ESTIMATE OF THE SPAWNING BIOMASS OF THE NORTHERN ANCHOVY CENTRAL SUBPOPULATION FOR THE 1979-80 FISHING SEASON

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ABSTRACT

The 1979 spawning biomass estimate for the central subpopulation of northern anchovies was 1,723,000 short tons. This estimate is based on the anchovy larva abundance as measured by four egg and larva surveys conducted over the period January-May 1979. Spawning biomass was estimated from larvae abundance using Smith's (1972) method. Based on the Pacific Fishery Management Council's Anchovy Plan (PFMC 1978), optimum yield for the central subpopulation during the 1979-80 season was 241,000 short tons. The optimum yield in the U.S. Fishery Conservation Zone was 168,700 short tons. The 1979-80 U.S. reduction quota was 156,100 short tons.

RESUMEN

En 1979 el cálculo de la biomasa del desove para la subpoblación central de anchoveta del norte fue de 1,564,000 toneladas métricas (1,723,000 toneladas). Este cálculo se basa en la abundancia de larvas de anchoveta que se midió en cuatro cruceros de reconocimiento de huevecillos y larvas efectuados en el período enero-mayo de 1979. El cálculo de la biomasa del desove se hizo de la abundancia de larvas usando el método de Smith (1972). Basado en el plan de anchoveta del Pacific Fishery Management Council (PFMC 1978), el rendimiento óptimo de la subpoblación central durante la temporada de 1979-80 fue de 218,630 toneladas métricas (241,000 toneladas). El rendimiento óptimo en la zona de conservación de la pesquería de los EE.UU. fue de 153,041 toneladas métricas (168,700 toneladas). La reducción de la cuota efectuada por los EE. UU. en 1979-80 fue de 141,611 toneladas métricas (156,100 toneladas).

INTRODUCTION

The Fishery Management Plan (FMP) for the Northern Anchovy Fishery (Pacific Fishery Management Council 1978) requires that catch quotas be determined on the basis of current estimates of spawner biomass. The purpose of this paper is to document the 1979 estimate of spawning biomass of the central subpopulation of northern anchovy to establish the optimum yield for the 1979-80 season. The estimate is based on the 1979 California Cooperative Oceanic Fisheries Investigations (CalCOFI) egg and larva survey for the winter and spring quarters. This cooperative survey was conducted under the auspices of the La Jolla Laboratory, Southwest Fisheries Center, National Marine Fisheries Service. Scripps Institution of Oceanography (SIO) cooperated in conducting the survey.

The procedure for estimating anchovy spawning biomass from anchovy larva abundance is based on the method given by Smith (1972), as documented in Appendix I of the FMP. In addition, the larva abundance estimate for the 1979 winter and spring quarters was expanded to an annual larva abundance based on the analysis of the historical data.

LARVA SURVEY

The geographic range of the central subpopulation is within the eight regions outlined on the CalCOFI station plan given in Figure 1. For convenience the author redefined those regions off southern California and Baja California in 1979 so that boundaries between the region group 7, 8, and 9 and the region group 11, 13, and 14 coincided with the U.S.-Mexico border. Four plankton surveys were conducted over the range of the central subpopulation during the five months, January through March 1979: 1) 7901 EB, January 12-22; 2) 7903 DS, February 25-March 13; 3) 7904 JD, March 22-April 17; 4) 7905 JD, April 30-May 21. The stations occupied by each cruise are shown in Figure 2. Unfortunately, only two of the four cruises, 7903 and 7905, received permits to conduct fishery research within Mexico's 200-mile zone.

Plankton samples on three of the four cruises were collected with a CalCOFI Bongo net, which is actually a pair of nets with a combined cross-sectional area equal to a CalCOFI 1-meter ring net. The 1-meter ring net was used on the first cruise, 7901. Station data and plankton samples were brought back to the Southwest Fisheries Center for processing and sorting. One-hundred percent of the plankton samples was sorted if the station was beyond 200 miles or if the plankton volume was less than 26 ml; otherwise, a 50% aliquot of the samples was sorted. The 1979 estimate includes station data from only the 118 standard stations defined by Smith (1972) to be those stations routinely occupied since 1951 and within the range of the central subpopulation.

