STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

CALIFORNIA COOPERATIVE OCEANIC
FISHERIES INVESTIGATIONS

ATLAS No.13
CALIFORNIA
COOPERATIVE
OCEANIC
FISHERIES
INVESTIGATIONS

Atlas No. 13

STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

Cooperating Agencies:
CALIFORNIA ACADEMY OF SCIENCES
CALIFORNIA DEPARTMENT OF FISH AND GAME
STANFORD UNIVERSITY, HOPKINS MARINE STATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICE
UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

June, 1971
THE CALCOFI ATLAS SERIES

This is the thirteenth in a series of atlases containing data on the hydrography and plankton from the region of the California Current. The field work was carried out by the California Cooperative Oceanic Fisheries Investigations, a program sponsored by the State of California under the direction of the State's Marine Research Committee. The cooperating agencies in the program are:

California Academy of Sciences
California Department of Fish and Game
Stanford University, Hopkins Marine Station
National Oceanic and Atmospheric Administration, National Marine Fisheries Service
University of California, Scripps Institution of Oceanography

CalCOFI atlases are issued as individual units as they become available. They provide processed physical, chemical and biological measurements of the California Current region. Each number may contain one or more contributions. A general description of the CalCOFI program with its objectives appears in the preface of Atlas No. 2.

This atlas was prepared by the Data Collection and Processing Group of the Marine Life Research Program, Scripps Institution of Oceanography.

CalCOFI Atlas Editorial Staff:
Abraham Fleminger and Hans T. Klein, Editors
John G. Wyllie, Cartographer

CalCOFI atlases in this series, through June 1971, are:

No. 7. Fleminger, A., 1967. Distributional atlas of calanoid copepods in the California Current region, Part II.

1Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.
2Formerly called U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries.
3For citation this issue in the series should be referred to as CalCOFI Atlas No. 13.

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DISTRIBUTIONAL ATLAS OF ZOOPLANKTON VOLUME IN THE CALIFORNIA CURRENT REGION, 1951 THROUGH 1966

Paul E. Smith

CALCOFI ATLAS NO. 13

Data Collection and Processing Group
Marine Life Research Program
Scripps Institution of Oceanography
La Jolla, California

June, 1971
INTRODUCTION

Bigelow and Sears (1939, p. 200) stated, "The most striking feature of volumetric distribution of zooplankton throughout has been the irregularity from station to station, often with volumes differing up to a hundredfold, between localities only a few miles apart . . . comparatively regular gradients nevertheless appear, both secular and regional, when averages are compared, for subdivisions large enough to include several stations each . . ." Small-scale irregularities within spatially and temporally persistent gradients also characterize the volumes of plankton collected in the California Current system.

The basic data for this atlas have been obtained from 11 years of monthly and five years of quarterly cruises generally centered on the United States-Mexican border and extending from Pt. Reyes near San Francisco to Cape San Lazaro in southern Baja California (Staff, South Pacific Fishery Investigations, 1952, 1953, 1954a, 1954b, 1955, 1956; Thrailkill, 1956, 1957, 1959, 1961, 1963, 1969, MS.). In general, the same techniques of sampling and the same station grid were used throughout.

To a certain extent, the local variability of plankton volume at adjacent stations obscures regular seasonal, annual and regional changes. As an aid to the interpretation of the individual cruise charts in this atlas, generalizations which have emerged from the analysis of the volume data will be discussed after the description of the important features of the sampling grid, sampling techniques, sampling gear, and laboratory techniques.
are 40 miles perpendicular to the coastline and 120 miles parallel to the coastline. Irregularities of the coastline cause pooled areas to vary between 2,027 and 8,388 square miles ("12.3" and "11.3"). Stations in the Los Angeles Bight ("8.4") and in Vizcaino Bay ("11.3") were arbitrarily pooled regardless of station or line number.

A special closely-spaced grid of stations in an area within the California Current region was occupied on five successive days in April, 1952. It seems clear from Kramer's (1963) study of these grids that major increases in the number of samples per unit area would have been necessary to substantially improve the estimates of mean zooplankton volume. It is equally clear that the same number of stations occupied on a random or stratified random basis would not have resulted in an appreciable improvement in precision, and Milne's (1959) conclusion can be applied to this set of field samples, that "with proper caution, one will not go very far wrong, if wrong at all, in treating the centric-systematic-area sample as if it were random."

SAMPLING TECHNIQUE

The towing method used over the period reported here may be characterized as an "even oblique" tow as contrasted with a stepped oblique tow or vertical tow. The objective of the oblique tow was to encompass the vertical distribution of fish eggs and larvae found largely in the mixed layer.

The tow itself requires the slowing of the ship to about 2 knots, lowering a 100-pound weight (45.5 kg) on a 3/16-inch (5 mm) wire to 10 meters and affixing the cable clamp to the wire. The cable clamp is lowered to the water and the wire meter is set at zero. With the ship's speed at about 2 knots, the net is lowered at about 50 meters per minute. After about one minute of lowering, the ship's forward motion is adjusted until the wire is at an angle of 45 degrees relative to the horizon. This angle is maintained within plus or minus 3 degrees for the remainder of the tow. The wire is retrieved smoothly at 20 meters per minute with the aid of a stop-watch. It is frequently possible by this technique to carry out a tow to within five seconds of the allotted tow period of 14.5 minutes. Experienced marine technicians can do this regularly.

THE CALCOFI STANDARD NET

The CalCOFI net is preceded through the water by a cable clamp, three or more meters of leadline, the junction of a three-leg bridle one meter ahead of the mouth and the bridle itself. Flow disturbances caused by the structures very likely contribute to underestimates of the numbers of more mobile organisms (Fleminger and Clutter, 1965; Clutter and Anraku, 1968). About 10-15 per cent of the water encountered by the mouth of the net is shunted aside because there is not enough aperture area in the body of the net to accept all the water encountered (Smith, Counts and Clutter, 1968). It appears unlikely that clogging appreciably lowers the filtering efficiency in the oblique tow over much of the extent of the California Current region.

The silk gauze used in the CalCOFI standard net is of two sizes: 30 xxx grit gauze (0.55 mm shrunken mesh), and 56 xxx grit gauze (0.25 mm shrunken mesh) in the proportions described by Ahlstrom (1948, Table 1). The smaller 56 xxx grit gauze was used in the cod end bag and in a 40 cm section immediately in front of it. The remainder of the mesh was 30 xxx comprising a 65-cm cylinder behind the mouth followed by a 270-cm truncate cone that tapers from 1 m to 20 cm in diameter. With canvas sleeves and seams the net is nearly five meters long.

Between July, 1956 and August, 1959, a nylon net was used on 21 cruises. On eight cruises the nylon net was used for every sample. Table 1 is a list of the cruises and ships on which the nylon net was used. Details of construction are essentially the same as the silk standard net except that the mesh was 0.471 mm rather than 0.55 mm typical of silk net after shrinking. The section with 56 xxx grit gauze was replaced by 0.280 mm nylon. This net very likely retained more zooplankton than the standard net but no
Figure 1. Pooled statistical areas of the CalCOFI pattern. Each rectangle represents 4,800 square miles (40 x 120 nautical miles) unless otherwise indicated as in the nearshore delineations.
estimates of the value of this difference have been made. Comparison with used silk nets at 0.55 mm and nylon nets of 0.505 mm yielded a 20 percent difference in plankton volumes in favor of the smaller mesh (unpublished data). The nylon mesh was abandoned (Ahlstrom, 1959b) when it was noted that filtration efficiency decreased when towing volume was listed in the order in which tows were taken. This clogging between tows was more severe than changes in silk nets with age; thus silk was retained for the surveys through 1966.

Table 1. Cruises conducted in part with 0.471 mm nylon nets.

