RESEARCH AND DATA NEEDS

2000-2002

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ACKNOWLEDGMENTS

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LIST OF ACRONYMS AND ABBREVIATIONS

ADMB	Auto-Differentiation Model Builder
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CDFG	California Department of Fish and Game
Council	Pacific Fishery Management Council
CPS	coastal pelagic species
CPUE	catch per unit of effort
CWT	coded-wire tag
EFH	essential fish habitat
FMP	fishery management plan
GLM	Generalized Linear Models
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MSY	maximum sustainable yield
NEV	net economic value
NMFS	National Oceanic and Atmospheric Administration
PacFIN	Pacific Coast Fisheries Information Network
POP	Pacific Ocean perch
PSMFC	Pacific States Marine Fisheries Commission
RecFIN	Recreational Fishery Information Network
SSC	Scientific and Statistical Committee
STAR Panel	Stock Assessment Review Panel
STAT	Stock Assessment Review Team
WDFW	Washington Department of Fish and Wildlife

EXECUTIVE SUMMARY

Council research and data needs are updated on a biennial cycle. This document presents a compilation of high priority data needs for the Pacific Fishery Management Council (Council) for the 2000 through 2002 cycle. As these data needs are identified for 2000 through 2002, the Council is completing work on a long-run strategic planning effort. Upon completion of the long-run strategic plan, it may be appropriate that this document be reviewed midcycle to ensure that it is consistent with and acts in concert with the strategic plan. Data needs are categorized by fishery management plan plus economic needs and needs related to marine reserves. The three to five highest priority items for each category are identified with the aid of a set of ranked criteria developed by the Scientific and Statistical Committee (SSC). Items in the section on "General Data Collection" are not included in the summarized priorities. In this summary the criteria are presented, followed by the highest priority needs in each category.

CRITERIA

1. **Projects address long-term fundamental problems of West Coast fisheries.**

2. **Projects improve the quality of information, models, and analytical tools used for biological assessment and management.**

3. **Projects increase the long-run market competitiveness and economic profitability of the industry.**

4. **Projects contribute to the understanding by decision makers of social and economic implications in meeting biological and conservation objectives.**

5. **Projects provide data and/or information to meet the requirements of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), the Regulatory Flexibility Act, and other applicable laws.**

HIGHEST PRIORITY NEEDS

Economic, Socioeconomic, and Social

- **Comparative analysis of limited access and rights-based management programs in the context of West Coast fisheries.**

- **Baseline description of the fishing industry and communities (combined with) periodic assessment of "status of the fisheries."**

- **Economic and social analysis of groundfish and salmon harvest and management strategies.**

- **Recreational fishery net economic value and angler participation models.**

Groundfish Fishery Management Plan

- **Establish a West Coast coordinator** to identify and prioritize stock assessment information needs, to track programs that fulfill those needs and to facilitate establishment of new programs to address unmet needs. This coordinator would report status of biological data collection activities to the Council, with emphasis on anticipated deficiencies identified with respect to stock assessment and management needs.

- **Develop and implement a coastwide multi-state system for electronic recording of fishticket information and fishery logbooks in consistent form.**

- **Develop methods, programs, or analytical tools to quantify amount of groundfish discarded by the various fishing sectors** to estimate total harvest removals for control of total harvest and stock assessments. Evaluate alternative methods of estimating and reducing discard rates.

- **Continue to work on a plan to conduct annual resource surveys** to meet shortcomings identified by the 1995 review of West Coast stock assessments. This includes establishing infrastructure, a role for cooperative opportunities with industry, survey staff, and analytical teams required to produce timely results from the surveys, so that they are incorporated into stock assessments as early as possible. Surveys should cover the full range of the fish distributions to the extent practical and should be coordinated with Canada.

- **Investigate impact of fishing gear on specific habitats and habitat productivity on the West Coast fishing grounds.** From existing and new sources, assemble information on fishing activities for each gear type to prioritize gear research by gear, species, and habitat type. Information on the extent of fishing impacts on the productivity of fishing ground bottom habitat is important to goals of ecosystem management.

Salmon Fishery Management Plan

- **A more accurate assessment of total fishing related mortality of natural stocks of coho and chinook.** Fishery management regimes designed to reduce impacts through nonretention or selective fishing depend for success on unbiased estimates of noncatch mortality.

- **Advances in genetic stock identification, otolith marking, and other techniques may make it feasible to use a variety of stock identification technologies to assess fishery impacts and migration patterns.** The increasing necessity for weak-stock management puts a premium on the ability to identify naturally reproducing stocks and stocks that contribute to fisheries at low rates. The coded-wire tag (CWT) marking system is not suitable for these needs. The Council should encourage efforts to apply these techniques to management.

- **Encourage development of probabilistic habitat-based models that incorporate environmental variation to establish harvest policies and enable risk assessment for fishing strategies.** Overfishing definitions are required to relate to a measure of maximum sustainable yield (MSY). MSY for salmon is related to productivity, which varies annually in freshwater and the marine environment. Techniques for evaluating productivity, or survival, in freshwater and marine habitats are needed to set appropriate harvest targets and associated conservation guidelines such as escapement floors and overfishing definitions.

At final adoption, the Council identified four additional salmon research and data needs that have high priority status (1) "Run Size Predictors" under "Planning Tools" on page 15; (2) "Selective Fisheries" under "Alternative Management Strategies" on page 16; "Limiting Factors" under "Life History Studies" on page 17; and (4) "Genetics" under "Hatchery/Wild Interactions" on page 17.

Coastal Pelagic Species Fishery Management Plan

- Gain more information about the status of the coastal pelagic species (CPS) resource in the north using egg pumps used during National Marine Fisheries Service (NMFS) surveys, sonar surveys, spotter planes.

- Develop a coastwide (Mexico to British Columbia, Canada) synoptic survey of sardine biomass, i.e., coordinate a coastwide sampling effort (during a specified time period) to reduce "double-counting" caused by migration.

- Evaluate the role of CPS resources in the ecosystem, the influence of climatic/oceanographic conditions on CPS; predatory/prey relationships. Increase the use of fishery information to estimate seasonal reproductive output of stock (e.g., fat/oil content).

Marine Reserves

- **Information on the location of current harvest** relative to a proposed marine reserve area is needed in order to begin to evaluate the degree of impact and effectiveness of the creation of marine reserves. Most harvest information currently collected is not on a fine enough geographic scale to use for evaluation of marine reserves.

- **Information on advection of eggs and larva and pre-settlement juveniles.** Particularly emphasis on differences between areas upstream and downstream of major geographical features. This will primarily be a physical oceanographic exercise.

- **Information on the movement of juveniles and adults.** This will primarily be a literature search followed by a biological field program. Little is known about the movement of post settlement juveniles.

- **Knowledge of when in the life cycle density dependent effects occur** is important in the assessment of the effects of marine reserves (as it is in assessing conventional catch management).

- **Increased biological monitoring of existing marine reserves** and other areas of restricted fishing in order to gain information on current reserves that might be extrapolated to evaluate the creation of additional reserves on the West Coast.

INTRODUCTION

Council research and data needs are updated on a biennial cycle. This document presents a compilation of high priority data needs for the Pacific Fishery Management Council (Council) for the 2000 through 2002 cycle. As these data needs are identified for 2000 through 2002, the Council is completing work on a long-run strategic planning effort. Upon completion of the long-run strategic plan, it may be appropriate that this document be reviewed midcycle to ensure that it is consistent with and acts in concert with the strategic plan.

The recent re-authorization of the Magnuson-Stevens Act (Magnuson-Stevens Act) added directives to 1) prevent overfishing, 2) rebuild depressed fish stocks to levels of abundance that produce MSY, 3) develop standardized reporting methodologies to assess the amount and type of bycatch, 4) adopt measures that minimize bycatch and bycatch mortality, to the extent practicable, 5) describe and identify essential fish habitat (EFH), and 6) assess the impact of human activities, including fishing impacts, on habitat. The Magnuson-Stevens Act encourages the participation of the fishing industry in fishery research. Additionally, Standard 8 mandates consideration of effects of fishery management measures on communities. These directives require substantial expansion of the data collection and research efforts required to support Council management of West Coast fisheries.

This document is a compilation of research and data needed by the Council to implement its responsibilities as defined by the Magnuson-Steven Act, the Regulatory Flexibility Act, and other pertinent legislation. In addition to an annotated list of "high priority needs", the SSC has chosen three to five "highest priority needs" in five categories 1) economic, socioeconomic, and social; 2) groundfish fishery management plan (FMP); 3) salmon FMP; 4) CPS FMP; and 5) marine reserves. These highest priority needs are highlighted in the introduction to each section. Following is the set of criteria used to identify the highest priority needs.

The following ranked criteria were used to guide the selection and prioritization of research and data projects:

1. **Projects address long-term fundamental problems of West Coast fisheries.**

2. **Projects improve the quality of information, models, and analytical tools used for biological assessment and management.**

3. **Projects increase the long-run market competitiveness and economic profitability of the industry.**

4. **Projects contribute to the understanding by decision makers of social and economic implications in meeting biological and conservation objectives.**

5. **Projects provide data and/or information to meet the requirements of the Magnuson-Stevens Act, the Regulatory Flexibility Act, and other applicable laws.**

All research and data projects listed in this document are considered either "high priority" needs or "highest priority needs" according to their ability to meet the criteria listed above.

GENERAL DATA COLLECTION

Fishery Information Networks

Funding of the Pacific Coast Fisheries Information Network (PacFIN) and Recreational Fishery Information Network (RecFIN) databases will continue to be high priority for the Council. While the PacFIN database was designed to support the groundfish FMP through the provision of data on the commercial fishery, the Council also relies on the database in fulfilling other management responsibilities.   As assessments are developed and management concerns arise regarding stocks targeted by sport fisheries, information provided by RecFIN will become more important in supporting the Council's conservation and allocation decisions.   There is a need to increase sampling levels in the RecFIN project in order to develop estimates that are more reliable at a finer geographic and species scale. A finer scale, however, is necessary, but not sufficient; some modifications of current RecFIN sampling procedures may also be needed. PacFIN and RecFIN projects are also important sources of data for economic and social analyses. Failure to maintain these databases could significantly disrupt Council management.

Economic Data Plan

The Council has adopted a plan that specifies how the collection and dissemination of economic data related to West Coast fisheries might be coordinated.   Continued development of a coordinated effort for the collection of economic data for West Coast fisheries is a high priority. The data needs covered by this plan include commercial enterprise operations and capital costs (harvesters, processors, and charter vessels), value and expenditure information on recreational fishers, and economic/socioeconomic information on fishing communities. Additional efforts need to be undertaken to implement the coordination aspects of the plan.   Funding needs to be maintained for the Pacific States Marine Fisheries Commission (PSMFC) project to collect and manage economic data for the commercial fisheries and for the RecFIN socioeconomic add-on survey.

