Abundance, Size and Age Composition, and Growth of Pacific Ocean Perch, *Sebastes alutus*, Sampled During 1977

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ABSTRACT–The 1977 rockfish survey provided the first opportunity for a detailed examination of Pacific ocean perch, Sebastes alutus, *stocks inhabiting waters off the coasts of California, Oregon, and Washington. From catch data, estimates of biomass, age and size composition were determined. Estimates of marketable biomass (≥30 cm) were 175 t in the INPFC Eureka area, 6,467 t in the Columbia area, and 7,685 t in the southern portion of the Vancouver area. The Columbia area estimate is well below that of the 1966-68 period but substantially greater than the estimate for the 1973-74 period. The 1970 year class dominated catches of Pacific ocean perch in most strata sampled. They were particularly abundant in the 100-149 fathom (183-272 m) depth strata. There were marked differences in age composition from south to north in the Columbia and Vancouver areas. Older fish were more abundant in the northern one-third of the Columbia area and throughout the Vancouver area. Statistical comparison of growth rates between the Columbia and Vancouver areas showed no significant difference in growth rate.*

Introduction

Marine resource surveys provide measures of abundance and size and age composition of rockfish that are independent of commercial landing data. This report contains a summary of analysis of data obtained on Pacific ocean perch, *Sebastes alutus*, from the 1977 coastwide rockfish survey. Because of the large number of species involved and the discontinuous distribution of major species within the geographic range of the survey, data analysis responsibilities were divided among the participating agencies. The Oregon Department of Fish and Wildlife (ODFW) elected to analyze data collected from Pacific ocean perch because it has a particular interest in this species, both in terms of stock assessment and the commercial fishery. The ODFW routinely samples commercial landings of Pacific ocean perch for age, size, sex, and maturity, and the survey provided a means of obtaining additional biological data on this species. The survey also provided the opportunity to sample deep water (>150 fathoms or 274 m) segments of perch stocks only lightly fished by the commercial fishery.

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Methods

Catch Composition

Commercial landings of perch-like species (those hailed as nominal perch by commercial fishermen) must be interpreted using catch composition samples to determine the landings of Pacific ocean perch. The proportion of Pacific ocean perch (by weight) in all rockfish as well as other perch-like rockfish caught during the 1977 rockfish survey was determined for each 30′ interval from Cape Blanco (lat. 42°30′N) north to Cape Flattery (lat. 48°30′ N). Perch-like species that were included in the calculations were darkblotched rockfish, *S. crameri*; splitnose rockfish, *S. diploproa*; redstripe rockfish, *S. proriger*; yellowmouth rockfish, *S. reedi*; stripetail rockfish, *S. saxicola*; and sharpchin rockfish, *S. zacentrus*. Only tows made at depths greater than 100 fathoms (183 m) were used in calculating the proportions for both indices.

Biomass

Biomass estimates (metric tons) of Pacific ocean perch were determined as outlined by Gunderson and Sample (1980), for International North Pacific Fisheries Commission (INPFC) Eureka, Columbia, and Vancouver statistical areas. Since the survey estimates included small fish (<30 cm) that are not suitable for market use, biomass estimates were adjusted downward so that they would be useful in comparison with biomass estimates derived from commercial catch per unit effort (CPUE) data (CPUE in t/hour). To accomplish this, a length-weight key was used to determine the weight of fish smaller than 30 cm, which was subsequently subtracted from the survey estimate. Biomass estimates based on commercial CPUE for the INPFC Columbia area were determined by dividing the total area available to the fleet (717 square miles) by the area swept by the trawl in 1 hour and multiplying the quotient by the average commercial CPUE. This method is based on an assumed towing speed of 2.5 knots with a horizontal trawl opening of 35 feet. Commercial biomass estimates were not stratified by depth or geographic area.

Age and Size Composition

Age and size composition samples were collected for Pacific ocean perch using the sampling scheme described by Gunderson and Sample (1980) at the latitudes and depth intervals within INPFC areas listed in Table 1. Samples were not available for all depths in some of the normal sampling density areas (tracklines spaced every 10 nautical miles). This was due in part to the low abundance of Pacific ocean perch at 50 to 99 fathoms (91-181 m).

The ages of the individuals sampled were determined by counting the translucent winter growth bands on the

otoliths following the method described by Westrheim (1973).

Age and length frequency samples for individual tows were weighted to the total catch from which the samples were taken. The expanded age or length compositions (sexes combined) were then combined within area and 50-fathom depth strata for each INPFC area, and further expanded to the total estimated population.

