SSC Groundfish Subcommittee Report on Rebuilding Analyses for Overfished Rockfish

The Groundfish Subcommittee of the Scientific and Statistical Committee (SSC) met October 3-4 at the Alaska Fisheries Science Center in Seattle to review seven rebuilding analyses that were recently completed for overfished rockfish stocks managed by the PFMC, viz. bocaccio, Pacific Ocean Perch (POP), cowcod, canary, yelloweye, widow, and darkblotched rockfish. The meeting was chaired by Martin Dorn, with participation from five other Subcommittee members (Owen Hamel, Tom Helser, Tom Jagielo, André Punt, and Steve Ralston), and was embedded within the "mop-up" panel, during which full blue and southern black rockfish stock assessments were reviewed.

In order to provide some legal and policy context during the meeting, the Subcommittee was briefed by Eileen Cooney, Mariam McCall from NOAA Office of General Counsel, and Frank Lockhart from the NWR. Current rebuilding harvest rates (expressed as spawning potential per recruit [SPR]) and median times to rebuild (T_{target}) for the overfished stocks are directly linked to one another and individually they reflect specific decisions the Council has previously made concerning rebuilding in as short a time as possible, taking into account the appropriate factors from the Magnuson Act. Amendment 16-4 to the groundfish FMP adopted specific SPRs and T_{target} values for each stock; there is a direct equivalency between T_{target} and SPR. When reviewing the results of the updated rebuilding analyses it was advised that, from a regulatory basis, maintaining stability in current harvest rates (SPRs) would be desirable, presuming there have been no fundamental changes in our perceptions about stock productivity. Specifically, in each case it would be important for the Subcommittee to determine if the biological parameters in the stock assessment had been revised to such an extent as to warrant a change in T_{target} and also, whether the technical basis of the rebuilding analysis was computationally correct.

Following upon these discussions with NWR staff, the Subcommittee considered how to proceed with its deliberations, with the goal of evaluating the rebuilding analyses and summarizing the review in an easy to understand, yet unified, way. First, as a technical matter, it was decided that year-specific recruitments occurring after the development of a rebuilding plan, which had been estimated in an assessment model (i.e., realized recruitments), would be incorporated as known quantities in subsequent rebuilding analyses when determining the time to rebuild in the absence of catch. The use of "realized" recruitments, as opposed to taking random draws from a probability distribution of recruitments, was justified on the basis of using the best available scientific information.

Generally, the subcommittee also decided to conduct its evaluation of each of the rebuilding analyses by following a sequence of steps. These were:

1) evaluate whether cumulative catches during the period of rebuilding exceeded the cumulative OY that was available.

2) determine whether or not the proper data and software were used in order to satisfy all technical requirements for accuracy.

3) using the most recent results from stock assessments conducted this year, determine the median time to rebuild ($T_{rebuild}$) under the currently adopted rebuilding harvest rate (SPR).

4) ascertain the degree of discrepancy between the current T_{target} and $T_{rebuild}$.

5) if the discrepancy is minor, progress towards rebuilding is deemed to be adequate.

6) if the discrepancy is large, determine the cause and, if appropriate, redefine a new maximum time to rebuild (T_{max}').

7) determine if the currently adopted SPR harvest rate will rebuild the stock before T_{max}' with reasonable certainty.

A table that summarizes the results of the Subcommittee applying these evaluation points to each rebuilding analysis is provided below:

Species	Total Catch ÷ Total OY	Current OY (2007-2008)	Current Harvest Rate (SPR)	Current T_{target}	New Time to Rebuild at Current SPR	Difference	New T_{max}
Darkblotched	97% (2001-2007)	2007 = 290 mt 2008 = 330 mt	60.7%	2011	2030	**-19**	2040
POP	42% (2000-2006)	2007 = 150 mt 2008 = 150 mt	86.4%	2017	2011	6	2037
Canary	114% (2000-2007)	2007 = 44 mt 2008 = 44 mt	88.7%	2063	2021	**42**	2041
Bocaccio	69% (2000-2006)	2007 = 218 mt 2008 = 218 mt	77.7%	2026	2023	3	2033
Cowcod	55% (2000-2007)	2007 = 4 mt 2008 = 4 mt	90.0%	2039	2065	**-26**	2098
Widow	48% (2002-2007)	2007 = 368 mt 2008 = 368 mt	95.0%	2015	2009	6	
Yelloweye	73% (2002-2007)	2007 = 23 mt 2008 = 20 mt	71.9%	2084	2084	0	2090

The SSC notes the following conclusions from the results presented in the above table:

1) Catches of six of the seven overfished rockfish stocks have been lower than what was available as a cumulative OY during the period of rebuilding. The only exception is canary rockfish, which exceeded its cumulative OY by 14% over the period 2000-2007. This overage was due primarily to an excess harvest of 40 mt in 2001, when constraints on the groundfish fishery were first being imposed. In some instances, catches have been far below the available OY (e.g., POP, cowcod, and widow rockfish). In general, management has been quite effective at curtailing fishing mortality on the overfished stocks in order to rebuild them as quickly as possible.

