AMENDMENT 5 (OVERFISHING DEFINITION)

TO THE FISHERY MANAGEMENT PLAN FOR

PACIFIC COAST GROUNDFISH

Including
ENVIRONMENTAL ASSESSMENT
AND
PROPOSED CHANGES TO THE FMP

ADOPTED BY
THE PACIFIC FISHERY MANAGEMENT COUNCIL
SEPTEMBER 1990

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NOVEMBER 1990

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1.0 INTRODUCTION

The domestic and foreign groundfish fisheries in the exclusive economic zone (EEZ) of the United States (3 to 200 miles offshore) in the Pacific Ocean off the coasts of California, Washington, and Oregon are managed under the "Pacific Coast Groundfish Fishery Management Plan (FMP) and Environmental Impact Statement (EIS) for the California, Oregon, and Washington Groundfish Fishery". The FMP was developed by the Council under the Magnuson Fishery Conservation and Management Act (MFCMA). It was approved by the Assistant Administrator for Fisheries, NOAA on January 4, 1982 and became effective on September 30, 1982. Implementing regulations were published in the Federal Register on October 5, 1982 (at 47 FR 43964) and appear at 50 CFR 663 and Part 675. Three amendments to the FMP have been implemented and a fourth amendment is currently under Secretarial review. This document describes and assesses the potential effects of changes that constitute Amendment 5 to the FMP.

1.1 List of the Management Measures

The Council is considering one major change to the FMP to address the newly established Guidelines for Fishery Management Plans (602 Guidelines) which requires each FMP establish measurable and objective overfishing standards for species addressed by that FMP.

1.2 Purpose of the Public Hearing Package

1.2.1 Environmental Assessment

One part of this public hearing package is the Environmental Assessment (EA) that is required by National Oceanic and Atmospheric Administration (NOAA) in compliance with the National Environmental Policy Act of 1969 (NEPA). The EA analyzes the impacts of major federal actions on the quality of the human environment. It serves as a means of determining if significant environmental impacts could result from a proposed action and describes those potential impacts. It is the basis for determining whether an Supplemental EIS must be prepared. An Supplemental EIS must be prepared if the proposed action may be reasonably expected to: (1) jeopardize the productive capability of the target resource species or any related stocks that may be affected by the action, (2) allow substantial damage to the ocean and coastal habitats, (3) have a substantial adverse impact on public health or safety, (4) affect adversely an endangered or threatened species or a marine mammal population, or (5) result in cumulative effects that could have a substantial adverse effect on the target resource species or any related stocks that may be affected by the action. This EA is prepared to analyze the possible impacts of management measures and their alternatives that are contained in Amendment 5.

Certain management measures are expected to have some impact on the environment. Such measures are those directed at harvests of stocks and may occur either directly from the actual harvests (e.g., removal of fish from the ecosystem) or indirectly as a result of harvest operations (e.g., effects of bottom trawling on the benthos [animals and plants living on, or in the bottom substrate]). Environmental impacts of management measures may be beneficial when they accomplish their intended effects (e.g., prevention of overharvesting stocks as a result of harvest limitations). Conversely, such impacts may be harmful when management measures do not accomplish their intended effects (e.g., overharvesting occurs when management measures do not adequately control fishing mortality). The extent of the harm is dependent on the amount of overfishing that has occurred. For purposes of this EA, the term "overfishing" is that which is described in the 602 Guidelines [50 CFR 602.11.c(9)] and incorporated into the FMP by this amendment. It is "a level or rate of fishing mortality that jeopardizes the long term capacity of a stock or stock complex to produce maximum sustainable yield (MSY) on a continuing basis". Environmental impacts that may occur as a result of fishery management practices are categorized as changes in predator–prey relations among invertebrates and vertebrates, including marine mammals and birds, physical changes as a direct result of on–bottom fishing practices, and nutrient changes due to processing and dumping of fish wastes. If more or less groundfish biomass is removed from the ecosystem, then adjustments occur in the ecosystem until a new equilibrium is established.

A detailed description of each major species is provided in Section 11 of the amendment, along with a discussion of the habitat requirements and the Council's habitat preservation policy.

1.2.2 Regulatory Impact Review (RIR)

Another part of the package is the RIR that is required by National Marine Fisheries Service (NMFS) for all regulatory actions or for significant Department of Commerce/NOAA policy changes that are of public interest. The RIR: (1) provides a comprehensive review of the level and incidence of impacts associated with a proposed or final regulatory action; (2) provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve the problems; and (3) ensures the regulatory agency systematically and comprehensively considers all available alternatives so the public welfare can be enhanced in the most efficient and cost effective way.

The RIR also serves as the basis for determining whether any proposed regulations are major under criteria provided in Executive Order 12291 and whether or not proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Act (P.L. 96–354, RFA). The primary purpose of the RFA is to relieve small businesses, small organizations, and small governmental jurisdictions (collectively, "small entities") of burdensome regulatory and recordkeeping requirements. This Act requires that if regulatory and recordkeeping requirements are not burdensome, then the head of an agency must certify that the requirement, if promulgated, will not have a significant effect on a substantial number of small entities.

The RIR analyzes the impacts that Amendment 5 would have on the Pacific coast groundfish fisheries. It also provides a description and an estimate of the number of vessels (small entities) to which regulations implementing amendment (if any) would apply.

1.3 Description of the 1987 Domestic Groundfish Industry Operating in the Washington, Oregon, and California Area

Section 11.3 of the FMP (Social and Economic Characteristics of the Fishery) provides a more detailed discussion of the business firms that directly utilize the groundfish resources of the region. U.S. commercial firms exploiting groundfish include commercial fishing vessels employing a wide variety of gear and delivering product to shoreside processors and processing vessels, party/charter vessels for recreational fishing, and shoreside fish processing firms. In addition, other industries provide materials and equipment to support these businesses.

1.3.1 Fishing Fleet

There is no federal groundfish permit requirement in the Washington, Oregon, and California fishery, so an accurate count of vessels landing groundfish is often difficult to develop. The numbers below are taken from the 1989 annual stock assessment document produced by the Council and a NMFS Southwest Fisheries Center Administrative Report Number LJ-88-01, titled "Importance of Selected Limited Access Criteria for Pacific Coast Groundfish Fleet Configuration" by Dale Squires. A total of approximately 531 vessels made substantial landings of groundfish in 1988, the most recent year for which data are available. This includes 349 trawl vessels delivering to shore plants, 156 longline vessels, and 26 pot/trap vessels. There may be a few additional trawl vessels (two in 1986) which operate in joint ventures, delivering to foreign processing ships, but make no deliveries to shore plants. A total of 40 trawl vessels engaged in the joint venture fishery in 1988. Vessels using certain other legal gear, such as salmon troll vessels and vessels using Portuguese (vertical) longlines or gill/set nets, may also land groundfish taken incidentally or intentionally. The most recent readily available information on the number of vessels in these categories is for 1985. In that year, 226 vessels derived a plurality of their income from troll and jig gears, 21 vessels from gill and dip nets, 111 from other nets, and 288 from other gears. A total of approximately 1,179 vessels participated in the west coast groundfish fishery in 1985.

1.3.2 Processing

1.3.2.1 Offshore Processing

Prior to 1989, there were no domestic vessels that both harvested and processed their catches (catcher/processor vessels) with the exception of a few pot vessels fishing for sablefish. However, there has been an increase in the number of vessels expressing interest in processing various groundfish species off the west coast, especially in 1990. There were 81 longline vessels, 12 pot vessels, and 67 trawl vessels operating as catcher/processors in Alaska in 1989. Because sablefish fishing and offshore processing could be profitable at this time for pot and longline vessels, additional vessels can be expected to enter this fishery in the immediate future. It is likely that some trawl catcher/processors will enter the Washington, Oregon, and California fishery as opportunities in Alaska are reduced.

There are currently no U.S. vessels that only process fish (mothership/processor vessels) operating in the west coast management area.

1.3.2.1 Shoreside Processing

In 1989, 121 potential groundfish processors were identified by port samplers and NMFS Fishery Market News Service. Of these, 106 were independent of the others (52 in Washington, 23 in Oregon, and 31 in California). In answer to a subsequent survey administered by the Council, 81 percent (60 of 74) of those responding identified themselves as groundfish processors. The break down by state was 31 of 39 in Washington, 13 of 18 in Oregon, and 16 of 17 in California.

1.3.3 Support Industries

In 1989, in response to a Council request, Sea Grant extension agents in Washington, Oregon, and northern California identified 276 firms directly involved in groundfish fishery support activities (exclusive of processors). Another indicator of numbers of firms which may supply inputs to the fishing industry is the NYNEX Commercial Marine Directory. This directory lists 1,284 firms for Washington and Oregon and includes suppliers of absorbants, cable and rope, steel, and valves, as well as accountants and architects who cater to the commercial marine industries. Some of these firms may cater more to commercial marine industries other than fishing. There is currently no commercial marine directory for California.

2.0 ISSUE 1: ESTABLISH STANDARDS TO PREVENT AND RESPOND TO OVERFISHING

2.1 Description of and Need for the Proposed Action

Section 301 of the MFCMA states that, in general,

> any fishery management plan prepared, and any regulation promulgated to implement any such plan, ... shall be consistent with the following national standards for fishery conservation and management.

The first national standard states that

> Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

While the priority to prevent overfishing is clear, the term is not defined in the MFCMA. To provide clearer guidance, NOAA prepared 50 CFR Part 602, Guidelines for FMPs (602 Guidelines) which provide a general definition of overfishing and directive to the regional councils to develop quantitative standards.

> Overfishing is a level or rate of fishing mortality that jeopardizes the long–term capacity of a stock or stock complex to produce MSY on a continuing basis. Each FMP must specify, to the maximum extent possible, an objective and measurable definition of overfishing for each stock or stock complex covered by that FMP, and provide an analysis of how the definition was determined and how it relates to reproductive potential.