Growth

Individual length observations weighted to the raw age composition of Pacific ocean perch were fitted to the von Bertalanffy growth in length curve following the procedure used by Tomlinson and Abramson (1961). Growth rates by sex were compared between 100-149 fathom (183-272 m) and 150-199 fathom (274-364 m) depth intervals within INPFC Columbia and Vancouver areas. Growth rates were then compared between INPFC areas after pooling the age composition for all depth intervals (i.e., 100-199 fathoms). Perch from 6 to 18 years of age were used in making estimates of L_∞, k, and t_0.

Results

Catch Composition

Pacific ocean perch represented 22.7 to 73.8 percent of the total weight of rockfish caught between Cape Blanco and Cape Flattery with the proportion of perch caught increasing with latitude. Similarly, Pacific ocean perch ranged from 30.7 to 83.7 percent of the weight of associated perch-like species (Fig. 1). Of the perch-like species (other than the Pacific ocean perch), the most important contributors to the catch composition were splitnose rockfish (9.1 percent), sharpchin rockfish (8.2 percent), and darkblotched rockfish (8.1 percent). Of non-perch-like species, shortspine thornyhead, *Sebastolobus alascanus* (8.2 percent), yellowtail rockfish, *S. flavidus* (4.6 percent), and rougheye rockfish, *S. aleutianus* (4.3 percent), were important in making up the catch of total rockfish. Pacific ocean perch represented 16.2, 62.3, and 92.3 percent of perch-like species in commercial landings in Pacific Marine Fisheries Commission (PMFC) areas 2B (lat. 42°50′-44°18′N), 2C (lat. 44°18′-45°46′N), and 3A (lat. 45°46′-47°20′N), respectively.

Table 1.—Numbers of Pacific ocean perch sampled for age and length composition at different latitudes and depth intervals within INPFC Eureka, Columbia, and Vancouver areas during the 1977 rockfish survey (number of otoliths read is shown in parentheses).

INPFC area	Sampling density type[1]	Latitude (N)	Depth interval (fathoms) 50-99		100-149		150-199		200-260	
Eureka	N	40°26′-43°	0	(0)	81	(0)	132	(0)	0	(0)
Columbia	N	43°-45°	0	(0)	439	(155)	247	(112)	6	(0)
	H	45°-46°44′	307	(190)	1,741	(982)	664	(304)	259	(23)
	N	46°44′-47°30′	0	(0)	283	[2](72)	270	[2](0)	131	(0)
Vancouver	N	47°30′-47°50′	0	(0)	130	(129)	0	(0)	0	(0)
	H	47°50′48°30′	70	(70)	1,040	[2](539)	383	(262)	136	(135)

[1]N = tracklines 10 nmi apart; H = tracklines 5 nmi apart.
[2]In INPFC Columbia area from lat. 46°44′ to 47°30′N, 126 and 67 otoliths from 100-149 and 150-199 fathoms, respectively, were unusable, and were not included in the totals in parentheses. Similarly, in INPFC Vancouver area from lat. 47°50′ to 48°30′N at 100-149 fathoms, 93 otoliths were unusable.

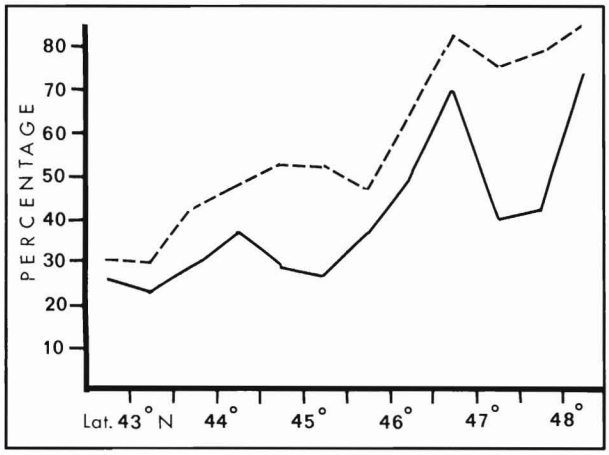

Figure 1.—The percentage of Pacific ocean perch in survey catches of rockfish (solid line) and perch-like rockfish (dashed line) by 30′ intervals of latitude from south to north.

Biomass

Estimated biomass based on the survey data is shown in Table 2. In the Columbia area, the estimate of biomass based on CPUE of the commercial catch was 9,600 t.

