GROUNDFISH ASSESSMENT: PACIFIC OCEAN PERCH (*SEBASTES ALUTUS*), ENGLISH SOLE (*PAROPHRYS RETULUS*) AND LINGCOD (*OPHIODON ELONGATUS*)

ANNUAL REPORT

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INTRODUCTION

This report summarizes activities from October 1, 1977 through September 30, 1978 (FY 77). Major activities were analysis of data collected from the cooperative coastwide rockfish survey, English sole (*Parophrys vetulus*) tagging in PMFC areas 2B and 2C and lingcod (*Ophiodon elongatus*) tagging off Newport, Oregon in PMFC area 2C.

Objectives of the work can generally be classed as stock assessment. However, objectives of the tagging studies were to determine stock delineation and fishing rate for English sole and inshore-offshore exchange of lingcod. Proposed objectives relating to rockfish assessment were generally to obtain: (1) abundance estimates of rockfish between the Columbia River and Cape Blanco, Oregon; (2) estimate mortality rates of principle rockfish species (*Sebastes alutus, S. flavidus, S. pinniger* and *S. crameri*); and (3) to determine estimates of growth parameters of the above mentioned species.

Data to be analyzed was obtained from a cooperative coastwide rockfish survey from Point Hueneme, California (Lat. 34°00'N) to Cape Flattery, Washington (Lat. 48° 26'N). Planning of the overall survey was coordinated by the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service (Gunderson, 1978).

Because of the large number of rockfish species involved and the discontinuous distribution of major species within the geographic range of the survey certain species were assigned to participating agencies. This decision was made early in the planning stage of the survey but several months after the start of the contract period. The approach taken greatly facilitated analysis of the data collected.

Oregon Department of Fish and Wildlife elected to analyze data from Pacific ocean perch (*Sebastes alutus*) because we have a particular interest in this species both in terms of stock assessment and a commercial fishery. Also we have developed considerable expertise in age determination of Pacific ocean perch. Oregon Dept. of Fish and Wildlife samples commercial landings of Pacific ocean perch for age, size, sex and maturity. The survey provided a means of obtaining additional data on these biological statistics as well as data on distribution. The survey also provided the opportunity to sample segments of Pacific ocean perch stocks only lightly fished by the commercial fishery, especially those stocks inhabiting the deeper depths. The body of data collected on Pacific ocean perch comprised catch data from 351 trawl hauls from four different vessels, size composition data from 6,318 fish, and age composition data from 2,982 otoliths.

Participating agencies in the survey were the National Marine Fisheries Service, California Department of Fish and Game, Washington Department of Fisheries, Oregon Department of Fish and Wildlife, Oregon State University, University of Washington and Polish Sea Fisheries Institute (Gdynia, Poland)[1/].

METHODS

Rockfish Survey

A detailed description of methodology (gear, stations, catch sampling and biomass estimation) is given by Gunderson (1978).

1/ Results, covering all aspects of the survey, are to be published in Marine Fisheries Review in late 1978 or early 1979.

Tagging Studies

The tagging studies on English sole and lingcod were conducted out of Newport, Oregon. Fish were tagged with the FD-67 anchor tag[1]/.

English sole Fish to be tagged were caught by trawl from a chartered commercial trawler. Tows were generally one hour in length but ranged from 0.5 to 3.0 hours. The area of tagging was generally in PMFC areas 2B and 2C; however, concentrations of fish were located in PMFC area 2B (Figure 1) and consequently most fish were tagged there (3,358 of 4,191). Tagging was scheduled to take place during the spawning season, November through March. Tagging actually took place on December 28-29, 1977 and March 14-17, 1978, thus there were essentially two tagging experiments (3,057 fish tagged in December, 1,134 in March). Depth of fishing ranged from 28 fms (51 m) to 82 fms (150 m) but was most often between 50 and 70 fms (91-128 m).

Since the objectives of the tagging were to determine stock delineation and estimate fishing rate it was decided not to measure fish at tagging because we wanted to get as many fish tagged as possible in as little time as possible. Also, a large data base on English sole growth was already available.

The area of tagging, generally between Yaquina Bay and Cape Blanco, was chosen because this particular area was the one remaining area between northern California and northern Washington in which English sole had not been tagged.

Lingcod Lingcod were tagged on inshore reefs adjacent to Yaquina Bay during the spawning period of December through March. Fish were caught by hook and line from a chartered commercial passenger fishing vessel. When netted aboard, fish were sexed, measured, tagged about midway and just under the first dorsal fin and released.

Lingcod tagged offshore were caught by commercial trawl adjacent to a rocky outcropping between July 14 and 27, 1978. Since the vessel lacked room for large live tanks, fish were confined to a deck checker and flooded with seawater from a deck hose. On small tows (<50 fish) fish were sexed, measured, tagged and released. On larger tows fish were sexed and tagged only. The latter method accounted for 72% of the tagged fish.

RESULTS

Pacific Ocean Perch

Biomass Estimates of biomass of Pacific ocean perch derived from the survey were 223 m.t., 7,015 m.t., and 7,728 m.t. for the INPFC Eureka, Columbia and Vancouver areas, respectively. Since these estimates of biomass included some fish too small for market use estimates of biomass were adjusted downward by subtracting weight of fish ≤30 cm. The adjustment was accomplished by use of a length-weight key. Adjusted estimates of biomass then became 175 m.t., 6,467 m.t. and 7,685 m.t. of utilizable fish for the Eureka, Columbia, and Vancouver areas respectively. An independent estimate of biomass for the Columbia area, based on

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1/ Floy Tag and Manufacturing Co., Seattle, Washington

