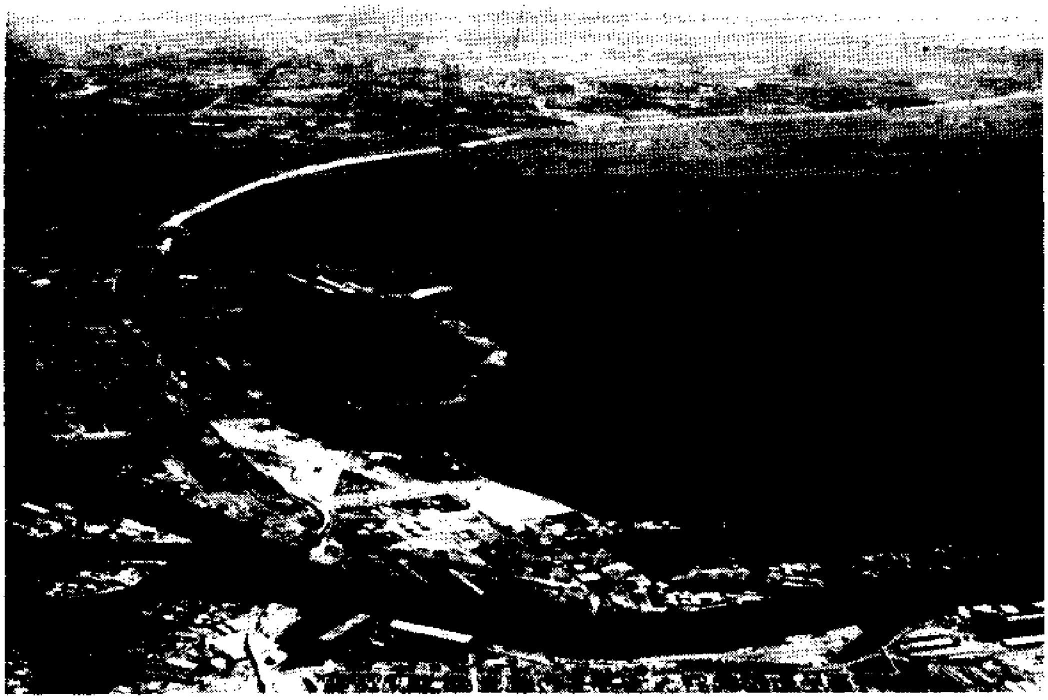
THE MARINE ENVIRONMENT IN LOS ANGELES AND LONG BEACH HARBORS DURING 1978

MARINE STUDIES OF SAN PEDRO BAY, CALIFORNIA

PART 17



A Report for the City of Los Angeles, Department of Public Works, the Port of Long Beach Division of Environmental Management, and the Port of Los Angeles Environmental Analysis Office.

by

HARBORS ENVIRONMENTAL PROJECTS
Dorothy F. Soule and Mikihiko Oguri, Editors

Published by:

Allan Hancock Foundation and
The Office of Sea Grant Programs
Institute for Marine and Coastal Studies
University of Southern California
Los Angeles, CA 90007

Printed by:

U.S. Army Corps of Engineers
Los Angeles District
Los Angeles, CA 90053

June 1980

THE MARINE ENVIRONMENT
IN LOS ANGELES AND LONG BEACH HARBORS
DURING 1978

A REPORT ON FIELD RESEARCH
CARRIED OUT UNDER CONTRACTS WITH:

THE CITY OF LOS ANGELES
Department of Public Works

THE PORT OF LONG BEACH
Division of Environmental Management

THE PORT OF LOS ANGELES
Office of Environmental Analysis

BY

HARBORS ENVIRONMENTAL PROJECTS
UNIVERSITY OF SOUTHERN CALIFORNIA
LOS ANGELES, CALIFORNIA 90007

JUNE 1980

MARINE STUDIES OF SAN PEDRO BAY, CALIFORNIA. PART 17.

USCSG-TR-02-80

Publication of this work was supported in part by NOAA Office of Sea Grant, Department of Commerce and the U.S. Army Corps of Engineers, Los Angeles District.

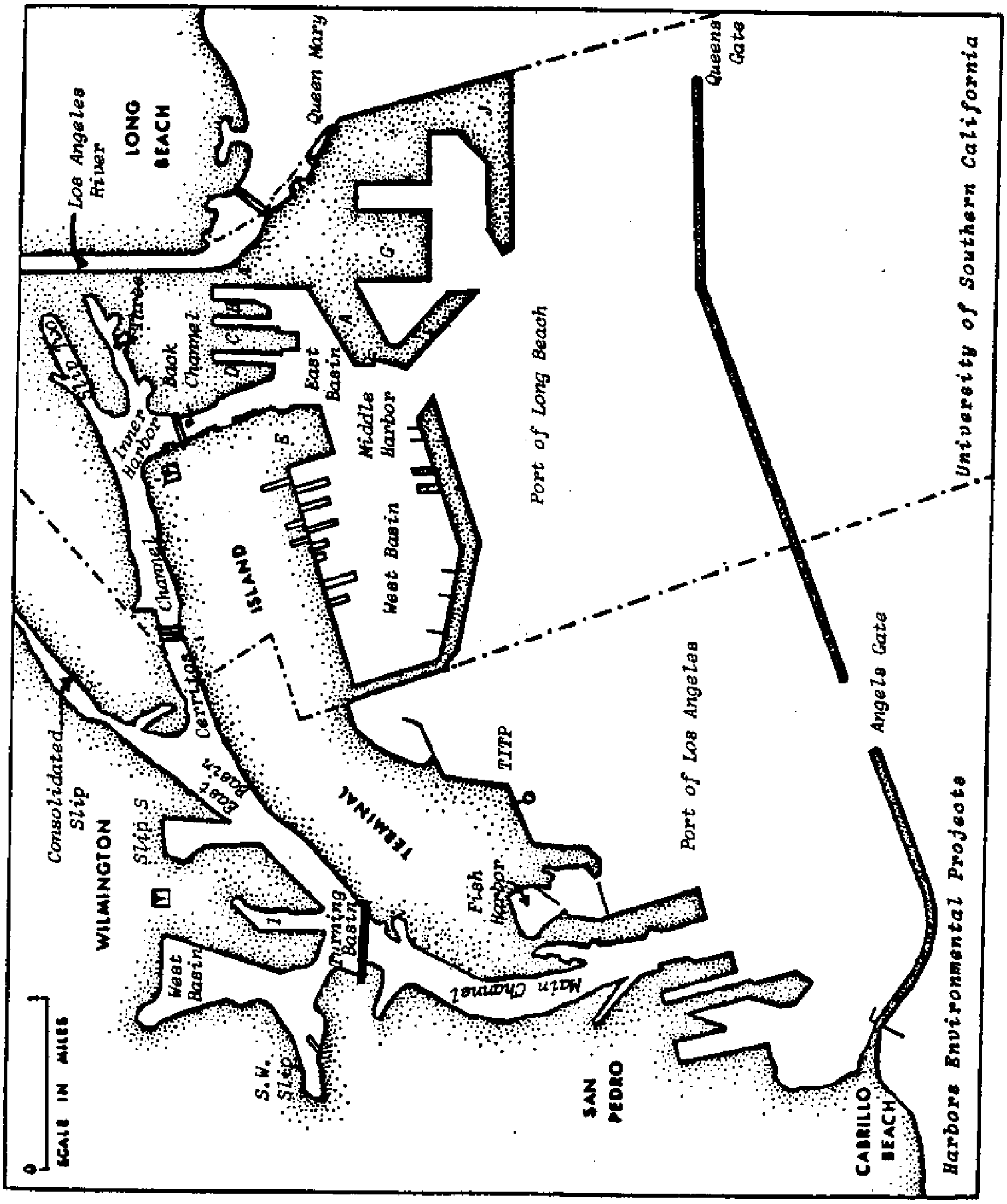

SCALE IN MILES
0
WILMINGTON
Consolidated Slip
Slip 5
West Basin
S.W. Slip
Turning Basin
Main Channel
Fish Harbor
TERMINAL
ISLAND
East Basin
Cerritos Channel
Channel
Inner Harbor
Back Channel
East Basin
West Basin
Middle Harbor
TTTP
SAN PEDRO
CABRILLO BEACH
Port of Los Angeles
Port of Long Beach
Angels Gate
Queens Gate
Queen Mary
Los Angeles River
LONG BEACH
Harbors Environmental Projects
University of Southern California

TABLE OF CONTENTS

FOREWORD

The present report is the result of research for three separate agencies, each of which has need for updated baseline information on the marine environment of particular areas in the Los Angeles-Long Beach Harbors region as well as for the entire harbor complex.

The City of Los Angeles Department of Public Works Bureau of Engineering was required to monitor the effects of newly constituted secondary waste effluent from the Terminal Island Treatment Plant in the central outer Los Angeles Harbor. The Port of Long Beach and City of Long Beach desired to update their Master Environmental Setting, which was published in 1976 and was based largely on 1973-1974 data. The Port of Los Angeles Environmental Analysis Office and the Army Corps of Engineers Los Angeles District needed an updated baseline in preparing for a major Main Channel dredging project. Thus Harbors Environmental Projects of the University of Southern California coordinated separate contracts so that the entire harbor from the innermost slips to the entries at Angels and Queens Gates, and from Cabrillo Beach on the west to the Los Angeles River plume in Long Beach on the east, was concomitantly monitored during the year 1978.

The present report is not an all-inclusive listing of raw data. It is, rather, intended to place the conditions found in the harbor in 1978 in the context of trends documented since the advent of California and Federal environmental quality enforcement, starting in 1970 and investigated by Harbors Environmental Projects in the outer harbor since 1971.

While no single study has covered the entire harbor during the 1971-1978 period, multiple parameter investigations for the Pacific Lighting Corporation (Southern California Gas Company) were carried on in outer Los Angeles Harbor for six years in the area of the waste discharges. Also, dissolved oxygen records of the cannery effluent plume were made for the Tuna Research Foundation for a similar period. A number of key investigations, referred to herein and reported in previous volumes of Marine Studies of San Pedro Bay, California, were funded in part by the University of Southern California Sea Grant Program (NOAA, Department of Commerce). Were it not for these investigations, the changes from year to year and season to season could not be compared with 1978 data, placing them in prespective.

Printing of this volume was contributed by the Army Corps of Engineers, Los Angeles District.

The Principal Investigator

EXECUTIVE SUMMARY

A year-long monitoring survey of the water quality and nutrient chemistry of San Pedro Bay was carried out in 1978 to update a similar survey conducted in 1973 and 1974. Both of these studies utilized many of the same stations and methods, which permits a more direct comparison of the data for the two periods.

Physical Environment (IIA)

The harbor waters reflect the properties of the adjacent ocean, as well as the terrestrial mediterranean climate and the urban uses of the waters during their residence time in the harbor. All of these influences on harbor water quality are variable, although the oceanic conditions are generally considered to be more stable over longer periods than are conditions in the shallower inshore waters.

Eastern Pacific surface water temperatures were compared to those at the entrance of Los Angeles Harbor for the years 1972 through 1978. Monthly temperatures at the entry for the same years were graphed, which showed that the January and February 1977 and 1978 temperatures were 3-5°C warmer than in the prior years.

Circulation patterns modelled at the Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, were illustrated, based on slides, showing changes in the outer harbor gyre under proposed landfill configurations.

Water Quality and Nutrient Chemistry (IIB)

Temperature. Intrusion of warmer, high salinity water into the harbor in November 1977 and in February, November and December of 1978 resulted in harbor mean temperatures that were one to two degrees Celsius higher than the averages in 1973 and 1974. At the sea buoys, the stations most reflecting the oceanic influence, the temperatures in 1978 averaged more than two degrees warmer than in the earlier years.

Within the harbor the reactivation of the Long Beach Generating Station with a capacity to discharge 734 mgd of cooling water, resulted in warmer waters in the Middle and Inner Harbor of the Port of Long Beach and the area east of Pier J, the direction of major ebb flow. The discharge probably altered circulation patterns in the harbor and may have resulted in the changed pattern of thermal distribution which showed Long Beach Harbor as warmer than Los Angeles Harbor. Warmer water also occurred in the vicinity of the Los Angeles River mouth; this may be due to easterly flow on ebb tide of Long Beach Harbor waters, suggested by thermal mapping (Section IIB).

Salinity. Salinity in the harbor is largely determined by oceanic characteristics with relatively lesser influence from land-related processes. However, a drop in mean salinities between 1973 and 1974 was due to cessation of oil brine dumping in the harbor. The surface salinity in the harbor in the summer and autumn is essentially marine. During winter and early spring 1978, storm runoff added a fresh water lens and reduced salinities through much of the harbor for a short time. The reduced salinity surface layer resulting from runoff did not persist from one sampling period to the next. This suggested that all parts of the harbor were effectively flushed within the one-month period between the field surveys. Special studies conducted in outer harbor areas indicated that flushing time may be as short as two weeks.

Dissolved Oxygen. Dissolved oxygen (DO) levels were generally higher in the outer harbors and lower in the inner harbors. The lowest mean seasonal values occurred in the summer, but low oxygen episodes may follow storm runoff or turbulence. The highest values occurred in the spring of 1978. Concentrations generally decreased with depth, except for locations with surface runoff.

pH. Mean seasonal pH values tend to be inverse to dissolved oxygen, with the lowest readings in the spring and the highest in summer and fall. However, pH is similar to dissolved oxygen in being highest at the surface and decreasing with depth, and in being higher in the outer harbor than in the inner harbor.

Nutrients. Analyses for nutrient chemicals included ammonia, nitrate, nitrite and phosphate. Highest concentrations were found near the Terminal Island Treatment Plant outfall and, except for ammonia, near the Los Angeles River mouth. Minima were generally found in the vicinity of the circulation gyre in the outer harbor and at the sea buoys outside the harbor. Values at the Los Angeles sea buoy (station A1) were always lower than those at the sea buoy (station B1) off Long Beach Harbor.

This indicates that the primary sources of nutrient enrichment in the harbor are wastewater discharges and terrigenous effluents of storm runoff. A net transport of water into Angels Gate, the entry to Los Angeles Harbor, is also suggested, based on the occurrence of a water area relatively low in nutrients extending from A1 into the harbor and eastward along the inside of the middle breakwater. Net transport at Queens Gate, the entry to Long Beach Harbor, appeared to be either minimally inward, or outward, as shown by nutrient concentrations.

Seasonal variation in the concentration of all of the nutrients measured showed winter maxima followed by progressive decreases in spring and summer. In fall the values increased.

Turbidity. Light transmittance, on an annual basis, did not change appreciably over the five-year period, although it was somewhat lower in 1978 than in 1973 at the sea buoys. Semi-annual means in the harbor showed wider fluctuations, due to seasonal storms or phytoplankton blooms. In the outfalls area during the summer of 1977 and winter 1977-78, when the treatment plant had been converted to secondary treatment, light transmittance was the poorest.

Harbor Sediments and Pollutants (IIC)

The distribution of sand, silt and clay in 1978 was not changed appreciably from that reported in 1973-1974. Seasonal variations were similar, as well.

There were improvements in levels of some pollutants in 1978 as compared with 1973-1974. Concentrations of PCB's, cadmium, copper, nickel and lead were clearly lower. Apparent decreases also occurred in total organic carbon and mercury, and sulfide dropped by an order of magnitude at stations analyzed.

DDT was absent from most of the harbor, but the levels increased at the entrance to Los Angeles Harbor, nearest to the Whites Point outfall outside the harbor to the west.

Increases in pollutants reflected petroleum-related events, with large increases in total oil and grease, and to a lesser extent total volatile solids. Other increases included those for immediate oxygen demand, total phosphorus, organic nitrogen, arsenic, chromium, iron, manganese and zinc.

The highest concentrations of eight out of 20 parameters occurred at the mouth of Dominguez Slough in Consolidated Slip, inner Los Angeles Harbor. These included Total Volatile Solids, Immediate Oxygen Demand, Total Organic Carbon, sulfide, oil and grease, chromium, lead and zinc.

Phytoplankton (IIIA)

Since 1973-1974 peak values for chlorophyll *a* (standing crop) and productivity have been reduced four-fold in the outer harbor and to twelve-fold in the inner harbor in 1978. While highest values were found during "blooms" and sometimes created anoxic conditions in earlier years, the 1978 reductions represented a decrease in available food, particularly for fish larvae or for detrital recycling.

In 1973-1974, coastal red tide blooms occurred from Baja California to Pt. Conception so the subsequent disappearance of harbor-wide blooms cannot be attributed solely to altered waste treatment or to control of urban runoff. The Los Angeles River continued to be an apparent source of phytoplankton stimulation, as did the Terminal Island Treatment Plant, but at reduced levels in 1978. Lowest annual mean values, representing ocean conditions, were generally found outside the breakwaters at the sea buoy stations and at the contiguous outer harbor stations.

Zooplankton (IIIB)

There was a decline at station A7 near the TITP outfall and adjacent stations in 1978 as a center of abundance of total zooplankton. Other notable changes which occurred were shifts in the distribution patterns and centers of populations of the dominant zooplankton species. It was discovered that the population, previously identified as *Acartia tonsa*, was composed of two species; *Acartia tonsa* occurred alone in the outer harbor and outside it, and in decreasing numbers in the Long Beach channel, while *Acartia californiensis* dominated inner Los Angeles Harbor.

The center of total zooplankton population density has shifted from the Long Beach channel and inner harbor area in 1973-74 to other areas, particularly inner Los Angeles Harbor. This is probably attributable to the Long Beach Edison generating plant operation, which can cycle 734 mgd of cooling water for heat exchange, and to improvement in inner Los Angeles Harbor.

Benthic Fauna (IIIC)

Over the 5-year period of 1973 to 1978, both numbers of species and numbers of benthic organisms per m^2 decreased by varying amounts. Following enforcement of water quality standards in 1970, numbers of species and populations increased precipitously from 1971 through 1973 in the Ports. A leveling off would have been expected, comparable to that which occurs in colonization of newly exposed substrates.

At A stations, in the outer Los Angeles Harbor area influenced by changes in waste effluents, species means peaked in 1976 and dropped sharply, to below 1972 levels in 1978. Populations decreased four-fold between 1973 and 1978. Decreases continued between January and October, 1978.

At B stations, primarily in the outer harbor or the principal Long Beach channel, mean species numbers peaked in 1973 and 1975 and decreased to 1978, but remained above 1972 levels. Mean populations decreased about three-fold between 1973 and 1978. Means of species and populations increased between January and October, 1978.

At C stations, inner Los Angeles Harbor Stations began with much lower means in 1972 than those at A and B stations. The means for species and populations peaked in 1975 but decreases were much less than those at A and B stations between 1975 and 1978.

Channel C stations alone showed greater increases in means in 1973-1975 than inner slip means. Mean species leveled off only slightly lower in 1978, but populations dropped about 1.5-fold from 1975. Between January and October 1978, mean species did not change appreciably and mean populations almost doubled. D stations east of Pier J at the mouth of the Los Angeles River showed wide fluctuations with a doubling of mean species between 1975 and 1978 but a 3.5-fold drop in mean populations. Between January and October 1978 both species and populations increased, probably reflecting recolonization after exceptionally heavy winter rains (37± in.).

Overall, harbor benthic mean populations dropped three-fold, due primarily to large decreases in the counts per m^2 in the outer harbor area that formerly received primary TITP and cannery wastes and was termed "enhanced".

Evenness improved, with less difference in numbers between the most numerous species than had been found previously. Species composition changed somewhat, but the fauna was still largly soft-bottom polychaetes.

Fish Populations (IIID)

Fish populations in the outer Los Angeles and Long Beach Harbors, as sampled by otter trawl, dropped four-fold between 1973 and 1978. The changes in fish populations were greatest in the period following the installation of dissolved air flotation (DAF) treatment at the fish processing plants in 1974-75, when there was a large reduction in organic load (BOD), particulates and suspended solids. There was further decline following the initiation of secondary waste treatment for both urban and cannery effluents in October 1977-January 1978.

Anchovy decreased from 50 to 100-fold in the harbor in five years, depending on the data source, while estimates based on acoustical surveys indicated a four-fold drop offshore, and commercial catch decreased more than ten-fold between 1975 and 1978.

Meroplankton (Settling Rack) Fauna (IIIE)

Settling racks were deployed at 3m depths at 23 stations throughout the harbor and changed monthly in 1978. Data were compared with those from the 1973-1974 studies at most of the same locations. The 1978 numbers of individuals and occurrences were reduced to 74 percent of the 1973-74 totals. There was a shift in dominance to the amphipod crustacean species and away from polychaete worms. This represents a decrease in available nutrients to consumer species as well as a reduction in organic load in the water and sediments.

Birds (IIIF)

Bird populations were surveyed quarterly in the outer harbor in 1978 in conjunction with Terminal Island Treatment Plant studies (Soule and Oguri, April, 1979). The data were compared with those of the two-year survey conducted weekly in 1973 and 1974 (AHF, 1976). Bird populations were reduced 2.5-fold in 1978 as compared with the earlier survey. Most notable reduction was in the gull species, which were reduced more than 3-fold. All other species, exclusive of gulls, decreased approximately 1.7-fold; these were principally fall and winter migratory species.

Two rare and endangered species increased. The Brown Pelican populations probably have continued to improve due to the control of DDT in effluents at Whites Point, west of the harbor. The Least Tern increased slightly, probably due to successful nesting nearby which had been disrupted in previous years.

SECTION I. INTRODUCTION

OBJECTIVE

The purpose of the present volume is to provide an updated report on the marine biological environment of the Ports of Los Angeles and Long Beach in the waters of San Pedro Bay, during the year 1978. Earlier, in 1973 and 1974, Harbors Environmental Projects (HEP) of the University of Southern California (USC) had undertaken the first comprehensive studies of the harbor waters, from Cabrillo Beach on the west to the San Gabriel River mouth on the east (Allan Hancock Foundation, 1975, 1976). Those investigations were carried out under funding from the U.S. Army Corps of Engineers, the USC Sea Grant Program, the Southern California Gas Company, and the Port of Los Angeles, each funding various portions of the research.

Further investigations were initiated in 1976 in outer Los Angeles Harbor for the City of Los Angeles Department of Public Works to determine the impacts of converting the Terminal Island Treatment Plant (TITP) to secondary waste treatment and eliminating the two fish processing outfalls. In 1978, the City and Port of Long Beach and the Port of Los Angeles agreed to fund studies of their particular districts that were not covered by the TITP investigations, in order to update the marine environmental baseline for the Port areas. Because the California Environmental Quality Act and the National Environmental Policy Act require current information on the environmental setting for Environmental Impact Reports and Environmental Impact Statements such information is needed for planning and implementation of Port or City projects.

Because there is now no long-term, harbor-wide monitoring program, it has been necessary to combine data and information from a number of projects to provide indications of long-term trends. Thus, all data are not directly comparable, but at the least they offer the opportunity to make comparisons from the same harbor areas rather than to force drawing of conclusions from the existing literature on widely differing harbors in other localities or oceans in the world.

Ideally, basic harbor-wide monitoring should be carried out on a continuing basis. That would permit specialized, research-oriented programs to use those data as a point of departure for studies such as causes of red tide, effects of wastes, oils and metals, and effects of new developments. As it now stands, basic research on problems is always superceded by the need for updated baselines and Environmental Impact Reports or Statements.

METHODS AND MATERIALS

Field methods for the 1978 Harbors Environmental Projects studies included standard biological oceanographic techniques and parameters, with the addition of some special techniques, as requested by supporting agencies. Table 1 lists the methods and technical references used in the present study. Soule and Oguri (1979) also summarized the methods used in various HEP investigations in Los Angeles-Long Beach Harbors since 1971. These are discussed below.

Parameters to be sampled and measured were selected in an effort to give the most effective, practicable evaluation of various components of the ecosystem, such as benthic, planktonic and nektonic biota. The physical (abiotic) parameters were selected to give a representative picture of the marine environment without costly *in situ* equipment or continuous recording of masses of data. Such equipment elevates the cost of monitoring to the point that public agencies and private industries may not choose to carry out baseline programs, except when required to do so by agencies as conditions of site-specific permits.

Harbors Environmental Projects established permanent stations in outer Los Angeles Harbor in 1971, and harbor-wide stations in 1972-73. Thus HEP has been able to gather data at standard locations for most parameters under their various contracts and grants, even though no single, long-term contract existed for the eight years of harbor research involved and all stations could not be maintained during that period.

In some cases techniques were changed over the years, either in consultation with peers, or at the request of funding agencies. Some sacrifice in comparability is almost always made for improving techniques. However, where the techniques and parameters were altered for different studies and objectives over time, the comparability is at least more fortuitous than is the case in the usual literature survey, so valued by public agencies and researchers. Instruments for measuring water parameters have been much improved over time, but nutrient analyses, phytoplankton productivity, and chlorophyll measurements used are standard methodology. Benthic sampling by box corer is much improved over any other sampler, but requires a large ship with an A-frame, so that some agencies may prefer the Van Veen grab usable from a smaller boat equipped with a davit (Word, 1976). Sorting of benthic samples has been done entirely with a 0.5mm mesh screen, because it recovers many more species and individuals than a 1.0 mm mesh. However, the finer screen is not preferred by those who wish for quicker (cheaper) sorting. Tyler screen sets are too small to be effective in washing the large box corer samples but the mesh size is the same.

Zooplankton were sampled by horizontal tows of a 253μm mesh, conical net in 1972-77. Timed oblique tows were tested and found to be too difficult to maneuver in harbor traffic, in confined slips and where rubble lay on the bottom to snag the nets. Plankton pumps were tested but were deemed unsatisfactory by HEP systematists, due to excessive breakage of fragile organisms. Vertical tows were adopted for 1978 after a number of samplings by paired horizontal and vertical tows showed that the vertical method better represented harbor species diversity. Also, vertical tows reflected the summertime populations better, when zooplankton migrate downward with increased light intensity.

Most of the techniques and most of the senior supervising staff have remained the same for the eight-year harbor research period. Since some particular techniques were carried out for specific short-term objectives, it was not possible to maintain all of the activities over the entire time or over the entire harbor, perhaps to the regret of any one who attempts to make comparisons after lapses in time. The following paragraphs outline the basic methods used in the 1978 studies, or for comparison and discussion.

<u>Biological Assessment</u>

1. Benthic fauna are sampled by grab sample devices selected according to substrate, sample size needed and water depth. The Campbell grab, or the similar Van Veen sampler, require a davit hoist and sample a 0.1 square meter of surface, but the grab mixes the sample. The Reinecke box corer requires a heavier A-frame and takes a sample of 0.06 m^2 surface, to a depth of 46 cm. It has the advantage of retaining the core intact and unmixed, and metal parts do not touch the surface sediment, so that uncontaminated trace metal or pesticide samples can be taken from the same core as the benthic animals. The box corer was used at all but the most shallow stations by HEP. The benthic sample is washed with running sea water through 0.5 mm mesh screens. The screened sample is preserved in 10% formalin-seawater solution and returned to the laboratory. Organisms are screened through 0.5 mm mesh Tyler screens and transferred to 70% ethanol for identification to species level, as feasible. Optionally, wet weights may be determined for major categories before transfer to alcohol; alcohol dehydrates the specimens and would lower wet weight values. Benthic organisms are good indicators of long-term environmental conditions and stress.

2. Zooplankton are sampled with a 253μm mesh conical nylon net equipped with a calibrated flow meter. The net was towed vertically through the water column for the 1978 sampling, to make the samples more comparable to the Edison Long Beach generating station data. Plankton are rinsed in the net to the cup end with running sea water. The cup is

emptied into a quart glass jar of sea water, and formalin is added to make a 9:1 dilution. In the laboratory settling volume is measured. An aliquot is then taken with a Folsom plankton splitter and organisms are identified to species level, as feasible. Count can then be calculated to numbers per cubic meter, based on flow meter readings.

Various special collections of the plankton may also be carried out using other gear, as is appropriate. Available for these purposes are paired bongo nets used for sampling ichthyoplankton.

3. Phytoplankton samples for determination of primary productivity and chlorophyll concentration are collected using a clear plastic bucket or other plastic sampler such as a Van Dorn or Nauman sampler.

For productivity measurements two clear and two opaque, glass stoppered, 124 ml pyrex bottles are filled with aliquots of the water sample. These are stored for up to five hours in a darkened cooler box until all samples are taken in a series and a predetermined "standard" time is set for starting incubation. Prior to starting incubation, a known quantity of isotopic ^{14}carbon as carbonate is injected into each of the paired bottles. These are then incubated in an artificially illuminated incubator held at ambient seawater temperature. Light sources are cool white fluorescent tubes arrayed so that two of the tubes illuminate each row of bottles. Following about three hours of incubation, the contents of each bottle is filtered through a Millipore AA filter which is then dried and returned to the laboratory. The filters containing the phytoplankton filtered from the water samples are then inserted into a Geiger counter to determine how much of the ^{14}carbon was photosynthetically fixed by the organisms. Based on these data, the productivity of the waters is calculated by a modification of the method described by Strickland and Parsons, 1968 (A Practical Handbook of Seawater Analysis. Bulletin 167, Fisheries Research Board of Canada, Ottawa).

4. Chlorophyll *a*. For chlorophyll measurements, an aliquot of the same water sample collected for productivity determination is filtered through a Millipore HA filter. A few milliliters of a suspension of magnesium carbonate are added to the sample prior to or during filtration to retard degradation of the chlorophyll. The filter is stored in a chilled dessicator for return to the laboratory. In the laboratory the pigments are extracted into 90% acetone and the peak absorbances for the different chlorophylls are read in a spectrophotometer. This method and subsequent calculations are described by Strickland and Parsons (1968) in the reference cited above.

5. Midwater settling racks are used to measure the biological potential of waters to recolonize harbor substrate and to assess the settling and fouling communities. Settling racks, consisting of a wooden frame containing 25 standard glass microscope slides and covered with plastic screening, are suspended at 3 meters from the surface for a period of one month. Upon retrieval, the rack is immediately immersed in a 10% formalin-seawater solution. In the laboratory the organisms are carefully scraped from the glass slides and are identified to the lowest possible taxa.

6. Settling and fouling communities have, in other studies, been evaluated by collecting samples from bulkheads, dikes, wharf pilings, breakwaters or riprap. This method samples more mature communities associated with fixed depths, or substrates which may have been treated to retard growth of marine organisms. At specified intervals along the length and depth of the substrate to be sampled, SCUBA-equipped divers collect all organisms that lie within the area of a 17 cm^2 template placed over the surface. These collections are preserved in formalin and returned to the laboratory for identification.

Diver teams, trained as biological observers, may qualitatively observe and record information on the biota, or they may sample along transect lines or within quadrat areas for quantitative data. The use of underwater photography for field assessment has been found to be variable in quality, depending on turbidity, and unreliable for critical determination of species identity. Dive activities are restricted to depths not exceeding 100 feet. Past SCUBA studies have included dredge site recolonization, oil spill site recovery and new habitat development.

7. Microbiological sampling has in the past been carried out in conjunction with other sampling for enumeration of organisms or for measurement of BOD. Samples collected have been used for determination of standard water quality tests, such as standard plate count, total and fecal coliforms, fecal strep and 5-day BOD. Methods used for these determinations are based on those described in the 14th edition of "Standard Methods for the Examination of Water and Wastewater" (APHA, 1975). Studies that required the development of special methods have investigated the trophic role of microbial population in the harbor. Acridine Orange Direct Counts fluorometrics and glucose and phosphate uptake procedures were used (Soule and Oguri, 1979).

8. Surveys of fish populations are carried out using several different methods, whose choice will be determined by the area to be sampled and the purposes of the study. Direct sampling of fish populations is carried out in relatively open areas by using a bottom trawl, the Marinovich (16 foot head rope) otter trawl. Trawl time is typically

ten minutes. For other studies beam trawls are used, and in limited access areas gill nets are used to sample the fish populations. Following collection the fish are counted, sorted by species, examined for health condition and age class, and measured.

Less precise methods of assessing fish populations are used for special projects or for supplementing the data base. These include direct observation by diver, creel census, queries directed to commercial fishermen, and California Department of Fish and Game party boat statistics.

9. Ornithological surveys are carried out periodically to determine the resident bird population, the nesting areas, the number of migratory species utilizing the harbor seasonally, and the activities, e.g., nesting, resting and foraging, of the birds. Surveys consist of visual observation by qualified observers who are familiar with the local avifauna and their behavior.

Water Quality

1. Physical parameters of a) temperature, b) salinity, c) oxygen and d) pH are measured from surface to bottom in the water column at one meter intervals using a Martek water quality analyzer. A HydroProducts transmissometer is usually used to measure transparency, but a Secchi disc may be used alternatively since the instruments frequently malfunction.

2. Nutrient chemistry is routinely carried out on aliquots of the same water sample from which the phytoplankton productivity and chlorophyll *a* samples are drawn. Phosphate, nitrate, nitrite and ammonia analyses are carried out on aliquots of filtered water, using the methods described by Strickland and Parsons (1968).

3. Studies of currents and circulation have not been routinely carried out in the past, but were done as special studies. Drogues have been used at various depths in the harbor. Current meters have also been used for longer-term deployment in a fixed location. Indirect assessment of the currents may be carried out by computer modeling, which permits testing proposed new configurations.

Sediment Analysis

1. Collection of sediment samples for subsequent chemical and grain size analysis are carried out in conjunction with benthic faunal sampling and are thus restricted to the surface layer of the sediment. Samples from other depths along the length of a core can also be taken. The sample to be analyzed is drawn from a portion of the core that is not

in contact with the metal sides of the coring device. Samples to be analyzed were taken in plastic cups, sealed and frozen for transport to the laboratory. For pesticide analysis of water samples, glass containers must be used.

2. Grain size analysis is based on settling rates and gravimetric determination of the fractions of sand, silt and clay (Felix, 1969; Gibbs, 1971).

3. Chemical analyses of sediment samples are done by the Environmental Engineering Laboratory of the University of Southern California. The methods used are outlined below and are based largely on those described in Standard Methods for the Examination of Water and Wastewater. 14th ed. 1975, and in the EPA Manual (Methods for Chemical Analysis of Water and Wastes, 1974), or on methods developed in the USC laboratory. Table 2 lists the detection limits and expected error for the various parameters.

Determination of metal concentrations is based on the use of atomic absorption spectrophotometry, using either a heated graphite analyzer or a flame atomizer and appropriate extraction techniques. The choice of atomizer techniques is based on the concentrations expected. In the case of mercury, cold vapor atomic absorption following digestion is used.

Chlorinated hydrocarbons analysis is based on the use of gas chromatographic separation. Linear temperature programming and flame ionization detectors and comparison with standard solutions are used. Following extraction into petroleum ether, preliminary separation is carried out using a column chromatograph.

All other parameters are measured by standard methods as described in the two references cited above.

Bioassay/Toxicity Studies

Short-term toxicity tests and longer-term bioassay tests are carried out using a variety of invertebrate organisms and fish species found in the local environment. The techniques used are based in part on those described in the 14th edition of Standard Methods for the Examination of Water and Wastewater, or are stipulated in the implementation manual for Section 103 of Publication 92-532 prepared by the Environmental Protection Agency and the U.S. Army Corps of Engineers (1977).

Organisms for testing are either obtained from cultures or are collected from nearby sites and maintained in environmentally controlled conditions until needed. Axenic and uni-algal cultures of various species of phytoplankton are available, as are cultures of some polychaetous annelids, such as *Neanthes*. As need arises, cultures of the copepod *Acartia* can be developed. Molluscs such as *Macoma* and *Parvilucina*, mysids such as *Acanthomysis* and crustaceans such as *Emerita* can be readily collected. Fishes used have included the sanddab, *Citharichthys stigmaeus*, the killifish *Fundulus parvipinnus*, anchovy eggs, larvae and adults (*Engraulis mordax*) and others. The selection of organisms is based on the objectives of the test, the requirements stipulated and the availability of the various species. Static or flow-through tests are carried out in portable cargo-container labs.

Computer Analysis

Methods for integrating and evaluating large bodies of data by computer analysis have been developed by HEP personnel (Smith, 1976) and were presented in detail, including formulations, by Smith in Soule and Oguri (1979). The first harbor-wide ecological study in 1973-1974 by HEP (AHF, 1976) used the initial analytical package, which has since been extensively revised.

Hierarchical classification is used to identify groups of stations (sites) with biological similarities. The groups developed from the biological (biotic) composition are then compared to patterns of the measured abiotic environmental parameters. Hypotheses are then suggested concerning the relationships of the organisms to their environment.

Prior to classification, species abundances are transformed by square root and standardized by species maxima. Flexible Sorting (3=.25) Strategy (Lance and Williams, 1967) and the Bray-Curtis Distance Index (Bray and Curtis, 1957; Clifford and Stephenson, 1975) are used to classify sampling sites.

The relationships between species and station groups as defined by classification dendrograms are examined in two-way coincidence tables (TWT) (Kikkawa, 1968; Clifford and Stephenson, 1975). The numbers in the TWT matrix represent the species maxima, transformed and converted to symbols.

Abiotic values are transformed by square root, or natural log, depending on how extreme the ranges of variation are. Ranges are examined by histograms to determine skewness. Coefficients of separate determination are then obtained by Weighted Discriminant Analysis (Smith, 1979). The coefficients are expressed in percents of total group separation.

Field Stations for 1978

Figure 1 shows the station locations surveyed in 1978. Stations A1-A4, A7-A9, A11-A17, B8 and B9 were surveyed as part of the City of Los Angeles Terminal Island Treatment Plant studies. These were reported on in Marine Studies of San Pedro Bay, Part 16, entitled Ecological Changes in Outer Los Angeles-Long Beach Harbors Following Initiation of Secondary Waste Treatment and Cessation of Fish Cannery Waste Effluent in April 1979.

The Port of Long Beach stations surveyed were B1-B7, B10 and B11, D1-3. The City of Long Beach requested adding station D10 at the site of the proposed Downtown Marina.

The Port of Los Angeles survey stations included A10 and C1-C11.

In 1973 and 1974, the stations surveyed were A1-A11, B1-B11, and C1-D9. Thus five A stations and special microbial station A0 were added in 1978. Stations A5 and A6 were dropped by the agencies, as were stations D4-D9. Figure 2 shows the 1973-1974 monitoring stations.

The Southern California Gas Company had supported monitoring of selected A and C stations from 1971 to 1978. Without their continued participation no long-term trends would have been documented.

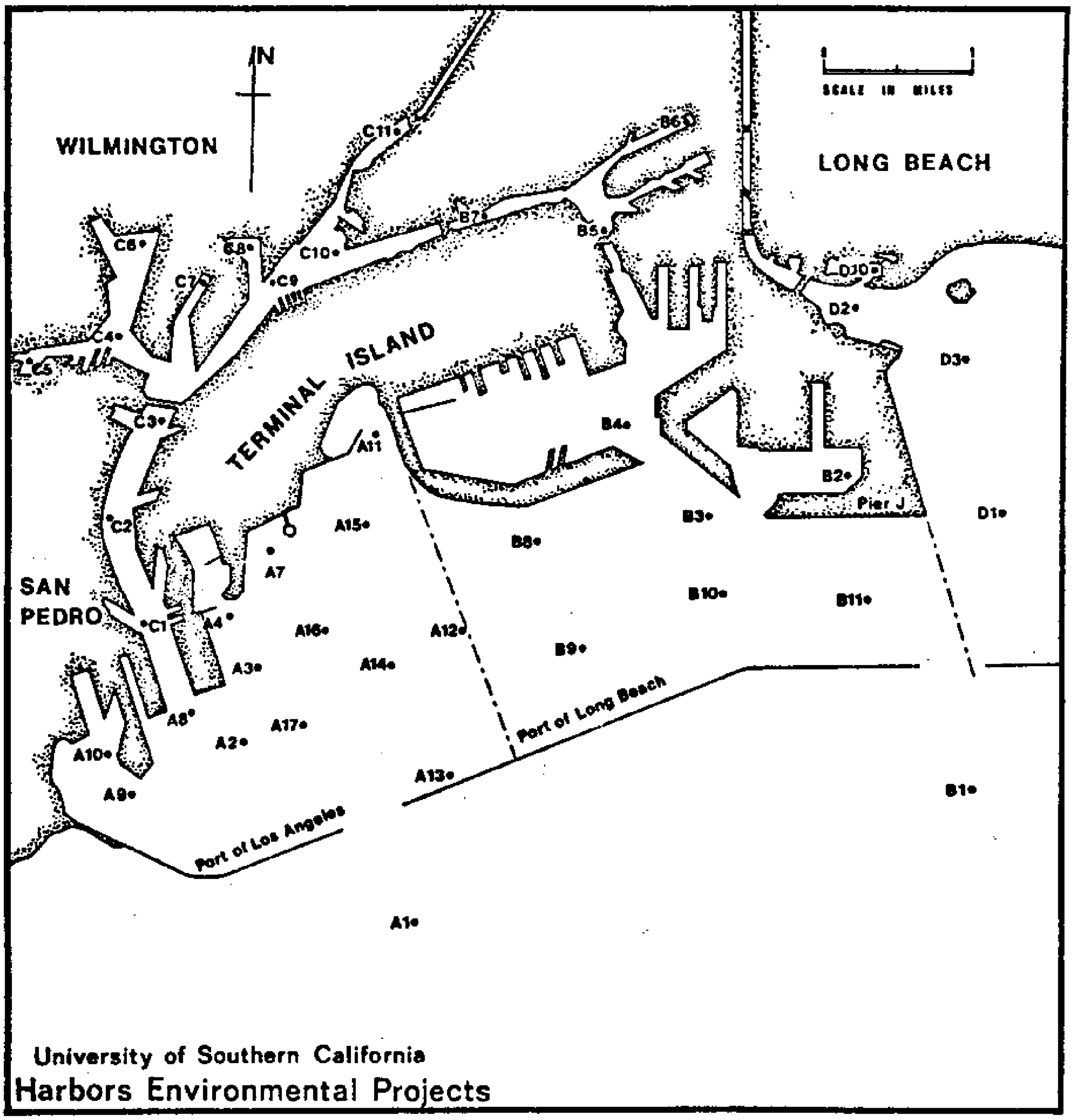


FIGURE 1. 1978 SURVEY STATIONS

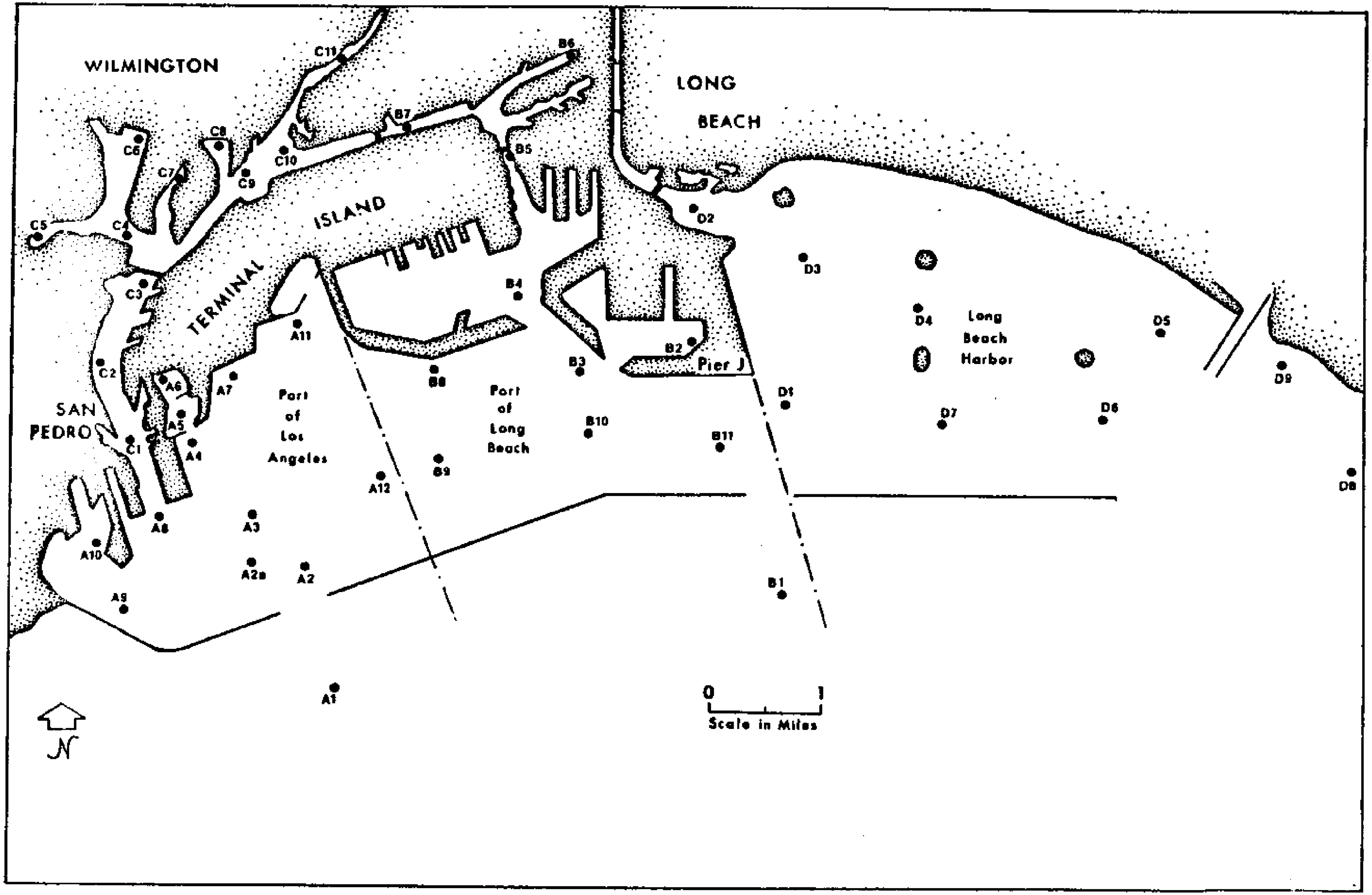


FIGURE 2. 1973-1974 SURVEY STATIONS.

Table 1. PARAMETERS MEASURED, LOS ANGELES-LONG BEACH HARBORS

A. MONTHLY MONITORING	METHODS
1. Abiotic Parameters	
a. Temperature b. Salinity c. Dissolved Oxygen d. pH	Martek electronic remote probe, at 1m intervals through the water column
e. Light transmittance	Hydroproducts Transmissometer, remote probe with self-contained light path, at 1m intervals through depth, or secchi disc
f. Ammonia	Solorzano (1969)
g. Nitrite	Strickland and Parsons (1968)
h. Nitrate i. Phosphate	Modified Strickland and Parsons (AHF, 1976)
2. Biotic Parameters	
a. Primary Productivity, Phytoplankton	Modified Steeman-Neilsen (1952) ^{14}C light and dark bottles, standard light source incubator with ambient water temperature
b. Chlorophyll *a*	Spectrophotometry, Strickland and Parsons (1968) equations
c. Assimilation ratio	
d. Zooplankton species	253μ mesh, 2 meter net surface tow with flow meter, vertical path
e. Water column fouling fauna, larvae and juveniles	25 glass microscope slides in wood slide box frame rack, plastic screened, suspended at 3m depth; 700 cm^2 of surface are exposed.

B. QUARTERLY MONITORING	METHODS
1. Biotic Parameters	
a. Benthic Fauna	Campbell grab or Reinecke box corner, 0.5mm screen
b. Fish species	Otter trawl, gill netting
c. Bird species	Visual Survey (outer harbor)
C. OTHER	
1. Abiotic Parameters	
a. Sediment grain size	Pettijohn (1957), Felix (1969), Gibbs (1971), AHF.
b. Trace metals pesticides	Amer. Publ. Health (1971) AHF (1976)
2. Biotic Parameters	
a. Biological Oxygen Demand (BOD)	Standard Methods (American Public Health 1971), modified by Juge and Greist (1975), surface samples
b. Total Coliforms	
c. Fecal Coliforms	Millepore (1972), AHF (1976)
d. Fecal Streptococcus	
e. Bacterial Standard Plate Count	Amer. Soc. Microbiol. (1957) AHF (1976)
f. Bacteria-Direct Count	Daley & Hobbie 1975
g. Bacterial Standing Crop	Ferguson & Rublee 1976

TABLE 2

SEDIMENT ANALYSIS

Variation and Detection Limit

Constituent	Error %	Det. Limit	Constituent	Error %	Det. Limit
Moisture %	0.5	0.01%	Arochlor 1242	5	1×10^{-10}gm
Dry Matter (%)	0.1	0.01%	Arochlor 1254	5	1×10^{-10}gm
COD	5	0.25 ppm	Arochlor 1260	5	5×10^{-11}gm
TOC	4	0.001%	Lindane	5	5×10^{-13}gm
TVS	1	0.01%	BHC	5	4×10^{-12}gm
IOD	5	0.25 ppm	Heptachlor	5	4×10^{-12}gm
Oil & Grease	5	10 ppm*	Aldrin	5	4×10^{-12}gm
Kjeldahl N	5	0.2 ppm	Heptachlor Epoxide	5	4×10^{-12}gm
Norg	5	0.2 ppm	Kelthane	5	5×10^{-11}gm
P	4	0.05 ppm	Methoxychlor	5	2×10^{-11}gm
Sulfide	5	2 ppm	Chlordane	5	8×10^{-12}gm
Hg	5	0.001 ppm	Toxaphene	5	1×10^{-10}gm
Pb	1.5	0.05 ppm	Dieldrin	5	4×10^{-12}gm
Zn	0.5	0.005 ppm	DDE	5	3×10^{-12}gm
As	6	0.005 ppm	DDD	5	6×10^{-12}gm
Cd	0.5	0.005 ppm	o, p', DDT	5	8×10^{-12}gm
Ni	1	0.025 ppm	p, p', DDT	5	8×10^{-12}gm
Cu	1	0.02 ppm	Total DDT		--
Fe	0.1	0.2 ppm	Endrin	5	1×10^{-10}gm
Cr	2	0.01 ppm	Others (name)		--

* Based on 10 grams of dry sediment.

TABLE 3

CONVERSION TABLE

(Metric Units to English Units)

Temperature (Values marked E = exact °F, others rounded)

°C	E	1	2	3	4	5E	6	7	8	9
0	32	34	36	37	39	41	43	45	46	48
10	50	52	54	55	57	59	61	63	64	66
20	68	70	72	73	75	77	79	81	82	84
30	86	88	90	91	93	95	97	99	100	102

Area

1 Hectare	=	2.471	Acres
1 Square Meter	=	1.196	Square Yards
1 Square Meter	=	10.76	Square Feet

Distance

1 Kilometer	=	0.6214	Mile
1 Meter	=	1.094	Yards
1 Meter	=	3.281	Feet
1 Centimeter	=	0.3937	Inch

Volume

1 Cubic Meter	=	1.308	Cubic Yards
1 Cubic Meter (liquid)	=	274.17	Gallons
1 Liter	=	0.2642	Gallons

Pressure

1 Newton/Square Meter	=	0.000148	Pound/Square Inch

Power

1 Kilocalorie	=	3.9685	British Thermal Units (BTU's)

Weight

1 Metric Ton	=	1.1	Short Tons
1 Kilogram	=	2.205	Pounds

EMPLOYEES OR ASSOCIATES OF HARBORS ENVIRONMENTAL PROJECTS - 1978/1979

MANAGEMENT BIOLOGISTS

Director: Dorothy F. Soule, Ph.D., Senior Research Scientist, Institute for Marine and Coastal Studies, Adjunct Professor of Environmental Engineering; Marine Biology.

Associate Director: Mikihiko Oguri, M.S., Research Scientist, Institute for Marine and Coastal Studies; Phytoplankton Ecology, Marine Biology.

Associate Director: John D. Soule, Ph.D., Professor of Histology and Biology, USC, and Research Associate, Allan Hancock Foundation; Histology, Pathology, Marine Invertebrates.

PRINCIPAL INVESTIGATORS/CONSULTANTS

B. C. Abbott, Ph.D. Director, Allan Hancock Foundation; Chairman, Department of Biological Sciences. Phytoplankton, red tide toxins, biostimulation. (Ph.D. Cambridge Univ.).

K. Y. Chen, Ph.D. Chairman, Environmental Engineering, USC. Trace metal chemistry, amplification, sanitation engineering. (Ph.D. Harvard Univ.).

John Dawson, M.A. Research Scientist, Harbors Environmental Projects, USC. Zooplankton fauna, ecology. (M.S. Cal.St.U.Humboldt).

Ethan D. Churchill, Ph.D. Research Associate, Terrestrial Botany, Harbors Environmental Projects, USC. (Ph.D. Catholic Univ. Amer.).

C. Robert Feldmeth, Ph.D. Associate Professor, Biology, Claremont Colleges, and Research Scientist, Harbors Environmental Projects, USC. Marine ecology (Ph.D. Univ. Toronto).

Patricia Kremer, Ph.D. Research Scientist, Harbors Environmental Projects, USC. Estuarine ecology, computer modelling, oxygen budgets. (Ph.D. Rhode Island).

J. J. Lee, Ph.D. Associate Professor, Civil Engineering, USC. Ocean Engineering, Ocean engineering, hydrodynamics, modelling, computer. (Ph.D. Cal Tech).

John McDonald, M.A. Lecturer, Geography, USC. Computer mapping, sociogeography. (U.S. Army and M.A. Cal State Northridge).

Mikihiko Oguri, M.S. Associate Director, Harbors Environmental Projects, IMCS-USC. Phytoplankton, productivity, physical water quality, radioisotopes. (M.S. Univ. Hawaii).

Dennis Power, Ph.D. Director, Santa Barbara Museum of Natural History. Associate for Ornithology. (Ph.D. Univ. Kansas).

Donald J. Reish, Ph.D. Professor of Biological Sciences, Calif. State Univ. Long Beach, and Research Associate, Harbors Environmental Projects, USC. Benthic ecology, bioassay. (Ph.D. USC).

Robert Smith, Ph.D. Research Scientist, Harbors Environmental Projects, USC. Benthic ecology, computer ecosystem analysis. (Also independent consultant, BLM, Los Angeles City, Texas A&M, etc.). (Ph.D. USC).

Dorothy F. Soule, Ph.D. Director, Harbors Environmental Projects and Harbor Research Laboratory, Senior Research Scientist, IMCS-USC, and Allan Hancock Foundation. Invertebrates, ecology. (Ph.D., Claremont Grad. School).

John D. Soule, Ph.D. Professor of Histology and Biology, USC, and Research Associate, Allan Hancock Foundation. Histology, pathology, marine invertebrates. (Ph.D. USC).

John S. Stephens, Jr., Ph.D. James Irvine Professor of Biology, Occidental College and Research Associate, Harbors Environmental Projects, USC. Ichthyology, marine ecology. (Ph.D. UCLA).

Cornelius W. Sullivan, Ph.D. Assistant Professor, Biological Sciences, USC. Marine microbiology, biogeochemistry, phytoplankton ecology. (Ph.D.UCSD).

Gary Troyer, M.S. Associate Professor, Claremont Colleges, and Research Consultant, Harbors Environmental Projects, USC. Ecological assessment, diver surveys. (M.S. Univ. Redlands).

Louis C. Wheeler, Ph.D. Professor Emeritus, USC, Associate for Terrestrial Botany. (Ph.D. Harvard Univ.).

Mary Wicksten, Ph.D. Research Scientist, Harbors Environmental Projects, USC. Marine ecology, crustacean biology, literature surveys. (Ph.D. USC).

Charles Woodhouse, Ph.D. Marine Mammalogist, Santa Barbara Museum of Natural History. Consultant.

ASSOCIATE INVESTIGATORS

Kent Adams, M.S. Research Assistant, Harbors Environmental Projects, USC. Bioassay, Environ. Engineering. (M.S. USC).

Scott Brady, Ph.D. Research Assistant, Harbors Environmental Projects, USC. Biochemistry. (Ph.D. USC).

Margaret Callahan, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Zooplankton.

Paul Collins, Santa Barbara Museum of Natural History. Vertebrate biology (UCSB).

Richard Hammer, M.S., Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Zooplankton, crustacean biology. (M.S. Texas A&M).

Clyde Henry, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Benthic ecology, computer ecosystems analysis. (M.A., Texas A&M).

Anne L. Holmquist, Ph.D.(cand.) Research Scientist, Harbors Environmental Projects, USC. Phytoplankton productivity.

David Krempin, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Radioisotopes, microbiology.

Larry Randall McGlade, M.S. Research Assistant, Harbors Environmental Projects, USC. (M.S., Cal. St.U.Long Beach).

Sarah McGrath, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Radioisotopes, microbiology.

Gregory Morey-Gaines, Ph.D.(cand.). Research Assistant, Biological Sciences, USC. Phytoplankton, biostimulation, food webs.

T.J. Mueller, Ph.D.(cand.). Consultant in statistical analysis, USC.

Marianne Ninos, Ph.D.(cand.). Research Assistant, ichthyoplankton, HEP, USC.

Robert Osborn, M.S. Research Assistant, Harbors Environmental Projects, USC. Benthic fauna, polychaete biology. (M.S., Cal.St.U.Long Beach).

Scott Ralston, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Ichthyology, developmental biology.

Timothy Sharp, M.S. Research Technician, Harbors Environmental Projects, USC. Microbiology, radioisotopes.

Sarah Swank, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Phytoplankton, bioassay, ecology.

Gordon Taylor, Ph.D.(cand.). Research Assistant, Harbors Environmental Projects, USC. Microbiology, radioisotopes.

TECHNICAL SUPPORT STAFF

Charles Robert Bostick
James Bryan
Debra Bright
Clairessa Cantrell
John Dmohowski
James Dorsey
Frank Edmands
Donna Eto
Melanie Hunter
Maria Lorente
Alawia Mahgoub
Vanessa McGlade
Steve Petrich
Roseanne Ruse
David Schomisch
James Shubsda
Joanne Woodcock

ADMINISTRATIVE STAFF

Lona Proffitt
Ruth Steiger
Anita Lai
Mary Jim
Sophia Ng

OTHER CONSULTANTS

Donna Cooksey
Kevin Green
Kirk M. Herring
Ronald Hill
Christine Jadomska
Steve Ziemba
Robert Watkins
Valerie Raco
Thomas McDonnell
Mark McMahan
Steve Petrich
Jill D. Sadler
Mary Siroky
Michelle Smith
Carol Stepien
Evelyn McDonald

SECTION IIA. THE PHYSICAL ENVIRONMENT

SAN PEDRO BAY

San Pedro Bay lies to the south of the Los Angeles basin, bounded by the cities of Los Angeles (including San Pedro), Wilmington, and Long Beach. The Palos Verdes Peninsula on the west separates the bay, formed by the alluvial fan of the Los Angeles and San Gabriel Rivers, from Santa Monica Bay to the west and north.

The shallow San Pedro Bay floor extends seaward (south) to the 300 foot contour for several miles, between latitude 33° 43' to 33° 34' N and longitude 118° 05' to 118° 17' W. However, the name, San Pedro Bay, is also used synonymously for the combined harbor areas of 58×10^6 meters^2 (14,300 acres) protected by breakwaters at the 45 to 65 foot depth contour. The harbor areas encompass the Port of Los Angeles on the west, the Long Beach Naval Facility and Port of Long Beach in the central harbor, and the City of Long Beach harbor area on the east. The eastern area contains artificial oil islands, the mouth of the Los Angeles River flood control channel, recreational beaches and marinas, but does not contain commercial port facilities.

HYDROLOGY OF THE HARBOR

Estuarine Characteristics

The Los Angeles-Long Beach Harbor area is estuarine in configuration, developed from the historical watersheds of the Los Angeles and San Gabriel Rivers. The paleontological history of the harbor was reviewed extensively by Kennedy (1975). The immediate history was detailed in Bancroft (1884) and Beecher (1915), and summarized by Harbors Environmental Projects (Allan Hancock Foundation, 1976).

While true estuaries have freshwater input year round and are characterized by salinity gradients, the local rivers have had only intermittent flows during winter rainy season runoff since the area was urbanized. In the last 50 or so years, rain waters which formerly entered the ground water table in the winter and flowed slowly seaward year round quickly drain off of urban lands into storm drains and concrete-lined flood control channels. Rainy season precipitation ranges from about 6 to 14 inches per year. Table 1 gives unofficial records of rainfall in the Los Angeles basin from July 1972 through 1978.

The Los Angeles River now drains about 832 square miles of the Los Angeles basin and San Fernando Valley into the harbor northeast of Pier J in the City of Long Beach. The river flow is controlled by upstream dams, largely above the urban area in the San Gabriel Mountains. The concrete-lined channel has a capacity of 146,000 cubic feet per second (12.6 billion cu ft per day or 94,255 mgd) and has operated at 75% capacity on occasion.

Another important flow is from Dominguez Slough, which drains about 80 square miles of urban area to the north of the inner harbor, entering the east channel of the Port of Los Angeles at Consolidated Slip. Harbor Lake overflow drains into the northwest basin of the Port of Los Angeles.

The other year-round influx of water into the harbor is the discharge of the Terminal Island Treatment Plant, measuring about 10 million gallons per day of low salinity secondary effluent. The plant has a design capacity of 30 mgd, which was exceeded due to storm water flow in March 1978.

The San Gabriel River was permanently diverted to its present concrete channel to the eastern end of the City of Long Beach harbor area in the 1920s, when the Los Angeles River was also confined to a concrete channel (AHF, 1976).

The Los Angeles River formerly entered the harbor area in what is now the Port of Long Beach at Slip Two, and flowed east to west back to Rattlesnake Island, which was subsequently filled and extended to become Terminal Island.

Although the Southern California climate is considered to be Mediterranean because of the limited rainy season, the river flows to the Mediterranean Sea are more often continual because they receive waters from distant mountain watersheds.

Aquifers

Old-time sailors knew of places in San Pedro Bay where a bucket lowered over the side of a boat would bring up potable fresh water. These places were evidence of the formerly seaward flow in the Gaspur aquifers. Dredging in the harbor and pumping of ground water inland as far as the Pacific Coast Highway have opened the aquifers to saline intrusion with a landward flow of sea water. The Los Angeles County Flood Control District initiated the Dominguez Gap barrier project, injecting fresh water into the aquifers in Wilmington in an effort to halt intrusion. Throughout much of the basin the aquifers have become contaminated with industrial wastes from ponding or disposal in wells (City of Los Angeles, 1979).

HYDROGRAPHY OF THE HARBOR

The channels, slips and land configurations of the present harbor were created over more than 100 years by dredging, landfills and construction of breakwaters, wharves and dikes. There was only a very small, shallow San Pedro landing area below the bluffs in the 1850s. The federal government began construction in 1871 of a jetty to connect Rattlesnake Island with Deadmans Island at the mouth of the main channel (AHF, 1976). The first breakwater was built in San Pedro between 1899 and 1910, sheltering 350 acres. In 1909, a channel to the sea was dredged for access to Long Beach, in the present Back Channel area. The diversion of the Los Angeles River to the east was completed in 1923.

Construction of the middle (federal) breakwater began in 1932 and the eastern segment was built after World War II. The breakwaters altered the area from open ocean to a semi-enclosed embayment and in so doing altered the biology of the waters irrevocably by reducing current velocities and wave action. Major construction of the Navy Mole in the 1930s and the Long Beach Piers A-J, completed in 1971, have further altered the flushing of the harbors (POLB, 1975; POLA, 1976).

Subsidence

A major feature of the Long Beach harbor area was subsidence that was centered in the Port of Long Beach middle harbor area at the eastern end of Terminal Island. The area sank almost 30 feet between 1928 and 1970 (Allen, 1973), inadvertently providing California with its only deepwater port. The cause was identified as oil well extraction, and when injection of brine waters was instituted (repressurization), subsidence was halted and the field rebounded slightly.

INFLUENCES OF THE SOUTHERN CALIFORNIA BIGHT

The marine conditions of the harbors are influenced by conditions in the coastal waters between the southern California mainland and the Channel Islands, an area known as the Southern California Bight. In general, the continental shelf lies a relatively short distance west of the Channel Islands and is marked by a number of submarine canyons. The bight between San Pedro Bay and Santa Catalina Island is affected by the California Current, which passes primarily outside the Channel Islands, flows southward and then forms a series of counter-clockwise gyres or eddies which move to the north or west, impinging on the shores (Jones, 1971). The California Current originates south of the Gulf of Alaska, which contains a large counter-clockwise gyre. The California Current carries remnants of waters from the northward-flowing Japanese (Kuroshio) Current, the northern mid-Pacific and some subarctic waters from the Gulf of Alaska gyre as it moves down the Eastern Pacific as a colder current of low salinity, warming gradually as it flows south (Reid, 1960). Large-scale oceanographic changes in the mid-Pacific can alter Pacific water temperatures and meteorology, affecting coastal weather conditions.

Thermal Regime

The ranges and mean temperatures at coastal stations from Neah Bay, Washington to Balboa, California for the years 1972 through 1978 are shown in Figures 1 to 7 . They are based on Scripps Institute of Oceanography data, except for Los Angeles Harbor data from Harbors Environmental Projects. Soule (1974) discussed 1969-1971 ocean temperatures and the effects on the biota of the Los Angeles-Long Beach Harbors.

In general, the sea buoy station outside Los Angeles Harbor has shown a narrower range of variation than either Balboa to the southeast, or Santa Monica to the northwest of Los Angeles-Long Beach Harbors. Temperatures along the coast were fairly similar in 1972-1974; however, in 1975 they were cooler for almost the entire coast except in the Morro Bay-Point Lobos area. In 1976, temperatures appeared to remain colder than in the prior years north of Pt. Lobos but were warmer to the south, expecially south of Santa Barbara. In 1977, the area north of Pt. Lobos was warmer than usual, as well. In 1978, there was some cooling between Santa Barbara and Santa Monica, but Los Angeles and Balboa remained warmer than normal, with mean temperatures about 17°C, above the more usual mean of 16°C, and the 14°C mean of 1975.

The variations in temperature along the Pacific Coast are not statistically significant because the ranges of the temperatures, as shown by the bars in Figures 1 to 7 , overlap throughout.

The Davidson Countercurrent (undercurrent) moves upcoast from Baja California in the winter months and generally surfaces somewhere in the bight south of Pt. Conception. It has at times been recorded as flowing as far north as Ft. Bragg, California, carrying tropical fauna with it. Thus the intermediate waters off southern California and some surface waters may be warmer in November-February than they are in March-May, depending on the strength and duration of countercurrent flow.

Coastal Temperature Effects

Seasonal changes in temperature seem to serve as biological "cues" for reproductive cycles in animals, more so than do the particular or preferred temperatures associated with reproduction. Therefore, the fact that some stocks fail to reproduce well in particular years and in others undergo tremendous increases may, at least in part, be tied to thermal fluctuations. Also, alterations in predator-prey relations can result if, for example, a species required as food for newly hatched fish larvae do not reproduce at the same precise time as the larvae appear. Therefore, the sequence of temperatures may have a much greater influence than the specific extremes or means of temperatures (Krenkel and Parker, 1969; Hokanson, 1977).

The flows of the major currents from both north and south provide maximal opportunity for the introduction of a wide variety of species into the harbor. That they are able to find satisfactory microhabitats is shown by the great diversity in harbor species present. Change or variation in faunal composition is a normal occurrence in such an area, for the spring colonizers, be they from the north or the south, may dominate for one season and be reduced the next.

At the same time, the more moderate temperature range for the Los Angeles Harbor entry shows that conditions are more stable in the harbor area, which should lead to generally more stable biological populations. These effects are discussed further in the sections on biology.

Mearns (1978) discussed coastal fish catches relative to low mean annual temperatures but did not discuss possible effects of seasonal lows, or perhaps more significantly, the changes in seasonal sequences of temperature. Yet seasonal changes may be much more important to species and populations than mean temperatures. High mean temperatures could indicate a variety of conditions, such as a longer influx of southern waters, reduction in upwelling, or a general warming of the northern Pacific.

It is interesting to note that the maxima of Santa Monica Bay have consistently been 2-4 degrees C higher than those of Los Angeles Harbor, and the means have also been higher, except in 1978.

The range of variation at the harbor entrance is smaller than at either Balboa Island or Santa Monica Bay. This should have created a more stable ecology in the harbor, but such has not been the case, since major changes have taken place in the harbor ecology in recent years (Soule and Oguri, 1979).

Temperatures have been taken monthly at 1 meter intervals through depth by HEP since June 1971 in outer Los Angeles Harbor. In Table 2, the monthly surface temperatures at the sea buoy, station A1 outside Angels Gate, are given; the variations for 1972-1978 are shown in Figure 8. The following can be seen:

January-February: Temperatures were low (11-14°C) in January and February for five of seven years; 1977 and 1978 temperatures were in the 15-17°C range.

March: Temperatures were cold in March in two of seven years (around 12°C in 1975 and 1976), at 14°C in 1972 and 1974, and warmer (near 15-16°) in 1973, 1977 and 1978.

April: In four years (1973, 1974, 1975 and 1977) temperatures were colder in April than in March; in 1972 and 1978 they were warmer.

May: 1973 and 1975 were the coolest (13-14°C); 1972 and 1974 were just above 14°C; 1976 and 1977 were above 15°C and 1978 was above 16°C.

June: Coolest year was 1973, near 13.5°C, followed by 1975, 1972 and 1974; 1978 was near 16°C, 1976 near 17°C and 1977 above 21°C.

July: Temperatures were within about a 4°C range, a narrower range than other months; this was the first cooling in 1978, however.

August: The coldest August was in 1975; all other years clustered near 17°C except 1977 with a high of 19°C.

September: The widest range was found in this month. The coldest was 1976 (near 13°C); 1973, 1974 and 1975 were between 14.5° and 16°C; followed by 1977, near 18°C.

October: Coldest year was 1974 (near 15°C) followed by 1975 (near 16°C). 1972, 1973 and 1977 were near 18°C, while 1976 was near 19°C and 1978 was above 21°C. October and June are second to September in the wide range of temperatures.

November: Lowest months were 1974 and 1975 (above 14°C); 1972 was near 15°C, 1973 was near 16°C, and 1976 and 1977 were near 19°C. 1978 was the warmest.

December: 1978 dropped from being warmest October and November to being near the coldest readings for December; 1972 and 1975 were near 14°C while 1977 remained near 18°C.

Upwelling

The California coast has a number of submarine canyons, usually continuations of channels cut by the historic river flows. As the prevailing offshore winds flow over headlands, certain areas experience a diversion of surface waters, especially in the summer, which brings colder subsurface (to 200m) waters to the shores as upwelling. These waters also bring up nutrients which have been recycled from the organic-laden fine sediments and debris that has drifted down the bottom slopes and canyons previously. While the harbor waters cannot really be considered as nutrient-limited for nitrogen, carbon, or phosphate, the nearshore waters experience considerable nutrient variation depending upon the current regime and amount of upwelling at any given period.

Downwelling has been proposed as a phenomenon caused by winds from the shore, which causes warmer inshore surface waters to be deflected seaward but prevents upwelling.

Distribution and dispersion of phytoplankton, zooplankton and detrital food particles are affected by such major circulation events and thermal patterns. Lasker (1978) has documented the effects on fish larvae when food particles do not occur in sufficient density to larval growth.

HARBOR CIRCULATION AND FLUSHING

The first investigations published on circulation in the outer Los Angeles-Long Beach Harbors after major landfills were completed were drogue studies by Harbors Environmental Projects (Soule and Oguri, 1972). These studies identified for the first time the existence of a large clockwise gyre extending east from the Los Angeles main channel to the angle of the Navy Mole, roughly bounded by stations A2, A3, A15, B8, B9 and A13. Subsequently HEP confirmed the gyre and found elements of a counterclockwise gyre at the 20 foot depth with current meter investgigations (Robinson and Porath, 1974).

The U.S. Army Engineers Waterways Experiment Station (WES) in Vicksburg, Mississippi verified the surface gyre in the physical model of Los Angeles-Long Beach Harbors there, and showed its persistence on both rising and falling tide (McAnally, 1975; AHF, 1976). Smaller gyres tend to occur in the Cabrillo (San Pedro) area, which are counterclockwise on incoming tide and reverse on a falling tide (Figures 9 and 10). Since the local tides are semi-diurnal, there may be two tides per day on some days but only one on other days.

The influence of the main gyre on benthic biology was clearly seen in Soule and Oguri (1979), including the effects of a sewage treatment plant upset in the summer of 1978. The prevailing wind from the southwest reinforces the tidal gyre, but when very strong Santa Ana winds from the east or southeast blow, the surface gyre breaks up. A surface gyre to the east of Pier J in Long Beach near Alamitos Bay appears to be consistently counterclockwise. The gyres are probably responsible for the good water quality in the outer harbor and for the mixing, which has prevented a build-up of organic waste near the outfalls. Instead, nutrients appear to be well distributed (Soule and Oguri, 1976).

Alterations in Flow

Circulation in the harbors was greatly altered by construction of Pier J in the 1960s. Reish (1959) showed water entering mainly from the east and flowing up the two main channels to a nodal point near Consolidated Slip, leading to Dominguez Slough (AHF, 1976; Figure 11).

The Southern California Edison Long Beach generating plant resumed operation in the Back Channel with new equipment in

1977. It has the capacity to cycle 734 million gallons per day, approximately 15 percent of the low-tide volume of the Long Beach Middle Harbor or one-third of a tidal cycle prism. When the plant is operating, it probably induces a net flow down the channel to the south and east, whereas WES calculated a small net flow to the west. The seasonal thermal maps, to be discussed shortly, tend to confirm the southward and eastward flow, as compared with the annual mean surface temperature map shown in the Master Environmental Setting of the Port of Long Beach (1976).

Figure 12 and Table 3 give the major water areas of the harbor and the tidal prism associated with them.

Future Development

In the HEP report to the Army Corps of Engineers (AHF, 1976) the impact of future harbor development was discussed. At that time, the Master Plans for both the Port of Long Beach and the Port of Los Angeles proposed dredging and creating a solid land barrier with the fill across the outer harbor at the dividing line between the two Ports, with lateral slips. HEP predicted a lowered water volume, decrease in tidal prism, reduction in flushing and an increase in residence time of the water. The main gyre would be broken up and replaced by smaller, transitory gyres.

Since the 1976 report, the Master Plan for the Port of Long Beach, which contains no western outer harbor fill, has been accepted by the California Coastal Commission. The Port of Los Angeles did not have an approved Master Plan until 1980, and has received Coastal Commission approval for a landfill of the area east of Fish Harbor, designated as Phase I. An opportunity to test the behavior of the principal outer harbor gyre under the Phase I configuration was presented when dye tests were carried out for the City of Los Angeles Terminal Island Treatment Plant to determine the site for relocation of their outfall pipe for Phase I construction. Figure 13 A, B and C are redrawn from kodachrome transparencies by D. F. Soule, and indicate circulation patterns of simulated tidal cycles with introduction of a conservative dye near station A15.

Figure 13 A shows the second tidal cycle on an incoming tide, with the main gyre and several smaller subgyres in the area of stations B8 and B9. This is not unlike the existing gyre in total area covered. Figure 13 B is of a falling tide during the third tidal cycle of dye injection. The outer Los Angeles area near the main channel appears to flush very well. The smaller gyres in the central area collapse somewhat and appear to move toward the Long Beach entry but are not seen to flush in that direction. Because of the camera angle on the model, it was not possible to determine accurately whether dye did spread up or down the channel in Long Beach. Figure 13 C shows the fourth tidal cycle; this and subsequent cycles were very similar. They suggest that the gyre will remain in the outer harbor, although it will be compressed somewhat to the north and expanded to the east.

Phase II Construction

The extension of Phase II fill to the Navy Mole and construction of an island in the Port of Los Angeles created quite different circulation patterns. Although the dimensions and shape of the fills may not be those finally selected, the approximate patterns created are instructive. Figure 14 A-F and Figure 14 G-J show a buildup of dye in outer Long Beach Harbor that may extend into the middle harbor and Pier J. Figures 14 C and 14 D show falling tide at 12 and 14 hours respectively. A small gyre south of the fill appears to be the only dynamic feature.

Figure 14 E and F represent the second tidal cycle at 12 and 24 hours respectively. Small subgyres appear near Fish Harbor and along the Navy Mole; patches of dye have entered the Los Angeles Main Channel, but station C2 appears to be the maximum incursion (Figure 14 E).

Figure 14 G is of tidal cycle 3 and suggests independent flow of incoming tide from each gate, with little mixing. Figure 14 H, of tidal cycle 5, suggests the presence of three separate small gyres in the Los Angeles main channel, south of the island, and east of the island.

Figure 14 I shows that ebb tide has flushed the Los Angeles gyres but has not flushed the major portion of the Long Beach gyre. Figure 14 J, of the seventh tidal cycle, shows the virtually stabilized condition in which the outer Long Beach Harbor is not flushing adequately.

These figures are not quantitative and cannot include effects such as prevailing southwest winds, or the down-channel flow caused by intermittent operation of the Edison plant.

The dye studies should not be interpreted as suggesting an unsafe buildup of sewage effluent from TITP. Bioassay studies showed the secondary waste to be non-toxic at 100 percent concentration. However, lack of flushing might well cause phytoplankton blooms and significant reduction of fish populations, in addition to those reductions caused by filling a part of the present fish habitat.

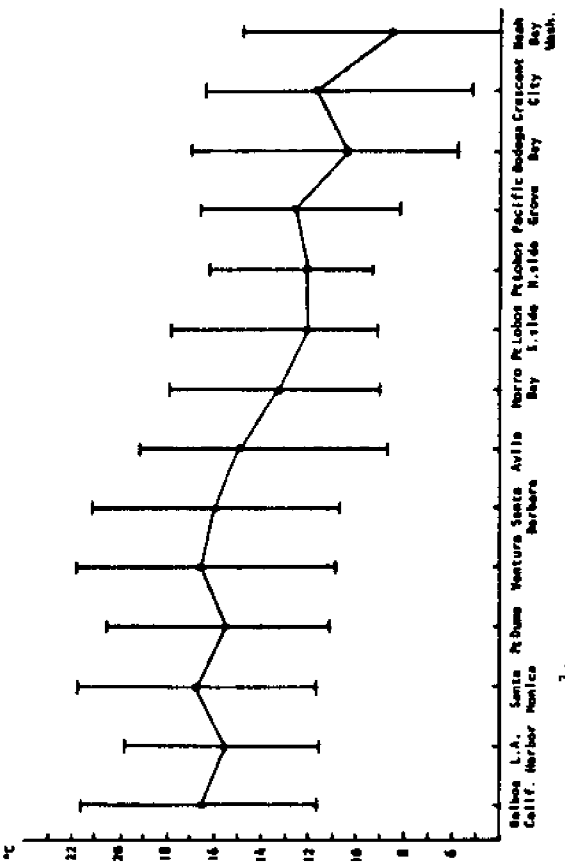


FIGURE 1. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1972.
(LA Harbor, HEP Sta A1; all other data courtesy SIO)

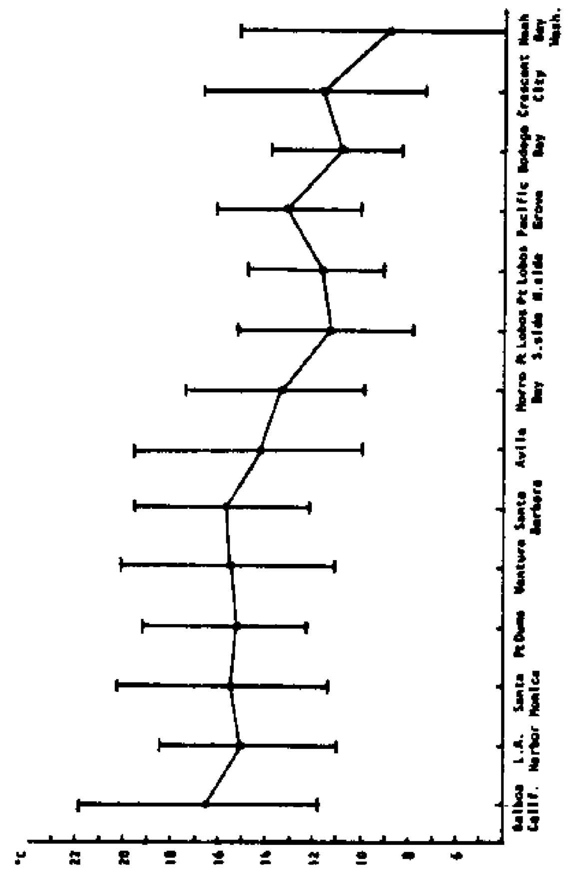


FIGURE 2. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1973.
(LA Harbor, HEP Sta A1; all other data courtesy SIO)

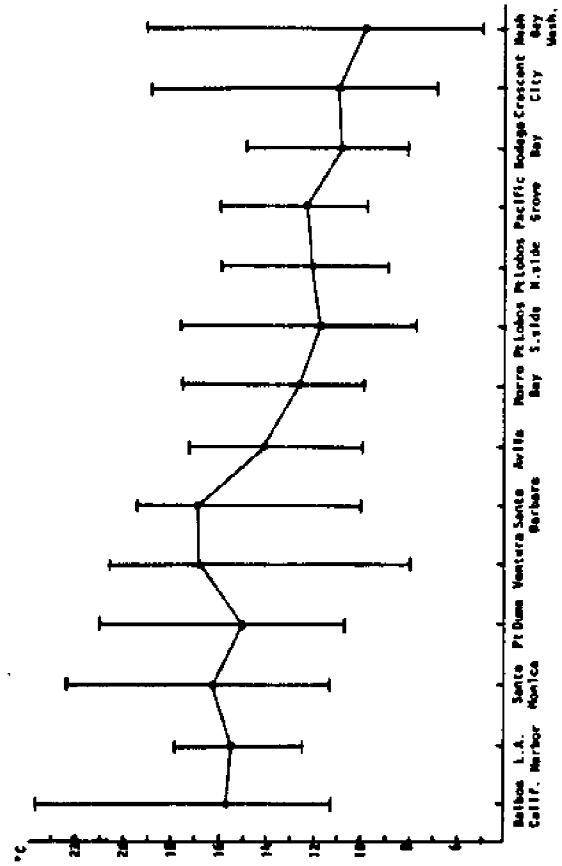


FIGURE 3. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1974.
(LA Harbor, HEP Sta A1; all other data courtesy SIO)

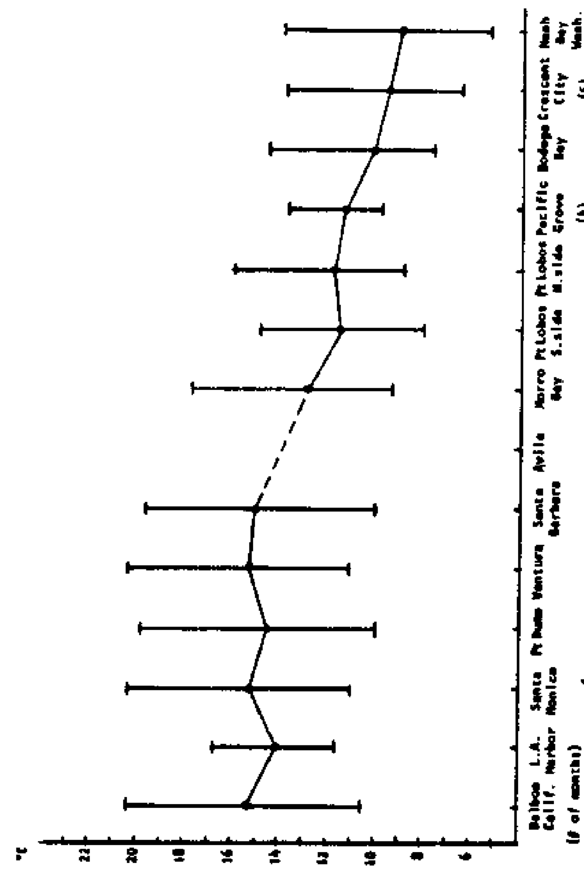


FIGURE 4. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1975.
(LA Harbor, HEP Sta A1; all other data courtesy SIO)

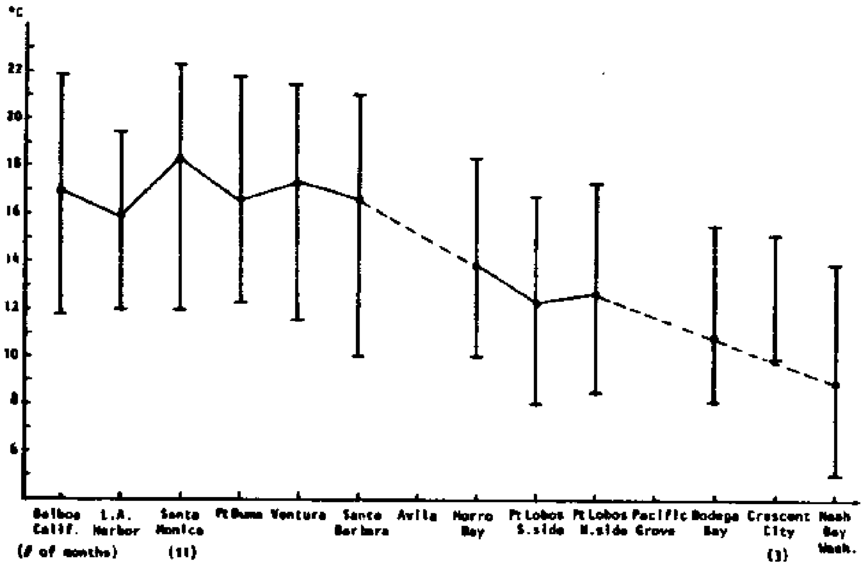


FIGURE 5. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1976.

(LA Harbor, HEP Sta A1; all other data courtesy SIO)

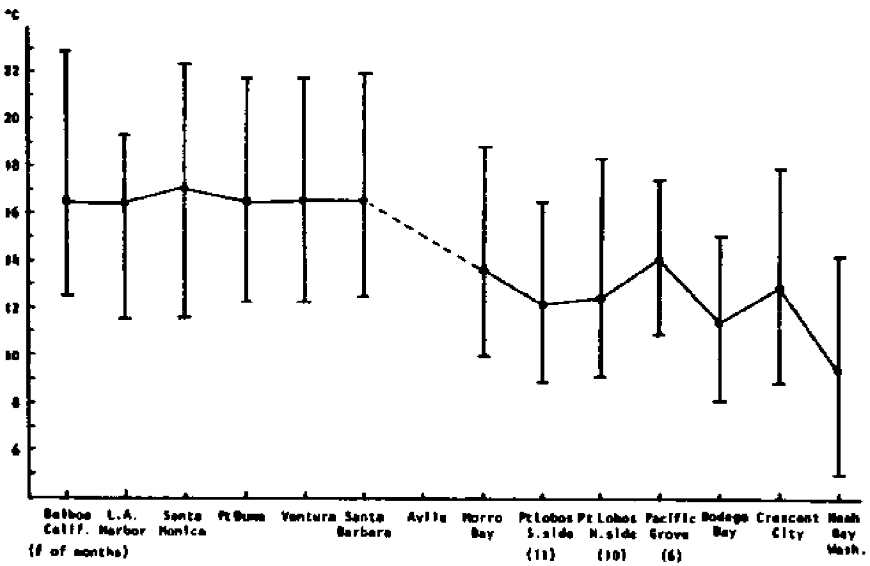


FIGURE 6. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1977.

(LA Harbor, HEP Sta A1; all other data courtesy SIO)

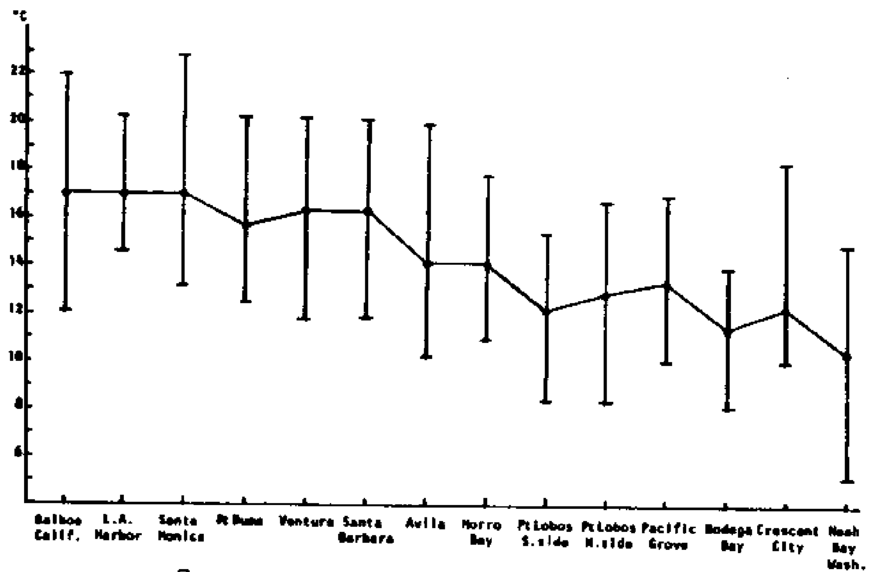


FIGURE 7. ANNUAL HIGH, LOW AND MEAN SURFACE WATER TEMPERATURES, EASTERN PACIFIC STATIONS, 1978.

(LA Harbor, HEP Sta A1; all other data courtesy SIO)

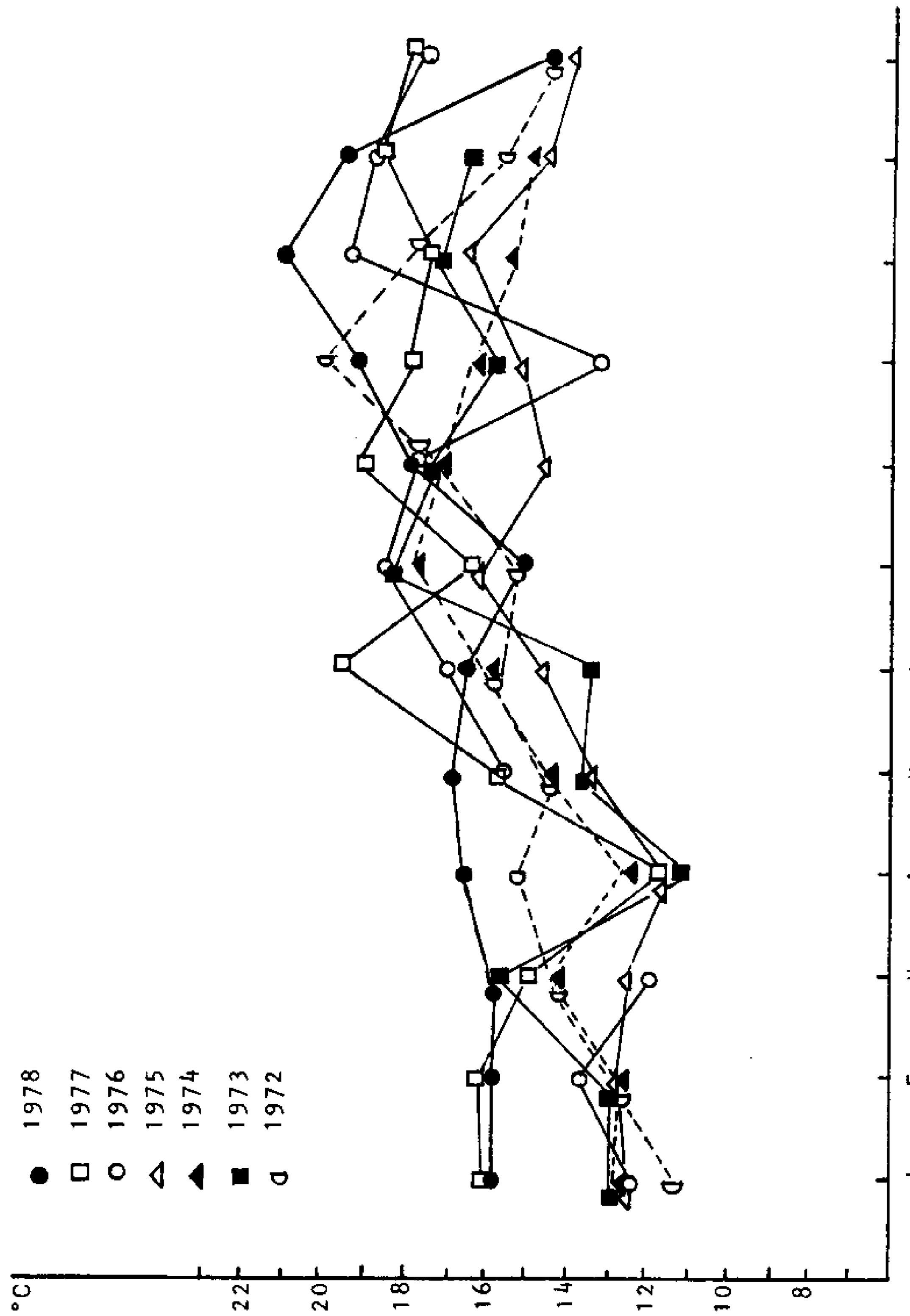
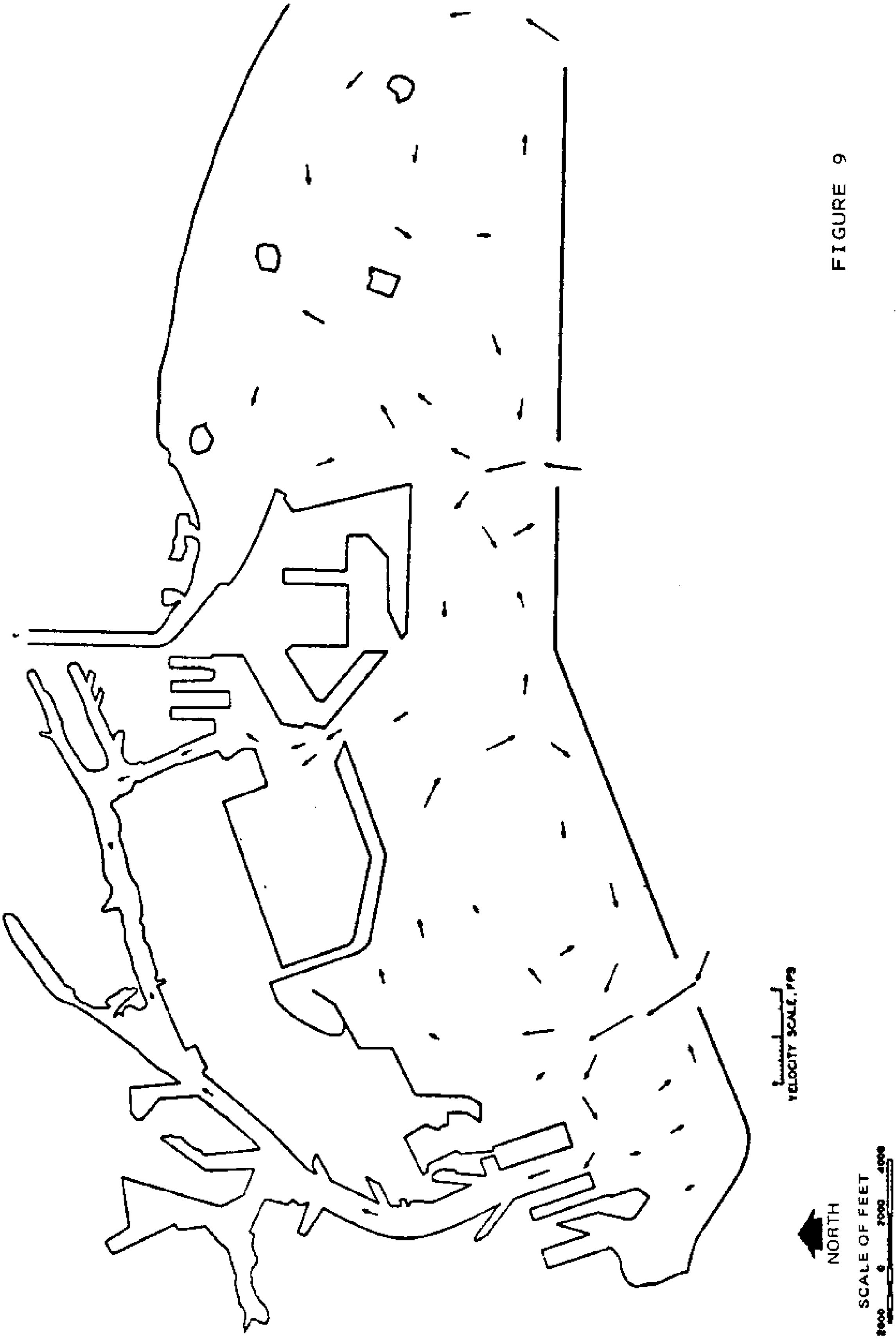


FIGURE 8. MONTHLY TEMPERATURES (°C) OUTSIDE LOS ANGELES HARBOR 1972-1978.



Source: McAnally, 1975

FIGURE 9

SURFACE CURRENT PATTERNS
Base Test, Spring Tide Hour 6

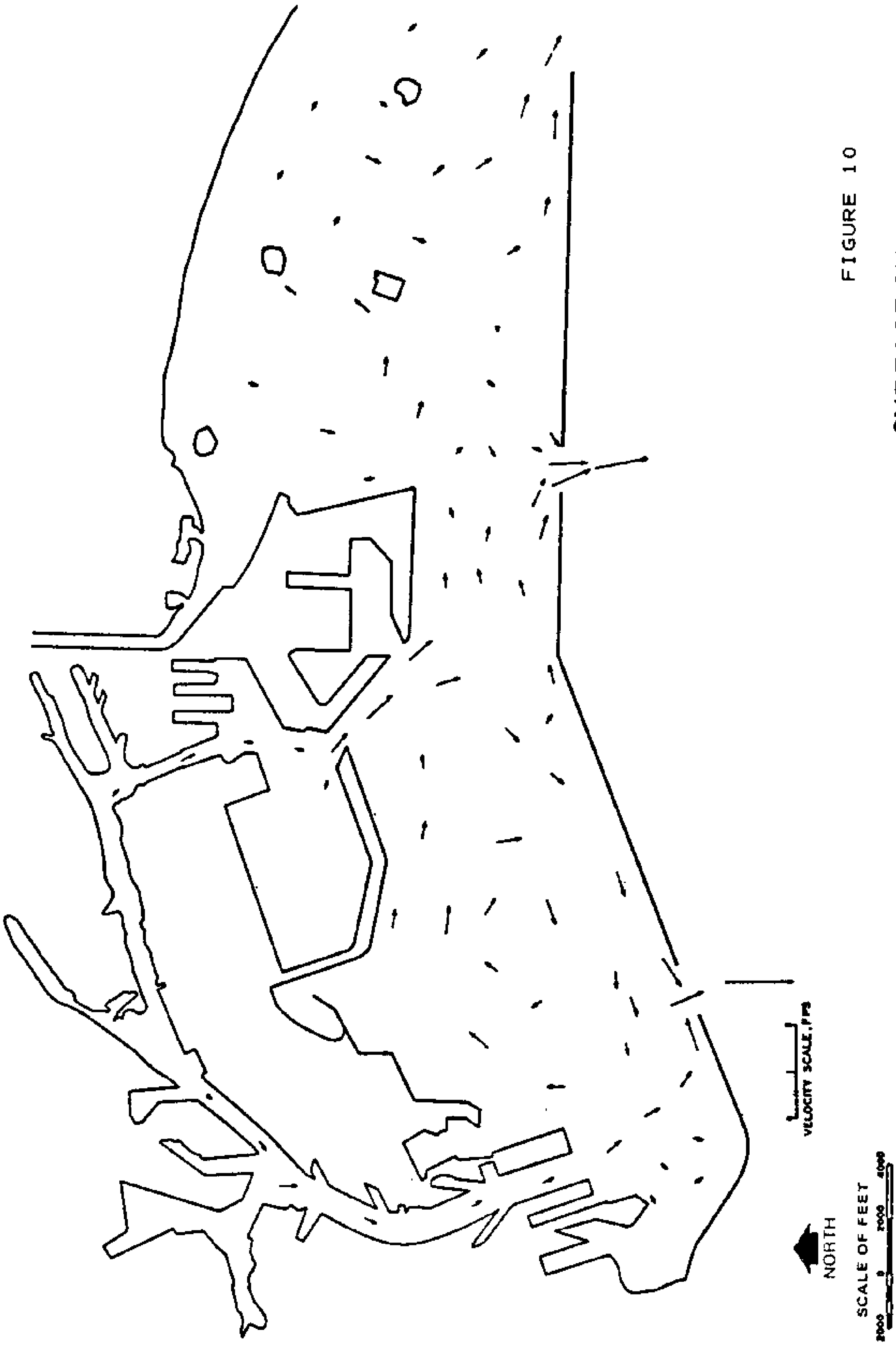


FIGURE 10

SURFACE CURRENT PATTERNS
Base Test, Spring Tide Hour 13

Source: McAnally, 1975

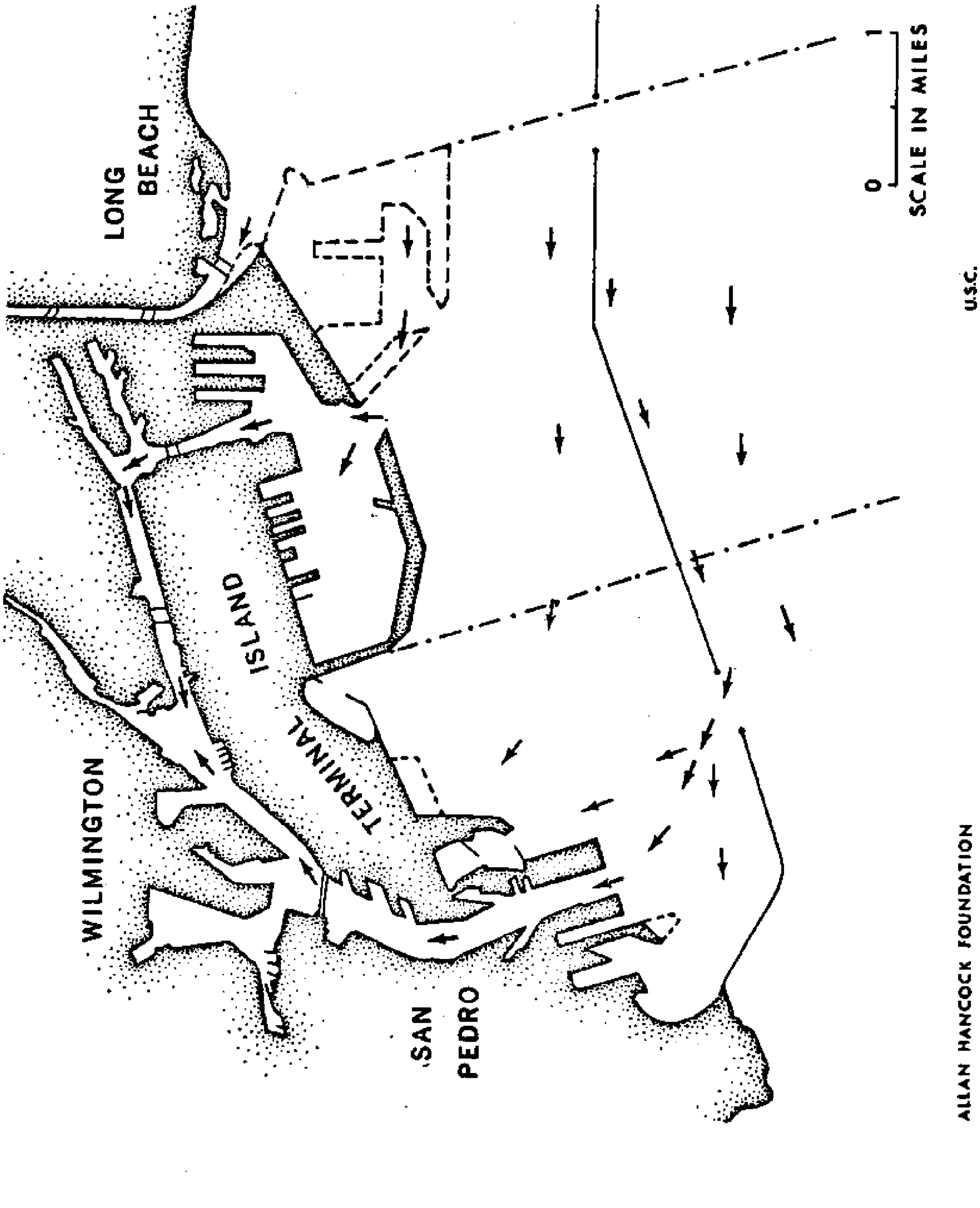


FIGURE 11. CIRCULATION IN 1954, ACCORDING TO REISH, 1959.

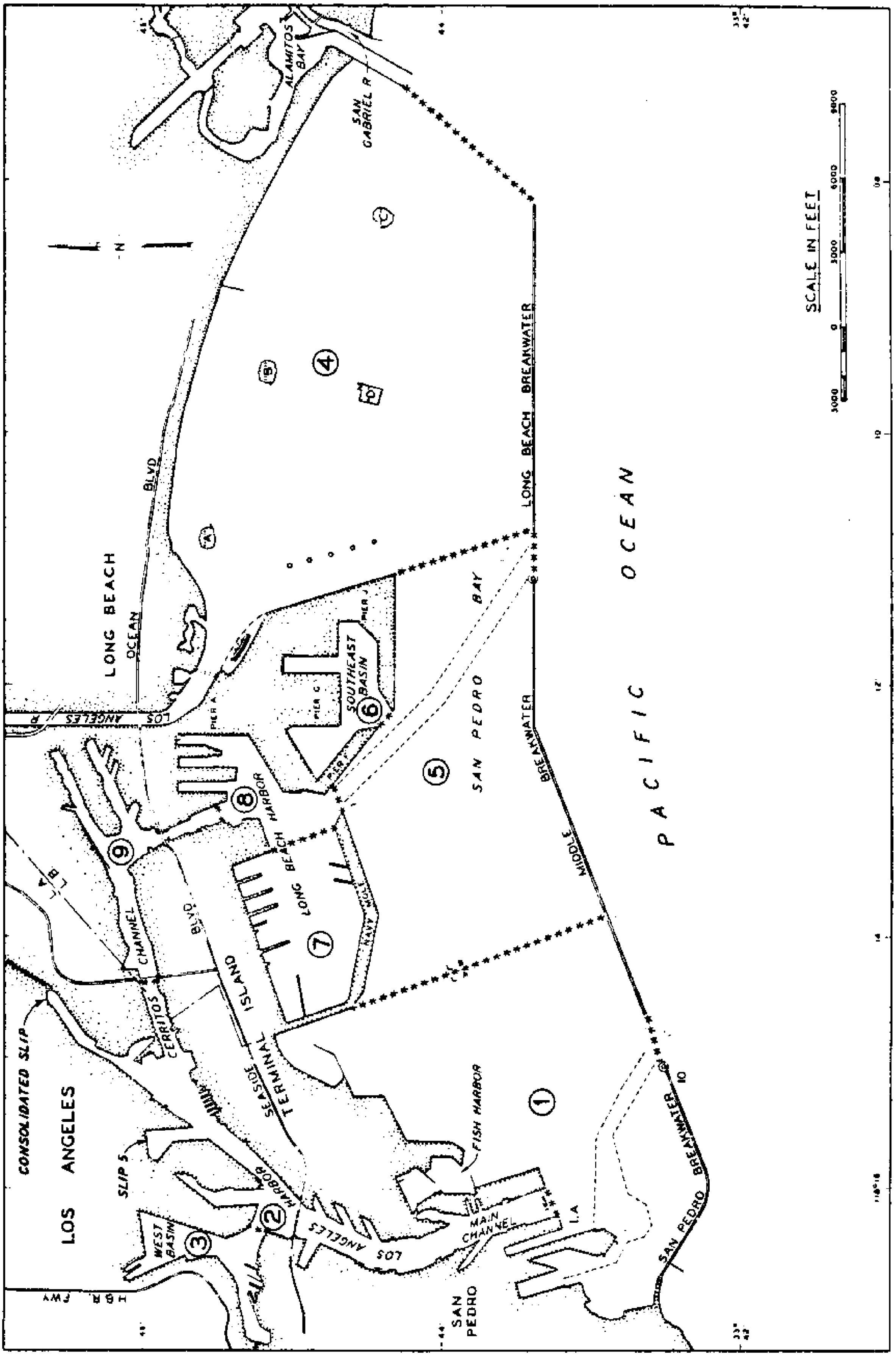
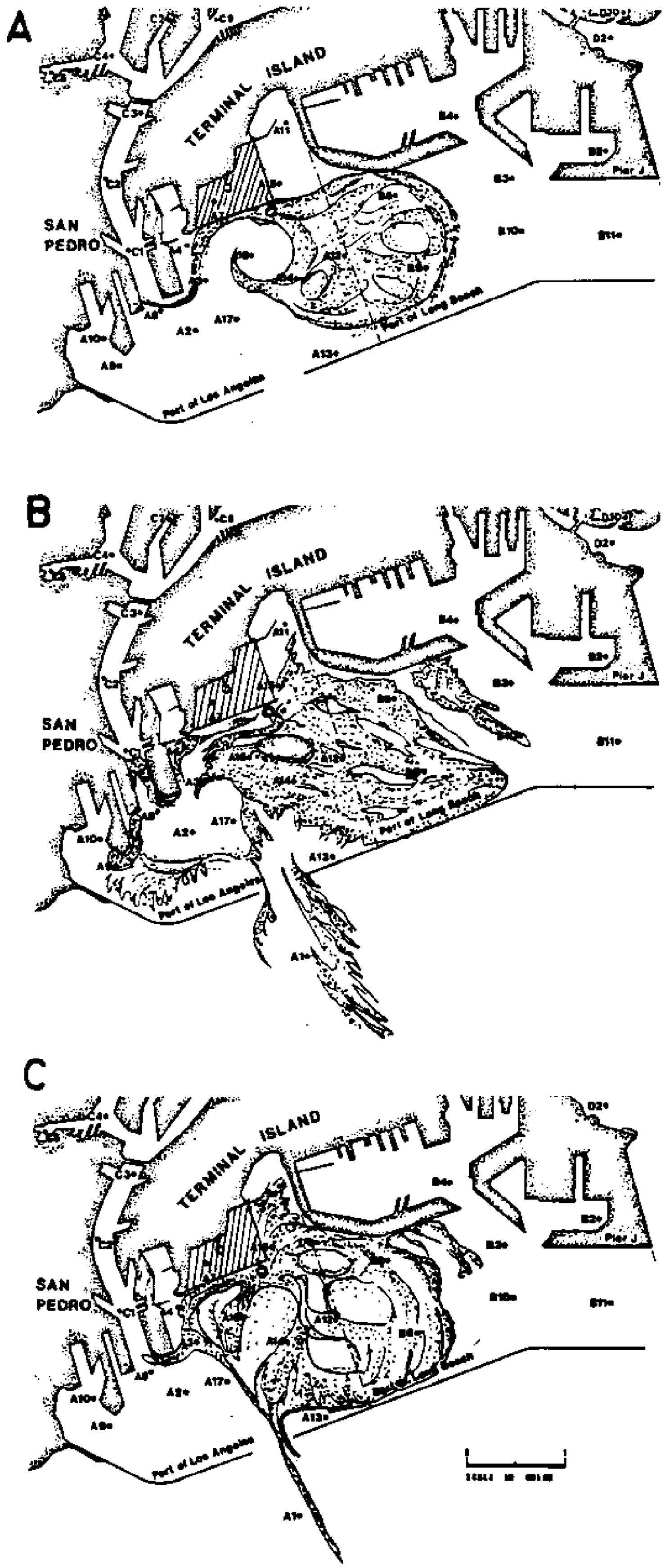


FIGURE 12. AREA AND VOLUME COMPUTATION SECTIONS (AFTER MCANALLY, 1975)

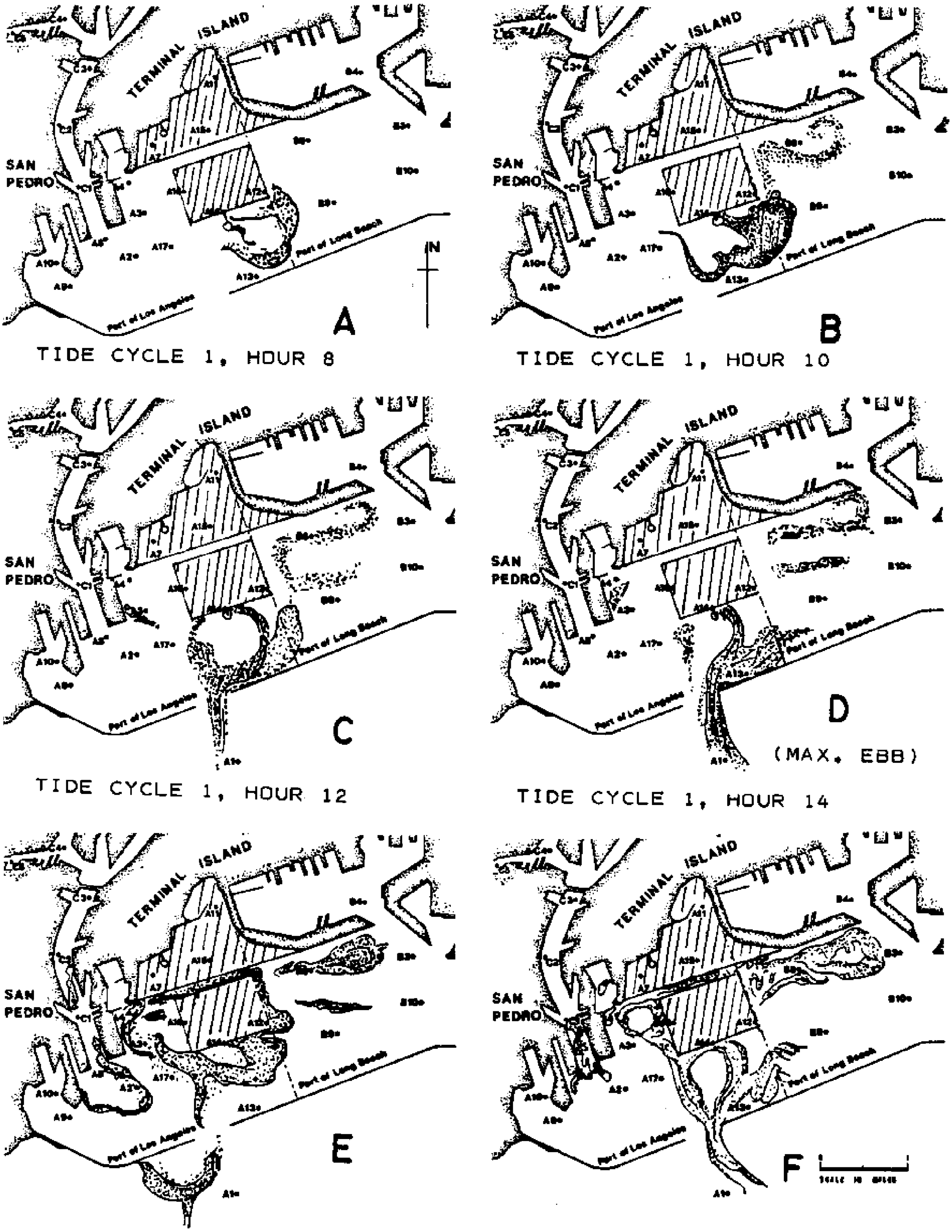


Phase I
Tide Cycle 2
Hour 8

Phase I
Cycle 3
Hour 16

Phase I
Cycle 4
Hour 9

FIGURE 13. PHASE I LANDFILL CIRCULATION



TIDE CYCLE 1, HOUR 8

TIDE CYCLE 1, HOUR 10

TIDE CYCLE 1, HOUR 12

TIDE CYCLE 1, HOUR 14

TIDE CYCLE 2, HOUR 10

TIDE CYCLE 2, HOUR 24

FIGURE 14. PHASE II (ENERGY ISLAND) DYE TESTS, WES MODEL

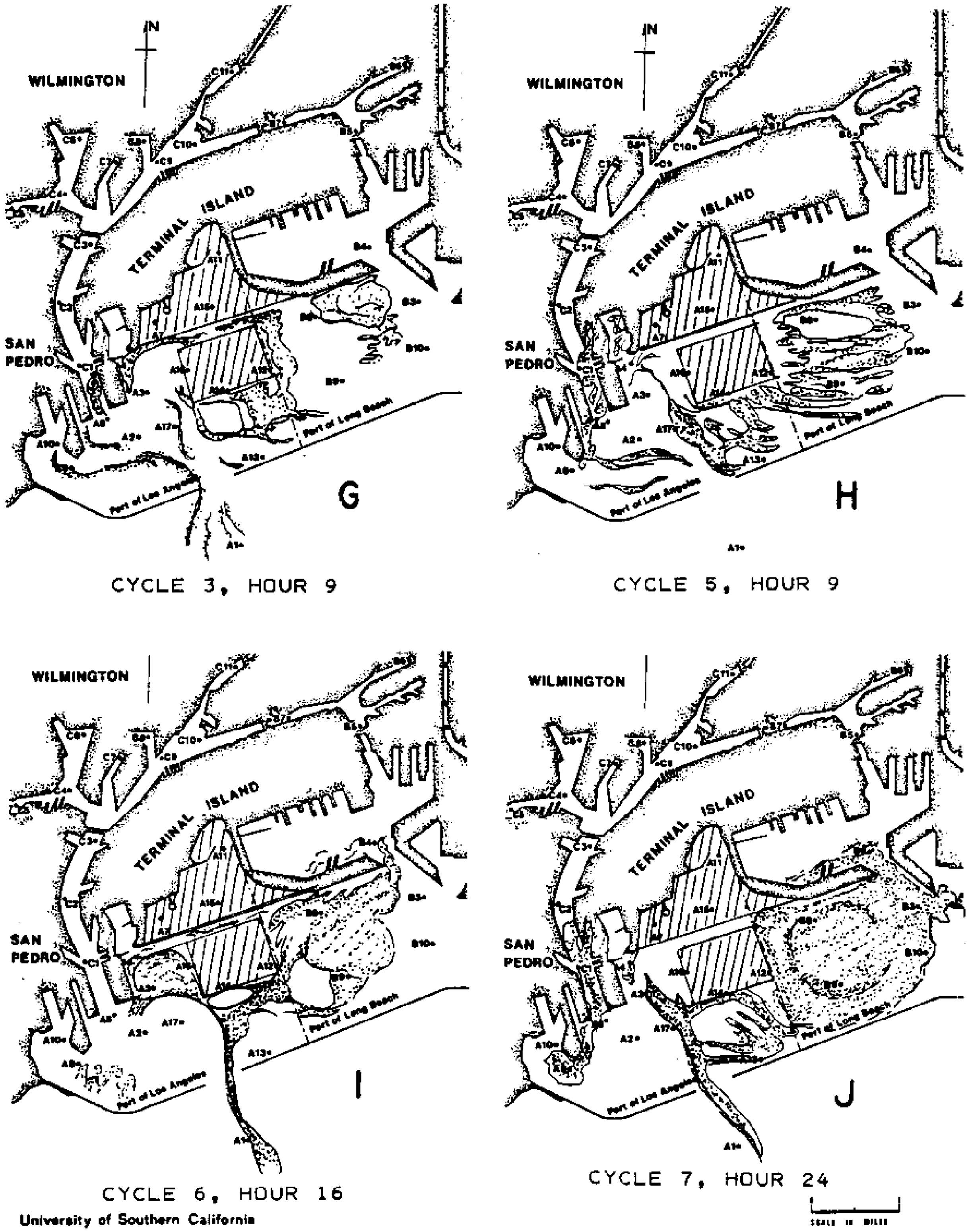


FIGURE 14. PHASE II (CONT)
DYE TESTS, WES MODEL

Table 1. Unofficial Rainfall Figures from Los Angeles Basin*

RAINFALL
(INCHES)

	YEAR						
Month	1972	1973	1974	1975	1976	1977	1978
Jan	NR	2.67	9.60	0.00	0.00	3.89	7.25
Feb	NR	+	0.00	2.60	4.23	0.15	10.66
Mar	NR	2.70	4.20	3.90	1.70	2.10	8.90
Apr	NR	0.00	0.00	1.60	0.45	0.00	3.00
May	NR	0.00	0.00	0.00	0.10	3.60	0.10
Jun	NR	0.00	0.00	0.00	0.20	0.00	0.00
Winter Cycle		72/73 7.19	73/74 14.55	74/75 12.36	75/76 7.40	76/77 14.84	77/78 37.61
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.32	0.00	0.00	0.00	0.00	2.20	0.00
Sept	0.00	0.00	0.00	0.00	2.30	0.00	0.58
Oct	0.00	0.00	0.66	0.00	1.10	0.00	0.10
Nov	0.00	+	0.00	0.00	1.10	0.10	1.90
Dec	1.5	0.75	3.60	0.36	0.60	5.40	2.40
Annual (Inc) Total	1.82	6.12	18.06	8.46	11.68	17.44	34.89

*Records from inland Los Angeles Basin by John D. Soule.

\+ = trace

Table 2. Monthly Surface Temperature for Station A1 (Sea Buoy) Los Angeles (°C).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean	Yr. High	Yr. Low
Year 1978	15.8	15.7	15.7+	16.4	16.7	16.3	15.0	17.9	18.9	20.6	19.3	14.5	16.9	20.6	14.5
Year 1977	16.0	16.1	13.7	11.6	15.6	19.4	16.2	18.9	17.7	17.2	18.3	17.9	16.6	19.4	11.6
Year 1976	12.3	13.6	11.9	****	15.5	17.0	18.7	17.9	13.4	19.3	18.6	17.5*	15.8	19.3	11.9
Year 1975	12.6	12.8	12.5	11.6	13.3	14.4	16.0	14.3	15.1	16.7	14.2	13.8	13.9	16.7	11.6
Year 1974	12.8	12.5	14.3	12.5	14.5	15.8	17.6	17.2	16.3	15.5	14.7	14.4+	14.8	17.6	12.5
Year 1973	13.1	13.1	15.7	11.0	13.6	13.4	18.4	17.5	15.7	17.0	16.2	****	15.0	18.4	11.0
Year 1972	11.3	12.3	14.2	15.1	14.5	18.8	15.4	17.8	19.6	17.3	15.2	14.5	15.5	19.6	11.3

**** Temperature Unavailable   +Temperature taken from Long Beach Buoy   *Approximate

Low	11.3	12.3	11.9	11.0	13.3	13.4	15.0	14.3	13.4	15.5	14.2	13.8
Hi	16.0	16.1	15.7	16.4	16.7	19.4	18.4	18.9	19.6	20.6	19.3	17.9
$\bar{X}$	13.4	13.7	13.7	13.0	14.9	16.4	16.8	17.4	16.7	17.7	16.6	15.2

Table 3. Surface and Volume of Harbor Areas

	surface area		low water volume		tidal prism (mean tide)	
	$10^6 ft^2$	$10^6 m^2$	10^9 cubic ft	gallons x 10^6	$\frac{\text{tidal prism}}{\text{low water volume}}$	gallons x 10^6
1. L.A. outer harbor	139	2.71	4.0	29,920	19%	5,685
2. L.A. main channel	35	3.25	1.1	8,228	17%	1,399
3. L.A. West Basin	10	0.93	0.3	2,244	16%	359
4. Eastern bay	250	23.23	8.8	65,824	15%	9,874
5. L.B. outer harbor	123	11.43	5.7	42,636	12%	5,116
6. L.B. SE basin	11	1.02	0.5	3,740	13%	486
7. L.B. west basin (Navy)	27	2.51	1.1	8,228	14%	1,152
8. L.B. east basin (Middle Harbor)	15	1.39	0.7	5,236	12%	628
9. L.B. inner harbor	13	1.21	0.6	4,488	12%	539
TOTALS	623	47.68	22.8	170,544		25,238

IIB. WATER QUALITY AND NUTRIENT CHEMISTRY

INTRODUCTION

The waters of San Pedro Bay are essentially marine in origin since freshwater input from the land is predominantly seasonal. Nevertheless, the land, because of its configuration and urban effluents, exerts a substantial influence on the characteristics of the waters in the harbor and on the structure and size of the biological populations present in the area. The water quality and nutrient chemistry data collected during the present survey, as they varied in magnitude, in time and in location, help to illustrate the patterns of environmental conditions and the sequential changes that occurred in the harbor during the year.

MATERIALS AND METHODS

A series of 41 stations throughout the Los Angeles and Long Beach Harbors area (Figure 1) were occupied each month for instrumental measurement of salinity, temperature, dissolved oxygen concentration, pH and turbidity. Surface water samples were also collected for later analysis for ammonia, nitrate, nitrite and phosphate concentration.

The 41 stations were divided into three series consisting of the A stations and stations B8 and B9 in the first series, the remainder of the B stations and the D stations in the second, and the C stations in the third. These were usually occupied respectively during the first, second and third Wednesdays of each month. The data are, therefore, quasi-synoptic but are consistent in timing, in sequence of sets of stations, and within sets of stations.

Measurements of temperature, salinity, conductivity, dissolved oxygen and pH were carried out using Martek Water Quality Analyzers, Mark III, V or VI. The dissolved oxygen and pH probes were calibrated prior to each day's use. On station the probe package was lowered into the water and readings were taken at the surface and at one meter intervals through the water column or to a maximum depth of 21 meters. Turbidity was measured with a Hydroproducts transmissometer or Secchi disc.

Water samples for chemical analysis were taken from the water surface, using a clean plastic bucket that had been well rinsed with sample water. The water was filtered through glass fiber filters, aliquotted into 125 ml glass flasks and frozen for later analysis in the laboratory. The subsamples for ammonia determination have 2 ml of phenol added prior to freezing.

Laboratory procedures are discussed in Section I; they are those accepted as standard for the parameters and are described by Strickland and Parsons (1968; 1972).

WATER QUALITY RESULTS

The data for temperature, salinity, dissolved oxygen and pH for the year 1978 are presented in Appendix A. Graphic presentation of the data, as shown in Figures 2-21, gives seasonal and annual averages of each of these parameters. Turbidity readings as percent light transmittance are included in the Appendix, but malfunctions of two instruments were frequent; differences with Secchi disc data resulted, which prevented computer mapping.

Salinity

The salinity data presented as seasonal and annual averages in Figures 2 to 6 show that highest surface salinities were encountered in the winter months and that a bimodal distribution of the averages occurred for that season. The tabulated data (Table 1) show that in December 1977 and February 1978 the subsurface salinities were high in all areas except in the inner Los Angeles Harbor. In areas where the low salinity appeared at the surface (see Figure 2) there was a layer of reduced salinity detectable at depths of no more than two meters. Below this halocline the high salinity values prevailed.

In January, quite a different pattern prevailed. Salinities throughout the C stations and at the D stations were low, reflecting roughly 23 inches of rainfall for December 1977, January and February 1978. Station C11, at the mouth of Dominguez Slough, was lowest, followed by C9 and C10 (Figure 2). Mixing was extensive, with only small differences between surface and bottom at most stations except C10, C11, and D2. There, low salinity (8.5-16.7 ppt) lenses occurred above waters of salinities in the 21-28 ppt range like the other stations.

Influx of warmer, high salinity waters in early February (36 ± ppt) probably signaled arrival of southern countercurrent waters, but rain again lowered readings. Thus the winter salinities were mixed, low and high yielding the averaged values plotted. The gradients noted, which extend from the Navy mole to the Federal Breakwater, are probably indicative of the influence of the outer harbor gyre and its source, through Angels Gate (station A1). Salinities there were 1.3 ppt higher than at Queens Gate, indicating the flow around Pier J. Station B2 was isolated, with high salinity water. The nodal point of tidal flushing in Cerritos Channel is suggested by the salinity discontinuity near the lift bridge (station B7), with a 6 ppt difference from that at station C10.

However, April and May in the spring season, showed averaged surface salinities that were more normally grouped (Figure 3), but the average was lower than in the winter. The study area as a whole showed greater uniformity. Low values were found in areas where stormwater runoff would be expected, such as Dominguez

Slough and the Los Angeles River mouth area. The highest spring average salinities were found near the Terminal Island Treatment Plant outfall and at A1, the sea buoy station. The tabulated data show that in April high salinity water was found throughout much of the harbor at all depths except at the C stations, in inner Los Angeles Harbor, and at A10 in the West Channel. Stations off the mouth of the Los Angeles River had a freshwater layer overlying the high salinity water.

