APPENDIX 3

TERMS OF REFERENCE FOR A CPS STOCK ASSESSMENT REVIEW PROCESS

TERMS OF REFERENCE FOR A COASTAL PELAGIC SPECIES
STOCK ASSESSMENT REVIEW PROCESS
APRIL 2003

Introduction

The purpose of this document is to help the Council family and others understand the coastal pelagic stock assessment review process (STAR). Parties involved are the National Marine Fisheries Service (NMFS); state agencies; the Council and its advisors, including the Scientific and Statistical Committee (SSC), Coastal Pelagic Species Management Team (CPSMT), Coastal Pelagic Species Advisory Subpanel (CPSAS), Council staff; and interested persons. The STAR process is a key element in an overall process designed to make timely use of new fishery and survey data, to analyze and understand these data as completely as possible, to provide opportunity for public comment, and to assure the results are as accurate and error-free as possible. The STAR process is designed to assist in balancing these somewhat conflicting goals of timeliness, completeness and openness.

Stock assessments for Pacific sardine and Pacific mackerel are conducted annually to assess the abundance, trends and appropriate harvest levels for these species.[1/] Assessments use statistical population models to analyze and integrate a combination of survey, fishery, and biological data. At its November 2001 meeting, the SSC reported that

> *The Coastal Pelagic Species Management Team (CPSMT) has recommended a peer review process for the coastal pelagic species similar to the groundfish STAR process. The CPSMT suggests that full sardine and Pacific mackerel stock assessments and reviews be conducted on a triennial cycle, with a less formal review by the CPSMT and SSC during interim years. Full stock assessment reports would be developed and distributed following each STAR Panel review. Details from interim-year assessments could be documented in executive summaries similar to the one produced for this year's (2001) sardine assessment. As entirely new assessments are developed, a STAR Panel would be convened to review the assessment prior to implementation of results for setting harvest guidelines. The SSC supports the CPSMT's proposal.*

1/ Stock assessments are conducted for species "actively" managed under the Coastal Pelagic Species Fishery Management Plan (FMP). That is, fisheries for Pacific sardine and Pacific mackerel are actively managed via annual harvest guidelines and management specifications, which are based on current stock assessment information. Jack mackerel, Northern anchovy, and market squid are "monitored" species under the FMP. Annual landings of these species are monitored and reported in the annual Stock Assessment and Fishery Evaluation (SAFE) report, but harvest guidelines are not set for them.

At its June 2002 meeting, the SSC further noted that the methodology on which the 2002 Pacific mackerel stock assessment was based...

> *is not fully documented in the Stock Assessment and Fishery Evaluation (SAFE) report precluding a detailed review by the SSC at this time. The SSC recommends the methodology be reviewed in detail by a stock assessment review panel in 2003. The CPS subcommittee of the SSC will develop Terms of Reference for such a review if it is supported and funded. The timing of any review needs to be coordinated with the timing of the groundfish Stock Assessment Review (STAR) Panels for 2003.*

Clearly there is a need to develop and implement a stock assessment and review (STAR) process for coastal pelagic species similar to that for groundfish. The first and most pressing candidates are Pacific sardine and Pacific mackerel.

Pacific sardine is now, along with Pacific whiting, the most abundant fish resource off the West Coast; at one time sardine was the largest single-species fishery in the world, yet the research program for supporting sardine assessment is seriously under funded and under reviewed. The current fishery independent surveys only provide indices of sardine egg abundance and daily egg production. The aerial fish spotter index (used as a measure of sardine recruitment) only covers the nearshore areas of the southern California Bight and, more recently, spotter effort has been at negligible levels as spotter pilots have focused on other non-CPS fisheries. The adult parameters used in recent biomass estimates are computed on the basis of biological data collected in 1994, at a time when the population was one-tenth of the 2002 biomass. The data sources for sardine are limited to geographic areas off Baja California, Mexico, and the State of California (particularly the area from San Diego to Monterey Bay). A migration model parameterized with historical estimates of sardine migration rates is used to extrapolate the stock assessment to the northern areas of the sardine distribution. With the recent expansion of the sardine population off Oregon, Washington, and British Columbia, there is an urgent need to incorporate fishery-dependent data for northern areas into the stock assessment and to initiate resource surveys to establish a fishery-independent time series for those areas.

