Agenda Item E.6.a
Attachment 9
June 2007

Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. West Coast in 2007

by

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Executive Summary

Stock

This assessment update reports the status of the yelloweye rockfish (*Sebastes ruberrimus*) resource off the west coast of the United States, from the Mexican border to the Canadian border. The assessment on which this update is based (Wallace, et al. 2006) contained both a coast-wide model and area models for Washington, Oregon, and California. This update only looks at the coast-wide model, on which management is currently based.

Catches

For this update, new catch data were added for 2006, based on the Groundfish Management Team's Bycatch Scorecard, and catch histories for all fleets were refreshed for the period 1983-2005. Catches prior to 1983 are taken from Wallace, et al. (2006). Annual total catch of yelloweye rockfish peaked around 1980, and remained above 200 mt throughout the mid-1990s. Catch declined sharply between 1997 and 2001.

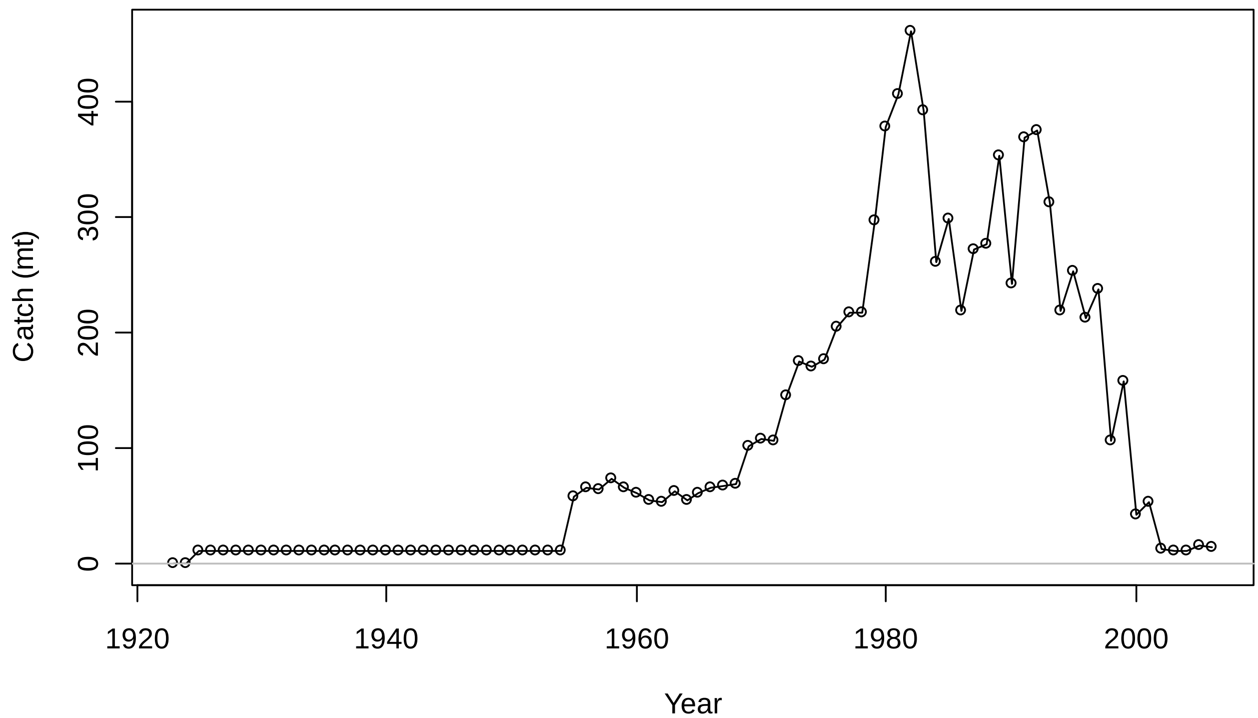

Figure ES1. Reconstructed historical catch (mt) by year and fleet, 1925-2006.

Table ES1. Updated (perhaps to the same value) recent commercial fishery catches by state and fishery. Fleets in the model combine trawl and line for all years in California and Oregon, and from 1923 to 1999 in Washington. Line gear in Washington from 1999 to 2006 is modeled as a separate fleet. (For values not updated see Wallace et al. 2006.)

	California			Oregon			Washington		
Year	Trawl	Line	Sport	Trawl	Line	Sport	Trawl	Line	Sport
1997	6.0	56.4	15.1	71.4	44.1		6.5		
1998	4.0	16.8	5.5	20.8	20.6		4.8		
1999	8.7	13.6	12.6	7.1	54.2		9.9		
2000	0.7	3.3	7.5	0.3	3.3		0.2		
2001	0.6	3.9	4.6	0.7	5.5		0.8		
2002	0.2	0.0	2.1	0.4	0.3		0.4	2.2	
2003	0.0	0.0	3.7	0.2	0.0		0.2	0.3	
2004	0.3	0.1	0.8	0.8	0.1	2.4	1.0	0.9	3.7
2005	0.1	0.0	1.6	0.3	0.1	4.1	0.4	3.0	5.2
2006	0.0	0.3	3.5	0.3	0.6	2.5	0.3	5.2	1.7

Data and Assessment

The most recent assessment for yelloweye rockfish was conducted using SS2, version 1.21 in 2006 by Wallace, et al. Fishery-independent data used in that assessment included a CPUE index and size-compositions from the longline survey conducted by the International Pacific Halibut Commission. Catch data, as well as age and size compositions, were included for commercial and recreational fisheries off Washington, Oregon, and California. CPUE indices were also constructed from recreational data from each state.