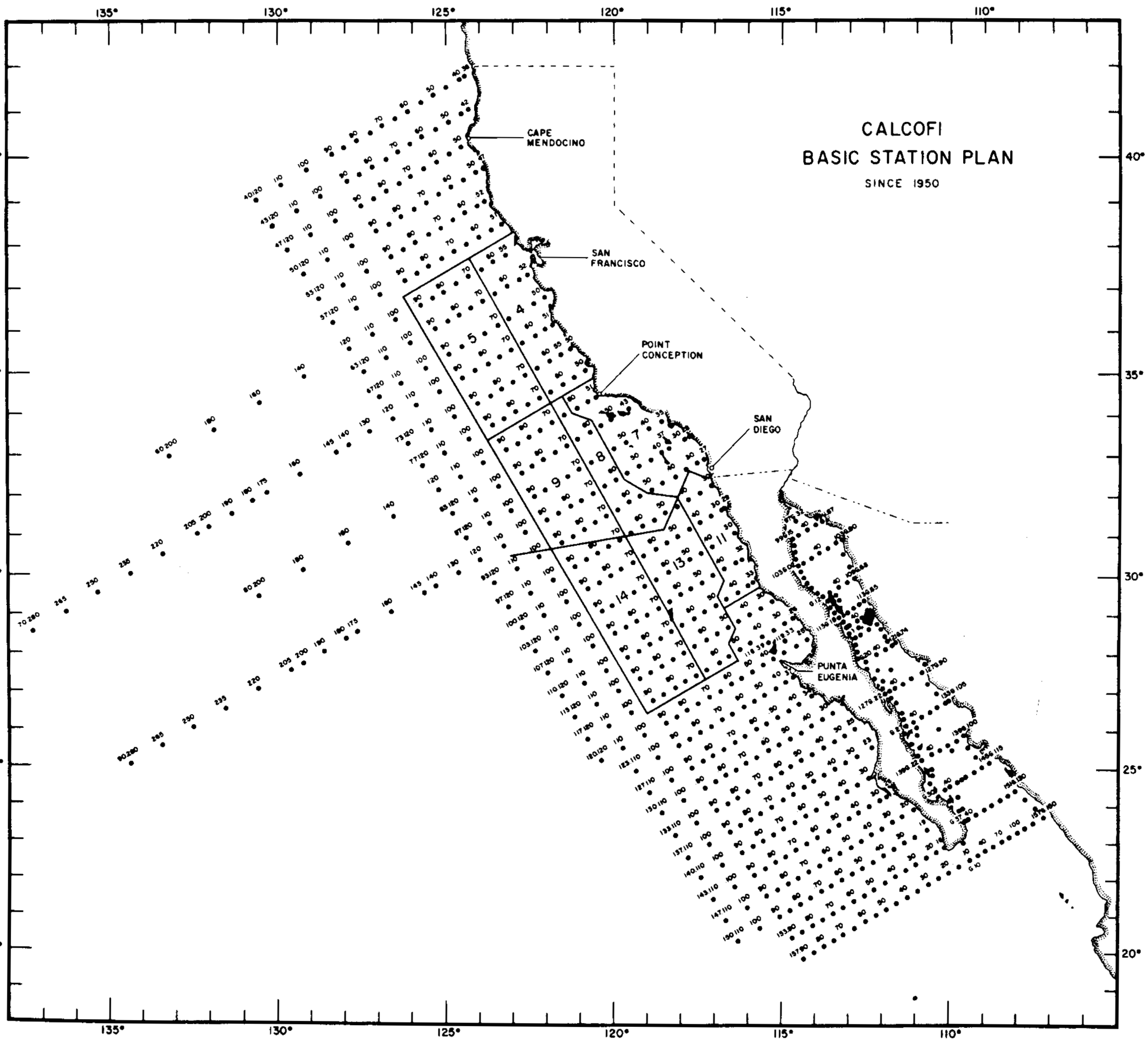

Figure 1. CalCOFI basic station plan. The geographic range of the central subpopulation of northern anchovy is within the eight numbered regions.

