

**ESTIMATES OF ACCEPTABLE BIOLOGICAL CATCH FOR 1995  
FOR GROUND FISH OFF THE PACIFIC COAST OF THE UNITED STATES**

by the

Groundfish Management Team  
of the  
Pacific Fishery Management Council

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ABSTRACT

The Groundfish Management Team of the Pacific Fishery Management Council has assessed the status of the groundfish resources off the west coast of the United States (Washington-Oregon-California region) through July 1994 and estimated their acceptable biological catch (ABC) for 1995. The recommendations will form the biological basis for management of the resources by the Council in 1995. The ABC for the groundfish resources total 393,355 t, down 119,645 t from 1994 due mainly to a 102,000 t decline in the Pacific whiting ABC. By species groups, the preliminary ABCs are: Pacific whiting (223,000 t for U.S. plus Canada), sablefish (9,125 t), Pacific cod (3,200 t), lingcod (1,800 t for U.S. plus Canadian waters), jack mackerel (52,600 t), bocaccio (1,540 t), canary rockfish (1,250 t), chilipepper rockfish (4,000 t), Pacific ocean perch (zero t), shortbelly rockfish (13,000 t), shortspine thornyhead rockfish (1,300 t), longspine thornyhead rockfish (6,600 t), widow rockfish (6,500 t), yellowtail rockfish (6,740 t), remaining rockfish (14,000 t), arrowtooth flounder (5,800 t), dover sole (14,700 t), English sole (3,100 t), Petrale sole (2,700 t), other flatfish (7,700 t), and other groundfish (14,700 t). Final ABC levels will be adopted by the Council in October 1994.

## GROUND FISH MANAGEMENT TEAM RECOMMENDED ESTIMATES OF ACCEPTABLE BIOLOGICAL CATCH FOR 1995

Stock assessments for West Coast groundfish are conducted by staff scientists of the California Department of Fish and Game, Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries and Wildlife, Southwest Fisheries Science Center of the National Marine Fisheries Service (NMFS), and the Alaska Fisheries Science Center of NMFS. Preliminary stock assessments were reviewed by an ad hoc group in June 1994. Revised assessments were reviewed by the team at its July 1994 meeting. At that meeting, the team developed recommendations for preliminary levels of acceptable biological catch (ABC). The Scientific and Statistical Committee will review these preliminary assessments at its August meeting. The Council will review the preliminary assessments and adopted preliminary ABCs in August. The GMT will review the final versions of the stock assessments in September. Final ABCs and resultant management measures will be adopted by the Council in October. Following is a synopsis of ABC estimates for each principal species. New or updated stock assessments were available for Pacific whiting, bank rockfish, splitnose rockfish, canary rockfish, black rockfish, Dover sole, sablefish, thornyheads, and lingcod. Some stocks assessments are updated only about every third year. Where appropriate, ABCs for these stocks are based on average potential yields for 1995-1997.

### General Features

#### Assessment Model

Assessments of West Coast groundfish stocks have generally been conducted through use of stock synthesis.<sup>1/</sup> This tool is similar to other stock assessment tools in its handling of the interaction between a fishery and the exploited stock, but it provides greater flexibility in the types of survey data that can be examined. Perhaps more importantly, synthesis provides a bridge between strictly biomass-based models (Stock Reduction Analysis) and strictly age-structured models (cohort analysis) and also provides the capability to examine size composition data. The model is structured to simultaneously analyze catch biomass, age and length composition and effort from multiple fisheries, and abundance and age and length composition from multiple surveys. This flexibility has allowed quantitative examination of stocks and fisheries that could not be analyzed by other techniques. The model has provided a useful tool for organizing the available data and exploring the limits of our knowledge with regard to the history and current status of each stock, although the nature of the available information often does not provide narrow constraints on the range of feasible model results.

#### Exploitation Rate

The team generally recommends that a fixed fraction of the exploitable stock be harvested each year by applying a constant fishing mortality rate ( $F$ ). The level of exploitation is designed to achieve a large fraction of maximum sustainable yield (MSY) while protecting the spawning potential of the stock. This standard level of exploitation is labeled  $F_{35\%}$ , and is the fishing mortality rate that would reduce average egg production per female to 35 percent of its unfished level (Figure 1). This standard was reviewed in the analysis for the overfishing definition (fishery management plan Amendment 5).  $F_{35\%}$  is intended as a proxy for the harvest rate that may produce MSY,  $F_{msy}$ , and it replaces other standards such as  $F_{0.1}$ . The short coming of  $F_{0.1}$  is that it examines only the marginal increase in yield per recruit as fishing mortality is increased and can cause large decreases in spawning biomass if fish recruit to the fishery

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1/ Methot, Richard D. 1990. Synthesis Model: An Adaptable Framework for Analysis of Diverse Stock Assessment Data. INPFC Bull. No. 50: 259-277.

before they become mature (e.g. trawl-caught sablefish). The problem with  $F_{msy}$  is that it is tightly linked to an assumed level of density-dependence in recruitment. For no stock do we have sufficient information to determine the level of density-dependence in recruitment.  $F_{35\%}$  strikes a balance between obtaining a large fraction of the MSY if recruitment is highly insensitive to reductions in spawning biomass, and preventing a rapid depletion in stock abundance if recruitment is found to be extremely sensitive to reductions in spawning biomass.

The long-term expected yield under an  $F_{35\%}$  policy depends upon the unknown level of density-dependence in recruitment (Figure 1). The recommended level of harvest will reduce the average, lifetime egg production by each female entering the stock to 35 percent of the lifetime egg production for females that are unfished. If this reduction in total egg production causes no reduction in recruitment, then the long-term average female spawning stock level will be 35 percent of its unfished level and a large long-term average yield will be obtained. However, if the reduction in total egg production causes some reduction in average recruitment, then future female spawning stock levels will be less than 35 percent of the virgin level and future yields will be reduced also. Thus, the expected, long-term average level of female spawning biomass, relative to the virgin level, is between 35 percent on the upper end and probably no lower than about 25 percent on the lower end. In some cases, MSY is calculated under the assumption that recruitment declines to 90 percent as spawning biomass is fished down to 50 percent of its virgin level. This is just one of several plausible levels of MSY, depending on the true level of density-dependence in recruitment, and is included for reference and continuity with past reports.

