Prioritization of Species for Stock Assessments in 2017 and Beyond

In November 2015, Dr. Richard Methot, Jr. briefed the Pacific Fishery Management Council (Council) on a newly published process for assembling and evaluating data, for the purpose of informing Council prioritization and selection of species to be assessed in each biennial cycle. This process is envisioned as a way of synthesizing a broad range of relevant information in a manner that can, over time, provide improved guidance on which species should be considered for Benchmark (i.e. Full) assessments, or subsequent Updates. The selection of stocks for assessment also requires an appraisal of the adequacy of (potentially) available data to provide the trend and compositional information that are needed for assessments of this type. The process of evaluating available data for higher-ranked species has begun, but will likely not be fully completed until after the April Council meeting. In some cases, the amount and quality of available data will be judged as inadequate to support a Benchmark assessment. Accordingly, another important outcome of this process will be in identifying data gaps for species that rank highly for assessment. The scoring and weighting of Factors in the Excel workbook (Attachment 2) represents a work in progress, as this is the first attempt to implement this system. The rankings that it contains should, above all, be considered advisory, as well as preliminary at this stage A slightly revised version of the Overview that accompanied Dr. Methot's presentation in November (Attachment 3) reflects minor changes in the current approach from that described in last summer's NMFS Technical Memorandum on Prioritizing Stock assessments.

Since November, NMFS staff have compiled fishery, assessment, and other data with the assistance of State-agency members of the GMT. Additionally, some elements of the process described by Dr. Methot, such as formulas for transforming data into Factor Scores and the maximum pre-weighted values of those scores, have been modified slightly, in order to improve the understandability or sensibility of the process and the guidance it provides. Two Factors are not currently included in the summary: that intended to capture ecosystem importance and that which reflects concern for unexpected biomass trends. An overview of the latter may be available for inclusion with supplemental materials for the April meeting, and is expected to be fully scored in the Final version presented to the Council in June. The Council has considered much of the same type of information as is included in this analysis, in prior assessment scheduling (and has not shied away from selecting species whose assessments might increase management challenges). Accordingly, the Council's past prioritization decisions have served as an important guide in developing the Factor Scores and the Factor Weights used in the 'Base' case.

The Excel workbook that accompanies this document contains an Overview tab, one which lists included and excluded species, a tab that documents the development of each Factor Score, a

Summary tab in which the Factor Scores are assembled and multiplied by the base-case weights, resulting in a total score and ranking. Also included is a tab which documents the effects of alternative weighting of the Factor Scores which are derived from commercial and recreational fishing, and a final tab that summarizes species ranks under a range of alternative approaches to weighting the entire suite of Factor Scores. The following text provides a description of the content and issues associated with each tab, along with the source of data and information used in scoring each Factor.

Excel Spreadsheet Descriptions

Overview

The Overview tab includes a table which lists all of the Factors, the information source(s) or basis for scoring each Factor. The scoring approach or formula, if applicable, is presented to the right of each Factor. As noted above, Factor Scores are not yet available for the Ecosystem and Stock Trend Factors. Additionally, the Ecosystem Importance component does not currently contribute to deriving the Target Frequency for each previously assessed (benchmark) stock, since it depends upon the Ecosystem Factor Scores/Ranks.

Species

The upper section of the Species tab lists the species which are included on every subsequent tab in the workbook. They are sorted in descending order based on combined commercial and recreational landed catch (mt) over the period 2010-14, with amounts shown for each state and fishery. Adjacent to the sum of fishery landings are two columns which indicate the ranking of each species based on the overall weighted sum of all Factor Scores, and the weighted sum of scores for only the Factors in the Fishery Importance category. Seventy-one species were included in the analysis, and their total 5-year landings ranging from 39,200 mt (Dover sole) down to 0.8 mt (cowcod). We have conducted at least one Benchmark or Update assessment for roughly half of this group (35) since 2005. Most of the rebuilding species have had at least four assessments over this period. Even with an increased use of Updates in the future, it is not clear how many species can be provided Benchmark assessments, while maintaining *no more than* a 6-10-year cycle for most others. Twenty-two of these species, with lower amounts of landings and low assessment prioritization rankings (using the current base model), are shaded in olive and merit consideration for less-frequent inclusion in the prioritization evaluation.

Below the ‘included species’ are several smaller categories of species that were not included. These include species with less than 0.3 mt of combined 2010-14 landings, Pacific hake (which has its own international process), Council-designated Ecosystem-component species, and other “groundfish” species not included in the Groundfish Fishery Management Plan (FMP).