In the process of refreshing data for use in this updated assessment, several errors were uncovered in the data and input files used for the previous assessment. These include the misspecification of the age- and length-bin values in the SS2 input file and the inclusion of Washington trawl ages in constructing age-composition inputs for the Washington hook and line fishery. These problems were corrected in developing the 2007 base model. Since the corrected bin values were lower than those used in the previous assessment and the Washington trawl data contained a higher proportion of old fish, all three of these corrections led to downward revisions in the amount of spawning biomass and the level of depletion, relative to the 2006 assessment.

In converting the model to SS2c, the prior assessment's old SS1 "super-year" approach for dealing with small sample sizes for age and size compositions in some years was updated using the recommended SS2 method. This change had little effect on model results. Additionally, during the 2006 STAR Panel review, a representative from the Canadian Department of Fisheries and Oceans, who was present, reported that the estimated value for yelloweye natural mortality (M) off British Columbia was 0.033. This information led the Panel to recommend lowering the value of M in the U.S. model from 0.045 (as used in 2005) to 0.036. Subsequently, it has been discovered that the actual estimated value of M for the B.C. stock is 0.043 (for females). The Chair of the STAR Panel has conveyed that if the correct value had been available during the review, it would likely have recommended for use, rather than the 0.036 value (Owen Hamel, personal communication). Additionally, sensitivity analysis conducted across a range of M values, as part of the current assessment, indicates a substantial degradation in model fit with M=0.036, relative to values of M in the 0.043-0.046 range. As a result, current and projected biomass and depletion levels for an alternative base case (with M=0.043) are also reported in this document.

For comparative purposes, the depletion level for 2006, using the 2006 base model was 17.7%. The 2007 base model estimates depletion in 2006 as 14%. The alternative base model, with M=0.043, estimates the 2006 depletion level as 15.8%.

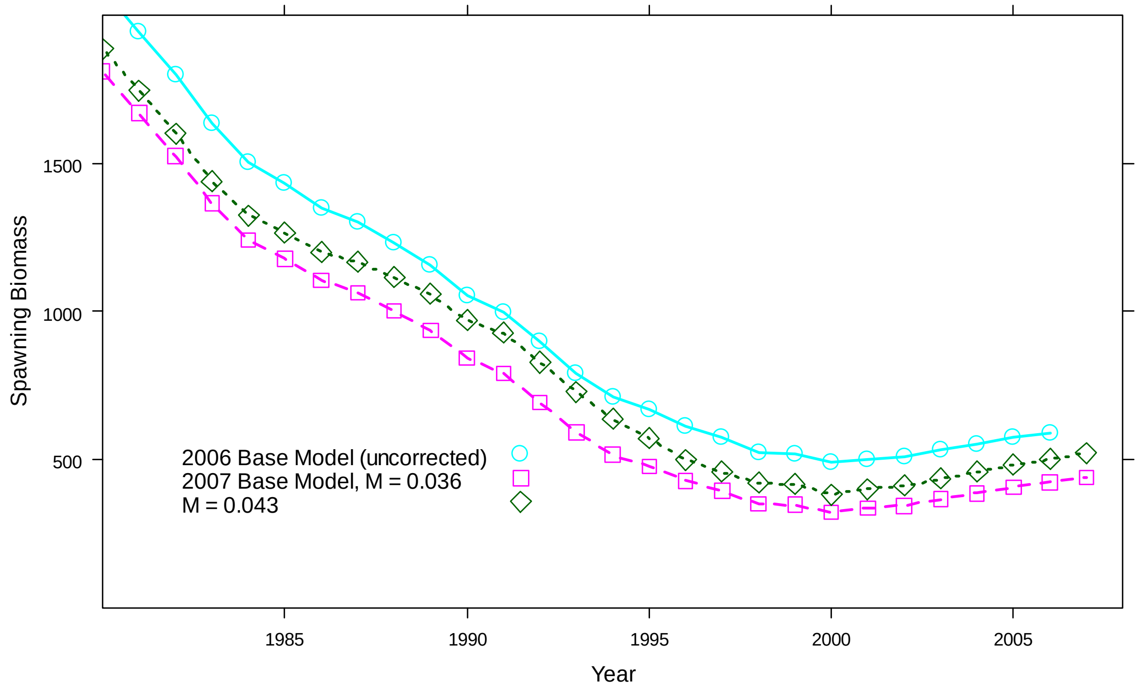

Figure ES2. Comparison of spawning biomass estimates for 1) the uncorrected 2006 coast-wide base model, 2) the 2007 base model, including corrected length- and age-composition specifications and adaptation of the “super-year” method for use with SS2, and 3) the 2007 base model run with natural mortality (M) fixed at 0.043 instead of 0.036. All models were run in SS2c.

Stock Biomass and Reference Points

The long-term biomass trajectory in this assessment is very similar to that in the 2006 assessment. Spawning biomass declined steadily and rather rapidly, beginning in the early-1970s, with no indication of increase until roughly 2001. The amount of spawning biomass in all years is lower in the current base model than in the previous assessment, due to the correction of data/input errors discussed above. Figure ES3 shows the complete spawning biomass trajectory for the 2007 base model. Table ES2 reports the estimated amounts of spawning biomass and depletions levels for the last 10 years. Figure ES4 shows the history of estimated depletion levels for the entire assessment period.