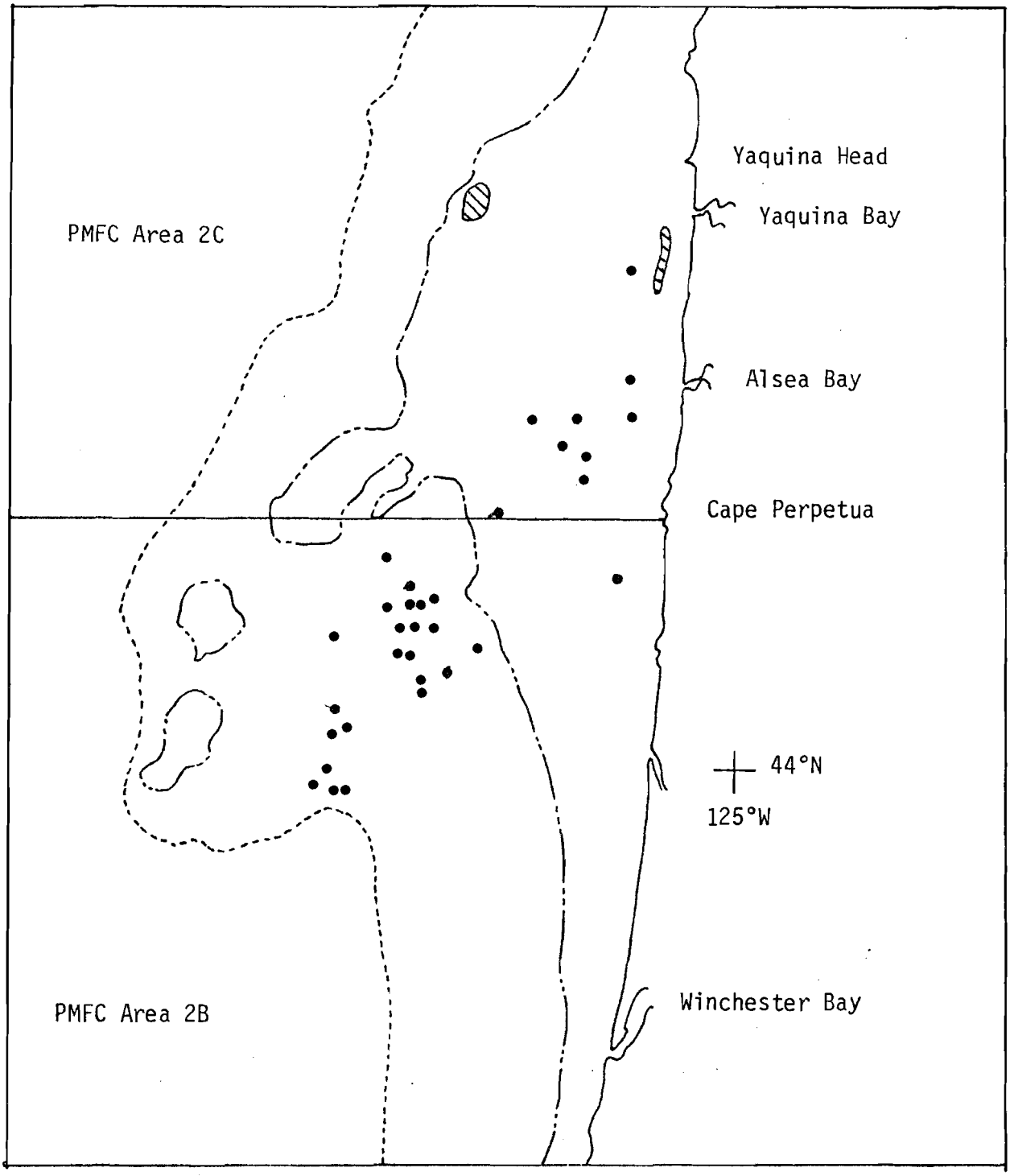

Figure 1. Location of English sole and lingcod tagging areas. Dots show location of tows from which English sole were tagged. Diagonal lines show areas where lingcod were tagged. Depth contours are 50 fm and 100 fm.

commercial CPUE, was 9,600 m.t.[1]/. A substantial difference exists between the estimates. However, both methods show an increase in stock biomass when compared to the 1973-74 estimate of 4,300 m.t. (Gunderson, et al, 1977) but still well below the estimated biomass of 35,000 m.t. present during the 1966-68 period (Westrheim, et al, 1972).

If landings and biomass are known, the exploitation rate can be calculated by dividing landings by biomass. Estimates of the exploitation rate (fish ≥30 cm) ranged from 0.40 in the Eureka area to 0.07 in the Columbia area. A value of 0.11 was estimated for the Vancouver area (Table 1).

Table 1. Estimates of exploitation rate (μ) for Pacific ocean perch by INPFC area. Biomass represents fish ≥30 cm.

Area	1977 catch, m.t.	Biomass, m.t.	Exploitation rate
Eureka	65	175	0.37
Columbia	478[1]/	6,467	0.07
Vancouver[2]/	817	7,685	0.11

[1]/ Includes foreign catch

[2]/ U.S. waters only

Age and Size Composition Age composition for individual tows was weighted to the catch from which the sample was taken. The expanded age composition was then combined by 50 fm (91 m) strata for the Columbia and Vancouver areas. There were no age samples collected in the Eureka area. Since there were substantial differences in age composition in the Columbia area, the Columbia area was stratified by latitudinal increments that would approximately align with PMFC statistical areas, thus allowing direct comparison of survey results with results of stock monitoring through sampling of commercial landings.

One feature, prominent in all data sorces, was dominance of the 1970 year class. Dominance of the 1970 year class was somewhat reduced in area 2B and nearly absent in the deeper depths regardless of area (Figure 2). The absence of the 1970 year class at deeper depths corresponds with work by Gunderson (1974) who also showed the lack of younger fish at deeper depths off the northern Washington coast. Gunderson concluded that recruitment of younger fish to deeper depths takes place over several years.

An interesting feature between areas 2C and 3A was the much greater abundance of older fish in area 3A than in other areas. The most plausible explanation for this is probably the lack of foreign fishing between 46°N and 47°N. Within this

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[1]/ Statistics used were: area available = 717 mi^2 (PMFC area 3A, 268 mi^2; PMFC areas 2B-2C, 449 mi^2); area swept 0.014391 mi^2 and CPUE of 0.333 mt/hr (PMFC area 3A) and 0.109 mt/hr (PMFC area 2B-2C).

