Assessment Methods for Data-Moderate Stocks

Report of the Methodology Review Panel Meeting

National Marine Fisheries Service (NMFS)
Alaska Fisheries Science Center (AFSC)
Seattle, Washington
26-29 June 2012

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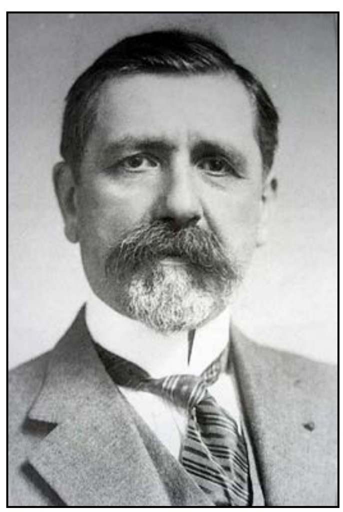

Émile Borel (1871-1956)

1. OVERVIEW

A review of data-moderate assessment methods was conducted by a Methodology Review Panel (Panel) at the Alaska Fisheries Science Center, Seattle, WA, during 26-29 June 2012. The review panel included three SSC members and two CIE reviewers. The Panel followed draft Terms of Reference for Stock Assessment Methodology Reviews (March 2012). Dr. James Hastie opened the meeting on behalf of the Northwest Fisheries Science Center, welcomed the participants, and introduced Dr. Martin Dorn, the panel chair. The Panel was provided extensive background material, including a number of primary documents, through an FTP site, two weeks prior to the review meeting. The Technical Team gave several presentations to the Panel during the meeting, and responded to panel requests for additional information.

The Pacific Fishery Management Council (the Council) approved a data-moderate assessment workshop to be held in 2012 at its September 2011 meeting. The workshop was planned as a follow-up to the review panel meeting in April 2011 that reviewed assessment methods for data-poor stocks. At that meeting, the Panel endorsed the use of several catch-only methods (DCAC, DB-SRA, and Simple Stock Synthesis (SSS)) for category 3 stocks, and considered new assessment methods for data-moderate category 2 stocks. The defining distinction between category 3 and category 2 stocks is that stock abundance trend information is incorporated in the assessment. The April 2011 review panel did not endorse any of the methods proposed for category 2 stocks, since these methods were not sufficiently developed at that time. The Panel recommended the following:

> *"To continue the progress that has been made, the Panel recommends that a similar off-year STAR Panel review be scheduled to further develop and finalize methods and to review example applications. The Panel suggests a few common data sets be used across all candidate methods. The meeting would involve participants from at least the NWFSC, the SWFSC, and various academic institutions. Methods should be sufficiently developed by the 2015-16 groundfish management cycle that it would be reasonable to bring forward a number of candidate category 2 stock assessments using simple assessment models for review at a STAR Panel in 2013."*

The goal of this meeting was to review progress in implementing the recommendations of the April 2011 workshop, and further discuss how to best conduct and review data-poor and data-moderate assessments within the Council process. In particular, the Panel evaluated several proposed refinements to catch-only methods, reviewed two proposed methods for category 2 stock assessments that incorporate abundance indices, evaluated performance of both methods in trial applications, and discussed data available to inform abundance trends for category 2 stocks.

The Panel agreed that substantial progress that has been made since the last review panel meeting. The Panel concluded that two data-moderate assessment methods, XDB-SRA and exSSS, are sufficiently well developed to form the basis for category 2 assessments in the next assessment cycle. However, simulation testing was recommended to further evaluate utility of both methods. The Panel also endorsed several refinements to data-poor methods, and provided recommendations on how to further improve inputs for DB-SRA and SSS. A comparison of data-moderate assessments results with outputs from full assessments suggests that data-moderate methods can provide improved results over data-poor approaches, such as DB-SRA and SSS. The Panel recommends that the data-moderate assessments be used for setting OFLs, ABCs, and ACLs. Data-moderate assessments, however, have greater uncertainty than full assessments, and the Panel recommends that a two-stage process be adopted for status determination, in which data-moderate assessments are used to evaluate whether a stock is of concern, followed by a full assessment (if warranted), which would utilize all available information.

The Chair thanked the NWFSC for hosting the meeting, acknowledged the assistance of AFSC in providing a meeting room and helping with meeting logistics, and thanked the participants for the creative and constructive atmosphere during the review, the results of which should help inform the Council and its advisory bodies determine the best available science for the assessment of groundfish.

2. COMMENTS ON THE TECHNICAL MERITS AND/OR DEFICIENCIES OF THE METHODOLOGY

2.1. Refinements to Catch-Only Methods for Category 3 stocks

DCAC and DB-SRA have been used by the Council to estimate OFLs and set harvest specifications for category 3 stocks. Both methods require four types of input, including a ratio of B_{MSY} to B_0, a ratio of F_{MSY} to M, natural mortality (M), and reduction in abundance, or delta parameter (which represents stock depletion). At the meeting, progress with efforts to better inform these inputs was presented.

2.1.1 B_{MSY}/B_0 ratio

Dr. James Thorson presented a meta-analysis that treats the Pella-Tomlinson shape parameter (and by extension B_{MSY}/ B_0) as a random effect while fitting surplus production models to catch time series and stock assessment estimates of spawning biomass from the RAM Legacy Stock Assessment Database. The results demonstrated that B_{MSY}/ B_0 differs among taxonomic orders, and is generally lower for Clupeiformes and higher for Scorpaeniformes. There is also a significant correlation between B_{MSY}/B_0 and maximum body size both within and between taxonomic orders. The estimate of B_{MSY}/B_0 for all stocks pooled was approximately 40%, which corresponds well with assumptions used in the Council process, although the mean values estimated for B_{MSY}/ B_0 for Scorpaeniformes (46%) and Pleuronectiformes (40%) were higher than currently assumed (40% and 25% respectively) by the Council.

The Panel found this analysis to be potentially useful in better informing the prior distribution of B_{MSY}/B_0 used in DB-SRA. To help interpret results of the analysis, the Panel made two requests (*Requests A* and *B*, below).

2.1.2 F_{MSY}/M ratio

Dr. Thorson presented results of Zhou et al. (2012), who assembled a database of F_{TARGET} estimates from assessed bony and cartilaginous species, and compared these estimates with estimates of natural mortality (M) within a hierarchical Bayesian model with measurement error. F/M ratios were estimated separately for different F_{TARGET} methods (i.e., F_{MSY}, F_{proxy}, and F set at 50% of an estimate of the intrinsic growth rate r), and taxonomic groups (bony vs. cartilaginous fishes). The estimate of mean F_{MSY} /M ratio was 0.41 for cartilaginous fish and 0.86 for bony fish before bias-correction. Application of the delta-method (while including bias-correction for M as well as F given M) yielded an estimate of F_{MSY}/M of 0.97 for bony fishes and 0.46 for cartilaginous fishes.

To help interpret results of the analysis, the Panel made one request (*Request C*, below).

2.1.3 M/k ratio
Dr. Thorson presented a new "Meta-analysis using Stock Assessment Software" (MESAS) framework to conduct meta-analyses, with specific application to the life history invariant M/k using the Stock Synthesis software and inputs used for peer-reviewed assessments of 11 stocks on the U.S. West Coast. This framework approximates the posterior distribution for the parameters of the stock assessment except natural mortality M and the von Bertalanffy growth coefficient k using marginal likelihood (while treating M given k as a random effect for each stock), and finds an expected value for M given k of 1.26 for rockfishes, with a coefficient of variation for M given k of 0.68.

The Panel notes that this approach uses the available data in a more appropriate matter, but the coefficient of variation for M given k was not lower than those for other methods which have been used in Council assessments.

2.1.4 Natural Mortality
Dr. Jason Cope gave a brief outline of Dr. Owen Hamel's work on developing a prior distribution for natural mortality (M) to be used in stock assessments. This approach combines existing methods to develop a meta-analytical prior for M. This method appears to be relevant to both full assessment and assessments for data-moderate stocks. The method has been applied in several assessments used by the Council, but has not gone through peer-review, or review by the Council's Statistical and Scientific Committee (SSC).

Complete details of this approach were not available (as Dr. Hamel was away on other work obligations). The Panel was unable to properly evaluate the specifics of the method and, therefore, and was unable to recommend it to be used in catch-only (as well as data-moderate) assessment methods at present. The Panel recommended this analysis be documented and brought for SSC review, ideally before the next assessment cycle.

2.1.5 Delta
Dr. Cope presented a relationship between the Productivity-Susceptibility Analysis (PSA, Patrick et al. (2010)) vulnerability score and depletion for Council-approved assessed species. He showed that the PSA vulnerability scores are correlated with the estimated delta values for the 31 previously-assessed stocks used to evaluate the performance of DB-SRA. This relationship, therefore, can be used to inform the prior distribution on delta (or depletion), and thus improve this input for catch-only models. Drs. E.J. Dick and Alec MacCall used PSA vulnerability scores to improve specification of the delta parameter in DB-SRA, which allowed DB-SRA to use stock-specific delta priors with a potential gain in performance. Although improved performance was demonstrated for a number of stocks, low values of delta (those that correspond to stocks that had declined very little in abundance) tended to result in poorer performance of DB-SRA, and the original fixed value of delta led to better estimates of OFL for those stocks. Drs. Dick and MacCall

proposed a modification where the regression value of delta was used for vulnerable stocks, but a minimum delta of 0.5 was used for less vulnerable stocks.

The Panel agreed that using PSA vulnerability scores to inform delta priors is an improvement to catch-only methods, and recommended that this approach be used in both DB-SRA and SSS. The Panel, however, recommended that instead of using a subjectively selected minimal delta value of 0.5 for less vulnerable stocks, three vulnerability bins with breaks at PSA scores of 1.8 and 2.2 (as defined in Cope et al. 2011) be used, and the delta values associated with each bin be set to the mean for the bin. Such an approach allows the use of PSA results already used in the Council process to define bins. This approach should also be used for the extended versions of DB-SRA and SSS where applicable.

2.1.6 Modified Production Function

Emil Aalto presented an analysis of a DB-SRA correction term proposed by Drs. Dick and MacCall to address a misspecification in the original DB-SRA production function. When the biomass has changed between time *t* (when recruitment is produced) and time *t+a* (when that recruitment joins the exploitable stock), the amount of recruitment needed to replace losses due to natural mortality (M) has also changed. For example, if the stock has declined, some of the recruitment produced at the initial higher biomass appears as spurious net production, when it joins an exploitable biomass that is smaller than that which produced it. The proposed correction term eliminates the spurious production due to trends in abundance. The Panel agreed that this modification is an improvement of the method previously used (see also *Request D* below).

2.1.7 Requests by the Panel and Responses by the Technical Team

Request A: For the B_{MSY}/ B_0 analysis (presented by Dr. Thorson), show the fits of outputs from the random effects and meta-analytic models presented to data for West Coast rockfish.
Rationale: To better interpret the results of the analysis, and further evaluate their utility for catch-only methods.
Response: The numbers generated using the global assessment database were found to be different from estimates produced when the database was limited to West Coast and Alaskan species only, probably due to decrease in sample sizes when using only a subset of species.

The Panel did not have sufficient information to thoroughly evaluate how the analyses were conducted and, hence, explore possible reasons for differences (particularly notable for Pleuronectiformes) between results presented and the proxy values currently assumed within the Council process. Therefore, the Panel does not recommend using results of the analysis presented to inform the prior distribution for B_{MSY}/B_0, but encourages further efforts in refining inputs required for catch-only methods.

Request B: Provide summaries of B_{MSY}/ B_0 for West Coast and Alaska stocks, grouping species into rockfish, flatfish, elasmobranches, others.
Rationale: To better interpret the results of the analysis, and further evaluate their utility for catch-only methods.
Response: see response to *Request A*.

Request C: Provide summary of F_{MSY}/M for West Coast and Alaska stocks, grouping species into rockfish, flatfish, elasmobranches, others.
Rationale: To better interpret results of the analysis, and further evaluate their utility for catch-only methods.
Response: The database assembled by Zhou et al. (2012) does not designate data by region so the request could not be fulfilled.

The Panel did not have sufficient information explore possible reasons for differences between results presented and the values currently assumed for DB-SRA and DCAC. Therefore, the Panel does not recommend using results of the analysis presented to inform the prior distribution for F_{MSY}/M, but encourages further efforts in refining the approach. The expected F_{MSY}/M value currently assumed for DB-SRA and DCAC is 0.8, which is reasonably consistent with the results of the Zhou et al. (2012) meta-analysis.

Request D: Calculate OFL distributions for 31 stocks, compare OFLs generated by DB-SRA with assessment results (by species), create bias correction distributions by PSA species groups, apply these bias-correction distributions to each species, generate a distribution of the absolute value of x-1 (where x is a draw from bias-corrected distribution), and compare the results for all four DB-SRA versions presented and discussed: (1) original DB-SRA (with delta of 0.6); (2) version with M correction applied (with delta of 0.6); (3) version with M correction and with three vulnerability bins (as identified in Cope et al. (2011)) used to inform delta; (4) with M correction and delta informed by depletion-vulnerability regression.
Rationale: To further evaluate the modifications proposed to the original DB-SRA, and particularly the use of vulnerability bins (rather than the depletion-vulnerability regression) to inform delta.
Response: The results of the requested runs were presented (Table 1). These results demonstrated that the version of DB-SA with vulnerability bins (version 3) outperformed the other two versions. The Panel recommends that future applications of DB-SRA include the correction for M as well as distributions for delta by PSA vulnerability bin.

2.2. Review and adoption of data-moderate methods

2.2.1 Stock Synthesis using only Catch and Index Time Series (SS-CI)

Dr. Jason Cope presented the Simple Stock Synthesis (SSS) and the extended Simple Stock Synthesis (exSSS) methods. SSS is based on sampling parameters (steepness, natural mortality and depletion) from prior distributions and using SS3 to solve for virgin recruitment (R_0) given inputs for selectivity, growth, and fecundity. ExSSS extends SSS by allowing index data (and potentially length and age data) to be used for parameter estimation. Unlike SSS, parameter estimation for exSSS is either based on maximum likelihood or Bayesian (MCMC) methods. Both SSS and exSSS assume that recruitment is related deterministically to the stock-recruitment relationship. The outputs from SSS and exSSS include biomass trajectories, as well as estimates of (and measures of uncertainty for) the OFL. SSS_V is a variant of SSS in which the prior for depletion is based on the results of a regression of depletion on the PSA vulnerability score. This approach will be replaced in future implementations by the procedure of binning by vulnerability score as described in Section 2.1.5 above. The methods were applied for illustrative purposes to data for seven stocks of west coast groundfish and the results compared to those of the associated full assessments. These applications were intended to show a progression of assessments and data usage from most data-limited (SSS) to full assessment (SS). Five of the seven comparisons were able to replicate the SS dynamics, including the ability to include the more complex treatment of fishery-dependent data in the petrale sole assessment. Two exSSS models (spiny dogfish and sablefish) were unable to replicate the SS model outputs, but were diagnosable as questionable without comparing them to the SS models.