Seasonally averaged salinities for the summer and autumn periods (Figures 4 and 5) reveal that marine waters of lower salinity (up to 31.67 ppt) had uniform distribution. These waters were probably cooler northern waters. The data for these months (refer to Appendix A) show that the uniformity of surface salinities also extended through the water column for both summer and fall. The pattern began to break down in November, when higher salinities were generally evident and inversions with the higher salinity near the surface appeared in the outer harbor. This is in keeping with earlier statements by HEP that harbor waters appear to turn over in the late fall (Soule and Oguri, 1974). Higher salinities continued into December 1978, although no inversions were found at that time.

The annual averages of salinity (Figure 6) show that the outer harbor, particularly the western San Pedro section, had high salinities, as did the Los Angeles sea buoy station (A1). Lower values were found in the inner harbor, to the east and particularly in areas where storm runoff occurred. The histogram for the figure suggests a rather more normal distribution than the monthly data indicated.

Temperature

As would be expected in southern California, the seasonal averages of surface temperatures, as shown in Figures 7 through 10, are lowest in the winter and rise through the consecutive seasons, with autumn being the warmest season. The annual pattern (Figure 11) indicates that there is a basic similarity in the distribution of annual and seasonal warm areas and cool areas. In the outer harbor there was a warm water area near the TITP outfall and a cool area along the inner face of the Federal Breakwater in the winter. The area near the Los Angeles River mouth is usually among the warmest areas, along with higher temperatures in the inner Long Beach Harbor, Middle Harbor and Back Channel, near the Edison plant. Temperatures in inner Los Angeles Harbor are generally lower, except for West Basin, where the harbor generating plant is located.

The winter temperatures extending into spring were quite uniform with depth, unless there was also freshwater runoff, as shown by low salinities. There was a slight tendency toward colder surface water, suggesting a thermal inversion, but this tendency did not last long and the temperature difference from top to bottom seldom exceeded a few tenths of a degree. The

The spring temperatures were colder at the river mouth, while the main channels and inner harbor waters were warmer throughout. Discontinuities in the vertical temperature profiles, not associated with runoff, started to appear in the spring and were generally apparent in inner Long Beach Harbor stations.

Thermocline formation was more apparent as the weather warmed up and the storms, which could stir the water from top to bottom, no longer occurred. During the summer, temperature discontinuities of as much as 0.5°C within 2 meters of depth occurred frequently, even in the outer harbor areas near the breakwater. It was not until late fall that these thermoclines started to disappear and, in December 1978, the temperatures appraoched those typical of winter. The December 1978 temperature was several degrees lower than in December 1977. Lower winter temperatures may be required to generate good fish reproduction in the spring, as is discussed in the biology section of this report.

Horizontal temperature zonation is apparent for much of the year. For example, in Cerritos Channel, the nodal point appears to be to the east of the lift bridge near station B7 and temperatures show discontinuities there. Also, a thermal discontinuity occurs throughout most of the year between the Navy mole and the angle of the federal breakwater. The warmed waters from the Edison plant may, by passing to the east of Pier J on ebb tide, warm that area. The outer Los Angeles Harbor gyre circulates incoming cooler water from Angels Gate (station A1), while the cooler waters of incoming tides at Queens Gate (station B1) seem not to penetrate far. In Figure 7, cooler water extends to the south side of Pier J in the winter. In the spring the colder water is blocked off at Queens Gate with a 1.5°C difference and with the gyre extending farther east to the Long Beach channel. Tidal water might reach the river mouth from the eastern end at Alamitos, but cooling more likely is from rainfall runoff, judging by salinities (Figure 3).

In summer, warm water appears to flow out of Queens Gate, being nearly a 2°C higher there than at Angels Gate. Cooler water from the gyre extends into Pier J (station B2), with warmer water otherwise all through Long Beach. While EQA-MBC (1978) reported a very limited thermal effect area for the Edison plant, these patterns would indicate that changes have occurred in thermal distribution since 1973-1974 (Port of Long Beach, 1976), which would influence the biota found there. The autumn map also showed the warmer water extending out of the harbor, but the gyre was less definitive and almost isolated from Pier J.

Dissolved Oxygen

Winter values for dissolved oxygen were higher in the eastern part of San Pedro Bay than in the western area (Figure 12). Station B1 at the Long Beach sea buoy also showed a high average value; these waters may have had a minor phytoplankton bloom. In the outer harbor there was also an area of slightly higher oxygen concentration in the gyre between Angels Gate and Terminal Island.

During the winter months the dissolved oxygen concentrations were moderate; seen in Appendix A, all were above 5 ppm except at the bottom at A7 and C11. At most stations, the values were relatively uniform through the water column. Some of the stations showed lower dissolved oxygen levels at or near the surface, which increased with depth. However, at the stations near the Los Angeles River mouth the high values were always near the surface.

The spring season had the highest dissolved oxygen concentrations in the study area, with higher values throughout most of outer harbor areas and in inner Long Beach Harbor (Figure 13). As in the winter, inner Los Angeles Harbor was the area with lowest dissolved oxygen. Distribution of oxygen with depth (see Appendix) generally showed a pattern of higher dissolved oxygen near the surface, except in the Los Angeles main channel, where the reverse occurred in the early spring months. Following high dissolved oxygen levels in April (up to 12.8 ppm), outer harbor high levels continued but inner harbor levels fell below 5 ppm in places.

The dissolved oxygen surface values found during the summer (Figure 14) were the lowest seasonal averages found during the year. The outer harbor, as a whole, had higher values than occurred at stations in the inner harbor. Maximum values occurred in the area of the outer harbor, associated with the clockwise gyre located between Terminal Island and the western half of the middle breakwater. The area near the Los Angeles River mouth also showed moderately high surface concentrations, but bottom readings were as low as 1.3 ppm at D2 in June, and 0.3 in July. The inner harbor, Los Angeles Main Channel, and West Basin were all low in dissolved oxygen. Low values, below the 5 ppm considered as acceptable for water quality, were found at the surface at many of the inner Los Angeles stations during the summer months, but more often occurred at subsurface depths (Appendix During this season stations in inner Long Beach Harbor and near the Los Angeles River mouth showed maxima at subsurface, while other stations in the study area showed highest values at the surface.

In the autumn (September, October and November) dissolved oxygen in the outer harbor gyre area continued to show good values (Figure 15), increasing in November to possible bloom conditions, but with few exceptions other stations showed decreased dissolved oxygen. In inner Los Angeles Harbor most of the readings were below 5 ppm through the water column during the fall, as with station B7 in Cerritos Channel of Long Beach. The C stations remained very low during November.

The annual average values (Figure 16) reflect the trends already noted. The outer harbor and the Los Angeles River mouth area characteristically had higher dissolved oxygen levels than the inner harbor. The Los Angeles Harbor main channel and inner harbor areas had the lowest dissolved oxygen levels for much of the year.

pH

Seasonally, pH of the surface waters was lowest during the spring throughout the entire harbor and highest in summer and fall (Figures 17 to 20). The winter season showed a bimodal distribution of values (see the histogram legend for Figure 17), with the inner harbor generally showing a mode of pH 8.00-8.10, and outer harbor stations, 8.60-8.90. No seasonal averages of less than pH 7.0 were found at any of the stations.

During each season the pH of the outer harbor was higher than the inner harbor. Both the mouth of the Los Angeles River and the area affected bythe gyre and the TITP outfall in the outer harbor appeared to be the centers of highest pH in distribution through the harbor annually (Figure 21).

Distribution of pH with depth showed no pattern of anomalies. Values were generally related to surface pH, which tended to be the highest in the water column. The lowest pH was always at the deepest depth measured.

Turbidity

Light transmission in the water column is one criterion subject to some question as to whether a high percentage of clarity is desirable or not. While clear waters are esthetically pleasing and discolored waters are not, the clearest water represents a lack of food items such as phytoplankton and zooplankton.

When light transmittance is lowered, it may be due to a variety of causes, some good and some bad. Turbidity caused by storm runoff or resuspension of sediments from ship propellors or storm waves contributes some recycled nutrients to the ecosystem. It may, however, damage the filter feeding organisms or cover them over. In the periods of heavy pollution, mostly prior to 1973, white cloudy waters (white tides) used to occur, which apparently were colloidal sulfur suspended in the water due to a die-off of sulfide bacteria living in or on the anaerobic sediments.

The cannery effluent formerly produced a *cafe-au-lait* color from proteins, fats and carbohydrates in the effluent. Proteins "salt out" in sea water, forming a floating scum known as gurry, which many small fish ate.

Reduction of light penetration prevents the growth of macroalgae in the harbor below about three to five meters in many places. However, there are advantages to turbid waters, for they hide the larval and juvenile fish from predators, and they provide particulate food for omnivorous larvae. Since sediment and fine detritus contain many surficial bacteria, some nutrients are gained by organisms that ingest seemingly inedible particulate matter. Anchovy larvae require dense concentrations of nutrient particles including phytoplankton, as they must feed continually by swimming with mouths open through food.

Light reduction may be due to phytoplankton growth. Good crops of phytoplankton contribute to the food chain, as in the case of the anchovy larvae (Lasker, 1978b), but less light penetrates to macroalgae. Blooms of phytoplankton, particularly of the red tide organism *Gonyaulax polyedra*, for several years caused anoxic water conditions. Fish trapped in blind-end slips sometimes died, and filter-feeding molluscs such as the mussels were killed by clogging of gills. Local red tides were not toxic, however, as they have been on the Atlantic Coast and in Mexico (Yentsch, 1979).

Turbidity was measured in the harbor with a Hydroproducts transmissometer, which contains a remote sensor with built-in light path. It is unfortunately an instrument that spends more time under repair than in the field, at which times the visual Secchi disc was used. The readings cannot indicate whether turbidity is caused by sediments or phytoplankton, and therefore must be interpreted by comparison with rainfall data, cannery processing data, phytoplankton data, and suspended solids data from the treatment plant.

Figure 42 gives comparisons of surface data from 1973 through 1978 at three stations having different characteristics for the winter (January) and the summer (July, or June where data are missing). Station A1, the sea buoy, represents ocean conditions outside the breakwater, although it is certainly influenced by tidal flushing of the harbor; Station A4 is near the entry of Fish Harbor, and Station A7 is between the former cannery outfalls and the treatment plant (TITP).

Figure 43 presents a comparison of the annual means of surface light transmittance for the same stations and years; it is readily apparent that the seasonal variations are smoothed by the means, but the differences between the stations are fairly consistent. In the summer of 1978, an upset at TITP released large amounts of suspended solids, but they seemed not to affect the turbidity measurements. Rather surprisingly, the extreme low for the summer of 1977 at Station A7 came when secondary waste treatment had been initiated; the low in January 1978 came when the cannery discharges had been eliminated. There was considerable rainfall in January, however.

The year 1974 had intermittent phytoplankton blooms throughout the harbor and the entire coast of the Los Angeles area.

Table 6 presents the surface data for the three stations for 1973-1978 period.

Nutrient Chemistry Results

The results of nutrient chemical analysis of surface water samples during this study are presented in the same fashion as those of physical water quality parameters. The data for each of the nutrient salts is presented in tabular form as microgram-atoms per liter. Four computer maps show the distribution throughout the harbor of seasonal averages for winter, spring, summer and fall for each parameter, and a fifth map gives annual averages. Table 1 and Figures 22-26 present the phosphate data, Table 2 and Figures 27-31 the data for ammonia, Table 3 and Figures 32-36 nitrate and Table 4 and Figures 37-41 nitrite.

Phosphate

The seasonal pattern of phosphate concentrations showed winter as the season of highest concentrates, with successive reductions from the peak values in spring and summer. Summer was the season of lowest value and fall had a bimodal distribution of values.

Throughout the year there was a consistent areal distribution of high values and low values. The lowest phosphate concentrations were found along the inside of the middle breakwater and at the sea buoy stations. The area of low values along the inside of the breakwater showed progressive shifts to the east through the summer and a reverse shift in the fall.

The highest concentrations of phosphate were found in areas of heaviest effluent flow, the areas near the Terminal Island Treatment Plant outfall, the Los Angeles River mouth and Dominguez Slough. Highs were also consistently found in the area of Slip 1, Slip 5 and the East Basin Channel of Los Angeles Harbor.

Ammonia

Ammonia concentrations in the harbor showed the same seasonal pattern that was observed for phosphate. Winter maxima were succeeded by progressive reductions to summer minima. Fall values were bimodal with modes at 1.00-1.50 µg·at/l and 5.51-9.02 µg·at/l $\left(\frac{x\ \mu g \cdot at/l}{at.wt.} \times 1000 = mg/l\right)$.

During all seasons high values of ammonia concentration were associated with the TITP outfall. In the winter high levels were also found near the Los Angeles River mouth and in the inner harbor areas, where other effluents are known to occur. These latter include thermal wastes from the Los Angeles Department of Water and Power plant discharging in West Basin of Los Angeles Harbor and the Edison plant discharging in the Back Channel of Long Beach Harbor. Storm drains from Dominguez Slough and into Channel Two of Long Beach Harbor also probably carried ammonia into harbor waters.

Low values were found at the sea buoy stations, A1 and B1, and in the southern part of the outer harbor, particularly along the inside of the middle breakwater.

Nitrate

There was agreement in seasonal changes in nitrate concentration with the changes in phosphate and ammonia. The winter values were the highest for the year and the values were progressively lower through spring and summer. Fall values formed a bimodal pattern of distribution of values. The lower mode of 1.00-2.00 μg·at/l was higher than the summer mode of 0.0-1.00 μg·at/l. The higher mode was lower than the winter mode but the same as that for spring.

Low values were consistently found in the southern part of the outer harbor, particularly along the inside of the middle breakwater and at station A1 near the Los Angeles Harbor sea buoy.

High values in the winter occurred in the Los Angeles River area and in the inner channels, particularly of Long Beach Harbor. Moderately high values were also found near the TITP outfall and in outer Long Beach Harbor.

In the spring the area near the Los Angeles River was very high in nitrate concentration. The outfall area, again, showed moderately high values, as did outer Long Beach Harbor.

In the summer moderately high values occurred only in the outer harbor near the outfall and in West Basin of Los Angeles Harbor.

Fall values appeared to be transitional to the pattern described for winter. Values in the inner harbor and near the Los Angeles River mouth were higher than in summer, but not as high as the winter values for those areas.

Nitrite

Nitrite values, as shown in Table 4 and Figures 37-41, followed the same seasonal trends noted for the other nutrient chemicals, for which analyses were carried out. The winter high values showed progressive decreases through summer. Fall values, higher than the summer ones, were more variable and extensive in range than for other seasons.

Values throughout the harbor were low except in winter, spring and fall near the Los Angeles River mouth and in fall near the TITP outfall. These high values near the outfall were due to very high concentrations found there in September. Data for October and November, the other fall months, were essentially similar to the low values of nitrite concentrations found at nearby stations.

DISCUSSION

The relative influence of some of the various factors that affect the harbor environment can be seen in these data.

The salinity of the harbor waters clearly establishes their marine origin, and the absence of salinity gradients in summer and fall shows that there is no continuous input of fresh water into the harbor. The harbor, therefore, is not a true estuary.

The high salinity values found in the harbor during December of 1977 and February of 1978 are felt to stem from intrusion of a southern water mass into the California coastal area. No high salinity water was found in the inner Los Angeles Harbor in February, but had been present at the only station occupied there in December 1977. In November of 1978, higher salinities and unseasonally warm temperatures signalled the return of the southern water to the harbor.

Circulation and Flushing

The appearance of the high salinity waters in the harbor and their disappearance within the period between the monthly monitoring cruises indicates roughly the speed of flushing within the harbor and its completeness. The distribution of salinities suggests that the outer harbor gyre feeds to some extent up the main Long Beach channel as far as station B7.

Net transport of water, in this case the deeper high salinity water, into the Long Beach inner harbor, moved to the west across the northern border of Terminal Island, but in the winter and spring did not mix with the low salinity water moving down the main channel of Los Angeles Harbor. EQA-MBC (1978) postulated that the Edison generating plant flow produced a reversal of the net flow formerly thought to move to the west in Cerritos Channel. The patterns of temperature around Pier J suggest that the net flow may now be to the east of Pier J.

Salinity Changes

The stations occupied for this survey and the techniques employed are essentially unchanged from those used in a similar study of the area in 1973 and 1974. Some of the averaged annual values found at that time are tabulated below in Text Table 1 with similar data from the 1978 study. A significant drop in salinity can be seen in comparing 1973-1974 data with that of 1978, and is more striking when considering that the salinity for the entire harbor dropped (Port of Long Beach, 1976). The reduction was apparently due to the action of the Regional Water Quality Control Board in ordering that oil field brines no longer be discharged into the harbor, according to Dr. Lewis A. Schinazi (pers. comm.). The salinities in the outer

Los Angeles Harbor were higher than those outside the harbor at the sea buoy in 1973, but this was reversed in 1974, and the latter pattern persisted into 1978. The further reduction in average salinity noted in the 1978 data are probably due to heavier storm runoff, as seen in the lower average salinity at the Dominguez Slough and Los Angeles River stations in 1978. The 1978 averaged data also reflect the less saline water surface of the Long Beach Harbor stations, as mentioned above.

Text Table 1. Average Annual Salinity of Surface Waters.

location and station number		1973	1974	1978
Sea Buoy - LA Harbor	A1	33.13	32.80	32.60
Sea Buoy - LB Harbor	B1	33.06	32.92	31.60
Outer LA Harbor	A2	33.68	31.79	31.90
Outer LA Harbor	A12	33.45	31.50	31.90
TITP outfall	A7	32.72	31.11	31.90
Outer LB Harbor	B3	33.08	32.72	30.90
Outer LB Harbor	B8	32.99	32.79	31.60
Dominguez Slough	C11	32.20	31.32	25.00
Los Angeles River	D2	32.13	30.70	25.60

Temperature Changes

The general pattern of temperature in the harbor showed that the inner harbor and the area near the Los Angeles River were warmer than the outer harbor. In the winter the increased storm runoff resulted in a general reversal of the pattern. This is probably due to the long residence times of water in the inner harbor and the thermal effluents discharged in the Back Channel of Long Beach Harbor and in West Basin of Los Angeles Harbor. The slower circulation of water in these areas not only results in the retention of the thermal effluent, but also permits the waters to be warmed by the sun.

In the deeper waters, vertical mixing would tend to maintain a more stable thermal regime, as occurs at the sea buoy stations.

A comparison of 1978 averaged temperatures with those for 1973 and 1974, as tabulated in Text Table 2, shows that 1978 was considerably warmer, over 2° C, than the sea buoy temperatures of the earlier years. This was probably due to the incursion of tropical waters into the coastal area of southern California, as discussed elsewhere in this report, and indicates the role of the oceanic temperature regime in influencing the basic harbor climate.

Text Table 2. Average Annual Temperature of Surface Waters at Selected Stations in San Pedro Bay in 1973, 1974 and 1978.

location and Station number		1973	1974	1978
Sea Buoy - LA Harbor	A1	15.06	14.77	17.30
Sea Buoy - LB Harbor	B1	15.24	15.37	17.60
Outer LA Harbor	A12	15.97	15.60	17.40
Inner LA Harbor	C4	17.64	17.65	19.40
TITP	A7	16.68	16.11	17.70
Outer LB Harbor	B3	15.69	15.61	18.40
Inner LB Harbor	C5	16.11	16.36	18.70
Dominguez Slough	C11	16.98	16.82	18.00
Los Angeles River	D2	15.85	16.36	18.60

The difference between sea buoy temperatures and harbor temperatures was greater in 1978 than in the previous years, particularly in Long Beach Harbor. This is probably due to the renewal of operation of the Southern California Edison Company's Long Beach Generating Station in 1977. The increase in temperature at the Los Angeles River mouth and to the east of Pier J is most probably related to the Edison thermal discharges.

The reduced temperatures in winter and spring, particularly at Dominguez Slough and the Los Angeles River mouth, are indicative of storm runoff occurring in these seasons.

Dissolved Oxygen Changes

Dissolved oxygen content of the harbor waters is regulated by several processes. Ocean waters carried into the area are physically mixed and are aerated at the air-sea interface. However, biological processes in the waters are usually the major means of contributing to the dissolved oxygen of the area.

In general, the processes that tend to add oxygen to the waters are surface turbulence, which is maximal during storms, and phytoplankton photosynthesis, which is greatest during periods of active production. Biological respiration and chemical oxygen demand are processes that reduce oxygen in the waters.

A comparison of the computer maps of dissolved oxygen concentration (Figures 12 to 16) with those of phytoplankton productivity (see Section IIIA) show general agreement. The prime discrepancy is in the winter and spring when values of dissolved oxygen were not accompanied with high values of productivity, although the seasonal ranges shown on the figures appeared to correspond with those for productivity.

In general, the inner harbor areas were lower in dissolved oxygen than the outer harbor, where the gyre in the circulation of the water between Terminal Island and the middle breakwater appeared to be the focus of high values of dissolved oxygen. Another area where high oxygen values occurred often was the area off the Los Angeles River mouth, with the river mouth itself being somewhat lower than the areas outside of it.

Low values of dissolved oxygen tended to occur throughout the inner harbor, West Basin and Main Channel of Los Angeles Harbor. Dissolved oxygen in inner Los Angeles Harbor was always lower than in inner Long Beach Harbor and was the only harbor area in which seasonal averages indicated less than 5 ppm of dissolved oxygen. This occurred in summer in Dominguez Slough, station C11, and in West Basin at station C6. Stations in West Basin and in Slip 1 had surface values below 5 ppm in each of the fall months. These values ranged from the low for the year 2.3 ppm at station C6 in November to 4.8 ppm at the same station in September and October. Summer and fall values found in West Basin were consistently the lowest for the entire study. This is the area where an electric generating plant cooling water outfall is released (station C6), where Harbor Lake drains (C5), and where a major shipyard is located (C4).

The range of annual average oxygen concentration in 1978 was from 5 ppm to 10.0 ppm and is similar to the ranges encountered for the averaged values for the years 1973 and 1974. The absolute range of 2.3 ppm to 13.1 ppm for 1978 is also similar but slightly narrower than in the earlier period. No periods of anoxia in surface waters were found in the present survey but were present in the data for the earlier study.

pH Variation

The pH of sea water in the open ocean normally varies only from about 8.1 to about 8.3. The controlling mechanisms are the equilibrium between atmosphere and dissolved carbon dioxide, and the functioning of a natural carbonate buffer system in sea water. Values above this range do occur and are usually related to phytoplankton blooms, in which the carbon dioxide is removed at a rate greater than it is replaced. Lower values also occur, down to about 7.5 in areas where carbon dioxide is being formed. Even lower pH values can occur in sea water if hydrogen sulfide is formed or other acids are present. A pH of less than 7.00 usually indicates that dissolved oxygen is absent or in very low concentration. Since rain water usually has a pH as low as 6.5 due to saturation with carbon dioxide and no buffering system, dilution of sea water can also result in reduction of the pH of sea water.

In the harbor, dilution from runoff occurs seasonally and a variety of wastewater effluents of relatively unknown composition are also discharged into various areas. In addition, biological activity, including both respiration and photosynthesis, are more intense than in oceanic or open coastal waters. The result is a wider range of variability than occurs in more oceanic environments.

The general distribution of pH showed that the inner harbor was generally lower in pH than the outer harbor. The area near the Los Angeles River mouth was usually intermediate in pH. These general patterns, as well as the seasonal trends, roughly paralleled the same changes seen in some of the other parameters, particularly dissolved oxygen and phytoplankton productivity. However, no significant correlation was expected or found. Interactions of these parameters and others measured are analyzed statistically in Section IV of this report.

The distribution of surface pH values in 1978 was similar to that found in 1973-1974, suggesting that similar factors controlled pH in the harbor. Discharge of waste waters into the harbor have, however, changed (Soule and Oguri, 1979). The major changes are the reactivation of the Long Beach generating station with its thermal waste outfall in the inner harbor and the secondary treatment of combined flows from TITP and the fish canneries in the outer harbor. The last mentioned would result in a general increase in pH in the outer harbor, since the production of CO_2, as oxidation of organic wastes occurred, would no longer be as large a factor in reducing the pH of the harbor waters. As a corollary result of this, there would also be less pressure on the supply of dissolved oxygen in the area.

These changes resulted in an alteration over the years in the pH values encountered in the harbor, although relative distribution remained essentially similar. The earlier range of pH values encountered was 6.5 to 8.6, and there were episodes of anoxia in the water column. In 1978 the range shifted upward and narrowed to 7.22 to 9.03. During 1978 no zero dissolved oxygen readings were found in this survey.

Nutrients

The nutrient chemicals analyzed during this study are also sometimes called fertilizer salts and are of importance primarily in supplying some of the mineral nutritional requirements of photosynthetic organisms such as the phytoplankton, which, in turn, may be used to satisfy the nutritional requirements of various heterotrophic organisms. These substances, in themselves, are not of significance in meeting the nutritional needs of the heterotrophic organisms.

The nutrient chemicals discussed in this report are nonconservative parameters and are often considered as factors limiting to the growth of phytoplankton in the open ocean. In the harbor this does not seem to be likely except, possibly, in the area of the harbor nearest Angels Gate. In all other harbor areas the levels of nutrients are substantially higher than they are at station A1, which is most representative of oceanic conditions of stations sampled in this study. The values found also were variable in space and in time. The seasonal changes generally showed that winter was the season of highest concentration. These levels dropped successively in spring and in summer, when they reached the annual minima. In fall, higher average values began to appear and the range of values was more extreme.

The nutrient levels are inversely proportional to phytoplankton patterns. The standing crop of phytoplankton, as shown by chlorophyll *a* values and levels of productivity, increased from the winter lows to the highest values of the year in the autumn in 1978. Seasonal levels of assimilation were low in the winter, moderate in spring, lowest in summer and highest in fall. The changes in assimilation ratios do not necessarily coincide with the changes in nutrient chemical concentrations.

The variability in space and time of the nutrient salts and their presence in higher concentration than in the open ocean indicate that they are probably available beyond the ability of the existing populations to utilize them. Nutrients are therefore not considered to be limiting to the production of phytoplankton in the harbor, except possibly in localized areas such as mentioned above.

The relatively low concentrations of the nutrient chemicals in the adjacent ocean as compared to the harbor indicate that these substances are probably of terrigenous origin. The pattern of spatial distribution indicates their source. Ammonia, which is invariably low or absent in the open ocean, is much higher in the harbor, particularly in the area of the TITP outfall. Since ammonia is a product of the degradation of organic material, this was expected. The levels of ammonia found in the winter in the inner harbor and in the Los Angeles River were probably due to the organic load of seasonal runoff. Bacteria metabolize ammonia very rapidly in sea water, and are in turn consumed by filter feeders.

The patterns of nitrate and nitrite concentrations indicated the same sources, but in reverse order. The Los Angeles River apparently was responsible for the highest concentrations of nitrate and nitrite, which suggested that nitrogen-bearing organic material in the effluent was not as prominent as more fully oxidized forms of nitrogen. Comparison of parameters, by season (Figures 27-41), show the seasonal difference in sources. Also, the phosphate concentrations in the harbor were equally high near the TITP outfall, the Los Angeles River mouth and Dominguez Slough.

CONCLUSION

The harbor waters, although basically marine in origin, have characteristics that are dominated by the configuration of the harbor and the uses to which its waters are subjected.

The salinity of the harbor waters is basically marine, modified by seasonal runoff. The basic thermal regime of the harbor also is marine, with modifications which are due to the configuration of the basin, and result in increased insolation and residence time of water. The uses of the waters as coolant by generating stations significantly adds heat to some of the harbor areas. Nevertheless, the seasonal temperature patterns of the harbor reflect ocean climate in annual and seasonal changes.

The pH of harbor waters is regulated by that of the ocean and its buffering capacity. The uses to which the harbor waters are put produce alterations in pH beyond that which normally occurs in sea water, but pH is nevertheless dominated by the ocean's influence.

Dissolved oxygen concentrations in the harbor show greater range and variability than in the ocean. In general, the levels of dissolved oxygen present are the product of localized processes, such as biochemical oxygen demand, photosynthesis through the water column, and surface turbulence.

The nutrient salts in the harbor are overwhelmingly of terrigenous origin. The levels of those substances present, except at the lowest levels found, were felt to be too high to be limiting to the local phytoplankton populations but may result in enhancing their productivity. There was no clear evidence of inhibition.

Turbidity variation was great; however, low light penetration episodes can be related to spring and fall phytoplankton, to wave turbulence and rainfall runoff, to anchovy canning season or to treatment plant malfunction.

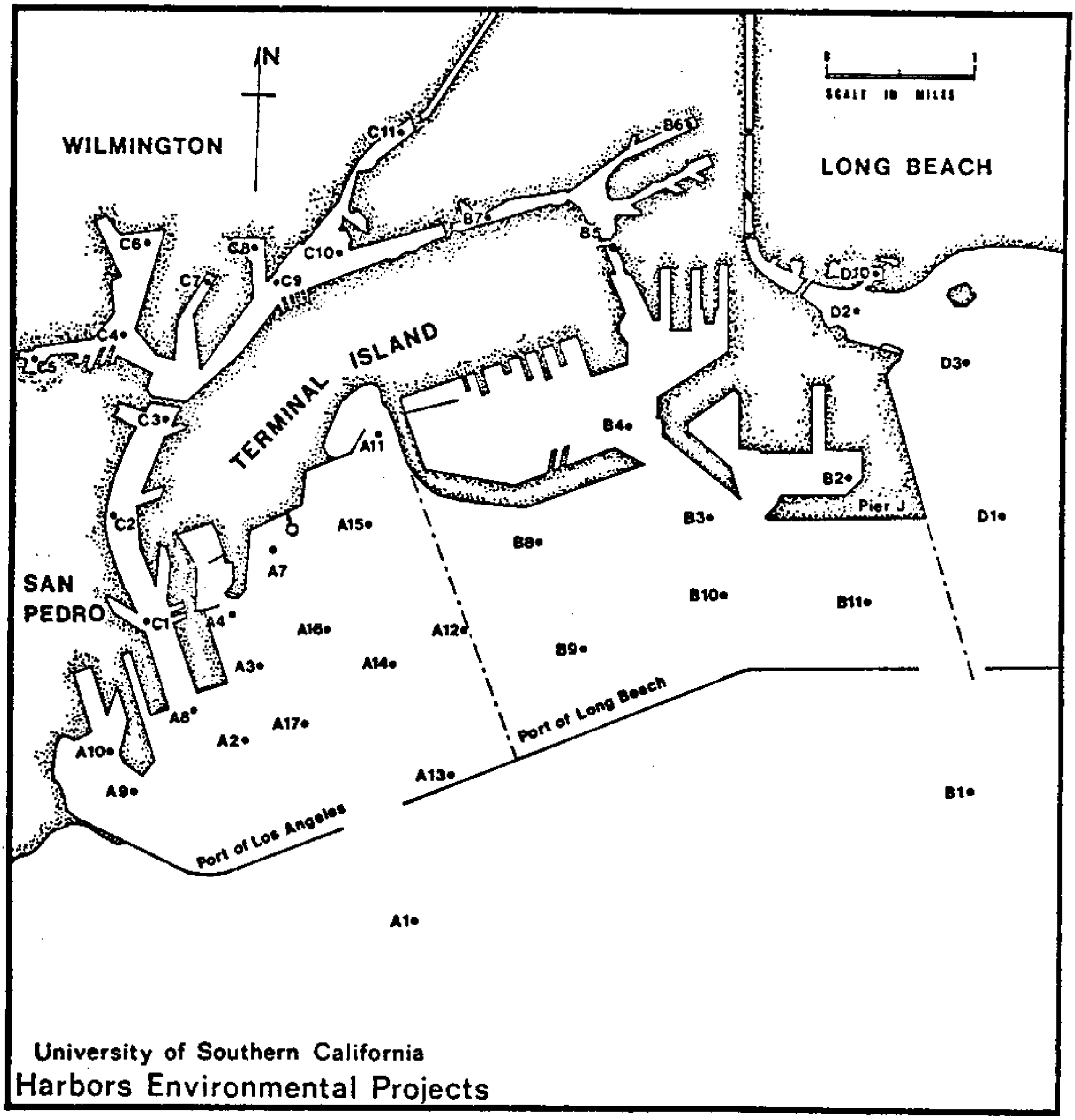


FIGURE 1. 1978 WATER QUALITY SAMPLING STATIONS

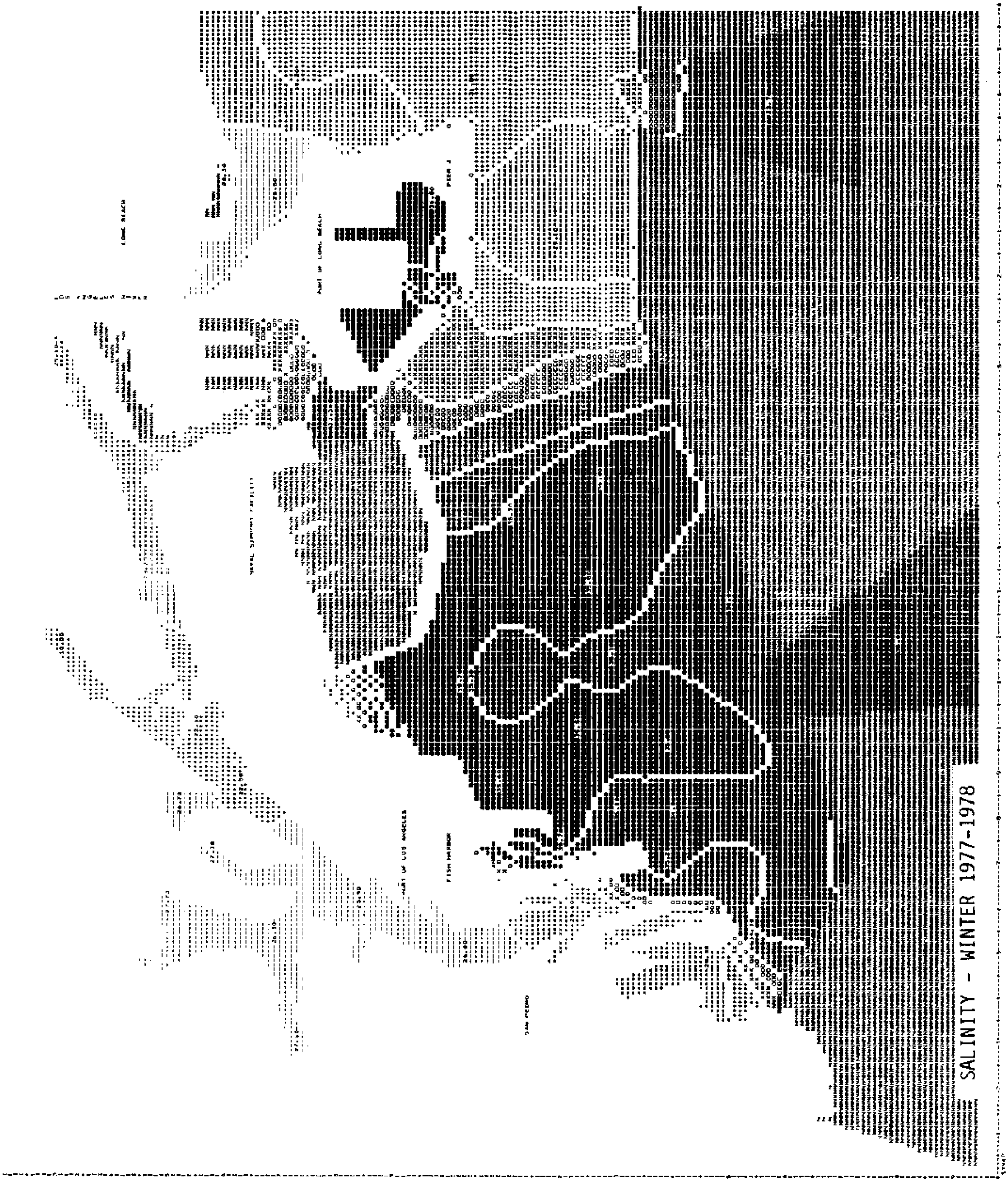

SALINITY - WINTER 1977-1978

FIGURE 2, MEAN SALINITY
WINTER 1977-1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE        10.00      36.00


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM    10.00    17.22    24.44    28.06    30.22    31.67    32.39    33.11    34.56    35.28
 MAXIMUM    17.22    24.44    28.06    30.22    31.67    32.39    33.11    34.56    35.28    36.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            27.78    27.78    13.89     8.33     5.56     2.78     2.78     5.56     2.78     2.78

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9         10
          ====================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  @@@@8@@@@  ■■■■9■■■■  ■■■■*■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
          ====================================================================================================
 FREQ.          1         2         8         6         3         1         1         3         6         10
     1      I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I@@8@@I   I■■9■■I   I■■*■■I
     2                I''2''I   I--3--I   I==4==I   I++5++I                       I@@8@@I   I■■9■■I   I■■*■■I
     3                          I--3--I   I==4==I   I++5++I                       I@@8@@I   I■■9■■I   I■■*■■I
     4                          I--3--I   I==4==I                                           I■■9■■I   I■■*■■I
     5                          I--3--I   I==4==I                                           I■■9■■I   I■■*■■I
     6                          I--3--I   I==4==I                                           I■■9■■I   I■■*■■I
     7                          I--3--I                                                               I■■*■■I
     8                          I--3--I                                                               I■■*■■I
     9                                                                                                I■■*■■I
    10                                                                                                I■■*■■I

0.603545 MINUTES FOR HISTOGRAM
```


SALINITY - SPRING 1978

FIGURE 3, MEAN SALINITY
SPRING 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMFS ARE        18.40       33.00


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM    10.00    17.22    24.44    28.06    30.22    31.67    32.39    33.11    34.56    35.28
  MAXIMUM    17.22    24.44    28.06    30.22    31.67    32.39    33.11    34.56    35.28    36.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             27.78    27.78    13.89     8.33     5.56     2.78     2.78     5.56     2.78     2.78

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9         10
             ==================================================================================================
             .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
             .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS    ....1....  ....2....  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  @@@@8@@@@  ■■■■9■■■■  ■■■■+■■■■
             .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
             .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
             ==================================================================================================
  FREQ.          0         3         6        20        10         0         2         0         0          0
        1              I..2..I   I--3--I   I==4==I   I++5++I             I00700I
        2              I..2..I   I--3--I   I==4==I   I++5++I             I00700I
        3              I..2..I   I--3--I   I==4==I   I++5++I
        4                        I--3--I   I==4==I   I++5++I
        5                        I--3--I   I==4==I   I++5++I
        6                        I--3--I   I==4==I   I++5++I
        7                                  I==4==I   I++5++I
        8                                  I==4==I   I++5++I
        9                                  I==4==I   I++5++I
       10                                  I==4==I   I++5++I
       11                                  I==4==I
       12                                  I==4==I
       13                                  I==4==I
       14                                  I==4==I
       15                                  I==4==I
       16                                  I==4==I
       17                                  I==4==I
       18                                  I==4==I
       19                                  I==4==I
       20                                  I==4==I

0.467438 MINUTES FOR HISTOGRAM
```

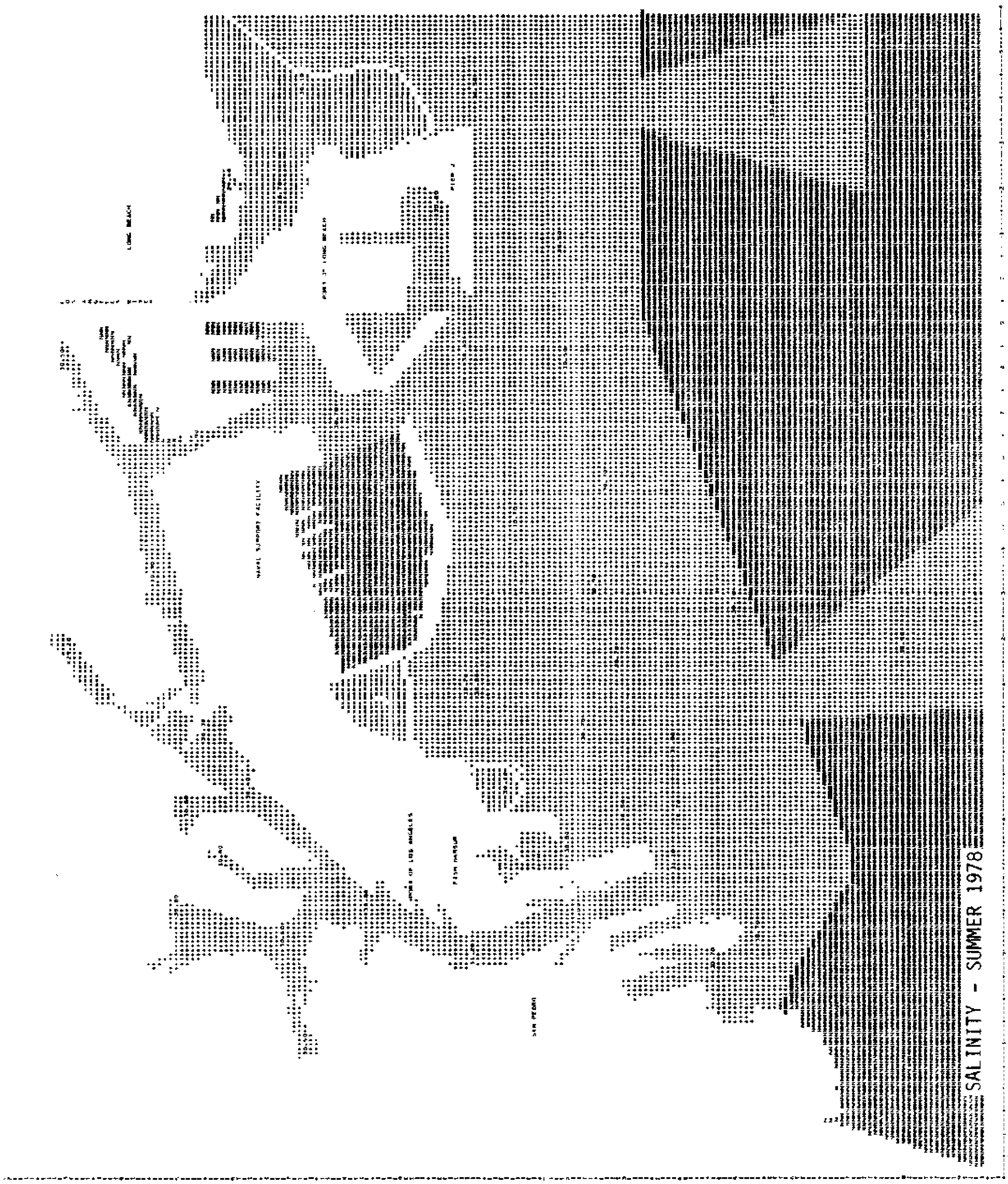

SALINITY - SUMMER 1978

FIGURE 4, MEAN SALINITY
SUMMER 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 28.70 31.20

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28
MAXIMUM	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28	36.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

27.78	27.78	13.89	8.33	5.56	2.78	2.78	5.56	2.78	2.78

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	0	0	0	5	36	0	0	0	0	0

SYMBOLS

0.562820 MINUTES FOR HISTOGRAM


SALINITY - AUTUMN 1978
LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 5, MEAN SALINITY
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 29.60 31.60

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28
MAXIMUM	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28	36.00

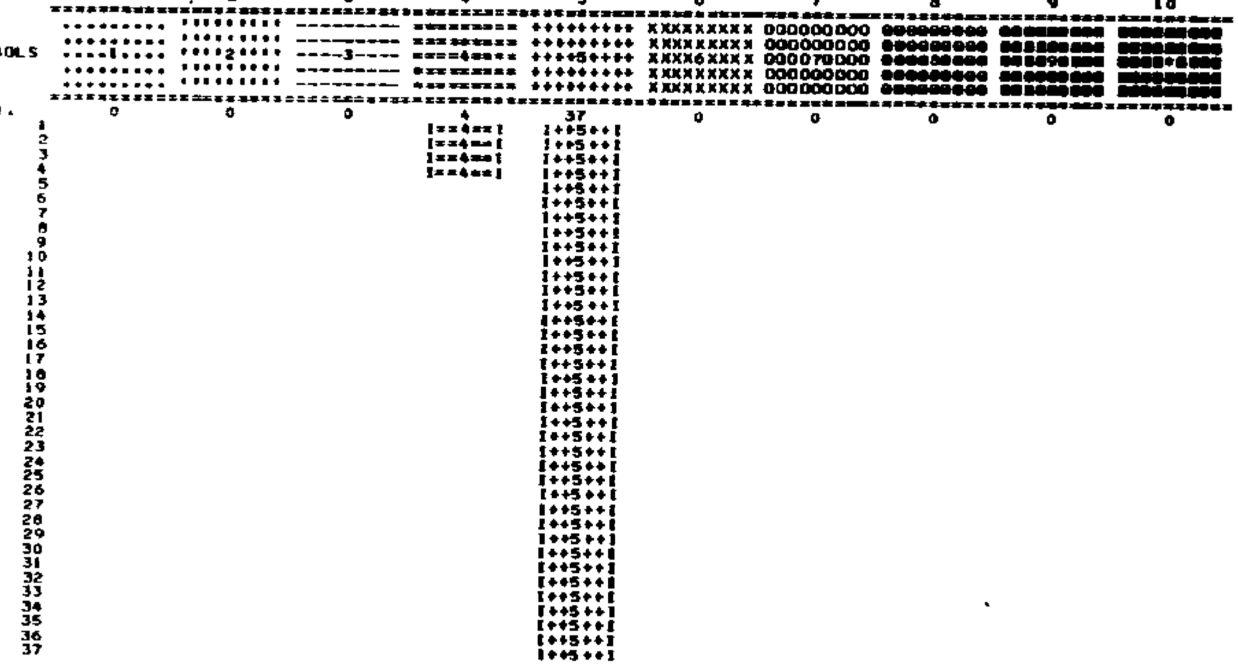
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

27.78	27.78	13.89	6.33	5.56	2.78	2.78	5.56	2.78	2.78

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	0	0	0	4	37	0	0	0	0	0

SYMBOLS



0.508179 MINUTES FOR HISTOGRAM

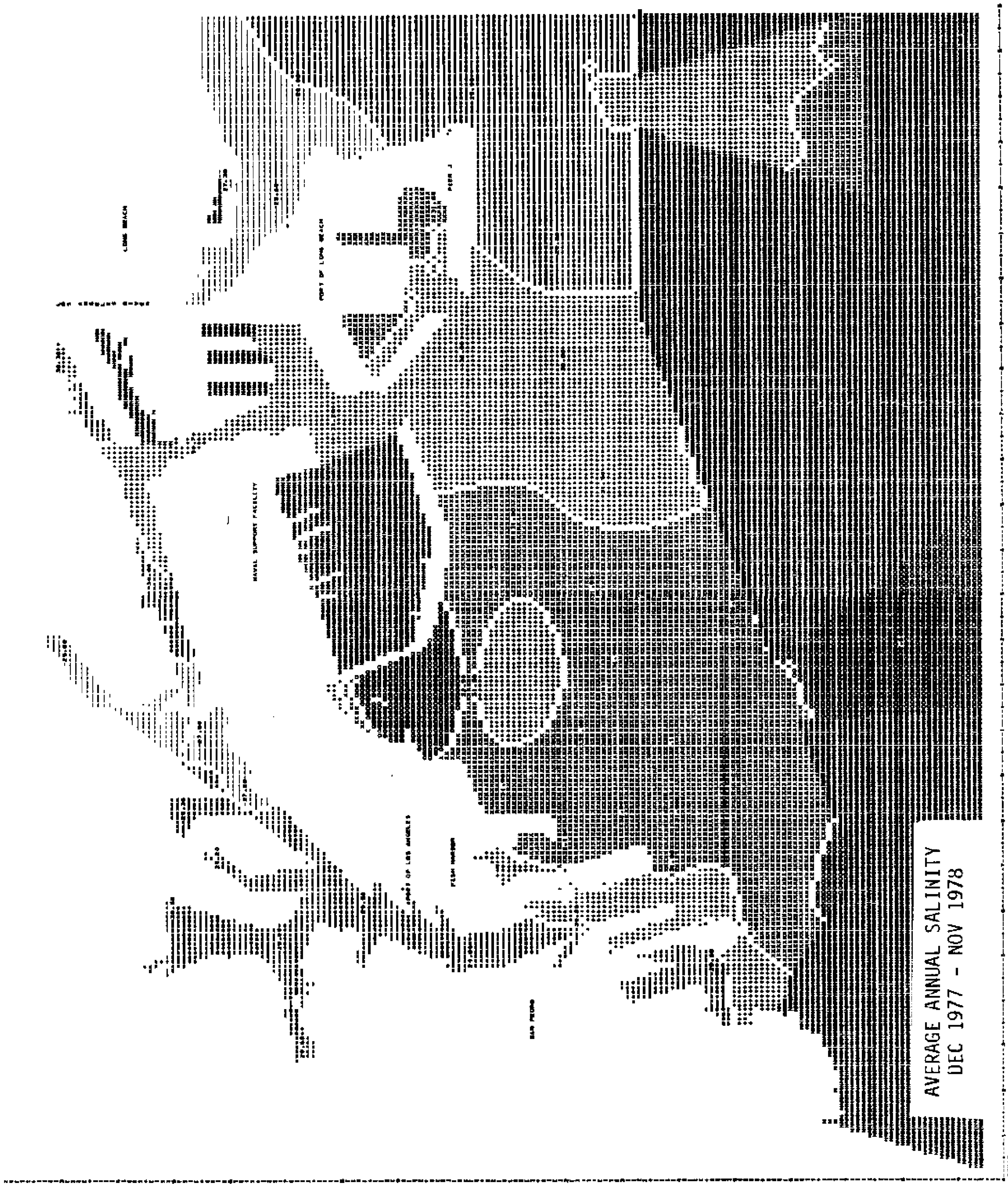

AVERAGE ANNUAL SALINITY
DEC 1977 - NOV 1978

FIGURE 6, SALINITY
AVERAGE ANNUAL SALINITY
DEC 1977 – NOV 1978

DATA VALUE EXTREMES ARE 25.00 32.60

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	10.00	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28
MAXIMUM	17.22	24.44	28.06	30.22	31.67	32.39	33.11	34.56	35.28	36.00

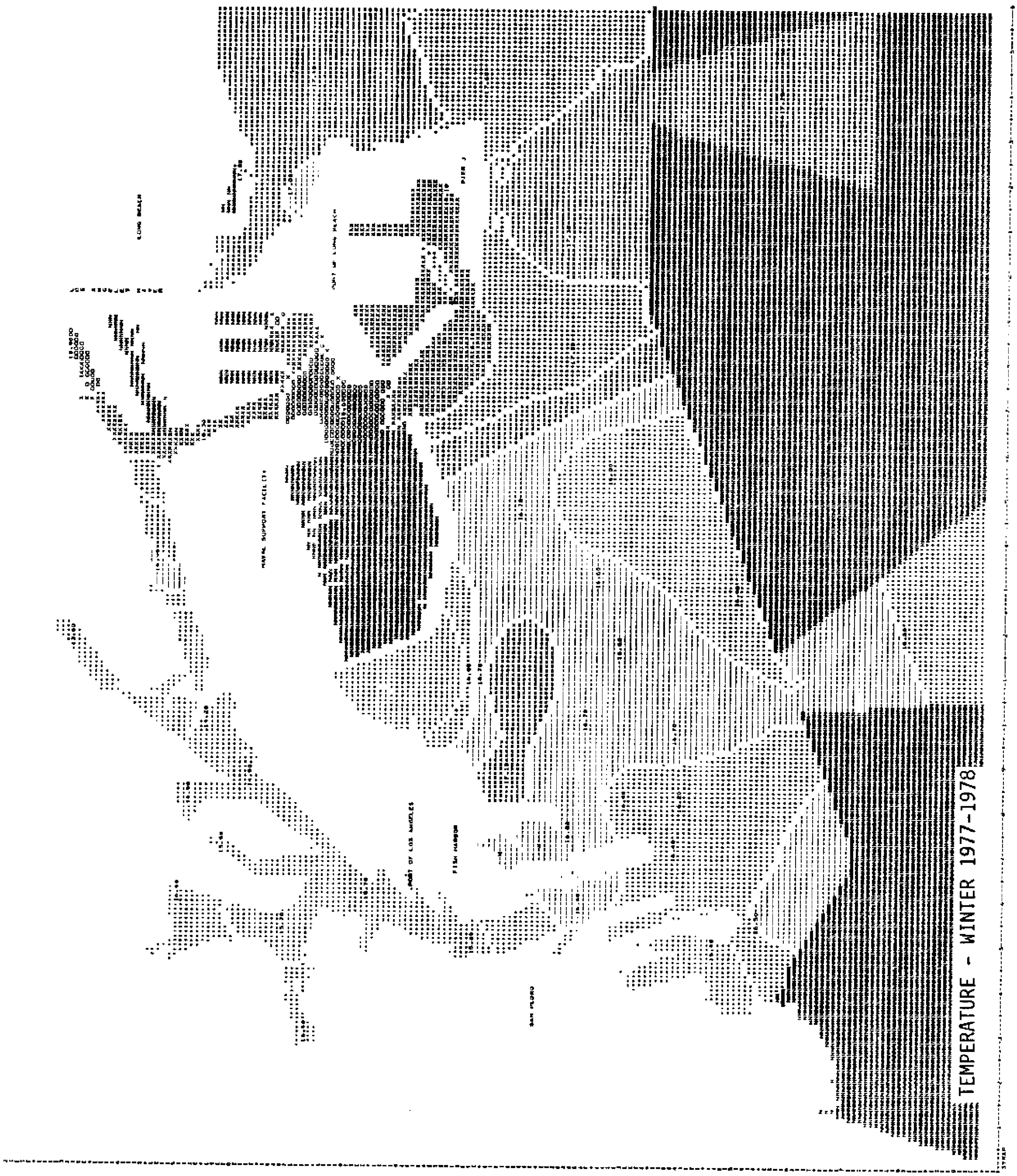
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

27.78	27.78	13.89	8.33	5.56	2.78	2.78	5.56	2.78	2.78

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL       1          2          3          4          5          6          7          8          9          10
        ==================================================================================================================
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
        ==================================================================================================================
 FREQ.       0          0          6          11         8          14         2          0          0          0
   1                            I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I
   2                            I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I
   3                            I--3--I    I==4==I    I++5++I    IXX6XXI
   4                            I--3--I    I==4==I    I++5++I    IXX6XXI
   5                            I--3--I    I==4==I    I++5++I    IXX6XXI
   6                            I--3--I    I==4==I    I++5++I    IXX6XXI
   7                                       I==4==I    I++5++I    IXX6XXI
   8                                       I==4==I    I++5++I    IXX6XXI
   9                                       I==4==I               IXX6XXI
  10                                       I==4==I               IXX6XXI
  11                                       I==4==I               IXX6XXI
  12                                                             IXX6XXI
  13                                                             IXX6XXI
  14                                                             IXX6XXI
```

0.350479 MINUTES FOR HISTOGRAM

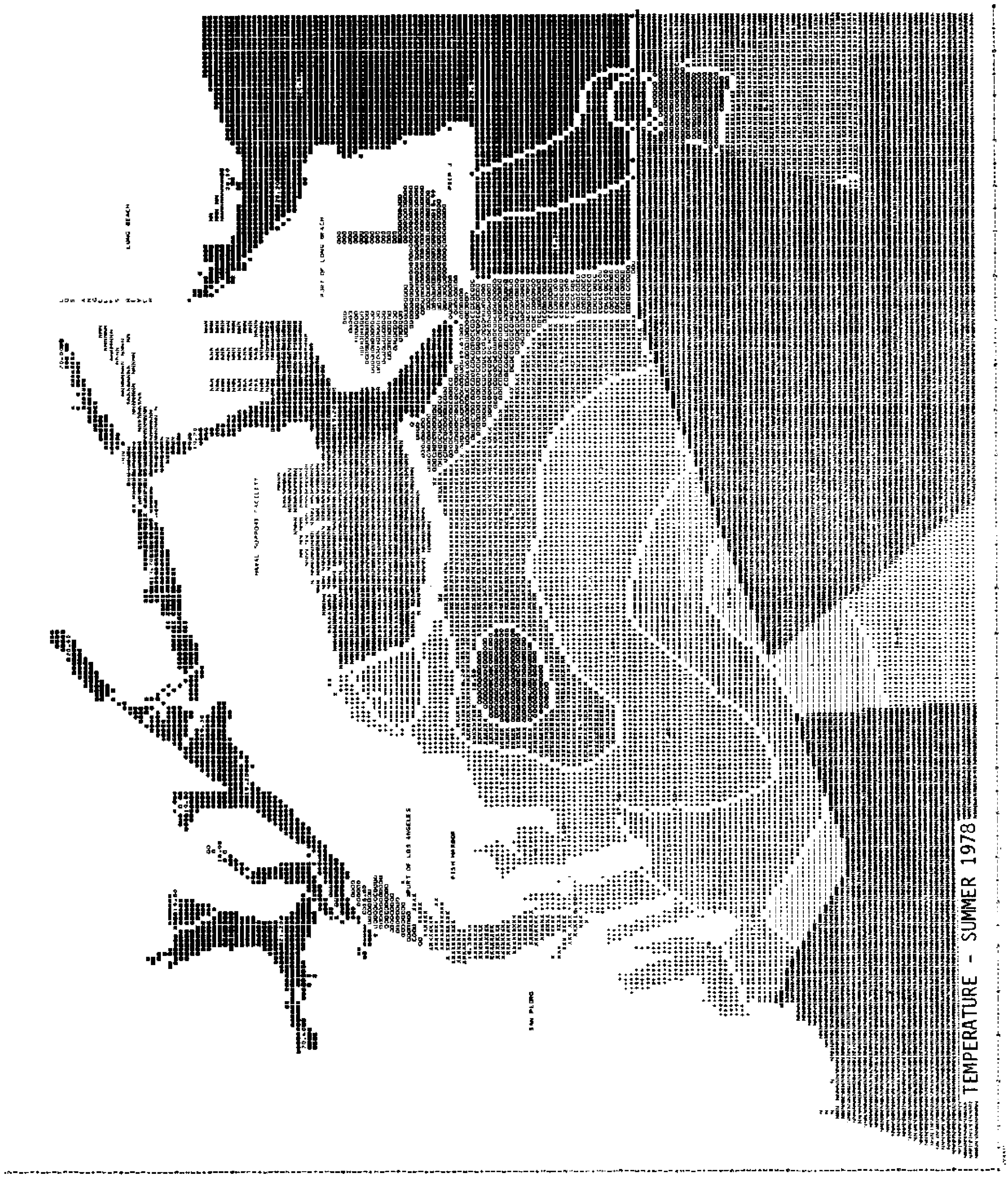

TEMPERATURE - WINTER 1977-1978
LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

```
FIGURE 7, MEAN TEMPERATURE
WINTER 1977-1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE        13.60       18.90


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0     15.90     16.50     17.00     17.50     18.00     18.50     19.00     19.50     20.00
  MAXIMUM    15.90     16.50     17.00     17.50     18.00     18.50     19.00     19.50     20.00     21.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             75.00      2.83      2.36      2.36      2.36      2.36      2.36      2.36      2.36      5.66

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL        1         2         3         4         5         6         7         8         9        10
           ====================================================================================================
             .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
             .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS    ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
             .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
             .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
           ====================================================================================================
  FREQ.        9         8        11         5         3         3         2         0         0         0
          1  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
          2  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
          3  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
          4  I..1..I   I''2''I   I--3--I   I==4==I
          5  I..1..I   I''2''I   I--3--I   I==4==I
          6  I..1..I   I''2''I   I--3--I
          7  I..1..I   I''2''I   I--3--I
          8  I..1..I   I''2''I   I--3--I
          9  I..1..I             I--3--I
         10                      I--3--I
         11                      I--3--I

 0.347809 MINUTES FOR HISTOGRAM
```


TEMPERATURE - SPRING 1978
LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 8, MEAN TEMPERATURE
SPRING 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE        15.60       18.70


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0     15.90    16.50    17.00    17.50    18.00    18.50    19.00    19.50    20.00
 MAXIMUM    15.90     16.50    17.00    17.50    18.00    18.50    19.00    19.50    20.00    21.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            75.00      2.83     2.36     2.36     2.36     2.36     2.36     2.36     2.36     5.66

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
                                                                                                          *
         ====================================================================================================
          .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS  ....1....  ....2....  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
          .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  .........  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         ====================================================================================================
 FREQ.          1         4        16         9         8         2         1         0         0         0
      1    I..1..I    I..2..I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
      2               I..2..I   I--3--I   I==4==I   I++5++I   IXX6XXI
      3               I..2..I   I--3--I   I==4==I   I++5++I
      4               I..2..I   I--3--I   I==4==I   I++5++I
      5                         I--3--I   I==4==I   I++5++I
      6                         I--3--I   I==4==I   I++5++I
      7                         I--3--I   I==4==I   I++5++I
      8                         I--3--I   I==4==I   I++5++I
      9                         I--3--I   I==4==I
     10                         I--3--I
     11                         I--3--I
     12                         I--3--I
     13                         I--3--I
     14                         I--3--I
     15                         I--3--I
     16                         I--3--I

0.343658 MINUTES FOR HISTOGRAM
```



TEMPERATURE - SUMMER 1978

FIGURE 9, MEAN TEMPERATURE
SUMMER 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 16.40 21.20

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	15.90	16.50	17.00	17.50	18.00	18.50	19.00	19.50	20.00
MAXIMUM	15.90	16.50	17.00	17.50	18.00	18.50	19.00	19.50	20.00	21.20

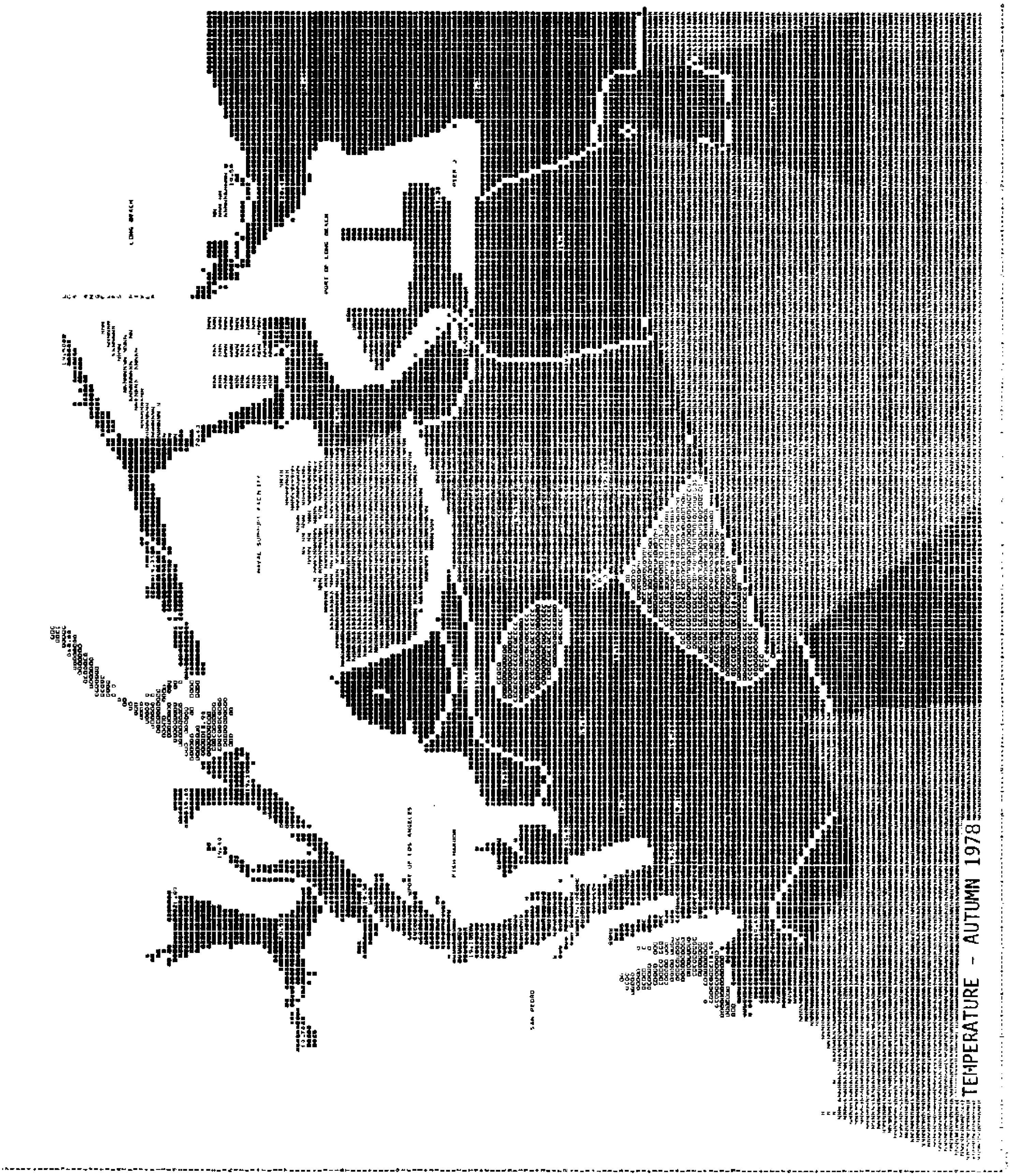
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

75.00	2.83	2.36	2.36	2.36	2.36	2.36	2.36	2.36	5.66

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7         8         9        10
          =========================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ████9████  ████+████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          =========================================================================================================
FREQ.        0         1         1         2         9         7         4         7         2         8
     1              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
     2                                  I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
     3                                            I++5++I   IXX6XXI   I00700I   I88888I             I██+██I
     4                                            I++5++I   IXX6XXI   I00700I   I88888I             I██+██I
     5                                            I++5++I   IXX6XXI             I88888I             I██+██I
     6                                            I++5++I   IXX6XXI             I88888I             I██+██I
     7                                            I++5++I   IXX6XXI             I88888I             I██+██I
     8                                            I++5++I                                           I██+██I
     9                                            I++5++I
```

0.483170 MINUTES FOR HISTOGRAM



TEMPERATURE - AUTUMN 1978

FIGURE 10, MEAN TEMPERATURE
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 18.80 21.00

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	15.90	16.50	17.00	17.50	18.00	18.50	19.00	19.50	20.00
MAXIMUM	15.90	16.50	17.00	17.50	18.00	18.50	19.00	19.50	20.00	21.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

75.00	2.83	2.36	2.36	2.36	2.36	2.36	2.36	2.36	5.66

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

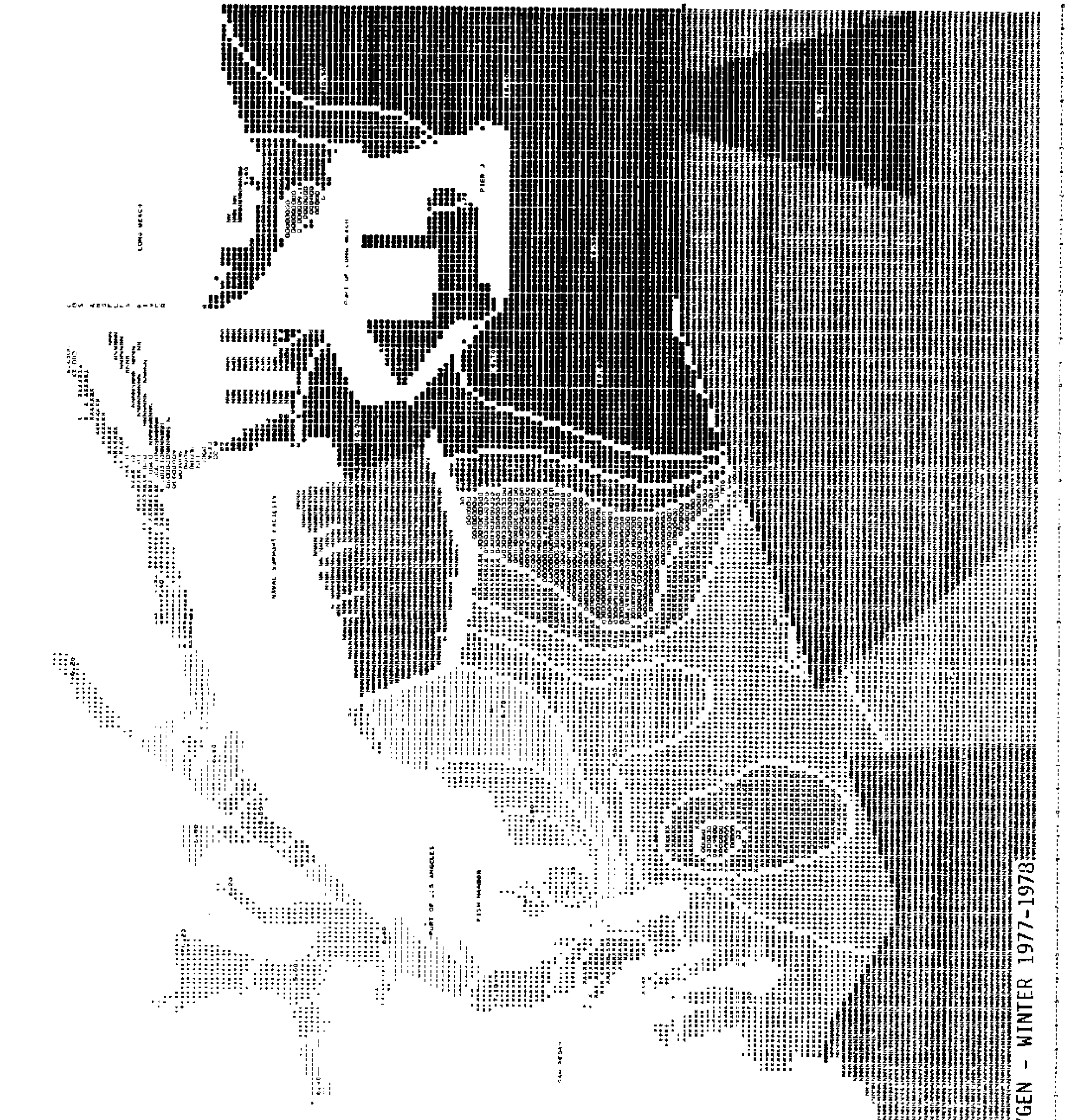
```
LEVEL          1          2          3          4          5          6          7          8          9          10
          =======================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ####9####  ####+####
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          =======================================================================================================
FREQ.          0          0          0          0          0          0          4          19         12         6
      1                                                                    I00700I    I88888I    I##9##I    I##+##I
      2                                                                    I00700I    I88888I    I##9##I    I##+##I
      3                                                                    I00700I    I88888I    I##9##I    I##+##I
      4                                                                    I00700I    I88888I    I##9##I    I##+##I
      5                                                                               I88888I    I##9##I    I##+##I
      6                                                                               I88888I    I##9##I    I##+##I
      7                                                                               I88888I    I##9##I
      8                                                                               I88888I    I##9##I
      9                                                                               I88888I    I##9##I
     10                                                                               I88888I    I##9##I
     11                                                                               I88888I    I##9##I
     12                                                                               I88888I    I##9##I
     13                                                                               I88888I
     14                                                                               I88888I
     15                                                                               I88888I
     16                                                                               I88888I
     17                                                                               I88888I
     18                                                                               I88888I
     19                                                                               I88888I
```

0.652603 MINUTES FOR HISTOGRAM


LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO
AVERAGE ANNUAL TEMPERATURE - 1978

FIGURE 11,
AVERAGE ANNUAL TEMPERATURE
DEC 1977 – NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE        17.10        19.40


TOTAL MISSING DATA POINTS IS         2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0      15.90      16.50      17.00      17.50      18.00      18.50      19.00      19.50      20.00
  MAXIMUM    15.90      16.50      17.00      17.50      18.00      18.50      19.00      19.50      20.00      21.20


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             75.00       2.83       2.36       2.36       2.36       2.36       2.36       2.36       2.36       5.66


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2          3          4          5          6          7          8          9         10
          ==============================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  █████████  █████████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  █████████  █████████
  SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  8888 8888  ████9████  ████+████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  █████████  █████████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  █████████  █████████
          ==============================================================================================================
  FREQ.          0          0          0          5         17          8          7          4          0          0
         1                                I==4==I    I++5++I    IXX6XXI    IOO7OOI    I88888I
         2                                I==4==I    I++5++I    IXX6XXI    IOO7OOI    I88888I
         3                                I==4==I    I++5++I    IXX6XXI    IOO7OOI    I88888I
         4                                I==4==I    I++5++I    IXX6XXI    IOO7OOI    I88888I
         5                                I==4==I    I++5++I    IXX6XXI    IOO7OOI
         6                                           I++5++I    IXX6XXI    IOO7OOI
         7                                           I++5++I    IXX6XXI    IOO7OOI
         8                                           I++5++I    IXX6XXI
         9                                           I++5++I
        10                                           I++5++I
        11                                           I++5++I
        12                                           I++5++I
        13                                           I++5++I
        14                                           I++5++I
        15                                           I++5++I
        16                                           I++5++I
        17                                           I++5++I

 0.427185 MINUTES FOR HISTOGRAM
```



OXYGEN - WINTER 1977-1978

FIGURE 12, MEAN OXYGEN
WINTER 1977-1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          5.30        10.80


TOTAL MISSING DATA POINTS IS        4


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0      5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00
  MAXIMUM      5.00     6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00     10.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              46.30     9.26      9.26      4.63      4.63      4.63      4.63      4.63      4.63      7.41

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
        ==========================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS ....1.... ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
        ==========================================================================================================
  FREQ.          0         3         8         7         3         2         5         3         1         7
           1            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I■■9■■I   I■■+■■I
           2            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I             I■■+■■I
           3            I''2''I   I--3--I   I==4==I   I++5++I             I00700I   I88888I             I■■+■■I
           4                      I--3--I   I==4==I                       I00700I                       I■■+■■I
           5                      I--3--I   I==4==I                       I00700I                       I■■+■■I
           6                      I--3--I   I==4==I                                                     I■■+■■I
           7                      I--3--I   I==4==I                                                     I■■+■■I
           8                      I--3--I

  0.472305 MINUTES FOR HISTOGRAM
```

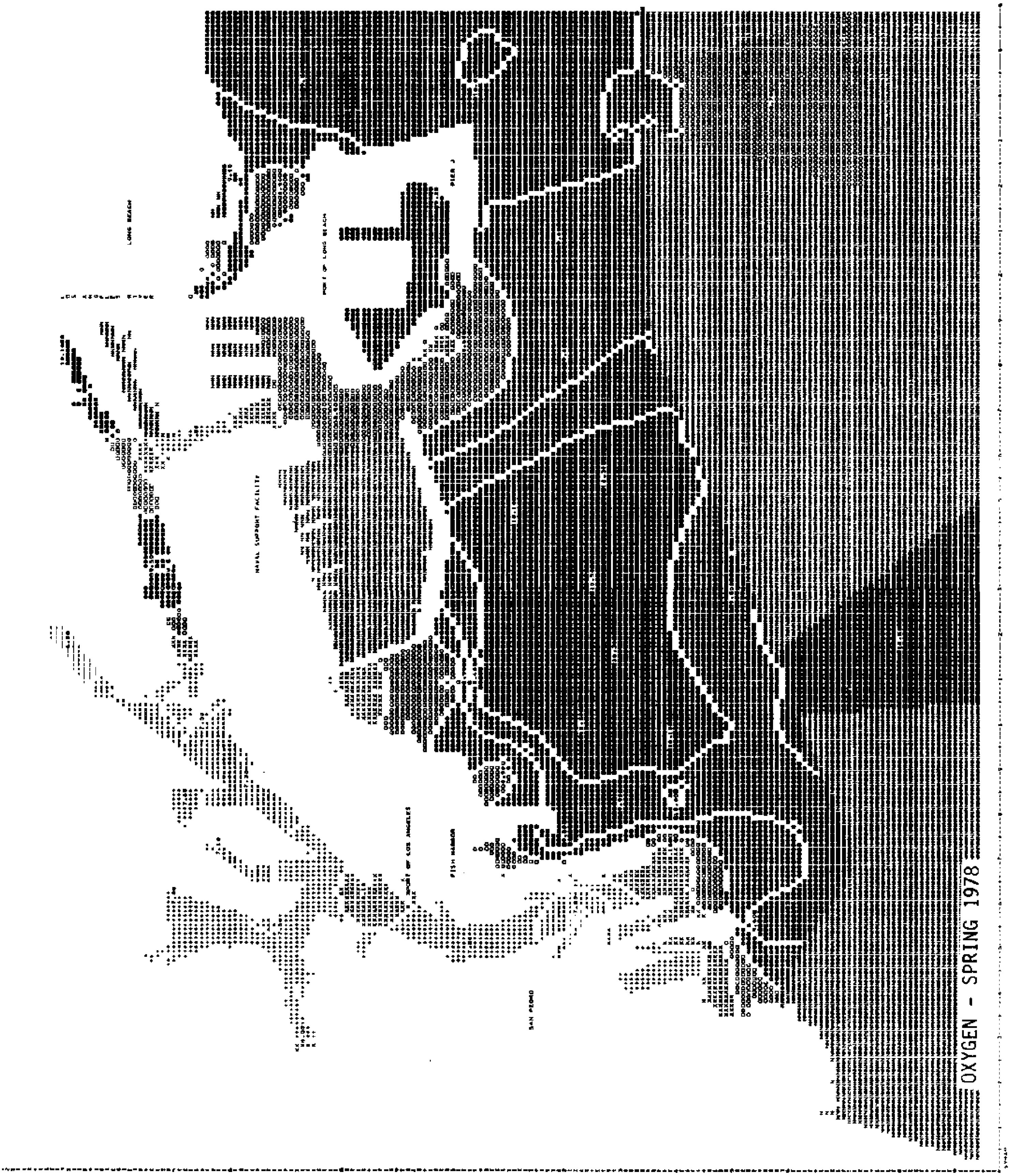
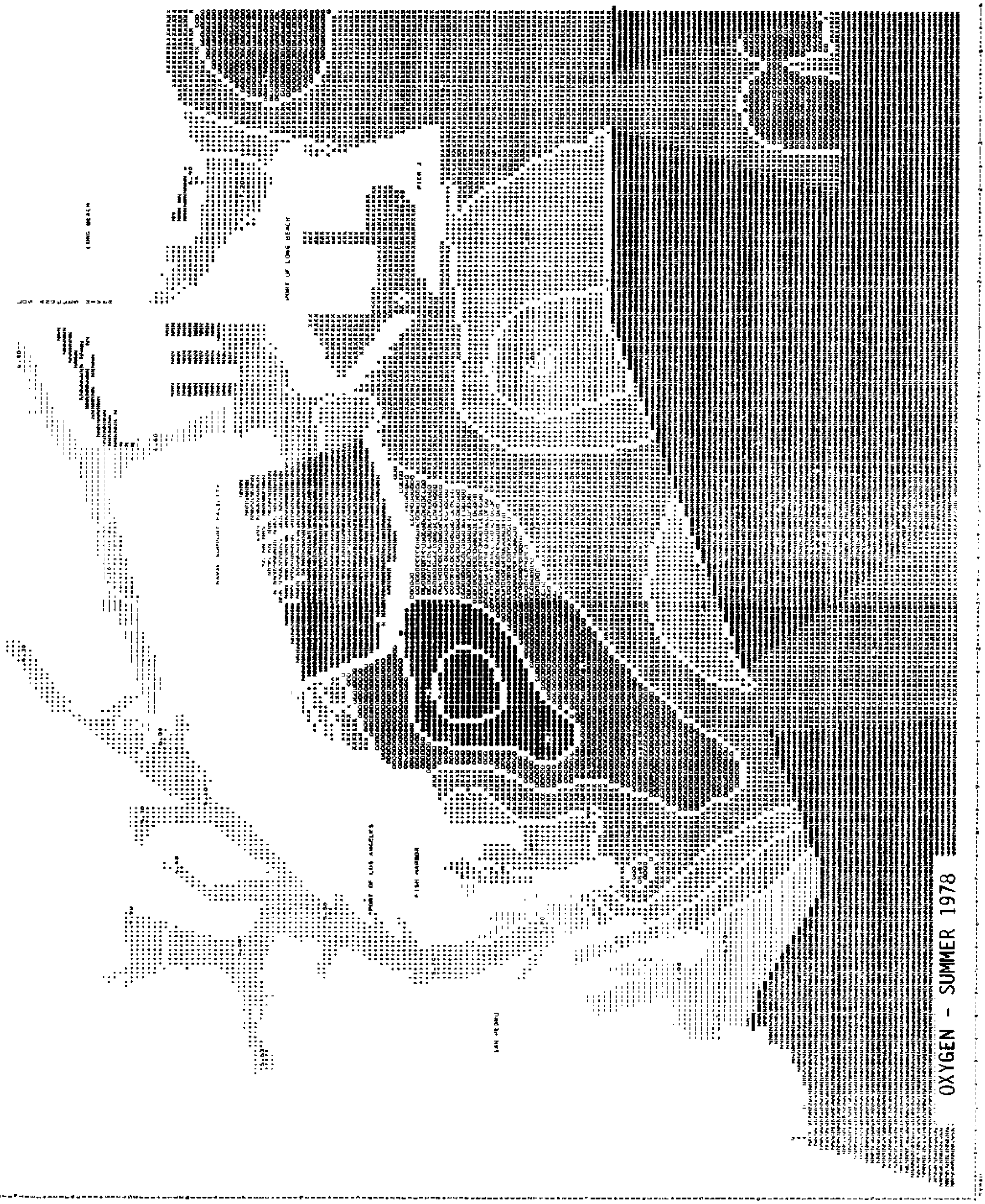
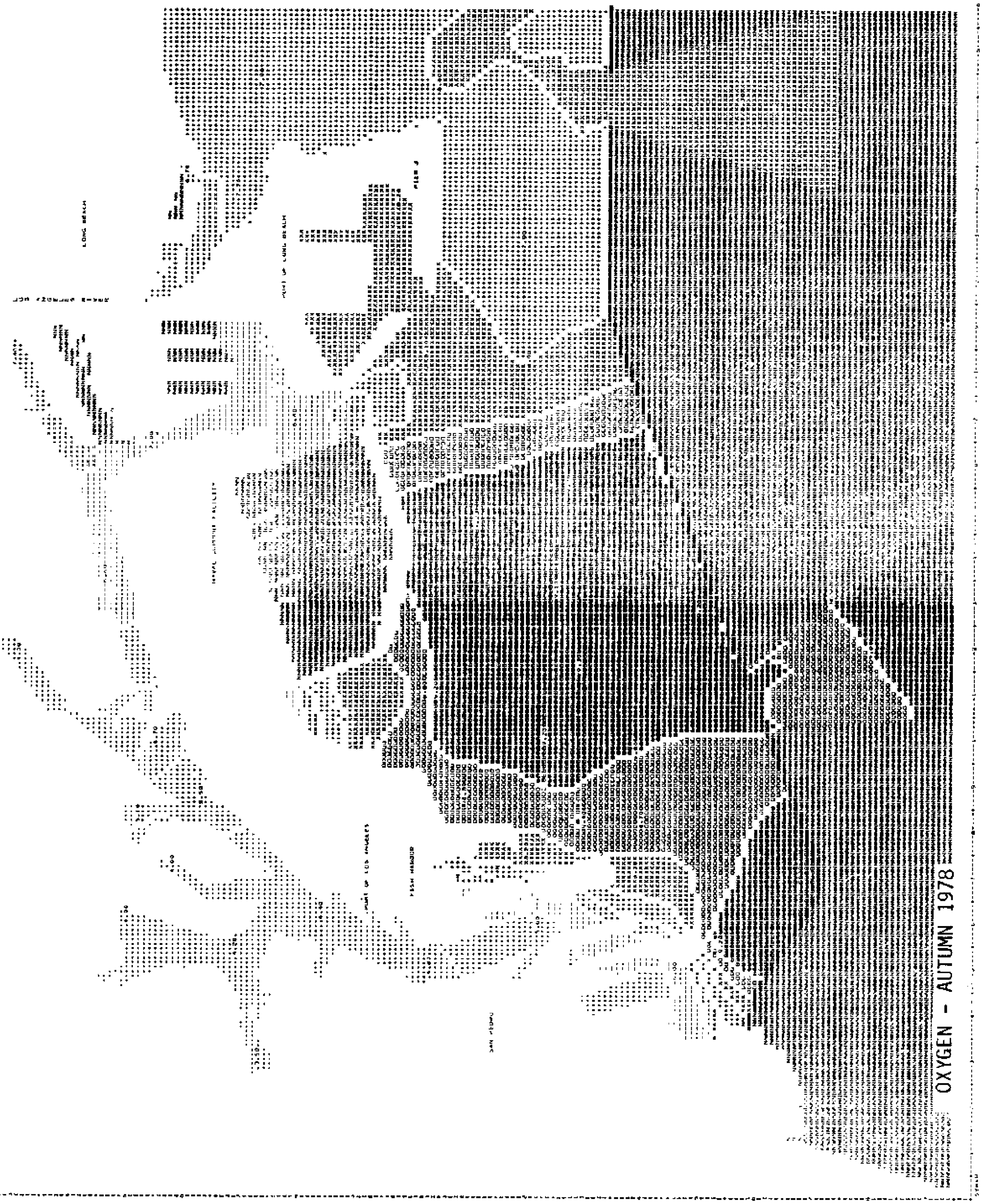

OXYGEN - SPRING 1978
LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 13, MEAN OXYGEN
SPRING 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          6.80        10.50


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0       5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00
 MAXIMUM      5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00     10.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             46.30      9.26      9.26      4.63      4.63      4.63      4.63      4.63      4.63      7.41

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL           1         2         3         4         5         6         7         8         9        10
          ==================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ████9████  ████+████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          ==================================================================================================
 FREQ.           0         0         1         3         6         4         6         4         6        11
        1                         I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
        2                                   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
        3                                   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
        4                                             I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
        5                                             I++5++I             I00700I             I██9██I   I██+██I
        6                                             I++5++I             I00700I             I██9██I   I██+██I
        7                                                                                               I██+██I
        8                                                                                               I██+██I
        9                                                                                               I██+██I
       10                                                                                               I██+██I
       11                                                                                               I██+██I

0.508179 MINUTES FOR HISTOGRAM
```


OXYGEN - SUMMER 1978

```
FIGURE 14, MEAN OXYGEN
SUMMER   1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE          4.30        9.60


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0       5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00
 MAXIMUM      5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00     10.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             46.30      9.26      9.26      4.63      4.63      4.63      4.63      4.63      4.63      7.41

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
          ==========================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■*■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          ==========================================================================================================
 FREQ.          2         8         6         4         5         6         7         2         1         0
       1    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I■■9■■I
       2    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
       3              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
       4              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
       5              I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I
       6              I''2''I   I--3--I                       IXX6XXI   I00700I
       7              I''2''I                                           I00700I
       8              I''2''I

 0.380722 MINUTES FOR HISTOGRAM
```



OXYGEN - AUTUMN 1978

```
FIGURE 15, MEAN OXYGEN
AUTUMN    1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE          3.50         9.30


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0       5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00
 MAXIMUM      5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00     10.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             46.30      9.26      9.26      4.63      4.63      4.63      4.63      4.63      4.63      7.41

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1         2         3         4         5         6         7         8         9        10
          ==========================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ █████████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ █████████
 SYMBOLS   ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ████9██████ ████*████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ █████████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ █████████
          ==========================================================================================================
 FREQ.         8         3         4         1         4         7         3        11         0         0
       1    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
       2    I..1..I   I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I   I88888I
       3    I..1..I   I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I   I88888I
       4    I..1..I             I--3--I             I++5++I   IXX6XXI             I88888I
       5    I..1..I                                           IXX6XXI             I88888I
       6    I..1..I                                           IXX6XXI             I88888I
       7    I..1..I                                           IXX6XXI             I88888I
       8    I..1..I                                                               I88888I
       9                                                                          I88888I
      10                                                                          I88888I
      11                                                                          I88888I
 0.435364 MINUTES FOR HISTOGRAM
```

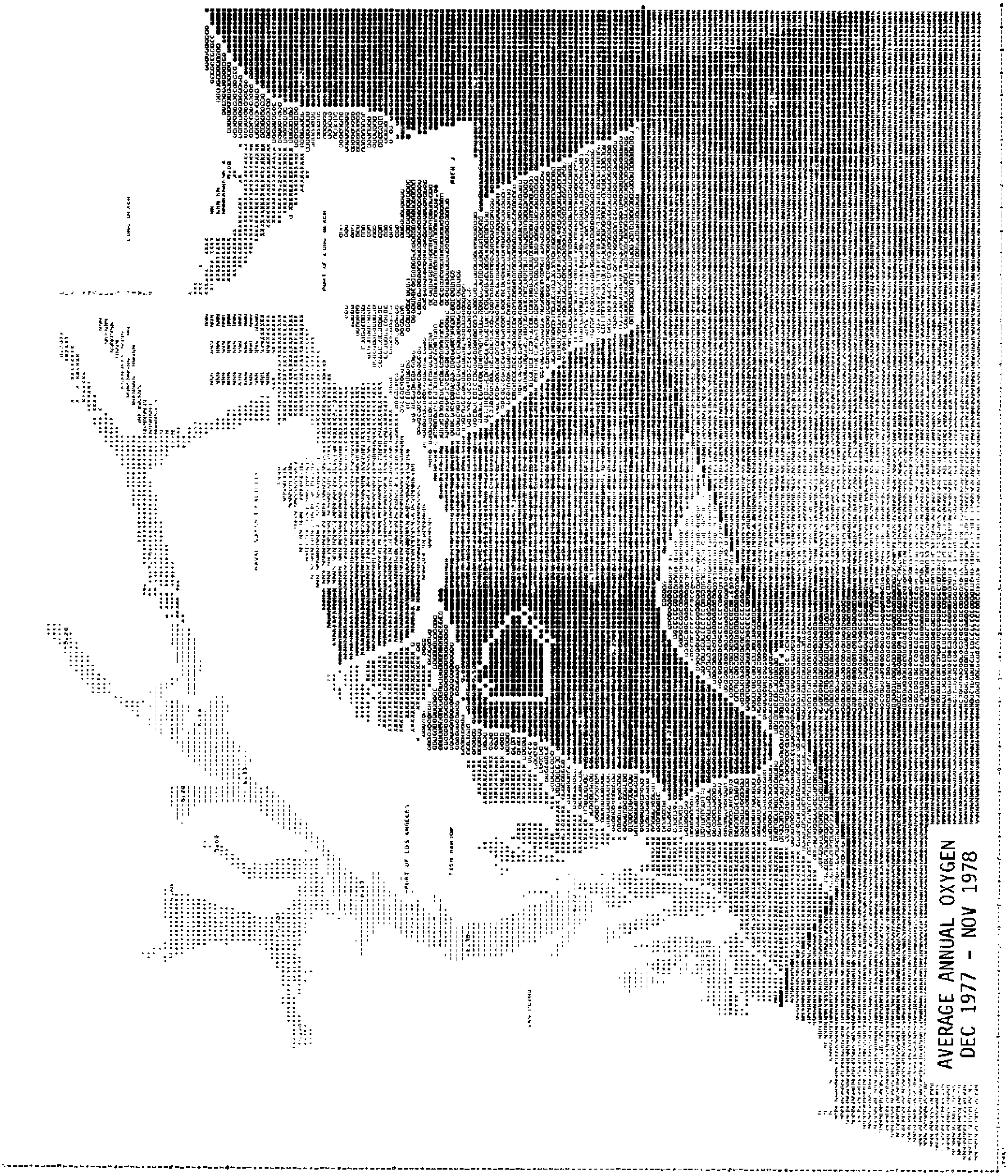

AVERAGE ANNUAL OXYGEN
DEC 1977 - NOV 1978

FIGURE 16, OXYGEN
AVERAGE ANNUAL OXYGEN
DEC 1977 - NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          5.20          9.50


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0      5.00      6.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00
 MAXIMUM      5.00     5.00      7.00      7.50      8.00      8.50      9.00      9.50     10.00     10.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             46.30     9.26      9.26      4.63      4.63      4.63      4.63      4.63      4.63      7.41

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
           ========================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
 SYMBOLS   ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ####9#### ####*####
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
           ========================================================================================================
 FREQ.          0         5         6         1         2         8         6        12         1         0
      1              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I##9##I
      2              I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I   I88888I
      3              I''2''I   I--3--I                       IXX6XXI   I00700I   I88888I
      4              I''2''I   I--3--I                       IXX6XXI   I00700I   I88888I
      5              I''2''I   I--3--I                       IXX6XXI   I00700I   I88888I
      6                        I--3--I                       IXX6XXI   I00700I   I88888I
      7                                                      IXX6XXI             I88888I
      8                                                      IXX6XXI             I88888I
      9                                                                          I88888I
     10                                                                          I88888I
     11                                                                          I88888I
     12                                                                          I88888I

 0.547134 MINUTES FOR HISTOGRAM
```

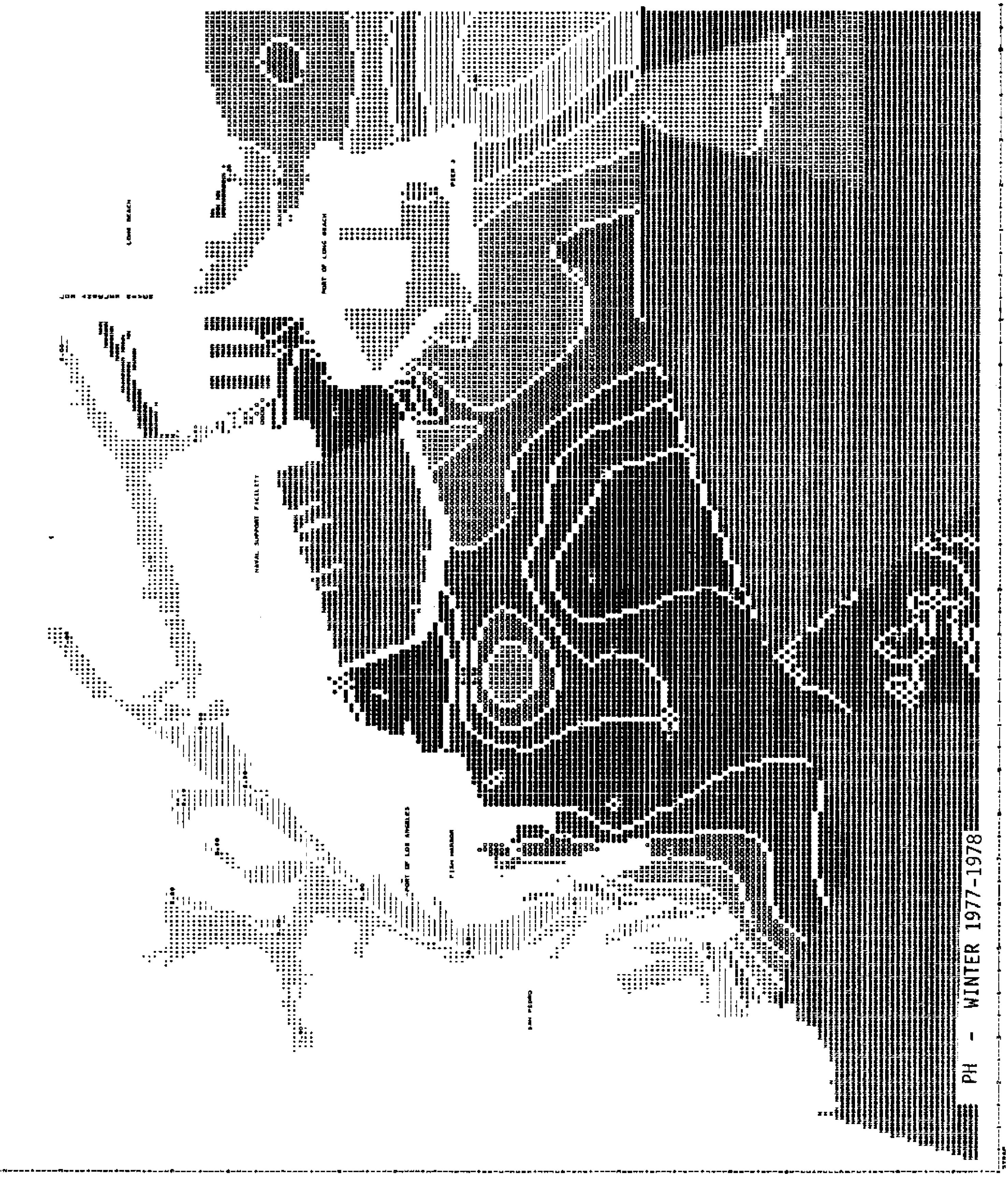

PH - WINTER 1977-1978
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO
NAVAL SUPPORT FACILITY
PORT OF LONG BEACH
LONG BEACH
PIER J

FIGURE 17, MEAN PH
WINTER 1977 - 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          7.70         8.90


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL CNLY)

  MINIMUM     0.0      7.20     8.00     8.10     8.20     8.30     8.40     8.50     8.60     8.70
  MAXIMUM     7.20     8.00     8.10     8.20     8.30     8.40     8.50     8.60     8.70     8.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             80.90     8.99     1.12     1.12     1.12     1.12     1.12     1.12     1.12     2.25

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL        1         2         3         4         5         6         7         8         9        10
         ==================================================================================================
          .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ ███████████
          .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ ███████████
  SYMBOLS ....1....  ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ████9██████ ████*██████
          .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ ███████████
          .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ███████████ ███████████
         ==================================================================================================
  FREQ.        0         3        12         1         2         3         5         3         6         6
          1          I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██*██I
          2          I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██*██I
          3          I''2''I   I--3--I                       IXX6XXI   I00700I   I88888I   I██9██I   I██*██I
          4                    I--3--I                                 I00700I             I██9██I   I██*██I
          5                    I--3--I                                 I00700I             I██9██I   I██*██I
          6                    I--3--I                                                     I██9██I   I██*██I
          7                    I--3--I
          8                    I--3--I
          9                    I--3--I
         10                    I--3--I
         11                    I--3--I
         12                    I--3--I

 0.471725 MINUTES FOR HISTOGRAM
```


PH - SPRING 1978
LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

```
FIGURE 18, MEAN PH
SPRING    1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE          7.70        8.30


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0      7.20      8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70
 MAXIMUM      7.20     8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70      8.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             80.90     8.99      1.12      1.12      1.12      1.12      1.12      1.12      1.12      2.25

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1          2          3          4          5          6          7          8          9          10
          ==========================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
 SYMBOLS   ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ████9████ ████+████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
          ==========================================================================================================
 FREQ.          0          6         16         12          6          1          0          0          0          0
          1            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
          2            I''2''I   I--3--I   I==4==I   I++5++I
          3            I''2''I   I--3--I   I==4==I   I++5++I
          4            I''2''I   I--3--I   I==4==I   I++5++I
          5            I''2''I   I--3--I   I==4==I   I++5++I
          6            I''2''I   I--3--I   I==4==I   I++5++I
          7                      I--3--I   I==4==I
          8                      I--3--I   I==4==I
          9                      I--3--I   I==4==I
         10                      I--3--I   I==4==I
         11                      I--3--I   I==4==I
         12                      I--3--I   I==4==I
         13                      I--3--I
         14                      I--3--I
         15                      I--3--I
         16                      I--3--I

  0.367493 MINUTES FOR HISTOGRAM
```

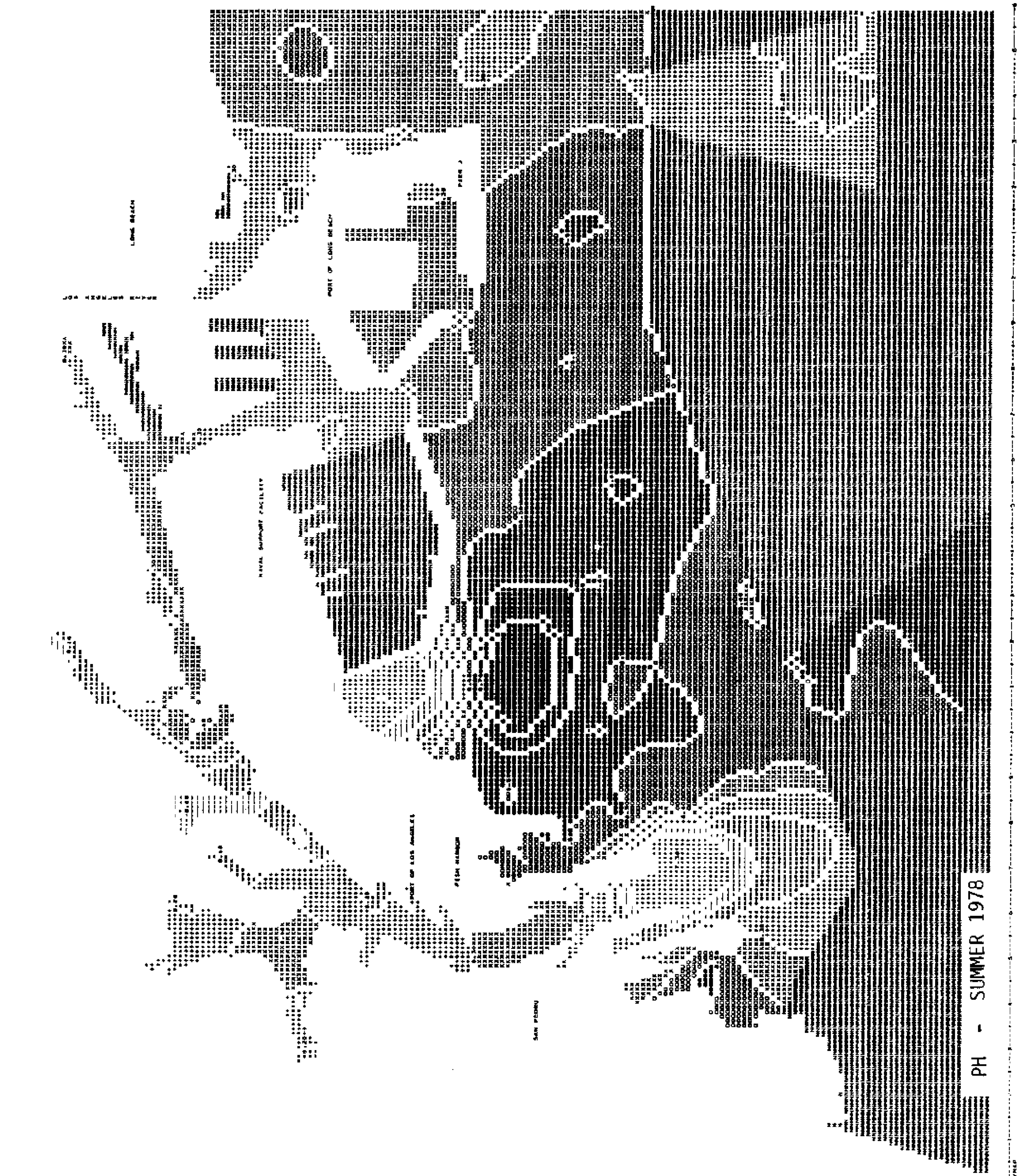

PH - SUMMER 1978
LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 19, MEAN PH
SUMMER 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 7.30 8.70

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	7.20	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70
MAXIMUM	7.20	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

80.90	8.99	1.12	1.12	1.12	1.12	1.12	1.12	1.12	2.25

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7         8         9        10
       ================================================================================================
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
SYMBOLS  ....1....  ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ████9████ ████+████
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
       ================================================================================================
FREQ.        0         1         1         3         6         9         8        10         2         1
     1              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I   I██+██I
     2                                  I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I██9██I
     3                                  I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
     4                                            I++5++I   IXX6XXI   I00700I   I88888I
     5                                            I++5++I   IXX6XXI   I00700I   I88888I
     6                                            I++5++I   IXX6XXI   I00700I   I88888I
     7                                                      IXX6XXI   I00700I   I88888I
     8                                                      IXX6XXI   I00700I   I88888I
     9                                                      IXX6XXI             I88888I
    10                                                                          I88888I
```

0.461197 MINUTES FOR HISTOGRAM

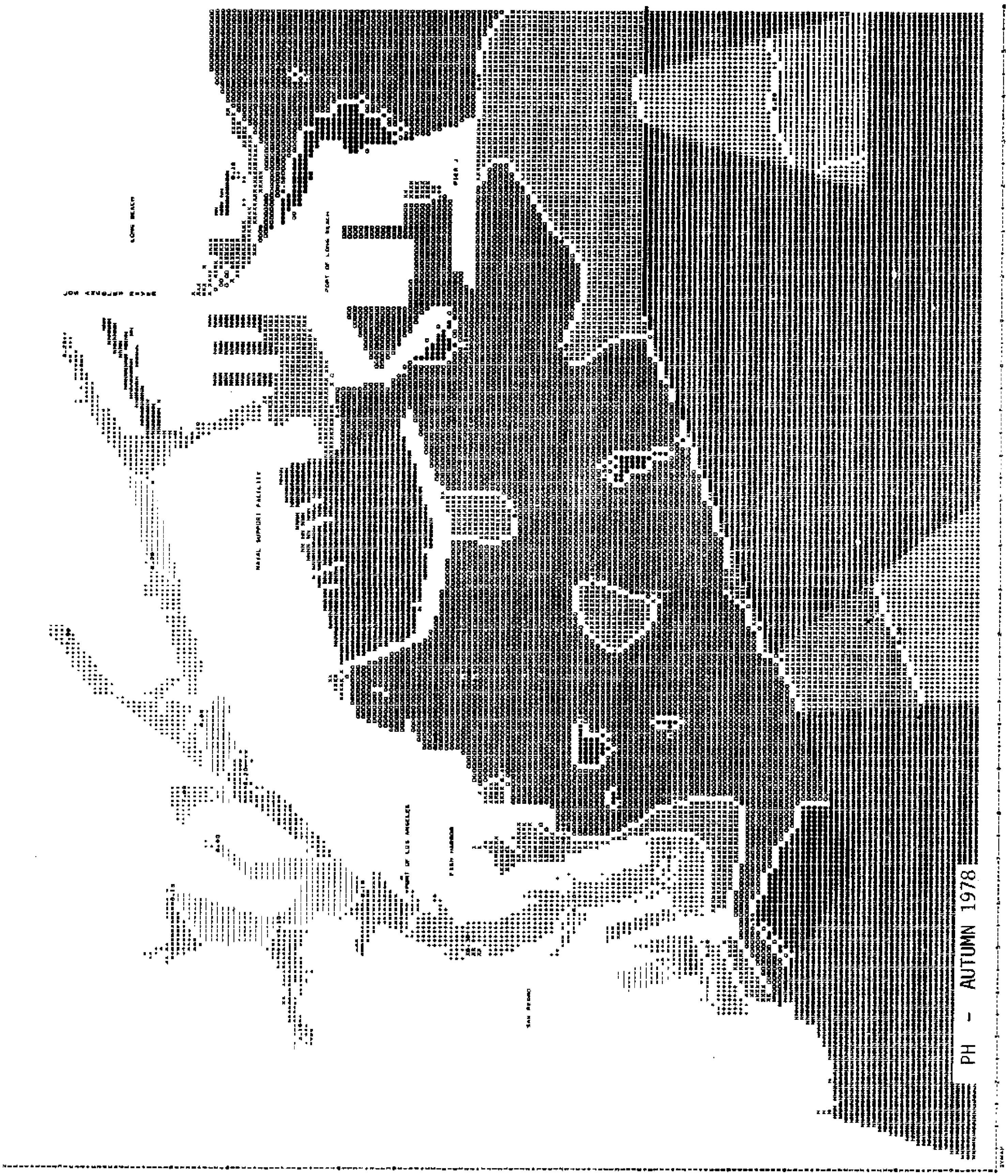

PH - AUTUMN 1978
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO
LONG BEACH

FIGURE 20, MEAN PH
AUTUMN 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          7.80          8.50



TOTAL MISSING DATA POINTS IS        2



ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0       7.20      8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70
 MAXIMUM     7.20      8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70      8.90


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            80.90      8.99      1.12      1.12      1.12      1.12      1.12      1.12     '1.12      2.25


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
           ==========================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  @@@@8@@@@  ■■■■9■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
           ==========================================================================================================
 FREQ.          0         2         3         5         7         2        12        10         0         0
       1              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I@@8@@I
       2              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I@@8@@I
       3                        I--3--I   I==4==I   I++5++I             I00700I   I@@8@@I
       4                                  I==4==I   I++5++I             I00700I   I@@8@@I
       5                                  I==4==I   I++5++I             I00700I   I@@8@@I
       6                                            I++5++I             I00700I   I@@8@@I
       7                                            I++5++I             I00700I   I@@8@@I
       8                                                                I00700I   I@@8@@I
       9                                                                I00700I   I@@8@@I
      10                                                                I00700I   I@@8@@I
      11                                                                I00700I
      12                                                                I00700I
 0.441299 MINUTES FOR HISTOGRAM
```

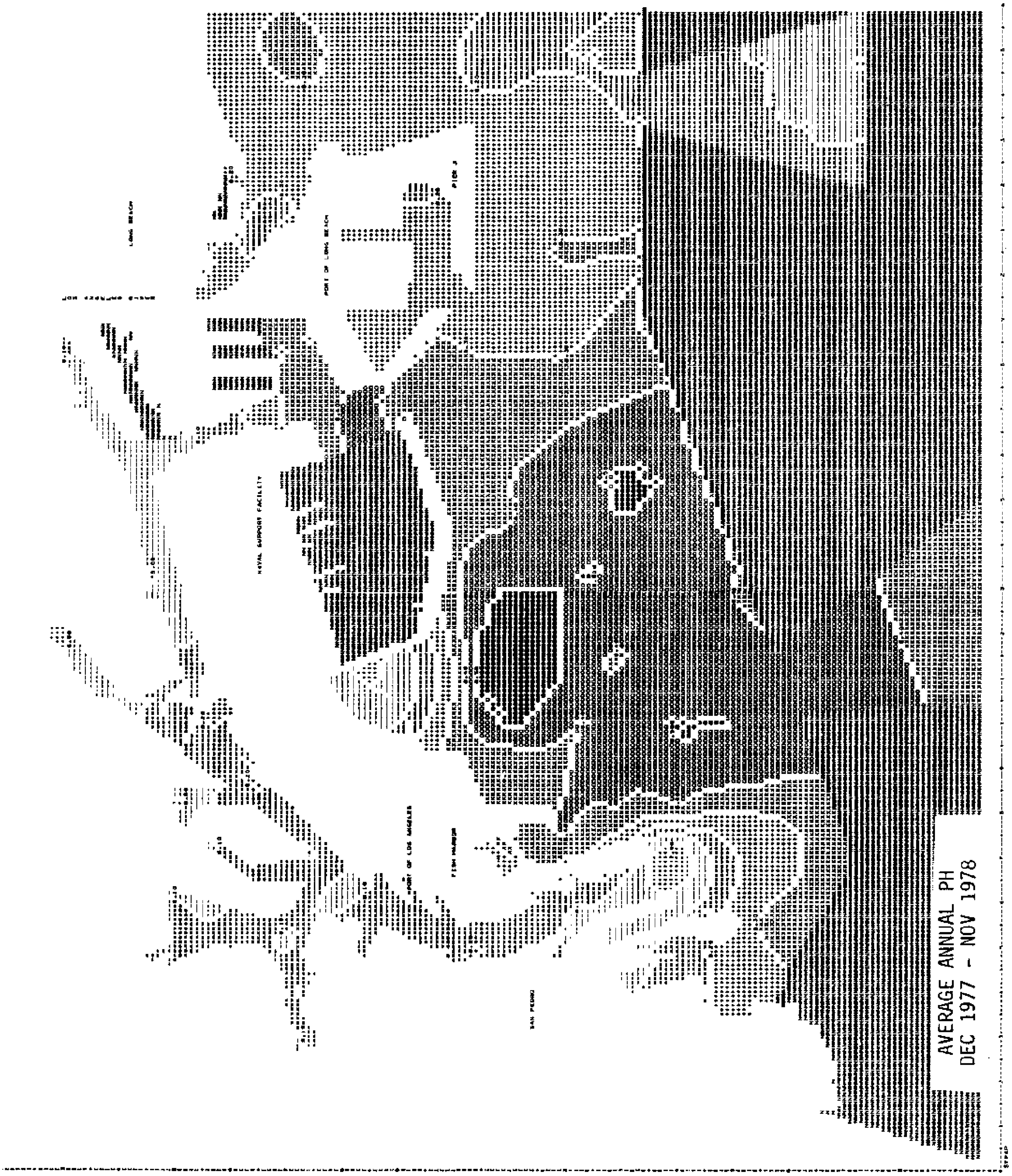

AVERAGE ANNUAL PH
DEC 1977 - NOV 1978

FIGURE 21, MEAN PH
AVERAGE ANNUAL PH
DEC 1977 - NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          7.90         8.50



TOTAL MISSING DATA POINTS IS        2



ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       7.20      8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70
  MAXIMUM      7.20      8.00      8.10      8.20      8.30      8.40      8.50      8.60      8.70      8.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              80.90      8.99      1.12      1.12      1.12      1.12      1.12      1.12      1.12      2.25

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9         10
          ==========================================================================================================
            .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
            .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
            .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
            .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          ==========================================================================================================
  FREQ.          0         1         3         9         8         6         10        4         0         0
        1               I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
        2                         I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
        3                         I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
        4                                   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I
        5                                   I==4==I   I++5++I   IXX6XXI   I00700I
        6                                   I==4==I   I++5++I   IXX6XXI   I00700I
        7                                   I==4==I   I++5++I             I00700I
        8                                   I==4==I   I++5++I             I00700I
        9                                   I==4==I                       I00700I
       10                                                                 I00700I

  0.359589 MINUTES FOR HISTOGRAM
```

PHOSPHATE (PO4) - WINTER 1977-1978

FIGURE 22, MEAN PHOSPHATE
WINTER 1977 - 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.50 5.60

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80
MAXIMUM	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80	5.60

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

14.29	3.57	5.36	1.79	3.57	5.36	8.93	8.93	16.07	32.14

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9          10
        ==========================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
        ==========================================================================================================
FREQ.        3          2          2          0          3          7          9          5          6          4
      1   I..I..I    I''2''I    I--3--I               I++5++I    IXX6XXI    I00700I    I88888I    I■■9■■I    I■■+■■I
      2   I..I..I    I''2''I    I--3--I               I++5++I    IXX6XXI    I00700I    I88888I    I■■9■■I    I■■+■■I
      3   I..I..I                                     I++5++I    IXX6XXI    I00700I    I88888I    I■■9■■I    I■■+■■I
      4                                                          IXX6XXI    I00700I    I88888I    I■■9■■I    I■■+■■I
      5                                                          IXX6XXI    I00700I    I88888I    I■■9■■I
      6                                                          IXX6XXI    I00700I               I■■9■■I
      7                                                          IXX6XXI    I00700I
      8                                                                     I00700I
      9                                                                     I00700I
```

0.385315 MINUTES FOR HISTOGRAM


LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO
PHOSPHATE (PO4) - SPRING 1978

FIGURE 23, PHOSPHATE
SPRING 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.30 3.80

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80
MAXIMUM	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80	5.60

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

14.29	3.57	5.36	1.79	3.57	5.36	8.93	8.93	16.07	32.14

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7         8         9        10
          ==================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  @@@@@@@@@  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  @@@@@@@@@  ■■■■■■■■■
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  @@@@9@@@@  ■■■■*■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  @@@@@@@@@  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  @@@@@@@@@  ■■■■■■■■■
          ==================================================================================================
 FREQ.        2         6        15         4         3         5         3         1         1         1
      1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I@@9@@I   I■■*■■I
      2   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
      3             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
      4             I''2''I   I--3--I   I==4==I             IXX6XXI
      5             I''2''I   I--3--I                       IXX6XXI
      6             I''2''I   I--3--I
      7                       I--3--I
      8                       I--3--I
      9                       I--3--I
     10                       I--3--I
     11                       I--3--I
     12                       I--3--I
     13                       I--3--I
     14                       I--3--I
     15                       I--3--I
```

0.358536 MINUTES FOR HISTOGRAM

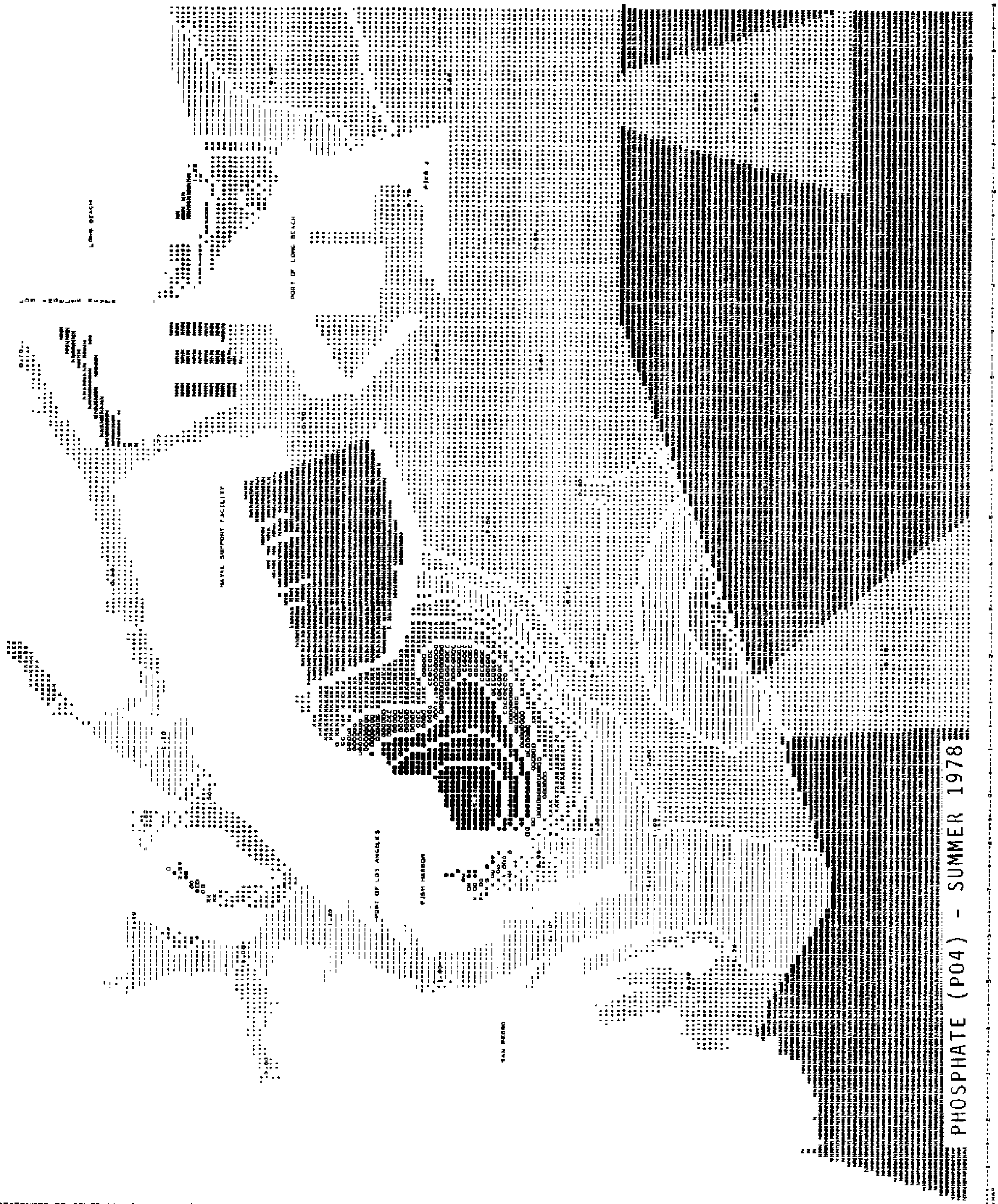

PHOSPHATE (PO4) - SUMMER 1978
PORT OF LONG BEACH
LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 24, MEAN PHOSPHATE
SUMMER 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.50         5.20



TOTAL MISSING DATA POINTS IS          2



ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       0.80      1.00      1.30      1.40      1.60      1.90      2.40      2.90      3.80
  MAXIMUM      0.80      1.00      1.30      1.40      1.60      1.90      2.40      2.90      3.80      5.60

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              14.29      3.57      5.36      1.79      3.57      5.36      8.93      8.93     16.07     32.14

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
            ==================================================================================================
             ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
             ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
  SYMBOLS    ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ####9#### ####*####
             ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
             ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
            ==================================================================================================
  FREQ.         13         8        10         1         2         3         1         2         0         1
         1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I007001   I88888I             I##*##I
         2   I..1..I   I''2''I   I--3--I             I++5++I   IXX6XXI             I88888I
         3   I..1..I   I''2''I   I--3--I                       IXX6XXI
         4   I..1..I   I''2''I   I--3--I
         5   I..1..I   I''2''I   I--3--I
         6   I..1..I   I''2''I   I--3--I
         7   I..1..I   I''2''I   I--3--I
         8   I..1..I   I''2''I   I--3--I
         9   I..1..I             I--3--I
        10   I..1..I             I--3--I
        11   I..1..I
        12   I..1..I
        13   I..1..I

 0.380722 MINUTES FOR HISTOGRAM
```


PHOSPHATE (PO4)-AUTUMN 1978

FIGURE 25, MEAN PHOSPHATE
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.40 4.50

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80
MAXIMUM	0.80	1.00	1.30	1.40	1.60	1.90	2.40	2.90	3.80	5.60

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

14.29	3.57	5.36	1.79	3.57	5.36	8.93	8.93	16.07	32.14

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7         8         9         10
          ==================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  888888888  ■■■■9■■■■  ■■■■*■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          ==================================================================================================
 FREQ.        7         9         5         2         1         6         4         2         2         3
       1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I88888I   I■■9■■I   I■■*■■I
       2   I..1..I   I''2''I   I--3--I   I==4==I             IXX6XXI   IOO7OOI   I88888I   I■■9■■I   I■■*■■I
       3   I..1..I   I''2''I   I--3--I                       IXX6XXI   IOO7OOI                         I■■*■■I
       4   I..1..I   I''2''I   I--3--I                       IXX6XXI   IOO7OOI
       5   I..1..I   I''2''I   I--3--I                       IXX6XXI
       6   I..1..I   I''2''I                                 IXX6XXI
       7   I..1..I   I''2''I
       8             I''2''I
       9             I''2''I
```

0.359329 MINUTES FOR HISTOGRAM

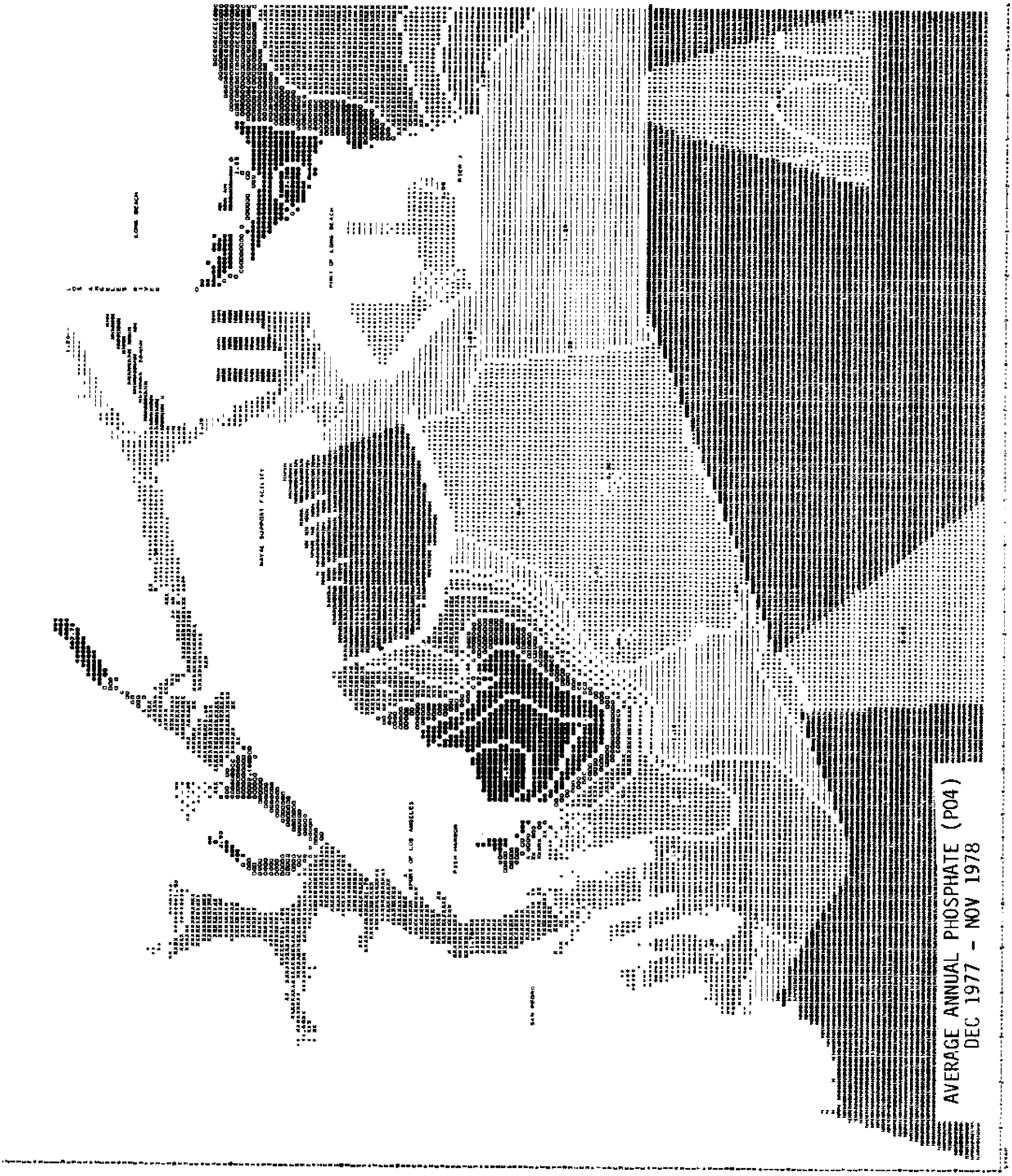

AVERAGE ANNUAL PHOSPHATE (PO4)
DEC 1977 - NOV 1978
LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 26, PHOSPHATE
AVERAGE ANNUAL PHOSPHATE
DEC 1977 - NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.60          4.50


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       0.80      1.00      1.30      1.40      1.60      1.90      2.40      2.90      3.80
  MAXIMUM      0.80      1.00      1.30      1.40      1.60      1.90      2.40      2.90      3.80      5.60

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              14.29      3.57      5.36      1.79      3.57      5.36      8.93      8.93     16.07     32.14

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
          ==================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■*■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          ==================================================================================================
  FREQ.          1         5         7         8         4         9         1         2         3         1
          1  I..I..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I■■9■■I   I■■*■■I
          2            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI             I88888I   I■■9■■I
          3            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI                       I■■9■■I
          4            I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
          5            I''2''I   I--3--I   I==4==I             IXX6XXI
          6                      I--3--I   I==4==I             IXX6XXI
          7                      I--3--I   I==4==I             IXX6XXI
          8                                I==4==I             IXX6XXI
          9                                                    IXX6XXI

0.319122 MINUTES FOR HISTOGRAM
```