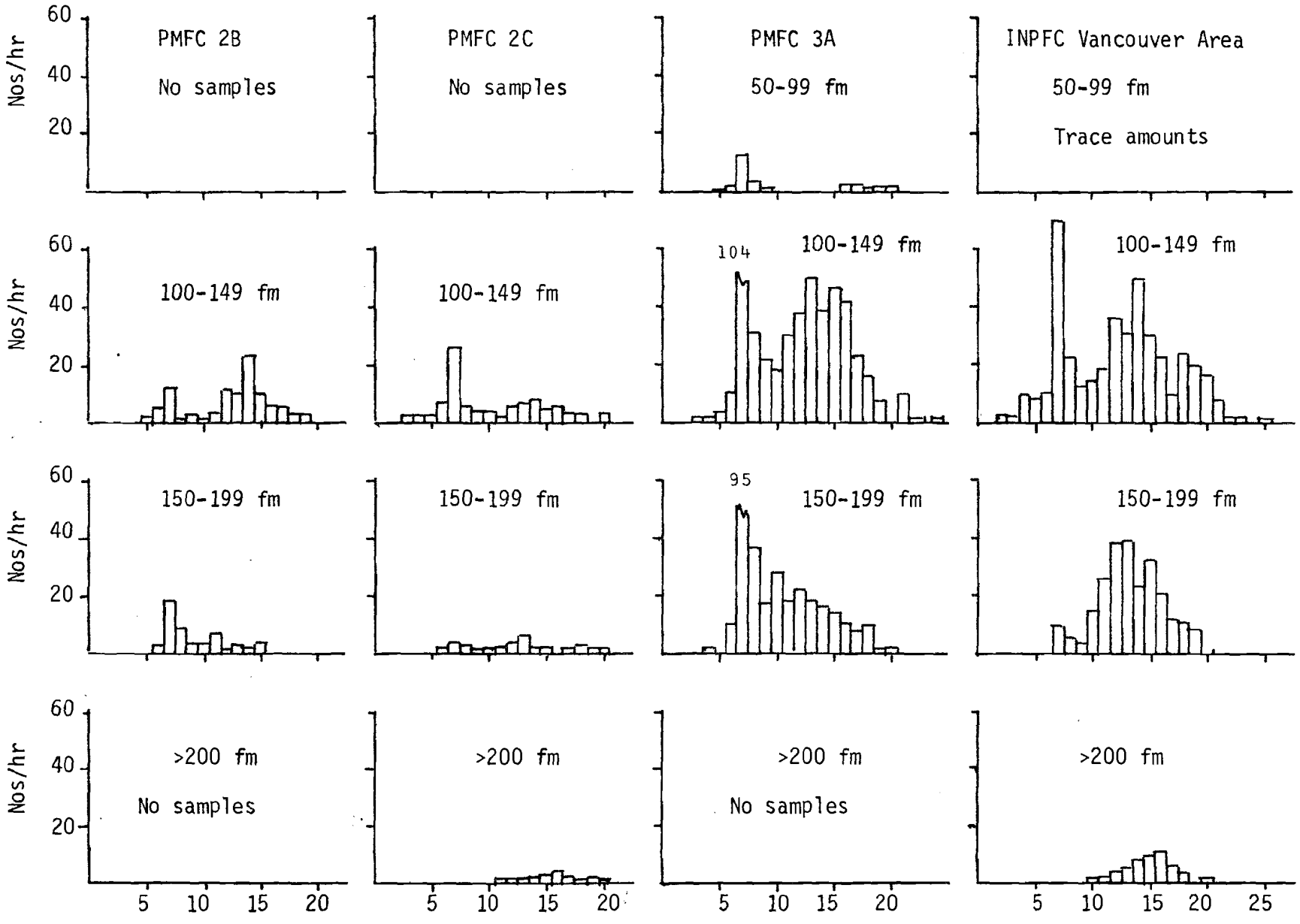


Figure 2. Age composition (nos/hr) of Pacific ocean perch caught on 1977 rockfish survey. Results shown for PMFC areas 2B, 2C and 3A comprise INPFC Columbia area.

area lies the Columbia river fixed gear sanctuary which has been closed to all foreign fishing since 1973.

Age composition of Pacific ocean perch in the Vancouver area was quite similar to that observed in the Columbia area, the 1970 year class was dominant in all but the deepest strata and was most abundant in the 100-149 fm strata. The abundance of older age groups was also substantially greater in the Vancouver area than in the Columbia area. This, in part, was also probably due to the absence of foreign fishing since the Vancouver area is closed to all foreign fishing.

Age composition was also available from samples of commercial landings and from catch sampling aboard commercial trawlers. Again, the 1970 year class was dominant but most abundant in PMFC area 3A. Dock samples and at-sea samples showed nearly the same age composition in area 2C catches (Figure 3).

The difference in age composition between survey data and commercial data is due to differences in fishing strategy. The survey was designed to sample the entire bathymetric range of Pacific ocean perch while the commercial fishery operates only in areas of high abundance, generally between 100 and 150 fms.

Size composition of Pacific ocean perch from survey data is summarized only by INPFC area. In the Eureka area there was nearly a total lack of large fish when compared to the Columbia area and especially the Vancouver area (Figure 4). The much greater abundance of larger fish in the Columbia and Vancouver areas reflects the greater abundance of older-aged fish.

Growth Growth data (length at age) between the Columbia and Vancouver areas were fitted via the von Bertalanffy growth equation. Only the 100-199 fm strata was used for comparison since sample sizes in other depth strata were too limited.

No significant differences in growth were found between the Columbia and Vancouver areas ($t = 2.24$, $p = 0.05$). Females had a slightly superior growth rate and grow to a larger size than do the males (Figure 5). Estimates of growth coefficient K, asymptotic length L_∞ and hypothetical age at zero length are shown in Table 2. There is generally good agreement between survey results and those reported by Gunderson (1977) for the von Bertalanffy growth constants.

Mortality Rate The total instantaneous mortality rate Z was estimated by both the Robson-Chapman (1960) method and the Jackson (1939) method for age classes 13-25. Estimates of total instantaneous mortality rate via the Robson-Chapman method were 0.34 and 0.31 for the Columbia and Vancouver areas respectively. Estimates were 0.24 and 0.20 via the Jackson method for the Columbia and Vancouver areas respectively. An estimate of F was determined by the formula $F = \frac{\mu Z}{a}$ where F = instantaneous fishing rate, μ = exploitation rate and a = annual mortality rate. Regardless of the method used, the values of F were the same within the Columbia area, i.e., 0.08 and nearly identical in the Vancouver area. The choice of method means little for F but in terms of M, the instantaneous natural mortality rate, the Jackson method provided the most agreeable estimate relative to previous work (Gunderson 1977). Gunderson determined that in the Vancouver area, M lay between 0.10 and 0.20, but most likely was nearer to 0.10. Estimates derived from the survey data are shown in Table 3.

