Stock Assessment of the Blackgill Rockfish (*Sebastes melanostomus*) Population off the West Coast of the United States in 2005

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August 31, 2005

Executive Summary

Stock

Little is known about the population structure of blackgill rockfish (*Sebastes melanostomus*), however, larvae and juveniles circulate in the plankton for up seven months and likely disperse over long distances before settling to the bottom. This prolonged pelagic phase is consistent with the hypothesis of a single biological (i.e. genetic) population or stock along the west coast. Over 90% of blackgill rockfish landings are taken in the Conception and Monterey areas. The majority of the stock biomass in U.S. waters, based on research surveys, is distributed between the Mexican border and Eureka, California. As such, this assessment reports the status of the blackgill rockfish resource off the coast of the United States in the Conception and Monterey areas modeled as a single stock.

Catches

Blackgill rockfish are primarily harvested by commercial hook and line, set net and trawl fisheries. Catches of blackgill rockfish are estimated from Conception and Monterey INPFC areas from 1978-2004, while historic catches from 1977 back to 1950 are extrapolated based on a ratio of blackgill rockfish to total California rockfish landings by gear type taken from a variety of sources. Landings increased gradually prior to the mid-1970s, concurrent with increases in overall rockfish landings in California. Landings in Conception and Monterey areas, combined, peaked in 1987 at over 1,100 mt and have gradually declined to the lowest levels in the time series.

Table a. Recent commercial fishery landings by INPFC area.

	Landings by INPFC Area					
Year	**Conception**	**Monterey**	**Eureka**	**Columbia**	**Vancouver**	**Total**
1995	276	74	2	8	6	366
1996	268	98	8	3	4	381
1997	159	112	1	5	9	286
1998	154	74	3	1	1	234
1999	26	23	7	5	3	64
2000	17	68	1	2	2	90
2001	49	79	2	2	0	132
2002	81	58	9	1	0	148
2003	125	61	3	2	1	192
2004	79	82	1	1	0	163
Total	1234	729	37	29	27	2056
Percent	60%	35%	2%	1%	1%	100%

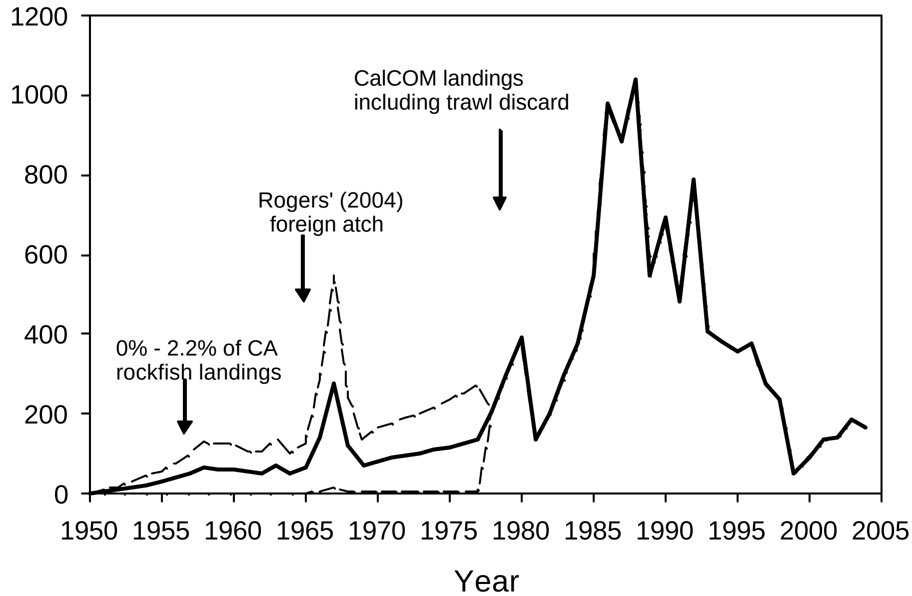

Figure a. Reconstructed historical landings (mt), 1950-1977, and estimated landings of blackgill rockfish. Stippled lines show historic catch levels examined for model sensitivity.

Data and assessment

The first and last assessment for blackgill rockfish was conducted in 1998 with catch data through 1997 (Butler et al. 1999). That assessment assumed a unit stock in southern and central California (Conception INPFC area) and was based on a stock reduction analysis assuming constant recruitment. The dynamics of this simple model were tuned to average mortality rates from catch curves and landings data. That assessment did not explicitly estimate fishery selectivity, alternatively assuming that it mirrors maturity at size/age, and as such estimated trends in fishable/mature biomass. The current assessment has expanded the geographic range and temporal scope of the previous assessment. In addition, time series of survey biomass indices, albeit short, have been developed as a tuning index to approximate recent trends in stock biomass. The time series of fishery landings has been extended back to1950 (extrapolated catches), with actual estimated catches (which include discards) covering 1978 to 2004. Additional information on age and growth has been incorporated into the current assessment to reflect improved ageing capabilities for blackgill. However, due to limited time-series of age data, a length-based model was developed, although growth parameters are estimated within the model. The modeling approach, Stock Synthesis 2 (Ver. 1.19), takes advantage of fishery and survey length compositions to explicitly estimate selectivity.

Stock biomass and Recruitment

Given the time series of deterministic and stochastic recruitments, in combination with the fishery catches and life history parameters (growth, maturity and natural mortality), the spawning stock biomass of blackgill rockfish is estimated to have declined from a high of 9,500 mt in 1950 to a low of 4,797 mt in 1999. Since 1999, spawning stock biomass has increased slightly to its present level of 4,977 mt in 2005. Since 1970 there have been several strong year classes during the middle 1970s to early 1980s. The recent 1991 and 1997 year classes are estimated to be greater than average.

Table b. Recent trend in blackgill rockfish spawning biomass and depletion level.

Year	Estimated spawning biomass (mt)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
1995	4,961	4,791 - 6,660	51.5%	NA
1996	4,895	4,724 - 6,604	50.8%	NA
1997	4,823	4,651 - 6,543	50.5%	NA
1998	4,801	4,627 - 6,533	50.5%	NA
1999	4,797	4,622 - 6,541	51.3%	NA
2000	4,879	4,704 - 6,637	52.0%	NA
2001	4,938	4,761 - 6,708	52.3%	NA
2002	4,971	4,792 - 6,754	52.5%	NA
2003	4,990	4,810 - 6,785	52.4%	NA
2004	4,979	4,799 - 6,783	52.4%	42.1% - 62.5%
2005	4,977	4,796 - 6,788	52.3%	42.0% - 62.4%

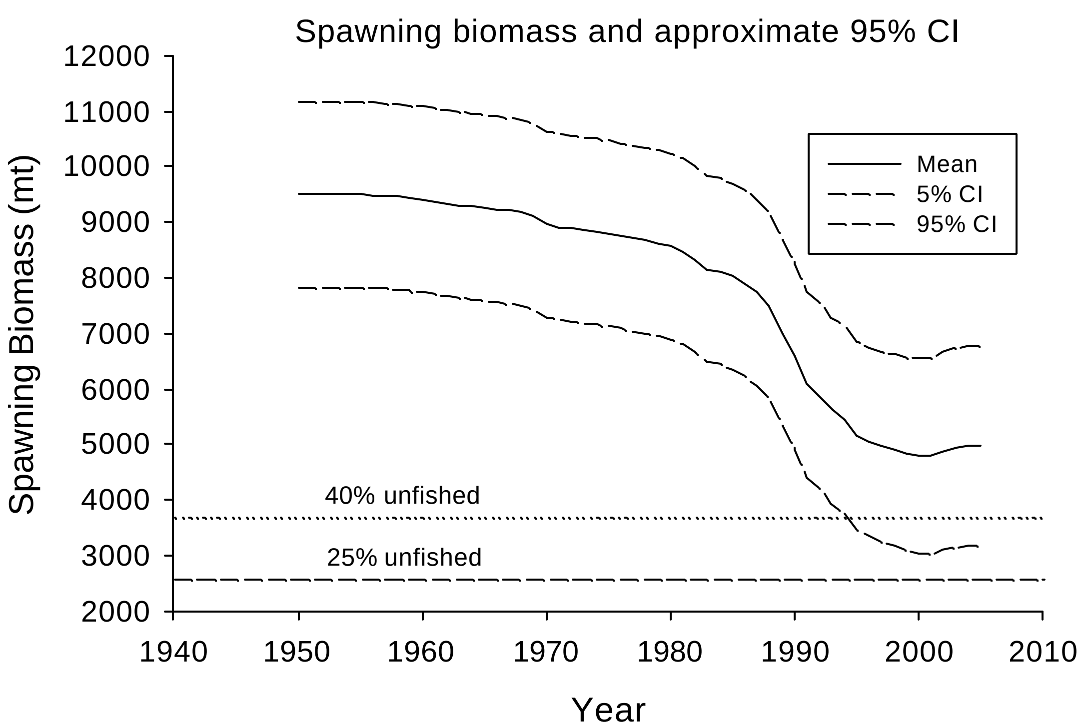

Figure b. Estimated spawning biomass time-series with approximate asymptotic 95% confidence intervals.

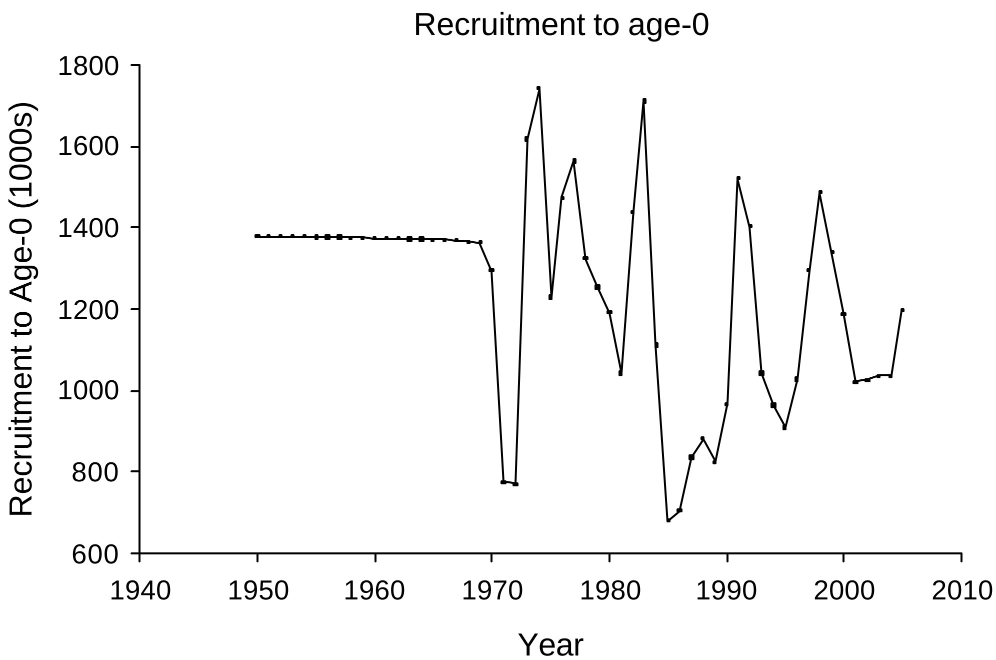

Figure c. Estimated recruitment to age-0 time-series.

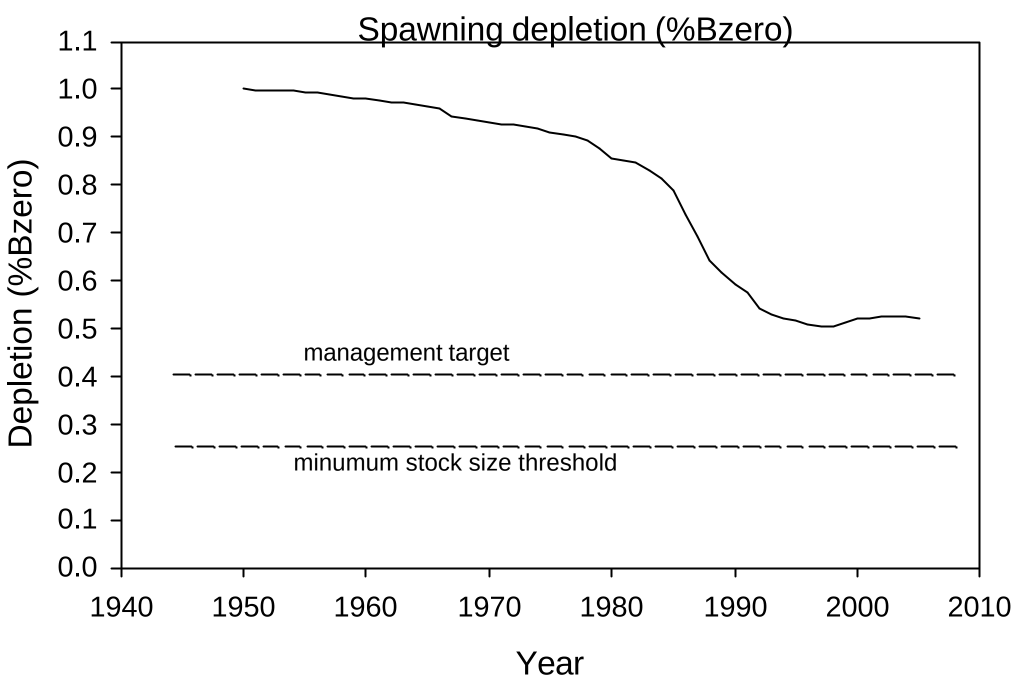

Figure d. Time series of estimated depletion level, 1950-2005.

Reference points

In terms of exploitation status, blackgill rockfish are presently above both the target biomass level (40% unfished biomass) and target fishing mortality (50% SPR). The full exploitation history is portrayed graphically in Figure e and f, which plots for each year the calculated spawning potential ratio (SPR) and spawning biomass level (B) relative to their corresponding targets; F50% and B40%, respectively. Given life history parameters and long term exploitation patterns, the fishing mortality that reduces the spawning biomass to 50% of the unfished level is referred to as F50%, which is the default Pacific Fishery Management Council proxy for F_{MSY}. Similarly, the proxy for B_{MSY} is spawning biomass corresponding to 40% of an unfished stock.

Unfished Spawning Stock Biomass (SB_0)	9.503
Unfished Summary Age Biomass (B_0)	21,558
Unfished Recruitment (R_0)	1,378,000
Spawning Stock Biomass at MSY *(SB_{msy})*	3,799
Basis for SB_{msy} (i.e $SB_{40\%}$proxy)	SB40%
SPR_{msy} or F_{msy} (specify which)	SPR
Basis for SPR_{msy} or F_{msy} (i.e. $F_{40\%}$ proxy)	F50%
Exploitation Rate corresponding to SPR_{msy} or F_{msy} (if available)	2.9%
MSY	223

Unexploited equilibrium spawning biomass (B_{zero}) of blackgill rockfish is estimated to be 9,503 mt (~ 95% confidence interval: 7,235 – 12,734 mt), with a mean expected recruitment of 1,378 thousand age-0 fish. Maximum sustainable yield (MSY), as approximated by application of the F50% harvest rate, is estimated in the assessment model to be 223 mt (182-264 mt). This amount is slightly below the long-term average catches and above the average catches for the last decade. The associated exploitation rate at MSY is 2.9%. The spawning stock biomass expected to produce MSY catch levels was 3,799 mt. This level of exploitation was estimated to result in a spawning potential ratio (SPR) of 0.49.

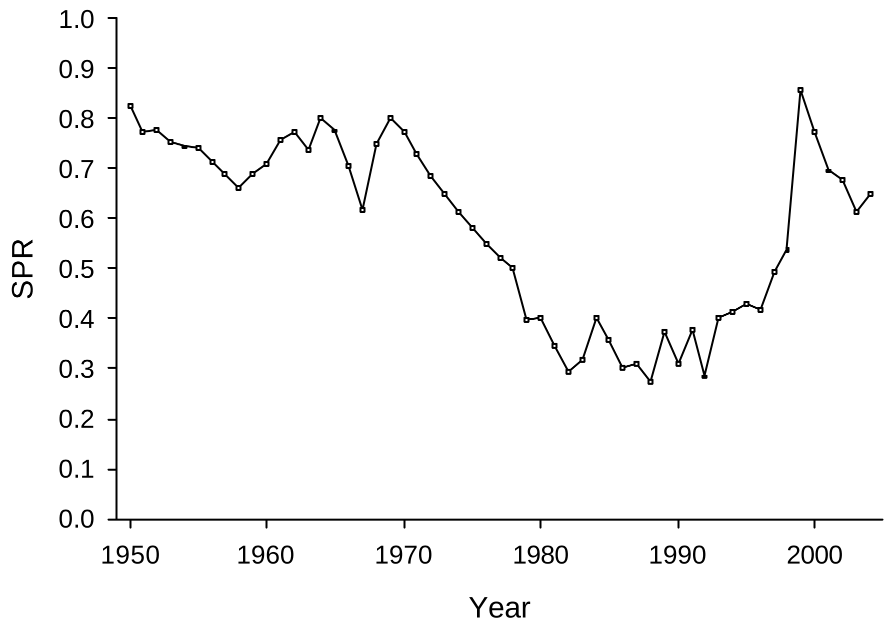

Figure e. Time series of estimated spawning potential ratios. Council proxy default is SPR=0.5.

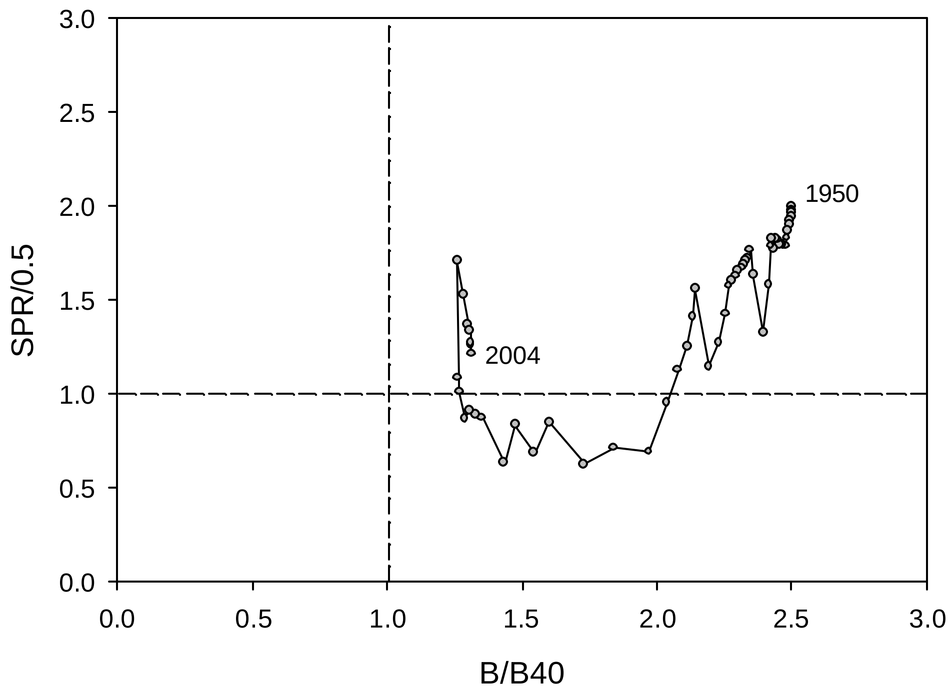

Figure f. Annual (1950-2005) values of calculated spawning potential ratio (SPR) and spawning biomass level (B) as a ratio to its corresponding targets; F50% and B40%, respectively.

Exploitation status

The blackgill rockfish population is presently above the target biomass reference level of 40% unfished and well above the minimum stock size threshold of 25% unfished. Based on measures of model uncertainty, there is less than 5% probability that the stock is below 25% unfished.

Table c. Recent trend in spawning potential ratio (SPR) and exploitation rate.

Year	Estimated SPR	Exploitation Rate
1995	0.45	2.7%
1996	0.44	2.8%
1997	0.51	2.1%
1998	0.54	1.8%
1999	0.85	0.4%
2000	0.76	0.7%
2001	0.68	1.0%
2002	0.67	1.1%
2003	0.61	1.4%
2004	0.63	1.3%

Management Performance

Blackgill rockfish have been managed as part of the southern Sebastes complex and aggregate ABCs and OYs are established from individual species' component harvest targets. While not explicitly estimated in the past assessment, the harvest guideline corresponding to a proxy ABC for blackgill was set at 305 mt in 2000. While the overall level of discard of blackgill rockfish is unknown (only discard information

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Catch	357	376	277	236	49	89	134	143	189	168	-
Discards (model predicted)	-	-	-	-	-	-	-	-	-	-	-
Landings	-	-	-	-	-	-	-	-	-	-	-
ABC	-	-	-	-	-	305	305	305	305	305	305
OY * (if different from ABC)	-	-	-	-	-	305	305	305	305	305	305
SPR	0.455	0.436	0.506	0.544	0.854	0.765	0.684	0.669	0.607	0.633	-
Exploitation Rate	0.027	0.028	0.021	0.018	0.004	0.007	0.010	0.011	0.014	0.013	-
Summary Age Biomass (B) at the beginning of the year (mt)	13,454	13,266	13,068	12,966	12,896	12,995	13,054	13,072	13,086	13,058	13,051
Spawning Stock Biomass (*SB*) at the beginning of the year (mt)	4,961	4,895	4,823	4,801	4,797	4,879	4,938	4,971	4,990	4,979	4,977
Recruitment at the beginning of the year (x1000)	909	1,027	1,295	1,487	1,338	1,188	1,022	1,025	1,036	1,035	1,197
Depletion level at the beginning of the year	0.515	0.508	0.505	0.505	0.513	0.520	0.523	0.525	0.524	0.524	0.523

* In the 1990's, harvest guidelines (hg) occasionally reflected only landed catch since assumed discards were subtracted prior to setting the hg. Please identify those harvest guidelines that were set after subtracting assumed discards.

from the trawl fishery was available) landings have been generally less (ranging from 64 to 286 mt between 1997 and 2004) than the harvest guideline during the last decade.

Table c. 10-year projections showing total catch, spawning biomass and depletion along with approximate 95% confidence intervals of blackgill rockfish under three different input values of natural mortality. An M=0.04 was assumed for the base case model.

M=0.04

Year	Spawning biomass	Approx. Confidence Interval		age-0 recruits	Approx. Confidence Interval		depletion	Approx. Confidence Interval		Total Catch	Approx. Confidence Interval	
2005	4960	3145	6775	617	-13	2404	52.2%	42.0%	62.4%	303	187	419
2006	4882	3130	6634	614	-12	2393	51.4%	41.6%	61.1%	299	186	411
2007	4808	3119	6498	611	-12	2383	50.6%	41.4%	59.8%	294	185	404
2008	4738	3109	6367	608	-11	2372	49.9%	41.1%	58.6%	290	185	396
2009	4673	3103	6242	605	-11	2362	49.2%	40.9%	57.4%	286	184	389
2010	4612	3100	6124	603	-10	2353	48.5%	40.8%	56.3%	282	183	381
2011	4556	3099	6013	600	-10	2344	47.9%	40.7%	55.2%	279	183	374
2012	4506	3102	5909	598	-9	2336	47.4%	40.6%	54.2%	275	182	368
2013	4461	3108	5813	596	-8	2328	46.9%	40.6%	53.3%	272	182	361
2014	4420	3116	5724	594	-8	2321	46.5%	40.6%	52.4%	269	182	355
2015	4383	3126	5641	592	-7	2315	46.1%	40.6%	51.6%	266	182	349
2016	4349	3135	5563	591	-7	2309	45.8%	40.7%	50.8%	263	182	344

M=0.03

Year	Spawning biomass	Approx. Confidence Interval		age-0 recruits	Approx. Confidence Interval		depletion	Approx. Confidence Interval		Total Catch	Approx. Confidence Interval	
2005	2777	1894	3660	507	1	1013	35.6%	27.7%	43.5%	119	70	169
2006	2784	1923	3644	507	1	1013	35.7%	28.0%	43.3%	120	72	168
2007	2790	1953	3627	508	1	1014	35.8%	28.4%	43.1%	120	73	167
2008	2796	1982	3610	508	2	1014	35.8%	28.8%	42.9%	120	75	166
2009	2802	2012	3593	508	2	1015	35.9%	29.2%	42.7%	121	76	165
2010	2808	2041	3575	509	2	1015	36.0%	29.6%	42.4%	121	78	164
2011	2815	2071	3558	509	3	1016	36.1%	30.0%	42.2%	121	80	163
2012	2821	2101	3541	510	3	1016	36.2%	30.3%	42.0%	122	81	162
2013	2828	2130	3525	510	3	1017	36.2%	30.7%	41.8%	122	83	161
2014	2835	2159	3510	510	3	1018	36.3%	31.1%	41.6%	122	84	160
2015	2841	2188	3495	511	4	1018	36.4%	31.5%	41.3%	123	86	159
2016	2847	2215	3480	511	4	1019	36.5%	31.9%	41.1%	123	87	158

M=0.05

Year	Spawning biomass	Approx. Confidence Interval		age-0 recruits	Approx. Confidence Interval		depletion	Approx. Confidence Interval		Total Catch	Approx. Confidence Interval	
2005	8493	4440	12545	2747	-130	5623	66.9%	55.1%	78.7%	693	345	1041
2006	8209	4354	12064	2725	-128	5578	64.7%	53.7%	75.7%	671	339	1004
2007	7946	4277	11615	2704	-126	5534	62.6%	52.5%	72.8%	650	332	968
2008	7704	4210	11197	2683	-124	5491	60.7%	51.3%	70.1%	630	327	934
2009	7482	4152	10812	2664	-122	5449	59.0%	50.3%	67.6%	612	321	902
2010	7281	4104	10458	2645	-119	5410	57.4%	49.4%	65.3%	594	316	872
2011	7101	4065	10136	2628	-117	5373	56.0%	48.7%	63.3%	578	312	843
2012	6941	4037	9845	2612	-115	5339	54.7%	48.0%	61.4%	562	308	817
2013	6800	4017	9583	2598	-112	5308	53.6%	47.5%	59.7%	548	305	792
2014	6676	4003	9349	2585	-110	5280	52.6%	47.1%	58.1%	536	302	770
2015	6566	3994	9139	2573	-108	5254	51.8%	46.7%	56.8%	524	300	749
2016	6469	3988	8949	2562	-105	5230	51.0%	46.4%	55.5%	514	298	730

Table d. Decision table showing consequences of a 12-year harvest policy consistent with three assumed states of nature (M=0.03, M=0.04, and M=0.05) when each alternative is the true state of nature. The bottom panel gives projections for a harvest policy consistent with the 2004-2006 catch under three different “true states of nature” or M=0.03, M=0.04 and M-=0.05.

ASSUMED STATE OF NATURE					TRUE STATE OF NATURE								
					M = 0.03 *5% probability*			M = 0.04 *90% probability*			M = 0.05 *5% probability*		
		Catch consistent with M											
	Year	H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	45	1	72	2777	35.6%	2.1%	4960	52.2%	6.6%	8493	66.9%	3.9%
	2008	46	1	73	2784	35.7%	2.2%	4707	49.5%	5.1%	8231	64.9%	2.9%
	2009	46	1	73	2790	35.8%	2.2%	4544	47.8%	1.3%	8062	63.5%	0.8%
	2010	46	1	73	2796	35.8%	2.2%	4567	48.1%	1.3%	8084	63.7%	0.8%
	2011	46	1	73	2802	35.9%	2.2%	4591	48.3%	1.3%	8110	63.9%	0.8%
M = 0.03	**2012**	46	1	73	2808	36.0%	2.2%	4616	48.6%	1.3%	8138	64.1%	0.7%
	2013	47	1	73	2815	36.1%	2.2%	4644	48.9%	1.3%	8172	64.4%	0.7%
	2014	47	1	74	2821	36.2%	2.2%	4673	49.2%	1.3%	8209	64.7%	0.8%
	2015	47	1	74	2828	36.2%	2.2%	4703	49.5%	1.3%	8251	65.0%	0.8%
	2016	47	1	74	2835	36.3%	2.2%	4734	49.8%	1.3%	8296	65.4%	0.8%
	2017	47	1	74	2841	36.4%	2.2%	4766	50.2%	1.3%	8341	65.7%	0.8%
	2018	47	1	74	2847	36.5%	2.2%	4797	50.5%	1.3%	8387	66.1%	0.7%
		Catch consistent with M											
	Year	H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	116	4	184	2777	35.6%	11.5%	4960	52.2%	3.2%	8493	66.9%	3.9%
	2008	114	4	181	2523	32.3%	10.7%	4882	51.4%	3.1%	8231	64.9%	3.4%
	2009	112	4	179	2321	29.8%	6.4%	4808	50.6%	3.1%	8026	63.3%	1.9%
	2010	111	3	176	2244	28.8%	6.6%	4738	49.9%	3.1%	7957	62.7%	1.9%
	2011	109	3	174	2170	27.8%	6.6%	4673	49.2%	3.1%	7895	62.2%	1.9%
M = 0.04	**2012**	108	3	171	2100	26.9%	6.6%	4612	48.5%	3.1%	7841	61.8%	1.9%
	2013	106	3	169	2035	26.1%	6.7%	4556	47.9%	3.1%	7796	61.4%	1.8%
	2014	105	3	167	1974	25.3%	6.8%	4506	47.4%	3.1%	7761	61.2%	1.8%
	2015	103	3	165	1917	24.6%	7.0%	4461	46.9%	3.1%	7734	61.0%	1.8%
	2016	102	3	163	1864	23.9%	7.1%	4420	46.5%	3.1%	7715	60.8%	1.8%
	2017	101	3	162	1814	23.2%	7.2%	4383	46.1%	3.0%	7701	60.7%	1.8%
	2018	100	3	160	1766	22.6%	7.2%	4349	45.8%	3.1%	7691	60.6%	1.7%
		Catch consistent with M											
	Year	H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	264	8	421	2777	35.6%	11.5%	4960	52.2%	6.6%	8493	66.9%	4.2%
	2008	256	8	407	2523	32.3%	13.6%	4707	49.5%	7.5%	8209	64.7%	4.2%
	2009	248	8	395	2251	28.9%	15.0%	4437	46.7%	7.8%	7946	62.6%	4.2%
	2010	240	7	383	1990	25.5%	16.4%	4177	44.0%	8.0%	7704	60.7%	4.2%
	2011	232	7	372	1747	22.4%	17.6%	3938	41.4%	8.1%	7482	59.0%	4.1%
M = 0.05	**2012**	225	7	361	1523	19.5%	19.0%	3717	39.1%	8.2%	7281	57.4%	4.1%
	2013	219	7	352	1318	16.9%	21.0%	3516	37.0%	8.3%	7101	56.0%	4.1%
	2014	213	7	343	1132	14.5%	23.7%	3333	35.1%	8.5%	6941	54.7%	4.1%
	2015	207	6	335	963	12.3%	27.3%	3167	33.3%	8.8%	6800	53.6%	4.1%
	2016	202	6	328	812	10.4%	31.8%	3017	31.8%	9.0%	6676	52.6%	4.1%
	2017	197	6	321	677	8.7%	37.2%	2881	30.3%	9.1%	6566	51.8%	4.0%
	2018	192	6	316	558	7.1%	43.5%	2759	29.0%	9.1%	6469	51.0%	3.9%
		Catch consistent with M											
	Year	H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	64	2	102	2777	35.6%	11.5%	4960	52.2%	6.6%	8493	66.9%	3.9%
	2008	64	2	102	2523	32.3%	9.7%	4707	49.5%	5.3%	8231	64.9%	3.1%
	2009	64	2	102	2346	30.1%	3.5%	4534	47.7%	1.9%	8052	63.5%	1.1%
	2010	64	2	102	2333	29.9%	3.6%	4533	47.7%	1.9%	8050	63.4%	1.1%
	2011	64	2	102	2321	29.8%	3.6%	4534	47.7%	1.9%	8052	63.5%	1.1%
2006	**2012**	64	2	102	2310	29.6%	3.5%	4536	47.7%	1.9%	8058	63.5%	1.1%
Catch	**2013**	64	2	102	2300	29.5%	3.6%	4540	47.8%	1.9%	8068	63.6%	1.1%
	2014	64	2	102	2291	29.4%	3.6%	4547	47.8%	1.9%	8084	63.7%	1.1%
	2015	64	2	102	2283	29.3%	3.6%	4556	47.9%	1.9%	8106	63.9%	1.1%
	2016	64	2	102	2276	29.2%	3.7%	4566	48.1%	1.9%	8131	64.1%	1.1%
	2017	64	2	102	2270	29.1%	3.7%	4578	48.2%	1.9%	8158	64.3%	1.1%
	2018	64	2	102	2263	29.0%	3.6%	4590	48.3%	1.8%	8185	64.5%	1.0%

Unresolved Problems and Major Uncertainties

1) Because the assessment is primarily length-based (except for conditional age-at-length data), long-term estimation of recruitment variation is problematic, especially for an extremely long-lived rockfish.
2) Survey selectivity is uncertain due to limited temporal availability of length-frequency data. Historic recruitment events, which first appear as young immature blackgill in the survey, may be over- or under-estimated due to uncertainty in survey selectivity.
3) The survey used to tune assessment model results is limited (at most 5 years) and does not extend far enough back in time to derive a more temporally comprehensive picture of stock biomass trends.
4) Historic landings of blackgill, and other rockfish, are uncertain. In addition, US flagged vessels presently fish in Mexican waters and land in the U.S., but it is uncertain whether these landings are excluded from those in CalCOM and PacFIN.
5) Knowledge of blackgill individual growth, natural mortality and selectivity of older/larger fish is central to an adequate assessment. These quantities are confounded in the absence of sufficient age data. The present assessment includes a small sample of age-at-length information from one or two contemporary years

Research Recommendations

1) A bomb radio-carbon isotope study of blackgill rockfish should be conducted to evaluate longevity and aging bias.
2) As the NWFSC ongoing slope/shelf survey matures and additional catch/length/age data is acquired better estimates of survey selectivity, trend and recruitment variation will be obtained.
3) Estimates of discard in the hook are needed.
4) Efforts should be undertaken to better identify blackgill rockfish in the present Santa Cruz and/or CalCOFI mid-water trawl juvenile rockfish surveys.
5) New and historic collections of aging structures (otoliths) should be read to develop a conditional age at length matrix (to better estimate growth within the model) or an age-length key for converting length frequency data into age frequency compositions (to assist in estimating recruitment deviations).
6) A better understanding of blackgill habitat affinity is needed to reconcile differences in density between trawlable and untrawlable habitat.
7) Historic estimates of blackgill (and other rockfish) are uncertain. A concerted study to estimate historic catches should be undertaken.
8) Better maturity and fecundity studies are need.

INTRODUCTION

Blackgill rockfish, also known as Blackmouth and deepsea rockfish, is a member of the family Scorpaenidae which consists of 4 genera and 61 species, more species than any other marine fish family in the eastern North Pacific (Eschmeyer et al. 1983). Compared to most other rockfish, blackgill are found in deeper waters, ranging from 87-768 m (48-419 fm, Eschmeyer et al. 1983), but are most abundant from 300-600 m (164-138 fm, Cross 1987).

Adults are usually associated with rocky outcrops (Allen and Smith 1988) although fishermen report some catches in midwater above rocky outcrops. They range from Washington to central Baja California (Moser and Ahlstrom 1978; Eschmeyer et al. 1983; Allen and Smith 1988) but are relatively rare off Oregon and Washington. Blackgill were caught, for example, in only five of 1,874 bottom trawl tows at depths up to 366 m (202 fm) between 43^{o} N and the U.S.-Canada border during bottom trawl surveys conducted by the National Marine Fisheries Service (Weinberg 1994). In contrast, similar rougheye rockfish (*S. aleutianus*) were taken in 241 tows.

No specific information is available on population structure but blackgill rockfish larvae and juveniles circulate in the plankton for up seven months and likely disperse over long distances before settling to the bottom. This prolonged pelagic phase is consistent with the hypothesis of a single biological (i.e. genetic) population or stock along the west coast.

Blackgill rockfish are a part of the *Sebastes* complex often referred to as "remaining rockfish" (Rogers et al. 1996) because they are managed as a group without species-specific estimates of acceptable biological catch (ABC) and harvest guidelines (HG). Blackgill rockfish are the most common species of remaining rockfish in catches from the Conception INPFC area and among the most common in catches from the Monterey INPFC area.

History of Management Affecting Blackgill Rockfish

The regulatory history of blackgill rockfish is complicated because the species has been managed as part of the "*Sebastes* complex" (PFMC 2000). Consequently PFMC establishes blackgill rockfish allowable biological catch (ABC) in combination with eleven other species of minor rockfishes called "remaining rockfish" and all "other" rockfish. Thus regulatory actions and optimum yield (OY) targeted for a single species in the complex may impact others depending the multispecies gear and spatial relationships.

Historically, the PFMC first imposed landing limits for the *Sebastes* complex on a per-trip basis, to slow the pace of harvest and promote a year-round fishery. Over time this approach evolved into 2-month cumulative retention limits for most species, in order to promote more flexibility to reduce discards. In 1983 the PFMC imposed a limit of 40,000 pounds per trip for the entire coastwide *Sebastes* complex. After recognizing the differential spatial distribution of the remaining rockfishes and the fisheries that target them, harvest limits on both open access and limited entry fisheries were divided between the northern and southern *Sebastes* complexes, separated by a line near Cape Mendocino.

Prior to 1999, cumulative trip limits for the southern *Sebastes* complex were high relative to landings of blackgill rockfish, and were unlikely to have impacted targeting and discard of blackgill. During 1998, cumulative limits for the southern Sebastes complex began the year at 40,000 pounds per month for open access, and 150,000 pounds per two months for limited entry. The limited-entry limits were subsequently reduced to 40,000 pounds per two months in July, and 15,000 pounds per month in October. Limits were dramatically reduced in 1999 for the southern Sebastes complex. Limited entry began the year with a 13,000-pound limit for the first three months. This was followed by one 2-month limit of 6,500 pounds, and two 2-month periods with cumulative limits of 3,500 pounds. For October-December, the southern *Sebastes* limit was 500 pounds per month. For the open-access fleet, the southern *Sebastes* cumulative limit was set at 3,600 pounds per month throughout 1999.

Since 2000, blackgill has been managed as part of the Minor Slope Rockfish sub-group, with limits ranging from 3,000-50,000 pounds per 2 months. In 2001, the Cowcod Conservation area was established outside of 20 fathoms and directly excludes directed groundfish fishing within an expansive area in the Conception and southern Monterey INPFC areas. This regulation may have had the greatest affect on blackgill since the main fishery for it takes place between 200 to 260 fathoms in the Conception zone.

Life History

As with other species of *Sebastes*, fertilization is internal and females give birth to fully formed planktonic larvae during the winter. Off southern California, the peak month for gravid (pregnant) females is February.

The planktonic phase, when larval and juvenile blackgill rockfish are transported passively in ocean currents, is prolonged with settlement to the bottom usually occurring after 3-4 months (Moser and Ahlstrom 1978). Most settle to the bottom by summer but some are still present in the plankton in October, which indicates that some juveniles may remain in the plankton phase for up to seven months.

The scientific literature suggests that juvenile blackgill rockfish settle to the bottom at depths greater than 185 m (101 fm). Mearns et al. (1980) report juvenile blackgill rockfish at depths of 275-305 m (150-167 fm). Moser and Ahlstrom (1978) report newly settled juveniles at 200 m (109 fm) off La Jolla, CA. Juvenile blackgill rockfish are taken in traps set for spot prawn (*Pandalus platyceros*) at about 200 m (109 fm) off Carmel, CA (R. M. Lea, California Department of Fish and Game, pers. comm.). Juvenile blackgill rockfish were not, however, taken in a large number (about 400) of otter trawl tows at 18-185 m (10-101 fm) in soft bottom areas bottom off southern California (Mearns et al. 1980).

Immature blackgill rockfish probably move onto rocky outcrops as they reach sexual maturity. Small immature individuals are often taken in bottom trawls on flat grounds north of Pt. Conception but are seldom taken on rocky outcrops where mature blackgill rockfish are most common.

Commercial Fisheries

Landings data for blackgill rockfish in California were obtained from CALCOM, while landings in Oregon and Washington were obtained from PacFIN databases. While California reports commercial state landings to the PacFIN database, CALCOM attempts a more aggressive routine of partitioning species level landings from aggregate market categories such as "unspecified" rockfish. This level of partitioning as not been accepted by PacFIN and therefore California landings of blackgill rockfish reported by PacFIN are slightly less than those obtained from CALCOM on a yearly basis. This difference was negligible since 1996 (<1%) but was as great as 20% in 1987. This assessment used the CALCOM estimates to characterize California landings.

Blackgill rockfish landings were available since 1978 in California, Oregon and Washington (Table 1). Landings of blackgill rockfish are negligible in Oregon and Washington compared to California (< 1%). Overall coastwide landings more than doubled between 1978 and 1982, peaking at 1,333 mt, and then declining afterwards (Figure 1). Since 2000, blackgill landings have averaged 145 mt.

Blackgill rockfish is an important part of rockfish landed in the Monterey and Conception management areas (Table 2, Figure 1). About 83% of the landings from 1978 to 2004 were from the Conception area and 15% were from the Monterey area. Less than 0.1% of the landings were taken from the Eureka and other northern areas.

Trends in statewide landings obscure trends at individual ports. Most of the catch in 1983 was landed in San Diego (Table 3). Landings in San Diego peaked at 583 m tons in 1983, then declined by about 90% to an average of 58 MT during 1991-1995 (Figure2). Landings for the state remain relatively high because blackgill are increasingly landed at ports north of San Diego.

Three primary gear types are used to harvest blackgill rockfish (Table 4-5; Figure 3). Set nets were first used in deepwater in the late 1970s. Landings during most of the 1980s (mostly in Southern California) were about equally divided between set nets and hook and line gear. The use of setnets declined because of the difficulty of deploying the nets at depth and the loss of gear. At present, horizontal longlines deployed along bottom features (escarpments, rocks, etc.) are the most common gear used to harvest blackgill rockfish off southern California. Trawls are most common on northern grounds.

Fishers report that during the 1980s fishable concentrations and good fishing locations could be located with acoustic gear. Pinnacles that routinely yielded 20,000 lbs were targeted. These locations reportedly now yield 500 lbs per trip and are covered with lost gear (Phil Kline, pers. comm.). Presently fishers report that fishing is usually conducted on likely grounds without acoustic confirmation that rockfish are present (Rob Durfos, pers. comm.).

Blackgill rockfish are taken off California with hook and line, set nets or by trawls. Hook and line currently accounts for 56%; set nets account for 12%; and trawling accounts for 32% of landings (Table 5, Figure 3). Although hook and line accounts for more landings, particularly in southern California, set nets may be preferred in calm weather. Hook and line gear is preferred when currents are likely to tangle set nets in the rocks. Individual fishers may alternate gear depending on weather conditions. Blackgill rockfish are taken primarily in bottom trawls within the Monterey and Eureka areas, whereas trawling accounts for only 10 % of landings in the Conception area.

Fishable concentrations of blackgill rockfish are known to occur in Mexican waters, but landings data for Mexico are not available. Industry sources in the U.S. familiar with the Mexican fishery suggest that blackgill rockfish were probably not targeted off Mexico or harvested in significant quantities during recent years and that landings to date have been small (R. Durfos, CA, pers. comm.). Mexican landings may increase in the future because fishers there were recently introduced to fishing techniques used to catch blackgill rockfish off California.

Prices for blackgill rockfish rank, on average, 26th out of 38 for California rockfish market categories (Butler et al. 1999). Prices for nominal blackgill rockfish landings by hook and line gear during 1992-1997 were higher, for example, than for nominal yellowtail (*S. flavidus*), nominal black (*S. melanops*), nominal bocaccio, nominal chilipepper and nominal widow rockfish (*S. enotmelas*). Prices for nominal blackgill rockfish were lower than prices for redbanded, nominal canary, vermilion and species important in the California live fish fishery (e.g. grass rockfish, (*S. rastrelliger*)). In general, hook and line gear command a higher ex-vessel price per pound ($0.86), followed by set nets ($0.64) and trawls ($0.38) (Table 6). Ex-vessel prices per pound paid for blackgill and nominal blackgill rockfish have generally been stable of have increased for the three primary gears since the late 1980s (Figure 4 and 5). However, when corrected for inflation via the Consumer Price Index the relative price has been rather stable over time.

ASSSESSMENT

Fishery Catches

In an attempt to characterize blackgill catches (landings + discards), the West Coast Observer Program data base was examined for estimates of discards. While these data are limited for blackgill rockfish, a total of 250 hauls in the trawl fishery between 2002 and 2004 had discards. The discard rate was calculated as the sum (over all years) of the discards over the sum of the total catch (retained+discard). The discard rate for the trawl fishery was 9% and 4.3% for Monterey and Conception areas, respectively (Table

7). These rates for Conception and Monterey were applied to the trawl landings from 2004 back to 1978. This implicitly assumes that the discard rate is time invariant. While very limited, 11 hauls obtained from the Pikitch study (Pikitch et al. 1988) in the northern Monterey area produced a similar discard estimate of 10%. Discard data on the hook and line and set net fishery were not available, and are thus not included.