<table>
<thead>
<tr>
<th>BLACK DOUGLAS</th>
<th>ORCA</th>
<th>PAOLINA-T</th>
<th>HORIZON</th>
<th>SPENCER F. BAIRD</th>
<th>STRANGER</th>
<th>HUGH M. SMITH</th>
</tr>
</thead>
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<tr>
<td>5607*</td>
<td>5607</td>
<td>5607</td>
<td>5612</td>
<td>5702</td>
<td>5707</td>
<td>5908*</td>
</tr>
<tr>
<td>5608*</td>
<td>5610</td>
<td>5702</td>
<td>5804</td>
<td>5710*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5609</td>
<td>5611</td>
<td>5704</td>
<td></td>
<td></td>
<td></td>
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<td>5702</td>
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<td>5705</td>
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<td>5703*</td>
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<td>5706*</td>
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<tr>
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</tr>
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<td>5709*</td>
<td>5901</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5805*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Nylon net used throughout.

LABORATORY TECHNIQUES

Through 1959, the plankton sample was preserved by adding formalin to make a 3% formalin solution in sea water. After 1959, the strength was increased to a 5% formalin solution. Plankton sample jars were filled to the top with sea water to prevent the damage that accompanies sloshing in partly filled jars and stored for periods of one month to two years before the volume was measured.

Two methods have been used for the determination of plankton volume by displacement. The first method consisted of measuring the total volume of plankton plus preserving liquid in a graduated cylinder. The plankton was poured into a draining sock and the preservative drained into a graduated cylinder; the difference in the volumes was the measure of the plankton (Thrailkill, in MS.). Between 20% and 50% of the displacement volume of the wet sample is due to water in the interstices of the plankton and 35% appears to be a representative central value for this error (Ahlstrom and Thrailkill, 1963, Table 6). More exhaustive treatment of the plankton sample to remove this error has not been done routinely because excessive handling adversely affects the condition of some of the organisms which must be subsequently sorted, identified, counted and measured.

In time, samples with appreciable quantities of coelenterates and thaliacians may undergo diminution of volume in direct proportion to the shrinking of these specimens. Most of the shrinkage occurs in the first 30 days (Ahlstrom and Thrailkill, 1963, Table 4). Shrinkage is slight among the crustacean constituents. For most samples the time between collection and determination has not been measured and is likely to vary between one month and two years.

Technical errors, such as partial spilling of a sample, malfunctioning flow meters, or excessive tow length occurred in a small proportion of the samples. If the error was detected on station, the tow was usually repeated. Estimates
of missing flow meter readings were obtained from the revolutions per second as a function of wire angle that is routinely established for each flow meter in use.

Organisms exceeding 5 cc as well as adult and juvenile fish were removed and their displacement volume redetermined. While total volume and total volume less "large" organisms are both reported in the original data, only the latter volume is presented in this atlas.

LIMITATIONS OF THE DATA

Due to the "patchy" distribution of zooplankton, the interpretation of a series of charts in an atlas must be done with considerable care. It is the purpose of this section to discuss the magnitude of contouring error caused by patchiness and day-night differences in catch and to sort them out from regional and seasonal trends.

Patchiness—Contouring obscures patchiness due to the assumption of continuity of zooplankton standing stock between adjacent stations. The importance of this problem diminishes as one widens the intervals of contour.

The contouring intervals used here are similar to those appearing in CalCOFI Atlas No. 10, on zooplankton biomass (Isaacs, Fleminger and Miller, 1969, p. xiii). The values are in cc/1000 m³ of sea water strained and the series increases by a factor of 4, i.e., 4, 16, 64, 256 ... Accordingly, the broad range of plankton volumes encountered in the California Current region can usually be represented by about six contours.

In 1940, duplicate plankton hauls were taken on 141 stations off southern California, with gear similar to that used later in the CalCOFI program. Table 2 shows the distribution of plankton volumes from the second tow on each station relative to that of the first tow when the measurements are arranged in the contouring intervals used in the present atlas. Of the 141 pairs, 106 (77%) would have been placed in the same contour intervals. Of the remaining 23% of paired tows none differed by more than one interval. Ahlstrom (in MS.) concluded that one could discriminate differences between stations of less than 0.6 or more than 1.7 times as large at the 95% level.

<table>
<thead>
<tr>
<th>First tow (cc/1000 m³)</th>
<th>Second tow (cc/1000 m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-16</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
</tr>
</tbody>
</table>

Day-night difference—Often there exists a day-night difference in the standing stock of zooplankton. King and Hida (1954) showed a sine wave correction which was suitable for the zooplankton in Hawaiian waters. Isaacs, Fleminger and Miller (1969) illustrated differences among functional groups and due to the resulting complexity chose the relatively simple method of ratio of medians for day and night to adjust catch size to the higher (night) values. The day-night difference may be ascribed to daily changes in vertical distribution which result in more organisms in the upper 140 m at night, and a marked day-night difference in the ability of mobile organisms to avoid capture by the slow moving (less than 2 knots) CalCOFI standard plankton net. Brinton (1962) described the catches of euphausiids in a rela-
tively long series of tows on the same stations (October 1950, Stations 72.62, 70.90 and 70.130; April 1952, Station 123.40). The zooplankton volumes have also been assembled for the same stations (Ahlstrom, unpublished data; Kramer, 1963). Table 3 illustrates the frequency with which contour values may change day and night. At Station 70.90 in October 1950, and Station 123.40 in April 1952, about half of the tows increased one contour level at night. At 70.130, however, 63 tows showed virtually no effect of time of day on zooplankton volume. The Kruskal-Wallis test (a non-parametric analogue of the variance-ratio test) of the data from Stations 70.90 and 70.130 supported the null hypothesis of identical sum of ranks for 70.130 (3 degrees of freedom, $H = 0.654, 0.900 > p > 0.750$) but did not support the null hypothesis for Station 70.90 ($H = 12.012, 0.017 > p > 0.005$). Brinton (1962) found day-night differences in the numbers of euphausiids from the same tows on both stations.

### Table 3. Percent distribution of day and night samples with repetitive tows in the same area.

<table>
<thead>
<tr>
<th>Plankton volume (cc/1000 m³)</th>
<th>17-</th>
<th>65-</th>
<th>257-</th>
<th>1025-</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cruise 5010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 70.90</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time—Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dusk</td>
<td>0%</td>
<td>44%</td>
<td>56%</td>
<td>0%</td>
<td>16</td>
</tr>
<tr>
<td>Night</td>
<td>0%</td>
<td>38%</td>
<td>63%</td>
<td>0%</td>
<td>16</td>
</tr>
<tr>
<td>Dawn</td>
<td>0%</td>
<td>50%</td>
<td>44%</td>
<td>6%</td>
<td>16</td>
</tr>
<tr>
<td>Station 70.130</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time—Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dusk</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>15</td>
</tr>
<tr>
<td>Night</td>
<td>63%</td>
<td>38%</td>
<td>0%</td>
<td>0%</td>
<td>16</td>
</tr>
<tr>
<td>Dawn</td>
<td>69%</td>
<td>31%</td>
<td>0%</td>
<td>0%</td>
<td>16</td>
</tr>
<tr>
<td>Cruise 5204</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 123.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drogue—Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night</td>
<td>73%</td>
<td>27%</td>
<td>0%</td>
<td>0%</td>
<td>15</td>
</tr>
<tr>
<td>Anchor—Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night</td>
<td>93%</td>
<td>7%</td>
<td>0%</td>
<td>0%</td>
<td>15</td>
</tr>
<tr>
<td>Grid—Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night</td>
<td>81%</td>
<td>19%</td>
<td>0%</td>
<td>0%</td>
<td>68</td>
</tr>
<tr>
<td>Night</td>
<td>16%</td>
<td>80%</td>
<td>2%</td>
<td>2%</td>
<td>51</td>
</tr>
</tbody>
</table>

Of the three errors noted here, the day-night difference probably imposes an appreciable bias over much of the California Current region, and patchiness can have effects similar in magnitude but produce either over- or under-estimates. Shrinkage due to fixation appears to be a negligible source of variability.