Commercial

The commercial importance score is based on the coastwide ex-vessel revenue generated by commercial landings of groundfish during the period 2010-14. The raw revenue amounts have a very large range (from $0 to $136 million) and so a logarithmic transformation is used to compress the distribution and reduce the differences between species, particular at the upper end of the range [Log(1+1000*Revenue)]. Each species' value is then scaled to the largest of these values [Maximum(0,5+Logged Species Revenue – Maximum Logged Revenue)], which is assigned a score of 10. All commercial revenue data were obtained from PacFIN, using the online Explorer Tool.

Recreational

Recreational landings lack a measure of value that is equivalent to commercial ex-vessel revenue. Instead, the current approach attempts to create surrogates for the value of recreational landings, by multiplying landed catch amounts in each state by a set of state-specific relative weights, which serve the same function as prices. These weights were initially developed in cooperation with the state recreational representatives to the GMT. Additional input on the ranks and values of these weights was requested of the recreational representatives on the GAP at the March Council meeting. After multiplying each species' landed mt by its relative weight, the resulting 'pseudo values' are then transformed into Factor Scores using the same logarithmic transformation as is used for commercial values. To the right of the main data section in this tab, the state-specific weights are listed in descending order. Tonnage of retained and discarded recreational catch was provided by State Agency representatives to the GMT.

Tribal

Because of the importance of Tribal use of west coast groundfish species, the Subsistence category identified in the NMFS guidance document has been expanded to include all Tribal fishing. Commercial landings by Tribal vessels were also obtained from PacFIN and were processed and scored in the same manner as other commercial landings, but to a maximum value of 7. A score representing the relative value of groundfish species to subsistence harvesters was then added to produce a total Tribal Factor Score. Species that are important for subsistence users were initially identified using results from a survey conducted in support of an earlier habitat assessment initiative. Subsequently, Tribal representatives have been consulted on the appropriateness of specific subsistence and total scores in reflecting species' importance to the Tribes.

Constituent Demand and Choke Species

This Factor includes two aspects of species importance that are less easily quantified through formulaic transformation of fisheries data. Constituent Demand is intended to capture elements of fishery importance that are not adequately captured by the coastwide, formulaic scoring for the Commercial and Recreational Factors. Four elements are currently reflected in the scoring of this component, three of which capture situations in which a species is considerably more

important to a sub-area or sub-fleet than is reflected in the coastwide scoring. The three elements compared with coastwide ranks were state-level rankings for both the commercial and recreational values, as well as commercial fixed-gear value. The reference scores and ranks are shown to the right of the scoring columns. The fourth element adds consideration where concern has been expressed for a species. These elements are noted with separate symbols in column E, and scored in column D.

Choke-species scores are intended to capture the degree to which unavoidable bycatch of a stock acts as a constraint on the catch of other healthy species. The highest component scores for Choke species are assigned to rebuilding species. Higher scores reflect the need for greater effort by management or fishermen to restrict or modify fishing behavior, resulting in higher harvesting or management costs and/or reduced harvest of co-occurring stocks. Additional points were added to non-rebuilding stocks where concern over the attainment of ACLs (or ACL contributions) may have a similar, if less pronounced effect on harvest of co-occurring species. The overall Factor Score is the sum or the two component scores.

Rebuilding Status

This Factor provides another means of emphasizing the importance of rebuilding stocks, whose harvest amounts are commonly highly restricted. The highest score is assigned to species that are being managed under rebuilding plans and where spawning biomass is continuing to decline. The next highest score acknowledges the importance of completing the rebuilding process (stocks projected to rebuild by the next cycle) and permitting the relaxation of constraints that rebuilding has presented. Species with longer anticipated rebuilding times receive lower scores than those with shorter ones. Finally, since there is a lag between completing rebuilding and the effects on the stock's harvest levels, a score of 3 is provided to such stocks, as compensation. This scoring of this Factor is informed by assessment results, rebuilding analyses, and landings data.

Non-Catch Value

Economics has long recognized resource values that are not linked to consumptive use. Some of these reflect society's valuation of the continued existence of a resource, it's availability for consumption by future generations, or the potential that a more valuable use for the resource may emerge in the future. These types of considerations are already addressed in the National Standards and Guidelines and the Council's Groundfish FMP, which emphasize that current harvesting must be done in a manner that is sustainable. Another form of non-consumptive value is tied to *in situ* viewing of fish resources, which is the basis used for scoring this Factor. Lacking a better approach for scoring, emphasis was placed on species appearance and having a near-shore and more southerly, warmer-water distribution. While scuba and snorkeling likely account for a greater share of the value generated by fish resources in many tropical areas, this Factor has been assigned very little weight in the current base model.

