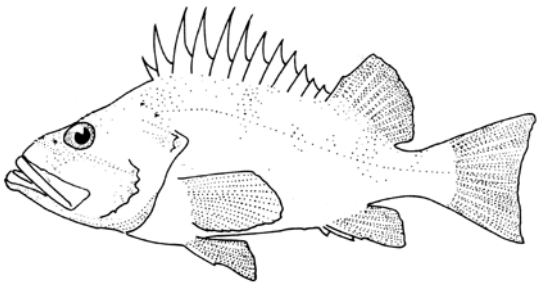
Agenda Item E.6.a
Attachment 8
June 2007

Status of cowcod, *Sebastes levis*, in the Southern California Bight



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Cowcod line drawing from CDF&G Fish Bulletin No. 157 (1972)

Executive Summary

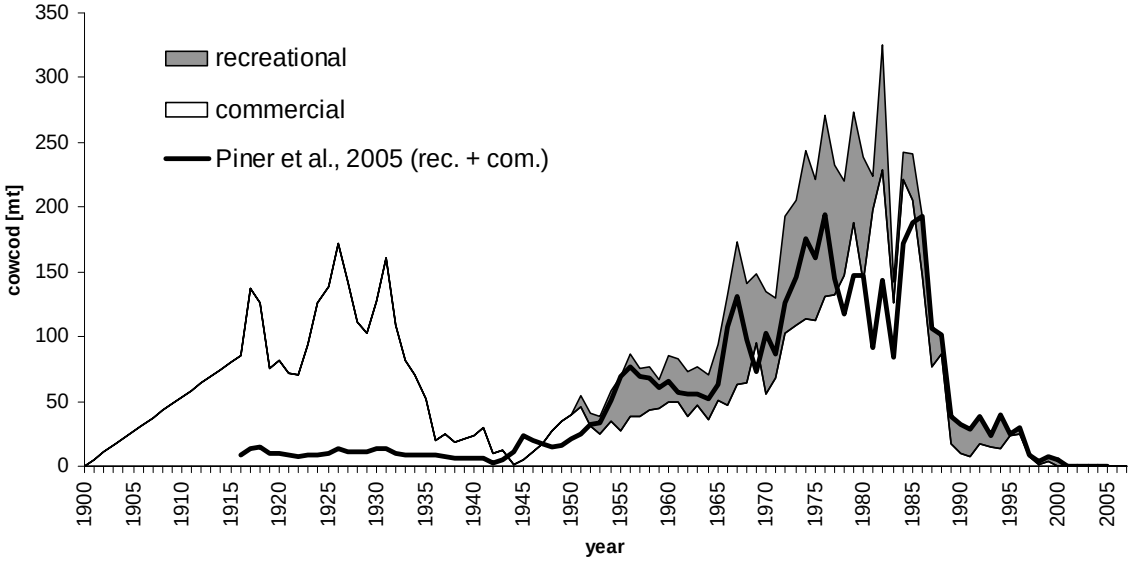
Stock: This stock assessment updates the last full assessment (Piner et al., 2005) of *Sebastes levis* in the Southern California Bight (SCB), defined as U.S. waters off California and south of Point Conception. Waters north and south of the SCB are not considered in this assessment due to sparse data and possible differences in abundance trends (Piner et al., 2005). The assumption of an isolated stock remains untested, and no information is available regarding dispersal across the northern or southern stock boundaries.

Catch: Retention of cowcod is currently prohibited. Recreational landings in this assessment are identical to those in the previous assessment, but estimates of commercial landings have been updated to reflect three additional data sources: 1) recovered port samples from Southern California (1983-1985), 2) regional summaries of total rockfish landings (1928-1968) provided by the NMFS SWFSC Environmental Research Division, and 3) California rockfish landings by region (1916-1927), published in CDF&G Fish Bulletin No. 105 (1958). From 2001 to the present, we assume a discard rate of 0.5 metric tons per year for the commercial and recreational fisheries combined (Table ES1).

