ESTIMATE OF THE SPAWNING BIOMASS OF THE NORTHERN ANCHOVY CENTRAL SUBPOPULATION FOR THE 1978-79 FISHING SEASON

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ABSTRACT

The 1978 spawning biomass estimate for the central subpopulation of northern anchovies was 1,304,000 short tons. This estimate is based on the anchovy larva abundance as measured by four egg and larva surveys conducted over the period January-June 1978. Spawning biomass was estimated from larva 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 1978-79 season was 101,333 short tons. The optimum yield in the U.S. Fishery Conservation Zone was 70,993 short tons. The 1978-79 U.S. reduction quota was 58,333 short tons.

RESUMEN

En 1978 el cálculo de la biomasa del desove para la subpoblación central de anchoveta del norte fue de 1,183,000 toneladas métricas (1,304,000 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-junio de 1978. 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 1978-79 due de 91, 927 toneladas métricas (101, 333 toneladas). El rendimiento óptimo en la zona de conservación de la pesquería de los EE.UU. fue de 64,403 toneladas métricas (70,993 toneladas). La reducción de la cuota efectuada por los EE. UU. en 1978-79 fue de 52,919 toneladas métricas (58,333 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 1978 estimate of spawning biomass of the central subpopulation of northern anchovy from which the optimum yield for the 1978-79 U.S. fishing season was established. The estimate was based on the 1978 California Cooperative Oceanic Fisheries Investigations (CalCOFI) egg and larva survey for the winter and spring quarters. This survey was conducted under the auspices of the La Jolla Laboratory, Southwest Fisheries Center, National Marine Fisheries Service. Scripps Institution of Oceanography (SIO), and Instituto Nacional de Pesca (INP), Mexico, cooperated in conducting this survey.

The procedure for estimating anchovy spawning biomass from anchovy larva abundance was based on the method given by Smith (1972), as documented in Appendix I of the FMP (PFMC 1978). In addition, the larva abundance estimate for the 1978 winter and spring quarters was expanded to an annual larva abundance based on the analysis of the historical data.

LARVA SURVEY

The data set of plankton samples for making the biomass estimate included only the four winter and spring surveys out of the eight planned for the 1978 CalCOFI triennial survey year. Only standard CalCOFI stations within the range of the central subpopulation were included even though stations were occupied as far south as CalCOFI line 137 at 25°N and approximately 400 nautical miles offshore on lines 90 and 93 (Figure 1).

Research vessels departed the weeks of 1 January 1978, 12 February 1978, 26 March 1978, and 7 May 1978. Each cruise was approximately 25 days long. The Mexican vessel, R/V *Humboldt*, sampled the southern waters, essentially south of the U.S.-Mexico border; the U.S. vessel, R/V *Jordan,* sampled the waters north of the border. Because of mechanical problems the *Jordan*'s station pattern for the third survey was modified to include the southern stations. The outermost stations within the geographic range of the central subpopulation were dropped from the pattern.

Plankton samples were taken with a CalCOFI Bongo net, a pair of plankton nets with a combined cross-sectional area equal to a CalCOFI 1-m ring net. Plankton data and samples were brought back to the Southwest Fisheries Center (SWFC) for processing and sorting. One-hundred percent of the plankton samples were sorted if the station was beyond 200 miles or if the plankton volume was less than 26 ml; otherwise, a 25% aliquot of the sample was sorted. The only samples sorted for this estimate are from the 118 standard stations defined by Smith (1972) to be those stations routinely occupied since 1951 and within the range of the central subpopulation. These last two criteria were