SURVEY RESULTS

The distribution of the number of anchovy larvae per plankton net tow for the four cruises that make up the basic data for the 1979 spawning biomass estimate is summarized in Figure 2. In general, evidence of anchovy spawning north of Point Conception in region 4 off cen-

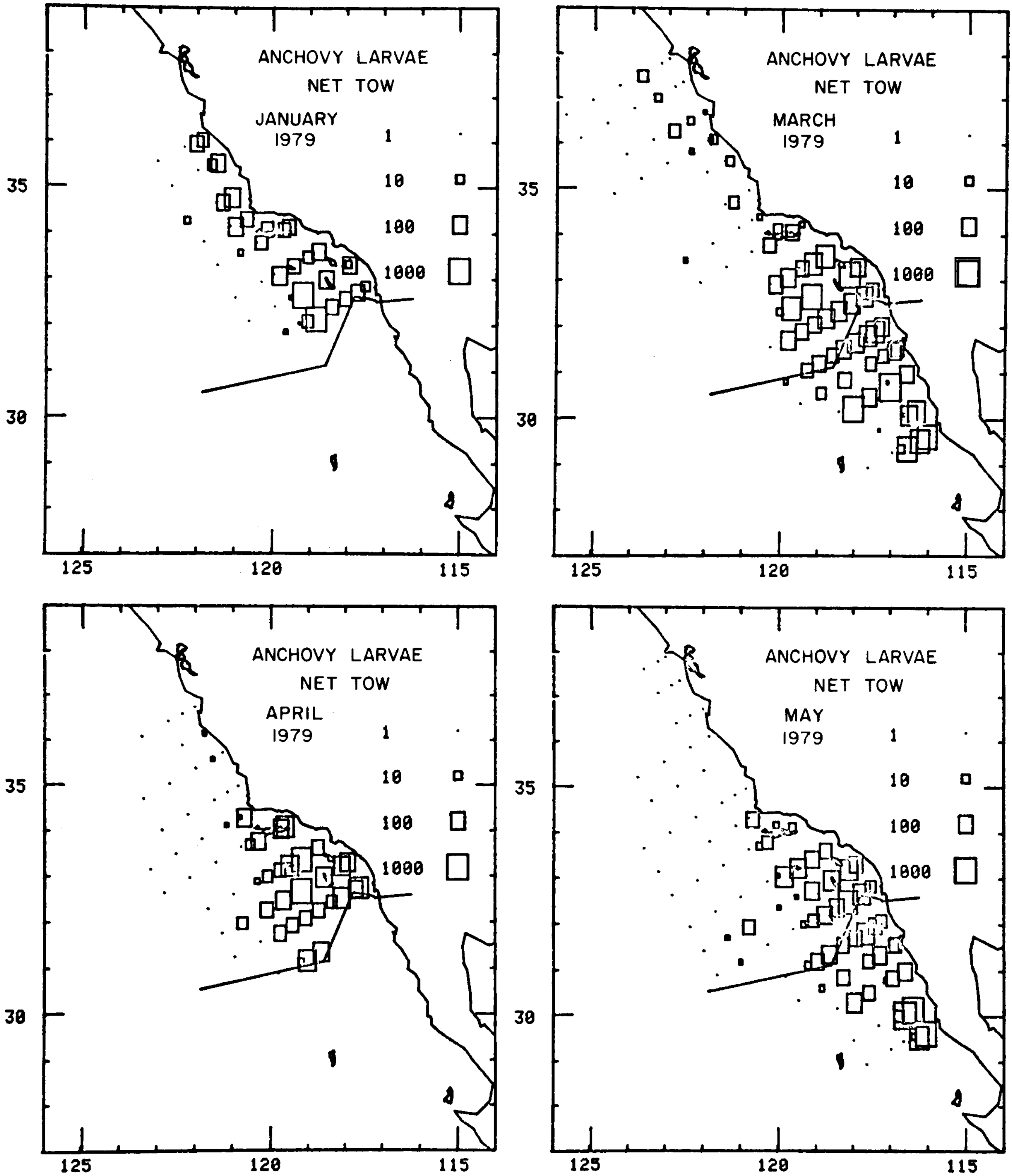

Figure 2. Pattern of occupied stations for the 1979 cruises and geographic distribution of anchovy larvae for central subpopulation in winter and spring months of 1979 spawning season. The legend is in numbers of larvae per net tow.

tral California was only found during the month of January. To the south, anchovy larvae were consistently taken on all four cruises as far out as 140 nautical miles, approximately 40 nautical miles farther than in 1978. The percent of the larvae south of the U.S.-Mexico border was 53.5% in 1979; the long-term average is 30%. Spawning persisted from January through May off southern California and Baja California.

Because the regions offshore of Baja California were only surveyed in the second half of each quarter, the quarterly larva abundance for the Baja regions 11, 13, and 14 (L_m) was estimated from a linear regression model using an adjusted larva abundance (L_a). Adjusted larva abundance is the larva abundance for the Baja regions 11, 13 and 14 based on the single cruise ($L_{m½}$) divided by the ratio of Southern California larva abundance for regions 7, 8, and 9 for the corresponding single cruise ($L_{c½}$) to the larva abundance in the same regions for the two cruises averaged together (L_c), i.e.

