Status of the Sablefish Resource off the Continental U.S. Pacific Coasts in 2007

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EXECUTIVE SUMMARY

Status: This assessment finds the overall status of the West Coast sablefish stock to be improved relative to the previous assessment. Estimates of biomass are made from the U.S./Canada border, continuing south to Point Conception (34.5° latitude). As indicated by the base model, both the depletion (≈ 38%) and the ending year biomass (≈ 93k mt) are greater than those reported in the previous 2005 assessment. This increase can be attributed in part to the continued progression of the strong 1999 and 2000 year-classes into the population, as well as into the spawning stock biomass. However, based on somewhat erratic levels of estimated recruitment from 2001-2006, the previously mentioned increasing trend should be viewed with caution. Furthermore, because of a series of poor recruitments in the mid- to late-1990's, if fished at the full OY level, depletion is forecasted to decrease for the next five years. Evidence continues to suggest that larval survival is modulated in part by climate change as expressed by annual fluctuations in the California Current System. Forecasts of the possible future status of the stock beyond the year 2006 do not take into account any possible future trends in either climate change or conditions of the California Current System.

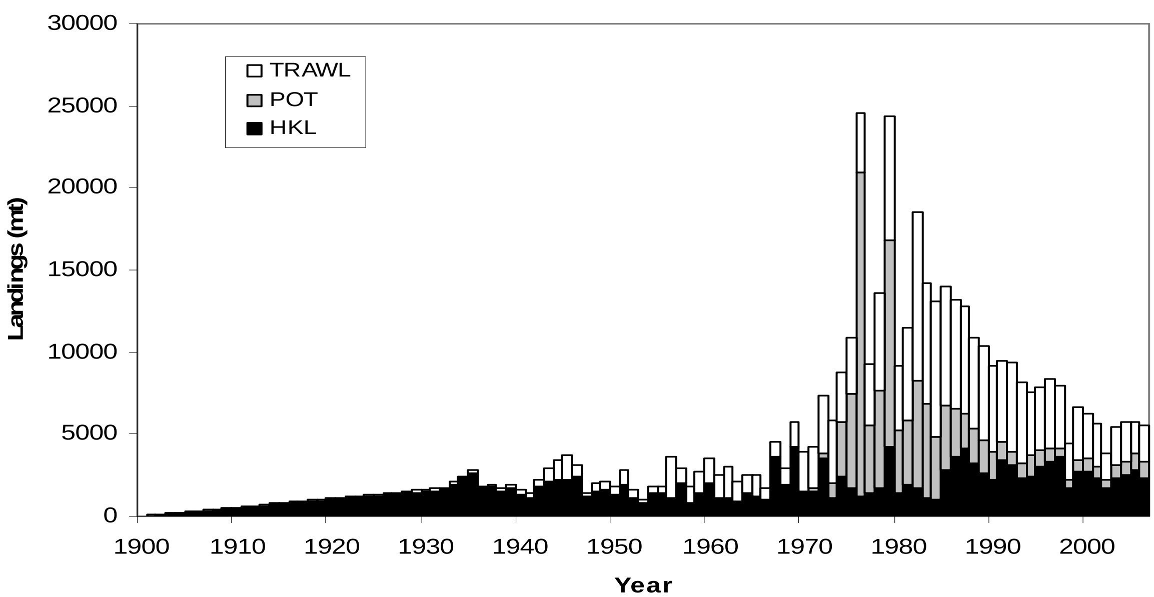


Figure ES- 1. *Total landings of sablefish off the US West Coast by gear, 1900-2006*

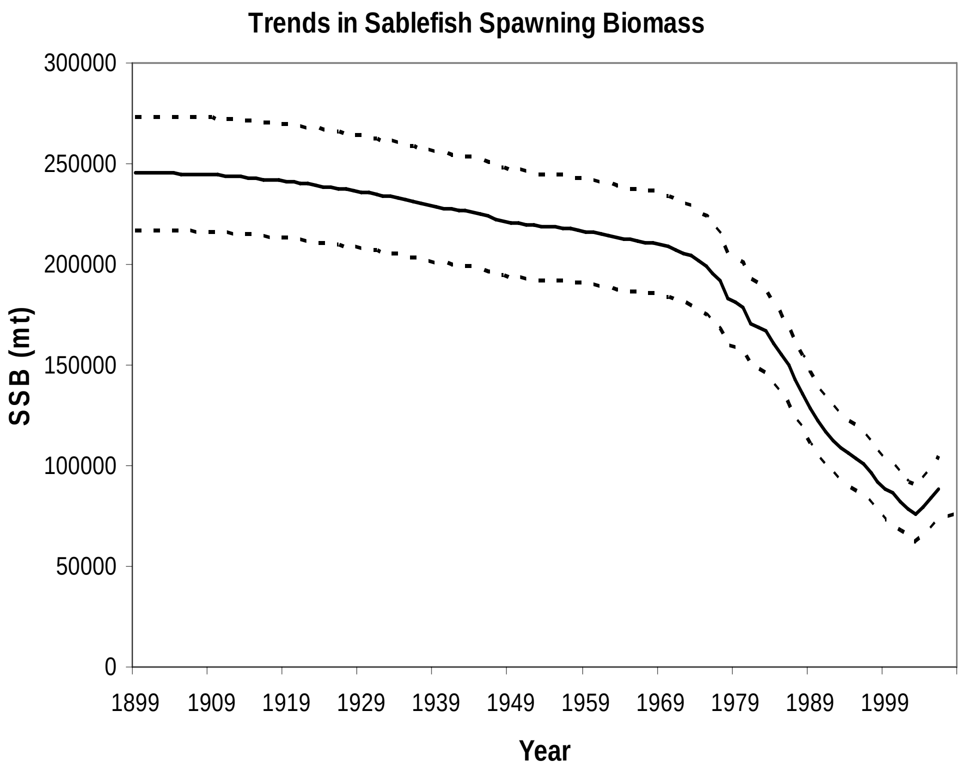
Stock: Sablefish, or blackcod, (*Anoplopoma fimbria*) are distributed in the Northeastern Pacific Ocean from the southern tip of Baja California, northward to the north-central Bering Sea and in the Northwestern Pacific Ocean from Kamchatka, southward to the northeastern coast of Japan. In this assessment, the West Coast sablefish population was modeled as single stock extending from the southern border of the Conception INPFC area through the northern border of the U.S. Vancouver INPFC area.