The short-term yield under an  $F_{35\%}$  policy will vary as the abundance of the exploitable stock varies. This is true for any fishing policy that is based on a constant exploitation rate. The abundance of the stock will vary because of the effects of fishing and because of natural variation in recruitment. When stock abundance is high (i.e. near its average unfished level) then short-term annual yields can be approximately two-three times greater than the expected long-term average annual yield. For many of the long-lived groundfish species common on the west coast, this "fishing down" transition can take decades. Many of the declines in ABC that occurred during the 1980s were the result of this transition from a lightly exploited, high abundance stock level to a fully exploited, moderately abundant stock level.

### Discard Mortality

Stock assessments must account for total mortality in order to be accurate. The team's recommendations on dealing with discard mortality were submitted to the Council in April 1990. Discards of commercial species are usually related to fish size, lack of immediate market (e.g. bycatch in the atsea whiting fishery), and trip limits. Trip limits cause discard when a fisher catches more than an intended amount when making a targeted tow, and when bycatch occurs after a species monthly cumulative limit has already been taken. Generally, the recommended harvest guideline is set below the ABC to account for the expected discard. However, discarded bycatch in the whiting fishery is always counted towards the harvest guideline inseason because this source of discard is measured accurately and is variable from year-to-year. Assumed levels of discard in other fisheries are generally based on field observations,<sup>2/</sup> but there is no monitoring to verify the current level of discard. The measured level of discard for widow rockfish was 16% of landed catch annually in 1985-87, and this level is used for all rockfish fisheries constrained by trip limits, except a lower level of 8% is used for the deepwater fishery for thornyheads. The discard rate in the trawl sablefish fishery is set at 25% of landed catch.

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2/ Pikitch, Ellen, K., Daniel L. Erickson and John R. Wallace. 1988. An evaluation of the effectiveness of trip limits as a management tool. NWAFC Processed Report 88-27, 33 p.

## Slope Surveys

Assessments for sablefish, Dover sole, and thornyheads must rely upon information from the trawl surveys conducted on the continental slope (100-700 fathoms). Because the coastwide area has been covered only once (except the central Columbia area), these surveys do not yet provide direct information on trends in relative abundance. However, by considering a range of potential values for the survey's catchability (Q) the assessment model can use the survey, in conjunction with the measured fishery removals, to infer the stock's trend and current level. Industry members have expressed substantial concerns regarding performance of the trawl in these surveys. In particular, the tow speed is only 2 knots and the net, at times, is retrieved with more mud than occurs in commercial tows. These concerns support use of Q values that are less than 1.0. On the other hand, experiments with similar trawls in the Bering Sea indicate that herding by the doors and bridles could cause survey gear to overestimate the abundance of some species. Differences between species' behavior in response to a trawl and differences between species in distribution across trawlable and untrawlable habitat can lead to different Q values for different species. It will be difficult to achieve a survey tool that simultaneously performs very well for both Dover sole and sablefish. Although replication of slope trawl surveys is urgently needed in some areas (particularly for Dover sole in the Eureka area), the 1994 sea time will be used for an evaluation of the performance of the survey gear and deployment methods. At this time, a slope Q near 0.5 is concluded in the sablefish assessment (see below) and in the Eureka Dover sole assessment, but a slope Q that is at least 1.0 provides the best fit for longspine thornyheads and for Dover sole in the Columbia area. Harvest recommendations for Dover sole in both areas are taken from model results with survey Q values near 0.5.

## Roundfish

### Pacific Whiting

The team recommends a coastwide (U.S. plus Canada) ABC in 1995 of 223,000 mt. This decrease from the 325,000 mt level in 1994 is due to the anticipated decline in stock level following the very large year classes produced in 1980 and 1984. The total harvest of Pacific whiting by the U.S. and Canada in 1993 was 199,994 mt, which exceeded the 1993 ABC of 178,000 mt because of lack of agreement between the U.S. and Canada regarding allocation of the total available yield. Again in 1994, the yield is expected to be above the 1994 ABC of 325,000 mt.

The stock assessment conducted in 1994 is a simple update of the substantially revised assessment conducted in 1993. The hydroacoustic survey in 1992 utilized new, more sensitive equipment, and extended further offshore and further north to better encompass the range of Pacific whiting. The result of these changes was a biomass measurement that was more than double the projected amount. A geographic version of synthesis that modeled the division of the population into U.S. and Canadian components was used to assess the Pacific whiting population. The new biomass estimate in 1992 was consistent with past survey biomass estimates only if they are interpreted as an index of total stock biomass. The biomass of age-3 and older fish in 1993 is estimated to be 2.871 million mt. The recruitment abundances of the 1987, 1988 and 1990 year classes were estimated to be close to the average 1977-1992 recruitment, but much below the very strong recruitments of the 1980 and 1984 year classes. The 1989 and 1991 year classes appears to be much weaker. An age-structured model was used to forecast yields for 1995-1997. Several harvesting strategies are presented and are ranked according to the percentage of years that female spawning biomass will fall below a level of 623,000 mt in long-term simulations of the population. When the harvest rate used in 1994 is applied to the projected numbers

at age in 1995, the potential yield (U.S. plus Canada) is 223,000 mt with declines to 159,000 mt in 1996 as the stock abundance declines below its expected long-term average level. Continuation of this conservative harvest policy is recommended at least until another hydroacoustic biomass estimate can be made.

### Sablefish

On the basis of a stock assessment conducted in 1994, the team recommends that ABC (for landed catch plus about 1,200 mt of discard) increase to 8,700 mt for the Monterey through U.S. Vancouver International North Pacific Fisheries Commission (INPFC) areas. The Conception area was explicitly excluded because of the smaller size-at-age and delayed maturity in that area. An ABC of 425 mt is recommended for the Conception area (including Morro Bay) on the basis of average annual landings since 1985.