The version of SSS presented to the Panel differs from the one presented to the April 2011 Panel by using a Monte Carlo method for parameter estimation (rather than a MCMC method in which priors are imposed on both depletion and R_0) and by exploring a variant of SSS in which the distribution for depletion is informed by the results of the PSA (SSS_V). The Panel agreed that the revised version of SSS successfully addresses the concerns raised by the previous review panel.

The Panel noted that some assessments adopted by the PFMC (e.g. that for cowcod) were conceptually based on exSSS (MLE version). The Panel therefore agreed that in principle, exSSS was an acceptable method for conducting assessments of data-moderate stocks. However, in common with all assessments that use indices of relative abundance, any assessments based on exSSS would require adequate review of model inputs (see Section 7 below). The Panel recommended that if measures of uncertainty were required for exSSS-based assessments, they should be based on the Sample Importance Resample (SIR) algorithm (perhaps implemented using Adaptive Importance Sampling).

2.2.2 Extended Depletion-Based Stock Reduction Analysis (XDB-SRA); using models with generalized stock recruit relationships

Drs. EJ Dick and Alec MacCall outlined how DB-SRA can be implemented within a Bayesian framework, with the priors for the parameters updated using index data. The additional parameters are “q” (the catchability coefficient) and “a” (the extent of observation variance additional to that inferred from sampling error). The priors for these parameters are respectively a weakly informative log-normal distribution and a uniform distribution. The Panel noted that the uniform prior is not usually the preferred distribution for a variance parameter, but this is unlikely to have a strong influence on the results. Sampling from the posterior distribution is achieved using Adaptive Importance Sampling (AIS). Results presented showed that this algorithm was capable of successfully capturing the posterior. Dr. Dick also outlined the locus of S_{MSY}/S_0 – R_{MSY}/R_0 points for the current Beverton-Holt assumption underlying most Stock Synthesis assessments, along with the (S_{MSY}/S_0--R_{MSY}/R_0) space for the Shepherd stock-recruitment relationship, illustrating the region of the space that cannot be sampled owing to the structural relationships underlying the population dynamics model. Dr. Dick noted that the hybrid production function used in DB-SRA is not constrained in terms of the choices for F_{MSY}/M and B_{MSY}/B_0.

In discussion, the Panel emphasized the importance of showing the transition from the priors for the parameters (and the inferred distributions for quantities such as the OFL) to the posteriors from DB-SRA (the post-model-pre-data distribution), which restrict the parameter space by imposing the constraint that the biomass was not negative in the past, and finally to the posteriors from XDB-SRA which account for index data. Specifically, the Panel was interested to understand whether the change to the prior distribution for M for some stocks was a consequence of imposing the biomass constraint or of fitting to the index data. The Panel felt that it is necessary to be able to understand the reason why some indexes are down-weighted relative to others by XDB-SRA (i.e., the posterior for the parameter “a” emphasized high values). In this regard, the Panel also recommended showing the fits of the model to the index data, for example in the form of posterior predictive distributions for the index data. Such plots should be provided for any XDB-SRA assessment.

The Panel noted the AIS appeared to be performing adequately. Nevertheless, it is still necessary in applications to check that the maximum weight assigned to any parameter vector is low (<<1%). Moreover, if the number of indexes is high, integrating out "q" and "a" should improve the efficiency of XDB-SRA. The application of XDB-SRA to northern lingcod resulted in markedly different posteriors for "a" for the two indexes, but it was not clear why this happened. The Panel recommended that the assessment for lingcod be explored further to better understand why this occurred. It was noted that the results from XDB-SRA are based on a deterministic population dynamics model and that it was possible to include process errors in the dynamics when applying SIR-based assessments. However, this may increase the computational demands of the calculations.

In relation to the form of the production function, the Panel noted that this issue was not limited to assessments for data-moderate stocks, but could be an issue for data-rich stocks assessed using, for example, Stock Synthesis. It was noted that (with the exception of codcod) the posterior distribution for B_{MSY}/B_0 for methods such as DB-SRA and XDB-SRA tend to resemble the priors, which implies that the data provide little information on the value of this parameter. Nevertheless, the posteriors for derived quantities (such as the OFL) capture the uncertainty associated with this parameter. However, estimating the parameters of a generalized stock-recruitment relationship using an approach such as Stock Synthesis could lead to estimates at the boundaries unless priors are imposed as penalties.

Dr. Dick presented XDB-SRA results for spiny dogfish and lingcod. For dogfish, the XDB-SRA estimate of depletion (posterior median 0.44) is somewhat closer to the SS value (0.63) than that from exSSS (0.23). The estimate of OFL (median 1319 t) from XBD-SRA is lower than the SS value (3041t) and higher than that from exSSS (665 t). The XBD-SRA application for northern lingcod was based on the default prior for delta (rather than the PSA value). M was updated substantially by adding the index data (tighter than the post-model-pre-data distribution). However, the XDB-SRA result was poorer than that from exSSS.

The Panel recommended that exSSS and XBD-SRA should be compared for range of actual and simulated species with different biological characteristics and exploitation history.

<u>*2.2.3 Progress report on evaluating uncertainty (σ) for category 2 and 3 stocks using simulation modeling*</u>

Chantel Wetzel presented a project she plans to do to explore the performance of management strategies based on data-moderate (Tier-2 like) and data-poor (Tier-3 like) assessment and management frameworks. She intends to evaluate SSS, DB-SRA, DCAC and XDB-SRA as well as alternative choices for the parameters which quantify the extent of scientific uncertainty associated with OFL (σ) given choices for P*. The results will be summarized in terms of catches, the probability of overfishing, and lost yield.

The Panel noted that the operating model on which the proposed simulations will be based has a Beverton-Holt stock recruitment relationship. This may unduly favor methods such as SSS which make this assumption. It was suggested that an operating model based on a more general stock-recruitment relationship (e.g. Shepherd) be considered to examine the size of this effect. The Panel has the following additional recommendations:

- Report the bias of the estimates of the OFL.
- Report the probability of the stock dropping below the overfished threshold.
- Explore control rules which set the OFL based on the maximum of the default choice for σ and the amount of uncertainty inferred from the methods such DB-SRA.
- Consider management strategies which set the ACL using a control rule such as 40-10. This will permit an exploration of the ability of methods such as XDB-SRA to estimate stock status.
- Report the multi-year probability of overfishing.
- Report cumulative catches.
- Consider an estimation method which bases the prior for current depletion on a vulnerability score. Testing of such of a method would need to account for the error about the PSA-depletion relationship.
- Consider combining data-moderate methods using model averaging.

2.2.4 General issues

The Panel discussed what constituted an appropriate evaluation of data-moderate methods. Most of the contributions to the workshop evaluated performance in terms of comparisons with the results of data-rich stock assessments. It was noted that care needs to be taken when making such evaluations to ensure that the number of indices included in the assessments reflected the number that would typically be available for data-moderate assessments. Furthermore, the Panel noted that the comparisons were based on predictions for a single year only and recommended that future evaluations be based on simulation testing. The Panel also recommended that the uncertainty associated with OFL estimates be computed using the approach applied by Ralston *et al*. (2011) to evaluate uncertainty in biomass estimates. This will provide guidance regarding the extent of error in OFL estimates which is already present even for Tier 1 assessments.

2.2.5 Requests by the Panel and Responses by the Technical Team

Request E: Plot depletion over time for SSS, $exSSS_{MLE}$, $exSSS_{MCMC}$, SS, SSS_V for the stocks in Table 2 of Dr. Cope's paper.
Rationale: The comparisons presented to the Panel only considered the most recent year of the assessments.
Response: Time-trajectories of depletion from SS, $exSS_{MLE}$, and $exSSS_{MCMC}$ were provided for canary rockfish, greenstriped rockfish, petrale sole, Dover sole, sablefish, lingcod, and spiny dogfish. The results for sablefish were notably poor. This may be attributable to the long sequence of poor recruitments which cannot be captured well by deterministic models such as exSSS. The question arose of how one could diagnose whether exSSS is performing poorly.

Request F: Show the fits of SS and $exSSS_{MLE}$ to the index data for the stocks in Table 2 of Dr. Cope's paper.
Rationale: The Panel wished to assess whether the fits could be used for diagnostic purposes and to understand the causes for the differences in the results for SS and $exSSS_{MLE}$.
Response: The model fits were consistent with the data for five of the six stocks (the fits for Dover sole could not be evaluated as the $exSSS_{MLE}$ model was implemented without a catchability break

in the triennial survey, unlike the SS model). The Panel concluded that it would have likely rejected the assessment for sablefish owing to the obvious residual pattern for the Combo survey (Fig. 1). The ability to diagnose poor performance is a positive feature of the exSSS approach.

Request G: Plot depletion over time for SSS, $exSSS_{MLE}$, SS, SSS_V for the stocks in Table 2 of Dr. Cope's paper. Use the revised bin structure for the SSS_V applications.
Rationale: The response to *Request E* did not include results for SSS and SSS_V, and the Panel recommended a change to how the PSA bins are to be treated in catch-only methods.
Response: There was evidence that moving from SSS to exSSS improved estimation performance for five of the seven stocks (the exceptions were sablefish and spiny dogfish).

Request H: Add the relative errors for depletion and the OFL for (a) the original DB-SRA method, (b) the version of DB-SRA selected by Drs. Dick and MacCall, and (c) extended DB-SRA (all not bias-corrected) to Table 2 of Dr. Cope's document.
Rationale: The Panel wished to compare the various data-poor and data-moderate methods for a common set of stocks.
Response: There was insufficient time to run all the analyses during the workshop. The STAT provided XDB-SRA results for dogfish and northern lingcod.

2.3. Developing standardized time series index methods

Dr. Alec MacCall presented a summary of trawl survey and recreational catch/effort data for 65 unassessed West Coast groundfish species, compiled from a variety of fishery-independent and fishery-dependent sources. The purpose of this summary was to outline the data that could be used to generate abundance indices for data-moderate assessments. This summary has been appended to this report (Appendix 4) to assist Council advisory bodies in considering which stocks should be selected for data-moderate assessments.

There have been four primary fishery-independent groundfish bottom-trawl surveys on the West Coast: the AFSC triennial survey, the AFSC slope survey, the NWFSC slope survey and the NWFS shelf-slope survey. The summary combined the NWFSC slope and shelf-slope surveys in one category, denoted the combo survey. All four surveys are commonly used in full assessments, and a number of approaches for treating the survey catch data have become established as best practice, though often without through evaluation or review. For example, it is common for assessments not to use 1977 triennial survey data, due to differences in depth surveyed and the large number of "water hauls," when the trawl footrope failed to establish contact with the bottom (Zimmermann et al. 2001). It has also become common to split the triennial time series between 1992 and 1995 to reflect a change in the survey timing. The Panel noted that it is important that these best practices would be well communicated between West Coast science centers. Virtually all recent assessments use a Generalized Linear Mixed Model (GLMM) method to generate abundance indices. The Panel discussed other options, for example the use of habitat-guild abundances or presence/absence, to analyze survey data within data-moderate stock assessments.

Index development may be most time-consuming part of data-moderate assessments. The technical team estimated that it will take about two weeks to develop abundance indices for a species, but then very little additional time to do the assessment. Multiple abundance indices are likely to be available for data-moderate assessments, and the assessment software should be able to accommodate these multiple indices, as well as to have the flexibility to treat them appropriately.

Recreational fisheries sampling is the major fishery-dependent source of data for abundance indices. Dr. MacCall noted that there are substantial difficulties in interpreting recreational catch rates, since various management measures have been put in place beginning in 2000, including changes to bag limits and closed areas. It is, therefore, unlikely that there will be continuity in the indices before and after 2000. The Panel recommended exploring approaches being used in other areas to account for the effect of management measures on recreational fisheries abundance indices. Other approaches, such as General Additive Models (GAM), could also be considered.

Sampling from party boat trips is likely to be the most reliable data to derive abundance indices from the recreational fishery. These data have been analyzed in some of the assessments, using Generalized Linear Models (GLMs) with county, wave and area as terms. This data source, however, has dockside and onboard sampling records combined, and it is not clear that they can be disaggregated. Nonetheless, the Central California party boat observer survey (though discontinued in 1998) can provide information on catches by site.

A summary presented showed that there is likely to be sufficient data to develop abundance indices for a number of data-poor species, including vulnerable stocks based on their PSA scores, such as china rockfish, copper rockfish, quillback rockfish, rougheye rockfish and aurora rockfish.

2.4. Incorporation of length data in data-moderate assessments

Current development of data-moderate assessment methods has focused on adding abundance indices to catch-only methods. However other types of data could potentially be included in these assessments, such as length composition data. Comparisons were made using sablefish and spiny dogfish data between exSSS models with and without length composition data. These results were compared to the full stock assessment, which was considered to provide the closest approximation to the true status and biomass of the stock. The performance of all exSSS models was generally poor for both species, most likely due to the complexity of the full assessment model and the modeling decisions made to arrive at final model (e.g., weighting of various datasets). The addition of length composition data to exSSS models did not substantially improve the performance of this approach for either sablefish or spiny dogfish. Since these comparisons were made for only two stocks, it is difficult to conclude how general this result is.

The use of length-composition data in data-moderate assessment adds another layer of complexity to the analysis. Appropriate treatment of length-composition data requires estimation of selectivity patterns, which raises additional considerations which are likely to be specific to the species being assessed. A more complex assessment requires detailed evaluation, which would add to the time needed for an assessment review. At present, it is not clear that the benefit of adding length-composition data to an assessment would justify the cost of the additional time needed to prepare and review the assessment. Therefore, for now, the Panel recommended that data-moderate assessments be limited to the use of abundance indices only.

2.5. Evaluating merits, deficiencies, and uncertainty of data-limited methods

Linsey Arnold presented a retrospective analysis comparing the results of canary rockfish assessments in 1984 and 1991 with DB-SRA and DCAC using information that was available at that time. Results indicated that DB-SRA and DCAC were not sufficiently conservative based on current understanding of canary abundance trends, but provided better estimates of sustainable yield compared to the actual assessments that were done in 1984 and 1991. As expected, performance of both methods depended strongly on the assumed level of depletion. Both methods performed extremely well when given the "correct" parameter values, suggesting that, at least in this case, most of the uncertainty in DB-SRA and DCAC is caused by uncertainty in input parameters.