$$L_a = L_{m½} \; (L_c \;/\; L_{c½}) \text{ and}$$

$$L_m = b_0 + b_1 \, L_a \qquad (1)$$

This relationship for the adjusted larva abundance is based on the premise that the Baja larva abundance for the single cruise ($L_{m½}$) divided by the abundance in the same area for the two cruises averaged together (L_m) is proportional to southern California larva abundance for the corresponding single cruise ($L_{c½}$) divided by the abundance in the same area for the two cruises together (L_c), i.e.

$$L_{m½} \;/\; L_m \approx L_{c½} \;/\; L_c$$

so that

$$L_m \approx L_{m½} \, (L_c \;/\; L_{c½})$$

The regression model (1) was fit to the historical CalCOFI larva data for only the standard stations and with new region boundaries. The model was fit to winter quarter data from the 15 years, 1951-60, 1966, 1969, 1972, 1975, and 1978, with the following result:

$$L_m = -0.2744 \times 10^{12} + 1.0913 \, L_a \, ; R^2 = 0.975 \qquad (2)$$

There were sufficient data for only 13 years, 1951-60, 1966, 1969, and 1978, to fit the model for the spring quarter. The fitted equation is

$$L_m = 0.3860 \times 10^{12} + 0.9108 \, L_a \, ; R^2 = 0.627 \qquad (3)$$

The fit of equations (2) and (3) is shown in Figure 3.

For the winter quarter in 1979, L_a equals 2.882×10^{12} larvae and L_m is estimated from equation (2) to be

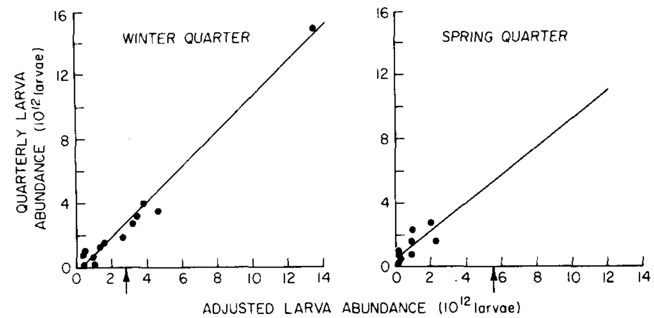

Figure 3. Regression models for estimating larva abundance in Mexico's 200-mile zone for winter and spring quarters from the adjusted larva abundance for the winter and spring quarter as defined in the text; arrows indicate 1979 values.

