Yellowtail Rockfish, *Sebastes flavidus*, Length and Age Composition Off California, Oregon, and Washington in 1977

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ABSTRACT–Yellowtail rockfish, Sebastes flavidus, *length and age samples from a 1977 survey of rockfishes off California, Oregon, and Washington were analyzed to produce length and age composition data for the area from lat. 35°30' to 48°30'N. There was evidence of a north to south cline of decreasing size and age. Length composition data showed strong single modes for males and many modes over a broader size range for females. Age composition data showed two prominent modes at 8-10 and 13-14 years old. No major differences in the age-length relationship were noted between areas using data from the survey and data from market samples from Washington's trawl fishery. Data for all areas were pooled to fit a common growth curve for the northern California to Queen Charlotte Sound, British Columbia, region.*

Introduction

Yellowtail rockfish, *Sebastes flavidus*, is a significant component of the shelf rockfish complex living on the Pacific coast continental shelf. Although living in depths of 0-300 fathoms (0-550 m) (Hart, 1973), this species is most abundant in the 50-100 fathom (91-183 m) depth zone (Alverson et al., 1964; Gunderson and Sample, 1980) where it is associated with canary rockfish, *S. pinniger*, and silvergray rockfish, *S. brevispinis*. The species range extends from San Diego, Calif., to Kodiak Island, Alaska (Hart, 1973), but its center of abundance is from Oregon to British Columbia (Alverson et al., 1964; Westrheim, 1970). Landings in this region by North American trawlers have ranged from approximately 1,600 to 5,000 t annually (Fraidenburg et al., 1977).

In the 1977 survey of rockfishes, yellowtail rockfish were most abundant off northern Oregon and Washington and 97.2 percent of the biomass present was at depths less than 100 fathoms (183 m). Because yellowtail rockfish are an abundant and commercially important species in the rockfish survey area, it was designated as a target species for collection of length and age composition data. To date, the only published data on length or age composition of the stocks or from the fishery in this area are in Alverson et al. (1964).

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Methods

Weighted length compositions were obtained by first calculating the number of fish caught per kilometer by size and sex (C'_{ijkl}):

$$C'_{ijkl} = \frac{s_{ijkl} \cdot C_{ij}}{\sum_{k=1}^{3} \sum_{l=1}^{L} s_{ijkl}} \div km_{ij}$$

where C_{ij} = total number of fish caught, s = number of fish sampled, i = stratum, j = station, k = sex (1 = male, 2 = female, and 3 = unsexed), l = length group, L = number of length groups, and km = kilometers towed.

These C'_{ijkl} values were then summed over all hauls in a stratum and expanded to the total estimated population ($\hat{P}_i$) to obtain the estimated population size for each size and sex group ($\hat{P}_{ikl}$):

$$\hat{P}_{ikl} = \frac{\sum_{j=1}^{J} C'_{ijkl}}{\sum_{j=1}^{J} \sum_{k=1}^{3} \sum_{l=1}^{L} C'_{ijkl}} \cdot \hat{P}_i$$

where J = number of stations for which length frequency data are available.

These length data were then used to examine the need for geographic and bathymetric stratification.

Otoliths were aged by the Washington Department of Fisheries using aging criteria developed by Kimura et al. (1979). Age compositions were calculated in each stratum by decomposing the weighted length frequencies into age compositions utilizing an age-length key developed from the age samples collected during the survey.

Results

A total of 2,288 length measurements and 1,321 usable otolith readings were available from the survey. Length samples were collected from lat. 35°30' to 48°30'N and age samples from lat. 40°26' to 40°30'N (Fig. 1).

For each sex, length compositions were examined by a variety of geographic areas and by depth as indicators for data stratification. No substantial differences in length composition were observed by depth, but differences among areas were present. Based on this analysis, all depths were combined, and five separate geographic areas (Fig. 1) were selected as strata (areas) for presenting length and age composition results.