Kristen Honey presented a comparison of DB-SRA and DCAC for a number of different West Coast groundfish species, again using results from full assessments as a yardstick for comparison. Both methods were relatively robust in that they tended to be consistent with full assessments. Overall both DB-SRA and DCAC tended to give lower and more precautionary estimates of the OFL, with DCAC providing the most precautionary results. The Panel recommends these comparative approaches be extended further, for example, by quantitatively comparing estimates of OFL from data-moderate and data-poor methods with estimates full assessments for multiple assessments and multiple stocks. This approach could be used to estimate the additional uncertainty due to using data-moderate or data-poor methods, which would be in addition to the uncertainty for full assessments.

3. AREAS OF DISAGREEMENT REGARDING PANEL RECOMMENDATIONS

There were no areas of disagreement regarding panel recommendations.

4. UNRESOLVED PROBLEMS AND MAJOR UNCERTAINTIES

The unresolved problems and major uncertainties for the data-moderate assessment methods are discussed in detail in Section 2. Here the Panel simply reiterates what it considers the most important issues.

- The methods being developed for data-poor and data-moderate assessments assume known historical catches, but there is considerable uncertainty in the catch estimates. This uncertainty has not been measured, and tools for incorporating this uncertainty in assessments are not well developed. This problem is not restricted to data-poor and data-moderate assessments—it is also a concern for most full assessments.
- Further work is necessary to improve inputs used in data-poor and data-moderate assessments, such as B_{MSY}/B_0 and F_{MSY} /M.
- The Panel endorsed two assessment approaches for data-moderate assessments, XDB-SRA and exSSS. However, their performance was only evaluated by comparing the results with outputs from full assessments, so the question remains of how these methods will perform in real applications. Work involving simulated population dynamics might help answer this question, and is encouraged.
- Data-moderate assessments will likely have greater uncertainty than full assessments for the simple reason that fewer data are used in the assessment. Both approaches use different assumptions that tend to reduce apparent uncertainty, so comparisons of the estimated uncertainty between different types of assessments may not show this expected difference. For full assessments, parameters such as natural mortality and the stock-recruit steepness parameter are often fixed. For data-moderate assessments, recruitment to the stock is assumed to only to depend on relative stock abundance with no year-to-year variability and selectivity patterns are fixed rather than estimated. The new data-moderate approaches fully recognize uncertainty in natural mortality and the stock-recruit relationship (both

steepness and shape). Further work is needed on how to treat uncertainty in both full assessments and data-moderate assessments.

- The Panel expects that data-moderate assessments will fill an important gap in the approaches used for stock assessment in the Council process, but some experience conducting and reviewing data-moderate assessments will be necessary to better evaluate their usefulness and applicability.

5. MANAGEMENT, DATA OR FISHERY ISSUES RAISED BY THE PUBLIC AND GMT AND GAP ADVISORS

The GMT advisor highlighted the GMT's concern regarding uncertainty in historical catch estimates. The Panel agrees that this is an important consideration. The methods being developed for data-poor and data-moderate assessments assume known historical catches, and there is a need to explore sensitivity to that assumption. Since catches are equal to landings plus discard, consideration of uncertainty in discard is also important.

Scenario analysis has been typically used as a way to evaluate the impact of uncertainty in catch estimates, and this should be part of a data-moderate assessment. Ideally, the uncertainty in catch estimates should be propagated through the assessment using Bayesian approaches, though methods to accomplish this are not yet available (it should be noted that DCAC has an option to incorporate uncertainty in catch). Aside from technical difficulties, catch estimation procedures usually do not provide estimates of uncertainty, so it is difficult to gauge the extent of the uncertainty. This concern is not limited to data-poor or data-moderate assessments, though arguably this issue is of greater consequence for these assessments. There was some discussion of potential approaches during the Panel review, but all would require further development before they can be implemented. The previous data-poor review panel recommended a review of the historical catch estimates once estimates from Washington State are available, and this Panel supports that recommendation. The Panel also recommends that this review evaluate the uncertainty of historical catch estimates, including estimates of discard.

The Council staff advisor recommended that the Panel consider how data-moderate assessments should be used in the Council process. At present, category 3 assessments are used to set OFLs and ABCs, usually by aggregating estimates for individual species into stock complexes, but are not used to determine stock status relative to overfished thresholds. Data-moderate assessments should be more reliable that category 3 assessments, but in general will be less reliable than full assessments. One alternative is to use data-moderate as a filter or screening tool to identify stocks of concern that would be a priority for full assessments during the next assessment cycle.

The Council staff advisor also advised the Panel to carefully describe the process for assessing and reviewing data-moderate stocks during the next assessment cycle, including criteria for selecting stocks to be assessed, any pre-assessment activities such as data workshops, recommended elements in the assessment, and the nature of the review process, i.e., whether by a STAR panel, the SSC groundfish subcommittee, or the SSC. The Panel agrees and has provided an outline in Section 7 below and a template for data-moderate assessments in Appendix 3.

6. RECOMMENDATIONS FOR RESEARCH AND DATA COLLECTIONS

6.1 Enhancements to catch-only methods

- Use binned PSA vulnerability scores for assessed stocks to obtain a prior for delta for use in data-poor and data-moderate assessments. Because this approach relies on a PSA analysis that was not developed for this purpose, scoring for the PSA analysis should be re-evaluated to ensure consistent time periods are used for all stocks. The year in which delta is assumed to apply should be consistent with the scoring period.
- Further develop meta-analysis methods for the ratios B_{MSY}/B_0 and F_{MSY}/M. While large-scale meta-analysis provides valuable information, synthesis of assessment results on a regional scale is likely to be more useful in determining priors. This is because the quality of the assessments going into the meta-analysis can be ascertained and consistent definitions for these quantities are used regionally. A comparison of regional results with global results would also be valuable.
- Compare the new 3-parameter stock-recruit relationship implemented in SS (Taylor et al. 2012) with the hybrid production function in DB-SRA and XDB-SRA.
- The prior for natural mortality developed by Dr. Owen Hamel, and used extensively in the previous assessment cycle, should be adequately documented and reviewed.

6.2 Extended DB-SRA and SSS

- XDB-SRA and exSSS are endorsed for use in data-moderate assessments in the next assessment cycle (see table 2 for distinguishing characteristics of the two approaches). The management strategy evaluation described in Section 2.2.3 may be informative about relative merits of the two approaches. A WebEx seminar for interested scientists should be conducted in Spring 2013 to present results from simulation testing comparing XDB-SRA and exSSS.
- The Sample Importance Resample (SIR) algorithm (perhaps implemented using Adaptive Importance Sampling) should be used to quantify uncertainty for exSSS-based assessments, should measures of uncertainty be required.
- The ability to incorporate a prior on depletion may be useful feature of data-moderate assessment that adds robustness to results. exSSS does not currently have this capability. A variant of exSSS should be developed that incorporates a prior for depletion (delta). This variant may be useful bridge between SSS and exSSS as they are currently implemented.
- The uncertainty associated with OFL estimates should be computed using the approach applied by Ralston *et al*. (2011) to evaluate uncertainty in biomass estimates. This will provide guidance regarding the extent of error in OFL estimates which is already present even for Tier 1 assessments. Systematic comparison of OFL estimates from data-moderate and data-poor assessments with estimates from full assessments may allow estimation of the additional uncertainty due to the use of these methods.

6.3 Development of abundance indices for use in data moderate assessment

- Consider alternative ways of developing abundance indices for surveys, such as post-stratification to more closely match the species presence and distribution, or developing indices based on presence/absence or stock distribution.
- It is not necessary to omit all recreational fishery data after 2000 due to regulatory changes. Instead an attempt should be made to account for management changes such as changes to area and bag limits to the extent possible in index development. Conduct a literature review

to determine best practices in developing indices from recreational fishery catch and effort data, with particular attention on methods for dealing with potential sources of bias due to regulatory changes, such as closed areas and bag limits. Focus on regions where this expertise is most advanced, such as the Southeast US.

7. RECOMMENDATIONS FOR THE ASSESSMENT AND PEER-REVIEW OF DATA-MODERATE ASSESSMENTS

- The NMFS Science Centers should develop a list of stocks for which the indices of abundance can be justified as likely to be related to abundance.
- The Panel had extensive discussion regarding the number of stocks that should be reviewed during a STAR panel. Arguments for keeping the number low focused on the concern that these assessments are based on new approaches, and there will be some learning involved both in developing the assessment and reviewing it. Arguments for a higher number of assessments included that more assessments are likely to be rejected or not even carried forward for review due to insurmountable difficulties. In addition, there would be more opportunity in learning from more assessments with contrasting features. Perhaps the best way to deal with this issue is to identify 6-12 stocks from the list developed by the NMFS science centers, but plan to drop the most dubious assessments before the STAR panel review.
- The assessments to be presented to the 2013 data-moderate assessment STAR panel should include stocks whose assessments would be based on the NMFS bottom trawl survey, and those for which the primary index of abundance would be a CPUE index derived from recreational catch and effort data. Carrying forward two groups of stocks with similar habitat and fishery characteristics provides both contrast and potential efficiency, since similar analytical approaches are likely to be applicable within each group.
- A data workshop should be held to focus on development of suitable indices for data-moderate assessments. Alternatively (and perhaps preferably), a concerted effort should be made to establish good communication among the core group conducting the data-moderate assessments to share ways of filtering and analyzing data, and promote adoption of consistent modeling approaches.
- The assessments presented to the 2013 data-moderate assessment STAR panel should not use age- or length-data. Assessments which use such data are likely to require more extensive review that is possible during the data-moderate STAR panel.
- Data-moderate stock assessments should follow the template in Appendix 3.
- The first review of data-moderate assessments should be conducted during a STAR Panel, but future reviews could be conducted by the SSC or its groundfish sub-committee. For this cycle, modeling approaches other than XDB-SRA and exSSS should not be used due to lack of time to conduct an adequate review of the method during a STAR Panel (however refinements to XDB-SRA and exSSS are permissible). The independent panelists at the data-moderate panel should be selected to provide expertise on survey design and analysis of recreational CPUE data.
- At present, both modeling approaches (XDB-SRA and exSSS) are considered appropriate for data-moderate assessments. Comparison of alternative models (both XDB-SRA and exSSS) is encouraged. It is acceptable to present an assessment using a single modeling approach, but the choice of modeling approach should be justified. The STAR Panel will make requests of the STATs, but will not impose an alternative method on the STAT if

they believe this is not appropriate for the stock concerned. The STAT may change their best model, but the Panel's job is to review what is presented by the STAT. The Panel will recommend adoption / rejection of the "best model." The STAR Panel will be charged with identifying a preferred approach in the event that both models are presented.

- Data moderate assessments should be used for deriving OFLs, ABCs, and ACLs. In addition, data-moderate assessments should provide estimates of the probability the stock is in each of three categories: less than $B_{25\%}$, between $B_{25\%}$ and $B_{40\%}$, and greater than $B_{40\%}$. The Panel recommends that these results not be used for status determination, but rather to identify whether there is potential concern with stock status, and to prioritize stocks for a full assessment in which all available information is considered.
- The SSC will review the assessment and the STAR Panel report. The key output from this exercise is an OFL and ABC, which addresses possible overfishing. If there is a sizeable probability the stock is in an overfished state (higher than 40%, for example), the SSC will recommend that a full assessment be conducted at the earliest opportunity. The Council may wish to implement management changes in pro-actively.
- The Panel was informed that the NWFSC has a 'stock assessment handbook' which includes a summary of key common assumptions when making assessments and recommended that it be made available to all assessment authors.

8. REFERENCES

Cope, J. M., J. D. DeVore, E. Dick, K. Ames, J. Budrick, D. L. Erickson, J. Grebel, G. Hanshew, R. Jones, L. Mattes, C. Niles, S. Williams. 2011. An approach to defining stock complexes for U.S. West Coast groundfishes using vulnerabilities and ecological distributions. North American Journal of Fisheries Management 31: 589-604.

Patrick, W. S., P. Spencer, J. Link, J. Cope, J. Field, D. Kobayashi, P. W. Lawson, T. Gedamke, E. Cortes, O. Ormseth, K. Bigelow, W. Overholtz. 2010. Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. Fishery Bulletin 1108: 305-322.

Ralston, S., A. E. Punt, O. S. Hamel, J. DeVore, and R.J. Conser. 2011. An approach to quantifying scientific uncertainty in stock assessment. *Fish. Bull*. 109: 217-231.

Taylor, I. G., V. Gertseva, R. D. Methot Jr., M. N. Maunder. 2012. A stock–recruitment relationship based on pre-recruit survival, illustrated with application to spiny dogfish shark. Fisheries Research (in press).

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Zimmermann, M., Wilkins, M.E., Weinberg, K.L., Lauth, R.R., Shaw, F.R. 2001. Retrospective analysis of suspiciously small catches in the National Marine Fisheries Service west coast triennial bottom trawl survey. NOAA Proc. Rep. 2001- 2003.

Table 1. Comparison of four DB-SRA versions conducted per *Request D, Section 2.1.7*: (1) original DB-SRA (with delta of 0.6); (2) version with M correction applied (with delta of 0.6); (3) version with M correction and with three vulnerability bins (as identified in Cope et al. (2011)) used to inform delta; (4) with M correction and delta informed by depletion-vulnerability regression.

Summaries of relative bias-corrected OFL, X

Percentile	no M correction	M correction	PSA regression	PSA bins
2.5%	0.086	0.085	0.069	0.114
25%	0.475	0.482	0.427	0.538
50%	0.999	1.000	1.007	1.006
75%	2.111	2.083	2.383	1.881
97.5%	11.600	11.431	14.934	9.056

Summaries of abs(X-1)

Percentile	no M correction	M correction	PSA regression	PSA bins
2.5%	0.033	0.032	0.039	0.028
25%	0.329	0.323	0.381	0.281
50%	0.650	0.641	0.717	0.568
75%	1.111	1.083	1.383	0.932
97.5%	10.828	10.431	13.934	8.056

Table 2. Comparison of the features of XDB-SRA and exSSS.