Table ES1: Recent landings [metric tons] of cowcod in the Southern California Bight

Year	Commercial	Recreational	Total
1997	7.30	1.85	9.15
1998	1.21	2.81	4.03
1999	3.47	3.77	7.24
2000	0.45	4.49	4.94
2001	--	--	0.5
2002	--	--	0.5
2003	--	--	0.5
2004	--	--	0.5
2005	--	--	0.5
2006	--	--	0.5

Figure ES1: Estimated cowcod landings, 1900-2006



Data and assessment: The model structure and data inputs are very similar to the 2005 assessment. It is an age-structured production model, with three estimated parameters: virgin recruitment (R_0), catchability for the CPFV logbook index, and catchability for the visual survey biomass estimate. In the 2005 assessment, the selectivity curves for the fishery and CPFV index were inadvertently set equal to female fecundity. In this update, length-based selectivities for the fishery and logbook index are set equal to the female maturity schedule, as was the intention of Piner et al. (2005). Changes to the historical catch data are summarized above, and described in detail in the "Updated data sources" section. The length-at-age relationship was slightly adjusted based on evidence that lengths recorded during the ageing process were total length rather than fork length. The logbook index from the Commercial Passenger Fishing Vessel (CPFV) fishery and the estimate of cowcod biomass in 2002 from the submersible line-transect survey are identical to the previous assessment (no new data). Steepness of the Beverton-Holt stock-recruitment curve was fixed, but model outputs are reported for three values (0.4, 0.5, 0.6). In the base model steepness is fixed at 0.5 and natural mortality is fixed at 0.055. The period modeled in the 2005 assessment (1916-2007) was extended by a linear ramp in catch from 1900-1916. The software used to fit the base model was Stock Synthesis 2 (SS2), version 2.00c.

Unresolved problems and major uncertainties: Uncertainty analyses show that estimates of steepness (h) and the natural mortality rate (M) are highly uncertain, and both parameters are treated as fixed and known. The CPFV time series of relative abundance ends in 2000, and no abundance indices are currently available to inform recent trends. Together, these characteristics imply that conclusions regarding rebuilding success are highly uncertain.

Reference points: For *Sebastes*, the PFMC currently uses $F_{50\%}$ as a proxy for the fishing mortality rate that achieves maximum sustainable yield (F_{MSY}). Estimates from the current model indicate that cowcod is currently overfished, with spawning biomass (SB) in 2007 between 6.4% and 8.0% of the unfished level. Retention of cowcod is prohibited and bycatch is thought to be minimal, so it is unlikely that overfishing is currently an issue.

Table ES2: Reference points

	Assumed value of steepness			
Reference Point	**h = 0.4**	**h = 0.5**	**h = 0.6**	**units**
Unfished summary (age-1+) biomass	5836	5466	5205	metric tons
Unfished spawning biomass (SB_0)	5489	5141	4895	metric tons
Unfished recruitment (R_0)	121	114	108	1000s of fish
40% of SB_0 (proxy for SB_{MSY})	2196	2056	1958	metric tons
Exploitation rate at $F_{50\%}$ (proxy for F_{MSY})	2.9%	2.9%	2.9%	percent
Spawning biomass in 2007 (SB_{2007})	353	367	392	metric tons
SB_{2007} / SB_0	6.4%	7.1%	8.0%	percent

Stock biomass: Estimates of 2007 spawning stock biomass, based on the three assumed values of steepness, have declined to 353-392 mt in 2007 from an unfished biomass of 4895-5489 mt.