Although the survey estimate is 33 percent less than the estimate based on commercial CPUE data, this is to be expected as a consequence of the fact that commercial trawlers bias their fishing towards areas of high local abundance. Both estimates showed an increase in stock biomass relative to the 1973-74 estimate reported by Gunderson et al. (1977) but remained well below the estimated biomass of 35,000 t reported during the 1966-68 period (Westrheim et al., 1972).

Table 2.—Biomass estimates, 95 percent confidence intervals, 1977 landings, and estimated exploitation rate. Numbers in parentheses are adjusted biomass estimates of marketable fish ≥30 cm.

INPFC area	Biomass (t)	95% C.E. (±%)	1977 landings	Exploitation rate
Monterey	2	±82	—	—
Eureka	223 (175)	±76	65	0.29
Columbia	7,105 (6,467)	±49	[1]479	0.07
Vancouver	7,728 (7,685)	±136	817	0.11

[1]Includes foreign catch.

Age and Size Composition

The presence of a strong 1970 year class was evident in depths from 50 to 199 fathoms (91-364 m) in the Columbia area (Fig. 2, 3). Secondary modes occurred at 13-14 years from lat. 43°00′ to 45°00′ N and at 10-16 years from lat. 45°00′ to 46°44′ N with the 1970 year class being absent at depths greater than 200 fathoms (366 m). A single sample from lat. 46°44′ to 47°30′ N indicated the presence of fish 11 years and older in the 100-149 fathom (183-272 m) zone (Fig. 4). Another sample from the region immediately to the north (lat. 47°30′-47°50′ N) once again showed the dominance of the 1970 year class in the 100-149 fathom depth interval, however (Fig. 4).

Due to the presence of a large catch of Pacific ocean perch that was not sampled for otoliths in the area bounded by lat. 47°51′-48°30′ N, the age composition for the 100-149 fathom interval was estimated using an age-length key derived from other samples taken in the same area. Although the 1970 year class is still obvious, it was far overshadowed by the presence of older, larger fish. The 1970 year class was present, but not dominant, in 150-199 fathoms (274-364 m) and was absent in depths greater than 200 fathoms (Fig. 5).

After adjusting the age composition to the total population estimate within each depth zone and geographic area, the data for all strata were combined and expanded to the total population for each INPFC area. The 1970 year class was dominant in the Columbia area and obvious but not dominant in the Vancouver area (Fig. 6). The modal age was 19 years in the Vancouver area. Secondary modes within the two areas occurred at 13 and 14 years, respectively.

In addition to survey age data from the Columbia area, age composition data from commercial landings were also available for comparison. Survey age composition showed a greater abundance of older fish because the survey included samples from depths greater than those which are normally fished by the fleet in the summer (Fig. 7). In addition, the depleted state of older fish combined with the presence of the strong 1970 year class have contributed to a concentration of effort by the fleet in areas of local high abundance (i.e., in shallower water).

Length frequency data for Pacific ocean perch were compiled for combined sexes and were expanded to the total population for each stratum where

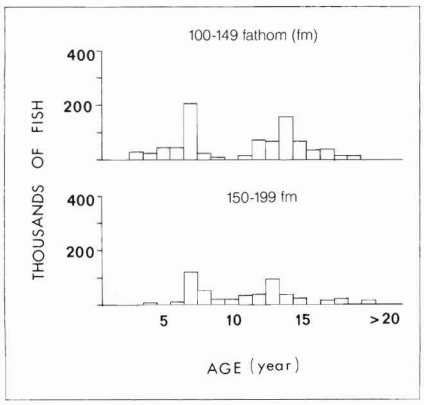

Figure 2.—Age composition of Pacific ocean perch in the southern portion of the INPFC Columbia area (lat. 43°00′-45°00′N), expanded to the total population.

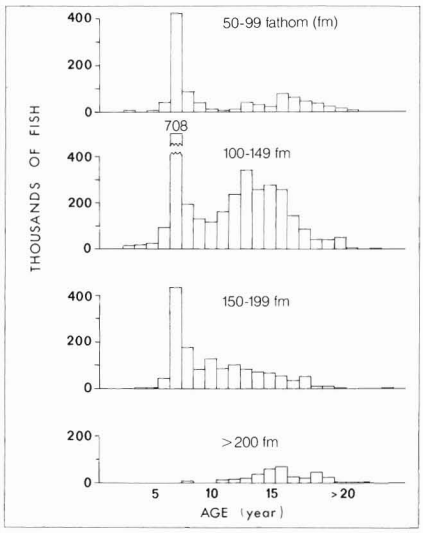

Figure 3.—Age composition of Pacific ocean perch in the middle portion of the INPFC Columbia area (lat. 45°00′-46°44′ N), expanded to the total population.