	XDB-SRA	*exSSS*	*Comments*
Population dynamics	Biomass difference model	Age-structured	An age-structured model can be adapted to unique stock characteristics.
Stock regeneration	Pella-Tomlinson joined to a Schaefer curve at low stock size	Beverton-Holt SRR	The hybrid production function in XDB-SRA has greater flexibility. Beverton-Holt is the standard approach for full assessments
Leading parameters	B_{MSY}/B_0, F_{MSY}/M, M, delta (depletion), catchability, extra variances	M, steepness, B_0, catchability	XDB-SRA is parameterized using leading management parameters; exSSS uses the same leading parameters as full assessments. XDB-SRA includes a prior on depletion, which may add robustness.
Treatment of uncertainty	Fully Bayesian; posterior distribution obtained using SIR with AIS, estimation of additional variance terms	MLE with Hessian approximation, or MCMC	XDB-SRA has more comprehensive treatment of uncertainty. For exSSS, the samples from MCMC often show signs of poor convergence of the MCMC algorithm, and asymptotic variance based on the Hessian is a questionable approximation.
Software	Purpose-built, coded in R. Long run times to generate posterior distributions with present computing capacity.	Simple stock synthesis model	XDB-SRA has limits on the number of indices that can be used in the assessment, and limits on how catchability can be modeled (e.g.: power relationship, catchability breaks, catchability trends, etc). Some of these problems may be overcome by integrating out the priors for q and a analytically. Stock Synthesis is a well-established software package for stock assessment, with lower likelihood of programming errors, and greater flexibility in modeling catchability and selectivity patterns. SS is not limited in the number of indices that can be used or the modeling choices. Allows a smoother bridge between data-poor assessments and full assessments. Stock synthesis has greater complexity, but much of that complexity is not used in exSSS.

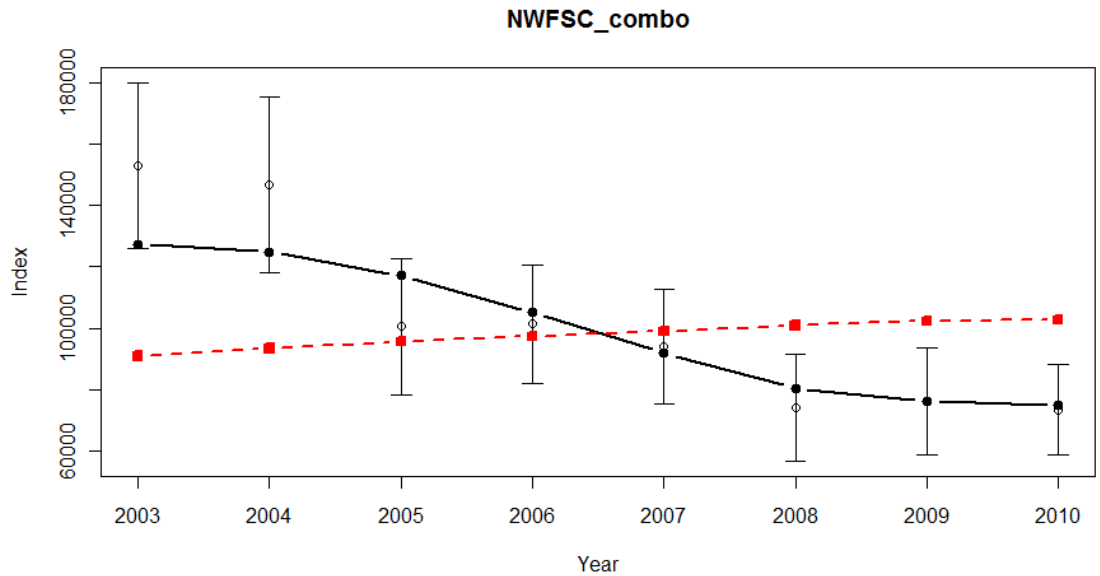

Figure 1. Fit of $exSSS_{MLE}$ (red, solid squares) and SS (block, solid circles) to the NWFSC Combo index for sablefish. Example of an unacceptable residual pattern that would provide a rationale for rejection of a data-moderate assessment.

Appendix 1: List of Participants

Methodology Review Panel Members:
Matthew Cieri, Center for Independent Experts
Martin Dorn (Chair), Scientific and Statistical Committee (SSC), NMFS, AFSC
Vladlena Gertseva, SSC, NMFS, NWFSC
Cynthia Jones, Center for Independent Experts
André Punt, SSC, University of Washington

Panel advisors:
John DeVore, PFMC Staff
Corey Niles, Groundfish Management Team
Gerry Richter, Groundfish Advisory Panel

Technical Team:
Emil Aalto, University of California, Davis
Linsey Arnold, Oregon State University
Jason Cope, NMFS, NWFSC
Edward Dick, NMFS, SWFSC
Kristen Honey, Stanford University
Alec MacCall, NMFS, SWFSC
James Thorson, NMFS, NWFSC
Chantel Wetzel, NWFSC, University of Washington

Others in Attendance:
Mariah Boyle, FishWise
Colby Brady, NFMS, Northwest Regional Office
Jeffrey Brust, New Jersey Division of Fish and Wildlife
Anne Cooper, International Council for the Exploration of the Sea (ICES), Denmark
Alison Dauble, Oregon Department of Fish and Wildlife
José de Olveira, Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft, United Kingdom
Jim Hastie, NMFS, NWFSC
Kyungman Ko, National Fisheries Research and Development Institute (NFRDI), Korea
Young Hoon Lim, National Fisheries Research and Development Institute (NFRDI), Korea
Carey McGilliard, NMFS, AFSC
Melissa Munk, University of California, Santa Cruz
Olav Ormseth, NMFS, AFSC
Joe Petersen, Makah Nation
Theresa Tsou, Washington Department of Fish and Wildlife
John Wallace, NMFS, NWFSC

Appendix 2: Documents reviewed

Aalto, E., E.J. Dick, and A. MacCall. *Separating fecundity and mortality time lags for a data-poor production model.*

Cope, J. M. *Extending catch-only Stock Synthesis models to include indices of abundance.*

Cope J. M., *Implementing a statistical catch-at-age model (Stock Synthesis) as a tool for deriving overfishing limits in data-limited situations*. Fisheries Research (in press).

DeYoreo, M., E.J. Dick, A. MacCall. *A Bayesian Approach to Estimating Sustainable Yields for Data-Poor Stocks.*

Dick, E. J., A. MacCall, M. DeYoreo, and B. Soper. *Refinements to Depletion-Based Stock Reduction Analysis.*

Dick, E. J., A. MacCall, B. Soper, and M. DeYorio. *Exploration of Bayesian Stock Reduction Analysis for Assessment of West Coast Groundfish.*

Honey, K., A.M. Apel, J. Cope, E.J. Dick, A. MacCall, and R. Fujita. *Rags To Fishes II: Quantitative comparison of data-poor methods for fisheries management.*

MacCall, A., E. J. Dick, B. Soper, and M. DeYoreo. *Sources of Abundance Information For 65 Unassessed Stocks of West Coast Groundfish.*

Thorson, J. T., J. M. Cope, T. A. Branch, and O. P. Jensen. *Spawning biomass reference points for exploited marine fishes, incorporating taxonomic and body size information*.

Thorson, J. T., I. Taylor, I. Stewart, A. E. Punt. *A statistically rigorous framework for testing life history theory, with application to the ratio of natural mortality to the individual growth coefficient in U.S. West Coast species.*

Wetzel C. *Management strategy evaluation for the determination of uncertainty about current biomass for data-limited and data-poor West Coast groundfish stocks.*

Zhou, S., Yin, S., Thorson, J., Smith, T., Fuller, M 2012. *Linking fishing mortality reference points to life history traits: an empirical study*. Canadian Journal of Fisheries and Aquatic Sciences (in press).

Appendix 3. Proposed template for a data-moderate assessments

1. Title page and list of preparers – the names and affiliations of the stock assessment team (STAT).
2. Introduction: Scientific name, distribution, basic biology (growth, longevity, ecology), the basis for the choice of stock unit(s)(no more than 1-2 paragraphs).
3. Development of indices (used and rejected). Novel approaches should be fully documented.
4. Survey of other data available for assessment: sample sizes by year and source of lengths, and ages (read and unread)--in case there is interest in conducting a full assessment in the future.
5. Selection of method (exSSS or XDB-SRA; authors “encouraged” to do both).
6. Assessment reporting
    a. Specification of priors / production function (defaults OK)
    b. Initial runs using catch-only methods (DB-SRA or SSS (or both))
    c. Diagnostics
        i. Evaluation of convergence
        ii. Residual plots
        iii. Posterior predictive intervals (if Bayesian)
        iv. Time-trajectories of biomass, depletion, etc.
        v. Sensitivity analyses using alternative catch streams, alternative priors for depletion, etc.
7. Estimates of OFL (median of the distribution), and the probability that that the stock is in each of three status categories: less than $B_{25\%}$, between $B_{25\%}$ and $B_{40\%}$, and greater than $B_{40\%}$.

Appendix 4:

Sources of Abundance Information

For 65 Unassessed Stocks of West Coast Groundfish

Submitted to Review Panel Meeting on Assessment Methods for Data-Moderate Stocks, 26-29 June, 2012, Seattle, WA

Prepared by Alec MacCall[1], E. J. Dick[1], Braden Soper[2] and Maria DeYorio[2]

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Abstract

This report documents time series of data on abundance of 65 species or stocks of unassessed west coast groundfish managed by the Pacific Fishery Management Council. These data are derived mainly from various fishery-independent bottom trawl surveys conducted since 1977, and various recreational fishery monitoring programs conducted since 1975. By supplementing Depletion-Based Stock Reduction Analyses (previously used for estimation of overfishing limits) with these data on abundance trends, it should be possible to elevate a substantial number of these data-limited stocks to the status of "assessed."

1. Introduction

Of the approximately 90 species or stocks of west coast groundfish managed by the Pacific Fishery Management Council (PFMC), about 60 remain unassessed. In order to provide the PFMC with a basis for setting Annual Catch Limits, Dick and MacCall (2011a,b) were able to calculate overfishing levels for most of these unassessed stocks using a method they called Depletion-Based Stock Reduction Analysis (DB-SRA). By supplementing DB-SRA with data on trends in abundance, it may be possible to upgrade the status of these analyses, thus providing minimal assessments for many of these stocks. This summary describes and quantifies most of the available sources of historical abundance information, and allows an initial evaluation of the feasibility of conducting DB-SRA assessments.

The sources of information considered in this document are summarized in the following table:

Name	Gear	Spatial Resolution	Time Span
Triennial Shelf Survey	Bottom Trawl	Site	1977-2004
Slope Survey	Bottom Trawl	Site	1984-2001
Combo Survey	Bottom Trawl	Site	1998-2010
RecFIN Monitoring	Hook and Line	County	1980-2003
Southern California Partyboat Observers	Hook and Line	Block	1975-78, 86-89
Northern California Partyboat Observers	Hook and Line	Site	1987-1998

There are additional sources of information that may potentially be useful. The Northwest Fisheries Science center has conducted a hook and line survey since 2004 in Southern California for most of the past decade (described by Harms et al. 2010). The California Cooperative Oceanic Fisheries Investigations ichthyoplankton surveys have been conducted in Southern and Central California waters since 1950, and provide abundance information on some species. In Southern California, entrainment estimates by electrical generating stations, and trawl surveys by some sanitation districts may in some cases provide useful time series of information on relative abundance.

2. Sources

We describe the principal surveys and fishery monitoring programs that are of greatest general utility, summarizing them by the number of positive samples for each year. Geographic and temporal coverage, and sample sizes vary substantially, but surveys covering multidecadal time spans are potentially the most informative. Some of the earlier surveys did not identify all relevant species, in which case no positive samples appear in the individual species summaries for those years. The data have been summarized by major west coast fishery management regions: North is Cape Mendocino to Cape Flattery, Central is Pt. Conception to Cape Mendocino, and South is the Mexican border to Pt. Conception. Pt. Conception is defined as 34.55 N Lat (decimal), and Cape Mendocino is defined as 40.167 N Lat (decimal).

3.1 Scientific Surveys

3.1.1 Triennial Shelf Survey

The Triennial Shelf Survey (or "Triennial") conducted by the AFSC and NWFSC utilized chartered commercial trawlers to survey North and Central area waters from 1977 to 2004. Coverage of these areas varied substantially among survey years by latitude (Table 1) and by depth (Figure 1). Years 1980, 1983 and 1986 ended near Monterey and did not extend to Pt. Conception (Lat 34.55N).

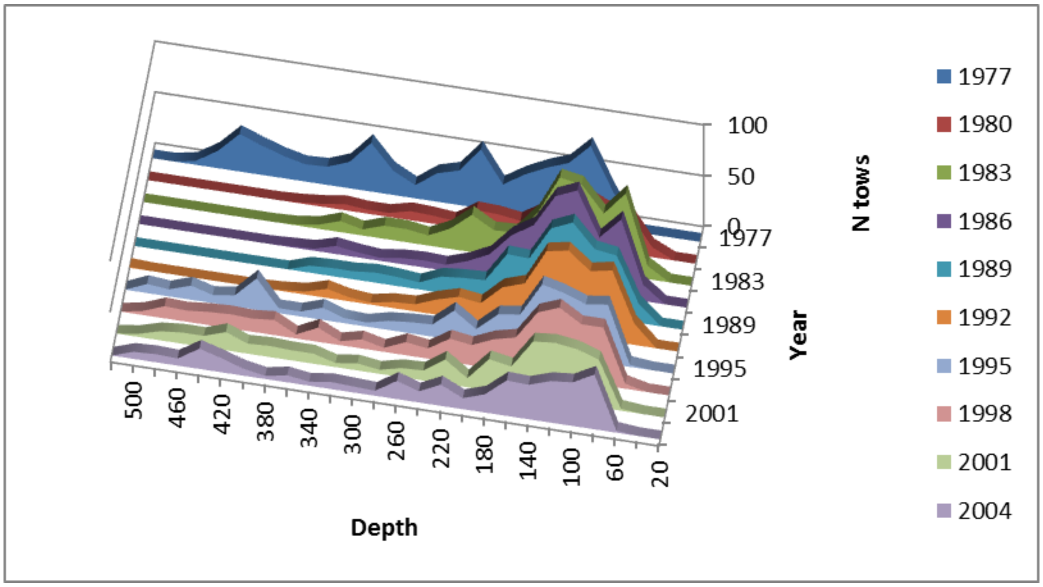

Figure 1. Frequency of Triennial Survey samples by depth (fathoms) and year.

Table 1. Number of trawl hauls conducted by the Triennial Survey.

Year	North	Central
1977	342	323
1980	485	74
1983	468	69
1986	444	71
1989	359	155
1992	356	131
1995	348	151
1998	340	157
2001	290	143
2004	256	127

3.1.2 Slope Survey

The slope survey was conducted irregularly from 1984 to 2001 by the AFSC, but only provides comprehensive coverage of depths and latitudes (Northern and Central Regions) beginning in 1997 (Table 2). The earlier years consisted of local studies (Figure 2). There was an increased sampling of deeper waters (values in fathoms) later in the time series (Figure 3). Earlier years also had an incomplete listing of taxa.

