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NOTES

COMPARISON OF VISCERAL FAT AND GONADAL FAT VOLUMES OF YELLOWTAIL ROCKFISH, *SEBASTES FLAVIDUS*, DURING A NORMAL YEAR AND A YEAR OF EL NIÑO CONDITIONS

One of the severest El Niño events of the century occurred off California during late 1982 and most of 1983 (Rasmusson 1984). Associated with the warm water and lack of upwelling were impressions by many fishermen and biologists that macroplanktonic organisms were at low densities and that fish were thinner than normal. A semiquantitative sampling program off of San Francisco indicated that euphausiids, a major component of the macroplankton, were considerably less common in 1983 than in either 1982 or 1984 (Smith[1]).

Yellowtail rockfish are abundant off northern California and are an important component of recreational and commercial catches in some areas. The species feeds mostly on macroplanktonic organisms such as euphausiids, salps, and small fish (Phillips 1964; Pereyra et al. 1969; Lorz et al. 1983). Annual cycles of visceral fat volume and gonad volume are documented in Guillemot (1982) and Guillemot et al. (1985). The studies showed that visceral fat volume in both sexes of yellowtail rockfish is at a maximum during fall. The viviparous species (Boehlert and Yoklavich 1984) mates in early fall (September) and releases larvae during winter (January-March) (Wyllie Echeverria[2]). Guillemot (1982) and Guillemot et al. (1985) showed that male gonad volumes peak in fall and female gonad volumes peak in winter.

The purpose of this study is to determine possible effects of El Niño conditions by comparing visceral fat and gonad volumes during 1983, a year of El Niño conditions, with data collected during 1980, a normal year (Guillemot 1982).

Methods and Materials

Guillemot (1982) and Guillemot et al. (1985) utilized data collected throughout the year. The 1983 data were collected only on 21 September, the approximate sexual activity peak for males, and 20 December, which slightly precedes the peak time of larval release for females. Only 1980 data collected within 20 d of the two 1983 collection dates and samples collected from central California, between Bodega Bay and Half Moon Bay, were used in this study. In 1983 all specimens were collected from landings made at Bodega Bay.

Specimens were sexed, measured to the nearest millimeter for total length, and viscera were removed and preserved in 10% buffered Formalin[3] in the field following the procedures of Guillemot et al. (1985). After about 90 d of storage, visceral fat and gonad volumes were measured to the nearest milliliter by water displacement. Visceral fat of some fish had dissolved to form a floating liquid. The volume of this liquid was measured and added to the total fat volume. Data from males larger than 379 mm, when 90% are mature, and from females larger than 380 mm, when 85% are mature, were used (Wyllie Echeverria fn. 2).

As in Guillemot (1982) and Guillemot et al. (1985) we used the following power equation to describe the relationship between fat or gonad volume and length:

$$Y = \alpha X^{\beta}$$

where Y = fat or gonad volume, and
X = total length.

The parameters were estimated by first transforming the variables to natural logarithms and then using standard least squares linear regression techniques. Analysis of covariance was used to determine if separate lines for the two years significantly reduced the variance from a common line (Kleinbaum and Kupper 1978). This is a fairly robust test in that if there is not a significant linear relationship between the two variables for one or both time periods, the test is nearly as powerful for comparing the two means as an analysis of variance.

[1]Smith, S. Unpublished data. Tiburon Laboratory, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, 3150 Paradise Drive, Tiburon, CA 94920.

[2]Wyllie Echeverria, T. 1983. Reproductive seasonality and maturity of the rockfishes (Scorpaenidae; *Sebastes*) off central California. Unpubl. manuscr., 66 p. Southwest Fisheries Center, Tiburon Laboratory, National Marine Fisheries Service, NOAA, Tiburon, CA 94920.

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Results

The regression lines for the male fat volume for the two years intersect and are not significantly different (Table 1). The results of the analysis of covariance for fat volume of females are highly significant (Table 1). Females had significantly higher fat volumes in 1980 for both months (Fig. 1).

The comparisons of gonad volumes produced highly significant results in December for both sexes, and for females in September (Table 2). Female gonad volumes were higher in 1980 during December and lines intersected in September (Fig. 2). Male gonad volumes were significantly higher in December 1983 than in December 1980.

The seasonality of gonad development was similar in the two years, but appeared to be delayed in 1983.

TABLE 1.—Results of analysis of covariance of fat volumes of yellowtail rockfish regressed on length. Observations were transformed to natural logarithms for the analysis.

		1980			1983			
Sex	Month	Sample size	Intercept	Slope	Sample size	Intercept	Slope	*F*
Male	September	20	−9.884	2.011	38	22.272	−3.355	2.753
Male	December	17	7.198	−0.978	35	35.402	−5.693	2.571
Female	September	25	−9.327	2.003	46	5.443	−0.449	11.917**
Female	December	19	21.813	−3.262	50	1.609	−0.058	5.889**

**Significant at 99% level of confidence.

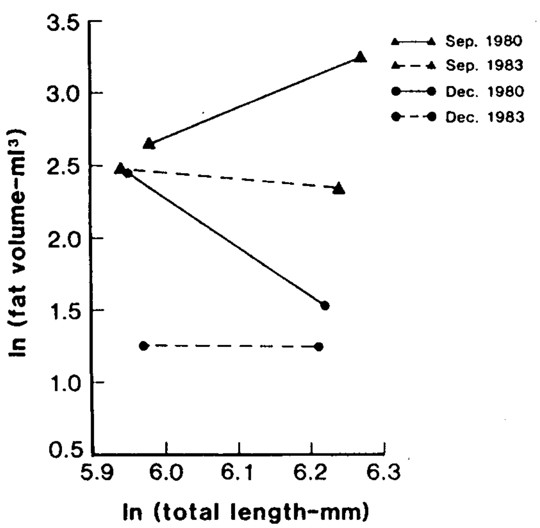

FIGURE 1.—Relationships between ln (visceral fat volume) and ln (total length) for female yellowtail rockfish in 1980 and 1983.

