FINAL REPORT
PACIFIC FISHERY MANAGEMENT COUNCIL
BYCATCH MODEL REVIEW WORKSHOP
January 27-29, 2003

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Overview

The Pacific Fishery Management Council (Council) first adopted trip limits for the groundfish fishery in the early 1980s. These regulations were intended to slow the rate of harvest of individual species, thereby supporting a year-round fishery while ensuring that harvest of each species did not exceed its optimum yield (OY). As trip limits declined, the Council gradually replaced them with cumulative landings limits (i.e., vessel landings limits per time period rather than per trip) that were intended to discourage discards while giving vessels more operational flexibility than they had under trip limits. Currently, the temporal duration of cumulative limits is two months. Because cumulative limits apply to landings and not catch, fishing can continue for other species once the limit for a particular species is reached. However, unintended bycatch can occur while fishing for these other species. Catch in excess of limits cannot be legally retained and is assumed to be discarded.

For purposes of this report, bycatch is defined to include all fish taken on a trip other than landings (retention) of target species. Thus bycatch includes discard of target species, as well as landings and discard of non-target species. The groundfish trawl bycatch model focuses on a particular subset of bycatch, that is, bycatch (landings + discard) of non-target (in this case, overfished) groundfish species.

The bycatch model was developed in 2001 by the Council's Groundfish Management Team (GMT) to project the effect of 2002 target species bimonthly limits on trawl bycatch of overfished species (i.e., lingcod, Pacific ocean perch, canary, darkblotched, widow and bocaccio rockfish). In 2003, in addition to bimonthly limits, the Council also implemented highly restrictive depth-based fishery closures to ensure bycatch of overfished species did not exceed their OYs. In order to facilitate the Council's consideration of management alternatives, the GMT modified the bycatch model used in 2002 to evaluate the combined effects of depth-based closures and bimonthly limits.

At their November 2002 meeting, the Council agreed to a recommendation from the Scientific and Statistical Committee (SSC) that a workshop be convened to review the bycatch model. The Council assigned responsibility for technical aspects of the workshop to the SSC; the National Marine Fisheries Service (NMFS) Northwest Fisheries Science Center (NWFSC) agreed to be responsible for meeting logistics. Terms of Reference for the workshop, including a draft agenda, are contained in Attachment 1 of this report.

The panel convened on January 27-29, 2003 at the NWFSC in Seattle, Washington. Prior to the meeting, Dr. Jim Hastie provided the panel with documentation on the bycatch model (Hastie, undated). The panel appreciates the thoroughness with which Dr. Hastie's document addressed the requirements of the terms of reference.

The panel also received other papers (Pikitch, Erickson and Wallace, 1988; Methot, Helser and Hastie, 2000; Wallace and Methot 2002; Gillis, Pikitch and Peterman, 1995; Babcock and Pikitch 2000) that provide information on previous efforts to collect and analyze data pertaining to groundfish trawl bycatch on the West Coast. Highlights of these papers are as follows:

- Pikitch *et al.* (1988) conducted the first comprehensive analysis of bycatch and discard in the West Coast groundfish trawl fishery. Their analysis is based on data from a voluntary at-sea observer program (hereafter referred to as the Pikitch study) conducted aboard commercial groundfish trawl vessels operating from Newport, Astoria, and Coos Bay, Oregon from June 1985 through December 1987. The analysis distinguishes major fishing strategies by gear, target species, and depth of fishing and provides estimates of discard rates by strategy and species for species managed by Council trip limits. Results of the analysis show a significant relationship between discard rates and trip limits.

- Methot *et al.* (2000) analyze discard of target species in the West Coast Dover sole/thornyhead/trawl-caught sablefish complex (DTS) bottom trawl fishery. Their analysis is the first to use data from the Enhanced Data Collection Program (EDCP), a voluntary observer program initiated by the Oregon Trawl Commission and the Oregon Department of Fish and Wildlife in conjunction with NMFS and other partners. The EDCP was conducted from Crescent City, California to Bellingham, Washington over the period November 1995 through December 1998. The analysis treats each trip in the EDCP data as a random draw without considering any vessel specific effects. Discard of DTS for each trawl trip landing DTS is estimated as a function of the remaining amount of the vessel's cumulative limit.

- Wallace and Methot (2002) analyze halibut bycatch in the West Coast bottom trawl groundfish fishery. The analysis uses data from the EDCP, combined with logbook data on trawl effort and fishticket data for Oregon and Washington from the Pacific Coast Fisheries Information Network (PacFIN). Bycatch rates are estimated as a function of tow hours, instead of target strategy as done by Pikitch *et al.* (1998).