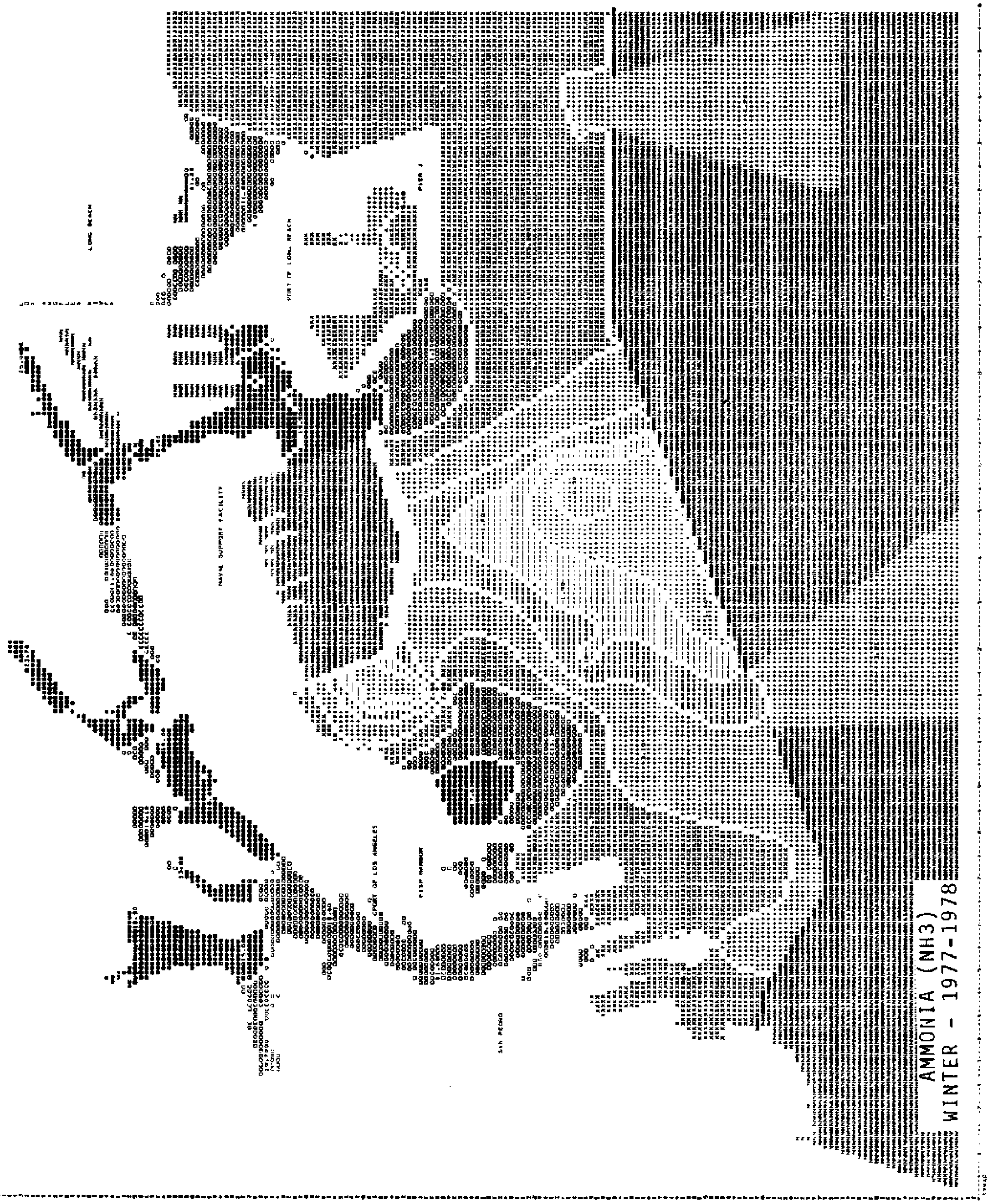

AMMONIA (NH3)
WINTER - 1977-1978
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR

FIGURE 27, MEAN AMMONIA
WINTER 1977 - 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.80        25.90


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86
  MAXIMUM       1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86     44.80


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                2.24      1.12      1.12      2.24      5.59      7.83     10.96     12.30     14.32     42.28


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           1         2         3         4         5         6         7         8         9        10

FREQ.             1         1         2         2         5        10        11         5         3         1
```

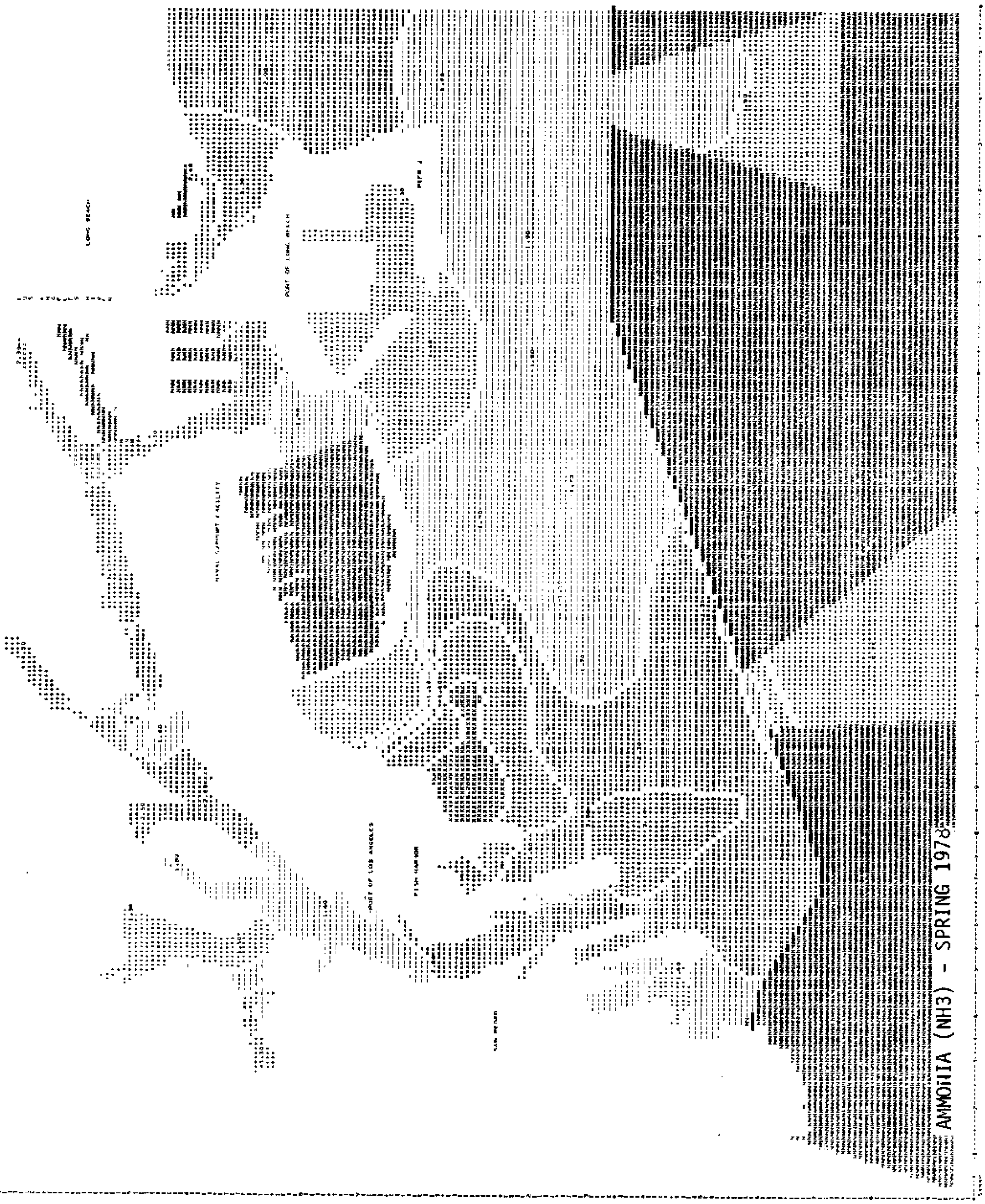

LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO
AMMONIA (NH3) - SPRING 1978

FIGURE 28, MEAN AMMONIA
SPRING 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.70 8.20

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	3.01	5.51	9.02	13.93	19.44	25.86
MAXIMUM	1.00	1.50	2.00	3.01	5.51	9.02	13.93	19.44	25.86	44.80

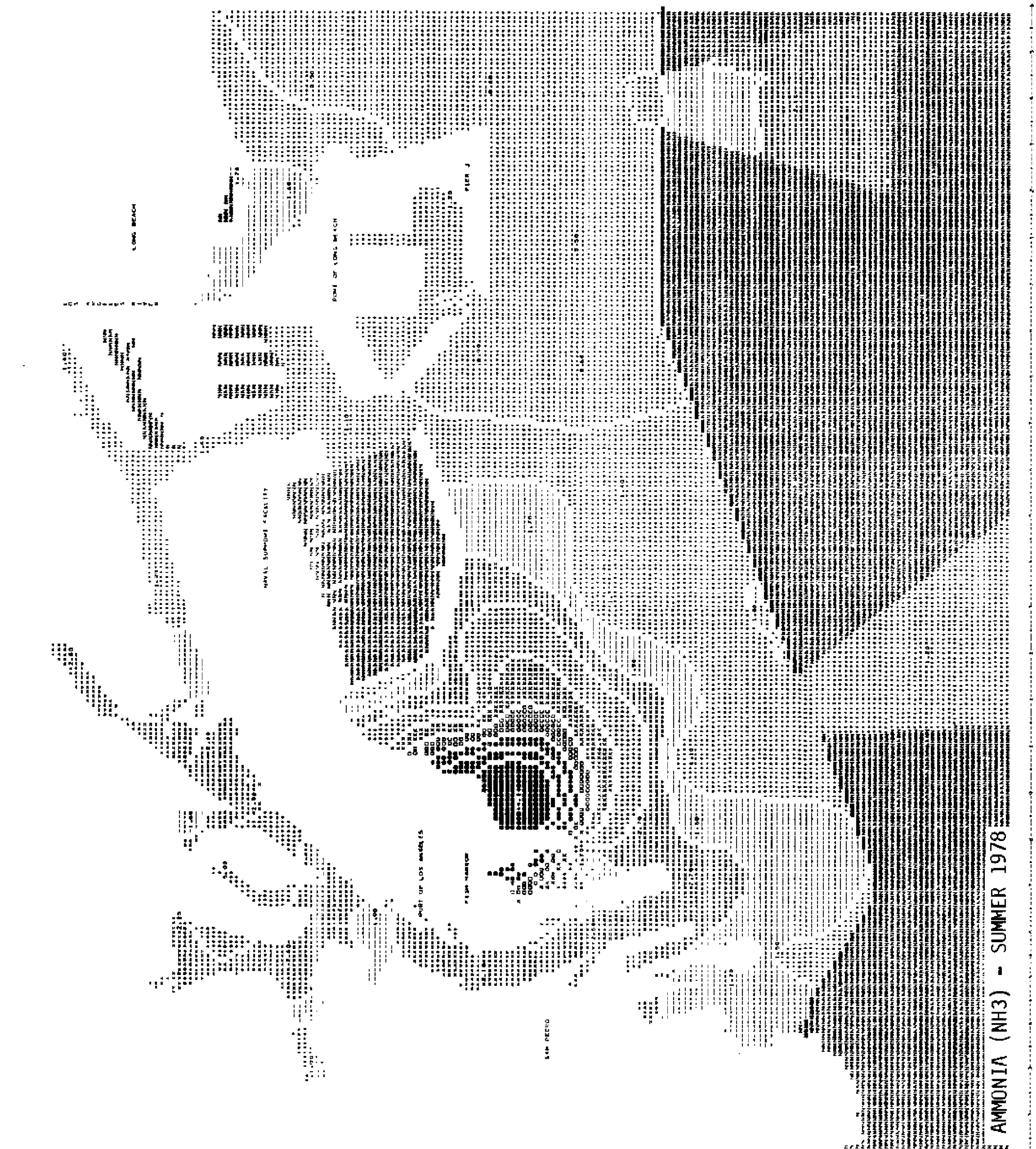
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

2.24	1.12	1.12	2.24	5.59	7.83	10.96	12.30	14.32	42.28

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL       1          2          3          4          5          6          7          8          9          10
        ==================================================================================================================
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
SYMBOLS ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  888888888  ■■■■9■■■■  ■■■■*■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
        .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
        ==================================================================================================================
FREQ.       1          8          11         13         7          1          0          0          0          0
      1  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
      2             I''2''I    I--3--I    I==4==I    I++5++I
      3             I''2''I    I--3--I    I==4==I    I++5++I
      4             I''2''I    I--3--I    I==4==I    I++5++I
      5             I''2''I    I--3--I    I==4==I    I++5++I
      6             I''2''I    I--3--I    I==4==I    I++5++I
      7             I''2''I    I--3--I    I==4==I    I++5++I
      8             I''2''I    I--3--I    I==4==I
      9                        I--3--I    I==4==I
     10                        I--3--I    I==4==I
     11                        I--3--I    I==4==I
     12                                   I==4==I
     13                                   I==4==I
```

0.328186 MINUTES FOR HISTOGRAM



AMMONIA (NH3) - SUMMER 1978

FIGURE 29, MEAN AMMONIA
SUMMER 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.50        44.80


TOTAL MISSING DATA POINTS IS         2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0       1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86
 MAXIMUM      1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86     44.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              2.24      1.12      1.12      2.24      5.59      7.83     10.96     12.30     14.32     42.28

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
          ====================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  888888888  ■■■■9■■■■  ■■■■*■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          ====================================================================================================
 FREQ.          7        10         9        10         3         1         0         0         0         1
        1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI                                  I■■*■■I
        2   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I
        3   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I
        4   I..1..I   I''2''I   I--3--I   I==4==I
        5   I..1..I   I''2''I   I--3--I   I==4==I
        6   I..1..I   I''2''I   I--3--I   I==4==I
        7   I..1..I   I''2''I   I--3--I   I==4==I
        8             I''2''I   I--3--I   I==4==I
        9             I''2''I   I--3--I   I==4==I
       10             I''2''I             I==4==I

 0.330978 MINUTES FOR HISTOGRAM
```

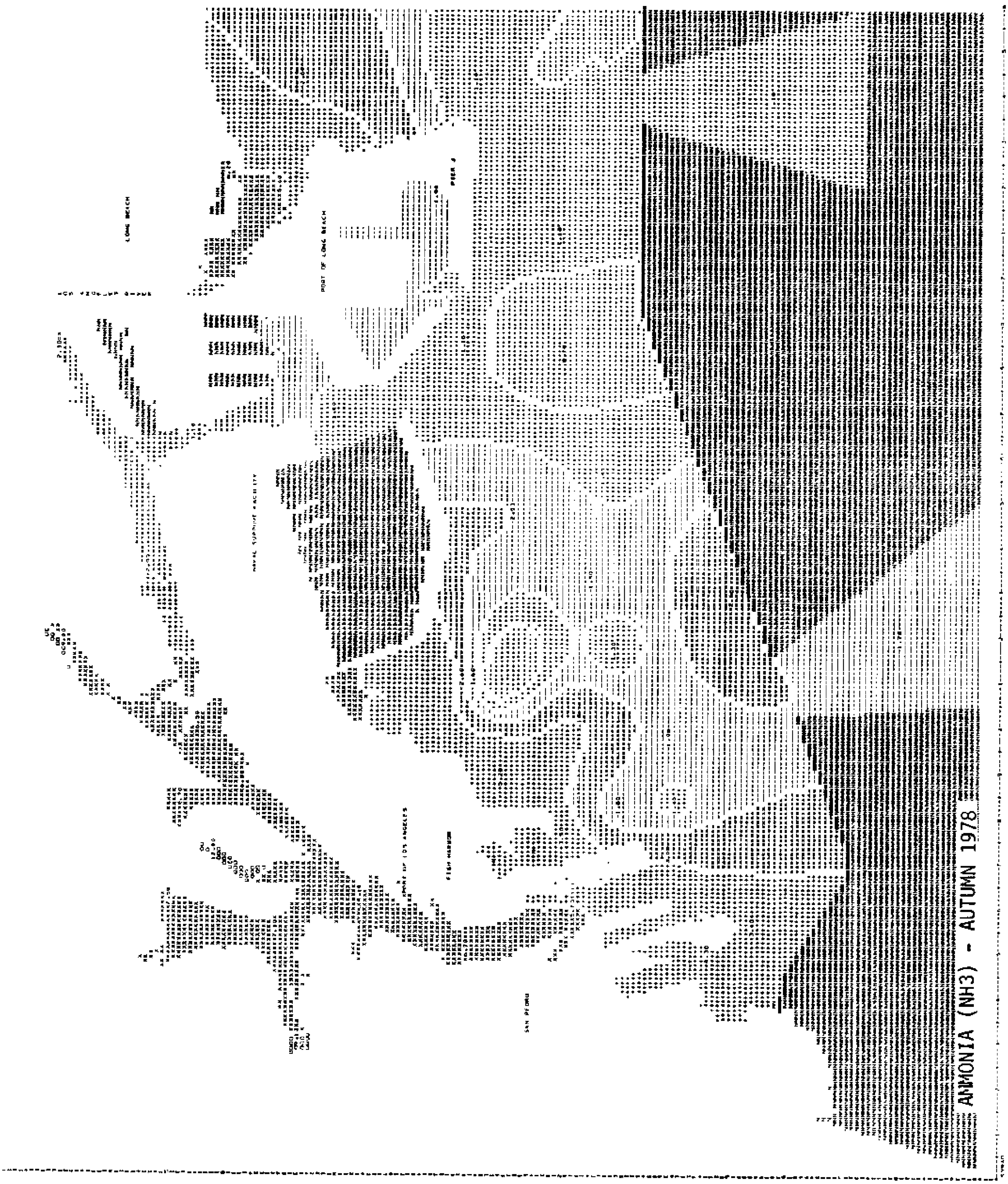
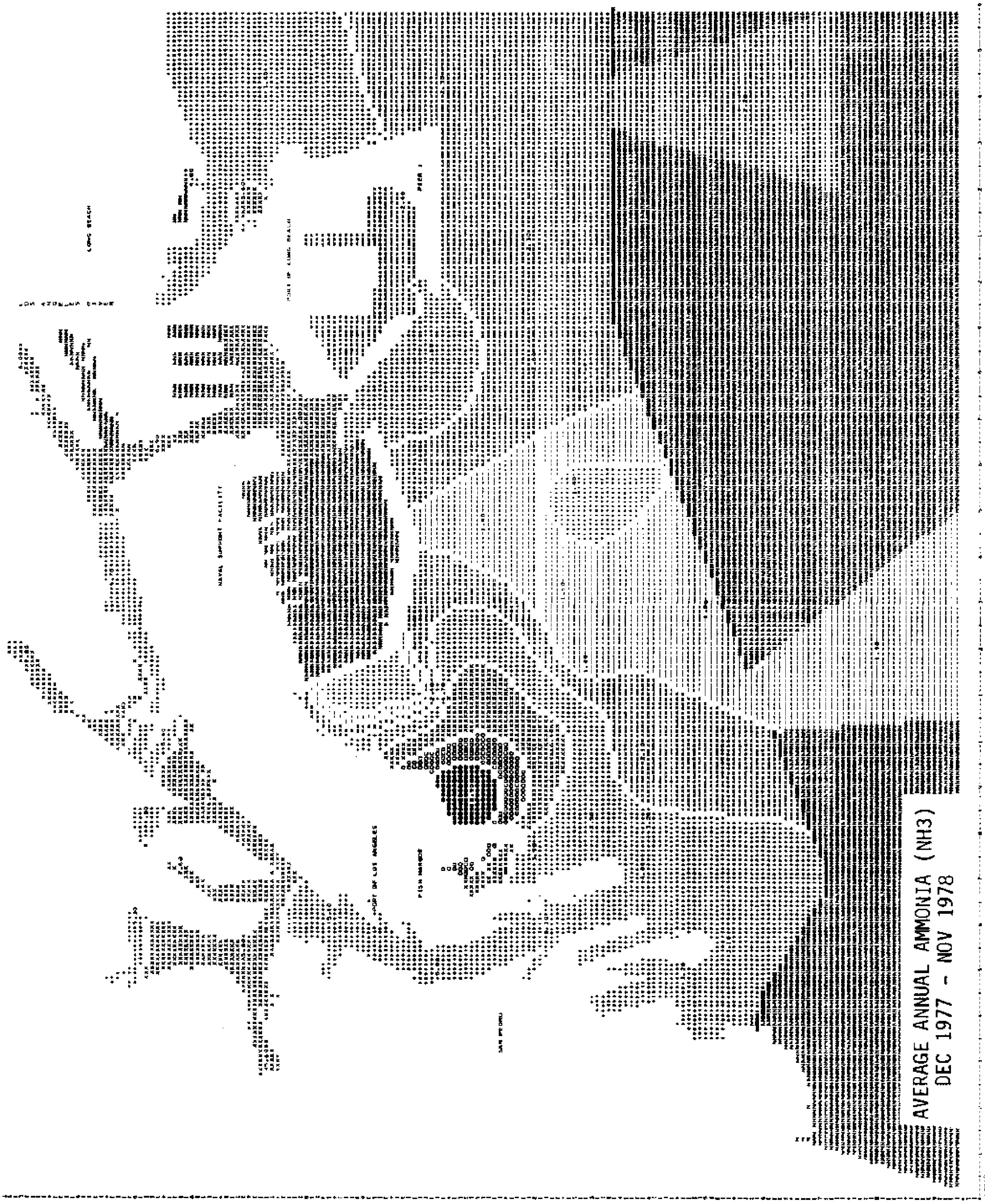

AMMONIA (NH3) - AUTUMN 1978
LONG BEACH
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

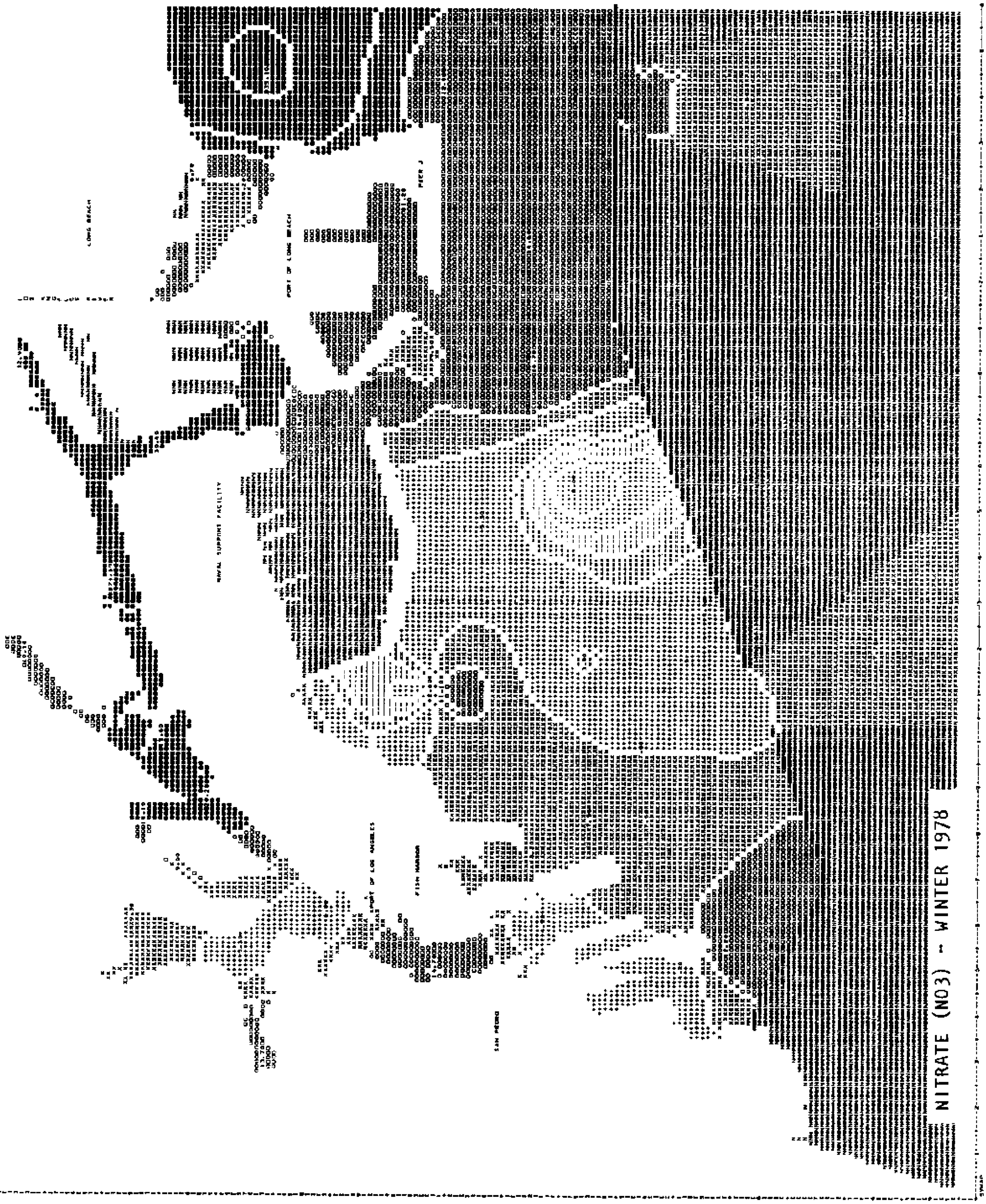
FIGURE 30, MEAN AMMONIA
AUTUMN 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.70        12.00


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86
  MAXIMUM      1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86     44.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               2.24      1.12      1.12      2.24      5.59      7.83     10.96     12.30     14.32     42.28

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
          ==========================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
  SYMBOLS  ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ####9#### ####*####
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ######### #########
          ==========================================================================================================
  FREQ.          1         8         7         6         6        11         2         0         0         0
       1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I007001
       2             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I007001
       3             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
       4             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
       5             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
       6             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
       7             I''2''I   I--3--I                       IXX6XXI
       8             I''2''I                                 IXX6XXI
       9                                                     IXX6XXI
      10                                                     IXX6XXI
      11                                                     IXX6XXI
 0.316879 MINUTES FOR HISTOGRAM
```



AVERAGE ANNUAL AMMONIA (NH3)
DEC 1977 - NOV 1978

```
FIGURE 31, AMMONIA
AVERAGE ANNUAL AMMONIA
DEC 1977 - NOV 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE          1.40        18.90


TOTAL MISSING DATA POINTS IS         2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0       1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86
 MAXIMUM     1.00      1.50      2.00      3.01      5.51      9.02     13.93     19.44     25.86     44.80

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             2.24      1.12      1.12      2.24      5.59      7.83     10.96     12.30     14.32     42.28

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1         2         3         4         5         6         7         8         9        10
         ==========================================================================================================
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
 SYMBOLS  ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ████9████ ████*████
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 █████████ █████████
         ==========================================================================================================
 FREQ.         0         1         5         7        17        10         0         1         0         0
       1             I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI             I88888I
       2                       I--3--I   I==4==I   I++5++I   IXX6XXI
       3                       I--3--I   I==4==I   I++5++I   IXX6XXI
       4                       I--3--I   I==4==I   I++5++I   IXX6XXI
       5                       I--3--I   I==4==I   I++5++I   IXX6XXI
       6                                 I==4==I   I++5++I   IXX6XXI
       7                                 I==4==I   I++5++I   IXX6XXI
       8                                           I++5++I   IXX6XXI
       9                                           I++5++I   IXX6XXI
      10                                           I++5++I   IXX6XXI
      11                                           I++5++I
      12                                           I++5++I
      13                                           I++5++I
      14                                           I++5++I
      15                                           I++5++I
      16                                           I++5++I
      17                                           I++5++I

0.362396 MINUTES FOR HISTOGRAM
```



NITRATE (NO3) - WINTER 1978

FIGURE 32, MEAN NITRATE
WINTER 1977 - 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.0 35.10

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	2.00	2.99	3.99	6.98	9.78	14.77	19.95	32.92
MAXIMUM	1.00	2.00	2.99	3.99	6.98	9.78	14.77	19.95	32.92	43.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

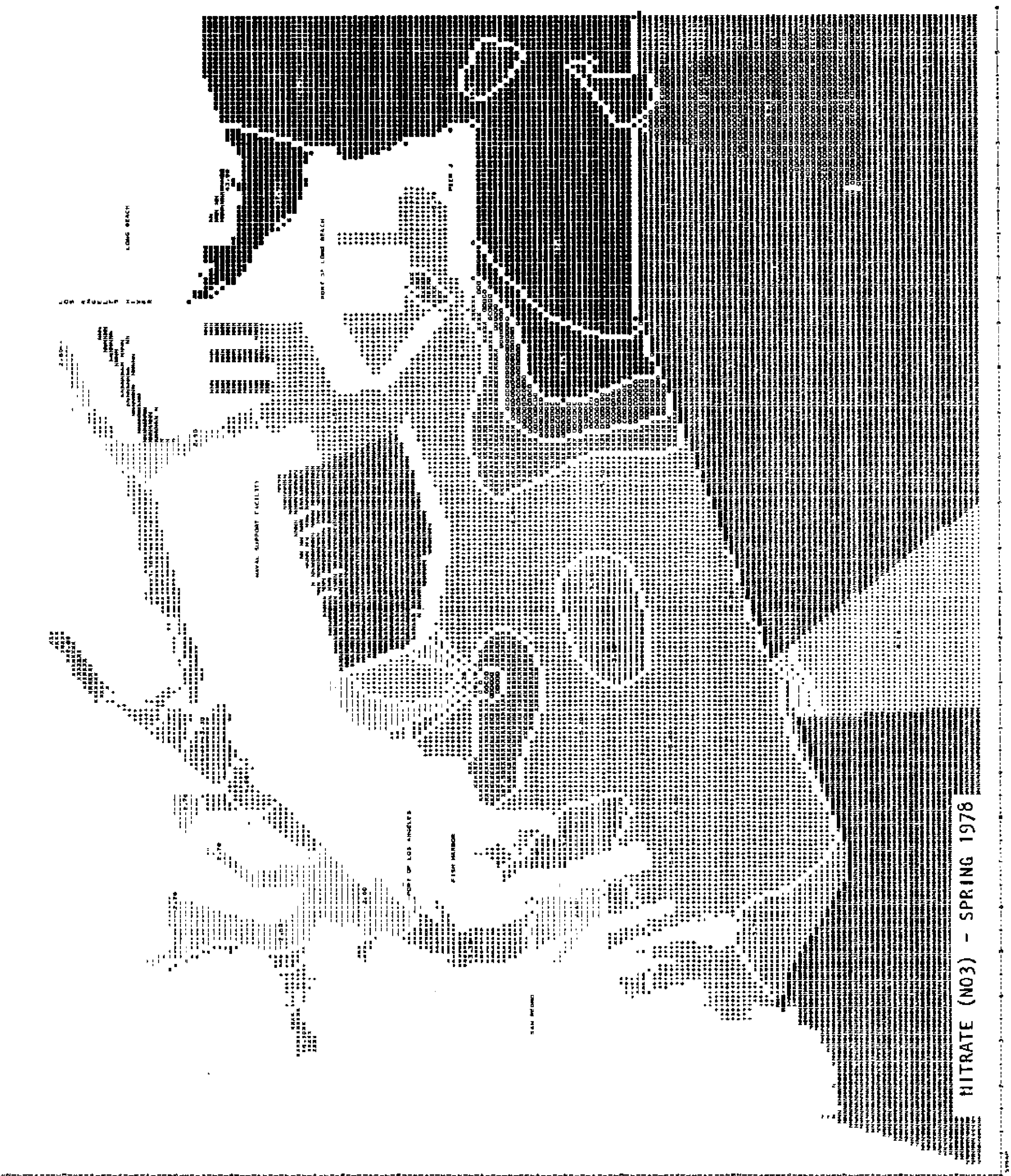
2.27	2.27	2.27	2.27	6.82	6.36	11.36	11.82	29.55	25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	1	0	1	1	8	13	10	2	4	1

```
FREQ.  1         0         1         1         8         13        10        2         4         1
  1  I..1..I             I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I##9##I   I##+##I
  2                                          I++5++I   IXX6XXI   I00700I   I88888I   I##9##I
  3                                          I++5++I   IXX6XXI   I00700I             I##9##I
  4                                          I++5++I   IXX6XXI   I00700I             I##9##I
  5                                          I++5++I   IXX6XXI   I00700I
  6                                          I++5++I   IXX6XXI   I00700I
  7                                          I++5++I   IXX6XXI   I00700I
  8                                          I++5++I   IXX6XXI   I00700I
  9                                                    IXX6XXI   I00700I
 10                                                    IXX6XXI   I00700I
 11                                                    IXX6XXI
 12                                                    IXX6XXI
 13                                                    IXX6XXI
```

0.380676 MINUTES FOR HISTOGRAM


NITRATE (NO3) - SPRING 1978
LONG BEACH
PORT OF LONG BEACH
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

```
FIGURE 33, MEAN NITRATE
SPRING 1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE          0.10       43.90


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0      1.00      2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.92
 MAXIMUM     1.00     2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.92     43.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             2.27     2.27      2.27      2.27      6.82      6.36     11.36     11.82     29.55     25.00 *

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1        2         3         4         5         6         7         8         9        10
        ================================================================================================
        ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 @@@@@@@@@ #########
        ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 @@@@@@@@@ #########
 SYMBOLS ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX OOOO7OOOO 888888888 @@@@9@@@@ ####+####
        ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 @@@@@@@@@ #########
        ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 @@@@@@@@@ #########
        ================================================================================================
 FREQ.         1        0         9         8        12         3         2         2         2         2
      1    I..1..I            I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I88888I   I@@9@@I   I##+##I
      2                       I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I88888I   I@@9@@I   I##+##I
      3                       I--3--I   I==4==I   I++5++I   IXX6XXI
      4                       I--3--I   I==4==I   I++5++I
      5                       I--3--I   I==4==I   I++5++I
      6                       I--3--I   I==4==I   I++5++I
      7                       I--3--I   I==4==I   I++5++I
      8                       I--3--I   I==4==I   I++5++I
      9                       I--3--I             I++5++I
     10                                           I++5++I
     11                                           I++5++I
     12                                           I++5++I
0.369995 MINUTES FOR HISTOGRAM
```

NITRATE (NO3) - SUMMER 1978

FIGURE 34, MEAN NITRATE
SUMMER 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.0          7.60


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0      1.00      2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.92
 MAXIMUM     1.00     2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.92     43.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             2.27     2.27      2.27      2.27      6.82      6.36     11.36     11.82     29.55     25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
        ====================================================================================================
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
 SYMBOLS ....1....  ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888808888 ■■■■9■■■■ ■■■■+■■■■
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
         .........  ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
        ====================================================================================================
 FREQ.         16        10         8         2         4         1         0         0         0         0
      1     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI
      2     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I
      3     I..1..I   I''2''I   I--3--I             I++5++I
      4     I..1..I   I''2''I   I--3--I             I++5++I
      5     I..1..I   I''2''I   I--3--I
      6     I..1..I   I''2''I   I--3--I
      7     I..1..I   I''2''I   I--3--I
      8     I..1..I   I''2''I   I--3--I
      9     I..1..I   I''2''I
     10     I..1..I   I''2''I
     11     I..1..I
     12     I..1..I
     13     I..1..I
     14     I..1..I
     15     I..1..I
     16     I..1..I

0.354385 MINUTES FOR HISTOGRAM
```

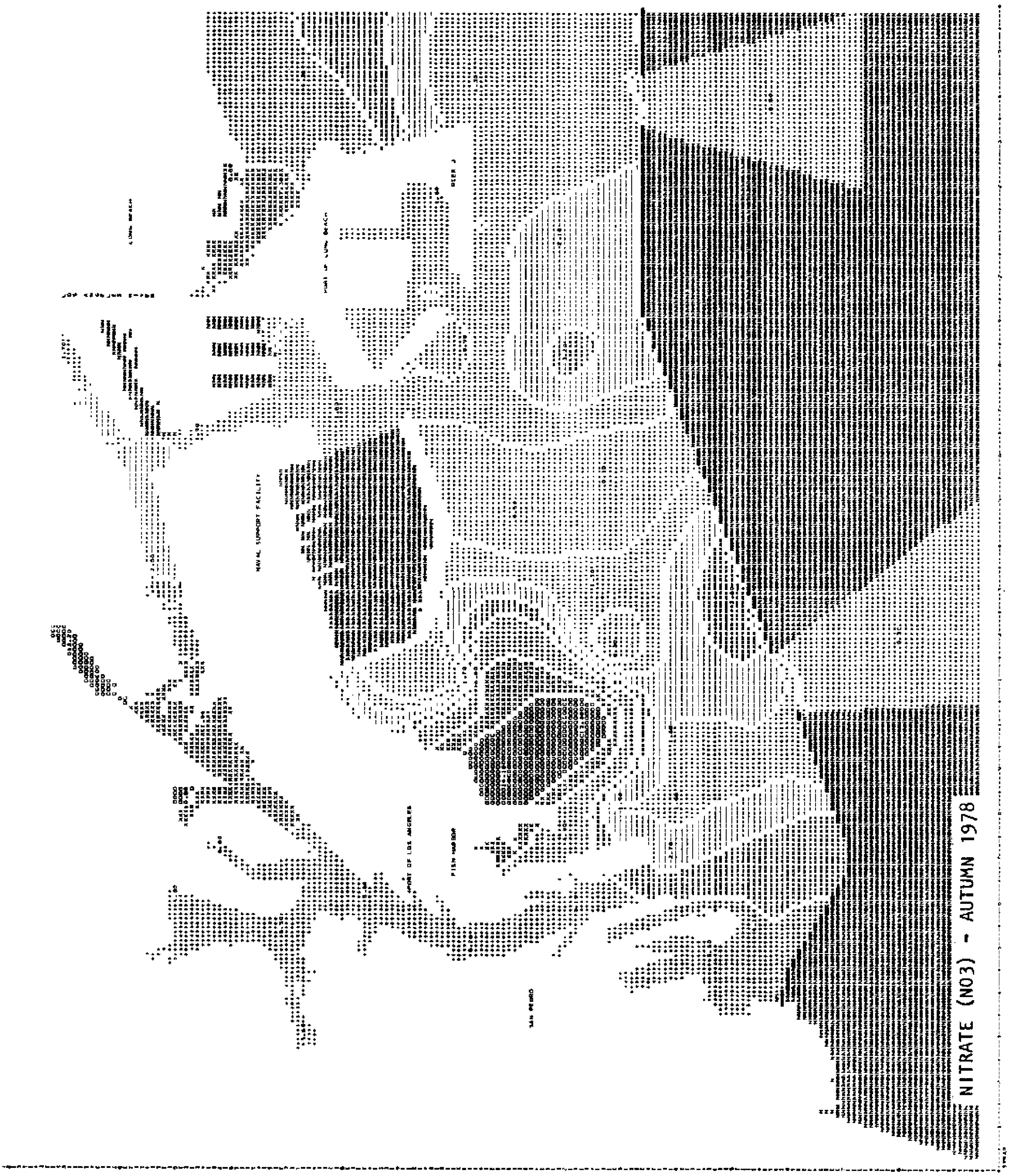

NITRATE (NO3) - AUTUMN 1978

FIGURE 35, MEAN NITRATE
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.10 14.10

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	2.00	2.99	3.99	6.98	9.78	14.77	19.95	32.92
MAXIMUM	1.00	2.00	2.99	3.99	6.98	9.78	14.77	19.95	32.92	43.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

2.27	2.27	2.27	2.27	6.82	6.36	11.36	11.82	29.55	25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL         1         2         3         4         5         6         7         8         9        10
          ==========================================================================================================
           .........  .........  ---------  =========  +++++++++  XXXXXXXX  000000000  @@@@@@@@@
           .........  .........  ---------  =========  +++++++++  XXXXXXXX  000000000  @@@@@@@@@
 SYMBOLS   ....1....  ....2....  ----3----  ====4====  ++++5++++  XXXX6XXXX 000070000  @@@@8@@@@
           .........  .........  ---------  =========  +++++++++  XXXXXXXX  000000000  @@@@@@@@@
           .........  .........  ---------  =========  +++++++++  XXXXXXXX  000000000  @@@@@@@@@
          ==========================================================================================================
 FREQ.         6         10         3         2         12         4         4         0         0         0
        1  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
        2  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I
        3  I..1..I   I''2''I   I--3--I             I++5++I   IXX6XXI   I00700I
        4  I..1..I   I''2''I                       I++5++I   IXX6XXI   I00700I
        5  I..1..I   I''2''I                       I++5++I
        6  I..1..I   I''2''I                       I++5++I
        7            I''2''I                       I++5++I
        8            I''2''I                       I++5++I
        9            I''2''I                       I++5++I
       10            I''2''I                       I++5++I
       11                                          I++5++I
       12                                          I++5++I
```

0.304688 MINUTES FOR HISTOGRAM

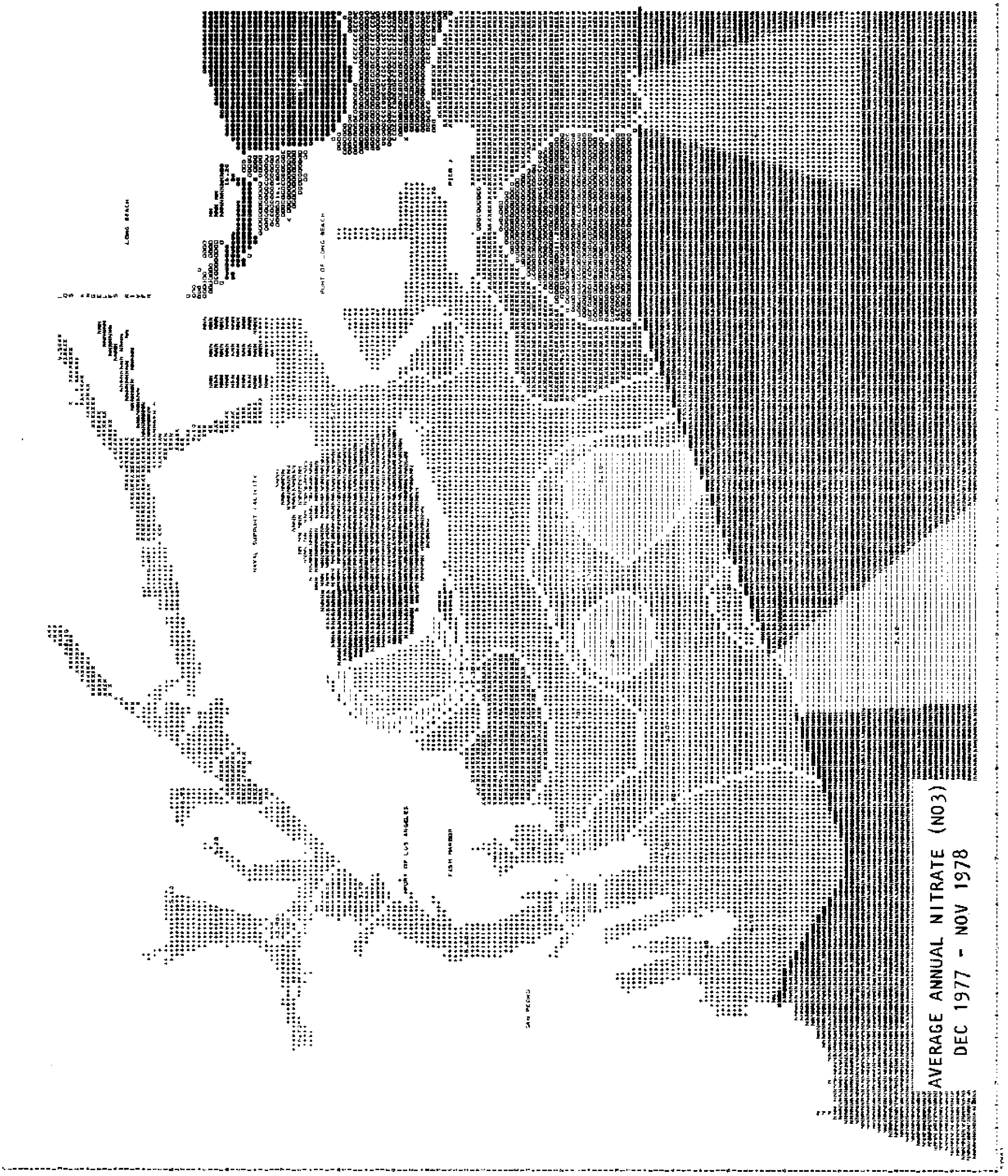

AVERAGE ANNUAL NITRATE (NO3)
DEC 1977 - NOV 1978
LONG BEACH
LOS ANGELES RIVER
PORT OF LONG BEACH
PIER J
NAVAL SUPPORT FACILITY
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 36, NITRATE
AVERAGE ANNUAL NITRITE
DEC 1977 - NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          1.70        17.00


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0      1.00      2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.52
  MAXIMUM       1.00     2.00      2.99      3.99      6.98      9.78     14.77     19.95     32.92     43.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                2.27     2.27      2.27      2.27      6.82      6.36     11.36     11.82     29.55     25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL            1         2         3         4         5         6         7         8         9        10
               ==============================================================================================
               .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX 000000000 @@@@@@@@@ █████████ █████████
               .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX 000000000 @@@@@@@@@ █████████ █████████
  SYMBOLS      ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX 000070000 @@@@@@@@@ ████9████ ████+████
               .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX 000000000 @@@@@@@@@ █████████ █████████
               .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX 000000000 @@@@@@@@@ █████████ █████████
               ==============================================================================================
  FREQ.            0         1         3         7         18        8         2         2         0         0
           1              I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I007001   I@@@@@I
           2                        I--3--I   I==4==I   I++5++I   IXX6XXI   I007001   I@@@@@I
           3                        I--3--I   I==4==I   I++5++I   IXX6XXI
           4                                  I==4==I   I++5++I   IXX6XXI
           5                                  I==4==I   I++5++I   IXX6XXI
           6                                  I==4==I   I++5++I   IXX6XXI
           7                                  I==4==I   I++5++I   IXX6XXI
           8                                            I++5++I   IXX5XXI
           9                                            I++5++I
          10                                            I++5++I
          11                                            I++5++I
          12                                            I++5++I
          13                                            I++5++I
          14                                            I++5++I
          15                                            I++5++I
          16                                            I++5++I
          17                                            I++5++I
          19                                            I++5++I

 0.349335 MINUTES FOR HISTOGRAM
```

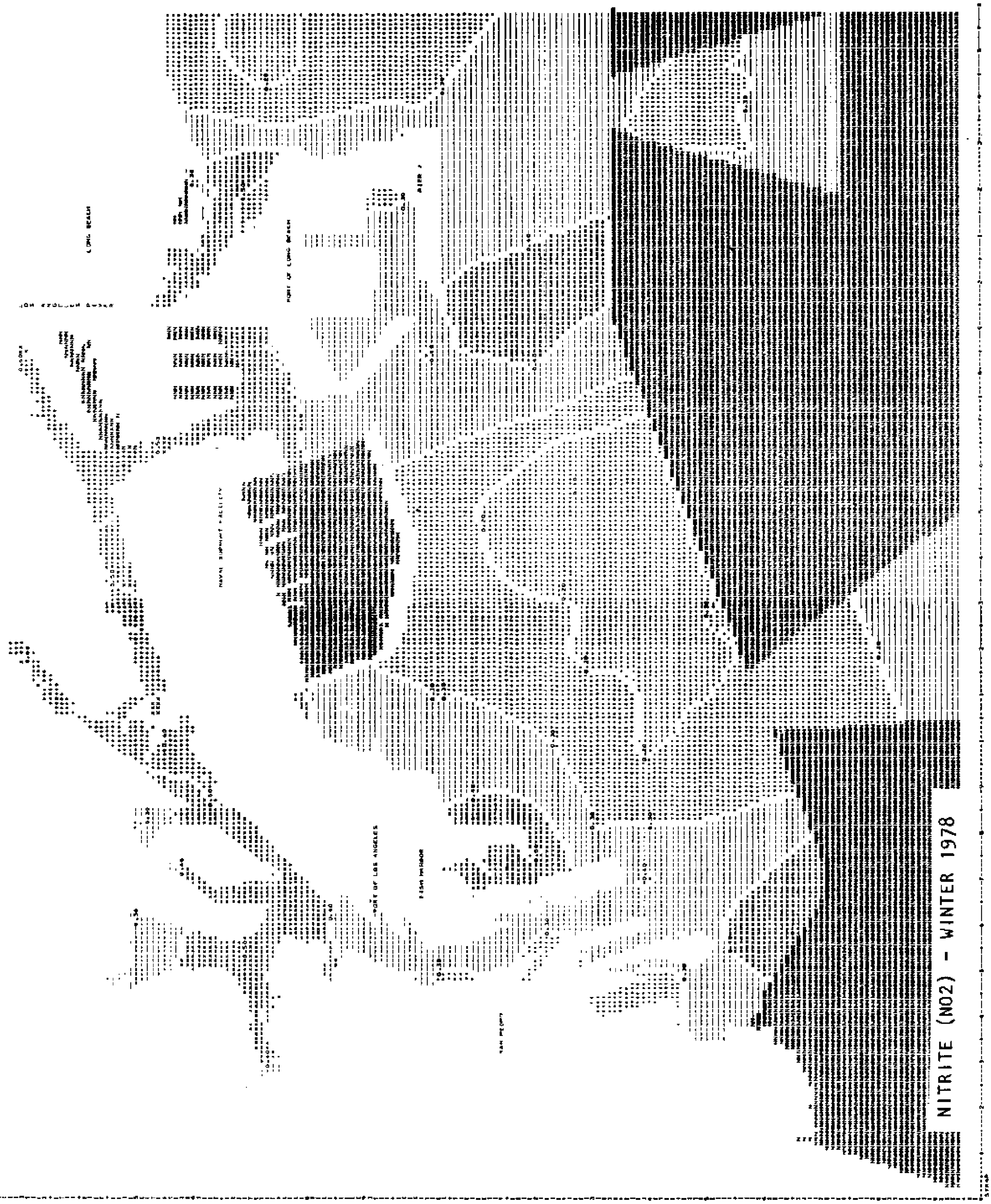

NITRITE (NO2) - WINTER 1978

FIGURE 37, MEAN NITRITE
WINTER 1977 - 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE         0.10         0.60



TOTAL MISSING DATA POINTS IS          2



ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0        0.20       0.30       0.40       0.50       0.60       0.70       0.80       1.00       1.10
 MAXIMUM     0.20       0.30       0.40       0.50       0.60       0.70       0.80       1.00       1.10       1.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            10.53       5.26       5.26       5.26       5.26       5.26       5.26      10.53       5.26      42.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1          2          3          4          5          6          7          8          9          10
          ==========================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  █████████  █████████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  █████████  █████████
 SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  @@@@8@@@@  ████9████  █████████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  █████████  █████████
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  █████████  █████████
          ==========================================================================================================
 FREQ.          1          6          15         10         6          3          0          0          0          0
         1   I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
         2              I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
         3              I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
         4              I''2''I    I--3--I    I==4==I    I++5++I
         5              I''2''I    I--3--I    I==4==I    I++5++I
         6              I''2''I    I--3--I    I==4==I    I++5++I
         7                         I--3--I    I==4==I
         8                         I--3--I    I==4==I
         9                         I--3--I    I==4==I
        10                         I--3--I    I==4==I
        11                         I--3--I
        12                         I--3--I
        13                         I--3--I
        14                         I--3--I
        15                         I--3--I

 0.393845 MINUTES FOR HISTOGRAM
```

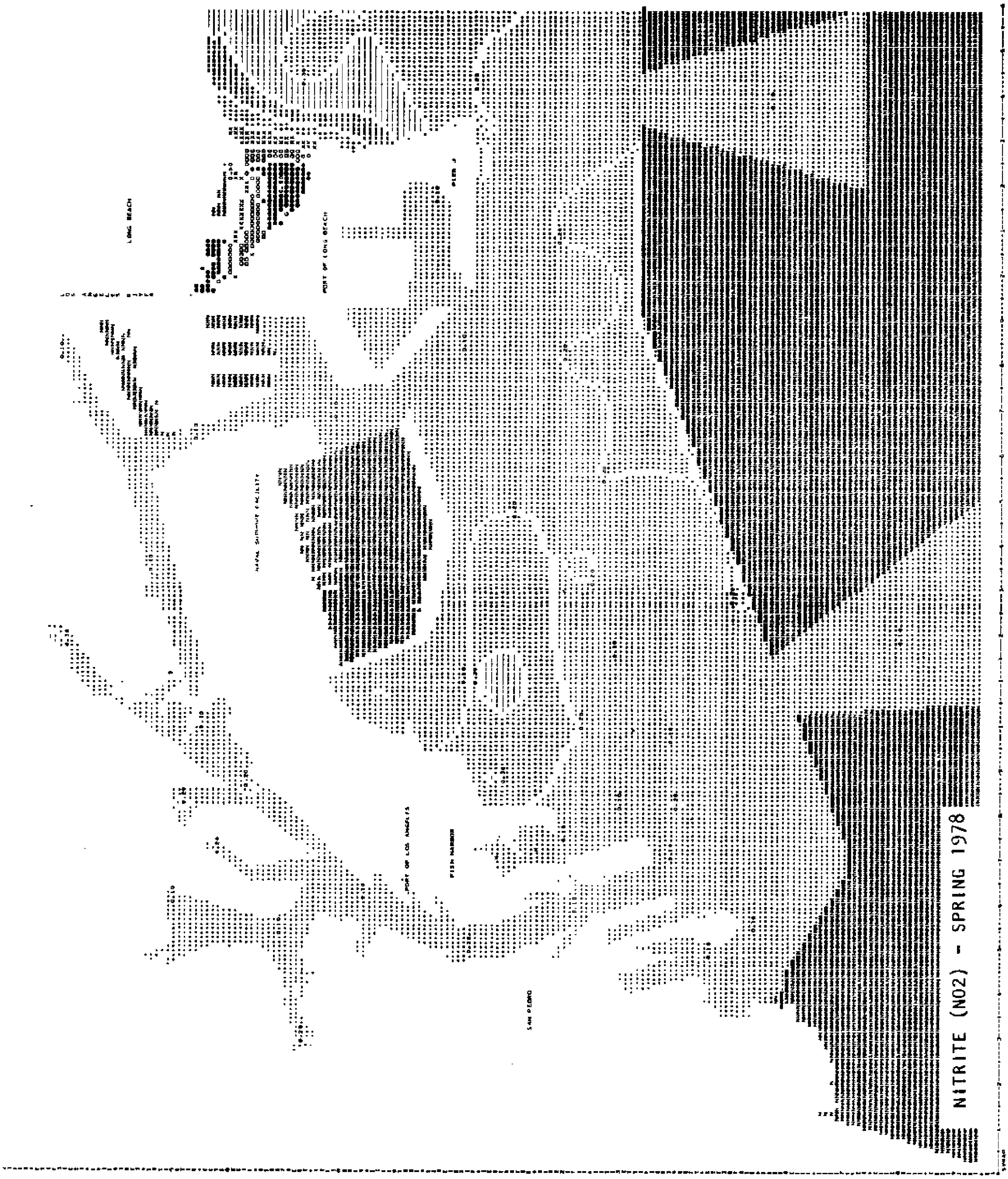

NITRITE (NO2) - SPRING 1978
LONG BEACH
PORT OF LONG BEACH
PORT OF LOS ANGELES
FISH HARBOR
SAN PEDRO

FIGURE 38, MEAN NITRITE
SPRING 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.10         0.90


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0      0.20      0.30      0.40      0.50      0.60      0.70      0.80      1.00      1.10
 MAXIMUM     0.20     0.30      0.40      0.50      0.60      0.70      0.80      1.00      1.10      1.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            10.53     5.26      5.26      5.26      5.26      5.26      5.26     10.53      5.26     42.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1        2         3         4         5         6         7         8         9        10
          ==================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
 SYMBOLS   ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 @@@@8@@@@ ■■■■9■■■■ ■■■■■■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
          ==================================================================================================
 FREQ.         22       13         4         0         1         0         0         1         0         0
          1  I..1..I  I''2''I  I--3--I            I++5++I             I@@8@@I
          2  I..1..I  I''2''I  I--3--I
          3  I..1..I  I''2''I  I--3--I
          4  I..1..I  I''2''I  I--3--I
          5  I..1..I  I''2''I
          6  I..1..I  I''2''I
          7  I..1..I  I''2''I
          8  I..1..I  I''2''I
          9  I..1..I  I''2''I
         10  I..1..I  I''2''I
         11  I..1..I  I''2''I
         12  I..1..I  I''2''I
         13  I..1..I  I''2''I
         14  I..1..I
         15  I..1..I
         16  I..1..I
         17  I..1..I
         18  I..1..I
         19  I..1..I
         20  I..1..I
         21  I..1..I
         22  I..1..I

0.421677 MINUTES FOR HISTOGRAM
```

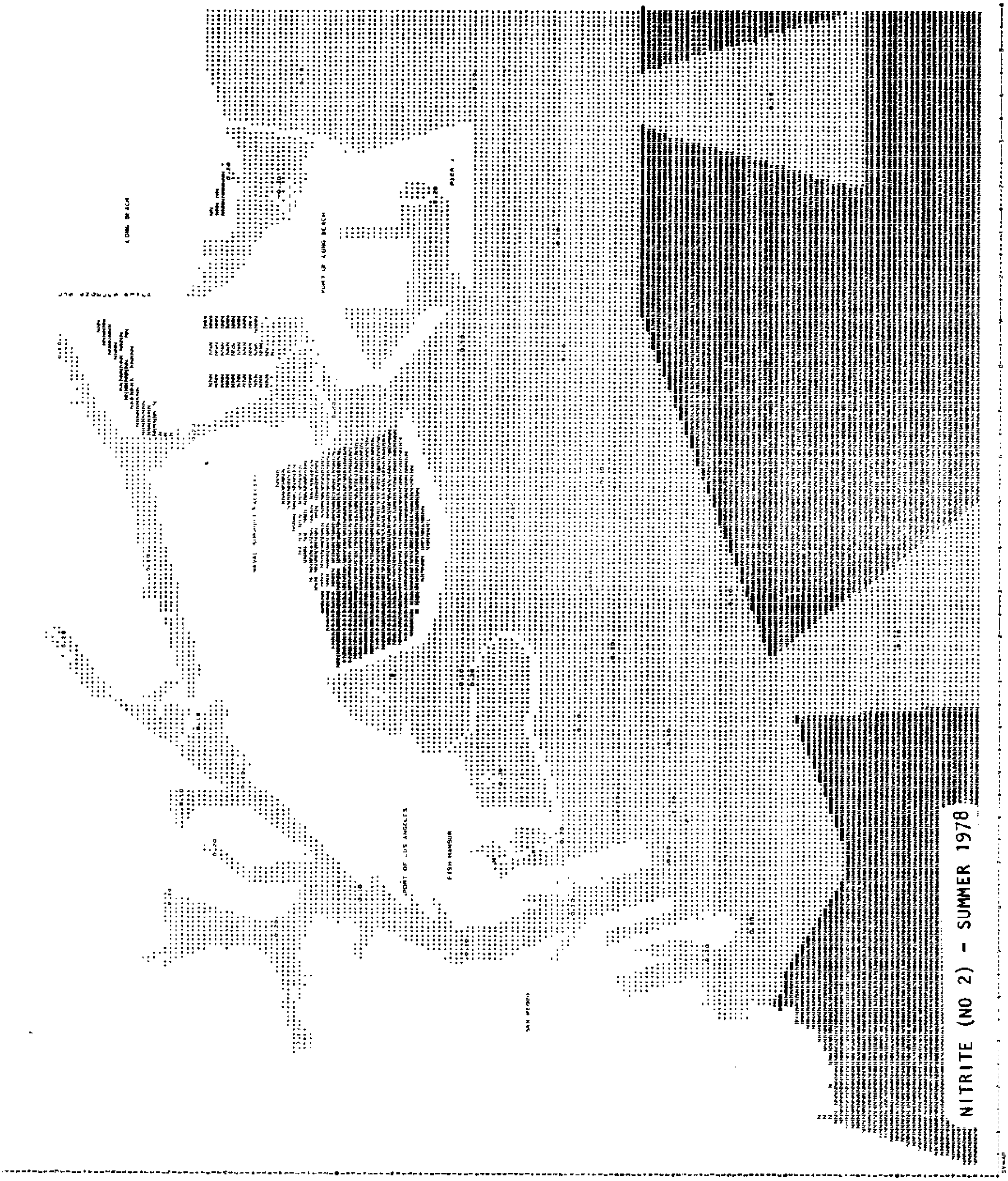

NITRITE (NO 2) - SUMMER 1978

FIGURE 39, MEAN NITRITE
SUMMER 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.10 0.30

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

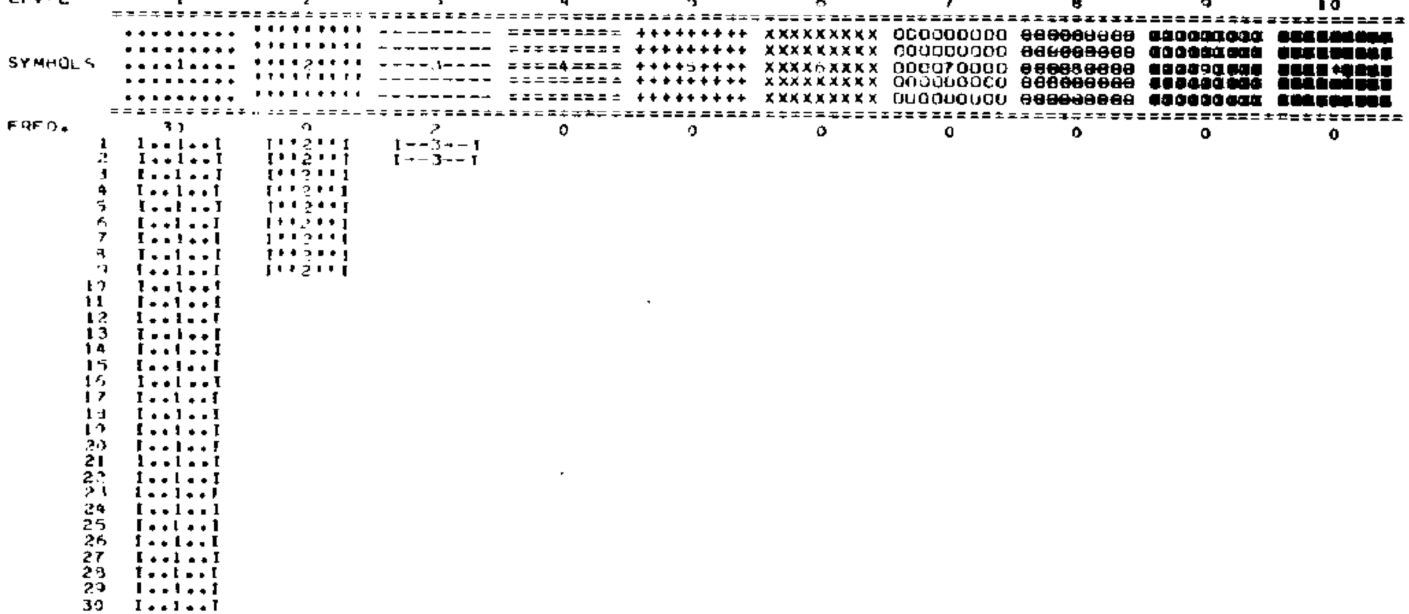
MINIMUM	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10
MAXIMUM	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10	1.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.53	5.26	5.26	5.26	5.26	5.26	5.26	10.53	5.26	42.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	30	9	2	0	0	0	0	0	0	0



0.477859 MINUTES FOR HISTOGRAM

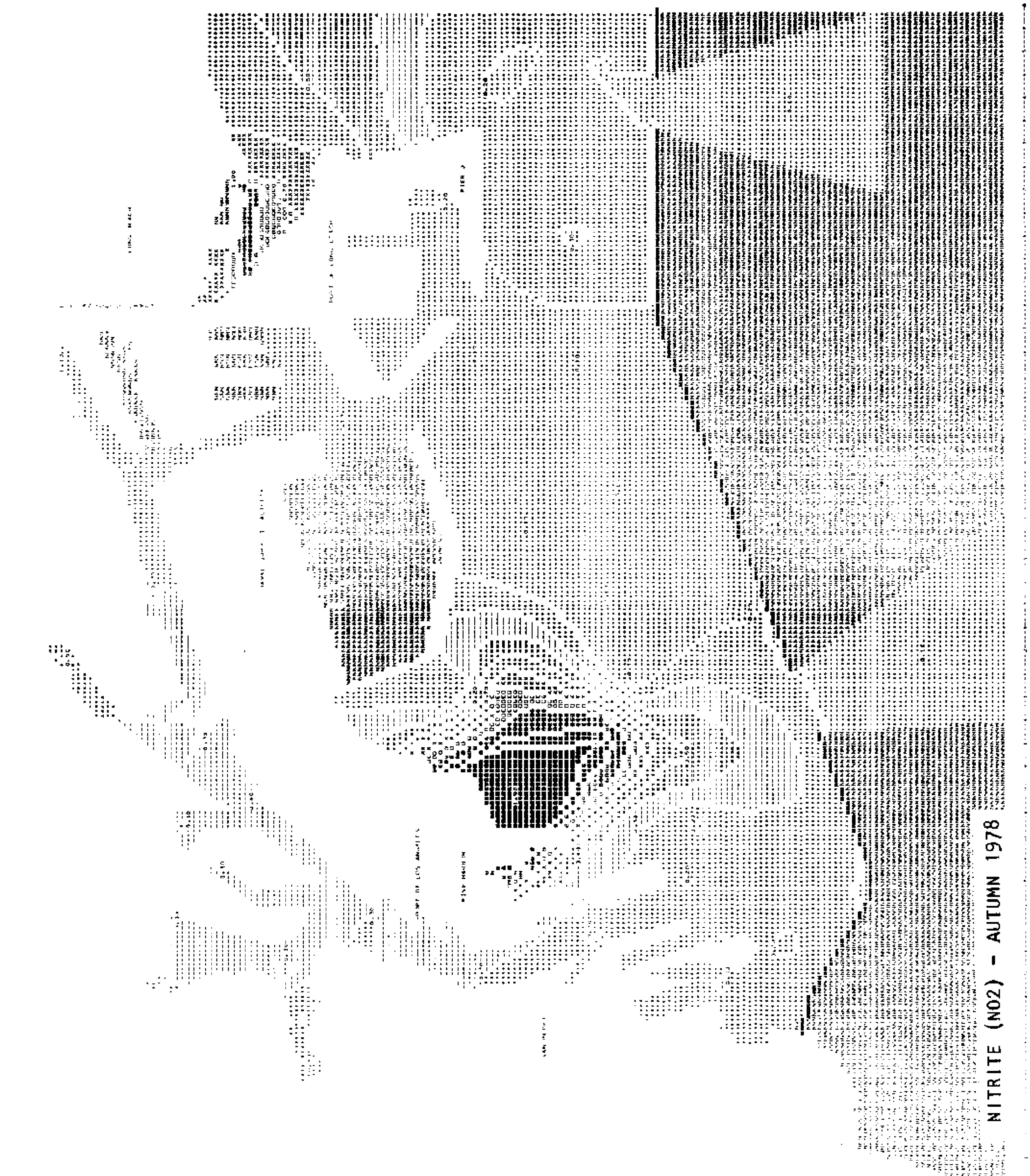

NITRITE (NO2) - AUTUMN 1978

FIGURE 40, MEAN NITRITE
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.10 1.90

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10
MAXIMUM	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10	1.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL.

10.53	5.26	5.26	5.26	5.26	5.26	5.26	10.53	5.26	42.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7         8         9        10
         =========================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  @@@@@@@@@  ■■■■9■■■■  ■■■■+■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  ■■■■■■■■■  ■■■■■■■■■
         =========================================================================================================
FREQ.       10         9        12         2         3         0         2         0         1         2
    1     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I             I00700I             I■■9■■I   I■■+■■I
    2     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I             I00700I                       I■■+■■I
    3     I..1..I   I''2''I   I--3--I             I++5++I
    4     I..1..I   I''2''I   I--3--I
    5     I..1..I   I''2''I   I--3--I
    6     I..1..I   I''2''I   I--3--I
    7     I..1..I   I''2''I   I--3--I
    8     I..1..I   I''2''I   I--3--I
    9     I..1..I   I''2''I   I--3--I
   10     I..1..I             I--3--I
   11                         I--3--I
   12                         I--3--I
```

0.402603 MINUTES FOR HISTOGRAM


AVERAGE ANNUAL NITRITE (NO2)
DEC 1977 - NOV 1978

FIGURE 41, NITRITE
AVERAGE ANNUAL NITRITE
DEC 1977 – NOV 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.10 0.70

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10
MAXIMUM	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00	1.10	1.90

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.53	5.26	5.26	5.26	5.26	5.26	5.26	10.53	5.26	42.11

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
                                                                                      *
LEVEL         1         2         3         4         5         6         7         8         9        10

SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ####9####  ####*####

FREQ.         5        23         7         3         1         1         1         0         0         0
       1  I..1..I   I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I
       2  I..1..I   I''2''I    I--3--I    I==4==I
       3  I..1..I   I''2''I    I--3--I    I==4==I
       4  I..1..I   I''2''I    I--3--I
       5  I..1..I   I''2''I    I--3--I
       6            I''2''I    I--3--I
       7            I''2''I    I--3--I
       8            I''2''I
       9            I''2''I
      10            I''2''I
      11            I''2''I
      12            I''2''I
      13            I''2''I
      14            I''2''I
      15            I''2''I
      16            I''2''I
      17            I''2''I
      18            I''2''I
      19            I''2''I
      20            I''2''I
      21            I''2''I
      22            I''2''I
      23            I''2''I
```

0.411255 MINUTES FOR HISTOGRAM

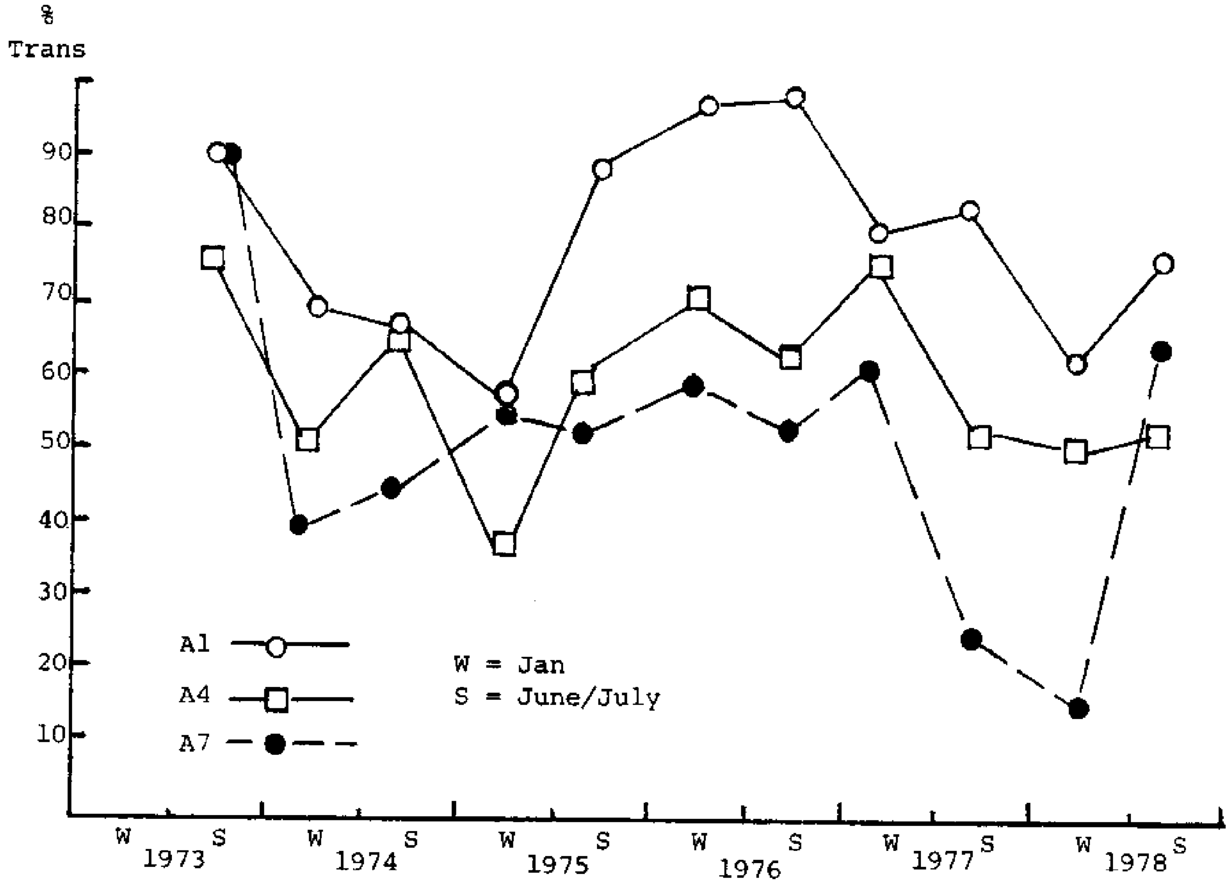


Figure 42. Seasonal Light Transmittance (%) at Stations A1, A4 and A7.

Figure 43. Annual Mean Light Transmittance at Stations A1, A4 and A7.

TABLE 1. PHOSPHATE DATA, LOS ANGELES-LONG BEACH HARBORS 1978

(µg·at/l)

Sta.	Dec'77	Jan'78	Feb'78	Mar'78	Apr'78	May'78	Jun'78	Jul'78	Aug'78	Sept'78	Oct'78	Nov'78	Dec'78
A-1	1.682	1.339	.701		.285	.353	.624	.487	.479	.394	.420	.288	1.019
A-2	1.846	2.051	1.792	2.358	1.304	4.474	1.203	.641	1.188	1.023	.706	.705	1.472
A-3	1.828	2.300	2.274	1.760	1.742	1.790	1.081	.631	1.362	1.034	.773	.690	1.282
A-4	2.433	2.131	1.249	1.196	1.216	.930	1.000	.728	.971	1.663	1.105	1.251	2.583
A-7	1.687	3.271	9.523	1.663	3.465	6.239	2.751	.456	12.391	2.625	3.024	6.549	2.379
A-8	1.173	2.086	1.548	2.494	.724	.711	1.365	.785	1.026	1.438	.849	1.206	1.535
A-9	2.096	2.027	1.325	1.352	.773	1.591	1.234	.723	.957	.998	.977	1.440	1.696
A-10		1.802	1.177	1.959	1.348	.843	1.303	.630	.809	.901	1.374	1.833	1.707
A-12	.518	.807	.761	.897	.600	.432	.838	.697	.539	.635	.450	1.718	1.379
A-13	.850	1.349	.609	1.502	.871	.855	1.264	1.733	1.183	.983	.670	.631	1.472
A-14	.723	.807	.609	1.682	.596	.572	1.030	.708	.525	.588	.583	.869	1.345
A-15	6.180	1.489	3.010	2.076	.625	7.332	5.883	.774	.585	1.351	1.996	2.130	1.228
A-16	1.214	1.095	8.873	1.755	.512	4.156	1.254	1.000	2.914	2.861	2.671	6.866	3.348
A-17	1.196	1.454	1.976	2.655	.650	.631	1.391	7.13	.654	1.208	.553	.586	1.396
B-1	.600	1.822	2.000	1.327	.256	.780	.599	.425	.426	.445	.610	.297	.730
B-2	1.419	1.807	1.345	1.468	.394	.580	.761	.695	.779	.501	.832	1.197	1.203
B-3	1.596	1.967	2.294	1.609	.340	.643	.528	.535	.605	.517	.777	..829	.996
B-4	1.169	2.285	2.325	1.634	.458	.687	.614	.465	.511	.476	.636	1.161	1.406
B-5	1.814	3.067	2.680	1.498	.768	.599	.878	.600	.560	.660	1.130	1.386	1.376
B-6	1.210	2.739	2.472	1.498	.640	.633	.726	.700	.580	.824	.958	1.529	1.420
B-7	1.028	5.552	2.457	2.028	.753	.862	.736	.535	.635	1.305	1.115	1.448	1.559
B-8	.814	1.036	.761	1.784	.689	.462	.817	.415	.585	.517	.450	1.102	1.170
B-9			.518	1.663	.763	.557	1.249	.744	.516	.855	.455	.864	1.769
B-10	.764	2.360	1.777	1.532	.369	.590	.670	.500	.660	.409	.847	.726	.809
B-11	.600	2.998	2.477	2.514	.172	.887	.604	.490	.580	.420	1.412	.757	1.480
C-1	2.46	2.689	1.721	1.418	1.117	1.179	1.200	.805	1.192	1.177	1.650	1.650	2.017
C-2		2.709	1.750	1.668	2.141	.960	.903	1.030	1.110	1.863	1.870	2.422	2.372
C-3		2.659	2.426	1.577	.989	1.023	1.277	1.085	1.350	2.252	2.051	2.374	2.658
C-4		3.122	2.052	1.969	1.029	.648	.908	1.010	1.085	1.719	1.850	2.764	3.423
C-5		2.744	1.906	1.480	1.649	.838	.662	.830	.921	2.057	2.282	2.768	2.451
C-6			1.668	1.571	1.826	.716	.938	1.190	1.305	1.868	1.680	2.457	1.835
C-7		3.087	2.173	2.276	1.703	2.183	2.626	2.081	2.671	5.568	4.403	3.485	3.132
C-8		1.703	1.964	1.204	.714	.994	.836	.915	.793	.911	1.459	2.647	1.998
C-9		5.154	3.423	1.888	.955	1.476	1.651	1.386	1.387	1.146	1.695	2.408	4.133
C-10		3.306	2.771	1.577	.763	.896	1.077	1.160	1.080	1.341	1.529	2.315	2.062
C-11		4.466	3.569	2.954	2.028	1.062	1.790	2.151	1.474	2.246	4.608	3.158	5.055
D-1	1.028	3.909	2.411	2.222	.354	.638	.467	.400	.898	.977	.837	.987	1.455
D-2	2.278	9.361	5.269	3.476	.763	1.189	.741	1.911	2.172	2.881	1.776	4.107	2.422
D-3	.991	5.393	2.335	4.196	.409	.687	.371	1.201	1.071	1.668	1.952	1.688	1.731
D-4	1.501	2.355	1.954	2.726	1.472	.560	.574	1.075	1.884	2.835	3.975	1.688	1.800

TABLE 2. AMMONIA DATA, LOS ANGELES-LONG BEACH HARBORS 1978

($\mu g \cdot at/l$)

Sta.	Dec'77	Jan'78	Feb'78	Mar'78	Apr'78	May'78	Jun'78	Jul'78	Aug'78	Sept'78	Oct'78	Nov'78	Dec'78
A-1	3.691	3.998	1.691		.789	.535	.966	1.434	1.270	1.010	2.095	1.859	2.618
A-2	6.871	4.752	5.979	6.303	1.941	2.626	.795	1.553	3.176	1.519	1.433	1.115	5.381
A-3	5.224	6.954	8.032	4.115	4.186	.827	1.193	1.912	4.941	2.011	.331	2.354	5.236
A-4	9.597	8.982	5.314	4.167	2.669	.632	.739	2.509	1.976	4.358	.331	5.948	11.199
A-7	7.609	9.793	35.388	4.433	10.253	9.773	7.215	8.005	119.279	9.462	1.654	4.337	7.417
A-8	7.837	6.432	7.005	7.292	1.881	1.167	.966	3.823	3.176	2.366	2.316	4.213	5.090
A-9	7.042	5.737	3.563	3.959	1.092	1.216	1.818	1.673	.988	3.976	1.654	5.205	6.108
A-10		6.099	7.017	1.868	.847	1.595	1.554	1.220	2.463	.797	4.642	7.563	3.223
A-12	.000	4.056	1.329	3.334	.789	.389	.795	1.195	1.623	.737	3.198	1.611	4.654
A-13	3.066	.000	1.208	4.948	1.456	.486	1.193	.717	1.059	1.392	4.962	1.363	4.218
A-14	1.079	4.056	1.268	3.959	.607	.389	1.136	2.987	1.694	.737	1.544	1.735	5.090
A-15	8.007	4.520	10.870	4.948	.849	7.439	13.521	1.195	.565	2.930	.772	.991	4.218
A-16	4.600	3.129	32.127	3.802	.607	3.550	.739	1.434	17.080	5.113	1.544	2.602	5.381
A-17	2.044	4.984	2.174	5.626	.789	.486	1.023	1.673	.706	2.074	1.875	1.735	4.218
B-1	1.817	5.733	5.133	2.699	1.072	.729	3.255	2.233	.696	.975	.611	1.709	2.046
B-2	3.464	9.362	3.261	2.647	.621	.681	1.085	1.576	.811	.731	1.343	3.590	4.604
B-3	2.669	26.770	4.469	2.387	.451	.340	.784	1.445	.522	.610	.855	1.800	2.941
B-4	4.202	36.816	20.472	4.515	.564	.486	.784	1.970	.638	.244	.855	2.991	4.859
B-5	6.701	35.238	18.057	7.992	.734	.389	1.567	1.839	.811	.488	4.396	4.444	6.394
B-6	5.054	49.964	22.767	7.992	.508	.486	.844	2.627	.869	.000	2.320	4.701	7.161
B-7	5.622		29.168	8.044	.903	.438	1.628	1.445	.464	2.316	1.343	4.957	8.056
B-8	.454	3.883	1.087	3.959	.849	.486	.625	2.748	1.764	.637	4.741	.744	4.363
B-9			.845	3.282	1.153	.681	.625	2.151	1.553	.762	2.316	1.115	4.363
B-10	2.896	6.995	5.133	4.152	.677	.438	.723	.657	.290	.122	.488	1.453	2.430
B-11	1.817	8.731	6.764	4.878	.508	.292	.603	.789	.116	.244	1.832	1.368	2.046
C-1	10.619	9.783	11.253	3.425	1.298	1.745	2.775	2.287	2.652	3.585	3.894	9.744	5.024
C-2		10.206	13.023	2.959	1.354	1.354	1.745	1.998	2.273	4.116	6.439	9.454	6.352
C-3		9.662	11.632	3.114	.959	.748	1.998	1.220	2.463	4.647	9.135	10.617	6.352
C-4		9.240	20.672	2.024	1.072	.798	2.664	1.067	3.979	4.249	7.637	9.890	4.550
C-5		9.542	11.759	5.812	2.935	1.246	.333	1.372	1.326	5.975	10.932	10.326	5.404
C-6			17.954	2.232	.903	.798	1.110	2.592	4.736	3.984	6.739	11.635	4.835
C-7		13.829	13.782	2.699	1.298	1.396	6.660	3.050	5.305	5.710	20.216	10.181	7.015
C-8		8.750	11.379	5.397	.677	1.495	.999	2.135	1.800	3.187	5.691	11.199	6.257
C-9		17.996	19.661	4.723	1.185	1.894	2.331	2.745	3.695	2.788	5.990	11.635	11.186
C-10		13.407	14.540	3.477	.790	.997	1.332	1.220	3.884	2.257	5.241	12.071	6.067
C-11		29.229	18.270	8.200	4.176	1.246	1.998	1.982	4.357	5.975	6.589	14.398	12.513
D-1	2.215	9.099	6.039	4.463	.564	.389	.723	.657	.290	.122	.733	2.393	4.220
D-2	8.916	19.302	7.609	8.822	.056	1.070	.904	1.970	1.797	.244	4.396	12.308	7.673
D-3	1.136	14.042	5.858	6.954	1.185	.632	1.025	1.445	.290	.610	2.686	4.444	5.499
D-10	8.688	10.045	13.648	5.864	.564	.729	1.145	2.496	1.449	4.023	10.257	4.359	6.905

TABLE 3. NITRATE DATA, LOS ANGELES-LONG BEACH HARBORS 1978

($\mu g \cdot at/l$)

Sta.	Dec'77	Jan'78	Feb'78	Mar'78	Apr'78	May'78	Jun'78	Jul'78	Aug'78	Sept'78	Oct'78	Nov'78	Dec'78
A-1	3.456	19.093	.394		.053	.129	.951	.294	1.146	.227	.566		4.259
A-2	3.867	16.214	2.379	10.887	1.023	7.161	.868	.128	.478	2.583	1.466	.717	6.903
A-3	2.698	18.136	1.579	8.080	1.165	1.761	.626	.191	.920	3.971	1.047	.787	6.991
A-4	4.786	17.898	1.980	7.492	.708	.718			.244	8.866	3.068	2.627	11.720
A-7	2.230	18.537	3.697	7.617	3.222	11.661	2.477	15.172	5.156	3.908	8.924	29.383	11.260
A-8	5.034	21.616	2.307	13.836	1.029	1.111		1.987	2.054	4.483	1.235	2.259	5.915
A-9	6.124	27.360	2.976	7.864	.845	2.396	7.878	9.213	1.149	6.814	2.679	2.816	7.968
A-10			8.339	9.791	1.311	2.068	6.695	2.313	5.899	1.700	6.816	8.320	5.350
A-12	.790	10.196		8.247		.816	.981	5.039	4.781	.056	.372	3.580	6.266
A-13	2.879	10.184	.131	7.858	9.502	1.127	6.167	.222	.327	8.127	1.727	..987	7.397
A-14	1.161	10.196	.264	7.962	2.228	.389	1.486	.685	.973	.241	.378	.211	5.532
A-15	1.212	30.188	1.917	10.395	1.070	18.836	5.098	.648		5.224	6.917	5.923	4.874
A-16	1.381	18.302	3.354	7.516	.	8.000		.065	.479	4.788	8.057	28.454	16.065
A-17	1.673	18.407	.846	9.070	5.859	.146	3.096		.265	4.797	.161	.395	6.225
B-1	2.147	15.059	8.278	30.290	.358	1.750	.607	.697	.322	.888	.011	.591	2.857
B-2	3.950	25.814	3.762	17.052		.128	.323	.402	.228	.146	1.513	3.001	4.058
B-3	1.044	21.067	6.279	12.843	.094	.233	.539			.099	.864	1.633	3.163
B-4	3.079	30.727	8.324	14.181		.241	.000	.054	.037	1.874	.479	2.425	4.031
B-5	3.291	64.824	23.184	7.584	.617	.294	.568	2.243	.377	.671	2.294	2.830	4.804
B-6	3.838	79.245	15.567	7.584	.108	.382	.590	.959	.236	.381	2.117	2.691	8.806
B-7	2.921	44.620	15.770	9.259	.465	.250		.164	.121	3.084	2.253	2.998	5.146
B-8	2.036	13.895	.069	14.309	6.172	.247	.080	.064	14.709	.515	.591	.264	4.346
B-9			.010	8.817	7.254	.541	.056	.204	3.274	.115	.215	.058	6.190
B-10	1.543	30.255	8.876	54.990	.043	.485	.123	.094	.000	.258	.577	8.629	2.918
B-11	1.413	30.474	11.638	82.970	.140	.306	.345	.274		.413	4.092	1.711	2.761
C-1	7.197		7.510	5.200	1.539	1.033	5.202	1.743	1.752	2.339	3.440	9.567	7.246
C-2		20.524	8.923	5.630	1.645	2.579	1.771	3.858	1.215	2.193	3.486	9.879	10.569
C-3			11.932	6.337	1.157	.231	2.051		1.137	2.921	3.675	10.881	11.268
C-4			10.624	5.707	1.723	.421	2.209	3.641	1.860	2.877	2.994	10.505	12.212
C-5			27.406	11.066	12.130	1.770	1.059	1.741	1.799	2.675	3.247	10.829	8.056
C-6			9.347	6.002	1.764	.314	17.273	1.959	1.780	3.274	3.251	7.810	6.975
C-7		10.155	8.788	5.825	1.654	.681	3.582	2.907	2.922	3.029	5.373	11.853	8.646
C-8		20.858	9.442	6.351	1.178	.694	2.852	1.352	.891	2.011	9.233	18.780	12.972
C-9		21.392	18.968	11.323	1.897	.392	3.181	1.685	1.646	2.062	2.796	19.526	33.244
C-10		16.107	15.160	8.261	.545	.956	2.480	1.439	1.698	1.524	2.577	19.518	12.886
C-11		20.203		20.256	5.633	.565	2.423	1.814	2.226	4.335	2.735	29.390	61.313
D-1	1.866	26.476	10.280	58.093	1.418	.163	.014	.301	.524		.998	2.823	6.532
D-2	6.426	4.099	17.202	74.750	29.554	9.330	.166	4.663	1.108	.632	5.832	15.513	13.063
D-3	2.296	95.459	7.645	69.636	14.704	..705	.826	.732		.122	6.097	6.262	7.962
D-10	2.599	18.105	10.802	75.025	54.987	1.605	2.955	2.402	1.385	4.526	15.527	6.227	8.570

TABLE 4. NITRITE DATA, LOS ANGELES-LONG BEACH HARBORS 1978

(μg·at/l)

Sta.	Dec'77	Jan'78	Feb'78	Mar'78	Apr'78	May'78	Jun'78	Jul'78	Aug'78	Sept'78	Oct'78	Nov'78	Dec'78
A-1	.334	.315	.197		.049	.063	.156	.171	.084	.152	.152	.064	.178
A-2	.219	.471	.174	.295	.079	.292	.048	.120	.053	.394	.077	.099	.162
A-3	.308	.438	.271	.166	.159	.106	.130	.210	.103	.722	.065	.096	.189
A-4	.520	.641	.238	.162	.102	.060	.167	.188	.114	.998	.102	.184	.286
A-7	.294	.652	.366	.172	.166	.576	.236	.148	.440	5.383	.071	.149	.274
A-8	.340	.387	.522	.232	.098	.106	.093	.122	.175	.388	.068	.160	.176
A-9	.485	.414	.243	.178	.083	.111	.162	.175	.105	.242	.115	.208	.251
A-10		.325	.278	.194	.093	.110	.114	.074	.147	.263	.197	.375	.299
A-12	.446	.127	.143	.235	.136	.086	.091	.082	.088	.171	.056	.103	.203
A-13	.281	.140	.151	.202	.240	.090	.206	.190	.021	.226	.112	.147	.189
A-14	.228	.127	.169	.200	.087	.117	.175	.080	.063	.161	.043	.064	.209
A-15	.265	.254	.276	.210	.062	.534	.273	.128	.082	1.950	.090	.120	.223
A-16	.265	.151	.432	.230	.076	.390	.063	.101	.177	3.023	.099	.158	.247
A-17	.262	.295	.176	.208	.127	.075	.158	.146	.044	1.485	.037	.083	.185
B-1	.232	.343	.343	.216	.057	.150	.126	.144	.163	.167	.066	.046	.191
B-2	.223	.409	.183	.232	.059	.101	.065	.330	.115	.170	.121	.179	.203
B-3	.442	.368	.266	.283	.042	.112	.147	.124	.150	.164	.092	.158	.191
B-4	.317	.599	.323	.235	.053	.089	.117	.276	.096	.118	.084	.166	.221
B-5	.313	.744	.550	.198	.083	.116	.095	.243	.130	.223	.216	.183	.215
B-6	.515	.652	.526	.198	.081	.047	.093	.165	.111	.118	.175	.156	.213
B-7	.334	.711	.599	.239	.104	.093	.147	.185	.057	.666	.179	.183	.247
B-8	.198	.184	.107	.237	.172	.060	.130	.117	.042	.158	.043	.072	.205
B-9			.095	.196	.197	.063	.132	.208	.084	.109	.046	.064	.195
B-10	.430	.297	.343	.281	.068	.260	.108	.087	.141	.118	.086	.152	.170
B-11	.274	.407	.474	.400	.079	.126	.091	.120	.107	.192	.409	.152	.195
C-1	.363	.394	.250	.223	.102	.060	.091	.091	.253	.266	.156	.298	.373
C-2		.409	.244	.213	.089	.092	.147	.076	.178	.266	.175	.310	.505
C-3		.453	.302	.255	.087	.036	.131	.132	.147	.310	.205	.345	.484
C-4		.611	.331	.202	.115	.036	.116	.153	.191	.313	.244	.377	.462
C-5		.440	.329	.232	.197	.204	.087	.155	.186	.328	.240	.333	.435
C-6			.278	.211	.161	.050	.004	.115	.180	.316	.232	.306	.338
C-7		.445	.357	.221	.193	.090	.122	.166	.235	.285	.288	.329	.371
C-8		.352	.311	.240	.089	.132	.065	.087	.174	.291	.216	.509	.614
C-9		.652	.387	.422	.121	.110	.085	.100	.163	.294	.209	.584	1.582
C-10		.563	.561	.246	.085	.090	.080	.140	.209	.313	.230	.507	.633
C-11		.747	.468	.680	.214	.046	.098	.123	.266	.353	.214	.921	1.941
D-1	.230	.233	.395	.281	.119	.103	.108	.165	.048	.297	.146	.241	.541
D-2	.511	.842	.208	.315	.539	1.801	.134	.608	.128	.118	.626	1.447	.977
D-3	.225	.092	.397	.372	.356	.203	.087	.204	.096	.161	.682	.543	.582
D-10	.271	.529	.373	.356	.872	.208	.199	.328	.122	.756	1.676	.499	.621

Table 5. Percent Light Transmittance at Selected Stations.

Sta	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean
						Year 1978							
A1	61.0	81.0	****	91.0	70.0	****	79.0	82.0	97.0	83.0	92.0	****	81.8
A4	52.0	70.0	57.0	50.0	****	****	56.0	90.0	36.0	61.0	79.0	****	61.2
A7	64.0	65.0	32.0	33.0	67.0	****	70.0	76.0	22.0	58.0	76.0	****	61.1
						Year 1977							
A1	80.0	96.5	54.9	89.5	92.0	98.0	82.0	****	85.0	95.0	76.5	****	84.9
A4	76.0	75.0	17.5	76.0	70.0	32.0	53.0	****	82.0	38.0	51.5	****	57.1
A7	26.0	69.0	****	37.0	45.0	34.0	14.5	****	70.0	2.0	****	47.0	38.3
						Year 1976							
A1	98.0	75.0	74.0	****	67.0	****	99.0	83.5	****	84.0	96.5	****	84.6
A4	70.0	70.0	44.0	****	52.0	****	61.5	69.5	****	72.0	64.0	****	62.9
A7	54.5	65.0	42.0	****	50.0	****	62.0	61.0	****	44.0	****	****	54.1
						Year 1975							
A1	57.0	85.0	84.0	75.5	79.0	90.0	89.0	85.0	78.5	85.0	77.0	93.0	81.5
A4	36.5	70.0	41.0	31.5	59.0	72.0	59.5	63.5	69.0	44.0	60.0	66.0	56.0
A7	53.0	58.0	29.5	58.0	50.0	52.0	59.0	42.5	42.5	29.5	47.0	47.0	48.0
						Year 1974							
A1	70.0	****	92.0	82.0	87.5	89.5	67.0	84.5	63.0	89.0	74.5	****	79.9
A4	50.0	****	40.0	67.5	62.0	66.0	****	64.5	27.0	66.0	44.5	53.0	54.1
A7	40.0	****	56.0	41.0	53.0	57.5	46.5	25.0	23.0	41.5	19.0	45.0	40.7
						Year 1973							
A1	****	****	****	97.0	100.0	90.0	****	****	86.0	87.0	92.0	****	92.0
A4	****	****	****	92.0	50.0	74.0	****	****	71.0	44.0	74.0	****	67.5
A7	****	****	****	86.0	76.0	90.0	****	****	63.5	55.0	58.0	****	71.4

HARBOR SEDIMENTS AND POLLUTANTS

INTRODUCTION

The upper 400 feet of the sediments in San Pedro Bay consist of unconsolidated Pleistocene and Holocene alluvial sediments deposited by the river drainage basins. Only along the outer Los Angeles main channel does the Palos Verdes rock underlie the bottom. Sediments are composed primarily of clay, sand and gravel; the harbors have accumulated a large measure of surficial silts as well.

The Los Angeles River flood control channel carries large loadings of sediment to the harbor during major storms. Prior to construction of dams upstream and the eastern breakwaters, the sediment load was carried farther seaward to be reworked coastally and later deposited as beach replenishment. Upstream damming of rivers and controlling of coastal wave action has reduced sand formation along much of the southern California beach areas. Reduction in the dispersion of the river loads creates depositions of sediments at the river mouth and necessitates dredging to maintain boating access upstream of station D3.

Prior to the 1920's the Los Angeles River entered the harbor where Slip Two in the Port of Long Beach is located and flowed west in Cerritos Channel behind Rattlesnake Island to the Los Angeles Main Channel. The island was a sandy barrier beach, receiving breakers that rolled in across the shoaling bay.

As the Ports developed new landfill by dredging channels along the present Cerritos and Main Channels, severe damage to facilities was caused by major winter storms and runoff into the Ports, and hence the river bed was diverted to the east. Upstream, dams were constructed and debris basins created, but flood stage still brings large flows from the foothills and basin, which covers 832 square miles.

Dominguez Slough has an improved channel and drains some 80 square miles. It, too, carries sediment as well as urban runoff into inner Los Angeles Harbor during storms; there are also storm drains throughout the harbors. Rains flush hydrocarbons and metals from streets and parking lots; natural organic debris is carried into the harbors in runoff, or may be brought in on tidal exchanges from adjacent coastal areas.

Resuspension of Sediments

While sediments that are carried into the harbors as runoff settle out when they reach the slow-moving deeper harbor, sediments do not remain stationary as deposited. Winter storm waves cause turbulence, which mixes the water column, resuspending the unconsolidated sediments and redistributing beach sands. Straughan (1975) noted a 6 ft change in beach height at Cabrillo Beach following a single winter storm. Generally, the beach is redeposited in the spring and summer.

Ship propellers often create large turbidity plumes, because larger ships come very close to the bottom in the shallower harbor channels. The Los Angeles turning basin above the bridge is thoroughly churned by ship movements. The entrance to Fish Harbor is another shallow area, where arriving tuna boats barely clear the entry. Deeper holes may occur along docks where propellers are used.

Natural events, such as Santa Ana winds, which reverse the prevailing wind direction, can cause turnover of outer harbor waters where the wind fetch is uninterrupted, with concomitant resuspension of sediments. Also, thermal inversions sometimes occur in the fall, when bottom waters are warm and surface waters are chilled by shorter days and colder nights. The phenomenon of turnover is usually associated with freshwater lakes, but has been documented in the outer harbor (Soule and Oguri, 1974).

The role of benthic organisms in stirring sediments should also be recognized, in view of the large population densities (above 40,000 per m^2) that were observed in the harbor (AHF, 1976; Soule and Oguri, 1976). Nichols (1974) and others have noted the ability of infaunal invertebrates to rework large soft-bottomed areas.

Characteristics of Harbor Sediments

The nature and distribution of benthic organism populations in the harbor is largely governed by sediment grain size, organic content, pollutant levels and circulation patterns. Benthic populations are discussed elsewhere in this volume in Section IIIC, and circulation patterns are discussed in Section IIA.

Limited investigations were carried out in 1978 on the distribution of sand, silt and clay, and on pollutant chemistry of sediments, as will be discussed in the following pages.

SEDIMENT DISTRIBUTION

Environmental conditions exert a profound influence on production, transportation and deposition of sediments. Sedimentary processes, however, are generally slow, and a response to changes in environmental conditions may not be clearly recognized for thousands of years (Menard, 1974). Readily visible changes are the result of man's activities. Energy patterns that define the depositional characteristics of an area are altered, thus affecting the size and distribution of sediments. Changes in distribution, in turn, are reflected by a change in the associated benthic population.

Previous work on sediment distribution in the Los Angeles-Long Beach Harbors was performed in 1973-74 by Harbors Environmental Projects (Allan Hancock Foundation, 1976; Port of Long Beach, 1976). Environmental Quality Analysts-Marine Biological Consultants conducted a three-year (1974-1976) benthic marine monitoring program as part of an investigation of receiving waters near the Southern California Edison Long Beach Generating Station located on the Back Channel, and also reported on sediments.

In order to determine whether there had been changes in sediment type and distribution in the intervening years, sediments were analyzed from benthic cores taken in the winter and summer of 1978 in Los Angeles and Long Beach Harbors.

Factors Affecting Distribution

The sedimentary regime of the Los Angeles-Long Beach Harbors area has been greatly modified by dredging, filling, construction of the breakwater, ship traffic, and runoff patterns. Dredged areas create deep traps for fine sediments and interrupt the flow of bed load sediments. Filled areas obstruct sediment movement, cause deposition or erosion of areas adjacent to them, and may themselves be sources of sediments (AHF, 1976). Since the breakwater reduces the amount of energy available to transport sediment, average current velocities are generally lower inside the breakwater, and this means that the finer sediments which would otherwise be flushed out to sea tend to remain inside the harbor area. Runoff is a major source of fine sediments. While ship traffic provides energy to transport sediment, particularly along the shallower shipping channels, that flow of energy is not constant in duration or magnitude.

Characteristics of Sediments

Marine sediments consist of discrete particle populations that tend to exhibit near log-normal size distributions. Thus, log-normal distributions provide a means of comparing observed grain size distributions (EQA-MBC, 1976). The grain types under consideration are sand, silt, and clay. The respective grain sizes, given below, are measured in millimeters and by the phi (ϕ) scale. Phi represents the logarithm of the diameter of the grain particle.

Grain Type	Grain Size in ϕ	Grain Size in MM
Sand	$\leq 4\phi$	0.0625 to 1.0000
Silt	$4\phi - 8\phi$	0.0625 to 0.0039
Clay	$> 8\phi$	< .0039

Sorting

Sorting results from the interaction between sediment grains and the transporting medium. The two methods of physical transportation, traction and suspension, tend to selectively separate the sediment grains on the basis of size, shape, and specific gravity. Sorting is conditioned by decreases in velocity of the carrying currents. If the rate of a decrease in velocity is small, sediments are distributed over a longer space, thus resulting in good sorting. The larger, more spherical, and heavier particles drop out first. The smaller, less spherical and lighter particles tend to remain in suspsnsion until the velocity has decreased sufficiently to allow them to settle out. If velocity decreases rapidly, the loads of both methods of transportation are dropped in a short time over a limited area, and poor sorting results (Twenhofel, 1950).

METHODS AND MATERIALS

The locations and depths of the 41 sediment stations sampled are shown in Figures 1 and 2 respectively. Although all stations have been sampled quarterly from January 1978 to January 1979, this report deals with winter and summer samples collected at each station in January and July 1978 as representative of the seasonal differences.

The samples that were analyzed for grain size were collected with a modified Reinecke box corer. The samples were collected from the top 6 cm. of the core, placed in a plastic container and frozen (for possible future chemical analysis). Prior to analysis, each sample was thawed, stirred thoroughly, and a split was taken, varying in size depending on sand content. The original sample was then re-frozen for archiving. Hydrogen peroxide (30%) was added to the sample to remove organic material. The samples were then washed three times with tap water and three times with distilled water to remove any trace of salt. The samples were then wet-screened through a 62μ screen. The material that passed through the 62μ screen was collected in a 1000 ml graduated cylinder. The material that was retained on the screen was collected in a 50 ml beaker and dried. When this material was dried it was re-screened through a dry 62μ screen, because a hydraulic factor causes some material that should have gone through the wet screen to be retained. The material that passes through on dry screening is added to the cylinder, and the remainder is weighed to a tenth of a milligram. A deflocculent (0.3 ml of 20% NH_4OH) is added to the cylinder and the contents were analyzed by the standard pipette method (Pettijohn, 1957).

The coarse fraction (62μ) was analyzed by a settling tube as described by Felix (1969) and calibrated according to Gibbs (1971). The coarse fraction (down to 4ϕ) was analyzed to ¼ϕ while the pipette fraction (down to 9.5ϕ) was analyzed at full ϕ intervals.

RESULTS

Utilizing the data obtained from the January and July 1978 samples, the percentages of sand, silt, and clay at each station were calculated for each sampling period. January/July averages were also calculated. The percentages are presented in Table 1. Pie graphs of sand, silt and clay percentages for each station were plotted and mapped to compare grain type distribution in the harbors. January, July, and January/July 1978 averages are shown in Figures 3, 4 and 5 respectively. Figure 6 illustrates the 1973-74 data for comparison with 1978. A ternary diagram of January/July averages was plotted in Figure 7 to show percent sand, silt and clay ratios. Using the position of each station on the diagram, types and degrees of sorting can be determined. Linear distances between the stations are related to similarities in composition. Thus, the stations closest to each other are undergoing similar processes and similar sorting results. Stations which occur near the three corners of the triangle tend to be well sorted. The stations occurring near the center have nearly equal proportions of each sediment type and tend to be poorly sorted.

In Figure 8, stations are grouped according to their locations in the harbor. They are separated into Outer Breakwater, Outer Los Angeles Harbor, Channel, Blind Slip, Long Beach Harbor, and Cabrillo Beach area stations. B2 and D10 are considered as individual stations having distinct and unique locations, although they might well be grouped with the blind end slips. In biotic analyses, B2 sometimes groups with outer harbor stations and sometimes with inner harbor sites (see Section IV, this volume).

DISCUSSION

The energy available for sediment transport in the harbor comes from tidal currents, wave action, storm runoff and turbulence (from ships). The breakwater has reduced the amount of wave action and has altered current patterns in the harbor. Average current velocities rarely exceed 1.5

knots. Circulation investigations in 1972 (Soule and Oguri, 1972) in the Los Angeles-Long Beach Harbors found that average current velocities five feet below the surface fell between .052 and .105 meters per second. Current velocities in the harbor, therefore, tend to sort primarily for silt and secondarily for sand. Sand drops out of suspension and is only moved over small distances. Silt tends to be transported to a greater degree. Clay mostly remains in suspension and is flushed out.

The Los Angeles-Long Beach area has a predominantly sand/silt composition. Clay makes up, with a few exceptions, less than 25% of the sediment composition at the stations sampled. Areas with greater percentages of clay are those with reduced circulation or with deeper basins such as dredged channels or borrow sites such as those in Long Beach. Increased rainfall during the winter will increase the input of clay and silt from runoff. In the January distributions, greater percentages of clay are present in the back channels and blind slips which initially receive the runoff. The silt is gradually transported throughout the harbor, and the clay is flushed out or covered up, resulting in an overall silting-up as seen in the July distributions. The overall distribution of sediments does not appear to have changed to any great extent. Average percentages of sand, silt, and clay of samples taken in 1973-1974 during investigations for the Army Corps of Engineers (AHF, 1976) are shown in Figure 6. Comparison with the 1978-79 distributions show little appreciable change in percentages.

The stations outside the breakwater (A1 and B1) are very well sorted for sand (Figure 5). Both stations lie along the paths of ship traffic and tidal currents, where current velocities are among the highest of all the stations under consideration.

Los Angeles Outer Harbor stations are also well sorted for sand. Current velocities are greatest near the openings of the breakwater and within a gyre in the Los Angeles Outer Harbor (Soule and Oguri, 1972; Robinson and Porath, 1974). The surface gyre travels in a clockwise direction, but counterclockwise flow occurs subsurface to some extent. Stations lying in the path of the gyre are more well sorted, and include stations A3, A12, A13, A14, A16 and A17. Figures 7 and 8 illustrate average percentages of sand, silt and clay, and degree of sorting observed.

Stations A2, A4, A15, B8 and B9 appear to be on the periphery of the gyre, where current velocities are lower and more silt tends to accumulate. The higher average percentage of clay at B9 may be the result of the station's proximity to the deep area between the Navy Mole and the breakwater, which acts as a sediment trap for clay and silt.

This served as the borrow site for fill used in construction of Pier J in 1965-1970.

Poorer sorting is also observed in the area near the former cannery outfalls, the treatment plant (TITP) outfall (A7), and the entrance to the seaplane anchorage (A11). Higher average percentages of silt and clay were found at station A7, which is in a shallow (5m), calm depositional area with little wave action and low flushing. Dumping of dredged material and shoreline fill also occurred in the area in the past (AHF, 1976).

About 30 inches of rain fell in January-March 1978, carrying an excessive flow of storm water through the TITP outfall. There was no indication of a buildup of organic debris near the outfall during primary treatment, as indicated by total organic carbon (TOC) measurements (AHF, 1976).

Areas along the main shipping channels, in general, tend to be poorly sorted. Fluctuating levels of turbulence from large ships create rapid increases and decreases in transport energy, resulting in irregular periods of deposition and resuspension of sediment. Poor sorting results and nearly equal proportions of sand, silt, and clay are found. Discrepancies are observed at stations A8, B5, B7, and C4.

Station A8, located at the entrance to the Main Channel, has a greater percentage of sand in July, unlike the trend of siltation discussed earlier. Since the station is in proximity to the Los Angeles outer harbor area it may be influenced by the gyre. If the samples were taken at slightly different locations, some variation may have been introduced since the dolphin marking the station is on the edge of the deeper channel. Stations B5 and B7 had 60-80% sand in 1974. Historically, this was a sandy beach area prior to Port of Long Beach development. The large quantities of water circulated since the Edison Long Beach generating station resumed operation across the Back Channel from station B5 may inhibit silt deposition locally; the plant has a flow capacity of 734 million gallons per day. The entrance to the Southwest Slip and West Basin (C4) is an area that is almost continuously used as a turning basin by large ships. The fine sediments tend to be kept in suspension and to be moved out. Hence, the area is found to be better sorted for sand.

Station B7, in the Cerritos Channel, east of the Heim lift bridge, is an area of higher sorting for silt. The area is deeper (19±m) than much of the channel, so that fine sediments can accumulate. Extensive sediment sampling in the Inner and Back Channels by HEP for a pipeline crossing showed sand along the banks of the channel (AHF, 1976). Blind slips (stations B6, C5, C6, C7 and C8) are, generally, still areas with reduced circulation, and energy to transport sediments is primarily from ship traffic. Therefore, the stations are found to be poorly sorted with, at least, a 50% composition of silt. The percentages of clay are higher in January and are most likely due to increased runoff during the winter. Clay is moved out or covered up, resulting in a general increase of percent silt in July. Stations B2, inside Pier J, and D10 in the City of Long Beach have similar sorting patterns. The Southwest Slip (C5) is an exception, in that it is well sorted for silt. The slip receives runoff from a channel located at its extreme west end. Runoff is a source of sediment, and the flow resulting from the runoff may be responsible for the degree of sorting in the area (AHF, 1976). The area is also a shallower backwash as compared with the deeper West Basin. Long Beach Harbor stations (B3, B10, B11, D1, D2 and D3) are found to be well sorted for silt. Stations B3 and B11 lie along the outside of a 60 foot dredged shipping channel. Station B10 is located near the periphery of the deep area between 60 and 70 feet. Because of the extreme depths of these stations, the tidal currents appear to have less of an effect in terms of sediment transport. Current velocities may be so reduced at the bottom that silt and clay tend to accumulate. Stations D1, D2 and D3 appear to receive large amounts of silt from the Los Angeles River Flood Control Channel. The runoff from the channel fans out in the outer Long Beach Harbor, resulting in a substantial deposition of silt throughout the area.

The Cabrillo Beach area (A9 and A10) has high percentages of silt and clay. Station A9 lies on the edge of a 47 foot dredged channel next to the Union Oil dock. Station A10 is in the marina channel interior to the Union Oil dock. Cabrillo Beach itself receives continuous wave action and is well sorted for sand. The silt and clay particles which are washed out by the wave action may fan out from the shore and be distributed out toward the area of the two stations. The dredged channel could act as a sediment trap. Also, the presence of oil and grease was noted in the analysis of samples from both stations. It is possible that fine sediment is adhering to the oil and is prevented from being washed away. Station A9 was the site of the tanker *Sansinena* explosion and Bunker C spill in December, 1976 (Soule and Oguri, 1978). A significant decrease in percent clay was noted in the July sample at A9. The area was dredged following cleanup of the residual oil to restore the depth for large tanker traffic at the dock. Dredging causes resuspension of fines, and clay would drift out, leaving the silt to be redeposited in the area.

Station B2, located in the Southeast Basin (Pier J) of Long Beach Harbor appears to be sorted for silt. Clay is notably absent, as there are no major sources of runoff from the surrounding land areas. The basin also receives much ship traffic, which provides energy to resuspend and transport fine sediments. Sand and silt tend to remain within the confines of the basin, and any clay that is present is carried out.

Station D10 is located in a small shallow artificial basin near the mouth of the Los Angeles River Flood Control Channel in Long Beach. It appears to receive much silt and clay from unimproved shoreline banks of dredged material. There is little circulation in or out of the area, and hence the fine sediments accumulate and remain in the basin. It is a remarkably rich benthic habitat, however (Section IIIC).

CONCLUSIONS

The Los Angeles-Long Beach Harbors have a basically silt-sand composition, although the proportions and distributions vary according to site. Up to 25 percent clay may be found in blind-end slips and in areas of deeper channels or pockets that are poorly flushed. So-called "borrow" sites, where fill material has been taken creating a pit, may contain finer sediment than the surrounding margins.

The distribution of sand, silt and clay in 1978 has not changed appreciably from those reported for 1973-1974 by Harbors Environmental Projects (AHF, 1976).

Increased runoff during winter rainfall and stirring by winter storms during the first few months of the year created a trend toward siltation from January to July, 1978. During the summer and fall it is postulated that finer surficial material will move down-slope via currents and tides and some of it will leave the harbor. Other fine material will settle into low, poorly flushed pockets which act as traps.

Sediment grain size, coupled with current velocities and organic content of sediments, govern to a large extent the structure and distribution of benthic populations. These factors are discussed in the present volume in the section below on sediment pollutants, and on benthic distributions in the harbors in section IIIC.

SEDIMENT CHEMISTRY

INTRODUCTION

The concentrations of pollutants such as trace metals, oil and grease, and chlorinated hydrocarbons in harbors, estuaries, nearshore waters and around urban effluents have long been of major concern. The survival and growth of particular organisms in a given area may be prevented or inhibited, or, conversely, the living organisms may be little affected themselves but may concentrate specific pollutants biologically to the point that food species become hazardous to the health of human consumers.

It has been very difficult to associate the levels of trace metals, as determined by elemental analysis, with inhibitory effects in the natural environment. Chen (Allan Hancock Foundation, 1976; Chen and Wang, 1976) reviewed the changes made in Environmental Protection Agency dredge disposal criteria, from determination of absolute concentrations, to elutriate tests of the migration of metal ions during resuspension of sediments. The EPA and Army Engineers (1977) have since switched to bioassay methods for predicting the impacts of resuspension (dredging of a given sediment). It was found that correlations with fixed analytical values did not protect particular species or habitats, and synergistic effects of multiple ions in the environment were not predictable, based on separate laboratory tests of individual ions.

The chemistry of metals in the marine benthos is extremely complex. As techniques and detection limits have improved, evidence has suggested that most metal ions are not being passed through food chains, at least in marine waters (Young and Mearns, 1978). Organic mercury, the chlorinated hydrocarbons, and cadmium are probably the important exceptions and can be extremely harmful to a variety of species (Calabrese, Thurberg and Gould, 1977).

In 1972-74, HEP obtained surface samples by box corer throughout the harbor stations and made transects to the seaward side of Santa Catalina Island (Chen and Lu, 1974). At that time some EPA requirements for allowable concentrations of metals in dredge site projects were more restrictive than ambient levels beyond the island. Evidence also indicated that metals, PCB's and DDT were being carried into the deepest parts of the Bight, apparently from the EPA dumpsite off Point Fermin or the Joint Counties Sanitation District plant at Whites Point, or both. Alluvium from the harbors could be plotted near the harbor entrances. The bottom transport of polluted sediments is contrary to studies carried out by agencies, in which flow of the Whites Point effluent was tracked as parallel to the coast, to the west along Palos Verdes Peninsula, and northwest to Redondo Canyon.

In 1975-1976, HEP undertook a series of studies for the Los Angeles Harbor Department, using field tests, elutriate bioassay tests and chemical analyses (Soule and Oguri, 1976; Brewer, 1976; Chamberlain, 1976; McConaugha, 1976; Emerson, 1976; Soule, 1976; Chen and Wang, 1976). Also included were literature reviews of trace metals and chlorinated hydrocarbons in fish (Chen and Eichenberger, 1976) and invertebrates (Reish and King, 1976).

In the present report, surface sediment samples were again taken in 1978 at the regular harbor stations in order to determine existing levels of pollutants, and also to compare them with the earlier data. Analytical methods are summarized in Section I.

Unfortunately, in the decisions on contract scopes among the City of Los Angeles and the Ports, the City chose to have the stations in their project analyzed in part by the city laboratory at Hyperion Treatment Plant, at the City Bureau of Standards laboratory and at SCCWRP laboratories. The Ports elected not to include sediment analyses. Thus HEP was able to carry out only one harbor-wide series of sediment analyses in October 1978 at HEP expense, while the City carried out those for their area (primarily the A stations). The City was provided with samples by HEP from each benthic box core in September 1977, January 1978, and April, July and October 1978; the January and April samples were not analyzed, however.

City analyses were irregular; for example, in one period hydrocarbons were analyzed but not metals, and in another, the reverse. No total organic carbon analyses were done, and samples collected for mercury analyses were mishandled in transfer so that values obtained were several orders of magnitude larger than comparable samples.

METHODS

Sediment samples were obtained with a Reinecke box corer from the R.V. *Vantuna*. The corer samples a 1/16 m^2 of surface to a depth of ½ meter. Cores reach the deck with surface sediments and organisms intact and sediment samples were taken with small plastic cups before the core was extruded. In this way an area untouched by metal parts can be sampled. Duplicate samples were taken and frozen for transport to the respective analytical laboratories. Methods for analysis are summarized in Section I, based primarily on Standard Methods (American Society Public Health, 1971, 1975).

RESULTS AND DISCUSSION

Sediment Pollutant Concentrations

In the outer Los Angeles Harbor A station samples for July 1978, metal pollutants were highest in the shallow water station A4, near Fish Harbor, and at station A7, nearest the Terminal Island Treatment Plant outfall. The oil and grease levels were high at station A9, the Union Oil dock which was the site of the explosion and Bunker C spill of the *Sansinena* in December 1976. Although cleanup measures were thorough, patches of oil remained in December 1977, and pile driving during reconstruction caused refloating of globules of oil (Soule and Oguri, 1978).

Levels of DDT were highest near the entrance of the harbor at A2, indicating an introduction from outside the harbor, presumably from the period of release of DDT at Whites Point outfall (Hershelman, Jan and Schafer, 1977). Maxima for DDT were lower than those recorded in the harbor in 1973-74 (AHF, 1976).

Harbor-wide Survey, October 1978

The October 1978 survey results are presented in Table 2. It was unfortunate that Total Organic Carbon and sulfide were not measured by the City, and their mercury results had to be discarded. However, several trends are clearly discernible.

Following a decade of active, public agency efforts in point source control and a lapse of four-five years since the HEP survey was made (AHF, 1976), it was a matter of some interest to observe the trends in sediment pollutants as found in 1978.

Centers of Pollutant Distribution

Table 3 presents 20 of the parameters measured in rank order of the ten highest stations among the 41 stations analyzed (Figure 1). As explained earlier, all parameters were not anlayzed at all stations, due to jurisdiction of the City of Los Angeles over analysis at most A stations.

In spite of upstream control efforts, station C11, at the entrance of Dominguez Slough, in Consolidated Slip, had the highest pollutant levels in eight of 20 parameters, and was in the top ten in seven others. This indicates that problems still exist from that drainage system in spite of efforts made.

Station B1 was lowest in six parameters. Perhaps one of the greatest surprises lay in the fact that station A4, at the entry of Fish Harbor and near to the TITP outfall, was lowest in four parameters. Station A13, next to the breakwater and Angels Gate, was lowest in four other parameters.

Station A7, nearest the TITP outfall, was not the source of pollutants it was expected to be. It ranked first in cadmium and organic nitrogen levels but appeared among the top ten only for seven other parameters. Stations A4, A7 and A13 are on the periphery of the major gyre, in shoaling waters. They may be cleansed of depositional material, although the organic nitrogen level and the sediment maps of silt would not indicate complete clearing of the A7 area. Other than cadmium, the sewer outfall does not appear to be the problem area that the runoff source areas and industrial docks and slips are.

Distribution Patterns

Figures 9 to 26 are computer maps of the pollutant concentrations found; in these maps the areas where various parameters were not analyzed by City laboratories, the symbol N for "no data" is used.

Computer maps are accompanied by legends which give the ranges in concentrations and histograms of the number of stations having the various concentrations of pollutants.

The inner harbor C station slips and areas downstream of C11 showed high levels of organics, metals, and PCB's. The Los Angeles River and Port of Long Beach areas showed higher levels of arsenic, manganese, and iron than other areas. Table 4 shows the "good news" and the "bad news" regarding changes in levels of pollutants between the 1973-74 survey (AHF, 1976) and the present 1978 survey.

DDT

The contour in the harbor for DDT (Figure 9) clearly indicates that the source is external to the harbor, since station A1 had the highest level. The Whites Point outfall of the Los Angeles County Sanitation Districts was the major source of DDT in the local area until it was controlled and the Montrose chemical plant flow eliminated. The persistence of DDT and its transport into the harbor clearly show that there is coastal water movement to the east, toward the harbor, as well as the flow to the west described by SCCWRP (Hershelman, Jan and Schafer, 1977). According to Schafer (1977) the Whites Point discharge released 21,700 kg per year in 1971, which dropped to 6,600 kg in 1972 and 1,673 by 1976.

The levels of DDT increased by an order of magnitude in 1978 over the 1973-74 levels, but most harbor stations were free of DDT.

Chlorinated hydrocarbons have been implicated in the decline of the brown pelican in the Channel Islands by interfering with egg shell production. Others attribute the pelican decline to declines in the northern anchovy populations on which they feed. Miller and Kinter (1977) reported on inhibition of osmoregulation in fish in the sodium-potassium ATPase activity and amino acid transport. According to them, exposure at the 0.1 ppm level for 24 hours was equivalent to 1.0 ppm exposure at 7 hrs. Dredging in the outer Los Angeles Harbor should not produce concentrations in suspended sediment of DDT sufficient to cause fish distress. Immediate dilutions should prevent significant bioaccumulation.

Decreasing Levels of Pollutants

PCB's. Total polychlorinated byphenyls have decreased fourfold since 1973-74 and have been eliminated from some areas. The industrial blind-end slips seem to retain the highest concentrations, along with the river mouth and sewer outfall (Figure 10).

Recently the federal government has proposed reducing the allowable levels from 5 ppm to 2 ppm in freshwater lake fish, resulting in severe economic impact on the fishing industry. Stringent controls were placed on the use of PCB's in electrical and heat transfer systems (Federal Registry, May 31, 1979). The Highest PCB Levels in harbor sediments were well below 2 ppm, whereas they were above 5 ppm in the 1973-74 study. Cahn, Foehrenbach and Guggino (1977) reported levels as high as 20 to several hundred ppm in several fish species near a General Electric plant north of Albany, New York. Cahn *et al.* (1977) concluded that bottom-living teleosts tend to accumulate PCB's in lipids in the liver, whereas pelagic teleosts accumulate PCB's in the muscle, which has higher lipid levels than does muscle of bottom-living fish.

Vernberg, Guram and Savory (1977) found that exposure of fiddler crab larvae to the PCB's Aroclor 1016 and 1254 produced an LC50 (lethal concentration of 50%) in 96 hours at concentrations in the parts per billion level (10 ppb), whereas adults withstood three weeks of this level. Earlier Vernberg and Vernberg (1970) had illustrated that interactions of multiple stresses in estuaries such as salinity, temperature and pollutants narrow the "biokinetic zone," the range in parameters in which particular species can survive. Mortalities result due to the synergistic effects of multiple stresses.

Cadmium. Levels of cadmium were reduced by 2 to 4 times in the five-year period. The highest level of 2.62 occurred at the sewer outfall (Figure 11).

Cadmium, at doses of 0.8-8.0 mg/l, can cause larval fishes to die rapidly with no indication of irritability prior to death, while a dose of 0.3-0.7 mg/l causes disoriented swimming prior to death (Middaugh, Davis, and Yoakum, 1975). A high does, 48 ppm, can cause serum abnormalities and at a lower dose of 3 ppm, reduced gill-tissue oxygen consumption can occur (Calabrese, Thurberg, and Gould, 1977).

Accumulation of cadmium through the gills and egg membrane tends to be insignificant in fishes, which may be why larval fishes are less sensitive to this metal than to other contaminants (Pentreath, 1975). Fishes that migrate through estuaries, such as whiting, coho salmon, and striped bass, have high tolerances for heavy metals, reflecting their ability to adapt readily to environmental changes (Calabrese *et al.*, 1977; Badsha and Sainsbury, 1977; Schreck and Lorz, 1978).

Species that feed on crustaceans accumulate more cadmium than those that eat fishes. In 73% of samples from blue sharks (*Prionace glauca*) examined by Stevens and Brown (1974), the cadmium content of the muscles was below detectable limits. The metal did occur in their food fish, especially those from estuaries. High cadmium levels have been found in European flounders, snailfish (*Liparis liparis*), bearded rockling (*Ciliata mustela*), and poor cod (*Trisopterus luscus*) which eat up to 90% crustaceans. Grey mullet (*Liza ramada*) and sand goby from the same estuaries had low cadmium contents, probably due to the low amounts of crustaceans in their diets (Hardisty, Kartar, and Sainsbury, 1974). The content of cadmium of Pacific hake probably comes from their diet of euphausiids (Cutshall, 1977). A possible exception to the general rule of uptake from crustacean prey is the Arctic cod (*Boreogadus saida*), in which the cadmium content of the prey, copepods, was higher than that of the cod (Bohn and McElroy, 1976).

Cadmium is absorbed efficiently by crustacean species which are eaten by fishes. In both green crabs (*Carcinus maenas*) and euphausiids, 10% of the cadmium ingested with radioactively labelled prey (*Artemia salina*) was incorporated into the internal tissues of the predators (Jennings and Rainbow, 1979; Benayoun, 1975). In small, filter-feeding crustaceans such as *A. salina*, cadmium may be acquired by the passage of water through the digestive tract during feeding (Jennings and Rainbow, 1979). Cadmium is concentrated in the digestive gland and other digestive organs of crustaceans.

In fishes, cadmium tends to accumulate in the liver, gut, and skin (Stevens and Brown, 1974; Bohn and McElroy, 1976; Pentreath, 1977). The uptake is slow, coming largely from ingestion of food (Pentreath, 1977; Calabrese *et al.*, 1977). The metal can be lost quickly through defecation. If assimilated into tissues, however, it can have a half-life in flatfish (*Pleuronectes platessa*) of 98-204 days (Pentreath, 1977). In whiting, levels of cadmium increase as the fish move up estuaries, but depletion of fat reserves used in the migration later causes cadmium levels to fall (Badsha and Sainsbury, 1977), indicating that cadmium is not retained permanently. As might be expected, levels of cadmium are higher in nearshore and estuarine fishes than in oceanic species (Stevens and Brown, 1974).

Since the harbor fishes near the outfall feed on benthic polychaetes, it is not known whether they bioaccumulate. High levels of cadmium were found in anchovy gonads several years ago (HEP unpublished data).

While laboratory tests of separate chemicals often produce lethal or sublethal effects, many of the metals complex chemically to sediments in ways that prevent or limit bioavailability in the natural environment. Reish, Rossi, Mearns, Oshida and Wilkes (1979) reviewed recent literature on marine and estuarine pollution, and tabulated referenced data on concentrations in marine species around the world. Also tabulated were experimental effects on marine organisms.

Total Organic Carbon. Although data are incomplete because the City does not analyze for Total Organic Carbon, it appeared that TOC levels decreased somewhat in the harbor, but the absence of A station data makes this questionable. However, station D2 in the river plume was highest in 1973-74 with 2.2 ppm and was down to 0.34 ppm in 1978, so the decline may be real. The river area, flushed by winter storms, may have been reduced more than other areas (Figure 12).

Sulfide. A considerable drop in sulfide of 10 to 100 times apparently occurred. Lack of analysis of A stations hampers this conclusion, for A8 was highest in sulfide in the earlier period, along with the mouth of the Los Angeles River. The river stations D1, 2 and 3 do not appear in the top 10, but the cul-de-sac station D10 did (Figure 13). The decrease there was about tenfold.

Mercury. Mercury levels (Figure 14) apparently dropped somewhat; the minimum was 10 times lower in 1978 than in 1973-74. However, the peak stations in 1973-74 were at A5 and A6 (4.17 and 2.10 ppm respectively) inside Fish Harbor, and these stations, along with other A stations, were not analyzed in the 1978 study. In 1973-74, the mercury level was 2.83 at C8, whereas the value was 1.78 in 1978. The literature on mercury and its chemical species is voluminous. Methyl mercury is extremely toxic.

Nickel. Nickel levels were down about one-third at the upper values to one-half at the minimum values of the range (Figure 15). Reish *et al.* (1979) reported experimental LC50's of gammarid amphipods at as low as 0.15 ppm, but fish and invertebrates tested ranged from 6 to 350 ppm for LC50.

Lead. While the upper levels of lead did not vary appreciably (Figure 16), the minimum level dropped more than tenfold from 1973-74. Experimental data has indicated that some types of lead suppressed photosynthetic activity and reproduction; in other types, no effects were seen. The LC50 of the harbor species of polychaete *Ctendrilus serratus* was 14 ppm (Reish, 1977).

Increasing Levels of Pollutants

Increases in some pollutants may reflect the increased handling of petroleum cargo in the ports, changes in the waste treatment, or other factors which cannot be explained on the basis of available data.

Total Volatile Solids. The maximum value increased by about 30% but the number is probably not of great importance since in both periods it occurred at runoff sites, stations D2 and C11 (Figure 17). Station D2 was suspect in 1973-74, because it was also the highest in Total Organic Carbon, in Chemical Oxygen Demand, sulfide and lead. Enforcement of prohibitions on dumping waste oil and industrial wastes into storm drains is difficult; a walk up the river bed in 1976 showed oily wastes and chemicals entering through drains. Natural flushing of streets and parking lots carries much oil and lead from gasoline into the drainage system.

Control efforts have apparently been effective for the river, because Dominguez Slough has largely taken over the top of the list in these parameters. Heavy river flow, with 30± inches of rain in the winter of 1977-78 may well have flushed heavily polluted sediments out of the D2 area.

Oil and Grease. Oil and grease levels have increased two- to seven-fold or more in some areas of the harbor; station C11 was the highest in 1978 and six stations had higher levels than the maximum at C8 in 1973-74. Station C11 had 1530 ppm in 1973-74 and 21,500 in 1978. Other areas of the harbor showed about tenfold decreases, however (Figure 18).

Phosphorus. Although lower phosphate detergents have been in use, phosphorus maxima increased but minima decreased (Figure 19). In 1973-74, the highest phosphorus levels were found at the mouth of the San Gabriel River and along the Long Beach City breakwater at D stations not surveyed in 1978. The unexpectedly high phosphorus (5400 ppm) at station A9 is at the site where the tanker *Sansinena* exploded in December 1976. The next highest is near the sewer outfall at A7; values were more than double those found nearby at stations A3, 4, 5, 6 and A11 in 1973-74. The increase in phosphorus did not result in increased phytoplankton (Soule and Oguri, 1979).

Organic Nitrogen. The highest value (2730 ppm) was near the sewer outfall (A7), and was almost three times higher than the highest value for Org-N in 1973-74. Station A7 was not sampled in 1973-74 because the R.V. *Velero* could not enter the 5m deep area. In spite of the large quantities of fish cannery waste and primary treated sewage entering the outer harbor in 1973-74, levels at A4, A5, A6 and A11 were in 200-400 ppm range and did not approach the 953 ppm found at C8 in the inner harbor.

The 30-fold drop in bacteria in 1978 (Soule and Oguri, 1979) may have altered the biochemical patterns in degradation of organic wastes and caused an increase of organic nitrogen rather than a decrease. Large drops in benthic populations and phytoplankton, discussed in Soule and Oguri (1979) and in this report may result in a build-up in organic nitrogenous material near the outfall (Figure 20).

Arsenic. Arsenic increased from seven to twenty-fold in the harbor, although analyses for most A stations were not carried out and thus the incomplete data were not mapped. In 1973-74 (AHF, 1976) arsenic was highest near a grain terminal (C9) and at C7, 8 and 11, and B6. The pattern differed in 1978, with much higher levels at stations B2, 3, 4 and 5 and at the D stations. Arsenic is bioaccumulated by sharks, skates and certain other fish species (Chen and Eichenberger, 1976). HEP investigators found an absence of benthic infaunal sediment feeders and bottom-feeding fish at an outfall carrying arsenic near C7 in 1974, but benthic epifauna and pelagic fish were normal. Invertebrates did not apparently bioaccumulate.

Chromium. While the maximum level of chromium in the harbor increased about 30% (Figure 22) , the minimum level was about 50% lower than previously. The C station area continued to have the highest concentrations, followed by stations B6 and 7 in the inner harbor, and at B10 and B11 and A10 in the outer harbor. While station A10 is near a boat yard, B10 and 11 are in open waters; concentrations may represent the drifting of polluted bottom sediments to deeper waters. Chromium is bioaccumulated by some fish species (Chen and Eichenberger, 1976).

Iron. The concentrations of iron rose over the five-year period. Highest levels were in the areas of stations B2, B3, B4, B6, B7 and B11 and D2 in Long Beach just as they were in 1973-74 and at A10, but stations C2 and C5 have shown relative increases (Figure 23). The iron may not be biologically active, but high levels are found in some invertebrates (Reish and King, 1976).

Manganese. The maxima for manganese (Figure 24) almost doubled, while the minimum was somewhat lower in 1978 than in 1973-74. The pattern of distribution almost the same as for iron in the Long Beach area.

Zinc. Zinc was highest at station C11 and other inner harbor C stations plus B6 and 7. In the outer harbor the sewer outfall was a source, and levels were high at A9 and A10. The maximum at C11 was 3.5 times higher than it was at C11 in 1973-74. Harbor levels are two- or three-fold higher than experimental LC50 levels in static bioassays, but effects in the harbor have not been demonstrated. Reish and Carr (1978) recorded suppression of reproduction and of withdrawal responses in polychaetes in laboratory tests.

Non-Definitive Changes

Chemical Oxygen Demand. Chemical Oxygen Demand (COD) is a general measure of pollutant inputs which oxidize when sediments are exposed to aerobic conditions. Resuspension of anaerobic sediments, or effluents containing materials with high oxygen demand, can seriously deplete the dissolved oxygen in the water column.

The range of COD levels in the harbor (Figure 25) is slightly decreased in 1978 from the range in 1973-74, but the difference is not sufficient to be definitive.

Copper. The range in copper concentrations was slightly lower in 1978 than in 1973-74, but the difference may not have been definitive. Reish *et al.* (1979) reviewed literature on copper concentrations in marine organisms. Fish apparently bioconcentrate copper, but invertebrates approach ambient concentrations (Chen and Eichenberger, 1976; Reish and King, 1976).

CONCLUSIONS

There were improvements in levels of some pollutants in the harbor in 1978 over the conditions reported in 1973-74. The levels of PCB's were clearly lower, as were those of cadmium, copper, nickel and lead. For several other parameters, data for A stations were incomplete, but it appeared that there were decreases in total organic carbon and mercury; more important was an apparent decrease in sulfide by about an order of magnitude. A slight decrease in chemical oxygen demand may have been within the range of variation.

While the maximum DDT level increased at the Los Angeles entry to the harbor, DDT's were eliminated altogether from most of the harbor. DDT had been high at Dominguez Channel in 1973-74. The increases in other pollutants reflect in part increased petroleum shipping, with large increases in oil and grease and a lesser increase in total volatile solids. Other increases in maxima were found in immediate oxygen demand, total phosphorus, organic nitrogen, arsenic, chromium, iron, manganese and zinc.

The decrease in sulfide may have influenced improvement in biota in blind-end slips. Prior to 1973-74, "white tides" of colloidal sulfur, released from sulfide bacterial blooms, occurred in areas having anoxic sediments. No such events have occurred since that period.

Clearly, there is considerable room for improvement in pollutant levels in the harbors. However, results of bioassay tests in other studies (Soule and Oguri, 1976; HEP, 1979) have indicated that concentrations of metals may not be directly related to the effects of contaminated sediments on organisms, and that sediments are rarely toxic to the hardy harbor species.

Distribution patterns, illustrated by computer maps for 1978 data, when compared with similar maps published in AHF (1976), show that there have been changes in centers of heavy concentrations for some parameters, while others have remained about the same. The sources of some parameters can be associated with specific past or present industrial activities other than runoff or waste effluents.

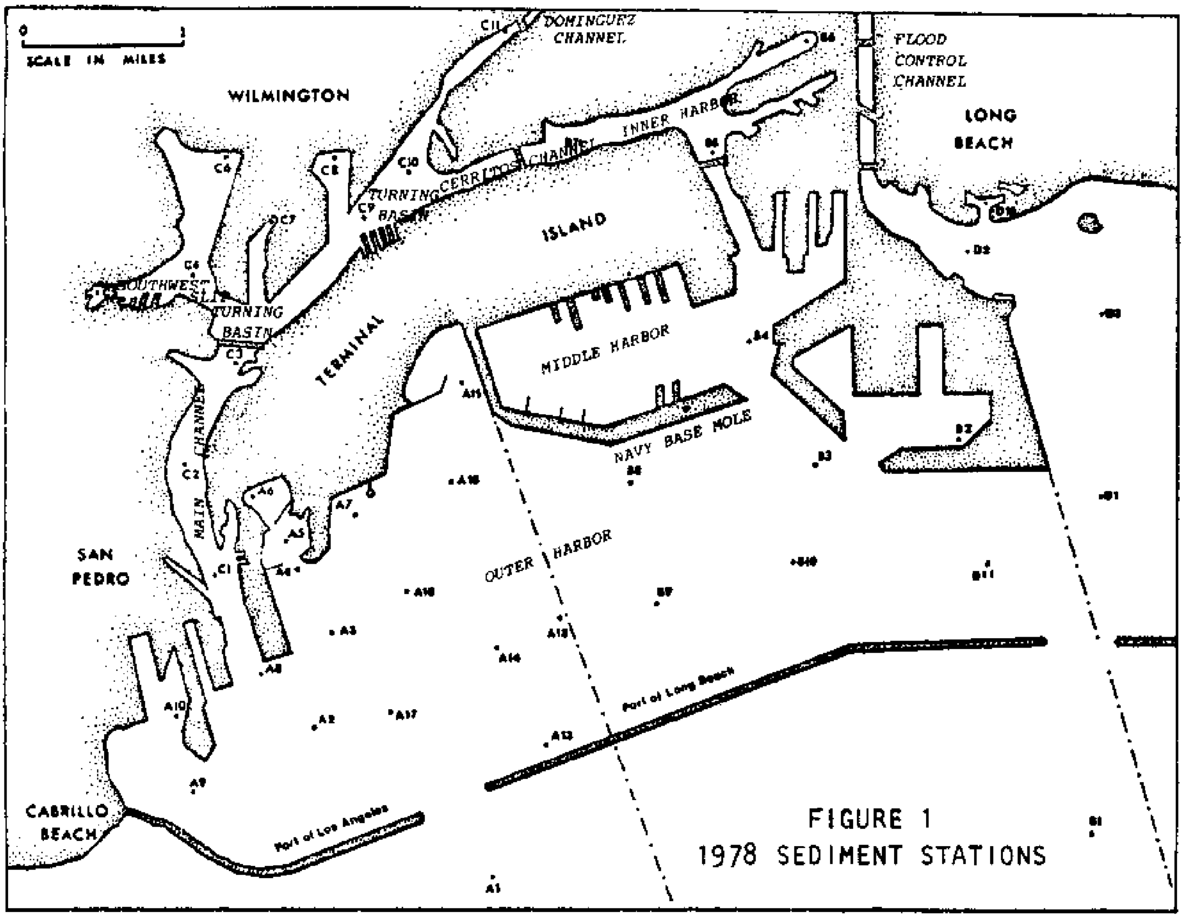


FIGURE 1
1978 SEDIMENT STATIONS

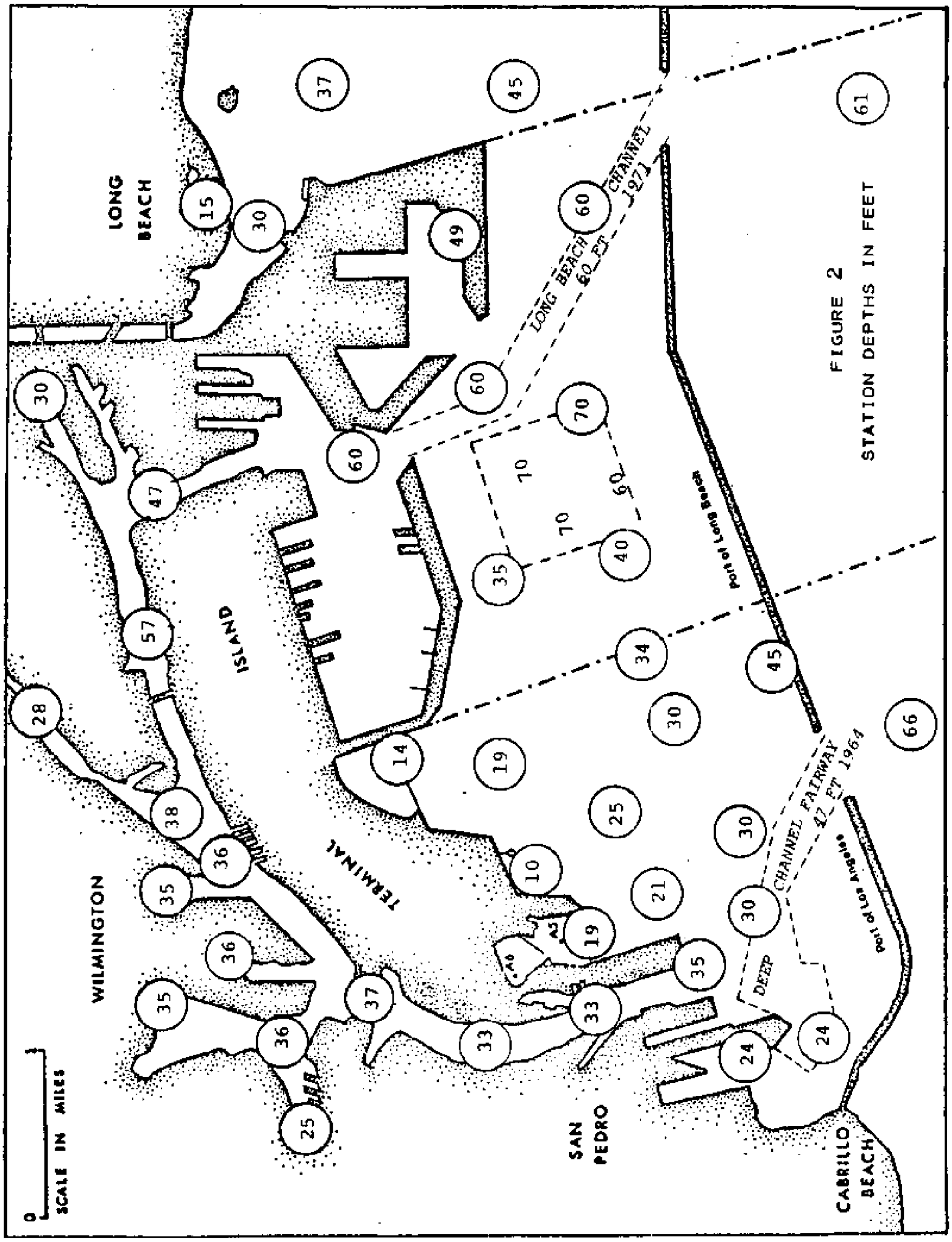


FIGURE 2
STATION DEPTHS IN FEET

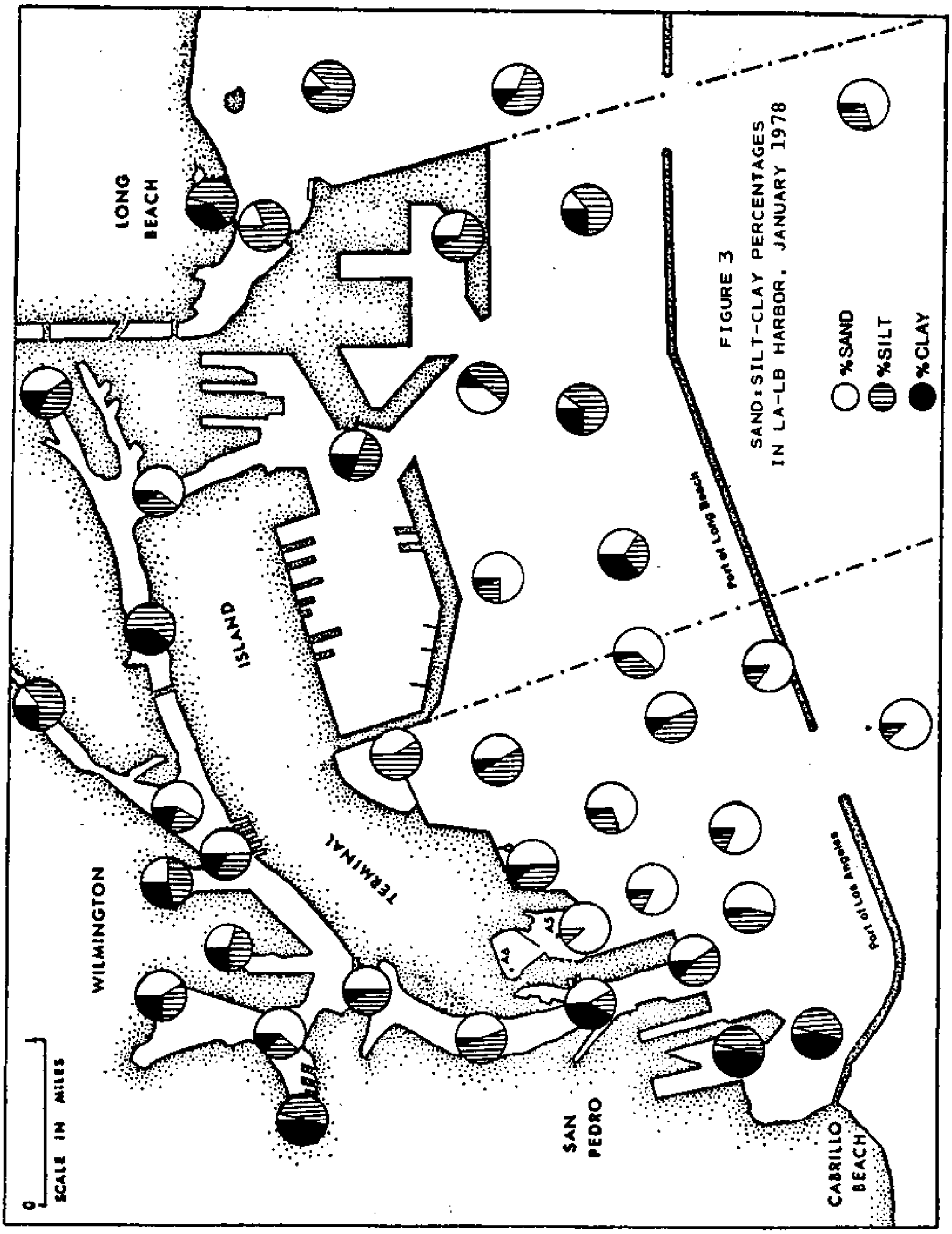


FIGURE 3
SAND:SILT-CLAY PERCENTAGES
IN LA-LB HARBOR, JANUARY 1978

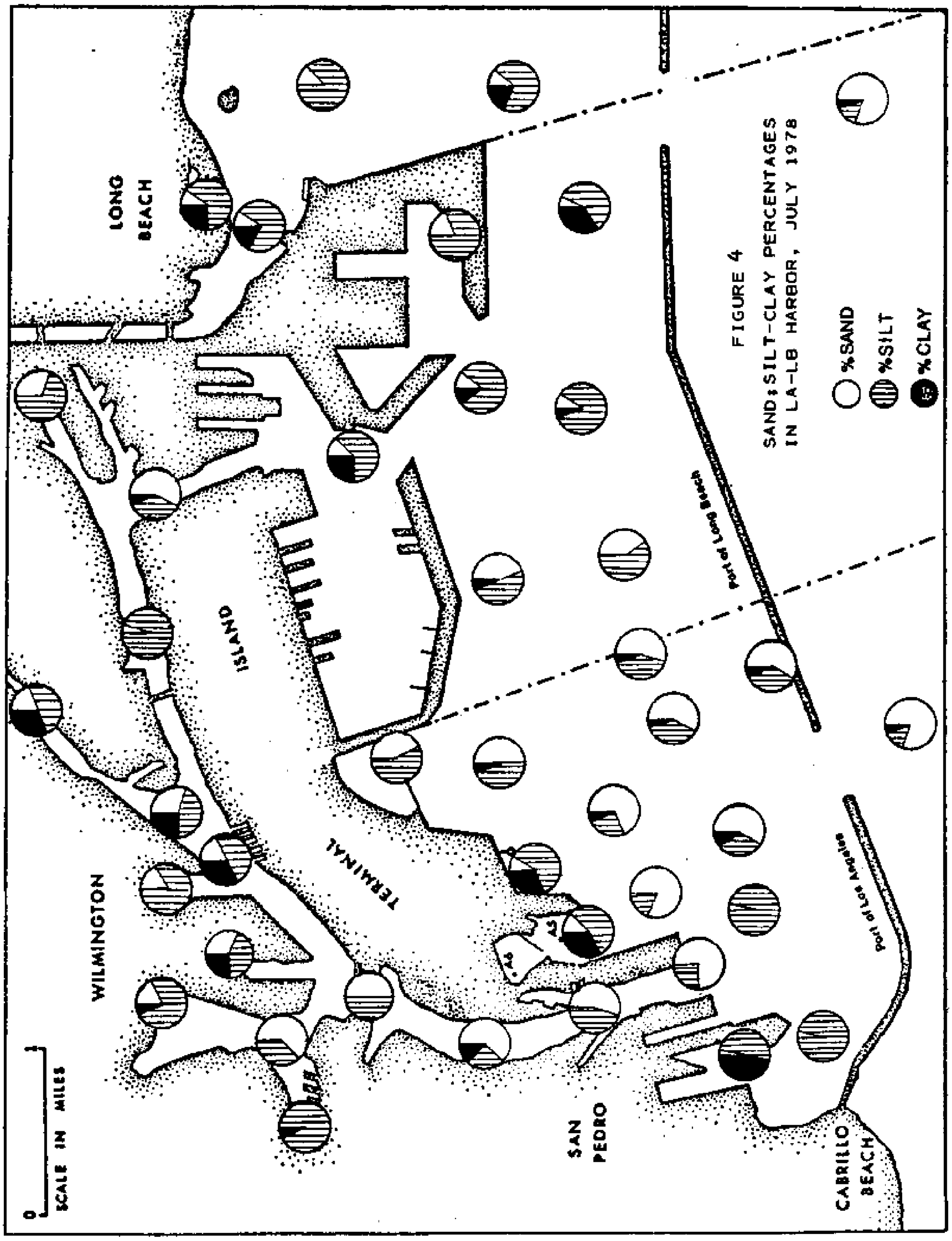


FIGURE 4
SAND:SILT-CLAY PERCENTAGES IN LA-LB HARBOR, JULY 1978

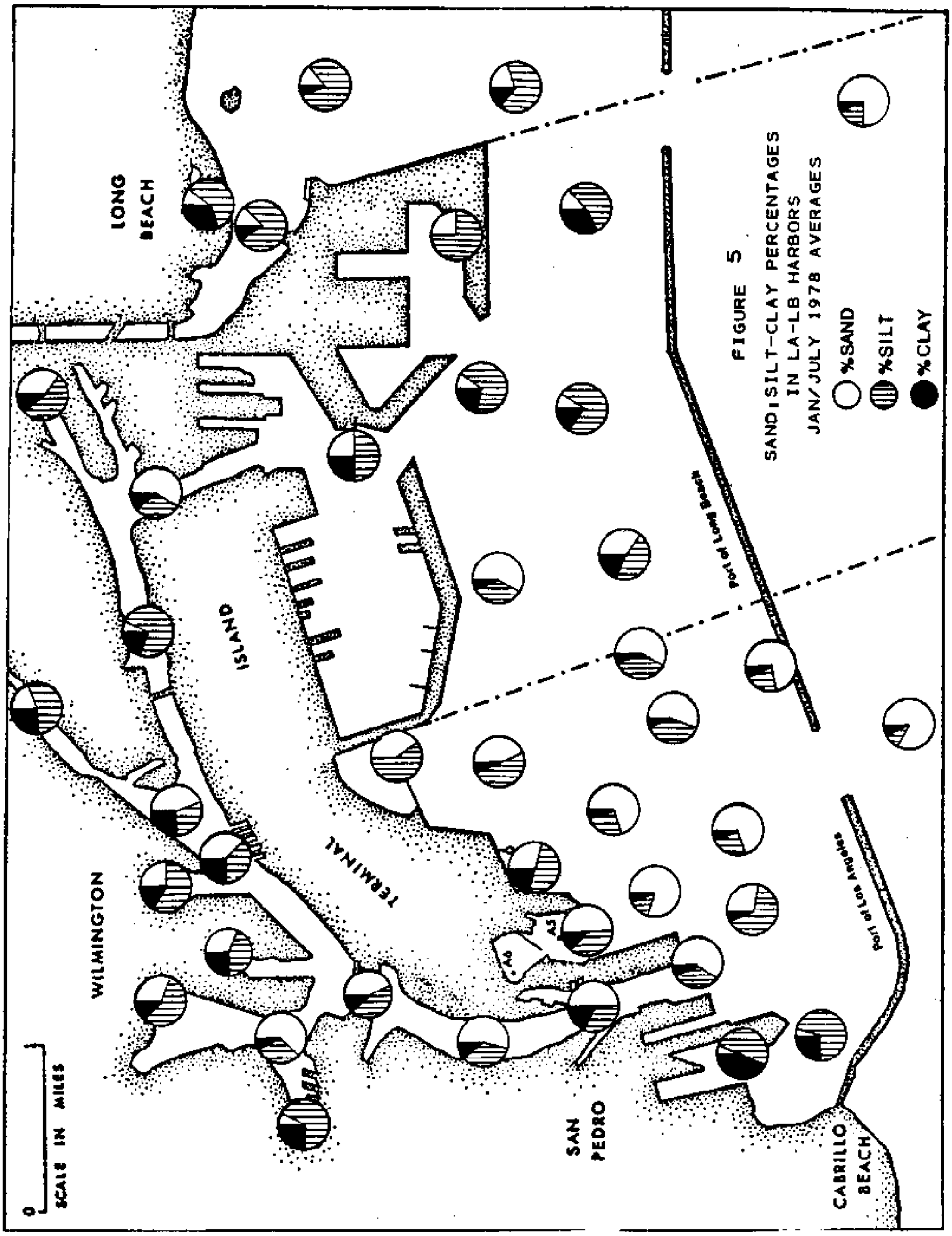


FIGURE 5
SAND, SILT-CLAY PERCENTAGES IN LA-LB HARBORS JAN/JULY 1978 AVERAGES

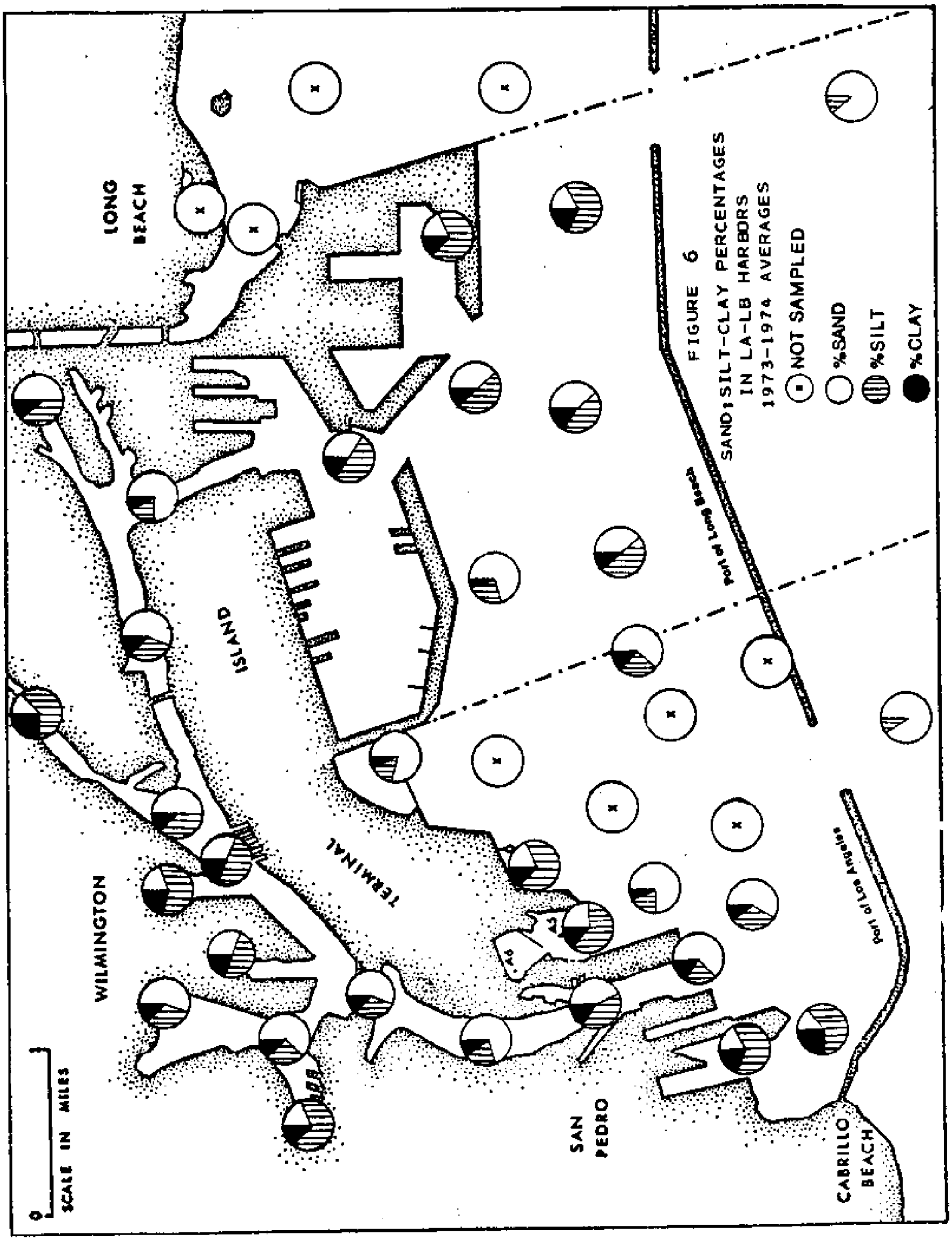


FIGURE 6
SAND:SILT-CLAY PERCENTAGES IN LA-LB HARBORS 1973-1974 AVERAGES

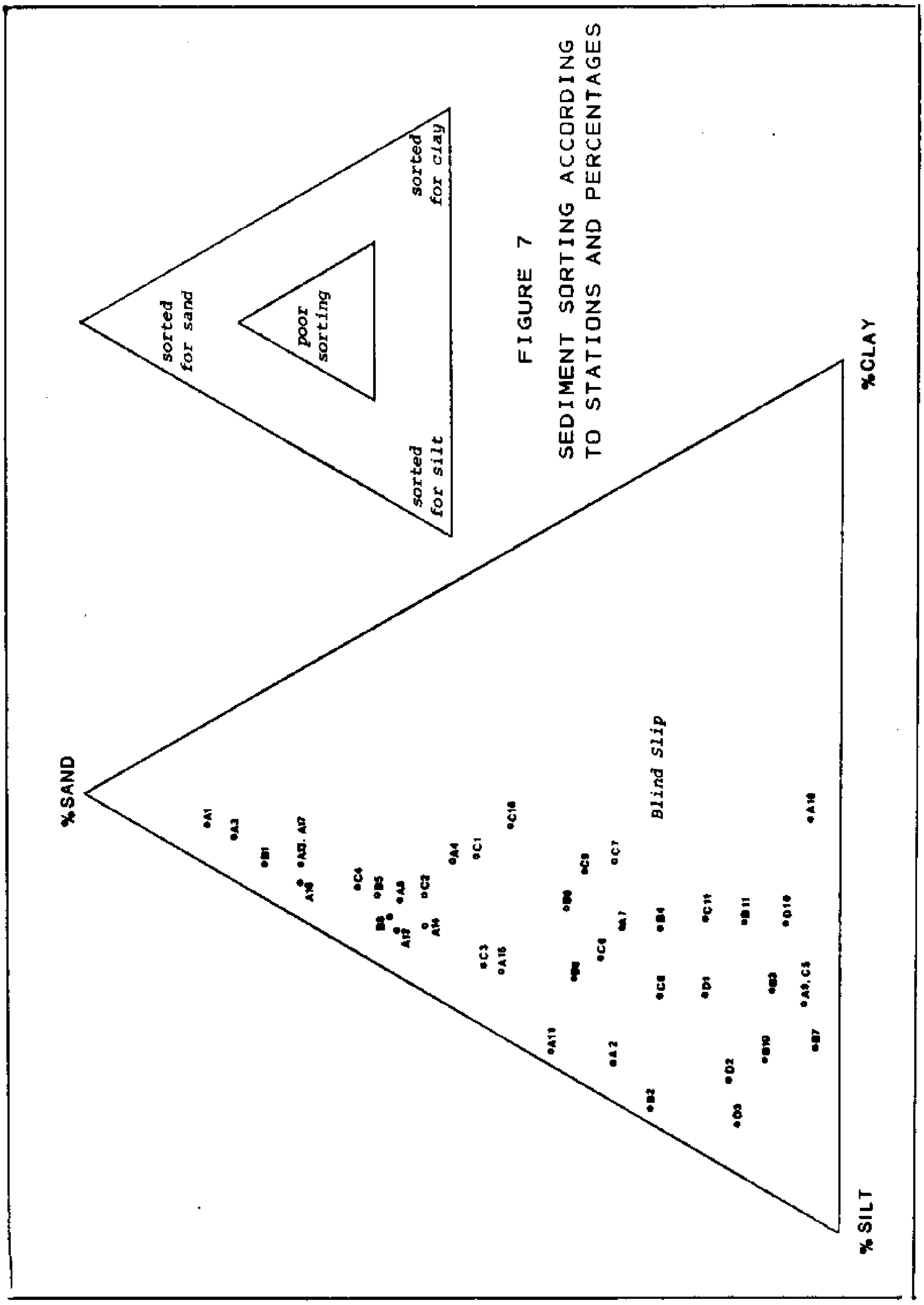


FIGURE 7
SEDIMENT SORTING ACCORDING TO STATIONS AND PERCENTAGES

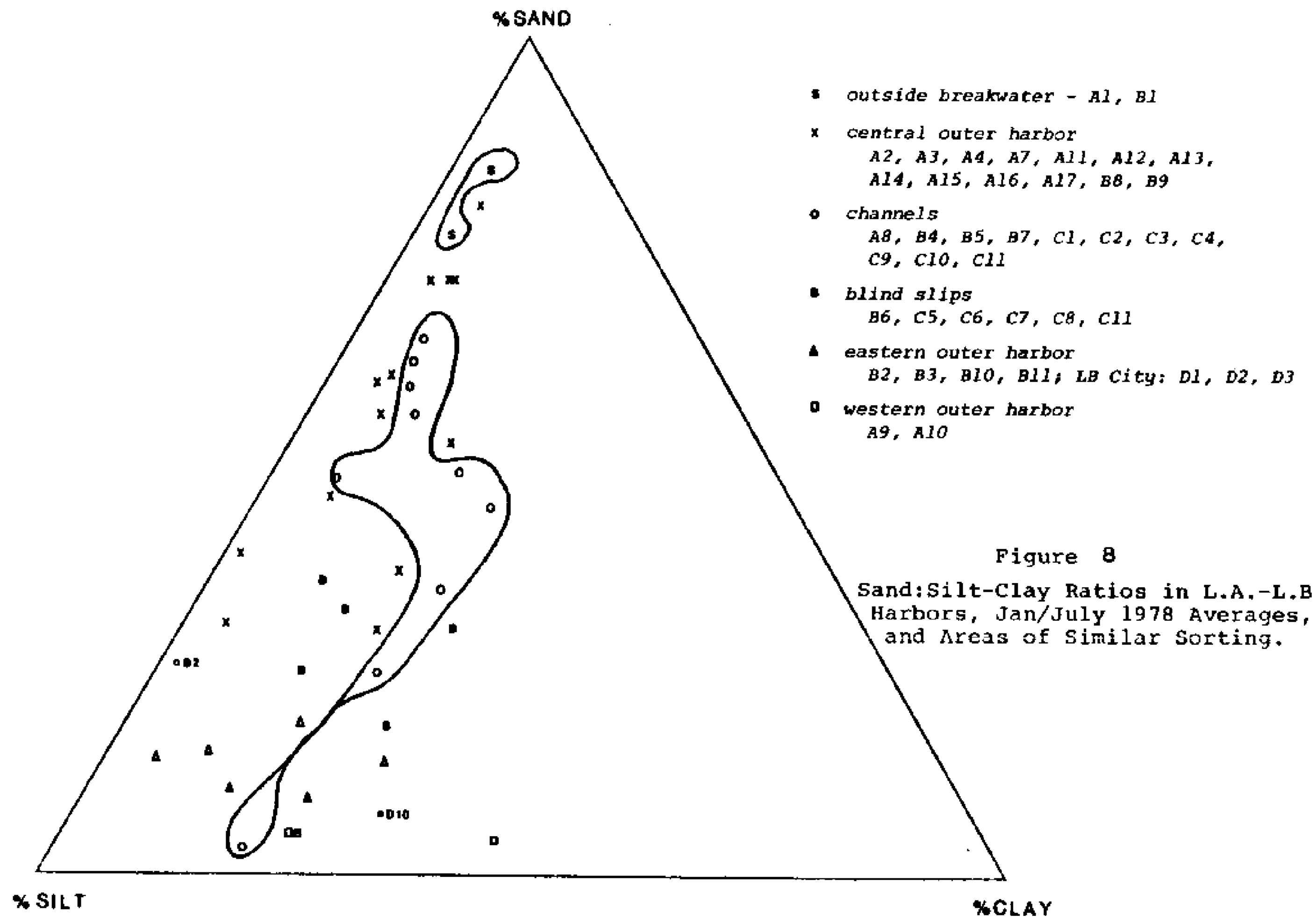


Figure 8

Sand:Silt-Clay Ratios in L.A.-L.B. Harbors, Jan/July 1978 Averages, and Areas of Similar Sorting.

FIGURE 9. TOTAL DDT
OCTOBER 13, 1978
DATA VALUE EXTREMES: 0.0-0.59

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.06	0.12	0.18	0.24	0.29	0.35	0.41	0.47	0.53
MAXIMUM	0.06	0.12	0.18	0.24	0.29	0.35	0.41	0.47	0.53	0.59

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL         1          2          3          4          5          6          7          8          9          10
          ===================================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ####9####  ####*####
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  #########  #########
          ===================================================================================================================
FREQ.         28         3          0          2          2          2          0          1          1          2
       1  I..1..I    I''2''I               I==4==I    I++5++I    IXX6XXI               I88888I    I##9##I    I##*##I
       2  I..1..I    I''2''I               I==4==I    I++5++I    IXX6XXI                                     I##*##I
       3  I..1..I    I''2''I
       4  I..1..I
       5  I..1..I
       6  I..1..I
       7  I..1..I
       8  I..1..I
       9  I..1..I
      10  I..1..I
      11  I..1..I
      12  I..1..I
      13  I..1..I
      14  I..1..I
      15  I..1..I
      16  I..1..I
      17  I..1..I
      18  I..1..I
      19  I..1..I
      20  I..1..I
      21  I..1..I
      22  I..1..I
      23  I..1..I
      24  I..1..I
      25  I..1..I
      26  I..1..I
      27  I..1..I
      28  I..1..I
```