The unfished spawning stock biomass is estimated to be 3,019 mt in the base model, and 3,062 mt in the alternative (M=0.043) model (Table ES3). The spawning biomass targets for these models are 1,208 mt and 1,225 mt, respectively. The overfished biomass levels for these models are 755 mt and 766 mt, respectively. The current spawning biomass is estimated to be 422 mt with the base model and 485 mt with the alternative model. Current depletion estimates for these models are 14.5% and 16.4%, respectively.

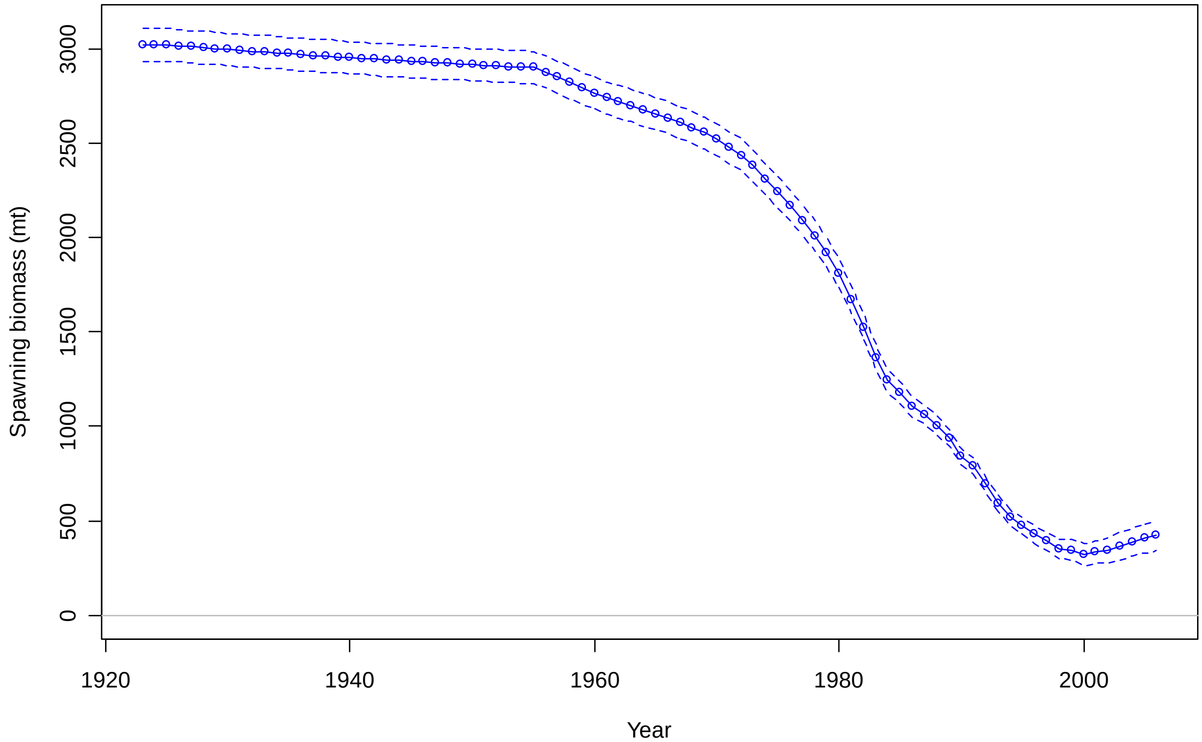

Figure ES3. Estimated spawning biomass time-series with approximate asymptotic 95% confidence interval, using the 2007 base model.

Table ES2. Recent trend in yelloweye spawning biomass and depletion level, using the 2007 base model.

Year	Estimated spawning biomass (mt)	~95% confidence interval	Estimated depletion	~95% confidence interval
1998	349	298-399	11.6%	NA
1999	346	292-400	11.5%	NA
2000	322	264-380	10.6%	NA
2001	336	274-398	11.1%	NA
2002	344	278-410	11.4%	NA
2003	365	295-435	12.1%	NA
2004	386	312-459	12.8%	NA
2005	406	328-483	13.4%	NA
2006	422	342-503	14.0%	11.4-16.6%
2007	438	355-522	14.5%	11.8-17.2%