The same can be said for Pacific mackerel. The 2002 harvest guideline (HG) was based on the same stock assessment methodology and harvest control rule used in 2001, with the addition of one additional year's data. Compared with the 2001 assessment, the biomass time series for the 2002 assessment was 14% lower over the last decade, and the July 1, 2001 biomass, a projection in the 2001 assessment, 30% lower. The methodology on which this (current) assessment is based is not fully documented in the SAFE report precluding a detailed review by the SSC. Therefore, in 2002 the SSC recommended (June 2002 minutes) that the methodology be reviewed in detail by a stock assessment review panel as soon as possible.

STAR Goals and Objectives

The goals and objectives for the CPS assessment and review process[2] are:

a. Ensure that CPS stock assessments provide the kinds and quality of information required by all members of the Council family.

b. Satisfy the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and other legal requirements.

c. Provide a well-defined, Council oriented process that helps make CPS stock assessments the "best available" scientific information and facilitates use of the information by the Council. In this context, "well-defined" means with a detailed calendar, explicit responsibilities for all participants, and specified outcomes and reports.

d. Emphasize external, independent review of CPS stock assessment work.

e. Increase understanding and acceptance of CPS stock assessment and review work by all members of the Council family.

f. Identify research needed to improve assessments, reviews and fishery management in the future.

g. Use assessment and review resources effectively and efficiently.

Shared Responsibilities

All parties have a stake in assuring adequate technical review of stock assessments. NMFS must determine that the best scientific advice has been used when it approves fishery management recommendations made by the Council. The Council uses advice from the SSC to determine whether the information on which it will base its recommendation is the "best available" scientific advice. Fishery managers and scientists providing technical documents to the Council for use in management need to ensure the work is technically correct. Program reviews, in-depth external reviews, and peer-reviewed scientific publications are used by federal and state agencies to provide quality assurance for the basic scientific methods used to produce stock assessments. However, the time-frame for this sort of review is not suited to the routine examination of assessments that are, generally, the primary basis for a harvest recommendation.

The review of current stock assessments requires a routine, dedicated effort that simultaneously meets the needs of NMFS, the Council, and others. Leadership, in the context of the stock assessment review process for CPS species, means consulting with all interested parties to plan, prepare terms of reference, and develop a calendar of events and a list of deliverables. Coordination means organizing

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2/ In this document, the term "stock assessment" includes activities, analyses, and management recommendations, beginning with data collection and continuing through to the development of management recommendations by the Coastal Pelagic Species Management Team and information presented to the Council as a basis for management decisions.

and carrying out review meetings, distributing documents in a timely fashion, and making sure that assessments and reviews are completed according to plan. Leadership and coordination both involve costs, both monetary and time, which have not been calculated, but are likely substantial.

The Council and NMFS share primary responsibility to a successful STAR process. The Council will sponsor the process and involve its standing advisory committees, especially the SSC. The chair of the SSC CPS subcommittee will coordinate, oversee and facilitate the process. Together they will consult with all interested parties to plan, prepare terms of reference, and develop a calendar of events and a list of deliverables. NMFS and the Council will share fiscal and logistical responsibilities.

The CPS STAR process is sponsored by the Council, because the Federal Advisory Committee Act (FACA) limits the ability of NMFS to establish advisory committees. FACA specifies a procedure for convening advisory committees that provide consensus recommendations to the federal government. The intent of FACA was to limit the number of advisory committees; ensure that advisory committees fairly represent affected parties; and insure that advisory committee meetings, discussions, and reports are carried out and prepared in full public view. Under FACA, advisory committees must be chartered by the Department of Commerce through a rather cumbersome process. However, the Magnuson-Stevens Act exempts the Council from FACA per se, but requires public notice and open meetings similar to those under FACA.