Other Fishery Sampling Programs

The Sport Fish Restoration Act, Anadromous Fish Act, and Interjurisdictional Fisheries Act all provide funds which support the vast majority of groundfish, salmon, and pelagic fish sampling programs conducted by the member states. Decreases in the funds provided through these legislative initiatives and the Pacific Salmon Treaty threaten the collection of vital information used in Council management. Some of the data collected in these sampling programs are central to the FIN databases discussed above (e.g., catch composition break downs for data that are aggregated on fishtickets).

Access to Alaska Fishticket Data

Alaska fishticket data are available to analysts for work on North Pacific Fishery Management Council issues, but may not be used by those same analysts to work on Pacific Fishery Management Council issues.   Access to these data for work in support of the Pacific Fishery Management Council is necessary to fully understand the activities of vessels which participate in West Coast and Alaska fisheries and to assess the response to and impacts of West Coast regulations.

Coordination of Economic and Biological Data Collection

Any plans for new efforts to collect biological or economic fishery-dependent data or plans for modification of existing programs should be coordinated with the economic data collection program being coordinated through PSMFC with the cooperation of NMFS.   Efforts to collect fishery-dependent data can benefit from

the economic perspective provided by the program and, where warranted and appropriate, serve as vehicles to assist in the collection of additional economic data.

Fishticket Data

Economic data on fishtickets are inadequate. Needed improvements include better recording of codes for condition, species, price, disposition, and gear type. A "days fished" field is provided and used by some states for salmon fishtickets. Such a field should be added to fishtickets for use in other fisheries or possibly a field for start date for the trip.

Improved Data Capture

Evaluate feasibility of alternative technologies for rapid and accurate capture of logbook and other real-time fishery data. Approaches might include optical scanning (such as is currently being used in California) and data entry at the processor and vessel level.

GENERAL ANALYTICAL NEEDS

General Ocean Productivity

Resources under Council jurisdiction respond to large shifts in ocean productivity. For instance, growth and recruitment of rockfish, ocean survival of salmon and the relative abundance of coastal pelagic species responded to the major North Pacific climate shift in the late 1970s. In addition, year to year patterns in fishery production tend to show similarities across species FMP groups. These holistic resource responses need to be assessed and incorporated into the management process.

Assessment of Enforcement Effectiveness

Assess the effectiveness of enforcement to evaluate which management measures are working. Identify areas where the management system may be resulting in the under reporting of landings.

ECONOMIC, SOCIOECONOMIC, AND SOCIAL DATA COLLECTION AND RESEARCH

Marine and anadromous fisheries are managed under a complex set of goals and objectives related to preserving the resource and meeting the needs of the fishing industry, consumers, and fishing communities. The common property nature of the resource combined with public goals and objectives results in regulations that are greater in number and more intrusive than for many other industries. A consequence of the intense regulatory environment is a greater need for economic analysis and information, compared to less regulated industries. The Magnuson-Stevens Act, Regulatory Flexibility Act, National Environmental Policy Act, and executive orders (EO), such as EO 12886 on Federal Regulations, all require consideration of economic impacts of government regulations. The demand for economic analysis and information becomes even more acute when allocation issues are involved. The widening gap between fishing capacity and allowable harvest has Increasing fishing capacity and declines in various fish stocks have resulted in an increasing number of management actions with direct and indirect allocation implications. Failure to adequately consider economic effects of regulations can result in lawsuits challenging the regulations.

Based on the criteria listed in the introduction of this document, **the following economic projects were selected as highest priority needs:**

- **Comparative analysis of limited access and rights-based management programs in the context of West Coast fisheries.**

- **Baseline description of the fishing industry and communities (combined with) periodic assessment of "status of the fisheries."**

- **Economic and social analysis of groundfish and salmon harvest and management strategies.**

- **Recreational fishery net economic value and angler participation models.**

These highest priority needs and other high priority needs are described below in more detail.

Data Collection

Social Data. An effort is needed to identify types of social analysis that may assist in fishery management decisions and to identify any data collection programs that should be initiated to support such analyses over the long-term, particularly regarding impacts on coastal communities. Based on the provisions of the Magnuson-Stevens Act and NMFS guidelines, determine what information is needed for decision making, then determine data and research needed to produce that information.

Baseline Description of the Fishing Industry and Communities. Develop a baseline description of the fishing industry and communities which are affected by Council-managed fisheries, including vessel characteristics, fishing strategies, catch mixes, and vessel mobility for both commercial vessels and recreational charter vessels. Based on the provisions of the Magnuson-Stevens Act and NMFS guidelines, determine what information is needed for decision making, then determine data and research needed to produce that information. This information would be useful in developing assessments of possible responses to closures or other regulatory constraints and for maintaining the Fishery Economic Assessment Model used for development of income impact assessments. For the commercial fishery significant progress is being made in this area through work ongoing under the PSMFC cost-earnings project. A project has been initiated for charter vessels and needs to be completed. Information is needed on the full range of commercial activities that might be undertaken by recreational charter vessels along different areas of the coast.

Socioeconomic Baseline Profiles of the Fishing Industry and Fishing Communities. Socioeconomic baseline studies need to be developed for the fishing industry including various gear groups (e.g., trawl, pot, hook and line), allocative sectors, (commercial and recreational) and fishing communities. Based on the provisions of the Magnuson-Stevens Act, Regulatory Flexibility Act, and NMFS guidelines, determine what socioeconomic information is needed for decision making by the Council, then determine data and research needed to produce that information.

Analysis

Comparative Analysis of Limited Access And Rights-Based Management Programs in the Context of West Coast Fisheries. Comparative analyses of existing limited access programs (including but not limited to license limitation, community development quotas, and individual quota programs) are needed to 1) understand their effects on management objectives including conservation, income distribution, efficiency, safety, enforcement costs, and management costs; 2) address long-run allocation problems including allocation between gear types and the recreational and commercial sectors; and, 3) increasing direct involvement of industry in research and management.

Periodic Assessment of "Status of the Fisheries." An annual or semi-annual analysis of "status" of Council-managed fisheries is needed to determine whether fisheries are meeting stated management objectives. Analysis would include economic, social, and conservation objectives. Economic analysis would include quantitative measures including profitability, jobs, and income.

Economic and Social Analysis of Groundfish and Salmon Management Strategies. Conduct economic and social analysis of alternative roundfish and salmon management strategies. For salmon this analysis should include 1) the potential economic and social implications of watershed-based management approaches; 2) the costs and benefits of alternative hatchery practices; 3) the costs and benefits of alternative harvest strategies; and 4) cost-effective analysis to meet objectives stemming from achieving biological objectives (e.g., Endangered Species Act) and treaty rights obligations. For groundfish, this analysis should include the costs and benefits of alternative harvest and management strategies, including capacity reduction.

Economic Analysis of Marine Reserves. Marine Reserves are being proposed as tools for fisheries management and science. There are many alternative designs which could be appropriate depending on management/science objectives and biological/ecological characteristics of the resource. Economic-policy analysis is needed for developing efficient and/or cost effective designs which reveal tradeoffs associated with 1) design elements, 2) ecological characteristics, and 3) management objectives.

Economic Analysis of Alternative Programs to Document, Analyze, and Reduce (Regulatory) Discards. There are many programs being proposed to document harvests and/or reduce discards. The potential costs of some programs may exceed benefits. Economic analysis is needed to evaluate alternative programs and potential for realizing program objectives.

Economic Analysis of Management Approaches Which Increase Fishery Stability and Reduce Harvest Variability. Stability in management and harvests can provide economic benefits to industry and communities. However, it may also generate costs associated with decreases in average harvests. Economic analysis is needed to evaluate the potential benefits and costs of alternative management strategies to reduce harvest variability.

Economic Analysis to Improve the Effectiveness of Fishery Science. The mandates of Sustainable Fisheries Act and the existing paucity of data relevant to fisheries increase the need for additional research. Scientific budgets, however, remain limited. Economic analysis is needed to assist in prioritizing research needs and evaluating alternative science approaches including collaboration with industry, nongovernment organizations, state agencies, and universities. Such analysis would be critical for designing and implementing a comprehensive and coordinated research and data plan.

Analysis to evaluate extent of overcapacity in the charter vessel fleet. A survey will be conduced in 2001 that may facilitate this analysis.

Modeling

Documentation of the Fishery Economic Assessment Model. The Fishery Economic Assessment Model generates income impact estimates used by the Council. There is a continuing need to collect and document expenditure information for the commercial and recreational fisheries. New commercial data should be forthcoming from the PSMFC economic data collection project.

Development of Industry Response Models. Participation models need to be developed to project industry responses to alternative management regulations. Some elements necessary for development of these models are identified above as separate needs. These elements are fishing cost and revenue information and baseline descriptions of the fishing industry. The participation models need to be considered when cost and revenue information collection plans and baseline descriptions are developed in order to ensure the data collected and baselines are useful for the participation model. Participation models are also needed to predict the effect of management measures on angler effort and harvest in the groundfish fishery and ocean and inriver components of the salmon fishery.

Recreational Fishery Net Economic Value and Angler Participation Models. A review of currently available estimates of net economic value (NEV) is needed for the salmon, groundfish, and halibut recreational fisheries. The need for information on groundfish fisheries may become particularly acute if the Council pursues development of allocations for the recreational fisheries in conjunction with the development of a groundfish trawl buyback program. Information is needed on the relationship of angler trip NEV to mode of fishing (private vessel, charter vessel, and bank fishing), success rates, retention opportunities and limits, and species caught. Studies of both ocean and inriver components of the salmon fishery, the rockfish, and the lingcod fisheries are of most immediate importance. Information on substitution rates between recreational activities is also needed as well as information on the net economic value generated by recreational fishing on charter vessels for each target species.

GROUNDFISH FISHERY MANAGEMENT PLAN

Recent increases in federal funding and scientific personnel, specifically for groundfish, have improved the outlook for enhancing monitoring, resource surveys, and research activities directed at stock assessments.   Improvements and expansion of groundfish surveys are underway and will include increased participation of the fishing industry.   Magnuson-Stevens Act directives require expansion of the West Coast stock assessment research effort to improve scientific information for groundfish management, specifically, additional effort is necessary to better quantify species abundance, to evaluate overfishing levels and rebuilding plans, to address bycatch, and to reduce the magnitude of bycatch in groundfish fisheries.   The challenge will be to expand survey effort using new designs and the existing fleet of West Coast fishing vessels to meet the high priority needs and generate information that can quickly be incorporated into the stock assessment process.

Groundfish research and data needs are broad, and efforts to address these needs may compete or overlap. In order to assure that the resources available for meeting these needs are utilized in an efficient and effective manner, **a plan is needed for the development of research and data collection projects.**   This plan should include specific projects as well as mechanisms for coordination and development of an ongoing interagency program for addressing West Coast groundfish research and data needs.

The top five highest priority groundfish management plan research and data needs are:

- **Establish a West Coast coordinator** to identify and prioritize stock assessment information needs, to track programs that fulfill those needs and to facilitate establishment of new programs to address unmet needs.   This coordinator would report status of biological data collection activities to the Council, with emphasis on anticipated deficiencies identified with respect to stock assessment and management needs.

