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The 2007 Assessment of Blue Rockfish (*Sebastes mystinus*) in California

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EXECUTIVE SUMMARY

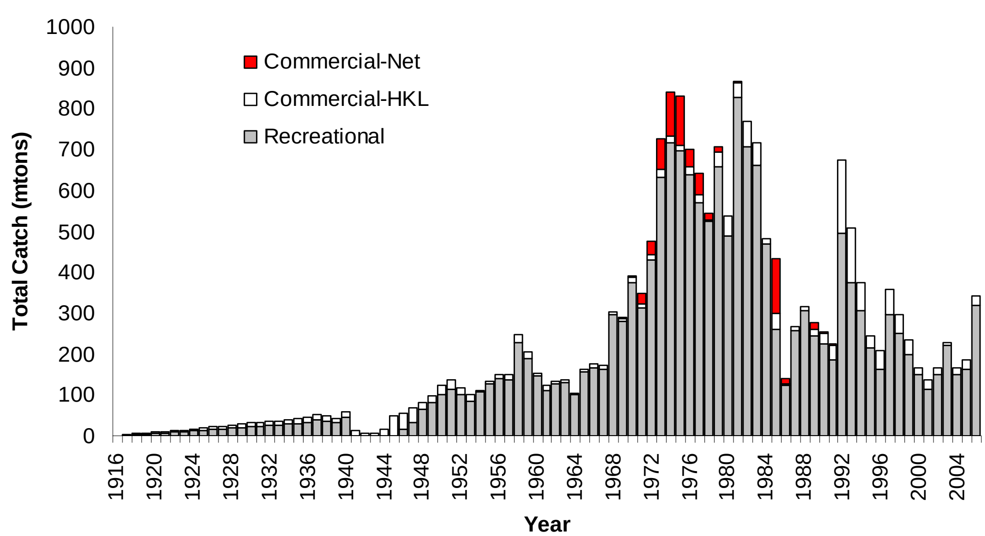
Stock

This is the first assessment of blue rockfish (*Sebastes mystinus*) on the West coast of the US. This assessment determines the status of the California stock from the Oregon border to Point Conception where blue rockfish are most commonly found, using data through 2006. This assessment treats these fish as a single stock. Blue rockfish are also harvested in Oregon and Washington, but black rockfish are more sought after in those waters. In southern California waters, a perceived decline in the relative abundance of blue rockfish may be related to environmental conditions, particularly declines in kelp cover observed in surveys throughout the 1990s.

The variability in growth over time and between areas along the coast of California were evident while assessing this stock, but the lack of sufficient data did not allow for the complex modeling needed to appropriately assess blue rockfish. Genetic evidence has also suggested two species of blue rockfish in California, so this status report is considered an assessment of a blue rockfish "complex" instead of a single species.

Catches

Blue rockfish are the primary recreational (CPFV/private) caught species in California and is also important in the commercial fishery (mainly hook and line), although landings from the commercial fishery are minor compared to the recreational catch. Due to the lack of historical reporting of blue rockfish catch, estimates back to 1916 rely primarily on a proportion of total rockfish prior to 1969 in the commercial fishery (non-trawl) and prior to 1980 in the recreational fishery. Trawl landings in the commercial fishery were removed from total rockfish catches since documented trawl studies did not report blue rockfish being landed in this gear. The catch history of blue rockfish is highly uncertain, especially in the earlier years.



Recent landings (mt) of blue rockfish in California, north of Point Conception.										
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Recreational	296.1	249.4	198.6	150.7	115.6	148.8	219.9	149.9	162.9	319.6
Commercial-HKL	63.7	47.7	35.7	15.6	19.7	18.5	9.2	14.8	21.7	21.9
Commercial-Net	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	359.7	297.1	234.4	166.3	135.3	167.4	229.1	164.6	184.6	341.4

Data and Assessment

This first assessment for blue rockfish used the Stock Synthesis 2 (version 2.00g) integrated length-age structured model. The model includes estimated historical catches dating back to 1916 for each fishery (recreational, commercial hook and line and setnet), length-frequency data from each fishery and conditional age-at-length frequency data from the early 1980s from the recreational CPFV fishery. Two recreational CPFV CPUE indices (RecFIN and CDFG onboard observer program) were used as abundance indices, with the RecFIN CPUE index being split into two time periods (1980-1999 and 2000-2006) to allow for potential changes in catchability due to the bag limit change (from 15 to 10) in the year 2000. Lastly, a coastwide pre-recruitment midwater trawl survey (NWFSC/SWFSC/PWCC) provided a source of recruitment strength information for the years 2001-2006.

In this assessment, variation in growth over time and space were evident, however the lack of data did not allow the appropriate modeling needed to accurately assess this stock. Recent genetic studies have also shown there are two species of blue rockfish, which adds additional uncertainty to the outcome. Most of the catch was represented by females (70-80%), which suggests either males have a higher natural mortality (M) or they are less selected in the fisheries. Even though there are various states of nature needed to capture the uncertainty in this assessment, the proposed states of nature were based on varying M for females and males with different streams of catch histories. Probabilities were not assigned to the states of nature; however, the STAT strongly believes and provides supporting evidence that the low and BASE catch stream scenarios, producing the BASE and high M bracket, are most likely.

Unresolved problems and major uncertainties

Recent genetic studies suggest that blue rockfish is two closely-related species that intermix in the area covered by the assessment. Knowing the differences (if any) in behavior, spatial distributions, and life histories between the two species may help explain and better capture the uncertainties in this assessment.

The variability in growth over time and space is another essential element that was not properly modeled in this assessment. The models estimated growth curve appeared to be an “average” of the 1980s growth curve and the 2000s growth curve that were explored. There was not enough recent data to support the use of time-varying growth for a base model, even though there was an attempt to do so.

Natural mortality is highly uncertain and cannot be reliably estimated. The scarcity of males in the landings could be either due to higher male natural mortality or lower fishery selectivity for males.

Historical catches of blue rockfish are highly uncertain, and in some cases are based on an extrapolation from a single year of sampling or reporting. Using a proportion of total rockfish to reconstruct the historical catches is very worrisome. Attention needs to be given to historical catch reconstruction in Oregon as well, so this area can be included in the next assessment of blue rockfish. A common problem in California and Oregon is the mixing of similar species (i.e. black and blue rockfish) in the commercial fishery catch data, which is difficult to tease apart.

This assessment had limited information to measure stock abundance. The results of this assessment depend on the assumption of constant proportionality between the recreational CPFV CPUE indices and stock abundance.

Reference points

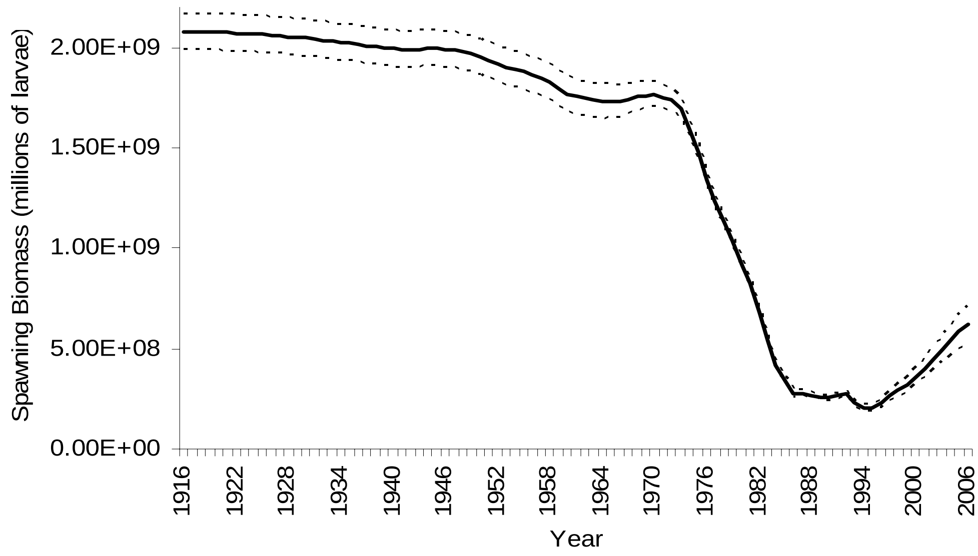
This assessment uses the default target rate of $F_{50\%}$ used for rockfishes on the West coast of the US. Under Pacific Fishery Management Council (PFMC) Groundfish management policy, if the current spawning biomass of the stock falls at or below 25% of the unexploited biomass, the stock is considered overfished. Under the state's guidelines, the stock is considered overfished at or below 30% of the unexploited biomass. Unfished spawning biomass was estimated to be 2077 million larvae in the base model, with the target stock size at 831 million larvae. The base model estimated that the stock could support a maximum sustainable yield (MSY) of 275 metric tons.

	Point Estimate	Uncertainty in estimates
Unfished Spawning Stock Biomass (SB_0) (millions of larvae)	2077	1986-2167
Unfished Summary Age 1+ Biomass (B_0) (mt)	13223	
Unfished Recruitment (R_0) at age 0 (1000s)	3220	3081-3359
Reference points based on SPR proxy for MSY		
Spawning Stock Biomass at SPR (SB_{SPR})(mt)	831	
$SPR_{MSY\text{-}proxy}$	0.5	
Exploitation rate corresponding to $SPR_{MSY\text{-}proxy}$	0.0403	
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)	275	

Stock biomass

Blue rockfish were not a highly sought species historically, but an increase in catches in the 1970s resulted in a continuous decline in spawning biomass through the early 1990s. Spawning biomass reached a minimum (10% of unexploited) in 1994 and 1995; however, there has been a constant increase since then. The base model estimated spawning output at 622 million larvae and relative depletion level at 29.7% in 2007.

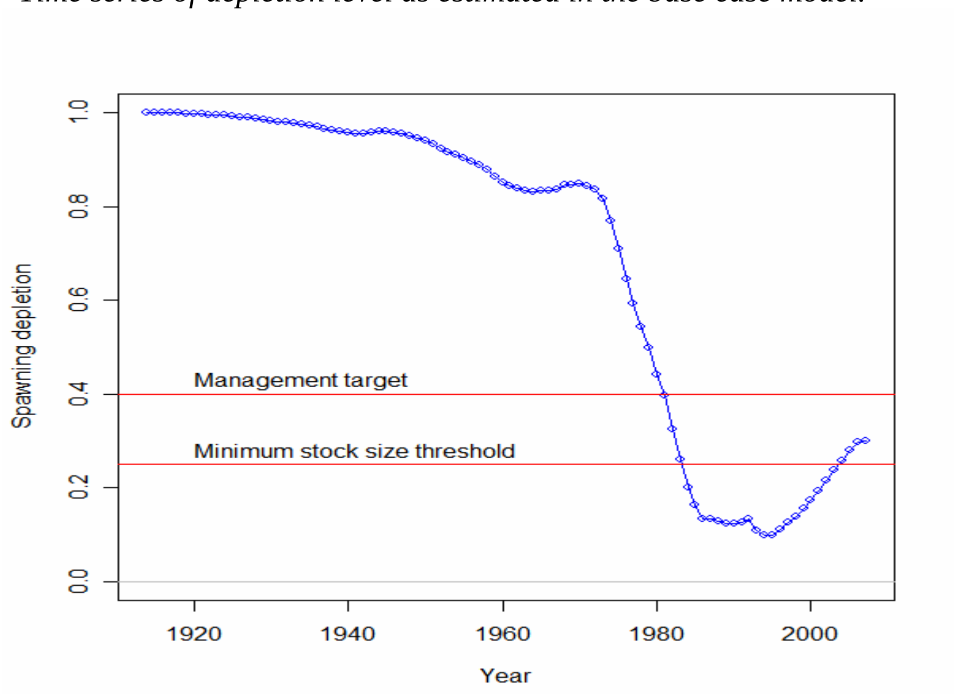
Time series of spawning biomass (~95% CI's) as estimated in the base case model.



Recent trend in estimated blue rockfish spawning biomass (millions of larvae) and depletion

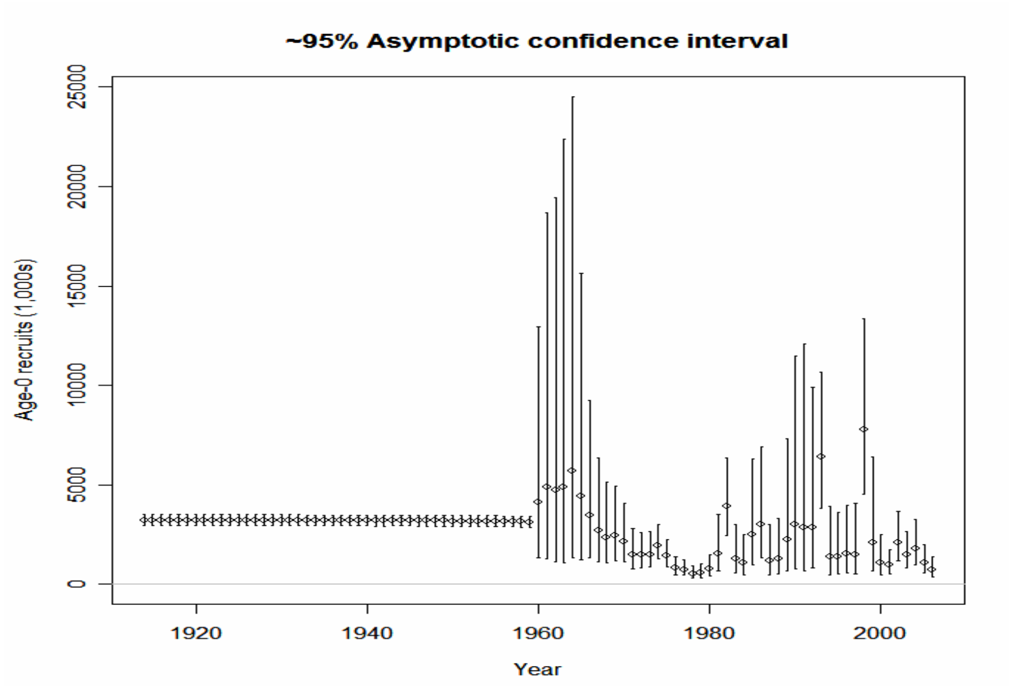
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Spawning Output	289	323	359	401	447	495	537	583	618	622
~95% CI	*259-318*	*286-359*	*317-402*	*352-450*	*391-503*	*431-559*	*464-610*	*501-665*	*528-708*	
Depletion	13.9%	15.5%	17.3%	19.3%	21.5%	23.8%	25.9%	28.1%	29.7%	29.9%

Time series of depletion level as estimated in the base case model.



Recruitment

Recruitment is variable and highly uncertain for blue rockfish. There is little information other than the pre-recruitment index in the recent years to inform the assessment model about recruitments. Recruitment appeared to be high in the 1960s, and more recently strong year classes appeared in 1993 and 1998. With the use of conditional age-at-length data in this assessment, estimated recruitment could potentially be off by a year in capturing the 1999 year class seen in most other groundfish stocks. The late 1970s showed all time low recruitment, with 2006 among the 3 lowest recruitment years estimated.

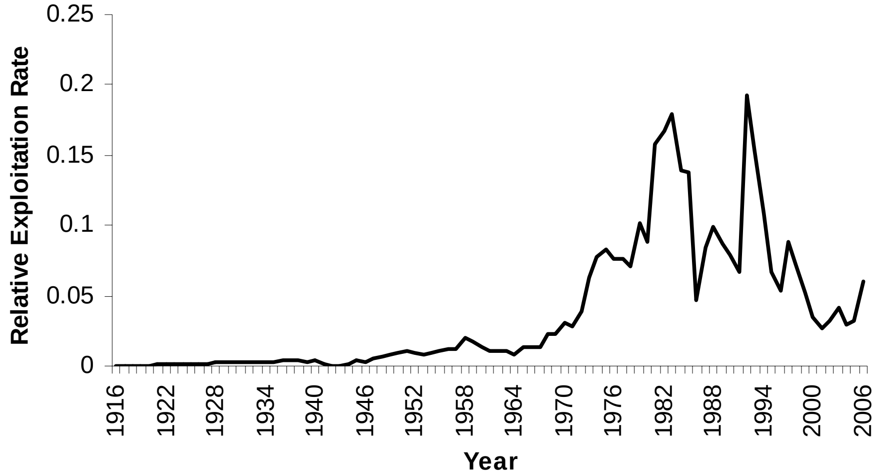


Recent trend in estimated blue rockfish recruitment (1000s)										
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Recruitment	7792	2074	1080	960	2094	1484	1806	1071	735	2261
~95% CI	*5609-9975*	*773-3374*	*592-1567*	*667-1252*	*1490-2698*	*1026-1941*	*1244-2368*	*725-1416*	*496-974*	

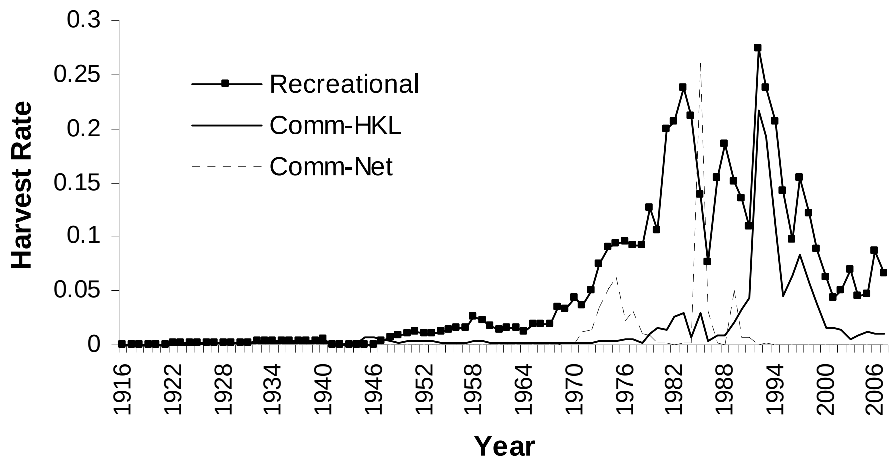
Exploitation status

Blue rockfish harvest was minor in the earlier years, but in the 1970s, recreational harvesting of blue rockfish began to increase with peaks in the early 1980s and early 1990s. The abundance of blue rockfish was at the management target ($SB_{40\%}$) in 1980 and at the overfished threshold in 1982. Fishing mortality exceeded current target levels from the mid 1970s through the late 1990s, but has been close to target levels since 2000.

Time series of estimated relative exploitation rate for the base model.



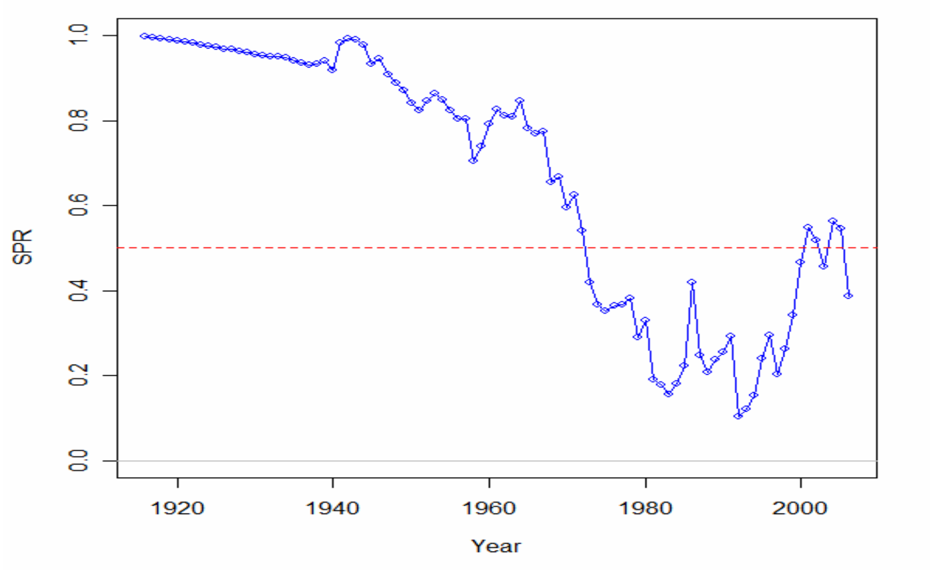
Time series of harvest rates by fishery for the base model.



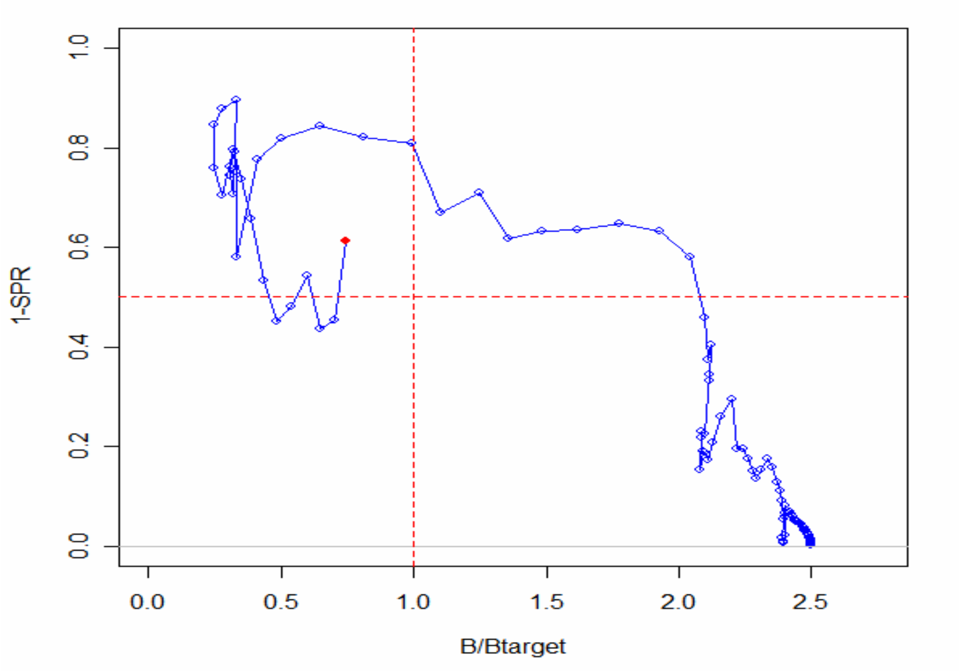
Recent trends in blue rockfish exploitation and harvest rates

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Exploitation	8.8%	7.2%	5.2%	3.4%	2.7%	3.2%	4.2%	3.0%	3.3%	6.0%
(fraction of summary biomass)										
Harvest										
(fraction of available biomass)										
Recreational	15.5%	12.1%	8.9%	6.2%	4.3%	5.1%	6.9%	4.5%	4.6%	8.7%
Comm-HKL	8.3%	5.8%	3.9%	1.5%	1.6%	1.3%	0.6%	0.9%	1.2%	1.1%
Comm-Net	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

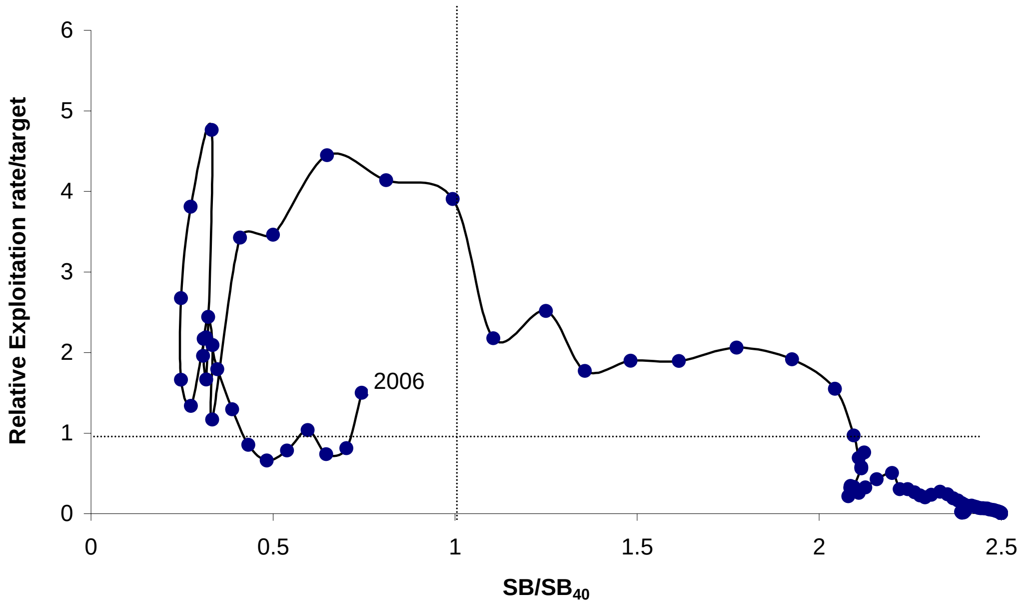
Time series of estimated spawning potential ratio (SPR) for the base case model.



Estimated spawning potential ratio relative to the proxy target of 50% vs. estimated spawning biomass relative to the proxy 40% level from the base case model.



Estimated fishing intensity vs. relative spawning biomass for the base case model. Fishing intensity is the relative exploitation rate divided by the level corresponding to the overfishing proxy (0.40).



Management performance

This is the first assessment of blue rockfish and in the past they have been managed under a "complex." Prior to 2000, this species was managed within the *Sebastes* complex, and since then has been managed under the minor nearshore rockfish complex, north and south of Cape Mendocino (40º10' N. lat.). Blue rockfish have not been considered a "point of concern" for management in the past; hence no ABCs or OYs have been set particularly for this species.

Forecasts

Future catch projections through 2016 were made based on an $F_{50\%}$ fishing rate with 40:10 adjustment. The sum of the average catches from each fishery for the years 2005 and 2006 (263 mtons) were applied to the beginning projection years of 2007 and 2008. The forecast predicts a slight increase in abundance but not enough to support increased harvesting of blue rockfish in the future. According to the base model, blue rockfish may be experiencing overfishing (current F > proxy F_{MSY}), and total catch should be reduced. However, the state of nature corresponding to higher natural mortality (M_{female} = 0.13, M_{male} = 0.15) remains above 40% and allows about 370 mtons to be taken in 2009.

Base model projections for blue rockfish ABC, OY, spawning biomass and depletion										
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
ABC (mtons)	*227*	*226*	223	221	219	217	215	215	216	218
OY (mtons)	*263*	*263*	199	198	196	193	192	192	193	195
Spawning Biomass (millions of larvae)	622	628	628	632	631	628	627	628	631	637
Depletion	29.9%	30.3%	30.3%	30.4%	30.4%	30.2%	30.2%	30.2%	30.4%	30.7%

Decision tables

Even though there are many uncertainties in this assessment, the STAR panel and STAT agreed that the decision table could capture some level of uncertainty through alternate scenarios of historical catches and natural mortality (for males and females separately) of blue rockfish. The scenario that suggested a lower level of abundance was with the high catch stream (double BASE) and lower natural mortality (M_{female} = 0.07, M_{male} = 0.09). The upper level of abundance was bracketed by the low catch stream (1/2 of BASE) and higher natural mortality (M_{female} = 0.13, M_{male} = 0.15). Even though the STAR and STAT agreed with not assigning probabilities to the states of nature, the –log likelihood values from the model runs for the BASE (1340) and high natural mortality (1338) scenarios suggest they are more likely than the scenario with lower natural mortality (1361).

Since blue rockfish are managed by the State of California under the minor nearshore rockfish complex, a second decision table with the 60:20 adjustment applied is also provided. The state, being more conservative, considers a stock to be overfished at or below 30% of unfished spawning biomass. However, fishing mortality rates have been above both state and federal target levels in recent years, suggesting that overfishing has occurred in the past.

*Decision table (**40:10** adjustment applied) of 10-year projections for alternate states of nature (columns) and management options (rows). Spawning output is in millions of larvae. Base model results are **bolded**. Landings in 2007 and 2008 were based on the sum of the 2005 and 2006 catch averages from the recreational and commercial fisheries.*

			State of nature					
			LOWER bracket (M = 0.07 f, 0.09 m)		Base case (M = 0.1 f, 0.12 m)		HIGHER bracket (M = 0.13 f, 0.15 m)	
			high catch stream		BASE catch stream		low catch stream	
Management decision	Year	Catch (mt)	Depletion	Spawning output	Depletion	Spawning output	Depletion	Spawning output
Low	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	42	14.0%	407	30.3%	628	50.0%	827
	2010	49	14.7%	429	31.6%	656	51.6%	855
	2011	54	15.4%	447	32.7%	679	52.8%	875
	2012	59	15.9%	464	33.7%	700	53.8%	891
	2013	64	16.5%	480	34.6%	720	54.7%	906
	2014	69	17.1%	497	35.6%	740	55.6%	921
	2015	75	17.7%	515	36.7%	762	56.6%	938
	2016	80	18.3%	533	37.8%	785	57.7%	955
Medium	2007	263	14.4%	418	**29.9%**	**622**	49.3%	817
	2008	263	14.3%	415	**30.3%**	**628**	49.9%	826
	2009	199	14.0%	407	**30.3%**	**628**	50.0%	827
	2010	198	13.9%	404	**30.4%**	**632**	50.2%	831
	2011	196	13.7%	398	**30.4%**	**631**	50.0%	828
	2012	193	13.4%	390	**30.2%**	**628**	49.7%	823
	2013	192	13.2%	384	**30.2%**	**627**	49.4%	818
	2014	192	13.0%	379	**30.2%**	**628**	49.3%	816
	2015	193	12.9%	376	**30.4%**	**631**	49.4%	817
	2016	195	12.9%	375	**30.7%**	**637**	49.6%	820
High	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	376	14.0%	407	30.3%	628	50.0%	827
	2010	363	12.9%	376	29.1%	604	48.6%	804
	2011	348	11.8%	343	27.8%	577	46.9%	776
	2012	335	10.7%	311	26.5%	550	45.2%	748
	2013	325	9.7%	282	25.4%	527	43.7%	724
	2014	317	8.8%	257	24.5%	509	42.6%	705
	2015	311	8.1%	235	23.8%	495	41.8%	691
	2016	308	7.4%	217	23.4%	485	41.2%	682

*Decision table (**60:20** adjustment applied) of 10-year projections for alternate states of nature (columns) and management options (rows). Spawning output is in millions of larvae. Base model results are **bolded**. Landings in 2007 and 2008 were based on the sum of the 2005 and 2006 catch averages from the recreational and commercial fisheries.*

			State of nature					
			LOWER bracket (M = 0.07 f, 0.09 m) high catch stream		Base case (M = 0.1 f, 0.12 m) BASE catch stream		HIGHER bracket (M = 0.13 f, 0.15 m) low catch stream	
Management decision	Year	Catch (mt)	Depletion	Spawning output	Depletion	Spawning output	Depletion	Spawning output
	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	0	14.0%	407	30.3%	628	50.0%	827
	2010	0	15.0%	435	31.9%	663	52.0%	861
Low	2011	0	15.9%	461	33.4%	694	53.7%	889
	2012	0	16.8%	487	34.8%	723	55.2%	913
	2013	0	17.7%	514	36.2%	753	56.6%	937
	2014	0	18.6%	542	37.7%	784	58.1%	962
	2015	0	19.7%	572	39.3%	816	59.7%	988
	2016	8	20.7%	604	41.0%	851	61.3%	1015
	2007	263	14.4%	418	**29.9%**	**622**	49.3%	817
	2008	263	14.3%	415	**30.3%**	**628**	49.9%	826
	2009	113	14.0%	407	**30.3%**	**628**	50.0%	827
	2010	121	14.3%	417	**31.1%**	**645**	51.0%	844
Medium	2011	125	14.6%	424	**31.6%**	**657**	51.5%	853
	2012	128	14.7%	428	**32.0%**	**665**	51.8%	858
	2013	132	14.9%	433	**32.5%**	**674**	52.1%	863
	2014	136	15.1%	438	**32.9%**	**684**	52.5%	869
	2015	142	15.3%	445	**33.5%**	**696**	53.0%	877
	2016	148	15.5%	452	**34.1%**	**708**	53.5%	885
	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	339	14.0%	407	30.3%	628	50.0%	827
	2010	323	13.1%	382	29.4%	610	48.9%	810
High	2011	307	12.2%	355	28.4%	589	47.6%	788
	2012	291	11.3%	330	27.4%	569	46.3%	766
	2013	279	10.6%	308	26.6%	552	45.2%	748
	2014	270	9.9%	289	26.0%	541	44.4%	735
	2015	266	9.4%	274	25.7%	533	43.9%	727
	2016	263	9.0%	262	25.5%	530	43.7%	723

Research and data needs

- As with many rockfish, reconstruction of the historical landings is difficult and very time consuming. A standard method should be applied, and historical documentation should be provided to highlight major fishery events to allow more certainty in these estimates.
- Continued genetic studies to confirm that blue rockfish is two species. Some major research that is needed related to this topic include: aging to determine differences in growth and longevity, fecundity, maturation schedules and their spatial distributions.
- More biological sampling, especially age composition information, of the recreational and commercial fisheries to be able to determine changes in life history parameters over time and space.
- Research to help understand the lack of males in the catches. Is this a selectivity issue or a substantial difference in natural mortality between males and females?
- Development of a fishery-independent survey to capture changes in stock abundance. Many assessments have used a recreational CPFV CPUE index to determine this, which is not as reliable considering management changes (i.e. bag limits, closures) that continue to occur.
- Sex-specific length and age information from the recreational fishery. Attempts have been made to gather sex-specific information from sampling the commercial fishery, and even though samples are small, it is informative.
- Environmental factors that affect survival of juvenile blue rockfish need to be explored further. The lack of kelp habitat caused by increasing ocean temperatures (warmer waters) in southern California since the 1990s led the STAT to believe that the lack of blue rockfish in this area was not due to fishing.

Regional Management Concerns

Blue rockfish are going to be a challenge for management. Even though efforts were made to accommodate the changes in growth over time and space, sufficient data were not available to accomplish this within the assessment model. Simulation studies are needed to determine how much affect these spatial and temporal changes have on model results. Also, the exclusion of Oregon and southern California in this assessment adds additional challenges for management. Finally, two species of blue rockfish exist which may have important implications for regional management, particularly not knowing their habitat associations and/or geographic distributions.

The STAT advises that this assessment be used with caution for management purposes. The STAT feels strongly that the decision table does not provide symmetrical bracketing of uncertainty (described in decision table section) and that the BASE and high M scenarios are more likely than the low M scenario. It is recommended that only the projections under the BASE and high M scenarios be considered for management purposes.

Summary Table	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landings (mt)	297	234	166	135	167	229	165	185	341	341
Estimated Discards (included in total catch)	0	0	0	0	0	0	0	0	0	0
Estimated Total Catch (mt)	297	234	166	135	167	229	165	185	341	341
ABC (mt)										
OY (mt)										
SPR	0.22	0.25	0.36	0.48	0.56	0.53	0.45	0.58	0.56	0.41
Exploitation Rate (total catch/summary biomass)	0.07	0.05	0.03	0.03	0.03	0.04	0.03	0.03	0.06	0.06
Summary Age 1+ Biomass (B) (mt)	4114	4488	4825	5084	5298	5474	5541	5636	5649	5447
Spawning Stock Biomass (*SB*) (millions of larvae)	289	323	359	401	447	495	537	583	618	622
Uncertainty in SB estimate	259-318	286-359	317-402	352-450	391-503	431-559	464-610	501-665	528-708	
Recruitment at age 0 (1000s)	7792	2074	1080	960	2094	1484	1806	1071	735	2261
Uncertainty in Recruitment estimate	5609-9975	773-3374	592-1567	667-1252	1490-2698	1026-1941	1244-2368	725-1416	496-974	
Depletion (SB/SB0)	13.9%	15.5%	17.3%	19.3%	21.5%	23.8%	25.9%	28.1%	29.7%	29.9%
Uncertainty in Depletion estimate	na	na	na	na	na	na	na	na	na	na

Uncertainty estimates based on 95% confidence intervals.

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INTRODUCTION

Blue rockfish (*Sebastes mystinus*) range from the Gulf of Alaska to northern Baja California, although they are most commonly found between Oregon and central California (Love et al. 2002). This assessment focuses on the stock from the Oregon border to Point Conception, California (Figure 1). They inhabit kelp forests and rocky reefs in relatively shallow depths usually to about 90 meters (50 fathoms) (Miller and Lea 1972, Reilly 2001), but have been landed as deep as 549 meters (300 fathoms) (Love et al. 2002). Blue rockfish are residential, with their movements restricted to a small area, usually near the kelp canopy or pinnacles for shelter and spatial orientation (Miller and Geibel 1973, Lea et al. 1999, Jorgensen et al. 2006). Genetic evidence suggests distinct subpopulations of blue rockfish with a biogeographic barrier at Cape Mendocino, California (Cope 2004). More recently, evidence suggests the presence of two genetically distinct species in central California (Petersen et al. in review).

Blue rockfish are primarily "selective opportunity" planktivores (Gotshall et al. 1965, Love and Ebeling 1978). As juveniles, they feed on planktonic crustacea, hydroids, and algae (Miller and Geibel 1973). Adults also consume fish, squid, tunicates, scyphozoids, bull kelp nori, and pelagic gastropods (Hobson et al. 1996, Lea et al. 1999, Love et al. 2002). Many of these prey items are made available from the relaxation of upwelling or southerly winds, explaining high blue rockfish numbers in the summer off central and northern California, where these conditions are well developed (Hobson and Chess 1988, Love et al. 2002).

Blue rockfish have been an important part of the recreational fishery in California since the late 1950s (Reilly et al. 1993, Wilson-Vandenberg et al. 1996, Mason 1998). Commonly taken by Commercial Passenger Fishing Vessels (CPFVs, aka partyboats), skiffs, and divers, it is among the most frequently caught species north of Point Conception (Karpov et al. 1995). However, since the mid-1980s the California recreational catch has declined significantly, especially in the south (Figure 2). This may be a result of overfishing from the more heavily populated southern coast (Love et al. 1998), where there is more angling opportunity due to more favorable access and ocean conditions (Bennett et al. 2004); poor recruitment resulting from a long-term shift away from preferred cold, productive waters (Love et al. 2002, Jarvis et al. 2004); or the effect of increasingly strict fishing regulations.

The California blue rockfish catch has played a relatively minor role in the commercial fishery compared to the recreational fishery. This has remained true, even with the advent of the live-fish fishery in the late 1980s (Figure 3), although the contribution of blue rockfish has been increasing in recent years. Since the preferred dinner plate-sized catch for this fishery results in immature fish being targeted in many cases, there is concern over the potential implications of the increasing effort in this fishery. Selection of younger, smaller individuals has led to lower lifetime egg production and consequently, threatened population viability (O'Farrell and Botsford 2005, O'Farrell and Botsford 2006). Due to their great abundance in kelp forests, blue rockfish juveniles are recognized as a key species in the piscivore trophic web of these ecosystems (Hallacher and Roberts 1985). Careful monitoring of blue rockfish populations, and of the factors impacting them, is needed to maintain the species and the kelp forest ecosystems they inhabit.

This assessment focuses on the northern and central California population of blue rockfish (north of Point Conception, Figure 1) where blue rockfish are most commonly found and abundant. There has been a significant decrease in catch and effort in southern California, most likely due to unfavorable habitat associated with the warmer waters since the 1990s. Mason (1998) noted size reductions in CPFV catch as evidence of less successful recruitment during warmer years. A decrease in kelp abundance could be the main reason why blue rockfish have not been abundant in southern California in over 15 years. Kelp is an important habitat for both recruiting and adult blue rockfish, and can be adversely affected by increases in water temperature. Blue rockfish caught in southern California have mainly come from the Santa Barbara Channel region, and historically, kelp has been abundant in this region. Long-term data on southern California kelp beds have been collected by ISP Alginates (formerly Kelco Co.), and have been made available as database SBCLTER: Reef Historical Kelp Database for giant kelp (*Macrocystis pyrifera)* biomass in California and Mexico by the Santa Barbara Coastal Long Term Ecological Research Project (<http://metadata.nbii.gov/>). The database provided approximate monthly values of the area of 16 discrete persistent kelp beds between Ventura and Point Conception. The area of each bed is expressed as a fraction of its long-term mean, and the overall index (Figure 4) is the annual average of these standardized values.

Regulation History

Prior to the adoption of the Pacific Coast Groundfish Fishery Management Plan (FMP) in 1982, blue rockfish (*Sebastes mystinus*) were managed through a regulatory process that included the California Department of Fish and Game (CDFG) along with either the California State Legislature or the Fish and Game Commission (FGC) depending on the fishery and sector (recreational or commercial). With implementation of the Pacific Coast Groundfish FMP, blue rockfish came under the management authority of the Pacific Fishery Management Council (PFMC), being incorporated, along with all genera and species of the family Scorpaenidae, into a federal rockfish classification (PFMC 2004) and was then jointly managed with the state.

Under the Pacific Coast Groundfish FMP, groundfish species and species groups were managed using estimates of Allowable Biological Catch (ABC). Starting in 1992, some of the rockfish species and species groups also began to be managed using harvest guidelines followed in 1999 by the use of Optimum Yields (OY). To keep landings within these adopted harvest targets, the Pacific Coast Groundfish FMP provided the Council with a variety of management tools including area closures, season closures, gear restrictions, and, for the commercial sector, cumulative limits (generally for two-month periods). With the implementation of a federal groundfish restricted access program in 1994, allocations of total catch and cumulative limits began to be specifically set for open access (including most of California's commercial fisheries that target nearshore rockfish) and limited entry fisheries (PFMC 2002; 2004).

During most of this time frame, management also concentrated on the commercial groundfish sector primarily because harvest from the recreational sector was considerably smaller than that from the commercial sector. This approach began to change in the later 1990's as commercial landings decreased and recreational harvest became a greater proportion of the available harvest.

The PFMC's rockfish management structure changed significantly in 2000 with the replacement of the *Sebastes* complex –north and –south areas with Minor Rockfish North (Vancouver, Columbia, and Eureka, International North Pacific Fisheries Commission (INPFC) areas) and Minor Rockfish South (Monterey and Conception INPFC areas only). The OY for these two groups was further divided (between north and south of 40º10' N. lat. ~ Cape Mendocino, Humboldt County, California) into nearshore, shelf, and slope rockfish categories with allocations set for Limited Entry and Open Access fisheries within each of these three categories (January 4, 2000, 65 FR 221; PFMC 2002, Tables 54-55). Species were parceled into these new categories depending on primary catch depths and geographical distribution.

Also, in 2000, seasonal 2-month closures were adopted in California for the first time for both commercial and recreational fisheries. In addition, the bag limit in California for rockfish was reduced from 15 to 10 rockfish, and recreational gear was limited to one line with three hooks.

Cowcod Conservation Areas (CCAs) were established in 2001 to reduce fishing effort for cowcod rockfish in southern California (PFMC 2002, Table 29). More importantly for blue rockfish management, Rockfish Conservation Areas (RCAs) were established in 2003 to allow for the closure of large areas based on depth for particular fishing sectors or gears. The trawl and non-trawl gear RCAs were two of these groundfish conservation areas established in 2003 with the purpose of reducing fishing effort on shelf and slope rockfish, including overfished species such as canary rockfish, while providing some limited bottom fishing opportunities in adjacent waters.

During the late 1990's and early 2000's, major changes also occurred in the way that California managed its nearshore fishery. The Marine Life Management Act (MLMA), which was enacted in 1999, gave authority to the FGC to regulate commercial and recreational nearshore fisheries through FMPs and provided broad authority to adopt regulations for the nearshore fishery during the time prior to adoption of a nearshore finfish FMP.

Following adoption of the Nearshore FMP in fall of 2002, the FGC adopted a nearshore restricted access program for the commercial fishery to be effective starting in the 2003 fishing year, including the establishment of a Deeper Nearshore Permit (DNP). Since blue rockfish were categorized in the Nearshore FMP as a deeper nearshore rockfish, commercial fishermen taking this species were required to possess a DNP.

Although the Nearshore FMP provided for the management of the nearshore rockfish, joint management authority for these species continued to reside with the Council and the State. Even so, for the 2003 and subsequent fishery seasons, the State provided recommendations to the Council specific to the nearshore species that followed the directives set out in the Nearshore FMP. These recommendations, which the Council incorporated into the 2003 management specifications, included a division of the Minor Rockfish North – Nearshore into two groups (black and blue rockfish; and other nearshore rockfish), recalculation and division of the OY for Minor Rockfish South - Nearshore into three groups (shallow nearshore rockfish; deeper nearshore rockfish; and California scorpionfish). The Council also incorporated specific harvest targets and recreational and commercial allocations for each of the above groups and adopted various management specifications to keep harvest within harvest targets.

Starting in 2004, management specifications adopted by the Council and State also included recreational RCAs which limited the maximum allowable fishing depth such as the California Rockfish Conservation Area (CRCA) (for more information on the CRCA, see Title 14 of the California Code of Regulations, Section 27.51). Also in 2004, black rockfish were removed from both the Minor Rockfish North and Minor Rockfish South ABCs and OYs. As a consequence, the groupings and harvest targets for the Minor Rockfish North – Nearshore changed; the blue rockfish proportion of the black and blue rockfish group harvest target was combined with that from the other nearshore rockfish and placed under a new group category, minor nearshore rockfish.

A timeline covering California regulations that applied to blue rockfish from 1990-2006 is provided in Table 1. Table 2 provides the commercial regulations and related gear changes from 1950-2006.

BIOLOGICAL PARAMETERS

Lea et al. (1999) found the following relationships between length (TL, mm) and weight (grams) of blue rockfish in California

Combined sex:	$W = 0.000009774 * TL^{3.09}$	(1)
Males:	$W = 0.00002934 * TL^{2.889}$	(2)
Females:	$W = 0.00003408 * TL^{2.874}$	(3)

Echeverria and Lenarz (1984) provide the following length (mm) conversion equations we use in this assessment

$$FL = -2.164 + 0.962\ (TL) \qquad (4)$$
$$FL = 0.352 + 1.192\ (SL) \qquad (5)$$
$$TL = 2.495 + 1.039\ (FL) \qquad (6)$$

The units of length for this assessment are in fork length, so Equations 4 & 5 were used to convert all lengths to fork length. The length to weight relationships (male and female) can be seen in Figure 5.

Parturition and Recruitment

Mating of blue rockfish occurs in October, and eggs are fertilized a few months later. Parturition occurs from November to March, with a peak in mid-January (Lea et al. 1999, Reilly 2001). Larval blue rockfish spend a few months in the water column before settling (April-June) in nearshore rocky habitats when they are about 1.5 inches in length (Love et al. 2002). Annual recruitment is highly variable, and recruitment is negatively correlated with water temperature (Gundelfinger 2005). Year-class strength is dependent on physical factors occurring at the larval stage (Ralston and Howard 1995). Settlement numbers and spatial variability also depend on geographic features (Field and Ralston 2005) or oceanic conditions such as El Niño, which can lead to starvation of juveniles, increased exposure to predation, or diminished reproductive condition (VenTresca et al. 1995, Moser et al. 2000, Sakuma et al. 2006).

Age, growth and natural mortality

Maximum lifespan has been estimated to be 44 years for male blue rockfish and 41 years for females (Laidig et al. 2003), using otoliths and the break-and-burn technique for aging. Miller and Geibel (1973) reported the oldest fish to be 24 years of age; however, scales were used in this study for aging, which are not as reliable as otoliths. Blue rockfish attain a maximum length of 53 cm TL (50 cm FL, 21 in), with females growing slower but attaining larger sizes (Mason 1998, Love et al. 2002). Figure 6 shows the differences in growth between the sexes (Laidig et al. 2003).

Most studies have shown that growth of blue rockfish (among individuals, sexes, geographic areas and depths) is highly variable. Due to the wide variation among individuals, the residential behavior of blue rockfish in shallow water and the relatively slow growth, Miller and Geibel (1973) were not able to construct an age-length curve from aging data. We also found this difficult to accomplish for this assessment.

Based on maximum ages (Laidig et al. 2003) and Hoenig (1983), natural mortality was initially estimated at M = 0.10 for both males and females. Tenera (2000) reported natural mortality for blue rockfish to be 0.14. The model section discusses this in more detail.

Maturity and Fecundity

Half of blue rockfish males mature at about 10 inches (25.4 cm, 5-6 years) and females at 11 inches (27.9 cm, 6 years), although this can vary considerably (Miller and Geibel 1973, Reilly 2001). Wyllie Echeverria (1987) derived maturity estimates (0%, 50% and 100%) for both male and female blue rockfish. For females, the first size and age at maturity was determined to be 22 cm TL (19 cm FL) and 5 years old, 50% were mature at 29 cm TL (26 cm FL) and 6 years old, and 100% were mature at 35 cm TL (32 cm FL) and 11 years old. We used these estimates to fit the spawning ogive curve (converted to fork length, Equation 4) which can be seen in Figure 7. Laidig et al. (2003) concluded younger ages from their study. They found that 50% maturity for females was age 5 instead of age 6 and the youngest were mature at 3 years instead of 4 or 5. This could be the result of a change in size and age at maturity over time.

No size-specific fecundity equation has been published; however a female at 9.8 inches TL (25 cm) is estimated to produce about 50,000 eggs, where a 15.9 inch TL (40 cm) female can produce about 524,000 eggs (CDFG 2002). The spawning output by length used in the model also used a linear relationship derived from the two females whose fecundity was reported. Using this information and Equations 3 & 6, we determined the spawning output (eggs per kg) for female blue rockfish (Figure 8).

DATA and ASSESSMENT

Available data used in this assessment consist of historical commercial and recreational landings information (1916-2006), age composition data (1980-1984) from the recreational CPFV fishery, and length compositions from the recreational and commercial fisheries (1978-2006). We were able to calculate two indices of abundance based on CPFV CPUE in the recreational fishery (1980-2006), and a third was also considered (CalPOLY) but it only represented the Morro Bay area for the past few years. Lastly, we used a pre-recruitment index of abundance from the juvenile rockfish midwater trawl survey (SWFSC/NWFSC/PWCC).

Removals

At the first STAR panel of blue rockfish in May 2007, the panel recommended reconstructing the catch history back to 1916, where the previous assessment used the estimated landings available back to 1968. Since blue rockfish have not been specifically identified in the catches back to that date, a great amount of time and effort was put into the historical reconstruction, which was mainly based on proportions of total rockfish removals. Table 3 provides the values of the reconstructed catch series and Figure 9 shows a visual representation of the estimated blue rockfish removals used in this assessment. Table 4 provides a summary of data sources and assumptions made during the catch reconstruction.

Recreational Catch

The first reportings of the recreational CPFV (partyboat) rockfish catch were given for the state of California in numbers of fish from 1936-1940 (Best 1963). Based on the 1947-1949 average proportion of total rockfish taken north of Point Conception (0.72), we could estimate total rockfish take for the assessment area during this time period. Miller and Gotshall (1965) reported that blue rockfish accounted for 31.5% of the total rockfish take on CPFVs in the Monterey area, and this mode of fishing represented about 70.5% of the total rockfish catch. Miller and Gotshall (1965) also reported the mean weight for blue rockfish was between 1.0 pound (CPFVs) and 1.3 pounds (all modes combined), so we converted numbers of fish to weight based on these estimates. Lastly, Miller and Gotshall (1965) reported discards at 6.8% from Bodega Bay to Avila, and that the abundance of blue rockfish drops considerably north of Fort Ross and is only of minor importance. Using the above information, we were able to estimate total blue rockfish removals for this time period. Prior to 1936, recreational catches were “ramped up” beginning in 1916, the same year the first commercial landings were reported.

No estimates were reported from 1941-1946 during World War II. The war ended in 1945, so the Mop-Up STAR panel requested that a value be included for 1946. The suggested 16 mtons (half of 1947 catch) was used. Beginning in 1947, Young (1969) reported CPFV estimates by major port area for rockfish in numbers of fish until 1967. We used the estimated catch from Crescent City to Morro Bay to account for total rockfish catch north of Point Conception. We then used the same method (as stated above) to come up with the total blue rockfish catch for these years. Landings in central and northern California during this time period were primarily blues, yellowtail, olive and bocaccio (Young 1969).

The recreational estimates from 1968-1979 were derived similarly to the previous years with two minor changes. Due to shifts in total rockfish take between northern and southern California, we evaluated the proportion of northern CPFV take in the 1947-1967 time period. The average proportion north of Point Conception for the previous three years (1965-1967) was 0.46, and this was applied to the years 1968-1972. The overall average from 1947-1967 was 0.58, which was applied to the years 1973-1979. We assumed that other modes of fishing were starting to pick up around this time period as well, so we used a 50% CPFV take of rockfish instead of the initial 70% reported in Miller and Gotshall (1965).

The Marine Recreational Fisheries Statistical Survey (MRFSS) estimated landings, effort, and discards for California from 1980 to 2003 (with a hiatus from 1990-1992 and missing CPFV data from 1993 through 1995. For the years 2004-2006, catch estimates came from the California Recreational Fisheries Survey (CRFS), a newly implemented state program that also estimates catch, effort and discards in California. Data from each survey is available on the RecFIN website (http://www.psmfc.org/recfin).

For the years 1990-1995, there were missing CPFV estimates in RecFIN, so we used estimates generated by California Department of Fish and Game (CDFG), using CPFV onboard observer survey data in conjunction with CPFV logbook information (Deb Wilson-Vandenberg, CDFG, pers. comm.). Historically, the CPFV and private recreational anglers landed similar proportions of the blue rockfish catch, so for years where there was missing private landings information (1990-1992), we used the same estimate provided for the CPFV fleet. The 1993 private sector estimate appeared to be an outlier at 450.97 mtons compared to the estimated 182.41 mtons in the CPFV fishery. The large estimate could potentially be the outcome of a large recruitment event observed in 1988 (Figure 32). VenTresca et al (1995) also reported an exceptionally strong year class in central California in 1988. Even though this event appeared to occur, we did not feel it would change the catch for blue rockfish to such numbers, hence we felt using the CPFV estimate in 1993 to represent the private sector was more appropriate.

Discards were included in the total removals of the recreational fishery (RecFIN, A+B1). Evaluation of discard rates showed a decrease in discards since the 1980s, perhaps because fishermen were keeping more blue rockfish due to the lack of more preferable species (i.e. bocaccio). In 2000, California reduced the recreational bag limit for combined rockfish from 15 to 10 fish. Judging by the distribution of RecFIN-sampled bag sizes, there was compliance with this change in regulations which will be discussed further in the RecFIN CPUE index section.

We also evaluated the Central California Spearfishing Tournament (CenCAL) data from 1958-2003 (David VenTresca, CDFG, pers. comm.). We did not directly include these selected removals (an average of 200 blue rockfish per year); however, spearfishing is covered and included in the shore modes (2% of total), which were included in total removals of the recreational catch.

The removals of blue rockfish in Oregon were not included in this assessment, but total reported landings of blue rockfish from 1980-2006 in the recreational fishery was 1209 metric tons.

Commercial Landings

Heimann and Carlisle (1970) reported a historical review of commercial rockfish landings from 1916-1968, which included rockfish brought into California from Oregon and Mexico. We compared these landings to the data available at Pacific Fisheries Environmental Laboratory (PFEL, NOAA, Pacific Grove, CA) from 1928-2002 which do not include landings brought in outside of California waters. Since this assessment focuses on the California stock only, we used the PFEL estimates to reconstruct the commercial catch history from 1928-1968. Since there was no significant difference between the two catch series (Figure 10), we felt using the reported landings in Heimann and Carlisle (1970) prior to 1928 were no cause for concern.

The Santa Barbara region includes San Luis Obispo (SLO), Santa Barbara and Ventura counties, so we investigated total rockfish landings in Morro Bay and Avila (SLO) from Fish Bulletins when available (covering some years between 1949-1968). We calculated a proportion of total rockfish north of Point Conception for years when that information was available, and used an average (80% in SLO) for years when information was not available.

Phillips (1939) provided information to help determine what proportion of total rockfish were blue rockfish in the Monterey Bay area. Five species (bocaccio, chilipepper, yellowtail, vermilion and canary) accounted for 91.3% of the landings in this area. Blue rockfish were in the "all other" category of < 2% of the total landings and represented only 1% of the examined catch. Assuming this is true in all regions north of Point Conception and has not changed substantially over the years, we estimated blue rockfish at 1.0% of total rockfish landings prior to 1969.

Trawl logs from 1934-1956 were found during our reconstruction of the catch history for this fishery, which was important in estimating blue rockfish take based on the 1% of total rockfish catch. As seen in Table 5, a substantial amount of rockfish were being removed by trawl gear during this time, and blue rockfish were not reported here nor in the 1950s through 1970s (Heimann and Miller 1960, Nitsos 1965, Gunderson et al. 1974). Nitsos (1965) reported trawl landings from 1954-1963, and an average of 91% of the total reported rockfish landings was from trawl gears. Considering this, we felt it necessary to remove the trawl landings from the catch series before estimating blue rockfish as a proportion of the total rockfish catch. An average of 17% from 1934-1936 was used to remove trawl landings from 1916-1933, and an average of 91% from

Nitsos (1965) was used to remove trawl landings from 1964-1968. All other landings were assumed to be hook and line from 1916-1976.

Commercial landing estimates from 1969-2006 come from the California Cooperative Survey (CALCOM) database (Figure 11). From 1969-1977, the estimates were based on a ratio estimator, using species compositions from the earliest sampled 3-year interval (Don Pearson, NMFS/SWFSC, pers. comm.). From 1978 to present, expansion procedures were used to estimate commercial landings from sampling commercial market categories (Pearson and Erwin 1997).

In a recent evaluation of market categories of the commercial fishery, the blue rockfish market category did not score high on reliability (Don Pearson, NMFS/SWFSC, pers. comm.), considering that its morphology and coloration is very similar to black rockfish, and that separation of these species is driven by size and price factors. In more recent years, state regulations mandate that nearshore fishes be sorted by species prior to weighing and that the weight be reported separately on the CDFG fish landing receipt (Section 150.16, Title 14, California Code of Regulations). In our evaluation of market category sampling data blue rockfish represented 88% in the blue rockfish market category, 10% in the black rockfish market category, and only 2.4% in the unidentified rockfish market category (Table 6).

The National Marine Fisheries Service (NMFS - NWFSC) has been conducting an onboard survey to estimate discards in the commercial nearshore fishery in recent years; however, length and weight associated with these discards are not available at this time (Jim Hastie, NMFS/NWFSC, pers. comm.). The average discard rate of blue rockfish in the nearshore fisheries as a percent of total catch in the years 2003-2005 is 18% (2003 - 24.9%, 2004 - 16.4%, 2005 - 12.5%). The 2003 rate is based on less than 1,000 lb of catch (as opposed to about 5,000 lb in the other 2 years). We accounted for discards in the years from 2000 on using this 18% discard rate, but did not apply additional discards in the 1990s.

When the CALCOM estimated landings from 1969-2006 were presented to fishermen at the Data Workshop, they did not agree with the landings in the earlier years of the series (details in Appendix A). They had two major concerns: 1) trawl estimates were underestimated due to many midwater trawlers “dumping” blues in the 1970s and 2) the non-trawl estimates were underestimated in the 1980s. Their concerns were accommodated through sensitivity analyses with high and low catch histories rather than changing the base catch history. As stated before, no blue rockfish were reported being taken in trawl gears from the 1950s through 1970s (Heimann and Miller 1960, Nitsos 1965, Gunderson et al. 1974). Rogers (2003) also estimated the foreign trawl rockfish catch off Washington, Oregon and California from 1966-1976 and blue rockfish were not noted in the analysis of these data.

