AGENDA D-2(c)
APRIL 1995

MEMORANDUM

TO: Council, SSC, and AP Members

FROM: Clarence G. Pautzke
Executive Director

DATE: April 12, 1995

SUBJECT: Pacific Ocean Perch (POP) Rebuilding

ESTIMATED TIME
1 hour

ACTIONS REQUIRED:

(a) Consider whether to adjust Gulf of Alaska POP rebuilding plan

(b) Consider whether to set 1995 POP TAC different from rebuilding plan

BACKGROUND

In setting 1995 final specifications for Gulf of Alaska Pacific ocean perch (POP) last December, the Council learned they could not set the TAC below that specified by the rebuilding formula outlined in Amendment 32 prepared in 1993. In addition, ADF&G staff recommended a conservative approach to GOA rockfish management (Item D-2(c)(1)). The Council did not set a TAC for POP in December, but expressed a desire to amend the FMP so that the rebuilding plan would serve as an upper limit, and the TAC could be less.

Current FMP rebuilding plan for POP TAC

Amendment 32 established the rebuilding plan for POP. Because of increased concern over status of the stocks, biomass assessment methodology has been improved and domestic harvest levels reduced. The 1994 TAC of 2,550 mt was specified as bycatch only. The 1994 spawner biomass was 74,000 mt or about 15-20 percent of that observed in the 1960s. The 1995 estimate is about 116,000 mt.

Increasing the biomass of POP to a level closer to historic amounts is necessary to achieve optimum yield. Factors other than fishing mortality contribute to the continued depressed state of this resource. Ecosystem changes or other biological factors may preclude rebuilding success. Nevertheless, the Council wants to minimize POP mortality to maximize the probability of rebuilding success in a realistic time period.

The FMP establishes the procedure for deriving the annual GOA TACs for POP. POP stocks are considered to be rebuilt when the total biomass of mature females is equal to or greater than B_{MSY} (estimated to be about 150,000 mt). Annual TACs of Pacific ocean perch are determined as follows:

(a) Determine the current and target biomass and optimal fishing mortality rate. For purposes of this rebuilding plan, the target biomass is B_{MSY}, the total biomass of mature females that would produce the maximum sustainable yield, on average. The optimal fishing mortality rate is the rate that maximizes expected biological and economic yields over a range of plausible stock-recruitment relationships.

(b) Determine the fishing mortality rate halfway between the optimal fishing mortality rate and the fishing mortality rate estimated to be sufficient to supply unavoidable bycatch of Pacific ocean perch in the Gulf based on 1992 bycatch.

(c) When the current biomass of mature females is less than B_{MSY}, adjust the resultant fishing mortality rate in

(b) by the ratio of current biomass to B_{MSY}. When B_{MSY} is attained, the fishing mortality rate will be the optimal fishing mortality.

(d) The TAC of Pacific ocean perch is the amount of fish resulting from the adjusted fishing mortality rate.

(e) The TAC is apportioned among regulatory areas in proportion to POP biomass distribution.

In addition to restricting the annual fishing mortality rate of POP, the Council has sought to reduce the total mortality of POP in other target fisheries. Overfishing used to be defined Gulf-wide, but Amendment 32 distributed the overfishing level among Eastern, Central, and Western areas in the same proportions as POP biomass to avoid localized depletion and rebuild POP at equal rates in all regulatory areas. This is necessary because, although POP biomass is greatest in the Eastern regulatory area, most trawling activity and incidental bycatch of POP are greatest in the Central regulatory area.

In December 1994 and January 1995, some Council members expressed concern with having to set POP TAC equal to the rebuilding plan level, rather than below it at bycatch only levels. A motion was made to recommend an emergency rule to set the 1995 POP TAC at the 1994 level, adjusted for estimated 1995 bycatch needs, but later was withdrawn to allow for more public notification.

A plan amendment would be needed to set TAC below the rebuilding plan TAC for 1996. An emergency action would be needed now to do it for the July 3 opening this year. As of April 1, 110 mt of POP were caught as bycatch; 83 mt were discarded because vessels exceeded directed fishing standards.

Status of the stock assessment for calculating POP TAC

The current status of the GOA POP rebuilding plan is described by Drs. Heifetz, Ianelli, and Fujioka in Item D-2(c)(2). Their paper addresses two main points raised by the ADF&G report: (1) whether there is a biological crisis which warrants an emergency rule to lower the TAC from the level set by the rebuilding plan; and (2) the appropriateness of the rebuilding plan, current stock assessment, and measures of reproductive potential. In summary, the report finds:

(1) No biological justification was found for an emergency rule to lower the TAC for the 1995 fishery. This conclusion is based on short term projections and spawner biomass per recruit analysis which show that at low fishing rates proposed for POP there is negligible effect on spawning biomass or age composition among alternative TAC levels.

(2) A preliminary analysis of updated stock-recruitment data and an alternative reproductive potential index (i.e., total fecundity) indicates that the stock may be more resilient to relative reductions in reproductive potential than originally estimated because the estimated recruitment levels remain the same but arise from relatively fewer units of reproductive output. This alternative measure of reproductive potential may indicate a slightly higher optimum fishing mortality rate than is currently estimated using spawning biomass.

(3) Incorporation of new data to estimate B_{MSY} and an optimal fishing rate appears to be consistent with the rebuilding plan.

(4) Age composition as a "benchmark" for assessment of stock condition is influenced by the high variation in recruitment strength.

(5) Under the rebuilding plan there will likely be a substantial increase in TAC for the first time the population is projected to be at or above target levels of female spawning biomass. It may be desirable to identify additional criteria for determination of rebuilding success and when normal fishing levels can be resumed.

Alaska Department of Fish and Game staff comments and recommendations regarding Gulf of Alaska rockfish management for 1995.

SLOPE ROCKFISH

PACIFIC OCEAN PERCH - The exploitable biomass as indicated by the triennial trawl survey more than tripled from 135,402 mt in 1990 to 453,605 mt in 1993 (Figure 1). Much of this change was the result of a dramatic increase in young fish which appeared for the first time in the 1993 survey in the Kodiak INPFC area. The department is encouraged by the apparent increase in POP biomass indicated by the 1993 survey. However, there is a great deal of uncertainty in the biomass estimate due to survey error inherent in using area swept trawl survey methods for assessing rockfish. Therefore, we recommend against relying too heavily on the results of the 1993 survey when establishing TAC levels until strength of the younger year classes can be confirmed.

The authors of the SOS document warn, "In past SAFE reports, we have speculated that a change in availability of rockfish to the survey, caused by unknown behavioral or environmental factors, may explain some of the observed variation in biomass. It seems prudent to repeat this speculation in the present r.eport..." As calculated according to the formula adopted by the Council under the POP rebuilding schedule, TAC would increase 121% from 2,550 in 1994 to 5,631 t in 1995 (Figure 2). Department staff questions whether one additional year of survey data provides adequate evidence of stock rebuilding to justify that level of increased harvest. Even if the indicated increase in biomass is real, virtually all of the increased biomass can be attributed to very young fish which were observed in the population for the first time during the 1993 survey.

There are several reasons the department encourages the Council to maintain a very conservative approach to POP management:

1. There is a great deal of uncertainty in the biomass estimate due to the high variability intrinsic in the use of area swept trawl surveys to assess rockfish. It is highly unlikely that the POP population has actually fluctuated (upward or downward) in the past decade to the extent indicated by the surveys.

2. Most of the increased biomass in the 1993 survey is attributed to young fish (<9 years) in the Central and Western Gulf. These fish are not fully mature and are not fully recruited to the fishery. A nine year old POP yields less than 0.3 pounds of fillets and, therefore, these young fish are of relatively little commercial value because of their small size (Figure 5-2, Table 5-12).

3. Directed fisheries for POP would likely occur if the TAC as calculated according to the rebuilding plan as currently written in the FMP. A directed fishery would target on the older and larger animals disproportionate to their abundance in the population with the potential of adversely impacting future rebuilding.

4. Of all POP caught in 1994, 84.2% were reported to have been discarded. It is presumed that many of the fish were discarded because such a large proportion of the population is currently comprised of fish too small to be of commercial value. This provides further justification to keep harvests at very low levels until the younger fish which apparently dominate the Central and Western Gulf POP population are larger and more valuable to the industry.

5. Directed POP fisheries would result in high bycatch levels of other species of concern such as shortraker/rougheye and thornyhead rockfish. If sufficient amounts of these other species are taken, fisheries for other species, such as deep-water flatfish or sablefish, could be impacted.

Recommendation:

Adopt a policy which restricts POP harvest to bycatch only until the apparent increase in the biomass estimate can be verified by the 1996 triennial trawl survey or other surveys, and until the young fish which currently make up most of the population in the Central and Western Gulf are fully recruited and reach a more desirable commercial market size. Adoption of this policy may require a modification to the current TAC-setting formula outlined in FMP.

OTHER SLOPE ROCKFISH - According to observer data, 65.3% of all other slope rockfish which were caught during 1994 were discarded. The department has gone on record voicing concern that many of the species in the other slope rockfish category are of little commercial value or are of limited abundance. Much of the fishery for other slope rockfish appears to be conducted to acquire ballast against which other more valuable bycatch species can be obtained. Most of the species which make up this group inhabit or overlap the same depth range as other rockfish species of concern including POP, shortraker/rougheye, and thornyhead rockfish, and high bycatch levels of these species can be anticipated.

The ABC for other slope rockfish is currently calculated as an accumulation of the estimated ABCs for the individual species which make up that group. An F = M exploitation rate is applied to the estimated biomass for each species as assessed by the triennial trawl survey. For many of the species where biology is poorly understood, natural mortality is assumed to be the average of the estimated natural mortality rates for several other similar species. There are several potential problems with this approach:

1. The triennial survey is not a reliable tool for assessing rockfish abundance. Therefore, biomass estimates for many of the species which make up the other rockfish group are questionable.

2. Because of the variability and uncertainty in natural mortality rates among the various species, there is a considerable risk of over-exploiting the slower-growing and older-aged species within the complex.

3. If any one of the species within the complex becomes the target of a directed fishery, that one species could potentially be harvested up to the TAC for the entire group, thus greatly exceeding the ABC (and OFL, if calculated) for that one species.

Recommendation:

The department urges the Council to consider adopting a policy which restricts harvest of other slope rockfish to bycatch only in fisheries for other species. Directed fisheries should not be allowed unless it can be demonstrated that there are species within the complex which are abundant enough, resilient enough, and valuable enough to support a directed fishery. Even if that determination is made, TAC should be set very low to reduce the risk that other species in the complex are over-exploited.

PELAGIC SHELF ROCKFISH

BLACK ROCKFISH - The department concurs with the Plan Team recommendation to set a separate ABC for black rockfish in the Central Gulf Regulatory District equal to the average recent-year harvest. However, using this default method of setting ABC would result in ABC equal to OFL, a situation which could potentially have adverse impacts on other fisheries. Therefore, we recommend that the Council set TAC at 90% of ABC to provide a 10% buffer between TAC and OFL.

Black rockfish should remain in the pelagic shelf rockfish management group in the Western Gulf and Eastern Gulf Regulatory Districts, at least for the time being.

DEMERSAL SHELF ROCKFISH

Demersal Shelf Rockfish - The department concurs with the SAFE Report author's and Plan Team's recommendation to reduce ABC for this species group in the Southeast Outside District from 960 t to 580 t. Because the department has the ability to closely monitor and manage the DSR fishery, we recommend setting TAC equal to ABC.

To remain within the reduced TAC, the department intends to release only 150 t of TAC for a directed fishery on January 1. The department will then close the directed fishery until it can be determined how much of the remaining TAC will be needed as bycatch in the halibut IFQ fishery. If there is sufficient TAC remaining at the end of the halibut season, the directed fishery may be reopened to harvest the balance.