Figure ES2: Time series of spawning biomass

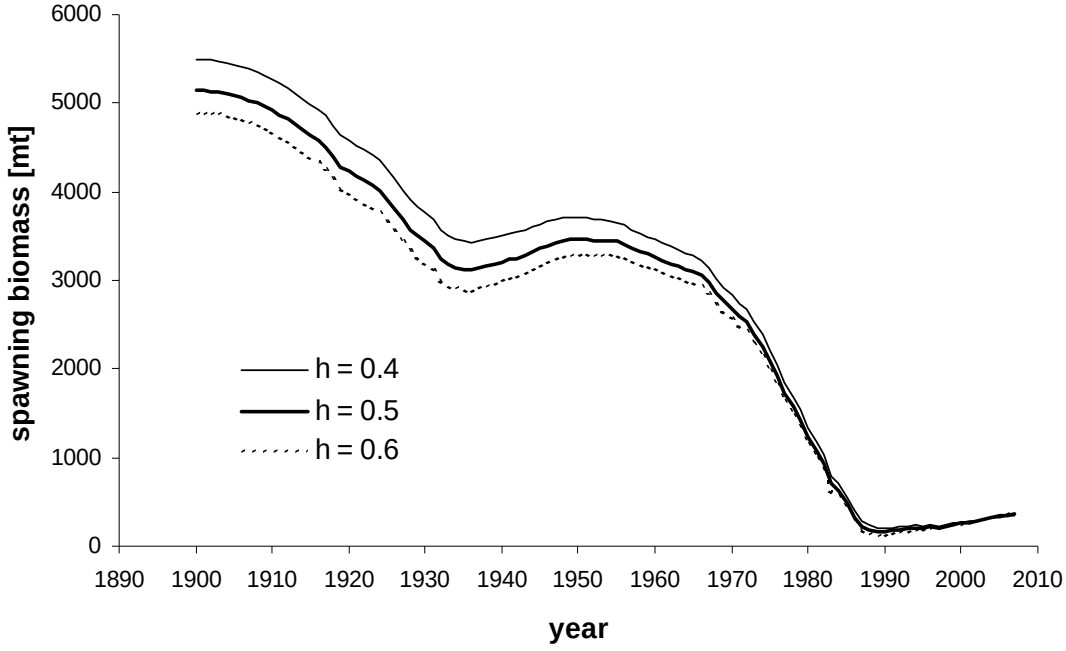
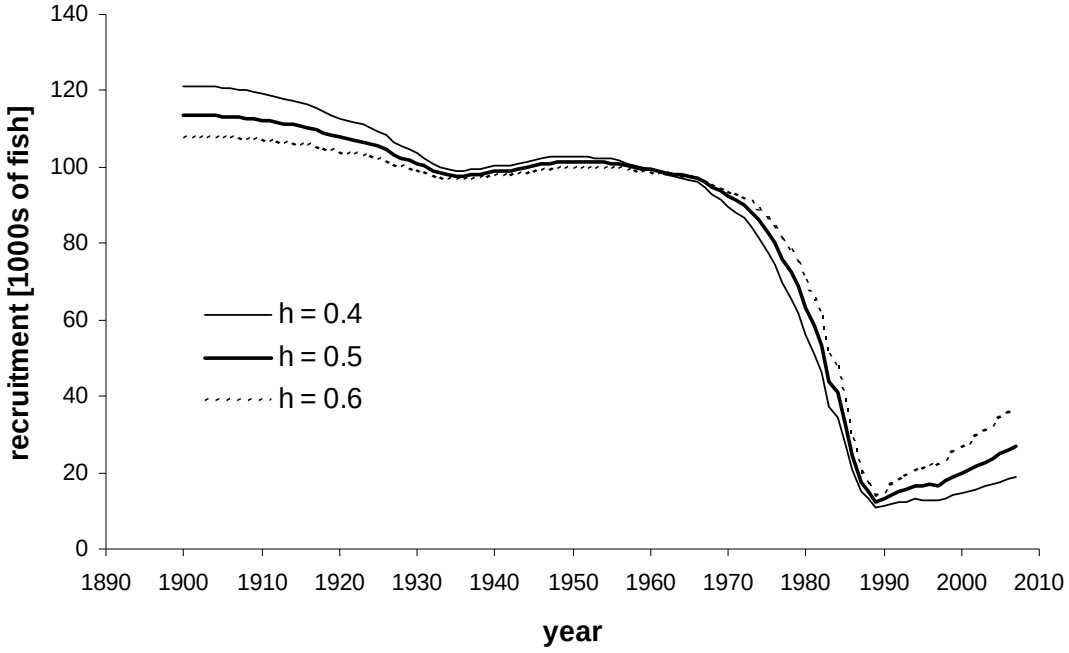


Table ES3: Recent trends in cowcod biomass and depletion

	h = 0.4			h = 0.5			h = 0.6		
year	Age 1+ biomass [mt]	SB [mt]	SB/SB_0	Age 1+ biomass [mt]	SB [mt]	SB/SB_0	Age 1+ biomass [mt]	SB [mt]	SB/SB_0
1998	282	241	4.4%	274	226	4.4%	273	218	4.5%
1999	294	256	4.7%	289	243	4.7%	292	237	4.8%
2000	303	266	4.8%	301	256	5.0%	307	253	5.2%
2001	313	277	5.0%	315	270	5.2%	325	270	5.5%
2002	328	291	5.3%	332	287	5.6%	347	290	5.9%
2003	341	305	5.5%	350	303	5.9%	370	310	6.3%
2004	355	317	5.8%	368	320	6.2%	392	330	6.7%
2005	368	330	6.0%	385	336	6.5%	415	351	7.2%
2006	381	342	6.2%	403	351	6.8%	439	371	7.6%
2007	393	353	6.4%	421	367	7.1%	464	392	8.0%