*The sablefish stock in the Monterey through the U.S.-Vancouver INPFC areas is assessed in 1994 through application of the synthesis model to fishery size and age composition data from 1986-1993 and trawl and pot survey data. Pot surveys conducted during 1979-1991 indicate a substantial decline in sablefish abundance, especially for medium and large fish in the 225-450 fathom depth zone. No pot surveys have been conducted since 1991. Slope trawl surveys during 1990-1993 have measured the biomass in the 100-700 fathom depth zone between Pt. Conception and the US-Canada border to be 61,409 mt, which represents approximately the age 2+ biomass with a reduced availability for the larger females. Survey biomass in the Monterey-Vancouver area is estimated to be about 51,000 mt. The triennial shelf trawl survey in 1992 measured a record high 55,021 mt of young sablefish in the 30-200 fathom depth zone of the Monterey - Vancouver INPFC areas.*

*The synthesis model was configured to explore trade-offs in fitting the biomass levels measured in the slope trawl surveys, the trend in numbers of sablefish in the pot survey, and the trend in recruitments from the shelf trawl surveys. No conventional model scenario could be found that fit all well. The slope trawl surveys indicate that about 30% of the biomass is in waters deeper than 500 fathoms, and all sources of information indicate that sablefish in these deep waters are old. A preliminary model with an emigration rate of about 3% per year, beginning at about age 4, from the <500 fathom depth zone to the >500 fathom depth zone can explain this pattern. When this emigration rate is incorporated as an extra amount of natural mortality in a model of only the <500 fathom portion of the stock, the model can achieve a reasonable fit to the decline in the pot survey while estimating that the catchability coefficient for the slope trawl survey ( $Q$ ) is near 1.0 for 50 cm sablefish (medium and large sablefish would have a  $Q$  that is only 30% of this level). This result substantially narrows the range of plausible model results. Previously, values of slope  $Q$  near 2.0 were necessary to fit the trend in the pot survey.*

*An optimistic model scenario indicates that the slope trawl survey has a  $Q$  of 0.53 (relative to Mon-Van biomass of 51,000 mt), fits trends in the shelf trawl surveys and the fishery size and age composition data well, but provides a degraded fit to the trend in the pot survey, even in the shallow zone model with enhanced mortality. This scenario indicates that fishing mortality over the past eight years has been close to the target level of  $F_{35\%}$  (7.5% exploitation rate on the age 2+ biomass) and that the female spawning biomass recently increased to slightly above its long-term target level. Under this scenario, the annual catch plus discard could be 11,107 mt during 1995-1998, and MSY may be 8,535 mt. A pessimistic model scenario has a slope survey  $Q$  of 0.94 and provides a reasonable fit to the trend of the pot survey if migration to deep water is accounted for. This scenario indicates that harvests during 1986-1992 were nearly at the overfishing level, the spawning biomass during 1990-1993 was nearly stable at a level below the target, and the annual catch plus discard at  $F_{35\%}$  should decline to*

*6,281 mt during 1995-1998, and MSY may be 7,216 mt. Under an intermediate scenario ( $Q=0.68$ ) the annual catch plus discard could be 8,689 mt during 1995-1998, and MSY may be 7,831 mt.*

### Pacific Cod

The team recommends no change in the coastwide ABC for Pacific cod from the previous level of 3,200 mt which was set in 1989 at the highest catch of record. The coastwide catch reported by Pacific Coast Fishery Information Network (PacFIN) was 1,065 mt for 1990, 1,796 mt for 1991, 1,776 mt for 1992 and 1,367 mt in 1993. No quantitative assessment is attempted for Pacific cod off Washington, Oregon and California because changes in stock abundance in this area are probably dominated by environmental factors which influence the contribution of fish from the north.

### Lingcod

The team recommends reduction in the lingcod ABC on the basis of new stock assessments conducted in 1994. In the area between Cape Falcon, OR and 49°N off Vancouver Island a comprehensive assessment based on fishery and survey data from 1979-1993 indicates that this stock has been heavily exploited by the U.S. and Canadian fisheries. The population biomass in this area is estimated to be 13,765 mt based on the synthesis model fit to trends in fishery effort, relative abundance in a nearshore tagging survey, and relative abundance in the NMFS triennial trawl survey. The average yield of 2,736 mt during 1989-1993 is just below the overfishing level. Application of a  $F_{35\%}$  fishing mortality rate in 1995-1997 indicates that total U.S. + Canada catch should be reduced to 1,800 mt.

At this time the Team recommends a preliminary range of 1,800 mt ( $F_{35\%}$  yield) to 2,700 mt (recent average yield) for the potential yield from this international area. The assessment indicates that the high end of this range would be overfishing and the range is included at this time only because of the newness of this assessment. The Team recommends that the ABC for the U.S. area be based on 50% of the calculated  $F_{35\%}$  yield (52% of 1989-1993 landings in this area were from U.S.). Canadian catch has averaged 1,320 mt during 1989-1993 and we understand that their ABC has just been increased to 2,100 mt. Thus, Canadian catch alone could exceed the  $F_{35\%}$  yield level for both nations in 1995. International coordination on assessment and management of this species is necessary. In the portion of the Columbia area south of Cape Falcon the recent average yield has been about 400 mt, which should be added to the above calculated ABC. Therefore, the Team recommends that the ABC for the combined Columbia and U.S.-Vancouver areas be reduced from the current 5,000 mt to the range 1,300 to 1,800 mt for combined commercial and recreational catch in 1995-1997. The commercial catch from this area was 1,267 mt in 1992 and 1,446 mt in 1993. In addition, approximately 100 mt of recreational catch occurs annually.

Port sampling of lingcod was extended to Oregon and California in 1992 and provides information on the biological characteristics of the catch in 1992 and 1993. In the Monterey-Columbia areas, the commercial catch is dominated by age 2-4 fish and about 50% of the females are immature. The size composition is shifted to smaller sizes than were observed in limited samples from the 1978-1983 period. Although the triennial trawl surveys does not exhibit a noticeable decline until 1992, there is concern that the young mean age in the catch indicates a substantial level of fishing mortality. The current ABC levels in the Eureka, Monterey, and Conception areas are 500, 1100 and 400 mt, respectively. Although these levels were previously set on the basis of commercial catch, it now

seems appropriate to utilize these levels as an interim measure of potential yield for combined commercial and recreational fisheries. Commercial catch from 1991-1993 and recreational catch from 1987-1989 have averaged:

Eureka	184 mt comm.	193 mt recr.
Mon	500 mt comm.	501 mt recr.
Con	69 mt comm.	152 mt recr.