Rogers (2003) estimated that landings of blackgill rockfish in the foreign fisheries ranged between 1 and 200 mt from 1966 to 1970. The foreign fleets were generally operating in waters off Oregon, north of the main concentrations of blackgill. Historical removals of blackgill rockfish in the US domestic fleet prior to 1978 are not known. While efforts to target blackgill in large concentrations probability did not occur until the mid 1970s (Butler et al. 1999), it is likely that incidental catches occurred as fisheries off California and Oregon moved into deeper waters in the late 1940s and early 1950s. In order to reconstruct domestic landings of blackgill rockfish prior to 1970, the ratio of blackgill (BLGL) and nominal blackgill rockfish (BGL1) landings to the total landings of rockfish in California from 1978-1981 was applied to the historical landings of California rockfish between 1950 and 1977. The percentage was increased linearly from zero percent in 1950 to 2.2% in 1977 to mimic the gradual movement of the fishery offshore. Total landings of rockfish in California for each year were obtained from Department of Interior (Fish and Wildlife Service) bulletins and California Department of Fish and Game bulletins. Total California rockfish landings were not available between 1971 and 1977, but landings were assumed to increase linearly to the start of the actual data time series in 1978. Figure 6 shows the entire catch history, both actual and extrapolated, of blackgill rockfish used in the stock assessment model. Sensitivity of model results to historical catches were performed by halving and doubling the historic catches between 1950 and 1977 (stippled lines).

Trawl logbook data

Trawl fishery logbook data from 1981-2004 were obtained from PacFIN. The distribution of catches of blackgill in the trawl fleet suggest that fishing occurs within a fairly narrow depth band along the shelf break (~300+ meters) and north of Point Conception to about Eureka (Figure 7). Trawl catch per unit effort (catch in pounds per hour fished), plotted as 1, 2 and 3 standard deviations from the mean, show high concentrations occur between 300-600 m. This is particularly the case just north of Point Conception, where the shelf break widens. Two measures of the trends in trawl logbook catch per unit effort (pounds per hour fished) were developed and included only tows with positive retained catch of blackgill. One trend is based on the raw CPUE of the entire fleet, while the other includes a subset consisting of only those trawlers that accounted for more than 5% of the total blackgill landings from 1986-2004. and plots the year regression coefficients based on a GLM model applied to trips associated with vessels that caught more than 2% of the total blackgill catch from 1988-2004. Trends in trawl logbook CPUE over time, while highly variable, show a general decline from the late 1980s to the early 1990s (Figure 8). The logbook CPUE data were not used to as indices of abundance since only of fraction of the total blackgill are landed in the trawl fishery.

Survey Abundance Indices

The Alaska Fisheries Science Center (AFSC) has conducted fishery resource surveys of the west coast continental shelf and slope since 1977 and 1990, respectively. The shelf survey, known as the triennial shelf survey, was conducted every third year on contract basis by two Alaska class trawlers. The AFSC slope survey has been conducted on a yearly by the FRV Miller Freeman. The spatial coverage of both the AFSC shelf and slope surveys has been highly variable over time. However, since 1995 the shelf survey consistently sampled the Monterey and Conception INPFC areas as far south as Point Conception (34.5^0 latitude) and to a depth of approximately 500 m. Similarly, the AFSC slope survey has sampled as far south as Point Conception to depths of 1000 m since 1997. The AFSC shelf and slope surveys were terminated in 2001.

The Northwest Fisheries Science Center (NWFSC) slope survey, which began in 1998, was intended to replace the AFSC slope survey and is ongoing. However, data on most slope rockfish, including blackgill, were not collected in 1998, as the pilot year focused on the Dover sole, thornyheads, and sablefish (DTS). The NWFSC consistently covered depths between 183 and 1280 m and in all years extended as far south as Point Conception (34.5^0 latitude). The survey was extended to the southern boundary of the Conception area (32.5^0 latitude) in 2002 and subsequent surveys. In 2004, the NWFSC conducted a shelf survey, with the intent of extending the time series of the discontinued AFSC Triennial shelf survey, using identical sampling protocols and types of vessels. Details of each of these surveys can be found in Lauth et al. (1998) and Turk et al. (2001) for the AFSC and NWFSC slope surveys, respectively.

Each of these surveys was used to develop an index of abundance for blackgill rockfish. Because blackgill rockfish are rare by DTS standards, the survey data were evaluated for post-stratification. A number of different metrics were developed from the survey data and analyzed, including: 1) trends in average body weight as a function of depth and latitude, 2) catch-weighted cumulative frequency histograms of depth and latitude, and 3) standardized catch rates, both raw and logarithmically transformed. Based on this information, a reasonable post-stratification scheme was developed for subsequent analysis using generalized linear models (GLMs).

Based on analysis of catch and biological data from both the AFSC and NWFSC slope surveys, the following patterns describe the distributional characteristics of blackgill rockfish and the post-stratification scheme for GLM analysis. First, blackgill rockfish catches were distributed from the southern Conception area (32.5^0 latitude) to the Columbia River (Figure 9-10). However, catches of blackgill are very rare north of Cape Blanco given the level of survey effort. Also relatively large hauls of blackgill were taken south of Point Conception during 2002-2004, following expansion of the NWFSC slope survey coverage. No less than 90% of the survey catches of blackgill rockfish occurred south of 40^0 N. latitude. Also, blackgill appear to be concentrated near the shelf break as more than 90% of the survey catches occur between 300 and 600 m of water (Figure 11-12). Average body size of blackgill rockfish increases with depth suggesting that deep habitats are more suitable for larger fish and/or possible ontogenetic movement with depth. Based on this information, only the Monterey and Conception INPFC areas between 300 – 600 m were considered for subsequent GLM analysis and Tables 8-9 give the data and statistics summary.

A Delta-GLM was applied to each survey to derive an index of population biomass. The delta distribution (Aitchison and Brown, 1957) was used to model the survey data because there are many zero catches. This error model is based on the premise that it is possible to treat separately the question of whether a catch rate is zero, and the size of the catch given that it is non-zero (Pennington 1983, Stefansson 1996). As such two separate GLMs were applied to each of the three surveys. The first GLM estimates the probability of a positive haul, which is assumed to arise from a Bernoulli process, and the data on zero / non-zero hauls were modeled using a binomial error model. The second GLM estimates the positive catch rate for each stratum with an assumed lognormal error structure. The lognormal error model was selected as the most appropriate among other competing models from the exponential family based on Akaike Information Criterion (AIC) (Akaiki 1974) as specified by Dick (2005). Also, in the case where the NWFSC uses four vessels chartered at random from the west coast groundfish trawl fleet, a generalized linear mixed model (GLMM) was applied to account for the extra variance components due to vessel. Details of applying the GLMM to the multi-vessel survey can be found in Helser et al. (2004).

In general, the Delta-GLMs fit the positive catch data reasonably well. Goodness of fit was evaluate by plotting the value of the deviance residual (McCulloch and Nelder 1989; p. 39) generated from the appropriate deviance function and inverse link of the linear predictor as function of the linear predictors and standardized normal Q-Q plots from the NWFSC-AFSC GLMMs (these were the most parameterized). As in the case of traditional linear models, measures of goodness-of-fit are seen as uniformly distributed deviance residuals above and below a zero reference line when plotted against the linear predictors and deviance residuals which are well approximated by a standard normal distribution (Figure 13-14). Results of the Delta-GLM applied to each of the three surveys are given in Tables 10-12 which provide the predicted proportion positive, the predicted catch rate (given a positive haul), and predicted biomass for each stratum. Predicted positive catch rates are higher in Conception than compared to Monterey and as such when expanded to the entire Conception area produce larger estimates of biomass. Despite the large variances, indices of total blackgill population biomass appear to have increase slightly in the AFSC shelf and NWFSC slope survey since the mid to late 1990s (Figure 15). The AFSC slope survey appears to be relatively flat compared to the other two surveys, but this may not be unexpected given that that survey ended in 2001. Unfortunately these surveys do not extend far enough back in time to derive a more temporally comprehensive picture of stock biomass trends.

Fishery Length Composition

Biological information from the commercial fisheries was extracted from the PacFIN system (CALCOM uploads biological port sampling information to PacFIN without additional post processing and as such the data in each are identical). These data included sex-specific length frequency data at the trip, gear and market category level. These data were analyzed based on the sampling protocols used to collect them, and expanded to estimate the corresponding statistic from entire landed catch for stratum and each year that sampling occurred. In general, the analytic steps can be summarized as follows:

1) Extract biological observations by sex, gear type and INPFC (Conception and Monterey areas).
2) Count lengths in each size bin and for each sex within trip as the "raw" frequency data.
3) Expand the raw frequencies from the trip level to account for the landings in each trip.
4) Sum frequencies within gear type and INPFC area.
5) Expand the summed frequencies by gear type to account for the total landings.
6) Calculate sample sizes (number of samples and number of fish within sample) and normalize to proportions that sum to unity over both sexes for each gear type within each year.

To complete step (3), it was necessary to derive a multiplicative expansion factor for the observed raw length frequencies of the sample. This expansion factor was calculated for each sample corresponding to the ratio of the total landed weight of the species in a trip divided by the total weight of all clusters in the sample from that trip. In some cases, where there was not an estimated sample weight, a predicted weight of the sample was computed by applying the length-weight relationship used in the assessment to each length in the sample, then summing these weights. Each expansion factor was computed and anomalies created by very small samples (number of fish lengths) from very large landings were avoided by limiting the expansion factor to a maximum of 500. The expanded lengths (N at each length times the expansion factor for the sample) were then summed within each gear and INPFC area and then weighted a second time by the relative proportion of landings for each gear between Monterey and Conception areas. Finally, the INPFC-expanded length frequencies were summed over INPFC areas for each gear type and normalized so that the sum of all lengths and sexes for each gear in a single year was equal to unity.

Table 13 provides the biological samples of length information from PACFIN by year and gives the total number of unique samples (trips) and number of lengths by gear type for Monterey and Conception INPFC areas. Ultimately the total sample size by gear type across INPFC areas is the multinomial sample size input into the stock assessment model. However it is presented in this table by INPFC areas to facilitate evaluation of the sampling level, relative to the total landings by gear type and INPFC (Table 5). Close scrutiny reveals that the trawl fishery was sampled most relative to the total amount of landings in both Monterey and Conception. On average, a sample was taken for every 5 metric tons of blackgill rockfish landed in port between 1981 and 2004 in the trawl fishery. The paucity of biological samples taken in the commercial hook and line and set net fisheries is more problematic. In particularly, these fisheries were not even sampled before 1986, when these gear types dominated the total landings. During the mid to late 1980s sample coverage for these fisheries was highest, averaging 13.3 and 12.0 metric tons per sample taken from the hook and line and set net fisheries, respectively. Biological sampling substantially worsened in the hook and line fishery during the early 1990s, when sampling covered average 179 metric tons per sample taken.

Fishery size compositions used in the assessment model for female and male blackgill rockfish are shown for the trawl (Figures 16-17), hook and line (Figures 18-19) and set net (Figures 20-21) gear types. Lengths were collapsed into 2 cm bins because of the limited sample sizes and numbers of length measurements. Based on the review of the literature, blackgill rockfish exhibit sexually dimorphic growth and hence size compositions were generated separately by sex. The fishery size compositions do indeed show females taken in each of the fisheries are larger than males; in many years greater than 50 cm. Also, the trawl fishery does appear to catch a slightly broader size range of both male and female blackgill rockfish than either the hook and line or set net fisheries. This may indicate that the hook and line and set net gears may have narrower selectivity on length. Also, there appears to be very little variation in the length compositions of either female or males taken in the hook and line or by set net fisheries. In contrast, size frequency distributions in the trawl fishery appear to have shifted toward smaller sizes of blackgill. In addition, information on recruitment variation in the size compositions seem to be lacking as the fisheries capture larger blackgill.

Survey Length Composition

Samples of length frequency data were rather sparse in the slope surveys, i.e. samples were taken in only two years of both the AFSC and NWFSC slope surveys (Table 14). In contrast, length samples were taken each of the four years when the AFSC shelf survey consistently sampled depths corresponding to the depth distribution of blackgill. Annual length frequencies by sex were generated by first standardizing the numbers of fish sampled in any give haul by the haul swept area. Length frequencies were then summed over haul within INPFC (Conception and Monterey only). On the basis of these INPFC-level length frequencies, the average weight within each INPFC was estimated by applying the length-weight equation used in the stock assessment to the length frequency distribution. The average weight was then divided into the total INPFC biomass estimate from the GLM analysis to derive numbers of fish within INPFC. The numbers were multiplied to the INPFC length frequency, summed over INPFC and normalized so that the sum of all lengths and sexes in a single year was equal to unity.

Size compositions used in the assessment model are shown by year and for each sex from AFSC shelf (Figure 22), AFSC slope (Figure 23) and NWFSC slope (Figure 24) surveys. In contrast to the fishery length compositions which appeared to lack information on recruitment variation, the survey size compositions indicate evidence of recent recruitment events. These recruitments can be seen as an increase in relative abundance of blackgill in the 20-24 cm range in 1999-2000 in the AFSC slope survey, 2001-2004 in the AFSC shelf survey and 2003-2004 in the NWFSC slope survey. Size compositions prior to 1999, which are only available from the AFSC shelf survey, do not show many small blackgill. Based on published growth curves, blackgill at approximately 24 cm would be 10 years old. Hence this recent recruitment information in the survey size compositions would represent fish spawned in the early- to mid-1990s. It is important to note that 20-24 cm blackgill in the NWFSC slope survey dominate the size compositions and are quite dissimilar from the other survey size compositions. A detailed examination of these survey data showed that the NWFSC slope survey in 2003 and 2004, which sampled below Point Conception, encountered hauls with more numerous small blackgill. Regardless of the differences in the size compositions between the different surveys, estimating survey selectivity may be problematic because there are so few years of size composition information available to approximate a long-term average curve.

At the suggestion of the STAR panel the NWFSC slope survey length composition data were excluded from the model, since it was determined that they have an inordinately strong affect on the estimated 1997 year class. For consistency, both the NWFSC CPUE and size composition data were removed. However, it was recognized that this survey may be the foundation for future indices of abundance and that the utility of the survey again be examined as the time series lengthens.

Biological Information

Only two blackgill rockfish age and growth studies were available from the literature. Butler et al. (1999) sampled 224 backgill from California ports in 1985 and 1997. They reported a female in their samples as old as 87 y (54.6 cm), but the oldest 3% ranged from 69 – 87 years. Eschmeyer et al. (1983) reported a maximum size of about 61 cm. More recently Stevens et al. (2003) conducted a longevity and growth study of blackgill rockfish with radiometric validation. They used the same 1985 and 1997 California commercial port samples used by Butler et al. (1999), but augmented their collection with additional age-length samples taken in 1998 and 1999 (n = 260 readable otoliths) from NMFS research surveys from central California and southern Oregon. They reported a 90-year old male (45 cm) taken during the 1999 cruise. Like many rockfish, blackgill rockfish otolith growth rings were difficult to interpret. However, they reported some remarkably clear otoliths and with those they obtained 87% between-reader agreement, and close agreement between predicted age and radiometric age. Their results, in addition to other reported studies, do indeed suggest blackgill rockfish exhibit longevity up to or greater than 90 years of age. Also, blackgill exhibit sexually dimorphic growth. Females reach a larger asymptotic size (~54 cm) than males (~44 cm) but grow at a slower rate; K=0.04 vs. K=0.068 for females and males, respectively (Table 15, Figure 25). Slow growth rates are characteristic of other deep, slope-dwelling rockfish species, including rougheye (*S.aleutianus*) and bank rockfish (*S. rufus*) (Love et al. 2002). In fact, blackgill rockfish was found to be among the slowest growing based on a heirachical meta-analysis of 46 species of rockfish in the Sebastes genus from California to Alaska (Figure 26).

The noted growth parameter estimates were used to parameterize the population dynamics model. However, the von Bertalanffy growth parameters were estimated within Stock Synthesis using only survey data input as conditional age at length (Table 16). This was done to circumvent possible size selectivity bias in the commercially obtained age-length samples and to allow the model to estimate growth conditioned on all other data used to model the stock, such as size composition information.

In the context of the slow growth rate, female blackgill rockfish do not attain age at 50% maturity until later in life (~ 20 years old) and are not fully (100%) mature until nearly 30 years old. The characterization of ages-at-maturity was inferred by estimating the fraction mature as a function of size, from a nonlinear regression using three estimates of the fraction mature (1%, 50%, 100%) at length from two different studies (Wyllie-Echeverria 1987, Love et al. 1990), and then converting the lengths to ages via the estimated growth curves. The maturity-length curve is plotted in Figure 27 along with estimates of maturity from Love et al. (1990) and Wyllie-Echeverria et al. (1987). Differences between the above estimates of maturity-at-age and published estimates are because Wyllie-Echeverria et al. (1987) likely underestimated age using whole otoliths.

Growth in weight as a function of length was estimated from data available from the 2004 triennial shelf and NWFSC slope surveys. The weight-length relationship was estimated by fitting a log-log linear regression on 182 observations from the triennial shelf survey and 184 observations from the NWFSC slope surveys (Figure 28). Parameters from the regressions (Table 15) indicate little difference in data from the different surveys. Weight-length relationships for blackgill rockfish from Love et al. (1990), which were based on California port samples, were essentially identical to those from the survey.

Natural mortality often times is the most difficult life history parameter to estimate and direct observations are rarely available, since most data are collected from a population of interest after some exploitation has occurred. Despite this, natural mortality, M, can sometimes be inferred from life history invariant parameter relationships with reproductive output (Gunderson 1997) and growth (Charnov 1993). Gunderson (1997) analyzed 28 stocks of fish to derive a relationship for M and reproductive output and growth, of which only 6 were rockfish. Estimates of M derived for Pacific ocean perch (M=0.05), rougheye rockfish (M=0.04) and darkblotched rockfish (M=0.10) from his analysis may be extrapolated to blackgill rockfish, due to similarities in life history (growth and longevity) and depth distribution. A natural mortality rate of M=0.1 probably represents an absolute upper bound since growth rates for darkblotched rockfish are nearly twice that of blackgill.

Other approaches to deriving natural mortality rates, such as Hoenigs's (1983) regression analysis for fish, produced estimates of M of 0.047 y^{-1} and 0.045 y^{-1} for blackgill rockfish for maximum longevities of 87 or 90 years, respectively. Since age determination error generally increases with age, estimation of M relying on oldest know ages will be imprecise. Nevertheless, an M=0.05 seems to be a reasonable first approximation based on the observed longevity, K equal to 0.05 (average of both sexes), and comparison to other similar species. Assessment results are nearly always sensitive to the assumed M and therefore a sensitivity based on M is warranted.

History of modeling approaches for Blackgill Rockfish

The first and last assessment for blackgill rockfish was conducted in 1998 with catch data through 1997 (Butler et al. 1999). That assessment assumed a unit stock in southern and central California (Conception INPFC area) and was based on a stock reduction analysis assuming constant recruitment. The dynamics of this simple model were tuned to average mortality rates from catch curves and landings data. That assessment did not explicitly estimate fishery selectivity alternatively assuming that it mirrors maturity at size/age, and as such estimated trends in fishable/mature biomass. It should be noted that, if the fishery selects larger sizes of fish, relative to the maturity curve, then the exploitation history of the stock will be lower, given an equivalent level of exploitable biomass.

The current assessment has expanded the geographic range and temporal scope of the previous assessment. In addition, time series of survey biomass indices, albeit short, have been developed as a tuning index to approximate recent trends in stock biomass. The time series of fishery landings has been extended back to 1950 (interpolated catches) and the actual estimated catches (which include discards) covering 1978 to 2004. Further, additional information on age and growth has been incorporated to reflect improved aging capabilities and individual growth estimated within the population dynamics model (fit as conditional age at length using only survey data). Finally, the modeling approach takes advantage of fishery and survey length compositions to explicitly estimate selectivity. Based on the magnitude of these changes, the length of time since the last assessment, and the use of a fundamentally different assessment modeling tool, no formal comparisons with the previous assessment were performed.

Model Description

This assessment used the Stock Synthesis modeling framework written by Dr. Richard Methot at the NWFSC (SS2 Version 1.19, April 27th, 2005). Stock Synthesis provides a general framework for the modeling blackgill rockfish because the complexity of the population dynamics can be made commensurate with the data quantity. In this regard, both complex and simple models were explored. The blackgill rockfish population is assumed to be a single stock represented within the Conception and Monterey INPFC areas. The model includes males and females as separate sexes in both the underlying dynamics and in all data sources were this was possible; mainly via growth and fishery and survey size compositions. The accumulator age for the internal dynamics of the population was set to 80 years, well within the expectation of asymptotic growth. The years explicitly modeled were 1950-2004 (last year of available data). Initial population conditions were assumed to be in equilibrium at the first year of the model due to the low level of landings. However, given the extensive longevity of blackgill it could be argued that many years of constant catch would be needed reach equilibrium conditions. No initial fishing mortality was estimated and the spawning biomass was assumed equal to Bzero in 1950, preceding a gradual build up of the fishery.

The following provides a narrative of the model structure, and detailed parameter specification and assumptions are found in Table 17. The assessment model includes three fleets of fishery types: commercial hook and line, commercial set net, and commercial trawl fisheries. As discussed in previous sections, sampling of length frequencies during some years and fisheries was sparse, and thus a decision was made to exclude length frequencies for those years and fisheries where fewer than 2 samples (trips) with at least 50 length observations were available. The commercial hook and line and set net fisheries are assumed to have the same selectivity (mirrored curves) based on similarity of the length frequency compositions. The selectivity curve is assumed to be dome-shaped and the ascending inflection, peak selectivity and final selectivity freely estimated. The commercial trawl fleet, which exploits smaller fish than the other fisheries, is parameterized to have two time-stanzas of selectivity: 1950-1990, 1991-2004.

A shift in selectivity toward smaller fish after 1990 was evident is the size composition data. The peak selectivity, the ascending infection (time varying) and the final selectivity at the largest size bin were freely estimated. The final selectivity for the commercial trawl fleet, when freely estimated from preliminary model runs, was approximately 0.5. This is unlikely reasonable since fishable concentrations of large fish were often targeted with acoustic gear that routinely yielded large hauls. Due to the limited availability of survey length compositions the AFSC shelf and both slope trawl surveys were modeled to have the same selectivity. The rationale was to let the composite length frequencies approximate a selectivity curve representing longer term average conditions. As with the commercial trawl fleet peak selectivity, the ascending infection and the final selectivity at the largest size bin were freely estimated. The surveys are assumed to occur instantaneously at the middle of July throughout the time series.

For the base case model, natural mortality is assumed to be age- and time-independent and equal to 0.04 y^{-1} (this value was arrived at by profiling over different values of M and will be discussed below). The stock-recruitment function was a Beverton-Holt parameterization, with the log of mean unexploited recruitment estimated. When freely estimated, the steepness parameter was at the upper limit of 1.0. It was fixed at 0.65 for all subsequent runs (except in the case of sensitivity runs). This value was based on Dorn's (2002) meta-analysis of steepness for west coast rockfish. Year-specific recruitment deviations are estimated from 1970-2004.

The constraint and bias correction standard deviation, $sigma_R$, is treated as a fixed quantity in SS2. Typically, the value is derived through an iterative process of adjusting the input value corresponding to the minimal difference between the root means square error (RMSE) of the predicted recruitment deviations and the input value. This ensures that the approximate bias-correction term would be appropriately and internally consistent for predicted recruitments estimated in the model and projected forward in time. However, in this assessment, which is predominately length-based (except for conditional age at length data used to fit growth parameters), there is limited information in the size compositions to inform recruitment variation (this is discussed in more detail in model results). As a result, *$sigma_R$* was set to a value of 0.5 and the model results showed little sensitivity to variation in this quantity.

Maturity of female blackgill rockfish is assumed to have a logistic functional form and increase asymptotically as a function of size. Fecundity is assumed to be a function only of mass and equivalent in form to the maturity at length relationship. Individual growth is modeled separately for males and females and based on the von Bertalanffy growth function, and growth parameters estimated freely within the model based on conditional age at length data. Length at age 2 is assumed to be equal for females and males, but size at age is estimated separately for the sexes based on separate von Bertlanffy K and length at maximum age (70 years old) parameters, which are parameterized as exponential offsets. Variability in length of individuals ate each age grouping the population is assumed to increase with increasing age through the use of a constant CV (~0.08 based empirically on length at age data) that is equal for both females and males.

Multinomial sample sizes for the length composition data used in this assessment are based on the number of trips sampled for the commercial fisheries and the number of tows in the research surveys. Sample sizes for conditional age at length data were taken as observed number of fish aged. Standard deviations from the survey indices were not adjusted as the RMSE from preliminary model runs were consistent with the mean of the input standard deviations. The base case model employs equal emphasis factors (lambdas=1.0) for each likelihood component, however, sensitivity analyses are performed.

Base Case Model and Sensitivity

Typically, many model runs are performed as the analyst attempts to ascertain the model's strengths and weaknesses, and to circumscribe the full dimensionality of uncertainty. It was evident from preliminary model runs that model results were most sensitive to different assumptions for the value of natural mortality. As such, multiple model runs were performed in which the objective function and depletion was profiled over values of M ranging from M=0.01 to M=0.10 by increments of 0.01 (Figure 29). In addition, the von Bertalanffy growth parameters and final selectivity at largest size bin for the fishery and survey were also estimated. Based on the profile, a value of M=0.04 yr^{-1} had the smallest objective function Log likelihood and as such was most plausible given the data. While not shown here, the final selectivity for both the fishery and survey were insensitive to variation in the value of M; resulting in a strong dome for the hook and line/set net fishery, partial dome (0.5) for the trawl fishery and asymptotic selectivity for the survey.

Estimated growth parameters were sensitive to natural mortality. Results show that female asymptotic size declines as M increases, while for male blackgill asymptotic size increases but then decreases (Figure 29). The growth rate, K, increases for both female and male blackgill with an increase in M. Where the objective function is minimized at an M=0.04, asymptotic size is 48 cm and 42 cm for female and male blackgill, respectively. These parameter estimates are slightly lower than literature values from Stevens et al. (2004) and are most likely free from potential bias problems encountered from commercial fishery samples which were excluded in the model. Estimated growth curves are shown in Figure 30 and do show reasonable fits to the observed survey samples of age-length when estimated internally to SS2 with all other available data.

Assuming an M=0.04 for the base case, model structure, model parameters and input data uncertainties were explored further. Alternative assumptions were examined regarding: 1) fishery and survey selectivity, 2) steepness on the stock-recruitment relationship, 3) natural mortality, and 4) level of historic catches prior to 1978. Full details of model results for these sensitivity runs are given in Table 18.

Results showed that halving or doubling the historic catches from 1950-1977 or varying steepness by +/- 50% had little effect on the overall level of stock depletion (values ranging from 52% to 54%) compared to the base case model (Table 18). The base case model was however more sensitive to the assumed shape of the fishery and survey selectivity, and most sensitive to the assumed value for natural mortality. On one extreme, the model was allowed to freely estimate the final selectivity on all fishery and survey selectivity curves, thereby testing how much of a descending limb the curves should have relative to the base model that imposed a final selectivity of 0.5 on the trawl fishery and surveys. The addition of two parameters resulted in only a decrease of two likelihood units of the objective function. In contrast, a model which assumed asymptotic fishery and survey selectivity curves, constraining the model by only two parameters, resulted in an increase in the objective function likelihood by approximately nine units. Most of the change occurred in the fishery length frequency distributions suggesting that the model prefers dome-shaped selectivity. These particular end points in asymptotic vs. dome-shaped fishery and survey selectivity resulted in spawning biomasses that were only 51% and 53% of the unfished level, respectively, compared to 52% for the base case. As noted, the base model assumed a fully dome-shaped selectivity curve (estimated) for the hook and line and set net fishery, but imposed a partial domed shape on the trawl fishery and survey selectivity curves. That rationale was based on the highly selective nature of the hook and line and set net fishery gears and the apparently greater availability of a broader size range of blackgill to the trawl fishery.

Assumptions regarding natural mortality generated the most variability in model results of all the structural and parameter sensitivities examined. Starting from the base case model, two initial runs using alternative M values of 0.02 and 0.07 resulted in depletion rates of 20% and 89% respectively (Table 18). Higher M would account for a higher level of starting biomass and ultimately a lighter exploitation history consistent with the availability of larger, presumably, older fish. These results suggest the starting input value of M=0.04 for the base case model was quite reasonable. However, subsequent 10-year projections and decision analyses were performed with the base case (M=0.04) and also M values of 0.03 and 0.05, which correspond roughly to the lower and upper 5th percentile of the distribution of depletion levels for the base case M=0.04 model.

Model Results – Stock size, depletion and Status

Base case model fits to the various data types used in this assessment are shown in Figures 31-38. Predicted vs. observed length frequencies, along with Pearson residuals for the hook and line fishery (Figures 31-32), set net fishery (Figure 33-34), trawl fishery (Figure 35-36) and trawl surveys (Figures 37-38), all indicate a reasonable model fit. The trawl fishery showed a shift in the length frequency distributions to smaller sizes of fish after 1991 and the model was able to accommodate this. Fits were obviously better to those size frequencies with larger samples sizes and poorer for those with more sparse data. This is particularly evident in the hook and line and set net fisheries, where in the mid to late 1980s sampling was good relative to the amount of blackgill landed in port (Figure 31). The model predicted a length frequency with a long ascending shoulder to accommodate the numerous small blackgill in the 20-30 cm range seen in the recent 1999-2000 AFSC slope and 2001-2004 AFSC shelf surveys (Figure 37).

Predicted biomasses from the model were generally within 90% intervals of the observed biomass indices (Figure 39). Point estimates of biomass from the AFSC shelf survey show a general increase from 1995-2004. The predicted biomass, however, shows comparatively less of an increase (Figure 39), with the last two survey years underestimating the observed values. This is not entirely unexpected, given the relative flatness of the AFSC slope survey and the large CVs associated with the higher biomass. As noted above, the slow growth rate of blackgill and the inconsistency of survey increases with the size frequency data also are probably affecting the model’s ability to fit the nearly doubling of the observed shelf survey biomass between 1998 and 2004.

Fishery and survey selectivity curves estimated by the base case model are shown in Figure 40. Selectivity curves for the hook and line and set net fisheries rise quickly from about 34 cm, peak at about 44cm and descend to a small selectivity at 61 cm. In contrast, the trawl fishery selectivity curve reflects greater selection of smaller blackgill relative to the other fisheries, with an apparent shift is the size at 50% selectivity of 38 cm during 1950-1990 to 34 cm during 1991-2004. A composite fishery selectivity curve (averaged predicted curves weighted by the fishery landings) shows that a relatively large segment of the population is reaching sexual maturity before being selected to the fisheries; size at 50% maturity and fishery selection is 34 cm and 39 cm, respectively. Based on the growth curves of females, this would allow 50% of the population to mature (34 cm = 20 years) and spawn at least once nearly 10 years before 50% of the population is exposed to exploitation (39 cm = 29 years). The survey selectivity curve is also shown in Figure 40. Again due to the limited availability of length frequency data (which is why all the curves were mirrored) the actual curve associated with these surveys is uncertain. The long ascending limb apparently attempts to capture the recent increase in small fish which are certainly available and captured by the trawl gear. The ascending form of the curve however under longer term conditions of recruitment remains uncertain.

Given the predominately length-based formulation of this assessment (due to a lack of more comprehensive age data), individual year-specific recruitments are difficult to estimate over a broader expanse of years. This, in addition to the fact that blackgill recruit to the fishery and mature over a wide range of ages (about 10 years), means that recruitment of periodic strong and weak year classes would be "smeared" over a decade or so. This is illustrated to some extent in Figure 41 by the smoothness of the historic trajectory of recruitment. A number of year classes are, however, prominent including several during the 1970s and early 1980s and more recently the 1991 and 1997 year classes. The model assumed deterministic Beverton-Holt recruitment dynamics for the years 1950-1970, with steepness (***h***) equal to 0.65, after which stochastic recruitment from 1971-2004 were allowed to deviate from the expected stock-recruitment curve (*sigmaR* = 0.5). Recruit deviations are shown as a long term decline from mean recruitment from the early 1970s to the mid 1980s followed by a period of increase in recruitment during the early to mid 1990s. Until additional age data are incorporated into the model it may be too optimistic to estimate recruitment deviations over a broader window of time. Nevertheless, it may be desirable to propagate whatever long-term recruitment uncertainty does exist into the final model output. The presence of numerous 20-26 cm blackgill in the 2000-2004 survey length compositions, corresponding to an age of about 10 years, are consistent with the sequence of positive recruitment deviations (from log mean recruitment from the curve) during the early to mid 1999s.

Given the time series of deterministic and stochastic recruitments, in combination with the fishery catches and life history parameters (growth, maturity and natural mortality), the spawning stock biomass of blackgill rockfish is estimated to have declined from a high of 9,503 mt in 1950 to a low of 4,797 mt in 1999 (Table 19, Figure 41). Since 1999, spawning stock biomass has increased slightly to its present level of 4,977 mt in 2004. This nominal increase is due more to lower fishery catches and residual growth of survivors in the population than to increased recruitment over the past 10 years, since blackgill take nearly 20 years of age to reach 50% maturity. From an assumed unexploited stock in 1950 (%Bzero = 100), a steady increase in exploitation to over 1,100 mt in 1987 resulted in a corresponding decline in stock biomass (Figure 41). Stock biomass fell most rapidly during the late 1980s, as a result of consecutive years of historically large removals. Between 1980 and 1997, estimated spawning biomass fell from 86% of the unexploited level in 1980 to 51% by 1997. The 2005 blackgill rockfish spawning biomass is presently estimated to be at 52% of the unexploited level, with approximate asymptotic confidence intervals ranging from 42% to 62% in 2005 (Figure 42). There is less than a 10% probability that current spawning biomass is below the minimum spawning biomass threshold of 25% of unfished (Figure 43).

In term of its exploitation status, blackgill rockfish are presently above both the target biomass level (40% unfished biomass) and the target fishing mortality (50% SPR) (Figure 44). The full exploitation history is portrayed graphically in Figure 44 which plots for each year the calculated spawning potential ratio (SPR) and spawning biomass level (B) relative to their corresponding targets, F50% and B40%, respectively. Given life history parameters and long term exploitation patterns, the fishing mortality that reduces the spawning biomass to 50% of the unfished level is referred to as F50%, which is the default Pacific Fishery Management Council proxy for F_{MSY}. Similarly, the proxy for B_{MSY} is spawning biomass corresponding to 40% of an unfished stock.

10-year Projections

Projections of forecasted total catch, spawning biomass and depletion under the base case model and for three different input values of M are given in Table 21. Forecasts were generated under the 40:10 harvest control rule using a 12-year average of the relative F contribution from each fishery, beginning in 2007 and ending in 2018. Since the last year of catch data in the model was 2004, the model was extended by assuming the same catch from each fishery for 2005 and 2006. In addition to mean bias-corrected state variables, approximate asymptotic 95% confidence intervals of these quantities are also given.

Decision Analysis

The content of the decision table was a result of extensive discussion during the STAR panel. The assumed value of natural mortality, M, was identified as an important source of uncertainty in this assessment; this "axis of uncertainty" was therefore selected for inclusion in the table. As such, a 12-year sequence of catch was generated from each fishery under the base case model and for values of M corresponding to M=0.03, 0.04 and 0.05. The catch streams (or "assumed state of nature") corresponding to these values of M were then input into the model as fixed levels of removals and the model again projected under the three different "true states of nature" corresponding to an M=0.03, 0.04 and 0.05. An M=0.03 and M=0.05 correspond roughly to the lower 5^{th} and 95^{th} percentile, respectively, of the distribution of 2005 depletion levels from the base case model (which assumed M=0.04). As such, the approximate probability associated with each true state of nature M=0.03, M=0.04 and M=0.05 were 5%, 50% and 5%, respectively. The decision table reports the estimated spawning biomass, relative depletion and catch for each of these alternate states of nature (Table 22).

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Table 1. Landings of Blackgill rockfish (mt) from 1978 – 2004 compiled from PacFIN (Oregon and Washington) and CalCOM (California) databases.

	Landings in mt by State			
Year	**California**	**Oregon**	**Washington**	**Total**
1978	315	0	0	315
1979	304	0	0	304
1980	470	0	0	470
1981	253	0	0	253
1982	427	0	0	428
1983	598	0	0	599
1984	327	0	0	328
1985	505	0	0	505
1986	959	0	0	960
1987	877	0	0	878
1988	1,031	0	0	1,031
1989	541	1	0	542
1990	676	1	0	678
1991	476	10	0	486
1992	780	3	0	783
1993	401	16	0	417
1994	376	5	0	381
1995	349	6	9	364
1996	366	2	5	373
1997	268	3	11	282
1998	228	2	1	231
1999	47	4	3	55
2000	85	2	2	89
2001	128	3	0	131
2002	139	1	0	140
2003	185	2	1	189
2004	161	1	1	162
Total	11,273	68	33	11,373

Table 2. Blackgill rockfish landings (mt) by PFMC area compiled from PacFIN and CalCOM databases.

	Landings by INPFC Area					
Year	**Conception**	**Monterey**	**Eureka**	**Columbia**	**Vancouver**	**Total**
1978	216	99	0	0	0	315
1979	290	14	0	0	0	304
1980	401	69	0	0	0	470
1981	168	85	0	0	0	253
1982	337	90	2	0	0	428
1983	333	265	0	0	0	599
1984	267	61	0	0	0	328
1985	412	92	0	0	0	505
1986	822	135	3	0	0	960
1987	830	48	17	0	0	878
1988	948	83	41	0	0	1031
1989	463	78	5	1	0	542
1990	478	199	25	1	0	678
1991	399	76	12	6	1	486
1992	647	133	2	2	0	783
1993	352	49	10	6	0	417
1994	335	41	2	3	0	381
1995	276	73	2	8	6	364
1996	268	97	8	3	4	373
1997	159	110	1	5	9	282
1998	154	74	3	1	1	231
1999	26	21	7	5	3	55
2000	17	68	1	2	2	89
2001	49	79	2	2	0	131
2002	81	58	9	1	0	140
2003	125	61	3	2	1	189
2004	79	82	1	1	0	162
Total	8932	2338	156	51	33	11373
Percent	79%	21%	1%	0%	0%	100%

Table 3. Blackgill rockfish landings (mt) by condensed port group, 1978-2004.

	Blackgill rockfish landings (mt) by port group					
Year	Crescent City-Eureka	Bodega-Ft. Bragg	Monterey-San Francisco	Morro Bay-Santa Barbara	Los Angeles-San Diego	Total
1978	0	3	96	25	191	315
1979	0	5	9	38	252	304
1980	0	51	18	55	346	470
1981	0	4	81	72	96	253
1982	0	47	42	198	139	428
1983	0	188	77	42	291	599
1984	0	26	34	23	245	328
1985	0	50	43	59	353	505
1986	3	43	94	181	641	960
1987	17	35	13	487	343	878
1988	41	10	73	804	144	1,031
1989	5	25	53	384	79	542
1990	25	55	144	261	217	678
1991	9	47	29	240	159	486
1992	1	62	71	407	242	783
1993	0	5	44	224	127	417
1994	1	7	35	178	157	381
1995	2	25	48	145	131	364
1996	7	27	71	146	123	373
1997	1	43	68	114	45	282
1998	3	33	41	143	11	231
1999	9	1	20	24	2	55
2000	1	44	24	13	5	89
2001	1	45	35	39	10	131
2002	9	32	26	51	30	140
2003	2	3	58	92	32	189
2004	1	44	38	46	33	162
Total	136	962	1,383	4,491	4,444	11,373
Percent	1%	8%	12%	39%	39%	100%

Table 4. Blackgill rockfish landings in California (mt) by gear type compiled from the CalCOM database.

	Landings by gear type			
Year	**Hook and Line**	**Setnet**	**Trawl**	**Total**
1978	208	1	105	315
1979	284	8	12	304
1980	390	1	79	470
1981	170	4	79	253
1982	202	134	91	427
1983	288	16	294	598
1984	142	119	66	327
1985	219	160	126	505
1986	340	354	265	959
1987	356	390	131	877
1988	319	491	221	1,031
1989	247	197	97	541
1990	339	117	220	676
1991	294	54	128	476
1992	493	136	151	780
1993	245	38	117	401
1994	245	10	121	376
1995	175	43	131	349
1996	200	9	157	366
1997	133	5	131	268
1998	111	2	116	228
1999	19	0	28	47
2000	32	0	53	85
2001	38	0	89	128
2002	75	1	62	139
2003	123	8	55	185
2004	64	2	95	161
Total	5,752	2,300	3,221	11,273
Percent	51%	20%	29%	

Table 5. Blackgill rockfish landings (mt) by gear type in the PFMC Conception and Monterey areas. Percentages are given by gear within a given INPFC area.

Landings by gear type in Conception and Monterey									
	CONCEPTION				MONTEREY				Grand
Year	**H & L**	**Setnet**	**Trawl***	**Total**	**H & L**	**Setnet**	**Trawl***	**Total**	**Total**
1978	206	1	9	216	2	0	105	107	324
1979	283	7	0	290	1	0	14	15	305
1980	389	1	11	401	0	0	75	75	476
1981	131	3	5	139	10	0	81	91	230
1982	197	3	4	204	0	3	95	98	302
1983	287	4	31	322	0	0	289	289	611
1984	142	115	10	267	0	3	62	66	333
1985	218	160	36	414	1	0	100	101	515
1986	334	346	148	828	6	8	135	148	976
1987	354	389	90	833	2	1	49	52	885
1988	315	451	190	956	5	40	42	86	1,042
1989	231	177	57	465	16	20	46	82	547
1990	335	107	37	479	4	10	201	215	695
1991	294	48	59	402	0	5	77	83	484
1992	424	134	93	651	69	3	66	139	790
1993	243	36	75	355	2	2	49	53	408
1994	242	7	89	338	3	3	38	44	383
1995	156	40	83	279	19	3	56	78	357
1996	176	7	89	272	24	2	78	104	376
1997	92	5	65	161	41	0	74	116	277
1998	92	2	64	157	20	0	59	79	236
1999	14	0	13	27	5	0	17	23	49
2000	13	0	4	17	19	0	54	73	90
2001	24	0	25	50	14	0	71	85	135
2002	57	1	24	82	18	0	43	62	143
2003	81	6	39	126	42	2	19	62	189
2004	54	1	26	80	10	1	77	88	168
Total	5,385	2,051	1,376	8,812	332	108	2,072	2,512	11,324
Percent	60%	23%	15%	78%	14%	5%	89%	22%	

* Discard rate of 4.3% and 9.0% applied to the trawl fishery for the Monterey and Conception areas, respectively.

Table 6. Ex-vessel value (in price per pound) by gear type of blackgill rockfish (BLGL) and nominal blackgill rockfish (BGL1) market categories from 1981-2004. Price per pound has not been inflation adjusted.

	Ex-vessel value (price per pound) by gear type[1]						
	Blackgill Rockfish (BLGL)			Nominal Blackgill Rockfish (BGL1)			
Year	**H&L**	**Nets**	**Trawl**	**H&L**	**Nets**	**Trawl**	**Average**
1981	0.579	0.465	0.175	0.260	-	-	0.370
1982	0.601	0.430	0.192	0.405	-	-	0.407
1983	0.638	0.482	0.215	0.250	0.238	0.230	0.342
1984	0.679	0.491	0.242	0.534	0.423	0.350	0.453
1985	0.705	0.530	0.276	0.621	0.544	0.353	0.505
1986	0.657	0.540	0.299	0.643	0.283	0.454	0.479
1987	0.662	0.524	0.298	0.631	0.475	0.485	0.513
1988	0.578	0.404	0.327	0.678	0.389	-	0.475
1989	0.752	0.412	0.296	0.659	0.438	0.353	0.485
1990	0.746	0.863	0.292	0.659	0.471	0.345	0.563
1991	1.032	0.685	0.315	0.680	0.532	0.360	0.601
1992	0.890	0.587	0.328	0.591	0.526	0.377	0.550
1993	1.062	0.859	0.397	0.685	0.548	0.382	0.656
1994	0.729	0.562	0.403	0.758	0.674	0.474	0.600
1995	0.772	0.778	0.401	0.766	0.610	0.412	0.623
1996	0.750	0.594	0.412	0.805	0.700	0.460	0.620
1997	0.811	0.963	0.358	0.892	0.455	0.330	0.635
1998	1.078	0.949	0.423	0.825	0.731	0.595	0.767
1999	0.963	0.486	0.437	0.889	0.620	0.410	0.634
2000	1.257	-	0.490	1.468	0.938	0.446	0.920
2001	1.127	0.842	0.535	1.422	0.853	0.429	0.868
2002	1.160	0.816	0.518	0.975	1.228	0.549	0.875
2003	1.355	-	0.549	0.949	0.936	0.568	0.871
2004	1.159	0.853	0.635	1.372	1.007	0.500	0.921
Average	0.864	0.641	0.367	0.767	0.619	0.422	0.614

[1] Ex-vessel price is not inflation adjusted and represents doller value of the landings divided by landed catch

Table 7. Estimates of total catch and discard fraction from the West Coast Observer Program from 2002-2004. Discard rates given are calculated as the sum (over all years) of the discards over the sum of the total catch (retained+discard).

	Monterey			Conception		
Year	Hauls > 0	Catch (lb)	Discard (lb)	Hauls > 0	Catch (lb)	Discard (lb)
2002	51	7,870	2,800	29	476	7
2003	26	199	31	16	3,920	32
2004	108	27,840	414	20	1,184	202
Sum over years		35,909	3,245		5,580	241
Discard rate		9.04%			4.32%	

Table 8. Post-stratified data and statistics summary for blackgill rockfish caught at depths between 300-567 m in the slope survey (AFSC and NWFC surveys combined).

Total number and number positive tows by year and spatial strata.