- Gillis *et al.* (1995) use optimal foraging theory to develop a dynamic model of discard due to high-grading, whereby fishermen discard marketable but lower-valued fish to leave space for more valuable fish that may be caught before the end of a trip. High-grading is distinct from discard associated with regulatory landings limits, the primary cause of discard in the West Coast groundfish fishery. This analysis applies dynamic programming methods to simulate discard of high, low, and medium valued classes of sablefish as a function of seasonal trip limits and availability. The analysis is based on data from the Oregon trawl fishery collected in the Pikitch study.

- Babcock and Pikitch (2000) extend the dynamic programming approach of Gillis *et al.* (1995) to include other fishing strategies and consider discard from all sources. The data come from a mesh size study involving voluntary observers aboard Oregon and Washington groundfish trawlers during 1988-1990. Results simulate discard of various species including sablefish, widow and yellowtail rockfish as a function of trip limits.

Groundfish Trawl Bycatch Model and Its Use in the Council Management Process

The general approach of the groundfish trawl bycatch model involves construction of an annual baseline participation pattern (landings by target species, target fishery, bimonthly period, management area, and depth) for individual groundfish trawl vessels. A set of algorithms is used to predict how the baseline pattern of individual vessels would be constrained by proposed management measures (closed areas, bimonthly limits). Aggregate effects are then predicted by summing the effects of the management measures across individual vessels. In order to understand specifically how groundfish trawl bycatch is estimated, it is important to understand both the details of the bycatch model and the manner in which it is utilized in the management process.

Step 1 - Defining the Baseline

Participation by individual vessels in specific target fisheries and time periods can vary widely from one year to the next, depending on species abundance and regulatory and market conditions in nongroundfish (e.g., shrimp) as well as groundfish fisheries. To ensure the baseline captures the possibility of extensive fishery participation within target fisheries and time periods and reflects recent fishery conditions, multiple years of fishticket data (1999-2001) are used to define the baseline, with greater weight given to data from more recent years (Hastie, Table 6). The baseline is defined on a vessel-by-vessel basis, with each trip made by each vessel assigned to a bimonthly period and management area. Each trip is also assigned to a target fishery based on explicit criteria (Hastie, Table 1). For each vessel, bimonthly period and management area, the landings distribution of each target species among target fisheries is also estimated.
To reflect the effect of the depth-based closures considered in 2003, the baseline defined in the 2002 version of the model was augmented to include information on the depth distribution of landings. Specifically, 1999 logbook data are used to estimate the relative depth distribution of each target species taken by each vessel in each bimonthly period and management area. The absolute level of landings associated with each depth stratum is then estimated by multiplying baseline landings for each vessel, target species, period, and area by the relative depth distribution of landings for the same vessel, target species, period, and area.

Step 2 - Predicting Redistribution of Harvest Associated with Depth-based Closures

For each depth-based closure scenario evaluated, an *ad hoc* effort redistribution formula (Hastie, Table 9) is used to predict the extent to which harvest taken at proposed closed depths would be redistributed to depths remaining open. Specifically, for each vessel, bimonthly period and management area, landings of each target species during the baseline period are summed across those depth strata that would remain open to fishing in 2003, and the percentage of the vessel's total baseline landings accounted for by these open depths is calculated. This percentage is entered into the redistribution formula to predict landings after the closure in the absence of a bimonthly limit constraint. Actual landings of each target species by each vessel in each period and area are then estimated by constraining the landings level predicted by the redistribution formula from exceeding the bimonthly limit for the species. Total landings of each target species after the closure are then estimated by summing appropriately across vessels, periods, and areas.

Step 3 - Selecting Bycatch Rates

For each overfished species and target fishery, the bycatch rate is calculated as the poundage of the overfished species caught (landings + discard) in the target fishery divided by the poundage of all target species landed in the same fishery. Bycatch rates are estimated on a target fishery basis to avoid the double counting that would occur if they were estimated on a target species basis.

For the area north of Cape Mendocino, a range of bycatch rates for each overfished species is derived for each bimonthly period/target fishery stratum, using data from the 1999 logbooks and the Pikitch and EDCP studies (Hastie, Table 3a). For the area south of Cape Mendocino, the 1999 logbooks are used to derive bycatch rates in each of the same strata (Hastie, Table 3b).[1/] For the northern management area, the GMT devises a range of bycatch rates for Council consideration, by evaluating the Table 3a rates in terms of factors such as sample size and the timeliness of the data source from which each rate was derived (the Pikitch rates being the most outdated, the logbook rates the most current) (Hastie, Table 4a). For the southern area, the range (Hastie, Table 4b) is calculated as ___ 50% of the rates contained in Table 3b.