CPS STAR Coordination

The SSC CPS subcommittee chair will work with the Council, Council staff, other agencies, groups or interested persons that carry out assessment work to coordinate and organize Stock Assessment Team (STAT) Teams and STAR Panels, and make sure that work is carried out in a timely fashion according to the calendar and terms of reference.

The SSC CPS Subcommittee chair, in consultation with the SSC, will select STAR Panel chairs, and will coordinate the selection of external reviewers following criteria for reviewer qualifications, nomination, and selection. The public is welcome to nominate qualified reviewers. Following any modifications to the stock assessments resulting from STAR Panel reviews and prior to distribution of stock assessment documents and STAR Panel reports, the coordinator will review the stock assessments and panel reports for consistency with the terms of reference, especially completeness. Inconsistencies will be identified. Authors will be requested to make appropriate revisions in time to meet the deadline for distributing documents for the CPSMT meeting at which HG recommendations are developed.

Individuals (employed by NMFS, state agencies, or other entities) that conduct assessments or technical work in connection with CPS stock assessments are responsible for ensuring their work is technically sound and complete. The Council's review process is the principal means for review of complete stock assessments, although additional in-depth technical review of methods and data is desirable. Stock assessments conducted by NMFS, state agencies, or other entities must be completed and reviewed in full accordance with the terms of reference, at times specified in the

calendar.

CPSMT Responsibilities

The CPSMT is responsible for identifying and evaluating potential management actions based on the best available scientific information. In particular, the CPSMT makes HG recommendations to the Council based on agreed control rules. The CPSMT will use stock assessments, STAR Panel reports, and other information in making their HG recommendations. Preliminary HG recommendations will be developed by the CPSMT according to the management process defined in Council Operating Procedures (COP-9). A representative of the CPSMT will serve as a liaison to each STAR Panel, but will not serve as a member of the Panel. The CPSMT will not seek revision or additional review of the stock assessments after they have been reviewed by the STAR Panel. The CPSMT chair will communicate any unresolved issues to the SSC for consideration. Successful separation of scientific (i.e., STAT Team and STAR Panels) from management (i.e., CPSMT) work depends on stock assessment documents and STAR reviews being completed by the time the CPSMT meets to discuss preliminary HG levels. However, the CPSMT can request additional model projections, based on reviewed model scenarios, in order to develop a full evaluation of potential management actions.

CPSAS Responsibilities

The chair of the CPSAS will appoint a representative to participate at the STAR Panel meeting. The CPSAS representative will participate in review discussions as an advisor to the STAR Panel, in the same capacity as the CPSMT advisor.

The CPSAS representative will attend the CPSMT meeting at which preliminary HG recommendations are developed. The CPSAS representative will also attend subsequent CPSMT, Council, and other necessary meetings.

The CPSAS representative will provide appropriate data and advice to the STAR Panel and CPSMT and will report to the CPSAS on STAR Panel and CPSMT meeting proceedings.

SSC Responsibilities

The SSC will participate in the stock assessment review process and provide the CPSMT and Council with technical advice related to the stock assessments and the review process. The SSC will assign one member from its CPS Subcommittee to each STAR Panel. This member is expected to attend the assigned STAR Panel meeting, the CPSMT meeting at which HG recommendations are made, and the Council meetings when CPS stock assessment agenda items are discussed. The SSC representative on the STAR Panel will present the STAR Panel report at CPSMT, SSC and Council meetings. The SSC representative will communicate SSC comments or questions to the CPSMT and STAR Panel chair. The SSC will review any additional analytical work on any of the stock assessments required or carried out by the CPSMT after the stock assessments have been reviewed by the STAR Panels. In addition,

the SSC will review and advise the CPSMT and Council on harvest guideline recommendations.