EXPLOITABLE BIOMASS OF POP
IN THE GULF OF ALASKA, 1984-1993

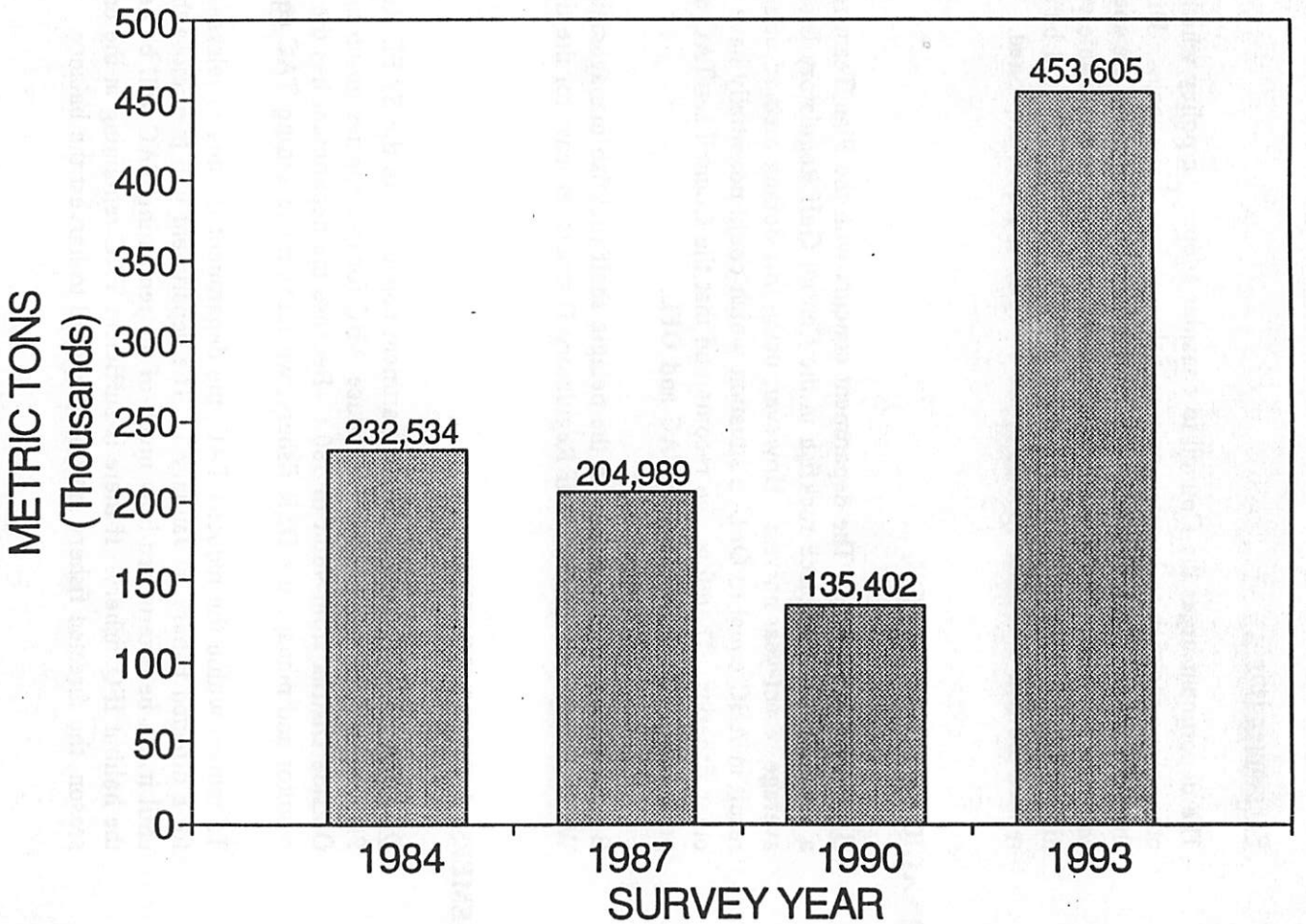


Figure 1

TOTAL ALLOWABLE CATCH OF POP
IN THE GULF OF ALASKA, 1991-1995

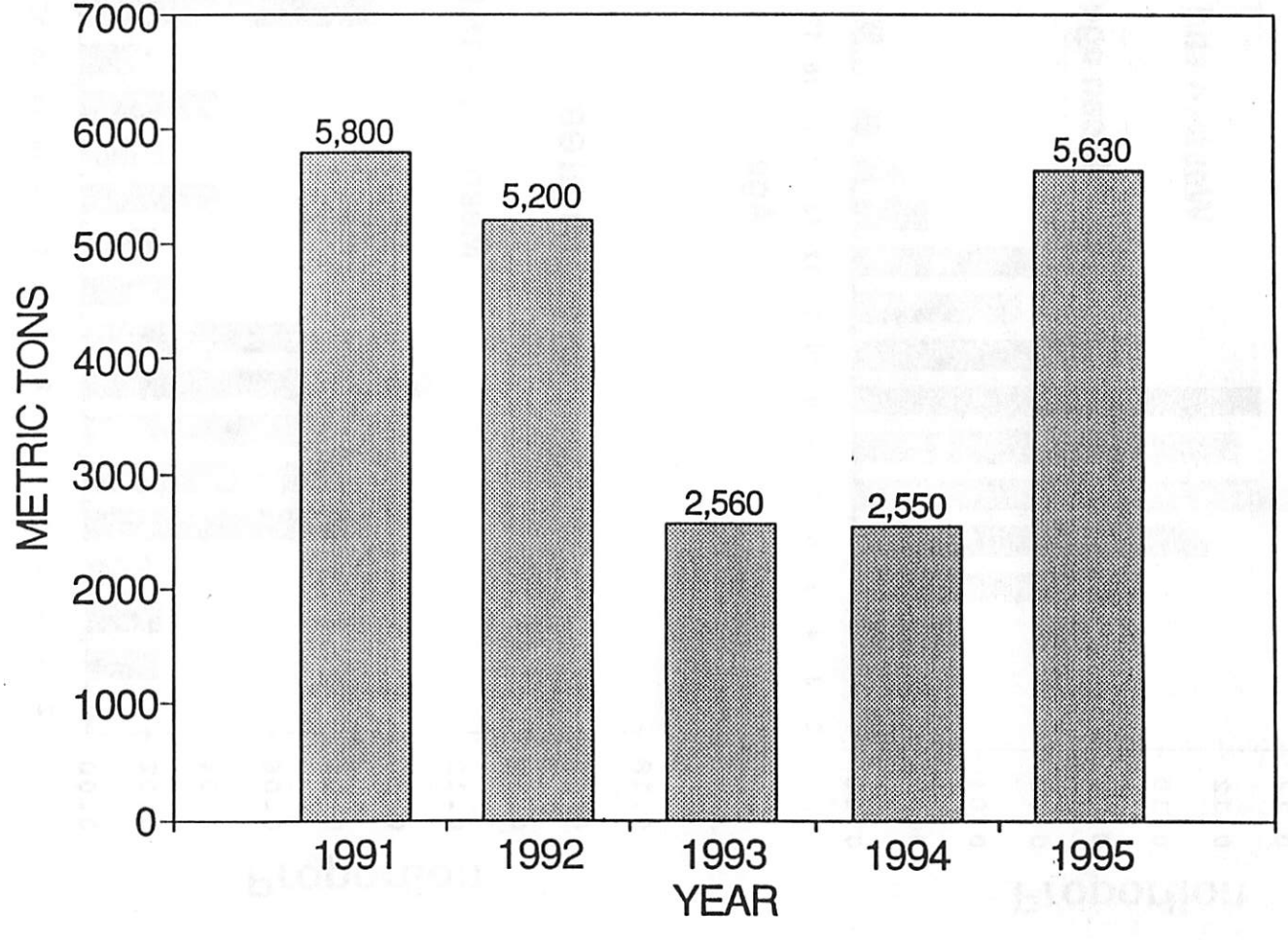
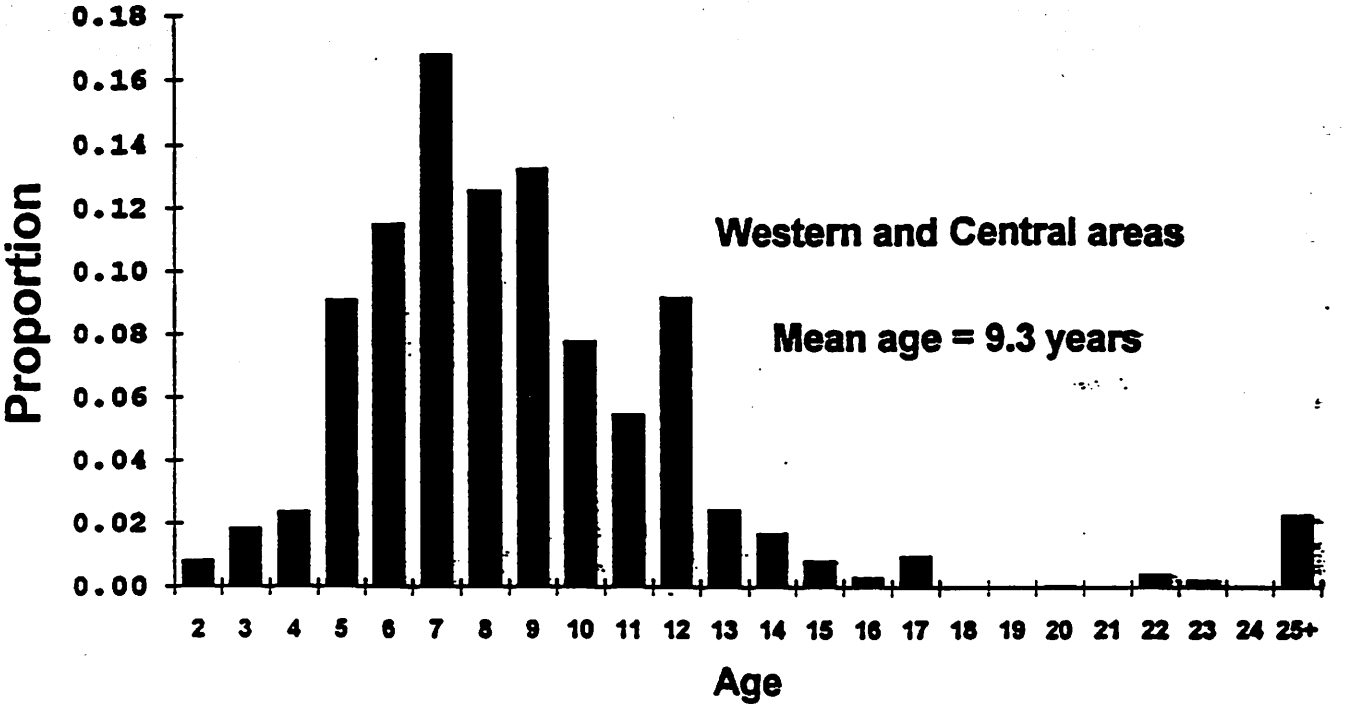


Figure 2



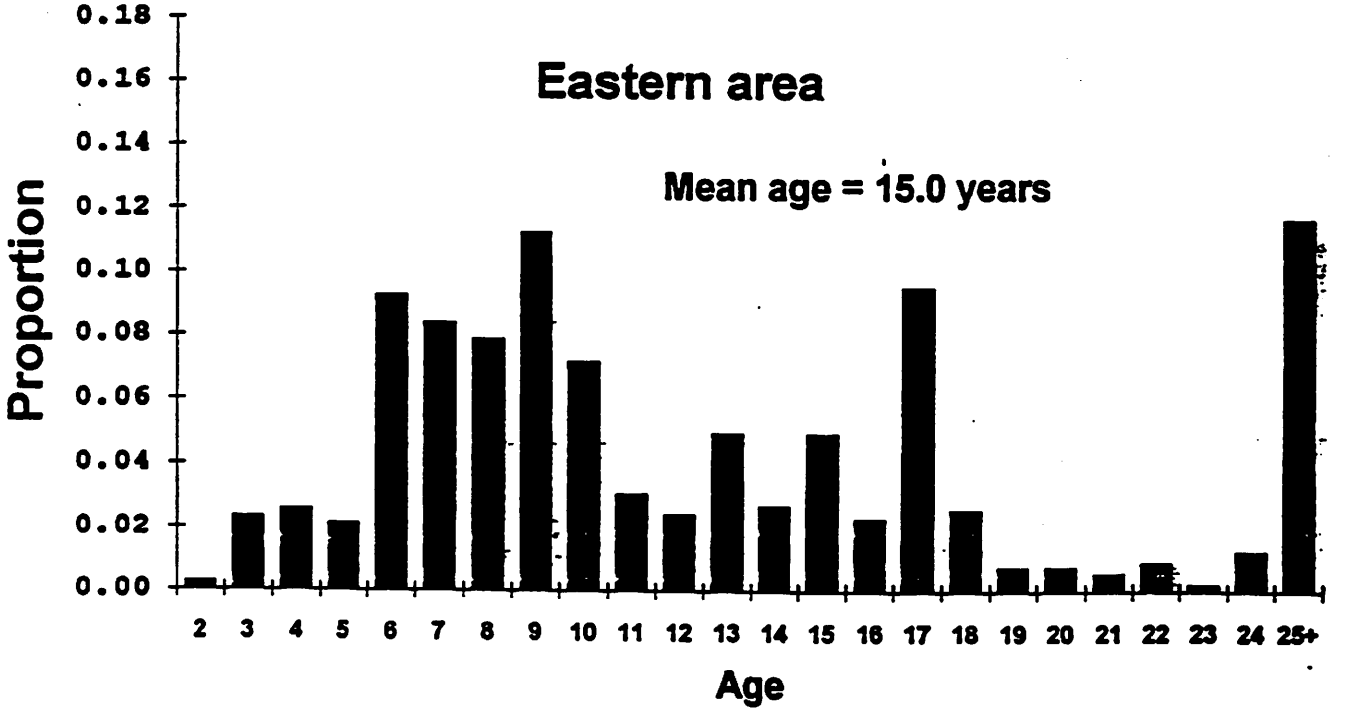


Figure 5-2. -- Age composition of the estimated population of Pacific ocean perch in th Gulf of Alaska based on the 1993 triennial trawl survey.

