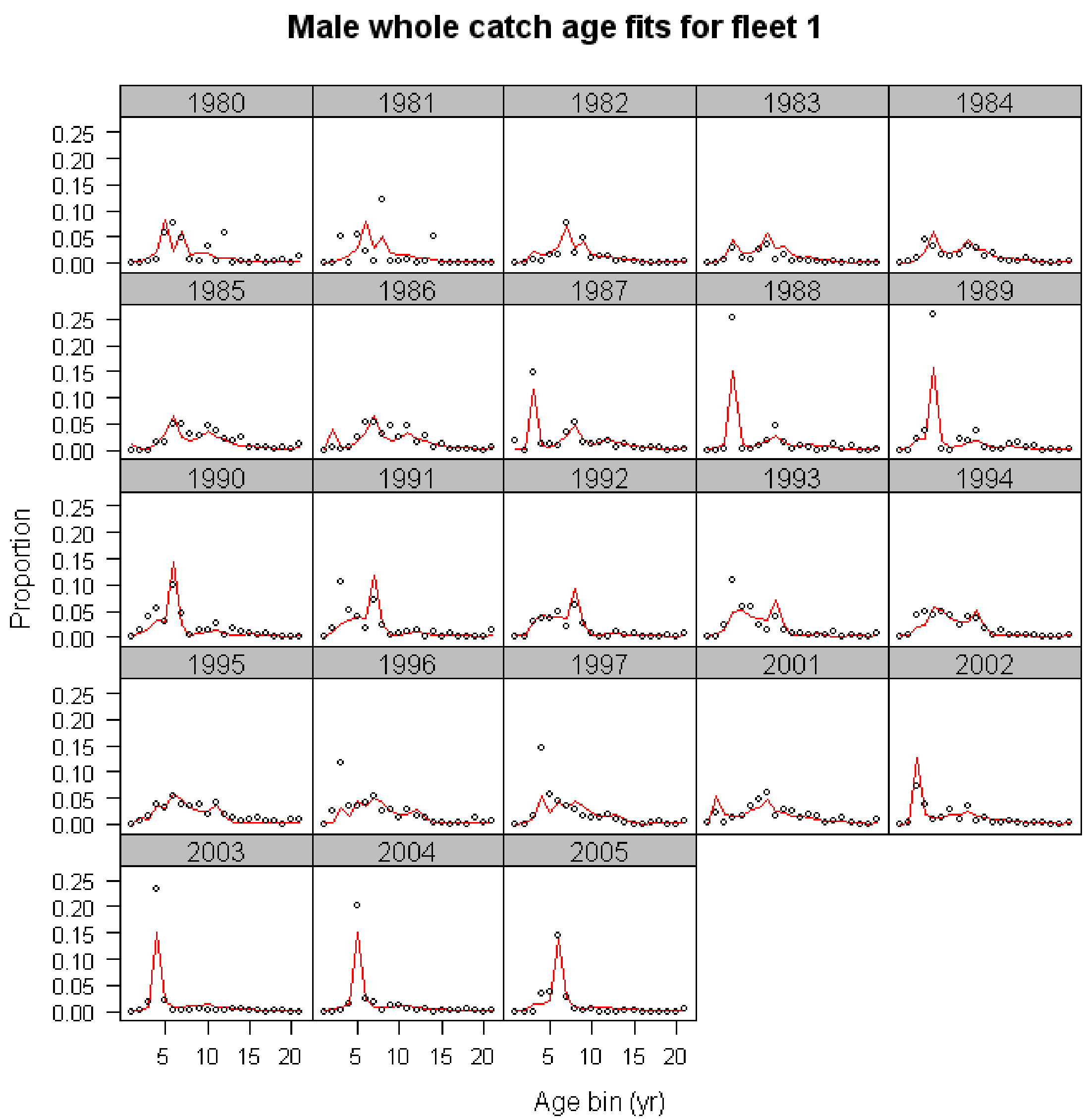
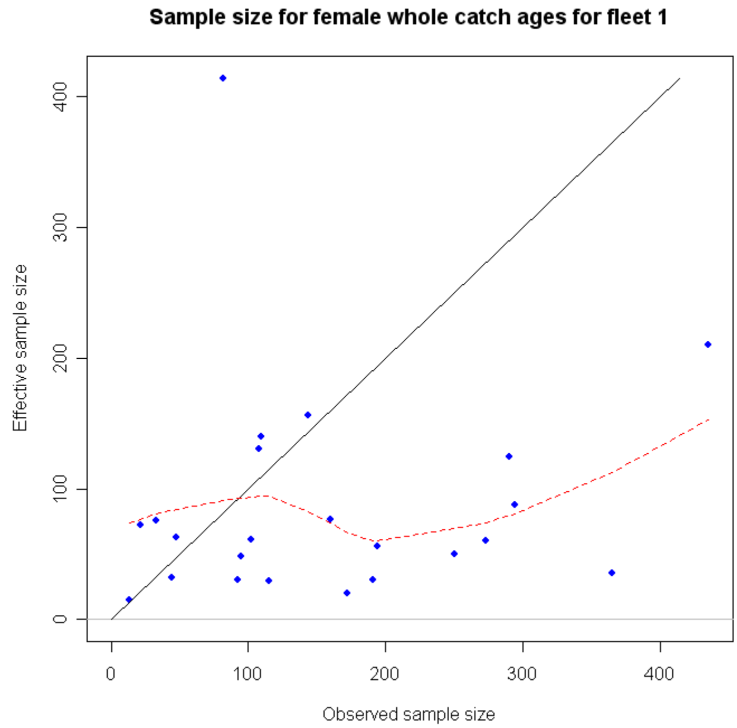


Figure 130: Observed and predicted catch at age data for males in the bottom trawl fishery.



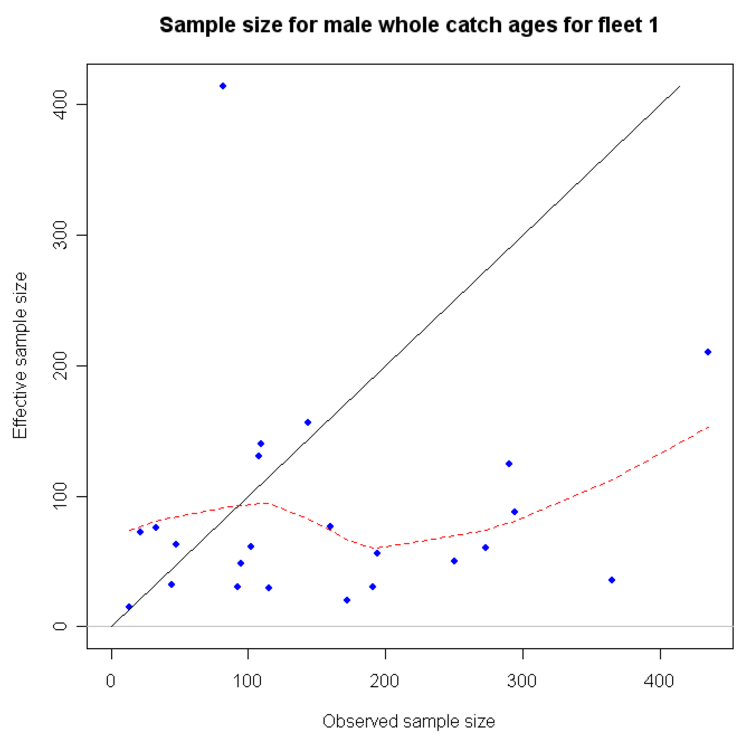
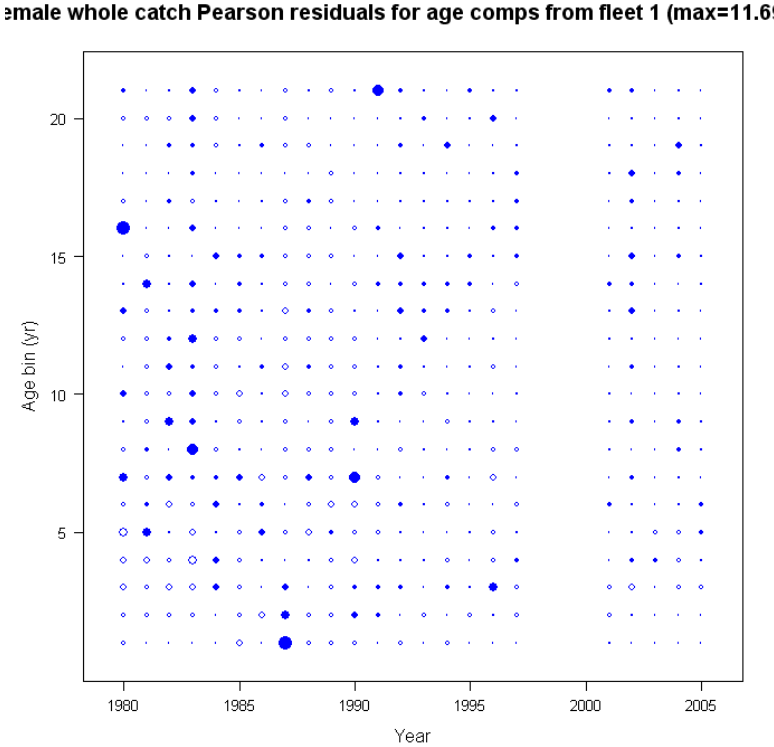


Figure 131-132: Observed and effective sample sizes for age composition data from the bottom trawl fishery.



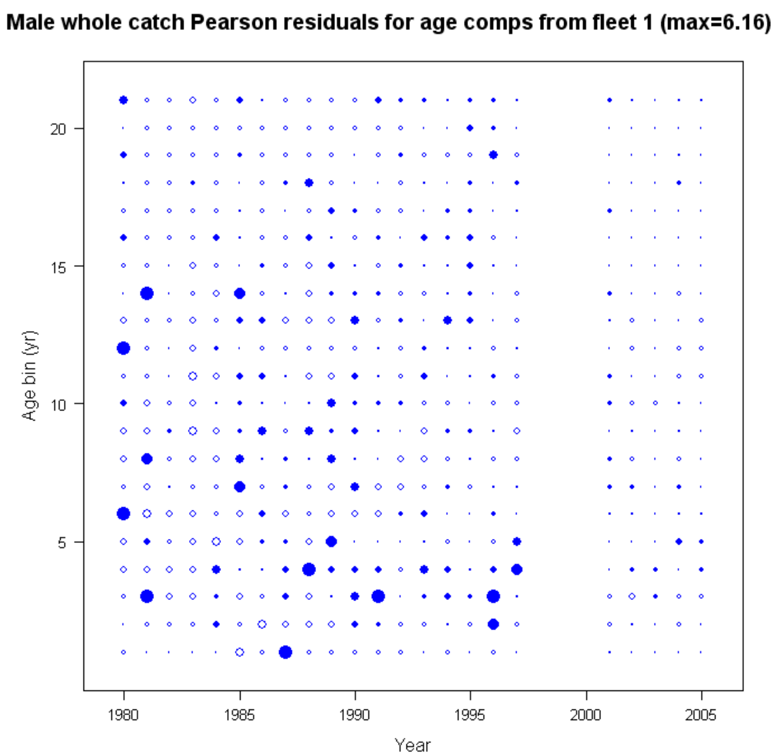
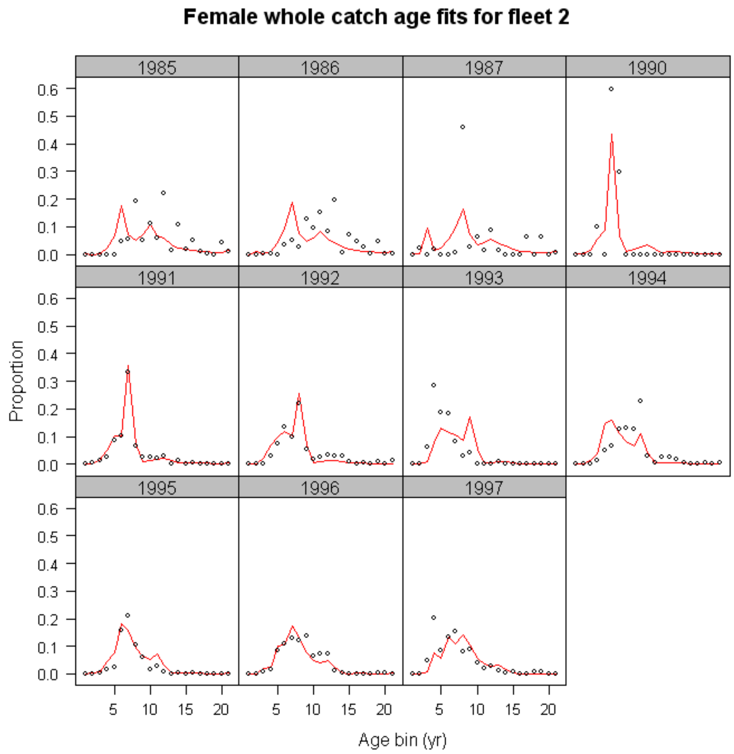


Figure 133-134: Residuals to the age composition data in the bottom trawl fishery



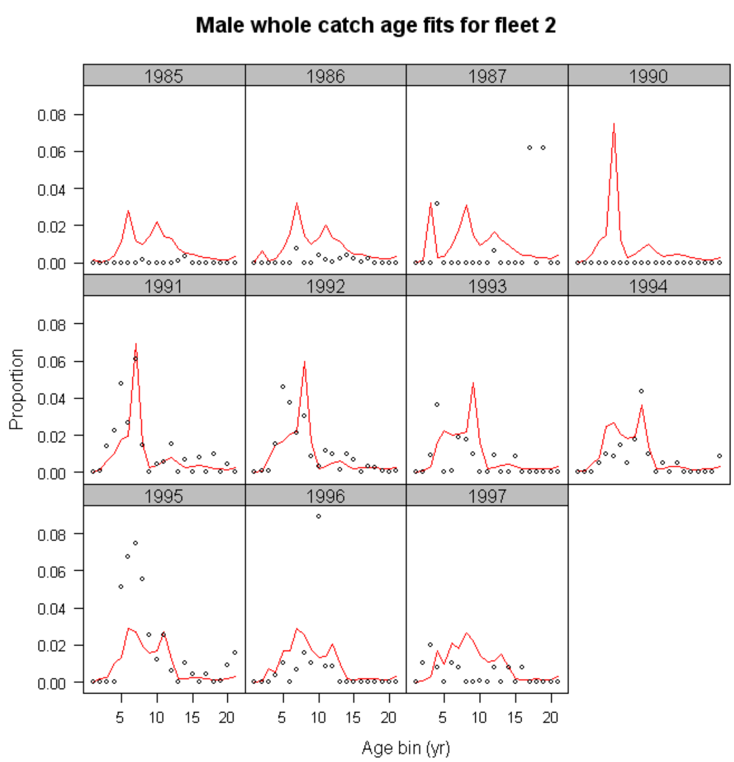
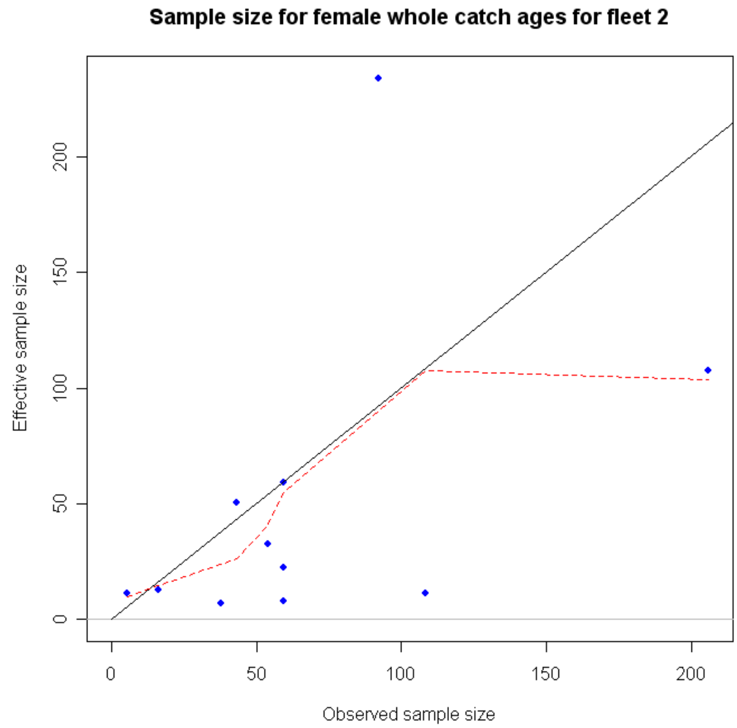


Figure 135-136: Observed and predicted catch at age data for females (top) and males (bottom) in the hook and line fishery.



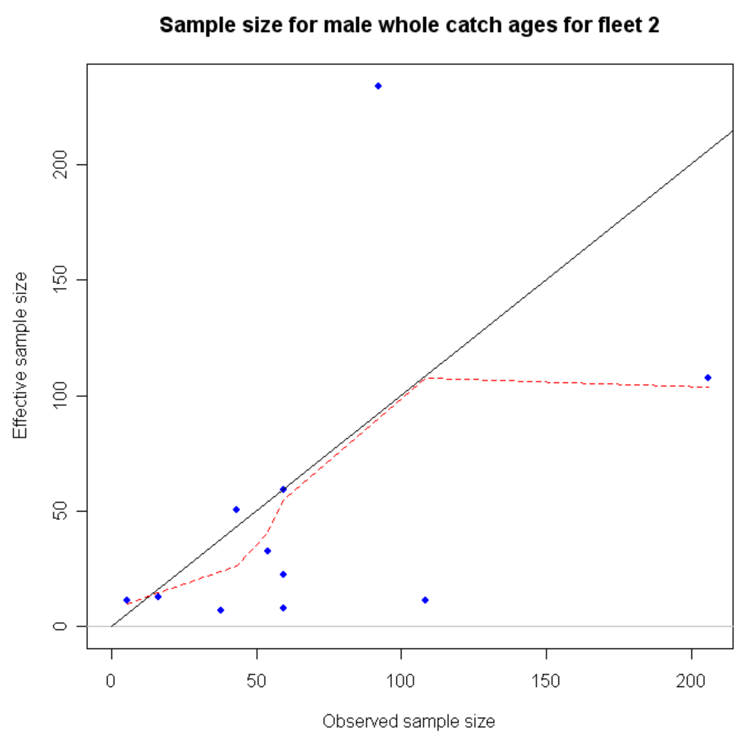
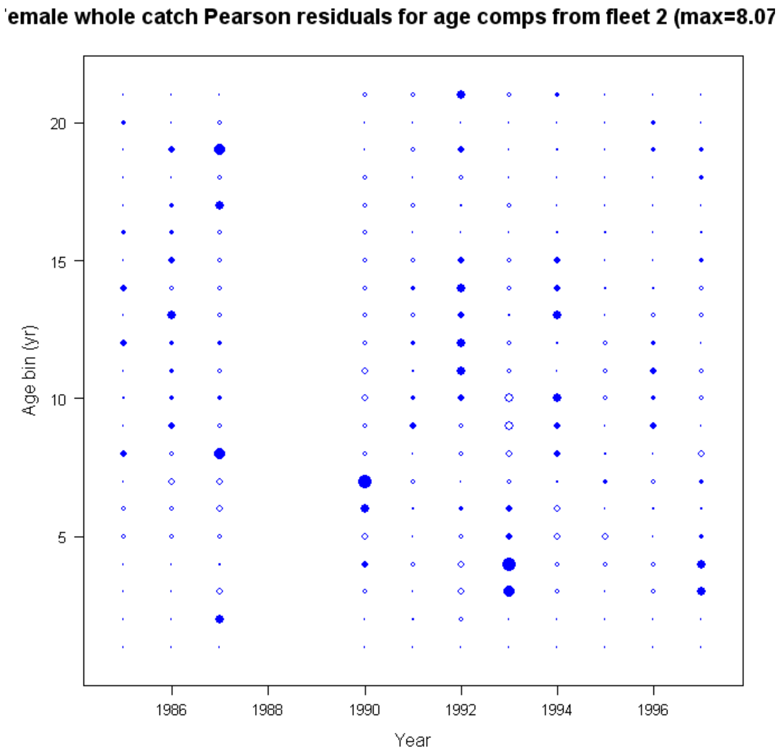


Figure 137-138: Observed and effective sample sizes for age composition data from the hook and line fishery.



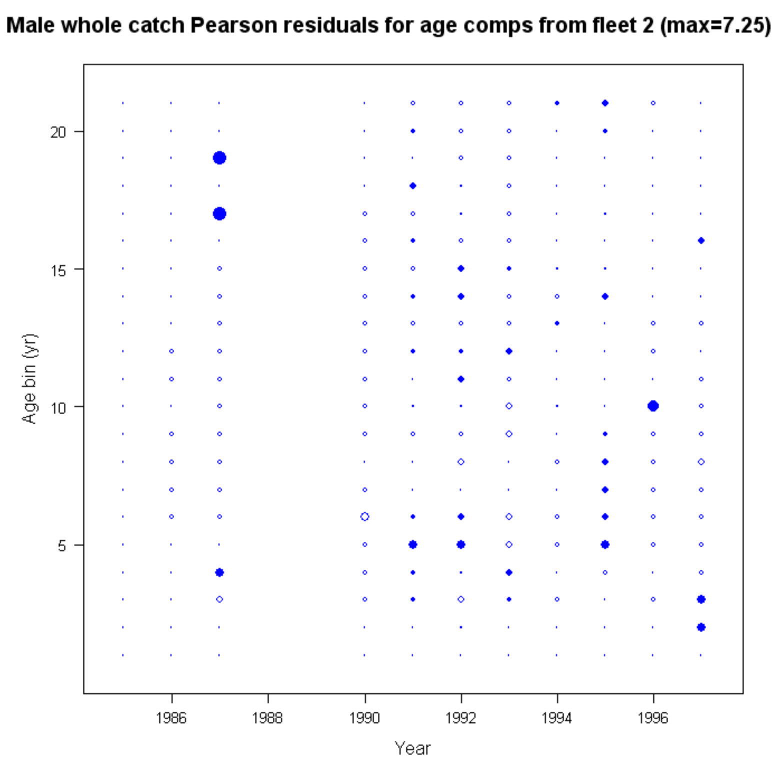
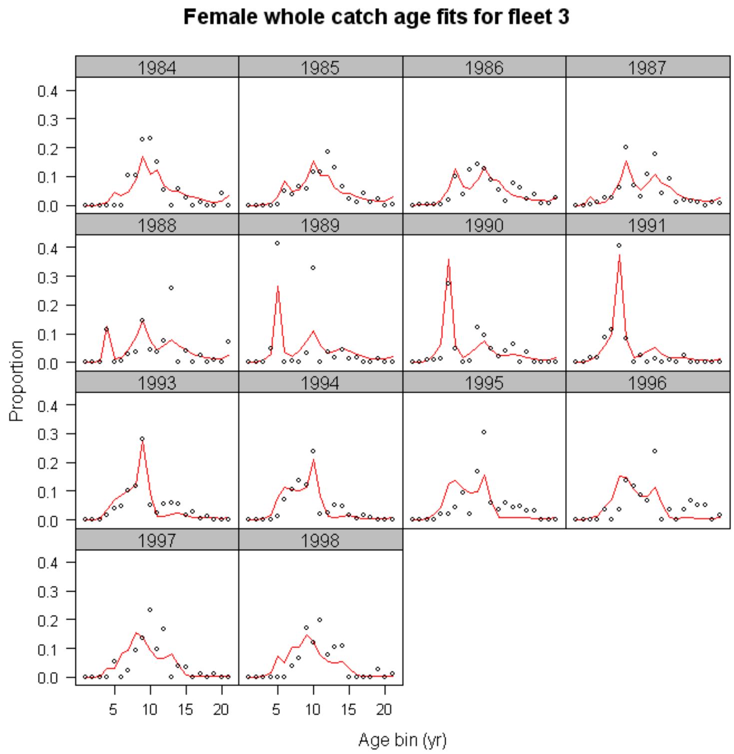


Figure 139-140: Residuals to the age composition data in the hook and line fishery



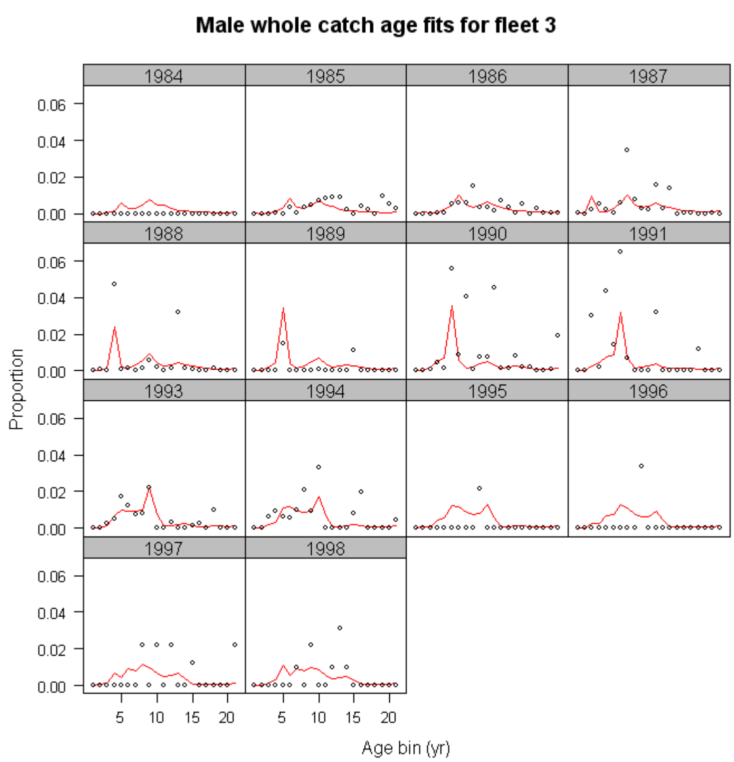
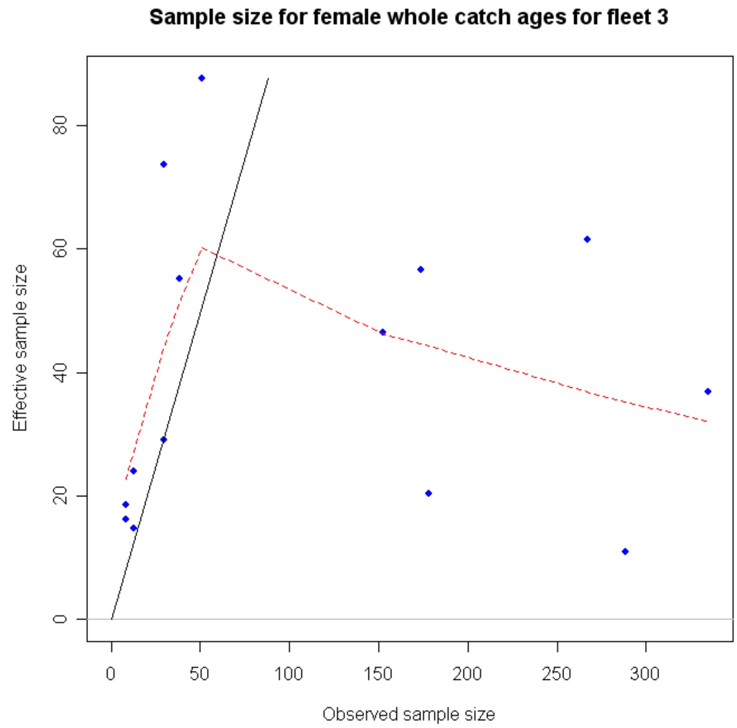


Figure 141-142: Observed and predicted catch at age data for females (top) and males (bottom) in the setnet fishery.



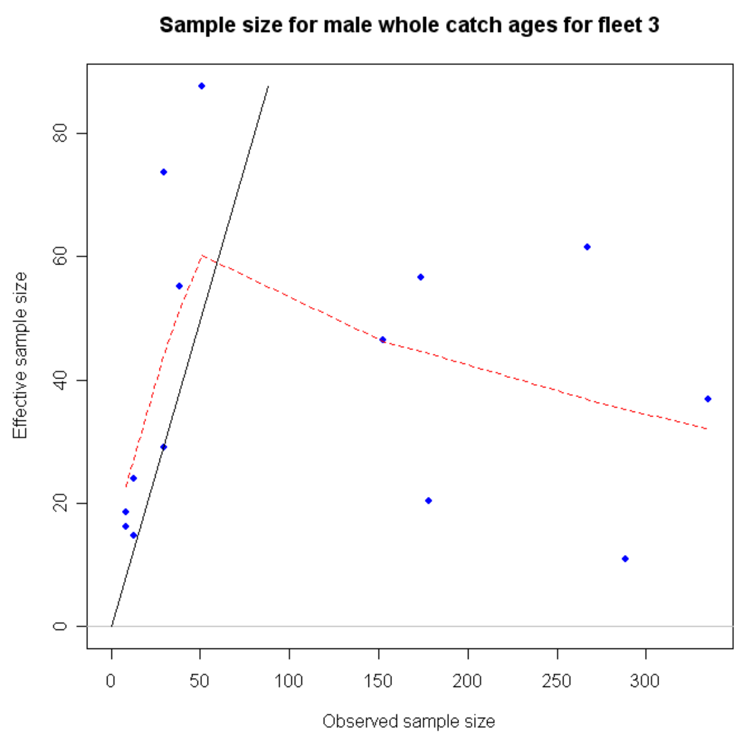
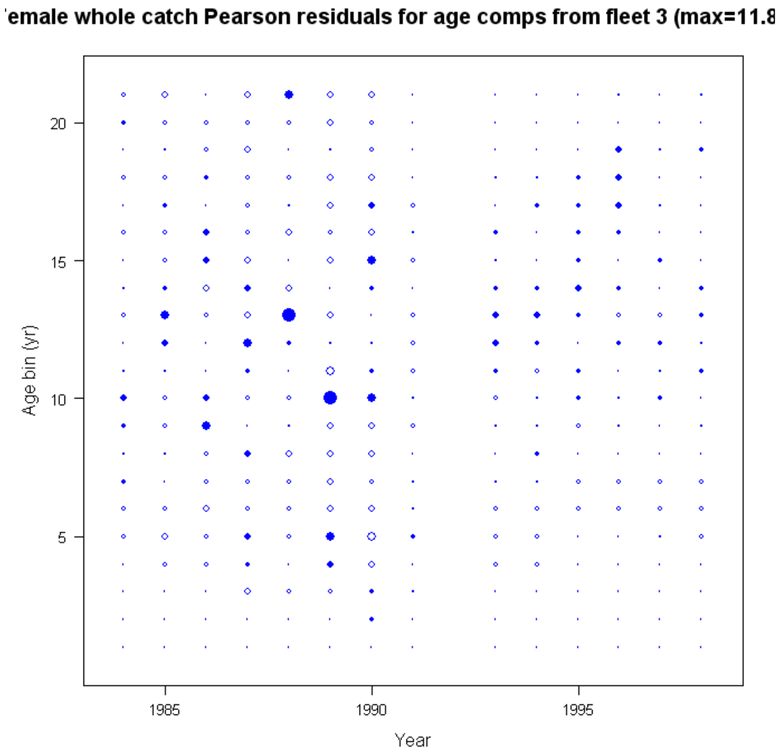


Figure 143-144: Observed and effective sample sizes for age composition data from the setnet fishery.