0.515671 MINUTES FOR HISTOGRAM

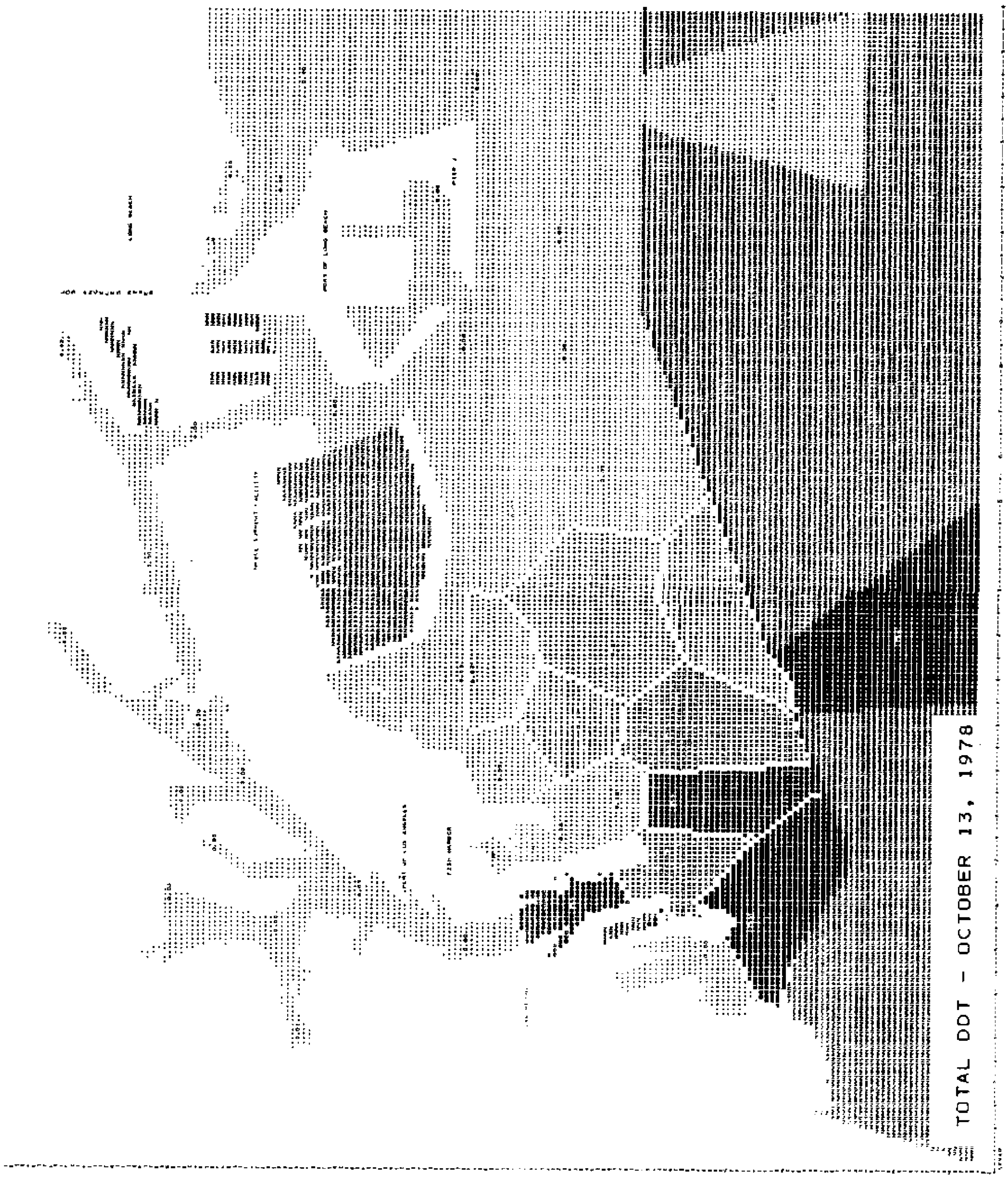

TOTAL DDT - OCTOBER 13, 1978

FIGURE 10. TOTAL PCB'S
OCTOBER 13, 1978
DATA VALUE EXTREMES: 0.0-1.25

```
TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0       0.12      0.25      0.37      0.50      0.62      0.75      0.87      1.00      1.12
 MAXIMUM     0.12      0.25      0.37      0.50      0.62      0.75      0.87      1.00      1.12      1.25

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             10.00     10.00     10.0C     10.00     10.00     10.00     10.00     10.00     10.00     10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL           1         2         3         4         5         6         7         8         9        10
          ====================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
 SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  EEEE9EEEE  ####*####
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
          ====================================================================================================
 FREQ.          29         4         4         2         1         0         0         0         0         1
       1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I                                             I##*##I
       2   I..1..I   I''2''I   I--3--I   I==4==I
       3   I..1..I   I''2''I   I--3--I
       4   I..1..I   I''2''I   I--3--I
       5   I..1..I
       6   I..1..I
       7   I..1..I
       8   I..1..I
       9   I..1..I
      10   I..1..I
      11   I..1..I
      12   I..1..I
      13   I..1..I
      14   I..1..I
      15   I..1..I
      16   I..1..I
      17   I..1..I
      18   I..1..I
      19   I..1..I
      20   I..1..I
      21   I..1..I
      22   I..1..I
      23   I..1..I
      24   I..1..I
      25   I..1..I
      26   I..1..I
      27   I..1..I
      28   I..1..I
      29   I..1..I

0.476807 MINUTES FOR HISTOGRAM
```

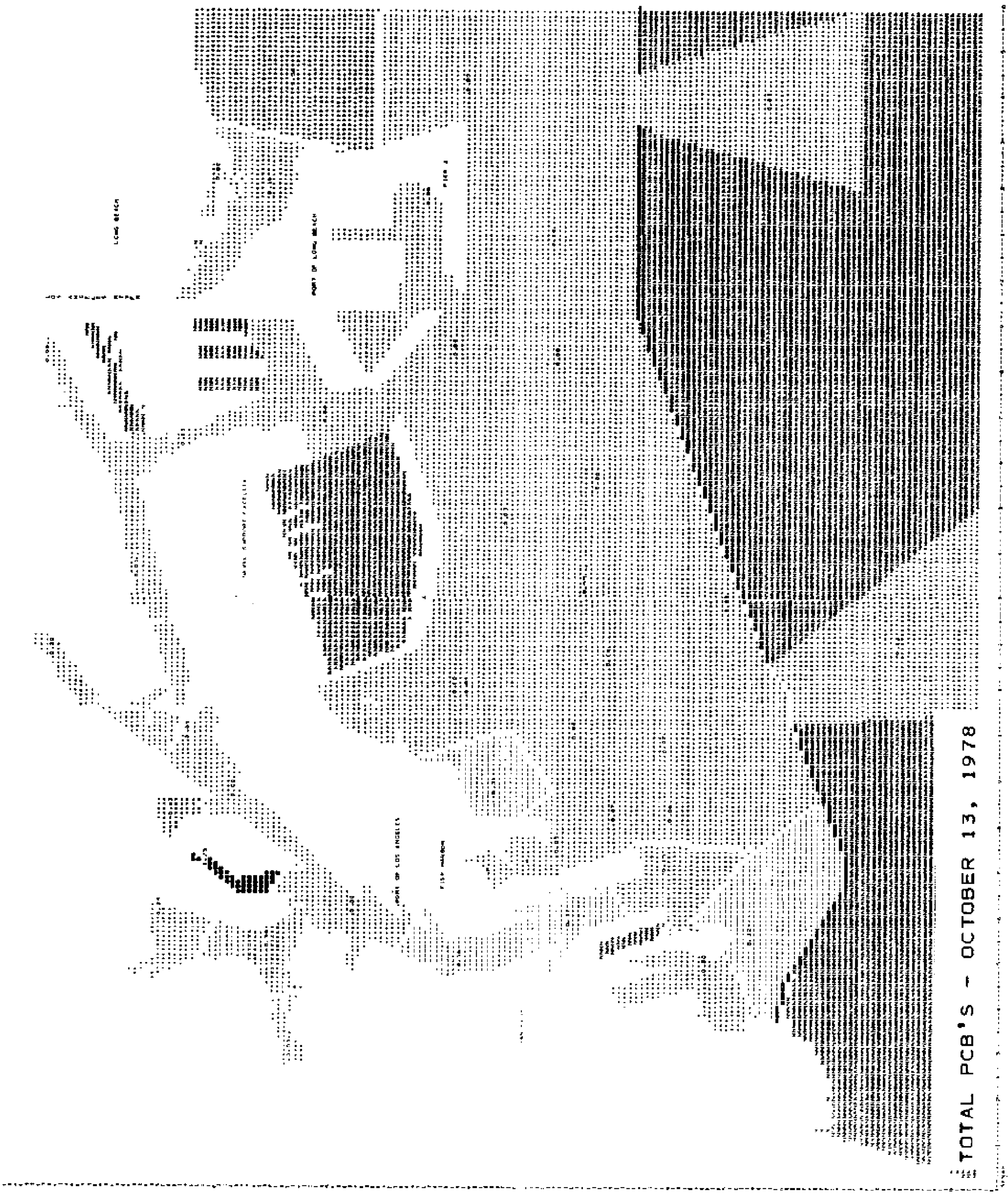

TOTAL PCB'S - OCTOBER 13, 1978
LONG BEACH
PORT OF LONG BEACH
PORT OF LOS ANGELES
FISH HARBOR

FIGURE 11. CADMIUM
OCTOBER 13, 1978
DATA VALUE EXTREMES: 0.30-2.62

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

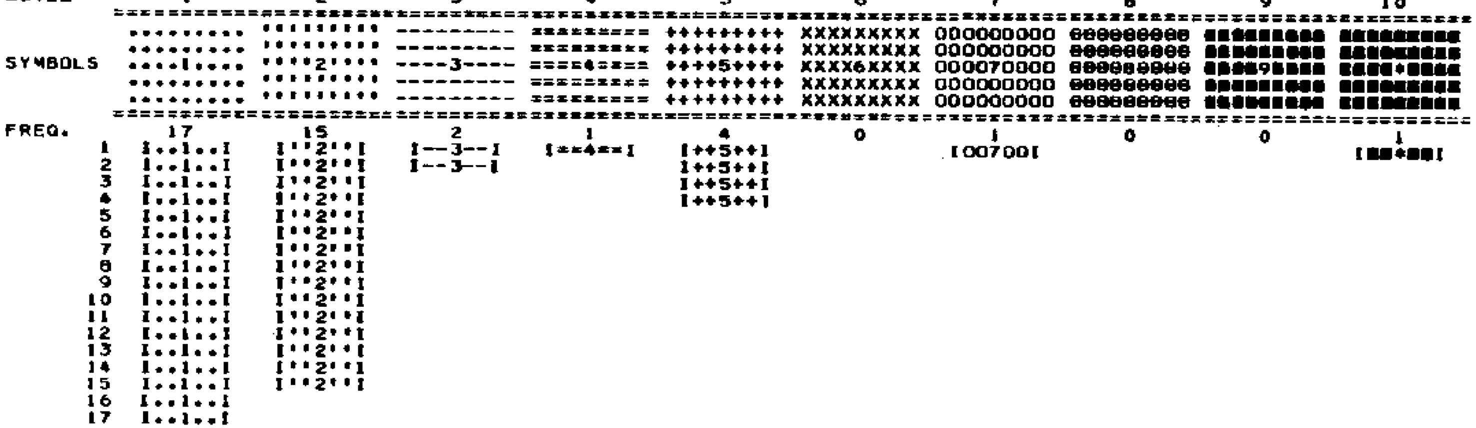
MINIMUM	0.30	0.53	0.76	1.00	1.23	1.46	1.69	1.92	2.16	2.39
MAXIMUM	0.53	0.76	1.00	1.23	1.46	1.69	1.92	2.16	2.39	2.62

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

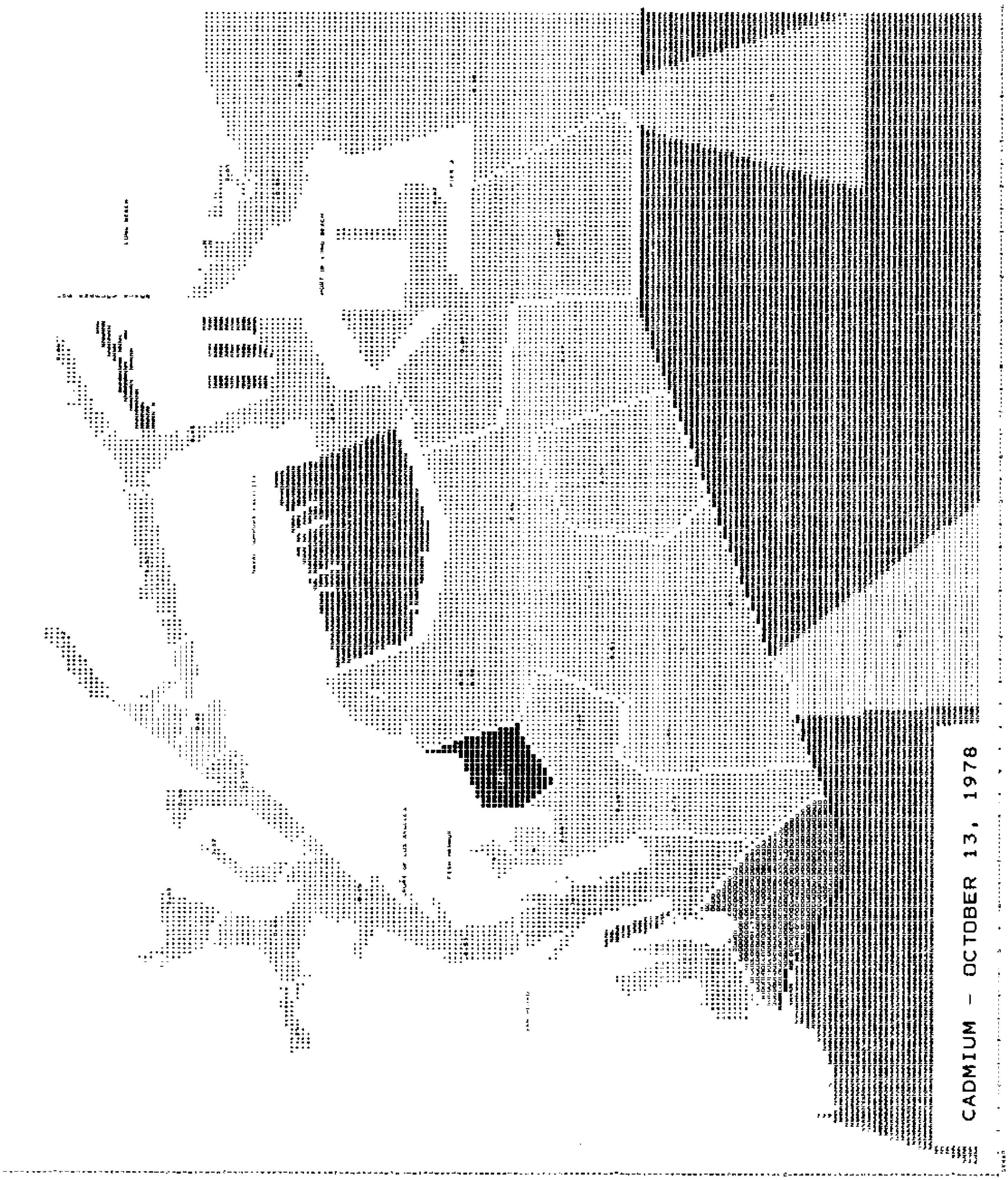
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	17	15	2	1	4	0	1	0	0	1



0.419922 MINUTES FOR HISTOGRAM



CADMIUM - OCTOBER 13, 1978

FIGURE 12. % TOTAL ORGANIC CARBON
OCTOBER 13, 1978
DATA VALUE EXTREMES: 0.26-1.67

```
TOTAL MISSING DATA POINTS IS        16


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.26      0.40      0.54      0.68      0.82      0.96      1.11      1.25      1.39      1.53
 MAXIMUM      0.40      0.54      0.68      0.82      0.96      1.11      1.25      1.39      1.53      1.67

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9         10
          ==========================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  EEEE9EEEE  ####+####
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  EEEEEEEEE  #########
          ==========================================================================================================
 FREQ.          8         9         3         1         2         0         0         1         0         1
       1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I                       I888888I             I##+##I
       2   I..1..I   I''2''I   I--3--I             I++5++I
       3   I..1..I   I''2''I   I--3--I
       4   I..1..I   I''2''I
       5   I..1..I   I''2''I
       6   I..1..I   I''2''I
       7   I..1..I   I''2''I
       8   I..1..I   I''2''I
       9             I''2''I

0.295471 MINUTES FOR HISTOGRAM
```

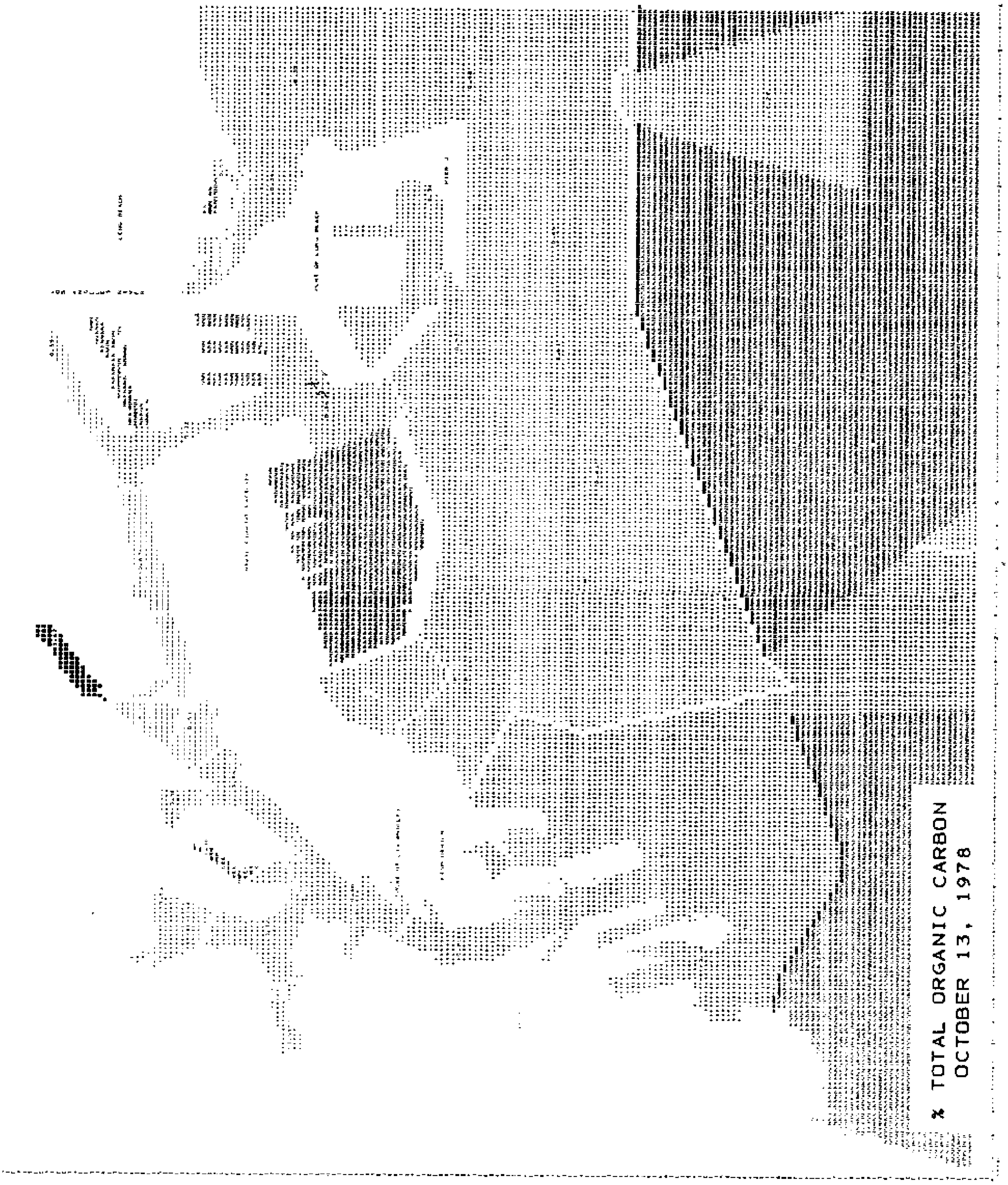

% TOTAL ORGANIC CARBON
OCTOBER 13, 1978

FIGURE 13. SULFIDE
OCTOBER 13, 1978
DATA VALUE EXTREMES: 108.00-473.00

TOTAL MISSING DATA POINTS IS 18

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	108.00	144.50	181.00	217.50	254.00	290.50	327.00	363.50	400.00	436.50
MAXIMUM	144.50	181.00	217.50	254.00	290.50	327.00	363.50	400.00	436.50	473.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9         10
         ==========================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
SYMBOLS   ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
         ==========================================================================================================
FREQ.       12          9          1          1          0          0          0          1          0          1
      1  I..1..I    I''2''I    I--3--I    I==4==I                                     I888888I              I■■+■■I
      2  I..1..I    I''2''I
      3  I..1..I    I''2''I
      4  I..1..I    I''2''I
      5  I..1..I    I''2''I
      6  I..1..I    I''2''I
      7  I..1..I    I''2''I
      8  I..1..I    I''2''I
      9  I..1..I    I''2''I
     10  I..1..I
     11  I..1..I
     12  I..1..I
```

0.348907 MINUTES FOR HISTOGRAM

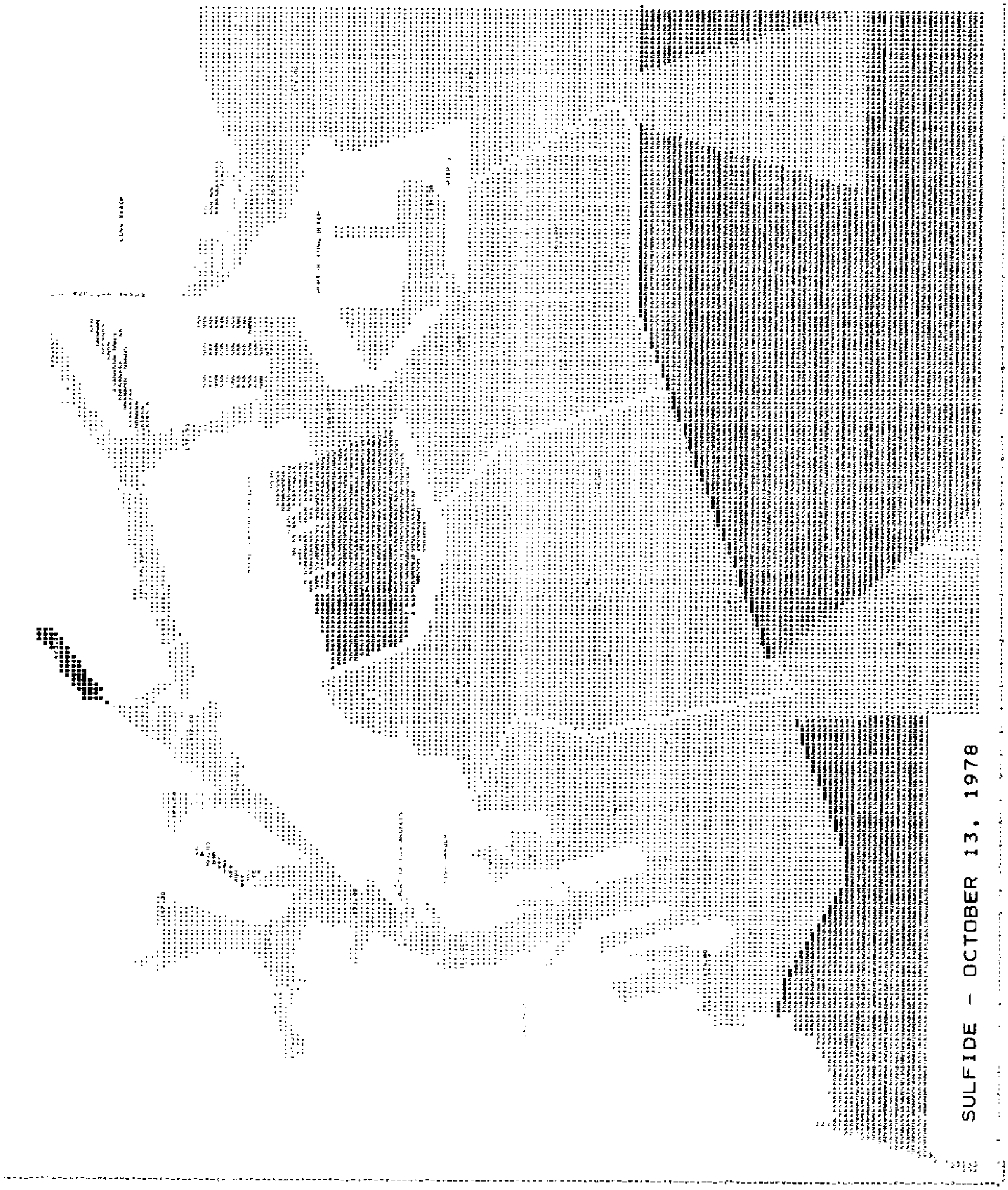

SULFIDE - OCTOBER 13, 1978

FIGURE 14. MERCURY
OCTOBER 13, 1978
DATA VALUE EXTREMES: 0.09-3.41

TOTAL MISSING DATA POINTS IS 21

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.09	0.42	0.75	1.09	1.42	1.75	2.08	2.41	2.75	3.08
MAXIMUM	0.42	0.75	1.09	1.42	1.75	2.08	2.41	2.75	3.08	3.41

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9          10
         ==================================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  ZZZZZZZZZ  #########
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  ZZZZZZZZZ  #########
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  @@@@8@@@@  ZZZZ9ZZZZ  ####+####
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  ZZZZZZZZZ  #########
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  ZZZZZZZZZ  #########
         ==================================================================================================================
FREQ.       12          6          2          0          0          1          0          0          0          1
     1   I..1..I    I''2''I    I--3--I                          IXX6XXI                                      I##+##I
     2   I..1..I    I''2''I    I--3--I
     3   I..1..I    I''2''I
     4   I..1..I    I''2''I
     5   I..1..I    I''2''I
     6   I..1..I    I''2''I
     7   I..1..I
     8   I..1..I
     9   I..1..I
    10   I..1..I
    11   I..1..I
    12   I..1..I
```

0.351807 MINUTES FOR HISTOGRAM


MERCURY - OCTOBER 13, 1978

FIGURE 15. NICKEL
OCTOBER 13, 1978
DATA VALUE EXTREMES: 8.20-106.50

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	8.20	18.03	27.86	37.69	47.52	57.35	67.18	77.01	86.84	96.67
MAXIMUM	18.03	27.86	37.69	47.52	57.35	67.18	77.01	86.84	96.67	106.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9         10
SYMBOLS  ....1....  '''2'''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  0000700C0
FREQ.       13          0          8         10          3          3          2          1          0          1
   1     I..1..I               I--3--I    I==4==I    I++5++I    IXX6XXI    I007 00I   I88888I              I888888I
   2     I..1..I               I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I
   3     I..1..I               I--3--I    I==4==I    I++5++I    IXX6XXI
   4     I..1..I               I--3--I    I==4==I
   5     I..1..I               I--3--I    I==4==I
   6     I..1..I               I--3--I    I==4==I
   7     I..1..I               I--3--I    I==4==I
   8     I..1..I               I--3--I    I==4==I
   9     I..1..I                          I==4==I
  10     I..1..I                          I==4==I
  11     I..1..I
  12     I..1..I
  13     I..1..I
```

0.353516 MINUTES FOR HISTOGRAM

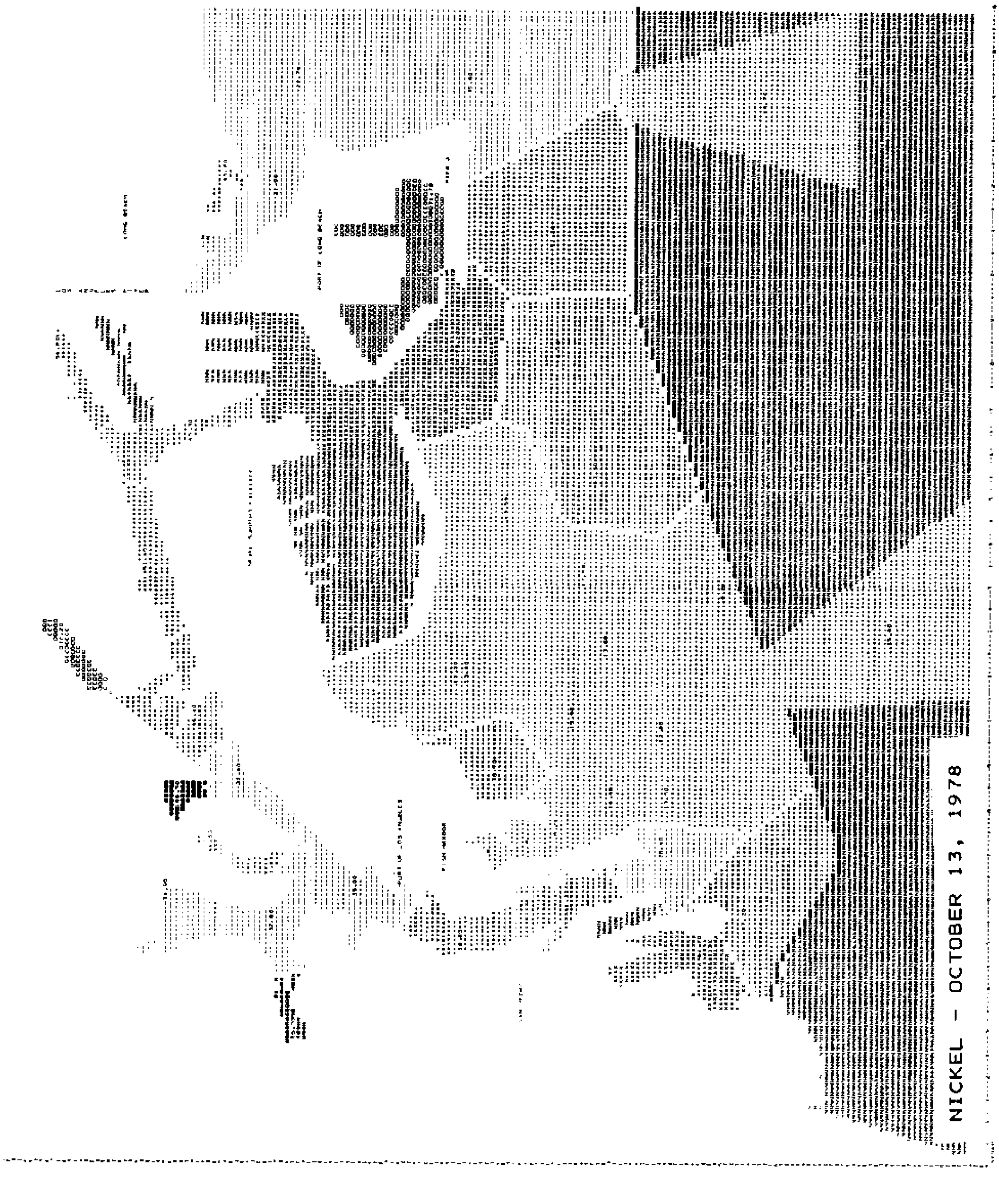

NICKEL - OCTOBER 13, 1978

FIGURE 16. LEAD
OCTOBER 13, 1978
DATA VALUE EXTREMES: 3.50-401.00

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	3.50	43.25	83.00	122.75	162.50	202.25	242.00	281.75	321.50	361.25
MAXIMUM	43.25	83.00	122.75	162.50	202.25	242.00	281.75	321.50	361.25	401.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	34	5	1	0	0	0	0	0	0	1

```
SYMBOLS  ....1....  '''''2'''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  8888888888  999999999  ####*####

    1    I..1..I    I''2''I    I--3--I                                                                          I##*##I
    2    I..1..I    I''2''I
    3    I..1..I    I''2''I
    4    I..1..I    I''2''I
    5    I..1..I    I''2''I
    6    I..1..I
    7    I..1..I
    8    I..1..I
    9    I..1..I
   10    I..1..I
   11    I..1..I
   12    I..1..I
   13    I..1..I
   14    I..1..I
   15    I..1..I
   16    I..1..I
   17    I..1..I
   18    I..1..I
   19    I..1..I
   20    I..1..I
   21    I..1..I
   22    I..1..I
   23    I..1..I
   24    I..1..I
   25    I..1..I
   26    I..1..I
   27    I..1..I
   28    I..1..I
   29    I..1..I
   30    I..1..I
   31    I..1..I
   32    I..1..I
   33    I..1..I
   34    I..1..I
```

0.507874 MINUTES FOR HISTOGRAM

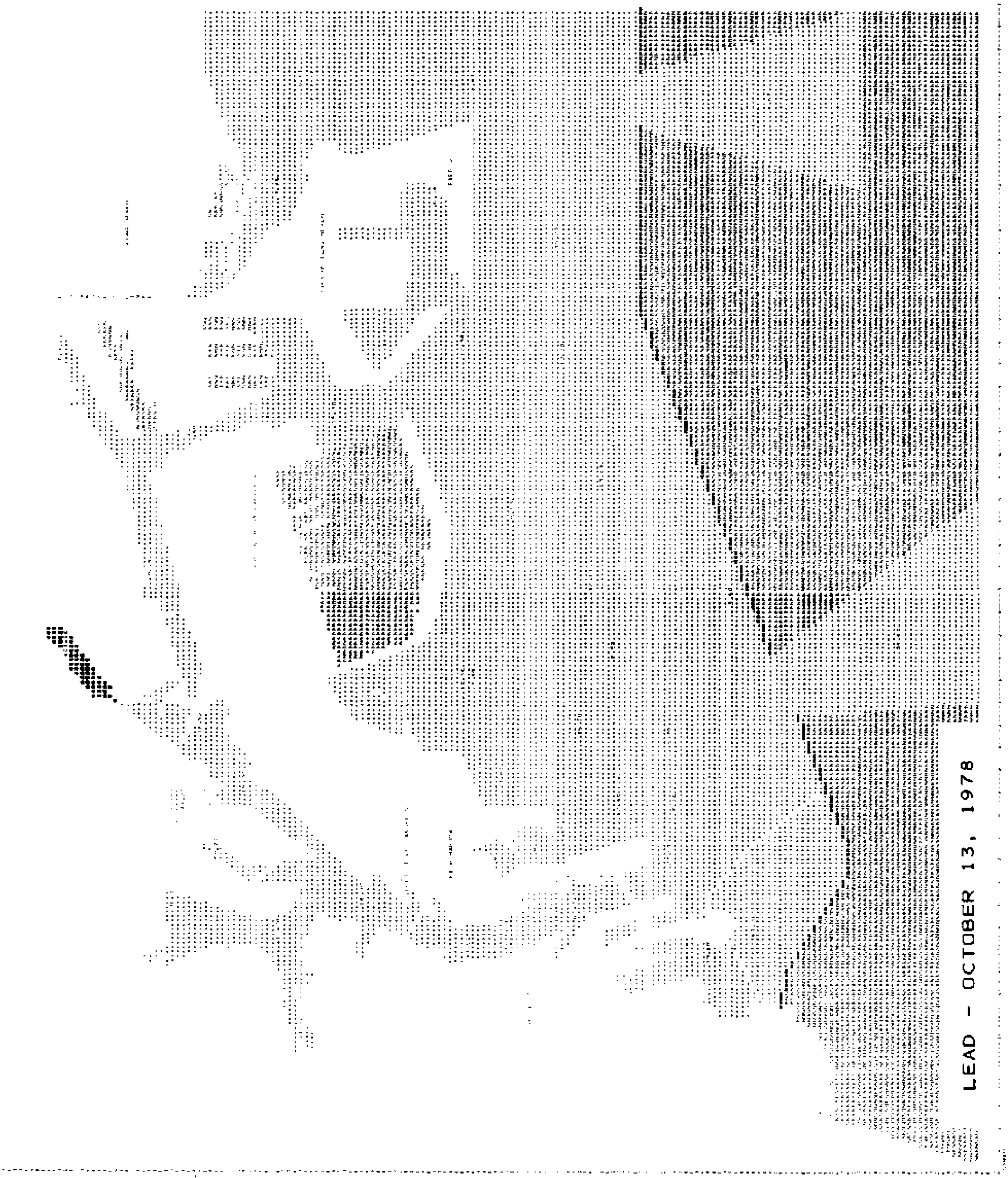

LEAD - OCTOBER 13, 1978

FIGURE 17. % TOTAL VOLATILE SOLIDS
OCTOBER 13, 1978
DATA VALUE EXTREMES: 2.00-14.40

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	2.00	3.24	4.48	5.72	6.96	8.20	9.44	10.68	11.92	13.16
MAXIMUM	3.24	4.48	5.72	6.96	8.20	9.44	10.68	11.92	13.16	14.40

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL         1          2          3          4          5          6          7          8          9          10
         ==================================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ooooooooo  █████████
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ooooooooo  █████████
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  oooo9oooo  █████████
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ooooooooo  █████████
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ooooooooo  █████████
         ==================================================================================================================
FREQ.         8          6          6          6          6          2          4          2          0          1
       1  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I    I88888I               I█████I
       2  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI    I00700I    I88888I
       3  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I               I00700I
       4  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I               I00700I
       5  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
       6  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
       7  I..1..I
       8  I..1..I
```

0.315674 MINUTES FOR HISTOGRAM

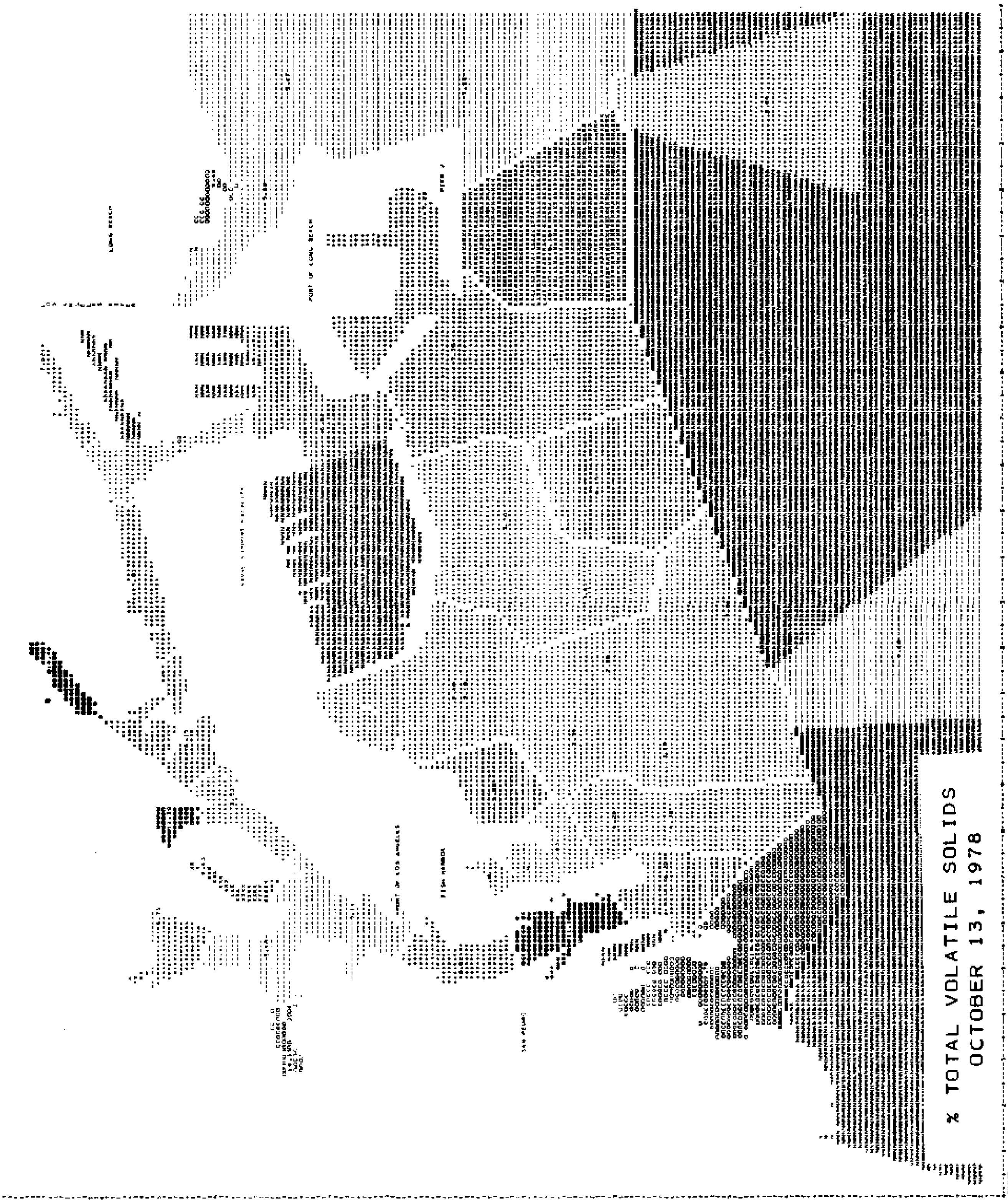

% TOTAL VOLATILE SOLIDS
OCTOBER 13, 1978

FIGURE 18. OIL AND GREASE
OCTOBER 13, 1978
DATA VALUE EXTREMES: 85.00-21500.00

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	85.00	2226.50	4368.00	6509.50	8651.00	10792.50	12934.00	15075.50	17217.00	19358.50
MAXIMUM	2226.50	4368.00	6509.50	8651.00	10792.50	12934.00	15075.50	17217.00	19358.50	21500.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7         8         9         10
SYMBOLS  .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ◘◘◘◘◘◘◘◘◘  ■■■■■■■■■
FREQ.        29        8         0         1         1         0         1         0         0         1
    1    I..I..I   I''2''I             I==4==I   I++5++I             IOO7OOI                       I■■+■■I
    2    I..I..I   I''2''I
    3    I..I..I   I''2''I
    4    I..I..I   I''2''I
    5    I..I..I   I''2''I
    6    I..I..I   I''2''I
    7    I..I..I   I''2''I
    8    I..I..I   I''2''I
    9    I..I..I
   10    I..I..I
   11    I..I..I
   12    I..I..I
   13    I..I..I
   14    I..I..I
   15    I..I..I
   16    I..I..I
   17    I..I..I
   18    I..I..I
   19    I..I..I
   20    I..I..I
   21    I..I..I
   22    I..I..I
   23    I..I..I
   24    I..I..I
   25    I..I..I
   26    I..I..I
   27    I..I..I
   28    I..I..I
   29    I..I..I
```

0.489685 MINUTES FOR HISTOGRAM

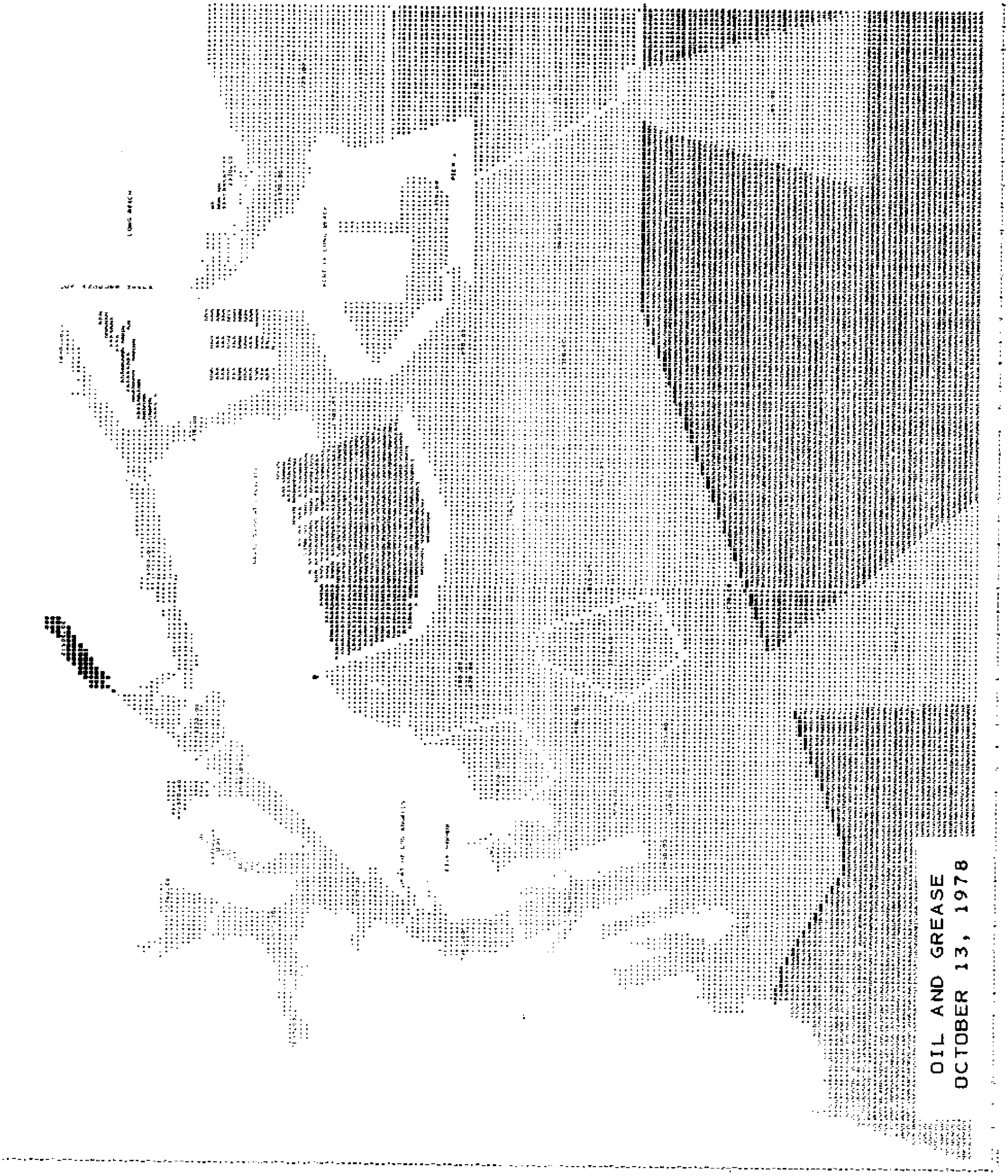

OIL AND GREASE
OCTOBER 13, 1978

FIGURE 19. PHOSPHORUS
OCTOBER 13, 1978
DATA VALUE EXTREMES: 246.00-5400.00

TOTAL MISSING DATA POINTS IS 2

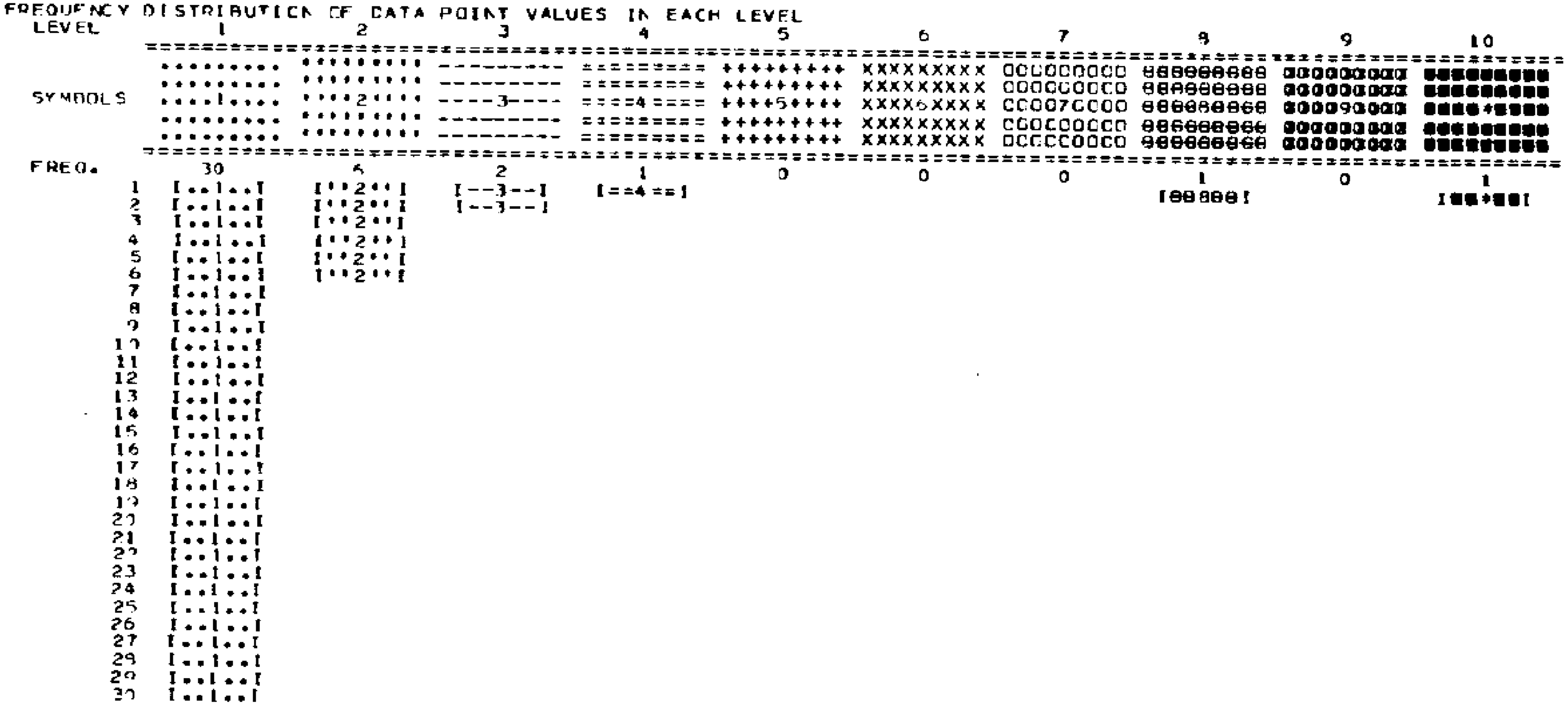
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	246.00	761.40	1276.80	1792.20	2307.60	2823.00	3338.40	3853.80	4369.20	4884.60
MAXIMUM	761.40	1276.80	1792.20	2307.60	2823.00	3338.40	3853.80	4369.20	4884.60	5400.00

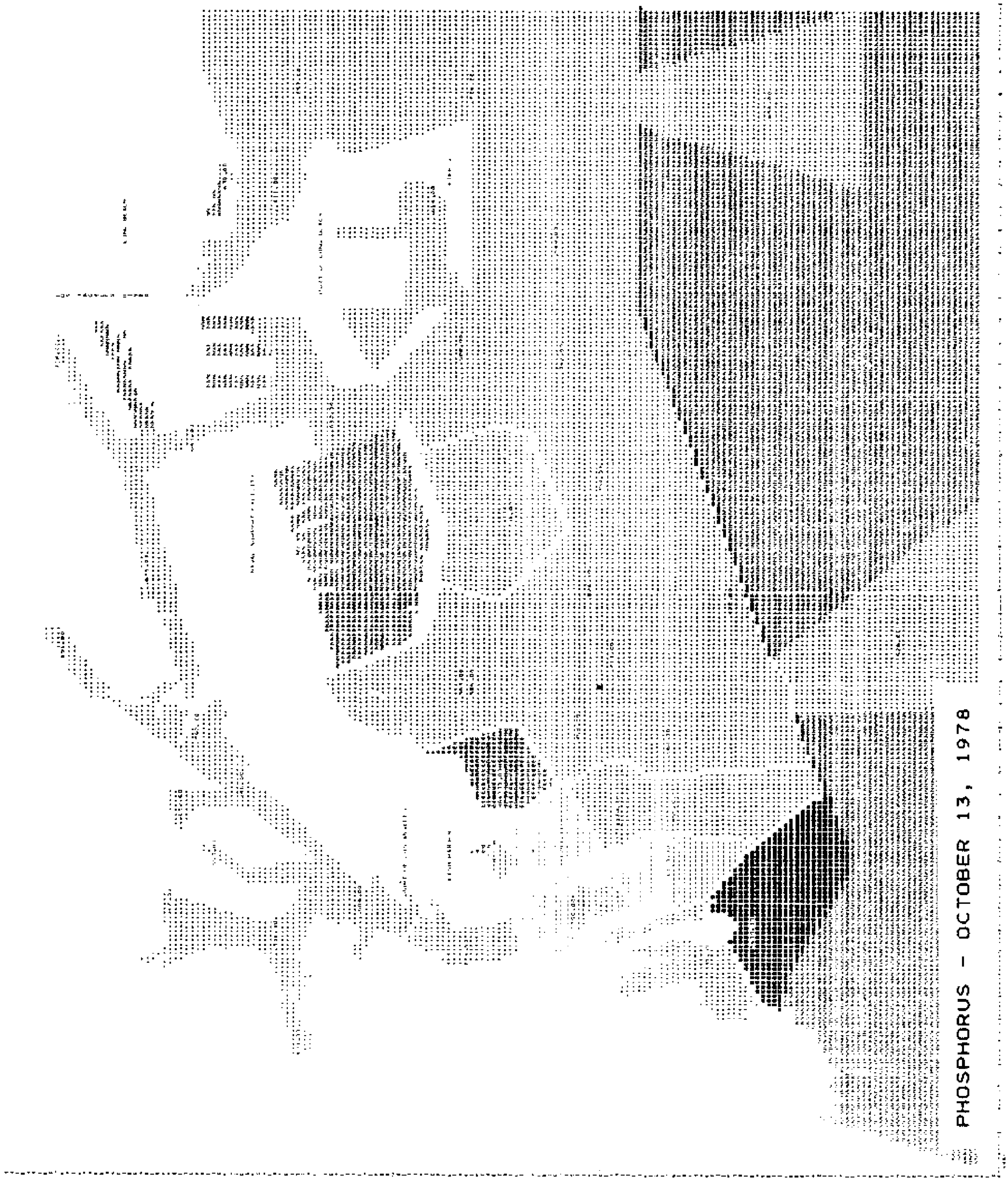
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



0.534531 MINUTES FOR HISTOGRAM



PHOSPHORUS - OCTOBER 13, 1978

FIGURE 20. ORGANIC NITROGEN
OCTOBER 13, 1978
DATA VALUE EXTREMES: 65.70-2730.00

TOTAL MISSING DATA POINTS IS 5

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	65.70	332.13	598.56	864.99	1131.42	1397.85	1664.28	1930.71	2197.14	2463.57
MAXIMUM	332.13	598.56	864.99	1131.42	1397.85	1664.28	1930.71	2197.14	2463.57	2730.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7         8         9        10
         ==========================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  IIIIIIIII  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  IIIIIIIII  ■■■■■■■■■
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  @@@@8@@@@  IIII9IIII  ■■■■*■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  IIIIIIIII  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  IIIIIIIII  ■■■■■■■■■
         ==========================================================================================
FREQ.        5        13         5         6         2         1         2         0         2         2
   1     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI             II9III    I■■*■■I
   2     I..1..I   I''2''I   I--3--I   I==4==I   I++5++I             IOO7OOI             II9III    I■■*■■I
   3     I..1..I   I''2''I   I--3--I   I==4==I
   4     I..1..I   I''2''I   I--3--I   I==4==I
   5     I..1..I   I''2''I   I--3--I   I==4==I
   6               I''2''I             I==4==I
   7               I''2''I
   8               I''2''I
   9               I''2''I
  10               I''2''I
  11               I''2''I
  12               I''2''I
  13               I''2''I
```

0.407074 MINUTES FOR HISTOGRAM

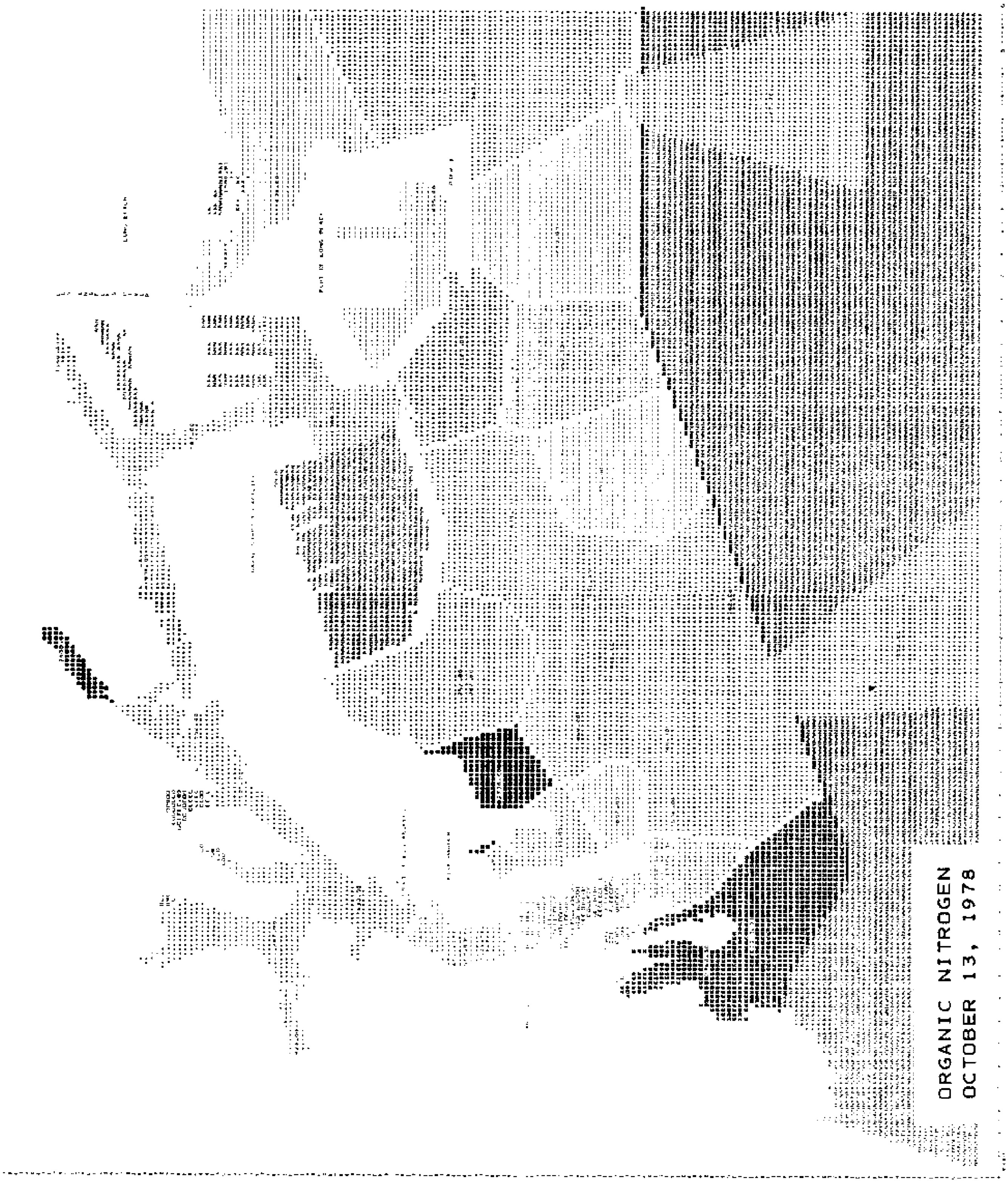

ORGANIC NITROGEN
OCTOBER 13, 1978

FIGURE 21. CHROMIUM
OCTOBER 13, 1978
DATA VALUE EXTREMES: 16.00-221.00

TOTAL MISSING-DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	16.00	36.50	57.00	77.50	98.00	118.50	139.00	159.50	180.00	200.50
MAXIMUM	36.50	57.00	77.50	98.00	118.50	139.00	159.50	180.00	200.50	221.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9          10
        ==========================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  &&&&&&&&&  #########
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  &&&&&&&&&  #########
SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  @@@@8@@@@  &&&&9&&&&  ####*####
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  &&&&&&&&&  #########
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  &&&&&&&&&  #########
        ==========================================================================================================
FREQ.       11          5          5          7          9          1          1          1          0          1
      1  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI    IOO7OOI    I@@8@@I               I##*##I
      2  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
      3  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
      4  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
      5  I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
      6  I..1..I                          I==4==I    I++5++I
      7  I..1..I                          I==4==I    I++5++I
      8  I..1..I                                     I++5++I
      9  I..1..I                                     I++5++I
     10  I..1..I
     11  I..1..I
```

0.316132 MINUTES FOR HISTOGRAM

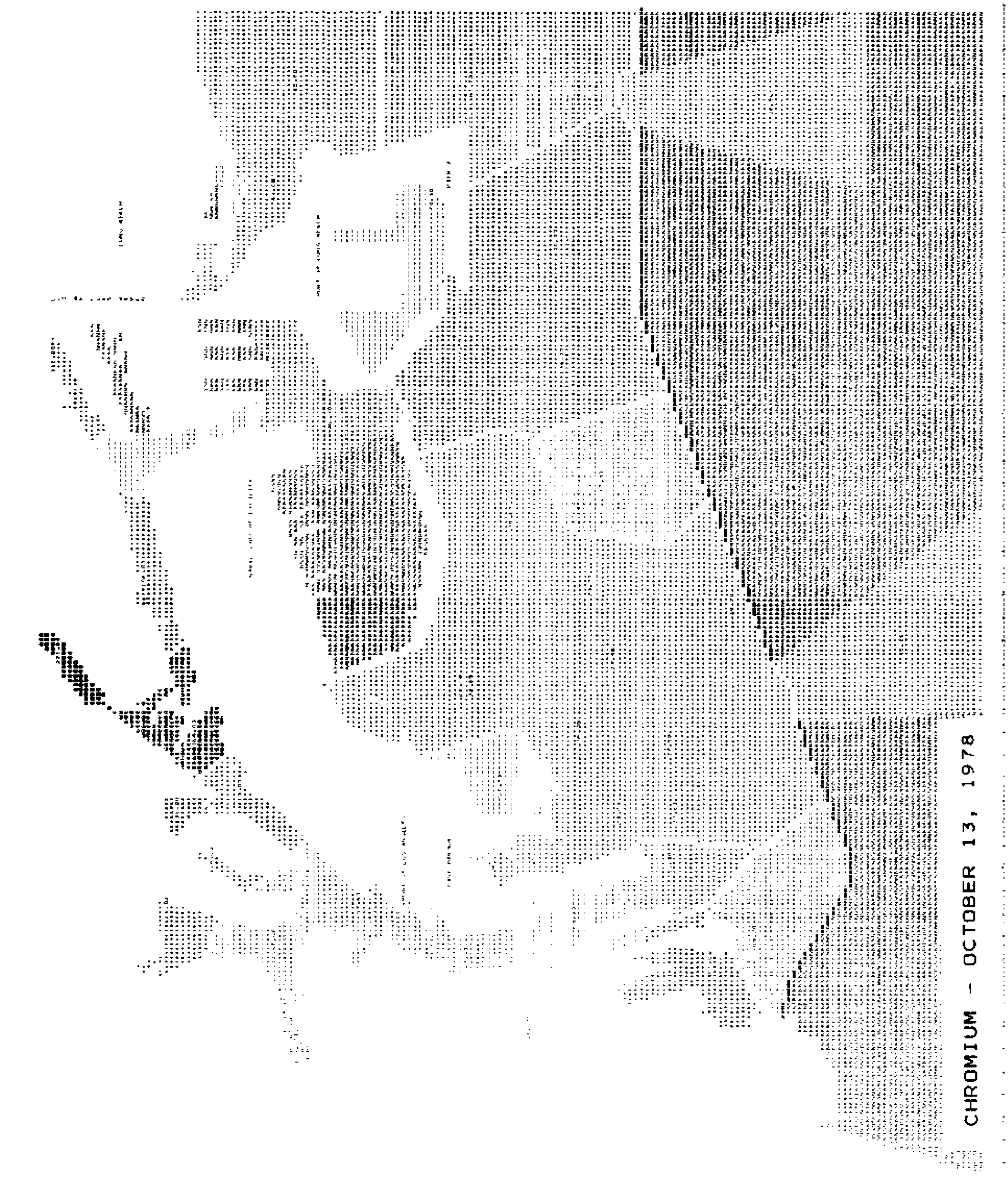

CHROMIUM - OCTOBER 13, 1978

FIGURE 22. IRON
OCTOBER 13, 1978
DATA VALUE EXTREMES: 13800.00-69600.00

```
TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM  13800.00  19380.00  24960.00  30540.00  36120.00  41700.00  47280.00  52860.00  58440.00  64020.00
 MAXIMUM  19380.00  24960.00  30540.00  36120.00  41700.00  47280.00  52860.00  58440.00  64020.00  69600.00


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

           10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
         ====================================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888
 SYMBOLS ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888
         ====================================================================================================
 FREQ.          5         5         4         6         6         6         2         5         0         2
       1   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I             I**+**I
       2   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I             I**+**I
       3   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI             I88888I
       4   I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI             I88888I
       5   I..1..I   I''2''I             I==4==I   I++5++I   IXX6XXI             I88888I
       6                                 I==4==I   I++5++I   IXX6XXI

 0.334946 MINUTES FOR HISTOGRAM

  1 MAPS HAVE BEEN PRODUCED
END OF JOB
```

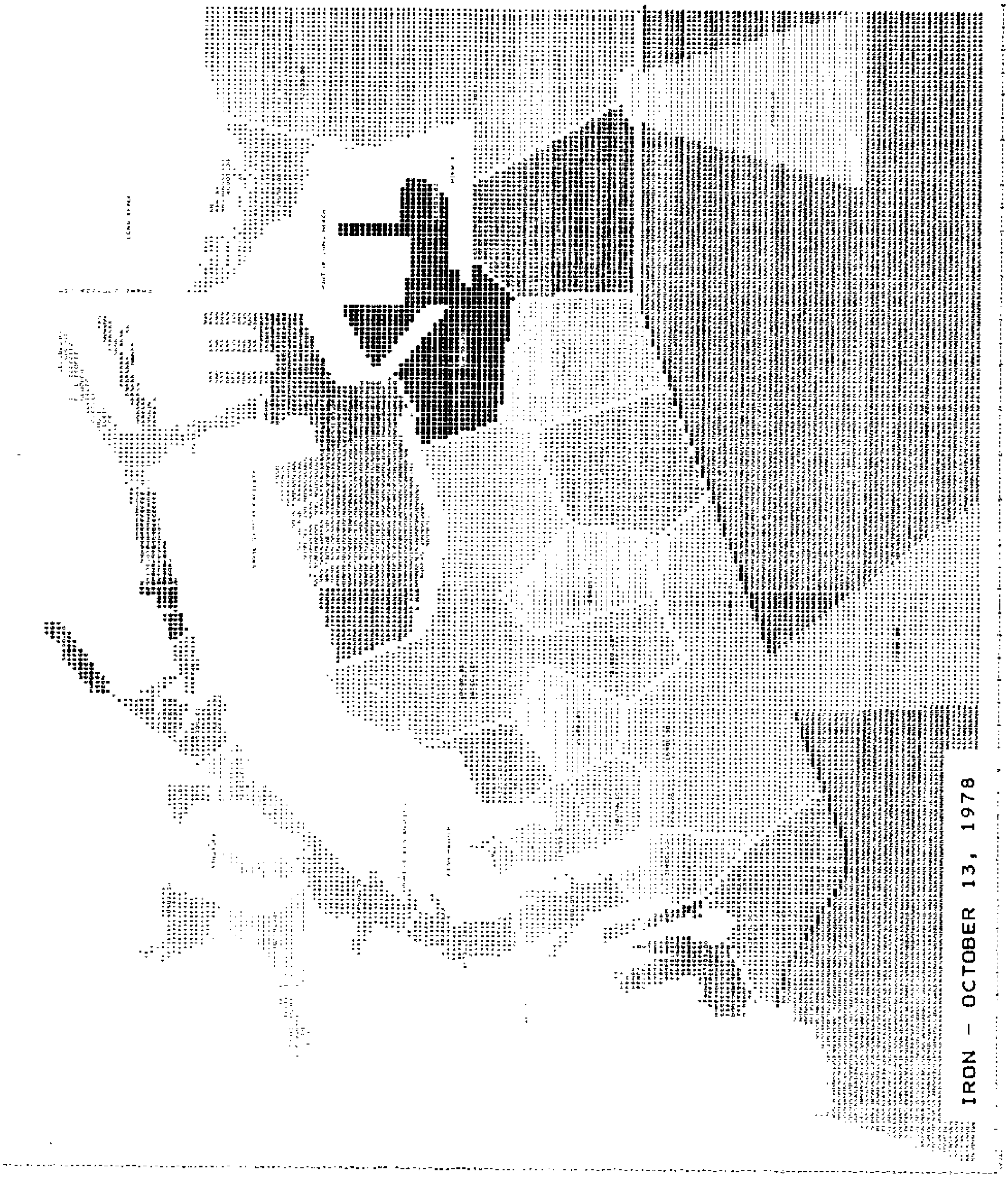

IRON - OCTOBER 13, 1978

FIGURE 23. MANGANESE
OCTOBER 13, 1978
DATA VALUE EXTREMES: 177.00-842.00

```
TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM    177.00    243.50    310.00    376.50    443.00    509.50    576.00    642.50    709.00    775.50
  MAXIMUM    243.50    310.00    376.50    443.00    509.50    576.00    642.50    709.00    775.50    842.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
          ==================================================================================================
          .........  :::::::::  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  000000000  #########
          .........  :::::::::  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  000000000  #########
  SYMBOLS ....1....  ::::2::::  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  000090000  ####*####
          .........  :::::::::  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  000000000  #########
          .........  :::::::::  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  000000000  #########
          ==================================================================================================
  FREQ.          5         5         4         4        12         1         5         1         3         1
        1   I..1..I    I::2::I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88881I   I##9##I   I##*##I
        2   I..1..I    I::2::I   I--3--I   I==4==I   I++5++I             I00700I             I##9##I
        3   I..1..I    I::2::I   I--3--I   I==4==I   I++5++I             I00700I             I##9##I
        4   I..1..I    I::2::I   I--3--I   I==4==I   I++5++I             I00700I
        5   I..1..I    I::2::I                       I++5++I             I00700I
        6                                            I++5++I
        7                                            I++5++I
        8                                            I++5++I
        9                                            I++5++I
       10                                            I++5++I
       11                                            I++5++I
       12                                            I++5++I

0.379395 MINUTES FOR HISTOGRAM
```

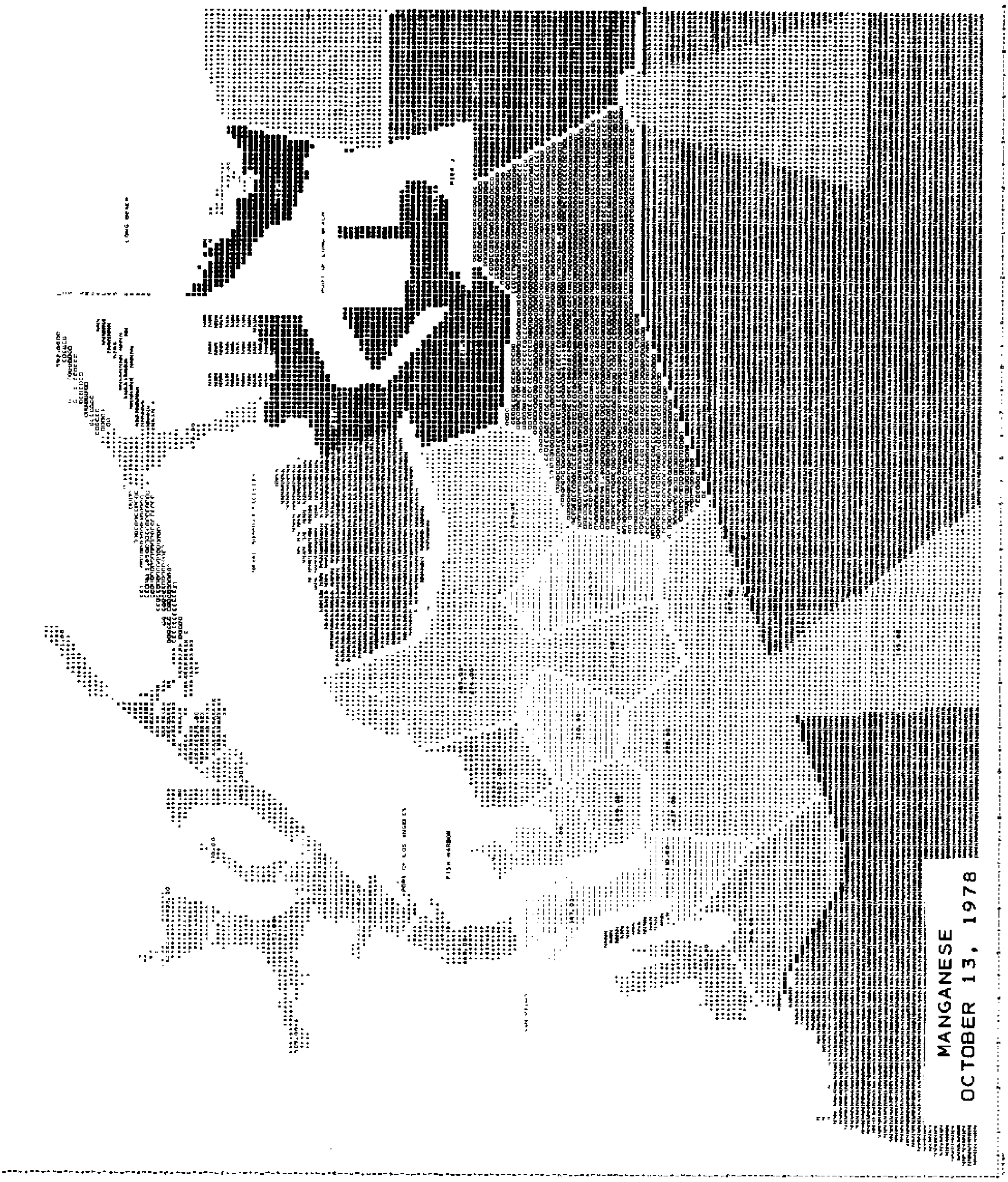

MANGANESE
OCTOBER 13, 1978

FIGURE 24. ZINC
OCTOBER 13, 1979
DATA VALUE EXTREMES: 53.10-1317.00

```
TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     53.10    179.49    305.88    432.27    558.66    685.05    811.44    937.83   1064.22   1190.61
 MAXIMUM    179.49    305.88    432.27    558.66    685.05    811.44    937.83   1064.22   1190.61   1317.00


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00     10.00


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
           ===================================================================================================
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 KKKKKKKKK ■■■■■■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 KKKKKKKKK ■■■■■■■■■
 SYMBOLS   ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 KKKK9KKKK ■■■■*■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 KKKKKKKKK ■■■■■■■■■
           ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 KKKKKKKKK ■■■■■■■■■
           ===================================================================================================
 FREQ.         19        13         6         2         0         0         0         0         0         1
        1   I..1..I   I''2''I   I--3--I   I==4==I                                                   I■■*■■I
        2   I..1..I   I''2''I   I--3--I   I==4==I
        3   I..1..I   I''2''I   I--3--I
        4   I..1..I   I''2''I   I--3--I
        5   I..1..I   I''2''I   I--3--I
        6   I..1..I   I''2''I   I--3--I
        7   I..1..I   I''2''I
        8   I..1..I   I''2''I
        9   I..1..I   I''2''I
       10   I..1..I   I''2''I
       11   I..1..I   I''2''I
       12   I..1..I   I''2''I
       13   I..1..I   I''2''I
       14   I..1..I
       15   I..1..I
       16   I..1..I
       17   I..1..I
       18   I..1..I
       19   I..1..I

0.369736 MINUTES FOR HISTOGRAM
```


ZINC - OCTOBER 13, 1978

FIGURE 25. COD
OCTOBER 13, 1979
DATA VALUE EXTREMES: 9580.00-125000.00

```
TOTAL MISSING DATA POINTS IS         2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM    9580.00   21122.00   32664.00   44206.00   55748.00   67290.00   78832.00   90374.00 101916.00 113458.00
  MAXIMUM   21122.00   32664.00   44206.00   55748.00   67290.00   78832.00   90374.00  101916.00 113458.00 125000.00


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             10.00      10.00      10.00      10.00      10.00      10.00      10.00      10.00      10.00      10.00


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5          6          7          8          9         10
           ==========================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  [illegible] [illegible]
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  [illegible] [illegible]
  SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  0000700C0  @@@@8@@@@  [illegible] [illegible]
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000C00000  @@@@@@@@@  [illegible] [illegible]
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  @@@@@@@@@  [illegible] [illegible]
           ==========================================================================================================
  FREQ.        11         16          4          3          1          4          0          0          1          1
        1   I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI                         [illegible] [illegible]
        2   I..1..I    I''2''I    I--3--I    I==4==I               IXX6XXI
        3   I..1..I    I''2''I    I--3--I    I==4==I               IXX6XXI
        4   I..1..I    I''2''I    I--3--I                          IXX6XXI
        5   I..1..I    I''2''I
        6   I..1..I    I''2''I
        7   I..1..I    I''2''I
        8   I..1..I    I''2''I
        9   I..1..I    I''2''I
       10   I..1..I    I''2''I
       11   I..1..I    I''2''I
       12              I''2''I
       13              I''2''I
       14              I''2''I
       15              I''2''I
       16              I''2''I

0.360413 MINUTES FOR HISTOGRAM
```

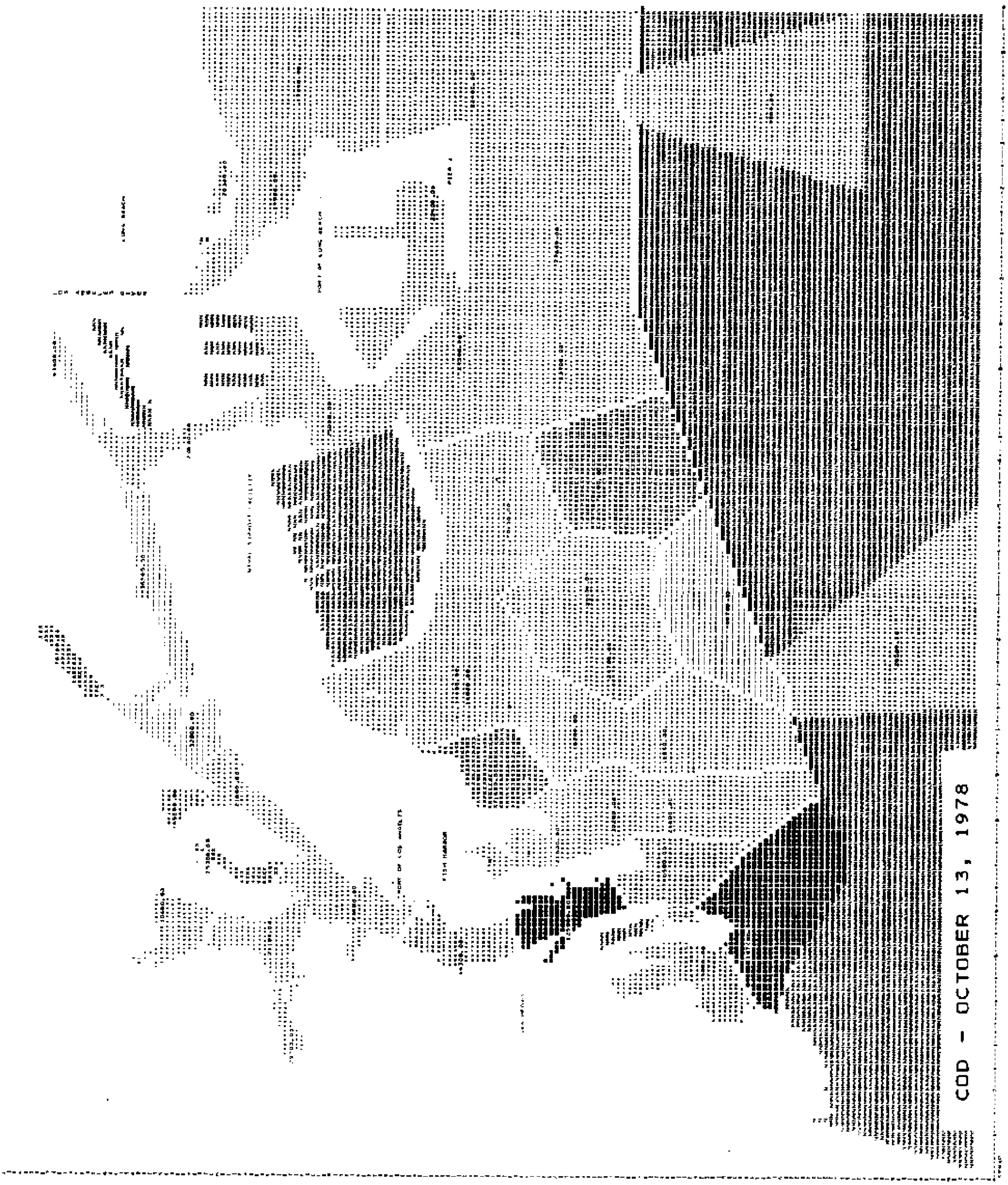

COD - OCTOBER 13, 1978

FIGURE 26. COPPER
OCTOBER 13, 1978
DATA VALUE EXTREMES: 15.80-233.00

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	15.80	37.52	59.24	80.96	102.68	124.40	146.12	167.84	189.56	211.28
MAXIMUM	37.52	59.24	80.96	102.68	124.40	146.12	167.84	189.56	211.28	233.00

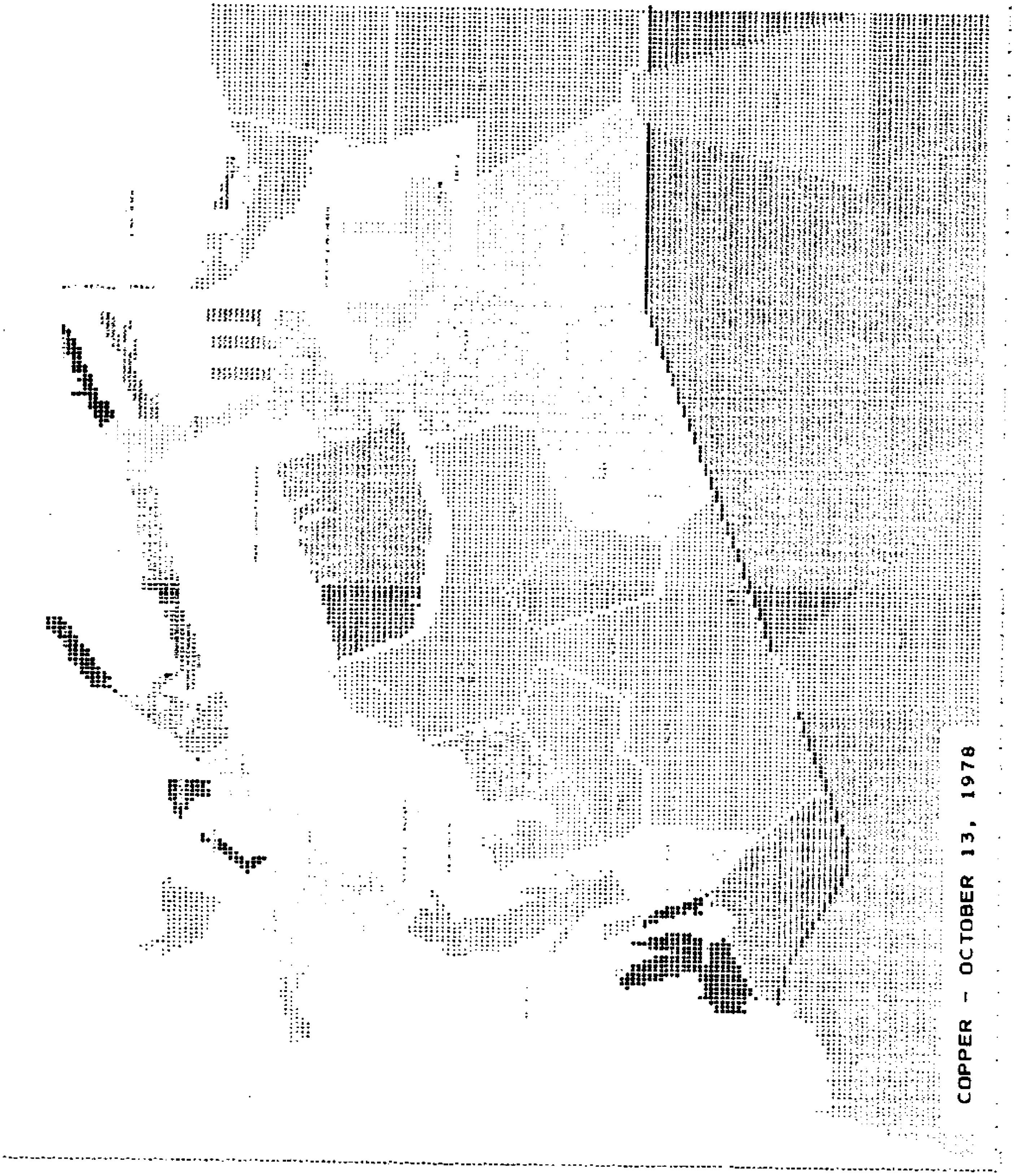
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL       1         2         3         4         5         6         7         8         9        10
         ==========================================================================================
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  KKKKKKKKK  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  KKKKKKKKK  ■■■■■■■■■
 SYMBOLS ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  @@@@8@@@@  KKKK9KKKK  ■■■■*■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  KKKKKKKKK  ■■■■■■■■■
         .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  @@@@@@@@@  KKKKKKKKK  ■■■■■■■■■
         ==========================================================================================
 FREQ.      10         6         4         8         1         3         3         1         2         3
      1  I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I@@8@@I   IKK9KKI   I■■*■■I
      2  I..1..I   I''2''I   I--3--I   I==4==I             IXX6XXI   IOO7OOI             IKK9KKI   I■■*■■I
      3  I..1..I   I''2''I   I--3--I   I==4==I             IXX6XXI   IOO7OOI                       I■■*■■I
      4  I..1..I   I''2''I   I--3--I   I==4==I
      5  I..1..I   I''2''I             I==4==I
      6  I..1..I   I''2''I             I==4==I
      7  I..1..I                       I==4==I
      8  I..1..I                       I==4==I
      9  I..1..I
     10  I..1..I
```

0.337250 MINUTES FOR HISTOGRAM



COPPER - OCTOBER 13, 1978

TABLE 1. SEDIMENT GRAIN SIZE ANALYSIS, LOS ANGELES-LONG BEACH HARBORS, 1978.

	January 1978			July 1978			Average		
Sta.	% Sand	% Silt	% Clay	% Sand	% Silt	% Clay	% Sand	% Silt	% Clay
A1	87	9	4	81	15	4	84	12	4
A2	55	40	5	6	92	2	30	66	4
A3	82	13	5	78	20	2	80	16	4
A4	87	13	0	15	54	31	51	33	16
A7	49	42	9	9	61	30	29	51	20
A8	39	45	16	76	23	1	58	34	8
A9	5	51	44	5	93	2	5	72	23
A10	4	50	46	4	52	44	4	51	45
A11	37	61	2	39	60	1	38	60	2
A12	63	33	4	54	41	5	58	37	5
A13	83	12	5	59	34	7	71	23	6
A14	47	44	9	62	33	5	55	38	7
A15	41	52	7	50	44	6	45	48	7
A16	71	26	3	70	25	5	71	25	4
A17	80	17	3	62	29	9	71	23	6
B1	70	27	3	81	14	5	76	20	4
B2	29	68	3	20	79	1	25	73	2
B3	10	52	38	8	83	9	9	68	23
B4	30	49	21	18	58	24	24	53	23
B5	59	30	11	63	33	4	61	32	7
B6	39	40	21	31	68	1	35	54	11
B7	1	62	37	4	94	2	3	78	19
B8	75	19	6	42	52	6	59	35	6
B9	35	28	37	37	62	1	36	45	19
B10	12	65	23	9	87	4	10	76	14
B11	18	58	24	7	59	34	13	58	29
C1	42	20	38	54	45	1	48	33	19
C2	47	48	5	64	22	14	55	35	10
C3	47	41	12	48	51	1	47	46	7
C4	64	23	13	64	35	1	64	29	7
C5	7	50	43	2	95	3	5	72	23
C6	41	34	25	23	73	4	32	53	15
C7	30	43	27	30	44	26	30	43	27
C8	27	43	30	21	78	1	24	61	15
C9	51	32	17	18	51	31	34	42	24
C10	60	18	22	28	45	27	44	32	24
C11	15	62	23	21	48	31	18	55	27
D1	29	55	16	8	73	19	18	64	18
D2	22	77	1	9	75	16	15	76	9
D3	15	78	7	13	85	2	14	81	5
D10	6	60	34	8	64	28	7	62	31

TABLE 2. CHEMICAL ANALYSIS OF BENTHIC SEDIMENTS IN LOS ANGELES-LONG BEACH HARBORS, OCTOBER 13, 1978.