Relative Stock Abundance

Holding other factors constant, scheduling an assessment in the upcoming cycle will be a higher priority for a stock that is more depleted than for a less depleted one, as estimated in the most recent assessment. Correspondingly, the highest scores for this Factor are assigned to stocks that are below the Minimum Stock Size Threshold (MSST), i.e. 'overfished'. Such cases are differentiated in the scoring by whether the spawning bioimass trend is decreasing (10), stable (9), or increasing (8). As the ratio of current stock biomass to the unfished level increases, this Factor Score decreases. Depletion in the terminal year of the most recent assessment for each species was used as the basis for scoring. However, most groundfish species have not been assessed in a manner that provides an estimate of relative abundance. For those stocks, the PSA (or Vulnerability) score has been used to assign a Factor Score, with the most vulnerable receiving a score of 6, and the lowest assigned a score of 3. Scoring criteria are described and illustrated in columns F and G. The scoring criteria for this Factor were expanded from those listed in the Tech Memo, as part of increasing the maximum score to 10 points.

Relative Fishing Mortality

Analogously to stock status, it will be a higher priority to assess a stock whose fishing mortality represents a larger percentage of its Overfishng Limit (OFL), all other things being equal. Here, again, the scoring criteria were expanded from those listed in the Tech Memo, in support of a maximum score of 10 points. Those criteria are listed and illustrated in columns G and H. Fishing mortality estimates developed by the West Coast Fisheries Observer Program were averaged over the 2012-14 period, and then divided by the average OFL (or OFL contribution) for each stock over the same period, to calculate the ratio used to scoring this Factor. Two species are highlighted for discussion: rougheye and tiger rockfishes. For rougheye, the mortality during the 2012-14 period greatly exceed its OFL contribution to the slope rockfish complex OFL during those years. However, those OFL contributions were based on a data-poor assessment, and suggest a greater negative impact on the stock than we now believe was the case, based on the full assessment conducted in 2013. Tiger rockfish mortality exceeded its OFL contribution by a similar percentage (~120%), but the amount of the overage was less than 1.25 mt annually. It is not clear whether such situations deserve special treatment in the context of this process, but they are currently both assigned Factor Scores of '10', according to the criteria listed.

Relevant New Type of Information Available

As new types/sources of useful information or methods become available for a species, the value of conducting a new assessment for it increases. The scoring of this Factor has been broken down into four categories. The first involves the Bayesian prior for the steepness parameter used to inform stock productivity in rockfish assessments, which increased steadily from 2005 through 2011, and has been stable since. Based on the SSC's guidance through the stock assessment Terms of Reference, updated priors are only introduced during full/benchmark

assessments. Because steepness has an important influence on assessment results, rockfish whose last full assessment occurred before 2011 are assigned points based on the age of their last full assessment. The next two categories are for new sources of trend information and for other information, such as age or maturity information that help inform stock structure or population dynamics in an assessment. Although these categories are intended to focus on new *sources* of information, some points have been assigned where there are significant amounts of new data from existing sources since the last benchmark or update. Points are assigned in the last category where issues/problems identified during the review of prior assessments can now be addressed through the inclusion of newly available data or methods. This Factor includes information from prior assessments, summaries of composition and other data collected from surveys and fisheries, along with review statements by STAR Panels or the SSC.

Years Assessment Overdue (relative to Target Frequency)

This Factor involves the calculation of a target assessment frequency for all stocks that have had a benchmark assessment, and then calculating a score as the difference between the target and the number of years since the last assessment (with a minimum score of zero). As described in the NMFS Tech Memo, the mean age of harvested fish serves as the primary input, and is subject to modification by a regional multiplier. Because there is more than a 10-fold difference in the mean age of assessed groundfish species, the range of ages was compressed down to a ratio of closer to 3-1 for purposes of calculating target frequency.

This adjusted mean-age value is then modified, based on each stock's recruitment variability (using the sigma-R value from the last assessment) and overall importance to fisheries (using the weighted sum of Fishery Factor Scores, as shown in columns AR-AS of the Factor Summary tab). The target frequencies are capped at 10, if needed, and for use on the west coast, were rounded to the closest multiple of 2 (not including zero). The years overdue is calculated as the difference between the years since the last assessment and the target frequency (with a minimum or zero). Species that have not previously had a benchmark assessment were assigned a value of '4' for the number of years overdue.

Although the Tech Memo indicates that mean catch age "should be measured as an average over several years to smooth out the effect of recruitment fluctuations," the intent (which was clarified after initial collection of the data) was that the period used should correspond to one mean generation time. Mean ages drawn from 2015 assessments were calculated over 4 years, and those from earlier assessments were calculated using only the terminal year. The difference in period length can make a difference, as in the case of bocaccio, where mean catch age was 2.66 in 2014, 2.97 over 2011-14, and 3.68 over the 12-year generation time. The mean age of catch will be recalculated following the submission of this package for April. This Factor is a key element in the ability of this process to elevate species from lower ranks to higher-priority levels

in a reasonable, cyclical manner. Further exploration will likely be required to achieve desirable, longer-tern performance.