Table 5-12. Estimated numbers (thousands) of Pacific ocean perch at age in 1995 and schedule of age specific maturity, fishery selectivity, and mean weight based on the stock synthesis model.

Age	Numbers in 1995	Percent mature	Percent Selected	Weight (grams)
2	42,026	0	1	53
3	39,969	0	2	116
4	38,008	5	3	194
5	48,452	12	5	279
6	24,580	27	8	363
7	49,123	50	13	442
8	49,919	73	20	515
9	92,694	88%	31	579
10	22,207	95	45	635
11	51,054	98	61	683
12	32,986	99	77	724
13	18,827	100	89	759
14	6,782	100	97	788
15	29,996	100	100	812
16	2,921	100	100	832
17	2,842	100	97	848
18	3,722	100	94	861
19	12,032	100	89	872
20	1,133	100	84	881
21	702	100	79	889
22	514	100	75	895
23	987	100	70	900
24	1,031	100	65	904
25+	14,974	100	61	907

1986 — 1.27 lbs (.28 lbs)

1.6 lbs (.35 lbs)

1.79 lbs (.39 lbs)

Interim Report on the Status of the Pacific Ocean Perch Rebuilding Plan in the Gulf of Alaska[1]

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Introduction

The purpose of the document is to address points brought up by Alaska Department of Fish and Game (ADF&G) about the stock assessment and rebuilding plan for Pacific ocean perch (POP) in the Gulf of Alaska (GOA). These concerns were first expressed by ADF&G at the December 1994 North Pacific Fishery Management Council Meeting (Appendix A) and then discussed at a meeting on March 3, 1995 at the Auke Bay Laboratory attended by staff of ADF&G, NMFS Alaska Fisheries Science Center, and NMFS Regional Office (Appendix B). Two primary concerns were discussed. First, whether there is a biological crisis which warrants an emergency rule to lower the TAC from the level set by the rebuilding plan in the FMP. ADF&G was concerned about relying too heavily on the 1993 survey results and the effects of taking young fish in the Central and Western areas and a directed fishery targeting older and larger fish. We address these concerns by reviewing the stock assessment and rebuilding plan and examining the short-term effects of alternative TAC levels on spawning biomass and age composition. Spawning biomass per recruit analysis is also provided to examine long-term implications of different selectivity patterns under present fishing rates. The second concern focused on the appropriateness of the rebuilding plan, current stock assessment, and measures of reproductive potential. Here, we discuss how this concern may be addressed in future assessments.

Review of current stock assessment

Current stock levels
The current stock assessment for POP in the GOA is based on the stock synthesis model (Heifetz and Ianelli 1992). The data sets used in this analysis included total catch biomass for years 1961-

[1] Report submitted to the North Pacific Fishery Management Council April 6, 1995.

1994, size compositions from the fishery for 1963-78 and 90-92, fishery CPUE for 1964-79, survey age compositions based on surface reading of otoliths (biased ages) for 1963-67, 78, and 79, survey size compositions for 1978-93, survey "break and burn" (unbiased ages) age compositions for 1980-82, 84, 87, 90 and 93, and survey biomass estimates for 1984, 87, 90 and 93. Ageing error, transformations from biased to unbiased ages, and standard errors of survey estimates of abundance were included in the model.

Initial exploratory runs of the model indicated that estimates of survey biomass were inconsistent with survey age and size compositions and fishery CPUE. In addition, regardless of the emphasis on survey biomass, the model did not fit the survey biomass levels very well. Even with extremely high emphasis on survey biomass, the trend in biomass suggested by the surveys could not be adequately modeled. The fluctuations in survey biomass estimates coupled with incompatibility with other data sources indicates that the sharp decline in biomass suggested by the 1987 and 1990 surveys was unlikely.

As in previous assessments, a model that had low emphasis on survey biomass was chosen as the best model to determine current stock condition. The fit to survey biomass for this model is shown in Figure 1. For three of the four years of the survey the model prediction of survey biomass is considerably less than the actual survey estimates, whereas fits to survey age composition are reasonably good (Fig. 1). As can be concluded from the 1994 SAFE report, the assessment presumes that the survey has in general poorly estimated POP abundance but the age compositions from the survey are reasonably accurate. Thus, the assessment does not rely heavily on biomass estimates from the 1993 survey or any other survey. A summary of the estimated age structure of the current population based on the model and other parameters is in Table 1. A prominent feature of this assessment is the dominance of the 1986 year-class especially in the Central and Western areas which was first documented in the 1990 survey and verified in the 1993 survey.

The estimate of female spawning biomass at the beginning of 1995 based on the current assessment is about 116,000 mt. In last years assessment, the estimate of female spawning biomass at the beginning of 1994 was about 75,000 mt. It is important to understand that we do not believe the female spawning biomass has increased from 75,000 mt to 116,000 from 1994 to 1995. This point is clarified in Figure 2 which shows the trend in female spawning biomass based on last years assessment and the current assessment. Based on the current assessment female spawning biomass has increased 13% from 1994 to 1995 (103,000 to 116,000 mt).

ABC, OFL, and TAC

The optimal fishing rate (Fopt) for POP has been estimated to be the $F_{44\%}$ rate (Ianelli and Heifetz 1995). If the rebuilding target female spawning biomass of 150,000 mt is used as an estimate of Bmsy, then to calculate ABC the fishing rate is reduced by the ratio of current female spawning biomass to target female spawning biomass (0.776). This computation resulted in an ABC of 8,230 mt that was recommended by the SAFE authors and the SSC. The $F_{44\%}$ rate is considered

an estimate of Fmsy, therefore the overfishing level (OFL) is set equal to ABC. To provide a reasonable buffer between OFL and ABC, the Plan Team (PT) guidelines require reducing the fishing rate by the ratio of $F_{35\%}$ to $F_{30\%}$ which resulted in an ABC of 6,530 mt. The PT ABC was adopted by the Council.

The TAC for POP is determined by the rebuilding plan. Under this plan the rate halfway between the optimum rate and the rate estimated to provide unavoidable bycatch of POP in 1992 is used to determine TAC. The $F_{55\%}$ rate was determined to be consistent with the rebuilding plan. This rate is adjusted downward by the ratio of current female spawning biomass to target female spawning biomass to give a fishing rate of 0.041 and a TAC of 5,630 mt.

Rebuilding analysis overview

Decline of the stock of POP in the GOA since the early period of the foreign fishery has raised concerns that harvest restrictions on the domestic fishery during the 1990's may have been insufficient to rebuild the POP stock. Consequently, the Council requested that an analysis be performed to: a) identify optimal fishing rates for rockfish species such as Pacific ocean perch, b) identify the biomass level that would produce an optimum yield, and c) evaluate alternative fishing policies designed to improve the condition of the POP resource. This analysis was carried out and presented as Plan Amendment 32 and reported in Ianelli et al. (1993) and Ianelli and Heifetz (1995).

The approach to address objectives (a) and (b) was to modify Clark's (1991) analysis in order to incorporate recruitment variability and to consider plausible stock-recruitment relationships in light of the available POP data. Objective © was addressed through Monte Carlo simulations under alternative hypotheses regarding stock productivity. This portion of the analysis was similar to other analyses found in the literature (e.g., Overholtz et al. 1986, Quinn et al. 1990, and Rosenberg and Brault 1991). In addition, Bayesian methods were used to develop probability estimates for the alternative hypotheses regarding stock productivity (Thompson 1992).

Recruitment variability was shown to play an important role in determining the effects of different harvest policies. Based on estimates of optimal biomass and fishing mortality rates, four alternative harvest policies were developed and evaluated using a stochastic simulation model. These policies ranged from harvests based on rates under the status quo policy to increasingly restrictive measures. Policy outcomes were measured in terms of yield in weight and dollar-value, female spawner biomass, and risks. We presented the results in the form of Bayesian decision tables. The main conclusion drawn from the simulations were that the ability to predict future stock levels with a high degree of certainty was poor.

Updated rebuilding analysis

Because of continuing concerns on the current status of the POP stocks in the GOA, the rebuilding analysis was updated based on this year's stock assessment. The main difference between the data used was the inclusion of recent estimates of age composition derived from the 1993 survey. The results from this analysis is presented below and in the section on the "need for emergency rule to reduce TAC."

Preliminary analyses using alternative reproductive potential measures

To date, the estimate of female spawning biomass has been used as an index of reproductive potential. Total fecundity or consideration of some other age specific index of reproductive value of the population may be more appropriate (Leaman 1991). However, there appears to be considerable uncertainty about the fecundity and age relationship for POP (Fig. 3). A preliminary analysis on the sensitivity of the current stock assessment to these uncertainties has been conducted in the context of the stock assessment and the rebuilding analysis. In place of mature female spawning biomass, an estimated age-specific fecundity index (Fig. 3) was used in stock synthesis and then re-analyzed for stock-recruitment relationships. The effect of using a measure of fecundity instead of spawner biomass results in a greater estimated reduction in reproductive potential relative to historical levels. In terms of stock productivity, this means that the stock would be more resilient to reduction in reproductive potential than originally estimated because the estimated recruitment levels remain the same but arise from relatively fewer units of reproductive output. This is illustrated in the estimated likelihood profile for the critical shape parameter from the stock-recruitment relationship (Fig. 4). While a large portion of the differences in the updated analysis is due to the addition of recruitment estimates up to 1992, some of this effect is due to the use of an alternative index of reproductive output. The updated results may likely indicate a slightly higher optimum fishing mortality rate than was previously estimated. Currently, new maturity data are planned for collection and we envision incorporating a more thorough analysis of effective age-specific reproductive output for the next stock assessment cycle.

Need for emergency rule to reduce TAC

Short-term projections and spawning biomass per recruit

Deterministic projections of the model to the year 2000 starting with the current estimated age composition were performed to address ADF&G's concern that removal of certain age components of POP may adversely impact reproductive potential. Three alternative harvest scenarios were examined: 1) a constant TAC of 2,550 mt (i.e., the 1994 TAC) and the currently estimated selectivity pattern of the fishery; 2) a variable TAC based on the rebuilding plan and the currently estimated selectivity pattern of the fishery; and 3) a variable TAC based on the rebuilding plan and an asymptotic selectivity pattern. The TAC for scenarios 2 and 3 was

identical. Scenario 3 was chosen to examine the possible effects of a fishery that shifts to targeting older individuals.

The projections indicate that there will be negligible gains in short-term levels of spawning biomass under scenario 1 (Fig. 5). By the year 2000, scenario 1 results in a 10% higher level of spawning biomass than either 2 or 3. In addition, there are minor differences among the scenarios in overall age compositions and the proportion of "old" fish (ie. > age 14) in the population (Fig. 6). From 1994 to 2000, the proportion of "old" fish increases from 7.6% to 23.5% for scenario 1, to 21.5% for scenario 2, and to 21.0% for scenario 3. Cumulative yields of 15,300 mt for scenario 1 and 52,400 mt for scenarios 2 and 3 would have been realized under these hypothetical scenarios (Fig. 5).

That there is very little difference in age composition and spawning biomass among the three scenarios also could have been concluded by consideration of a spawner biomass per recruit plot. Figure 7 shows equilibrium spawning biomass per recruit isopleths for all combinations of F from 0 to 0.25 and age at 50% selection from 4 to 14. The F rates in question range between 0.02 - 0.04. At such low fishing rates, regardless of the selectivity pattern of the fishery, there is negligible difference in spawning biomass.

These illustrations support the conclusion reached at the March 3, 1995 meeting (Appendix B) that there is not a biological justification for an emergency rule to lower the TAC for the 1995 fishery.