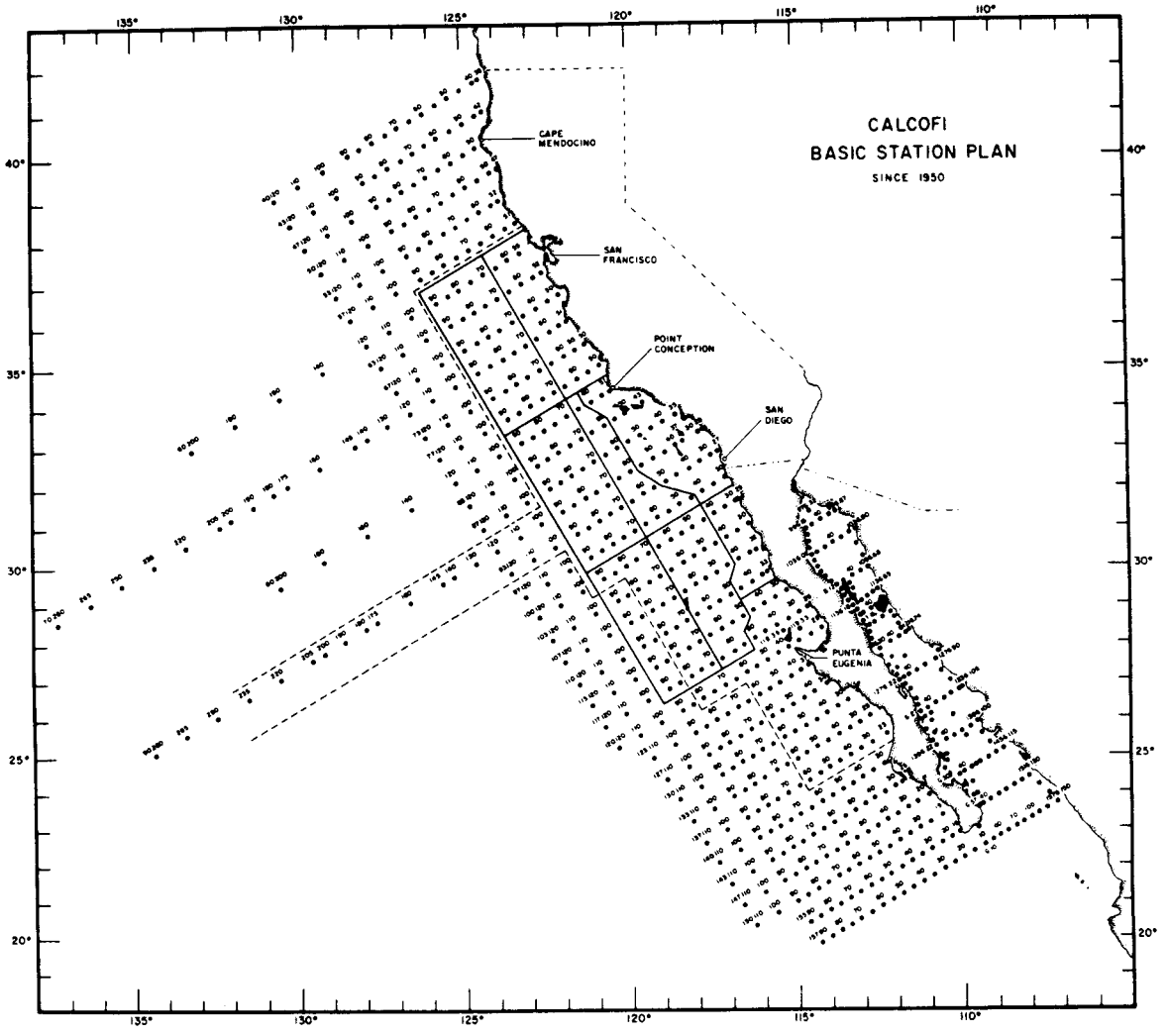

Figure 1. CalCOFI basic station plan. Solid outline is the area of the central subpopulation of northern anchovies. Dashed outline is boundary of winter and spring surveys, 1978.

necessary so that samples could be sorted by the deadline of July 1 for the biomass estimate.

SURVEY RESULTS

The distributions of larvae for the four cruises beginning with the January cruise, which form the basis for the 1978 spawning biomass estimate, are summarized in Figure 2. In general, the spawning intensity in the Southern California Bight and nearshore region was approximately the same as in earlier years, but only about ⅓ of the range of the central subpopulation contained anchovy eggs and larvae. Spawning was most intense during the March cruise. By the May cruise, spawning had fallen off considerably. Ocean temperatures in the upper mixed layer and sea surface from mid-December to mid-April were the warmest since 1958 (J. Renner, SWFC, personal communication). The unusual weather pattern that developed in the latter half of December brought numerous Pacific storms into southern California. These events resulted in increased ocean surface temperatures along the entire U.S. west coast at a time when seasonal cooling normally takes place. The storm activity also at times inhibited the southerly flow of the California Current (Miller 1978). The February or March upwelling did not develop as usual (A. Bakun, SWFC/PEG, personal communication), These conditions may have accounted