	AFSC Slope					NWFSC Slope			
	Monterey		Conception			Monterey		Conception	
Year	Total # tows	# tows > 0	Total # tows	# tows > 0	Year	Total # tows	# tows > 0	Total # tows	# tows > 0
1997	11	5	9	6	**1997**	-	-	-	-
1998	-	-	-	-	**1998**	-	-	-	-
1999	12	6	8	6	**1999**	34	18	9	1
2000	13	8	8	3	**2000**	30	13	13	7
2001	14	7	8	5	**2001**	27	10	15	8
2002					**2002**	41	17	27	13
2003					**2003**	22	6	38	13
2004					**2004**	8	1	35	12

Summary statistics (mean, CV) for all tows in Kg/2ha.

	Monterey		Conception			Monterey		Conception	
Year	mean	cv	mean	cv	Year	mean	cv	mean	cv
1997	1.6	0.46	2.4	0.59	**1997**	-	-	-	-
1998	-	-	-	-	**1998**	-	-	-	-
1999	7.9	0.68	5.5	0.52	**1999**	1.7	0.29	0.1	0.85
2000	3.2	0.39	8.2	0.85	**2000**	2.3	0.31	1.7	0.45
2001	4.4	0.44	4.2	0.61	**2001**	4.9	0.55	1.2	0.43
2002					**2002**	1.9	0.30	6.1	0.53
2003					**2003**	1.2	0.90	1.9	0.40
2004					**2004**	1.0	1.00	8.0	0.50

Summary statistics (mean, CV) for all postive tows in kg/2ha.

	Monterey		Conception			Monterey		Conception	
Year	mean	cv	mean	cv	Year	mean	cv	mean	cv
1997	3.5	0.33	3.6	0.56	**1997**	-	-	-	-
1998	-	-	-	-	**1998**	-	-	-	-
1999	15.9	0.64	7.4	0.48	**1999**	3.6	0.25	0.8	-
2000	5.2	0.33	21.6	0.79	**2000**	5.4	0.22	3.1	0.39
2001	8.8	0.35	6.7	0.55	**2001**	13.0	0.52	2.1	0.35
2002					**2002**	4.6	0.24	12.6	0.50
2003					**2003**	4.2	0.88	5.7	0.34
2004					**2004**	7.2	0.50	21.1	0.44

In 1998, the NWFSC slope survey focused primarily on DTS species and therefore catch information is not available for slope rockfish.

Table 9. Post-stratified data and statistics summary for blackgill rockfish caught at depths between 300-567 m in the AFSC triennial shelf survey (Note: 2004 was conducted by NWFC).

Total number and number positive tows by year and spatial strata.				
	Monterey		**Conception**	
Year	Total # tows	# tows > 0	Total # tows	# tows > 0
1995	23	15	22	11
1998	31	18	22	12
2001	30	23	24	18
2004	20	18	13	8
Summary statistics (mean, CV) for all tows in Kg/4ha.				
	Monterey		**Conception**	
Year	**mean**	**cv**	**mean**	**cv**
1995	2.90	0.27	3.98	0.40
1998	4.88	0.35	6.61	0.41
2001	5.45	0.30	8.12	0.30
2004	9.95	0.47	9.32	0.37
Summary statistics (mean, CV) for all postive tows in kg/4ha.				
	Monterey		**Conception**	
Year	**mean**	**cv**	**mean**	**cv**
1995	4.45	0.22	7.96	0.34
1998	8.40	0.31	12.11	0.37
2001	7.10	0.28	10.92	0.26
2004	11.06	0.46	15.16	0.30

Table 10. Predicted proportion positive, catch rate given positive haul (kg/2 Ha) and biomass (mt) of blackgill rockfish between 300-567 m from the Delta-GLM applied to AFSC slope survey.

Predicted proportion positive based on Delta-GLM model				
	Monterey		**Conception**	
Year	**fraction pos.**	**cv**	**fraction pos.**	**cv**
1997	0.37	0.31	0.45	0.27
1998	-	-	-	-
1999	0.43	0.29	0.50	0.27
2000	0.38	0.30	0.45	0.29
2001	0.44	0.26	0.51	0.26
2002	-	-	-	-
2003	-	-	-	-
2004	-	-	-	-
Predicted catch rate (kg/2 Ha) given positive haul based on Delta-GLM model				
	Monterey		**Conception**	
Year	**mean**	**cv**	**mean**	**cv**
1997	3.6	0.69	3.6	0.63
1998	-	-	-	-
1999	16.0	0.63	7.4	0.64
2000	5.3	0.50	20.9	1.67
2001	8.9	0.61	6.8	0.70
2002	-	-	-	-
2003	-	-	-	-
2004	-	-	-	-
Predicted biomass (mt) by strata				
	Monterey		**Conception**	
Year	**bio.**	**cv**	**bio.**	**cv**
1997	162.2	0.82	833.6	0.75
1998	-	-	-	-
1999	828.1	0.79	1920.3	0.74
2000	244.8	0.65	4856.8	1.76
2001	481.3	0.72	1771.2	0.79
2002	-	-	-	-
2003	-	-	-	-
2004	-	-	-	-

Table 11. Predicted proportion positive, catch rate given positive haul (kg/2 Ha) and biomass (mt) of blackgill rockfish between 300-567 m from the Delta-GLM applied to NWFSC slope survey.

Predicted proportion positive based on Delta-GLM model				
	Monterey		**Conception**	
Year	**fraction pos.**	**cv**	**fraction pos.**	**cv**
1999	0.43	0.21	0.48	0.21
2000	0.50	0.19	0.55	0.19
2001	0.46	0.21	0.52	0.20
2002	0.47	0.18	0.52	0.17
2003	0.29	0.29	0.34	0.24
2004	0.26	0.34	0.31	0.28
Predicted catch rate (kg/2 Ha) given positive haul based on Delta-GLM model				
	Monterey		**Conception**	
Year	**mean**	**cv**	**mean**	**cv**
1999	3.4	0.66	1.0	7.49
2000	6.6	0.59	3.1	0.91
2001	11.8	0.67	2.7	0.79
2002	4.0	0.53	10.8	0.52
2003	4.5	0.77	5.2	0.55
2004	5.7	5.50	21.3	0.63
Predicted biomass (mt) by strata				
	Monterey		**Conception**	
Year	**bio.**	**cv**	**bio.**	**cv**
1999	180.91	0.69	236.22	9.01
2000	390.71	0.66	863.84	1.00
2001	659.74	0.68	704.10	0.82
2002	229.76	0.59	2881.06	0.57
2003	158.64	0.95	925.08	0.66
2004	186.67	4.66	3436.27	0.72

Table 12. Predicted proportion positive, catch rate given positive haul (kg/2 Ha) and biomass (mt) of blackgill rockfish between 300-567 m from the Delta-GLM applied to AFSC triennial shelf survey.

Predicted proportion positive based on Delta-GLM model				
	Monterey		**Conception**	
Year	**fraction pos.**	**cv**	**fraction pos.**	**cv**
1995	0.62	0.13	0.49	0.18
1998	0.63	0.12	0.49	0.17
2001	0.81	0.07	0.71	0.11
2004	0.85	0.08	0.76	0.11
Predicted catch rate (kg/2 Ha) given positive haul based on Delta-GLM model				
	Monterey		**Conception**	
Year	**mean**	**cv**	**mean**	**cv**
1995	3.2	0.41	3.3	0.50
1998	3.4	0.37	4.8	0.47
2001	3.2	0.31	4.9	0.38
2004	3.8	0.37	5.8	0.65
Predicted biomass (mt) by strata				
	Monterey		**Conception**	
Year	**bio.**	**cv**	**bio.**	**cv**
1995	122.28	0.44	517.33	0.44
1998	129.89	0.40	604.68	0.53
2001	158.66	0.33	900.19	0.39
2004	195.24	0.38	1150.28	0.65

Table 13. Biological samples (number of trips sampled and number of length measurements) for Blackgill rockfish from PacFIN BDS data base by gear type in Conception and Monterey.

	CONCEPTION						MONTEREY					
	Hook and Line		Set Net		Trawl		Hook and Line		Set Net		Trawl	
Year	# Trips	# Lgts	# Trips	# Lgts	# Trips	# Lgts	# Trips	# Lgts	# Trips	# Lgts	# Trips	# Lgts
1978	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	1	4	-	-	-	-	5	28
1982	-	-	1	12	1	2	-	-	-	-	13	115
1983	-	-	-	-	8	20	-	-	-	-	36	249
1984	-	-	-	-	13	77	-	-	-	-	28	224
1985	-	-	-	-	34	410	-	-	-	-	55	542
1986	58	1957	90	1469	33	239	-	-	2	2	45	494
1987	53	1781	53	776	19	154	-	-	-	-	25	242
1988	25	878	31	827	26	290	-	-	2	31	20	141
1989	10	282	7	166	12	69	-	-	6	22	28	70
1990	13	376	11	209	17	170	-	-	14	31	19	116
1991	-	-	-	-	29	416	-	-	2	18	41	462
1992	1	41	1	24	13	366	6	129	-	-	11	173
1993	2	46	-	-	10	231	-	-	1	2	18	225
1994	1	42	-	-	8	168	-	-	1	1	9	30
1995	2	65	-	-	19	476	-	-	-	-	7	96
1996	1	48	-	-	33	665	-	-	-	-	10	47
1997	3	89	-	-	14	527	-	-	-	-	21	103
1998			1	4	13	525	-	-	-	-	18	154
1999	1	53	-	-	6	158	-	-	-	-	14	285
2000	1	1	-	-	3	24	2	41	-	-	18	375
2001	-	-	-	-	1	3	4	61	1	2	22	235
2002	-	-	-	-			4	98	-	-	39	427
2003	-	-	-	-	4	10	2	22	-	-	19	287
2004	-	-	-	-	1	8	2	5	-	-	13	108

Table 14. Biological samples (number of trips sampled and number of length measurements) for Blackgill rockfish taken in the AFSC and NWFSC shelf and slope trawl surveys within INPFC area.

Monterey						
	NWFSC Slope		**AFSC Slope**		**AFSC Shelf**	
year	**# hauls**	**# lengths**	**# hauls**	**# lengths**	**# hauls**	**# lengths**
1995	-	-	-	-	14	93
1998	-	-	-	-	18	193
1999	-	-	11	276	-	-
2000	-	-	-	-	-	-
2001	-	-	15	273	24	193
2003	-	-	-	-	-	-
2004	1	15	-	-	19	154
Conception						
	NWFSC Slope		**AFSC Slope**		**AFSC Shelf**	
year	**# hauls**	**# lengths**	**# hauls**	**# lengths**	**# hauls**	**# lengths**
1995	-	-	-	-	9	101
1998	-	-	-	-	11	142
1999	-	-	10	106	-	-
2000	-	-	-	-	-	-
2001	-	-	8	230	18	232
2003	13	72	-	-	-	-
2004	12	394	-	-	9	114

Table 15. Biological parameters used in the blackgill rockfish assessment.

Function	Parameter	Males	Females
W-L	"	1.01E-05	1.01E-05
	ß	3.12	3.12
von Bertalanffy	L_8	54.5	44.5
	K	0.04	0.068
	T_0	-4.48	-2.37
Maturity	"	-	34
	ß	-	-0.866

Table 16. Conditional age at length samples for blackgill rockfish from the 1998 triennial shelf survey. Data provided courtesy of Melissa Stevens.

	Lower	Lower Age bin																																	
Sex	Length bin	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
F	2	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6	0.000	0.000	0.000	0.000	0.000	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.000	0.000	0.498	0.000	0.000	0.000	0.000	0.000	0.498	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	8	0.000	0.000	0.000	0.399	0.199	0.399	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	9	0.000	0.000	0.000	0.000	0.166	0.000	0.498	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	10	0.000	0.000	0.000	0.000	0.000	0.249	0.249	0.249	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	11	0.000	0.000	0.000	0.125	0.000	0.125	0.125	0.249	0.125	0.000	0.125	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.332	0.000	0.498	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.000	0.249	0.000	0.000	0.000	0.249	0.249	0.000	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.000	0.166	0.000	0.000	0.166	0.000	0.166	0.166	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.332	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	16	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.000	0.166	0.000	0.166	0.000	0.000	0.166	0.000	0.000	0.000	0.000	0.000
	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.997	0.000	0.000
	23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.498	0.498	0.000	0.000	0.000	0.000	0.000
M	3	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.000	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5	0.000	0.000	0.332	0.332	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6	0.000	0.498	0.249	0.000	0.000	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	7	0.000	0.498	0.000	0.498	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	8	0.000	0.000	0.000	0.000	0.000	0.332	0.332	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	9	0.000	0.166	0.332	0.000	0.166	0.166	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	10	0.000	0.000	0.000	0.000	0.000	0.332	0.166	0.166	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	11	0.000	0.000	0.000	0.000	0.100	0.100	0.299	0.100	0.000	0.199	0.000	0.000	0.000	0.199	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.374	0.000	0.125	0.125	0.125	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	13	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.125	0.000	0.374	0.125	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.285	0.000	0.000	0.000	0.285	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.285	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.000
	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.166	0.000	0.166	0.166	0.000	0.166	0.000	0.166	0.000	0.000	0.166	0.000	0.000	0.000	0.000	0.000	0.000
	16	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.285	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.000
	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.000	0.000	0.000	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.000	0.000	0.000	0.249
	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 17. Parameter assumptions and set up of Stock Synthesis (Ver. 1.19) for blackgill rockfish.

Parameter	Number Estimated	Bounds (low,high)	Prior (Mean, SD)
Natural Mortality	-	NA	Fixed at 0.04
~~Stock and recruitment~~			
Ln(Rzero)	1	(3,31)	~N(15,99)
Steepness	-	NA	Fixed at 0.65
Sigma R	-	NA	Fixed at 0.5
Ln(Reruitment deviations): 1970-2004	35	(-15,15)	~Ln(N(0.Sigma R))
Catchability			
Ln(AFSC Shelf survey)	1	(-5,3)	~N(-1,99)
Ln(AFSC slope survey)	1	(-5,3)	~N(-1,99)
Selectivity (double logistic)			
Hook & Line and Set net Fishery:			
Initial selectivity	-	NA	Fixed at 0.0
Ascending inflection (arcsin trans.)	1	(-10,10)	~N(.1,99)
Ascending slope	-	NA	Fixed at 0.2
Length at peak	1	(20,80)	~N(40,99)
Final selectivity	1	(-10,10)	~N(0.1,99)
Descending inflection (arcsin trans.)	-	NA	Fixed at 0.0
Descending slope	-	NA	Fixed at 0.3
Note: Set net fishery mirrors H&L fishery			
Trawl fishery:			
Initial selectivity	-	NA	Fixed at 0.0
Ascending inflection (arcsin trans.)	1	(-10,10)	~N(.1,99)
Ascending slope	-	NA	Fixed at 0.2
Length at peak	1	(20,80)	~N(40,99)
Final selectivity	-	NA	Fixed at 0.0
Descending inflection (arcsin trans.)	-	NA	Fixed at 0.0
Descending slope	-	NA	Fixed at 0.3
Block offset for peak selectivity (1978 - 1990, 1991 - 2004)	3		
AFSC shelf, AFSC slope surveys:			
Initial selectivity	-	NA	Fixed at 0.0
Ascending inflection (arcsin trans.)	1	(-10,10)	~N(.1,99)
Ascending slope	1	(0.0001,10)	~N(.3,0.1)
Length at peak	-	NA	Fixed at 45
Final selectivity	1	(-10,10)	~N(0.1,99)
Descending inflection (arcsin trans.)	-	NA	Fixed at 0.0
Descending slope	-	NA	Fixed at 0.3
Note: surveys mirrored			
Individual growth			
Females:			
Length at age 2	1	(8,32)	~N(12,99)
Length at age 70	1	(30,80)	~N(53,99)
von Bertalanffy K	1	(0.01,0.1)	~N(04,99)
CV of length at age 2	1	NA	Fixed at 0.08
Males:			
Lmax as offset to females	1	(-3,3)	~N(-2,99)
K as offset to females	1	(-3,3)	~N(0.53,99)
Total number of parameters: 20 + 35 recruitment devs = 55			

Table 18. Results of base case model to uncertainty in assumptions about: 1) fishery and survey selectivity, 2) steepness on the stock-recruitment relationship, 3) natural mortality, and 4) level of historic catches prior to 1978.

	Base	Selectivity options			Steepness		M		Historic Catch	
	2a	asymptotic	full dome	surv. Sel	0.30	0.90	0.02	0.07	0.5x	2.0x
Likelihoods										
Objective function	877.760	883.105	873.768	977.359	878.545	877.512	899.057	897.986	876.273	876.909
Indices	-3.942	-3.943	-3.942	-4.049	-3.825	-3.983	-3.060	-3.824	-3.908	-3.996
Length Frequencies	552.825	558.381	548.822	617.612	554.048	552.412	558.568	566.245	552.297	554.021
Recruitment	-19.806	-19.779	-19.810	13.562	-19.850	-19.791	-18.710	-19.447	-19.810	-19.770
Priors	2.182	2.257	2.225	4.237	2.337	2.115	2.203	4.603	2.143	2.267
AFSC shelf survey likelihood	-3.600	-3.601	-3.600	-3.798	-3.500	-3.635	-2.832	-3.531	-3.571	-3.647
AFSC slope survey likelihood	-0.342	-0.342	-0.342	-3.798	-0.325	-0.348	-0.227	-0.293	-3.571	-3.647
H&L fishery LF likelihood	77.271	78.516	76.697	77.303	77.446	77.209	76.110	84.073	76.844	78.116
Set net fishery LF likelihood	78.278	81.623	77.191	76.437	78.246	78.293	73.807	80.983	78.043	78.674
Trawl fishery LF likelihood	314.034	314.947	311.660	319.955	314.692	313.823	324.919	316.553	314.151	314.013
AFSC shelf LF likelihood	53.864	54.028	54.059	59.205	54.346	53.686	55.245	54.943	53.915	53.762
AFSC slope LF likelihood	29.378	29.267	29.215	84.712	29.318	29.402	28.487	29.693	29.344	29.456
AFSC shelf age likelihood	354.818	354.506	354.791	355.701	354.153	355.076	368.373	358.727	355.255	354.092
Parameters										
Stock-Recruitment function										
Log Rzero	7.229	7.242	7.215	7.896	7.218	7.232	5.719	10.809	7.17016	7.3455
Catchbility and Selectivities										
log AFSC shelf survey catchability	0.091	0.089	0.094	0.029	0.093	0.090	0.277	0.009	0.097	0.079
log AFSC slope survey catchability	0.238	0.233	0.246	0.074	0.244	0.236	0.714	0.024	0.255	0.207
H&L/set net fishery peak selectivity	44.077	44.408	44.199	43.899	44.098	44.069	42.752	44.641	44.011	44.195
H&L/set net fishery ascending inflection	2.151	2.106	2.142	2.149	2.147	2.153	2.139	2.294	2.149	2.154
H&L/set net fishery final selectivity	-8.668	100.000	-8.549	-8.512	-8.664	-8.670	-8.530	-8.709	-8.667	-8.667
Trawl fishery peak selectivity (1978-1990)	41.645	41.743	41.644	41.340	41.698	41.624	39.956	43.620	41.534	41.842
Trawl fishery ascending inflection	1.966	1.956	1.968	41.340	1.953	1.971	1.935	2.006	41.534	41.842
Trawl fishery peak selectivity (1990-2004)	36.525	36.475	36.493	41.340	36.462	36.547	36.165	37.902	36.527	36.516
Trawl fishery final selectivity	0.000	100.000	0.200	0.300	0.000	0.000	0.000	0.000	0.000	0.300
AFSC shelf ascending inflection	0.486	0.477	0.501	0.625	0.378	0.523	0.293	0.956	0.497	0.461
AFSC shelf ascending slope	0.122	0.117	0.118	0.077	0.112	0.126	0.096	0.154	0.121	0.123
AFSC shelf final selectivity	100.000	100.000	9.256	100.000	100.000	100.000	100.000	100.000	100.000	100.000
AFSC slope peak	-	-	-	20.231	-	-	-	-	-	-
AFSC slope ascending inflection	-	-	-	0.341	-	-	-	-	-	-
Management quantities										
Bzero (mt)	9503	9502	9325	18902	9407	9535	6916	62132	8929	10750
Rzero	1378	1397	1360	2686	1364	1383	305	49461	1300	1549
2005 spawning biomass	4977	5048	4823	17530	4703	5075	1411	55417	4632	5766
Current (2005) depletion	52.4%	53.1%	51.7%	89.4%	50.0%	53.2%	20.4%	89.2%	# 51.9%	53.6%
Asymptotic SD depletion	42%-63%	42%-64%	41%-60%	79%-99%	41%-61%	42%-63%	11%-31%	79%-91%	42%-62%	43%-64%

Table 19. historic estimates of total biomass, spawning biomass, recruitment and depletion of blackgill rockfish.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion %Bzero	Age-0 recruits (1000s)	Year	Total biomass (mt)	Spawning biomass (mt)	Depletion %Bzero	Age-0 recruits (1000s)
1950	21,558	9,503	100.0%	1,378	1978	19,975	8,564	89.2%	1,325
1951	21,558	9,503	100.0%	1,378	1979	19,814	8,473	87.7%	1,254
1952	21,553	9,500	99.9%	1,378	1980	19,577	8,335	85.7%	1,192
1953	21,545	9,495	99.8%	1,378	1981	19,259	8,148	85.3%	1,042
1954	21,531	9,486	99.7%	1,378	1982	19,190	8,108	84.5%	1,439
1955	21,511	9,473	99.5%	1,378	1983	19,070	8,032	83.2%	1,712
1956	21,486	9,457	99.3%	1,377	1984	18,850	7,907	81.5%	1,112
1957	21,453	9,436	99.0%	1,377	1985	18,548	7,741	78.8%	681
1958	21,410	9,408	98.6%	1,376	1986	18,104	7,486	73.7%	705
1959	21,355	9,373	98.3%	1,375	1987	17,284	7,003	69.2%	835
1960	21,304	9,341	98.0%	1,374	1988	16,567	6,579	64.1%	882
1961	21,255	9,310	97.7%	1,374	1989	15,718	6,089	61.8%	825
1962	21,215	9,284	97.4%	1,373	1990	15,333	5,875	59.0%	967
1963	21,177	9,260	97.1%	1,372	1991	14,824	5,607	57.4%	1,522
1964	21,125	9,227	96.9%	1,371	1992	14,509	5,451	54.1%	1,403
1965	21,091	9,205	96.6%	1,371	1993	13,912	5,144	53.1%	1,043
1966	21,046	9,176	95.8%	1,370	1994	13,670	5,044	52.2%	963
1967	20,930	9,106	94.4%	1,368	1995	13,454	4,961	51.5%	909
1968	20,694	8,966	93.8%	1,365	1996	13,266	4,895	50.8%	1,027
1969	20,607	8,914	93.5%	1,363	1997	13,068	4,823	50.5%	1,295
1970	20,569	8,890	93.2%	1,295	1998	12,966	4,801	50.5%	1,487
1971	20,503	8,859	92.9%	775	1999	12,896	4,797	51.3%	1,338
1972	20,434	8,825	92.5%	769	2000	12,995	4,879	52.0%	1,188
1973	20,385	8,790	92.1%	1,618	2001	13,054	4,938	52.3%	1,022
1974	20,327	8,752	91.7%	1,743	2002	13,072	4,971	52.5%	1,025
1975	20,242	8,711	91.2%	1,230	2003	13,086	4,990	52.4%	1,036
1976	20,159	8,666	90.7%	1,474	2004	13,058	4,979	52.4%	1,035
1977	20,074	8,617	90.1%	1,564	2005	13,051	4,977	52.3%	1,197
					2004	5% - 95% Asymptotic CI		42.1%	62.5%
					2005	5% - 95% Asymptotic CI		42.0%	62.4%

Table 20. Annual standard deviations for spawning biomass and recruitment of blackgill rockfish from the base case model.

Year	SD Spawning biomass (mt)	SD Recruitment (1000s)	Year	SD Spawning biomass (mt)	SD Recruitment (1000s)
1950	852	138	1978	854	613
1951	852	138	1979	854	546
1952	852	138	1980	854	508
1953	852	138	1981	854	466
1954	852	138	1982	854	546
1955	852	138	1983	854	631
1956	852	138	1984	854	484
1957	852	138	1985	854	259
1958	852	138	1986	854	268
1959	852	138	1987	855	316
1960	852	138	1988	855	348
1961	852	138	1989	855	333
1962	852	138	1990	856	415
1963	852	138	1991	856	694
1964	852	138	1992	858	704
1965	852	138	1993	860	499
1966	852	138	1994	864	456
1967	853	138	1995	867	421
1968	853	138	1996	872	496
1969	853	138	1997	878	685
1970	853	533	1998	884	834
1971	853	322	1999	890	729
1972	853	319	2000	897	639
1973	853	816	2001	903	508
1974	853	826	2002	910	507
1975	853	573	2003	916	514
1976	854	627	2004	921	514
1977	854	703	2005	924	617

Table 21. 10-year projections showing total catch, spawning biomass and depletion along with approximate 95% confidence intervals of blackgill rockfish under three different input values of natural mortality. An M=0.04 was assumed for the base case model.

Year	Spawning biomass	Approx. Confidence Interval		age-0 recruits	Approx. Confidence Interval		depletion	Approx. Confidence Interval		Total Catch	Approx. Confidence Interval	
M=0.04												
2005	4960	3145	6775	617	-13	2404	52.2%	42.0%	62.4%	303	187	419
2006	4882	3130	6634	614	-12	2393	51.4%	41.6%	61.1%	299	186	411
2007	4808	3119	6498	611	-12	2383	50.6%	41.4%	59.8%	294	185	404
2008	4738	3109	6367	608	-11	2372	49.9%	41.1%	58.6%	290	185	396
2009	4673	3103	6242	605	-11	2362	49.2%	40.9%	57.4%	286	184	389
2010	4612	3100	6124	603	-10	2353	48.5%	40.8%	56.3%	282	183	381
2011	4556	3099	6013	600	-10	2344	47.9%	40.7%	55.2%	279	183	374
2012	4506	3102	5909	598	-9	2336	47.4%	40.6%	54.2%	275	182	368
2013	4461	3108	5813	596	-8	2328	46.9%	40.6%	53.3%	272	182	361
2014	4420	3116	5724	594	-8	2321	46.5%	40.6%	52.4%	269	182	355
2015	4383	3126	5641	592	-7	2315	46.1%	40.6%	51.6%	266	182	349
2016	4349	3135	5563	591	-7	2309	45.8%	40.7%	50.8%	263	182	344
M=0.03												
Year	**Spawning biomass**	**Approx. Confidence Interval**		**age-0 recruits**	**Approx. Confidence Interval**		**depletion**	**Approx. Confidence Interval**		**Total Catch**	**Approx. Confidence Interval**	
2005	2777	1894	3660	507	1	1013	35.6%	27.7%	43.5%	119	70	169
2006	2784	1923	3644	507	1	1013	35.7%	28.0%	43.3%	120	72	168
2007	2790	1953	3627	508	1	1014	35.8%	28.4%	43.1%	120	73	167
2008	2796	1982	3610	508	2	1014	35.8%	28.8%	42.9%	120	75	166
2009	2802	2012	3593	508	2	1015	35.9%	29.2%	42.7%	121	76	165
2010	2808	2041	3575	509	2	1015	36.0%	29.6%	42.4%	121	78	164
2011	2815	2071	3558	509	3	1016	36.1%	30.0%	42.2%	121	80	163
2012	2821	2101	3541	510	3	1016	36.2%	30.3%	42.0%	122	81	162
2013	2828	2130	3525	510	3	1017	36.2%	30.7%	41.8%	122	83	161
2014	2835	2159	3510	510	3	1018	36.3%	31.1%	41.6%	122	84	160
2015	2841	2188	3495	511	4	1018	36.4%	31.5%	41.3%	123	86	159
2016	2847	2215	3480	511	4	1019	36.5%	31.9%	41.1%	123	87	158
M=0.05												
Year	**Spawning biomass**	**Approx. Confidence Interval**		**age-0 recruits**	**Approx. Confidence Interval**		**depletion**	**Approx. Confidence Interval**		**Total Catch**	**Approx. Confidence Interval**	
2005	8493	4440	12545	2747	-130	5623	66.9%	55.1%	78.7%	693	345	1041
2006	8209	4354	12064	2725	-128	5578	64.7%	53.7%	75.7%	671	339	1004
2007	7946	4277	11615	2704	-126	5534	62.6%	52.5%	72.8%	650	332	968
2008	7704	4210	11197	2683	-124	5491	60.7%	51.3%	70.1%	630	327	934
2009	7482	4152	10812	2664	-122	5449	59.0%	50.3%	67.6%	612	321	902
2010	7281	4104	10458	2645	-119	5410	57.4%	49.4%	65.3%	594	316	872
2011	7101	4065	10136	2628	-117	5373	56.0%	48.7%	63.3%	578	312	843
2012	6941	4037	9845	2612	-115	5339	54.7%	48.0%	61.4%	562	308	817
2013	6800	4017	9583	2598	-112	5308	53.6%	47.5%	59.7%	548	305	792
2014	6676	4003	9349	2585	-110	5280	52.6%	47.1%	58.1%	536	302	770
2015	6566	3994	9139	2573	-108	5254	51.8%	46.7%	56.8%	524	300	749
2016	6469	3988	8949	2562	-105	5230	51.0%	46.4%	55.5%	514	298	730

Table 22. Decision table showing consequences of a 12-year harvest policy consistent with three assumed states of nature (M=0.03, M=0.04, and M=0.05) when each alternative is the true state of nature. The bottom panel gives projections for a harvest policy consistent with the 2004-2006 catch under three different "true states of nature" or M=0.03, M=0.04 and M-=0.05.

ASSUMED STATE OF NATURE					TRUE STATE OF NATURE M = 0.03 *5% probability*			M = 0.04 *90% probability*			M = 0.05 *5% probability*		
	Year	Catch consistent with M H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	45	1	72	2777	35.6%	2.1%	4960	52.2%	6.6%	8493	66.9%	3.9%
	2008	46	1	73	2784	35.7%	2.2%	4707	49.5%	5.1%	8231	64.9%	2.9%
	2009	46	1	73	2790	35.8%	2.2%	4544	47.8%	1.3%	8062	63.5%	0.8%
	2010	46	1	73	2796	35.8%	2.2%	4567	48.1%	1.3%	8084	63.7%	0.8%
	2011	46	1	73	2802	35.9%	2.2%	4591	48.3%	1.3%	8110	63.9%	0.8%
M = 0.03	**2012**	46	1	73	2808	36.0%	2.2%	4616	48.6%	1.3%	8138	64.1%	0.7%
	2013	47	1	73	2815	36.1%	2.2%	4644	48.9%	1.3%	8172	64.4%	0.7%
	2014	47	1	74	2821	36.2%	2.2%	4673	49.2%	1.3%	8209	64.7%	0.8%
	2015	47	1	74	2828	36.2%	2.2%	4703	49.5%	1.3%	8251	65.0%	0.8%
	2016	47	1	74	2835	36.3%	2.2%	4734	49.8%	1.3%	8296	65.4%	0.8%
	2017	47	1	74	2841	36.4%	2.2%	4766	50.2%	1.3%	8341	65.7%	0.8%
	2018	47	1	74	2847	36.5%	2.2%	4797	50.5%	1.3%	8387	66.1%	0.7%
	Year	Catch consistent with M H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	116	4	184	2777	35.6%	11.5%	4960	52.2%	3.2%	8493	66.9%	3.9%
	2008	114	4	181	2523	32.3%	10.7%	4882	51.4%	3.1%	8231	64.9%	3.4%
	2009	112	4	179	2321	29.8%	6.4%	4808	50.6%	3.1%	8026	63.3%	1.9%
	2010	111	3	176	2244	28.8%	6.6%	4738	49.9%	3.1%	7957	62.7%	1.9%
	2011	109	3	174	2170	27.8%	6.6%	4673	49.2%	3.1%	7895	62.2%	1.9%
M = 0.04	**2012**	108	3	171	2100	26.9%	6.6%	4612	48.5%	3.1%	7841	61.8%	1.9%
	2013	106	3	169	2035	26.1%	6.7%	4556	47.9%	3.1%	7796	61.4%	1.8%
	2014	105	3	167	1974	25.3%	6.8%	4506	47.4%	3.1%	7761	61.2%	1.8%
	2015	103	3	165	1917	24.6%	7.0%	4461	46.9%	3.1%	7734	61.0%	1.8%
	2016	102	3	163	1864	23.9%	7.1%	4420	46.5%	3.1%	7715	60.8%	1.8%
	2017	101	3	162	1814	23.2%	7.2%	4383	46.1%	3.0%	7701	60.7%	1.8%
	2018	100	3	160	1766	22.6%	7.2%	4349	45.8%	3.1%	7691	60.6%	1.7%
	Year	Catch consistent with M H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	264	8	421	2777	35.6%	11.5%	4960	52.2%	6.6%	8493	66.9%	4.2%
	2008	256	8	407	2523	32.3%	13.6%	4707	49.5%	7.5%	8209	64.7%	4.2%
	2009	248	8	395	2251	28.9%	15.0%	4437	46.7%	7.8%	7946	62.6%	4.2%
	2010	240	7	383	1990	25.5%	16.4%	4177	44.0%	8.0%	7704	60.7%	4.2%
	2011	232	7	372	1747	22.4%	17.6%	3938	41.4%	8.1%	7482	59.0%	4.1%
M = 0.05	**2012**	225	7	361	1523	19.5%	19.0%	3717	39.1%	8.2%	7281	57.4%	4.1%
	2013	219	7	352	1318	16.9%	21.0%	3516	37.0%	8.3%	7101	56.0%	4.1%
	2014	213	7	343	1132	14.5%	23.7%	3333	35.1%	8.5%	6941	54.7%	4.1%
	2015	207	6	335	963	12.3%	27.3%	3167	33.3%	8.8%	6800	53.6%	4.1%
	2016	202	6	328	812	10.4%	31.8%	3017	31.8%	9.0%	6676	52.6%	4.1%
	2017	197	6	321	677	8.7%	37.2%	2881	30.3%	9.1%	6566	51.8%	4.0%
	2018	192	6	316	558	7.1%	43.5%	2759	29.0%	9.1%	6469	51.0%	3.9%
	Year	Catch consistent with M H&L	Set Net	Trawl	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation	Spawning biomass	Depletion	Exploitation
	2007	64	2	102	2777	35.6%	11.5%	4960	52.2%	6.6%	8493	66.9%	3.9%
	2008	64	2	102	2523	32.3%	9.7%	4707	49.5%	5.3%	8231	64.9%	3.1%
	2009	64	2	102	2346	30.1%	3.5%	4534	47.7%	1.9%	8052	63.5%	1.1%
	2010	64	2	102	2333	29.9%	3.6%	4533	47.7%	1.9%	8050	63.4%	1.1%
	2011	64	2	102	2321	29.8%	3.6%	4534	47.7%	1.9%	8052	63.5%	1.1%
2006	**2012**	64	2	102	2310	29.6%	3.5%	4536	47.7%	1.9%	8058	63.5%	1.1%
Catch	**2013**	64	2	102	2300	29.5%	3.6%	4540	47.8%	1.9%	8068	63.6%	1.1%
	2014	64	2	102	2291	29.4%	3.6%	4547	47.8%	1.9%	8084	63.7%	1.1%
	2015	64	2	102	2283	29.3%	3.6%	4556	47.9%	1.9%	8106	63.9%	1.1%
	2016	64	2	102	2276	29.2%	3.7%	4566	48.1%	1.9%	8131	64.1%	1.1%
	2017	64	2	102	2270	29.1%	3.7%	4578	48.2%	1.9%	8158	64.3%	1.1%
	2018	64	2	102	2263	29.0%	3.6%	4590	48.3%	1.8%	8185	64.5%	1.0%

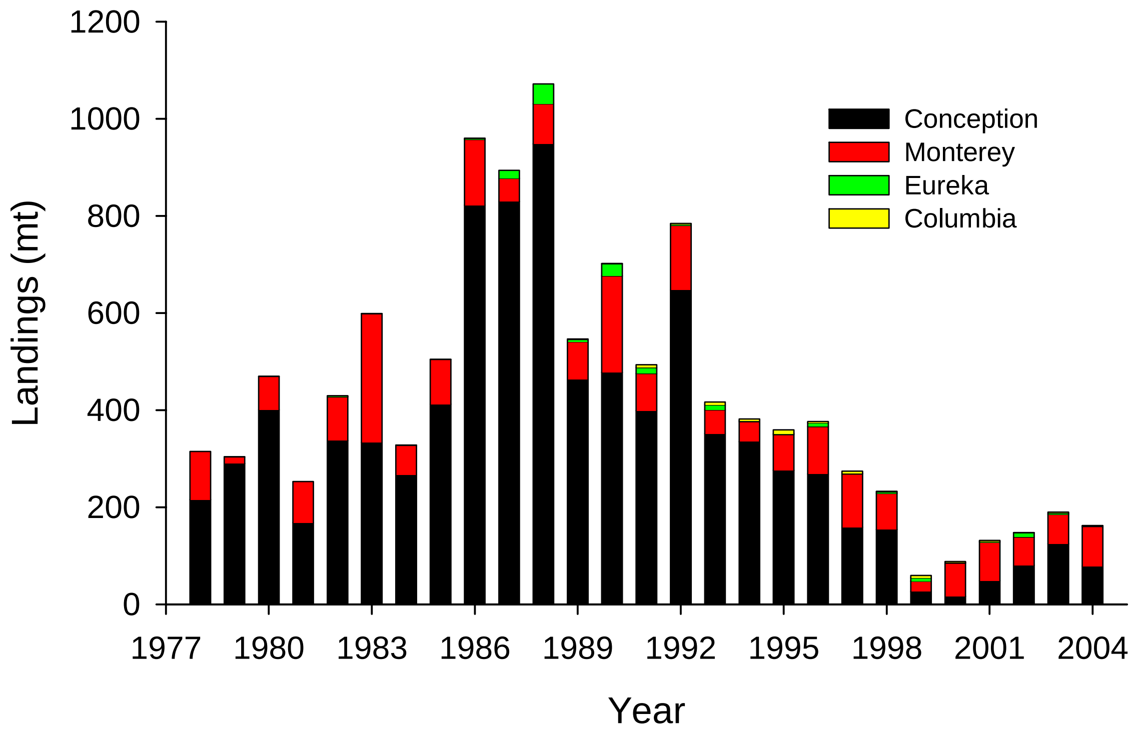


Figure 1. Landings of blackgill rockfish (*Sebastes melanostomus*) by Pacific Fishery Management Council's area designation from the West Coast of North America during 1978-2004. Landings in the Columbia area are too small to be visible on graph.

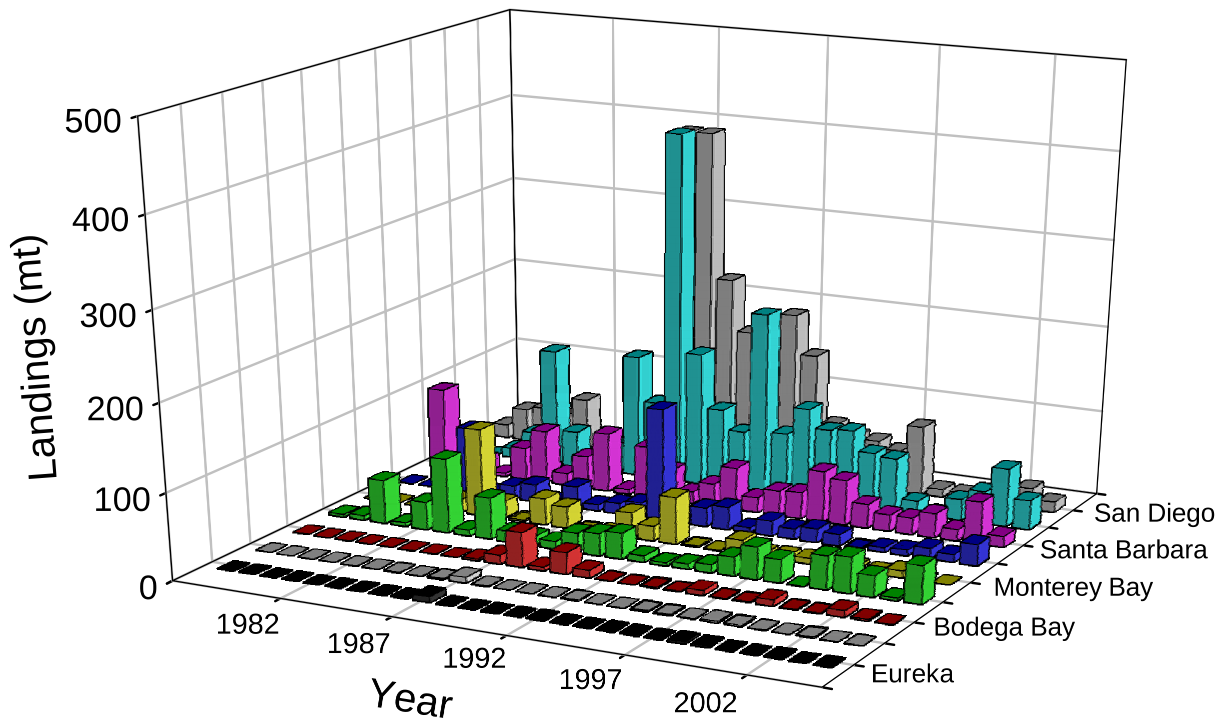


Figure 2. Landings of blackgill rockfish (*Sebastes melanostomus*) by major port group in California during 1978-2004.

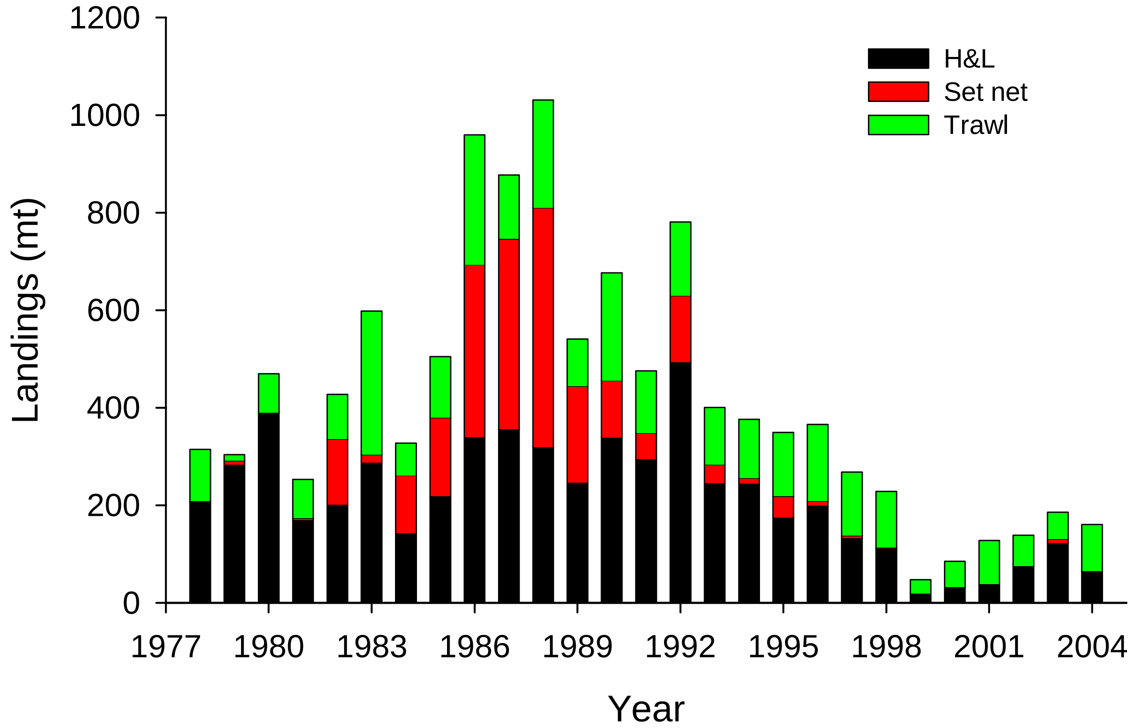


Figure 3. Landings of blackgill rockfish (*Sebastes melanostomus*) by gear group from the West Coast of North America during 1978-2004.