The rates used in the bycatch model are selected by the Council (Hastie, Tables 12a, and 12b), based on the ranges provided in Hastie's Tables 4a and 4b and additional information from the GMT regarding the historical performance of the rates in predicting retained bycatch. In this regard, the GMT gave special consideration to bocaccio. Specifically, given that bocaccio harvest in the first four months of 2002

1/ Coverage of the area south of Cape Mendocino by the Pikitch and EDCP surveys was too limited to allow use of these data sources to estimate bycatch rates in the southern area.

exceeded model projections by 350% (Hastie, Table 7), the GMT increased the raw logbook bycatch rates for bocaccio by factors of 3.9 to 9.0 for depths less than 80 fathoms and by a factor of 2.0 for depths greater than 150 fathoms. These upward adjustments are intended to improve model performance with regard to bocaccio bycatch.

Bycatch rates for each overfished species in each target fishery, bimonthly period, management area, and depth are calculated from the 1999 logbooks based on the start position of the tow. These rates are calibrated to the Council-approved bycatch rates, by multiplying each logbook rate by the ratio of the corresponding Council-approved rate to the (all depths) logbook rate. These calibrated rates are then compared with information from the NMFS trawl survey regarding the depth distribution of bycatch species. In cases where a positive bycatch rate is estimated for a depth at which a particular bycatch species is not found (according to trawl survey data), the rate is set to zero. This latter procedure is intended to help correct for possible erroneous inferences in the logbooks regarding depth of harvest associated with the fact that the start depth of the tow reported in the logbook database is not necessarily the depth at which the fish are caught.

Step 4 - Predicting Bycatch Levels

Landings of each target species within each target fishery are estimated for each vessel, bimonthly period, and management area by multiplying the projected landings of each target species by each vessel in each period and area after the closure (derived in step 2) by the baseline landings distribution of target species among target fisheries for the same vessel, period, and area (derived in step 1). Landings of all target species within each target fishery are derived for each vessel, period, and area by summing appropriately across species. Bycatch of each overfished species is estimated by multiplying total target species landings projected for each vessel in each target fishery, bimonthly period, and management area after the depth-based closures by the appropriate bycatch rate (derived in step 3). Total bycatch of each species is then estimated by summing appropriately across vessels, fisheries, periods, and areas.

Step 5 - Model Evaluation and Iteration

If either (i) projected landings of any target species (derived in step 2) exceeds the trawl landed OY for that species or (ii) projected bycatch of any overfished species (derived in step 4) exceeds the trawl bycatch OY for that species, target species bimonthly limits and/or depth closures are adjusted, and the model is rerun. Model iterations continue until all regulatory conditions are met. This iterative process is manual rather than automated.

Comments on Technical Merits and/or Deficiencies of the Bycatch Model

The bycatch model explicitly links groundfish policy instruments (bimonthly limits and depth closures) to the intended regulatory objective (ensuring that estimated bycatch of each overfished species does not exceed OY). The model is complex, reflecting the complexity of trawl regulations and fishing behavior. The detailed stratification of fishing activity - by vessel, bimonthly period, management area, target species, target fishery, and depth - reflects the demands that are placed on the model. The panel does not know if available data can support the level of stratification used in the model.

The effort redistribution formula used in the model is *ad hoc*. Furthermore, it will not be possible to assess the predictive ability of the redistribution formula even when 2003 logbook data become available, as the formula-generated harvest estimates are subject to bimonthly limit constraints before being converted into actual harvest projections. Use of the redistribution formula was prompted by recognition of the limited usefulness of recent historical data for predicting 2003 fishing activity, given the unprecedented depth-based closures implemented in that year. The formula is expected to be phased out, as fishticket and logbook data for 2003 and beyond become available.

The bycatch rates used in the model are selected by the Council from a range of rates derived from logbook, Pikitch, and EDCP data. Factors such as sample size, currency of the data used to estimate each rate, and historical performance of the rates in predicting retained bycatch are considered in the final selection of bycatch rates. These are all appropriate factors to consider. The manner in which the bycatch rates are selected is *ad hoc* and constrained by the limitations of existing data. It is not possible for the panel to directly evaluate the accuracy of the bycatch rates.

The model is deterministic (as opposed to stochastic) and does not include any explicit consideration of risk. Moreover, it is not possible for the panel to evaluate whether the model implicitly reflects any particular attitude toward risk. For instance, while the effort redistribution formula takes a "middle ground" in terms of assuming partial (rather than 0% or 100%) redistribution of effort from closed to open areas, it is not possible to know whether assuming a "middle ground" is risk neutral relative to the extent of the effort shift actually occurring as a result of the closures. A risk averse strategy would be to assume 100% redistribution of effort. The need to validate this and other model assumptions has not yet received any attention.