- **Develop and implement a coastwide multistate system for electronic recording of fishticket information and fishery logbooks in consistent form.**

- **Develop methods, programs, or analytical tools to quantify amount of groundfish discarded by the various fishing sectors** to estimate total harvest removals for control of total harvest and stock assessments. Evaluate alternative methods of estimating and reducing discard rates.

- **Continue to work on a plan to conduct annual resource surveys** to meet shortcomings identified by the 1995 review of West Coast stock assessments.   This includes establishing infrastructure, a role for cooperative opportunities with industry, survey staff, and analytical teams required to produce timely results from the surveys, so that they are incorporated into stock assessments as early as possible.   Surveys should cover the full range of the fish distributions to the extent practical and should be coordinated with Canada.

- **Investigate impact of fishing gear on specific habitats and habitat productivity on the West Coast fishing grounds.**   From existing and new sources, assemble information on fishing activities for each gear type to prioritize gear research by gear, species, and habitat type. Information on the extent of fishing impacts on the productivity of fishing ground bottom habitat is important to goals of ecosystem management.

Species specific groundfish research and data are provided in Appendix A. The Council's high priority and immediate groundfish research and data needs have been divided into five categories:

Fishery Monitoring and Data Collection. One of the most important Council needs is accurate assessment of total removals to estimate fishing mortality and accurate tally of fishery landings in-season. The benefits of fishing regulations cannot be evaluated unless there is good information on the effects of the regulation on

harvest. In-season monitoring of catch rates is necessary to ensure that harvests do not substantially deviate from target levels. Currently, the greatest concerns are accurate estimates of amounts of fish discarded in multispecies fisheries and unreported or under reported landings.

Resource Assessment Surveys. For the Council to set appropriate target harvest levels, accurate estimates of current biomass and size of incoming year classes for the groundfish resources are needed. Groundfish survey strategy is primarily based on a triennial schedule that includes a bottom trawl survey of the shelf resources and an acoustic/midwater trawl survey for Pacific whiting and an annual bottom trawl survey of slope resources. The bottom trawl survey design is inadequate for estimating many of the nearshore flatfish, does not extend beyond the shelf, and has too few stations to estimate shelf rockfish with the desired level of precision. Annual California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys off California, which have been used for coastal pelagic stocks, may have application to some groundfish stocks. An annual trawl survey of the slope groundfish resources using chartered commercial vessels is being conducted that is synoptic of the entire coast. Data from this survey will become more useful as the time series becomes longer. With the expanding emphasis to improve the stock assessments for the groundfish, new opportunities and sampling technologies are becoming available to expand the survey frequency and areas and species not normally sampled by trawling.

Biological Information Including Fishery and Productivity Parameters. Assessment models of the productivity of the various groundfish stocks depends not only on good estimates of fishery catch by age and current estimates of biomass and recruitment, but also reliable parameter estimates of growth in length and weight, fecundity and sexual maturity, natural mortality, and differential location/movement by size, age, and sex. The data from which these parameters can be derived come from sampling of fish in commercial and recreational catches and survey catches. With possible expansion in survey activities and increased fishery sampling, there will be new opportunities to collect basic biological data to improve fishery and biological parameters needed for improving stock assessment modeling.

Stock Assessment Modeling. Development of reliable stock assessment models of the dynamics of the important fish stocks is critical to evaluating optimum yield and MSY control rules for species or species groups for managing annual fisheries. These model results are usually presented as updated stock assessment reports.

Habitat. The reauthorized Magnuson-Stevens Act established new priorities for the consideration of impacts on habitat. Additionally, the Council is moving forward on the development of marine reserves. More information is needed to understand the impacts of different fishing gears on habitat and the importance of different habitats and/or refugia for maintaining the fishery.

FISHERY MONITORING AND DATA COLLECTION

It is critical that the agencies maintain and expand a coastwide comprehensive fishery monitoring program. Ongoing monitoring of the fishery and collection of information is essential for effective management of the groundfish fishery, including sampling to determine species, size, and age composition of landings stratified by area and depth; effort levels by fishery, area, and/or gear type; landed value; etc. This information would improve both stock assessments and control of total harvest, and economic evaluation.

Review Data Collection Projects

Conduct a review of the main modeling methodologies, major data sources used for stock assessments (i.e., port samples, gear, and vessel information, age structures, etc.) and plans for future data collection. Set priorities for the most effective use of available personnel, equipment, and funds.

Establish a West Coast coordinator to identify and prioritize stock assessment information needs, to track programs that fulfill those needs and to facilitate establishment of new programs to address unmet needs. This coordinator would report status of biological data collection activities to the Council, with emphasis on anticipated deficiencies identified with respect to stock assessment and management needs.

Port Sampling

Monitor the effectiveness of port sampling efforts coastwide to ensure there are no major gaps in data, such that no major components of the landings and/or species go unsampled including the rapidly growing live-fish fishery, particularly in California. Maturity, average weight and age data need to be collected using a more systematic approach.
Evaluate the results of data collected to determine whether plant workers can, in a cost effective manner, collect representative samples to augment the port sampling program. Such in plant sample collection may particularly benefit species like Dover sole.

Expand monitoring for species, age and length composition by specific depth and area strata for important nearshore recreational fisheries and the growing hook-and-line fisheries (e.g., blackgill rockfish). In California, categorization of species for species composition sampling is inadequate for management purposes, and levels of sampling are sparse in some ports. Oregon has attempted to extend rockfish species composition sampling to miscellaneous gears, yet coverage remains low, and few biological samples are obtained. In Washington, longline, shrimp trawl, and miscellaneous gears are not sampled.

Reinstate sampling of flatfish age structures by the port sampling program. English sole and Petrale sole stock assessments could not be extended into California, because biological sampling of nearshore flatfish in California had not occurred.

Fishticket Data

Develop and implement a coastwide multistate system for electronic recording of fishticket information as part of a fully integrated fishery statistics program, including logbooks, observer program, and biological sampling.

Pursue coastwide standardized species and market categories on fishtickets and ensure states apply standard product recovery rates for dressed fish landings.

Improve the quality and coverage of all types of fisheries landing data particularly for southern rockfish and the two species of thornyhead rockfish.

Evaluate accuracy of current landings data and systematically eliminate significant sources of under-reporting. Receipt of premium fish by wholesale buyers in California is very different from the traditional landing of fresh fish. Most is purchased by dealers operating from trucks or vans equipped with live wells. Off-loading sites can be quite variable. This leads to a strong suspicion of under-reporting of landings.

Logbook Data

Continue development and implementation of a coastwide multistate system for electronic recording of fishery logbooks.

Develop a logbook system for nontrawl sectors of the fleet including recreational charter vessels for target species such as sablefish, lingcod, rockfish, and specifically for blackgill rockfish to generate an information base on spatial distribution of fishing effort and levels of catch per unit of effort (CPUE).

Continue evaluation of the use of trawl logbook data to measure relative abundance of groundfish. At the same time, conduct an evaluation of the current logbook data collection system including types of information related to fishing power (e.g., mesh size, head rope, and foot rope parameters, etc.). Continue to pursue programs such as the port interview program to gain additional insight on interpretation of the logbook data.

Refine and increase the number of species categories in logbooks to make reporting equivalent to species categories used in port samples and to facilitate integration of fish ticket, logbook, biological sample, and economic data.

Discard Data

Develop methods, programs, or analytical tools to quantify amount of groundfish discarded by the various fishing sectors, particularly the trawl fleet, to estimate total harvest removals for control of total harvest and stock assessments. Include an evaluation of a mandatory observer program and full retention program for all sectors of the fishing industry. Evaluate alternative methods of estimating discard rates against accurate observations made by observers.

Collect size frequency information for at-sea discards would be useful for some species (e.g., Petrale sole).

Continue examination of observer data from Oregon Trawl Commission/agency program for potential insight on the appropriateness of the assumed discard rates.

Continue laboratory and field research for sablefish, lingcod, halibut, and other critical species to document acute and chronic mortality of discarded and bycatch species by the various gear types, and develop improved field criteria for predicting the mortality of at-sea discards.

Management Approaches

Evaluate the extent to which proposed management measures minimize bycatch to the extent practicable, as per the national standards guidelines Section 600.350 (d)(3)). Regulations which induce discards should be evaluated to determine their effects on yield. Oregon Trawl Commission/Oregon Department of Fish and Wildlife observer data and PacFIN price and size data may be available for such an analysis.

Evaluate the effectiveness of revised recreational bag limits (black rockfish) and minimum size limits (lingcod) to accomplish their original intended purpose (should be undertaken prior to the next stock assessment).

Evaluate the current use of cumulative limits to achieve a year-round fishery and possibilities for developing alternative management approaches given the limitations on management resources, data, modeling, and enforcement. Provide scientific information to guide the development of alternative approaches such as individual quotas.

<div align="center">RESOURCE ASSESSMENT SURVEYS</div>

Develop and implement a cooperative agency/fishing industry plan to conduct annual resource surveys to meet shortcomings identified by the 1995 review of West Coast stock assessments. This includes establishing infrastructure, survey staff, and analytical teams required to produce timely results from the surveys, so that they are incorporated into stock assessments as early as possible. Surveys should

cover the full range of the fish distributions to the extent practical and should be coordinated with Canada. Surveys should be conducted in a manner that allows better definition of temporal patterns in spatial distribution.

Slope Surveys

For slope groundfish:

- Continue expanded *Miller Freeman* slope trawl survey to provide synoptic coverage and to calibrate and complement the survey being conducted using chartered commercial vessels.

- Continue the expanded annual synoptic slope trawl survey started in 1998 using commercial trawl vessels and standard gear. This survey should continue to collect biological information by depth as well as harvest rate information. (Slope trawl surveys should be coordinated with annual shelf trawl surveys).

- Establish regular pot or longline surveys for sablefish, conducted at appropriate depths and coordinated and standardized coastwide. Such a survey could also target thornyheads and grenadiers. Conduct this survey using industry vessels in conjunction with the research vessel *Miller Freeman* slope survey and the new cooperative trawl survey to calibrate the three surveys.

Shelf Surveys

For shelf groundfish and nearshore recreational species:

- Conduct an annual shelf bottom trawl survey (coordinated with slope trawl surveys). Include the entire California coast, along with Oregon and Washington. If the area south of Point Conception cannot be surveyed with trawl gear, institute a hook-and-line survey in the area. During development of the survey evaluate the adequacy of the methods for assessment of shelf flatfish stocks.
- Conduct annual whiting acoustic surveys. Measure in-situ target strength as a function of fish length for converting NMFS acoustic survey data to improve the estimates of whiting biomass and reduce uncertainty of the annual stock assessment results. There will be opportunities for collaborative work involving agencies in the U.S., the fishing industry, and Canadian scientists.

- Implement a periodic survey effort (depth and area specific) for important nearshore recreational species and flatfish stocks(coordinated with shelf surveys).