Length compositions (Fig. 2) showed strong modes in all areas. Males showed particularly strong single modes and a cline of generally decreasing mean length and increasing proportion of fish less than 45 cm from north to south. Females had a larger mean size than males in each area and, rather than strong single modes, had many modes over a broader size range. A cline similar to that observed for males was not evident. A cline may

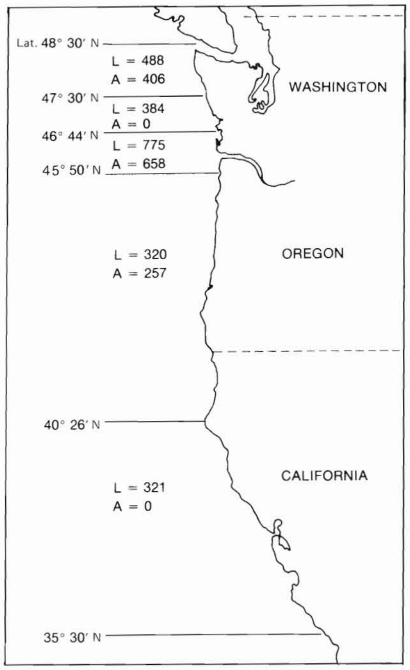

Figure 1.—Areas chosen for analysis of length and age composition of yellowtail rockfish. L = number of length observations in an area and A = number of otolith readings available in an area.

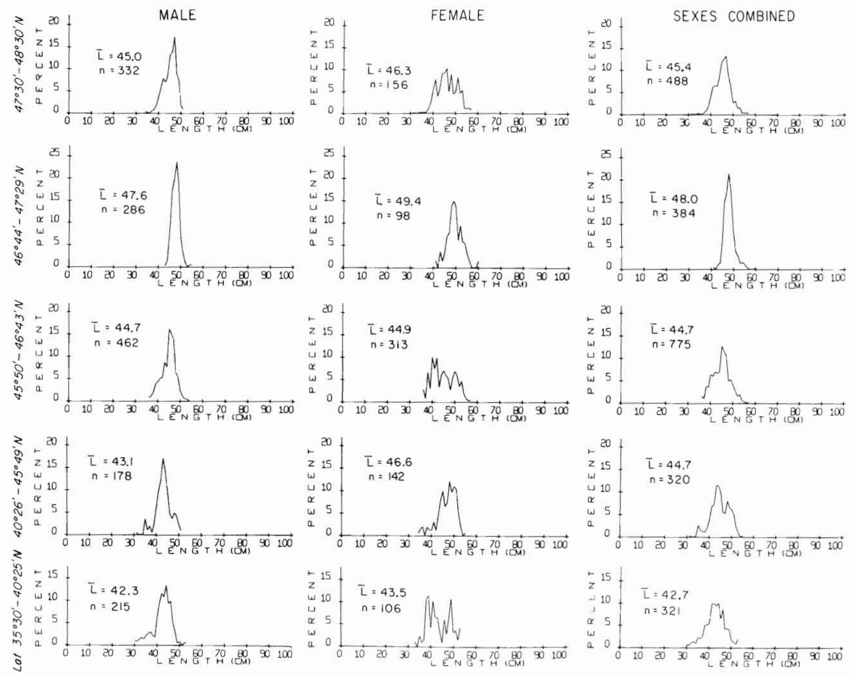

Figure 2.—Size composition of yellowtail rockfish by area and sex.

exist, but low female sample sizes in this study may have obscured such a trend. More data would be desirable for both sexes and future studies of size and age composition should be designed to examine north-south clines in more detail. Sex ratios varied from 74 percent to 56 percent male, with no obvious latitudinal trend (Fig. 2).

The sex ratio data may suggest that a portion of older females were not available to the survey. The lack of exceptionally large fish (Fig. 2) may also suggest this because the record size is reported to be about 66 cm (Hart, 1973).

Prior to construction of the age-length key used for calculating age compositions, mean length at age data from three areas (lat. 40°26′ to 45°49′, 45°50′ to 46°44′, and 47°30′ to 48°30′N) were examined for geographic differences. These data (Fig. 3) did not show any important differences that were consistent among areas, so the data were pooled to produce a single age-length key by sex for decomposing length frequencies into age compositions.

Coastwide age compositions (Fig. 4) show two prominent modes at 8-10 and 13-14 years. For males there is a cline of increasing importance of the 8- to 10-year-old fish from north to south corresponding to the cline observed in length composition data. A demarcation line is evident at lat. 40°50′N where 13- to 14-year-old males were most important to the north and 8- to 9-year-olds most important to the south. For females, a cline or demarcation line is not evident, and excepting the area from lat. 46°44′ to 47°29′N, 8- to 10-year-old fish were most important coastwide.