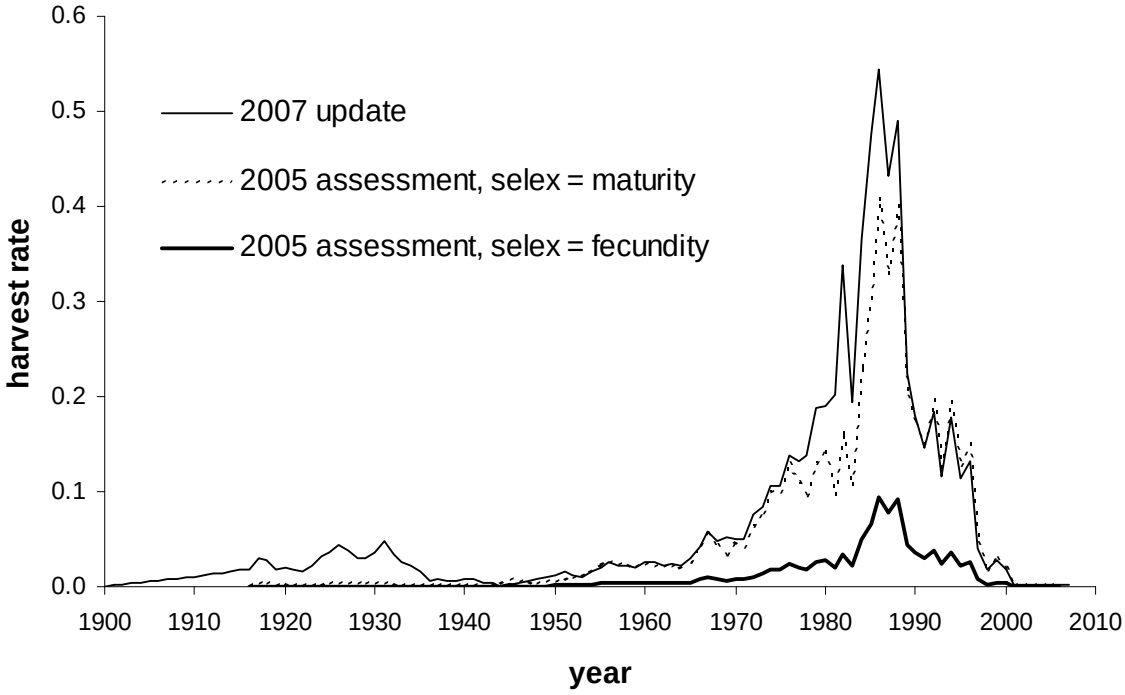
Recruitment: Predicted recruitments were taken directly from the assumed stock-recruitment relationship, estimating only virgin recruitment. The updated models suggest that recruitment declined rapidly from about 1965-1990, followed by an increasing trend (Fig. ES3).

Figure ES3: Time series of estimated recruitment



Exploitation status: The 2005 assessment with the corrected selectivity curve (no other changes) generates harvest rates over 13 times the rate at MSY (Fig. ES4). The revised landings and growth estimates in the 2007 update assessment amplify this effect.

Figure ES4: Estimated annual harvest rates (h = 0.5)



The history of exploitation according to the update model (steepness fixed at 0.5) is summarized here with two phase diagrams. Figure ES5(a) shows annual harvest rates relative to the target harvest rate ($F_{50\%}$), plotted against spawning biomass relative to 40% of unfished spawning biomass ($SB_{40\%}$). Figure ES5(b) replaces harvest rates with spawning potential ratios (SPR), the ratio of equilibrium spawning output per recruit under fished conditions to spawning output per recruit in the virgin population.

Figure ES5(a): Phase diagram of cowcod exploitation history (relative harvest rates)