Abundance indices

Given the lack of survey-based abundance indices of blue rockfish, recreational fishery catch per unit effort (CPUE) is the only available source of information on historical changes in abundance of blue rockfish. The MRFSS and subsequent CRFS samples residing in the RecFIN database provide trip-based catches and angler effort from 1980 to 2006 with some missing years. An independent CDFG CPFV onboard observer survey that targeted rockfish and lingcod also provided site-based catch and angler effort from 1987 to 1998.

Each data set was subject to record filtering in order to eliminate trips and sites that were unlikely to have been associated with blue rockfish. The CDFG samples were restricted to sites that had a history of blue rockfish presence. The RecFIN trips were filtered by the Stephens and MacCall (2004) method based on other species of fish taken on those trips. The Stephens and MacCall method was endorsed by an “off-year” workshop on the subject of recreational fishery data analysis (Recreational CPUE Statistics Workshop, June 29-30, 2004). The method has proven to be robust in previous applications to other species.

RecFIN CPUE Indices

CPUE from recreational fisheries in southern California waters is not used in this assessment, and was not calculated due to the high frequency of zero-catches in recent years. Wade VanBuskirk (PSMFC, pers. comm.) provided northern California (north of Point Conception) trip-level summaries of CPFV catch and angler effort from the RecFIN database, covering years 1980-1989 and 1993-2006. These RecFIN intercept data reflect sampling and interviews conducted at the end of 3680 fishing trips, and do not include information on specific fishing locations. Because the data include both relevant trips in which blue rockfish were reasonably likely to be taken, and non-relevant trips such as trips targeting salmon or tuna, the logistic regression method of Stephens and MacCall (2004) was used to obtain a subset of the trip data that would be appropriate for calculating blue rockfish CPUE. This method uses the species composition of catches from each trip to determine whether fishing occurred in a habitat likely to be associated with the presence of blue rockfish and therefore, to determine which trips had the potential to encounter blue rockfish.

The top 50 species in frequency of occurrence were extracted and blue rockfish (target species) were removed. The remaining 49 species served as potential explanatory variables. All trips with take of striped bass, albacore, or salmon were deleted from the data, as any catch of blue rockfish is very likely to reflect a small portion of the fishing effort on that trip. Potential explanatory species that occurred in less than 20 trips were not used in the analysis. Logistic regression of blue rockfish presence/absence on categorical presence/absence of the explanatory species provided predicted probabilities that blue rockfish would be taken on a trip, given the other species that were taken on that trip. Species associations (coefficients from the logistic regressions) are shown in

Figure 12 and a cumulative-cumulative plot is shown in Figure 13. A threshold probability of 0.39 was chosen on the basis of equal probabilities of false negatives and false positives (Stephens and MacCall 2004). Selection of the threshold probability defines the subset of RecFIN trip data to be used for calculation of the CPUE index.

Initial examination of CPUE values showed unusually high values of catch per angler hour in years 1997 and 1998 (Figure 14), similar to the anomalous patterns seen for several other species in the RecFIN data (e.g., gopher rockfish, vermilion rockfish). This problem was reported to RecFIN, and Wade VanBuskirk (PSMFC, pers. comm.) recommended that data for 1997 and 1998 not be used in this stock assessment.

This analysis uses retained catch (RecFIN type A) per angler hour as the measure of CPUE. The abundance index is calculated by a delta-GLM of catch and effort data from 893 trips. Edward Dick (NMFS/SWFSC, pers. comm.) provided the R language code for the delta-GLM model, which uses a binomial (delta) model to describe presence-absence, and a lognormal or gamma model to describe values of CPUE if blue rockfish were present (Stefánsson 1996).

Four sets of explanatory variables (with number of levels) were initially considered: YEAR(24), WAVE(6), REGION(4), and 3_MILES(2), where WAVE represents two-month intervals, REGION represents geographical county groupings (San Luis Obispo (SLO), Monterey+Santa Cruz (MONSC), San Mateo (SANMAT), and Sonoma+Mendocino (SONMEN)), and 3MILES represents inside and outside three miles from shore; estimated YEAR values provide the annual index. Because of small sample sizes, data from San Francisco Bay-area counties (San Francisco, Marin and Alameda) and from the northern counties (Humboldt and Del Norte) were not used. Based on a Bayesian Information Criterion (BIC), which favors simple models, an interaction term between REGION and 3_MILES should be included. Rather than using an interaction term, a new main effect LOC(8) was created, consisting of the eight combinations of REGION and 3_MILES, which were treated as independent locations. Sample sizes are given in Table 7.

For this revised main effects model, a delta-gamma distribution (AIC=259) was favored over a delta-lognormal distribution (AIC=318). When diagnostics were attempted under the gamma distribution, the results were odd, so we used the lognormal distribution for purposes of providing diagnostics for this index (Dunn and Smyth 1996). Figures 15-18 show the results, including residual plots and Q-Q plots. Analysis of deviance indicated that all three main effects (Figures 19-21) were significant (Table 8). Based on BIC, all models containing interaction terms were rejected (Table 9). Precision of the estimated YEAR effects was estimated by use of a jackknife procedure and can be seen in Table 10.

The bag limit changed from 15 to 10 in 2000, and although this regulatory change has the potential to influence an index of abundance based on CPUE, two hypotheses can be considered: either compliance was achieved by higher discard rates, or it was achieved by shortened trip durations. Because this RecFIN CPUE index is based on catch per angler hour (rather than catch per angler trip), a shortened trip duration would preserve the validity of the CPUE ratio estimate. Because of small sample size and perhaps because the bag limit applied to all rockfish species (thus adding unexplained variability), there was no direct evidence either for or against a shortening of trip duration as catches approached 10 blue rockfish per angler in recent years. A RecFIN query of estimated retained and discarded blue rockfish shows no marked increase in discard rate following the change in bag limit (Figure 22). During the Mop-Up STAR panel, we also evaluated the bag frequency before and after the change in bag limit (Figure 23). Considering this, the STAT and the STAR agreed to separate this index into two time periods to account for the change in catchability (half) since the year 2000. Even though changes in assessment results were minor, the two RecFIN CPUE indices for the pre- and post- bag limit change were included in the final base model.

CDFG CPUE Index

The CDFG CPFV onboard observer survey provided catch and effort data to produce a second CPUE index (catch per angler hour, CPAH) of relative abundance for the time period 1987 to 1998 in central and northern California. This survey provided specific location information for each stop in a trip (Table 11). Depth was calculated as an average of the minimum and maximum depths recorded at each fishing location and binned in 10 fathom bins up to 40 fathoms. Since the occurrence of blue rockfish being landed in depths greater than 40 fathoms was rare (5% in greater depths) and the CVs were very large for those depths, all depths greater than 40 fathoms were included in this bin. For locations where blue rockfish were not landed in at least 4 of the 12 years, we removed those locations from further analysis. The remaining 140 locations were mapped in ArcView (EJ Dick, NMFS/SWFSC, pers. comm.) and 6 areas (Fort Bragg, Salt Point, Bodega Bay/Farallon Islands, Half Moon Bay/Santa Cruz, Monterey, San Simeon/Morro Bay) were identified to be used in the model to develop the CPUE index. Bodega Bay and the Farallon Islands were grouped together because they both had low CPAH values and there was a better fit to the model once the two areas were combined. Salt Point had the highest average CPUE and one point from that area was removed from the analysis due to its implausibly high CPUE (CPAH = 57.14).

The abundance index was calculated using the same delta-GLM approach as mentioned in the previous RecFIN CPUE index description. Our initial run included YEAR(12), MONTH(12), AREA(6) and DEPTH(5) effects, with the best fit being lognormal (AIC=7043) over the gamma (AIC=7113). Month was shown to be insignificant, so we removed month from the model. The analysis of deviance table (Table 12) then showed the remaining main effects to be significant. Based on BIC, all models containing interaction terms were rejected (Table 13). Precision of the estimated YEAR effects was estimated by use of a jackknife procedure and can be seen in Table 14. Diagnostics, including residual plots and Q-Q plots can be seen in Figures 24-27. Figures 28-30 provide the annual index of abundance for blue rockfish as well as the main effects (AREA and DEPTH) that remained in the final model.

Pre-Recruitment Indices

In September 2006, a Pre-Recruit Survey Workshop was held in Santa Cruz, CA (NMFS-SWFSC) that concluded data collected during SWFSC (*R/V David Starr Jordan)* and PWCC/NWFSC (*F/V Excalibur)* midwater trawl surveys for young-of-the-year (YOY) pelagic juvenile groundfish could be pooled to provide a coastwide pre-recruit index from 2001-2006 for YOY *Sebastes* spp (Hastie and Ralston 2007). The SWFSC surveys have been conducted in California since 1983 and provide an index in the "core-area" waters surrounding Monterey/San Francisco (i.e., lat. 36º30', 38º20' N). PWCC/NWFSC surveys have been conducted coastwide since 2001.

The pre-recruit index used in the base model was based on the pooling of the two surveys during 2001-2006 (Figure 31). Three different methods (design-based, deltaGLM and ANOVA) were considered to evaluate the best model to be used for the pre-recruit index and the "superior" model was found to be the ANOVA (Steve Ralston, NMFS/SWFSC, pers. comm.). Based on recommendations in Hastie and Ralston (2007), the "core-area" index provided a longer time series (Figure 32) and could be used for species that have a latitudinal center around the core-area. Blue rockfish would be a good candidate for using this index, although initial attempts to use this index did not improve the model. Also, the extremely high recruitment events in 1988 and 2002 were not in agreement with other data sources.

During the Mop-Up STAR panel, the model fits to the pre-recruit index were questioned. The initial CVs had been set to the error estimates, which were extremely small and did not account for all sources of potential variability. The STAR panel recommended CVs of this index to be set to 0.35 for all years in the final base model.

Age Compositions

Our age composition data (sexes combined) represents the recreational fishery from 1979-1984. The data were treated as an unbiased sample of fishery length and age composition. Don Pearson (NMFS/SWFSC, pers. comm.) aged nearly 2200 otoliths (break and burn method) for this assessment (Table 15). We plotted numbers at age to define ages where the majority of blue rockfish were being selected (98% between ages of 5-18) in the CPFV fishery during this time period (Figure 33) and saw no evidence of year class modes from the age composition data (Figure 34).

We also evaluated age and growth for areas where this information was collected. Although highly variable, if areas had similar mean length at age distributions they were combined (Figure 35) to increase the sample size to determine age and growth parameters between the sexes. Monterey and Half Moon Bay/Princeton provided the best representation for this time period (Table 16).

Lastly, we evaluated age compositions from the 2003-2006 Groundfish Ecology (GE) survey (Don Pearson, NMFS/SWFSC, pers. comm.) in the Monterey Bay area (n=205). Even though there was not a lot of information here, we were able to see differences in mean size at age for females between Santa Cruz (n=47) and Big Sur (n=31). Santa Cruz (more heavily fished area) consisted of younger females, whereas older females appeared in the waters around Big Sur (less fished area) (Figure 36). More importantly, this information provided sex-specific lengths and ages to determine a growth curve for the 2000s, which was compared to growth in Monterey during the 1980s (Figure 37). This comparison suggests a change in growth over time that led to the exploration of a time-varying growth model that will be discussed in the model section.

To evaluate precision, a subset of 101 otoliths from the GE survey were subject to re-reads by the same ager. This amounts to a test of among-ager precision (Table 17). The otoliths represented an age range of approximately 3 to 25 years, and samples were fairly evenly distributed across that range (average age 10.8 yr, SD 6.2 yr). An analysis was completed to incorporate aging error into the model. The first reading was treated as the “true age” and precision was estimated as the standard deviation of the second reading relative to the first reading (SDrelage). As would be expected, the estimates of precision by individual ages are imprecise due to small sample size. Consequently, the data were divided by age range into three groups of approximately similar sample size, ages 3-6 (N=39, SDrelage = 0.42yr), ages 7-12 (N=26, SDrelage = 0.81yr), and ages 13-25 (N=39, SDrelage = 1.59yr). The values of SDrelage are approximately linear with the means of the respective age ranges (Figure 38). A linear regression of SDrelage against mean age gave the relationship SDrelage=0.0809+0.0518*age, and this was applied to individual integer ages to create the vector of age determination errors.

Minimal mean length at age data was available (Don Pearson, NMFS/SWFSC, pers. comm.) to evaluate potential differences between the two putative species of blue rockfish during the Mop-Up STAR panel. If the two species are demographically similar, there would be less cause for concern. Figure 39 shows similar mean age at length patterns between the two species; however, there is a need to study the two species in much greater detail.

Length Compositions

Recreational length composition information was obtained from RecFIN and the CDFG CPFV onboard observer survey. Sex-specific information was not available for these sources to separate the compositions for males and females. All lengths were set up in 2 cm bins. RecFIN length data for the CPFV and private boat sectors from 1980-2006 showed compositions to be very similar (Figure 40), so we combined all lengths into one recreational fishery. Lengths from the 1980s, 1997 and 1998 were not used because they appeared to be converted from weights and were not actual lengths. Weighted length data did not provide sample sizes so the unweighted length data were used. Comparisons between the unweighted and weighted length compositions (Figure 41) showed minor differences, so the Mop-Up STAR panel approved the use of the unweighted samples being used in this assessment.

Length compositions were also used from the CDFG CPFV onboard observer survey (Figure 42) for the years 1987-1998. Total lengths were converted to fork lengths using Equation 4. Tables 18 and 19 show the number of trips and actual lengths associated with the RecFIN and CDFG survey, respectively. Strong modal progressions were not evident in either of these data sources.

Lastly, length composition data from the recreational CPFV fishery (1978-1984) were incorporated for use in this assessment. Considering we used conditional age-at-length data in the base model, concerns are minimal for using a subset from the age data used in this assessment. This will be discussed further in the model section.

Commercial length compositions were obtained from the CALCOM sampling database for years 1992 to 2006. Comparison of length compositions for the hook and line and net fisheries showed that net gears catch larger fish (Figure 43), so the two fisheries could not be combined. There were insufficient sample sizes for setnet gear, so they were used only to determine the selectivity of this fishery. However, there were sufficient sample sizes for the hook and line fishery since 1992, and annual length frequencies can be seen in Figure 44. Again, no evidence of strong modal-progression was seen. Table 20 provides sample sizes and actual lengths available for the commercial fishery. This table also provides an example of females (79%) being selected more often than males (21%) in the commercial hook and line fishery.

DESCRIPTION OF MODEL

Appendix B describes the ASPIC (production) model and results that were presented at the first STAR panel (May 2007) in Portland, OR. Additionally, a comparison of depletion and stock biomass between the ASPIC and SS2 models were included in response to a request from the Mop-Up STAR panel (October 2007) in Seattle, WA. Overall, the general trends are very similar; however, the ASPIC model results in higher estimated productivity when compared to the results of the SS2 model. The strong similarities between the two model results suggests that alternative modeling approaches may be appropriate for stock assessments with limited data.

Stock Synthesis II

We developed a size- and age-structured model using Stock Synthesis 2 (ver_ 2g) (Methot 2005) to model the population dynamics of the blue rockfish stock in California, north of Point Conception. The Stock Synthesis model estimates and projects the survival, growth and reproduction of individual age classes and incorporates ageing errors and variation in growth. It allows a variety of data types to be combined and used to estimate parameters in one formulation. The data and control files for the final base model can be seen in Appendices C and D.

Based on maximum ages of 41 (females) and 44 (males) (Laidig et al. 2003) and Hoenig (1983), natural mortality was initially assumed to be M = 0.10 for males and females in the base model. During the review process, the under-representation of males in the fishery data was consistent in all model runs. To try to capture this, a range of values for M and male offsets for M were explored, and male M was fixed at 0.12 in the final base model with female M remaining fixed at 0.10.

Considering the recommendation based on the meta-analysis by Martin Dorn (NMFS/AFSC, pers. comm.), steepness (*h)* was fixed at 0.58. Recruitment was estimated from 1960-2006. The logistic selectivity function was used for each fishery and survey, with a male offset also estimated from the recreational data. A convergence criterion of 0.00001 log-likelihood units was used for all runs of the model.

The final base model included the historical catch series from each fishery, conditional age-at-length compositions from the recreational CPFV fishery (1980-1984), length compositions from the recreational (RecFIN, CDFG onboard observer survey, 1980s CPFV) and commercial (hook and line and setnet) fisheries, two recreational CPUE indices (RecFIN separated pre- and post- bag limit change in 2000 and CDFG survey) and a pre-recruit index (2001-2006). We assumed equal likelihood weights (= 1.0) for all data sources. There were very few samples (n<10) in the commercial setnet fishery, so we used the length compositions only to determine the selectivity and did not tune between model runs. Since the recreational fishery did not have any sex information available for the length compositions, we used the sex-specific age compositions from the 1980s to determine the selectivities for this fishery. We set a male offset to help in estimating the differences in selectivity between the sexes. In every data source we explored for this assessment, females were selected much more (70-80%) than males. Depth is one potential factor that could be contributing to this selection. In three observed occasions, male numbers were greater than or equal to female numbers in depths <12 fathoms (Don Pearson, NMFS/SWFSC, pers. comm.)

The growth parameters of k and L_{max} were estimated in the final base model, with L_{min} remaining fixed at the externally estimated value (Figure 45). Prior to the Mop-Up STAR panel, we estimated growth outside of the model (Figures 46, a-b) using the combined area data from the 1980-1984 CPFV age and length data, as well as dive data (young fish, ages 1-3) provided by Tom Laidig (NMFS/SWFSC). External fits of the Schnute (1981) parameterization of the von Bertalanffy growth equation were the following: female parameters - t_1=2 (years), L_1=17.9 (cm FL), t_2=25 (years), L_2=37.5 (cm FL) and k=0.147 (n= 2340, CV=0.089); male parameters - t_1=2 (years), L_1=15.7 (cm FL), t_2=25 (years), L_2=31.2 (cm FL) and k=0.295 (n=667, CV=0.108).

The age composition data was limited in this assessment to samples collected in the recreational fishery between 1980 and 1984. These data were fitted as conditional age-at-length data, in which length and age observations are analogous to entries in an age-length matrix with ages in the columns and lengths in the rows. This approach was implemented in 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, particularly when age structures are collected as a subset of the measured fish (Stewart 2006; Helser et al. 2006; Punt et al. 2006). For blue rockfish, conditional age-at-length data represent individual fish rather than expanded age-at-length compositions, as the latter could not be derived from the recreational samples. Initial multinomial sample sizes were the number of trips sampled for each year, with this effective sample number partitioned among the length bins (rows) for any given year based on the fraction of aged fish in that length bin for that year (Figures 47, a-b). The same age composition data were included as traditional age composition data in the data file with no emphasis values in order to graphically illustrate the relative (marginal) fits to the data, a useful diagnostic for more rapidly evaluating the relative fit to all of the data and the improvement in fit gained by freeing (rather than fixing) growth rate parameters in particular.

Model results

The total number of parameters estimated was 74, including the unfished equilibrium recruitment (R_0), eight parameters for logistic selectivity curves (two surveys and two fisheries), four parameters for growth curves (L_{min} was fixed) and 47 recruitment deviation values (for the years 1960-2006). Male offset parameters for selectivity were estimated based solely on the recreational age composition data that included early 1980s CPFVs and then fixed for all fisheries, as these were the only data that had clearly identified catches to sex (and which illustrated that males were much less frequently encountered than females). Table 21 provides the point estimates for these parameters, as well as the model estimated standard deviations. The base model estimates of summary biomass (age1+), spawning biomass, recruitment, total catch, exploitation and depletion are provided in Table 22.

All results shown and discussed are relative to a base model with the same parameter configuration as the final model in which the assumed sample sizes and survey CVs were tuned to the effective sample sizes and CVs output from initial model runs. Tuning was conducted using the variance adjustment factor vectors available in SS2, such that variance was added to survey index CVs, and multipliers were used to scale the effective sample sizes for length and age composition information. The length composition information for the setnet fishery is based on extremely low sample sizes, and the length information was solely intended to provide a selectivity curve, so this index was not tuned to reflect the "more informative" effective sample sizes reflected by the model. All other indices and composition information were tuned to the point where the ratio effective and the input CVs/sample sizes were close to one.

The model estimated an unfished spawning biomass (SSB_0) of 2077 million larvae, an unfished summary biomass of 13,222 mtons and a 2007 spawning biomass of 622 million larvae, which results in a relative spawning biomass estimate of 0.297 in 2006. The depletion level at its lowest point (1994 and 1995) was estimated to be 205 million larvae, or 10% of SSB_0. Figures 48 (a-b) show the total spawning biomass and depletion (with reference 25% and 40% of unfished biomass). The highest exploitation rates (and greatest relative population declines) seemed to occur from the 1970s through the 1990s, (Figures 49 a-b). In recent years, fishing mortality rates have been close to the current target SPR of 50% but the biomass is below target levels. The model estimated proxy MSY based on an $F_{50\%}$ SPR is 275 metric tons. This value is associated with an exploitation rate (catch over summary biomass) of 0.06, and an equilibrium spawning output of 831 million larvae, which corresponds to 40.0% of the unfished larval production.

Although the length data are aggregated by sex and there are no clear modes visible in evaluating the length compositions with the eye, the model fit improved significantly with recruitment deviations estimated freely (1960-2006). Figures 50 (a-b) show estimated annual recruitment values over the time period with 95% asymptotic confidence limits. Estimated recruitment deviation values and deviation variance checks can be seen in Figures 51 (a-b). Importantly, the variance on most of the recruitment deviation estimates is large, consistent with the general observation that strong year classes are not obvious in the data. This suggests that although there are signs of highly variable recruitment in the data, the actual years of strong recruitment are likely to be poorly specified.

Fits to each of the relative abundance indices (in both arithmetic and log scale) and scatterplots of observed versus predicted indices are shown as Figures 52-55. Some serial autocorrelation is suggested in the residuals to the fits to the two recreational CPUE time series, although the fits capture the general trends reasonably well and are comparable to the type of fit often achieved to relatively noisy recreational CPUE time series. The fits to the pre-recruit survey should be interpreted with caution as there is essentially no available data to conflict with the survey predictions of year class strength. As this dataset is of short duration and the "core area" (longer time series) failed to capture the magnitude of the 1999 year class, the results should be treated with caution. This is particularly true as the model predicts the 2001-2006 recruitments to be considerably lower than previous years; the explanation for this is unclear. However, the overall effect of including the juvenile abundance dataset is negligible with respect to estimates of reference points and biomass trend through the present period.

The estimated selectivity (length-based, sex-specific) curves for each fishery and survey are shown as Figures 56-57. Fits to catch at length data by fleet and Pearson residual plots are shown as Figures 58-63. Fits to the catch-at-length data for the recreational fishery (fleet 1), the hook and line fishery (fleet 2) and the recreational onboard observer program (fleet 4, treated as a survey) are generally quite reasonable, although as noted previously there is little obvious suggestion of the strong year classes that are estimated in the recruitments. The setnet fishery (fleet 3) had extremely sparse data, and the length data that are included were included solely for the purpose of fitting the selectivity curve.

The fits to the conditional age-at-length data are shown as Figures 64-68, with the residuals shown as Figures 69-71 and the assumed and effective sample sizes of the (tuned) conditional data shown as Figures 72 (a-b). Freeing the growth parameters improved the fit to the age and length data significantly relative to the externally estimated values (approximately 120 likelihood units), primarily through the effect of reducing the K growth coefficient in order to slow the growth and better fit to the age-at-length information. However, the relative contribution to informing strong or weak cohorts was modest, as illustrated by the marginal fits to age composition data (representing the conditional age-at-length data in a more traditional format by using a "ghost" fishery and mirrored selectivity to fleet 1, the recreational fishery). This is consistent with the observation that strong cohorts are not readily apparent in either the age composition or the length composition data. This could be due to low recruitment variability, a high degree of ageing error, small sample sizes, or the combination of all of these factors. Fits to catch at age data for the early 1980s recreational data improved considerably with the changes made during the Mop-Up STAR panel (Figures 73, a-b).

Sensitivity Analysis

Prior to the Mop-Up STAR panel (no conditional age-at-length, recruitment deviations (recruit devs) estimated from 1980-2006 and M=0.1 for both males and females), a sensitivity test was performed turning off the recruit devs, and the result was a considerably poorer fit to all of the sources of data (indices, catch at length, and interestingly even catch at age from the period prior to which recruit devs were estimated). The model result without the recruit devs freely estimated was considerably more pessimistic, and suggested that the stock is below the overfished threshold. Interestingly, exclusion of the age data gave a similar (although not as extreme) result, with a more pessimistic assessment of stock status. By contrast, when both of the CPUE time series and their associated length data were removed, the results were considerably more optimistic.

Also, likelihood profiles were developed for both steepness and natural mortality, and were shown graphically as relative likelihoods for the total fit as well as the separate components (indices, length composition data, age composition data). The overall likelihood was minimized at a relatively low steepness value (~0.3), which was strongly influenced by the age and length composition information; the relative abundance indices favored a higher value (~0.5) but were less influential in the model fit. (Note: results are different from the final base model after the Mop-Up panel.) Similarly, a considerably lower natural mortality rate provided an improved fit to the age composition information, a moderately lower natural mortality rate improved the fit to the length composition information, and the fits to the indices were consistent with the base model estimate of 0.1. The model results were considerably more sensitive to changes in the estimate of natural mortality, with the model suggesting that the current biomass was well above the unfished equilibrium biomass level when a higher natural mortality rate was assumed, and suggesting considerably greater depletion when a lower rate was assumed.

During the Mop-Up STAR panel, numerous sensitivities were performed to refine the specifications of the base model. Starting year for estimating recruit devs was evaluated in 5 year increments from 1940 to 1980. The starting value for recruitment deviations was set to 1960, which was approximately the year that data began to be informative about year class magnitude.

A sensitivity was also conducted to determine σ_R . Initially, σ_R was set at 1.0 but was believed to be too high and allowed for too much variability in recruitment. Values ranging from 0.5 (likelihood 1468) to 0.1 (likelihood 1719) were evaluated and the panel recommended setting the base model value $\sigma_R = 0.5$.

A sensitivity early on with low catches (half of BASE) and high catches (double BASE) showed little sensitivity in terminal depletion levels.

Given the evidence of a potential change in growth in blue rockfish over time, we explored a time-varying growth model. The 1980s recreational CPFV data and the sparse 2003-2006 Groundfish Ecology survey data were used to estimate two growth curves for differing time periods. Setting up time blocks (1916-1985, 1986-2006) for growth and selectivity resulted in model instability with the limited amount of age data in the last 20 years.

When the CVs of length at age were internally estimated, the female CVs ranged from 0.07-0.09 and the male CVs ranged from 0.07-0.16. We then let the model estimate CVs for the young and old. Based on the internal estimates just stated and the external estimates (Figures 74, a-b) provided by EJ Dick (NMFS/SWFSC), it was recommended that the CVs for the young males and females be fixed at 0.085. The CV for the old females was fixed at 0.095 and the CV for the old males was fixed at 0.11.

Much effort was put into trying to determine an appropriate estimate for natural mortality (M). The lack of old males in the fishery data could be due to either selectivity or a higher natural mortality for males. The male selectivity curve was estimated to be much lower than females and was dome-shaped due to the dog-leg parameterization of the male selectivity offset. We attempted to explore this formulation, fixing the slope and keeping the shape the same while allowing the level to vary to see if a simple offset to the female selectivity pattern would fit the data just as well. We found that this could not be accomplished in SS2 and was not explored further.

Initially, male and female natural mortality were assumed to be 0.1, based on maximum ages and Hoenig (1983). Throughout numerous sensitivities, improvements in fit with a male M offset were large enough to justify differing M's between males and females. Examples of some of these sensitivities are as follows: estimating male M (0.115), fixing M based on Tenera (2000) estimate of 0.14, assuming a ramp for male M between ages 10 and 20 - estimating young (0.1) and old (0.134) M and then fixing those values. The results of the ramp in male M were ambiguous, but when comparing the likelihood values associated with the initial fixed value of 0.1 (1355), a fixed value of 0.14 (1375) and the model estimated value of 0.115 (1341), the decision was made to fix male M = 0.12, leaving female M = 0.10. Figures 75 (a-b) profile natural morality and steepness for the final base model.

Forecasts

Future catch projections through 2016 were made based on an $F_{50\%}$ fishing rate with 40:10 adjustment. The sum of the average catch from each fishery for the years 2005 and 2006 (263 mtons) were applied to the beginning projection years of 2007 and 2008. The forecasts from the base model predict a slight increase in abundance but not enough to support increased harvesting of blue rockfish in the future. However, the state of nature corresponding to higher natural mortality (M females = 0.13, M males = 0.15) remains above 40% and allows about 370 mtons to be taken in 2009.

Decision Tables

The base model assumes natural mortality (M) for females to be 0.10 and 0.12 for males. To bracket the uncertainty in this assessment, the STAR panel suggested the state of nature to be based on high and low estimates of M with high and low catch streams. The initial request to offset M from the base model was ± 0.02 which gave equal likelihoods (1338) for the base and the higher M scenarios, with the likelihood of the low M scenario being 9 points higher (1347). Considering this did not provide enough contrast to capture the uncertainty, the STAR panel then suggested a ± 0.03 offset for further investigation which was completed after the review. The results of this request proved the likelihood of low M values were even less likely (1361) than the previous offset, and the base and high M scenarios were still nearly the same (Table 23).

For direct comparison, the likelihood values when changing M only (not the catch stream) can be seen in Table 24. In each case, the likelihood for all low M scenarios are much higher, indicating they are not as likely. Even though the STAR panel did not assign probabilities to the states of nature, the STAT feels strongly that the base and high M scenarios are most likely, based on the discussion above and also considering the estimate of M (0.14) provided by Tenera (2000). Table 25 provides all likelihood components for each of the states of nature. Decision tables of 10-year projections (under the 40:10 and 60:20 adjustments) for alternate states of nature and management options can be seen in Tables 26 and 27.

RESEARCH NEEDS

- As with many rockfish, reconstruction of the historical landings is difficult and very time consuming. A standard method should be applied, and historical documentation should be provided to highlight major fishery events to allow more certainty in these estimates.
- Continued genetic studies to confirm that blue rockfish are two species. Some major research that is needed related to this topic include: aging to determine differences in growth and longevity, fecundity, maturation schedules and their spatial distributions.
- More biological sampling, especially age composition information, of the recreational and commercial fisheries to be able to determine changes in life history parameters over time and space.
- Research to help understand the lack of males in the catches. Is this a selectivity issue or a substantial difference in natural mortality between males and females?
- Development of a fishery-independent survey to capture changes in stock abundance. Many assessments have used a recreational CPFV CPUE index to determine this, which is not as reliable considering management changes (i.e. bag limits, closures) that continue to occur.
- Sex-specific length and age information from the recreational fishery. Attempts have been made to gather sex-specific information from sampling the commercial fishery, and even though samples are small, it is informative.
- Environmental factors that affect survival of juvenile blue rockfish need to be explored further. The lack of kelp habitat caused by increasing ocean temperatures (warmer waters) in Southern California since the 1990s led the STAT to believe that the disappearance of blue rockfish in this area was not due to fishing.

MANAGEMENT RECOMMENDATIONS

Blue rockfish are going to be a challenge for management. Even though efforts were made to accommodate the changes in growth over time and space, sufficient data were not available to accomplish this within the assessment model. Simulation studies are needed to evaluate the potential effect of these spatial and temporal changes on model results. Also, the exclusion of Oregon and southern California in this assessment adds additional challenges for management. Finally, two species of blue rockfish exist which may have important implications for regional management, particularly not knowing their habitat associations and/or geographic distributions.

The STAT advises that this assessment be used with caution for management purposes. The STAT feels strongly that the decision table does not provide symmetrical bracketing of uncertainty (described in decision table section) and that the BASE and high M scenarios are more likely than the low M scenario. It is recommended that only the projections under the BASE and high M scenarios be considered for management purposes.

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TABLES and FIGURES

Table 1. California regulations that applied to blue rockfish from 1990-2006.

Year	Commercial	Recreational
1990	Limits on set line length established; Gill nets not allowed within 30 fm	Bag limit for rockfish, 15 fish in combination; No gear restrictions
1994	*Sebastes* complex split coastwide into limited entry (LE) and open access (OA); LE trip limits = 80,000 pounds per month; OA trip limits = 40,000 pounds per month; Gill nets not allowed within 3 miles of shore	
1995	Additional limitations for set lines established; No set line fishing on weekends north of Santa Cruz; Fishing restricted in Districts 12 & 13	
1999	OA trip limits (north of 40º 10' N. lat) = 3,500 pounds per month for black & blue rockfish combined; OA trip limits (south of 40º 10' N. lat) for *Sebastes* complex: Jan.–Sept. 2,000 pounds per month; Oct.-Dec. 500 pounds per month	
2000	*Sebastes* complex split into nearshore, shelf, and slope; Seasonal 2-month closures first adopted for some areas	
		Bag limit for rockfish reduced to 10 fish, in combination; Gear limited to one line with three hooks
2001	Cowcod Conservation Area (CCA) established; In addition to seasonal closures, depth restrictions also adopted	
		G Gear limited to one line with two hooks
2002	Nearshore Fishery Management Plan adopted	
	Commercial nearshore rockfish fishery closed early	
2003	Groundfish fishing restricted by region, season, and depth; Minor Nearshore rockfish north of 40º 10' N. lat. split into black & blue rockfish, and other nearshore rockfish; Minor Nearshore rockfish south of 40º 10' N. lat. split into shallow, deeper, and California scorpionfish; Minor Nearshore rockfish OY south revised using updated commercial & recreational estimates	
	Formal restricted access program adopted; Deeper Nearshore Permit (DNS) required statewide; DNS holders = 278; Trawl and non-trawl gear Rockfish Conservation Areas (RCAs) established; Commercial nearshore rockfish fishery closed early	Recreational nearshore rockfish fishery closed Jan. – June south of 40º 10' N. lat.; Recreational nearshore rockfish fishery closed early
2004-2006	Groundfish fishing continued to be restricted by region, season, and depth; Black rockfish removed from Minor Rockfish (north and south of 40º 10' N. lat.) in 2004 and blue rockfish north of 40º 10' N. lat. lumped with other nearshore rockfish	
		In 2004, recreational RCAs such as the California Rockfish Conservation Area established

Table 2. Changes in commercial regulations, 1950-2006, and related changes in gear use.

1950	
1953	Legislation prohibits trawling off coast of Santa Barbara County within 3-nautical-mile limit; entire California coast now closed to trawling within the 3-nautical-mile limit
1960	
1963	Foreign factory trawlers fishing off the West Coast; primarily targeting deeper-water rockfish
1970	Take from foreign trawlers targeting Pacific whiting, shelf rockfish (widow, bocaccio, chilipeppers) includes blue rockfish bycatch; local trawlers and California trawlers targeting widow rockfish also catch blue rockfish
1976	Magnuson Act passed; gives U.S. jurisdiction over fisheries within 200 miles of the coast
1980	With waning of trawl fisheries, commercial hook-and-line and gill net fisheries expanded
1989	Live fin-fish fishery, which initially started in the Los Angeles and San Francisco Bay areas, begins to expand to other parts of the state
1990	California Propostion 132, prohibiting gill nets within state waters, passed by voters
1991	Buyout of set gill-net vessels
1994	Gill nets prohibited within 3 miles of mainland coast, and waters less than 70 fathoms or within one nautical mile of the Channel Islands, whichever is less
2000	Seasonal 2-month closures first adopted for some areas along California coast
2001	In addition to seasonal closures, depth restrictions also adopted
2002	Nearshore Fishery Management Plan adopted
2003	Groundfish fishing restricted by region, season, and depth; formal restricted access program for nearshore rockfish adopted; Deeper Nearshore Permit required statewide
2006	

Table 3. Commercial and recreational estimated harvest (mtons) for blue rockfish, north of Point Conception, 1916-2006 used in this assessment.

	Commercial by gear			Recreational by mode				
Year	Hook & Line	Gillnet	Sub Total	Shore-based	CPFVs	Private and rental boats	Sub Total	TOTAL REMOVALS
1916	0.4	0.0	0.4				0.0	0.4
1917	1.3	0.0	1.3				1.6	2.9
1918	2.1	0.0	2.1				3.2	5.3
1919	1.8	0.0	1.8				4.8	6.6
1920	2.4	0.0	2.4				6.4	8.7
1921	2.4	0.0	2.4				8.0	10.4
1922	2.6	0.0	2.6				9.5	12.1
1923	3.5	0.0	3.5				11.1	14.6
1924	3.6	0.0	3.6				12.7	16.3
1925	4.6	0.0	4.6				14.3	19.0
1926	6.1	0.0	6.1				15.9	22.0
1927	5.9	0.0	5.9				17.5	23.4
1928	7.6	0.0	7.6				19.1	26.6
1929	7.2	0.0	7.2				20.7	27.8
1930	10.4	0.0	10.4				22.3	32.7
1931	10.1	0.0	10.1				23.9	34.0
1932	9.1	0.0	9.1				25.4	34.5
1933	8.6	0.0	8.6				27.0	35.7
1934	9.0	0.0	9.0				28.6	37.6
1935	11.8	0.0	11.8				30.2	42.0
1936	14.5	0.0	14.5				31.8	46.3
1937	12.8	0.0	12.8				37.8	50.6
1938	11.4	0.0	11.4				37.2	48.6
1939	9.7	0.0	9.7				32.6	42.3
1940	12.3	0.0	12.3				46.9	59.2
1941	11.6	0.0	11.6				0.0	11.6
1942	5.1	0.0	5.1				0.0	5.1
1943	6.6	0.0	6.6				0.0	6.6
1944	15.6	0.0	15.6				0.0	15.6
1945	49.1	0.0	49.1				0.0	49.1
1946	39.9	0.0	39.9				16.0	55.9
1947	35.8	0.0	35.8				32.0	67.8
1948	18.9	0.0	18.9				64.0	82.9
1949	14.6	0.0	14.6				82.9	97.5
1950	21.1	0.0	21.1				101.1	122.2
1951	21.9	0.0	21.9				115.5	137.4
1952	16.0	0.0	16.0				100.5	116.5
1953	15.7	0.0	15.7				85.5	101.2
1954	5.9	0.0	5.9				106.3	112.2
1955	5.4	0.0	5.4				126.8	132.2
1956	8.0	0.0	8.0				141.6	149.6
1957	10.3	0.0	10.3				138.1	148.4
1958	19.7	0.0	19.7				226.7	246.4
1959	16.9	0.0	16.9				188.2	205.1

Table 3 (continued). Commercial and recreational estimated harvest (mtons) for blue rockfish, north of Point Conception, 1916-2006 used in this assessment.

	Commercial by gear			Recreational by mode				
Year	Hook & Line	Gillnet	Sub Total	Shore-based	CPFVs	Private and rental boats	Sub Total	TOTAL REMOVALS
1960	7.5	0.0	7.5				146.7	154.2
1961	12.2	0.0	12.2				110.9	123.1
1962	7.5	0.0	7.5				127	134.5
1963	5.0	0.0	5.0				130.7	135.7
1964	6.2	0.0	6.2				99.5	105.7
1965	7.3	0.0	7.3				154.7	162.0
1966	8.1	0.0	8.1				167	175.1
1967	7.7	0.0	7.7				164	171.7
1968	7.1	0.0	7.1				296.8	303.9
1969	8.5	3.5	12.0				279.3	291.3
1970	10.5	4.5	15.0				376	391.0
1971	7.8	26.0	33.8				313.8	347.6
1972	12.2	32.2	44.5				431.2	475.7
1973	19.3	74.7	94.0				632.6	726.6
1974	15.6	106.5	122.1				716.8	838.9
1975	16.0	119.2	135.2				695.6	830.8
1976	22.2	39.1	61.3				637.4	698.7
1977	18.2	52.2	70.4				569.9	640.3
1978	4.6	16.8	21.4				523.7	545.1
1979	34.9	13.3	48.3				658	706.3
1980	49.6	2.3	51.8	6.4	371.9	108.7	487.0	538.8
1981	37.9	1.2	39.2	8.2	554.6	263.7	826.5	865.7
1982	60.6	0.5	61.1	6.1	457.9	243.7	707.7	768.8
1983	55.2	0.8	56.1	13.0	435.2	213.0	661.2	717.3
1984	11.3	1.3	12.6	6.2	264.2	198.8	469.2	481.8
1985	36.5	134.5	170.9	5.7	140.4	115.5	261.7	432.6
1986	2.8	12.8	15.7	7.8	32.9	84.0	124.7	140.4
1987	7.8	0.4	8.2	4.7	49.6	204.6	258.9	267.2
1988	7.7	0.1	7.8	15.5	109.4	182.1	307.1	314.9
1989	17.2	14.1	31.2	11.9	80.7	152.3	245.0	276.2
1990	26.8	1.5	28.4	10.8	106.8	106.8	224.4	252.8
1991	35.4	1.4	36.8	10.8	88.1	88.1	186.9	223.8
1992	181.4	0.0	181.5	10.8	241.4	241.4	493.6	675.1
1993	134.3	0.3	134.6	9.6	182.4	182.4	374.4	509.1
1994	68.8	0.0	68.8	3.1	141.0	161.7	305.8	374.7
1995	28.5	0.0	28.5	11.4	113.6	91.3	216.3	244.8
1996	44.0	0.1	44.1	1.4	89.8	72.9	164.0	208.1
1997	63.7	0.0	63.7	1.4	215.9	78.7	296.1	359.7
1998	47.7	0.0	47.7	1.9	116.8	130.6	249.4	297.1
1999	35.7	0.1	35.7	1.2	106.2	91.2	198.6	234.4
2000	15.6	0.0	15.6	3.7	100.0	47.1	150.7	166.3
2001	19.7	0.0	19.7	4.3	74.6	36.6	115.6	135.3
2002	18.5	0.0	18.5	2.5	68.8	77.5	148.8	167.4
2003	9.2	0.0	9.2	0.4	47.6	171.9	219.9	229.1
2004	14.8	0.0	14.8	7.8	98.2	43.8	149.9	164.6
2005	21.7	0.0	21.7	1.0	73.8	88.1	162.9	184.6
2006	21.9	0.0	21.9	8.2	179.5	131.9	319.6	341.4
Total	3,616.1	659.4	4,275.5	166.1	4,541.4	3,608.6	17,519.1	21,773.0

Table 4. Summary of data sources and assumptions made for reconstructing the base model catch history. Estimates of blue rockfish (pre-RecFIN and pre-CALCOM) are based on proportions of total rockfish being landed. In the recreational fishery, blue rockfish were reported at 30% of total rockfish in the CPFV fishery, and the CPFV fishery accounted for 70% of total rockfish from Oregon to Point Arguello (FB#130). Estimates were based on an average 1 pound fish. In the commercial fishery, blue rockfish were reported at 1% of the observed total rockfish landings in the Monterey area (FB#44), which was assumed for all port areas. Past studies showed no reported blue rockfish landings in trawl gears, so trawl landings were removed from total rockfish landings prior to calculating blue rockfish proportions.

<table>
<tr><th></th><th>Recreational</th><th colspan="2">Commercial</th></tr>
<tr><th></th><th>Estimate source</th><th>Estimate source</th><th>Trawl removals</th></tr>
<tr><td>1916</td><td rowspan="20">linear ramp</td><td rowspan="33">PFEL - an avg (1949-1951) proportion (0.31) of Santa Barbara County removed.</td><td rowspan="18">ramp</td></tr>
<tr><td>1917</td></tr>
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<tr><td>1933</td></tr>
<tr><td>1934</td><td rowspan="23">trawl logs</td></tr>
<tr><td>1935</td></tr>
<tr><td>1936</td><td rowspan="5">FBs#121,130 & 145 - proportion north of conception (0.72), blues (0.3), modes (0.7), discards (0.068)</td></tr>
<tr><td>1937</td></tr>
<tr><td>1938</td></tr>
<tr><td>1939</td></tr>
<tr><td>1940</td></tr>
<tr><td>1941</td><td rowspan="5">WWII - no estimates</td></tr>
<tr><td>1942</td></tr>
<tr><td>1943</td></tr>
<tr><td>1944</td></tr>
<tr><td>1945</td></tr>
<tr><td>1946</td><td>STAR recommended catch</td></tr>
<tr><td>1947</td><td rowspan="21">FB#145, along with 1936-1940 FB info on blues, modes, discards</td></tr>
<tr><td>1948</td></tr>
<tr><td>1949</td><td rowspan="20">PFEL and a proportion of Santa Barbara area removed. In years where information was not available, the average proportion (0.22) was used. FBs#117, 121, 125, 129, 149</td></tr>
<tr><td>1950</td></tr>
<tr><td>1951</td></tr>
<tr><td>1952</td></tr>
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<tr><td>1955</td></tr>
<tr><td>1956</td></tr>
<tr><td>1957</td><td rowspan="7">Heimann and Miller (1960) and Nitsos (1965)</td></tr>
<tr><td>1958</td></tr>
<tr><td>1959</td></tr>
<tr><td>1960</td></tr>
<tr><td>1961</td></tr>
<tr><td>1962</td></tr>
<tr><td>1963</td></tr>
<tr><td>1964</td><td rowspan="5">removed avg (0.91) from total rf landings</td></tr>
<tr><td>1965</td></tr>
<tr><td>1966</td></tr>
<tr><td>1967</td></tr>
<tr><td>1968</td><td rowspan="12">FBs#121,130 & 145 - proportion north of conception (0.46 avg 1965-67 and 0.58 overall avg 1937-67), blues (0.3), modes (0.7), discards (0.068)</td></tr>
<tr><td>1969</td><td rowspan="11">CALCOM</td><td rowspan="11">CALCOM</td></tr>
<tr><td>1970</td></tr>
<tr><td>1971</td></tr>
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<table>
<tr><th></th><th>Recreational</th><th colspan="2">Commercial</th></tr>
<tr><th></th><th>Estimate source</th><th>Estimate source</th><th>Trawl removals</th></tr>
<tr><td>1980</td><td rowspan="10">RecFIN</td><td rowspan="27">CALCOM
Discards (18%) were included in the 2000s based on NMFS onboard observer bycatch program</td><td rowspan="27">CALCOM</td></tr>
<tr><td>1981</td></tr>
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<tr><td>1989</td></tr>
<tr><td>1990</td><td rowspan="6">RecFIN - CDFG CPFV estimates and 50/50 private to CPFV ratios</td></tr>
<tr><td>1991</td></tr>
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<tr><td>1996</td><td rowspan="11">RecFIN</td></tr>
<tr><td>1997</td></tr>
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<tr><td>2005</td></tr>
<tr><td>2006</td></tr>
</table>

Table 5. Reported pounds from trawl logs for total rockfish and other species, north of Point Conception (1934-1956). “Other” consists of greenspot, China, striped and pelican.

		additional species listed (n.CA)								
	Total rockfish (n.CA)	***boc***	***red***	***chili***	***blacks***	***bolina***	***yellowtail***	***b&y***	***other***	**TOTAL**
1934	529,908	56,617		13,354						599,879
1935	529,691	31,337		9,385						570,413
1936	439,765	50,808		58,606						549,179
1937	523,219	73,797		67,529	300					664,845
1938	489,171	37,746		109,386	380					636,683
1939	558,299	22,840		38,451	9,371					628,961
1940	461,367	15,533		10,505	100					487,505
1941	353,068	10,275		9,602	1,650					374,595
1942	65,210	1,276	35,641	1,437	20,460		90			124,114
1943	323,546	2,510	821,699	6,640	13,588					1,167,983
1944	1,604,421	1,849	2,095,688	8,482	6,586					3,717,026
1945	3,826,680	2,014	1,215,994	61,059	5,789					5,111,536
1946	3,107,122	165	617,009	15,438	194,683					3,934,417
1947	270,990	57,254	1,009,190	31,196	423,877	690			566	1,793,763
1948	2,033,458	21,097	488,842	103,143	38,582	447	143			2,685,712
1949	936,599	901,903	692,214	25,679	105,718	30				2,662,143
1950	650,238	1,711,462	898,894	40,097	753,028	575	338		20	4,054,652
1951	3,012,329	2,703,339	668,722	393,643	287,421	2,852	265		35	7,068,606
1952	3,022,882	3,483,923	535,922	611,056	77,577	8,226			70	7,739,656
1953	2,718,909	5,104,633	734,962	688,697	278,348	8,328	4,685	1,985	75	9,540,622
1954	2,031,802	4,633,654	799,126	920,270	524,123	668			575	8,910,218
1955	1,070,034	3,031,919	1,487,839	570,945	351,389	1,185	476			6,513,787
1956	1,998,858	4,166,895	1,715,478	857,772	82,328	2,878			125	8,824,334
Totals	30,557,566	26,122,846	13,817,220	4,652,372	3,175,298	25,879	5,997	1,985	1,466	78,360,629

Table 6. Sampled proportions of blue rockfish (BLUR) and other species (at least 0.1%) in the blue and black rockfish market categories (CALCOM).

Blue rockfish market category (665)		Black rockfish market category (252)	
BLUR	**88.0%**	BLCK	85.6%
BLCK	5.5%	**BLUR**	**10.4%**
YTRK	2.2%	YTRK	2.1%
BANK	1.0%	CHNA	0.4%
OLVE	0.6%	WDOW	0.4%
BRWN	0.5%	KLPG	0.2%
BCAC	0.4%	BRWN	0.1%
KLPG	0.3%	BLGL	0.1%
CBZN	0.3%	YMTH	0.1%
GPHR	0.3%	GPHR	0.1%
WDOW	0.3%	QLBK	0.1%
COPP	0.2%	BYEL	0.1%
BYEL	0.2%	CNRY	0.1%
CLPR	0.1%		
RSTN	0.1%		

Table 7. Sample sizes associated with RecFIN CPUE analysis. San Luis Obispo (SLO), Monterey/Santa Cruz (MONSC), San Mateo (SANMAT) and Sonoma/Mendocino (SONMEN), along with inside (1) and outside (2) 3 miles were combined for a location (LOC) variable in the delta-GLM. The majority of the sampling takes place in MONSC and SLO areas.

	SLO1	SLO2	MONSC1	MONSC2	SANMAT1	SANMAT2	SONMEN1	SONMEN2	TOTAL
1980	9	4	20			1	5	2	41
1981		6	5		1	3	4		19
1982	4	1	4			1	8		18
1983	3		13	2		1	8		27
1984	12	1	7	1		1	4	2	28
1985	4	6	6		3	7	6	3	35
1986	7	4	5	1	1	1	7	1	27
1987	9		3		3	5		5	25
1988	4	2	5	2	2	2	1	2	20
1989	10	1				3	2		16
1993	42	12							54
1994	61								61
1995	5		9	2		2	4		22
1996	20	2	5	17	2	14	4	1	65
1999	19	2	16	2	9	12	6	3	69
2000	4				3	7		1	15
2001	7		5	4	18	5	2		41
2002	16		14		4		1		35
2003	20		23		4		8		55
2004	28	1	35		7	1	15		87
2005	23		16		3	1	10		53
2006	22		34		18		6		80
Total	329	42	225	31	78	67	101	20	893

Table 8. Analysis of deviance in delta-gamma GLM analysis of RecFIN CPUE.

	Positive portion (gamma)				Binomial portion		
	SS	Df	F	Pr(>F)	Chisq	Df	Pr(>Chisq)
YEAR	110.8	21	5.00	3.71E-12	53.6	21	0.0001113
WAVE	6.0	5	1.14	0.3361	22.4	5	0.00043
LOC	36.1	7	4.88	2.11E-05	26.4	7	0.0004292
Residuals	778.0	737					

Table 9. Bayes Information Criterion (BIC) values for interation models (gamma portion) of RecFIN CPUE. Tabulated value is BIC (interaction model) - BIC (main effects model).

diff	WAVE	LOC
YEAR	354.2	298.7
WAVE		147.1

Table 10. Values of delta-gamma YEAR effects and estimated precision (CV = Std. Error / Index) from RecFIN CPUE.

YEAR	Index	Std. Error	CV
1980	0.37	0.09	0.25
1981	0.51	0.15	0.29
1982	0.62	0.19	0.30
1983	0.38	0.10	0.27
1984	0.35	0.09	0.26
1985	0.34	0.09	0.28
1986	0.06	0.02	0.26
1987	0.09	0.03	0.37
1988	0.14	0.05	0.35
1989	0.08	0.03	0.33
1993	0.22	0.05	0.24
1994	0.16	0.04	0.25
1995	0.35	0.16	0.46
1996	0.25	0.05	0.19
1999	0.25	0.04	0.17
2000	0.09	0.03	0.29
2001	0.07	0.02	0.32
2002	0.32	0.06	0.20
2003	0.19	0.04	0.19
2004	0.32	0.05	0.17
2005	0.30	0.05	0.18
2006	0.41	0.06	0.15

Table 11. Samples sizes (number of stops) included in the CDFG CPFV CPUE index. Total number of trips = 1633.

	Fort Bragg	Salt Point	Bodega Bay /Farallon Isl	Half Moon Bay /Santa Cruz	Monterey	San Simeon /Morro Bay	TOTALS
1987				4	93		97
1988	2	5	32	38	107	50	234
1989	5	6	44	54	72	78	259
1990			14	24	8	38	84
1991	9		3	13	12	45	82
1992	22	2	14	45	59	97	239
1993	11	7	16	50	120	95	299
1994	5	13	22	54	105	96	295
1995	7	5	50	47	114	117	340
1996	6	22	34	36	101	148	347
1997		28	35	28	68	114	273
1998		10	20	31	72	67	200
TOTALS	67	98	284	424	931	945	2749

Table 12. Analysis of deviance in delta-lognormal GLM analysis of CDFG CPFV onboard survey CPUE.

	Positive portion (lognormal)				Binomial portion		
	SS	DF	F	Pr(>F)	Chisq	DF	Pr(<Chisq)
YEAR	362.1	11	23.4	2.20E-16	30.5	11	0.001324
AREA	316.3	5	45.0	2.20E-16	53.4	5	2.84E-10
DEPTH	270.4	4	48.1	2.20E-16	194.6	4	2.20E-16
Residuals	2979.9	2120					

Table 13. Bayes Information Criterion (BIC) values for interation models (lognormal portion) for CDFG CPFV CPUE. Tabulated value is BIC (interaction model) - BIC (main effects model).

diff	AREA	DEPTH
YEAR	220.8	275.2
AREA		82.7

Table 14. Values of delta-lognormal YEAR effects and estimated precision (CV = Std.Error / Index) from the CDFG CPFV CPUE.

	index	Standard Error	CV
1987	1.08	0.22	0.20
1988	0.89	0.12	0.13
1989	1.01	0.10	0.10
1990	0.88	0.13	0.14
1991	1.14	0.16	0.14
1992	2.25	0.19	0.08
1993	1.90	0.17	0.09
1994	1.33	0.12	0.09
1995	1.42	0.13	0.09
1996	1.37	0.12	0.09
1997	3.15	0.30	0.09
1998	3.76	0.35	0.09

Table 15. Number of trips and ages for recreational age compositions used in this assessment. Males represent only 30% of the total ages by sex.

	all sexes ages	all sexes trips	males & females ages	males & females trips
1980	388	99	340	97
1981	430	91	364	86
1982	488	81	403	77
1983	339	32	260	30
1984	553	66	474	64
totals	2198	369	1841	354

Table 16. Actual number of aged fish by year and area from the CPFV fishery.

AREA	1980	1981	1982	1983	1984	TOTAL
Ft. Bragg - Bodega Bay	43	61	6		148	258
SF Bay - Salt Point	122		5			127
Half Moon Bay - Princeton	190	190	329	160	191	1060
Monterey		138	148	156	141	583
San Simeon - Morro Bay	33	41		23	73	170

Table 17. Precision of first and second reads (among reader, not between readers) of the age data used in the assessment.

	AGE2																							
AGE1	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	total
3	1																							1
4		7	3																					10
5			15	1																				16
6			3	9																				12
7					5	1																		6
8					2	1																		3
9						2	3	1																6
10								1	2															3
11							1	1	2															4
12								1		3														4
13											2		1											3
14												1		1										2
15												1	2	1		1								5
16													1	1										2
17														2				1						3
18															1	1								2
19														1			2		1					4
20																1	1	2						4
21																	1							1
22																1			3	1				5
23																	1				1	1		3
24																								
25																			1				1	2
total	1	7	21	10	7	4	4	4	4	3	2	2	4	6	1	4	5	3	5	1	1	1	1	101

Table 18. Sample sizes and number of lengths associated with the RecFIN length compositions used in this assessment. The 1980s and 1997, 1998 were not used because they were based on weight to length conversions.

YEAR	total lengths	total trips
1993	3197	358
1994	1425	201
1995	1110	157
1996	2951	299
1999	4097	284
2000	1029	140
2001	799	91
2002	2818	198
2003	4219	285
2004	8952	692
2005	988	128
2006	775	93
totals	32,360	2926

Table 19. Number of trips and blue rockfish lengths by area associated with the CDFG CPFV onboard observer survey (1987-1998).

	Cresent City		Eureka		Fort Bragg		Bodega Bay		SanFran		Monterey		Morro Bay		TOTALS	
	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths
1987											42	908			42	908
1988					3	80	7	226	39	1,064	47	1,336	35	583	131	3,289
1989			1	36	3	31	10	362	49	1,213	39	823	52	937	154	3,402
1990					1	4			21	479	6	76	23	273	51	832
1991					10	160	1	17	10	228	10	187	28	932	59	1,524
1992					22	568	9	337	29	986	36	763	67	1,800	163	4,454
1993	1	6	5	45	12	299	10	239	29	845	46	1,863	65	1,472	168	4,769
1994			1	10	8	275	8	256	36	713	53	1,675	74	1,409	180	4,338
1995					7	158	6	209	59	2,160	53	1,728	65	1,891	190	6,146
1996					5	97	14	686	43	1,532	47	1,865	57	1,541	166	5,721
1997							45	2,349	44	2,037	43	2,687	73	3,612	205	10,685
1998							24	1,332	35	1,639	39	2,063	41	2,196	139	7,230
TOTAL	1	6	7	91	71	1,672	134	6,013	394	12,896	461	15,974	580	16,646	1,648	53,298

Table 20. Sample sizes (trips) and actual lengths taken for the commercial hook and line and setnet fisheries used in this assessment. Commercial setnet samples were used only to determine selectivity for the fishery. Seen here, females are selected more often (79%) than males (21%).