**SPATIAL AND TEMPORAL TRENDS**

Figure 2 illustrates the major regional and seasonal trends of median zooplankton volume data for the period 1951-1960. The data for each pooled statistical area in each adequately sampled month are presented in Table 4. Medians are used here to represent the central value of a suite of samples.

It may be observed in Table 4 that peak values commonly occur from May through July and minimum values occur in October and January. Also, the months of August, September, November and December are not sampled adequately for a decade summary. The best sampling has been during the spawning seasons of the pelagic fish in this region (January to
Figure 2. Median zooplankton volumes (cc/1000 m³; large organisms removed) 1951-1960 (based on Table 4).
Table 4. Median zooplankton volumes (cc/1000 m³; large organisms removed) 1951-1960, listed by months and pooled areas.

<table>
<thead>
<tr>
<th>Area</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5</td>
<td>*</td>
<td>-</td>
<td>-</td>
<td>238</td>
<td>264</td>
<td>272</td>
<td>376</td>
<td>-</td>
</tr>
<tr>
<td>6.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>496</td>
<td>455</td>
<td>300</td>
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<td>6.7</td>
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<td>-</td>
<td>291</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>273</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>209</td>
</tr>
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<td>-</td>
<td>656</td>
<td>565</td>
<td>202</td>
<td>254</td>
<td>347</td>
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<td>7.5</td>
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<td>-</td>
<td>-</td>
<td>232</td>
<td>325</td>
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<td>-</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
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<td>188</td>
<td>388</td>
<td>272</td>
<td>448</td>
<td>-</td>
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<td>-</td>
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<td>135</td>
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<td>7.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>160</td>
<td>96</td>
<td>215</td>
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</tr>
<tr>
<td>8.4</td>
<td>63</td>
<td>114</td>
<td>121</td>
<td>221</td>
<td>234</td>
<td>210</td>
<td>166</td>
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<td>8.5</td>
<td>64</td>
<td>143</td>
<td>222</td>
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</table>

*Undersampled; pooled area sampled in less than 8 of the 10 years or fewer than 10 samples in total.
July) when zooplankton volumes are rising. When zooplankton standing stock is decreasing (August to January), only the months of October and January are available to indicate the decrease.

While the median value for a ten-year period is instructive, it must be remembered that the distribution of zooplankton, and especially individual species, is extremely complex and changeable from year to year. As an example, the ten-year distribution of zooplankton volumes is shown in Table 5. While this area of 4589 square miles is composed primarily of the waters of the gyre in the Los Angeles Bight, the diversity of zooplankton volumes within its boundaries is great. The seasonal cycle of medians is among the best defined (mean 133 cc/1000 m³, amplitude 84 cc/1000 m³) but nearly a 1000-fold range is possible with individual sample values in any month.

Table 5. Percent occurrence of sample volumes (cc/1000 m³) by month in Los Angeles Bight (pooled area "8.4").

<table>
<thead>
<tr>
<th>Month</th>
<th>5-16</th>
<th>17-64</th>
<th>65-256</th>
<th>257-1024</th>
<th>1025-4096</th>
<th>4097-16384</th>
<th>Md</th>
<th>N</th>
</tr>
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<tbody>
<tr>
<td>October</td>
<td>10%</td>
<td>31%</td>
<td>53%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>94</td>
<td>51</td>
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<tr>
<td>January</td>
<td>9</td>
<td>41</td>
<td>48</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<td>February</td>
<td>2</td>
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<td>7</td>
<td>0</td>
<td>0</td>
<td>114</td>
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<tr>
<td>March</td>
<td>4</td>
<td>13</td>
<td>74</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>121</td>
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<td>April</td>
<td>0</td>
<td>3</td>
<td>59</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>221</td>
<td>61</td>
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<td>May</td>
<td>1</td>
<td>10</td>
<td>42</td>
<td>45</td>
<td>1</td>
<td>0</td>
<td>234</td>
<td>69</td>
</tr>
<tr>
<td>June</td>
<td>2</td>
<td>9</td>
<td>42</td>
<td>36</td>
<td>8</td>
<td>3</td>
<td>210</td>
<td>64</td>
</tr>
<tr>
<td>July</td>
<td>2</td>
<td>16</td>
<td>54</td>
<td>18</td>
<td>9</td>
<td>2</td>
<td>166</td>
<td>56</td>
</tr>
</tbody>
</table>

Extreme differences may also be seen over the entire surveyed area of 200,000 square miles. For example, compare the July results for the years 1956 and 1958 (Chart No. 82 and 84).

**Onshore-offshore trends**—Onshore-offshore trends by percent frequency distribution, median and arithmetic mean are shown for pooled areas "8.4'" through "8.9'" running from the Los Angeles Bight 240 miles southwest approximately normal to the coast and the California Current (Table 6). In these pooled areas the zooplankton maximum is offshore 80-120 miles, diminishing toward the coast as well as toward the central water mass. This general offshore-onshore trend of higher standing stocks offshore which diminish seaward and inshore is typical of the rest of the coastline but is most pronounced in this transect.

The analysis of onshore-offshore trends is complicated by the incidence of tows in shallow water. Such an oblique tow spends an inordinate amount of time in the upper layers. When a tow from 140 meters deep to the surface is compared with a tow from 70 meters deep for example, the latter should normally yield more plankton per 1000 m³ strained. In the section used for illustration, advection from the north may bring plankton-rich water into the nearshore and offshore regions (pooled areas "8.4," "8.5") which are derived from the nearshore regions of the coast of Central California (pooled area "7.5") (Fleminger, personal communication).

**Upstream-downstream trends**

In the northern portion of the California Current surveys, the zone of high plankton standing stock is relatively broad, usually more than 100 miles wide. In the south, the band of high standing stock is often less than 80 miles wide (Table 4). An index of this trend may be derived from the histograms present on each chart of the atlas.

**GROUP COMPOSITION**

Large sample estimates of the group composition of the zooplankton volumes are now becoming available (Table 7, after Isaacs, Flem-
inger and Miller, 1969). The April and October samples from 1955-1959, show the extent of changes in group composition. In all years except 1957, the rank of components changed very little from spring to fall. The year 1957 has previously been noted as a year of transition over the entire California Current area (Thrailkill, 1959) with regard to zooplankton volumes. Thaliaceans and larvaceans were second to crustaceans in 1955 and became first for the April cruises of 1956, 1957 and the intervening October. In October 1957, the thaliaceans and larvaceans were ranked fourth and remained there through April and October of 1958.

It is important to know the group composition, for differences in the proportions of the crustaceans and thaliaceans bear on the carbon content of the sample. The thaliaceans differ from the crustaceans in dry weight per unit wet weight and in carbon per unit dry weight (Curl, 1962; Ahlstrom and Thrailkill, 1963).