Although recent catches have been within the ABC level, further reductions in lingcod ABC from these southern areas may be necessary if subsequent stock assessments indicate that the fishing mortality rates are as high as the rate estimated in the northern area.

### Jack Mackerel

The team reviewed and revised the jack mackerel ABC in 1990. Available data indicated that the current, nearly unfished spawning biomass is about 1.5 million short tons, the natural mortality rate is in the range of 0.1 to 0.2, a fishery located north of 39° would harvest fish that are mostly older than age-16, and the long-term potential yield for this age range is 19,000 mt. The team recommends continuation of the 52,600 mt ABC on the basis of a constant exploitation rate (equal to natural mortality) applied to estimates of current biomass of ages-16+. Biomass and short-term yield are expected to slowly decline under this level of exploitation. If this level of exploitation reduces long-term biomass to approximately 30 to 50 percent of the current biomass, then the long-term average yields for this age range would be near 19,000 mt. The team recommends close tracking of this fishery, especially with regard to catches outside of the exclusive economic zone and to the age composition of the harvested fish.

### Rockfish (alphabetical order)

#### Bank Rockfish

This is a new assessment in 1994. Estimation of catch of this, and some other, rockfish species in California is difficult because of the low level of species composition sampling for some gear types/market categories and lack of sampling south of Morro Bay in some years. At this time it appears that during 1986-1990 total catch was about 1,100 mt, setnet and trawl had similar catch levels, and Monterey and Conception had similar catch levels. There have been declines in the mean size of fish landed by the trawl and setnet fisheries, but a quantitative assessment is hindered by the low incidence of bank rockfish in the trawl surveys. No ABC recommendation is made at this time, and the Team is concerned about our ability to provide advice on management of species for which there is such a low amount of information. This assessment is intended to contribute in 1995 to a review of management of the Sebastes complex, particularly the deeper living species.

#### Black Rockfish

An assessment of black rockfish off northern Oregon was conducted in 1993 using age composition and catch per unit effort (CPUE) data from the recreational fishery during 1984-1991. The data were

examined with cohort analysis, CAGEAN, and synthesis. The results indicated that the 1991 fishing mortality rate was half the  $F_{35\%}$  level (cohort and synthesis) to near this level (CAGEAN). Although the results cannot be extrapolated to other areas to develop an ABC estimate, the assessment concluded that the fishery is impacting the stock in the northern Oregon area. Controls on fishing effort could reduce future declines in recreational CPUE in this area.

An assessment of black rockfish off Washington was conducted in 1994 using age composition data from the recreational, jig, and trawl fishery during 1980-1993 and catch per unit effort (CPUE) data from the sport fishery (1984-1993) and from a nearshore jigging survey (1987-1990). Recent catch is dominated by the sport fishery (307 mt/yr in 1991-1993) followed by the handline jig (80 mt), trawl (54 mt), and salmon troll (47 mt). The synthesis model fit to available data indicates that the biomass in 1994 is 7,460 - 9,283 mt and that the female potential egg production in 1994 is about 43% of its unfished level. The assessment indicates that expected long-term yield under a  $F_{45\%}$  strategy would produce about 500 mt/year while a  $F_{35\%}$  strategy would produce about 600 mt/year but result in lower biomass and, potentially, lower CPUE for the recreational fishery. The Team does not have a recommendation for an ABC in 1995 because current catches are below the levels of potential yield calculated in the assessment.

### Bocaccio

The team recommends that the ABC for landed catch of bocaccio in the Eureka-Monterey-Conception INPFC area remain at 1,540 mt. The assessment in 1992 incorporated improved estimates of historical catch, including trawl, setnet, hook-and-line, and recreational. Analyses using the synthesis model indicated that biomass has declined substantially since 1980 and is approaching 20 percent of its estimated unfished level. This result was in agreement with trends in both recreational catch/effort and a research survey index of abundance, and year class patterns in all data sources. The estimated total landed catch in 1991 (about 1,700 mt) was a substantial decline from the level that occurred prior to imposition of trip limits, and was near the target catch level now indicated by application of the  $F_{35\%}$  harvest policy. There is some risk in maintaining harvests at this level, because weak recruitments since 1979 will cause the stock to continue to decline unless the total harvest is kept closer to 1,100 mt. The team recommended setting ABC at 1,540 mt to adhere to the  $F_{35\%}$  harvest policy while accommodating some expected trip limit discard in the trawl and setnet fisheries that often fish to the cumulative vessel limit. (Note: for consistency with other species, the ABC should be revised to reflect total estimated potential yield, 1700 mt) and the HG should be set for landed catch).

### Canary Rockfish

A new assessment of canary rockfish in 1994 indicates that the stock has undergone a substantial decline and that continuation of current catch levels, which are at the ABC levels set in 1990, would be overfishing. The trawl survey in 1992 detected a drop in biomass and a decrease in the mean size of surveyed canary rockfish. The new assessment, which includes survey and fishery data from the Columbia and the U.S. Vancouver areas, tracks this decline and even the optimistic scenario indicates that spawning biomass has declined about 50% since 1977. The Team's preliminary recommendation is that the ABC for canary rockfish in the Columbia-U.S. Vancouver area be reduced from 2,300 mt to 1,000 mt; the catch in 1993 was 2,463 mt. The previous assessment indicated that the low end

of the ABC range for just the Columbia area was 1,050 mt. Exceeding this level in 1991-1993 has contributed to, but not necessarily caused the observed stock decline. Because the survey trend in the Eureka area is even more sharply downward than in the northern areas, the Team recommends that the ABC for the Eureka area be reduced from 600 mt to 250 mt, which is above the recent average catch from this area. The ABC for the Sebastes complex in the Van-Col area should be reduced by 1,300 mt and the ABC for the Sebastes complex in the southern area should be reduced by 350 mt to reflect the changes in the canary rockfish ABC.