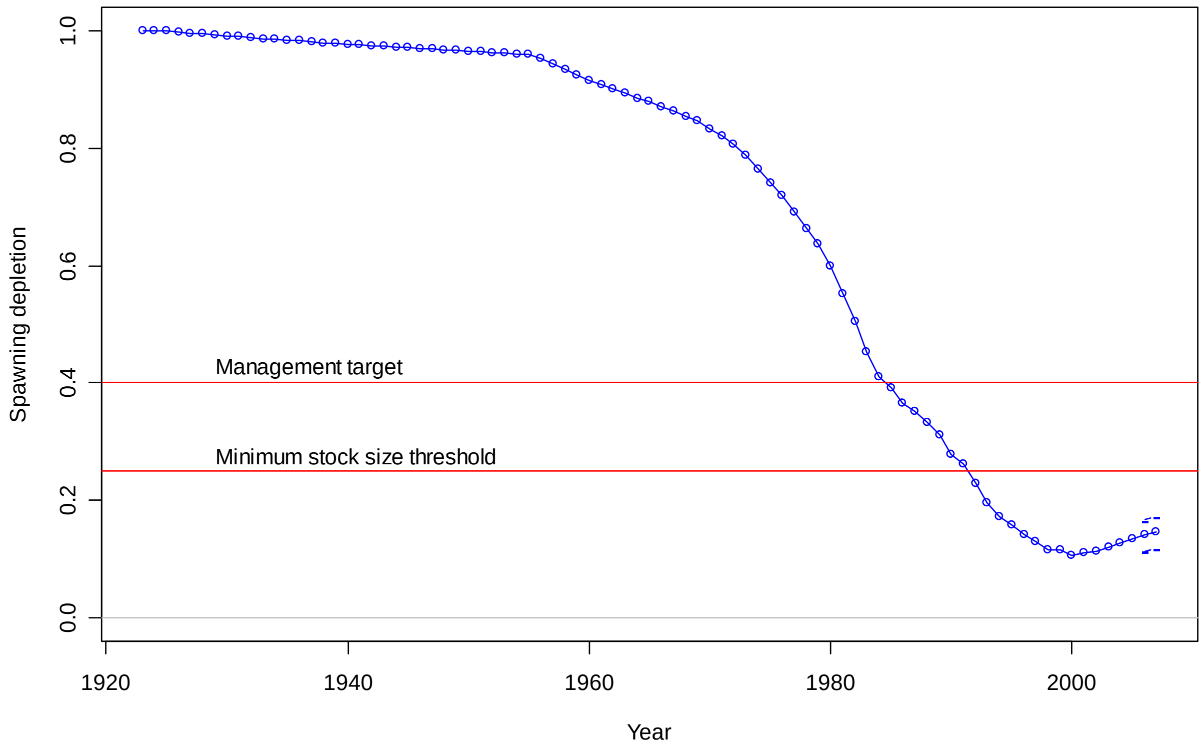

Figure ES4. Time-series of estimated depletion level, 1925-2007 with approximate asymptotic 95% confidence interval for 2006 and 2007, using the 2007 base model.

Table ES3. Benchmarks for comparison of the coast-wide 2006 base model to the 2007 base and alternative models.

Reference Point	2006 Base Model	2007 Base model, with all corrections to age- and size-composition data	2007 Alternative model with M = 0.043
[1/]Unfished Spawning Stock Biomass (SSB_0)	3,322	3,019	3,062
Unfished Exploitable Biomass (B0)	7,448	6,811	7,044
Unfished Recruitment (log(R0))	4.85	4.76	4.76
[1/]SSB_{2006}	588	422	485
Depletion Level (2006)	17.7%	14.0%	15.8%
Depletion Level (2007)		14.5%	16.4%

[1/] These values are expressed in female biomass (one-half of the single-sex model's SSB_0).

Recruitment

As in the 2006 assessment, the level of recruitment is deterministic from the start of the modeled time-period through 1967. From 1968 through 1992, the model estimates very large recruitments in four of the years, and recruitments below the initial level in all other years (Figure ES6). Recruitments after 1992 are taken from the stock-recruit curve. The last 10 years of these amounts are reported in Table ES4.

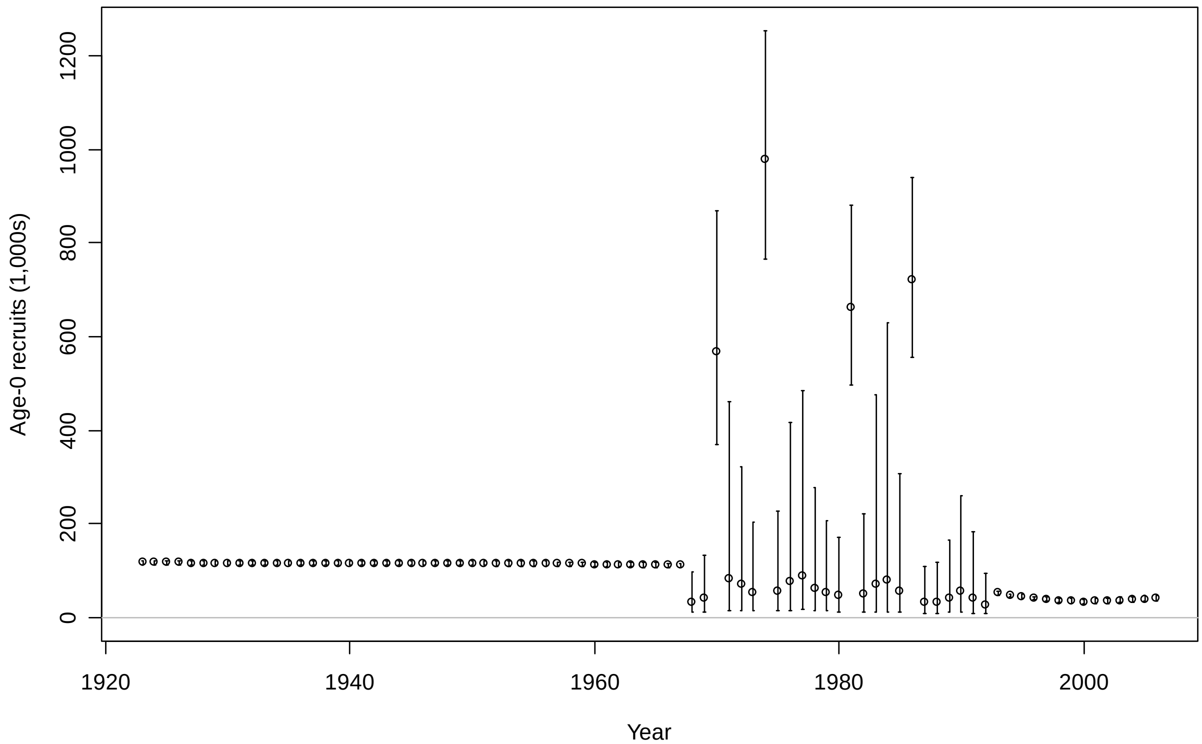

Figure ES6. Time-series of estimated yelloweye recruitments with approximate asymptotic 95% confidence interval.