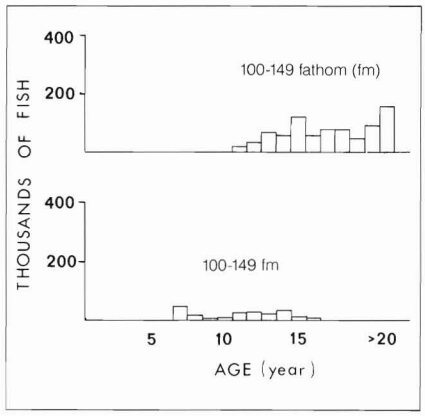

Figure 4.—Age composition of Pacific ocean perch in the northernmost portion of the INPFC Columbia area (lat. 46°44′-47°30′N) (top) and the southernmost portion of the INPFC Vancouver area (lat. 47°30′-47°50′N) (bottom), expanded to the total population.

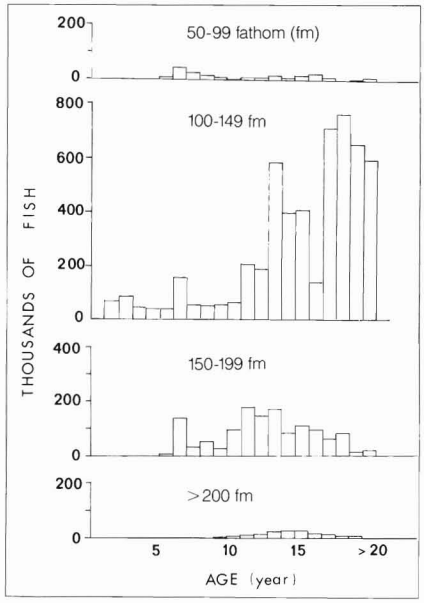

Figure 5.—Age composition of Pacific ocean perch in the middle portion of the Vancouver area (lat. 47°51′-48°30′N), expanded to the total population.

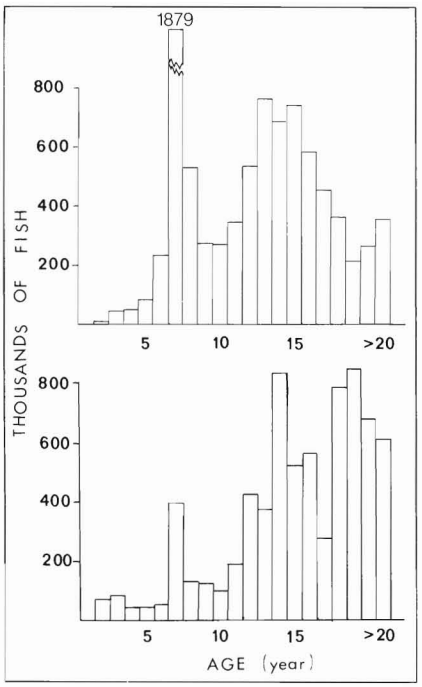

Figure 6.—Age composition of Pacific ocean perch in INPFC Columbia (lat. 43°00′-47°30′N) (top) and Vancouver (lat. 47°30′-48° 30′N) (bottom) areas, all depth intervals combined. Samples expanded to the total population.

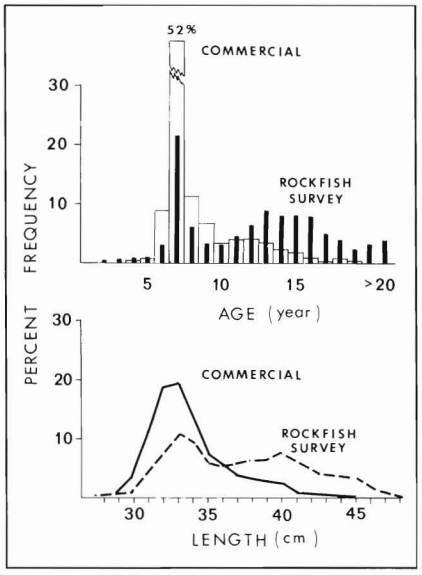

Figure 7.—Top: Age composition of Pacific ocean perch sampled at the dock (open bars), and sampled during the rockfish survey (dark bars), in 1977 in the INPFC Columbia area. Bottom: Length frequency distribution of Pacific ocean perch sampled at the dock (solid line), and sampled during the survey (broken line), for same.

samples were taken. Figures 8 through 11 show the length frequency composition by depth interval in the Eureka, Columbia, and Vancouver areas. The modes in length frequency composition reflect the modal distribution in age composition in most strata where age samples were taken.