There is also provision for exceptions to the requirement to prevent overfishing, but any exception requires an analysis demonstrating positive net benefits to the Nation. This exception is constrained by the Endangered Species Act.

> There are certain limited exceptions to the requirement of preventing overfishing. Harvesting the major component of a mixed fishery at is optimum level may result in the overfishing of a minor (smaller or less valuable) stock component in the fishery. A Council may decide to permit this type of overfishing if it is demonstrated by analysis ... that it will result in net benefits to the Nation, and if the Council's action will not cause any stock to require protection under the Endangered Species Act (ESA).

National standard 1 makes a distinction between achieving optimum yield (OY) and preventing overfishing. This distinction is important. OY relates to maximization of net benefits to the Nation and to maintaining MSY. The overfishing definition relates to preservation of each stock as a valuable asset. Harvesting at levels which approach overfishing may increase short–term benefits but reduce or threaten long–term benefits. The overfishing standards are to be used as constraints rather than targets. As a general rule, these should not coincide, although in some cases they may. However, the purposes are distinctly different.

The Council's policy for setting the level of acceptable biological catch (ABC) generally provides some protection against overfishing. For species with sufficient quantitative information, the ABC typically is set by forecasting the yield that would be obtained by applying the optimal fishing mortality (F_{MSY} or its proxy) to the exploitable biomass. Because of this fishing mortality policy, the ABC declines as the estimated stock abundance declines. Quotas and harvest guidelines may be set above the ABC only as a deliberate and conscious decision. The points of concern framework established by the FMP provides another line of defense against overfishing.

2.2 The Alternatives

The 602 Guidelines provide examples of ways to define overfishing, but the decision of what approach to use is left to the Council. Council discussions about overfishing definitions originally focused primarily on the minimum female spawning population size or "threshold" concept, and the use of maximum fishing mortality rate (F) was considered less viable. Neither approach is uncomplicated, and ultimately consensus of the scientific community converged on the use of fishing mortality rate rather than population threshold. The use of thresholds was rejected because of the dilemma of the degree of density–dependence in the spawner–recruit relationship and the disadvantage, when the stock is near the threshold, of an on/off fishery, high variability in catch, and high sensitivity to the precision of the stock assessments. Therefore, most of the alternative overfishing standards considered would set an upper limit on fishing mortality rate without depending on thresholds. The range of alternative overfishing standards presented below involve two major factors: (1) the relation between the target fishing mortality rate (F_{MSY} or its proxy, $F_{35\%}$) and the overfishing rate (F_{OF}), and (2) the degree to which the overfishing rate should decline as stock abundance declines below a specified level. The Council adopted Alternatives 2 and 6.

Alternative 1. Status quo: An explicit level of overfishing is not defined. ABC is determined by applying a target fishing mortality rate (F_{MSY}, $F_{0.1}$, or other criteria) to current available biomass. Harvest guideline or quota may be set above ABC, but a point of concern will be triggered if harvest is excessive.

Alternative 2 (PREFERRED). Overfishing is defined as exceeding the fishing mortality rate that would reduce spawning biomass per recruit to 20 percent of its unfished level.

Alternative 3. If MSY has been estimated through a comprehensive assessment,then set F_{OF} equal to 10 percent greater than F_{MSY}, otherwise calculate F_{OF} as the fishing mortality rate that would reduce spawning biomass per recruit to 30 percent of unfished spawning biomass per recruit (SBPR).

Alternative 4. If MSY has been estimated through a comprehensive assessment, then set F_{OF} equal to F_{MSY}, otherwise calculate F_{OF} as the fishing mortality rate that would reduce spawning biomass per recruit to 35 percent of unfished SBPR.

Alternative 5. Calculate maximum F_{OF} as in Option 3. If the spawning biomass is greater than or equal to the target level, then set the overfishing rate equal to maximum F_{OF}. If the spawning biomass is less than the target level, then F_{OF} declines in proportion to spawning biomass. The target absolute spawning biomass is defined as the equilibrium spawning biomass that would occur if F_{OF}

were applied and the spawner–recruitment curve followed a Beverton–Holt form and the level of recruitment was reduced by 10 percent when the absolute level of spawning biomass is reduced by 50 percent.

Alternative 6 (PREFERRED). For Options 2, 3, 4, or 5 when spawning biomass is greater than that which produces MSY, set F_{OF} equal to the greater of $F_{20\%}$ and the rate that would, in one year, reduce the spawning biomass to the level that produces MSY.

2.3 Biological and Physical Impacts

The overfishing guidelines make a clear distinction between the prevention of overfishing and the achievement of OY. Thus the specification of overfishing definition is not to be an optimal harvest policy. The overfishing definition is to be used as a constraint and not as a target. This amendment would establish standard criteria for evaluation of overfishing and identify necessary data for inclusion in the annual SAFE document. Overfishing parameters to be compared to the standards cannot be estimated for all species because of the wide range of knowledge available for the many species managed under the FMP. Three categories of species are identified. The first includes the few species for which a quantitative stock assessment can be conducted on the basis of catch–at–age or other data. The second category includes a large number of species for which some biological indicators are available, but a quantitative analysis cannot be completed. The third category includes minor species which are caught, but for which there is, at best, only partial information on landed biomass. Overfishing standards in general are linked to the same productivity assumptions that determine the ABC levels. Overfishing parameters for the second category of species, though, are difficult to estimate a priori, but indicators of long term, potential overfishing can be identified. ABC for species in this category are typically set at a constant level and some monitoring is necessary to determine if this level of catch is causing a slow decline in stock abundance. For the third category, it is impossible to determine MSY or ABC, or to estimate overfishing parameters.

The overfishing definition creates two issues that complicate the development of overfishing standards. First, the terms "long term" and "capacity" admit a range of interpretation with regard to the relationship between the optimal fishing mortality rate and a rate that would cause overfishing. A very high level of fishing mortality will reduce a stock to such a low level that a change in the ecosystem may occur. With this change, the species may no longer have the "capacity" to return to the level of abundance that could produce MSY. The level at which such depensation occurs is unknown. Generally, it is assumed that if an excessive fishing mortality rate is reduced, then the stock retains the "long–term capacity" to return to the MSY level. The most conservative perspective is that any level of fishing mortality greater than F_{MSY} will eventually reduce the stock below the level of abundance that produces MSY and prevent attainment of MSY. Thus three possible levels of overfishing may occur. The first is a very high level of fishing mortality that triggers depensation. Clearly this situation should be avoided and target fishing mortality rates should be set so that species do not approach such a reduction in stock abundance. The second level of overfishing is somewhat above F_{MSY} and related to the time horizon for stock recovery to the level that produces MSY; e.g., what is "long term"?. This level is sub–optimal from the single species perspective, and would have to be justified on the grounds of by–catch in multi–species fisheries or for short–term social or economic reasons. The third level identifies the fishing mortality rate that produces MSY as the upper end of a range of allowable mortality.

The second complication concerns the lack of information and knowledge regarding stock productivity. Overfishing is defined from the perspective that an adequate female spawning biomass must be maintained in order to provide continued potential recruitment. This does not necessarily require that a threshold of spawning biomass be determined, but it does require some assumptions with regard to the dependence of recruitment on spawning biomass at low levels of spawning biomass. MSY is similarly dependent on a balance between maximization of yield per recruit and minimization of reduction in recruitment. This balance depends on the degree of density–dependence in the relation between recruitment and spawner abundance. Unfortunately, the degree of density–dependence is unknown, even for the few species for which spawner–recruit data are available. The dilemma is that the degree of density–dependence for each species will not be known until recruitment is monitored for many years at lower stock levels, but if long–lived stocks are experimentally fished down to a very low level, they will be very slow in rebuilding (Pacific ocean perch, for example).

In lieu of knowledge regarding F_{MSY}, a compromise approach is to select a target fishing mortality rate that will produce a large fraction of the potential MSY under optimistic levels of density–dependence, while preventing large declines in stock biomass that would occur if the pessimistic level of density–dependence turns out to be true (Clark, in press). Figures 11.1–3 in Amendment 5 present a rationale for setting the target fishing mortality rate at a level, $F_{35\%}$, that would reduce female SBPR to 35 percent of its unfished level. The absolute level of spawning biomass declines to less than 35 percent of its unfished level because there is likely to be some reduction in the absolute level of recruitment. Clark (in press) indicates the fishing mortality rate that reduces the SBPR to 35 percent of the unfished level is a reasonable compromise when F_{MSY} is unknown. In general, as fishing mortality is increased, the yield per recruit increases and the spawning biomass per recruit decreases. The reduction in the absolute level of spawning biomass depends on how much the absolute level of recruitment declines as the absolute level of spawning biomass declines. F_{MSY}, $F_{0.1}$, and $F_{35\%}$ may all be of similar magnitude, especially when recruitment to the fishery occurs at the same age as recruitment to the spawning biomass. Differences between these levels of fishing mortality depend on the degree of density–dependence in the spawner–recruit relationship, which affects F_{MSY}, and the difference between mean age at recruitment to the fishery and mean age at maturity, which affects F_{MSY} and $F_{35\%}$. If the level of density–dependence is such that recruitment is 95 percent of pristine recruitment when spawning biomass is 50 percent of pristine spawning biomass, then the F_{MSY} is 0.38. The $F_{35\%}$ of 0.28 would maintain spawning biomass at a higher level and provide an equilibrium yield that is a large fraction of the MSY. If the level of density–dependence is 90 percent at 50 percent of pristine biomass, then $F_{35\%}$ is essentially identical to F_{MSY}. If the level of density–dependence is 80 percent at 50 percent of pristine biomass, then $F_{35\%}$ will cause a nearly 60 percent decline in recruitment and the absolute level of spawning biomass would be reduced, in this example, to only 14 percent of its unfished level. A recruitment decline of this magnitude should be measurable, and this observation of declining recruitment could be used to justify a decrease in the fishing mortality rate.