Table ES4. Recent estimated trend in yelloweye recruitment, using the 2007 base model

Year	Estimated recruitment (1000's)	~95% confidence interval
1998	34.8	30.6 - 39.5
1999	34.5	30.1 - 39.6
2000	32.6	27.9 - 38.2
2001	33.7	28.8 - 39.6
2002	34.4	29.2 - 40.5
2003	36.1	30.7 - 42.4
2004	37.6	32.1 - 44.2
2005	39.1	33.4 - 45.8
2006	40.4	34.5 - 47.2
2007	41.5	16.3 - 105.8

Exploitation status

The estimated spawning potential ratio (SPR) for yelloweye rockfish first dropped below the proxy target of 50% in the early 1970s, where it remained until 2002 (Figure ES7). Throughout the 1980s and 1990s, SPR was below 20%.

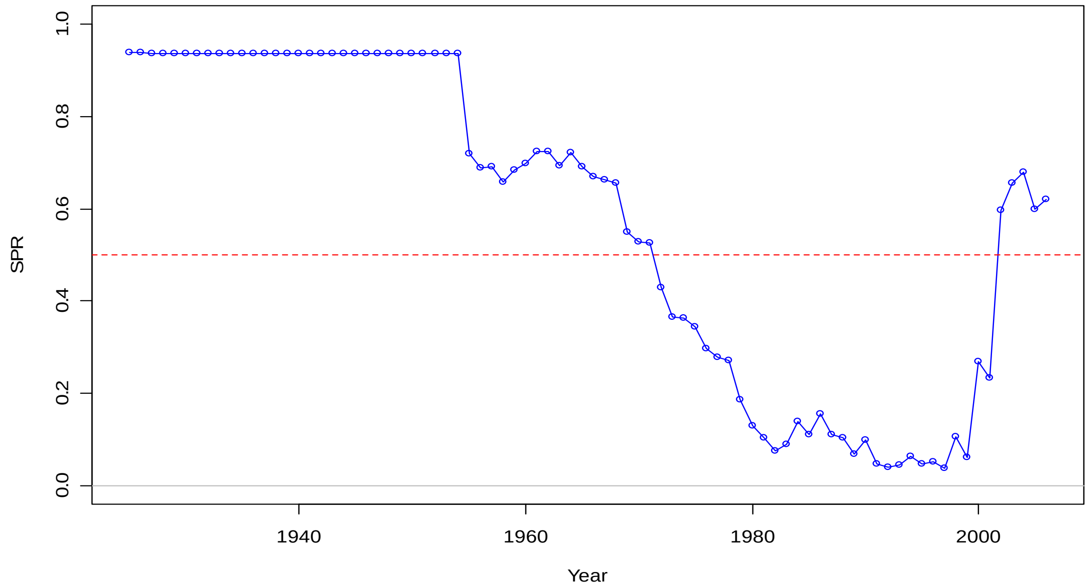

Figure ES7. Time-series of estimated spawning potential ratio 1925-2006.

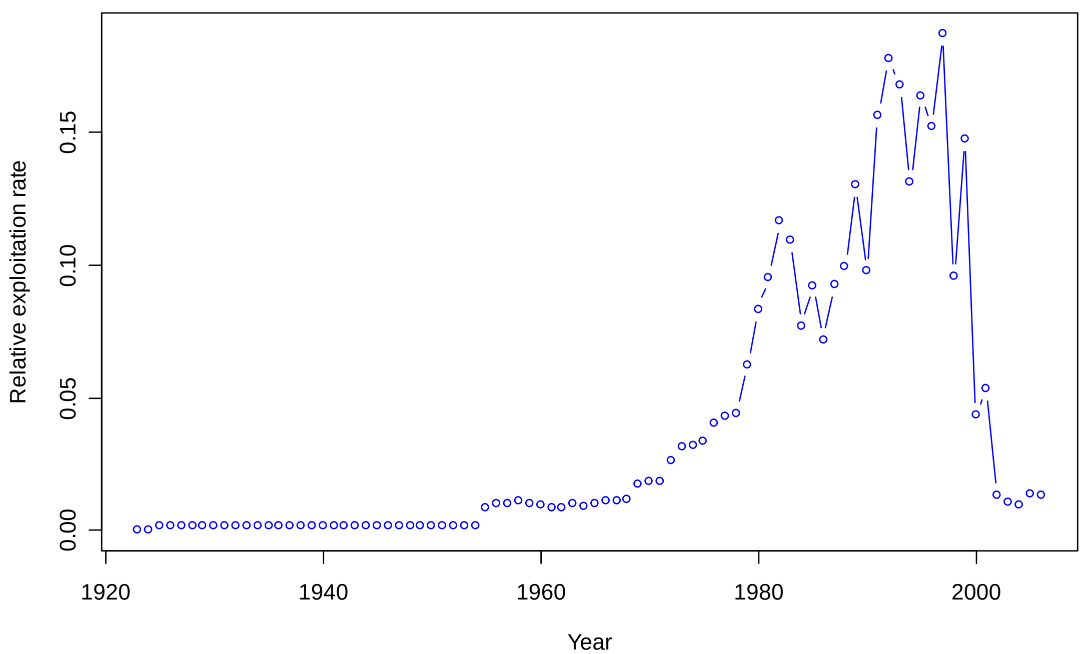

Figure ES8. Time-series of relative exploitation rate (catch/biomass of age 3+ fish) 1925-2006.