Growth was estimated by combining rockfish survey data with market sampling data from Washington's trawl fishery for yellowtail rockfish. The details of this analysis are being described by Fraidenburg (in prep.). From this analysis, homogeneous growth was observed in the northern California to Queen Charlotte Sound, British Columbia, region. A total of 4,211 age-length observations were available for

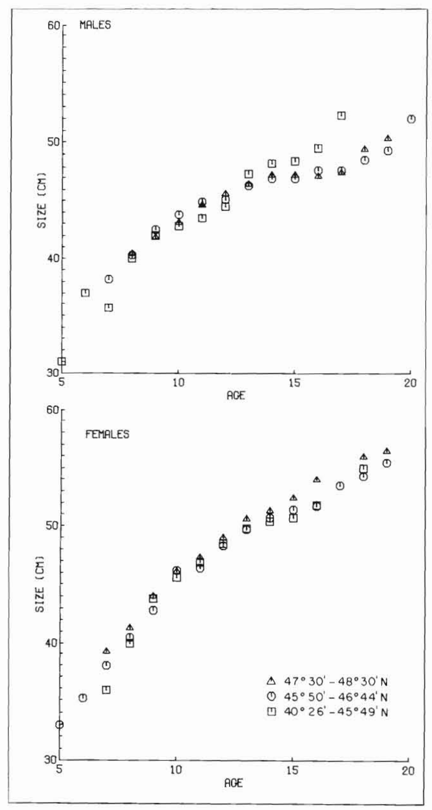

Figure 3.—Mean length at age for yellowtail rockfish by area and sex.

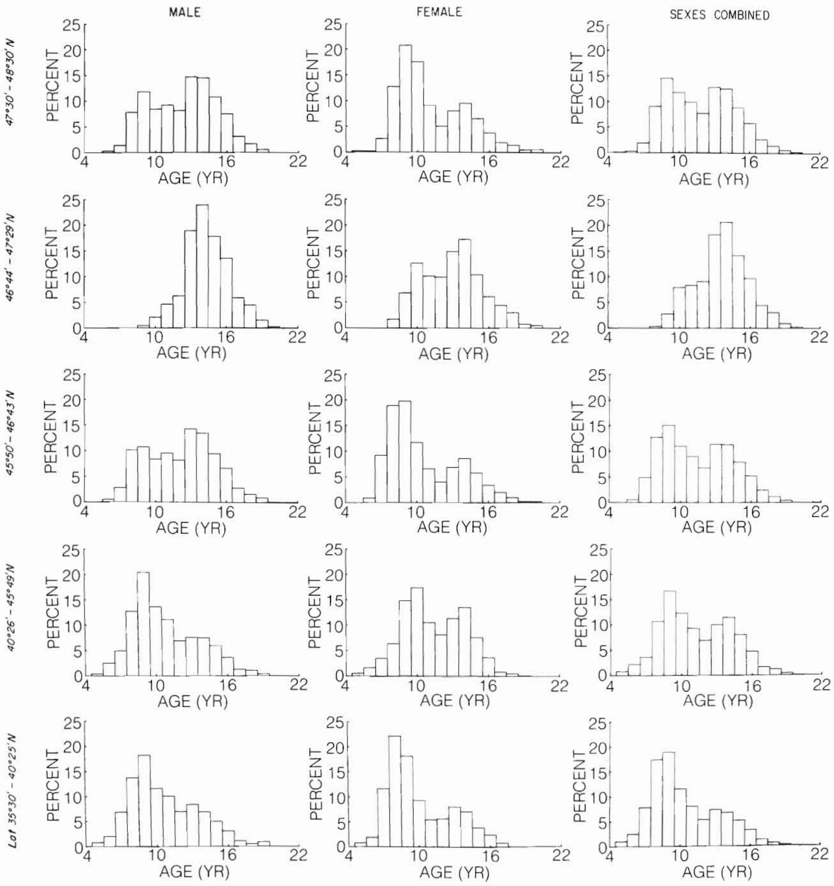

Figure 4.—Age composition of yellowtail rockfish by area and sex.

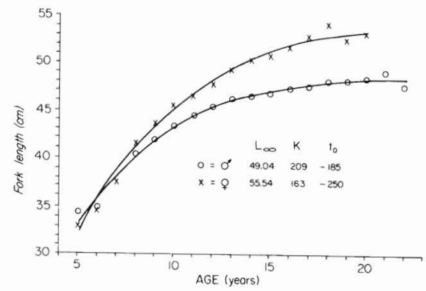

Figure 5.—Yellowtail rockfish mean length at age and calculated growth curves by sex. Survey and market sampling data combined.