2) All assessments that were completed in SS2 met the appropriate technical requirements by utilizing the latest version of the rebuilding program (2.11) and by using the appropriate outputs from the model (e.g., realized recruitments). Likewise, the two analyses completed in ADMB (i.e., POP and widow rockfish) also were implemented and executed properly.

2) There are four instances where calculated times to rebuild are very similar to T_{target} (POP, bocaccio, widow, and yelloweye rockfish), with the greatest discrepancy being 6 years. For these stocks progress towards rebuilding is considered adequate and no redefinition of T_{target} or adjustment to the rebuilding harvest rate is required.

3) There are three stocks that depart strongly from the T_{target} values adopted in Amendment 16-4: cowcod, darkblotched, and canary rockfish; canary rockfish is very much ahead of schedule (42 years), while darkblotched rockfish and cowcod are substantially behind schedule (19 years and 23 years, respectively), given the most recent information on stock status and productivity. For canary and darkblotched rockfishes, these deviations from T_{target} are due to changes in our current view of stock productivity. Specifically the spawner-recruit steepness parameter (***h***) was increased in the recently completed canary rockfish stock assessment, whereas it was decreased in the assessment for darkblotched rockfish. These alterations represent a fundamental revision to our understanding of the biology of these species, which in turn warrants a revision in T_{target}. In the case of cowcod, the departure from the expected rebuilding trajectory is due to correction of a technical flaw that existed in the 2005 assessment. The effect of this correction was to lower the estimated depletion level substantially, necessitating a longer time to rebuild the cowcod stock than was originally estimated.

4) Given the results of this year's assessments, new maximum times to rebuild (T_{max}') were calculated for each stock using realized recruitments and estimates of the stock-recruitment parameters from the most recent assessment models. These are needed for the three stocks that are either markedly ahead or markedly behind schedule. For those stocks it is apparent that, if the current target SPR harvest rate is maintained, rebuilding will occur well within the required time if the maximum allowable time to rebuild is revised (T_{max}'). For example, if the current harvest rate for cowcod is maintained (SPR = 90.0%), the median time to recovery to 40% of B_0 is estimated to be 2065, which is well before T_{max}' (2098). For this reason the SSC suggests that considering *status quo* harvest rates for all overfished stocks is a reasonable starting point for the Council's deliberative process when developing OYs for the 2009-2010 biennial cycle.

Following are short descriptions of

Darkblotched Rockfish

The darkblotched rebuilding analysis presented to the SSC incorporated a number of changes to both the stock assessment on which the rebuilding analysis is based and the rebuilding analysis itself. The major changes to the 2007 assessment included use of more extensive age data, lower steepness in the stock-recruitment relationship, and a higher natural mortality rate. As such, the productivity of the darkblotched stock is perceived to be lower than implied from the 2005 assessment. Changes to the rebuilding analysis, which was last conducted in 2005, include parametric simulation of recruitments from the stock-recruitment relationship based on new estimates of productivity (i.e., B_0, steepness, natural mortality), instead of re-sampling a range of historically estimated recruitments. Optimum yields for 2007 and 2008 were specified at 1,118 mt and 1,273 mt, respectively. Based on the new rebuilding analysis, the darkblotched rockfish stock is projected to recover 19 years later (2030) than anticipated from the 2005 rebuilding analysis. The new rebuilding time in 2030 at the currently specified SPR of 60.7% compares with the current target of 2011. However, the new rebuilding analysis suggests that the current SPR is within legal requirements of rebuilding by a newly defined T_{max}' of 2040. Do to the large difference in the rebuilding targets the SSC recommends a redefinition of T_{target}.

Pacific Ocean Perch (POP)

The 2007 stock assessment update of POP was reviewed at the June groundfish subcommittee, SSC, and PFMC meetings. Estimated steepness has increased from 0.55 to 0.65 and current depletion, estimated from the median of the MCMC posterior distribution, is now estimated to 31.0%, due, in large part, to an increase in the strength of the 1999 year class,. POP is unusual in that the full MCMC results are used in the rebuilding analysis, which is desirable as it more adequately captures the uncertainty inherent in the assessment. Catches have been very low relative to the available OY, averaging 42% over the period 2000-2006. Moreover, the estimated time to rebuild the stock, if the current harvest rate is maintained at an SPR of 86.4%, is 2011, which is 6 years ahead of schedule (T_{target} = 2017). Given these conditions, the SSC concludes that no change is necessary to POP harvest policies and that progress towards rebuilding is adequate.