- Continue and expand annual recruitment surveys for juvenile sablefish, Pacific whiting, and rockfishes.

Alternative Survey Methodologies

- Evaluate feasibility of and develop as appropriate alternative survey methodologies for measuring abundance and distribution of groundfish, including egg and larval survey, visual, acoustic and laser systems.

- Develop improved survey methodologies for rockfish in untrawlable habitat. This is important for the northern Washington coast and southern California. Estimates of abundance for reef-oriented rockfish depend on information on available habitat and fish densities for specific habitat types. Existing survey methodologies, such as transect surveys using submersible vehicles or longlines could be applied on an expanded basis to estimate local fish densities. Side-scan sonar can map bottom habitat. Many of these species are now targeted by a growing hook-and-line fishery and are

vulnerable to over harvest due to their extreme longevity. This is important for yellowtail, widow, yelloweye, canary, blackgill, grass, gopher, china, and copper rockfishes.

Environmental Data Collection

Collect analyze and synthesize data to determine whether there have been long-term changes in productivity or recruitment relationships due to environmental changes. Collect oceanographic data to determine the relationship between oceanographic conditions and productivity and recruitment. Conduct filed studies to validate relationships. Equip cooperating trawlers with electronic oceanographic and environmental monitoring instruments to increase the amount of environmental data that can be correlated to the biological and fishery information.

Other Collection Tasks

Calibrate trawl surveys by estimating survey catchability coefficients (Q) to increase the accuracy of stock assessments, particularly those based on short time series.

Continue the Enhanced Data Collection Program and the Depth-Specific Sampling Project to meet the need for depth-specific biological samples for sablefish, thornyheads, and Dover sole.

Re-establish the northern Washington lingcod tagging project to improve annual estimates of lingcod recruitment, adult abundance, and mortality.

Develop an intensive sablefish tagging study to acquire information about migratory patterns, growth, mortality, and abundance. Re-establish cooperative U.S.-Canada tagging program for sablefish.

Consider a northward expansion of the CalCOFI ichthyoplankton surveys to estimate spawning biomass of slope species, nearshore flatfish, and, potentially, rockfish off central/northern California, Oregon, and Washington.

Continue the evaluation of Russian survey data related to Pacific Ocean perch (POP) and other slope rockfish.

Age Data

Validation. Age validation studies are important to assure the basic data used in stock assessments are accurate, particularly for species like shortspine thornyhead and bocaccio. Aging techniques routinely employed have not been researched and/or validated for many rockfish species. Radiometric studies of shortspine thornyheads should be continued, and tagging data should be collected for both shortspine thornyheads and bocaccio. Radiochemical dating is also needed for cowcod and blackgill rockfish otoliths. Conduct an interagency comparison of the reading of lingcod age structures to establish consistent aging criteria and validate annuli. Improper aging results in unreliable stock assessment data. Collaboration with Canadian efforts may be appropriate for some transboundary stocks.

Collection. Age composition data are critical to generate precise stock assessments with stock synthesis and other assessment models. Collection and analysis of coastwide age structure data from research surveys and commercial fishing needs to be expanded and continued for whiting, POP, chilipepper rockfish, lingcod, Petrale sole and other flatfish. There are species and areas in which the collection of age data is very incomplete, (e.g., sablefish dressed at sea and rockfish taken by nontrawl gear). Also, data on particular size ranges areis sparse for some species (e.g., small Petrale sole). For POP, resume the collection and reading of otoliths from the commercial fishery and re-read, if possible, pre-1983 otoliths using the break and burn technique. The frequency of the collection of flatfish otoliths from port samples has diminished and should be increased. There is a need to increase the amount of otoliths read per year to provide sufficient catch-at-age data and estimates of growth for groundfish stock assessments.

Stock Structure

Conduct research on the population genetic structure of groundfish stocks to monitor the long-term implications of management measures. In particular, the genetic structure of sablefish and many rockfish populations are largely unknown.

Evaluate implications of assessment and management boundaries at US-Canada border for species with transboundary distributions.

Species Group/Complex Specific Needs

Expand research on basic life history of the other nearshore groundfish stocks that are targeted by hook and line fisheries and recreational fisheries.

Biological information, including size and age sampling, is needed for the large majority of rockfish species. Standardized sampling methods and tools need to be developed for dockside handling of live fish, to quickly obtain measurement data without injury to the specimens.

For canary rockfish, thornyheads and POP laboratory-based histological examination of reproductive tissue would be useful for evaluating the visual determinations of maturity made by port biologists and determining the age of sexual maturity.

Place a high priority on conducting assessments for species that have not been previously assessed. Develop new models for species for which fishery-independent data are not available (e.g., nearshore rockfishes).

Localized Depletion

Localized depletion of groundfish stocks, especially Dover sole, shortspine and longspine thornyheads, black rockfish, may occur in areas where fisheries are concentrated. The use of area-specific harvest guidelines for these species should be evaluated.

Multispecies Management

Groundfish management must ultimately evolve to multispecies management. The need for management of this type is epitomized by the deepwater trawl fishery where sablefish, Dover sole, and thornyheads are the dominant species. To manage such an assemblage effectively, biological, oceanographic, and economic factors (including foreign markets) must be considered and melded into multispecies management plans and management models. A theoretical framework for assemblage management is needed. NMFS's program in Newport, Oregon, is focusing on the deepwater assemblage.

Harvest Policies and Biological Reference Points

Continue the evaluation of MSY control rules, biological reference points, spawner-recruit relationships and harvest policies used to make decisions about acceptable biological catch and harvest guideline/optimum yield for groundfish. This work is particularly important for groundfish with diverse or extreme life histories (e.g., Bocaccio rockfish and POP). The evaluation of the appropriate harvest policy may involve consideration of whether the fishery is being managed for commercial or recreational purposes and whether there have been long-term changes in productivity or recruitment relationships due to environmental changes.

Performance of Stock Assessment Models

Evaluate the statistical properties (i.e., bias, estimability, variance, etc.) of current stock assessment models used for groundfish. This should include an evaluation of the quality, quantity, and frequency of basic input data from fishery dependent (e.g., fishery age compositions) and independent sources (e.g., surveys).

Conduct field projects and modeling studies to determine which selectivity assumptions (dome shape vs. asymptotic) are most appropriate for the various groundfish stocks including lingcod and numerous species of rockfish with age structured assessment.

Conduct an evaluation of characteristic patterns of discrepancies in stock assessment retrospective analyses to develop a knowledge base for interpreting information in these patterns.

Decision Theory and Uncertainty Analysis

Evaluate how best to account for and present uncertainty in the results in all stock assessments.

Socioeconomic and Management Factors Affecting Assessment Data

Develop indices for monitoring and documenting market, fishery management, and other factors that may affect fishery dependent data which can be used in the annual stock assessments to improve interpretation of the results.

HABITAT

- Investigate impact of fishing gear on specific habitats on the West Coast fishing grounds. From existing and new sources, assemble information on fishing activities for each gear type to prioritize research by gear, species, and habitat type. Information on the extent of fishing impacts on the productivity of fishing ground bottom habitat is important to goals of ecosystem management.

- Test methods for reducing the impacts of gear on habitat.

- Map benthic habitats on spatial scales of the fisheries and with sufficient resolution to identify and quantify fish/habitat associations, fishery effects on habitat, and spatial structure of populations. Mapping of the rocky areas of the continental shelf is critical for the identification of the rocky shelf and nonrocky shelf composite EFHs.

- Identify habitat areas of particular concern: habitats that are rare, sensitive, and vulnerable to fishing and nonfishing effects. Identify associated life stages and their distributions, especially for species and life stages with level one (or no) information.

- Standardize methods, classification systems, and calibrate equipment and vessels to provide comparable results in habitat research studies and enhance collaborative efforts.

- Develop technologies to determine the fish associations related to particular sea floor features.

SALMON FISHERY MANAGEMENT PLAN

Salmon fishery management in the Pacific Northwest is undergoing a shift from mixed stock fisheries to selective fisheries for hatchery stocks. Successful implementation of selective fisheries will require accurate estimates of nonretention mortalities and new, more detailed information on fishery stock contributions and migration patterns. Recent expansion of listings under the Endangered Species Act, and the new definition of EFH, expand the Council's concerns with both freshwater and marine habitat in relation to harvest strategies and conservation. The revised Magnuson-Stevens Act requires better definitions of MSY and better understanding of population dynamics.

The three highest priority research and data needs for the Salmon FMP are:

- **A more accurate assessment of total fishing related mortality of natural stocks of coho and chinook.** Fishery management regimes designed to reduce impacts through nonretention or selective fishing depend for success on unbiased estimates of noncatch mortality.

- **Advances in genetic stock identification, otolith marking, and other techniques may make it feasible to use a variety of stock identification technologies to assess fishery impacts and migration patterns.** The increasing necessity for weak-stock management puts a premium on the ability to identify naturally reproducing stocks and stocks that contribute to fisheries at low rates. The CWT marking system is not suitable for these needs. The Council should encourage efforts to apply these techniques to management.

- **Encourage development of probabilistic habitat-based models that incorporate environmental variation to establish harvest policies and enable risk assessment for fishing strategies.** Overfishing definitions are required to relate to a measure of MSY. MSY for salmon is related to productivity, which varies annually in freshwater and the marine environment. Techniques for evaluating productivity, or survival, in freshwater and marine habitats are needed to set appropriate harvest targets and associated conservation guidelines such as escapement floors and overfishing definitions.

The comprehensive list of research and data needs is grouped in three main categories:

- **Stock Assessment**. Programs needed to provide information on stock-specific impacts of fishery management regimes.

- **Planning Tools.** Stock-specific management puts a premium on the ability of run-size predictors and harvest models to accurately evaluate impacts of regulatory proposals.

- **Life History.** Research needed to obtain an improved understanding of relationships between habitat and productivity and between hatchery and wild stocks.

Stock Assessment

- **Indicator Stocks**. Indicator stock programs are needed for Central Valley spring, fall, and winter Chinook; California and Oregon coastal spring and fall Chinook; Northern California coho; and four components of Oregon Coastal Natural coho to provide information on distribution and migration patterns and stock exploitation rates. Escapement goals are needed for Washington and Oregon coastal fall chinook.

- **Metapopulations.** Research is needed to quantify the rate of genetic flow between naturally-spawning populations and to better delineate populations for fisheries management.

Understanding of metapopulation structure may also contribute to better evaluation of stock status and improved estimates of allowable exploitation rates.

- **Design of Data Collection Programs.** Research is needed to determine optimal release group sizes, number of replications, and recovery sampling programs for fisheries and escapement. Improved interagency reporting of CWT returns is needed for adult salmon escaping to hatcheries.

- **Data Reporting.** Improvements in reporting of CWT data are required to permit the completion of cohort analyses to estimate exploitation rates and fishery impacts. Improvements in the timeliness of data are needed to evaluate fishery performance and design corrective measures to constrain impacts on stocks of concern. For some areas, particularly escapements and inland fisheries, recovery data are sporadically reported, often without rigorous estimates of expansion factors.