### Chilipepper Rockfish

The ABC for chilipepper rockfish increased from 3,600 mt to 4,000 mt in 1994 on the basis of a new assessment conducted in 1993. Most catch comes from the Conception-Monterey-Eureka areas. The catch in 1991 was 3,906 mt. Catch in 1992 fell to 2,895 mt (trawl 1,207 mt, setnet 276 mt, hook-and-line 1,104 mt, recreational 308 mt).

The new assessment uses synthesis to analyze size composition data from the four fisheries, age composition from the trawl fishery, trends in relative abundance indicated by CPUE in the triennial bottom trawl survey and in the recreational fishery. Both trend indicators show an increase in 1988-1989, and the 1992 trawl survey value is double the level observed in 1980, 1983 and 1986. The analysis indicates that this increase is due to a very strong 1984 year class and that the stock is now at a level above that expected under the recommended level of exploitation. With the best-fitting model, the estimated biomass in 1992 is 76,000 mt, the long-term average yield is in the range 4,988 to 6,516 mt, and the 1994-1996 average yield is 9,709 mt. With a more conservative scenario, the long-term average yield is in the range 3,025 to 3,941 mt and the 1994-1996 average yield is 4,919 mt.

Although even higher levels seem possible from the assessment result, the assessment author recommends caution and higher catches of chilipepper are likely to have increased bycatch of bocaccio which is at a low stock level.

### Darkblotched Rockfish

The team recommends development of a plan for management of the deepwater rockfishes on the basis of this assessment in 1993 and a review in 1991 of declining mean size in several rockfish species off California. The coastwide catch of darkblotched rockfish was 1,073 mt with 732 mt coming from the Columbia INPFC area. Other members of the deepwater rockfish assemblage off Oregon and Washington are splitnose, yellowmouth, and Pacific ocean perch.<sup>3/</sup>

The new assessment examines life history information and determines that, like many deepwater rockfish species, the natural mortality rate of darkblotched rockfish is low and the annual harvest should only be four to six percent of the stock. There is insufficient fishery or survey data to determine the current stock abundance or the current rate of exploitation. However, declining trends in mean size suggest that recent exploitation rates have been greater than the overfishing exploitation rate of 7 to 11 percent.

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3/ Rogers, J.B. and E.K. Pikitch. 1992. Numerical definition of groundfish assemblages caught off the coasts of Oregon and Washington using commercial fishing strategies. *Can. J. Fish. Aquat. Sci.*, 49: 2648-2656.

### Pacific Ocean Perch

The team reviewed a new stock assessment in 1992 and recommended that the Pacific ocean perch ABC in the Columbia-Vancouver areas remain at zero. A rebuilding program was established for Pacific ocean perch in 1981 following depletion of this stock during the 1960s and early 1970s. The 1992 comprehensive review of fishery and survey data did not indicate any significant rebuilding. The stock abundance is estimated to be about 50 percent of its target level and the recent harvests of about 1,000 mt are near the level of overfishing. If the stock recovers to its target level, then annual yields of about 1,400 mt may be possible. The review also indicates that strong year classes, which are necessary to rebuild the stock, occur infrequently so the lack of rebuilding is not unexpected. The team recognizes that incidental catches will occur and recommends that trip limits be set to discourage targeting while allowing landing of incidental catches. In 1992, the trip limit was 3,000 pounds per trip or 20 percent of all groundfish on board, whichever is less, and the total landed catch reported by PacFIN was 1,054 mt. With respect to other areas, Pacific ocean perch are neither common nor important and are included in the "Remaining Rockfish" category.

### Shortbelly Rockfish

The potential yield of shortbelly rockfish was last examined in 1989. Shortbelly rockfish remains an unexploited stock at present, thus is difficult to quantitatively assess. The extremes of the MSY estimates from two alternative yield calculations were 13,900 to 47,000 mt, and a value of 23,500 mt is the midpoint of recently revised estimates.<sup>4/</sup> In recent years, the team has recommended maintaining the ABC at 13,000 mt until further data can be collected. Upon further consideration, the short-term yield of an unexploited stock may be about three times as high as the long-term potential yield (MSY). The team recommends setting the ABC in the range 13,000 to 23,500 mt, but recognizes that maintaining the harvest guideline at 13,000 mt may be appropriate until more is known about this stock.

### Splitnose Rockfish

An initial assessment of splitnose rockfish was made in 1994 to prepare for a review in 1995 of *Sebastes* complex management, particularly the deepwater rockfish species. Landings of splitnose rockfish since 1980 have been about 170 mt per year in Oregon and Washington, and about 420 mt per year in California. Like many rockfish species, splitnose has a low rate of natural mortality (0.05) so is not able to sustain a high rate of exploitation. However, most of the catch is of individuals that are above the size at 50% maturity, so this species may be less vulnerable to overfishing than later-maturing species. Biomass estimates from four different types of surveys did not show any consistent downtrend in abundance over time, particularly when the imprecision of the estimates was considered. There was also no consistent downtrend in the estimated body size of fish in the commercial landings and surveys, although these estimates were also imprecise. The Team has no ABC recommendation at this time.

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4/ Pearson, D.E., J.E. Hightower, and J.T.H. Chan. 1991. Age, growth, and potential yield for shortbelly rockfish *Sebastes jordoni*. Fish. Bull., U.S. 403-409.

### Thornyhead Rockfish

The team recommends that single species ABC levels be reduced from 1,900 to 1,300 mt for shortspine thornyheads and from 10,100 to 6,600 mt for longspine thornyheads on the basis of the 1994 stock assessment. These new ABC levels apply to the entire area between Pt. Conception (Lat. 34° 30'N) in the south and the U.S.-Canada border in the north. In 1993 the landed catch in the Mon-Eur-Col area was 7,024 mt and the catch in the entire area was 9,044 mt. Shortspine thornyheads constituted 41% of the landed catch in 1993, following a low of 32% in 1991. There are two significant changes in the availability of information for thornyheads. First, the set of slope trawl surveys has been extended to cover the entire area between Pt. Conception and the U.S.-Canada border. Analysis of these surveys indicates that biomass extrapolations necessary in the previous assessment resulted in an overestimate of coastwide biomass, especially for shortspine thornyheads. The estimate for shortspines has declined from 97,000 mt survey biomass for Mon-Eur-Col to 28,000 mt (in 1993) for the entire area. The estimate for longspines has declined from 128,000 mt for Mon-Eur-Col to 84,000 mt (in 1993) for the entire area. The second major change is in age validation for shortspine thornyheads. Radiometric examination of otoliths with ring counts near 147 indicate an age in the range of 50-100 years. This uncertainty in age determination introduces substantial uncertainty in estimates of natural mortality and growth rate.