Geographic comparisons

Another useful way to put the situation for the GOA POP in perspective is to compare abundance and harvest patterns of this species from nearby areas. Here we contrast the habitat area, harvest levels, and survey catch rates between the GOA and the Aleutian Islands region. In the depth strata where POP are abundant, the survey CPUE's are on the order of three times greater in the Aleutian Islands than the GOA (Table 2). However, the surface area of the two strata between 100-300 meters is more than 5 times greater in the GOA than in the Aleutians. While the difference in average depth-stratified survey CPUE in these areas is cause for concern, the level of harvests suggested by the rebuilding plan are relatively low. The recent harvests in the Aleutians have, until this year, proceeded at the $F_{35\%}$ rate without any apparent detrimental effects (eg. Ianelli and Ito 1994). Along the Canadian British Columbia coast, an area considerably smaller than the GOA, TAC's of POP in recent years have been on the order of 3,000 to 4,000 mt. On balance, there should be continuing concerns regarding the status of POP rebuilding in the GOA. However, the current situation and the plan for rebuilding does not seem to justify alarm if the goal is to manage a *fishery*.

Future considerations

According to the POP rebuilding plan in the FMP, "rebuilding is determined to have occurred when the current total biomass of mature females is equal to, or greater than, Bmsy." The document further states that "when Bmsy is obtained, the fishing mortality rate will be the optimal fishing mortality" rate.

Incorporation of new data to estimate Bmsy and an optimal fishing rate appears to be consistent with the rebuilding plan. Under this plan there will be a substantial increase in TAC the first time the population is projected to be at or above the target level of female spawning biomass (Fig. 8). After the target is attained, the population will likely fluctuate around the target level. There probably will be disagreement on whether the population has actually reached the rebuilt level and whether other criteria may be more appropriate. Thus, in addition to the target level of female spawning biomass, alternative measures of rebuilding success may need to be identified. Such alternative measures will need an amendment to be included in the POP rebuilding plan in the FMP.

Age composition as a measure of stock condition
Referencing papers by Leaman (1991, 1993), ADF&G has suggested that age structure characteristics, in addition to female spawning biomass, should be considered as a measure of rebuilding success or stock condition. Leaman (1991) states that consideration of reproductive value should be incorporated into management strategies. Reproductive value is incorporated into ABC recommendations for POP and other species by basing fishing rates on the reduction of spawning biomass per recruit, such as $F_{35\%}$, $F_{44\%,}$ or the target biomass criteria used to adjust the fishing rate.

Spawning biomass may only be an approximation to actual reproductive potential, and fecundity may be more appropriate. While we could not find substantiation of Leaman's (1991) statement that "fecundity of older fish is greater than for younger fish of the same somatic weight", we have made a preliminary incorporation of length-fecundity data to provide a more precise measure of reproductive potential (reported in the section "Rebuilding analysis overview")

Trippel and Morgan (1994) point out that "If gamete quality and related fertilization and hatching success change with reproductive experience, then the stock component of a stock-recruitment relationship should also be adjusted for gamete quality in relation to the relative abundance of different mature age groups in the population". The POP stock-recruitment relationship can be re-estimated incorporating a hypothetical function reflecting age-specific probability of reproductive experience into the measure of reproductive potential. New estimates of Fopt, target reproductive potential, current reproductive potential, and ABC would result.

"Benchmarks" such as the proportion of stock above a given age (or size), or number of strong age classes were suggested by ADF&G as examples of possible measures of stock condition or reproductive potential. While Leaman and Stanley (1993) illustrate the change in proportion of POP greater than 40 cm. as a stock experiences exploitation, it is not clear that they recommend

such a value as a measure of stock condition. Instead, they point out how it is influenced by the occurrence of varying year class strengths. Leaman (1991) illustrates that age composition is unstable due to high variation in cohort strength by pointing out that the mean age of a lightly exploited stock decreased by 15 years within a span of 6 years, due to recruitment variability. Quast (1972) warned of dangers of interpreting catch curves in POP, noting that a fairly flat catch curve in later phases of exploitation could be mistaken for evidence of a low exploitation rate, whereas it could have been caused by reduced recruitment, perhaps caused by the reduction of reproductive potential. Likewise, Leaman's (1991) observations seem to show that the age composition of a heavily exploited stock cannot be distinguished from a lightly exploited stock that has recent strong recruitment.

Criteria for rebuilding success

Recent FAO draft guidelines for fishery management contain criteria for defining stages of stock rebuilding (FAO 1994) . The guidelines postulate that "following precautionary principles, a policy of stock rebuilding cannot be considered successful, and normal fishing level[2] should not be resumed, until the first year class generated subsequent to this policy", has itself generated one respectably large year-class, further, that this second year class has reached commercially exploited sizes". While the derivation of this criterion is unclear, it does assure the opportunity of reproductive success. Determination of whether this criterion has been met would be objective, and combined with the attainment of Bmsy or other reproductive potential target, may assure that normal fishing can be safely resumed.

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[2] "normal fishing levels" in the FAO (1994) document were harvests corresponding to the F0.1 fishing rate which is considerably higher than the rates proposed for POP in the Gulf of Alaska.

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Table 1. Estimated numbers (thousands) of Pacific ocean perch at age in 1995 and schedule of age specific maturity, fishery selectivity, and mean weight based on the stock synthesis model.

Age	Numbers in 1995	Percent mature	Percent Selected	Weight (grams)
2	42,026	0	1	53
3	39,969	0	2	116
4	38,008	5	3	194
5	48,452	12	5	279
6	24,580	27	8	363
7	49,123	50	13	442
8	49,919	73	20	515
9	92,694	88	31	579
10	22,207	95	45	635
11	51,054	98	61	683
12	32,986	99	77	724
13	18,827	100	89	759
14	6,782	100	97	788
15	29,996	100	100	812
16	2,921	100	100	832
17	2,842	100	97	848
18	3,722	100	94	861
19	12,032	100	89	872
20	1,133	100	84	881
21	702	100	79	889
22	514	100	75	895
23	987	100	70	900
24	1,031	100	65	904
25+	14,974	100	61	907

Table 2. Area, CPUE, and biomass estimates by 100 meter depth strata for the 1993 GOA survey and the 1994 Aleutian Islands survey.

	Sum of area (km2)		Average of CPUE (kg/km2)		Sum of Biomass (mt)	
Depth (m)	**Gulf of Alaska**	**Aleutians**	**Gulf of Alaska**	**Aleutians**	**Gulf of Alaska**	**Aleutians**
0-100	89,315	14,704	62	24	6,920	354
101-200	119,983	18,978	2,831	8,802	303,331	167,046
201-300	32,501	10,111	6,637	23,385	125,011	236,451
301-500	12,968	12,746	2,096	119	20,761	1,515
Total	254,767	56,539	-	-	456,023	405,366

Source: NMFS RACE Division staff, 7600 Sand Point Way NE. Seattle, WA 98115.

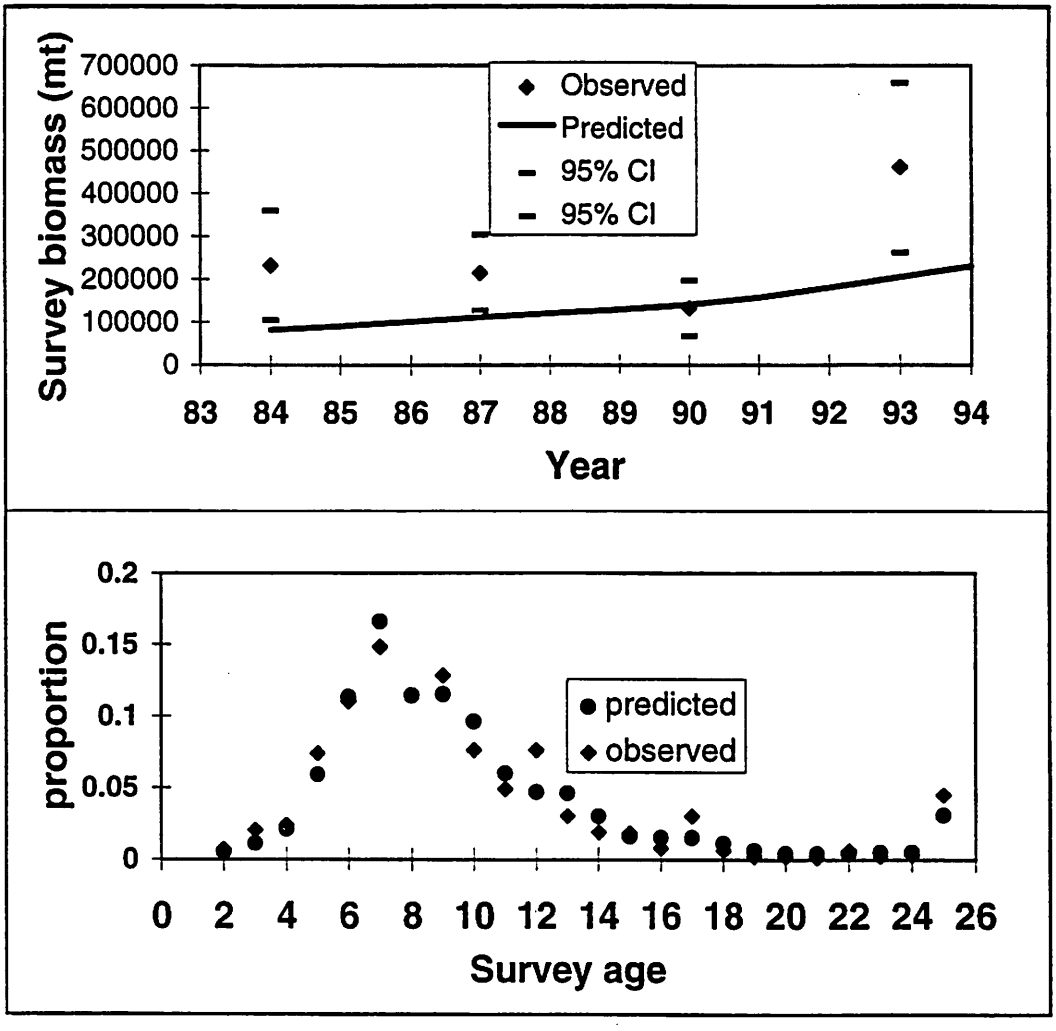


Figure 1. Fit to observed survey biomass of Pacific ocean perch in the Gulf of Alaska based on the stock synthesis model (upper panel). Fit to observed 1993 survey age composition of Pacific ocean perch in the Gulf of Alaska based on the stock synthesis model (lower panel).

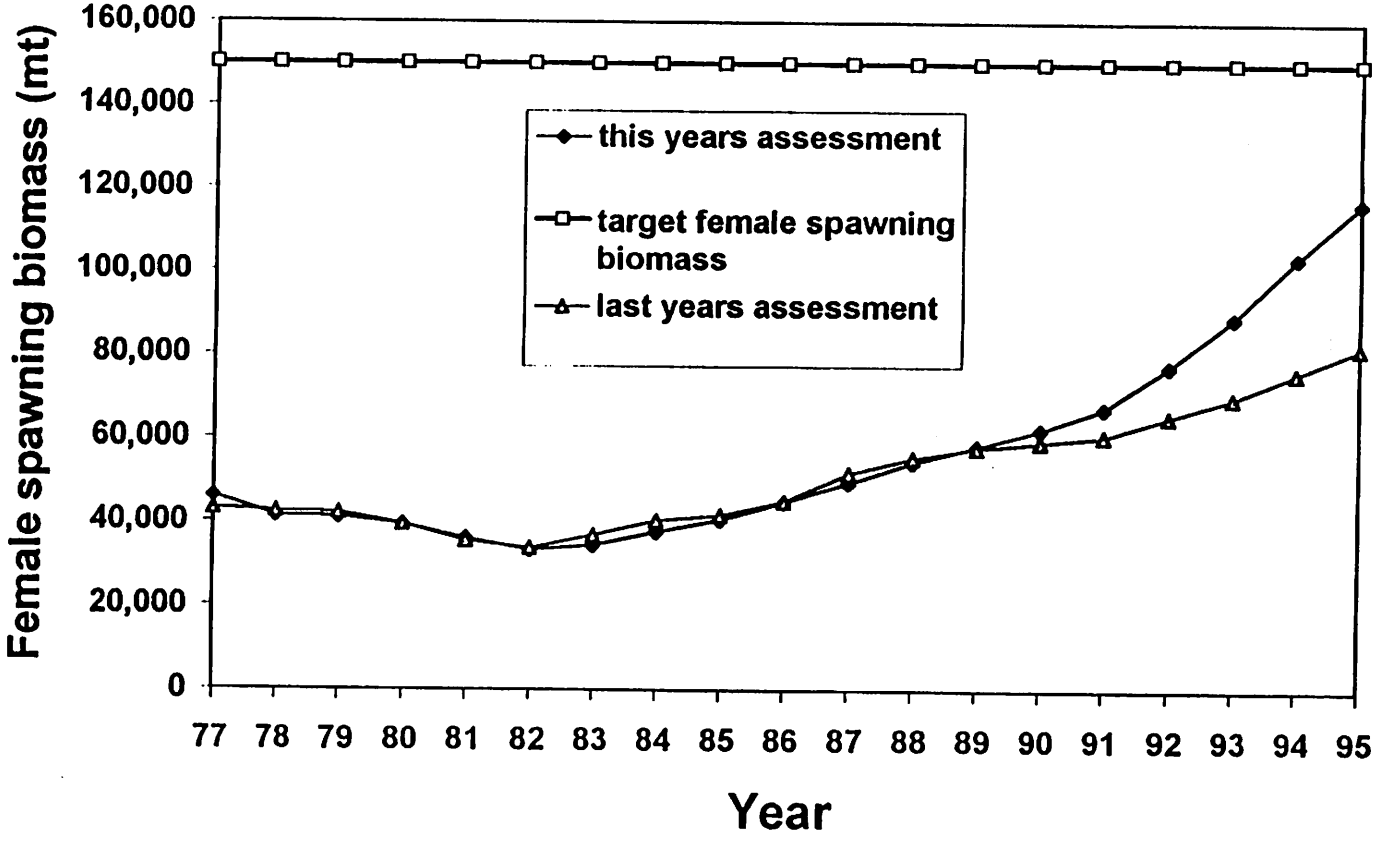


Figure 2. Recent trend in female spawning biomass relative to the rebuilding target of 150,000 mt based on last years assessment and the current assessment.