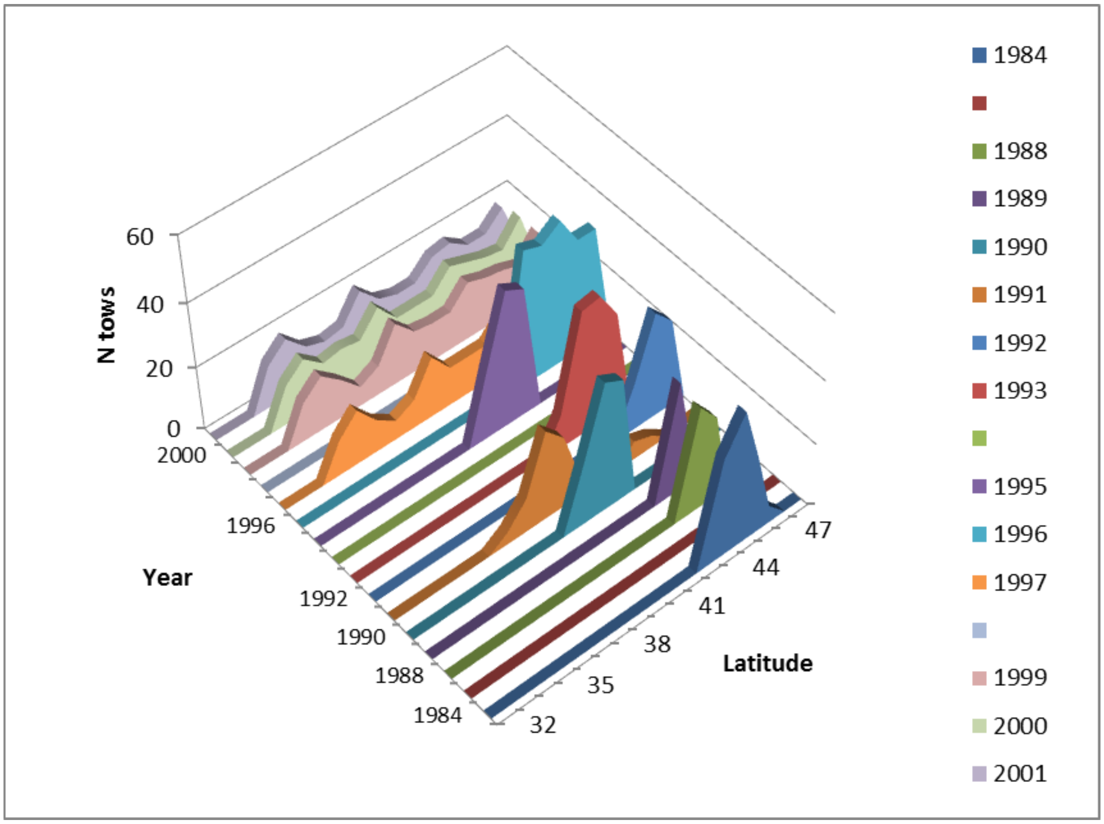

Figure 2. Latitudinal coverage of the Slope Surveys.

Table 2. Number of trawl hauls conducted by the Slope Survey.

Year	North	Central	Year	North	Central
1984	109				
			1995	105	
1988	61		1996	204	
1989	46		1997	107	73
1990	101				
1991	37	52	1999	124	76
1992	78		2000	120	86
1993	124		2001	115	84

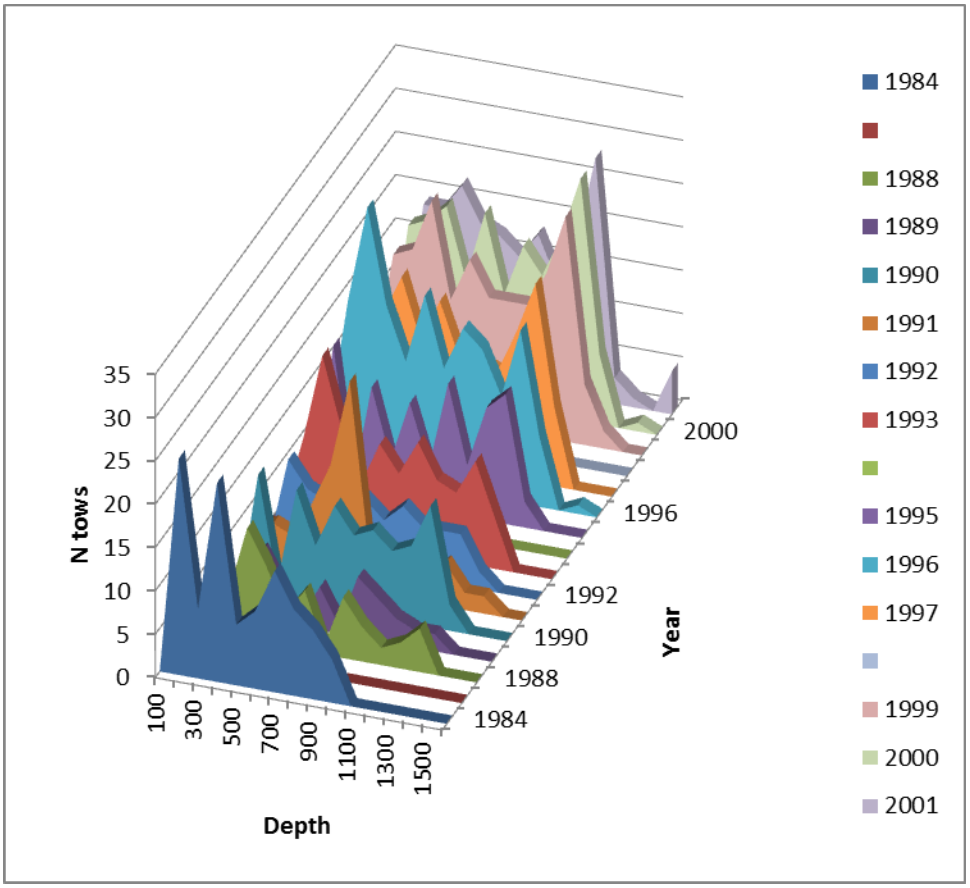

Figure 3. Distributions of depths in the Slope Surveys.

3.1.3 Combo Survey

The West Coast Shelf/Slope Bottom Trawl Surveys (a.k.a, Combo Surveys) were initiated by the NWFSC as a successor to the Slope and Triennial Shelf Surveys that had been inherited from the AFSC (Bradburn et al., 2011). The Combo Surveys achieved a broad and consistent coverage of latitudes and depths (Table 3), and included waters south of Pt. Conception beginning in 2002. The list of identified taxa in 1998 was incomplete.

Table 3. Number of tows by the Combo Survey, by year and latitude. Latitude groups compare approximately to North, Central and Southern Regions.

Lat\Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
50													
49	4		6	3	4	39	22	19	18	24	18	21	22
48	16	23	20	24	20	53	28	36	37	45	45	40	47
47	18	30	18	22	23	39	30	42	33	54	41	40	51
46	25	28	25	31	26	38	41	55	61	62	55	60	52
45	27	28	29	26	30	32	49	66	61	69	68	58	61
44	26	25	26	25	29	26	25	44	51	40	33	43	34
43	24	28	28	24	30	46	27	33	32	38	37	30	34
42	23	30	20	24	29	43	19	38	28	36	36	47	48
41	24	11	29	28	26	31	17	25	28	27	28	28	34
40	25	23	29	27	27	26	18	28	29	15	31	20	26
39	21	30	26	17	29	21	28	27	30	30	30	28	30
38	17	21	18	21	20	19	23	24	32	21	34	45	35
37	24	20	20	26	29	14	15	18	19	22	29	12	24
36	24	26	34	23	29	22	25	42	36	58	52	59	58
35	3	1		12	26	50	52	59	61	57	54	73	66
34					38	28	39	55	66	59	66	56	57
33					10	13	13	24	20	29	22	22	33
32													
40-50	161	162	176	178	263	267	249	340	349	354	382	390	411
36-39	102	109	108	106	115	142	142	198	205	209	193	191	181
32-35	38	53	44	49	47	131	80	97	88	123	104	101	120
total	301	324	328	333	425	540	471	635	642	686	679	682	712

3.2 Recreational Fishery Sampling

3.2.1 Partyboat Trips

The RecFIN database contains data for recreational trips sampled by the MRFSS program beginning in 1980. For most purposes, the most useful samples come from partyboat (a.k.a. "commercial passenger fishing vessels" or CPFVs) trips. The sampling program was conducted in four regions: Washington, Oregon, and north and south of Pt. Conception California. The Washington samples are of little use and are not considered here. The North Region reported here consists of combined samples taken in Oregon and in California north of Cape Mendocino. The Central Region is represented by the remainder of Northern California samples, covering the coast from Pt. Conception to Cape Mendocino (Central Region partyboat data from years 1997 and 1998 are anomalous and have been deleted for the present purpose). Sampling was conducted by two-month "wave" and by county (Tables 4-9). Although recreational fishery sampling is ongoing, the data reported here extend only through 2003 after which the catch rates were severely impacted by restrictive bag limits and area closures. For the present purpose, the unit of sampling is a completed trip (which may have visited multiple fishing sites), and describes the combined catches by all of the sampled fishermen on that trip.

Although the trip-level data used here are based on sample data downloaded from RecFIN (http://www.recfin.org/), these trip-level summaries are not easily reconstructed from that source, and required substantial manipulation of the query results. Sample data from Northern California and Oregon have been examined and edited for problematic entries, and are available from CALCOM (URL 128.114.3.187). Southern California data have yet to be "cleaned-up", but a spreadsheet database can be obtained by request to the senior author (Alec.MacCall@noaa.gov).

3.2.2 On-board Observers

The State of California conducted on-board partyboat sampling in the Southern and Central Regions. Large numbers of Southern California partyboat trips were sampled during 1975-1978, and again during 1986-1989 (sample sizes for individual species are for each four-year period combined). These data are available from the California Department of Fish and Game, but pose some difficulties in defining equivalencies, including locations for the two time periods. The Central Region was sampled from 1987 to 1998, with detailed identification of individual fishing sites, and the data (available from the California Department of Fish and Game) are relatively easy to work with. Because the Central California data are identified by fishing site, there is no convenient general summary statistic for sample size, but the species tables report numbers of fish observed by species.

Table 4. Number of partyboat trips sampled in Northern Region (Northern California and Oregon) by two-month wave.

Year\Wave	1	2	3	4	5	6	Total
1980	15	15		4	24	4	62
1981	7	7		1	21	5	41
1982	7	10	12	1	19	7	56
1983	1	14	23			2	40
1984	4	11	57	2	22	2	98
1985	4	5	38		22	6	75
1986	1	9	45		17	2	74
1987	5	7	19	2	15	10	58
1988	11	27	37		25	5	105
1989	10	21	21	1	46	3	102
1993	11	26	74		31	13	155
1994		58	132	1	54		245
1995		24	71	16	46	6	163
1996	12	22	48	14	39	8	143
1997	7	23	33	75	31	8	177
1998	2	18	64	62	37	2	185
1999	4	21	54	67	49	2	197
2000	8	16	27	20	15	10	96
2001	4	9	24	38	9	12	96
2002	6	19	26	31	23	5	110
2003	6	10	4	34			54
Total	125	372	809	374	545	112	2332

Table 5. Number of partyboat trips sampled in Northern Region (Northern California and Oregon) by county, listed north to south.

Year\County	Clatsop, OR	Tillamook, OR	Lincoln, OR	Lane, OR	Douglas, OR	Coos, OR	Curry, OR	Del Norte, CA	Humboldt, CA	Total
1980		5	45			5	7			62
1981		1	37			2		1		41
1982		4	47			2	2		1	56
1983		6	30				4			40
1984	4	19	34		16	21	4			98
1985	2	13	30		5	17	6	2		75
1986	7	12	26	1	6	15	7			74
1987		8	40			4	4	1	1	58
1988		10	70		6	9	6	3	1	105
1989		1	77		1	11	11		1	102
1993	1	11	117		2	16	8			155
1994	1	36	145	1	2	38	22			245
1995	3	13	79			29	30	4	5	163
1996	6	11	78		1	18	16	2	11	143
1997	3	24	100			25	25			177
1998	5	30	99		3	23	25			185
1999	6	34	114			19	22		2	197
2000	1	27	54		1	4	9			96
2001	7	20	43			8	5	1	12	96
2002	5	13	75		2	9	6			110
2003		1	12		2		3	9	27	54
Total	51	299	1352	2	47	275	222	23	66	2332

Table 6. Number of partyboat trips sampled in Central Region (Pt. Conception to Cape Mendocino) by two-month wave.

Year\Wave	1	2	3	4	5	6	Total
1980	26	17	30	27	31	23	154
1981	7	11	18	16	20	10	82
1982	19	11	31	21	23	6	111
1983	2	8	29	24	18	9	90
1984	38	20	43	48	56	32	237
1985	67	56	80	88	66	41	398
1986		43	58	71	68	33	273
1987	29	19	53	63	67	19	250
1988	17	31	10	72	16	21	167
1989				71	22	31	124
1993	1			1	6	6	14
1994	3	7	1	2	6	1	20
1995		14	23	59		2	98
1996	21	60	89	104	96	19	389
1997	1	14	14	71	44	46	190
1998							
1999							
2000	4	4	22	43	25	14	112
2001	8	10	34	96	50	6	204
2002	47	34	68	247	55	4	455
2003	17	28	62	266	153	37	563
Total	307	387	665	1390	822	360	3931

Table 7. Number of partyboat trips sampled in Central Region (Pt. Conception to Cape Mendocino) by county, listed north to south.

Year\County	Mendocino	Sonoma	Marin	San Francisco	Alameda	Contra Costa	San Joaquin	San Mateo	Santa Cruz	Monterey	San Luis Obispo	Total
1980	8	11	6					15	1	86	27	154
1981	7	11	8	2	1			14	2	23	14	82
1982	30	7	4		1		1	17	7	37	7	111
1983	14	4	3					9	12	41	7	90
1984	21	24	7		6			8	25	89	57	237
1985	25	43	9		13	5		45	36	129	93	398
1986	14	17	7			10		20	35	91	79	273
1987	5	53	15		43	28		22		30	54	250
1988	1	31	9	2	16			26	22	38	22	167
1989	10		18		2	17		29	25	4	19	124
1993											14	14
1994											20	20
1995	21	5	9					8	5	24	26	98
1996	16	91	7		24			68	44	65	74	389
1997		42			12	6		23	15	34	58	190
1998												
1999												
2000	7	10	16	1	7			18	19	6	28	112
2001	11	23	20	20	24			44	40	10	12	204
2002	41	46	20	50	80			67	55	32	64	455
2003	39	79	20	14	63			97	60	82	109	563
Total	270	497	178	89	292	66	1	530	403	821	784	3931

Table 8. Number of partyboat trips sampled in Southern Region, by two-month wave.