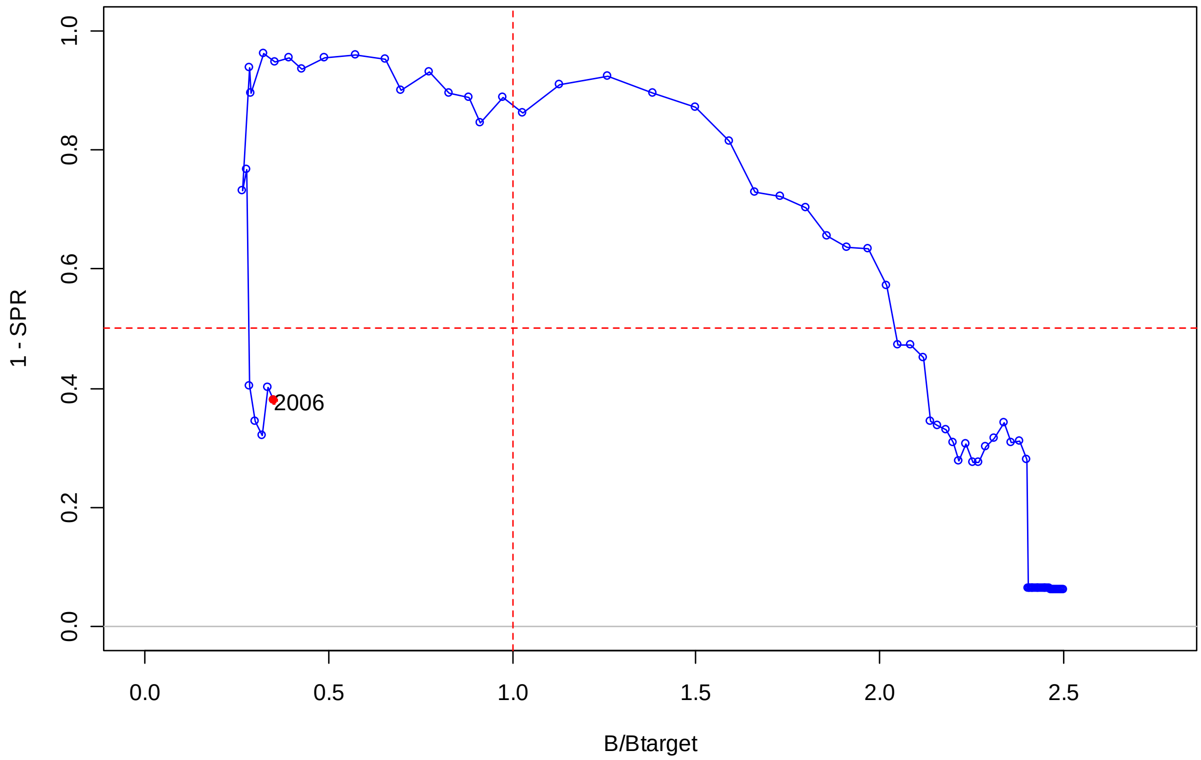

Figure ES9. One minus the estimated spawning potential ratio relative to the proxy target of 50% vs. estimated spawning biomass relative to the proxy 40% level. Higher biomass occurs on the left side of the x-axis, higher exploitation rates occur on the upper side of the y-axis.