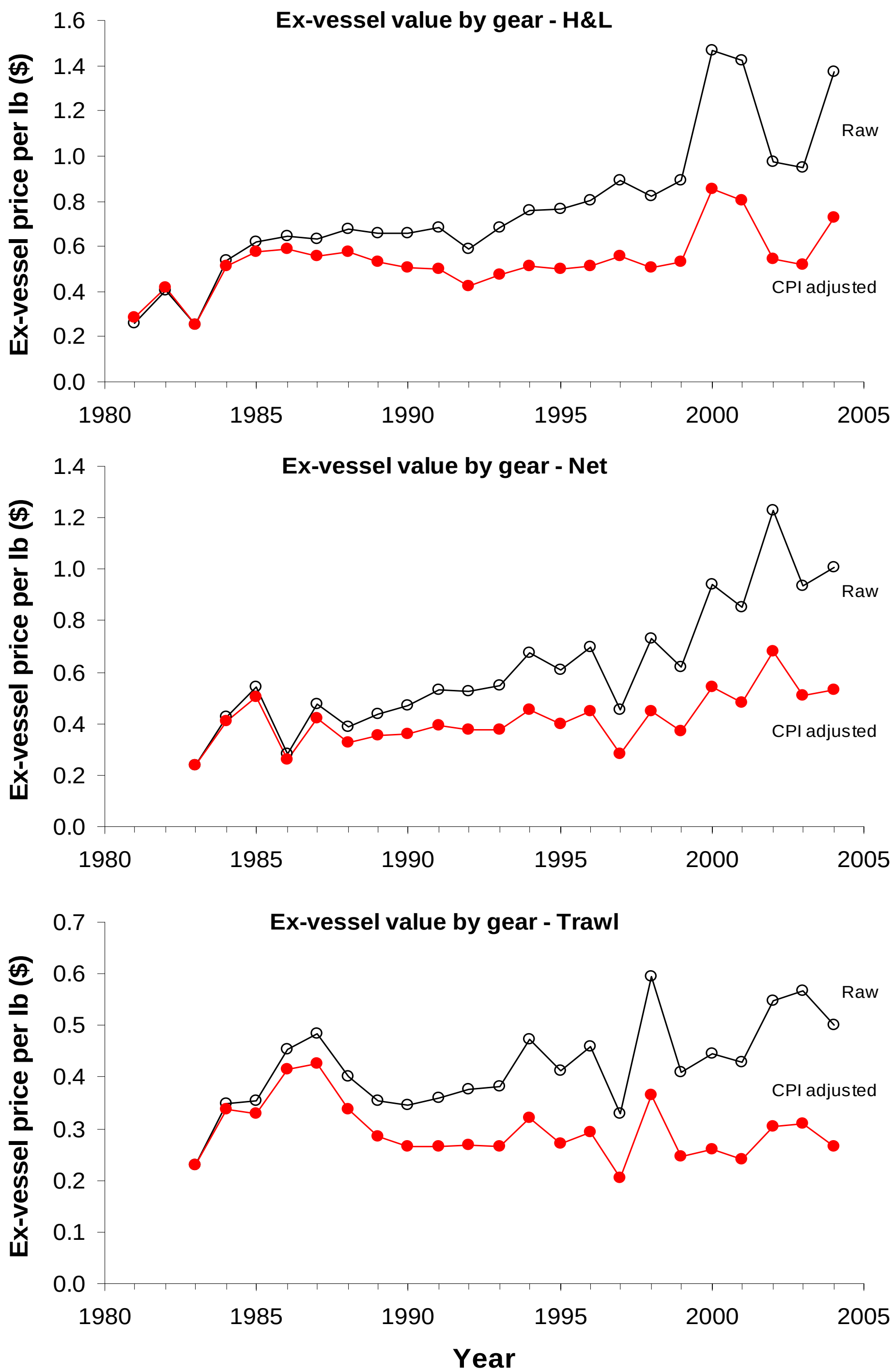


Figure 4. Ex-vessel value (price per pound) by gear group of blackgill rockfish (BLGL market category) from the West Coast of North America during 1981-2004. Ex-vessel prices represent dollar value divided by landings from PacFIN. Trends are shown for both the nominal and consumer price index (CPI) adjusted prices.

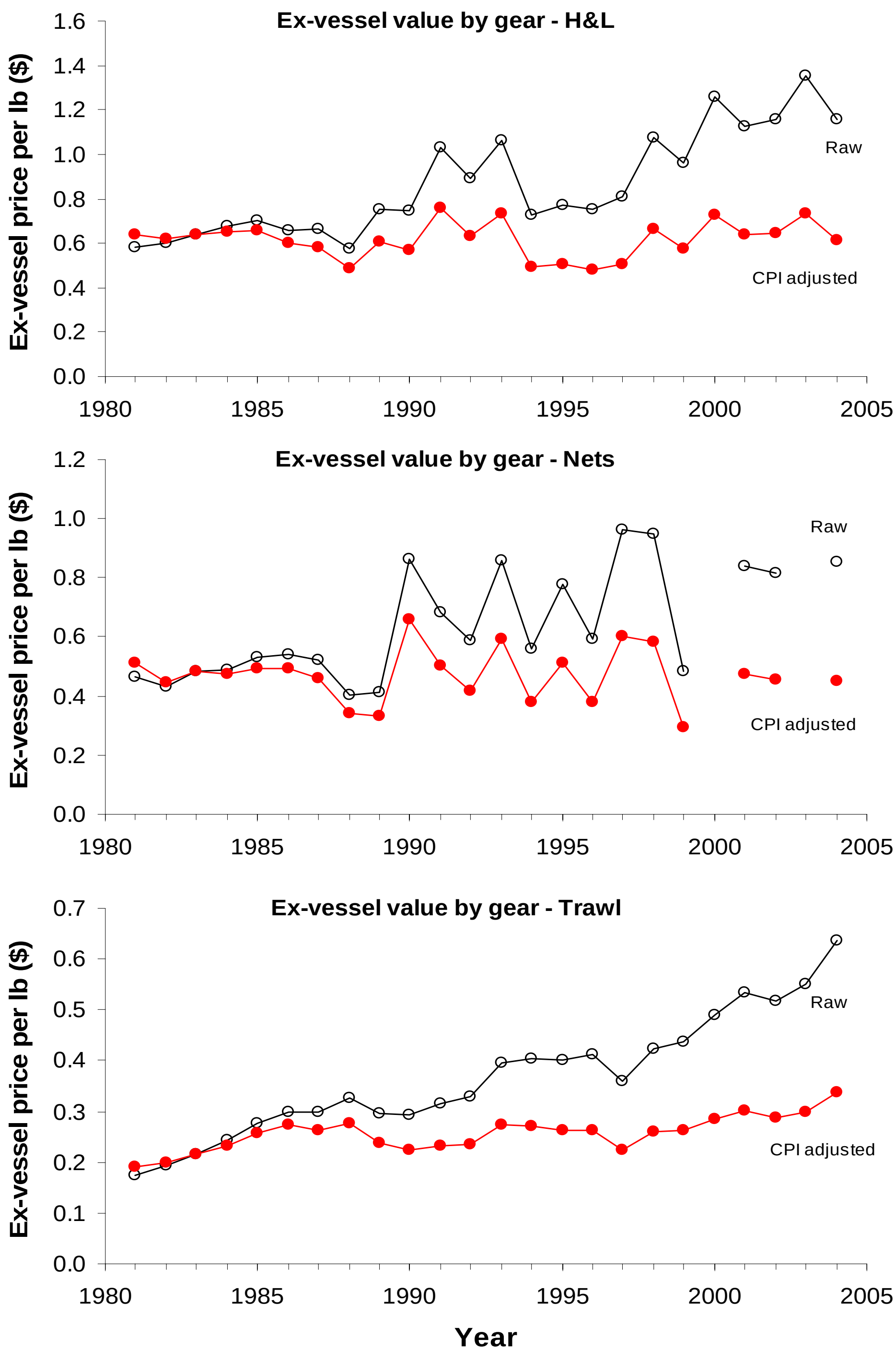


Figure 5. Ex-vessel value (price per pound) by gear group of nominal blackgill rockfish (BGL1 market category) from the West Coast of North America during 1981-2004. Ex-vessel prices represent dollar value divided by landings from PacFIN. Trends are shown for both the nominal and consumer price index (CPI) adjusted prices.

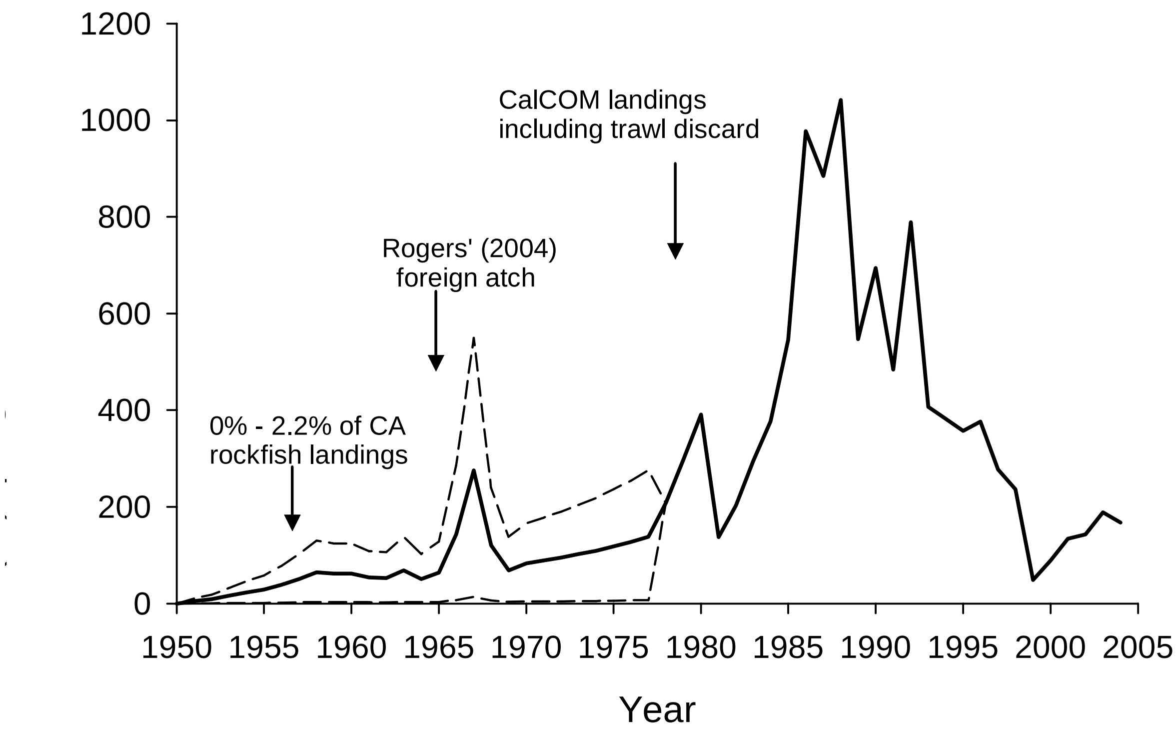


Figure 6. Estimated (1978-2004) and historic reconstructed (1950-1977) blackgill rockfish catches. Discards in the trawl fishery have been added to the CALCOM estimated landings from 1978-2004. Historic catches represent one possible pathway of exploitation and was calculated by taking 0% to 2.2% (ratio of BLGL and BGL1 to total CA rockfish landings from PACFIN) of total California rockfish landings from 1950 to 1977. Roger's (2002) foreign catches have been added 1966-1970. Stippled lines represent 0.5x and 2.0x of the historic catches for model sensitivity.

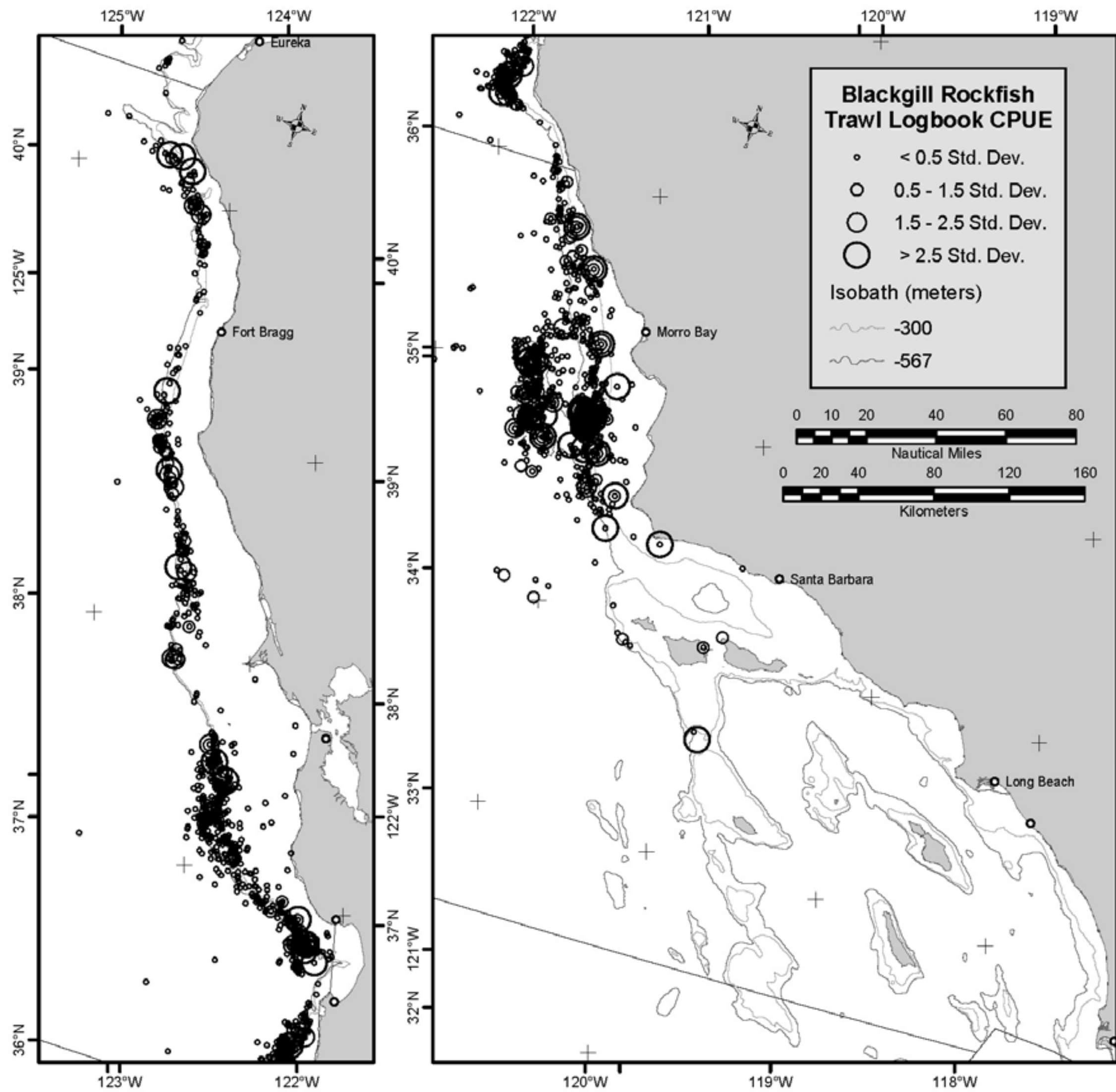


Figure 7. Distribution of blackgill rockfish CPUE (catch per hour fished) from trawl logbooks. Graded circles represent <1 to 3> standard deviations from the mean CPUE.

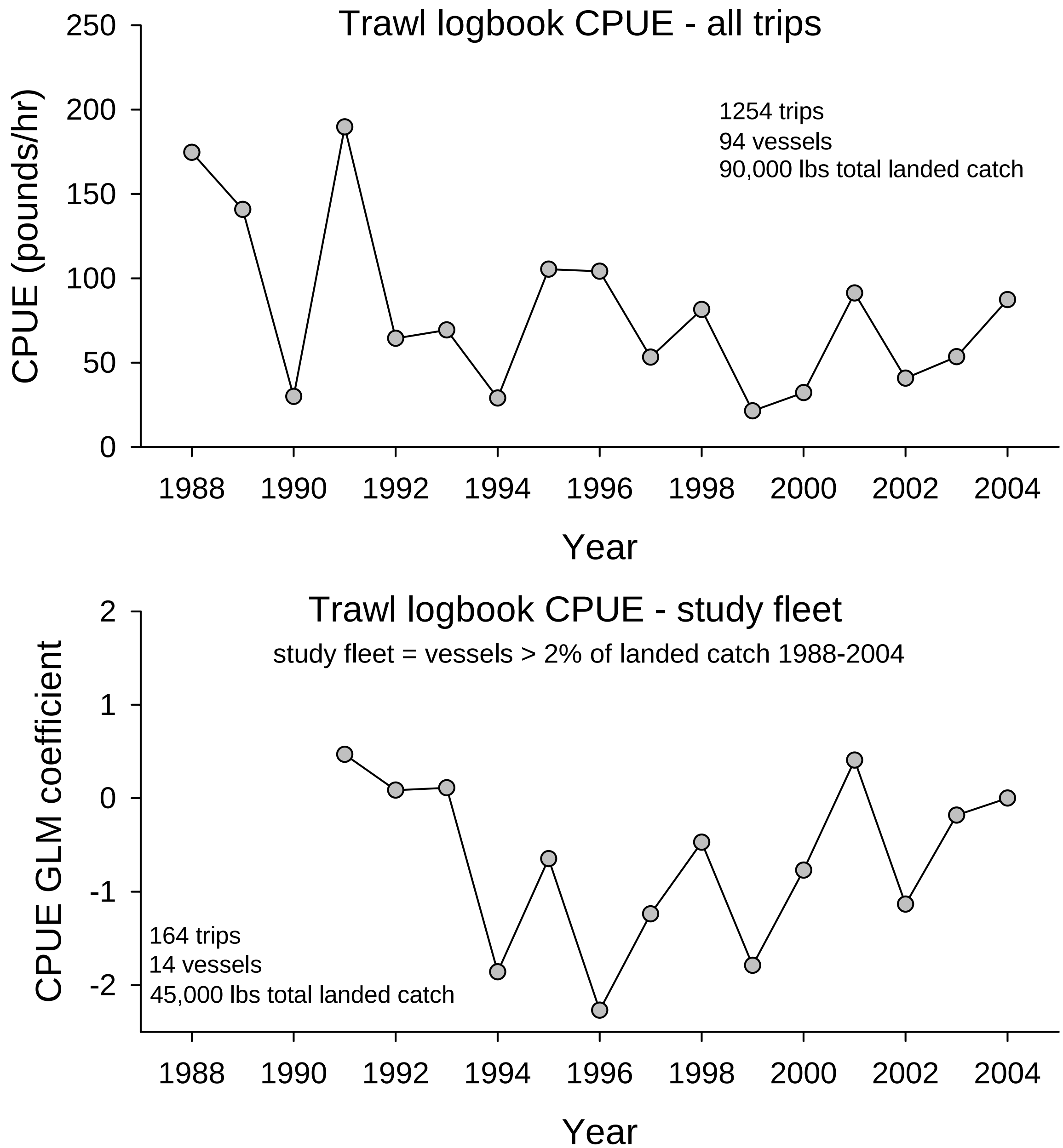


Figure 8. Two measures of trends in trawl logbook catch per unit effort (pounds per hour fished) between 1988-2004 based on positive retained catch of blackgill rockfish. Top panel shows raw CPUE from trips based on all vessels. Bottom panel shows year regression coefficients based on a GLM model applied to trips associated with vessels that caught more than 5% of the total blackgill catch from 1988-2004.

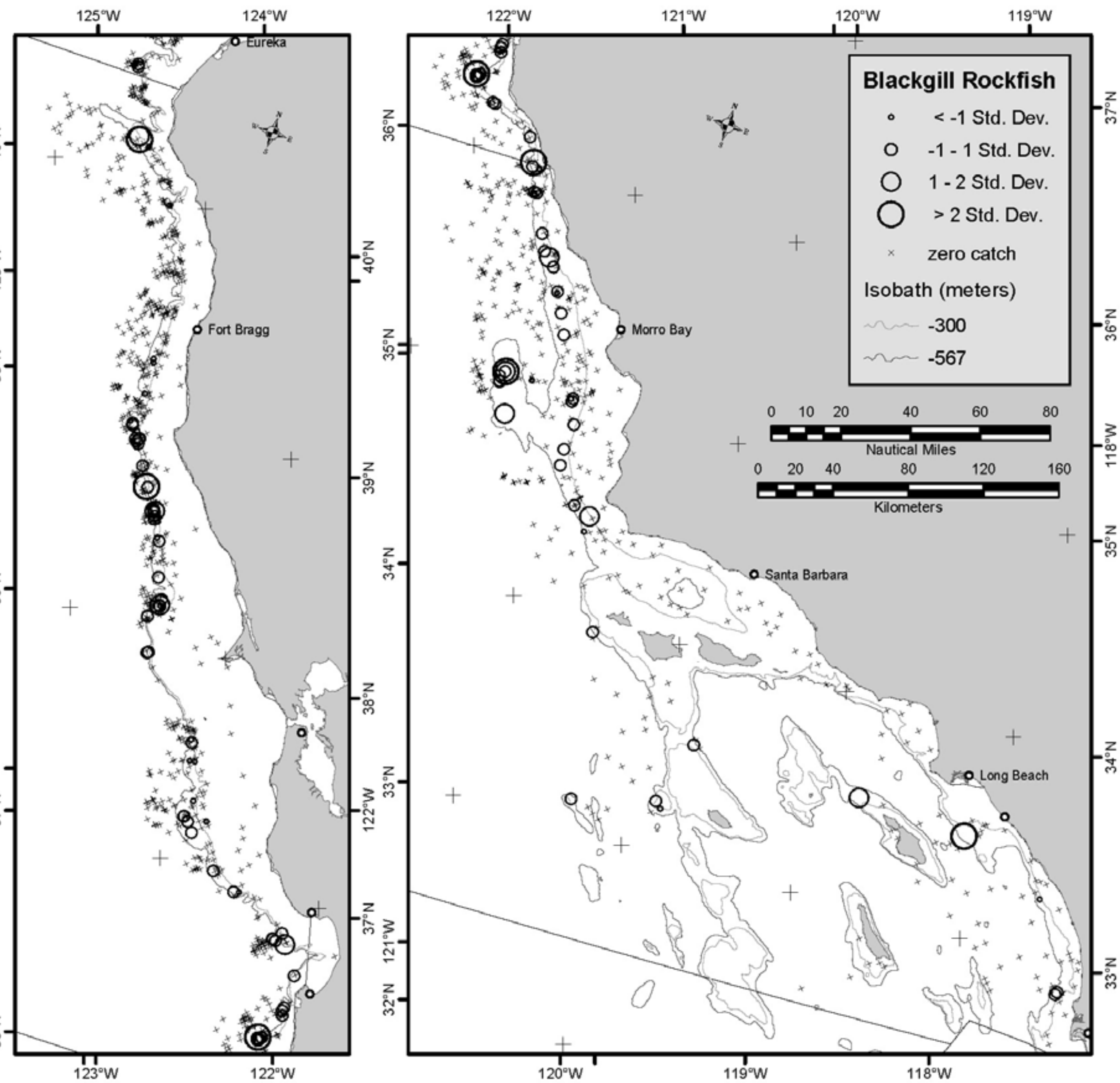


Figure 9. Distribution of Blackgill rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

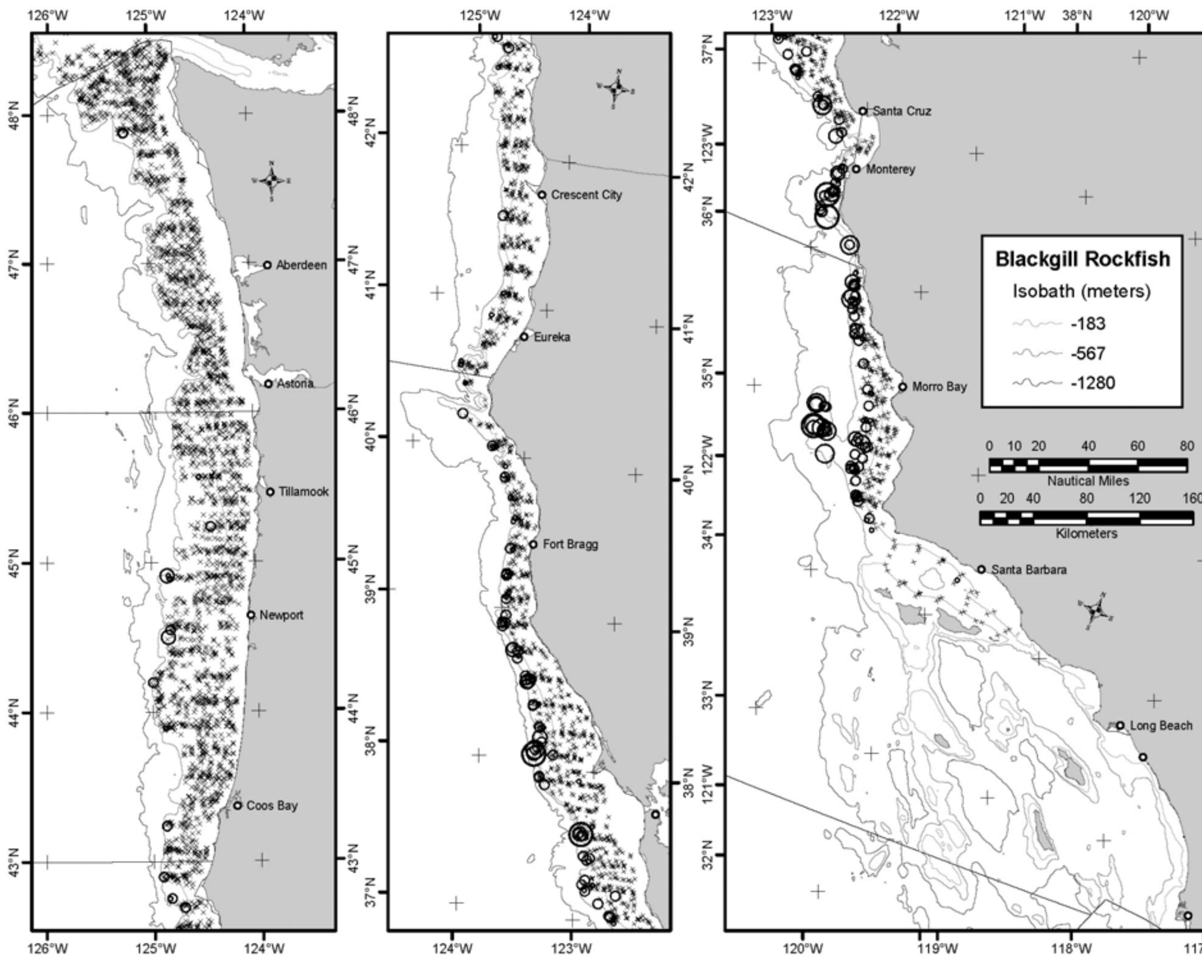


Figure 10. Distribution of Blackgill rockfish caught in the AFSC triennial shelf survey. Graded circles represent <1 to >3 standard deviations from the mean catch.

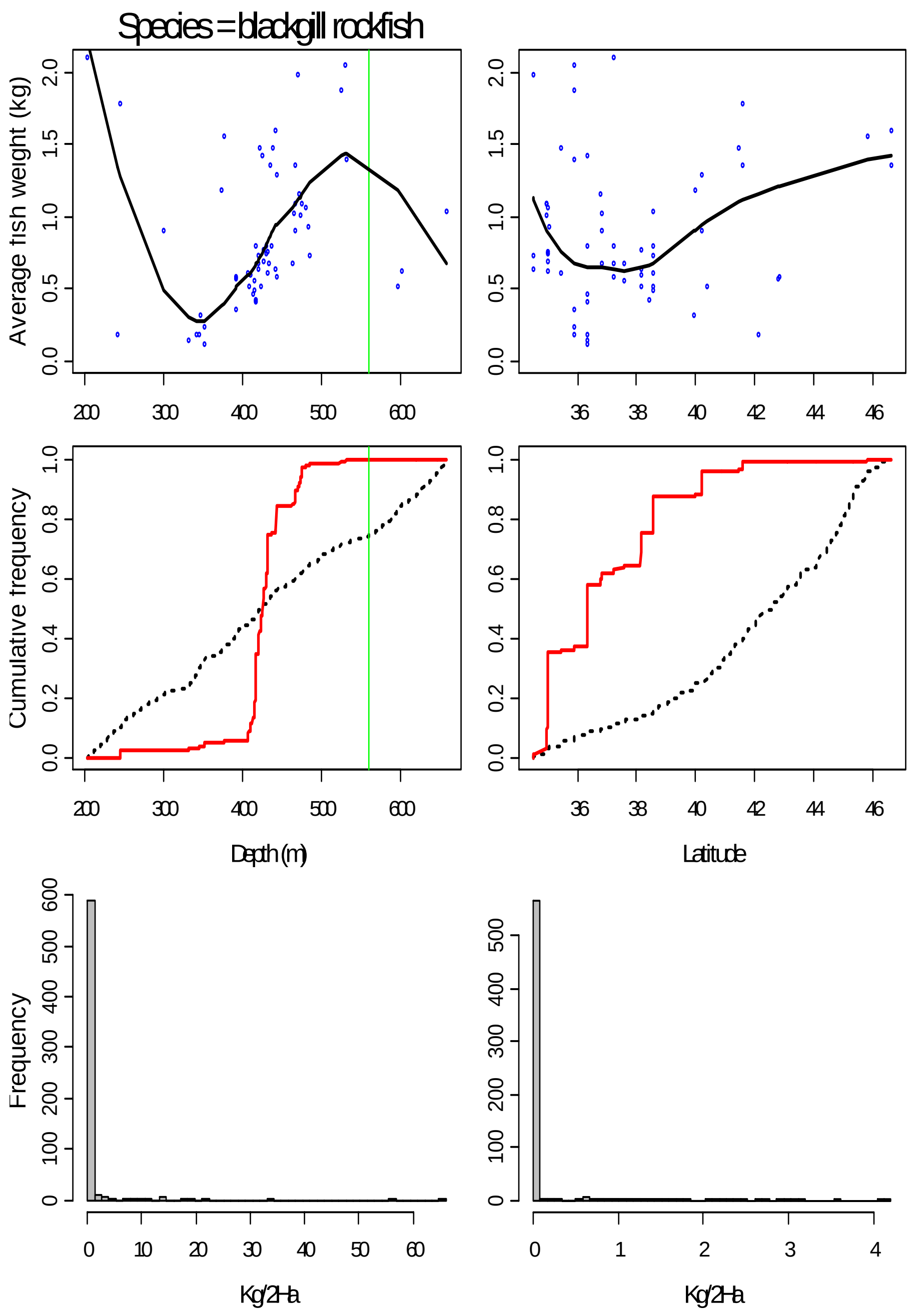


Figure 11. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Blackgill rockfish caught in the AFSC slope survey.

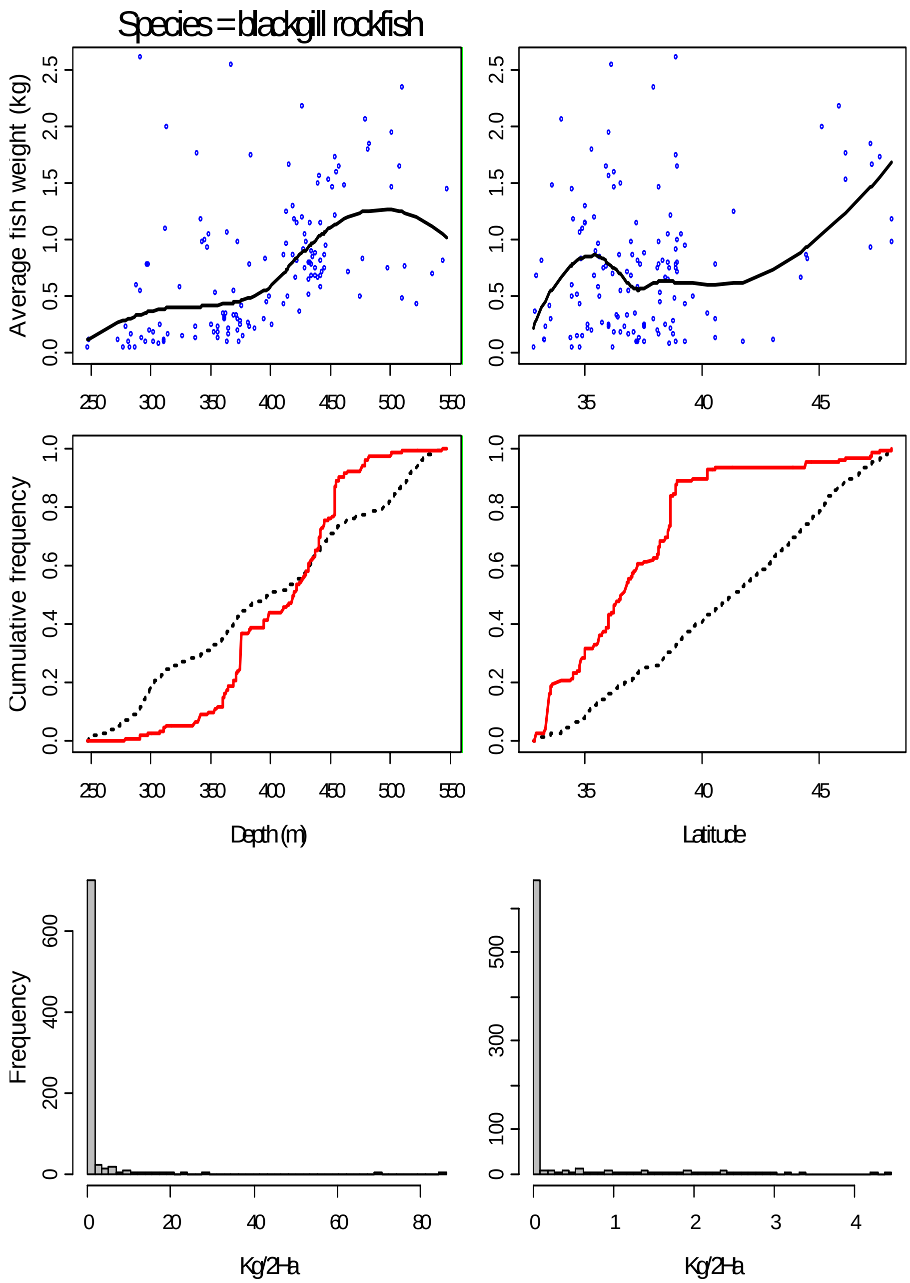


Figure 12. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Blackgill rockfish caught in the NWFSC slope survey

Blackgill rockfish

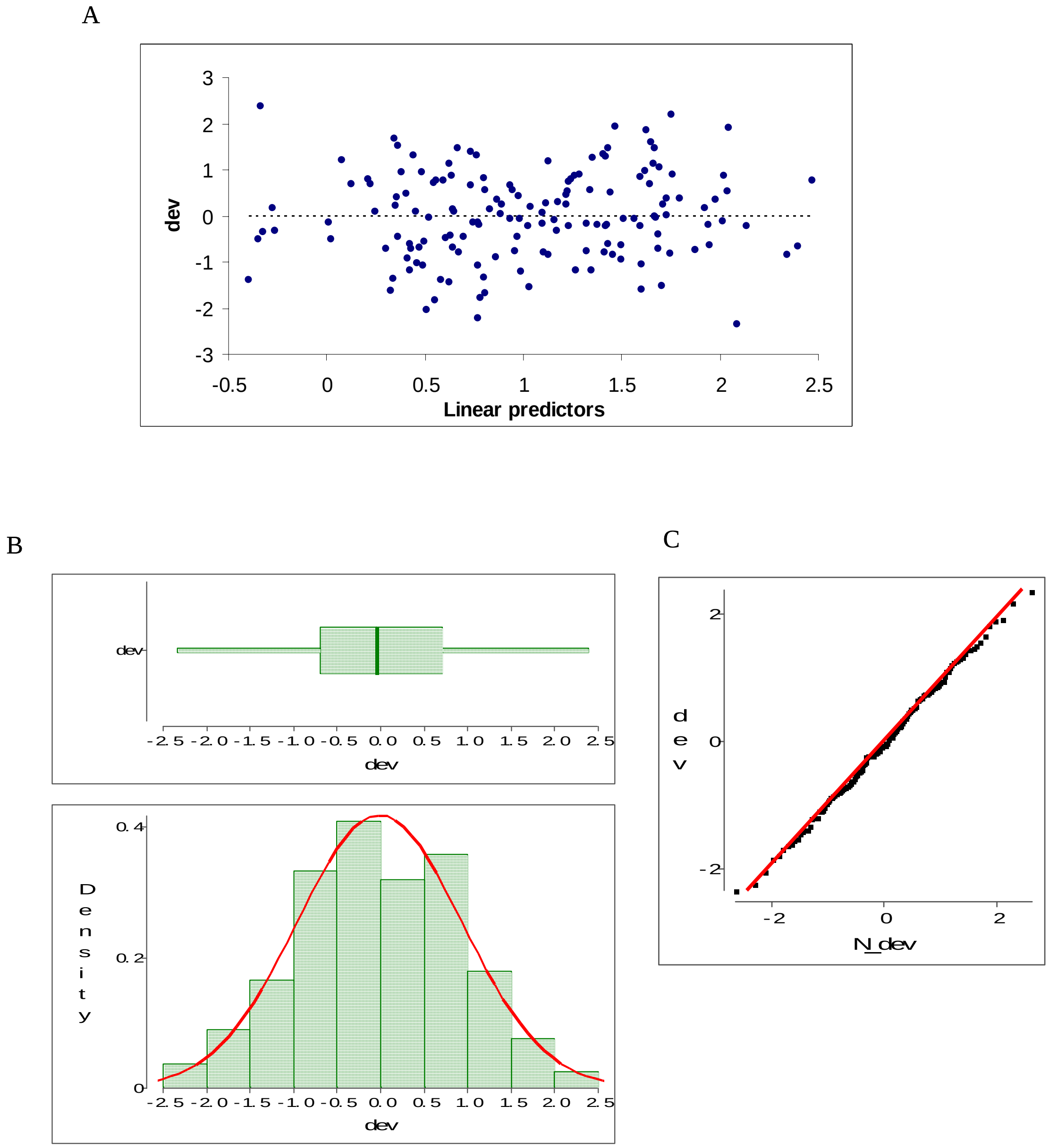


Figure 13. Diagnostic plots from the generalized linear mixed model fit to Blackgill rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

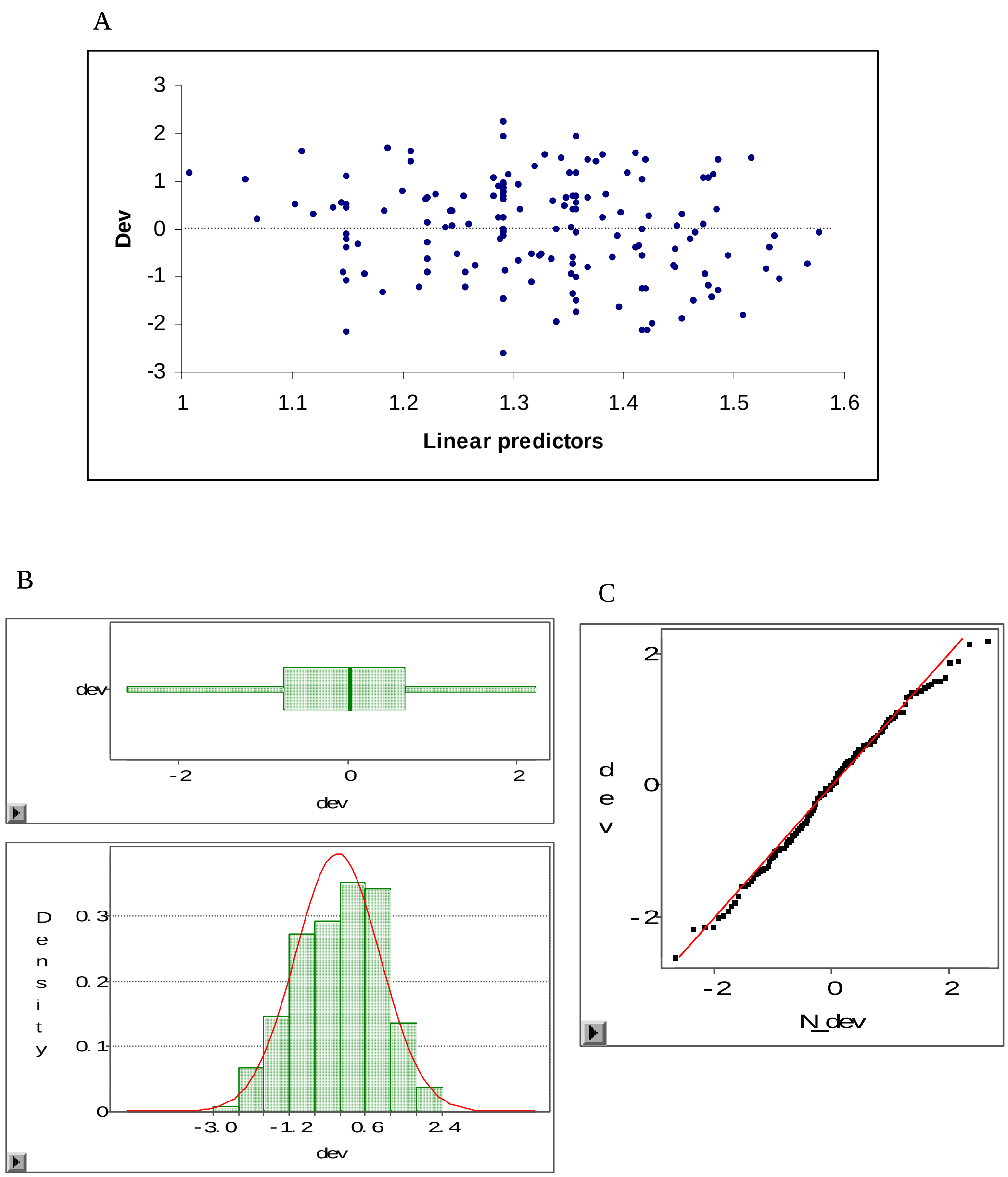


Figure 14. Diagnostic plots from the generalized linear model fit to Blackgill rockfish from the AFSC triennial shelf survey. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

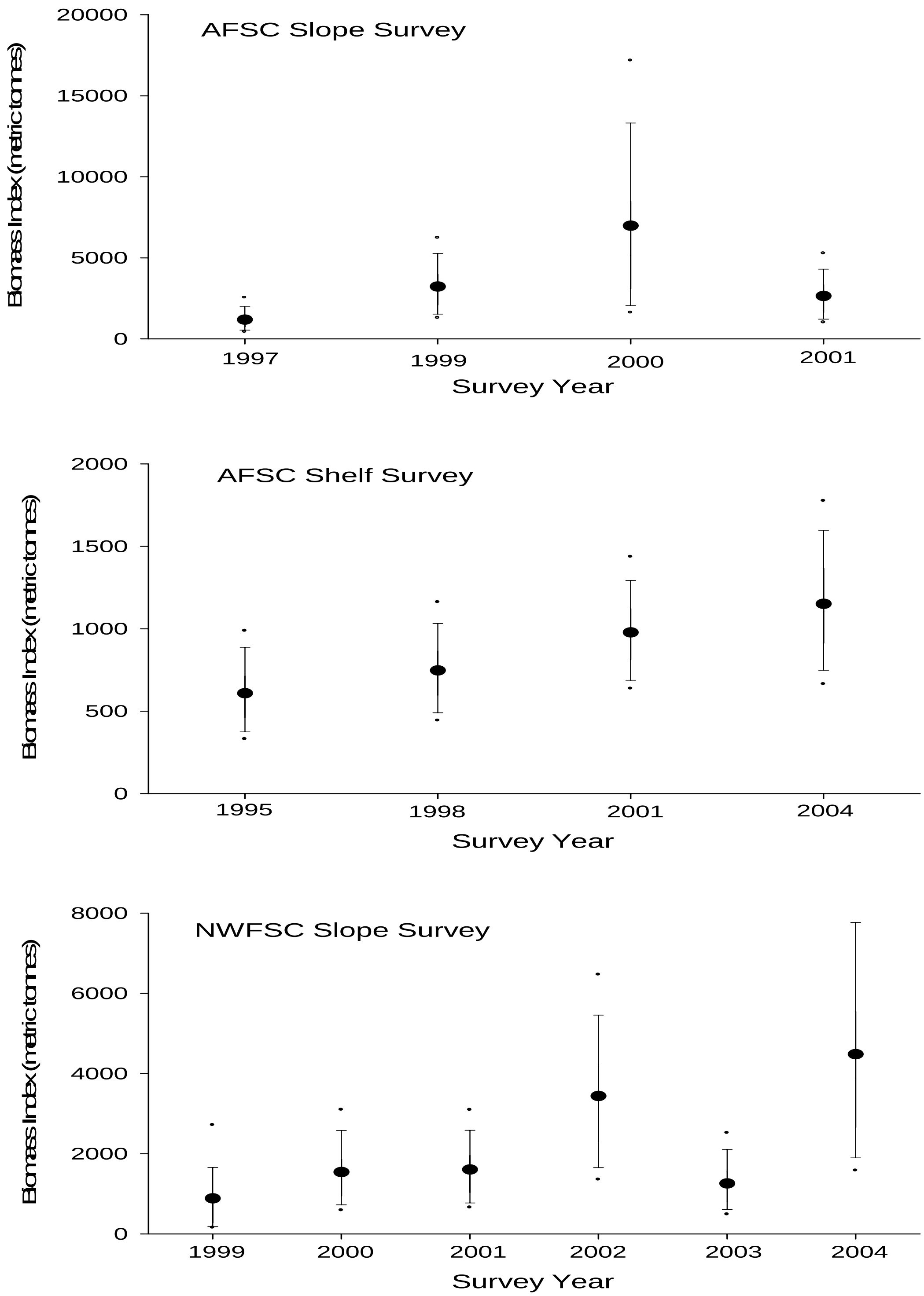


Figure 15. Biomass indices from AFSC triennial shelf, AFSC slope and NWFSC slope trawl surveys derived from a Delta-GLM applied to proportion positive and positive catch rate data. (Note: the 2004 shelf survey was conducted by NWFSC as a continuation of the AFSC survey)

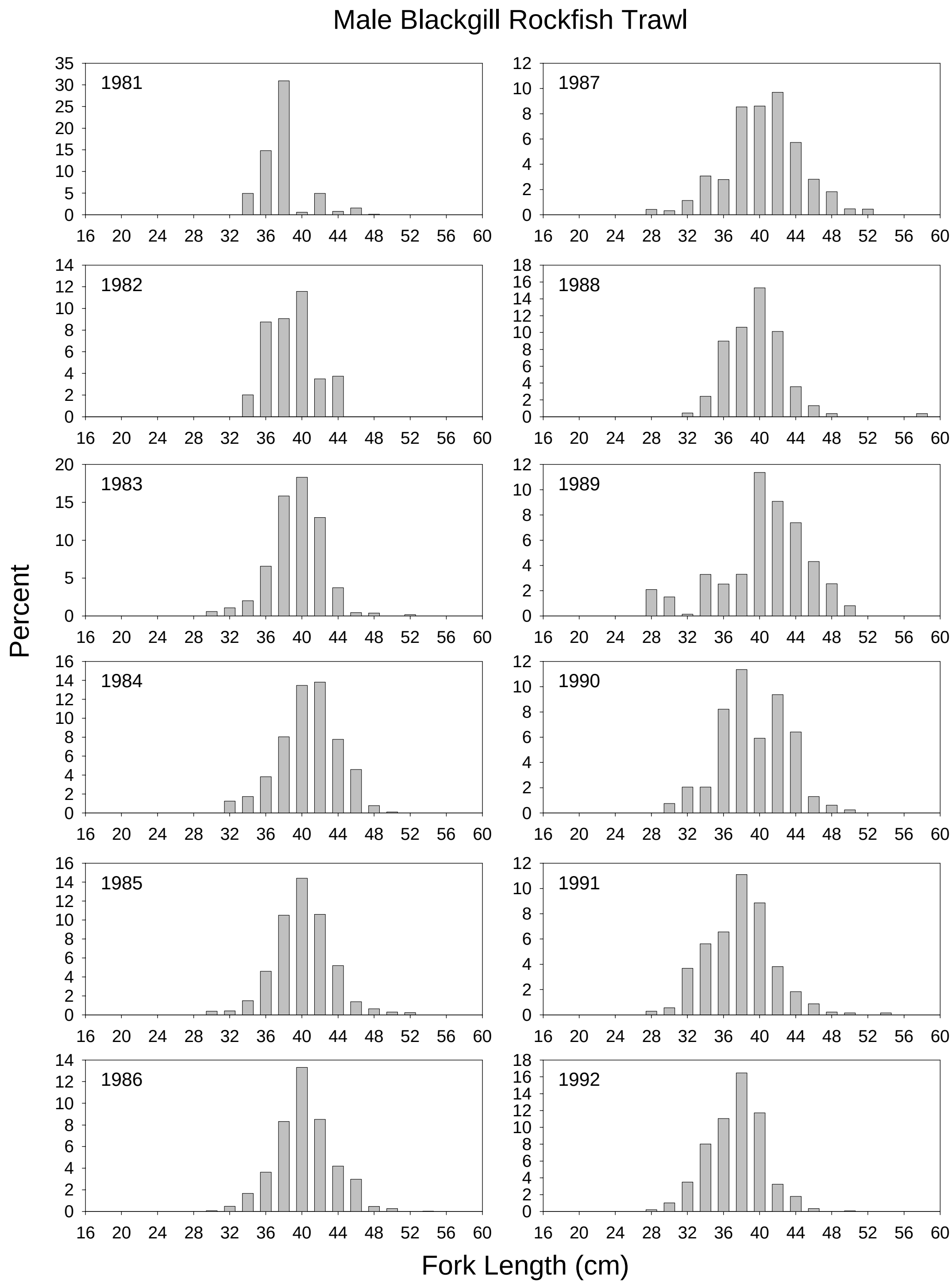


Figure 16. Size frequency distribution of male Blackgill rockfish (*Sebastes melanostomus*) taken by trawl (1981-2004).