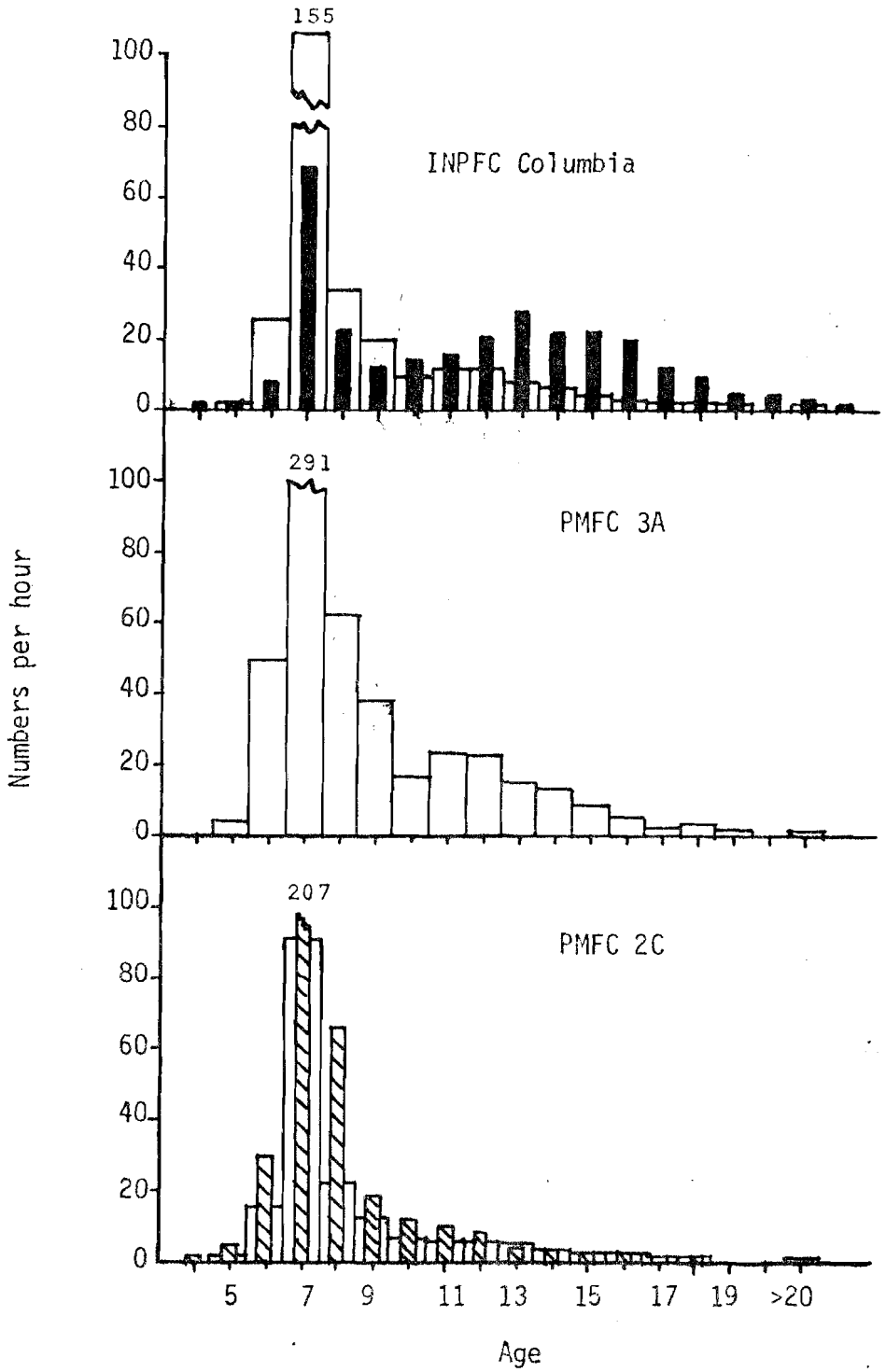


Figure 3. Age composition (nos/hr) of Pacific ocean perch (*S. alutus*) in 1977 in INPFC Columbia area and PMFC area 3A and 2C. Open bars represent commercial landings. Shaded bars represent rockfish survey. Diagonal bars represent at-sea sampling in PMFC area 2C.

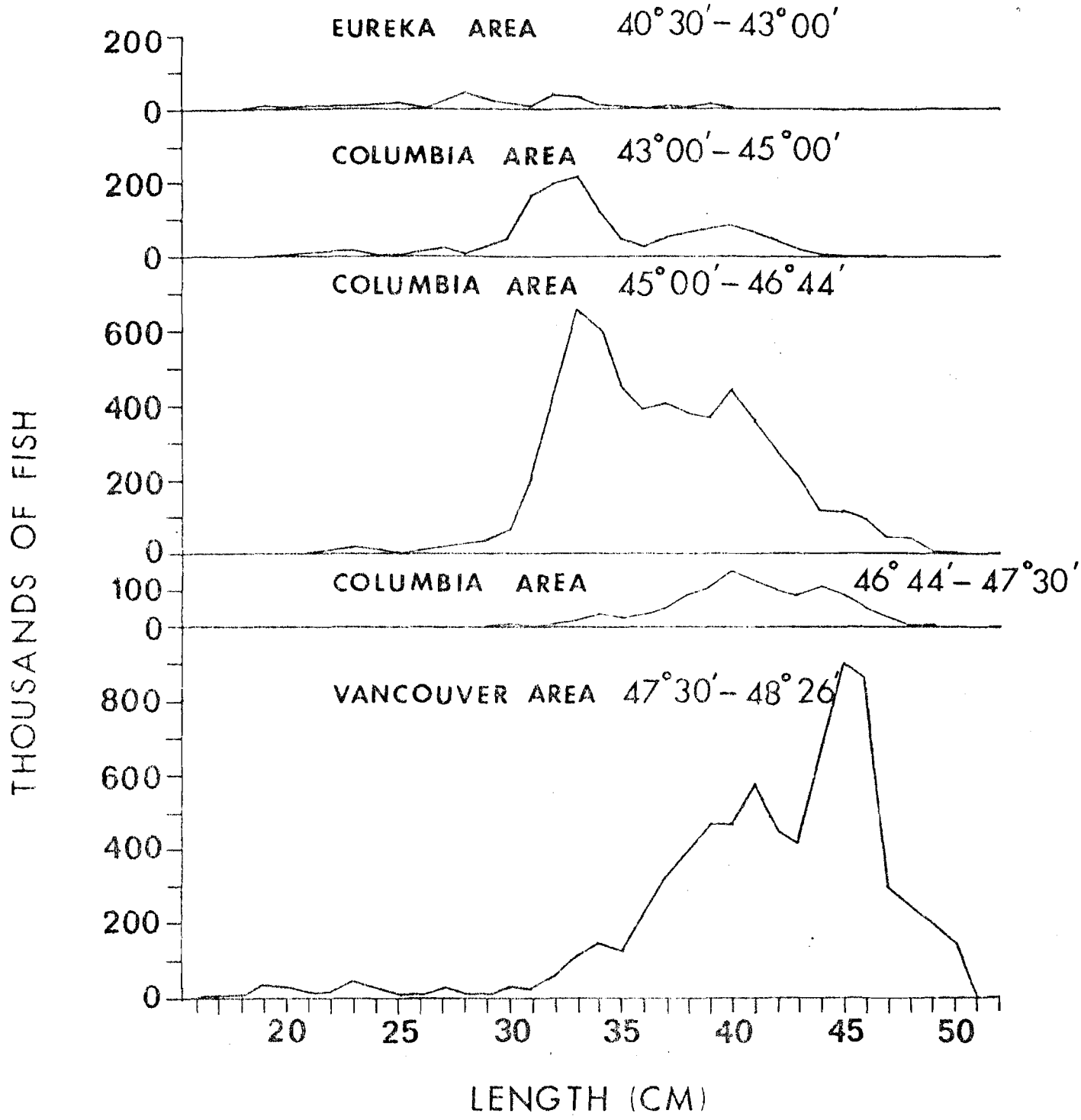


Figure 4. Size composition of *S. alutus* (sexes and depth intervals combined) caught by INPFC area during the 1977 synoptic rockfish survey.