Plankton volume data have been used (Las
er, 1970) to describe the use of zooplankton

| Table 6. Percent distribution of zooplankton volumes (cc/1000 m³) along onshore-offshore transect at Los Angeles Bight, 1951-1960. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| 17-1025         | Md              | N               |
| October         |                 |                 |                 |                 |
| 8.4             | 10%             | 31%             | 53%             | 6%              | 0%              | 0%              | 99               | 117             | 51              |
| 8.5             | 4               | 28              | 48              | 20              | 0               | 0               | 110              | 148             | 50              |
| 8.6             | 4               | 21              | 64              | 14              | 0               | 0               | 109              | 144             | 28              |
| 8.7             | 0               | 13              | 73              | 13              | 0               | 0               | 142              | 149             | 15              |
| 8.8             | 0               | 36              | 57              | 7               | 0               | 0               | 86               | 111             | 14              |
| 8.9             | 7               | 33              | 60              | 0               | 0               | 0               | 69               | 68              | 15              |
| January         |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 8.4             | 9%              | 41%             | 48%             | 2%              | 0%              | 0%              | 63               | 80              | 46              |
| 8.5             | 2               | 31              | 33              | 13              | 0               | 0               | 64               | 126             | 45              |
| 8.6             | 0               | 11              | 57              | 32              | 0               | 0               | 167              | 224             | 28              |
| 8.7             | 0               | 17              | 72              | 11              | 0               | 0               | 103              | 142             | 18              |
| 8.8             | 0               | 50              | 38              | 13              | 0               | 0               | 63               | 159             | 16              |
| 8.9             | 8               | 38              | 38              | 8               | 8               | 0               | 87               | 185             | 13              |
| April           |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 8.4             | 0%              | 3%              | 39%             | 38%             | 0%              | 0%              | 221              | 246             | 61              |
| 8.5             | 2               | 9               | 54              | 33              | 2               | 0               | 195              | 333             | 57              |
| 8.6             | 0               | 5               | 61              | 27              | 7               | 0               | 189              | 289             | 41              |
| 8.7             | 0               | 8               | 67              | 18              | 8               | 0               | 149              | 344             | 39              |
| 8.8             | 0               | 32              | 54              | 14              | 0               | 0               | 84               | 141             | 37              |
| 8.9             | 0               | 21              | 39              | 32              | 7               | 0               | 170              | 286             | 28              |
| July            |                 |                 |                 |                 |                 |                 |                 |                 |                 |
| 8.4             | 2%              | 16%             | 54%             | 18%             | 9%              | 2%              | 166              | 406             | 56              |
| 8.5             | 2               | 5               | 50              | 32              | 11              | 0               | 225              | 464             | 56              |
| 8.6             | 0               | 2               | 42              | 44              | 9               | 2               | 300              | 576             | 43              |
| 8.7             | 0               | 10              | 52              | 39              | 0               | 0               | 196              | 232             | 31              |
| 8.8             | 0               | 21              | 55              | 24              | 0               | 0               | 138              | 209             | 29              |
| 8.9             | 0               | 22              | 39              | 28              | 11              | 0               | 113              | 334             | 18              |
energy by the Pacific sardine. The location and timing of zooplankton increases coincide with the migration, fat deposition and spawning of that species. It is apparent that the usefulness of plankton volume data would increase if we knew more about 1) estimates of the transport of plankton from one area to another, 2) the species composition of the individual samples, 3) the population dynamics of the major crustacean and thaliacean species and 4) the abundance of zooplankton of smaller sizes.

### Table 7.

Group composition of zooplankton samples (in percent) representing five spring and fall surveys: data from Isaacs, Fleminger and Miller, 1969.

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<th>5510</th>
<th>5604</th>
<th>5610</th>
<th>5704</th>
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<td>39%</td>
<td>17%</td>
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<td>35%</td>
<td>60%</td>
<td>51%</td>
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<td>75</td>
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<td>17</td>
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### Table 8.

Page numbers of charts. Charts arranged by month and year. (-) No cruise. (*) Distribution for early and late monthly cruises are shown on the same chart. (**) Special cruises, no distribution charts included.

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<td>144</td>
</tr>
</tbody>
</table>

xv
REFERENCES


MS. Variability in plankton tow-net catches.


Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.65 \quad \frac{N}{T} = 1.09 \]

CALCOFI CRUISE 5101
9-29 JANUARY 1951

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES

60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 0.94  N = 1.02

CALCOFI CRUISE 5401
5 JANUARY - 4 FEBRUARY 1954

STATIONS: • NIGHT  • SUNRISE
○ DAY  • SUNSET

Zooplankton Displacement Volume

SAN FRANCISCO
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.76 \quad \frac{N}{T} = 1.18 \]

CALCOFI CRUISE 5501
13-29 JANUARY 1955

STATIONS: • NIGHT • SUNRISE • SUNSET

SAN FRANCISCO
CAPE MENDOCINO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc / 1000 m³) PER SAMPLE

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

16
64
256
1024

Zooplankton Displacement Volume
Zooplankton Displacement Volume

\[
\frac{N}{D} = 0.81 \quad \frac{N}{T} = 0.98
\]

CALCOFI CRUISE 5701

3 - 19 JANUARY 1957

STATIONS: ● NIGHT  ○ SUNRISE
○ DAY  ● SUNSET

SAN FRANCISCO

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume
MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

- 60-67
- 70-77
- 80-87
- 90-97
- 100-107
- 110-119
- 120-127
- 130-137
- 140-147
- 150-157

Zooplankton Displacement Volume

cc/1000 m³ seawater strained

$\frac{N_D}{N_T} = 1.45 \quad \frac{N_T}{N_D} = 0.84$

CALCOFI CRUISE 5801
8 JANUARY - 2 FEBRUARY 1958

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ● SUNSET
Zooplankton Displacement Volume

$\text{cc/1000 m}^3 \text{ seawater strained}$

$\frac{N}{D} = 1.78 \quad \frac{N}{T} = 1.41$

CALCOFI CRUISE 6001
8 JANUARY - 13 FEBRUARY 1960

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

0 200 400 600 800

0 25 50 75 100

20° 25° 30° 35° 40°
Zooplankton Displacement Volume

cc / 1000 m³ seawater strained

N_D = 2.20
N_T = 1.38

CALCOFI CRUISE 6101
5 JANUARY - 20 FEBRUARY 1961
STATIONS: ● NIGHT ● SUNRISE ○ DAY ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

0 200 400 600 800 1000

25° 30° 35°
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tow, stations are marked "0." When present, abundance at those stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N D = 1.29  N T = 1.22

CALCOFI CRUISE 6501

6 JANUARY - 18 FEBRUARY 1965

STATIONS: ● NIGHT ● SUNRISE
○ DAY ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-119
120-127
130-137
140

San Francisco
San Diego
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$\frac{N}{D} = 1.69$  $\frac{N}{T} = 1.43$

CALCOFI CRUISE 5102
6-25 FEBRUARY 1951

STATIONS:● NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE
Zooplankton Displacement Volume

$cc/1000m^3$ seawater strained

$N_D = 1.55$  $N_T = 1.01$

CALCOFI CRUISE 5202
6 - 22 FEBRUARY 1952

STATIONS • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$\frac{N}{D} = 2.14 \quad \frac{N}{T} = 1.25$

CALCOFI CRUISE 5302
4 - 26 FEBRUARY 1953

STATIONS: ● NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINES
90-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5302
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

\[
\frac{N}{D} = 1.47 \quad \frac{N}{T} = 1.23
\]

CALCOFI CRUISE 5402
2-16 FEBRUARY 1954

STATIONS
- NIGHT
- SUNRISE
- DAY
- SUNSET

SAN FRANCISCO

MENDOCINO

POINT CONCEPTION

SAN DIEGO

PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

<table>
<thead>
<tr>
<th>LINES</th>
<th>0</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
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<td>110-117</td>
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<td>130-137</td>
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</tbody>
</table>

Zooplankton Displacement Volume

5402
Zooplankton Displacement Volume

\[ \frac{N}{D} = 1.42 \quad \frac{N}{T} = 0.98 \]

CALCOFI CRUISE 5502
9-23 FEBRUARY 1955

STATIONS • NIGHT • SUNRISE
• DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N₁ = 1.51  N₂ = 1.54

CALCOFI CRUISE 5602
3 - 21 FEBRUARY 1956

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.12 \quad \frac{N}{I} = 0.92 \]

CALCOFI CRUISE 5702
6 - 26 FEBRUARY 1957

STATIONS: ● NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

Zooplankton Displacement Volume

5702
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 1.30
N = 0.89

CALCOFI CRUISE 6002
11 FEBRUARY – 3 MARCH 1960

STATIONS: NIGHT, SUNRISE, DAY, SUNSET

SAN FRANCISCO

CAPE MENDOCINO

SAN DIEGO

Zooplankton Displacement Volume (cc/1000 m³) per sample
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