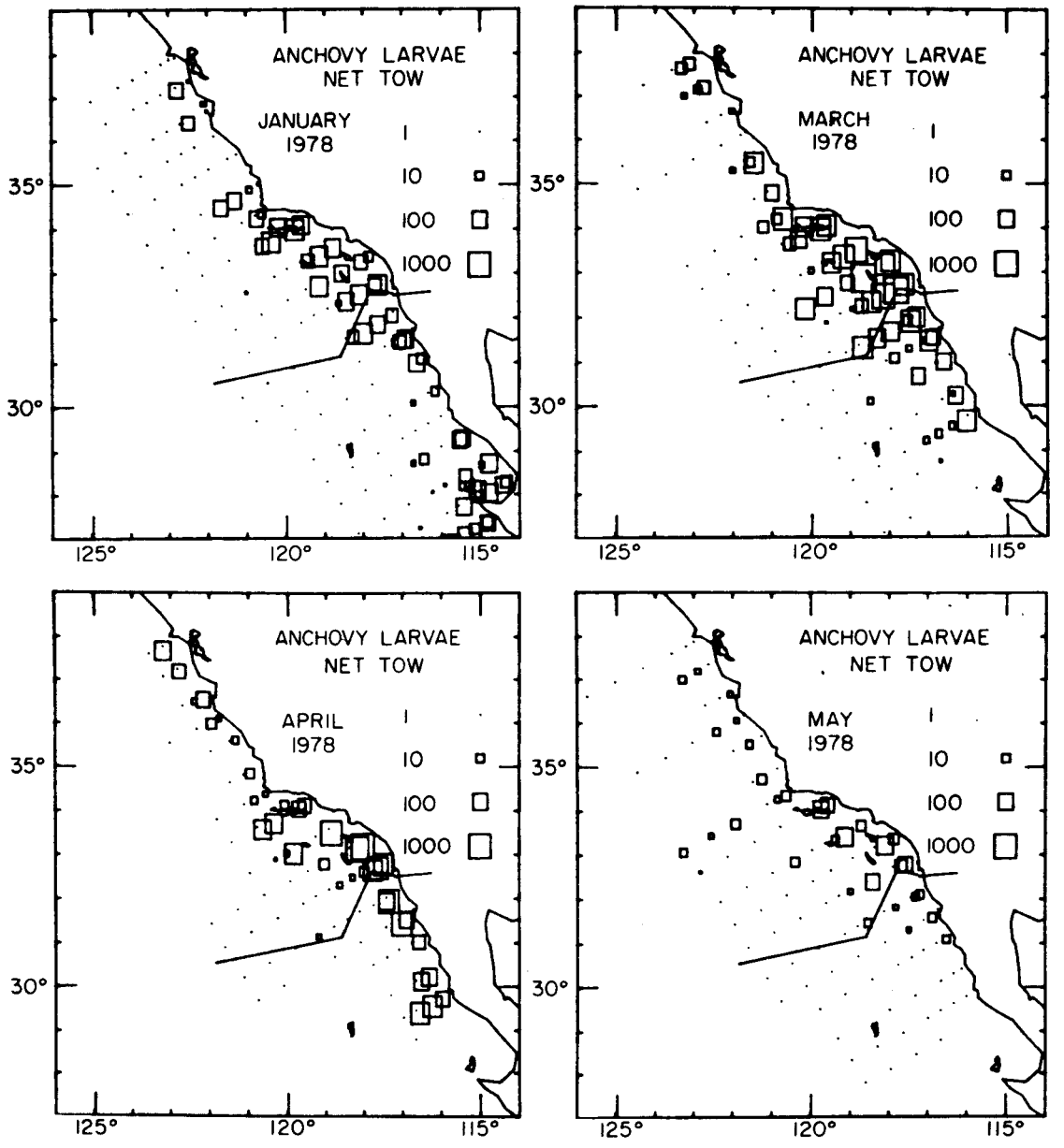

Figure 2. Geographic distribution of anchovy larvae for central subpopulation in winter and spring months of 1978 spawning season. The legend is in numbers of larvae per $10m^2$ of surface area.

for the lack of offshore anchovy spawning during winter and spring months.

In the winter quarter, 240 standard stations were occupied and 98 contained anchovy larvae. In the spring, 195 stations were occupied and 64 contained larvae. The number of occupied stations decreased in the spring quarter because the station pattern of the April *Jordan* cruise was modified mid-cruise so that priority stations south of the U.S.-Mexico border would be sampled.

