AN ANALYSIS OF CURRENT RECRUITMENT IN THE WASHINGTON AND OREGON PACIFIC OCEAN PERCH STOCKS

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INTRODUCTION

A detailed assessment of the Pacific ocean perch (Sebastes alutus) stocks in waters off the Washington and Oregon coast was conducted in 1986 (Ito et al. 1986, 1987). In that assessment, trawl survey information and a variety of analytic models were employed to evaluate the current and future condition of the resource. The results of the assessment indicated that the Pacific ocean perch stocks continue at depressed levels of abundance and that stock recovery will likely be a slow process, involving a long period of time. It is believed, however, that significant rebuilding may occur sooner if one or more strong year classes recruit to the stocks.

The purpose of this study is to examine recent commercial and research fishery data for the presence of incoming strong year classes. From a fishery management standpoint it is valuable to know when such year classes have recruited to the stocks. If detected early enough, fishery managers can begin developing management strategies that take full advantage of these year classes to produce the maximum benefit to the fishery and/or the resource. For example, one strategy may be to conduct the fishery in such a way as to maximize the yield from the strong recruitment. Another tactic may be to lightly exploit the strong year class(es) with the expectation that the surviving recruits will contribute significantly to the reproductive potential of the stocks in future years. In any case, the identification of incoming strong year classes is valuable information for fishery managers to know.

METHODS

The Pacific Fishery Management Council (PFMC), charged with management of offshore fisheries from Washington to California, manages the Pacific ocean perch resource as two discrete stocks, one stock inhabiting the International North Pacific Fisheries Commission (INPFC) Vancouver area and the other stock occupying the Columbia area (Figure 1). Because the PFMC's management authority is restricted to U.S. waters, only data from the U.S. portion of the Vancouver area were analyzed. Analyses of the data were conducted separately for each management area.

The primary goal of this study was to determine whether or not strong year classes have recently entered the west coast Pacific ocean perch populations. To accomplish this objective, length data from the commercial trawl fishery and length and age data from research trawl surveys were analyzed. The commercial fishery data consisted of length samples collected by Washington Department of Fisheries (WDF) port samplers. The length data were based on random samples from commercial trawlers fishing in the INPFC Vancouver and Columbia areas. Although WDF has been collecting Pacific ocean perch samples since 1966, only the most recent data (1981-1986) were extracted from WDF's data base and