$N_D = 1.45$  $N_T = 1.27$

CALCOFI CRUISE 6602
15 FEBRUARY - 6 MARCH 1966

STATIONS: • NIGHT  • SUNRISE  ○ DAY  • SUNSET

The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m³ PER SAMPLE)

- 80-87
- 90-97
- 100-107
- 110-119
- 120

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ N_D = 1.30 \quad N_T = 0.90 \]

CALCOFI CRUISE 5103
8-23 MARCH 1951

STATIONS - NIGHT - SUNRISE
○ DAY - SUNSET

SAN FRANCISCO
CAPE MENDOCINO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA

Zooplankton Displacement Volume

Mean Displacement Volume (cc/1000 m³) per Sample

Lines:
- 80-87
- 90-97
- 100-107
- 110-117
- 120-127
- 130-137
- 140-147
- 150-157

Zooplankton Displacement Volume

5103
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$\frac{N}{D} = 1.33$  $\frac{N}{T} = 1.13$

**CALCOFI CRUISE 5203**

5 MARCH - 3 APRIL 1952

STATIONS • NIGHT • SUNRISE
• DAY • SUNSET

**MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE**

<table>
<thead>
<tr>
<th>Lines</th>
<th>0</th>
<th>200</th>
<th>400</th>
<th>600</th>
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<td>110-117</td>
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<td>120-127</td>
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<tr>
<td>130-137</td>
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</tbody>
</table>
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.42 \quad \frac{N}{T} = 1.11 \]

CALCOFI CRUISE 5303
6 MARCH - 5 APRIL 1953

SAN FRANCISCO

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ● SUNSET

SAN DIEGO

PUNTA EUGENIA

Zooplankton Displacement Volume (cc/1000 m³) per sample
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.52 \quad \frac{N}{T} = 1.16 \]

CALCOFI CRUISE 5403
3 MARCH 5 APRIL 1954

STATIONS: • NIGHT ○ SUNRISE ○ SUNSET

Zooplankton Displacement Volume

5403
Zooplankton Displacement Volume

cc/1000m³ seawater strained

\[ \frac{N}{D} = 1.27 \quad \frac{N}{T} = 1.11 \]

CALCOFI CRUISE 5503
8-22 MARCH 1955

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ○ SUNSET

EUGENIA
PUNTA

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

25°
20°
15°
10°
5°
0°

0 200 400 600 800 1000

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

Zooplankton Displacement Volume

5503
Zooplankton Displacement Volume
cc / 1000 m³ seawater strained

\( \frac{N}{D} = 1.60 \quad \frac{N}{T} = 1.21 \)

CALCOFI CRUISE 5603
4 - 19 MARCH 1956

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

SAN FRANCISCO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc / 1000 m³) PER SAMPLE

LINES
80-87
90-97
100-107
110-119
120-127
130-137

Zooplankton Displacement Volume
5603
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.74 \quad \frac{N}{T} = 1.43
\]

CALCOFI CRUISE 6003
10 - 29 MARCH 1960

STATIONS: ● NIGHT ○ SUNRISE ○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

6003
Zooplankton Displacement Volume

cc/1000m³ seawater strained

\[ \frac{N}{D} = 1.51 \quad \frac{N}{T} = 1.11 \]

CALCOFI CRUISE 5104
2-17 APRIL 1951

STATIONS: • NIGHT ○ DAY ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5104
Zooplankton Displacement Volume

\[ \frac{N}{D} = 1.24 \quad \frac{N}{T} = 1.20 \]

CALCOFI CRUISE 5204
2 - 15 APRIL 1952

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

5204
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N_D = 1.56  N_T = 1.51

CALCOFI CRUISE 5304
31 MARCH - 19 APRIL 1953

STATIONS: • NIGHT  ○ SUNRISE  ○ SUNSET

ZOOPLANKTON DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

ZOOPLANKTON DISPLACEMENT VOLUME

5304
Zooplankton Displacement Volume

\( \text{mean displacement volume (cc/1000 m\textsuperscript{3}) per sample} \)

- 0 - 200
- 201 - 400
- 401 - 600
- 601 - 800
- 801 - 1000
- 1001 - 1200
- 1201 - 1400
- 1401 - 1600
- 1601 - 1800
- 1801 - 2000
- 2001 - 2200
- 2201 - 2400
- 2401 - 2600
- 2601 - 2800
- 2801 - 3000
- 3001 - 3200
- 3201 - 3400
- 3401 - 3600
- 3601 - 3800
- 3801 - 4000
- 4001 - 4200
- 4201 - 4400
- 4401 - 4600
- 4601 - 4800
- 4801 - 5000
- 5001 - 5200
- 5201 - 5400
- 5401 - 5600
- 5601 - 5800
- 5801 - 6000
- 6001 - 6200
- 6201 - 6400
- 6401 - 6600
- 6601 - 6800
- 6801 - 7000
- 7001 - 7200
- 7201 - 7400
- 7401 - 7600
- 7601 - 7800
- 7801 - 8000
- 8001 - 8200
- 8201 - 8400
- 8401 - 8600
- 8601 - 8800
- 8801 - 9000
- 9001 - 9200
- 9201 - 9400
- 9401 - 9600
- 9601 - 9800
- 9801 - 10000
- 10001 - 10200
- 10201 - 10400
- 10401 - 10600
- 10601 - 10800
- 10801 - 11000
- 11001 - 11200
- 11201 - 11400
- 11401 - 11600
- 11601 - 11800
- 11801 - 12000

Zooplankton Displacement Volume

CALCOFI CRUISE 5504
5-22 APRIL 1955
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N/D = 1.28  N/T = 0.90

CALCOFI CRUISE 5704
5 - 30 APRIL 1957

STATIONS: • NIGHT  • SUNRISE
○ DAY  ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
90-96
100-107
110-119
120-127
130-137
140-147
150-157
200-207

Zooplankton Displacement Volume

5704
Zooplankton Displacement Volume
cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.76 \quad \frac{N}{T} = 1.08
\]

CALCOFI CRUISE 5804
30 MARCH - 27 APRIL 1958

STATIONS:
- NIGHT
- SUNRISE
- DAY
- SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

- 60-67
- 70-77
- 80-87
- 90-97
- 100-107
- 110-119
- 120-127
- 130-137

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 1.89  N = 1.27

CALCOFI CRUISE 5904
7-26 APRIL 1959

STATIONS: ● NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

LINE

0 200 400 600 800 1000

20° 25° 30° 35° 40°

125° 120° 115° 110°
Zooplankton Displacement Volume
cc/1000 m$^3$ seawater strained

$N_0 = 2.02 \quad N_T = 1.54$

CALCOFI CRUISE 6204
15 MARCH - 2 MAY 1962
STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

<table>
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<th>Lines</th>
<th>0</th>
<th>200</th>
<th>400</th>
<th>600</th>
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PUNTA EUGENIA
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

Zooplankton Displacement Volume
cc/1000m³ seawater strained

N = 1.37  N = 1.18

CALCOFI CRUISE 6304
9 APRIL - 24 MAY 1963
STATIONS:  • NIGHT  • SUNRISE
          o DAY  • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

LINES

60-67
70-77
80-87
90-97
100-107
110-119
120-127
130-137
140

600  800  1000  1200  1400

0  4  8  12  16

1  4  8  16

25°  30°  35°  40°  45°
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.32 \quad \frac{N}{T} = 1.46 \]

CALCOFI CRUISE 6404
10 APRIL - 1 MAY 1964

Zooplankton Displacement Volume

The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/harves appear in tows, stations are marked "N." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