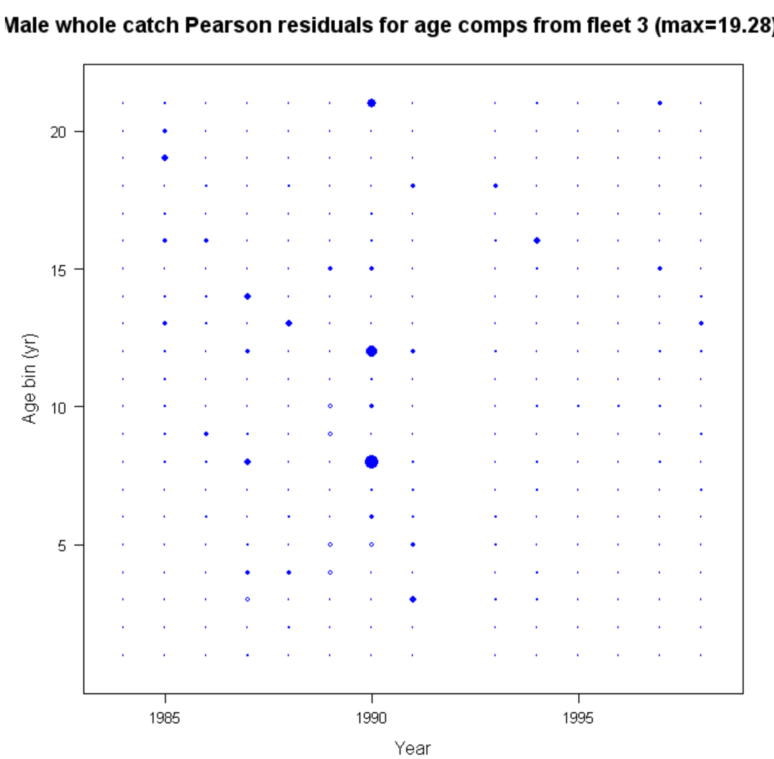
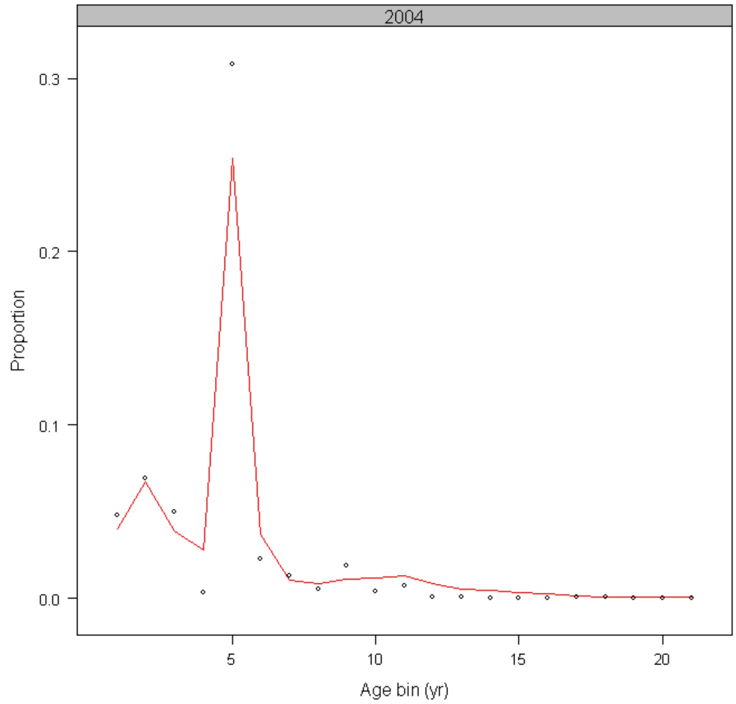


Figure 145-146: Residuals to the age composition data in the setnet fishery

Female whole catch age fits for fleet 6



Male whole catch age fits for fleet 6

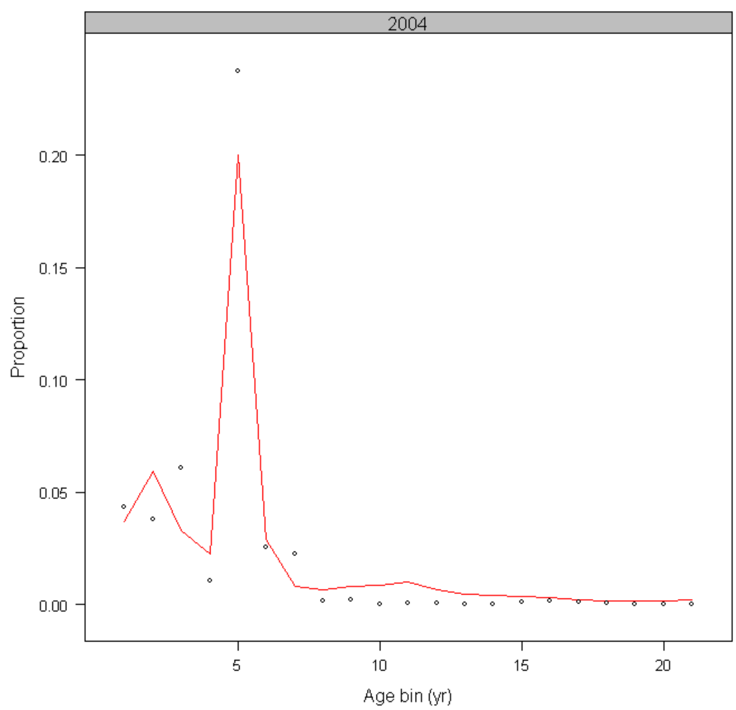
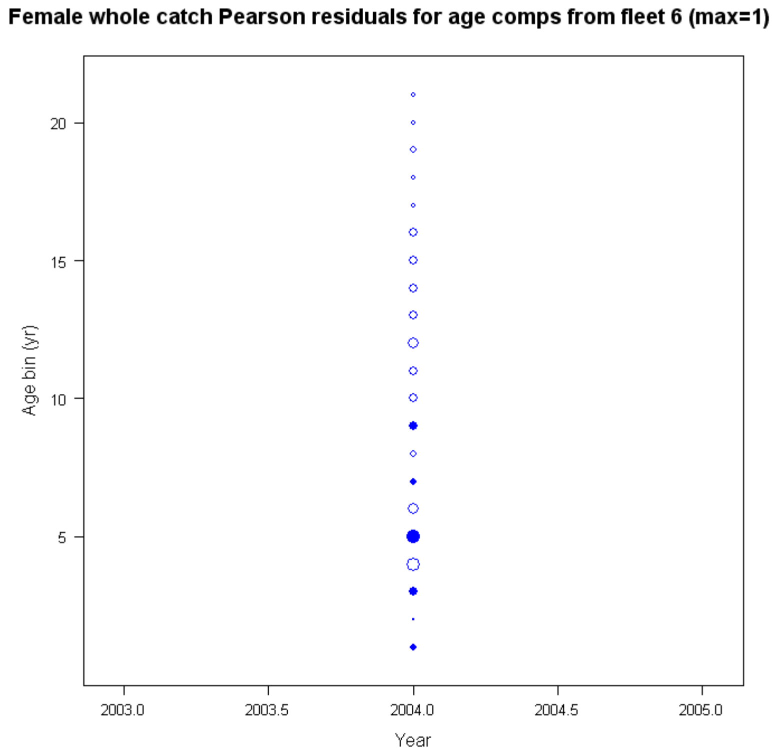


Figure 147-148: Observed and predicted catch at age data for females (top) and males (bottom) for the year 2004 in the NWC Combined survey.



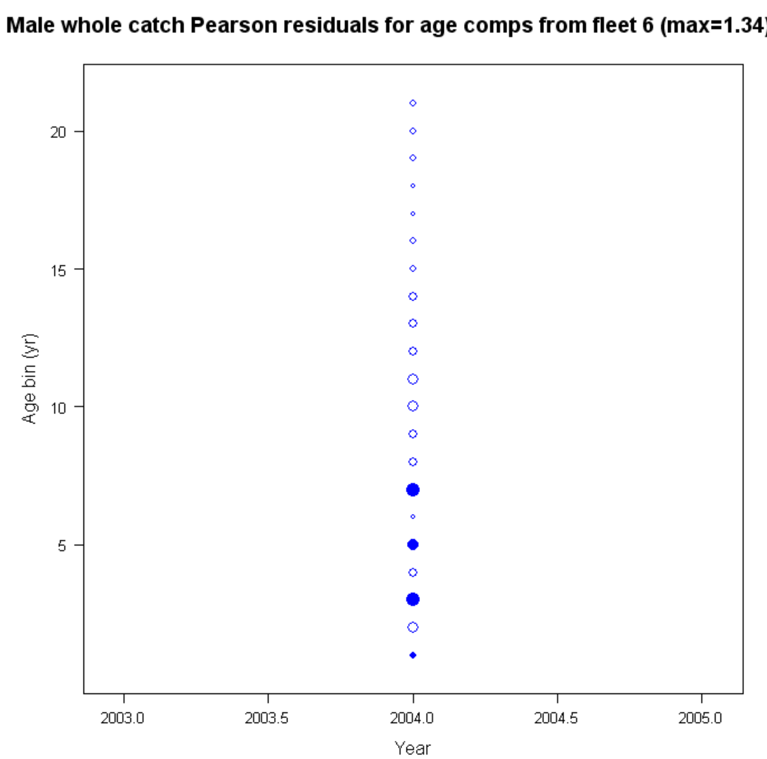
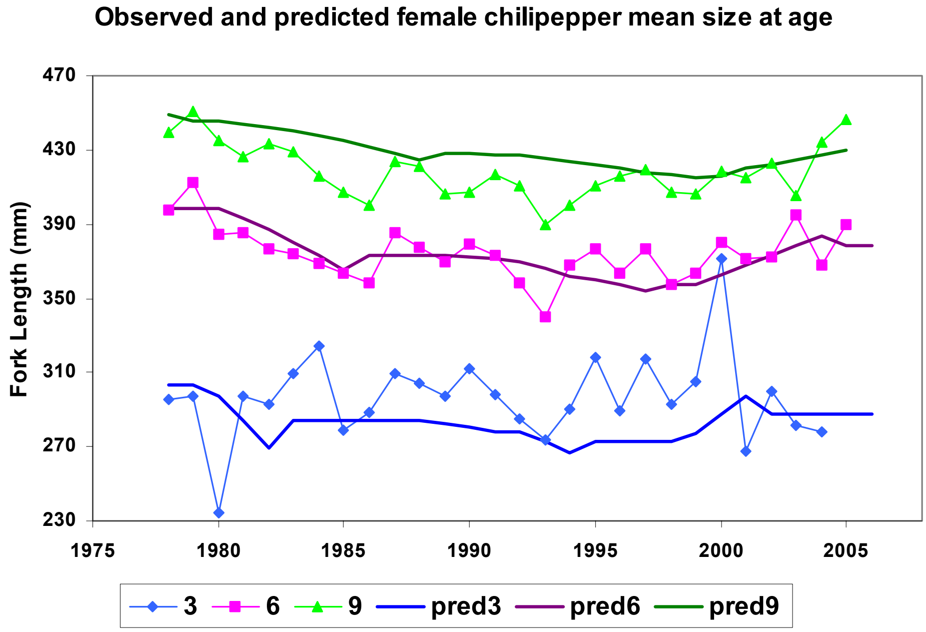


Figure 149-150: Residuals to the age composition data in the NWC combined survey



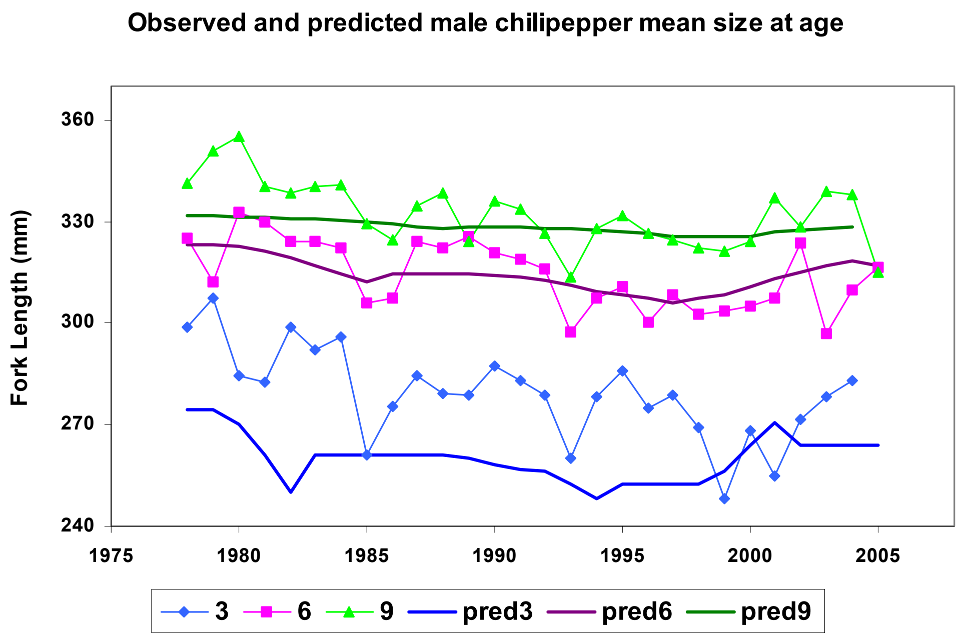


Figure 151-152: Observed (from commercial fisheries) and predicted (with time-varying k parameter) size at age for chilipepper rockfish females (top) and males (bottom).

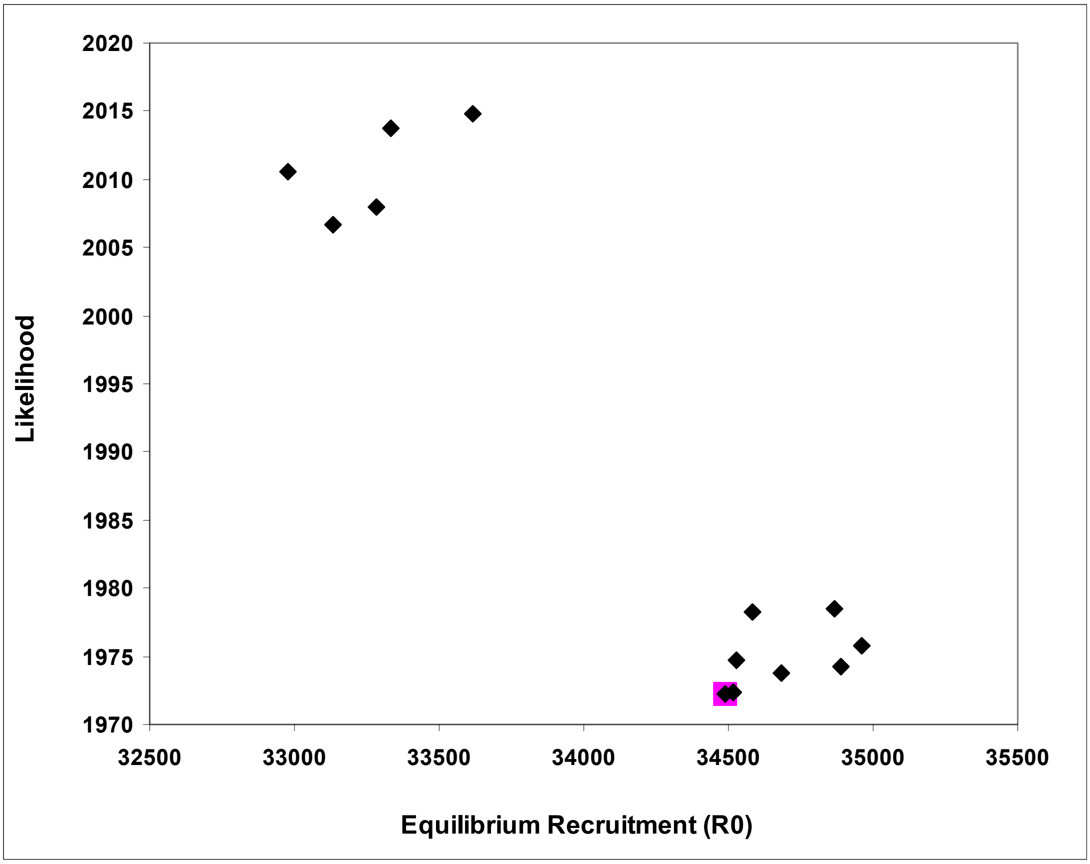


Figure 153: Estimates of equilibrium recruitment (R0) plotted against likelihood values for twelve "jittered" base model runs.

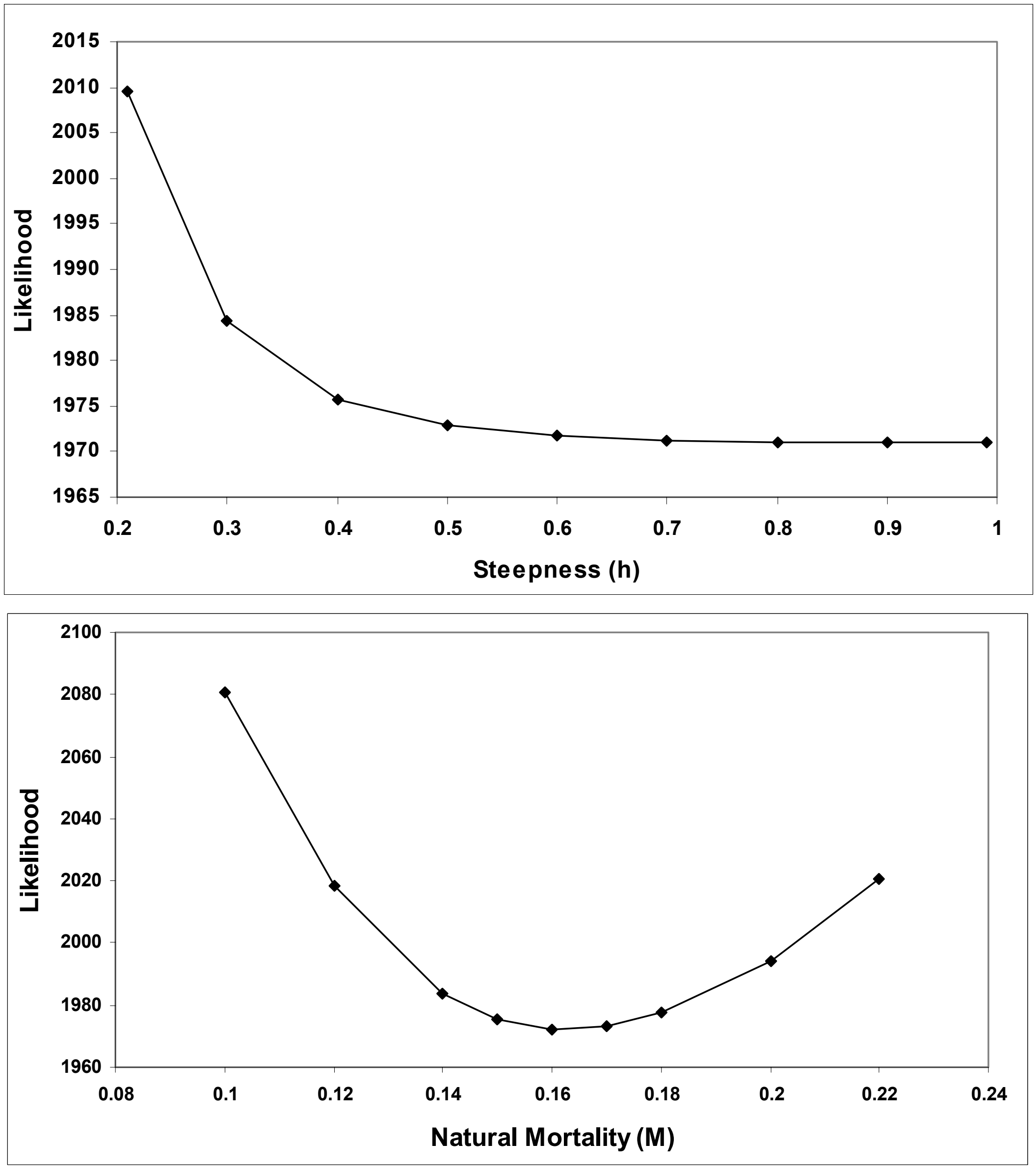


Figure 154-155: Likelihood profiles for steepness (top) and female natural mortality in which the male offset is constant (bottom).

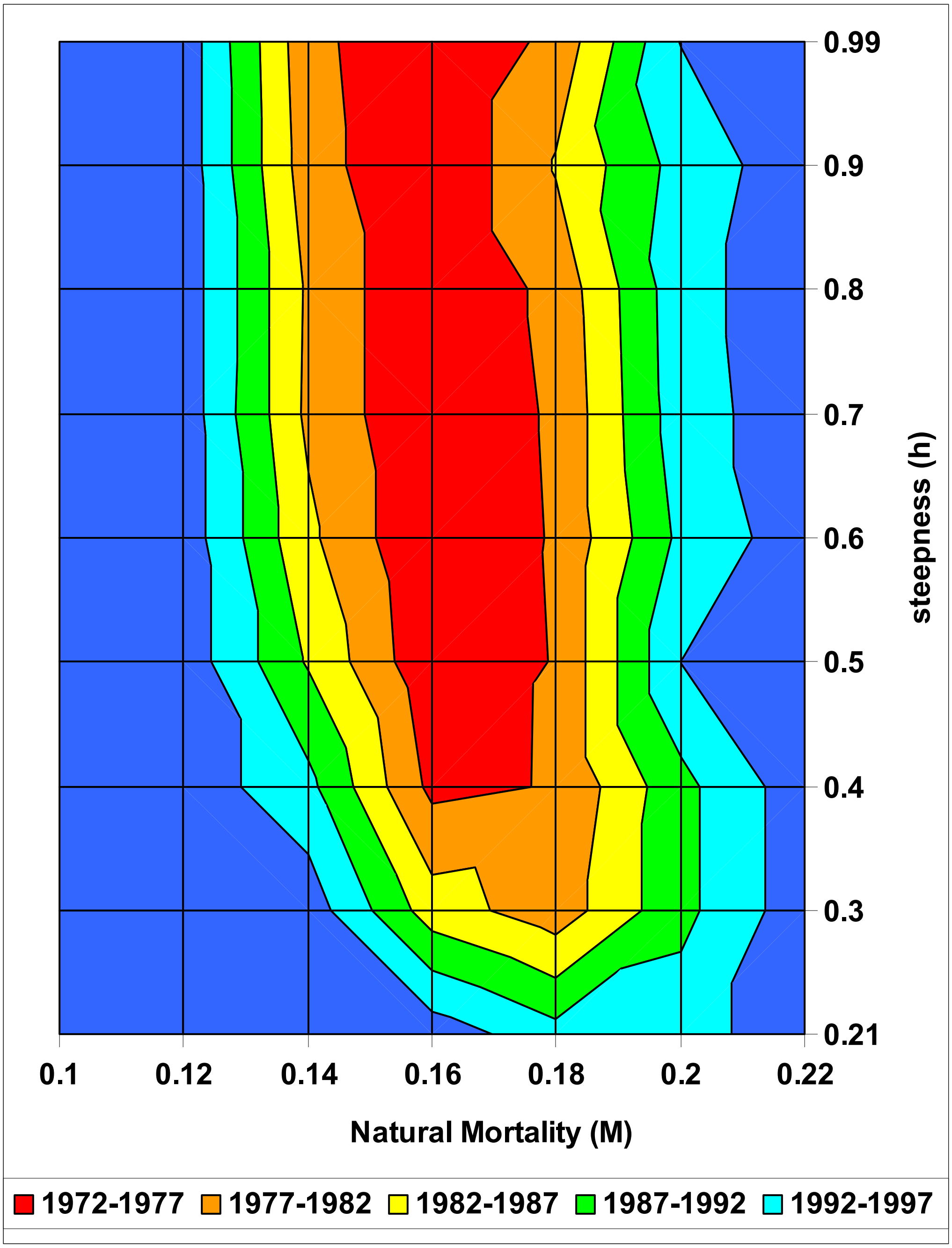


Figure 156: Likelihood surface plot for steepness against female natural mortality (in which the male offset is constant).

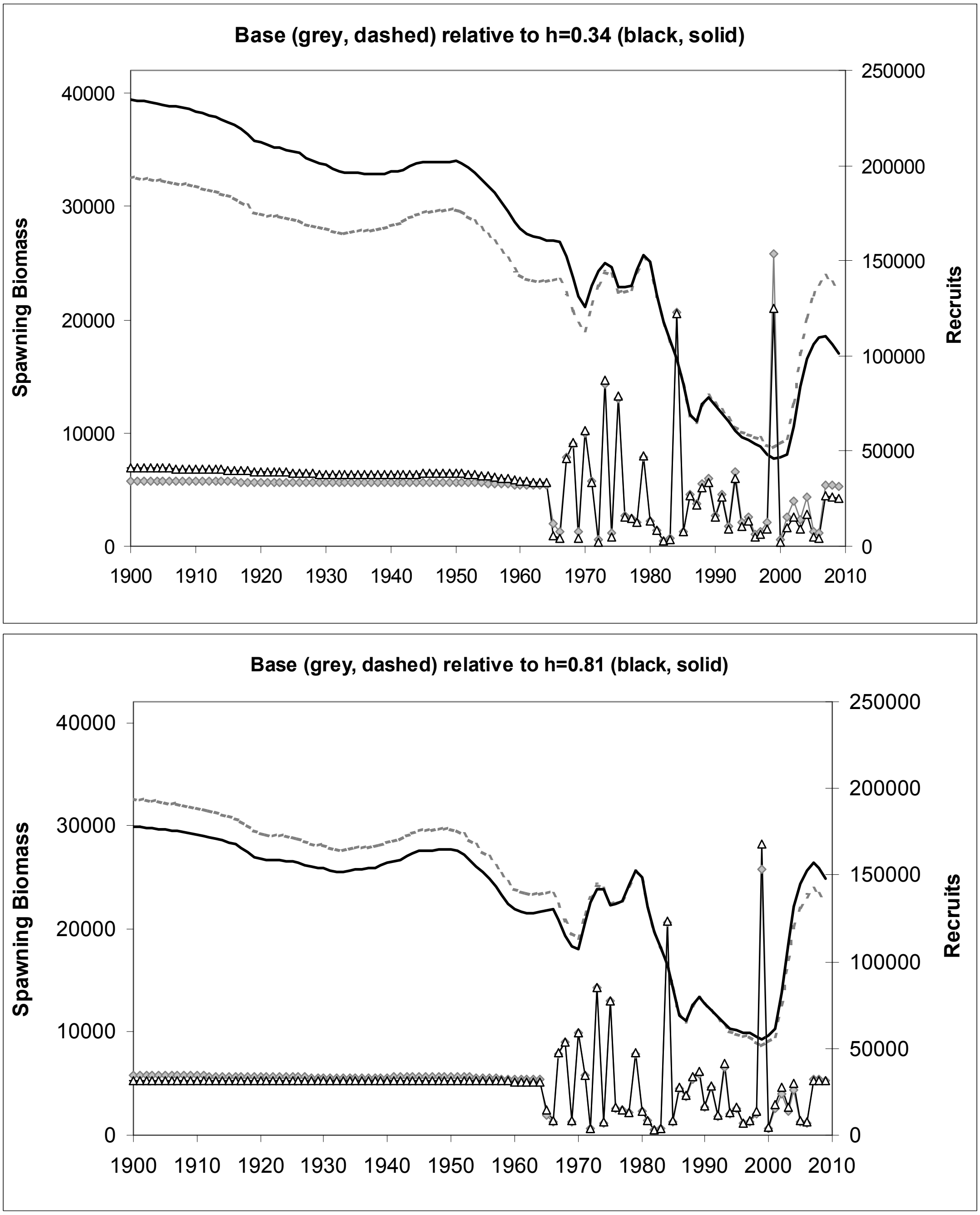


Figure 157-158: Estimated spawning biomass and recruitment trajectories when steepness is set to 0.34 (top, solid black lines) relative to the base model (grey, dashed lines) and when steepness is set to 0.81 (bottom).