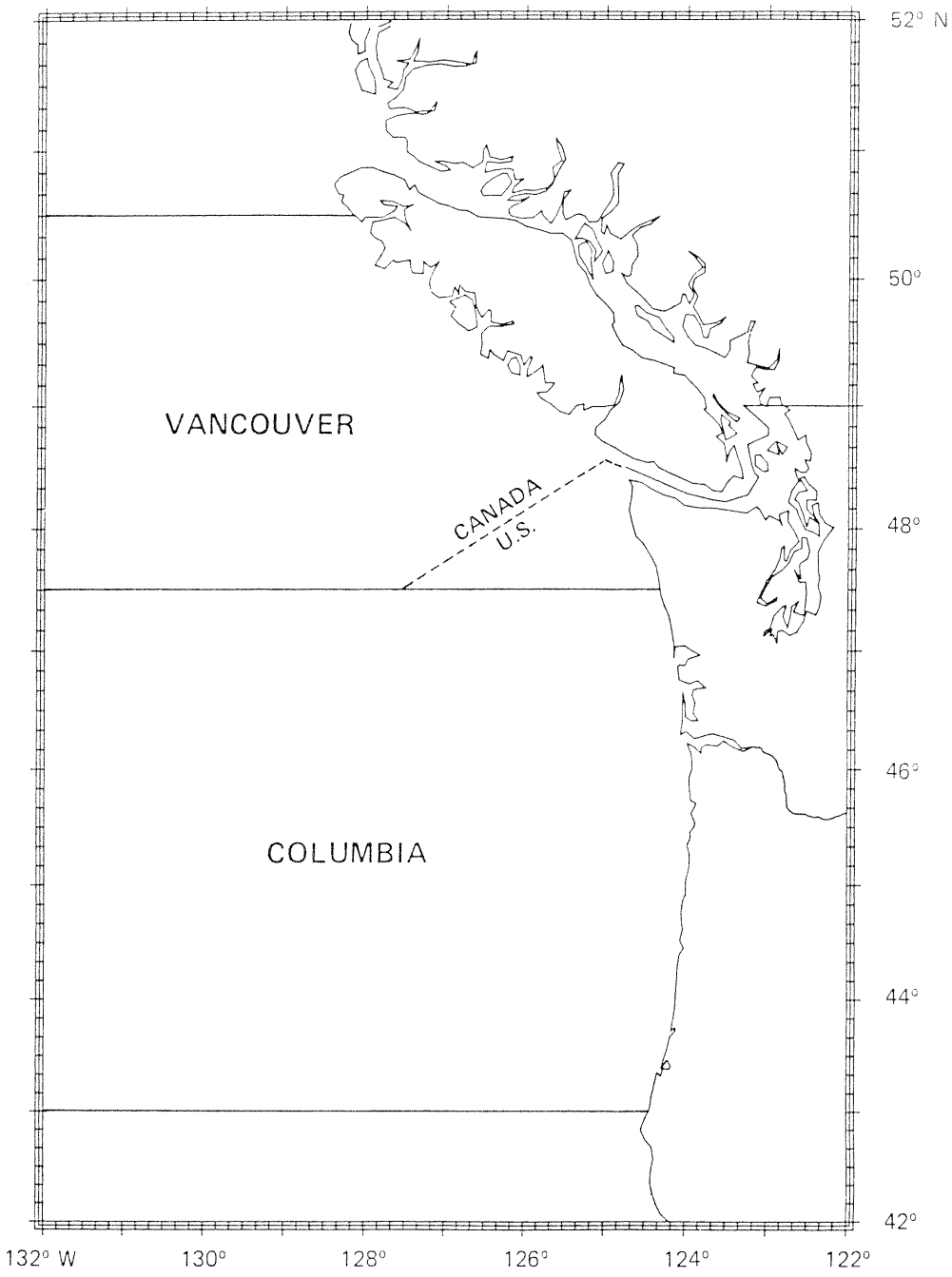

Figure 1.--Boundaries of the International North Pacific Fisheries Commission (INPFC) areas, Vancouver and Columbia.

analyzed. Unfortunately, age data determined by the currently accepted "break-and-burn" age determination technique were not available.

The research data used in this study were derived from three trawl surveys completed during 1979, 1985 and 1986. The three surveys were conducted primarily by the Northwest and Alaska Fisheries Center (NWAFC) of the National Marine Fisheries Service (NMFS). The 1979 and 1985 surveys were designed to specifically assess the distribution, abundance, and biological features of the west coast Pacific ocean perch resource (Wilkins and Golden 1983; Wilkins and Weinberg 1987). The 1986 survey, however, was a general groundfish survey that did not target specifically on Pacific ocean perch.

Length data were collected during all three surveys, with age structures (otoliths) collected during the 1979 and 1985 surveys. The 1979 otolith samples were read according to the surface aging technique of Westrheim (1973) which tends to underestimate the age of older fish. Otolith samples from the 1985 survey were aged according the currently accepted "break-and-burn" aging technique (Chilton and Beamish 1982; Beamish 1979 a,b). This relatively new aging technique apparently provides more accurate age and growth information, especially in older fish. All age structures were read by the NWAFC's Age and Growth unit.

To determine the presence or absence of strong year classes, the length and age data were summarized by pooling the sexes and then generating length and age frequency distributions for each management area. The resulting distributions were then examined.

RESULTS AND DISCUSSION

Commercial Fishery Data

Since 1981, the average size of Pacific ocean perch in the commercial catch has not varied by more than 2.4 cm in either the INPFC U.S-Vancouver or Columbia areas (Table 1). Mean length, sexes combined, has ranged from 38.7 to 39.5 cm in the U.S.-Vancouver area and from 39.0 to 41.4 cm in the Columbia area. The commercial trawl fishery apparently captures a wide range of sizes, from 25 to 53 cm (Figures 2 and 3). However, the bulk of the catch is generally comprised of individuals between 35 and 45 cm. Fish less than 30 cm are generally not suitable for market use.

The length frequency distributions from the commercial catch were typically unimodal in shape, with modes between 38 and 41 cm (Figures 2 and 3). Based on these distributions, there does not appear to be significantly strong year classes entering the commercial fishery in either of the two INPFC areas. The last dominant year class to enter the fishery was the 1970 cohort.

Table 1. Mean lengths of Pacific ocean perch in Washington Department of Fisheries samples of commercial trawl landings, 1981-1986.

Year	U.S.-Vancouver[1] Sample Size	U.S.-Vancouver[1] Mean Length (cm)	U.S.-Vancouver[1] S.D.	Columbia[1] Sample Size	Columbia[1] Mean Length (cm)	Columbia[1] S.D.
1981	1,185	39.5	3.6	699	40.1	3.8
1982	1,299	39.4	3.2	500	40.6	3.0
1983	1,300	39.8	3.5	300	39.8	2.9
1984	1,400	38.8	3.0	500	39.0	3.1
1985	1,200	39.5	3.6	899	39.0	3.3
1986	900	38.7	4.1	800	41.4	2.8