Catch: Catches of sablefish from waters off Oregon, Washington, and California are classified into three gear types: hook and line, pot, and trawl. Catch estimates by gear type were available starting in 1915. Catches in the assessment model began at zero in the year 1900 and were increased linearly through the year 1915. Data were generally available for the years from 1916 through 1932, though landings were estimated through interpolation for years without data. Landings in 1933 were reported to be approximately 2,000 metric tons and stayed at this level until approximately 1967 when they began increasing to more recent levels.

ES-1*. Recent sablefish catches (mt) by INPFC area and gear type*

	Vancouver-Columbia			Eureka-Monterey			Conception			Combined			
Year	HKL	POT	TWL	HKL	POT	TWL	HKL	POT	TWL	HKL	POT	TWL	TOTAL
1992	1997	363	2649	989	249	2504	93	187	301	3079	798	5457	9366
1993	1743	613	2729	499	180	1965	85	55	266	2328	847	4959	8147
1994	1498	1048	2075	761	309	1582	115	13	161	2375	1370	3822	7579
1995	1982	749	1872	882	315	1761	115	2	213	2978	1065	3848	7905
1996	1920	522	2121	1309	227	1876	125	1	214	3354	750	4211	8318
1997	2105	356	1872	1372	227	1743	107	1	154	3585	584	3771	7943
1998	1190	384	1097	468	63	978	99	0	115	1757	448	2191	4401
1999	1909	628	1726	712	125	1365	96	2	83	2717	755	3175	6649
2000	1944	661	1449	683	190	1148	83	1	37	2711	852	2727	6291
2001	1634	508	1639	612	163	945	111	1	29	2357	672	2624	5655
2002	1173	307	830	444	154	715	128	11	50	1745	472	1597	3817
2003	1568	569	1226	609	219	1001	127	12	79	2304	799	2331	5435
2004	1933	527	1415	504	269	789	87	16	80	2524	811	2447	5785
2005	1995	649	1081	730	336	815	78	12	55	2803	996	1955	6212
2006	1657	678	1293	611	272	834	66	87	9	2334	1037	2137	5861

Data and Assessment. Landings and age- and length-composition data for this assessment were obtained from the Sablefish Port (SPORT) database, maintained by the North West Fisheries Science Center (NWFSC). Historic landings were derived from Pacific Marine Fisheries Commission, Bulletin Number 3. This year's assessment (2007) utilized several indices of abundance: the 1980-2004 Alaska Fisheries Science Center (AFSC) and NWFSC Triennial shelf survey; the 1997-2001 AFSC slope survey; the 1998-2006 NWFSC "slope survey" (i.e. deep tows from the NWFSC bottom trawl survey); the 2003-2006 NWFSC "shelf survey" (i.e. shallow tows from the NWFSC survey years with expanded depth coverage); sea surface height (SSH) data, 1925-2006; and zooplankton abundance data, 1979-2001. Sea-surface height and zooplankton data were used to index recruitment deviations from the estimated stock-recruitment function. These multiple data sources were combined in a maximum likelihood statistical framework using the Stock Synthesis Model 2 (SS2, version 2.00b, March 22, 2007).



Reference Points. For sablefish, the proxy for BMSY is calculated as 40% of the unfished spawning stock biomass (SSB). The stock is declared overfished if the current SSB is estimated to be below 25% of the unfished SSB. The MSY-proxy harvest rate for sablefish is SPR = F45%. The current assessment estimates that sablefish can support maximum sustainable yield (MSY) of approximately 6,328 mt using the SB40% proxy, 4,871 mt when using the SPR proxy, and 6,303 mt when using the actual estimated values instead of proxies.