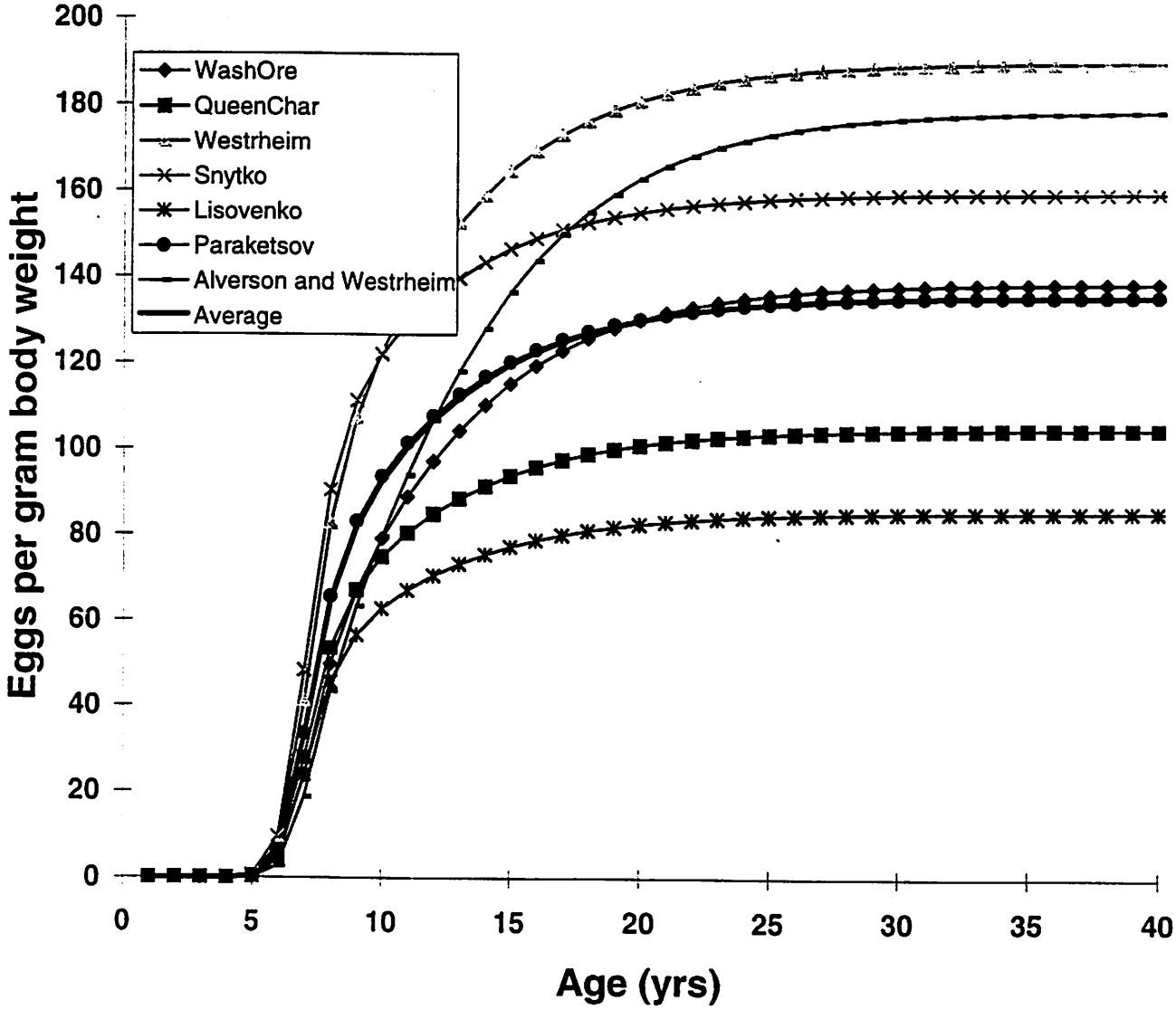


Figure 3. Estimated relationship between fecundity per gram of body weight and age for POP (computed from length-fecundity relationships in Alverson and Westrheim (1961), Chikuni (1975), and Gunderson (1976)).

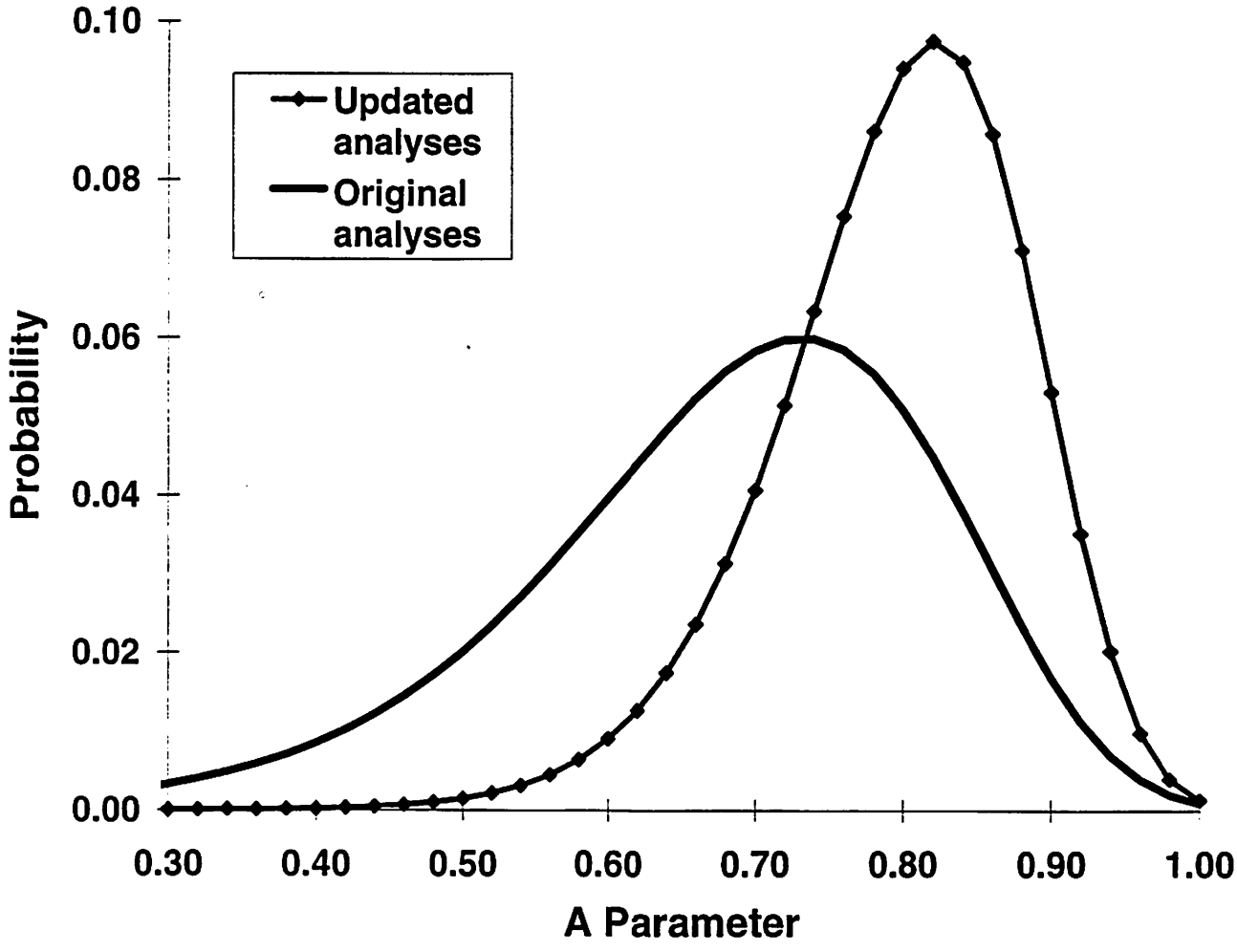


Figure 4. Probability profile of critical stock-recruitment parameter under the original rebuilding plan analyses versus the updated analyses with a longer time series of data. The updated analysis is based on additional stock recruitment data, and stock is measured as fecundity instead of spawning biomass.

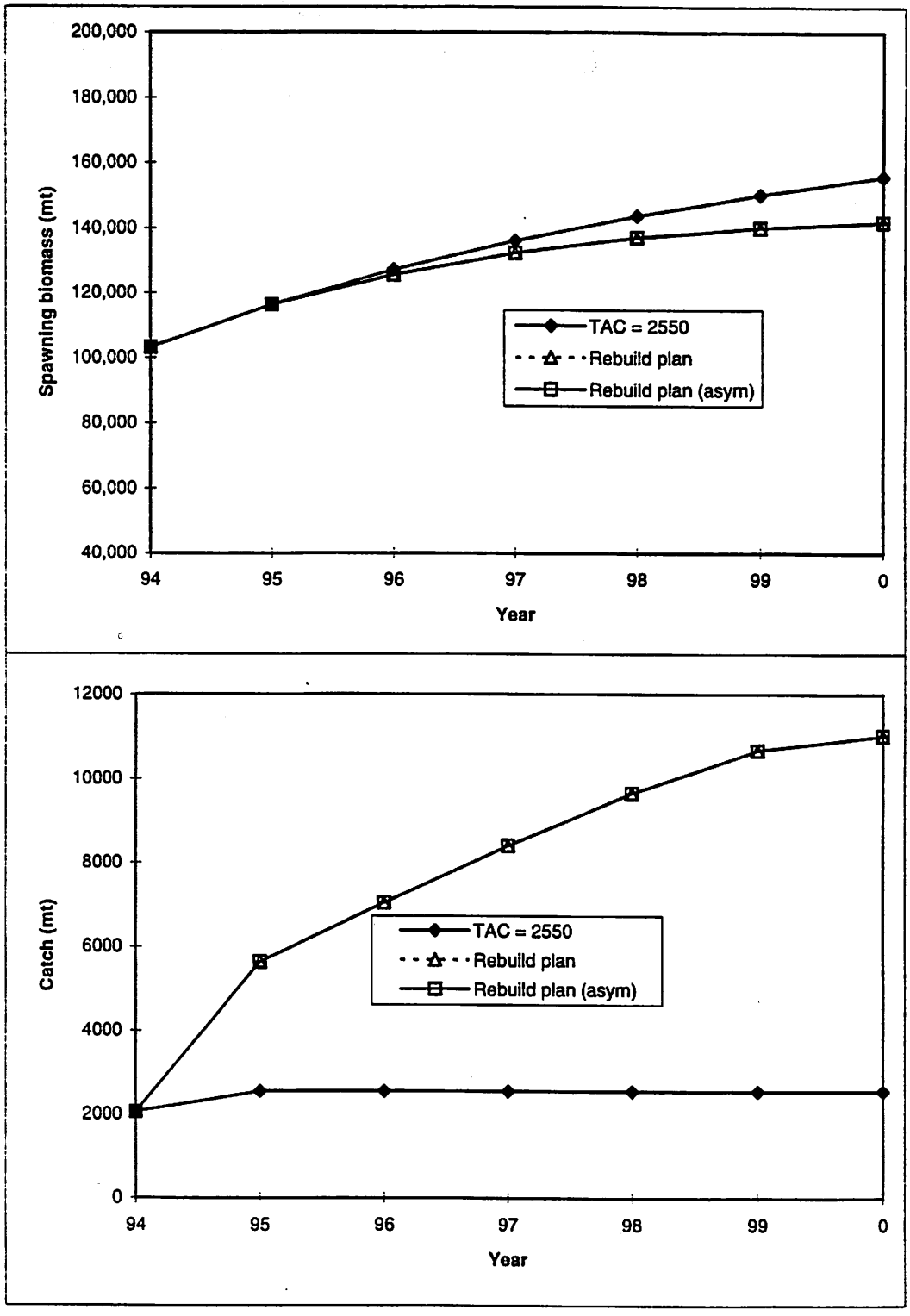


Figure 5. Projected trend in spawning biomass and catch for three harvest scenarios.