In the Eureka area (lat. 40°26′-42°59′N) there was a conspicuous absence of larger, presumably older fish at all depths. The mode at 33 cm in 100-149 fathoms (183-272 m) indicated the presence of the 1970 year class. Within the Columbia area the 1970 year class was dominant from 100 to 250 fathoms (183-457 m) between lat. 43°00′ and 44°59′N and from 50 to 199 fathoms (91-364 m) between lat. 45°00′ and 46°43′N. Further north in the Columbia area (lat. 46°44′-47°29′N), the length frequencies shifted to larger fish.

Size composition data from samples of commercial landings were also available for comparison with the survey data for the INPFC Columbia area (Fig. 7, bottom). The commercial data also showed the dominance of the 1970 year class, but contained a smaller proportion of larger fish than the survey data. Again, this reflects the fishing strategy of the commercial fleet.

The influence of the 1970 year class appears to diminish northerly into the Vancouver area, as greater numbers of large fish appear. One of the Vancouver area samples (lat. 48°01′N, 140 fathoms) appeared to influence the length frequency distribution substantially due to a very large catch (3,020 kg) with a modal length of 46 cm.[1] A geographic shift in length can be clearly seen in the composite Figure 12, where all depth intervals were combined for each area.

[1]Unfortunately, no otolith sample was collected for this tow.

The appearance of larger fish with increasing latitude may be an indication of a pattern of recruitment from south to north. Evaluation of this hypothesis, however, is confounded by the fact that closures to foreign fishing exist from lat. 46°00′ to 47°00′ N and from 47°30′ to 48°30′ N which may have allowed the build-up (and conservation) of older, larger perch. In addition, there were 60 percent females in the Vancouver area as opposed to 49 percent in the Columbia area, a situation which would account for some of the differences in size composition. Also, the inherent patchiness and variability of rockfish size and abundance between samples make it difficult to generalize about length frequency distributions for Pacific ocean perch from one geographic area to the next.

Growth

The growth of Pacific ocean perch sampled in depths of 100-149 fathoms (183-272 m) was compared with their growth in 150-199 fathoms (274-364 m) for lat. 45°00′-46°43′N (Columbia area) and lat. 47°50′-48°30′N (Vancouver area). No significant differences ($P \geq 0.05$) were detected between L_∞, k, and t_0 parameters of males and females between depth intervals in the Columbia area (Table 3). Highly significant differences occurred between depth intervals for estimates of k for male perch in the Vancouver area ($Z = 2.61$, $P \geq 0.01$), together with significant differences between estimates of t_0 ($Z = 1.97$, $P \geq 0.05$). There were no significant differences in L_∞ between the two depth strata. Males sampled in 100-149 fathoms had higher values for k and t_0 ($k = 0.170$ and $t_0 = -1.64$) compared with those in 150-199 fathoms ($k = 0.080$ and $t_0 = -8.65$). No significant differences were found between depth strata for estimates of L_∞, k, and t_0 for female Pacific ocean perch in the Vancouver area.

Male Pacific ocean perch sampled from 100 to 149 fathoms (183-272 m) in the Columbia area had a significantly higher estimate for L_∞ ($L_\infty = 47.0$ cm) compared with the Vancouver area