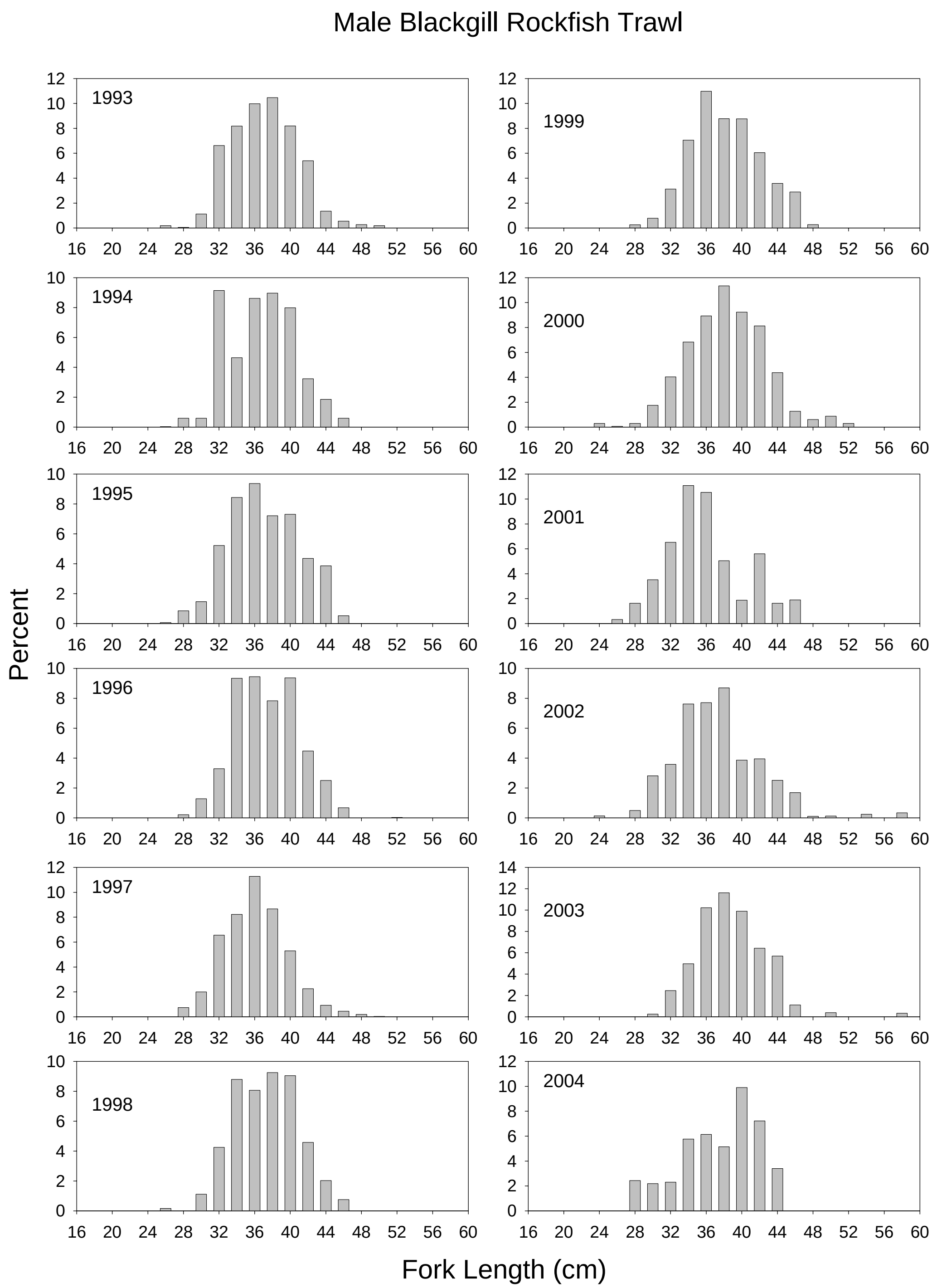


Figure 16. Continued.

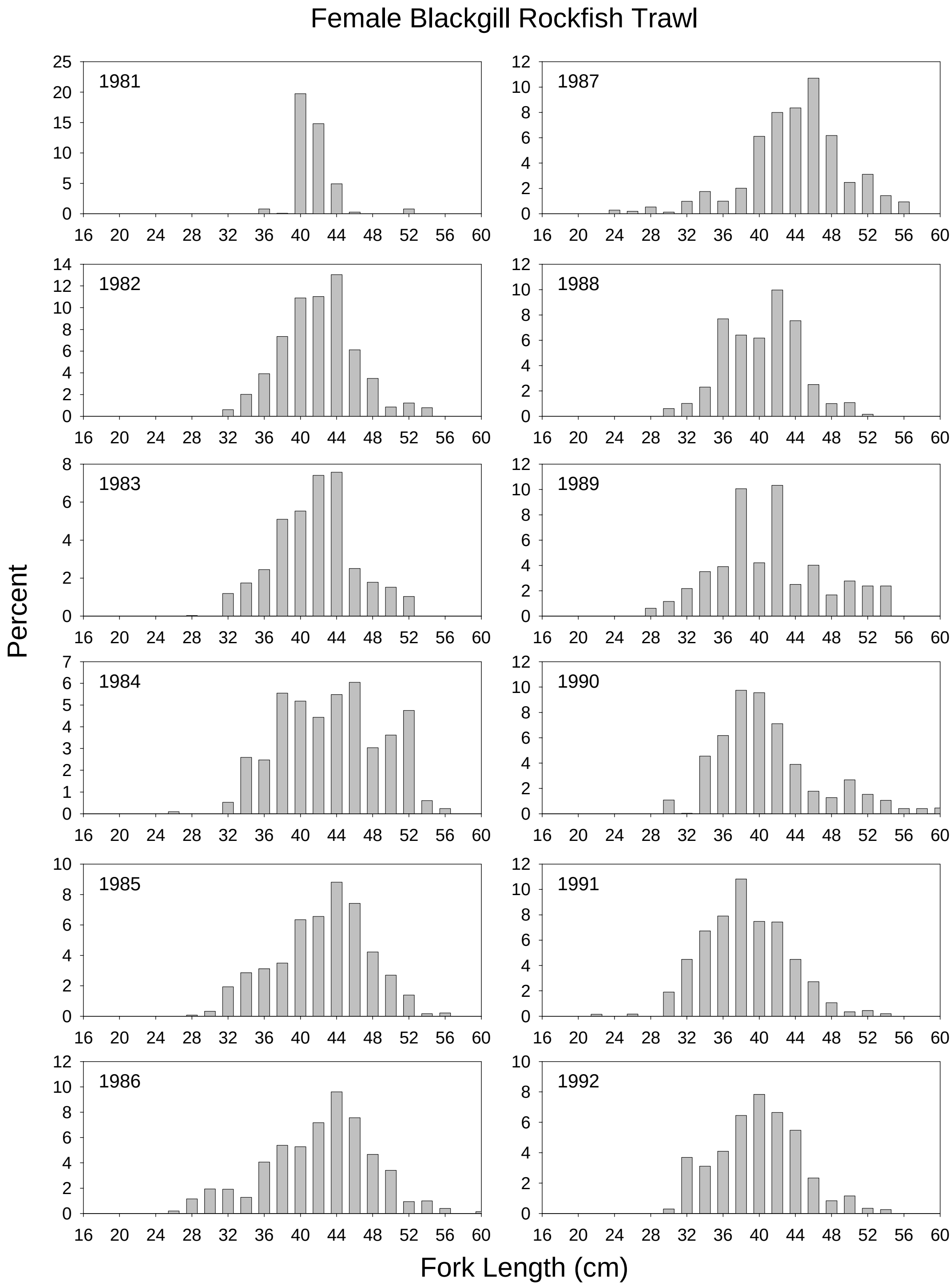


Figure 17. Size frequency distribution of female Blackgill rockfish (*Sebastes melanostomus*) taken by trawl (1981-2004).

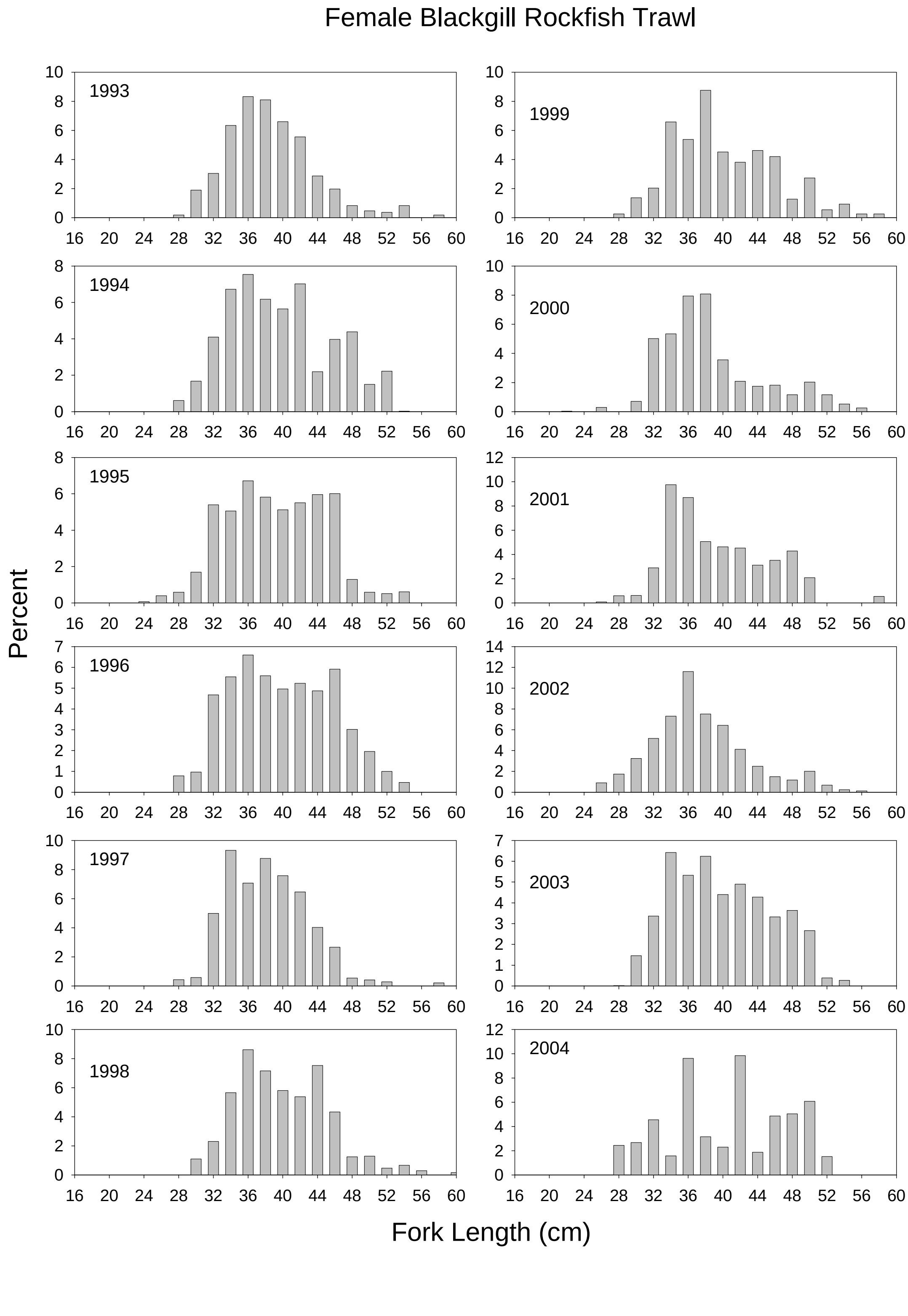


Figure 17. Continued.

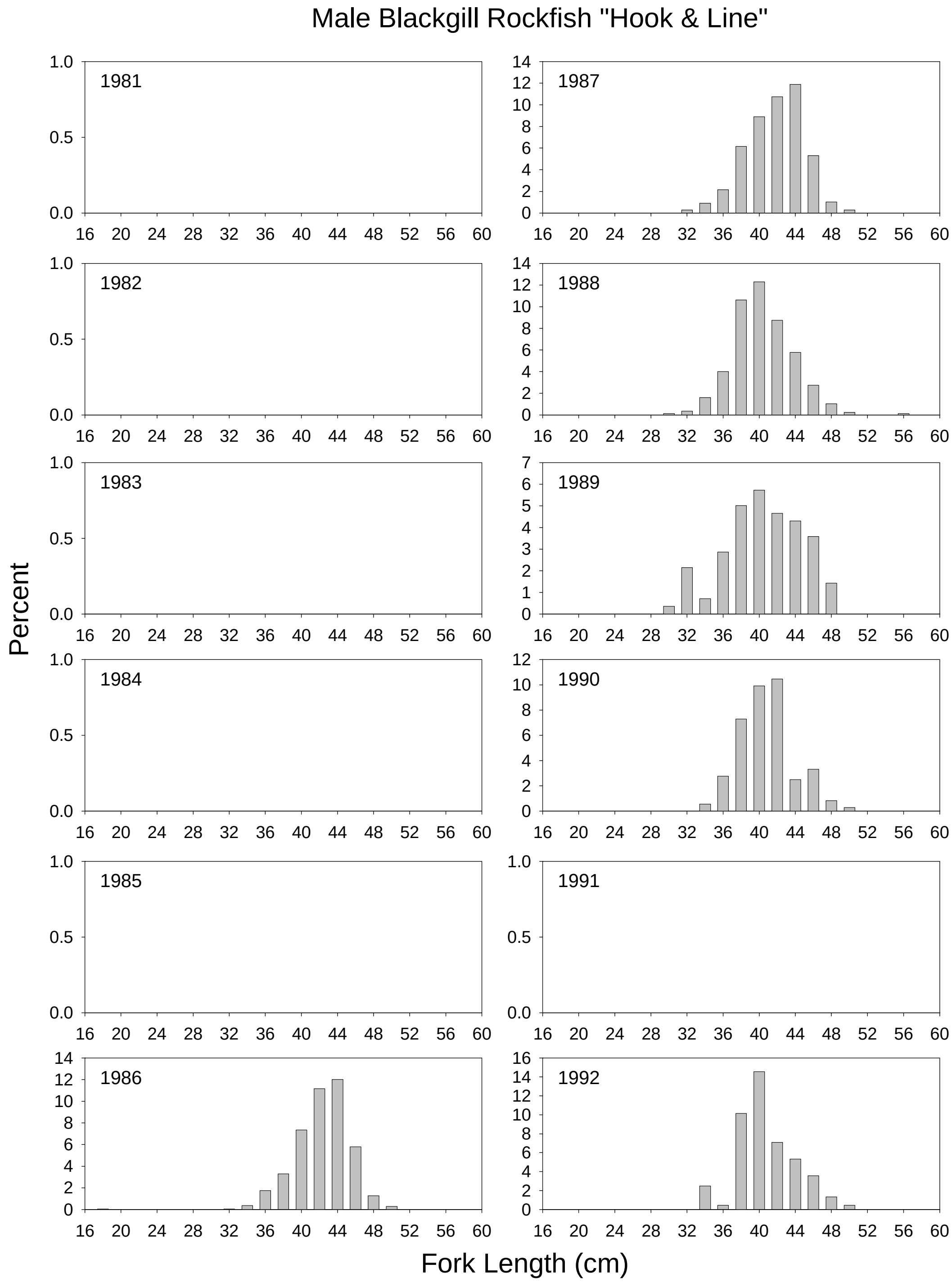


Figure 18. Size frequency distribution of male Blackgill rockfish (*Sebastes melanostomus*) taken by commercial hook and line (1986-2004).

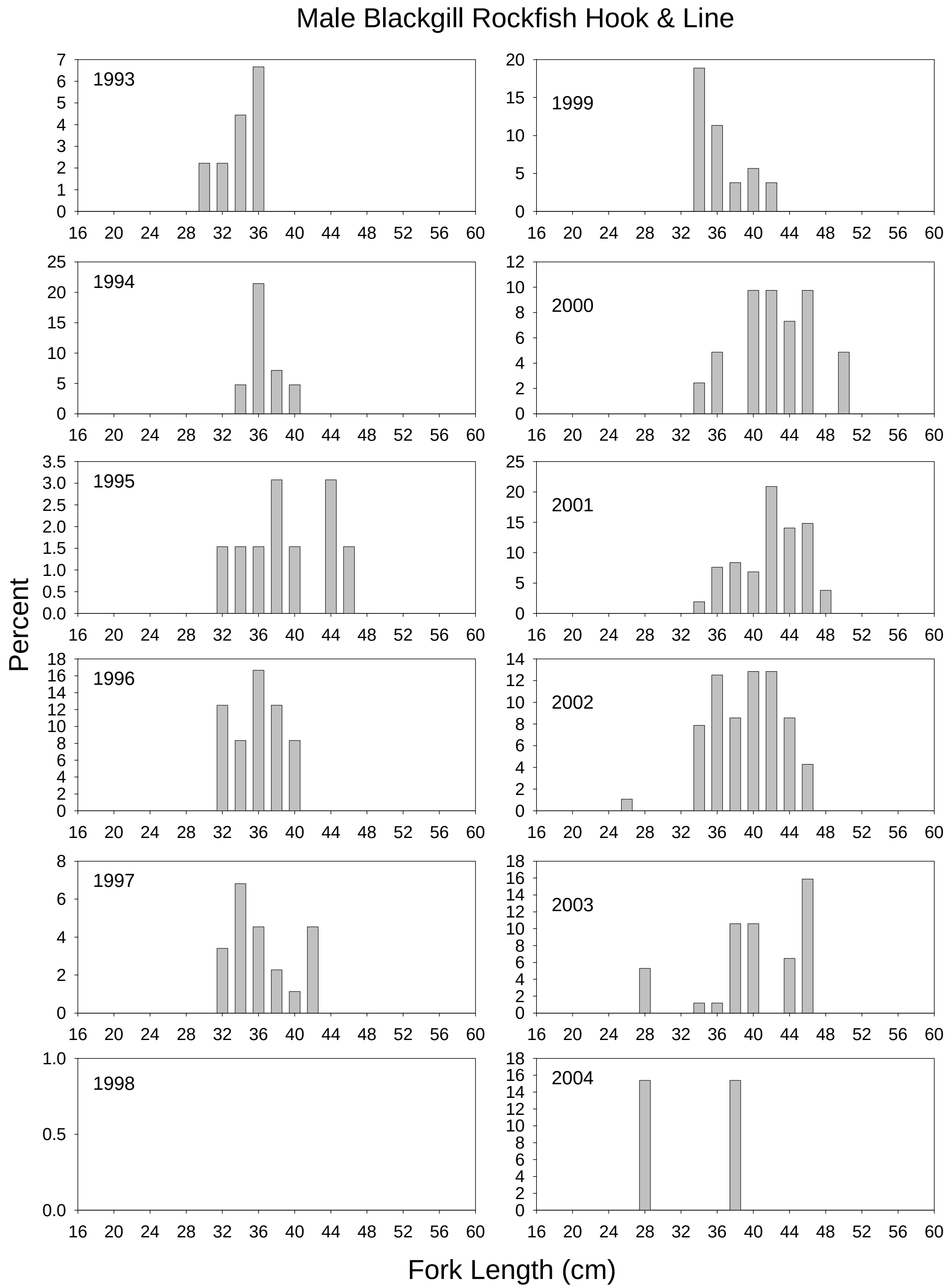


Figure 18. Continued.

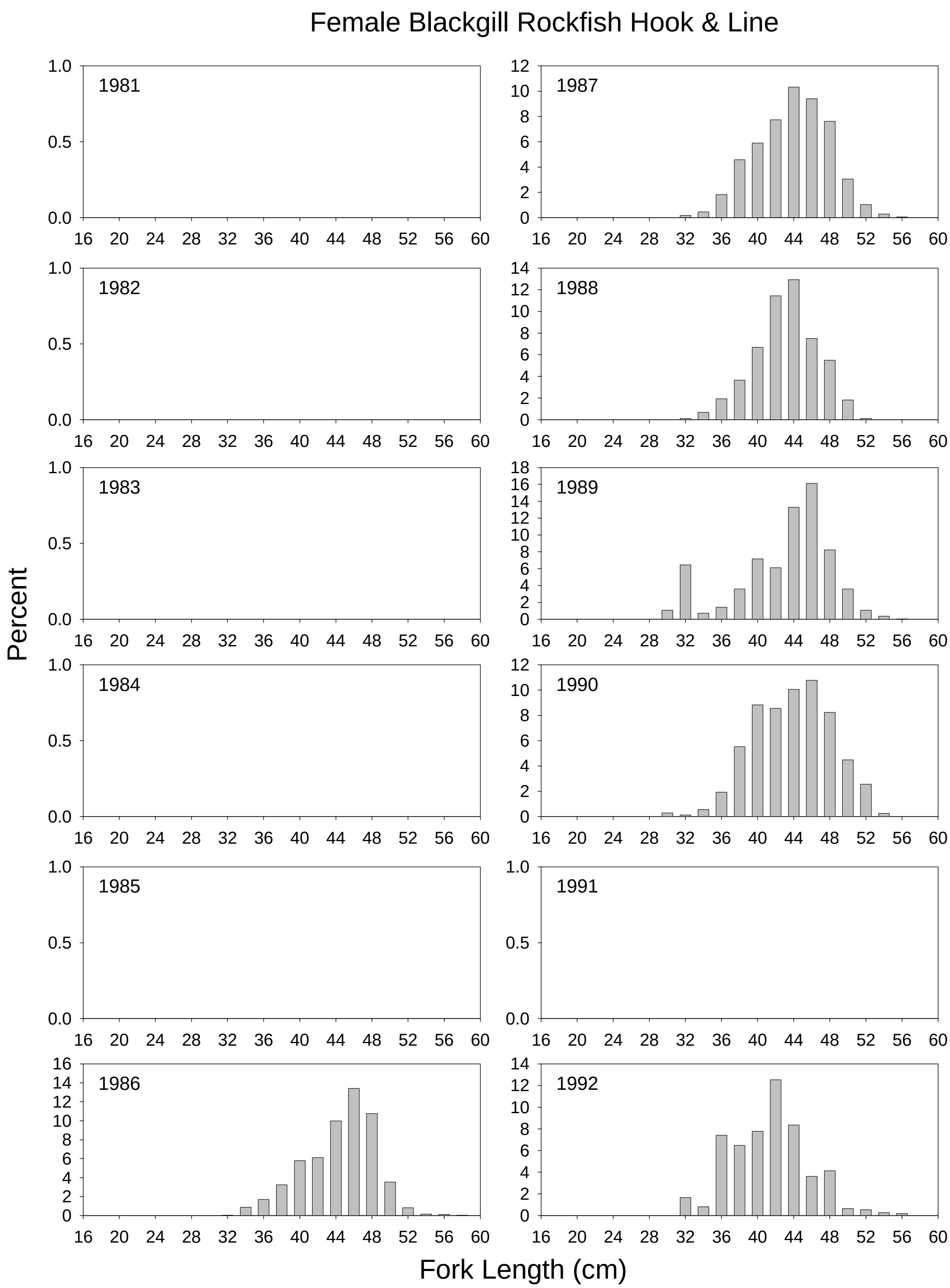


Figure 19. Size frequency distribution of female Blackgill rockfish (*Sebastes melanostomus*) taken by trawl (1981-2004).

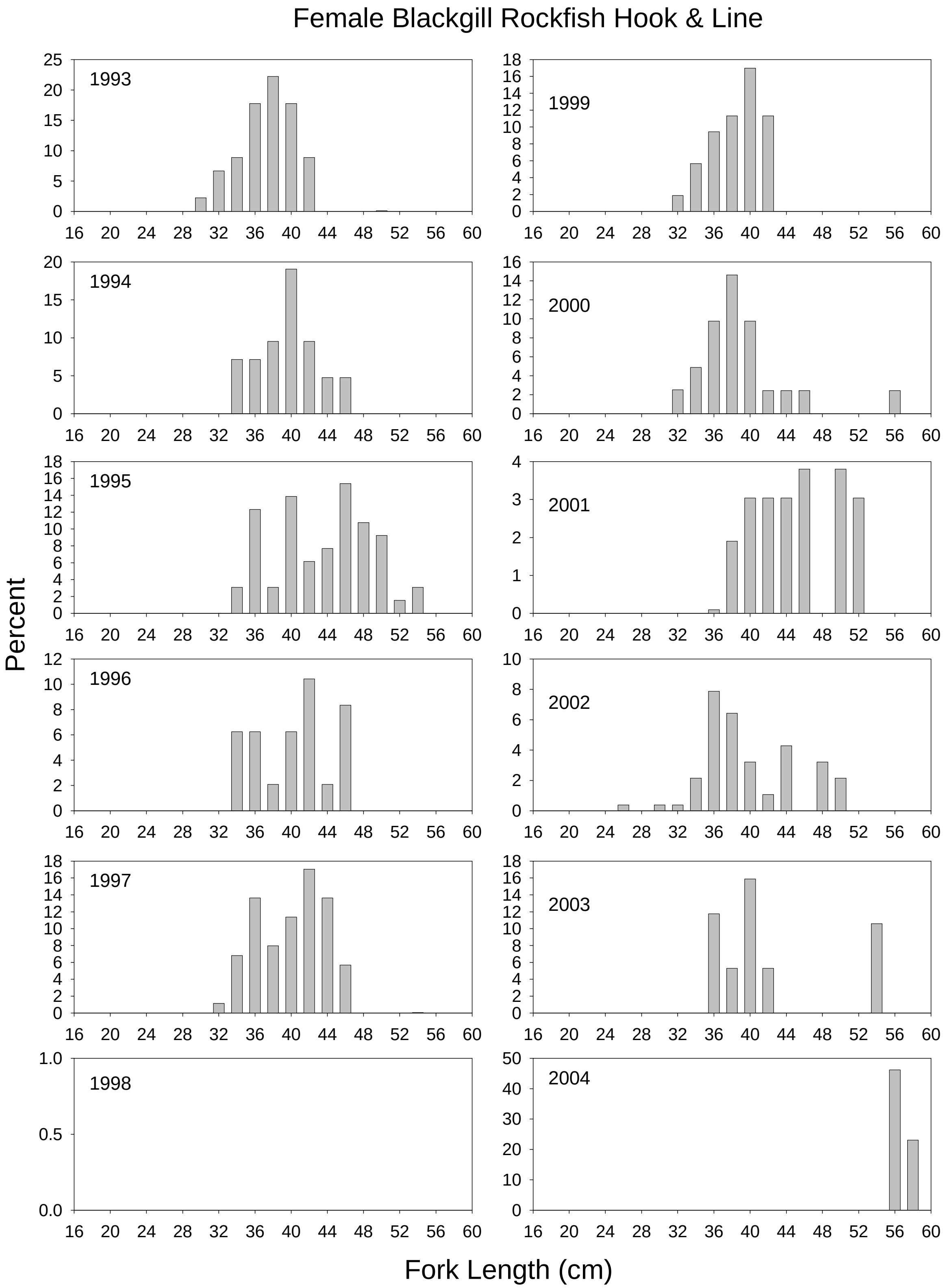


Figure 19. Continued.

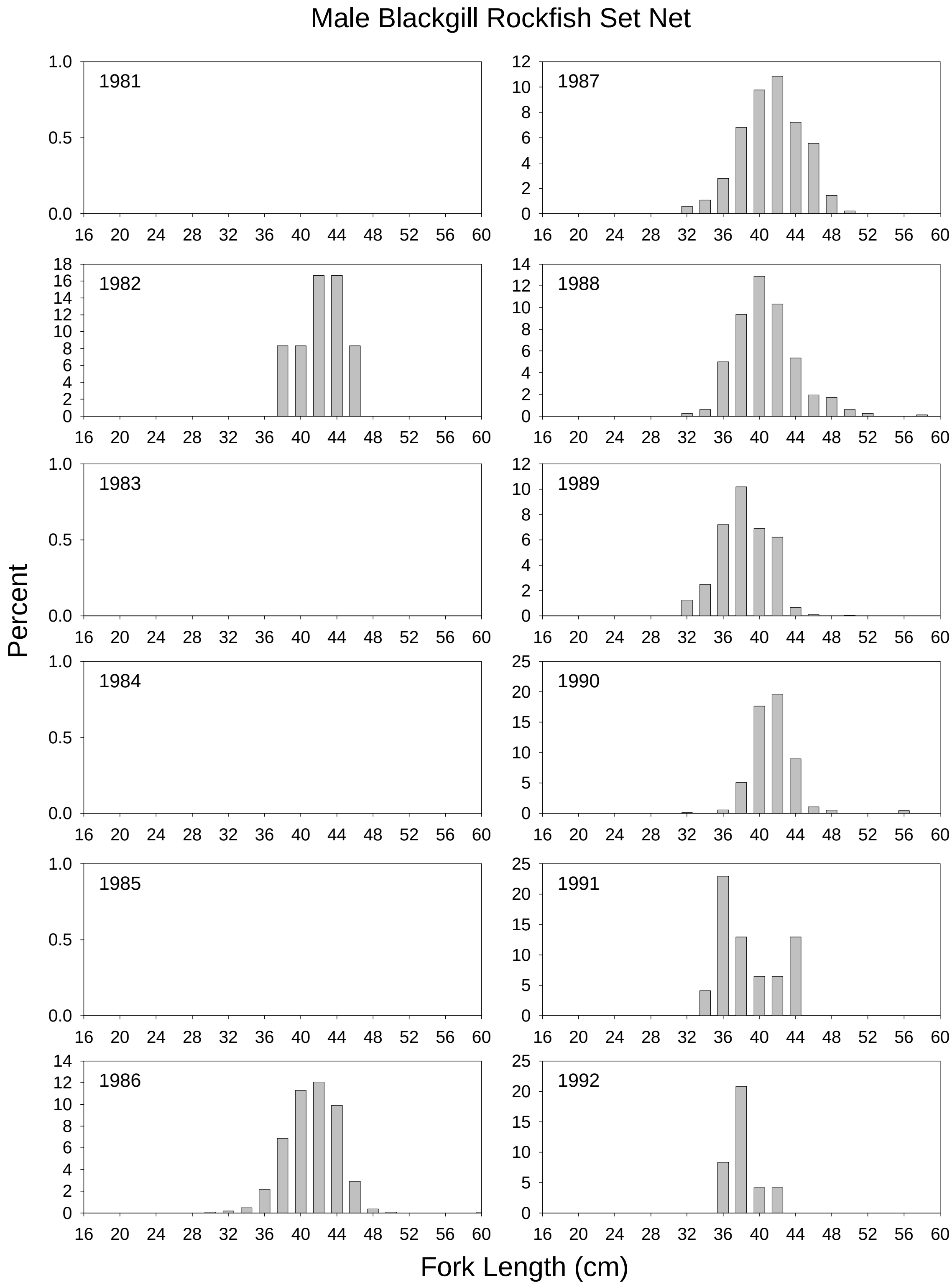


Figure 20. Size frequency distribution of male Blackgill rockfish (*Sebastes melanostomus*) taken by set net (1986-2004).

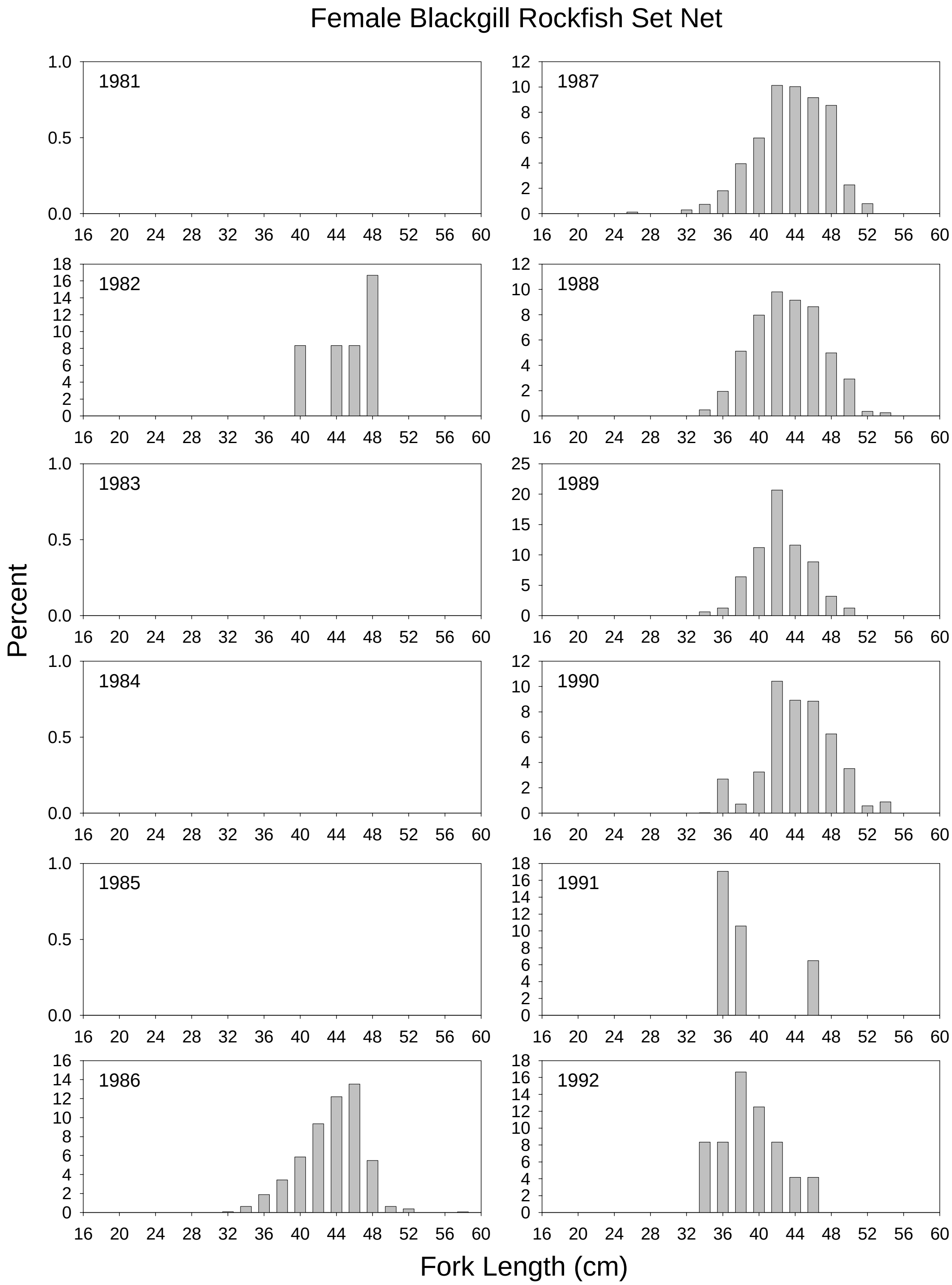


Figure 21. Size frequency distribution of female Blackgill rockfish (*Sebastes melanostomus*) taken by set net (1986-2004).

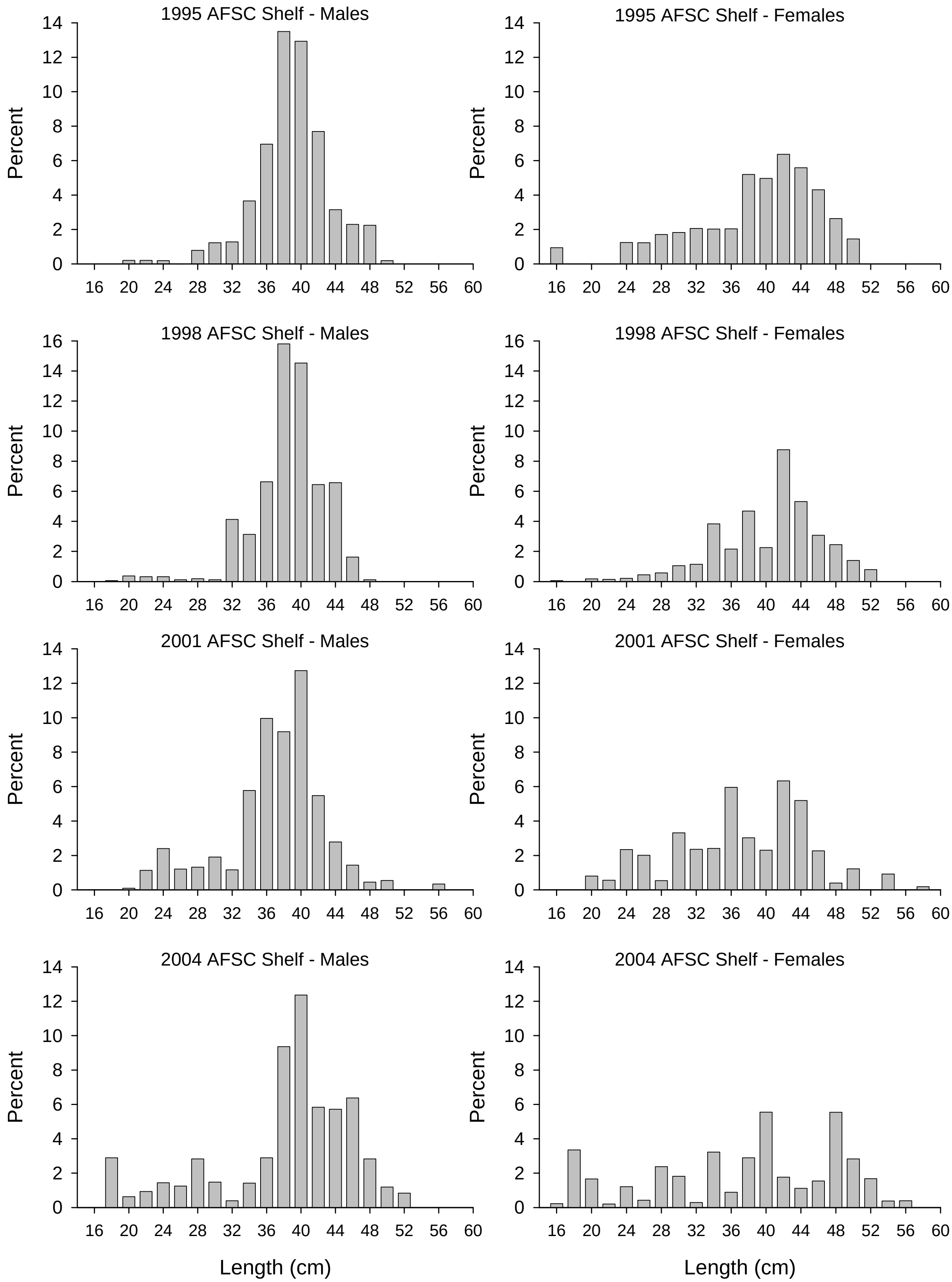


Figure 22 Size frequency distribution of male and female Blackgill rockfish (*Sebastes melanostomus*) sampled between 1995-2004 from the Alaska Fisheries Science Center's (AFSC) triennial shelf trawl survey. (Note: the 2004 shelf survey was conducted by NWFSC as a continuation of the AFSC survey).

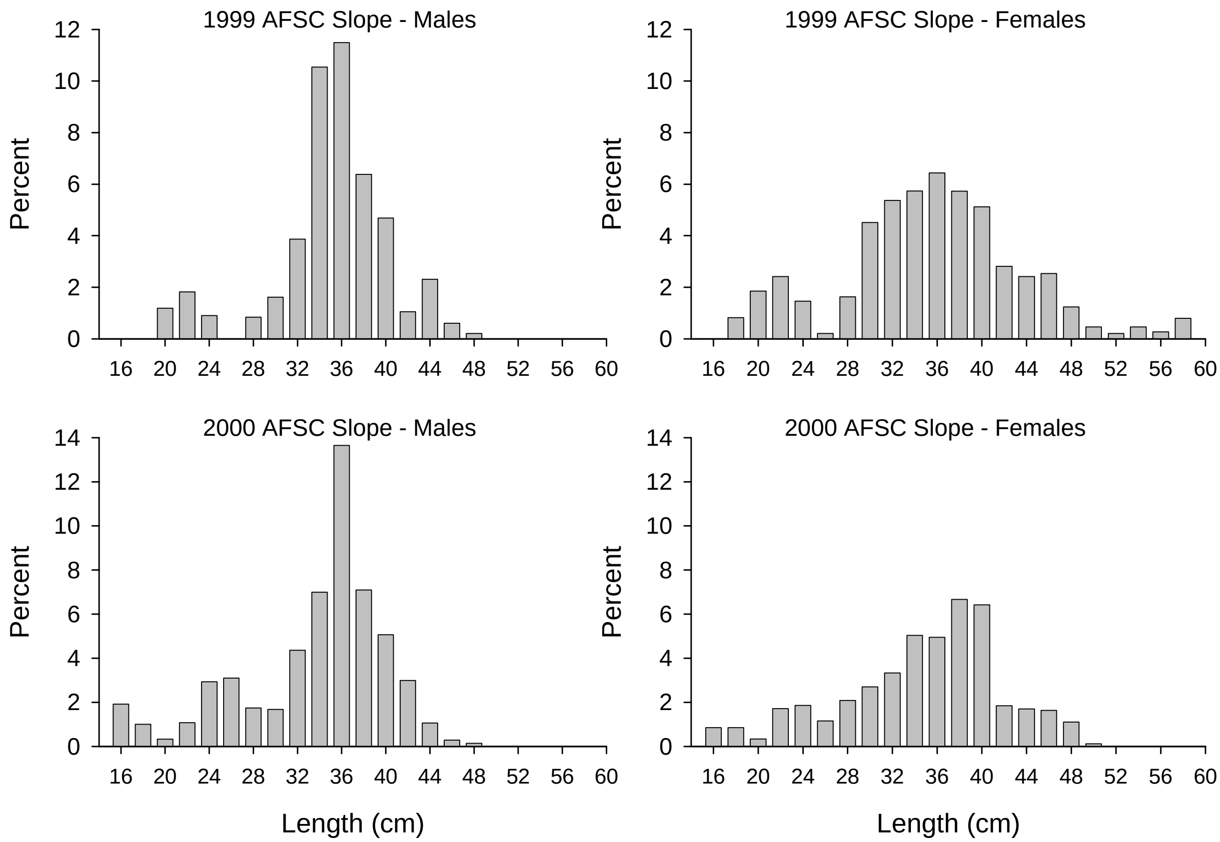


Figure 23 Size frequency distribution of male and female Blackgill rockfish (*Sebastes melanostomus*) sampled during the 1999 and 2000 Alaska Fisheries Science Center's (AFSC) slope trawl survey.