Even if landed catch stays within the harvest guidelines or quotas established by the target fishing mortality rate, it is possible for the spawning biomass to fall below the target range. First, discarded catch and other fishery activities may cause the total kill by the fishery to be greater than the landed catch, thus causing a gradual decline in stock abundance. Second, a sequence of poor recruitment may cause a natural decline in stock abundance. Third, a revision in the assessment of the stock may indicate that past levels of fishing were too high and caused the stock to decline below the target level. In all three cases, ABCs will decline as revised fishing mortality rates are applied to the lower estimates of available biomass. If harvest levels did not exceed ABC, the stock should gradually return to the target level. The recovery of the stock can be hastened if the fishing mortality is reduced below the target level while the stock is below its target level. This adjustment to the fishing mortality rate is, in effect, a rebuilding schedule. The benefits of this accelerated rebuilding rate should be compared to the costs in terms of increased variability in the available yield.

Amendment 5 adds a new Section 11.1.3.2 to the FMP which documents the recent quantitative assessments that allow evaluation of overfishing. The results are presented in Table 11.2 and Figures 11.4–6 of the amendment. In each case, current fishing mortality rates are compared to the potential standards. A hypothetical level of F_{MSY} is calculated for each species under the assumption that recruitment declines by 10 percent when spawning biomass (egg production) declines to 50 percent of its unfished level, however the degree of density-dependence is not known for any of these species. Because these fishing mortality rates are relatively low, changes in recommended yield will be in approximate proportion to changes in fishing mortality.

The impact of Alternative 1 will be nil since it represents the status quo with respect to the current process of setting ABCs. The current management scheme for setting and monitoring harvest levels will trigger a point of concern if a stock reaches a level below that which produces MSY for those stocks in which the status of stock information is available. The ABCs in this case serve as targets for exploitation and do not necessarily provide an upper constraint to the harvest that would initiate a review of overfishing if exceeded.

Alternative 2 sets a liberal upper constraint to exploitation above ABCs that would allow exploitation up to a fishing mortality rate that would reduce spawning biomass per recruit to 20 percent of its unfished level. In all cases, a point of concern should be triggered before overfishing criteria would be exceeded.

Alternative 3 creates an upper limit for annual catch that exceeds ABC based on an F_{OF} set equal to $F_{30\%}$ or 110 percent of F_{MSY}. For those species managed with quotas or harvest guidelines, this would allow for a harvest of about 110 percent of ABC before the overfishing criterion would be triggered initiating a review of overfishing. This alternative would not impact the 1990 fishing mortality rate or the recommended harvest level for Pacific whiting. In 1990, the biomass of mature female sablefish is 29 percent of the estimated unfished female spawning biomass and the fishing mortality rate being applied is expected to reduce the spawning biomass per recruit to about 24 percent of its unfished level. For sablefish the recommended 1990 fishing mortality rate is approximately 0.15, which is approximately 10 percent greater than the $F_{30\%}$ rate. Therefore, under Alternative 3 fishing mortality rates for sablefish would have to be reduced to prevent triggering an overfishing review. For widow rockfish, the 1990 fishing mortality rate is 0.37, which is substantially greater than $F_{30\%}$. The spawning biomass is estimated to be about 29 percent of the unfished biomass. Therefore, under Alternative 3 fishing mortality rate and the harvest for widow rockfish would have to be reduced in the future to prevent an overfishing review. For yellowtail rockfish, the preliminary estimate of fishing mortality rate is also approximately 10 percent greater than $F_{30\%}$, rates at this level would trigger an overfishing review.

Alternative 4 is more conservative than Alternative 3 in that F_{OF} would set be equal to that which sets ABC. An overfishing review would be triggered whenever ABC is exceeded by the fishery. Under the 1990 conditions, only the Pacific whiting fishery would not be impacted. Overfishing standards would be exceeded for sablefish, widow and yellowtail rockfish, and harvest rates would have to be reduced from the current level to provided the desired protection to the stocks.

The overfishing standards for Alternative 5 with respect to Alternative 3 are more conservative for biomass levels below that which produces MSY. At levels above MSY, Alternative 5 is equivalent to Alternative 3 and more liberal than Alternative 4. The overfishing constraint imposed by this alternative would have a greater impact on the fisheries for widow and yellowtail rockfish and sablefish than Alternative 3 and would provide greater protection to the fish stocks if abundance continues to decline.

Alternative 6 would modify Alternatives 2, 3, 4 or 5 only when spawning biomass was estimated to be above that level which produces MSY. In this case, the overfishing standard would increase faster than ABC values. This would reduce the potential constraint on the fisheries but could increase the risk of reducing the productivity of the stocks if the fisheries were allowed to harvest greatly in excess of ABC.

2.4 Social and Economic Impacts

The impacts of any overfishing definition depend in large part on the Council's success in avoiding conditions where the definition will come into play. If management is oriented to obtaining MSY, none of the alternative definitions should be overly restrictive on the fishery. However, even a well-managed stock can fall below the biomass level that produces MSY due to fluctuation in recruitment and natural mortality resulting from environmental/ecological factors. In addition, imperfect information and understanding of population size and dynamics make it reasonable to assume that overfishing conditions will occur for some species.

Prudent management would limit harvests even in the absence of overfishing standards; any difference is probably only a matter of degree and the rate of rebuilding to MSY levels. In most cases, the rate of rebuilding probably cannot be predicted accurately. Thus, it is difficult to assess the relative impacts of the alternatives. In general, if a species' reproductive rate is higher and it would naturally return to MSY levels in a relatively short period of time, it will be better to rebuild the stock more quickly by maintaining a lower fishing mortality rate (i.e., choosing a more conservative overfishing definition). For species that reproduce more slowly, the payback from reduced harvest would be delayed, thus making it more difficult to recoup any losses generated in the short run. In that case, a higher fishing mortality rate could be advisable.

Alternative 6 is actually a suboption for Alternatives 2, 3, 4 and 5. It provides the flexibility to increase harvests when a stock is above the MSY level. For example, if the biomass which produces MSY is 150,000 mt and current biomass is 200,000 mt, as much as 50,000 mt (i.e., 200,000 to 150,000) could be taken in that year without overfishing (assuming no other factors would reduce the biomass below MSY in that year). This does not imply the overfishing standard should be the optimum fishing strategy. This approach maximizes the potential short-term gain, but allows greater year to year variation in harvest levels. This situation arose with Pacific whiting for the 1988 fishing year when the Groundfish Management Team (GMT) presented a range of ABC values to the Council. Applying F_{MSY} to the biomass estimate resulted in an ABC of 327,000 mt for the entire stock in U.S. and Canadian waters. Simulation modeling indicated higher average yields could be obtained with a variable effort policy which would take 587,000 mt in 1988 but by 1990 would drop to 182,000 mt. The model indicated that a level catch of 325,000 mt per year between 1988 and 1990 would result in the same drop in biomass by 1990. The Council chose the level catch approach in order to maintain stability. Such fluctuations are less likely for long-lived species.

The mixed-stock nature of most fisheries complicates the overfishing issue because the value of commingled species must be taken into account when considering the maximum benefit to the nation. The 602 Guidelines recognize the possibility that such values may be justification for harvesting beyond any standard for overfishing (within the constraint that no species may be fished to the point of threatened or endangered status under the ESA). The Council will consider such economic information prior to recommending management measures.

Under current conditions, Alternatives 3 and 4 are particularly constraining on the Council. Under Alternative 3, overfishing rates would be set up to 10 percent above the F_{MSY} level ($F_{35\%}$). Sablefish, widow rockfish, and yellowtail rockfish harvests would be constrained. Alternative 4 is even more conservative and would set overfishing equal to the Council's policy of setting ABCs and harvest levels using F_{MSY}. Harvest of all individually-managed species would be constrained under this approach. There is a fundamental problem with this approach in that it equates optimum fishing strategy with overfishing.

2.4.1 Administrative, Enforcement and Information Costs and Benefits

No additional administrative or enforcement costs are anticipated under any of the alternatives. However, for many species, insufficient information is available to estimate overfishing parameters or to quantitatively measure harvest levels. To achieve the information level necessary to bring all groundfish species into Category 1 status, significant state and federal expenditures would be required, as well as substantial increases in reporting by fishermen and fish processors. While such a scenario is feasible, it is not likely.

If a stock rebuilding program becomes necessary due to any of the alternatives, it will become necessary to constrain the total harvest of that species so that the fishing mortality rate is within the acceptable range. If the species is caught in conjunction with the harvest for other species, it will be impossible to completely eliminate all fishing-related mortality. Measuring by-catch in those fisheries could be an integral part of a rebuilding program, and could impose costs on the industry to provide the necessary information. The benefits of obtaining that information would include a better understanding of the effectiveness of the recovery program and a more accurate schedule for achieving the rebuilding objectives.

2.4.2 Impacts on Consumers

Availability of fish and fish products is not expected to be affected by any of the alternatives considered in this amendment. It is anticipated that continuation of the Council's past management practices will avoid situations where overfishing standards are necessary to constrain harvests. In cases where the Council decides to intentionally overfish, it will do so only after determining that it is in the best interest of the Nation to do so; i.e., that positive net benefits would result from such a policy.

2.4.3 Redistribution of Benefits and Costs

No redistribution of costs or benefits is anticipated from any of the alternatives.

2.5 Overfishing Standard Adopted by the Council

The Council adopted Alternatives 2 and 6. Alternative 2 sets an upper constraint to exploitation above ABCs that would allow exploitation up to a fishing mortality rate that would reduce spawning biomass per recruit to 20 percent of its unfished limit. Alternative 6 reduces the potential constraint on harvest when a stock is above the MSY level.