Recent estimated trend in spawning stock biomass and depletion

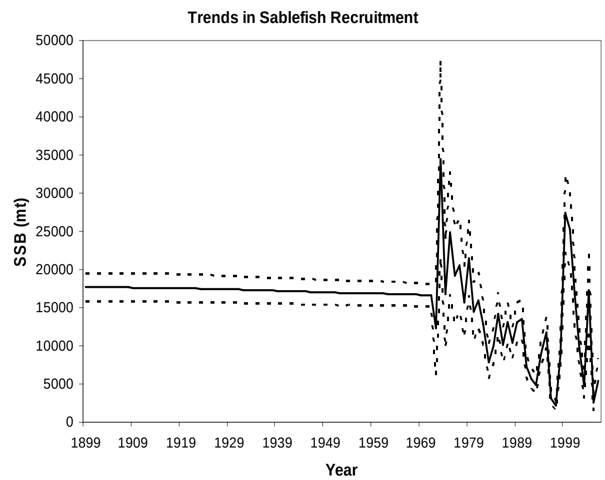
Year	SSB	95% CI	Depletion	95% CI
1997	92,013	76,991 - 107,035	37.5%	NA
1998	88,345	73,554 - 103,136	36.0%	NA
1999	86,227	71,640 - 100,814	35.2%	NA
2000	82,288	67,986 - 96,590	33.6%	NA
2001	78,176	64,188 - 92,164	31.9%	NA
2002	76,171	62,302 - 90,040	31.1%	NA
2003	79,264	64,934 - 93,594	32.3%	NA
2004	83,826	68,636 - 99,014	34.2%	NA
2005	88,632	72,398 - 104,866	36.1%	NA
2006	91,686	74,559 - 108,813	37.4%	32.1% - 44.5%
2007	93,895	75,968 - 111,822	38.3%	32.4% - 45.4%

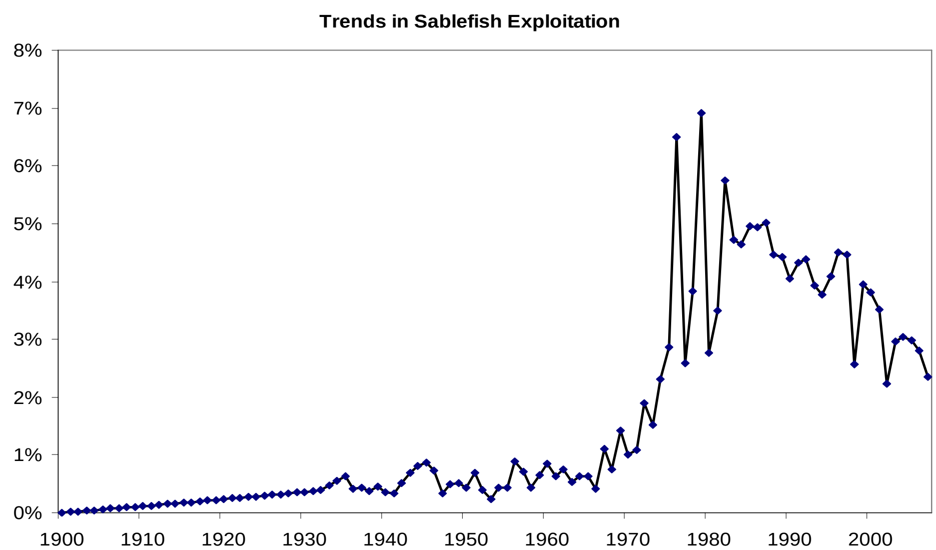
Stock Biomass. As modeled here, sablefish SSB steadily declined during the period 1900-2002. Increases in SSB since 2002 are primarily the result of two recent strong year classes (1999 and 2000) recruiting into the population.

Recruitment. Two strong year classes, one in 1999 and another in 2000 have punctuated the past twenty years of sablefish recruitment. A significant relation was observed between second quarter (April, May, and June) sea surface height in the northern coast (44-48 degrees latitude) and age-0 sablefish survivorship. A weaker, yet still significant, relationship was found between recruitment deviations and zooplankton species composition. While SSH is thought to affect sablefish recruitment at the physical oceanographic level, zooplankton species composition is thought to affect survival at a more basic biological level. The SSH and zooplankton index were significantly related, suggesting they are acting in concert on overall survivorship.

Recent estimated trend in sablefish recruitment

Year	Recruitment (1000s)	95% CI
1997	2,103	360 - 2,516
1998	8,828	804 - 6,167
1999	27,369	1,925 - 19,080
2000	25,330	2,138 - 19,728
2001	16,747	1,502 - 11,287
2002	9,698	1,045 - 6,546
2003	4,726	635 - 3,011
2004	17,357	1,770 - 8,783
2005	2,609	584 - 1,986
2006	5,343	1,545 - 2,447