Males were 50% maturing and 50% resting in September 1980, and 100% resting during December. In 1983 males were 100% maturing during September, and 8% maturing and 92% resting during December. Females were 35% maturing and 65% resting in September 1980, and 83% maturing and 17% resting in December. In 1983 females were 100% maturing during September, and 97% maturing and 2% resting during December. Data on season or parturition for 1981-84 (Table 3) indicate that parturition was delayed in 1983 and 1984 compared with 1981 and 1982.

Discussion

The results tend to agree with expectations. Female fat volumes were lower in 1983 than in 1980, which is in agreement with the impressions of fishermen and the expectation that El Niño would produce relatively poor feeding conditions and consequently result in thin fish.

TABLE 2.—Results of analysis of covariance of gonad volumes of yellowtail rockfish regressed on length. Observations were transformed to natural logarithms for the analysis.

		1980			1983			
Sex	Month	Sample size	Intercept	Slope	Sample size	Intercept	Slope	*F*
Male	September	20	−35.589	6.161	38	−25.205	4.450	0.274
Male	December	17	−50.003	8.290	35	−11.037	1.962	8.170**
Female	September	25	−54.09	9.171	46	−31.019	5.406	3.404*
Female	December	19	−56.674	9.855	50	−45.723	7.908	12.224**

**Significant at 99% level of confidence.
*Significant at 95% level of confidence.

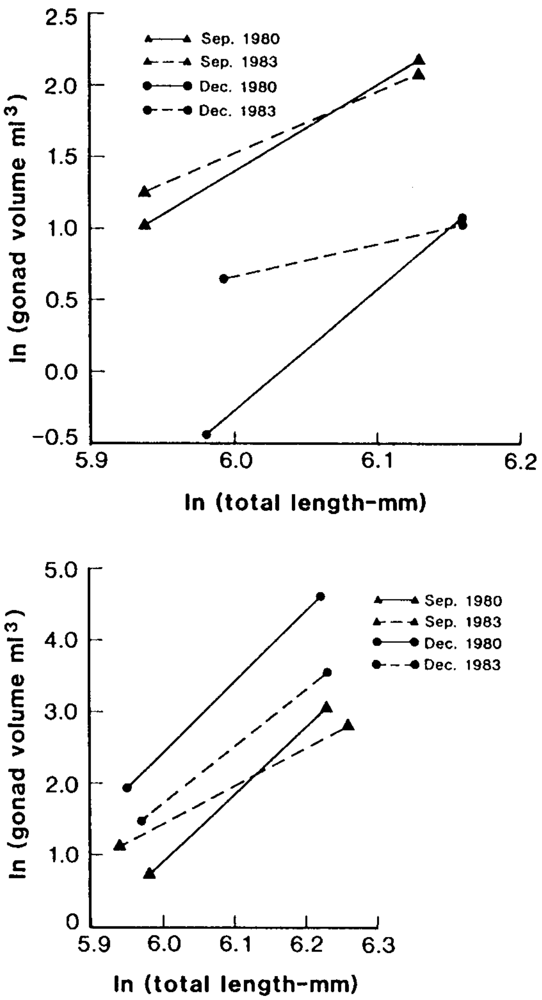

FIGURE 2.—Relationships between ln (gonad volume) and ln (total length) for yellowtail rockfish in 1980 and 1983. (Top) males; (bottom) females.

TABLE 3.—Percent of yellowtail rockfish females with eyed-larvae observed in samples collected in central and northern California, 1981-1984.

Year	January	February	March	April	May	June
1981	5	0	0	0	0	0
1982	0	15	0	0	0	0
1983	0	18	16	6	0	4
1984	3	10	15	0	0	0

The lower ovary volumes in 1983 than 1980 could have been related to either delayed parturition and/or lower reproductive effort. Wootton (1979) described relationships between feeding conditions and fish fecundity. The significantly higher gonad volumes for males in December 1983 compared with 1980 were not expected. December is later than the normal period of sexual activity for males, but the unexpected gonad volume results may be caused by delayed mating. The gonad stage data indicated that male sexual activity was later in 1983 than in 1980.

While fish condition and reproduction were different in 1983 than in the preceding non-El Niño years, the documentation of such differences for marine fish is uncommon. The season of parturition of yellowtail rockfish is more variable than we realized when the study was designed and the data on fish condition and gonad volume should have been collected over a wider period of time. The results of our study indicate that the assumption of constant adult fish condition and reproductive effort that is usually made in models of the population dynamics of fish is questionable.

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