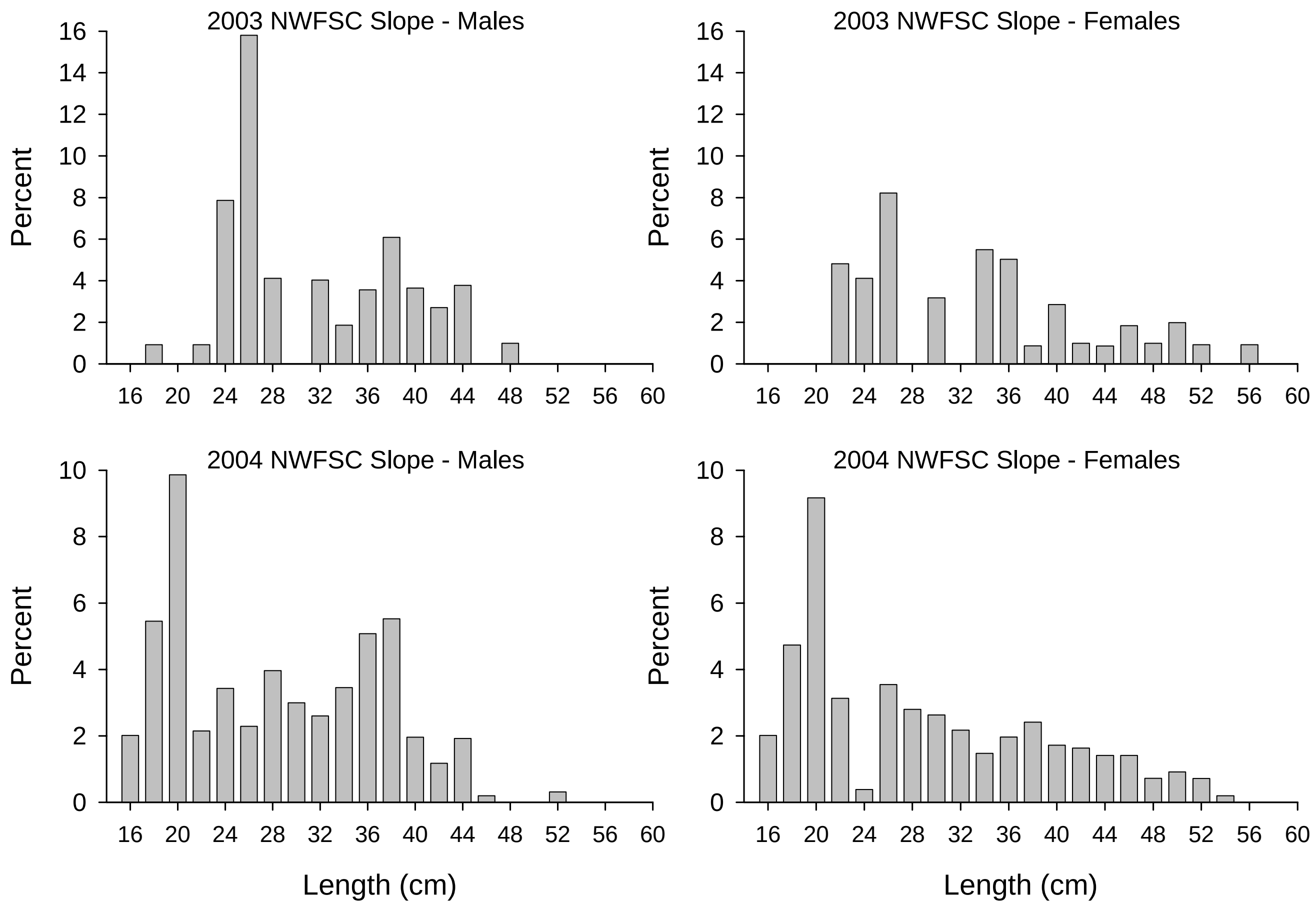


Figure 24 Size frequency distribution of male and female Blackgill rockfish (*Sebastes melanostomus*) sampled during the 2003 and 2004 Northwest Fisheries Science Center's (NWFSC) slope trawl survey.

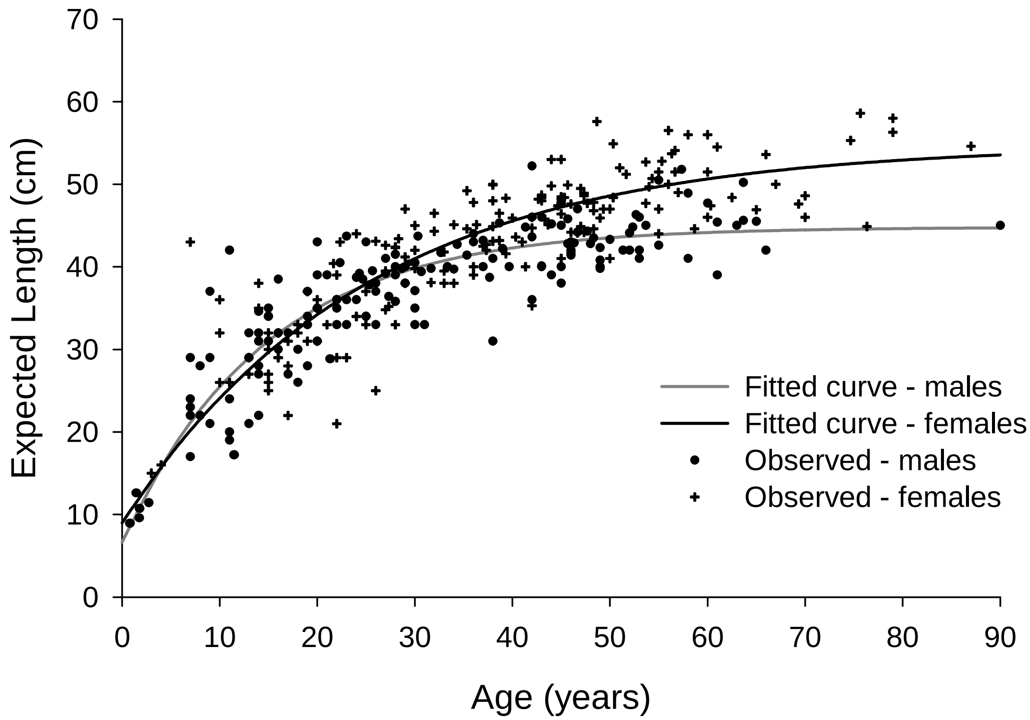


Figure 25. Observed lengths at age and fitted von Bertalanffy growth curves for male and female blackgill rockfish. Data provided by Melissa Stevens (Stevens et al. 2004).

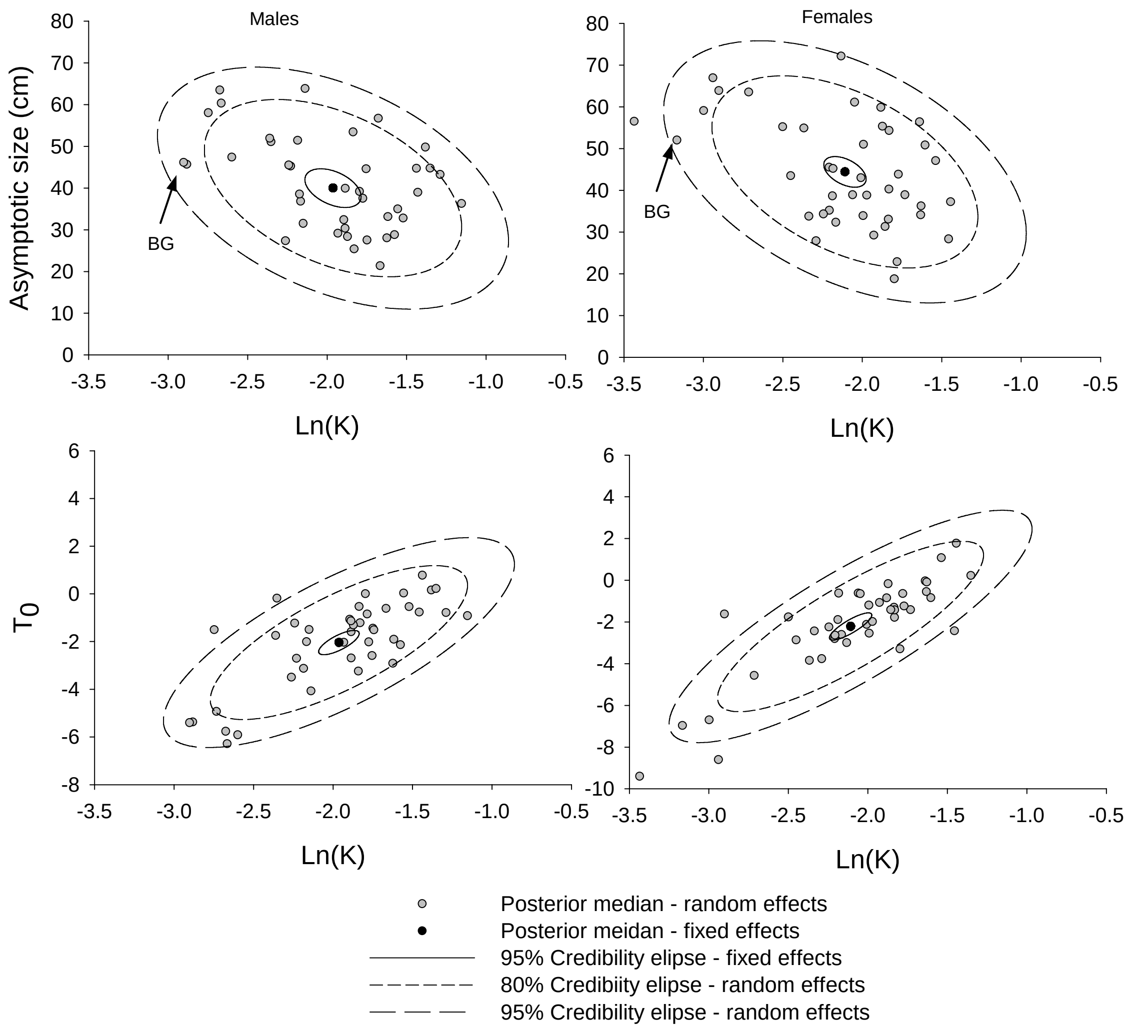


Figure 26. Estimates of von Bertalanffy growth parameters, asymptotic size ($L\infty$) and growth coefficient (K), from a Bayesian hierarchical meta-analysis of 46 species of the Sebastes genus from California to Alaska (see Helser et al. 2004).

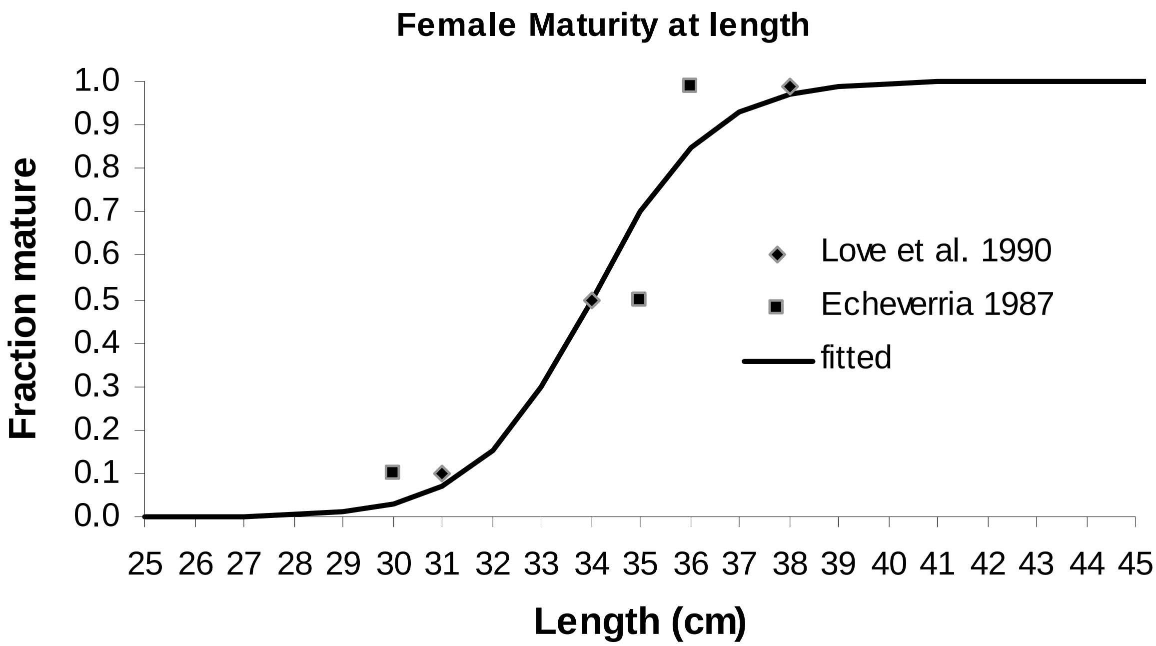


Figure 27. Estimates of the proportion of female blackgill rockfish at length that are mature (1%, 50%, 99% mature at size) from two different studies (Wyllie-Echeverria 1987, Love et al. 1990). Solid line shows the fitted relationship used in the stock assessment.

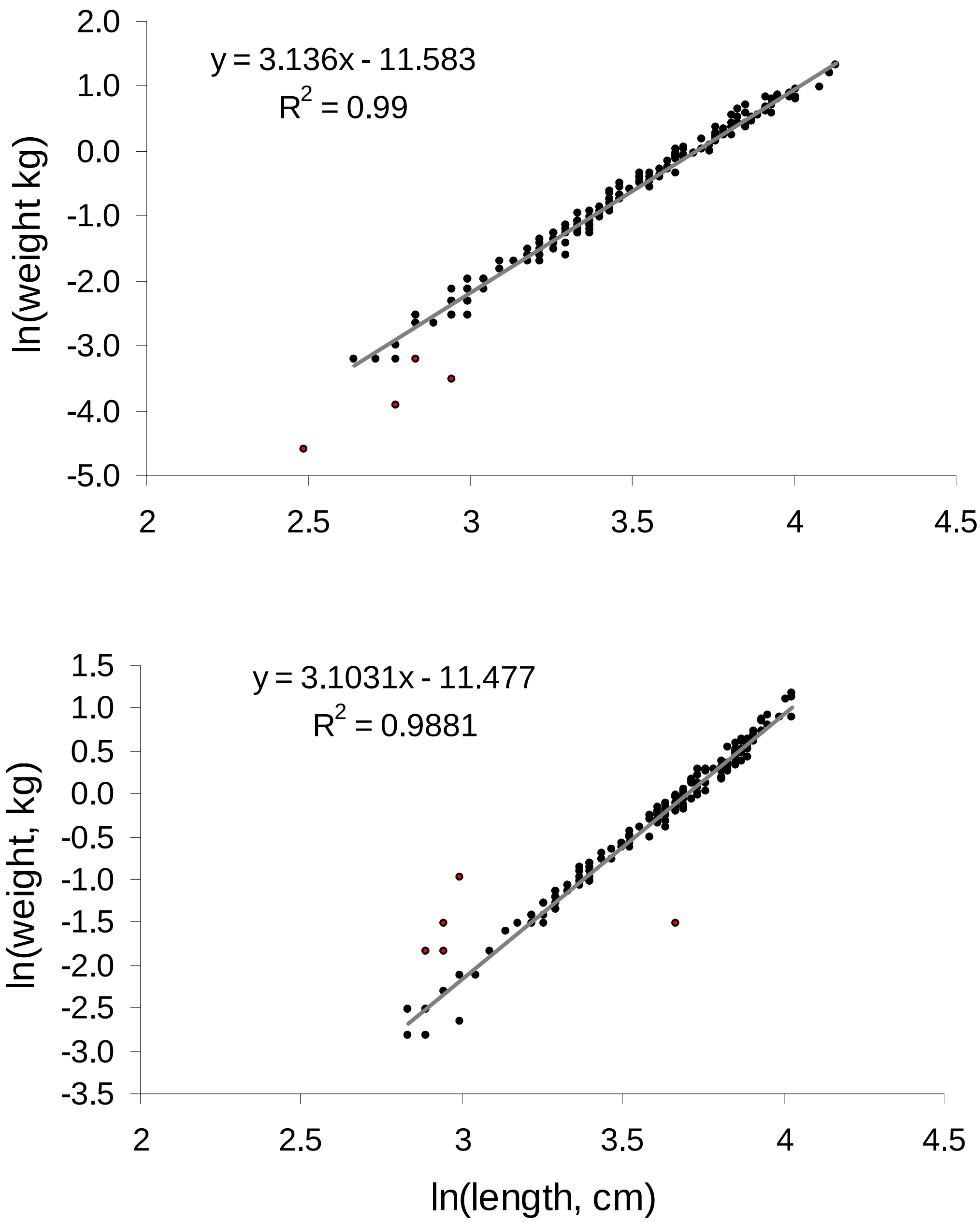


Figure 28. Growth of blackgill rockfish (sexes combined) in weight as a function of length (ln-ln transform) from data taken during the 2004 NWFSC shelf and slope surveys. Parameters from a linear regression to these data are given in Table 15.

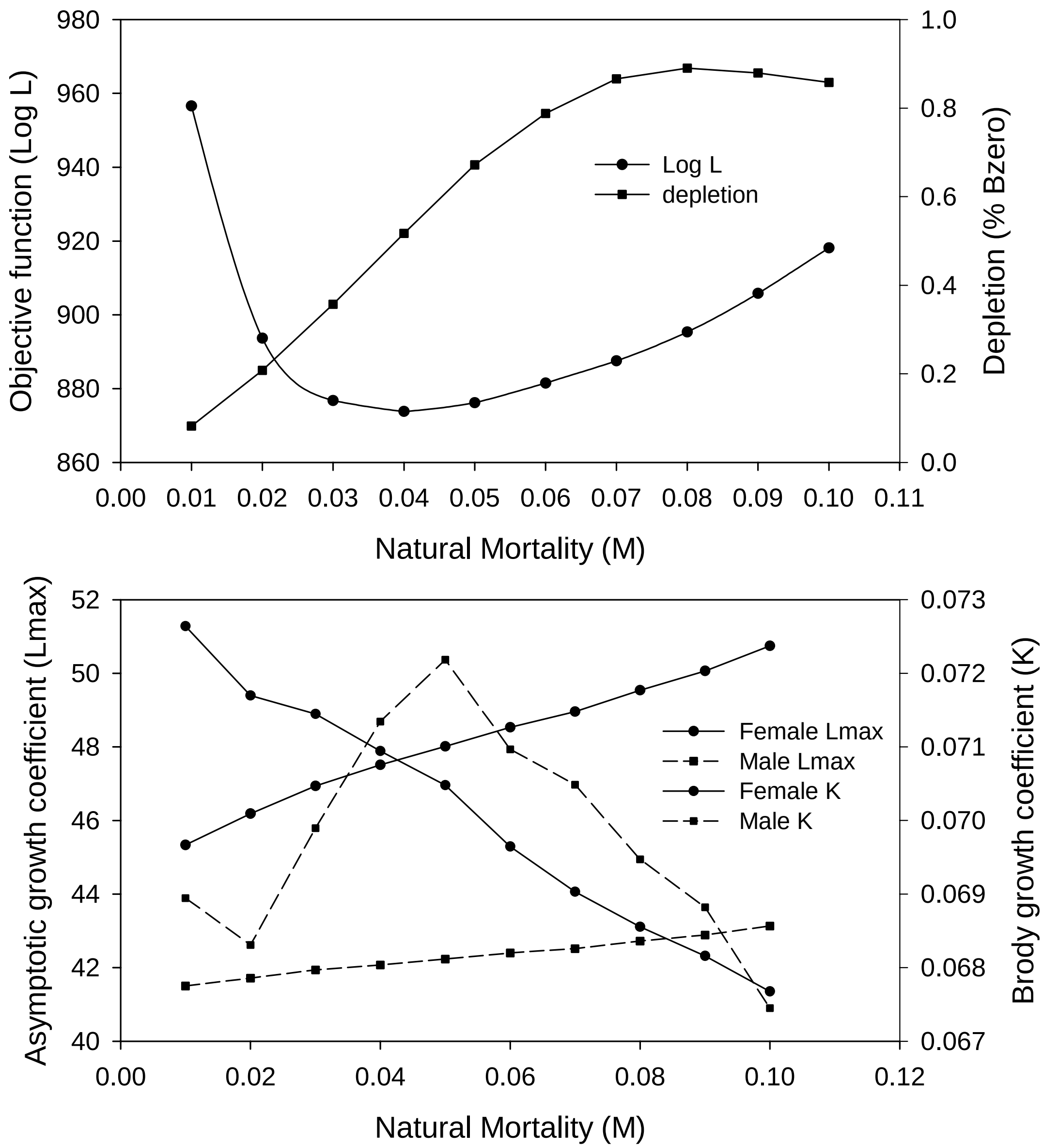


Figure 29. Profile of response in the objective function likelihood to alternative specifications of natural mortality (M=0.01 to 0.10), using the base case model (upper panel). The corresponding spawning stock biomass depletion (as percent unfished biomass) are also given. Lower panel shows the resulting growth parameter estimates of Lmax and K for females and males when freely estimated within the model from different fixed values of M.

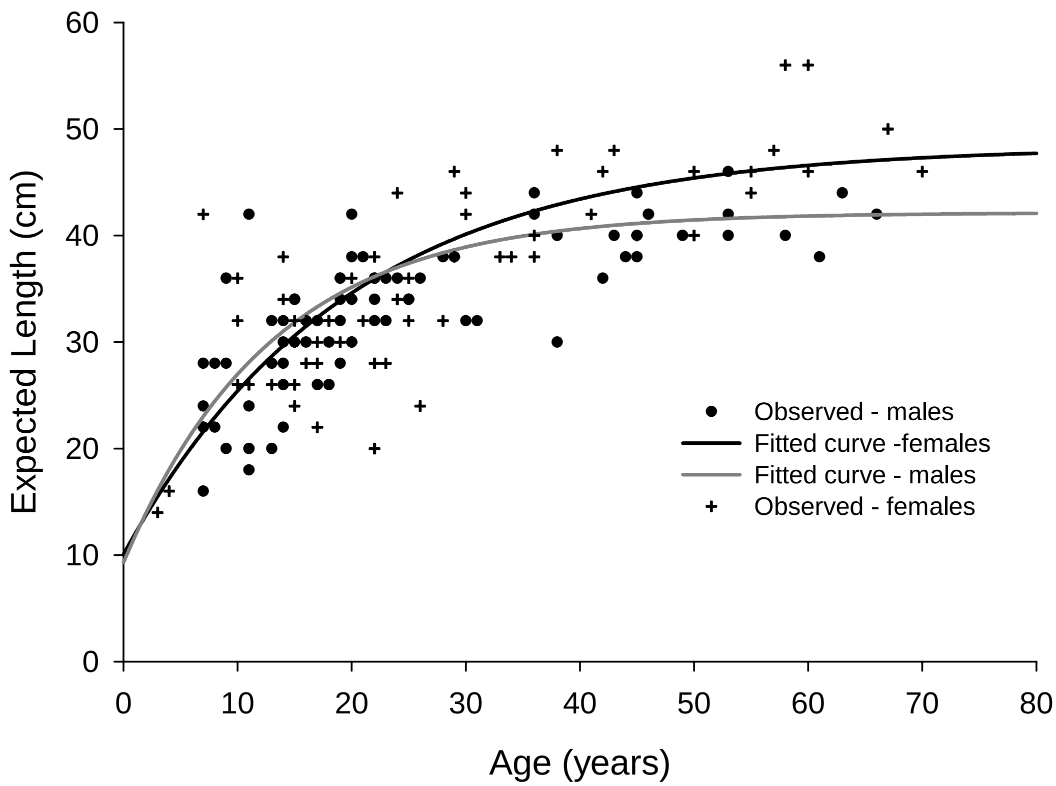


Figure 30. Observed length at age data for blackgill rockfish sampled by NMFS Triennial shelf survey with fitted von Bertalanffy growth curves estimated within the stock synthesis model (SS2).

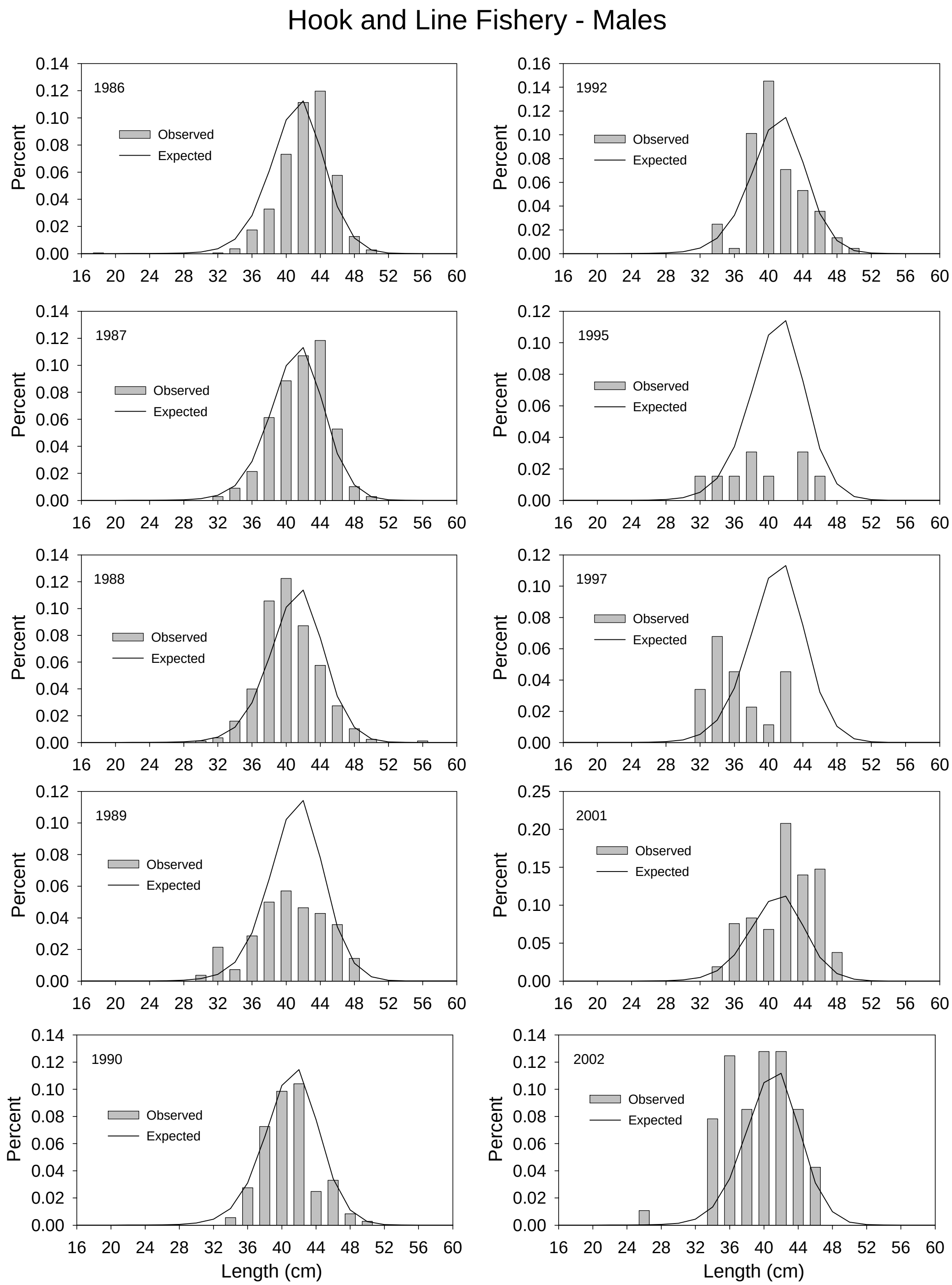


Figure 31. Predicted vs. observed fits to blackgill rockfish male length compositions in the hook and line fishery.

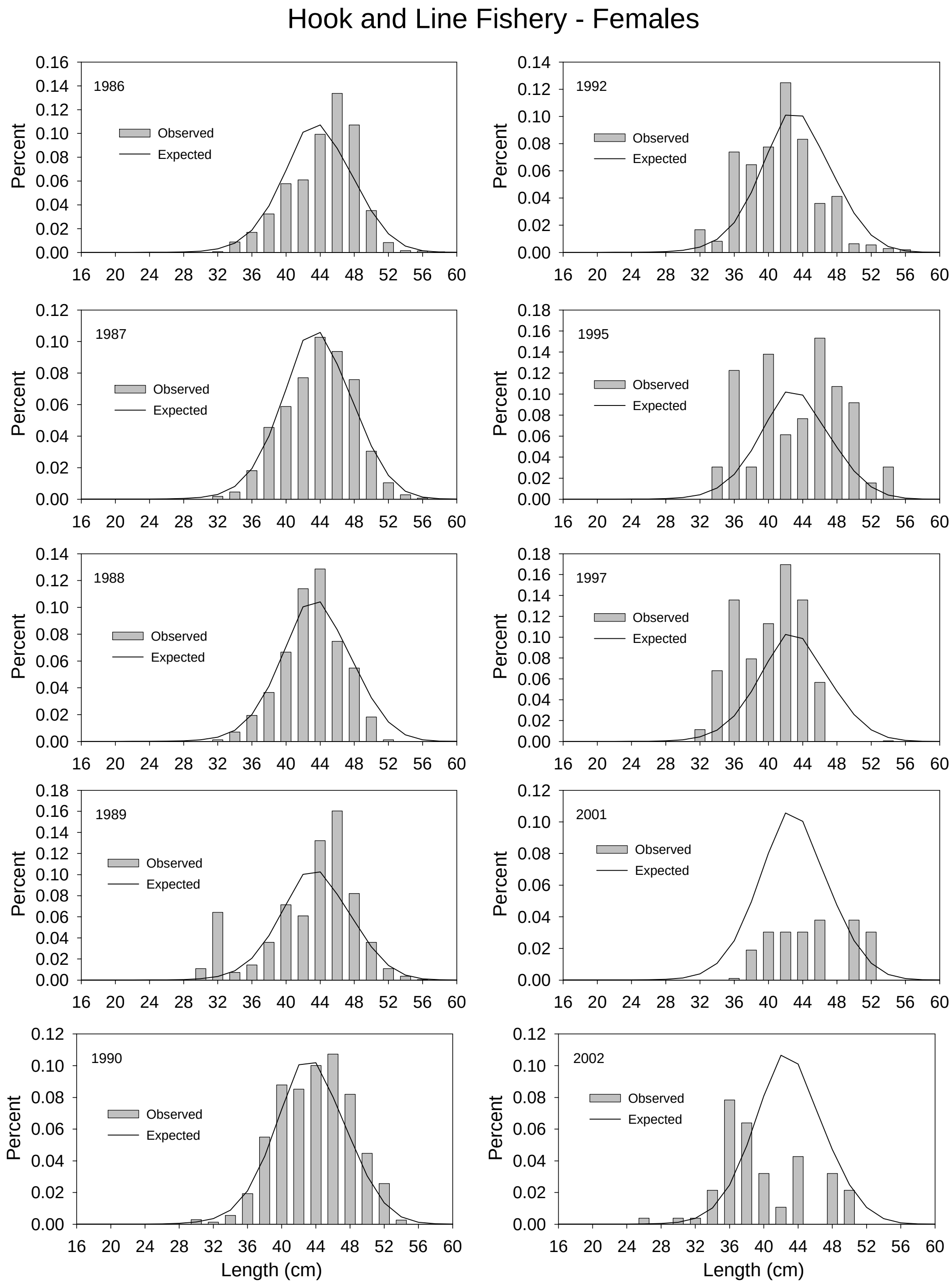


Figure 31 (Continued). Predicted vs. observed fits to blackgill rockfish female length compositions in the hook and line fishery.

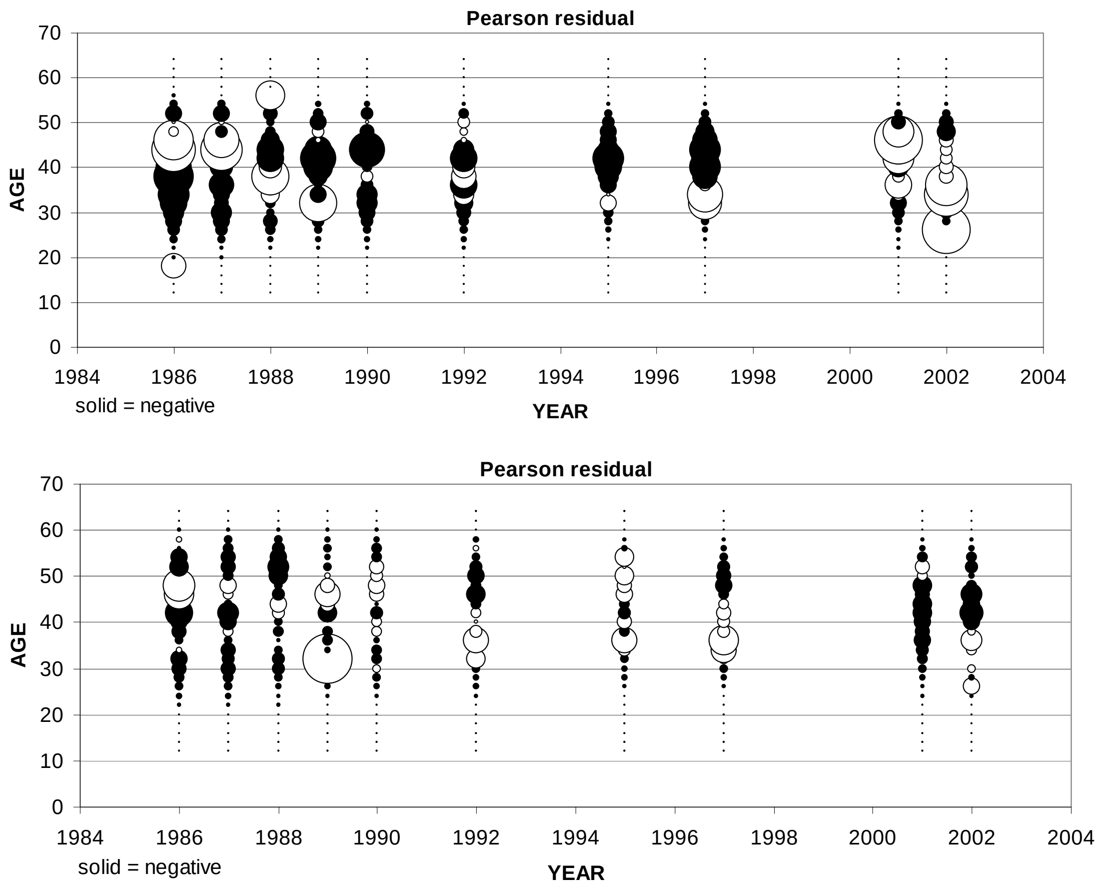
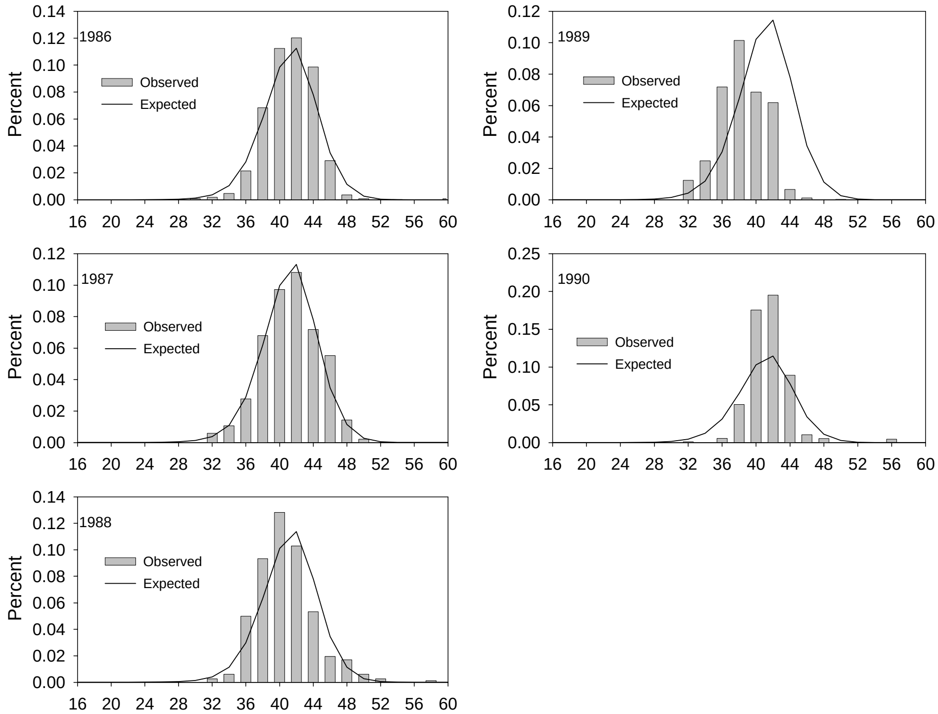


Figure 32. Diagrams showing Pearson residual plots (top: males, middle: females) and effective vs. observed sample sizes of fits to the hook and line length frequency compositions.

Set net Fishery - Males



Set net Fishery - Females

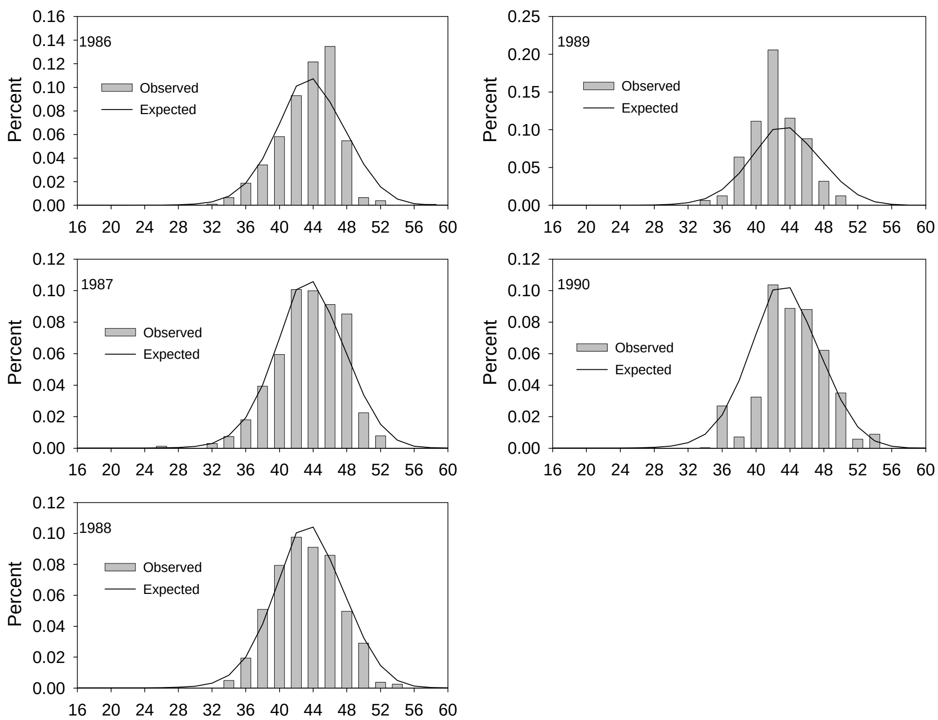
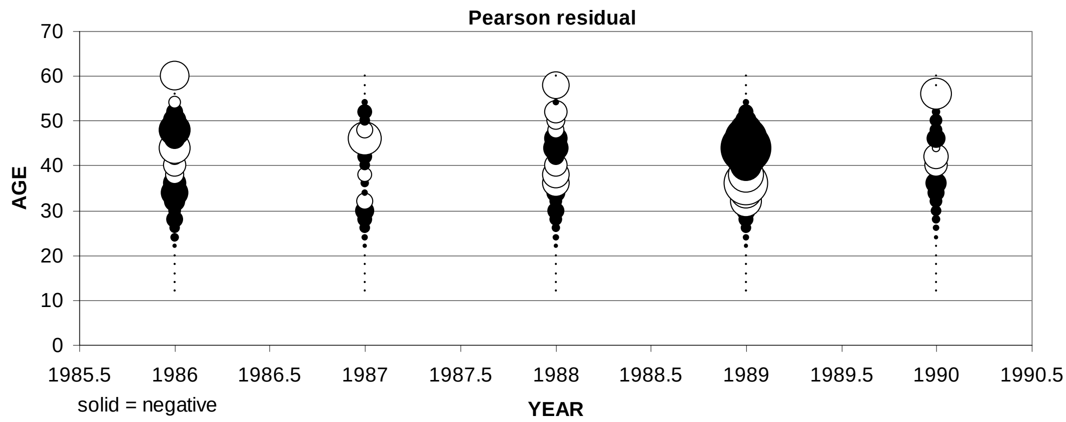


Figure 33. Predicted vs. observed fits to blackgill rockfish length compositions in the set net fishery.



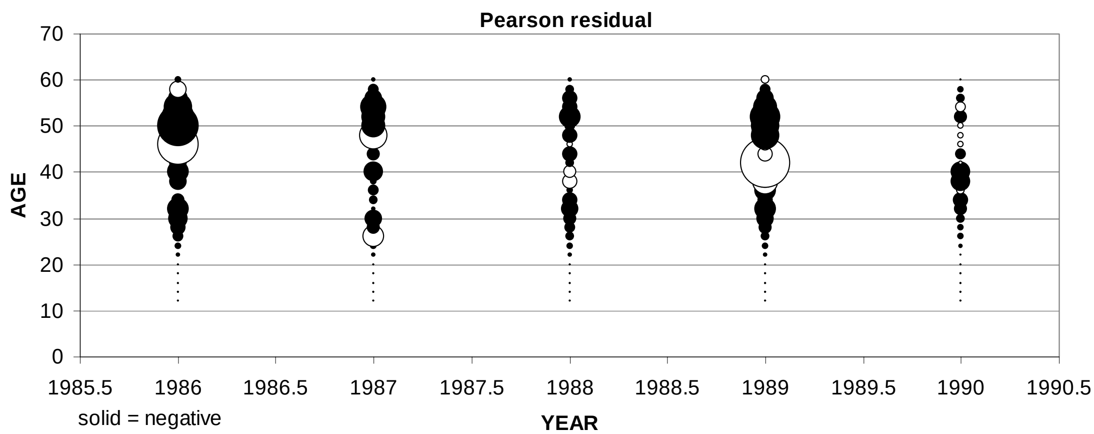


Figure 34. Diagrams showing Pearson residual plots (top: males, middle: females) and effective vs. observed sample sizes of fits to the set net length frequency compositions.

Trawl Fishery - Males

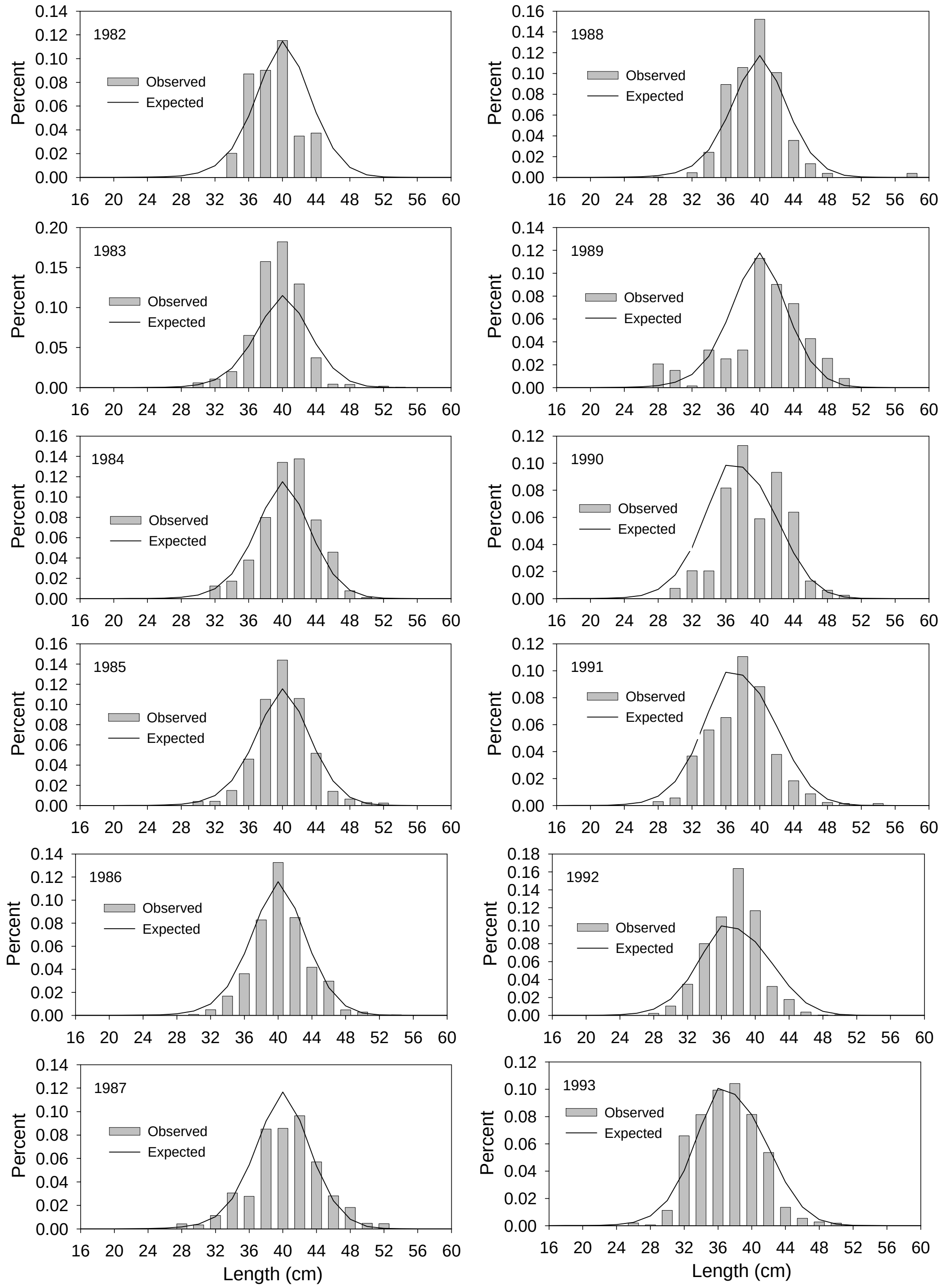


Figure 35. Predicted vs. observed fits to male blackgill rockfish length compositions in the trawl fishery.