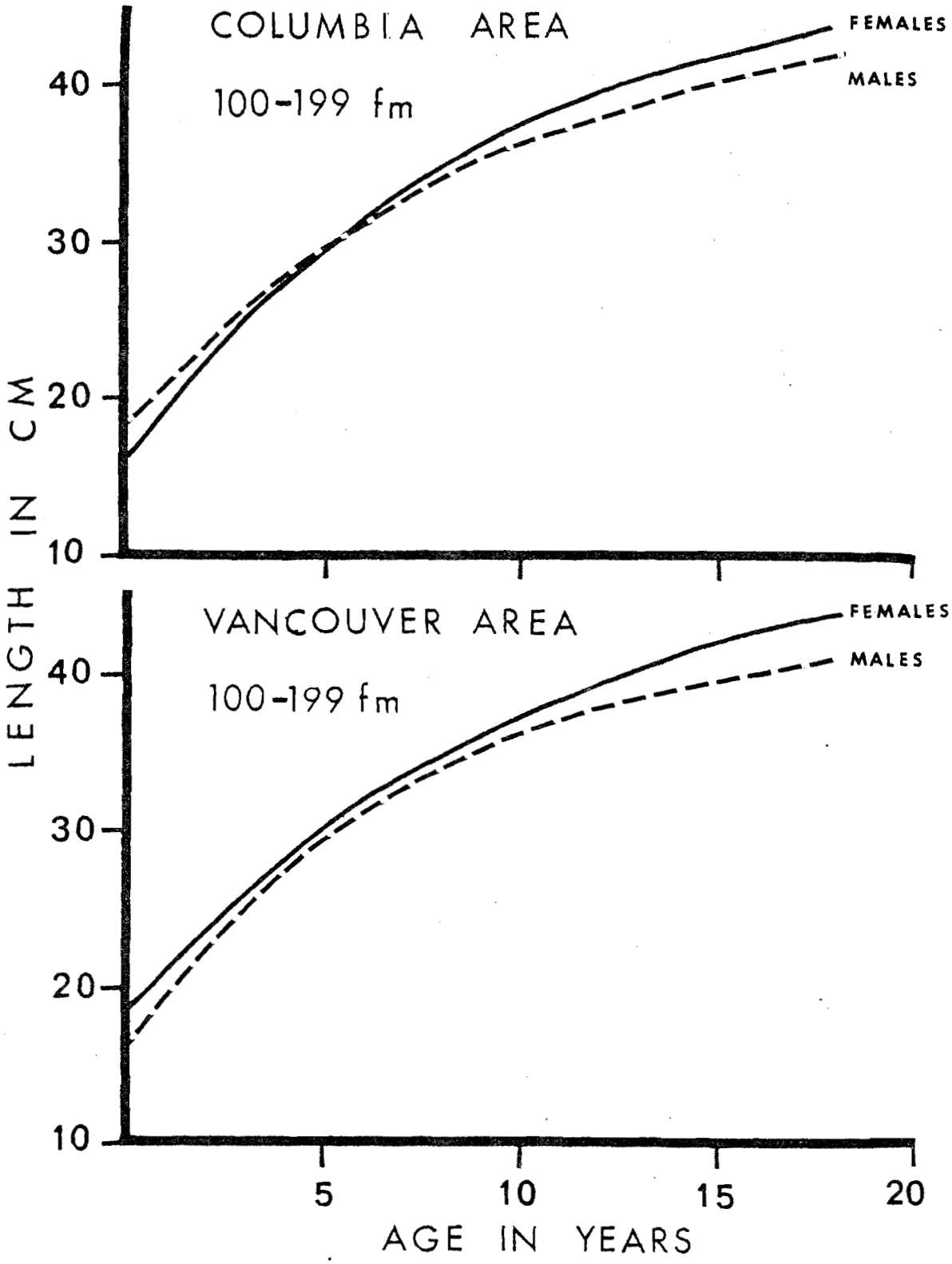


Figure 5. Growth-in-length curves fitted by von Bertalanffy equation for Pacific ocean perch from INPFC Columbia and Vancouver areas (100-199 fm).

Table 2. Estimates of growth coefficients (K), asymptotic length (L_∞), and hypothetical age at zero length (t_0) with sample size (n) and standard errors for Pacific ocean perch of ages 6-18 yrs caught in INPFC Columbia and Vancouver areas respectively, during the 1977 rockfish survey.

INPFC Area	Depth(fms)	N	K	L_∞(cm)	t_0(yrs)
Columbia					
Males	100-149	433	0.099 ± 0.019	47.00 ± 1.9	-4.9 ± 1.4
	150-199	191	0.120 ± 0.032	43.97 ± 2.0	-4.5 ± 2.0
Females	100-149	474	0.105 ± 0.016	49.10 ± 1.6	-3.8 ± 1.0
	150-199	78	0.102 ± 0.051	47.47 ± 4.5	-4.8 ± 3.9
Vancouver					
Males	100-149	304	0.170 ± 0.020	42.30 ± 0.6	-1.6 ± 0.8
	150-199	176	0.080 ± 0.028	46.17 ± 3.1	-8.6 ± 3.5
Females	100-149	128	0.096 ± 0.024	51.30 ± 2.9	-4.1 ± 1.7
	150-199	64	0.110 ± 0.060	45.07 ± 3.7	-5.8 ± 5.0
Columbia					
Males	100-199	623	0.104 ± 0.016	46.21 ± 1.43	-4.8 ± 1.1
Females	100-199	552	0.110 ± 0.015	48.27 ± 1.37	-3.7 ± 1.0
Vancouver					
Males	100-199	481	0.134 ± 0.016	43.14 ± 0.72	-3.6 ± 1.0
Females	100-199	191	0.097 ± 0.026	49.39 ± 2.76	-4.7 ± 2.0

Table 3. Estimates of mortality rates calculated by two different methods.

	Statistic				
	Z	a	μ	F	M
Robson-Chapman method:					
Columbia area	0.34	0.29	0.07	0.08	0.26
Vancouver area	0.31	0.27	0.11	0.13	0.20
Jackson method:					
Columbia area	0.24	0.21	0.07	0.08	0.16
Vancouver area	0.20	0.18	0.11	0.12	0.08

Z = F + M
.13 + .20 = .33

Distribution and Species Composition Since all catch data was made available to each participating agency it was possible to determine relative incidence based on CPUE (kg/km) for the various INPFC areas. As shown by the table below, Pacific ocean perch were not caught south of the Eureka area (southern boundary 40°30'N) and incidence increased to the north, being highest in the Vancouver area. By depth strata Pacific ocean perch were more abundant in the 100-149 fm strata followed by the 150-199 fm strata as shown below:

Area	Incidence (kg/km) by depth strata				
	50-99	100-149	150-199	>200	All depths combined
Vancouver	0.9	101.2	45.0	9.0	35.4
Columbia	1.5	26.5	16.6	3.1	9.6
Eureka	0.1	3.2	2.2	0.1	1.3
Monterey	0	0	0	0	0
Conception	0	0	0	0	0

A character of Pacific ocean perch distribution, as well as for other rockfish, is their patchiness. It was not uncommon to encounter Pacific ocean perch in large schools that provided catch rates as high as 6,000 pounds (2.7 m.t.) per tow, yet a slight spatial change would result in a low catch (<100 lbs) or no catch at all (Figure 6).

The proportion of Pacific ocean perch, by weight, of all rockfish as well as associated perch-like rockfish caught during the survey was determined for each 30' interval of latitude from Cape Blanco (42°30'N) north to Cape Flattery (48°26'N). Pacific ocean perch represented 23% to 74% of the total weight of rockfish caught with the proportion of Pacific ocean perch caught increasing with increasing latitude. Similarly, Pacific ocean perch ranged from 31% to 84% of the weight of associated perch-like species (Figure 7). Associated species were *Sebastes crameri, S. diploproa, S. propriger, S. reedi, S. saxicola* and *S. zacentrus*.

English Sole Tagging

There were 4,191 English sole tagged during the winter of 1977-78. As of August 15, 1978 recoveries amounted to 2.5% (105 fish) of fish tagged. The area of tagging, PMFC areas 2B-2C, accounted for most of the recoveries (60%) followed by area 3A (13%), area 3B (11%), area 3C (3%) and area 1C (10%). It is too early yet to discuss tag returns in detail or to attempt estimating fishing rate.