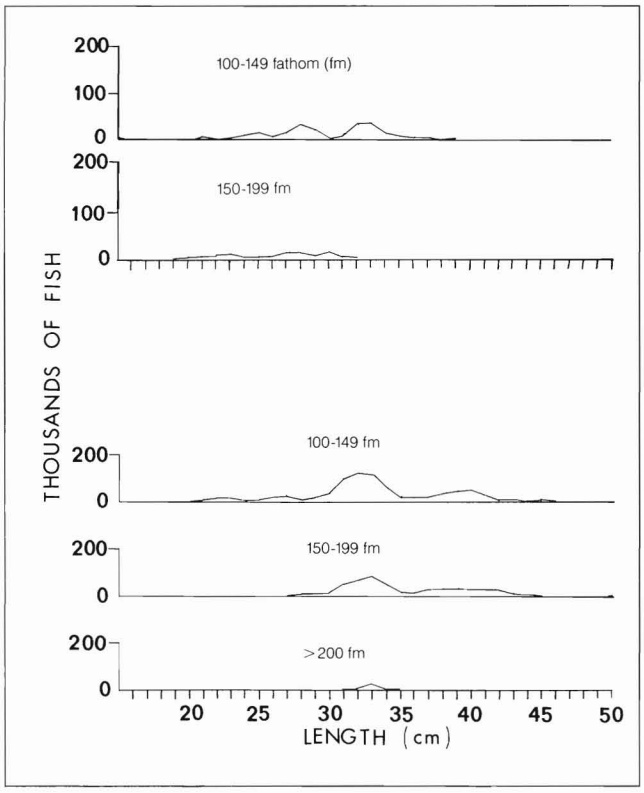

Figure 8.—Length frequency distribution of Pacific ocean perch sampled during the 1977 rockfish survey for INPFC Eureka area (lat. 40°26′-42°59′N) (top) and the southern portion of the INPFC Columbia area (lat. 43°00′-44°59′N) (bottom). Samples were expanded to the total population.

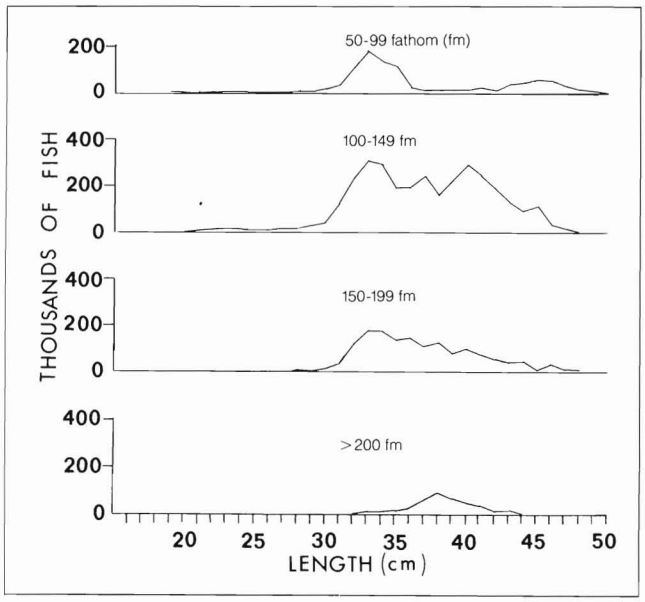

Figure 9.—Length frequency distribution of Pacific ocean perch sampled during the 1977 rockfish survey for the middle portion of the INPFC Columbia area (lat. 45°00′-46°43′N), expanded to the total population.

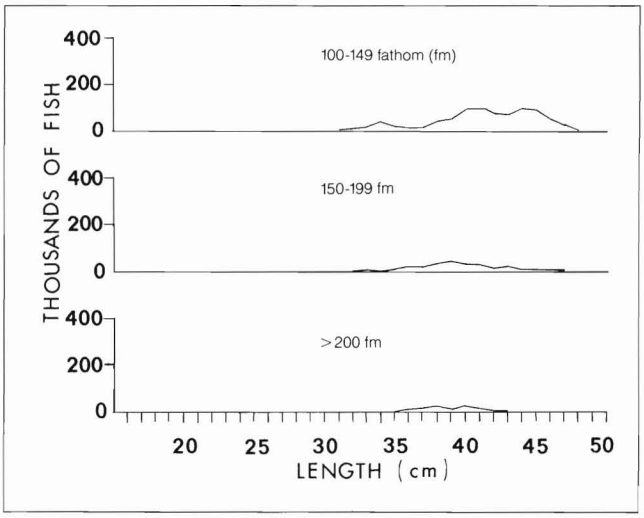

Figure 10.—Length frequency distribution of *S. alutus* sampled during the 1977 rockfish survey for the northernmost portion of the INPFC Columbia area (lat. 46°44′-47°29′N), expanded to the total population.