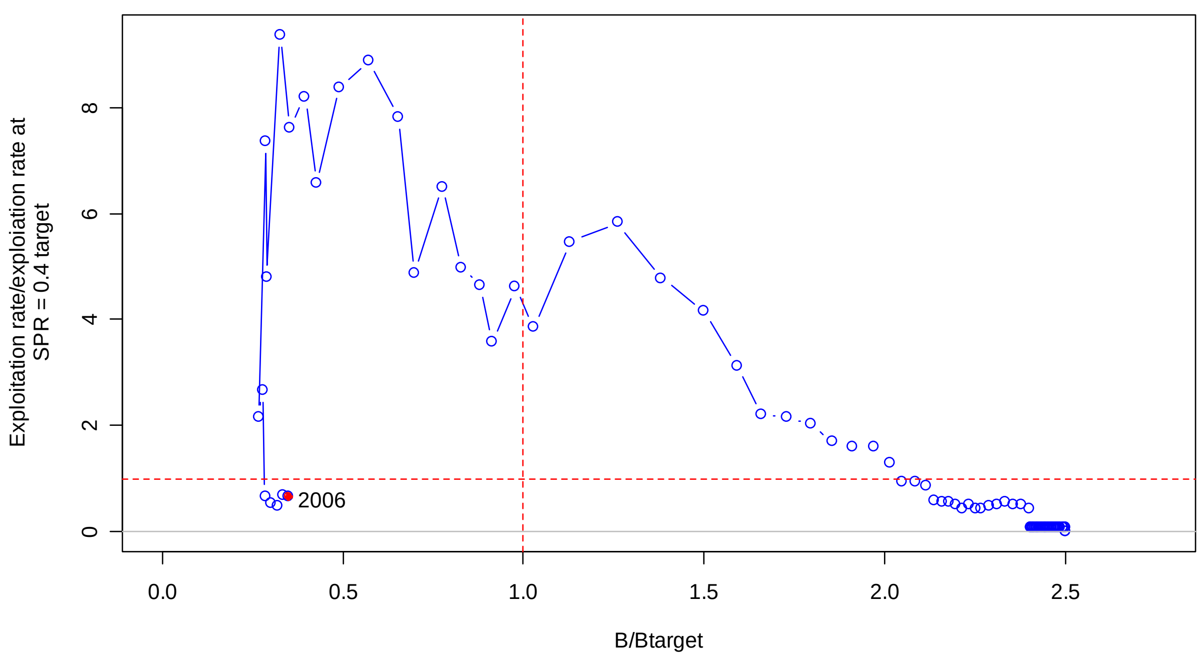

Figure ES10. Relative exploitation rate/exploitation rate at SPR = 0.5 target vs. estimated spawning biomass relative to the proxy 40% level.

Management Performance
Total catches of yelloweye rockfish have been below the specified OYs and ABCs since individual specifications were first established for this species in 2002.

Table ES5. Yelloweye rockfish management performance.

	Total Catch mt	OY mt	ABC mt
2002	13.0	22	52
2003	10.8	22	52
2004	15.7	22	52
2005	15.7	26	54
2006	14.4	27	55

Unresolved problems and major uncertainties (*from Wallace, et al., 2006*)
As in the previous assessments, the sparseness of the size and age composition data and the lack of a relevant fishery-independent survey has limited the model's ability to properly assess the status of the resource... Further, due to catch restrictions since 2002, catch-per-unit-effort (CPUE) data no longer reflect the real changes in population abundance, and discard estimates are highly uncertain.

The landings data are basically derived from total landings of unclassified rockfish times an estimated fraction that are yelloweye. In recent years, actual samples are available in many areas, but because yelloweye are rare in the overall catch and that species composition estimates derived from mixed rockfish categories is limited, substantial substitution for missing cells is required. In earlier years (prior to 1983), estimates of fraction yelloweye had to be borrowed from remote years and areas. The consequence of these estimation steps is that the catch is known only with considerable uncertainty and the current version of SS2 does not allow for uncertainty measurements of landings. This makes it nearly impossible to evaluate the true uncertainty of model results. Internal estimates of standard error on depletion estimates were on the order of 2-2.5% and are likely to be serious underestimates of uncertainty.

Research and Data Needs (*from Wallace, et al., 2006*)
Additional effort to collect age and maturity data is essential for improved population assessment. Collection of these data can only be accomplished through research studies and/or by onboard observers because this species is now prohibited. In 2006, IPHC and WDFW scientists are conducting a study to increase our knowledge of current stock biomass off Washington coast. Loss of the study due to declining OY will have significant detrimental effects on our ability to adequately assess this stock in the future. We strongly urge Management to make this study the highest priority. Increased effort toward habitat mapping and in-situ observation of behavior will provide information on the essential habitat and distribution for this species.

Alternative survey such as the in-situ 2002 US Vancouver submersible survey in untrawlable habitat is required for future assessment of yelloweye rebuilding status. This study has demonstrated that submersible visual transect surveys can provide a unique alternative method for estimating demersal fish biomass in habitats not accessible to conventional survey tools. For example, because of the low frequency of yelloweye rockfish encountered in the NMFS shelf trawl survey tows, those data were not considered a reliable indicator of abundance and were not used in the 2002 yelloweye stock assessment for PFMC (Methot et al. 2002). Results from this study support this conclusion and illustrate the need for large-scale surveys to assess bottomfish densities in habitats that are not accessible to trawl survey gear. Further, stratified random sampling designs should be employed with sample sizes sufficient to ensure acceptable levels of statistical power (Jagielo et al. 2003). At present, the in-situ visual transect submersible survey method appears to be a useful tool for this purpose, and the utility of this method will likely improve further with technological advances such as the 3-Beam Quantitative Mensuration System (QMS).

Forecasts

Ten-year forecasts were generated for the base and alternative models. In both cases, harvests for 2007-2010 were fixed at the ramped-down amounts adopted by the Council in the 2006 yelloweye rebuilding plan. OY amounts for 2011-2018 were estimated through application of the harvest rate (SPR=71.9%) adopted for 2011 and beyond in existing rebuilding plan. Given these specifications, both models exhibit increases in depletion percentage throughout the forecast period. However, in the base model, the projected OY for 2011 declines from 14 mt (the 2010 ramp-down amount) to 10.3 mt (Table ES6). In the alternative model, with M=0.043, the 2011 OY is 13.7 mt.

Table ES6. Forecast for yelloweye rockfish. OY for 2007-2010 represents the currently adopted ramp-down; 2011-2018 represents fishing at SPR = 71.9% to mimic rebuilding plan.

