From:

Status of the Pacific coast groundfish fishery through 2008, stock assessment and fishery evaluation

Stock assessments, STAR Panel reports, and rebuilding analyses

October 2008

Pacific Fishery Management Council
Portland, Oregon

http://www.pcouncil.org/groundfish/stock-assessments/safe-documents/

STATUS OF BOCACCIO OFF CALIFORNIA IN 2007

Alec D. MacCall

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
Fishery Ecology Division
110 Shaffer Rd.
Santa Cruz, CA 95060
<Alec.MacCall@noaa.gov>

May, 2008

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Executive Summary – Bocaccio

Approach: This assessment was conducted primarily as an "update" which follows the methodology and assumptions of the 2003 bocaccio assessment as closely as possible. The main differences from the previous assessment are addition or revision of recent data, and revision of the historical commercial catches. One additional model is added, based on a prior distribution of stock-recruitment steepness. The assessment used the original Stock Synthesis model (SS1), and does not develop an equivalent new Stock Synthesis 2 (SS2) version of the assessment. Accordingly, some features of SS2 output, such as precision estimates, do not appear in this assessment.

Stock: Bocaccio rockfish (*Sebastes paucispinis*) occurring in waters off the state of California. For management purposes, the stock may be considered to reside in U.S. waters south of Cape Mendocino. This stock assessment treats the resource in Southern and Central California as a combined unit.

Catches: Catches have declined steeply from the 1970s, reflecting both a long-term decline in abundance and progressive restrictions on harvest of bocaccio (Table ES1, Figure ES1). Values of catches since 2000 are imprecise because of management-induced discarding. Recent discards in the trawl fishery have been monitored; for lack of better information, discard rates in other commercial fisheries are assumed to be similar those for the trawl fishery. Discards in the recreational fishery were obtained from RecFIN. Details are given in Table ES2.

Data and assessment: This assessment follows the methodology and assumptions of the 2003 bocaccio assessment as closely as possible. This assessment uses the original Stock Synthesis model (SS1, synl32r.exe, compiled 4/2/2003), and does not develop an equivalent new Stock Synthesis 2 (SS2) version of the assessment.

Input data extend back to 1951. Data include catches from five fisheries segments reflecting three statewide commercial gears (trawl, setnet, hook&line), and separate southern California and central/northern California recreational fisheries, length compositions from six sources (all five fisheries segments, and the Triennial Survey), and six indexes of abundance (trawl logbook CPUE, three recreational CPUEs, Triennial Survey abundance, and CalCOFI larval index of spawning output). The assumed natural mortality rate (M) was 0.15/yr in accordance with the 2003 assessment.

Unresolved problems and major uncertainties: Within the scope of this update assessment, there were no unresolved problems or uncertainties. The STATc model developed in the 2003 assessment is the focus of the update, with more limited consideration of the STARb1 and STARb2 models. Differences among the three models are described in Table ES3. One additional model developed in this document is based on the maximum posterior density estimate of bocaccio stock-recruitment steepness (h = 0.44) from a meta-analysis of rockfish stock

Table ES1. Summary of historical bocaccio catches (mtons, including discards)

	Trawl	Hook&Line	Setnet	RecSOUTH	RecNORTH	Total
1950	1287	200	0	39	86	1612
1960	2163	351	0	63	125	2702
1970	1660	298	0	289	204	2451
1980	3641	335	216	1755	178	6037
1990	1144	497	793	233	91	2451
1995	377	69	281	44	3	777
1996	288	93	92	67	26	573
1997	230	58	35	49	107	480
1998	73	42	39	29	23	209
1999	45	21	7	71	53	197
2000	54	21	2	52	60	189
2001	59	35	4	60	49	207
2002	41	7	0	76	8	132
2003	1	2	0	11	0	14
2004	11	9	0.3	59	2	82
2005	23	26	0.1	32	6	87
2006	5	20	0.2	31	11	67

Table ES2. Estimated recent fishery removals (mtons) of bocaccio. Parentheses indicate value used in 2003 assessment.

	TRAWL				H&L		SETNET		RecSouth	RecCen	Total
	Retained	Disc Rate*	Discard**	Est	Retained	Est	Retained	Est	A + B1	A + B1	Est
2000	20.1		34.0	54(54)	7.0	21(21)	0.7	2(2)	52	60	189(187)
2001	13.7		45.7	59(37)	7.8	35(23)	0.9	4(2)	60	49	207(187)
2002	18.2	56%		41(99)	3.0	7(17)	0.2	0(1)	76	8	132(201)
2003	0.2	79%		1	0.5	2	0.0	0	11	0	14
2004	6.2	42%		11	5.5	9	0.3	0.3	60	2	83
2005	3.9	83%		23	4.4	26	0.1	0.1	32	6	87
2006	0.9	83%		5	3.4	20	0.2	0.2	31	11	68

* Discard rate from J. Hastie (email 2007); **Discards from J. Hastie (email 2005); 2006 discard rate assumed same as 2005

Table ES3. Summary of 2003 bocaccio models. Bold type indicates updated aspects of the models.

M = 0.15
Years: background, 1950 to **2002**
Recruitments (age 1):
STAR B1: expval 1951-59, individual 1960-**2001, expectval 2002, 2003**; SRR lambda=0
STAR B2: expval 1951-69, individual 1970-**2001, expectval 2002, 2003**; SRR lambda=0
STAT C: expval 1951-59, individual 1960-**2001, expectval 2002, 2003**: SRR lambda=0.1
Age bins: 1 to 21+
Length bins: 24, 26, …… 66, 68, 72,76, 80+
Growth: Von Bertalanffy fitted in model, separate male and female curves
Length CVs: 0.107 at age 1.5, 0.033 at age 99

Modeled Segments:	Selectivity form	First LF	Last LF	Nyears	Sexes	Used?
Trawl	Dbl. Logistic	1978	**2002**	**25**	yes	all
Hook and Line	Dbl. Logistic	1980	**2002**	**22**	yes	all
Set Net	Dbl. Logistic	1978	**2002**	**18**	yes	all
Recreational South	Dbl. Logistic	1975	**2002**	**24**	no	all
Recreational North	Dbl. Logistic	1980	**2002**	**23**	no	all
Triennial Trawl Survey	Dbl. Logistic	1986	**2001**	**6**	yes	not in STAR B1

Abundance Indexes	Selectivity source	First	Last	Nyears	CV	Used?
RecFIN CPUE North	Rec North	1980	2002	20	0.67	not in STAR B2
CDFG CPUE North	Rec North	1987	1998	12	0.37	all
RecFIN CPUE South	Rec South	1980	2002	20	0.71	not in STAR B2
Trawl CPUE (north)	Trawl	1982	1996	15	0.32	all
Triennial Trawl	Triennial	1977	**2001**	**9**	0.81	not in STAR B1
CalCOFI Larval	Spawn Ogive	1951	**2003**	**47**	0.68	all

Recruitment Indexes	Selectivity source	First	Last	Nyears	CV	Used?
Power Plant Ent'nment	age 1	1972	2000	29	2.10	no
Cen Cal Juvenile Trawl	age 1	1983	2002	20	2.05	no
Rec Pier CPUE	age 1	1980	2002	20	3.29	no

assessments (Dorn, pers. comm. 2007), with full emphasis (lambda = 1) on the Beverton-Holt model fit to the recruitment estimates, with all other aspects of the model similar to the STATc model.

Reference points: Values in this discussion are from the STATc model; values for all four models are given in Table ES4. Population reproductive potential is measured as spawning output (units of billion eggs). Unfished abundance cannot be estimated reliably from historical stock and recruitment due to lack of curvature in the relationship. An imprecise estimate of unfished spawning output was obtained by multiplying the average age-1 recruitment (1951 to 1986) by unfished SPR, giving 13572 billion eggs.

The 50%SPR exploitation rate (Catch/Biomass age 1+) is 0.0630, which is used as a proxy Fmsy rate by the PFMC. Proxy Bmsy (40% of Bunfished) corresponds to an approximate equilibrium total biomass of 31341 mtons, and if this is fished at proxy Fmsy, the MSY is estimated to be 1974 mtons. Although calculations related to MSY are imprecise, estimates vary relatively little among alternative models and methods of calculation. The overfishing threshold is Fmsy, in this case the proxy value of F(SPR50%), and corresponding catch levels are the ABC values given in the rebuilding projections.

Stock biomass: The estimated history of the biomass (age 1+) and spawning output (billion eggs) estimated by the four alternative models are shown in Figures ES2 and ES3 and values are given in Table ES5. Notably the three models (STARb1, STATc and STATcMPDh) that are allowed to estimate early biomass indicate that biomass was near the minimum stock size threshold at the beginning of the assessment period, ca. 1950. This is not surprising, given that the assumed pre-1950 “background” catch was 2000 mtons, which slightly exceeds estimated MSY. CalCOFI larval abundances indicate a relatively low biomass in the 1950s, and a substantial increase in spawning abundance during the 1960s.

Recruitment: The estimated history of recruitment (omitting earlier years with little data to inform estimates) is shown in Figure ES4 and values are given in Table ES6. The strong 1999 year class was followed by a moderately strong 2003 year class. Strength of the 2004 and 2005 year classes is not estimated from data, but rather is taken from the stock-recruitment relationship. The recruitment values for these years are not substantiated by other sources of information, and these values may be overly optimistic.

Exploitation status: The history of exploitation rates is shown in Figure ES5 and ES6, and values are given in Table ES6. From the STATc model, the estimated spawning output in 2006 is 1727 billion eggs, or 12.7% of the estimated unfished level. The estimated 2006 total biomass (age 1+) is 10752 mtons. The 2006 exploitation rate of 0.0062 was far below the reference exploitation rate of 0.0630 that is the maximum fishing mortality threshold under the SPR50% proxy (see Figure ES1). At the Fmsy proxy, the STATc model gives a 2006 catch (ABC) of 677 mtons (this is also the overfishing threshold) and a “40-10" policy optimum yield (OY) of 193 mtons.

Management performance: The 2006 OY was set at 218 mtons, the retained catch was about 42 mtons, and the estimated total catch including discards was 68 mtons (Tables ES2 and ES7). Including mortality of estimated discards, estimated total kill in 2006 was 67 mtons. Thus, recent management has been achieving total removals well below target levels, and far below maximum levels. A ten-year history of management performance is given in Table ES7.

Table ES4. Management reference points for bocaccio.

	units	Model STARb1	STARb2	STATc	STATcMPDh
Steepness(h)		ca. 0.2	ca. 0.2	ca. 0.2	0.44
Unfished Reference Points					
Reference source		Ravg51-86	Ravg51-86	Ravg51-86	SRR
Spawning Output	billion eggs	13563	13132	13572	12591
Summary (1+) Biomass	mtons	71104	68894	71195	66036
Mean Recruitment at age 1	thousands	5451	5270	5449	5039
SPR(F=0)		2.488	2.492	2.491	2.502
Current status (2006)					
Spawning Output	billion eggs	2075	1430	1727	2049
Spawning Output at SB40%	billion eggs	5425	5253	5429	5036
Relative depletion		15.3%	10.9%	12.7%	16.3%
Summary (1+) Biomass	mtons	14559	9582	10752	13661
2006 Catch (including discards)	mtons	67	67	67	67
Exploitation rate		0.0046	0.0070	0.0062	0.0049
Overfishing threshold (ExpRate at SPR50%)		0.0633	0.0631	0.0630	0.0633
ABC	mtons	922	605	677	865
OY (40-1010)	mtons	426	66	193	401
Reference Points based on SPR50% proxy at SB40%					
Spawning Output at SB40	billion eggs	5425	5253	5429	5036
SPRmsy proxy		50%	50%	50%	50%
Exploitation rate at SPR50%		0.0633	0.0631	0.0630	0.0633
Approx Bsummary at SB40% given Exploitation rate at SPR50%	mtons	30928	30313	31341	29146
Yield with SPR50% at SB40%	mtons	1958	1913	1974	1845
Reference Points based on estimated MSY values from SRR					
Smsr, Spawning Output at MSY	billion eggs	undefined	undefined	undefined	4549
Smsr/Sunfished					36%
R at Smsr	thousands				4138
SPRmsy					1.0992
rel SPRmsy					44%
Exploitation rate at SPRmsy					0.0768
Bsummary at Smsy	mtons				29671
MSY	mtons	undefined	undefined	undefined	2279

Forecasts: The first year of projection was 2006, so that the recruitment of age 1 fish in 2007 and later was obtained by random resampling of R/S value from the spawning years of 1969 through 2003 (Figure ES7, Table ES8). Catches were fixed at the observed 67 mtons in 2006, and at a projected 151 mtons in both 2007 and 2008. Beginning in 2009, the projections use a constant fishing rate corresponding to an SPR of 77.7% (2009 rebuilding OY would be 288 mtons), without reversion to the 40-10 harvest policy upon reaching the rebuilding target of B40. Based on 2000 simulations, approximately half of the projections reach the rebuilding target by 2023, and 67% of the simulations were rebuilt by the current statutory rebuilding target date of 2026. If the probability of attaining the rebuilding target by 2026 is reduced to 50%, the SPR could be decreased to 66.4%, allowing larger catches (in which case, 2009 rebuilding OY would be 468 mtons).

Decision tables: No table was developed because this stock is subject to a rebuilding plan.

Table ES5. History of bocaccio biomass and spawning output.

	Total biomass (age 1+)				Spawning output (billion eggs)							
	STARb1	STARb2	STATc	STATcMPDh	STARb1		STARb2		STATc		STATcMPDh	
	mtons	mtons	mtons	mtons	sp out	rel depl	sp out	rel depl	sp out	rel depl	sp out	rel depl
avg unexpl	71104	68894	71195	70069	13563	100%	13132	100%	13572	100%	13368	100%
1950	23644	39688	22625	23029	3764	28%	6871	52%	3580	26%	3650	27%
1960	16575	33291	16405	16320	2546	19%	5666	43%	2359	17%	2429	18%
1970	44285	32447	43288	42458	8306	61%	5099	39%	7910	58%	7450	56%
1975	30504	28662	30969	30069	4980	37%	4115	31%	5034	37%	4829	36%
1980	29064	29148	29561	28792	3467	26%	3406	26%	3600	27%	3426	26%
1985	13229	13434	13504	13091	2160	16%	2239	17%	2256	17%	2136	16%
1990	8994	8876	9039	8880	1140	8%	1170	9%	1179	9%	1117	8%
1995	5510	4842	5348	5474	820	6%	757	6%	820	6%	812	6%
1996	5257	4466	5037	5223	819	6%	730	6%	808	6%	812	6%
1997	5222	4297	4944	5198	826	6%	712	5%	804	6%	820	6%
1998	5136	4091	4796	5117	835	6%	697	5%	802	6%	830	6%
1999	5276	4126	4888	5274	881	6%	718	5%	836	6%	877	7%
2000	6562	4918	5882	6511	928	7%	739	6%	871	6%	925	7%
2001	7412	5416	6522	7374	970	7%	757	6%	901	7%	970	7%
2002	8611	6137	7422	8559	1050	8%	797	6%	958	7%	1050	8%
2003	9712	6788	8213	9634	1277	9%	938	7%	1134	8%	1274	10%
2004	11341	7720	9283	11047	1599	12%	1145	9%	1386	10%	1592	12%
2005	12805	8563	10024	12275	1863	14%	1309	10%	1585	12%	1852	14%
2006	14559	9582	10752	13661	2075	15%	1430	11%	1727	13%	2049	15%

Table ES6. Recent trends in recruitment (thousands) and exploitation rate.

	Recruitment at age 1				Exploitation rate (C/B1+)			
Year	STARb1	STARb2	STATc	STATcMPDh	STARb1	STARb2	STATc	STATcMPDh
1995	879	690	796	867	14.0%	16.0%	14.5%	14.1%
1996	509	369	435	497	10.8%	12.7%	11.2%	10.8%
1997	1061	843	1006	1109	9.2%	11.1%	9.7%	9.2%
1998	334	205	245	317	4.0%	5.0%	4.3%	4.0%
1999	384	297	368	432	3.7%	4.8%	4.0%	3.7%
2000	7385	4977	5944	7043	2.9%	3.8%	3.2%	2.9%
2001	56	50	50	249	2.8%	3.8%	3.2%	2.8%
2002	625	442	481	607	1.5%	2.2%	1.8%	1.5%
2003	861	469	489	710	0.1%	0.2%	0.2%	0.1%
2004	4602	2433	2732	3480	0.7%	1.1%	0.9%	0.7%
2005	2651	1907	917	2279	0.7%	1.0%	0.9%	0.7%
2006	3080	2176	1049	2524	0.5%	0.7%	0.6%	0.5%

* Recruitment values for 2005 and 2006 are expected values from SRR, not estimated.

Table ES7. Recent history of management performance.

	Commercial			Recreational			Total			ABC	OY
Year	Catch	Discard	Total	Catch	Discard	Total	Catch	Discard	Total		
1997	323	*	323	145	11	156	468	11	479	265	265
1998	154	*	154	52	0	52	206	0	206	230	230
1999	73	*	73	120	4	124	193	4	197	230	230
2000	28	49	77	103	9	112	128	58	189	164	100
2001	22	76	98	103	6	109	125	82	207	122	100
2002	21	27	48	82	2	84	103	32	132	122	100
2003	1	2	3	9	2	11	10	4	14	244	<20
2004	12	8	20	55	8	62	66	18	82	400	199
2005	8	41	49	34	4	38	42	45	87	566	307
2006	5	20	25	37	5	42	42	25	67	549	306
2007			53**			98**			151**	602	218
2008										618	218

* Discarded commercial catch was not estimated and is assumed to be negligible.
** Projected as of August, 2007 (John. DeVore, pers. comm.)

Research and data needs: The recommendations presented here are from the STAT Team; STAR Panel reports also contain recommendations on this subject. Future bocaccio assessments should utilize the Stock Synthesis 2 model, and time-varying growth rates should be explored because of apparent interdecadal variability in progressions of modal lengths. A two-area model (north and south of Pt. Conception) may help distinguish the state of the resource in those two areas, but migration patterns and rates are not known well enough to project rebuilding trajectories separately for the two areas. The southern California segment may be a vitally important source of migrants to central California waters. The CalCOFI larval survey, including central California stations, is critical to future bocaccio assessments. Tracking intra-annual patterns of gonadal states could improve its interpretation and eventually lead to calibrated estimates of true abundance. The STAT recommends against pursuing trawl-based abundance estimates, due to poor ability to sample rocky habitats preferred by bocaccio. An acoustic-optical system being developed at the SWFSC may be suitable for estimating bocaccio abundance.

Table ES8. Median projected abundances of bocaccio, at F(SPR=77.7%) beginning in 2009, without reversion to 40-10 policy. Estimates are based on model STATc and future projections do not include imprecision in estimated 2006 status. Bold values indicate rebuilt status. Catch is observed value in 2006, and is assumed in 2007-08.

Year	SPR	Catch	ABC	Depletion			Spawning Output		
	projected	median	median	5%	median	95%	5%	median	95%
2006	0.939	67	677	12.7%	12.7%	12.7%	1727	1727	1727
2007	0.871	151	693	13.8%	13.8%	13.8%	1872	1872	1873
2008	0.823	218	704	14.9%	14.9%	14.9%	2015	2016	2024
2009	0.777	288	718	15.6%	15.7%	16.4%	2117	2128	2221
2010	0.777	302	753	15.9%	16.3%	18.9%	2156	2209	2564
2011	0.777	323	806	15.9%	17.0%	22.1%	2154	2298	2994
2012	0.777	354	882	15.8%	17.8%	25.7%	2137	2419	3480
2013	0.777	387	964	15.6%	18.9%	28.8%	2115	2561	3900
2014	0.777	426	1062	15.6%	20.2%	32.5%	2109	2744	4404
2015	0.777	467	1165	15.6%	21.8%	35.8%	2113	2960	4856
2016	0.777	507	1263	15.7%	23.7%	**40.2%**	2130	3212	**5452**
2017	0.777	546	1361	16.1%	25.9%	**44.5%**	2183	3505	**6036**
2018	0.777	586	1460	16.4%	27.9%	**49.2%**	2226	3782	**6665**
2019	0.777	622	1550	16.9%	30.1%	**54.0%**	2291	4079	**7320**
2020	0.777	661	1649	17.4%	32.4%	**59.7%**	2365	4396	**8092**
2021	0.777	723	1804	18.1%	34.5%	**66.6%**	2454	4680	**9033**
2022	0.777	772	1926	18.7%	37.1%	**74.4%**	2532	5025	**10084**
2023	0.777	826	2060	19.3%	39.9%	**83.3%**	2622	5408	**11295**
2024	0.777	890	2220	20.2%	**43.0%**	**91.2%**	2743	**5829**	**12367**
2025	0.777	936	2334	20.9%	**46.4%**	**101.2%**	2839	**6285**	**13721**
2026	0.777	1018	2538	21.9%	**49.4%**	**110.4%**	2962	**6699**	**14961**

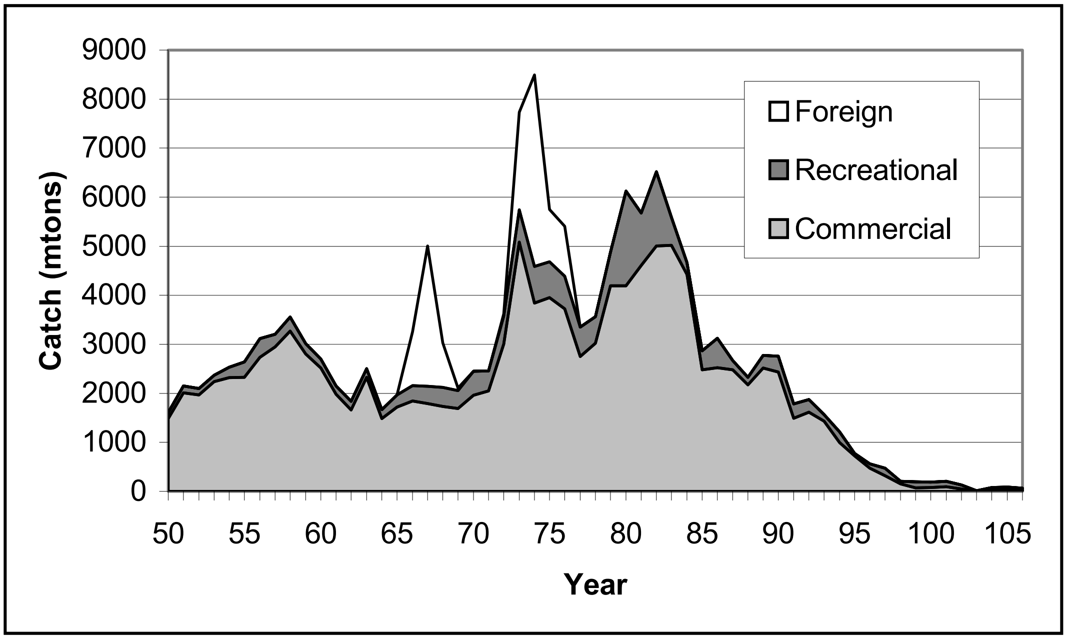

Figure ES1. History of bocaccio catches, showing foreign, recreational and commercial components. A catch of 2000 mtons is assumed prior to 1950.

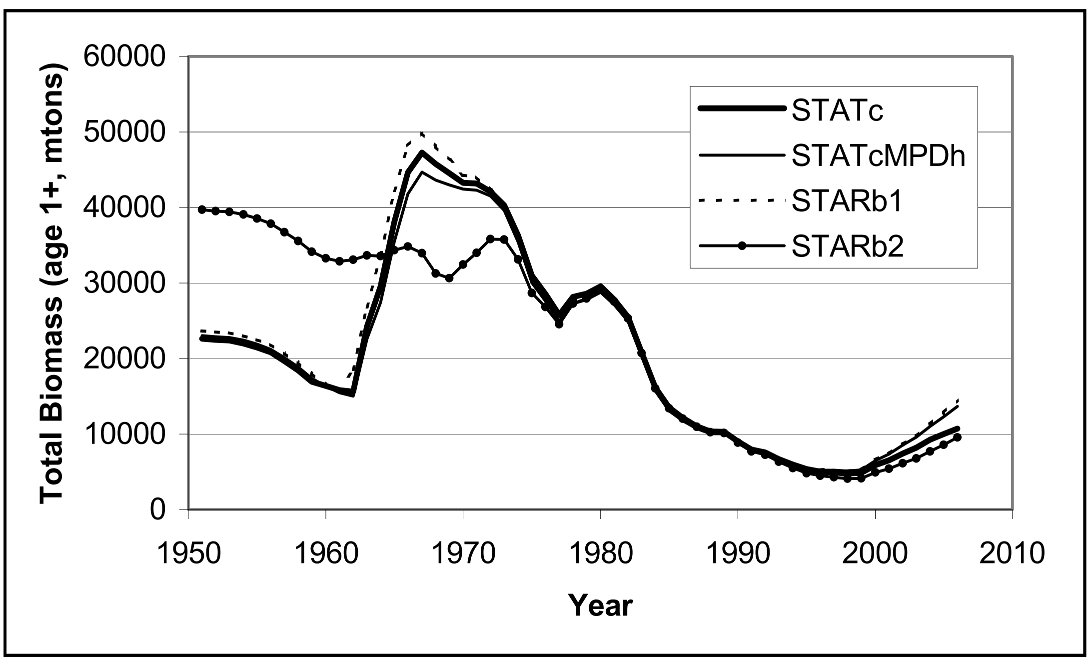

Figure ES2. History of total biomass (age 1+) of bocaccio estimated by four alternative models.