3.0 EFFECTS ON ENDANGERED SPECIES AND ON THE COASTAL ZONE

The ESA is discussed in Section 11.6.2 of the FMP. It is possible that alternatives being considered would constitute actions that "may affect" endangered species or their habitat within the meaning of the regulations implementing Section 7 of the ESA of 1973. The Council has requested a consultation under Section 7 in conjunction with Amendment 4, which will be applicable to this amendment also.

The relationship of the FMP to the Coastal Zone Management Act of 1972 is discussed in Section 11.6.1 of the FMP. Each of the alternatives in Amendment 5 is consistent, to the maximum extent practicable, with the coastal zone management programs of Washington, Oregon, and California within the meaning of Section 307(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations.

4.0 OTHER EXECUTIVE ORDER 12291 REQUIREMENTS

Executive Order 12291 requires that the following three issues be considered:

(a) Will the amendment have an annual effect on the economy of $100 million or more?

(b) Will the amendment lead to an increase in the costs or prices for consumers, individual industries, federal, state, or local government agencies or geographic regions?

(c) Will the amendment have significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S. based enterprises to compete with foreign enterprises in domestic or export markets?

Regulations do impose costs and cause redistribution of costs and benefits. Implementation of this amendment is not expected to result in significant costs relative to total operational costs.

The amendment will not have significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S. based enterprises to compete with foreign enterprises in domestic or export markets.
The amendment should not lead to a substantial increase the price paid by consumers, local government, or geographic regions since no significant quantity changes are expected in the groundfish markets.

This amendment will not have an annual effect of $100 million, since the total value of the domestic catch of all groundfish species is generally under $100 million. This amendment is not expected to substantially alter the amount or distribution of this catch.

5.0 IMPACT OF THE AMENDMENT RELATIVE TO THE REGULATORY FLEXIBILITY ACT

The RFA requires that impacts of regulatory measures imposed on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions with limited resources) be examined to determine whether a substantial number of such small entities will be significantly impacted by the measures. Fishing vessels are considered to be small businesses. A total of 1,179 vessels may fish for groundfish off Washington, Oregon, and California in 1990. While these numbers are considered substantial, any regulatory measures resulting from this amendment will only affect a smaller proportion of the fleet.

6.0 FINDING OF NO SIGNIFICANT IMPACT

For the reasons discussed above, neither implementation of the status quo nor any of the alternatives is expected to significantly affect the quality of the human environment, and the preparation of an EIS on the final action is not required by Section 102(2)(c) of the NEPA or its implementing regulations.

____________________________ ________________

Assistant Administrator for Fisheries — Date

7.0 COORDINATION WITH OTHERS

The preparers of this document consulted extensively with members of the GMT which includes representatives from the California Department of Fish and Game, Washington Department of Fisheries, Oregon Department of Fish and Wildlife and National Marine Fisheries Service.

8.0 LIST OF PREPARERS

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9.0 REFERENCES

Clark, W. G. (in press) Groundfish Exploitation Rates Based of Life History Parameters. Can. J. Fish. Aquat. Sci. vol. 48.

10.0 PROPOSED CHANGES TO THE FMP

Amendment 5 makes the following changes to the FMP (as amended through Amendment 4).

(1) Section 2.2 Operational Definitions of Terms – Add the following terms:

Exploitable biomass is the biomass that is available to a unit of fishing effort. Defined as the sum of the population biomass at age (calculated as the mean within the fishing year) multiplied by the age–specific availability to the fishery. Exploitable biomass is equivalent to the catch biomass divided by the instantaneous fishing mortality rate.

Spawning biomass is the biomass of mature female fish at the beginning of the year. If the production of eggs is not proportional to body weight, then this definition should be modified to be proportional to expected egg production.

Spawning biomass per recruit is the expected egg production of a female fish over its lifetime. Alternatively, this is the mature female biomass of an equilibrium stock divided by the mean level of recruitment that produced this stock.

Density dependence is the degree to which recruitment declines as spawning biomass declines. Typically we assume that a Beverton–Holt form is appropriate and that the level of density–dependence is such that the recruitment only declines by 10 percent when the spawning biomass declines by 50 percent.

F is the instantaneous rate of fishing mortality. F typically varies with age, so the F values are presented for the age with maximum F. Fish of other ages have less availability to the fishery, so a unit of effort applies a lower relative level of fishing mortality to these fish.

F_{MSY} is the fishing mortality rate that maximizes catch biomass in the long term.

$F_{0.1}$ is the fishing mortality rate at which a change in fishing mortality rate will produce a change in yield per recruit that is 10 percent of the slope of the yield curve at nil levels of fishing mortality.

F_{OF} is the rate of fishing mortality defined as overfishing.

$F_{x\%}$ is the rate of fishing mortality that will reduce female spawning biomass per recruit to x percent of its unfished level. $F_{100\%}$ is zero, and $F_{35\%}$ is a reasonable proxy for F_{MSY}.

(2) Section 5.0 SPECIFICATION AND APPORTIONMENT OF HARVEST LEVELS

(A) Revise the first paragraph of Section 5.0 to read as follows:

The ability to establish and adjust harvest levels is the first major tool at the Council's disposal to exercise its resource stewardship responsibilities. Each fishing year, the Council will assess the biological, social, and economic condition of the Pacific coast groundfish fishery, **update overfishing parameters for specific stocks where new information on the population dynamics is available,** and will make its assessment available to the public in the form of the SAFE document described in

Section 5.1. Based upon the most recent stock assessments, the Council will **evaluate the current level of fishing relative to the overfishing standards for stocks where sufficient data are available to estimate overfishing parameters to compare against the standards** and develop estimates of the ABC for major species or species groups and identify those species or species groups which it proposes to be managed by the establishment of numerical harvest levels. **For those stocks for which overfishing is judged to characterize current conditions or for which biomass is judged to be below the target level, the Council will consider a stock rebuilding management strategy**. The specification of numerical harvest levels includes the estimation of ABC, the establishment of harvest guidelines or quotas for specific species or species groups, and the apportionment of numerical specifications to domestic annual processing, joint venture processing, total allowable level of foreign fishing, and the reserve. The specification of numerical harvest levels described in this chapter is the process of designating and adjusting overall numerical limits for the a species or species group either throughout the entire fishery management area or throughout specified subareas. The process normally occurs annually between September and November, but can occur, under specified circumstances at other times of the fishing year. Numerical limits which allocate the resource or which apply to one segment of the fishery and not another are imposed through the socio-economic framework process described in Chapter 6 rather than the specification process.

(B) Add the following as step one in the annual specification process, page 5-1, and sequentially renumber the others:

1. Update the overfishing parameter estimates for comparison with the overfishing standards for those species or species groups where sufficient data and information are available.

(3) Section 5.1, Stock Assessment and Fishery Evaluation (SAFE) Document

(A) On page 5-2, revise the first paragraph to read as follows:

For the purpose of providing the best available scientific information to the Council for **evaluating the status of the fisheries relative to the overfishing definition,** developing ABCs, determining the need for individual species or species group management, setting and adjusting numerical harvest levels, assessing social and economic conditions in the fishery, and updating the appendices of this FMP, a SAFE document is prepared annually. Not all species and species groups can be re-evaluated every year due to limited state and federal resources. However, the SAFE document will, at a minimum, contain the following information:

(B) On page 5-2, add the following as item 2 in the list of information contained in the SAFE document, and sequentially renumber the others:

2. Specify and update estimates of overfishing parameters for those species or species groups for which information is available.

(4) Section 5.2 Establishment and Adjustment of ABC

(A) Revise the section number to 5.2.2

(B) Add the following new sections 5.2, 5.2.1, 5.2.1.1, and 5.2.1.2.

5.2 Establishment and Adjustment of the Specifications of Overfishing and ABC

5.2.1 Specification of Overfishing

In 50 CFR Part 602, the NOAA presented guidelines for FMPs which require each FMP to include an objective and measurable definition of overfishing for each stock or stock complex under management. These guidelines make a clear distinction between the prevention of overfishing and the achievement of OY. Thus the specification of overfishing definition is not to be an optimal harvest policy. The overfishing definition is to be used as a constraint and not as a target. Overfishing, as defined, is "a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis". Standard criteria are established for evaluation of overfishing, and necessary data are identified for inclusion in the annual SAFE document. Overfishing parameters to compare with the standards cannot be estimated for all species because of the wide range of knowledge available for the many species managed under the FMP. Three categories of species are identified. The first are the few species for which a quantitative stock assessment can be conducted on the basis of catch-at-age or other data. The second category includes a large number of species for which some biological indicators are available, but a quantitative analysis cannot be conducted. The third category includes minor species which are caught, but for which there is, at best, only information on landed biomass. Overfishing standards in general are linked to the same productivity assumptions that determine the ABC levels. Overfishing parameters for the second category of species are difficult to estimate a priori, but indicators of long term, potential overfishing can be identified. ABC for species in this category are typically set at a constant level and some monitoring is necessary to determine if this level of catch is causing a slow decline in stock abundance. For the third category, it is impossible to determine MSY, ABC, or to estimate overfishing parameters.

The overfishing standard is defined as an upper limit to fishing mortality rate. Specifically, it is defined as exceeding the fishing mortality rate that would reduce spawning biomass per recruit to 20 percent of its unfished level. When spawning biomass is greater than that which produces MSY, F_{OF} equals the greater of $F_{20\%}$ and the rate that would, in one year, reduce the spawning biomass to the level that produces MSY.