2.871×10^{12} larvae. This added to the larva abundance north of the U.S.-Mexico border gives a total anchovy larva abundance of 6.546×10^{12} larvae for the winter quarter. For the spring quarter, L_a equals 5.625×10^{12} larvae. The resulting L_m using equation (3) is 5.509×10^{12} larvae. Adding this amount to the northern abundance gives a spring quarter abundance of 9.124×10^{12} larvae. The sum of the two quarterly estimates give a winter-plus-spring larva abundance (L_{ws}) of 15.670×10^{12} larvae. For historical time series, the quarterly and winter-plus-spring larva abundance estimates presented in Table 2 of Appendix I in the FMP (PFMC 1978) are repeated here in Table 1, along with the 1979 values.

TABLE 1

Estimated Larva Abundance (10^{12} Larvae) and the Spawner Biomass[1] for the Central Subpopulation[2]

Year	Winter	Spring	Winter and Spring	Annual	Spawner biomass in millions of short tons
1951.....	.298	.690	.988	1.841	.180
1952.....	.407	.457	.864	1.600	.156
1953.....	1.210	.373	1.583	5.208	.510
1954.....	4.469	.988	5.457	7.838	.768
1955.....	5.588	1.709	7.297	8.618	.845
1956.....	1.911	1.206	3.117	4.944	.485
1957.....	5.954	4.308	10.262	11.906	1.167
1958.....	8.114	5.236	13.350	15.087	1.479
1959.....	6.341	8.155	14.496	15.440	1.514
1960.....	7.552	7.547	15.099	15.713	1.540
1961.....	.992	6.714	7.706	11.827	1.159
1962.....	4.814	23.567	28.381	30.478	2.986
1963.....	17.377	24.818	42.195	43.407	4.254
1964.....	8.941	14.383	23.324	29.559	2.901
1965.....	19.155	22.690	41.845	47.540	4.650
1966.....	15.103	15.865	30.968	36.452	3.572
1969.....	19.756	6.538	26.294	30.594	2.998
1972.....	8.213	14.335	22.548	28.373	2.781
1975.....	29.754	4.071	33.825	36.768	3.603
1978.....	6.704	4.184	10.888	13.306	1.304
1979.....	6.546	9.124	15.670	17.580	1.723

[1]in tons, calculated from annual larvae abundance ([spawner biomass = $9.8 \times 10^{-8} \times$ larvae abundance] from Smith 1972).
[2]taken from Appendix I, Table 2, Fishery Management Plan.

BIOMASS ESTIMATE

Anchovy spawning biomass estimates for previous years are based on annual larva abundance estimates. For years in which surveys are conducted in only the winter and spring quarters, the annual larva abundance (L) can be predicted from the winter-plus-spring quarters larva abundance using the regression equation (see Figure 4)

$$L = 1.8233 \times 10^{12} + 1.0055\ L_{WS}\ ; R^2 = 0.990 \qquad (4)$$

This equation is slightly different from the one Stauffer and Parker (1980) used for making the 1978 biomass estimate because the historical time series of L_{WS} was recalculated for the redefined regions and with data from only the standard stations. Also, equation (4) was fit to data points for only those years (1951-60, 1966, and 1969) in which surveys were conducted in each half of the winter and spring quarters (see Figure 5).

The 1979 estimate of annual larva abundance using equation (4) is 17.580×10^{12} larvae, where $L_{WS} = 15.670 \times 10^{12}$ larvae. The estimate of the 1979 spawning biomass, B, using Smith's (1972) method,

$$B = 9.8 \times 10^{-8}\ L,$$

is 1,723,000 short tons. This is a 23% increase over the 1978 biomass estimate. The historical estimates of anchovy spawning biomass of the central subpopulation are shown in Figure 5.