[1]International North Pacific Fisheries Commission (INPFC) areas

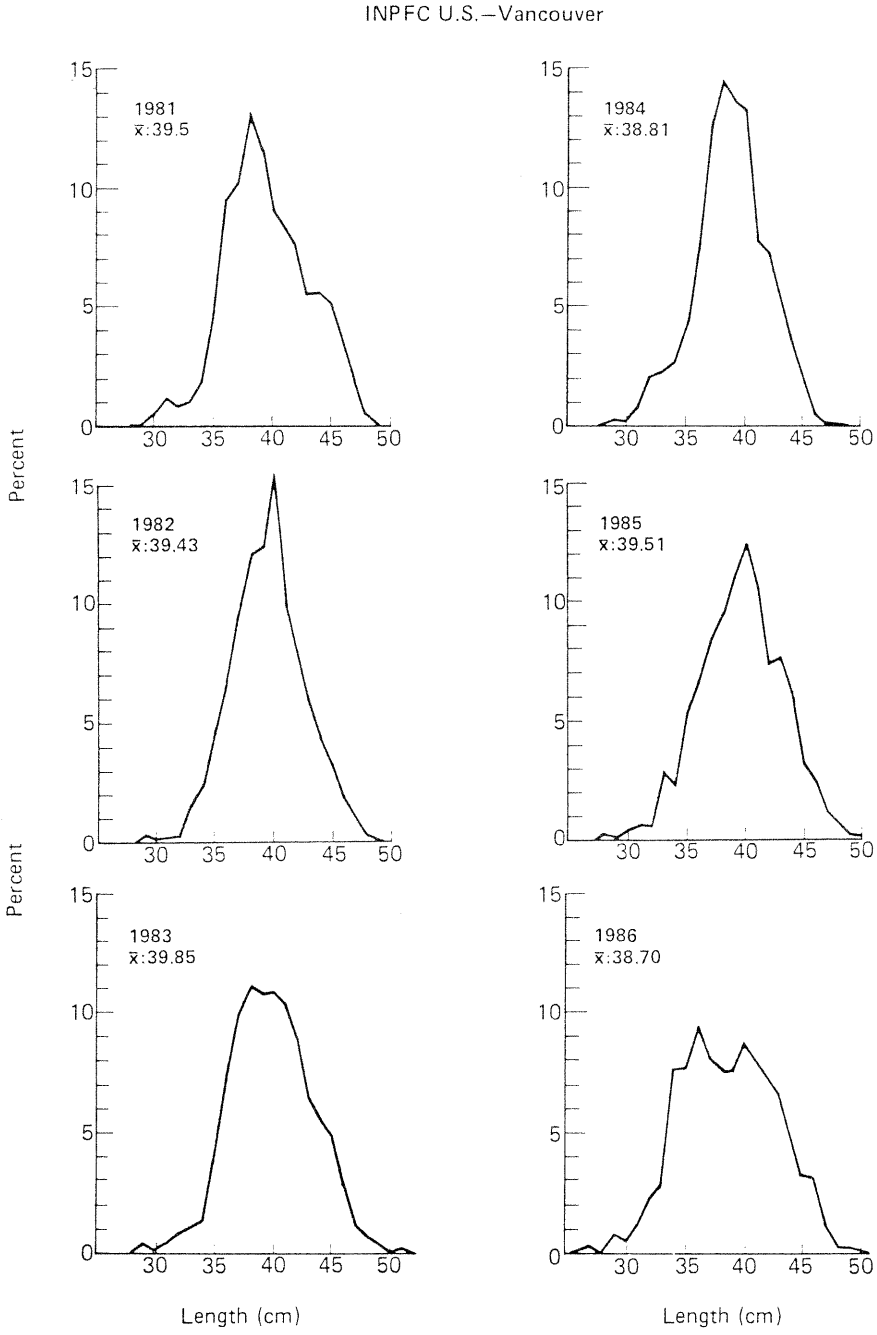

Figure 2.--Size composition of trawl caught Pacific ocean perch in the INPFC U.S.-Vancouver area as shown by data collected by Washington Department of Fisheries port samplers from 1981 to 1986.