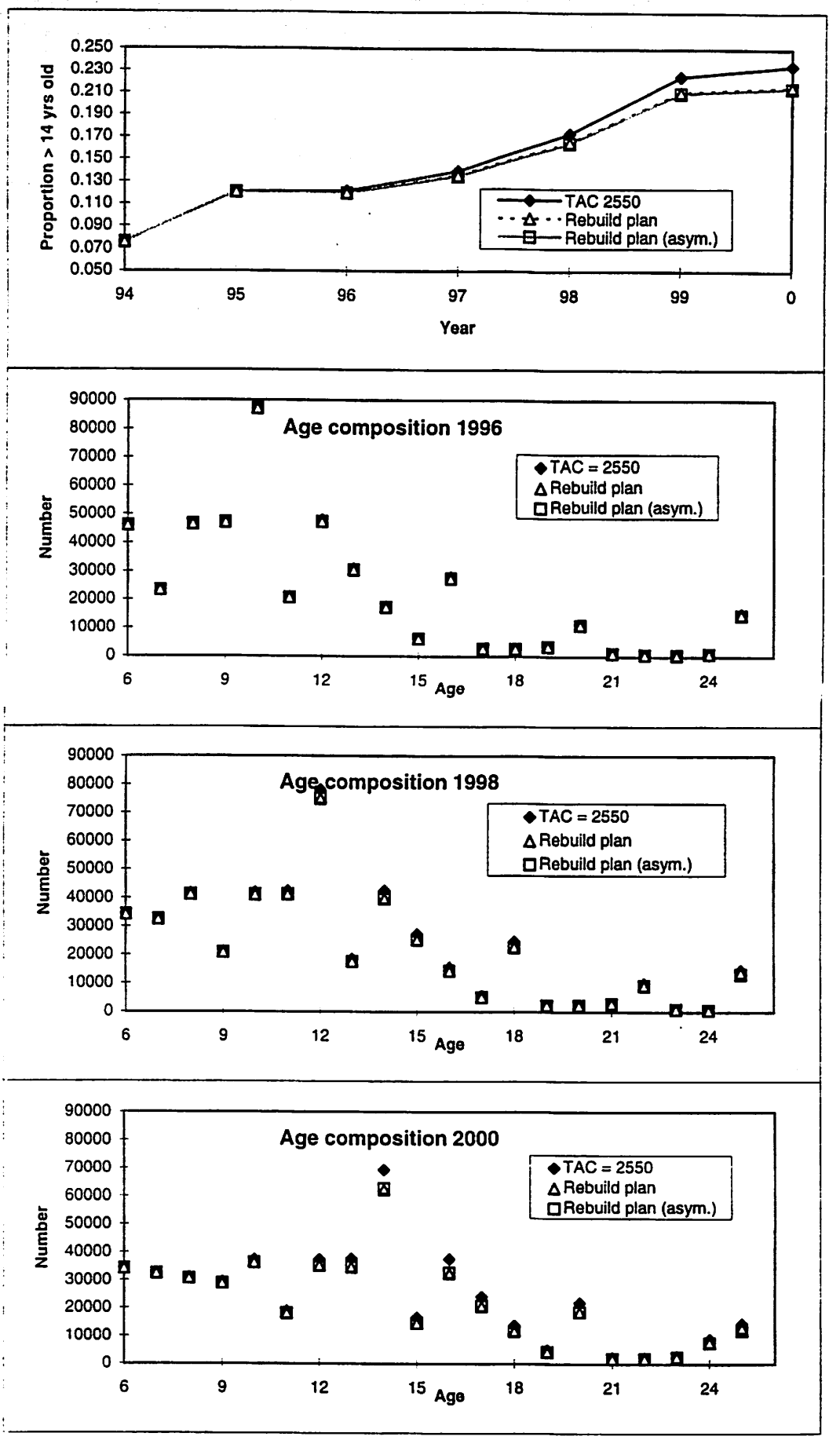


Figure 6. Projected trend in age composition of Pacific ocean perch for three harvest scenarios.

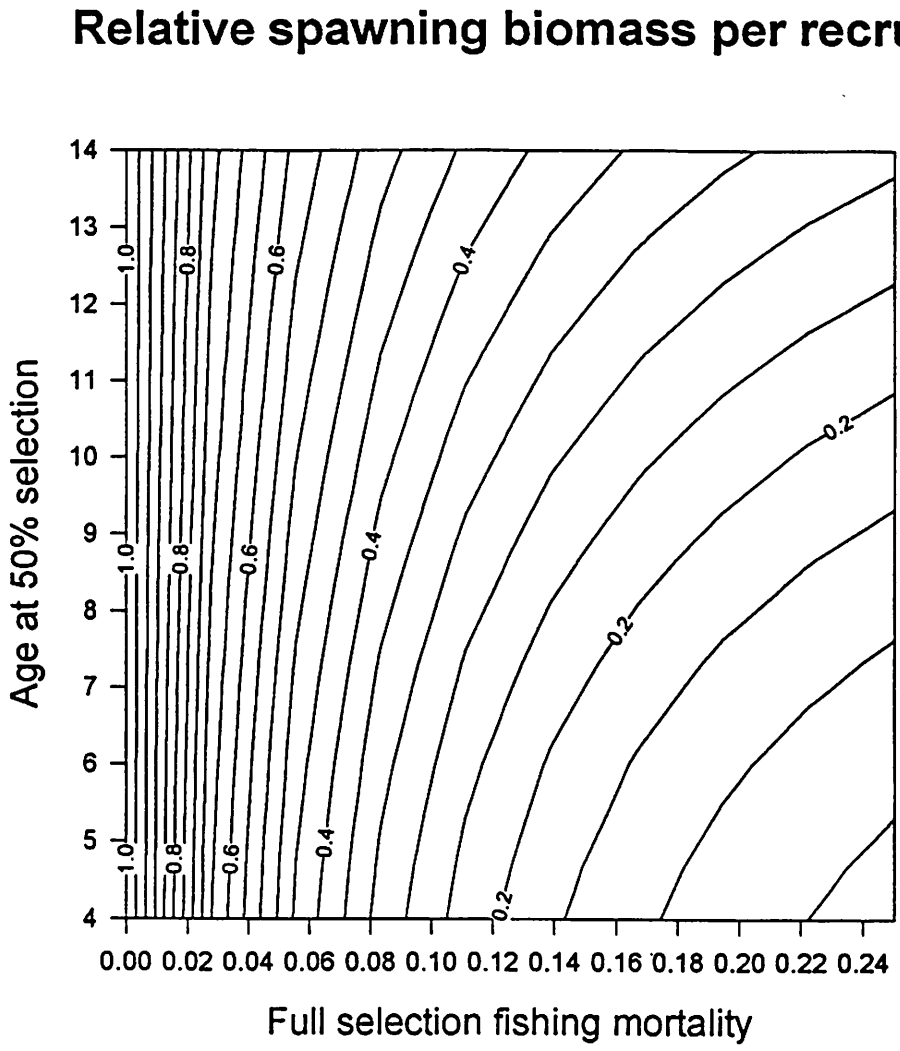


Figure 7. Spawning biomass per recruit isopleths for Pacific ocean perch in the Gulf of Alaska.

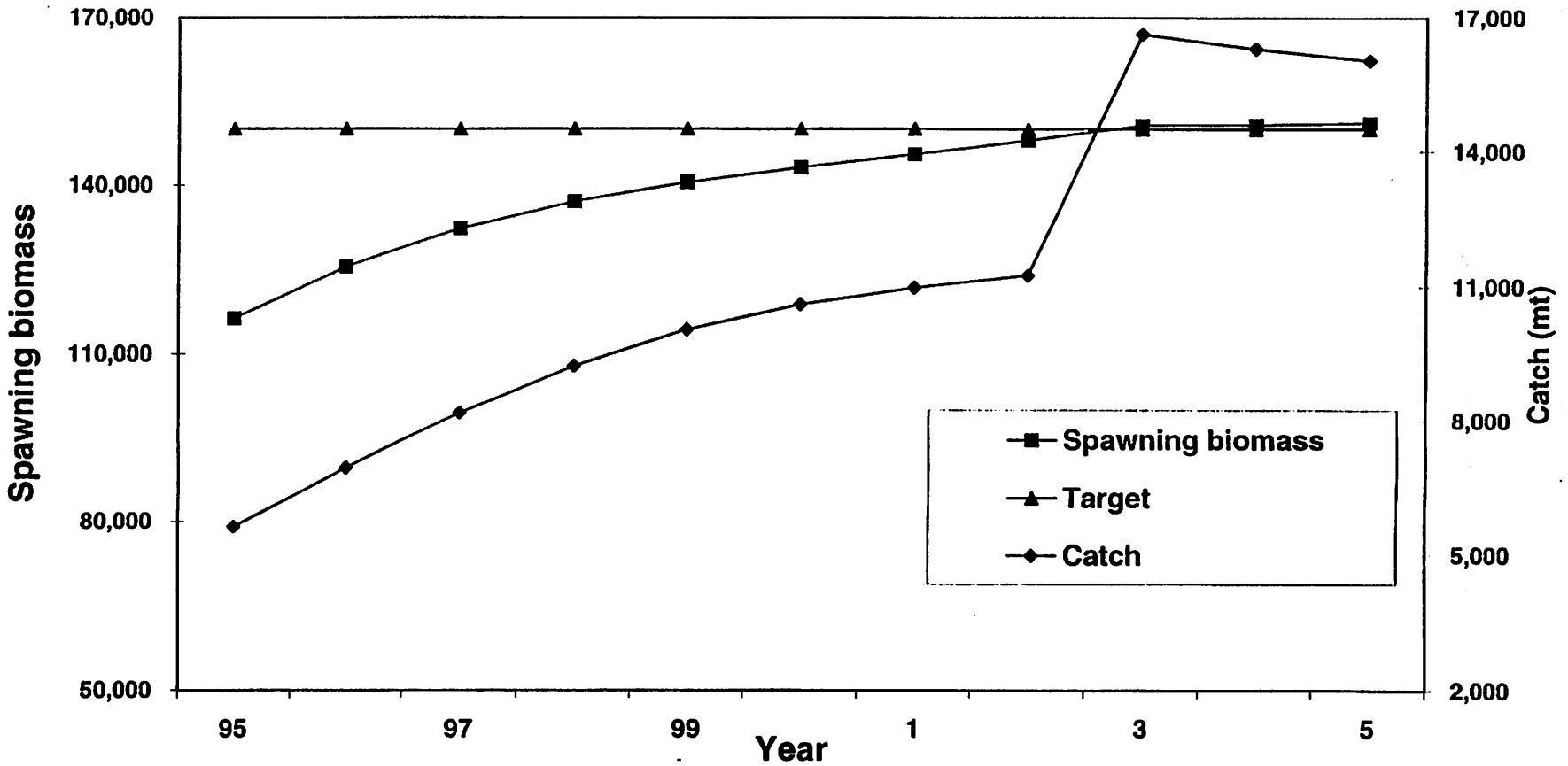


Figure 8. Hypothetical example of TAC levels that would result under the rebuilding plan.

APPENDIX A

Alaska Department of Fish and Game staff comments and recommendations regarding Gulf of Alaska rockfish management for 1995.

SLOPE ROCKFISH

PACIFIC OCEAN PERCH - The exploitable biomass as indicated by the triennial trawl survey more than tripled from 135,402 mt in 1990 to 453,605 mt in 1993 (Figure 1). Much of this change was the result of a dramatic increase in young fish which appeared for the first time in the 1993 survey in the Kodiak INPFC area. The department is encouraged by the apparent increase in POP biomass indicated by the 1993 survey. However, there is a great deal of uncertainty in the biomass estimate due to survey error inherent in using area swept trawl survey methods for assessing rockfish. Therefore, we recommend against relying too heavily on the results of the 1993 survey when establishing TAC levels until strength of the younger year classes can be confirmed.