<table>
<thead>
<tr>
<th>Lines</th>
<th>0</th>
<th>200</th>
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</table>
CALCOFI CRUISE 6504
31 MARCH - 24 APRIL 1965

STATIONS:
- NIGHT
- SUNRISE
- DAY
- SUNSET

The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

6504
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

**Zooplankton Displacement Volume**

cc/1000 m$^3$ seawater strained

$\frac{N}{D} = 1.37 \quad \frac{N}{T} = 1.29$

**CALCOFI CRUISE 6604**

26 MARCH - 3 MAY 1966

STATIONS • NIGHT • SUNRISE • SUNSET
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 1.32
N = 1.34

CALCOFI CRUISE 5205
9 - 26 MAY 1952

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume
Zooplankton Displacement Volume

\[ \frac{N}{D} = 2.03 \quad \frac{T}{F} = 1.85 \]

CALCOFI CRUISE 5305
28 APRIL - 30 MAY 1953

STATIONS: • NIGHT ○ SUNRISE ○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5305
Zooplankton Displacement Volume

cc/1000m³ seawater strained

N_D = 1.06
N_T = 0.70

CALCOFI CRUISE 5505
12 MAY-7 JUNE 1955

STATIONS
• NIGHT
• SUNRISE
• DAY
• SUNSET

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
63-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

25°
30°
35°
40°
125° 120° 115° 110°

PUNTA EUGENIA
SAN DIEGO
POINT CONCEPTION
SAN FRANCISCO
CAPE MENDOCINO
Zooplankton Displacement Volume

$cc/1000m^3$ seawater strained

\[ N_D = 1.44 \quad N_T = 1.54 \]

CALCOFI CRUISE 5705
9 - 23 MAY 1957

STATIONS: • NIGHT  ○ SUNRISE
○ DAY  ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINE5 5705

Zooplankton Displacement Volume
Zooplankton Displacement Volume

$\text{cc/1000 m}^3$ seawater strained

$N_D = 1.76 \quad N_T = 1.24$

CALCOFI CRUISE 6005
13 - 29 MAY 1960

STATIONS: • NIGHT ø SUNRISE
○ DAY ø SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m$^3$) PER SAMPLE

LINES
73 - 77
62 - 67
90 - 97
103 - 107
110 - 119
120 - 127
130 - 137

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N_D = 1.32
N_T = 1.15

CALCOFI CRUISE 6605
5 - 29 MAY 1966

STATIONS: • NIGHT  • SUNRISE
○ DAY  • SUNSET

The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

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</table>
Zooplankton Displacement Volume

CC/1000 m³ seawater strained

N
D = 1.76
N
T = 1.44

CALCOFI CRUISE 5106
30 MAY - 20 JUNE 1951

STATIONS: ● NIGHT  ○ SUNRISE  ● SUNSET

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (CC/1000 M³) PER
SAMPLE

LINES
60-69
70-77
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

PUNTA EUGENIA

SAN DIEGO

SAN FRANCISCO

CAPE MENOCINO

POINT CONCEPTION

Zooplankton Displacement Volume

5106
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.97 \quad \frac{N}{T} = 1.20
\]

CALCOFI CRUISE 5206
3 - 21 JUNE 1952

STATIONS: NIGHT • SUNRISE
DAY • SUNSET

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N_D}{N} = 0.89 \quad \frac{N}{T} = 0.83 \]

CALCOFI CRUISE 5306

3 JUNE - 3 JULY 1953

STATIONS: • NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$N_D = 0.98$  $N_T = 0.94$

CALCOFI CRUISE 5406
2-23 JUNE 1954

STATIONS: • NIGHT  ○ SUNRISE
○ DAY  ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

0  200  400  600  800  1000

50-57
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5406
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N/D = 1.12   N/T = 1.00

CALCOFI CRUISE 5506

11-28 JUNE 1955

STATIONS: • NIGHT   • SUNRISE
           ○ DAY     • SUNSET

SAN FRANCISCO

POINTE CONCEPTION

SAN DIEGO

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

5506
Zooplankton Displacement Volume

cc / 1000 m$^3$ seawater strained

\[
\frac{N}{D} = 1.35 \quad \frac{N}{T} = 0.90
\]

CALCOFI CRUISE 5606
26 MAY - 25 JUNE 1956

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

Zooplankton Displacement Volume

SAN FRANCISCO

POINT CONCEPTION

SAN DIEGO

PUNTA EUGENIA
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$N/D = 1.24$  $N/T = 1.29$

CALCOFI CRUISE 5706
5 - 23 JUNE 1957

STATIONS: • NIGHT  ○ SUNRISE
       ○ DAY  ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

Zooplankton Displacement Volume

5706
Zooplankton Displacement Volume

cc/1000 m$^3$ seawater strained

$N_D = 1.09 \quad N_T = 0.94$

CALCOFI CRUISE 5806
4-26 JUNE 1958

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

Zooplankton Displacement Volume cc/1000 m$^3$ seawater strained

N = 1.09
T = 0.94

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

- 0
- 200
- 400
- 600
- 800
- 1000

LINES
50-57
60-67
70-77
80-87
90-97
100-107
110-119
120-127
130-137
Zooplankton Displacement Volume

$N_D = 1.79 \quad N_T = 1.37$

CALCOFI CRUISE 5906
3 - 30 JUNE 1959

STATIONS
• NIGHT  ○ SUNRISE
○ DAY    ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m$^3$) PER SAMPLE

Zooplankton Displacement Volume

5906
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N_D = 1.88  N_T = 0.99

CALCOFI CRUISE 6006
14 - 30 JUNE 1960

STATIONS: • NIGHT  • SUNRISE
○ DAY  • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

6006
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Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 0.77 \quad \frac{N}{T} = 0.64 \]

CALCOFI CRUISE 5307
8 - 27 JULY 1953

STATIONS: • NIGHT ● SUNRISE ○ DAY ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N_D}{N_T} = 2.19 \quad \frac{N_T}{N_D} = 1.42 \]

CALCOFI CRUISE 5407
7-23 JULY 1954

STATIONS

- NIGHT
- SUNRISE
- DAY
- SUNSET

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

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</table>

Zooplankton Displacement Volume

5407
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.22 \quad \frac{N}{T} = 1.41
\]

CALCOFI CRUISE 5507

8 - 23 JULY 1955

STATIONS: NIGHT SUNRISE
            DAY SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
63-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5507
Zooplankton Displacement Volume

cc/1000m³ seawater strained

\[ \frac{N}{D} = 1.50 \quad \frac{N}{T} = 1.14 \]

CALCOFI CRUISE 5807

30 JUNE - 22 JULY 1958

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

LINES:
- 40-47
- 50-57
- 60-67
- 70-77
- 80-87
- 90-97
- 100-107
- 110-119
- 120-127
- 130-137

Zooplankton Displacement Volume

5807
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N/D = 1.74  N/T = 1.36

CALCOFI CRUISE 5907
9 JULY - 3 AUGUST 1959

STATIONS: • NIGHT  ○ SUNRISE  ○ SUNSET

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N/D = 1.62  N/T = 1.31

CALCOFI CRUISE 6007
12 JULY – 14 AUGUST 1960

STATIONS: • NIGHT  • SUNRISE  • SUNSET

PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc 1000 m³) PER SAMPLE

0  200  400  600  800  1000

25°

LINES

60 - 67
70 - 77
80 - 87
90 - 97
100 - 107
110 - 119
120 - 127
130 - 137
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 2.08
N T = 1.51

CALCOFI CRUISE 6107
12 JULY - 1 AUGUST 1961

STATIONS: NIGHT SUNRISE
DAY SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

0 200 400 600 800 1000

LINES
60-67
70-76
80-87
90-97
100-107
110-119
120-127
130-137

SAN FRANCISCO

PUNTA EUGENIA
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

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Zooplankton Displacement Volume