Planning Tools

- **Run Size Predictors**. Many abundance projections are currently expressed in terms of terminal run sizes and consequently reflect uncertain assumptions regarding impacts of prior ocean fisheries. These types of forecasts become less useful under conditions of substantial variability in ocean fishery impacts. Research is needed to develop accurate predictors of ocean abundance, including incorporation of the influence of environmental factors on intra-brood year survival rates and maturation schedules.

- **Noncatch Fishing Mortality.** In recent years, an increasing proportion of impacts of Council fisheries on naturally-spawning stocks have been caused by noncatch mortality as regulations such as landing ratio restrictions and mark-selective retention have been employed. Research, using standardized methodologies (e.g., handling, holding, reporting, post-mortem autopsies, etc.), is needed to estimate release mortality, encounter, and drop-off rates associated with gears and techniques that are typically employed in different areas and fisheries. Special attention needs to be paid to mid-term and long-term mortality. Fleet profile data (i.e., fishing technique and gear compositions) are needed to estimate release mortality rates for individual fisheries.

Improvements in Management Planning Models

- **Explicit Consideration of Uncertainty and Risk.** Current planning models employed by the Council are deterministic. Most aspects of salmon management, such as abundance forecasts and effort response to regulations, are not known with certainty. Given the increased emphasis on stock-specific concerns and principles of precautionary management, the Council should receive information necessary to evaluate the degree of risk associated with the regulations under consideration.   Research is needed to evaluate the accuracy of existing planning models, characterize the risk to stocks and fisheries of proposed harvest regimes, and to effectively communicate information on uncertainty for use in the Council's deliberations.

- **Continuous Catch Equations.** Because current planning models employed by the Council are constructed using simple linear, independent equations, interactions between stocks and fisheries within a given time step are ignored. This can result in biased estimates of impacts. Research is needed to investigate the feasibility of recasting the models from discrete to continuous forms. e.g., competing exponential risk catch equations.

- **Migration.** The Council currently employs "single pool" type models (i.e., ocean fisheries operate simultaneously on the entire cohort) for evaluating alternative regulatory proposals. Under certain conditions, such models can produce results that are inconsistent with expectations of biological behavior. For example, if a fishery off Central California is closed to coho fishing for a given time period, the fish that were saved become available to fisheries off the Northwest Coast of Washington

in the next time period. Research is needed to determine the feasibility of incorporating explicit migration mechanisms into planning models.

- **Resolution.** Some of the models currently employed by the Council attempt to represent time-area-fishery strata at a level of resolution which is difficult to support with available data. This creates a public impression of management precision that does not reflect reality and obscures problems of uncertainty in parameter estimation. Consideration should be given to reducing the number of time-area-fishery strata to levels that can be reliably supported by available information.

Catch Composition.   Research is needed to compare stock and age compositions from fishery samples against model-generated estimates.   This is a model validation exercise.

- **Coastwide Models.** Currently, at least five models are employed to evaluate impacts of proposed regulatory alternatives considered by the Council. A single coastwide chinook model would provide analytical consistency and eliminate the need to reconcile and integrate disparate results. Additionally, research is needed to determine the feasibility of combining chinook and coho into a single model to simplify tasks of estimating mortalities in fisheries operated under retention restrictions (e.g., landing ratios or nonretention).

Alternative Management Strategies

- **Alternatives to Time-Area Management.** The annual planning process centers on the crafting of intricate time-area management measures by various groups. The feasibility of using alternative approaches (e.g., pre-defined decision rules to establish upper limits on fishery impacts, individual quotas, effort limitation) to reduce risk of error, decrease reliance on preseason abundance forecasts, improve fishery stability, simplify regulations, and reduce management costs needs to be investigated.   For instance, the integration of Council planning processes with the abundance-based coho management frameworks under consideration by the Pacific Salmon Commission and by the State of Washington and western Washington treaty tribes to streamline the preseason planning process needs to be developed and evaluated.

- **Selective Fisheries.**   The Council began to employ mark-selective retention restrictions for coho fisheries in 1998.   Research is needed to investigate the utility of other types of selective fisheries. For example, time-area closures might reduce exploitation rates on concentrations of stocks of conservation concern.

Stock Identification

- **Mass Marking**. Estimates of mark rates are essential for planning mark-selective fisheries. The accuracy of mark and release rates needs to be evaluated as well as the variability of mark-induced mortalities under operational conditions.

- **Stock Identification.** In most cases it is not feasible to rely upon coded-wire-tagging of natural stocks, particularly those in depressed status, to obtain direct information on patterns of distribution and exploitation. Alternative stock identification technologies should be explored as a means to collect data necessary for stock assessment purposes. Research is needed to improve ability to estimate contributions of natural stocks in ocean fisheries and escapement.   Potential research areas include 1) association studies to determine the degree to which hatchery stocks can be used to represent distribution and migration patterns of natural stocks; 2) genetic stock identification, DNA, otolith marking, and scale studies; 3) improved statistical methods and models; and 4) basic research on stock distribution and migration patterns.

Life History Studies

Under the National Standards for the Sustainable Fisheries Act, MSY is identified as an upper limit to fishery impacts. Further, MSY is a consideration under principles of precautionary management embraced by the United States in the U.N. Convention for Highly Migratory and Straddling Fish Stocks and the determination of overfishing. MSY for salmon is related to productivity, which varies annually in freshwater and the marine environment. Techniques for evaluating productivity, or survival, in freshwater and marine habitats are needed to set appropriate harvest targets and associated conservation guidelines.

Freshwater Habitat

Research is needed to identify and quantify those factors in the freshwater habitat which limit the productivity of salmon stocks. Research should focus on 1) quantifying relationships between habitat factors and salmon production; 2) measuring the quantity and quality of these habitat factors on a periodic basis; and 3) evaluating habitat restoration projects for both short-term and long-term effects. Activities such as water diversions, logging, road building, agriculture, and development have reduced production potential by adversely affecting freshwater conditions. Habitat quality and quantity are crucial for the continued survival of wild stocks. The following specific research areas have been identified as being of particular importance.

Predictive Models for Land-Use Impacts. Determine if reliable, quantified relationships between land use patterns and anadromous fish production can be developed. Efforts are underway to link maps of freshwater habitats with models of salmon production for use in risk assessment, in designing habitat restoration programs, and in guiding land use policy development. As part of the Oregon Plan for Salmon and Watersheds, indicator watersheds are being established and monitored for land use impacts and fish production.

- **Limiting Factors.** Identify limiting factors. Develop strategies to prioritize actions to reduce or overcome limiting factors to restore wild fish production and essential ecological processes.

Estuarine and Ocean Survival

- **Environmental Influences on Survival.** Determine natural survival and stock distribution in the estuary and ocean, year-to-year, age-to-age, and life-history variability, and relationships to measurable parameters of the environment (i.e., temperature, upwelling, etc.). Some work has been done for coho, but little is known for chinook. Included in the information need are long-term and short-term relationships between environmental conditions and fluctuations in chinook and coho salmon survival, abundance, and maturation rates. (Substantial predictive errors in forecasts based on previous year returns and apparent large-scale multistock fluctuations in abundance suggest important large-scale environmental effects.)

- **Immunocompetence.** Studies of juvenile and adult salmon are needed to evaluate relationships among physiological state, environmental conditions, and survival.

- **Predation**. Research is needed to quantify the mortality rate on salmon by pinnipeds, seabirds, and predatory fish. Predation is potentially a problem in certain estuaries and in the ocean. Potential for restoration of some runs may be limited by predatory pinniped or bird populations.

Hatchery/Wild Interactions

- **Genetics.** Determine the extent to which there may be gene flow between hatchery and wild stocks. One approach would be to estimate the stray rate of hatchery fish into natural spawning areas the rate at which and wild fish interbreed, and survival rates of progeny.

- **Freshwater Ecology.** Investigate the ecological (competition, predation, displacement) effects of hatchery fish on natural production in freshwater.   All life stages from spawner to egg to smolt may be affected.

- **Estuary Ecology.** Migration timing, habitat utilization patterns, competition for food or space, and predator interactions are areas of interest.   Differences between hatchery and natural smolts in these areas could help address the questions of the importance of density-dependent growth and survival and potential negative effects of hatchery releases on natural stock production.

- **Early Ocean Life-history.**   Points of comparison between hatchery and wild stocks could include: ocean distribution, migration paths and timing, size and growth, food habits, and survival rates.

- **Identification of Hatchery Fish.**   The presence of hatchery fish may interfere with the accurate assessment of the status of natural stocks.   This problem may be alleviated by the use of mass-marking using otolith marking, CWT, genetic marking, fin removal, or other technologies to estimate the contribution of hatchery fish to fisheries and natural spawning populations.

- **Supplementation.**   Research is needed to investigate the utility of using artificial propagation to supplement and rebuild natural stocks. Guidelines for the conduct of supplementation to preserve genetic diversity and legacy of populations are needed. Special care is needed to ensure that supplementation programs do not unintentionally jeopardize natural runs.

COASTAL PELAGIC SPECIES FISHERY MANAGEMENT PLAN

The CPS FMP includes northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel, and market squid. Annual stock assessments are currently conducted for Pacific sardine and Pacific mackerel, the two actively-managed species in the plan. Whereas, in years past, the geographic coverage of CPS stock assessments has been largely limited to California, several recent developments highlight the need to enhance current assessment procedures in order to meet the requirements of the FMP. These include 1) the development of new fisheries for Pacific sardine, Pacific (chub) mackerel, and squid in Oregon and Washington; 2) increasing recognition of the importance of CPS as principal forage for many salmon and groundfish stocks that are currently at low abundance levels; and 3) the importance of CPS biomass estimates to the Council's annual determination of allowable coastal pelagic harvests. A pressing need exists for stock assessments that accurately reflect the reproductive characteristics of CPS stocks throughout their geographic range and for additional stock assessment personnel in NMFS and the three Pacific Coast states to carry out these assessments.

The highest priority research and data needs for the CPS FMP are:

- Gain more information about the status of the CPS resource in the north using egg pumps used during NMFS surveys, sonar surveys, and spotter planes.

- Develop a coastwide (Mexico to British Columbia, Canada) synoptic survey of sardine and Pacific mackerel biomass, i.e., coordinate a coastwide sampling effort (during a specified time period) to reduce "double-counting" caused by migration.

- Increase fishery sampling for age structure (Pacific sardine and Pacific mackerel) in the northern and southern end of the range. Establish a program of port sample data exchange with Mexican scientists (Instituto Nacional de la Pesca [INP], Ensenada).

- Evaluate the role of CPS resources in the ecosystem, the influence of climatic/oceanographic conditions on CPS; predatory/prey relationships. Increase the use of fishery information to estimate seasonal reproductive output of stock (e.g., fat/oil content).

- Improve information on salmon and other bycatch in the CPS fishery.