With regard to overall model performance, preliminary data from January through April 2002 suggest that the ability of the model to predict target species landings varies widely by species (Hastie, Table 7). The percent deviation between actual and projected landings ranges from –14% to +36%, with the notable exception of widow and yellowtail rockfish. The large deviations indicated for widow and yellowtail rockfish (-97% and -75% respectively) are due to the fact the 2002 bimonthly limits for these species were so low as to discourage targeted fishing. This result suggests the model is better suited to projecting landings associated with marginal changes in bimonthly limits than changes significant enough to affect the targeting behavior of the fleet.

A comparison of actual and projected cumulative landings of target species in 2002 (Hastie, Table 8) shows annual deviations ranging from -9% to +39%, suggesting a tendency for bimonthly deviations to even out over the course of the year. According to Dr. Hastie, actual landings of target species (even longspines, for which the model underestimates actual landings by 39%) were consistently lower than their respective OYs in 2002. This result is due largely to the effect of bycatch constraints on target fishery activity. The effect of errors in target species landings projections on bycatch estimates is difficult to evaluate and varies by species, depending on the extent to which each target species contributes to total landings in each target fishery and the bycatch rates associated with each fishery.

Hastie's Table 7 also provides a comparison of model projections of bycatch with bycatch estimates. The panel notes it is not possible to meaningfully evaluate the model's ability to predict total bycatch, as the bycatch estimates reported in the table combine "real world" data on bycatch landings with *ad hoc* assumptions regarding bycatch discard. Even the "real world" portion of bycatch cannot be compared against model projections, as model results cannot be disaggregated to distinguish between landings and discard of bycatch species.

The model should not be considered the only (or the best) modeling approach to estimating and monitoring bycatch. However, it is a reasonable approach, given the data and time constraints present at the time of model development and the unprecedented nature of the depth-based closures that the model attempts to address. *Due to the uncertainties surrounding the model and the bycatch rate assumptions, it is critical the model be validated against results from the early months of the 2003 fishery before being utilized in the 2004 management cycle. The lack of attention to methods of validating model assumptions and data must also be addressed with some urgency. Over the longer term, the panel recommends that an effort-based model be developed that explicitly considers the separate effects of changes in effort and catch per unit of effort (CPUE) on bycatch. As a first step, it is important the data requirements of such a model be identified and addressed.*

Comments on Technical Merits and/or Deficiencies of the Data

The bycatch model relies heavily on trawl logbook data. Trawl logbooks provide detailed tow-by-tow data that allow identification of the mix of fishing strategies pursued on a trip. Logbooks also provide depth data needed to evaluate effects of the depth-based closures implemented by the Council in 2003. Relative to other available historical sources of bycatch data (i.e., the Pikitch and EDCP studies), logbook data are collected on an ongoing annual basis and provide larger sample sizes and broader geographic coverage.

The logbooks also have their limitations. For instance, the logbook program is administered by the three states within their respective boundaries, and each state uses different procedures to adjust the hailed

weights reported in the logbooks. The logbooks provide information on retained bycatch, but not discards. While the logbooks include fields for the start and end location of tows, only the start location is entered into the database. Some inaccuracy in catch location can be expected, regardless of whether catch is characterized in terms of start or end location of the tow. It is not clear to the panel whether vessel operators would be able to provide more accurate information regarding location of catch on a tow-by-tow basis, although it was noted that operators who use net-mounted transducers know where the majority of their fish are caught.
The bycatch model relies on 1999-2001 fishticket data to characterize baseline trawl fishing activity by vessel, target species, target fishery, bimonthly period, and management area. While fishtickets are a useful source of information on target fishery, logbooks would be a more discriminating source of information, as the tow-by-tow data contained in the logbooks would allow the assignment of multiple target strategies to a single trip. Dr. Hastie indicates the use of logbooks to evaluate target strategy is a high priority for further model development.

The bycatch model relies on 1999 logbook data to estimate the depth distribution of landings. The use of more recent years of logbook data would be better suited for ensuring the bycatch model captures recent behavior of the fleet with regard to depth of landings.