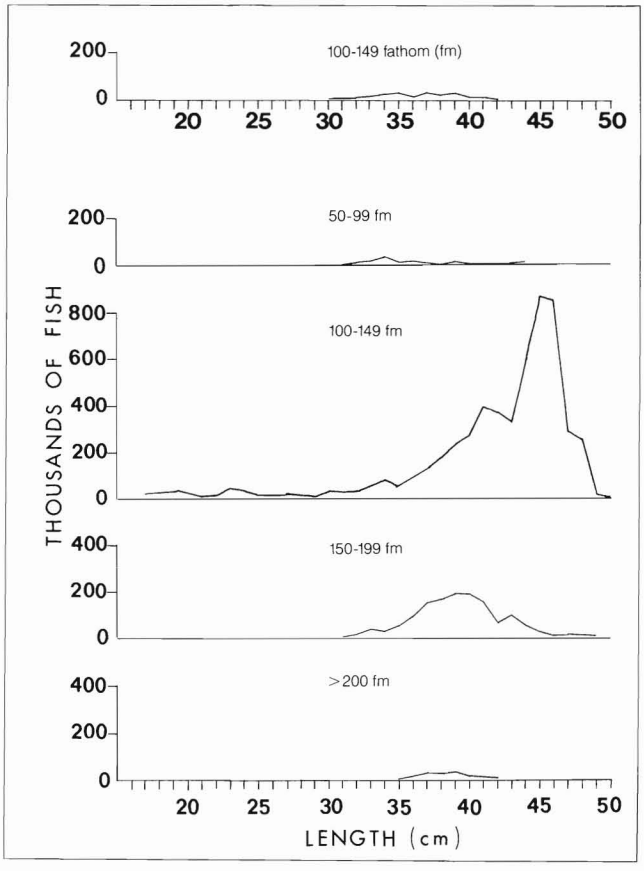

Figure 11.—Length frequency distribution of Pacific ocean perch sampled during the 1977 rockfish survey for the INPFC Vancouver area (lat. 47°30′-47°50′N, top; lat. 47°51′-48°30′N, bottom), expanded to the total population.

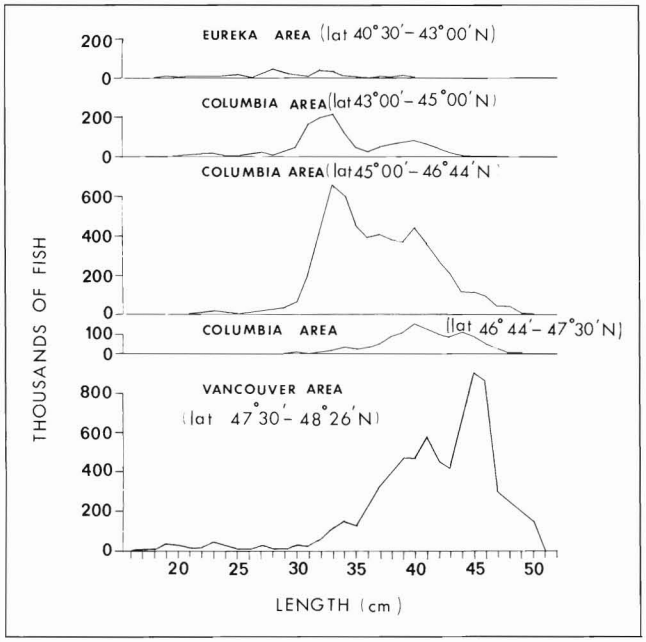

Figure 12.—Size composition of Pacific ocean perch (sexes and depth intervals combined) caught by INPFC area during the 1977 synoptic rockfish survey.

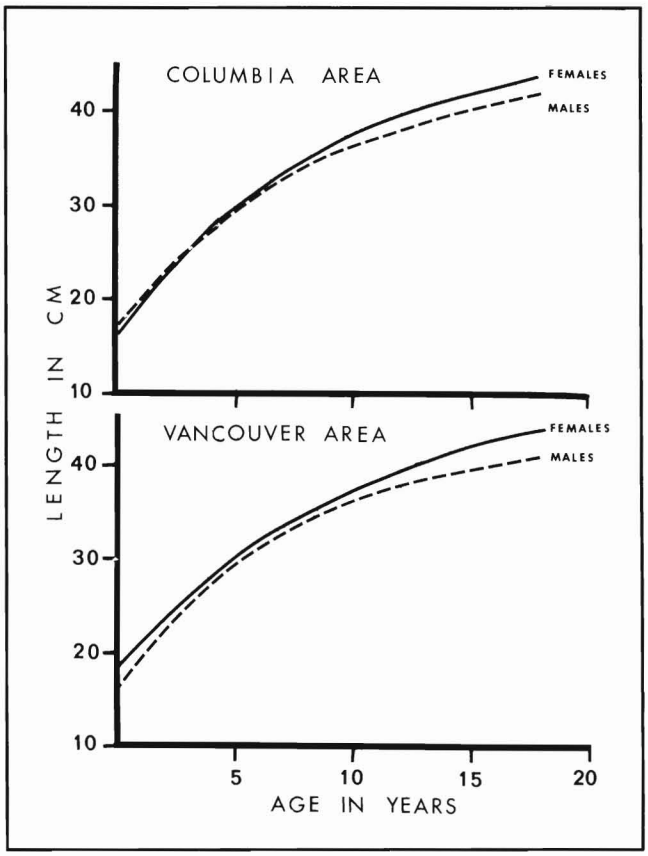

Figure 13.—Growth-in-length curves fitted by von Bertalanffy equation for Pacific ocean perch from INPFC Columbia and Vancouver areas (100-199 fathoms).