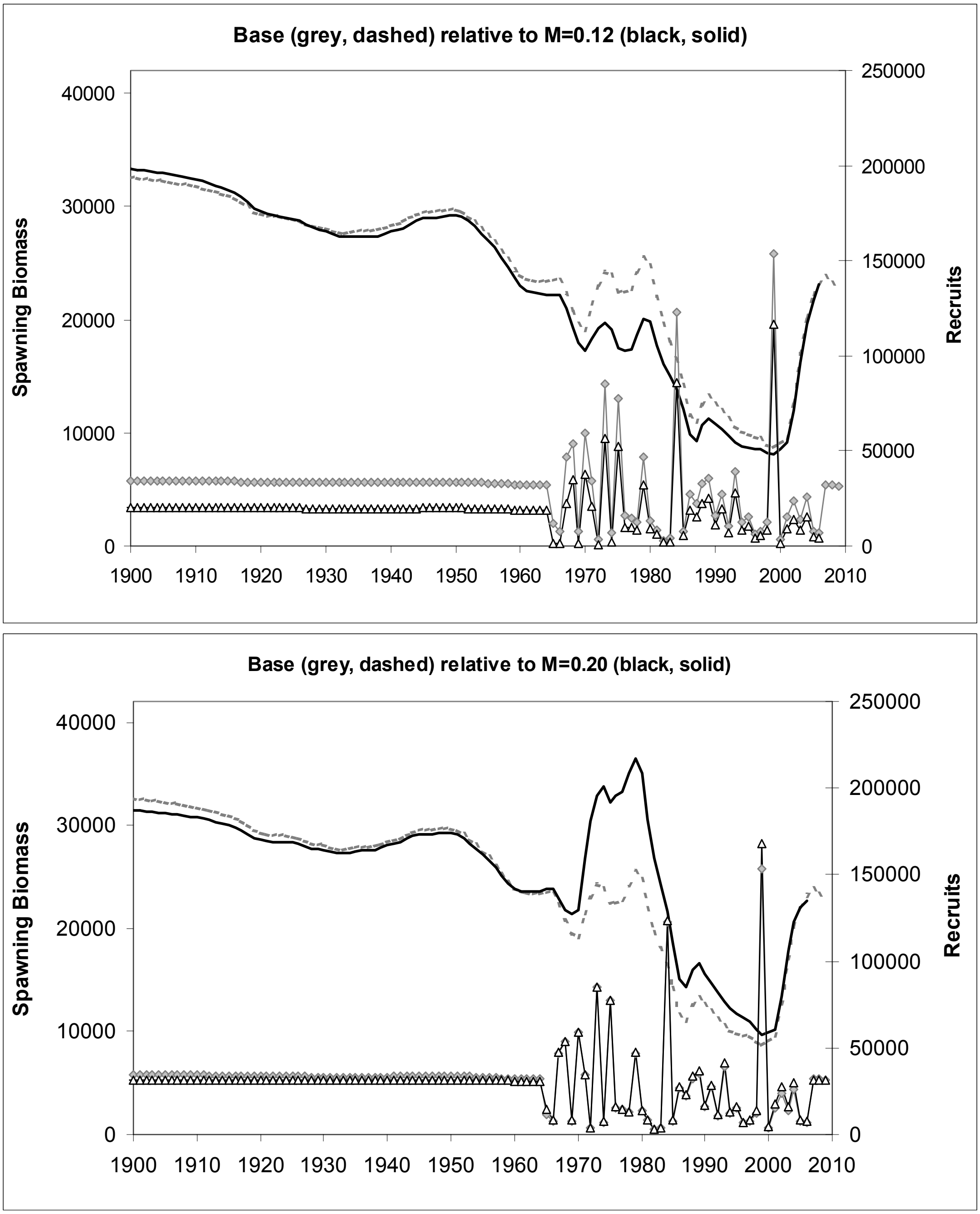
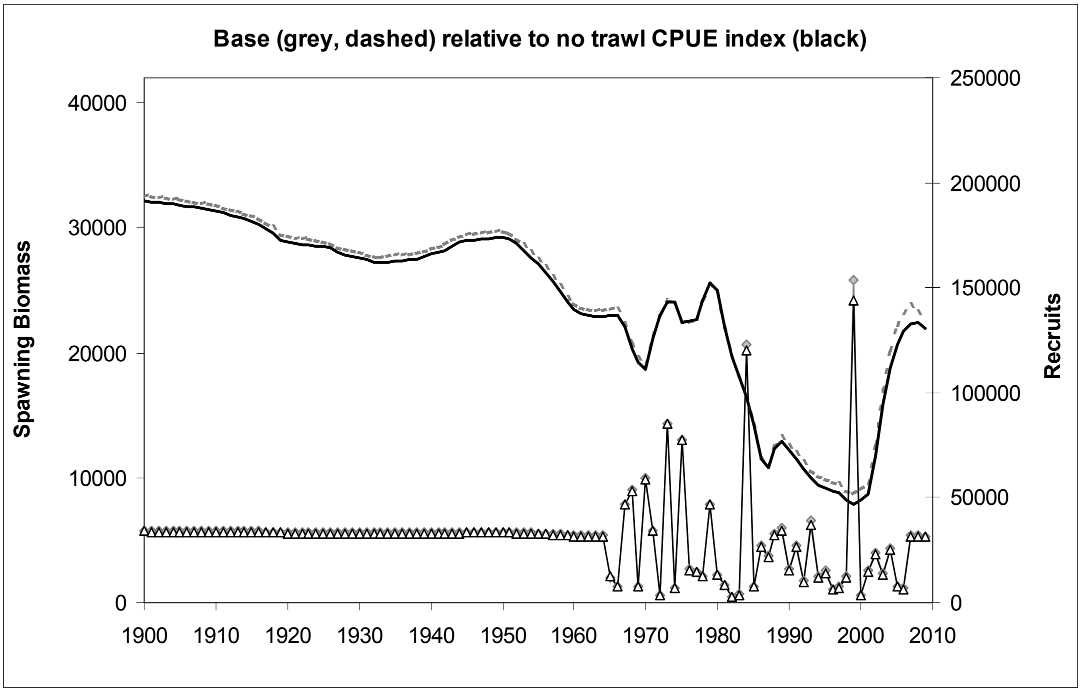


Figure 159-160: Estimated spawning biomass and recruitment trajectories when female natural mortality is set to 0.12 (top, solid black lines) relative to the base model (grey, dashed lines) and when steepness is set to 0.20 (bottom).



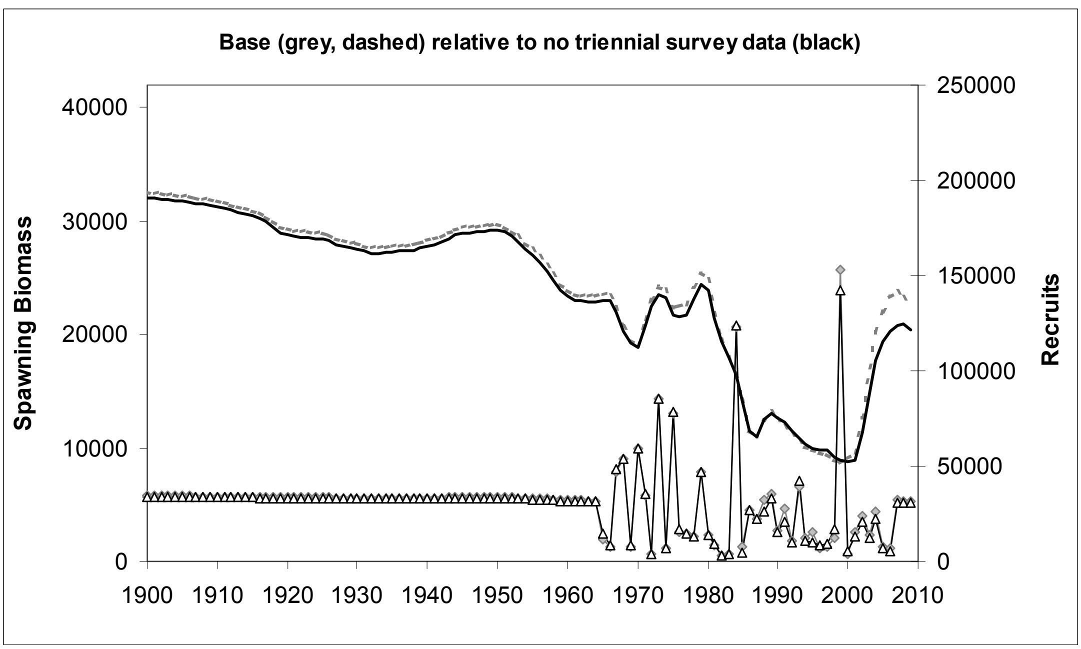
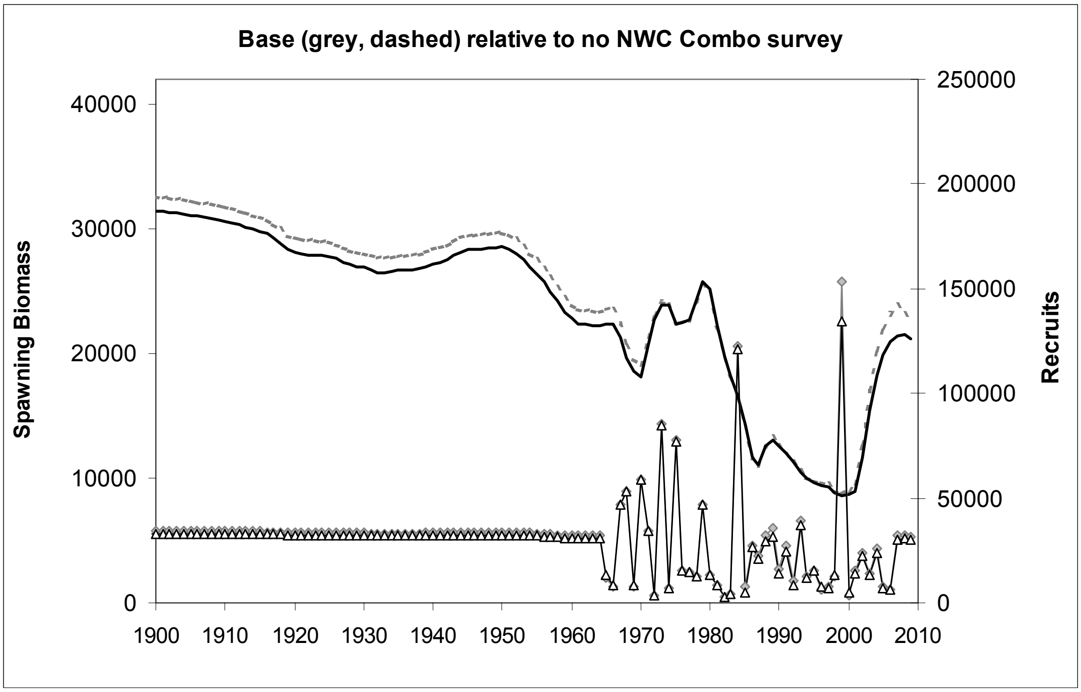


Figure 161-162: Estimated SSB and recruitment trajectories when the trawl fishery CPUE time series is excluded (top) relative to the base model and when the triennial survey index and length frequency data are excluded (bottom).



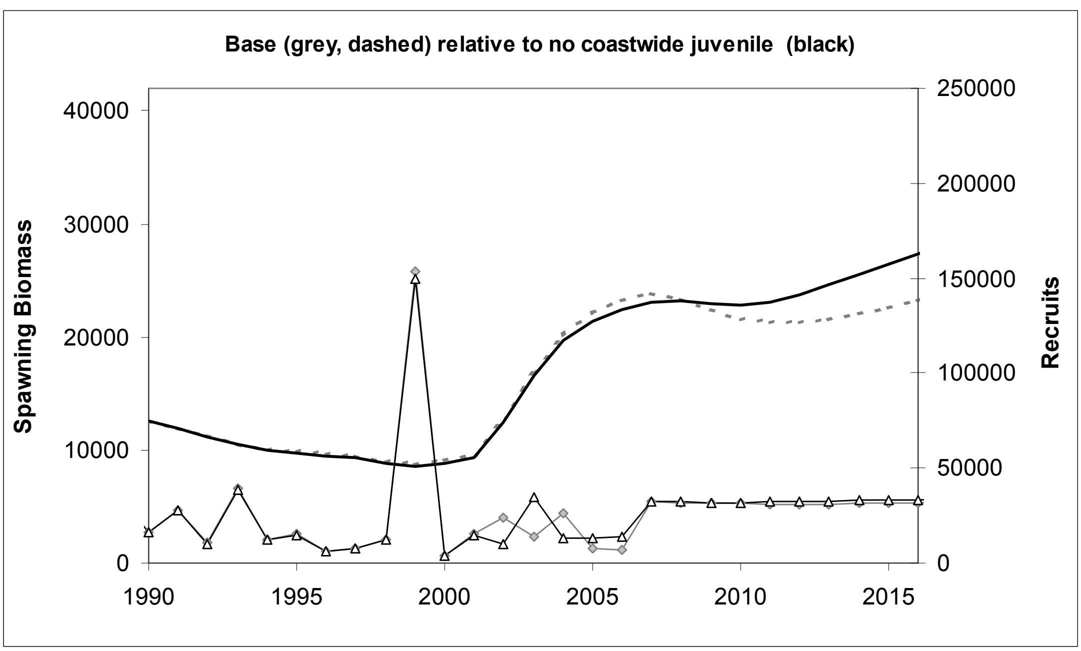
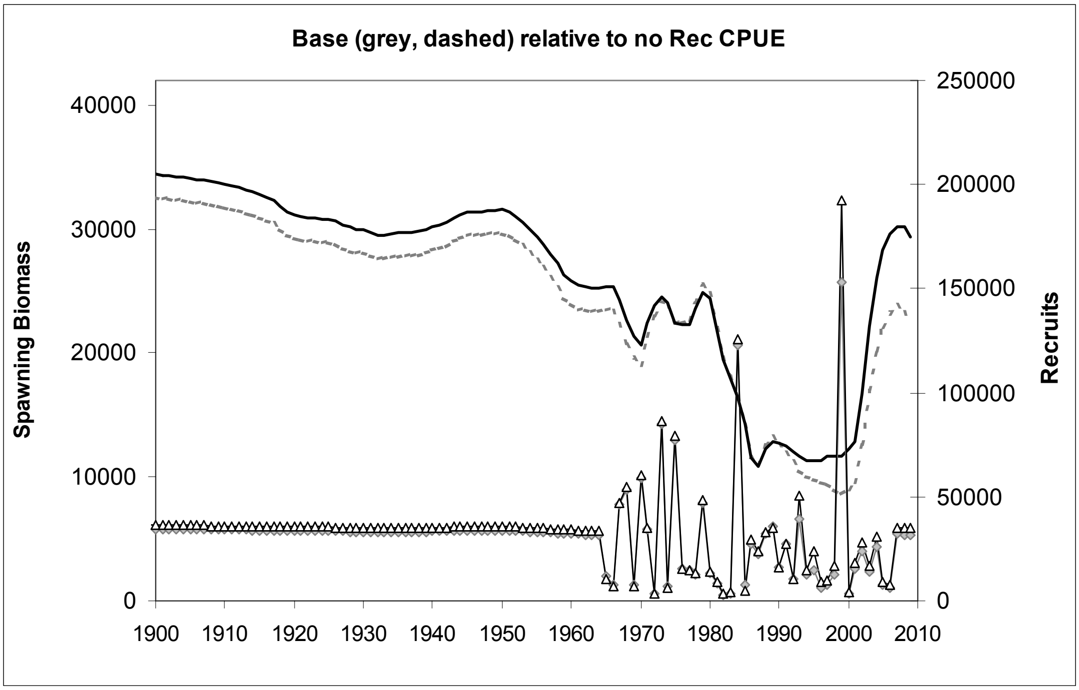


Figure 163-164: Estimated SSB and recruitment trajectories when the NWC combined survey data are excluded (top) and when the coastwide juvenile survey index is excluded (including forecast, bottom).



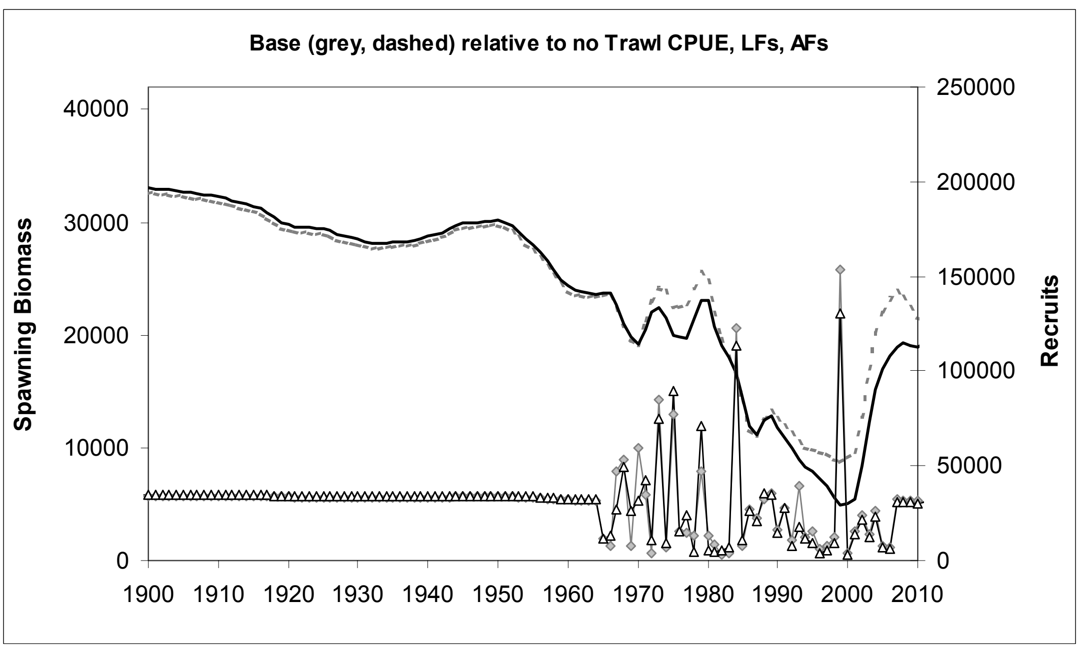
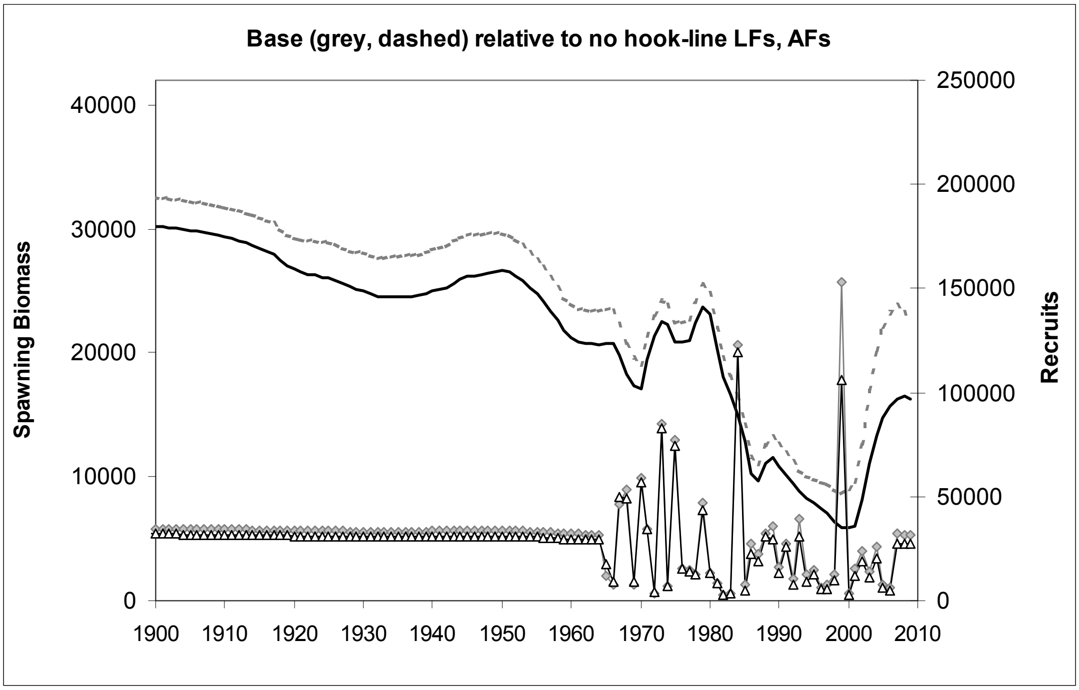


Figure 165-166: Estimated spawning biomass and recruitment trajectories when the recreational CPUE data are excluded (top), and when all trawl fishery data (CPUE, length composition, age composition) are excluded.



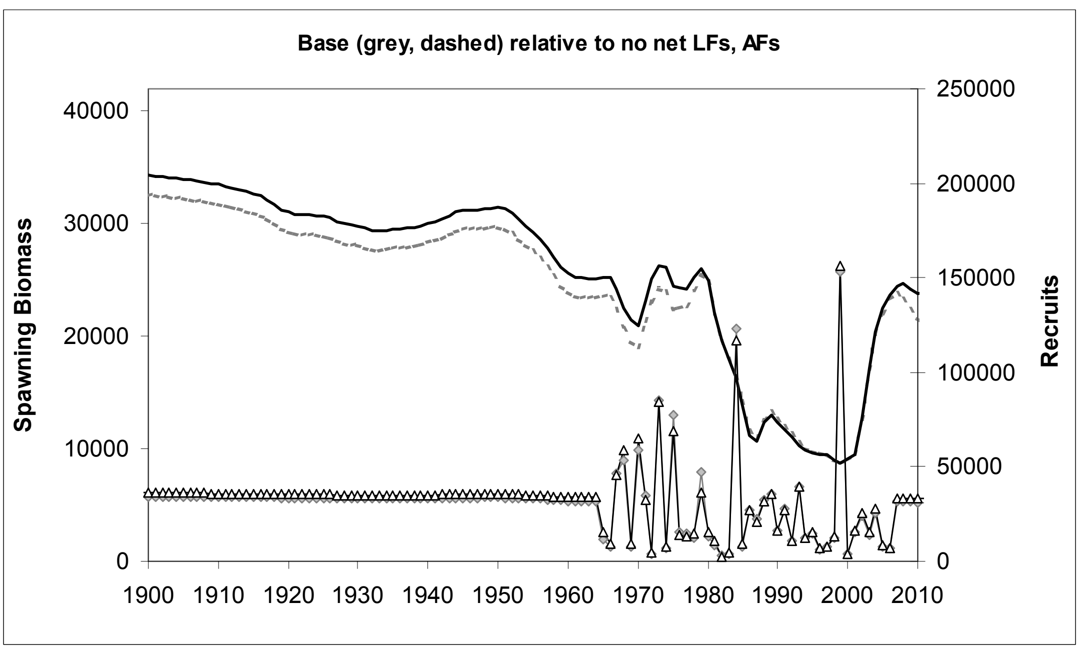


Figure 167-168: Estimated spawning biomass and recruitment trajectories when hook and line age and length data are excluded (top, solid black lines) and when the setnet fishery data are excluded (bottom).

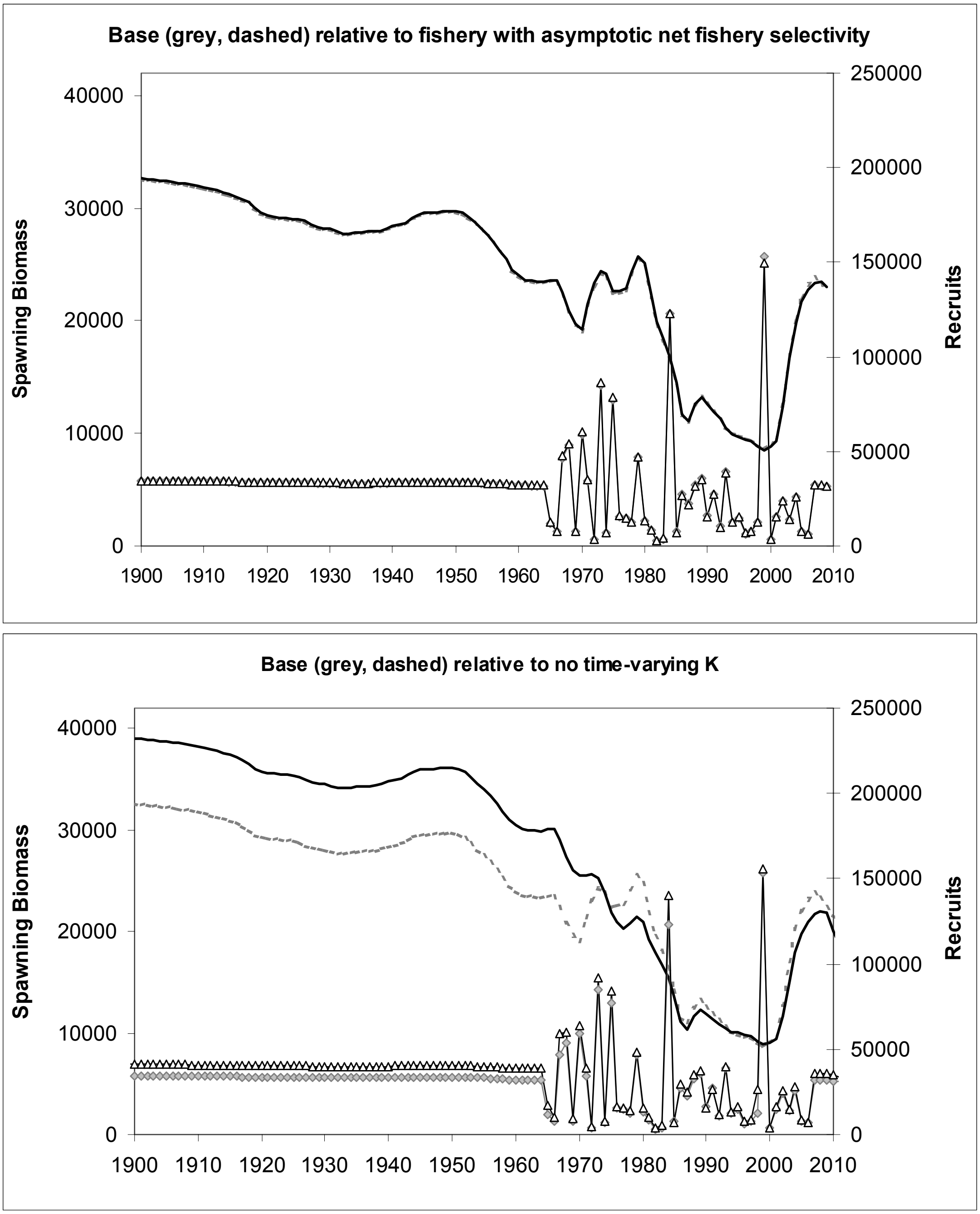
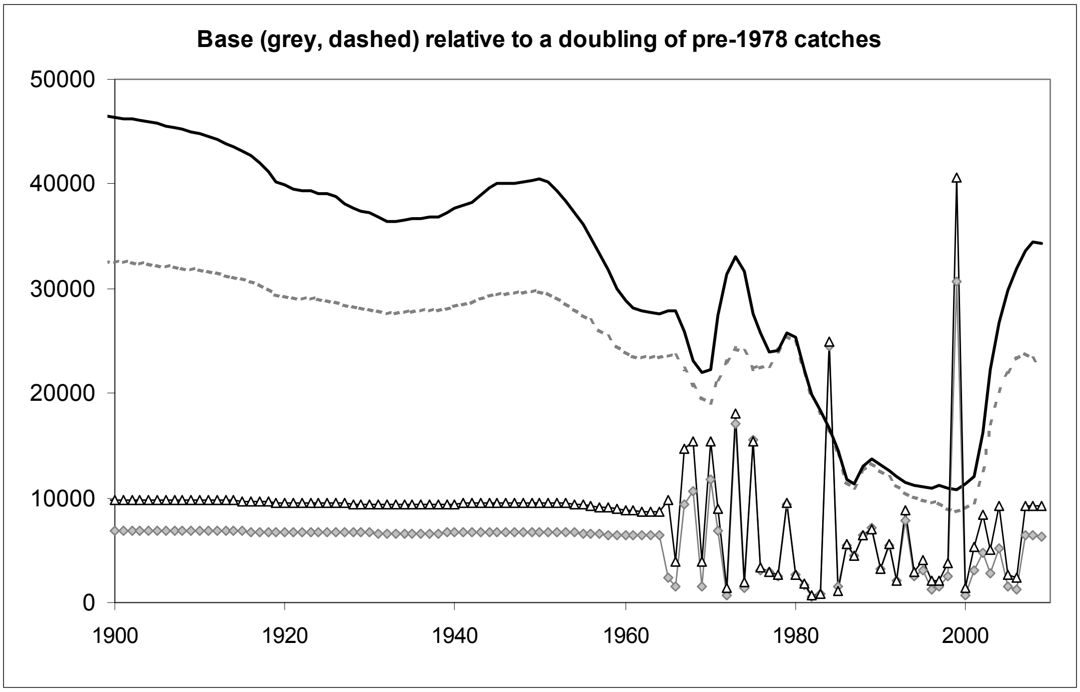


Figure 169-170: Estimated spawning biomass and recruitment trajectories with asymptotic selectivity estimated for the setnet fishery (top) and with time-invariant growth (bottom).