	Commercial hook and line								Commercial Setnet							
	MALES		FEMALES		UNKNOWN		COMBINED		MALES		FEMALES		UNKNOWN		COMBINED	
	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips	lengths	trips
1978									6	4	79	4			85	4
1979					33	4	33	4					10	1	10	1
1980			2	1			2	1								
1981					7	1	7	1								
1982	5	2	11	3			16	3								
1983	1	1	7	2	1	1	9	3			1	1			1	1
1984	1	1	2	1			3	1								
1985	1	1	3	1			4	1			32	3			32	3
1986			4	1			4	1								
1987																
1988																
1989											16	1			16	1
1990			3	1	9	2	12	3								
1991			34	5	54	1	88	5			1	1			1	1
1992	38	5	65	7	1205	94	1308	102								
1993	19	2	36	2	3640	210	3695	212								
1994					1825	154	1825	154								
1995					604	92	604	92								
1996					1079	105	1079	105								
1997	11	2	60	4	836	63	907	67								
1998			32	3	447	27	479	30								
1999					1040	96	1040	96								
2000					111	25	111	25					14	1	14	1
2001					131	28	131	28								
2002					253	15	253	15								
2003					41	5	41	5								
2004					108	12	108	12								
2005	1	1	31	1	141	16	173	17								
2006					140	12	140	12								
totals	77	15	290	32	11705	963	12072	995	6	4	129	10	24	2	159	12

Table 21. Estimated parameter values from the base model.

param	value	std	param	value	std
R0	3219.90	139.02	1979 rec	-1.43	0.31
Rec inflect	27.11	0.35	1980 rec	-1.09	0.35
Rec width	7.38	0.28	1981 rec	-0.37	0.44
Hook inflect	32.70	0.41	1982 rec	0.65	0.26
Hook width	6.87	0.23	1983 rec	-0.37	0.44
Net inflect	37.91	1.68	1984 rec	-0.40	0.43
Net width	3.47	1.73	1985 rec	0.53	0.49
Obs. inflect	24.47	0.19	1986 rec	0.84	0.45
Obs. width	4.98	0.17	1987 rec	-0.08	0.50
1960 rec	0.40	0.64	1988 rec	0.03	0.50
1961 rec	0.57	0.78	1989 rec	0.58	0.67
1962 rec	0.55	0.82	1990 rec	0.89	0.76
1963 rec	0.58	0.90	1991 rec	0.82	0.84
1964 rec	0.73	0.87	1992 rec	0.80	0.69
1965 rec	0.48	0.72	1993 rec	1.71	0.26
1966 rec	0.24	0.53	1994 rec	0.24	0.57
1967 rec	-0.02	0.46	1995 rec	0.26	0.51
1968 rec	-0.16	0.42	1996 rec	0.29	0.51
1969 rec	-0.12	0.38	1997 rec	0.15	0.56
1970 rec	-0.24	0.34	1998 rec	1.76	0.25
1971 rec	-0.63	0.34	1999 rec	0.37	0.62
1972 rec	-0.62	0.30	2000 rec	-0.34	0.44
1973 rec	-0.59	0.29	2001 rec	-0.52	0.29
1974 rec	-0.32	0.23	2002 rec	0.20	0.27
1975 rec	-0.62	0.24	2003 rec	-0.19	0.29
1976 rec	-1.14	0.26	2004 rec	-0.03	0.30
1977 rec	-1.21	0.25	2005 rec	-0.59	0.31
1978 rec	-1.56	0.29	2006 rec	-1.00	0.31

Table 22. Biomass, spawning biomass, recruitment, catch, exploitation and depletion for the base model result (1916-1960).

year	Summary Biomass	Spawning Biomass	Recruitment	Catch	Exploitation	Depletion
Equil.	13223	2077	3220	0.0	0.000	100.0%
1916	13223	2077	3220	0.4	0.000	100.0%
1917	13223	2077	3220	2.9	0.000	100.0%
1918	13220	2076	3220	5.3	0.000	100.0%
1919	13216	2075	3219	6.6	0.000	99.9%
1920	13210	2074	3219	8.8	0.001	99.9%
1921	13203	2073	3219	10.4	0.001	99.8%
1922	13195	2071	3218	12.1	0.001	99.7%
1923	13185	2069	3218	14.6	0.001	99.6%
1924	13174	2066	3217	16.3	0.001	99.5%
1925	13162	2064	3216	18.9	0.001	99.4%
1926	13148	2060	3215	22.0	0.002	99.2%
1927	13132	2057	3214	23.4	0.002	99.0%
1928	13116	2053	3213	26.7	0.002	98.9%
1929	13098	2049	3212	27.9	0.002	98.7%
1930	13080	2045	3211	32.7	0.003	98.5%
1931	13058	2040	3209	34.0	0.003	98.2%
1932	13037	2035	3208	34.5	0.003	98.0%
1933	13016	2030	3207	35.6	0.003	97.8%
1934	12995	2026	3205	37.6	0.003	97.5%
1935	12974	2021	3204	42.0	0.003	97.3%
1936	12950	2015	3202	46.3	0.004	97.0%
1937	12923	2009	3200	50.6	0.004	96.7%
1938	12894	2003	3198	48.6	0.004	96.4%
1939	12868	1997	3197	42.3	0.003	96.1%
1940	12850	1992	3195	59.2	0.005	95.9%
1941	12817	1985	3193	11.6	0.001	95.6%
1942	12831	1987	3194	5.1	0.000	95.7%
1943	12849	1991	3195	6.6	0.001	95.9%
1944	12866	1994	3196	15.6	0.001	96.0%
1945	12874	1996	3196	49.1	0.004	96.1%
1946	12851	1990	3195	39.9	0.003	95.8%
1947	12838	1987	3194	67.8	0.005	95.7%
1948	12800	1978	3191	82.9	0.006	95.2%
1949	12749	1967	3188	97.5	0.008	94.7%
1950	12686	1954	3184	122.2	0.010	94.1%
1951	12604	1937	3178	137.4	0.011	93.3%
1952	12512	1917	3172	116.5	0.009	92.3%
1953	12444	1903	3167	101.2	0.008	91.6%
1954	12394	1892	3164	112.2	0.009	91.1%
1955	12337	1879	3160	132.2	0.011	90.5%
1956	12263	1864	3155	149.6	0.012	89.7%
1957	12178	1845	3148	148.4	0.012	88.9%
1958	12098	1828	3142	246.4	0.020	88.0%
1959	11931	1793	3130	205.1	0.017	86.3%
1960	11811	1767	4120	154.2	0.013	85.1%

Table 22 (continued). Biomass, spawning biomass, recruitment, catch, exploitation and depletion for the base model result (1961-2007).

year	Summary Biomass	Spawning Biomass	Recruitment	Catch	Exploitation	Depletion
1961	11797	1752	4867	123.1	0.010	84.4%
1962	11892	1744	4739	134.5	0.011	84.0%
1963	12026	1735	4908	135.7	0.011	83.5%
1964	12207	1728	5678	105.7	0.009	83.2%
1965	12498	1732	4428	162.0	0.013	83.4%
1966	12732	1733	3484	175.1	0.014	83.5%
1967	12904	1741	2694	171.7	0.013	83.8%
1968	13006	1757	2336	303.9	0.023	84.6%
1969	12910	1758	2439	291.3	0.023	84.7%
1970	12775	1765	2158	391.0	0.031	85.0%
1971	12487	1752	1466	347.6	0.028	84.4%
1972	12160	1740	1474	475.6	0.039	83.8%
1973	11652	1698	1509	726.6	0.062	81.7%
1974	10878	1600	1958	838.9	0.077	77.0%
1975	10012	1473	1420	830.8	0.083	70.9%
1976	9148	1342	826	698.7	0.076	64.6%
1977	8370	1231	752	640.3	0.077	59.3%
1978	7634	1127	519	545.1	0.071	54.3%
1979	6966	1038	575	706.2	0.101	50.0%
1980	6144	918	775	538.9	0.088	44.2%
1981	5502	826	1538	865.6	0.157	39.8%
1982	4610	673	3946	768.8	0.167	32.4%
1983	4002	539	1297	717.2	0.179	25.9%
1984	3456	416	1107	481.8	0.139	20.0%
1985	3136	341	2520	432.7	0.138	16.4%
1986	2979	277	3035	140.3	0.047	13.3%
1987	3170	277	1205	267.1	0.084	13.3%
1988	3199	268	1310	314.9	0.098	12.9%
1989	3162	257	2224	276.3	0.087	12.4%
1990	3204	256	3032	252.7	0.079	12.3%
1991	3331	263	2876	223.7	0.067	12.7%
1992	3518	275	2883	675.0	0.192	13.3%
1993	3316	228	6385	509.0	0.153	11.0%
1994	3477	205	1364	374.6	0.108	9.9%
1995	3655	205	1390	244.8	0.067	9.9%
1996	3867	228	1540	208.1	0.054	11.0%
1997	4082	263	1465	359.8	0.088	12.7%
1998	4114	289	7792	297.1	0.072	13.9%
1999	4488	323	2074	234.4	0.052	15.5%
2000	4825	359	1080	166.3	0.034	17.3%
2001	5084	401	960	135.3	0.027	19.3%
2002	5298	447	2094	167.3	0.032	21.5%
2003	5474	495	1484	229.1	0.042	23.8%
2004	5541	537	1806	164.7	0.030	25.9%
2005	5636	583	1071	184.6	0.033	28.1%
2006	5649	618	735	341.5	0.060	29.7%
2007	5447	622	2261	263.1	0.048	29.9%

Table 23. Offset of natural mortality (M) suggested by the Mop-Up STAR panel for bracketing uncertainty in this assessment. The initial recommendation (M = +-0.02 from BASE) did not give enough contrast in likelihood or depletion, so M = +-0.03 (from BASE) was recommended and used for final decision tables.

catch stream	Natural Mortality (M)		Likelihood	Depletion	MSY
Low	High (+0.02 from base)		1338	43.0%	274
1/2 BASE	Females	0.12			
	Males	0.14			
Medium	Medium (BASE)		1338	29.9%	275
BASE	Females	0.10			
	Males	0.12			
High	Low (-0.02 from base)		1347	19.0%	300
double BASE	Females	0.08			
	Males	0.10			
Low	High (+0.03 from base)		1340	48.8%	299
1/2 BASE	Females	0.13			
	Males	0.15			
Medium	Medium (BASE)		1338	29.9%	275
BASE	Females	0.10			
	Males	0.12			
High	Low (-0.03 from base)		1361	14.6%	267
double BASE	Females	0.07			
	Males	0.09			

Table 24. Likelihoods associated with model runs changing only natural mortality (not catch streams) for all scenarios. The likelihoods presented here are accepted as being more comparable, which supports the argument of the BASE and high M bracketing of the decision table to be most likely. The low M scenarios produce much larger likelihood values for each catch stream.

	Natural Mortality (M)		
Catch Stream	LOW M (M = 0.07 f, 0.09 m)	Base case (M = 0.1 f, 0.12 m)	HIGH M (M = 0.13 f, 0.15 m)
HIGH	1361	1338	2.18E+35
Medium BASE	1376	**1338**	1342
LOW	1393	1345	1340

Table 25. Comparing likelihood values of the BASE model with a high and low bracket of uncertainty. The low bracket consists of a low natural mortality (M) and double catches and the high bracket consists of high M and low catches.

	LOW M	**BASE**	HIGH M
female M	0.07	**0.10**	0.13
male M	0.09	**0.12**	0.15
catch stream	double	**BASE**	half
LIKELIHOOD	1360.8	**1338.8**	1339.5
Indices	67.6	**61.2**	58.7
Length_comps	614.5	**625.3**	638.5
Age_comps	615.5	**603.1**	597.6
Recruitment	63.2	**49.3**	44.7
Indices			
RecFIN Index (1980-1999)	29.8	**27.7**	26.9
CDFG index	17.5	**14.2**	12.3
Juvenile survey	1.1	**1.3**	1.5
RecFIN Index (2000-2006)	19.2	**18.0**	18.0
Length comps			
Recreational Fishery	277.2	**290.4**	305.2
Hook and Line	239.0	**238.7**	238.3
Setnet	2.5	**2.5**	2.4
CDFG survey	95.8	**93.8**	92.6
Age comps			
Conditional age-at-length	615.5	**603.1**	597.6
Laidig 90s ages	*150.1*	***144.4***	*141.7*
Laidig conditional age-at-length	*115.0*	***110.3***	*107.9*
marginal ages (traditional/ghost!)	*58.8*	***52.3***	*48.0*

Table 26. Decision table (**40:10** adjustment applied) of 10-year projections for alternate states of nature (columns) and management options (rows). Spawning output is in millions of larvae. 2007 and 2008 catches were based on the sum of the average catch for each fishery from 2005-2006. Base model results are **bolded**.

			State of nature					
			LOWER bracket (M = 0.07 f, 0.09 m)		Base case (M = 0.1 f, 0.12 m)		HIGHER bracket (M = 0.13 f, 0.15 m)	
			high catch stream		BASE catch stream		low catch stream	
Management decision	Year	Catch (mt)	Depletion	Spawning output	Depletion	Spawning output	Depletion	Spawning output
Low	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	42	14.0%	407	30.3%	628	50.0%	827
	2010	49	14.7%	429	31.6%	656	51.6%	855
	2011	54	15.4%	447	32.7%	679	52.8%	875
	2012	59	15.9%	464	33.7%	700	53.8%	891
	2013	64	16.5%	480	34.6%	720	54.7%	906
	2014	69	17.1%	497	35.6%	740	55.6%	921
	2015	75	17.7%	515	36.7%	762	56.6%	938
	2016	80	18.3%	533	37.8%	785	57.7%	955
Medium	2007	263	14.4%	418	**29.9%**	**622**	49.3%	817
	2008	263	14.3%	415	**30.3%**	**628**	49.9%	826
	2009	199	14.0%	407	**30.3%**	**628**	50.0%	827
	2010	198	13.9%	404	**30.4%**	**632**	50.2%	831
	2011	196	13.7%	398	**30.4%**	**631**	50.0%	828
	2012	193	13.4%	390	**30.2%**	**628**	49.7%	823
	2013	192	13.2%	384	**30.2%**	**627**	49.4%	818
	2014	192	13.0%	379	**30.2%**	**628**	49.3%	816
	2015	193	12.9%	376	**30.4%**	**631**	49.4%	817
	2016	195	12.9%	375	**30.7%**	**637**	49.6%	820
High	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	376	14.0%	407	30.3%	628	50.0%	827
	2010	363	12.9%	376	29.1%	604	48.6%	804
	2011	348	11.8%	343	27.8%	577	46.9%	776
	2012	335	10.7%	311	26.5%	550	45.2%	748
	2013	325	9.7%	282	25.4%	527	43.7%	724
	2014	317	8.8%	257	24.5%	509	42.6%	705
	2015	311	8.1%	235	23.8%	495	41.8%	691
	2016	308	7.4%	217	23.4%	485	41.2%	682

Table 27. Decision table (**60:20** adjustment applied) of 10-year projections for alternate states of nature (columns) and management options (rows). Spawning output is in millions of larvae. 2007 and 2008 catches were based on the sum of the average catch for each fishery from 2005-2006. Base model results are **bolded**.

			State of nature					
			LOWER bracket (M = 0.07 f, 0.09 m)		Base case (M = 0.1 f, 0.12 m)		HIGHER bracket (M = 0.13 f, 0.15 m)	
			high catch stream		BASE catch stream		low catch stream	
Management decision	Year	Catch (mt)	Depletion	Spawning output	Depletion	Spawning output	Depletion	Spawning output
	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	0	14.0%	407	30.3%	628	50.0%	827
	2010	0	15.0%	435	31.9%	663	52.0%	861
Low	2011	0	15.9%	461	33.4%	694	53.7%	889
	2012	0	16.8%	487	34.8%	723	55.2%	913
	2013	0	17.7%	514	36.2%	753	56.6%	937
	2014	0	18.6%	542	37.7%	784	58.1%	962
	2015	0	19.7%	572	39.3%	816	59.7%	988
	2016	8	20.7%	604	41.0%	851	61.3%	1015
	2007	263	14.4%	418	**29.9%**	**622**	49.3%	817
	2008	263	14.3%	415	**30.3%**	**628**	49.9%	826
	2009	113	14.0%	407	**30.3%**	**628**	50.0%	827
	2010	121	14.3%	417	**31.1%**	**645**	51.0%	844
Medium	2011	125	14.6%	424	**31.6%**	**657**	51.5%	853
	2012	128	14.7%	428	**32.0%**	**665**	51.8%	858
	2013	132	14.9%	433	**32.5%**	**674**	52.1%	863
	2014	136	15.1%	438	**32.9%**	**684**	52.5%	869
	2015	142	15.3%	445	**33.5%**	**696**	53.0%	877
	2016	148	15.5%	452	**34.1%**	**708**	53.5%	885
	2007	263	14.4%	418	29.9%	622	49.3%	817
	2008	263	14.3%	415	30.3%	628	49.9%	826
	2009	339	14.0%	407	30.3%	628	50.0%	827
	2010	323	13.1%	382	29.4%	610	48.9%	810
High	2011	307	12.2%	355	28.4%	589	47.6%	788
	2012	291	11.3%	330	27.4%	569	46.3%	766
	2013	279	10.6%	308	26.6%	552	45.2%	748
	2014	270	9.9%	289	26.0%	541	44.4%	735
	2015	266	9.4%	274	25.7%	533	43.9%	727
	2016	263	9.0%	262	25.5%	530	43.7%	723

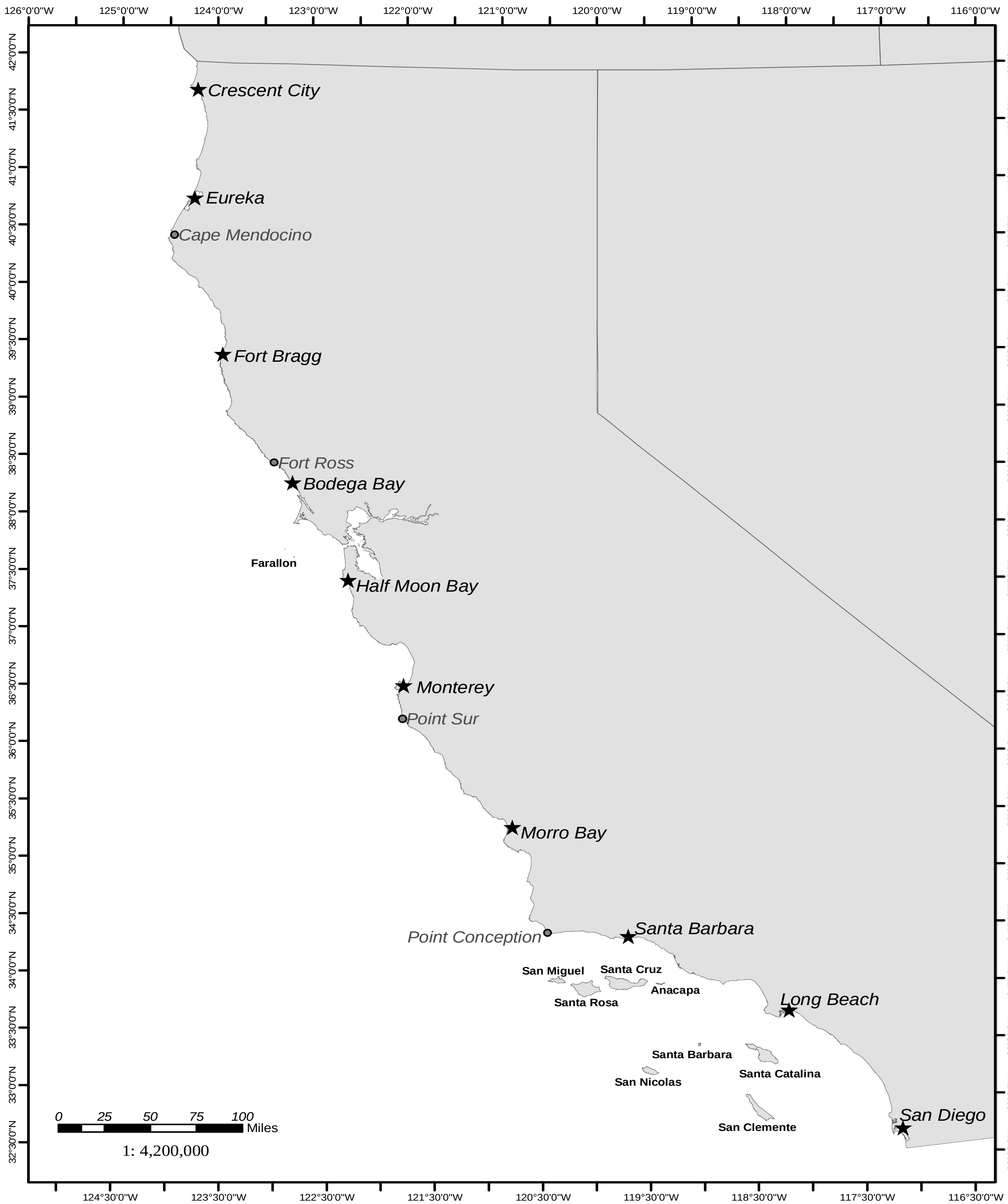


Figure 1. Map of coastal California. This assessment focuses on the area from the Oregon border to Point Conception, where blue rockfish are most commonly found (Love et al. 2002).

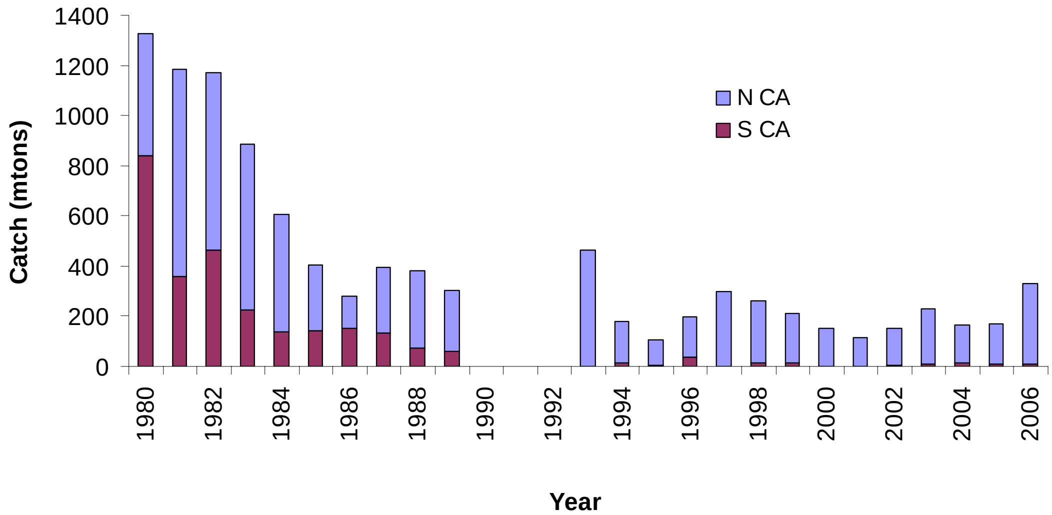


Figure 2. California blue rockfish recreational catch north and south of Point Conception from 1980-2006, sum of A (sampler examined dead) and B1 (sampler unexamined reported dead) catch. Data from Recreational Fisheries Information Network (RecFIN); no sampling from 1990-1992.

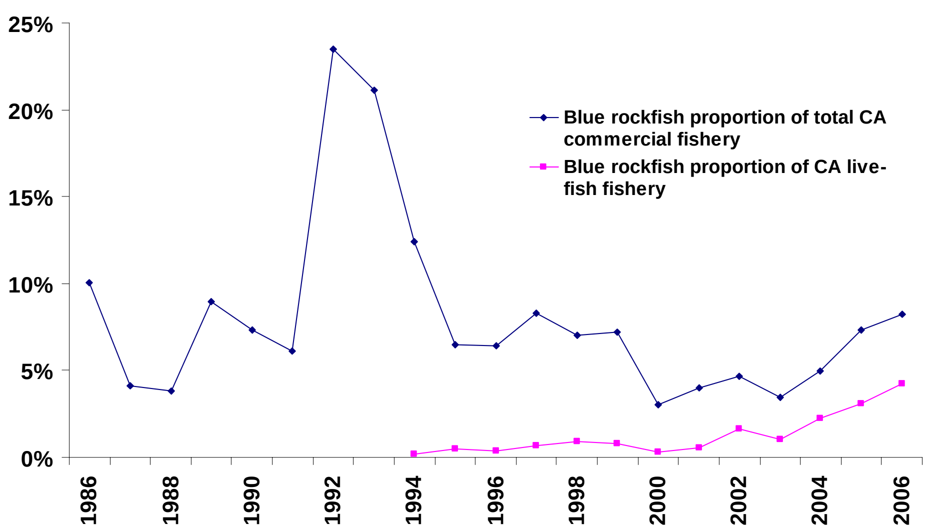


Figure 3. California blue rockfish proportions of estimated commercial and live-fish (nearshore rockfishes, cabezon, greenlings, sheephead) landings from 1986-2006. Data from California Cooperative Survey (CALCOM).

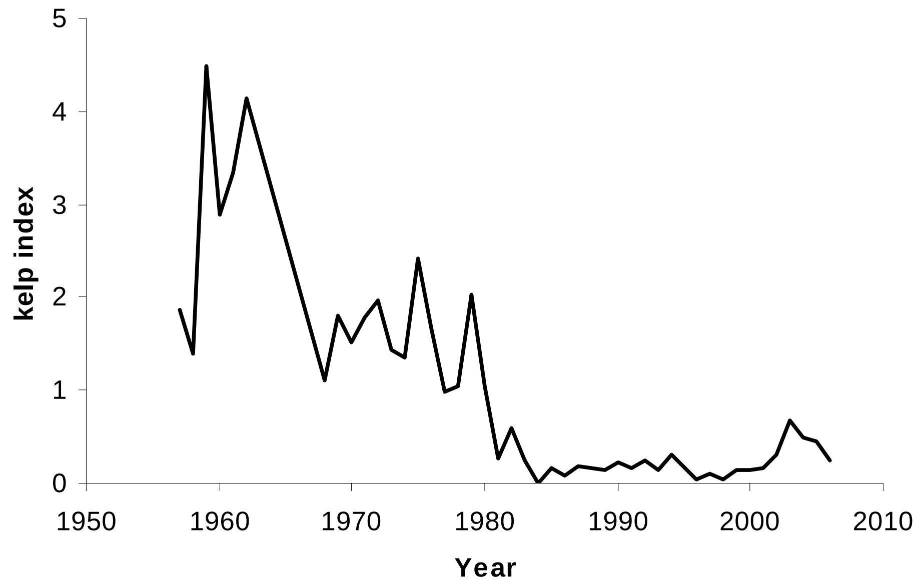


Figure 4. Kelp index for the Santa Barbara area in southern California. The area of each kelp bed is expressed as a fraction of its long-term mean, and the index is the annual average of the standardized values. Data from SBCLTER.

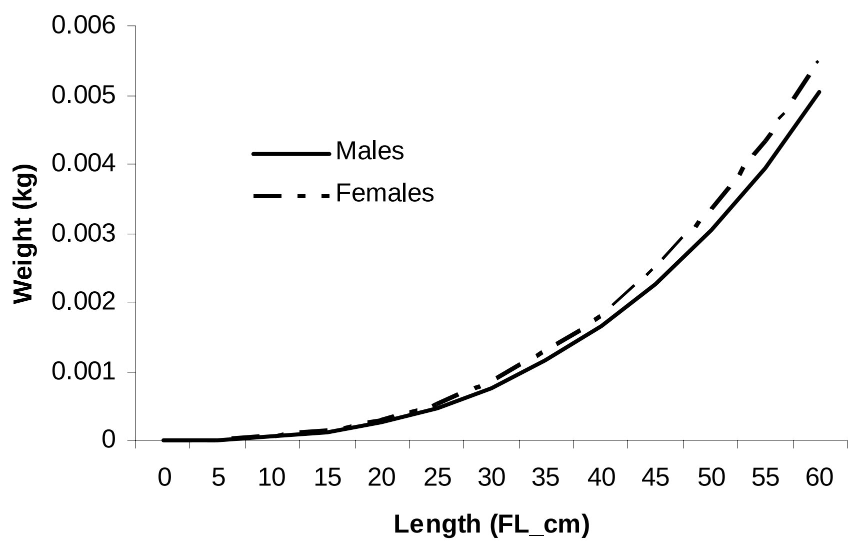


Figure 5. Male (solid line) and female (dashed line) length to weight relationships of blue rockfish in California.

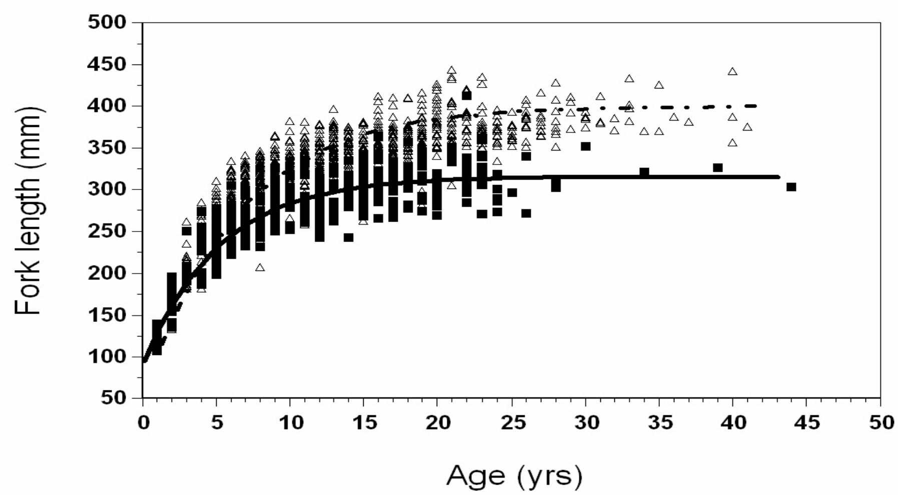


Figure 6. Length at age between male (solid line) and female (dashed line) blue rockfish (Laidig et al. 2003). Female blue rockfish grow slower but attain larger sizes.

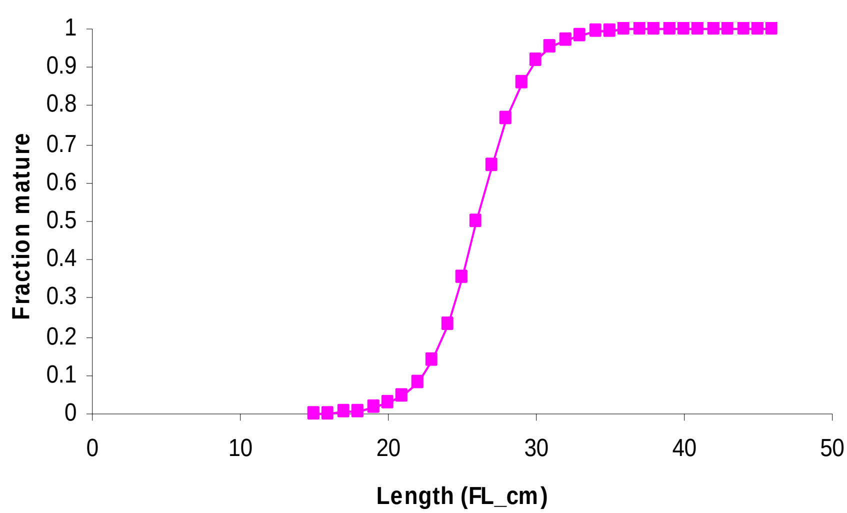


Figure 7. Spawning ogive for female blue rockfish. 50% of females are mature at 26 cm (FL) and 100% at 32 cm (FL), Wyllie Echeverria (1987).

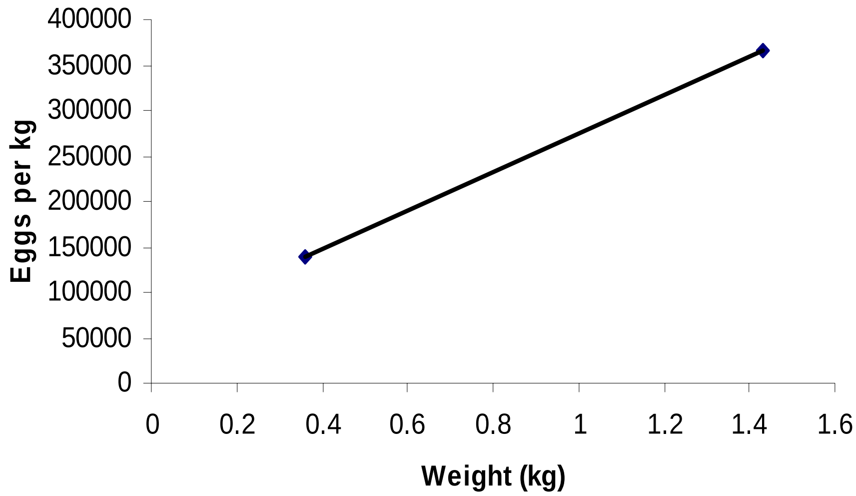


Figure 8. Spawning output for female blue rockfish (y = 211,841x + 62,585). This relationship is derived from two individual fish represented by the endpoints of the line.

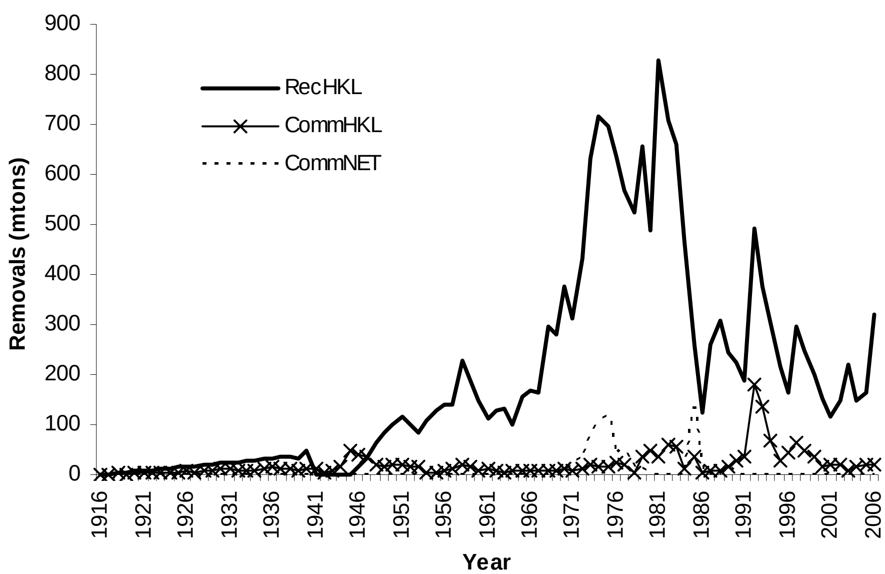


Figure 9. Reconstructed historical estimated catches by fishery for blue rockfish in California (north of Point Conception), 1916-2006.

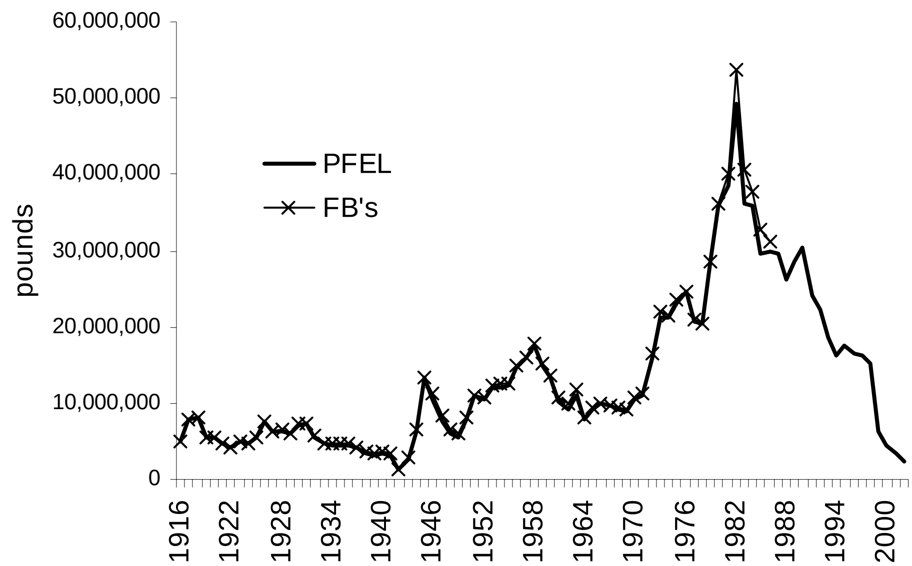


Figure 10. Comparison of reported total commercial rockfish landings between Heimann and Carlisle (1970) and PFEL. PFEL does not include rockfish brought into California, which we used for this assessment.

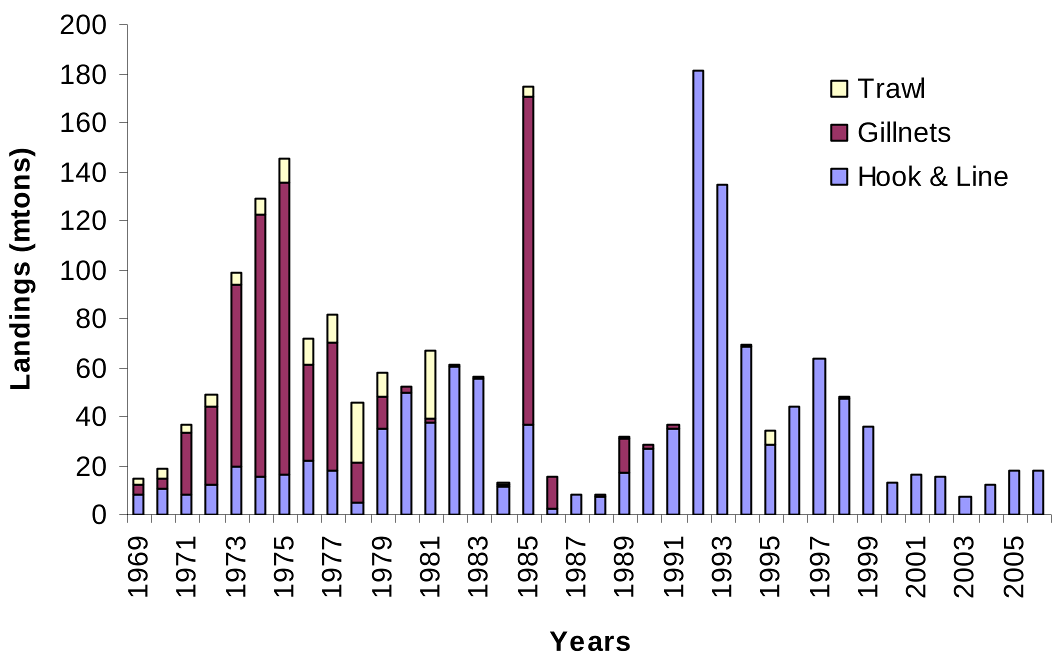


Figure 11. Estimated commercial landings by gear, 1969-2006 (CALCOM).

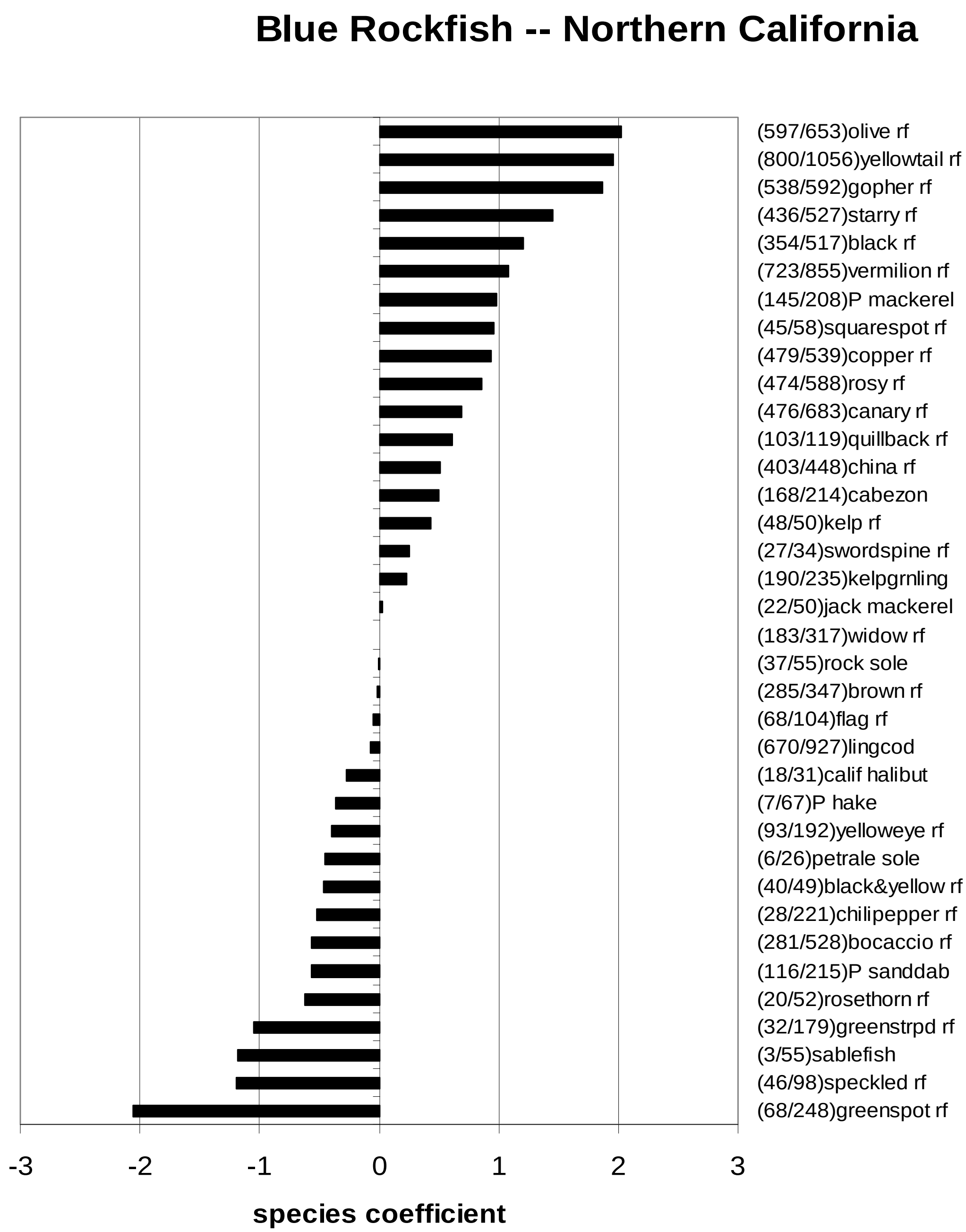


Figure 12. Coefficients from logistic regression of blue rockfish presence-absence on presence of other species in RecFIN CPFV trips. Numbers in parentheses are number of co-occurrences with blue rockfish and overall number of occurrences.

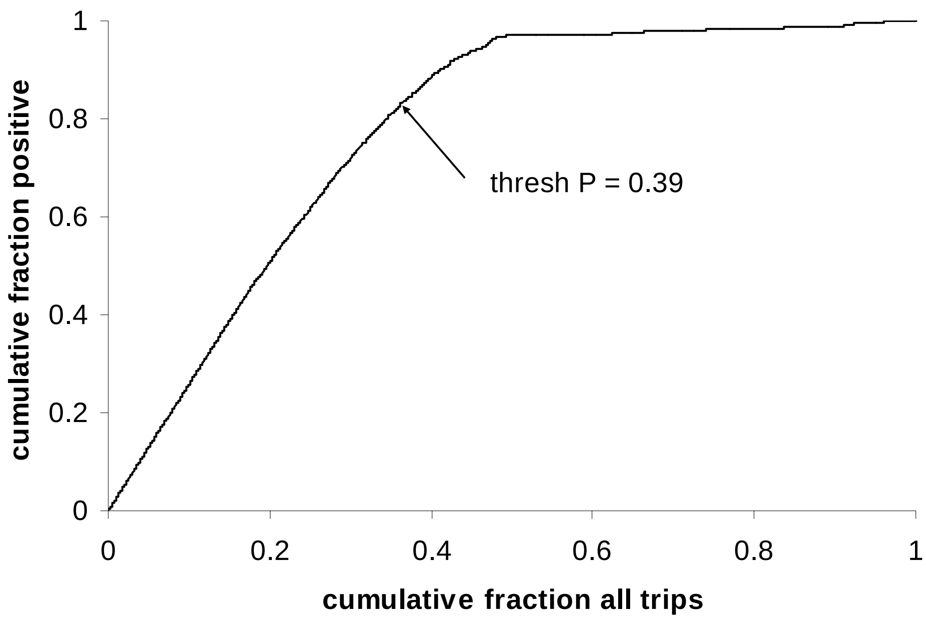


Figure 13. Cumulative-cumulative plot of RecFIN trips. A threshold of 0.39 is used as criterion for selecting trips.

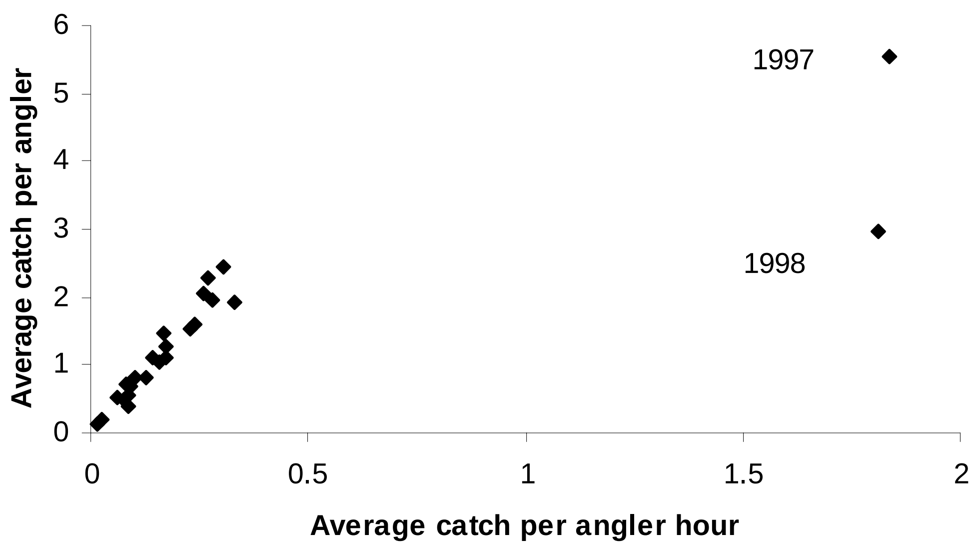


Figure 14. Relationship between annual average catch per angler and catch per angler hour. The outliers in 1997 and 1998 were not well understood and were removed from the RecFIN CPUE index.

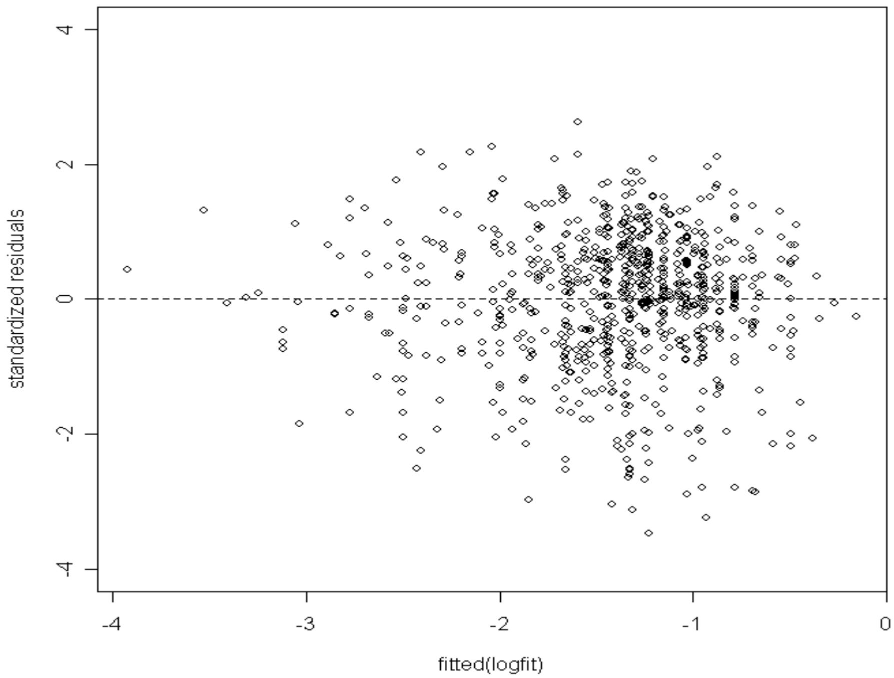


Figure 15. Standardized residual plot from the results of the delta-GLM given the RecFIN CPUE index.

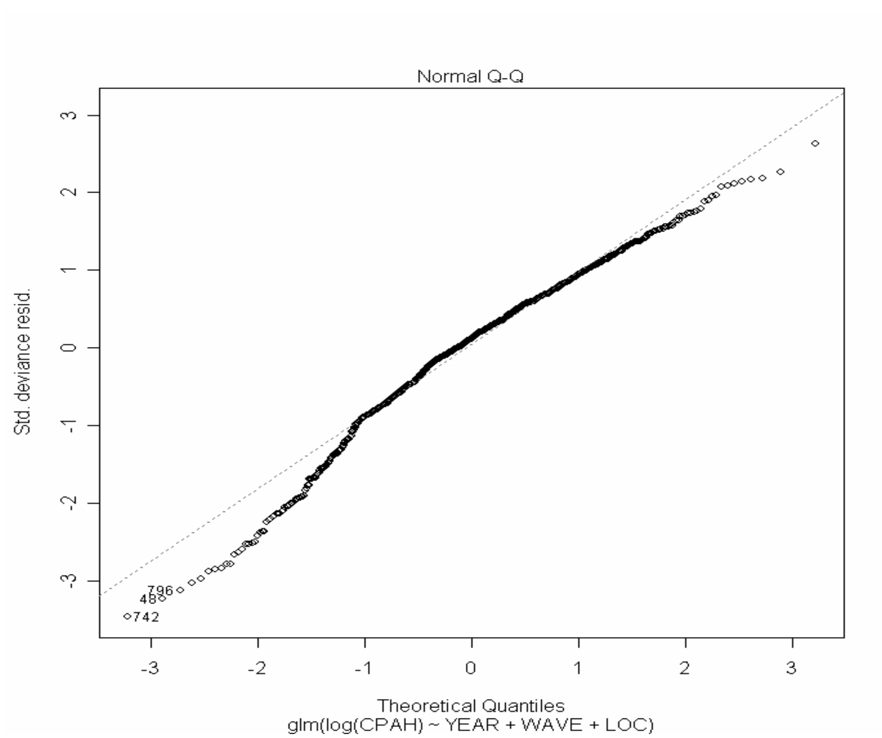
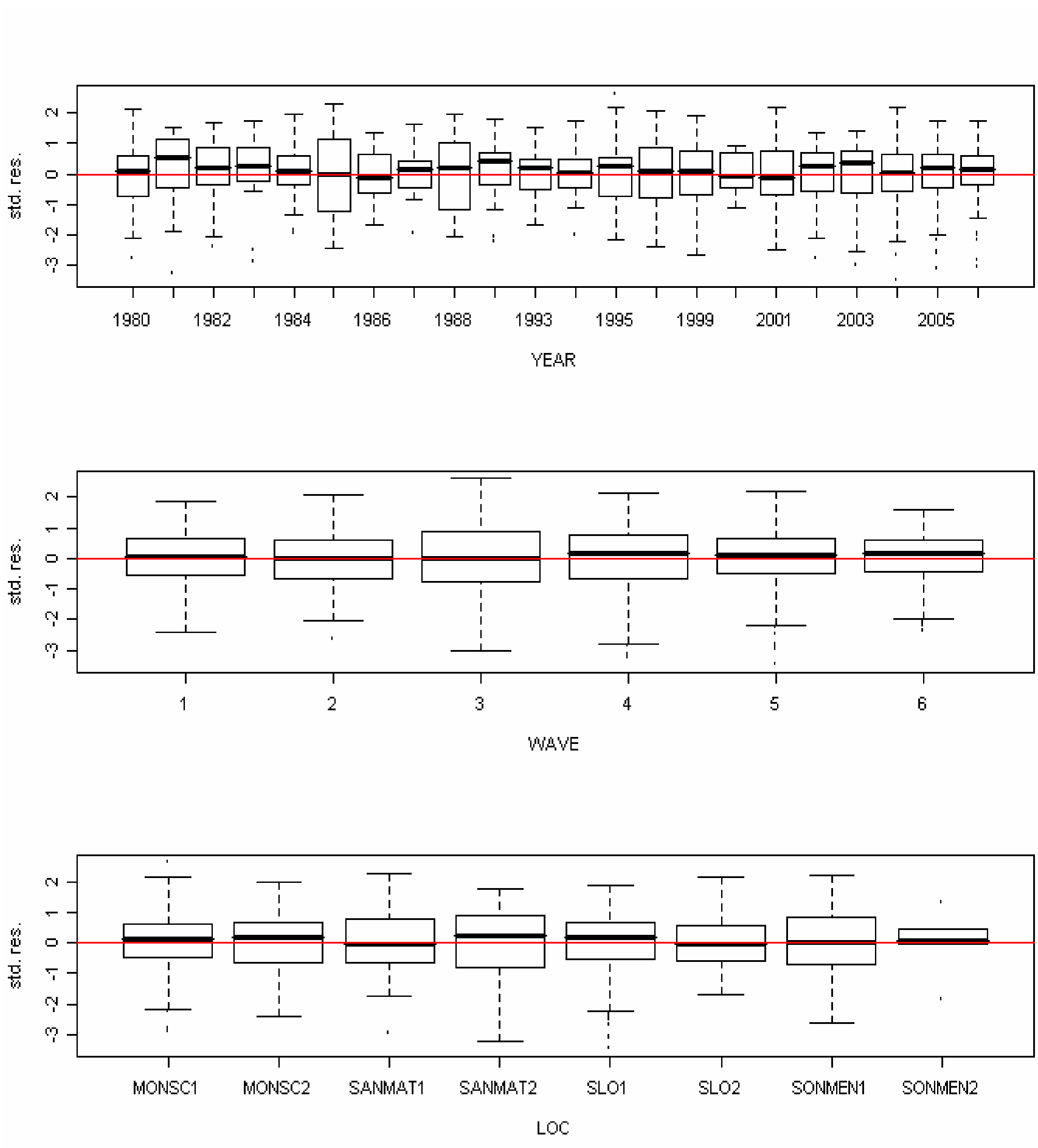


Figure 16. Q-Q plot from the results of the delta-GLM given the RecFIN CPUE index.



Figures 17 (a-c): Standardized residual plots for the main effects of the delta-GLM given the RecFIN CPUE index. (YEAR-top, WAVE-middle, LOC-bottom).

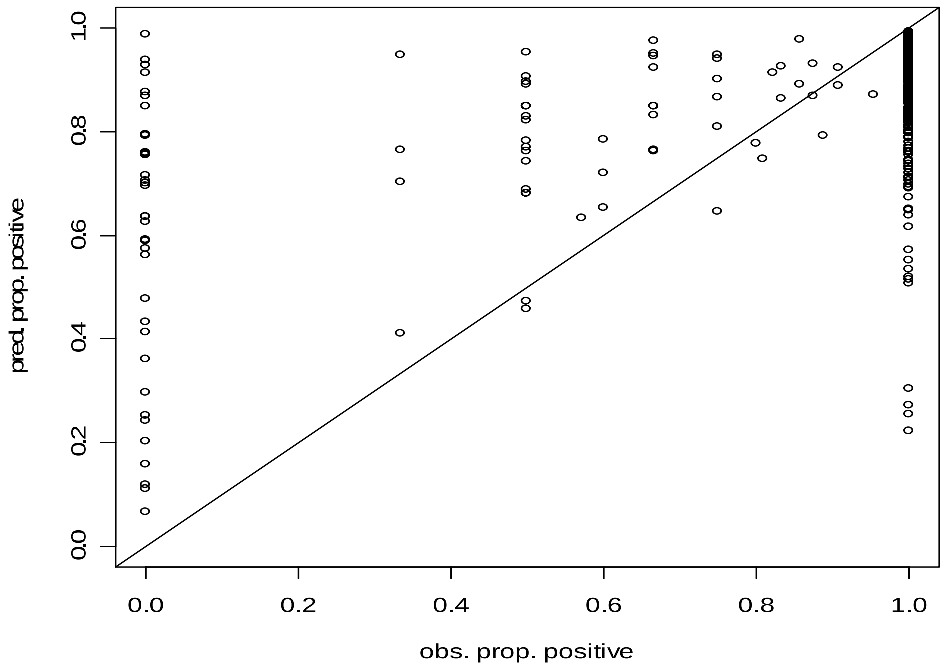


Figure 18. Observed versus predicted proportion positive as a result of the delta-GLM given the RecFIN CPUE index.

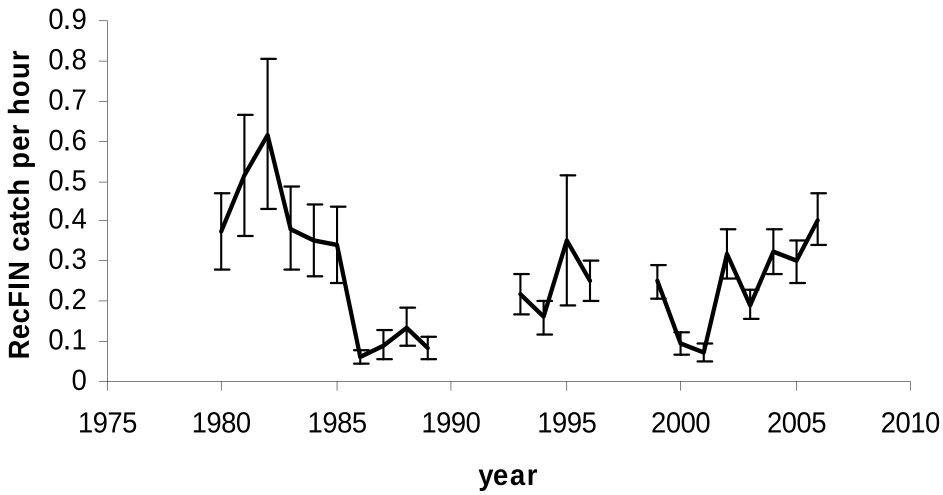


Figure 19. RecFIN CPUE index from delta-gamma GLM analysis of catches of blue rockfish on selected CPFV trips from 1980-2006.

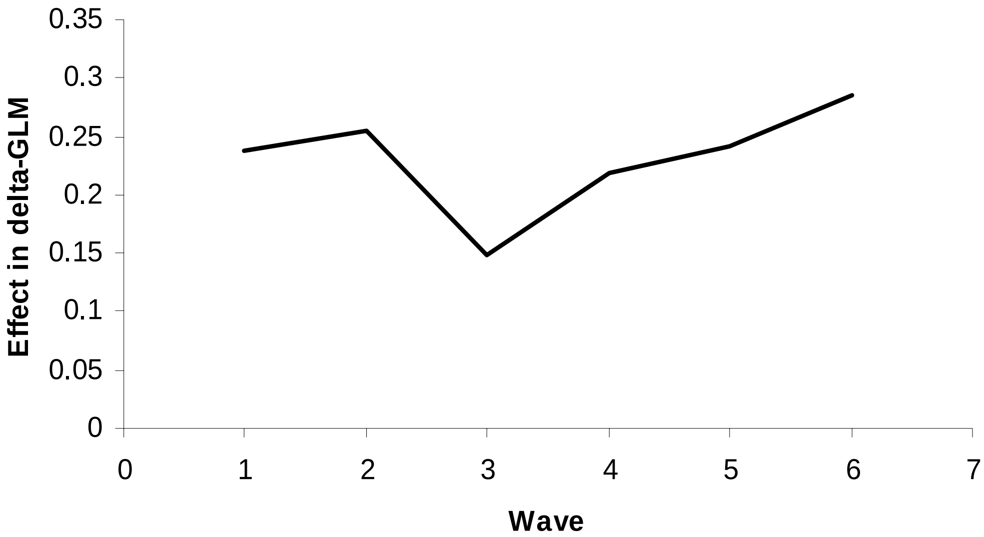


Figure 20. Wave effects from delta-gamma GLM analysis of catches of blue rockfish on selected CPFV trips from 1980-2006. Wave 3 (May-June) contributes the least to the overall CPUE estimate.