CALCOFI CRUISE 6307
10 JULY - 8 AUGUST 1963

SAN FRANCISCO

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

6307
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
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**Mean Displacement Volume (cc/1000 m³) Per Sample**

- 0
- 200
- 400
- 600
- 800
- 1000

**Lines:**
- 60-67
- 70-77
- 80-87
- 90-97
- 100-107
- 110-119
- 120-127
- 130-137

**CALCOFI CRUISE 6607**

8 - 29 JULY 1966

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET
Zooplankton Displacement Volume

cc/1000m³ seawater strained

N/D = 1.40  N/T = 1.05

CALCOFI CRUISE 5208
8 - 19 AUGUST 1952

STATIONS: ● NIGHT  ● SUNRISE
○ DAY  ● SUNSET

SAN FRANCISCO
CAPE MENDOCINO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
60 - 67
70 - 77
80 - 87
90 - 97
100-107
110-119
120-127
130-137

Zooplankton Displacement Volume

5208
Zooplankton Displacement Volume

$\text{cc/1000m}^3$ seawater strained

$\frac{N}{D} = 1.50 \quad \frac{N}{T} = 1.38$

CALCOFI CRUISE 5308
5 - 30 AUGUST 1953

STATIONS: • NIGHT ◦ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINES
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137
CALCOFI CRUISE 5408
18 AUGUST-10 SEPTEMBER 1954

STATIONS: NIGHT • SUNRISE
• DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.50 \quad \frac{N}{T} = 1.31 \]
Zooplankton Displacement Volume

$\text{cc/1000 m}^3 \text{ seawater strained}$

\[
\frac{N}{D} = 2.11 \quad \frac{N}{T} = 1.28
\]

CALCOFI CRUISE 5608
7 - 19 AUGUST 1956

STATIONS: • NIGHT  • SUNRISE
○ DAY  • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINES

0 200 400 600 800 1000

110-118
120-127
130-137
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
\begin{align*}
\frac{N}{D} &= 222 \\
N &= 0.83
\end{align*}
\]

CALCOFI CRUISE 5808
6-21 AUGUST 1958

SAN FRANCISCO

CAPE MENDOCINO

SUNRISE

SUNSET

STATIONS: • NIGHT ○ DAY

PUNTA EUGENIA

SAN DIEGO

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

0 200 400 600 800 1000

LINES

110-119
120-127
130-137

Zooplankton Displacement Volume

5808
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contour of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

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Zooplankton Displacement Volume
cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.47 \quad \frac{N}{T} = 1.20 \]

CALCOFI CRUISE 5109
30 AUGUST–13 SEPTEMBER 1951

STATIONS
○ NIGHT  ● SUNRISE
○ DAY  ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

5109
Zooplankton Displacement Volume

cc/1000 m³ sea water strained

\[ \frac{N}{D} = 1.45 \quad \frac{N}{T} = 1.10 \]

CALCOFI CRUISE 5209

4 - 19 SEPTEMBER 1952

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ■ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³ PER SAMPLE)

LINES
0 - 60 60 - 67
70 - 77 80 - 87
90 - 97 100 - 107
110 - 117 120 - 127
130 - 137

21 - 26 SEPTEMBER 1952
Zooplankton Displacement Volume

cc / 1000 m³ seawater strained

\[
\frac{N}{D} = 1.06 \quad \frac{N}{T} = 1.49
\]

CALCOFI CRUISE 5309
9 - 19 SEPTEMBER 1953

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc / 1000 m³) PER SAMPLE

LINES
83 - 87
113 - 119
120 - 121

Zooplankton Displacement Volume

5309
CALCOFI CRUISE 5609
5 - 17 SEPTEMBER 1956

STATIONS
- NIGHT
- SUNRISE
- DAY
- SUNSET

Zooplankton Displacement Volume
cc/1000 m³ seawater strained

N = 1.92
D = 1.70

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

5609
Zooplankton Displacement Volume

$\text{cc} / 1000 \text{m}^3$ seawater strained

$N_D = 0.98 \quad N_T = 1.04$

CALCOFI CRUISE 5709
4 - 21 SEPTEMBER 1957

STATIONS
- NIGHT
- SUNRISE
- DAY
- SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINE
110-119
120-127
130-137

Zooplankton Displacement Volume

5709
Zooplankton Displacement Volume

$\text{cc/1000 m}^3$ seawater strained

$\frac{N}{D} = 2.28 \quad \frac{N}{T} = 1.49$

CALCOFI CRUISE 5809
4-19 SEPTEMBER 1958

STATIONS: • NIGHT ○ SUNRISE ○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINES

90-93
110-119
120-127
130-137

Zooplankton Displacement Volume

5809
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 2.02 \quad \frac{N}{T} = 1.22 \]

CALCOFI CRUISE 6009
9 - 21 SEPTEMBER 1960

STATIONS: ● NIGHT • SUNRISE ○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
103 - 107
110 - 119
20 - 121
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

The map shows the Zooplankton Displacement Volume with cc/1000 m³ seawater strained. The stations are marked for Night, Sunrise, Day, and Sunset. The map includes the stations along the California coast from Cape Mendocino to San Francisco, with specific levels of abundance indicated by color coding.

**Zooplankton Displacement Volume**

cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.04 \quad \frac{N}{T} = 1.15
\]

**CALCOFI CRUISE 6509**

31 August - 25 September 1965

**SAN FRANCISCO**
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 1.65

N = 1.73

CALCOFI CRUISE 5110
26 SEPTEMBER - 8 OCTOBER 1951

STATIONS: ● NIGHT ● SUNRISE
● DAY ● SUNSET

Mean Displacement Volume (cc/1000 m³) per sample

Lines
60-67
70-77
80-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc / 1000 m$^3$ seawater strained

$\frac{N}{D} = 1.89 \quad \frac{N}{T} = 1.89$

CALCOFI CRUISE 5210
8 - 22 OCTOBER 1952

STATIONS • NIGHT • SUNRISE
○ DAY • SUNSET

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

LINES
60 - 67
70 - 77
80 - 87
90 - 97
100 - 107
110 - 117
120 - 127
130 - 137
CALCOFI CRUISE 5310
7 - 24 OCTOBER 1953

STATIONS
○ NIGHT
○ SUNRISE
○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N_D = 1.36
N_T = 1.15
Zooplankton Displacement Volume

cc / 1000 m³ seawater strained

N = 1.62  N = 0.93

CALCOFI CRUISE 5410
6-24 OCTOBER 1954

STATIONS: • NIGHT  • SUNRISE
○ DAY  • SUNSET

SAN FRANCISCO
CAPE MENDOCINO
PUNTA EUGENIA
POINT CONCEPTION
SAN DIEGO

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

0  200  600  800  1000

Zooplankton Displacement Volume

5410
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.89 \quad \frac{N}{T} = 1.10 \]

CALCOFI CRUISE 5610
27 SEPTEMBER - 5 OCTOBER 1956

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
80 - 87
90 - 97
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N 0.18
D

CALCOFI CRUISE 5710
4 OCTOBER - 8 NOVEMBER 1957

SAN FRANCISCO

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

80-87
90-97
100-107
110-119
120-127
130-137

PUNTA EUGENIA

16
64
256
1024

Point Conception

San Diego
Zooplankton Displacement Volume

cc / 1000 m$^3$ seawater strained

\[
\frac{N}{D} = 2.27 \quad \frac{N}{T} = 1.32
\]

CALCOFI CRUISE 5810
8 OCTOBER - 6 NOVEMBER 1958

STATIONS: • NIGHT ○ SUNRISE ○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

Zooplankton Displacement Volume
CALCOFI CRUISE 6010

22 SEPTEMBER - 22 OCTOBER 1960

SAN FRANCISCO

Zooplankton Displacement Volume

cc/1000m³ seawater strained

N = 1.37  N = 0.96

16  64  256  1024

STATIONS: • NIGHT  • SUNRISE  • SUNSET  • DAY

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

Zooplankton Displacement Volume
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
The numbers to the right of the shoreline represent abundance at special inshore stations. When eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-87</td>
<td>25</td>
<td>75</td>
<td>150</td>
<td>250</td>
<td>350</td>
<td>450</td>
</tr>
<tr>
<td>90-97</td>
<td></td>
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</tr>
<tr>
<td>100-107</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>110-119</td>
<td>150</td>
<td>250</td>
<td>350</td>
<td>450</td>
<td>550</td>
<td>650</td>
</tr>
<tr>
<td>120-127</td>
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</tr>
<tr>
<td>130-137</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
</tr>
</tbody>
</table>

Zooplankton Displacement Volume
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contour of abundance shown on this chart.