Data from the 1999 logbooks, the 1995-1998 EDCP study and the 1985-1987 Pikitch study were used to establish an initial range of bycatch rates for further consideration by the GMT and Council. The use of pre-2000 data as a starting point for determining appropriate bycatch rates for the current fishery is problematic, given the significant changes that have occurred in terms of regulations (reduced cumulative limits, small footrope restriction) and the types of fishing opportunities and incentives faced by the fleet. The use of 1999 logbook data to estimate bycatch rates is necessitated by the fact that 1999 is the most recent year in which cumulative limits were sufficiently high to allow estimation of bycatch rates. However, unlike the EDCP and Pikitch data, which include information on both landings and discards, it is significant to note that only landings (not discards) are reported in the logbooks. The magnitude of the introduced error and its effect on logbook-derived bycatch rates is unknown.

Integrating Model and Data from Observer Program

The West Coast Groundfish Observer Program is intended to collect data on discards, not retained catch. Although the observer program was not originally designed to provide input to the bycatch model (which did not exist at the time the program was initiated), observer data will be an important input into the bycatch model as they become available.

Since the objective of the observer program is to provide data on discarded catch only, reconstruction of bycatch rates by target fishery requires information on retained catch. Retained catch is available from (1) observer-recorded hailed weights, (2) fishtickets, (3) unadjusted logbook data, and (4) fishticket-adjusted logbook data. Adjusted logbook data are the preferred source of information on retained catch.

Evaluation of the number of observed tows, trips, and vessels in 2001 and 2002 (Appendix C) indicates relatively sparse coverage in many model strata. In some cases the lack of coverage may be attributed to little or no fishing effort in the stratum. Reliance on observer data to estimate bycatch rates will require a strategy for combining data across strata when sample sizes are inadequate to support an estimate for an individual stratum.

A number of opportunities exist for collapsing target fishery and season strata to increase the sample size within strata, including (1) eliminating the arrowtooth target strategy, (2) combining periods 1 and 6 for the petrale sole target, and (3) combining several periods to estimate bycatch for the DTS target in the winter season. Given the limited targeting opportunities under the current management system, another alternative is to dispense with target fishery strata entirely and collapse the model to deep and shallow water strata in the north and south.

With regard to the specific issue of seasonal aggregation, the panel suggests the following approaches:

- Combining data across all periods and estimating an annual bycatch rate.

- Combining data from adjacent periods as needed.

- Applying the seasonal pattern of bycatch in the 1999 logbook data to the annual rate.

Although each of these alternatives has some merit, the panel is reluctant to recommend a preferred method without seeing a comparison of the seasonal bycatch patterns that are produced by each method. The panel recommends a comparison of this type be conducted, based on a minimum sample size of two vessels and 10 tows per stratum.

As a follow-up to this workshop, the panel recommends the SSC do the following: (1) review the sampling protocol used in the observer program, (2) evaluate how to best integrate the observer data into the bycatch model, and (3) provide advice regarding the issue of small observer sample sizes in the context of the stratification used in the bycatch model. One task specific to (3) would be to review the comparison of seasonal bycatch patterns associated with the three alternative approaches identified above for obtaining bycatch rates for strata without sufficient observer data. Dr. Hastie has agreed to perform this comparison for the SSC.

As more observer data become available, consideration should be given to whether data from only the most recent year should be used, or whether data from previous years should also be used. There is a tradeoff between increasing the sample size (and precision) of bycatch rate estimates by including more years of data versus the potential of estimating bycatch rates that do not reflect current conditions. If multiple years of data are needed to obtain sufficiently precise bycatch rates, a weighting scheme with more weight on the most recent data should be considered, such as a running average or an exponentially weighted average.

Recommendations for Bycatch Estimation in 2003 and Beyond

Inseason Management in 2003

For inseason management in 2003, the panel recommends the current model be used, with potential adjustment of historical vessel landings and/or bycatch rates to bring the projected inseason landings into agreement with fishticket and observer data. Any adjustment of model bycatch rates should be presented to the SSC for review and comment, along with a comparison of model-projected inseason landings with actual landings of target species and all bycatch species managed under rebuilding plans.

2004 and Beyond

1. *As soon as feasible, the panel recommends the bycatch rates currently used in the model be replaced with rates from the observer program, in accordance with guidance provided by the SSC.* Since the observer program is intended to provide estimates of discarded catch only, reconstruction of bycatch rates by target fishery will also require information on retained catch. *The panel recommends state agencies give high priority to making 2002 fishticket-adjusted logbook data available by April of 2003, so bycatch rates can be estimated for the 2004 management cycle using the 2002 observer data in combination with the best available estimates of retained catch. Timely availability of adjusted logbook data will continue to be important in future years.*

2. The bycatch model currently defines the baseline level of fishing trips and assigns landings of target species to a target fishery on the basis of 1999-2001 fishticket data. *The panel recommends target fishery assignments be based on the most recent years of logbook data, as the tow-by-tow data contained in the logbooks provide greater discrimination than the fishtickets in terms of allowing for multiple target strategies on a single trip.*

3. The bycatch model currently relies on 1999 logbook data to estimate the depth distribution of landings. *The panel recommends the three most recent years of available logbook data be used to estimate*

depth distribution. The depth distribution should be updated each year with the most currently available logbook data.