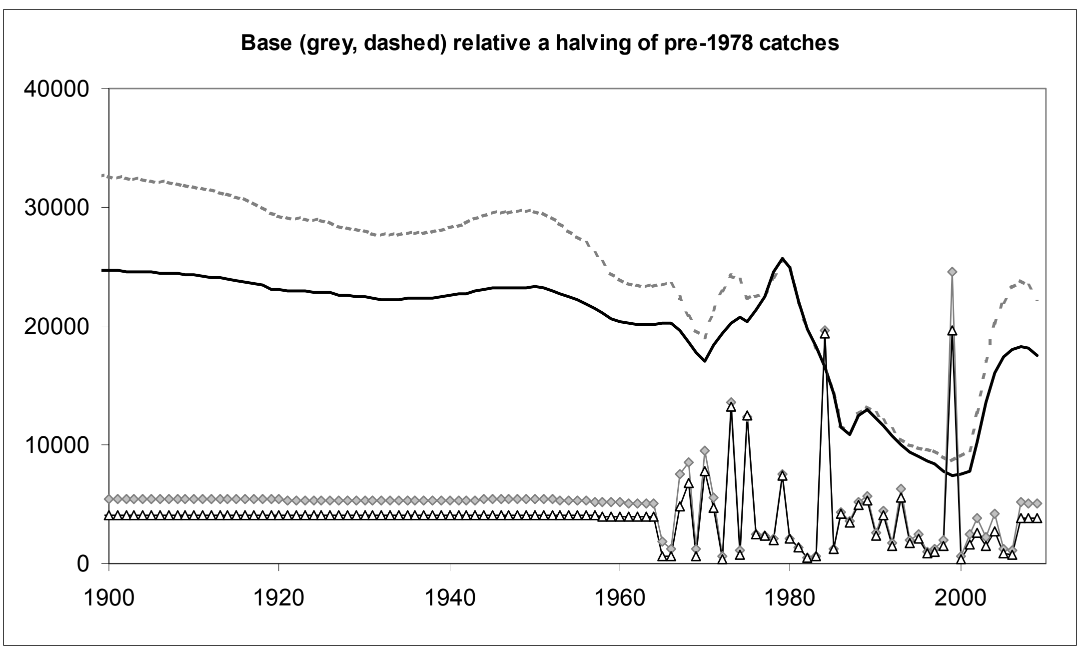
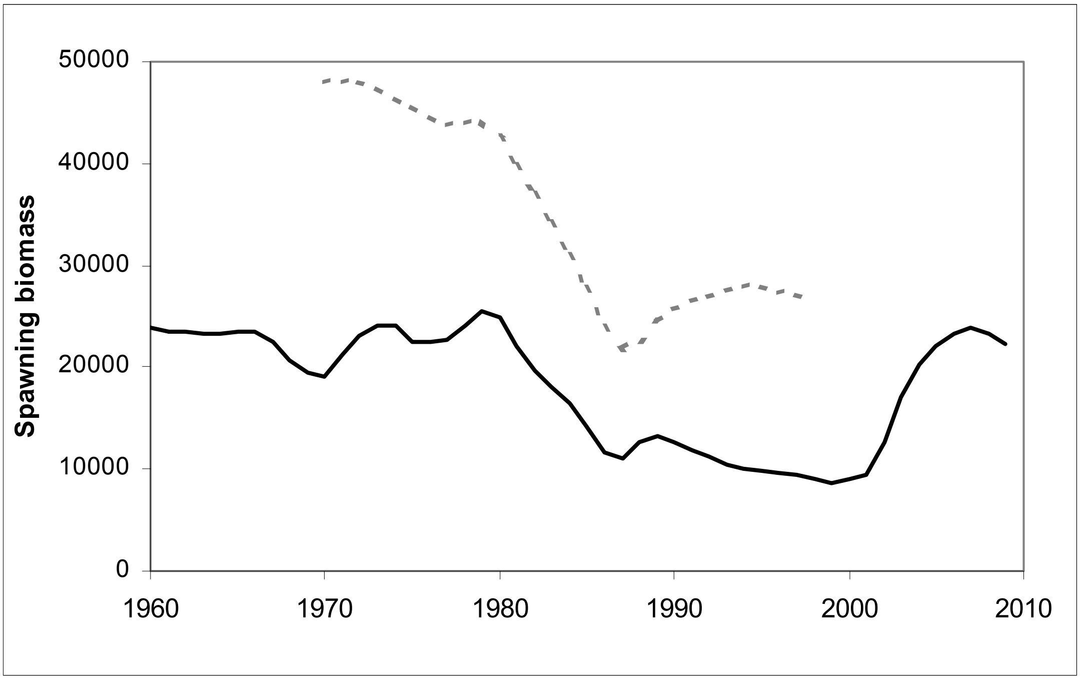


Figure 171-172: Estimated spawning biomass and recruitment trajectories when historical (pre-1970) catches are doubles (top) or halved (bottom)



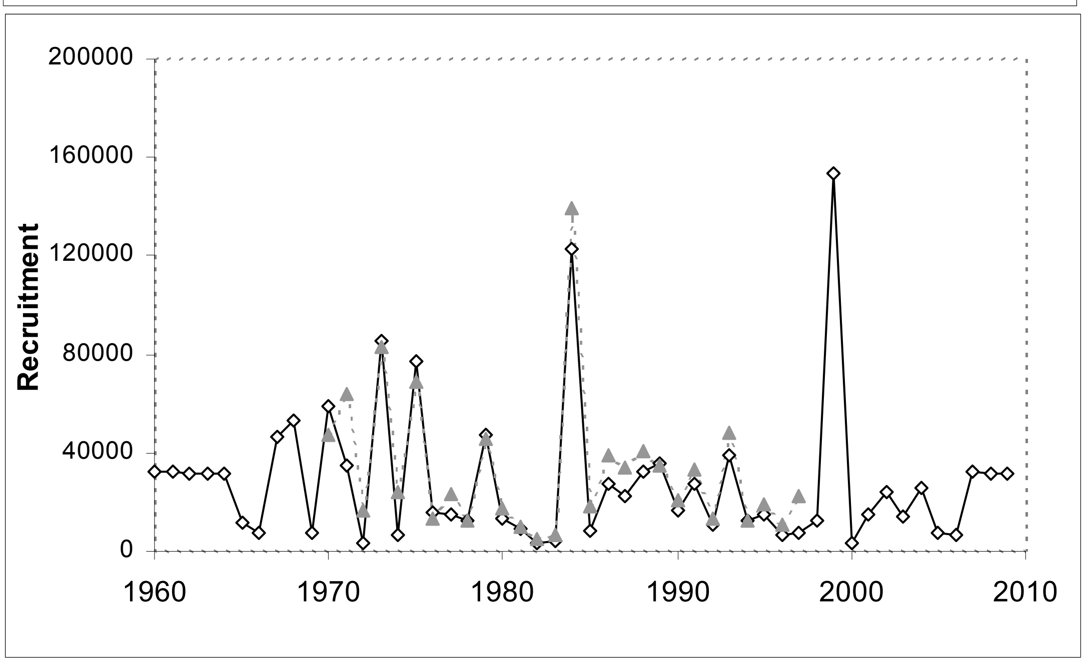
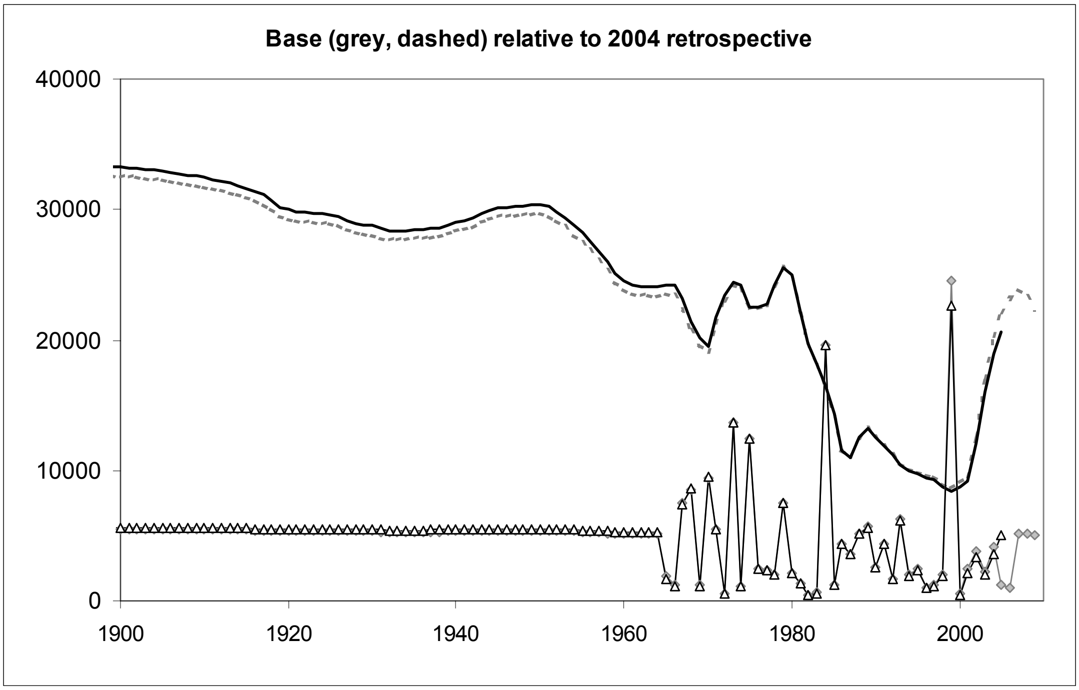


Figure 173-174: Comparison of the base model results with the results of the 1998 assessment for spawning biomass (top) and recruitment (bottom).



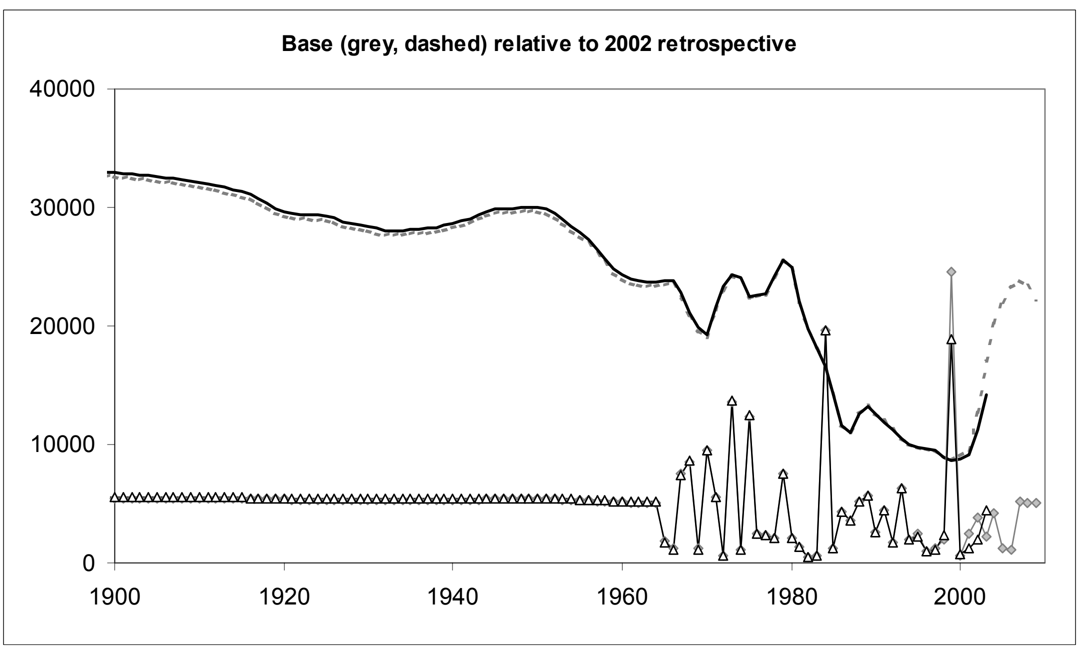


Figure 175-176: Comparison of the base model results with the results of the 2004 retrospective (top) and 2002 retrospective (bottom).

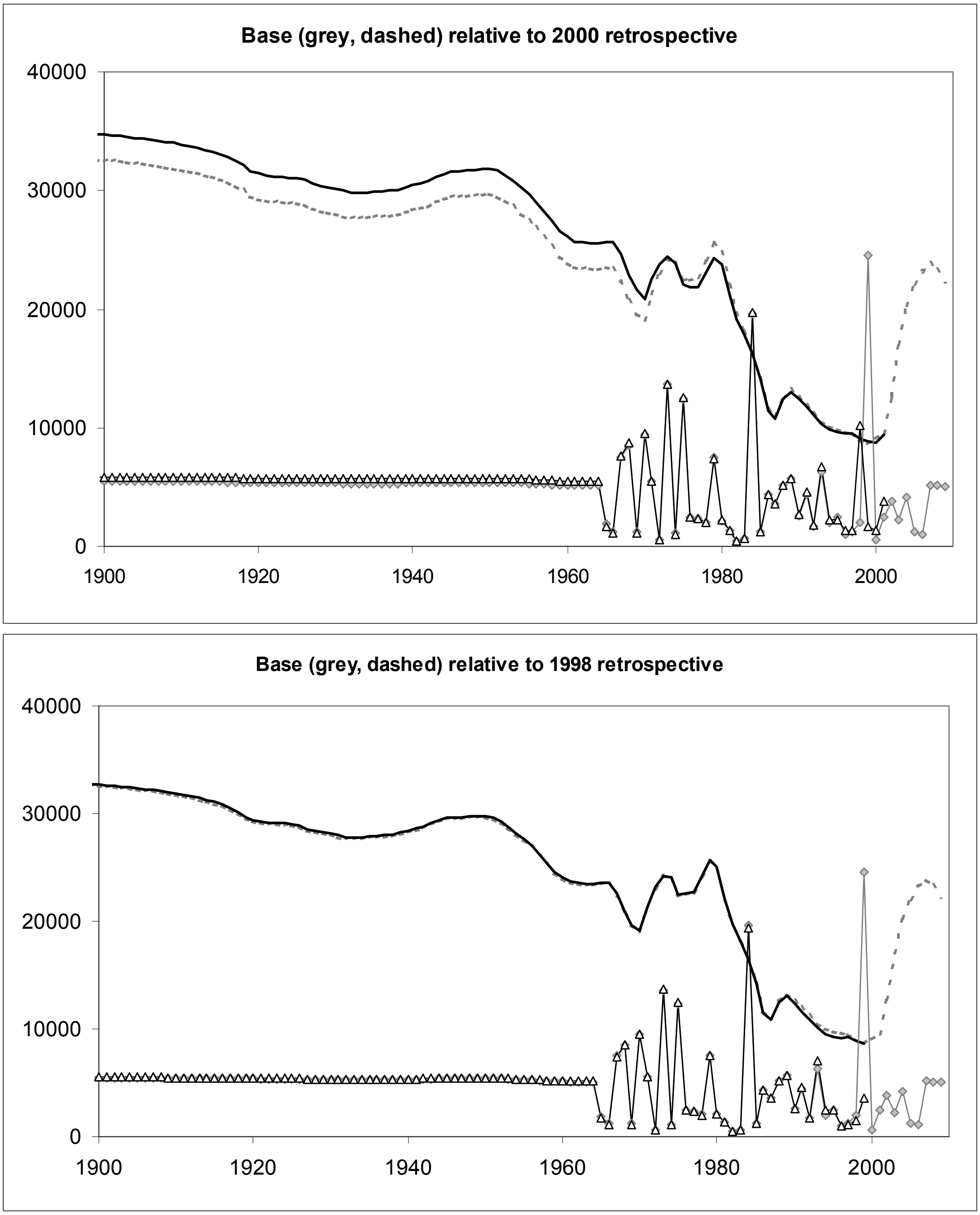


Figure 177-178: Comparison of the base model results with the results of the 1998 assessment for spawning biomass (top) and recruitment (bottom).

Appendix A: Detailed history of regulations affecting the harvest of chilipepper rockfish

Year	Period	Sector (s)	Cum. Limit	Area(s)	RCA Configuration
1983	Jan. 1 - June 27 June 28 - Sep. 9 Sep. 10 - Dec. 31	All comm.	40,000 lbs Sebastes/trip [1]	Coastwide	NA
1984	Jan. 1 - Dec. 31		40,000 lbs Sebastes/trip [2]	Eur., Mon., Concep.	
1985	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1986	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1987	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1988	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1989	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1990	Jan. 1 - Dec. 31	All comm.	40,000 lbs Sebastes/trip	Eur., Mon., Concep.	NA
1991	Jan. 1 - Dec. 31	All comm.	25,000 lbs Sebastes/trip of which no more than 5,000 lbs may be bocaccio	Eur., Mon., Concep.	NA
1992	Jan. 1 - Dec. 31	All comm.	50,000 lbs Sebastes/2 weeks of which no more than 8,000 lbs may be yellowtail (north of Cape Lookout, OR), no more than 10,000 lbs may be bocaccio (south of Cape Mendocino at 40°30' N lat.) [3]	Coastwide	NA
1993	Jan. 1 - Dec. 31	All comm.	50,000 lbs Sebastes/2 weeks of which no more than 8,000 lbs may be yellowtail (north of Coos Bay, OR), no more than 10,000 lbs may be bocaccio (south of Cape Mendocino at 40°30' N lat.) [4]	Coastwide	NA
1994	Jan. 1 - Dec. 31	All comm.[5]	80,000 lbs Sebastes/month of which no more than 14,000 lbs may be yellowtail (north of Cape Lookout, OR), no more than 30,000 lbs may be yellowtail (south of Cape Lookout, OR), no more than 30,000 lbs may be bocaccio (south of Cape Mendocino at 40°30' N lat.)	Coastwide	NA
	May 1 - Dec. 31	Setnet	40,000 lbs Sebastes/month	Off California	
	Sept. 1 - Dec. 31	LE	100,000 lbs Sebastes/month	South of Cape Mendocino at 40°30' N lat.	
1995			50,000 lbs Sebastes/month of which no more than 30,000 lbs may be yellowtail and no more than 6,000 lbs may be canary (coastwide)	Cape Lookout, OR - Cape Mendocino at 40°30' N lat.	NA
			100,000 lbs Sebastes/month of which no more than 30,000 lbs may be bocaccio and no more than 6,000 lbs may be canary (coastwide)	South of Cape Mendocino at 40°30' N lat.	
		OA	35,000 lbs Sebastes/month	North of Cape Lookout, OR	
			40,000 lbs Sebastes/month	South of Cape Lookout, OR	
		OA: hook-and-line and pot gears only	10,000 lbs Sebastes/trip	Coastwide	

1996	Jan. 1 - Oct. 31		100,000 lbs Sebastes/2 months of which no more than 70,000 lbs may be yellowtail and no more than 18,000 lbs may be canary (coastwide)	Cape Lookout, OR - Cape Mendocino at 40°30' N lat.	NA
	Jan. 1 - Dec. 31		200,000 lbs Sebastes/2 months of which no more than 60,000 lbs may be bocaccio and no more than 18,000 lbs may be canary (coastwide)	South of Cape Mendocino at 40°30' N lat.	
	Nov. 1 - Dec. 31		50,000 lbs Sebastes/month of which no more than 35,000 lbs may be yellowtail and no more than 9,000 lbs may be canary (coastwide)	Cape Lookout, OR - Cape Mendocino at 40°30' N lat.	
		OA	40,000 lbs Sebastes/month	South of Cape Lookout, OR	
		OA: hook-and-line and pot gears only	10,000 lbs Sebastes/trip	Coastwide	
1997	Jan. 1 - Apr. 30		150,000 lbs Sebastes/2 months of which no more than 12,000 lbs may be bocaccio and no more than 14,000 lbs may be canary (coastwide)	South of Cape Mendocino at 40°30' N lat.	NA
	May 1 - Sept. 30		150,000 lbs Sebastes/2 months of which no more than 10,000 lbs may be bocaccio and no more than 14,000 lbs may be canary (coastwide)		
	Oct. 1 - Dec. 31		75,000 lbs Sebastes/month of which no more than 5,000 lbs may be bocaccio and no more than 10,000 lbs may be canary (coastwide)		
	Jan. 1 - Dec. 31	OA [6]	40,000 lbs Sebastes/month	Coastwide	
		OA: hook-and-line and pot gears only [7]	10,000 lbs Sebastes/trip	Coastwide	
1998	Jan. 1 - June 30		150,000 lbs Sebastes/2 months of which no more than 2,000 lbs may be bocaccio and no more than 15,000 lbs may be canary (coastwide)	South of Cape Mendocino at 40°30' N lat.	NA
	July 1 - Aug. 31		40,000 lbs Sebastes/2 months of which no more than 10,000 lbs may be bocaccio and no more than 14,000 lbs may be canary (coastwide)		
	Sept. 1-30		40,000 lbs Sebastes/month of which no more than 10,000 lbs may be bocaccio and no more than 14,000 lbs may be canary (coastwide)		
	Oct. 1 - Dec. 31		15,000 lbs Sebastes/month of which no more than 10,000 lbs may be bocaccio and no more than 500 lbs may be canary (coastwide)		
	Jan. 1 - Dec. 31	OA [8]	40,000 lbs Sebastes/month	Coastwide	
	Oct. 1 - Dec. 31		Canary closed		
	Jan. 1 - Dec. 31	OA: hook-and-line and pot gears only [9]	10,000 lbs Sebastes/trip		

1999	Jan. 1 - March 31 (phase 1)	LE [10]	45,000 lbs chilipepper/3 months	South of Cape Mendocino at 40°30' N lat.	NA
	Apr. 1 - Sept. 30 (phase 2)		25,000 lbs chilipepper/2 months		
	Oct. 1 - Dec. 31 (phase 3)		5,000 lbs chilipepper/month		
	Jan. 1 - Dec. 31	OA	6,000 lbs chilipepper/month		
2000	Jan. 1 - Dec. 31	LE Trawl [11]	MW trawls: 25,000 lbs chilipepper/2 months; Sm. FR trawls: 7,500 lbs chilipepper/2 months	South of Cape Mendocino at 40°10' N lat.	NA
	Jan. 1 - Feb. 29	LE FG	2,000 lbs chilipepper/month	36° - 40°10' N lat.	
	Mar. 1 - Apr. 30		Closed		
	May 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29		Closed	South of 36° N lat.	
	Mar. 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29	OA	2,000 lbs chilipepper/month	36° - 40°10' N lat.	
	Mar. 1 - Apr. 30		Closed		
	May 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29		Closed	South of 36° N lat.	
	Mar. 1 - Dec. 31		2,000 lbs chilipepper/month		
2001	Jan. 1 - Oct. 31	LE Trawl [12]	MW trawls: 25,000 lbs chilipepper/2 months; Sm. FR trawls: 7,500 lbs chilipepper/2 months	South of Cape Mendocino at 40°10' N lat.	Cowcod Conservation Areas implemented.
	Nov. 1 - Dec. 31		MW trawls: 25,000 lbs chilipepper/2 months; Sm. FR trawls: 5,000 lbs chilipepper/2 months		
	Jan. 1 - Feb. 29	LE FG	2,000 lbs chilipepper/month	36° - 40°10' N lat.	
	Mar. 1 - Apr. 30		Closed		
	May 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29		Closed	South of 36° N lat.	
	Mar. 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29	OA	2,000 lbs chilipepper/month	36° - 40°10' N lat.	
	Mar. 1 - Apr. 30		Closed		
	May 1 - Dec. 31		2,000 lbs chilipepper/month		
	Jan. 1 - Feb. 29		Closed	South of 36° N lat.	
	Mar. 1 - Dec. 31		2,000 lbs chilipepper/month		
2002	Jan. 1- Apr. 30	LE Trawl	MW trawls: 25,000 lbs chilipepper/2 months; Sm. FR trawls: 7,500 lbs chilipepper/2 months; Lg. FR trawls: 500 lbs chilipepper/trip not to exceed the sm. FR cumulative limit	South of Cape Mendocino at 40°10' N lat.	NA
	May 1 - June 30		MW trawls: 25,000 lbs chilipepper/2 months; Sm. FR trawls: 4,000 lbs chilipepper/2 months; Lg. FR trawls: 500 lbs chilipepper/trip not to exceed the sm. FR cumulative limit		
	July 1 - Dec. 31		Closed		

	Jan. 1 - Feb. 28	LE FG	500 lbs chilipepper/month	34°27' - 40°10' N lat.	
	Mar. 1 - Dec. 31		Closed		
	Jan. 1 - Feb. 28		Closed	South of 34°27' N lat.	
	Mar. 1 - June 30		2,000 lbs chilipepper/month		
	July 1 - Dec. 31		Closed		
	Jan. 1 - Feb. 28	OA	500 lbs chilipepper/month	34°27' - 40°10' N lat.	
	Mar. 1 - Dec. 31		Closed		
	Jan. 1 - Feb. 28		Closed	South of 34°27' N lat.	
	Mar. 1 - June 30		2,000 lbs chilipepper/month		
	July 1 - Dec. 31		Closed		
2003	Jan. 1 - Feb. 28	LE Trawl	MW and sm. FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month	38° - 40°10' N lat.	50 - 250 fm w/ petrale areas
	Mar. 1 - Apr. 30				60 - 250 fm
	May 1 - Oct. 31				60 - 200 fm
	Nov. 1 - Dec. 31				shoreline - 200 fm w/ petrale areas
	Jan. 1 - Feb. 28			34°27' - 38° N lat.	50 - 150 fm
	Mar. 1 - Apr. 30				60 - 150 fm
	May 1 - Oct. 31				60 - 200 fm
	Nov. 1 - Dec. 31				shoreline - 200 fm w/ petrale areas
	Jan. 1 - Apr. 30			South of 34°27' N lat.	100 - 150 fm along mainland coast; shoreline - 150 fm around islands
	May 1 - Oct. 31				100 - 200 fm along mainland coast; shoreline - 200 fm around islands
	Nov. 1 - Dec. 31				shoreline - 200 fm along mainland coast and around islands w/ petrale areas
	Jan. 1 - Feb. 28	LE FG and OA	100 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months	34°27' - 40°10' N lat	20 - 150 fm
	Mar. 1 - Apr. 30		Closed		
	May 1 - June 30		200 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		
	July 1 - Aug. 31		250 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		
	Sept. 1 - Oct. 31		200 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		
	Nov. 1 - Dec. 31		100 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		shoreline - 150 fm
	Jan. 1 - Feb. 28		100 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months	South of 34°27' N lat.	20 - 150 fm along mainland coast and around islands
	Mar. 1 - Apr. 30		Closed		
	May 1 - June 30		200 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		

	July 1 - Aug. 31		250 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		
	Sept. 1 - Oct. 31		200 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		30 - 150 fm along mainland coast and around islands
	Nov. 1 - Dec. 31		100 lbs minor shelf rockfish, widow, chilipepper, and yellowtail/2 months		shoreline - 150 fm along mainland coast and around islands
2004	Jan. 1 - Apr. 30	LE Trawl	MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month	38° - 40°10' N lat.	75 - 150 fm; shoreline - 10 fm around Farallon Islands
	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month through June 30, then 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		100 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months through Dec. 31; sm FR trawls: 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		75 - 150 fm; shoreline - 10 fm around Farallon Islands
	Oct. 1 - Dec. 31		MW, lg. FR, and sm. FR trawls: 8,000 lbs of chilipepper/2 months		shoreline - 250 fm
	Jan. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month	36° - 38° N lat.	75 - 150 fm; shoreline - 10 fm around Farallon Islands
	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month through June 30, then 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		100 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months through Dec. 31; sm FR trawls: 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		75 - 150 fm; shoreline - 10 fm around Farallon Islands
	Oct. 1 - Dec. 31		MW, lg. FR, and sm. FR trawls: 8,000 lbs of chilipepper/2 months		shoreline - 200 fm
	Jan. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month	34°27' - 36° N lat.	75 - 150 fm
	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month through June 30, then 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		100 - 150 fm
	Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months through Dec. 31; sm FR trawls: 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		75 - 150 fm
	Oct. 1 - Dec. 31		MW, lg. FR, and sm. FR trawls: 8,000 lbs of chilipepper/2 months		shoreline - 150 fm
	Jan. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month	South of 34°27' N lat.	75 - 150 fm along mainland coast; shoreline - 150 fm around islands

	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, widow, and chilipepper/month through June 30, then 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		100 - 150 fm along mainland coast; shoreline - 150 fm around islands
	Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months through Dec. 31; sm FR trawls: 1,000 lbs of minor shelf rockfish, widow and chilipepper/month no more than 200 lbs of which may be minor shelf and widow rockfish through Sept. 30		75 - 150 fm along mainland coast; shoreline - 150 fm around islands
	Oct. 1 - Dec. 31		MW, lg. FR, and sm. FR trawls: 8,000 lbs of chilipepper/2 months		shoreline - 150 fm along mainland coast and around islands
	Jan. 1- Apr. 30	LE FG	2,000 lbs of chilipepper/2 months (opportunity only available seaward of the non-trawl RCA)	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands
	May 1 - Aug. 31				20 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - Dec. 31				30 - 150 fm; shoreline - 10 fm around Farallon Islands
	Jan. 1 - Dec. 31			South of 34°27' N lat.	60 - 150 fm along mainland coast and around islands
	Jan. 1 - Apr. 30	OA	300 lbs of minor shelf rockfish, widow, and chilipepper/2 months in period 1 (Jan. & Feb.); closed in period 2 (Mar. & Apr.)	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands
	May 1 - Aug. 31		200 lbs of minor shelf rockfish, widow, and chilipepper/2 months		20 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - Dec. 31		300 lbs of minor shelf rockfish, widow, and chilipepper/2 months		30 - 150 fm; shoreline - 10 fm around Farallon Islands
	Jan. 1 - Feb. 29		Closed	South of 34°27' N lat.	60 - 150 fm along mainland coast and around islands
	Mar. 1 - Dec. 31		500 lbs of minor shelf rockfish, widow, and chilipepper/2 months		
2005	Jan. 1 - Feb. 28	LE Trawl	MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month	38° - 40°10' N lat.	75 - 200 fm w/ petrale areas
	Mar. 1 - Apr. 30				100 - 200 fm
	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		100 - 150 fm
	Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		
	Oct. 1 - Dec. 31				shoreline - 250 fm
	Jan. 1 - Feb. 28		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month	36° - 38° N lat.	75 - 150 fm
	Mar. 1 - Apr. 30				100 - 150 fm
	May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		

Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		
Oct. 1 - Dec. 31				shoreline - 200 fm
Jan. 1 - Feb. 28		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month	34°27' - 36° N lat.	75 - 150 fm
Mar. 1 - Apr. 30				100 - 150 fm
May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		
Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		50 - 200 fm
Oct. 1 - Dec. 31				
Jan. 1 - Feb. 28		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month	South of 34°27' N lat.	75 - 150 fm along mainland coast; shoreline - 150 fm around islands
Mar. 1 - Apr. 30				100 - 150 fm along mainland coast; shoreline - 150 fm around islands
May 1 - Aug. 31		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		
Sept. 1 - 30		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of minor shelf rockfish, shortbelly, widow, yelloweye, and chilipepper/month		
Oct. 1 - Dec. 31				50 - 200 fm along mainland coast; shoreline - 200 fm around islands
Jan. 1- Apr. 30	LE FG	2,000 lbs of chilipepper/2 months (opportunity only available seaward of the non-trawl RCA)	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands
May 1 - Aug. 31				20 - 150 fm; shoreline - 10 fm around Farallon Islands
Sept. 1 - Dec. 31				30 - 150 fm; shoreline - 10 fm around Farallon Islands
Jan. 1 - Dec. 31			South of 34°27' N lat.	60 - 150 fm along mainland coast and around islands
Jan. 1 - Feb. 28	OA	300 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands
Mar. 1 - Apr. 30		Closed		
May 1 - Aug. 31		300 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		20 - 150 fm; shoreline - 10 fm around Farallon Islands
Sept. 1 - Dec. 31		300 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		30 - 150 fm; shoreline - 10 fm around Farallon Islands
Jan. 1 - Feb. 28		500 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months	South of 34°27' N lat.	60 - 150 fm along mainland coast and

	Mar. 1 - Apr. 30		Closed		around islands
	May 1 - June 30		500 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		
	July 1 - Dec. 31		750 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		
2006	Jan. 1 - Feb. 28	LE Trawl	MW and lg. FR trawls: 1,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month	38° - 40°10' N lat.	75 - 150 fm
	Mar. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month		100 - 150 fm
	May 1 - June 30		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		
	July 1 - Aug. 31				100 - 200 fm
	Sept. 1 - Oct. 31		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		100- 250 fm
	Nov. 1 - Dec. 31				75 - 250 fm w/ petrale areas
	Jan. 1 - Feb. 28		MW and lg. FR trawls: 1,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month	34°27' - 38° N lat.	75 - 150 fm
	Mar. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month		100 - 150 fm
	May 1 - June 30		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		
	July 1 - Aug. 31				
	Sept. 1 - Oct. 31		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		
	Nov. 1 - Dec. 31				75 - 150 fm
	Jan. 1 - Feb. 28		MW and lg. FR trawls: 1,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month	South of 34°27' N lat.	75 - 150 fm along mainland coast; shoreline - 150 fm around islands
	Mar. 1 - Apr. 30		MW and lg. FR trawls: 2,000 lbs of chilipepper/2 months; sm FR trawls: 300 lbs of chilipepper/month		100 - 150 fm along mainland coast; shoreline - 150 fm around islands
	May 1 - June 30		MW and lg. FR trawls: 12,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		
	July 1 - Aug. 31				
	Sept. 1 - Oct. 31		MW and lg. FR trawls: 8,000 lbs of chilipepper/2 months; sm FR trawls: 500 lbs of chilipepper/month		
	Nov. 1 - Dec. 31				75 - 150 fm along mainland coast; shoreline - 150 fm around islands
	Jan. 1- Apr. 30	LE FG	2,000 lbs of chilipepper/2 months (opportunity only available seaward of the non-trawl RCA)	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands
	May 1 - Aug. 31				20 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - Dec. 31				30 - 150 fm; shoreline - 10 fm around Farallon Islands
	Jan. 1 - Dec. 31			South of 34°27' N lat.	60 - 150 fm along mainland coast and around islands
	Jan. 1 - Feb. 28	OA	300 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months	34°27' - 40°10' N lat	30 - 150 fm; shoreline - 10 fm around Farallon Islands

	Mar. 1 - Apr. 30		Closed		
	May 1 - Aug. 31		200 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		20 - 150 fm; shoreline - 10 fm around Farallon Islands
	Sept. 1 - Dec. 31		300 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months		30 - 150 fm; shoreline - 10 fm around Farallon Islands
	Jan. 1 -Dec. 31		750 lbs of minor shelf rockfish, shortbelly, widow, and chilipepper/2 months	South of 34°27' N lat.	60 - 150 fm along mainland coast and around islands

(1) From Jan. 1 to June 27, Van. & Col. Sebastes HG = 14,000 mt, from June 28-Sept. 9, Van. & Col. Sebastes HG = 18,500 mt, 1 trip/week, from Sept. 10-Dec. 31, Van. & Col. 3,000 lbs/trip, no weekly trip limit.
(2) From 1984-1991, no weekly trip limits
(3) Sebastes harvest guideline north of Cape Lookout, OR = 8,000 mt; min. mesh size for trawl codends increased from 3 to 4.5 inches effective May 9, 1992.
(4) Sebastes harvest guideline north of Coos Bay, OR = 11,200 mt
(5) Groundfish fishery separated into limited entry and open access sectors w/ LE gear endorsements for trawl, longline, and pot/trap gears
(6) Setnets only legal south of 38° N lat.; setnets limited to 4,000 lbs bocaccio/month.
(7) Limits include 300 lbs bocaccio/trip, not to exceed 2,000 lbs/month south of Cape Mendocino (Jan. 1 - Apr. 30); 250 lbs bocaccio/trip not to exceed 2,000 lbs/month south of Cape Mendocino (May 1 - Dec. 31).
(8) Setnets only legal south of 38° N lat.; setnets limited to 2,000 lbs bocaccio/month.
(9) 250 lbs bocaccio/trip not to exceed 1,000 lbs/month south of Cape Mendocino (Jan. 1 - Dec. 31).
(10) First year of limits specifically for chilipepper rockfish. For limited entry fishery, a new three-phase cumulative limit period system is introduced: phase 1 is a single 3-month cum. limit period from Jan.1 - March 31, phase 2 has three separate 2-month cum. limit periods (Apr. 1 - May 31, June 1 - July 31, and Aug. 1 - Sept. 30, and phase 3 has three separate 1-month cum. limit periods (Oct. 1-31, Nov. 1-30 and Dec. 1-31); only POP and bocaccio have monthly limits within a cum. limit period.
(11) Cumulative landing limit periods redefined to encompass six 2-month periods through the year (Jan-Feb, Mar-Apr, May-June, July-Aug, Sept-Oct, and Nov-Dec). Chilipepper rockfish required to be sorted south of 40°10' N lat. Small footrope trawls required to land chilipepper rockfish in the LE trawl sector.
(12) Small footrope trawls required to land chilipepper rockfish in the LE trawl sector.