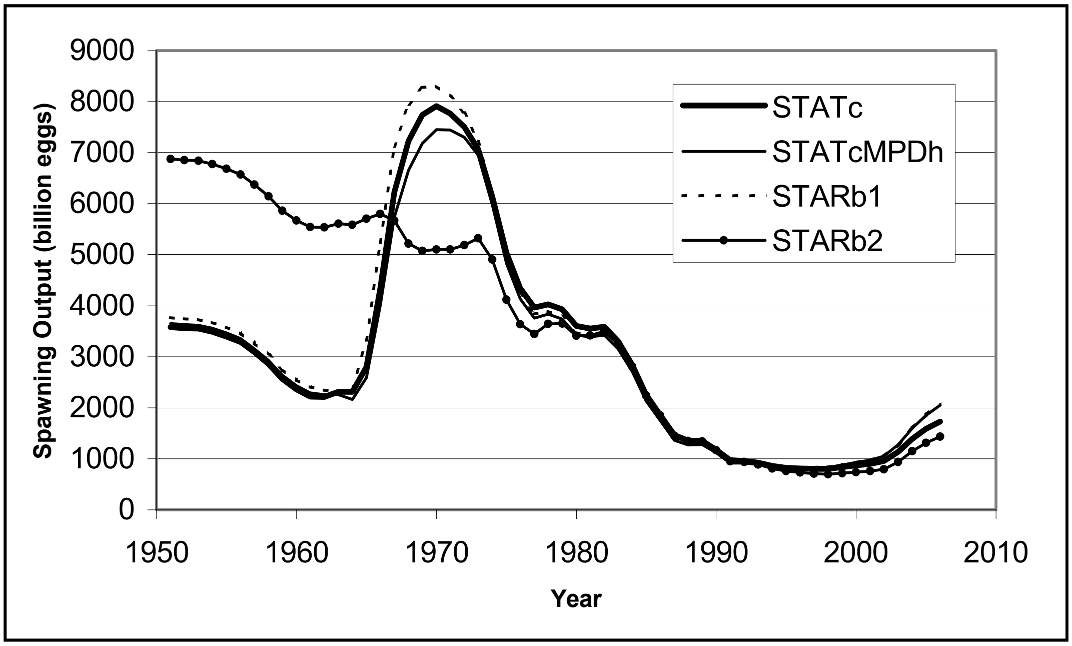

Figure ES3. History of spawning output of bocaccio estimated by four alternative models.

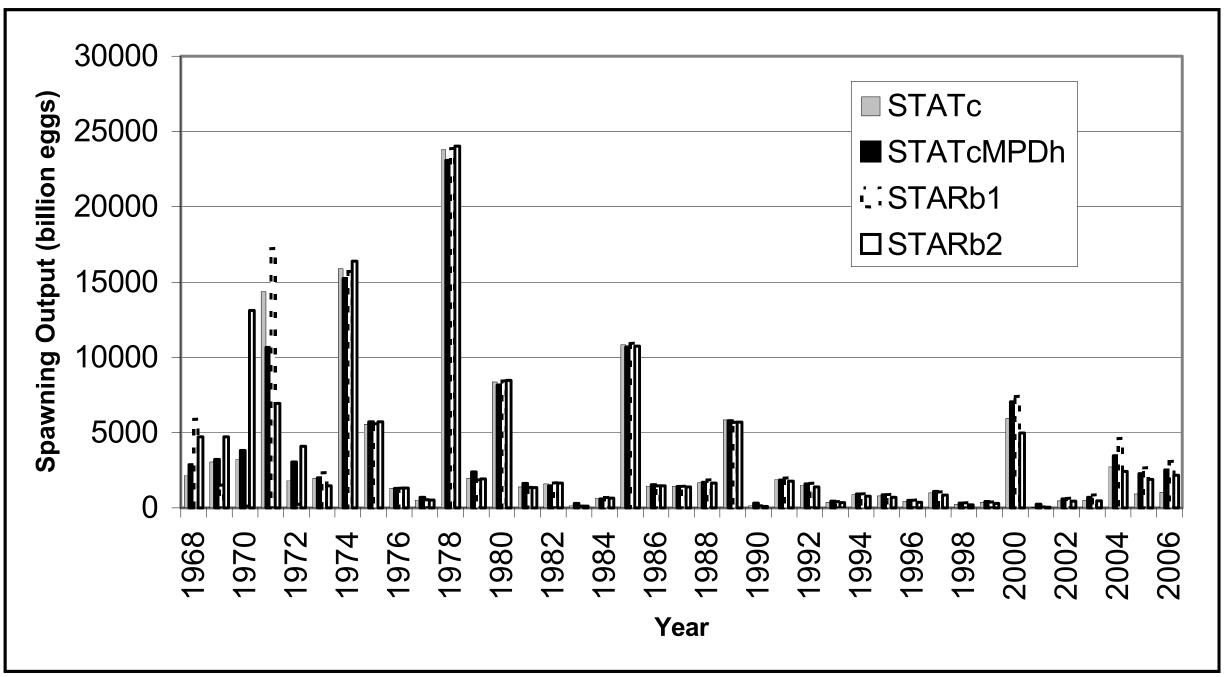

Figure ES4. Trends in bocaccio recruitment (thousand fish at age 1) estimated by four alternative models. Indicated year is age 1, spawning occurred in previous year.

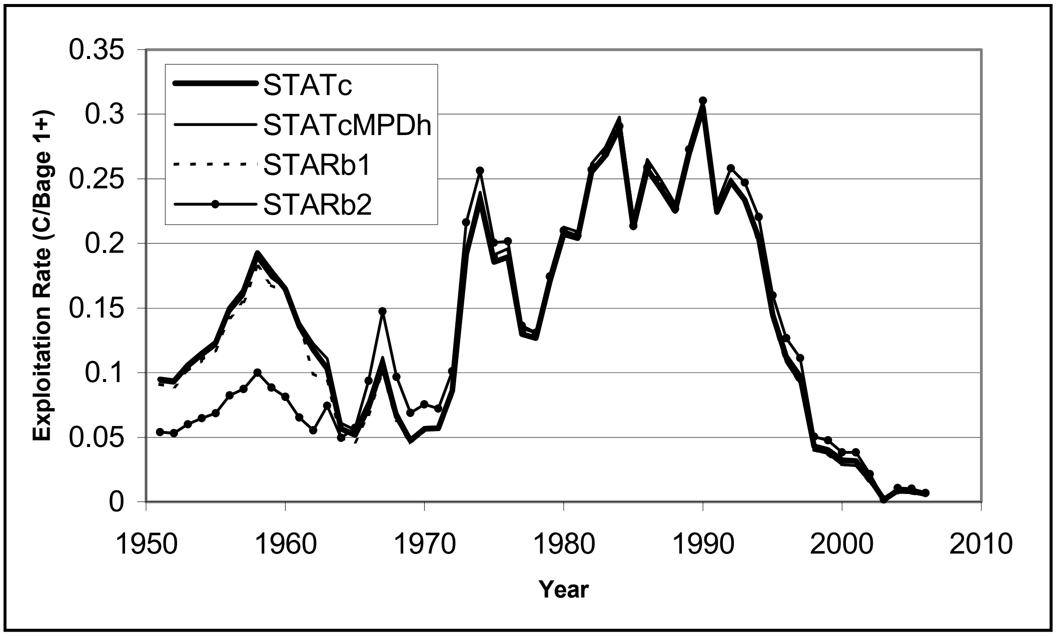

Figure ES5. Trends in bocaccio exploitation rate indicated by four alternative models.

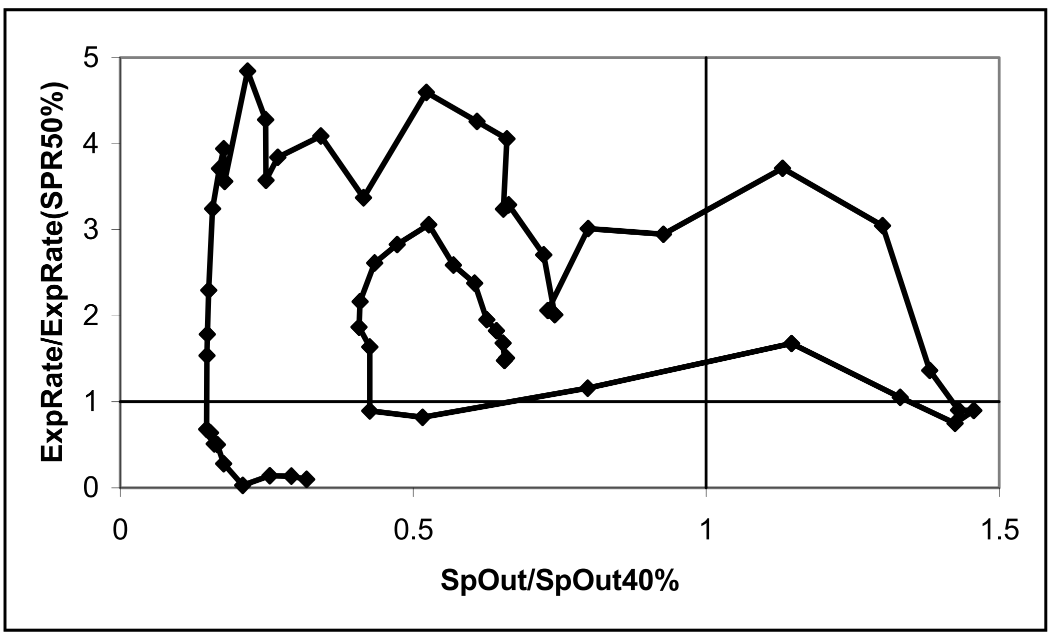

Figure ES6. Historical exploitation rates and spawning outputs relative to target values. Plot begins in 1951 (near center) and ends in 2006 (lower left). Model is STATc.

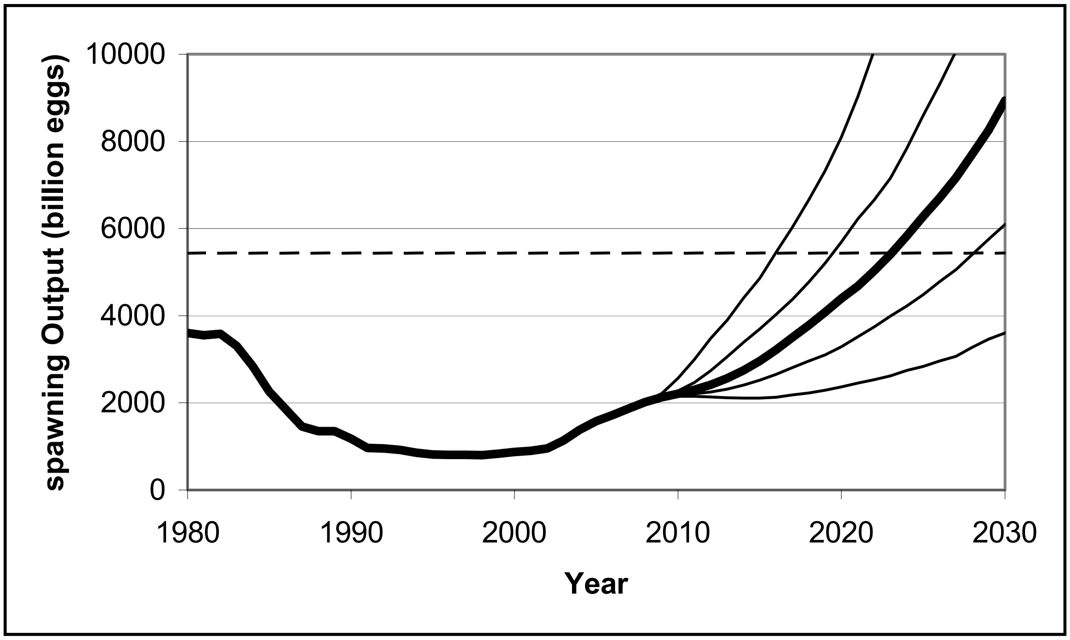

Figure ES7. Projected spawning output under a constant SPR=77.7% rebuilding policy. Trajectories are 5, 25, 50 (median, bold line), 75 and 95 percentiles; broken line is B40 rebuilding target.

Status of bocaccio off California in 2007

Introduction

A full stock assessment of bocaccio off California was last conducted in 2003 (MacCall 2003a), and an update assessment was conducted in 2005 (MacCall 2005a). Although initial plans were to convert the model to SS2 and do an extensive bocaccio assessment in 2007, a variety of unanticipated events resulted in a revision of the work plan. Rather than cancelling the assessment altogether, an assessment equivalent to an update in scope was proposed for 2007 (email MacCall to Clarke, 10/18/06). However, the STAR Panel review schedule was not modified.

This assessment is equivalent to an "update" assessment, but the STAR Panel review allows additional leeway to consider alternative models. According to the TOR for stock assessment updates, an update stock assessment must carry forward its fundamental structure from a model that was previously reviewed and endorsed by a STAR Panel. Accordingly, this assessment adheres to the model frameworks established in 2003, and is similar to the update developed in 2005 (MacCall 2005a). With regard to the specific requirements for an update assessment, there must be similarity in:

- a) the particular sources of data used,
- b) the analytical methods used to summarize data prior to input to the model,
- c) the software used in programming the assessment,
- d) the assumptions and structure of the population dynamics model underlying the stock assessment,
- e) the statistical framework for fitting the model to the data and determining goodness of fit,
- f) the procedure for weighting the various data components, and
- g) the analytical treatment of model outputs in determining management reference points, including Fmsy, Bmsy, and B0.

The present assessment satisfies all of these requirements.

For clarity of presentation, this document treats current results relative to the original 2003 assessment, without attempting to reconcile very minor changes from the 2005 update, most of which were due to use of incomplete data from 2004 and 2005 in the latter assessment. Specifications of the three models developed in the 2003 assessment are summarized in Table 1. The STARb1 and STARb2 models omit portions of the data. The STATc model includes all of the data sources and is the accepted basis of management decisions. One additional model described later in this document is a variant of the STATc model where the stock-recruitment curve has increased influence on the model.

Fishery data

Catches

Revision of commercial catches: The time series of commercial catches was revised, due to recovery of misplaced data from landings sampling during the late-1970's to early 1990's. The new (2007) catch values are compared with the previous (2003) catch values in Figure 1. Annual values of catches by individual fishery segments are given in the Stock Synthesis data file (Appendix B).

Historical catches by major fishery segments are shown in Figure 2, and detail of landings and discard in recent years are given in Table 2. Five distinct fishery segments are recognized in this assessment: commercial trawl, hook and line and set net gears, and recreational fisheries north and south of Pt. Conception. Recent estimates of recreational catch and discards (Table 2) were obtained from the RecFIN database. Commercial catches were obtained from the CALCOM database (Don Pearson, SWFSC, pers. comm.), and estimated rates of bycatch/discard from the trawl fishery were provided by Jim Hastie (NWFSC, pers. comm.). Because gears other than trawl were not observed sufficiently, the trawl discard rate was applied to all commercial gears. The estimated three-year 2000-2002 cumulative catch and discard (528 mtons) is slightly lower than in the 2003 assessment (575 mtons). Annual catch rates declined in the subsequent 2003-2006 period due to severe restrictions imposed by management.

Length Compositions

Recreational fisheries: Length compositions of retained bocaccio are available from the southern California recreational fishery in 2003-2006 (Figure 3), and in the central California recreational fishery in 2004-2006 (Figure 4). Sample sizes are given in Table 3. In central California, the strong 1999 year class remains dominant through 2006. In southern California, the 1999 year class declines in importance after 2004, and the 2003 year class dominates the size composition in 2005-2006.

Commercial fisheries: The severe decline in commercial landings of bocaccio has resulted in few length composition samples of commercially-caught bocaccio (Figure 5, Table 3). Useful data exist only from the trawl fishery in 2004 and the hook and line fishery in 2006. Samples exist for the set net fishery in 2004 and hook and line fishery in 2005 but were too small to be used.

Fishery-Dependent Abundance Indexes

No attempt was made to update the recreational fishery CPUE abundance indexes because of difficulty interpreting catch rates under the strong restrictions that were placed on landing bocaccio.

Fishery-Independent Data: Surveys and Indexes

Triennial Survey

The information from the Triennial Survey is unchanged from the 2005 update, but is included here for completeness. A Triennial Trawl Survey was conducted in 2004 (data provided by Mark Wilkins, AFSC, and Beth Horness, NWFSC, pers. comm.). The length composition of bocaccio taken in that survey is show in Figure 5. As was done previously, I used a simple log-transformed GLM to produce year-specific indexes of abundance. This approach allows a consistent interpretation of the survey results even though the Conception area was not sampled in 1980, 1983 and 1986. The GLM predicts stratum means with fixed area, depth and year effects (Figure 6), and a minor error for year 1980 was corrected as in the 2005 update. The new index values are consistent with those used in the 2003 assessment.

CalCOFI Survey

The 2003 assessment included the January 2003 CalCOFI ichthyoplankton survey, but did not include the April 2003 survey. This assessment includes both CalCOFI surveys through April 2006 (Richard Charter, SWFSC, pers. comm.). Annual sample sizes for the southern and central California portions of the survey are given in Table 2. As before, a delta-lognormal GLM with fixed year, month and station effects was use to produce annual index values (Figure 7). Consistency between values in the 2003 assessment and this assessment is shown in Figure 8. The index value for 2003 decreased slightly when the April survey data for that year were included.

Recruitment Indexes

In its review of the 2003 assessment, the STAR Panel recommended excluding use of recruitment indexes. Those indexes are not used in this assessment, and updated values were not calculated.

Assessment Model

The assessment was conducted using the “Stock Synthesis 1” length-based maximum likelihood model (synl32r.exe, compiled 4/2/2003), and is directly comparable to the 2003 assessment. As in the 2003 assessment, natural mortality rate is set at M=0.15. All three of the models developed in the 2003 assessment (STARB1, STARB2 and STATC; see Table 1 for model details) are updated here.

This assessment includes consideration of one additional model, based on an assumed value of Mace-Doonan steepness (h) in a Beverton-Holt stock-recruitment relationship (SRR). Martin Dorn (ms in prep) recently conducted a Bayesian meta-analysis of Beverton-Holt SRRs for a number of west coast rockfish stocks. The bocaccio information in that analysis was based on the STATc model used for the 2005 update. Dorn provided a maximum posterior density (mpd) estimate of h = 0.44 for bocaccio (Dorn email 6/4/07). That value of steepness is used here in model STATcMPDh. The only differences from the STATc model are the assumed value of h = 0.44 and an increase in emphasis (lambda) on the stock-recruitment residuals to 1.

Model Results

Model results, including a retrospective view of results for 2003 from the new model, are compared in Table 4, and more details are given in Tables 5 and 6. Abundance trajectories, recruitments and exploitation rates are shown in Figures 9-13. Fits to abundance time series are shown in Figure 14 and fits to recent length compositions are shown in Figure 15. All four models are in general agreement for the most recent 30 years (models STARb1 and STARb2 differ in specification of early recruitments).

Reference points: Values in this discussion are from the STATc model; values for all four models are given in Tables 4 and 5. Population reproductive potential is measured as spawning output (units of billion eggs). Except for model STATcMPDh with its explicit stock-recruitment relationship (SRR), unfished abundance cannot be estimated reliably from historical stock and recruitment due to lack of curvature in the estimated relationship. An imprecise estimate of unfished spawning output was obtained by multiplying the average age-1 recruitment (1951 to 1986) by unfished SPR, giving 13572 billion eggs. The SRR from model STATcMPDh is used to estimate the values of reference points for that model (Table 5). Estimated values of reference points vary little among alternative models.

The 50%SPR exploitation rate (Catch/Biomass age 1+) is 0.0630, which is used as a proxy Fmsy rate by the PFMC. Proxy Bmsy (40% of Bunfished) corresponds to an approximate equilibrium total biomass of 31341 mtons, and if this is fished at proxy Fmsy, the MSY is estimated to be 1974 mtons. Although calculations related to MSY are imprecise, estimates vary relatively little among alternative models and methods of calculation. The overfishing threshold is Fmsy, in this case the proxy value of F(SPR50%), and corresponding catch levels are the ABC values given in the rebuilding projections.

Stock biomass: The estimated history of the biomass (age 1+) and spawning output (billion eggs) estimated by the four alternative models are shown in Figures 9 and 10 and recent values are given in Table 6. Notably the three models (STARb1, STATc and STATcMPDh) that are allowed to estimate early biomass indicate that biomass was near the minimum stock size threshold at the beginning of the assessment period, ca. 1950. This is not surprising, given that the assumed pre-1950 "background" catch was 2000 mtons, which slightly exceeds estimated MSY. CalCOFI larval abundances indicate a relatively low biomass in the 1950s, and a substantial increase in spawning abundance during the 1960s. Abundance has approximately doubled since rebuilding began in year 2000.

Recruitment: The estimated history of recruitment (omitting earlier years with little data to inform estimates) is shown in Figure 11 and values are given in Table 6. The strong 1999 year class was followed by a moderately strong 2003 year class. Strength of the 2004 and 2005 year classes is not estimated from data, but rather is taken from the stock-recruitment relationship. The recruitment values for these years are not substantiated by other sources of information, and these values may be overly optimistic.

Exploitation status: The history of exploitation rates is shown in Figure 12 and 13, and values are given in Table 6. From the STATc model, the estimated spawning output in 2006 is 1727 billion eggs, or 12.7% of the estimated unfished level. The estimated 2006 total biomass (age 1+) is 10752 mtons. The 2006 exploitation rate of 0.0062 was far below the reference exploitation rate of 0.0630 that is the maximum fishing mortality threshold under the SPR50% proxy (see Figure 13). At the Fmsy proxy, the STATc model gives a 2006 catch (ABC) of 677 mtons (this is also the overfishing threshold) and a "40-10" policy OY of 193 mtons.

Retrospective patterns: Retrospective patterns given in Table 4 indicate that 2003 estimates from model STARb2 are nearly unchanged in the 2007 assessment (estimated 2003 spawning output increases by 2%). The 2007 STATc model results for 2003 provide upward revisions of 2003 abundance estimates, with an 11% increase in estimated 2003 spawning output. The 2007 STARb1 model indicates substantial upward revision of its 2003 estimates, with a 44% upward revision of estimated 2003 spawning output. For a more detailed year-by-year analysis of retrospective patterns, the reader is referred to the 2005 assessment document.

Rebuilding Projections

Projections used the SSC Default Rebuilding Analysis (Version 2.10b) programmed by Andre Punt (program available at http://www.fish.washington.edu/people/punt/software.html). The first year of projection was 2006, so that the recruitment of age 1 fish in 2007 and later was obtained by random resampling of R/S value from the spawning years of 1969 through 2003 (Figure 16, Table 7). Catches were fixed at the observed 67 mtons in 2006, and at a projected 151 mtons in both 2007 and 2008. Beginning in 2009, the projections use a constant fishing rate corresponding to an SPR of 77.7% (2009 rebuilding OY would be 288 mtons), without reversion to the 40-10 harvest policy upon reaching the rebuilding target of B40. Based on 2000 simulations, approximately half of the projections reach the rebuilding target by 2023, and 67% of the simulations were rebuilt by the current statutory rebuilding target date of 2026. If the probability of attaining the rebuilding target by 2026 is reduced to 50%, the SPR could be decreased to 66.4%, allowing larger catches (in which case, 2009 rebuilding OY would be 468 mtons).

Research and Data Needs

The recommendations presented here are from the STAT Team; STAR Panel reports also contain recommendations on this subject. Future bocaccio assessments should utilize the Stock Synthesis 2 model, and time-varying growth rates should be explored. Although a two-area model (north and south of Pt. Conception) is worth exploring to distinguish the state of the resource in those two areas, migration patterns and rates are not known well enough to project rebuilding trajectories separately for the two areas. The southern California segment may prove to be less depleted, but may be a vitally important source of migrants to central California waters. Continuation of the CalCOFI larval survey, including central California stations, is critical to future bocaccio assessments. Tracking intra-annual patterns of gonadal states could improve its interpretation and eventually lead to calibrated estimates of true abundance. The STAT recommends against pursuing trawl-based abundance estimates, due to poor ability to sample rocky habitats preferred by bocaccio. An acoustic-optical survey system being developed at the SWFSC in La Jolla may be suitable for estimating bocaccio abundance.