The assessment uses the synthesis model to examine the time series of fishery and survey data under a broad range of possible values for the important biological parameters. For longspine thornyheads, the model examines the impact of different levels of catchability (Q) for the trawl survey and different levels of natural mortality (M). The best model fits occurred at Q levels greater than 1.0 (survey overestimates true biomass) and M values of 0.07-0.08. The assessment recommendation is based on a less conservative scenario with a Q value of 1.0 and M equal to 0.07. On this basis, the F35% rate is 0.169 and the short-term potential yield is 6,550 mt. For shortspine thornyheads, the great uncertainty in biological parameters forced an assumption of survey Q equal to 1.0. Examination of the data under a range of values for maximum size, growth rate, and natural mortality indicates that M probably is at least 0.07, but values above 0.10 would be inconsistent with the radiometric estimate of longevity. At M=0.07, the estimated F35% rate is 0.057 and the short-term potential yield is only 1,260 mt.

### Widow Rockfish

In 1994 the ABC for widow rockfish was reduced from 7,000 to 6,500 mt based on the stock assessment conducted in 1993. The landed catch in 1992 was 6,057 mt and 448 mt was discarded as bycatch in the Pacific whiting fishery.

The revised assessment uses the stock synthesis model to analyze fishery age composition data from 1980-1991. In this revised assessment fishery data are stratified into midwater and bottom trawl components, north (Vancouver and Columbia) and south (Eureka - Conception) areas, and male and female data are kept separate. More importantly, the bycatch of widow rockfish in the at sea Pacific whiting fishery is introduced as an index of widow rockfish abundance. Previous assessments relied solely on trends in the fishery age composition.

The new model achieves its best fit to the data at essentially the same stock abundance level as the

previous assessment. The stock in 1994 is estimated to be at 76,000 mt which is about one-third of the stock level in 1980 and is near the long-term average level that is expected under the  $F_{35\%}$  level of exploitation. If recent recruitments remain near the average level, then stock abundance is expected to remain nearly constant under an 1994-1996 annual harvest of 8,150 mt (7,000 mt landed). However, a plausible alternative with lower stock abundance and recent recruitments at a lower, median level would support only a 5,000 mt landed catch during 1994-1996.

(Note: to be consistent with other stocks, the ABC should be revised to 7,540 mt and the HG should remain at 6,500 mt to account for estimated discard.)

### Yellowtail Rockfish

The ABC was increased to 6,740 mt for the U.S. Vancouver-Columbia-Eureka areas on the basis of an updated assessment conducted in 1993. The previous ABC for these areas was 4,700 mt and the catch in 1992 was 6,029 mt. The increased ABC is due to evidence from trawl surveys that biomass has not declined in recent years, and evidence in fishery age composition data of strong year classes in 1983-1984. The ABC is based on assessments in three independent areas (Eureka and Columbia south of Cape Falcon, Columbia north of Cape Falcon, and Vancouver south of 49°N in Canada):

Area	Previous ABC	1994-1996 ABC
Eureka-South Columbia	1,350 mt	2,580 mt
North Columbia	2,085 mt	2,970 mt
U.S.-South Vancouver	1,226 mt	1,190 mt

Previously, 300 mt of the ABC was set aside for the Eureka area and a harvest guideline was set for the combined Columbia-U.S. Vancouver area. The team recommends that the management areas be aligned with the assessment areas which, in turn, correspond to evidence for stock delineation. An ABC of 2,580 mt for the Eureka-South Columbia area and 4,160 mt for the combined northern areas is recommended.

This assessment uses synthesis to examine fishery age composition data through 1991 and trends in relative abundance indicated by CPUE in the triennial bottom trawl survey (1977-1992). The previous assessment identified that natural mortality probably increases for older females; i.e., the same pattern that was identified for canary rockfish. New age composition data for yellowtail rockfish are consistent with this pattern.

In the Eureka/South Columbia area, the stock is estimated to have recently increased because of strong year classes in 1983-1984. Biomass at the beginning of 1993 is estimated to be 25,000 mt. Current spawning biomass in this area is estimated to be 93 percent of the unfished level. The projected average yield for 1994-1996 is 2,580 mt with a declining trend as the strong year classes move through the stock. This level is near the total catch in 1992 when trip limits in this area were removed for part of the year, but substantially above the approximately 1,100 mt average yield from previous years. Some caution should be attached to this optimistic assessment because the trawl survey in the Eureka area shows a declining trend that is not well matched by the assessment.

In the North Columbia area, the fishery age composition data and the nearly constant survey CPUE

are consistent with a stock that is only slowly declining and in 1993 is at about 30,000 mt. The recommended average yield for 1994-1996 is 2,970 mt; but future declines are expected as large year classes in 1983 and 1984 move through the stock. This level of ABC is above the 1992 catch of 2,476 mt and similar to average catch levels during 1986-1989.

In the South Vancouver area, which extends into Canadian waters to near the middle of Vancouver Island there are contrary indicators of stock condition. The trawl survey indicates no trend during 1980-1992 and is consistent with a healthy stock and a 1994 yield of 2,200 to 4,300 mt (U.S. plus Canada). However, the fishery age composition data do not indicate a particularly strong 1983-1984 year class, as in southern areas, and are most consistent with a steeply declining stock and a 1994 yield of only 250 to 800 mt. The team bases its recommendation on the lower end of the optimistic scenario, prorated to 1994-1996 according to the trend in the North Columbia area. The recommended harvest in the U.S. portion of the South Vancouver area during 1994-1996, is 60 percent of the total or 1,190 mt.