Appendix B: Data (.dat) and Control (.ctl) files for chilipepper rockfish model

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# ************************************************************
#  Chilipepper rockfish .dat file
#  final model from June 2007 STAR Panel
#  SS2 Version 2.00c by_Richard_Methot_(NOAA);_using_Otter_Research_ADMB_7.0.1
# ************************************************************
#
1892    # start year- first year of CalCOFI data
2006    # end year
1       # n seasons
12      # months/season
1       # spawning season
4       # fishing fleets
6       # surveys
trawl%hookline%setnet%rec%triennial%combined%juvsurvey%calcofi%juv2%ghost
0.5     0.5     0.5     0.5     0.5     0.5     0.5     0.1     0.5     0.5     #timing
2       # number of genders
21      # accumulator age
# catch (mtons)
0       0       0       0       # init equil
#trawl  hookln  gillnet rec
11      206     0       0       #       1892
10      195     0       0       #       1893
10      183     0       0       #       1894
9       171     0       0       #       1895
9       162     0       0       #       1896
8       152     0       0       #       1897
8       143     0       0       #       1898
7       133     0       0       #       1899
8       147     0       0       #       1900
8       161     0       0       #       1901
9       176     0       0       #       1902
10      190     0       0       #       1903
11      204     0       0       #       1904
11      218     0       0       #       1905
12      232     0       0       #       1906
13      246     0       0       #       1907
14      260     0       0       #       1908
15      292     0       0       #       1909
17      325     0       0       #       1910
19      358     0       0       #       1911
21      390     0       0       #       1912
22      423     0       0       #       1913
24      455     0       0       #       1914
26      488     0       0       #       1915
33      633     0       0       #       1916
41      778     0       0       #       1917
49      924     0       0       #       1918
32      605     0       0       #       1919
33      631     0       0       #       1920
28      534     0       0       #       1921
25      483     0       0       #       1922
30      571     0       0       #       1923
28      532     0       0       #       1924
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32	615	0	0	#	1925
44	845	0	0	#	1926
38	716	0	0	#	1927
37.05	701.45	0	0	#	1928
33.28	626.11	0	0.02	#	1929
41.41	780.81	0	0.11	#	1930
41.63	788.44	0	0.26	#	1931
32.87	622.52	0	0.46	#	1932
28.42	539.33	0	0.72	#	1933
26.63	503.03	0	1.04	#	1934
28.68	541	0	1.41	#	1935
29.29	552.03	0	1.84	#	1936
26.9	508	0	2.46	#	1937
20.24	371.34	0	2.69	#	1938
16.69	298.89	0	2.59	#	1939
19.81	362.24	0	4.07	#	1940
92.13	267.63	0	0	#	1941
55.41	51.91	0	0	#	1942
122.97	32.15	0	0	#	1943
210.21	9.15	0	0	#	1944
417.86	16.31	0	0	#	1945
362.4	17.56	0	0	#	1946
321.63	21.59	0	3.42	#	1947
312.78	25.71	0	8.83	#	1948
324.8	28.86	0	14.79	#	1949
510.48	47.9	0	17.61	#	1950
777.91	74.8	0	16.79	#	1951
935.3	97.74	0	21.66	#	1952
1068.63	111.16	0	27.36	#	1953
1036.67	117.59	0	60.75	#	1954
1149.08	122.25	0	109.39	#	1955
1344.04	163.3	0	135.95	#	1956
1433.55	173.86	0	79.32	#	1957
1504.31	326.47	0	57.85	#	1958
1286.21	271.22	0	35.8	#	1959
1258.21	148.56	0	36.69	#	1960
956.33	146.41	0	42.99	#	1961
917.45	155.6	0	45.01	#	1962
917.46	111.18	0	48.64	#	1963
711	105.72	0	66.79	#	1964
765.36	136.09	0	91.87	#	1965
1904.92	140.17	0	137.25	#	1966
2497.6	127.21	0	171.21	#	1967
1468.36	112.75	0	193.89	#	1968
810.32	103.79	0	176.31	#	1969
907.76	114.21	0	250.66	#	1970
866.94	154.71	0	231.32	#	1971
1371.84	215.02	0	312.43	#	1972
2893.25	371.42	0	379.74	#	1973
3192.94	282.37	0	485.07	#	1974
2588.29	260.32	0	379.17	#	1975
2334.62	210.45	0	546.82	#	1976
1490.73	166.5	0	433.94	#	1977
1293.23	169.16	25.83	445.32	#	1978
2003.71	176.6	54.19	490.43	#	1979
2720.86	95.87	45.38	392.91	#	1980

2294.63	139.13	71.28	271.32	#	1981
1680.73	356.35	85.42	369.44	#	1982
1879.45	80.23	345.21	159.78	#	1983
2447.65	98.1	231.04	145.75	#	1984
1807.06	278.99	738.69	357.66	#	1985
1269.14	330.88	1161.46	385.97	#	1986
1313.85	172.61	461.11	111.75	#	1987
1777.91	333.47	289.36	290.01	#	1988
2363.3	425.58	361.37	245.15	#	1989
2317.2	232.12	372.77	188.11	#	1990
2229.02	618.32	332.08	131.08	#	1991
1329.79	1052.67	296.72	74.04	#	1992
1282.12	860.86	232.91	17	#	1993
1267.12	484.99	107.71	17.16	#	1994
1594.58	324.9	94.05	7.17	#	1995
1528.08	254.23	57.67	30.31	#	1996
1613.97	339.29	82.97	73.47	#	1997
1137.97	208.84	77.62	5.39	#	1998
838.61	104.18	9.67	24.29	#	1999
403.38	50.6	6.11	38.92	#	2000
435.57	25.18	4.9	51.74	#	2001
300.03	6.22	0.42	22.25	#	2002 data from 2002 onward include
20.33	0.25	0.05	0	#	2003 WCGOP estimates of discard
203.1	10.43	2.86	19.43	#	2004
171.97	9.77	0.14	10.17	#	2005
104.74	17.62	0.45	3.85	#	2006

Abundance indices
94 # number of observations

#year	season	type	value	SD
1980	1	1	249	0.25
1981	1	1	150	0.25
1982	1	1	121	0.25
1983	1	1	116	0.25
1984	1	1	91	0.25
1985	1	1	88	0.25
1986	1	1	76	0.25
1987	1	1	116	0.25
1988	1	1	158	0.25
1989	1	1	172	0.25
1990	1	1	149	0.25
1991	1	1	146	0.25
1992	1	1	109	0.25
1993	1	1	80	0.25
1994	1	1	112	0.25
1995	1	1	126	0.25
1996	1	1	96	0.25

#
triennial GLM tuned

1980	1	5	3954.37	1.625
1983	1	5	1994.42	0.613
1986	1	5	1166.33	1.213
1989	1	5	2400.58	0.300
1992	1	5	368.77	0.581
1995	1	5	1545.10	0.264
1998	1	5	945.46	0.341

2001	1	5	806.63	0.285
2004	1	5	2157.54	0.254

#NWC combo survey glm tuned

2003	1	6	3932	0.61654
2004	1	6	24559	1.19248
2005	1	6	9540	0.4466
2006	1	6	7384	0.40252

juvenile survey- FED

#year	season	type	value	SD
1984	1	7	7.3254	0.37012
1985	1	7	8.1232	0.4589
1986	1	7	0.7227	0.3300
1987	1	7	13.2204	0.3468
1988	1	7	16.3753	0.3859
1989	1	7	0.3869	0.4811
1990	1	7	0.3093	0.4094
1991	1	7	0.9761	0.3383
1992	1	7	0.1687	0.5192
1993	1	7	10.3256	0.2972
1994	1	7	0.0235	0.8093
1995	1	7	0.2455	0.6069
1996	1	7	0.0909	0.5163
1997	1	7	0.1310	0.7428
1999	1	7	0.2059	0.4342
2000	1	7	0.0888	0.5242
2001	1	7	0.8528	0.3412
2002	1	7	2.2921	0.3228
2003	1	7	1.0052	0.4103
2004	1	7	1.3333	0.3902

#

2001	1	8	1.7161	0.0401
2002	1	8	2.7629	0.0451
2003	1	8	1.5719	0.0367
2004	1	8	2.9379	0.0360
2005	1	8	0.8658	0.0346
2006	1	8	0.7523	0.0301

#

#

CalCOFI survey

#year	season	type	Index	CV
#year	season	type	Index	CV
1951	1	9	0.14183053	0.8414901
1953	1	9	0.16864622	0.4698166
1954	1	9	0.21885162	0.3547108
1955	1	9	0.2545118	0.4020231
1956	1	9	0.12075705	0.6590477
1957	1	9	0.30887709	0.522799
1958	1	9	0.39454343	0.3479359
1959	1	9	0.08842933	0.4466416
1960	1	9	0.18220879	0.3299083
1961	1	9	0.08775916	0.5532203
1962	1	9	0.068755	0.6127899
1963	1	9	0.19684699	0.4639924
1964	1	9	0.0631976	0.5157418
1965	1	9	0.14914866	0.3859004

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1966	1	9	0.24731002	0.3842774
1967	1	9	0.34379234	0.540158
1968	1	9	0.63368278	0.5381044
1969	1	9	0.55183877	0.3579827
1970	1	9	0.27392882	0.5389176
1975	1	9	0.02550871	0.6909198
1992	1	9	0.12549796	0.5956311
2002	1	9	0.04308614	0.6761029
2003	1	9	0.08688551	0.4902213
2004	1	9	0.1717815	0.4136779
2005	1	9	0.01187012	0.7130089
2006	1	9	0.03316714	0.7720739
# rec cpue
#year	season	type	index	jack.cv
1987	1	10	0.166856206	0.1631351
1988	1	10	0.083010716	0.1794928
1989	1	10	0.054122438	0.1633441
1990	1	10	0.031462634	0.4267126
1991	1	10	0.040173333	0.3545357
1992	1	10	0.064866103	0.5545214
1993	1	10	0.026517113	0.2333201
1994	1	10	0.023850668	0.2796596
1995	1	10	0.024610012	0.4197283
1996	1	10	0.015093027	0.4449115
1997	1	10	0.008328447	0.3430329
1998	1	10	0.006612019	0.421573


# Discard section- currently I have no discard data
2	# Discard biomass (1=biomass, 2=fraction)
0	# number of observations
# mean body weight (in kg)
0	# number of observations
# length composition
-1	# compress tails of composition (negative turns off)
0.0001	# constant added to observed and expected proportions at age
19	# number of length bins
16	18	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52
112	# number of length observations-
# length composition
#
# Trawl fishery		Females first, then males			females

		males

#year	season	type	gender	partition	# samples		16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52	16
	18	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52
1978	1	1	3	0	147	0.00022	0	0	0.01818	0.00388	0.00229	0.00744
	0.01194	0.04564	0.05786	0.04806	0.05182	0.07637	0.10655	0.05257	0.04429	0.07482	0.01717	0.01018	0
	0	0	0.00021	0.00069	0.00102	0.01447	0.05906	0.18275	0.04776	0.04849	0.01021	0.00039	0
	0.00018	0.00121	0	0.00429	0
1979	1	1	3	0	110	0	0	0.00049	0	0.00004	0.00132	0.02087	0.0092
	0.01246	0.04269	0.03287	0.03745	0.1193	0.066	0.17126	0.10614	0.08089	0.00735	0.00528	0	0
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	0	0	0.00041	0.00095	0.00821	0.04017	0.0724	0.06751	0.05974	0.03585	0.00011	0.00001	0.0008
	0	0.00008	0.00017	0									
1980	1	1	3	0	191	0	0	0.00039	0	0	0.00349	0.00287	0.0041
	0.02768	0.05072	0.06043	0.1232	0.09582	0.10987	0.08439	0.07823	0.03707	0.0149	0.00063	0	0
	0	0	0.00342	0.00256	0.00799	0.03147	0.08474	0.09921	0.04584	0.01837	0.00273	0.00223	
	0.00025	0.00042	0.0066	0.00008	0.0003								
1981	1	1	3	0	125	0	0	0	0	0	0.00088	0.00667	
	0.00529	0.01266	0.01064	0.09861	0.2005	0.09316	0.10213	0.0487	0.07159	0.04917	0.00273	0.00009	0
	0	0	0	0	0.00064	0.00026	0.04874	0.11222	0.12205	0.0119	0.00084	0.00005	
	0.00046	0	0.00002	0	0	0							
1982	1	1	3	0	195	0	0	0	0.00035	0.00022	0.00067	0.00525	
	0.01354	0.01678	0.0125	0.06505	0.08043	0.13048	0.18373	0.15391	0.076	0.03757	0.01085	0.00174	0
	0	0	0.00078	0.00005	0.00359	0.00727	0.02841	0.07633	0.06915	0.02099	0.00408	0.00023	
	0.00006	0	0	0	0	0							
1983	1	1	3	0	275	0	0	0	0	0.0002	0.00113	0.00338	
	0.01176	0.01812	0.01728	0.02633	0.03683	0.13454	0.20614	0.14642	0.11552	0.07491	0.02504	0.00759	0
	0	0	0.00004	0.0001	0.00066	0.00736	0.03449	0.03921	0.05539	0.02184	0.00391	0.00018	
	0.00244	0.00191	0.00005	0.00001	0.00007	0.00715							
1984	1	1	3	0	305	0	0	0	0.00003	0.00006	0.00369	0.00333	
	0.01501	0.05746	0.08824	0.16352	0.06524	0.10441	0.07823	0.06725	0.04769	0.02093	0.00477	0.0017	
	0.00002	0	0	0	0.00009	0.00102	0.02879	0.03878	0.0771	0.06447	0.05422	0.00792	
	0.00032	0.00166	0.00061	0.00242	0.00049	0.00052	0.00002						
1985	1	1	3	0	338	0	0	0	0.001	0.00035	0.00128	0.00832	
	0.02207	0.04019	0.06271	0.08883	0.11605	0.06376	0.05989	0.07079	0.04972	0.02535	0.00534	0.00193	0
	0	0	0.00009	0.00011	0.00232	0.01902	0.06599	0.10678	0.1175	0.04632	0.01314	0.00603	
	0.00042	0.00045	0.00138	0.0015	0.00138	0							
1986	1	1	3	0	219	0.00044	0.0001	0	0.00022	0.00009	0.00458	0.00832	
	0.02425	0.0379	0.0594	0.07245	0.09209	0.07529	0.05696	0.07571	0.06683	0.03424	0.03705	0.00078	0
	0.00004	0	0.00093	0.0034	0.00564	0.01592	0.09321	0.10176	0.06953	0.03448	0.01659	0.00662	
	0.00095	0	0.0018	0.00244	0	0							
1987	1	1	3	0	211	0.00016	0	0.00012	0.00003	0.00189	0.01545	0.07235	
	0.16683	0.09549	0.04457	0.03733	0.04516	0.04761	0.04209	0.0179	0.00896	0.00521	0.00057	0.00056	0
	0	0	0	0.00112	0.04064	0.1188	0.06182	0.08213	0.06136	0.02295	0.00782	0.00086	
	0.00019	0.00001	0.00001	0	0	0							
1988	1	1	3	0	199	0	0	0	0	0.00003	0.01118	0.03265	
	0.08052	0.0893	0.10642	0.08444	0.01661	0.03359	0.05067	0.02813	0.01291	0.00676	0.00425	0.0009	0
	0	0	0.00003	0.00014	0.04746	0.12885	0.10265	0.08427	0.0428	0.03387	0.00139	0	
	0.00016	0.00001	0	0	0	0							
1989	1	1	3	0	183	0.00007	0	0	0	0.00207	0.00491	0.0133	
	0.01524	0.05436	0.09059	0.13372	0.17294	0.02935	0.01437	0.01396	0.00704	0.00758	0.00131	0	0
	0	0	0.00096	0.00612	0.00994	0.0414	0.15366	0.12776	0.06141	0.03496	0.00173	0.00017	
	0.00098	0	0.00009	0	0	0							
1990	1	1	3	0	204	0.00001	0	0.00006	0	0.00355	0.00738	0.03629	
	0.04755	0.04567	0.04607	0.06876	0.14846	0.10491	0.043	0.03709	0.00822	0.00432	0.00119	0.00018	0
	0	0	0	0.00195	0.02245	0.05403	0.08982	0.12547	0.04891	0.04953	0.004	0.00087	0
	0.00021	0	0.00002	0.00005	0								
1991	1	1	3	0	208	0.00017	0	0.0005	0.00091	0.00456	0.01515	0.02599	
	0.05384	0.08291	0.06996	0.06904	0.07213	0.07997	0.04056	0.03088	0.01192	0.0107	0.00363	0.00104	0
	0	0.00015	0.00013	0.00662	0.01265	0.05956	0.10457	0.13979	0.06707	0.02766	0.00608	0.00157	0
	0.00009	0	0.0002	0	0								
1992	1	1	3	0	132	0	0	0	0.00005	0.00405	0.0288	0.05881	
	0.09328	0.08427	0.06824	0.04726	0.07089	0.06935	0.07266	0.04536	0.03254	0.02026	0.00379	0	0
	0	0.00001	0.00008	0.00384	0.02468	0.03734	0.0624	0.08162	0.05922	0.01503	0.00609	0.00293	
	0.00213	0.00284	0.00075	0.00142	0	0							
1993	1	1	3	0	126	0	0.00012	0.00001	0.00064	0.00864	0.01402	0.05882	
	0.16809	0.08456	0.08385	0.08023	0.05142	0.04641	0.04061	0.02042	0.00764	0.00506	0.00094	0	0

	0	0	0.00203	0.00957	0.06125	0.11245	0.07924	0.04639	0.01194	0.00498	0.00006	0	0
	0	0	0	0.0006	0								
1994	1	1	3	0	117	0	0	0	0	0.00167	0.0112	0.02259	
	0.02581	0.04153	0.06489	0.1126	0.06874	0.07034	0.05595	0.05194	0.02649	0.01075	0.00073	0.0009	0
	0	0	0	0.00184	0.04468	0.08946	0.12132	0.0972	0.06042	0.01519	0.0029	0.00021	
	0.00068	0	0	0	0	0							
1995	1	1	3	0	114	0	0	0	0.00035	0.00078	0.00111	0.00893	
	0.03026	0.05741	0.05007	0.08525	0.12008	0.09374	0.06827	0.0388	0.02381	0.00884	0.00242	0.00119	
	0.00175	0	0	0.00205	0	0.01412	0.03783	0.08782	0.14094	0.0774	0.03078	0.00468	
	0.00073	0.00171	0.00223	0.0049	0	0	0.00175						
1996	1	1	3	0	116	0	0	0	0.00033	0.00445	0.03196	0.08891	
	0.08369	0.0443	0.04167	0.05217	0.04535	0.06299	0.06357	0.01947	0.01333	0.00335	0.00023	0.00019	0
	0	0	0.00168	0.01966	0.10183	0.10599	0.06959	0.07843	0.0509	0.01033	0.00186	0.00194	0.0005
	0.00132	0	0	0	0								
1997	1	1	3	0	136	0	0	0	0.00077	0.00202	0.00216	0.02881	
	0.12925	0.10512	0.03317	0.02917	0.05403	0.05664	0.04962	0.04472	0.01526	0.00855	0.0007	0.00001	0
	0	0	0.0033	0.00045	0.06268	0.14975	0.09977	0.06919	0.02845	0.01467	0.00857	0.0001	
	0.00137	0.00127	0.00042	0	0	0							
1998	1	1	3	0	123	0	0	0	0	0.00397	0.01444	0.0224	
	0.03925	0.06226	0.09141	0.0686	0.06555	0.07515	0.05957	0.04919	0.03089	0.00886	0.00108	0.0018	0
	0	0	0	0.04411	0.01694	0.06933	0.12133	0.08988	0.03285	0.02736	0.00183	0.00042	0.0005
	0.00085	0.00014	0.00003	0.00001	0								
1999	1	1	3	0	84	0.00047	0.00112	0	0	0.00036	0.00233	0.03304	
	0.08849	0.0807	0.03665	0.06671	0.08052	0.05581	0.07201	0.05503	0.04537	0.01173	0.00715	0.00016	0
	0	0	0	0.00011	0.03147	0.08443	0.10657	0.07571	0.04674	0.01023	0.00673	0	
	0.00002	0.00035	0	0	0	0							
2000	1	1	3	0	50	0	0	0	0.00228	0.00019	0.00019	0.00928	
	0.01157	0.02875	0.05166	0.05578	0.11252	0.10642	0.09753	0.11272	0.08519	0.03014	0.00908	0.00308	
	0.00002	0	0	0.00031	0	0.01031	0.02243	0.0715	0.0666	0.07021	0.0207	0.01719	0.0016
	0.00051	0.00101	0.00089	0.00033	0	0							
2001	1	1	3	0	58	0	0	0	0.0083	0.01993	0.00771	0.01187	
	0.01642	0.03758	0.0536	0.05483	0.06074	0.05892	0.10988	0.03332	0.05608	0.0312	0.0132	0.05663	0
	0	0	0.01426	0.02615	0.01599	0.02994	0.0876	0.10742	0.0699	0.01551	0.0022	0.00032	0
	0.0004	0	0	0	0.00011								
2002	1	1	3	0	54	0	0.00586	0.00114	0.00864	0.03363	0.07192	0.09017	0.0404
	0.02739	0.0244	0.01947	0.05204	0.05112	0.08519	0.0902	0.07081	0.04005	0.00877	0.00706	0.00113	
	0.00452	0.00124	0.0041	0.02706	0.07152	0.02883	0.03737	0.03884	0.03246	0.01081	0.00224	0.00322	
	0.00246	0.00284	0	0	0.00083	0.0023							
2003	1	1	3	0	18	0	0	0	0.00218	0.00084	0.00031	0.00632	
	0.19441	0.31227	0.10404	0.01206	0.00536	0.00727	0.01577	0.01604	0.00329	0.00214	0	0.00096	0
	0.00023	0.00011	0.00084	0.00011	0.07587	0.12785	0.0586	0.02396	0.02086	0.00712	0.00119	0	0
	0	0	0	0	0								
2004	1	1	3	0	54	0	0	0	0.00012	0.00048	0.00063	0.00095	
	0.00524	0.02633	0.21118	0.27406	0.05632	0.01742	0.03838	0.05902	0.04136	0.02919	0.0043	0	0
	0	0	0.00023	0.00058	0.00026	0.02585	0.10078	0.07134	0.02827	0.00561	0.00212	0	0
	0	0	0	0	0								
2005	1	1	3	0	20	0	0	0	0.00095	0	0	0	
	0.01986	0.0208	0.00037	0.06466	0.3323	0.18004	0.04388	0.04495	0.02574	0.01096	0	0	0
	0	0	0	0	0	0.06488	0.12996	0.03707	0.00865	0.00543	0	0.00949	0
	0	0	0	0	0								
2006	1	1	3	0	31	0	0	0	0	0	0	0	
	0.00112	0.01377	0.00514	0.02027	0.08864	0.3692	0.25929	0.03989	0.06281	0.0263	0.00508	0.00053	0
	0	0	0	0	0	0	0.01525	0.01022	0.04	0.04166	0	0.00083	0
	0	0	0	0	0								

#

Hook and line fishery females

males

#year	season	type	gender	partition	# samples		16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52	16
	18	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52								
1980	1	2	3	0	1	0	0	0	0	0	0	0	0
	0	0	0	0.05346	0.0004	0.0002	0.10731	0.21581	0.62144	0.0004	0	0	0
	0	0	0	0	0	0	0	0	0.0002	0	0	0	0
	0.0002	0.0004	0	0									
1982	1	2	3	0	20	0	0	0	0	0	0	0	0
	0	0	0	0.02656	0.07327	0.14654	0.35618	0.19872	0.17263	0.02609	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0									
1983	1	2	3	0	8	0	0	0	0	0	0	0	0
	0	0	0	0.01666	0.14961	0.06663	0.09964	0.26559	0.38521	0	0	0	0
	0	0	0	0	0	0	0.01666	0	0	0	0	0	0
	0	0	0	0									
1984	1	2	3	0	9	0	0	0	0	0	0	0	0
	0	0	0	0.05882	0.11765	0.17647	0.23529	0.17647	0.17647	0	0.05882	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0									
1985	1	2	3	0	14	0	0	0	0	0	0	0	0
	0	0.00023	0.0222	0.10922	0.15438	0.09717	0.3143	0.15556	0.0774	0.01025	0	0	0
	0	0	0	0	0	0	0.01315	0.02107	0.0246	0	0	0	
	0.00047	0	0	0	0								
1986	1	2	3	0	8	0	0	0	0	0	0	0	
	0.00138	0	0.00204	0.00836	0.02555	0.14258	0.10739	0.35049	0.17396	0.11928	0.04642	0.0002	0
	0	0	0	0	0	0.00003	0	0	0.01824	0.0004	0	0	
	0.00191	0	0.00178	0	0	0							
1987	1	2	3	0	9	0	0	0	0	0	0	0.00657	
	0.02064	0.0066	0	0.05516	0.17066	0.23488	0.1451	0.10775	0.05923	0.1022	0.00734	0.00004	0
	0	0	0	0	0	0.00319	0.00657	0.00657	0.00319	0	0.06432	0	0
	0	0	0	0	0								
1989	1	2	3	0	16	0	0	0	0	0	0	0	0
	0.03538	0.08849	0.08298	0.02435	0.0592	0.01779	0.01218	0.01826	0.02435	0	0	0	0
	0	0	0	0	0.01769	0.08846	0.05308	0.33615	0.12388	0.01769	0	0.00007	0
	0	0	0	0									
1990	1	2	3	0	16	0	0	0	0	0	0	0	
	0.00205	0	0.05716	0.16326	0.58683	0.16725	0	0.0032	0.00326	0	0	0	0
	0	0	0	0	0	0	0.00483	0	0.00526	0.00689	0	0	0
	0	0	0	0	0								
1991	1	2	3	0	41	0	0.00143	0	0	0.00003	0.01129	0.00118	
	0.01025	0.06023	0.08648	0.19366	0.08308	0.15067	0.07261	0.05628	0.01759	0.00397	0.00164	0	0
	0	0	0	0.00003	0.00045	0.02487	0.04852	0.09975	0.06582	0.00883	0.00088	0.00025	
	0.00019	0	0	0	0	0							
1992	1	2	3	0	84	0	0	0	0	0	0.00081	0.00155	
	0.03048	0.03815	0.08563	0.08881	0.1549	0.11131	0.13644	0.08134	0.03369	0.01247	0.00425	0	0
	0	0	0	0	0.00315	0.01819	0.07305	0.05973	0.05016	0.01027	0.00158	0.00079	
	0.00311	0	0	0	0	0							
1993	1	2	3	0	87	0	0	0.00036	0	0	0.0251	0.10349	
	0.25814	0.18048	0.14098	0.08223	0.05605	0.00957	0.0072	0.0021	0.001	0.00086	0	0	0

```
	0	0	0.00036	0.01122	0.02667	0.02754	0.02959	0.03582	0.00116	0.00007	0	0	0
	0	0	0	0	0
1994	1	2	3	0	86	0	0	0	0	0	0	0
	0.00284	0.01322	0.04427	0.08209	0.16641	0.19531	0.21998	0.08578	0.03136	0.03328	0.00023	0	0
	0	0	0	0	0	0	0.03582	0.05304	0.02098	0.00407	0.0113	0	0
	0	0	0	0	0
1995	1	2	3	0	23	0	0	0	0	0	0	0
	0.02018	0.02427	0.02279	0.10374	0.2622	0.10859	0.0662	0.02693	0.0042	0.00013	0	0	0
	0	0	0	0	0	0.01229	0.03623	0.0747	0.04455	0.06782	0.05856	0.03752
	0.00387	0.01682	0	0	0	0
1996	1	2	3	0	41	0	0	0	0	0	0	0.01667	0.0016
	0.01394	0.08846	0.1179	0.22555	0.21468	0.07447	0.04815	0.03936	0.00221	0.00204	0	0	0
	0	0	0	0	0	0.01948	0.05499	0.06521	0.00247	0.01121	0	0.0016	0
	0	0	0	0
1997	1	2	3	0	38	0	0	0	0	0.00215	0.00078	0
	0.01598	0.08748	0.09409	0.08517	0.14414	0.19467	0.10841	0.07685	0.04188	0.01266	0.00378	0	0
	0	0	0	0	0.00303	0.03014	0.04673	0.02531	0.02327	0.00078	0.00239	0.00003
	0.00027	0	0	0	0	0
1998	1	2	3	0	38	0.00326	0	0	0	0	0	0.00563	0.0064
	0.03196	0.13658	0.09991	0.06159	0.11968	0.13457	0.07747	0.04899	0.00844	0.00774	0.00391	0	0
	0	0	0.00461	0.00326	0.00226	0.06047	0.09318	0.07127	0.01461	0.00047	0	0.00372	0
	0	0	0	0
1999	1	2	3	0	11	0	0	0	0	0	0	0
	0.02659	0.06492	0.07368	0.17232	0.24041	0.09193	0.11931	0.06458	0.02409	0.00238	0	0	0
	0	0	0	0	0.00467	0.00517	0.02843	0.04026	0.02993	0.01134	0	0	0
	0	0	0	0	0
2000	1	2	3	0	9	0	0	0	0	0	0.00031	0.00031
	0.01411	0.02543	0.13084	0.25728	0.12122	0.16961	0.077	0.05276	0.0226	0.02131	0	0	0
	0	0	0	0	0.00031	0.01034	0.01534	0.04837	0.02074	0.00626	0	0
	0.00587	0	0	0	0	0
2001	1	2	3	0	12	0	0	0	0	0	0	0
	0.00132	0	0.01175	0.03414	0.0829	0.11837	0.1749	0.12195	0.05119	0.02052	0.01335	0	0
	0	0	0	0	0	0.01026	0.06216	0.17562	0.10756	0.01241	0	0	0.0016
	0	0	0	0	0
2002	1	2	3	0	3	0	0	0	0	0	0.02632	0.10526	0
	0	0	0	0.02632	0	0	0.05263	0.02632	0.02632	0	0	0	0
	0	0	0.02632	0.02632	0	0.15789	0.39474	0.13158	0	0	0	0	0
	0	0	0	0
2006	1	2	3	0	3	0	0	0	0	0	0	0	0
	0	0.01272	0	0.16185	0.23815	0.25318	0.10867	0.05549	0.10636	0	0	0	0
	0	0	0	0	0	0	0.02543	0	0	0	0.02543	0.01272	0
	0	0	0	0
#


#Net fishery							females


#year	season	type	gender	partition	# samples		16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52	16
	18	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52
1983	1	3	3	0	24	0	0	0	0	0	0	0	0
	0	0	0.01248	0.06211	0.14868	0.19754	0.332	0.13685	0.02443	0	0.00307	0	0
```