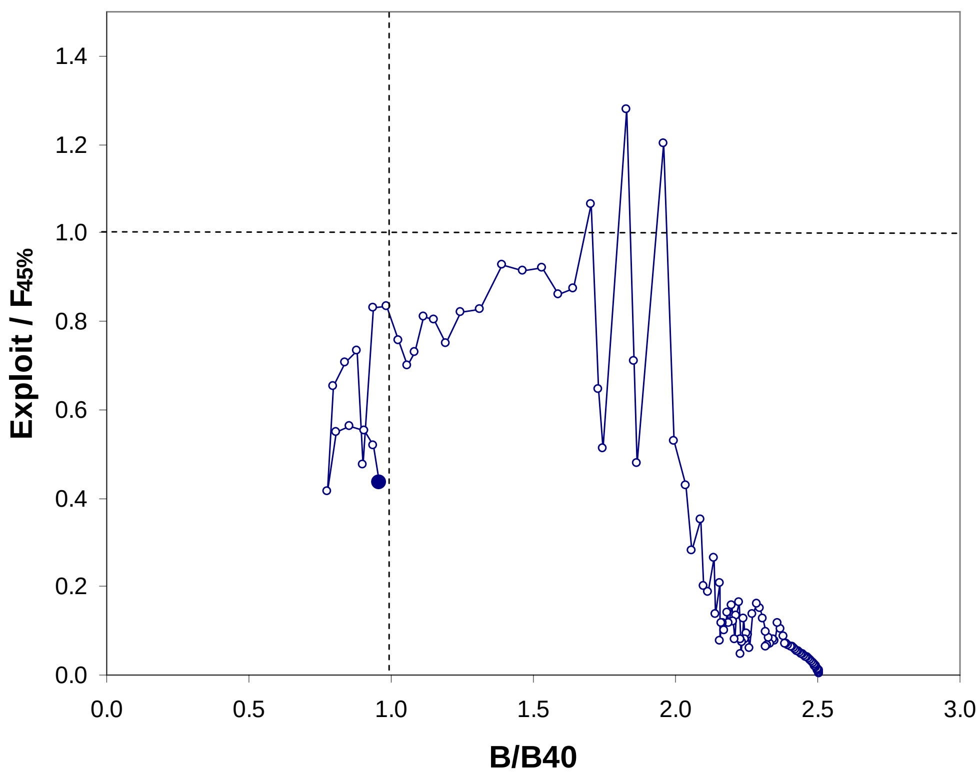




Exploitation Status: The base model for sablefish produces an estimated unfished SSB of 244,688 mt (~95% confidence interval: 216,898 - 273,542) with a mean expected recruitment of 17,656 thousand age-0 fish. The current SSB is estimated to be 93,895 mt (~95% CI: 75,968 - 111,822). Therefore, with this model configuration, the current depletion level for the year 2007 is estimated to be 38.3% (~95% CI: 32.4 - 45.4). Historical exploitation rates peaked in the late-1970s at over 6%. The current total exploitation rate in 2007 is estimated to be 2.35%.

Recent trends in Sablefish exploitation

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
4.47%	2.57%	3.95%	3.81%	3.52%	2.24%	2.97%	3.03%	2.98%	2.80%	2.35%



Management Performance. Sablefish catch (landings plus estimated/assumed discards) has been below the ABC for the past ten years.

Forecasts. Forecasts of the possible future status of the sablefish stock were generated for the base case model, with future selectivity equal to the average of 2005-2007, catch being allocated between the three gear types in approximately the same manner as prescribed by the Pacific Fishery Management Council, and recruitments taken directly from the estimated stock-recruitment function. Based on the current estimates of recruitment strength in recent years, the depletion level is projected to fall from 38.3% to 32.1% by 2019, assuming full harvest of future OYs assuming the "40/10" harvest policy

Projected potential sablefish catch, landings, spawning stock biomass and depletion for base model

Year	ABC Catch	OY Catch	SSB	95% CI	Depletion	95% CI
2008	6,058	5,933	95,389	76,791 - 113,987	38.9%	32.4% - 45.4%
2009	9,914	9,795	94,686	75,646 - 113,726	38.6%	31.8% - 45.4%
2010	9,217	8,988	91,285	73,113 - 109,457	37.2%	30.7% - 43.7%
2011	8,808	8,484	88,354	70,802 - 105,906	36.0%	29.7% - 42.4%
2012	8,623	8,225	86,164	68,786 - 103,542	35.1%	28.7% - 41.6%
2013	8,567	8,110	84,561	66,988 - 102,134	34.5%	27.8% - 41.1%
2014	8,564	8,058	83,316	65,377 - 101,255	34.0%	27.1% - 40.9%
2015	8,569	8,019	82,264	63,936 - 100,592	33.5%	26.3% - 40.7%
2016	8,562	7,973	81,317	62,640 - 99,994	33.2%	25.7% - 40.6%
2017	8,538	7,914	80,434	61,465 - 99,403	32.8%	25.2% - 40.4%
2018	8,501	7,843	79,600	60,390 - 98,810	32.5%	24.6% - 40.3%
2019	8,454	7,765	78,810	59,398 - 98,222	32.1%	24.2% - 40.1%

Research and Data Needs. Despite a long history of scientific investigations, there remain many questions with regard to sablefish biology, the fishery (past and present) and the possible current and future status of the stock:

(1) While the significant relation between the SSH index and sablefish age-0 survival demonstrates that this should be a reliable (at least near term) index, the zooplankton index may support the underlying biological mechanism as to exactly WHY this relationship is being observed. Investigations into the food habits of age-0 fish, especially during the spring months, could help with this understanding. The date of the Spring Transition also shows promise as an early indicator of recruitment strength and should be investigated further. Also, further research should be conducted to evaluate alternative methods for incorporating ecosystem metrics into the assessment. For example, should the two current indices be combined into one index by way of a principal component analysis or should the current (or similar) multivariate method be used. The simulation work conducted for the recent B-zero Workshop should be continued and should address issues of this nature.