Factor Summary

All of the Factor Scores are assembled in columns C-M of this tab, with the Base-Model Factor Weights being found in row 7 of those columns. The products of the Factor Scores and Weights are found in columns R-AB, and are summed into a total weighted score in column AC, with the rank across species in the adjoining column. Yellowtail Rockfish emerges as the highest-ranked species for 2017. Although it was assessed using data-moderate methods in 2013 (using no compositional data), the previous benchmark assessment was conducted in 2001. Given that it ranks in the top-10 in commercial, recreational, and tribal importance, and is a stock with an abundance of compositional information, its last full assessment in 2001 was used as the basis for determining the number of years it is overdue for an assessment. Despite having been assessed last cycle, sablefish is the 6th-ranked stock. That result and petrale having the #14 rank, after having also been assessed last cycle, suggest that some additional tuning will be needed in order to have stocks rotate into and out of the highest priorities over a series of cycles, as noted above. Except for the two rebuilding stocks that are likely to be rebuilt using updates, all of the stocks assessed in 2015 were removed from a re-ranked list in column AI, with assessment-related notes provided in AJ-AM.

Five of the ten highest-ranked species are near-shore stocks. For some of these, there is insufficient observed recreational catch to support the estimation of indices of abundance. Additionally, all of these stocks are present in California (several exclusively), where most have minimal availability of age data. The likelihood that assessments of some species would include multiple models to cover the extent of the species is also another consideration in determining which stocks to include in the suite that will be assessed in 2017. The rankings serve the purpose of highlighting species whose importance indicates the desirability of conducting more thorough assessments, however there may be several current impediments to being able to do so. They also can help identify where we lack the data to conduct benchmark assessments of important species.

The weights assigned to Factors in the Base Model reflect an iterative process, influenced by the degree to which the rankings of various weighting approaches reflect the values implicit in prior Council selection of species for assessment. A factor that led to the Commercial Factor being assigned considerably more weight than the Recreational or Tribal Factors is that the latter have a considerable number of zero Scores, many of which are for species with high Commercial Scores. This is illustrated in the figure in the 'Comm vs Rec' tab. All of the points included in the yellow ellipse along the horizontal axis have Commercial Scores of at least '4', and Recreational Scores of zero. These are primarily slope species, three of which have Commercial scores among the top 5. Conversely, most of the species that are most important for recreational

and Tribal fishers have at least intermediate ranks for Commercial. With equal weighting, the #2 Commercial species, Dover sole, would have a lower weighted sum of scores for both Factors than quillback rockfish, which is 26th –ranked for Recreational and 41st for Commercial. This is due to the logarithmic transformation of the species' values.

To the right of the figure, in columns Q-AB, the Commercial and Recreational Scores are presented in descending order, along with their overall rankings. Even with only 6% of the total weight on recreational, only one of the top-11 species is not within the top-22, overall. Even with 28% of the total weight, those three slope species in the Commercial top-5 still rank outside the overall top-25 (although part of that is due to their having been assessed more recently). The effect on slope species ranks of using more equal weighting for Recreational Scores can be seen by comparing their locations (shaded in pink) between columns Y-AB and AD-AG. They occupy ranks from 24 to 42 with the Base Weighting, and 32 to 55 when the weights are nearly equal.

The final tab illustrates how species' ranks changes with alternative weighting schemes. The arrays of weight values are shown in Columns B-F. In addition to the two scenarios included in the 'Comm vs Rec' tab, Alternative 2 emphasizes the timeliness of assessments, relative to their target frequency, and Alternative 3 the weights relating to stock and fishery status. Alternative 4 maintains the same Factor weights as the Base, but assigns a '-2' as the score for the Years Overdue for all of the stocks assessed in the last cycle.

Conclusion

This effort to standardize the analysis used in considering assessment priorities is not without precedent, as this Council been presented with much of the same information as is included here, as part of recent considerations of assessment priorities. However, the distillation of these diverse types of information into a single score/rank is a novel undertaking, at which we are attempting to be the first to succeed. We will not perfect the use of this approach by June, but then we don't have to. First, the rankings that emerge from this synthesis are intended to be advisory, and must always be considered in the light of data and staffing limitations. Second, it is to be expected that we will learn a great deal from our first effort to implement this approach, as well as from the efforts of other Councils. The questions that are raised and the understanding gained from this first implementation will provide the basis for meaningful future improvements.