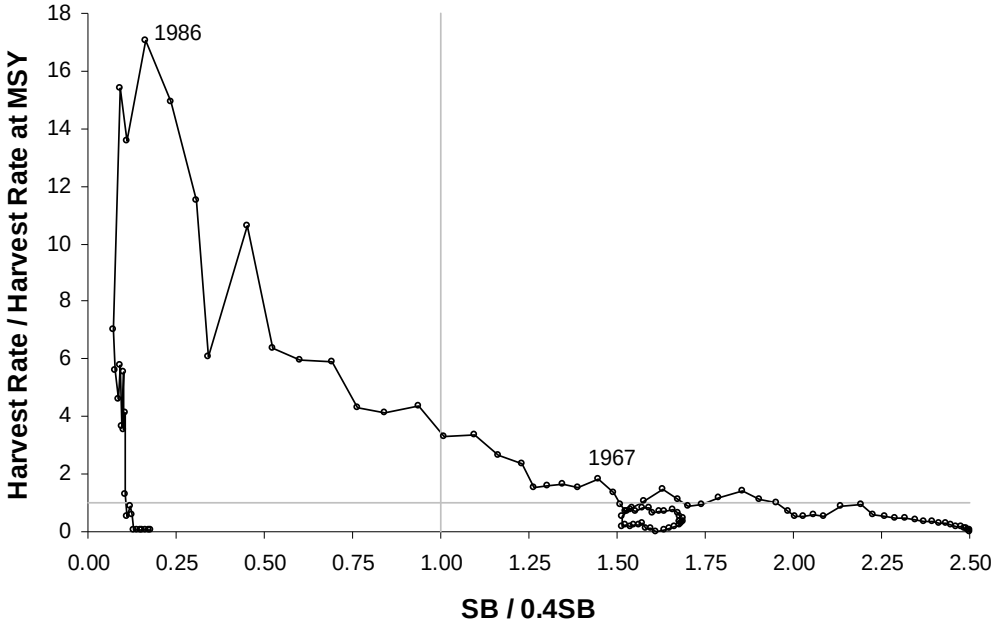
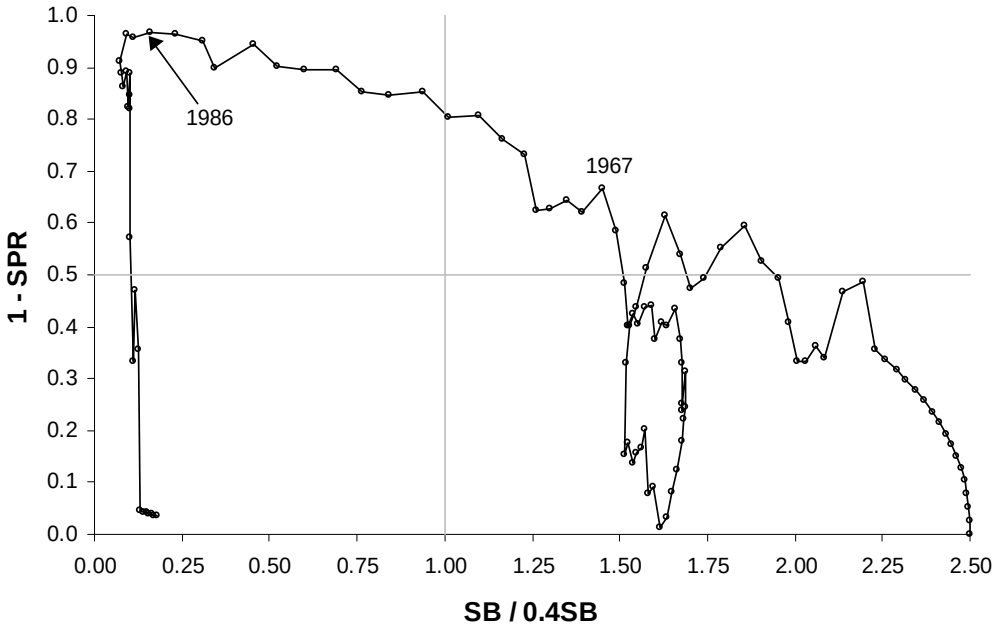


Figure ES5(b): Phase diagram of cowcod exploitation history (SPR)



Management performance: Retention of cowcod is currently prohibited. Piner et al. (2005) and Butler et al. (1999) describe the recent history of management measures.

Table ES4: Recent management performance

Years	ABC [mt]	OY [mt]	Catch [mt]
2001-2004	5	2.4	< 1
2005-2006	5	2.1	< 1

Forecasts: We used SS2 to generate 60-year forecasts for three fixed values of steepness (0.4, 0.5, 0.6), assuming no retention and a total discard rate of 0.5 metric tons per year.