OPTIMUM YIELD

As specified in the Northern Anchovy FMP (PFMC 1978), optimum yield for 1979-80 season for the central subpopulation with the estimated spawning biomass of 1,723,000 short tons was 241,000 short tons. Of this amount, the optimum yield in the U.S. zone was 70% or 168,700 short tons. A total of 12,600 tons was reserved for U.S. nonreduction fishing. The 1979-80 reduction quota was 156,100 short tons, of which 10,000 tons were reserved for the fishery north of Point Buchon and 146,100 short tons were available for the U.S. fishery south of Point Buchon.

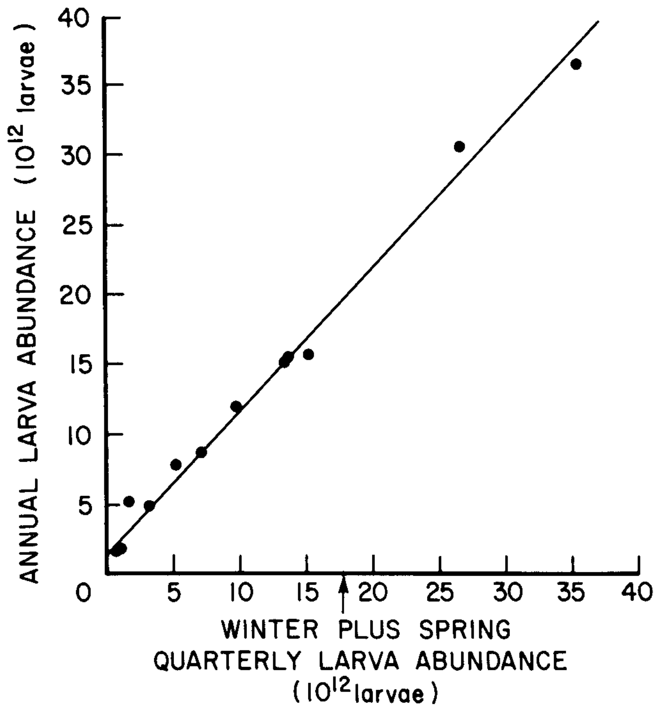

Figure 4. Regression model for estimating the annual larva abundance from winter-plus-spring quarterly larva abundance; arrow indicates 1979 value.

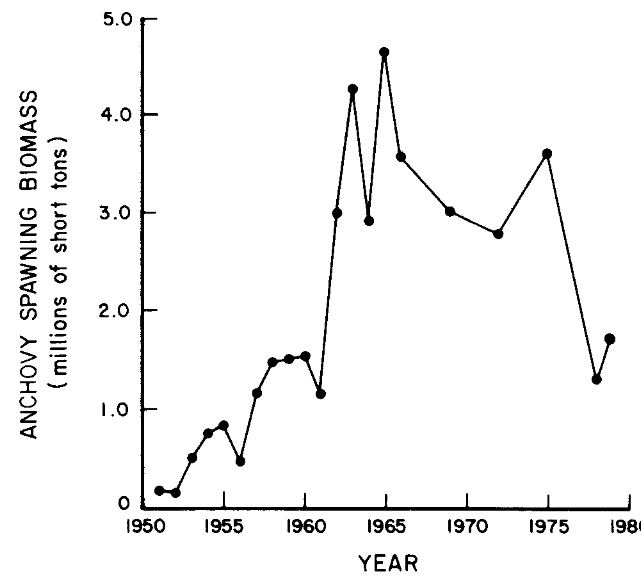

Figure 5. Estimated spawning biomass for the central subpopulation of northern anchovies, 1951-1979.

ACKNOWLEDGMENTS

The collection and processing of the ichthyoplankton data for this biomass estimate depends on the cooperation and hard work of a number of dedicated employees on the staff of the National Marine Fisheries Service (NMFS), Scripps Institution of Oceanography (SIO), and the NOAA ship R/V *David Starr Jordan*. I specifically thank the SIO plankton sorting group, Messrs. James Thrailkill, Richard Charter, Oden Burris, Robert Counts, and William Flerx of NMFS. I thank Drs. Daniel Huppert and Paul Smith of NMFS and Mr. Alec MacCall of California Department of Fish and Game for their useful suggestions and constructive review of this manuscript.

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