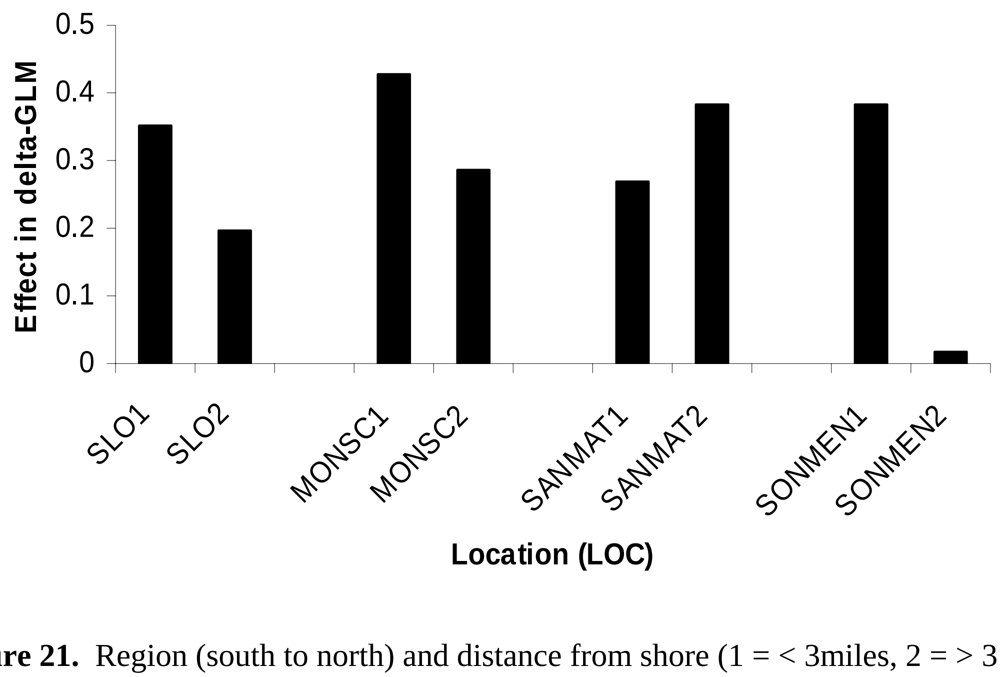


Figure 21. Region (south to north) and distance from shore (1 = < 3miles, 2 = > 3 miles) effects from delta-gamma GLM analysis of blue rockfish catches on selected CPFV trips.
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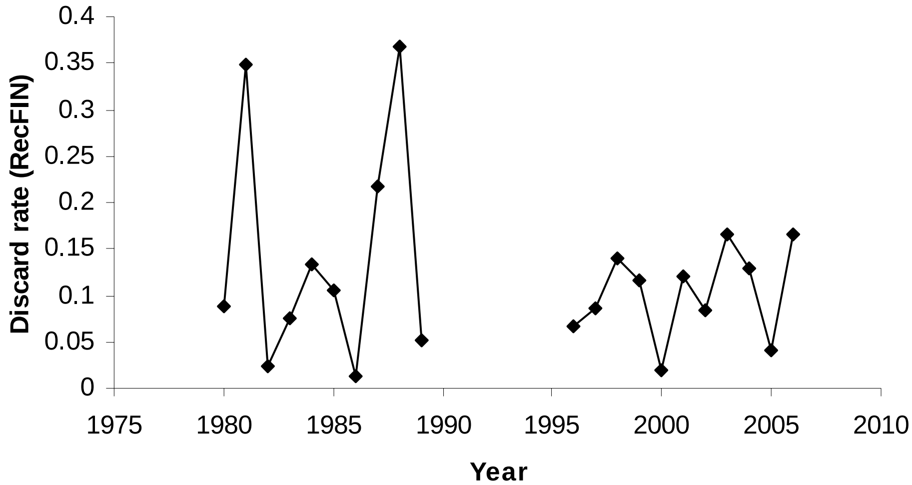


Figure 22. RecFIN estimates of discard rates (numbers) of blue rockfish, 1980-2006. Estimated discard rate is catch in numbers (B1+B2)/(A+B1+B2), where A is estimated retained catch, B1 is estimated discard "dead", and B2 is estimated discard "alive." Estimates of blue rockfish hooking mortality are not available.

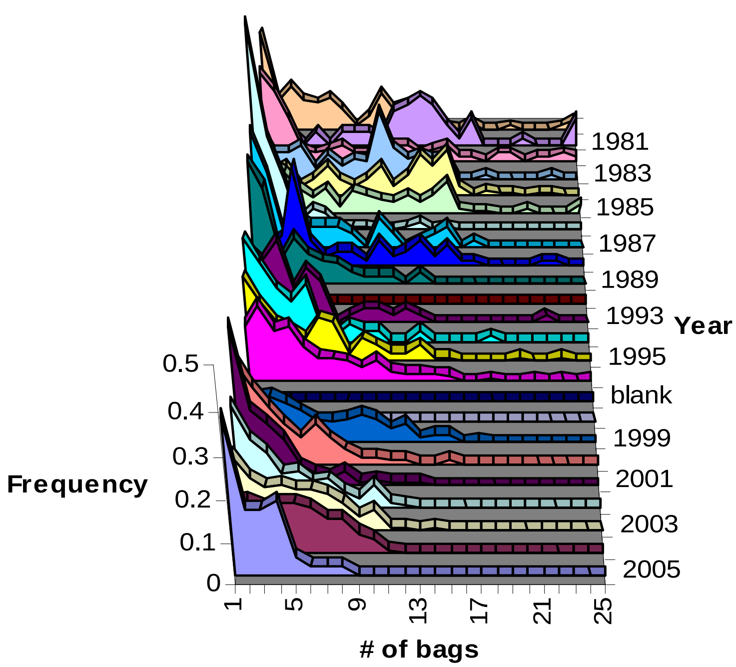


Figure 23. Recreational CPFV bag frequency before and after the bag limit reduction from 15 to 10 fish in 2000.

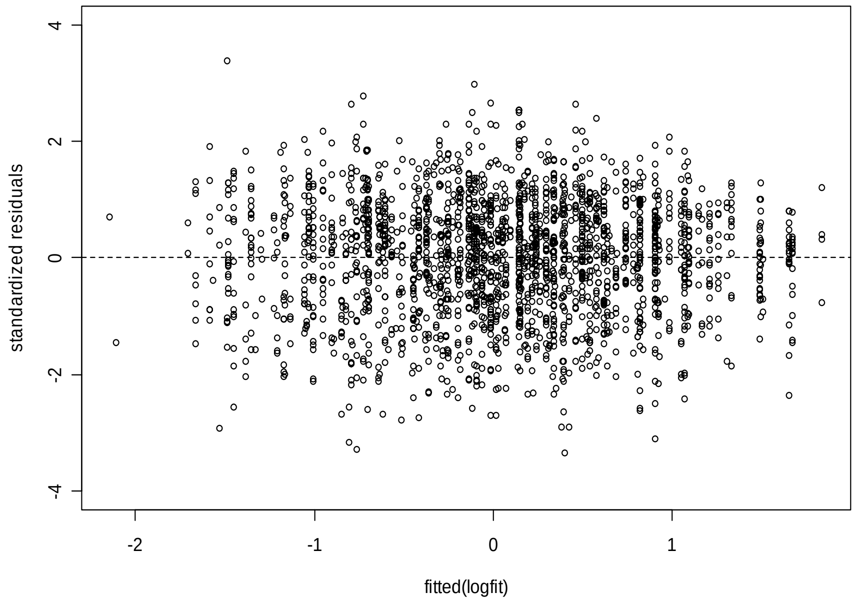


Figure 24. Standardized residual plot from the results of the delta-GLM given the CDFG CPFV onboard observer survey index.

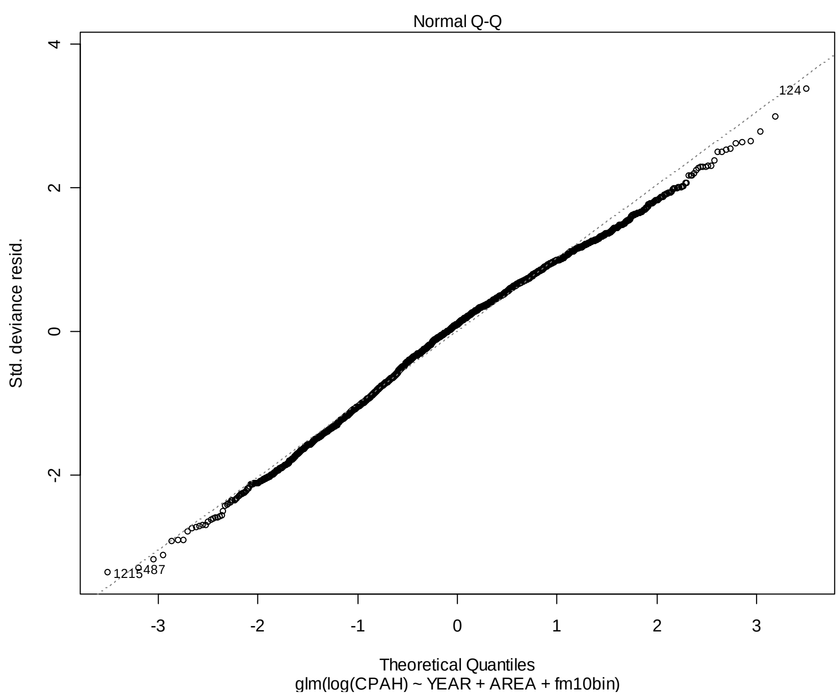
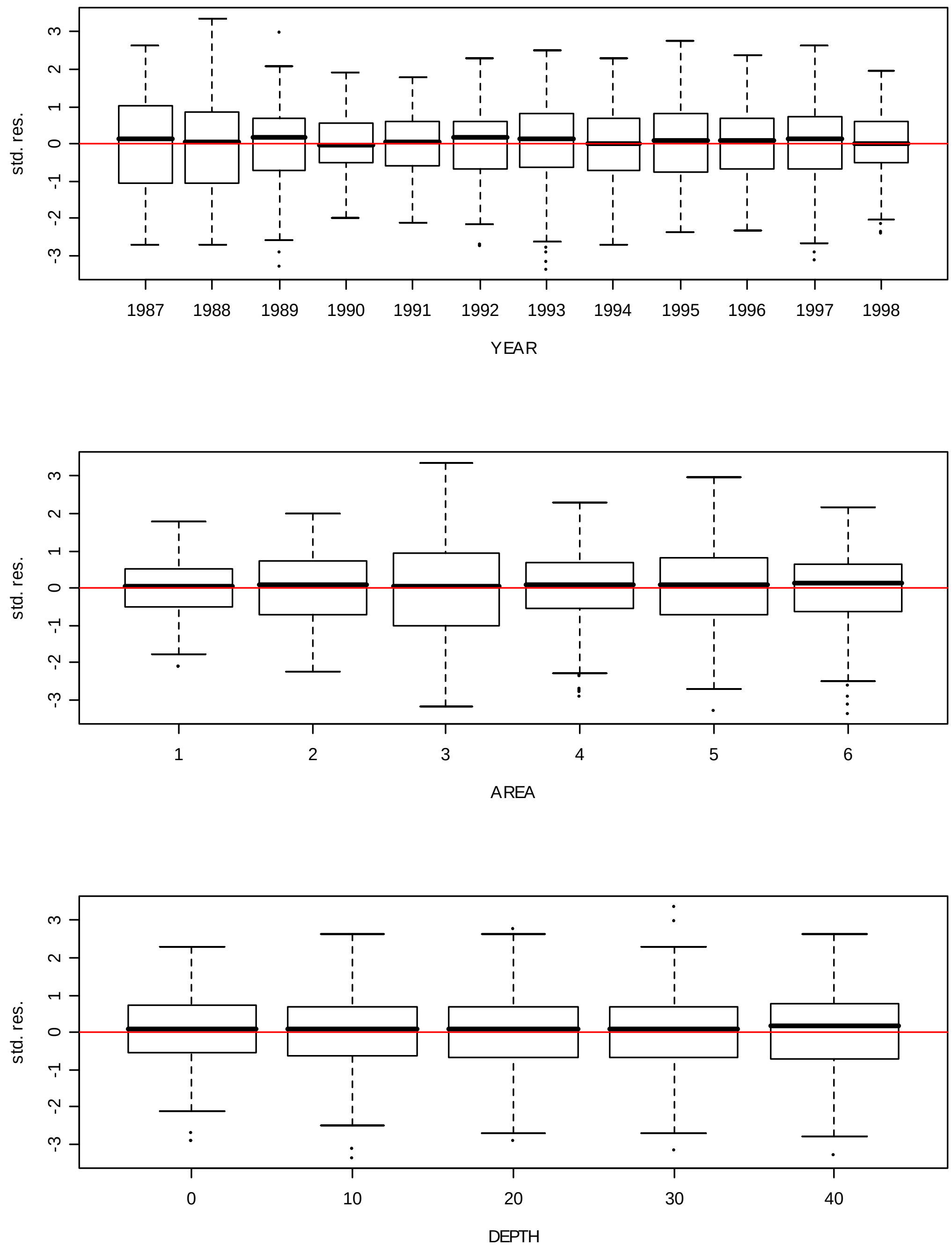


Figure 25. Q-Q plot from the results of the delta-GLM given the CDFG CPFV onboard observer survey index.



Figures 26 (a-c): Standardized residual plots for the main effects of the delta-GLM given the CPFG CPFV onboard observer survey index. (YEAR-top, AREA-middle, DEPTH-bottom).

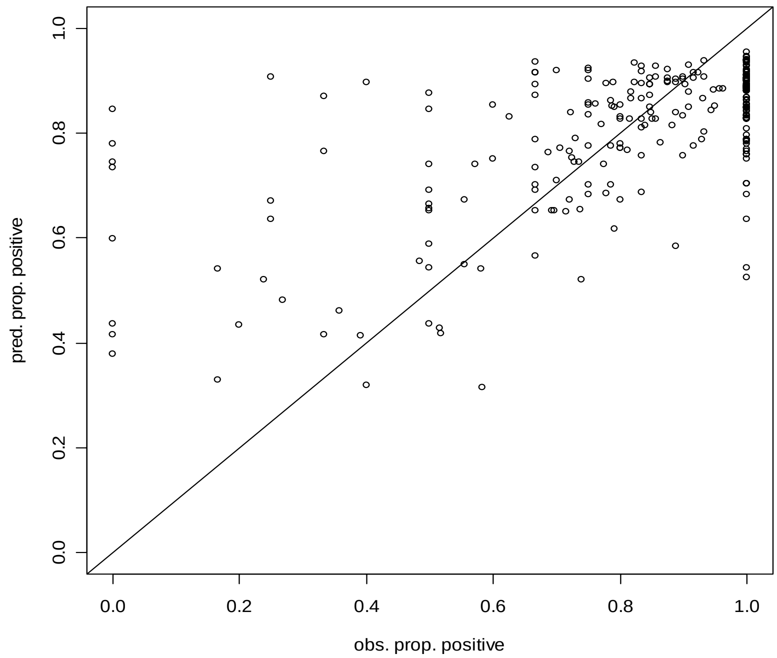


Figure 27. Observed versus predicted proportion positive as a result of the delta-GLM from the CDFG CPFV onboard observer survey index.

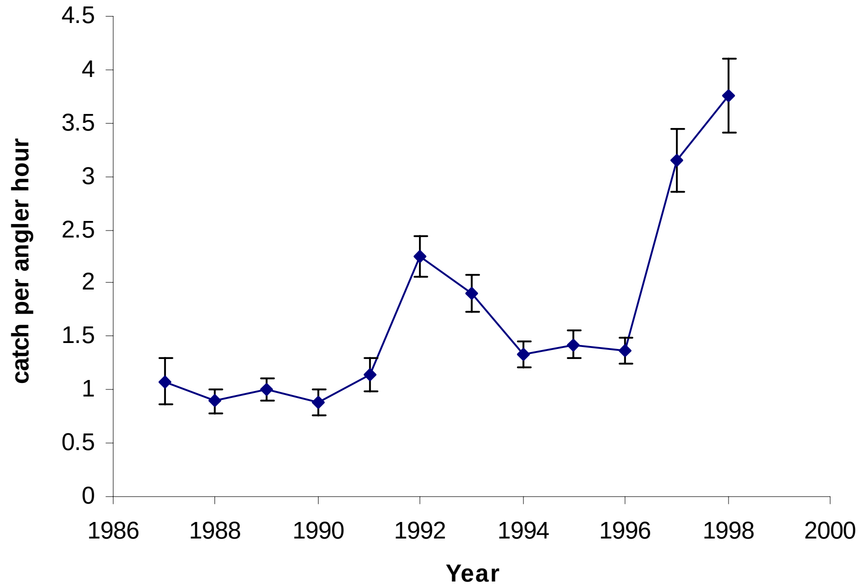


Figure 28. CDFG CPFV onboard observer survey index of abundance (±1SD), 1987-1998. 1997 and 1998 are also inflated, like RecFIN, but no valid reason to exclude.

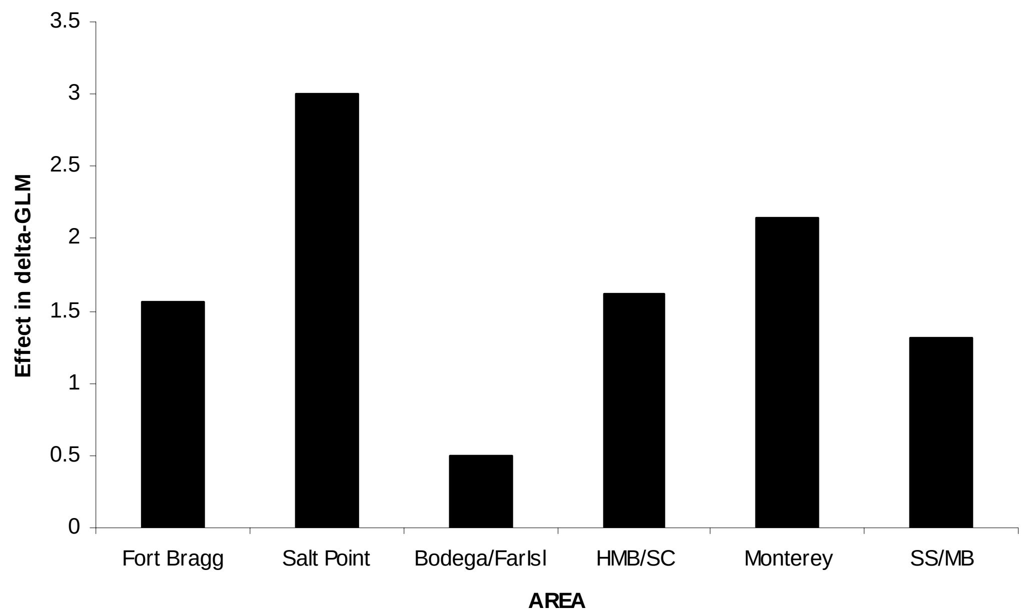


Figure 29. Area effects from the delta-lognormal GLM of the CDFG CPUE index.

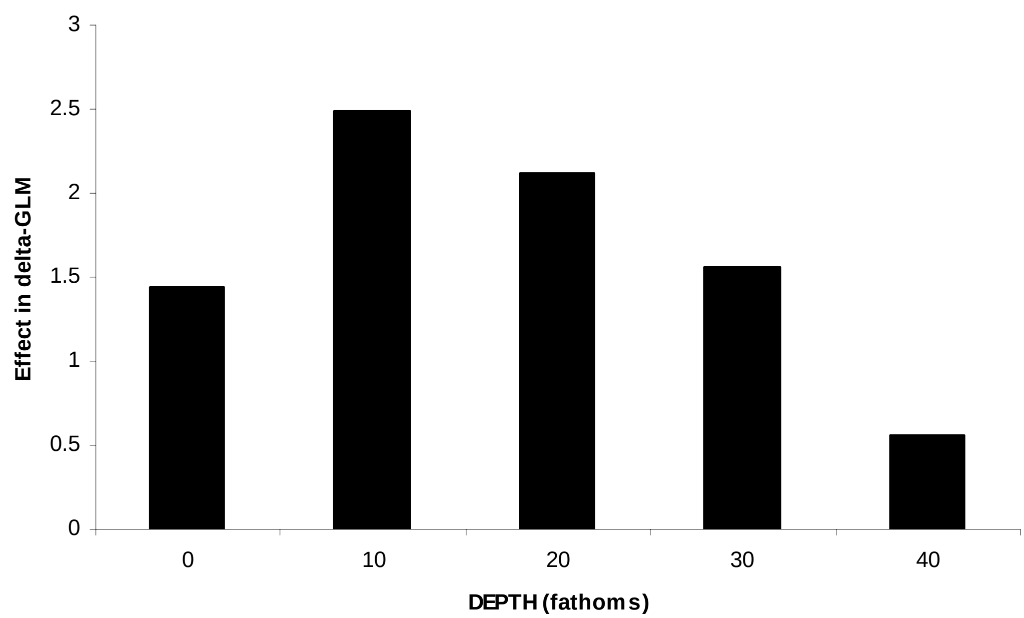


Figure 30. Depth effects from delta-lognormal GLM of the CDFG CPUE index.

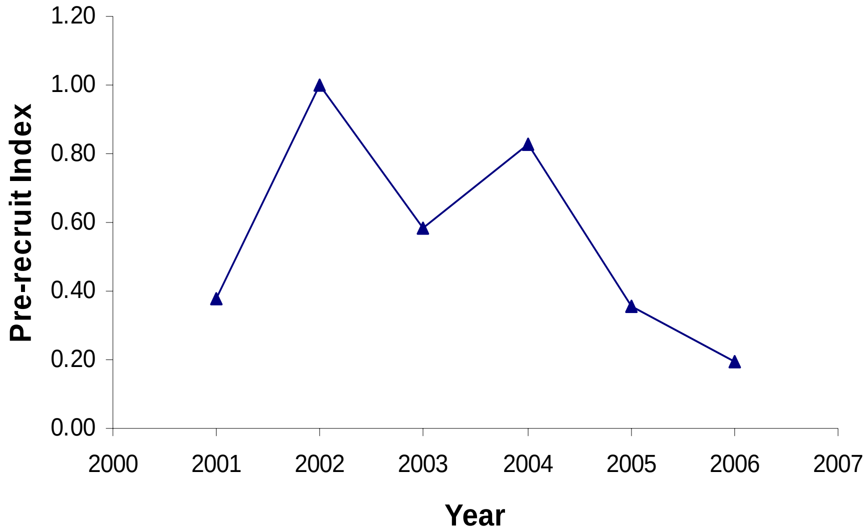


Figure 31. Coastwide juvenile rockfish midwater trawl pre-recruitment index for blue rockfish in California (north of Point Conception), 2001-2006. Indices from pooled data (SWFSC and PWCC/NWFSC surveys).

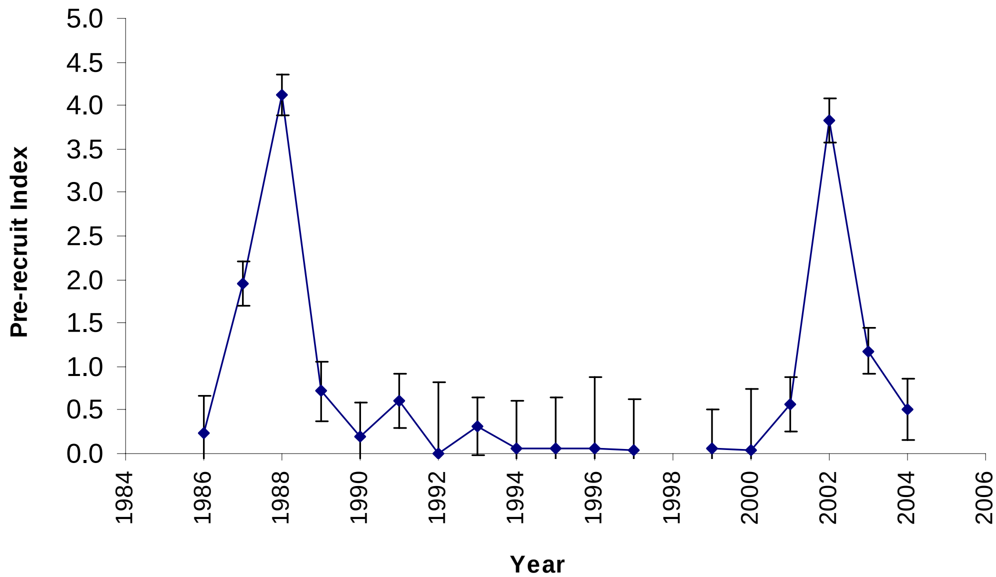


Figure 32. Juvenile rockfish midwater trawl pre-recruitment index for Monterey / San Francisco ("core") area. Extreme recruitment events appear to have occurred in 1988 and 2002. Data from SWFSC midwater trawl surveys.

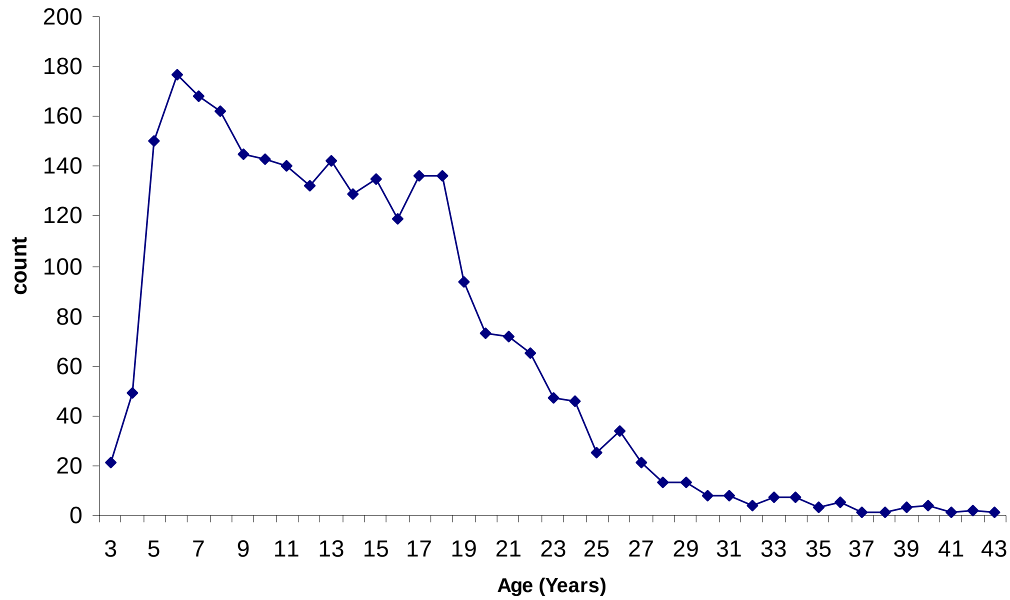


Figure 33. Age composition data (1979-1984) from the recreational CPFV fishery. Ages 5-18 were evaluated to look at year class strength. Age 30 was used as the accumulator age in the base model, since < 2% were older than 30.

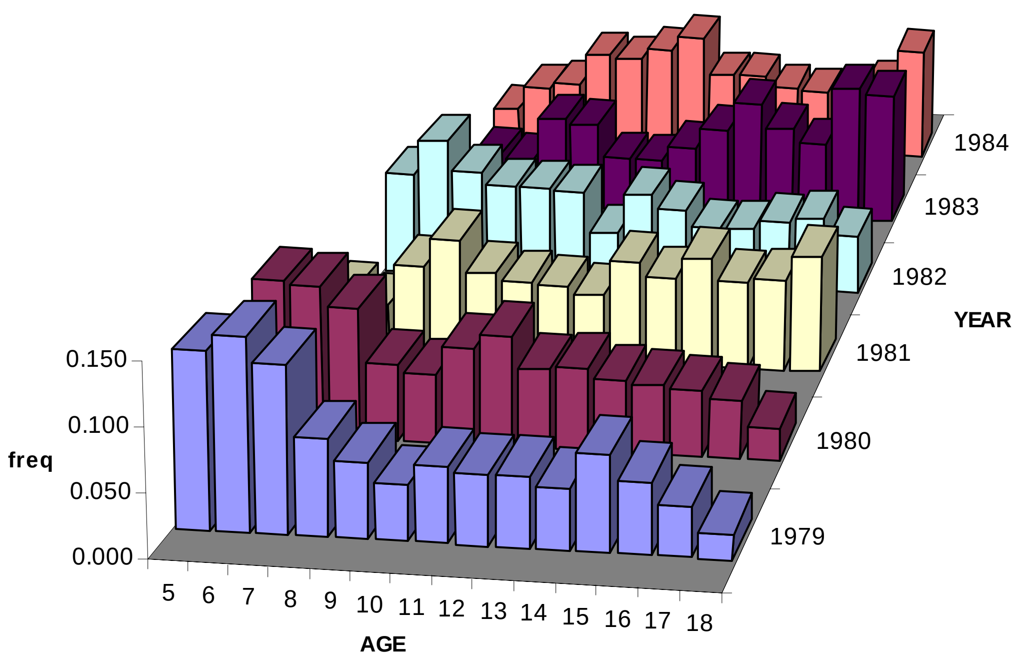


Figure 34. Age composition data (ages 5-18, sexes combined) from CPFVs, 1979-1984.

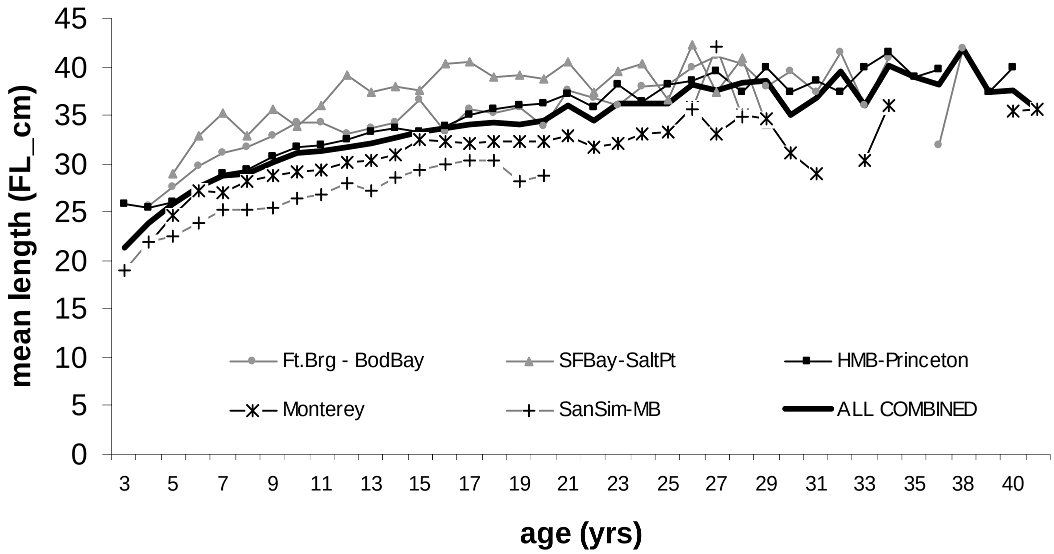


Figure 35. Mean length at age by area (Fort Bragg to Morro Bay) for 1980s CPFV recreational fishery.

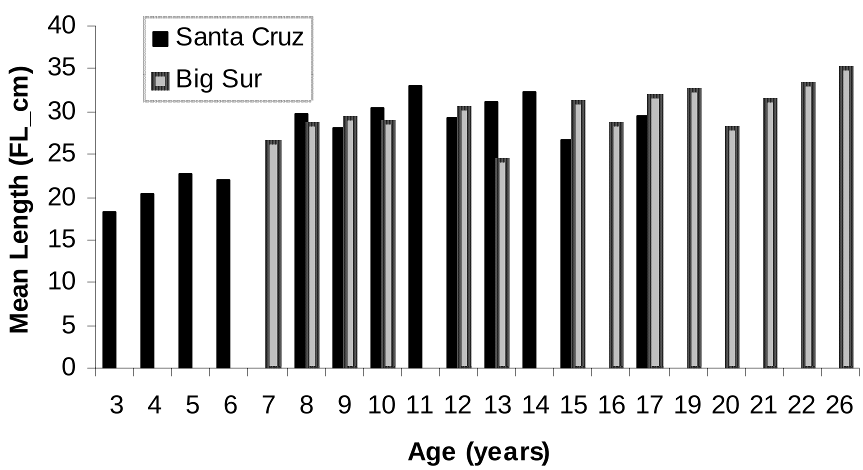


Figure 36. Mean length at age for females in Santa Cruz (heavily fished area) compared to Big Sur (less fished area). Data from Groundfish Ecology survey, 2003-2006.

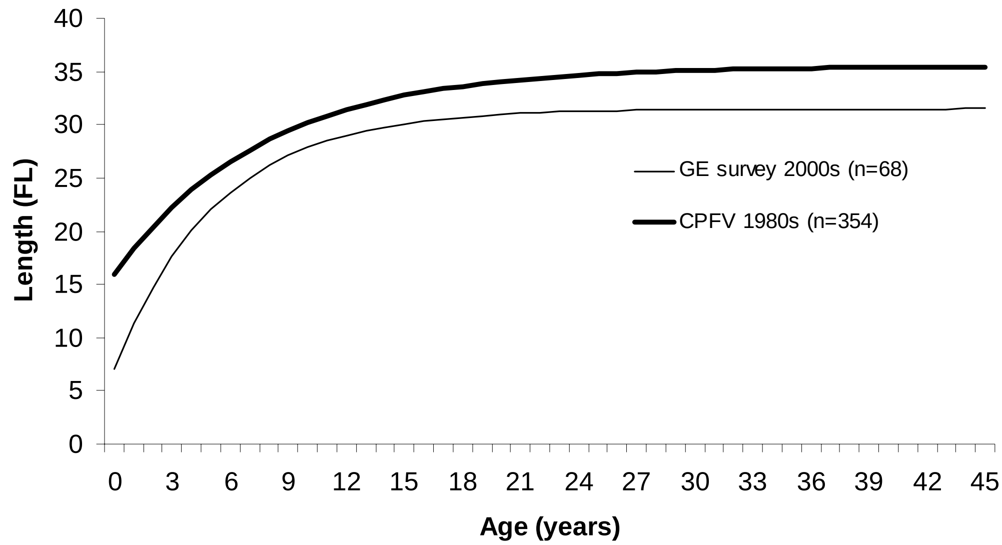


Figure 37. Representation of change in growth of female blue rockfish in Monterey from the 1980s to the 2000s.

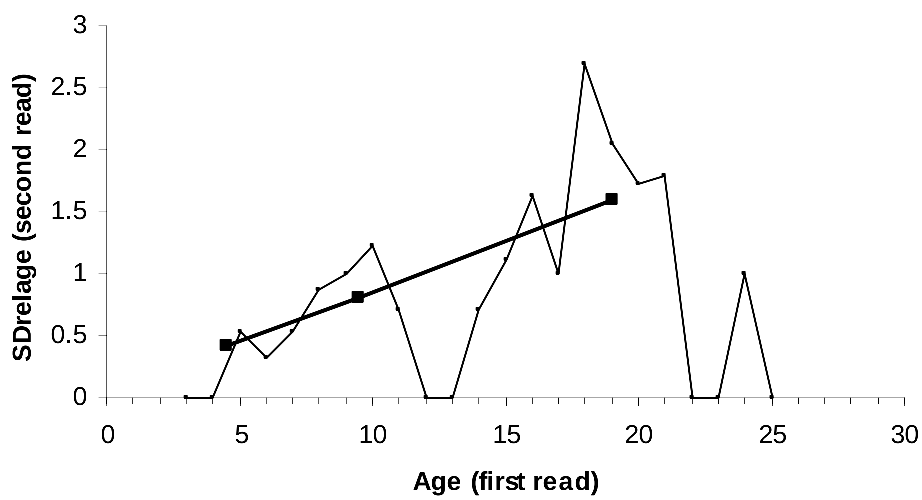


Figure 38. Precision of second otolith reading relative to first reading for individual ages and for three age ranges.

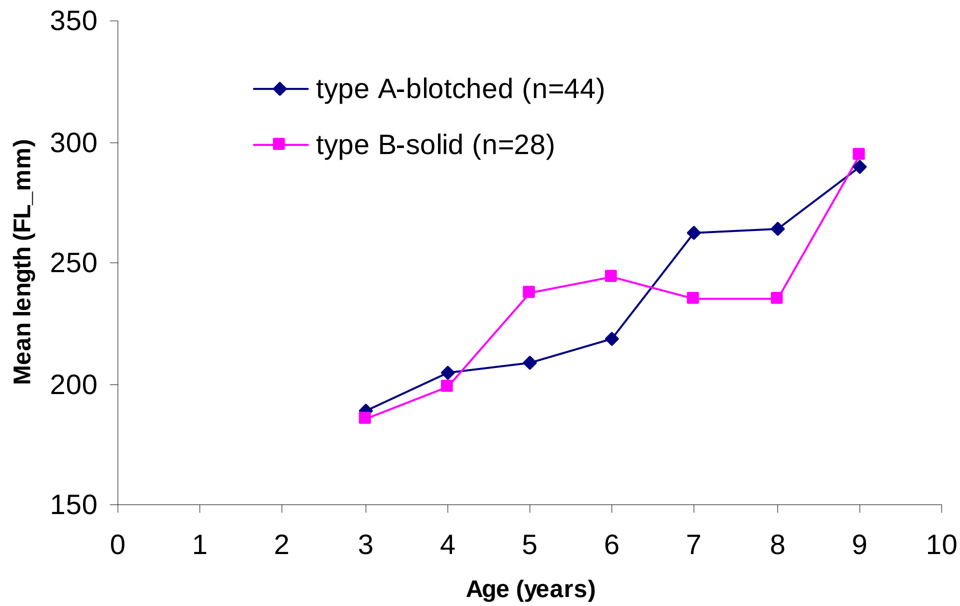


Figure 39. Comparison of mean length at age of the genetically different species of blue rockfish. Data from Don Pearson, NWFSC.

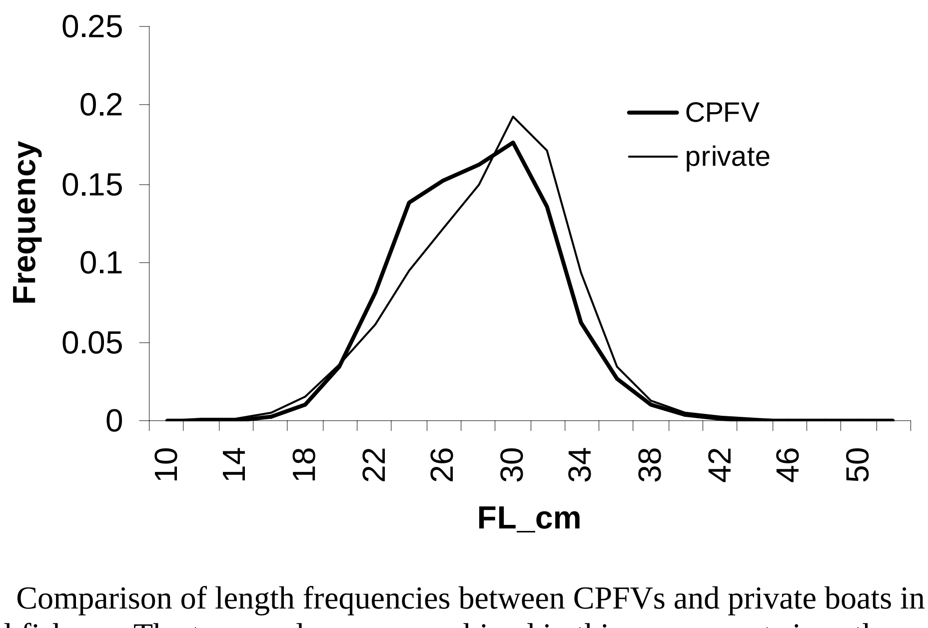
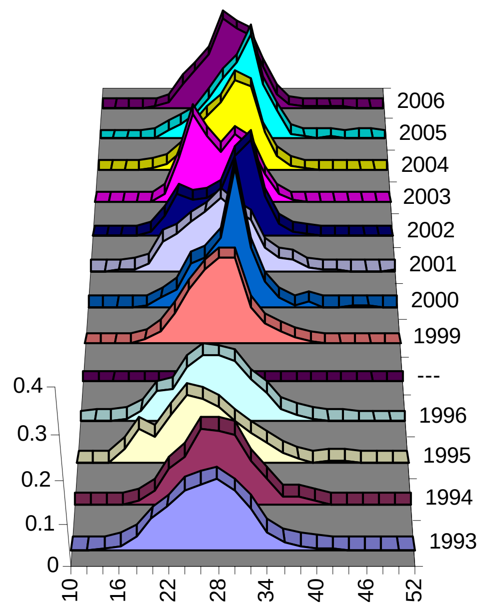
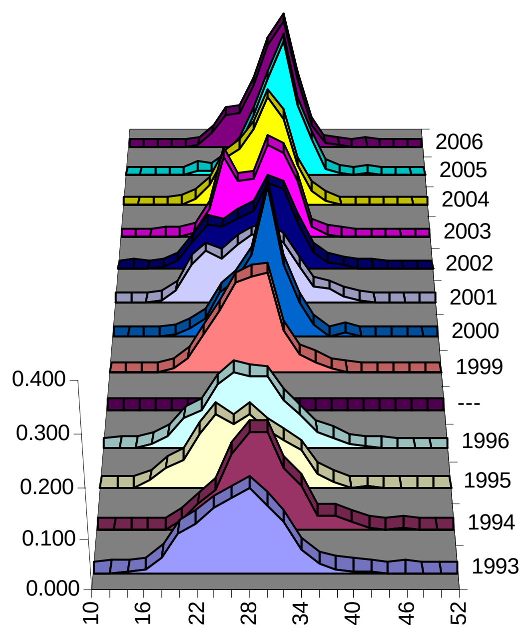


Figure 40. Comparison of length frequencies between CPFVs and private boats in the recreational fishery. The two modes were combined in this assessment since they appear to catch similar sizes of blue rockfish. Data from RecFIN, 1993-2006.

UNWEIGHTED



WEIGHTED



Figures 41 (a-b). Unweighted (top) and weighted (bottom) annual length compositions for the recreational fishery, CPFV and private boats combined (RecFIN). Unweighted compositions were used in this assessment. Strong modal progressions are not obvious here, as seen in other rockfish species.

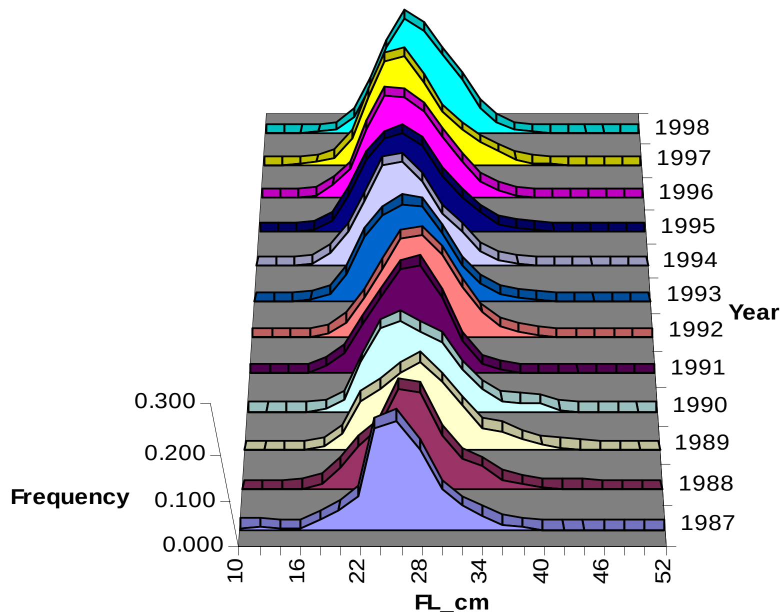


Figure 42. Annual length compositions for the recreational fishery from the CDFG CPFV onboard observer survey (1987-1998). Like RecFIN, strong modal progressions are not obvious, as seen in other rockfish species.

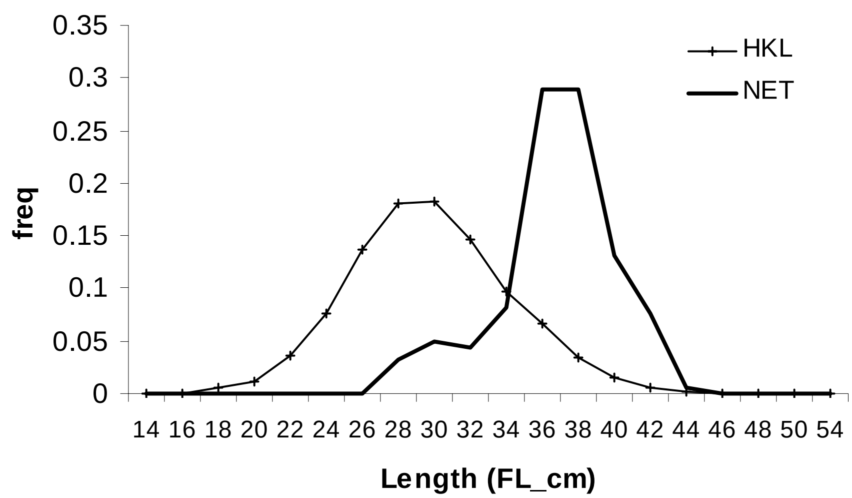


Figure 43. Comparison of length frequencies between hook and line and net gears in the commercial fishery. The two fisheries could not be combined because of differing selectivities. Data from CALCOM, 1992-2006.

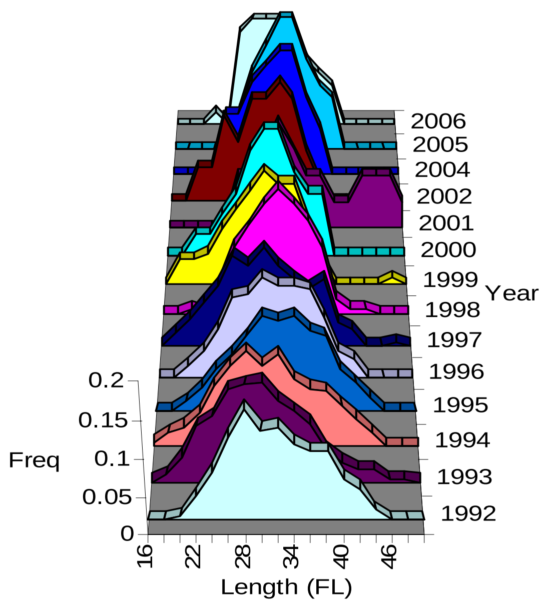


Figure 44. Annual length compositions for the commercial hook and line fishery (CALCOM). Again, strong modal progressions are not obvious here, as seen in other rockfish species.

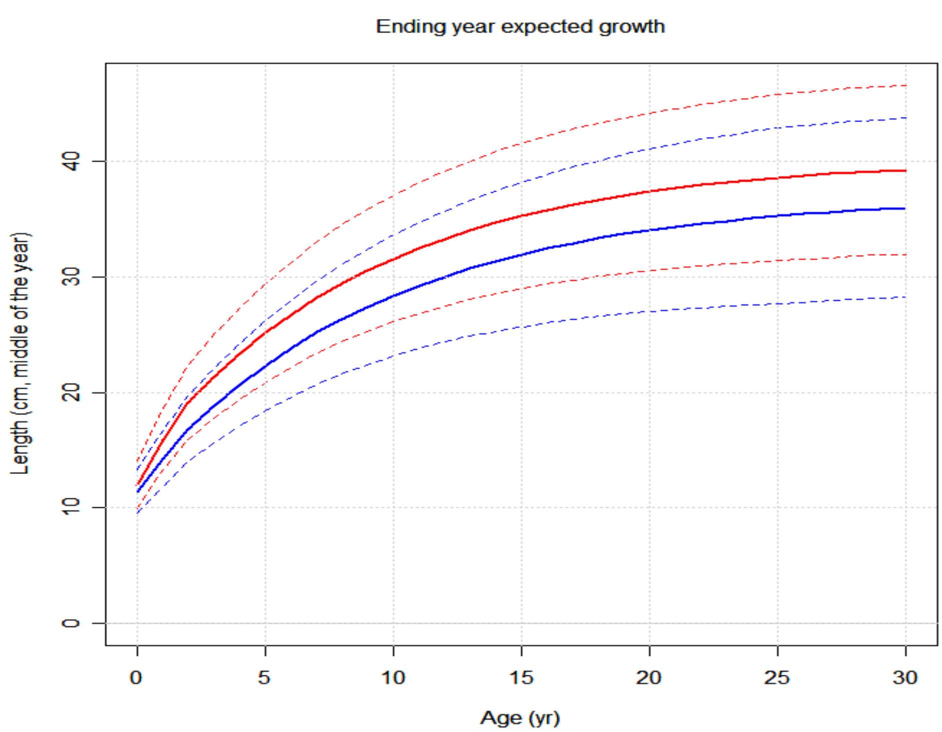
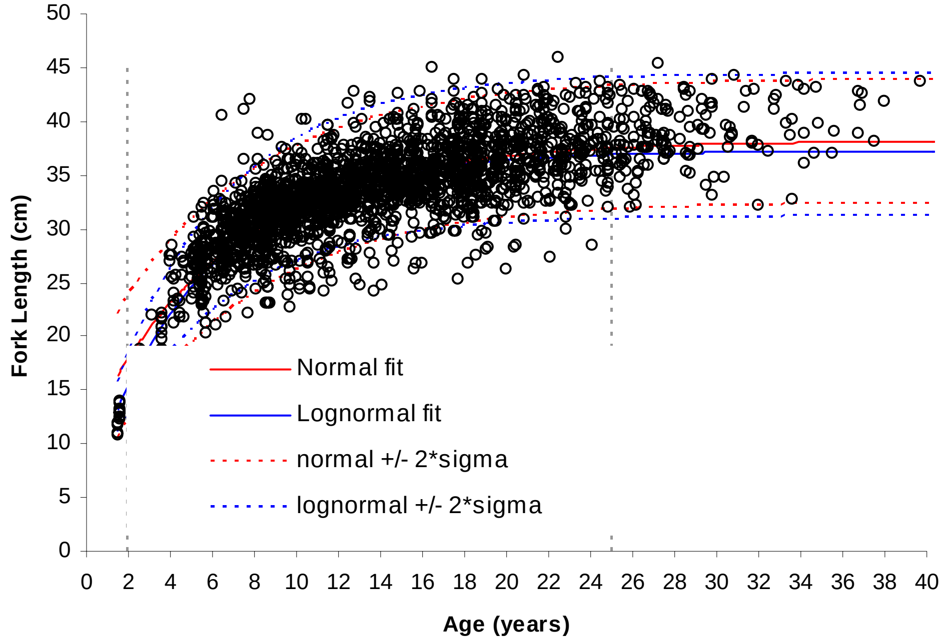
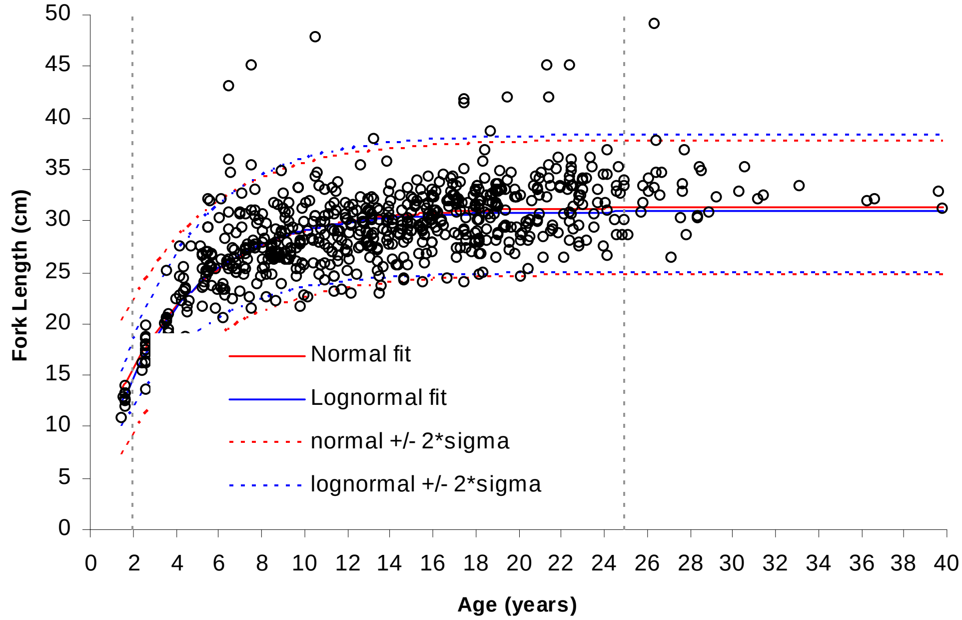
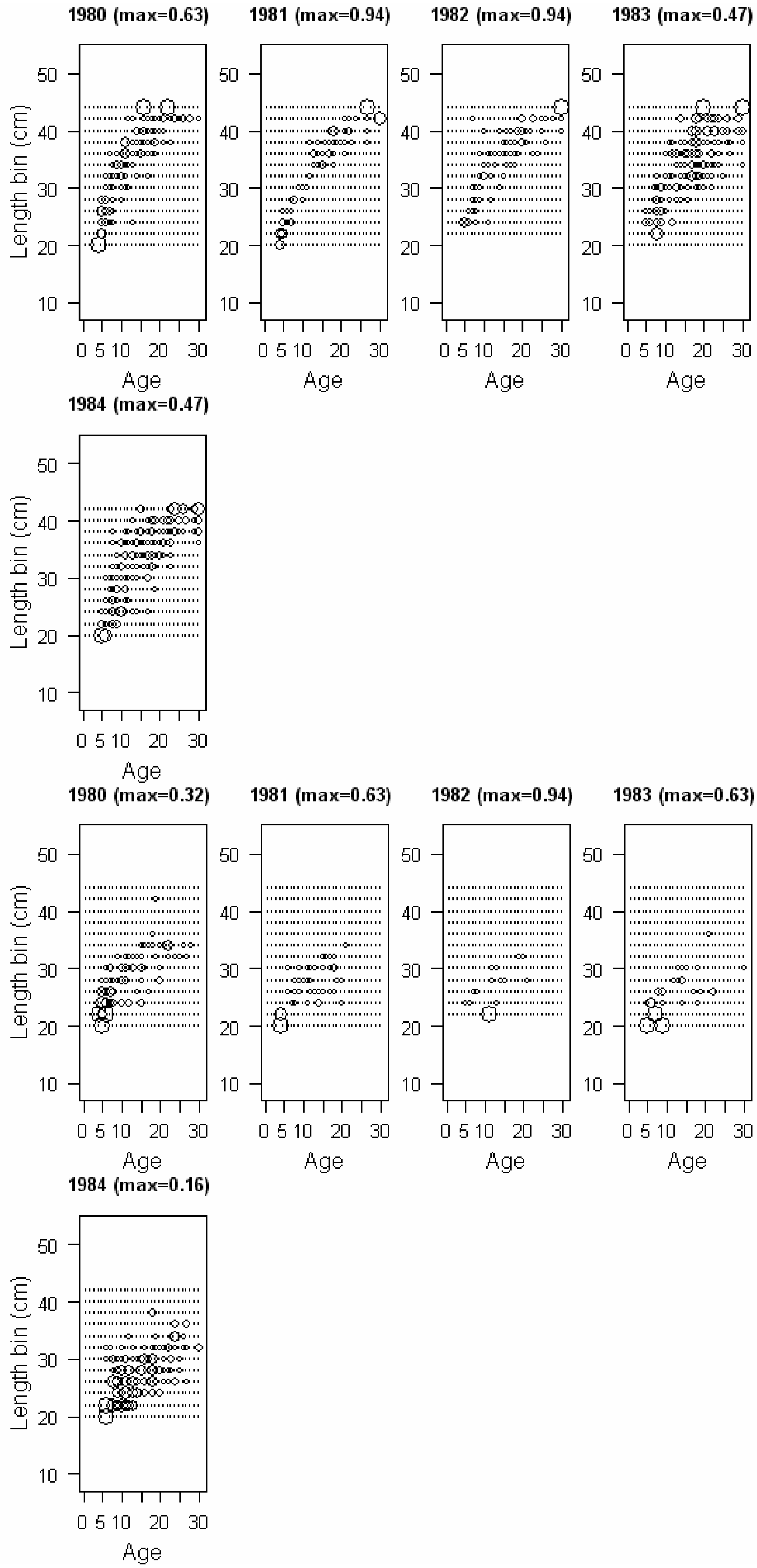


Figure 45. Estimated female (solid top, red) and male (solid bottom, blue) growth curve from the base model. (L_{min} fixed.)