The larva abundance estimates compiled by region

quarter strata after Smith (1972) are 6704.1×10^9 and 4183.6×10^9 larvae for the winter and spring quarters, respectively. These give a combined winter-spring larva abundance of $10,887 \times 10^9$ larvae.

BIOMASS ESTIMATE

Anchovy spawning biomass estimates for previous years are based on annual larva abundance estimates. Because over 80% of the anchovy spawning takes place in the winter-spring months, the 1978 annual larva abundance ($\hat{L}$) is predicted from the sum of the winter and spring quarters larva abundance (L_{WS}) using the regression equation

$$\hat{L} = 1.062\, L_{WS} + 1743.0 \times 10^9. \qquad (1)$$

This equation is derived from the historical time series presented in Table 2 of Appendix I in the FMP (PFMC 1978) and is repeated here in Table 1. This regression is illustrated in Figure 3. The 1978 estimate of annual larva abundance using (1) is $13,305.8 \times 10^9$ larvae, where $L_{WS} = 10,887.7 \times 10^9$ larvae. The estimate of 1978 spawning biomass B, using Smith's (1972) method

$$B = 9.8 \times 10^{-8}\, \hat{L} \qquad (2)$$

is 1,304,000 short tons. Historical estimates of anchovy spawning biomass of the central subpopulation are shown in Figure 4.

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	17,277	24.818	42.195	43.407	4.254
1964	8.941	14.383	23.324	29.599	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

[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.

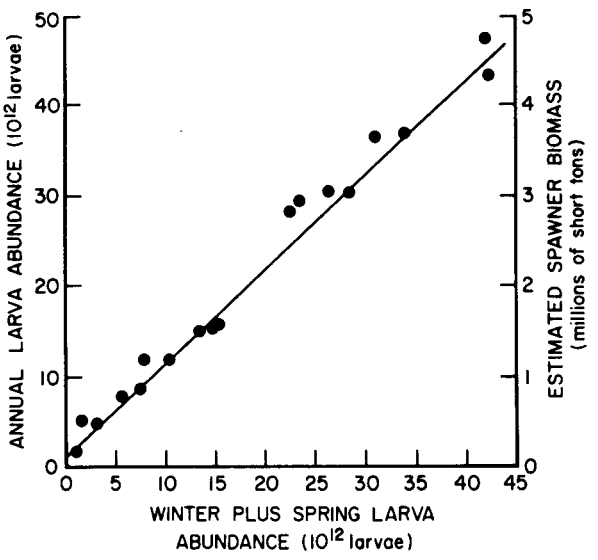

Figure 3. Larva abundance estimates (10^{12} larvae) and estimated spawner biomass in millions of tons. Plot of estimated spawner biomass and annual larva abundance versus winter plus spring larva abundance. Linear regression, Model: $Y = 1.062 X + 1.743 \times 10^{12}$

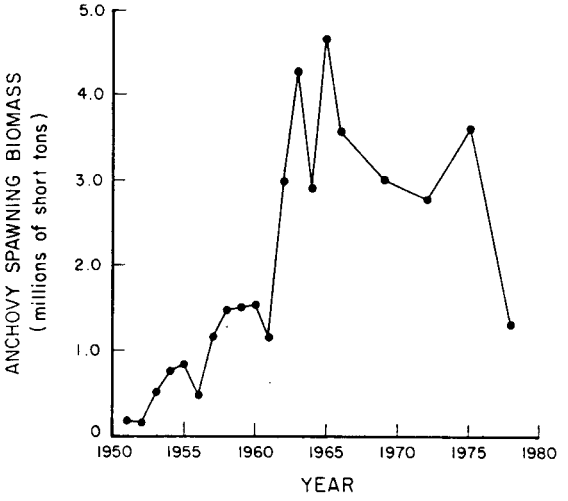

Figure 4. Estimated spawning biomass for the central subpopulation of northern anchovies, 1951-78.

OPTIMUM YIELD

As specified in the Northern Anchovy Fishery Management Plan, optimum yield for the 1978-79 season for the central subpopulation with the estimated spawning biomass of 1,304,000 short tons was 101,333 short tons. Of this amount, the optimum yield in U.S. zone was 70% or 70,933 short tons. A total of 12,600 tons was reserved for U.S. nonreduction fishing. The 1978-79 reduction quota was 58,333 short tons, of which 5,833 tons were reserved for the fishery north of Point Buchon and 52,500 short tons were available for the U.S. fishery south of Point Buchon.

ACKNOWLEDGMENTS

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