Sta.	WC %	DM %	TVS %	BOD	TOC %	COD mg/l	Oil & Gr.	P	Org. N	Total N	S=	As	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
														Metals Concentrations (mg/Kg/Dry)								
A1	29.9	70.1	4.6	ND	ND	29500	560	926	552	ND	ND	<1.0	ND	0.83	45.8	42.0	17800	ND	215	15.4	36.6	92.3
A2	30.8	69.2	4.3	ND	ND	24600	910	855	504	ND	ND	<1.0	ND	0.71	32.6	30.4	17600	ND	237	13.5	7.2	78.6
A3	33.9	66.1	4.2	ND	ND	30200	580	1120	607	ND	ND	<1.0	ND	0.69	23.0	44.6	20200	ND	249	14.4	12.4	99.4
A6	27.0	73.0	2.8	ND	ND	21800	950	1280	309	ND	ND	<1.2	ND	0.64	16.0	33.6	13800	ND	177	8.2	8.4	75.5
A7	51.4	48.6	5.8	ND	ND	71400	4120	4230	2730	ND	ND	<1.2	ND	3.62	57.7	149	43200	ND	467	38.9	11.8	389
A8	41.6	58.4	6.2	ND	ND	66500	1850	1380	1070	ND	ND	<1.2	ND	1.25	53.1	89.4	31800	ND	330	20.4	27.5	184
A9	62.6	37.4	10.4	ND	ND	107000	610	5400	2230	ND	ND	1.6	ND	1.73	88.2	184	43800	ND	398	47.2	43.3	289
A10	53.21	46.79	9.78	1080	0.94	54800	954	830	2240	2240	175	ND	40.1	1.17	105	222	53800	1.31	652.	61.7	30.1	369
A11	29.5	70.5	2.6	ND	ND	14100	180	563	252	ND	ND	<1.0	ND	<0.47	21.1	36.2	20600	ND	289	13.3	10.9	90.6
A12	29.3	70.7	3.4	ND	ND	25500	510	524	501	ND	ND	<1.0	ND	<0.48	28.3	43.6	25400	ND	315	17.5	12.1	111
A13	27.6	72.4	2.0	ND	ND	40700	1030	472	342	ND	ND	<1.1	ND	<0.52	19.7	15.8	14400	ND	387	8.8	<3.6	53.1
A14	30.2	69.8	2.2	ND	ND	24700	3770	733	441	ND	ND	<1.1	ND	<0.54	27.9	29.7	21400	ND	281	13.8	6.5	81.8
A15	26.4	73.6	2.1	ND	ND	14800	620	586	282	ND	ND	<1.0	ND	<0.49	22.0	31.9	20500	ND	276	11.4	7.4	89.4
A16	31.9	68.1	1.5	ND	ND	16200	410	758	469	ND	ND	<1.1	ND	0.40	26.0	42.8	25200	ND	310	15.9	15.3	116
A17	28.1	71.9	1.1	ND	ND	16800	230	568	348	ND	ND	<1.0	ND	<0.47	27.0	26.3	16800	ND	228	12.2	5.7	71.2
B1	36.09	73.91	2.04	77	0.26	9500	85	664	65.7	65.7	113	ND	70.1	0.45	36.5	17.6	25000	0.116	492	14.7	4.67	64.5
B2	42.00	58.00	7.23	203	0.34	22400	4350	614	805	805	134	ND	121	0.62	70.1	67.9	68500	0.139	768	71.7	6.54	187
B3	47.77	52.23	7.25	731	0.53	29300	870	588	1180	1180	150	ND	104	0.64	99.7	83.3	69600	0.219	721	59.2	12.8	242
B4	46.25	53.75	6.82	415	0.35	25000	1000	630	1080	1080	156	ND	117	0.47	86.9	96.4	58100	0.270	711	61.1	15.0	223
B5	33.62	66.38	4.02	197	0.32	20600	938	643	549	766.	126	ND	121	0.45	75.4	64.0	37400	0.243	478	45.3	9.45	133
B6	43.99	56.01	7.02	1050	0.55	43800	1880	758	1180	1180	179	ND	34.9	0.60	116	221	51800	0.941	592	54.6	36.4	442
B7	49.44	50.56	8.0	578	0.62	38200	3700	425	904	904	178	ND	23.3	0.55	106	157	58100	0.642	613	51.4	22.8	317
B8	34.9	65.1	3.3	ND	ND	20100	700	791	438	ND	ND	<1.0	ND	<0.46	23.4	29.5	21900	ND	289	17.1*	5.5	76.4
B9	38.61	61.39	6.18	383	0.43	76100	500	359	700	770	115	ND	34.8	0.54	92.3	87.1	43600	0.256	641	42.5	13.8	186
B10	47.16	52.84	7.15	640	0.43	23700	1060	742	952	952	168	ND	46.3	0.47	104	86.2	33400	0.310	615	40.5	13.2	213
B11	45.44	54.56	8.38	404	0.45	27600	1080	549	840	896	165	ND	58.9	0.69	100	45.3	57200	0.206	584	52.8	35.2	185
C1	51.8	48.2	11.1	ND	ND	125000	340	2290	1750	ND	ND	1.4	ND	1.36	68.9	140	37100	51.1	347	41.3	67.3	274
C2	46.11	53.89	8.06	772	0.85	44300	2940	774	966	1060	160	ND	23.4	0.53	93.9	143	46300	0.797	460	38.8	67.5	334
C3	35.35	64.65	5.11	356	0.46	28400	1230	604	430	474	133	ND	67.5	0.45	87.4	90.3	36500	0.444	402	35.0	16.9	181
C4	33.44	66.56	5.48	154	0.32	21100	985	331	247	247	137	ND	53.1	0.44	67.6	65.7	30200	0.352	653	32.0	10.2	146
C5	48.05	51.95	10.3	827	0.54	29200	2190	490	924	924	157	ND	33.4	1.25	145	104	50700	0.187	508	86.1	35.1	376
C6	45.28	54.72	6.76	647	0.53	30400	2740	547	ND	ND	142	ND	21.6	0.68	114	127	40900	0.712	408	34.9	31.3	277
C7	47.0	53.0	9.43	1940	1.36	75300	13730	693	ND	117	399	ND	40.6	0.62	118	233	33000	3.41	470	41.8	56.7	364
C8	50.31	49.69	11.3	1120	0.83	45300	9370	652	1710	1735	384	ND	34.6	0.56	138	287	41500	1.78	451	106.5	99.2	489
C9	28.11	71.89	3.53	511	0.38	21600	1680	246	505	505	108	ND	62	0.59	113	92.6	32100	0.460	454	32.6	19.0	225
C10	39.15	60.85	4.15	795	0.59	32800	3370	582	553	588	112	ND	61.2	0.82	168	154	45700	0.739	528	46.4	33.5	368
C11	55.76	44.24	14.4	3540	1.67	78700	21500	651	3600	2810	473	ND	33.6	1.42	221	210	54600	0.578	471	76.2	47.1	1311
D1	35.3	64.7	3.51	617	0.48	22400	8570	504	540.7	540.7	122	ND	91.1	0.4	67.7	41.8	33000		654	35.8	8.43	128
D2	37.73	62.27	5.58	403	0.34	19900	1370	611	638.4	638.4	136	ND	103	0.44	49.0	49.6	38600	0.090	847	31	7.89	131
D3	33.5	66.5	5.67	400	0.30	17100	720	597	ND	ND	121		75.3	0.30	45.6	29.8	32000	ND	474	28.7	9.61	109
D10	56.8	43.2	9.49	1490	0.53	20300	3330	630	1580	1580	218		49.8	0.65	67.2	91.5	46000	0.198	433	45.8	55.5	219

ND = Not Done by City or Sample Damaged

TABLE 2 (CONTINUED)

Stn.	op' DDE ppm	op' DDD ppm	op' DDT ppm	pp' DDE ppm	pp' DDD ppm	pp' DDT ppm	Total DDT	PCB 1242 ppm	PCB 1254 ppm	PCB 1260 ppm	Total PCB ppm	Chlordane ppm	Dieldrin ppm
A1	0.075	0.007	0.002	0.459	0.034	0.012	0.589	0.049	0.076		0.125		
A2	0.067	0.008	0.003	0.397	0.031	0.024	0.530	0.023	0.038		0.061		
A3	0.015	N.D.	0.001	0.076	0.009	0.002	0.103	0.010	0.057		0.067		
A4	0.003	N.D.	N.D.	0.066	0.007	N.D.	0.076	0.010	0.040		0.050		
A7	N.D.	0.002	N.D.	0.015	0.030	N.D.	0.047	0.067	0.241		0.308		
A8	0.054	N.D.	0.002	0.262	0.018	0.006	0.342	0.038	0.110		0.148		
A9	0.091	0.006	N.D.	0.409	N.D.	N.D.	0.555	0.069	0.252		0.321		
A10													
A11	N.D.	N.D.	0.005	0.013	N.D.	0.014	0.032	0.002	0.094		0.096		
A12	0.045	N.D.	0.004	0.215	0.018	0.011	0.293	0.015	0.038		0.053		
A13	0.025	0.003	N.D.	0.159	0.013	0.006	0.206	0.005	0.023		0.028		
A14	0.026	0.002	0.001	0.194	0.017	0.020	0.270	0.006	0.031		0.037		
A15	0.005	0.001	0.001	0.058	0.007	0.003	0.075	0.004	0.040		0.044		
A16	0.011	0.001	0.001	0.167	0.010	0.004	0.194	0.012	0.049		0.061		
A17	0.033	0.005	0.001	0.276	0.023	0.003	0.341	0.017	0.050		0.067		
B1									0.0276	0.0027	0.030		
B2												0.0137	
B3													
B4			0.00199				0.002						
B5				0.0006			0.0006	0.023	0.082	0.0082	0.1136		
B6		0.0164					0.0164						
B7				0.004			0.0043					0.0399	
B8	0.004	N.D.	N.D.	0.020	0.003	N.D.	0.033	0.005	0.026		0.031		
B9												0.5162	
B10												0.1424	
B11			0.0008				0.0008		0.088	0.0088	0.0972	0.0127	
C1	0.057	N.D.	0.0002	0.333	0.038	0.022	0.452	0.055	0.317		0.372		
C2			0.0036				0.0036		0.325	0.0326	0.358		
C3			0.0251				0.0251						
C4			0.0004855				0.0004855	0.05730	0.2922	0.0292	0.37870		
C5		0.0057					0.0057					0.0242	
C6								0.247			0.247		
C7									1.234	0.1134	1.347		
C8								0.4348			0.436		
C9													
C10									0.076	0.0076	0.084		
C11													
D1			0.0034				0.0034					0.0308	
D2									0.132	0.0132	0.145		
D3									0.457	0.0458	0.503		
D4													

Blanks indicate test done, nothing present.

Table 3. 1978 Rank Order of Sediment Chemical Concentrations, by Station Number and Parameter (in ppm unless indicated).

Parameter / Rank	% Total Volatile Solids		Immediate O_2 Demand*		Total Org. Carbon*		Chem O_2 Demand	
(highest) 1	C11	14.4	C11	3560	C11	1.67	C1	135,000
2	C8	11.3	C7	1940	C7	1.36	A9	107,000
3	C1	11.1	D10	1490	A10	0.94	C11	78,700
4	A9	10.4	C8	1120	C9	0.85	B9	76,100
5	C5	10.3	A10	1080	C8	0.81	C7	75,300
6	A10	9.78	B6	1050	B7	0.62	A7	71,400
7	D10	9.49	C5	827	C10	0.59	A8	66,500
8	B11	8.38	C10	795	B6	0.55	A10	54,800
9	C2	8.06	C2	772	C5	0.54	C6	45,500
10	A7	5.80	C6	647	B3,C6,D10	0.53	B6	43,400
(lowest)	A13	2.2	B1	77	B1	0.26	B1	9,560

Parameter / Rank	Sulfide*		Organic N		Phosphorus		Oil & Grease	
(highest) 1	C11	473	A7	2730	A9	5400	C11	21,500
2	C7	399	C11	2600	A7	4230	C7	13,730
3	D10	218	A10	2240	C1	2290	C8	9,370
4	C6	184	A9	2230	A8	1360	D1	6,570
5	B6	179	C1	1750	A4	1280	B2	4,350
6	B7	178	C8	1710	A3	1120	A7	4,320
7	B10	168	D10	1580	A1	926	A14	3,770
8	B11	165	B6,B3	1180	A2	855	B7	3,700
9	C2	160	B4	1080	A10	830	D10	3,330
10	B4	156	A8	1070	B8	791	C10	3,220
(lowest)	B1	113	B1	65.7	C9	246	B1	85

Parameter / Rank	Arsenic*		Cadmium		Chromium		Copper	
(highest) 1	B2	121	A7	2.62	C11	221	C7	233
2	B4	117	A9	1.73	C10	168	A10	222
3	B3	104	C11	1.42	C5	145	B6	221
4	D2	103	C1	1.36	C8	138	C11	210
5	B5	101	C5,A8	1.25	B6	116	C6	197
6	D1	91.1	A10	1.17	C6	114	A9	184
7	D3	75.3	A1	0.93	B7	106	B7	157
8	B1	70	C10	0.82	A10	105	C10	154
9	C3	67.5	A2	0.71	B10	104	A7	149
10	C9	62	A3,B11	0.69	B11	[illegible]	C2	143
(lowest)	C6	21.6	D3	0.30	A4	26	A13	15.8

Parameter / Rank	Iron		Mercury*		Manganese		Nickel	
(highest) 1	B3	69,600	C7	3.41	D2	842	C6	106.5
2	B2	68,500	C8	1.78	B2	748	C5	86.2
3	B4,B7	58,100	A10	1.31	B3	721	C11	76.2
4	B11	57,200	B6	0.961	B4	711	B2	71.7
5	C11	54,600	C2	0.797	D1	654	A10	61.7
6	A10	53,800	C10	0.739	B9	641	B4	61.1
7	B6	51,800	C6	0.712	B7,B10	623	B3	59.2
8	C5	50,700	B7	0.642	B6	592	B6	54.8
9	C2	46,300	C11	0.578	B11	584	B11	52.8
10	D10	46,000	C9	0.460	C10	528	B7	51.4
(lowest)	A4	13,800	D2	0.09	A4	177	A4	8.2

Parameter / Rank	Lead		Zinc		Total DDT		Total PCB	
(highest) 1	C11	401	C11	1317	A1	0.589	C7	1.247
2	C8	99.2	C8	488	A9	0.555	D3	0.503
3	C1	60.3	B6	440	A2	0.530	C8	0.434
4	C7	58.7	A7	389	C1	0.452	C4	0.378
5	D10	55.5	A10	369	A8	0.342	C1	0.372
6	C2	47.5	C7	366	A17	0.341	C2	0.358
7	A9	43.3	C10	348	A12	0.293	A9	0.321
8	B6	36.4	C2	334	A14	0.270	A7	0.308
9	B11	35.2	B7	317	A13	0.206	C6	0.247
10	A1	34.6	A9	289	A16	0.194	A8	0.148
(lowest)	A13	<3.6	A13	53.2	Not in B sta or C11	0.0		0.0

* Based on incomplete City data (see text).

Table 4. 1978 Sediment Pollutants Compared with 1973-74 (in ppm unless indicated).

1978 increase ↑ decrease ↓		1978 Ranges	1973-74 Ranges**
	% moisture content	62.6-26.09	57.56-21.94
	% Dry Matter	73.91-37.4	78.06-47.40
↑	% Total Volatile Solids	14.4-2.0	10.16-2.19
↑	Immediate O_2 Demand*	3560-647	1698-190
↓	% Total Organic Carbon*	1.67-0.26	2.239-0.302
-	Chemical O_2 Demand	125,000-9,580	128,502-11,050
↑	Oil and Grease	21,500-85	4,260-1,020
↑	Total Phosphorus	5,400-246	2,300-910
↑	Organic Nitrogen	2,730-65.7	953-107
↓	Sulfide*	473-113	4,216-86
↑	Arsenic*	121-21.6	17.0-1.01
↓	Cadmium	2.62-0.30	6.56-1.26
↑↓	Chromium	221-16	170-34.6
↓	Copper	233-15.8	296-36.4
↑	Iron	69,600-13,800	45,370-12,310
↓	Mercury*	0.134-0.09	4.17-0.10
↑	Manganese	842-177	489-210
↓	Nickel	106.8-8.2	148-17.3
↓	Lead	401-<3.6	413-38.4
↑	Zinc	1,317-53.1	516-61.0
↑↓	Total DDT	0.589-0.000	0.047-0.018
↓	Total PCB	1.247-0.000	5.728-0.222

* incomplete data
** AHF, 1976.

III. THE BIOLOGICAL ENVIRONMENT

A. PHYTOPLANKTON

INTRODUCTION

The phytoplankton, through photosynthetic conversion of non-living chemicals to organic matter, form a basic source of food on which many other marine organisms ultimately depend. Those organisms which graze on the phytoplankton serve in turn as forage for other trophic levels in the food web. The size and species composition of phytoplankton populations and their activities are affected by a variety of environmental factors including availability of nutrients and other chemical entities, temperature, light, and residence time in any given area.

In Los Angeles-Long Beach Harbors several studies of the phytoplankton and their activities have been conducted with sufficient areal coverage and long enough periods of time to establish the patterns of occurrence and the factors that shape these patterns. These include the Harbors Environmental Projects (HEP) monitoring study (Allan Hancock Foundation, 1976) of the entire San Pedro Bay in the years 1973-1974, the four-year monitoring study for Southern California Edison of part of the Port of Long Beach by Environmental Quality Analysts and Marine Biological Consultants (EQA-MBC, 1978), and the seven-year study of outer Los Angeles Harbor by HEP (Soule and Oguri, 1979).

These studies outlined a seasonal pattern in which the winter low levels of standing crop and production or productivity were succeeded by a spring bloom, primarily of diatoms. Following a slight reduction during the summer there was usually a secondary bloom in the fall that could exceed in magnitude the spring bloom. This bloom usually was dominated by dinoflagellates.

The patterns were similar to the seasonal succession of events in adjacent oceanic waters. However, the magnitude of populations and their activities was considerably greater in the harbor than in the ocean, and the timing of events sometimes showed differences. The differences were also magnified during periods of active blooming.

The effects of short-term traumatic events on marine ecology, such as the explosion of the tanker *Sansinena* in 1976, were reported on by Soule and Oguri (1978) as these occurrences affected the marine ecology. In the aftermath of that explosion there was a moderate increase in phytoplankton productivity in the immediate vicinity which lasted for about two weeks.

The impacts of a variety of ongoing environmental changes in the harbors have also been considered as they affect the phytoplankton. Emerson (1976a, 1976b) considered some of the short-term effects of primary treated sewage and of cannery wastes on phytoplankton productivity. This was further considered in a report by Soule and Oguri (1979) which followed the patterns of productivity and standing crop in natural populations as different types of waste treatment were instituted by the canneries and by Terminal Island Treatment Plant over a period of several years. The last study, which first presented some of the data discussed here, also considered the effects of a plant upset at the treatment plant during the summer of 1978. The greatest change was a more than four-fold decrease in phytoplankton after canneries installed DAF units in 1974-1975. It was reported that, at a series of stations in outer Los Angeles Harbor, productivity and assimilation ratios showed decreases from 1976 levels in both 1977, when secondary treatment was initiated at the Terminal Island Treatment Plant (TITP), and in 1978, when the cannery wastes were diverted into TITP for treatment prior to discharge. There was relatively little effect on the standing crop of chlorophyll *a* in the receiving water area as a result of these changes.

The present report documents the results of a harbor-wide survey during 1978 of phytoplankton standing crop, as shown by chlorophyll *a* concentrations, photosynthetic productivity and assimilation ratios. The stations occupied and the methods used are largely unchanged from those of the earlier harbor-wide survey of 1973-1974, except for the addition of stations in outer Los Angeles Harbor and deletion of those near the San Gabriel River. Therefore, it is felt that the data are directly comparable to those reported in AHF (1976) and by Oguri (1976).

METHODS

Samples of surface waters were collected in a seawater-rinsed plastic bucket at 41 stations in the area of the Long Beach and Los Angeles Harbors (Figure 1). The stations were sampled monthly from December 1977 through December 1978.

A portion of each sample (0.3-1.0L, depending on cell concentrations) was filtered on shipboard through a 0.45 μm Millipore filter and buffered with a few drops of a suspension of magnesium carbonate. The filtered cells were stored in a light-tight refrigerated container for later analysis. In the laboratory chlorophyll was extracted and the concentration in mg chlorophyll *a* per cubic meter was determined spectrophotometrically according to the methods and formulae of Strickland and Parsons (1968; 1972).

Another portion of the water sample was used to fill duplicate light and dark 125 ml glass stoppered bottles. All bottles were held in the dark until a standard time for incubation. A known quantity of radioactive carbon as $NaH^{14}CO_3$ (0.75 or 2.4mCi, depending on preparation used) was added to each bottle with subsequent mixing. The bottles were then filtered on 0.8 μm Millipore AA filters and the filters stored in a light-tight dessicator. In the laboratory the amount of radioactive carbon taken up in each sample was determined in a Nuclear-Chicago gas-flow radiation counter. The amount of carbon fixed by the phytoplankton expressed as mgC/m^3hr was calculated according to the method of Steiman Neilsen (1952), modified.

Assimilation ratios were calculated from chlorophyll *a* values and carbon fixed according to the formula $A - \frac{mg\ C/m^3/hr}{mg\ chl\ \underline{a}/m^3}$. The units of A are mgC/mg chl.

RESULTS

The monthly data for the 1978 study are presented in Table 1. Seasonal and annual averages for each station are presented in Figures 2 through 16. Based on past seasonal records, the months considered as winter are December through February, spring is March through May, summer months are June through August and the fall months are September, October and November.

Chlorophyll *a*

Chlorophyll *a* concentration is considered herein as a measure of the standing crop of phytoplankton in the waters.

In the winter, chlorophyll *a* concentration was at the seasonal minimum for the harbor as a whole. With the exception of the area to the south and east of the TITP outfall, the standing crop appeared to be fairly uniform and low. The high average values at stations A15 and A16, as shown in the legend for Figure 2, were due to unusually high values found there in December. Even if those values were ignored, that area would still have had the highest values during the winter season. The inner harbor, with the exception of station C1 in the mouth of the Los Angeles Main Channel, had values of less than 1 milligram per cubic meter of chlorophyll *a*, values even lower than at the stations outside the breakwater A1 and B1.

In the spring, when a phytoplankton bloom would be expected, based on past occurrences, there was an overall moderate increase in the standing crop. This is most readily apparent from inspection of the legends for Figures 2 and 3, which show an increase of values, but it is less apparent in the figures themselves, due to the two high values mentioned in the previous paragraph. The higher values during the spring are associated, as during the winter, with the area to the southeast of the outfalls in outer Los Angeles Harbor, and also the area off the mouth of the Los Angeles River.

The Los Angeles inner harbor channels showed localized differences in levels of standing crop, but with few exceptions no values were lower than those at the sea buoys outside the inner harbor and none were higher than those adjacent to the outfall (A4 and A15) in the spring.

Summer values, shown in Figure 4, in general followed the same trends. Values tended to be higher, with the highest levels of chlorophyll *a* appearing near the outfall and off the mouth of the Los Angeles River. Minima were, as before, at the stations near the sea buoys outside the harbor. The inner channels of both harbors showed increased standing crop in the summer, with values in the Port of Long Beach inner channels exceeding those in inner Los Angeles Harbor.

The standing crop of chlorophyll *a* in the fall, as seen in Figure 5, showed patterns somewhat similar to the previous seasons. There was a general overall increase in standing crop, although values in inner Los Angeles Harbor were generally lower and less uniformly distributed. Higher values occurred in the outer harbor generally, although patterns were more disjunct. The inner harbor of the Port of Long Beach showed the high values, particularly at station B7, where concentrations of chlorophyll *a* indicated the occurrence of bloom conditions. Values typical of bloom conditions were even higher at the mouth of the Los Angeles River. Low values were also found at the two stations outside the breakwater.

Annual averages of chlorophyll *a* concentrations throughout the harbor are shown in Figure 6. These data show the same distributional pattern seen in the seasonal averages. The highest values are found in the area near the outfall and off the Los Angeles River. Lowest values occurred at the stations near the sea buoys. The inner channels of the Port of Long Beach had generally higher chlorophyll concentration and more uniform distribution than occurred in the inner Los Angeles River.

Productivity

The seasonal changes in productivity were similar to those described above for chlorophyll *a*. Productivity values during the year are shown in Figures 7 through 10 for the four seasons and the annual average is shown in Figure 11. Winter, as seen in Figure 7, showed the lowest average values. As discussed above for the winter chlorophyll *a* data presented in Figure 2, the highest values found were unusually high and occurred at stations A15 and, to a lesser extent, A16 during the month of December 1977. If these two data points are ignored, this area would still be the one with the highest productivity during this season. Throughout the rest of the harbor productivity was low, as is characteristic for the winter season. Even the area off the Los Angeles River mouth and Consolidated Slip, where seasonal runoff could enrich the waters, had low productivity values.

In the spring, shown in Figure 8, there was an overall increase in levels of productivity throughout the study area, although the outfall area showed only a slight increase. Highest values nevertheless occurred in this part of the outer harbor to the south of Terminal Island and in several localized areas of inner Los Angeles Harbor. Stations outside the breakwater showed the lowest productivity.

Productivity values, given in Figure 9 for the summer, showed a small overall increase in average. However, this increase was due more to localized higher productivity, primarily in the outer Los Angeles Harbor, than to a general increase.

Productivity during the fall (Figure 10) throughout the entire study area was sharply higher, particularly in the area near the mouth of the Los Angeles River and in both inner and outer Long Beach Harbor. Lowest values occurred at the sea buoys and in the West Basin of Los Angeles Harbor. Even in the outer harbor productivity appeared to increase from west to east.

The annual averages for the year at the different stations are shown in Figure 11. The lowest average values are found at the sea buoys, stations A1 and B1, although productivity at these stations was not the lowest during the winter and summer seasons. Maxima occurred in the waters near the Los Angeles River mouth and in the area to the east and south of the outfall.

Assimilation Ratio

Assimilation ratios represent the functional efficiency of a given amount of phytoplankton. Natural or man-made environmental stress can affect the ability of the phytoplankton to function. Figures 12 through 16 present the four seasonal and the annual values for the assimilation ratio.

Seasonal variation in assimilation ratios differed from those of chlorophyll *a* and productivity. The low values for winter were followed by a small increase in the spring. Summer assimilation ratios were the lowest for the year and fall values were the highest. However, there were no areas that consistently showed patterns of high and low assimilation for all seasons, although the stations near the sea buoys, A1 and B1, showed low values except in the fall. Also, in every season, some part of inner Los Angeles Harbor showed high values and in general higher assimilation than inner Long Beach Harbor.

DISCUSSION

Spatial Distribution

Several persistent patterns occurred in 1978. For the three types of parameters measured, the area between Terminal Island

and the Federal (middle) Breakwater was frequently shown to be an area of high standing crop, high productivity and high assimilation. This is in the area affected by the discharge of secondary treated wastes from TITP (Soule and Oguri, 1979). Several studies of circulation have shown the presence in this area of a clockwise gyre (Soule and Oguri, 1972; 1979; McAnally, 1975) which would tend to keep the material discharged and populations of phytoplankton in the area. This would enhance the effect of any stimulating material present such as nutrient salts or particulate matter.

Another area of frequent high values in the phytoplankton measurements was the area of receiving waters near the mouth of the Los Angeles River, shown as stations D1, D2, D3 and D10 in Figure 1. Although it is not a prominent area during each season for the different parameters, the annual averages (Figures 6, 11 and 16) indicate that it is an area of high productivity. The area east of Pier J had been noted as an area of frequent red tides up through 1974 (AHF, 1976). The river serves as a storm drain for a large part of the Los Angeles basin (Section I). A variety of effluents are also discharged into the area. The bottom sediments of the area are anoxic, suggesting that there is a continual input of material with a high oxygen demand, probably organic. The flow from the Los Angeles River and mineralization from the bottom sediments could contribute nutrients to the high standing crop and productivity found there.

The stations at the sea buoys A1 and B1, one-half mile outside the harbor entries, are notable for being among the lowest in standing crop, productivity and assimilation at all times. While these stations are influenced to some extent by tidal flow, they are more typical of the ocean environment. If these stations are accepted as more representative of oceanic conditions than others, it suggests that the harbor is most strongly influenced by factors other than those stemming from the ocean. The residence time of the waters, once they have entered the harbor, the influence of terrigenous inputs, and the uses of the waters within the harbor are among the factors that could explain the differences.

The oceanic influence extends into the harbor as a "tongue" of low phytoplankton values similar to those found at the sea buoy stations. The intrusion of waters at Queens Gate, to the north of station B1, is usually not as great as the one at A1. In some cases, there is a reversal with waters at B1, reflecting the higher values of the harbor. The tongue of oceanic waters which enters Angels Gate from A1 is somewhat more extensive, often moving toward the Los Angeles Main Channel and eastward along the inside of the breakwater. Normal tidal circulation in the harbor results in a net flow eastwards through the outer harbor. Calculations based on both prototype data and hydraulic model data show a substantial net influx of water into the harbor at Angels Gate, which sustains the gyre (Section I, Hydrology).

The phytoplankton patterns were variable in the inner channels of the harbors, those around Terminal Island, throughout the seasons. Localized patches of high or low values occurred, particularly in the inner Los Angeles Harbor C stations. This could be due to the presence of a variety of outfalls throughout the inner harbor. Thermal effluents are discharged near B5 in Long Beach and C6 in Los Angeles West Basin. Dominguez Slough, near C11, serves as a storm drain for part of the Los Angeles area and apparently still carries some urban wastes. The area near station C11, and station D1 near the river mouth, both show the intrusion of low saline waters into the area during every season. A variety of other effluents, including ballast water discharge, took place in these waters near C4, as did some oil and chemical spills. Runoff of storm water and industrial washings are also common inputs into the harbor. The low rate of tidal water movement reported in the inner harbor (McAnally, 1975) would also tend to promote the patchy occurrences of phytoplankton.

Seasonality

The seasonal patterns usually attributed to phytoplankton would include winter low standing crop and productivity data, since lower temperature and less light limit photosynthesis and therefore limit assimilation. With the warming trend of spring and the increased insolation, the phytoplankton productivity and assimilation would increase, resulting in increased levels of standing crop. This increase is often referred to as a spring bloom, and a modest one did occur in the harbor in the spring of 1978. During the summer of 1978, there was an increase in levels of chlorophyll *a* but no overall increase in productivity resulted, which caused a reduction in the average rate of assimilation. Although productivity showed no mean increase during the summer, increases did occur at stations in the outer harbor in the area affected by the circulation gyre and the treatment plant discharges. During the fall of 1978, a bloom occurred that resulted in elevated values of chlorophyll *a*, productivity and assimilation ratio, the highest values of the year.

The year 1978 was the first since HEP studies at the harbor began in 1971, in which all wastes discharged into the outer harbor had been processed as secondary treatment at TITP. During the summer the plant had a major upset which resulted in the discharge of substantial levels of BOD and suspended solids into the receiving waters. The plant also chlorinated their effluent from March through August, corresponding to the periods designated spring and summer for this report.

It is notable that the levels of chlorophyll *a*, productivity and assimilation ratio increase somewhat during the spring when chlorine was used, over the winter values, when chlorine was not used. During the summer months, when both plant upset and chlorine were present, there was a further increase in the standing crop of chlorophyll *a* and in that area a very modest increase in productivity. However, the assimilation ratios were lower, indicating both increased nutrients and increased stress or toxic inhibition.

The fall bloom coincided with resolution of the plant upset at TITP and the cessation of chlorine usage, but the bloom was more general, affecting the waters at A1 and B1 as well as those within the breakwaters.

Chemical analysis of mineralized nutrients (nitrate, nitrite, phosphate, and ammonia) discussed elsewhere in this report, was carried out on aliquots of the same water samples that were used for the productivity and chlorophyll measurements. These showed seasonal values that were almost the inverse of the productivity and chlorophyll values. Values for all of the nutrient salts measured were the highest in the winter. Nutrient levels tended to drop through the spring and summer and then showed a modest increase in the fall. Nitrite values were similar in spring and summer. In almost all seasons the concentrations of the nutrient salts were lowest at A1 and B1. This suggests that the nutrients were either used rapidly during periods of high levels of phytoplankton activity, or were only carried into the harbor seasonally from runoff and subsequently depleted. The levels maintained, however, suggest that nutrients were not limiting.

Temperature

The role of temperature in regulation of phytoplankton activities has been briefly mentioned. In the water quality section of this report (Section I) the data show that there is usually a trend of progressive increase in temperature from winter through fall, throughout the entire harbor. This parallels the increases noted in average values chlorophyll *a* and, to a lesser extent, increases in productivity through the seasons. A comparison of temperature data from selected areas with chlorophyll and productivity information showed that in some areas there was a parallel change in the parameters and in others there was none. There was generally a positive correlation for temperature and phytoplankton in the outer harbor area that receives TITP effluent (stations A7 and A11, and in the stations near the Los Angeles River mouth. These were also among the most productive and had the highest standing crop at all seasons of the year. Both localities apparently receive enrichment from their respective effluents. However, the trends in seasonal temperature averages did not coincide with the phytoplankton measurementts in the areas near thermal effluents, at stations C4, C6 in West Basin of Los Angeles, and at B5 in Long Beach Back Channel.

Comparison to Other Studies

Soule and Oguri (1979) presented and compared data for representative outer Los Angeles Harbor stations with regard to chlorophyll *a* concentrations, productivity and assimilation ratios during the years 1976, 1977 and 1978. These data showed annual decreases in productivity and assimilation ratio but no major change in chlorophyll *a* concentration during this period.

An earlier monitoring program (AHF, 1976; Soule and Oguri, 1976) conducted in 1973-1974 covered the area of the present study and most of the same stations. For both studies the same techniques were used. The data are therefore directly comparable.

Standing crop of phytoplankton, as shown by the chlorophyll *a* concentrations, showed similar patterns of distribution of averaged annual results, but absolute values were considerably higher in the earlier period. During both periods the areas of highest standing crop were the area by the Los Angeles River mouth, the northeastern part of inner Long Beach Harbor, near Channel 2, and the area to the south and east of the outfalls, where the main current gyre is. The lowest values occurred at A1 and B1, the sea buoy stations. In the inner harbor there was a general pattern of increasing chlorophyll *a* concentration in moving from west to east around Terminal Island (Figures 17-20).

The values found for productivity for the two periods showed the same patterns described above for standing crop (Figures 21-24). Maxima and minima of the annual averages occurred in the same areas and the overall average values were 5 to 10 times higher in the earlier period than in 1978. Assimilation ratios in the earlier period were higher than in 1978. In 1973 typical average values were about 3.5 to 5.0, in 1974 they were about 4.5 to 6.0, but in 1978 the typical values ranged from about 2.0 to 4.0. Distribution of these values was similar during both periods but differed from the distribution of the productivity and chlorophyll *a* data. In the inner harbor areas there was a reversal in trends, with higher values appearing in the Los Angeles inner harbor and near the Los Angeles River mouth, especially in the autumn (Figure 15). Spatial seasonal and annual differences are illustrated in Figures 25 to 28. The highest values for productivity and chlorophyll *a* that occurred in 1973 and 1974 reflect the occurrence of intense red tides during those years. The red tides of 1973 were most widespread during the summer and early fall in both the inner and outer harbors. In the Los Angeles River mouth area red tide occurrence started earlier and extended later with peaks during the summer, particularly July, and in December. In 1974, blooms were less restricted in time. High productivity, standing crop and assimilation were seen in January and April in the outer harbor, during the summer and early fall in inner Long Beach Harbor, and near the Los Angeles River mouth. In inner Los Angeles Harbor an intense bloom occurred only in the fall, involving the entire study area but with maxima in the area of the Los Angeles River mouth and in the outer harbor in the area of the main current gyre. Values for productivity and to a lesser extent to chlorophyll *a* were substantially lower than for the earlier period.

The occurrence of the blooms in time and space during the

1973-1974 study period precludes close comparison of the seasonal patterns between the two periods. However, it appears that winter for both periods was the season of lowest values. A spring bloom was evident in the data for the earlier study but not in the 1978 data. Secondary blooms occurred primarily in the summer during 1973-1974 but only in the fall during 1978, and the magnitude was less by a factor of 5 to 10.

From 1974 through early 1978 a study including measurements of phytoplankton standing crop, production and assimilation was carried out in parts of the Port of Long Beach by EQA-MBC (1978). The exact station locations and the methods used differed from the ones used in this study, precluding direct correlation, but the overlap in time and the nearness of stations permits some very limited comparison and several conjectures.

The sampling for this study in the Port of Long Beach began in December 1977, allowing an overlap of 4-5 months with the Edison survey. Unfortunately, this overlap includes the seaonal minima in standing crop, productivity and assimilation.

The data presented for 1974 by EQA-MBC are in general agreement with the trends in standing crop noted above for the AHF (1976) study. High values were found during the summer of that year, particularly in the inner channels, due to the occurrence of red tide. This was also reflected in the high seasonal productivity values reported. The trends are roughly comparable, but the absolute values reported reflect the use of different methods.

During the months of 1978 when both surveys were underway, January through April, there was a substantial agreement in trend but no agreement in absolute data values. The techniques used by EQA-MBC appear to yield data somewhat lower in absolute value but not by a simple factor.

Comparison of the HEP phytoplankton data for chlorophyll *a*, productivity and assimilation ratios show that a great deal of variation has occurred in both the timing and abundances from year to year. The virtual absence of a spring peak in 1978 would have had great influence on those zooplankton and fish species that are dependent on a precisely timed bloom for larvae or juvenile feeding. The 37$\pm$ inches of rain in the December 1977-April 1978 period may well have dispersed phytoplankton from the harbor, or at least decreased populations below the density needed by fishes, discussed in the section on Fishes herein. The larger September peak appears to be typical of harbor dynamics and may coincide with either the fall reproductive period or could represent the decrease in predation by those juveniles in the spring stock that move to deeper water during the summer.

The present investigations did not include identification of phytoplankton species. These have been investigated in the vicinity of the Southern California Edison Company's Long Beach

Generating Station located in the Long Beach Harbor near station B5. EQA-MBC (1978) reported that diatoms and dinoflagellates comprise most of the total phytoplankton; diatoms dominated the Long Beach area except for the major dinoflagellate blooms, in June, August and September 1974, and less so in November 1975. The genus *Chaetoceros* dominated the phytoplankton, including 24 species plus unidentified *Chaetoceros* spp. Other numerically important species were *Asterionella japonica* and *Skeletonema costatum*. *Eucampia zoodiacus, Leptocylindrus danicus, Nitzschia* spp. and *Thalassiothrix* sp. were occasionally important in the populations.

In the dinoflagellate blooms, *Prorocentrum micans* had the highest recorded numbers of any dinoflagellate in the Edison surveys in June 1974. *Gonyaulax polyedra* was important in the August and September 1974 blooms, but *Noctiluca scintillans* was the most abundant dinoflagellate in September 1974. *Ceratium* spp. were recorded in each year and *Dinophysis caudata* was the dominant dinoflagellate in February 1978.

According to EQA-MBC (1978), the peak numbers of species were found in the pre-operational period (1974-1976) during April, June, March and May and the lowest were found in September, July and January. The greatest mean numbers of species occurred in the outer harbor, apparently correlated with depth. During the operational period of the generating station and its thermal effluent (1977 to April 1978) the peak periods for mean numbers of species were October, June and July, and the low periods were January, February and November.

Numbers of species were increased when abundances of total phytoplankton were increased (EQA-MBC, 1978).

The local *Gonyaulax polyedra* is not considered to be fatally toxic, but may cause gastroenteritis. It has caused fish kills by depleting the dissolved oxygen and kills mussels and other filter-feeders by clogging gills. Mass mortalities in turn cause problems with masses of decaying fish and shellfish with further oxygen demand.

Dale and Yentsch (1978) reviewed the world-wide incidence of dinoflagellate blooms ("red-tides") which cause paralytic shellfish poisoning (PSP). They noted that blooms in some cases were associated with reduced salinity and high organic runoff from land. Others pointed out the occurrence in areas between upwelling and passive concentrating mechanisms (harbors, bays and islands may cut down wind or circulation and concentrate the phytoplankton). This does not explain the large, local blooms in 1973-1974 in years with 7 to 14 inches of rain, no blooms in 1975-1977, with similar rainfalls. Anderson and Morel (1978) found that cupric ions inhibited the Atlantic species *Gonyaulax tamarensis*. They postulate that heavy rainfall or mixing of organic materials would lower the Cu levels or complex them to the organics. High levels of organic iron are also needed.

Locally, iron levels were high around Pier J in Long Beach and near the Los Angeles River mouth, as well as at the entrance of the Los Angeles main channel in 1973-1974 (AHF, 1976). Levels decreased greatly at the river mouth (station D2) in 1978 after the heavy winter-spring rains. Copper levels are highest in the inner harbor stations and in the outer harbor at A7, A9 and A10. This might account for the consistently higher primary productivity and chlorophyll *a* values and lower assimilation ratios in 1973 and 1974 near the river (Figures 20, 24 and 28). Note that A station productivity values ranged to a maximum of 91.87 mgC/hr/m^3 and D stations reached 402.15 mgC/hr m^3. Similar rescaling was necessary to plot chlorophyll *a* values; A stations had a June 1974 maximum of 21.17 mg/l, while the two B stations had a June 1974 maximum of 112.74 and the D stations peaked near 80 in September 1974.

Dale and Yentsch (1978) showed there where igneous rocks, including waste rock from abandoned copper mines, occurred along the Miami coast, outbreaks of PSP did not occur. It would indeed by ironic if prohibiting copper anti-fouling compounds had actually increased phytoplankton blooms. There have been changes in point-source controls in regard to the river channel over the past several years. However, the lack of coastal blooms in 1976-1978 suggests that the causes and solutions cannot be attributed solely to river runoff along the coast and in the harbor.

Morey-Gaines (1978) noted that the phytoplankton populations were more stable in 1977 near the cannery plume (near station A16) than near the sea buoy (A1). He noted that unicellular ciliates increased following the die-off of blooms, indicating their importance in recycling nutrients along with bacteria. Cannery wastes, in laboratory tests, shifted wild plankton populations from diatoms and dinoflagellates toward unicellular flagellates and ciliates. These unshelled microzooplankton would, like bacteria, not be evident in gut contents studies of fish or invertebrates; their importance has thus been largely overlooked. Soule and Oguri (1979) documented the nutrient transfer in the food chain via microheterotrophs (bacterioplankton).

CONCLUSIONS

Variations in time of chlorophyll *a* concentrations, productivity and assimilation ratios in San Pedro Bay during 1978 were largely seasonal. With minor exceptions the general pattern in 1973-74 was of winter minima, followed by a spring bloom, with secondary blooms in summer and fall. The 1978 results were similar to the sequence described for other years and other studies in the area, except that a major departure occurred in which there was a large reduction in the spring blooms, particularly in the outer harbor.

Distributional patterns of the same parameters within the Bay during 1978 also appeared to be essentially similar to that described in the other studies. In general the circulation, and the uses to which the waters in any area were put, appeared to be related to the relative magnitude of the standing crop, productivity or assimilation occurring in any given area.

The low current velocities in the harbor, particularly around Terminal Island, and the current gyre and the net eastward drift in the outer harbor, result in longer residence times for the water in any area and therefore longer times for any buildup of pollutants, either biostimulatory or bioinhibitory, that may be discharged into the area. The long residence times also permit the growth of populations in response to the local impacts. These may have been due to waste effluents from TITP near station A7, or Lever Brothers plant near station B6, both of which seem to enhance phytoplankton activities. Thermal effluents near C6 in West Basin of Los Angeles Harbor and B5 in the Back Channel of Long Beach Harbor also appear to be stimulatory. Freshwater input from the Los Angeles River and Dominguez Slough during the dry seasons of summer and fall probably result in negligible flows. Nevertheless, these areas show the effect of biostimulation during almost all seasons of the year.

The influence of the ocean on the phytoplankton activities within the harbor is most apparent at the sea buoys but is largely masked by the stimulatory influences of the harbor environment.

A comparison of these data with those from other surveys of the harbor or parts of it shows substantial agreement in the seasonal trends of events and the distribution of the relative values throughout the area. The values reported, however, indicate that the harbor, as a whole, is at the lowest level of phytoplankton standing crop and productivity since the earliest comprehensive survey was conducted in 1973-1974. Standing crop, as shown by chlorophyll *a* measurements, productivity and assimilation ratio all showed a consistent downward trend over the years and the occurrence of intense phytoplankton blooms has been sharply reduced.

Mean total Chlorophyll *a* (standing crop) was greatly reduced in 1978 over 1973 and 1974 levels, when extensive summer red tide blooms last occurred. The usual spring peak was much smaller in 1978, and was almost non-existent at B and C stations. Mean Chlorophyll *a* maxima were reduced about four-fold at A stations, about nine-fold at B stations, more than 12-fold at C stations between 1974 and 1978. A September 1978 D station bloom rose to about 60% of 1974 values.

Mean productivity maxima were reduced six-fold at A stations which peaked in November 1978 as compared with the 1973

July maximum; B station peaks were reduced four-fold, as were C stations. D station peaks were reduced about eight-fold, but the 1974 D station maximum had exceeded 400 mg $C/hr/m^3$ as compared with 140 at B stations in 1973 and close to 100 at A and C stations at that time. While the earlier high values represented blooms, which reduced dissolved oxygen below acceptable levels, they represented food available to fish larvae in particular. The phytoplankton reductions may thus be related in part to reductions in harbor fish populations. No harbor-wide red tiedes have occurred since 1974. Since coastal red tides occurred from Baja California to Pt. Conception at that time, the phenomenon cannot be directly related to effluent changes.

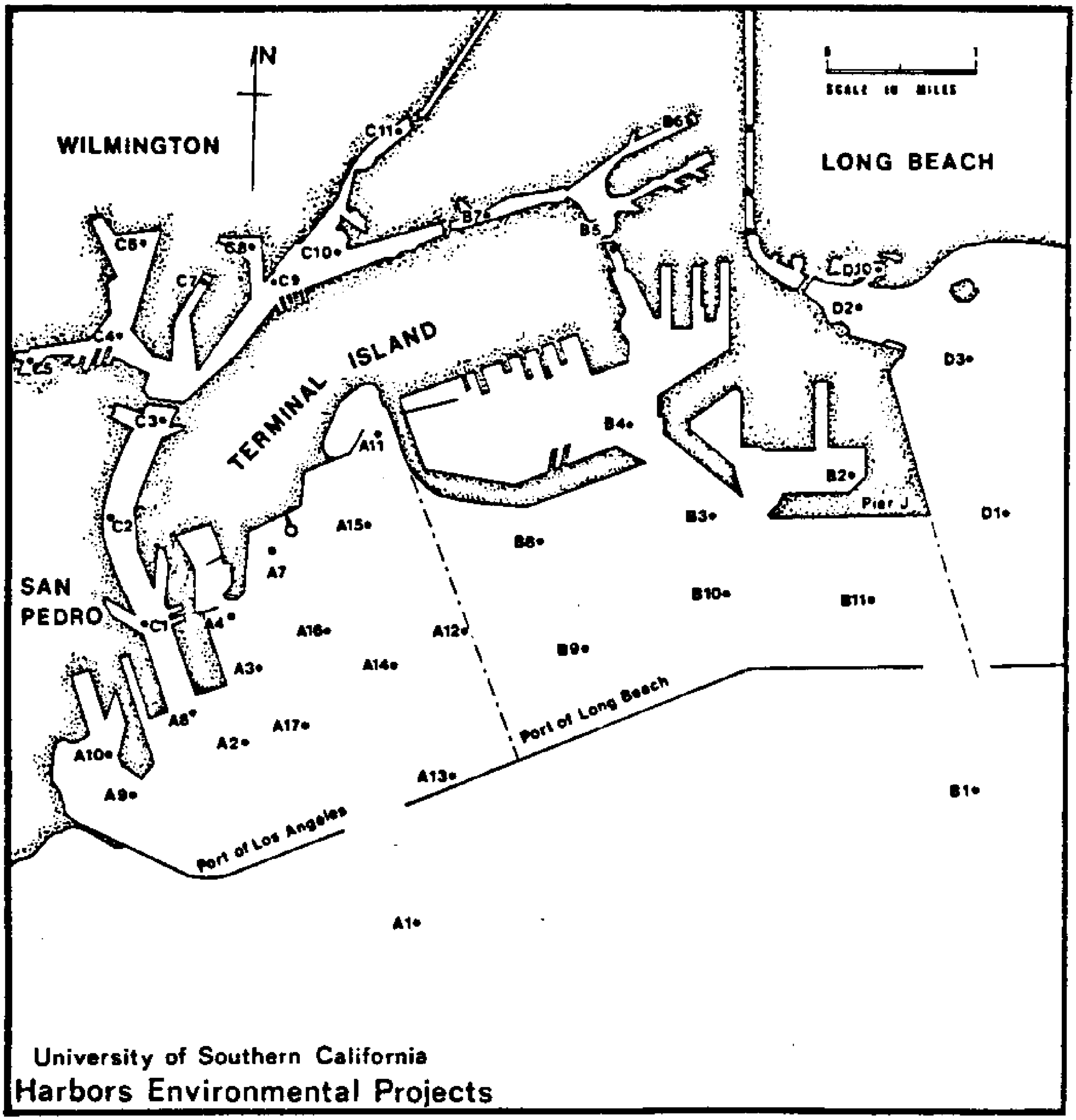


Figure 1. Phytoplankton Sampling Stations, 1978.

FIGURE 2. CHLOROPHYLL a
WINTER 1977-1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.0        13.20


TOTAL MISSING DATA POINTS IS          3


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM     0.0      1.00      1.50      2.00      2.50      3.00      4.00      6.00     12.00     15.00
  MAXIMUM     1.00     1.50      2.00      2.50      3.00      4.00      6.00     12.00     15.00     18.70

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              5.35     2.67      2.67      2.67      2.67      5.35     10.70     32.09     16.04     19.79

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1         2         3         4         5         6         7         8         9        10
          ====================================================================================================
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
  SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■*■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
           .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          ====================================================================================================
  FREQ.         19         7         9         3         0         1         0         0         1         0
        1   I..1..I   I''2''I   I--3--I   I==4==I            IXX6XXI                        I■■9■■I
        2   I..1..I   I''2''I   I--3--I   I==4==I
        3   I..1..I   I''2''I   I--3--I   I==4==I
        4   I..1..I   I''2''I   I--3--I
        5   I..1..I   I''2''I   I--3--I
        6   I..1..I   I''2''I   I--3--I
        7   I..1..I   I''2''I   I--3--I
        8   I..1..I             I--3--I
        9   I..1..I             I--3--I
       10   I..1..I
       11   I..1..I
       12   I..1..I
       13   I..1..I
       14   I..1..I
       15   I..1..I
       16   I..1..I
       17   I..1..I
       18   I..1..I
       19   I..1..I

0.369064 MINUTES FOR HISTOGRAM
```

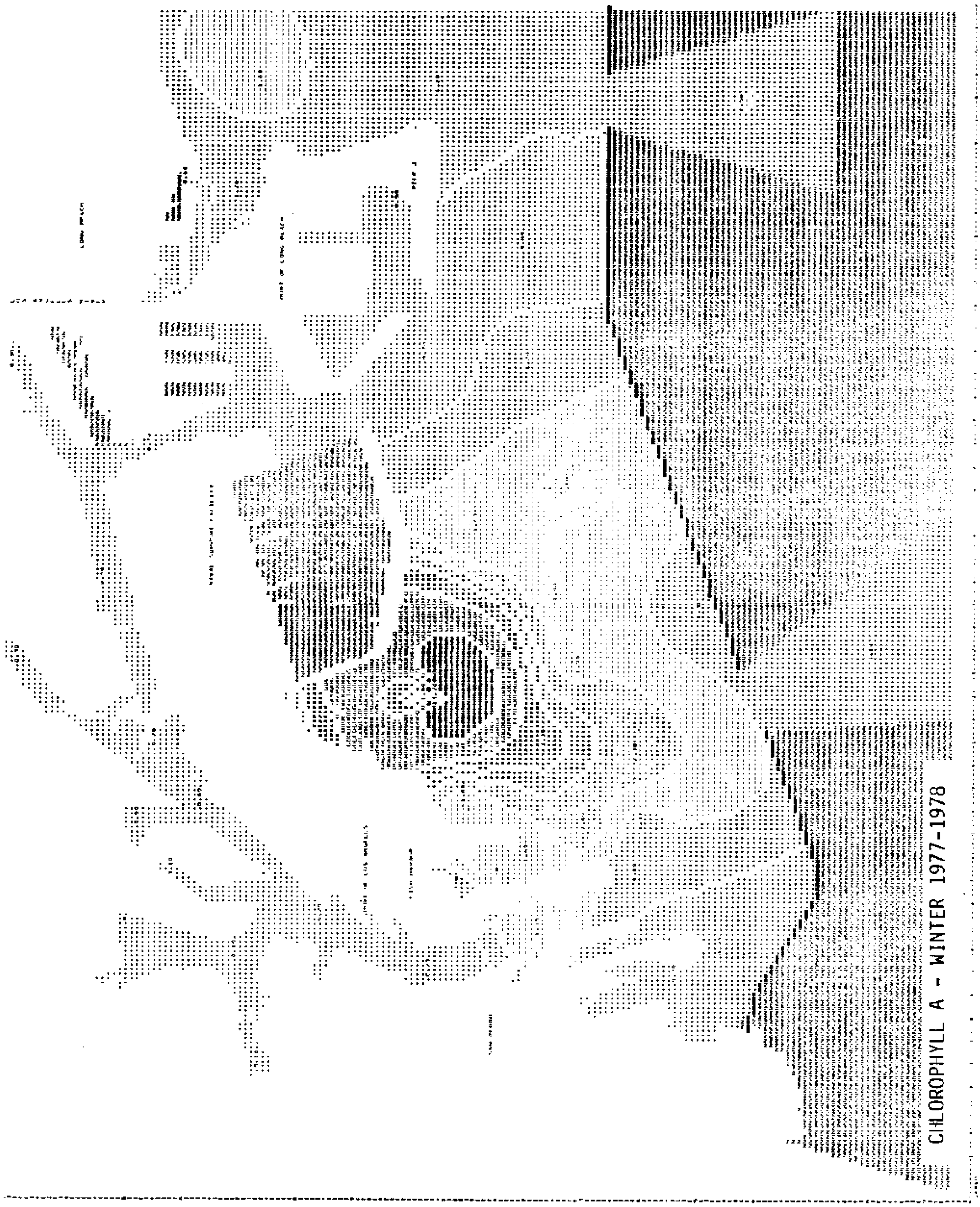

CHLOROPHYLL A - WINTER 1977-1978

FIGURE 3. CHLOROPHYLL a
SPRING 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.60 3.60

TOTAL MISSING DATA POINTS IS 2

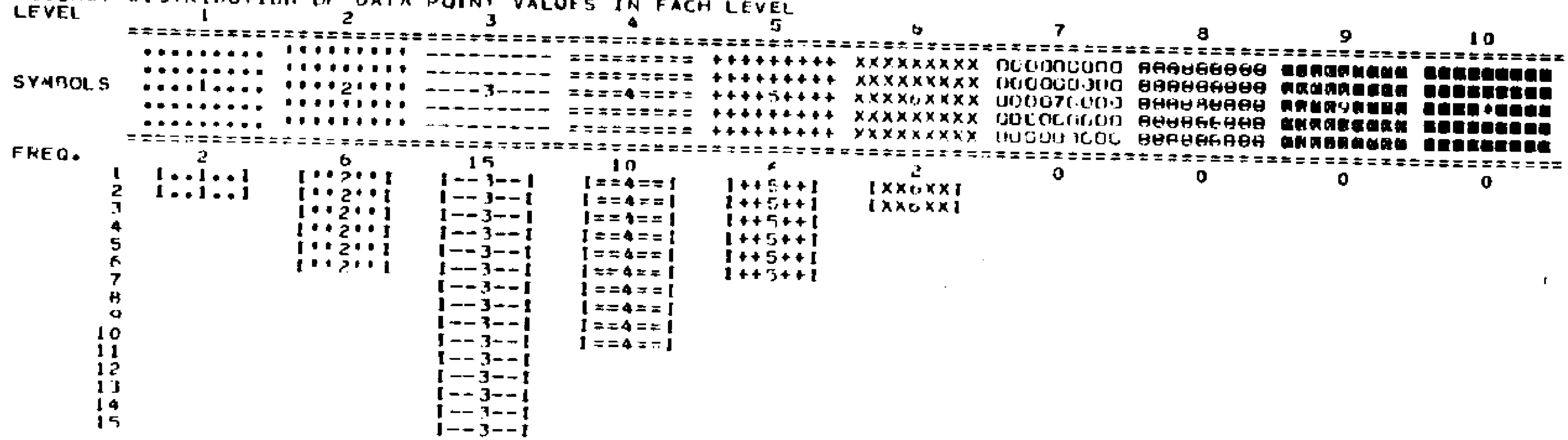
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00	18.70

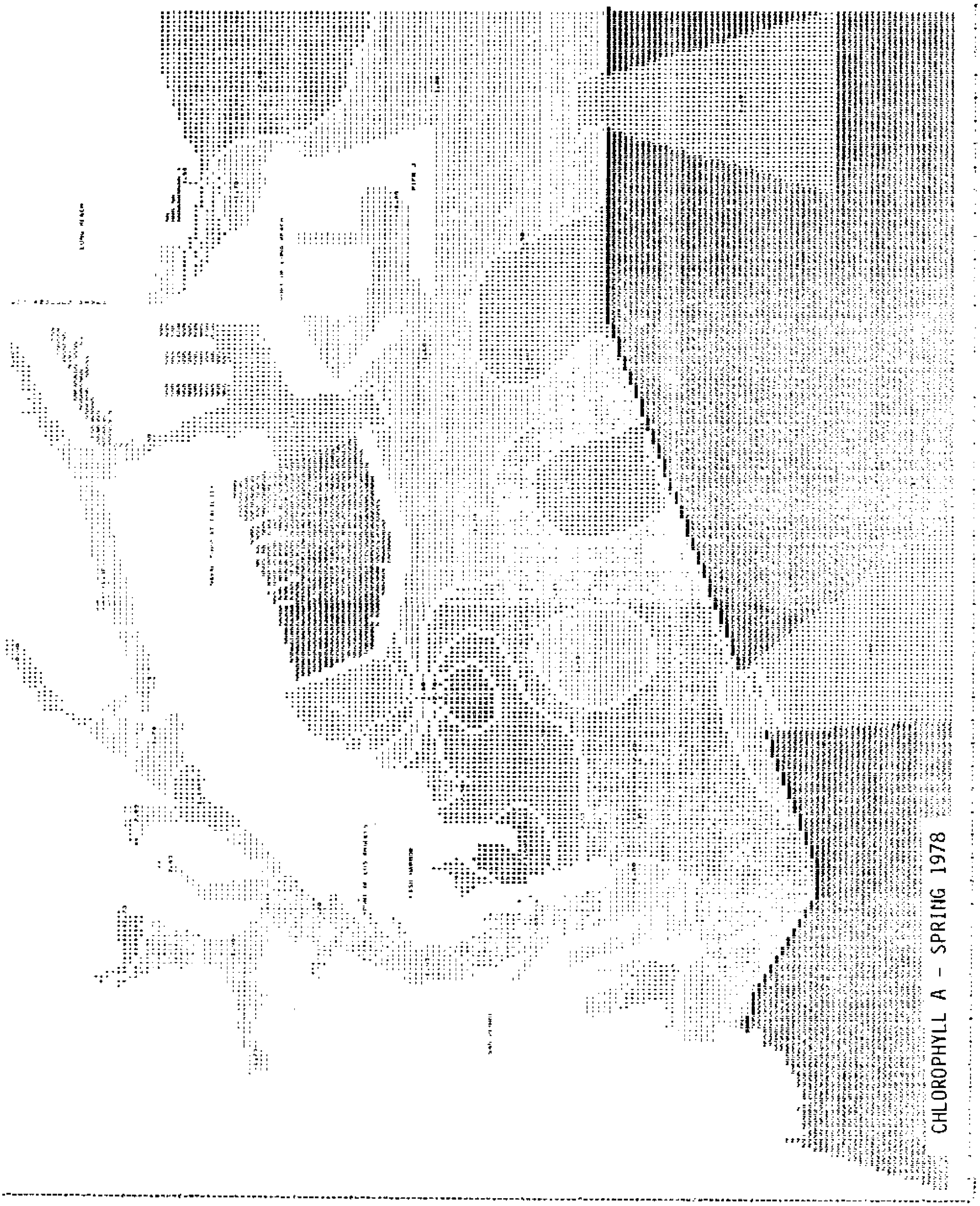
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

5.35	2.67	2.67	2.67	2.67	5.35	10.70	32.09	16.04	19.79

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



0.391251 MINUTES FOR HISTOGRAM



CHLOROPHYLL A - SPRING 1978

FIGURE 4. CHLOROPHYLL *a*
SUMMER 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.80 8.70

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00	18.70

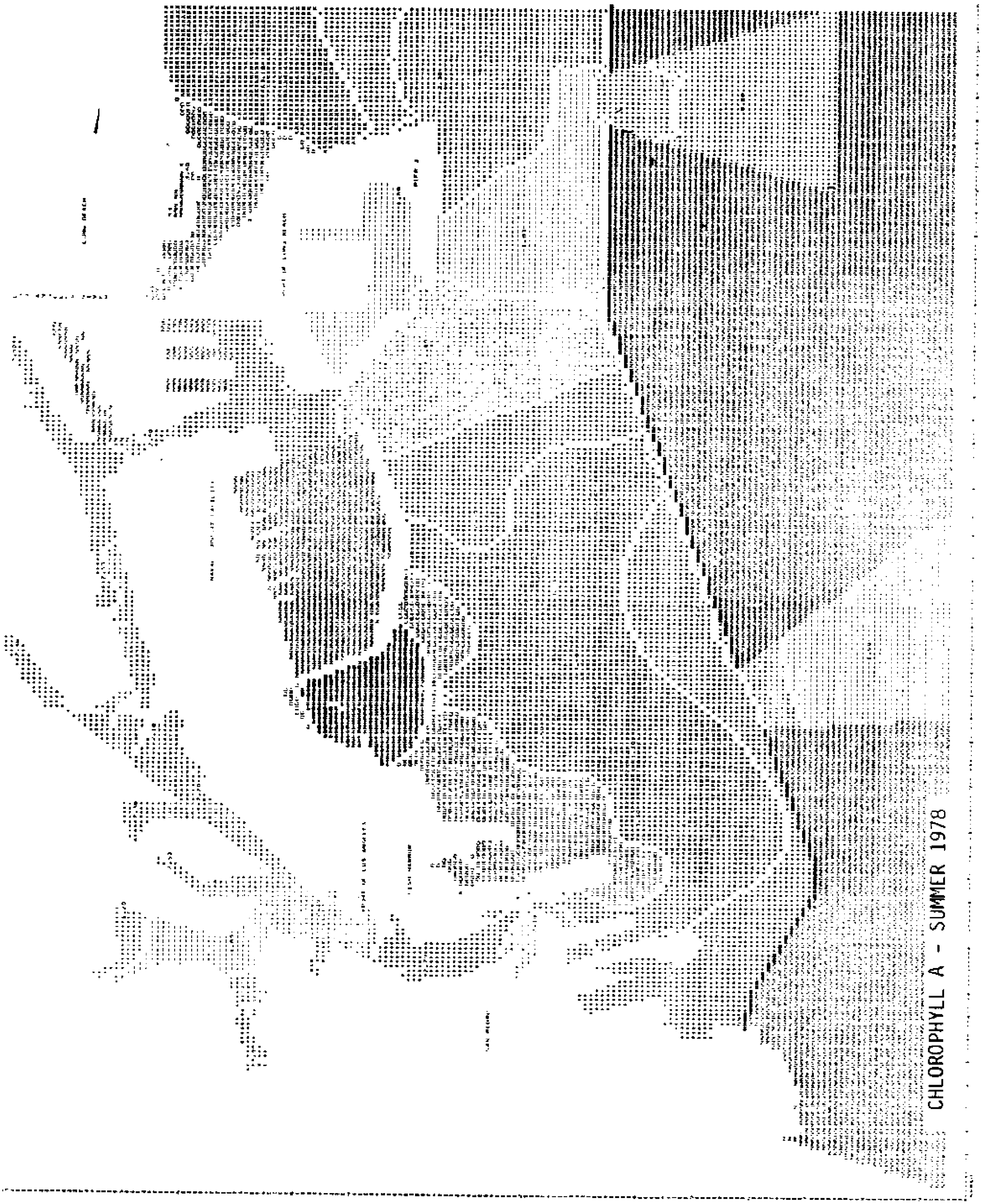
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

5.35	2.67	2.67	2.67	2.67	5.35	10.70	32.09	16.04	19.79

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7         8         9         10
          ==========================================================================================================
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 ■■■■■■■■■ ■■■■■■■■■
 SYMBOLS  ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX OOOO7OOOO 888888888 ■■■9■■■■■ ■■■■+■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO 888888888 ■■■■■■■■■ ■■■■■■■■■
          ==========================================================================================================
 FREQ.        1         1         4         8         11        10        5         1         0         0
     1    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I88888I
     2                        I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI
     3                        I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI
     4                        I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI
     5                                  I==4==I   I++5++I   IXX6XXI   IOO7OOI
     6                                  I==4==I   I++5++I   IXX6XXI
     7                                  I==4==I   I++5++I   IXX6XXI
     8                                  I==4==I   I++5++I   IXX6XXI
     9                                            I++5++I   IXX6XXI
    10                                            I++5++I   IXX6XXI
    11                                            I++5++I
```

0.352020 MINUTES FOR HISTOGRAM



CHLOROPHYLL A - SUMMER 1978

FIGURE 5. CHLOROPHYLL *a*
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 1.00 18.70

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	6.00	12.00	15.00	18.70

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

5.35	2.67	2.67	2.67	2.67	5.35	10.70	32.09	16.04	19.79

```
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL        1         2         3         4         5         6         7         8         9         10
          ==========================================================================================================
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
 SYMBOLS  ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 888888888 ■■■■9■■■■ ■■■■*■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ==========================================================================================================
 FREQ.        0         5         2         5         2         6         11        6         1         3
     1               I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I   I■■9■■I   I■■*■■I
     2               I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   I00700I   I88888I             I■■*■■I
     3               I''2''I             I==4==I             IXX6XXI   I00700I   I88888I             I■■*■■I
     4               I''2''I             I==4==I             IXX6XXI   I00700I   I88888I
     5               I''2''I             I==4==I             IXX6XXI   I00700I   I88888I
     6                                                       IXX6XXI   I00700I   I88888I
     7                                                                 I00700I
     8                                                                 I00700I
     9                                                                 I00700I
    10                                                                 I00700I
    11                                                                 I00700I
```

0.406464 MINUTES FOR HISTOGRAM

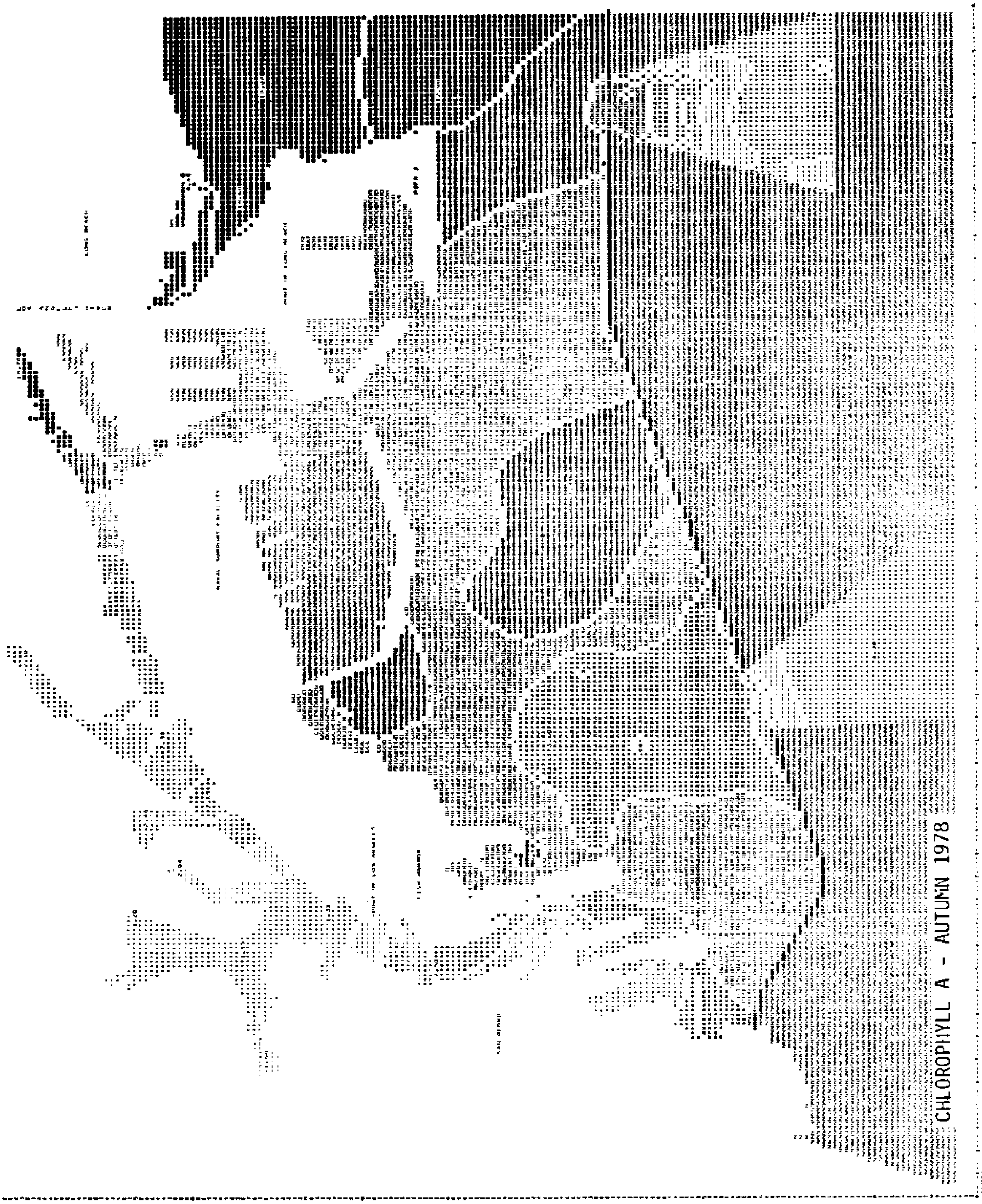

CHLOROPHYLL A - AUTUMN 1978

FIGURE 6.
AVERAGE ANNUAL CHLOROPHYLL *a*
DEC 1977 – NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          1.20        6.80


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0     1.00     1.50     2.00     2.50     3.00     4.00     6.00    12.00    15.00
  MAXIMUM      1.00    1.50     2.00     2.50     3.00     4.00     6.00    12.00    15.00    18.70

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               5.35    2.67     2.67     2.67     2.67     5.35    10.70    32.09    16.04    19.79

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           1         2         3         4         5         6         7         8         9        10
          ====================================================================================================
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
  SYMBOLS ....1.... ''''2'''' ----3---- ====4==== ++++5++++ XXXX6XXXX OOOO7OOOO @@@@8@@@@ ■■■■9■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
          ......... ''''''''' --------- ========= +++++++++ XXXXXXXXX OOOOOOOOO @@@@@@@@@ ■■■■■■■■■ ■■■■■■■■■
          ====================================================================================================
  FREQ.           0         4         9         5         9         6         5         3         0         0
        1                I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I@@8@@I
        2                I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I@@8@@I
        3                I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI   I@@8@@I
        4                I''2''I   I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI
        5                          I--3--I   I==4==I   I++5++I   IXX6XXI   IOO7OOI
        6                          I--3--I             I++5++I   IXX6XXI
        7                          I--3--I             I++5++I
        8                          I--3--I             I++5++I
        9                          I--3--I             I++5++I

0.355774 MINUTES FOR HISTOGRAM
```

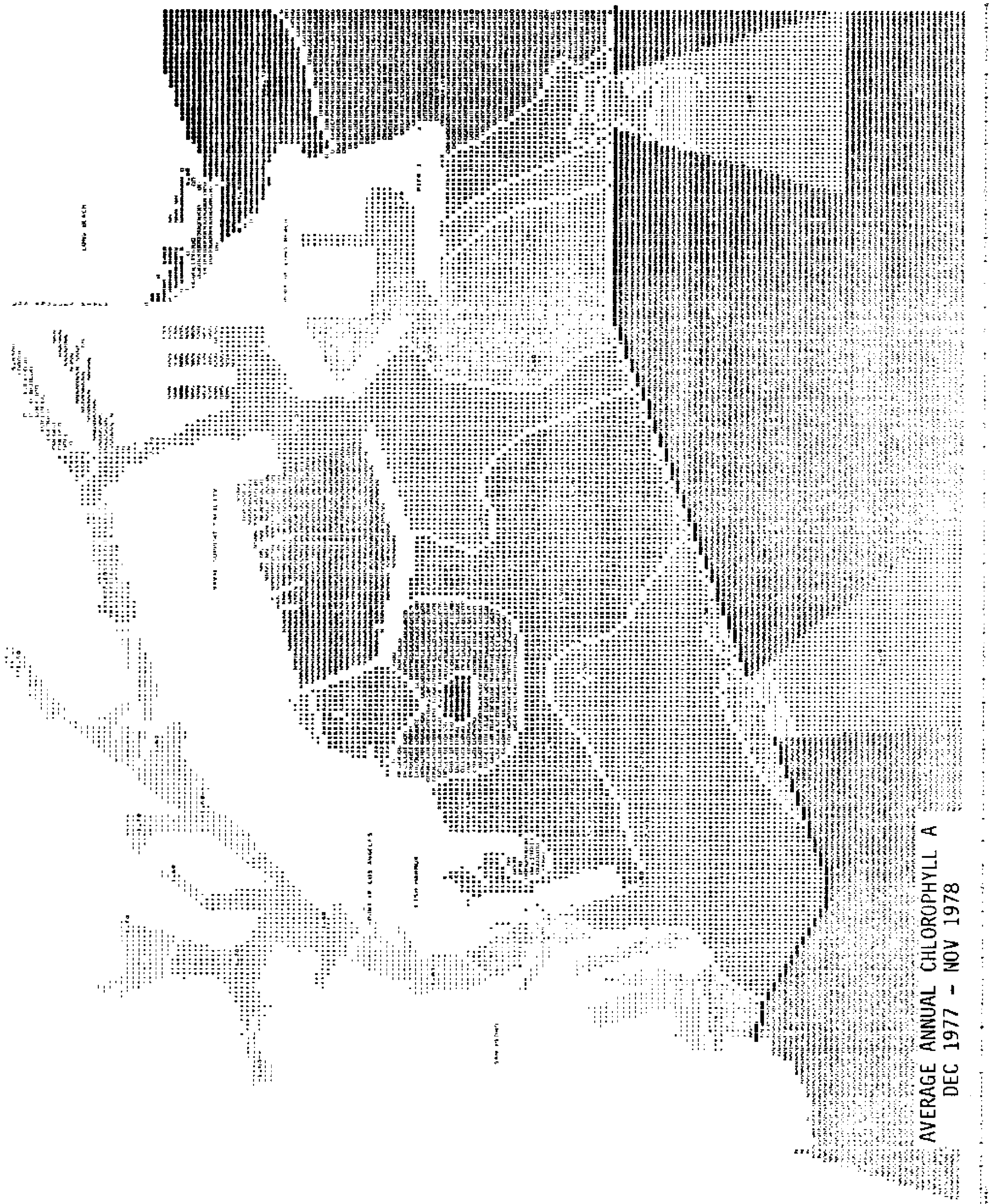

AVERAGE ANNUAL CHLOROPHYLL A
DEC 1977 - NOV 1978

FIGURE 7. PRODUCTIVITY WINTER 1977-1978 WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.0 15.40

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.51	3.01	4.02	5.02	10.05	16.08	20.10	30.15	35.17
MAXIMUM	1.51	3.01	4.02	5.02	10.05	16.09	20.10	30.15	35.17	41.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

3.66	3.66	2.44	2.44	12.20	14.63	9.76	24.39	12.20	14.63

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	26	7	2	4	1	1	0	0	0	0

0.495779 MINUTES FOR HISTOGRAM

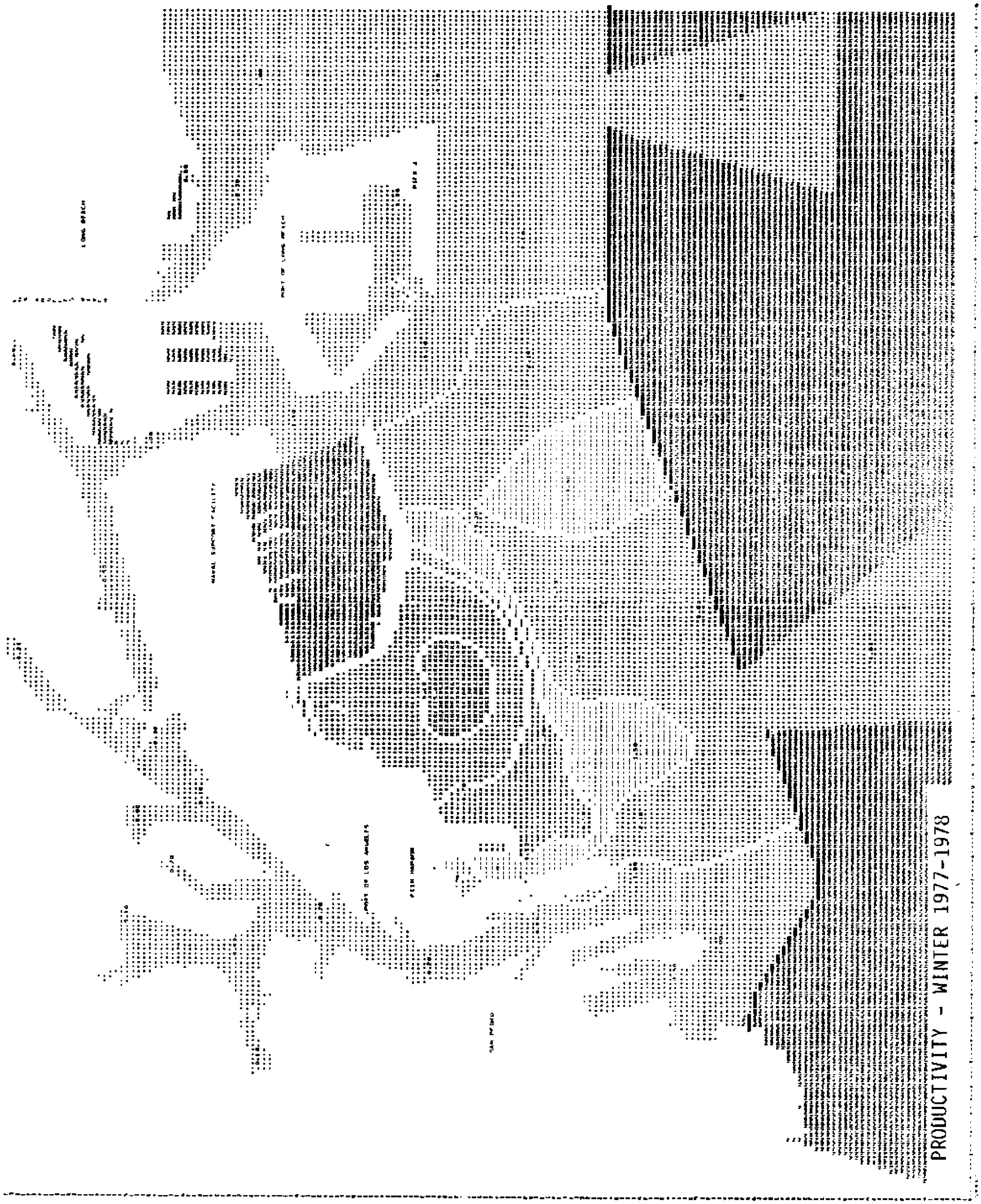

PRODUCTIVITY - WINTER 1977-1978

FIGURE 8. PRODUCTIVITY
SPRING 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.80 7.90

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(*MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.51	3.01	4.02	5.02	10.05	16.08	20.10	30.15	35.17
MAXIMUM	1.51	3.01	4.02	5.02	10.05	16.08	20.10	30.15	35.17	41.20

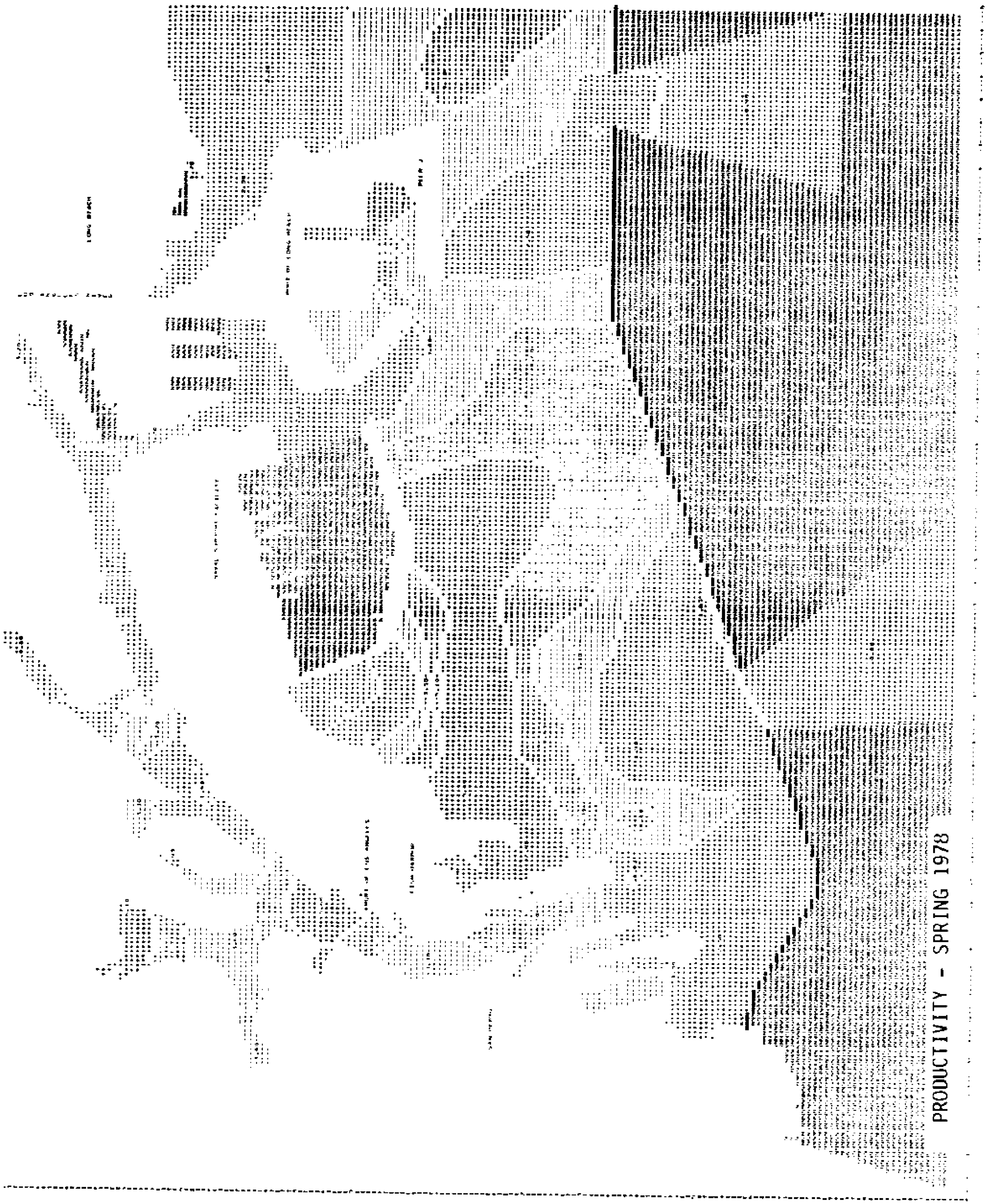
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

3.65	3.66	2.44	2.44	12.20	14.63	9.76	24.39	12.20	14.63

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1          2          3          4          5          6          7          8          9          10
          ====================================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  OOOO7OOOO  888898888  ■■■■9■■■■  ■■■■*■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  OOOOOOOOO  888888888  ■■■■■■■■■  ■■■■■■■■■
          ====================================================================================================================
 FREQ.        6          11         9          9          6          0          0          0          0          0
      1   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      2   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      3   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      4   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      5   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      6   I..I..I    I''2''I    I--3--I    I==4==I    I++5++I
      7              I''2''I    I--3--I    I==4==I
      8              I''2''I    I--3--I    I==4==I
      9              I''2''I    I--3--I    I==4==I
     10              I''2''I
     11              I''2''I
```

0.345091 MINUTES FOR HISTOGRAM


PRODUCTIVITY - SPRING 1978

```
FIGURE 9. PRODUCTIVITY
SUMMER 1978
WITH HISTOGRAM


DATA VALUE EXTREMES ARE          0.90        9.20


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0      1.51      3.01      4.02      5.02     10.05     16.08     20.10     30.15     35.17
 MAXIMUM      1.51     3.01      4.02      5.02     10.05     16.08     20.10     30.15     35.17     41.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              3.66     3.66      2.44      2.44     12.20     14.63      9.76     24.39     12.20     14.63

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4         5         6         7         8         9        10
          ==========================================================================================================
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
 SYMBOLS  ....1....  ''''2''''  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ■■■■9■■■■  ■■■■+■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          .........  '''''''''  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  ■■■■■■■■■  ■■■■■■■■■
          ==========================================================================================================
 FREQ.          2        15        10         3        11         0         0         0         0         0
       1    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I
       2    I..1..I   I''2''I   I--3--I   I==4==I   I++5++I
       3              I''2''I   I--3--I   I==4==I   I++5++I
       4              I''2''I   I--3--I             I++5++I
       5              I''2''I   I--3--I             I++5++I
       6              I''2''I   I--3--I             I++5++I
       7              I''2''I   I--3--I             I++5++I
       8              I''2''I   I--3--I             I++5++I
       9              I''2''I   I--3--I             I++5++I
      10              I''2''I   I--3--I             I++5++I
      11              I''2''I                       I++5++I
      12              I''2''I
      13              I''2''I
      14              I''2''I
      15              I''2''I

 0.388855 MINUTES FOR HISTOGRAM
```

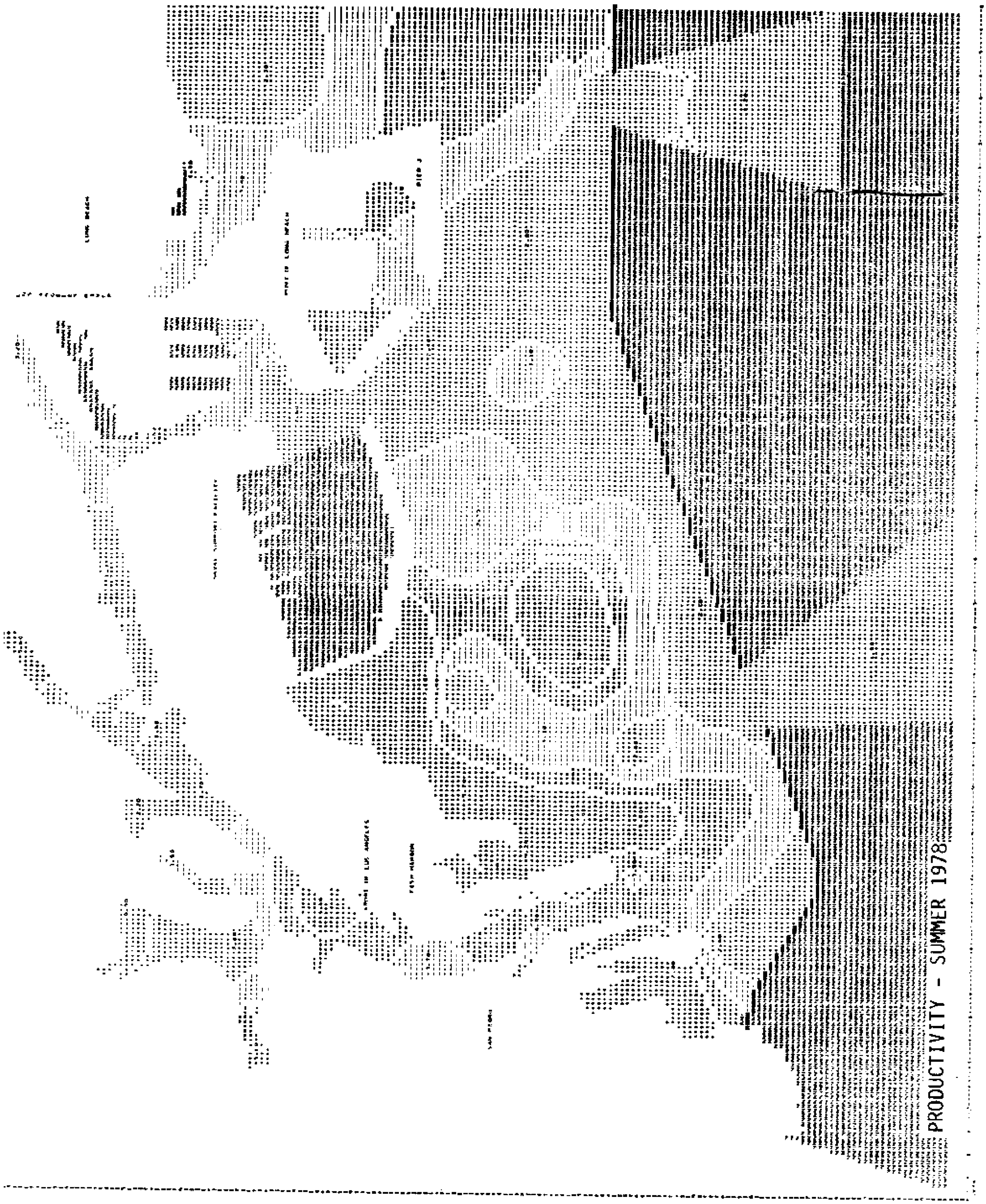

PRODUCTIVITY - SUMMER 1978

FIGURE 10. PRODUCTIVITY
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 4.30 41.20

TOTAL MISSING DATA POINTS IS 2

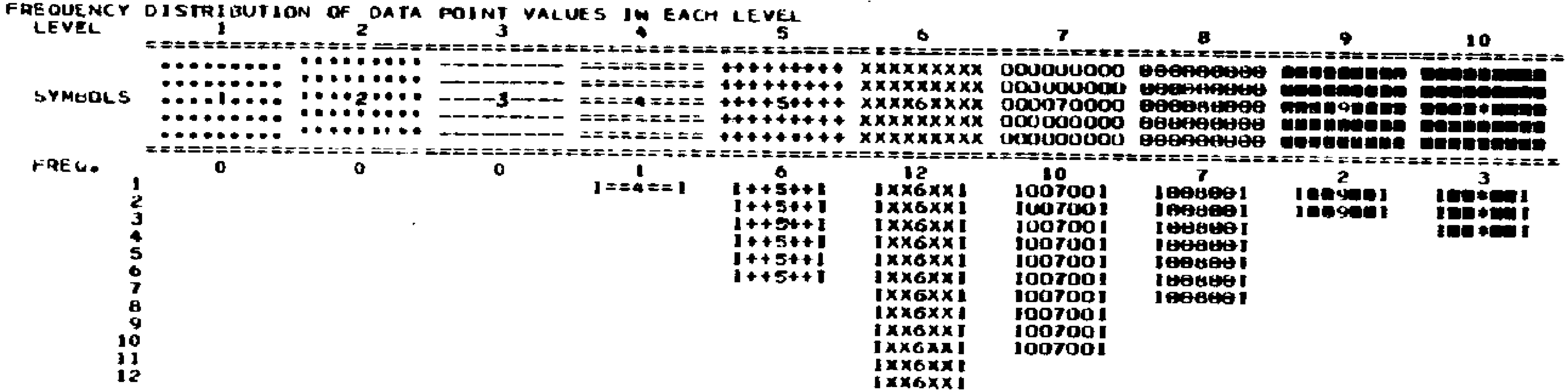
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.50	3.00	4.00	5.00	10.00	16.00	20.00	30.00	35.00
MAXIMUM	1.50	3.00	4.00	5.00	10.00	16.00	20.00	30.00	35.00	41.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

3.64	3.64	2.43	2.43	12.14	14.56	9.71	24.27	12.14	15.05

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



0.460724 MINUTES FOR HISTOGRAM

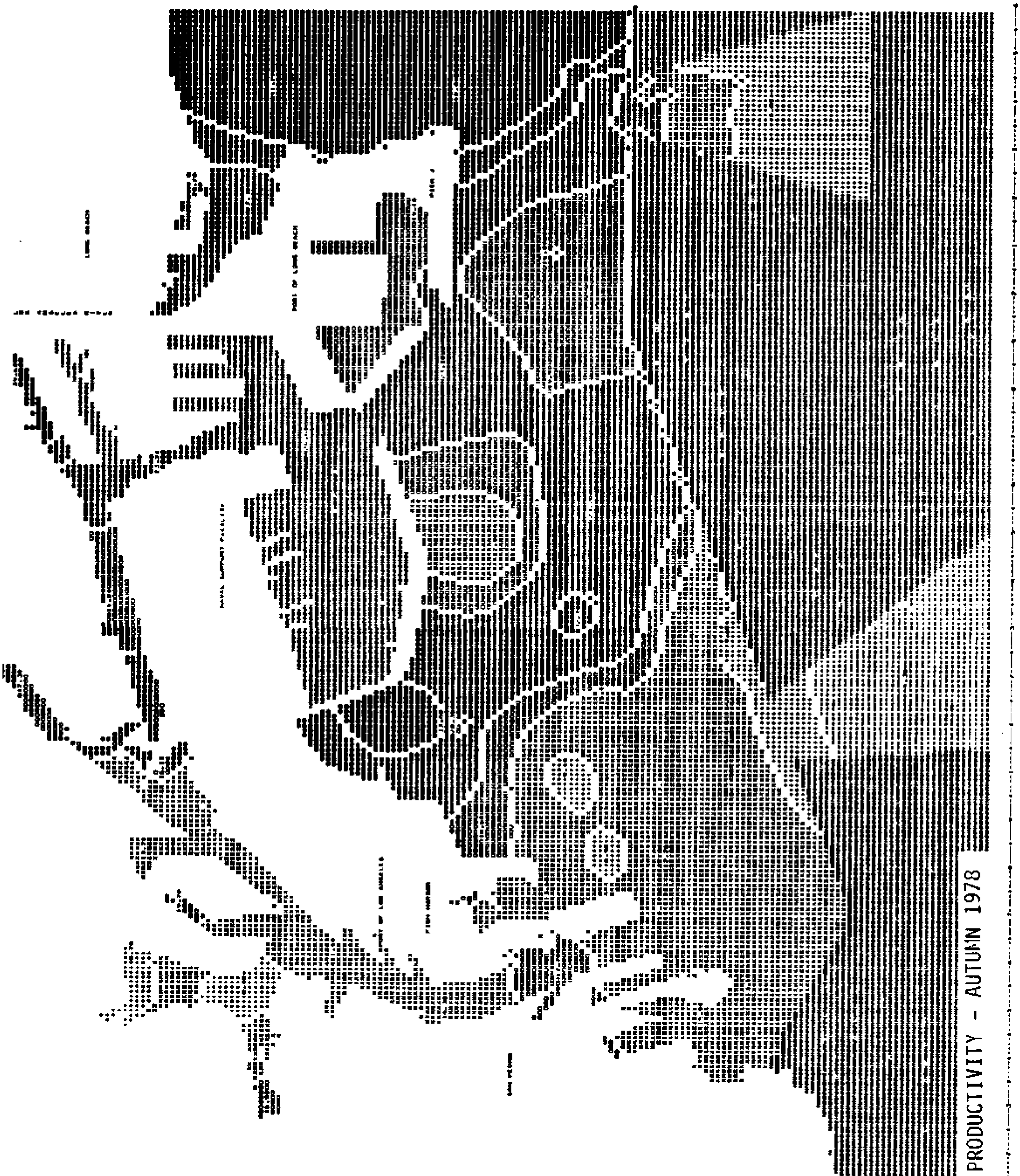

PRODUCTIVITY - AUTUMN 1978

FIGURE 11.
AVERAGE ANNUAL PRODUCTIVITY
DEC 1977 - NOV 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 2.20 13.10

TOTAL MISSING DATA POINTS IS 2

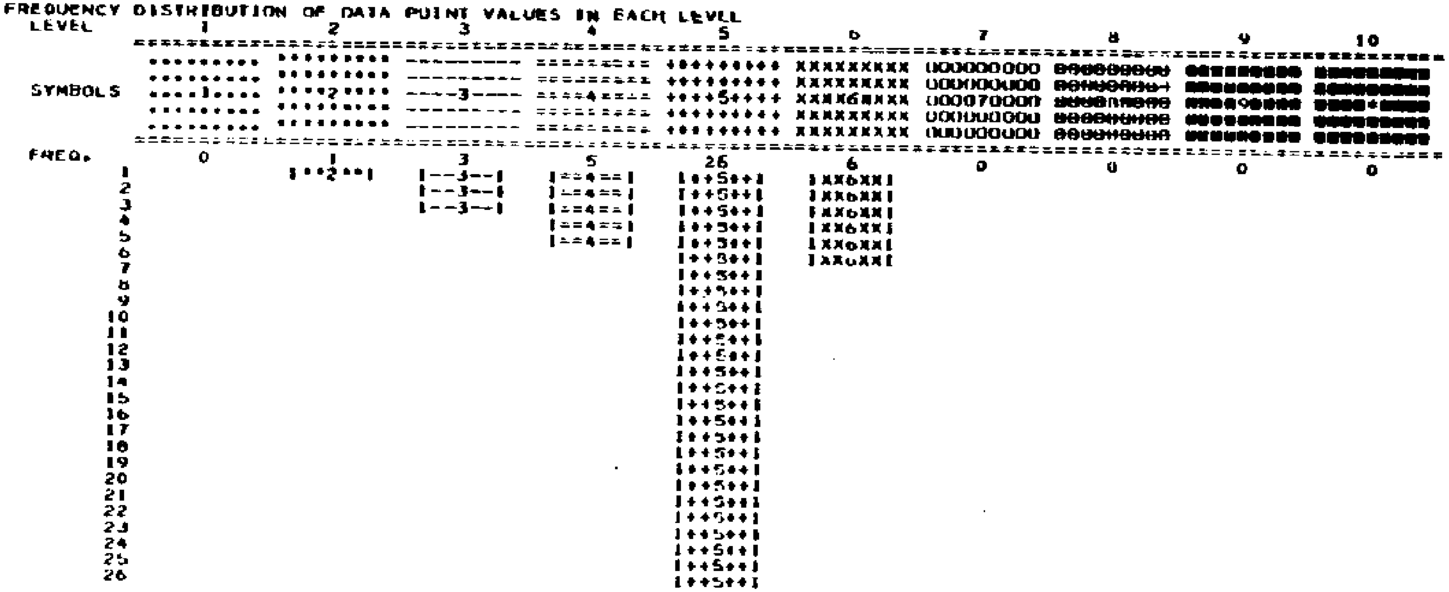
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.50	3.00	4.00	5.00	10.00	16.00	20.00	30.00	35.00
MAXIMUM	1.50	3.00	4.00	5.00	10.00	16.00	20.00	30.00	35.00	41.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

3.64	3.64	2.43	2.43	12.14	14.56	9.71	24.27	12.14	15.05

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL



0.502396 MINUTES FOR HISTOGRAM

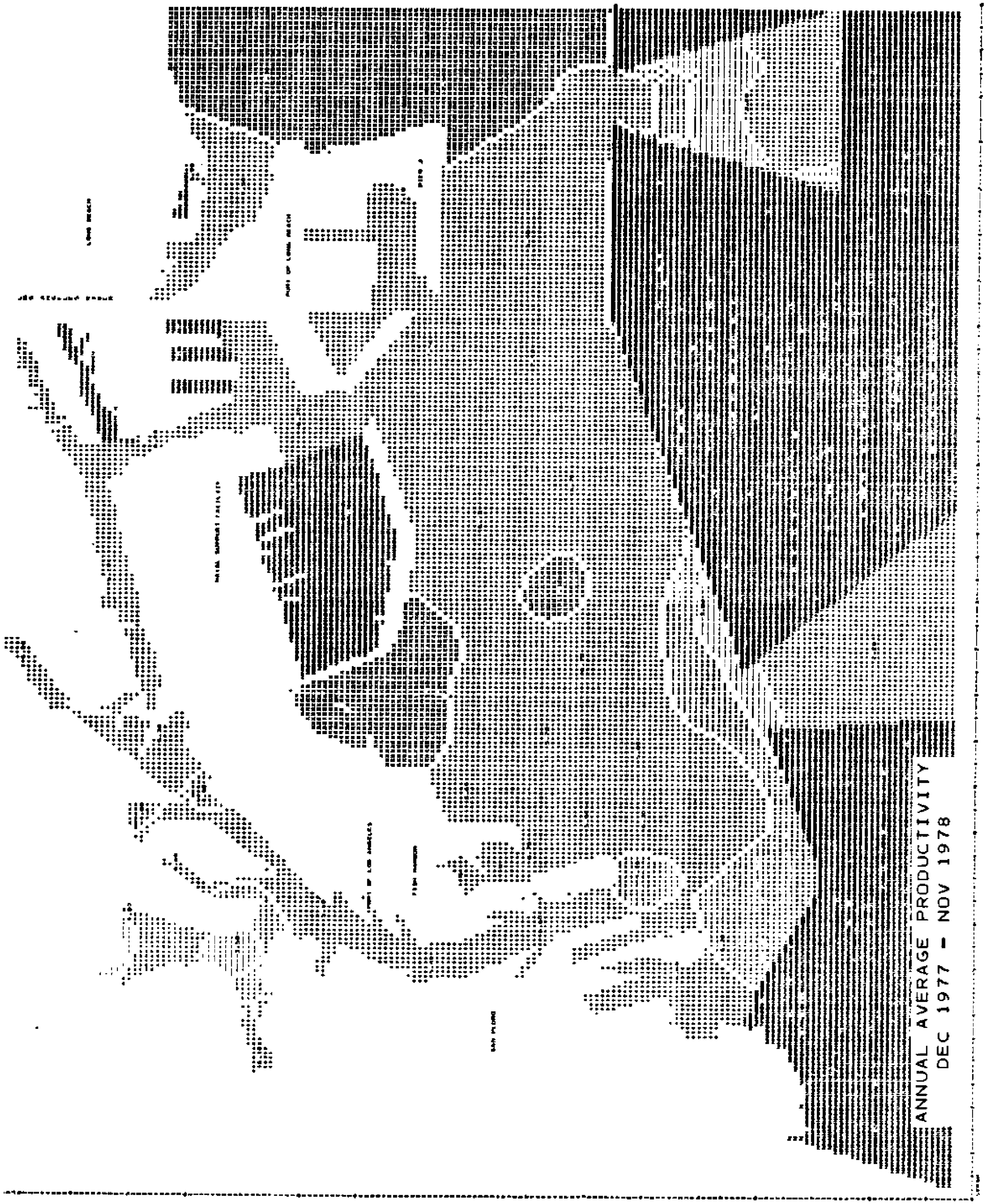

ANNUAL AVERAGE PRODUCTIVITY
DEC 1977 - NOV 1978

FIGURE 12.
ASSIMILATION RATIO
WINTER 1977-1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.50 5.00

TOTAL MISSING DATA POINTS IS 3

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00	10.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

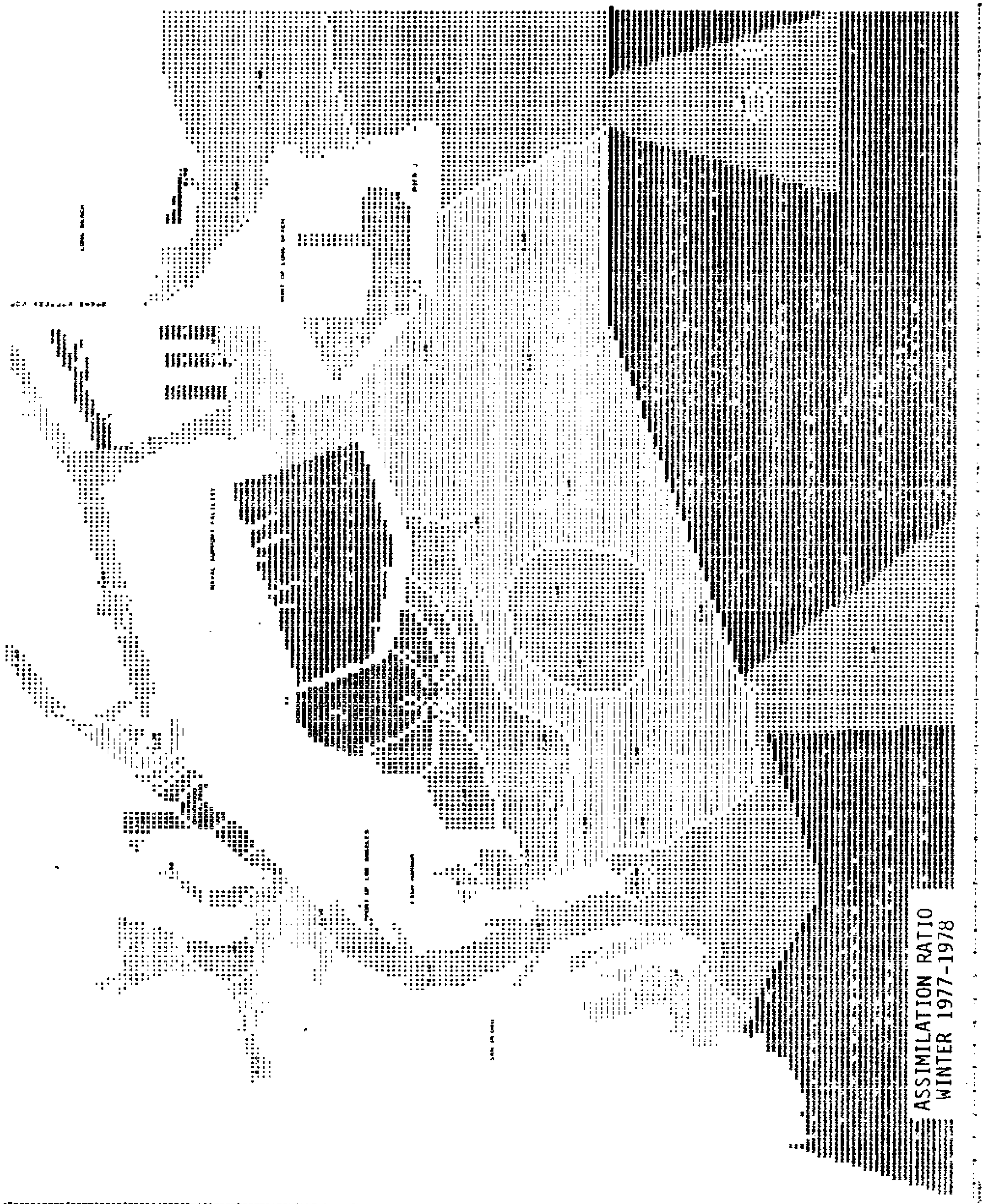
9.80	4.90	4.90	4.90	4.90	9.80	9.80	19.61	9.80	21.57

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
FREQ.	6	11	11	6	3	1	1	1	0	0

```
FREQ.    6        11        11        6        3        1        1        1        0        0
    1  I..1..I  I**2**I  I--3--I  I==4==I  I++5++I  IXX6XXI  I007001  I888881
    2  I..1..I  I**2**I  I--3--I  I==4==I  I++5++I
    3  I..1..I  I**2**I  I--3--I  I==4==I  I++5++I
    4  I..1..I  I**2**I  I--3--I  I==4==I
    5  I..1..I  I**2**I  I--3--I  I==4==I
    6  I..1..I  I**2**I  I--3--I  I==4==I
    7           I**2**I  I--3--I
    8           I**2**I  I--3--I
    9           I**2**I  I--3--I
   10           I**2**I  I--3--I
   11           I**2**I  I--3--I
```

0.344070 MINUTES FOR HISTOGRAM



ASSIMILATION RATIO
WINTER 1977-1978

FIGURE 13.
ASSIMILATION RATIO
SPRING 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 0.50 7.20

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00	10.20

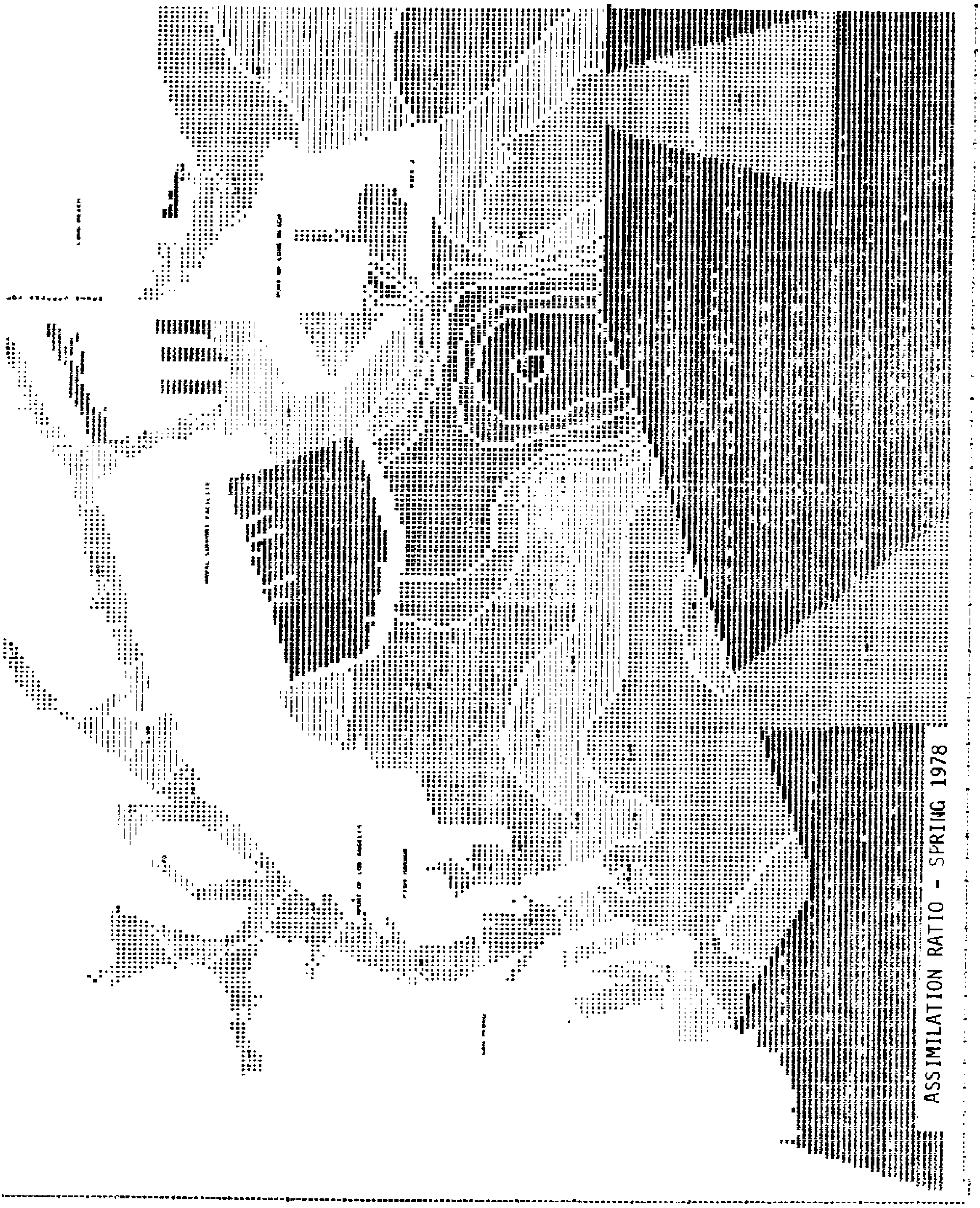
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

9.80	4.90	4.90	4.90	4.90	9.80	9.80	19.61	9.80	21.57

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7         8         9        10
          ====================================================================================================
          ......... ......... --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ......... --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
 SYMBOLS  ....1.... ....2.... ----3---- ====4==== ++++5++++ XXXX6XXXX 000070000 8888A8888 ■■■■9■■■■ ■■■■+■■■■
          ......... ......... --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ......... ......... --------- ========= +++++++++ XXXXXXXXX 000000000 888888888 ■■■■■■■■■ ■■■■■■■■■
          ====================================================================================================
 FREQ.        4         7        10        13         5         1         0         0         1         0
       1   I..1..I   I..2..I   I--3--I   I==4==I   I++5++I   IXX6XXI                       I■■9■■I
       2   I..1..I   I..2..I   I--3--I   I==4==I   I++5++I
       3   I..1..I   I..2..I   I--3--I   I==4==I   I++5++I
       4   I..1..I   I..2..I   I--3--I   I==4==I   I++5++I
       5             I..2..I   I--3--I   I==4==I   I++5++I
       6             I..2..I   I--3--I   I==4==I
       7             I..2..I   I--3--I   I==4==I
       8                       I--3--I   I==4==I
       9                       I--3--I   I==4==I
      10                       I--3--I   I==4==I
      11                                 I==4==I
      12                                 I==4==I
      13                                 I==4==I
```

0.393494 MINUTES FOR HISTOGRAM



ASSIMILATION RATIO - SPRING 1978

FIGURE 14.
ASSIMILATION RATIO
SUMMER 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          0.60        2.40


TOTAL MISSING DATA POINTS IS          2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM     0.0      1.00      1.50      2.00      2.50      3.00      4.00      5.00      7.00      8.00
  MAXIMUM     1.00     1.50      2.00      2.50      3.00      4.00      5.00      7.00      8.00     10.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              9.80     4.90      4.90      4.90      4.90      9.80      9.80     19.61      9.80     21.57

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1         2         3         4         5         6         7         8         9         10
          ====================================================================================================
            .........  *********  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
            .........  *********  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
  SYMBOLS   ....1....  ****2****  ----3----  ====4====  ++++5++++  XXXX6XXXX  000070000  888888888  ████9████  ████*████
            .........  *********  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
            .........  *********  ---------  =========  +++++++++  XXXXXXXXX  000000000  888888888  █████████  █████████
          ====================================================================================================
  FREQ.        14        12        10         5          0          0          0          0          0          0
         1  I..1..I  I**2**I  I--3--I  I==4==I
         2  I..1..I  I**2**I  I--3--I  I==4==I
         3  I..1..I  I**2**I  I--3--I  I==4==I
         4  I..1..I  I**2**I  I--3--I  I==4==I
         5  I..1..I  I**2**I  I--3--I  I==4==I
         6  I..1..I  I**2**I  I--3--I
         7  I..1..I  I**2**I  I--3--I
         8  I..1..I  I**2**I  I--3--I
         9  I..1..I  I**2**I  I--3--I
        10  I..1..I  I**2**I  I--3--I
        11  I..1..I  I**2**I
        12  I..1..I  I**2**I
        13  I..1..I
        14  I..1..I

0.369069 MINUTES FOR HISTOGRAM
```

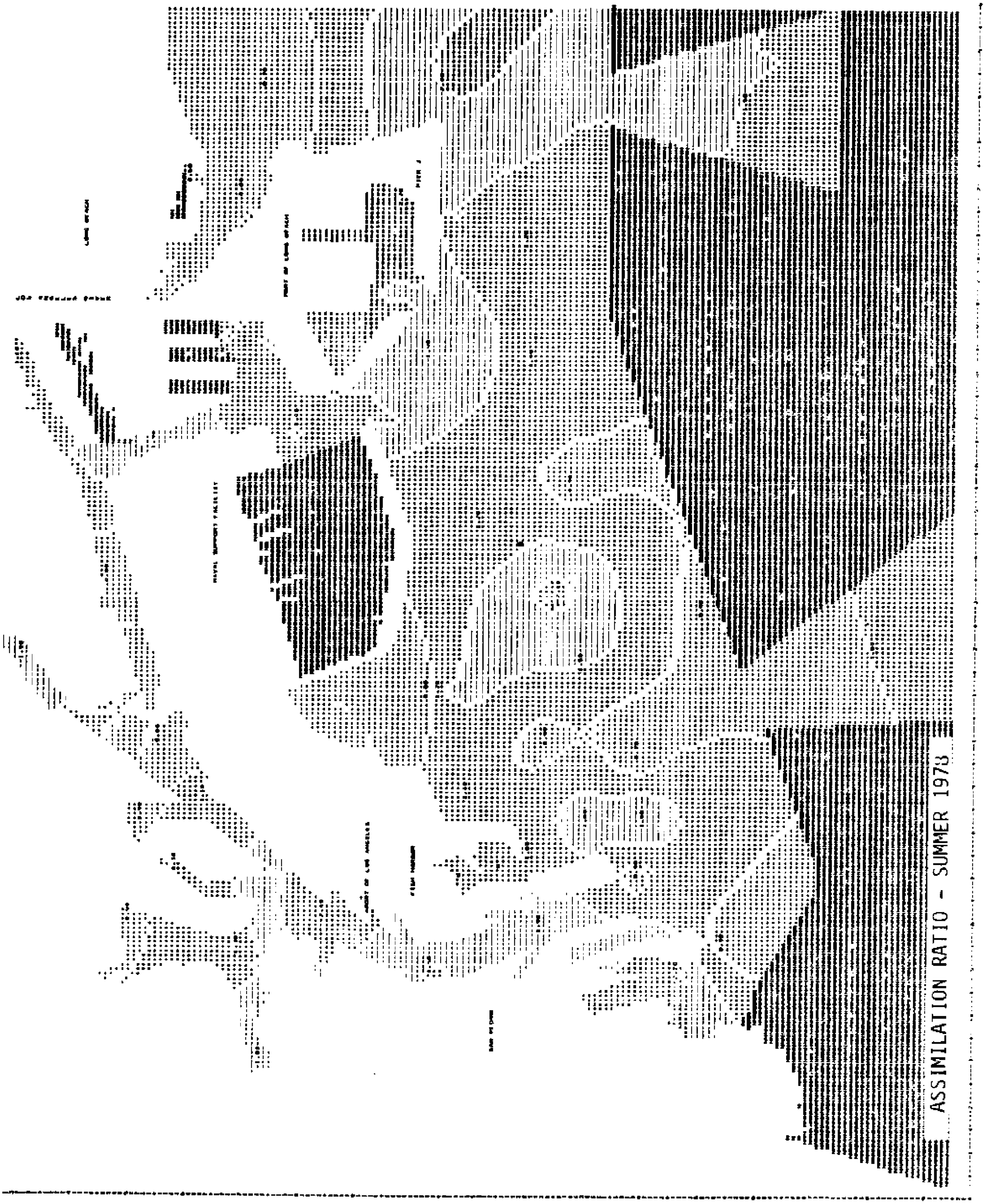

ASSIMILATION RATIO - SUMMER 1978

FIGURE 15.
ASSIMILATION RATIO
AUTUMN 1978
WITH HISTOGRAM

DATA VALUE EXTREMES ARE 2.30 10.20

TOTAL MISSING DATA POINTS IS 2

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00
MAXIMUM	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.00	8.00	10.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

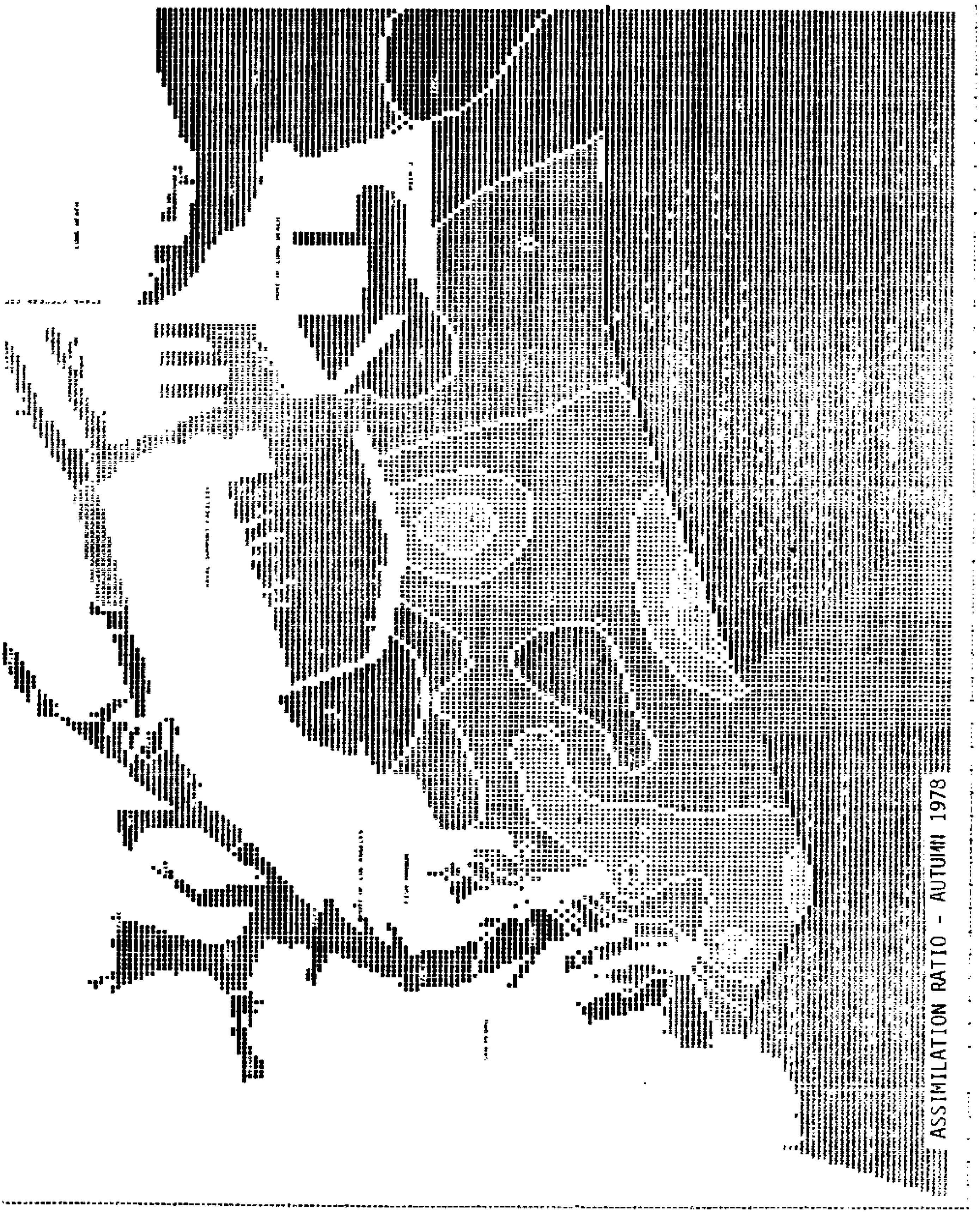
9.80	4.90	4.90	4.90	4.90	9.80	9.80	19.61	9.80	21.57

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7	8	9	10
SYMBOLS	....1....	....2....	----3----	====4====	++++5++++	XXXX6XXXX	0000700000	8888888888	████9████	████+████
FREQ.	0	0	0	3	4	4	10	9	8	3

```
FREQ.   0    0    0     3        4        4         10        9         8         3
  1                 I==4==I  I++5++I  IXX6XXI  I007001  I888881  I██9██I  I██+██I
  2                 I==4==I  I++5++I  IXX6XXI  I007001  I888881  I██9██I  I██+██I
  3                 I==4==I  I++5++I  IXX6XXI  I007001  I888881  I██9██I  I██+██I
  4                          I++5++I  IXX6XXI  I007001  I888881  I██9██I
  5                                            I007001  I888881  I██9██I
  6                                            I007001  I888881  I██9██I
  7                                            I007001  I888881  I██9██I
  8                                            I007001  I888881  I██9██I
  9                                            I007001  I888881
 10                                            I007001
```

0.476669 MINUTES FOR HISTOGRAM

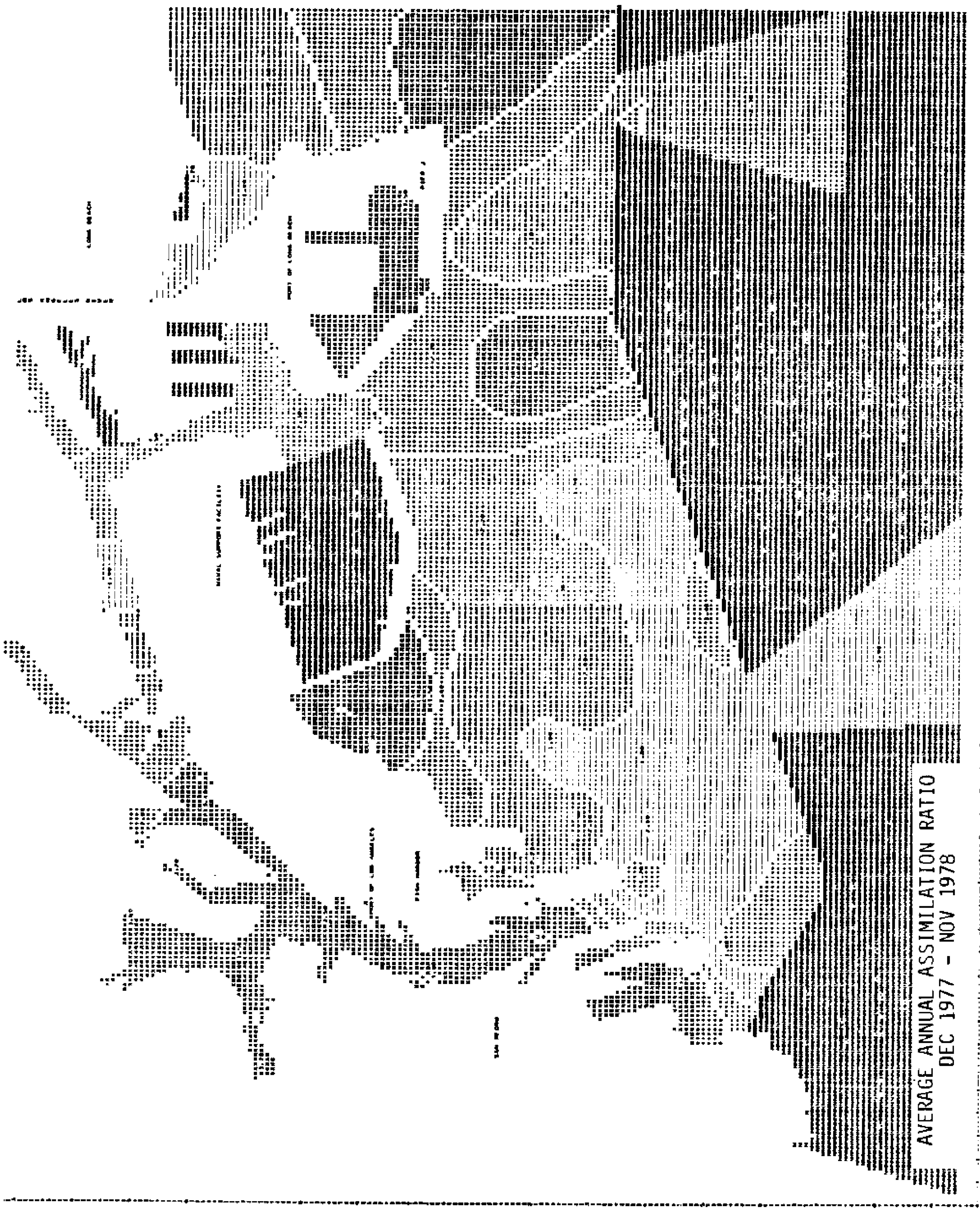


ASSIMILATION RATIO - AUTUMN 1978

FIGURE 16.
AVERAGE ANNUAL
ASSIMILATION RATIO
DEC 1977 – NOV 1978
WITH HISTOGRAM

```
DATA VALUE EXTREMES ARE          1.20        4.00


TOTAL MISSING DATA POINTS IS        2


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM     0.0      1.00     1.50     2.00     2.50     3.00     4.00     5.80     7.00     8.00
 MAXIMUM     1.00     1.50     2.00     2.50     3.00     4.00     5.00     7.00     8.00    10.20

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             9.80     4.90     4.90     4.90     4.90     9.80     9.80    19.61     9.80    21.57

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1        2        3        4        5        6        7        8        9       10

 FREQ.         0        3        7       11        7       12        1        0        0        0
                                                                1007001
```

0.385406 MINUTES FOR HISTOGRAM


AVERAGE ANNUAL ASSIMILATION RATIO
DEC 1977 - NOV 1978

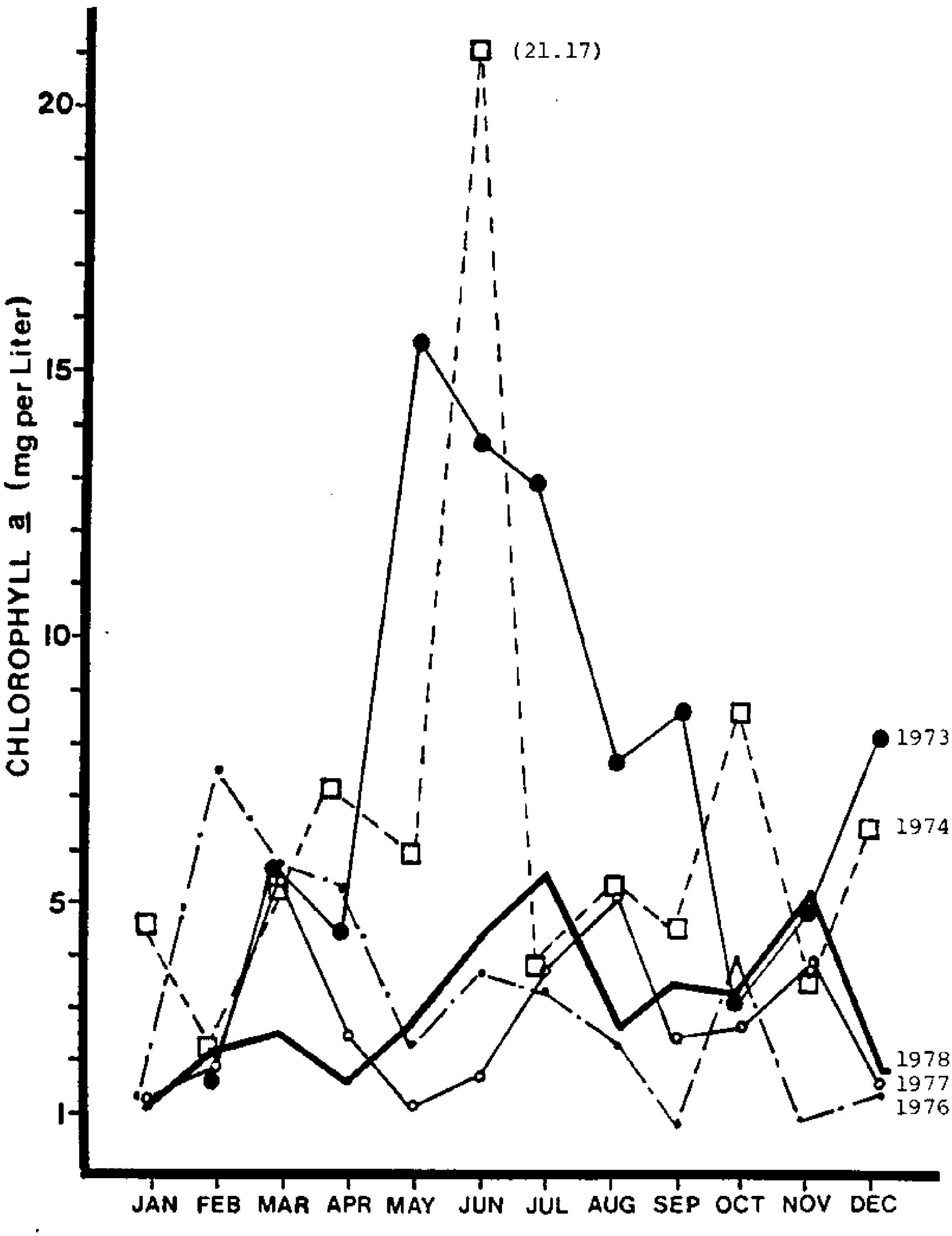


Figure 17. Mean Chlorophyll *a* for Stations A1,2,3,4,7 and A8 Compared for 1973, 1974, 1976, 1977 and 1978.