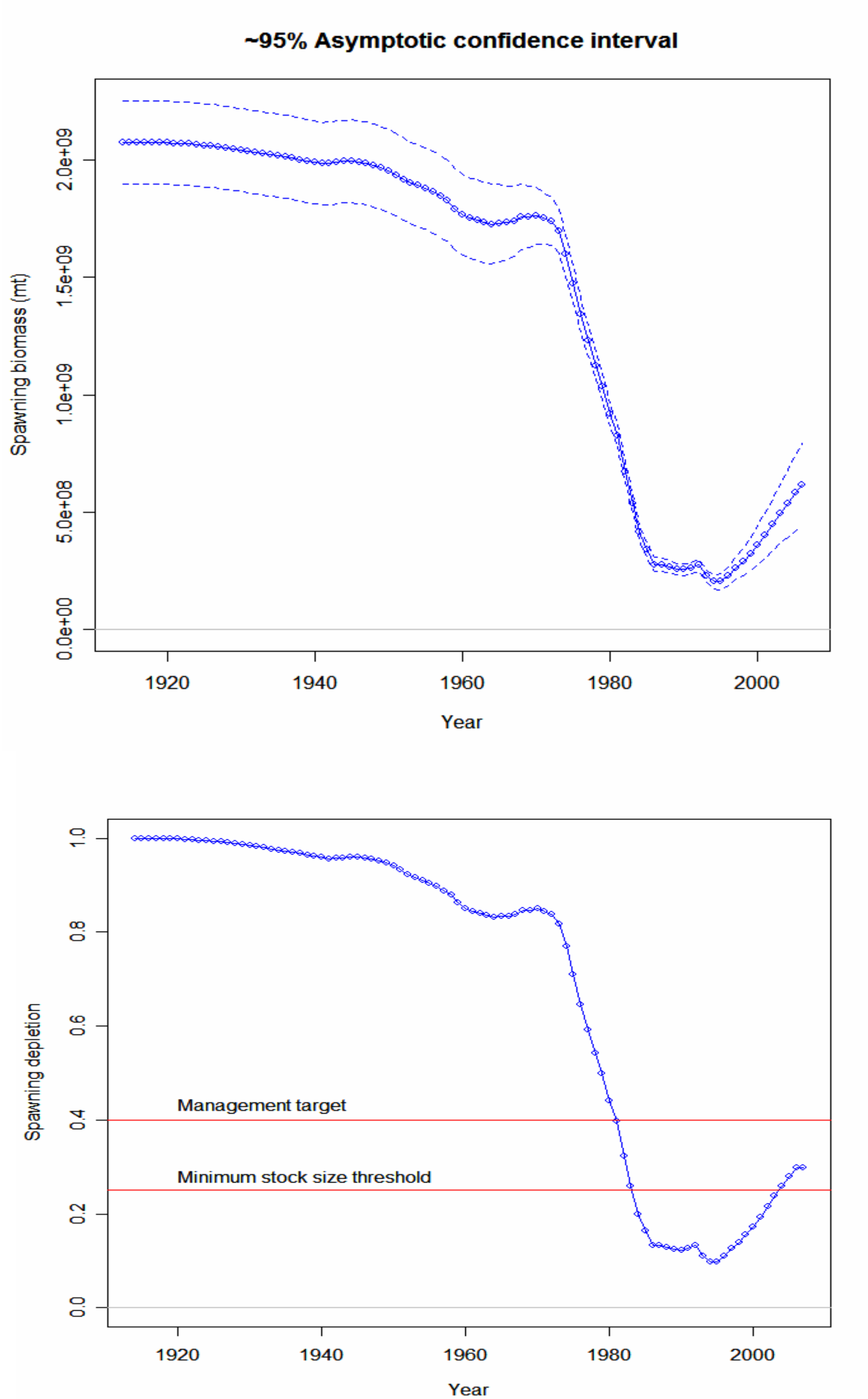




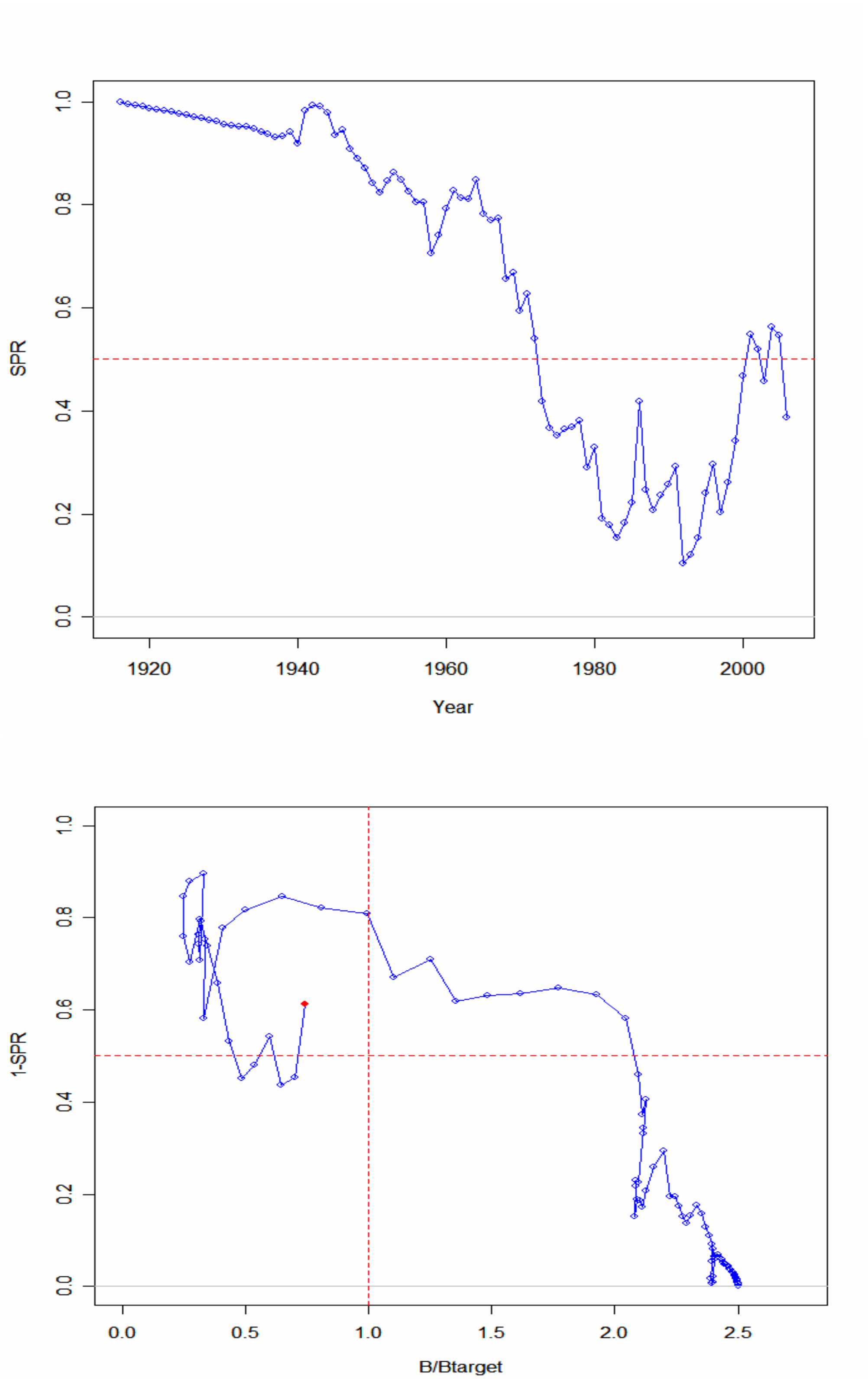
Figures 46 (a-b). External fits of the Schnute (1981) parameterization of the von Bertalanffy growth equation in the 1980s prior to the Mop-Up STAR panel. Females (top): t_1=2 (years), L_1=17.9 (cm FL), t_2=25 (years), L_2=37.5 (cm FL) and k=0.147 (n= 2340, CV=0.089); Males (bottom): t_1=2 (years), L_1=15.7 (cm FL), t_2=25 (years), L_2=31.2 (cm FL) and k=0.295 (n=667, CV=0.108).



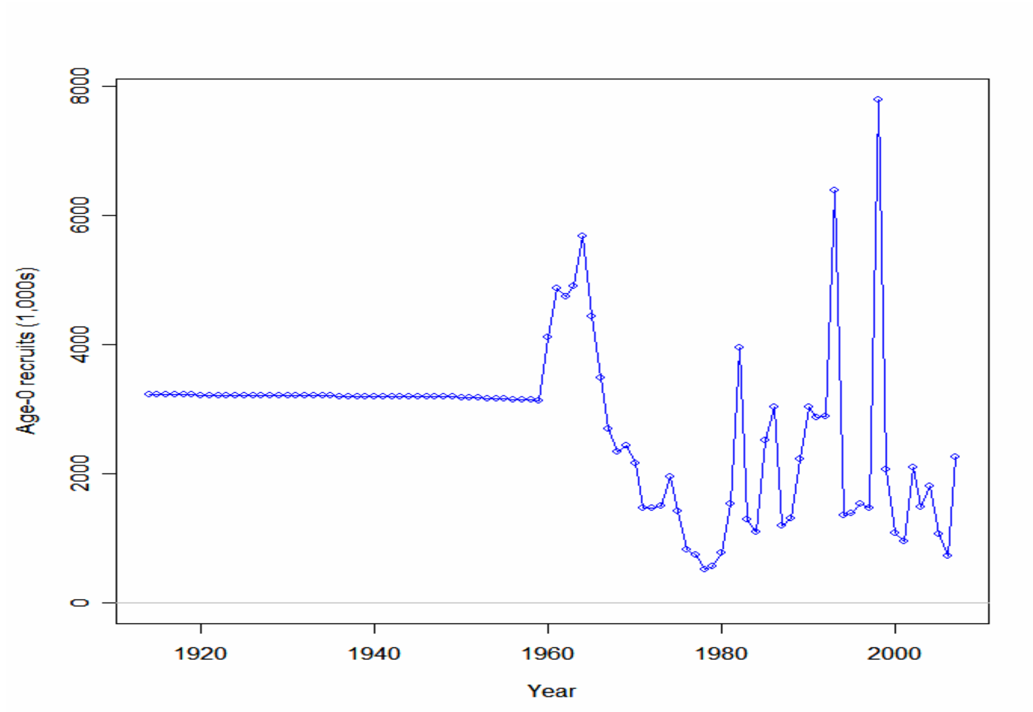
Figures 47 (a-b): Conditional age-at-length data for females (top) and males (bottom) from the 1980s recreational CPFV age data (1980-1984).

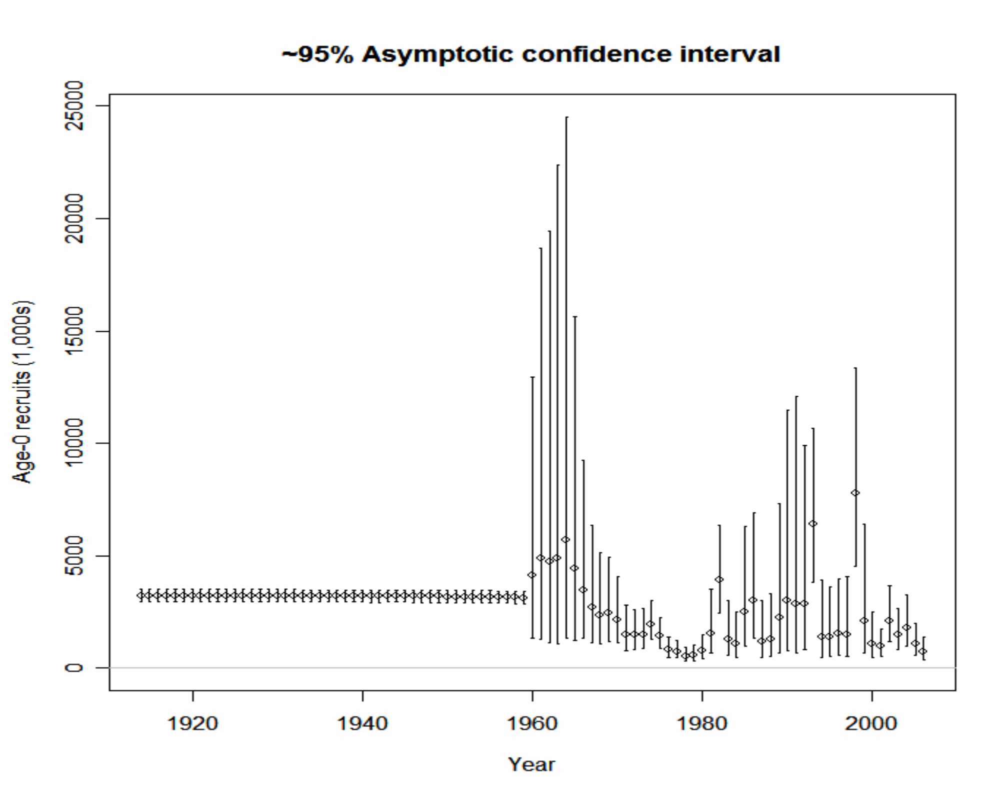


Figures 48 (a-b). Estimated spawning biomass (with approximate 95% confidence intervals) (top) and depletion (bottom) from the base model. [***Note*** that spawning biomass in this assessment is in millions of larvae, not metric tons as the figure labels.]

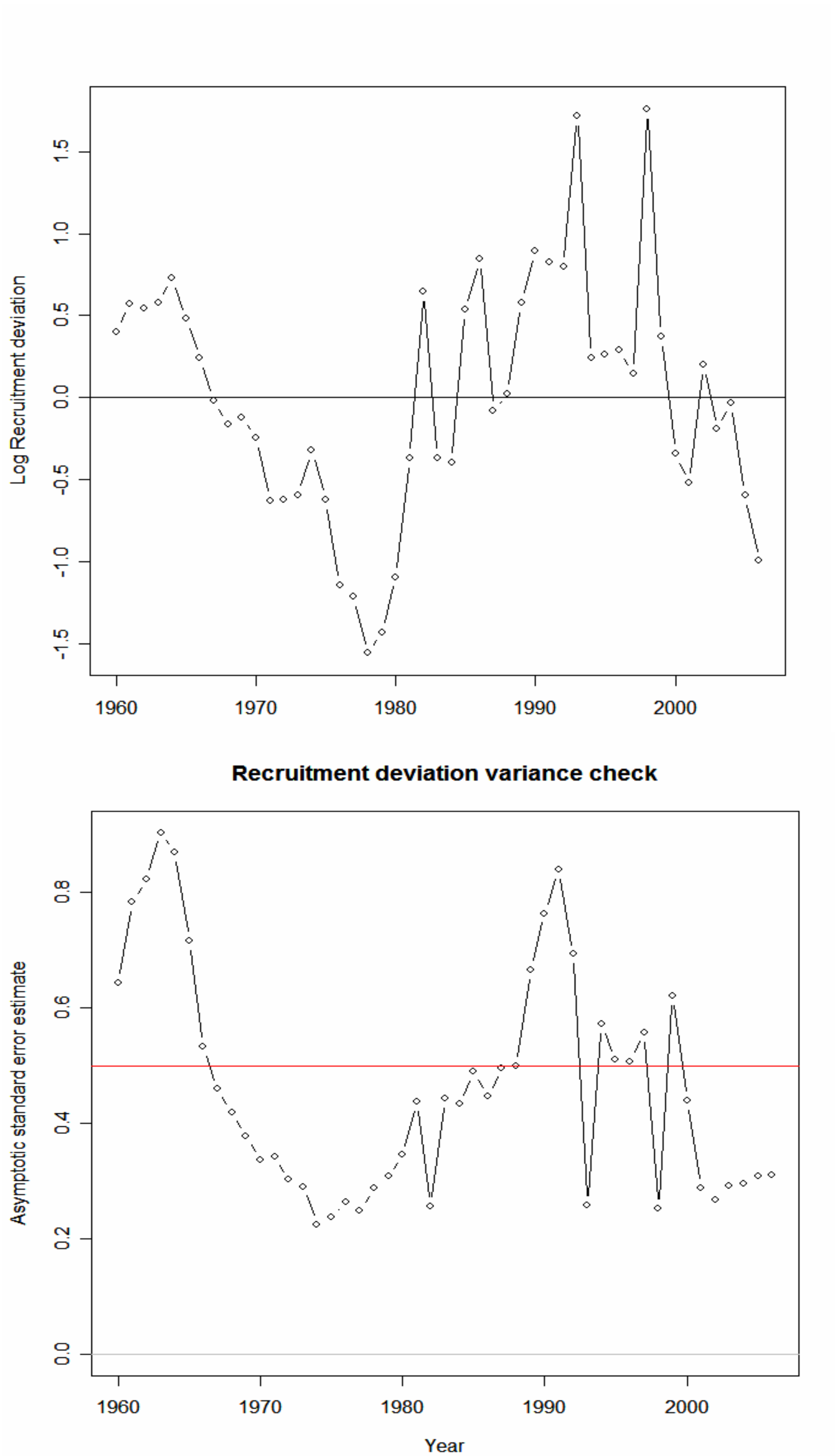


Figures 49 (a-b). Time series of estimated spawning potential ratio (SPR) for the base case model (top). Values of SPR below 0.5 reflect harvests in excess of the current overfishing proxy. Estimated spawning potential ratio relative to the proxy target of 50% vs. estimated spawning biomass relative to the proxy 40% level from the base case model (bottom). Higher biomass occurs on the right side of the x-axis, higher exploitation rates occur on the upper side of the y-axis.

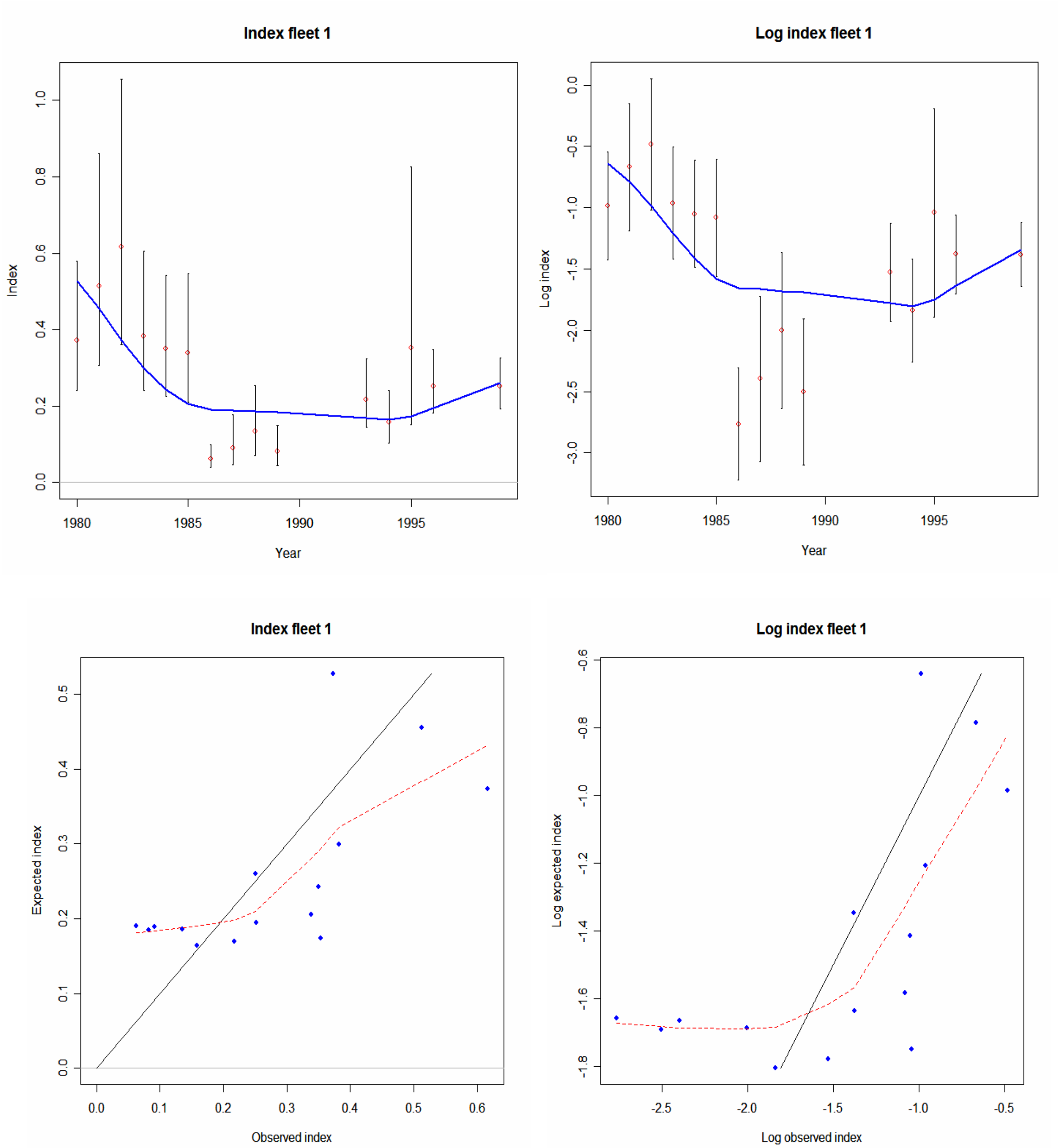




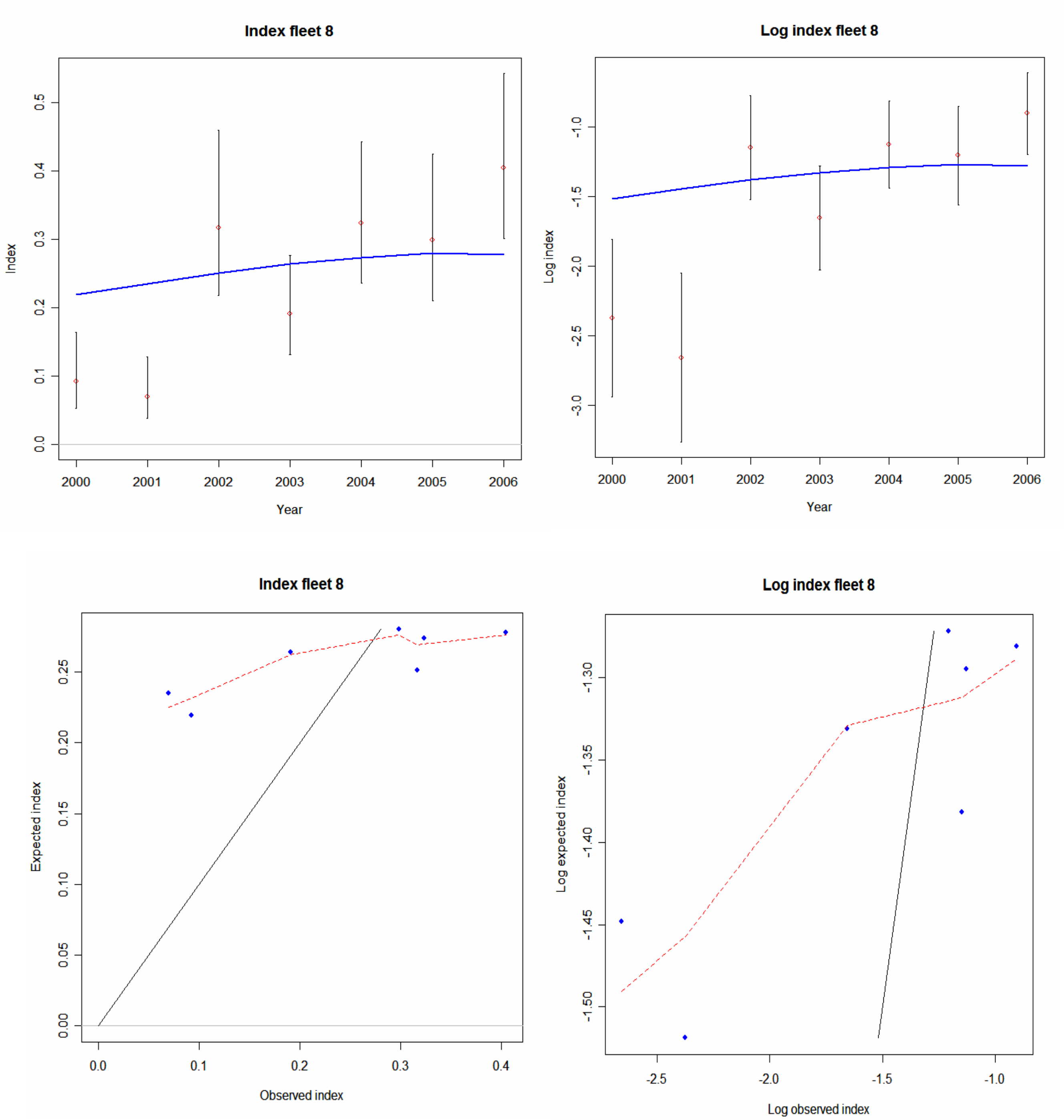
Figures 50 (a-b). Estimated age -0 recruitment (1000s) (top) and approximate 95% confidence intervals (bottom) from the base model.



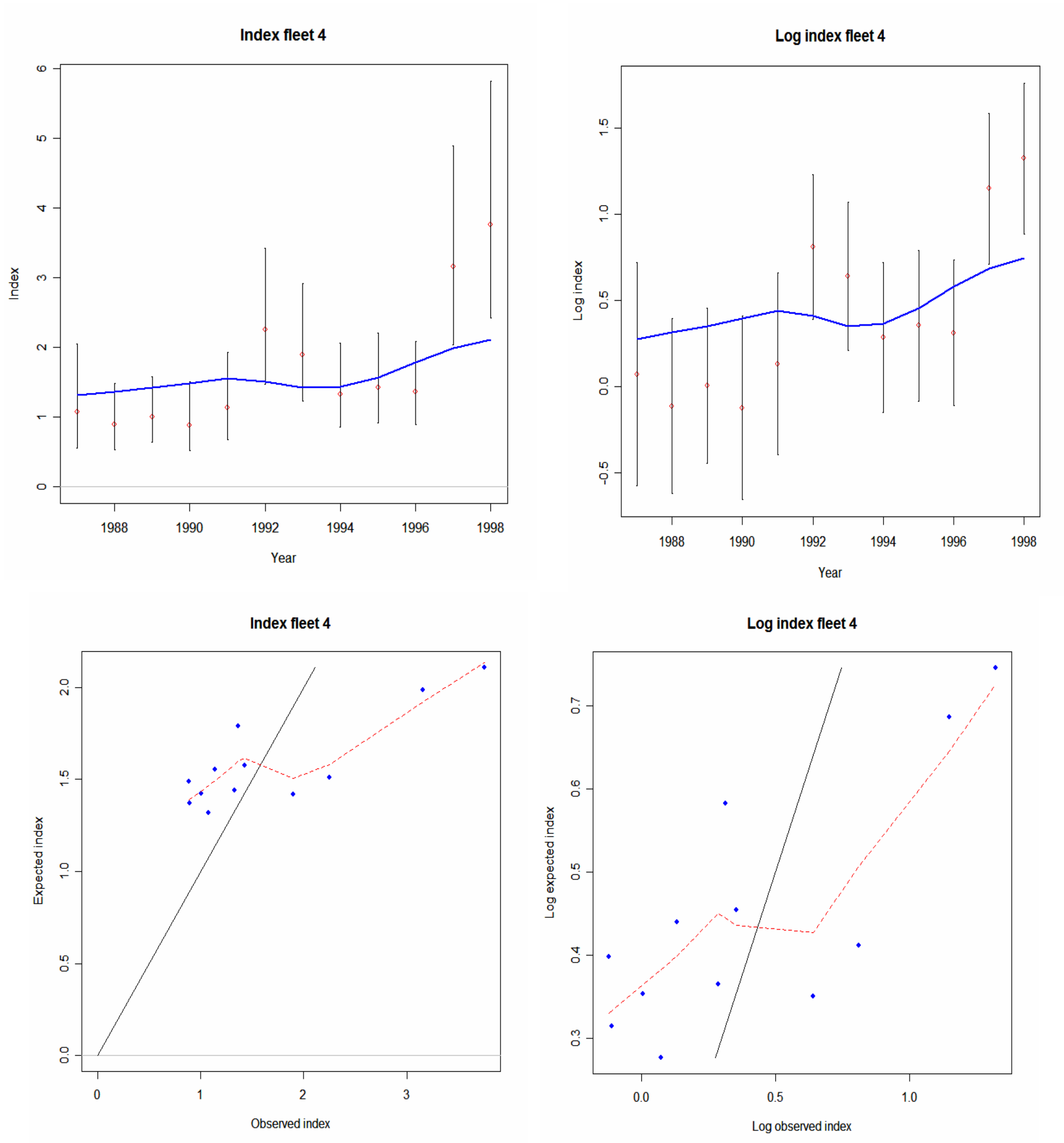
Figures 51 (a-b). Estimated log recruitment deviations (top) and variance check ($\sigma R=0.5$) (bottom) from the base model.



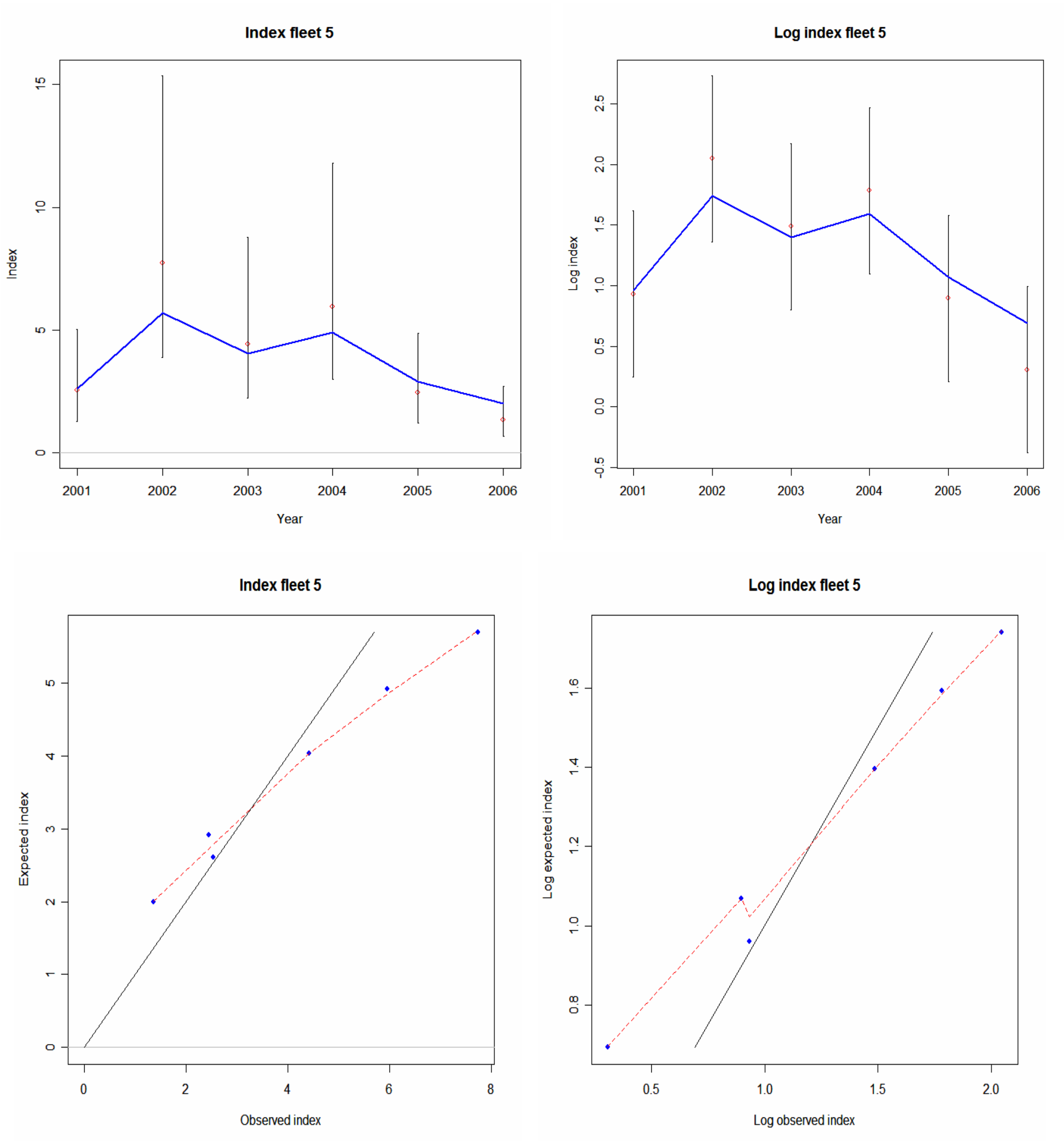
Figures 52 (a-d). Fits to 1980-1999 recreational RecFIN CPUE index (top) and the observed vs. expected sample sizes (bottom). This index was split into two separate indices to account for the change in q once the bag limit changed from 15 to 10 fish in 2000.



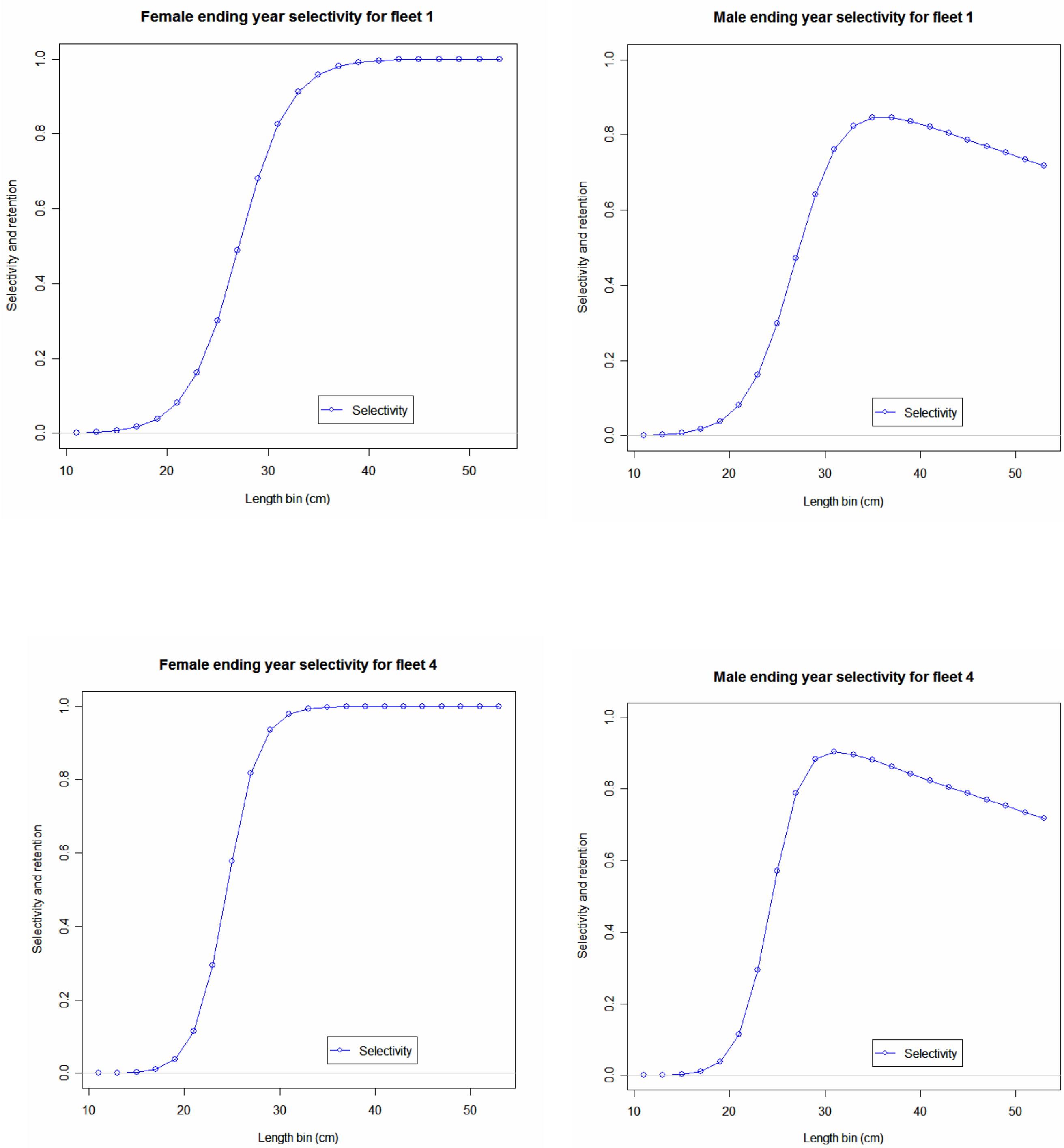
Figures 53 (a-d). Fits to 2000-2006 recreational RecFIN CPUE index (top) and the observed vs. expected sample sizes (bottom). This index was split into two separate indices to account for the change in q once the bag limit changed from 15 to 10 fish in 2000.



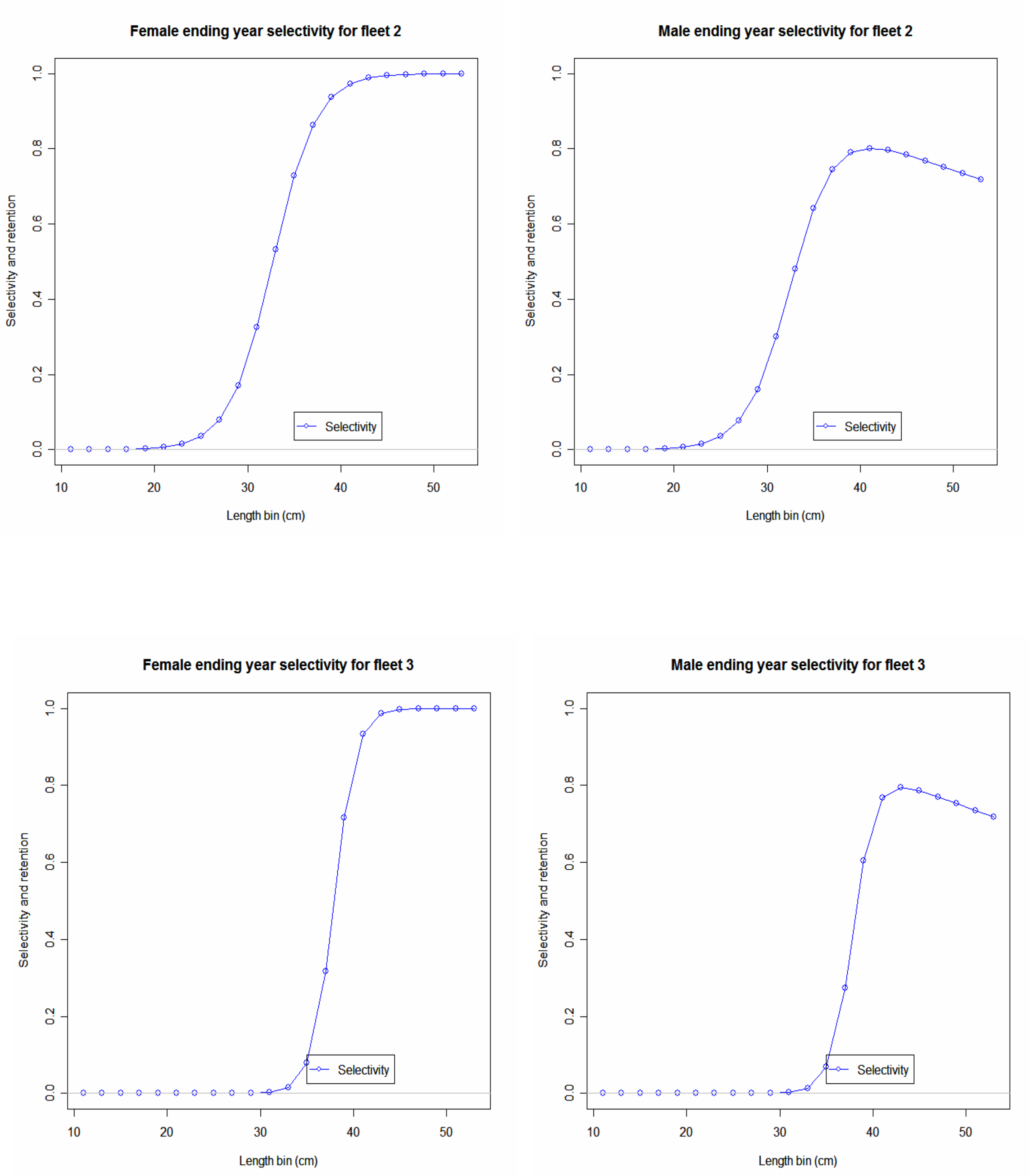
Figures 54 (a-d). Fits to 1987-1998 recreational CDFG CPFV onboard observer survey index (top) and the observed vs. expected sample sizes (bottom).



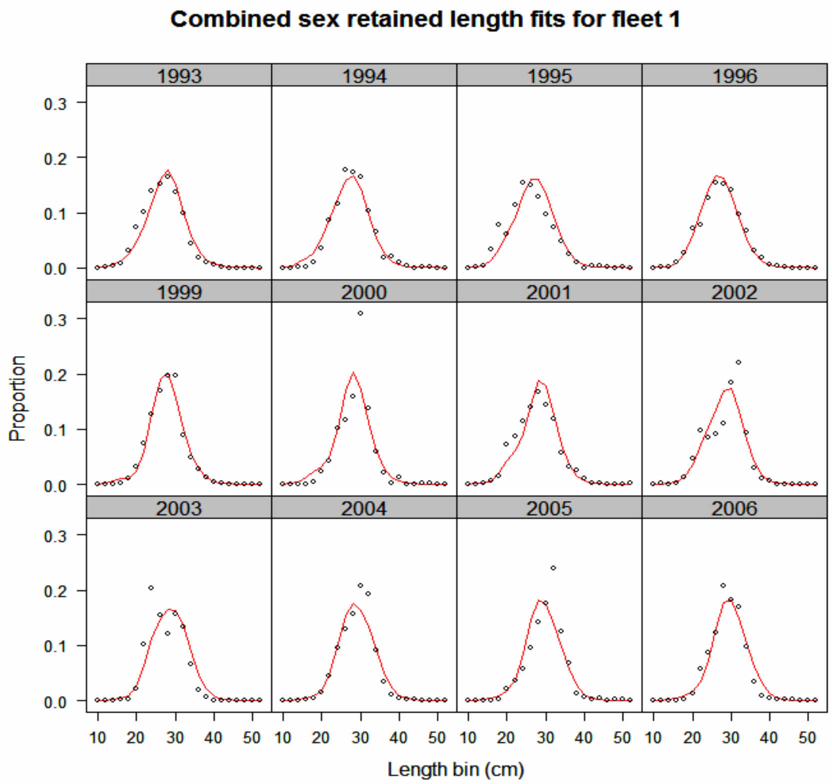
Figures 55 (a-d). Fits to 2001-2006 juvenile rockfish midwater trawl survey (top) and the observed vs. expected sample sizes (bottom).

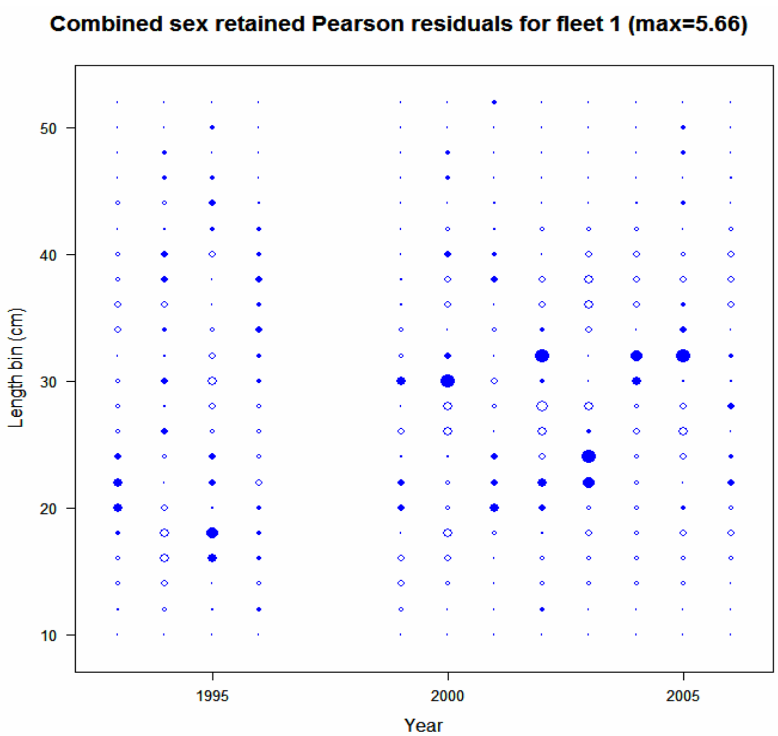


Figures 56 (a-d). Estimated selectivity curves for females (left) and males (right) of the recreational fishery (top, fleet 1) and the CDFG CPFV onboard observer survey (bottom, fleet 4).

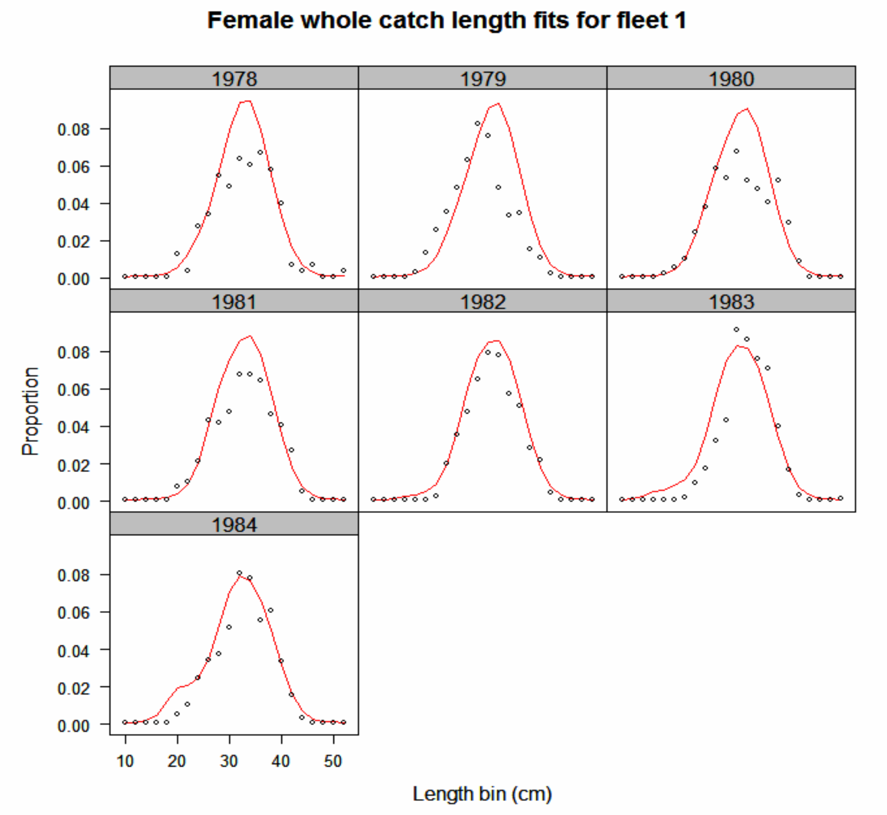


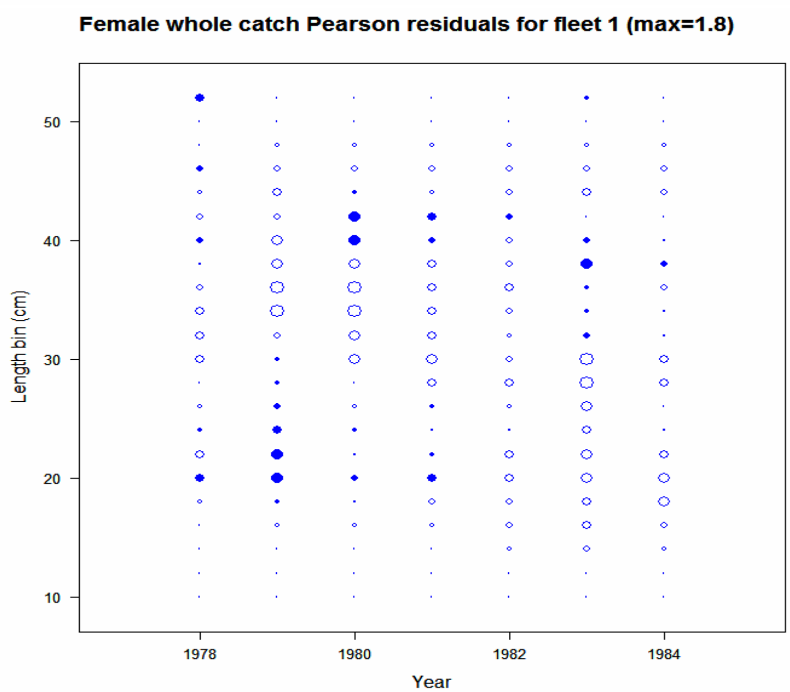
Figures 57 (a-d). Estimated selectivity curves for females (left) and males (right) of the commercial hook and line (top, fleet 2) and setnet (bottom, fleet 3) fisheries.



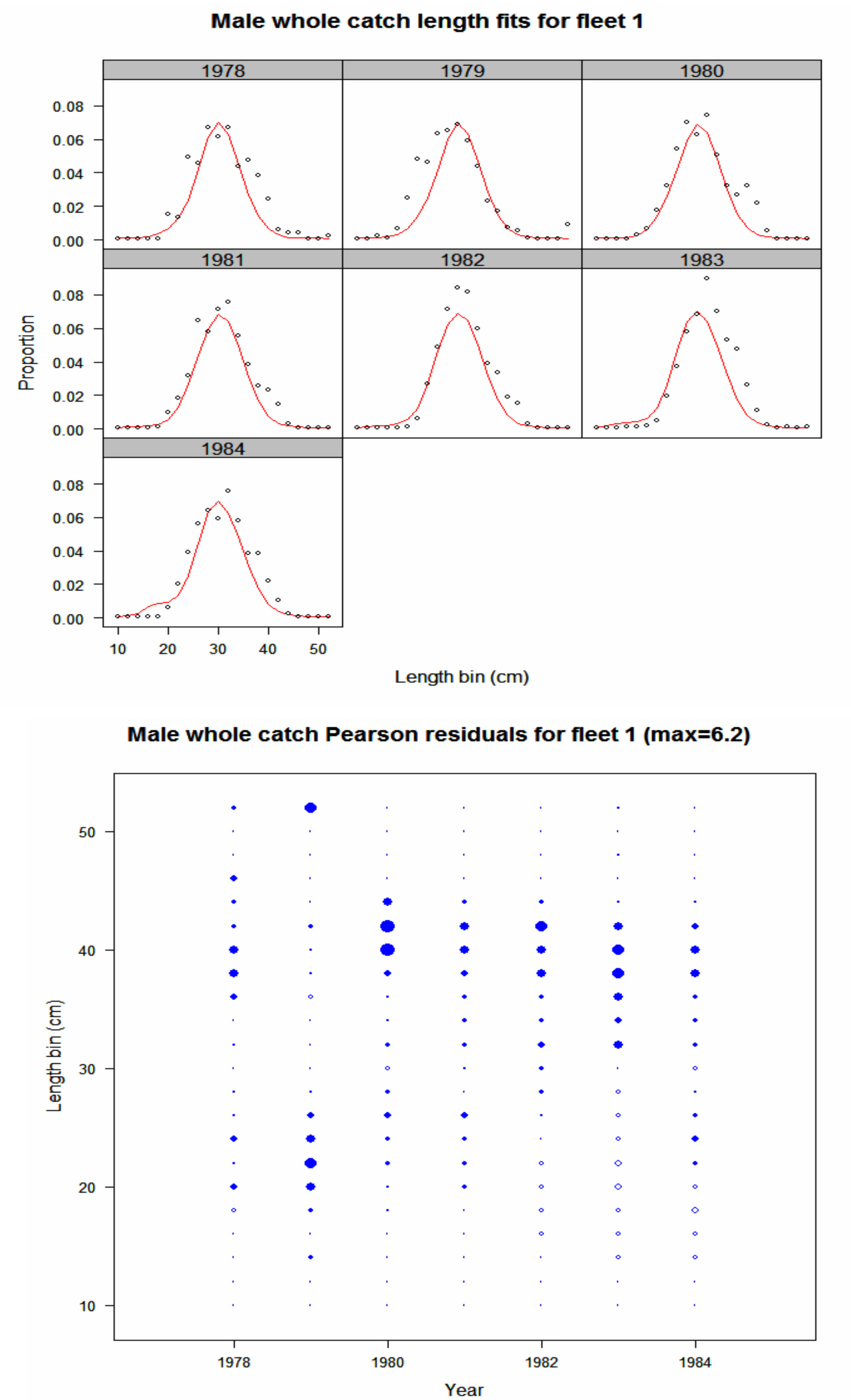


Figures 58 (a-b). Fits to the recreational (combined sex) length compositions (top) from RecFIN and the Pearson residual plots (bottom).

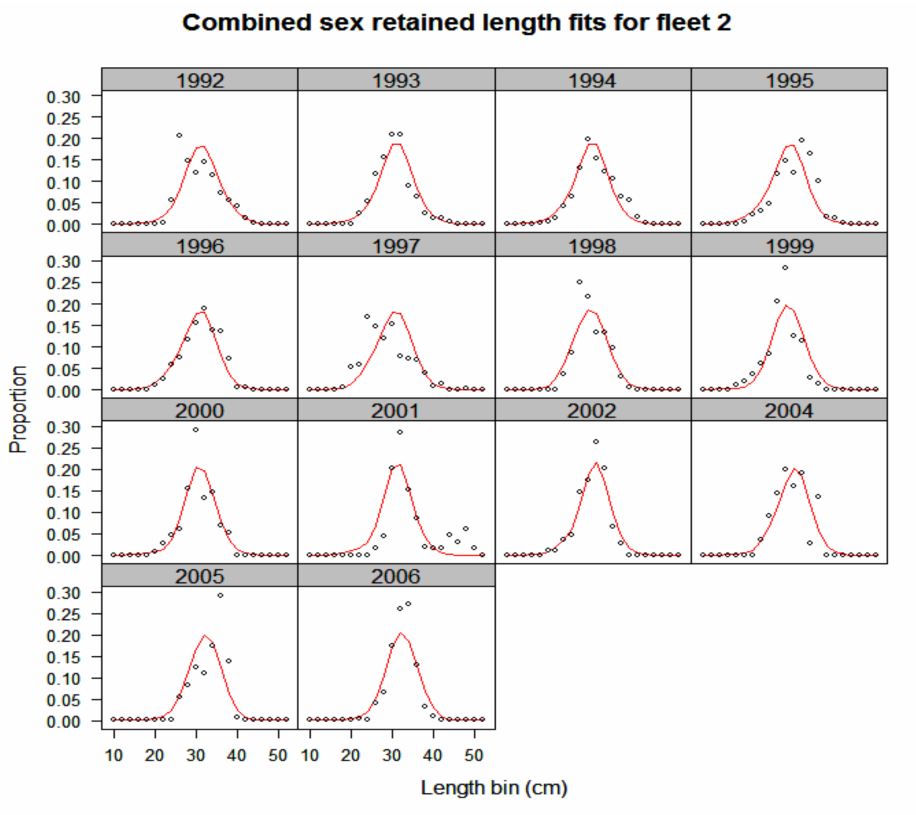


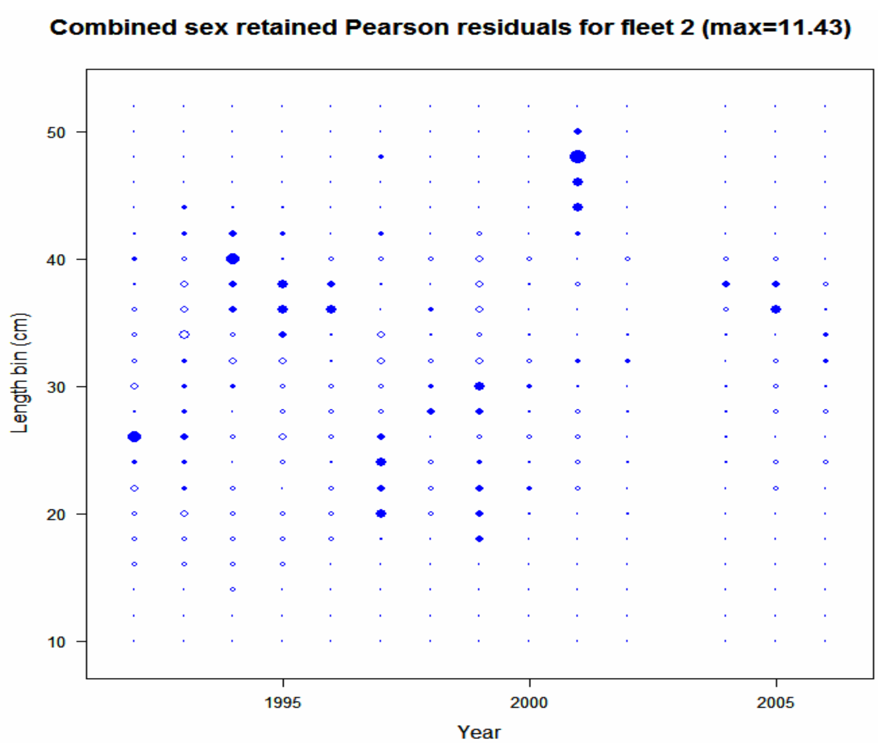


Figures 59 (a-b). Fits to the "1980s" recreational CPFV length compositions for females (top) and the Pearson residual plots (bottom).

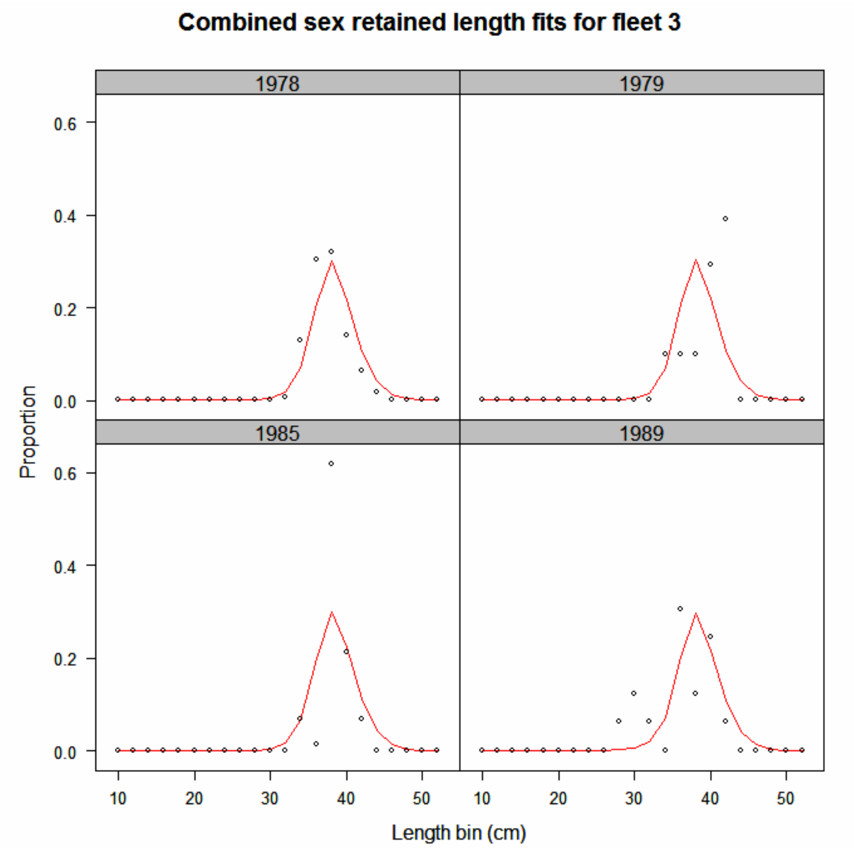


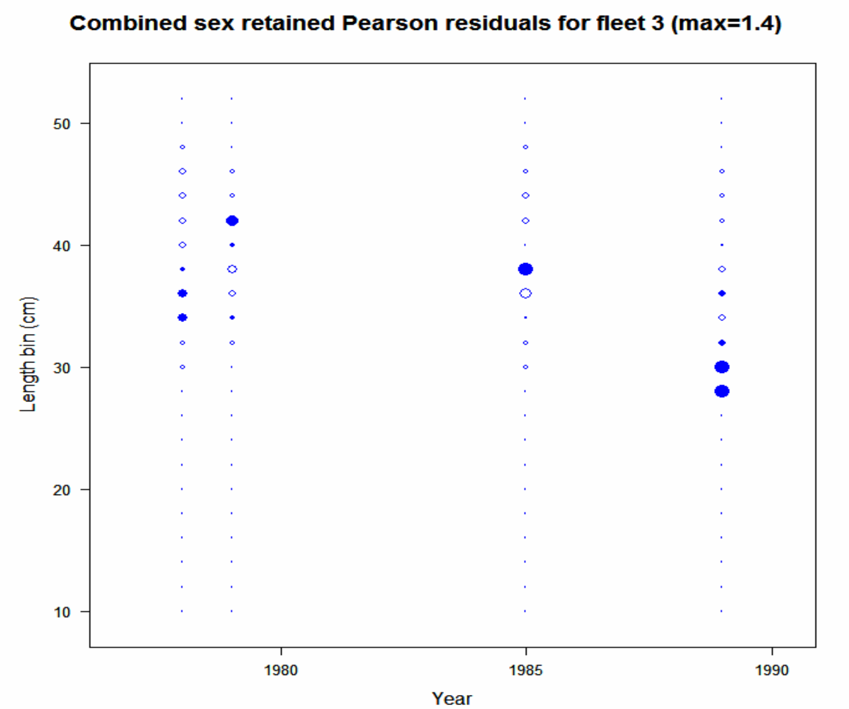
Figures 60 (a-b). Fits to the “1980s” recreational CPFV length compositions for males (top) and the Pearson residual plots (bottom).