0 0 0 0 0 0.01248 0.03545 0.02297 0 0.01195 0 0 0
0 0 0 0
1984 1 3 3 0 68 0 0.01047 0 0 0 0 0 0
0 0 0 0 0.16667 0.29147 0.32045 0.10306 0.09742 0.01047 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0
1985 1 3 3 0 155 0 0 0 0 0 0 0.00122 0
0.00021 0.00467 0.02343 0.07395 0.09334 0.15591 0.24592 0.23791 0.06391 0.00509 0.00302 0 0
0 0 0 0 0.00015 0.00273 0.02204 0.03686 0.01733 0.01211 0 0.0002 0
0 0 0 0
1986 1 3 3 0 113 0 0 0 0 0 0 0.00023 0.0004
0.00057 0.00026 0.01582 0.06056 0.18991 0.18421 0.21071 0.20903 0.05679 0.00621 0 0 0
0 0 0 0 0 0.00011 0.00566 0.02964 0.00568 0.00403 0.00343 0.00667 0
0 0 0 0
1987 1 3 3 0 92 0 0 0 0 0 0 0.00079
0.00162 0.00036 0.00232 0.00897 0.01165 0.19355 0.2855 0.17057 0.1123 0.0467 0.01564 0.00089 0
0 0 0 0 0 0.00347 0.04653 0.01944 0.01772 0.01386 0.04378 0.00194
0.00186 0 0 0 0 0
1988 1 3 3 0 70 0 0 0 0 0 0.00041 0.00044
0.00117 0.0638 0.12296 0.00271 0.00163 0.00385 0.31123 0.257 0.09212 0.01448 0.00127 0 0
0 0 0 0.00006 0.00015 0.00097 0.11848 0.00267 0.00138 0.00279 0.00013 0.00005 0
0 0 0 0 0
1989 1 3 3 0 82 0 0 0 0 0 0 0.01848
0.01832 0.03839 0.12987 0.14382 0.11016 0.07334 0.12715 0.10056 0.13359 0.01859 0.01313 0.01893 0
0 0 0 0 0 0.0123 0.01375 0.01428 0.00822 0.00655 0.00043 0.00014 0
0 0 0 0 0
1990 1 3 3 0 99 0 0 0.00078 0 0 0.00057 0.0025
0.00785 0.01569 0.01327 0.0751 0.1624 0.13408 0.04108 0.2186 0.08537 0.05356 0.00613 0.00021 0
0 0 0 0 0 0.00171 0.0388 0.04572 0.02568 0.01163 0.04536 0.00371 0
0.0102 0 0 0 0
1991 1 3 3 0 35 0 0 0 0 0 0.00144 0.00352
0.00863 0.0187 0.03612 0.08646 0.16717 0.23046 0.13553 0.04859 0.03628 0.00927 0 0 0
0 0 0 0 0.00016 0.02781 0.06585 0.05945 0.04155 0.00943 0.00767 0
0.00591 0 0 0 0 0
1992 length comps had several large males from Morro Bay area - probably mis-ID'd sex or species- thus sample size turned to negative 1
1992 1 3 3 0 -1 0 0 0 0 0 0 0.00216
0.01539 0.00683 0.04506 0.07463 0.09314 0.14088 0.16453 0.10951 0.10248 0.06281 0.00667 0 0
0 0 0 0 0.00139 0.01445 0.02481 0.08037 0.03203 0.01596 0.00178 0.00095
0.00059 0.00027 0 0 0 0
1993 1 3 3 0 35 0 0 0 0 0 0.00102 0.00848
0.01798 0.0186 0.03445 0.10195 0.15712 0.24255 0.15447 0.09174 0.01546 0 0 0 0
0 0 0 0.00473 0.00358 0.04126 0.06158 0.02809 0.01171 0.00428 0 0.00097 0
0 0 0 0 0
1994 1 3 3 0 47 0 0 0 0 0 0 0 0
0.00085 0.01046 0.03534 0.05834 0.11516 0.34256 0.15397 0.0921 0.05238 0.00712 0 0 0
0 0 0 0 0.00085 0.02841 0.03954 0.0351 0.0278 0 0 0 0
0 0 0 0
1995 1 3 3 0 32 0 0 0 0 0 0 0 0
0 0.00906 0 0.0436 0.08736 0.31989 0.22707 0.20206 0.07282 0.02 0 0 0
0 0 0 0 0 0 0 0.01813 0 0 0 0 0
0 0 0 0
1996 1 3 3 0 21 0 0 0 0 0 0 0 0
0 0.01626 0.03252 0.0813 0.1626 0.26016 0.25203 0.09756 0.07317 0 0 0 0
0 0 0 0 0 0 0.01626 0 0 0 0 0
0.00813 0 0 0 0

1997	1	3	3	0	14	0	0	0	0	0	0	0	0
	0.01361	0.00537	0.00956	0.05249	0.15283	0.29519	0.25541	0.11019	0.01381	0.01074	0	0	0
	0	0	0	0	0	0.00517	0.01829	0.03229	0.02504	0	0	0	0
	0	0	0	0									
1998	1	3	3	0	11	0	0	0	0	0	0	0	0
	0	0.01304	0.0087	0.01739	0.14783	0.27391	0.33913	0.07826	0.02609	0	0	0	0
	0	0	0	0	0	0.02174	0	0.04783	0.01304	0	0.01304	0	0
	0	0	0	0									

#

Recfin length comps Coastwide (N and S)

#year	season	type	gender	part	Nsamp	16	18	20	22	24	26	28	30
	32	34	36	38	40	42	44	46	48	50	52	16	18
	20	22	24	26	28	30	32	34	36	38	40	42	44
	46	48	50	52									
1980	1	4	0	0	50	0.00255	0	0.01278	0.0358	0.07928	0.07672	0.13554	
	0.11253	0.11253	0.09718	0.07161	0.08439	0.07161	0.04092	0.02813	0.02301	0.01278	0	0.00255	
	0.00255	0	0.01278	0.0358	0.07928	0.07672	0.13554	0.11253	0.11253	0.09718	0.07161	0.08439	
	0.07161	0.04092	0.02813	0.02301	0.01278	0	0.00255						
1981	1	4	0	0	47	0.00127	0	0	0.00508	0.02033	0.0343	0.06607	
	0.14485	0.11689	0.13214	0.10673	0.1385	0.08767	0.04447	0.04066	0.02668	0.02033	0.0127	0.00127	
	0.00127	0	0	0.00508	0.02033	0.0343	0.06607	0.14485	0.11689	0.13214	0.10673	0.1385	
	0.08767	0.04447	0.04066	0.02668	0.02033	0.0127	0.00127						
1982	1	4	0	0	59	0	0	0	0	0.02427	0.05663	0.07605	
	0.08252	0.09061	0.06796	0.08576	0.12621	0.13754	0.11488	0.05501	0.05016	0.02427	0.00647	0.00161	0
	0	0	0	0.02427	0.05663	0.07605	0.08252	0.09061	0.06796	0.08576	0.12621	0.13754	
	0.11488	0.05501	0.05016	0.02427	0.00647	0.00161							
1983	1	4	0	0	45	0	0	0.00464	0.01547	0.02321	0.07739	0.10371	
	0.15634	0.12848	0.07894	0.05417	0.0712	0.09287	0.07739	0.04489	0.04334	0.02321	0.00309	0.00154	0
	0	0.00464	0.01547	0.02321	0.07739	0.10371	0.15634	0.12848	0.07894	0.05417	0.0712	0.09287	
	0.07739	0.04489	0.04334	0.02321	0.00309	0.00154							
1984	1	4	0	0	90	0	0	0.00254	0.00636	0.01908	0.03053	0.0547	0.0916
	0.15267	0.20101	0.13613	0.07506	0.10432	0.07633	0.0318	0.01653	0.00127	0	0	0	0
	0.00254	0.00636	0.01908	0.03053	0.0547	0.0916	0.15267	0.20101	0.13613	0.07506	0.10432	0.07633	0.0318
	0.01653	0.00127	0	0									
1985	1	4	0	0	138	0.00099	0.00049	0.00198	0.00596	0.00994	0.01838	0.03628	
	0.09045	0.1332	0.12176	0.12524	0.14015	0.11282	0.08697	0.0656	0.02932	0.01391	0.00546	0.00099	
	0.00099	0.00049	0.00198	0.00596	0.00994	0.01838	0.03628	0.09045	0.1332	0.12176	0.12524	0.14015	
	0.11282	0.08697	0.0656	0.02932	0.01391	0.00546	0.00099						
1986	1	4	0	0	115	0	0.00095	0.00381	0.01858	0.07435	0.10724	0.05052	
	0.04718	0.07769	0.1101	0.0958	0.10247	0.13203	0.09103	0.04385	0.0305	0.01096	0.00238	0.00047	0
	0.00095	0.00381	0.01858	0.07435	0.10724	0.05052	0.04718	0.07769	0.1101	0.0958	0.10247	0.13203	
	0.09103	0.04385	0.0305	0.01096	0.00238	0.00047							
1987	1	4	0	0	22	0	0	0.00761	0.01776	0.04568	0.08375	0.12436	
	0.11675	0.11675	0.10659	0.04568	0.05076	0.03299	0.06852	0.07614	0.04314	0.01776	0.0203	0.02538	0
	0	0.00761	0.01776	0.04568	0.08375	0.12436	0.11675	0.11675	0.10659	0.04568	0.05076	0.03299	
	0.06852	0.07614	0.04314	0.01776	0.0203	0.02538							
1988	1	4	0	0	72	0	0	0	0.00323	0.02047	0.04956	0.12931	
	0.20474	0.23922	0.16056	0.02693	0.01724	0.02693	0.06142	0.03987	0.01185	0.00646	0	0.00215	0
	0	0	0.00323	0.02047	0.04956	0.12931	0.20474	0.23922	0.16056	0.02693	0.01724	0.02693	
	0.06142	0.03987	0.01185	0.00646	0	0.00215							
1989	1	4	0	0	29	0	0	0	0.00219	0.0307	0.04495	0.0921	
	0.14692	0.1546	0.21052	0.21052	0.06469	0.02083	0.00986	0.00877	0.00328	0	0	0	0

```
        0       0       0.00219 0.0307  0.04495 0.0921  0.14692 0.1546  0.21052 0.21052 0.06469 0.02083
        0.00986 0.00877 0.00328 0       0       0
1994    1       4       0       0       5       0       0       0       0       0.09677 0.06451 0.16129
        0.16129 0.2258  0.16129 0.09677 0.03225 0       0       0       0       0       0       0       0
        0       0       0       0.09677 0.06451 0.16129 0.16129 0.2258  0.16129 0.09677 0.03225 0       0
        0       0       0       0       0
1995    1       4       0       0       5       0       0       0       0.08053 0.05369 0.22147 0.26174
        0.20134 0.12751 0.02684 0.02013 0       0       0       0       0       0       0       0.00671 0
        0       0       0.08053 0.05369 0.22147 0.26174 0.20134 0.12751 0.02684 0.02013 0       0       0
        0       0       0       0       0.00671
1996    1       4       0       0       20      0       0       0.00359 0.05215 0.07553 0.14928 0.19064
        0.09892 0.07553 0.10431 0.07913 0.05935 0.05575 0.04136 0.01258 0.00179 0       0       0       0
        0       0.00359 0.05215 0.07553 0.14928 0.19064 0.09892 0.07553 0.10431 0.07913 0.05935 0.05575
        0.04136 0.01258 0.00179 0       0       0
1997    1       4       0       0       15      0       0       0       0.00338 0.0305  0.08305 0.05254
        0.07627 0.05423 0.05423 0.07796 0.18474 0.17288 0.12542 0.05254 0.02203 0.00677 0.00338 0       0
        0       0       0.00338 0.0305  0.08305 0.05254 0.07627 0.05423 0.05423 0.07796 0.18474 0.17288
        0.12542 0.05254 0.02203 0.00677 0.00338 0
1998    1       4       0       0       6       0       0       0       0       0.0114  0.01901 0.06083
        0.19771 0.13307 0.12167 0.08365 0.06463 0.11026 0.08745 0.07604 0.01901 0.0152  0       0       0
        0       0       0       0.0114  0.01901 0.06083 0.19771 0.13307 0.12167 0.08365 0.06463 0.11026
        0.08745 0.07604 0.01901 0.0152  0       0
1999    1       4       0       0       47      0       0.00516 0.01204 0.02065 0.02925 0.07056 0.07917
        0.09294 0.06196 0.07228 0.06196 0.0981  0.11187 0.16179 0.09122 0.02409 0.00516 0       0.00172 0
        0.00516 0.01204 0.02065 0.02925 0.07056 0.07917 0.09294 0.06196 0.07228 0.06196 0.0981  0.11187
        0.16179 0.09122 0.02409 0.00516 0       0.00172
2000    1       4       0       0       31      0       0.01086 0.08695 0.06521 0.02898 0.07246 0.07608 0.0942
        0.06521 0.0471  0.02173 0.05797 0.0942  0.09057 0.08695 0.08695 0.01086 0.00362 0       0
        0.01086 0.08695 0.06521 0.02898 0.07246 0.07608 0.0942  0.06521 0.0471  0.02173 0.05797 0.0942
        0.09057 0.08695 0.08695 0.01086 0.00362 0
2001    1       4       0       0       16      0       0       0.02675 0.09698 0.1806  0.0903  0.05685
        0.05016 0.07692 0.05351 0.03678 0.05351 0.08361 0.07023 0.07023 0.04013 0.01337 0       0       0
        0       0.02675 0.09698 0.1806  0.0903  0.05685 0.05016 0.07692 0.05351 0.03678 0.05351 0.08361
        0.07023 0.07023 0.04013 0.01337 0       0
2002    1       4       0       0       18      0       0       0       0.00888 0.13777 0.14666 0.14666
        0.07111 0.01333 0.02666 0.04888 0.00888 0.05333 0.07555 0.12    0.11111 0.02666 0.00444 0       0
        0       0       0.00888 0.13777 0.14666 0.14666 0.07111 0.01333 0.02666 0.04888 0.00888 0.05333
        0.07555 0.12    0.11111 0.02666 0.00444 0
#2004   1       4       0       0       41      0.00429 0.01716 0.01287 0.03433 0.11587 0.21459 0.13304
        0.09442 0.1545  0.11158 0.07296 0.02575 0.00429 0       0       0.00429 0       0       0
        0.00429 0.01716 0.01287 0.03433 0.11587 0.21459 0.13304 0.09442 0.1545  0.11158 0.07296 0.02575
        0.00429 0       0       0.00429 0       0       0
#2005   1       4       0       0       16      0       0.07547 0.30188 0.09433 0.01886 0.07547 0.0566
        0.09433 0.03773 0.01886 0.13207 0.0566  0.03773 0       0       0       0       0       0       0
        0.07547 0.30188 0.09433 0.01886 0.07547 0.0566  0.09433 0.03773 0.01886 0.13207 0.0566  0.03773 0
        0       0       0       0       0
#
# Triennial survey length data-
1977    1       5       3       0       56      0.00132 0.0028  0.01864 0.04554 0.02555 0.01866 0.01316
        0.01863 0.04304 0.08371 0.05878 0.02463 0.03757 0.05619 0.05998 0.05109 0.04681 0.02098 0.00456
        0.00157 0.0026  0.01833 0.04147 0.01525 0.01458 0.01431 0.06889 0.08181 0.06158 0.03506 0.00853
        0.00065 0.00107 0.00148 0.00043 0.00057 0       0
1980    1       5       3       0       17      0       0       0       0       0       0.00102 0.00022
        0.00442 0.03417 0.0489  0.06656 0.04987 0.08431 0.09185 0.06391 0.0378  0.0108  0.01103 0.00138 0
        0       0.00092 0.00123 0.00056 0.00021 0.01013 0.06132 0.15277 0.18459 0.06082 0.00831 0.00208
        0.00842 0.00156 0.00056 0.00014 0       0
```

```
1983 1 5 3 0 17 0.00147 0.00236 0.00222 0.00237 0.01546 0.03155 0.05519
 0.09165 0.11927 0.04888 0.01741 0.01022 0.02294 0.02131 0.01335 0.01473 0.01341 0.00281 0.00054
 0.00129 0.00236 0.00082 0.00187 0.01964 0.04507 0.13632 0.1805 0.0633 0.03084 0.02869 0.00197 0
 0 0.00003 0 0 0 0
1986 1 5 3 0 14 0.00021 0.00021 0.054 0.09675 0.10531 0.03826 0.00166
 0.00191 0.00319 0.01658 0.03826 0.06103 0.04773 0.04995 0.01422 0.00968 0.00458 0.00138 0 0
 0.00214 0.042 0.0741 0.12401 0.01268 0.01143 0.06192 0.07889 0.03768 0.0074 0.00226 0.00044 0
 0 0 0 0 0
1989 1 5 3 0 91 0.14115 0.08542 0.00522 0.01077 0.0188 0.01236 0.02578
 0.03328 0.01295 0.01263 0.03708 0.04408 0.00765 0.01092 0.01361 0.00611 0.00323 0.00099 0.00065
 0.15814 0.07824 0.00423 0.01606 0.01862 0.03192 0.05855 0.05072 0.05481 0.02932 0.01254 0.00347
 0.00022 0.00004 0.00005 0 0 0.00009 0.00009
1992 1 5 3 0 59 0.24397 0.02135 0.01956 0.025 0.00991 0.0186 0.04261
 0.03886 0.01397 0.00795 0.00448 0.00373 0.00244 0.00253 0.00212 0.00026 0.00065 0.00006 0 0.2715
 0.01878 0.02134 0.02997 0.01546 0.0718 0.06547 0.0214 0.01717 0.00594 0.00245 0.00024 0.00006 0
 0 0 0.00012 0.00006 0
1995 1 5 3 0 79 0.07182 0.0105 0.02365 0.03701 0.03052 0.00774 0.01664
 0.03555 0.02933 0.02137 0.02177 0.04439 0.03114 0.02686 0.02366 0.01874 0.00794 0.00212 0.00033
 0.08029 0.0065 0.02289 0.03343 0.02708 0.04323 0.06932 0.08634 0.09242 0.05937 0.01576 0.00175
 0.00006 0.00016 0.00008 0.00008 0 0 0
1998 1 5 3 0 81 0.01317 0.03329 0.02219 0.01371 0.05545 0.10907 0.02906
 0.01489 0.0305 0.05614 0.00735 0.00612 0.01038 0.01613 0.00776 0.00386 0.00265 0.00042 0
 0.00908 0.02868 0.02244 0.03439 0.12487 0.07326 0.08847 0.09834 0.06031 0.02068 0.00673 0.00042 0
 0 0 0.00003 0 0 0
2001 1 5 3 0 77 0.00367 0.01002 0.05792 0.2417 0.11619 0.00883 0.00665
 0.00424 0.00695 0.00655 0.00921 0.00452 0.00343 0.00301 0.00261 0.00244 0.00065 0.00001 0
 0.00531 0.00575 0.09168 0.27631 0.08195 0.00664 0.01412 0.018 0.00695 0.00373 0.00063 0.00013 0
 0.00001 0 0 0 0 0
2004 1 5 3 0 88 0.11449 0.00173 0.00278 0.00155 0.00074 0.0159 0.01839
 0.00552 0.01475 0.07254 0.14576 0.06047 0.01188 0.00359 0.00538 0.00669 0.00589 0.00154 0.00022 0.1552
 0.00081 0.0029 0.0018 0.00745 0.01609 0.05755 0.12913 0.1032 0.02382 0.01048 0.00153 0.00004 0
 0 0.00004 0 0 0
#
# NWC combo survey
#year season type gender part #_samp 16 18 20 22 24 26 28 30
 32 34 36 38 40 42 44 46 48 50 52 16 18
 20 22 24 26 28 30 32 34 36 38 40 42 44
 46 48 50 52
2003 1 6 3 0 91 0.00298 0.00807 0.00688 0.00342 0.00746 0.00424 0.00967
 0.02817 0.1095 0.18554 0.03815 0.00738 0.00217 0.00154 0.00099 0.00393 0.00067 0.00251 0
 0.00677 0.01157 0.0043 0.00725 0.00539 0.01074 0.08931 0.19781 0.11868 0.09394 0.03074 0.00002
 0.00019 0 0 0.00002 0 0 0
2004 1 6 3 0 88 0.03914 0.01214 0.00471 0.03843 0.0303 0.01527 0.01859
 0.01287 0.03111 0.07962 0.14332 0.08634 0.02108 0.0039 0.00402 0.00361 0.00326 0.0023 0.00012
 0.03949 0.01135 0.00811 0.02011 0.01754 0.0103 0.02772 0.14081 0.13563 0.03042 0.00772 0.00057 0
 0 0 0.00008 0 0 0
2005 1 6 3 0 91 0.01717 0.00979 0.01818 0.01461 0.00422 0.00865 0.00481 0.0195
 0.01542 0.03592 0.19109 0.14109 0.04185 0.01576 0.00738 0.00624 0.00384 0.00164 0.0004 0.02127
 0.01078 0.01367 0.01604 0.00897 0.00515 0.09415 0.14629 0.08918 0.03161 0.00381 0.00036 0.0011 0
 0 0 0 0 0
2006 1 6 3 0 70 0.00242 0.00734 0.00929 0.01924 0.01731 0.01448 0.01335
 0.00833 0.01775 0.01951 0.01799 0.05114 0.10618 0.08986 0.02131 0.02241 0.00883 0.00433 0.00089
 0.00113 0.00712 0.00966 0.02279 0.02103 0.02015 0.01599 0.04448 0.15975 0.21062 0.03326 0.00071
 0.00021 0.00113 0 0 0 0 0
#
#Recreational Length data - June 15 fix to TL-> FL conversion!!
```

```
#year	season	type	gender	part	numsamp		16	18	20	22	24	26	28
	30	32	34	36	38	40	42	44	46	48	50	52	16
	18	20	22	24	26	28	30	32	34	36	38	40	42
	44	46	48	50	52
1987	1	10	0	0	43	0.0007	0	0.00141	0.01131	0.03182	0.13932	0.30622
	0.31046	0.13649	0.01909	0.01202	0.01202	0.01131	0.00353	0.00353	0.0007	0	0	0	0.0007
	0	0.00141	0.01131	0.03182	0.13932	0.30622	0.31046	0.13649	0.01909	0.01202	0.01202	0.01131
	0.00353	0.00353	0.0007	0	0	0
1988	1	10	0	0	44	0.0011	0.00221	0.00832	0.03329	0.07103	0.07047	0.12042
	0.22031	0.24028	0.15149	0.04495	0.00832	0.00998	0.00887	0.00277	0.00166	0.00332	0.0011	0	0.0011
	0.00221	0.00832	0.03329	0.07103	0.07047	0.12042	0.22031	0.24028	0.15149	0.04495	0.00832	0.00998
	0.00887	0.00277	0.00166	0.00332	0.0011	0
1989	1	10	0	0	58	0	0.00122	0.00183	0.01102	0.02205	0.03063	0.09803
	0.19852	0.17401	0.1734	0.17095	0.06617	0.02205	0.0147	0.00857	0.00428	0.00183	0	0.00061	0
	0.00122	0.00183	0.01102	0.02205	0.03063	0.09803	0.19852	0.17401	0.1734	0.17095	0.06617	0.02205	0.0147
	0.00857	0.00428	0.00183	0	0.00061
1990	1	10	0	0	16	0	0	0	0	0.00716	0.04659	0.09318
	0.15412	0.17204	0.07526	0.10394	0.17921	0.09318	0.04659	0.02508	0.00358	0	0	0	0
	0	0	0	0.00716	0.04659	0.09318	0.15412	0.17204	0.07526	0.10394	0.17921	0.09318
	0.04659	0.02508	0.00358	0	0	0
1991	1	10	0	0	15	0	0	0.00256	0.01794	0.04615	0.12564	0.11794
	0.14871	0.07948	0.05128	0.04871	0.12051	0.10769	0.06923	0.04358	0.01794	0.00256	0	0	0
	0	0.00256	0.01794	0.04615	0.12564	0.11794	0.14871	0.07948	0.05128	0.04871	0.12051	0.10769
	0.06923	0.04358	0.01794	0.00256	0	0
1992	1	10	0	0	32	0	0	0.00941	0.04143	0.05775	0.15379	0.20966
	0.17137	0.09165	0.05963	0.03766	0.04331	0.04959	0.05524	0.00941	0.0069	0.00251	0.00062	0	0
	0	0.00941	0.04143	0.05775	0.15379	0.20966	0.17137	0.09165	0.05963	0.03766	0.04331	0.04959
	0.05524	0.00941	0.0069	0.00251	0.00062	0
1993	1	10	0	0	37	0	0.00061	0.00553	0.02642	0.0381	0.08358	0.09649
	0.13952	0.16041	0.11124	0.07682	0.05777	0.06883	0.06084	0.03749	0.02274	0.01167	0.00184	0	0
	0.00061	0.00553	0.02642	0.0381	0.08358	0.09649	0.13952	0.16041	0.11124	0.07682	0.05777	0.06883
	0.06084	0.03749	0.02274	0.01167	0.00184	0
1994	1	10	0	0	26	0.0008	0.00161	0.00726	0.03069	0.10904	0.1155	0.1357	0.1042
	0.10339	0.10985	0.11227	0.07108	0.0315	0.02827	0.02019	0.01615	0.00242	0	0	0.0008
	0.00161	0.00726	0.03069	0.10904	0.1155	0.1357	0.1042	0.10339	0.10985	0.11227	0.07108	0.0315
	0.02827	0.02019	0.01615	0.00242	0	0
1995	1	10	0	0	22	0	0.00892	0.05535	0.03928	0.06428	0.07142	0.10535
	0.10892	0.18214	0.10892	0.08571	0.06785	0.05357	0.02321	0.01607	0.00714	0.00178	0	0	0
	0.00892	0.05535	0.03928	0.06428	0.07142	0.10535	0.10892	0.18214	0.10892	0.08571	0.06785	0.05357
	0.02321	0.01607	0.00714	0.00178	0	0
1996	1	10	0	0	19	0	0	0.01167	0.02918	0.0642	0.11867	0.13035	0.0642
	0.09533	0.13424	0.09338	0.10894	0.07782	0.05058	0.01945	0.00194	0	0	0	0	0
	0.01167	0.02918	0.0642	0.11867	0.13035	0.0642	0.09533	0.13424	0.09338	0.10894	0.07782	0.05058
	0.01945	0.00194	0	0	0
1997	1	10	0	0	19	0	0	0	0.00523	0.04712	0.12565	0.08115
	0.09162	0.04973	0.0445	0.06806	0.1335	0.17015	0.10471	0.04712	0.01832	0.01047	0.00261	0	0
	0	0	0.00523	0.04712	0.12565	0.08115	0.09162	0.04973	0.0445	0.06806	0.1335	0.17015
	0.10471	0.04712	0.01832	0.01047	0.00261	0
1998	1	10	0	0	9	0	0	0	0	0.00955	0.01592	0.0605
	0.18471	0.13057	0.10828	0.08917	0.09554	0.12101	0.08598	0.07006	0.01592	0.01273	0	0	0
	0	0	0	0.00955	0.01592	0.0605	0.18471	0.13057	0.10828	0.08917	0.09554	0.12101
	0.08598	0.07006	0.01592	0.01273	0	0
#
# Age composition data
21	# number of age bins
```

```
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
1	# number of unique ageing error matrices to generate
# ageing error matrix- no bias, has imprecision (st dev)
0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5
0.03	0.091	0.153	0.214	0.275	0.336	0.398	0.459	0.52	0.581	0.643	0.704	0.765	0.826
	0.888	0.949	1.01	1.072	1.133	1.194	1.255	1.317
61	# number of age observations-
# this run goes back to traditional age comps-
#year	season	type	gender	part	errmat	Lbinlo	LbinHi	# samp	1	2	3	4	5
	6	7	8	9	10	11	12	13	14	15	16	17	18
	19	20	plus	1	2	3	4	5	6	7	8	9	10
	11	12	13	14	15	16	17	18	19	20	plus
1978	1	1	3	0	1	1	52	-1	0	0	0.00378	0.00192
	0.05193	0.06229	0.08103	0.11205	0.0285	0.02318	0.1395	0.04135	0.00805	0.00451	0.01162	0.01389
	0.03325	0.01976	0.03987	0.0299	0.0635	0	0	0.00086	0.00094	0.01108	0.03327	0.03173
	0.02462	0.00872	0.00288	0.01137	0.02357	0.02161	0.04333	0.00117	0.00127	0.00263	0.00019	0.00142	0.0035
	0.00597
1979	1	1	3	0	1	1	52	-1	0	0	0.02289	0.04417
	0.03256	0.12065	0.06067	0.05047	0.1531	0.09065	0.03673	0.0262	0.01061	0.00285	0.02734	0.01818
	0.01339	0.00627	0.02685	0.00403	0.00893	0	0	0.01917	0.05047	0.03043	0.00964	0.00342	0.0042
	0.02474	0.00362	0	0.00462	0.00335	0.01917	0.00044	0.00141	0.05746	0.00223	0.00531	0.00335
	0.00044
1980	1	1	3	0	1	1	52	120	0	0	0.00079	0.01116
	0.07118	0.03558	0.24243	0.01848	0.04077	0.07396	0.01513	0.0116	0.04232	0.01038	0.00231	0.05865
	0.00011	0.00244	0.0029	0.00044	0.01973	0	0.00102	0.00435	0.007	0.05788	0.07713	0.04955
	0.00622	0.00431	0.03101	0.00437	0.05813	0.00071	0.00266	0.00096	0.00918	0.00028	0.00333	0.00621
	0.00103	0.01431
1981	1	1	3	0	1	1	52	80	0	0	0.00121	0.00551
	0.15777	0.20849	0.03943	0.15607	0.01213	0.00378	0.00498	0.00835	0.0039	0.05709	0.00182	0.00056
	0.00245	0.00194	0.00101	0.00021	0.00806	0	0	0.04975	0.00037	0.05482	0.02426	0.00489
	0.12049	0.00215	0.00208	0.00777	0.00153	0.00261	0.05139	0.0007	0.00008	0.00007	0.00024	0
	0.00015	0.00187
1982	1	1	3	0	1	1	52	135	0	0.00006	0.00795	0.02247
	0.05293	0.03563	0.21462	0.053	0.17273	0.01588	0.04724	0.04183	0.0206	0.01731	0.01459	0.00567
	0.00705	0.002	0.01187	0.00069	0.01252	0	0	0.00646	0.00462	0.01703	0.01767	0.07607
	0.01949	0.04761	0.00885	0.01292	0.01438	0.00282	0.00729	0.00479	0.00001	0.00012	0	0
	0.00026	0.00296
1983	1	1	3	0	1	1	52	254	0	0	0.00712	0.04191
	0.02014	0.03882	0.07728	0.22797	0.09597	0.08751	0.04105	0.05616	0.0338	0.02631	0.00968	0.01863
	0.00111	0.00751	0.00826	0.01526	0.02535	0	0.00006	0.00528	0.02822	0.01055	0.00792	0.02584
	0.03455	0.00701	0.01561	0.00306	0.00564	0.00299	0.00495	0.00147	0.00218	0.00057	0.00277	0
	0.00071	0.00073
1984	1	1	3	0	1	1	52	202	0	0.00002	0.03783	0.10336
	0.17369	0.086	0.05089	0.04349	0.09149	0.02664	0.02702	0.01316	0.02271	0.01373	0.02425	0.00804
	0.00912	0.00185	0.00051	0.00106	0.00579	0	0.00335	0.01033	0.04641	0.03068	0.01707	0.013
	0.01551	0.03336	0.02777	0.01319	0.01903	0.00578	0.00412	0.00282	0.01028	0.00259	0.00077	0.00085
	0.00012	0.00234
1985	1	1	3	0	1	1	52	303	0	0.00002	0.00279	0.02507
	0.06476	0.16204	0.08104	0.0408	0.03527	0.0363	0.04287	0.02739	0.02872	0.0188	0.01871	0.00889
	0.00452	0.00542	0.00493	0.00236	0.00932	0	0.00006	0.00011	0.01536	0.01544	0.04936	0.04948
	0.03218	0.02924	0.04719	0.03604	0.0216	0.01902	0.02613	0.00676	0.00622	0.00532	0.00345	0.00422
	0.00134	0.01145
1986	1	1	3	0	1	1	52	111	0	0.00466	0.0088	0.02095
	0.07726	0.1109	0.08903	0.04127	0.03736	0.03883	0.06767	0.02447	0.03381	0.01699	0.02167	0.009
```