Lingcod Tagging

During the winter of 1977-78 we tagged 296 lingcod on an inshore reef adjacent to Yaquina Bay. In addition we also tagged 209 fish of other species caught

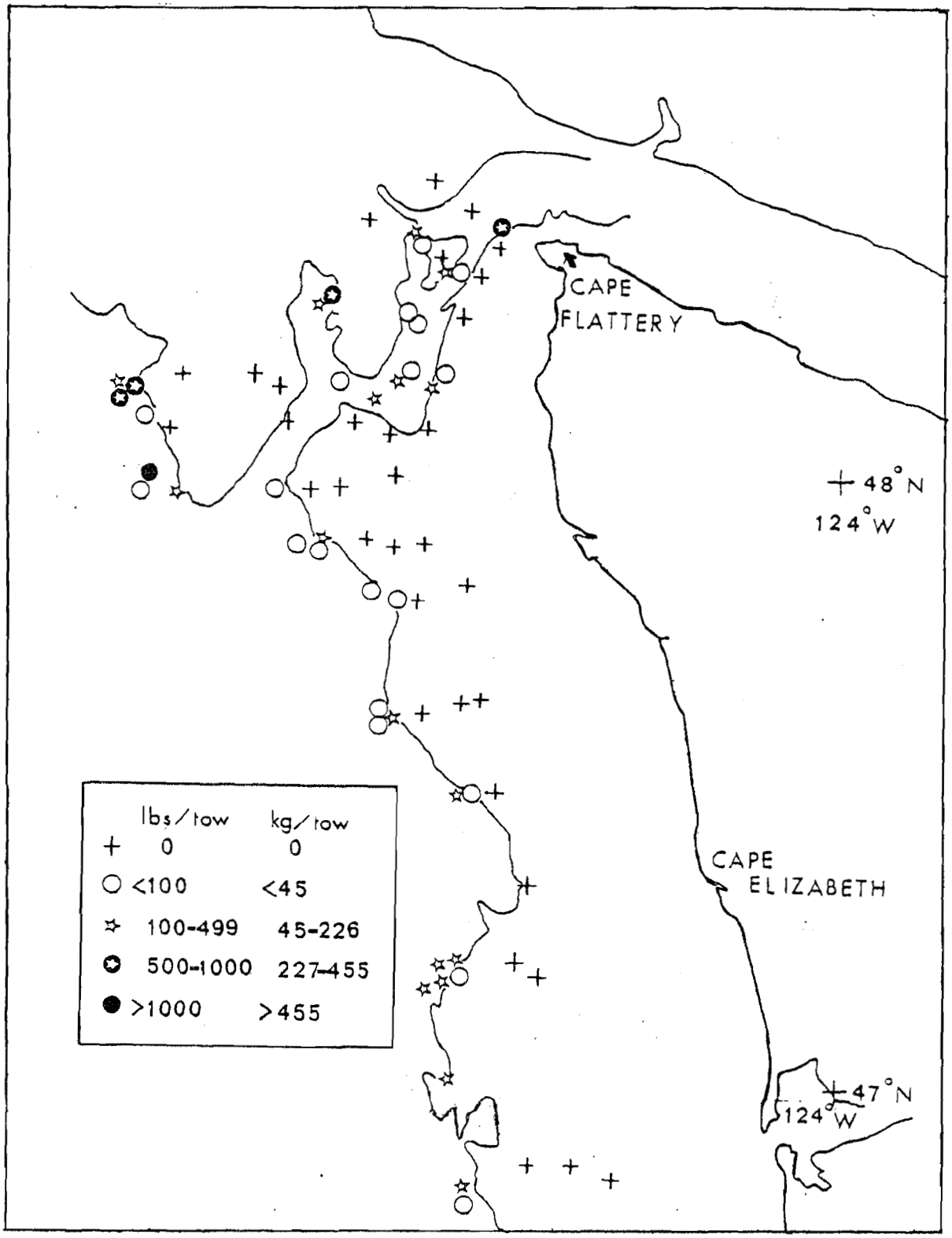
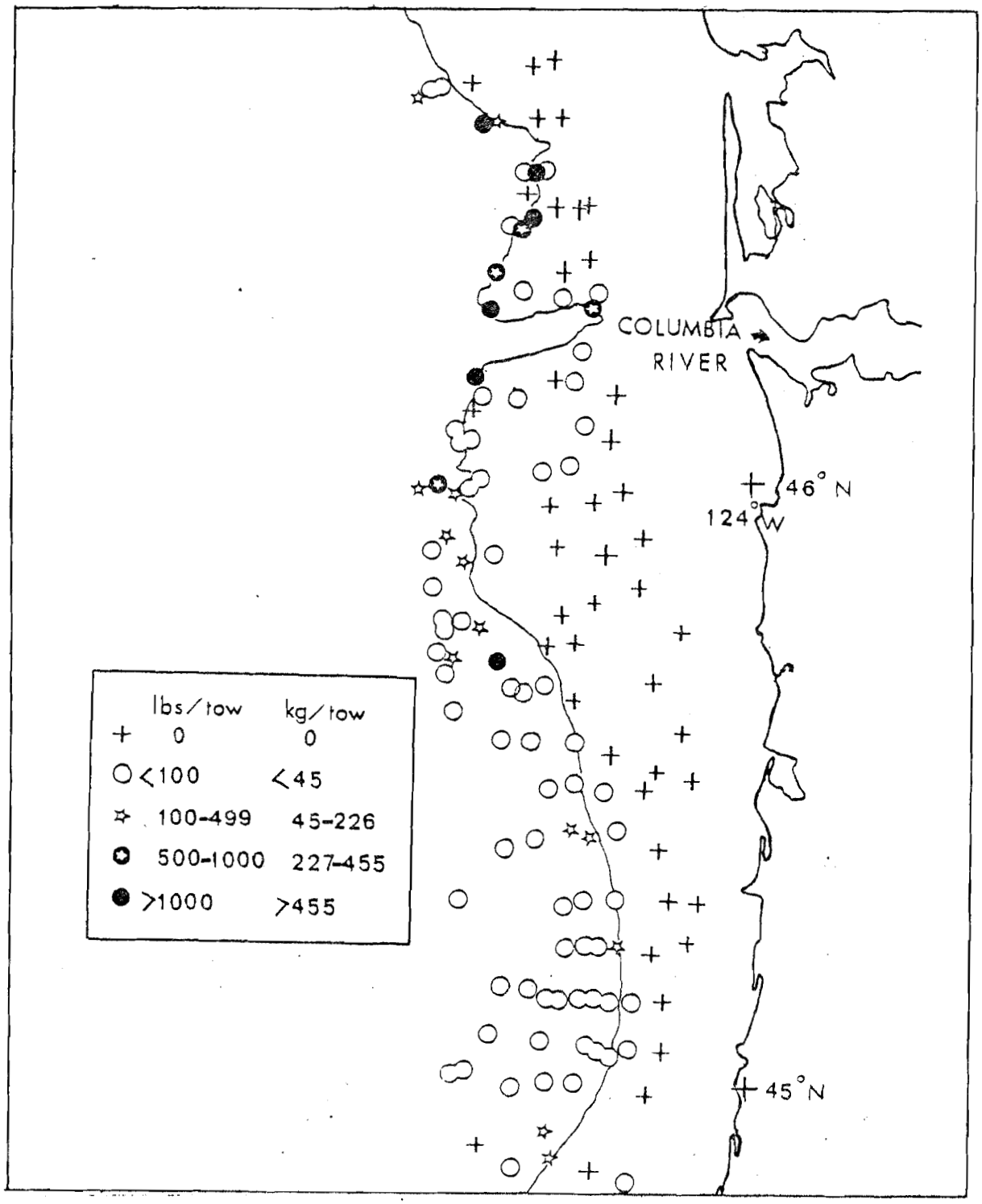


Figure 6. Location of tows made during the 1977 rockfish survey and catches of *S.alutus* (lbs/tow or kg/tow).