4. Until logbook data for 2003 (the first year of the depth-related closures) become available, it will be necessary to continue relying on the effort redistribution formula, in combination with pre-2003 logbook data, to project fishery participation and depth distribution of harvest. The effort distribution formula is *ad hoc* and cannot be independently validated. Even if the formula provides a reasonable depiction of effort redistribution between 2002 and 2003, the formula is likely to become more outdated the longer it is used, as fishermen displaced from closed areas become more adept at operating in open areas. The panel notes that 2003 logbook data (because they represent actual behavior after the depth-based closures) will likely provide a much better basis for predicting future bycatch than an untestable redistribution formula. The potential repercussions of delay in receipt of 2003 logbook data may be exacerbated by the shift to multi-year management of the groundfish fishery. Specifically, unless the 2003 logbook data become available early enough in 2004 to affect Council deliberations for the 2005-2006 management cycle, the Council's ability to take advantage of information contained in the 2003 data would be limited to inseason adjustments until the 2007-2008 management cycle. *The panel recommends fishticket-adjusted logbooks for 2003 be made available by April of 2004 to allow information pertaining to fishing behavior after the Council's depth-based closures to be incorporated into the bycatch model in time for the 2005-2006 management cycle. Timely receipt of logbook data (as well as fishticket data) is both an immediate and ongoing need.*

5. The bycatch model is an empirical model with critical *ad hoc* assumptions. The only possible test of the model is how well the model predicts what actually occurs. Once the changes to the bycatch model recommended by this panel for the 2004 management cycle are made (e.g., use of 1999-2001 logbook data to assign harvest to target fisheries and estimate the depth distribution of harvest, use of fishticket-adjusted observer data rather than 1999 logbook data to estimate bycatch rates), the model should be run with the depth closures and cumulative limits in effect in 2003. *Model results should be compared with actual harvest levels from the early months of 2003 and correction factors applied, as appropriate, to calibrate the model for 2004.*

6. *The choice of bycatch rates is a technical, not a policy, decision. This decision should be made by the GMT, in consultation with the GAP, and subject to the approval of the SSC.*

Other Research and Data Recommendations

1. The three states use different procedures for adjusting hailed weights in the trawl logbooks. *These adjustment procedures should be evaluated in terms of their comparability and potentially differential effects on bycatch estimation results.*

2. The effort redistribution formula used in the bycatch model is actually a catch redistribution formula that reflects the combined effects of changes in effort and CPUE. The validity of the formula cannot be tested. As suggested above, dynamic optimization models and discrete choice models are potentially useful frameworks for evaluating the effects of depth-based area closures; such models are based on testable hypotheses and can be used to distinguish the separate effects of closures on effort and CPUE. Explicit consideration of effort effects will make the model more transparent in terms of fleet behavior assumptions and thus facilitate the ability of the industry to make concrete suggestions for model improvement. Explicit consideration of CPUE effects will allow the effect of changes in stock abundance and environmental factors to be reflected in the model. *The panel recommends that suitable optimization models be devised, and the data needed to estimate such models be collected, so model development can proceed*.[1/]

3. Uncertainty in the bycatch rates obtained from the observer program should be evaluated using bootstrap variance estimates. In order for this type of analysis to be feasible, it will be necessary to eliminate the *ad hoc* features of the current bycatch model and recast the model into an automated

2/ Babcock and Pikitch (2000) and the papers presented at the October 2002 NMFS Social Science Workshop in Silver Spring, Maryland may provide a useful starting point for model development.

framework. *Dealing with uncertainty should be an important consideration in future development of the bycatch model.*

4. Optimization models may be useful for identifying and evaluating a broad range of management alternatives for consideration by the Council. For instance, such models may facilitate evaluation of alternative combinations of depth-based closures and bimonthly limits relative to Council objectives. While no single model outcome or single objective is expected to be the deciding factor in setting regulations, models of this type may enhance the ability of the Council to identify a broad range of regulatory options and anticipate the effects of these options in a more systematic and transparent manner. *The panel recommends development of such models as a long term research goal.*

