

THE FISH ....

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The best current estimate of the average weight of yellowfin from the area between the CYRA boundary and 150°W is 56.4 pounds. The final estimates for 1974-1978 are 80.3, 73.3, 73.8, 57.2 and 67.0 pounds respectively.

### SKIPJACK AND THE MIXING INDEX

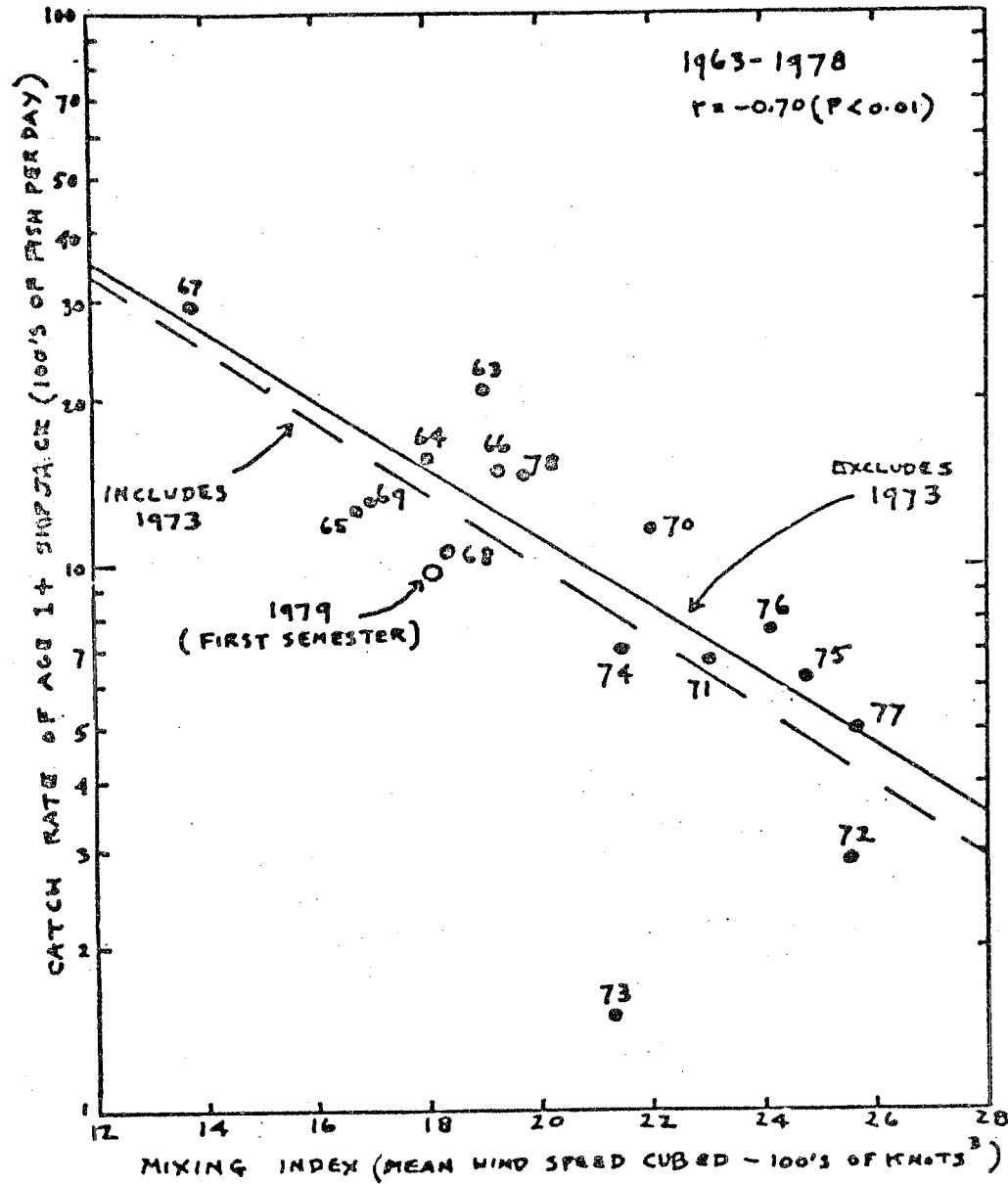
Dr. Reuben Lasker of the NMFS Southwest Fisheries Center in La Jolla, California, first proposed that survival of larval anchovies in the California Current was dependent on the upper mixed layer being in a stable condition for a sufficient time. Concentrations of food suitable for first-feeding larvae have been found in aggregations and well-defined layers. Upwelling and mixing disrupt the layering and disperse the food organisms, so that many of the anchovy larvae are unable to obtain sufficient food for survival. The amount of mixing caused by wind is roughly proportional to the cube of the wind speed. For the limited data available, Dr. Lasker has found that weak winds and suitable food during the larval stages resulted in strong year classes, and that strong winds or unsuitable food resulted in weak year classes.