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

<table>
<thead>
<tr>
<th>Range</th>
<th>0</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-67</td>
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<td>70-77</td>
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<tr>
<td>80-87</td>
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<tr>
<td>90-97</td>
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<tr>
<td>100-107</td>
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<tr>
<td>110-119</td>
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<tr>
<td>120-127</td>
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<tr>
<td>130-137</td>
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</tr>
</tbody>
</table>

CALCOFI CRUISE 6610
8 - 28 OCTOBER 1966
Zooplankton Displacement Volume

N = 1.77
T = 1.64

CALCOFI CRUISE 5111
30 OCTOBER - 12 NOVEMBER 1951

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[ \frac{N}{D} = 1.24 \quad \frac{N}{X} = 1.09 \]

CALCOFI CRUISE 5211

6 - 21 NOVEMBER 1952

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N D AND N T INDETERMINABLE

CALCOFI CRUISE 5311
9 - 14 NOVEMBER 1953

STATIONS:
- NIGHT
- SUNRISE
- DAY
- SUNSET

MEAN DISPLACEMENT VOLUME (cc /1000 m³) PER SAMPLE
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 1.53
D = 1.05

CALCOFI CRUISE 5711
16 - 25 NOVEMBER 1957

STATIONS:
● NIGHT
● SUNRISE
○ DAY
○ SUNSET
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N.D. AND N.T. INDETERMINABLE

CALCOFI CRUISE 5811
13-24 NOVEMBER 1958

STATIONS: • NIGHT ○ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

100 200 300 400 500 600 700 800 900 1000

Zooplankton Displacement Volume
Zooplankton Displacement Volume

\[ \frac{N}{D} = 2.32 \quad \frac{N}{T} = 0.91 \]

CALCOFI CRUISE 5911
16 - 25 NOVEMBER 1959

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

LINES
77
80-87
90-93

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m$^3$/seawater strained

N = 1.14
T = 1.16

CRUISE 6611*
2-23 NOVEMBER 1966

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

Zooplankton Displacement Volume

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

* Scripps Tuna Oceanography Research
Cruise TO - 66 - 1
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
N = 1.64 \\
\frac{N}{D} = 1.54
\]

CALCOFI CRUISE 5112
25 NOVEMBER - 9 DECEMBER 1951

STATIONS: ● NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

- 0
- 200
- 400
- 600
- 800
- 1000

LINES:
- 60-67
- 70-77
- 80-87
- 90-97
- 100-107
- 110-117
- 120-127

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

\[
\frac{N}{D} = 1.37 \quad \frac{N}{T} = 1.40
\]

CALCOFI CRUISE 5312
1 - 13 December 1953

STATIONS: • NIGHT ○ SUNRISE ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

LINES
83-87
90-97
100-107
110-117
120-127
130-137

Zooplankton Displacement Volume

5312
Zooplankton Displacement Volume

cc/1000m³ seawater strained

N / D = 1.43
N / T = 1.38

CALCOFI CRUISE 5412
30 NOVEMBER–16 DECEMBER 1954

STATIONS:
- NIGHT
- SUNRISE
- DAY
- SUNSET

SAN DIEGO
PUNTA EUGENIA

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

0 200 400 600 800 1000

LINES
80-87
90-97
100-107
110-117
120-127
130-137
140-147
150-157

Zooplankton Displacement Volume

5412
Zooplankton Displacement Volume

cc/1000m³ seawater strained

\[ \frac{N}{D} = 1.53 \quad \frac{N}{T} = 1.24 \]

CALCOFI CRUISE 5512
29 NOVEMBER - 16 DECEMBER 1955

STATIONS
- NIGHT
- SUNRISE
- DAY
- SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

- 200
- 400
- 600
- 800
- 1000

80-87
90-97
100-107
110-117
120-127
130-137
140-147

Zooplankton Displacement Volume
Zooplankton Displacement Volume

cc/1000 m³ seawater strained

N = 3.6
T = 2.6

CALCOFI CRUISE 5612
24 NOVEMBER - 21 DECEMBER 1956

SAN FRANCISCO

STATIONS: ● NIGHT ○ SUNRISE ○ DAY ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m³) PER SAMPLE

Zooplankton Displacement Volume

5612
CALCOFI CRUISE 5712
12 - 20 DECEMBER 1957

Zooplankton Displacement Volume
cc/1000 m$^3$ seawater strained

\[
\frac{N}{D} = 1.13 \quad \frac{N}{T} = 1.32
\]

STATIONS: • NIGHT • SUNRISE
○ DAY • SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

CAPE MENDOCINO
SAN FRANCISCO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA
Zooplankton Displacement Volume

$cc/1000m^3$ seawater strained

$N/D = 1.68$  $N/T = 1.52$

CALCOFI CRUISE 5812
1 - 11 DECEMBER 1958

STATIONS: • NIGHT  ○ SUNRISE  ○ SUNSET

SAN FRANCISCO

Zooplankton Displacement Volume
Zooplankton Displacement Volume

$cc/1000\ m^3$ seawater strained

$N_{D} = 3.33$  $N_{I} = 2.00$

CALCOFI CRUISE 5912
9 - 19 DECEMBER 1959

STATIONS: ● NIGHT  ● SUNRISE
           ○ DAY    ● SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000 m$^3$) PER SAMPLE

0  200  400  600  800  1000

CAPE MENOCINO
SAN FRANCISCO
POINT CONCEPTION
SAN DIEGO
PUNTA EUGENIA

Zooplankton Displacement Volume

5912
The numbers to the right of the shoreline represent abundance at special inshore stations. When no eggs/larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated-abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

Zooplankton Displacement Volume

cc/1000m³ seawater strained

\[ \frac{N}{D} = 1.30 \quad \frac{N}{T} = 1.09 \]

CALCOFI CRUISE 6612
2-19 DECEMBER 1966

STATIONS: • NIGHT  ○ SUNRISE  ○ SUNSET

MEAN DISPLACEMENT VOLUME (cc/1000m³) PER SAMPLE

- 0
- 200
- 400
- 600
- 800
- 1000

60-67  70-77  80-87  90-97  100-107  110-119  120-127  130-137
These maps are designed to show essential details of the area most intensively studied by the California Cooperative Oceanic Fisheries Investigations. This is approximately the same area as is shown in color on the front cover. Geographical place names are those most commonly used in the various publications emerging from the research. The cardinal station lines extending southwestward from the coast are shown. They are 120 miles apart. Additional lines are utilized as needed and can be as closely spaced as 12 miles apart and still have individual numbers. The stations along the lines are numbered with respect to the station 60 line, the numbers increasing to the west and decreasing to the east. Most of them are 40 miles apart, and are numbered in groups of 10. This permits adding stations as close as 4 miles apart as needed. An example of the usual identification is 120.65. This station is on line 120, 20 nautical miles southwest of station 60.

The projection of the front cover is Lambert’s Azimuthal Equal Area Projection. The detail maps are a Mercator projection.
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Paul E. Smith

Distributional atlas of zooplankton volume in the California Current region, 1951 through 1966

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