### Remaining Rockfish

Remaining rockfish in the Vancouver and Columbia areas are defined as all rockfish except Pacific ocean perch, yellowtail rockfish, canary rockfish, widow rockfish and shortbelly rockfish. In the Eureka, Monterey and Conception areas, bocaccio and chilipepper rockfish are excluded from this category, but yellowtail and canary rockfishes are included. In 1991, thomyheads were removed from this category in the Monterey-Eureka-Columbia areas. The ABCs for remaining rockfish have been unchanged since about 1983. The levels have been: Vancouver - 800 mt; Columbia - 3,700 mt; Eureka - 1,900 mt; Monterey - 4,300 mt; and Conception - 3,300 mt.

The ABCs in the three southern areas (Conception-Monterey-Eureka) were set simply at 1.2 times the 1977 catch and sum to 9,500 mt for the combined area. During 1983-1992, the catch of remaining rockfish in this area has ranged from 5,100 mt to 7,200 mt with a mean of 6,600 mt (values calculated by subtracting bocaccio and chilipepper catch, as documented in stock assessment documents, from the summed *Sebastes* complex and unspecified rockfish catch as documented in PacFIN). Although annual catches have never achieved the 9,500 mt ABC level, an examination of declines in mean length for several rockfish species in the Conception-Monterey-Eureka area suggests that the fishery removals are having a noticeable impact on these stocks. Although there is insufficient information to conduct a quantitative stock assessment for the remaining rockfish in this southern area, the GMT recommends reduction of the ABC to 7,000 mt which is near the upper end of the range of realized harvests during 1983-1992. During 1990-1992, the remaining rockfish catch in the Conception-Monterey-Eureka has averaged 6,060 mt.

### Flatfish

#### Arrowtooth Flounder

The team reviewed a new assessment in 1993 and recommended keeping the ABC in U.S. waters at 5,800 mt (equal to peak catch in 1990). The assessment author recommends conservative management, especially until new data and models can estimate absolute biomass and exploitation rates. However, the team recommends no change in ABC because there has been no decline in fishery CPUE during 1987-1992, and no trend in triennial bottom trawl survey CPUE during 1977-

1992, although survey CPUE has fluctuated over a three-fold range. Future work on this assessment probably should include the Canadian zone. Fishery logbook data indicate that most of the U.S. catch occurs near the U.S.-Canada border. The survey indicates that the biomass is about two times higher in the surveyed portion of the Canadian zone than in U.S. waters. Catch in Canada increased greatly in 1990 and was nearly 50 percent of the U.S. catch in 1992.

### Dover Sole

The team recommends reducing ABC levels from 3,500 to 2,500 mt in the Eureka area and from 4,000 to 3,800 mt in the Columbia area on the basis of an assessment conducted in 1994. The coastwide ABC would be reduced from 15,900 mt to 14,700 mt, which is below the 1991 landed catch of 18,198 mt and similar to the 1993 catch of 14,300 mt.

In the 1994 assessment, size and age composition data from the INPFC Eureka and Columbia areas were analyzed by stock synthesis. The analyses for each area were conducted independently because tag return data indicate little coastwise movement of adult Dover sole. The fishery data are influenced by changing market conditions and by changing depth distribution of the fishing effort. In each area, separate fishery selectivities were estimated for several time periods to track these changes. In both areas the model was run at various levels of initial biomass to generate a range of fits to the biomass measured in the slope trawl surveys. Runs with the slope survey catchability (observed slope survey abundance divided by the population biomass after survey selectivities are applied) between 0.5 (high population biomass) and 1.0 (lower population biomass) were taken as a plausible range of biomass levels. In the Eureka area, the best fit to the fishery size and age composition data tended to occur at the higher biomass levels ( $Q=0.5$ ), and at lower biomass levels in the Columbia area ( $Q > 1.0$ ). The surest way to reduce this uncertainty is replication of the slope trawl surveys.

In the Eureka area, the results with survey  $Q$  near 0.5 indicates that the biomass has declined to a low level because of declining recruitment. Female spawning biomass is estimate to be only 16% of its unfishied level. Catch has declined from 5,000-6,000 mt during the early 1980s to only 3,062 mt in 1993. These catches have been near the F35% exploitation level for this declining stock, and a further decline to 2,500 mt is recommended for 1995. If recruitments return to historical average levels, then a long-term average yield of 6,000 mt may be possible.

In the Columbia area, the best model fits occur at a survey  $Q$  level of at least 1.0. At survey  $Q = 1.0$ , the model indicates that harvest during the past 6 years has been at the overfishing level, and that the annual catch needs to decline from 5,600 mt in 1992-1993 to only 1,930 mt in 1995. At this time the Team recommends a less conservative approach with  $Q = 0.5$ . In this scenario, the female spawning biomass is estimated to be slightly above its expected, long-term average level. The short-term potential yield is 3,800 mt and the MSY may be near 3,900 mt. Catch has declined from a peak of 9,000 mt in 1989 to 5,600 mt in 1992-1993.

### English Sole

The team reviewed a new assessment in 1993 and recommended that the coastwide ABC of 1,900 mt be changed to an ABC of 1,100 mt for the Eureka-Conception areas, and 2,000 mt for the Columbia-Vancouver areas. The coastwide landed catch during 1983-1991 averaged 2,113 mt.

The age-structured version of the stock synthesis program was used to assess the status of the stock of female English sole occurring off Oregon and Washington (Columbia and Vancouver INPFC areas). The analysis used age composition data from the Oregon and Washington trawl fisheries, and estimates of relative abundance and length composition from the 1977-1992 triennial bottom trawl surveys. The survey CPUE increased ten-fold over this period. The assessment indicates a large and steady increase in the biomass to about 133,000 mt of age-4 and older females in 1992. The increase is attributed to high recruitment during the period examined. A specific ABC was not estimated, but the early age at maturity, which allows a high exploitation rate, and the large biomass suggests that a ten-fold increase in short-term yield may be possible in the Columbia-Vancouver areas. The team recommended a 2,000 mt ABC which is equal to a doubling of the average catch during 1983-1991.

The Monterey-Conception areas contributed 52 percent of the total catch during 1983-1991 but there is no new assessment for these areas. The survey CPUE in the Monterey-Eureka area has been without trend during 1983-1992. The team recommends that the ABC for these areas be set equal to the 1983-1991 average yield which was 1,100 mt.