Acknowledgements

I would like to thank people who provided updated data sets used in this assessment: Don Pearson, Richard Charter, Beth Horness, Mark Wilkins, and Jim Hastie. My thanks also extend to the much larger number of people who did the field work and data processing that underlie the summary information I received.

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Table 1. Summary of 2003 bocaccio models. Bold type indicates updated aspects of the models.

M = 0.15
Years: background, 1950 to **2002**
Recruitments (age 1):
STAR B1: expval 1951-59, individual 1960-**2001, expectval 2002, 2003**; SRR lambda=0
STAR B2: expval 1951-69, individual 1970-**2001, expectval 2002, 2003**; SRR lambda=0
STAT C: expval 1951-59, individual 1960-**2001, expectval 2002, 2003**: SRR lambda=0.1
Age bins: 1 to 21+
Length bins: 24, 26, …… 66, 68, 72,76, 80+
Growth: Von Bertalanffy fitted in model, separate male and female curves
Length CVs: 0.107 at age 1.5, 0.033 at age 99, interpolated on mean length at age

Modeled Segments:	Selectivity form	First LF	Last LF	Nyears	Sexes	Used?
Trawl	Dbl. Logistic	1978	**2002**	**25**	yes	all
Hook and Line	Dbl. Logistic	1980	**2002**	**22**	yes	all
Set Net	Dbl. Logistic	1978	**2002**	**18**	yes	all
Recreational South	Dbl. Logistic	1975	**2002**	**24**	no	all
Recreational North	Dbl. Logistic	1980	**2002**	**23**	no	all
Triennial Trawl Survey	Dbl. Logistic	1986	**2001**	**6**	yes	not in STAR B1

Abundance Indexes	Selectivity source	First	Last	Nyears	CV*	Used?
RecFIN CPUE North	Rec North	1980	2002	20	**0.67**	not in STAR B2
CDFG CPUE North	Rec North	1987	1998	12	**0.37**	all
RecFIN CPUE South	Rec South	1980	2002	20	**0.71**	not in STAR B2
Trawl CPUE (north)	Trawl	1982	1996	15	**0.32**	all
Triennial Trawl	Triennial	1977	**2001**	**9**	**0.81**	not in STAR B1
CalCOFI Larval	Spawn Ogive	1951	**2003**	**47**	**0.68**	all

Recruitment Indexes	Selectivity source	First	Last	Nyears	CV	Used?
Power Plant Ent'nment	age 1	1972	2000	29	2.10	no
Cen Cal Juvenile Trawl	age 1	1983	2002	20	2.05	no
Rec Pier CPUE	age 1	1980	2002	20	3.29	no

* Re-tuning of CVs is automatic based on RMSE of fit (log scale).

Table 2. Estimated recent fishery removals (mtons) of bocaccio. Parentheses indicate value used in 2003 assessment.

	TRAWL				H&L		SETNET		RecSouth	RecCen	Total
	Retained	Disc Rate*	Discard**	Est	Retained	Est	Retained	Est	A + B1	A + B1	Est
2000	20.1		34.0	54(54)	7.0	21(21)	0.7	2(2)	52	60	189(187)
2001	13.7		45.7	59(37)	7.8	35(23)	0.9	4(2)	60	49	207(187)
2002	18.2	56%		41(99)	3.0	7(17)	0.2	0(1)	76	8	132(201)
2003	0.2	79%		1	0.5	2	0.0	0	11	0	14
2004	6.2	42%		11	5.5	9	0.3	0.3	60	2	83
2005	3.9	83%		23	4.4	26	0.1	0.1	32	6	87
2006	0.9	83%		5	3.4	20	0.2	0.2	31	11	68

* Discard rate from J. Hastie (email 2007); **Discards from J. Hastie (email 2005); 2006 discard rate assumed same as 2005

Table 3. Sample size and model tuning information for updated information sources. Starred samples were small and not used.

Length Compositions	Year	Nobs	Neff	Units	Nsamples
Trawl	2004	110	78	Fish	9
Set Net	2004	17*	n.a.	Fish	2
Hook&Line	2005	11*	n.a.	Fish	2
	2006	78	13	Fish	10
So Calif Recreational	2003	122	84	Fish	
	2004	889	86	Fish	
	2005	571	85	Fish	
	2006	1330	88	Fish	
Cen Calif Recreational	2004	80	14	Fish	
	2005	73	13	Fish	
	2006	49	9	Fish	
Triennial Survey	2004	33	23	Hauls	
Abundance Index	**Year**	**Cen Calif**	**So Calif**	**Units**	
CalCOFI	2003	52	92	Stations	
	2004	49	88	Stations	
	2005	86	191	Stations	
	2006	40	148	Stations	

Table 4. Comparison of model results.

Model	Total Biomass mt, age 1+	Spawning Output	Spawn Output Unfished	Spawn Output rel to Unfished
STAR B1	(exclude Triennial Survey index)			
2003 original	8913	1136	13412	8.5%
2003 new	9712	1277		9.4%
2007 new	14559	2075	13563	15.3%
STAR B2	(exclude Recreational CPUE)			
2003 original	5455	733	13064	5.6%
2003 new	6783	938		7.1%
2007 new	9582	1430	13132	10.9%
STAT C	(use all abundance indexes)			
2003 original	7133	984	13387	7.4%
2003 new	8213	1134		8.4%
2007 new	10752	1727	13572	12.7%
STAT C MPDh	(use all abundance indexes)			
2003 original				
2003 new	9634	1274		9.5%
2007 new	13661	2049	13368	15.3%

Table 5. Management reference points for bocaccio.

	units	STARb1	STARb2 (Model)	STATc	STATcMPDh
Steepness(h)		ca. 0.2	ca. 0.2	ca. 0.2	0.44
Unfished Reference Points					
Reference source		Ravg51-86	Ravg51-86	Ravg51-86	SRR
Spawning Output	billion eggs	13563	13132	13572	12591
Summary (1+) Biomass	mtons	71104	68894	71195	66036
Mean Recruitment at age 1	thousands	5451	5270	5449	5039
SPR(F=0)		2.488	2.492	2.491	2.502
Current status (2006)					
Spawning Output	billion eggs	2075	1430	1727	2049
Spawning Output at SB40%	billion eggs	5425	5253	5429	5036
Relative depletion		15.3%	10.9%	12.7%	16.3%
Summary (1+) Biomass	mtons	14559	9582	10752	13661
2006 Catch (including discards)	mtons	67	67	67	67
Exploitation rate		0.0046	0.0070	0.0062	0.0049
Overfishing threshold (ExpRate at SPR50%)		0.0633	0.0631	0.0630	0.0633
ABC	mtons	922	605	677	865
OY (40-1010)	mtons	426	66	193	401
Reference Points based on SB40%					
Spawning Output at SB40%	billion eggs	5425	5253	5429	5036
Recruitment at SB40	thousands				4322
SPR resulting in SB40%					47%
Exploitation rate at SB40%					0.0707
Bsummary at R(SB40%)	mtons				29565
Yield with SPR(SB40%) at SB40%		undefined	undefined	undefined	2090
Reference Points based on SPR50%					
Spawning Output at SPR50%	billion eggs				5668
Recruitment at SB(SPR50%)	thousands				4531
SPRmsy proxy		50%	50%	50%	50%
Exploitation rate at SPR50%		0.0633	0.0631	0.0630	0.0633
Bsummary at R(SB(SPR50%))	mtons				32803
Yield with SPR50% at SB(SPR50%)		undefined	undefined	undefined	2076
Reference Points based on SPR50% proxy at SB40%					
Spawning Output at SB40	billion eggs	5425	5253	5429	5036
SPRmsy proxy		50%	50%	50%	50%
Exploitation rate at SPR50%		0.0633	0.0631	0.0630	0.0633
Approx Bsummary at SB40% given Exploitation rate at SPR50%	mtons	30928	30313	31341	29146
Yield with SPR50% at SB40%	mtons	1958	1913	1974	1845
Reference Points based on estimated MSY values from SRR					
Smsr, Spawning Output at MSY	billion eggs	undefined	undefined	undefined	4549
Smsr/Sunfished					36%
R at Smsr	thousands				4138
SPRmsy					1.0992
rel SPRmsy					44%
Exploitation rate at SPRmsy					0.0768
Bsummary at Smsy	mtons				29671
MSY	mtons	undefined	undefined	undefined	2279

Table 6. Results of model STATc for recent years. Approximate values at MSY assume F(SPR=0.5) at B=0.4Bunfished where Bunfished is estimated from the unfished biomass resulting from average recruitment from 1951 to 1986.

Year	Spawning Output	Relative Abundance	Total age1+ Biomass	Recruits at age 1	Catch	Exploitation Rate
avg value unfished	13572	100%	71230	5456	0	0
approx value at MSY	5429	40%	31340	2182	1974	6.30%
1995	820	6.0%	5348	796	774	14.5%
1996	808	6.0%	5037	435	566	11.2%
1997	804	5.9%	4944	1006	479	9.7%
1998	802	5.9%	4796	245	206	4.3%
1999	836	6.2%	4888	368	197	4.0%
2000	871	6.4%	5882	5944	189	3.2%
2001	901	6.6%	6522	50	207	3.2%
2002	958	7.1%	7422	481	132	1.8%
2003	1134	8.4%	8213	489	14	0.2%
2004	1386	10.2%	9283	2732	82	0.9%
2005	1585	11.7%	10024	917	87	0.9%
2006	1727	12.7%	10752	1049	67	0.6%

Table 7. Median projected abundances of bocaccio, at SPR of 77.7% beginning in 2009, without reversion to 40-10 policy upon attainment of rebuilding target. Estimates are based on model STATc and future projections do not include imprecision in estimated 2006 status. Bold values indicate rebuilt status. Catch is observed value in 2006, and is assumed in 2007-08.

Year	SPR	Catch	ABC	Depletion			Spawning Output		
	projected	median	median	5%	median	95%	5%	median	95%
2006	0.939	67	677	12.7%	12.7%	12.7%	1727	1727	1727
2007	0.871	151	693	13.8%	13.8%	13.8%	1872	1872	1873
2008	0.823	218	704	14.9%	14.9%	14.9%	2015	2016	2024
2009	0.777	288	718	15.6%	15.7%	16.4%	2117	2128	2221
2010	0.777	302	753	15.9%	16.3%	18.9%	2156	2209	2564
2011	0.777	323	806	15.9%	17.0%	22.1%	2154	2298	2994
2012	0.777	354	882	15.8%	17.8%	25.7%	2137	2419	3480
2013	0.777	387	964	15.6%	18.9%	28.8%	2115	2561	3900
2014	0.777	426	1062	15.6%	20.2%	32.5%	2109	2744	4404
2015	0.777	467	1165	15.6%	21.8%	35.8%	2113	2960	4856
2016	0.777	507	1263	15.7%	23.7%	**40.2%**	2130	3212	**5452**
2017	0.777	546	1361	16.1%	25.9%	**44.5%**	2183	3505	**6036**
2018	0.777	586	1460	16.4%	27.9%	**49.2%**	2226	3782	**6665**
2019	0.777	622	1550	16.9%	30.1%	**54.0%**	2291	4079	**7320**
2020	0.777	661	1649	17.4%	32.4%	**59.7%**	2365	4396	**8092**
2021	0.777	723	1804	18.1%	34.5%	**66.6%**	2454	4680	**9033**
2022	0.777	772	1926	18.7%	37.1%	**74.4%**	2532	5025	**10084**
2023	0.777	826	2060	19.3%	39.9%	**83.3%**	2622	5408	**11295**
2024	0.777	890	2220	20.2%	**43.0%**	**91.2%**	2743	**5829**	**12367**
2025	0.777	936	2334	20.9%	**46.4%**	**101.2%**	2839	**6285**	**13721**
2026	0.777	1018	2538	21.9%	**49.4%**	**110.4%**	2962	**6699**	**14961**

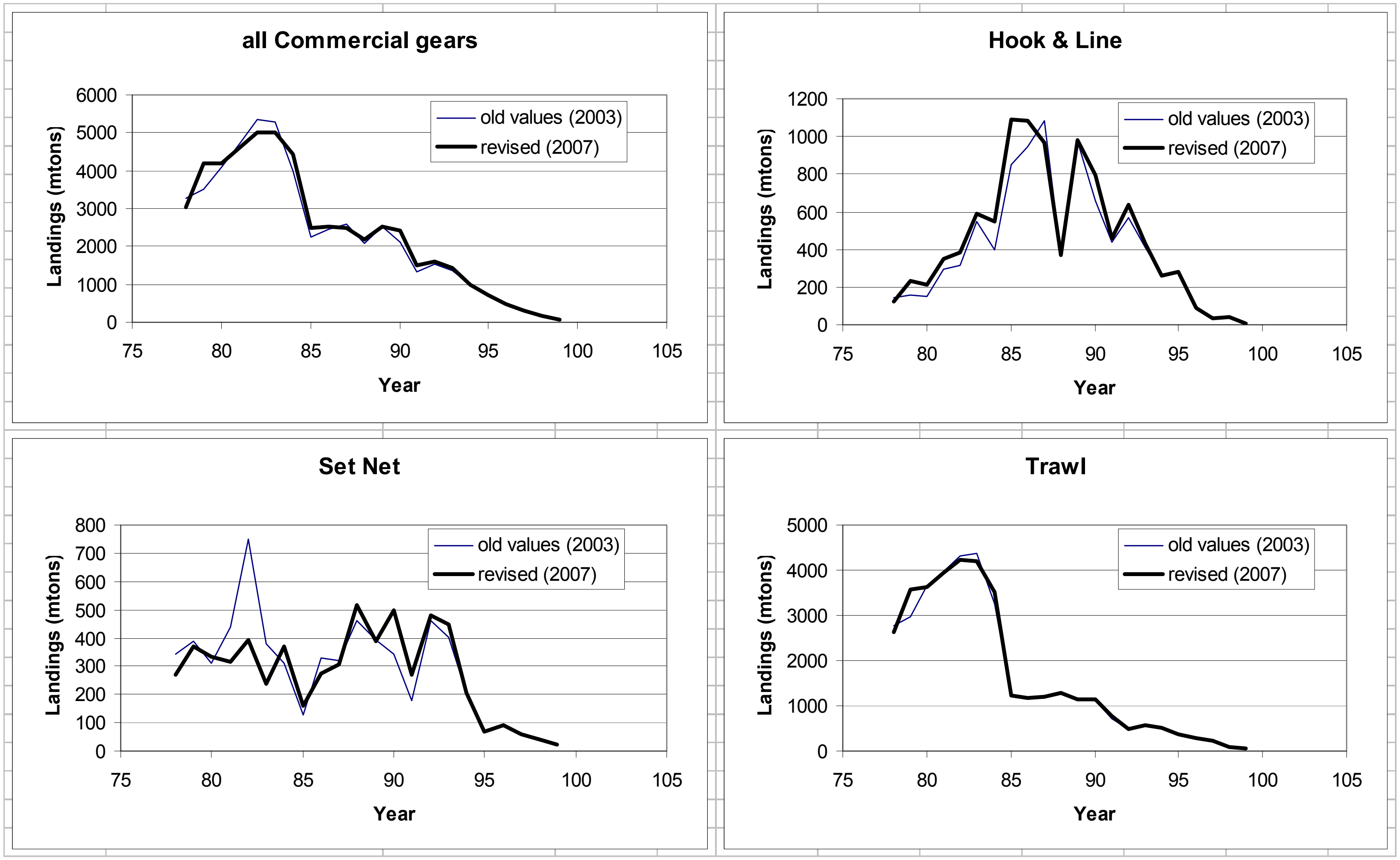


Figure 1. Comparison of revised commercial landings of bocaccio with values used in the 2003 assessment.

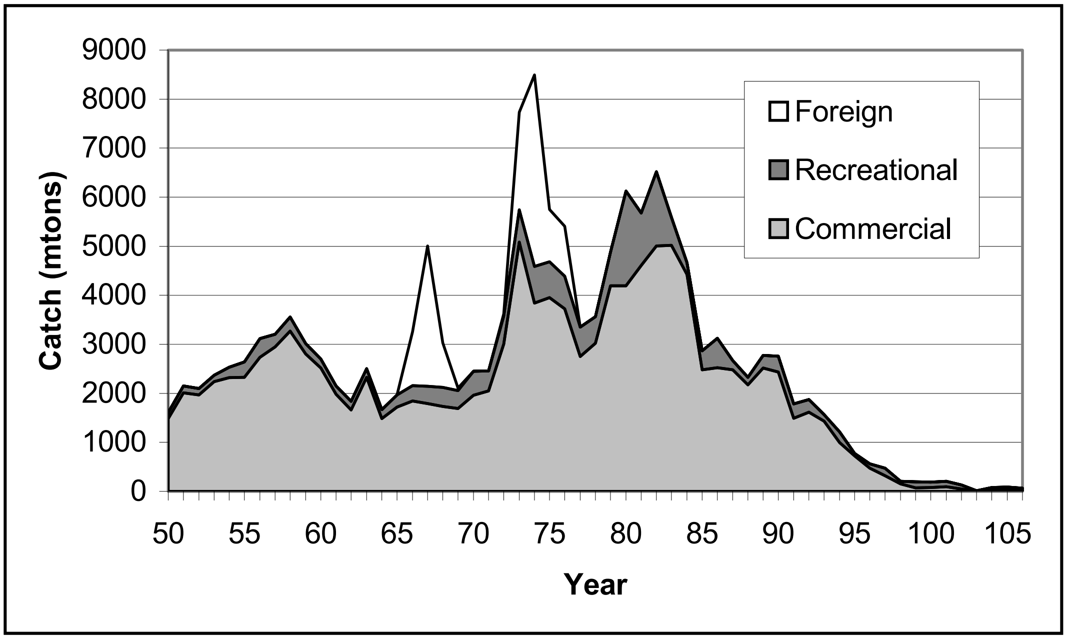


Figure 2. History of bocaccio catches, showing foreign, recreational and commercial components. A catch of 2000 mtons is assumed prior to 1950.

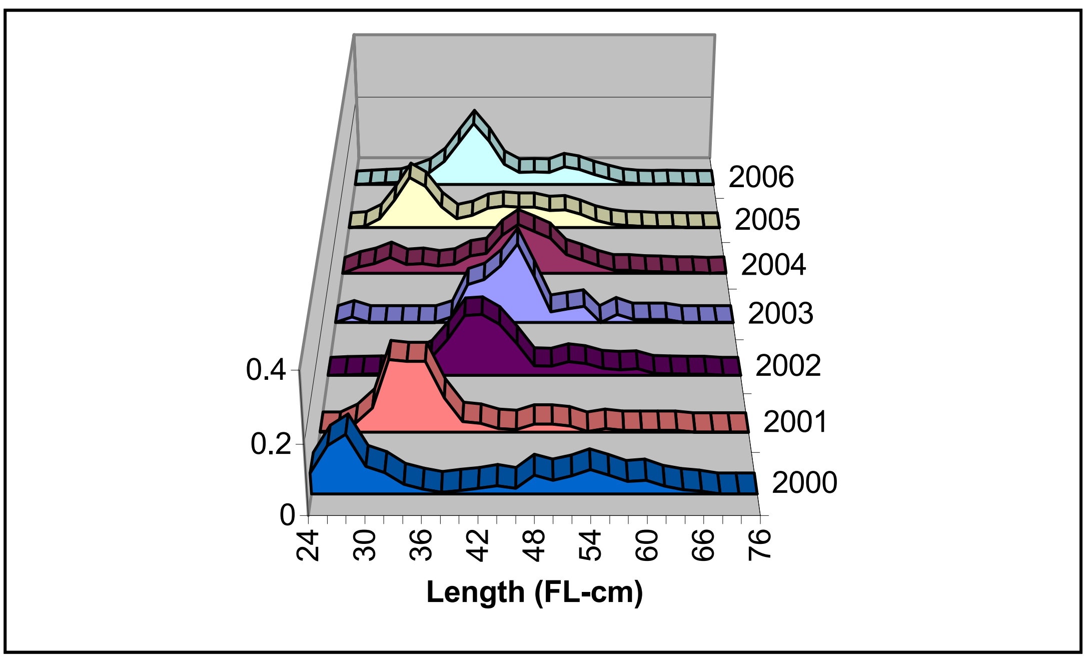


Figure 3. Length composition of bocaccio landed by the southern California recreational fishery.

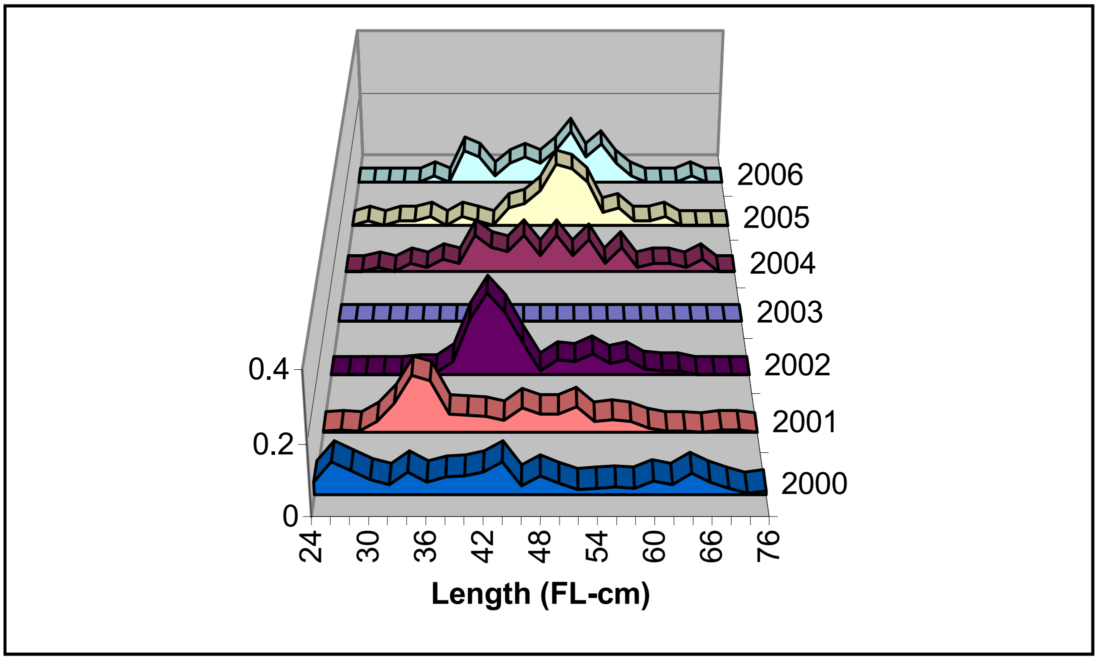


Figure 4. Length composition of bocaccio landed by the central California recreational fishery.

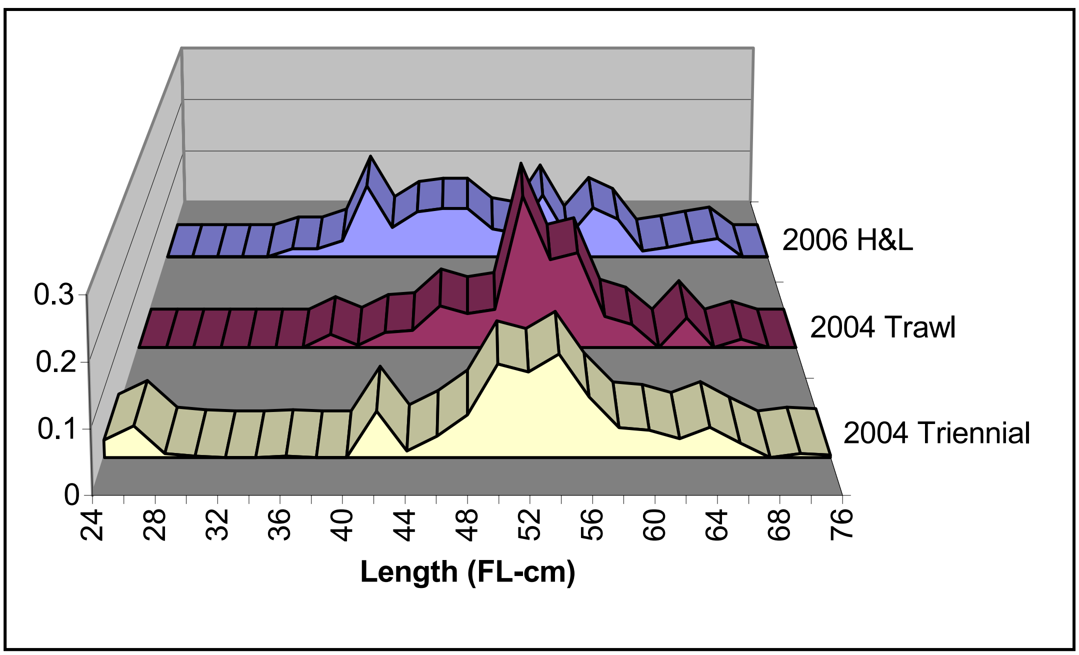


Figure 5. Other length compositions used in the 2007 bocaccio update.