SARDINE

Sardine have been increasing in abundance along the entire coast from Baja California to British Columbia, Canada. New fisheries for sardine in Oregon, Washington, and British Columbia, Canada are developing.

The following research and data needs for sardine were drawn largely from the Sardine Symposium 2000 (May 23-25, 2000), organized by PSMFC, NMFS, California Department of Fish and Game (CDFG), and the Scripps Institute of Oceanography. Practicality of items were not determined and no priorities were set; items are listed in no particular order.

- Increase sampling for age structure throughout its range.

- Convert Oregon-Washington egg surveys carried out by National Marine Fisheries Service, Northwest Fisheries Science Center to biomass by estimating adult parameters (batch fecundity and spawning frequency).

- Improve existing southern California spawning biomass estimates based on egg surveys by measuring adult spawning parameters (batch fecundity and spawning frequency).

- Conduct aerial surveys of sardine schools using spotter pilots to provide coastwide indices of sardine abundance and estimate the extent of offshore distribution.

- Add airborne lidar to the above aerial surveys.

- Conduct coast-wide inventory of sardine biomass using Continuous Underway Fish Egg Sampler.

- Conduct acoustic-trawl survey coastwide to provide coastwide estimate of biomass.

- Conduct coast-wide intensive sampling for certain periods using industry and multiple agency contributions resembling the URICA biomass surveys of Peru, except the focus would be on age structure and reproductive rates. One suggestion was to focus on April since the April CalCOFI survey provides the longest fishery independent time series; a summer focus would also be useful since the northern fishery occurs in the summer.

- Conduct short fishing vessel cruises to establish offshore limit to sardine distribution and to obtain age structure information.

- Examine micro-constituents of sardine otoliths to determine the origins of fish (a low cost alternative to tagging).

- Implement electronic logbooks with Global Positioning System and time stamp to improve locality and time data on catches.

- Establish network to archive industry derived estimates of size specific oil yield to be used in estimating seasonal reproductive output of stock.

- Investigate feeding selectivity and the role of diet to determine the causal factors of bursting abdomens (the hot tummy phenomena).

PACIFIC MACKEREL

California's Pacific mackerel fishery has been sampled by CDFG for age composition and size-at-age since the late-1920s. The current stock assessment model incorporates a complete time series of landings and age composition data from 1929 onward. Ensenada (Baja California) landings have rivaled California's over the past decade, however, no biological information is currently available from Mexico's fishery. Landings are accounted for in the assessment, but size and age composition are assumed to be similar to the San Pedro, California fishery. Like sardine, there is a need to establish a program of port sample data exchange with Mexican scientists (INP, Ensenada) to fill this major gap in the stock assessment.

Fishery-independent survey data for measuring relative changes in Pacific mackerel recruitment and spawning biomass are generally lacking. The current CalCOFI sampling pattern provides information on mackerel egg distributions in the Southern California Bight, the extreme northern end of the spawning area. Mexican scientists have conducted a number of egg and larval surveys off of Baja California in recent years (e.g., IMECOCAL program). Access to this data would enable us to continue the historical CalCOFI time series which begins in 1951. This information could be directly incorporated into the assessment model.

Pacific mackerel biomass has been declining since the early 1980s, but recent El Niño events have concurrently extended their northern range to British Columbia, Canada. Pacific mackerel are caught

incidentally in the Pacific whiting and salmon troll fisheries. A simple reporting system is needed to document incidental take of mackerel in fisheries to the north. Presence-absence information may allow us to detect southward movement or further decreases in biomass.

MARKET SQUID

Market squid are poorly understood, relative to CPS finfish, as extensive biological data needed for assessment purposes is lacking. Recent age and growth information suggests that maximum age is less than one year, and the average age of squid taken in the fishery is approximately six to seven months. Landings data indicates a sharp decline in squid availability associated with El Niño events.

Although some information exists on coastwide market squid distribution and abundance from fishery-independent midwater and bottom trawl surveys aimed at assessing other species, there is no good measure of annual recruitment success beyond information attained from the fishery. As fishing activity occurs only on shallow-water spawning aggregations, it is not clear if reduced landings reflect only a decline in availability to the fishery, or if overall stock size is diminished, since squid have been commonly documented at greater depths using other gear methods.

Better information on the extent and distribution of spawning grounds along the Pacific Coast is required, particularly in deep water and areas north of central California. Additionally, fecundity, egg survival and paralarvae production per unit area estimates in different types of spawning habitats and water conditions are needed. Furthermore, information describing mechanisms and patterns of dispersal of adults and paralarvae along the coast (i.e., stock structure) is required for determining how local impacts might be mitigated by recruitment from other areas in this short-lived species.

Although some fishery effort information is now being collected with a newly-implement logbook program in the state of California, the continuation of this program is essential to provide estimates of catch per unit effort in the future. Continuation and/or establishment of annual surveys using midwater trawls, bottom trawls, Remotely Operated Vehicles, satellite, and aerial surveys may also provide useful to provide annual indices of abundance and effort.

Potential impacts to EFH would most likely occur during fishing activity with purse-seine gear on spawning aggregations in shallow water, when gear may possibly make contact with the bottom. There are two areas of potential concern that have not been quantified; damage to substrate where eggs may be deposited, and damage or mortality to egg masses from contact with the gear itself.

LIVE BAIT FISHERY

Although tonnage of CPS and squid taken in the live bait fishery is minimal compared with volume taken in the commercial fishery, better estimates of live-bait landings and sales of sardine, anchovy and squid is essential as it pertains to estimates of the overall economic value of these fisheries. Outdated estimates have previously shown that the value of the live-bait fishery for sardine has equaled that of the commercial catch. In the case of squid, there is no documentation of the dramatic expansion of live-bait sales in southern California made by commercial light vessels in recent years.

The live bait fishery supplies a product for several recreational fisheries along the Pacific Coast, primarily in southern California. Live bait catch is generally comprised of both Pacific sardine and northern anchovy, the predominant species depends on biomass levels and local availability. Recent landings estimates range between 5,000 mt and 8,000 mt annually statewide, with effort increasing in summer months. However, these estimates are based only on voluntary logbooks provided by some bait haulers, and estimates provided by the coastal pelagic fishery vessel industry. Since the sale of live bait in California is not documented in a manner similar to that used for the commercial sale of CPS, estimates of tonnage and value are imprecise.   No estimates of volume or value for the sale of market squid for live bait are available at this time whatsoever.

PACIFIC HALIBUT ALLOCATION

BYCATCH

Data are needed to estimate halibut bycatch rates and mortality of discarded halibut bycatch by gear type for West Coast fisheries.   Also, see discussion of Discard Data under Groundfish Data Needs.

DISTRIBUTION AND ABUNDANCE

Continue with setline surveys to estimate halibut abundance and distribution in Area 2A and Area 2B.

MARINE RESERVES

The Council has specified a two-stage process to evaluate whether or not marine reserves may have a role in more effectively managing the West Coast groundfish fisheries. The first phase is a conceptual evaluation of the potential role marine reserves may play. If marine reserves appear to be a potentially valuable tool, specific sites would be proposed as part of a second phase. During the initial evaluation process, certain data shortcomings were identified pertaining to both the general analysis and the specific siting of marine reserves.

While marine reserves are being considered primarily with respect to the groundfish fishery, a variety of fisheries may be affected depending on the types of fishing that need to be controlled in order to create an adequate marine reserve system.   The Council has the authority to regulate only those fisheries that take species managed under a Council FMP.

The top priority research and data needs related to marine reserves are:

- **Identify type and scale of information needed to conduct stock assessments** after establishment of marine reserves and evaluate the feasibility and cost of collecting such information.

- **Information on the location and structure of current harvest** relative to a proposed marine reserve area is needed in order to begin to evaluate the degree of impact and effectiveness of the creation of marine reserves. Most harvest information currently collected is not on a fine enough geographic scale to use for evaluation of marine reserves.

- **Research is needed to understand the biological effects of marine reserves** and determine the extent to which acceptable biological catches would need to be modified when marine reserves are implemented, over the short-term and long-term

- **Information on advection of eggs and larva and pre-settlement juveniles.** Particularly emphasis on differences between areas upstream dn downstream of major geographical features.   This will primarily be a physical oceanographic exercise.

- **Information on the movement of juveniles and adults.**   This will primarily be a literature search followed by a biological field program. Little is known about the movement of post settlement juveniles.

- **Knowledge of when in the life cycle density dependent effects occur** is important in the assessment of the effects of marine reserves (as it is in assessing conventional catch management).

- **Increased biological monitoring of existing marine reserves** and other areas of restricted fishing in order to gain information on current reserves that might be extrapolated to evaluate the creation of additional reserves on the West Coast.

Increase Monitoring of Existing Areas with Restricted Fishing

There is a need for increased biological monitoring of existing marine reserves and other areas of restricted fishing in order to gain information on current reserves that might be extrapolated to evaluate the creation of additional reserves on the West Coast.   There are 17 very small reserves in California that prohibit either recreational, commercial, or all harvest.   The is one very small no fishing reserve off Oregon (Whale Cove).   There are three or four small reserves that prohibit recreational and commercial bottom fishing in Puget Sound.   There are no marine reserves deeper than 100 meters anywhere off the

West Coast. There are some other types of marine reserves in California that may also benefit from study. These include spawning/nursery grounds with restricted fishing, the prohibition of trawling within three miles of shore and the exclusion of gillnetting for nearshore rockfishes.

Modeling of Marine Reserve Impacts

Current information limits reserve models are fairly simplistic. More sophisticated models require additional information. Development of realistic species specific models is limited by the lack of basic information on fish mobility, larval transport, recruitment mechanisms, and habitat-dependent life history parameters. Modeling recruitment for populations with a significant proportion of their biomass in reserves will be more problematic than for current stock assessments, because the reserve stocks will have different age structures, population densities, and possibly different recruitment success than areas open to fishery. Lacking this information, current models do not demonstrate substantial benefits as compared to fisheries properly regulated to achieve optimum yield, however, it has not been demonstrated that the regulatory intent of achieving optimum yield is being met by current fishery management regulations. Information limits for successful application of marine reserves are not necessarily greater than the information limits for successful traditional management, however, it will require significant data analysis and probably additional monitoring to acquire the information needed to assess reserve effects.

Assessment of the effects of reserves on ecosystems is severely limited by the lack of knowledge concerning the long-term effects of the selective removal of specific components of the fauna, alternation of the benthos by fishing gear and inter-specifies interactions.

Design of Marine Reserve

Species Movement

General information is needed on species movement by life history stage (larval, juvenile, and adult), particularly where improvement of stock health is one of the primary purposes of the reserve. Little is known about the movement of post settlement juveniles.

Area specific information is needed on reproductive success and subsequent patterns of settlement and recruitment. The design and siting of a marine reserve system would be enhanced by understanding of the hydrographic links between source and settlement populations. The connection between adult source populations and sites of successful settlement and recruitment may be critical in designing effective reserves. Part of this involves understanding mechanisms of larval dispersal (including patterns of dispersal, retention, and redistribution).