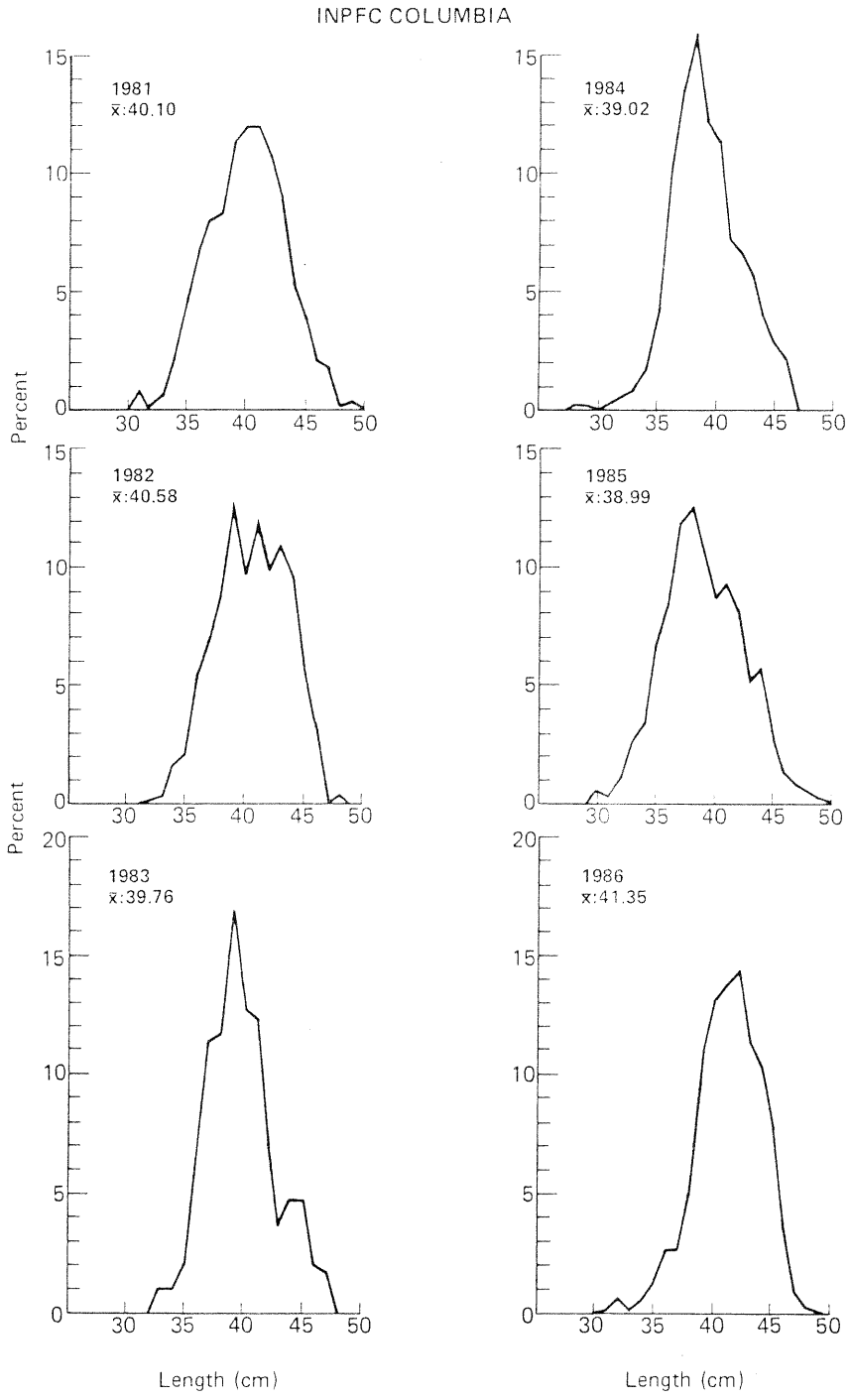

Figure 3.--Size composition of trawl caught Pacific ocean perch in the INPFC Columbia area as shown by data collected by Washington Department of Fisheries port samplers from 1981 to 1986.

This year class showed up as a 32-33 cm mode in the length frequency distribution of the 1977 commercial landings (Golden et al. 1980). If a dominant year class were to have entered the current fishery, one would expect a shift to a lower average size and perhaps a bimodal length frequency distribution. No evidence of this was found from analyses of the WDF commercial fishery data.

Research Trawl Surveys

Research trawl surveys provide a valuable source of recruitment information. These surveys generally capture smaller and younger Pacific ocean perch than do the commercial fleet and, therefore, are probably the best source of data for detecting incoming strong year classes. Ideally, strong year classes would show up first after analyzing survey data versus commercial data collected in the same year. Data from three trawl surveys were examined: length and age data from the 1985 Pacific ocean perch survey; age data from the 1979 Pacific ocean perch survey; and length data from the 1986 triennial general groundfish survey.

Length and Age Data -- 1985 Survey

The 1985 trawl survey sampled a greater percentage of smaller sized fish than that observed in the 1985 commercial landings (Figures 4 and 5; subpanels A and B). Fish sampled during this survey ranged in length from 15 to 51 cm, with fish less than 30 cm accounting for about 26% of the total length distribution in the U.S.-Vancouver area and about 11% in the Columbia area. Based on the 1981-86 length data from the commercial fishery, however, fish less than 30 cm never comprised more than 1.5% of the total sample. Mean length of Pacific ocean perch from survey catches, sexes combined, was 35.0 cm for the U.S. Vancouver area and 36.5 cm for the Columbia area, a reduction in the average length from the commercial landings of 4.5 and 2.5 cm, respectively.

Bimodality was evident in the survey length frequency distributions from both the U.S.-Vancouver and Columbia areas (Figures 4 and 5; subpanel B). The first mode in the U.S.-Vancouver length data occurred at 25 cm which preceded a major mode at 38-40 cm. In the Columbia area, bimodality was much more distinct. The incoming mode in this case occurred at 30 cm, with the larger mode occurring at 37-38 cm. The observed bimodality in both areas is an encouraging sign because it indicates that recruitment may be improving. Age structures were collected during the 1985 survey and were read by the now accepted "break-and-burn" aging technique. This information helps elucidate the age structure of the incoming mode of smaller fish.