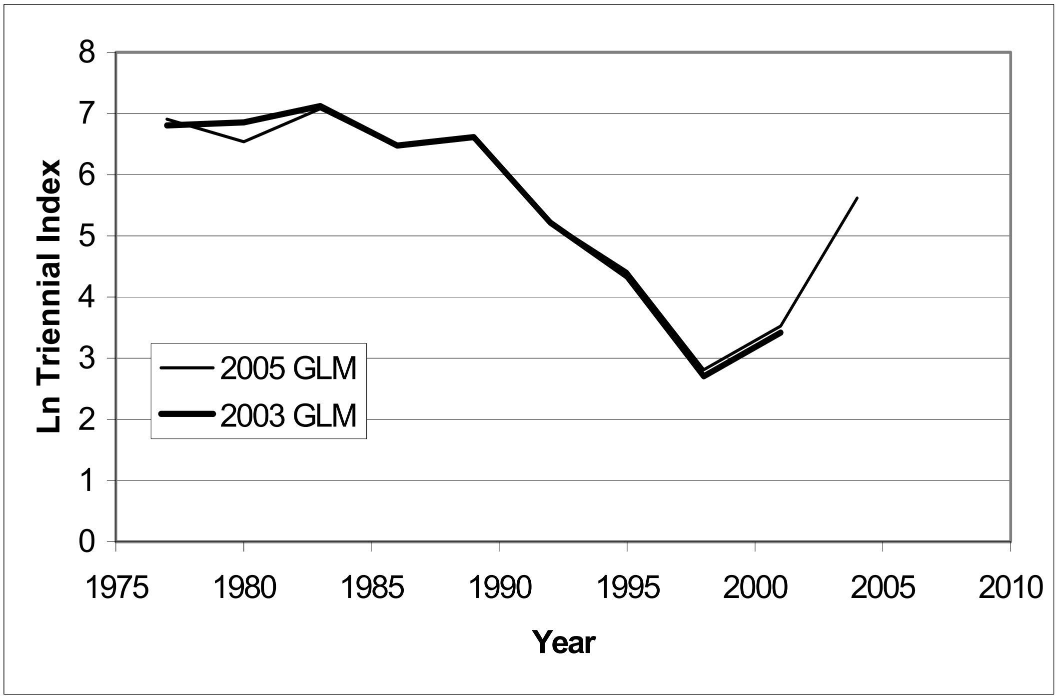


Figure 6. Triennial Trawl Survey index of bocaccio abundance (note log scale).

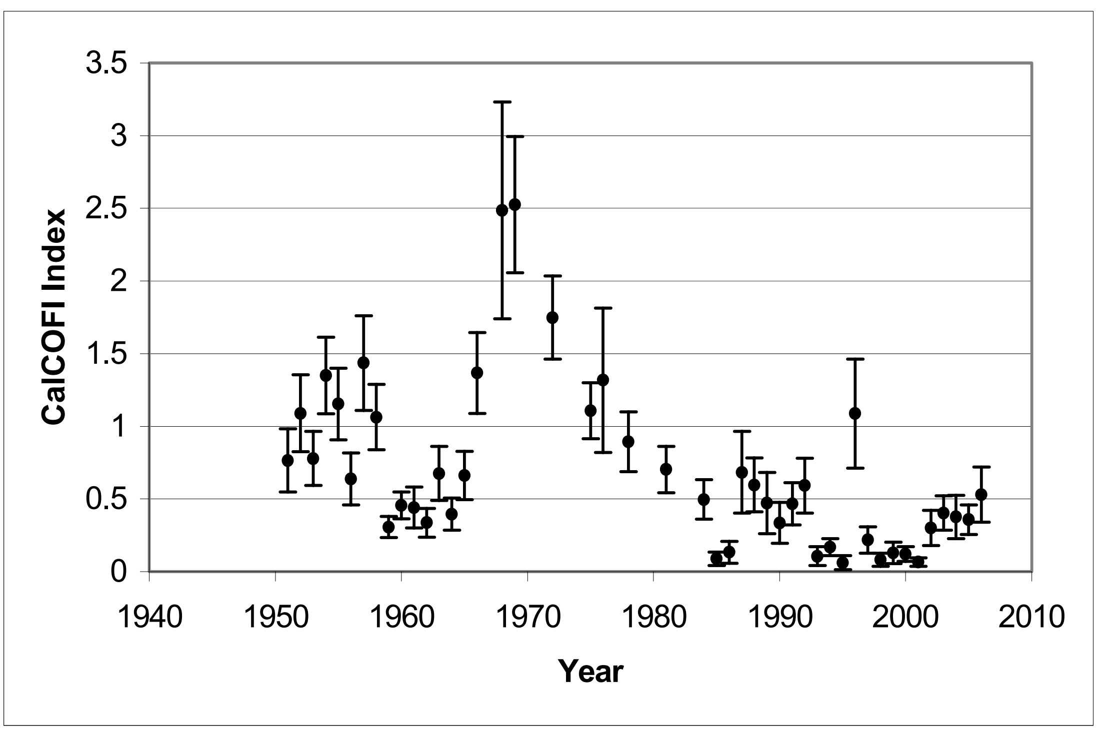


Figure 7. CalCOFI Survey index of bocaccio spawning output. Error bars are ± 1SE.

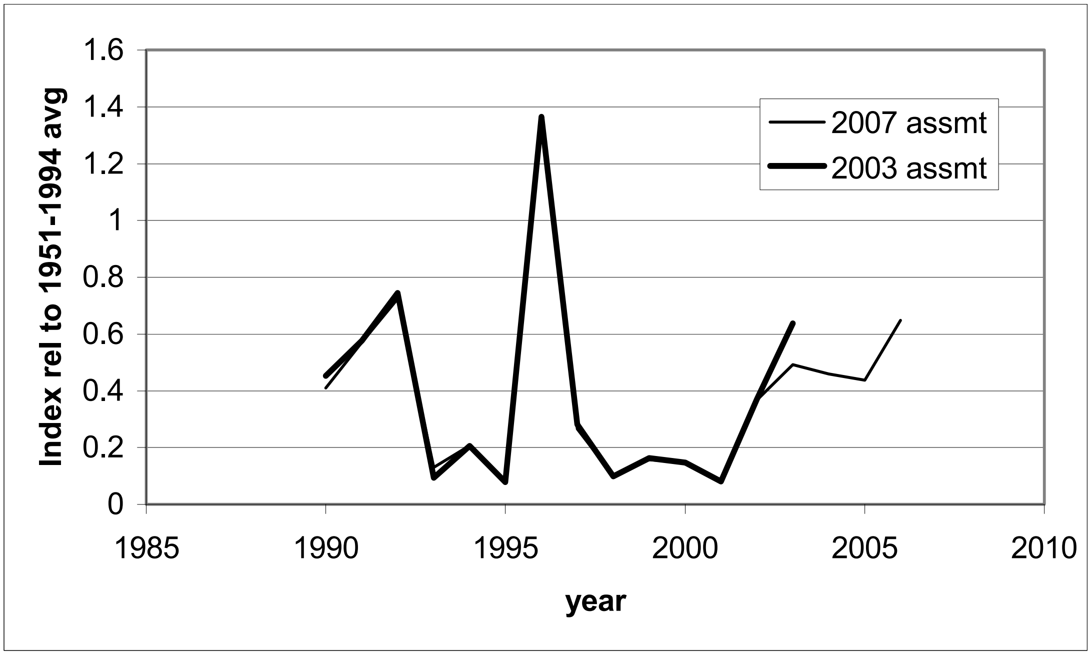


Figure 8. Comparison of updated recent CalCOFI Index values with values used in the 2003 bocaccio assessment (standardized for comparison). The 2003 point was based on incomplete data available in the 2003 assessment.

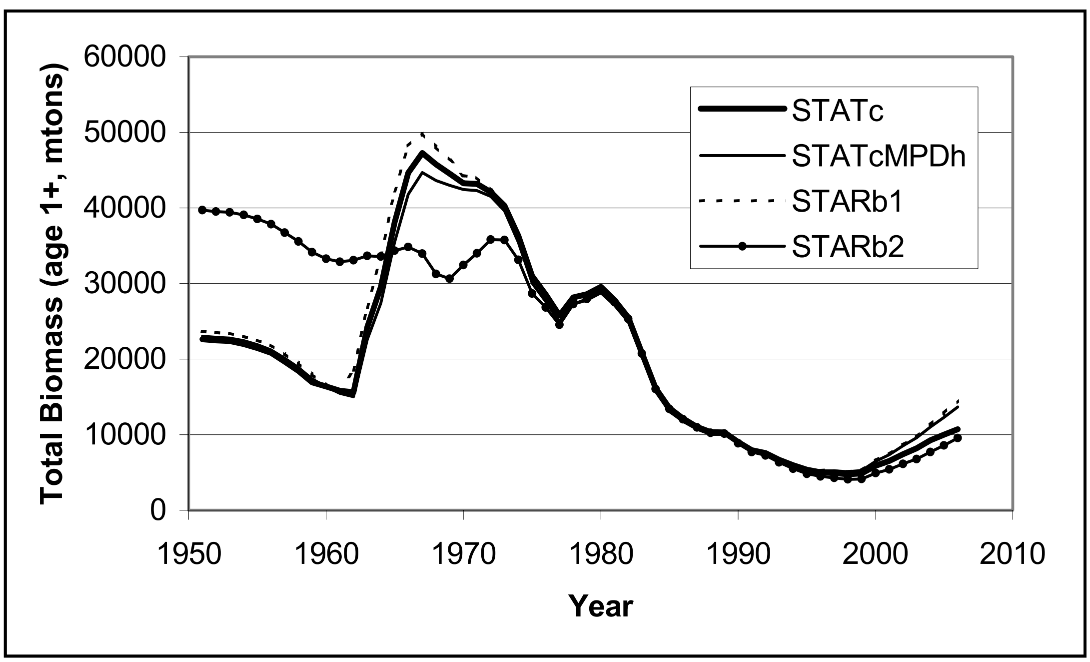


Figure 9. History of total biomass (age 1+) of bocaccio estimated by four alternative models.

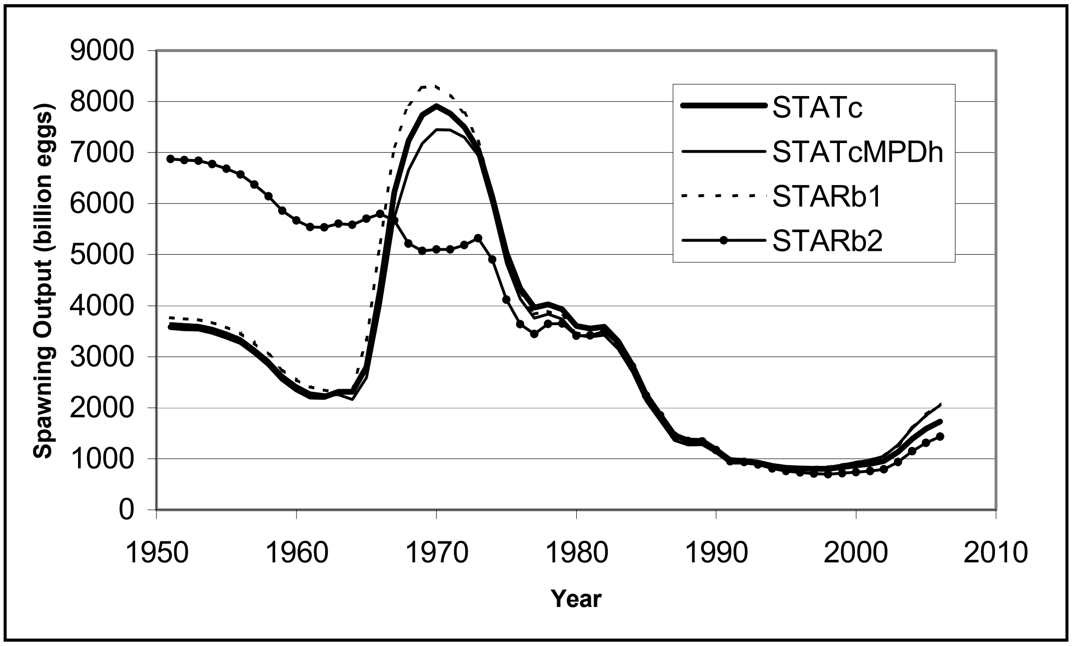


Figure 10. History of spawning output of bocaccio estimated by four alternative models.

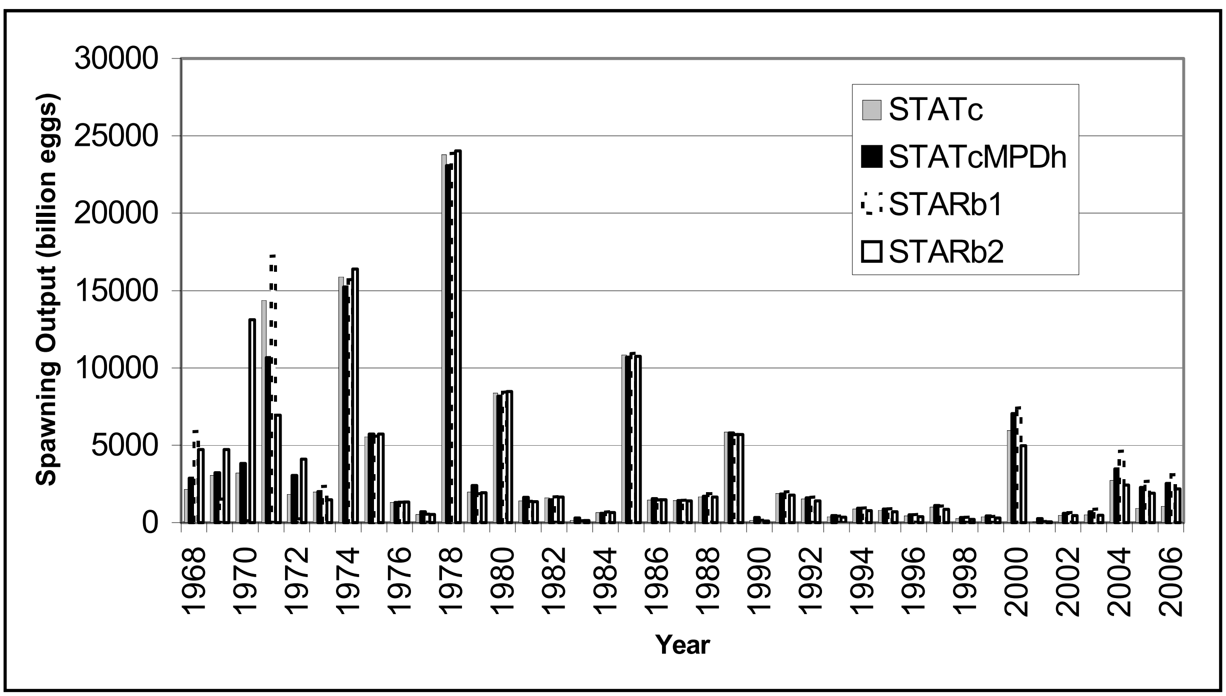


Figure 11. Trends in bocaccio recruitment (thousand fish at age 1) estimated by four alternative models. Indicated year is age 1, spawning occurred in previous year.

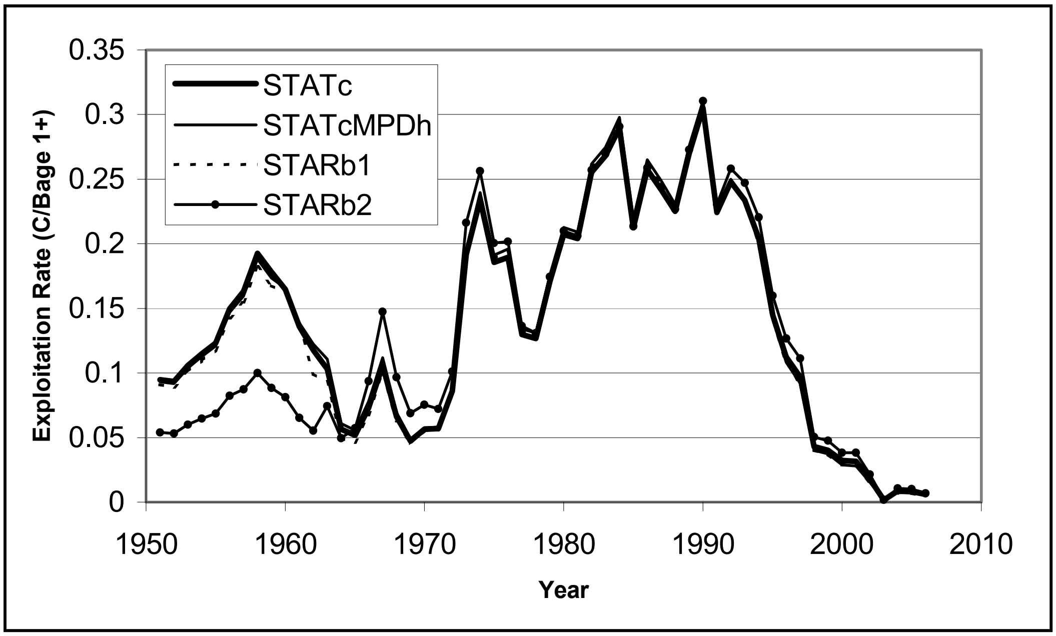


Figure 12. Trends in bocaccio exploitation rate indicated by four alternative models.

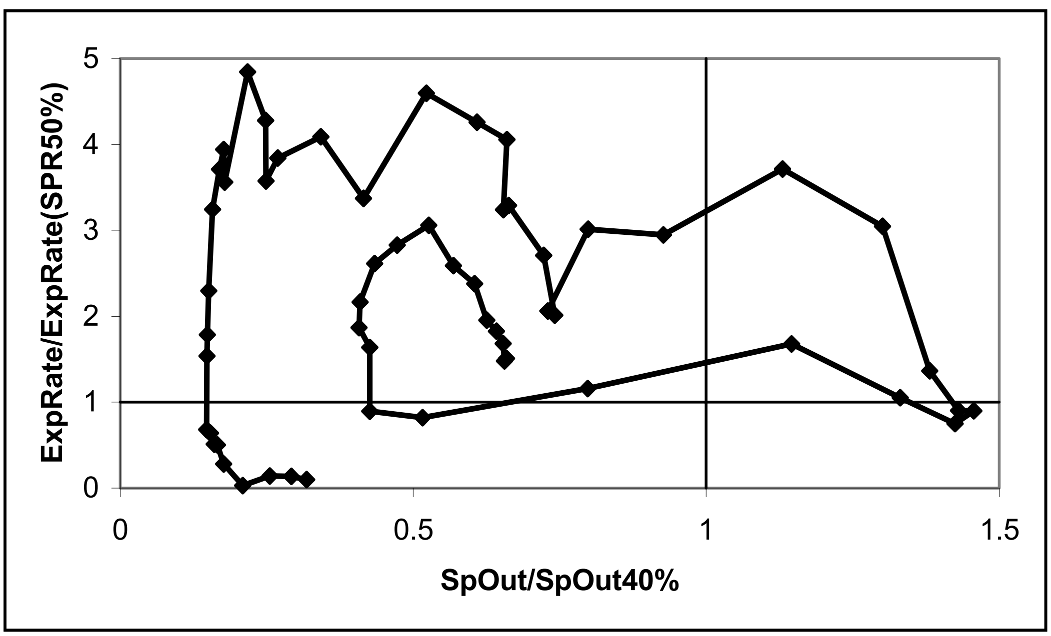


Figure 13. Historical exploitation rates and spawning outputs relative to target values. Plot begins in 1951 (near center) and ends in 2006 (lower left). Model is STATc.

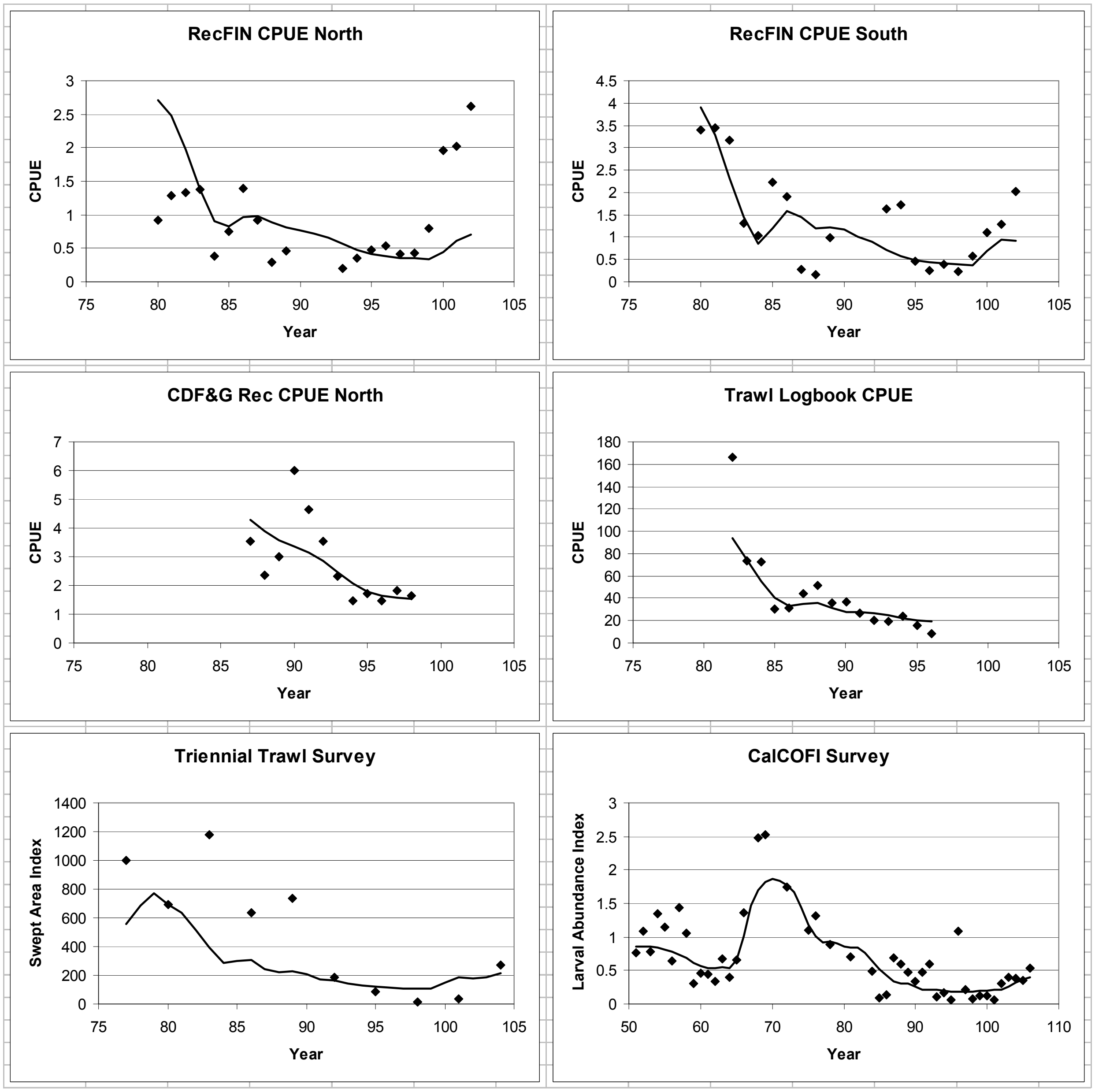


Figure 13. Model STATc2007 fits to abundance indexes and surveys. Triennial trawl survey in 2004 and CalCOFI indexes for 2003-2006 are the only new data since 2003.