Life Phase of Density Dependent Effects

Knowledge of when in the life cycle density dependent effects occur is important in the assessment of the effects of marine reserves (as it is in assessing conventional catch management). It is likely that density dependent effects occur either during adult or post settlement life phases. Negative density dependent effects during the adult phase could result in less production per unit of biomass when adults are concentrated in an area such as marine reserves as compared to when they are dispersed. On the other hand, negative density dependent effects in the post-settlement juvenile stage would imply a higher probability that marine reserves will have a positive effect on stock populations outside the reserve area.

Catch and Bycatch Location

Better precision is needed on the location of catch and bycatch in order to enhance the potential usefulness of reserves for controlling fishing mortality in a multispecies fisheries. For example, areas may be closed where a particular species is taken as bycatch at a higher rate than in other areas.

Stock Assessment Models (With Reserves in Place)

Significant data collection and substantial monitoring will likely be needed to acquire the necessary information. Reserve stocks will have different age structures, population densities, and possibly different recruitment success than areas open to fishing. Information may be needed to develop area-specific stock parameters. As part of the evaluation of marine reserves relative to the status quo, the types and scale of information needed to conduct stock assessments after establishment of reserves should be identified and the feasibility and cost of collecting such information should be analyzed.

Social and Economic Data Needs

Much of the data needed for analysis of marine reserves is not available from traditional fishery data systems. Details on area of catch are needed on a fine enough scale to model the effects of marine reserves. Information is also needed on the extent of displacement of fishing activity from the reserve and the extent to which effort is diverted to other fisheries.

Location of Current Harvest

Information on the location of current harvest relative to a proposed marine reserve area is needed in order to begin to evaluate the degree of impact and effectiveness of the creation of marine reserves. Location of harvest information would allow statements to be made about:

1. The number of harvesters and amount of harvest that will be dislocated by the creation of a marine reserve area.

2. The number of harvesters and amount of harvest by harvesters in the area that may be secondarily impacted by the shift of harvest effort out of the marine reserve area.

Information about the location of alternative fishing grounds would allow analysts to begin to analyze some differences in travel costs to the different fishing grounds.

Knowledge about amounts of displaced effort and catch as a proportion of the effort and catch in alternative fishing areas would begin to indicate the magnitude of cost increases related to the additional competition on the alternative fishing grounds.

Some information of this nature is available from trawl logbooks and some from charter vessel logs in California. In 1999 and 2000 there has been an effort to collect specific fishing location information from recreational fishers.

	Groups				
	Nonconsumptive on site (e.g., ecotourism)	Recreational Fishers	Charter Vessels	Seafood Harvesters	Processors
Source of Ocean Area Data	None identified	California Charter Vessel Logs 1999-2000 RecFIN Data (sample data–not expanded)	California Charter Vessel Logs	Trawl Logbooks	If information is available on seafood harvesters it can be tied to a processor ID.

Current Catch Per Unit of Efforts For Different Harvest Areas

A second piece of information needed for an economic analysis is the size of alternative fishing areas and CPUEs in those alternative fishing areas. With this information a short-term initial assessment might be made of the differences in costs of fishing between the marine reserve area and the alternative areas. This information may be available for groundfish trawl vessels coastwide and recreational charter vessels in California (Thomson, 1998).

Stock movement and total abundance information for the ranges of the stocks in the alternative fishing area; stock recruitment and growth parameters; and relationships of these and other factors to CPUE would be needed to assess the ability of alternative fishing areas to absorb displaced effort over the long-term.

Harvester Costs and Differentials Between Harvest Areas

Harvester cost and expenditure information is necessary to quantify impacts to local and national economies. The impacts that need to be modeled with respect to short-term costs relate to how costs vary between fishing sites. Over the long-term, changes in costs depend on the effectiveness of marine reserves in preserving and rebuilding stocks and the relationship of stock abundance to CPUE. Prediction of such changes are problematic given the constrained data available for models.

Recreational Harvester and Site Specific Demand

A completely quantitative economic analysis would require information on site specific angler preferences and expected changes in recreational harvester demand associated with site-specific closures. These values could be used to generate estimates of total trips expected with changing fishing opportunities and changes in consumer surplus. A recent RecFIN socioeconomic survey of West Coast anglers collected information on hypothetical responses to hypothetical changes in rockfish and lingcod bag limits. This data might be useful in gaining some insight into changes in demand with changes in harvest opportunity.

Processors

If the impacts of a marine reserve on commercial landings to a specific port can be estimated, the next question is whether product is processed locally or shipped to another location for processing or direct sale. Information required for a full quantitative assessment of impacts on processors would include amounts of product processors acquire from local and outside sources, processor variable costs, fixed and variable costs, exprocessor prices, and overall effect of marine reserve policies on total fish available from West Coast fisheries.

Offsite Nonconsumptive Values

Estimates of existence, bequest, and option values are difficult to derive. The methods most generally used to estimate such values are surveys. Another indicators of such values might be the portion of environmental organization budgets dedicated to the creation of marine reserves on the West Coast.

Other Marine Related Industries. Inventory and assess dependence of businesses supporting commercial and recreational fisheries as well as other ocean based activities (e.g., ecotourism).

Family Dependence

Information will be needed on the dependence of families in the community on income from fishing, alternative sources of income, and resources available in the community to assist families in adapting to change.

APPENDIX A
Species Specific Groundfish Research and Data Needs

The following species specific groundfish research and data needs were derived largely from the Stock Assessment Review (STAR) Panel reports on stock assessments conducted in 1999 and 2000.

Bank Rockfish 2000

1. Set up a separate species market category for Bank rockfish in Monterey and northern Conception ports to improve tracking of landings and improve length and age composition sampling for this species.

2. Obtain better catch information from southern Conception fishery.

3. Develop a new survey sampling project to provide a fishery independent measure of population abundance and recruitment.

4. Investigate more robust decision rules for data limited species assessments.

Black Rockfish 1999

1. There were benefits to the multiple model descriptions which were presented and continuation of the practice is recommended. These models should include simpler models and analyses, (e.g., catch curve, production models, size frequency information).

2. The black rockfish is recruited to the fishery before the 50% maturity age. Yield and spawning stock biomass isopleths should be examined to assess the effect of changing size of capture.

3. The tagging study should be expanded to better define the stock and to produce better abundance estimates.

4. The STAR Panel was concerned about the high M estimates, especially on females, and recommends that both model configurations and independent data be investigated.

5. Stock status data, either abundance or effort, which were not used in tuning, should be compared to model outputs in order to integrate this information.

6. The implications of using tagging data only from the central area (near Westport) to assess the population throughout the stock unit needs to be investigated.

Bocaccio Off California 1999

1. Examine the long time series of nuclear power plant larval fish impingement data to see if a pre-recruitment index could be developed.

2. Environmental data and recruitment patterns should be examined for trends. Research should include exploring the possibility of community interactions along with environmental coupling in an effort to develop alternative models that more accurately affect the population dynamics of this species. Changes to the synthesis model or model inputs should be made to explore alternative hypotheses about fish that may be 'hidden' from the fisheries.

3. Fishery independent methods of monitoring the bocaccio resource should be continued, and additional fishery independent methods of sampling should be developed. Anticipated low future

harvest levels under a rebuilding plan may reduce or eliminate sampling opportunities needed to track recovery of the stocks.

4. Examine the CalCOFI data set when it becomes available. By extending the model back into the 1950s and 1960s, it may be possible to calibrate stock productivity to the colder conditions during those years as opposed to the warm conditions that have prevailed since the mid-1970s.

Canary Rockfish (Northern and Southern) 1999

1. Future canary rockfish stock assessments could be significantly improved by increased sampling of commercial landings and increased frequency of fishery-independent resource surveys. Currently, port sampling protocols are neither consistent from year to year nor strictly standardized between the three states. The current status of the resource is quite depressed. The size and age composition derived from collection of data from all segments of the canary rockfish fishery will be extremely important in tracking its recovery and assessing the productivity of the stock(s). These data must be collected annually over the geographic range of the fisheries to eliminate the current data gaps in size and age data from the fishery.

2. The current frequency of the NMFS bottom trawl survey should be increased from the triennial schedule to an annual basis. Canary rockfish captured in the survey must be sampled to determine length, sex, and age composition. The annual age-composition information from the survey will be very valuable for tracking the magnitude of incoming recruitment, as well as following cohorts through the fishery.

3. The canary rockfish age structures (otoliths) collected from the fisheries and surveys must also be routinely processed. Routine data collection over time will also provide insight into stock structure and natural mortality schedules of the older females.

4. Given that the resource appears to be very depressed, efforts to reduce fishing mortality under the Council's available management measures will likely result in higher discard mortalities. Therefore, improved effort to monitor total fishing mortality, including discard catches, will be important to track stock rebuilding progress.

5. A major research effort should be undertaken along the U.S. West Coast to resolve whether a model with constant female mortality and dome-shaped age-specific selectivity or an age-dependent mortality model with asymptotic selectivity is closest to reality. A number of U.S. West Coast groundfish stocks appear to have an unusually low number of older female fish given the life span of the male population. The alternative modeling assumptions of age-dependent mortality versus dome-shaped selectivity patterns can both replicate the age structure of the female population as observed in the fishery or summer bottom trawl surveys. This lack of resolution contributes considerable uncertainty in estimates of current stock condition and yield projections. A major research effort to locate larger females or to examine age-dependent mortality for mature female fish would benefit a number of assessments and stock rebuilding plans.

6. The STAR Panel discussed potential effects of environmental changes (regime shifts) on stock productivity, and the possible influence on expected recruitments and estimates of future unfished stock size. The increasing trend in sea surface temperatures for the California Current region since the late 1970s has been well documented and is associated with increased productivity of sardines (and decreased zooplankton volumes in CalCOFI time series). Sufficient recruitment information may now be available from recent stock assessments to test for regime effects in groundfish stock productivity, and a rigorous analysis would benefit management. No clear evidence has been presented for a productivity response to environmental conditions in groundfish stocks, possibly due to life history traits, such as longevity, delayed age at maturity, and the presence of numerous year classes in the spawning biomass. However, it may be a relevant management issue for groundfish,

particularly for those stocks in need of formal rebuilding. Possible environmental effects on productivity are a germane management issue, as demonstrated by its inclusion in the sardine harvest control rule.

Cowcod 1999

1. The analysis of the recreational logbook data made excellent use of available information. An improvement in the precision of this analysis may be possible by using spatially contiguous statistical blocks for determination of habitat areas and aggregation of the data.
2. The extreme decline in recruitment and abundance of cowcod is probably due to a combination of a climate shift (increasing water temperature and decreased ocean productivity beginning in 1977) affecting stock productivity and the high levels of catch. In order to better distinguish the relative contribution from these two causes and to predict time frames for rebuilding, further research is needed on the effect of the ocean climate on the distribution and recruitment of cowcod.