Year\Wave	1	2	3	4	5	6	Total
1980	12	25	22	26	24	14	123
1981	25	17	33	24	27	29	155
1982	18	28	45	60	32	22	205
1983	35	46	44	52	41	48	266
1984	52	33	41	53	47	38	264
1985	49	43	50	46	31	33	252
1986	36	48	49	55	37	35	260
1987	8	20	25	30	16	16	115
1988	19	11	22	23	15	12	102
1989			23	30	26	13	92
1993	285	300	442	631	393	344	2395
1994	234	202	450	544	429	188	2047
1995		22	46	49	52	28	197
1996	31	20	71	62	61	39	284
1997	16	18	41	48	47	22	192
1998	38	50	84	84	68	73	397
1999	57	79	117	132	190	136	711
2000	72	90	87	58	66	73	446
2001	50	89	88	77	33	35	372
2002	83	116	102	126	111	72	610
2003	111	119	153	159	136	110	788
Total	1231	1376	2035	2369	1882	1380	10273

Table 9. Number of partyboat trips sampled in Southern Region by county, listed north to south.

Year\County	Santa Barbara	Ventura	Los Angeles	Orange	San Diego	Total
1980	20	19	18	25	41	123
1981	22	16	28	45	44	155
1982	15	19	48	62	61	205
1983	18	26	78	73	71	266
1984	18	28	83	74	61	264
1985	17	28	71	64	72	252
1986	19	28	81	65	67	260
1987	5	3	53	34	20	115
1988	5	8	32	33	24	102
1989	1	14	36	12	29	92
1993	203	304	756	479	653	2395
1994	108	383	507	314	735	2047
1995	14	42	50	32	59	197
1996	10	59	75	75	65	284
1997	2	31	64	39	56	192
1998	16	60	122	52	147	397
1999	22	97	251	96	245	711
2000	11	36	159	62	178	446
2001	12	42	119	80	119	372
2002	14	80	217	108	191	610
2003	16	86	281	142	263	788
Total	568	1409	3129	1966	3201	10273

3. Relative Abundance

The survey and monitoring data require a substantial amount of processing to be useful for stock assessment. Often, filtering the data based on co-occurring species, depth, location, or other consistent habitat attributes (e.g., by the logistic regression method of Stephens and MacCall 2004) allows identification of an appropriate subset of the data for the target species. Although swept-area estimates of abundance are possible and have been produced for some of these trawl surveys, a common statistical approach to developing indexes of relative abundance is to employ a General Linear Model (GLM) with factors such as year, location and season (Maunder and Punt 2004). For sparse data (i.e., containing frequent zeroes), it may be useful to use a delta-GLM approach, where a log-linear model is used for the abundance at positive stations, and a joint logistic (or similar) regression is used to describe the probability of a positive observation. In either case, the values of the “year” effects are a basis for the desired annual indexes, provided interaction terms involving "year" can be ignored. Importantly for the less common species, the data may be too sparse to estimate index values for individual years in which case it may be appropriate to aggregate the abundance data into time-blocks of years.

4. Additional information

Only partyboat-based sampling is included in these summaries, but other sampled segments of the recreational fisheries such as private boats may be useful in some cases such as brown and grass rockfish and kelp greenling. CalCOFI ichthyoplankton surveys may be useful for Mexican rockfish and for several species of flatfishes. For some deep water Southern California rockfishes such as bronzespotted and pink it may be possible to develop an absolute estimate of abundance in recent years based on sightings in submersible surveys conducted for cowcod (Yoklavich et al. 2007). No useful source of information was found for soupfin shark. Dusky rockfish are exceeding rare on the US West Coast which is at the southern end of the species' range, and do not merit consideration. No useful information was found for four small species of rockfishes (chameleon, freckled, harlequin and pinkrose) that are seldom encountered or retained, and may be difficult to identify.

5. References

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6. Acknowledgement

This work was partially supported by the National Marine Fisheries Service "Expand Annual Stock Assessments" program.

7. Tables of positive occurrences (pages 17-63)

Common Name	**Scientific Name**
Aurora rockfish	*Sebastes aurora*

Region	Cape Mendocino			Point Conception			
Source	Triennial	North Slope	Combo	Triennial	Central Slope	Combo	South Combo
Year							
1975							
1976							
1977	28			73			
1978							
1979							
1980	0			1			
1981							
1982							
1983	4			0			
1984		14					
1985							
1986	0			1			
1987							
1988		13					
1989	0	8		0			
1990		19					
1991		2					
1992	1	7		0			
1993		23					
1994							
1995	45	19		44			
1996		30					
1997		14			22		
1998	46			42			
1999		20	25		24	42	
2000		16	25		20	30	
2001	42	17	44	40	19	33	
2002			41			42	15
2003			26			26	14
2004	34		21	29		22	12
2005			33			34	22
2006			38			27	22
2007			45			28	21
2008			42			45	31
2009			38			38	12
2010			28			41	23

Common Name | **Scientific Name**

Bank rockfish | *Sebastes rufus*

Region	North			Central		South		
		Cape Mendocino			Point Conception			
Source	Triennial	Combo	Triennial	Slope	Combo	Combo	RecFIN	Observer
Year								
1975								93
1976								*
1977	1		57					*
1978								*
1979								
1980	2		7				9	
1981							9	
1982							4	
1983	3		6				11	
1984							12	
1985							12	
1986	4		2				2	88
1987							0	*
1988							0	*
1989	1		6				3	*
1990								
1991								
1992	1		10					
1993							6	
1994							31	
1995	4		29				1	
1996							10	
1997				1			4	
1998	1		8				6	
1999		1		4	14		13	
2000		0		3	9		2	
2001	2	1	16	1	3		2	
2002		2			4	0	2	
2003		3			0	1	4	
2004	14	0	0		5	3		
2005		0			3	8		
2006		1			4	6		
2007		2			4	9		
2008		3			10	4		
2009		1			4	7		
2010		1			6	6		

Common Name	**Scientific Name**
Black rockfish	*Sebastes melanops*

Region	Central	
Source	RecFIN	Observer
Year		(fish)
1975		
1976		
1977		
1978		
1979		
1980	12	
1981	11	
1982	11	
1983	7	
1984	20	
1985	44	
1986	18	
1987	32	55
1988	14	727
1989	11	736
1990		220
1991		326
1992		366
1993	2	660
1994	1	996
1995	18	586
1996	52	706
1997	44	1235
1998		329
1999		
2000	14	
2001	39	
2002	95	
2003	174	

Common Name	**Scientific Name**
Black and yellow rockfish	*Sebastes chrysomelas*

Region	Central		South
		Point Conception	
Data Source	RecFIN	Observer	Observer
Year		(fish)	(trips)
1975			40
1976			*
1977			*
1978			*
1979			
1980	2		
1981	1		
1982	0		
1983	0		
1984	1		
1985	5		
1986	2		71
1987	4	4	*
1988	0	26	*
1989	1	10	*
1990		0	
1991		9	
1992		12	
1993	1	9	
1994	1	8	
1995	5	9	
1996	2	10	
1997		8	
1998		18	
1999	6		
2000	6		
2001	7		
2002	10		
2003	19		

Common Name		**Scientific Name**		
Blackgill rockfish		*Sebastes melanostomus*		
	Cape Mendocino		Point Conception	
Region	North	Central		South
Source	Combo	Slope	Combo	Combo
Year				
1997		12		
1998				
1999	2	13	24	
2000	3	12	23	
2001	6	14	19	
2002	4		24	8
2003	3		14	5
2004	6		9	5
2005	4		13	11
2006	4		15	16
2007	3		14	13
2008	9		17	18
2009	3		24	13
2010	3		22	20

Common Name | **Scientific Name**

Bocaccio | *Sebastes paucispinis*

Region	North			
Source Year	Triennial	Slope	Combo	RecFIN
1975				
1976				
1977	50			
1978				
1979				
1980	70			3
1981				1
1982				4
1983	91			1
1984		8		8
1985				6
1986	180			1
1987				2
1988				3
1989	31	3		1
1990		3		
1991		1		
1992	17			
1993		2		11
1994				4
1995	11	3		3
1996		3		2
1997		1		2
1998	14			4
1999		2	2	8
2000		1	0	5
2001	10	2	0	2
2002			1	1
2003			9	1
2004	32		0	
2005			5	
2006			4	
2007			5	
2008			5	
2009			0	
2010			1	

Common Name	**Scientific Name**
Brown rockfish	*Sebastes auriculatus*

Cape Mendocino

Region	Central			South	
Source	Combo	RecFIN	Observer	RecFIN	Observer
Year			(fish)		(trips)
1975					199
1976					*
1977					*
1978					*
1979					
1980		17		7	
1981		12		12	
1982		4		14	
1983		8		27	
1984		31		26	
1985		52		19	
1986		27		13	414
1987		27	9	3	*
1988		35	583	10	*
1989		22	641	13	*
1990			210		
1991			365		
1992			323		
1993		4	282	8	
1994		5	321	23	
1995		4	544	11	
1996		55	412	22	
1997				4	
1998				16	
1999		53		33	
2000		18		19	
2001		43		24	
2002		80		36	
2003	5	128		28	
2004	6				
2005	4				
2006	4				
2007	1				
2008	1				
2009	2				
2010	3				

Common Name			**Scientific Name**
Calico rockfish			*Sebastes dallii*
Region		South	
Source	Combo	RecFIN	Observer
Year			(trips)
1975			151
1976			*
1977			*
1978			*
1979			
1980		2	
1981		8	
1982		2	
1983		7	
1984		5	
1985		18	
1986		17	468
1987		1	*
1988		5	*
1989		6	*
1990			
1991			
1992			
1993		8	
1994		8	
1995		6	
1996		6	
1997		2	
1998		11	
1999		23	
2000		4	
2001		1	
2002		2	
2003	2	2	
2004	5		
2005	7		
2006	7		
2007	9		
2008	3		
2009	6		
2010	3		

Common Name	**Scientific Name**
China rockfish	*Sebastes nebulosus*

	Cape Mendocino		
Region	North	Central	
Source	RecFIN	RecFIN	Observer (trips)
Year			
1975			
1976			
1977			
1978			
1979			
1980	10	18	
1981	15	8	
1982	9	10	
1983	7	9	
1984	14	9	
1985	19	29	
1986	7	30	
1987	15	34	34
1988	23	18	375
1989	26	27	288
1990			115
1991			111
1992			123
1993	42	3	180
1994	35	5	207
1995	28	25	132
1996	28	57	220
1997	42		149
1998	37		96
1999	52	46	
2000	25	19	
2001	16	34	
2002	22	73	
2003	5	110	

Common Name | **Scientific Name**
Copper (or Whitebelly) rockfish | *Sebastes caurinus*

Cape Mendocino | Point Conception

Region	North	Central				South		
Source	RecFIN	Triennial	Combo	RecFIN	Observer (fish)	Combo	RecFIN	Observer (trips)
Year								
1975								154
1976								*
1977		2						*
1978								*
1979								
1980	2	1		32			20	
1981	1			28			19	
1982	0			31			23	
1983	1	4		27			14	
1984	4			40			25	
1985	3			53			28	
1986	4	1		61			18	501
1987	4			20	39		5	*
1988	3			21	498		12	*
1989	12	13		45	713		29	*
1990					300			
1991					208			
1992		5			681			
1993	14			11	803		29	
1994	19			14	470		29	
1995	4	5		20	443		10	
1996	9			106	388		35	
1997	30				396		6	
1998	30	4			221		29	
1999	45			81			76	
2000	20			18			39	
2001	14	2		32			19	
2002	13			39			30	
2003	5		3	62		5	37	
2004		0	4			1		
2005			2			1		
2006			2			1		
2007			0			4		
2008			6			5		
2009			5			2		
2010			5			4		

Common Name Cowcod

Scientific Name *Sebastes levis*

	Cape Mendocino						Point Conception	
Region	North			Central			South	
Source	Combo	Triennial	Slope	Combo	RecFIN	Observer (fish)	Combo	Observer (trips)
Year								
1975								148
1976								*
1977		11						*
1978								*
1979								
1980		2			0			
1981					2			
1982					3			
1983		4			4			
1984					1			
1985					4			
1986		0			3			95
1987					1	5		*
1988					6	2		*
1989		19			3	8		*
1990						5		
1991						6		
1992		3				10		
1993					0	6		
1994					0	13		
1995		21			1	5		
1996					0	0		
1997			3			5		
1998		11				0		
1999	0		4	3	10			
2000	0		2	1	0			
2001	1	8	3	1	0			
2002	1			5	2		2	
2003	1			3	0		3	
2004	0	0		16			5	
2005	2			13			6	
2006	0			5			6	
2007	0			3			6	
2008	0			2			9	
2009	0			7			7	
2010	1			11			17	

Common Name Flag rockfish

Scientific Name *Sebastes rubrivinctus*

Region	Central		Point Conception	South	
Source	RecFIN	Observer (fish)	Combo	RecFIN	Observer (trips)
Year					
1975					273
1976					*
1977					*
1978					*
1979					
1980	9			19	
1981	6			22	
1982	12			24	
1983	7			30	
1984	15			30	
1985	23			33	
1986	16			32	361
1987	3	10		6	*
1988	3	36		9	*
1989	10	104		16	*
1990		29			
1991		38			
1992		120			
1993	5	84		16	
1994	8	85		19	
1995	6	47		4	
1996	19	56		23	
1997		49		9	
1998		22		25	
1999	29			74	
2000	8			46	
2001	12			18	
2002	6			28	
2003	0		6	17	
2004			7		
2005			5		
2006			8		
2007			12		
2008			7		
2009			9		
2010			7		

Common Name Greenblotched rockfish

Scientific Name *Sebastes rosenblatti*

Region		Central		Point Conception South	
Source	Triennial	Combo	RecFIN	Combo	Observer
Year					
1975					128
1976					*
1977	0				*
1978					*
1979					
1980	0		0		
1981			0		
1982			0		
1983	1		0		
1984			0		
1985			2		
1986	0		2		113
1987			3		*
1988			11		*
1989	5		4		*
1990					
1991					
1992	7				
1993			0		
1994			0		
1995	1		2		
1996			2		
1997					
1998	3				
1999			2		
2000			1		
2001	3		0		
2002		3	0	1	
2003		1	0	5	
2004	0	1		6	
2005		1		8	
2006		2		12	
2007		4		3	
2008		3		14	
2009		1		10	
2010		3		17	