5. While the focus of this panel has been on evaluation and improvement of bycatch estimates for the limited entry trawl fleet, it is important to note that trawlers account for a minor portion of the harvest of some overfished species (e.g., bocaccio, lingcod). *The panel recommends a technical review of procedures and data currently used to account for total catch by recreational, fixed gear, and open access sectors of the groundfish fishery be undertaken in the near future, and solutions be devised to address whatever deficiencies may exist in such procedures and data.*

6. Some modification of existing recreational sampling procedures and design of new procedures will be occurring as a result of the ongoing reorganization of Recreational Fishery Information Network (RecFIN). *The panel recommends that all recreational fishery sampling protocols be designed to produce statistically valid estimates of total catch, and sound procedures be devised to ensure appropriate calibration in transitioning from current to future data collection and estimation methods.*

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ATTACHMENT 1

Terms of Reference for the January Bycatch Workshop
December 5, 2002

Introduction

In 2001, the Natural Resources Defense Council (NRDC) filed a lawsuit against the U.S. Secretary of Commerce that successfully challenged the adequacy of the bycatch rates used by the Pacific Fishery Management Council (Council) in setting annual specifications for the groundfish fishery in 2001. The Council's Groundfish Management Team (GMT) subsequently developed and documented a bycatch model that was intended to enhance the transparency and accuracy of its bycatch estimation methods. The details of this new model were discussed at a September 25, 2001 GMT meeting attended by other interested parties - including representatives from the NRDC and the Council's Scientific and Statistical Committee (SSC). This model was used to set annual specifications for the 2002 fishery.

Partway through the 2002 season, amid concerns regarding premature attainment of the bocaccio OY and to ensure the OY for darkblotched rockfish would not be exceeded prior to the end of the season, the Council imposed inseason adjustment measures on the groundfish fishery in the form of depth-based area closures. Area closures of this type will continue to be a key element of groundfish fishery management in 2003 and beyond. In order to improve its ability to conduct preseason evaluation of the effects of such closures on bycatch and discards, the GMT incorporated a number of new features into the 2002 bycatch model - including calibration of bycatch rates to depth strata and a behavioral response formula that predicts the redistribution of trawl effort and catch associated with area closures. At the Council's September 2002 meeting, the SSC noted the briefing it had received regarding this revised bycatch model was only the first step toward a comprehensive evaluation of the type of bycatch estimation methodology that will be required in conjunction with the depth-based area closures being utilized by the Council. The SSC offered to organize a bycatch model review panel that would, (1) review the methodological aspects of the bycatch model and (2) make recommendations regarding how new observer data being gathered by the NMFS Northwest Fisheries Science Center (NWFSC) would be incorporated into the bycatch model.

A panel will convene during January 27-29, 2003 in Seattle, Washington to be briefed on the nature and status of the new observer data, to formally review all elements of the bycatch model, and to recommend an approach for incorporating the new observer data (as the data become available) into the bycatch model. The panel will include two members each from the SSC Economics Subcommittee, the SSC Groundfish Subcommittee, the GMT, the Groundfish Advisory Subpanel (GAP), and independent experts. The chair of the SSC Economics Subcommittee will chair the panel. The NWFSC, Fishery Regulation Assessment Model (FRAM) Division will be responsible for the overall logistics of the meeting and for obtaining the services of the independent experts as panel members. Dr. Ed Waters will be the primary Council staff contact for the panel.

Terms of Reference for the Bycatch Model Review Panel

1. **Briefly review existing literature and methodologies for estimating bycatch rates and discards, including the use of observer data.** Methodologies reviewed should include, at least, the study by Pikitch *et al.* (1988), and previous work based on the Enhanced Data Collection Project (EDCP) and trawl logbook data. Summaries of these approaches and documentation of how these approaches have been used for management should be made available to all panel members by Friday January 17, 2003.

2. **Review documentation, code, and results for the bycatch model.** Complete documentation of the bycatch model should be available to all panel members by Friday January 17, 2003. The documentation should contain the following:

   (a) An introductory section that briefly reviews past work. Review of past work should include an overview of the 2001 version of the bycatch model, how it was used for management, and a table that compares results of its predictions for 2002 with observed data for the 2002 season.