(2) Consistency in the manner in which the three states collect port samples of length-and age-composition data should be a goal. Given the problems associated with grading, samples should not sub-sampled by these categories. Furthermore, at-sea observer collection of otolilths from fixed-gear vessels that land their fish headed should be continued.

(3) While well under way, continued observer coverage of both trawl and fixed gears is critical to estimating the quantity and length composition of the discarded catch. Field-oriented work to investigate discard mortality rates should be conducted to compliment the existing lab work.

Rebuilding Projections. The stock of sablefish of the Continental United States was not found to be currently overfished, and therefore does not require rebuilding projections.

Regional Management Concerns. While sablefish growth has been shown to differ from Washington to California, it is doubtful that the existing amount of fishing effort in the south warrants managing the sablefish as two separate stocks. More interesting is the possibility of developing a transboundary stock assessment covering U.S. West Coast and the waters off southern Vancouver Island in Canada. Many of the recent recruitment trends observed in each area show a great deal of similarity.

Unresolved Problems and Major Uncertainties. The major sources of uncertainty in this stock assessment are (1) survey catchability (Q), and (2) discard quantity and length composition, and, in a very inter-related manner, discard mortality. When freely estimated, the value was $Q = 0.36$). However, based on the framework suggested by the STAR Panel during the meeting, survey catchability was fixed at a value of 0.56 for the base-run. Values that went into the estimation framework were arrived at via consensus of those in attendance. Given the steep descending limb of the NWFSC “slope” survey selectivity curve, a Q of 0.56 most correctly can be said to apply only to those fish of a total length of 53 cm., the peak of the integrated length/age selectivity curve. The shape of this curve still allows for the ability of fish larger than 53 cm. to out-swim the trawl gear (as has been presumed) and for the smaller fish to escape capture based on size and age. Although discard quantity and length-composition data were available from the NWFSC Observer Program, these data only cover a short, recent time period. Still unknown are the discard rates for the three gear types for the vast majority of the time period covered by the assessment. Depending on the discard mortality rate of discarded sablefish (which presumably differs by depth, time of year, time on deck, etc.), assumed historic discard rates may or may not be have a significant influence on the estimated current status of the stock. Finally, there is a great deal of uncertainty surrounding the estimate of virgin spawning stock biomass (*B0*). This assessment assumes that there is a significant relation between climatic conditions of the California Current System (CCS) and survival of age-0 sablefish. Sea surface height data going back to 1925 suggests that there may have been a fundamental shift in the mean SSH around the year 1961. If this is the case, it is difficult to estimate how or even if, this shift may have affected the productivity of the stock. Furthermore, the variability of productivity of the CCS prior to 1925 are unknown. Consequently, the concept of a static “virgin” biomass is challenged by one in which an unfished sablefish population would exhibit substantial variability in response to long-term oscillation in environmental conditions. Without a longer time series of environmental data, it is not possible to determine if environmental conditions near 1925 represent a reasonable long-term average state, relative to the productivity for the sablefish stock.

Overall Perspectives. A unification of sablefish recruitment, climate change, and the factors that affect the California Current System is suggested: as goes climate change, so goes sablefish recruitment. If future climate change results in a more erratic California Current System, as predicted by some models, the results may be more erratic sablefish recruitment. Should this happen, the fishery may end up being supported by fewer, less frequent, strong year classes rather than by a greater number of “average” strength year classes.

At present, the strong 1999 and 2000 years classes are fully within the fishery. Whether these two year classes are due to past management actions or merely favorable oceanographic conditions is not clear. Caution should be exercised when using the apparent high abundance of these two year classes as an index of overall stock health. Although the two year classes are estimated to be the strongest in recent history, adjacent year classes do not appear to be as strong.

STAT Response to Issues Raised in the STAR Panel Report

The STAT found many of the concerns raised in the report to be either totally unfounded or too general to be of any help to the process. The STAT made written mention of these generalities and inaccuracies during the report writing process, but the final report failed to address many of the STAT concerns and maintained many of its original criticisms and extremely ambiguous tone. As a result, the STAT feels compelled to address several Panel comments in this document.