0.00728 0.00213 0.0115 0.00149 0.00566 0 0.00432 0.00224 0.00663 0.02418 0.05423 0.05353
0.03077 0.04701 0.02541 0.04662 0.01493 0.02899 0.00422 0.01179 0.00263 0.00212 0.00145 0.00082
0.00062 0.00677
1987 1 1 3 0 1 1 52 205 0.04462 0.03154 0.32482 0.01466
0.01095 0.03123 0.04142 0.06563 0.01636 0.00299 0.00499 0.01538 0.00375 0.00637 0.0031 0.0003
0.00124 0.0015 0.00091 0.00021 0.00033 0.01785 0.00009 0.14746 0.01224 0.01089 0.00733 0.03271
0.05213 0.01475 0.01071 0.01644 0.0176 0.0049 0.01238 0.00473 0.00156 0.00458 0.00502 0.00004
0.00111 0.00318
1988 1 1 3 0 1 1 52 190 0 0.00014 0.02819 0.4067
0.00423 0.00113 0.05054 0.01579 0.04125 0.00992 0.01415 0.00033 0.01861 0.00391 0.00258 0.00003 0.006
0.00209 0.00002 0.00026 0.00374 0 0.00029 0.00118 0.25377 0.00371 0.00355 0.0084 0.01968
0.04651 0.01432 0.00167 0.00778 0.00472 0.00051 0.00218 0.01048 0.00127 0.00903 0.00018 0.00018
0.00099
1989 1 1 3 0 1 1 52 174 0 0.00011 0.03457 0.03029
0.42988 0.00165 0.00067 0.00855 0.00895 0.01759 0.00249 0.00141 0.00068 0.00803 0.0001 0.00207 0
0.00005 0.00022 0.00004 0.00045 0 0.00009 0.0226 0.03778 0.26056 0.00339 0.0004 0.02036
0.01849 0.03719 0.00432 0.00165 0.00124 0.01195 0.0142 0.00599 0.00869 0.00042 0.0009 0.00006
0.00193
1990 1 1 3 0 1 1 52 133 0 0.02742 0.05254 0.03834
0.05285 0.21303 0.15181 0.00314 0.03976 0.00441 0.00642 0.00111 0.00497 0.00056 0.00317 0.00028
0.00123 0.00031 0.0009 0.00119 0.00411 0.00003 0.01388 0.03816 0.0536 0.02873 0.10087 0.04477
0.00425 0.01313 0.01413 0.0257 0.00296 0.01804 0.00942 0.0079 0.00345 0.00728 0.00259 0.0012
0.00036 0.00199
1991 1 1 3 0 1 1 52 66 0 0.03237 0.08143 0.08939
0.06549 0.04964 0.15004 0.03589 0.00976 0.01119 0.01278 0.00956 0.00144 0.0128 0 0.00836 0
0.00124 0 0 0.03012 0 0.01674 0.10708 0.05087 0.03811 0.01699 0.07145 0.02294
0.00555 0.0088 0.01073 0.01334 0.00211 0.00911 0.00072 0.00827 0.0001 0.00199 0.00012 0
0.01349
1992 1 1 3 0 1 1 52 100 0 0.00306 0.088 0.12952
0.10098 0.10262 0.05166 0.09095 0.03579 0.00788 0.01178 0.00858 0.0194 0.01313 0.01225 0.00157
0.00301 0.00157 0.00611 0.00128 0.00551 0 0.0016 0.02928 0.03758 0.03687 0.04847 0.02022
0.06001 0.02501 0.0074 0.0019 0.00156 0.01092 0.00271 0.0066 0.00209 0.00136 0.00054 0.00501
0.00004 0.00615
1993 1 1 3 0 1 1 52 75 0.00025 0.00174 0.02104 0.1297 0.118
0.09357 0.05244 0.0481 0.07239 0.01097 0.00529 0.01416 0.0095 0.01103 0.00428 0.0025 0.00186
0.00289 0.00071 0.00513 0.00153 0 0.00166 0.02201 0.10917 0.05945 0.05701 0.02266 0.01381 0.04
0.01438 0.00794 0.00644 0.00507 0.00306 0.00583 0.01028 0.00096 0.00355 0.00057 0.00192 0.00717
1994 1 1 3 0 1 1 52 76 0 0.00248 0.07104 0.0454
0.13842 0.08056 0.09087 0.04623 0.01417 0.06873 0.02104 0.00153 0.00473 0.0061 0.00337 0.00383
0.00147 0.00061 0.00588 0.00062 0.00098 0 0.0046 0.04132 0.04996 0.04147 0.04859 0.04356
0.02342 0.03959 0.03571 0.01772 0.00435 0.01236 0.00557 0.0056 0.0057 0.0051 0.00122 0.00013
0.00105 0.00494
1995 1 1 3 0 1 1 52 57 0 0.00404 0.02541 0.0728
0.08673 0.12557 0.08214 0.06132 0.04067 0.01859 0.04225 0.01223 0.00378 0.00687 0.00515 0.00146
0.00288 0.00047 0 0.00172 0.00367 0 0.00544 0.01632 0.03919 0.03082 0.05457 0.03673
0.03411 0.03743 0.01884 0.03969 0.02024 0.01218 0.00496 0.00986 0.01253 0.00477 0.00522 0.00009
0.00915 0.01012
1996 1 1 3 0 1 1 52 64 0 0.00763 0.1728 0.01501
0.07585 0.07577 0.02908 0.0377 0.04358 0.01553 0.00983 0.03194 0.00415 0 0.00155 0.00496
0.00284 0.00158 0 0.00624 0.00107 0 0.02565 0.11716 0.03339 0.034 0.04137 0.05519
0.02609 0.02877 0.01265 0.02855 0.01731 0.01346 0.00214 0.00171 0.00015 0.00179 0.00063 0.01215
0.00359 0.00716
1997 1 1 3 0 1 1 52 71 0 0.00132 0.01069 0.18465
0.07381 0.06563 0.06212 0.05927 0.04544 0.03139 0.01655 0.01236 0.01119 0.00124 0.00447 0.00364
0.00324 0.00406 0.00196 0 0.00173 0 0 0.0152 0.14505 0.05635 0.04362 0.03408

```
     0.02759 0.01579 0.01125 0.01111 0.0176  0.00923 0.00209 0.00123 0.00056 0.0022  0.00571 0.00007
     0.00099 0.00552
1998 1       1       3       0       1       1       52      -1      0       0.00185 0.01358 0.01991
     0.11579 0.06233 0.08108 0.07869 0.07642 0.05378 0.04527 0.02623 0.01928 0.01991 0.00429 0.00127
     0.00187 0.0018  0.0023  0.00021 0.00795 0.00031 0.00093 0.01815 0.01496 0.06433 0.01016 0.04198
     0.04395 0.03572 0.03541 0.01461 0.01351 0.03056 0.00985 0.01385 0.00231 0.00231 0.00326 0.00503
     0.00238 0.00265
1999 1       1       3       0       1       1       52      -1      0       0.00006 0.00173 0.10925
     0.06315 0.13796 0.04408 0.0662  0.04837 0.05063 0.04667 0.01942 0.01212 0.00903 0.0089  0.00263
     0.00008 0.00094 0.00205 0.0029  0.00533 0       0.00332 0.00007 0.05304 0.03379 0.10262 0.02641
     0.04117 0.02579 0.02087 0.01269 0.00879 0.00482 0.0069  0.00728 0.00496 0.00373 0.00287 0.00227 0.0001
     0.00702
2000 1       1       3       0       1       1       52      -1      0       0.00002 0.00014 0.01344
     0.06178 0.06835 0.11776 0.06001 0.07294 0.03955 0.07104 0.05061 0.04365 0.02505 0.0218  0.01716
     0.00218 0.00061 0.00321 0.00504 0.00363 0       0.00003 0.0051  0.00683 0.04577 0.02892 0.05689
     0.01984 0.03343 0.00977 0.0231  0.01241 0.03636 0.00292 0.00904 0.00465 0.00715 0.00008 0.00178
     0.00268 0.01525
2001 1       1       3       0       1       1       52      23      0.0009  0.01761 0.0093  0.02139
     0.03552 0.13228 0.07052 0.13274 0.05431 0.04817 0.02637 0.02695 0.028   0.02513 0.00513 0.00408 0
     0.00405 0.00102 0       0.00518 0.0018  0.02358 0.00336 0.01142 0.01598 0.03543 0.04657 0.06113
     0.01708 0.02996 0.0256  0.01227 0.01829 0.01634 0.00428 0.00515 0.01275 0.0018  0       0.00071
     0.00784
2002 1       1       3       0       1       1       52      31      0.00126 0.00519 0.14825 0.07593
     0.03391 0.03431 0.07351 0.04639 0.09528 0.02917 0.04017 0.02066 0.05252 0.0251  0.02963 0.00392
     0.01029 0.01613 0.00166 0.00083 0.00317 0.0003  0.00388 0.07294 0.03825 0.00824 0.01287 0.02868
     0.01071 0.03351 0.00561 0.01174 0.00248 0.00351 0.00683 0.00442 0.00052 0.00317 0.00247 0
     0.00006 0.00257
2003 1       1       3       0       1       1       52      9       0       0.00016 0.01887 0.61473
     0.01414 0.00693 0.00484 0.00961 0.00441 0.0041  0.00512 0.00221 0.00276 0.00221 0.00102 0.00307
     0.00102 0.00118 0.00102 0       0       0       0.00063 0.01768 0.23438 0.0206  0.00197 0.00228
     0.00221 0.00607 0.00087 0.0026  0.00173 0.00347 0.00347 0.00189 0.00087 0       0.00087 0.00102 0
     0
2004 1       1       3       0       1       1       52      33      0       0.00099 0.00483 0.02117
     0.32677 0.07346 0.02548 0.03422 0.05385 0.02661 0.03364 0.01354 0.01335 0.00763 0.01656 0.01126
     0.00744 0.00654 0.0117  0.00401 0.00143 0       0       0.00313 0.01417 0.20207 0.02458 0.0176
     0.00118 0.00983 0.01118 0.00368 0.00148 0.00346 0       0.00203 0.00074 0.00074 0.00434 0.00203 0
     0.00327
2005 1       1       3       0       1       1       52      15      0       0.00082 0       0.05207
     0.11353 0.4349  0.04918 0.01954 0.02939 0.01235 0.00348 0.00256 0.0001  0.00985 0.0098  0.00251
     0.00256 0.00005 0.00251 0       0       0       0       0       0.03266 0.0368  0.14335 0.02588
     0.00343 0.00251 0.00343 0       0       0       0.00082 0.00251 0       0       0       0       0
     0.00343
#

#

#                                                                    Hook-line - females

                                       Hook-line males
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#Hook and Line									# samples		1	2	3
	4	5	6	7	8	9	10	11	12	13	14	15	16
	17	18	19	20	plus	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16	17	18	19	20	plus
1985	1	2	3	0	1	1	52	1	0	0	0	0	0
	0.04536	0.05328	0.19343	0.05236	0.11135	0.05757	0.2199	0.01276	0.10755	0.01731	0.05256	0.01011	
	0.00383	0	0.0445	0.01204	0	0	0	0	0	0	0	0.00179	0
	0	0	0	0.00086	0.00343	0	0	0	0	0	0	0	
1986	1	2	3	0	1	1	52	3	0	0	0.00204	0.00148	0
	0.03329	0.04987	0.02766	0.1301	0.09393	0.15182	0.082	0.19844	0.00591	0.07306	0.04547	0.0265	0.0038
	0.04702	0.00225	0.00148	0.00004	0	0	0	0	0	0.00732	0	0	
	0.00394	0.00183	0.00028	0.00232	0.00408	0.0019	0.00014	0.00204	0	0	0	0	
1987	1	2	3	0	1	1	52	7	0	0.02078	0	0.01888	0
	0	0.00618	0.46082	0.0254	0.0622	0.0127	0.0876	0.0127	0	0	0	0.0622	0
	0.0622	0	0.00618	0	0	0	0.03158	0	0	0	0	0	0
	0	0.00618	0	0	0	0	0.0622	0	0.0622	0	0		
1990	1	2	3	0	1	1	52	11	0	0	0	0.1	0
	0.6	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	0	0	0	0	0		
1991	1	2	3	0	1	1	52	17	0	0.00476	0.01476	0.02609	
	0.08713	0.10463	0.33351	0.06743	0.02424	0.02449	0.02101	0.02871	0	0.01271	0.00142	0.00539	0
	0.00273	0	0	0	0	0.00057	0.01381	0.02257	0.04766	0.02672	0.06108	0.0148	0
	0.0044	0.00532	0.01512	0	0.00692	0	0.00791	0	0.0099	0	0.00419	0	
1992	1	2	3	0	1	1	52	38	0	0	0.0014	0.03133	
	0.07605	0.13621	0.0988	0.22181	0.05191	0.01575	0.02486	0.03549	0.02768	0.02943	0.00976	0.00214	
	0.00497	0.00063	0.008	0.0009	0.01247	0	0.00099	0.00055	0.01498	0.04606	0.03756	0.02124	
	0.03045	0.00864	0.00296	0.01137	0.01003	0.00167	0.00978	0.00704	0.00023	0.00298	0.00272	0.00049	0
	0.00066												
1993	1	2	3	0	1	1	52	20	0	0	0.06322	0.28475	
	0.18681	0.18307	0.08329	0.03099	0.04344	0.00095	0.00031	0.00033	0.00986	0.00056	0.00009	0.00034	
	0.00006	0.00036	0.00041	0.00009	0.00029	0	0	0.00892	0.03631	0.00024	0.00054	0.01886	
	0.01789	0.00957	0.00017	0.00014	0.00892	0.00008	0.00002	0.00879	0.00005	0	0.00002	0.0003	0
	0												
1994	1	2	3	0	1	1	52	11	0	0	0.00204	0.01527	
	0.05033	0.06699	0.12842	0.13083	0.12713	0.22705	0.03146	0.00527	0.02674	0.02452	0.01832	0.00342	0
	0	0.00379	0	0.00629	0	0	0	0.0049	0.00981	0.00833	0.01471	0.0049	
	0.01739	0.04386	0.00972	0	0.0049	0	0.0049	0	0	0	0	0	0.0087
1995	1	2	3	0	1	1	52	8	0	0	0.00187	0.01532	
	0.02451	0.15618	0.20948	0.10585	0.06084	0.01692	0.0284	0.00986	0	0.00475	0	0.00403	0
	0	0.00029	0.00073	0	0	0	0	0	0.05106	0.06784	0.07469	0.05575	
	0.02552	0.01207	0.02556	0.00579	0	0.01021	0.00402	0	0.00402	0	0.00029	0.00873	
	0.01542												
1996	1	2	3	0	1	1	52	11	0	0	0.00672	0.0158	
	0.08338	0.10917	0.13115	0.12225	0.13751	0.06567	0.0743	0.0743	0.0139	0.00463	0	0	0
	0	0.00427	0.00463	0	0	0	0	0.00336	0.01008	0	0.00672	0.01553	
	0.01035	0.08919	0.00854	0.00854	0	0	0	0	0	0	0	0	0
1997	1	2	3	0	1	1	52	10	0	0	0.04794	0.20447	
	0.08564	0.13285	0.15286	0.08235	0.08854	0.03996	0.0217	0.02629	0.01015	0.00295	0.00769	0.00139	0
	0.00729	0.00711	0	0.00121	0	0.01006	0.02013	0.00768	0	0.01006	0.00768	0	0
	0.00057	0	0.00768	0	0.00768	0	0.00809	0	0	0	0	0	
1998	1	2	3	0	1	1	52	-1	0	0	0.00213	0.02347	
	0.05733	0.06901	0.06024	0.08737	0.13578	0.15112	0.08453	0.04459	0.03388	0.02155	0.005	0.00189	
	0.00189	0.00402	0.00991	0	0.00927	0	0	0	0	0	0.01595	0.00601	
	0.02622	0.035	0.02812	0.02959	0.01547	0.00991	0.01179	0.01004	0.00189	0.00301	0.00213	0.00189	0
	0												

1999	1	2	3	0	1	1	52	-1	0	0	0	0.04742	
	0.08607	0.37575	0.09088	0.0561	0.0608	0.0513	0.07462	0.0102	0.00748	0.00669	0.00669	0	
	0.00079	0	0	0	0	0	0	0	0	0.00739	0.05183	0.00942	
	0.01883	0.00079	0.00942	0	0.01338	0.00669	0.00079	0.00669	0	0	0	0	0
	0												
2000	1	2	3	0	1	1	52	-1	0	0.00132	0.02549	0.0523	
	0.09041	0.13052	0.10797	0.0791	0.05472	0.09137	0.01976	0.03555	0.00624	0.00059	0.00566	0.0152	0
	0	0.00059	0	0	0	0	0	0.01373	0.01241	0.05369	0.01579	0.01711	
	0.02931	0.03335	0.02255	0.0282	0.01579	0.01645	0	0.01241	0	0	0	0	
	0.01241												
2001	1	2	3	0	1	1	52	-1	0	0	0	0.00172	
	0.01954	0.01552	0.01753	0.10458	0.04813	0.07298	0.04295	0.00172	0.01451	0.01451	0.00891	0.00891	0
	0	0	0	0.00891	0	0	0	0.00891	0.01781	0.04683	0.09869	0.12771	
	0.03793	0.08648	0.04683	0.02902	0.05804	0	0.01451	0.02342	0	0.02342	0	0	0
2002	1	2	3	0	1	1	52	-1	0	0	0.02632	0	
	0.05263	0	0.05263	0.05263	0.02632	0	0	0	0	0	0	0.02632	0
	0.02632	0	0	0	0	0	0	0	0	0.07895	0	0.10526	
	0.18421	0.13158	0.07895	0.10526	0	0.02632	0	0	0.02632	0	0	0	0
#													
#													
#									Net - females				
					net - males								
#Net								# samples		1	2	3	4
	5	6	7	8	9	10	11	12	13	14	15	16	17
	18	19	20	plus	1	2	3	4	5	6	7	8	9
	10	11	12	13	14	15	16	17	18	19	20	plus	
1983	1	3	3	0	1	1	52	-1	0	0	0	0	
	0.02676	0.04003	0.09744	0.18161	0.13584	0.15997	0.09485	0.05798	0.01296	0.08973	0	0.0265	0
	0	0	0	0	0	0	0	0	0	0.01353	0	0.03788	0
	0.02491	0	0	0	0	0	0	0	0	0	0	0	
1984	1	3	3	0	1	1	52	7	0	0	0	0	0
	0	0.10225	0.10225	0.23027	0.23108	0.14895	0.05153	0	0.05636	0.02576	0	0.01047	0
	0	0.04106	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0		
1985	1	3	3	0	1	1	52	36	0	0	0	0	0.0004
	0.04985	0.03887	0.06337	0.05768	0.11556	0.11659	0.18543	0.13259	0.06512	0.02013	0.01098	0.04088	0.0085
	0.02041	0.00005	0.00264	0	0	0	0.00033	0	0.00323	0.00046	0.00367	0.00463	
	0.00705	0.00807	0.00897	0.0089	0.00199	0	0.0041	0.00195	0	0.00965	0.00523	0.00269	
1986	1	3	3	0	1	1	52	41	0	0.00039	0.0003	0.00022	
	0.00023	0.01824	0.10149	0.0392	0.1235	0.14438	0.12603	0.08913	0.05311	0.01379	0.07571	0.0592	
	0.02077	0.03545	0.00555	0.00722	0.02524	0	0	0	0.00006	0.00006	0.00502	0.00612	
	0.00573	0.01498	0.00355	0.00317	0.0015	0.00735	0.00351	0.00049	0.00555	0	0.00269	0.00026	
	0.00057	0.00026											
1987	1	3	3	0	1	1	52	63	0	0	0.00408	0.0086	
	0.02549	0.02475	0.06117	0.20162	0.06769	0.03134	0.10648	0.17654	0.04042	0.0921	0.00948	0.01664	
	0.01234	0.00956	0	0.00945	0.00641	0.00019	0	0.00204	0.00496	0.00241	0.00048	0.00582	
	0.03464	0.00774	0.00259	0.00245	0.01552	0.00274	0.01393	0	0.00007	0.00019	0	0	
	0.00007	0											

1988 1 3 3 0 1 1 52 42 0 0 0.00067 0.1144
0.00112 0.00482 0.02916 0.03724 0.14749 0.04565 0.03701 0.07402 0.26009 0.00213 0.04172 0
0.02535 0 0.01009 0 0.07133 0 0.00101 0 0.04744 0.00101 0.00168 0
0.00168 0.00594 0.00202 0 0.00112 0.0323 0.00112 0.00101 0 0 0.00135 0 0
0
1989 1 3 3 0 1 1 52 68 0 0 0.00031 0.04789
0.41627 0 0.00348 0.00234 0.03069 0.33092 0.00052 0.03721 0.01504 0.04579 0.01175 0.01738
0.00009 0 0.01224 0 0 0 0 0 0.00006 0.01467 0.00003 0
0.00003 0.00031 0.00065 0 0.00003 0.00043 0 0.01153 0 0.00012 0.00022 0 0
0
1990 1 3 3 0 1 1 52 79 0 0.00227 0.00965 0.01093 0.0132
0.27502 0.04884 0.00185 0.00554 0.12338 0.09399 0.04657 0.01903 0.0389 0.06318 0.00014 0.03748
0.00043 0 0 0.00014 0 0 0.00099 0.00426 0.00114 0.05594 0.00852 0.04089
0.00057 0.00781 0.00753 0.04572 0.00142 0.0017 0.00838 0.00199 0.00227 0.00014 0.00014 0.00057
0.01945
1991 1 3 3 0 1 1 52 7 0 0 0.01502 0.01502
0.08834 0.11352 0.40592 0.08216 0 0.02606 0.00221 0.01193 0 0.00928 0 0.02385 0
0 0 0 0 0 0 0.03004 0.00221 0.04373 0.01413 0.06537 0.00707 0
0 0 0.03224 0 0 0 0 0 0.01193 0 0 0
1992 1 3 3 0 1 1 52 -1 0 0 0 0.01552
0.06707 0.03244 0.08285 0.26658 0.07167 0.01541 0.07176 0.04182 0.03368 0.0175 0.01385 0.01981
0.02353 0.01624 0.01472 0 0.00251 0 0 0.00048 0.01162 0.00295 0.01433 0.02943
0.07371 0.00964 0.00145 0 0.016 0.00531 0.00491 0.01054 0 0.00645 0.00075 0.00546 0
0
1993 1 3 3 0 1 1 52 12 0 0 0 0.01679
0.03743 0.04886 0.10278 0.11866 0.28306 0.04927 0.02559 0.05382 0.05969 0.05412 0.01487 0.02802
0.00344 0.01325 0 0 0 0 0 0.00233 0.00465 0.017 0.01254 0.00718
0.00799 0.02226 0 0 0.00303 0 0 0.00132 0.00223 0 0.00981 0 0
0
1994 1 3 3 0 1 1 52 9 0 0 0 0
0.01278 0.07036 0.10557 0.13574 0.12117 0.23743 0.02058 0.02415 0.05076 0.04652 0.01438 0.00504 0.0153
0.00719 0 0 0 0 0 0.00633 0.00922 0.00596 0.00547 0.01008 0.02065
0.00922 0.03343 0 0 0 0 0.00811 0.01997 0 0 0 0
0.00461
1995 1 3 3 0 1 1 52 3 0 0 0 0 0.0212
0.0212 0.0424 0.09385 0.0212 0.16669 0.30604 0.05738 0.03618 0.05955 0.04381 0.04787 0.03072
0.03072 0 0 0 0 0 0 0 0 0 0 0 0
0.0212 0 0 0 0 0 0 0 0 0 0 0
1996 1 3 3 0 1 1 52 2 0 0 0 0
0.03388 0 0.03388 0.13553 0.11862 0.08474 0.06776 0.23737 0 0.03388 0 0.03388
0.06783 0.05092 0.05086 0 0.01697 0 0 0 0 0 0 0 0
0 0.03388 0 0 0 0 0 0 0 0 0 0 0
1997 1 3 3 0 1 1 52 2 0 0 0 0
0.05571 0 0.02455 0.09254 0.13598 0.23513 0.09537 0.16619 0 0.03683 0.03399 0
0.01228 0 0.01228 0 0 0 0 0 0 0 0 0
0.02172 0 0.02172 0 0.02172 0 0 0.01228 0 0 0 0 0
0.02172
1998 1 3 3 0 1 1 52 3 0 0 0 0 0
0 0.0377 0.06604 0.16985 0.11951 0.19811 0.0786 0.10374 0.11006 0 0 0 0
0.02513 0 0.00945 0 0 0 0 0 0 0.00945 0 0.02201 0
0 0.00945 0.03146 0.00945 0 0 0 0 0 0 0
#
2004 1 6 3 0 1 1 52 87 0.0481 0.06947 0.0497 0.0034
0.30939 0.02263 0.01291 0.00537 0.01858 0.00393 0.00693 0.00032 0.00074 0 0.00016 0 0.0009
0.00037 0 0.00004 0.0001 0.04323 0.03786 0.06075 0.01039 0.23843 0.02529 0.02268 0.00128
0.00208 0 0.0006 0.0006 0 0 0.00077 0.00135 0.00081 0.0006 0 0.00008 0

#
Mean size at age data
0 # number of size at age observations
environmental data-
0 # num env. Variables
0 # num env. Observations
999 # end of file