Common Name Halfbanded rockfish

Scientific Name *Sebastes semicinctus*

Region	North		Central		South		
		Cape Mendocino		Point Conception			
Source	Triennial	Combo	Triennial	Combo	Combo	RecFIN	Observer (trips)
Year							
1975							28
1976							*
1977	0		6				*
1978							*
1979							
1980	0		0			2	
1981						4	
1982						1	
1983	0		0			8	
1984						11	
1985						12	
1986	0		0			12	144
1987						0	*
1988						1	*
1989	2		22			1	*
1990							
1991							
1992	0		44				
1993						5	
1994						17	
1995	1		30			2	
1996						10	
1997						5	
1998	1		27			15	
1999						45	
2000		0		1		13	
2001	1	0	27	1		3	
2002		0		2	1	10	
2003		1		4	16	5	
2004	16	2	0	15	26		
2005		1		19	31		
2006		0		15	30		
2007		1		15	31		
2008		0		19	32		
2009		1		20	38		
2010		0		26	35		

Common Name	**Scientific Name**
Kelp rockfish	*Sebastes atrovirens*

Point Conception

Region	Central		South	
Source	RecFIN	Observer	RecFIN	Observer
Year		(fish)		(trips)
1975				112
1976				*
1977				*
1978				*
1979				
1980	1		17	
1981	0		11	
1982	0		11	
1983	3		27	
1984	3		24	
1985	0		23	
1986	1		15	350
1987	3	0	2	*
1988	5	2	1	*
1989	0	8	7	*
1990		0		
1991		5		
1992		12		
1993	0	8	25	
1994	1	34	26	
1995	1	30	6	
1996	2	65	16	
1997		34	5	
1998		83	11	
1999	6		23	
2000	2		13	
2001	1		24	
2002	5		27	
2003	9		23	

Common Name	**Scientific Name**
Olive rockfish	*Sebastes serranoides*

	Point Conception			
Region	Central		South	
Source	RecFIN	Observer (fish)	RecFIN	Observer (trips)
Year				
1975				637
1976				*
1977				*
1978				*
1979				
1980	53		38	
1981	16		42	
1982	28		45	
1983	39		42	
1984	44		27	
1985	84		27	
1986	48		53	843
1987	30	130	10	*
1988	11	624	13	*
1989	39	819	26	*
1990		174		
1991		516		
1992		1169		
1993	8	885	60	
1994	4	637	33	
1995	28	1687	6	
1996	106	1175	14	
1997		1274	4	
1998		1177	11	
1999	123		24	
2000	21		6	
2001	23		36	
2002	54		59	
2003	97		36	

Common Name		**Scientific Name**		
Pygmy rockfish		*Sebastes wilsoni*		

		Cape Mendocino		Point Conception
Region	North		Central		South
Source	Triennial	Combo	Triennial	Combo	Combo
Year					
1975					
1976					
1977	3		0		
1978					
1979					
1980	9		0		
1981					
1982					
1983	23		0		
1984					
1985					
1986	101		2		
1987					
1988					
1989	38		1		
1990					
1991					
1992	28		3		
1993					
1994					
1995	20		1		
1996					
1997					
1998	12		2		
1999					
2000					
2001	11		2		
2002		1		0	0
2003		11		3	0
2004	0	5	2	0	0
2005		7		1	2
2006		13		0	2
2007		9		0	7
2008		5		1	3
2009		10		4	5
2010		5		1	1

Common Name	**Scientific Name**
Quillback rockfish	*Sebastes maliger*

Cape Mendocino

Region	North		Central	
Source	Triennial	RecFIN	RecFIN	Observer
Year				(fish)
1975				
1976				
1977	1			
1978				
1979				
1980	2	5	0	
1981		2	2	
1982		7	2	
1983	4	4	5	
1984		5	3	
1985		7	11	
1986	12	2	8	
1987		4	2	7
1988		5	0	90
1989	3	12	17	89
1990				36
1991				6
1992	9			21
1993		23	1	52
1994		23	0	26
1995	2	14	2	104
1996		15	21	59
1997		41		47
1998	7	44		45
1999		50	27	
2000		26	5	
2001	7	18	7	
2002		26	1	
2003		7	12	
2004	0			

Common Name — Redbanded rockfish

Scientific Name — *Sebastes babcocki*

Region / Source / Year	Triennial	North Slope	Combo	Triennial	Central Slope	Combo	South Combo
			Cape Mendocino			Point Conception	
1975							
1976							
1977	100			40			
1978							
1979							
1980	57			7			
1981							
1982							
1983	86			4			
1984		31					
1985							
1986	37			6			
1987							
1988		14					
1989	67	13		13			
1990		13					
1991		2					
1992	60	15		7			
1993		23					
1994							
1995	83	13		19			
1996		30					
1997		14			4		
1998	73			11			
1999		17	33		6	17	
2000		19	34		5	16	
2001	69	14	26	19	5	13	
2002			31			10	0
2003			52			8	3
2004	13		31	47		6	0
2005			46			4	4
2006			41			7	0
2007			47			5	0
2008			42			10	2
2009			39			13	1
2010			34			3	0

Common Name Redstripe rockfish

Scientific Name *Sebastes proriger*

Cape Mendocino

Region	North				Central		
Source / Year	Triennial	Slope	Combo	RecFIN	Triennial	Combo	RecFIN
1975							
1976							
1977	31				0		
1978							
1979							
1980	66			1	0		0
1981				0			2
1982				0			2
1983	64			1	1		5
1984		4		3			3
1985				2			11
1986	36			2	1		8
1987				0			2
1988		5		0			0
1989	58	4		0	1		17
1990		3					
1991							
1992	60	2			1		
1993		3		1			1
1994				4			0
1995	29	3		6	1		2
1996		12		2			21
1997		4		0			
1998	41			2	0		
1999		10	4	1		3	27
2000		3	1	1		0	5
2001	23	2	0	1	2	4	7
2002			3	1		1	1
2003			24	1		1	12
2004	8		15		12	0	
2005			17			0	
2006			16			0	
2007			9			0	
2008			9			3	
2009			13			1	
2010			11			0	

Common Name Rosethorn rockfish

Scientific Name *Sebastes helvomaculatus*

Cape Mendocino | Point Conception

Region	North				Central					South
Source Year	Trienn	Slope	Combo	RecFIN	Trienn	Slope	Combo	RecFIN	Obs (fish)	Combo
1975										
1976										
1977	47				14					
1978										
1979										
1980	67			2	1			15		
1981				0				5		
1982				7				15		
1983	81			3	2			17		
1984		14		8				2		
1985				7				17		
1986	37			5	1			5		
1987				2				0	9	
1988		7		2				6	28	
1989	69	7		1	9			3	48	
1990		3							20	
1991		0							55	
1992	76	11			7				15	
1993		14		12				0	26	
1994				16				0	54	
1995	51	3		20	9			1	43	
1996		22		10				2	47	
1997		6		10		1			22	
1998	58			15	8				12	
1999		9	13	11		5	10	9		
2000		10	16	6		2	8	0		
2001	35	5	10	1	9	3	4	1		
2002			15	4			5	0		5
2003			56	2			1	0		6
2004	42		32		26		4			5
2005			30				3			14
2006			39				6			13
2007			44				4			5
2008			37				5			2
2009			35				6			17
2010			39				2			15

Common Name Rosy rockfish

Scientific Name *Sebastes rosaceus*

Region	Central		South	
Source	RecFIN	Observer (fish)	RecFIN	Observer (trips)
Year				
1975				177
1976				*
1977				*
1978				*
1979				
1980	50		9	
1981	21		12	
1982	23		12	
1983	27		25	
1984	92		28	
1985	141		33	
1986	106		26	319
1987	29	432	2	*
1988	33	1631	5	*
1989	38	2284	18	*
1990		1030		
1991		633		
1992		1534		
1993	11	1526	17	
1994	15	1605	16	
1995	39	1564	3	
1996	137	1646	24	
1997		1372	4	
1998		766	23	
1999	118		85	
2000	31		31	
2001	29		14	
2002	24		20	
2003	29		13	

Point Conception (boundary between Central and South)

Common Name		**Scientific Name**	
Rougheye rockfish		*Sebastes aleutianus*	

Region Source Year	Triennial	North Slope	Combo	Cape Mendocino Central Triennial
1975				
1976				
1977	72			0
1978				
1979				
1980	22			0
1981				
1982				
1983	36			0
1984		14		
1985				
1986	100			0
1987				
1988		12		
1989	56	5		1
1990		4		
1991				
1992	60	14		0
1993		17		
1994				
1995	88	2		0
1996		27		
1997		10		
1998	70			6
1999		11	18	
2000		15	13	
2001	68	9	21	1
2002			13	
2003			34	
2004	3		27	45
2005			27	
2006			34	
2007			37	
2008			36	
2009			27	
2010			29	

Common Name	**Scientific Name**
Sharpchin rockfish	*Sebastes zacentrus*

Cape Mendocino

Region Source Year	Triennial	North Slope	Combo	Triennial	Central Slope	Combo
1975						
1976						
1977	77			6		
1978						
1979						
1980	83			12		
1981						
1982						
1983	112			5		
1984		16				
1985						
1986	1			10		
1987						
1988		14				
1989	87	13		19		
1990		17				
1991		1				
1992	98	17		13		
1993		29				
1994						
1995	56	15		14		
1996		30				
1997		19			3	
1998	55			10		
1999		19	14		3	10
2000		11	18		5	8
2001	41	14	6	10	5	11
2002			17			3
2003			51			2
2004	14		30	36		3
2005			31			3
2006			34			7
2007			31			4
2008			24			2
2009			30			9
2010			36			5

Common Name			**Scientific Name**	
Shortraker rockfish			*Sebastes borealis*	

Region				Cape Mendocino
Source Year	Triennial	North Slope	Combo	Triennial
1975				
1976				
1977	10			2
1978				
1979				
1980	2			0
1981				
1982				
1983	3			0
1984		0		
1985				
1986	13			0
1987				
1988		0		
1989	0	2		0
1990		0		
1991		0		
1992	0	4		1
1993		1		
1994				
1995	10	0		0
1996		6		
1997		2		
1998	6			1
1999		5	1	
2000		2	1	
2001	9	4	4	1
2002			4	
2003			1	
2004	0		3	3
2005			2	
2006			0	
2007			0	
2008			0	
2009			0	
2010			0	

Common Name	**Scientific Name**
Speckled rockfish	*Sebastes ovalis*

Point Conception				
Region	Central		South	
Source	RecFIN	Observer (fish)	RecFIN	Observer (trips)
Year				
1975				106
1976				*
1977				*
1978				*
1979				
1980	10		10	
1981	3		15	
1982	13		10	
1983	13		29	
1984	27		20	
1985	36		17	
1986	11		9	126
1987	1	60	1	*
1988	1	39	0	*
1989	2	134	3	*
1990		20		
1991		75		
1992		166		
1993	0	93	3	
1994	0	78	32	
1995	5	152	1	
1996	20	104	3	
1997		235	3	
1998		115	9	
1999	38		19	
2000	8		18	
2001	5		3	
2002	2		10	
2003	1		4	

Common Name	**Scientific Name**
Squarespot rockfish	*Sebastes hopkinsi*

	Point Conception			
Region	Central		South	
Source	RecFIN	Observer (fish)	RecFIN	Observer (trips)
Year				
1975				197
1976				*
1977				*
1978				*
1979				
1980	18		3	
1981	15		0	
1982	19		2	
1983	28		1	
1984	38		17	
1985	28		19	
1986	26		2	249
1987	3	98	0	*
1988	6	190	2	*
1989	10	120	0	*
1990		17		
1991		1		
1992		80		
1993	20	55	0	
1994	27	71	1	
1995	4	173	4	
1996	24	64	9	
1997	12	194	34	
1998		168	16	
1999			12	
2000	35		2	
2001	6		0	
2002	18		0	
2003	22		1	

Common Name	**Scientific Name**
Starry rockfish	*Sebastes constellatus*

Point Conception

Region	Central		South	
Source	RecFIN	Observer	RecFIN	Observer
Year		(fish)		(trips)
1975				267
1976				*
1977				*
1978				*
1979				
1980	41		21	
1981	19		20	
1982	21		30	
1983	27		54	
1984	64		48	
1985	105		49	
1986	90		46	533
1987	21	266	9	*
1988	20	625	16	*
1989	29	681	23	*
1990		199		
1991		379		
1992		690		
1993	12	707	40	
1994	16	819	63	
1995	23	749	16	
1996	101	936	34	
1997		721	9	
1998		299	48	
1999	130		136	
2000	26		74	
2001	30		29	
2002	30		53	
2003	22		36	

Common Name | **Scientific Name**
Stripetail rockfish | *Sebastes saxicola*

Cape Mendocino | Point Conception

Region	North			Central				South
Source	Triennial	Slope	Combo	Triennial	Slope	Combo	RecFIN	Combo
Year								
1975								
1976								
1977	48			143				
1978								
1979								
1980	47			30			3	
1981							0	
1982							0	
1983	65			33			1	
1984		14					5	
1985							8	
1986	22			45			8	
1987							0	
1988		2					0	
1989	46	4		97			0	
1990		13						
1991		1						
1992	47	3		73				
1993		7					0	
1994							0	
1995	93	15		81			0	
1996		11					1	
1997		11			9			
1998	55			74				
1999		11	24		10	25	2	
2000		9	17		10	31	0	
2001	53	9	7	59	12	30	0	1
2002			19			29	0	14
2003			41			49	0	32
2004	67		29	38		56		34
2005			40			70		39
2006			56			46		40
2007			62			43		40
2008			30			53		41
2009			46			60		48
2010			47			78		45

Common Name	**Scientific Name**
Swordspine rockfish	*Sebastes ensifer*

	Point Conception		
Region	Central	South	
Source	RecFIN	Combo	Observer
Year			(trips)
1975			52
1976			*
1977			*
1978			*
1979			
1980	13		
1981	6		
1982	9		
1983	12		
1984	13		
1985	3		
1986	1		85
1987	3		*
1988	2		*
1989	0		*
1990			
1991			
1992			
1993	0		
1994	0		
1995	0		
1996	0		
1997			
1998			
1999	0		
2000	0		
2001	0		
2002	0		
2003	0	1	
2004		2	
2005		1	
2006		3	
2007		8	
2008		5	
2009		3	
2010		4	