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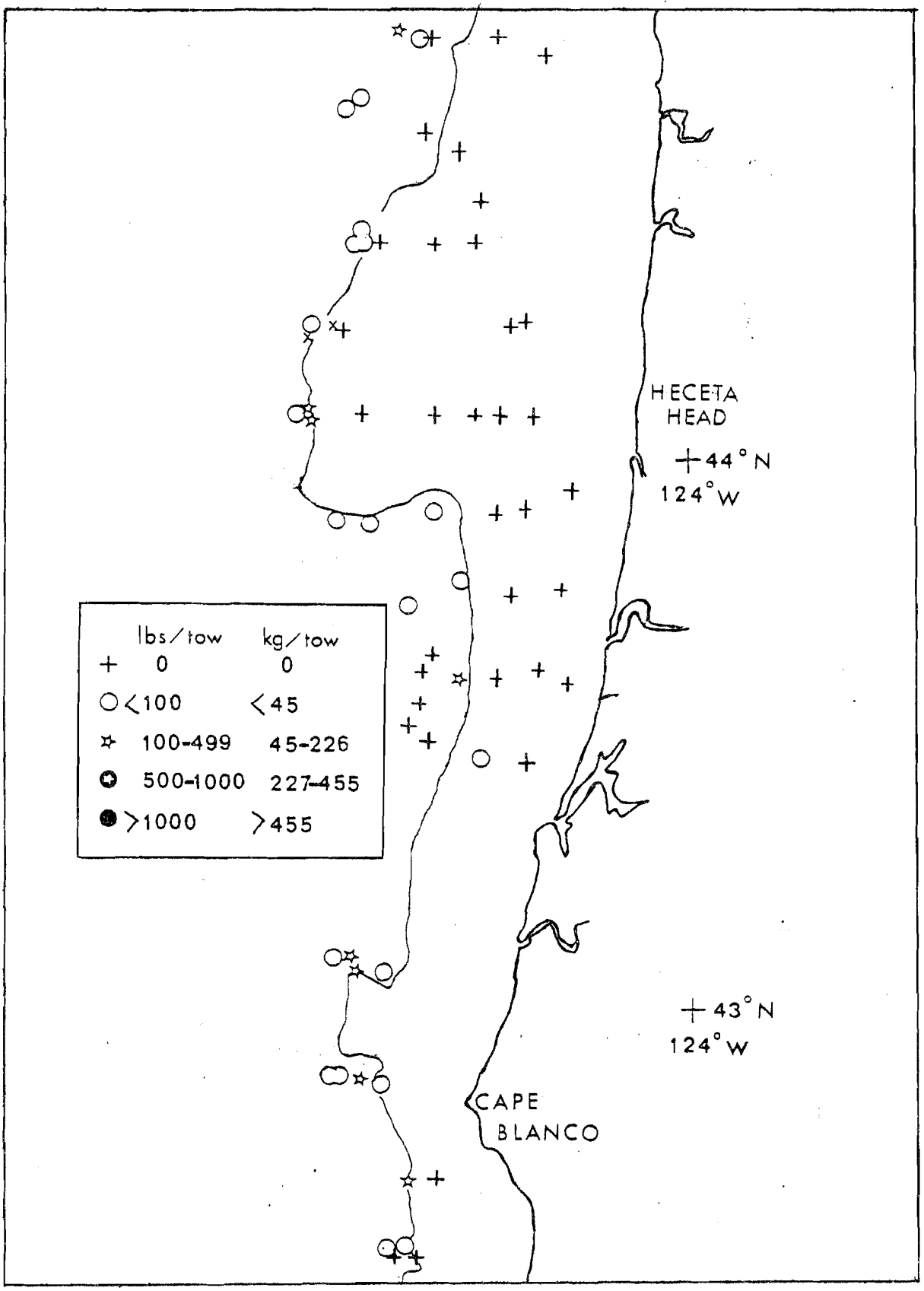

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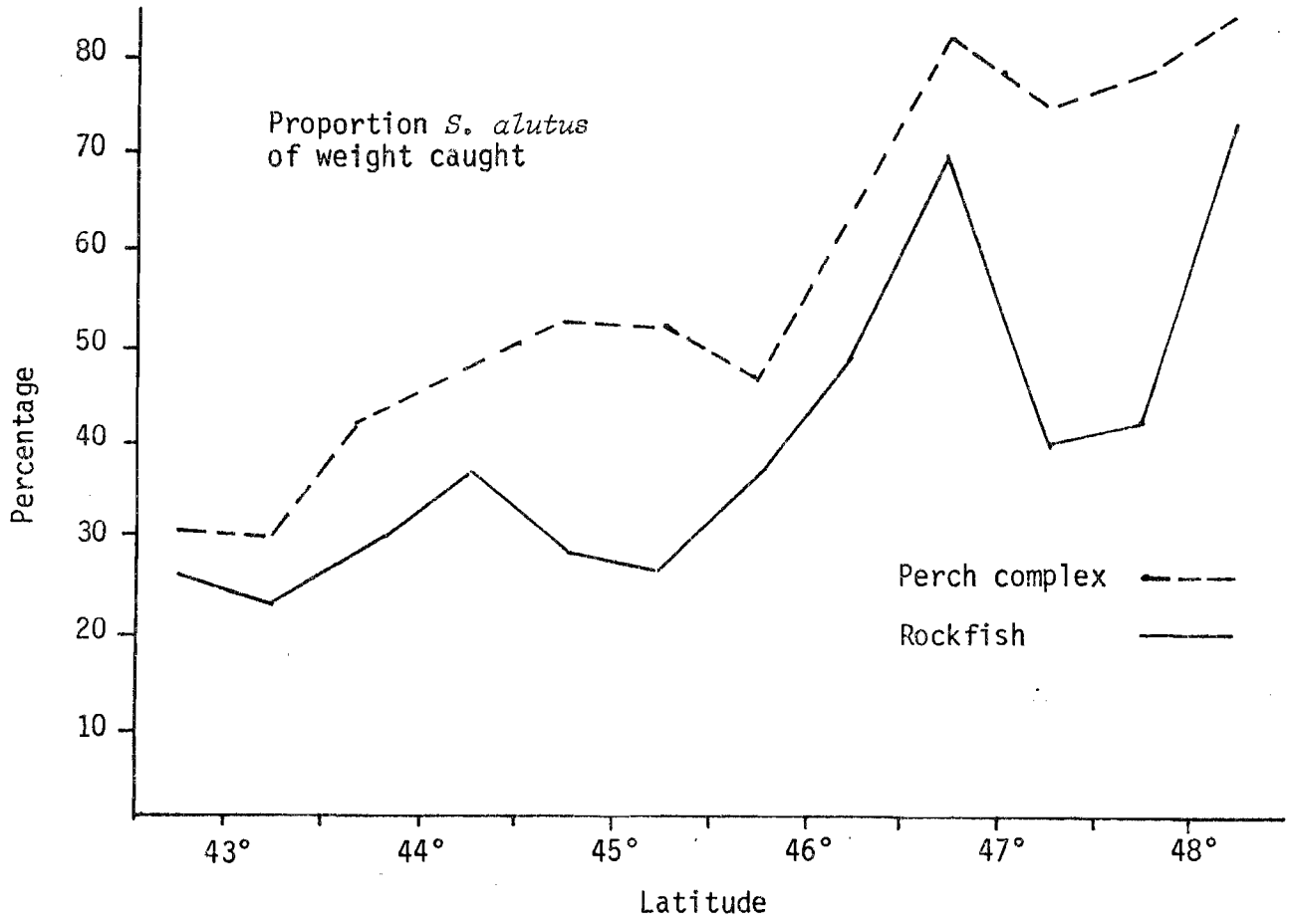