The authors of the SOS document warn, "In past SAFE reports, we have speculated that a change in availability of rockfish to the survey, caused by unknown behavioral or environmental factors, may explain some of the observed variation in biomass. It seems prudent to repeat this speculation in the present r.eport..." As calculated according to the formula adopted by the Council under the POP rebuilding schedule, TAC would increase 121% from 2,550 in 1994 to 5,631 t in 1995 (Figure 2). Department staff questions whether one additional year of survey data provides adequate evidence of stock rebuildin to justify that level of increased harvest. Even if the indicated increase in biomass is rea virtually all of the increased biomass can be attributed to very young fish which were observed in the population for the first time during the 1993 survey.

There are several reasons the department encourages the Council to maintain a very conservative approach to POP management:

1. There is a great deal of uncertainty in the biomass estimate due to the high variability intrinsic in the use of area swept trawl surveys to assess rockfish. It is highly unlikely that the POP population has actually fluctuated (upward or downward) in the past decade to the extent indicated by the surveys.

2. Most of the increased biomass in the 1993 survey is attributed to young fish (<9 years) in the Central and Western Gulf. These fish are not fully mature and are not fully recruited to the fishery. A nine year old POP yields less than 0.3 pounds of fillets and, therefore, these young fish are of relatively little commercial value because of their small size (Figure 5-2, Table 5-12).

3. Directed fisheries for POP would likely occur if the TAC as calculated according to the rebuilding plan as currently written in the FMP. A directed fishery would target on the older and larger animals disproportionate to their abundance in the population with the potential of adversely impacting future rebuilding.

4. Of all POP caught in 1994, 84.2% were reported to have been discarded. It is presumed that many of the fish were discarded because such a large proportion of the population is currently comprised of fish too small to be of commercial value. This provides further justification to keep harvests at very low levels until the younger fish which apparently dominate the Central and Western Gulf POP population are larger and more valuable to the industry.

5. Directed POP fisheries would result in high bycatch levels of other species of concern such as shortraker/rougheye and thornyhead rockfish. If sufficient amounts of these other species are taken, fisheries for other species, such as deep-water flatfish or sablefish, could be impacted.

Recommendation:

Adopt a policy which restricts POP harvest to bycatch only until the apparent increase in the biomass estimate can be verified by the 1996 triennial trawl survey or other surveys, and until the young fish which currently make up most of the population in the Central and Western Gulf are fully recruited and reach a more desirable commercial market size. Adoption of this policy may require a modification to the current TAC-setting formula outlined in FMP.

OTHER SLOPE ROCKFISH - According to observer data, 65.3% of all other slope rockfish which were caught during 1994 were discarded. The department has gone on record voicing concern that many of the species in the other slope rockfish category are of little commercial value or are of limited abundance. Much of the fishery for other slope rockfish appears to be conducted to acquire ballast against which other more valuable bycatch species can be obtained. Most of the species which make up this group inhabit or overlap the same depth range as other rockfish species of concern including POP, shortraker/rougheye, and thornyhead rockfish, and high bycatch levels of these species can be anticipated.

The ABC for other slope rockfish is currently calculated as an accumulation of the estimated ABCs for the individual species which make up that group. An $F = M$ exploitation rate is applied to the estimated biomass for each species as assessed by the triennial trawl survey. For many of the species where biology is poorly understood, natural mortality is assumed to be the average of the estimated natural mortality rates for several other similar species. There are several potential problems with this approach:

1. The triennial survey is not a reliable tool for assessing rockfish abundance. Therefore, biomass estimates for many of the species which make up the other rockfish group are questionable.

2. Because of the variability and uncertainty in natural mortality rates among the various species, there is a considerable risk of over-exploiting the slower-growing and older-aged species within the complex.

3. If any one of the species within the complex becomes the target of a directed fishery, that one species could potentially be harvested up to the TAC for the entire group, thus greatly exceeding the ABC (and OFL, if calculated) for that one species.

Recommendation:

The department urges the Council to consider adopting a policy which restricts harvest of other slope rockfish to bycatch only in fisheries for other species. Directed fisheries should not be allowed unless it can be demonstrated that there are species within the complex which are abundant enough, resilient enough, and valuable enough to support a directed fishery. Even if that determination is made, TAC should be set very low to reduce the risk that other species in the complex are over-exploited.

PELAGIC SHELF ROCKFISH

BLACK ROCKFISH - The department concurs with the Plan Team recommendation to set a separate ABC for black rockfish in the Central Gulf Regulatory District equal to the average recent-year harvest. However, using this default method of setting ABC would result in ABC equal to OFL, a situation which could potentially have adverse impacts on other fisheries. Therefore, we recommend that the Council set TAC at 90% of ABC to provide a 10% buffer between TAC and OFL.

Black rockfish should remain in the pelagic shelf rockfish management group in the Western Gulf and Eastern Gulf Regulatory Districts, at least for the time being.

DEMERSAL SHELF ROCKFISH

Demersal Shelf Rockfish - The department concurs with the SAFE Report author's and Plan Team's recommendation to reduce ABC for this species group in the Southeast Outside District from 960 t to 580 t. Because the department has the ability to closely monitor and manage the DSR fishery, we recommend setting TAC equal to ABC.

To remain within the reduced TAC, the department intends to release only 150 t of TAC for a directed fishery on January 1. The department will then close the directed fishery until it can be determined how much of the remaining TAC will be needed as bycatch in the halibut IFQ fishery. If there is sufficient TAC remaining at the end of the halibut season, the directed fishery may be reopened to harvest the balance.