The ages from the 1985 survey ranged from 2 to 71 years in the U.S.-Vancouver area and from 3 to 76 years in the Columbia area; only ages through 60 years were included in the age composition histograms (Figures 4 and 5; subpanel C). In the

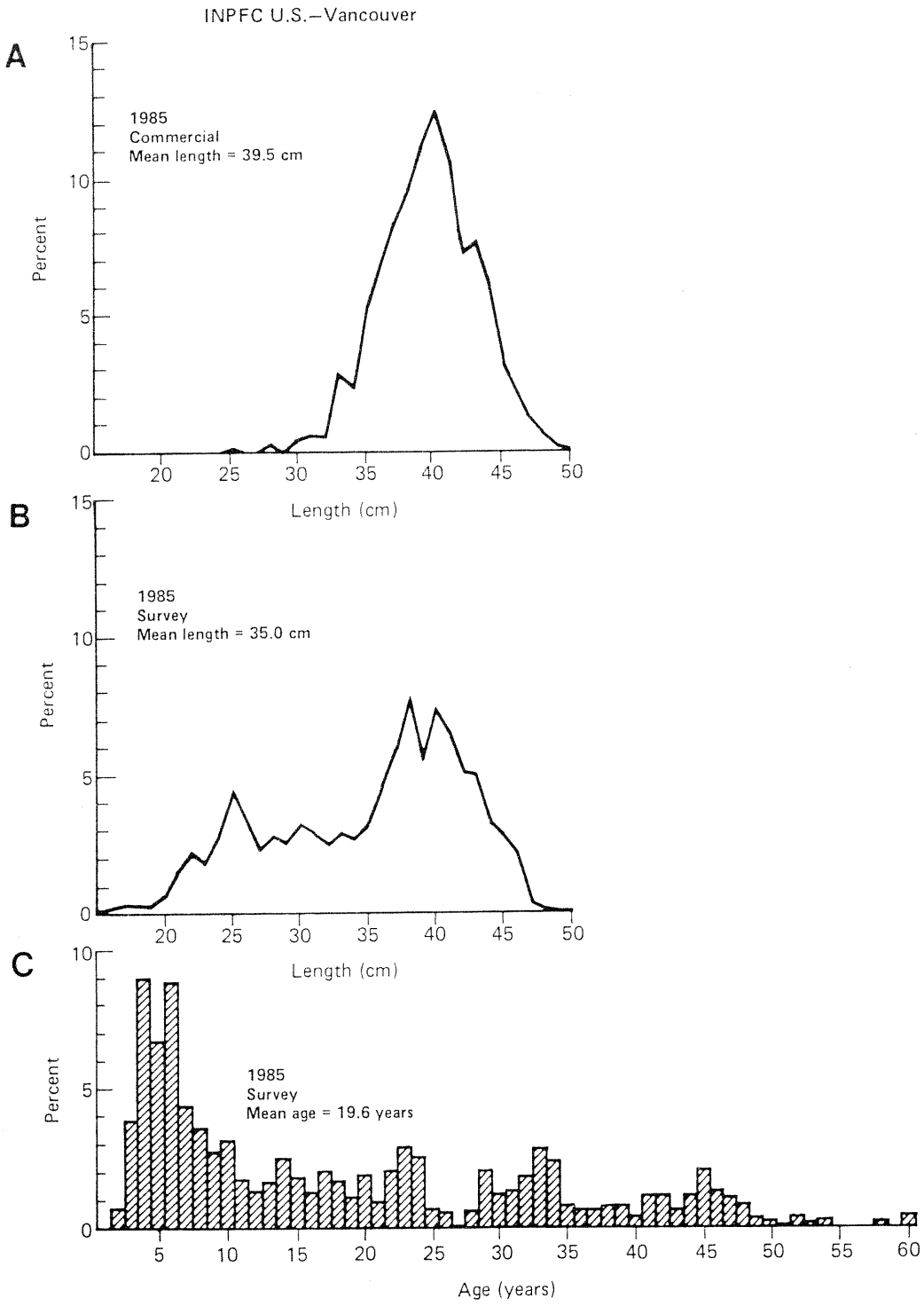

Figure 4.--Size and age composition of Pacific ocean perch in the INPFC U.S.-Vancouver area in 1985. Subpanel A: size composition from the commercial fishery. Subpanel B: size composition from research survey data. Subpanel C: age composition from research survey data.