Figure 7. The percentage of Pacific ocean perch to rockfish (solid line) and perch-like rockfish (dashed line) by 30' intervals from south to north.

incidental to lingcod. There were 11 species involved but rockfish accounted for 65% of which black rockfish (*Sebastes melanops*) accounted for 43% alone. Cabezon (*Scorpaenichthys marmoratus*) accounted for 24% of the incidentally tagged fish.

As of August 15, 1978 a total of 13 lingcod and two black rockfish have been recovered from the inshore tagging. All but one of the tagged lingcod were recaptured at the area of tagging. The exception was a lingcod recaptured approximately 50 miles north of the tagging area.

Of the 3,818 lingcod tagged offshore in July 1978, 110 fish have been recovered, all at the area of tagging. An additional 170 tagged lingcod were recovered and re-released during the tagging period by the field crew.

During the winter inshore tagging 85% of lingcod tagged were males as opposed to only 11% males for the summer offshore tagging. The nearly complete reversal in sex ratio is most likely real since size composition of the males is quite similar even though fish were caught by different gear. However, a greater proportion of smaller fish were caught by hook and line than by trawl thus there might have been some escapement through the trawl codend (Figure 8).

Size composition of inshore females was quite different from size composition of offshore females. Inshore fish were mostly of two different size groups: 42-77 cm and 77-107 cm. The offshore fish were predominantly between 62 and 92 cm (Figure 8). Whether or not these distributions reflect distinct populations will only be determined by future tag returns.

Approximate sexual maturity is also shown in Figure 8. Approximately 17% of the inshore males were immature while about 10% of the offshore males were immature. In the case of females 33% of both the inshore and offshore fish were immature.

Work in 1979 will concentrate on analysis of tag recoveries for lingcod and English sole, and also on further field studies on Pacific ocean perch to supplement 1977 survey data.

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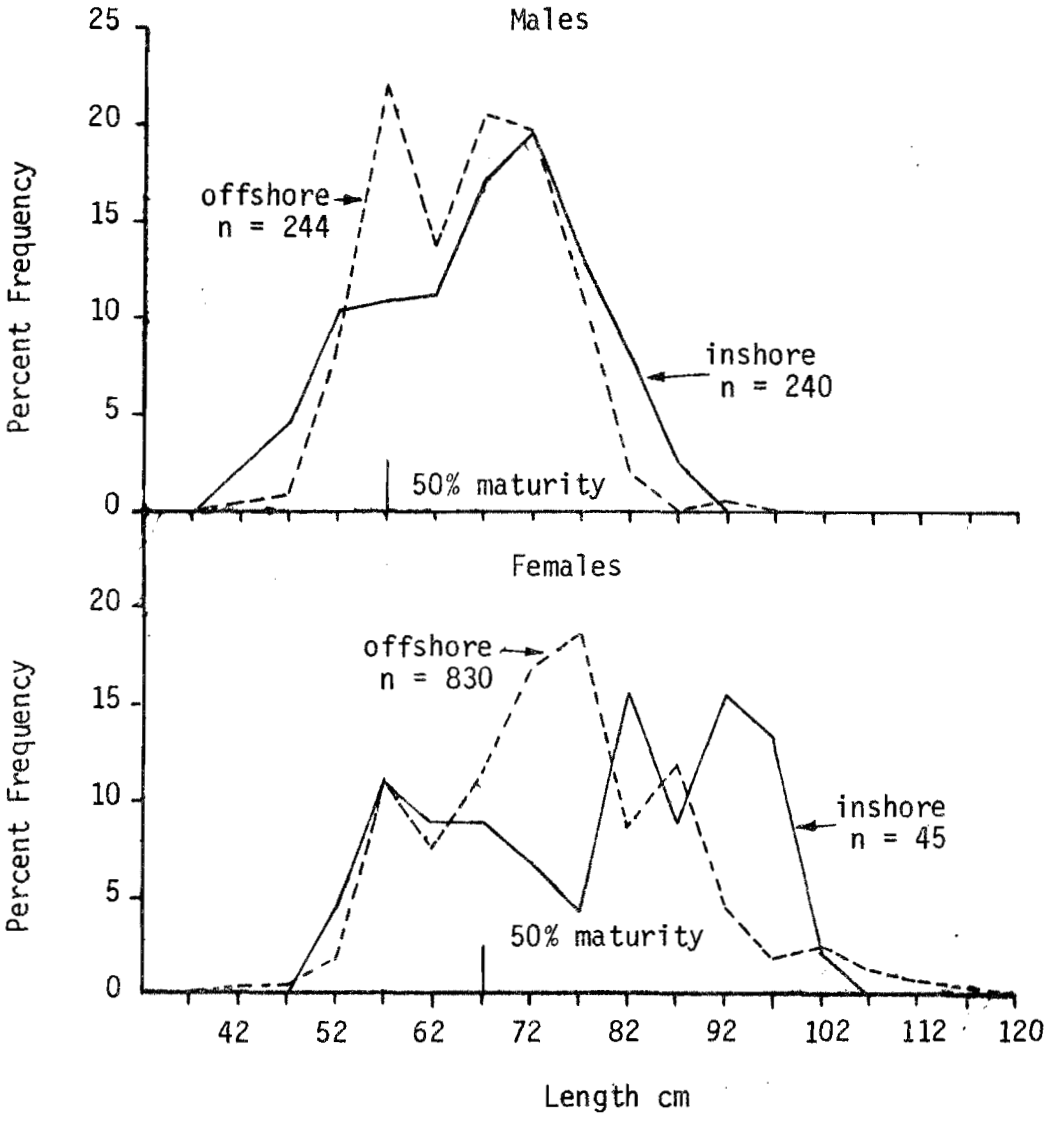

Figure 8. Length frequency distribution of lingcod tagged inshore and offshore. Approximate length at 50% maturity is indicated.