5.2.1.1 Species with Quantitative Stock Assessment, Category 1

The species with quantitative stock assessments are those that have recently been assessed by a catch-at-age analysis. Annual evaluation of overfishing for species in this category will require some specific information in the SAFE document. Estimated age-specific maturity, growth, and availability to the fishery (with evaluation of changes over time in these characteristics) are sufficient to determine the relationship between fishing mortality and yield-per-recruit and spawning biomass-per-recruit. The estimated time series of recruitment, spawning biomass, fishing mortality are also required to determine whether recent trends indicate a point of concern. This information enables the following investigation:

a. Is the current spawning biomass below the level that produces MSY? What is the apparent cause of the current condition (historical fishing patterns, a declining abundance or recruitment trend, a change in assessment methodology, or other factors)?

b. Is there a downward trend in recruitment that may indicate insufficient compensation in the spawner–recruitment relationship? (Recruitment below about 60 percent of previous levels may indicate the current policy is too aggressive and target fishing mortality should be decreased.)

c. Based on an comparison of historical harvest levels (including discards) relative to recommended ABC levels, has there been chronic overharvest?

d. Is human–induced environmental degradation implicated in the current stock condition? Have natural environmental changes been observed that may be affecting growth, reproduction and/or survival?

e. Would reduction in fishing mortality be likely to improve the condition of the stock?

f. Is the particular species caught incidentally with other species? Is it a major or minor component in a mixed–stock complex?

Based on this investigation, if the Council determines that overfishing has occurred or is expected to occur, the provisions of <u>Section 5.6 Stock Rebuilding Programs</u> will be followed.

If a significant reduction in fishing mortality is recommended to hasten rebuilding and the species is harvested jointly with other species, then the costs and benefits of the rebuilding schedule will be reviewed with respect to the total value of the relevant portion of the entire fishery.

5.2.1.2. Species with ABC Set by Non–Quantitative Assessment, Category 2

These species with ABC set by non–quantitative assessments typically do not have a recent, quantitative assessment, but there may be a previous assessment or some indicators of the status of the stock. Detailed biological information is not routinely available for these species, and ABC levels have typically been established on the basis of average historical landings. Although the overfishing standard criteria apply, setting an overfishing level for these species is problematic because the spawning biomass, level of recruitment, or the current fishing mortality rate are unknown.

Each species in a multi–species fishery probably has an unique optimal rate of harvest, so the multi–species fishery probably cannot simultaneously attain the MSY from all species. However, if the optimum rates of harvest do not differ greatly among species, then minor species caught incidentally to major, target species probably will not be overfished as long as the fishing mortality rate for the target species is well controlled. Overfishing of minor, by–catch species is possible, and some monitoring of these species is prudent. Changes in the level of landed catch are the first indicator of a change in the status of these stocks. These changes in landed catch must be examined with respect the level of effort, market demand, and catch of the assemblage of species in the fishery. Short–term changes in market demand, recruitment and the distribution of the stock may influence the level of landed catch and various indicators of stock abundance. Therefore, only longer–term monitoring of these factors can reliably indicate true potential for overfishing. Most of these indicators would exhibit trends during the normal fishing down process, and it is assumed that fishing down has been essentially completed and that future trends may be indicators of excessive fishing mortality. The groundfish species managed in the FMP are typically long-lived and annual catch can be only a small fraction of available biomass. Thus, the consequences of overfishing will only be realized in the long term, unless there are great increases in the level of fishing effort, or some cause of catastrophic mortality. The following are a list of potential indicators:

catch per effort from logbooks
catch area from logbooks
index of stock abundance from surveys
stock distribution from surveys
mean size of landed fish

If declining trends persist for more than three years, then a focused evaluation of the status of the stock, its ABC and the overfishing parameters will be quantified. If data are available, such an evaluation should be conducted at approximately five year intervals even when negative trends are not apparent. In fact, many stocks are in need of a re-evaluation to establish a baseline for monitoring of future trends. Whenever an evaluation indicates the stock may be declining and approaching an overfished state then the Council should:

1. improve data collection for this species;

2. determine the rebuilding rate that would increase the multi-species value of the fishery.

5.2.1.3 Species Without ABC Values, Category 3

A total of 83 species are identified for management under the FMP (Table 3.1). ABC values and assessments are not available for approximately 70 of these species. Fish of these species are incidentally landed and usually are not listed separately in fish landing receipts. Information from fishery independent surveys are often lacking for these species because of their low abundance or they are not vulnerable to survey sampling gear. Without an at-sea observer program, it is unlikely that a data base will be developed in the future for these species to upgrade the assessment capability or evaluate their overfishing potential.

(5) Section 5.6 Stock Rebuilding Programs

(A) In the first paragraph, revise the second sentence to read:

Rebuilding objectives may be established by the Council on a case by case basis, taking into account the **approved overfishing standard,** ABC, MSY, spawner recruit relationships, growth and maturation rates, age of recruitment, anticipated or assessed year class strength and age structure of the population, economic importance, and any other relevant social, economic, biological, or ecological factors.

Also, delete the last two sentences.

(B) In the last paragraph on page 5-7, delete references to Amendment 4. Replace the first sentence with the following:

"A 20-year rebuilding program for Pacific ocean perch established by the FMP in 1982 is currently in effect."

Revise the fourth sentence to read:

"Quotas and trip limits have been used in the past to allow retention only of amounts of Pacific ocean perch taken incidentally to fisheries for other groundfish species."

(6) In Section 11, APPENDIX

(A) Add a new Section as follows:

<u>11.1.2.2 Overfishing Model</u>

Overfishing, as defined, is "a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis". This definition creates two issues that complicate the development of overfishing standards. First, the terms "long term" and "capacity" admit a range of interpretation with regard to the relationship between the optimal fishing mortality rate and a rate that would cause overfishing. A very high level of fishing mortality will reduce a stock to such a low level that a change in the ecosystem may occur. With this change, the species may no longer have the "capacity" to return to the level of abundance that could produce MSY. The level at which such depensation occurs is unknown, and it is assumed that if an excessive fishing mortality rate is reduced, then the stock retains the "long-term capacity" to return to the MSY level. A more conservative perspective is that any level of fishing mortality greater than F_{MSY} will eventually reduce the stock below the level of abundance that produces MSY and prevent attainment of MSY. Thus three possible levels of overfishing may occur. The first is a very high level of fishing mortality that triggers depensation. Clearly this situation should be avoided and target fishing mortality rates should be set so that species do not approach such a reduction in stock abundance. The second level of overfishing is related to the time horizon for stock recovery to the level that produces MSY, e.g. what is "long term"?. This level is sub-optimal from the single species perspective, and would have to be justified on the grounds of by-catch in multi-species fisheries or for short-term social or economic reasons. The third level identifies the fishing mortality rate that produces MSY as the upper end of a range of allowable mortality.

The second complication concerns the lack of information and knowledge regarding stock productivity. Overfishing is defined from the perspective that an adequate female spawning biomass must be maintained in order to provide continued potential recruitment. This does not necessarily require that a threshold of spawning biomass be determined, but it does require some assumptions with regard to the dependence of recruitment on spawning biomass at low levels of spawning biomass. MSY is similarly dependent on a balance between maximization of yield per recruit and minimization of reduction in recruitment. This balance depends on the degree of density-dependence in the relation between recruitment and spawner abundance. Unfortunately, the degree of density-dependence is unknown, even for the few species for which spawner-recruit data are available. The dilemma is that the degree of density-dependence for each species will not be known until recruitment is monitored for many years at lower stock levels, but if long-lived stocks are experimentally fished down to a very low level, they will be very slow in rebuilding; e.g., Pacific ocean perch.

In lieu of knowledge regarding F_{MSY}, a compromise approach is to select a target fishing mortality rate that will produce a large fraction of the potential MSY under optimistic levels of density-dependence, while preventing large declines in stock biomass that would occur if the pessimistic level of density-dependence turns out to be true (Clark, in press). Figures 11.1-3 present a rationale for setting the target fishing mortality rate at a level, $F_{35\%}$, that would reduce female SBPR to 35 percent of its unfished level. The absolute level of spawning biomass declines to less than 35 percent of its unfished level because there is likely to be some reduction in the absolute level of recruitment. Clark (in press) indicates that the fishing mortality rate that reduces the SBPR to 35 percent of the unfished level is a reasonable compromise when F_{MSY} is not known. As fishing mortality is increased, the yield per recruit increases and the spawning biomass per recruit decreases (Figure 11.1). The reduction in the absolute level of spawning biomass depends on how much the absolute level of recruitment declines as the absolute level of spawning biomass declines (Figure 11.2). The combination of the factors in Figures 11.1 and 11.2 allows presentation of the relation between equilibrium yield and spawning biomass for different levels of fishing mortality and for different levels of density-dependence (Figure 11.3). F_{MSY}, $F_{0.1}$, and $F_{35\%}$ may all be of similar magnitude, especially when recruitment to the fishery occurs at the same age as recruitment to the spawning biomass. Differences between these levels of fishing mortality depend on the degree of density-dependence in the spawner-recruit relationship, which affects F_{MSY}, and the difference between mean age at recruitment to the fishery and mean age at maturity, which affects F_{MSY} and $F_{35\%}$. Figures 11.1-3 illustrate the performance of $F_{35\%}$ relative to a range of plausible levels of density-dependence. If the level of density-dependence is such that recruitment is 95 percent of pristine recruitment when spawning biomass is 50 percent of pristine spawning biomass, then the F_{MSY} is 0.38. The $F_{35\%}$ of 0.28 would maintain spawning biomass at a higher level and provide an equilibrium yield that is a large fraction of the MSY. If the level of density-dependence is 90 percent at 50 percent, then $F_{35\%}$ is essentially identical to F_{MSY}. If the level of density-dependence is 80 percent at 50 percent, then $F_{35\%}$ will cause a nearly 60 percent decline in recruitment and the absolute level of spawning biomass would be reduced, in this example, to only 16 percent of its unfished level. A recruitment decline of this magnitude should be measurable, and this observation of declining recruitment could be used to justify a decrease in the fishing mortality rate. These considerations of the relationship between fishing mortality and spawning biomass lead to an overfishing standard that is defined as an upper limit to fishing mortality rate, rather than a lower threshold limit to female spawning biomass.