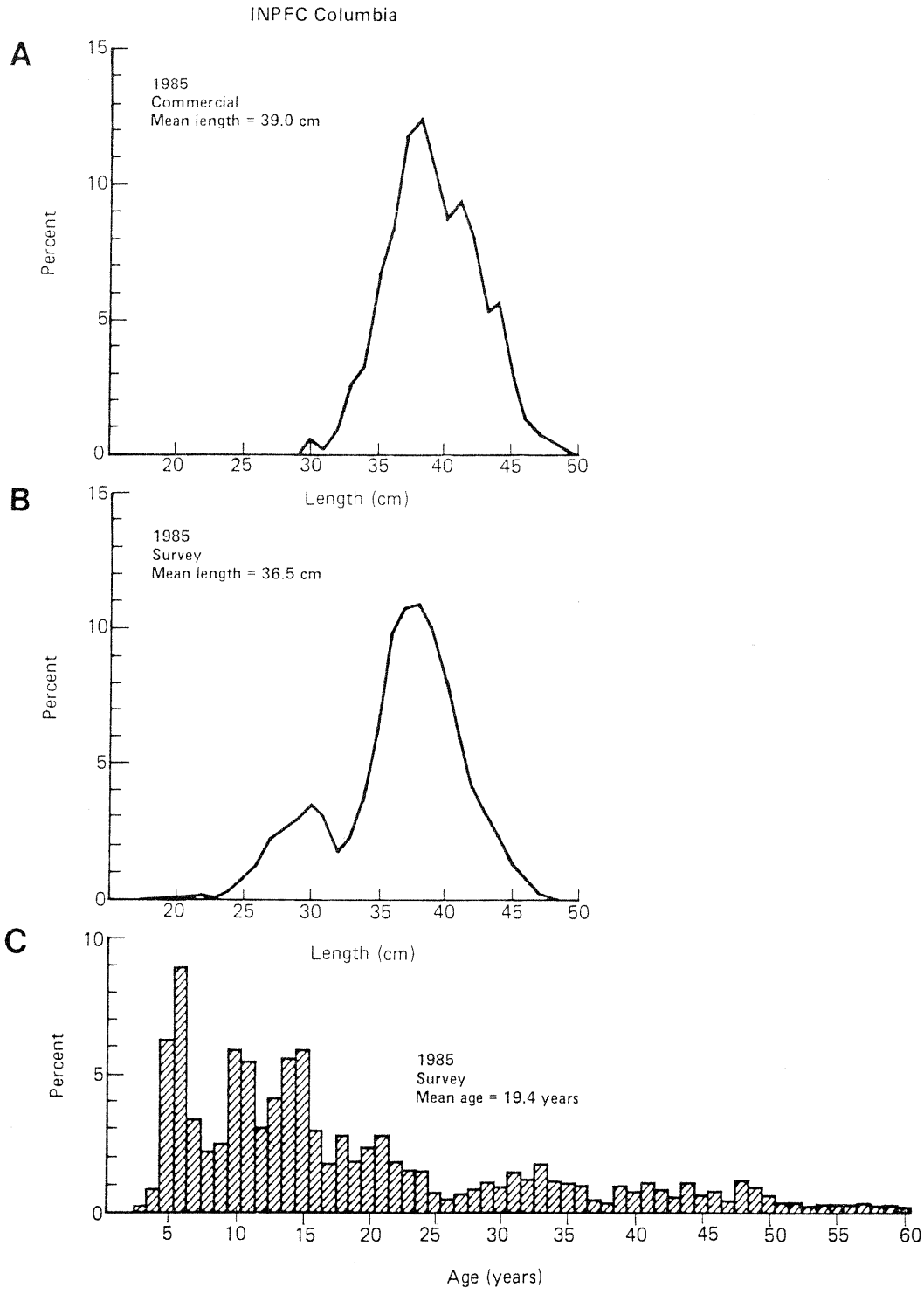

Figure 5.--Size and age composition of Pacific ocean perch in the INPFC Columbia area in 1985. Subpanel A: size composition from the commercial fishery. Subpanel B: size composition from research survey data. Subpanel C: age composition from research survey data.

U.S.-Vancouver area, the 1979-81 year classes (4-6 year olds) were the three most abundant year classes in the population during 1985. In the Columbia area, the 1979 and 1980 year classes contributed strongly to the 1985 population as did the 1970-75 year classes (10-15 years old).

Based on the percentage of 2-4 year olds in the 1985 population, recent recruitment appears to have been stronger in the U.S.-Vancouver area than in the Columbia area. The 2-4 year olds in the U.S.-Vancouver area comprised over 15% of the total population; whereas, the same age groups in the Columbia area accounted for just under 1.5% (Figures 4 and 5). The abundance of these three age groups evidently resulted in the 25 cm mode observed in the U.S.-Vancouver length frequency distribution (Figure 4; subpanel B and C). A mode at this short length was absent in the Columbia area length data (Figure 5; subpanel B). The distinct mode that did occur at 30 cm in the Columbia area was probably comprised mainly of 5-8 year olds.

The analysis of recruitment up to this point was based solely on examining length and age groups expressed as percentages of the total sample or population. Although this provides a descriptive means of noting relative differences within distributions, it does not adequately describe interannual changes in absolute abundance. For example, if two age samples collected in different years, show that 5 year old fish comprise 25% of the total population, one could infer that recruitment was good in both years. However, this may not be the case in terms of absolute numbers. The stock abundance in one year may be considerably higher or lower than in another year. For this reason the 1985 age data were compared, in terms of absolute numbers, with age data collected during the 1979 Pacific ocean perch survey.

Age Comparisons -- 1979 and 1985 Surveys

Otoliths collected during the 1979 survey were read employing the surface aging technique of Westrheim (1973). The currently accepted method is sectioning or breaking the otolith and then identifying annuli on the new surface (Chilton and Beamish 1982; Beamish 1979 a,b). This method apparently provides more accurate age information, especially in older fish. Stanley (1987) showed that the two aging methods give comparable ages up to about age 14-15. Therefore, only data through age 15 years were used in the comparisons.