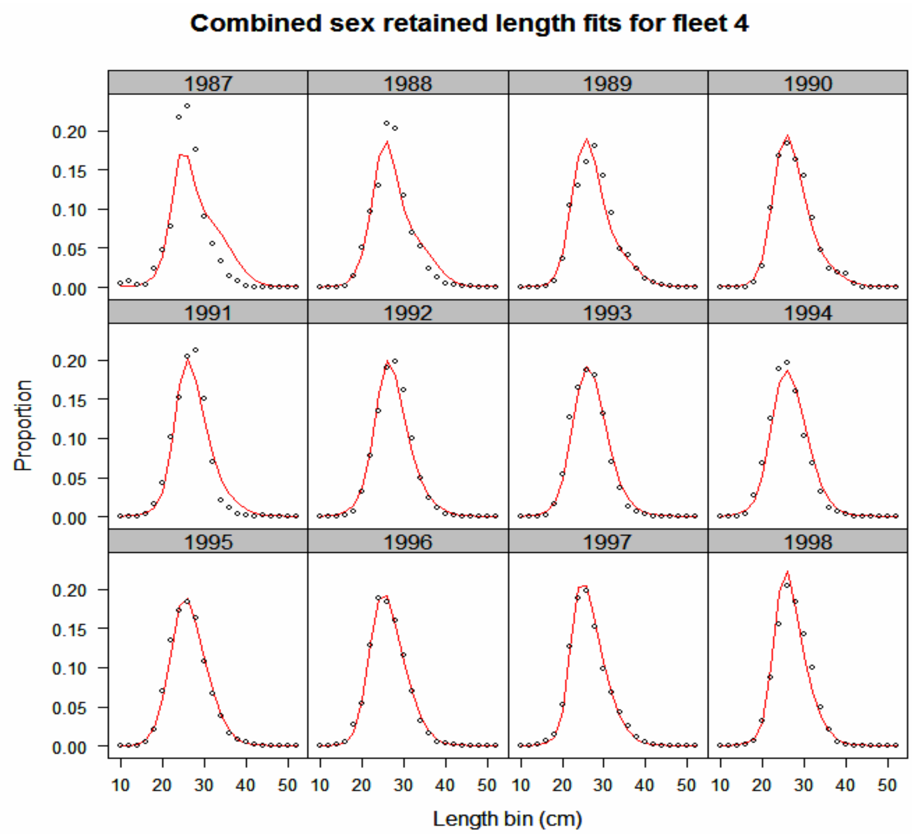


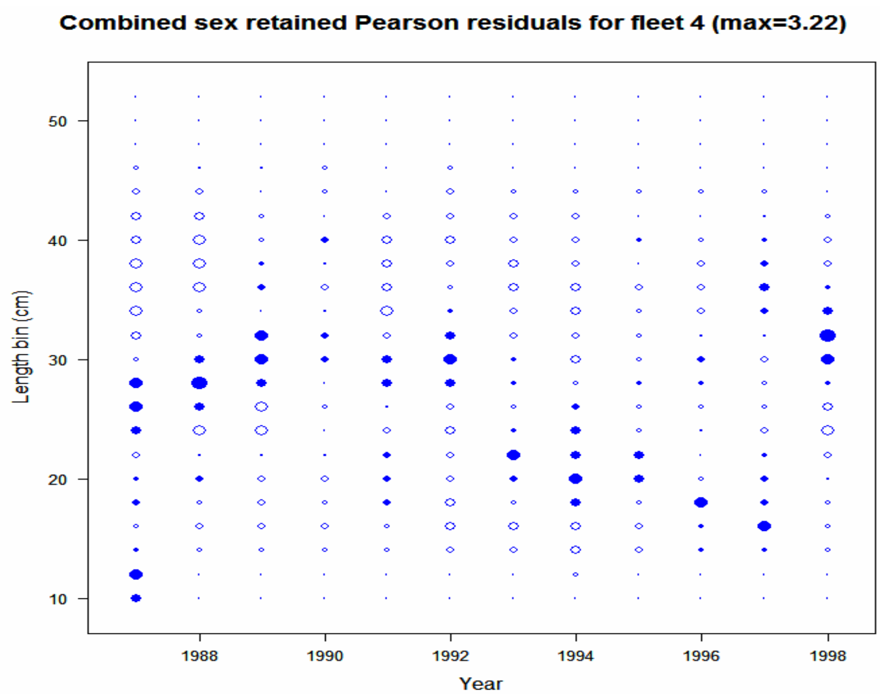
Figures 61 (a-b). Fits to the commercial hook and line (combined sex) length compositions (top) and the Pearson residual plots (bottom).



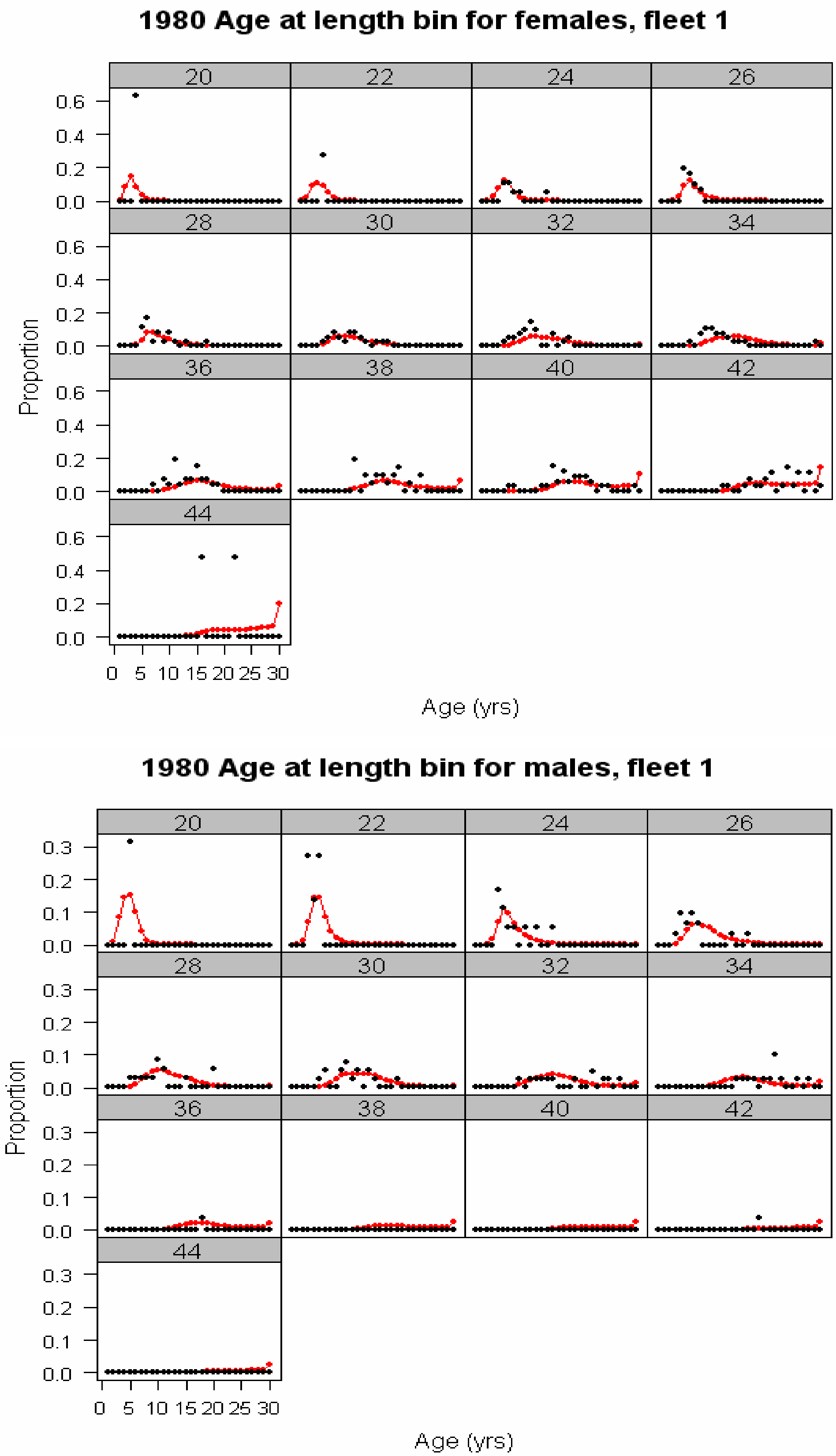


Figures 62 (a-b). Fits to the commercial setnet (combined sex) length compositions (top) and the Pearson residual plots (bottom). There were extremely low sample sizes associated with this fishery (n<10).

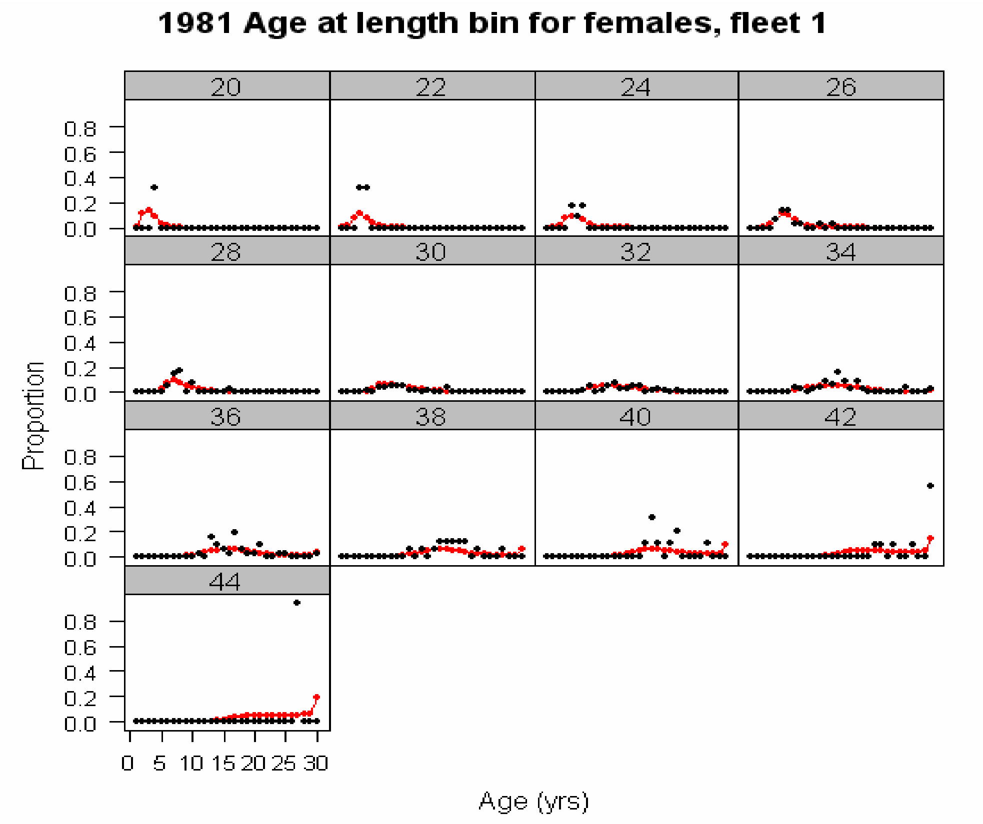


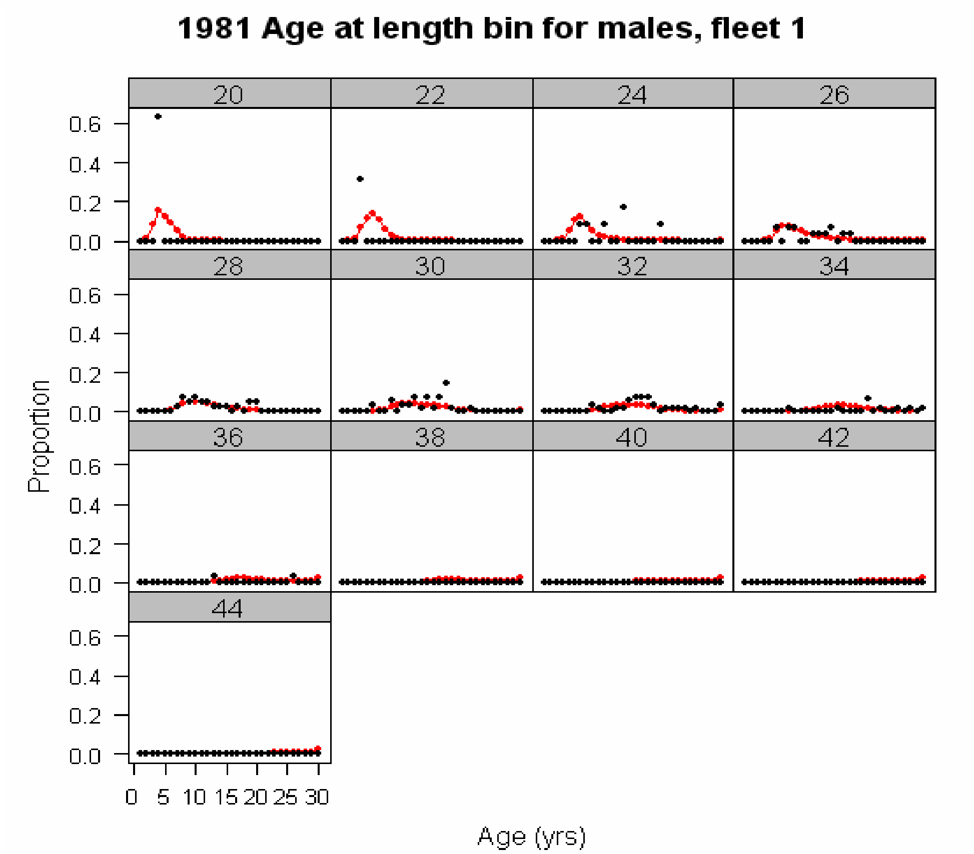


Figures 63 (a-b). Fits to the recreational (combined sex) length compositions from the CDFG CPFV onboard observer survey (top) and the Pearson residual plots (bottom).

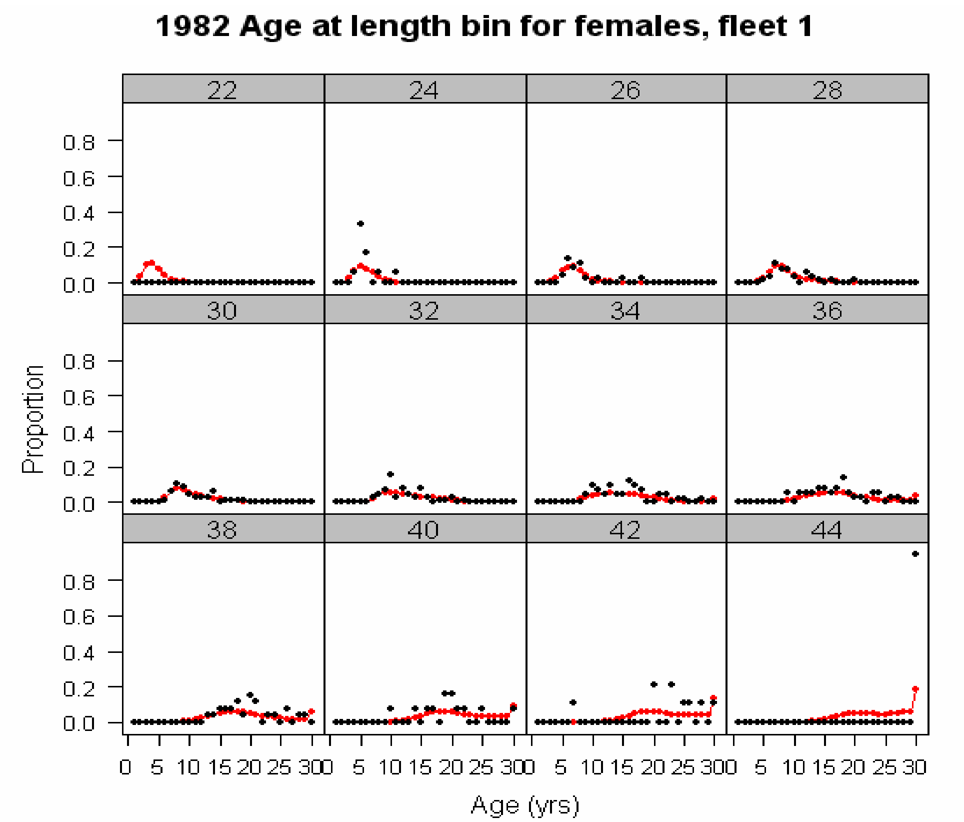


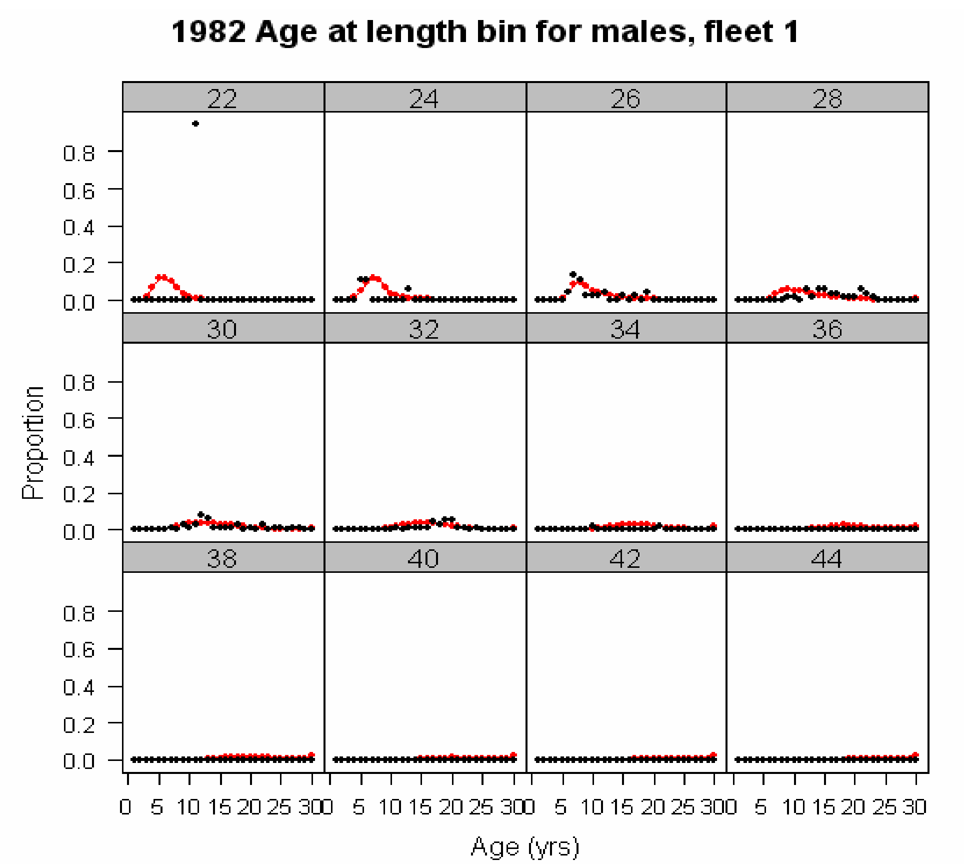
Figures 64 (a-b): Fits to conditional age-at-length data for 1980 females (top) and males (bottom) from the recreational fishery.



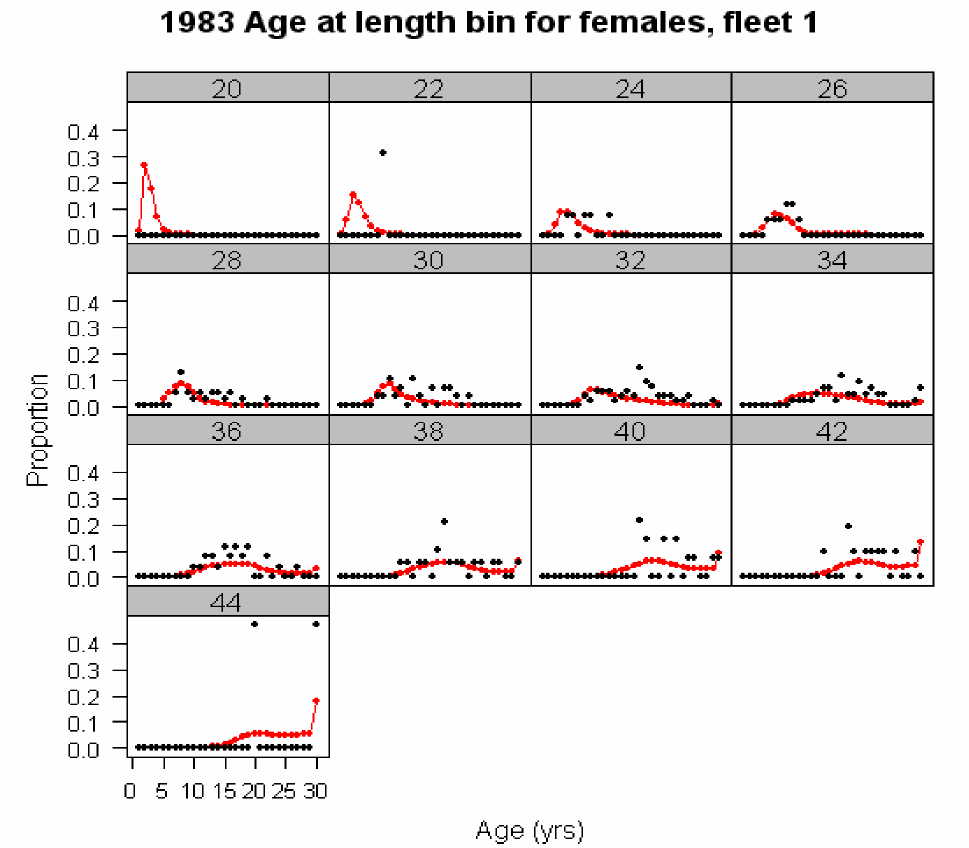


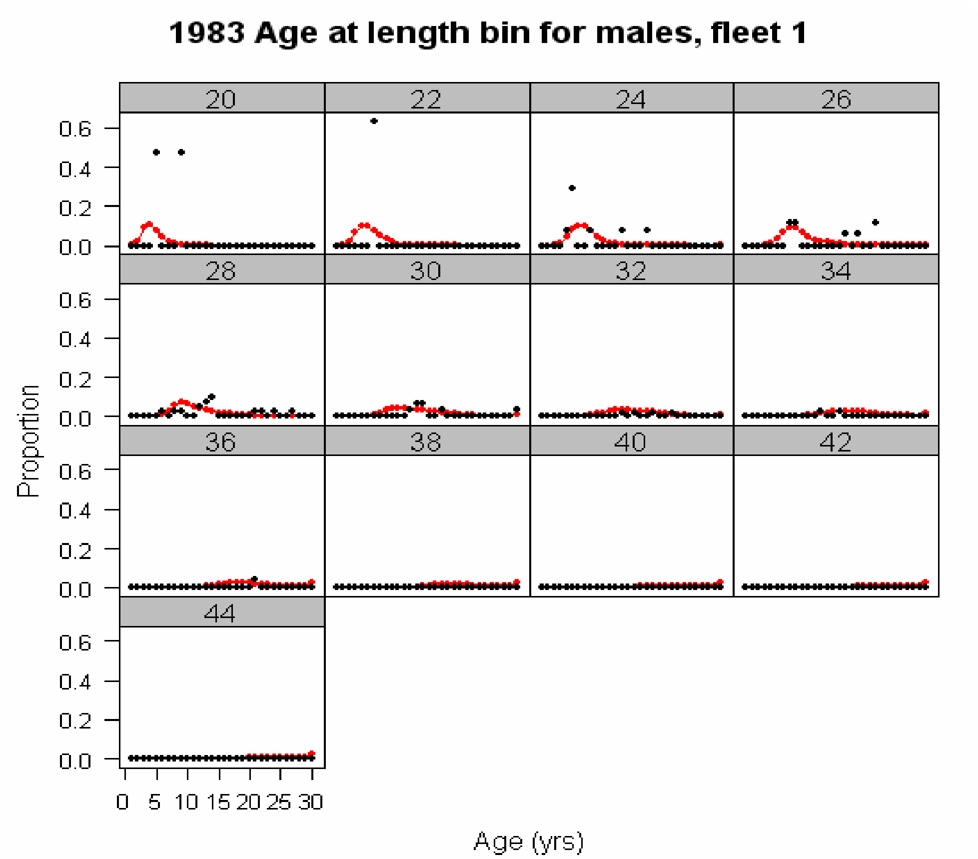
Figures 65 (a-b): Fits to conditional age-at-length data for 1981 females (top) and males (bottom) from the recreational fishery.



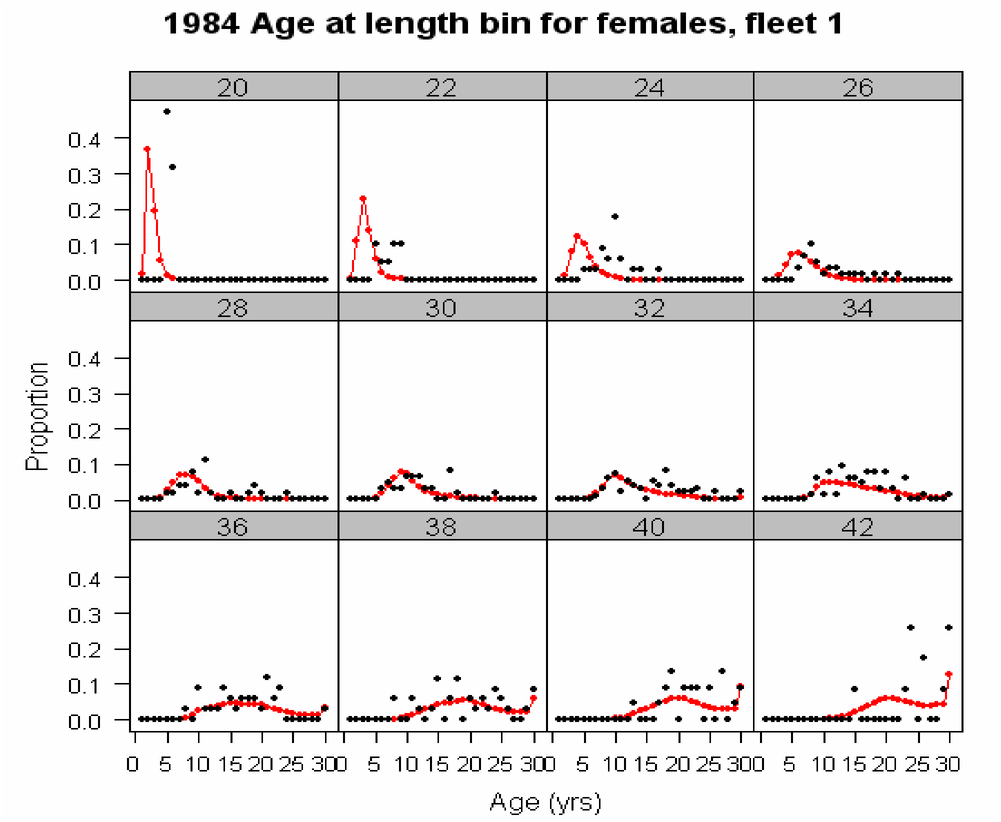


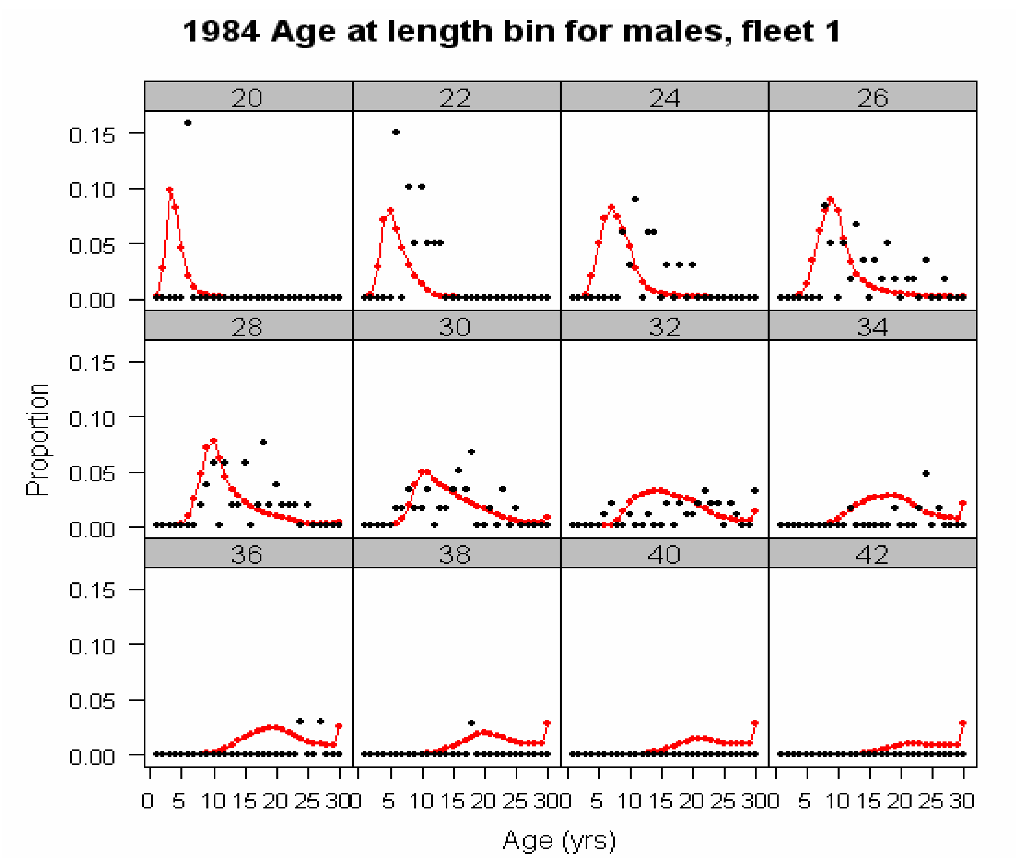
Figures 66 (a-b): Fits to conditional age-at-length data for 1982 females (top) and males (bottom) from the recreational fishery.



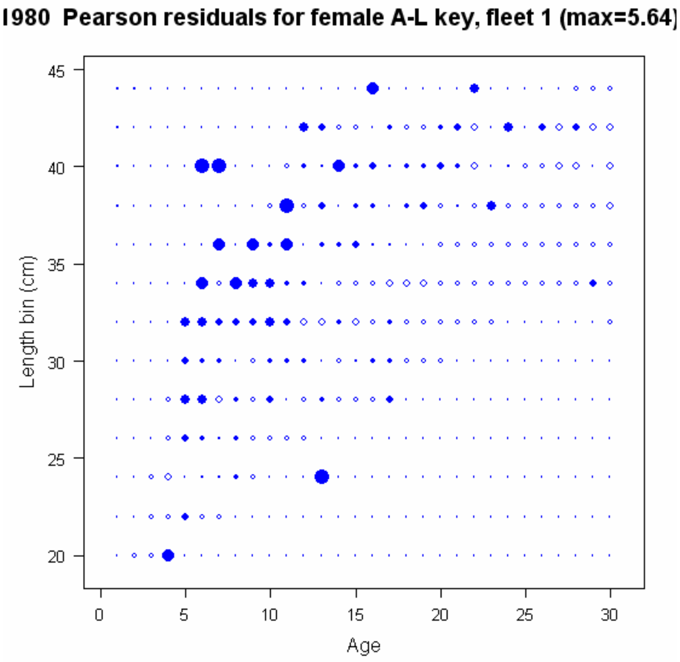


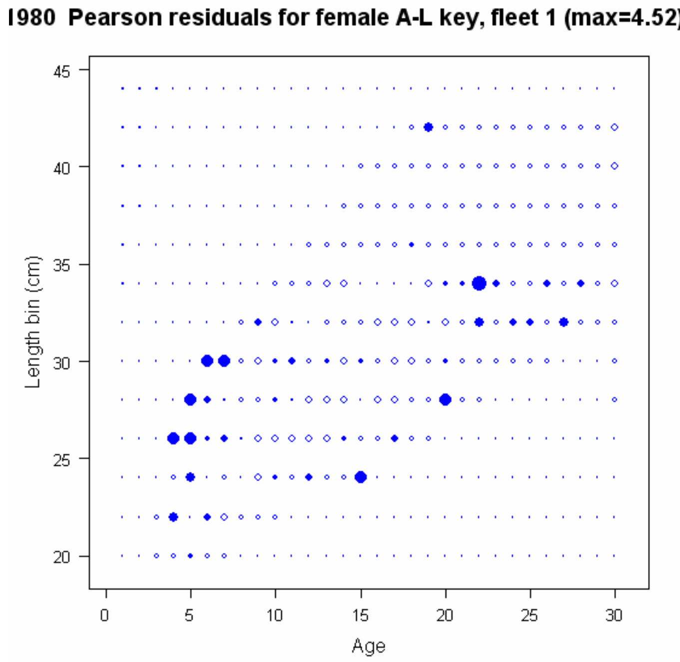
Figures 67 (a-b): Fits to conditional age-at-length data for 1983 females (top) and males (bottom) from the recreational fishery.

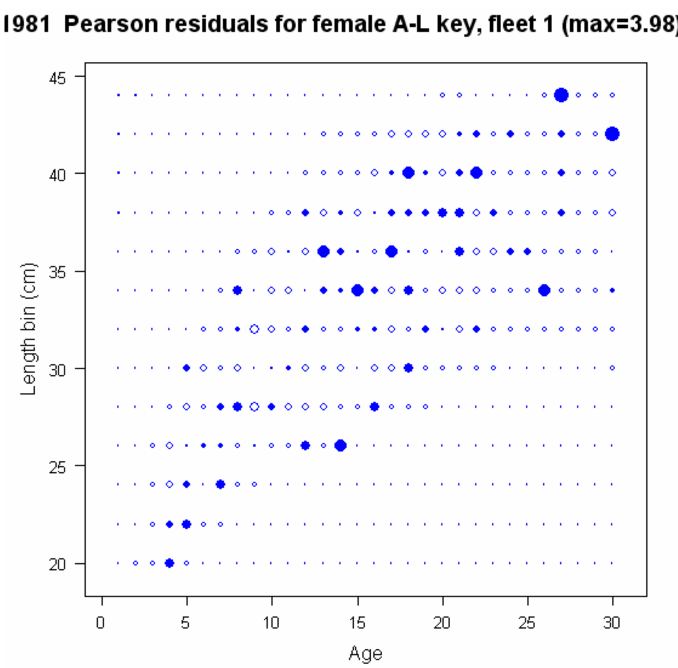


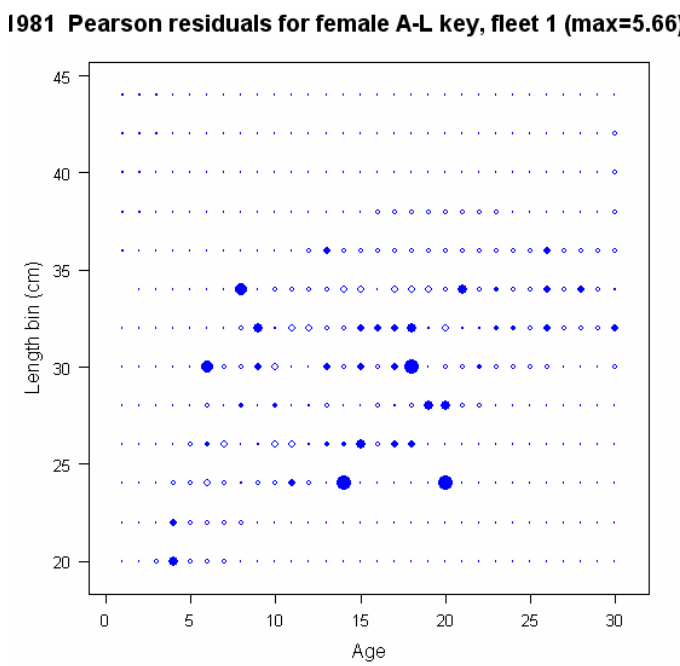


Figures 68 (a-b): Fits to conditional age-at-length data for 1984 females (top) and males (bottom) from the recreational fishery.

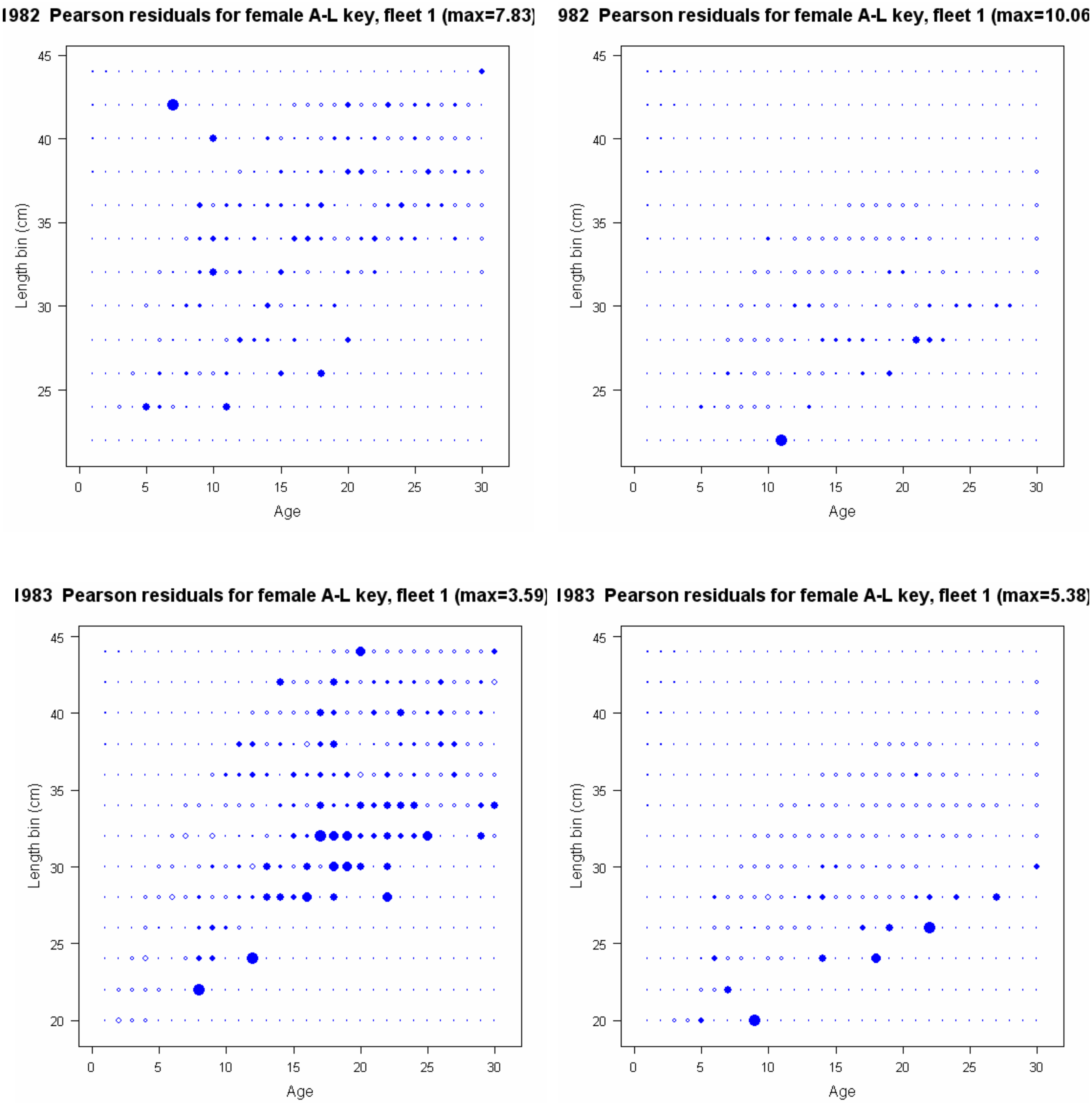




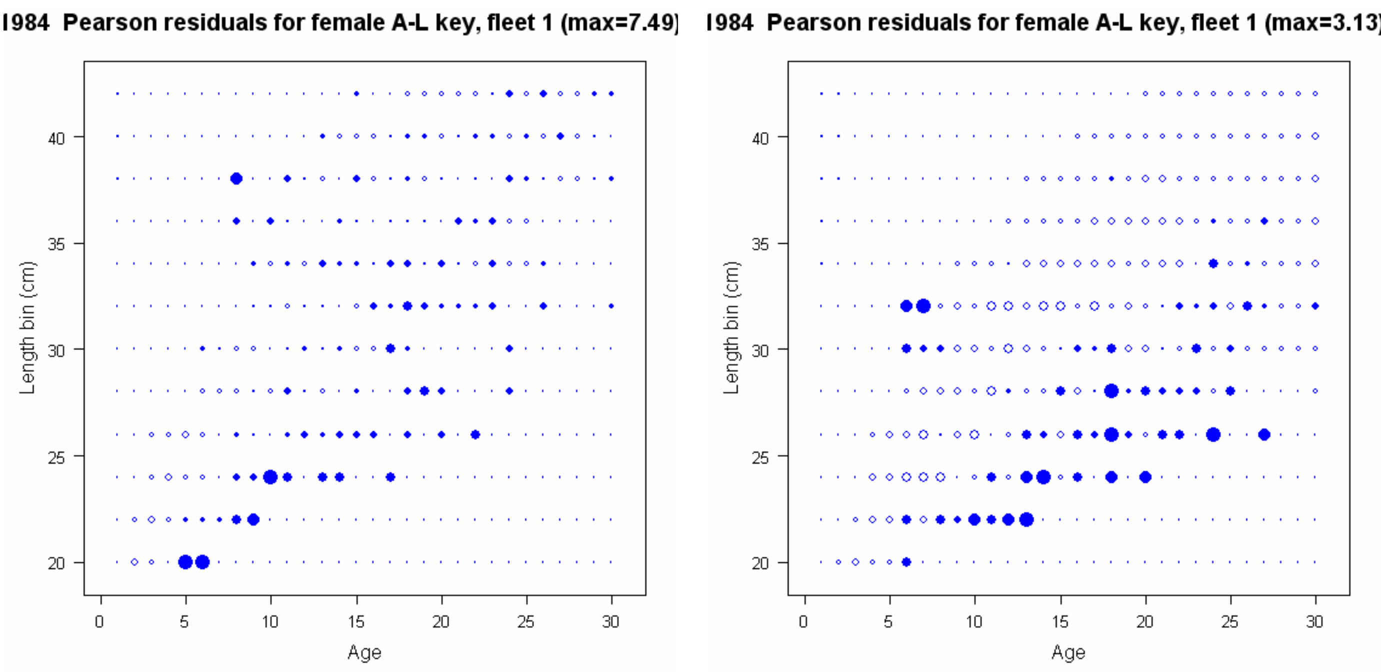


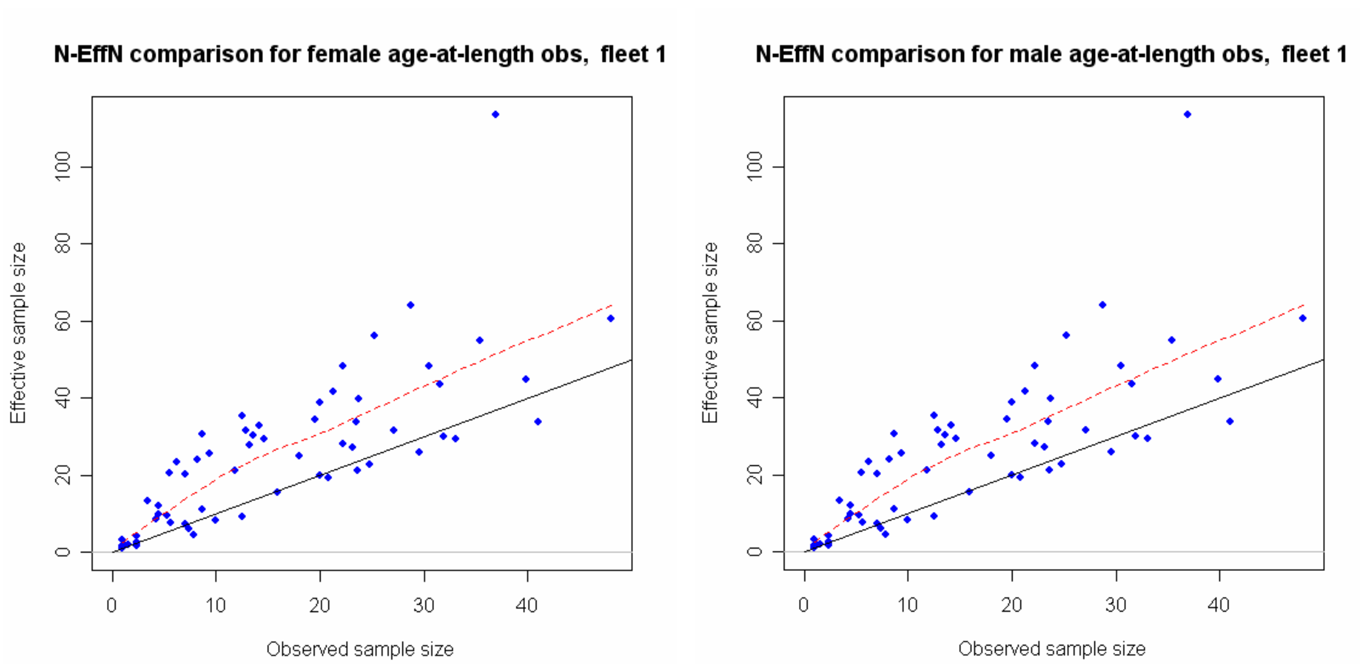


Figures 69 (a-d): Pearson residual plots from fits to age-at-length data by sex for 1980 (top) and 1981 (bottom). [***Note*** that figures on the left are for females, figures on right are for males. There was a slight labeling error in the graphics package.]

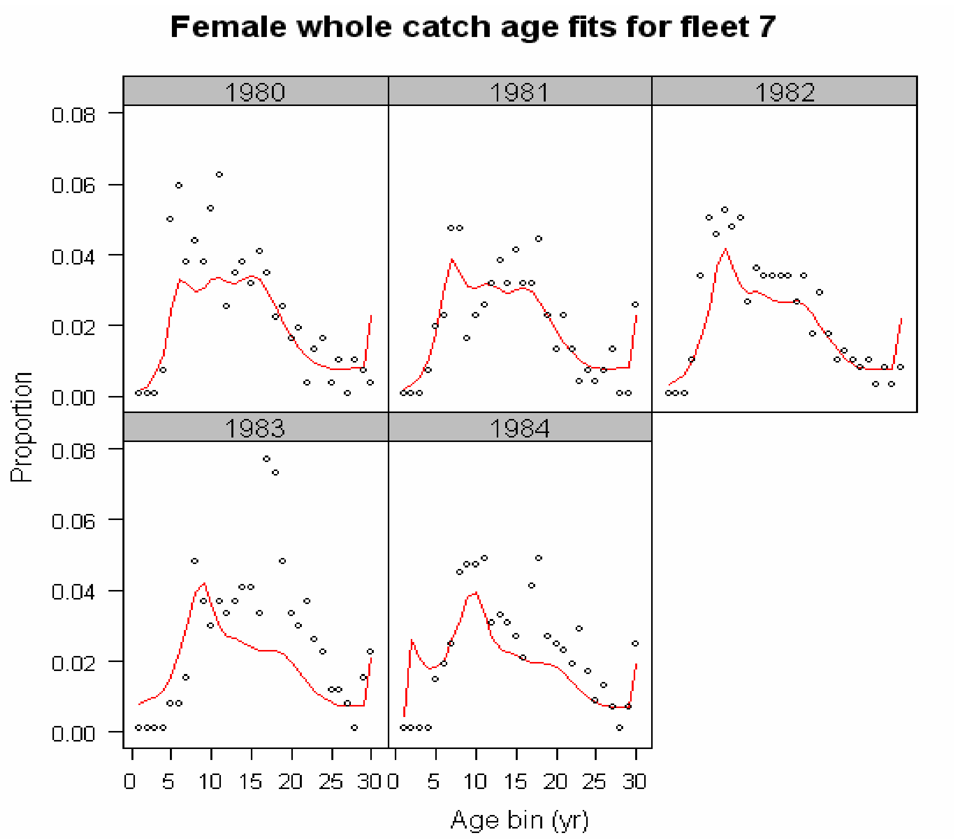


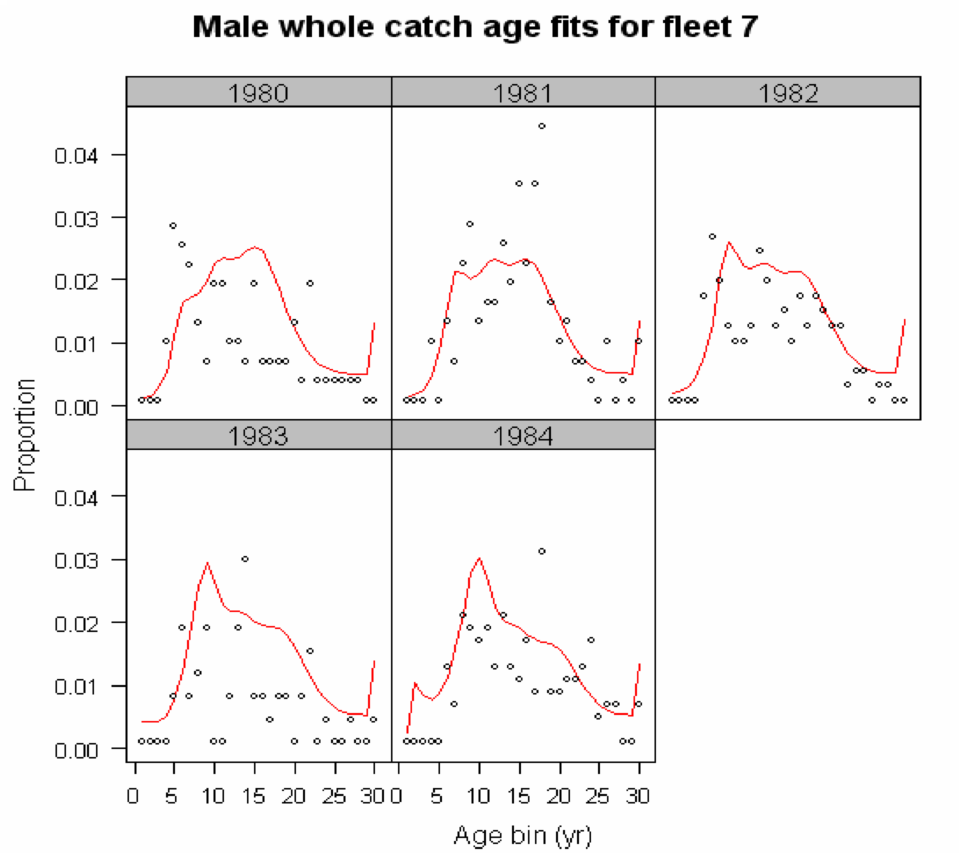
Figures 70 (a-d): Pearson residual plots from fits to age-at-length data by sex for 1982 (top) and 1983 (bottom). [***Note*** that figures on the left are for females, figures on right are for males. There was a slight labeling error in the graphics package.]



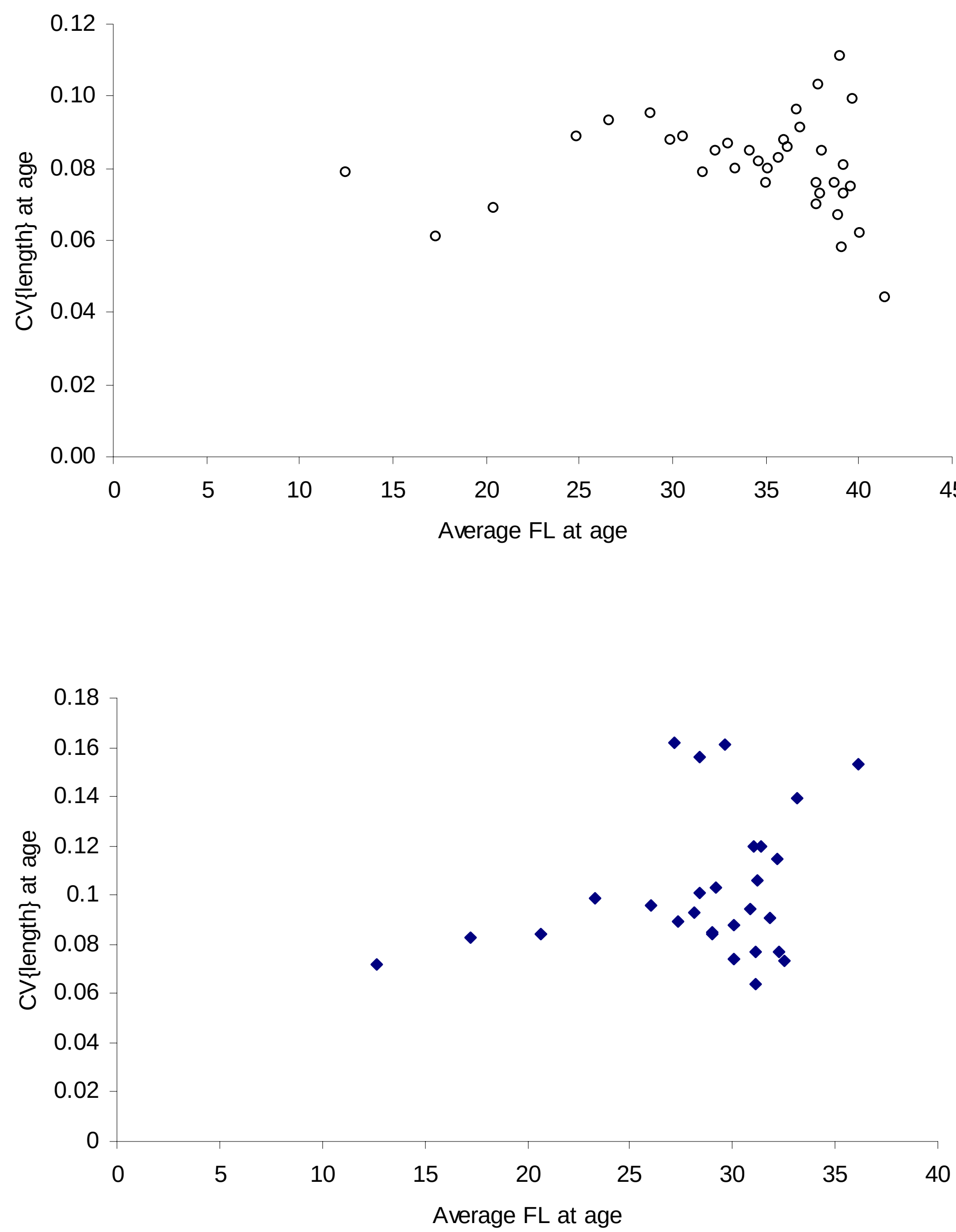


Figures 71 (a-b, top) and 72 (a-b, bottom). Pearson residual plots from fits to age-at-length data by sex for 1984 (top) and the observed and effective sample sizes for conditional age-at-length data (bottom). [***Note*** for top figures: left are for females, right are for males. There was a slight labeling error in the graphics package.]

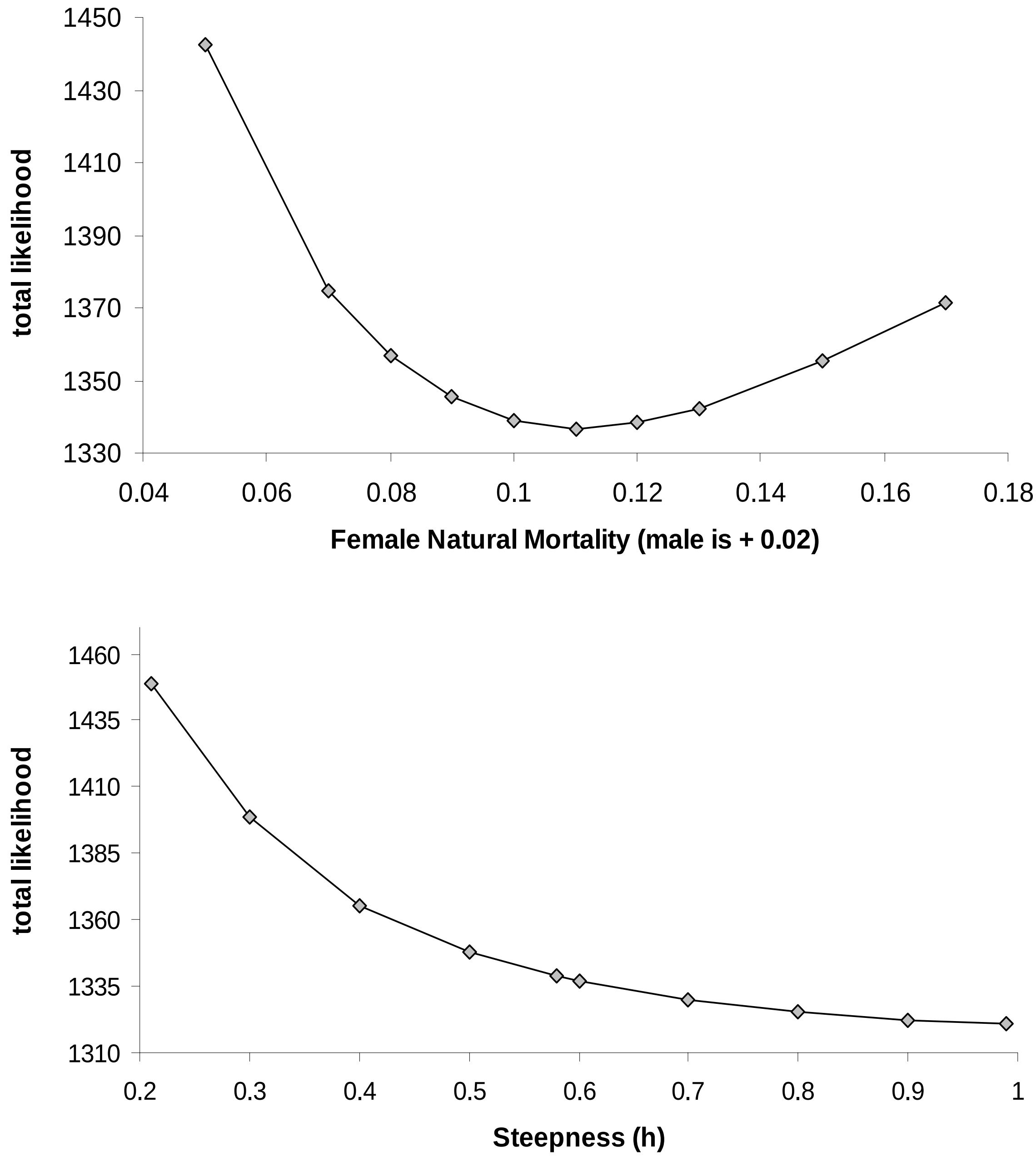




Figures 73 (a-b) : Marginal fits to age composition data (representing the conditional age-at-length data in a more traditional format by using a "ghost" fishery and mirrored selectivity to fleet 1, the recreational fishery) for females (top) and males (bottom).



Figures 74 (a-b). Externally estimated CVs for length at age for females (top) and males (bottom) using the 1980s recreational age data. The variation in growth from young to old for females appears to be more constant than males.



Figures 75 (a-b). Profiles for natural mortality (top) and steepness (bottom) for the final base model.

APPENDIX A

Pre-Assessment Data Workshop - Blue Rockfish

March 14, 2007
Monterey, CA 1:00-5:00

Participants:

Brian Cutting - Big Sur (recreational)
Ken Stagnaro - Santa Cruz (recreational)
Josh Churchman - Bolinas (commercial)
Bruce Miller - Crescent City (commercial)
Tom Mattusch - Half Moon Bay (recreational)
William Smith - Half Moon Bay (recreational)
Jim Martin - Ft. Bragg (recreational)

Meisha Key - CDFG
Alec MacCall - NMFS, SWFSC
Debbie Aseltine-Neilson - CDFG
Kirk Lynn - CDFG
Deb Wilson-Vandenberg - CDFG
Bob Leos - CDFG

Where are they?