(b) A data section that thoroughly describes all sources of data used in the bycatch model, for example fishticket and logbook data.
(c) A section on model structure that clearly identifies and describes all of the model's assumptions, including behavioral assumptions such as those pertaining to effort shifts. The section on model structure should clearly describe how the data are stratified for purposes of the model, and identify how target strategies are associated with individual tows in model runs.
(d) A results section that presents baseline results of the model, including estimates of bycatch rates and discards, in a tabular format, that facilitates comparison with results from other analyses.
(e) A section on sensitivity analysis of the bycatch model that presents results with variations and perturbations in model inputs from baseline levels. At a minimum, the sensitivity analysis should include at least two variations from baseline levels for bycatch rates in particular strata and the parameter values used in the power function that determines shifts in fishing effort. A clear rationale for the particular scenarios should be provided.
(f) A discussion section that summarizes results, including a qualitative discussion of uncertainty that relates explicitly to the sensitivity analysis, and an outline of next steps to be taken with the bycatch model, including a proposal for incorporating the observer data.
(g) A references section that lists citations for all relevant literature.
(h) An appendix to the model documentation that contains a thoroughly commented printout of the model code.
(i) A second appendix that describes all input data files, including field descriptions for the records in each of the files, and contains sample printouts with the format for each of the input data files.
(j) A third appendix that describes model outputs, including descriptions of each field in all output files, and contains sample printouts with the format of each output file.

3. **Review status of NMFS West Coast observer data and coverage.** The observer data is anticipated to be work in progress at the time of the workshop, and final results are not expected. A progress report on the observer data should be available to all panel members by Monday January 27, 2003. The report should include the following elements:

   (a) A description of how the observer data are collected, descriptions of fields in the observer data, the strata sampled, and summary statistics for each of the fields and strata in the data;.
   (b) Maps delineating the exact geographical area covered by the observer data overlaid with maps of the areas closed by the Council's 2003 management specifications.
   (c) Problems encountered while compiling the observer data, with any suggestions for avoiding these problems in the future.
   (d) A schedule for next steps including the anticipated date for completing work with the observer data and when the data will be available for the bycatch model.

4. **Review proposals for incorporating observer data into the 2003 bycatch model.** Alternative proposals for incorporating the observer data into the bycatch model should be considered and discussed.

5. **Provide a report for the Council.** A comprehensive report that clearly documents the findings and recommendations of the review panel and describes research and data needs will be made available to the Council, SSC, GMT, GAP, and other advisory bodies following the workshop. The rapporteurs and workshop chair will have primary responsibility for writing the report. A draft of the report should be prepared before the end of the workshop on January 29, so that all panelists will have an opportunity to comment before adjourning.

Because a major focus of the panel will be the behavioral response of the fleet to area-based regulations, and because the GMT and GAP representatives have significant expertise in this area, the GMT and GAP representatives will be co-equal voting members of the panel. The opinions and views of all panelists will be weighted equally in the determination of final outcomes. The panel will be responsible for determining whether the terms above are met by (i) the bycatch model document, and (ii) the progress report on the observer data. The panel should strive to reach consensus on these items and a recommended approach for using the bycatch model with the observer data. If the panel cannot reach consensus for any reason, the nature of the disagreement must be described in the panel's report.

These Terms of Reference concern technical aspects of the bycatch model, the observer data, and use of the observer data with the bycatch model. The panel will strive for a risk-neutral approach in its report and deliberations. A reasonable range of uncertainty should be reflected in the bycatch model documentation and the report prepared by the panel. Recommendations and requests to the presenters and other participants at the panel meeting for additional or revised analyses must be clear, explicit, and in writing. A written summary of discussion on significant technical points and lists of all panel recommendations and requests are required in the panel report. The report should be completed, at least in draft form, prior to the end of the meeting. The chair and rapporteurs are responsible for carrying out any follow-up work to complete the panel's report.

Draft Agenda

Monday January 27

10:00-10:15	Welcome, introductions, and logistics
10:15-10:30	Review terms of reference, approve agenda, assign rapporteurs
10:30-12:00	Presentations on existing methodologies for estimating bycatch rates and discards
12:00-1:00	Lunch
1:00-3:00	Presentation of bycatch model
3:00-4:30	Discussion of bycatch model and methodologies
4:30-5:00	Instructions to model authors regarding overnight model runs
5:00-5:30	Review of rapporteur notes on bycatch model

Tuesday January 28

8:00-9:00	Review revisions and discussion of bycatch model
9:00-11:00	Draft report on bycatch model
11:00-12:00	Presentation of observer data
12:00-1:00	Lunch
1:00-2:00	Discussion of observer data
2:00-3:00	Presentation of proposal for incorporating observer data into bycatch model
3:00-4:30	Discussion of proposal for incorporating observer data into bycatch model
4:30-5:00	Review of rapporteur notes on observer data and proposal

Wednesday January 29

8:00-10:00	Review revisions and discussion
10:00-11:00	Draft report on observer data
11:00-12:00	Draft report on proposal for incorporating observer data into bycatch model
12:00-1:00	Lunch
1:00-3:30	Review reports
3:30-4:30	Summarize research and data needs and finalize reports
4:30	Adjourn

PFMC
03/25/03