The SSC, during their normally scheduled meetings, will serve as arbitrator to resolve disagreements between the STAT Team, STAR Panel, or CPSMT. The STAT Team and the STAR Panel may disagree on technical issues regarding an assessment. In this case, a complete stock assessment must include a point-by-point response by the STAT Team to each of the STAR Panel recommendations. Estimates and projections representing all sides of the disagreement need to be presented, reviewed, and commented on by the SSC.

Council Staff Responsibilities

Council staff will prepare meeting notices and distribute stock assessment documents, stock summaries, meeting minutes, and other appropriate documents. Council staff will assist in coordination of the STAR process. Staff will also publish or maintain file copies of reports from each STAR Panel (containing items specified in the STAR Panel's term of reference), the outline for CPS stock assessment documents, comments from external reviewers, SSC, CPSMT, and CPSAS, letters from the public, and any other relevant information. At a minimum, the stock assessments (STAT Team reports, STAR Panel reports, and stock summaries) should be published and distributed in the Council's annual CPS SAFE document.

Terms of Reference for STAR Panels and Their Meetings

The principal responsibility of the STAR Panel is to carry out the following terms of reference. The STAR Panel's work includes:

1. reviewing draft stock assessment documents and any other pertinent information (e.g.: previous assessments and STAR Panel reports, if available);
2. working with STAT Teams to ensure assessments are reviewed as needed;
3. documenting meeting discussions; and
4. reviewing summaries of stock status (prepared by STAT Teams) for inclusion in the SAFE document.

STAR Panels normally include a chair, at least one "external" member (i.e., outside the Council family and not involved in management or assessment of West Coast CPS), and one SSC member. The total number of STAR members should be at least "n+2" where n is the number of stock assessments and "2" counts the chair and external reviewer. In addition to Panel members, STAR meetings will include CPSMT and CPSAS advisory representatives with responsibilities laid out in their terms of reference.

STAR Panels normally meet for one week.

The number of assessments reviewed per Panel should not exceed two.

The STAR Panel is responsible for determining if a stock assessment document is sufficiently complete.

It is the Panel's responsibility to identify assessments that cannot be reviewed or completed for any reason. The Panel's decision that an assessment is complete should be made by consensus. If a Panel cannot reach agreement, then the nature of the disagreement must be described in the Panel's report.

The STAR Panel's terms of reference concern technical aspects of stock assessment work. The STAR Panel should strive for a risk neutral approach in its reports and deliberations. Confidence intervals of indices and model outputs, as well as other measures of uncertainty that could affect management decisions, should be provided in completed stock assessments and the reports prepared by STAR Panels. The STAR Panel should identify scenarios that are unlikely or have a flawed technical basis.

Recommendations and requests to the STAT Team 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 STAR Panel recommendations and requests to the STAT Team are required in the STAR Panel's report. This should be completed (at least in draft form) prior to the end of the meeting. It is the chair and Panel's responsibility to carry out any follow-up review work that is required.

Additional analyses required in the stock assessment should be completed during the STAR Panel meeting. If follow-up work by the STAT Team is required after the review meeting, then it is the Panel's responsibility to track STAT Team progress. In particular, the chair is responsible for communicating with all Panel members (by phone, email, or any convenient means) to determine if the revised stock assessment and documents are complete and ready to be used by managers in the Council family. If stock assessments and reviews are not complete at the end of the STAR Panel meeting, then the work must be completed prior to the CPSMT meeting where the assessments and preliminary HG levels are discussed.

The STAR Panel, STAT Team, and all interested parties are legitimate meeting participants that must be accommodated in discussions. It is the STAR Panel chair's responsibility to manage discussions and public comment so that work can be completed.