The number of individual fish in each age group was estimated for each stock and survey year (Wilkins, personal comm., NWAFC, Seattle). In both areas, the total number of fish less than 7 years old in the 1985 survey exceeded that observed for the same age groups in the 1979 survey (Table 2). Although, this indicates that the recruitment of fish less than age 7 has improved, a closer look at the data indicates that this may not be a substantial improvement. The abundance of 8-12 year olds in

Table 2. Abundance (in thousands of individuals) by age group (2-15 year olds) as estimated by the 1979 and 1985 Pacific ocean perch surveys. Numbers in parenthesis denotes the year class.

	U.S.-Vancouver[1]		Columbia[1]	
Age	1979 survey	1985 survey	1979 survey	1985 survey
2	0.2 (77)	21.2 (83)	2.3 (77)	--
3	7.5 (76)	111.8 (82)	5.8 (76)	10.6 (82)
4	101.3 (75)	258.1 (81)	127.0 (75)	74.2 (81)
5	200.6 (74)	192.4 (80)	466.4 (74)	538.8 (80)
6	139.4 (73)	250.5 (79)	512.9 (73)	766.7 (79)
7	178.3 (72)	123.2 (78)	691.9 (72)	295.4 (78)
8	411.8 (71)	103.0 (77)	1,929.4 (71)	187.2 (77)
9	812.2 (70)	76.2 (76)	2,910.2 (70)	218.3 (76)
10	558.9 (69)	92.4 (75)	1,105.0 (69)	511.4 (75)
11	543.7 (68)	50.2 (74)	604.7 (68)	473.4 (74)
12	618.7 (67)	36.7 (73)	550.5 (67)	264.5 (73)
13	482.3 (66)	45.8 (72)	522.7 (66)	359.3 (72)
14	603.0 (65)	71.2 (71)	477.8 (65)	482.0 (71)
15	470.5 (64)	49.0 (70)	463.2 (64)	505.2 (70)
Total	5,128.4	1,481.7	10,369.8	4,687.0

[1]International North Pacific Fisheries Commission (INPFC) areas

1985 (the survivors of the 2-6 year old recruits in 1979), were considerably less than the numbers of 8-12 year olds present in 1979.

By comparing the number of age 4-6 fish in 1979 (1973-75 cohorts) surviving to 1985 (Table 2), one can obtain a gross estimate of the contribution that the 4-6 year olds in 1985 will have six years as 10-12 year olds in 1991. (Note: ages 2 and 3 were not used because they were not well represented in the 1985 survey samples.) Such a calculation was done for both stocks. In the U.S.-Vancouver area, the total number of the 1973-75 cohorts in 1979 amounted to 441,300 fish and then dropped to 179,300 individuals by 1985. For the Columbia area, the same cohorts in 1979 totaled 1,106,300 fish and then increased to 1,249,300 individuals by 1985. The "survivorship" factors for the number of 4-6 year olds in 1979 surviving to become 10-12 year olds in 1985 were 0.41 and 1.13 for the U.S.-Vancouver and Columbia areas, respectively.

By multiplying these survivorship factors by the total number of 4-6 year olds present in 1985, a gross approximation of the total number of 10-12 year olds in 1991 was obtained. For the U.S.-Vancouver area this approximation amounted to 287,400 fish and 1,559,100 individuals for the Columbia area. These projected recruitment figures for the 10-12 year olds in 1991 were considerably less than the total number of 10-12 year olds that were observed in the 1979 survey. In 1979, the 10-12 year olds accounted for 1,721,300 individuals in the U.S.-Vancouver area and over 2,260,200 fish in the Columbia area. The 1991 projections assume, of course, that the conditions during the period from 1985 to 1991 will be identical to that observed during the 1979-85 period (i.e., the same gear selectivity, environmental conditions, etc. will prevail).

Another way of comparing recruitment is to compare the abundance of pre-recruits (i.e., those ages less than the age at full recruitment) in 1979 and 1985. Generally, Pacific ocean perch begin entering the commercial trawl fishery as 5 or 6 year olds and are fully recruited anywhere from age 11 to 14 (Gunderson 1977). The age of recruitment has varied with time and is related to a variety of factors such as growth, fishing mortality, year-class strength, and year to year variations in availability. For purposes of this study it was assumed that recruitment was "knife-edged" at age 11. The total number of pre-recruits was estimated as the sum of the individuals in each age group from ages 2 through 10.

The estimated number of pre-recruits in the 1979 population totaled 2,410,200 fish in the U.S.-Vancouver area and 7,750,900 in the Columbia area. The 1985 survey results, however, showed a sizeable decline in the total number of pre-recruits six years later. In 1985, the abundance of these recruits accounted for 1,228,800 and 2,602,600 individuals in the U.S.-Vancouver and Columbia areas, respectively. These numbers represented a

decline in the number of pre-recruits of about 49.0% in the U.S.-Vancouver area and 66.4% in the Columbia area during the period from 1979 and 1985.