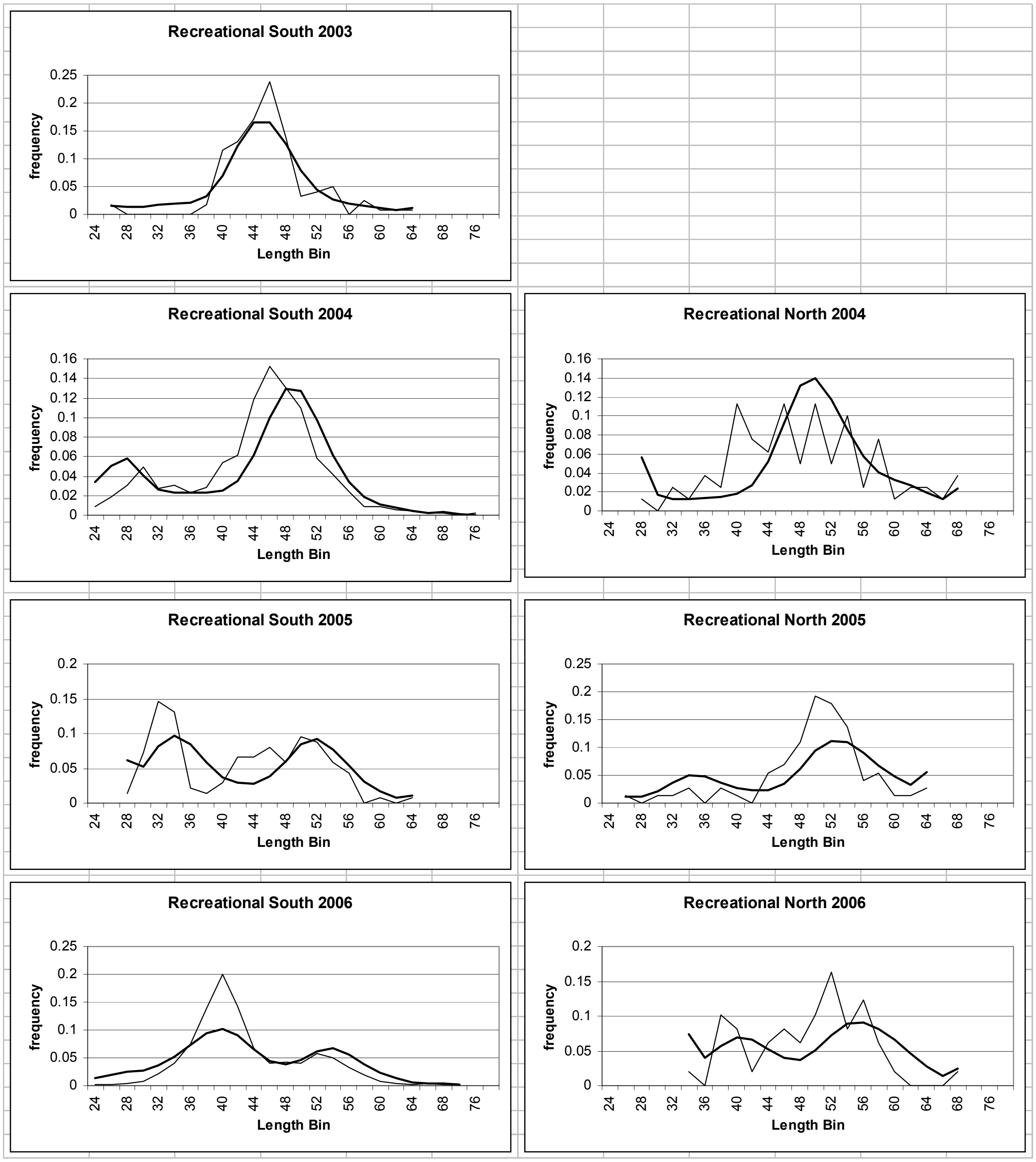


Figure 14. STATc model fits to recreational fishery length compositions collected since 2003.

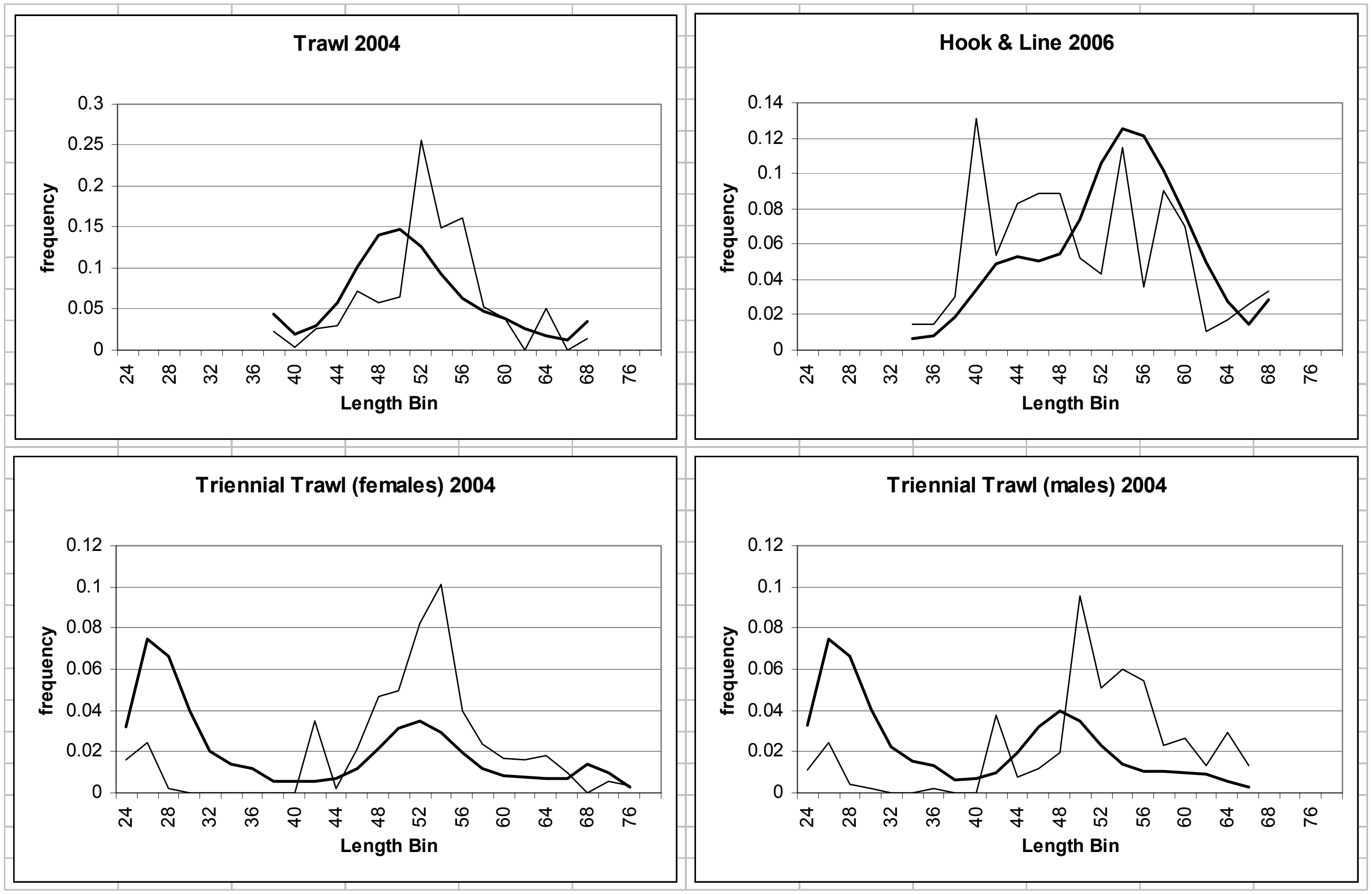


Figure 15. STATc model fits to commercial fishery and Triennial Trawl Survey length compositions.

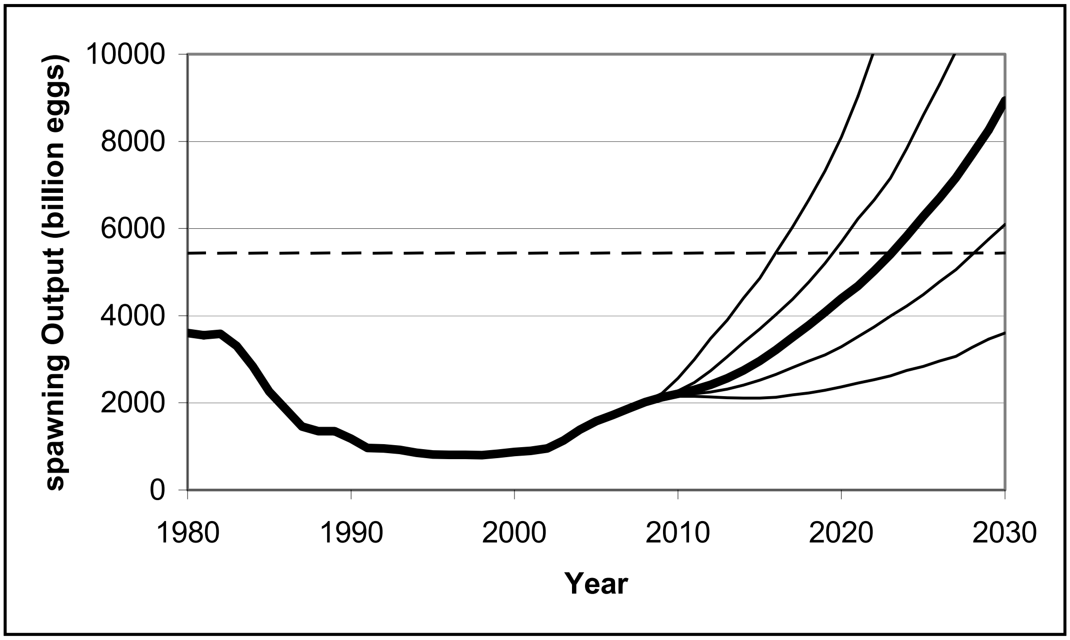


Figure 16. Projected spawning output under a constant SPR=77.7% rebuilding policy. Trajectories are 5, 25, 50 (median, bold line), 75 and 95 percentiles; broken line is B40 rebuilding target.

Appendix A. Responses to STAR Panel requests

Some requests are repeats of earlier requests, but were given a new sequence number:

The response to Request B is given as the responses to requests H and L.
The response to Request E is given as the response to request J.
The response to Request F is given as the response to request I.
The response to Request G is given as the response to request K.

STAR Panel request A. Re-examine the historical rockfish catch (back to 1916) using the ratio of bocaccio to total rockfish to estimate historical catches.

Reason: This will determine if the assumed equilibrium catch of 2000t is reasonable.

STAT response: The assumed 2000 ton historical catch was based on the few years prior to 1950. The entire history of rockfish catch in California is shown in Figure A1. Species compositions from early years indicate that bocaccio comprised approximately 50% of the total rockfish. The equilibrium value should be based on a weighted average catch, with recent years receiving more weight than much earlier years. Using an F=M assumption, an exponentially declining relative weight of exp(-0.3*yrs) gives a weighted pre-1951 average rockfish catch of 3150 mtons, or about 1575 mtons of bocaccio, which is somewhat below the value assumed in the assessment.

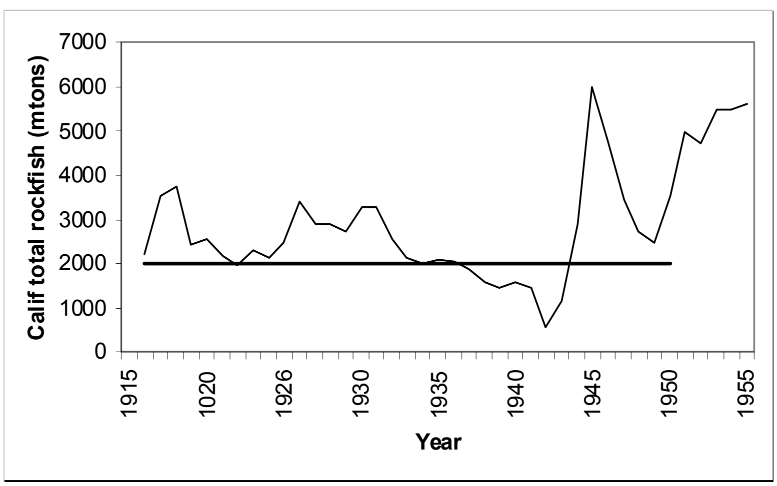


Figure A1. Rockfish catches from early California landings records. Horizontal line is bocaccio catch assumed in the model.

STAR Panel request C. Do a model run using steepness=0.44, lambda=1 on the S/R curve and remove the recent recreational CPUE values. Retune the CPUE and survey S.E.

Reason: This is a working model to be used in the subsequent runs. Removing the recent cpue values removes the conflict with the triennial survey.

STAT response: This model run (termed the STAR model) was done as requested, and results are shown in Figure A2. The effect of removing recent recreational CPUE values has little effect on the model. Assuming steepness h=0.44 with full emphasis on the SRR has an effect mainly on pre-1970 estimates of abundance, including estimated unfished abundance. The STAR model gives an estimated unfished spawning output of 9763 and a current spawning output of 1761, for a currrent depletion level of 18%. The STATc model (h=0.2) does not give a SRR-based estimate of unfished spawning output, but the standard SSC procedure of applying unfished SPR to the average early recruitments gives an unfished spawning output of 13572, and the current spawning output of 1660 is a depletion level of 12%.

The STAT considers the Triennial Survey, which is conducted in inappropriate habitat for bocaccio, to be the least reliable source of abundance information in the bocaccio model, and disagrees with the STAR Panel in the rationale for downweighting the recent recreational CPUE values. Adoption of a steepness of h=0.44 is arbitrary, and is one of a wide range of plausible values rom Dorn's meta-analysis. Proper treatment of the uncertainty in steepness requires a full MCMC integration of model outcomes, but cannot be done in SS1.

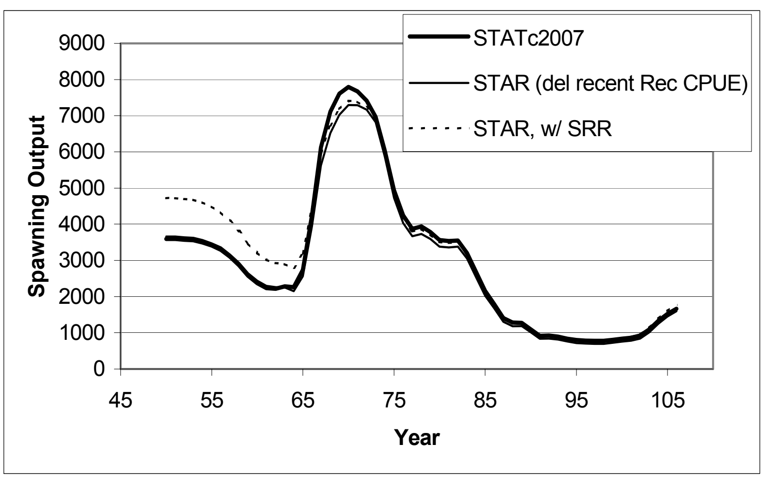


Figure A2. Model requested by STAR Panel request C, showing cumulative effect of deleting recent CPUE, and then assuming steepness h=0.44.

STAR Panel request D. Do sensitivity runs to equilibrium catches of 1000 and 3000t using the working model (Request C). Output the biomass trajectory and depletion.

Reason: Determine the effect of the magnitude of equilibrium catch on estimated abundance.

STAT response: The model values of spawning output are shown in Figure A3. Alternative assumptions of early catches has an effect mainly on pre-1970 estimates of abundance, including estimated unfished abundance. Depletion and related reference points are as follows:

Model	Unfished Sp Output	Current Sp Output	Relative Depletion
STAR, eq C = 1000	9376	1971	21%
STAR, eq C = 2000	9763	1761	18%
STAR, eq C = 3000	11654	1682	14%

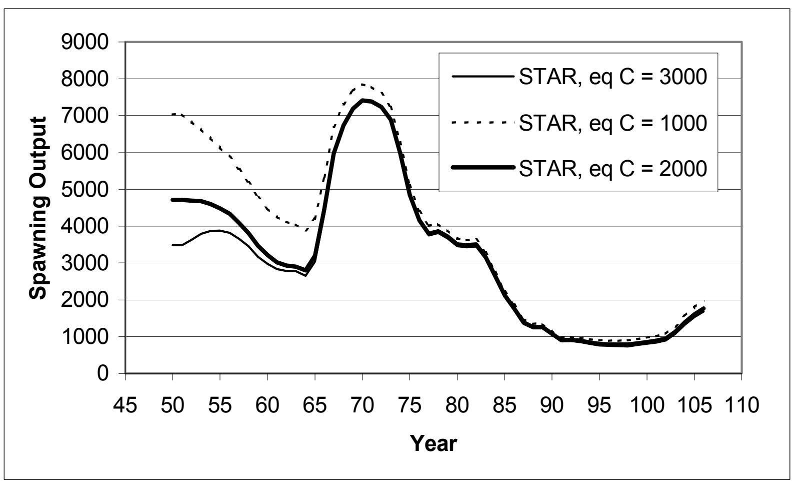


Figure A3. STAR model with alternative assumed values of pre-1951 catch.

STAR Panel request E. Do a new model run starting in 1916 with no equilibrium catch and ramping up catch to 2000t in 1930. This will be done using the working model (Request C). Output the biomass trajectories and depletion.

Reason: To demonstrate the effect of assuming equilibrium conditions as opposed to assuming the population was not in equilibrium conditions with a similar magnitude of catch.

STAT response: Array limitations in SS1 do not allow the model to start as early as 1916. The STAR Panel produced a modified request J below.

STAR Panel request H. (Repeats request B) Determine the co-occurrence of other species in RecFIN trips that caught bocaccio from 1993-2006. For trips that caught bocaccio, produce the proportion of those trips that also caught other species (only the top 20 or so).

Reason: Attempt to distinguish near shore from offshore fishing using co-occurrence of species in the RecFIN source, to confirm no change in recreational fishery selection patterns in recent years.

STAT response: (Southern California is given under Request L). The data were divided into four time periods, the 1980s, the 1990, 2000-2002, when bocaccio catches were restricted but fishing areas were unrestricted, and 2004-2006 when fishing was restricted mostly to nearshore areas (no samples were taken in 2003). As expected, the species co-occurrences tend to show a higher probability of catching nearshore species in the latter time period. However, the STAT disagrees with the STAR Panel interpretation. Any increase in selectivity of nearshore fish in central California is irrelevant to the estimated strength of the 2003 year class because it was not seen in central California length comps–it was only seen in southern California.

In the following table, a BOLD entry indicates a value higher than in any preceding column, and a small ***italic*** entry indicates a value smaller than in any preceding column.

species\years	1980's	1990's	2000-02	2004-06
n bocaccio trips (Cen CA)	241	238	29	92
yellowtail rockfish	0.618	0.895	0.828	*0.587*
blue rockfish	0.324	0.647	*0.310*	**0.924**
lingcod	0.390	0.622	*0.310*	**0.826**
canary rockfish	0.494	0.655	0.621	*0.228*
vermilion rockfish	0.232	0.517	0.379	**0.870**
rosy rockfish	0.373	0.706	*0.587*	*0.511*
starry rockfish	0.340	0.643	0.483	**0.739**
olive rockfish	0.199	0.521	0.276	**0.826**
copper rockfish	0.154	0.382	0.310	**0.815**
gopher rockfish	0.058	0.193	0.103	**0.457**
widow rockfish	0.261	0.529	0.448	*0.261*
China rockfish	0.071	0.126	0.103	**0.435**
black rockfish	0.033	0.034		**0.087**
greenspotted rockfish	0.402	0.361	**0.621**	*0.098*
brown rockfish	0.041	0.076	*0.034*	**0.272**
yelloweye rockfish	0.299	0.214	0.276	*0.033*
chub (Pacific) mackerel	0.116	0.239		0.141
Pacific sanddab	0.083	0.214	0.138	0.185
greenstriped rockfish	0.336	0.248	**0.345**	*0.011*
chilipepper	0.432	0.155	0.379	*0.054*
kelp greenling	0.017	0.013		**0.152**
speckled rockfish	0.104	0.277	0.207	*0.076*
cabezon	0.021	0.017		**0.185**
flag rockfish	0.075	0.176	**0.241**	0.228

STAR Panel request I. (Repeats request F) Do a new model assuming a logistic selectivity pattern (estimated) for the triennial survey and using the working model (Request C). Produce a table of likelihoods for all components, biomass trajectories and depletion. Show the fits to the triennial proportion at length data, CPUE series, and surveys.

Reason: To see the effect of the current selectivity pattern on the estimates of recruitment in the recent period.

STAT response: The resulting "logistic" selectivity is uniform for all sizes, as there is no ascending limb. The log-likelihood for the Triennial Survey length comps is 11.7 units worse, and the overall model is 11.2 units worse. This selectivity curve would be rejected by conventional goodness-of-fit criteria. The table of likelihood values is given below.

		Model		
Source	Type	base	logistic	difference
TWL	Length Comps	-539.144	-538.437	0.707
H&L	Length Comps	-203.397	-203.141	0.256
SetNet	Length Comps	-258.783	-258.286	0.497
RECLso	Length Comps	-319.271	-320.059	-0.788
RECLnor	Length Comps	-267.985	-268.389	-0.404
TRIENNIAL	Length Comps	-83.199	-94.901	-11.702
RecFINno	CPUE (N)	1.003	0.939	-0.064
NoCalDFG	CPUE (N)	8.198	8.183	-0.015
RecFINso	CPUE (N)	-3.867	-3.885	-0.018
TrawlLogbooks	CPUE (B)	9.036	9.345	0.309
TRIENNIAL	SURVEY (BIOMASS)	-5.772	-5.549	0.223
CALCOFI	SURVEY (SSB)	-1.722	-1.582	0.14
BEV-HOLT SRR	MODEL	-25.411	-25.787	-0.376
TOTAL		-1690.32	-1701.55	-11.2329

STAR Panel request J. (a modification of request E). Do a new model run starting in 1930 (due to SS1 constraints) with no equilibrium catch and catches after 1930 until the start of the measured catches set at 2000t. This will be done using the working model (Request C). Output the biomass trajectories and depletion.

Reason: To demonstrate the effect of assuming equilibrium conditions as opposed to assuming the population was not in equilibrium conditions with a similar magnitude of catch.

STAT response: The requested model uses a stock reduction analysis (SRA) between unfished conditions and the 1951 start of data. Output is shown in Figure A4. The model had difficulty converging, and is an approximate solution; also, there are not enough model years to allow Again, the alternative treatment of initial conditions has an effect mainly on pre-1970 estimates of abundance, including estimated unfished abundance. Results are not plausible, given the disagreement with CalCOFI abundance index values the early 1950s. The STAT does not consider a stock reduction analysis approach for setting initial conditions to be plausible for bocaccio because it does not recognize that abundance is determined by rare large recruitments. Because recruitment is sporadic, there is no basis for assuming that the population was at the theoretical unfished level at any particular year in the past–it could have been anywhere is a wide range about that value. This bocaccio model is insensitive to these initial conditions, as all models converge to approximately the same result by 1970. This is partially because the model tracks only ages 1 to 20, and all recruitments prior to 1950 are collapsed into the "plus-group" by 1970.

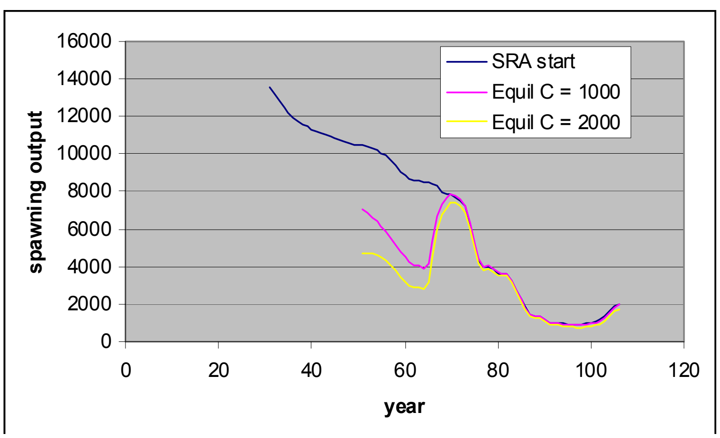
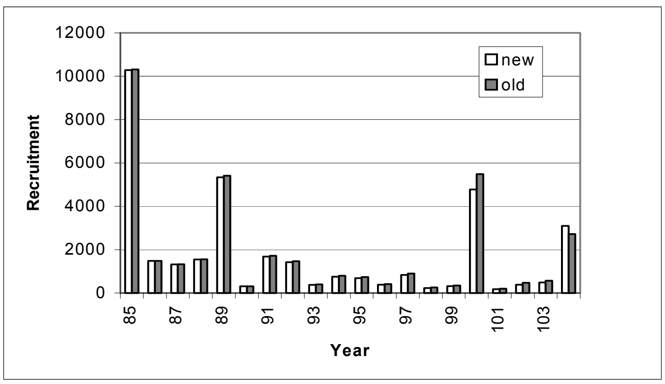


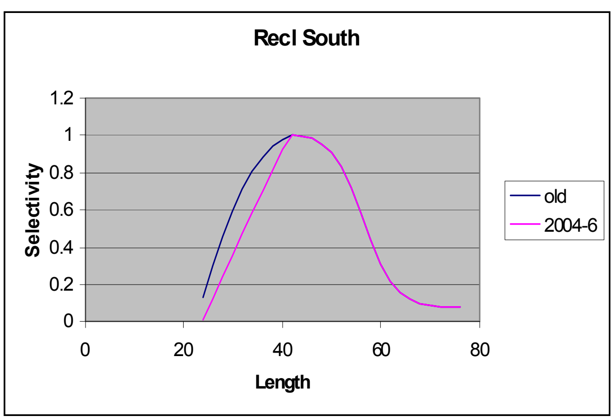
Figure A4. Trajectory of spawning output resulting from initializing the model with a stock reduction analysis from 1930 to 1950, as opposed to assuming equilibrium under a constant catch.