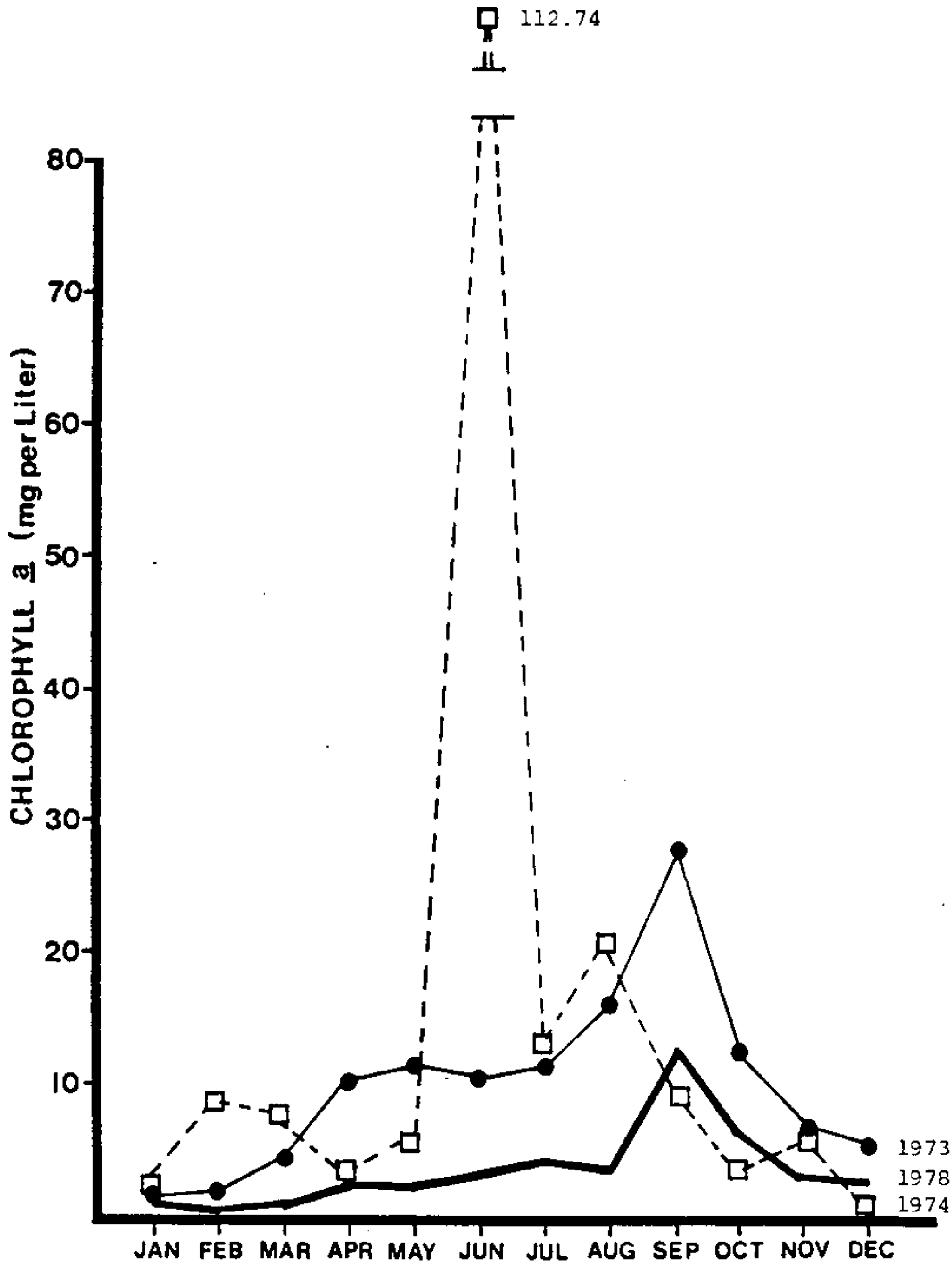


Figure 18. Mean Chlorophyll *a* for Stations B4 and B5 Compared for 1973, 1974 and 1978.

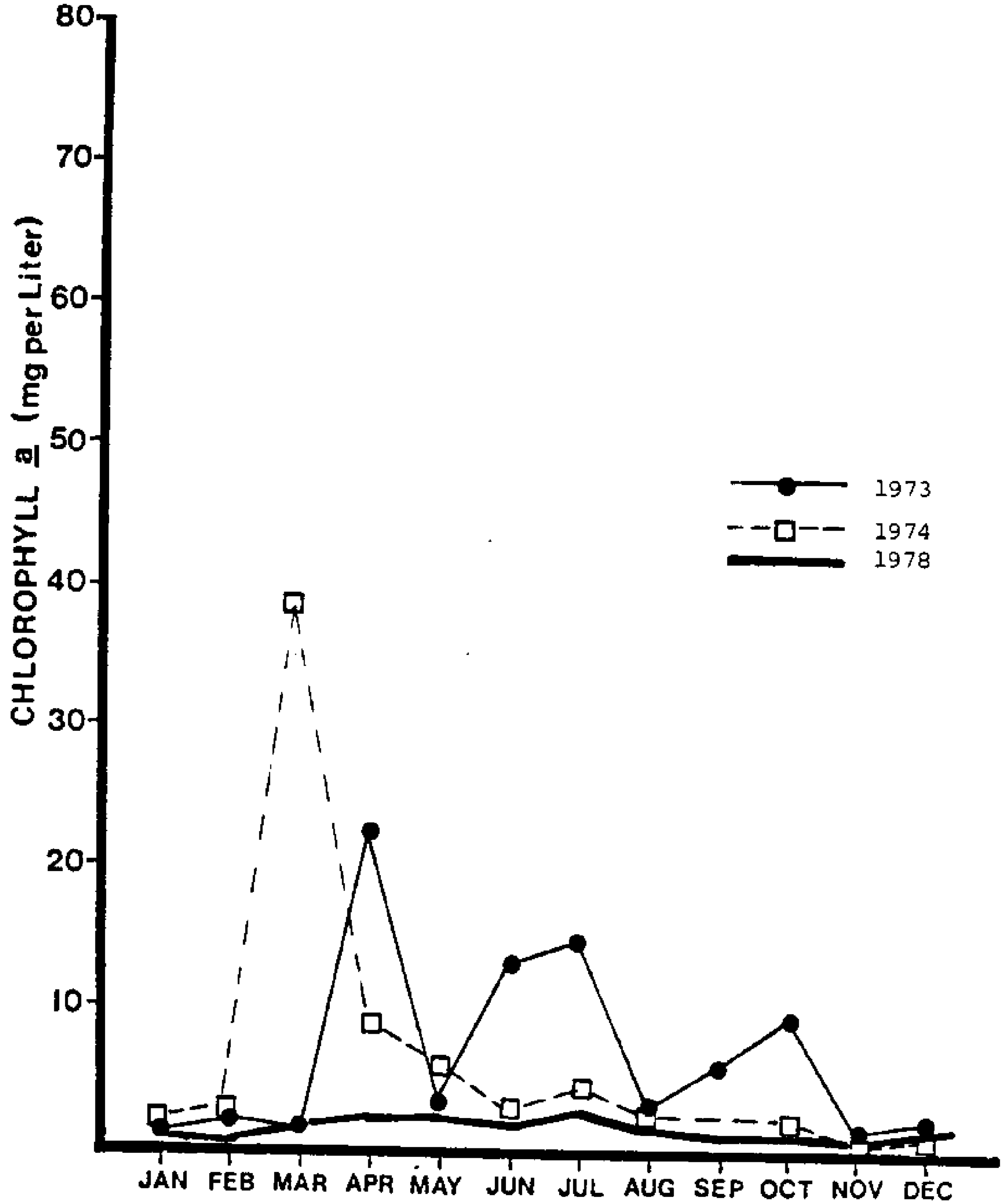


Figure 19. Mean Chlorophyll *a* for Stations C2 and C3 Compared for 1973, 1974 and 1978.

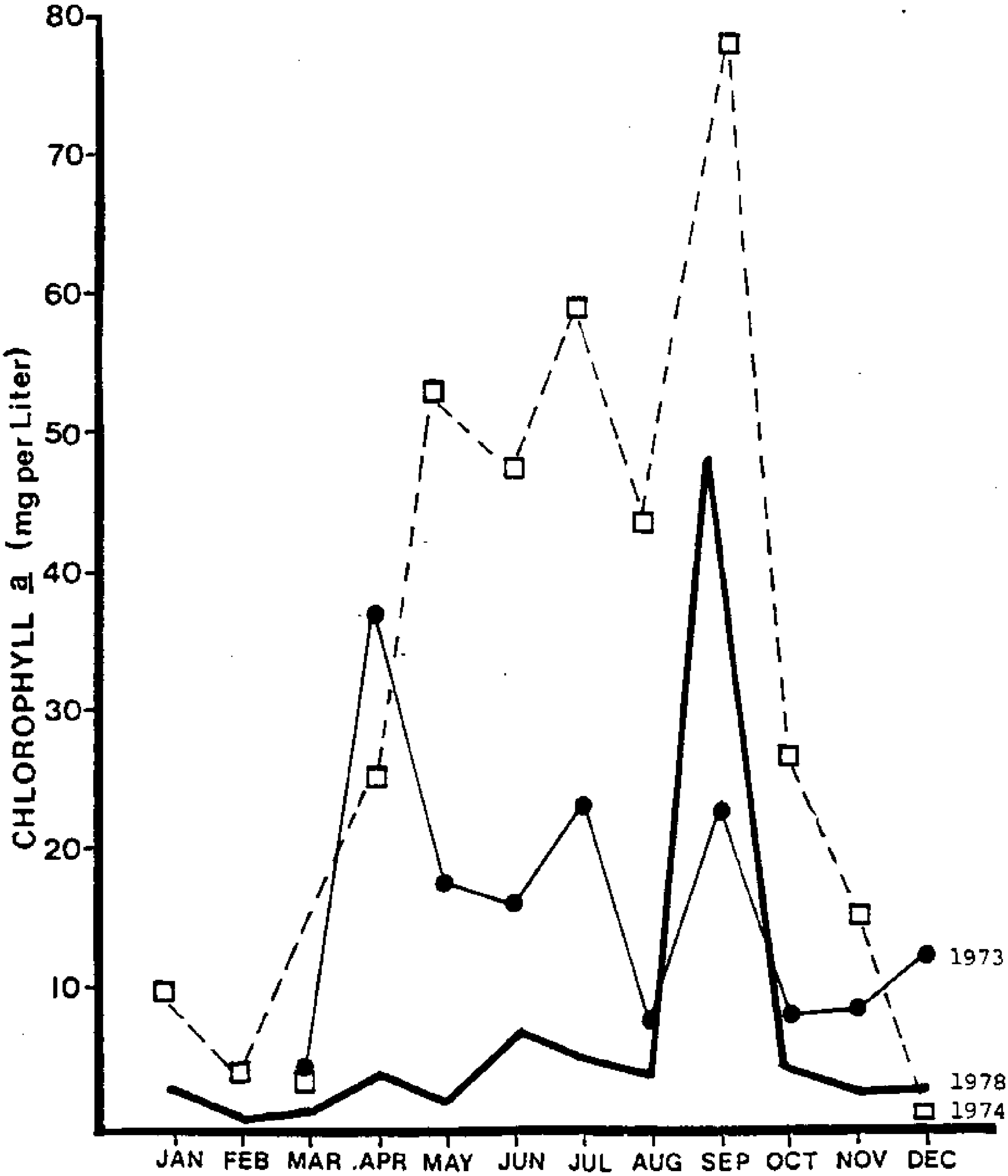


Figure 20. Mean Chlorophyll *a* for Stations D2 and D3 Compared for 1973, 1974 and 1978.

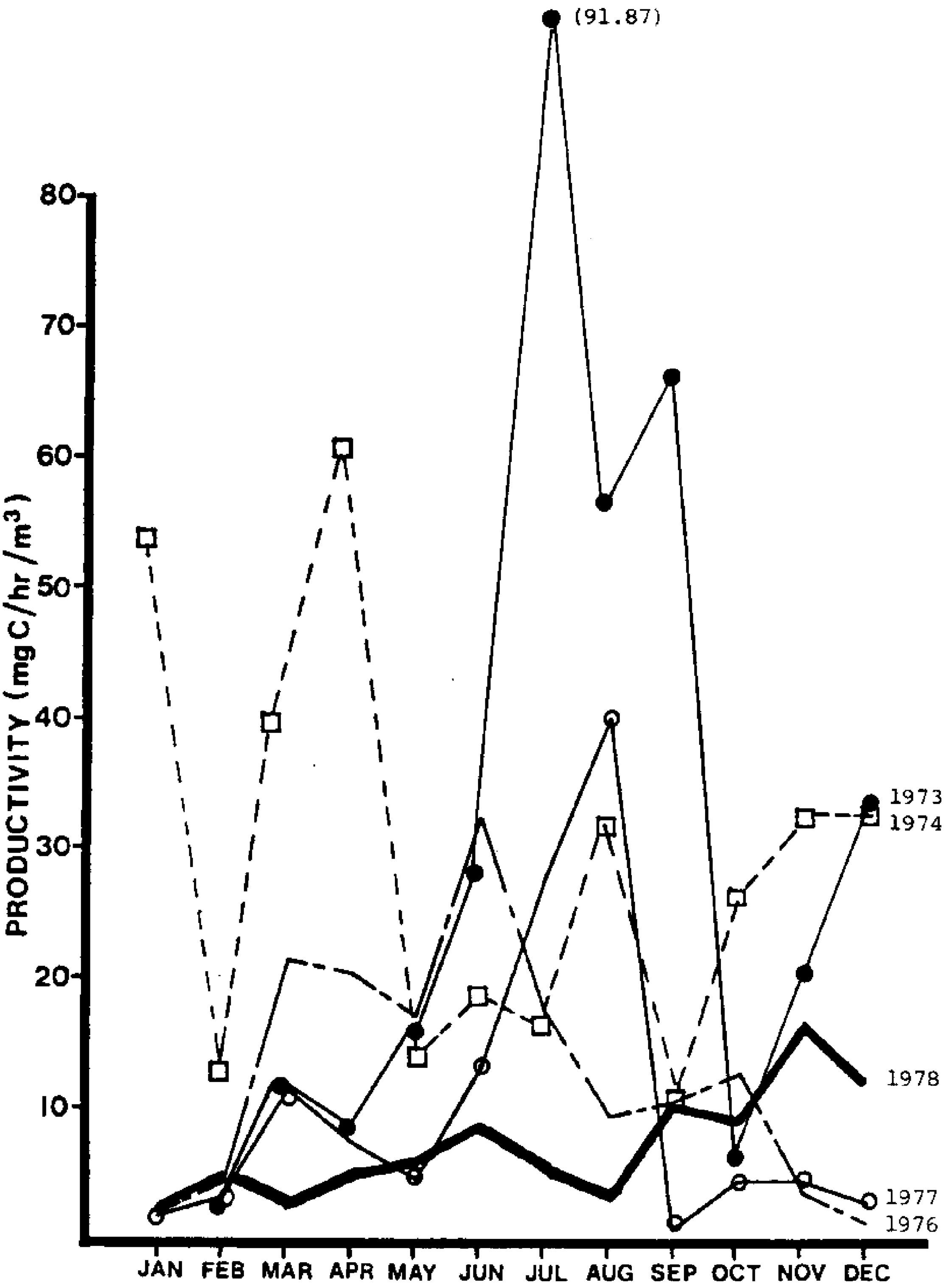


Figure 21. Mean Productivity at Stations A1,2,3,4, 7 and A8 Compared for 1973, 1974, 1976, 1977 and 1978.

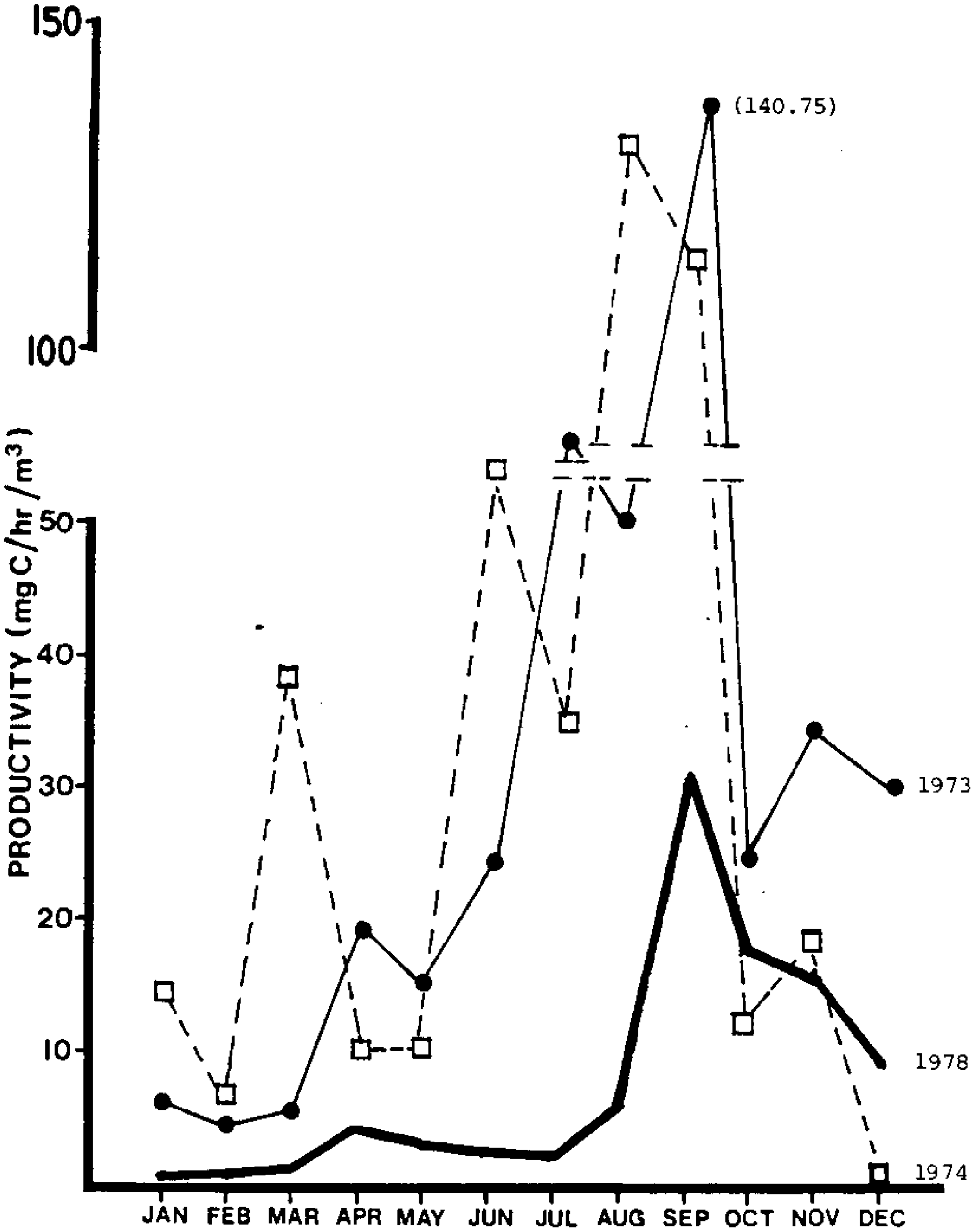


Figure 22. Mean Productivity at Stations B4 and B5 Compared for 1973, 1974 and 1978.

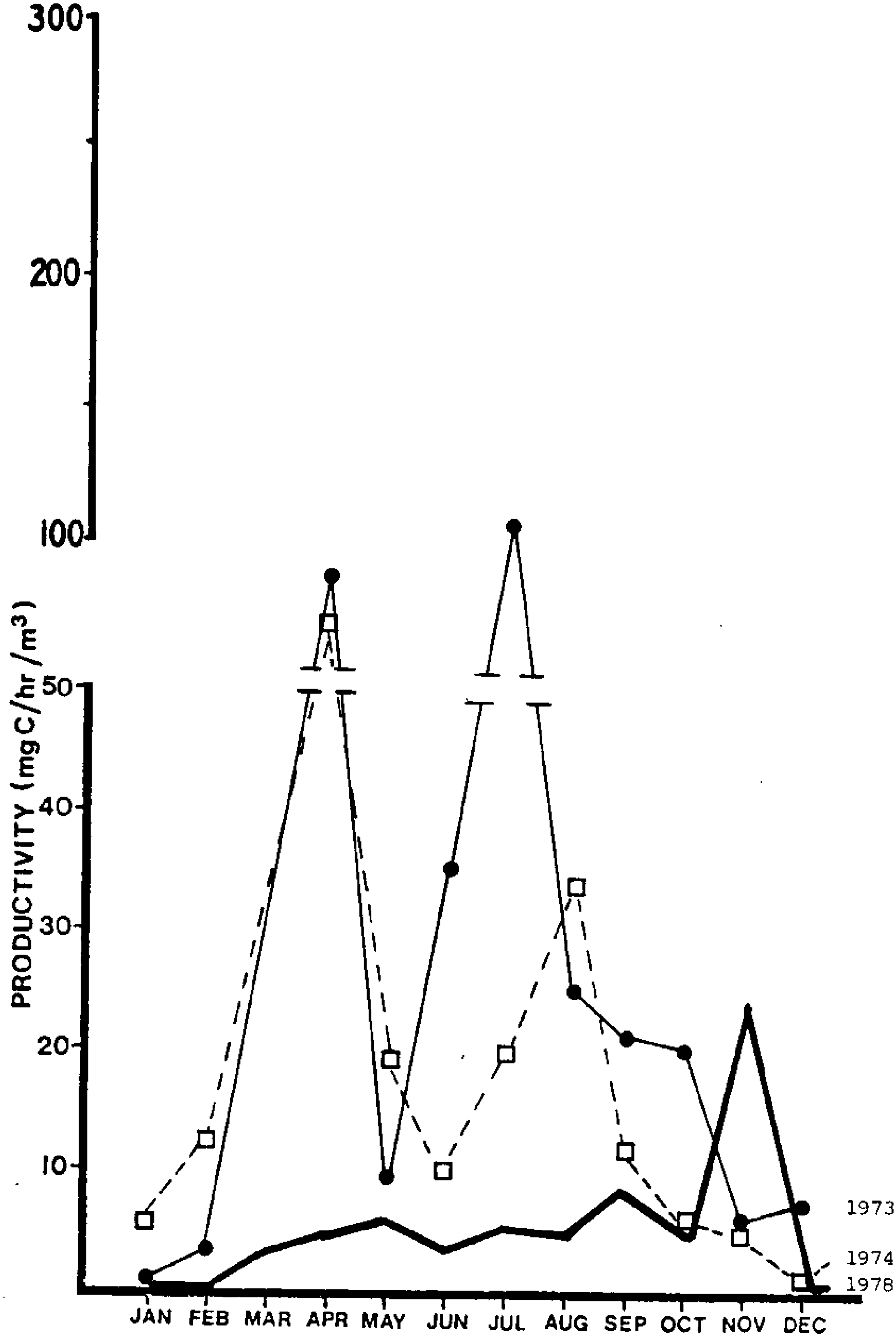


Figure 23. Mean Productivity at Stations C2 and C3 Compared for 1973, 1974 and 1978.

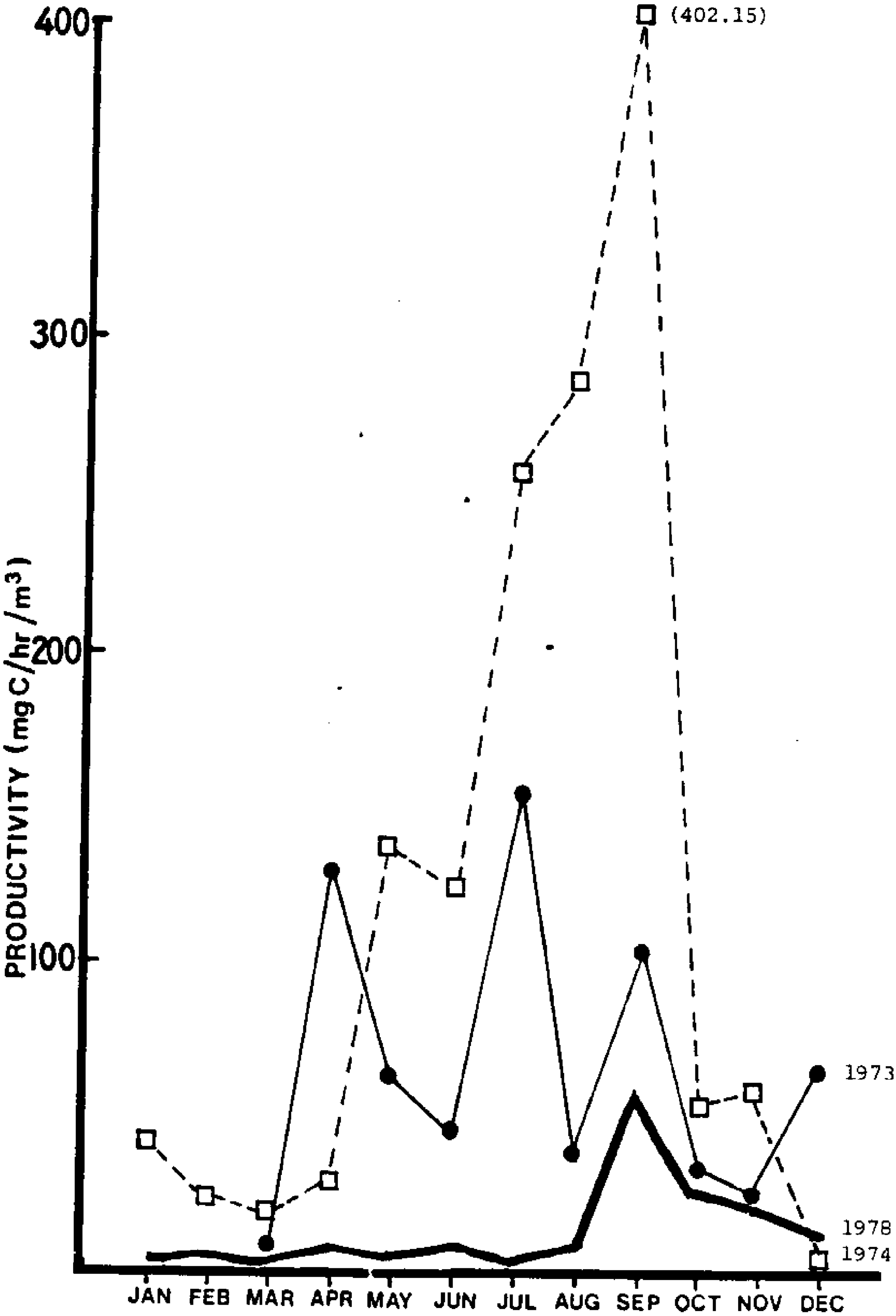


Figure 24. Mean Productivity at Stations D2 and D3 Compared for 1973, 1974 and 1978.

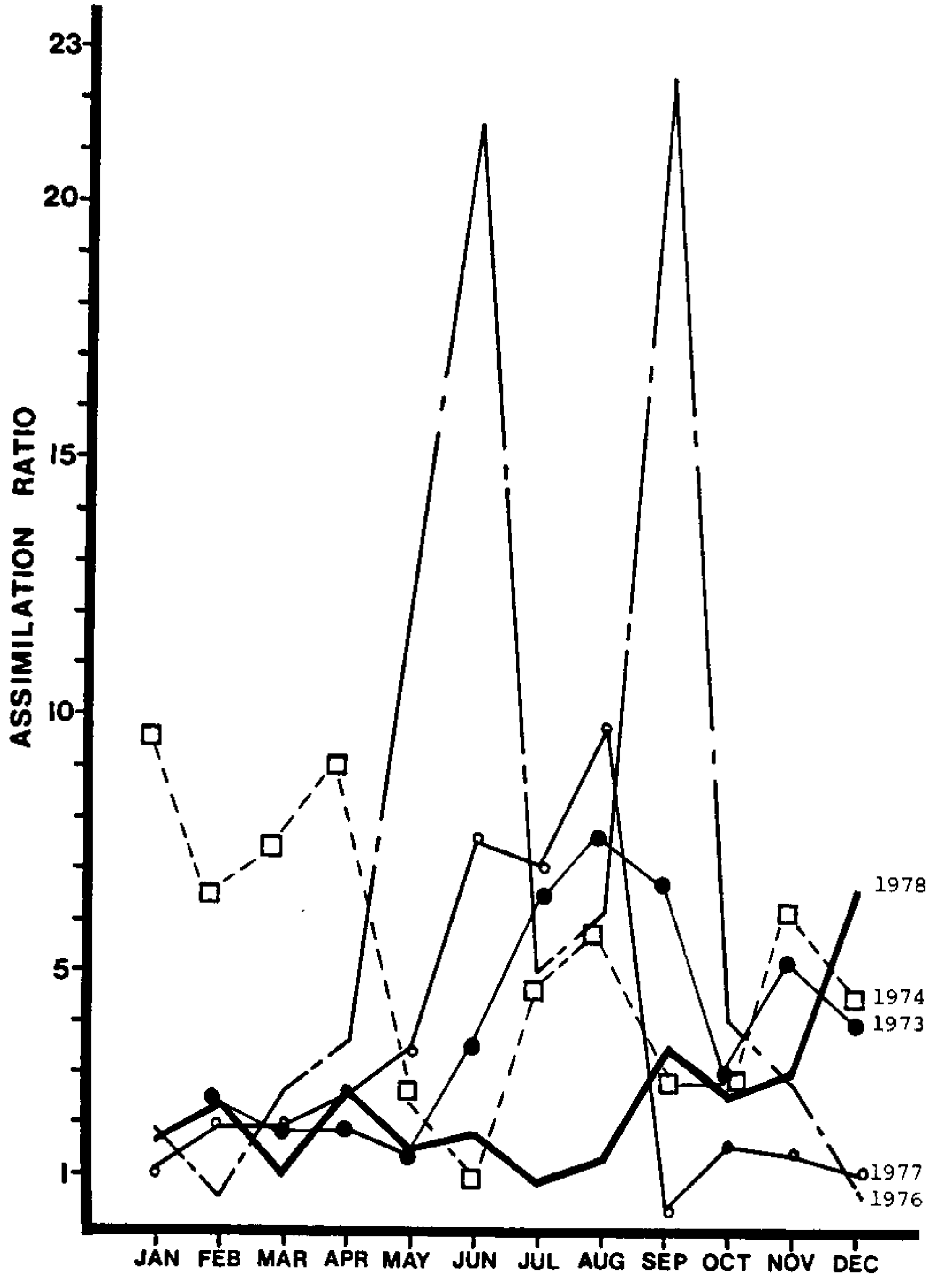


Figure 25. Mean Assimilation Ratios for Stations A1,2,3,4,7 and A8 Compared for 1973, 1974, 1976, 1977 and 1978.

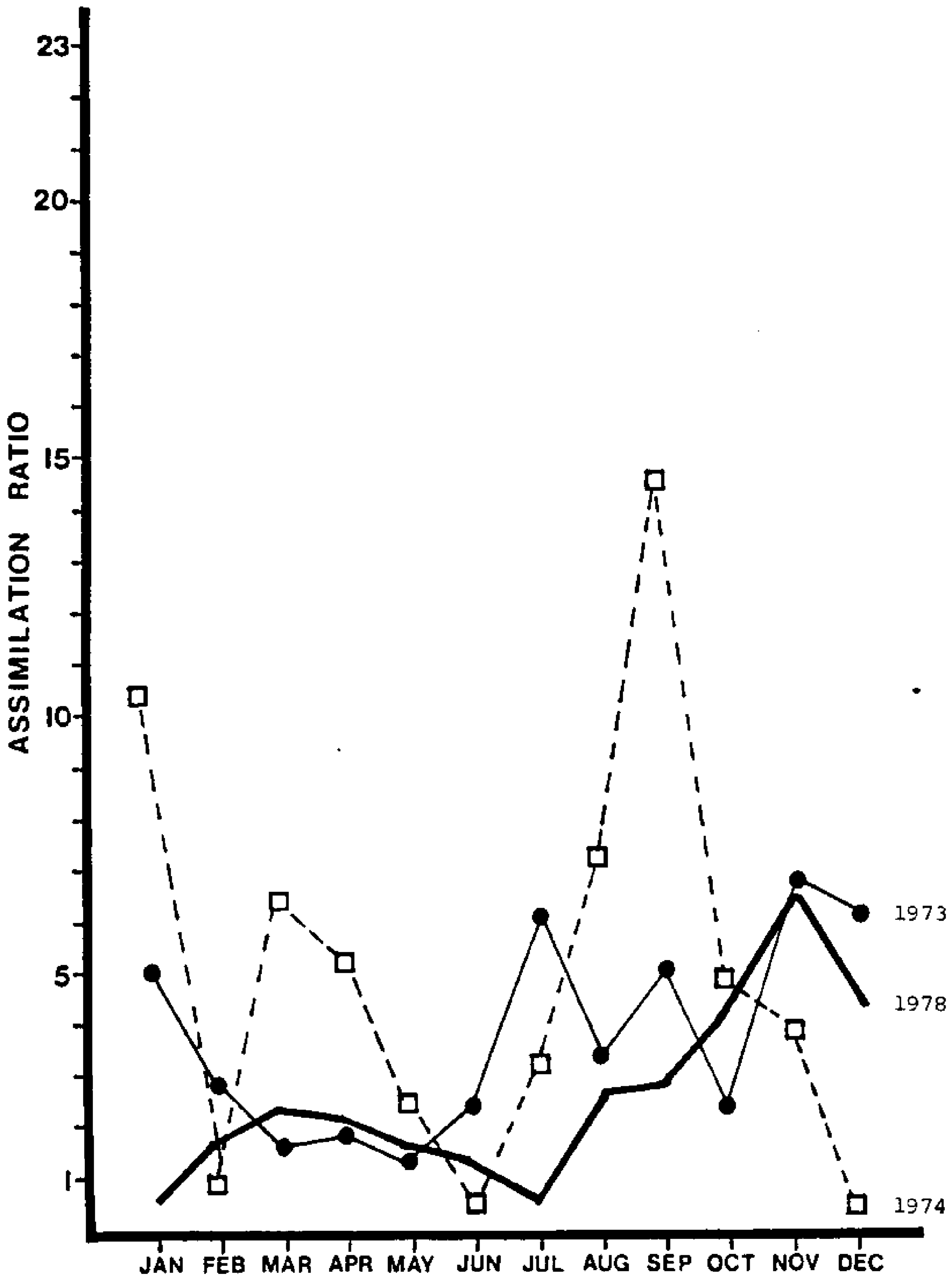


Figure 26. Mean Assimilation Ratios for Stations B4 and B5 Compared for 1973, 1974 and 1978.

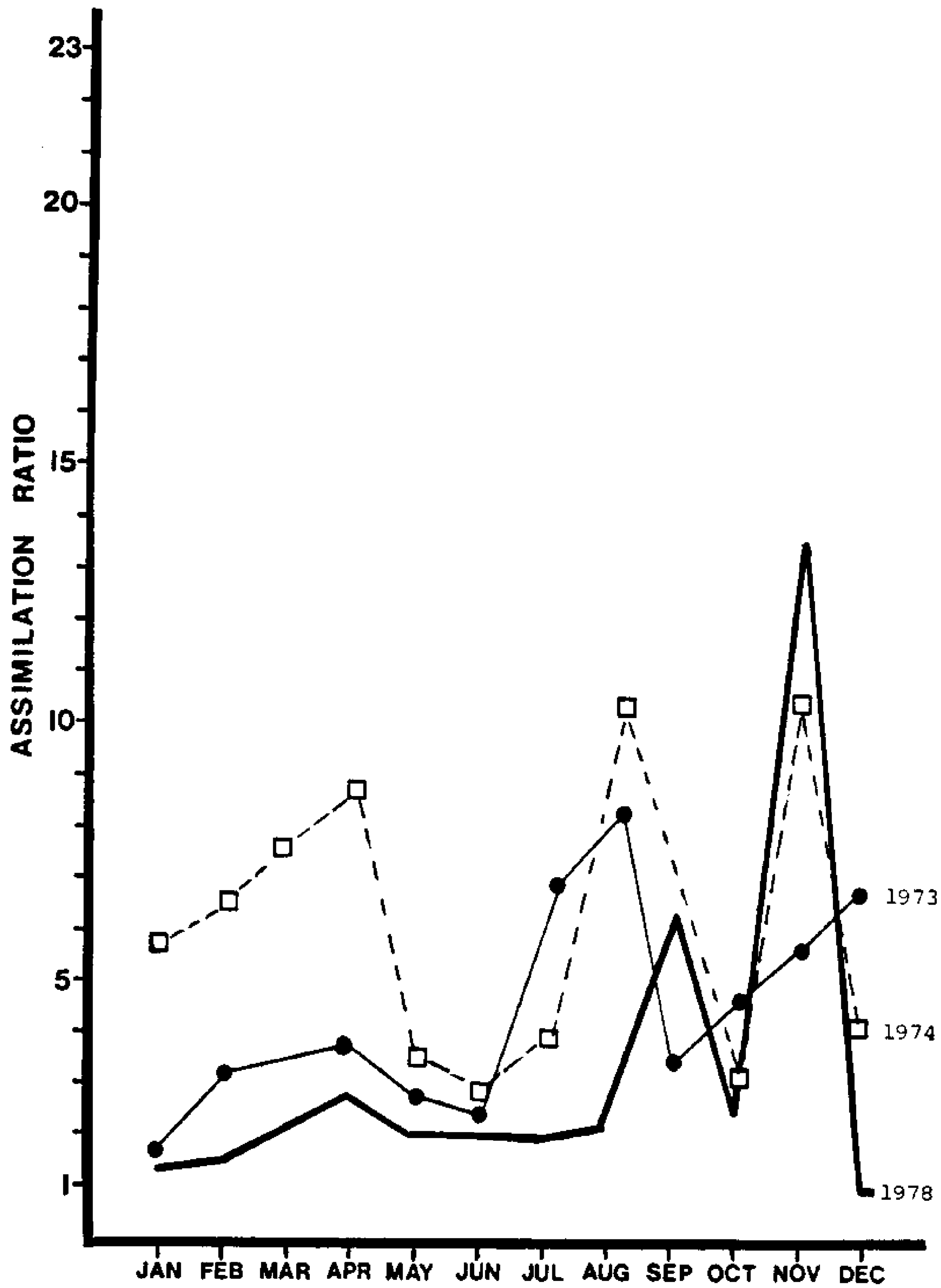


Figure 27. Mean Assimilation Ratios for Stations C2 and C3 Compared for 1973, 1974 and 1978.

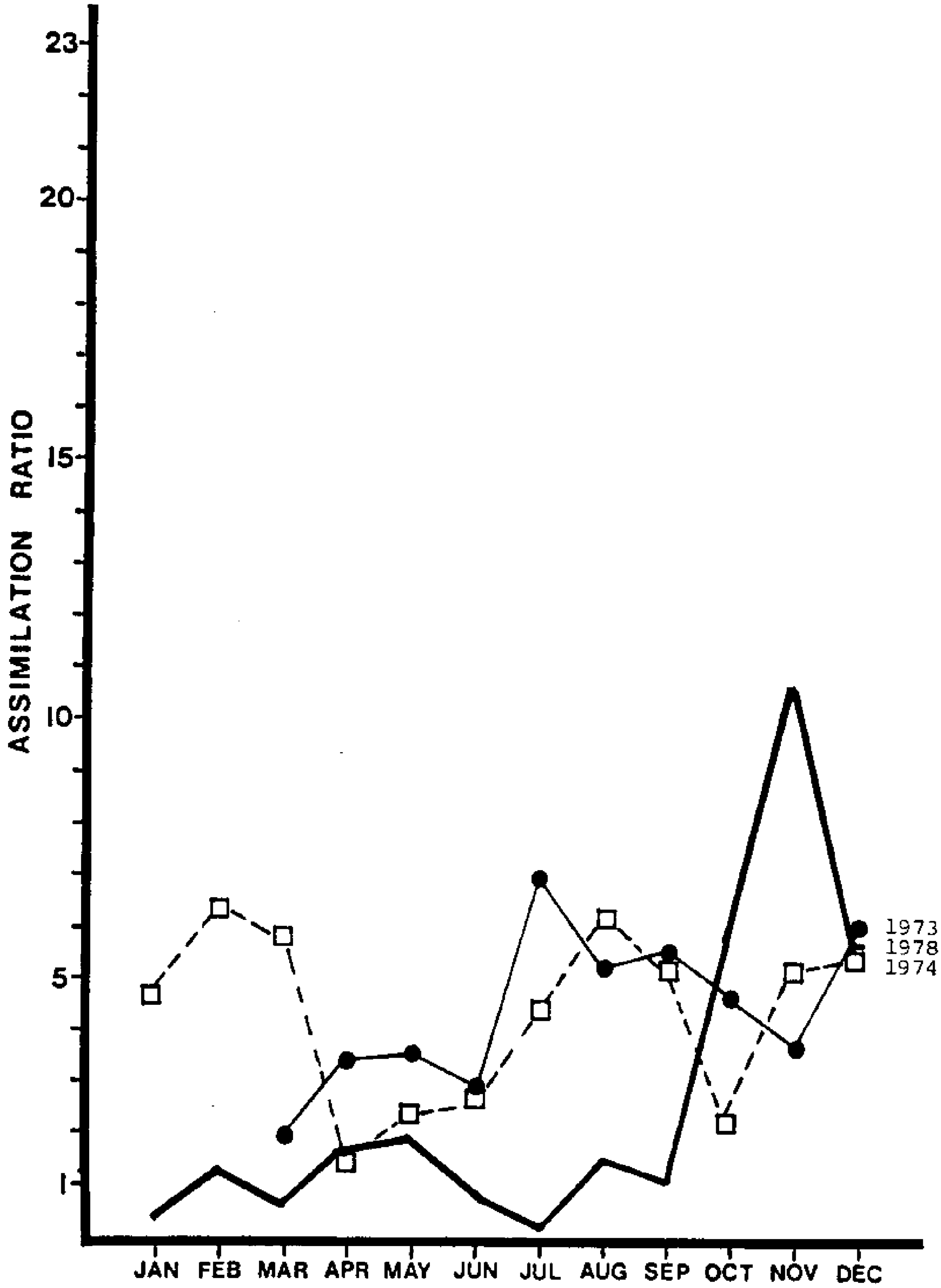


Figure 28. Mean Assimilation Ratios for Stations D2 and D3 Compared for 1973, 1974 and 1978.

TABLE 1. 1978 PRODUCTIVITY, CHLOROPHYLL *a*, AND ASSIMILATION RATIO A.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
A1	PROD	1.05	3.21	****	0.94	.70	2.52	2.51	0.59	2.99	4.72	5.27	13.03
	CHLA	1.04	1.49	****	0.53	.65	2.55	2.76	0.48	0.73	2.04	1.09	2.53
	ASMA	1.01	2.15	****	1.77	1.08	.89	.91	1.23	4.10	2.31	4.83	5.15
A2	PROD	1.98	3.26	0.68	6.15	6.51	10.10	6.16	2.98	20.09	9.20	7.20	5.73
	CHLA	1.16	2.16	1.29	2.36	3.37	3.75	4.04	2.14	6.46	4.06	3.55	1.49
	ASMA	1.71	1.51	0.53	2.61	1.93	2.69	1.53	1.39	3.11	2.27	2.03	4.82
A3	PROD	3.84	5.42	2.81	3.08	7.12	7.72	4.11	5.94	9.93	11.06	5.73	12.85
	CHLA	1.69	3.24	2.68	0.96	3.79	4.77	8.45	2.18	2.77	4.38	3.12	1.47
	ASMA	2.27	1.67	1.05	3.21	1.88	1.62	1.08	2.73	3.59	2.53	1.84	8.74
A4	PROD	3.06	6.03	4.20	11.42	7.98	13.08	10.14	4.47	8.67	12.81	19.26	8.39
	CHLA	1.20	2.00	3.72	2.86	4.14	5.37	8.21	3.38	2.63	2.93	13.62	1.24
	ASMA	2.55	3.02	1.13	3.99	1.93	1.44	1.24	0.32	3.30	4.37	1.41	6.77
A7	PROD	2.13	8.91	3.73	3.72	8.89	13.75	2.83	0.39	14.09	10.16	31.67	16.97
	CHLA	1.21	1.92	2.32	1.09	4.06	5.21	5.76	4.15	3.65	3.78	5.79	2.27
	ASMA	1.76	4.64	1.61	3.41	2.19	2.64	0.49	0.09	3.86	2.70	6.51	7.48
A8	PROD	0.85	1.66	1.06	1.39	1.65	3.81	2.72	5.23	6.24	6.24	17.82	4.69
	CHLA	1.03	1.43	1.18	1.76	2.39	5.86	4.70	3.73	4.06	5.12	4.05	1.04
	ASMA	0.83	1.16	0.90	0.79	.69	.65	.58	1.40	1.54	1.22	6.51	4.51
A9	PROD	1.40	1.11	2.06	1.70	3.62	1.88	2.36	2.83	7.85	5.33	26.01	7.67
	CHLA	1.03	0.78	2.53	1.44	2.72	2.54	2.42	3.01	3.79	2.91	8.27	1.19
	ASMA	1.36	1.42	0.81	1.18	1.33	.74	.98	0.99	2.07	1.83	3.75	6.45
A10	PROD	0.34	0.65	2.41	4.32	2.21	1.86	14.73	4.27	24.04	5.93	17.60	0.66
	CHLA	0.31	0.19	1.47	1.62	1.21	1.60	4.03	2.50	2.85	2.21	1.72	****
	ASMA	1.09	3.44	1.64	2.66	1.83	1.16	3.66	1.71	8.44	2.68	10.23	****
A11	PROD	****	8.07	****	4.31	2.79	8.68	****	5.59	11.78	21.87	67.75	6.83
	CHLA	****	1.60	****	1.67	1.61	8.46	****	9.01	2.40	2.90	13.26	1.53
	ASMA	****	5.04	****	2.58	1.73	1.03	****	0.62	4.91	7.54	5.11	4.46
A12	PROD	1.31	2.24	5.15	4.30	3.43	9.10	7.17	2.13	31.60	4.83	61.56	19.23
	CHLA	1.08	1.75	3.02	1.69	1.74	2.40	5.51	1.59	5.74	2.82	16.43	2.48
	ASMA	1.21	1.28	2.04	2.54	1.97	3.79	1.30	1.34	5.51	1.71	3.75	7.75

VALUES OF **** REPRESENT DATA NOT AVAILABLE

Table 1 (Cont.). 1978 PRODUCTIVITY, CHLOROPHYLL a, AND ASSIMILATION RATIO A.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
A13	PROD	1.65	2.29	1.79	1.58	1.49	3.59	0.94	1.51	19.48	4.04	5.42	13.17
	CHLA	0.84	1.98	3.64	1.52	1.23	2.60	3.64	1.45	7.34	2.50	2.00	2.00
	ASMA	1.96	1.16	0.49	1.04	1.21	1.38	0.26	1.04	2.65	1.64	2.71	6.59
A14	PROD	1.40	3.72	5.23	1.97	2.03	8.19	6.66	2.23	23.54	6.86	15.79	13.78
	ÇHLA	0.90	2.25	2.47	1.57	0.89	2.86	5.70	1.54	4.17	2.88	2.32	2.05
	ASMA	1.56	1.65	2.12	1.25	2.28	2.86	0.17	1.45	5.15	2.38	6.81	6.72
A15	PROD	3.67	6.33	7.12	3.46	4.80	6.34	2.65	2.47	17.00	6.11	37.89	21.27
	CHLA	1.78	2.09	3.79	0.95	3.42	5.05	3.36	1.64	2.87	6.07	7.39	1.53
	ASMA	2.06	3.03	1.88	3.64	1.40	1.26	0.79	1.51	5.92	1.01	5.13	13.90
A16	PROD	2.14	6.98	6.22	3.20	4.30	5.67	2.54	0.97	10.10	11.21	5.99	14.72
	CHLA	0.82	1.98	3.76	1.32	3.26	3.27	4.34	2.99	2.90	3.48	4.28	1.65
	ASMA	2.61	3.53	1.65	2.42	1.32	1.73	0.59	0.32	3.48	3.22	1.40	8.92
A17	PROD	2.31	5.65	2.53	2.06	1.05	3.80	3.01	0.33	21.58	7.86	6.82	14.32
	CHLA	1.70	3.21	1.49	3.40	1.61	3.11	4.88	1.91	5.13	2.49	1.34	1.79
	ASMA	1.36	1.76	1.70	0.61	0.65	1.22	0.62	0.17	4.21	3.16	5.09	8.00
B1	PROD	2.29	0.83	0.24	1.26	1.22	1.89	1.08	0.56	2.14	11.63	12.64	23.64
	CHLA	2.77	0.53	0.21	1.57	1.67	1.03	0.93	0.40	0.87	1.73	1.55	4.50
	ASMA	0.83	1.57	1.14	0.80	0.73	1.84	1.16	1.40	2.46	6.72	8.15	5.25
B2	PROD	1.33	1.36	3.25	5.44	3.54	5.15	1.74	5.30	24.07	19.31	13.79	6.55
	CHLA	0.65	0.36	1.16	2.22	1.89	2.26	1.57	1.59	8.33	4.24	1.05	1.60
	ASMA	2.05	3.78	2.80	2.45	1.87	2.28	1.11	3.33	2.89	4.55	13.13	4.09
B3	PROD	0.97	1.29	0.78	5.45	2.87	4.18	0.43	4.15	31.99	11.86	25.60	17.01
	CHLA	0.91	0.50	0.33	3.30	1.29	1.15	3.09	****	9.99	3.29	2.80	3.93
	ASMA	1.07	2.58	2.36	1.65	2.23	3.64	0.14	****	3.20	3.61	9.14	4.33
B4	PROD	****	0.92	0.99	3.07	2.35	2.03	1.55	4.10	24.22	20.95	16.52	15.66
	CHLA	0.68	0.41	0.42	1.85	1.61	1.93	3.17	2.59	9.97	4.54	2.48	2.39
	ASMA	****	2.24	2.36	1.66	1.46	1.05	0.49	1.58	2.43	4.62	6.66	6.55
B5	PROD	0.19	0.33	1.10	4.75	3.85	3.43	1.97	8.29	41.76	14.35	13.57	4.55
	CHLA	0.33	0.32	0.55	1.95	2.11	2.46	2.57	2.34	12.58	3.63	1.79	1.58
	ASMA	0.58	1.03	2.00	2.44	1.83	1.39	0.77	3.54	3.32	3.95	7.58	2.88

VALUES OF **** REPRESENT DATA NOT AVAILABLE

TABLE 1 (Cont.). 1978 PRODUCTIVITY, CHLOROPHYLL *a*, AND ASSIMILATION RATIO A.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
B6	PROD	0.20	0.52	0.35	5.03	4.21	0.86	0.93	7.92	81.26	21.99	15.55	9.88
	CHLA	0.08	0.30	0.16	1.49	2.70	2.08	3.29	3.00	49.96	4.96	1.27	1.58
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.64	1.63	4.43	12.24	6.25
B7	PROD	0.20	0.54	0.22	2.94	1.98	3.29	1.02	1.33	18.11	17.13	15.03	2.44
	CHLA	0.22	0.43	0.21	3.18	1.99	2.15	2.86	2.45	3.71	4.96	2.44	1.18
	ASMA	0.91	1.26	1.05	0.92	1.00	1.53	0.36	0.54	4.88	3.45	6.16	2.07
B8	PROD	2.64	3.27	7.64	4.76	4.28	3.82	3.30	2.47	9.19	9.83	19.54	11.28
	CHLA	1.22	1.65	1.59	1.31	2.30	3.10	3.77	1.82	****	3.86	7.32	1.66
	ASMA	2.16	1.98	4.81	3.63	1.86	1.23	0.88	1.36	****	2.55	2.07	6.50
B9	PROD	0.40	3.76	5.52	5.71	3.87	1.12	5.32	1.66	34.66	6.48	28.51	11.82
	CHLA	0.38	2.12	3.72	****	2.07	4.05	3.95	1.74	11.83	3.95	6.08	2.34
	ASMA	1.05	1.77	1.48	****	1.87	0.28	1.35	0.95	2.93	1.64	4.69	5.05
B10	PROD	2.78	1.43	5.84	4.93	3.05	2.68	1.89	4.71	25.42	20.73	13.54	24.75
	CHLA	1.22	0.87	0.34	2.43	1.32	1.78	3.10	2.11	7.65	4.11	2.70	4.71
	ASMA	2.28	1.64	17.18	2.03	2.31	1.51	0.61	2.23	3.32	5.04	5.01	5.25
B11	PROD	1.43	0.86	0.34	5.03	2.20	1.24	1.09	3.59	19.08	20.18	8.69	24.80
	CHLA	0.65	0.59	0.31	2.62	1.47	1.52	2.38	1.55	9.19	3.37	2.24	5.53
	ASMA	2.20	1.46	1.10	1.92	1.50	0.82	0.46	2.32	2.08	5.99	3.88	4.48
C1	PROD	0.52	0.22	2.69	4.76	5.29	0.78	5.79	5.31	14.03	21.02	17.97	1.93
	CHLA	0.48	0.10	1.04	1.01	3.90	2.11	2.40	1.91	2.08	1.94	1.38	1.09
	ASMA	1.09	2.16	2.58	4.72	1.36	0.37	2.41	2.78	6.75	10.84	13.02	1.77
C2	PROD	0.34	0.16	1.60	3.79	4.47	3.81	3.31	4.09	10.19	7.58	25.21	0.07
	CHLA	0.22	0.24	0.77	1.43	3.40	1.99	3.85	2.23	1.43	4.04	1.96	0.90
	ASMA	1.56	0.66	2.08	2.65	1.32	1.92	0.86	1.83	7.13	1.88	12.86	0.08
C3	PROD	0.21	0.18	4.30	5.36	7.24	2.30	7.72	6.13	6.46	3.30	23.65	2.74
	CHLA	0.23	0.09	1.62	1.85	3.09	1.32	2.83	2.19	1.14	1.03	1.68	1.33
	ASMA	0.92	2.00	2.66	2.90	2.34	1.74	2.73	2.80	5.67	3.20	14.08	2.06
C4	PROD	0.57	0.22	2.21	3.55	5.16	1.58	2.99	1.43	5.31	2.81	15.94	3.27
	CHLA	0.01	0.25	0.95	0.94	3.91	1.27	3.33	0.78	1.06	0.60	1.28	4.37
	ASMA	4.75	0.89	2.34	3.78	1.32	1.24	0.90	1.83	5.01	4.68	12.45	0.75

TABLE 1 (Cont.). 1978 PRODUCTIVITY, CHLOROPHYLL *a*, AND ASSIMILATION RATIO A.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
C5	PROD	0.08	0.05	2.72	1.21	6.39	4.56	1.08	9.80	5.12	13.57	31.99	2.36
	CHLA	0.15	****	0.68	.52	3.99	1.98	3.73	3.36	0.78	1.75	2.19	1.46
	ASMA	0.54	****	4.01	2.34	1.60	2.30	0.29	2.92	6.56	7.75	14.61	1.62
C6	PROD	****	0.13	2.96	4.56	10.78	1.10	0.26	1.39	7.20	4.69	14.33	5.39
	CHLA	****	****	0.97	1.22	5.85	1.34	1.32	0.88	1.21	1.18	1.28	0.53
	ASMA	****	****	3.05	3.74	1.84	0.82	0.20	1.58	5.95	3.98	11.20	10.17
C7	PROD	0.20	0.22	0.99	3.88	3.83	2.34	6.90	1.24	7.80	6.70	44.49	2.34
	CHLA	0.14	0.10	2.43	6.36	2.15	1.58	3.92	1.99	1.33	1.38	3.25	1.14
	ASMA	1.48	2.24	0.41	2.86	1.78	1.48	1.76	0.62	5.87	4.86	13.69	2.05
C8	PROD	****	0.05	1.02	3.91	4.84	0.83	4.65	1.25	17.14	3.67	20.15	2.15
	CHLA	****	0.02	1.27	2.34	2.25	1.88	2.66	2.37	4.03	1.01	2.02	0.84
	ASMA	****	3.13	0.80	1.67	2.15	0.44	1.75	0.53	4.25	3.63	9.98	2.56
C9	PROD	0.09	0.14	0.47	2.26	1.57	0.05	5.54	2.40	13.85	5.31	26.70	0.55
	CHLA	0.83	0.02	0.59	1.19	1.59	1.94	2.39	2.24	4.25	1.33	2.29	1.28
	ASMA	0.11	9.33	0.80	1.89	0.99	0.03	2.32	1.07	3.26	3.99	11.70	0.43
C10	PROD	0.35	0.17	1.59	4.13	3.77	1.51	0.45	2.95	27.26	4.07	16.93	3.46
	CHLA	0.23	0.17	0.80	1.75	2.57	1.58	2.40	2.45	3.85	1.64	1.46	2.08
	ASMA	1.56	1.01	1.99	2.37	1.47	0.96	0.19	1.20	7.08	2.48	11.60	1.66
C11	PROD	0.12	0.24	0.32	1.04	0.94	2.77	7.94	6.23	6.67	7.15	35.10	1.47
	CHLA	0.36	0.30	0.45	0.53	1.69	2.36	2.87	3.26	1.37	1.81	3.16	****
	ASMA	0.33	0.81	0.71	1.96	0.56	1.17	2.77	1.91	4.87	3.95	12.60	****
D1	PROD	1.55	1.23	0.50	9.77	1.94	5.39	1.94	6.48	58.28	35.90	25.79	25.61
	CHLA	1.67	0.58	0.25	4.31	0.89	1.75	2.08	3.21	31.73	4.79	2.09	4.62
	ASMA	0.93	2.12	2.00	2.27	2.18	3.08	0.93	2.02	1.84	7.50	12.34	5.54
D2	PROD	0.23	0.36	0.47	3.97	2.92	6.92	1.56	2.89	43.05	19.92	18.97	8.22
	CHLA	2.58	0.38	0.81	2.58	****	9.62	5.27	2.04	50.21	3.67	1.89	1.85
	ASMA	0.09	0.95	0.58	1.54	****	0.72	0.30	1.42	0.86	5.43	10.04	4.44
D3	PROD	1.10	0.80	0.03	4.45	2.02	1.08	0.78	5.14	71.89	28.95	22.73	17.93
	CHLA	2.12	0.50	****	3.63	1.13	1.74	3.74	3.91	47.60	4.44	2.09	2.41
	ASMA	0.52	1.60	****	1.23	1.79	0.62	0.21	1.32	1.51	6.52	10.88	7.44
D10	PROD	0.63	0.55	0.20	1.48	1.80	2.67	0.76	2.38	31.27	11.52	17.75	4.66
	CHLA	0.58	0.48	****	4.74	2.28	4.01	3.97	2.90	20.44	2.60	2.09	1.03
	ASMA	1.09	1.15	****	0.31	0.79	0.67	0.19	0.82	1.82	4.43	8.49	4.52

VALUES OF **** REPRESENT DATA NOT AVAILABLE

B. ZOOPLANKTON

INTRODUCTION

The zooplankton include those animals in the water column that are unable to swim or have such weak swimming ability that they are unable to make headway against a current. Thus, these organisms are carried from place to place by the prevailing currents and as a result may be transitory members of the fauna of any particular location, although particular species have habitat requirements or preferences.

The permanent members of the zooplankton which spend their entire lives as drifting organisms are termed holoplankton. Such holoplankton include the copepods, cladocerans, and larvaceans. Other organisms, called meroplankton, inhabit the water column only temporarily as eggs, larvae or immature forms which metamorphose and either settle out to become sessile or attached to substrates, or develop in swimming ability sufficiently to become nektonic. The sessile forms include crustaceans, molluscs, worms, bryozoans, hydroids and ascidians, while fish and some crustaceans join the nekton.

Zooplankton investigations of outer Los Angeles Harbor have been conducted from 1972 to 1979 by Harbors Environmental Projects. Plankton were collected from the entire harbor area from Cabrillo Beach to the San Gabriel River, including the ports, both of Los Angeles and Long Beach, during 1973 and 1974, for Southern California Gas Company, the USC Sea Grant Program and the Army Corps of Engineers (AHF, 1976). Environmental Quality Analysts-Marine Biological Consultants have investigated the zooplankton of the middle and inner Long Beach Harbor area for the marine studies of the Southern California Edison plant impacts (EQA-MBC, 1975; 1976; 1977; 1978). Soule and Oguri (1978) also conducted investigations of the impact on the zooplankton and other marine organisms in the western portion of outer Los Angeles Harbor caused by the explosion and spill of Bunker C fuel oil by the tanker Sansinena. Soule and Oguri (1979), using zooplankton samples collected from 1972 through 1978 in outer Los Angeles Harbor, described the impact of secondary treatment and cessation of cannery effluent upon the zooplankton of Los Angeles Harbor.

The purpose of the present report is to update, for the year 1978, the baseline studies (AHF, 1976) for the Ports of Los Angeles and Long Beach.

METHODS

Zooplankton samples were taken aboard the University of Southern California research vessel Golden West. Station locations are shown with data in Figures 1-13. Vertical plankton tows were taken during 1978 using a ½ meter, 253 μm mesh nylon conical plankton net. The volume of water filtered by the net was calculated from the revolutions of a flow meter mounted halfway between the center and rim in the mouth of the net. Following each tow the net was washed down into the cup end and the plankton sample was preserved in 10% formalin. Earlier HEP studies used horizontal surface tows, which tended to reduce species diversity and bias the data according to a series of comparative tests carried out at representative harbor stations by HEP.

Aliquots of the samples were made using a Folsom plankton splitter such that each subsample contained from 500 to 1000 organisms. The copepods and cladocerans from these aliquots were identified to species and all other groups of plankton to the lowest possible taxonomic levels.

Despite the fact that previous HEP zooplankton studies (AHF, 1976; Soule and Oguri, 1978) of the Los Angeles-Long Beach Harbors were made using surface horizontal tows to collect zooplankton, the present study employed vertical tows. The change in collecting procedure was instituted primarily because it was felt that results concerning species preferences for particular depths and behavior of zooplankton to abiotic stimuli (e.g. light) were being biased by the horizontal sampling procedure. An example was the depressed summer concentrations of *Acartia* spp. using surface tows when other studies (Esterly, 1930; EQA-MBC, 1976) indicated elevated concentrations. *Paracalanus parvus* and *Corycaeus anglicus* similarly showed low summer concentrations using surface horizontal tows. Raymont (1963) and others have indicated light to be the primary motivating factor in vertical migrations and the higher intensities of summer light would cause the zooplankton to move out of the surface horizon of surface horizontal tows. Thus, vertical sampling has the advantage of integrating the water column, and collection will occur despite the position of the species in the water column.

The disadvantage in switching to vertical tows is that new data are no longer strictly comparable with prior data because of differing collecting methods. It was assumed, however, that the differences caused by change in collecting method would be similar throughout the harbor and that the relative position of one station to another within each sampling locality would be the same using the different sampling techniques, with the possible qualification of the shallowest stations sampled. A relatively sparsely populated station under one sampling procedure would probably remain relatively sparsely populated in another. If this premise is valid, then a relative change in distribution patterns or population density between sampling localities should reflect an environmental change. On this basis, relative changes in population distribution can be compared between the AHF (1976) study using horizontal tows and this study.

RESULTS

The zooplankton of Los Angeles-Long Beach Harbors are composed primarily of copepods, which make up more than 63 percent, and cladocerans, which contribute nearly 21 percent of the total zooplankton. Other important contributors include Cirripedia (barnacle) nauplii (3.2%), larvacea (2.9%), and ophiopluteus (2.8%). Fifty species of copepod were identified in the present study. The copepods are dominated by the calanoids, of which *Acartia* spp. (composed of *A. tonsa* and *A. californiensis*) make up over 36% and *Paracalanus parvus* comprises better than 15% of the total zooplankton. The cyclopoid copepods are represented mainly by *Corycaeus anglicus* (3.2%) and *Oithona* spp. (1%). Cladocerans are represented by four species: *Evadne nordmanni* (11%); *Penilia avirostris* (4%); *Podon polyphemoides* (3%); and *Evadne spinifera* (2.6%). Table 1 shows the rank order of eight dominant zooplankton by season. Table 2 gives the number of species and number of individuals per m^3 by season.

Spatial Distribution

Acartia spp.

For the purposes of this report, *Acartia* spp. consists of two species: *A. tonsa* and *A. californiensis*. *Acartia californiensis* was described by Trinast (1976) from Newport Bay, California and has not previously been reported by EQA-MBC (1978) or Soule and Oguri (1978, 1979; AHF, 1976) to occur in the Los Angeles-Long Beach Harbors. This is undoubtedly an oversight because of the nearly identical appearance of the two species. Close examination and dissection of *Acartia* spp. revealed, however, that *A. californiensis* is the dominant *Acartia* in the inner harbor channels and *A. tonsa* predominates in the outer harbor. The areal distribution for these two species for November 1978 is shown in Figure 1. There is an apparent mixing of the two species, probably by tidal action, at stations A8, C1 and C2. The shallower outer harbor stations which seem to have more restricted circulation and more variable salinities also show an increased *A. californiensis* percentage. While stations A10 and A7 both indicate this, station A 11, in an area subjected to surge, does not. Even the isolated small inlet at D10 shows an 85 percent *A. californiensis* and the lower concentrations of this species at D2 may represent "spill out" from D10. The lower concentrations of *A. californiensis* at the inner B stations (B5, B6, B7) appear to be anomalous when viewed with the rest of the inner harbor stations. AHF (1976) has found that this area is one of overlapping characteristics of inner and outer harbor planktonic fauna. Typically outer harbor dominant cladocerans, fish eggs and fish larvae were present in equally large numbers at the inner B stations, while other species such as *Oithona oculata*, which are present in large numbers only in the inner harbor, were similarly present at the inner B stations. The possibility also exists that distribution is affected by the Edison power plant operation near station B5.

Drogue studies (Soule and Oguri, 1972) and tidal model studies (McAnally, 1975) have shown a large clockwise circulating gyre between Angels Gate and Terminal Island. The distribution of *A. californiensis* in the outer Los Angeles Harbor reflects this circulation. *A. californiensis* is presumably entrained from the mouth of the main channel (A8), swept through stations A3 and A4, A16 and A15, and then circling up to A12, after which it presumably dies out or becomes so diluted as not to appear in the samples.

The distribution of the two *Acartia* species is shown in Figure 2. It can be seen that this genus had its highest concentrations in 1978 in the inner Los Angeles Harbor channels. High concentrations were shown throughout both inner harbors in 1973-1974 by AHF (1976), with the peak at station B7 in inner Long Beach Harbor. Concentrations were much lower at B4, B5 and B7 in 1978. This might be due to increased flushing caused by the Edison plant entrainment capacity of over 700 mgd, or to entrainment mortality, to changes in the thermal regime, or other, unknown factors.

The lowest mean *Acartia* spp. concentration is at A7, the station nearest the Terminal Island Treatment Plant effluent. Station A15, lying in the path of the prevailing currents that pass through A7, was the next lowest mean concentration for this genus. It would appear that the secondary effluent of TITP has an inhibitory effect on the presence of this genus, greater than that of the primary effluent. Chlorination of TITP effluent occurred between March 9 and the end of August, 1978. Emerson (1976) reviewed the effects of chlorination on selected invertebrates, which are severe. Biocides used at the power plant would have similar, but transitory effects.

Although the EQA-MBC (1978) data indicate that critical thermal temperatures were not approached for *Acartia*, thermal preferences may have been affected. The seasonal and annual maps of temperature indicate that thermal differences existed between HEP stations B5, opposite the Edison discharge, and B4, which are located near the Edison stations P7 and P10 respectively. Figures in Section II (of this report) illustrate the seasonal mean thermal distribution in surface waters and the annual means. The HEP data taken at 1 meter intervals in the water column are tabulated in the Appendix. Station P7 was identified as the "treatment station", as being continuously within the thermal plume, and station P10 was considered a "reference station", wherein species composition was similar to P7 but temperatures were outside the 1°F isotherm of the plume.

Effects of entrainment, studied by EQA-MBC (1978) with and without heat, showed higher net mortalities for *Acartia tonsa* and *Paracalanus parvus* without heat than with heat. Intake mortalities were lower than discharge mortalities.

Paracalanus parvus

The harbor-wide spatial distribution of *Paracalanus parvus* is shown in Figure 3. While the three peak concentrations are located in the back inner channels (stations C4, C6, C7), the species is abundant in many outer harbor stations as well as the Long Beach mid-harbor locations. *Paracalanus parvus* was found to be more evenly distributed than most species of the planktonic fauna of Los Angeles-Long Beach Harbors (AHF, 1976; EQA-MBC, 1978).

The lowest concentrations of *P. parvus* in 1978 were found in the vicinity of the TITP outfall at station A7, as well as at A4, A11 (at the seaplane base), A16, and A8, at the mouth of the main channel.

Stations A12 and A15 were the next lowest *P. parvus* stations in the outer Los Angeles Harbor. While other stations throughout the harbor complex show low concentrations of *P. parvus*, the triangular area between stations A11, A4, and A12 is the largest area of low *P. parvus* concentrations and follows the 6 meter depth contours. It is also the area most affected by TITP effluent. It appears that the change in quality of the TITP effluent has a negative impact on *P. parvus*. In 1973-74, station A12 had the highest concentrations inside the harbor, in surface waters.

The mean concentration of this species over 1978 at all stations showed a three-fold increase over what was found by HEP (AHF, 1976) for the 1972-1974 sampling period (713 compared to 238, respectively). This increase was probably an artifact, the result of the change from surface horizontal to vertical tows, since EQA-MBC (1978) found that *P. parvus* concentrations increase with depth and that the greatest concentrations occurred in the Long Beach channels at 12 meters.

Corycaeus anglicus

Except for the high concentration of *Corycaeus anglicus* at station C6, this species was most abundant in 1978 on the seaward side of Terminal Island in the outer Los Angeles-Long Beach Harbors (Figure 4), and outside the harbor at stations A1 and B1. This species followed the pattern of *Paracalanus parvus* in having the lowest concentrations in the A7 area, with increasing concentration at the stations beyond the shallow water, 6 meter contour line. Low concentrations for this species were also found at C5 and D10, which are also in shallow water.

Corycaeus anglicus was found to be about 2.8 times more abundant in 1978 than HEP found in 1972-74 (AHF, 1976). This increased concentration probably also resulted in the change from surface horizontal tows to vertical tows since EQA-MBC (1978) showed that this species has a distinct preference for deeper water (6 and 12 meters). However, the incidence in the inner Long Beach Harbor had decreased relative to outer harbor concentrations in 1978.

Evadne nordmanni

Evadne nordmanni was the dominant cladoceran and composed 11 percent of the planktonic fauna in 1978. It was, strikingly, virtually absent from the inner harbor channels and was most abundant in the outer harbor area (Figure 5). A similar outer harbor dominance was shown for *Evadne* by HEP (AHF, 1976) for the years 1972-1974, which included station A7 as one of the points of high concentration. Stations B3, B4, B5 and, to a lesser extent, B7 had substantial populations in 1973-1974.

The opposite was shown in the present study for station A7; stations A4 and A7 had the lowest concentrations of the outer harbor area. A four-fold decrease occurred in 1978 in total *Evadne* concentrations over the HEP 1973-1974 period. Since the preference appears largely to be in deeper water areas of the harbor, vertical tows might have been expected to increase the total capture, but that did not occur. The decrease is thus considered to be genuine. The retreat from A7, A4, A9 and A10 and B3, B4, B5 and B7 may indicate a withdrawal from harbor waters to population centers outside the harbor, perhaps due to oceanographic conditions. This species was generally in very low concentrations during most of the first half of 1978 (Jan-July $\bar{X}$ = 15; Aug-Dec $\bar{X}$ = 85), which would account for much of the difference in mean concentrations between the two studies.

Penilia avirostris

While *Penilia avirostris* accounted for only 0.05 percent of the plankton in 1972-1974 (AHF, 1976), *Penilia avirostris* was the second most abundant cladoceran, accounting for 4 percent of the plankton collected during 1978. Both investigations showed that *P. avirostris* is dominant in the outer harbor area, especially in the Los Angeles outer harbor (Figure 6). The higher Los Angeles outer harbor concentration might have resulted from the circulation of cannery and primary TITP effluent in this area until the end of 1977 (Soule and Oguri, 1972; McAnally, 1975) and the secondary TITP effluent in 1978. In both studies one of the highest concentrations of *P.avirostris* was at A7, the site of these effluents. Thus, *P. avirostris* appeared to be enhanced by effluents discharged by the Terminal Island Treatment Plant, with greatly increased numbers occurring in 1978.

Podon polyphemoides

Podon polyphemoides was the third most abundant cladoceran present in 1978 studies and accounted for 3 percent of the planktonic fauna. Its low concentration is in marked contrast with that found by HEP (AHF, 1976) in 1973-1974, when it comprised 11 percent of the fauna. EQA-MBC (1978) found *Podon* to dominate the cladoceran catch in 1977, but it virtually disappeared in the spring of 1978. This species seemed to be most numerous in the outer harbor (Figure 7), although not to the extent that *E. nordmanni* was (Figure 5). In 1973-1974, large numbers were also found in the Long Beach channels as well as at most outer harbor stations (AHF, 1976).

Podon polyphemoides was absent from the plankton from January through May in HEP samples, which accounted for the low percentage ranking of this species. The absence would support the belief of EQA-MBC (1978) that this species does not maintain a permanent population within the harbor, and that harbor individuals are recruited from offshore populations. However, the populations at stations A1 and B1, outside the harbor, were much lower in 1978 than in 1973-1974.

Larvacea

Larvaceans were ranked eighth among the most numerous members of the zooplankton fauna. These organisms were concentrated largely in the gyre area of the outer harbor and at the mouth of the Los Angeles River, although smaller numbers occurred at the innermost "C" stations (Figure 8). Larvaceans showed a predominantly outer harbor distribution in 1973-1974 (AHF, 1976) but the larger concentrations were found in the eastern Long Beach outer harbor, whereas the 1978 study showed the highest concentrations in the Los Angeles outer harbor. Total numbers were greater in 1978 than in the earlier study.

Fish Eggs and Larvae

Although the fish eggs and larvae showed their greatest abundance in the seaward side of the outer harbor area, a moderate number were collected in the plankton tows at stations C3, C4, and C6 in the inner harbor (Figure 9). This seems to show an increase in spawning in the inner Los Angeles Harbor as compared to that reported by HEP (AHF, 1976). However, station C5 had the lowest numbers of any harbor station with a mean of less than one per m^3. There was a reduction in numbers at stations B4, B5, B6 and B7 over the 1973-1974 totals.

Cirripedia Nauplii

Cirripedia (barnacle) nauplii were ranked sixth in importance in the zooplankton fauna of the harbor. They have a very different distribution from the other dominant zooplankton species in that the highest concentrations are not only in the outer Los Angeles-Long Beach Harbor gyre area but also in the inner harbor stations C8, C9, and B6 (Figure 10). While the concentration at A7 was low, the density of

Cirripedia nauplii increased in an arc away from this station. This might indicate that as the effluent from TITP is diluted, it enhances the growth of barnacle nauplii. However, the distribution is greatly changed from that which occurred in 1973-1974, when HEP found that the highest concentrations were reported in the Long Beach mid-harbor channel areas. Only the Long Beach station B6 remained high in 1978. Temperature changes might have altered the pattern. EQA-MBC (1978) recorded a slight decrease in barnacle nauplii during the operational period.

Total Zooplankton

Concentrations of total zooplankton (Figure 11) show that on the whole the zooplankton is fairly evenly distributed throughout the Los Angeles-Long Beach Harbors. The highest concentrations occurred at stations C3, C6 and C7 in inner Los Angeles Harbor and at B9 in outer Long Beach Harbor. However, there were very low numbers at station A7, where the mean concentration was 1596 organisms/m^3 as compared to 4460 organisms/m^3 for the entire harbor. The next lowest concentration for total zooplankton was D3, with 2360 organisms/m^3. The very low concentration at A7 is probably a response to the secondary effluent from TITP. In contrast, HEP found that the highest concentrations in 1973-1974 were in the inner and middle Long Beach Harbor channels and that A7 also had a moderately high concentration of total zooplankton. The shift from the Long Beach channels may be the result of entrainment and/or alterations and variations in the thermal regimes.

Species Diversity

The Shannon-Wiener species diversity and Margalef species richness indices were calculated for copepod and cladoceran species only, for great uniformity. The areal distribution throughout the harbor is shown in Figures 12 and 13, respectively. Both indices show that diversity is greatest outside the harbor at stations A1 and B1 and nearest the breakwater at A13 and B10. Diversity decreases to moderate levels in the outer harbor and is generally the lowest in the inner harbor channels. A similar distribution of species diversity was found by AHF (1976) for the years 1972-1974. This would be expected because of the variability of the harbor waters due to runoff, extremes in temperature, turbidity, and other environmental stresses such as wastes or accidents.

Temporal Distribution

Acartia spp.

The temporal distribution of *Acartia* spp. is shown in Figure 14A. It can be seen that in 1978 this genus maintained relatively low concentrations in the winter, rose in the spring, attained maximum population in June, and fell off rapidly in the next two months. The increase in December was the result of a bloom of *Acartia* spp. at C7 for that month, and was not a result of a general increase throughout the harbor. This distribution is similar to that found in 1977 by EQA-MBC (1978), except that they found a drop in abundance in June followed by a recovery in July. A maximum summer abundance was also found by Esterly (1930) off La Jolla, California.

Plankton data from the Los Angeles Harbor (Soule and Oguri, 1979) from 1972 to 1977 for horizontal surface tows showed that there existed a consistent spring increase and a drop-off to very low concentrations during the summer. The discrepancy between those results and the present study probably is due to the change in plankton sampling method. Horizontal surface tows were used for 1972-1977. If the *Acartia* spp. exhibited mid-summer light avoidance and moved to deeper water, they would have escaped being captured by the surface horizontal tows. The use of vertical tows in the present study avoided that potential problem.

Paracalanus parvus

Paracalanus parvus had a somewhat erratic temporal distribution in 1978 (Figure 14B). It showed a yearly maximum in February flanked by low concentrations in January and March, and then assumed an increased concentration through late spring and early summer with a drop-off in late summer and fall. This was followed by another peak in December. Patterns such as this were followed to a certain extent in previous years (EQA-MBC, 1978; Soule and Oguri, 1979).

Corycaeus anglicus

Corycaeus anglicus exhibited a spring bloom, achieving maximum concentrations in April, May, and June; it dipped to a concentration minimum in late summer and showed a reduced bloom in November and December (Figure 14C) in 1978. This classic spring-late fall bloom cycle was seen also in data from EQA-MBC (1978) but quarterly HEP data showed the spring bloom early in the year, *i.e.*, February in 1972, 1973 and 1974 (AHF, 1976). However, at selected stations analyzed in Soule and Oguri (1979) the pattern showed early spring blooms in 1972, 1973, 1974 and 1976. The 1974 spring peak extended much longer. In 1978 there were only summer and fall peaks.

Evadne nordmanni

Evadne nordmanni showed a temporal distribution which was similar to the *C. anglicus* spring-fall bloom (Figure 15B). In this case the May bloom was the minor one and the major maximum concentration occurred in October. HEP also showed a mean quarterly spring (May) bloom, but no fall bloom was evident in 1973-1974. At selected outer harbor stations Soule and Oguri (1979) showed similar bloom cycles from 1972 to 1978. However, none of the years showed both spring and fall blooms in the same year.

Penilia avirostris

P. avirostris shows a minimum concentration during the summer months followed by a bloom in late fall and early winter (Figure 15C). The fall bloom has been shown to be consistent from 1972 through 1978 (Soule and Oguri, 1979) except in years when this species was totally absent from the plankton (1974-1975).

Podon polyphemoides

Podon polyphemoides was absent from the plankton through May (Figure 15A), which was similarly shown by EQA-MBC (1978). Following this absence, *P. polyphemoides* achieved concentrations from about 300 to 500 per m^3 from July to October. November showed a drop in abundance followed by a resurgence in December. *P. polyphemoides* seems to be a species which undergoes a periodic dominance and absence from the cladoceran fauna. Its presence in the harbor appears to be dependent on its presence and distribution off the coast. Baker (1938) indicated that this species has a limited seasonal occurrence in areas where conditions are more extreme and less stable. The Los Angeles-Long Beach Harbors could be an area of stress for *P. polyphemoides*; however, the occurrences were similar outside the harbors at A1 and B1.

Larvacea

The larvaceans exhibited a temporal distribution very similar to that of the copepod *Paracalanus parvus* (Figure 14D). Larvaceans showed a peak abundance in February, followed by a secondary peak in April and May. Through the summer and fall, the concentrations declined until December, when there was a great resurgence in numbers.

Cirripedia nauplii

The Cirripedia nauplii (Figure 15D) had concentration minimums in mid-winter (December and January), which is confirmed by EQA-MBC (1978). The greatest peak was in February followed by a small secondary peak in May. August showed another large increase in Cirripedia nauplii which was followed by a decline to very low numbers ($8/m^3$) in December. EQA-MBC (1978) showed their major peaks a month or two later than this study and a secondary peak more or less corresponding to the August peak of this study.

Fish eggs and larvae

Peak periods of fish spawning were determined by quantities of fish eggs and larvae present in the plankton. Figure 16A shows that there was a maximum spawning activity in late winter with February being the peak month. This is confirmed by ichthyoplankton studies discussed in the ichthyology section of this report. A secondary spawning peak occurred in June followed by a decline through November.

Total zooplankton

The temporal distribution of total zooplankton (Figure 16B) is largely a function of the distribution of the dominant zooplankters. Since *Acartia* spp. and *Paracalanus parvus* compose 47 percent of the zooplankton, the temporal distribution of total zooplankton is largely a summation of these two major contributors. Since *Acartia* spp. is dominant mainly in the spring and summer and *P. parvus* had peaks in February, April through July, and December, total zooplankton distribution showed peaks in February, an extended high concentration from spring through early summer, and a peak in December in 1978.

Species diversity

The temporal distribution of the Shannon-Wiener species diversity for copepods and cladocerans is shown in Figure 16C. Clearly this indicates that diversity is higher in winter and low in the late spring/early summer. In comparing the diversity distribution in time with that of *Acartia* spp., it can be seen that the two are very close to being the inverse of one another. Thus, it may be that the dominance of *Acartia* spp. in summer depresses the species diversity or that diverse species withdraw from the warmer harbor, leaving the field to the more tolerant *Acartia*. To study these possibilities, a second diversity index was used, *i.e.*, the Margalef species richness index. While the Shannon-Wiener index places great weight on evenness of abundance of major species, the Margalef index is really a "richness" index and emphasizes the number of species collected, giving less weight to the evenness of major contributors. The temporal distribution of the Margalef species richness index (Figure 16D) also has a similar high winter-low spring/early summer distribution. The mean number of species of copepods and cladocerans was also determined and showed a very similar pattern, from January through December, as follows: 12.7, 12.3, 10.6, 8.8, 8.3, 7.8, 7.7, 9.8, 9.9, 9.7, 10.1, and 12.2/m^3. Thus the low species diversity in late spring and early summer, and high diversity in winter is not related to the changing abundances of the major zooplankton component alone, but represents actual changing diversity in the species present.

The high species diversity appears to correlate with maximum downwelling off the southern California coast (Mearns, 1978). Downwelling is caused by offshore water being moved onshore, in this case probably by winter storms. The offshore water thus brings in more oceanic species of plankton and with it an increased species diversity of the zooplanktonic fauna.

DISCUSSION AND CONCLUSIONS

With the use of vertical tows, *Acartia* spp. has been shown to have a very clear, smooth peak in concentration in the late spring and early summer. Similar spring-summer increases were shown for the other two dominant copepods, *Paracalanus parvus* and *Corycaeus anglicus*. EQA-MBC (1976) found a mid-bloom depression for June between two months of increased concentrations. That June depression may also have been anomalous due to the strict 2, 6, and 12 meter sampling horizons and the possible vertical copepod movement between them. Other zooplankton species which EQA-MBC (1978) has shown to prefer deeper water include *P. parvus* and *C. anglicus*. These species showed a nearly three-fold increase from samples collected with surface tows (AHF, 1976) to the present study using vertical tows. Table 3, comparing the percent composition of zooplankton in 1973-74 and 1978, suggests that there is actually a more balanced distribution of numbers among the dominant species than was indicated by earlier studies.

Outer Los Angeles Harbor

The most notable change in outer Los Angeles Harbor was the decline in abundance of zooplankton collected at station A7 and adjacent stations. The three dominant copepod species (*Acartia* spp., *P. parvus*, *C. anglicus*) showed the lowest concentrations in the entire harbor complex at these stations. The dominant cladoceran species, *E. nordmanni*, and the Cirripedia nauplii which are normally abundant in the outer harbor, had the lowest concentrations of all outer harbor stations in the A7 area. By contrast, HEP surface tow data from 1972-1974 (AHF, 1976) showed that none of these species had their lowest concentrations in the A7 area.

Changes which have taken place at A7 between the 1973-1974 HEP study (AHF, 1976) and the present one are: 1) conversion from primary to secondary treatment at the Terminal Island Treatment Plant, and 2) secondary treatment of all cannery effluent. It would appear, therefore, that five of the six normally most abundant species groups have been reduced in numbers by the secondary waste treatment. A possible explanation for this is that secondary waste treatment and treatment of cannery effluent removed much of the organics upon which these organisms were feeding, while largely leaving mineralizing nutrients available only to phytoplankton. The formerly organic wastes may also have provided a site for the adsorption of any toxic chemicals and effectively removed them from the effluent water column. No new toxic wastes have been taken into the TITP plant, so far as can be determined, but chlorination between March and September 1978 could have caused complex chemical reactions leading to formation of chloramines or other new and possibly toxic components. Bioassays, however, showed no evidence of toxicity in 1978 (Soule and Oguri, 1979).

Whatever is limiting these species in the A7 area appears to diminish in stations more distant from A7. This can be clearly seen among many of the species reduced or absent at station A7, as well as for the total zooplankton concentrations.

Not all species are hindered by conditions at A7. *Penilia avirostris* appears to be enhanced at A7, just as it was during the 1972-1974 (AHF, 1976) study. The larvaceans also are abundant at A7 as well as most of the other outer Los Angeles Harbor stations. The vertical tows may well skew the results, when comparing them to earlier surveys, but the trends seem to be valid.

Soule and Oguri (1979) have shown that with these changes there is a concomitant decrease of as much as 30-fold in bacterial concentration of the area. The role of bacteria in the nutrition of filter feeding organisms has become well established (Jørgensen, 1966; Barsdate *et al.*, 1974) and includes cladocerans and copepods (Saunders, 1967). The decline of bacteria may thus have contributed to a decline of major components of the zooplankton fauna. A decrease in detritus would also coincide with initiation of secondary treatment of sewage and cannery effluent. The nutritive role of detritus for zooplankton has been acknowledged by various workers (Darnell, 1967; Qasim and Sankaranarayanan, 1972). Heinle and Flemer (1975) have concluded that the copepod *Eurytemora affinis* must consume detritus to meet part of its nutrient requirements. Darnell (1967) has also shown that areas of zooplankton abundance were correlated with centers of detritus rather than with phytoplankton abundance. While detrital diets seldom equal algae controls, Odum and de la Cruz (1967) have found that colonization of detritus by microorganisms substantially increases its nutritive value. It appears then that the nutritive role of detritus lies in its colonization by bacteria rather than the detritus itself.

Another form of detritus which may be more nutritious is that described by Baylor and Sutcliffe (1963) and Riley (1963). This mechanism involves the flocculation of dissolved organics on the surface if air bubbles are formed in the sea and is considered a potentially important food source for marine zooplankton. With the initiation of secondary waste treatment of sewage and cannery effluent, the "organic soup" has disappeared around the A7 area. Zooplankton sampling has showed that five of the six usually most abundant species groups are now in very low numbers and appear to be limited or inhibited by the secondary waste treatment. Formerly, amino acids, fats, and carbohydrates were identified in the receiving waters. Now only mineralized nutrients such as nitrate, nitrite, phosphate, plus amines, have been measured or identified in the water column.

Long Beach Harbor

Another area of apparent change was the Long Beach mid- and inner harbor areas. This area was the most productive of the harbor (AHF, 1976) during 1973-1974 with high concentrations of *Acartia* spp., *P. polyphemoides*, and Cirripedia nauplii. Total zooplankton was about two times the concentration of any other part of the Los Angeles-Long Beach Harbors. The 1978 study, however, shows that the mid- and inner Long Beach Harbor areas were no longer as productive as other areas of the harbor.

One major environmental change that has taken place since the AHF (1976) study is the operation of the Southern California Edison Long Beach Generating Station starting in January 1977. This plant is located adjacent to Station B5. The impact of this plant on the zooplankton fauna may be by heating of the receiving waters or by killing plankton in the entrained cooling water.

While the Edison power plant does not appear (EQA-MBC, 1978) to be heating the surrounding water outside the immediate area of discharge above the critical thermal maximum (30°C) described by Heinle (1969) for *Acartia tonsa*, the effect of the elevated temperatures on other zooplankton such as *P. polyphemoides* and Cirripedia are unknown. Despite the fact that this temperature increase is sublethal, other changes can occur in the receiving water species composition discussed by Conover (1957) and Raymont (1964). A further change can result as described by Heinle (1969) if, as he found, epibenthic copepod species are more temperature-tolerant than holoplanktonic species such as *A. tonsa*. In this case there is a potential for a diversion of energy from the plankton to the benthos.

Because of the general tendency of zooplanktonic fauna to be smaller when reared at higher temperatures, certain energy flow patterns can change in the heated receiving waters of a power plant. Heinle (1969) concluded that a decrease in size of copepod species would tend to favor passive feeders such as medusae, ctenophores and menhaden at the expense of mechanically selective filter feeders (*e.g.* alewives) and behaviorally selective filter feeders (*e.g.* silversides and anchovies).

Perhaps more important in the case of the generating plant in Long Beach mid-harbor area is the entrainment and subsequent death of a large percentage of zooplankton. In this light, Enright (1977) has viewed power plants as a giant non-selective predator ingesting large quantities of zooplankton and producing nearly equivalent amounts of "fecal" material. He points out that there will be a replacement of predator biomass which ordinarily feed on zooplankton (*e.g.* fish larvae) with a compensatory increase of decomposers and detritus feeders which live off this "fecal" material.

The causes and extent of zooplankton being killed by passing through the cooling system of power plants have been investigated in a number of studies (Carpenter *et al.*, 1974; Davies and Jensen, 1975; Heinle, 1976). Such causes have included temperature shock, biocide action by chlorination and mechanical or hydraulic shock.

Suchanek and Grossman (1971) found a mortality of 100% when temperature was in excess of 34°C. EQA-MBC (1976) also found temperature elevation to be an important factor in the percent mortality of *A. tonsa* and *P. parvus*. They found mortalities of 88.6 and 81% respectively for these species when mean ΔT was 12.2°C and mortalities were reduced to 60.7 and 35.4% respectively for mean ΔT of 4.6°C.

These mortalities, however, may be underestimates, since Reeve (1970) has indicated that delayed effects of passage were important in assessing thermal effects on zooplankton and that death could not be determined with certainty for up to 24 hours following the temperature shock. Similarly, Carpenter, *et al.* (1974) showed, using vital staining, that less than 15% died immediately following passage, 50% died in 3½ days and 70% died in 5 days of the passage, with a control mortality of 10%.

Thus the 9% *A. tonsa* and 7.2% *P. parvus* removed from the back channel per day, while being significantly large in themselves, may be underestimates of the longer-term effects of entrainment. With this potential underestimation of entrainment mortality and the largely unknown effect of heating the receiving waters, the Long Beach Generating Station may indeed have caused the decline in zooplankton in this mid-inner Long Beach harbor area. The extremes of variation in the operation of the plant produce false thermal indications of seasonal warming or cooling, and may affect fecundity as well.

Inner Los Angeles Harbor

Other areas of notable change between the HEP (1973-1974) study (AHF, 1976) and the present 1978 study are: changes in relative abundance of zooplankton in the West Basin (station C6), where there are also warm water discharges from a Union Oil refinery and the Harbor steam plant, and changes in the southwest slip (station C5), the location of Todd shipyards. During the earlier HEP study, C6 had the lowest mean zooplankton concentration of the entire harbor complex and C5 had one of the highest concentrations of zooplankton in the inner Los Angeles Harbor. The 1978 HEP study has shown a complete reversal between these two stations, and now C6 has one of the highest, and C5 one of the lowest, zooplankton concentrations of the inner Los Angeles Harbor. This dramatic switch may indicate that intermittent oil slicks and chemical leaks previously reported in the West Basin (AHF, 1976) have ceased while the industrial activity or storm drainage into the Southwest slip may be polluting more now than it did in 1973-1974.

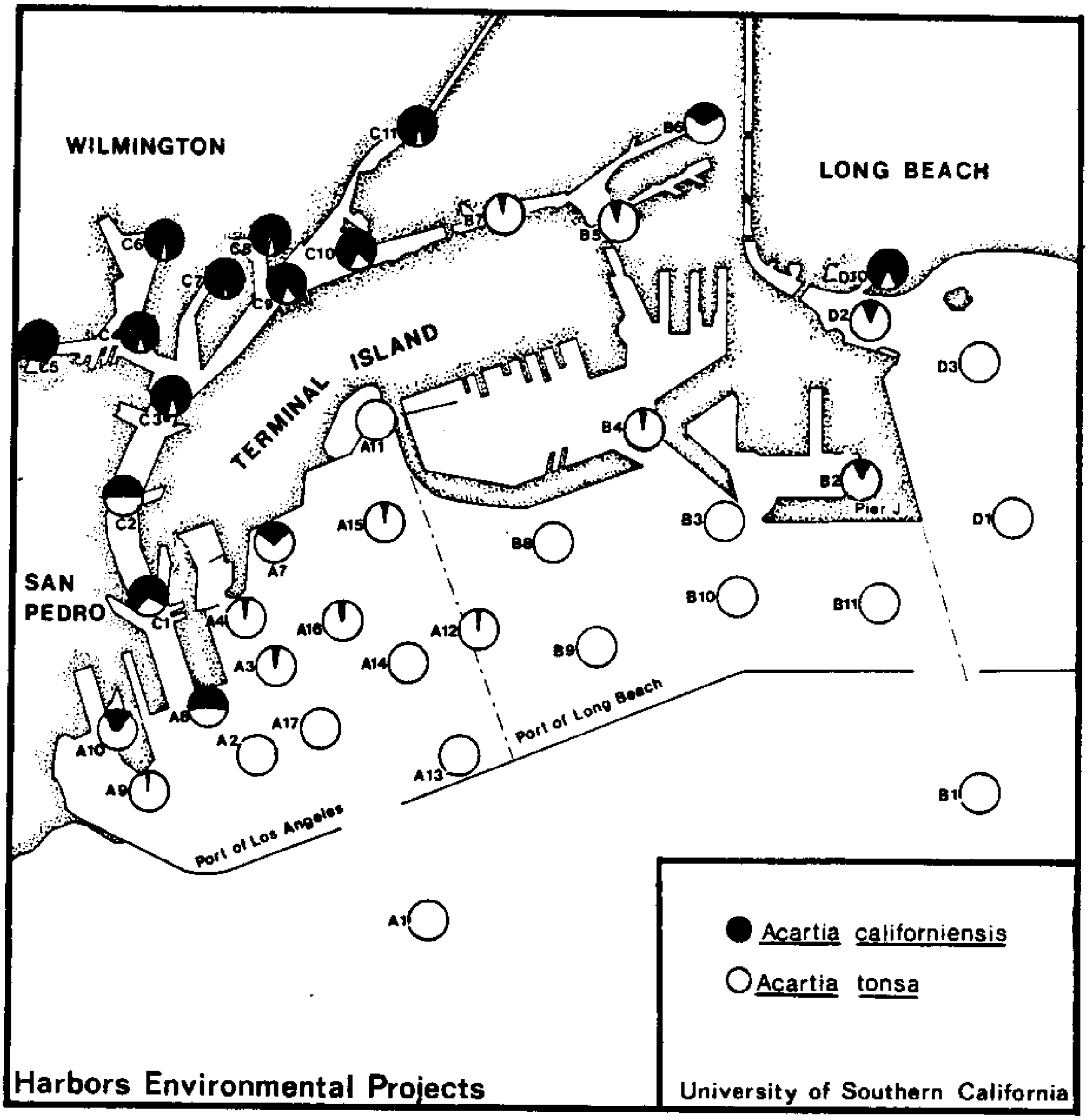


Figure 1. Spatial distribution of *Acartia californiensis* and *Acartia tonsa*, November 1978.

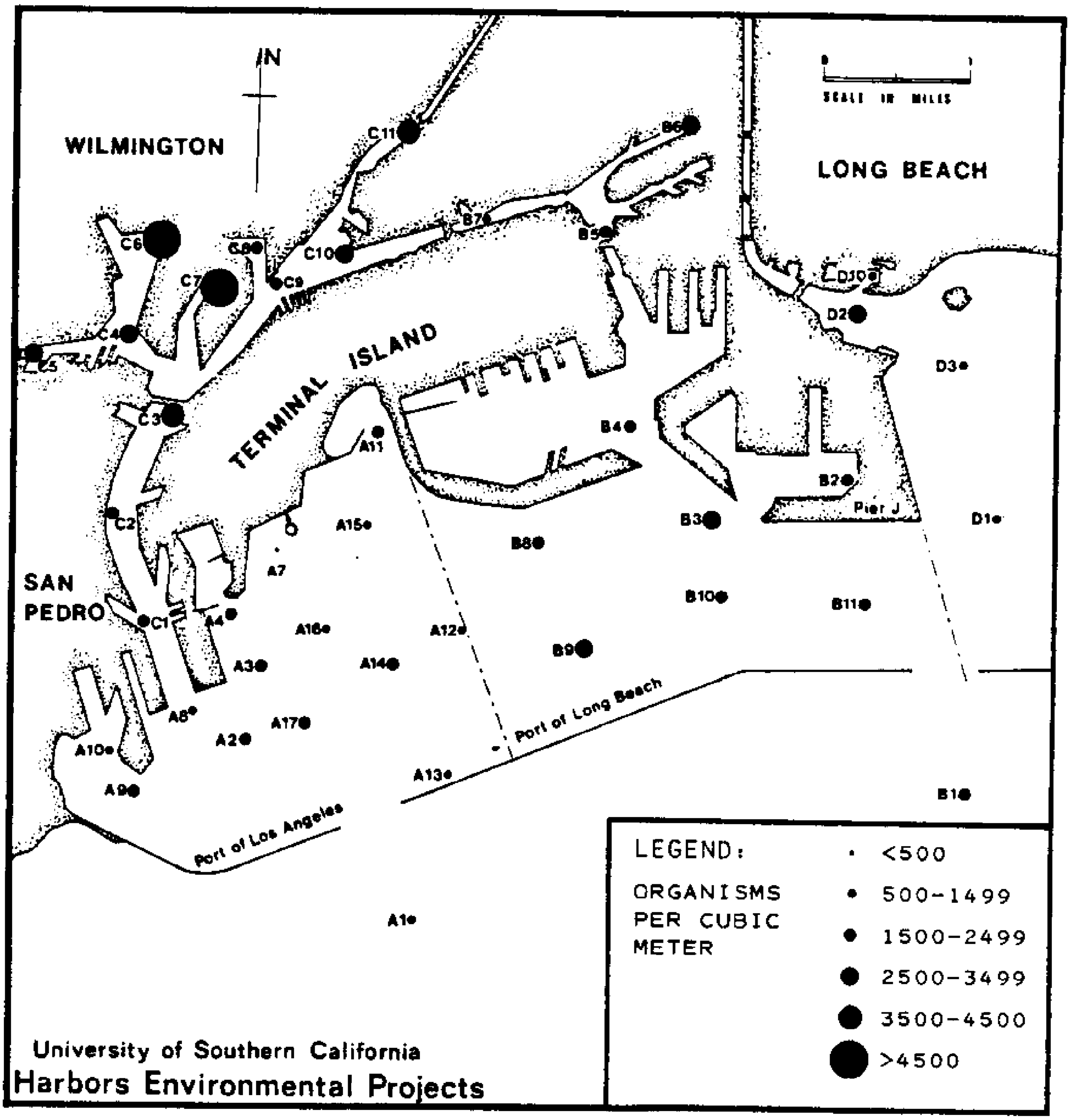


Figure 2. Spatial distribution of *Acartia* spp.

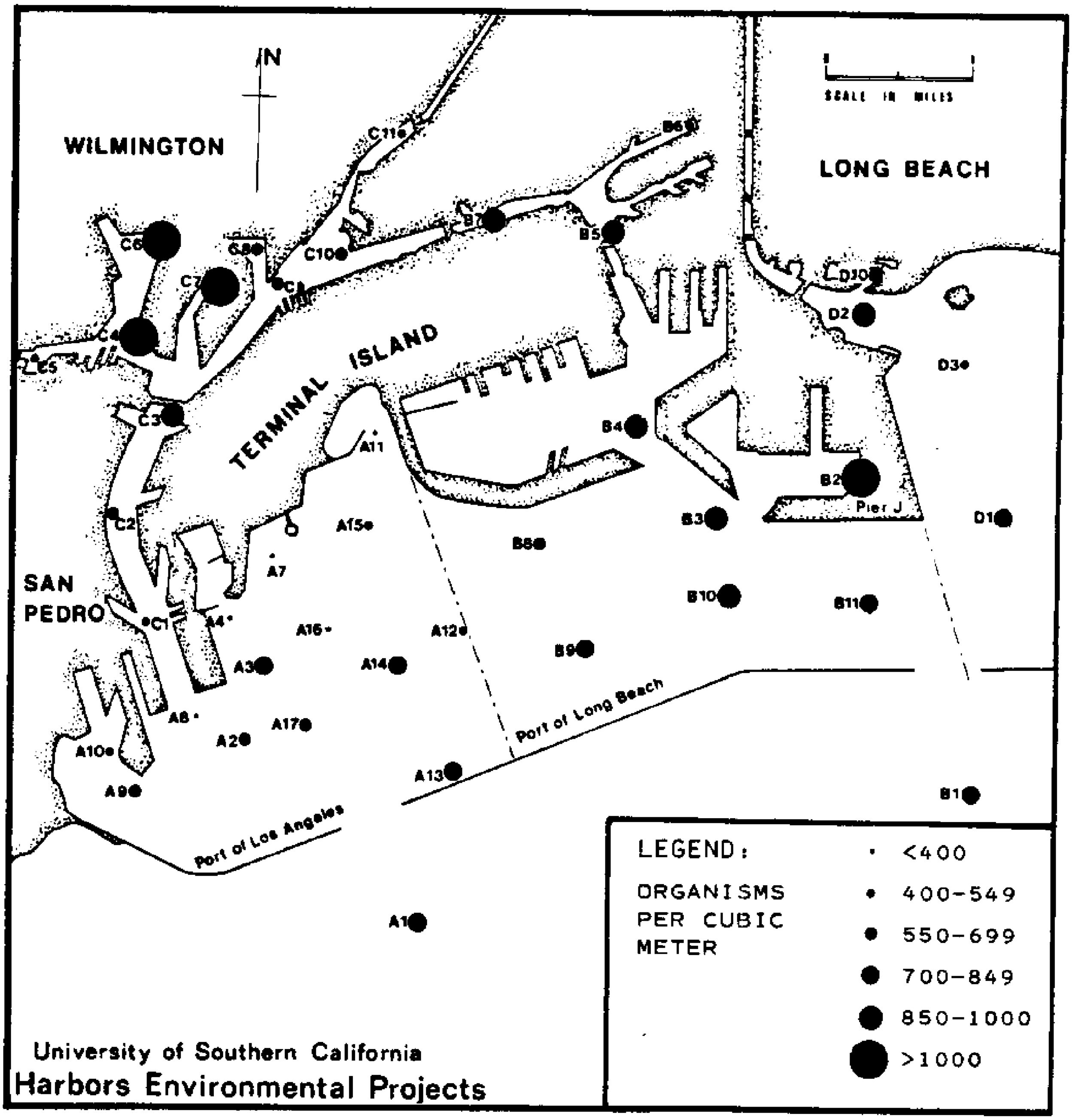


Figure 3. Spatial distribution of *Paracalanus parvus*.

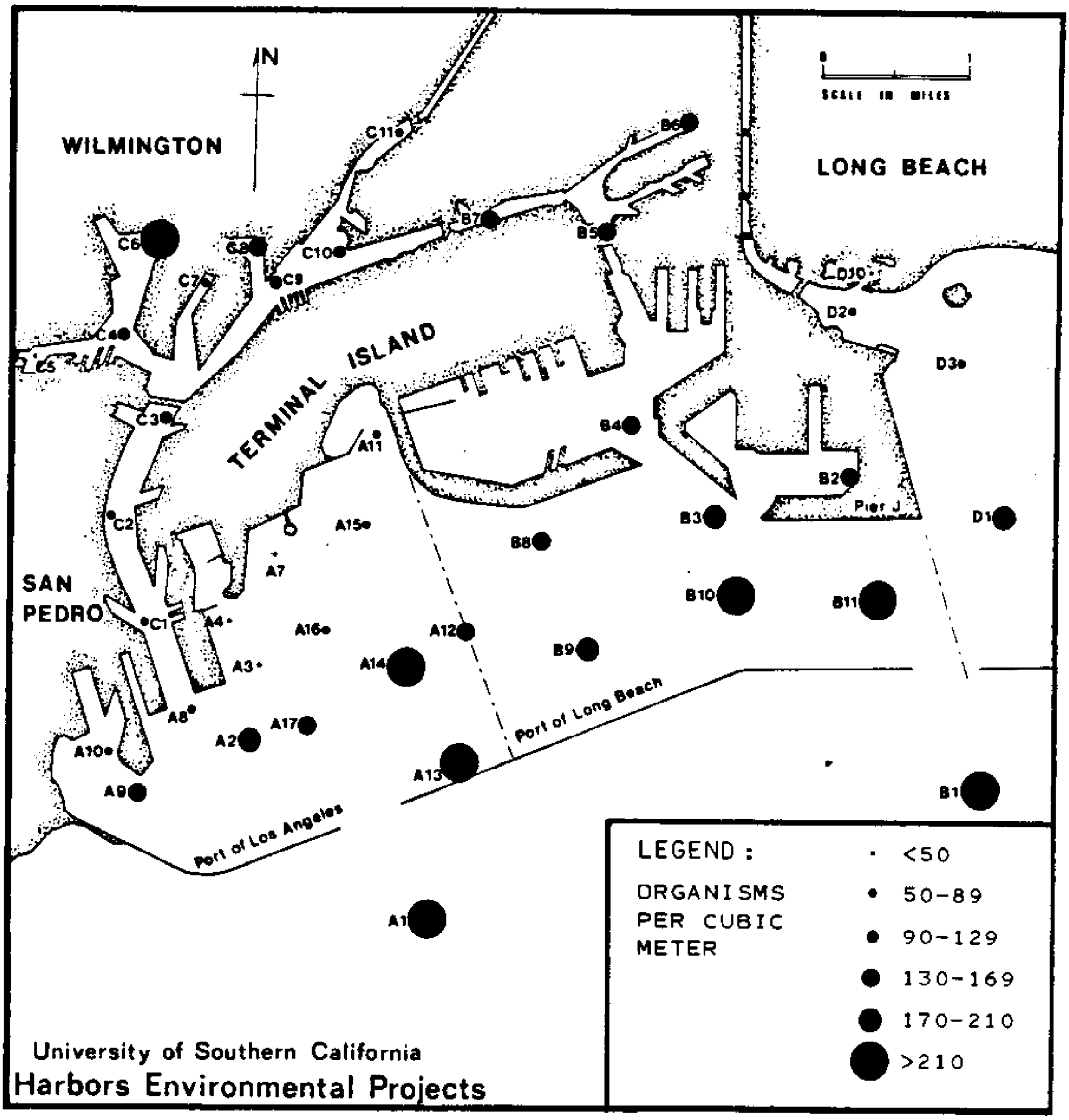


Figure 4. Spatial distribution of *Corycaeus anglicus*.

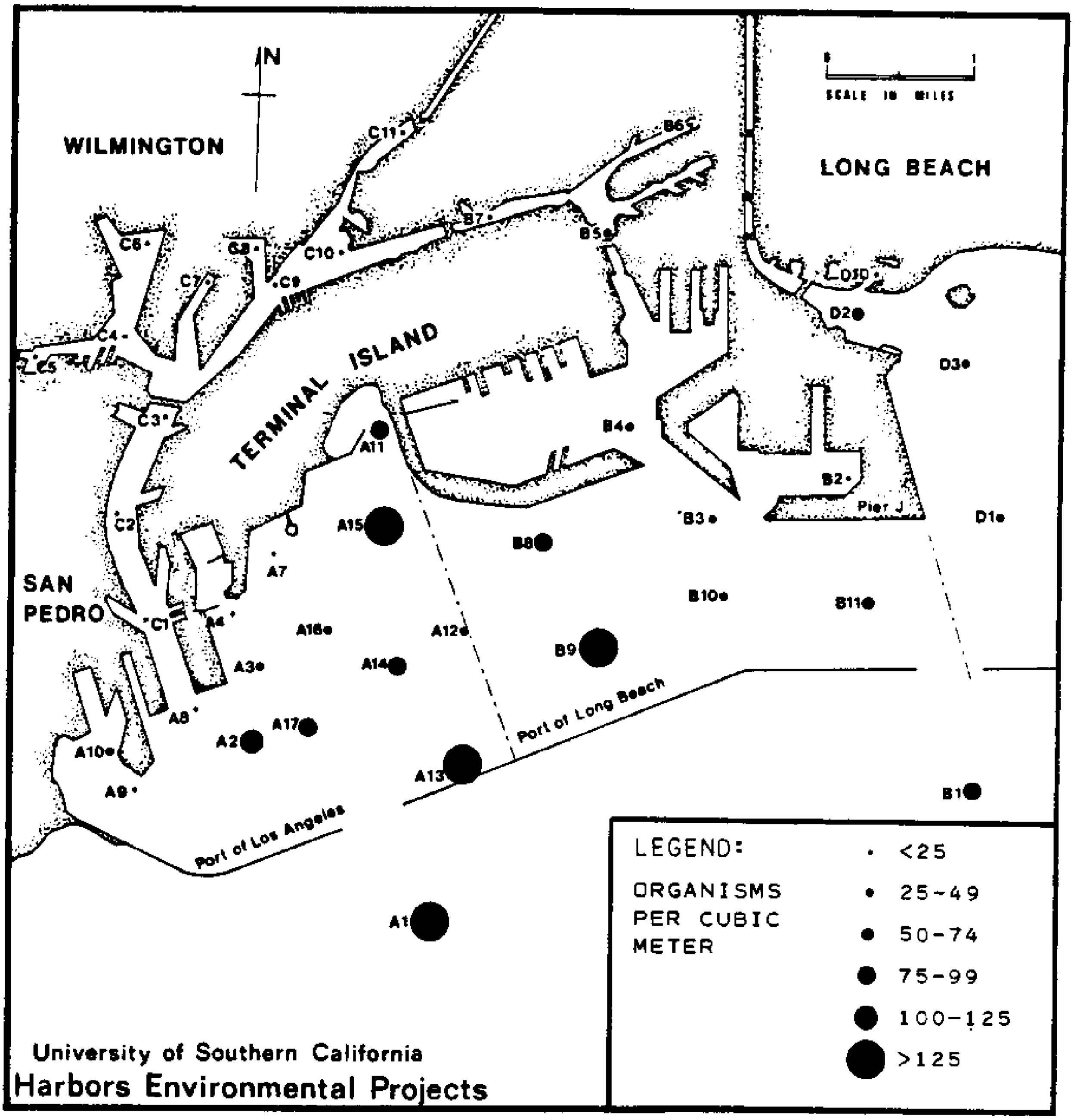


Figure 5. Spatial distribution of *Evadne nordmanni*.

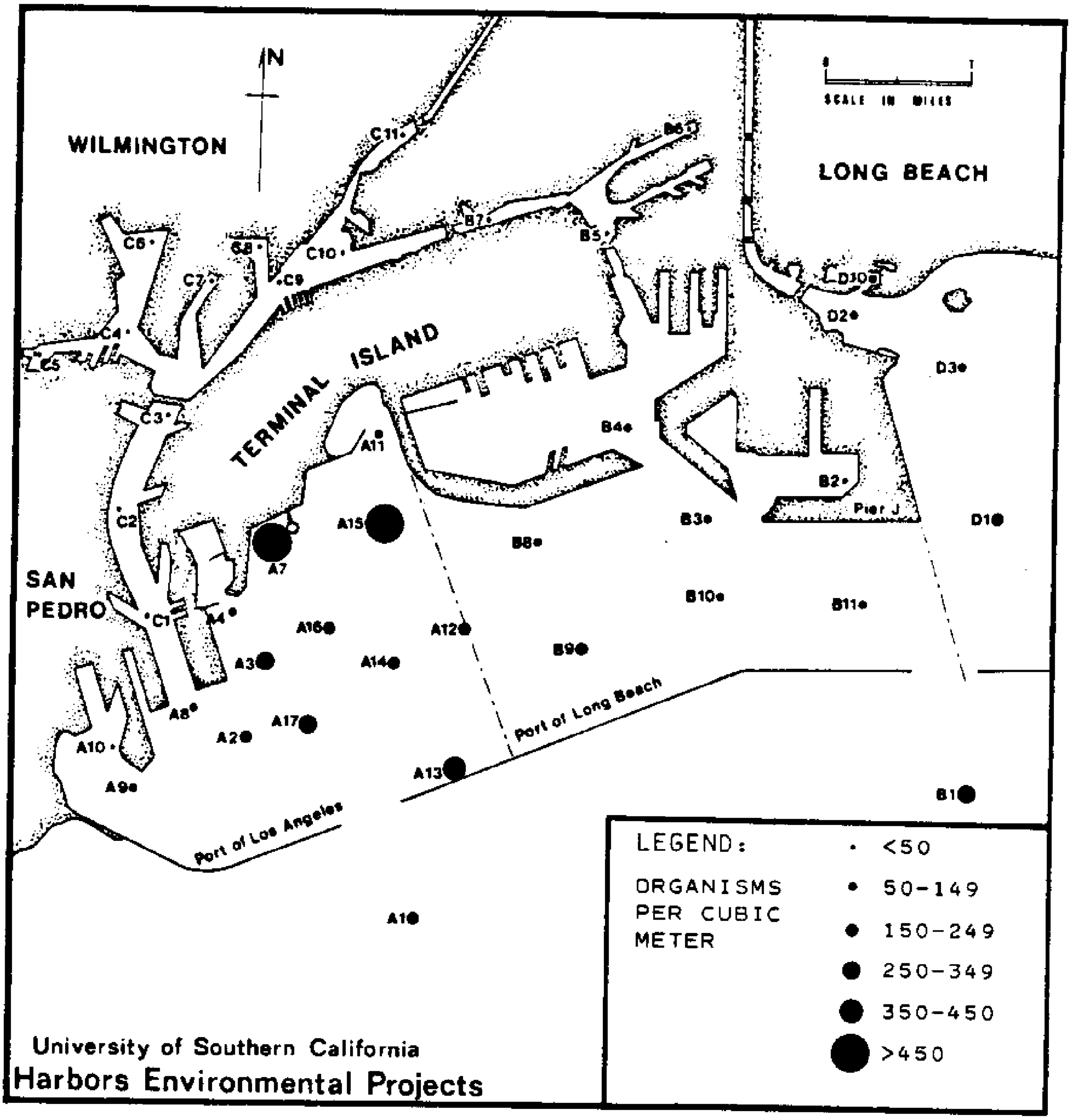


Figure 6. Spatial distribution of *Penilia avirostris*.

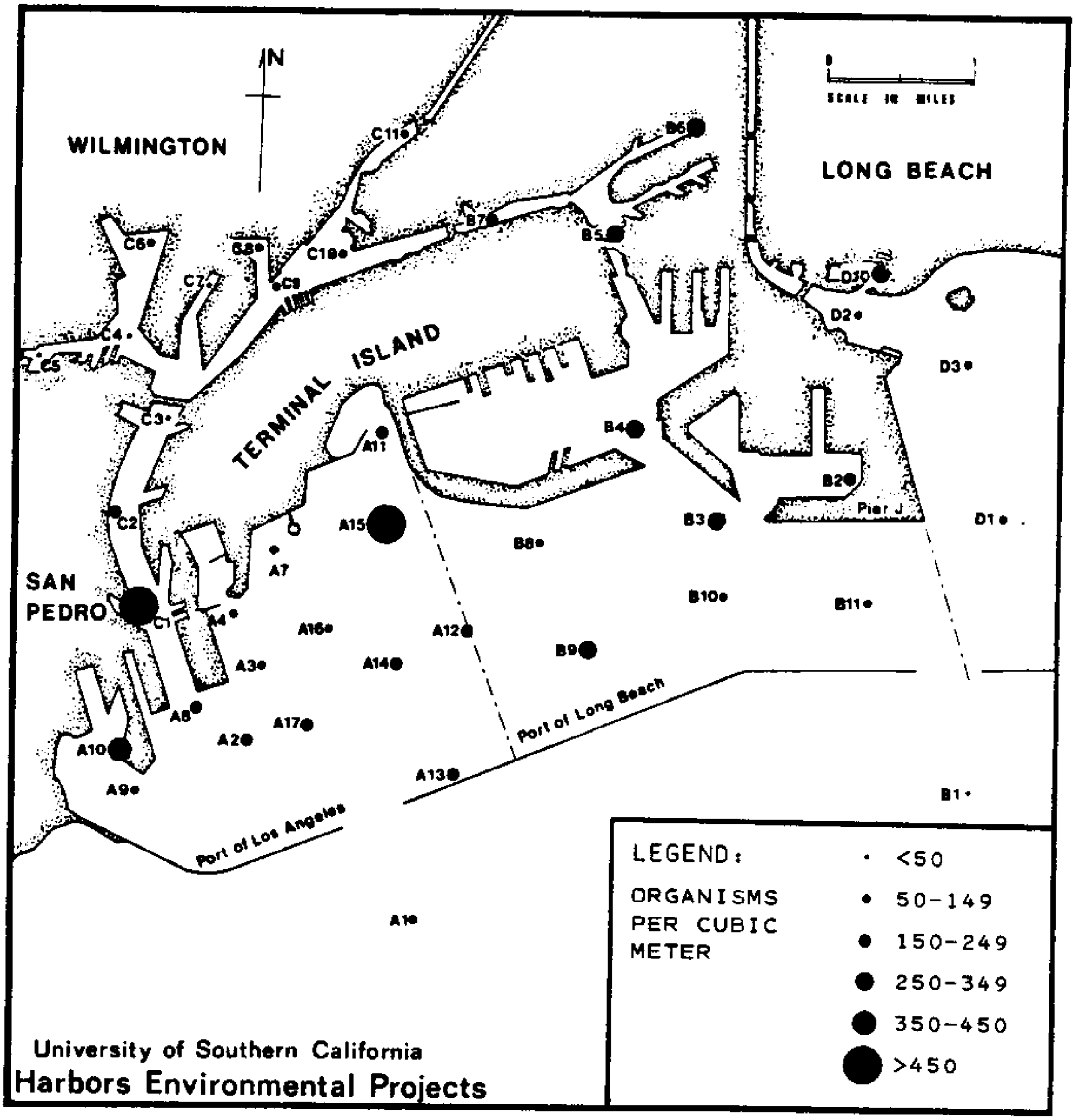


Figure 7. Spatial distribution of *Podon polyphemoides*.

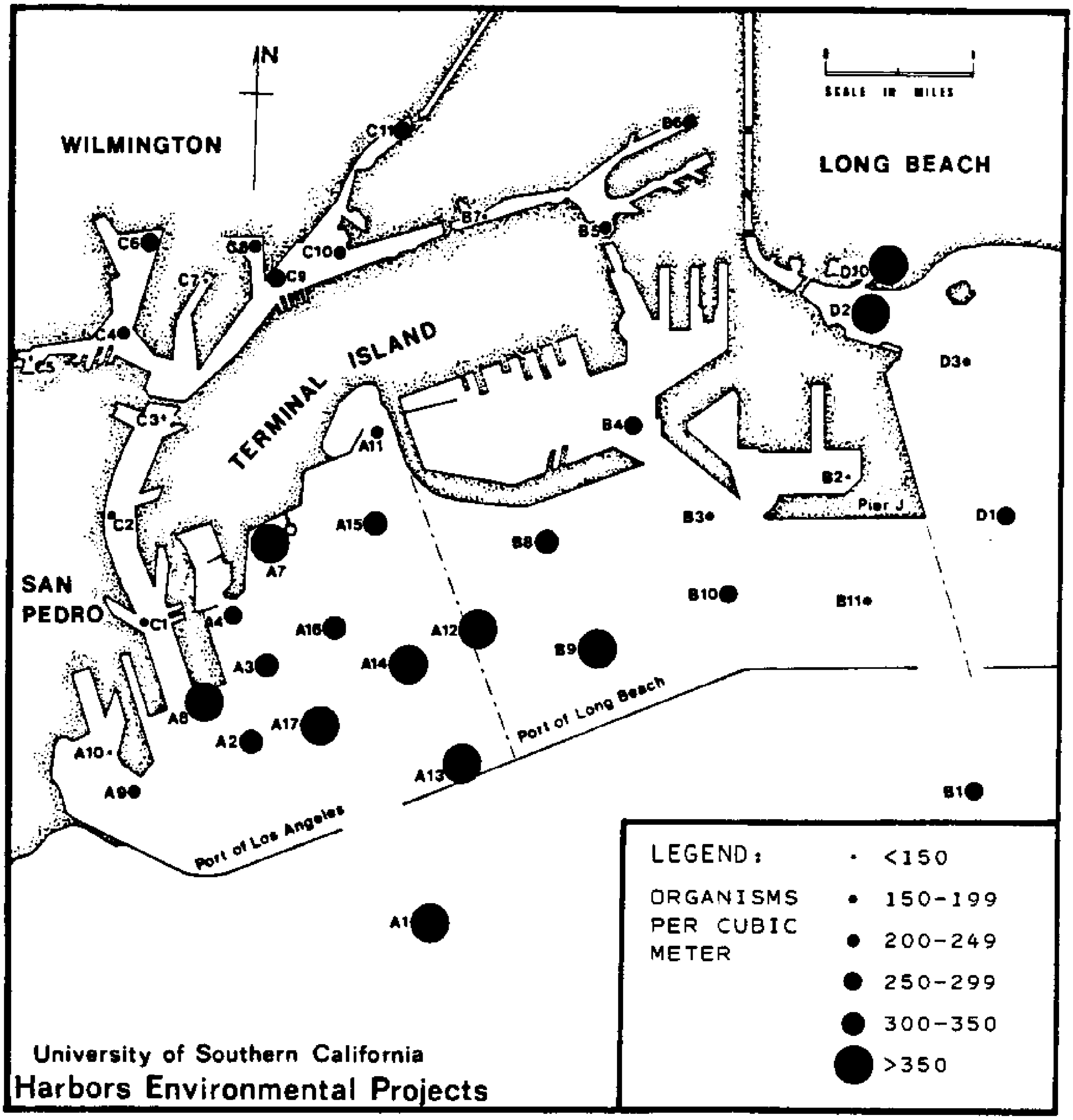


Figure 8. Spatial distribution of Larvacea.