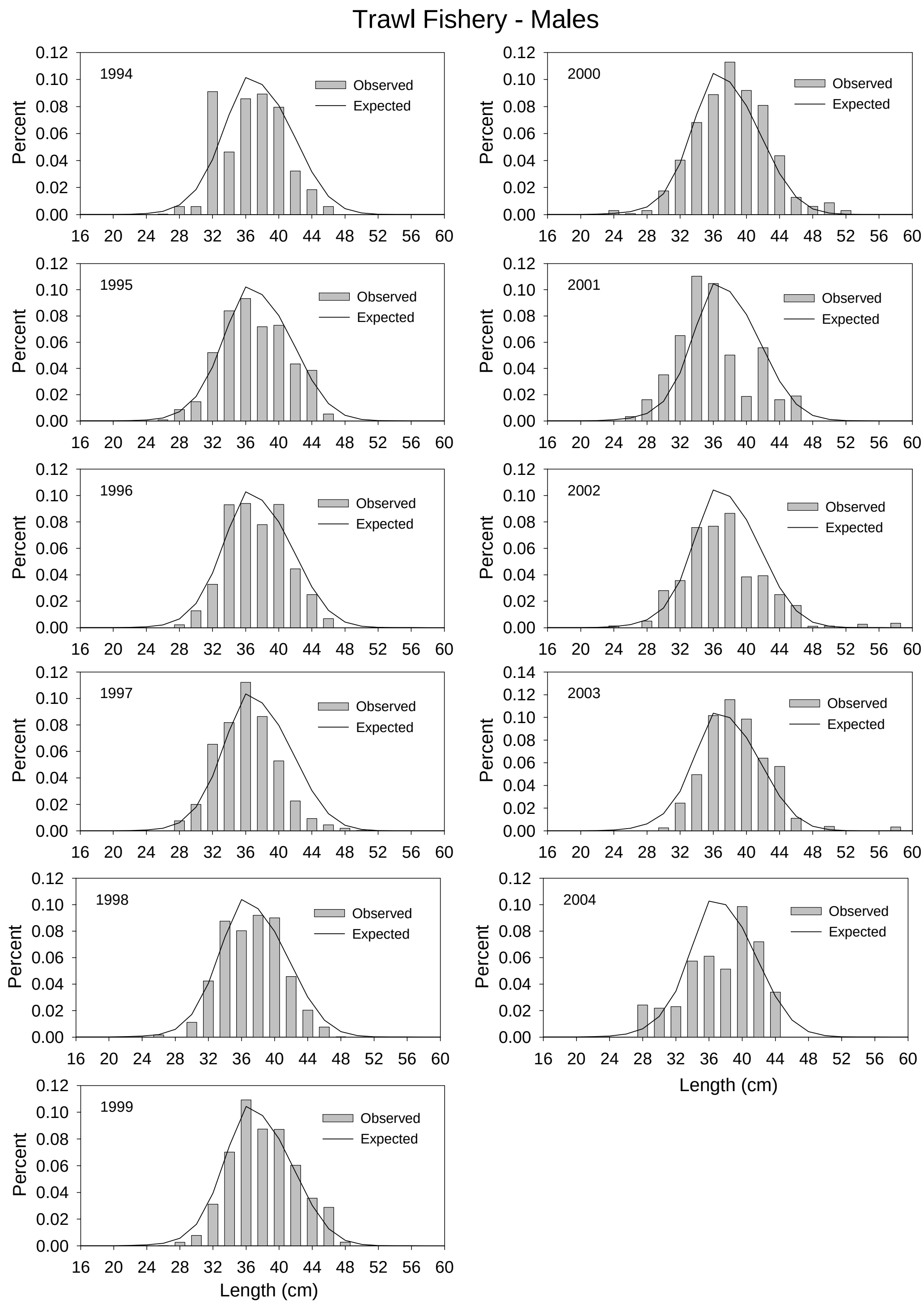


Figure 35 (continued). Predicted vs. observed fits to male blackgill rockfish length compositions in the trawl fishery.

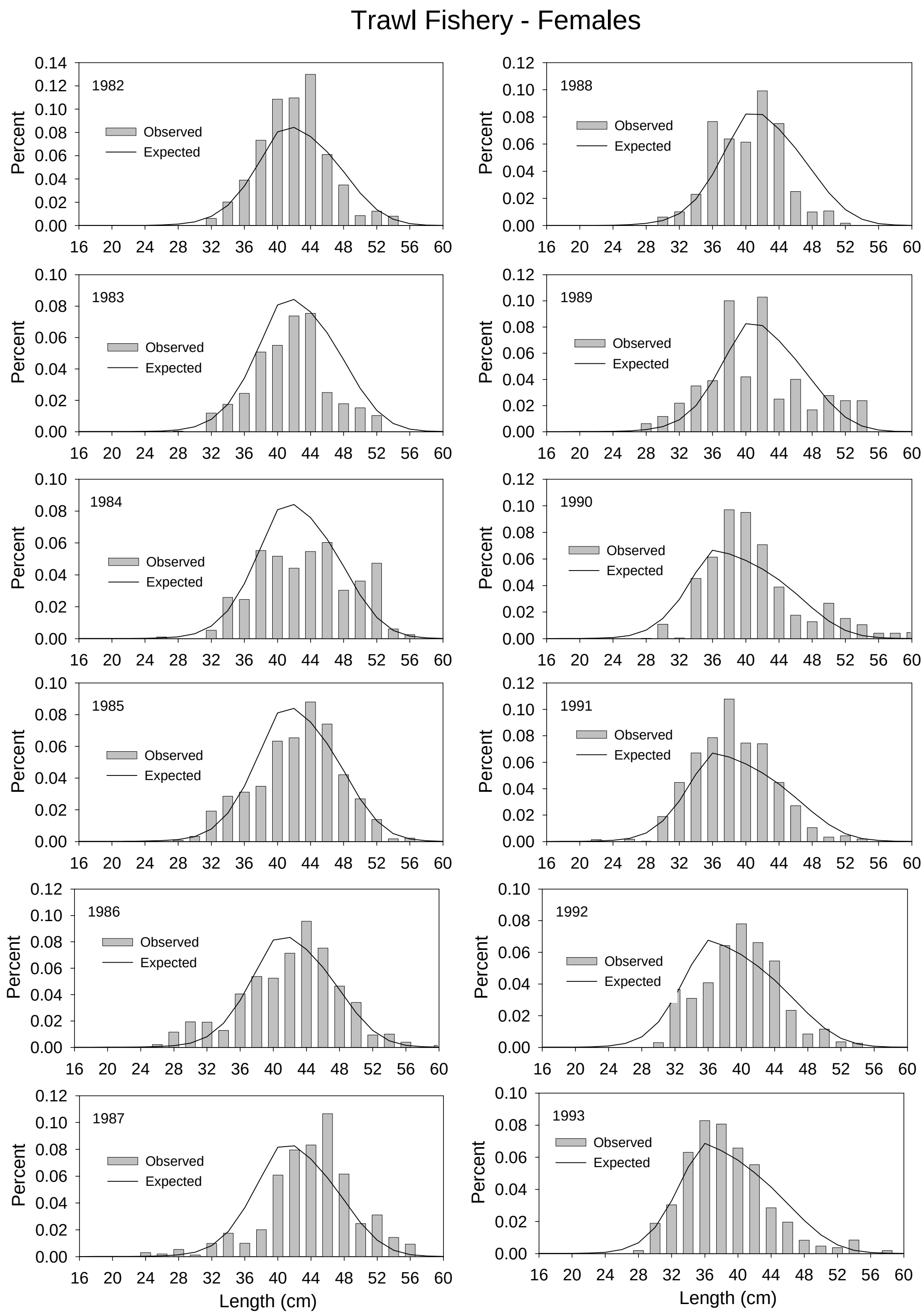


Figure 35 (continued). Predicted vs. observed fits to female blackgill rockfish length compositions in the trawl fishery.

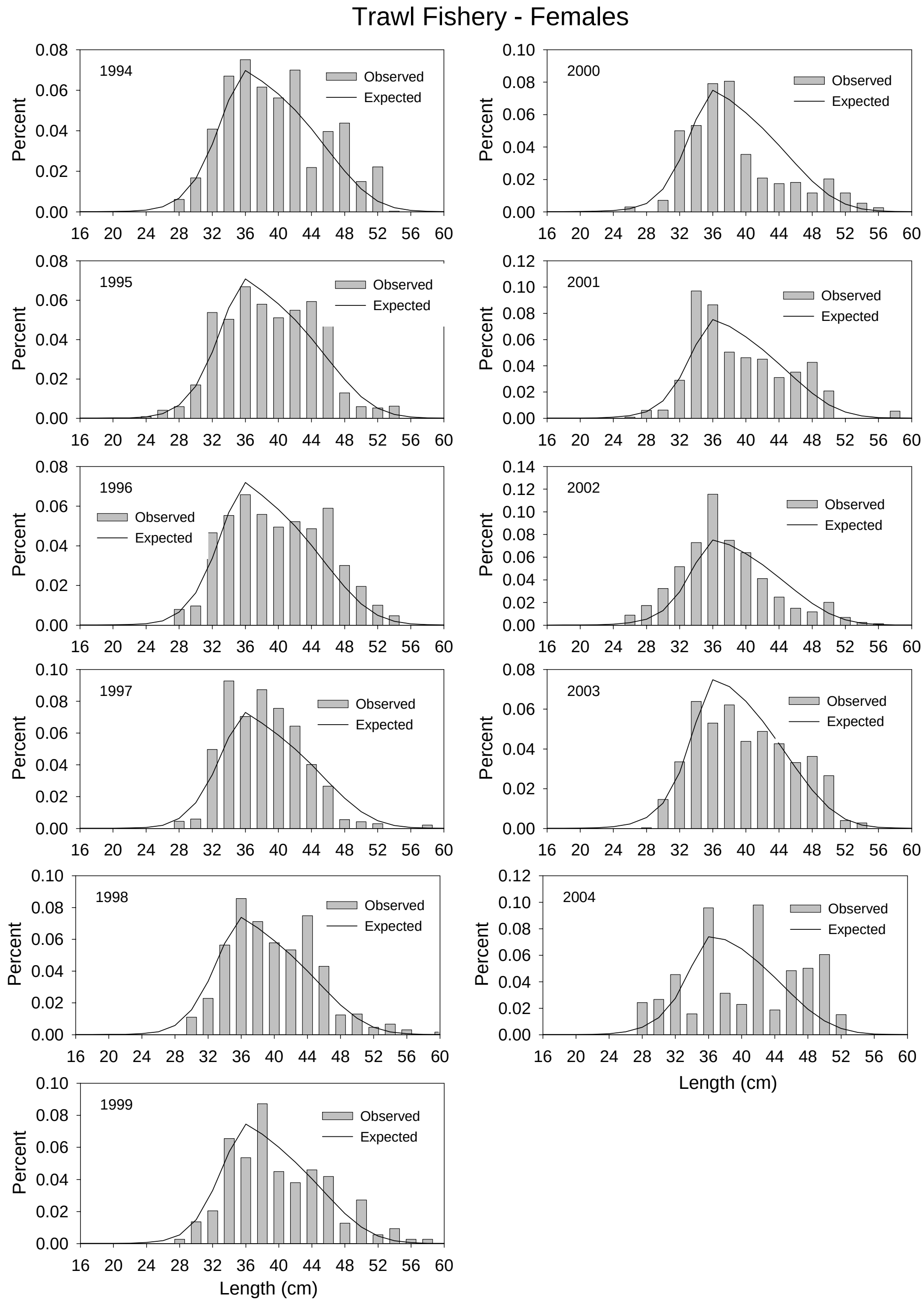
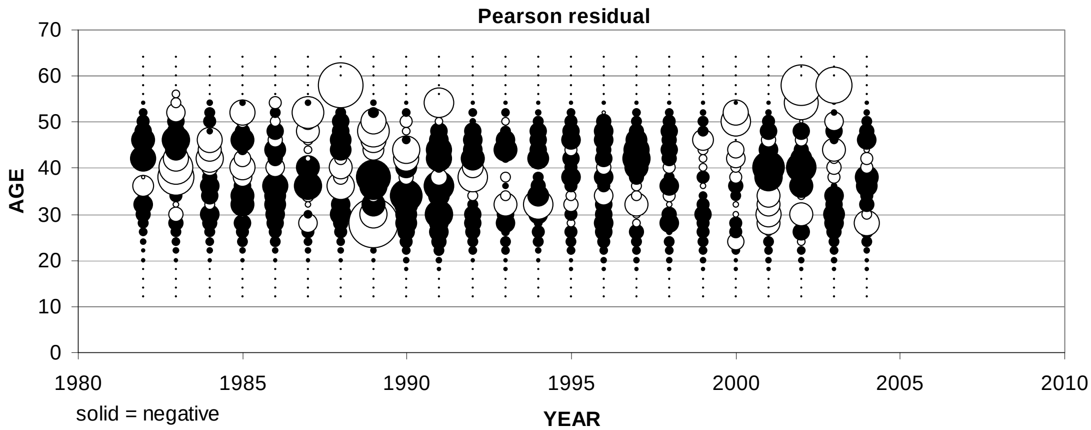


Figure 35 (continued). Predicted vs. observed fits to female blackgill rockfish length compositions in the trawl fishery.



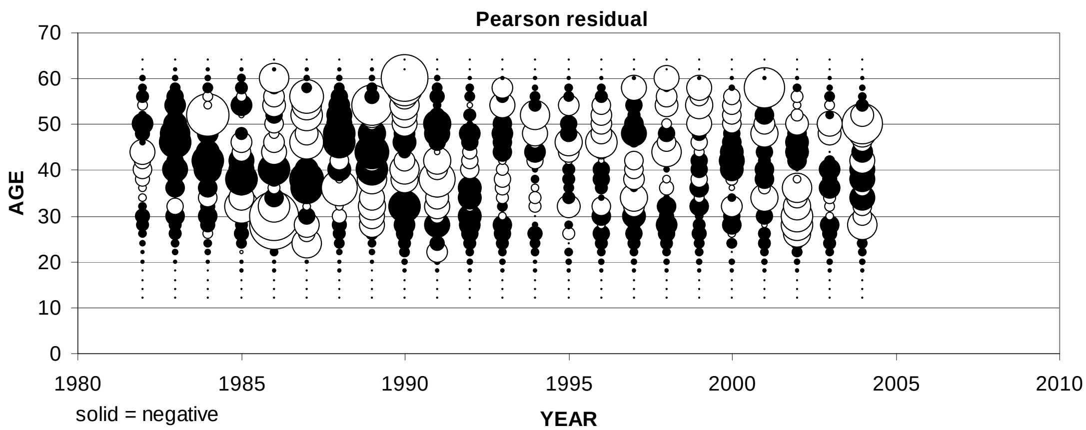


Figure 36. Diagrams showing Pearson residual plots (top: males, middle: females) and effective vs. observed sample sizes of fits to the trawl length frequency compositions.

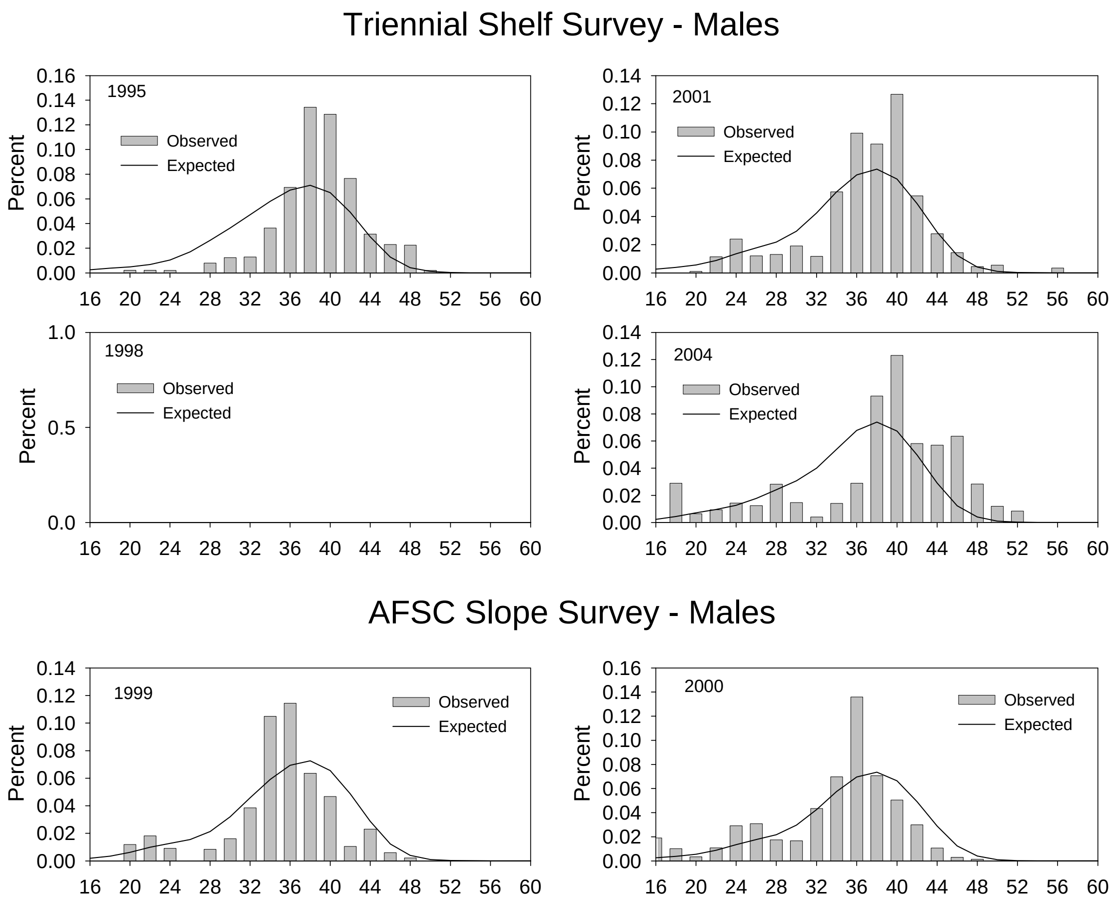


Figure 37. Predicted vs. observed fits to male blackgill rockfish length frequency compositions from the AFSC shelf, AFSC slope and NWFSC slope surveys.

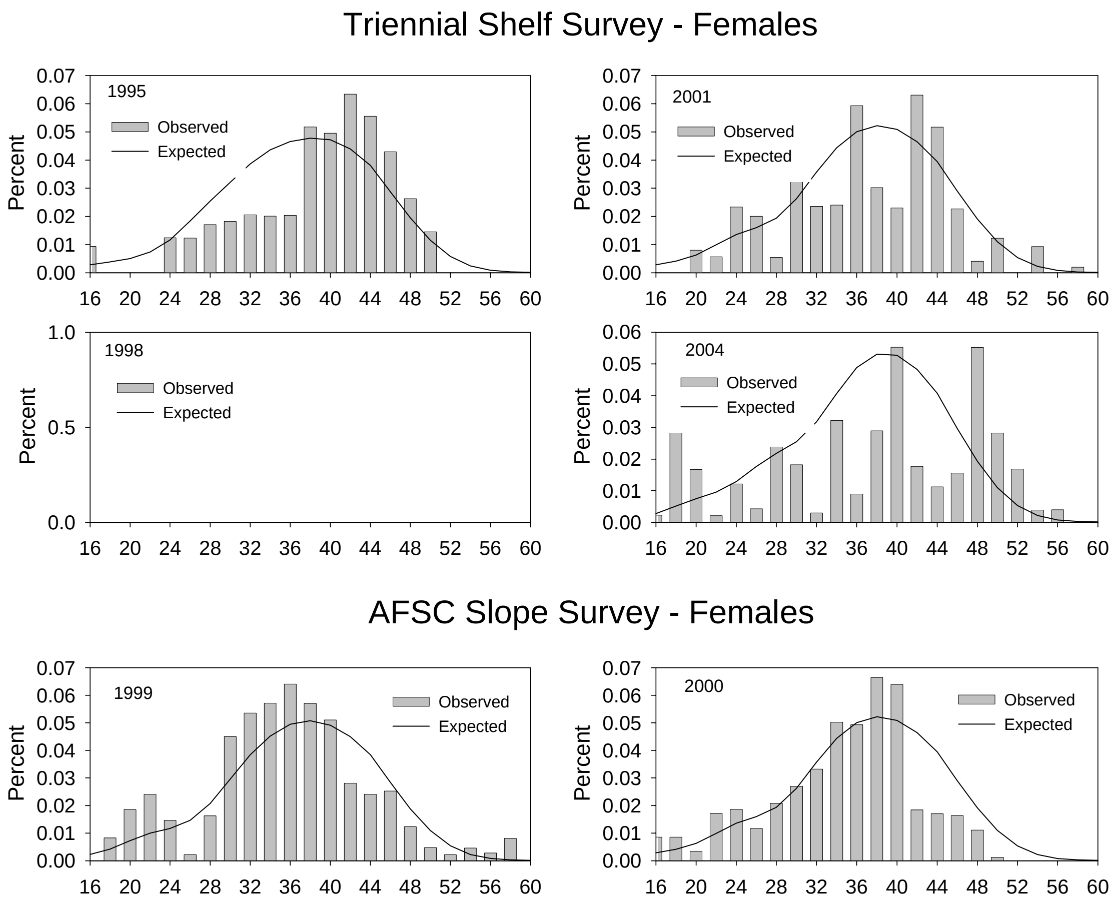
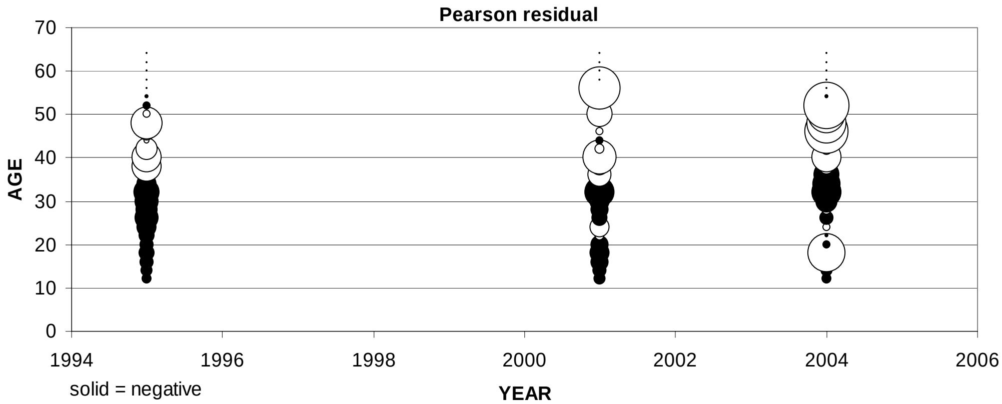


Figure 37 (continued). Predicted vs. observed fits to female blackgill rockfish length frequency compositions from the AFSC shelf, AFSC slope and NWFSC slope surveys..



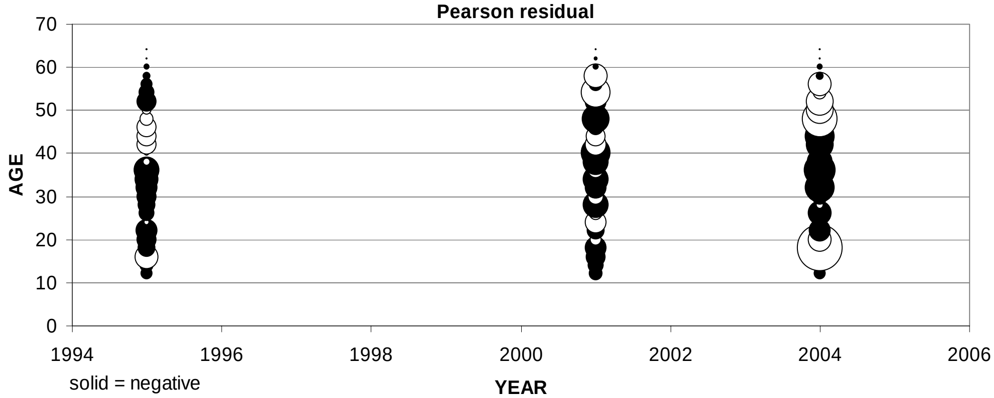


Figure 38. Diagrams showing Pearson residual plots (top: males, middle: females) and effective vs. observed sample sizes of fits to the hook and line length frequency compositions.

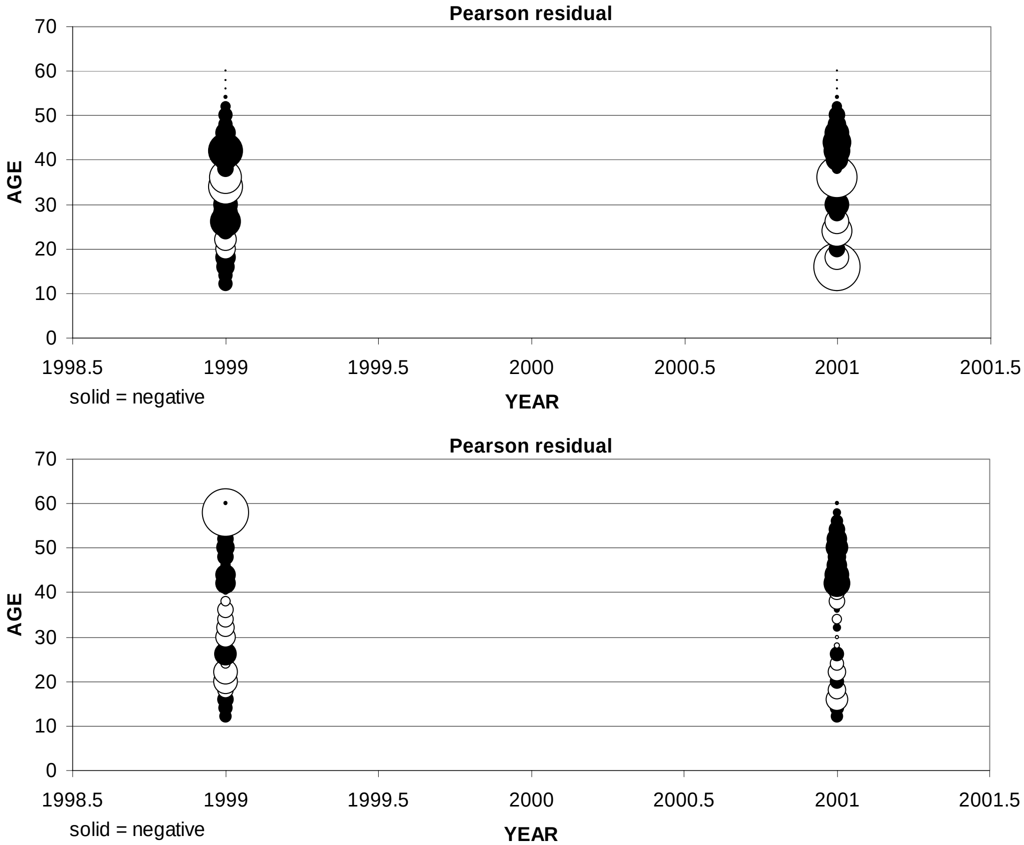


Figure 38 (continued). Diagrams showing Pearson residual plots (top: males, middle: females) and effective vs. observed sample sizes of fits to the hook and line length frequency compositions.

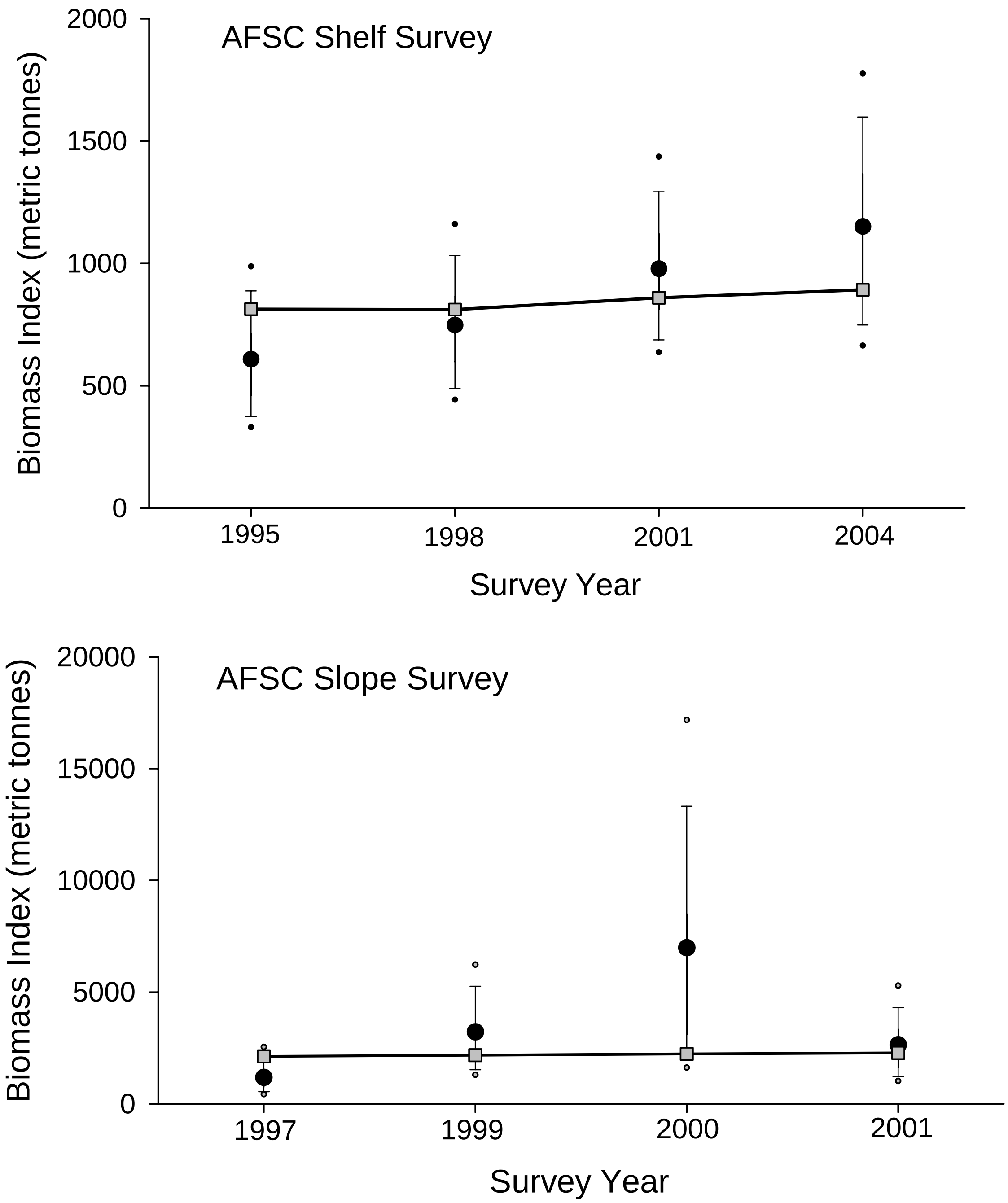
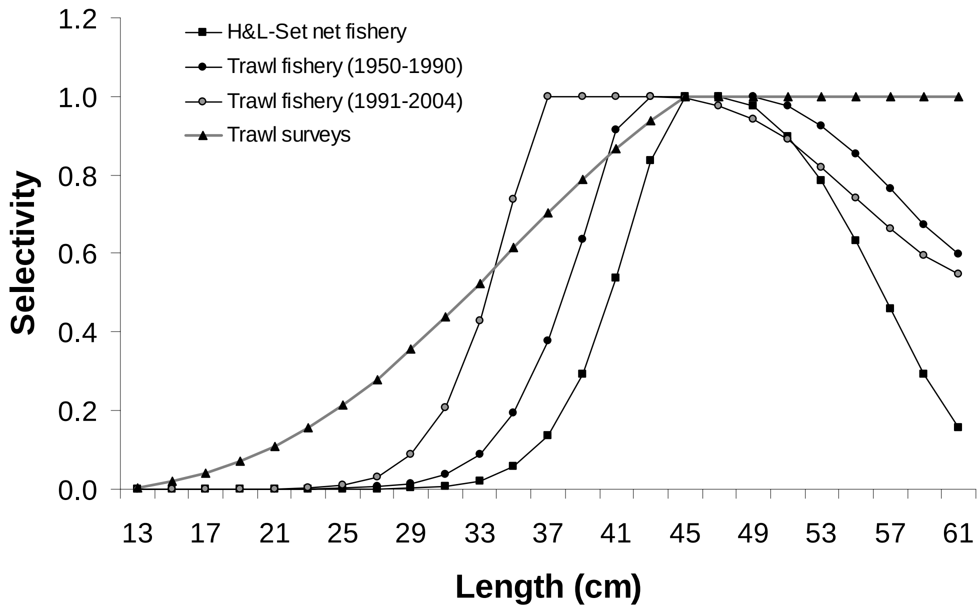


Figure 39. Predicted an observed biomass index for the AFSC shelf, AFSC slope and NWFSC slope trawl surveys. Point estimate along with 90% (bars) intervals are shown for the observed indices. . (Note: the 2004 shelf survey was conducted by NWFSC as a continuation of the AFSC survey).



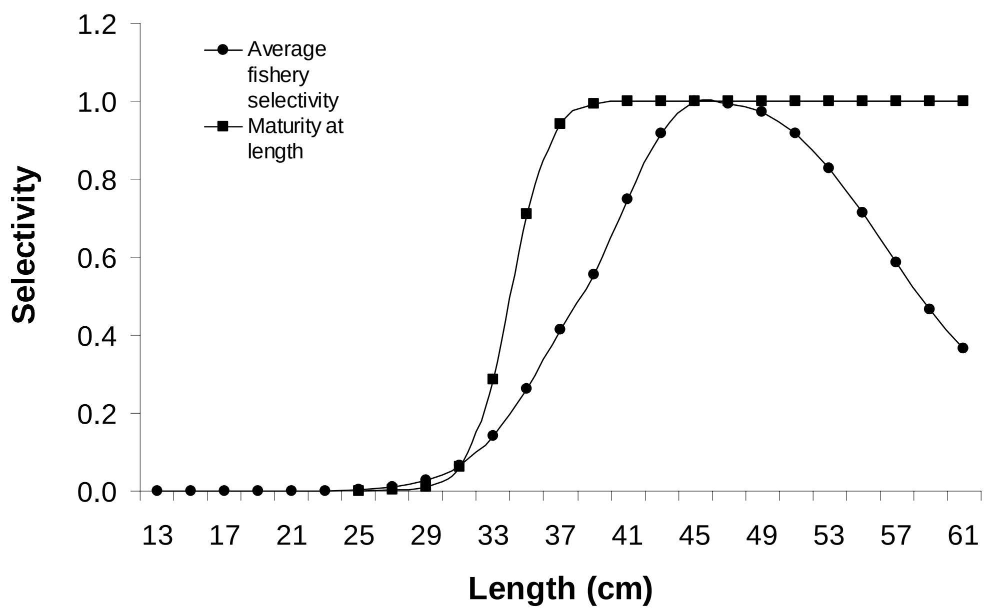


Figure 40. Predicted selectivity curves for the hook and line fishery and set net fishery (mirrored), trawl fishery (two blocks of time), and trawl surveys (all mirrored). Bottom panel shows the composite fishery selectivity (average selectivity curves weighted to fishery landings) relative to maturity at size.

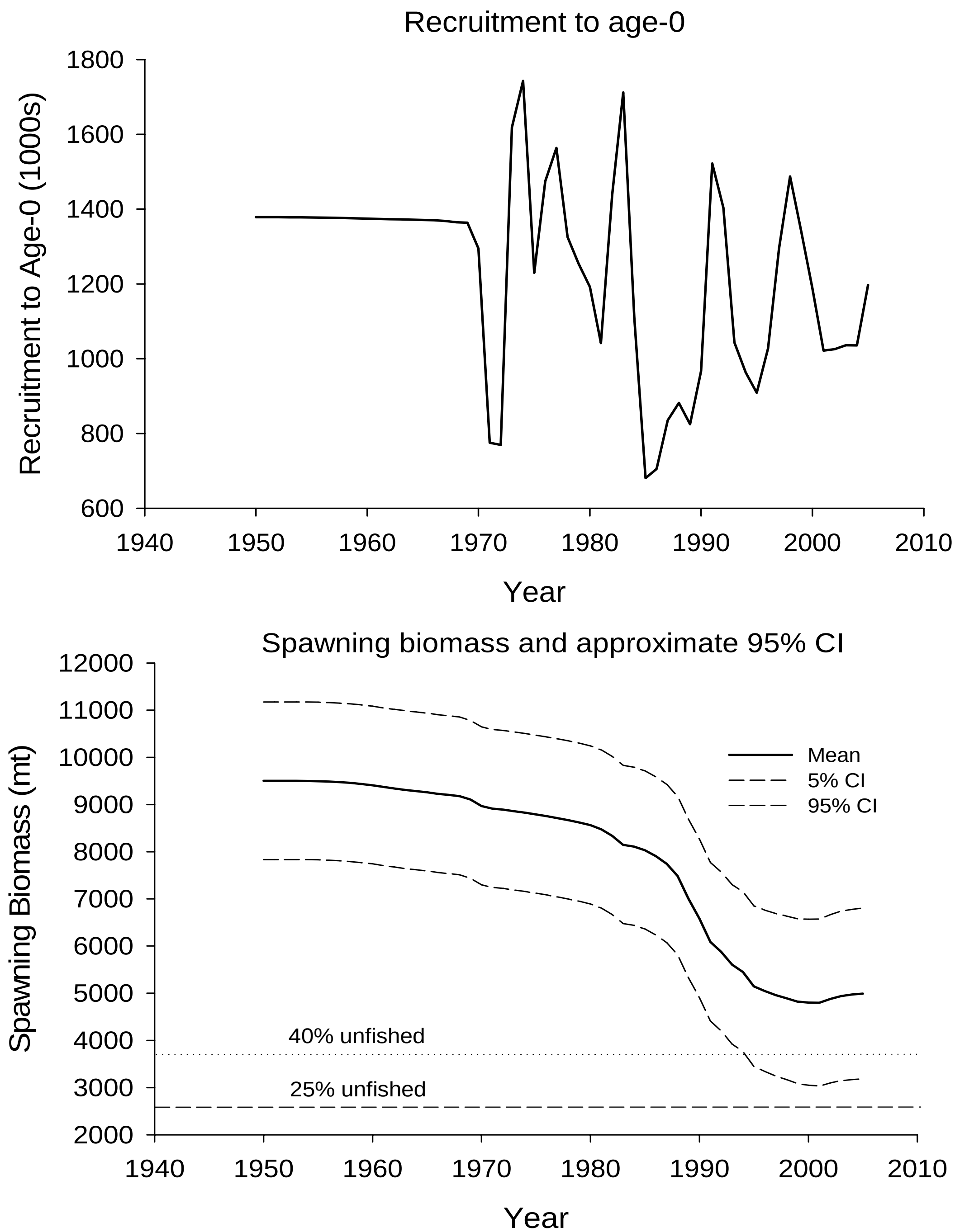


Figure 41. Historic reconstruction of age-0 recruitment and spawning stock biomass of blackgill rockfish estimated from the base case model. Approximate asymptotic 95% confidence intervals of spawning biomass are given.

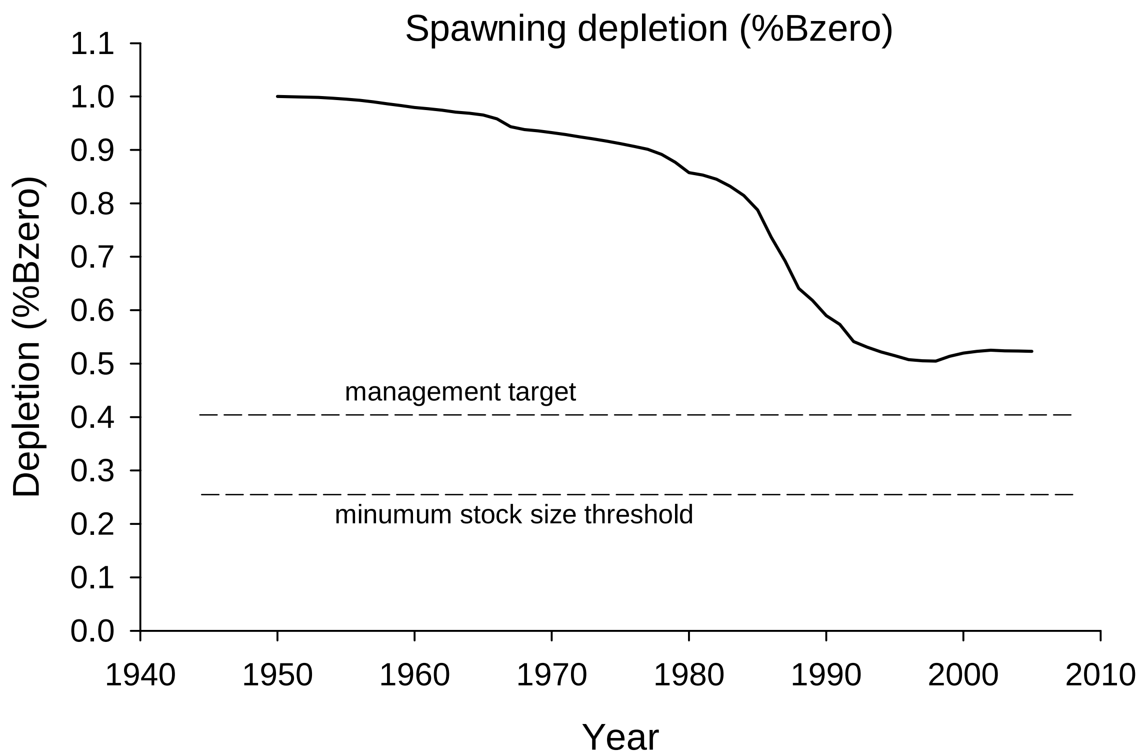


Figure 42. Historic depletion (spawning stock biomass as a percentage of unfished biomass) of blackgill rockfish relative to the B40% management target and minimum stock size threshold of 25% unfished.