It was thought that this effect might also occur in the skipjack spawning areas of the central Pacific. Wind velocities by five-degree areas between 180° and 135°W from 1961 on were obtained from the NMFS (Southwest Fisheries Center). The area was divided into two sectors (180°-155°W and 155°W-135°W) because warm water suitable for spawning reaches farther north in all months in the western sector than it does in the eastern sector. Preliminary calculations have been made for the area between 15°N and 15°S in the western sector, and between 10°N and 10°S in the eastern sector. These latitudes were selected because during the winter months in the northern hemisphere the average latitude of the 80°F (26.7°C) isotherm of sea surface temperature is located near 15°N in the western sector and near 10°N in the eastern sector. During the winter months in the southern hemisphere the average position of the 80° isotherm is near 20°S in the western sector and near 15°S in the eastern sector. To maintain equal areas in both hemispheres, however, the latitudes within which wind data were used were selected to be 15°S in the western sector and 10°S in the eastern sector. With the exception of an upwelling area along the equator in the eastern sector, the area selected for calculating wind velocities is likely to have temperatures most suitable for spawning (>80°F, 26.7°C). This method is preliminary: further calculations will be made using latitudinal limits that follow seasonal movements of the 80°F isotherm.

## THE FISH ....

Wind data are scarce in both sectors south of the equator, with many five-degree areas having few or no observations. Mean values for five-degree areas were given equal weight regardless of the number of observations. Although it is theoretically correct to cube each individual wind velocity observation before averaging to obtain a mixing index for the entire area, this causes extreme variation because of the scarcity of data and the effects of extreme values. Instead, mean values for each five-degree area were averaged for the entire area in a month and the mean monthly wind velocities were averaged for the 12-month period July-June, to obtain a mean value which was then cubed to obtain the mixing index.

Plots of the mixing index and catch rates of age 1 + skipjack (12 to 24 months of age) captured by purse seiners based on effort in 22 selected skipjack fishing areas where some of the effort on yellowfin has been eliminated are shown in the figure on the next page. The logarithm of the catch rate (number of fish per day standardized to purse seine class-3 days) is significantly correlated with the mixing index at an earlier time. For example, the logarithm of the catch rate for 1963 is paired with the mixing index (mean wind speed cubed) in the selected portions of the spawning area during the period July 1961-June 1962. Wind data before 1961 are insufficient to obtain reliable indices. The product-moment coefficient of correlation ( $r$ ) which assumes normality of distribution is -0.70, significant at the 1% level; the rank-difference coefficient of correlation ( $r_d$ ) which does not assume normality is -0.76, also significant at the 1% level. The numbers in the figure refer to the year of catches. The alignment of the points is close with the exception of 1973 which deviates greatly. There is no explanation yet for this anomalous year, but conditions and habitat limits in the fishing areas during 1973 will be investigated later. The dashed regression line is for the 1963-78 period, including 1973; the solid regression line is for the same period, excluding 1973. The solid line is regarded as better for estimating catch rates for 1979 and 1980, seeing that the 1973 catch rate appears to have been influenced by other factors. The 1977-78 mixing index of 1810 knots<sup>3</sup> would indicate a catch rate of 1450 fish per day for 1979 as a best estimate based on the solid line; the catch rate for the first semester of 1979 is 970 fish per day and does not deviate greatly from the line. In past years catch rates during the first semester and for the entire year have been highly correlated. The 1978-79 mixing index of 2210 knots<sup>3</sup> would indicate a catch rate of 810 fish per day for 1980 as a best estimate based on the solid line, slightly above the rate of 760 fish per day in 1976. The plots show that there was a series



## THE FISH ....

of 12-month periods with mixing indices above 2000 knots<sup>3</sup> from July 1968 to June 1976.

As expected there was a significant correlation ( $r = -0.61$ ,  $P < 0.01$ ) between the mean sea-surface temperature and the mixing index for the same area and periods. However, there was no significant correlation between the logarithm of the catch rate and the sea-surface temperature. This is surprising considering the percent-occurrence of skipjack larvae in plankton nets is highly correlated with sea-surface temperature. The mixing index thus explains 49% of the variation in the logarithm of the catch rate of skipjack in the fishery, while the southern oscillation (S.O.) index explains only 36% of the variation. The S.O. index was originally used because of the scarcity of temperature data in the southern hemisphere but is not a desirable indicator of skipjack abundance because the pressure variations are so far removed geographically as well as functionally from the environment of the skipjack larvae. Furthermore, the position of the Easter Island high pressure cell appears to have shifted in recent years, judging from the unusually low pressure at Easter Island and Tahiti, and the S.O. index is now suspected of being a poorer indicator of conditions in the presumed spawning areas than in earlier years.

OTOLITH STUDY

Work continues on the preparation of data for correlating several yellowfin morphometrics with otolith increment counts. Total counts will be used as a measure of time based on the assumption that each increment is equivalent to one day. Preparation of approximately 200 otolith replicas is now complete and counting is in progress.

FEEDING HABITS OF YELLOWFIN TUNA

In recent months work has continued on identifying the food organisms found in stomach samples of yellowfin tuna caught in off-shore areas from 1970 to 1973. About 3,950 stomach samples have been processed to date, including all 1970 and 1971 samples. Upon completing laboratory procedures on the remaining samples from 1972, data processing will begin on the approximately 4,150 yellowfin tuna stomachs that will have been worked up. The some 1,050 stomachs sampled in 1973 will be held in reserve and processed only if the existing data indicate that more information is needed.