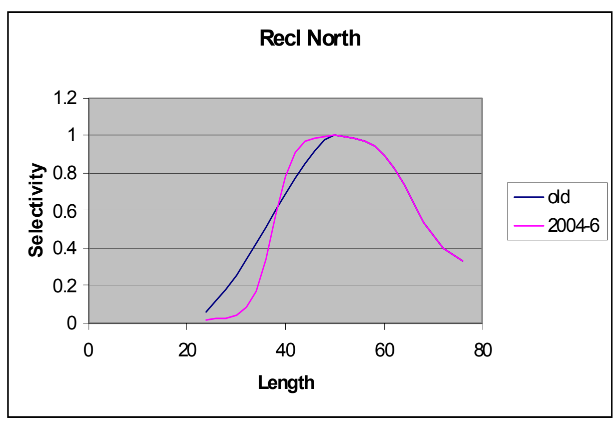
STAR Panel request K (repeats request G). Produce a model with separate blocks of selectivity for the southern recreational fleet pre and post 2003. Use the working model (Request C). You may have to extend the last block including earlier years to get convergence.

Reason: Determine the effect of a constant selectivity on the magnitude of recruitment given that the fishery may have changed due to management.

STAT response: Separate selectivity curves for 2003-2006 were obtained by creating a separate southern and central California recreational fisheries for that period. Total log likelihood improved by 13.7 points at a cost of estimating 14 new parameters, which would be rejected by conventional criteria. The resulting estimate of the 2003 year class strength is larger than before, contradicting the STAR Panel's motivation based on a possible overestimate of the 2003 year class due to changes in selectivity. The recreational fishery selectivity curve for central California indicates greatly decreased selectivity of small fish, presumably because the 2003 year class does not appear in the length compositions.







STAR Panel request L (repeats requests H and G) Determine the co-occurrence of other species in southern RecFIN trips that caught bocaccio from 1993-2006. For trips that caught bocaccio, produce the proportion of those trips that also caught other species (only the top 20 or so).

Reason: Attempt to distinguish near shore from offshore fishing using co-occurrence of species in the RecFIN source, to confirm no change in recreational fishery selection patterns in recent years.

STAT response: In southern California, the 2004-2006 pattern of co-occurrences was more like those of the 1980s and 1990s than was the case for 2000-2003. The STAT disagrees with the STAR Panel opinion that selectivity changes may account for the large estimated 2003 year class.

In the following table, a BOLD entry indicates a value higher than in any preceding column, and a small ***italic*** entry indicates a value smaller than in any preceding column.

species\years	1980s	1990s	2000-03	2004	2005	2006
n bocaccio trips (So CA)	200	95	117	385	394	513
Pacific mackerel	0.515	0.295	***0.239***	***0.223***	0.305	***0.228***
kelp bass	0.195	0.095	***0.077***	**0.213**	0.180	0.148
barred sandbass	0.125	0.074	**0.128**	**0.130**	0.157	0.097
Pacific barracuda	0.085	0.063	***0.051***	0.073	0.058	***0.033***
California scorpionfish	0.275	0.242	**0.496**	***0.197***	0.246	***0.242***
ocean whitefish	0.225	0.253	**0.333**	***0.153***	***0.195***	***0.175***
Pacific bonito	0.180	0.053	***0.034***	0.101	0.056	0.107
California halibut	0.065	0.011	**0.103**	**0.083**	**0.071**	0.039
California sheephead	0.155	0.168	**0.171**	***0.138***	***0.140***	***0.109***
vermilion rockfish	0.455	0.453	**0.718**	**0.727**	0.652	0.696
white croaker	0.120	0.021	0.085	***0.016***	***0.015***	0.035
starry rockfish	0.445	0.295	**0.496**	0.312	0.343	0.392
treefish	0.070	0.116	**0.239**	0.091	0.104	0.099
olive rockfish	0.240	0.042	0.145	0.135	0.119	0.136
yellowtail	0.020	0.084	***0.017***	0.029	0.030	0.023
lingcod	0.175	0.189	**0.564**	0.452	0.457	0.370
honeycomb rockfish	0.145	0.168	**0.274**	0.164	0.188	0.183
copper rockfish	0.185	0.284	**0.359**	0.281	0.234	0.351
flag rockfish	0.425	0.242	**0.470**	0.270	0.279	0.333
squarespot rockfish	0.345	0.253	0.274	***0.127***	***0.132***	***0.160***
Pacific sanddab	0.190	0.221	**0.385**	0.195	***0.157***	0.259
greenspotted rockfish	0.390	0.242	**0.410**	0.312	0.269	0.316
rosy rockfish	0.265	0.189	**0.308**	***0.151***	***0.129***	***0.142***

Appendix B. Responses to comments and recommendations in 2003 and 2005 STAR reports.

1.0 Items from Bocaccio 2003 STAR Panel Report

1.1 STAR: Triennial survey selectivity is implausible. The selectivity curve of the triennial survey appeared nearly uniform over all sizes, which appeared very unlikely for a research bottom trawl survey.

STAT response: The STAT considers the Triennial Survey to be inappropriate for bocaccio, because it samples the wrong habitat. The selectivity curve for ages 2+ is flat, but the value for age 1 (the most pelagic period in the life history) is higher. This is not implausible.

The swept-area abundance estimates can be compared with the 2005 model re-run using only data north of Pt. Conception, and approximate values of q are shown in the table below. This provides an equivalent geographic area for comparison; the sum of the two area-specific models is approximately equal to the single stock model (this comparison is the best we can do for now). The opinion of the STAT is that the Triennial Survey (and similarly, the NWFSC combo survey) should be excluded from the assessment model.

year	Triennial tons	Synthesis CenCal only	est q
1977	13778	18530	0.74
1989	19132	4098	4.67
1992	2584	3225	0.80
1995	1646	2606	0.63
1998	424	2276	0.19
2001	485	3372	0.14
2004	6934	4279	1.62

1.2 STAR: A rebuilding analysis was not brought forward, and was not reviewed. The Panel provided in this report what it feels are appropriate recommendations for the parameters and historic recruitments to be used. Specifically, the Panel recommends B1-base and B2 models with constant recruitment to 1969 as alternative model scenarios (equal probability) with recruitment resampled only back to 1970. The Panel re-emphasizes its recommendation against using the Stock Synthesis estimates of steepness or recruitment strength prior to 1970 in rebuilding analyses.

Biomass and recruitment prior to 1970 are highly uncertain since the only available time series is the CalCOFI index, which may not be reliable, and in any case would be unable to resolve the relative strength of individual year-classes.

STAT response: Rebuilding analyses have complied with this recommendation. Values of R/S were resampled for recruiting years (age 1) since 1970, and have included both B1 and B2 models. Resampling R/S is consistent with the model estimate of steepness ca. 0.2.

1.3 STAR: The RecFIN CPUE indices and the triennial survey trends are contradictory. Fishery- dependent CPUE indices can mask real declines in abundance if fishers are able to redirect effort to areas of high density. Similarly, the triennial trawl survey may be less efficient at low stock abundance because bocaccio preferentially occupy untrawlable habitat (varying q with stock abundance). Generally, the Panel felt that data sources with conflicting information should not be used together in the assessment.

STAT response: Various STAR Panels have differed on how to treat this kind of conflicting information. The Council requires a single biomass as the basis of its action. If the assessment presents two different "equally plausible" numbers, the Council is left with little alternative but to take a simple average. The STAT considers a model that included both sources of information (model STATc) to be a better approach than to average the B1 and B2 results. The SSC concurred with this approach.

1.4 STAR: In general, Stock Synthesis predicted modes within the size composition data for bocaccio reasonably well, but had a tendency to consistently under-fit the magnitude of the modal size and overestimate the dispersion about the mode. The residual pattern from the fit to the length frequency data is unusual and indicates systematic lack of fit. Its effect on the assessment results is unknown.

STAT response: One promising area of future work would be to develop a time-varying growth model (similar to that for chilipepper in 2007). This requires migration to the SS2 modeling framework.

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

STAT response: CPUE indexes cease being used in the model after 2003, due to these sorts of uncertainties. Development of a monitoring program of site-specific CPUE is desirable, but is not within the scope of the STAT's capability.

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

STAT response: The STAT agrees with the recommendation to develop a variable growth rate model, which requires use of SS2. Ageing could be revisited if resources were provided to do the work. Unfortunately, the formal program budget has been insufficient since 2004.

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

STAT response: The STAT agrees, though the SS2 model is unlikely in itself to resolve the problems associated with diverse and in some cases contradictory data sets.

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

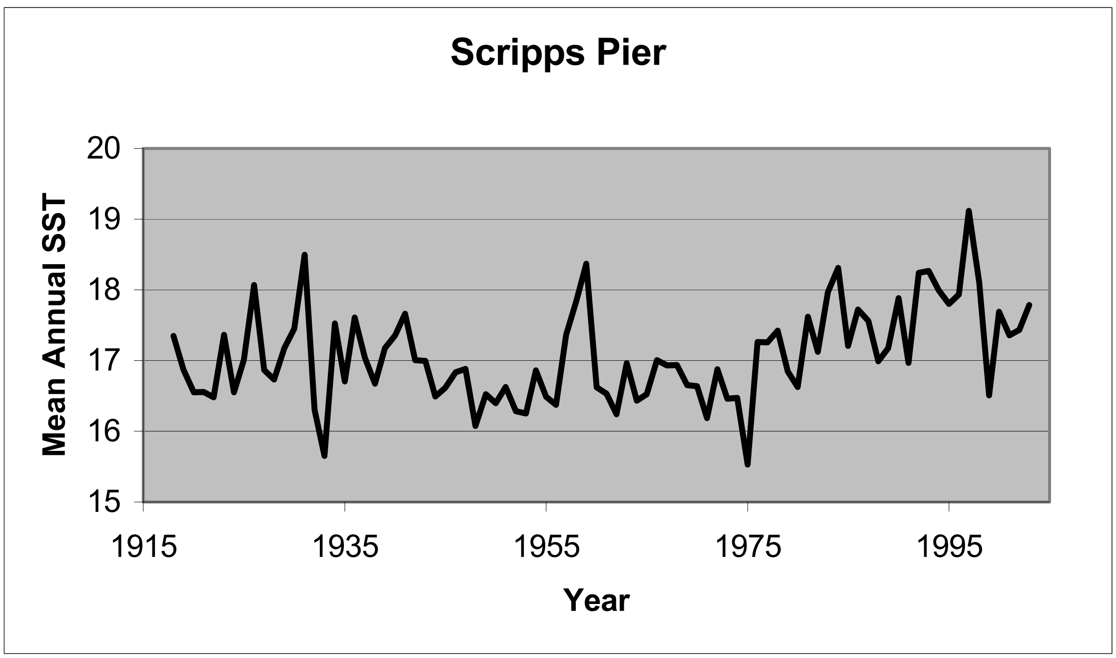
STAT response: We are making significant progress on this issue, but there is still a long ways to go The CDFG has now released landings receipt information back to 1969. We have obtained significant outside funding from the NESDID CDMP program to capture earlier historical landing data, and have captured summary data by market category (not strictly equivalent to species), month and geographic block of origin back to 1931. Unfortunately these summaries do not include gear information. We have microfiche of individual vessel landings data back to 1950, and work will begin this year to process portions of that massive data set.

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

STAT response: The initial conditions in the model are completely plausible, and there is nothing wrong with them. The assumed background level of annual catch (2000 mtons) is very close to the estimated MSY values in Table ES4, suggesting that the stock could easily have been at or below (especially given bocaccio’s tendency toward rare large recruitments) Bmsy at the beginning of the modeled period, ca. 1950.

1.10 STAR: The relationship between the CalCOFI index and climate should be evaluated. Two analyses are suggested. The first is to compare the residual patterns in model fits to an environmental index such as the Scripps Pier water temperatures. Adding an environmental covariate to the CalCOFI index catchability coefficient may improve the model fit to the index if annual egg production is influenced by environment conditions. A second analysis would be to compare biomass trends to indices associated with regime-scale environmental variability to see if significant correlations exist that would help explain long-term abundance trends.

STAT response: Both of these studies are desirable, but are not yet possible due to lack of information on colder ocean conditions. There was a major warming of California coastal waters between 1976 and 1998, and there is little sign that temperatures have returned to pre-1976 levels even yet. Given that the bocaccio model does not produce "reliable" independent estimates before the early 1970s (when the CalCOFI index itself is the only source of information), we lack the necessary contrast in ocean conditions to provide the needed information.



2.0 Items from Bocaccio 2005 STAR Panel Report

2.1 STAR: The triennial survey will likely be discontinued in 2006 so it is desirable to calibrate the triennial survey indices with those from the NWFSC Combined Survey.

STAT response: The NWFSC has taken the lead on calibration of the trawl surveys, and may want to consider doing this.

2.2 STAR: Exempted fishing permits are unlikely to provide the quality of catch and effort data hoped for. If exempted fishing permits are to be used to provide indices of abundance, it is necessary to check the power of the monitoring program first.

STAT response: This appears to be a response to a recommendation in the 2003 STAR report.

2.3 STAR: An exploratory delta-GLM analysis of the triennial survey was provided to the STAR Panel. The STAR Panel considered the analysis to be promising and suggested that it be applied to the NWFSC Combined Survey.

STAT response: The NWFSC is welcome to do this. Generically, they haven't been willing to release the data.

2.4 STAR: This species exhibits multiple annual spawning (as a function of age, size, or environment?). This possibility needs to be investigated based on fish collected from the fisheries or the survey if an index of spawning output based on larval counts is to be developed for comparison with the CALCOFI index or juvenile surveys.

STAT response: The STAT concurs. Due to management restrictions, sampling is no longer encountering enough fish to do this. Funding has been insufficient since 2004.

2.5 STAR: The indices of abundance are assumed to be linearly related to abundance. There is a possibility of non-linear relationships between the triennial indices and abundance due to density dependence and habitat (trawlable and untrawlable) considerations. Investigation of historical data and in situ observations may shed light on some possible relationships.

STAT response: The STAT concurs, though it still may not produce a useful index of abundance.

2.6 STAR: Models with time-varying growth should be included in the assessment if data can support them. The length data exhibit strong modes which could form the basis for such estimates.

STAT response: The STAT concurs. This requires SS2.

2.7 STAR: Although ageing of bocaccio is difficult, there are large numbers of otoliths that have been collected, but not been read. There is potential for using the age information to resolve broad-scale questions regarding changes over time in growth. Multiple reader studies, or other methods of validation, are desirable to assess reader bias and imprecision.

STAT response: Also see 1.6 above. Funding has been insufficient since 2004.

2.8 STAR: Models could be fitted to data on check marks if there is uncertainty about the interpretation of check marks as annuli. Check mark data could be treated in the same way as age data, i.e. subject to ageing bias and ageing imprecision, with the extent of ageing error treated as estimable within the model.

STAT response: The STAT concurs, but funding has been insufficient since 2004.

2.9 STAR: Future assessments should be based on Stock Synthesis 2. This should allow more formal quantification of parameter uncertainty. The next assessment should include a formal comparison of the results of SS1 and SS2 based on the current assessment.

STAT response: The STAT concurs.

2.10 STAR: Consideration should be given to the development of a more spatially disaggregated model for bocaccio. Although this approach was rejected by the 2002 STAR Panel, improved CalCOFI coverage north of Pt Conception since 2003 may support more spatial structure within the assessment.

STAT response: The STAT concurs, with reservations. This requires SS2, which has a limited capacity to model migration of adults between geographic areas. However, we lack knowledge of age-specific migration rates, so any model results would be very tentative.

2.11 STAR: According to the STATC model, the spawning output was close to the overfished threshold in the first year of the model (1951), which differs from the common assumption that the biomass is close to B0 at the beginning of the analysis. This species has highly variable recruitment and its biomass would vary substantially over time and a single B0 may not be appropriate. The STAR Panel stresses the need for guidelines for defining B0 (and hence proxies for BMSY) for stocks with episodic recruitment. The related problem of what subset of annual recruitments to average to obtain Recruits/Spawning output values for forecasts should also be addressed.

STAT response: Also see 1.9 above. The initial conditions are plausible, given the magnitude of the near-MSY level of assumed background catch. The SS2 model will allow a much earlier start date, and should be able to portray the dynamics leading to the relatively low 1950 abundance.

2.12 STAR: There should be further consideration of the implications of using the prior on steepness derived by He et al. (in review), including its implications for species with other life history characteristics.

STAT response: The old Stock Synthesis cannot do this. However, in 2007 the STAT has included a model (model STATcMPDh) with a stock-recruitment relationship based on the Maximum Posterior Distribution (MPD) value of steepness (h) from Dorn's unpublished analysis, which accomplishes much the same thing.

2.13 STAR: The approach used to estimate B0 for widow rockfish had been modified from the 2003 assessment to be consistent with that on which rebuilding analyses are based (multiplying average recruitment in the early years of the fishery by unfished spawning biomass per recruit). This led to a change to the current depletion of 10%. There is a need for more explicit guidance regarding determination of B0 in assessments and in rebuilding analyses.

STAT response: It is unclear what this means for bocaccio.

2.14 STAR: There is a need for a series of cut-off dates for data to be included in assessments, with cut-offs dependent on the type of data. The lack of such dates means that assessment authors may be forced to revise decisions on base-case models very close to the date the assessment needs to be submitted to the STAR Panel, and even revise the draft assessment after this. Given that documents are supplied to reviewers two weeks in advance of meetings, major changes in assessments thereafter could compromise the integrity of the review.

STAT response: Late receipt of critical data was a problem in 2005, but not in 2007.

2.15 STAR: Several of the 2005 assessments have conducted historical catch reconstructions. An effort needs to be made to develop a consistent approach to reconstructing catch histories. The ideal outcome would be a single document outlining the best reconstructed catch histories for each species (c.f. Rogers (2003) that lists foreign catches). The California landing receipts on microfilm back to 1950 should be incorporated into the landings database.

STAT response: We are currently working on this, with support from the NESDIS/CDMP. It is not a small job, and may take years.

2.16 STAR: There is still some inconsistency in how assessment authors decide whether to include or exclude recreational indices in assessments. Attempts to provide guidelines for the development and use of indices of abundance based on recreational catch and effort data would be worthwhile.

STAT response: The methodology use in this assessment was presented at a recreational CPUE workshop, and was endorsed for use.

2.17 STAR: Stock Synthesis 2 should be extended to: a) allow assessment authors to include weight-frequency data in assessments; b) estimate the parameters of the ageing error matrix; and c) estimate the extent of overdispersion of the indices.

STAT response: When the model migrates to SS2, these features would be useful.

2.18 STAR: The raw data on which recreational length-frequency and catch-effort information are based should be made available to assessment authors in a convenient format. This will allow more detailed examination of the spatial patterns, and allow more sophisticated analyses of the catch-effort information; at present it is impossible to distinguish between lack of data and zero catch records.

STAT response: Retrieval of recreational data has been an ongoing problem. Some aspects are "friendly" but others, especially involving disaggregated data can be difficult.