In the Bolinas area, blue rockfish are present in offshore schools around underwater islands (pinnacles).

Near Half Moon Bay, @ Deep Reef, blues move around the reef out to 30-40 fm , with high numbers wherever found the slightest structure (e.g. small rock piles) and in shallow waters. They are all around the area in November, but by late fall had tailed off.

Groundswell surge pushes blues offshore and can also push them off reefs.

Small schools suspend (“hover”) off the bottom with the swell in Santa Cruz, out to about 40-45 fm. It is the surge itself, and not the turbidity that affects them.

Also in Santa Cruz, “deepwater blues” come and go; they are lighter in color.

Off Big Sur, large blues are seen 6-7 miles offshore outside the reef.

Large numbers of variably-sized blues are seen at multiple sites at Pt. St. George (Crescent City).

Juvenile rockfish trawl data suggest northward distribution trend, but it may be difficult to verify adult populations using subsequent fishery-dependent data (with targeting of catch and depth restrictions).

BLUE numbers

Blue rockfish are as prolific as when first seen. In the late 1970s, gill nets began targeting offshore reefs and pinnacles; by 1988 there were low abundances in these areas. The population has come back. (Bolinas)

Blues are rebounding in Half Moon Bay, but numbers are cyclic (due partly to moving around?). At Deep Reef, blues are prolific in shallow waters; the fishing is better than seen in years – haven't seen such numbers since the 1970s.

Increases seen in Santa Barbara, Morro Bay in recent years.

In southern CA, there has been noticeably colder water and an increase in # of fish.

From what has been heard and seen from divers, there have been more fish around the Channel Is – "filling in" areas where once inhabited (with onset of colder waters).

BLUE Biology

An important topic is what do blue rockfish eat and what eats them (predator-prey relationships).

(Bolinas) Blues feed on ctenophores, especially in the spring. Three solid year classes were observed of large fish (up to 3 lbs). They were pelagic, in areas with no kelp.

(Santa Cruz, Deep Reef - HMB) Blues do move around.

Food availability may fluctuate – greater in bays and canyon areas vs. where the coast is straight? Tied to the urchin fishery? As urchins are depleted, there is more kelp to provide a nursery area. Is there a kelp index? Kelp increases are not seen coastwide, however. Runoff is impacting kelp beds in some areas.

Two different morphs have been seen: "Alaskan blues" are hardier, hold their scales better, have larger spots (stripe?); "California blues" can't be kept alive as easily, and have a lighter color than Alaskan blues.

Catch Data comments

During the 1970s – 1988, many blues from the gillnet fishery did not show up in CALCOM (probably listed under "spp unidentified", "rockfish spp." categories).

The number of samplers for CPFVs has decreased significantly; in 1980s – 1990s, CPFV operators saw 3+ observers / week (however, most of these observers came from the central/northern CPFV study going on at that time).

The RecFIN data from the early 1980s seem too high, should be about 400 mt from 1980-1985. Blues were not targeted; other spp. were targeted and kept (could target others easily then, use bigger hooks). There was more effort from CPFVs then, but blues make up more of the catch now.

There was more trawl poundage taken than shows during the 1970s due to many midwater trawlers dumping blues. For 2 years in the 1970s (pre-Magnuson Act) there were Russian trawlers in the San Francisco and Monterey areas targeting hake taking more than 50 tons – much of this discarded. For a short time prior to 1976, joint venture (midwater shelf for widow, bocaccio, chilipeppers, blues in 1976) trawlers also were responsible for much catch, dumping blues. After 1976 the joint venture trawlers went north. Also, there were the domestic widow trawl fleet and local trawlers, with a discard/landed catch ratio of 1:1.

The commercial data from 1980-1988 seems too low. There was "heaven to earth" in the Farallons: blues and olives (no separation), along with blacks. One boat in Bolinas would take 20-30 tons (of blues). Commercial non-gillnet took 100,000 lbs (including blacks). The graph for commercial non-gillnet should use 400 mt from 1980-1988, dropping to 100 mt in 1990 and remaining there. We also may want to look at permits from 1980-1988 for longliners and gillnetters. There were 3 times as many longliners working than CPFVs prior to 1988 - then they got pushed out. During the 1980s there should be more gill net poundage than what is shown. For commercial gillnets, the "white van" catch should be 400 mt in 1980 down to 300 mt in 1986, and then dropping from there to 0 mt from 1988 on.

CenCAL data and rules (size, bag limits) need to be checked and evaluated for analysis prior to use in assessment. Divers can only keep 4 fish, and these must be at least 14" limit (therefore only gives catch of 14"+ fish/hr). Rules were roughly the same for all areas.

Fishery issues

Many larger blue rockfish are lost because they pop off hooks due to soft mouths, so catch may consist of smaller fish. However, large fish that pop up to surface because of extended gas bladders become "floaters" and will also be picked up. The experience of the fisherman plays a part in whether the big ones fall off hooks. It also depends on how the fish are feeding, if they are hungry or swiping at the hook. Their air bladders are out even at 20 fm. The blues are feisty in shallow water, and not so in deeper water.

In Bolinas, the live finfish fishery market is good, with demand high ($1.85/lb). North of 40 10, they are close and easy to catch. The public will buy 13-14", 1-1.5 lb fish. Blacks are targeted here, as most blues ("Alaskan Blues" excepted) don't make the trip to market in good enough shape. There is a limited potential for growth of blues in the live finfish fishery due to survivability to market.

In the Channel Is., MPAs have reduced the area where can fish. It would be good to include four areas for the stock assessment analysis.

Trawl nets took larger fish – caught all sizes but discarded small fish.

Regular gill nets took narrow range of fishes (large fish bounce off net and small ones swim through). Then gill netters started using trammel gill nets more in the San Francisco area; these trammel gill nets are able to take larger fish than regular gill nets.

The CPFV fishery is now more targeted towards blues because of depth restrictions and abundance of blues.

Participants comments

1. Had an opportunity to learn about stock assessments.
2. Getting information from fishermen is important – their views and opinions on catch #'s, which provide information from the field.
3. Science has lectured fishermen – want them to provide anecdotal information, then they go back to own data after leaving room. Today I feel if we're genuinely working together w/DFG.
4. There has been a large reduction in fisheries, with infrastructure falling apart (buyers).
5. First meeting where I feel we're all working together – providing input, feel that scientists/government is listening.
6. Glad I came, good to be involved with stock assessments.
7. Out of all stock assessment people, I appreciate work by Alec. For many spp. deal with data-poor situation, starting to see shift in getting fisherman's view; "B1 factor" – estimates are not correctly capturing take, constrains and puts fishermen into a box. I see we're moving into a more "realistic" place.
8. Helpful to take anecdotal information and put into quantitative terms. Look forward to review process and reviewers' opinions on use of anecdotal data.
9. Good, interesting.
10. Chance to listen to recreational fishermen since I work more w/commercial. Nice to see the willingness for Stock Assessment Team (STAT) to hear changes regarding catch.

Written comments were received by the following who did not attend the workshop:

David Allen
Kenyon Hensel
Gerry Richter
Jim Webb

APPENDIX B

ASSESSMENT OF BLUE ROCKFISH *(Sebastes mystinus)* IN CALIFORNIA

STAR PANEL
May 21, 2007

MODEL SELECTION - Comparison of ASPIC and SS2

Initial attempts to develop an SS2 model of Blue rockfish were inconclusive. The model was set up as a stock reduction analysis, i.e., driven by a stock-recruitment relationship with no variability (recruit devs were turned off). The model did not search the parameter space effectively, probably due to combined properties of a flat response surface, and nearness of the maximum likelihood value to the region where a "crash penalty" is invoked. The "crash penalty" results from parameter sets that cause catches to exceed the model's estimate of fish available to be caught.

Aside from the fact that we resorted to the ASPIC production model because we were unable to obtain a properly functioning SS2 model (which is probably not a fault of the SS2 model), there are also some comparative virtues in the production model approach. The following discussion relates to a data-poor specification of a SS2 model as attempted for blue rockfish, and does not necessarily reflect properties of other SS2 implementations that could be attempted in more data-rich situations.

Catch uncertainty: The magnitude of the catch is a major uncertainty in the case of blue rockfish, even to the extent that it is the basis of our proposed decision table, which will be discussed further in this document. SS2 makes the assumption that catch is known without error, which may be an important model mis-specification in this context. In contrast, ASPIC emphasizes fitting the catch series, which is especially appropriate in the case of uncertain catches. In this regard, ASPIC may theoretically be the better specified model, but in practice, sensitivity to this aspect of model specification is not known, but is evaluated here.

Model rigidity and the virtual population constraint: A commonly encountered problem in stock reduction models is the SS2 "crash penalty" which is invoked when modeled abundance of available fish is insufficiently large to support the observed subsequent removals. We will call this the virtual population (VP) constraint, in that the lower bound of estimated abundance is constrained by a minimum virtual population size related to the sum of subsequent observed catches (i.e., the population could not have been smaller than the amount of fish we actually took from it). Importantly, in the absence of the "crash penalty" in SS2, or some other model specification to deal with this problem, the VP constraint can exist independently of the likelihood function, preventing an efficient search of the likelihood response surface for a maximum value. In some cases, the "theoretical" maximum likelihood value can lie on the prohibited side of the VP constraint (A. MacCall, personal observation), resulting in severe estimation difficulties.

Although production models can also encounter the VP constraint, the detailed internal demographic structure of SS2 can make stock reduction model implementations prone to estimation problems associated with this constraint, e.g., in the 2005 cowcod assessment (Piner et al. 2005). In reality, fishery selectivity curves tend to adapt to the demographics of available fish, so that when large fish become rare, full selectivity often shifts to a smaller size. Also, geographic variability in growth curves can produce catches with size compositions that are difficult to portray in a single homogeneous SS2 representation. For blue rockfish we lack the data to model these fishery and resource behaviors in SS2, and must settle for an overly rigid treatment of time and space-invariant growth and selectivity curves. In contrast, the less explicit ASPIC model does not attempt to account for such detailed demographic differences among catch compositions from various fishery segments, which may in some ways be less realistic, but also makes it less vulnerable to estimation problems associated with the VP constraint.

Unknown demographics: Both ASPIC and SS2, in the present specification as a stock reduction analysis, model the same fundamental process of a deterministic production function based on resource abundance, and simple periodic removals of catch. ASPIC assumes that the catch and abundance index reflect similar but unspecified demographics to the extent that the absolute reduction in abundance is proportional to catch. In contrast, SS2 contains a detailed age and size-structured demographic model of the resource and individual fishery segments, which is necessarily over-simplified in the data-poor case of blue rockfish. Important demographic parameters, such as the natural mortality rate, are unknown and cannot be estimated in the present context, so values are assumed (based on conventional rules-of-thumb) but are treated as known constants in SS2. In contrast, a production model does not require some of these assumptions.

Management reference points: The detailed demographic model in SS2 allows calculation of management reference values, such as SPR that are used in the management of fishing mortality rates west coast groundfish. ASPIC produces a different but analogous measure of fishing mortality rate, relative to the Fmsy specified by the underlying production function (logistic or generalized). It can be argued that the Fmsy reference point from ASPIC is at least based on blue rockfish data, whereas the west cost groundfish proxy reference point of SPR=50% is a generic value for all rockfish, and is not based on blue rockfish data at all.

Beverton-Holt steepness: Steepness, as currently considered in assessment of west coast groundfish, is a property of the Beverton-Holt SRR, which itself is a conventionally assumed rather than objectively determined specification of groundfish models. Other stock-recruitment relationships have been considered in a meta-analytic context (Dorn 2002), and have been shown to be statistically indistinguishable. (It is interesting to note that the difference between a Beverton-Holt SRR and a Ricker SRR becomes progressively smaller as steepness declines, and the currently favored prior distribution of steepness is even lower than previously found by Dorn, and is extraordinarily low in comparison to other world fisheries.) The implicit stock-recruitment relationship underlying an ASPIC model fit would almost certainly be statistically indistinguishable from any SRR fit to blue rockfish by an SS2 model. Consideration of alternative values of steepness (including the currently favored steepness prior distribution) has an analog in exponents used in the generalized production model. However, there is no simple relationship between ASPIC and SS2 that can be compared quantitatively because each SRR is no longer invariant when it is considered in the demographic context of the alternative model. Approximate comparisons could be attempted, but time has not allowed this to be explored. In this regard, experience has shown that the logistic case of ASPIC is robust (Prager, ASPIC documentation).

ASPIC 5.10.3

The available data were well-suited for the use of a production model. We used a stock production model incorporating covariates (ASPIC_Version 5.10.3, May 2007) (Prager 1994) that was available in NOAA's toolbox: http://nft.nefsc.noaa.gov/. Where version 3 would estimate parameters of a non-equilibrium solution to a Schaefer logistic production model, version 5 has the ability to fit the Pella-Tomlinson generalized model in the revised parameterization of Fletcher (Prager 2004). Ludwig and Walters (1985) concluded that "simple production models should often be used in stock assessments based on catch/effort data, even when more realistic and structurally correct models are available to the analyst."

The estimated parameters consist of K (the stock's carrying capacity), MSY, ratio of B_1/K (beginning biomass relative to K), and a catchability coefficient for each abundance index series (q_i) for the Schaefer logistic model. When parameter B_1/K is estimated freely, the estimated biomasses are unrealistically small relative to the unfished state. Accordingly we use a value of B_1/K that was fixed at a value of 0.77, which is plausible, given the lack of a targeted fishery before 1969. We explored a range of values (0.1, 0.2, … 1.0) and found that values from 0.77 and 1.0 did not alter the ending results (Table 1). Punt (1990) determined that pre-specifying B_1 substantially improved the performance of a production model in a case like this.

Table 1. Exploration of beginning values for B1/K for the logistic (Shaefer) surplus-production model (ASPIC_v5.10.3). Average catches (|(original estimated + fishermen recommended)/2) were used for these runs.

	current biomass	unfished biomass	% unfished biomass	MSY
$B_1/K = 0.77$	1904	3999	0.48	700
$B_1/K = 0.78$	1905	3996	0.48	700
$B_1/K = 0.79$	1904	3998	0.48	700
$B_1/K = 0.8$	1902	3992	0.48	700
$B_1/K = 0.9$	1908	3986	0.48	699
$B_1/K = 1.0$	1907	3981	0.48	699

Base Model

The base model uses an intermediate catch series from 1969 to 2006, which is the average of the fishermen-supplied estimates and the documented landings from various sources. The CPUE series is based on RecFIN data from 1980 to 2006, with some missing years. This index was originally based on numbers of fish caught per angler hour, rather than biomass, and even though Prager and Goodyear (2001) found that production model performance was "surprisingly robust" to use of mixed-metric data, we multiplied each index by the average annual weight to base it on biomass. B_1/K is fixed at 0.77. Detailed results are given in the attached ASPIC output. Current biomass is estimated to be at 1905 mtons, which is 48 percent of unfished abundance. MSY is estimated to be 700 mtons, compared with a 2006 total catch of 341.5 mtons.

Baseline model results of fits and estimated F using average catches.
Number of bootstrap trials = 500.

Year	Obs CPUE	Est. CPUE	Est. F	Obs yield	Model yield	Resid in log scale
1969		0.99	0.070	223.00	223.00	0.000
1970		1.05	0.072	244.00	244.00	0.000
1971		1.06	0.097	334.00	334.00	0.000
1972		1.06	0.116	395.00	395.00	0.000
1973		1.01	0.197	643.00	643.00	0.000
1974		0.93	0.276	829.00	829.00	0.000
1975		0.83	0.353	947.00	947.00	0.000
1976		0.78	0.262	662.00	662.00	0.000
1977		0.76	0.320	786.00	786.00	0.000
1978		0.74	0.285	683.00	683.00	0.000
1979		0.72	0.353	818.00	818.00	0.000
1980	0.51	0.67	0.403	870.00	870.00	0.272
1981	0.76	0.59	0.545	1034.00	1034.00	-0.258
1982	0.80	0.49	0.605	959.00	959.00	-0.488
1983	0.51	0.40	0.705	909.00	909.00	-0.244
1984	0.40	0.32	0.745	766.00	766.00	-0.228
1985	0.34	0.25	0.796	649.00	649.00	-0.297
1986	0.07	0.23	0.560	408.00	408.00	1.171
1987	0.14	0.22	0.634	451.00	451.00	0.453
1988	0.11	0.20	0.683	449.00	449.00	0.616
1989	0.09	0.20	0.519	336.00	336.00	0.802
1990		0.23	0.387	285.00	285.00	0.000
1991		0.29	0.273	252.00	252.00	0.000
1992		0.30	0.697	672.00	672.00	0.000
1993	0.18	0.21	1.153	776.00	776.00	0.147
1994	0.15	0.14	0.829	375.00	375.00	-0.068
1995	0.30	0.13	0.611	251.00	251.00	-0.858
1996	0.23	0.14	0.464	208.00	208.00	-0.504
1997		0.14	0.820	360.00	360.00	0.000
1998		0.11	0.818	297.00	297.00	0.000
1999	0.24	0.10	0.741	234.00	234.00	-0.897
2000	0.10	0.10	0.517	166.00	166.00	-0.005
2001	0.06	0.12	0.340	135.00	135.00	0.717
2002	0.34	0.16	0.314	167.00	167.00	-0.726
2003	0.19	0.22	0.329	229.00	229.00	0.126
2004	0.32	0.29	0.173	164.00	164.00	-0.086
2005	0.34	0.41	0.137	184.00	184.00	0.199
2006	0.46	0.54	0.197	341.00	341.00	0.156

Baseline model results for F/Fmsy and B/Bmsy using average catches.
Number of bootstrap trials = 500.

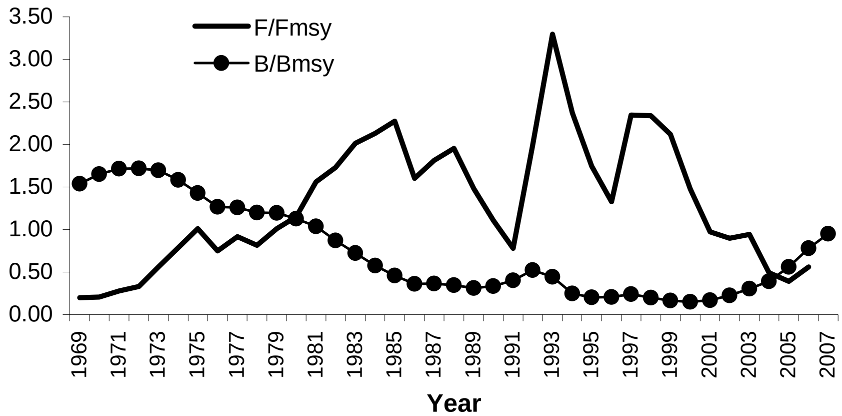
ESTIMATED POPULATION TRAJECTORY

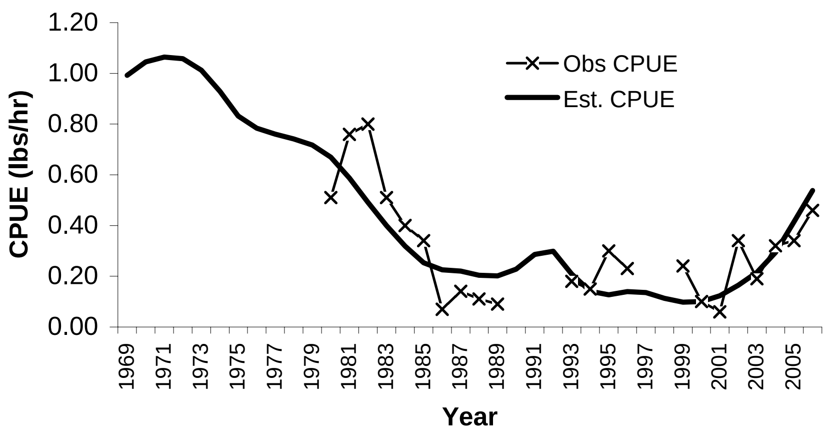
Year	Est. Total F Mort	Est. Beg. Biomass	Est. Avg Bio	Obs Tot Yield	Model Tot Yield	Est. Surplus Prod	F/Fmsy	B/Bmsy
1969	0.07	3082.00	3203.00	223.00	223.00	446.80	0.20	1.54
1970	0.072	3306.00	3375.00	244.00	244.00	370.10	0.21	1.65
1971	0.097	3432.00	3436.00	334.00	334.00	340.50	0.28	1.72
1972	0.116	3439.00	3414.00	395.00	395.00	351.00	0.33	1.72
1973	0.197	3395.00	3270.00	643.00	643.00	417.90	0.56	1.70
1974	0.276	3170.00	3001.00	829.00	829.00	523.90	0.79	1.58
1975	0.353	2864.00	2683.00	947.00	947.00	617.00	1.01	1.43
1976	0.262	2534.00	2529.00	662.00	662.00	651.20	0.75	1.27
1977	0.32	2524.00	2457.00	786.00	786.00	663.20	0.91	1.26
1978	0.285	2401.00	2395.00	683.00	683.00	672.70	0.82	1.20
1979	0.353	2391.00	2317.00	818.00	818.00	682.10	1.01	1.19
1980	0.403	2255.00	2160.00	870.00	870.00	694.90	1.15	1.13
1981	0.545	2080.00	1896.00	1034.00	1034.00	696.20	1.56	1.04
1982	0.605	1742.00	1585.00	959.00	959.00	668.30	1.73	0.87
1983	0.704	1451.00	1290.00	909.00	909.00	610.10	2.02	0.73
1984	0.745	1152.00	1028.00	766.00	766.00	533.50	2.13	0.58
1985	0.796	919.60	815.70	649.00	649.00	453.60	2.28	0.46
1986	0.56	724.20	728.70	408.00	408.00	416.80	1.60	0.36
1987	0.634	733.00	711.30	451.00	451.00	408.90	1.81	0.37
1988	0.683	690.90	657.30	449.00	449.00	384.10	1.95	0.35
1989	0.519	626.00	648.00	336.00	336.00	379.70	1.48	0.31
1990	0.387	669.70	736.60	285.00	285.00	420.00	1.11	0.33
1991	0.273	804.70	924.80	252.00	252.00	496.40	0.78	0.40
1992	0.697	1049.00	964.30	672.00	672.00	511.50	1.99	0.52
1993	1.153	888.50	673.10	776.00	776.00	389.30	3.30	0.44
1994	0.829	501.90	452.30	375.00	375.00	280.40	2.37	0.25
1995	0.611	407.30	410.60	251.00	251.00	257.70	1.75	0.20
1996	0.464	413.90	448.70	208.00	208.00	278.50	1.33	0.21
1997	0.82	484.50	439.10	360.00	360.00	273.20	2.35	0.24
1998	0.817	397.70	363.30	297.00	297.00	230.90	2.34	0.20
1999	0.741	331.60	316.00	234.00	234.00	203.50	2.12	0.17
2000	0.517	301.10	321.10	166.00	166.00	206.50	1.48	0.15
2001	0.34	341.60	396.90	135.00	135.00	249.80	0.97	0.17
2002	0.314	456.50	531.30	167.00	167.00	321.90	0.90	0.23
2003	0.329	611.30	695.70	229.00	229.00	401.50	0.94	0.31
2004	0.173	783.80	948.50	164.00	164.00	504.40	0.49	0.39
2005	0.137	1124.00	1339.00	184.00	184.00	620.30	0.39	0.56
2006	0.196	1560.00	1736.00	341.00	341.00	685.70	0.56	0.78
2007		1905.00						0.95

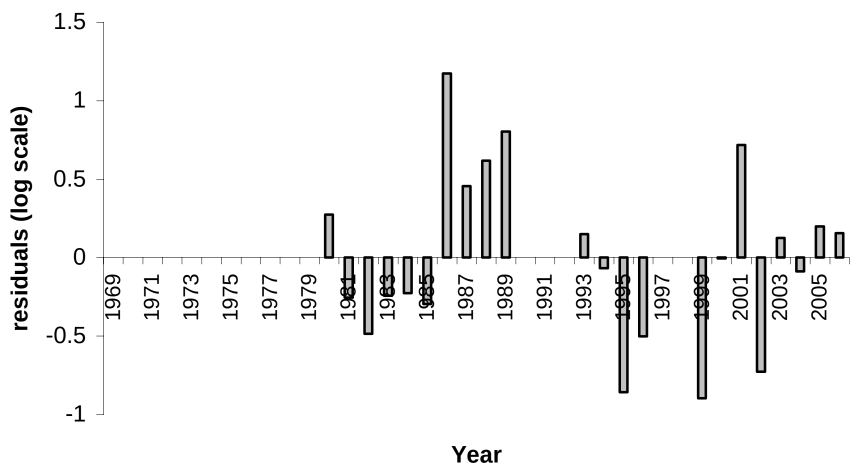
Baseline model reference point results using average catches. Number of bootstrap trials = 500.
CV from the bootstrap distribution = 0.32

	Point Est.	Est. bias in Pt. Est.	Est. rel. bias	Bias-corrected Approximate CLs 80% L	80% U	50% L	50% U	Inter-quartile range	Rel. IQ range
B1/K	0.77	0.00	0.00%	0.77	0.77	0.77	0.77	0.00	0.000
K	4003.00	256.10	6.40%	3856.00	4972.00	3881.00	4271.00	389.30	0.097
q(1)	0.00	0.00	-2.31%	0.00	0.00	0.00	0.00	0.00	0.277
MSY	699.80	-9.26	-1.32%	651.70	707.50	686.10	706.10	20.05	0.029
Ye(2007)	698.10	-53.11	-7.61%	682.80	711.00	699.30	708.60	9.30	0.013
Y.@Fmsy	666.10	-21.08	-3.16%	464.40	928.30	562.40	815.90	253.60	0.381
Bmsy	2002.00	128.00	6.40%	1928.00	2486.00	1941.00	2135.00	194.60	0.097
Fmsy	0.35	-0.02	-4.79%	0.26	0.37	0.32	0.36	0.04	0.120
fmsy(1)	1129.00	7.13	0.63%	1031.00	1480.00	1099.00	1359.00	259.40	0.230
B./Bmsy	0.95	-0.02	-2.42%	0.66	1.31	0.79	1.14	0.35	0.364
F./Fmsy	0.56	0.07	11.88%	0.39	0.82	0.46	0.67	0.21	0.373
Ye./MSY	1.00	-0.06	-6.25%	0.99	1.00	1.00	1.00	0.00	0.001

Figures for baseline model results of F/Fmsy, B/Bmsy, fit to the CPUE index and residuals. Actual values represented in previous tables.







Sensitivity Analysis

Three different catch series were considered in this assessment. First, the original estimates that were provided from various sources (ie. RecFIN, CALCOM). Secondly, recommended catches that were received during a Data Workshop with fishermen that have a history in the blue rockfish fishery (details in the draft document). Lastly, the average of the two series that were used in the baseline model. Considering there is uncertainty in all of these estimates, we ran sensitivities on the original estimates and the fishermens recommended catch series. Table ? provides the catch scenarios used in the baseline model and the described sensitivity analysis.

Catch streams considered in this assessment. Estimated catches came from RecFIN and CALCOM data sources. Fishermen's catches came from recommendations of fishermen that attended the Data Workshop for blue rockfish. Average catches is the average between the two and were used in the baseline model.

	Estimated Catches				**Fishermen's recommended Catches**				**Average Catches**			
Year	Recreational	Comm - Hook & Line	Comm - Gillnet	*total*	Recreational	Comm - Hook & Line	Comm - Gillnet	*total*	Recreational	Comm - Hook & Line	Comm - Gillnet	*total*
5 yr avg	***388.2***	***15.3***	***28.2***	*431.7*	***103.6***	***104.4***	***95.6***	*303.6*	***245.9***	***59.8***	***61.9***	*367.6*
1969	128.8	11.0	3.5	*143.3*	103.6	159.0	41.0	*303.6*	116.2	85.0	22.2	*223.4*
1970	164.9	14.0	4.5	*183.3*	103.6	159.2	40.8	*303.6*	134.2	86.6	22.6	*243.4*
1971	326.9	10.6	26.0	*363.5*	103.6	68.1	131.9	*303.6*	215.2	39.3	79.0	*333.5*
1972	436.6	16.7	32.2	*485.5*	103.6	79.1	120.9	*303.6*	270.1	47.9	76.5	*394.5*
1973	884.1	24.3	74.7	*983.1*	103.6	56.4	143.6	*303.6*	493.8	40.3	109.1	*643.3*
1974	1149.1	22.2	106.5	*1277.7*	129.4	53.3	196.7	*379.4*	639.3	37.7	151.6	*828.6*
1975	1294.3	25.7	119.2	*1439.3*	155.3	68.8	231.2	*455.3*	724.8	47.2	175.2	*947.3*
1976	644.3	33.0	39.1	*716.5*	207.1	211.4	188.6	*607.1*	425.7	122.2	113.8	*661.8*
1977	730.8	29.7	52.2	*812.7*	258.9	220.2	279.8	*758.9*	494.9	124.9	166.0	*785.8*
1978	409.3	29.1	16.8	*455.1*	310.7	456.8	143.2	*910.7*	360.0	242.9	80.0	*682.9*
1979	515.1	44.3	13.3	*572.8*	362.5	560.8	139.2	*1062.5*	438.8	302.6	76.3	*817.6*
1980	487.0	49.8	2.3	*539.1*	400.0	400.0	400.0	*1200.0*	443.5	224.9	201.1	*869.6*
1981	826.5	65.7	1.2	*893.4*	400.0	375.0	400.0	*1175.0*	613.2	220.3	200.6	*1034.2*
1982	707.7	60.6	0.5	*768.8*	400.0	350.0	400.0	*1150.0*	553.9	205.3	200.2	*959.4*
1983	661.2	55.3	0.8	*717.4*	400.0	325.0	375.0	*1100.0*	530.6	190.2	187.9	*908.7*
1984	469.2	11.5	1.3	*482.0*	400.0	300.0	350.0	*1050.0*	434.6	155.8	175.7	*766.0*
1985	261.7	39.9	134.5	*436.1*	261.7	275.0	325.0	*861.7*	261.7	157.5	229.7	*648.9*
1986	124.7	3.0	12.8	*140.6*	124.7	250.0	300.0	*674.7*	124.7	126.5	156.4	*407.7*
1987	258.9	7.8	0.4	*267.2*	258.9	225.0	150.0	*633.9*	258.9	116.4	75.2	*450.6*
1988	307.1	7.7	0.1	*314.9*	307.1	200.0	75.0	*582.1*	307.1	103.9	37.6	*448.5*
1989	245.0	17.4	14.1	*276.4*	245.0	150.0	0.0	*395.0*	245.0	83.7	7.0	*335.7*
1990	221.1	26.9	1.5	*249.6*	221.1	100.0	0.0	*321.1*	221.1	63.5	0.8	*285.3*
1991	183.7	35.4	1.4	*220.5*	183.7	100.0	0.0	*283.7*	183.7	67.7	0.7	*252.1*
1992	490.3	181.4	0.0	*671.8*	490.3	181.4	0.0	*671.8*	490.3	181.4	0.0	*671.8*
1993	643.0	134.3	0.3	*777.6*	643.0	134.3	0.0	*777.3*	643.0	134.3	0.2	*777.5*
1994	305.8	69.2	0.0	*375.1*	305.8	69.2	0.0	*375.0*	305.8	69.2	0.0	*375.1*
1995	216.3	34.7	0.0	*251.0*	216.3	34.7	0.0	*251.0*	216.3	34.7	0.0	*251.0*
1996	164.0	44.0	0.1	*208.1*	164.0	44.0	0.0	*208.0*	164.0	44.0	0.0	*208.1*
1997	296.1	63.7	0.0	*359.7*	296.1	63.7	0.0	*359.7*	296.1	63.7	0.0	*359.7*
1998	249.4	47.9	0.0	*297.3*	249.4	47.9	0.0	*297.3*	249.4	47.9	0.0	*297.3*
1999	198.6	35.7	0.1	*234.4*	198.6	35.7	0.0	*234.3*	198.6	35.7	0.0	*234.3*
2000	150.7	15.6	0.0	*166.3*	150.7	15.6	0.0	*166.3*	150.7	15.6	0.0	*166.3*
2001	115.6	19.7	0.0	*135.3*	115.6	19.7	0.0	*135.3*	115.6	19.7	0.0	*135.3*
2002	148.8	18.5	0.0	*167.4*	148.8	18.5	0.0	*167.4*	148.8	18.5	0.0	*167.4*
2003	219.9	9.2	0.0	*229.1*	219.9	9.2	0.0	*229.1*	219.9	9.2	0.0	*229.1*
2004	149.9	14.8	0.0	*164.6*	149.9	14.8	0.0	*164.6*	149.9	14.8	0.0	*164.6*
2005	162.9	21.7	0.0	*184.6*	162.9	21.7	0.0	*184.6*	162.9	21.7	0.0	*184.6*
2006	319.6	21.9	0.0	*341.4*	319.6	21.9	0.0	*341.4*	319.6	21.9	0.0	*341.4*

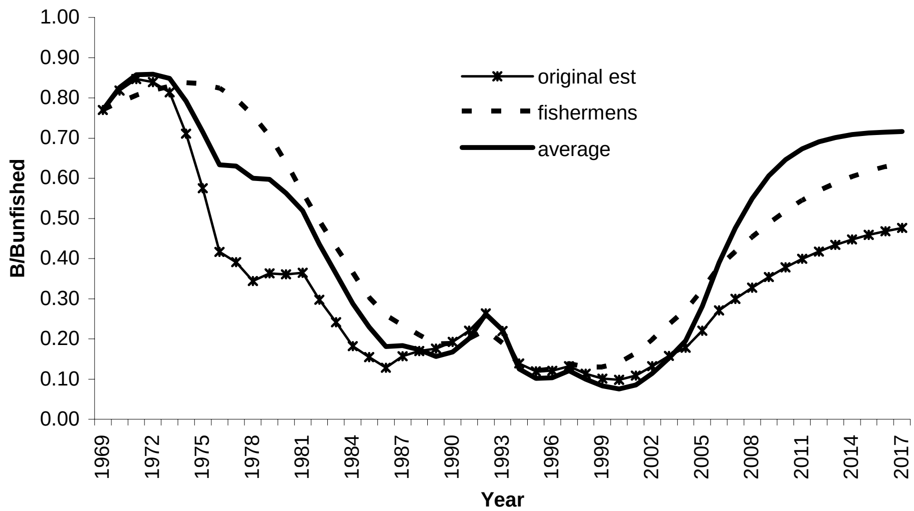
First, for each catch scenario, we attempted to fit the Pella-Tomlinson generalized model. We initially scanned values of the model shape that produced the best fit and then used that value to fit the model. In all three scenarios, it was noted that the generalized fit was not a better than the logistic fit, so the sensitivity analysis is now limited to the results of the logistic (Shaefer) model.

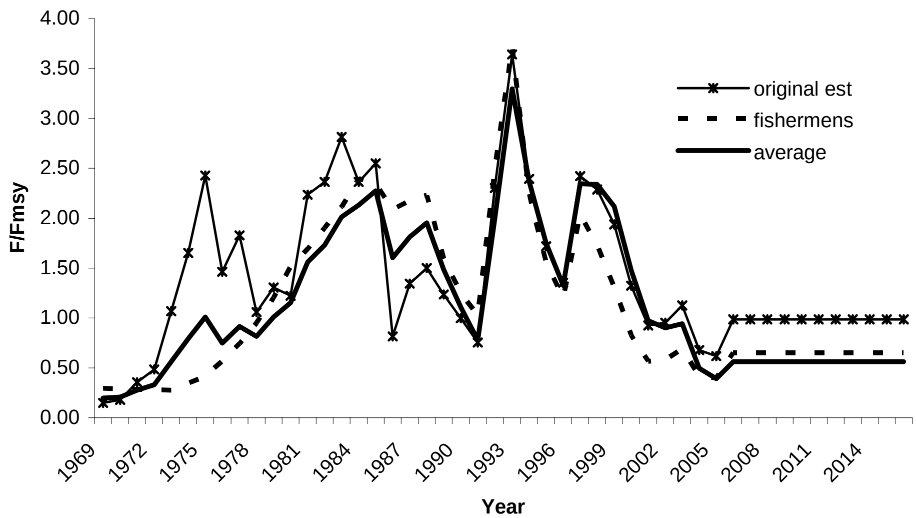
Reference points calculated from the three catch series sensitivity analysis. The base model uses the average catches of the estimated and fishermen recommended catches.

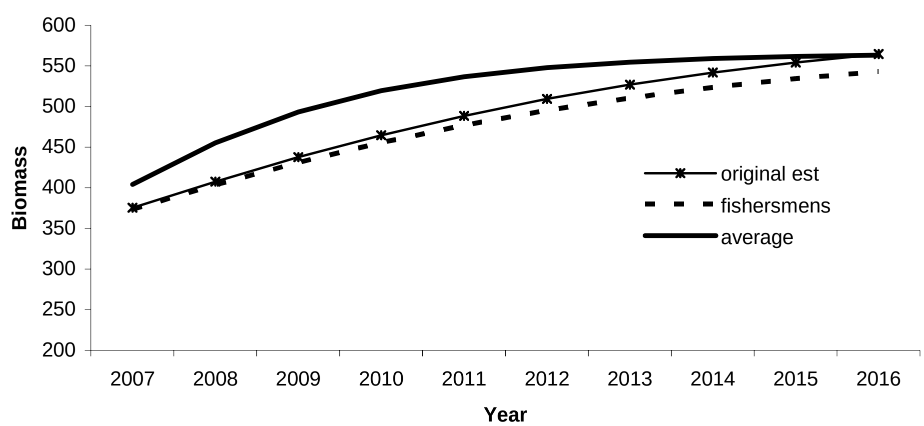
		Schaefer Logistic		
		Estimated	Fishermens	*** Average**
B1/K	Starting relative biomass	0.77	0.77	**0.77**
MSY	Maximum sustainable yield	607	659	**700**
K	Maximum population size	5281	7483	**4003**
phi	Shape of production curve	0.50	0.50	**0.50**
Bmsy	Stock biomass given MSY	2641	3742	**2002**
Yield(F_{msy})	Yield available at Fmsy in 2007	364	550	**666**
B/B_{msy}	B_{2007}/B_{msy} (as proportion on MSY)	0.60	0.83	**0.95**
$B/B_{unfished}$	(B_{2007}/B_{msy}) / 2	0.30	0.42	**0.48**
B_{2007}/K	*Depletion*	*0.30*	*0.42*	***0.48***
Yield	Equillibrium yield available in 2007	510	641	**698**
	as proportion of MSY	0.84	0.97	**1.00**
Fmsy	Fishing mortality given MSY	0.23	0.18	**0.35**
F/Fmsy	F_{2006}/F_{msy}	0.98	0.65	**0.56**
F_{msy}/F	F_{msy}/F_{2006}	1.02	1.54	**1.78**
B_{2007}	Beginning biomass in 2007	1583	3123	**1905**
C_{2006}	Total catch in 2006	342	342	**342**
R2	CPUE	0.42	0.60	**0.63**
CV	bootstrapped	0.55	0.41	**0.32**

* Baseline model - Shaefer logistic surplus-production model with average catch series.

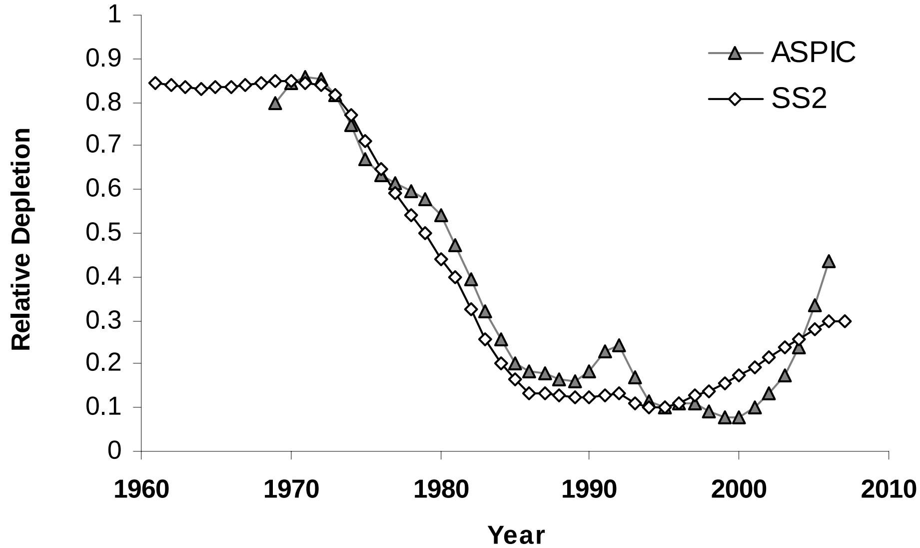
Figures comparing the biomass, fishing mortality and projections from three catch streams: original estimates, fishermens recommended changes to those estimates, and an average (base model) of the two catch streams.

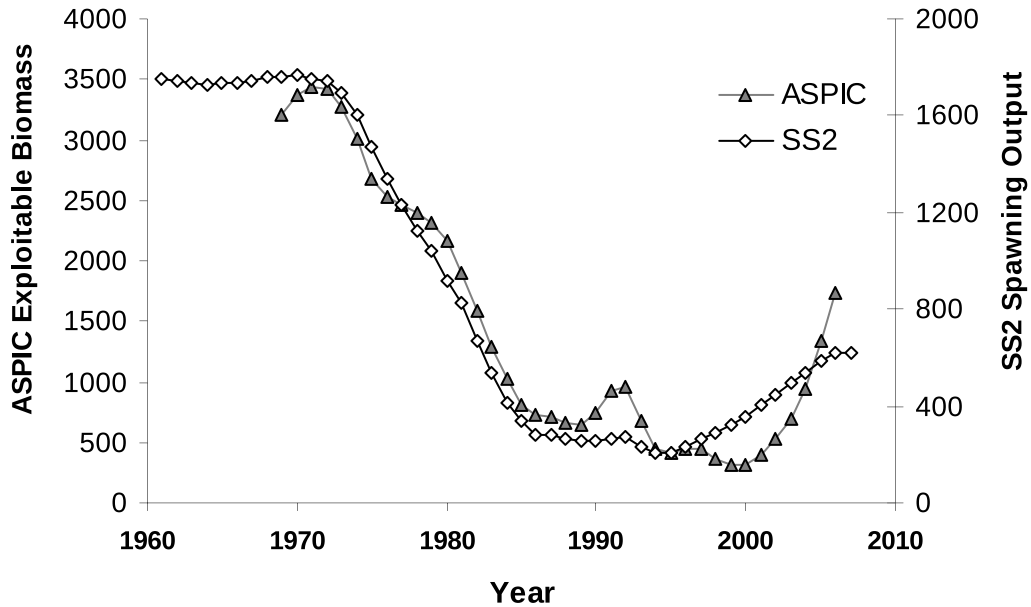






The Mop-Up STAR panel (October 2007, Seattle WA) requested that a comparison be made between the two base models in ASPIC and SS2. The following is a comparison of relative depletion (top) and biomass between ASPIC (exploitable biomass) and SS2 (spawning output), (bottom).





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APPENDIX C - DATA FILE FOR 2007 BLUE ROCKFISH STOCK ASSESSMENT

```
# California stock, north of Point Conception
#
# SS2 Version 2.00g (July 2007)
# BASE catch stream
# M females = 0.10, M males = 0.12
# steepness = 0.58 based on Dorm recommendation
# RecFIN CPUE index split: post-2000 q as separate fishery
#
#
1916
2006
1
12
1
3
5
REC%COMMHKL%COMMNET%CDFGCPFV%juvcore%juvdive%ghost%post2000
0.5  0.5  0.5  0.5  0.5  0.5 0.5 0.5
2
30  # 30+ in this bin
# Initial Equil Catch
0       0       0.0
# Landings
0.0     0.4     0.0     #1916
1.6     1.3     0.0     #1917
3.2     2.1     0.0     #1918
4.8     1.8     0.0     #1919
6.4     2.4     0.0     #1920
8.0     2.4     0.0     #1921
9.5     2.6     0.0     #1922
11.1    3.5     0.0     #1923
12.7    3.6     0.0     #1924
14.3    4.6     0.0     #1925
15.9    6.1     0.0     #1926
17.5    5.9     0.0     #1927
19.1    7.6     0.0     #1928
20.7    7.2     0.0     #1929
22.3    10.4    0.0     #1930
23.9    10.1    0.0     #1931
25.4    9.1     0.0     #1932
27.0    8.6     0.0     #1933
28.6    9.0     0.0     #1934
30.2    11.8    0.0     #1935
31.8    14.5    0.0     #1936
37.8    12.8    0.0     #1937
37.2    11.4    0.0     #1938
32.6    9.7     0.0     #1939
46.9    12.3    0.0     #1940
0       11.6    0.0     #1941
0       5.1     0.0     #1942
0       6.6     0.0     #1943
0       15.6    0.0     #1944
0       49.1    0.0     #1945
16      39.9    0.0     #1946
32      35.8    0.0     #1947
64      18.9    0.0     #1948
82.9    14.6    0.0     #1949
101.1   21.1    0.0     #1950
115.5   21.9    0.0     #1951
100.5   16.0    0.0     #1952
85.5    15.7    0.0     #1953
106.3   5.9     0.0     #1954
126.8   5.4     0.0     #1955
141.6   8.0     0.0     #1956
138.1   10.3    0.0     #1957
226.7   19.7    0.0     #1958
188.2   16.9    0.0     #1959
146.7   7.5     0.0     #1960
110.9   12.2    0.0     #1961
```

```
127     7.5     0.0     #1962
130.7   5.0     0.0     #1963
99.5    6.2     0.0     #1964
154.7   7.3     0.0     #1965
167     8.1     0.0     #1966
164     7.7     0.0     #1967
296.8   7.1     0.0     #1968
279.3   8.5     3.5     #1969
376     10.5    4.5     #1970
313.8   7.8     26.0    #1971
431.2   12.2    32.2    #1972
632.6   19.3    74.7    #1973
716.8   15.6    106.5   #1974
695.6   16.0    119.2   #1975
637.4   22.2    39.1    #1976
569.9   18.2    52.2    #1977
523.7   4.6     16.8    #1978
658     34.9    13.3    #1979
487     49.6    2.3     #1980
826.5   37.9    1.2     #1981
707.7   60.6    0.5     #1982
661.2   55.2    0.8     #1983
469.2   11.3    1.3     #1984
261.7   36.5    134.5   #1985
124.7   2.8     12.8    #1986
258.9   7.8     0.4     #1987
307.1   7.7     0.1     #1988
245     17.2    14.1    #1989
224.4   26.8    1.5     #1990
186.9   35.4    1.4     #1991
493.6   181.4   0.0     #1992
374.4   134.3   0.3     #1993
305.8   68.8    0.0     #1994
216.3   28.5    0.0     #1995
164     44.0    0.1     #1996
296.1   63.7    0.0     #1997
249.4   47.7    0.0     #1998
198.6   35.7    0.1     #1999
150.7   15.6    0.0     #2000
115.6   19.7    0.0     #2001
148.8   18.5    0.0     #2002
219.9   9.2     0.0     #2003
149.9   14.8    0.0     #2004
162.9   21.7    0.0     #2005
319.6   21.9    0.0     #2006
56   # Surveys
#RecFIN CPUE
#split as another survey in 2000 below, bag limit change, change in q
#year season type index jack.cv
1980  1  1  0.373  0.25
1981  1  1  0.513  0.29
1982  1  1  0.617  0.30
1983  1  1  0.382  0.26
1984  1  1  0.350  0.25
1985  1  1  0.339  0.27
1986  1  1  0.063  0.26
1987  1  1  0.091  0.37
1988  1  1  0.135  0.35
1989  1  1  0.082  0.33
1990  1  1  -0.1  -1
1991  1  1  -0.1  -1
1992  1  1  -0.1  -1
1993  1  1  0.217  0.23
1994  1  1  0.159  0.24
1995  1  1  0.353  0.46
1996  1  1  0.252  0.19
1997  1  1  -0.1  -1
1998  1  1  -0.1  -1
1999  1  1  0.251  0.16
#
#CDFG CPFV onboard observer survey - central California
#year   season  type    index   jack.cv
```

```
1987    1       4       1.0751251       0.20050221
1988    1       4       0.8947557       0.12897137
1989    1       4       1.0064529       0.10044706
1990    1       4       0.8847844       0.14203142
1991    1       4       1.1419153       0.13896742
1992    1       4       2.2500415       0.08450166
1993    1       4       1.897683        0.08993578
1994    1       4       1.3319015       0.09220232
1995    1       4       1.4248993       0.0937878
1996    1       4       1.3668195       0.0853881
1997    1       4       3.1537675       0.09389103
1998    1       4       3.7558219       0.094172
#
#juvenile midwater trawl "core" area survey - did not use in final model
#year   season  type    index   jack.cv
#1986   1       5       0.2387  0.4257
#1987   1       5       1.9584  0.2526
#1988   1       5       4.1236  0.2300
#1989   1       5       0.7153  0.3365
#1990   1       5       0.1943  0.3898
#1991   1       5       0.6095  0.3096
#1992   1       5       0.0041  0.8144
#1993   1       5       0.3058  0.3337
#1994   1       5       0.0626  0.5440
#1995   1       5       0.0495  0.5945
#1996   1       5       0.0640  0.8181
#1997   1       5       0.0400  0.5784
#1999   1       5       0.0622  0.4550
#2000   1       5       0.0480  0.6980
#2001   1       5       0.5694  0.3178
#2002   1       5       3.8316  0.2586
#2003   1       5       1.1813  0.2681
#2004   1       5       0.5068  0.3442
# changed values to represent stock assessment area only
# CVs changed to 0.35 as recommended at mopup review
2001    1       5       2.54    0.35
2002    1       5       7.74    0.35
2003    1       5       4.42    0.35
2004    1       5       5.95    0.35
2005    1       5       2.45    0.35
2006    1       5       1.36    0.35
#
#average CPUE from Miller and Geibel 1973 - did not use in final model
#year   season  type    index   make up cv
#1959   1       6       1.01836394      0.25 - Monterey area only
1960    1       6       0.717757718     0.25
1961    1       6       0.367636936     0.25
1962    1       6       0.388962527     0.25
1963    1       6       0.474032959     0.25
1964    1       6       0.317549519     0.25
1965    1       6       -1      -1
1966    1       6       0.264060688     0.25
1967    1       6       0.274436168     0.25
1968    1       6       0.216010569     0.25
1969    1       6       0.430684584     0.25
1970    1       6       0.452762666     0.25
#1971   1       6       0.69063893      0.25 - Monterey area only
#
# post 2000 is new survey - RecFIN bag limit change - change in q
2000  1  8  0.093  0.29
2001  1  8  0.070  0.31
2002  1  8  0.317  0.19
2003  1  8  0.191  0.19
2004  1  8  0.324  0.16
2005  1  8  0.299  0.18
2006  1  8  0.405  0.15
1       # Discard type
0       # number of observations
0       # Mean Body Weight
# Composition Conditioners
-1
0.001
```

```
22 # Number of Length Bins
10  12  14  16  18  20  22  24  26  28  30  32  34  36  38  40  42  44  46  48  50  52
53   # Length Composition Observations
#
#year   season  type    gender  part    #samp   10      12      14      16      18      20      22      24      26      28      30      32      34      36
        38      40      42      44      46      48      50      52      10      12      14      16      18      20      22      24      26      28      30
        32      34      36      38      40      42      44      46      48      50      52
#1980s CPFV
1978    1       1       3       0       57      0       0       0       0       0       0.025   0.00625 0.05625 0.06875 0.1125  0.1     0.13125 0.125   0.137
5       0.11875 0.08125 0.0125  0.00625 0.0125  0       0       0.00625 0       0       0       0       0       0.02996 0.02621 0.10112 0.09363 0.13857 0.127
34      0.13857 0.08988 0.09737 0.07865 0.04868 0.01123 0.00749 0.00749 0       0       0.00374
1979    1       1       3       0       106     0       0       0       0       0.00412 0.02613 0.05226 0.07152 0.09903 0.12929 0.17056 0.1568  0.09903 0.067
4       0.07015 0.03026 0.02063 0.00275 0       0       0       0       0       0       0.00362 0.0012  0.01147 0.05012 0.09903 0.0948  0.13103 0.13466 0.142
51      0.12198 0.08937 0.04649 0.03321 0.01328 0.00905 0.0012  0       0       0       0.0169
1980    1       1       3       0       200     0       0       0       0       0.00301 0.01054 0.01957 0.04969 0.0768  0.12048 0.10993 0.13855 0.10692 0.097
89      0.08283 0.10692 0.06024 0.01656 0       0       0       0       0       0       0       0       0.00452 0.01268 0.03532 0.06612 0.11141 0.14402 0.129
52      0.15398 0.10326 0.06521 0.05434 0.06612 0.04347 0.00996 0       0       0       0
1981    1       1       3       0       133     0       0       0       0       0       0.01421 0.01895 0.04265 0.08767 0.0853  0.09715 0.13981 0.13981 0.132
7       0.09478 0.08293 0.0545  0.00947 0       0       0       0       0       0       0       0       0.00122 0.01838 0.03676 0.06495 0.13357 0.11887 0.147
05      0.15563 0.11397 0.07843 0.05147 0.04656 0.02818 0.0049  0       0       0       0
1982    1       1       3       0       139     0       0       0       0       0       0       0.00366 0.04029 0.07142 0.09706 0.13369 0.163   0.16117 0.117
21      0.10439 0.05677 0.04395 0.00732 0       0       0       0       0       0       0       0       0       0.00115 0.01038 0.0542  0.10034 0.14763 0.174
16      0.16839 0.12341 0.07958 0.06805 0.03806 0.02998 0.00461 0       0       0       0
1983    1       1       3       0       182     0       0       0       0       0       0       0.00266 0.01865 0.03374 0.06571 0.0888  0.18916 0.1785  0.157
19      0.14653 0.08081 0.03285 0.00444 0       0       0       0.00088 0       0       0       0.00054 0.00054 0.00164 0.00877 0.03947 0.07565 0.11951 0.140
89      0.1853  0.14473 0.10855 0.09703 0.05263 0.02083 0.00274 0       0.00054 0       0.00054
1984    1       1       3       0       92      0       0       0       0       0       0.00914 0.0201  0.04936 0.06946 0.07678 0.10603 0.16636 0.16087 0.113
34      0.12431 0.06764 0.03107 0.00548 0       0       0       0       0       0       0       0       0       0.01137 0.03981 0.07963 0.11604 0.13196 0.121
72      0.15585 0.11945 0.07849 0.07849 0.04436 0.01934 0.00341 0       0       0       0
#RecFIN
1993    1       1       0       2       200     0.000   0.001   0.003   0.008   0.031   0.075   0.103   0.141   0.154   0.167   0.139   0.100   0.044   0.019
        0.009   0.005   0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
1994    1       1       0       2       200     0.000   0.000   0.001   0.002   0.010   0.035   0.087   0.118   0.181   0.176   0.168   0.104   0.065   0.019
        0.020   0.010   0.003   0.000   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
1995    1       1       0       2       157     0.000   0.001   0.003   0.033   0.079   0.062   0.116   0.158   0.152   0.131   0.099   0.074   0.049   0.025
        0.010   0.000   0.004   0.004   0.001   0.000   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
1996    1       1       0       2       200     0.000   0.002   0.001   0.009   0.028   0.072   0.078   0.129   0.157   0.155   0.143   0.099   0.068   0.031
        0.018   0.006   0.003   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
1999    1       1       0       2       200     0.000   0.000   0.000   0.001   0.009   0.031   0.074   0.129   0.172   0.201   0.201   0.089   0.048   0.028
        0.013   0.004   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2000    1       1       0       2       140     0.000   0.000   0.000   0.000   0.004   0.022   0.043   0.104   0.118   0.161   0.315   0.139   0.060   0.020
        0.002   0.011   0.000   0.000   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2001    1       1       0       2       91      0.000   0.000   0.001   0.005   0.015   0.072   0.087   0.115   0.141   0.171   0.146   0.121   0.057   0.032
        0.025   0.009   0.002   0.001   0.000   0.000   0.000   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2002    1       1       0       2       198     0.000   0.001   0.000   0.001   0.012   0.047   0.099   0.085   0.092   0.111   0.188   0.224   0.094   0.029
        0.010   0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2003    1       1       0       2       200     0.000   0.000   0.000   0.001   0.002   0.021   0.104   0.207   0.157   0.122   0.160   0.135   0.067   0.019
        0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2004    1       1       0       2       200     0.000   0.000   0.000   0.001   0.004   0.014   0.044   0.097   0.130   0.160   0.211   0.196   0.092   0.034
        0.011   0.003   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2005    1       1       0       2       128     0.000   0.000   0.000   0.000   0.001   0.021   0.036   0.057   0.097   0.145   0.180   0.245   0.128   0.068
        0.012   0.005   0.002   0.003   0.000   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
2006    1       1       0       2       93      0.000   0.000   0.000   0.000   0.001   0.012   0.058   0.087   0.125   0.210   0.186   0.173   0.099   0.034
        0.008   0.003   0.001   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # RecFIN
#commecial hook and line
1979    1       2       0       2       -4      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.019   0.075   0.063   0.219   0.094   0.125   0.019
        0.044   0.088   0.176   0.078   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1982    1       2       0       2       -2      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.083   0.083   0.400   0.000   0.083
        0.000   0.000   0.234   0.117   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
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        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1991    1       2       0       2       -4      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.085   0.014   0.250   0.370   0.099   0.125
        0.056   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1992    1       2       0       2       89      0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.057   0.210   0.150   0.121   0.148   0.117   0.074
        0.056   0.044   0.015   0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1993    1       2       0       2       200     0.000   0.000   0.000   0.000   0.000   0.001   0.027   0.055   0.120   0.158   0.212   0.213   0.091   0.064
        0.026   0.013   0.013   0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1994    1       2       0       2       135     0.000   0.000   0.000   0.000   0.003   0.005   0.014   0.044   0.065   0.134   0.202   0.156   0.126   0.109
        0.065   0.056   0.017   0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1995    1       2       0       2       83      0.000   0.000   0.000   0.000   0.000   0.007   0.024   0.030   0.048   0.118   0.150   0.123   0.199   0.167
        0.103   0.016   0.013   0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1996    1       2       0       2       89      0.000   0.000   0.000   0.000   0.000   0.010   0.024   0.059   0.076   0.119   0.157   0.192   0.142   0.139
        0.073   0.005   0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1997    1       2       0       2       52      0.000   0.000   0.000   0.000   0.004   0.054   0.058   0.173   0.149   0.121   0.154   0.080   0.074   0.070
        0.040   0.007   0.013   0.000   0.000   0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1998    1       2       0       2       23      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.036   0.086   0.253   0.221   0.134   0.135   0.100
        0.030   0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
1999    1       2       0       2       86      0.000   0.000   0.000   0.000   0.012   0.020   0.037   0.063   0.085   0.208   0.289   0.127   0.117   0.028
        0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2000    1       2       0       2       19      0.000   0.000   0.000   0.000   0.000   0.008   0.026   0.046   0.062   0.158   0.295   0.134   0.148   0.071
        0.052   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2001    1       2       0       2       12      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015   0.045   0.206   0.289   0.154   0.088
        0.018   0.015   0.015   0.046   0.031   0.061   0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2002    1       2       0       2       11      0.000   0.000   0.000   0.000   0.000   0.011   0.011   0.035   0.048   0.150   0.177   0.267   0.207   0.067
        0.027   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2003    1       2       0       2       -3      0.000   0.000   0.000   0.000   0.000   0.000   0.021   0.021   0.085   0.218   0.174   0.193   0.199   0.089
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2004    1       2       0       2       10      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.037   0.092   0.147   0.203   0.162   0.194   0.026
        0.139   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2005    1       2       0       2       16      0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.056   0.083   0.127   0.113   0.176   0.297
        0.141   0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
2006    1       2       0       2       9       0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.000   0.041   0.066   0.177   0.265   0.276   0.131
        0.032   0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commhl
#commercial setnet
1978    1       3       0       2       4       0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007   0.131   0.309
        0.327   0.144   0.065   0.017   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commnet
1979    1       3       0       2       1       0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.100   0.100
        0.100   0.300   0.400   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commnet
1985    1       3       0       2       3       0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.070   0.015
        0.630   0.216   0.068   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commnet
1989    1       3       0       2       1       0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.063   0.125   0.063   0.000   0.313
        0.125   0.250   0.063   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # commnet
#CDFG CPFV
1987    1       4       0       2       42      0.004   0.007   0.003   0.003   0.023   0.047   0.078   0.220   0.235   0.178   0.092   0.056   0.033   0.013
        0.007   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1988    1       4       0       2       131     0.000   0.000   0.000   0.001   0.014   0.051   0.098   0.132   0.213   0.206   0.119   0.070   0.052   0.023
        0.012   0.004   0.003   0.001   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1989    1       4       0       2       154     0.000   0.000   0.000   0.001   0.008   0.036   0.105   0.131   0.163   0.183   0.144   0.096   0.049   0.041
        0.024   0.011   0.005   0.002   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
```

```
1990    1       4       0       2       51      0.000   0.000   0.000   0.000   0.006   0.026   0.103   0.171   0.186   0.165   0.144   0.089   0.048   0.023
        0.019   0.017   0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1991    1       4       0       2       59      0.000   0.000   0.000   0.002   0.016   0.043   0.102   0.154   0.208   0.216   0.153   0.070   0.021   0.010
        0.003   0.001   0.000   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1992    1       4       0       2       163     0.000   0.000   0.000   0.001   0.006   0.031   0.079   0.137   0.192   0.200   0.163   0.101   0.050   0.023
        0.011   0.003   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1993    1       4       0       2       168     0.000   0.000   0.000   0.001   0.015   0.054   0.129   0.167   0.189   0.183   0.133   0.070   0.036   0.013
        0.005   0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1994    1       4       0       2       180     0.000   0.000   0.000   0.003   0.027   0.068   0.127   0.191   0.200   0.162   0.104   0.068   0.031   0.011
        0.005   0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1995    1       4       0       2       190     0.000   0.000   0.000   0.004   0.021   0.070   0.137   0.175   0.186   0.165   0.109   0.067   0.038   0.015
        0.008   0.004   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1996    1       4       0       2       166     0.000   0.000   0.001   0.004   0.027   0.055   0.130   0.192   0.187   0.163   0.117   0.070   0.032   0.015
        0.005   0.002   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1997    1       4       0       2       200     0.000   0.000   0.001   0.006   0.014   0.052   0.128   0.191   0.201   0.154   0.100   0.068   0.043   0.026
        0.010   0.004   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
1998    1       4       0       2       139     0.000   0.000   0.000   0.001   0.006   0.031   0.089   0.158   0.208   0.186   0.144   0.101   0.049   0.021
        0.005   0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
        0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   # CDFGonboard
#
#
30 # 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  22  23  24  25  26  27  28  29  30
1 # Number of Aging Error Matrices
0.5   1.5   2.5   3.5   4.5   5.5   6.5   7.5   8.5   9.5   10.5  11.5  12.5  13.5  14.5  15.5  16.5  17.5  18.5  19.5  20.5  21.5  22.5  23.5  24.5  25.5  2
6.5  27.5  28.5  29.5  30.5
0.13  0.21  0.29  0.38  0.46  0.54  0.62  0.70  0.78  0.86  0.94  1.02  1.10  1.18  1.27  1.35  1.43  1.51  1.59  1.67  1.75  1.83  1.91  1.99  2.07  2.16  2
.24  2.32  2.40  2.48  2.56
160   # Age Composition Observations
#
#conditional age at length for 1980-1984 recreational age data
#year   Seas    Flt/Svy Gender  Part    Ageerr  Lbin_lo Lbin_hi Nsamp   1       2       3       4       5       6       7       8       9       10      11
        12      13      14      15      16      17      18      19      20      21      22      23      24      25      26      27      28      29      30
        1       2       3       4       5       6       7       8       9       10      11      12      13      14      15      16      17      18      19
        20      21      22      23      24      25      26      27      28      29      30
#                                                               bin FL  1       2       3       4       5       6       7       8       9       10      11
        12      13      14      15      16      17      18      19      20      21      22      23      24      25      26      27      28      29      30
        1       2       3       4       5       6       7       8       9       10      11      12      13      14      15      16      17      18      19
        20      21      22      23      24      25      26      27      28      29      30
1980    1       1       3       0       1       6       6       0.8501  0       0       0       0.666666        0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0.333333        0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0
1980    1       1       3       0       1       7       7       1.9837  0       0       0       0       0.285714        0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0.285714        0.142857        0.285714        0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
1980    1       1       3       0       1       8       8       4.8175  0       0       0       0       0.117647        0.117647        0.058823        0.058
823     0       0       0       0       0.058823        0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0.17647 0.117647        0.058823        0.058823        0       0.058823        0
        0.058823        0       0       0.058823        0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0
1980    1       1       3       0       1       9       9       8.2182  0       0       0       0       0.206896        0.172413        0.103448        0.068
965     0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0.034482        0.103448        0.068965        0.103448        0.068965        0       0       0
        0       0       0.034482        0       0       0.034482        0       0       0       0       0       0       0       0       0       0       0
        0       0
1980    1       1       3       0       1       10      10      9.6351  0       0       0       0       0.117647        0.17647 0.029411        0.088235
        0.029411        0.088235        0.029411        0       0.029411        0       0       0       0.029411        0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0.029411        0.029411        0.029411        0.029
411     0.029411        0.088235        0.058823        0       0       0       0.029411        0       0       0       0       0.058823        0       0
        0       0       0       0       0       0       0       0
1980    1       1       3       0       1       11      11      10.2019 0       0       0       0       0.027777        0.055555        0.083333        0.055
555     0.027777        0.083333        0.083333        0.055555        0.027777        0       0.027777        0.027777        0.027777        0       0
```

```
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.027777	0.055
555	0	0	0.055555	0.083333	0.027777	0.055555	0	0.055555	0.027777	0	0	0	0.027
777	0	0	0	0	0	0	0	0	0	0
1980	1	1	3	0	1	12	12	11.3355 0	0	0	0	0.025	0.05	0.05	0.075	0.1	0.15	0.1
	0	0	0.075	0	0.025	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.025	0	0.025	0.025	0.025	0.025	0.025	0	0	0	0.025
	0	0	0.05	0	0.025	0.025	0	0.025	0	0	0
1980	1	1	3	0	1	13	13	10.4853 0	0	0	0	0	0.027027	0	0.081081	0.108
108	0.108108	0.081081	0.081081	0.054054	0.027027	0.027027	0.027027	0	0	0	0	0
	0	0	0	0	0	0	0	0.027027	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.027027	0.027027	0.027027	0.027027	0	0.027027	0.027027	0.108
108	0.027027	0	0	0.027027	0	0.027027	0	0
1980	1	1	3	0	1	14	14	7.0846	0	0	0	0	0	0	0.04	0	0.08	0.04	0.2
	0.04	0.08	0.08	0.16	0.08	0.08	0.04	0.04	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0
	0	0	0	0	0	0	0	0	0	0	0
1980	1	1	3	0	1	15	15	5.6677	0	0	0	0	0	0	0	0	0	0	0.2
	0	0.1	0.05	0.1	0.1	0.05	0.1	0.15	0	0.05	0	0.1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1980	1	1	3	0	1	16	16	8.785	0	0	0	0	0	0.032258	0.032258	0	0
	0	0	0.032258	0.032258	0.16129 0.064516	0.129032	0.064516	0.096774	0.096774	0.096774
	0.064516	0	0.032258	0.032258	0	0	0	0	0.032258	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0
1980	1	1	3	0	1	17	17	7.368	0	0	0	0	0	0	0	0	0	0	0
	0.038461	0.038461	0	0	0.038461	0.076923	0.038461	0.038461	0.076923	0.115384	0
	0.038461	0.153846	0.038461	0.115384	0	0.115384	0	0.038461	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.038461	0	0	0	0
	0	0	0	0	0	0	0
1980	1	1	3	0	1	18	18	0.5667	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
#


1981	1	1	3	0	1	6	6	0.8388	0	0	0	0.333333	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.666666	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	1	1	3	0	1	7	7	0.8388	0	0	0	0.333333	0.333333	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.333333	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	1	1	3	0	1	8	8	3.0756	0	0	0	0	0.181818	0.090909	0.181818	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.090909	0.090909	0	0	0.090909	0	0
	0.181818	0	0	0	0	0	0.090909	0	0	0	0	0	0	0	0	0	0
1981	1	1	3	0	1	9	9	7.5493	0	0	0	0	0.074074	0.148148	0.148148	0.037
037	0.037037	0	0	0.037037	0	0.037037	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0.074074	0	0.074074	0.074074	0
	0	0.037037	0.037037	0.037037	0.074074	0	0.037037	0.037037	0	0	0	0	0
	0	0	0	0	0	0	0
1981	1	1	3	0	1	10	10	11.1842 0	0	0	0	0	0.05	0.15	0.175	0	0.075	0
	0	0	0	0	0.025	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.025	0.075	0.05	0.075	0.05	0.05	0.025	0.025	0.025	0	0.025	0	0.05
	0.05	0	0	0	0	0	0	0	0	0	0
1981	1	1	3	0	1	11	11	14.5394 0	0	0	0	0.01923 0	0.038461	0.038461	0.057
692	0.057692	0.057692	0.01923 0.01923 0	0.01923 0	0	0.038461	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.038461	0	0	0.057692	0	0.038461
	0.038461	0.076923	0.01923 0.076923	0.01923 0.076923	0.153846	0.01923 0	0	0.01923 0	0	0
	0	0	0	0	0
1981	1	1	3	0	1	12	12	17.0559 0	0	0	0	0	0	0.016393	0.04918 0	0.016
393	0.04918 0.081967	0.032786	0.032786	0.04918 0.04918 0	0.016393	0.032786	0.016393	0	0.016393
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.032786	0.016
393	0	0	0.016393	0.016393	0.065573	0.081967	0.081967	0.081967	0.032786	0	0.016393
	0.016393	0.016393	0.016393	0	0.016393	0	0	0	0.032786
1981	1	1	3	0	1	13	13	11.7434 0	0	0	0	0	0	0	0.047619	0.023809
	0	0.023809	0.047619	0.095238	0.071428	0.166666	0.095238	0.023809	0.095238	0.023809
	0	0	0	0	0	0	0.047619	0	0	0	0.023809	0	0	0	0	0	0
```