Table ES5: 60-yr forecasts of age 1+ biomass and depletion (SB/SB_0)

	h = 0.4		h = 0.5		h = 0.6	
year	age 1+ biomass	depletion	age 1+ biomass	depletion	age 1+ biomass	depletion
2008	406	6.6%	439	7.4%	489	8.4%
2009	418	6.8%	457	7.8%	514	8.9%
2010	430	7.0%	476	8.1%	541	9.4%
2011	443	7.2%	495	8.4%	568	9.8%
2012	455	7.4%	514	8.7%	597	10.3%
2013	468	7.6%	534	9.0%	626	10.8%
2014	480	7.8%	554	9.4%	656	11.4%
2015	493	8.0%	575	9.7%	687	11.9%
2016	506	8.2%	596	10.1%	719	12.5%
2017	519	8.4%	618	10.5%	753	13.1%
2018	533	8.7%	641	10.9%	787	13.7%
2019	546	8.9%	664	11.3%	822	14.4%
2020	560	9.1%	688	11.7%	859	15.0%
2021	575	9.3%	713	12.1%	896	15.7%
2022	589	9.6%	738	12.5%	935	16.4%
2023	604	9.8%	764	13.0%	975	17.1%
2024	619	10.1%	791	13.4%	1016	17.9%
2025	635	10.3%	818	13.9%	1057	18.7%
2026	650	10.6%	846	14.4%	1100	19.4%
2027	667	10.9%	875	14.9%	1144	20.3%
2028	683	11.1%	904	15.4%	1189	21.1%
2029	700	11.4%	934	16.0%	1234	21.9%
2030	717	11.7%	965	16.5%	1281	22.8%
2031	735	12.0%	997	17.1%	1329	23.7%
2032	753	12.3%	1029	17.6%	1377	24.6%
2033	771	12.6%	1062	18.2%	1426	25.5%
2034	790	12.9%	1095	18.8%	1476	26.5%
2035	809	13.2%	1130	19.4%	1527	27.4%
2036	828	13.5%	1165	20.0%	1578	28.4%
2037	848	13.8%	1200	20.7%	1630	29.4%
2038	868	14.2%	1237	21.3%	1682	30.4%
2039	888	14.5%	1274	22.0%	1735	31.4%
2040	909	14.9%	1311	22.6%	1789	32.4%
2041	930	15.2%	1349	23.3%	1843	33.4%
2042	952	15.6%	1388	24.0%	1897	34.5%
2043	974	15.9%	1428	24.7%	1952	35.5%
2044	996	16.3%	1467	25.4%	2007	36.6%
2045	1019	16.7%	1508	26.1%	2062	37.7%
2046	1042	17.1%	1549	26.9%	2118	38.7%
2047	1066	17.5%	1591	27.6%	2173	39.8%
2048	1089	17.9%	1633	28.4%	2229	40.9%
2049	1114	18.3%	1675	29.2%	2284	42.0%
2050	1138	18.7%	1718	29.9%	2340	43.0%
2051	1163	19.1%	1762	30.7%	2395	44.1%
2052	1189	19.5%	1805	31.5%	2451	45.2%
2053	1215	19.9%	1849	32.3%	2506	46.3%
2054	1241	20.4%	1894	33.1%	2561	47.4%
2055	1267	20.8%	1939	33.9%	2615	48.4%
2056	1294	21.3%	1984	34.8%	2670	49.5%
2057	1321	21.7%	2029	35.6%	2724	50.5%
2058	1349	22.2%	2075	36.4%	2778	51.6%
2059	1377	22.7%	2121	37.3%	2831	52.6%
2060	1405	23.1%	2167	38.1%	2884	53.7%
2061	1434	23.6%	2213	38.9%	2936	54.7%
2062	1463	24.1%	2260	39.8%	2988	55.7%
2063	1492	24.6%	2306	40.6%	3039	56.7%
2064	1522	25.1%	2353	41.5%	3090	57.7%
2065	1552	25.6%	2399	42.3%	3140	58.7%
2066	1582	26.1%	2446	43.2%	3189	59.7%
2067	1612	26.6%	2492	44.1%	3238	60.7%

Decision table: [tbd]

Research and data needs: There is an urgent need for an informative abundance index that monitors the recovery of this stock. The submersible line-transect survey (Yoklavich et al., in review) included in this assessment is a direct measure of cowcod abundance and was formally reviewed in 2004. A pilot study for an acoustical-optical survey (D. Demer, pers. comm.) has estimated cowcod abundance by first estimating rockfish biomass using echosounders, and then apportioning that biomass to species based on video and still camera images. These types of non-lethal surveys could potentially monitor the recovery of cowcod, and given the projected length of time to recovery, it may be sufficient to conduct the surveys on a less than annual basis.

Rebuilding projections: [tbd]

Regional management: The current model assumes that cowcod in the Southern California Bight are isolated from cowcod north of Point Conception and south of the U.S.-Mexico border. This assumption remains untested. Cowcod landings in California (1969-2005) primarily occur within the current stock boundaries (Fig. ES6).

Figure ES6: Cowcod Landings by California Port Complex, 1969-2005