Appendix C. Data file for model STATc

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82,1,7,14,2.807,-1.4035,MRFpierRectmt
83,1,7,14,0.003,-0.0015,MRFpierRectmt
84,1,7,14,0.005,-0.0025,MRFpierRectmt
85,1,7,14,43.127,-21.5635,MRFpierRectmt
86,1,7,14,6.987,-3.4935,MRFpierRectmt
87,1,7,14,0.498,-0.249,MRFpierRectmt
88,1,7,14,13.529,-6.7645,MRFpierRectmt
89,1,7,14,77.056,-38.528,MRFpierRectmt
90,1,7,14,1.081,-0.5405,MRFpierRectmt
91,1,7,14,-9,-9,Placeholder
92,1,7,14,-9,-9,Placeholder
93,1,7,14,-9,-9,Placeholder
94,1,7,14,18.623,-9.3115,MRFpierRectmt
95,1,7,14,0.003,-0.0015,MRFpierRectmt
96,1,7,14,0.312,-0.156,MRFpierRectmt
97,1,7,14,0.13,-0.065,MRFpierRectmt
98,1,7,14,0.003,-0.0015,MRFpierRectmt
99,1,7,14,0.003,-0.0015,MRFpierRectmt
100,1,7,14,0.105,-0.0525,MRFpierRectmt
101,1,7,14,0.003,-0.0015,MRFpierRectmt
102,1,7,14,0.003,-0.0015,MRFpierRectmt,,,,,,,,,,,,,,,,,
103,1,7,14,0.003,-0.0015,MRFpierRectmt,,,,,,,,,,,,,,,,,
-1,1,1,1,1,1,END,OF,,,,,,,,,,,,,,,,,
-1,-1,<==,No,aging,error(not,used),,,,,,,,,,,,,,,,,
-1,-1,,,,,,,,,,,,,,,,,,,,,,
-1,-1,,,,,,,,,,,,,,,,,,,,,,
25,25,"<==25lengthbins24..68at2cm,72,76 bins",,,,,,,,,,,,,,,,,,,,,
24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,60,62,64,66,68,72,76,80
47.6,-0.2876,length@50%matureslopeEcheverria1987,,,,,,,,,,,,,,,,,,,,,
6.17E-06,3.1712,Length-weightparsfemale1995TriennialTrawl(Ralston),,,,,,,,,,,,,,,,,,,,,
0.22475,0.03657,eggs/kginterceptandslopeReinterpretedfromPhillipsbyRalston1996,,,,,,,,,,,,,,,,,,,,,
6.17E-06,3.1712,Length-weightparsmale1995TriennialTrawl(Ralston),,,,,,,,,,,,,,,,,,,,,
YEAR,PER,TYPE,KIND,MAXSEX,TOTAGED,MIN1,MIN2,MAX1,MAX2,MARKET,,,,,,,,,,,,,,
75,1,4,4,0,157,1,1,25,25,0,nfish=,21486,,,,,,,,,,,,
136,1199,2795,1908,1664,3328,3599,2204,826,502,584,765,691,455,311,203,110,71,52,36,17,9,13,7,1,
76,1,4,4,0,173,1,1,25,25,0,nfish=,26209,,,,,,,,,,,,
151,457,781,545,625,2751,4173,2594,3197,3597,2066,1087,985,1003,820,518,297,212,129,93,52,29,32,14,1
77,1,4,4,0,122,1,1,25,25,0,nfish=,11155,,,,,,,,,,,
54,88,138,93,208,424,484,432,1011,1645,1570,1535,1047,611,566,428,332,177,106,72,60,42,24,7,1
77,1,10,4,3,0,1,1,25,25,0,nfish=,,nsamps=,30,,,,,,,,,
2100,0,1088,1088,8225,26005,35918,154731,161624,170535,138161,93622,111977,44689,48380,104669,60728,98818,66653,112582,70692,665
36,119451,11354,637
6583,2702,4354,4779,14761,20887,44556,79087,227801,190667,131989,102300,79657,92392,100508,174131,106070,189490,106751,134337,4
4918,11575,0,0,0
78,1,1,4,3,106,1,1,25,25,0,nfish=,1565,nsamps=,142,,,,,,,,,
100,121,585,4005,6572,4236,2302,1640,9773,3363,13568,13662,42582,41869,36318,18511,14589,9568,23918,21089,13940,7623,14640,13339,
7477
0,0,74,1675,892,2802,3004,6250,5968,13768,39199,62849,51166,30362,25922,10772,22040,19771,14616,10438,3286,3355,972,603,603
78,1,3,4,3,19,1,1,25,25,0,nfish=,61,nsamps=,6,,,,,,,,,
0,0,0,0,0,0,0,0,417,476,441,900,494,763,999,685,209,232,232,166,232,122,607,209,163
0,0,0,0,0,0,0,0,0,166,209,288,1508,1021,859,807,209,209,456,0,0,122,0,0,122
78,1,4,4,0,145,1,1,25,25,0,nfish=,17988,,,,,,,,,,,
2046,3184,2073,552,125,199,299,272,500,870,1084,1360,1414,1220,914,655,457,325,210,114,45,35,27,6,2
79,1,1,4,3,104,1,1,25,25,0,nfish=,1448,nsamps=,102,,,,,,,,,
0,0,0,0,1108,2883,28218,105365,22315,2141,13913,13913,389,17719,105814,61823,19433,1996,22315,46172,614,2630,6620,1821,1013
0,0,0,0,700,15142,25270,25032,0,23061,0,758,70685,118299,44871,19611,42608,84105,14990,17943,8853,1292,700,2186,132
80,1,1,4,3,108,1,1,25,25,0,nfish=,1673,nsamps=,225,,,,,,,,,
0,0,0,10142,11618,10534,10473,62228,244551,308435,228392,70611,19166,19756,60228,66162,42242,29128,22454,31675,27028,18012,42322,
7925,361
```

0,5071,0,0,12622,24720,31673,108613,266944,232919,70825,48886,81575,57566,65004,33864,67178,9899,20704,16301,1543,0,752,0,0
80,1,2,4,3,3,1,1,25,25,0,nfish=,30,nsamps=,2,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,1607,0,0,4821,388,4821,2383,5209,1607
0,0,0,0,0,0,0,0,0,0,0,0,0,1607,0,1607,6428,8035,388,1995,0,0,0,0
80,1,4,4,0,92,1,1,25,25,0,nfish=,2577,,,,,,,,,,,
55,67,75,63,73,105,232,517,524,258,113,77,72,83,80,61,48,39,18,7,4,5,1,0,0
80,1,5,4,0,45,1,1,25,25,0,nfish=,250,,,,,,,,,,,
5,10,3,6,0,1,9,22,25,17,18,12,15,18,13,11,9,7,12,6,6,10,6,5,4
80,1,10,4,3,0,1,1,25,25,0,nfish=,,nsamps=,17,,,,,,,,,
33117,93977,33116,0,0,0,25548,223786,540038,730159,489799,141297,0,65385,24126,36625,0,32693,1966,22160,0,0,0,0,0
33116,146555,57954,8279,0,0,53971,254433,827132,761859,270912,32441,1966,11185,24126,3567,65386,98731,54853,28300,21256,0,0,0,0
81,1,1,4,3,101,1,1,25,25,0,nfish=,1290,nsamps=,160,,,,,,,,,
0,0,0,8132,15419,10123,0,9428,38669,66076,110869,224391,271337,137066,7854,1291,9356,20144,11479,6821,5277,27488,13201,16702,780
0,0,0,4148,1551,4207,47800,68793,90004,161622,173418,126448,68308,63466,33931,25411,43006,27675,51709,7999,7098,3184,10855,0,0
81,1,4,4,0,91,1,1,25,25,0,nfish=,2227,,,,,,,,,,,
7,22,26,61,146,261,267,179,158,157,215,265,122,78,67,67,48,40,21,9,6,1,1,3,0
81,1,5,4,0,45,1,1,25,25,0,nfish=,250,,,,,,,,,,,
0,0,1,1,3,2,13,10,6,27,40,30,22,6,6,13,13,13,9,6,8,6,8,5,2
82,1,1,4,3,122,1,1,25,25,0,nfish=,2399,nsamps=,242,,,,,,,,,
0,0,21,21,245,111,2107,32901,31959,46688,63213,40021,60016,169057,145053,209144,19139,6476,14085,19319,17509,12616,24086,54532,13
18
0,0,7,7,682,155,8412,35822,120468,58028,52391,139363,165215,67210,33173,20159,27226,56484,33410,24561,7645,54,0,0,0
82,1,2,4,3,3,1,1,25,25,0,nfish=,19,nsamps=,2,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,7237,21711,0,7237,13987,6750,13500,6750,13987,0,6750,6750,0
0,0,0,0,0,0,0,0,0,6750,0,0,0,0,0,0,0,13500,0,0,0,6750,0,0
82,1,4,4,0,90,1,1,25,25,0,nfish=,1828,,,,,,,,,,,
1,2,9,18,36,39,61,156,211,218,214,187,224,176,112,70,45,22,11,5,7,0,3,1,0
82,1,5,4,0,55,1,1,25,25,0,nfish=,310,,,,,,,,,,,
0,0,0,0,3,5,4,9,15,12,10,25,47,43,49,29,19,13,5,9,7,2,4,0,0
83,1,1,4,3,128,1,1,25,25,0,nfish=,2675,nsamps=,308,,,,,,,,,
0,0,0,0,101,0,879,939,2635,29438,44537,58133,52133,51175,82114,111799,129765,37199,24640,11723,19779,21341,32899,57707,10927
0,0,449,71,0,258,623,2075,4027,15157,39981,70037,86302,90871,74135,39829,34316,16150,29115,8781,13600,100,202,0,0
83,1,2,4,3,7,1,1,25,25,0,nfish=,55,nsamps=,5,,,,,,,,,
0,0,0,0,0,0,0,0,304,304,0,608,912,1207,2702,2560,1414,3382,0,903,259,259,903,0,0
0,0,0,0,0,0,0,0,304,0,2702,563,304,1718,2488,1326,1725,2560,0,1790,0,0,0,0,0
83,1,3,4,3,18,1,1,25,25,0,nfish=,44,nsamps=,7,,,,,,,,,
0,0,0,0,0,0,0,0,2364,4774,7746,3120,12516,5382,2912,10404,9856,0,0,0,4728,0,2410,0,0
0,0,0,0,0,0,0,0,3120,0,6908,12799,3718,4774,13378,13352,6763,1456,0,0,0,0,0,0,0
83,1,4,4,0,86,1,1,25,25,0,nfish=,706,,,,,,,,,,,
0,2,0,2,9,20,51,73,63,61,83,56,51,43,50,46,33,21,12,13,8,2,6,1,0
83,1,5,4,0,64,1,1,25,25,0,nfish=,359,,,,,,,,,,,
0,0,2,3,4,4,1,4,6,8,19,27,40,45,52,47,37,22,14,9,8,4,1,0,2
83,1,10,4,3,0,1,1,25,25,0,nfish=,,nsamps=,15,,,,,,,,,
0,0,0,0,0,5559,0,2590,7260,18905,25146,40713,88899,60051,200335,377143,447870,99634,6881,13005,9991,0,23761,13346,0
0,0,0,0,0,0,11118,0,0,41461,48905,50500,146252,499926,457074,114536,105259,102367,31229,19404,6947,0,0,0,0
84,1,1,4,3,126,1,1,25,25,0,nfish=,2603,nsamps=,276,,,,,,,,,
0,0,0,0,0,27,4,1222,997,4350,4593,5385,6391,19206,17669,21232,30809,34952,19181,7068,7117,4547,8704,13830,2149
0,0,0,0,0,334,130,1155,3075,8964,7765,12360,28371,63068,42630,32984,13427,9467,19091,6474,10536,1279,1143,0,0
84,1,2,4,3,3,1,1,25,25,0,nfish=,34,nsamps=,2,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,2659,0,5909,0,2659,4875,3250,1034,2659,0
0,0,0,0,0,0,0,0,0,0,0,0,2068,1034,7977,3102,3102,1034,2659,0,0,0,0,0,0
84,1,3,4,3,18,1,1,25,25,0,nfish=,44,nsamps=,7,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,0,0,679,248,1003,517,196,321,642,321,0,0,147,0
0,0,0,0,0,0,0,0,0,0,196,0,1318,1251,789,856,1713,196,0,388,0,0,0,0,0
84,1,4,4,0,85,1,1,25,25,0,nfish=,481,,,,,,,,,,,
2,3,4,3,8,8,6,21,31,40,57,70,63,48,44,28,16,13,5,3,6,0,2,0,0
84,1,5,4,0,33,1,1,25,25,0,nfish=,183,,,,,,,,,,,
0,0,0,1,2,2,9,9,9,12,15,17,15,14,23,11,8,7,11,4,6,5,1,1,1
85,1,1,4,3,108,1,1,25,25,0,nfish=,1658,nsamps=,262,,,,,,,,,
0,20,106,1224,1354,826,312,55,259,805,558,1425,1422,5282,4758,4550,5330,13190,14374,4732,2161,1023,2133,1445,185
0,41,62,338,1291,864,371,729,228,851,2588,4546,4477,11444,21066,17782,8281,2438,2559,1054,847,108,0,0,0
85,1,2,4,3,5,1,1,25,25,0,nfish=,34,nsamps=,4,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,54,54,390,216,789,399,27,27,0,0,237,135,0,0
0,0,0,0,0,0,0,0,0,0,0,0,249,214,1531,264,1024,0,0,0,0,0,0,0,0
85,1,3,4,3,29,1,1,25,25,0,nfish=,274,nsamps=,38,,,,,,,,,
0,0,0,37,0,0,0,0,0,810,159,508,167,2220,2268,2095,2694,4699,15713,11258,4965,1144,6781,5688,0

0,0,0,37,0,0,0,0,0,0,1486,5206,3244,3108,14332,11954,22873,3434,9025,3900,1242,2648,0,0,0
85,1,4,4,0,88,1,1,25,25,0,nfish=,1256,,,,,,,,,,,,
126,244,246,151,81,22,8,15,11,22,32,43,57,57,41,43,29,13,14,1,0,0,0,0,0
85,1,5,4,0,95,1,1,25,25,0,nfish=,532,,,,,,,,,,,,
45,103,98,44,7,11,7,6,8,13,15,17,20,16,24,12,14,22,12,16,9,6,4,3,0
86,1,1,4,3,123,1,1,25,25,0,nfish=,2431,nsamps=,189,,,,,,,,,,
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0,145,90,1205,11842,26146,31768,19894,9987,3879,422,1688,984,3245,10560,14182,12740,7080,1763,1830,305,118,40,0,0
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86,1,4,4,0,88,1,1,25,25,0,nfish=,1267,,,,,,,,,,,,
27,54,45,38,96,223,350,208,54,10,10,20,23,23,20,23,21,4,8,5,3,1,0,1,0
86,1,5,4,0,168,1,1,25,25,0,nfish=,942,,,,,,,,,,,,
8,19,13,25,64,167,245,167,47,4,2,8,13,14,15,16,19,27,16,17,12,12,8,3,1
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2969,50738,32197,0,55012,68986,140922,58386,18851,0,0,0,0,0,70640,101516,51786,70640,61754,61754,48650,0,0,0,0
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0,0,0,421,1988,6062,9338,24878,45343,49617,29868,10514,1573,2702,2457,4427,9931,4691,3114,1325,196,483,0,0,0
87,1,2,4,3,29,1,1,25,25,0,nfish=,274,nsamps=,22,,,,,,,,,,
0,0,0,85,0,2457,289,275,354,2126,3746,1154,252,768,1255,1922,1445,755,283,17,691,0,0,0,0
0,0,0,0,36,81,7605,15561,8827,6034,5064,162,4566,8823,951,231,2551,220,4914,2457,2457,2457,2457,0,0
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0,0,0,0,0,0,984,161,9853,9354,6880,6260,18255,5464,17485,11960,9145,8437,679,1099,944,12,0,0,0
87,1,4,4,0,84,1,1,25,25,0,nfish=,121,,,,,,,,,,,,
3,8,12,2,5,8,14,14,16,8,6,8,2,4,3,4,3,1,0,0,0,0,0,0,0
87,1,5,4,0,203,1,1,25,25,0,nfish=,1136,,,,,,,,,,,,
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88,1,1,4,3,111,1,1,25,25,0,nfish=,1822,nsamps=,165,,,,,,,,,,
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0,0,0,0,0,0,0,64,0,5771,25977,12757,619,176,1070,32,0,507,0,0,0,0,0,0,0
88,1,3,4,3,73,1,1,25,25,0,nfish=,1189,nsamps=,86,,,,,,,,,,
0,0,0,0,0,254,0,0,159,630,1988,3833,5465,2144,1381,858,1792,944,872,619,404,145,492,0,0
0,0,0,0,0,14,14,47,340,2048,2721,3800,2623,1594,1548,2052,718,238,113,75,2,0,14,0,0
88,1,4,4,0,79,1,1,25,25,0,nfish=,79,,,,,,,,,,,,
0,7,3,3,1,2,8,10,11,6,8,6,4,5,3,1,0,1,0,0,0,0,0,0,0
88,1,5,4,0,226,1,1,25,25,0,nfish=,1264,,,,,,,,,,,,
6,15,11,11,16,31,82,58,107,191,153,157,129,82,41,18,16,27,24,20,15,20,26,6,2
89,1,1,4,3,98,1,1,25,25,0,nfish=,1112,nsamps=,141,,,,,,,,,,
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89,1,2,4,3,31,1,1,25,25,0,nfish=,399,nsamps=,24,,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,265,264,612,2945,228,7830,5265,326,122,2584,2538,0,0,0,0
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96,1,3,4,3,24,1,1,25,25,0,nfish=,170,nsamps=,7,,,,,,,,,
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97,1,3,4,3,21,1,1,25,25,0,nfish=,104,nsamps=,4,,,,,,,,,
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0,0,0,0,0,0,0,0,41,67,108,190,985,486,263,67,115,74,0,0,0,0,0,0,0
97,1,4,4,0,54,1,1,25,25,0,nfish=,54,,,,,,,,,,,
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98,1,4,4,0,84,1,1,25,25,0,nfish=,106,,,,,,,,,,,
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98,1,5,4,0,167,1,1,25,25,0,nfish=,937,,,,,,,,,,,
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99,1,4,4,0,85,1,1,25,25,0,nfish=,421,,,,,,,,,,,
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2,0,1,3,10,13,11,38,44,47,34,41,57,71,47,40,50,30,35,21,22,8,6,6,0
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100,1,2,4,3,12,1,1,25,25,0,nfish=,69,nsamps=,9,,,,,,,,,

0,0,0,28,0,0,0,0,0,0,66,28,0,160,94,132,56,132,28,0,0,0,28,0,0
0,0,0,0,0,0,0,0,0,0,66,160,226,122,132,160,28,28,56,56,56,56,28,0,0,0
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101,1,4,4,0,85,1,1,25,25,0,nfish=,380,,,,,,,,,,,
1,1,10,27,80,78,78,38,12,10,4,3,9,9,7,1,4,2,2,2,2,0,0,0,0
101,1,5,4,0,58,1,1,25,25,0,nfish=,324,,,,,,,,,,,
1,2,1,10,27,53,48,17,16,15,11,23,17,17,24,10,12,10,4,1,1,0,2,2,0
101,1,10,4,3,21,1,1,25,25,0,nfish=,114,nsamps=,31,,,,,,,,,
0,0,0,2367,28385,11560,25465,3103,5351,2289,2289,0,0,0,2516,0,0,2516,0,0,0,0,2744,0,0
0,0,0,2539,21189,22364,34500,2984,5031,0,0,0,0,8417,3103,4878,5804,0,2047,2047,0,0,0,0,0
102,1,1,4,3,82,1,1,25,25,0,nfish=,320,nsamps=,15,,,,,,,,,
0,0,0,0,0,0,0,218,510,552,341,337,123,54,236,393,114,173,163,153,340,131,120,0,70
0,0,0,0,57,78,93,259,661,307,281,199,178,336,61,73,0,0,90,30,3,0,0,0,0
102,1,2,4,3,1,1,1,25,25,0,nfish=,14,nsamps=,1,,,,,,,,,
0,0,0,0,0,0,0,0,0,2,2,0,2,4,8,2,2,0,0,0,0,0,0,0,0
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,6,0,0,0,0,0,0,0,0,0
102,1,3,4,3,17,1,1,25,25,0,nfish=,25,nsamps=,1,,,,,,,,,
0,0,0,0,0,0,0,0,0,0,0,0,0,2,0,0,0,0,0,0,0,0,0,2,0
0,0,0,0,0,0,0,0,0,0,0,2,2,10,20,14,0,0,0,0,0,0,0,0,0
102,1,4,4,0,86,1,1,25,25,0,nfish=,771,,,,,,,,,,,
0,1,2,3,2,20,39,83,137,139,117,72,22,21,31,27,16,13,15,4,3,2,2,0,0
102,1,5,4,0,32,1,1,25,25,0,nfish=,180,,,,,,,,,,,
0,0,0,0,0,1,1,7,29,43,33,17,2,8,7,11,6,8,3,2,2,0,0,0,0
103,1,4,4,0,84,1,1,25,25,0,nfish=,122,,,,,,,,,,,
0,2,0,0,0,0,0,2,14,16,21,29,17,4,5,6,0,3,1,1,1,0,0,0,0
104,1,1,4,0,78,1,1,25,25,0,nfish=,110,nsamps=,9,,,,,,,,,
0,0,0,0,0,0,0,25,4,29,33,80,65,73,288,168,181,60,44,0,57,0,16,0,0
104,1,4,4,0,86,1,1,25,25,0,nfish=,889,,,,,,,,,,,
8,17,27,44,24,27,20,25,48,55,105,135,116,97,52,37,21,8,8,5,4,2,2,0,2
104,1,5,4,0,14,1,1,25,25,0,nfish=,80,,,,,,,,,,,
0,0,1,0,2,1,3,2,9,6,5,9,4,9,4,8,2,6,1,2,2,1,3,0,0
104,1,10,4,3,23,1,1,25,25,0,nfish=,216,nsamps=,33,,,,,,,,,
19065,29801,2189,0,0,0,0,0,0,42045,2356,26204,56703,59820,99071,121898,48127,28657,19776,19405,21625,11473,3,7044,4580
13679,29672,4912,2456,0,0,2456,0,0,45264,9674,14121,23379,115715,61595,72185,65801,27955,31884,16194,35618,15942,0,0,0
105,1,4,4,0,84,1,1,25,25,0,nfish=,571,,,,,,,,,,,
0,0,2,10,20,18,3,2,4,9,9,11,8,13,12,8,6,0,1,0,1,0,0,0,0
105,1,5,4,0,13,1,1,25,25,0,nfish=,73,,,,,,,,,,,
0,1,0,1,1,2,0,2,1,0,4,5,8,14,13,10,3,4,1,1,2,0,0,0,0
106,1,2,4,0,13,1,1,25,25,0,nfish=,78,nsamps=,10,,,,,,,,,
0,0,0,0,0,20,20,40,175,72,111,119,119,69,58,153,48,121,93,14,23,35,45,0,0
106,1,4,4,0,88,1,1,25,25,0,nfish=,1330,,,,,,,,,,,
2,3,6,10,29,54,101,183,265,189,89,54,55,54,78,66,43,26,9,4,2,4,2,1,1
106,1,5,4,0,9,1,1,25,25,0,nfish=,49,,,,,,,,,,,
0,0,0,0,0,1,0,5,4,1,3,4,3,5,8,4,6,3,1,0,0,0,1,0,0

Appendix C. Parameter file for model STATc

```
boc2007revC.csv  **** UNKNOWN CONVERGENCE STATUS
statc07revC.r01
statc07revC.par
2007 starting from statc2005 assessment postSTAR include all & 0.1srr, revised c
     10.000000       .000100     BEGIN AND END DELTA F PER LOOP1
   3   .95              FIRST LOOP1 FOR LAMBDA & VALUE
   1.100                 MAX VALUE FOR CROSS DERIVATIVE
   1 READ HESSIAN
STARB2.hes
   1 WRITE HESSIAN
STARB2.hes
    .001                MIN SAMPLE FRAC. PER AGE
   1  21   1  21        MINAGE, MAXAGE,  SUMMARY AGE RANGE
    51   106            BEGIN YEAR, END YEAR
  1      12  0  0  0    NPER, MON/PER
  1.00                  SPAWNMONTH
  5  9 NFISHERY, NSURVEY
  2 N SEXES
   50000.  REF RECR LEVEL
  0 MORTOPT
    .150000    .010000     .250000 'M             '   0     1  0     .000000   .0000 !   1 NO PICK    .000       0.      .0000000
 -999.000000    .010000    1.000000 'M SAME FOR M+F  '   0     1  0     .000000   .0000 !   2 NO PICK    .000       0.      .0000000
   TRAWL    TYPE:  1
  7 SELECTIVITY PATTERN
   0   0   0   2   0   0   0  AGE TYPES USED
     1.00000      .10 ' TWL CATCH BIOMASS  '  ! # =  1 VALUE:         .00000
     1.00000      .30 ' TWL  SIZE COMPS    '  ! # =  2 VALUE:      -537.43774
  1  1  0  0  0  0  SEL. COMPONENTS
  51.916183   20.000000   70.000000 'Trawl:transition'   2     1  0     .000000   .0000 !   3 OK       -.005     -27.  1672.6971612
    .000001     .000001    1.000000 'Trawl:InitSelect'   0     1  0     .000000   .0000 !   4 NO PICK    .000       0.      .0000000
    .488685     .001000    1.000000 'Trawl:SmlInflect'   2     1  0     .500000  1.0000 !   5 OK         .000  -45676.      .5484042
    .336529     .001000    3.000000 'Trawl:SmlSlope '   2     1  0     .900000  1.0000 !   6 OK         .000   -3199.      .0015743
    .595213     .001000    1.000000 'Trawl:femfinal '   2     1  0    1.000000  1.0000 !   7 OK         .000   -4823.      .0066239
    .348224     .001000    1.000000 'Trawl:feminflct '   2     1  0     .500000  1.0000 !   8 OK         .000   -2896.     1.5064589
   1.347485     .001000    5.000000 'Trawl:femSlope '   0     1  0     .900000  1.0000 !   9 NO PICK    .000       0.      .0000000
   H&L      TYPE:  2
  7 SELECTIVITY PATTERN
   0   0   0   4   0   0   0  AGE TYPES USED
     1.00000      .10 ' H&Lso CATCH BIOMASS'  ! # =  3 VALUE:         .00000
     1.00000      .30 ' H&Lso SIZE COMPS   '  ! # =  4 VALUE:      -204.38755
  1  1  0  0  0  0  SEL. COMPONENTS
  48.382066   20.000000   70.000000 'H&L:transition  '   2     1  0     .000000   .0000 !  10 OK         .000      -7.     5.2163052
    .003059     .000001    1.000000 'H&L:InitSelect  '   2     1  0     .000000   .0000 !  11 OK         .000  -56790.      .0001048
    .840932     .001000    1.000000 'H&L:SmlInflect  '   2     1  0     .500000  1.0000 !  12 OK         .000   -1877.      .0306416
    .333099     .001000    3.000000 'H&L:SmlSlope    '   2     1  0     .900000  1.0000 !  13 OK         .000   -2281.      .0114772
    .275881     .001000    1.000000 'H&L:femfinal    '   2     1  0    1.000000  1.0000 !  14 OK         .000    -363.      .0798732
    .380517     .001000    1.000000 'H&L:feminflct   '   2     1  0     .500000  1.0000 !  15 OK         .000    -305.      .0222269
    .268922     .001000    5.000000 'H&L:femSlope    '   2     1  0     .900000  1.0000 !  16 OK         .000     -89.      .1777621
  SETNET    TYPE:  3
  7 SELECTIVITY PATTERN
   0   0   0   6   0   0   0  AGE TYPES USED
     1.00000      .10 'SetNetCATCHBIOM    '  ! # =  5 VALUE:         .00000
     1.00000      .30 'SetNetSizeComps    '  ! # =  6 VALUE:      -258.61169
  1  1  0  0  0  0  SEL. COMPONENTS
  49.540604   20.000000   60.000000 'StNso:transition'   2     1  0     .000000   .0000 !  17 OK         .004     -19.    23.4146939
    .004154     .000001    1.000000 'StNso:InitSelect'   2     1  0     .000000   .0000 !  18 OK         .000 -313878.      .0000070
    .785004     .001000     .990000 'StNso:YngInflect'   2     1  0     .500000  1.0000 !  19 OK         .000  -11461.      .0296508
    .653476     .001000    3.000000 'StNso:YngSlope  '   2     1  0     .900000  1.0000 !  20 OK         .000    -458.      .0135755
    .147646     .001000    1.000000 'StNso:femfinal  '   2     1  0     .000000   .0000 !  21 OK         .000   -1213.      .0059668
    .131565     .001000    1.000000 'StNso:feminflct '   2     1  0     .500000  1.0000 !  22 OK        -.001    -344.      .3510564
    .247784     .001000    5.000000 'StNso:femSlope  '   2     1  0     .900000  1.0000 !  23 OK         .000   -1044.      .0459814
  RECLso    TYPE:  4
  7 SELECTIVITY PATTERN
```