Canary Rockfish

A full assessment of canary rockfish was completed this year in SS2, which included a number of major changes in the data and modeling approach, i.e., a complete re-evaluation of the age data, simplification of time blocks for fishery selectivity, and splitting the triennial survey into two segments with separate catchability coefficients (q). Given changes to the model structure, spawner-recruit steepness (h) could no longer be reliably estimated internally, and a steepness prior from a hierarchical meta-analysis of west coast *Sebastes* was used instead (h = 0.511). Based on these revisions the current depletion of canary rockfish is estimated to be 32.4%, compared with 9.4% from the 2005 assessment. For the rebuilding analysis, the full 2007-08 OY catches (44 mt) were pre-specified and the spawner recruit curve was resampled (σ_r = 0.50). Also, the 12 fleets represented in the stock assessment were simplified to 5 fleets in the rebuilding analysis. Rebuilding projections also incorporated uncertainty in h by weighting

according to the three states of nature identified in the assessment. Results showed that if the current harvest rate is maintained (SPR = 88.7%) the stock will rebuild by 2021, which is 42 years before the T_{target} (2063) specified in Amendment 16-4. Given this marked change in our perception of when recovery will most likely occur, a redefinition of T_{target} is appropriate. If so, a newly defined T_{max}' is 2041. If the current harvest rate is maintained, stock recovery would be expected to occur some time around 2021.

Bocaccio

Bocaccio was declared overfished in 1999 and the first rebuilding analysis for this stock was conducted in 2000. The most recent full assessment was completed in 2003 using the SS1 modeling platform, which was then updated in 2005 and again this year. This year's update indicates that current depletion is 13% of unfished, which is about double the depletion reported at the beginning of rebuilding. The bocaccio rebuilding analysis does not use a spawner-recruit relationship, but instead defines B_0 based on average recruitments from 1950-85 (multiplied by $SPR_{F=0}$) and, in addition, resamples recruits-per-spawner from 1970-2005. Resampling R/S in this instance is justified because the estimated steepness is close to 0.20 (no density-dependence). The analysis indicates that the median time to rebuild if the current SPR harvest rate (77.7%) is maintained is 2023, which is 3 years ahead of schedule (current T_{target} = 2026). Recovery is being driven by strong 1999 and 2003 year-classes. Given these results, the SSC concludes that progress towards rebuilding is adequate and that existing management practices are effective and not in need of change. The stock assessment model will be migrated to SS2 for the next biennial management cycle.

Cowcod

Although the cowcod assessment was originally scheduled to be an update during 2007, the Council recommended that a full assessment be completed, based on a number of issues that were raised in the June update review. The estimated depletion of cowcod was strongly affected as a result of including recommended changes into a full assessment, dropping from 17.8% to 3.8%. The principal cause of the change was the correction of a technical error that was discovered in the 2005 assessment. The rebuilding projections indicate that it will not be possible to rebuild the cowcod stock by 2039 (the current T_{target}), even if all catches are eliminated. Although three states of nature were developed in the full assessment, the rebuilding analysis was conducted in a manner similar to the 2005 rebuilding analysis. Uncertainty in the outcomes of the stock assessment was propagated solely through a discretized distribution of steepness, developed from the *Sebastes* meta-analysis "prior" for cowcod; no variability in recruitment *per se* was modeled ($\sigma_r = 0$). Cumulative catches since 2000, which are very uncertain, are nevertheless substantially below the available rebuilding OY. Still, due to the substantial decline in relative abundance, the time to rebuild is now 26 years greater than the T_{target} adopted in Amendment 16-4. The Subcommittee therefore advises a revision to T_{target} is warranted, but adherence to the current harvest rate (SPR = 90.0%) provides continuity with past management practices and should rebuild the stock within T_{max}'.

Widow Rockfish

The widow rebuilding analysis presented to the Subcommittee was based on a 2007 update of the 2005 stock assessment and of the rebuilding analysis conducted in 2005. The new

assessment update indicates that widow spawning stock biomass has increased since being declared overfished in 2001 due to low catches and recruitment of the strong 1999 year class into the spawning population, and that the current level of depletion is estimated to be 35.5%. The new projections are based on the same underlying model structure and rebuilding assumptions as before, except that recruitment is simulated from the stock-recruitment curve for 2007 and beyond, and 2007-2008 OYs are specified as 368 mt. The new median rebuilding time is 6 years earlier than previously calculated at the currently specified SPR of 95.0% (2009 compared to the current target of 2015). The widow stock is on track for recovery by the next assessment cycle.

Yelloweye Rockfish

The yelloweye rockfish rebuilding analysis presented to the SSC was based on a 2007 update of the 2006 stock assessment and of the rebuilding analysis conducted in 2006. The updated assessment corrected several technical issues associated with the previous assessment, but a change in the natural mortality rate revised the spawning stock biomass and associated depletion level down to 16.4% of B_0. Equilibrium unfished spawning biomass was calculated from the stock-recruitment relationship, with future recruitments generated from the S-R curve. Despite changes from the assessment, the yelloweye stock is on track to rebuild by 2084 if the current SPR of 71.9% is maintained. The calculated new T_{max}' is 2090.

Notes:

In forecasting stock rebuilding the subcommittee considered how to treat recruitments during the period of time between when a stock is declared overfished (T_0) and the time of the current update. Two points of view were expressed: (1) all recruitments should be forecasted from T_0 and (2) realized recruitments that occurred between T_0 and the present should be fixed in the rebuilding model. The former approach has been used to estimate T_{min}, while estimates from the latter approach have been variously referred to as T_{min}′. After some discussion the subcommittee decided that the latter method, i.e., incorporating explicit realized recruitment estimates for known years, was the preferred approach because this incorporated the best available scientific information.