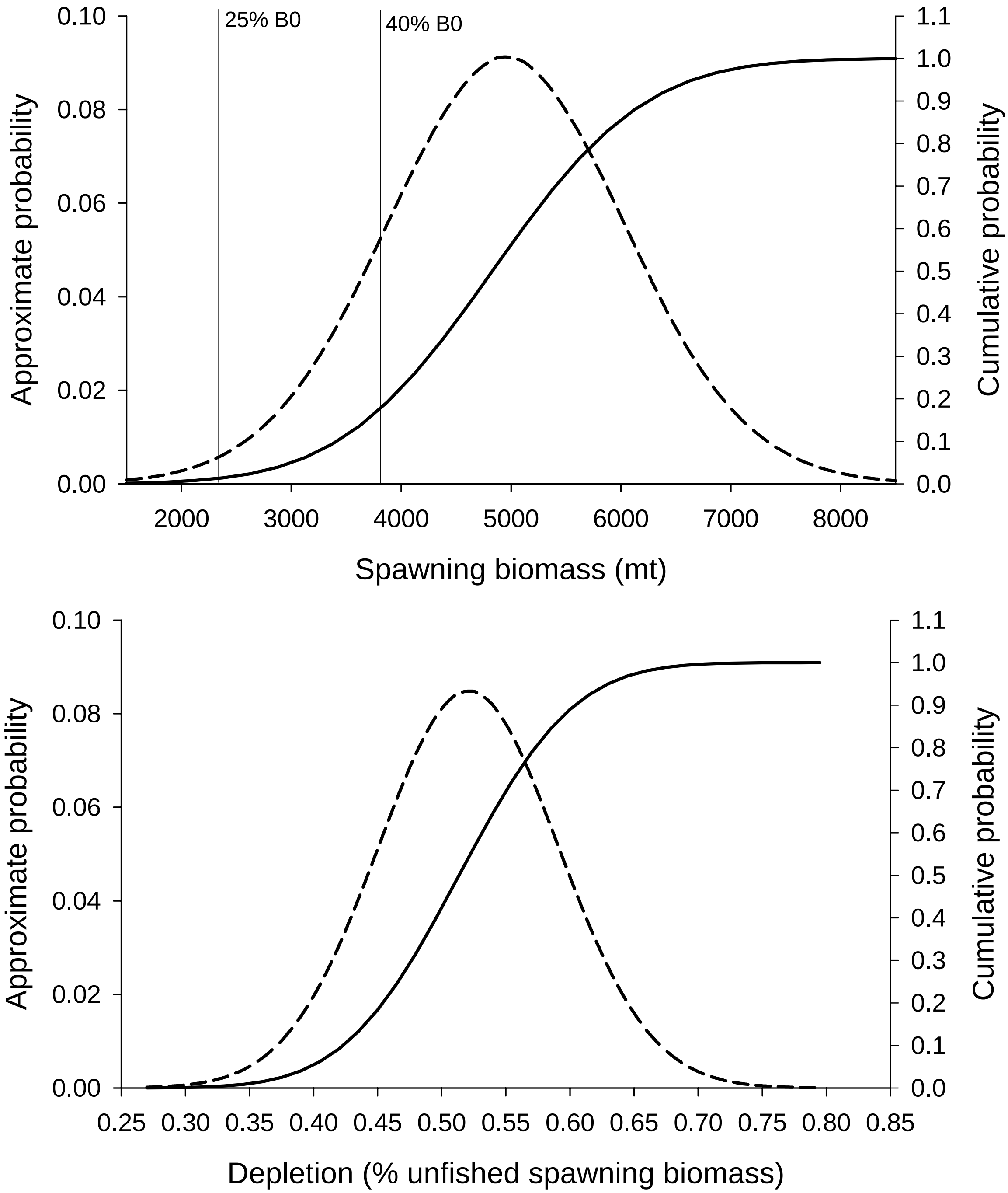


Figure 43. Uncertainty in 2005 spawning biomass and depletion level for Blackgill rockfish. Approximately probability and cumulative probability are based on asymptotic standard deviations.

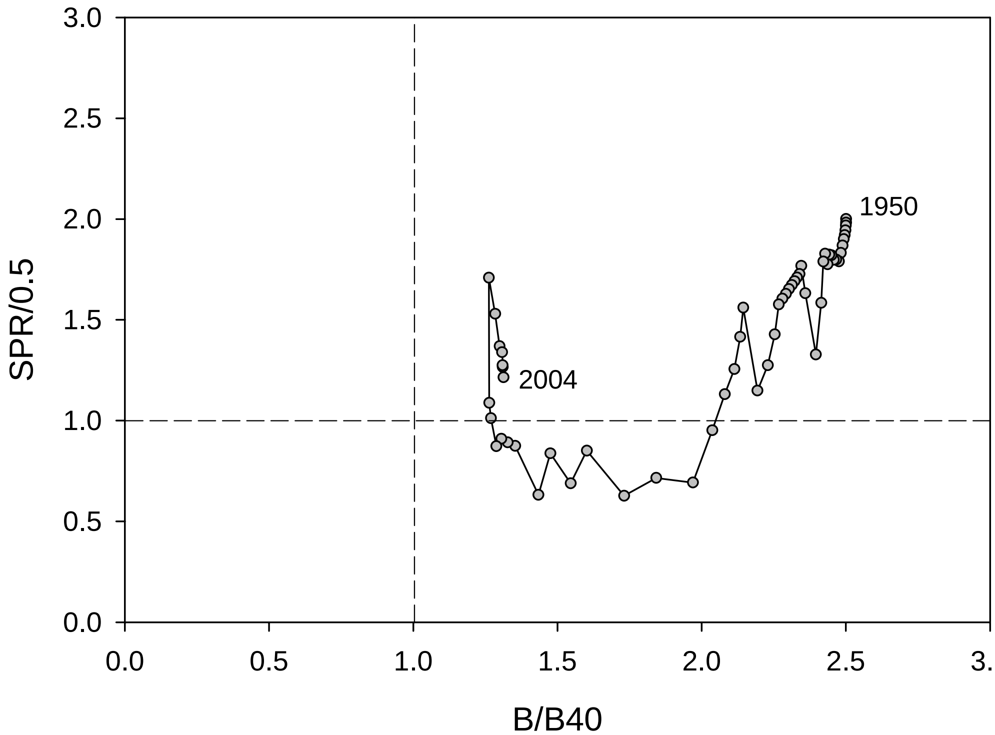


Figure 44. Annual status showing the calculated spawning potential ratio (SPR) and spawning biomass level (B) relative to their corresponding targets; F50% and B40%, respectively. Given life history parameters and long term exploitation patterns, the fishing mortality that reduces the spawning biomass to 50% of the unfished level is referred to as F50%, which is the default Pacific Fishery Management Council proxy for F_{MSY}. Similarly, the proxy for B_{MSY} is spawning biomass corresponding to 40% of an unfished stock.

APPENDIX

```
# 7.18.05 Draft SST Dat for Blackgill - Tom Helser

#	MODEL	DIMENSIONS

1950	#	start_year
2004	#	end_year
1	#	N_seasons_per_year
12	#	vector_with_N_months_in_each_season
1	#	spawning_season_-_spawning_will_occur_at_beginning_of_this_season
3	#	N_fishing_fleets
3	#	N_surveys;_data_type_numbers_below_must_be_sequential_with_the_N_fisheries
hk%setnet%Trawl%Triennial%AFSCslope%NWFSCslope

0.5	0.5	0.5	0.5	0.5	0.5

2	#	Number of genders
80	#	Number of ages

#	catch	(mt)	#Year
0	0	0	#	initial_equilibrium
73	89	0	#	1950	# 4.4% of CA rockfish landings
99	121	0	#	1951
96	118	0	#	1952
110	134	0	#	1953
114	139	0	#	1954
114	139	0	#	1955
128	157	0	#	1956
143	175	0	#	1957
160	196	0	#	1958
137	168	0	#	1959
123	151	0	#	1960
97	119	0	#	1961
88	108	0	#	1962
106	129	0	#	1963
73	89	0	#	1964
85	103	0	#	1965
91	111	70	#	1966	# add in Rogers Foreign catches
88	108	199	#	1967
70	86	56	#	1968
68	83	4	#	1969
81	99	1	#	1970	# Linear ramp up to CalCOM
104	127	0	#	1971
126	154	0	#	1972
149	182	0	#	1973
171	209	0	#	1974
194	237	0	#	1975
216	264	0	#	1976
239	292	0	#	1977
273	184	114	#	1978	# CalCOM with trawl discards
473	388	23	#	1979
538	198	86	#	1980
442	533	86	#	1981
620	622	99	#	1982
310	404	321	#	1983
217	334	72	#	1984
198	425	135	#	1985
340	354	283	#	1986
356	390	139	#	1987
319	491	232	#	1988
247	197	103	#	1989
339	117	238	#	1990
294	54	136	#	1991
493	136	160	#	1992
245	38	124	#	1993
245	10	127	#	1994
175	43	139	#	1995
200	9	167	#	1996
133	5	139	#	1997
```

```
111        2           123        #          1998
19         0           30         #          1999
32         0           57         #          2000
38         0           96         #          2001
75         1           67         #          2002
123        8           58         #          2003
64         2           102        #          2004

14      #       #_Abundance_Indices      #_N_observations
#       #Year   Seas    Type    Value   CV
#       #
# 1977   1      4       196    0.26#  Triennial  MON-CON 300-566 m
#1980    1      4       763    2.13    #  only to 34.5 degress
#1983    1      4       1177    2.53    #  1977-1992 excluded < 366 m
#1986    1      4        15    2.54
#1989    1      4        15    2.54
#1992    1      4        37    2.12
#1995    1      4        187    0.26
#1998    1      4        240    0.34
#2001    1      4        317    0.24
#2004    1      4        368    0.32
1995    1      4       587    0.35   # Triennial expanded to 32.5 degress
1998    1      4       714    0.31
2001    1      4       955    0.25
2004    1      4       1084    0.32
#1992       1             5            1069  0.98          #  AFSC slope  MON-CON 300-566 m
1997    1      5      1019        0.59    #  EXPANDED TO FULL CONCEPTION AREA 32.5
1999    1      5      2856        0.55    #  NOMIAL DIFFERENCES IN CATCH RATES
2000    1      5      5301        0.95
2001    1      5      2347        0.57
1999    1      6       448        1.79        #  NWFSC slope  Mon-Con 300-566 m
2000    1      6      1305        0.68    #  EXPANDED TO FULL CONCEPTION AREA 32.5
2001    1      6      1444        0.55    #  NOMIAL DIFFERENCES IN CATCH RATES
2002    1      6      3146        0.51
2003    1      6      1105        0.57
2004    1      6      3867        0.63

2       #       #_Discard_Biomass       #_(1=biomass;_2=fraction)
0       #       #_N_observations
#       #Year   Seas    Type    Value   CV
#1986    1      1       0.28    0.15
#1991    1      1       0.03    1
#1995    1      1       0.132   0.4
#1996    1      1       0.155   0.15
#1997    1      1       0.201   0.16
#1998    1      1       0.136   0.17
#1999    1      1       0.252   0.3
#       #WCGOP
#2002    1      1       0.1941  0.15
#2003    1      1       0.2116  0.15

#       "#_Mean_BodyWt: 1 = discard, 2 = retained, 0 = combined"
0       #       # number of observations - need to revisit
#       #Year   Seas    Type    Mkt     Value   CV
#2002    1      1       1       0.408   0.2
#2002    1      1       2       1.3258  0.2
#2003    1      1       1       0.4165  0.2
#2003    1      1       2       1.2018  0.2

-1      #       #min_proportion_for_compressing_tails_of_observed_composition frequencies
0.0001  #       #_constant      added   to      expected
25      #       #_N_length_bins
#       #_lower_edge_of_length_bins
12          14          16          18          20          22          24          26          28          30          32          34
            36          38          40          42          44          46          48          50          52          54          56
            58          60
46      #N_observations
#       #Year   Seas    Fleet   sexes   Mkt  Nsamp    data:

#       "# Fishery length comps"
```

1986	1	1	3	2	58	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000514	0.008742	0.016969	0.032396	0.058004	0.061089	0.099758
	0.134211	0.107600	0.035301	0.008227	0.001440	0.001234	0.000411	0.000000	0.000000	0.000000	0.000000
	0.000514	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000514	0.003600	0.017483	0.032910
	0.073430	0.111688	0.120173	0.057850	0.012650	0.002777	0.000000	0.000000	0.000000	0.000000	0.000000
1987	1	1	3	2	53	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.001692	0.004513	0.018052	0.045694	0.059008	0.077285	0.103179
	0.094040	0.076129	0.030519	0.010324	0.002821	0.000564	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002821	0.009026	0.021437	0.061490
	0.088906	0.107523	0.118918	0.053084	0.010154	0.002821	0.000000	0.000000	0.000000	0.000000	0.000000
1988	1	1	3	2	25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.001144	0.006863	0.019445	0.036603	0.066914	0.114384	0.129254
	0.074921	0.054904	0.018301	0.001144	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001144	0.003432	0.016014	0.040034	0.106091
	0.122963	0.087504	0.057764	0.027452	0.010295	0.002288	0.000000	0.000000	0.001144	0.000000	0.000000
1989	1	1	3	2	10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.010743	0.064458	0.007162	0.014324	0.035810	0.071620	0.061056	0.132856
	0.161146	0.082363	0.035810	0.010743	0.003581	0.000358	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003581	0.021486	0.007162	0.028648	0.050134
	0.057296	0.046553	0.042972	0.035810	0.014324	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1990	1	1	3	2	13	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.002759	0.001241	0.005517	0.019310	0.055172	0.088276	0.085517	0.100552
	0.107724	0.082345	0.044828	0.025655	0.002483	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005517	0.027586	0.072966
	0.099034	0.104552	0.024828	0.033103	0.008276	0.002759	0.000000	0.000000	0.000000	0.000000	0.000000
1992	1	1	3	2	7	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.016721	0.008182	0.074110	0.064753	0.077792	0.125226	0.083519
	0.036168	0.041266	0.006409	0.005455	0.002727	0.001909	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.024902	0.004500	0.101467
	0.145544	0.070993	0.053266	0.035727	0.013364	0.004500	0.000000	0.000000	0.000000	0.000000	0.000000
1995	1	1	3	2	2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.030769	0.123077	0.030769	0.138462	0.061538	0.076923
	0.153846	0.107692	0.092308	0.015385	0.030769	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.015385	0.015385	0.015385	0.030769
	0.015385	0.000000	0.030769	0.015385	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1997	1	1	3	2	3	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.011357	0.068143	0.136286	0.079500	0.113572	0.170358	0.136286
	0.056786	0.000000	0.000000	0.000000	0.000568	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.034072	0.068143	0.045429	0.022714
	0.011357	0.045429	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2001	1	1	3	2	4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000950	0.018993	0.030389	0.030389	0.030389
	0.037987	0.000000	0.037987	0.030389	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018993	0.075973	0.083571
	0.068376	0.208927	0.140551	0.148148	0.037987	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2002	1	1	3	2	4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.003745	0.000000	0.003745	0.003745	0.021402	0.078652	0.064205	0.032103	0.010701	0.042804
	0.000000	0.032103	0.021402	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.010701	0.000000	0.000000	0.000000	0.078652	0.125201	0.085607
	0.128411	0.128411	0.085607	0.042804	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1986	1	2	3	2	53	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000821	0.006421	0.018779	0.034310	0.058428	0.093448	0.121972
	0.135299	0.054882	0.006421	0.003883	0.000075	0.000000	0.000747	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000747	0.001717	0.004741	0.021467	0.068695
	0.112899	0.120739	0.099085	0.029158	0.003547	0.000747	0.000000	0.000224	0.000000	0.000000	0.000747
1987	1	2	3	2	33	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.001168	0.000000	0.000000	0.002846	0.007298	0.017952	0.039407	0.059695	0.101219	0.100343
	0.091513	0.085529	0.022550	0.007809	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005838	0.010655	0.027804	0.068160
	0.097643	0.108516	0.072101	0.055462	0.014376	0.002116	0.000000	0.000000	0.000000	0.000000	0.000000
1988	1	2	3	2	13	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.004865	0.019404	0.051126	0.079696	0.097986	0.091482
	0.086321	0.049759	0.029127	0.003641	0.002488	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002438	0.006068	0.050080	0.093756
	0.128798	0.103326	0.053521	0.019418	0.016991	0.006068	0.002427	0.000000	0.000000	0.001214	0.000000
1989	1	2	3	2	25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.006212	0.012566	0.063965	0.111814	0.206554	0.115861
	0.088564	0.031876	0.012424	0.000000	0.000000	0.000000	0.000000	0.000178	0.000000	0.000000	0.000000

	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012424	0.024848	0.072058	0.101875
	0.068792	0.062119	0.006522	0.001065	0.000000	0.000284	0.000000	0.000000	0.000000	0.000000	0.000000
1990	1	2	3	2	2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000220	0.026878	0.007070	0.032456	0.104121	0.089124
	0.088398	0.062442	0.035188	0.005683	0.008872	0.000049	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001044	0.000000	0.005488	0.050674
	0.176340	0.196107	0.089556	0.010438	0.005219	0.000000	0.000000	0.000196	0.004436	0.000000	0.000000
1982	1	3	3	2	14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.006123	0.020206	0.039187	0.073476	0.108989	0.110214	0.130420
	0.061230	0.034901	0.008572	0.012246	0.007960	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.020206	0.087559	0.090620
	0.115783	0.034901	0.037350	0.000000	0.000000	0.000058	0.000000	0.000000	0.000000	0.000000	0.000000
1983	1	3	3	2	44	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000296	0.000000	0.011852	0.017481	0.024468	0.050961	0.055263	0.074072	0.075706
	0.025096	0.017812	0.015214	0.010281	0.000069	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005926	0.010666	0.020148	0.065583	0.158218
	0.183017	0.130070	0.037367	0.004301	0.003852	0.000000	0.001778	0.000296	0.000207	0.000000	0.000000
1984	1	3	3	2	41	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000966	0.000000	0.000000	0.005248	0.025948	0.024718	0.055538	0.051877	0.044358	0.054864
	0.060521	0.030367	0.036243	0.047522	0.005976	0.002379	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012537	0.017201	0.038183	0.080311
	0.134710	0.138127	0.077715	0.045910	0.007719	0.001014	0.000048	0.000000	0.000000	0.000000	0.000000
1985	1	3	3	2	89	0.000000	0.000000	0.000000	0.000000	0.000000	0.000093
	0.000000	0.000000	0.000683	0.003241	0.019205	0.028541	0.031167	0.034904	0.063372	0.065532	0.088112
	0.074176	0.042153	0.026975	0.013829	0.001604	0.002033	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003889	0.004109	0.014789	0.045982	0.105139
	0.144192	0.106066	0.051808	0.013890	0.006254	0.002969	0.002330	0.000000	0.000000	0.000000	0.000000
1986	1	3	3	2	78	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.001959	0.011498	0.019333	0.019142	0.012726	0.040543	0.053831	0.052603	0.071638	0.095996
	0.075541	0.046560	0.034136	0.009361	0.009931	0.003919	0.000000	0.001448	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000784	0.004856	0.016766	0.036322	0.083104
	0.133161	0.085190	0.041908	0.029721	0.004737	0.002811	0.000085	0.000392	0.000000	0.000000	0.000000
1987	1	3	3	2	44	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.002874	0.001916	0.005269	0.001198	0.009820	0.017546	0.009858	0.020150	0.061111	0.079947	0.083526
	0.107024	0.061832	0.024728	0.031103	0.014300	0.009288	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.004236	0.003220	0.011263	0.030713	0.027822	0.085454
	0.086050	0.096906	0.057304	0.028154	0.018288	0.004706	0.004393	0.000000	0.000000	0.000000	0.000000
1988	1	3	3	2	46	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000186	0.006145	0.010087	0.022969	0.076881	0.064049	0.061718	0.099646	0.075469
	0.025026	0.009962	0.010742	0.001571	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000275	0.000000	0.004433	0.024154	0.089851	0.106313
	0.152976	0.101325	0.035697	0.013075	0.003724	0.000000	0.000000	0.000000	0.000000	0.003724	0.000000
1989	1	3	3	2	40	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.006180	0.011599	0.021809	0.035081	0.039074	0.100548	0.042136	0.103305	0.025004
	0.040158	0.016714	0.027742	0.023730	0.023730	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.020783	0.015116	0.001407	0.032933	0.025232	0.033028
	0.113591	0.090660	0.073832	0.043048	0.025555	0.008005	0.000000	0.000000	0.000000	0.000000	0.000000
1990	1	3	3	2	36	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000194	0.010828	0.000388	0.045502	0.061693	0.097460	0.095508	0.071051	0.038981
	0.017685	0.012697	0.026669	0.015301	0.010549	0.004051	0.004051	0.004557	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007511	0.020508	0.020478	0.082081	0.113560
	0.059214	0.093665	0.064101	0.012963	0.006220	0.002532	0.000000	0.000000	0.000000	0.000000	0.000000
1991	1	3	3	2	70	0.000000	0.000000	0.000000	0.000000	0.000000	0.001473
	0.000000	0.001622	0.000177	0.019016	0.044840	0.067261	0.078979	0.108232	0.074788	0.074285	0.044829
	0.027175	0.010610	0.003392	0.004333	0.001915	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.002800	0.005541	0.036846	0.056258	0.065629	0.111021
	0.088676	0.038080	0.018337	0.008669	0.002210	0.001473	0.000059	0.001473	0.000000	0.000000	0.000000
1992	1	3	3	2	24	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.002974	0.036861	0.031087	0.040956	0.064482	0.078342	0.066464	0.054746
	0.023407	0.008323	0.011508	0.003407	0.002592	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.002176	0.010277	0.034968	0.080177	0.110457	0.164539
	0.117217	0.032431	0.017916	0.003657	0.000222	0.000815	0.000000	0.000000	0.000000	0.000000	0.000000
1993	1	3	3	2	28	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.001801	0.018913	0.030348	0.063360	0.083139	0.080946	0.065938	0.055512	0.028642
	0.019633	0.008284	0.004706	0.003602	0.008307	0.000000	0.001801	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.001946	0.000450	0.011212	0.066155	0.081797	0.099793	0.104627
	0.081866	0.053854	0.013463	0.005403	0.002701	0.001801	0.000000	0.000000	0.000000	0.000000	0.000000
1994	1	3	3	2	17	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.006052	0.016754	0.040938	0.067278	0.075430	0.061744	0.056407	0.070243	0.021940
	0.039729	0.043880	0.014975	0.022185	0.000245	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

0.000000 0.000000 0.000000 0.000000 0.000296 0.005930 0.005930 0.091393 0.046402 0.086131 0.089614
0.079778 0.032340 0.018457 0.005930 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
1995 1 3 3 2 26 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000685 0.004009 0.005867 0.016915 0.053932 0.050511 0.067100 0.058172 0.051238 0.055052 0.059546
0.060091 0.012899 0.005867 0.005180 0.006158 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000685 0.008508 0.014666 0.052245 0.084322 0.093667 0.072142
0.073153 0.043593 0.038615 0.005180 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
1996 1 3 3 2 43 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.007826 0.009626 0.046738 0.055456 0.066009 0.055991 0.049633 0.052359 0.048749
0.059144 0.030187 0.019554 0.009992 0.004696 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000 0.002035 0.012734 0.032916 0.093378 0.094449 0.078335
0.093594 0.044665 0.024966 0.006731 0.000000 0.000000 0.000235 0.000000 0.000000 0.000000 0.000000
1997 1 3 3 2 35 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.004385 0.005846 0.049863 0.093221 0.070725 0.087630 0.075832 0.064606 0.040323
0.026659 0.005440 0.004159 0.002908 0.000000 0.000000 0.002064 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000 0.007488 0.020016 0.065560 0.082222 0.112742 0.086683
0.053062 0.022628 0.009309 0.004471 0.001876 0.000281 0.000000 0.000000 0.000000 0.000000 0.000000
1998 1 3 3 2 31 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.011019 0.022929 0.056567 0.086037 0.071528 0.058040 0.053668 0.075229
0.043271 0.012471 0.012993 0.004692 0.006595 0.002947 0.000000 0.001574 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.001574 0.000000 0.011089 0.042503 0.087892 0.080678 0.092440
0.090423 0.045805 0.020294 0.007529 0.000140 0.000070 0.000000 0.000000 0.000000 0.000000 0.000000
1999 1 3 3 2 20 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.002591 0.013601 0.020406 0.065765 0.053718 0.087518 0.045149 0.038051 0.046124
0.041996 0.012717 0.027248 0.005440 0.009349 0.002591 0.002591 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000130 0.002591 0.007772 0.031266 0.070461 0.109799 0.087792
0.087573 0.060487 0.035737 0.028849 0.002689 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
2000 1 3 3 2 21 0.000000 0.000000 0.000000 0.000000 0.000000 0.000290
0.000000 0.002902 0.000000 0.007033 0.050199 0.053490 0.079396 0.080847 0.035546 0.020892 0.017440
0.018136 0.011607 0.020312 0.011607 0.005223 0.002466 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.002902 0.000580 0.002902 0.017555 0.040368 0.068335 0.089262 0.113376
0.092263 0.081171 0.043625 0.012687 0.005983 0.008705 0.002902 0.000000 0.000000 0.000000 0.000000
2001 1 3 3 2 23 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000812 0.005955 0.006226 0.028963 0.097446 0.086889 0.050618 0.046319 0.045204 0.031160
0.035189 0.042768 0.020843 0.000000 0.000000 0.000000 0.005414 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.003248 0.016241 0.035189 0.065235 0.110741 0.105296 0.050347
0.018677 0.056031 0.016241 0.018948 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
2002 1 3 3 2 39 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.008894 0.017358 0.032420 0.051786 0.073160 0.116052 0.075169 0.064266 0.041314 0.024817
0.014919 0.011620 0.020083 0.006742 0.002295 0.001148 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.001291 0.000000 0.004877 0.028116 0.035719 0.076173 0.077033 0.086932
0.038588 0.039449 0.025104 0.016784 0.001004 0.001148 0.000000 0.002439 0.000000 0.003299 0.000000
2003 1 3 3 2 23 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000194 0.014571 0.033611 0.064156 0.053234 0.062423 0.043939 0.048960 0.042743
0.033223 0.036331 0.026617 0.003886 0.002720 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.002526 0.024522 0.049737 0.102114 0.116103
0.098891 0.064309 0.056926 0.011074 0.000000 0.003886 0.000000 0.000000 0.000000 0.003303 0.000000
2004 1 3 3 2 14 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.024298 0.026728 0.045559 0.015794 0.096178 0.031452 0.022948 0.098408 0.018695
0.048596 0.050419 0.060745 0.015186 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000 0.024298 0.021868 0.023083 0.057573 0.061353 0.051498
0.099015 0.072287 0.034017 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

Triennial length comps 55-366 meters

1995 1 4 3 0 23 0.000000 0.000000 0.009354 0.000000 0.000000 0.000000
0.012431 0.012298 0.017041 0.018189 0.020540 0.020163 0.020354 0.051912 0.049686 0.063634 0.055782
0.043033 0.026344 0.014498 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.001980 0.001980 0.001831 0.000000 0.007857 0.012312 0.012802 0.036551 0.069535 0.134903
0.129317 0.076910 0.031503 0.022969 0.022461 0.001831 0.000000 0.000000 0.000000 0.000000 0.000000
1998 1 4 3 0 29 0.000000 0.005197 0.000615 0.000000 0.001837 0.001472
0.002166 0.004465 0.005728 0.010566 0.011516 0.038320 0.021646 0.046885 0.022591 0.087676 0.053200
0.030796 0.024518 0.013986 0.007911 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000615 0.003689 0.003235 0.003235 0.001230 0.001845 0.001251 0.041322 0.031380 0.066305 0.161816
0.145305 0.064457 0.065787 0.016249 0.001191 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
2001 1 4 3 0 42 0.000000 0.000000 0.000000 0.000000 0.007979 0.005591
0.023381 0.020083 0.005344 0.033071 0.023545 0.024046 0.059499 0.030282 0.023017 0.063323 0.051831
0.022660 0.003948 0.012250 0.000000 0.009263 0.000000 0.001882 0.000000 0.000000 0.000000 0.000000
0.000000 0.000981 0.011314 0.023986 0.012063 0.013167 0.019103 0.011617 0.057703 0.099626 0.091868
0.127349 0.054792 0.027811 0.014362 0.004459 0.005416 0.000000 0.000000 0.003390 0.000000 0.000000

```
2004    1         4         3         0         28        0.000000 0.000000 0.002202 0.033524 0.016644 0.001994
        0.012088 0.004219 0.023836 0.018153 0.002884 0.032244 0.008872 0.028948 0.055485 0.017668 0.011176
        0.015506 0.055438 0.028244 0.016802 0.003795 0.003889 0.000000 0.000000 0.000000 0.000000 0.000000
        0.028944 0.006300 0.009316 0.014371 0.012448 0.028256 0.014708 0.003922 0.014124 0.028935 0.093591
        0.123620 0.058355 0.057188 0.063718 0.028306 0.011914 0.008374 0.000000 0.000000 0.000000 0.000000

#   "# AFSC slope survey data"

1999    1         5         3         0         21        0.000000 0.000000 0.000000 0.008204 0.018519 0.024165
        0.014597 0.002101 0.016283 0.045135 0.053721 0.057366 0.064350 0.057262 0.051235 0.028153 0.024179
        0.025299 0.012342 0.004588 0.002094 0.004578 0.002723 0.008004 0.000000 0.000000 0.000000 0.000000
        0.000000 0.011859 0.018165 0.009045 0.000000 0.008439 0.016165 0.038710 0.105385 0.114901 0.063802
        0.046880 0.010542 0.023099 0.006009 0.002101 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
2001    1         5         3         0         23        0.000000 0.000000 0.008491 0.008491 0.003397 0.017120
        0.018636 0.011626 0.020828 0.027015 0.033347 0.050373 0.049466 0.066692 0.064205 0.018438 0.016993
        0.016339 0.011113 0.001175 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.001698 0.019170
        0.010091 0.003298 0.010819 0.029326 0.030961 0.017453 0.016770 0.043595 0.069976 0.136542 0.071020
        0.050669 0.029905 0.010645 0.002893 0.001422 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000

#   " NWFSC survey length comps"

2003    1         6         3         0         13        0.000000 0.000000 0.000000 0.000000 0.000000 0.048155
        0.041185 0.082092 0.000000 0.031731 0.000000 0.054938 0.050378 0.008697 0.028554 0.009907 0.008639
        0.018353 0.009907 0.019814 0.009176 0.000000 0.009176 0.000000 0.000000 0.000000 0.000000 0.000000
        0.009176 0.000000 0.009176 0.078663 0.164504 0.041185 0.000000 0.040370 0.018604 0.035546 0.060880
        0.036521 0.027050 0.037714 0.000000 0.009907 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
2004    1         6         3         0         13        0.000000 0.002238 0.020136 0.047371 0.091683 0.031347
        0.003843 0.035473 0.027994 0.026294 0.021726 0.014773 0.019693 0.024091 0.017216 0.016330 0.014113
        0.014113 0.007226 0.009193 0.007191 0.001957 0.000000 0.000000 0.000000 0.002238 0.000000 0.020136
        0.054531 0.098634 0.021478 0.034299 0.022847 0.039643 0.029983 0.025996 0.034586 0.050769 0.055274
        0.019610 0.011714 0.019196 0.001957 0.000000 0.000000 0.003106 0.000000 0.000000 0.000000 0.000000


0       #   #_N_age'_bins
0   #   #_number_of_ageerr_types
0   #   #_N_age_observations
0   #   #_N_size@age_observations;_values_on_row1;_N_on_row2
0   #   #_environmental_data   N_variables
0   #   #_environmental_data   N_observations
999  #   #end   of   file
```

```
#  sst.ctl 6.2.2005 BLACKGILL ROCKFISH
2       # _N_growthmorphs

# assign_sex_to each_morph_(1=female;_2=male)
1       # Females
2       # Males

1       # N_Areas_(populations)

# each_fleet/survey_operates_in_just_one_area
# but_different_fleets/surveys_can be assigned_to_share_same_selex(FUTURE_coding)
1     # Fishery 1 - hook and line
1     # Fishery 2 - set net
1     # Fishery 3 - trawl
1     # Triennial survey
1     # AFSC slope survey
1     # NWFSC slope survey

0       # do_migration_(0/1)

1       # N_Block_Designs
1       # N_Blocks_per_Design(Block_1_always_starts_in_styr)
1990    2004    # block design 1

# Natural_mortality_and_growth_parameters_for_each_morph

20      # Last age for M young
40      # First age for M old
2       # Age for growth Lmin
70      # Age for growth Lmax
-4      # Mortality and growth parameter deviance phase
#      LO      HI      INIT    PRIOR   PR_type SD      PHASE   env-variable  use_dev   dev_minyr      dev_maxyr      dev_stddev
       0.03    0.08    0.05    0.05    0       0.15    -3      0       0       0       0       0.5     0       0       # F_natM_young
       -3      3       0       0       0       0.2     -3      0       0       0       0       0.5     0       0       # F_natM_old_as_exponential_offset(rel_young)
       8       16      12      9       0       2       -2      0       0       0       0       0.5     0       0       # F_Lmin
       32      72      53      53      0       5       -2      0       0       0       0       0.5     0       0       # F_Lmax
       0.01    0.1     0.04    0.08    0       0.8     -2      0       0       0       0       0.5     0       0       # F_VBK
       0.02    0.16    0.08    0.1     0       0.8     -3      0       0       0       0       0.5     0       0       # F_CV-young
       -3      3       0       0       0       0.8     -3      0       0       0       0       0.5     0       0       # F_CV-
old_as_exponential_offset(rel_young)
       -3      3       0       0       0       0.8     -3      0       0       0       0       0.5     0       0       #
M_natM_young_as_exponential_offset(rel_morph_1)
       -3      3       0       0       0       0.8     -3      0       0       0       0       0.5     0       0       #
M_natM_old_as_exponential_offset(rel_young)
       -3      3       0       0       0       0.8     -3      0       0       0       0       0.5     0       0       # M_Lmin_as_exponential_offset
       -3      3       -0.2015 -.1     0       0.8     -2      0       0       0       0       0.5     0       0       # M_Lmax_as_exponential_offset
       -3      3       0.5306  0       0       0.8     -3      0       0       0       0       0.5     0       0       #M_VBK_as_exponential_offset
       -3      3       0.      0       0       0.8     -3      0       0       0       0       0.5     0       0       #M_CV-young_as_exponential_offset(rel_CV-
young_for_morph_1)
       -3      3       0       0.      0       0.8     -3      0       0       0       0       0.5     0       0       #M_CV-old_as_exponential_offset(rel_CV-
young)

# Add 2+2*gender lines to read the wt-Len and mat-Len parameters
       -3      3       1.01E-05 1.01E-05 0     0.8     -3      0       0       0       0       0.5     0       0       #Female wt-len-1
       -3      3       3.120   3.120   0       0.8     -3      0       0       0       0       0.5     0       0       #Female wt-len-2
       -3      3       34.0    22      0       0.8     -3      0       0       0       0       0.5     0       0       #Female mat-len-1
       -3      3       -0.87   -0.4    0       0.8     -3      0       0       0       0       0.5     0       0       #Female mat-len-2
       -3      3       1.      1.      0       0.8     -3      0       0       0       0       0.5     0       0       #Female eggs/gm intercept
       -3      3       0.      0.      0       0.8     -3      0       0       0       0       0.5     0       0       #Female eggs/gm slope
       -3      3       1.01E-05 1.01E-05 0     0.8     -3      0       0       0       0       0.5     0       0       #Male wt-len-1
       -3      3       3.120   3.120   0       0.8     -3      0       0       0       0       0.5     0       0       #Male wt-len-2

# pop*gmorph lines For the proportion of each morph in each area
0       1       0.5     0.2     0       9.8     -3      0       0       0       0       0.5     0       0 # frac to morph 1 in area 1

0       1       0.5     0.2     0       9.8     -3      0       0       0       0       0.5     0       0

# pop lines For the proportion assigned to each area
0       1       1       1       0       0.8     -3      0       0       0       0       0.5     0       0       #frac to area 1
```

```
#_custom-env_read
0      #_      0=read_one_setup_and_apply_to_all_env_fxns; #1=read_a_setup_line_for_each_MGparm_with_Env-var>0

#_custom-block_read
0      #_      0=read_one_setup_and_apply_to_all_MG-blocks;    #1=read_a_setup_line_for_each_block x MGparm_with_block>0

#      LO      HI      INIT    PRIOR   Pr_type SD      PHASE

#_Spawner-Recruitment_parameters
1      # SR_fxn:  1=Beverton-Holt
#LO    HI      INIT    PRIOR   Pr_type SD      PHASE
3      31      10.1    15.0    0       50      1      #Ln(R0)
0.2    1       0.65    0.5     0       99      -2     #steepness
0      2       0.5     0.5     0       0.8     -4     #SD_recruitments
-5     5       0       0       0       1       -3     #Env_link
-5     5       0       0       0       1       -4     #init_eq
0      #env-var_for_link
#      recruitment_residuals
#      start_rec_year  end_rec_year    Lower_limit     Upper_limit     phase
       1970    2004    -15     15      4

#init_F_setupforeachfleet
#LO    HI      INIT    PRIOR   PR_type SD      PHASE
0      1       0.00    0.01    0       99      -1  # Hook and Line fishery
0      1       0.00    0.01    0       99      -1  # Setnet fishery
0      1       0.00    0.01    0       99      -1  # Trawl fishery

#_Qsetup
#_add_parm_row_for_each_positive_entry_below(row_then_column)
#-Float(0/1)    #Do-power(0/1)  #Do-env(0/1)    #Do-dev(0/1)  #env-Var  #Num/Bio(0/1)   for     each    fleet   and     survey
0      0       0       0       0       1
0      0       0       0       0       1
0      0       0       0       0       1
1      0       0       0       0       1
1      0       0       0       0       1
1      0       0       0       0       1

#LO    HI      INIT    PRIOR   PR_type SD      PHASE   env-variable
-5     3       -1.0    -.5     0       2       1       # Q for triennial survey
-4     2       -1.0    -.5     0       2       1       # Q for AFSC slope survey
-4     2       -1.0    -.5     0       2       1       # Q for NWFSC slope survey

#_SELEX_&_RETENTION_PARAMETERS
#Pattern        Retention(0/1)  Male(0/1)   mirror(fishery/survey to equal)
# Size_selex
7      0       0       0       #_Hook and Line
5      0       0       1       #_Set net
7           0            0             0             #_Trawl
7      0       0       0       #_Triennial
5      0       0       4       #_AFSC Slope survey
5      0       0       4       #_NWFSC Slope survey

#_Age_selex
10     0       0       0       #_Trawl
10          0            0             0             #_Hook and Line
10     0       0       0  #_Trawl
10     0       0       0       #_Triennial
10     0       0       0       #_AFSC Slope survey
10     0       0       0       #_NWFSC Slope survey

#LO    HI      INIT    PRIOR   PR_type SD      PHASE   env-variable    use_dev dev_minyr       dev_maxyr       dev_stddev
Block_Pattern
#Size-Selectivity for Hook and Line fishery (double logistic)
20          80      45      40      0       99      2       0       0       0       0       0.5     0       0       #peak
0.0000  0.1     0.0     0       0       99      -2      0       0       0       0       0.5     0       0       #init
-10.    50.     1.9     1.0     0       99      4       0       0       0       0       0.5     0       0       #infl
0.0     10      0.3     0.3     0       99      -4      0       0       0       0       0.5     0       0  #slope1
-10     100     -7.0    9       0       99      3       0       0       0       0       0.5     0       0       #final
-10.    5       0.0     0.1     0       99      -4      0       0       0       0       0.5     0       0       #infl2
0.00001 10      0.3     .3      0       99      -3      0       0       0       0       0.5     0       0       #slope2
```

```
0.   25   4   4   0   99   -2   0   0   0   0   0.5   0   0   #width of top

#Size-Selectivity for set net fishery (double logistic)
#20   80   45   40   0   99   3   0   0   0   0   0.5   0   0   #peak
#0.0000  0.1   0.0  0   0   99   -2   0   0   0   0   0.5   0   0   #init
#-10.   50.   2.2   1.0   0   99   2   0   0   0   0   0.5   0   0   #infl
#0.001   10   0.4   0.3   0   99   -4   0   0   0   0   0.5   0   0  #slope1
#-10   100   -5.0   9   0   99   -3   0   0   0   0   0.5   0   0   #final
#-15   5   0.0   0.1   0   99   -3   0   0   0   0   0.5   0   0   #infl2
#0.00001 10   0.3   .3   0   99   -2   0   0   0   0   0.5   0   0   #slope2
#0.   25   4   4   0   99   -2   0   0   0   0   0.5   0   0   #width of top

0   25   1   40   0   99   -3   0   0   0   0   0.5   0   0   #peak
20   40   25   0   0   99   -2   0   0   0   0   0.5   0   0   #init

#Size-Selectivity for trawl fishery (double logistic)
20   80   45   40   0   99   2   0   0   0   0   0.5   1   0   #peak
0.0000  0.1   0.0   0   0   99   -2   0   0   0   0   0.5   0   0   #init
-10.   50.   1.6   1.0   0   99   2   0   0   0   0   0.5   0   0   #infl1
0.001   10   0.3   0.3   0   99   -4   0   0   0   0   0.5   0   0  #slope1
-5   0   0   9   0   99   -4   0   0   0   0   0.5   0   0   #final
-10.   5   0.0   0.1   0   99   -3   0   0   0   0   0.5   0   0   #infl2
0.00001 10   0.3   .3   0   99   -4   0   0   0   0   0.5   0   0   #slope2
0.   25   8   4   0   99   -4   0   0   0   0   0.5   0   0   #width of top

#Size-Selectivity for Triennial shelf survey (double logistic)
20   60   45   40   0   99   -2   0   0   0   0   0.5   0   0   #peak
0.0000  0.1   0.0   0   0   99   -2   0   0   0   0   0.5   0   0   #init
-10.   50.   0.0   0.0   0   99   3   0   0   0   0   0.5   0   0   #infl
0.0001  10   0.3   0.3   0   .1   4   0   0   0   0   0.5   0   0  #slope1
-5   100   0   9   0   99   -3   0   0   0   0   0.5   0   0   #final
-10.   5   0.0   0.1   0   99   -4   0   0   0   0   0.5   0   0   #infl2
0.00001 10   0.3   .3   0   99   -4   0   0   0   0   0.5   0   0   #slope2
0.   25   4   4   0   99   -4   0   0   0   0   0.5   0   0   #width of top

#Size-Selectivity for AFSC slope survey (double logistic)
#20   60   45   40   0   99   4   0   0   0   0   0.5   0   0   #peak
#0.000   0.1   0.0   0   0   99   -2   0   0   0   0   0.5   0   0   #init
#-10.   50.   0.0   0.0   0   99   4   0   0   0   0   0.5   0   0   #infl
#0.001   10   0.3   0.3   0   99   -4   0   0   0   0   0.5   0   0 #slope1
#-5   100   0   9   0   99   -4   0   0   0   0   0.5   0   0   #final
#-10.   5   0.0   0.1   0   99   -4   0   0   0   0   0.5   0   0   #infl2
#0.00001 10   0.3   .3   0   99   -4   0   0   0   0   0.5   0   0   #slope2
#0.   25   10   4   0   99   -4   0   0   0   0   0.5   0   0   #width of top

0   25   1   40   0   99   -3   0   0   0   0   0.5   0   0   #peak
20   40   25   0   0   99   -2   0   0   0   0   0.5   0   0   #init

#Size-Selectivity for NWFSC slope survey (double logistic)
#20   60   45   40   0   99   4   0   0   0   0   0.5   0   0   #peak
#0.0000  0.1   0.0  0   0   99   -2   0   0   0   0   0.5   0   0   #init
#-10.   50.   0.0   0.0   0   99   4   0   0   0   0   0.5   0   0   #infl
#0.001   10   0.3   0.3   0   99   -2   0   0   0   0   0.5   0   0 #slope1
#-5   100   0   9   0   99   -4   0   0   0   0   0.5   0   0   #final
#-10.   5   0.0   0.1   0   99   -4   0   0   0   0   0.5   0   0   #infl2
#0.00001 10   0.3   .3   0   99   -4   0   0   0   0   0.5   0   0   #slope2
#0.   25   10   4   0   99   -4   0   0   0   0   0.5   0   0   #width of top

0   25   1   40   0   99   -3   0   0   0   0   0.5   0   0   #peak
20   40   25   0   0   99   -2   0   0   0   0   0.5   0   0   #init

#Age selectivity for North trawl
#0.01   10   1   25   0   99   -5   0   0   0   0   0.5   0   0   #infl_for_logistic
#0.00001   60   70   15   0   99   -5   0   0   0   0   0.5   0   0   #95%width_for_logistic#Size-Selectivity
for Combined Slope survey (logistic)
#Age selectivity for South trawl
#0.01   10   1   25   0   99   -5   0   0   0   0   0.5   0   0   #infl_for_logistic
#0.00001   60   70   15   0   99   -5   0   0   0   0   0.5   0   0   #95%width_for_logistic#Size-Selectivity
for Combined Slope survey (logistic)
#Age selectivity for Triennial 55-366 survey
```

```
#0.01   10      1       25      0       99      -5      0       0       0       0       0.5     0       0       #infl_for_logistic
#0.00001        60      70      15      0       99      -5      0       0       0       0       0.5     0       0       #95%width_for_logistic
#Age selectivity for triennial 366-500 survey
#0.01   10      1       25      0       99      -5      0       0       0       0       0.5     0       0       #infl_for_logistic
#0.00001        60      70      15      0       99      -5      0       0       0       0       0.5     0       0       #95%width_for_logistic
#Age selectivity for AFSCsurvey
#0.01   10      1       25      0       99      -5      0       0       0       0       0.5     0       0       #infl_for_logistic
#0.00001        60      70      15      0       99      -5      0       0       0       0       0.5     0       0       #95%width_for_logistic
#Age selectivity for NWFSC survey
#0.01   10      1       25      0       99      -5      0       0       0       0       0.5     0       0       #infl_for_logistic
#0.00001        60      70      15      0       99      -5      0       0       0       0       0.5     0       0       #95%width_for_logistic


#_custom-env_read
0
#_0=read_one_setup_and_apply_to_all;_1=Custom_so_read_1_each;

#_custom-block_read
0       #_0=read_one_setup_and_apply_to_all;_1=Custom_so_see_detailed_instructions_for_N_rows_in_Custom_setup
#       LO      HI      INIT    PRIOR   PR_type SD      PHASE
 -10 10 0 0 0 99 6

-4      #_phase_for_selex_parm_devs

1       #_max_lambda_phases:_read_this_Number_of_values_for_each_componentxtype_below
1       #_include (1) or not (0) the constant offset For Log(s) in the Log(like) calculation
#_survey_lambdas
                0               0               0               1               1       1
#_discard_lambdas
                0       0       0       0       0       0
#_meanbodywt
0
#_lenfreq_lambdas
        1       1       1       1       1  1
#_age_freq_lambdas
        0       0       0       0       0  0
#_size@age_lambdas
        0       0       0       0       0  0
#_initial_equil_catch
0
#_recruitment_lambda
1
#_parm_prior_lambda
1
#_parm_dev_timeseries_lambda
0
# crashpen lambda
100
#max F
0.9

999     #_end-of-file
```