```
# ************************************************************
#  Chilipepper rockfish .ctl file
#  final model from June 2007 STAR Panel
#  SS2 Version 2.00c by_Richard_Methot_(NOAA);_using_Otter_Research_ADMB_7.0.1
# ************************************************************
#
#
1  #_N_Growth_Patterns
1 #_N_submorphs

1 #_N_areas
 1 1 1 1 1 1 1 1 1 1#_area_assignments_for_each_fishery_and_survey

 #_recruit_design_(G_Pattern_x_birthseas_x_area)_X_(0/1_flag)
 1
0 #_recr_distr_interaction
0 #_Do_migration
 #_movement_pattern_(for_each_season_x_source_x_destination)_input_(0/1_flag)_minage_maxage
 0 0 0
2 #_Nblock_Designs
5 10 # blocks per design
1970 1979
1980 1988
1989 1991
1992 1998
1999 2006
# block design 2
1972 1977
1978 1980
1981 1983
1984 1986
1987 1989
1990 1992
1993 1995
1996 1998
1999 2001
2002 2006

0.5 #_fracfemale
1000 #_submorph_between/within
1 #vector_submorphdist_(-1_first_val_for_normal_approx)
4 #_natM_amin
5 #_natM_amax
2 #_Growth_Age-at-L1
18 #_Growth_Age-at-L2
0.1 #_SD_add_to_LAA
0 #_CV_Growth_Pattern
1 #_maturity_option
1 #_First_Mature_Age
3 #_parameter_offset_approach
1 #_env/block/dev_adjust_method(1/2)
-5 #_MGparm_Dev_Phase

#_growth_parms
#_LO     HI          INIT       PRIOR   PR_type SD         PHASE  env-var use_dev dev_minyr dev_maxyr dev_stddev Block
Block_Fxn
```

```
0.05	0.3	0.16	0.22	0	0.8	-4	0	0	0	0	0.5	0	0
#_Gpattern:_1_Gender:_1
-3	3	0	0	0	0.8	-4	0	0	0	0	0.5	0	0
5	50	19.659	19	0	20	-2	0	0	0	0	0.5	0	0
25	70	47.3	45	0	20	-2	0	0	0	0	0.5	0	0
0.05	0.3	0.1945	0.1772	0	0.8	-2	0	0	0	0	0.5	1	0
0.02	0.5	0.06	0.065	0	0.8	-2	0	0	0	0	0.5	0	0
-3	3	0.06	0.065	0	0.8	-2	0	0	0	0	0.5	0	0
-6	3	0.232	0.1279	0	0.8	-4	0	0	0	0	0.5	0	0
#_Gpattern:_1_Gender:_2
-6	3	0	0	0	0.8	-4	0	0	0	0	0.5	0	0
-3	3	-0.03	-0.1	0	0.8	-2	0	0	0	0	0.5	0	0
-3	3	-0.35 -0.3	0	0.8	-2	0	0	0	0	0.5	0	0
-3	3	0.605 0.05	0	0.8	-2	0	0	0	0	0.5	0	0
-3	3	0	0	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	0	0	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	4.05e-006 4.1e-006	0	0	-3	0	0	0	0	0.5	0
	0 #_wt-len&maturity
-3	10	3.2	3.25	0	0.5	-3	0	0	0	0	0.5	0	0
1	50	25.713	25	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	-0.316 -0.3	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	1	1	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	0	0	0	0.8	-3	0	0	0	0	0.5	0	0
-3	3	2.24e-006 2.2e-006	0	0	-3	0	0	0	0	0.5	0
	0
-3	10	3.32	3.32	0	0.05	-3	0	0	0	0	0.5	0	0
-4	4	0	0	-1	99	-3	0	0	0	0	0.5	0	0
#_recrdistribution_by_growth_pattern
-4	4	0	0	-1	99	-3	0	0	0	0	0.5	0	0
#_recrdistribution_by_area 1
-4	4	4	0	-1	99	-3	0	0	0	0	0.5	0	0
#_recrdistribution_by_season 1
1	1	1	1	-1	99	-3	0	0	0	0	0.5	0	0
#_cohort_growth_deviation

0 #_custom_MG-env_setup
0 #_custom_MG-block_setup
#K block param setup (one setup for all devs)
#_LO	HI	INIT	PRIOR	PR_type SD	PHASE
-10	10	0	0	0	.5	5

#_Spawner-Recruitment
1 #_SR_function
#_LO	HI	INIT	PRIOR	PR_type SD	PHASE
9	13	14	10	0	5	1
0.2	1	0.57	0.573	0	0.183	-4
0	2	1	1	0	1	-3
-5	5	0	0	0	1	-3
-5	5	0	0	0	1	-2
0.0	0.5	0.0	0.0	-1.	99	-2  #_reserve for future autocorrelation
0 #_SR_env_link
1 #_SR_env_target_1=devs;_2=R0;_3=steepness
1 #do_recr_dev:  0=none; 1=devvector; 2=simple deviations
1965 2006 -3 3 2 #_recr_devs
1492 #_first_yr_fullbias_adj_in_MPD
```

#_initial_F_parms

#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE
0	0.1	0	0.01	0	0.2	-1
0	0.1	0	0.05	0	0.2	-1
0	1	0	0	0	0.2	-1
0	1	0	0	0	0.2	-1

#_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
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	1	0
0	0	0	0	0	0

#
#_Q_parms(if_any)
LO HI INIT PRIOR PR_type SD PHASE

#-10	20	0	0	0	10	-3 # juv survey1 power
#-10	20	0	0	0	10	-3 # juv survey2 power
#-10	20	0	0	0	10	1 # triennial q
#-10	20	0	0	0	10	1 # NWC combo q

#_size_selex_types
#_Pattern Discard Male Special

1	0	1	0	# 1
1	0	1	0	# 2
24	0	1	0	# 3
24	0	0	0	# 4
1	0	0	0	# 5
1	0	0	0	# 6
0	0	0	0	# 7
0	0	0	0	# 8
30	0	0	0	# 9
24	0	0	0	# 10

#
#_age_selex_types
#_Pattern Discard Male Special
10 0 0 0 # 1
10 0 0 0 # 2
10 0 0 0 # 3
10 0 0 0 # 4
10 0 0 0 # 5
10 0 0 0 # 6
11 0 0 0 # 7
11 0 0 0 # 8
10 0 0 0 # 9
20 0 1 0 # 10

#_selex_parms

```
#_size_sel: 1
#size sel 1 logistic
5	50	40.28	30	0	100	2	0	0	0	0	0	0	0 #
0.0001	35	14.31	5	0	10	3	0	0	0	0	0	0	0 #
# 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	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at minL
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at dogleg
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel) at maxL
#
#_size_sel: 2
5	45	45	40	0	10	2	0	0	0	0	0	0	0 #
0.0001	35	14.31	5	0	10	2	0	0	0	0	0	0	0 #
# size_se1: 2- male offsets- 4 lines
1	60	16	20	0	10	-5	0	0	0	0	0.5	0	0
	#	size@dogleg
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at minL
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at dogleg
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel) at maxL
# size sel 3
#5	45	40	45	0	100	2	0	0	0	0	0	0	0 #
#0.001	35	14.31	5	0	10	2	0	0	0	0	0	0	0 #
#_size_sel: 3
1	60	45.17	50	0	100	2	0	0	0	0	0.5	2	0
	#	PEAK	value
-6	50	-2.19	-0.75	0	10	4	0	0	0	0	0.5	0	0
	#	TOP	logistic
-1	9	3.87	3.5	0	10	2	0	0	0	0	0.5	0	0
	#	WIDTH exp
-1	9	1.98	5	0	10	4	0	0	0	0	0.5	0	0
	#	WIDTH exp
-50	9	-4.76	-4.5	0	10	2	0	0	0	0	0.5	0	0
	#	INIT	logistic
-50	9	-0.54	2.9	0	10	2	0	0	0	0	0.5	0	0
	#	FINAL	logistic
# size_se1: 3- male offsets- 4 lines
1	60	16	20	0	10	-5	0	0	0	0	0.5	0	0
	#	size@dogleg
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at minL
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at dogleg
-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel) at maxL
#_size_sel: 4
1	60	33.85	32	0	10	2	0	0	0	0	0.5	0	0
	#	PEAK	value
-20	4	-1.27	-0.75	0	10	2	0	0	0	0	0.5	0	0
	#	TOP	logistic
```

```
-10	9	3.4	3.5	0	10	2	0	0	0	0	0.5	0	0
	#	WIDTH exp
-10	9	3.68	5	0	10	2	0	0	0	0	0.5	0	0
	#	WIDTH exp
-10	9	-3.37	-4.5	0	10	2	0	0	0	0	0.5	0	0
	#	INIT	logistic
-10	9	0.79	2.9	0	10	2	0	0	0	0	0.5	0	0
	#	FINAL	logistic
#_size_sel: 5
5	35	15.7	25.7	0	10	-2	0	0	0	0	0	0	0 #
0.000001	35	0.0002	5	0	10	-2	0	0	0	0	0	0
	0 #
# size sel 6
5	35	20	15	0	100	2	0	0	0	0	0	0	0 #
0.000001	35	14	5	0	10	2	0	0	0	0	0	0
	0 #
#_size_sel: 7,8 - none- pre recruit survey
#_size_sel: 9 set to maturity-
#_size_sel: 10 Rec CPUE
1	60	33.85	32	0	100	2	0	0	0	0	0.5	0	0
	#	PEAK	value
-6	4	-1.27	-0.75	0	10	2	0	0	0	0	0.5	0	0
	#	TOP	logistic
-1	9	3.4	3.5	0	10	2	0	0	0	0	0.5	0	0
	#	WIDTH exp
-1	9	3.68	5	0	10	2	0	0	0	0	0.5	0	0
	#	WIDTH exp
-10	9	-3.37	-4.5	0	10	2	0	0	0	0	0.5	0	0
	#	INIT	logistic
-10	9	0.79	2.9	0	10	2	0	0	0	0	0.5	0	0
	#	FINAL	logistic
# size_se1: 10- male offsets- 4 lines
#1	60	16	20	0	10	-5	0	0	0	0	0.5	0	0
	#	size@dogleg
#-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at minL
#-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel)at dogleg
#-10	10	0	0	0	10	-5	0	0	0	0	0.5	0	0
	#	log(relmalesel) at maxL
#
#
#_age_sel: 1
#_age_sel: 2
#_age_sel: 3
#_age_sel: 5
#_age_sel: 6
#_age_sel: 7 - juv survey 1
 0 0 0 0 0 10 -3 0 0 0 0 0 0 0 # 39
 0 0 0 0 0 10 -3 0 0 0 0 0 0 0 # 40
#_age_sel: 8 - juv survey 2
 0 0 0 0 0 10 -3 0 0 0 0 0 0 0 # 39
 0 0 0 0 0 10 -3 0 0 0 0 0 0 0 # 40
#_age_sel: 10
1	10	1	1	0	1	2	0	0	0	0	0.5	0	0
	#	PEAK	value
```

```
-60     60      -13     -23     0       1       2       0       0       0       0       0.5     0       0
        #       TOP     logistic
-40     20      -2      -20     0       1       2       0       0       0       0       0.5     0       0
        #       WIDTH exp
-40     10      0       0       0       1       3       0       0       0       0       0.5     0       0
        #       WIDTH exp
-40     10      -17     -17     0       1       2       0       0       0       0       0.5     0       0
        #       INIT    logistic
-40     20      -4.5    -4.5    0       1       2       0       0       0       0       0.5     0       0
        #       FINAL   logistic

# agesel 10- male offsets- 4 lines
1       60      2       2       0       1       -5      0       0       0       0       0.5     0       0
        #       size@dogleg
-10     10      0       0       0       1       -5      0       0       0       0       0.5     0       0
        #       log(relmalesel)at minL
-10     10      0       0       0       1       -5      0       0       0       0       0.5     0       0
        #       log(relmalesel)at dogleg
-10     10      0       0       0       1       -5      0       0       0       0       0.5     0       0
        #       log(relmalesel) at maxL


1 #_env/block/dev_adjust_method(1/2)

0 #_custom_sel-env_setup

0 #_custom_sel-block_setup
# currently for trawl fishery only, 3 params, 4 blocks
#_LO    HI      INIT    PRIOR   PR_type SD      PHASE
-10     10      0       0       0       99      -6



-4 #_selparmdev-phase

#_Variance_adjustments_to_input_values
#_1 2 3 4 5 6 7 8

#0 0 0 0 0 0 0 0 0 0#_add_to_survey_CV
0.036251
0
0
0.19632
-0.049828
0
0
0
0.00
0
0 0 0 0 0 0 0 0 0 0#_add_to_discard_CV
0 0 0 0 0 0 0 0 0 0#_add_to_bodywt_CV
# tune length
0.69
0.75
0.73
1
```

0.68
0.35
1
1
1
2.5
#1 1 1 1 1 1 1 1 1 1#_mult_by_lencomp_N
1.43714
5.41864
4.24022
1
1
0.75
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#_mult_by_size-at-age_N
30 #_DF_for_discard_like
30 #_DF_for_meanbodywt_like

1 #_maxlambdaphase
0 #_sd_offset
#_lambdas_(columns_for_phases)
1 #_CPUE/survey:_1
0 #_CPUE/survey:_2
0 #_CPUE/survey:_3
0 #_CPUE/survey:_4
1 #_CPUE/survey:_5
1 #_CPUE/survey:_6
0 #_CPUE/survey:_7
1 #_CPUE/survey:_8
0 #_CPUE/survey:_9
1 #_CPUE/survey:_10
0 #_discard:_1
0 #_discard:_2
0 #_discard:_3
0 #_discard:_4
0 #_discard:_5
0 #_discard:_6
0 #_discard:_7
0 #_discard:_8
0 #_discard:_9
0 #_discard:_10
0 #_meanbodyweight
0.1 #_lencomp:_1
0.1 #_lencomp:_2
0.1 #_lencomp:_3
1 #_lencomp:_4
1 #_lencomp:_5
0.1 #_lencomp:_6
0 #_lencomp:_7
0 #_lencomp:_8
0 #_lencomp:_9
1 #_lencomp:_10

1	#_agecomp:_1
1	#_agecomp:_2
1	#_agecomp:_3
0	#_agecomp:_4
0	#_agecomp:_5
1	#_agecomp:_6
0	#_agecomp:_7
0	#_agecomp:_8
0	#_agecomp:_9
0	#_agecomp:_10
0	#_size-age:_1
0	#_size-age:_2
0	#_size-age:_3
0	#_size-age:_4
0	#_size-age:_5
0	#_size-age:_6
0	#_size-age:_7
0	#_size-age:_8
0	#_size-age:_9
0	#_size-age:_10
0	#_init_equ_catch
1	#_recruitments
0	#_parameter-priors
1	#_parameter-dev-vectors
100	#_crashPenLambda
0.9	#_maximum allowed harvest rate
999	

Appendix C: Detailed list of STAR Panel requests and STAT responses.

Round 1 requests

A. Compare the length-composition of the aged fish with non-aged fish for each fishery and each year.

B. Fix the code for the recreational CPUE to be number-based rather than biomass-based.

C. Reset the lambdas on LFs to 0.1 if age data exist, and to 1 if there are no associated age data for the same samples. Run with:

- No CalCOFI or core juvenile;
- No time varying K – fix at the values of all growth parameters of the earlier conditional runs;
- Trawl CPUE indices;
- Rec CPUE;
- Triennial Survey;
- Combined survey;
- Coast-wide juvenile index;
- Fix h at something reasonable;
- Fix M for females and estimate offset for males;
- Fix CV of length at age at 0.06 [based on external analysis done by the STAT];
- Profile over M including likelihood components;
- Estimate selectivity parameters;
- Estimate SSB0;
- Estimate depletion.

D. Save the results from the un-tuned model

E. Tune the trial reference model – see fit for everything. Plots and tables of diagnostics and results.

F. Profile over M for the tuned model looking at individual likelihood components – identify inconsistencies among data sources.

G. Plot or tabulate spatial distribution of samples in recreational data from observers over time.

Round 1 responses

A. The length-compositions of the aged and non-aged chilipepper rockfish were for approximately 50% of the samples from each fishing gear. The results suggested that the size compositions of aged versus unaged fish (plotted as individuals, rather than expanded length compositions) may be biased for some years.

B. The SS2 control switch for the CPFV survey (the recreational fishery CPUE index) was corrected to indicate that the data represented numbers of fish rather than biomass.

C. The SS2 model specified for this request was set up and run with steepness fixed at 0.57 and female natural mortality fixed at 0.16, consistent with the point estimate of steepness associated with the informative prior and the results of profiling over natural mortality. The length-composition data were down-weighted as requested, which was recognized by both the STAR Panel and the STAT as an ad hoc correction for non-independence of the data.

D. Results of the un-tuned model were saved as requested.

E. The revised model was tuned and the results evaluated. As with the earlier model, the relative abundance indices failed to reflect the increase in biomass associated with the large 1984 cohort apparent in observed data. Similarly, the predicted values for the CPFV survey (which began in 1988) showed no decline despite a clear downward trend in the observed values for this index.

F. The profile plot over M revealed tension between the data sets, particularly between the trawl fishery (particularly the length composition data, but including the trawl CPUE time series) and the recreational CPFV survey (with the triennial survey tending to be in agreement with the recreational CPFV survey). Higher estimates of spawning stock biomass were associated with higher values of M.

G. Plots of the number of observed CPFV trips and the number of chilipepper rockfish caught by depth categories and year demonstrated that a relatively small number of samples from deeper depths, each of which encountered large number of fish, were recorded in the years prior to 1994. To ensure consistency in depth ranges covered by the survey through time, trips taken in depths greater than 80 fathoms were excluded from the GLM analysis. The location of the blocks that were included in the CPUE index was also displayed graphically to the STAR Panel, and although a majority of these blocks occurred in the Cordell Bank and Monterey Bay regions, the locations ranged from just south of Point Arena to the Morro Bay region. This spatial coverage was considered adequate (albeit not optimal) for reflecting relative trends throughout the core area of the stock biomass.

H. In the spirit of the discussions with the STAR Panel, the CPUE index was also reproduced using the Stephens/MacCall filter, which was very similar to that produced by the GLM using depth and block data. This indicated that the filter was working properly to identify trips likely to catch chilipepper, although both the STAT and the STAR agreed to continue with the GLM based on location and depth data. The CVs of the results from the filter were less than those from the GLM. Based on discussions with the STAR Panel regarding the triennial survey indices developed with GLMM approaches and area-swept estimates of biomass, a more detailed description of the GLMM analysis provided by T. Helser (pers. Com) was also presented to the STAR Panel. Both the STAT and the STAR agreed that the GLMM provided good predictions of the data.

Round 2 requests

Based on the reference run that was established on Monday evening (Round 1):

H. Test for block-year interaction in GLM for recreational observer CPFV data. If a strong interaction is detected, report back to this issue and complete points I to M, but do not undertake the additional runs at points N to P.

I. Plot length-compositions of aged versus non-aged fish in remaining samples to determine those samples which are relatively unbiased. Weed out obviously biased samples from the SS2 input including those samples that had infeasible numbers of large males.

J. Investigate samples that had extraordinarily large proportions of males.

K. Link RecFIN length-compositions to the recreational fishery and CPFV observer length-composition to the CPFV CPUE survey to assist in elucidating the respective selectivity curves.

L. Remove whole of deep trips >80.

M. Use Helser's GLMM rather than area swept index.

N. Estimate an appropriate selectivity pattern for triennial survey.

O. Systematically set lambda for recreational observer CPFV index to 1, 5, 10, … till a reasonable fit to this index is attained and investigate changes in likelihood for all other components.

P. Profile over R0 as was done for M, plotting against B0.

Round 2 responses

H. Due to the large number of interaction parameters necessary to adequately test for interactions between year and block effects, it was not possible to detect block-year interactions in a satisfactory manner, however the indication was that there were no significant interactions.

I. The length-compositions of aged and non-aged samples were plotted for samples not examined in the initial request, and several potentially problematic years of age-composition data were excluded from further analysis (see the section on commercial age and length composition data for specific years that were effectively removed from the objective function).

J. After filtering to remove outliers, the length-composition for one sample still contained a number of unfeasibly large males. This length-composition year was also "turned off" in all subsequent analyses as well as the base model.

K. In the preliminary model the CPFV index was biomass-based and was linked with the recreational fishery along with the CPFV length-composition data. In discussions with the STAR Panel it was agreed to treat the CPFV index and length compositions as a separate survey, and use RecFIN length-composition data to represent the full range of recreational fishing modes. These changes did not have a major effect on the model results.

L. Removing the data for trips >80 fathoms, including associated length data, had little effect on the biomass trajectory.

M. The use of the GLMM results rather than the swept area indices for the triennial and NWFSC combination survey resulted in slightly greater depletion than in the previous run. As the GLMM analysis was agreed to more appropriately account for the highly variable nature of tow-specific catch rates, this was agreed by both the STAT and the STAR Panel to be a more appropriate index for the final model and was used in all further analyses.

N. The selectivity curve for the triennial survey was essentially a horizontal line, with the result that the parameters were poorly specified and the Hessian for this run could not be inverted. To invert the Hessian required fixing the selectivity parameters at their estimated values.

O. Elevated lambdas on the CPFV index resulted in lower biomass trajectories and apparently greater depletion, with a better fit to the CPFV and triennial indices but poorer fit to the trawl CPUE index. However, even with lambda = 25 the predicted CPFV index failed to reflect the increase in biomass that resulted from the 1984 year class, which was evident in other data sources. A more effective approach for capturing the signal of the 1984 year class was to set the CPFV index lambda at 5, and incorporate both length and age selectivity (similar to the sablefish model), and including time-varying growth (with a 3-year blocking pattern). The resulting predicted length-compositions for the CPFV survey reflected the bimodality present in the observed length data, which was not as well reflected when using length-based selectivity alone.

P. The STAT had insufficient time to satisfy this request.

Round 3 requests

Q. Modify the SS2 input specification to turn off the age-composition data where samples were biased (as determined from comparison of aged and non-aged LF data) and turn length-composition data back on. For the sample with an infeasible number of large males, turn off both age and length-compositions.

R. Using lambda for CPFV survey data set to 1, run SS2 to provide a reference for subsequent runs

S. Investigate alternative parameterisation for sex-specific selection curves for the CPFV survey using either age OR length selection (but not both) and hence determine a suitable selection pattern to use. Save runs.

T. Using the final selection curve from Request S, produce a simple profile analysis based on R0 to explore the tension among different indices and data sets.

Round 3 responses

Q. The changes were completed to remove the effect of biased sampling for age but retain the associated length data.

R. The run was completed as requested. Turning off the biased age-composition data did not have a major impact on the predictions of biomass, nor did it help the fit to the CPFV survey data.

S. The rationale for this request was to find a selection curve for the CPFV survey that would fit the CPFV index and length-composition data without the complexity of the composite age- and length-based curve that the STAT had used in response O. The STAT replaced the CPFV length-based selection curve with an age-based curve, which went asymptotic when fitted. The resulting fit appeared slightly better than that obtained with length-based selectivity. However, the request that the selectivity curve be sex-specific was not implemented. Consequently the response to request T was not informative, and that request was repeated in the next round.

Round 4 requests

U. Complete Request S. That is, search for alternative parameterisation for sex-specific selection curves for the CPFV survey using either age OR length selection (but not both) and hence determine a suitable selection pattern to use. Save runs.

V. Using the final selection curve from Request U, produce a simple profile analysis based on R_0 to explore the tension among different indices and data sets.

W. Explore alternative blocking for time-varying growth based on external environmental variables.

Round 4 responses

U. The STAT attempted to find an alternative parameterization for sex-specific selectivity curves, but was unable to fit an age-based or length-based, sex-specific selection curve that provided as good a model fit as that obtained by the combined age- and length-based selection curve (which were not sex-specific).

V. The relative impact on the overall likelihood of the different model components at different values of R_0 could not be compared easily using the profile plots because the plots did not account for the effect of lambda, which was reduced to 0.1 for some components. Using sex-specific selection for the CPFV survey did not appear to warrant further investigation.

W. An alternative block formulation was developed based on the major shifts in the sign of the Pacific Decadal Oscillation (PDO) index, which has been shown to be related to physical ocean conditions, zooplankton production, salmon smolt survival and other indices of marine productivity. The Panel agreed with the STAT that the PDO provided an adequate basis for blocking offsets for the growth parameter K into six time-blocks. The results included a large improvement in the log-likelihood, but the value of K for the final time-block was far lower than the values for previous time-blocks.

Round 5 requests

X. Investigate feasibility of driving K with PDO (spend no more than half hour on this task).

Y. Adopt time-varying growth based on the better of using either PDO blocks (with slightly-informative prior on K to avoid infeasible reduction in K for last period) or using environmentally-driven growth (Request X), and using both age and size-selectivity on the CPFV CPUE recreational survey, create tuned base. Demonstrate adequate convergence of tuned run.

Z. Produce profile plots on R0 accounting for lambda.

AA. Using base run, produce standard diagnostics for STAR Panel review.

Round 5 responses

X. The direct forcing of the growth parameter K with a three-year running mean of the PDO index showed promise, and resulted in an improved fit (approximately 25 likelihood units) relative to the time-invariant K model. However, the improvement in fit was notably less than using blocked time intervals, and consequently it was agreed that the base model should use the time-blocking approach.

Y. A value of 0.5 was used as the standard deviation for a slightly informative prior on K for the configuration with six PDO-based time-blocks for changes in K. The convergence-test runs that used "jittered" starting parameter values revealed convergence problems, suggesting that the likelihood surface is quite irregular. Requests Z and AA were not completed due to these convergence problems.

Round 6 requests

AB. Explore convergence and results of time-varying K with (a) last two blocks combined into a single large block and (b) changing the standard deviation for the prior on the deviations on K from 0.5 to 0.35.

AC. Use 0.5 on the K-dev prior. Run with five-block rather than 6-block model. Examine results.

AD. Turn off all priors. Run with five-block rather than 6-block model. Examine results

AE. Use run from Request AD. Clean up initial values. Make qs analytical. Clean up phasing. Do jitters and alternative phasing to confirm model convergence. If not converged, report back ASAP. If converged, produce a full set of diagnostic results and profile plots on R_0 accounting for lambda. If these are satisfactory, this will be the base model.

Round 6 responses

AB. The two requested runs explored alternative methods for constraining the growth coefficient K in the final time block. The Panel was concerned that the unconstrained estimate for the final K value was extremely small and would have a strong influence on forecasts. The run with the standard deviation for the prior probability reduced to 0.35 still produced a low value for the final K. The run that merged the last two blocks in combination with a standard deviation of 0.35 for the prior probability resulted in an intermediate value of K.

AC. The Panel sought confirmation that having the longer final block in the five-block model would provide sufficient constraint for the final K value and that the prior probability on the K-offsets could be eliminated. The use of a standard deviation value of 0.5 for the prior probability on the K-offsets had little effect on the results.

AD. As several parameters had very modest likelihood values associated with weakly informative priors other than the offsets to K, all prior probabilities were removed and the lambda on priors was set to zero in order to simplify the model configuration.

AE. Convergence test runs with jittered initial parameter values indicated there still were convergence problems associated with roughness in profile plots, although the effects did not appear too severe. The panel provided guidance to jitter the final profile plots in the revised assessment to ensure convergence to the best model fit, and this was done for all sensitivity runs.

Round 7 requests

AF. Set process error added to CPFV survey indices to 0. Re-run. Confirm that this is appropriate to use as a base model through jitters and alternative phasing to confirm model convergence.

AG. With settings resulting from Request AF, increase emphasis to 20 on both CPFV survey indices and length frequencies to estimate age-based, sex-specific selectivity. Assess whether this gives sensible selection patterns. If so, using the resulting parameter space and selectivity pattern (possibly fixing selectivity parameters to the resulting values), de-emphasise, re-fit, and re-tune to produce plausible alternative results (removing process error if necessary after tuning). Note – no more than ~45 minutes to be spent on this task. Produce a plot of the biomass trajectory of this compared with the result from Request AF as a sensitivity analysis. Compare the depletion estimates.

AH. With settings resulting from Request AF, explore the following dimensions of uncertainty using low and high values for (a) historical catch prior to 1978 (half and double), (b) M, and (c) h. Retain SS2 results from each run. Produce comparative plots of the biomass trajectories of these compared with the result from Request AF. Produce a table showing comparison of likelihood contributions from different components. Produce a table of comparative depletion estimates.

Round 7 responses

AF. Removing the variance adjustment on the CPFV survey index had the desired effect of producing a better fit to the CPFV survey. After reviewing diagnostic plots the Panel recommended acceptance of this model configuration as the base model.

AG. These sensitivity runs re-explored using an alternative configuration for the CPFV survey selection curve. Previous explorations had increased the lambda on the CPFV survey index but not on the CPFV length-composition data. The new runs produced a very good fit to the CPFV index even when lambda was decreased from 20 to 10, but the CPFV selectivity curve had been configured as age- and length-based and sex-specific. Convergence tests with jittered initial parameter values still produced fits that appeared not fully converged.

During discussions the STAT indicated that the CVs for the triennial and combination surveys had been reduced externally rather than with a variance adjustment factor in the SS2 control file. Because the model provided good fits to several survey data points that had very large input CVs, the standard variance adjustment approach would have produced negative CVs for other data points with small input CVs. The Panel notes that further consideration is needed to develop an appropriate approach for handling survey variance adjustments that could potentially become negative.

AH. The runs were completed as requested. The resulting profile plots were somewhat jagged, suggesting that the model had failed to converge fully at many values of the reference variable. Following examination of the profile plots the Panel concluded that, of the variables considered, h was likely to provide the most useful axis of uncertainty. The Panel recommended assuming a normal distribution for h with a mean value of 0.573 and standard deviation of 0.183 to determine the bracketing values.

Round 8 requests

AI. Complete Request AG to estimate age-based, sex-specific selectivity. Run and produce comparison of results.

AJ. For developing a decision table, run the base model with h = 0.34 and 0.81 [mean values of the lower and upper 25% of the prior probability distribution for h] to obtain results likely to be representative of the lower 25% and upper 25% of values, respectively. Use the alternative phasing supplied by the STAR Panel. Jitter and ensure convergence for each value of h.

Round 8 responses

AI. The response to AG had used a sex-specific, age- and length-based selection curve for the CPFV survey. Results demonstrated that, although needing further refinement, an age-based, sex-specific selectivity curve could be developed to replace the age- and length-based, sex-specific selectivity curve.

AJ. While there were still convergence issues that required jittering of input parameter values for each analysis, the jittered runs for each level of steepness produced reasonably similar results. Depletion for the base case was 0.7, while those from the lower and higher values of h were 0.46 and 0.78, respectively. The Panel accepted that use of these values of h produced the required lower and upper runs to bracket uncertainty around the base-run results.