(B) In Section 11.1.3, revise the title to read **11.1.3 Status of Stocks: MSY and Exploitable Biomass Estimates, and Overfishing Parameter Estimates**

(C) Before the first paragraph, insert a new section title <u>11.1.3.1 MSY and Exploitable Biomass Estimates</u> and renumber the individual species sections sequentially beginning with <u>11.1.3.1.1 Lingcod</u>.

(D) Add a new section as follows:

Section 11.1.3.2 Overfishing Parameter Estimates by Species

This section identifies the species in each category for 1989 based on the quantitative assessment information available in 1988 and 1989. Species in Category 1 include sablefish, widow rockfish, and yellowtail rockfish. Species in Category 2 are Pacific ocean perch, shortbelly rockfish, bocaccio rockfish, canary rockfish, chilipepper rockfish, jack mackerel, lingcod, Pacific cod, Dover sole, English sole, and petrale sole. The remaining species listed in Table 3.1 are in Category 3. Dover sole and canary rockfish should join Category 1 in 1991, and other species may be added as more information becomes available in the future. This information will be updated annually in the SAFE document. The results are presented in Table 11.2 and Figures 11.4–6. In each case, current fishing mortality rates are compared to the potential standards. A hypothetical level of F_{MSY} is calculated for each species under the assumption that recruitment declines by 10 percent when spawning biomass (egg production) declines to 50 percent of its unfished level, however the degree of density-dependence is not known for any of these species. Because these fishing mortality rates are relatively low, changes in recommended yield will be in approximate proportion to changes in fishing mortality.

Pacific Whiting. The high variability of recruitment to this stock influenced recommendation of a conservative harvest strategy that protects the spawning stock when a sequence of poor recruitments cause a decline in stock abundance. The current harvest strategy varies the recommended fishing mortality rate in proportion to the estimate of spawning biomass. Quotas keep the actual harvest close to the target level, and there is little by-catch in other fisheries. The mean level of fishing mortality for this species was designed to allow the population to fluctuate below about 25 percent of its unfished female spawning biomass in 25 percent of the years. The mean female spawning biomass under this strategy is expected to be about 39 percent of the unfished female spawning biomass. In 1990, the stock level and recommended yield are very close to the expected long-term average. The current fishing mortality rate is very similar to $F_{0.1}$, F_{MSY} and $F_{35\%}$, and substantially less than $F_{30\%}$.

Sablefish. Sablefish has been managed by setting an annual quota and allocating a portion of this quota to a target fishery by fixed gear and a portion to the trawl fishery that harvests sablefish in conjunction with other species. The recommended ABC has been based on a constant fishing mortality rate. In 1990, this rate was the average of F_{MSY}, calculated under the assumption that recruitment declines by 10 percent when spawning biomass declines by 50 percent, and $F_{0.1}$. It was noted, however, that $F_{0.1}$ was an optimistic policy that would reduce spawning biomass to 21 percent of its unfished level. This occurs because sablefish recruit to the trawl fishery before they are mature. In 1990 the biomass of mature female sablefish is 29 percent of the estimated unfished female spawning biomass and the fishing mortality rate being applied is expected to reduce the spawning biomass per recruit to about 24 percent of its unfished level. The fishing mortality rate recommended for 1990, 0.15, is approximately 10 percent greater than the $F_{30\%}$ rate.

Widow Rockfish. The recommended ABC for widow rockfish in 1990 was determined by applying $F_{0.1}$ to the estimated current biomass. The quota for widow rockfish in 1990 was set above the recommended ABC level on the basis of a substantial drop in recommended ABC between 1989 and 1990, and uncertainty with regard the current status of the stock. The upper range of estimated, exploitable biomass in 1990 was 22 percent greater than the level recommended in the assessment. This evaluation of overfishing is linked to the status of stock recommended by the GMT and not the higher level used in the setting of the quota.

Widow rockfish have been determined to have increased fecundity per unit body weight as they get older (larger). This factor has been incorporated into the this overfishing analysis and reduces the recommended level of fishing mortality substantially below $F_{0.1}$. The $F_{0.1}$ calculation does not incorporate consideration of impacts on spawning biomass (egg production), and fishing at this rate would reduce egg production to about 12 percent of its unfished level if the level of density-dependence portrayed in Figure 11.6 is correct. A substantial reduction in the widow rockfish fishing mortality rate is indicated by this analysis.

Yellowtail Rockfish. This species is a dominant component of the Sebastes complex in the northern Columbia and Vancouver areas. It is managed by trip limits designed to achieve specified harvest guidelines, but quotas have not been set for this species. An assessment of yellowtail rockfish was last conducted in 1988 utilizing catch-at-age data through 1985. This assessment did not include presentation of spawning biomass levels that would allow evaluation of overfishing. A revised, updated assessment is in preparation. Table 11.2 presents fishing mortality rates which fall in the range 0.15 to 0.18. The recommended fishing mortality rates have also been in this range. The actual fishing mortality rate in 1990 is indicated as greater than 0.20, but this value may change with the revised assessment.

For species that lack detailed biological information and estimates of critical population parameters and do not have an up-to-date quantitative assessment, ABC levels have typically been established on the basis of average historical landings. Species without recent quantitative assessments include lingcod, bank rockfish, Pacific ocean perch, arrowtooth flounder, English sole, petrale sole, and rex sole. The available information for these species is summarized in Table 11.1 and in Sections 11.1.1 and 11.1.3.1.

Table 11.2. Summary of female spawning biomass (F.S.B.) and fishing mortality rates for four major west coast species. F.S.B. has units of 1000 mt (except for widow rockfish, see notes). Fishing mortality rates (F) are relative to the age at full selectivity. Target F.S.B. and F_{MSY} are calculated assuming a spawner–recruit relationship with a 10 percent decline in recruitment occurring with a 50 percent decline in F.S.B.

	WHITING	SABLEFISH	WIDOW	YELLOWTAIL
UNFISHED F.S.B.	1628	200	454	---
CURRENT TARGET F.S.B.	615	42–52	102	---
1990 F.S.B.	599	58	131	---
Age at full selectivity	8	5	8–9	10
Age at 50% maturity	3	5	7	10
Natural mortality	.20	.09	.15–.20	.11
Current Target F	.46	.12–.19	.32	.16–.19
1990 F	.45	.15	.37	>.20?
$F_{0.1}$	.49	.22	.32	.18
F_{MSY}	.45	.12	.21	.15
$F_{20\%}$	>1.00	.20	.35	.30
$F_{30\%}$	.57	.14	.24	.18
$F_{35\%}$	.45	.12	.20	.15

NOTES:

Whiting: Recommended F varies in proportion to F.S.B.
Sablefish: Two fisheries (trawl and fixed gear). Assume that half of F is applied by each fishery.

Widow rockfish: F.S.B. is in terms of egg production because older females produce nearly twice as many eggs per unit body weight as do younger females. For comparison, the biomass of female spawners in 1990 was 39,000 mt. Calculations based on M=.15, tuned to mean of alternatives in 1989 stock assessment.
Yellowtail rockfish: results from 1988 stock assessment, revised assessment is in preparation.