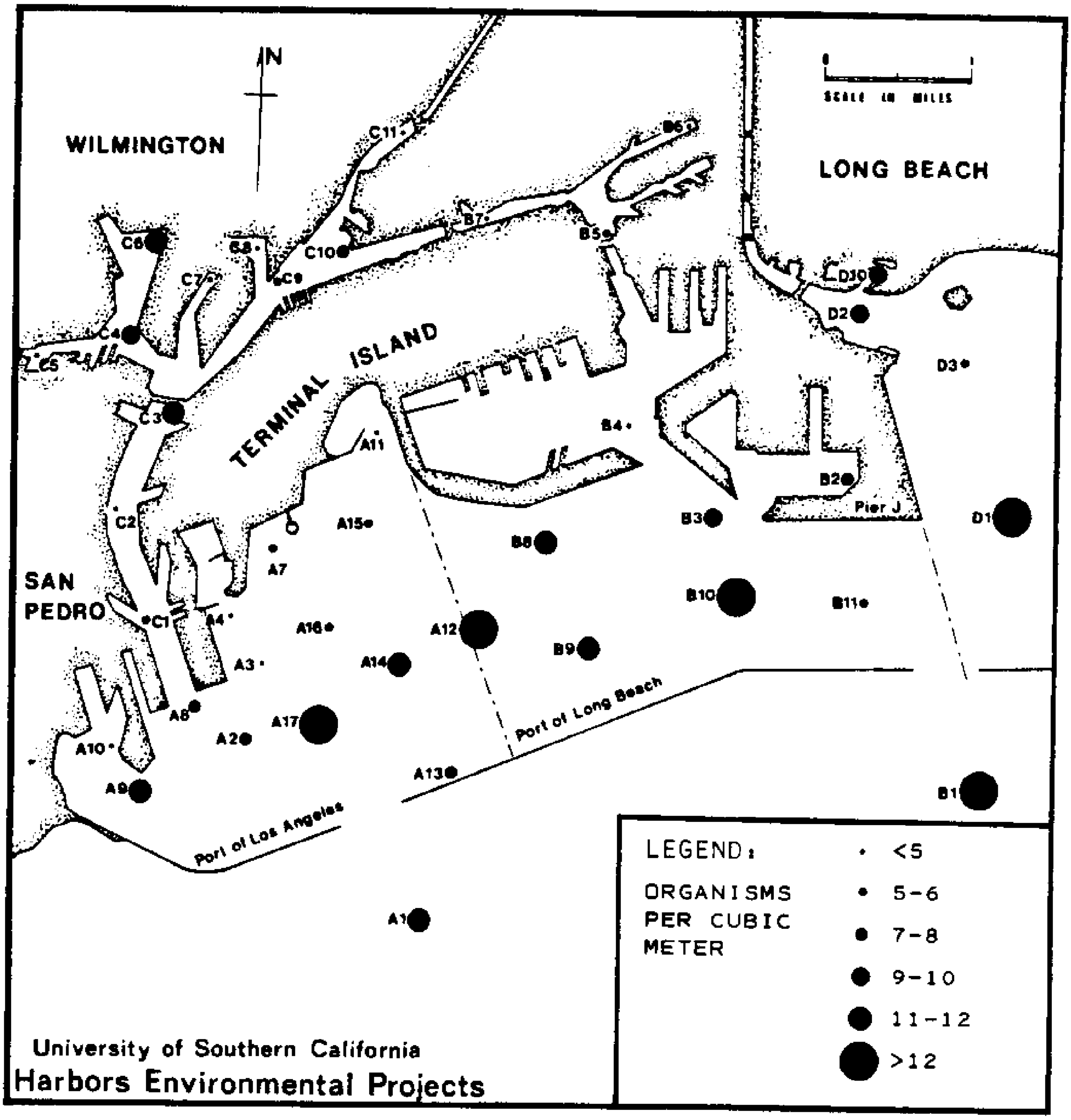


Figure 9. Spatial distribution of fish eggs and larvae.

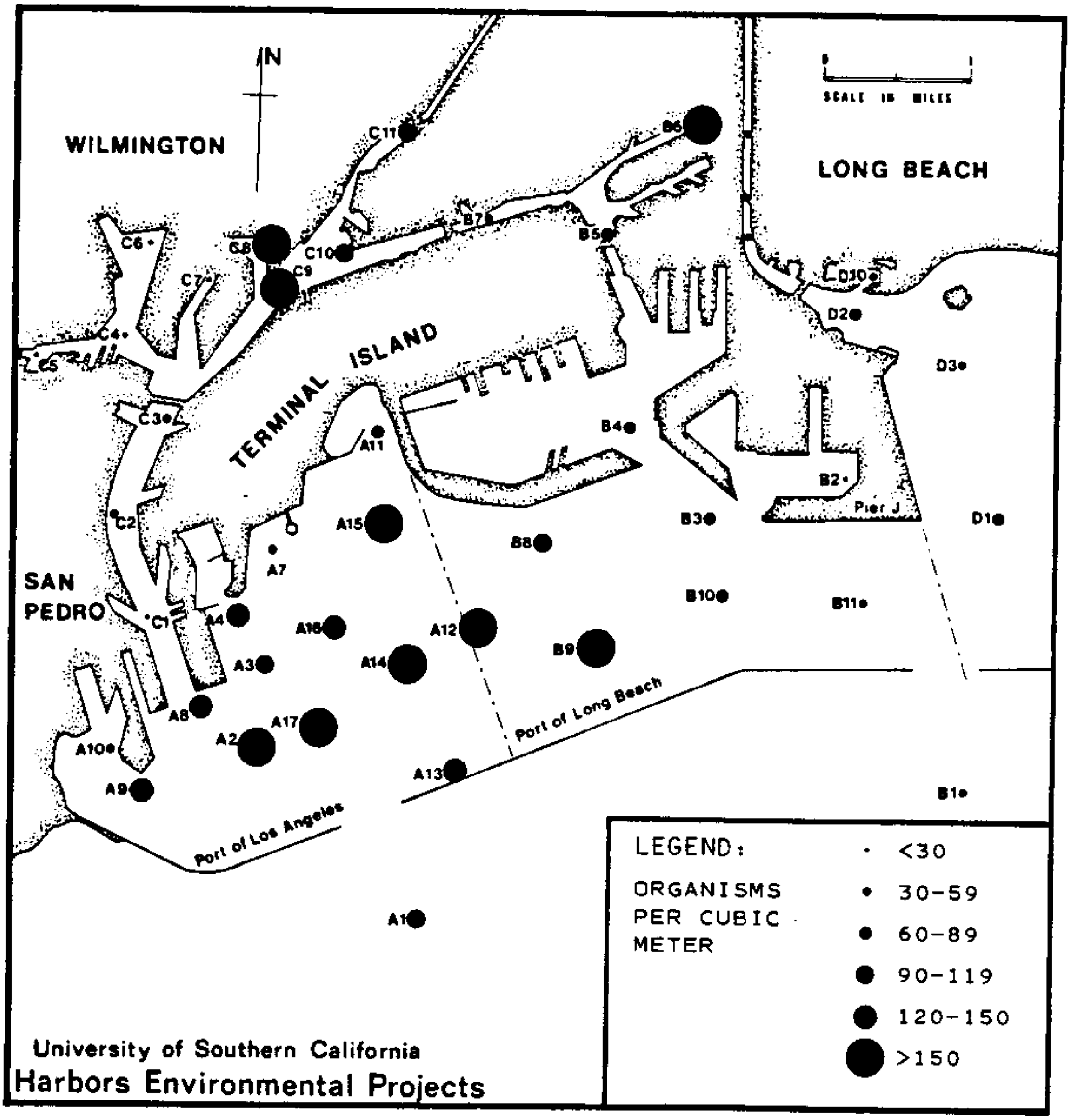


Figure 10. Spatial distribution of Cirripedia nauplii.

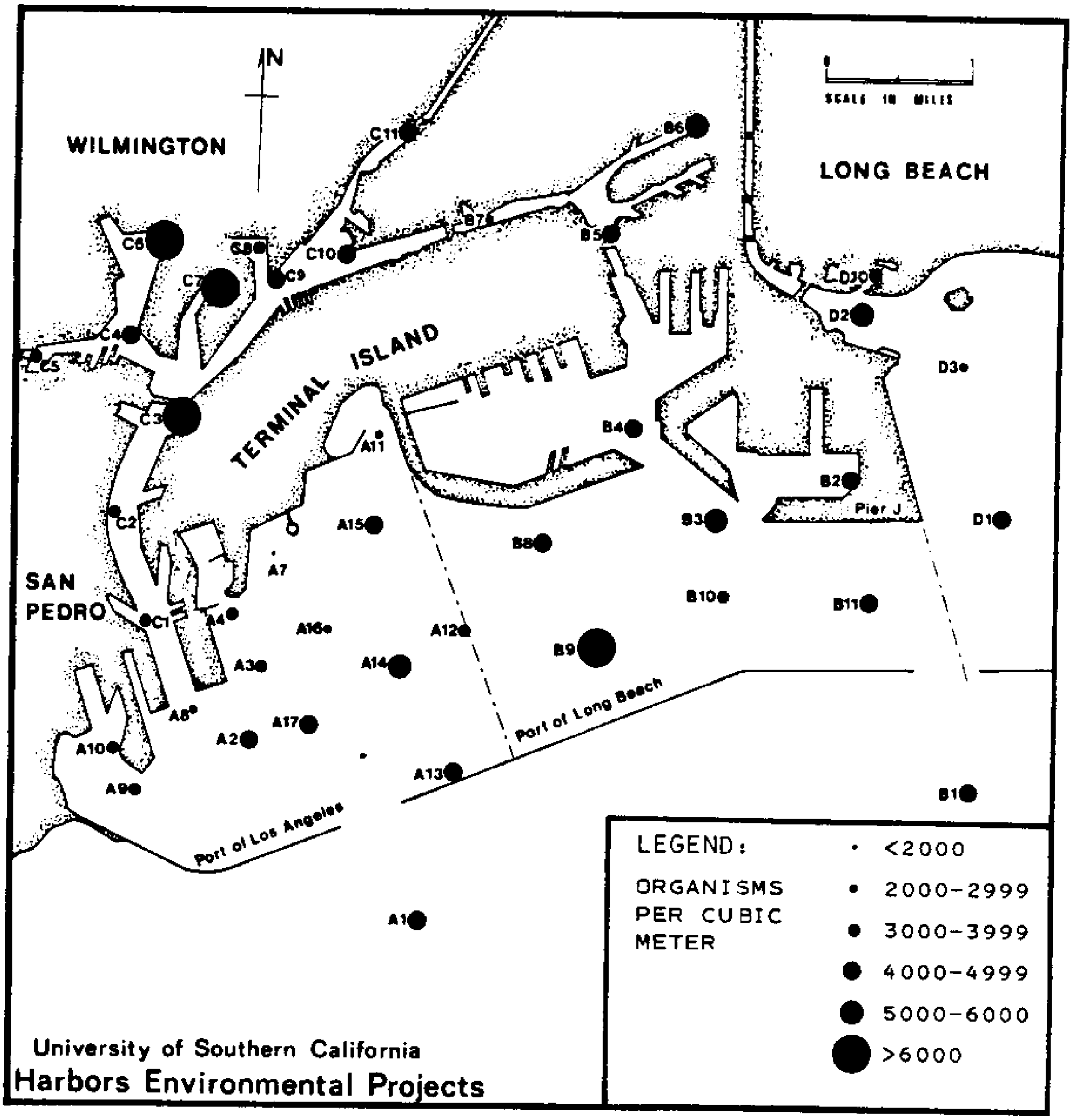


Figure 11. Spatial distribution of total zooplankton.

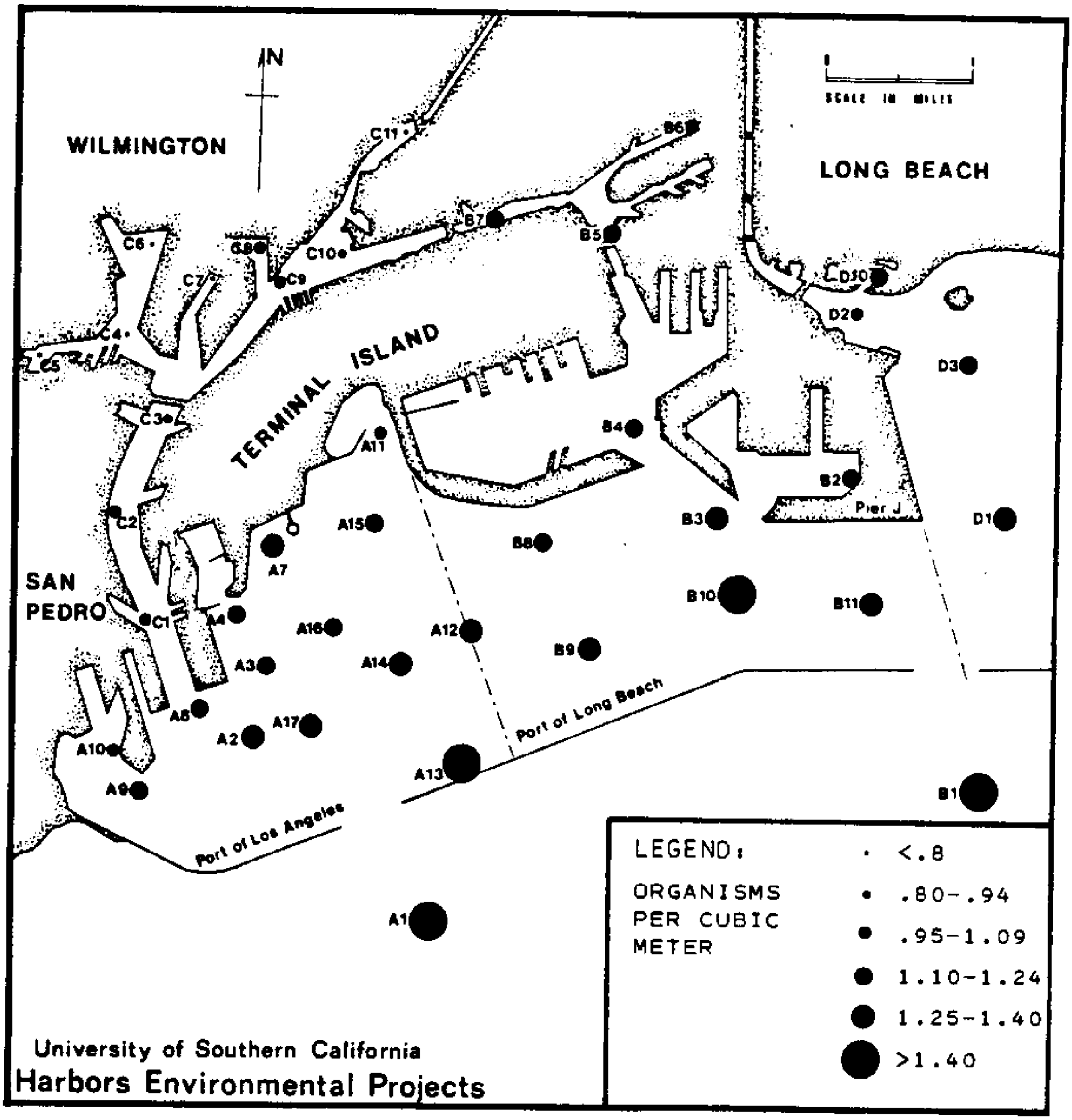


Figure 12. Spatial distribution of Shannon-Wiener species diversity.

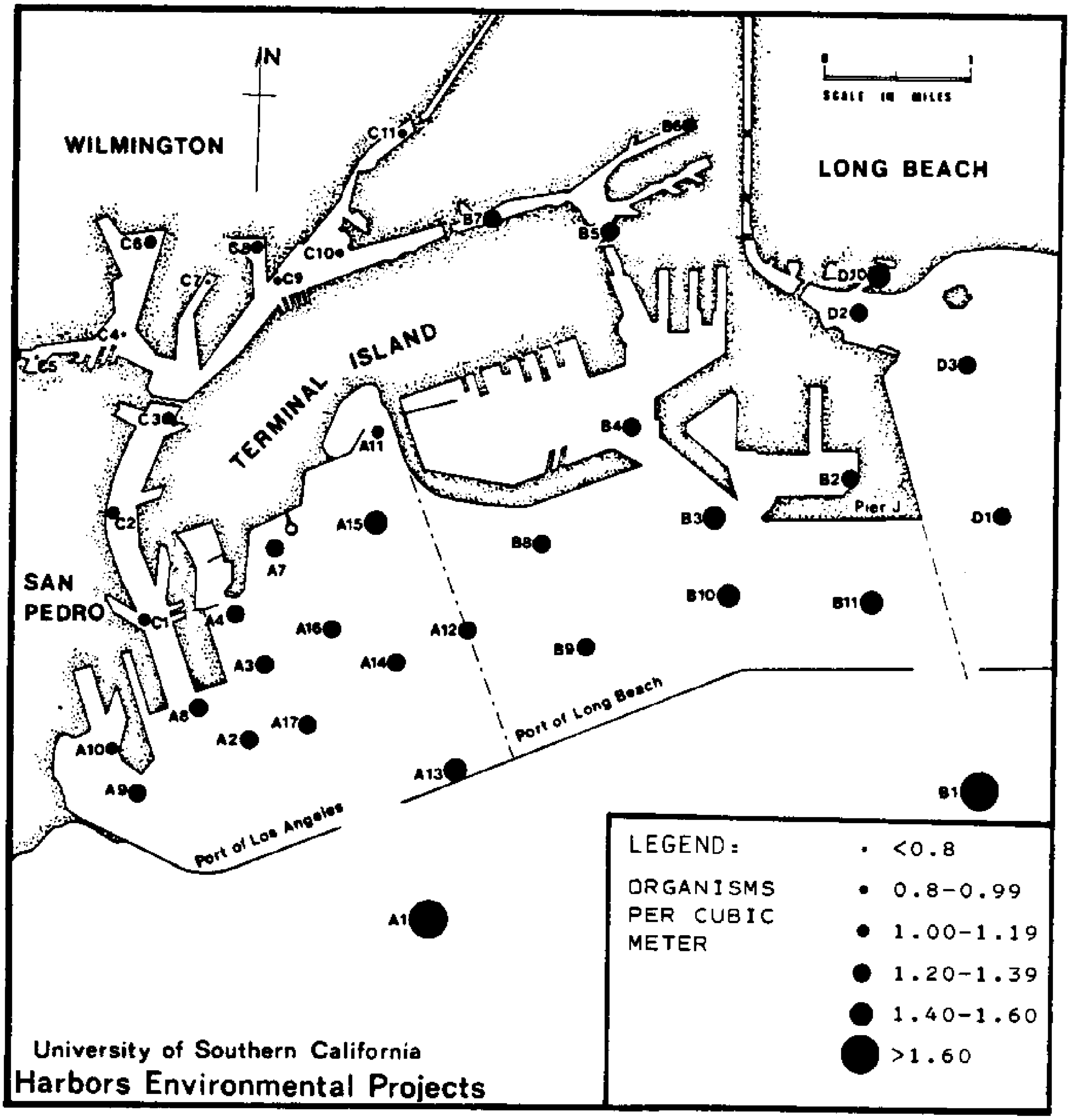


Figure 13. Spatial distribution of Margalef species richness index.

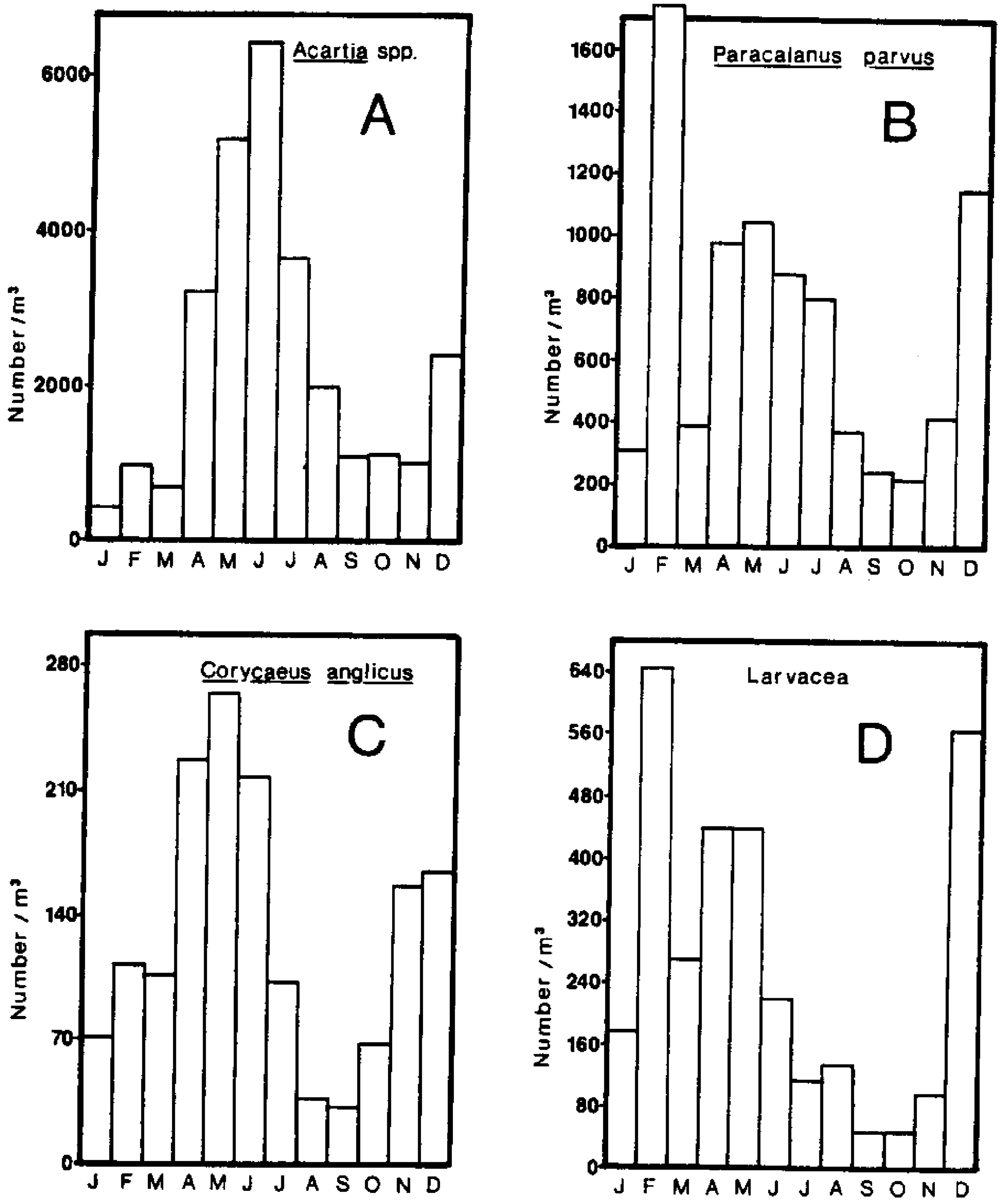


Figure 14. Temporal distribution of *Acartia* spp. (A); *Paracalanus parvus* (B); *Corycaeus anglicus* (C); *Larvacea* (D).

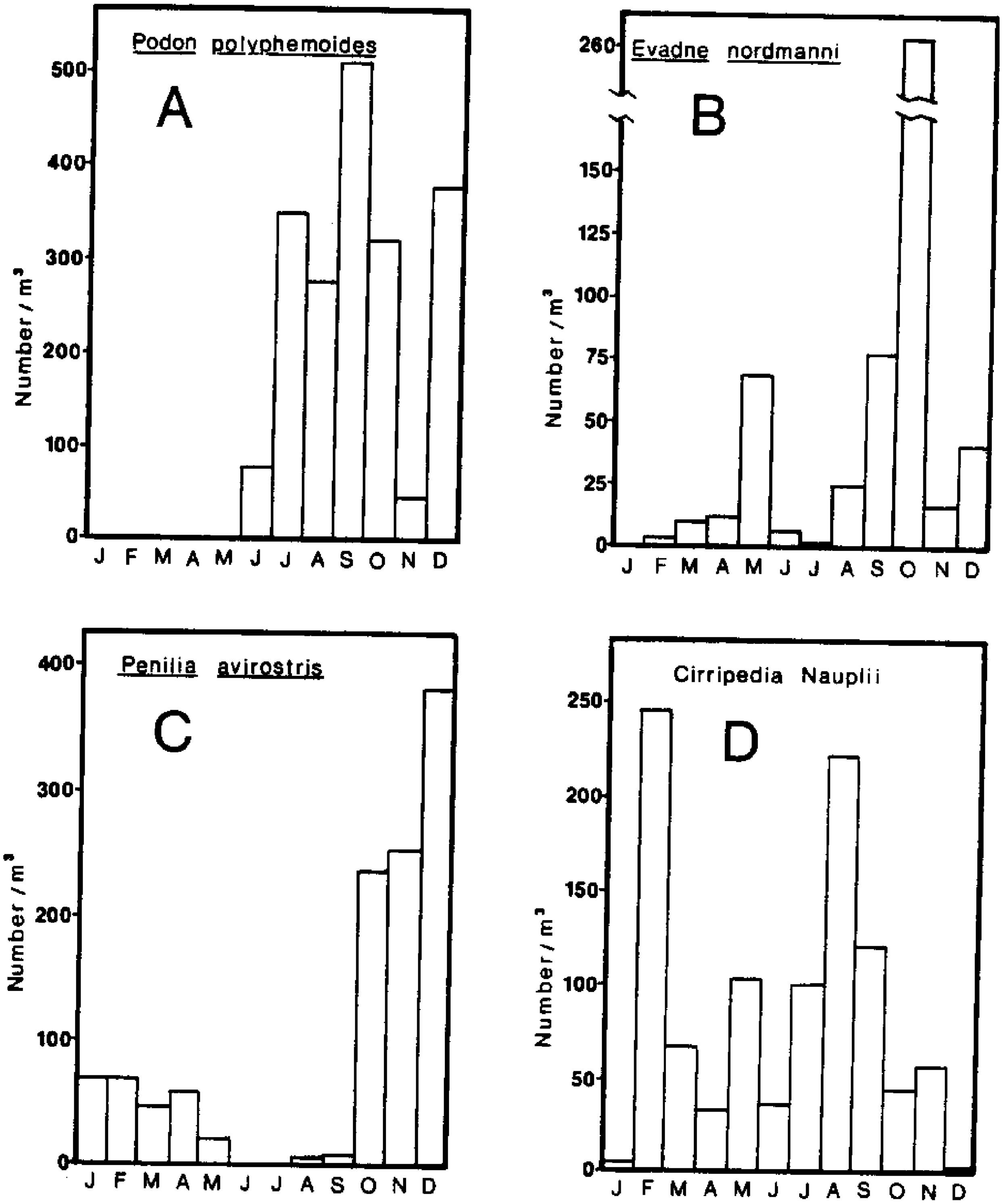


Figure 15. Temporal distribution of *Podon polyphemoides* (A); *Evadne nordmanni* (B); *Penilia avirostris* (C); *Cirripedia nauplii* (D).

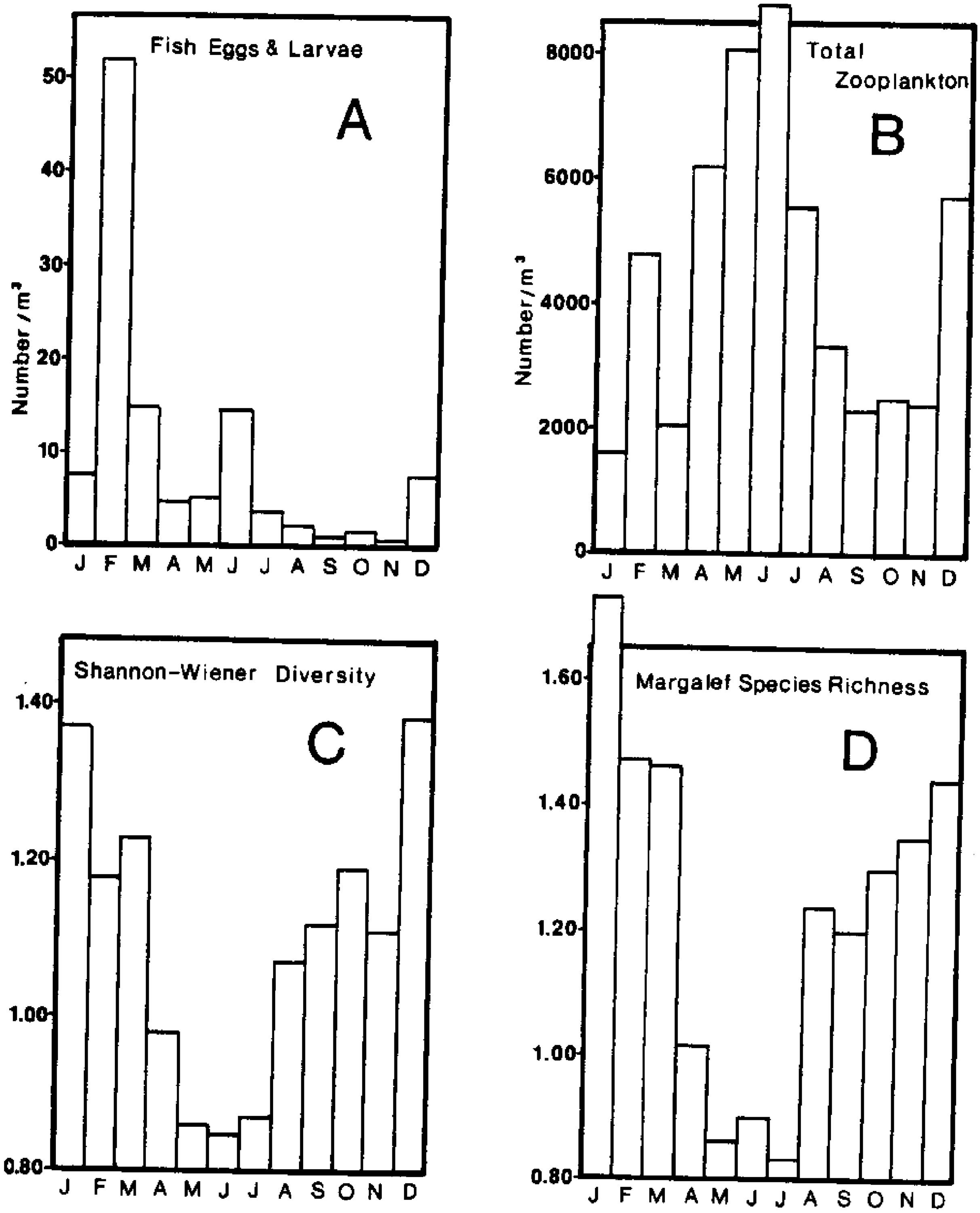


Figure 16. Temporal distribution of fish eggs and larvae (A); total zooplankton (B); Shannon-Wiener species diversity (C); Margalef species richness (D).

TABLE 1. RANK ORDER OF EIGHT DOMINANT GROUPS OF ZOOPLANKTON BY SEASONS
Los Angeles-Long Beach Harbors, December 1977-November 1978

December 1977-February 1978

Rank	Species/Group	% Composition
1	*Paracalanus parvus*	27.1
2	*Acartia* spp*	24.4
3	*Penilia avirostris*	10.1
4	larvacea	9.7
5	*Corycaeus anglicus*	4.3
6	*Cirripedia* nauplius	3.1
7	*Evadne nordmanni*	1.5
8	*Podon polyphemoides*	.1
		80.3%

March-May 1978

Rank	Species/Group	% Composition
1	*Acartia* spp*	46.5
2	*Paracalanus parvus*	14.9
3	larvacea	7.1
4	*Corycaeus anglicus*	3.7
5	*Cirripedia* nauplius	1.2
6	*Penilia avirostris*	.8
7	*Evadne nordmanni*	.5
8	*Podon polyphemoides*	.0
		74.7%

June-August 1978

Rank	Species/Group	% Composition
1	*Acartia* spp*	68.4
2	*Paracalanus parvus*	11.4
3	*Podon polyphemoides*	4.0
4	larvacea	2.7
5	*Corycaeus anglicus*	2.0
6	*Cirripedia* nauplius	2.0
7	*Evadne nordmanni*	.2
8	*Penilia avirostris*	.1
		90.8%

September-November 1978

Rank	Species/Group	% Composition
1	*Acartia* spp*	44.4
2	*Paracalanus parvus*	12.1
3	*Podon polyphemoides*	12.1
4	*Evadne nordmanni*	10.2
5	*Penilia avirostris*	6.8
6	*Corycaeus anglicus*	3.5
7	*Cirripedia* nauplius	3.0
8	larvacea	2.7
		94.8%

* *Acartia* spp = *Acartia tonsa* and *Acartia californiensis* Trinast, 1976.

TABLE 2. TOTAL ZOOPLANKTON BY SEASONS

Number of Plankton Species and Number of Individuals Per Cubic Meter
(#species/#organisms/m^3)

Station	Winter Dec.'77-Feb.'78	Spring Mar.'78-May'78	Summer Jun.'78-Aug.'78	Autumn Sept.'78-Nov.'78	1978 Mean
A1	18/4190	12/3156	14/3953	14/6177	15/4369
A2	13/4257	11/3827	10/5866	10/4092	11/4511
A3	13/5020	8/2778	9/886	9/6870	10/3889
A4	14/2586	10/5102	9/2145	10/2505	11/3085
A7	12/1918	8/2701	8/465	10/1111	10/1549
A8	14/2907	9/3353	10/1455	9/2749	11/2616
A9	15/2546	10/5369	10/4868	10/2837	11/3905
A10	9/2278	9/4073	8/3908	10/1592	9/2963
A11		6/7348	7/238	8/832	7/2806
A12	14/4907	10/3180	9/5282	11/1646	11/3754
A13	17/4079	11/3727	11/5665	10/5169	12/4660
A14	17/4969	9/4511	9/8152	10/6189	11/5955
A15	15/2758	10/2414	9/648	8/5622	11/2861
A16	14/5326	8/3693	9/1419	8/1821	10/3065
A17	15/7636	10/4815	11/2707	10/4640	12/4950

TABLE 2 (continued)

Number of Plankton Species and Number of Organisms Per Cubic Meter
(#species/#organisms/m^3)

Station	Winter Dec.'77-Feb.'78	Spring Mar.'78-May'78	Summer Jun.'78-Aug.'78	Autumn Sept.'78-Nov.'78	1978 Mean
B1	18/3602	15/4633	11/5834	18/3311	16/4345
B2	15/2435	10/3445	8/9472	10/2283	11/4409
B3	16/4717	13/5308	7/1067	13/1732	12/3206
B4	15/4696	12/2685	8/9100	12/2816	12/4824
B5	11/3992	10/4813	10/4573	12/3253	11/4158
B6	13/2691	8/6109	8/9219	9/3455	10/5369
B7	12/3180	11/3313	9/4293	12/1449	11/3059
B8	16/5530	10/4714	9/5034	8/4015	11/4823
B9	19/3608	12/4872	9/8319	8/2620	12/4855
B10	18/4639	11/5417	11/3309	14/2276	14/3910
B11	19/2402	9/4940	10/5276	12/2300	13/3730
D1	17/6707	11/4522	8/2167	13/1281	12/3669
D2	13/6145	9/6455	6/5893	11/1035	10/4882
D3	15/4933	11/3922	7/313	10/519	11/2422
D10	13/5468	12/4639	8/1385	11/467	11/2990

TABLE 2 (continued)

Number of Plankton Species and Number of Organisms Per Cubic Meter
(#species/#organisms/m^3)

Station	Jan.'78-Feb.'78	Mar.'78-May'78	Jun.'78-Aug.'78	Sept.'78-Nov.'78	1978 Mean
C1	6/1579	7/2952	10/4296	10/975	8/2451
C2	8/1409	7/4801	9/4038	7/1559	8/2952
C3	9/2137	9/3378	9/15,742	7/1915	9/5793
C4	7/1832	8/8722	7/6926	6/1588	7/4767
C5	4/4230	8/5223	4/6750	6/463	6/4167
C6	8/2957	9/18,605	8/13,215	8/912	8/8922
C7	8/3252	6/9800	6/16,623	8/870	7/7636
C8	9/1580	8/5543	8/6153	9/760	9/3509
C9	9/1112	7/6689	8/6579	9/1052	8/3858
C10	9/1000	7/7504	7/8308	8/1198	8/4503
C11	9/2048	8/9878	6/5541	10/2702	8/5042

TABLE 3. COMPARISON OF RANK AND PERCENTAGE OF DOMINANT ZOOPLANKTON

Mean Annual Rank 1973-74[1]		Mean Annual Rank 1978[2]	
1. *Acartia tonsa* (spp.)	57.9%	1. *Acartia*, spp.	45.9%
2. *Podon polyphemoides*	11.1	2. *Paracalanus parvus*	16.4
3. *Paracalanus parvus*	10.0	3. larvaceans	5.6
4. larvaceans	5.7	4. *Penilia avirostris*	4.5
5. *Evadne nordmanni*	4.7	5. *Podon polyphemoides*	4.0
6. *Cirripedia nauplii*	4.2	6. *Corycaeus anglicus*	3.4
7. *Corycaeus anglicus*	1.6	7. *Evadne nordmanni*	3.1
8. *Labdocera trispinosa*	0.9	8. *Cirripedia* nauplii	2.3
	96.1%		85.2%

[1]Horizontal tows
[2]Vertical tows

C. BENTHIC FAUNA

INTRODUCTION

The San Pedro Bay benthos has been radically altered as a habitat over the past 150 years by largely irreversible changes. The construction of breakwaters alone would slow circulation, reduce or eliminate turbulent mixing from breakers, reduce sand transport and replenishment and alter the benthic, intertidal and subtidal communities. Dredge and fill activities drained salt marshes; channelized urban drainage resulted in much heavier and faster runoff, and deeper blind-end channels reduced flushing rates. The changes resulted in deposition of fine silty bottom muds in place of sand, reduction in aeration, elimination of year-round freshwater flow into marshes and reduction in marsh grasses and macroalgae.

Early accounts of biota in the harbor area bear out these observations. When Richard Henry Dana visited San Pedro in 1835, he landed between Pt. Fermin and Timms Point, near present-day Ports of Call. It was impossible to enter the channel at low tide, as there was only about a 2 ft clearance at Deadmans Island, in the present Los Angeles Main Channel. It was a poor anchorage, with surf breaking over the sandy barrier beach of Rattlesnake Island. An eighth of a mile of seaweed-covered boulders, much like outer Cabrillo Beach today, was exposed at low tide near the landing.

In 1890-1900, San Pedro gained national reknown as a good place to collect shells. Monks (1893), White (1896), and Becks (1897), early shore collectors, reported on notable specimens taken on the sand flats, among eelgrass, and on rocky bottoms in the bay. Lowe (1899) provided a list of species taken at 5-20 fathoms (9-37m) with a dredge. Williamson (1892) provided an ample list of species from San Pedro. Although she listed 213 species, some of her records are in error, some are fossils and others have fallen into synonymy. She updated this list in 1905. T.D.A. Cockerell reported the sea hare *Aplysia californica* and the nudibranchs *Flabellina iodinea, Chromodoris macfarlandi, Hermissenda crassicornis, Hypselodoris californiensis, Hermaeina smithi, Dendrodoris albopunctatus, Aegires albopunctatus, Dirona picta,* and others at San Pedro and Deadmans Island (Cockerell, 1901a, 1901b, 1901c, 1902; Cockerell and Eliot, 1905). Although these early collectors were concerned primarily in reporting unusual finds or large, showy specimens rather than giving complete lists for the locality, their records give some basis for comparison with the modern fauna.

The coast at San Pedro was quite different in 1890-1900 than it is today. The San Pedro Breakwater was being built. Docks were present, but the modern facilities built by dredging and filling had not yet been constructed. Timms Point, a small, flat sand bar, extended from shore near modern Ports of Call Village. A bed of oysters (*Ostrea lurida*) occurred near the point. Across from the modern docks for fishing boats at San Pedro was the site of Deadmans Island, a barren, rocky islet famed for its fossils. A kelp bed was present along its shore. A rocky breakwater connected this islet with Rattlesnake Island, a long sand bar. Beyond this island were sloughs inhabited by the clams of the genus *Chione* and the hornshell *Cerithidea californica*. The outer areas near the site of Cabrillo Beach had vast sand flats and beds of eelgrass, *Zostera marina* (Williamson, 1892). However, by 1905, W.E. Ritter mentioned that the best shell collecting grounds within the inner harbor at San Pedro had been destroyed by harbor improvements.

A list of thirty species reported from early intertidal collections by Monks (1893), White (1896), and Becks (1897) is given in Table 1. Modern names of the species are used herein instead of the older synonyms found in the literature. Dr. M. K. Wicksten (pers. comm.) reported that she had not found 18 of those species during 1973-1979. Of the 18 species, the brachiopod *Glottidia albida* and the molluscs *Nassarius tegula, Notoacmaea paleacea, Bulla gouldiana, Forreria belcheri*, and *Chione* spp. prefer gently sloping sand flats or beds of eelgrass. *Cerithidea californica*, reported by Williamson (1892), today lives along the banks of the Venice Canal. Loss of habitat may be responsible for their absence from the area in modern times. Seven other species were recorded in eelgrass drift, in which the minute shells were entangled. *Glottidia albida* has been found in benthic samples taken in the outer harbor recently and *Bulla* occurred occasionally on settling racks. Some species inhabiting rocky bottoms or sand-and-silt bottoms seem to have fared better than species characteristic of sand flats. The brachiopod *Terebratalia transversa* is more common off Santa Catalina Island now than along mainland coasts.

A large, obvious clam barely mentioned in early records is *Tresus nuttalli*, the gaper clam. This big, edible clam is abundant along inner Cabrillo Beach. Williamson (1892) reported finding "a few young shells and single valves only of adults". The gaper clam, more tolerant of silt than the species of *Chione*, may have increased after changes in circulation caused by the San Pedro Breakwater. *Tressus nuttalli* is common in the Timms Point and Mesa Street fossil beds (Kennedy, 1975). Out of the 70 species of molluscs and the one brachiopod recorded from dredgings by Lowe (1899), most are small species likely to be overlooked by collectors. The brachiopod *Terebratalia transversa* has not been taken in San Pedro Bay lately. Of the soft-bottom species taken by Lowe, *Odostomia* sp., *Tellina modesta*, and *Olivella baetica* have been taken in box cores by Harbors Environmental Projects. *Tellina idae* still occurs at Cabrillo Beach. Rocky bottom species still found around San Pedro or nearby along the Palos Verdes Peninsula include the top shells *Calliostoma gloriosum*, *Calliostoma tricolor*, and *Calliostoma supragranosum*; the murexes *Pteropurpura trialata*, *Ocenebra foveolata*, and *Maxwellia santarosana*; the scallop *Leptopecten latiauratus*, and the pelecypods *Pododesmus cepio* and *Semele rupicola*. *Nassarius mendicus* and *Parvilucina tenuisculpta*, common in modern benthic samples, were not reported by Lowe. A larger proportion of the rocky subtidal species apparently still inhabit the area, while the fauna of soft bottoms seems to have shifted from that of clean, fine sand to a fauna more tolerant of silt.

The degradation of the harbor by pollution from sewage and industry was advanced by 1926, when complaints were raised about workers being made ill and boat paints being damaged by sulfide fumes. Pollution accelerated during World War II. Few biological studies were made; a survey of pilings in the inner harbor in 1937 showed that there weren't even any marine boring organisms there. Dissolved oxygen was at or near zero, sulfides were as high as 51 ppm and sludge beds 6 to 8 ft deep were found in Cerritos Channel (State of California Resources Agency, 1969).

In 1954 Reish (1959) conducted surveys of benthic biota at a number of locations in the inner harbor, the channels, Fish Harbor and near the TITP sewer outfall in the outer harbor. The bottoms in Los Angeles West Basin, Consolidated Slip at the mouth of Dominguez Slough and East Basin were devoid of macrofauna. Outer harbor areas contained the polychaete worms *Nereis procera*, *Tharyx parvus (?)* and *Cossura candida*, which Reish described as typical of "healthy" soft-bottomed benthos. In the main channels, species of the stress-resistant *Capitella capitata* complex were found.

Major local cleanup efforts of the 1960's were reinforced by the passage of federal and state environmental laws in 1969. Reish (1970) observed that in only a year macrofauna began to move into areas previously devoid of all but bacterial life.

In 1971, HEP began a monitoring program for the Southern California Gas Company, which included benthic sampling in outer Los Angeles Harbor at stations A1 to A7, plus West Basin (C6). In 1973 and 1974 stations in the B, C and D series were added in a harbor-wide survey for the Army Corps of Engineers, with cooperation from the USC Sea Grant Program and the Ports. Some outer Los Angeles Harbor sampling was continued for the Gas Company until 1978.

Soule and Oguri (1976a, b) analyzed previous biological data for the outer harbor and concluded that it was the richest soft-bottom inshore area in southern California for benthic organisms and demersal fish. In both diversity of benthic species and numbers of benthic organisms it exceeded by far other coastal areas. Counts higher than 70 species and 70,000 individuals per m^2 were found. They concluded that the central gyre provided optimal mixing and dispersion of cannery waste nutrients. There was a shallow (6m) zone of reduced population less than 300m distant from the outfalls; beyond that point nutrients had already been assimilated, based on BOD measurements. Following installation of dissolved air flotation (DAF) units in 1974-75, populations dropped rapidly. Species diversity increased for about two years thereafter, but decreased extensively in 1978 in the outer Los Angeles Harbor receiving waters following conversion to secondary waste treatment.

The present 1978 HEP harbor-wide survey was undertaken for the City of Los Angeles Terminal Island Treatment Plant following conversion to secondary waste treatment of domestic and fish cannery effluents. The Port of Long Beach, the City of Long Beach and Port of Los Angeles joined in the survey.

Other benthic studies in parts of the harbor include the Navy base (Hill, 1974) and the 1974-1978 pre- and post-operational surveys of part of the Port of Long Beach for the Southern California Edison Company generating plant (EQA-MBC, 1976, 1978).

METHODS

Sampling

The Reinecke box corer, which samples $1/16m^2$ of surface, was used aboard the R.V. *Velero IV* for all benthic sampling in 1973-74 and the R.V. *Vantuna* in 1978, except for shallowest stations. At those, the Campbell grab aboard the R.V. *Golden West* was used, which samples $1/10m^2$. The box corer has the advantage that it does not mix the surface sediments, which are not touched by metal so that chemical analyses are more accurate. A larger vessel with an A-frame is required for the boxcorer, however. The Campbell grab, similar to the Van Veen grab, can be used from a smaller boat davit. Replicate samples from each station are taken for security but are not identified. Earlier HEP studies showed that results have been uniform in the harbor sampling. The replicates that were needed in other studies which used the small, inefficient Shipek grab, were not considered necessary and unduly increased time, effort and cost. Screening through a 0.5mm screen is considered essential to sample the small soft-bottom fauna accurately. Samples were screened in running sea water on board and preserved in 10% formalin-sea water. They were drained and transferred to 70% ethanol in the laboratory and sorted under 10X power microscopes for identification to the lowest feasible taxon.

Analysis

By far the major portion of the benthic organisms identified to species or generic level in the harbor are polychaetes and molluscs. For this reason species diversity calculations and multivariate computer analyses (Part IV) are limited to those two categories to increase accuracy of comparisons. The City of Los Angeles Sanitation District laboratories at Hyperion Treatment Plant provided identifications of the A station benthic organisms in 1978. Identifications were verified by HEP personnel, and the less commonly identified non-polychaete or non-mollusc species were tabulated but not used in the comparative calculations below.

In 1978 stations A13 through A17 were added to the station pattern in outer Los Angeles Harbor in order to examine the Terminal Island Treatment Plant receiving waters more closely. Stations A5 and A6, which were sampled in 1973-1974, were deleted, as were the 1973-1974 stations near Alamitos Bay, D4-D9. Stations A5 and A6 were low in species and numbers (AHF, 1978). The D stations were analyzed separately (Henry, 1978) so those data are not included in harbor means.

Species Diversity Formulae

The formulations used in calculating diversity, evenness and richness are as follows:

H' = Shannon-Wiener Index (Diversity)

SWI emphasizes the number of individuals.

$$H' = -\sum_{j=1}^{S} \frac{n_j}{N} \ln \frac{n_j}{N}$$

where n_j = number of individuals in the jth species
S = total number of species
N = number of individuals
ln = natural log

J' = Evenness in Sampled Community where:

$$J' = \frac{H'}{\ln S}$$

where: S = total species
ln = natural log

H'max is a diversity index of a hypothetical community, uses as a standard, having both the same number of species and individuals as the observed community.

$$H'max - \frac{H'}{J'}$$

Gleason's Index (modified) = Margolef (1951)

$$\frac{S - 1}{\ln(N)}$$

where: S = # of species in sample
N = total # individuals in sample
ln = natural log

RESULTS

Numerically Dominant Species

The numerically dominant benthic species in 1978 was *Cossura candida* in all four seasons. The benthic polychaetes dominated in numbers, as would be expected in a soft-bottomed harbor with fine-grained sediments (Part IIC). *Mediomastus californiensis* (=*Capitita ambiseta*) ranked second, except in January when *Tharyx* shifted to second and *M. californiensis* to third place. *Tharyx* sp., an undescribed species earlier identified as *Tharyx? parvus* was numerically dominant in 1973-74 (AHF, 1976). *Tharyx* dropped from second in January, 1978 to third in April and July and to fourth rank in October (Table 2), for unknown reasons.

For the most part, 80 to 90 percent of the populations are composed of twelve species; the numberical rank order changed slightly with the seasons, however. *Capitella capitata*, known as an opportunistic species (Grassle and Grassle, 1974), reproduces year around and is tolerant of a wide range of environmental conditions. In 1973-74, it comprised 5.7 percent of the benthic organisms. In January, 1978 the percentage of *C. capitata* was the same (5.7 percent), rising to 8.34 percent in April, but it dropped below 1.0% in July and October, 1978. Seasonality may affect relative numbers; however, the heavy rains of the winter and spring and/or the changes in effluent nutrients may have stressed the benthic community to alter its structure.

Widely distributed Species

The same three species, *Cossura candida*, *Mediomastus californiensis* and *Tharyx* sp., that were dominant in numbers, also were most widely distributed, at 35-41 of the 41 harbor stations sampled. Table 3 lists the top twelve species, ranked by number of occurrences in each quarterly sampling period. All twelve species occurred at more than half the stations. *Capitella capitata* occurred at 19 stations in January, 12 stations in April, 9 stations in July, and 12 stations in October. *Cossura candida* was listed as an indicator of a "healthy" benthos by Reish (1959) and Hill (1974). Hill also included *Tharyx* sp.(as *Tharyx parvus*) as "healthy". Among the molluscs, *Parvilucina* sp. (=*P. tenuisculpta*) was the most common, ranking thirteenth in number of occurrences (24) and eighteenth in number of individuals, in January. It ranked eighteenth in both occurrences and numbers in April with 20 occurrences, and remained at about sixteenth in July and October, 1978. Warm summer weather causes some species to retreat from the shallowest waters, resulting in reduced numbers of occurrences.

Number of Species and Individuals

In 1973-1974, the number of species ranged from 1 to 60 per sample, and the number of individuals ranged from 32 to over $80,000/m^2$, with means of 28 species and 22,464 individuals per sample.

In 1978, the number of species ranged from 4 to 68, and the individuals ranged from 240 to $37,728m^2$. The mean number of species was almost the same, 28.7, but the mean number of individuals dropped almost threefold, to $8102/m^2$ (Text Table 1).

Test Table 1. Comparison of 1973-74 and 1978 Mean Benthic Species and Numbers for All Stations.

	# Species		# Individuals	
Period	Range	Mean	Range	Mean
1973-74	1-60	28	32-80,000±	22,264
1978	4-68	28.7	240-38,000±	8,102

While the inner harbor blind-end slips were lower in number of species than the outer harbor, the largest reductions in mean numbers occurred in the outer harbor (Soule and Oguri, 1976; 1979).

Seasonally, the number of species fluctuated, being lowest in April, while the fewest individuals were found in July (Text Table 2). The peak number of individuals occurred in October, 1978.

When all species or taxa of benthic organisms are included in counts per $meter^2$ for 1978, the mean number of species is increased from 28.7 to 38.7 and mean number of individuals is increased from 8102 to $9448/m^2$. Since identifications of minor taxa varied over the eight-year period of outer harbor studies, the total numbers of all taxa cannot be compared as well as can the polychaete and molluscan taxa alone, nor with 1973-74 data.

Text Table 2. Seasonal 1978 Comparison of Numbers of Benthic Species and Individuals (Polychaete, Mollusca).

Period, 1978	Total # Species All stations	$\bar{X}$ Species Per Station	Total # Individuals	$\bar{X}$ Individuals Per Station
January	119	27.02	324,674	7823.56
April	98	30.63	320,766	7918.87
July	113	27.27	280,228	6834.82
October	127	29.98	402,998	9829.22

Population and Species Diversity

Comparison by Station

The area outside the breakwater and in the outer Los Angeles Harbor had reduced numbers per m^2 in 1978 than other areas of the harbor, as compared to conditions in 1973-1974. Figures 1 and 2 compare the populations for the two periods. In 1978, no stations had above 30,000/m^2, and only two were above 20,000m^2. The highest numbers of individuals were found at station A10, in the marina area peripheral to the *Sansinena* spill of December, 1976, and at station C2 on the main Los Angeles Channel (Table 5), both of which had annual means above 25,000 individuals/m^2. The outer harbor stations A1, A 11, A12, A13, A14, A17 and B8 had under 5000 individuals /m^2, as did D2 at the Los Angeles River mouth. The lowest mean 1978 number (1560) occurred at station A1, outside the harbor, although some quarterly numbers were lower, for example at A14, where a severe decline occurred in the summer and fall (see Part IV).

Surprisingly, station A10 also had a high mean number of species; stations A10, A17, B4, B5, B9 and B11 exceeded 50 species. Station B1, outside the Long BEach entry, had a mean of 69 species, by far the highest. Figures 1 and 2 also compare number of species/m^2 for the 1973-1974 period with 1978 data.

Seasonal Comparisons

The quarterly means for all benthic organisms, including polychaetes, molluscs and all other organisms, differ from those used to calculate the diversity indices, in which only polychaete and molluscan taxa were used (Table 4). The mean numbers of all benthic species and mean numbers of all benthic organisms per m^2 for each area period and each area of the harbor are presented in Table 5.

Normally, in a stable harbor community low populations would be expected in the January (winter) period, along with a fairly uniform number of species, and increased populations would occur during the spring and fall. Text Table 1 indicated the trends for the entire harbor for polychaetes and molluscs. Table 5 indicates that only five of fifteen stations (A4, A14, A15, A16 and A17) showed increases in April; all other A stations decreased, as did the total means. Five of eleven B stations increased in population and two increased in species in April. The C stations followed the more expected curve, with stable numbers of species, and with increases in populations in April and October. Lower mean numbers for the area were found in January and in July, but some stations increased in July, as well.

Species Diversity Index

Calculation of Shannon-Wiener diversity index (H') showed a range of 0.11 at station C11 to 3.18 at station A1 in January and 3.5 at station B 1 in October (Table 4). As would be expected, the stations with significant runoff or effluent have lower diversity indices. Station C11 is near the entry of urban runoff from Dominguez Slough. Station A7, the TITP outfall and runoff area, had an S-W of 0.36 in January and 0.74 in April; it rose to 2.22 in July, when the treatment plant was malfunctioning, increasing particulate matter, BOD, and suspended solids, but dropped back to 0.69 in October. Thus the advent of secondary treatment did not improve diversity at A7. The summer malfunction lowered total numbers by an order of magnitude, however.

Long-Term Trends

The long-term trends of benthic species and numbers in outer Los Angeles Harbor were analyzed for the A stations, the receiving waters studied for the Terminal Island Treatment Plant by HEP (Soule and Oguri, 1979). Following the enforcement of water quality standards initiated in 1970, mean numbers of species and individuals rose precipitously between 1971 and 1972. Table 6A presents the annual means of all benthic A stations sampled from 1971 to 1978. Figure 3A graphs only the means of the stations sampled over most of the seven-year period. Thus stations A5, A6, A10 and A13-A17 are not included in the means shown. The system appeared to react as a newly exposed substrate would, with rapid colonization in 1971-1973. A leveling off would be expected in forming a stable community, and this occurred in 1974.

The curve for numbers of species continued to rise through 1976, after which the mean fell below the 1972 level. The 1975-1977 species means may have been artificially increased because multiple grab samples were taken during that period (see dotted line on Figure 3A). In contrast, the population means dropped steeply in 1975 and continued to decline through 1978. A four-fold decline in population numbers occurred over the five-year period at A stations.

The changes at the A stations have coincided in time with changes in waste effluents in outer Los Angeles Harbor near station A7. In 1974-75, dissolved air flotation (DAF) was installed by fish processors, which significantly reduced BOD and particulate matter. An approximately four-fold drop in benthic faunal populations occurred between 1973 and 1978. In 1977, the Terminal Island Treatment Plant was converted from primary to secondary treatment, and by January 1978 the fish wastes were diverted from the harbor to TITP for secondary greatment.

Changes in effluent quality have been directly related to changes in benthic populations by Soule and Oguri (1979). Thus comparison of previously analyzed data from the A station area with other areas of the harbor is of interest. All B stations are in the outer Long Beach Harbor and main channel (Middle Harbor, Back Channel) except for two inner harbor stations (B6, B7). No B station sampling was carried out by HEP in 1971 or 1976-77. Figure 3B and Table 6B present annual mean numbers of species and individuals in those for which data were available, and furnish a basis for comparison.

The mean numbers of species (53) at B stations peaked in 1973 and 1975; in 1978 the numbers still remained slightly above the 1972 level. The outer harbor stations are influenced by waste effluent quality and were within the zone of enhancement as defined by Soule and Oguri (1976) during 1973-1974. A three-fold drop in benthic mean populations occurred between 1973 and 1978 at B stations.

The C stations in inner Los Angeles Harbor and the main channel probably reflect more accurately the effects of increasing environmental quality, although the inner harbor and blind-end slips do not support as rich assemblages. In Figure 3C, the solid symbols represent means at the nine C stations for which there are most complete data; thus stations C7 and C11 data were deleted from calculations. Table 6C presents all the C station data. The clear symbols in Figure 3C represent the three outer main channel stations. The three C stations had higher species and population means in 1972 than the means for all stations. The species means did not increase as steeply as did the A station species means, but the increase was similar to that at the B stations. In both C station sets the mean species numbers leveled off at considerably higher numbers in 1978 than in 1972, whereas the B station species means were only slightly higher than 1972 levels, and A station species means for the nine stations analyzed dropped from 41 to 37 per m^2.

The D stations present quite a different picture. The mean number of species was high in 1973, dropped to less than half in 1975 and returned to the 1973 level in 1978. The mean number of individuals/m^2 rose from about 19,000 in 1973 to more than 28,000 in 1974 and 1975, but dropped fourfold, to about 7,300 in 1978. The record rainfall of more than 34 inches in the Los Angeles Basin in 1978 undoubtedly resulted in increased diversity and reduced populations at the river mouth due to the large volume and rapid runoff (Part II, this volume). Figure 3D and Table 6D show the trends for stations D1, 2 and 3, east of Pier J and at the Los Angeles River mouth.

DISCUSSION AND CONCLUSIONS

Species Numbers

There were downward trends in mean numbers of species throughout the harbor from 1975 through 1978, except for the D stations at the river mouth, where species numbers rose. During 1978 there were very slight decreases in species means at A and B stations, means were stable at C stations and increased at D stations by 30%. In balance, species numbers decreased at 19 stations harborwide, and increased at 18 stations during 1978. The other stations showed little or no change.

The curves for species means dropped much more steeply in the outer harbor, at A stations, than did curves for B and C stations. The curves for all C stations and for outer main channel C stations alone, more closely followed that expected for increased environmental quality, similar to curves for colonization of newly available substrate.

Population Numbers

The decrease in mean numbers of individuals was fourfold at A stations over the 1973-1978 period for those stations with sufficient annual data to analyze. Mean numbers from all A stations sampled in 1978 indicated a decrease as well.

Numbers decreased about three-fold at B stations from 1973 through 1978. During 1978 mean numbers increased very slightly from January to October.

Mean numbers decreased between 1975 and 1978 at C stations, but not as steeply as at A and B stations. The means for outer main channel C stations alone increased more in 1973 than that for all C stations and declined by 1.4X between 1976 and 1978. The outer main channel C stations are more closely associated with outer harbor A stations, and receive water tidally from the gyre (Section II, this report). Mean numbers increased at most C stations during 1978.

The mean numbers at D stations also decreased about four-fold between 1975 and 1978. Numbers doubled between January and October of 1978, no doubt representing recolonization after the record rainfall runoff of the winter of 1977-1978.

Assuming that the curves for all C stations (except C7 and C11) and the B stations species curve represent the expected curve for colonization of a formerly impacted area, the changes at A stations are regarded as demonstrating some impacts over and above natural variations. If changes were due to oceanic influences, all areas of the harbor would show similar effects, since tidal exchange occurs, and during the dry season the harbor is entirely marine. Impacts of the rainy seasons are transitory and should be compensated for by increased recolonization. Rainfall exceeded 14 inches only in 1974, 1977 and 1978.

The conclusion by Harbors Environmental Projects associates is that outer harbor decreases are due largely to changes in waste treatment (Soule and Oguri, 1979; Reish, Soule and Soule, 1979).

Since no outer harbor benthic sampling was done in 1979, it is not possible to determine whether the benthic populations have stabilized, decreased or increased. The TITP effluent quality has not stabilized and the plant is under Regional Water Quality Control Board cease and desist orders for repeated violations of suspended solids criteria. These violations may in fact benefit the benthic organisms rather than inhibit them by providing more detrital food material.

The *Sansinena* Site

Of particular note was the condition of the benthos at station A9, which was directly in the path of spilled Bunker C fuel from the explosion of the tanker *Sansinena* (Soule and Oguri, 1978). The station had moderate to high numbers of species and individuals, with intermediate species diversity. The numbers were comparable to other outer harbor areas inside the breakwaters, indicating that there were either no differences due to the oil, or that effects were comparable to those imposed by effluents in the outer harbor. The A9 area was cleaned and dredged subsequent to the explosion, but small blobs of residual tarry material are occasionally found on the bottom (see also Section IV, multivariate analysis).

Food Web Relationships

Since polychaetes are among the most frequent and abundant organisms in the benthic environment, they must be included in discussions of trophic structure and energy budgets. Fauchald and Jumars (1979) used the concept of "guilds", as functional groupings of organisms, to delineate feeding strategies. The morphology and behavior of feeding appears to be one of the most important elements in determining the associations of the benthic species. Some of these relationships are tabulated and discussed in Section IIIG.

The importance of benthic polychaetes in the harbor food web has not been well recognized by some environmentalists and others, who still equate all worms with the conditions in 1954 (Reish, 1959) when *Capitella capitata* was the only macroinvertebrate in some areas, or with nematodes and "sludgeworms". Polychaetes filter organic detritus and bacteria from the water or consume them from the sediments. Polychaetes in turn furnish a major food source for bottom-feeding fishes. Based on 1974 data (Soule and Oguri, 1976) benthic biomass in outermost Los Angeles Harbor averaged 20-30 gm/m^2, 200 gm/m^2 at nearshore areas, and 500 gm/m^2 in the central outer harbor.

If both ports were to complete the Southwest Basin as was planned in 1974 (AHF, 1976), an estimated 8.5 X 10^8 grams (850 tons) of organisms would be lost by burial, and dredging would destroy an additional 6.8 X 10^8grams (680 tons).

Since large polychaetes may weigh less than 0.1 gram, that represents 15.3 billion worms. In one fish stomach, 600 freshly consumed worms were found, identifiable to genus. The direct consequences for fish feeding on benthic poluchaete worms was a loss of 25 million "fish meals", as calculated by HEP (Port of Long Beach, 1976).

Since bacteria were reduced 30-fold in outer Los Angeles Harbor in 1978 (Soule and Oguri, 1979) and benthic organisms were reduced four-fold there, this may bear direct relationship to the four-fold drop in fish trawl catch in the outer harbor in 1978 (Soule and Oguri, 1979; Section IIID, this volume).

Dominant Species

Dominant species changed from 1973-74 to 1978. *Tharyx* sp. (*T. parvus?*) comprised 45 percent, dominating the total benthic organisms in 1973-74, while *mediomastus californiensis* (=*Capitita ambiseta*) was second, with about 15% of the population and *Cossura candida* was third with about 13%. In 1978, *C. candida* moved to first place, furnishing about 30% of the population. *Tharyx* sp. dropped to about 12% overall and *Mediomastus* furnished about 22%. During the year, *C. candida* increased seasonally, while *tharyx* decreased greatly from January to October.

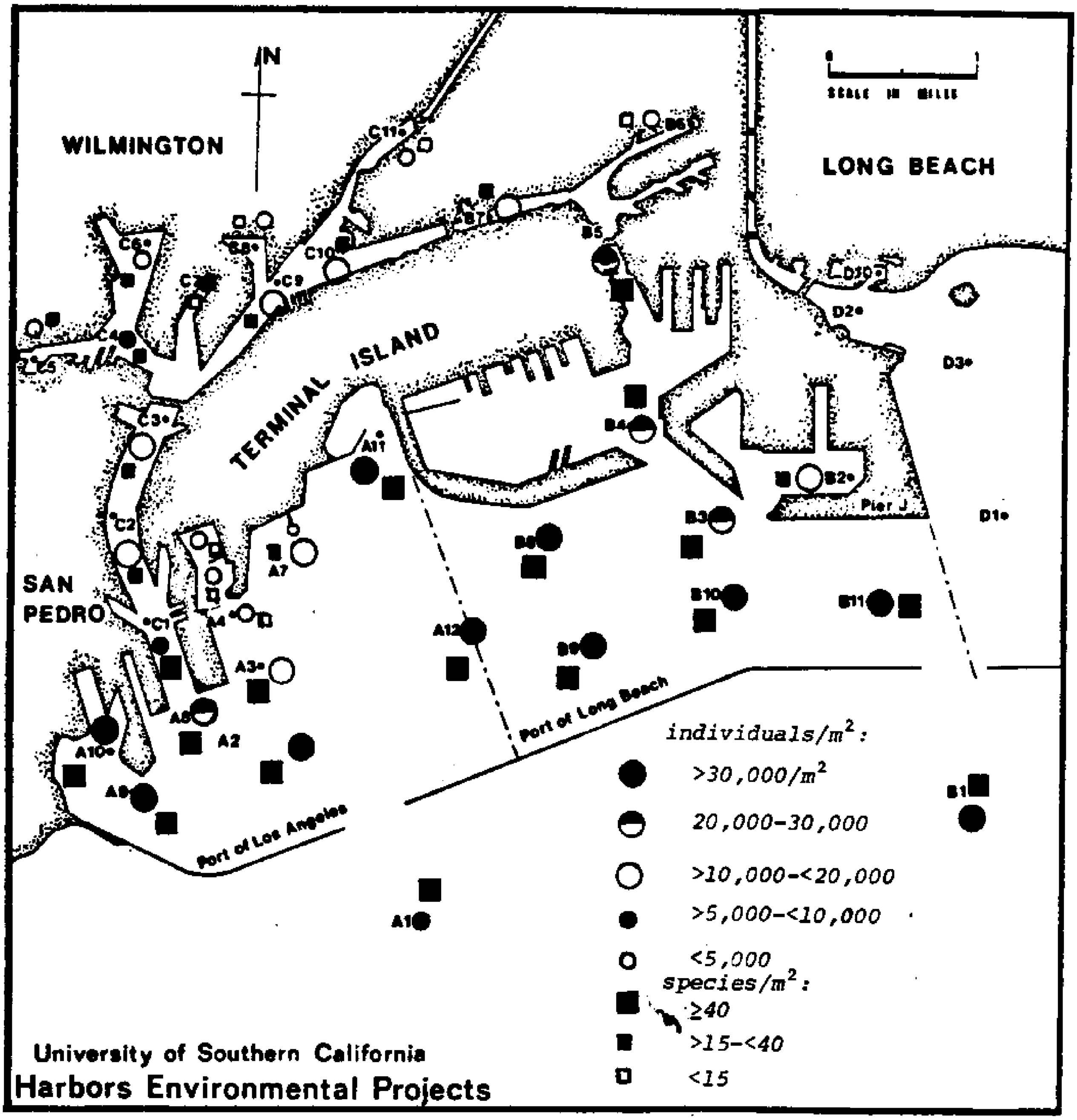


Figure 1 Numbers of Benthic Species and Individuals Per Square Meter, 1973-1974.

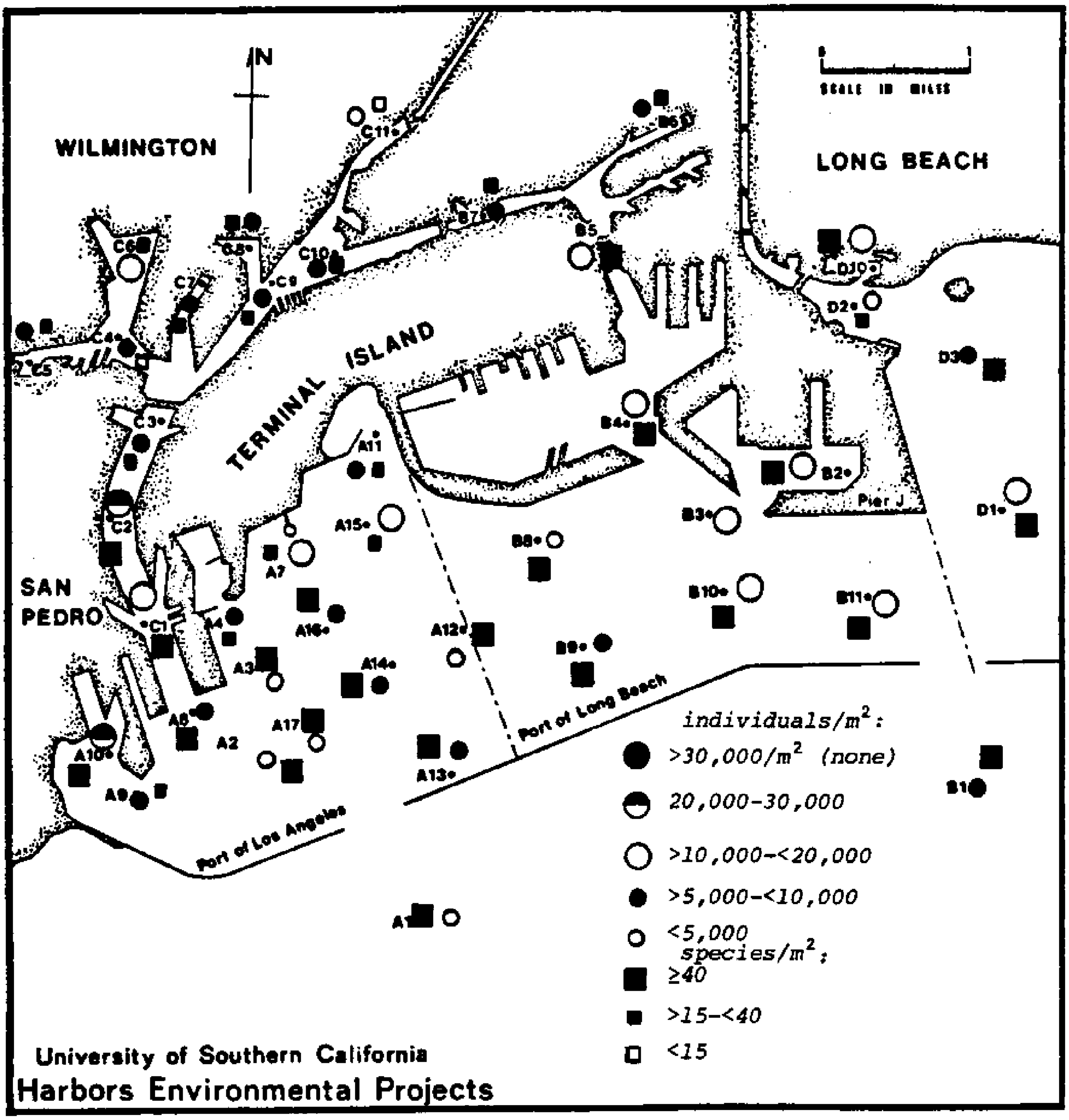


Figure 2 Numbers of Benthic Species and Individuals Per Square Meter, 1978.

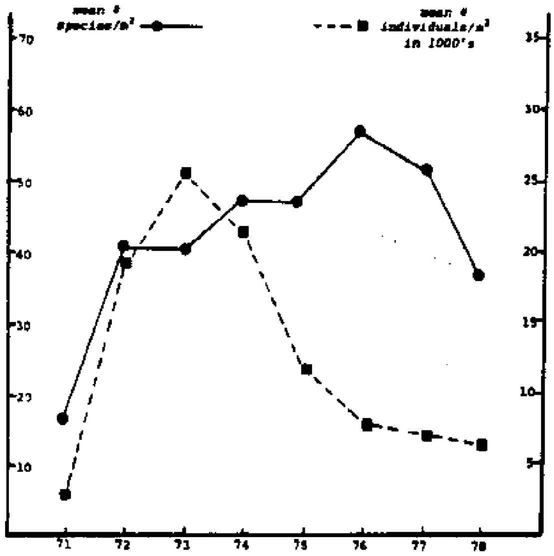


Figure 3A. Annual Means for Numbers of Benthic Species and Individuals/m² at A stations, 1971-1978. *Stations analyzed, 1971: A1-4, 7, 9; 1972: A1-4, 7-9, 12; 1973-78: A1-4, 7-9, 11, 12 (multiple grabs enhanced diversity in 1975-77).

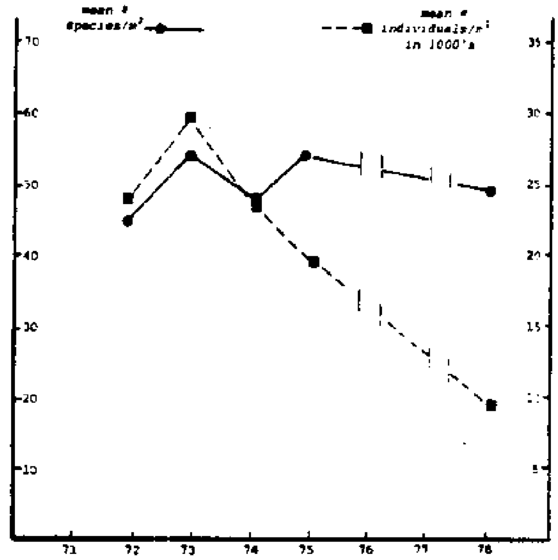


Figure 3B. Annual Means for Numbers of Benthic Species and Individuals/m² at B stations B1-B11* 1972-75, 1978. *1972: B10 not sampled.

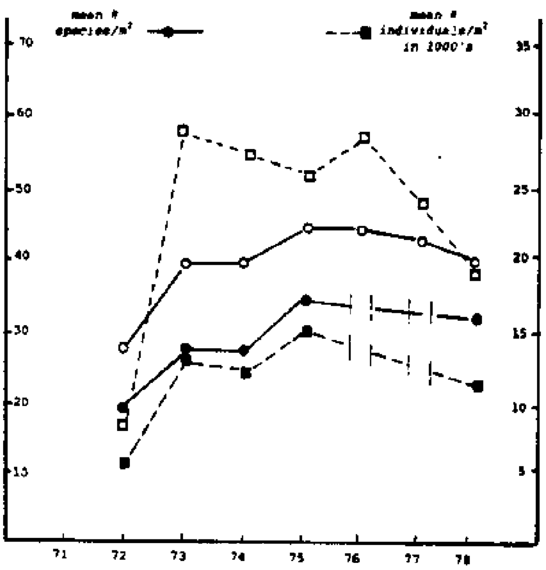


Figure 3C. Annual Means for Numbers of Benthic Species and Individuals/m² at C stations, except C7 and C11, 1972-75, 1978 (solid symbols) and stations C1-3 for 1972-1978 (clear symbols).

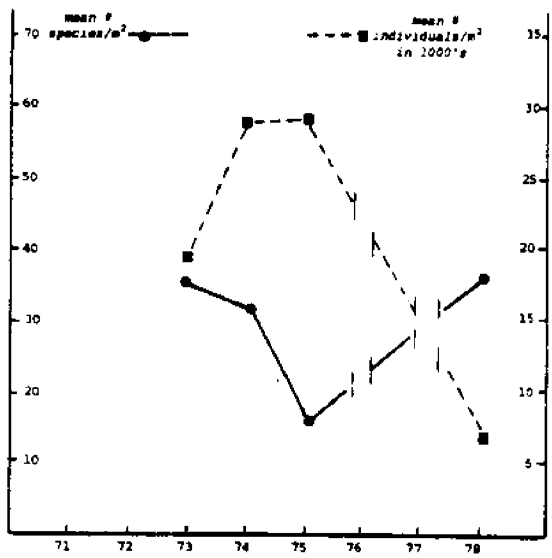


Figure 3D. Annual Means for Numbers of Benthic Species and Individuals/m² at stations D1-3, 1974-75, 1978.

Table 1. Recent Collection in Los Angeles Harbor of Intertidal Species Found in Collections Made in 1892-1897.*

Species	Collected 1973-1979	Comments
Phylum Brachiopoda		
Glottidia albida	-	Found in benthic samples in 1978
Terebratalia transversa	-	
Phylum Mollusca - Class Gastropoda		
Bulla gouldiana	-	
Bursa californica	+	Worn shells cast ashore at Pt. Fermin
Caecum sp.	+	Taken at Pt. Fermin
Cerithiopsis sp.	-	
Conus californianus	+	Taken at Pt. Fermin
Cystiscus jewettii	-	
Fissurella volcano	+	Taken at Pt. Fermin
Forreria belcheri	-	
Haminoea virescens	+	Taken at inner Cabrillo Beach
Littorina planaxis	+	Taken at inner Cabrillo Beach & Pt. Fermin
Megasurcula carpenteriana	+	Cast ashore on outer Cabrillo Beach
Mitra idae	+	Taken at Pt. Fermin
Mitromorpha sp.	-	
Nassarius fossatus	+	Taken at inner Cabrillo Beach
Nassarius tegula	-	
Notoacmaea paleacea	-	
Olivella spp.	+	Taken at inner and outer Cabrillo Beach
Polinices spp.	+	Taken at inner and outer Cabrillo Beach
Rictaxis punctocaelatus	+	Taken in harbor by benthic box core
Tegula aureotincta	+	Taken at Pt. Fermin
Truncatella spp.	-	
Volvarina taeniolata	+	Taken at Pt. Fermin
Class Pelecypoda		
Chione spp.	-	
Lasaea subquadrata	-	
Lima hemphilli	+	Cast ashore at Pt. Fermin
Periploma planiusculum	-	
Trachycardium quadrigenarium	-	

* Data courtesy of Dr. M. K. Wicksten.

Table 2. Rank Order of Benthic Species with Most Numerous Individuals by Season in Los Angeles-Long Beach Harbors in 1978.

January 1978

Rank	Species/Group	% Composition
1.	*Cossura candida*	22.60
2.	*Tharyx*	19.63
3	*Mediomastus californiensis* (=*Capitita ambiseta*)	19.49
4.	*Capitella capitata*	5.06
5.	*Prionospio cirrifera*	3.44
6.	*Paraonis gracilis oc.*	3.15
7.	*Euchone limnicola*	2.66
8.	*Sigambra tentaculata*	2.08
9.	*Chaetozone corona*	1.85
10.	*Haploscoloplos elongatus*	3.75
11.	*Nephtys cornuta fr.*	1.40
12.	*Lumbrineris* sp.	1.21
		86.32

April 1978

Rank	Species/Group	% Composition
1.	*Cossura candida*	30.15
2.	*Mediomastus californiensis* (=*Capitita ambiseta*)	19.65
3.	*Tharyx* sp.	10.30
4.	*Capitella capitata*	8.34
5.	*Prionospio cirrifera*	5.91
6.	*Euchone limnicola*	3.89
7.	*Paraonis gracilis oc.*	3.23
8.	*Sigambra tentaculata*	1.93
9.	*Chaetozone corona*	1.91
10.	*Nephtys cornuta fr.*	1.39
11.	*Haploscolopos elongatus*	1.39
12.	*Lumbrineris* sp.	1.28
		89.36

July 1978

Rank	Species/Group	% Composition
1.	*Cossura candida*	28.27
2.	*Mediomastus calif.* (=*Capitita ambiseta*)	25.07
3.	*Tharyx* sp.	10.78
4.	*Prionospio cirrifera*	5.45
5.	*Nephtys cornuta fr.*	1.53
6.	*Sigambra tentaculata*	1.94
7.	*Lumbrineris* sp.	0.97
8.	*Gyptis brevipalpa*	0.81
9.	*Paraonis gracilis oc.*	2.84
10.	*Theora lubrica*	1.72
11.	*Haploscoloplos elongatus*	1.44
12.	*Chaetozone corona*	1.08
		81.91

October 1978

Rank	Species/Group	% Composition
1.	*Cossura candida*	37.54
2.	*Mediomastus calif.* (=*Capitita ambiseta*)	25.04
3.	*Prionospio cirrifera*	6.70
4.	*Tharyx* sp.	6.70
5.	*Theora lubrica*	2.90
6.	*Paraonis gracilis oc.*	2.20
7.	*Euchone limnicola*	2.10
8.	*Nephtys cornuta fr.*	1.87
9.	*Sigambra tentaculata*	1.45
10.	*Haplocoloplos elongatus*	1.13
11.	*Lumbrineris* sp.	0.97
12.	*Capitella capitata*	0.78
		89.43

Table 3. Rank Order of Benthic Species with Most Station Occurrences by Seasons in Los Angeles-Long Beach Harbors in 1978.

January 1978

Rank	Species/Group	# Occurrences*
1.	*Mediomastus calif. (=Capitita ambiseta)*	41
2.	*Tharyx* sp.	40
3.	*Cossura candida*	40
4.	*Lumbrineris* sp.	38
5.	*Prionospio cirrifera*	34
6.	*Nephtys cornuta fr.*	33
7.	*Sigambra tentaculata*	33
8.	*Chaetozone corona*	32
9.	*Haploscoloplos elongatus*	32
10.	*Nereis procera*	29
11.	*Paraprionospio pinnata*	27
12.	*Gyptis brevipalpa*	24

April 1978

Rank	Species/Group	# Occurrences*
1.	*Cossura candida*	39
2.	*Mediomastus calif. (=Capitita ambiseta)*	38
3.	*Tharyx* sp.	38
4.	*Nephtys cornuta fr.*	36
5.	*Lumbrineris* sp.	34
6.	*Nereis procera*	31
7.	*Prionospio cirrifera*	30
8.	*Sigambra tentaculata*	30
9.	*Haploscoloplos elongatus*	30
10.	*Chaetozone corona*	28
11.	*Paraprionospio pinnata*	27
12.	*Gyptis brevipalpa*	26

* maximum possible = 41 stations.

July 1978

Rank	Species/Group	# Occurrences*
1.	*Cossura candida*	38
2.	*Mediomastus calif. (=Capitita ambiseta)*	36
3.	*Tharyx* sp.	36
4.	*Prionospio cirrifera*	32
5.	*Nephtys cornuta fr.*	30
6.	*Sigambra tentaculata*	29
7.	*Lumbrineris* sp.	28
8.	*Gyptis brevipalpa*	25
9.	*Paraonis gracilis oc.*	25
10.	*Theora lubrica*	25
11.	*Haploscoloplos elongatus*	24
12.	*Chaetozone corona*	23

October 1978

Rank	Species/Group	# Occurrences*
1.	*Mediomastus calif. (=Capitita ambiseta)*	36
2.	*Tharyx* sp.	35
3.	*Cossura candida*	35
4.	*Lumbrineris* sp.	35
5.	*Prionospio cirrifera*	34
6.	*Nephtys cornuta fr.*	32
7.	*Sigambra tentacula*	31
8.	*Haploscoloplos elongatus*	29
9.	*Chaetozone corona*	27
10.	*Paraprionospio pinnata*	26
11.	*Theora lubrica*	26
12.	*Gyptis brevipalpa*	25

* maximum possible = 41 stations.

Table 4. Benthic Species Diversity Indices

January 6, 1978

Stn.	Per Meter² Species	Per Meter² Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
A1	38	1744	3.1779	3.6376	0.8736	4.9572
A2	42	2992	3.1034	3.7377	0.8303	5.1226
A3	31	3952	2.3968	3.4340	0.6980	3.6223
A4	26	8672	1.3758	3.2581	0.4223	2.7570
A7	6	17,760	0.3583	1.7918	0.2000	0.4876
A8	41	22144	1.5893	3.7136	0.4280	3.9979
A9	35	15168	1.5941	3.5553	0.4484	3.5318
A10	41	26592	1.7586	3.7136	0.4736	3.9260
A11	16	330	2.4639	2.7726	0.8887	2.3927
A12	31	5680	2.2628	3.4340	0.6589	3.4703
A13	36	3360	2.8797	3.5835	0.8036	4.3105
A14	39	6528	2.7668	3.6636	0.7552	4.3261
A15	26	9216	1.2474	3.2581	0.3829	2.7386
A16	33	3952	2.4185	3.4965	0.6917	3.8638
A17	37	2912	2.8640	3.6109	0.7931	4.5132
B1	52	5536	2.9783	3.9510	0.7538	5.8070
B2	38	19744	2.0923	3.6376	0.5752	3.7409
B3	39	8624	2.3009	3.6636	0.6281	4.1932
B4	40	6752	2.4459	3.6889	0.6630	4.4230
B5	47	12432	2.4143	3.8501	0.6271	4.8791
B6	34	4448	2.0543	3.5261	0.5826	3.9302
B7	25	8832	1.4594	3.2189	0.4534	2.6414
B8	41	3888	2.6985	3.7136	0.7267	4.8393
B9	39	1952	3.1640	3.6636	0.8636	5.0154
B10	40	11280	2.0582	3.6889	0.5579	4.1797
B11	40	7488	2.6278	3.6889	0.7124	4.3717
C1	29	6560	1.8255	3.3673	0.5421	3.1859
C2	31	17488	1.8286	3.4340	0.5325	3.0709
C3	16	9440	1.5231	2.7726	0.5494	1.6389
C4	22	3424	2.0219	3.0911	0.6541	2.4631
C5	14	6752	1.2076	2.6391	0.4576	1.4743
C6	24	12256	1.4734	3.1781	0.4636	2.4432
C7	14	1856	1.4442	2.6391	0.5472	1.7273
C8	29	6128	1.7329	3.3675	0.5146	3.0989
C9	16	2272	1.9744	2.7726	0.7121	1.9409
C10	25	8240	1.6278	3.2189	0.5057	2.6617
C11	4	272	1.1407	1.3863	0.8229	0.5352
D1	40	10928	2.0823	3.6889	0.5645	4.1940
January 11, 1978						
D2	16	5720	1.2034	2.7726	0.4340	1.7338
D3	31	4320	1.6005	3.4340	0.4661	3.5838
D10	33	7040	2.3534	3.4965	0.6731	3.6120

Table 4 (continued)

April 10, 1978

Stn.	Per Meter² Species	Per Meter² Individuals	(H^1) Shannon-Wiener	H^1(Max)	(J^1) Evenness	Gleason
A1	24	992	2.7236	3.1781	0.8570	3.3335
A2	33	2150	2.7626	3.4965	0.7901	4.1703
A3	29	4032	1.6697	3.3673	0.4959	3.3727
A4	14	11408	0.6273	2.6391	0.2377	1.3916
A7	15	7860	0.7410	2.7080	0.2736	1.4831
A8	23	2496	2.4775	3.1355	0.7901	2.8124
A9	18	1392	2.3143	2.8904	0.8007	2.3486
A10	35	18928	1.8834	3.5553	0.5297	3.4523
A11	23	1360	1.9256	3.1355	0.6141	3.0491
A12	27	1104	2.9942	3.2958	0.9085	3.6150
A13	40	3184	3.1024	3.6889	0.8410	4.8352
A14	33	9104	2.1782	3.4963	0.6230	3.4018
A15	29	21584	1.2610	3.3673	0.3745	2.8057
A16	40	8144	2.1620	3.6889	0.5861	4.3309
A17	35	7264	2.2765	3.5553	0.6403	3.8242
B1	52	7280	2.7010	3.9512	0.6836	5.7349
B2	34	26752	1.5821	3.5264	0.4487	3.2371
B3	30	8032	2.3451	3.4012	0.6895	3.2254
B4	40	7648	2.4050	3.6889	0.6520	4.3613
B5	36	11104	2.1788	3.5836	0.6080	3.7579
B6	24	4768	1.6327	3.1781	0.5138	2.7156
B7	20	7984	1.7401	2.9957	0.5809	2.1146
B8	38	3616	2.7868	3.6376	0.7661	4.5160
B9	40	7296	2.7803	3.6889	0.7537	4.3844
B10	42	10336	2.4292	3.7377	0.6499	4.4356
B11	29	4176	2.3151	3.3674	0.6875	3.3631
C1	31	17968	1.7597	3.4340	0.5125	3.0624
C2	29	20608	1.8074	3.3673	0.5367	2.8188
C4	19	4144	1.8126	2.9444	0.6156	2.1610
C5	12	6352	1.2457	2.4849	0.5013	1.2562
C6	21	13824	1.4162	3.0445	0.4652	2.0977
C7	18	6432	1.8829	2.8904	0.6514	1.9386
C8	10	6416	0.8182	2.3026	0.3553	1.0266
C9	23	9072	1.4397	3.1355	0.4592	2.4141
C10	23	6880	2.0152	3.1355	0.6427	2.4897
C11	5	11888	0.1161	1.6094	0.0721	0.4263
D1	38	3940	2.0401	3.6376	0.5608	4.4692
D2	8	340	1.1756	2.0794	0.8443	1.2009
D3	31	1830	2.3874	3.4340	0.6952	3.9936
D10	37	11110	2.0912	3.6109	0.5791	3.8645

Table 4 (continued)

July 10, 1978

Stn.	Per Meter² Species	Per Meter² Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
A1	26	1120	2.8273	3.2581	0.8678	3.5607
A2	34	7442	2.0074	3.5261	0.5693	3.5913
A3	45	5216	2.4876	3.8067	0.6535	5.1405
A4	20	11472	1.1104	2.9954	0.3707	1.9262
A7	20	1710	2.2208	2.9957	0.7413	2.5523
A8	29	3648	2.1531	3.3673	0.6394	3.4138
A9	41	10096	1.8959	3.7136	0.5105	4.3384
A10	42	18624	2.1078	3.7377	0.5639	4.1700
A11	34	12352	1.5741	3.5262	0.4464	3.2912
A12	35	6432	2.0891	3.5553	0.5876	3.8773
A13	16	640	2.5537	2.7726	0.9210	2.3215
A14	21	432	2.9684	3.0445	0.9750	3.2957
A15	21	7568	1.1689	3.0445	0.3839	2.2392
A16	32	5536	2.3215	3.4657	0.6698	3.5967
A17	38	2480	2.9320	3.6376	0.8060	4.7339
B1	51	8960	2.3504	3.9317	0.5978	5.1769
B2	16	2400	2.1881	2.7726	0.7892	1.9272
B3	42	11264	2.6484	3.7375	0.2086	4.2888
B4	41	10160	2.7238	3.7134	0.7335	4.1323
B5	37	17664	1.9025	3.6109	0.5269	3.6813
B6	21	3472	1.9320	3.0445	0.6346	2.4532
B7	24	8912	1.7421	3.1781	0.5482	2.5288
B8	26	2144	2.4497	3.2581	0.7519	3.2593
B9	34	1728	3.0904	3.5264	0.8764	4.4267
B10	36	12416	2.1346	3.5835	0.5957	3.7128
B11	37	9952	2.0626	3.6110	0.5712	3.8034
C1	34	12272	2.0589	3.5264	0.5839	3.5050
C3	19	5840	1.9522	2.9445	0.6630	1.9156
C4	21	10832	1.7041	3.0445	0.5597	2.1528
C5	13	3056	1.6264	2.5649	0.6341	1.4954
C6	22	15024	1.5356	3.0910	0.4968	2.1835
C7	12	5072	1.0478	2.4849	0.4216	1.2893
C8	19	2976	1.6667	2.9444	0.5660	2.2505
C9	16	4240	1.0823	2.7725	0.3904	1.6769
C10	29	10224	1.9309	3.3673	0.5734	3.0328
C11	6	5392	0.1477	1.7918	0.0824	0.5819
D1	33	7120	1.7435	3.4965	0.4986	3.6091
D2	15	3820	1.1904	2.7079	0.4396	1.5766
D3	38	3770	2.3652	3.6376	0.6502	4.3731
D10	23	6750	1.9147	3.1355	0.6106	2.4951

Table 4 (continued)

October 13, 1978

Stn.	Per Meter² Species	Per Meter² Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason*
A1	21	736	2.7182	3.0445	0.8928	3.0297
A2	39	3726	2.8717	3.6633	0.7839	4.6257
A3	32	9104	1.8223	3.4657	0.5258	3.4004
A4	27	2352	2.2155	3.2958	0.6722	3.3492
A7	14	11710.	0.6929	2.6391	0.2626	1.4943
A8	29	2544	2.3107	3.3673	0.6862	3.5707
A9	40	10480	2.6283	3.6889	0.7125	4.2129
A10	50	37840	1.8306	3.9123	0.4679	4.6498
A11	21	2200	1.4093	3.0445	0.4629	2.4790
A12	25	3968	1.9373	3.2186	0.6019	2.8979
A13	51	10128	2.0441	3.9317	0.5199	5.4700
A14	10	240	2.1762	2.3026	0.9451	1.6421
A15	38	17824	1.7156	3.6376	0.4716	3.7800
A16	22	8400	1.0671	3.0910	0.3452	2.3240
A17	36	2336	2.8864	3.5835	0.8055	4.5125
B1	68	4944	3.4985	4.2195	0.8291	7.8769
B3	39	14512	2.0605	3.6638	0.5624	3.9609
B4	46	13760	2.3400	3.8286	0.6112	4.7222
B5	41	9952	2.2994	3.7136	0.6192	4.3452
B6	27	6128	1.9412	3.2958	0.5890	2.9814
B7	25	8960	1.7279	3.2189	0.5368	2.6372
B8	29	2448	2.7698	3.3673	0.8226	3.5884
B9	45	9792	2.6305	3.8068	0.6910	4.6827
B10	36	5808	2.4097	3.5835	0.6725	4.0383
B11	46	14464	1.9720	3.8284	0.5151	4.6869
C1	37	29600	0.6589	3.6109	0.1825	3.4967
C2	35	40320	1.4071	3.5553	0.3958	3.2062
C3	25	10192	2.1575	3.2189	0.6703	2.6004
C4	25	6928	1.9803	3.2189	0.6152	2.7139
C5	13	4752	1.6841	2.5649	0.6566	1.3704
C6	21	17824	1.3485	3.0445	0.4429	2.0433
C7	13	2000	1.8119	2.5649	0.7064	1.5788
C8	24	3968	2.2140	3.1788	0.6967	2.7785
C9	22	6080	1.6756	3.0910	0.5421	2.4103
C10	26	6416	1.9067	3.2581	0.5852	2.8517
C11	9	2432	0.6825	2.1972	0.3106	1.0261
D1	42	13312	2.0306	3.7377	0.5433	4.3174
D2	12	6496	1.4247	2.4849	0.5733	1.2530
D3	36	20752	1.6560	3.5835	0.4621	3.5210
D10	32	17570	1.4643	3.4657	0.4225	3.0262

* (=Margolef, 1951).

Table 5A

Number of Benthic Species and Number of Organisms Per Square Meter
(# Species/ # organisms/m^2)

Station	Jan '78	Apr '78	Jul '78	Oct '78	1978 Mean	1978 SD(n-1)
A1	53/2192	36/1376	42/1584	29/1088	40/1560	10/468
A2	51/3376	37/2432	45/7904	50/4080	46/4448	6/2401
A3	45/4704	35/4208	60/5936	46/10,400	47/6312	10/2820
A4	37/9840	21/11,600	32/12,512	33/2608	31/9140	7/4494
A7	10/18,200	23/12,460	24/1780	19/12,300	19/11,185	6/6844
A8	51/22,864	30/2704	47/4544	39/2832	42/8236	9/9788
A9	45/15,552	18/1392	46/10,352	42/10,720	38/9504	13/5904
A10	49/27,024	44/19,424	51/19,104	59/38,432	51/25,996	6/9063
A11	20/720	34/2240	44/14,176	26/2720	31/4964	10/6200
A12	48/6480	35/1376	49/7040	34/4384	42/4820	8/2565
A13	49/4256	49/3520	22/960	72/11,216	48/4988	20/4386
A14	50/7168	47/9792	27/608	18/448	36/4504	16/4715
A15	35/10,352	42/22,384	28/7920	51/18,576	39/14,808	10/6804
A16	49/4848	52/8624	43/6208	32/8960	44/7160	9/1969
A17	50/3424	48/7888	51/2864	49/3472	50/4412	1/2334
Mean	43/9400	37/7428	41/6899	40/8816	40/8136	3/1168
SD(n-1)	12/7975	10/6693	11/5345	15/9667	9/5945	

Table 5B

Number of Benthic Species and Number of Organisms Per Square Meter
(# species/# organisms/m^2)

Station	Jan '78	Apr '78	Jul '78	Oct '78	1978 Mean	SD(n-1)
B1	71/7136	68/8080	71/11,632	65/5216	69/8016	3/2689
B2	50/11,848	46/28,816	27/3328	40/5856	41/12,462	10/11,473
B3	47/9424	42/8784	57/12,128	51/15,392	49/11,432	6/3012
B4	54/7600	53/8464	53/11,424	61/14,752	55/10,560	4/3239
B5	63/13,072	45/12,304	53/20,016	59/12,416	55/14,452	8/3725
B6	44/5056	35/5264	33/4512	36/7232	37/5516	5/1187
B7	35/9904	29/8864	31/9744	38/10,864	33/9844	4/819
B8	58/6128	49/4224	36/3072	39/3232	46/4164	10/1405
B9	46/2400	54/8080	44/2240	59/10,496	51/5804	7/4143
B10	51/12,352	55/11,472	45/14,112	45/6720	49/11,164	5/3159
B11	57/8592	42/5216	52/10,640	55/15,376	52/9956	7/4249
Mean	52/8501	47/9961	46/9350	50/9777	49/9397	3/650
SD(n-1)	10/3273	11/6728	13/5524	11/4372	10/3183	
D1	51/11,632	43/4760	44/7620	52/13,776	48/9447	5/4034
D2	21/6310	12/380	26/4160	14/6544	18/4349	6/2855
D3	40/4660	37/2020	50/4240	46/21,392	43/8078	6/8951
D10	39/7400	48/11,950	36/7920	47/18,460	43/11,433	6/5107
Mean	38/7501	35/4778	39/5985	40/15,043	38/8327	2/4614
SD(n-1)	12/2976	16/5112	10/2065	17/6476	14/2988	

Table 5C

Number of Benthic Species and Number of Organisms Per Square Meter
(# species/# organisms/m^2)

Station	Jan '78	Apr '78	Jul '78	Oct '78	1978 Mean	SD(n-1)
C1	38/6912	47/19,104	46/12,880	42/29,792	43/17,172	4/9776
C2	43/21,072	41/25,984	48/21,440	50/42,816	46/27,828	4/10,239
C3	28/10,240	22/8640	26/6480	33/10,704	27/9016	5/1908
C4	28/3744	30/4768	32/11,504	34/7728	31/6936	3/3482
C5	19/7408	16/8544	22/4896	21/6464	20/6828	3/1543
C6	28/13,328	27/15,024	33/17,136	23/18,384	28/15,968	4/2241
C7	19/2544	24/9744	14/5232	16/2944	18/5116	4/3305
C8	39/6592	16/7776	22/3152	27/4192	26/5428	10/2127
C9	24/3696	32/9392	18/4288	30/6544	26/5980	6/2585
C10	32/8576	32/7632	38/11,840	31/8112	33/9040	3/1906
C11	7/1152	8/18,832	8/6000	11/8320	9/8576	2/7461
Mean	28/7751	27/12,313	28/9532	29/13,273	28/10,633	
SD(n-1)	10/5663	11/6520	13/5916	11/12414		

Table 6A

ANNUAL MEAN NUMBERS OF BENTHIC SPECIES AND ORGANISMS PER M^2

(# SPECIES/# ORGANISMS)

	1971	1972	1973	1974	1975	1976	1977	1978	Mean
A1	16/553	52/7347	54/6645	68/10580	62/6706	79/2300	49/2580	40/1560	52/4784
A2	24/4117	52/29284	66/35360	64/38296	62/18133	65/17060	74/10993	46/4448	56/19711
A3	18/3213	51/24089	53/16395	52/17836	62/11353	73/6472	64/8000	47/6312	52/11708
A4	4/1345	19/17169	6/8331	7/2728	17/9910	23/1932	50/15363	31/9140	19/8239
A5	4/90	10/6074	15/10192	4/684	15/19040				9/7216
A6	5/77	4/178	10/12272	6/2332	29/54064				10/13784
A7	7/1680	14/6603	14/12256	17/7930	10/2665	8/808	6/3737	19/11185	11/5858
A8		39/30362	57/55093	58/21000	54/3600	71/5640	48/1813	42/8236	52/17963
A9	36/11810	44/32118	47/45456	46/37900	44/16155	71/24952	48/11370	38/9504	46/23658
A10		44/19984	48/53520	47/28616	51/36464			51/25996	48/32916
A11			64/21880	54/26040	48/13961	68/5220	62/6408	31/4964	54/13078
A12		60/28200	66/29280	59/30864	62/13161	55/4790	63/7843	42/4820	58/16994
A13							69/15970	48/4988	58/10479
A14							39/1590	36/4504	37/3047
A15							49/6450	39/14808	44/10629
A16							58/4600	44/7160	51/5880
A17							43/2740	50/4412	46/3576
Mean	14/2860	35/18309	41/25556	40/18733	43/17101	57/7686	51/7104	40/8135	41/12324

Table 6B

ANNUAL MEAN NUMBERS OF BENTHIC SPECIES AND ORGANISMS PER M^2

(# SPECIES/# ORGANISMS)

	1971	1972	1973	1974	1975	1976	1977	1978	Mean
B1		49/3050	81/14341	72/12488	58/11120			69/8016	65/9803
B2		61/23880	40/23371	28/23644	37/31840			41/15212	41/23589
B3		55/15650	59/17621	57/32632	72/27216			49/11432	58/20910
B4		37/39360	53/37435	51/38484	60/30416			55/10560	51/31251
B5		44/18540	46/27371	40/14660	38/10144			55/14502	44/17043
B6		13/65550	16/10955	12/2704	28/2880			37/5516	21/17521
B7		39/24880	30/26091	36/17516	36/17536			33/9844	34/19173
B8		50/9940	61/41403	62/34012	62/15728		69/16290	46/4164	58/20256
B9		50/9420	66/41200	58/27008	60/21696			51/5804	57/21025
B10			74/50792	60/29994	61/19312			49/11164	61/27815
B11		54/32420	55/36704	52/24997	71/30624			52/9956	56/26940
Mean		45/24269	53/29753	48/23467	53/19865		69/16290	49/9647	49/6363

Table 6C

ANNUAL MEAN NUMBERS OF BENTHIC SPECIES AND ORGANISMS PER M^2
(# SPECIES/# ORGANISMS)

	1971	1972	1973	1974	1975	1976	1977	1978	Mean
C1		43/17080	52/53824	47/32444	48/26264	42/29405	41/33103	43/17172	44/29898
C2		22/5180	37/24475	38/35720	46/33904	46/39172	48/27090	46/27832	40/27624
C3		18/3680	28/8181	32/11640	38/16418	43/16778	36/9040	27/9016	31/10679
C4		14/1160	29/6245	24/2620	26/3216			31/6936	24/4035
C5			21/2853	21/6460	22/10688			20/6828	21/6707
C6	10/907	16/3628	22/5568	26/6428	39/23264			28/15968	21/9293
C7			21/5643	9/7704				18/5116	16/6154
C8			19/3253	14/2332	21/3280			26/5428	20/3573
C9		19/2530	28/6976	22/2884	39/10208			26/5980	26/5715
C10		12/2920	28/11568	29/6104	23/5840			33/9060	25/7098
C11			4/3611	4/12840				9/8576	5/8342
Mean	10/907	20/5168	26/12017	24/11561	33/14786	43/28451	41/23077	27/10719	25/10828

Table 6D

ANNUAL MEAN NUMBERS OF BENTHIC SPECIES AND ORGANISMS PER M^2
(# SPECIES/# ORGANISMS)

	1971	1972	1973	1974	1975	1976	1977	1978	Mean
D1			61/38245	54/36900	34/44112			48/9447	49/32176
D2			25/9867	22/25204	5/11264			18/4349	17/12671
D3			20/9525	18/22712	9/30976			43/8078	22/17822
D10								43/11433	43/11433
Mean			35/19212	31/28272	16/28784			38/8326	32/18525

D. FISH POPULATIONS

INTRODUCTION

Until Chamberlain (1973) and Stephens, Gardiner and Terry (1973) undertook investigations for Harbors Environmental Projects under the USC Sea Grant Program, beginning in 1971, the fish species and populations of Los Angeles-Long Beach Harbors had not been studied extensively since Ulrey and Greeley (1928), prior to construction of the Federal and Long Beach breakwaters. Young (1964), who reported on a 1956-1960 study of the California halibut *Paralichthys californicus* in the Long Beach area, indicated that the condition of the fish was "poor" at that time and suggested that sewer effluent pollution was the cause. Figure 1 shows the 1928 trawl stations.

During the 1971-1973 period, Dr. J. S. Stephens made 76 trawls in the outer Los Angeles-Long Beach Harbors (Stephens, Terry, Subber and Allen, 1974; Chamberlain, 1974). Stephens *et al.* (1973) compared harbor fish trawl data to similar data taken in San Pedro Bay outside the harbor and stated that the average catch in the harbor of 221 fish per trawl represented a density of one fish per 12.5 m^2 trawled whereas the density was one fish per 23.9 m^2 outside the harbor (AHF, 1975; 1976).

The Harbors Environmental Projects trawl program was reduced following completion of studies in 1975 for the Army Corps of Engineers Los Angeles District in 1974, and for the USC Sea Grant Program, so that there were 18 trawls in 1974, 20 in 1975, but only 5 in 1976, and 9 trawls between January and November in 1977. Under a program for the City of Los Angeles Department of Public Works Terminal Island Treatment Plant, 55 trawls were carried out between December 1977 and October 1978. Results of the 1971-1978 trawl studies were presented in Soule and Oguri (1979) and will be summarized in this section herein. Earlier, Chamberlain (1974) summarized gill net and beach seine records up to that time as part of his checklist, but no harbor-wide gill net surveys have been carried out. Trawl stations are shown in Figure 2.

During 1974-1976 the Southern California Edison generating plant on the Back Channel in Long Beach Harbor was out of operation for conversion of equipment, and pre-baseline trawl and gill net surveys were carried out (EQA-MBC, 1975, 1976) in that area. Surveys when operations resumed were carried out from January 1977 to March 1978. Figure 3 gives the location of the Edison trawl stations.

When comparing data for the various reports cited, it is important to note that the Edison surveys for January 1977-March 1978 did not occur for the most part in the same time intervals or in the same places as the HEP outer harbor surveys conducted between December 1977 and October 1978.

HABITAT CHARACTERISTICS

The outer harbor area is quite different from the inner channels, in both physical and biological oceanographic perspectives. Thus the fish species composition differs to some extent between the areas. The existence of a large clockwise surface gyre was discovered in a drogue study in 1971 in the outer Los Angeles Harbor area (Soule and Oguri, 1972); this area was also influenced by the sewage and fish cannery outfalls. The gyre, later shown to have some subsurface counterclockwise components (Robinson and Porath, 1974), was confirmed and simulated in the physical model at the Army Engineers Waterways Experiment Station, Vicksburg, Mississippi and later in computer models (McAnally, 1975). In Section I Figures 9 and 10 show patterns of rising and falling spring tides. Major components of the ebb tide flow down the Long Beach Channels and move around Pier J to the east, as was indicated by the temperature maps as well in Section II.

The outer harbor areas of the Ports of Los Angeles and Long Beach consist of a semi-enclosed basin covering 24.34×10^6 square meters of water. This is almost equalled by the 23.23×10^6 square meter area of the basin to the east of the Ports, off the City of Long Beach. The outer harbor port areas are relatively free of impediments to circulation, and their waters are mixed by tidal currents, wind fetch and the gyre. Nutrient loading from the fish canneries was managed successfully to some extent between 1975 and 1977, according to assimilation capacity estimates of the outer harbor waters (Soule and Oguri, 1976; 1978).

The middle Harbor of the Port of Long Beach has an area of 1.39 m^2 and the Back Channel and Inner Harbor areas combined are 1.21×10^6 m^2 in area for a total in the Port of Long Beach of 2.60×10^6 square meters. Channels are much narrower than in the outer harbor and more subject to tidal prism. The pilings, riprap, and rock dikes offer extensive damping of flow at the edges with small-scale turbulent mixing and more rapid flow in the middle of the channels.

The outer harbor is attractive largely to soft-bottom obligate benthos fish, to facultative benthos fish, or to omnivores and pelagic fish; the channels, on the other hand, offer a mixed habitat with shelter and food on pilings and rocks, in addition to the benthic habitat. These areas attract and/or support a number of different fish and invertebrate species, in addition to some of the same benthic and water column species that occur in the outer harbor.

Ecological computer analysis has shown that the harbor benthic invertebrates and plankton populations can characterize and generally separate the harbor into outer harbor habitats, main channel habitats, and blind-end inner slip habitats (AHF, 1975; 1976). Pollutants can influence and alter the groupings greatly, but physical characteristics of the habitats also are determinants of species groups.

Changes in Habitat

Prior to pollution control measures in 1960-1970, indiscriminant dumping of industrial and oil field wastes, sewage, fish scrap and ballast waters had grossly overloaded the receiving waters. Following control of refinery wastes and recovery of fish scrap, the harbor underwent a spectacular improvement in environmental quality (Reish, 1971; AHF, 1976). Assimilation of nutrient loads was dependent upon the gyre. Cannery and primary-treated sewage effluent wastes entrained in the gyre containing proteins, carbohydrates, fats, and amino acids, as well as ammonia, nitrite, nitrate and phosphate, provided high levels of nutrients in the outer harbor. The result was the richest soft-bottom, shallow water fish habitat in southern California. The benthic invertebrate fauna included more species and more organisms per square meter than any other embayment recorded in southern California.

As indicated in Soule and Oguri (1979), there were major changes between 1973 and 1978 in the complex organic nutrient content of wastes and in the thermal character of other effluents. In 1974-75, the canneries in outer Los Angeles Harbor installed dissolved air flotation (DAF) pretreatment, which removed much of the complex nutrients (proteins, carbohydrates, fats) by flocculation and creation of sludge.

In April 1977, the Terminal Island Treatment Plant (TITP) was converted to secondary waste treatment, and between October 1977 and January 1978 the cannery wastes were diverted to TITP for secondary treatment. A major TITP upset in the summer of 1978 released large quantities of suspended solids and chlorination was also used to prevent bacterial contamination.

In January 1977, the Southern California Edison Long Beach generating plant resumed operation, with a capacity of once-through cooling water flow of 734 mgd. The flow is governed by power plant operation and thus demand fluctuates widely.

TRAWL STUDIES

Methods

In the 1978 HEP studies of fish populations in the outer harbor, trawl stations used in the 1971-1974 surveys were reactivated. The method was discussed in Section I. In addition, surveys of recreational anglers were made. California Department of Fish and Game data on bait catch and on the commercial party boat (recreational) fishery were analyzed for trends between 1970 and 1978. The limitations of trawl studies are well known: for example, faster moving fish are adept at avoiding the nets; sweeps of one area may move fish away from an adjacent area yet to be trawled; rocky areas, confined spaces and areas with debris on the bottom are avoided to prevent damage to ship or gear. Nevertheless, in the open spaces of the harbor, the trawl method is essential in order to obtain comparable data.

RESULTS

The data and analyses of the December 1977-October 1978 investigations were presented in Soule and Oguri (April, 1979). Since that time, some new data for comparison have become available, such as the Southern California Edison Report (EQA-MBC, 1978) and the National Marine Fisheries anchovy data. Thus the 1978 results are summarized and discussed in the following pages.

Distribution Patterns

The HEP trawl stations (Figure 2) in the outer harbors represent a variety of depths, spatial and circulation patterns, food sources and habitats.

Table 1 contains a master list of all fish species found in the harbor since 1971, with indications of the types of localities in which they have been found. The trawls in the outer harbor samples include all the HEP and Occidental College trawls, courtesy of Dr. John S. Stephens, plus data from two outer harbor Edison trawl stations (EQA-MBC, 1978). Even single occurrences in a locality were used to indicate locality. However, Tables 2 and 3 show in detail the single occurrences by year. Table 2 lists species that were collected in HEP trawls that do not normally occur in the Inner Harbor.

A measure of the reduction in number of species in the outer harbor in 1978 is seen in Table 2, where only three of nineteen species whose distributions were common to the outer harbor were found in 1978. The other columns show the rare occasions when a few outer harbor species were collected in the Edison Long Beach trawls in the Inner Harbor, all in 1976.

Conversely, Table 3 lists fourteen other species that rarely or never were taken in the outer harbor but were taken in the Inner Harbor in the Edison trawls (Long Beach Middle Harbor, Back Channel and Cerritos Channel). The rare incidences of occurrence in outer harbor HEP trawls are shown, in various years.

Numbers of Species and Abundances

The reduction in number of species taken in HEP trawls is biased to some extent by the low number of trawls in 1974-1977 (Stephens in Soule and Oguri, 1979). However, the trends are of interest because the species numbers did not drop in proportion to the number of trawls (Text Table 1):

Text Table 1. Number of Fish Species and Mean Number of Individuals, 1971-1978.

No. of HEP trawl species			No. of Trawls	Mean No. of Individuals
1971-73	-	37	76	423.2*
1974	-	32	18	342
1975	-	30	20	161.8
1976	-	17	5	88.8
1977	-	16	9	173.6
Dec/Oct 77 / 78	-	26	55	93.8

* 803.6 with croaker juveniles.

Figure 4 shows the mean abundances of fish per trawl for December 1977-October 1978. Higher mean values (350-750) found by Stephens (AHF, 1976) were not represented in 1977-78 at any station.

The outer harbor has been treated as a single area for purposes of contrasting it with the Long Beach Inner Harbor channels sampled by others. However, there are areas of the outer harbor where particular species appear to be concentrated. Table 4 presents the HEP data by grouping the trawls of the outer Los Angeles Harbor area (Trawls 9-14), the outer Port of Long Beach area (Trawls 5-8), and the City of Long Beach area east of Pier J (Trawls 2/3, 4, 15 and 16).

The most productive area by far was the trawl area closest to the TITP outfall, T13; it contained more than five times as many fish as the next station, T8.

The popularly held view that sewer outfalls cause a decrease in numbers of species (richness) is not borne out by the rankings. The outer harbor gyre appears to support diverse populations, in spite of a drop of about 30% over the number of species in 1973. This was the area identified as bioenhanced in 1973-1974 studies (Soule and Oguri, 1976).

Other than the sewer outfall, the area of the Long Beach main channel opposite the entrance to Pier J had the highest populations; areas in the middle of the outer Long Beach Harbor (T6) and to the southeast of Pier J were next (Text Table 2).

Text Table 2. Rank of Trawl Stations by Number of Species and Individuals (HEP data).

Rank by Number of Species			Rank by Number of Individuals		
1)	T6, T12	- 16	1)	T13	- 225
2)	T13, T10	- 15	2)	T8	- 413
3)	T9	- 14	3)	T6	- 354
4)	T14	- 13	4)	T4	- 345
5)	T11, 7, 8, 4, 16	- 12	5)	T12	- 296
6)	T5	- 10	6)	T9, 16	- 294
7)	T2/3	- 8	7)	T11	- 280
			8)	T5	- 261
			9)	T14	- 206
			10)	T2/3	- 204
			11)	T10	- 184
			12)	T7	- 182

Species Ranking and Population Centers

Genyonemus lineatus (white croaker)

The white croaker *Genyonemus lineatus* comprised about 57 percent of the trawl catch, about the same as in 1972-1975 (Stephens, in AHF, 1976). However, the catch dropped from over 800 per trawl in 1972-73 to about 60 in 1977-78, a 13-fold drop, when juvenile fish are included.

The center of population was still near the sewer outfall, with the second most productive site at T8, off the entrance to Pier J. *Genyonemus* formerly constituted a prominent resource for the low socio-economic group that fished near the cannery outfalls with unbaited hooks. With elimination of cannery flows, the area is no longer fished. (On the main Los Angeles channel fishermen have been seen to sell croaker filleted under the name "butterfish", although it is illegal. *Peprillus simillimus* is the legal Pacific butterfish).

Symphurus atricauda (California tonguefish)

The California tonguefish was ranked second, replacing *Engraulis mordax* in the 1973-74 surveys, although *Symphurus* had much reduced numbers during 1976 and the first part of 1977. It constituted 22.6% of the trawl catch in 1977-78. While *Symphurus atricauda* averaged 75 fish per trawl in 1972-73, it averaged only about 24 fish per trawl in 1977-78. Figure 5 shows the centers of population of these and other species. Figure 6 shows the number of species and individuals, totalled.

The population center for *Symphurus* was in the City of Long Beach Trawls 15, 2/3 and 14, followed by T8, T16 and the main Los Angeles channel entry, T14.

Seriphus politus (queenfish)

The population center for the queenfish was at T12, and to a lesser extent at T13, next nearest and nearest the sewer outfall in outer Los Angeles Harbor. Also a large number were found east of Pier J at T15. The species was ranked sixth in 1972-73 and moved up to third in 1977-78. It comprised about 6 percent of the total 1978 catch, and averaged about 6 fish per trawl, as compared with 3.4% of the 1972-73 catch and 32 fish per trawl.

Citharichthys stigmaeus (speckled sanddab)

Although the sanddabs are also benthic fishes, they are not found at T13 but are present in small numbers at T12. In contrast to the queenfish, the largest numbers of sanddabs are found on the Los Angeles main channel at T14, followed by T11, T10 and T9. These are sandier areas of the harbor than those closer to the sewer outfall, and are also deeper. However, they occur only in very small numbers in either Long Beach outer harbor area. The Pacific sanddab (*C. sordidus*) occurred at T14, T10 and T9 in 1977-78, after an absence from trawls since 1972. The *Citharichthys* species together comprised about 6 percent of the catch, as did *Seriphus politus*. In 1972-73 *C. stigmaeus* averaged about 55 specimens per trawl; in 1977-78 it averaged about 20 per trawl.

Engraulis mordax (northern anchovy)

The northern anchovy was the most important fish economically in the harbor as the main source of the live bait fishery (U.S. Army Engineers Los Angeles District, 1972; AHF, 1975). The second most numerous fish in 1972-73, it dropped radically thereafter. The species averaged 145 fish per trawl in 1972-73, and only about 2.5 fish per trawl in 1977-78. Since the anchovy does not appear regularly in trawls but generally is found in late summer and early fall, comparison of total numbers is of interest. Nearly 9,900 anchovies were caught in 68 trawls in the earlier period, and based on that number close to 8,000 would have been expected in 1978. Only 135 were caught, almost entirely near the sewer outfall in July 1978 during the TITP malfunction. Suspended solids no doubt attracted the young pelagic anchovies. Though the numbers are very low, they still constituted about 2% of the total in both periods. The greatest difference in the outer harbor was the drop of *Engraulis mordax*, the northern anchovy, from first to fifth place a two orders of magnitude decrease in that species between 1973 and 1978, compared with a four-fold drop offshore (acoustical trawl data, Soule and Oguri, 1979).

Phanerodon furcatus (white surf perch)
Synodus lucioceps (California lizardfish)

These two species were the only other fish to contribute significant numbers to the totals, each adding about one percent. *Phanerodon furcatus* was distributed in small numbers throughout the harbor, but had its population center at T13 and T12. *Synodus lucioceps* also occurred in small numbers but was more evenly spread throughout the harbor, with the largest number at T8. Text Table 3 compares 1972-73 abundance with 1977-78.

Text Table 3. Comparison of Most Abundant Species 1972-73 and 1977-78.

1972-73 Total (68 trawls)		Dec 1977-Oct 1978 Total (55 trawls)	
1) *Genyonemus lineatus*	30,184	1) *Genyonemus lineatus*	3,387
2) *Engraulis mordax*	9,871	2) *Symphurus atricauda*	1,345
3) *Symphurus atricauda*	5,102	3) *Seraphus politus*	343
4) *Citharichthys stigmaeus*	3,723	4) *Citharichthys stigmaeus*	302
5) *Seraphus politus*	2,172	5) *Engraulis mordax*	135
6) *Cymatogaster aggregata*	2,148	6) *Phanerodon furcatus*	67
7) *Phanerodon furcatus*	2,111	7) *Synodus lucioceps*	65
8) *Pleuronichthys verticalis*	283	8) *Citharichthys sordidus*	44

Other Species

Pleuronichthys verticalis, the hornyhead turbot, ranked eighth in the earlier period, dropped to fifteenth from 0.8% to .003% of the catch. *Cymatogaster aggregata*, the shiner surfperch, dropped from sixth to seventeenth place, from 3.8% of the catch to 0.002%.

Community Patterns

In 1974, Stephens, Terry, Subber and Allen categorized resident fishes according to substrate preference and feeding strategies. They arranged 25 of the common species into five groups, which accounted for over 97% of all fish taken in the trawl studies during 1972-73. A similar grouping of the species caught in 1978 was assembled for comparison with the earlier study. Annual trends are shown in Figure 6. As in 1974, the fish so categorized comprise over 97% of the total catch in 1978.

Fishes in the first group designated were termed Obligate Benthic Species - those fish spending the majority of their lives foraging on the bottom while remaining in contact with the bottom. This group consisted of *Symphurus atricauda*, *Citharichthys stigmaeus*, *Pleuronichthys verticalis*, *P. decurrens*, *Paralichthys californicus* and *Lepidogobius lepidus*. All except the bay goby, *L. lepidus*, are flatfish. This group represented 23% (1,423 of 6,154) of the fish considered in the five groups. In 1978, this group comprised over 34% of the catch. *Symphurus atricauda*, the most abundant, made up 22% of the total catch and 76% of the group. *Citharichthys stigmaeus* percentages were 6% of the total catch and 20% of the group.

The second category, Facultative Benthic Species, consisted of fish that live in proximity to the bottom but are predominantly sight feeders in the water column. This group includes *Porichthys myriaster*, *Sebastes miniatus*, *S. serranoides*, *Scorpeana guttata*, *Paralabrax nebulifer*, *P. maculatofasciatus* and *Synodus lucioceps*. In 1974, these species represented less than .5%. Since *S. miniatus* and *S. serranoides* were not captured in either 1974 or 1978 in trawls, they were dropped from the calculations and do not appear in the species list for 1978. This group is of little significance numerically, but collectively comprise some of the most desirable sportfishing species living in the harbor. In 1978 fishes in this group comprised about 2% of the total catch. The most numerous in this group was *Synodus lucioceps*, which represented about 1% of the total catch and 73.6% of the group.

The third group, the Benthos Feeders, included the two common sciaenids, *Genyonemus lineatus* and *Seriphus politus*. These together with three genera of embiotocids, *Damalichthys* (*Rhaccochilus ?*) *Phanerodon* and *Embiotoca* comprise a group that swim in the water column but feed on benthic organisms. These foragers, so-called 'pickers' because of their behavior, are numerically dominant. Together they account for over 70% of fish taken in the 1974 trawl study. The predominance of *Genyonemus*, 66% of the total catch, explains this high percentage.

In 1978 *G. lineatus* was again the most frequently caught fish in the harbor, representing 53% of the total catch and 92% of the group. *Seriphus politus* made up 6% of the total harbor catch and 5% of the group. The largest concentration of croakers, 42%, came from trawl station 13, near the outfalls. *Seriphus politus* was caught more widely, with most being caught in trawls at stations 12 and 13.

The fourth group, called the Water Column Fish, are those that live and forage in the water mass. This group includes three species of the genus *Sebastes* - *S. saxicola*, *S. goodei*, *S. serranoides* (juveniles) as well as *Cymatogaster aggregata* and *Seriphus politus*. Since none of the three species of *Sebastes* were found in either 1974 or 1978 trawls, *S. dallii* (1 caught in 1972-73 and 29 caught in 1978) was substituted for the calculations. The sciaenid, *Seriphus*, is both a benthos feeder and a water column forager. Consequently it is listed in both groups. For the calculations, the total number of *Seriphus* was divided in half and distributed in either group. Water column fish as a whole make up 1% of the total trawl catch for 1974.

The most numerous fish was *Seriphus politus*, which comprised 83% of the fish caught in this group.

The last group, the Epipelagic Fish, consists of only the northern anchovy, *Engraulis mordax*, and the top smelt, *Atherinops affinis*. Since *Atherinops* is found in the inner harbor, only *Engraulis* was used in the calculations; the latter represented slightly under 2% of the catch for both the periods. However, the numerical difference was about 100-fold. Of 130 *E. mordax* caught, 80% were from trawls near the outfall at station 13. The water there is only about 6m deep, and anchovies have been sighted by divers feeding on the bottom as well as feeding on fish gurry floating on the surface. Apparently the 0-1 year age class are more omnivorous than previously suspected. Figure 7 compares annual trends.

Seasonality

While a number of fish remain in the harbor year around, others are seasonal in occurrence. Peak periods for fish eggs and larvae to appear in plankton tows are the spring and fall (Soule and Oguri, 1979). Peak periods for trawl catch vary from year to year, but generally are expected in the summer and/or early fall. Table 5 shows the 1977-78 HEP trawl catch by area and by seasonality. In outer Los Angeles Harbor the peak was in July 1978, at the peak of the TITP malfunction when suspended solids were being released.

In the Long Beach City and Port areas, the peak period was in April for most stations. This anomaly cannot be explained, except to refer to the temperature and salinity patterns in Section II. These show an effective thermal "barrier" between the Navy mole and the breakwater. It may be that the warmer water causes earlier spawning or phytoplankton or zooplankton blooms for larval feeding.

DISCUSSION

COMPARISON OF HEP AND EDISON DATA

Soule and Oguri (1979) showed the decrease in the mean number of fish per trawl from the 1971-73 period through 1978 from 423.2 fish per trawl (or over 800 if larval fish are included) to under 100 fish per trawl for the December 1977-October 1978 period (Figure 8).

While the Southern California Edison Report (EQA-MBC, 1978) stated that Long Beach Harbor supports a large, healthy, stable and diverse population of fishes that are common to nearshore southern California waters, and indicated that there was a large increase in mean harbor fish populations, analysis of the Edison data and HEP data shows agreement in major trends, if not in conclusions. Differences in species composition were discussed previously.

In the following paragraphs, differences in analyses of numbers will be pointed out.

The HEP trawl data taken by Dr. J. S. Stephens for the outer harbor were gathered in daylight hours. The data were plotted (Soule and Oguri, 1979) both as annual means, between 1973 and 1978, and as seasonal means. Dr. Stephens calculated that the HEP mean number of fish for 1974-1976 was 212 per trawl, whereas he calculated the Edison mean for that same period as 180 fish per trawl, a fairly close agreement for the two different areas. However, the Edison data were summed, and thus no trends could be shown; a four-way analysis by Stephens indicated significant annual variation but that cannot indicate direction.