### Petrale Sole

A new stock assessment for the Vancouver and Columbia areas was conducted in 1993. The team recommended reducing the ABC for this area from 1,700 mt to 1,200 mt, which is above the 1992 catch of 972 mt. The team recommends continuation of the current ABCs in the southern areas: Eureka - 500 mt; Monterey - 800 mt; and Conception - 200 mt. However, recent catch in the southern areas has been only about 800 mt per year and these ABC levels should be reviewed.

The new assessment in the Columbia-U.S. Vancouver area used the size-structured version of stock synthesis to analyze fishery size and age composition and CPUE since 1966, ODFW flatfish trawl surveys conducted in the mid 1970s, and NMFS triennial multispecies bottom trawl surveys during 1977-1992. The assessment tracks a twofold decline in fishery CPUE from the mid-1970s to the mid-1980s, and also tracks a gradual increase in biomass during 1980-1992 as indicated by the triennial survey. The assessment indicates that the stock in this area is essentially at the expected long-term average level of abundance and recent yields are slightly below the potential. The projected average available yield for 1994-1996 is 1,230 mt under the higher biomass scenario and 1,100 mt under the lower biomass scenario. The long-term expected yield is 1,070 to 1,390 mt under the higher biomass scenario, and 980 to 1,280 mt under the lower biomass scenario. The team based its preliminary ABC on the higher biomass scenario which achieves a much better fit to the fishery size composition data however, the lower biomass scenario achieves a better fit to all the trend indicators. The assessment author notes that the previous ABC of 1,700 mt included Area 3C in Canada. The new ABC is close to the U.S. portion of the previous ABC.

### Other Flatfish

Arrowtooth flounder was removed from this group of species in 1991 and there was no change in the ABC for the remaining species: Vancouver - 700 mt; Columbia - 3,000 mt; Eureka - 1,700 mt; Monterey - 1,800 mt; and Conception - 500 mt. These ABC levels were originally set on the basis of historical catch levels prior to the development of the arrowtooth flounder fishery, and current catch levels remain well below the level of ABC.

### Other Groundfish

The team recommends no change in the coastwide ABC of 14,700 mt.

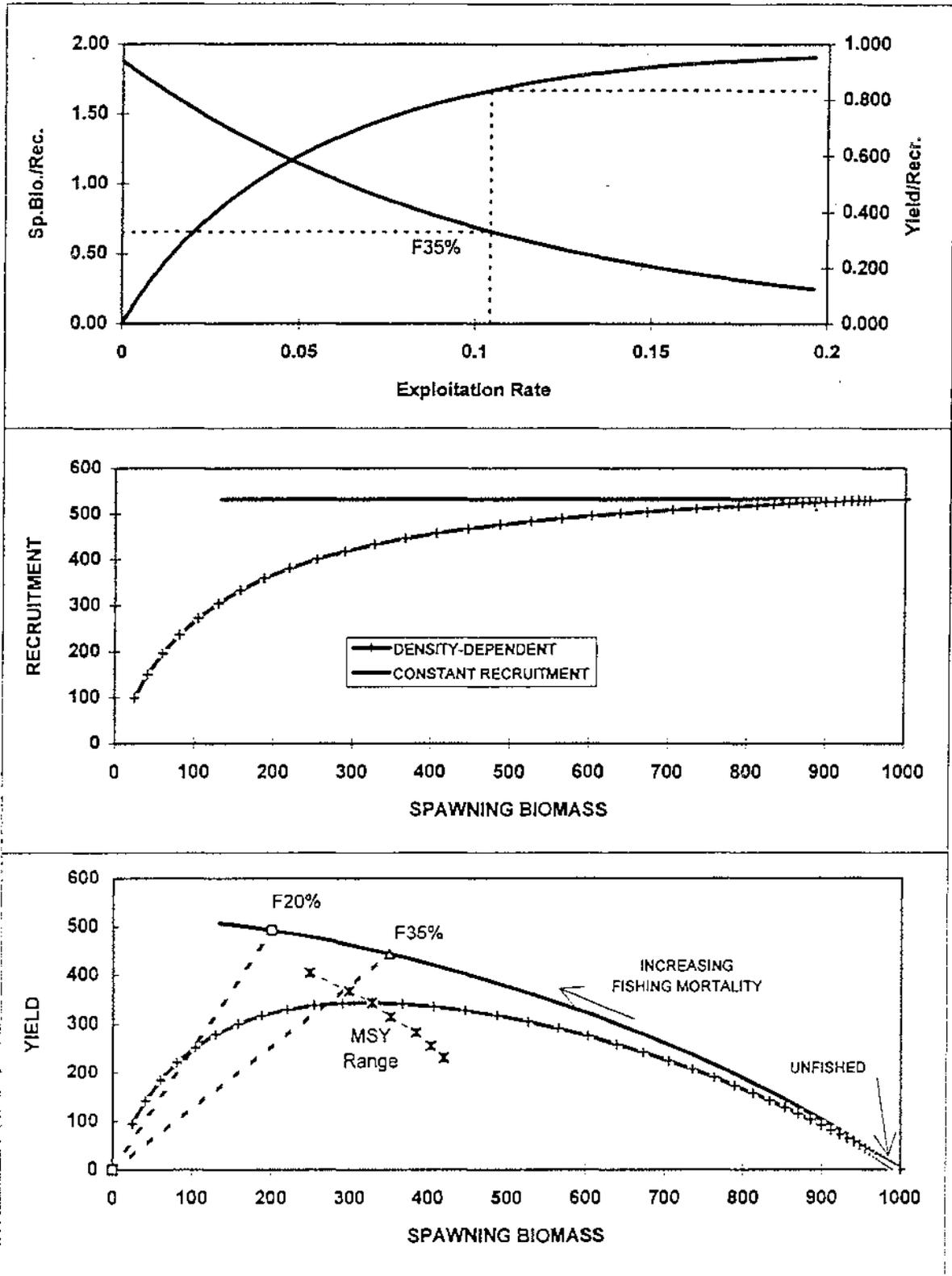


Figure 1. Biological reference points with reference to spawning biomass, recruitment, and yield.