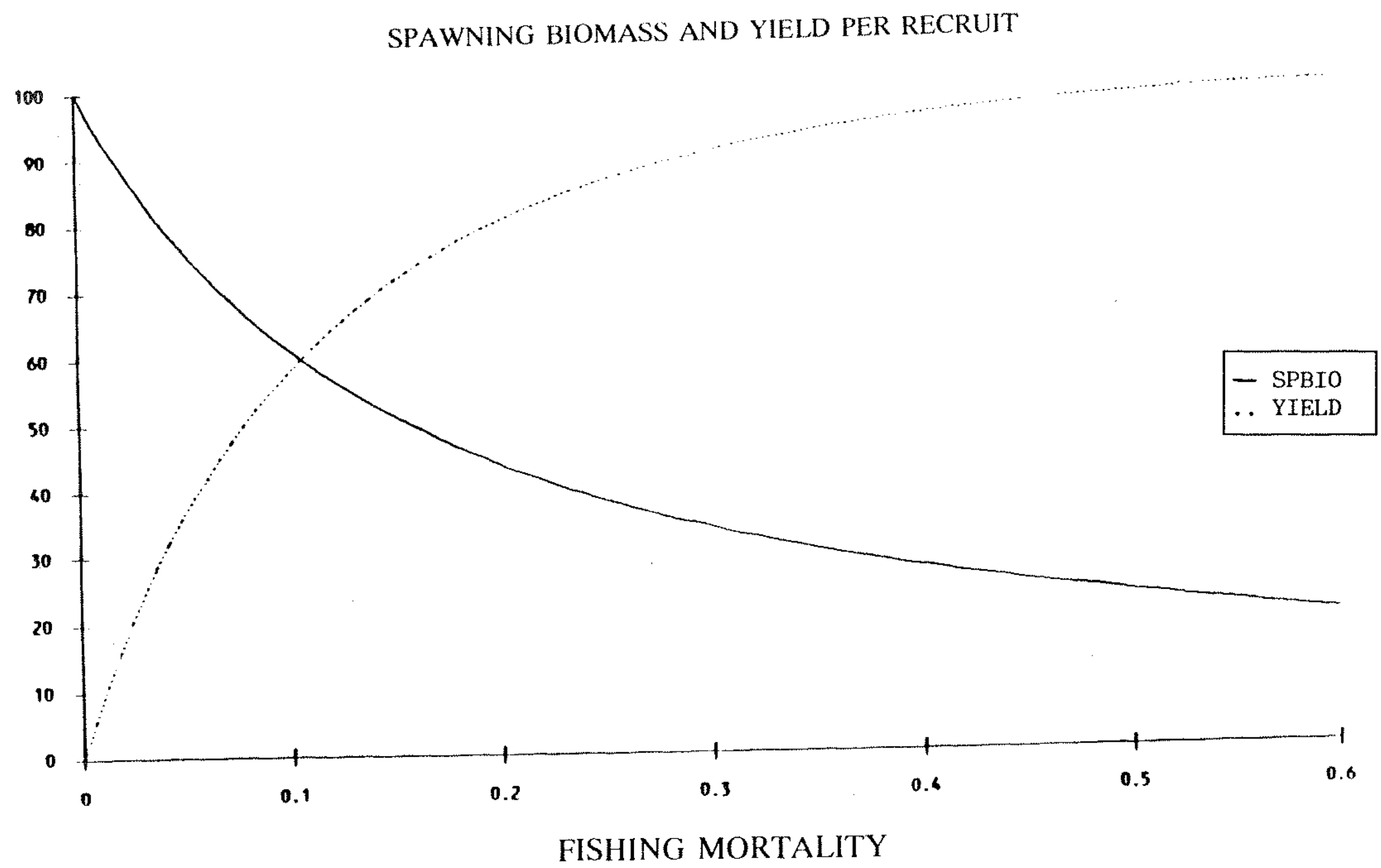

Figure 11.1. Yield per recruit and spawning biomass per recruit expressed as a function of the fishing mortality rate. In this example, natural mortality is set equal to 0.20 and age-specific recruitment to the fishery is identical to age-specific recruitment to the spawning biomass. Here, the F that reduces spawning biomass per recruit to 35 percent of its unfished level is 0.28, and the $F_{0.1}$ is 0.26.

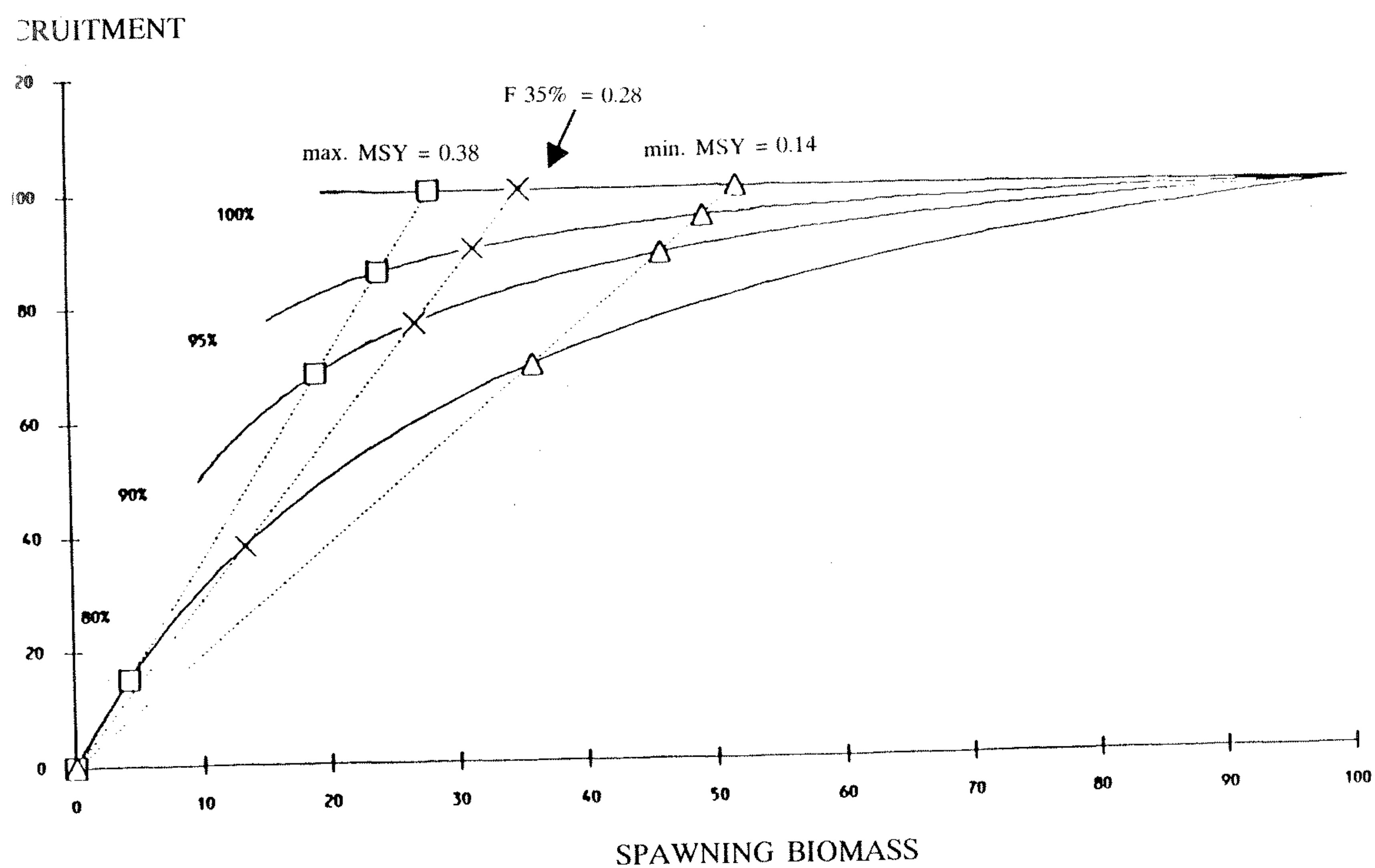

Figure 11.2. Relationships among recruitment, equilibrium yield, and spawning biomass. The solid lines indicate the level of expected recruitment for different degrees of density-dependence in recruitment; e.g. the 90 percent line assumes that recruitment is reduced by 10 percent when spawning biomass is reduced to 50 percent of the unfished level. Dashed lines indicate the recruitment that would be obtained by applying the indicated fishing mortality rate. Intersections between dashed lines and solid lines indicate equilibrium points for specified levels of fishing mortality and density-dependence.

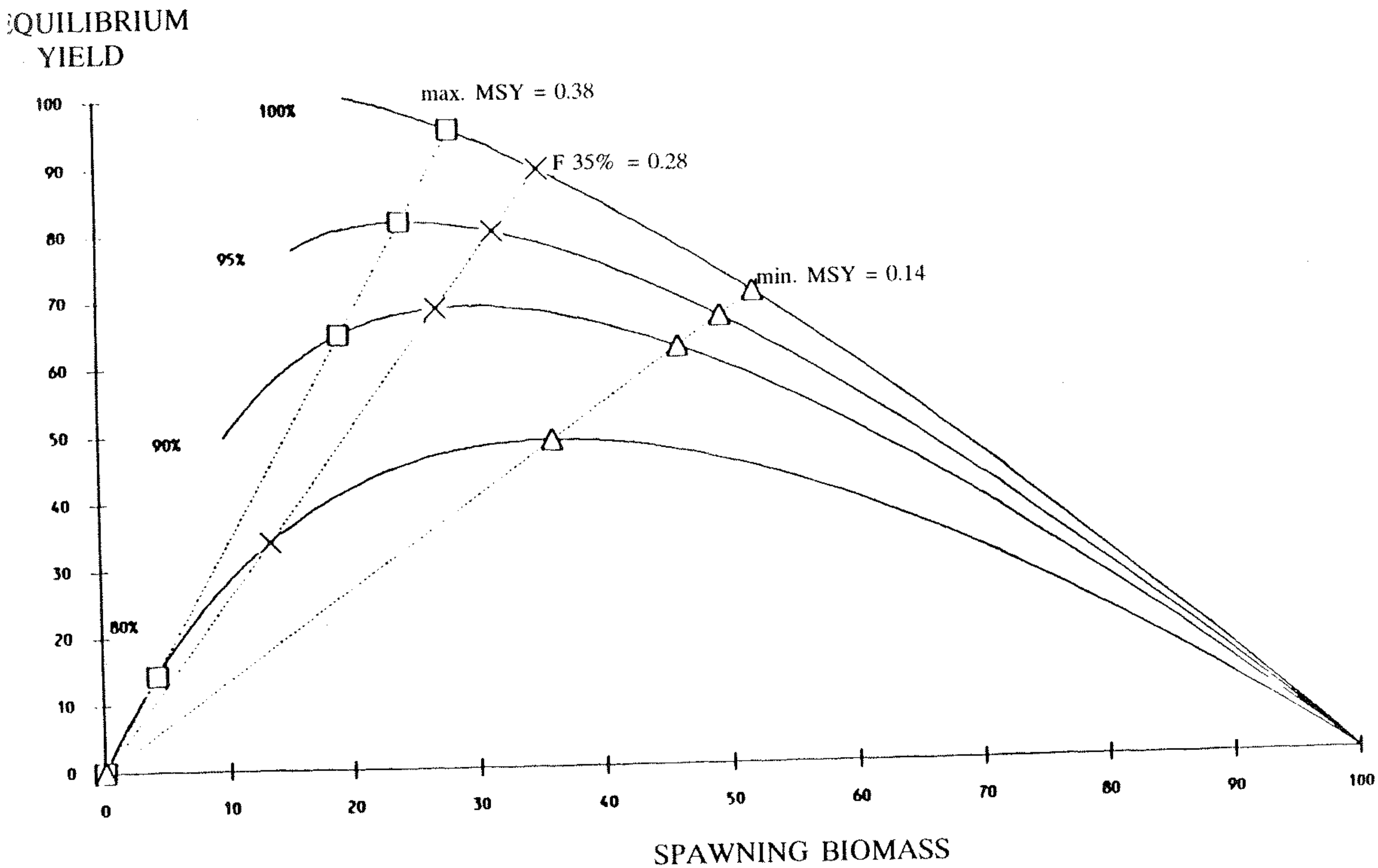

Figure 11.3. Relationships among recruitment, equilibrium yield, and spawning biomass. The solid lines indicate the level of equilibrium yield expected for different degrees of density-dependence in recruitment.