As catch estimates are made further into the future, the use of environmental indicators to help forecast recruitment strength will become more important. The environmental indices used are and exactly the same as those used in the previous assessment and extremely similar to those published in Schirripa and Colbert (2004). Despite statements made in the STAR Panel report, this publication does indeed do a type of validation that was fully accepted by the peer reviewers of the documents. Given the low p-values of the regression ($p = 0.00004191$) and the biology supporting the index, it is highly unlikely that the relationship is spurious. There was an obvious difference of philosophy between the STAR Panel and the

STAT as to the importance of including these data. While the report terms the use of such indices as "fashionable", the STAT challenges this characterization by pointing out that no other assessment on the west coast is currently using environmental data to help determine and/or forecast recruitment.

The STAR Panel's conclusion that the complexity of the model was not justified given the likely information content of the data was not supported by any specific details or examples of consequence. In fact, the STAT made large strides to decrease the complexity of previous model configurations by reducing the number of fisheries to both one and two gear types, partitioning the commercial and survey data into fewer units, doing away with the "super year" approach to the biomass estimates, and utilizing a "swept-area" estimation procedure for biomass estimates to make survey catchability easier to interpret.

The STAR Panel's conclusion that "many of the data sets had not been scrutinized or analyzed enough" was not accompanied by any specific examples of data sets to which they were referring. The Panel's conclusion is especially puzzling to the STAT for two reasons, (1) following careful examination of the data, the STAT's base model had fully dismissed 6 of the 12 previously used data sets (including lengths and ages) and partially dismissed one other. Furthermore, the STAT spent a great of time and effort reviewing the commercial landings data with a designated industry representative until a mutually agreed upon resolution was reached. This left only the survey data, which is known to be highly scrutinized on an ongoing basis.

The STAR Panel report is inaccurate in its use of the terms "ad hoc methods" and "smoothing" to get the model working. As was explained during the STAR panel, some lengths at L-infinity were mistakenly left in the data file, however there was no predetermined intention of leaving the data in this condition, as "smoothing" would suggest. The report fails to mention that the values were all at L-infinity and as such had very little, if any, influence on model outcomes.

Finally, the reference to model runs made by the STAR Panel itself was somewhat troubling and does not seem to adhere to procedures outlines in the Terms of Reference. While the STAT sees no problem with, in fact encourages, examination of the assessment input files, it seems irregular to have the STAR do it's own model runs and then bring those results to the meeting, even if not for consideration as a final run.

Summary tables for Sablefish

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landings (mt)	4396	6647	6290	5653	3814	5434	5782	5754	5508	4600
Estimated Discards (mt)	8.42	4.64	4.93	231.24	112.52	16.6	16.02	3.91	16.37	
Estimated Total Catch (mt)	4404	6652	6295	5884	3927	5451	5798	5758	5524	4600
ABC (mt)	5200	9700	9700	7900	5000	8500	8500	8400	8200	6200
OY * (if different from ABC) (mt)	5200	7900	7900	7000	4600	6800	7800	7800	7600	4600
SPR	61.4%	47.6%	48.6%	49.9%	64.3%	58.8%	61.0%	63.7%	66.0%	70.5%
Exploitation Rate (total catch/summary biomass)	2.6%	3.9%	3.8%	3.5%	2.2%	3.0%	3.0%	3.0%	2.8%	2.3%
Summary Age "x+" Biomass (B) (mt)	170,075	163,427	156,921	160,923	170,558	180,956	187,899	189,613	195,783	194,425
Spawning Stock Biomass (*SB*) (mt)	88,345	86,227	82,288	78,176	76,171	79,264	83,826	88,632	91,686	93,895
Uncertainty in Spawning Stock Biomass estimate (SD)	7,395	7,293	7,151	6,994	6,935	7,165	7,594	8,117	8,564	8,963
Recruitment at age "x"	8,828	27,369	25,330	16,747	9,698	4,726	17,357	2,609	5,343	9,564
Uncertainty in Recruitment estimate (SD)	1,013	2,531	2,510	1,909	1,276	780	2,578	576	1,506	5,805
Depletion (SB/SB0)	36.0%	35.2%	33.6%	31.9%	31.1%	32.3%	34.2%	36.1%	37.4%	38.3%
Uncertainty in Depletion estimate	-	-	-	-	-	-	-	-	3.1%	3.3%

	Point Estimate	Uncertainty in estimates (If Available)		
Unfished Spawning Stock Biomass (SB_0) (mt)	244,688	216,898	-	273,542
Unfished Summary Age 2+ Biomass (B_0) (mt)	464,652	NA		NA
Unfished Recruitment (R_0) at age 0	17,656	15,802	-	19,510
Reference points based on $SB_{40\%}$				
MSY Proxy Spawning Stock Biomass ($SB_{40\%}$)	97,919	86,604	-	109,234
SPR resulting in $SB_{40\%}$ ($SPR_{SB40\%}$)	60.2%	51.8%	-	68.5%
Exploitation rate resulting in $SB_{40\%}$	3.13%	NA		NA
Yield with $SPR_{SB40\%}$ at $SB_{40\%}$ (mt)	6,328	4,607	-	8,048
Reference points based on SPR proxy for MSY				
Spawning Stock Biomass at SPR (SB_{SPR})(mt)	41,544	2,096	-	80,992
$SPR_{MSY\text{-}proxy}$	45.00%			
Exploitation rate corresponding to SPR	5.40%	NA		NA
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)	4,871	245	-	9,496
Reference points based on estimated MSY values				
Spawning Stock Biomass at MSY (SB_{MSY}) (mt)	91,559	71,670	-	111,448
SPR_{MSY}	58.56%	46.86%	-	70.26%
Exploitation Rate corresponding to SPR_{MSY}	3.33%	NA		NA
MSY (mt)	6,303	4,529	-	8,077

Decision Table 1 based on model that includes sea surface height index and three states of nature which assume varying degrees of stock size by varying the NWFSC Combined survey catchability (Q) and various catch levels. Catch is in metric tons of killed fish.