Length Data -- 1986 Survey

The most recent source of information for examining year class strength was the length data collected during the 1986 triennial groundfish survey. Unfortunately, Pacific ocean perch otoliths were not collected during this survey. Unlike the 1979 and 1985 surveys, which targeted specifically on Pacific ocean perch, the 1986 survey was a general groundfish survey. It should be further noted that the 1986 survey took place in August-September, whereas the 1979 and 1985 surveys were conducted in March-May. Pacific ocean perch exhibit pronounced seasonal migrations that may result in quite different distributions during these two periods.

The modes in the length frequency distributions from the 1986 survey (Figure 6) were not as definitive as those shown by the 1985 Pacific ocean perch survey data (Figures 4 and 5; subpanel B). The mean length of Pacific ocean perch in the 1986 survey was 35.6 and 31.5 cm for the U.S.-Vancouver and Columbia areas, respectively. This compares with the 1985 survey results of 35.0 cm for the U.S.-Vancouver area and 36.5 cm for the Columbia area. The reduction in the average length in the Columbia area from 36.5 cm in 1985 to 31.5 cm in 1986 may be a reflection of increased recruitment. A distinct mode was present at about 21 cm in 1986 (Figure 6) but was absent in the 1985 survey data (Figure 5; subpanel B). Although this may indicate improved recruitment to the Columbia stock, the absolute number of these recruits may be relatively low by historic standards. As pointed out by recent assessments of the west coast Pacific ocean perch resource, the stocks are at depressed levels of abundance (Wilkins and Golden 1983; Wilkins and Weinberg 1987; Ito et al. 1986, 1987).

CONCLUSIONS AND RECOMMENDATIONS

The goal of this study was to determine whether or not strong year classes have recently entered the west coast Pacific ocean perch stocks. Length data from the commercial trawl fishery and length and age data from research trawl surveys were analyzed in an attempt to accomplish this objective. Analysis of the commercial fishery length data did not indicate any significantly strong year classes entering the fishery in either of the two INPFC areas. The research surveys, which generally capture smaller and younger fish did indicate some evidence of incoming strong year classes. Although these data did not demonstrate any year classes rivalling the magnitude of the 1970 cohort, they did indicate that recruitment is improving at relatively low levels.

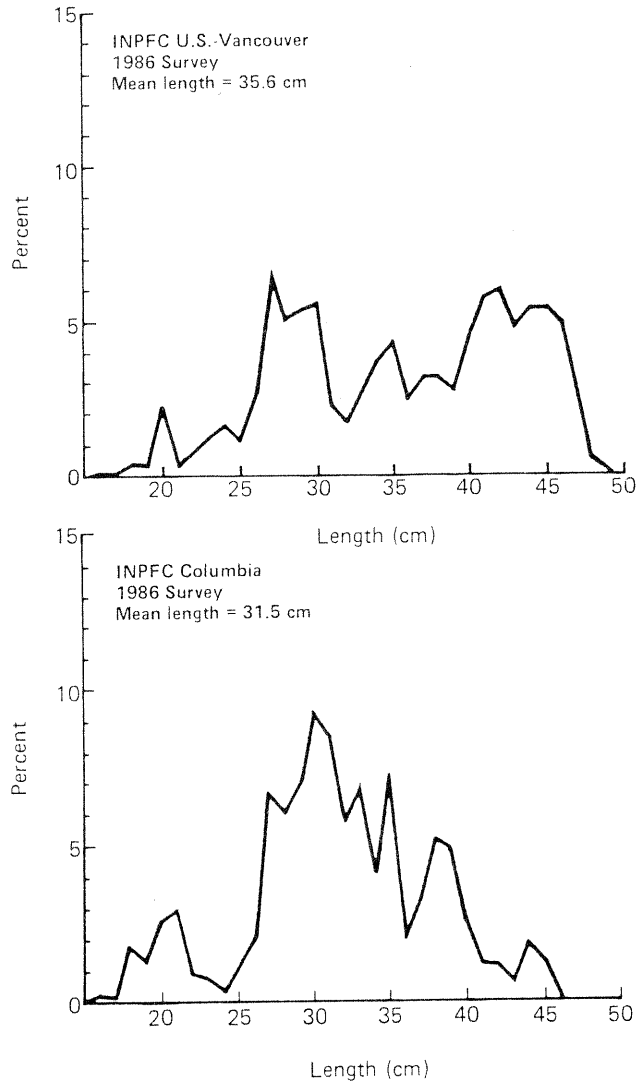

Figure 6.--Size composition of Pacific ocean perch in the INPFC U.S.-Vancouver and Columbia areas as shown by data collected during the 1986 NWAFC groundfish trawl survey.

In light of the Pacific Fishery Management Council's goal of rebuilding the Pacific ocean perch stocks, these recruitment trends are encouraging. It suggests that the Council's current management practices of restricting harvests are appropriate. However, both stocks are still severely depressed and continued restrictive management is warranted.

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