Table 1.—Mean and calculated fork length at age for yellowtail rockfish, and least squares estimates of von Bertalanffy growth parameters.

	Male			Female		
Age	Mean	*n*	Calculated	Mean	*n*	Calculated
5	34.38	13	32.45	32.86	22	31.94
6	34.95	19	35.58	34.69	26	35.49
7	37.35	65	38.12	37.34	53	38.50
8	40.26	198	40.18	41.48	128	41.07
9	41.83	193	41.85	43.59	160	43.24
10	43.11	167	43.20	45.37	128	45.09
11	44.43	198	44.31	46.47	117	46.66
12	45.29	278	45.20	47.63	128	48.00
13	46.06	366	45.92	49.31	203	49.13
14	46.43	350	46.51	50.12	230	50.10
15	46.98	278	46.99	50.51	150	50.92
16	47.22	219	47.38	51.76	102	51.61
17	47.59	153	47.69	52.73	44	52.20
18	48.00	114	47.94	54.16	19	52.70
19	48.35	40	48.15	52.20	10	53.13
20	48.42	19	48.32	53.00	5	53.49
21	49.12	8	48.45	50.50	2	—
22	47.67	6	48.57			

	L_∞	k	t_o	L_∞	k	t_o
Est.	49.04	0.209	−0.185	55.54	0.163	−0.250
SD	0.27	0.012	0.386	0.92	0.016	0.549

growth studies. Kimura[1] has described a procedure and provided an example for calculating von Bertalanffy growth parameters using the general purpose nonlinear least squares computer program BMD 07R available in Dixon (1976). This approach was used here to estimate the growth parameters for yellowtail rockfish from the data in Table 1 and Figure 5. Only mean length at age data based on five or more observations were used for these calculations.

A comparison of the results obtained from these data with those of previous workers is presented in Fraidenburg (in prep.). The parameters presented here compared well with von Bertalanffy estimates by other authors (Westrheim and Harling, 1975 and Phillips, 1964). Growth reported by Six and Horton (1977), however, was observed to fit a power function better than a von Bertalanffy and this observation was attributed to a lack of young fish in the samples. It is also possible this could have resulted from low sample size in general and/or a tendency to under-age old fish.

[1]Daniel K. Kimura, Fisheries Biometrician, Washington State Department of Fisheries, M-1 Fisheries Center, University of Washington, Seattle, WA 98195, pers. commun.

Literature Cited

Alverson, D. L., A. T. Pruter, and L. L. Ronholt. 1964. A study of demersal fishes and fisheries of the northeastern Pacific Ocean. H.R. MacMillan Lectures in Fisheries, Inst. Fish., Univ. Brit. Columbia, Vancouver, 190 p.

Dixon, W. J. 1976. *Biomedical computer programs*. Univ. Calif. Press, Los Angeles, 738 p.

Fraidenburg, M., J. E. Smith, W. H. Barss, and T. Jow. 1977. Minimum estimates of the all nation removals, North American trawl species composition and CPUE for "other rockfish" in the northeastern Pacific Ocean. Wash. Dep. Fish., Tech. Rep. 34, 31 p.

Gunderson, D. R., and T. M. Sample. 1980. Distribution and abundance of rockfish off Washington, Oregon, and California during 1977. Mar. Fish. Rev. 42(3-4):2-16.

Hart, J. L. 1973. Pacific fishes of Canada. Fish. Res. Board Can., Bull 180, 740 p.

Kimura, D. K., R. R. Mandapat, and S. L. Oxford. 1979. Method, validity, and variability in the age determination of yellowtail rockfish (*Sesbastes flavidus*), using otoliths. J. Fish. Res. Board Can. 36:377-383.

Phillips, J. B. 1964. Life history studies on ten species of rockfish (genus *Sebastodes*). Calif. Dep. Fish Game, Fish Bull. 126, 70 p.

Six, L. D., and H. F. Horton. 1977. Analysis of age determination methods for yellowtail rockfish, canary rockfish, and black rockfish off Oregon. Fish. Bull., U.S. 75:405-414.

Westrheim, S. J. 1970. Survey of rockfishes, especially Pacific ocean perch, in the northeast Pacific Ocean, 1963-66. J. Fish. Res. Board Can. 27:1781-1809.

———, and W. R. Harling. 1975. Age-length relationships for 26 scorpaenids in the northeast Pacific Ocean. Environ. Can., Fish. Mar. Serv., Tech. Rep. 565, 12 p.