						Low Stock Size		Base Case		High Stock Size	
						Q = 0.712		Q = 0.56		Q = 0.445	
						Less Likely (p=0.25)		More likely (p=0.50)		Less Likely (p=0.25)	
Management Decision	**Year**	**H&L Catch**	**Pot Catch**	**Trawl Catch**	**TOTAL**	**SSB**	**Depletion**	**SSB**	**Depletion**	**SSB**	**Depletion**
	2009	1,243	1,341	4,685	7,269	73,394	32.2%	94,693	38.6%	120,581	45.5%
	2010	1,128	1,249	4,342	6,719	71,142	31.2%	92,541	37.7%	118,545	44.7%
	2011	1,025	1,185	4,177	6,387	69,270	30.4%	90,744	37.0%	116,816	44.0%
Low Catch	2012	958	1,147	4,131	6,236	67,988	29.8%	89,587	36.5%	115,772	43.7%
	2013	924	1,127	4,142	6,194	67,164	29.4%	88,951	36.3%	115,313	43.5%
40:10	2014	913	1,117	4,169	6,199	66,606	29.2%	88,636	36.1%	115,234	43.5%
Low Stock Size	2015	912	1,112	4,189	6,213	66,179	29.0%	88,494	36.1%	115,372	43.5%
	2016	916	1,108	4,195	6,219	65,809	28.8%	88,440	36.1%	115,628	43.6%
	2017	921	1,104	4,187	6,211	65,464	28.7%	88,433	36.1%	115,952	43.7%
	2018	924	1,099	4,170	6,192	65,136	28.5%	88,455	36.1%	116,317	43.9%
	2009	1,672	1,986	6,139	9,797	73,394	32.2%	94,693	38.6%	120,581	45.5%
	2010	1,502	1,845	5,641	8,989	69,884	30.6%	91,292	37.2%	117,270	44.2%
	2011	1,351	1,747	5,387	8,485	66,868	29.3%	88,361	36.0%	114,378	43.1%
Base Case Catch	2012	1,248	1,686	5,293	8,226	64,547	28.3%	86,170	35.1%	112,271	42.3%
	2013	1,189	1,646	5,275	8,111	62,751	27.5%	84,567	34.5%	110,819	41.8%
40:10	2014	1,162	1,620	5,277	8,058	61,253	26.8%	83,321	34.0%	109,788	41.4%
Base Case	2015	1,151	1,600	5,270	8,020	59,901	26.2%	82,269	33.5%	109,001	41.1%
	2016	1,147	1,582	5,245	7,974	58,615	25.7%	81,322	33.2%	108,359	40.9%
	2017	1,145	1,565	5,204	7,914	57,363	25.1%	80,439	32.8%	107,808	40.7%
	2018	1,143	1,549	5,152	7,843	56,137	24.6%	79,604	32.5%	107,328	40.5%
	2009	2,147	2,512	7,718	12,377	73,394	32.2%	94,693	38.6%	120,581	45.5%
	2010	1,942	2,351	7,143	11,437	68,635	30.1%	90,019	36.7%	116,005	43.7%
	2011	1,755	2,239	6,866	10,860	64,433	28.2%	85,869	35.0%	111,902	42.2%
High Catch	2012	1,622	2,167	6,780	10,569	60,986	26.7%	82,515	33.6%	108,639	41.0%
	2013	1,543	2,120	6,780	10,443	58,096	25.5%	79,779	32.5%	106,063	40.0%
40:10	2014	1,493	2,073	6,750	10,316	55,507	24.3%	77,404	31.6%	103,918	39.2%
High Stock Size	2015	1,468	2,036	6,711	10,214	53,081	23.3%	75,248	30.7%	102,049	38.5%
	2016	1,454	2,003	6,650	10,107	50,731	22.2%	73,214	29.9%	100,351	37.8%
	2017	1,444	1,973	6,570	9,988	48,425	21.2%	71,262	29.1%	98,772	37.2%
	2018	1,434	1,945	6,478	9,857	46,152	20.2%	69,377	28.3%	97,292	36.7%
	2009	1,061	1,124	3,901	6,086	73,394	32.2%	94,705	38.7%	120,581	45.5%
	2010	985	1,069	3,688	5,742	71,709	31.4%	93,152	38.1%	119,120	44.9%
	2011	913	1,031	3,607	5,551	70,308	30.8%	91,856	37.5%	117,870	44.4%
Catch to	2012	866	1,013	3,617	5,496	69,422	30.4%	91,125	37.2%	117,229	44.2%
Stablize at B40%	2013	845	1,008	3,674	5,527	68,944	30.2%	90,868	37.1%	117,122	44.2%
40:10	2014	842	1,012	3,743	5,597	68,697	30.1%	90,899	37.1%	117,356	44.3%
Base Case	2015	851	1,018	3,805	5,675	68,555	30.0%	91,075	37.2%	117,774	44.4%
	2016	864	1,027	3,853	5,744	68,446	30.0%	91,313	37.3%	118,280	44.6%
	2017	878	1,035	3,888	5,800	68,335	29.9%	91,569	37.4%	118,819	44.8%
	2018	890	1,042	3,911	5,843	68,212	29.9%	91,824	37.5%	119,367	45.0%