0 0.023809 0 0 0 0 0 0 0 0.023809 0 0 0 0 0.071428 0
0.023809 0 0 0.023809 0 0.023809 0 0.023809
1981 1 1 3 0 1 14 14 8.3881 0 0 0 0 0 0 0 0 0 0 0.033
333 0 0.166666 0.1 0.066666 0.033333 0.2 0.066666 0.033333 0.033333 0.1 0 0 0.033
333 0.033333 0 0 0 0 0.033333 0 0 0 0 0 0 0 0 0 0 0
0 0.033333 0 0 0 0 0 0 0 0 0 0 0 0 0.033333 0 0
0 0
1981 1 1 3 0 1 15 15 4.194 0 0 0 0 0 0 0 0 0 0 0
0.066666 0 0.066666 0 0.066666 0.133333 0.133333 0.133333 0.133333 0.133333 0
0.066666 0 0 0 0.066666 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0
1981 1 1 3 0 1 16 16 2.5164 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.111111 0.333333 0.111111 0 0.111111 0.222222 0 0 0
0 0.111111 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1981 1 1 3 0 1 17 17 2.796 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0.1 0.1 0 0.1 0 0 0.1 0 0 0.6
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1981 1 1 3 0 1 18 18 0.2796 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
#

1982 1 1 3 0 1 7 7 0.2082 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1982 1 1 3 0 1 8 8 3.5397 0 0 0 0.058823 0.352941 0.17647 0 0.058823
0 0 0.058823 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0.117647 0.117647 0 0 0 0 0 0 0.058
823 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1982 1 1 3 0 1 9 9 8.9534 0 0 0 0 0.046511 0.139534 0.093023 0.116
279 0.023255 0 0.023255 0 0 0 0.023255 0 0 0.023255 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.046511 0.139534 0.116279 0.023
255 0.023255 0.023255 0.046511 0 0 0.023255 0 0.023255 0 0.046511 0 0 0
0 0 0 0 0 0 0 0
1982 1 1 3 0 1 10 10 10.8273 0 0 0 0 0.01923 0.038461 0.115384 0.076923
0.076923 0.038461 0 0.057692 0.038461 0.01923 0 0.01923 0 0 0.01923 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.01923 0.01923 0 0.057
692 0.01923 0.057692 0.057692 0.038461 0.038461 0.01923 0.01923 0.01923 0.057692 0.038461 0.01923 0 0
0 0 0 0 0
1982 1 1 3 0 1 11 11 13.1178 0 0 0 0 0 0.015873 0.063492 0.111111
0.095238 0.047619 0.031746 0.031746 0.031746 0.063492 0 0.015873 0.015873 0.015873
0.015873 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.015873 0 0.031746 0.015873 0.031746 0.079365 0.063492 0.015873 0.015873 0.015873
0.015873 0.031746 0 0.015873 0 0.031746 0 0.015873 0.015873 0 0.015873 0.015
873 0 0
1982 1 1 3 0 1 12 12 14.1589 0 0 0 0 0 0 0.029411 0.044117 0.073
529 0.161764 0.029411 0.088235 0.044117 0.029411 0.088235 0.029411 0 0.014705 0.014705
0.029411 0 0.014705 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0.014705 0 0.014705 0.014705 0.014705 0.014705 0.044117 0.029411
0.058823 0.058823 0.014705 0.014705 0 0.014705 0 0 0 0 0 0
1982 1 1 3 0 1 13 13 8.3287 0 0 0 0 0 0 0 0 0.05 0.1 0.075
0.05 0.1 0.05 0.05 0.125 0.1 0.075 0 0 0.05 0.05 0 0.025 0.025 0 0 0.025 0 0
0 0 0 0 0 0 0 0 0 0.025 0 0 0 0 0 0 0 0 0
0 0.025 0 0 0 0 0 0 0 0 0
1982 1 1 3 0 1 14 14 7.0794 0 0 0 0 0 0 0 0 0.058823 0
0.058823 0.058823 0.058823 0.088235 0.088235 0.058823 0.088235 0.147058 0.058823 0.029
411 0.029411 0 0.058823 0.058823 0 0.029411 0.029411 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1982 1 1 3 0 1 15 15 5.2054 0 0 0 0 0 0 0 0 0 0 0
0 0.04 0.04 0.08 0.08 0.08 0.12 0.04 0.16 0.12 0 0.04 0.04 0 0.08 0 0.04 0.04 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1982 1 1 3 0 1 16 16 2.4986 0 0 0 0 0 0 0 0 0 0.083333
0 0 0 0.083333 0 0.083333 0.083333 0 0.166666 0.166666 0.083333 0.083333

```
	0	0	0.083333	0	0	0	0	0.083333	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0
1982	1	1	3	0	1	17	17	1.8739	0	0	0	0	0	0	0.111111	0	0	0
	0	0	0	0	0	0	0	0	0	0.222222	0	0	0.222222	0	0.111111	0.111
111	0	0.111111	0	0.111111	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	1	1	3	0	1	18	18	0.2082	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
#



1983	1	1	3	0	1	6	6	0.2461	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.5	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	7	7	0.3692	0	0	0	0	0	0	0	0.333333	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.666666	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	8	8	1.6	0	0	0	0	0.076923	0.076923	0	0.076923
	0.076923	0	0	0.076923	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0.076923	0.307692	0	0	0.076923	0	0
	0	0	0.076923	0	0	0	0.076923	0	0	0	0	0	0	0	0	0	0
	0	0
1983	1	1	3	0	1	9	9	1.9692	0	0	0	0	0.0625	0.0625	0.0625	0.125	0.125	0.0625	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.125	0.125	0	0	0	0	0	0	0	0.0625	0	0.062
5	0	0	0.125	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	10	10	4.6769	0	0	0	0	0	0	0.052631	0.131578	0.052
631	0.026315	0.052631	0.026315	0.052631	0.052631	0.026315	0.052631	0	0.026315	0	0
	0	0.026315	0	0	0	0	0	0	0	0	0	0	0	0	0	0.026315	0
	0.026315	0.026315	0	0	0.052631	0.078947	0.105263	0	0	0	0	0	0	0.026
315	0.026315	0	0.026315	0	0	0.026315	0	0	0
1983	1	1	3	0	1	11	11	3.323	0	0	0	0	0	0	0.037037	0.037037	0.111
111	0.037037	0.074074	0	0.111111	0.037037	0	0.074074	0	0.074074	0.074074	0.037037
	0	0.037037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.037037	0.074074	0.074074	0	0	0.037037	0	0	0	0	0
	0	0	0	0	0	0	0.037037
1983	1	1	3	0	1	12	12	6.4	0	0	0	0	0	0	0	0.038461	0.01923	0.057
692	0.057692	0.057692	0.01923	0.038461	0.057692	0.038461	0.153846	0.096153	0.076923	0.038461
	0.038461	0.038461	0.01923	0.01923	0.038461	0	0	0	0.01923	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.01923	0	0.01923	0	0	0.01923	0	0	0.01923	0	0	0
	0	0	0	0	0
1983	1	1	3	0	1	13	13	5.0461	0	0	0	0	0	0	0	0	0.02439	0.02439	0.024
39	0.02439	0.04878	0.07317	0.07317	0.02439	0.121951	0.04878	0.04878	0.09756	0.04878	0.07317	0.04878	0.04878	0	0	0	0	0.024
39	0.07317	0	0	0	0	0	0	0	0	0	0	0	0	0.02439	0	0	0.02439	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	14	14	3.0769	0	0	0	0	0	0	0	0	0	0.04	0.04
	0.08	0.08	0.04	0.12	0.08	0.12	0.08	0.12	0	0	0.08	0	0.04	0	0	0.04	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.04	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	15	15	2.2153	0	0	0	0	0	0	0	0	0	0	0.055
555	0.055555	0	0.055555	0.055555	0	0.111111	0.222222	0.055555	0.055555	0.055555	0
	0.055555	0.055555	0	0.055555	0.055555	0	0	0.055555	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0
1983	1	1	3	0	1	16	16	1.6	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.230769	0.153846	0	0	0.153846	0	0.153846	0	0.076923
	0.076923	0	0	0.076923	0.076923	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	17	17	1.2307	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.1	0	0	0	0.2	0.1	0	0.1	0.1	0.1	0.1	0	0.1	0	0	0.1	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1983	1	1	3	0	1	18	18	0.2461	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.5
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
```

```
#

1984 1 1 3 0 1 6 6 0.8297 0 0 0 0 0.5 0.333333 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0.166666 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0
1984 1 1 3 0 1 7 7 2.6276 0 0 0 0 0.105263 0.052631 0.052631 0.105
263 0.105263 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0.157894 0 0.105263 0.052631 0.105263 0.052
631 0.052631 0.052631 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0
1984 1 1 3 0 1 8 8 4.4255 0 0 0 0 0.03125 0.03125 0.03125 0.09375 0.0625 0.1875 0.062
5 0 0.03125 0.03125 0 0 0.03125 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0.0625 0.03125 0.09375 0 0.0625 0.0625 0 0.03125 0 0.03125 0
 0.03125 0 0 0 0 0 0 0 0 0 0
1984 1 1 3 0 1 9 9 7.8829 0 0 0 0 0 0.035087 0.070175 0.105263
 0.052631 0.017543 0.035087 0.035087 0.017543 0.017543 0.017543 0.017543 0 0.017543
 0 0.017543 0 0.017543 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0.087719 0.052631 0 0.052631 0.017543 0.070175 0.035087 0 0.035087 0.017
543 0.052631 0.017543 0 0.017543 0.017543 0 0.035087 0 0 0.017543 0 0 0
1984 1 1 3 0 1 10 10 6.9148 0 0 0 0 0.02 0.02 0.04 0.04 0.08 0.02 0.12
 0.02 0 0 0.02 0 0 0.02 0.04 0.02 0 0 0 0.02 0 0 0 0 0 0
 0 0 0 0 0 0 0 0.02 0.04 0.06 0 0.06 0.02 0.02 0.06 0 0.02 0.08 0.02
 0.04 0.02 0.02 0.02 0 0.02 0 0 0 0 0
1984 1 1 3 0 1 11 11 7.8829 0 0 0 0 0 0.035087 0.052631 0.035087
 0.035087 0.070175 0.070175 0.070175 0.035087 0.035087 0 0 0.087719 0.017543 0
 0 0 0 0 0.017543 0 0 0 0 0 0 0 0 0 0 0 0.017543
 0.017543 0.035087 0.017543 0.017543 0.035087 0 0.017543 0.017543 0.035087 0.052631
 0.035087 0.070175 0 0 0.017543 0 0.035087 0 0.017543 0 0 0 0 0
1984 1 1 3 0 1 12 12 12.5851 0 0 0 0 0 0 0.010989 0.032967 0.065
934 0.076923 0.021978 0.054945 0.043956 0.032967 0 0.054945 0.043956 0.087912 0.043956
 0.021978 0.021978 0.021978 0.032967 0 0 0.021978 0 0 0 0.021978 0 0
 0 0 0 0.010989 0.021978 0 0 0.010989 0 0 0.010989 0 0 0.021978
 0 0.021978 0.010989 0.010989 0.021978 0.032967 0.021978 0.021978 0 0.021978 0.010
989 0 0 0.032967
1984 1 1 3 0 1 13 13 8.4361 0 0 0 0 0 0 0 0.016393 0.065573
 0.016393 0.081967 0.016393 0.09836 0.065573 0.065573 0.04918 0.081967 0.081967 0.032786 0.081
967 0.032786 0 0.065573 0 0 0.016393 0 0 0 0.016393 0 0 0 0 0
 0 0 0 0 0 0 0.016393 0 0 0 0 0 0 0.016393 0 0 0
 0.016393 0.04918 0 0.016393 0 0 0 0
1984 1 1 3 0 1 14 14 4.4255 0 0 0 0 0 0 0 0.03125 0 0.09375 0.031
25 0.03125 0.03125 0.09375 0.0625 0.03125 0.0625 0.0625 0.0625 0.03125 0.125 0.0625 0.09375 0 0 0 0 0 0 0.031
25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0.03125 0 0 0.03125 0 0 0
1984 1 1 3 0 1 15 15 4.5638 0 0 0 0 0 0 0 0.060606 0 0
 0.060606 0.030303 0 0.030303 0.121212 0 0.060606 0.121212 0 0.060606 0.030303
 0.060606 0.030303 0.090909 0.060606 0.030303 0 0 0.030303 0.090909 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.030303 0 0 0
 0 0 0 0 0 0 0 0 0
1984 1 1 3 0 1 16 16 2.9042 0 0 0 0 0 0 0 0 0 0 0
 0 0.047619 0 0 0 0.047619 0.095238 0.142857 0 0.095238 0.095238 0.095238
 0 0.095238 0 0.142857 0 0.047619 0.095238 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0
1984 1 1 3 0 1 17 17 1.5212 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0.090909 0 0 0 0 0 0 0 0.090909 0.272727 0 0.181818
 0 0 0.090909 0.272727 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
#these are here just to evaluate overall fit to all conditional age data (by source) at once
#ALL YEARS COMBINED (composite)- USED TO VISUAL EVALUATE FIT ONLY! 0.001075 0.002
15 0.003225 0.004301 0.005376 0.006451 0.007526 0.008602 0.009677 0.010752 0.011827 0.012
903 0.013978 0.015053 0.016129 0.017204 0.018279 0.019354 0.02043 0.021505 0.02258 0.023655 0.024
731 0.025806 0.026881 0.027956 0.029032 0.030107 0.031182 0.032258 0.001075 0.00215 0.003225
 0.004301 0.005376 0.006451 0.007526 0.008602 0.009677 0.010752 0.011827 0.012903 0.013
978 0.015053 0.016129 0.017204 0.018279 0.019354 0.02043 0.021505 0.02258 0.023655 0.024731 0.025
806 0.026881 0.027956 0.029032 0.030107 0.031182 0.032258
1985 1 4 3 0 1 6 6 1.9361 0 0 0 0.214285 0.214285 0.142857 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0.142857 0.142857 0.071428 0 0 0.071428 0 0 0
```

```
        0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1985    1 4 3 0 1 7 7 4.5638 0 0 0 0.030303 0.151515 0.030303 0.030303
        0.090909 0.060606 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
        0 0 0 0 0 0 0 0 0 0.090909 0.030303 0.151515 0.060606 0.060606
        0.030303 0.060606 0.060606 0.030303 0.030303 0 0 0 0 0 0 0 0 0
        0 0 0 0 0 0 0 0
1985    1 4 3 0 1 8 8 12.4468 0 0 0 0.011111 0.133333 0.088888 0.044444
        0.066666 0.033333 0.066666 0.033333 0.011111 0.022222 0.011111 0 0 0.011111 0
        0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.066666 0.088
888     0.022222 0.022222 0.033333 0.022222 0.044444 0.011111 0.033333 0.055555 0.011111 0.011
111     0 0.022222 0 0.022222 0 0 0 0 0 0 0 0 0 0
1985    1 4 3 0 1 9 9 23.7872 0 0 0 0 0.063953 0.104651 0.093023 0.093
023     0.040697 0.011627 0.017441 0.017441 0.005813 0.011627 0.011627 0.005813 0 0.011627
        0 0.005813 0 0.005813 0 0 0 0 0 0 0 0 0 0 0.005813
        0.017441 0.034883 0.052325 0.093023 0.046511 0.005813 0.023255 0.023255 0.029069 0.023
255     0.017441 0.011627 0.029069 0.023255 0.023255 0 0.005813 0.017441 0 0.011627 0
        0 0.005813 0 0 0
1985    1 4 3 0 1 10 10 29.5957 0 0 0 0 0.028037 0.051401 0.079439 0.098
13      0.051401 0.046728 0.042056 0.023364 0.023364 0.014018 0.009345 0.018691 0.004672 0.009
345     0.009345 0.009345 0 0.004672 0 0.004672 0 0 0 0 0 0 0 0 0
        0 0.004672 0.009345 0.009345 0.028037 0.03271 0.046728 0.018691 0.046728 0.028037 0.042
056     0.037383 0.009345 0.018691 0.023364 0.018691 0.03271 0.023364 0.018691 0.009345 0.004672
        0.004672 0 0.004672 0 0 0
1985    1 4 3 0 1 11 11 32.5 0 0 0 0 0.00851 0.021276 0.055319 0.059574
        0.063829 0.059574 0.059574 0.038297 0.038297 0.029787 0.00851 0.017021 0.029787 0.025531
        0.012765 0.004255 0 0.004255 0 0.004255 0 0 0 0 0 0 0 0 0
        0 0 0.017021 0.017021 0.00851 0.025531 0.017021 0.038297 0.034042 0.051063 0.021276
        0.046808 0.025531 0.029787 0.063829 0.004255 0.00851 0.004255 0.012765 0.00851 0.004255 0.008
51      0 0.004255 0.004255 0 0.004255
1985    1 4 3 0 1 12 12 43.1489 0 0 0 0 0.003205 0.00641 0.01923 0.044871 0.051
282     0.089743 0.044871 0.060897 0.032051 0.038461 0.038461 0.041666 0.044871 0.048076 0.035
256     0.022435 0.01282 0.01923 0.01282 0.003205 0.00641 0.00641 0 0 0.003205 0.00641 0 0 0 0 0
        0.003205 0.00641 0 0.009615 0.00641 0.00641 0.003205 0.01282 0.01282 0.01923 0.028846 0.025641 0.028846
        0.028846 0.016025 0.01282 0.025641 0.009615 0.016025 0.003205 0.009615 0.00641 0 0 0.016
025
1985    1 4 3 0 1 13 13 30.5638 0 0 0 0 0 0.004524 0 0.027149 0.054
298     0.045248 0.058823 0.040723 0.081447 0.058823 0.076923 0.063348 0.067873 0.063348 0.022
624     0.040723 0.027149 0.022624 0.027149 0.013574 0.004524 0.013574 0 0.004524 0.009049
        0.022624 0 0 0 0 0 0 0 0.004524 0 0.004524 0 0.004524 0.004524
        0 0.004524 0.013574 0.004524 0.004524 0.004524 0.004524 0.022624 0.018099 0.013574
        0.013574 0 0.013574 0 0.009049 0 0.004524
1985    1 4 3 0 1 14 14 20.1914 0 0 0 0 0 0 0.006849 0.006849 0.027
397     0.034246 0.068493 0.041095 0.082191 0.082191 0.09589 0.054794 0.109589 0.082191 0.061643
        0.020547 0.054794 0.027397 0.034246 0.027397 0.006849 0.006849 0.013698 0 0 0.013
698     0 0 0 0 0 0 0 0 0 0 0 0 0.006849 0 0 0 0 0.006
849     0 0 0.006849 0 0 0.006849 0 0.006849 0.006849 0 0 0
1985    1 4 3 0 1 15 15 15.351 0 0 0 0 0 0 0 0.018018 0 0
        0.063063 0.027027 0.027027 0.045045 0.081081 0.045045 0.081081 0.135135 0.063063 0.081
081     0.072072 0.018018 0.054054 0.045045 0.018018 0.036036 0.018018 0.009009 0.018018 0.036
036     0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.009009
        0 0 0 0 0 0 0 0 0 0 0 0
1985    1 4 3 0 1 16 16 11.8936 0 0 0 0 0 0.011627 0.011627 0 0
        0.011627 0 0.011627 0.023255 0.069767 0.023255 0.058139 0.093023 0.116279 0.104651
        0.058139 0.093023 0.058139 0.058139 0.011627 0.046511 0.011627 0.046511 0 0.034883
        0.046511 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
        0 0 0 0 0 0 0 0 0 0 0 0 0
1985    1 4 3 0 1 17 17 9.1276 0 0 0 0 0 0 0.015151 0 0 0
        0 0.015151 0.015151 0.015151 0.015151 0.015151 0.030303 0.045454 0.030303 0.060606
        0.075757 0.030303 0.075757 0.136363 0.030303 0.10606 0.015151 0.060606 0.030303 0.166666
        0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.015
151     0 0 0 0 0 0 0 0 0 0 0
1985    1 4 3 0 1 18 18 0.8297 0 0 0 0 0 0 0 0 0 0 0
        0 0 0 0 0.166666 0 0 0 0.166666 0 0.166666 0 0 0 0 0.166
666     0 0 0.333333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
        0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
#Laidig composite - dive data - not used
#year   Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp 1 2 3 4 5 6 7 8 9 10 11
        12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
        1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
        20 21 22 23 24 25 26 27 28 29 30
1995    1 4 3 0 1 1 1 0.3 1 0 0 0 0 0 0 0 0 0 0
```

```
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	2	2	0.6	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	3	3	0.2	0.5	0.5	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	4	4	0.5	0	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	5	5	0.6	0	0.5	0.5	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	6	6	0.4	0	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	7	7	0.5	0	0	0.285714	0.571428	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.142857	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	8	8	1.1	0	0	0	0.333333	0.2	0.066666	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.066666	0.066666	0.133333	0.066666	0.066666	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	9	9	3.8	0	0	0	0.117647	0.215686	0.078431	0.117647
	0.058823	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.019607	0.039215	0.058823	0.117647	0
	0.078431	0.058823	0.019607	0.019607	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0
1995	1	4	3	0	1	10	10	7.8	0	0	0	0.009708	0.116504	0.194174	0.213592
	0.165048	0.048543	0	0	0.009708	0	0	0	0	0	0.009708	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.009708	0.009
708	0.019417	0	0.019417	0.019417	0.029126	0.029126	0.019417	0.019417	0.029126	0.019417
	0	0	0	0.009708	0	0	0	0	0	0
1995	1	4	3	0	1	11	11	12.2	0	0	0	0	0.012345	0.074074	0.209876	0.228
395	0.19753 0.080246	0.061728	0.030864	0.018518	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.006172	0	0	0	0
	0	0	0	0	0.012345	0.006172	0	0.012345	0.006172	0	0.012345	0.006172	0.012
345	0	0	0	0	0.012345	0
1995	1	4	3	0	1	12	12	19.8	0	0	0	0	0	0.019083	0.045801	0.125954
	0.171755	0.122137	0.148854	0.141221	0.064885	0.061068	0.053435	0.0229	0.003816	0.007633
	0	0	0	0	0	0.003816	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0.003816	0	0	0	0	0	0
	0	0	0	0	0	0.003816
1995	1	4	3	0	1	13	13	19.5	0	0	0	0	0	0	0.003875	0.023255	0.015
503	0.034883	0.085271	0.096899	0.104651	0.127906	0.077519	0.100775	0.089147	0.062015	0.050
387	0.034883	0.011627	0.023255	0.015503	0.015503	0.007751	0.007751	0	0.003875	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.003875
	0.003875	0	0	0	0	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	14	14	11.6	0	0	0	0	0	0	0	0	0.006493	0.006
493	0	0.025974	0.045454	0.051948	0.032467	0.058441	0.071428	0.084415	0.077922	0.064935
	0.071428	0.051948	0.064935	0.058441	0.077922	0.032467	0.038961	0.025974	0.006493	0.038
961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0.006493	0	0	0	0	0	0	0	0
1995	1	4	3	0	1	15	15	4.3	0	0	0	0	0	0	0	0	0	0	0.017
543	0	0.017543	0	0.035087	0.017543	0.017543	0	0.105263	0.052631	0.070175	0.14035 0.052
631	0.070175	0.035087	0.087719	0.087719	0.017543	0.017543	0.157894	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0
1995	1	4	3	0	1	16	16	0.8	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0.1	0.2	0	0.1	0	0	0.2	0	0.1	0.2	0.1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
#
#Laidig conditional age @ length - dive data - not used
```

```
#year Seas Flt/Svy Gender Part Ageerr Lbin_lo Lbin_hi Nsamp 1 2 3 4 5 6 7 8 9 10 11
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27 28 29 30
1988 1 6 3 0 1 8 8 0.1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1988 1 6 3 0 1 9 9 0.1 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1988 1 6 3 0 1 10 10 0.9 0 0 0 0 0 0.214285 0.428571 0.071428
0.071428 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0.071428 0.071428 0.071428 0 0 0 0 0 0 0 0 0 0 0
1988 1 6 3 0 1 11 11 1.3 0 0 0 0 0 0.15 0.35 0.1 0.25 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0.05 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0.05 0.05 0 0 0 0 0 0 0
1988 1 6 3 0 1 12 12 2.0 0 0 0 0 0 0 0.129032 0.290322 0.225
806 0.129032 0.032258 0.032258 0.096774 0.032258 0.032258 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1988 1 6 3 0 1 13 13 1.3 0 0 0 0 0 0 0 0.095238 0.047619
0 0.190476 0.190476 0.142857 0.095238 0 0.047619 0.047619 0.047619 0 0 0
0 0.047619 0.047619 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
1988 1 6 3 0 1 14 14 1.1 0 0 0 0 0 0 0 0 0 0 0
0.058823 0 0.17647 0 0 0.058823 0.117647 0.058823 0 0.058823 0 0 0.117647
0.117647 0 0.117647 0 0 0.117647 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
1988 1 6 3 0 1 15 15 0.1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0.5 0 0 0 0 0 0 0 0 0 0 0.5
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1988 1 6 3 0 1 16 16 0.1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1989 1 6 3 0 1 8 8 0.2 0 0 0 0.333333 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0.333333 0.333333 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 1 6 3 0 1 9 9 0.9 0 0 0 0 0.166666 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.083333 0 0.083333 0.166666 0.166666 0 0.25 0 0 0.083
333 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 1 6 3 0 1 10 10 0.5 0 0 0 0.142857 0.142857 0.142857 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0.142857 0 0 0 0 0.142
857 0 0 0 0 0.142857 0 0 0 0.142857 0 0 0 0 0 0
1989 1 6 3 0 1 11 11 2.1 0 0 0 0 0.034482 0.034482 0.241379 0.413
793 0.172413 0.034482 0.068965 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 1 6 3 0 1 12 12 3.6 0 0 0 0 0 0.061224 0.061224 0.204081
0.183673 0.10204 0.122448 0.081632 0.040816 0.061224 0.020408 0.020408 0.020408 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0.020408
1989 1 6 3 0 1 13 13 4.3 0 0 0 0 0 0 0.017241 0.034482 0
0.068965 0.086206 0.206896 0.034482 0.120689 0.068965 0.103448 0.034482 0.017241 0.051
724 0.068965 0 0.034482 0.017241 0.017241 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0.017241 0 0 0 0
0 0 0 0 0 0 0 0
1989 1 6 3 0 1 14 14 2.7 0 0 0 0 0 0 0 0 0 0 0
0.027027 0.027027 0.054054 0.108108 0 0.027027 0.108108 0.027027 0.135135 0.081081
0.081081 0.054054 0.027027 0.054054 0.054054 0.027027 0.027027 0.027027 0.027027 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

0 0 0.027027 0 0 0 0 0 0 0
1989 1 6 3 0 1 15 15 1.2 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.0625 0 0.125 0.0625 0 0.1875 0.0625 0.125 0.0625 0.125 0.0625 0 0.0625 0.062
5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1989 1 6 3 0 1 16 16 0.4 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0.333333 0 0 0 0 0.166666 0 0
0.333333 0.166666 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 7 7 0.3 0 0 0 0.2 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0.2 0.4 0.2 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 8 8 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 0.25 0.5 0 0 0.25 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 9 9 0.3 0 0 0 0.25 0.25 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0.25 0 0 0 0 0.25 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 10 10 0.3 0 0 0 0 0.4 0 0.2 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.2 0.2 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 11 11 1.0 0 0 0 0 0 0.066666 0.2 0.2 0.133333
0.133333 0.2 0 0.066666 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1 6 3 0 1 12 12 3.3 0 0 0 0 0 0.020833 0 0.083333 0.125
0.041666 0.125 0.145833 0.083333 0.083333 0.208333 0.041666 0 0.041666 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0
1990 1 6 3 0 1 13 13 4.8 0 0 0 0 0 0 0 0 0 0.014285
0.028571 0.057142 0.028571 0.128571 0.114285 0.157142 0.171428 0.071428 0.071428 0.042
857 0.014285 0.042857 0.014285 0.014285 0.028571 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0
1990 1 6 3 0 1 14 14 2.7 0 0 0 0 0 0 0 0 0 0 0
0 0.051282 0 0 0.102564 0.128205 0.025641 0.102564 0.025641 0.076923 0.128205
0.102564 0.051282 0.128205 0 0.025641 0.025641 0 0.025641 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0
1990 1 6 3 0 1 15 15 1.0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0.071428 0 0 0 0 0 0.214285 0.142857 0.142857 0 0 0.071
428 0.214285 0.071428 0 0.071428 0 0 0 0 0 0 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 6 3 0 1 7 7 0.1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1991 1 6 3 0 1 8 8 0.3 0 0 0 0.25 0.25 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0.25 0 0 0 0.25 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
1991 1 6 3 0 1 9 9 0.9 0 0 0 0.153846 0.153846 0.307692 0.076923
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0.076923 0.076923 0 0 0 0.076923
0.076923 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1991 1 6 3 0 1 10 10 1.5 0 0 0 0 0.095238 0.190476 0.238095 0.285
714 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.047619 0.047619
0.047619 0 0 0 0.047619 0 0 0 0 0 0 0 0 0 0 0
1991 1 6 3 0 1 11 11 2.1 0 0 0 0 0 0.103448 0.310344 0.068965
0.241379 0.103448 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0.034482 0.034482 0 0 0 0.068965 0 0 0 0.034482 0
0
1991 1 6 3 0 1 12 12 3.3 0 0 0 0 0 0 0.021739 0.065217 0.217
391 0.304347 0.217391 0.108695 0.043478 0.021739 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 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	6	3	0	1	13	13	2.0	0	0	0	0	0	0	0	0.035714		0.071428
	0.142857		0.035714		0.071428		0.142857		0.25	0.035714		0.107142		0	0.071428		0	0	0.035
714	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	6	3	0	1	14	14	0.7	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.3	0.1	0	0.2	0.2	0	0	0	0.1	0	0.1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1991	1	6	3	0	1	15	15	0.2	0	0	0	0	0	0	0	0	0	0	0.333
333	0	0	0	0	0	0	0	0.333333		0	0	0.333333		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	1	6	3	0	1	8	8	0.2	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1992	1	6	3	0	1	9	9	0.4	0	0	0	0	0.2	0	0	0.4	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0.2	0	0	0	0	0	0.2	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1992	1	6	3	0	1	10	10	0.8	0	0	0	0	0.1	0.1	0.4	0.1	0	0	0
	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.1
	0	0	0	0	0	0	0	0	0	0	0
1992	1	6	3	0	1	11	11	1.8	0	0	0	0	0	0.090909		0.136363		0.272727
	0.136363		0.090909		0.045454		0.136363		0.045454		0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.045454		0	0	0	0	0	0	0
	0
1992	1	6	3	0	1	12	12	2.3	0	0	0	0	0	0	0.071428		0.107142		0.142
857	0	0.142857		0.285714		0.035714		0.071428		0.035714		0.071428		0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.035714		0	0	0	0	0	0	0	0	0	0	0
	0
1992	1	6	3	0	1	13	13	2.1	0	0	0	0	0	0	0	0.038461		0	0
	0.153846		0.038461		0.115384		0.115384		0.115384		0.038461		0.115384		0.076923		0.038461		0.038
461	0	0.038461		0	0.038461		0	0.038461		0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0
1992	1	6	3	0	1	14	14	1.2	0	0	0	0	0	0	0	0	0	0.066666
	0	0	0.066666		0	0	0	0.066666		0.2	0.066666		0.133333		0.133333		0	0.066666
	0.133333		0.066666		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0
1992	1	6	3	0	1	15	15	0.3	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.25	0	0.25	0.25	0	0.25	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1993	1	6	3	0	1	8	8	0.2	0	0	0	0.666666		0	0.333333		0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	1	6	3	0	1	9	9	0.8	0	0	0	0	0.416666		0	0.25	0.083333		0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0.083333		0	0	0	0.083333		0	0	0.083333		0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	1	6	3	0	1	10	10	1.4	0	0	0	0	0.136363		0.272727		0.090909		0.136
363	0.090909		0	0	0.045454		0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.045454
	0	0	0.045454		0.045454		0.045454		0	0.045454		0	0	0	0	0	0	0	0
	0	0
1993	1	6	3	0	1	11	11	1.4	0	0	0	0	0	0	0.090909		0.318181		0.136
363	0.090909		0.045454		0.045454		0.045454		0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.090909		0.045454		0	0.045454		0	0	0	0	0	0	0	0	0.045454
	0	0
1993	1	6	3	0	1	12	12	1.5	0	0	0	0	0	0	0	0.086956		0.130434
	0.043478		0.173913		0.217391		0.086956		0.173913		0	0.043478		0	0	0	0	0	0
	0	0.043478		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
```

```
	0
1993	1	6	3	0	1	13	13	1.4	0	0	0	0	0	0	0	0	0	0	0.045
454	0.045454	0.136363	0.136363	0.090909	0.090909	0	0.181818	0.045454	0	0.045454	0
	0.045454	0	0	0.045454	0	0.045454	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0.045454	0	0	0	0	0	0	0
	0	0	0
1993	1	6	3	0	1	14	14	1.3	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.05	0	0	0.05	0.05	0.1	0	0.1	0	0.15	0	0.1	0.1	0.1	0.1	0	0.1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1993	1	6	3	0	1	15	15	0.8	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0.166666	0.083333	0	0.083333	0	0	0	0.166666
	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	1	6	3	0	1	16	16	0.1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0.5	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	7	7	0.3	0	0	0.25	0.5	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	8	8	0.1	0	0	0	0	0.5	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	9	9	0.5	0	0	0	0.125	0	0	0.25	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0.25	0	0	0	0.25	0	0.125	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	10	10	1.4	0	0	0	0	0.130434	0.217391	0.173913	0.260
869	0.086956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0.043478	0	0	0	0	0.043
478	0	0.043478	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	11	11	1.4	0	0	0	0	0.043478	0.043478	0.130434	0.217
391	0.260869	0.130434	0.130434	0.043478	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	12	12	1.9	0	0	0	0	0	0.033333	0.066666	0.066666
	0.166666	0.166666	0.2	0.166666	0.066666	0.033333	0.033333	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0
1994	1	6	3	0	1	13	13	2.0	0	0	0	0	0	0	0	0	0	0	0.161
29	0.032258	0.32258	0.064516	0.064516	0.064516	0.129032	0.032258	0.096774	0.032258	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	14	14	0.9	0	0	0	0	0	0	0	0	0.066666	0
	0	0.133333	0.2	0.066666	0.066666	0.133333	0.066666	0.133333	0.066666	0	0	0
	0	0.066666	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0
1994	1	6	3	0	1	15	15	0.4	0	0	0	0	0	0	0	0	0	0	0
	0	0.166666	0	0.166666	0.166666	0	0	0	0.166666	0.166666	0	0	0.166666
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	6	3	0	1	16	16	0.1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
#
#marginal age comp data - CPFVs - females then males
#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
1980	1	7	3	0	1	-1	-1	97	0	0	0	2	16	19	12	14	12	17	20
	8	11	12	10	13	11	7	8	5	6	1	4	5	1	3	0	3	2	1
	0	0	0	3	9	8	7	4	2	6	6	3	3	2	6	2	2	2	2
	4	1	6	1	1	1	1	1	1	0	0
1981	1	7	3	0	1	-1	-1	86	0	0	0	2	6	7	15	15	5	7	8
	10	12	10	13	10	10	14	7	4	7	4	1	2	1	2	4	0	0	8
	0	0	0	3	0	4	2	7	9	4	5	5	8	6	11	7	11	14	5
```

	3	4	2	2	1	0	3	0	1	0	3								
1982	1	7	3	0	1	-1	-1	77	0	0	0	4	14	21	19	22	20	21	11
	15	14	14	14	14	11	14	7	12	7	4	5	4	3	4	1	3	1	3
	0	0	0	0	7	11	8	5	4	4	5	10	8	5	6	4	7	5	7
	6	5	5	1	2	2	0	1	1	0	0								
1983	1	7	3	0	1	-1	-1	30	0	0	0	0	2	2	4	13	10	8	10
	9	10	11	11	9	21	20	13	9	8	10	7	6	3	3	2	0	4	6
	0	0	0	0	2	5	2	3	5	0	0	2	5	8	2	2	1	2	2
	0	2	4	0	1	0	0	1	0	0	1								
1984	1	7	3	0	1	-1	-1	64	0	0	0	0	7	9	12	22	23	23	24
	15	16	15	13	10	20	24	13	12	11	9	14	8	4	6	3	0	3	12
	0	0	0	0	0	6	3	10	9	8	9	6	10	6	5	8	4	15	4
	4	5	5	6	8	2	3	3	0	0	3								

```
#
#
0 # Mean Size at Age Observations
0 # Number of Environmental Variables
0 # Environmental Observations
999 #
```

APPENDIX D - CONTROL FILE FOR 2007 BLUE ROCKFISH STOCK ASSESSMENT

```
# California stock, north of Point Conception
#
# SS2 Version 2.00g (July 2007)
# BASE catch stream
# M females = 0.10, M males = 0.12
# steepness = 0.58 based on Dorm recommendation
# RecFIN CPUE index split: post-2000 q as separate fishery
#
#
1 # Morphs - growth patterns - not gender
1 # Sub-Morphs
1 # Areas
1  1  1  1  1  1  1  1 # Areas per Type
1       # Recruitment Distribution Pattern
0       # Do not allow for Seasonal Recruitment Interaction
0       # Do not allow for Migration
0  0  0 # No movement patterns - must have a line of 3 numbers here
0       # Blocks
0.5     # Recruit Fraction Female
1000    # Sub-Morph Ratio Between/Within
-1      # Sub-Morph Distribution - set equal to -1 for normal approximation
#
# Natural Mortality & Maturity
1       # last age for constant young
2       # first age for constant old
2       # reference age for first size-at-age parameter
25      # reference age for second size-at-age parameter
0
1       # CV=f(A)
1       # maturity option - length logistic
3       # first mature age - (Laidig et al)
1       # MG parm as offset - direct assignment
1       # MG parm adjustment - log transform
-1
#
# mortality & growth_parms
# LO    HI      INIT    PRIOR   PR_type SD      PHASE   env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0.001   0.4     0.1     0.006   0       0.8     -1      0 0 0 0 0.5 0 0 # female natural mortality young
0.0     0.2     0.1     0.1     0       0.8     -1      0 0 0 0 0.5 0 0 # female natural mortality old (offset)
10      25      17.9    17.9    0       0.8     -1      0 0 0 0 0.5 0 0 # female length at Amin
26      45      37.5    37.5    0       0.8     1       0 0 0 0 0.5 0 0 # female length at Amax
0.01    0.3     0.147   0.088   0       0.8     1       0 0 0 0 0.5 0 0 # female k, von Bertalanffy growth coef.
0.001   0.2     0.085   0.105   0       0.8     -2      0 0 0 0 0.5 0 0 # female CV young
0.001   0.2     0.095   0.105   0       0.8     -2      0 0 0 0 0.5 0 0 # female CV old (exp. offset)

-3      3       0.12    0.006   0       0.8     -1      0 0 0 0 0.5 0 0 # male natural mortality young
0.00    0.2     0.12    0.1     0       0.8     -1      0 0 0 0 0.5 0 0 # male natural mortality old (offset)
7       20      15.7    15.7    0       0.8     -1      0 0 0 0 0.5 0 0 # male length at Amin
21      40      31.2    31.2    0       0.8     1       0 0 0 0 0.5 0 0 # male length at Amax
0.01    0.4     0.295   0.295   0       0.8     1       0 0 0 0 0.5 0 0 # male k, von Bertalanffy growth coef.
0.07    0.23    0.085   0.111   0       0.8     -2      0 0 0 0 0.5 0 0 # male CV young
0.07    0.23    0.11    0.111   0       0.8     -2      0 0 0 0 0.5 0 0 # male CV old (exp. offset)
#
#_wt-len, maturity, and [eggs/kg]=a+b*weight
3.4e-5  3.4e-5  3.4e-5  3.4e-5  0       0.8     -1      0 0 0 0 0.5 0 0 # female - coef. to convert L in cm to Wt in kg (Lea et al 1999)
1       3       2.87    2.87    0       0.8     -1      0 0 0 0 0.5 0 0 # female - exp. in female L to W conversion     (Lea et al 1999)
22      32      26      26      0       0.8     -1      0 0 0 0 0.5 0 0 # maturity logistic inflection                  (Wyllie 1987)
-0.7    -0.5    -0.6    -0.6    0       0.8     -1      0 0 0 0 0.5 0 0 # maturity logistic slope (negative values)     (Wyllie 1987)
0       2       62585   62585   0       0.8     -1      0 0 0 0 0.5 0 0 # alpha (intercept) = 1
-1      1       211841  211841  0       0.8     -1      0 0 0 0 0.5 0 0 # beta (slope) = 0   --  these alpha and beta values causes fecundity to = SB
2.9e-5  2.9e-5  2.9e-5  2.9e-5  0       0.8     -1      0 0 0 0 0.5 0 0 # male - coef. to convert L in cm to Wt in kg   (Lea et al 1999)
1       3       2.89    2.89    0       0.8     -1      0 0 0 0 0.5 0 0 # male - exp. in female L to W conversion       (Lea et al 1999)
#
# recruitment apportionment
-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 # Environmental Custom Flag
0 # TimeBlock Custom Flag
#
#_Spawner-Recruitment
1       # SR Function (1=BH w flat-top beyond Bzero, 2=Ricker, 3=standard BH)
#_LO    HI      INIT    PRIOR   PR_type SD      PHASE
5       12      8.3     10      1       10      1       # virgin recruitment
0.2     1.0     0.58    0.58    1       0.181   -1      # steepness
0.1     1       0.5     1       1       1       -1      # sigma-r
-5      5       0       0       0       1       -3      # env-link
-5      5       0       0       0       1       -4      # offset for initial equilibrium
0       0.5     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
#
#first_yr   last_yr   min_log_res  max_log_res  phase
1960    2006    -2      2       3       #_recr_devs
1492    #_first_yr_fullbias_adj_in_MPD
#
#_initial_F_parms for each fishery
#_LO    HI      INIT    PRIOR   PR_type SD      PHASE
0       0.1     0.00    0.01    0       1       -2
0       0.1     0.00    0.01    0       1       -2
0       0.8     0.00    0.1     0       1       -2
#
#_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 0 0  #this makes q analytical for cpfv survey; no difference in fit relative to freely estimating q
1 0 0 0 1 0
1 0 0 0 1 0
0 0 0 0 1 0
0 0 0 0 0 0  #POST2000 RECFIN
#
#_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 survey1 power
#-50    50      -9      -7      0       10      2 # catchability for CPFV index
#
# Selectivity and Retention
#_size_selex_types
#_Pattern Discard Male Special
1 0 1 0 # 1-recreational
1 0 1 0 # 2-commercial hkl
1 0 1 0 # 3-commercial net
1 0 1 0 # 4-CPFV survey
0 0 0 0 # 5-juv survey
0 0 0 0 # 6-dive juv survey
5 0 0 1 # 7-ghost fishery
5 0 0 1 # 8-POST2000RECFIN
#
#_age_selex_types
#_Pattern Discard Male Special
10 0 0 0 # 1-recreational
10 0 0 0 # 2-commercial hkl
10 0 0 0 # 3-commercial net
10 0 0 0 # 4-CPFV survey
11 0 0 0 # 5-juv survey
10 0 0 0 # 6-dive juv survey
10 0 0 0 # 7-ghost fishery
10 0 0 0 # 8-POST2000RECFIN
#
#_selex_parms
# LO    HI      INIT    PRIOR   PR_type SD      PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
#_size_sel: 1 - recfin
```

```
15      50      24.32   28      0       0.5     2       0 0 0 0 0.5 0 0 # 50%
1       15      6.75    6       0       0.5     2       0 0 0 0 0.5 0 0 # diff. in size b/t 50 & 95%
#
# size_sel: 1 - male offsets- 4 lines
1       60      24      20      0       10      -2      0 0 0 0 0.5 0 0 #size@dogleg
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at minL
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at dogleg
-10     0       -0.33   2       0       10      -2      0 0 0 0 0.5 0 0 #log(relmalesel)at maxL
#_size_sel: 2 - comm hkl
15      40      31.57   30      0       0.5     2       0 0 0 0 0.5 0 0
1       15      8.36    8       0       0.5     2       0 0 0 0 0.5 0 0
#
# size_sel: 2 - male offsets- 4 lines
1       60      24      20      0       10      -4      0 0 0 0 0.5 0 0 #size@dogleg
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at minL
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at dogleg
-10     10      -0.33   2       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at maxL
#_size_sel: 3 - comm net
15      40      38.80   37      0       0.5     2       0 0 0 0 0.5 0 0
1       15      3.57    4       0       0.5     2       0 0 0 0 0.5 0 0
#
# size_sel: 3 - male offsets- 4 lines
1       60      24      20      0       10      -4      0 0 0 0 0.5 0 0 #size@dogleg
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at minL
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at dogleg
-10     10      -0.33   2       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at maxL
#
#_size_sel: 4 - rec survey
15      40      22.27   37      0       0.5     2       0 0 0 0 0.5 0 0
1       15      3.749   4       0       0.5     2       0 0 0 0 0.5 0 0
#
# size_sel: 4 - male offsets- 4 lines
1       60      24      20      0       10      -4      0 0 0 0 0.5 0 0 #size@dogleg
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at minL
-10     10      0       0       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at dogleg
-10     10      -0.33   2       0       10      -4      0 0 0 0 0.5 0 0 #log(relmalesel)at maxL
#
#_length mirror CPFV for rec
-2      0       -1      1       0       0.5     2       0 0 0 0 0.5 0 0
-2      0       -1      31      0       0.5     2       0 0 0 0 0.5 0 0
#
#_length mirror POST2000 for rec
-2      0       -1      1       0       0.5     2       0 0 0 0 0.5 0 0
-2      0       -1      31      0       0.5     2       0 0 0 0 0.5 0 0
#  Age-based for juv survey (sel. age 0s only)
#_age_sel: 5 - juv survey 1
0 0 0 0 0 10 -3 0 0 0 0 0 0 0 #
0 0 0 0 0 10 -3 0 0 0 0 0 0 0 #
#
#_age_sel: 6 - juv survey 2 - Laidig, did not use
#0 0 0 0 0 10 -3 0 0 0 0 0 0 0 #
#0 0 0 0 0 10 -3 0 0 0 0 0 0 0 #
#
1       #_env/block/dev_adjust_method(1/2)
0       #_env setup
0       # block setup
-1      #_selparmdev-phase
#
#_Variance_adjustments_to_input_values
#_1 2 3 4 5 6 7
-0.025699 0 0 0.129625 0 0 0 0 #_add_to_survey_CV
0 0 0 0 0 0 0 0                #_add_to_discard_CV
0 0 0 0 0 0 0 0                #_add_to_bodywt_CV
1.7393 3.15333 1 3.19761 1 1 1 1 #_mult_by_lencomp_N
2.81663 1 1 1 1 1 1 1            #_mult_by_agecomp_N
1 1 1 1 1 1 1 1                  #_mult_by_size-at-age_N
#
30      #_DF_for_discard_like
30      #_DF_for_meanbodywt_like
#
1       #_maxlambdaphase
0       #_sd_offset
```

```
#
#_lambdas_(columns_for_phases)
1       # rec fishery - cpue index
0       # comm hkl fishery
0       # comm net fishery
1       # CPFV survey - cpue index
1       # coast juv survey - prerecruit index
0       # Miller Geibel survey
0       # ghost fisherY
1       # POST2000 - RecFIN cpue index
0       #_discard:_1
0       #_discard:_2
0       #_discard:_3
0       #_discard:_4
0       # discard:_5
0       # discard 6
0       # ghost
0       # POST2000
0       #_meanbodyweight
1       #_lencomp:_1
1       #_lencomp:_2
1       #_lencomp:_3
1       #_lencomp:_4
0       # lencomp:_5
0       # length6
0       # ghost
0       # POST2000 (comps left in 1)
1       #_agecomp:_1
0       #_agecomp:_2
0       #_agecomp:_3
0       #_agecomp:_4
0       # agecomp5
0       # age6
0       # age ghost
0       # POST2000
0       #_size-age:_1
0       #_size-age:_2
0       #_size-age:_3
0       #_size-age:_4
0       # size-age5
0       # sizeage6
0       # size age ghost
0       # POST2000
0       #_init_equ_catch
1       #_recruitments
0       #_parameter-priors
0       #_parameter-dev-vectors
1000    #_crashPenLambda
0.9     #_maximum allowed harvest rate
999
```