Common Name Treefish

Scientific Name *Sebastes serriceps*

Region	Central	Point Conception South	
Source	RecFIN	RecFIN	Observer
Year			(trips)
1975			181
1976			*
1977			*
1978			*
1979			
1980	2	20	
1981	0	14	
1982	0	22	
1983	0	45	
1984	0	33	
1985	0	27	
1986	0	30	565
1987	0	11	*
1988	1	10	*
1989	2	17	*
1990			
1991			
1992			
1993	0	55	
1994	0	34	
1995	0	28	
1996	1	34	
1997		21	
1998		48	
1999	6	102	
2000	3	51	
2001	3	41	
2002	10	53	
2003	20	52	

Common Name	**Scientific Name**
Vermilion rockfish	*Sebastes miniatus*
Sunset rockfish	*Sebastes crocotulus*

	Cape Mendocino				Point Conception			
Region	North	Central				South		
Source	RecFIN	Triennial	Combo	RecFIN	Observer (fish)	Combo	RecFIN	Observer (trips)
Year								
1975								332
1976								*
1977		2						*
1978								*
1979								
1980	0	0		34			21	
1981	2			16			19	
1982	0			28			19	
1983	0	1		19			34	
1984	1			37			46	
1985	4			58			50	
1986	9	0		52			42	690
1987	2			33	64		11	*
1988	6			37	674		19	*
1989	8	10		39	1274		46	*
1990					583			
1991					388			
1992		9			1173			
1993	7			12	1079		46	
1994	11			17	753		74	
1995	13	2		40	968		9	
1996	14			161	630		37	
1997	30				1278		8	
1998	24	0			662		40	
1999	27			162			167	
2000	12			28			97	
2001	15	6		43			58	
2002	13			108			105	
2003	6		1	178		5	103	
2004		0	2			1		
2005			1			4		
2006			2			3		
2007			1			7		
2008			6			7		
2009			9			6		
2010			5			10		

Common Name			**Scientific Name**
Yellowmouth rockfish			*Sebastes reedi*
Region Source Year	Triennial	North Slope	Combo
1975			
1976			
1977	7		
1978			
1979			
1980	7		
1981			
1982			
1983	14		
1984		1	
1985		0	
1986	127	0	
1987		0	
1988		2	
1989	10	2	
1990			
1991		0	
1992	13	1	
1993		1	
1994			
1995	6	2	
1996		1	
1997		1	
1998	4		
1999			1
2000			1
2001	2		1
2002			0
2003			5
2004	1		0
2005			2
2006			0
2007			0
2008			0
2009			0
2010			1

Common Name Yellowtail rockfish

Scientific Name *Sebastes flavidus*

Region	Central			Point Conception South
Source	Triennial	RecFIN	Observer (fish)	Observer (trips)
Year				
1975				53
1976				*
1977	11			*
1978				*
1979				
1980	4	82		
1981		48		
1982		84		
1983	9	74		
1984		144		
1985		250		
1986	12	149		51
1987		89	1848	*
1988		71	5033	*
1989	9	88	7133	*
1990			2215	
1991			2551	
1992	16		6204	
1993		12	5370	
1994		16	4716	
1995	14	68	6240	
1996		231	4827	
1997			6715	
1998	4		4129	
1999		288		
2000		35		
2001	3	57		
2002		95		
2003		91		
2004	48			

Common Name		**Scientific Name**		
Curlfin sole		*Pleuronichthys decurrens*		

		Cape Mendocino		Point Conception
Region	North		Central		South
Source	Triennial	Combo	Triennial	Combo	Combo
Year					
1975					
1976					
1977	0		6		
1978					
1979					
1980	4		6		
1981					
1982					
1983	8		12		
1984					
1985					
1986	1		14		
1987					
1988					
1989	12		47		
1990					
1991					
1992	14		40		
1993					
1994					
1995	12		36		
1996					
1997					
1998	31		51		
1999					
2000					
2001	27		52		
2002					
2003		17		31	8
2004	37	12	12	33	7
2005		30		34	5
2006		13		24	7
2007		14		23	11
2008		22		23	16
2009		23		40	16
2010		19		28	17

Common Name | **Scientific Name**
Pacific sanddab | *Citharichthys sordidus*

		Cape Mendocino				Point Conception			
Region	North		Central				South		
Source	Triennial	Combo	Triennial	Combo	RecFIN	Obs (fish)	Combo	RecFIN	Obs (trips)
Year									
1975									107
1976									*
1977	30		78						*
1978									*
1979									
1980	100		36		14			14	
1981					4			11	
1982					1			3	
1983	231		48		4			4	
1984					18			18	
1985					41			22	
1986	349		57		19			21	351
1987					4	26		3	*
1988					16	185		9	*
1989	142		129		3	334		14	*
1990						61			
1991						129			
1992	191		135			196			
1993					4	325		11	
1994					2	383		22	
1995	165		86		9	304		4	
1996					46	334		19	
1997						307		8	
1998	206		94			85		15	
1999					37			60	
2000					16			31	
2001	162		89		9			24	
2002					13			53	
2003		65		47	38		22	36	
2004	65	82	77	62			24		
2005		116		71			30		
2006		85		64			31		
2007		95		60			35		
2008		95		66			43		
2009		86		86			48		
2010		114		81			46		

Common Name	**Scientific Name**
Rex sole	*Glyptocephalus zachirus*

		Cape Mendocino		Point Conception	
Region	North		Central		South
Source	Triennial	Combo	Triennial	Combo	Combo
Year					
1975					
1976					
1977	300		249		
1978					
1979					
1980	332		58		
1981					
1982					
1983	433		66		
1984					
1985					
1986	1		72		
1987					
1988					
1989	338		147		
1990					
1991					
1992	363		141		
1993					
1994					
1995	366		148		
1996					
1997					
1998	362	90	160	66	
1999		96		67	
2000		108		68	
2001	339	111	160	59	
2002		111		73	23
2003		236		92	22
2004	92	197	159	89	26
2005		269		113	42
2006		247		111	39
2007		282		105	38
2008		257		107	34
2009		247		115	36
2010		290		115	38

Common Name		**Scientific Name**		
Rock sole		*Lepidopsetta bilineata*		

	Cape Mendocino		Point Conception		
Region / Source / Year	North Combo	Combo	Central RecFIN	Observer (fish)	South Combo
1975					
1976					
1977					
1978					
1979					
1980			2		
1981			0		
1982			0		
1983			2		
1984			7		
1985			11		
1986			5		
1987			4	12	
1988			6	13	
1989			5	37	
1990				23	
1991				3	
1992				15	
1993			1	8	
1994			0	21	
1995			1	14	
1996			6	19	
1997				12	
1998				9	
1999			6		
2000			4		
2001			2		
2002			2		
2003			12		
2004	13	10			1
2005	19	8			2
2006	14	8			3
2007	19	11			7
2008	14	8			8
2009	14	15			5
2010	17	10			6

Common Name | **Scientific Name**
Sand sole | *Psettichthys melanostictus*

Region		North		Central	
Source	Triennial	Combo	RecFIN	Combo	RecFIN
Year					
1975					
1976					
1977	0				
1978					
1979					
1980	6		1		3
1981			0		1
1982			0		0
1983	7		1		0
1984			0		1
1985			1		2
1986	61		0		0
1987			0		1
1988			1		2
1989	6		2		0
1990					
1991					
1992	20				
1993			3		0
1994			10		0
1995	3		0		1
1996			1		1
1997			10		
1998	11		5		
1999			1		1
2000			0		1
2001	6		1		3
2002			0		2
2003		4	0	2	3
2004	2	5		1	
2005		6		0	
2006		3		0	
2007		6		1	
2008		6		6	
2009		7		3	
2010		7		3	

Cape Mendocino

Common Name	**Scientific Name**
Big skate	*Raja binoculata*

	Cape Mendocino		Point Conception			
Region	North		Central		South	
Source	Triennial	Combo	Triennial	Combo	RecFIN	Combo
Year						
1975						
1976						
1977	10		0			
1978						
1979						
1980	10		2		0	
1981					0	
1982					3	
1983	28		4		3	
1984					3	
1985					3	
1986	79		6		1	
1987					1	
1988					1	
1989	41		14		3	
1990						
1991						
1992	52		18			
1993					1	
1994					1	
1995	22		22		3	
1996					6	
1997					1	
1998	48		12		3	
1999					14	
2000					13	
2001	24		19		2	
2002					15	
2003		48		14	19	1
2004	25	58	32	26		1
2005		85		15		3
2006		47		19		2
2007		61		17		1
2008		42		13		1
2009		60		24		1
2010		99		28		2

Common Name Ratfish

Scientific Name *Hydrolagus colliei*

		Cape Mendocino		Point Conception	
Region	North		Central		South
Source	Slope	Combo	Slope	Combo	Combo
Year					
1975					
1976					
1977					
1978					
1979					
1980					
1981					
1982					
1983					
1984	40				
1985					
1986					
1987					
1988	22				
1989	16				
1990	9				
1991	2				
1992	22				
1993	31				
1994					
1995	10				
1996	40				
1997	26		21		
1998		41		48	
1999	23	40	19	52	
2000	18	31	18	54	
2001	15	30	15	43	
2002		32		47	22
2003		156		66	33
2004		151		63	33
2005		200		87	44
2006		191		84	53
2007		209		89	53
2008		184		107	58
2009		146		106	58
2010		200		95	55

Common Name	**Scientific Name**
Pacific rattail	*Coryphaenoides acrolepis*
(Pacific grenadier)	*Coryphaenoides spp.*

Region	North		Central		South
		Cape Mendocino		Point Conception	
Source	Slope (multispp)	Combo	Slope (multispp)	Combo	Combo
Year					
1975					
1976					
1977					
1978					
1979					
1980					
1981					
1982					
1983					
1984	21				
1985					
1986					
1987					
1988	59				
1989	23				
1990	152				
1991	57				
1992	104				
1993	154				
1994					
1995	144				
1996	275				
1997	139		101		
1998					
1999	270	103	98	62	
2000	173	98	115	48	
2001	85	92	64	45	
2002		104		58	8
2003		107		17	3
2004		52		18	10
2005		89		23	12
2006		75		41	14
2007		88		42	16
2008		80		38	10
2009		65		52	15
2010		76		36	15

Common Name	**Scientific Name**
California skate	*Raja inornata*

Region Source Year	North Combo	Central Combo	South Combo
2001			
2002			
2003	1	30	19
2004	2	39	17
2005	4	53	21
2006	1	43	20
2007	0	40	18
2008	2	41	19
2009	1	53	19
2010	3	49	22

Common Name	**Scientific Name**
Finescale codling (Pacific flatnose)	*Antimora microlepis*

Region Source Year	North Combo	Central Combo	South Combo
1995			
1996			
1997			
1998	69	73	
1999	110	70	
2000	122	63	
2001	123	59	
2002	118	79	16
2003	108	23	11
2004	53	23	18
2005	71	24	19
2006	70	46	23
2007	74	48	23
2008	51	32	12
2009	23	42	16
2010	35	28	17

	Grass RF *S. rastrelliger*		Honeycomb RF *S. umbrosus*		Mexican RF *S. macdonaldi*	Pink RF *S. eos*
Region	Central	South	South		South	South
Source	RecFIN	Observer	RecFIN	Observer	Observer	Observer
Year		(trips)		(trips)	(trips)	(trips)
1975		94		127	30	75
1976		*		*	*	*
1977		*		*	*	*
1978		*		*	*	*
1979						
1980	0		8			
1981	0		5			
1982	1		15			
1983	0		18			
1984	1		26			
1985	0		30			
1986	1	179	35	391	20	23
1987	2	*	1	*	*	*
1988	4	*	9	*	*	*
1989	0	*	6	*	*	*
1990						
1991						
1992						
1993	0		22			
1994	1		17			
1995	0		6			
1996	0		20			
1997			9			
1998			36			
1999	0		114			
2000	1		50			
2001	6		11			
2002	2		44			
2003	1		46			

	Silvergray RF *S. brevispinis*		Tiger RF *S. nigrocinctus*	Ocean Whitefish *Caulolatilus princeps*	
Region	North		North	South	
Source	RecFIN	Combo	RecFIN	RecFIN	Observer (trips)
Year					
1975					325
1976					*
1977					*
1978					*
1979					
1980	2		0	8	
1981	0		0	7	
1982	3		0	17	
1983	0		0	33	
1984	0		8	34	
1985	0		0	45	
1986	1		1	44	823
1987	0		0	16	*
1988	0		2	9	*
1989	1		3	23	*
1990					
1991					
1992					
1993	2		4	44	
1994	9		4	109	
1995	5		3	34	
1996	3		3	33	
1997	3		7	26	
1998	4		4	44	
1999	4	2	11	97	
2000	2	1	5	95	
2001	0	1	2	57	
2002	0	0	3	69	
2003	0	9	2	67	
2004		3			
2005		6			
2006		3			
2007		8			
2008		5			
2009		5			
2010		8			

	Butter sole *Isopsetta isolepis*		Flathead sole *Hippoglossoides elassodon*	
Region	North		North	
Source	Triennial	Combo	Triennial	Combo
Year				
1975				
1976				
1977	0		43	
1978				
1979				
1980	2		85	
1981				
1982				
1983	2		76	
1984				
1985				
1986	24		279	
1987				
1988				
1989	4		91	
1990				
1991				
1992	6		79	
1993				
1994				
1995	3		87	
1996				
1997				
1998	3		64	
1999				
2000				
2001	10		159	
2002				
2003		6		52
2004	3	3	1	44
2005		6		41
2006		4		49
2007		9		27
2008		11		24
2009		12		39
2010		11		55

	Leopard shark *Triakis semifasciata*		Kelp greenling *Hexagrammos decagrammus*		Pacific cod *Gadus macrocephalus*	
Region	Central	South	Central		North	
Source	RecFIN	RecFIN	RecFIN	Observer (fish)	Triennial	Combo
Year						
1975						
1976						
1977					84	
1978						
1979						
1980	6	6	10		56	
1981	1	2	1			
1982	1	2	2			
1983	2	3	3		85	
1984	1	6	4			
1985	2	4	4			
1986	1	1	6		75	
1987	14	3	4	5		
1988	3	1	3	65		
1989	0	4	6	92	110	
1990				19		
1991				18		
1992				34	96	
1993	5	3	1	56		
1994	7	4	0	40		
1995	3	1	11	56	55	
1996	6	4	23	84		
1997		1	25	62		
1998		4	7	16	69	
1999	1	9	10			2
2000	3	1	6			4
2001	1	2	24		35	3
2002	0	2	6			3
2003	1	8	55			68
2004					1	48
2005						28
2006						14
2007						25
2008						19
2009						20
2010						49