Decision Table 2 based on model that does not includes sea surface height index and three states of nature which assume varying degrees of stock size by varying the NWFSC Combined survey catchability (Q) and various catch levels. Catch is in metric tons of killed fish.

						Low Stock Size Q = 0.712 Less Likely (p=0.25)		Base Case Q = 0.56 More likely (p=0.50)		High Stock Size Q = 0.445 Less Likely (p=0.25)	
Management Decision	**Year**	**H&L Catch**	**Pot Catch**	**Trawl Catch**	**TOTAL**	**SSB**	**Depletion**	**SSB**	**Depletion**	**SSB**	**Depletion**
	2009	1,185	1,461	4,381	7026	73,561	30.8%	95,386	36.9%	122,045	43.2%
	2010	1,072	1,370	4,048	6489	71,298	29.8%	93,241	36.0%	120,013	42.5%
	2011	972	1,306	3,879	6156	69,381	29.0%	91,387	35.3%	118,201	41.8%
Low Catch	2012	903	1,265	3,820	5988	67,997	28.4%	90,102	34.8%	116,981	41.4%
	2013	866	1,238	3,814	5918	67,031	28.0%	89,290	34.5%	116,283	41.1%
40:10	2014	849	1,220	3,820	5889	66,315	27.7%	88,777	34.3%	115,932	41.0%
Low Stock Size	2015	843	1,206	3,821	5870	65,727	27.5%	88,431	34.2%	115,784	41.0%
	2016	842	1,193	3,808	5843	65,201	27.3%	88,176	34.1%	115,754	40.9%
	2017	842	1,182	3,784	5808	64,709	27.1%	87,974	34.0%	115,796	41.0%
	2018	841	1,171	3,752	5764	64,240	26.9%	87,810	33.9%	115,886	41.0%
	2009	1,699	1,843	6,151	9693	73,561	30.8%	95,386	36.9%	122,045	43.2%
	2010	1,522	1,704	5,626	8852	69,982	29.3%	91,912	35.6%	118,688	42.0%
	2011	1,363	1,598	5,345	8306	66,872	28.0%	88,846	34.4%	115,685	40.9%
Base Case Catch	2012	1,251	1,526	5,227	8003	64,428	27.0%	86,481	33.5%	113,392	40.1%
	2013	1,184	1,477	5,185	7846	62,490	26.2%	84,681	32.8%	111,703	39.5%
40:10	2014	1,148	1,442	5,164	7754	60,846	25.5%	83,230	32.2%	110,406	39.1%
Base Case	2015	1,130	1,414	5,134	7678	59,350	24.8%	81,973	31.7%	109,340	38.7%
	2016	1,120	1,390	5,086	7596	57,927	24.3%	80,826	31.3%	108,413	38.3%
	2017	1,112	1,368	5,023	7504	56,546	23.7%	79,748	30.9%	107,578	38.1%
	2018	1,104	1,348	4,951	7402	55,201	23.1%	78,728	30.5%	106,818	37.8%
	2009	2,163	2,611	7,692	12466	73,561	30.8%	95,386	36.9%	122,045	43.2%
	2010	1,953	2,450	7,094	11497	68,617	28.7%	90,554	35.0%	117,306	41.5%
	2011	1,758	2,330	6,783	10872	64,203	26.9%	86,202	33.3%	112,972	40.0%
High Catch	2012	1,599	2,221	6,589	10410	60,525	25.3%	82,599	31.9%	109,410	38.7%
	2013	1,499	2,140	6,496	10135	57,450	24.1%	79,642	30.8%	106,549	37.7%
40:10	2014	1,440	2,076	6,431	9947	54,724	22.9%	77,083	29.8%	104,144	36.8%
High Stock Size	2015	1,405	2,022	6,359	9786	52,177	21.8%	74,749	28.9%	102,013	36.1%
	2016	1,383	1,974	6,268	9624	49,723	20.8%	72,549	28.0%	100,056	35.4%
	2017	1,365	1,930	6,160	9455	47,328	19.8%	70,440	27.2%	98,223	34.7%
	2018	1,348	1,890	6,043	9280	44,981	18.8%	68,409	26.4%	96,495	34.1%