```
 0  0  0  8  0  0  0  AGE TYPES USED
  1.00000      .10 'RECLsoCATCHBIOM     ' ! # =  7 VALUE:          .00000
  1.00000      .30 'RECLsoSIZECOMPS     ' ! # =  8 VALUE:     -310.73584
1  1  0  0  0  0  SEL. COMPONENTS
 41.756833   15.000000   60.000000 'RCLso:transition'   2    1  0     .000000   .0000 !  24 OK        -.003      -3.    53.1311282
   .140186     .000001    1.000000 'RCLso:InitSelect'   2    1  0     .000000   .0000 !  25 OK         .000   -2921.     .0004495
   .001000     .001000    1.000000 'RCLso:SmlInflect'   0    1  0     .500000  1.0000 !  26 NO PICK    .000       0.     .0000000
   .194675     .001000    5.000000 'RCLso:SmlSlope  '   2    1  0     .900000  1.0000 !  27 OK         .000   -1909.     .0027112
   .067805     .001000    1.000000 'RCLso:femfinal  '   2    1  0     .000000   .0000 !  28 OK         .000   -4034.     .0012391
   .386057     .001000    1.000000 'RCLso:feminflct '   2    1  0     .500000  1.0000 !  29 OK         .000   -5940.     .0252360
   .298196     .001000    5.000000 'RCLso:femSlope  '   2    1  0     .900000  1.0000 !  30 OK         .000    -941.     .0045968
RECLnor   TYPE:  5
7 SELECTIVITY PATTERN
 0  0  0  10  0  0  0  AGE TYPES USED
  1.00000      .10 'RECLnorCATCHBIOM    ' ! # =  9 VALUE:          .00000
  1.00000      .30 'RECLnorSIZECOMPS    ' ! # = 10 VALUE:     -267.58865
1  1  0  0  0  0  SEL. COMPONENTS
 48.733482   15.000000   60.000000 'RCLno:transition'   2    1  0     .000000   .0000 !  31 OK        -.001      -2.   164.7240616
   .065319     .000001    1.000000 'RCLno:InitSelect'   2    1  0     .000000   .0000 !  32 OK         .000  -12248.     .0014999
   .496223     .001000    1.000000 'RCLno:SmlInflect'   2    1  0     .500000  1.0000 !  33 OK         .000    -606.     .6273304
   .129680     .001000    5.000000 'RCLno:SmlSlope  '   2    1  0     .900000  1.0000 !  34 OK         .000   -1046.     .2221516
   .279615     .001000    1.000000 'RCLno:femfinal  '   2    1  0     .000000   .0000 !  35 OK         .000    -398.     .0133749
   .584202     .001000    1.000000 'RCLno:feminflct '   2    1  0     .500000  1.0000 !  36 OK         .000    -686.     .0526584
   .268031     .001000    5.000000 'RCLno:femSlope  '   2    1  0     .900000  1.0000 !  37 OK         .000    -114.     .0271967
 NoRec   TYPE:  6
2 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
   .000168  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .67 'RecFINnoCPUE        ' ! # = 11 VALUE:       -4.91890
  5.000000    -.200000    1.000000 'NoCalCPU:Seltype'   0  -80  0     .000000   .0000 !  38 NO PICK    .000       0.     .0000000
 24.000000     .010000   24.000000 'NoCalCPUl:minsiz'   0  -80  0     .000000   .0000 !  39 NO PICK    .000       0.     .0000000
 76.000000     .001000   76.000000 'NoCalCPUl:maxsiz'   0  -80  0     .000000   .0000 !  40 NO PICK    .000       0.     .0000000
DFGcpuN   TYPE:  7
2 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
   .000733  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .37 ' NoCalDFG           ' ! # = 12 VALUE:        8.19614
  5.000000    -.200000    1.000000 'NoCalDFG:Seltyp '   0  -87  0     .000000   .0000 !  41 NO PICK    .000       0.     .0000000
 24.000000     .010000   24.000000 'NoCalDFG:minsi  '   0  -87  0     .000000   .0000 !  42 NO PICK    .000       0.     .0000000
 76.000000     .001000   76.000000 'NOCalDFG:maxsi  '   0  -87  0     .000000   .0000 !  43 NO PICK    .000       0.     .0000000
SoRecFI   TYPE:  8
2 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
   .000196  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .71 'RecFINsoCPUE        ' ! # = 13 VALUE:       -4.06754
  4.000000    -.200000    1.000000 'SoCalCPU:Seltype'   0  -80  0     .000000   .0000 !  44 NO PICK    .000       0.     .0000000
 24.000000     .010000   24.000000 'SoCalCPUl:minsiz'   0  -80  0     .000000   .0000 !  45 NO PICK    .000       0.     .0000000
 76.000000     .001000   76.000000 'SoCalCPUl:maxsiz'   0  -80  0     .000000   .0000 !  46 NO PICK    .000       0.     .0000000
TwlCPUE   TYPE:  9
2 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
   .004940  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .32 'TrawlCPUE           ' ! # = 14 VALUE:        9.45784
  1.000000    -.200000    1.000000 'TrawlSeltype    '   0  -82  0     .000000   .0000 !  47 NO PICK    .000       0.     .0000000
 20.000000     .010000   20.000000 'TrawlCPUE:minsiz'   0  -82  0     .000000   .0000 !  48 NO PICK    .000       0.     .0000000
 84.000000     .001000   84.000000 'TrawlCPUE:maxsiz'   0  -82  0     .000000   .0000 !  49 NO PICK    .000       0.     .0000000
TRITRAW   TYPE: 10
7 SELECTIVITY PATTERN
 0  0  0  16  0  0  0  AGE TYPES USED
   .044151  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .81 'TRI SURVEY BIO      ' ! # = 15 VALUE:       -5.56087
  1.00000      .30 'TRI SIZE COMPS      ' ! # = 16 VALUE:      -82.35644
1  1  0  0  0  0  SEL. COMPONENTS
 34.311827   26.000000   76.000000 'TriSv:transition'   0   89  0     .000000   .0000 !  50 NO PICK    .000       0.     .0000000
   .363817     .001000    1.000000 'TriSv:InitSelect'   2   89  0     .000000   .0000 !  51 OK         .000     -55.     .0195570
   .001000     .001000    1.000000 'TriSv:YngInflect'   0   89  0     .500000  1.0000 !  52 NO PICK    .000       0.     .0000000
```

```
 3.000000    .001000    3.000000 'TriSv:YngSlope  '   0    89  0     .900000  1.0000 !  53 NO PICK    .000       0.      .0000000
  .484561    .001000    1.000000 'TriSv:femfinal  '   2    89  0     .000000   .0000 !  54 OK         .000    -169.      .0127043
  .001000    .001000    1.000000 'TriSv:feminflct '   0    89  0     .500000  1.0000 !  55 NO PICK    .000       0.      .0000000
 5.000000    .001000    5.000000 'TriSv:femSlope  '   0    89  0     .900000  1.0000 !  56 NO PICK    .000       0.      .0000000
CALCOFI   TYPE: 11
4 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
  .000233  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
  1.00000      .68 'CALCOFISPB         ' ! # = 17 VALUE:      -1.11389
PowPlnt   TYPE: 12
3 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
  .011220  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   .00000     2.10 'PowPltRectIndex    ' ! # = 18 VALUE:     -35.54367
 1.000000    .000000    1.000000 'PowplntAge1Nos  '   0   -73  0     .000000   .0000 !  57 NO PICK    .000       0.      .0000000
 1.000000    .000000    1.000000 'PowplntAge1Nos  '   0   -73  0     .000000   .0000 !  58 NO PICK    .000       0.      .0000000
JuvSurv    TYPE: 13
3 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
  .000078  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   .00000     2.05 'CenCalJuvIndex     ' ! # = 19 VALUE:     -25.19993
 1.000000    .000000    1.000000 'JuvSurvAge1Nos  '   0   -84  0     .000000   .0000 !  59 NO PICK    .000       0.      .0000000
 1.000000    .000000    1.000000 'JuvSurvAge1Nos  '   0   -84  0     .000000   .0000 !  60 NO PICK    .000       0.      .0000000
PierCPU    TYPE: 14
3 SELECTIVITY PATTERN
 0  0  0  0  0  0  0  AGE TYPES USED
  .000275  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   .00000     3.29 'PierRectIndex      ' ! # = 20 VALUE:     -32.84073
 1.000000    .000000    1.000000 'PierIndex1Nos   '   0   -81  0     .000000   .0000 !  61 NO PICK    .000       0.      .0000000
 1.000000    .000000    1.000000 'PierIndex1Nos   '   0   -81  0     .000000   .0000 !  62 NO PICK    .000       0.      .0000000
 1 AGEERR: 1: MULTINOMIAL,  0: S(LOG(P))=CONSTANT,  -1: S=P*Q/N
500.000 : MAX N FOR MULTINOMIAL
 3 1=%CORRECT, 2=C.V., 3=%AGREE, 4=READ %AGREE @AGE
  .800000    .300000    .950000 'p AGREE. @1     '   0    80  0     .000000   .0000 !  63 NO PICK    .000       0.      .0000000
  .050000    .000000    .900000 'p agree @21     '   0    80  0     .000000   .0000 !  64 NO PICK    .000       0.      .0000000
 1.000000    .001000    2.000000 'POWER           '   0    80  0     .000000   .0000 !  65 NO PICK    .000       0.      .0000000
  .150000    .010000    .300000 'OLD DISCOUNT    '   0    80  0     .000000   .0000 !  66 NO PICK    .000       0.      .0000000
  .000001    .001000    .100000 '%MIS-SEXED      '   0    80  0     .000000   .0000 !  67 NO PICK    .000       0.      .0000000
 0 END OF EFFORT
 0 FIX n FMORTs
 0  MATURITY
 1  GROWTH: 1=CONSTANT, 2=MORT. INFLUENCE
 1.5000 99.0000  AGE AT WHICH L1 AND L2 OCCUR
 1 1=NORMAL, 2=LOGNORMAL
 27.000000   20.000000   60.000000 'FEMALE L1       '   0     1  0     .000000   .0000 !  68 NO PICK    .000       0.      .0000000
 75.892728   60.000000   90.000000 'FEMALE LINF     '   0     1  0     .000000   .0000 !  69 NO PICK    .000       0.      .0000000
  .183673    .050000    .400000 'FEMALE K        '   2     1  0     .000000   .0000 !  70 OK         .000-2186705.      .0000036
  .107000    .010000    .990000 'FEMALE CV1      '   0     1  0     .000000   .0000 !  71 NO PICK    .000       0.      .0000000
  .033000    .010000    .990000 'FEMALE CV21     '   0     1  0     .000000   .0000 !  72 NO PICK    .000       0.      .0000000
-999.000000   20.000000   40.000000 'MALE L1         '   0     1  0     .000000   .0000 !  73 NO PICK    .000       0.      .0000000
 65.555310   50.000000   80.000000 'MALE LINF       '   0     1  0     .000000   .0000 !  74 NO PICK    .000       0.      .0000000
  .210373    .100000    .400000 'MALE K          '   2     1  0     .000000   .0000 !  75 OK         .000-1146616.      .0001222
-999.000000    .010000    .990000 'MALE CV1        '   0     1  0     .000000   .0000 !  76 NO PICK    .000       0.      .0000000
-999.000000    .010000    .990000 'MALE CV21       '   0     1  0     .000000   .0000 !  77 NO PICK    .000       0.      .0000000
       0  DEFINE MARKET CATEGORIES
 0 ENVIRONMENTAL FXN:    [-INDEX]  [FXN TYPE(1-4)]  [ENVVAR USED]
 0 ESTIMATE N ENVIRON VALUES
21 PENALTIES
   .00000      .30 ' Parm Penalty      ' ! # = 21 VALUE:     -40.61406
-1  1.0  1.0
 0 ENVIRONMENT EFFECT ON EXP(RECR)
22  STOCK-RECR
 3 1=B-H, 2=RICKER, 3=new B-H, 4=HOCKEY
 0 disabled option
   .10000    -1.00 'SPAWN RECR.        ' ! # = 22 VALUE:     -44.15689
   .00001     -.30 'S-R means          ' ! # = 23 VALUE:    -527.37648
```

```
 10.000000     .001000   10.000000 'VIR. RECR. MULT.'  0     1  0     .000000   .0000 !  78 NO PICK     .000       0.     .0000000
   .200000     .200000     .990000 'B-H S/R PAR.    '  0     1  0     .000000   .0000 !  79 NO PICK     .000       0.     .0000000
   .070451     .001000   10.000000 'BACK RECR.      '  0     1  0     .000000   .0000 !  80 NO PICK     .000       0.     .0000000
  1.000000     .010000    2.000000 'S/R STD.        '  0     1  0     .000000   .0000 !  81 NO PICK     .000       0.     .0000000
   .000000    -.100000     .100000 'RECR. TREND     '  0     1  0     .000000   .0000 !  82 NO PICK     .000       0.     .0000000
  1.000000     .000000    2.000000 'RECR. MULT.     '  0     1  0     .000000   .0000 !  83 NO PICK     .000       0.     .0000000
-2 INIT AGE COMP
-999.000000    .001000   30.000000 'Recruit 51      ' -2    51  0     .000000   .0000 !  84 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 52      ' -2    52  0     .000000   .0000 !  85 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 53      ' -2    53  0     .000000   .0000 !  86 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 54      ' -2    54  0     .000000   .0000 !  87 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 55      ' -2    55  0     .000000   .0000 !  88 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 56      ' -2    56  0     .000000   .0000 !  89 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 57      ' -2    57  0     .000000   .0000 !  90 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 58      ' -2    58  0     .000000   .0000 !  91 NO PICK     .000       0.     .0000000
-999.000000    .001000   30.000000 'Recruit 59      ' -2    59  0     .000000   .0000 !  92 NO PICK     .000       0.     .0000000
   .113969     .001000   30.000000 'Recruit 60      '  2    60  0     .000000   .0000 !  93 OK          .000   -6425.    2.2671210
   .026661     .001000   30.000000 'Recruit 61      '  2    61  0     .000000   .0000 !  94 OK          .000   -7798.     .0332638
   .023849     .001000   30.000000 'Recruit 62      '  2    62  0     .000000   .0000 !  95 OK          .000   -9434.     .0281218
  1.046731     .001000   30.000000 'Recruit 63      '  2    63  0     .000000   .0000 !  96 OK          .000  -11018.    1.2380030
   .017206     .001000   30.000000 'Recruit 64      '  2    64  0     .000000   .0000 !  97 OK          .000  -13153.     .0115736
   .015136     .001000   30.000000 'Recruit 65      '  2    65  0     .000000   .0000 !  98 OK          .000  -15536.     .0040839
   .017790     .001000   30.000000 'Recruit 66      '  2    66  0     .000000   .0000 !  99 OK          .000  -18350.     .0064730
   .026870     .001000   30.000000 'Recruit 67      '  2    67  0     .000000   .0000 ! 100 OK          .000  -21294.     .0415621
   .043123     .001000   30.000000 'Recruit 68      '  2    68  0     .000000   .0000 ! 101 OK          .000  -23888.     .1460500
   .060870     .001000   30.000000 'Recruit 69      '  2    69  0     .000000   .0000 ! 102 OK          .000  -25965.     .0289535
   .063977     .001000   30.000000 'Recruit 70      '  2    70  0     .000000   .0000 ! 103 OK          .000  -27508.     .0330586
   .287270     .001000   30.000000 'Recruit 71      '  2    71  0     .000000   .0000 ! 104 OK          .000  -29243.     .0873928
   .036365     .001000   30.000000 'Recruit 72      '  2    72  0     .000000   .0000 ! 105 OK          .000  -32986.     .0280150
   .039638     .001000   30.000000 'Recruit 73      '  2    73  0     .000000   .0000 ! 106 OK          .000  -38974.     .0061877
   .317521     .001000   30.000000 'Recruit 74      '  2    74  0     .000000   .0000 ! 107 OK          .000  -44829.     .0009801
   .110900     .001000   30.000000 'Recruit 75      '  2    75  0     .000000   .0000 ! 108 OK          .000  -53937.     .0003446
   .025811     .001000   30.000000 'Recruit 76      '  2    76  0     .000000   .0000 ! 109 OK          .000  -72778.     .0000723
   .010744     .001000   30.000000 'Recruit 77      '  2    77  0     .000000   .0000 ! 110 OK          .000  -85472.     .0000415
   .475827     .001000   30.000000 'Recruit 78      '  2    78  0     .000000   .0000 ! 111 OK          .000  -59696.     .0007582
   .039606     .001000   30.000000 'Recruit 79      '  2    79  0     .000000   .0000 ! 112 OK          .000  -61134.     .0006102
   .167462     .001000   30.000000 'RECRUIT 80      '  2    80  0     .000000   .0000 ! 113 OK          .000  -65065.     .0004003
   .027938     .001000   30.000000 'RECRUIT 81      '  2    81  0     .000000   .0000 ! 114 OK          .000  -82601.     .0001300
   .031985     .001000   30.000000 'RECRUIT 82      '  2    82  0     .000000   .0000 ! 115 OK          .000 -122236.     .0000850
   .003014     .001000   30.000000 'RECRUIT 83      '  2    83  0     .000000   .0000 ! 116 OK          .000 -297957.     .0000076
   .012743     .001000   30.000000 'RECRUIT 84      '  2    84  0     .000000   .0000 ! 117 OK          .000 -160645.     .0000216
   .216766     .001000   30.000000 'RECRUIT 85      '  2    85  0     .000000   .0000 ! 118 OK          .000  -89087.     .0001718
   .029077     .001000   30.000000 'RECRUIT 86      '  2    86  0     .000000   .0000 ! 119 OK          .000 -122308.     .0000765
   .028413     .001000   30.000000 'RECRUIT 87      '  2    87  0     .000000   .0000 ! 120 OK          .000 -153583.     .0000179
   .033653     .001000   30.000000 'RECRUIT 88      '  2    88  0     .000000   .0000 ! 121 OK          .000 -133208.     .0000195
   .117140     .001000   30.000000 'RECRUIT 89      '  2    89  0     .000000   .0000 ! 122 OK          .000  -92186.     .0000478
   .002850     .001000   30.000000 'RECRUIT 90      '  2    90  0     .000000   .0000 ! 123 OK          .000 -191316.     .0000158
   .037624     .001000   30.000000 'RECRUIT 91      '  2    91  0     .000000   .0000 ! 124 OK          .000 -157201.     .0000164
   .030549     .001000   30.000000 'RECRUIT 92      '  2    92  0     .000000   .0000 ! 125 OK          .000 -195647.     .0000420
   .007710     .001000   30.000000 'RECRUIT 93      '  2    93  0     .000000   .0000 ! 126 OK          .000 -337838.     .0000195
   .017371     .001000   30.000000 'RECRUIT 94      '  2    94  0     .000000   .0000 ! 127 OK          .000 -347802.     .0000125
   .015919     .001000   30.000000 'RECRUIT 95      '  2    95  0     .000000   .0000 ! 128 OK          .000 -392818.     .0000073
   .008697     .001000   30.000000 'RECRUIT 96      '  2    96  0     .000000   .0000 ! 129 OK          .000 -460757.     .0000042
   .020112     .001000   30.000000 'RECRUIT 97      '  2    97  0     .000000   .0000 ! 130 OK          .000 -311071.     .0000131
   .004891     .001000   30.000000 'RECRUIT 98      '  2    98  0     .000000   .0000 ! 131 OK          .000 -482180.     .0000058
   .007352     .001000   30.000000 'RECRUIT 99      '  2    99  0     .000000   .0000 ! 132 OK          .000 -205674.     .0000094
   .118887     .001000   30.000000 'RECRUIT 100     '  2   100  0     .000000   .0000 ! 133 OK          .000  -13098.     .0004233
   .001000     .001000   30.000000 'RECRUIT 101     '  0   101  0     .000000   .0000 ! 134 NO PICK     .000       0.     .0000000
   .009630     .001000   30.000000 'RECRUIT 102     '  2   102  0     .000000   .0000 ! 135 OK          .000  -99226.     .0000237
   .009787     .001000   30.000000 'RECRUIT 103     '  2   103  0     .000000   .0000 ! 136 OK          .000  -82446.     .0000204
   .054638     .001000   30.000000 'RECRUIT 104     '  2   104  0     .000000   .0000 ! 137 OK          .000  -16128.     .0001699
  -.018345     .001000   30.000000 'RECRUIT 105     ' -2   105  0     .000000   .0000 ! 138 NO PICK     .000       0.     .0000000
  -.020981     .001000   30.000000 'RECRUIT 106     ' -2   106  0     .000000   .0000 ! 139 NO PICK     .000       0.     .0000000
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Appendix E. Summary of results.

Table E1. Results of bocaccio model STATc2007. Bage1+ is summary biomass of age 1 and older fish (mtons). SpOut is spawning output in 10E9eggs. Recruits is of age 1 fish (10E3 fish). Catch is in mtons. ExploitRate is exploitation rate (Catch/Bage1+).

Year	Bage1+	SpOut	Recruits	Catch	ExploitRate	Year	Bage1+	SpOut	Recruits	Catch	ExploitRate
pre-1951	22625	3580	3523	2000	8.8%	1978	28130	4027	23791	3565	12.7%
1951	22625	3580	3523	2148	9.5%	1979	28586	3923	1980	4878	17.1%
1952	22478	3560	3523	2098	9.3%	1980	29561	3600	8373	6125	20.7%
1953	22381	3547	3523	2370	10.6%	1981	27814	3552	1397	5680	20.4%
1954	22007	3486	3523	2529	11.5%	1982	25511	3584	1599	6518	25.5%
1955	21468	3396	3523	2645	12.3%	1983	20837	3305	151	5587	26.8%
1956	20807	3285	3523	3116	15.0%	1984	16131	2837	637	4671	29.0%
1957	19667	3088	3523	3207	16.3%	1985	13504	2256	10838	2870	21.3%
1958	18457	2858	3523	3558	19.3%	1986	12129	1858	1454	3123	25.7%
1959	16936	2565	3523	3018	17.8%	1987	11034	1459	1421	2671	24.2%
1960	16405	2359	5698	2702	16.5%	1988	10324	1351	1683	2324	22.5%
1961	15787	2221	1333	2151	13.6%	1989	10291	1349	5857	2773	26.9%
1962	15597	2213	1192	1836	11.8%	1990	9039	1179	143	2758	30.5%
1963	24259	2311	52337	2503	10.3%	1991	7946	968	1881	1782	22.4%
1964	29563	2312	860	1667	5.6%	1992	7552	958	1527	1874	24.8%
1965	38092	2801	757	1971	5.2%	1993	6693	921	385	1565	23.4%
1966	44622	4331	890	3258	7.3%	1994	5948	857	869	1216	20.4%
1967	47280	6221	1344	5003	10.6%	1995	5348	820	796	774	14.5%
1968	45736	7227	2156	3029	6.6%	1996	5037	808	435	566	11.2%
1969	44532	7736	3044	2106	4.7%	1997	4944	804	1006	479	9.7%
1970	43288	7910	3199	2451	5.7%	1998	4796	802	245	206	4.3%
1971	43158	7766	14364	2459	5.7%	1999	4888	836	368	197	4.0%
1972	42115	7499	1818	3623	8.6%	2000	5882	871	5944	189	3.2%
1973	40308	7063	1982	7734	19.2%	2001	6522	901	50	207	3.2%
1974	36304	6137	15876	8494	23.4%	2002	7422	958	481	132	1.8%
1975	30969	5034	5545	5750	18.6%	2003	8213	1134	489	14	0.2%
1976	28518	4335	1291	5410	19.0%	2004	9283	1386	2732	82	0.9%
1977	25775	3961	537	3348	13.0%	2005	10024	1585	917	87	0.9%
						2006	10752	1727	1049	67	0.6%

Table E2. Age structure in 2006. BEGWT is weight (kg)at the beginning of the year. MIDWT is weight (kg) in the middle of the year. MATURE is fraction mature. EGGS is eggs per gram for mature fish. SPAWN is net fucundity at age. N106 is abundance (10E3 fish) at age at the beginningof 2006. RELATIVE F is fishing mortality rate relative to the maximum value.

	FEMALES							MALES			
AGE	BEGWT	MIDWT	MATURE	EGGS	SPAWN	N 106	RELATIVE F	BEGWT	MIDWT	N 106	RELATIVE F
1	0.1741	0.2227	0.0018	0.232	0.0001	524.5	0.21	0.1766	0.2235	524.5	0.21
2	0.3668	0.4983	0.0203	0.2396	0.0018	394	0.56	0.3495	0.4604	393.9	0.52
3	0.7092	0.8752	0.1388	0.2529	0.0257	1002.4	0.81	0.6322	0.7631	1002.8	0.75
4	1.1233	1.3083	0.4165	0.2688	0.1296	153	0.98	0.9528	1.0904	153.2	0.93
5	1.5736	1.7649	0.6992	0.286	0.322	128.1	0.96	1.2823	1.4172	128.2	1.00
6	2.0314	2.2191	0.8667	0.3035	0.5436	11.2	0.82	1.6006	1.7266	11.3	0.98
7	2.476	2.6541	0.9423	0.3204	0.7579	1119.3	0.66	1.8949	2.0089	1119.6	0.90
8	2.8953	3.0613	0.9735	0.3366	0.9606	57.1	0.52	2.1591	2.2597	57.1	0.80
9	3.2842	3.4362	0.9867	0.3522	1.155	31.1	0.42	2.3908	2.478	31.2	0.72
10	3.6375	3.7726	0.9926	0.3669	1.3396	105.3	0.35	2.5908	2.6652	104.9	0.65
11	3.9482	4.0643	0.9955	0.3798	1.5077	36.8	0.31	2.7612	2.8241	36.5	0.58
12	4.213	4.3101	0.997	0.3905	1.6538	52.8	0.29	2.9049	2.9578	52.5	0.54
13	4.434	4.5145	0.9978	0.3988	1.7766	43.6	0.27	3.0256	3.0698	43.3	0.50
14	4.6168	4.6831	0.9983	0.4052	1.8782	14	0.26	3.1262	3.163	13.9	0.47
15	4.767	4.8214	0.9986	0.41	1.9613	37.9	0.25	3.2099	3.2404	37.9	0.45
16	4.8896	4.9333	0.9989	0.4137	2.0289	30.9	0.24	3.2792	3.3044	30.5	0.44
17	4.9883	5.0235	0.999	0.4165	2.0831	1.5	0.24	3.3366	3.3574	1.4	0.42
18	5.0676	5.0958	0.9991	0.4187	2.1266	38.1	0.23	3.3837	3.4008	34.5	0.41
19	5.1312	5.1537	0.9992	0.4204	2.1612	6.9	0.23	3.4225	3.4364	5.7	0.40
20	5.182	5.2002	0.9993	0.4217	2.189	3.7	0.23	3.4542	3.4656	2.8	0.40
21	5.2888	5.2963	0.9994	0.4242	2.2466	27.8	0.22	3.518	3.5245	12.4	0.39

Relative fishing intensity by gear in 2006:
Trawl 23%, Hook&Line 15%, Set Net 1%, Recreational South 44%, Recreational North 17%