Year	Summary Biomass	Spawning Biomass	Depletion	Recruitment (age-0)	OY (mt) Ramp-down SPR=71.9 (mt)	ABC
2007 Base model with M = 0.036						
2007	1134	877	0.15	41.5	23	
2008	1150	899	0.15	42.3	20	
2009	1168	922	0.15	43.1	17	22.9
2010	1187	944	0.16	43.9	14	23.3
2011	1208	967	0.16	44.7	10.3	
2012	1231	991	0.16	45.5	10.5	
2013	1254	1013	0.17	46.2	10.7	
2014	1276	1034	0.17	46.9	10.9	
2015	1298	1053	0.17	47.5	11.1	
2016	1319	1071	0.18	48.1	11.3	
2017	1339	1089	0.18	48.6	11.5	
2018	1360	1105	0.18	49.2	11.6	
2007 Alternative model with M = 0.043						
2007	1327	1007	0.16	61.8	23	
2008	1348	1034	0.17	63.0	20	
2009	1371	1061	0.17	64.2	17	30.4
2010	1396	1087	0.18	65.4	14	31.0
2011	1423	1115	0.18	66.5	13.7	
2012	1449	1140	0.19	67.6	14.0	
2013	1474	1163	0.19	68.5	14.2	
2014	1499	1185	0.19	69.4	14.5	
2015	1523	1205	0.20	70.2	14.7	
2016	1547	1224	0.20	71.0	15.0	
2017	1570	1242	0.20	71.7	15.2	
2018	1593	1260	0.21	72.4	15.4	

Table ES7. Summary of recent trends in yelloweye exploitation and stock levels; all values reported at the beginning of the year.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landings (mt)	106.6	157.6	42.3	52.7	13.0	10.8	10.1	14.8	14.4	NA
Estimated Discards (mt)	0	0	0	0	0	0	0	0	0	NA
Estimated Total Catch	106.6	157.6	42.3	52.7	13.0	10.8	10.1	14.8	14.4	NA
Exploitation Rate (catch/age 3+ biomass)	0.096	0.148	0.043	0.054	0.013	0.011	0.010	0.014	0.013	NA
Age 3+ Biomass (mt)	1110.0	1068.2	975.0	984.8	984.2	1016.8	1049.7	1082.1	1108.8	1134.4
Base with M = 0.036										
Spawning Biomass (mt)	348.7	345.9	321.9	335.6	343.8	364.9	385.6	405.5	422.5	438.4
~95% Interval	298.4-399	291.9-399.8	264.2-379.7	273.8-397.5	277.9-409.7	295.0-434.8	311.9-459.4	328.2-482.8	341.9-503.1	354.8-521.9
Recruitment (1000's)	34.8	34.5	32.6	33.7	34.4	36.1	37.6	39.1	40.4	41.5
~95% Interval	30.6-39.5	30.1-39.6	27.9-38.2	28.8-39.6	29.2-40.5	30.7-42.4	32.1-44.2	33.4-45.8	34.5-47.2	16.3-105.8
Depletion	11.6	11.5	10.7	11.1	11.4	12.1	12.8	13.4	14.0	14.5
~95% Interval	NA	NA	NA	NA	NA	NA	NA	NA	11.4-16.6	11.8-17.2
Alternative model with M = 0.043										
Spawning Biomass (mt)	392.5	391.9	369.8	386.3	396.9	420.7	443.9	466.2	485.3	503.4
~95% Interval	334.3-450.8	329.9-453.9	303.8-435.8	316.0-456.5	322.4-471.4	342.0-499.3	361.4-526.4	380.1-552.2	396.0-574.6	411.2-595.6
Recruitment (1000's)	51.2	51.2	48.9	50.6	51.7	54.1	56.3	58.4	60.2	61.8
~95% Interval	45.0-58.3	44.7-58.6	42.0-57.0	43.4-59.1	44.2-60.5	46.3-63.1	48.4-65.6	50.3-67.8	51.9-69.8	24.3-157.4
Depletion	12.8	12.8	12.1	12.6	13.0	13.7	14.5	15.2	15.8	16.4
~95% Interval	NA	NA	NA	NA	NA	NA	NA	NA	13.0-18.7	13.5-19.3

Table ES8. Summary of yelloweye reference points. The symmetric approximation of the 95% confidence interval included zero for some quantities, the lower limit is therefore rounded up.

Quantity	Estimate	~95% Confidence interval
Unfished spawning stock biomass (*SB_0*, mt)	3,019	2,933 - 3,105
Unfished 3+ biomass (mt)	6,810	NA
Unfished recruitment (*R_0*, thousands)	116.2	111.4 – 121.0
Reference points based on $SB_{40\%}$		
MSY Proxy Spawning Stock Biomass ($SB_{40\%}$)	1,208	1,173 - 1,242
SPR resulting in $SB_{40\%}$ ($SPR_{SB40\%}$)	0.583	0.583 - 0.583
Exploitation rate resulting in $SB_{40\%}$	0.015	NA
Yield with $SPR_{SB40\%}$ at $SB_{40\%}$ (mt)	43.7	42.3 – 45.0
Reference points based on SPR proxy for MSY		
Spawning Stock Biomass at SPR (SB_{SPR})(mt)		
$SPR_{MSY\text{-}proxy}$		
Exploitation rate corresponding to SPR		
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)		
Reference points based on estimated MSY values		
Spawning Stock Biomass at *MSY* (SB_{MSY}) (mt)	1,164	1,130 – 1,198
SPR_{MSY}	0.573	0.573 - 0.574
Exploitation Rate corresponding to SPR_{MSY}	0.016	NA
MSY (mt)	43.7	42.4 - 45.1