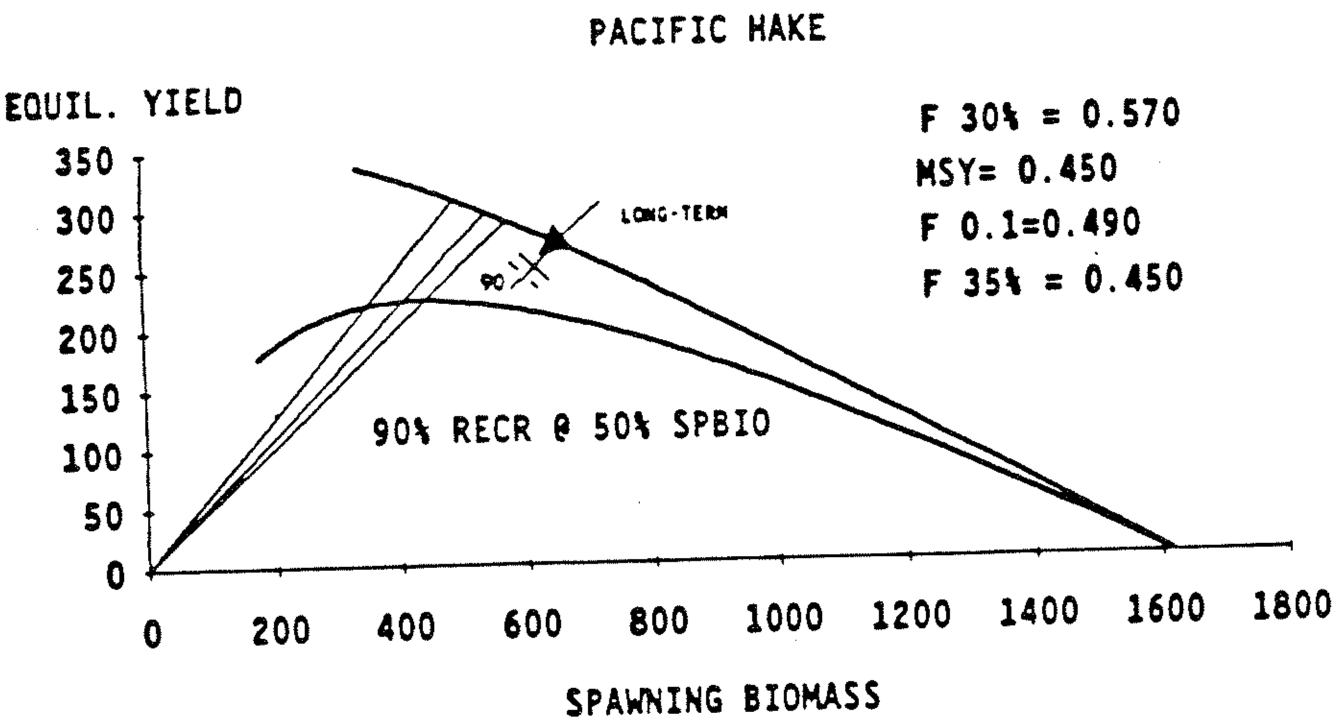

Figure 11.4. Yield and spawning biomass for Pacific whiting.

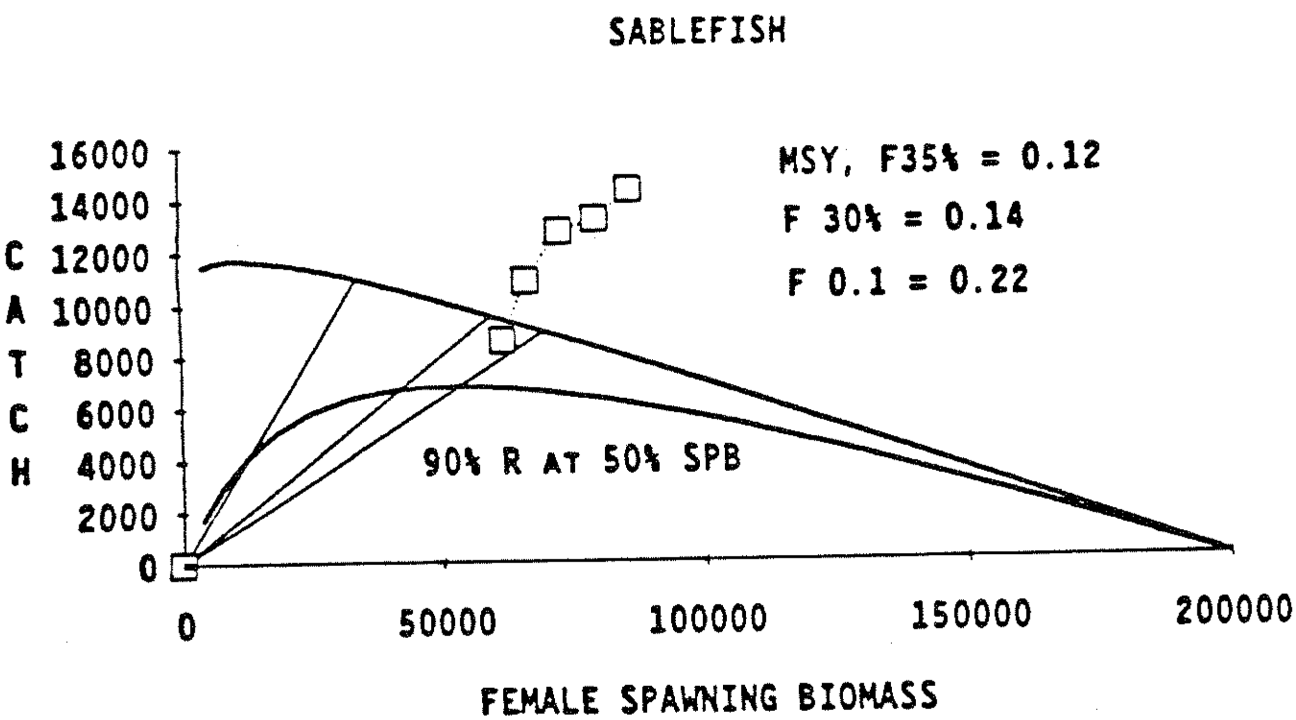

Figure 11.5. Yield and spawning biomass for sablefish.

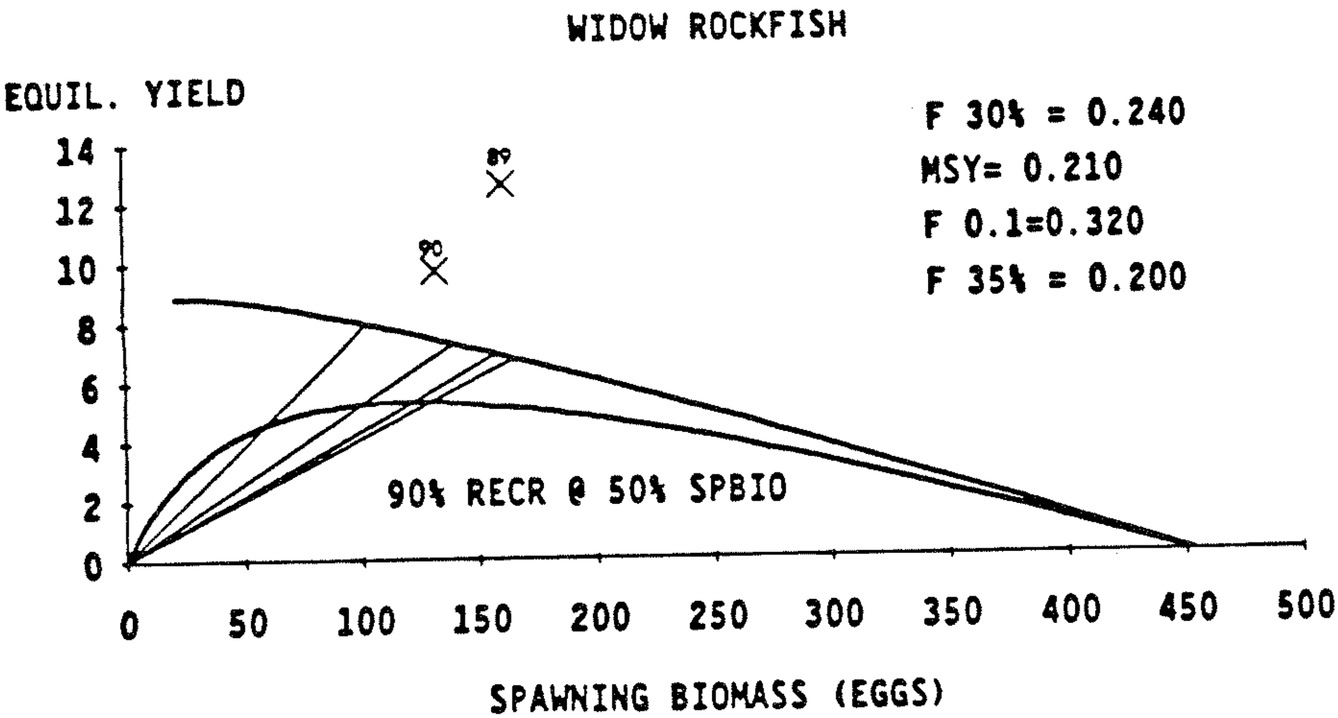

Figure 11.6. Yield and spawning biomass for widow rockfish.