STAT Teams and STAR Panels may disagree on technical issues. If the STAR Panel and STAT Team disagree, the STAR Panel must document the areas of disagreement in its report. The STAR Panel may request additional analysis based on alternative approaches. Estimates and projections representing all sides of the disagreement need to be presented in the assessment document, reviewed, and commented on by the SSC. It is expected that the STAT Team will make a good faith effort to complete these analyses.

The SSC representative on the STAR Panel is expected to attend CPSMT and Council meetings where stock assessments and harvest projections are discussed to explain the reviews and provide other technical information and advice.

The chair is responsible for providing Council staff with a camera ready and suitable electronic version

of the Panel's report for inclusion in the annual SAFE report.

Suggested Template for STAR Panel Report

- Minutes of the STAR Panel meeting, including name and affiliation of STAR Panel members.
- List of analyses requested by the STAR Panel.
- Comments on the technical merits and/or deficiencies in the assessment and recommendations for remedies.
- Explanation of areas of disagreement regarding STAR Panel recommendations:
  - among STAR Panel members (majority and minority reports), and
  - between the STAR Panel and STAT Team.
- Unresolved problems and major uncertainties, (e.g., any special issues that complicate scientific assessment, questions about the best model scenario).
- Prioritized recommendations for future research and data collection.

Terms of Reference for CPS STAT Teams

The STAT Team will carry out its work according to these terms of reference.

Each STAT Team will appoint a representative to coordinate work with the STAR Panel and attend the STAR Panel meeting.

Each STAT Team will appoint a representative who will attend the CPSMT, CPSAS, and Council meetings where preliminary harvest levels are discussed. In addition, a representative of the STAT Team should attend the CPSMT and Council meeting where final HG recommendations are developed, if requested or necessary. At these meetings, the STAT Team member shall be available to answer questions about the STAT Team report.

The STAT Team is responsible for preparing three versions of the stock assessment document, (1) a "draft" for discussion at the stock assessment review meeting; (2) a revised "complete draft" for distribution to the CPSMT, CPSAS, SSC, and Council for discussions about preliminary harvest levels; (3) a "final" version published in the SAFE report. Other than authorized changes, only editorial and other minor changes should be made between the "complete draft" and "final" versions. The STAT Team will distribute "draft" assessment documents to the STAR Panel, Council, and CPSMT and CPSAS representatives at least two weeks prior to the STAR Panel meeting.

The STAT Team is responsible for bringing computerized data and working assessment models to the review meeting in a form that can be analyzed on site. STAT Teams should take the initiative in building and selecting candidate models. If possible, the STAT Team should have several complete models and be prepared to justify model recommendations.

The STAT Team is responsible for producing the complete draft by the end of the STAR Panel meeting. In the event that the complete draft is not completed, the Team is responsible for completing

the work as soon as possible and to the satisfaction of the STAR Panel at least one week before the CPSMT meeting.

The STAT Team and the STAR Panel may disagree on technical issues regarding an assessment, but a complete stock assessment must include a point-by-point response by the STAT Team to each of the STAR Panel recommendations. Estimates and projections representing all sides of the disagreement need to be presented, reviewed, and commented on by the SSC.

Electronic versions of final assessment documents, parameter files, data files, and key output files will be provided to Council staff.

Appendix A: Outline for CPS Stock Assessment Documents

This is an outline of items that should be included in stock assessment reports for CPS managed by the Pacific Fishery Management Council. The outline is a working document meant to provide assessment authors with flexible guidelines about how to organize and communicate their work. All items listed in the outline may not be appropriate or available for each assessment. In the interest of clarity and uniformity of presentation, stock assessment authors and reviewers are encouraged (but not required) to use the same organization and section names as in the outline. It is important that time trends of catch, abundance, harvest rates, recruitment and other key quantities be presented in tabular form to facilitate full understanding and followup work.