EXPLOITABLE BIOMASS OF POP
IN THE GULF OF ALASKA, 1984-1993

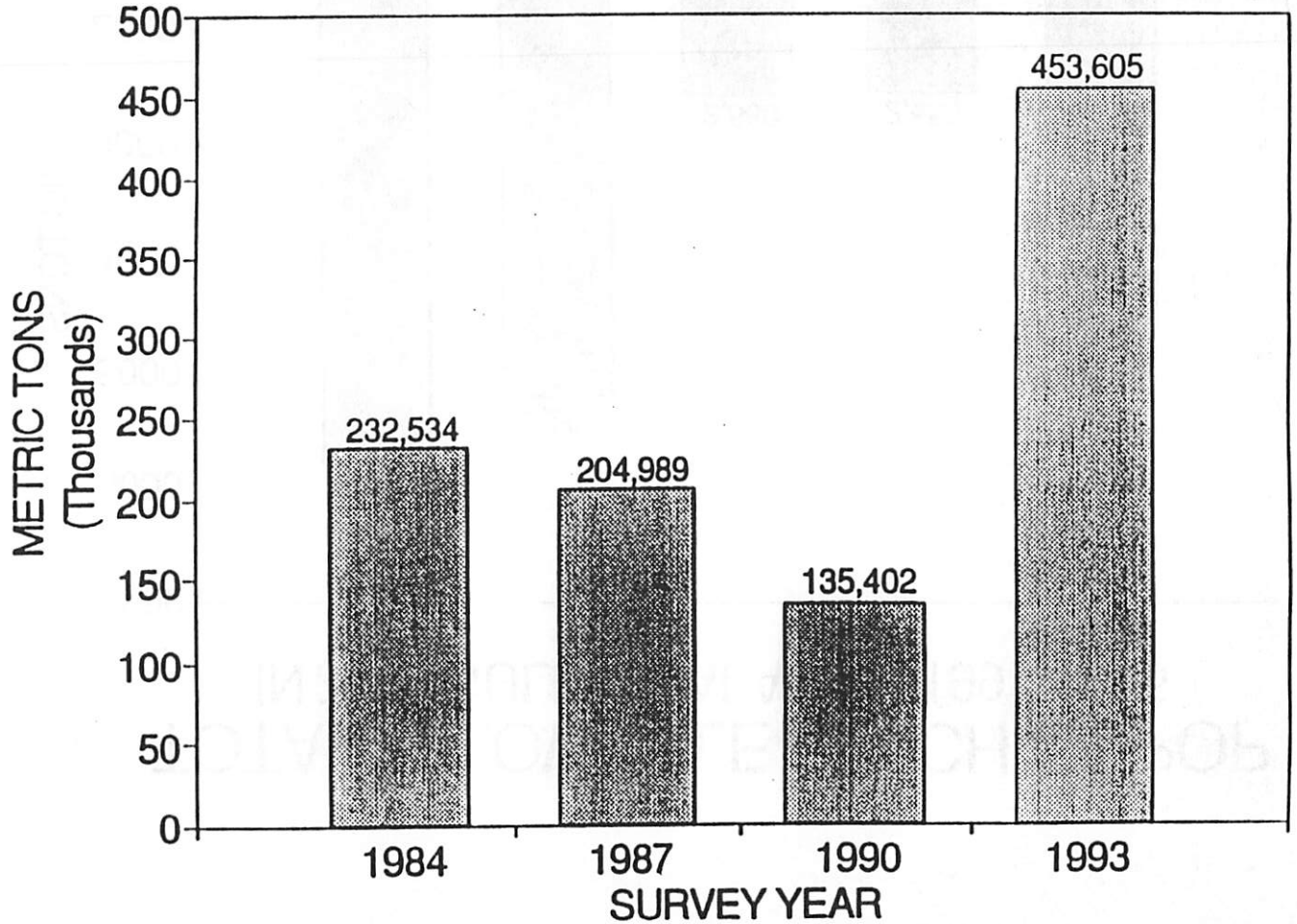


Figure 1

TOTAL ALLOWABLE CATCH OF POP
IN THE GULF OF ALASKA, 1991-1995

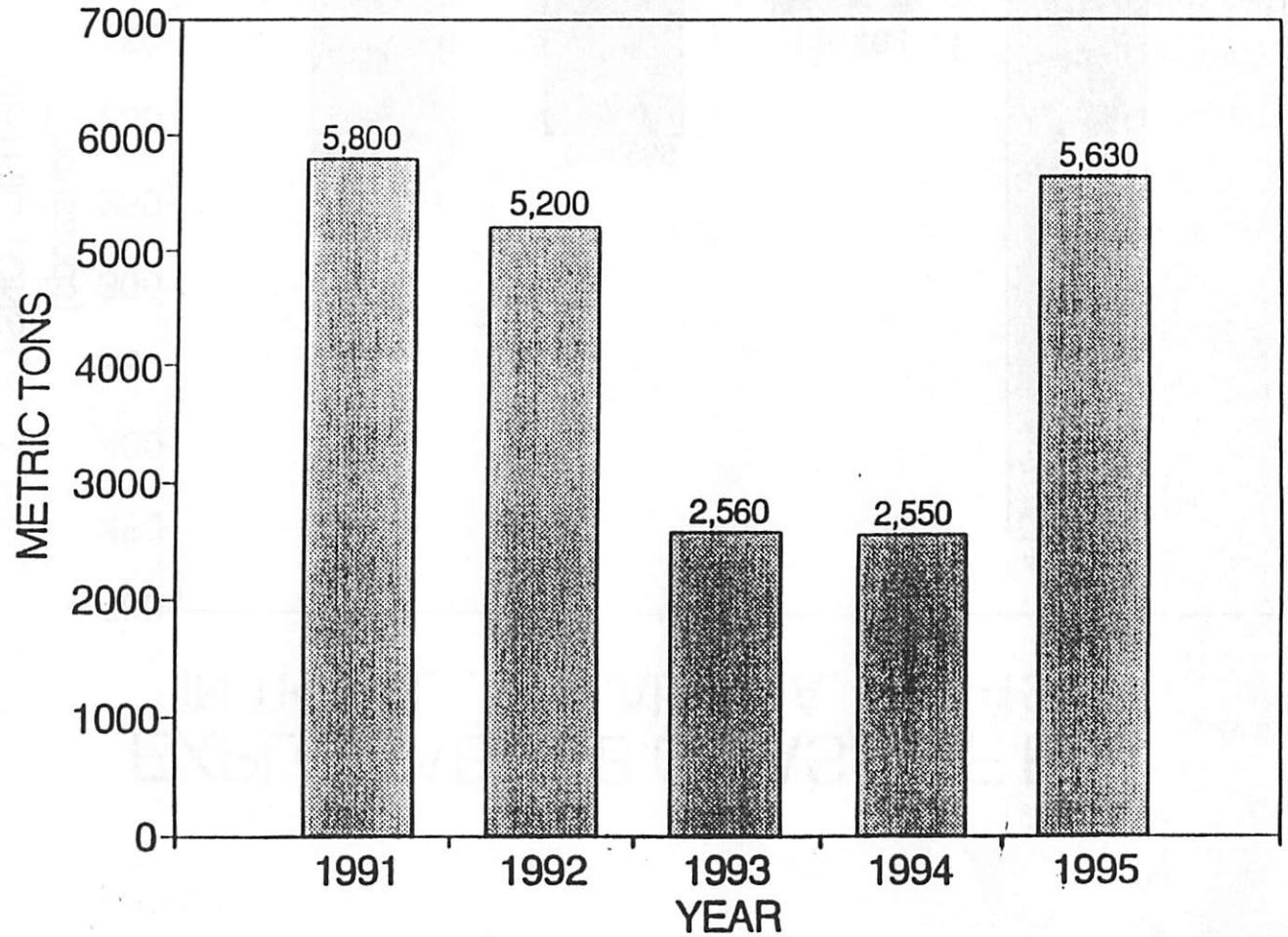
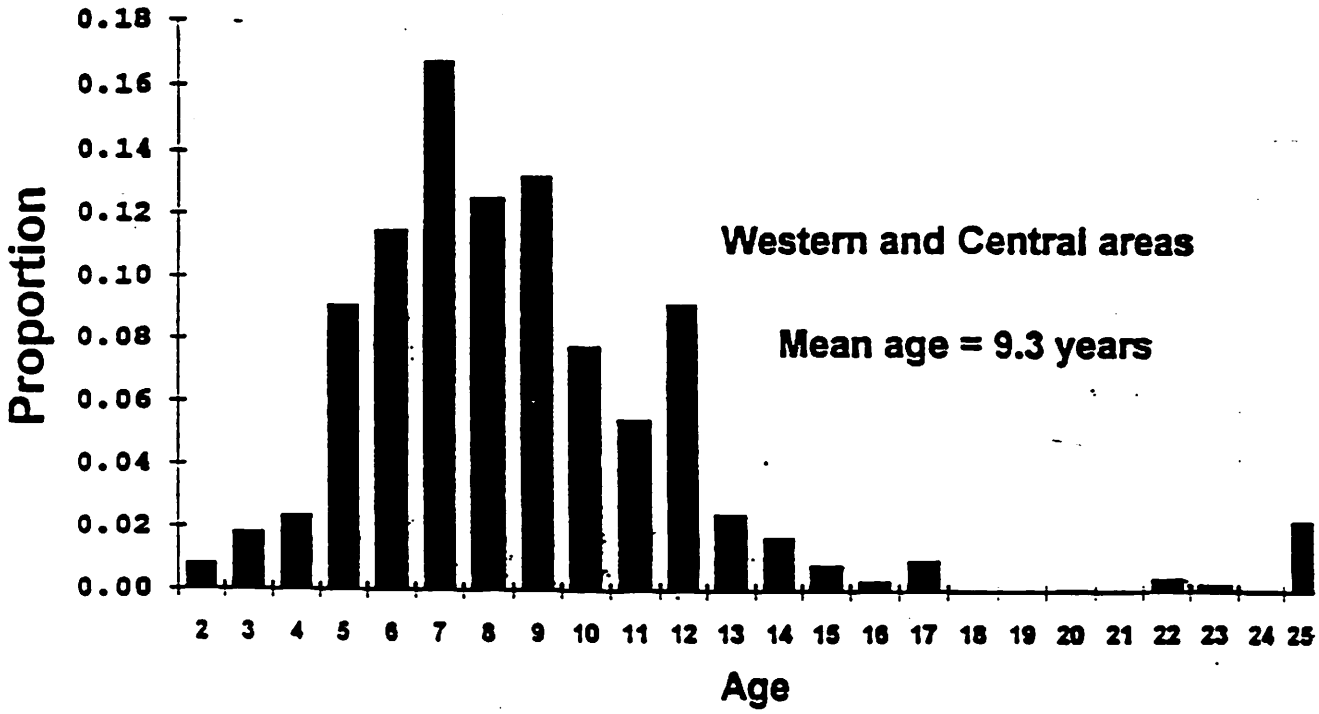


Figure 2



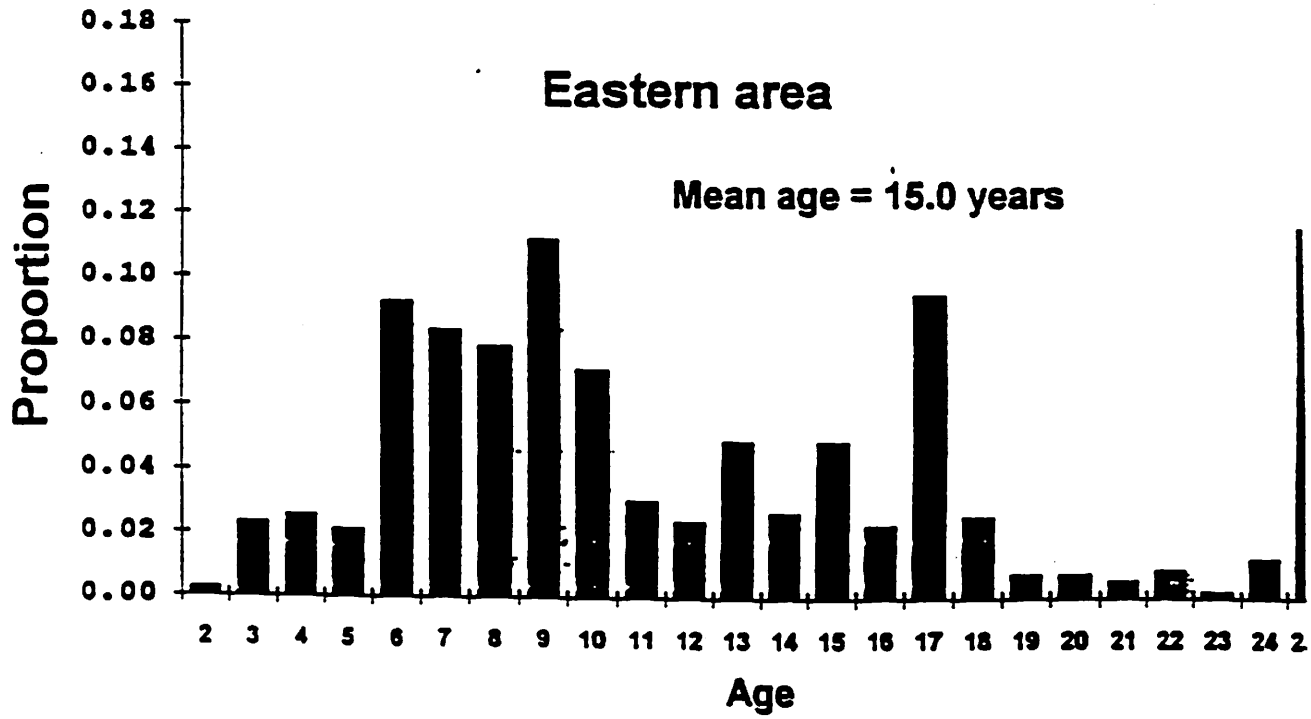


Figure 5-2. -- Age composition of the estimated population of Pacific ocean perch in the Gulf of Alaska based on the 1993 triennial trawl survey.

Table 5-12. Estimated numbers (thousands) of Pacific ocean perch at age in 1995 and schedule of age specific maturity, fishery selectivity, and mean weight based on the stock synthesis model.

Age	Numbers in 1995	Percent mature	Percent Selected	Weight (grams)
2	42,026	0	1	53
3	39,969	0	2	116
4	38,008	5	3	194
5	48,452	12	5	279
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19	12,032	100	89	872
20	1,133	100	84	881
21	702	100	79	889
22	514	100	75	895
23	987	100	70	900
24	1,031	100	65	904
25+	14,974	100	61	907

1986

1.27 lbs (.28 lbs)

1.6 lbs (.35 lbs)

1.79 lbs (.39 lbs)

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

COMMERCIAL FISHERIES MANAGEMENT AND DEVELOPMENT DIVISION

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March 10, 1995

Dr. Jeff Fujioka
Fisheries Biologist
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801

Dear Dr. Fujioka:

This letter is a summary of the most important points discussed at March 3 meeting at the Auke Bay Laboratory. I believe the discussions were very informative and productive. National Marine Fisheries (NMFS) staff in attendance were Dave Clausen, Jon Heifitz, and Jeff Fujioka from Auke Bay Lab, Kaja Brix from the NMFS Alaska Regional Office, and James Iannelli via speaker-phone from the Alaska Fishery Science Center. Alaska Department of Fish and Game (ADF&G) staff were Barry Bracken, Dave Carlile, Earl Krygier, and Phil Rigby. The meeting was requested by ADF&G staff to discuss two primary issues related to the management of Pacific ocean perch (POP) in the Gulf of Alaska:

1. Is there a biological crisis which warrants the development of an emergency rule to adjust the 1995 Total Allowable Catch (TAC) from the level set by the rebuilding plan in the Gulf of Alaska (GOA) Groundfish Fisheries Management Plan (FMP)?

2. Further discussion of the concerns expressed by ADF&G at the December 1994 North Pacific Fishery Management Council meeting and how these concerns might best be addressed.

After deliberating these issues at length, the group agreed that a harvest of approximately 5,600 mt for one year (1995) is not likely to impact POP abundance to any large extent given the current estimate of biomass. However, ADF&G staff expressed concern about possible policy precedents that might be set by increasing the TAC to that level and the need to allow the Council greater flexibility in determining future TACs.

The Auke Bay staff has been tasked with writing a report to analyze the need for an emergency rule to reduce TAC for 1995. ADF&G staff agreed to review the report and provide comment. They also requested that several issues be discussed in the emergency rule report and fully examined in the next stock assessment (for the 1996 fishery) taking into account alternative inputs and biological assumptions for the stock synthesis model. The most vital, from our perspective, is a need to place a stronger emphasis on the importance of older age classes in

the POP population. We would also like to see an analysis of the effects of delaying the harvest of young fish which are now just beginning to recruit into the fishery.

Below is a list of items which were discussed and concerns which the ADF&G staff believe should be incorporated into the forthcoming documents and future POP stock assessments.

For the Emergency Rule Report:

- Include a discussion regarding the use of biological "benchmarks" in addition to female spawning biomass level to determine when the stock is "rebuilt." This could include the age structure of the population, the proportion of the stock above a given age, or the number of strong age classes currently present in the population. Papers by Leaman and draft FAO guidelines were referenced.

- Include a discussion of the potential importance of older year classes to the reproductive success of POP and reexamine the current maturity and fecundity-at-age schedules. Specifically, we would like to see the results of utilizing a slower maturity schedule such as that presented by Leaman (1991) for Rennell Sound (Table 4) where age at 50% maturity is 11.5 years. The age at 50% maturity currently used in the model is 7. A section discussing the possible changes resulting from these alternative inputs may be all that is possible for this report.

For an FMP Amendment EA/RIR:

- Establish and discuss options for modifying the FMP language to allow the Council more flexibility when setting TAC.

- Examine the effects (on both the industry and on the POP population) of not increasing harvests above what is needed for legitimate bycatch until the strong 1986 year class is fully recruited into the reproductive component of the population.

- Expand on the points listed in the section above as part of the amendment document.

- Decide whether the rebuilding targets are fixed or whether they should be updated as additional data become available. For example, current target biomass is based on the spawner-recruit relationship estimated from data available at the time the stock rebuilding EA/RIR was drafted. New survey estimates may change the spawner-recruit relationship, B_{msy}, and therefore the target biomass.

For the Next Stock Assessment:

- Discuss the status of and need for better and more recent age data from the fisheries (bycatch and directed).

- Discuss and evaluate the significance of excluding immature fish (for example those less than

80% mature) from the estimation of exploitable biomass.

- To the extent possible, obtain and utilize new information on age composition and maturity specific to POP in the Gulf of Alaska.

- Include alternative maturity and fecundity schedules within the stock synthesis model for the (SAFE for the 1996 fishery) and discuss the effects of the various schedules on the model output.

- Further examine the implications of using a dome-shaped selectivity function for POP and provide a biological explanation for why that type of selectivity is appropriate for POP.

- ADF&G staff is very supportive of surveys and survey methodology specifically designed to collect biological data on rockfish species, including POP and encourages NMFS efforts to include the most recent maturity and age data in future assessments. There is some possibility that ADF&G can provide age determination assistance, and we will be glad to discuss this possibility.

Jeff, we thank you for opportunity to meet with NMFS analysts and to express our specific concerns and exchange ideas. The status of POP off Alaska has been a concern to department since the implementation of the MFCMA, and staff remain committed to conserving and rebuilding that population. We look forward to working with you and other NMFS scientists to accomplish that objective. The points addressed in this letter are rather general, and I hope that we will have a future opportunity to further discuss rebuilding objectives and management strategies.

Sincerely,

Phil Rigby
Scientific Program Manager

CC: Dave Clausen
Jon Heifitz
Kaja Brix
James Iannelli
Barry Bracken
Dave Carlile
Earl Krygier