3. An assessment for cowcod in the areas north of Point Conception should be conducted, especially to improve understanding of the possible climate effects on cowcod in the southern area.

4. Cowcod occur in a mixed species fishery, and are relatively rare components of this fishery. In order to better determine the current level of fishery impacts on this stock, there should be improved species differentiation in the catch, either through increased sampling for species proportions, or by requiring more complete sorting of the catch.

Darkblotched Rockfish 2000

Landings values used in the assessment from the foreign fishery in the late 1960s and 1970s are based for the most part on observations from samples obtained from the domestic fishery. Data from Russian scientific cruises are now available and should be examined to determine if the species composition of the foreign fisheries can be more accurately estimated. In any case a consistent methodology should be developed and documented so that all assessments are working with the same landing data.

Grenadiers

Research is needed to develop information on the biology and population abundance of grenadiers. Since 1995, the fishery has been expanding. An assessment should be conducted in the near term. This effort would be facilitated by separating the catches of Pacific and giant grenadiers in the official landing statistics.

Lingcod (Eureka, Monterey, and
Conception International North Pacific Fishery Commission Areas) 1999

1. With the current low level of spawning biomass, sampling opportunities are likely to be reduced along with reduced catches. If nearshore initiatives allow increased sampling in California – some funds should be used to review and improve sample design for lingcod. The Council, state, and federal managers may need to consider alternative management approaches if data are inadequate to provide a clear picture of stock status.

2. Estimates of growth parameters should be improved by additional sampling of younger, and perhaps older fish. Methods should be developed to estimate growth parameters and associated transition array within the model.

3. If nearshore management decreases traditionally used fishery-dependent sampling opportunities, new research initiatives should be pursued to increase development of fishery-independent methods of sampling or surveying lingcod populations.

4. Data should be more formally evaluated including a spatial analysis of fishery and fishery independent data. Such analysis should focus on at least two products. First, the statistical structure of the data should be examined with the goal of improving sampling design. Second, models should be reviewed and modified to more accurately reflect distribution of the resource, and the distribution of the fishery in time and space. For lingcod, areas of particular concern is sexual dimorphism, separation of sexes and sizes by area and impacts these population features may have on sampling and interpretation of sampling products in the modeling process.

5. Additional approaches to modeling that might improve assessments should be considered. In particular, exploration of alternative model variance structures (multinomial vs. multivariate) was identified as one possible area of fruitful research.

Lingcod (Coastwide) 2000

1. The Auto-Differentiation Model Builder (ADMB) models for lingcod-north and lingcod-south were unable to handle length frequency data. The time series of length data for lingcod is much longer than the series of age data. Also, in some cases, length composition data might provide more information for resolving selectivity curves, stock separation, and geographic movements. Future ADMB assessment models for lingcod should be extended to accommodate length composition data. Alternatively, the length-based version of Stock Synthesis could be used.

2. The apparent discrepancy in age-reading methods between Washington Department of Fish and Wildlife (WDFW) and Tiburon should be resolved by a controlled experiment of multiple readings by staff from both laboratories. The experiment should use fin ray collections that cover the entire West Coast and thus test for potential north-south differences in growth-ring formation.

3. The sex-specific natural mortality coefficients (M) should be reevaluated given the available data on sex ratio and age composition based on the new age-reading criteria. The current assessment uses values for M (0.18/yr for females; 0.32/yr for males) that were based on age composition data derived using the old WDFW age reading criteria.

4. A fishery-independent survey is needed to evaluate changes in stock abundance, especially given recent management measures that undoubtedly have influenced the relationship between fishery catch-per-unit-effort and abundance. The current NMFS trawl survey is not effective at catching lingcod and the survey biomass index is highly variable. Other gear types (e.g., gill-net or longline) might provide a more reliable and useful biomass index.

5. A study should be conducted to evaluate the mortality rates for lingcod that are discarded by the recreational and commercial fisheries.

6. The California recreational CPUE data should be further evaluated and analyzed by development of Generalized Linear Models (GLM) to standardize the data for area, season, and gear-type effects and their possible interactions.

7. Expanded tagging experiments should be conducted to evaluate exploitation rates and geographic movements. Results from the tagging program by WDFW may not be representative of the entire West Coast.

8. Canadian assessment scientists and fishery biologists should be invited to participate in future stock assessment workshops and STAR Panel reviews.

9. The trawl logbook CPUE data should be evaluated using more comprehensive GLM analyses that include provisions for zero-catch hauls and main effects for trawl-type (e.g., roller gear versus flatfish trawl) and season and potential interaction terms.

10. In future assessment reviews that use newly coded models the Stock Assessment Review (STAT) Teams should be required to demonstrate that their software is working correctly, either from simulated test data sets with known characteristics or by reproducing previous assessment results.

11. Lingcod length and age data are needed for the nontrawl fishery and private recreational vessels.

Pacific Ocean Perch 2000

1. The accuracy and precision of stock status evaluations would be increased if more resources were devoted to data collection. For example, the assessment would improve if the 1995 survey ages were processed, discard rate was monitored, age composition of catch was sampled, and frequency of surveys were increased.

2. Investigate methods to estimate the proportion of POP in historical foreign red rockfish catch, including analysis of Soviet exploratory fishing data and domestic trawl fishery species composition data from the same era. Consider the technical merits of developing estimates that are consistent with other rockfish estimates. Information from the Soviet cruises should also be examined for consideration as an index of relative stock size.

3. Re-examine standardization of POP CPUE data from the domestic fishery logbook data to confirm abundance index time series for 1956 through 1973.

4. The technical merits and feasibility of assessing the resource as a trans-boundary stock should be considered.

5. Evaluate the advantages and sensitivities of general model features. One is exploration of methods for constraining recruitment estimates and including spawner-recruitment relationships. Another is use of constant fishery selectivity, versus changes in selectivity indexed to known events such as mesh size changes, versus constrained time-varying fishery selectivity. Investigation and guidance on these two issues would be useful for all assessments that use similar models.

6. Collaborate with Canadian scientists to conduct a coastwide stock assessment for POP.

Petrale 1999

1. For juvenile petrale sole it is clear that it is not possible to obtain size at age or abundance indices except through surveys. Need increased survey data, both coverage in terms of increased age sampling and annual surveys. In particular in all surveys should collect age, length and sex samples. Maturity and length relationships are needed for Petrale sole in the late summer and autumn.

2. There is an urgent need for a consistent long-term strategy for sampling for ageing and length measurements from commercial catches. In particular age and length samples are needed from all regions and all years and techniques for age reading should be standardized.

Sablefish 1998

The 1998 sablefish assessment suffered from the need for fishery sample data that were more representative, temporally, spatially, and across gear types. Previous sablefish age sampling programs have not been extensive enough to allow examination of age composition by area, season, and gear type. Failure to account for these components of sablefish catch can lead to biased results and erroneous

conclusions. There is a particular need to collect otoliths of sablefish caught in the nontrawl fishery, much of which is headed and gutted prior to unloading. The high percentage of dressed fish in some gear/area strata severely compromises age composition estimates. At-sea collections by observers may be needed to gather the necessary data.

Whiting 1999

Evaluate the effect of using a more straightforward catch-at-age matrix in the stock assessment without the accumulation of "marginal" age groups. The accumulation rules employed in the stock assessment are somewhat arbitrary and further examination may show that such accumulation is unnecessary.

Widow Rockfish 2000

1. The age composition data used in current assessment includes a mix of surface ages and break-and-burn ages and treats them as being equivalent. Future assessments of widow rockfish should evaluate whether there are important discrepancies between the age-reading methods.

2. The current model was unable to handle length frequency data. In some cases, these length data might provide more information for resolving selectivity curves and geographic movements. For future assessments a model should be developed that can use these types of additional data. Alternatively, the length-based version of Stock Synthesis could be used.

3. The STAR Panel discussed the STAT Team's approach to power transformation of the mid-water recruitment index and agreed that it was adequate in the current assessment. However, alternative approaches to variance stabilization, such as iterative weighting schemes, might be more appropriate and should be considered.

4. The lack of good fishery independent abundance indices, and conflicts among the indices used, indicate that a hydroacoustic survey for widow rockfish, possibly using industry vessels, could provide invaluable information that would improve the assessment. Recent management measures undoubtedly have influenced the relationship between fishery catch-per-unit-effort and abundance, thus disrupting the consistency of both the trawl logbook CPUE index and the whiting fishery widow bycatch/minute index.

5. The California bottom trawl logbook data should be separated from the midwater trawl data. Catch rates from these distinctly different fishing methods do not necessarily share the same relationship with stock size. For example, midwater CPUE is unlikely to be proportional to stock abundance given unrecorded search effort to locate suitable fish schools.

6. More comprehensive analyses of the Oregon and California bottom trawl logbook CPUE data are required. GLM analyses that include provisions for zero-catch hauls and main effects such as trawl-type (e.g., roller gear versus flatfish trawl) and season, as well as potential interaction terms, would help elucidate issues concerning interpretation of the indices.

7. All widow rockfish collected during surveys should be measured for length and sex and otoliths should be taken. These extra data would clearly help provide information on the size, age, and sex structure of the population, as well as lead to improved interpretation of the survey indices themselves.

8. A fecundity study, especially to determine the fecundity of small fish, would update current estimates and improve confidence in their values. The current assessment used an assumed relationship for fish in the south. However, a member of the STAR Panel checked fecundity estimates available from Southern California Bight and found little discrepancy with relationship used in current assessment.

9. The NMFS triennial bottom trawl survey data should be examined more closely to reconcile the discrepancies between the survey trends and the apparent population trends based on the population dynamics model.

10. In future reviews of assessments that use newly coded models, the STAT Teams should be required to demonstrate that their software is working correctly, e.g., from simulated data or by reproducing previous assessment results.

11. Future coastwide assessments of widow rockfish should re-examine the sensitivity of the North-South biomass division, and determine whether and how this biological separation might affect the population dynamics and the fishery.

Yellowtail Rockfish 2000

Prioritized recommendations:

1. Increase the frequency of the trawl survey.

2. The presently used maturity/fecundity ogive should be updated to include the observed changes in growth.

3. An updated estimate of discards should be made, especially in the light of increased regulations.

4. Evaluate factors that could cause year-to-year changes in trawl survey catchability.

5. Include the trawl survey information within the Canadian portion of the Vancouver area.

6. Examine trawl survey data to better estimate growth of young fish.
7. Re-evaluate North Columbia/South Columbia border based on locations of aggregations in the trawl survey and in fishery logbook data.

8. Tissue samples should be collected for DNA analysis of stock structure.

9. The status of yellowtail rockfish south of Cape Mendocino is unknown. This could be investigated either as a southward extension of this assessment, or as a component of a multispecies investigation of rockfish species in the south.

10. Hook and line and recreational data should be included in the assessment, especially when the assessment is extended south of Cape Mendocino.

11. If the whiting bycatch CPUE is going to be used in the future, then a GLM approach should be used to incorporate a month/area effect.