1. Title page and list of preparers (the names and affiliations of the stock assessment team (STAT) either alphabetically or as first and secondary authors)

2. Executive Summary (this also serves as the STAT summary included in the SAFE)

3. Introduction
   a. Scientific name, distribution, stock structure, management units
   b. Important features of life history that affect management (e.g., migration, sexual dimorphism, bathymetric demography)
   c. Important features of current fishery and relevant history of fishery
   d. Management history (e.g., changes in management measures, harvest guidelines)
   e. Management performance – a table or tables comparing annual biomass, harvest guidelines, and landings for each management subarea and year

4. Assessment
   a. Data
      i. Landings by year and fishery, catch-at-age, weight-at-age, survey and CPUE data, data used to estimate biological parameters (e.g., growth rates, maturity schedules, and natural mortality) with coefficients of variances (CVs) or variances if available. Include complete tables and figures if practical
      ii. Sample size information for length and age composition data by area, year, etc.

   b. History of modeling approaches used for this stock – changes between current and previous assessment models

   c. Model description
      i. Complete description of any new modeling approaches
      ii. Assessment program with last revision date (i.e., date executable program file was compiled)
      iii. List and description of all likelihood components in the model
      iv. Constraints on parameters, selectivity assumptions, natural mortality, assumed level of

age reader agreement or assumed ageing error (if applicable), and other assumed parameters
v. Description of stock-recruitment constraint or components
vi. Critical assumptions and consequences of assumption failures
vii. Convergence criteria

d. Model selection and evaluation
   i. Evidence of search for balance between realistic (but possibly over-parameterized) and simpler (but not realistic) models
   ii. Use hierarchical approach where possible (e.g., asymptotic vs. domed selectivities, constant vs. time varying selectivities)
   iii. Do parameter estimates make sense, are they credible?
   iv. Residual analysis (e.g., residual plots, time series plots of observed and predicted values, or other approach)
   v. Convergence status and convergence criteria for "base-run(s)"
   vi. Randomization run results or other evidence of search for global best estimates

e. Base-run(s) results
   i. Table listing all parameters in the stock assessment model used for base runs, their purpose (e.g., recruitment parameter, selectivity parameter) and whether or not the parameter was actually estimated in the stock assessment model
   ii. Time-series of total and spawning biomass, recruitment and fishing mortality or exploitation rate estimates (table and figures)
   iii. Selectivity estimates (if not included elsewhere)
   iv. Stock-recruitment relationship

f. Uncertainty and sensitivity analyses
   i. The best approach for describing uncertainty and range of probable biomass estimates in CPS assessments may depend on the situation. Possible approaches include:
      A. Sensitivity analyses (tables or figures) that show ending biomass levels or likelihood component values obtained while systematically varying emphasis factors for each type of data in the model
      B. Likelihood profiles for parameters or biomass levels may also be used
      C. CVs for biomass estimated by bootstrap, implicit autodifferentiation, or the delta method
      D. Subjective appraisal of magnitude and sources of uncertainty
      E. Comparison of alternate models
      F. Comparison of alternate assumptions about recent recruitment
   ii. If a range of model runs (e.g., based on CV's or alternate assumptions about model structure or recruitment) is used to depict uncertainty, then it is important that some qualitative or quantitative information about relative probability be included. If no statements about relative probability can be made, then it is important to state that all scenarios (or all scenarios between the bounds depicted by the runs) are equally likely

iii. If possible, ranges depicting uncertainty should include at least three runs: (a) one judged most probable; (b) at least one that depicts the range of uncertainty in the direction of lower current biomass levels; and (c) one that depicts the range of uncertainty in the direction of higher current biomass levels. The entire range of uncertainty should be carried through stock projections and decision table analyses
iv. Retrospective analysis (retrospective bias in base model or models for each area)
v. Historic analysis (plot of actual estimates from current and previous assessments for each area)
vi Simulation results (if available)

5. Harvest Control Rules

Pacific Sardine

The CPS FMP defines the maximum sustainable yield (MSY) control rule for Pacific sardine. This formula is intended to prevent Pacific sardine from being overfished and maintain relatively high and consistent catch levels over a long-term. The harvest formula for sardine is:

HG = (TOTAL STOCK BIOMASS - CUTOFF) • FRACTION • U.S. DISTRIBUTION,

where harvest guideline (HG) is the total U.S. (California, Oregon, and Washington) harvest recommended for the next fishing year, TOTAL STOCK BIOMASS is the estimated stock biomass (ages 1+) from the current assessment, CUTOFF is the lowest level of estimated biomass at which harvest is allowed, FRACTION is an environment-based percentage of biomass above the CUTOFF that can be harvested by the fisheries, and U.S. DISTRIBUTION is the percentage of TOTAL STOCK BIOMASS in U.S. waters.

The value for FRACTION in the MSY control rule for Pacific sardine is a proxy for F_{MSY} (i.e., the fishing mortality rate that achieves equilibrium MSY). Given F_{MSY} and the productivity of the sardine stock have been shown to increase during relatively warm-water ocean conditions, the following formula has been used to determine an appropriate (sustainable) FRACTION value:

$$\text{FRACTION or } F_{MSY} = 0.248649805(T^2) - 8.190043975(T) + 67.4558326,$$

where T is the running average sea-surface temperature at Scripps Pier, La Jolla, California during the three preceding years. Under the harvest control rule, F_{MSY} is constrained and ranges between 5% and 15% depending on the value of T. Based on the T values observed throughout the period covered by this stock assessment (1983-2002), the appropriate F_{MSY} exploitation fraction has consistently been 15%; and this remains the case under current oceanic conditions (T_{2002} = 17.3 °C). However, it should be noted that the decline in sea-surface temperature observed in recent years (1998-2002) may invoke environmentally-based reductions in the exploitation fraction in the near future and could substantially reduce the harvest guideline.

The harvest guideline recommended for the U.S. (California, Oregon, and Washington) Pacific sardine

fishery for 2003 was 110,908 mt.

Pacific Mackerel

The CPS FMP defines the MSY control rule for Pacific mackerel as:

HG = (BIOMASS-CUTOFF) x FRACTION x STOCK DISTRIBUTION,

where HG is the U.S. harvest guideline, CUTOFF (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed, FRACTION (30%) is the fraction of biomass above CUTOFF that can be taken by fisheries, and STOCK DISTRIBUTION (70%) is the average fraction of total BIOMASS in U.S. waters.

CUTOFF and FRACTION values applied in the Council's harvest policy for mackerel are based on simulations published by MacCall et al. in 1985. BIOMASS is the estimated biomass of fish age 1 and older for the whole stock as of July 1. As for Pacific sardine, FRACTION is a proxy for F_{MSY}.

Based on this formula and current BIOMASS of 77, 516 mt, the HG for the July 1, 2002 - June 30, 2003 season was 12,456 mt. The recommended harvest guideline was 1,381 mt lower (-10%) than the 2001-2002 HG, but similar to the average yield (14,053 mt) realized by the fishery since the 1992-1993 season.

6. Target Fishing Mortality Rates (if changes are proposed)

7. Harvest Projections and Decision Tables

   a. Harvest projections and decision tables should cover the plausible range of uncertainty about current biomass and the full range of candidate fishing mortality targets used for the stock or requested by the CPSMT. Ideally, the alternatives described in the decision table will be drawn from a probability distribution which describes the pattern of uncertainty regarding the status of the stock and the consequences of alternative future management actions. Where alternatives are not formally associated with a probability distribution, the document needs to present sufficient information to guide assignment of approximate probabilities to each alternative

   b. Information presented should include biomass and yield projections for at least three years into the future, beginning with the first year for which management action could be based upon the assessment

8. Management Recommendations

9. Research Needs (prioritized)

10. Acknowledgments (include STAR Panel members and affiliations as well as names and affiliations of persons who contributed data, advice or information but were not part of the assessment team)

11. Literature Cited

12. Complete Parameter Files and Results for Base Runs