Table 3.—Estimates of Pacific ocean perch growth parameters at depths of 100-149 fathoms compared with estimates at 150-199 fathoms in two International North Pacific Fisheries Commission (INPFC) areas.

INPFC area	Depth (fm)	n[1]	k[2]	L.L.[3] U.L.	L_∞ (cm)[4]	L.L.[3] U.L.	t_0[5]	L.L.[3] U.L.
Columbia								
Males	100-149	433	0.099	0.062	47.00	43.28	−4.86	−7.57
				0.137		50.72		−2.15
	150-199	[6]184	0.125	0.057	43.92	39.88	−4.09	−8.02
				0.193		47.96		−0.16
Females	100-149	474	0.105	0.074	49.10	46.00	−3.82	−5.83
				0.137		52.20		−1.82
	150-199	74	0.071	0.000	53.01	38.74	−6.92	−14.74
				0.142		67.26		0.90
Vancouver								
Males	100-149	304	0.170	0.130	42.30	41.17	−1.64	−3.25
				0.210		43.43		−0.02
	150-199	[7]176	0.080	0.026	46.17	40.00	−8.65	−15.42
				0.134		52.34		−1.87
Females	100-149	128	0.096	0.049	51.30	45.60	−4.05	−7.32
				0.142		57.00		−0.79
	150-199	[7]64	0.110	−0.011	45.07	37.67	−5.76	−15.76
				0.230		52.47		4.25
Columbia								
Males	100-199	621	0.110	0.079	45.74	43.28	−4.36	−6.41
				0.141		48.20		−2.31
Females	100-199	548	0.100	0.071	49.53	46.44	−4.24	−6.20
				0.128		52.62		−2.28
Vancouver								
Males	100-199	481	0.134	0.102	43.14	41.73	−3.57	−5.48
				0.166		44.55		−1.67
Females	100-199	191	0.097	0.046	49.39	43.98	−4.67	−8.52
				0.148		54.80		−0.82

[1]Sample size.
[2]Growth coefficient.
[3]95 percent confidence interval, L.L. = lower limit, U.L. = upper limit.
[4]Asymptotic length.
[5]Hypothetical length (cm) at age 0.
[6]Pacific ocean perch ages from 6 to 16 years.
[7]Pacific ocean perch ages from 7 to 18 years.

males from the same depth ($L_\infty = 42.3$ cm, $Z = 2.37$, $P \geq 0.02$). For the same comparison, estimates of k were significantly lower for Columbia area males ($k = 0.099$) compared with those in the Vancouver area ($k = 0.170$, $Z = 2.52$, $P \geq 0.02$). Significant differences occurred between t_0 estimates for male Pacific ocean perch sampled from 100 to 149 fathoms between the Columbia and Vancouver areas with $t_0 = -4.86$ and -1.64, respectively ($Z = 2.00$, $P \geq 0.05$). No significant differences for estimates of L_∞, k, and t_0 were detected between males sampled from 150-199 fathoms between the Columbia and Vancouver areas. There were also no significant differences for estimates of L_∞, k, and t_0 between females sampled in the Columbia and Vancouver areas in either depth interval.

The width of the 95 percent confidence intervals indicated that more variation was associated with estimates of L_∞, k, and t_0 for Pacific ocean perch sampled in the deeper interval when compared with those sampled from 100 to 149 fathoms. This may be due to the smaller sample sizes in deeper water as well as the effects of changes in age composition between depth strata.

After pooling the data from each depth interval (even though some differences occurred for estimates of k and t_0 for Vancouver males between depth strata), no significant differences in the L_∞, k, or t_0 values were present between Pacific ocean perch from the INPFC Columbia and Vancouver areas ($P \geq 0.05$). Age-length relationships predicted by the von Bertalanffy parameters from the pooled samples are shown in Figure 13.

Growth parameters estimated from the 1977 rockfish data for the INPFC Vancouver area are similar to those reported by Gunderson (1977) for Pacific ocean perch sampled in 1972. Males from the Vancouver area in that study had L_∞, k, or t_0 values of 43.15 cm, 0.1320, and -2.1186 years, respectively, with a standard error of the estimate equal to 0.68. Females had values of 48.47 cm, 0.0908, -3.5041 years, respectively, with a standard error of the estimate equal to 0.45. All of these values fell within the 95 percent confidence interval of the 1977 rockfish survey estimates for the Vancouver area.

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