Stephens (in Soule and Oguri, 1979) mentioned the deficiency of outer harbor trawl data during 1975-1977. The Edison trawls in 1977 far outnumbered the trawls carried out by Stephens and his Occidental College students, who provided their data for the Soule and Oguri report. However, HEP trawls numbered 55 between December 1977 and October 1978 for the Terminal Island Treatment Plant Study. Edison trawl data are available only through March 1978. In Figure 9, the mean trawl data for the Edison plant are plotted against the HEP mean data for 1971-1976. Extreme variation can be seen in the Edison trawl numbers in 1977, a "yo-yo" effect to the lines; seasonal means have been combined to give comparable data points for both Edison and HEP data. In Figure 10, all Edison trawl data for 1977 are plotted, along with a separate plot for the mean data from the outer harbor Edison trawl station (T13) nearest the HEP stations, and for HEP 1977 data (data from EQA-MBC, 1978; Soule and Oguri, 1979; J. Stephens, unpublished). The 1978 HEP surveys continued through October 1978. The lower plot (based on data in EQA-MBC, 1978) shows the variations in the Edison plant operation, which was reported as percent generating capacity, during the 1977-1978 period.

When the Edison mean daytime data are broken into the same time periods as the HEP data, the downward trends are strikingly similar (Figure 11) in spite of numerical differences. The mean data from all Edison daytime trawls (AED) were plotted; then the means for two Edison trawl stations T13 and T15 in the outer harbor (OED) closest to HEP stations were plotted separately, and the HEP means were also plotted. These data were all recalculated into the same time periods reported in Soule and Oguri (1979) for greater comparability; the periods were January-June 1977, July-November 1977, December 1977/January 1978 and March/April 1978. Edison trawls were not reported after March 1978, but April, July and October 1978 mean trawls for HEP were plotted. The data are shown in Table 6. Reading down the columns, the Edison data show reductions in trawl numbers and means.

The Edison trawl data showed much higher 1977 means; 508 fish for all stations (daytime) and 336 for T13 and T15 in the outer harbor in the Long Beach Pier J-Channel area, as compared with 174 in the HEP total outer harbor area. However, for the Edison trawls, the trends in the means from January-June levels to the July-November 1977 levels were strongly down. The means were further depressed in December 1977/January 1978, with an outer harbor Edison (OED) mean of 24.5 fish and an HEP mean of 26.7 fish. These are, as Stephens indicated (Soule and Oguri, 1979), unprecedentedly low trawl numbers. The mean of 76.5 for all Edison trawls for January 1978 is hardly much better.

The smallest symbol used on Stephens' *et al.*(1974) on mean abundance was 85-90 fish. In Soule and Oguri (1979), Figure 8 showed large areas with fewer than 10 fish per trawl in December 1977, with only the outfalls area having 155 fish; that station provided the only numbers of consequence to give the mean of 26.7 fish to the period. (See Figure 4).

It is normal for fish counts to be low in winter, but this seemed impoverished. It also coincided in time with removal of fish cannery waste effluents from the outer harbor, representing an enormous drop in available energy (calories) to the ecosystem. The December 1977 trawls came before the major rainfall at the end of the month, and the water was still warm. Fish will sometimes leave the harbor as a storm front approaches, but this did not appear to be the case then.

The March/April 1978 means were up, slightly more so for the two outer harbor Edison stations than for all Edison trawls, or for HEP trawls. However, both Edison means for the January-March period were almost identical, at 146.4 and 146.7, and this trend was upward.

The outer harbor HEP fish numbers increased during the summer of 1978, which appeared to coincide in time with release of suspended solids and nutrients during the treatment plant malfunction. Over 900 fish were in the sewer outfall area in July, whereas the largest number (>300) had been in the Long Beach area in April 1978. Numbers dropped below 100 in October 1978, when the treatment plant was again producing secondary effluent. The HEP mean for the December 1977-October 1978 period was 94.6 fish per trawl, as compared with 173 in January-November 1977. Distribution maps of HEP data for each quarter were included in Soule and Oguri (1979).

The cannery and TITP outfalls have certainly served as an attractant and undoubtedly as a source of complex organic nutrients for fish, especially prior to secondary treatment. Secondary wastes favor fishes which feed on phytoplankton, which are in turn based on inorganic nutrient salts. The high incidence of smaller young fish found by Chamberlain (1973) and Stephens *et al.*(1974), indicated the importance of the harbor at that time for sustenance as well as shelter, and as nursery grounds. This no longer appears to be an important center for recruitment to San Pedro Bay populations.

It might be said that the Edison plant, when operating, attracts fish from the outer harbor and thus the decrease indicated in outer harbor populations is not real. However, in 1977 the outer harbor showed a slight summer increase (Figure 8), though not a large one, probably because no June-July HEP sampling was done. No doubt the 1977 HEP mean would have been higher and closer to the Edison mean had the summer period been sampled. While the 1977 Edison fish data show some peaks in numbers similar to peaks in power plant operation, the extreme drop in November 1977-January 1978 populations in both the inner and outer harbors can hardly be attributed to the power plant output variations. The two studies were in extremely close agreement during that period.

The Edison plant has the capacity to cycle about 734 million gallons of sea water per day (510 X 10^3 gals/min) through the cooling system, although it apparently does not operate at that level. Their output was reported in megawatts and capacity factor (EQA-MBC, 1978, p. 1-4, 5). The enormous water flow capacity compares with 10 million gallons per day of TITP effluent, and exceeds the totals of other local outfalls (*e.g.*, Hyperion, 350 mgd). It could recycle about 30% of the tidal prism of the combined Long Beach Middle, Back and Inner Harbor channels per day of two tidal cycles.

<u>Species Composition in the Inner and Outer Harbor</u>

Although the most numerous species are similar in both the inner and outer harbor, the total species composition differs greatly. For example, there were 18 species in the HEP outer harbor master trawl list that did not occur in the 1977-78 Edison Inner Harbor trawl. Since the HEP species list dropped from 37 species in 1973 to around 20 species in 1978, only three of those 18 species found only by HEP were still present in the outer harbor in 1978.

That differences between the outer harbor species composition and the nearshore exist, was indicated in Soule and Oguri (1978), wherein trawl data taken by J. S. Stephens and his group in 1977 from around Whites Point to the west of the harbor showed no species overlap whatever with harbor trawls taken. The checklist of species found by Ulrey and Greeley (1928) in the harbor area before construction of the middle and eastern breakwaters and the Pier J landfill differed almost completely from that of the harbor (AHF, 1976).

However, these data do not negate the fact that there are extensive fish population interchanges between inshore waters, the harbor, and offshore (AHF, 1976). Also pointed out (AHF, 1976) was the lack of an endemic anchovy stock, although some localization of croaker population was suspected.

The sampling method influences the species caught; different trawl methods, gill netting and beach seining will each produce somewhat different species lists, as will the time of day sampled. Also, diver surveys such as the HEP kelp survey (Soule and Oguri, 1978) showed the presence in the harbor of species not caught by the above-mentioned techniques, species that perhaps were attracted to the kelp bed on Cabrillo breakwater built for the Port of Los Angeles by HEP. More than a dozen of the breakwater-kelp bed fishes listed had not been caught in outer harbor HEP trawls. Nine of those were not caught by Edison channel trawls either, and Edison trawls lacked two kelp bed species caught by HEP trawls. However, many of the harbor kelp bed species were caught in the Edison gill net surveys, as would be expected.

EQA-MBC (1978) found a downward trend in gill net catch for the Inner Channel, Back Channel and the Navy mole. The drop at the Navy mole was greatest, from 790 fish and 39 species down to 318 fish and 31 species. The catch per unit effort at the Navy mole dropped from 8.70 individuals and 0.43 species to 3.14 individuals and 0.31 species. They state that the "pooled catch data" show that the overall catch per unit area was "consistently but not significantly lower" in 1977-78 during the so-called operational period. It would have been interesting to compare these data with exact levels of power plant operation, instead of just pre-operation to operational periods (1974-76 and 1977-Mar 1978, respectively) because the operational level varied greatly (EQA-MBC, 1978).

The shoreline angler catch survey at ten stations in the outer harbor from Cabrillo Beach to Belmont Pier (Soule and Oguri, 1979) shows much the same species composition as the kelp surveys and Edison gill netting, which indicates that the results are consistent in the shoreline angler survey as carried out by HEP.

THE HARBOR AS A NURSERY GROUND

The outer harbor has been recognized for some years as a significant nursery ground for a number of fish species; in fact, some opposition to further outer harbor development has been based on the threat to that function (U.S. Army Engineers, 1972; AHF, 1976). In particular, the outer harbor supported large numbers of juvenile anchovies (*Engraulis mordax* of the 0-1 year age class, which appeared to be recruited to offshore colder waters during or after the initial year. The anchovy supplied an active live-bait business for commercial sports fishing boats (party boats).

Studies in 1973-74, which focused on thermal tolerance as well as anchovy egg and larvae distribution (AHF, 1976), indicated that eggs were mostly shed outside the breakwater and were presumably carried into the harbor on tides. Because anchovy eggs occur near the surface, those studies were carried out with plankton net tows at 4m depth. Incidental catch of other eggs led to identifications, where possible, to the family level; however, most eggs could not be identified at that time (almost 85,000 out of more than 100,000) as part of that study.

Egg and Larvae Census

Because of concern over declining adult fishes in the harbor, HEP initiated studies in 1977-78 of fish eggs and larvae using methods similar to those used by National Marine Fisheries Service egg and larvae census offshore. Oblique tows of paired (bongo) nets are made from surface to bottom and back. Results are discussed in detail in Soule and Oguri, 1979. Figure 12, from that publication, compares the eggs and larvae (minus anchovies) caught in 1974 and 1978, although it must be noted that the methods used in the recent survey would be expected to increase the yield.

Engraulis constituted 38.4% of the larvae caught in 1974, whereas they constituted 27.7% of the larvae in 1978. The numbers of total eggs and larvae found in early 1978 were impressively high, even allowing for the change in technique to increase egg capture.

The Food Webs

The harbor still appears to be an important area for eggs and larvae. However, maturation of larvae and ultimate recruitment does not appear to be as successful as it was previously. The four-fold drop in mean adult fish populations between 1973 and 1978 parallels the drop in fine particle-bearing cannery wastes following installation and operation of DAF equipment. It also follows an approximately five-fold drop in maximum phytoplankton productivity. There was a 30-fold drop in microheterotrophs (bacterioplankton) as well, following conversion to secondary waste treatment in 1977 (Soule and Oguri, 1979). The role of microheterotrophs in food webs is poorly defined. Generally, from 60% to 80% of the uptake of labelled phosphate was by bacterioplankton (<.0μm) in the harbor in 1978, except in July and September, when it was 40-50% during phytoplankton peaks. Bacterioplankton are also responsible for about 75% of the uptake of labelled adenylates (ATP, ADP and AMP).

Certainly it is clear that changes within the harbor food web have occurred, which could result in maturation of fewer juveniles. The reduction in predation might well be responsible for higher numbers of fish eggs. However, only 1.3% of the eggs found in 1978 were anchovy eggs (Soule and Oguri, 1979).

Larval Fish Survival

Lasker (1975, 1978a, b) and Lasker and Zweifel (1978) indicated that first-feeding anchovies require, at temperatures of 13-14°C, about thirty particles per ml of 40-50 μm diameter (*Gymnodium* size) to stimulate feeding and fill guts. They will ignore particles of less than 20 μm in diameter. About 40 small particles/ml are required for growth and survival; large particles (copepod nauplii-size, 95-105 μm) make little difference at that level. The field of visual perception is 2.7 mm, so capturable food must be encountered in that distance; 30-40 particles/ml would be within less than 2.0 mm range and would increase successful feeding.

Gonyaulax polyedra , a major component of harbor red tides in 1973-74 and along the coast in the winter of 1975, did not support growth of anchovies in the laboratory and diatoms such as *Dunaliella* were not fed upon. *Gymnodinium splendens* is also a coastal red tide organism, which supported growth (Lasker and Zweifel, 1978) in laboratory studies. Morey-Gaines (1978) found that cannery wastes in laboratory tests selected against the diatom-dinoflagellate communities in favor of nanoflagellates and ciliates, as did ammonia. Nitrates stimulated diatom-dinoflagellate communities. This nutrient shift occurred after secondary waste treatment.

According to Lasker and Zweifel's (1978) model, concentrations of nauplii would need to be 10,000/L to ensure survival through the second day, with a 10% capture rate. At 20-30% capture rates, concentrations of 4,000/L would be needed. This is abnormally high for ocean concentrations; however, a number of locations in Los Angeles-Long Beach Harbors in 1973-74 mean annual total zooplankton (copepods and cladocerans) densities in that range. In March 1972 concentrations reached 26,000 per liter, and in June 1976, 84,000/L! Certainly at these densities, fish larval success should be maximized, unless they overwhelmed the larvae.

Turbidity

Turbidity has also been associated with larval success by shielding larvae from predators. The *cafe-au-lait* color of the cannery waste plume resulted in much greater densities of juvenile fish (25,000+ juvenile croakers in one trawl in 1973), and also in adults. Protection from predation is an important factor in a model system.

BOD

The drop in BOD from secondary treatment of cannery wastes and domestic sewage has perhaps been from 10- to 100-fold in the harbor. While water quality regulators consider this to be good, it represents a very great loss to the food dynamics of the harbor. When unlimited dumping was permitted, anoxia occurred frequently, but in recent years controlled loading of wastes had permitted the nutrients to be assimilated (Soule and Oguri, 1976).

Oceanographic Conditions

Reviewers (California Department of Fish and Game (pers. comm.) have attempted to attribute all of these above-mentioned losses at the various food web levels (from bacteria to birds, Soule and Oguri, 1979) to coastal weather conditions. There can be little question that ocean temperatures impose a considerable variability on the harbor, as reviewed in Section II.

Lasker (1978) pointed out that food particles were abundant within 5 km of the California shore in chlorophyll maximum layers prior to January 1975, before an intense upwelling period. After the spring upwelling, the dinoflagellate populations had been dissipated and replaced by diatoms, which are inadequate for anchovy larval survival.

Stable sea surface conditions are required for phytoplankton to reach optimal densities. The heavy rainfalls in the first three months of 1978 affected the harbor by decreasing salinities, flushing out nutrients, and dispersing blooms. This would have been the normal spawning period, and indeed anchovy spawning was not evident until May in the harbor. The 1-year age class recruited late for 1979 (Herbert Frey, pers. comm.).

Water Temperature and Harbor Anchovy Catch

Attempts have been made to associate the occurrence of large fish populations with temperature, upwelling, rainfall and turbidity (Mearns, 1978). Discriminant computer analysis would have been interesting to use with those data to identify the relevant parameters.

If an attempt is made to associate the drastic drop in anchovies in Los Angeles-Long Beach Harbors with temperature alone, the difference should be found between 1973 and 1974 (Figure 13). Yet the two years were almost identical in temperature in January and February; 1973 was slightly warmer in March and slightly colder in April and May, but the differences were small and the trends were very similar. In June the 1973 temperature was the colder by several degrees, but in July both 1973 and 1974 were warm. Both 1973 and 1974 followed a slight cooling trend in August and September, while 1973 was warmer in October and November (Figure 13).

The only major difference between 1973 and 1974 appeared to be colder water in June 1973, which might have indicated upwelling, and thus extra nutrients for harbor populations were high. The two years were typical in rainfall period but the 1972-1973 winter seasonal total was 7.19 in. and the 1973-74 total was 14.55 in. (unofficial figures).

There has not been a good anchovy year in the harbor since 1973, although 1974 was better than any of the subsequent years there. The coastal anchovy harvest was best in 1975, which might have been associated with the recruitment from previous years (1973-1974). Figure 14 compares the commercial anchovy catch, based on National Marine Fisheries Service data made public in 1979, with Stephens' HEP data as tabulated in Soule and Oguri (1979) for anchovies in the outer harbor.

Coastal temperatures could hardly be responsible for the radical differences between nearshore anchovy populations and fish populations in the harbor between 1975 and 1977. Coastal temperatures may well have been responsible for the enormous drop in nearshore populations in 1978, although the drop in coastal upwelling in 1978 (Lasker, 1978) deprives the anchovy of particulate nutrients and/or phytoplankton, as shown by water clarity comparisons. The supply of particulate matter, nutrients and/or phytoplankton in the harbor has not been dependent in the past on upwelling, but on canneries, and sewer outfall, and river runoff. It is therefore likely that cessation of nutrient-turbidity produced results similar to coastal decreases.

Whereas the 1977 and 1978 temperatures in the harbor were among the highest in January and February and low in March and April, the same months in 1976 were much closer to the "optimal" 1973-75 temperatures. Offshore, there was a good increase in party boat catch from 1971-72 through 1975, except near the Orange County outfall, and anchovy catch rebounded from a low 1974 to a peak 1975 catch (Figure 15). Yet in the harbor (Figure 9) the mean trawl catch showed little recovery from the low of 1975 and declined further through 1978; plotted against anchovy commercial catch, the differences are pronounced.

Winter rainfall in 1975-1976 was very similar to that of 1972-73, yet harbor catches peaked in 1973 and recovered only a little in 1976. Rainfall figures were similar in the winters of 1973-1974, 1974-1975 and 1976-1977 (12.36-14.84); only in the winter of 1977-1978 did 37.6 in. inundate the harbor and coastal waters, undoubtedly causing the late spawning season. However, the unprecedented low fish trawls in December 1977 occurred <u>before</u> the record rainfall.

Busch, Scholl and Hartman (1975) reported significant correlations between <u>rate</u> of warming and both egg deposition and 0 year juvenile <u>density</u>, in studies on freshwater lake fish; that density is a good predictor of year-class strength.

Koonce, Bagenal, Carline, Hokanson and Nagięć (1977) also found significant correlations in two lake fish genera for <u>rate</u> of spring warming and year-class strength. Their model <u>results</u> suggested that temperature may limit year-class strength directly only under severe climatic extremes. However, spawning behavior may be affected by weather conditions in a short spring period.

Availability of specific types of food at various critical phases of development, predation rates, and various abiotic factors may act synergistically with temperature to affect juvenile mortality.

Data sets needed for modelling bioenergetics of fish populations include a known growth curve, a record of thermal experience, estimates of feeding rates and prey types. Food habit studies are few and feeding rate studies are scarce (Kitchell, Stewart, and Weininger, 1977). A number of papers have suggested that the timing of the thermal lows and rising temperatures are more important than actual temperatures for spawning, so long as the ranges of tolerance and synergistic effects are not exceeded (Bayne, 1976; Talmage and Coutant, 1978).

CONCLUSIONS

As was stated in Soule and Oguri (1979), harbor fish populations have dropped four-fold since 1973, just prior to installation of DAF treatment at the fish cannery plants. A similar drop in commercial anchovy catch was accompanied by a record recovery in 1975; no such recovery occurred in the harbor through 1978. The initiation of secondary waste treatment in 1977 may have caused a further decline to the unprecedented low number of 26.7 fish per trawl in December. The trawls were made <u>prior</u> to the record rainfall in December 1977-March 1978.

While the harbor ecology is influenced by coastal oceanographic conditions, the harbor is much more stable thermally than are the adjacent coastal waters (Section II). Man-made events in the harbor hydrography have profound influence on the ecosystem. Except for the record rainfall, the most important change has been the removal of complex nutrients which formed fine particles or coagulum that floated on the surface or salted out, to be fed upon by benthic organisms and demersal fish.

A major harbor food chain has been depleted by factors of at least 4 to 30 times. The nearly 100-fold drop in anchovy overrides a four- to ten-fold drop outside the harbor. The food chain consisted of:

```
bacteria → protozoans → omnivore fish → birds
    ↓           ↓      → copepods
    benthic organisms → benthic fish
```

Another important food chain has been decreased greatly, the chain of phytoplankton → zooplankton → fish. It appears to be less affected, perhaps because predation has been reduced. However, major blooms have not occurred since 1974.

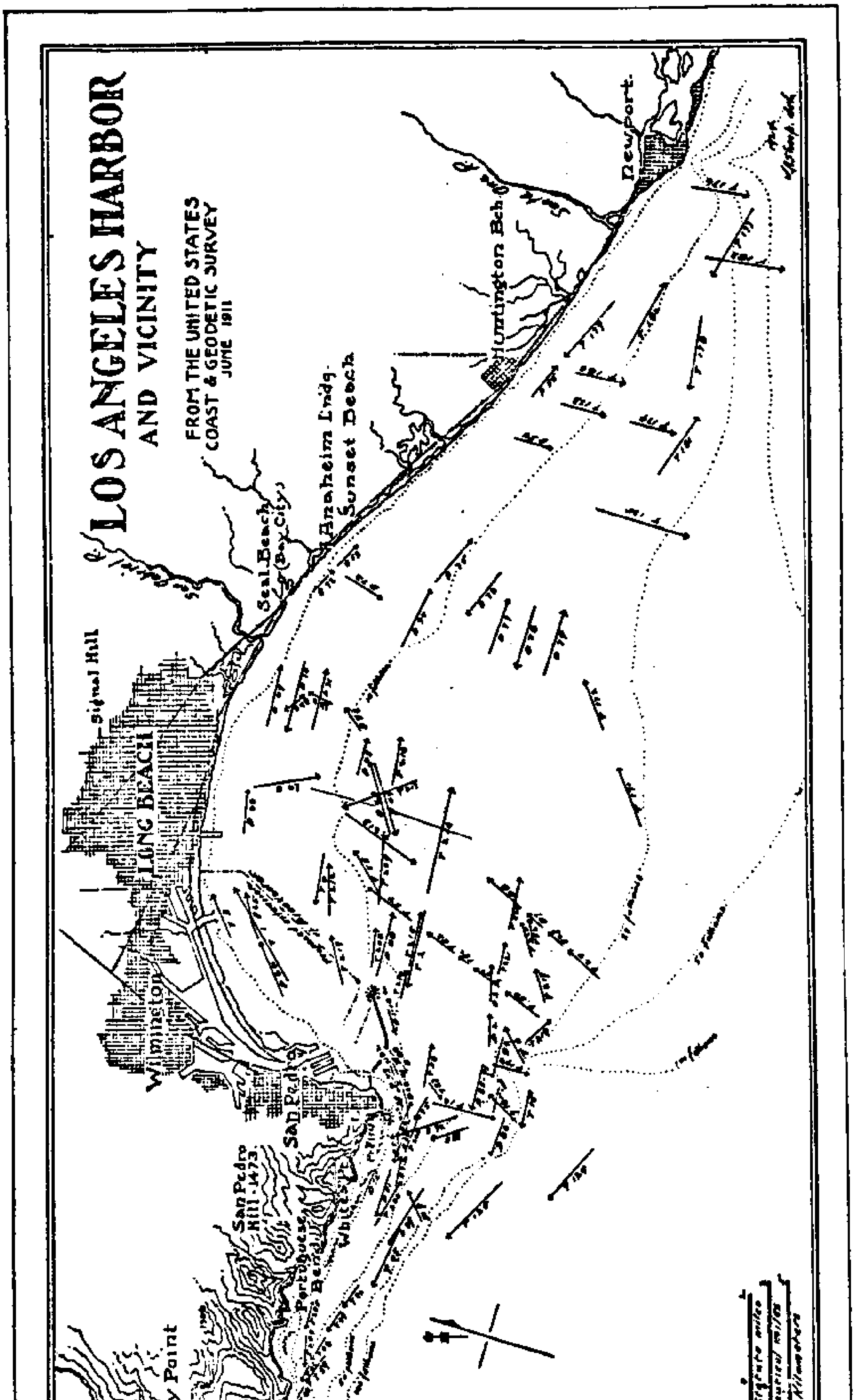
Attempts to force comparisons of outer harbor HEP data and Inner Harbor Edison data resulted in misleading agency statements (California Department of Fish and Game, pers. comm.), that fish populations were unchanged in the harbor since 1974. The variability in operation and heated effluent near the Edison plant produced extreme oscillation in numbers attracted to the area in 1977.

While it has long been noticed that fishes are attracted to warm water effluents, it is possible that at least part of the attraction by generating plants is due to entrained zooplankton and other food particles which are released in the effluent at the surface. Past discussions have been inconclusive as to whether effluents, and other installations such as kelp beds and artificial reefs, serve only as "attractants" and net increases are difficult to document without killing off the organisms. However, if more fish and invertebrates find a steady food source, better than that available to them elsewhere, some net gain in recruitment, survival and reproduction in the population would occur even though the initial stimulus was an "attractant" and would continue to be so. No conclusions can be made on the effect of intermittent heat and cold on fish populations. Since thermal changes are important "cues" for seasonal reproduction in nature, the confusing "cues" given by intermittent operation may ultimately affect fish populations.

Dealing only with annual, or longer-period, mean population numbers can mask completely the wide range of variation and trends which can occur over several seasons or years, as is seen in Figure 11. This is particularly evident in the 1974-1976 period, which had means of 212 for HEP fish trawl data and about 180 for Edison data, when these are compared to the slope of the HEP lines.

Even mean numbers, if broken into smaller segments, can be revealing. Figure 11 showed an Edison mean of 508 for January through November 1977; but the mean drops to 146 from November through March 1978. Yet if the mean for the period of January 1977 through March 1978 alone is given as 327, the trends are completely masked and the appearance of an increase over the 1974-1976 mean of 180 is indicated. The contrary appears to be true, although it is not possible to predict on the basis of available published Edison data whether the 1978 populations would have rebounded.

The 1978 trends for HEP data indicated still lower populations than 1977. By breaking the year 1977 into January-June and either July-November or July-December, the seasonal peaks and lows should have been fairly evenly divided. Certainly, there is no valid basis for stating that either the HEP or the Edison report is in error; the differences lie in the selection of data groupings such as long-term means for illustration. The unfortuante situation of data gaps also lies in the patchy distribution of public and/or private support for ongoing, harbor-wide monitoring, as well as in the patchy distribution of organisms.



INSERT NO. 1. THE SAN PEDRO BAY REGION
Bulletin, Southern California Academy of Sciences. Vol. XXVII. January, 19[illegible].

Figure 1. Ulrey and Greeley Fish Trawls

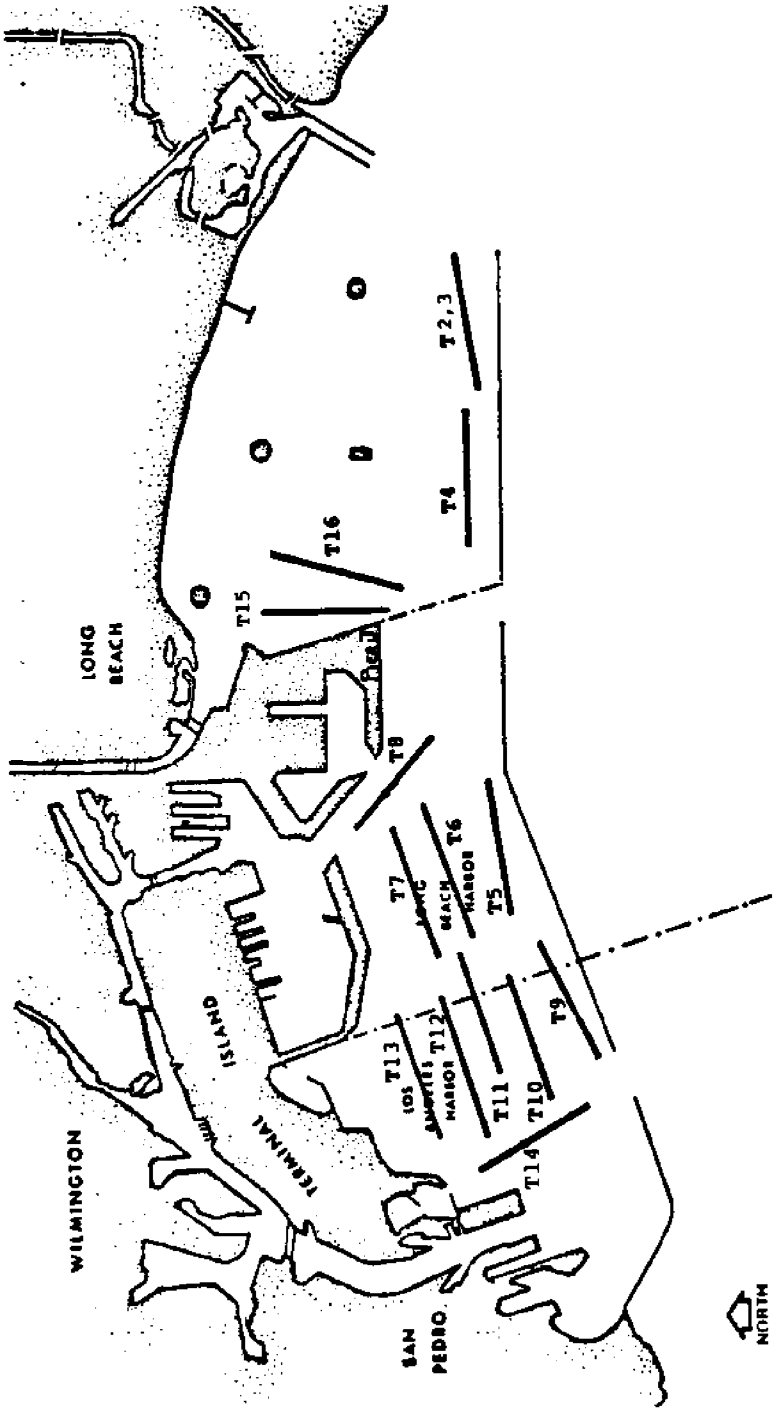


Figure 2

LOCATION OF LOS ANGELES–LONG BEACH HARBOR FISH SURVEYS

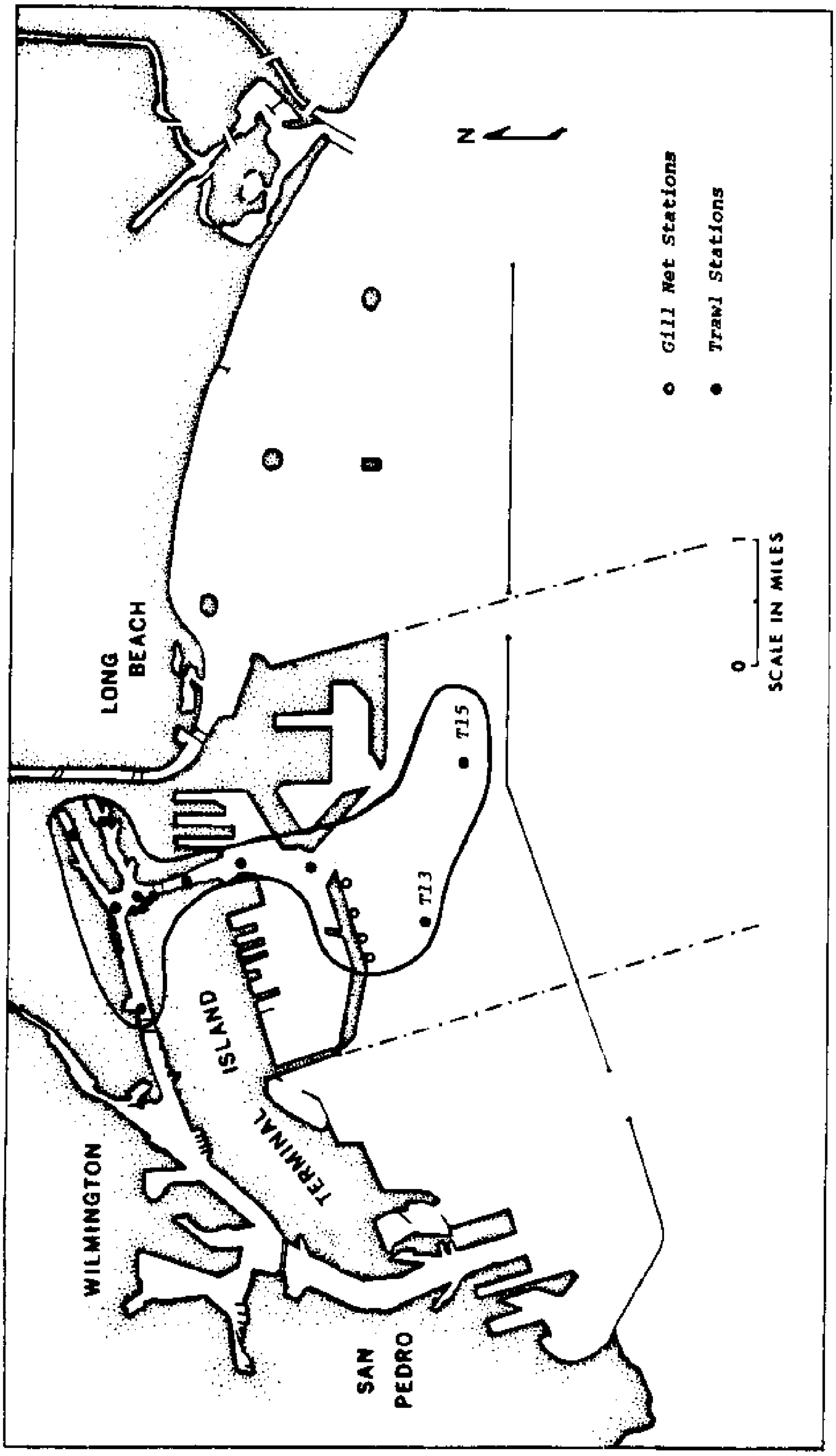


Figure 3. Approximate locations of Edison Fish Stations (after EQA-MBC, 1978)

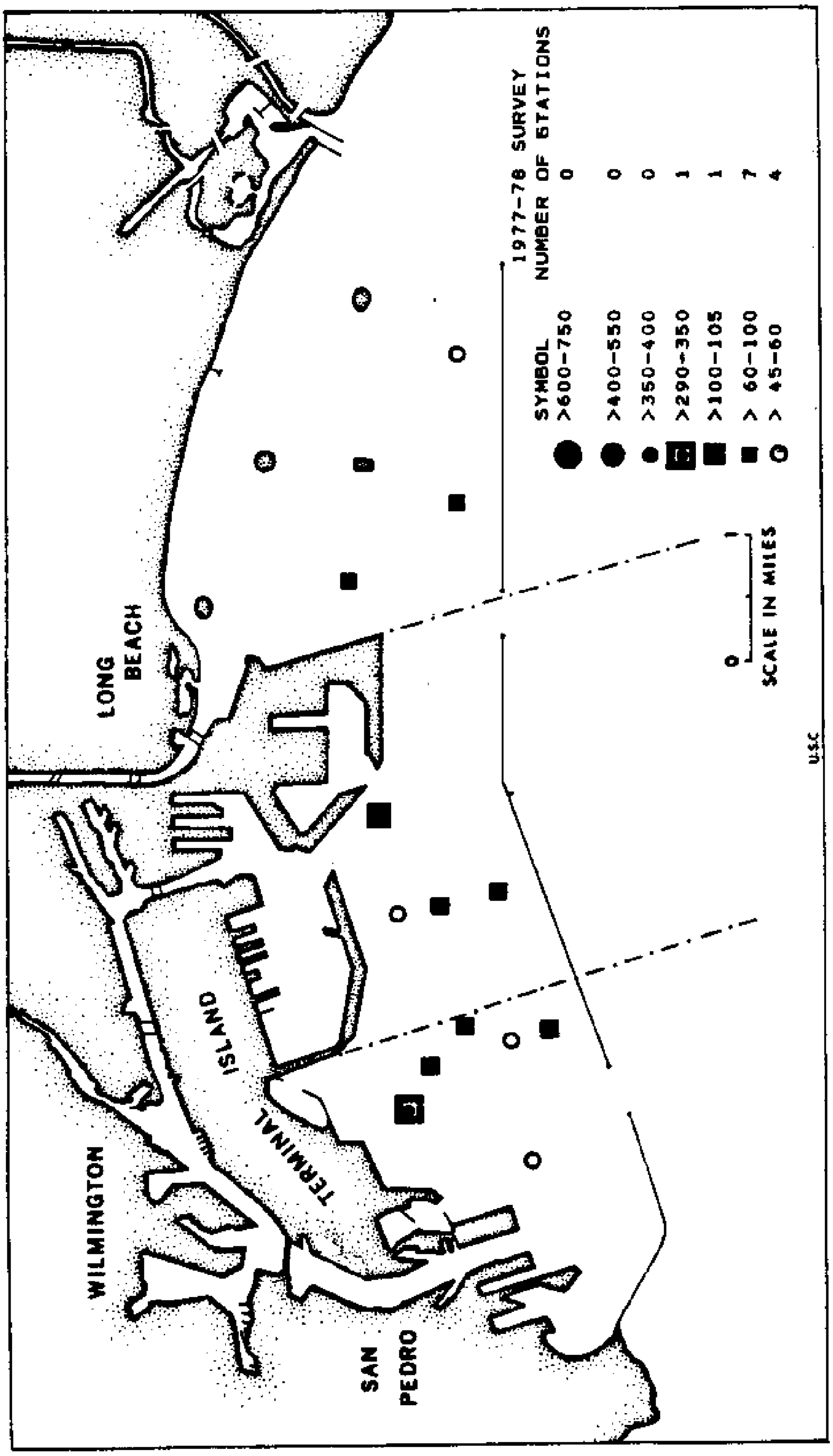


Figure 4. Mean Fish Trawl Abundance (Dec. 1977-Oct. 1978)

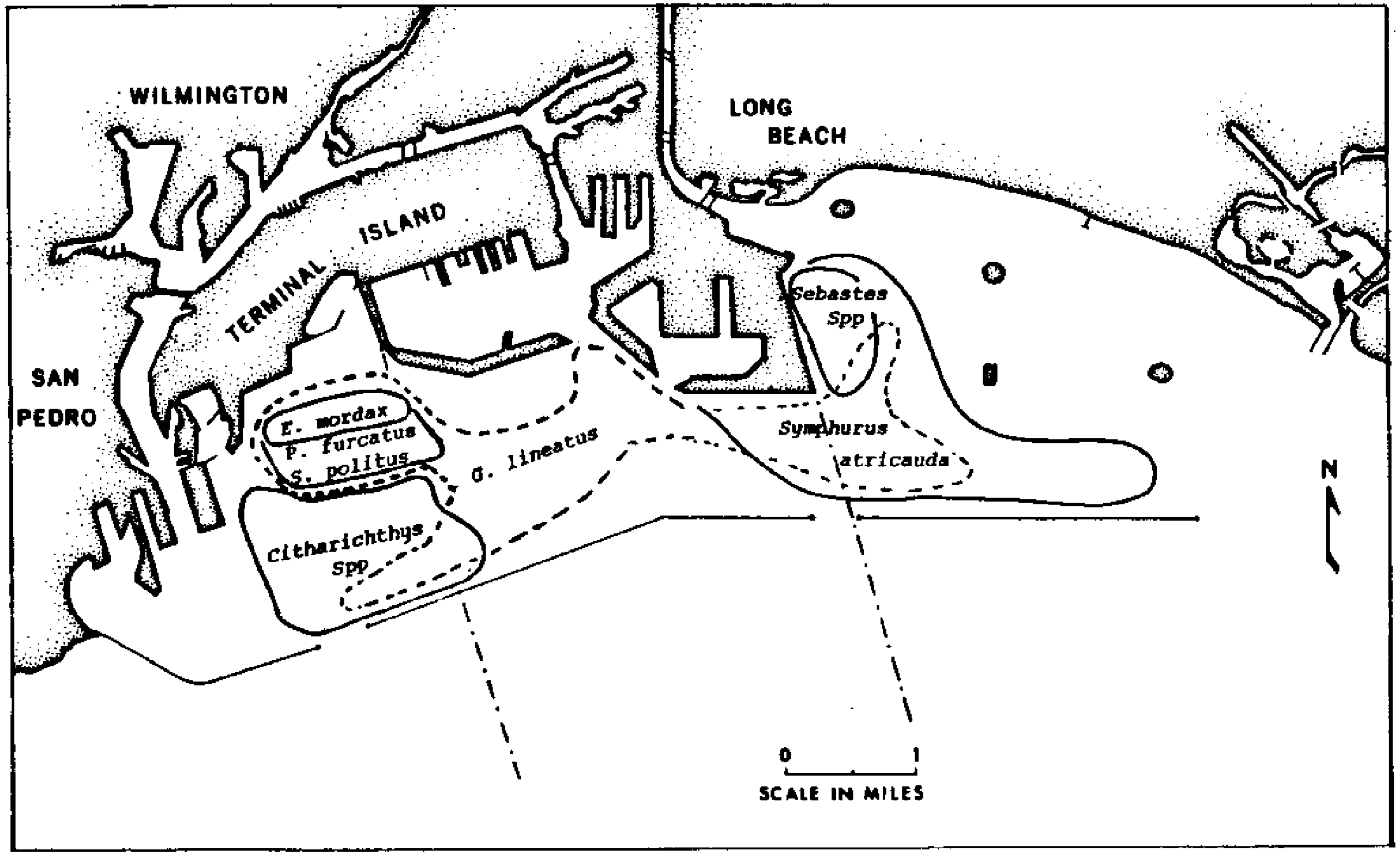


Figure 5. Population Centers of Dominant Species, 1978.

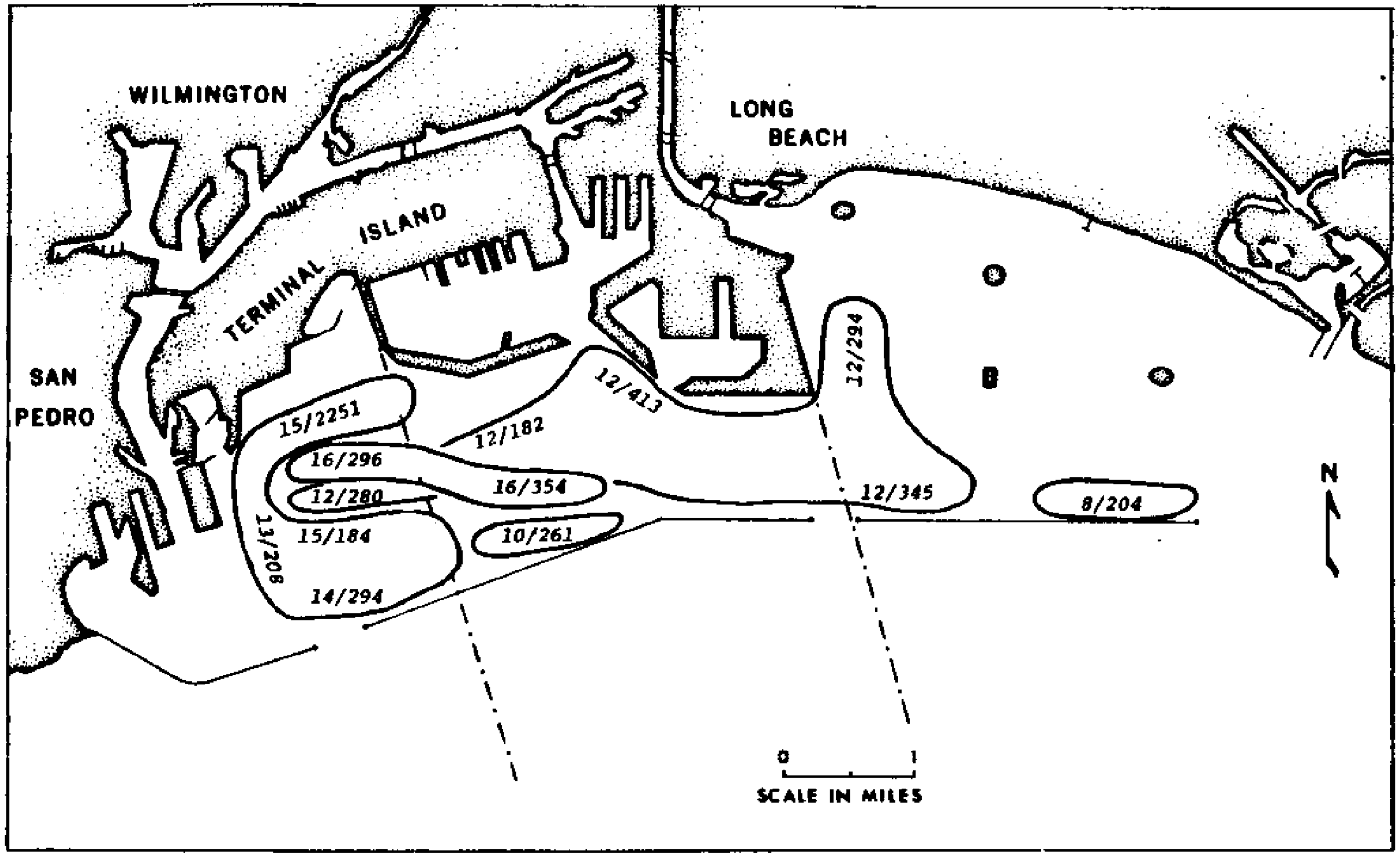


Figure 6. Number of Fish Species/Number of Individuals in HEP Trawls (Dec 1977-Oct 1978).

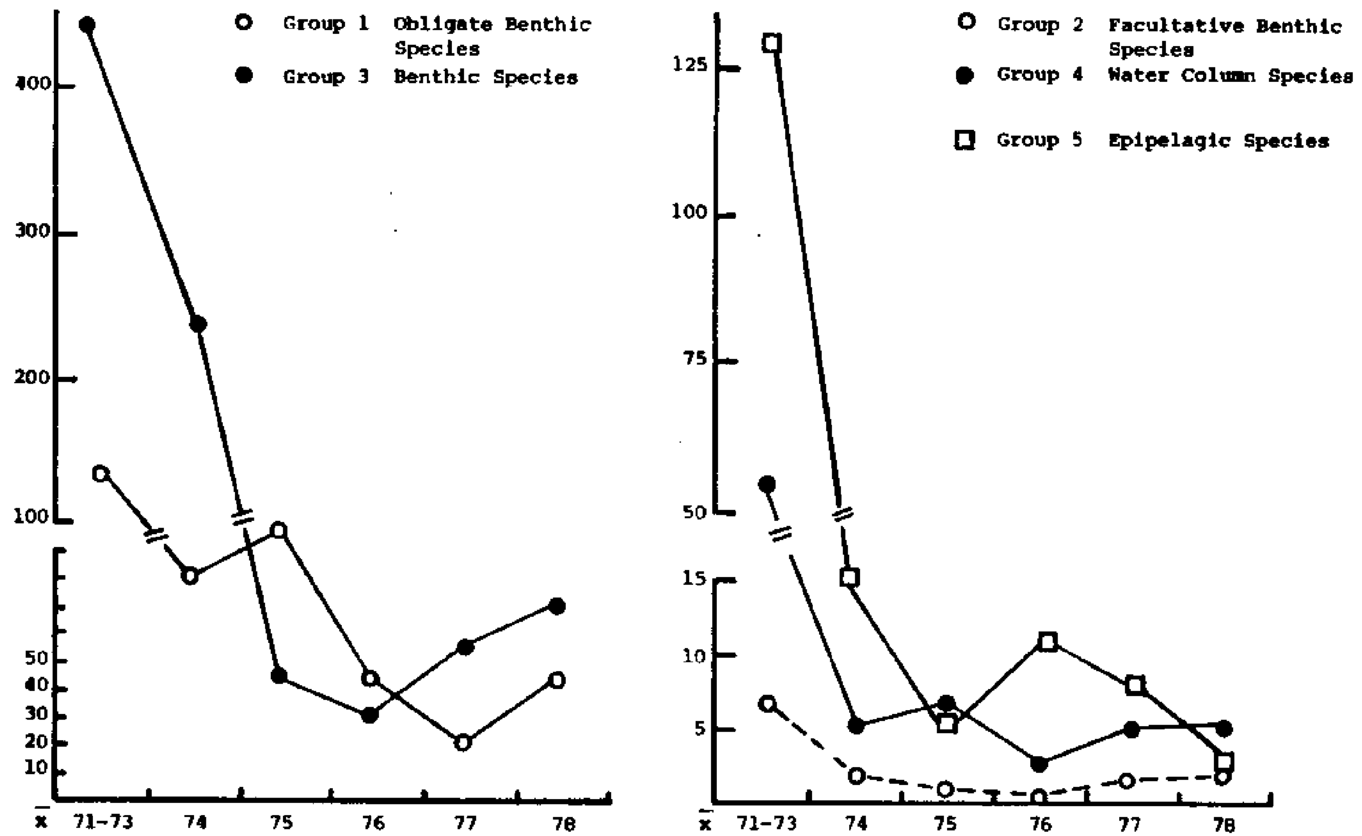
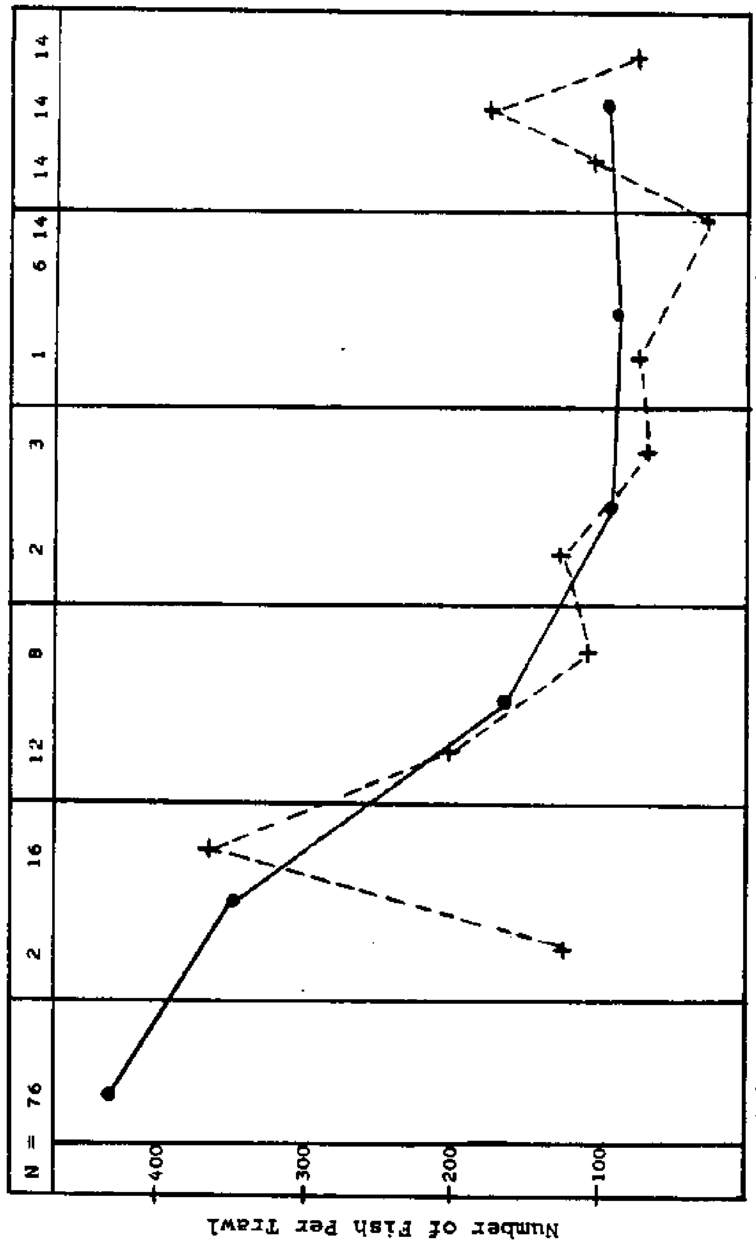


Figure 7. Mean Number of Fish Trawled by Feeding Group by Year.



N = *Number of Trawls*

Annual Mean
Semiannual or Quarterly Mean

**Additional trawl records from Stephens further lowered means from those reported in Soule and Oguri 1979.*

Figure 8. Mean Number of Fish Per Trawl in Outer Los Angeles Harbor, 1971-1978.

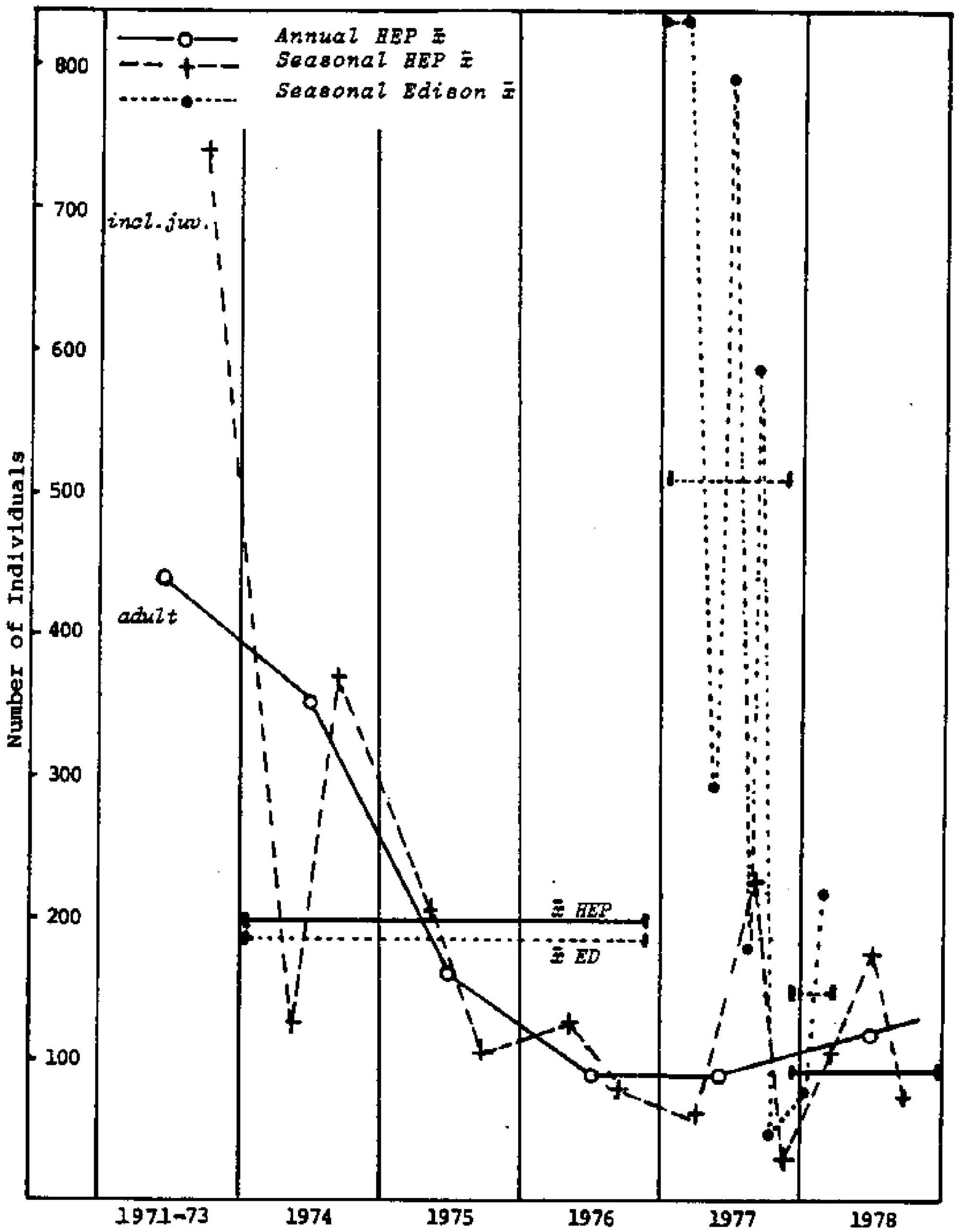


Figure 9. Comparison of HEP Outer Harbor Data and Means with EQA-MBC Edison Long Beach Generating Plant Data (Daytime).

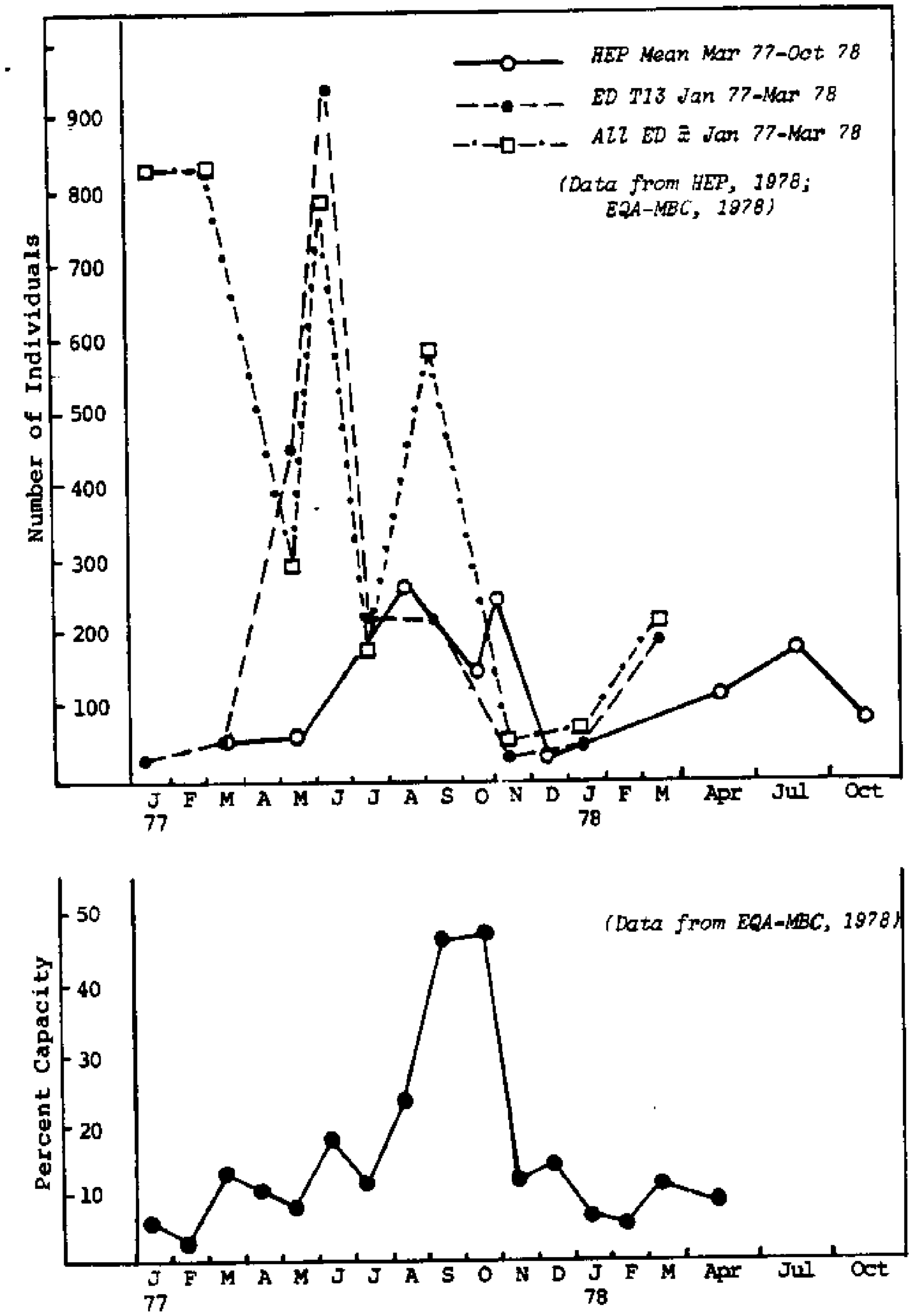


Figure 10. Comparison of Thermal Output with Means of All Edison Trawls, and Outer Harbor Edison T13 and HEP Trawls (Daytime).

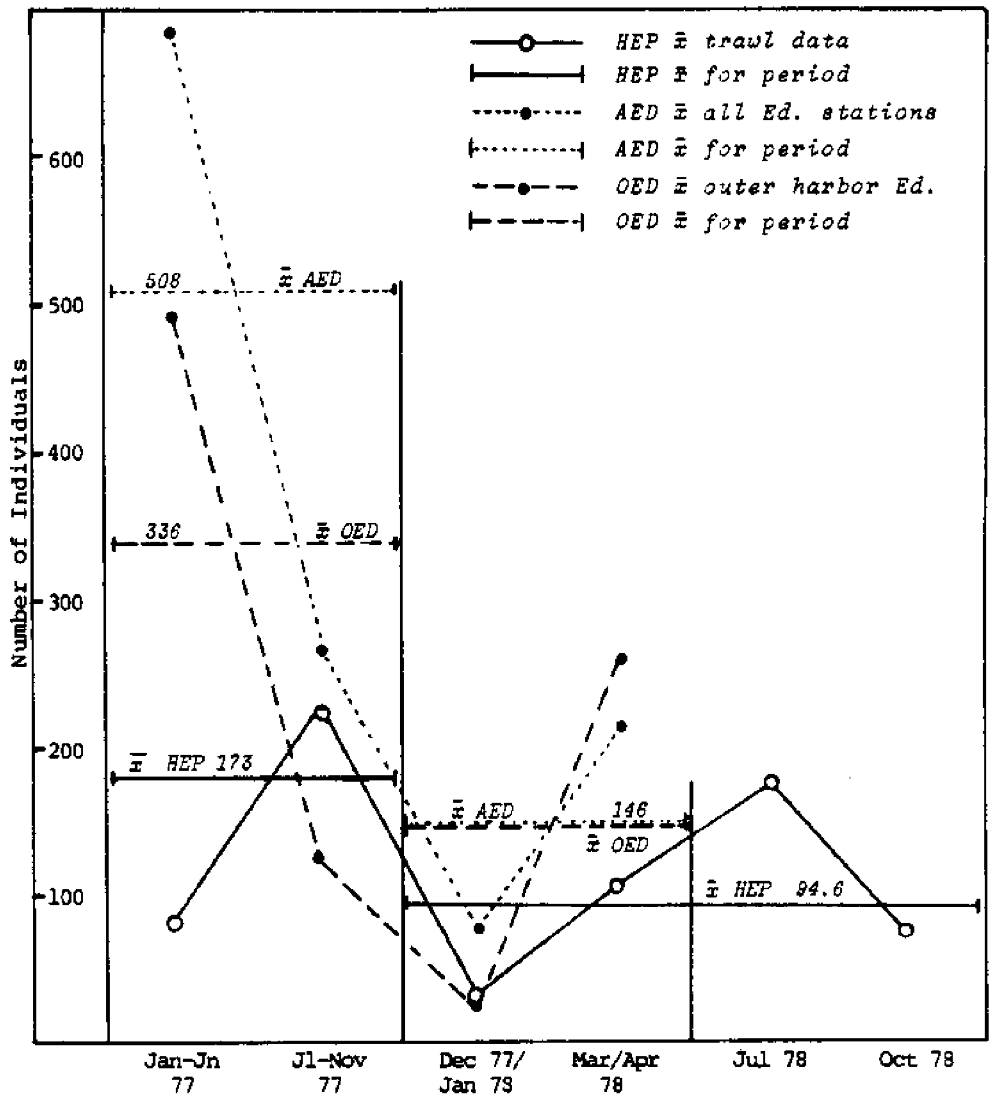


Figure 11. Comparison of HEP Outer Harbor Data and EQA-MBC Edison Data Adjusted to Season and Daytime for All Stations (AED) and for Outer Harbor Edison Trawls (T13, T15) Only (OED).

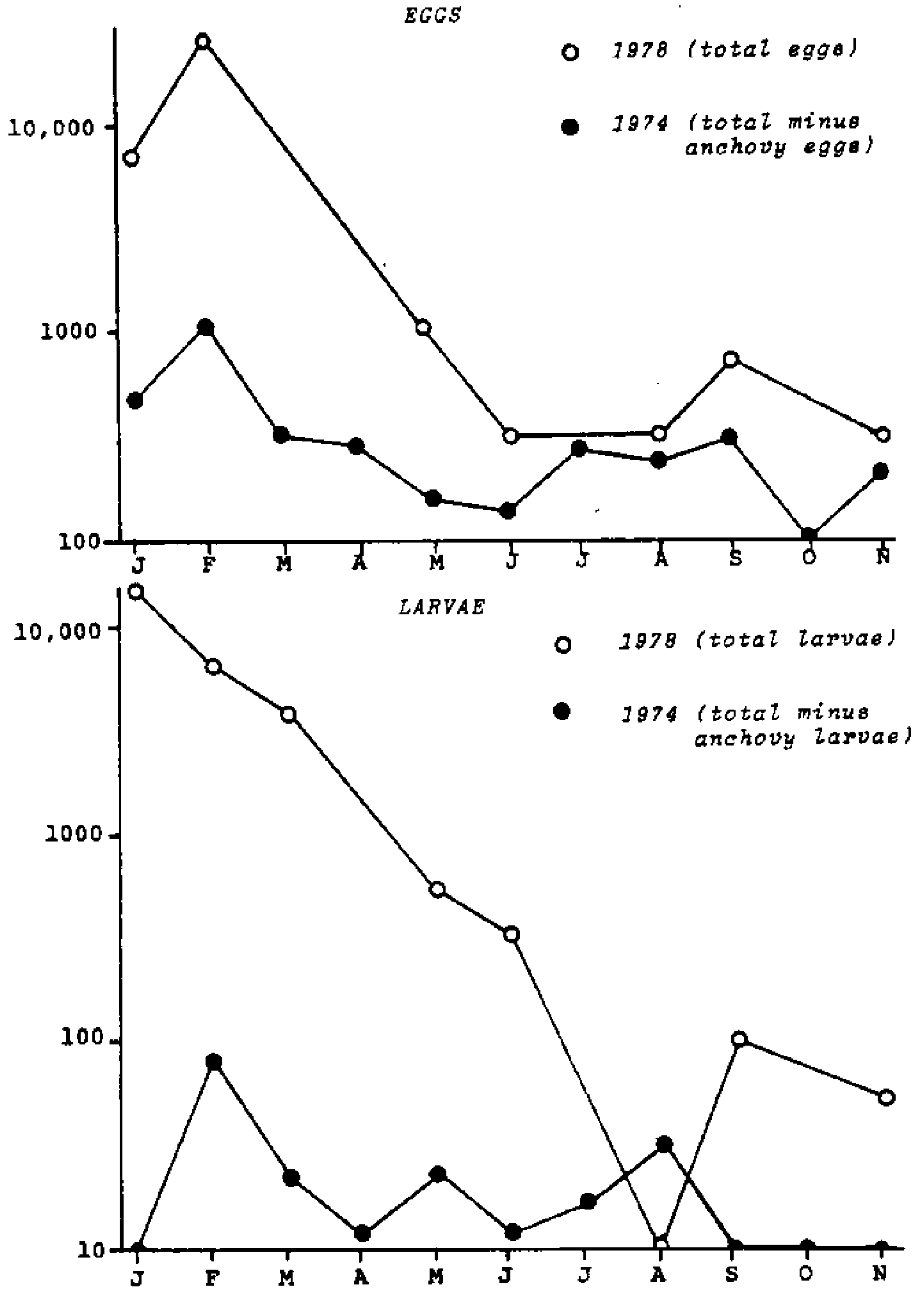


Figure 12. Mean number of fish eggs and larvae collected per m³ of water filtered for Los Angeles Harbor and in 1974 from San Pedro Bay. Latter values represent total numbers excepting anchovy eggs and larvae.

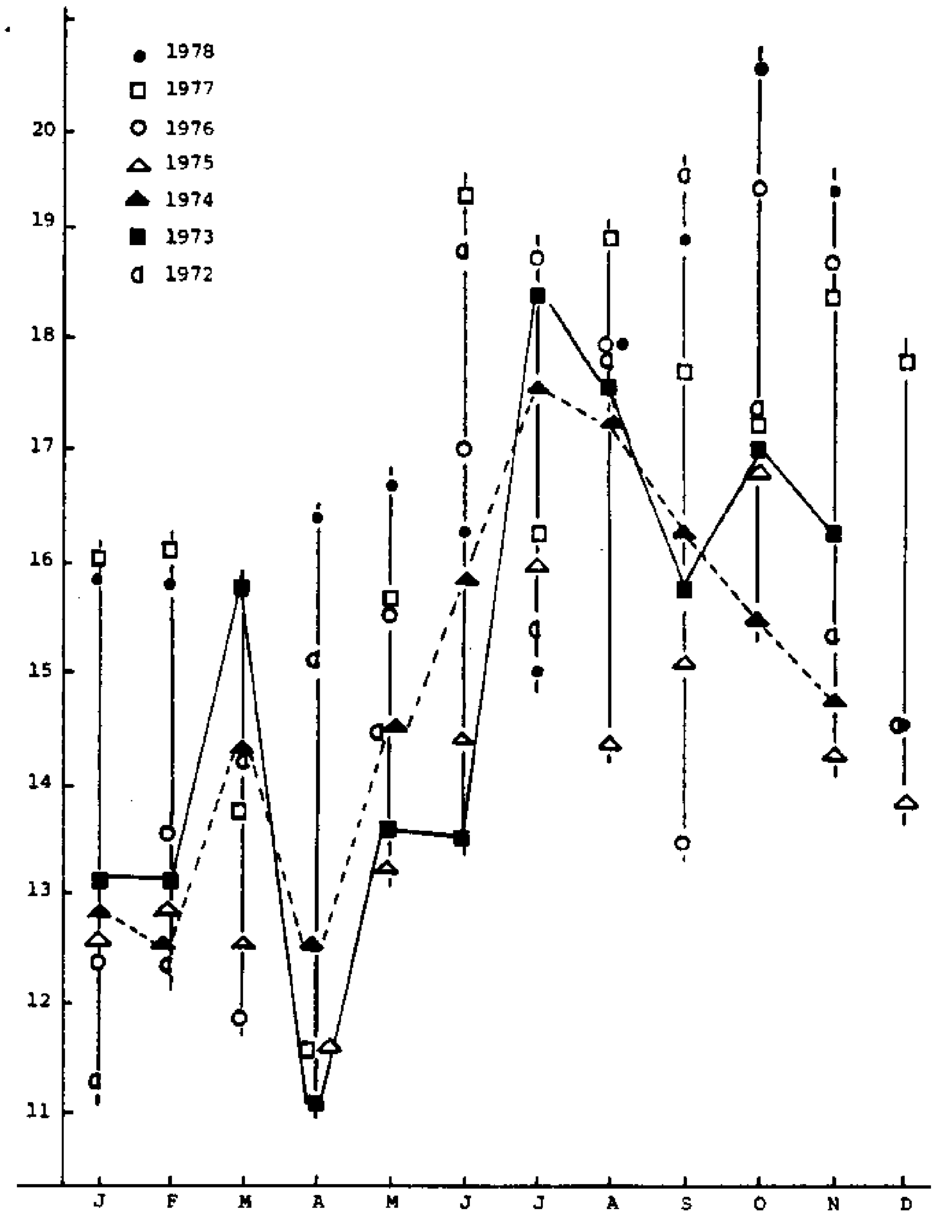
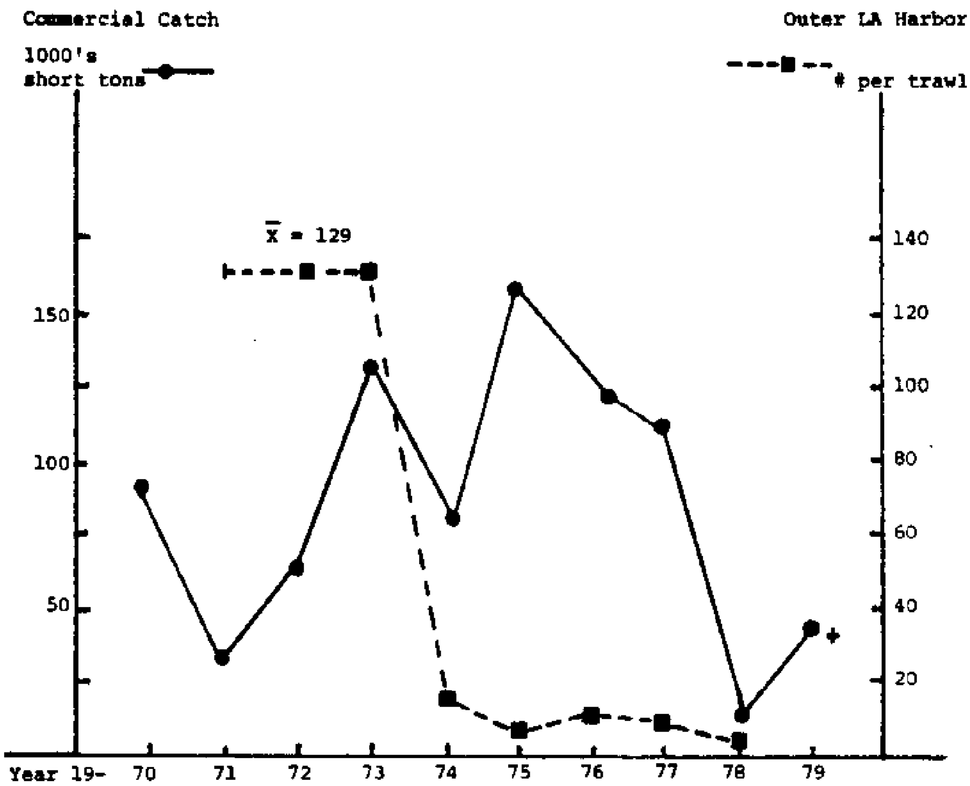


Figure 13. Surface Temperatures at the Sea Buoy, Station A1 Outside Los Angeles Harbor.

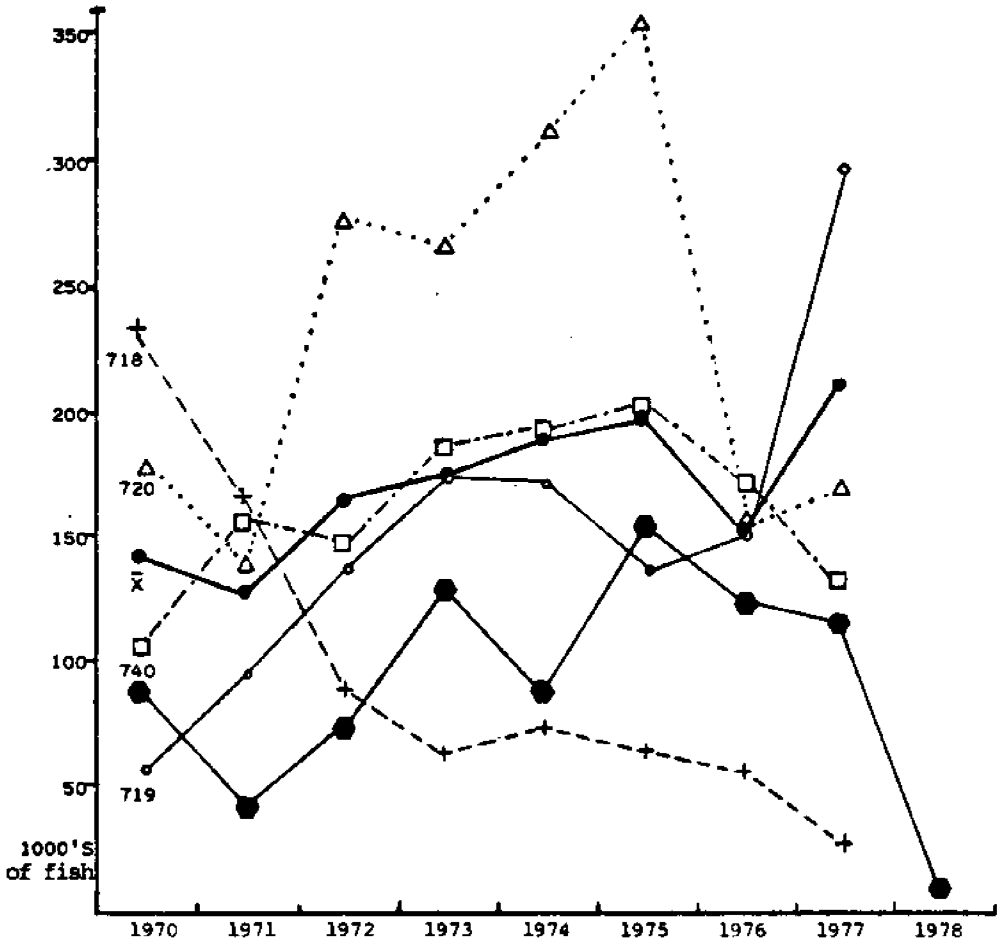


+ incomplete data

Figure 14. Comparison of Commercial Anchovy Catch with HEP Outer Harbor Trawl Anchovy Catch.

Harbor trawl data from Soule and Oguri, 1979.

Anchovy catch data from:
National Marine Fisheries
Southwest Fisheries Center Admin. Rept. No. LJ-79-23



719 Outside Harbor
718 Off Orange County
740 So. Calif. Bight
720 Off Palos Verdes
X̄ mean
Commercial Anchovy Catch

Figure 15. California Department of Fish and Game Data on Total Party Boat Catches by Year, by Block and Mean of Four Blocks, Compared with National Marine Fisheries Service Commercial Anchovy Catch Data.

Table 1. Fish Species Found in Los Angeles-Long Beach Harbors, 1971-1979.

Species Name*	Common Name	Outer Harbor	Inner Harbor	Gill Net	Kelp Bed
Acanthogobius flavimanus	yellowfin goby			+	
Amphistichus argenteus	barred surfperch	+		+	+
Anchoa compressa	deepbody anchovy	+	+	+	
Anchoa delicatissima	slough anchovy	+	+		
Anisotremus davidsonii	sargo		+		
Artedius lateralis	smoothhead sculpin		+		
Atherinops affinis	topsmelt	+	+	+	
Atherinopsis californiensis	jacksmelt			+	
Atractoscion nobilis	white seabass		+	+	
Brachyistius frenatus	kelp surfperch			+	+
Cheilotrema saturnum	black croaker		+	+	
Chilara taylori	cusk eel	+	+		+
Chromis punctipinnis	blacksmith			+	+
Citharichthys sp.					+
Citharichthys sordidus	Pacific sanddab		+		
Citharichthys stigmaeus	speckled sanddab	+	+	+	
Clevelandia ios	arrow goby	+	+		
Clinocottus analis	wooly sculpin				+
Coryphopterus nicholsii	blackeye goby				+
Cymatogaster aggregata	shiner surfperch	+	+	+	+
Cynoscion nobilis = *Atractoscion nobilis*	white seabass				
Cyprinus carpio	carp	+	+	+	+
Damalichthys vacca	pile surfperch	+	+	+	+
Embiotoca jacksoni	black surfperch	+	+	+	+
Engraulis mordax	northern anchovy	+	+	+	+
Genyonemus lineatus	white croaker	+	+	+	
Gibbonsia sp.	kelpfish				+
Girella nigricans	opaleye			+	+
Glyptocephalus zachirus	rex sole				0
Gobiesox rhessodon	Calif. clingfish				+
Gobiidae (unid)		+	+		
Gymnura marmoratus	Calif. butterfly ray	+			
Halichoeres semicinctus	rock wrasse	+			
Heterodontus francisci	horn shark			+	
Heterostichus rostratus	giant kelpfish		+	+	+
Hexagrammos decagrammus	kelp greenling				+
Hippoglossina stomata	bigmouth sole	+	+		
Hyperprosopon argenteum	walleye surfperch	+	+	+	
Hyperprosopon ellipticum	silver surfperch			+	
Hypsoblennius gilberti	rockpool blenny				+
Hypsopsetta guttulata	diamond turbot	+			+
Hypsurus caryi	rainbow surfperch				+
Hypsypops rubicundus	garibaldi				+
Ilypnus gilberti	cheekspot goby		+		
Lepidogobius lepidus	bay goby	+	+		
Lepomis macrochirus	blue gill	+			
Leptocottus armatus	staghorn sculpin		+		+
Leuresthes tenuis	California grunion	+	+		
Medialuna californiensis	halfmoon				+
Menticirrhus undulatus	California corbina			+	

Table 1 (continued)

Species Name	Common Name	Outer Harbor	Inner Harbor	Gill Net	Kelp Bed
Micrometrus minimus	dwarf surfperch			+	
Microstomus pacificus	dover sole				0
Mustelus californicus	gray smoothhound			+	
Mustelus henlei	brown smoothhound	+	+	+	
Myliobatis californica	bat ray	+	+	+	
Neoclinus blanchardi	sarcastic fringehead				+
Neoclinus stephensae	yellowfin fringehead				+
Neoclinus uninotatus	onespot fringehead	+	+		
Odontopyxis trispinosa	pygmy poacher	+	+		
Orthonopias triacis	snubnose sculpin				+
Otophidium scrippsi	basketweave cusk-eel		+		
Oxyjulis californica	senorita				+
Oxylebius pictus	painted greenling				+
Paralabrax clathratus	kelp bass			+	+
Paralabrax maculatofasiatus	spotted sand bass	+		+	
Paralabrax nebulifer	barred sand bass	+	+	+	+
Paralabrax sp.	sand bass				+
Paralichthys californicus	California halibut	+	+	+	
Parophrys vetulus	English sole	+	+		
Peprilus simillimus	Pacific butterfish	+	+	+	
Phanerodon furcatus	white surfperch	+	+	+	+
Pimelometopon pulchrum	sheephead				+
Platichthys stellatus	starry flounder	+			
Pleuronectidae sp.					+
Pleuronichthys coenosus	c-o turbot				+
Pleuronichthys decurrens	curlfin turbot		+	+	
Pleuronichthys ritteri	spotted turbot		+		
Pleuronichthys verticalis	hornyhead turbot	+	+	+	
Porichthys myriaster	specklefin midshipman	+	+	+	
Porichthys notatus	plainfin midshipman		+		
Psettichthys melanostictus	sand sole				+
Rhacochilus(= Damalichthys) vacca					
Rhacochilus toxotes	rubberlip surfperch		+	+	
Rhinobatos productus	shovelnose guitarfish	+	+		
Roncador sternsii	spotfin croaker			+	
Sarda chiliensis	Pacific bonito			+	
Sardinops sagax caeruleus	Pacific sardine			+	
Sciaenidae (unid)					+
Scomber japonicus	Pacific mackerel			+	
Scorpaena guttata	sculpin or spotted scorpionfish	+	+	+	+
Scorpaenichthys marmoratus	cabezon				+
Sebastes atrovirens	kelp rockfish				+
Sebastes auriculatus	brown rockfish	+	+	+	
Sebastes dalli	calico rockfish	+	+		+
Sebastes goodei	chilipepper			+	
Sebastes melanops	black rockfish			+	
Sebastes miniatus	vermilion rockfish	+	+		
Sebastes mystinus	blue rockfish		+	+	+
Sebastes paucispinis	bocaccio	+	+	+	

Table 1 (continued)

Species Name	Common Name	Outer Harbor	Inner Harbor	Gill Net	Kelp Bed
Sebastes rastrelliger	grass rockfish	+			
Sebastes saxicola	stripetail rockfish	+	+		+
Sebastes semicintus	halfbanded rockfish		+		
Sebastes serranoides	olive rockfish	+	+	+	+
Sebastes serriceps	treefish				+
Sebastes sp.			+		+
Seriphus politus	queenfish	+	+	+	+
Sphyraena argentea	California barracuda			+	
Squalus acanthias	spiny dogfish	+	+	+	
Symphurus atricauda	Calif. tonguefish	+	+	+	
Synodus lucioceps	Calif. lizardfish	+	+	+	
Syngnathus sp.		+	+		
Torpedo californica	Pacific electric ray	+			
Trachurus symmetricus	jack mackerel		+	+	
Triakis semifasciata	leopard shark			+	
Tridentiger trigonocephalus	chameleon goby				x
Umbrina roncador	yellowfin croaker				+
Urolophus halleri	round stingray	+	+	+	
Xeneretmus latifrons	blackedge poacher				0
Xystreurys liolepis	fantail sole	+	+		
Zaniolepis frenata	shortspine combfish	+			

* names according to Miller and Lea, 1972, or J.S. Stephens in Soule and Oguri, 1979.

0 outside breakwater.
x Cabrillo area.

Table 2. Fish Species Taken By Trawl that are Restricted Primarily to the Outer Harbor

Outer Harbors HEP 1971-77	1978	Edison T13, T15 Jan 1977-Mar 78	Edison Inner Harbor 1976-78
Amphistichus argenteus			
Atherinops affinis			
Clevelandia ios			
Gymnura marmorata			
Hippoglossina stomata			
Hypsopsetta guttulata	'78		
Leuresthes tenuis			
Neoclinus uninotatus			'76
Odontopyxis trispinosa			'76
Paralabrax maculatofasciatus	'78		
Parophrys vetulus			
Pleuronichthys decurrens		Sept '77	
Pleuronichthys ritteri			
Sebastes saxicola		May '77	
Sebastes serranoides			
Squalus acanthias			'76
Sygnathus sp.	'78		'76
Torpedo californica			
Zaniolepis frenata			

Table 3. Fish Species Taken By Trawl that are Restricted Primarily to the Inner Harbor

Present, Inner Harbor	Outer Harbor	
Edison Trawls 1977-78	Edison T13, T15 1977-78	HEP Trawls
Anchoa compressa		'74,'77
Anchoa delicatissima		'74,'75
Heterostichus rostratus		
Ilypnus gilberti		
Leptocottus armatus		
Mustelus henlei		
Myliobatis californica		'75
Porichthys notatus		
Rhinobatos productus		'74
Sebastes miniatus		'71-'73
Sebastes paucispinis		'71-'73
Trachurus symmetricus		
Urolophus halleri		
Xystreurys liolepis		

Table 4. Harbors Environmental Projects Data, December 1977-October 1978 by Outer Harbor Area

Species	Outer Los Angeles Harbor						Outer Port of Long Beach				City of Long Beach				Total
	T14	T9	T10	T11	T12	T13*	T5	T6	T7	T8	T2/3	T4	T16	T15+	
Amphistichus argenteus		1								1					2
Chilara taylori		1		1				1	1	2					6
Citharichthys sordidus	19	6	14				1	4							44
Citharichthys stigmaeus	97	37	59	71	16		2	3		7	7	1	2		302
Cymatogaster aggregata	2		1			7			1						12
Damalichthys vacca = *Rhacochilus vacca*											1		1		2
Embiotoca jacksoni			2	2	2	9					1				16
Engraulis mordax		1	1	2	16	104						4	2	5	135
Genyonemus lineatus	6	120	26	71	77	980	152	243	61	261	36	165	144	34	2176
Gymnura marmorata						1									
Hyperprosopon argenteum			2		2	26							1		31
Hypsopsetta guttulata	2		1		1										4
Lepidogobius lepidus		1	1		1			6	7	4			1	2	23
Paralabrax maculatofasciatus						1									1
Paralabrax nebulifer								1	1			1			3
Paralichthys californicus	2	3	1	5	3	9	1	2						3	29
Parophrys vetulus								1							1
Peprilus simillimus				1	1	2		1				1			6
Phanerodon furcatus	2	2	11	2	16	17		1	1	2	10	2	1		67
Pleuronichthys verticalis	5	1	3					2	2	2		2	1		18
Porichthys myriaster		2			1		6	2	2		3	1		3	20
Porichthys notatus														1	1
Scorpaena guttata	2						1								3
Sebastes auriculatus	1									1					2
Sebastes dalli					1 (sp)		2	6	2			3		16	31
Sebastes paucispinis														39	39
Seriphus politus		1		18	110	67	6	3	2	1		12	28	95	343
Symphurus atricauda	65	115	55	97	41	18	87	73	90	119	142	148	108	187	1345
Syngnathus sp.															2
Synodus lucioceps	3	3	3	9	6	7	3	5	1	11	4	5	4	1	65
Urolophus halleri						1									
Xystreurys liolepis	2		2	1	2								1		
Number of individuals	208	294	184	280	296	2251	261	354	182	413	204	345	294		5941
Number of species	13	14	15	12	16	15	10	16	12	12	8	12	12		

*Station Nearest TITP Outfall
+Station T15 April and July Only

Table 5. Trawl Catch by Area and Season

Outer Los Angeles	Dec'77	Apr'78	July'78	Oct'78	Total
T14	7	16	$\boxed{151}$	34	208
T9	13	57	$\boxed{188}$	36	294
T10	7	28	$\boxed{105}$	44	184
T11	14	32	$\boxed{126}$	108	280
T12	4	22	87	$\boxed{183}$	296
T13*	155	125	$\boxed{933}$	40	1253
$\bar{x}$	33.3	46.7	265.0	74.2	419.2
SD(n-1)	59.7	40.9	329.2	60.2	411.2

Outer Long Beach	Dec'77	Apr'78	July'78	Oct'78	Total
T5	2	108	$\boxed{139}$	12	261
T6	9	$\boxed{216}$	96	33	354
T7	1	70	71	40	182
T8	6	$\boxed{306}$	42	59	413
$\bar{x}$	4.5	175	87.0	36.0	302.5
SD(n-1)	3.3	107.0	41.1	19.4	101.8

Long Beach City	Dec'77	Apr'78	July'78	Oct'78	Total
T2/3	31	34	95	44	204
T4	15	$\boxed{154}$	107	69	345
T16	2	$\boxed{121}$	60	111	294
T15	ND	$\boxed{161}$	$\boxed{185}$	ND	ND
$\bar{x}$	16.0	117.5	111.8	74.7	281.0
SD(n-1)	14.5	58.3	52.7	33.9	71.4

$$\left.\begin{array}{l}\text{EdT13 (near T8) Jan'77–Mar'78 } \bar{x} = 274.6 \\ \text{EdT15 (near T6) Jan'77–Mar'78 } \bar{x} = 351\end{array}\right\} \bar{x}\ 297.8$$

* nearest TITP outfall.

Boxes show peak periods. Note peak catch periods in outer Los Angeles Harbor coincide with peak sewer malfunction in July 1978.

Table 6. Comparison of Edison Trawl Data (Daytime) with HEP Data

	All Edison Trawl Sta. $\bar{x}$ (ED)	ED Season Means	ED T-13 Trawls	ED T-13 $\bar{x}$	ED T-15 Trawls	ED T-15 $\bar{x}$	All HEP Trawls	HEP $\bar{x}$
Jan 77	835.4		20		613			
Feb	-		-		-			
Mar	835.7	688	45	364	1622	631.7		69.3
Apr	-		-		-			
May	292.6		448		227			
Jn	789.6		945		65			
Jl	174.0		207		53			
Aug	-		-		-			
Sep	583.5	268	213	151	136	93.3		225.8
Oct	-		-		-			
Nov	46.6		33		91			
Dec	-		-		-		26.7	
Jan 78	76.5	146.4	37	114	12	178.5	-	
Feb	-		-		-		-	65.4
Mar	216.4		191		345		-	94.6
Apr							104.1	
Jl							174	
Oct							73.8	
Total	3850.3		2139		3164		5941	
$\bar{x}$	427.8		237.6		351.5		92.8	

E. MEROPLANKTON (SETTLING RACK) FAUNA

INTRODUCTION

In attempting to characterize the fauna of an area, an array of sampling techniques can be used, generally to take discrete samples at intervals in time and space. Uses and results of such procedures are reported in preceding sections for planktonic, benthic and pelagic species. However, the planktonic and pelagic methods of net tows or trawls largely cannot compensate for the transitory nature of populations found at specific times and locations. The benthic fauna are less transitory than plankton, but are governed by the characteristics and availability of particular substrates, such as rock, pilings, wharves, ships hulls and hard or soft benthos, as well as degree of pollution. Where unconsolidated fine sediments are present, or where sediments are contaminated by a variety of pollutants, the fauna taken by coring or grab samplers may not accurately represent those organisms that are available in the water column or on adjacent substrates for potential colonization.

Meroplankton are those organisms that are temporarily planktonic as eggs, larvae or juvenile stages and which settle out after metamorphosis for a sessile or attached adult stage. Meroplankton from coastal waters are being continually introduced by tidal exchange into the harbor, while other organisms, fouling species already living in or on substrates in the harbor, may have planktonic reproductive stages and so be carried from one area of the harbor to another.

To assess this type of fauna, one of several techniques may be used; transects may be plotted along substrates and surveyed visually by divers, or rocks and/or pilings may be scraped at intervals. In such cases, the smallest species may remain unseen, unidentified, or lost. Substrates that have been treated or accidentally coated with creosote, oil or other chemicals will not support a representative fauna. Also, the age and succession of such communities cannot be determined. For these reasons, settling racks were selected by HEP in 1971 for sampling in outer Los Angeles Harbor for the Southern California Gas Company (Abbott, D. Soule, M. Oguri and J. Soule, 1973).

Earlier studies in the harbors on fouling fauna included the work of Barnard (1958), who discussed the distribution of amphipod crustaceans in relation to water turbidity, Reish (1961, 1971) who researched seasonal settlement of polychaetous annelids, and Crippen and Reish (1969) who discussed polychaetes associated with fouling organisms. The 1973-1974 HEP studies in Los Angeles and Long Beach Harbors for the Army Engineers were discussed in detail in Allan

Hancock Foundation (1976). Soule, Soule and Henry (1979) discussed the incidence of bryozoans on settling racks in relation to physical parameters.

METHODS

Settling racks were deployed at 24 stations in the Ports (Figure 1). The racks were constructed by adapting 8.5 x 16.5 cm wooden microscope slide boxes (D. Soule and J. Soule, 1971). The bottom panel of each box was removed and the corners reinforced with wire brads. A 6 mm hole was drilled in each end and a short length of rope inserted, with a weight at one end and a loop for suspension on the other. Fifteen glass microscope slides (2.54 X 9.62 cm) were spaced in the notches of the box, and the top and bottom were covered with 1.6 mm mesh plastic screen. Racks were changed every four weeks so that monthly records of harbor reproduction and settling were obtained.

The rack deployed at a special buoy at B8 disappeared in a storm the first month. Replaced, it was apparently run down by a ship in the next month so the station was abandoned. Storms and occasional vandalism are recurrent problems for deployed sampling devices.

On collection each rack was placed in a 10% formalin-seawater solution. Slides were removed and examined in the laboratory under a dissecting (X 25) microscope for encrusting bryozoans and then scraped. Wet weights were determined by displacement volume and samples were rinsed in tap water and stored in 70% ethanol. Samples were sorted using Tyler screens of 2.79 mm, 0.7 mm and 0.25 mm meshes. The 0.25 mm screen retains the largest number of individuals, mostly juveniles of those retained on the 0.7 mm screen. Contents were aliquoted for counting and identification when necessary during peak seasons (AHF, 1976).

Colonial organisms cannot be counted as individuals and thus hydroids and bryozoans were recorded as wet weights. These species must also be excluded from diversity indices calculations since they cannot be counted, which can skew the results considerably. Zooplankton juveniles also are caught in the racks; many copepods were collected but since these are dealt with extensively in the zooplankton section (IIIB) they were not identified to species level for the settling rack investigations.

RESULTS

Numerically Dominant Species

The two most numerous species in the harbor in 1978 were the same as those in 1973-74, the cosmopolitan crustacean amphipods *Jassa falcata* and *Corophium acherusicum*. The total numbers of individuals for the two species had decreased somewhat, to about 74% of the 1973-74 levels. Among the fifteen dominant species, this trend was consistent, with total numbers being about 73% of the earlier survey totals (a 1.4-fold decline).

There was a shift, however, in the dominant species toward the crustacean fouling fauna and away from polychaete worms. Of the dominant 15 species, crustaceans increased from 7 to 10 species. The total numbers of the crustaceans increased about 3%, indicating the increased diversity in amphipod species. Table 1, which gives the dominant species in both numbers of occurrences and individuals, offers comparison with the 1973-74 data. Molluscs increased from one to two species. *Mytilus edulis*, the bay mussel, increased in numbers but retained about the same relative ranking, while *Leptopecten latiauratus* appeared in the dominant species in 1978. The tunicate *Ciona intestinalis* dropped from third to fifth place; its numbers decreased 2.5-fold from almost 93,000 to 34,885 *Hydroides pacificus*, the common fouling serpulid polychaete worm, dropped from fourth to eighth rank, and decreased 2.7-fold in total numbers.

Also indicative of the change is the decline of other worm species; *Polydora limnicola* dropped about 27-fold from fifth to 22nd place, *Ctenodrilus serratus* declined from tenth to 24th rank, *Armandia bioculata* from twelfth to 25th, and *Capitella capitata* dropped from 14th to below 25th. The last three species dropped about 7-fold in total numbers. There are implications in this shift with regard to a reduction in organic nutrients and in available food which will be discussed later.

Numerical Distribution

Crustaceans

Numerical dominance is related to species that are cosmopolitan, or ubiquitous, in being found at all stations and in all seasons. Although distribution of *Jassa falcata* and *Corophium acherusicum* have been associated with turbidity and pollution in Los Angeles and Long Beach Harbors (Barnard, 1958) other factors appear to be important. For example, *Jassa falcata* dominated the outer harbor gyre area A stations but the Long Beach Harbor main channel station B3 had the peak number of 36,488 individuals and that location is well flushed. Numbers of *J. falcata* were quite low in the inner harbor stations B6 and B7 and at all C stations, including those on the Main Channel in Los Angeles Harbor. Station A13, near the breakwater, A3, A8. A9 and the outfall station A7 all had 20,000 to 30,000 total counts (Table 2).

In contrast, *Corophium* had over 22,000 individuals at station A7, but station A13 had only 320. However, the rest of the total was much more evenly distributed than that of *J. falcata*, with about 8,000 to 10,000 individuals of *Corophium* at some inner harbor B and C stations. Neither *Jassa* nor *Corophium* preferred the sea buoys.

Caprella equilibra and *C. verrucosa* are restricted almost entirely to the outer harbor; however, *C. equilibra* dominated the sea buoys A1 and B1 and station B3 on the channel, whereas *C. verrucosa* was most numerous at station A1 (15,000±), but there were only about 600 at station B1.

Ericthonius brasiliensis was numerous only in the B station area, perhaps favoring the water warmed by the Edison plant discharge, or nutrients there. *Podocerus brasiliensis* was spread over the outer harbor and into the main channels but was rarely found in blind-end slips. *Elasmopus rapax* preferred the warmer B stations.

The increase of the burrowing isopod (gribble) *Limnoria tripunctata* was notable, since in the pre-1970 period even these nuisances were absent from the harbor. They were especially prominent at Consolidated Slip, station C11, and numerous at stations B6, B7, C5 and C7. Few were found in other areas. The isopod *Ianeropsis*, sp. was numerous at station B5, closest to the Edison effluent, but numerical distribution was spotty, high at stations C2, C8 and D1, while the isopod *Paracerceis sculpta* as most numerous at stations B2, B6 and B7.

<u>Non-crustaceans</u>

Ciona intestinalis, a large tunicate, dropped from third to fifth ranking and decreased about 2.5-fold in number. Except for the sea buoys, the species was common throughout the harbor. It was most numerous at stations A9 and B4, and numerous along both main channels.

Mytilus edulis, the bay mussel, was must numerous near the outfalls at station A7 and at station B3. Numbers were very much reduced in the inner harbor, increasing on the main channels toward the outer harbor along the shore and then decreasing toward the breakwater and sea buoys.

Of the polychaetes, the highest numbers in the outer harbor were at the outfalls, station A7, for *Polydora limnicola*, *Ctenodrilus serratus*, *Paleonotus bellis* and *Armandia bioculata*. However, counts for Ctenodrilus were much higher at station C2 on the main Los Angeles channel, and for *Paleonotus* were much higher at station B3 on the Long Beach main channel. *Capitella capitata* was much reduced in 1978; its peak was at station C11, where its stress resistance to disruption by runoff and fast recolonization permit it to compete favorably with other species. It is otherwise virtually limited to blind-end slips.

Numbers of Occurrences

The total number of occurrences for the 15 dominant species appeared to have decreased in 1978 to about 73% of the 1973-74 mean annual number of occurrences. This is about a 1.4-fold difference, the same proportion as was found in the numbers of individuals.

The rank order in 1978 showed *Corophium acherusicum* in first place, as it was in 1973-74. However, *Hydroides pacificus* moved from 12th place to second rank in 1978, and *Jassa falcata* fell to third, while *Ciona intestinalis* dropped to fourth place (Table 1, Table 3).

Crustaceans

The amphipod crustaceans moved up in relative rankings at this point; *Stenothoe valida* moved up from eighth to fifth, *Caprella californica* was up from seventh to sixth, and *Caprella equilibra* was up from ninth to seventh, while the tanaid *Anatanais normani* moved up one place, to ninth rank. *Podocerus brasiliensis* dropped from sixth to eighth, in its outer harbor distribution.

Non-crustaceans

Mytilus edulis moved up from 14th to ninth place, although the number of occurrences actually decreased by 20%. *Hydroides pacificus* was the only species to increase in numbers of occurrences in the top fifteen; in moving from 12th to second place, it increased only about 10%. *Ciona intestinalis* decreased by more than 30% (about 1.5-fold).

Among the polychaetes, *Polydora limnicola* dropped from fourth to 19th in occurrences. *Platynereis bicanaliculata* dropped from fifth to 11th, and was the only polychaete other than *Hydroides pacificus* to remain in the fifteen species dominating occurrences. *Ctenodrilus serratus* dropped from 15th to 20th, *Armandia bioculata* dropped from 11th to 25th, and *Capitella capitata* decreased from 13th to 16th. The three polychaetes underwent decreases of from 1.7 to 2.9-fold.

Although an improved ecology would presumably lead to increased evenness in distribution of numbers of species occurrences and individuals, this is not apparent. The dominant 15 species still represent from 85 to 98% of the numbers, as they did in 1973-74 (AHF, 1976).

Statistical Biases

About half of the total occurrences cannot be calculated as species occurrences or numbers. These are in part associated with the colonial organisms, which in some seasons constitute substantial portions of the biomass. In particular, the hydroids *Obelia* sp., *Tubularia* sp. and *Aglaophenia* sp. are important.

The bryozoans, as arborescent or encrusting colonial species, are important food for browsing nudibranchs and caprellids, and for some fish species. Two colonial tunicates, *Diplosoma macdonaldi* and *Botryllus* sp. are also present at times. All of these species are weighed.

In other cases, the organisms are not identifiable to categories at the species or generic level. Copepods were quite numerous, but as very small juveniles were not identified further on settling racks. *Caprella* sp. also was recorded for large numbers, but it is impossible to determine whether the unidentified numbers consisted of one or several species. The same problem exists for large numbers of Pycnogonida (sea spiders), Nudibranchia (shell-less molluscs), Nematoda (round worms), and Platyhelminthes (flat worms).

Species Diversity

While the settling rack may be accepted as representing the fouling community, the difficulties of enumerating colonial species and of identifying many juveniles to species level artificially reduce calculations of species diversity. Table 4 presents Shannon-Wiener (H'), Diversity Index calculations. Comparison with the H' max calculations are indicative of the differences described. S-WD indices were good for the most part and exceeded many of those achieved in zooplankton calculations (Section IIIB). Section IIIC gives details of S-W calculations). The S-WDI for settling racks ranged from 0.19 at station C11 in March 1978, a period of exceedingly heavy rainfall runoff, up to 2.66 at station A8 in January, 1978. The S-WDI for benthic organisms ranged from 0.11, also at station C11 up to 3.5.

Seasonality

Perhaps the principal reason for the dominance of the top ten or so species is that they occur year around in the harbor. Among species ranked below that, a few species occur in low numbers all year, but most species are missing from the harbor for one or more months. As the months of presence decrease, the ranking of the species is likely to decrease also.

Jassa falcata was first in number of individuals in all months except September, when it was second. *Caprella verrucosa*, on the other hand, ranked first in September, second in August and third in April but was tenth in January and below that in February.

Seasonal Distribution

The distribution of individual species also varies with the seasons, even though the principal species are present in the harbor throughout the year. While *Corophium acherusicum* was found on occasion at all stations and at all seasons, it was most numerous at station A7, except in the summer when peak numbers shifted to the inner harbor at B6 and B7.

Jassa falcata was also present all year, with population centers at stations A3 and B3; it was absent from the C stations in the winter (1977-78), however.

Hydroides pacificus was found at all stations except in the summer, when it was absent from stations A1 and B1; the centers of population shifted from station A3 in the winter to the inner harbor (station C10) in the summer. A somewhat similar pattern occurred for *Ciona intestinalis*, which centered at A9 and B5 in the winter, but moved to the inner C stations in the spring and summer. It was absent from A1 and B1 in the summer, but returned to an outer harbor dominance in the autumn. A number of species that are found only or largely in the outer harbor in the winter return to the inner harbor stations in the spring and summer. *Anatanais normani* is a good example of this pattern, as are *Polyophthalmus pictus* and *Ericthonium brasiliensis*. *Caprella equilibra* is absent from most B and C stations in the winter, returned to B stations in quantity in the spring, and was present except at C6, C7 and C11 during the summer and fall. *Caprella californica* populations were centered at the sea buoy station B1 in winter but the center moved to B3 and B4 for the rest of the year, while *C. verrucosa* was centered at the A stations A1, A2 and A3, and was generally absent from the inner harbor.

Mytilus edulis was centered at station A7 most of the year, and at B1 in the winter and B3 the remainder of the year. It was found at all stations in the spring but retreated from C stations in the summer and fall.

The polychaete *Platynereis bicanaliculata*, unlike the dominant *Hydroides*, remained centered in the outer harbor and was found only in the autumn in quantity in the inner harbor.

It seems clear that the dominant settling rack organisms are ubiquitous species, capable of reproducing year around and tolerant of wide fluctuations in environment. Detailed discussion of settling rack data are presented in Section IV, which contains multivariate statistical analyses of biotic and abiotic parameters. There, the two-way tables show by symbols the relative numbers of species at stations and in station groups.

DISCUSSION AND CONCLUSIONS

There was a decline of 26% in 1978 in both the numbers of individuals and numbers of occurrences on settling racks shown by the 15 dominant species as compared with annual means for 1973-74. Although this might be anticipated as indicating increased evenness among the remainder of the species, this did not appear to be the case. The fifteen dominant species continued to represent 85 to 98% of the fauna.

The shift to increased dominance by crustacean amphipods, plus isopods and a tanaid is difficult to explain and the impact of the shift is even more so. Ten of the 15 numerically dominant organisms are such crustaceans, as are 14 of the dominant 25. The mollusc *Mytilus edulis* moved up in rank but not in number and *Leptopecten latiauratus* moved into the top 15. The tunicate *Ciona intestinalis* and the serpulid worm *Hydroides pacificus* are also common. Most of the species are characteristically protected by exockeletons and/or by tube dwelling habitats or, in the case of molluscs, shells.

Benthic organisms decreased between 3 and 4-fold in 1978 (Section IIIC) throughout the harbor, but the polychaetes species that had been dominant in settling rack sampling decreased 7-fold or more, except for *Hydroides* (down 2.7X) and *Platynereis bicanaliculata* (down 1.6X).

Barnard (1958) related distribution of amphipods to turbidity and to the amount of organic detritus in the waters. Since the organisms are filter feeders for the most part, the decrease up to 30-fold in microheterotrophs found in the outer harbor by Sullivan et al. (Soule and Oguri, 1979) would be expected to affect the nutrient web. Bacteria colonize detritus and probably form the nutritive component of debris. A reduction in BOD from canneries and the treatment plant may have had a similar impact on the outer harbor. Population centers for particular species such as *Jassa falcata* and *Corophium acherusicum*, the *Caprella* species, *Stenothoe valida* and *Podocerus brasiliensis* are in the outer harbor.

The warm water effluent of the Edison generating plant attracts those species as well, except for *Caprella verrucosa*. *Ericthonius brasiliensis* and *Elasmopus rapax* are dominant only in the warmer B stations in the main channel. Barnard and Reish (1959) remarked that *Elasmopus* was common in Newport Bay but scarce in Los Angeles Harbor. Temperature differences could have been involved as well as pollution. Power plant discharges offer warmer water but also provide particulate food in the form of the dead and macerated zooplankton in water entrained. The capacity of 734 mgd entrained has altered the circulation and flushing of the Long Beach Harbor complex.

The concept offered earlier of pollution indicator species and "healthy" or "semi-healthy" are more simplistic than desirable, since some organisms prefer warmer waters, quieter waters, or the opposites. There are varying degrees of tolerance to episodes of low oxygen, and few species tolerate sulfide or ammonia. Certain benthic organisms select sandy, silty or shelly bottoms for habitats. The ability of organisms to reproduce, and hence recolonize, year around also gives some species competitive advantage.

There is no question that the harbor is remarkably better than it was ten years ago; zero oxygen episodes no longer occur, sulfide levels have decreased by an order of magnitude and the bottom has no sludge beds (Reish, 1959, 1971; AHF, 1976; Section II, this volume). There are increases in oil and grease and a number of other parameters in sediments that may well inhibit reproduction of the meroplanktonic species in spite of improved conditions.

Stenothoe valida is usually found associated with the hydroid, *Tubularia crocea*, according to Barnard and Reish (1959). *Armandia bioculata* and *Platynereis bicanaliculata* were associated by them with algae or eel grass. The algal growth on pilings has improved in recent years but both species have decreased in numbers and occurrences.

The implications of the apparent change in composition of the higher consumers in the food chain may be important, as is discussed in Section IIIG of this volume. Polychaetes for which caloric values were examined had a range of 4350 to 5680 calories per gram (ash-free). Amphipods and copepods tested had 4346 to 4374 cal/g. However, the chitenous exoskeletons of crustaceans represent more feeding effort to obtain the nutrients and an indigestible waste material which some animals cannot digest.

It is of interest that *Jassa falcata* disappeared from the harbor following the *Sansinena* Bunker C spill in December 1976, and did not return in substantial numbers until mid summer 1977.

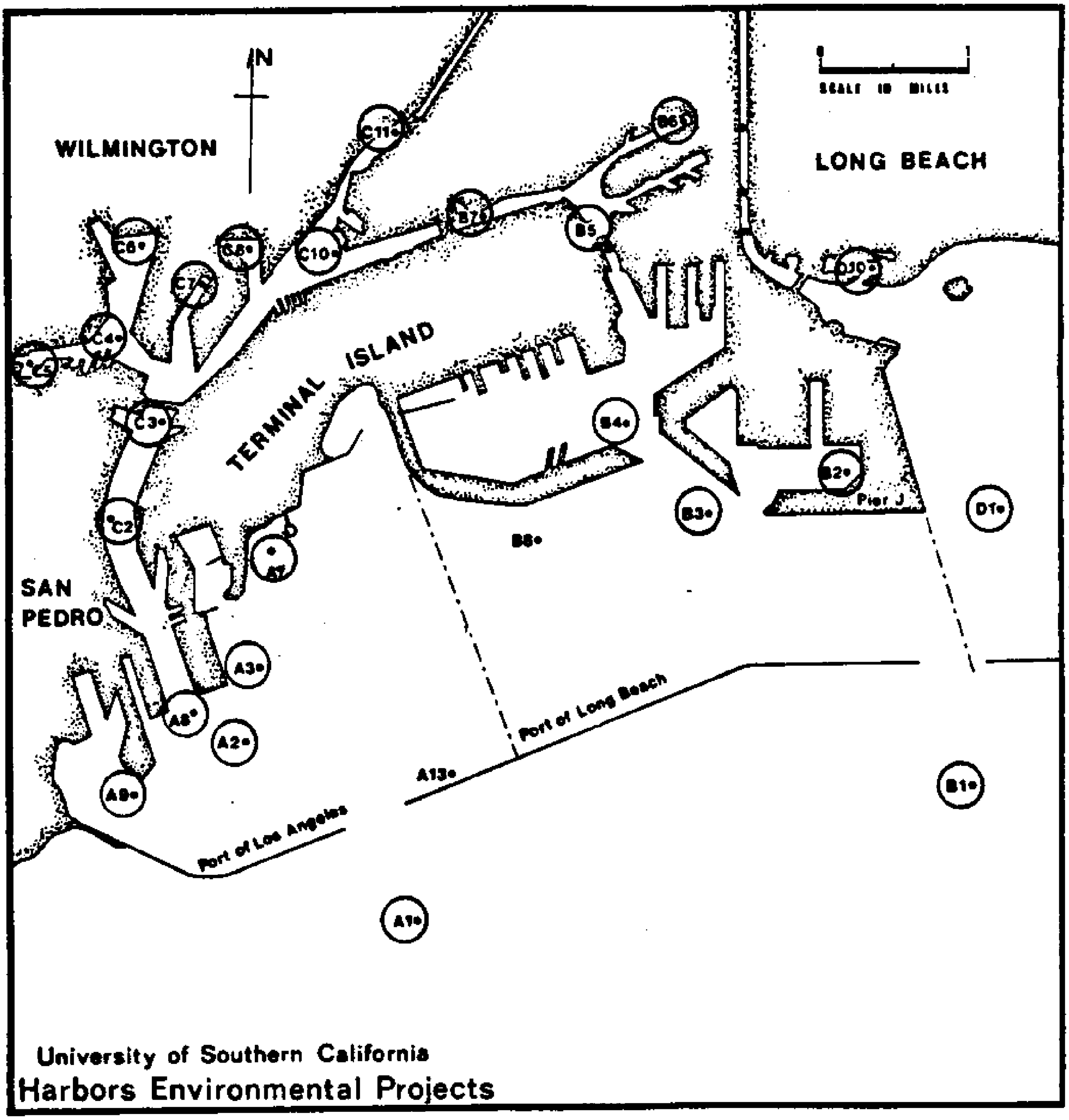


Figure 1. Settling Rack Locations, 1978.

TABLE 1. RANKING OF DOMINANT SETTLING RACK SPECIES BY NUMBERS OF OCCURRENCES AND INDIVIDUALS, 1978 COMPARED WITH 1973-74.

1978 Rank	Species	Type	1978 # Occurrences	Rank 1973-74	$\bar{X}$ Annual # Occurrences	1978 Rank	Species	1978 Total #	1973-74 Rank	1973-74 $\bar{X}$ Annual #
1.	*Corophium acherusicum*	amphipod	223	1	327	1.	*Jassa falcata*	216,394	1	312,950
2.	*Hydroides pacificus*	polychaete	189	12	177	2.	*Corophium acherusicum*	106,916	2	133,051
3.	*Jassa falcata*	amphipod	184	2	298	3.	*Caprella verrucosa*	57,500		
4.	*Ciona intestinalis*	ascidian	176	3	274	4.	*Caprella equilibra*	44,048	7	14,630
5.	*Stenothoe valida*	amphipod	152	8	190	5.	*Ciona intestinalis*	34,885	3	92,720
6.	*Caprella californica*	amphipod	145	7	191	6.	*Podocerus brasiliensis*	30,744	6	23,758
7.	*Caprella equilibra*	amphipod	144	9	189	7.	*Mytilus edulis*	20,319	8	14,066
8.	*Podocerus brasiliensis*	amphipod	139	6	220	8.	*Hydroides pacificus*	14,794	4	41,174
9.	*Mytilus edulis*	pelecypod	132	14	166	9.	*Caprella californica*	13,646	11	8,424
10.	*Anatanais normani*	tanaid	131	10	187	10.	*Stenothoe valida*	12,955	9	8,825
11.	*Platynereis bicanaliculata*	polychaete	128	5	229	11.	*Ericthonius brasiliensis*	12,358		
12.	*Elasmopus rapax*	amphipod	116			12.	*Polyophthalmus pictus*	6,966		
13.	*Caprella verrucosa*	amphipod	106			13.	*Limnoria tripunctata*	5,620		
14.	*Ericthonius brasiliensis*	amphipod	106			14.	*Anatanais normani*	4,763	13	4,758
15.	*Polyophthalmus pictus*	polychaete	99			15.	*Leptopecten latiauratus*	3,066		
16.	*Capitella capitata*	polychaete	96	13	171	16.	*Elasmopus rapax*	2,706		
17.	*Limnoria tripunctata*	burrowing isopod	96			17.	*Ianiropsis*, sp.	2,637		
18.	*Balanus amphitrite*	barnacle	92			18.	*Paracerceis sculpta*	1,997		
19.	*Polydora limnicola*	polychaete	90	4	238	19.	*Platynereis bicanaliculata*	1,815	15	3,028
20.	*Ctenodrilus serratus*	polychaete	89	15	160	20.	*Gammaropsis thompsoni*	1,513		
21.	*Ianiropsis*, sp.	isopod	83			21.	*Balanus amphitrite*	1,438		
22.	*Leptopecten latiauratus*	pelecypod	68			22.	*Polydora limnicola*	1,263	5	34,268
23.	*Paracerceis sculpta*	isopod	66			23.	*Paleonotus bellis*	1,240		
24.	*Paleonotus bellis*	polychaete	65			24.	*Ctenodrilus serratus*	1,217	10	8,695
25.	*Armandia bioculata*	polychaete	59	11	184	25.	*Armandia bioculata*	907	12	7,506
						( )	*Capitella capitata*	537	14	4,060

TABLE 2. NUMBERS OF INDIVIDUALS OF DOMINANT SETTLING RACK SPECIES BY STATION, DECEMBER 1977 THROUGH DECEMBER 1978 (245 racks analyzed).

Rank	Species \ Station	A1	A2	A3	A7	A8	A9	A13	B1	B2	B3	B4	B5	B6	B7	D1	C2	C3	C5	C6	C7	C8	C10	C11	
1.	*Jassa falcata*	5164	15955	27903	29026	27552	20412	30380	9346	2723	36458	4606	2962	50	1075	11800	172	94	6	13	10	23	19	15	222,374
2.	*Corophium acherusicum*	1071	1645	1918	22269	5973	4389	370	262	5838	6963	1748	7718	11775	8058	1687	3776	1384	1847	9301	3007	1419	3137	1545	109,070
3.	*Caprella verrucosa*	15137	10926	6103	3549	1151	8843	2496	6	202	4178	69	5	4	2	5359	0	2	9	1	2	3	8	8	58,411
4.	*Caprella equilibra*	8308	1775	453	1019	170	691	2980	11046	417	8198	4191	1026	58	134	1977	359	39	3	1	1	21	782	1	46,650
5.	*Ciona intestinalis*	20	756	758	1168	1469	4985	313	2	480	1457	4122	2722	1659	1372	105	2634	2142	1174	832	1103	2283	3635	1913	36,504
6.	*Podocerus brasiliensis*	2247	3844	2776	2512	7180	2605	124	1571	4237	3157	216	1368	0	101	282	506	183	1	2	8	3	68	2	32,877
7.	*Mytilus edulis*	457	1325	1850	5169	1803	1117	112	528	142	5535	512	164	16	17	1326	78	26	4	46	27	1	66	0	20,430
8.	*Hydroides pacificus*	10	237	334	479	422	502	36	18	561	901	804	628	2195	752	212	814	535	196	79	123	870	3510	876	15,112
9.	*Stenothoe valida*	2927	1771	431	350	1026	1780	88	1521	174	3033	192	111	3	1	313	129	30	4	5	2	2	288	3	14,684
10.	*Caprella californica*	640	74	381	103	515	1365	28	1962	1227	3144	2237	717	55	213	16	306	77	1	4	4	5	367	3	13,943
11.	*Ericthonius brasiliensis*	8	0	68	20	21	97	8	1	4871	733	1482	1691	772	1036	352	51	45	0	3	2	8	1159	1	12,429
12.	*Polyophthalmus pictus*	43	389	329	2789	888	498	188	24	351	1059	538	135	2	5	103	21	6	0	6	0	1	8	1	7,304
13.	*Limnoria tripunctata*	2	3	3	1	2	11	0	4	0	9	3	93	883	611	0	14	53	579	202	754	4	30	2439	5,632
14.	*Anatanais normani*	4	169	573	287	812	1186	24	0	117	68	120	110	36	1155	23	16	92	9	24	6	14	24	24	4,093
15.	*Leptopecten latiauratus*	885	560	232	300	520	195	16	374	54	84	55	95	4	6	0	30	14	0	2	2	0	34	0	3,470
16.	*Elasmopus rapax*	5	2	12	20	77	61	0	3	701	90	34	271	657	474	0	76	71	6	63	126	23	44	7	2,835
17.	*Janiropsis, sp.*	0	0	5	0	37	5	0	3	144	3	0	716	44	205	359	455	5	0	307	43	335	2	33	2,696
18.	*Paracerceis sculpta*	7	2	0	4	1	0	0	0	1127	0	0	49	307	369	0	3	11	2	5	26	2	6	1	1,997
19.	*Platynereis bicanaliculata*	195	289	234	350	138	125	180	79	36	145	47	27	4	9	0	25	15	4	3	3	3	13	4	1,856
20.	*Gammaropsis thompsoni*	0	53	16	92	895	53	0	0	382	3	12	14	0	0	0	0	0	0	0	0	0	0	3	1,523
21.	*Balanus amphitrite*	16	6	16	51	41	0	0	5	0	23	55	65	95	99	15	110	68	4	11	0	75	508	156	1,445
22.	*Polydora limicola*	1	41	73	225	113	164	8	0	56	106	16	56	10	6	67	79	95	3	114	15	6	12	13	1,279
23.	*Ctenodrilus serratus*	5	45	19	100	9	45	0	0	6	74	4	1	47	71	0	154	279	74	163	39	95	21	14	1,265
24.	*Palaeonotus bellis*	73	108	120	127	49	27	88	81	19	226	76	13	1	42'	177	19	1	0	0	0	0	4	1	1,247
25.	*Armandia bioculata*	0	10	78	390	114	25	0	0	132	7	56	73	1	12	0	60	13	0	5	0	0	0	0	984

TABLE 3. RANKING OF DOMINANT SETTLING RACK SPECIES BY NUMBER OF OCCURRENCES BY MONTH (245 samples analyzed)

	Dec* '77	Jan '78	Feb '78	Mar '78	Apr '78	May '78	Jun '78	Jul '78	Aug '78	Sep '78	Oct '78	Nov '78	Dec '78	Total # Occurrences
1. *Corophium acherusicum*	7	15	16	15	16	21	17	21	21	20	21	20	20	230
2. *Hydroides pacificus*	7	13	15	8	11	17	16	18	20	19	18	19	15	196
3. *Jassa falcata*	6	10	10	12	13	19	14	20	21	16	19	16	14	190
4. *Ciona intestinalis*	8	10	12	7	12	17	14	16	18	18	18	18	16	184
5. *Stenothoe valida*	5	11	12	12	12	14	10	12	14	14	15	14	12	157
6. *Caprella californica*	6	12	7	6	8	14	13	15	14	15	13	14	14	151
7. *Caprella equilibra*	2	7	7	8	14	13	12	13	14	17	15	14	10	146
8. *Podocerus brasiliensis*	6	13	10	9	7	12	8	11	13	14	15	12	15	145
9. *Anatanais normani*	6	6	6	6	10	15	14	16	15	14	11	9	9	137
10. *Mytilus edulis*	2	8	10	12	14	17	12	8	11	10	10	12	8	134
11. *Platynereis bicanaliculata*	6	10	10	12	13	13	7	8	11	13	10	10	11	134
12. *Elasmopus rapax*	5	10	8	5	5	9	8	8	10	15	11	12	15	121
13. *Caprella verrucosa*	5	6	5	6	8	12	5	9	10	10	13	11	11	111
14. *Ericthonius brasiliensis*	5	10	8	3	2	9	9	10	9	9	15	11	11	111
15. *Polyophthalmus pictus*	6	3	5	0	5	4	12	7	10	10	15	15	13	105
16. *Balanus amphitrite*	3	4	0	3	10	17	10	12	6	11	8	8	3	95
17. *Capitella capitata*	5	4	5	9	9	11	9	9	8	4	8	10	10	101
18. *Limnoria tripunctata*	1	4	9	10	11	11	8	8	7	7	7	8	6	97
19. *Ctenodrilus serratus*	3	3	5	4	6	10	8	14	13	9	9	4	4	92
20. *Polydora limnicola*	2	1	1	7	7	13	6	10	11	11	7	10	6	92
21. *Ianiropsis*, sp.	2	2	4	3	6	10	8	7	8	9	11	8	7	85
22. *Leptopecten latiauratus*	3	9	15	11	12	8	3	0	1	1	2	1	5	71
23. *Paleonotus bellis*	3	4	0	2	8	12	11	10	7	6	2	2	1	68
24. *Paracerceis sculpta*	0	5	5	3	4	5	7	2	4	9	8	7	7	66
25. *Armandia bioculata*	4	5	0	0	3	7	7	6	5	3	6	7	10	63

* outer harbor only

Table 4. Species Diversity of Settling Rack Fauna

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason *
Dec. 6, 1977						
A1	23	6346	1.8735	3.1355	0.5975	2.5127
A3	24	6794	1.3895	3.1781	0.4372	2.6066
A7	23	2470	1.5819	3.1355	0.5045	2.8162
A8	28	3932	2.5907	3.3322	0.7775	3.2621
A9	25	3592	2.2113	3.2189	0.6870	2.9317
C2	24	917	1.7920	3.1781	0.5639	3.3719
C3	19	668	1.6978	2.9444	0.5766	2.7674
Jan. 4, 1978						
A1	19	5494	2.0576	2.9444	0.6988	2.0902
A2	25	1836	2.2663	3.2189	0.7041	3.1935
A7	28	2085	1.8892	3.3322	0.5669	3.5329
A8	30	1425	2.6609	3.4012	0.7823	3.9934
C2	22	604	1.4697	3.0910	0.4755	3.2793
C3	24	331	1.6302	3.1781	0.5130	3.9641
Jan. 13, 1978						
B1	19	4742	1.9210	2.9444	0.6524	2.1266
B2	11	34	1.7682	2.3979	0.7374	2.8358
B3	29	4451	1.4316	3.3673	0.4251	3.3330
B4	19	996	1.6855	2.9444	0.5724	2.6073
B5	21	821	1.2347	3.0445	0.4055	2.9804
B6	13	177	1.8994	2.5649	0.7405	2.3183
B7	12	551	1.0803	2.4849	0.4349	1.7428
D2	14	336	1.5240	2.6391	0.5775	2.2348
February 1, 1978						
C2	11	28	2.1557	2.3979	0.8990	3.0010
C3	16	109	1.5091	2.7726	0.5443	3.1974
February 8, 1978						
B1	18	848	2.3529	2.8904	0.8141	2.5212
B3	19	709	1.8180	2.9444	0.6174	2.7423
B4	14	610	0.8290	2.6391	0.3141	2.0270
B5	14	211	1.8399	2.6391	0.6972	2.4291
B6	14	370	1.7793	2.6391	0.6742	2.1984
B7	19	211	1.3174	2.9444	0.4474	3.3633
February 15, 1978						
C2	5	10	1.4185	1.6094	0.8814	1.7372
C3	9	16	1.9770	2.1972	0.8998	2.8854
C5	11	40	1.6172	2.3979	0.6744	2.7108
C7	15	75	2.3069	2.7080	0.8519	3.2426
C10	12	61	1.7191	2.4849	0.6918	2.6758
C11	5	82	0.6270	1.6094	0.3896	0.9077

* Gleason = Margalef, 1951.

Table 4 (continued)

March 2, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
A1	26	2285	2.2022	3.2581	0.6759	3.2324
A2	21	1609	2.0106	3.0445	0.6604	2.7088
A3	24	3977	1.8694	3.1781	0.5882	2.7750
A7	27	5717	1.9584	3.2958	0.5942	3.0054
A8	25	1119	2.0229	3.2189	0.6285	3.4187
A9	22	1487	2.1264	3.0910	0.6879	2.8749

March 8, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
B3	24	2781	1.5968	3.1781	0.5024	2.9002
B4	18	569	0.9411	2.8904	0.3256	2.6797
B5	17	275	1.9541	2.8332	0.6897	2.8486
B6	12	232	1.1979	2.4849	0.4821	2.0196
B7	14	223	1.2495	2.6391	0.4735	2.4042

March 15, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
C2	13	116	1.6110	2.5649	0.6281	2.5244
C3	14	95	1.2671	2.6391	0.4801	2.8547
C5	8	168	0.6582	2.0794	0.3165	1.3661
C6	9	72	1.5168	2.1972	0.6903	1.8706
C7	11	136	1.9359	2.3979	0.8073	2.0356
C8	5	85	0.6535	1.6094	0.4060	0.9004
C10	17	189	1.2211	2.8332	0.4310	3.0524
C11	6	508	0.1943	1.7918	0.1084	0.8025

April 5, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
A1	19	4483	1.8748	2.9444	0.6367	2.1408
A2	22	8264	2.0067	3.0910	0.6492	2.3282
A3	22	11932	1.4303	3.0910	0.4627	2.2371
A7	29	18234	1.3422	3.3673	0.3986	2.8539
A8	42	5247	2.2525	3.7377	0.6027	4.7867

April 12, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
B1	17	597	2.0236	2.8332	0.7143	2.5032
B3	32	25048	1.3242	3.4657	0.3821	3.0607
B5	28	700	2.5004	3.3322	0.7504	4.1215
B6	20	443	1.7111	2.9957	0.5712	3.1180
B7	27	2819	1.2413	3.2958	0.3766	3.2729
D1	27	3445	2.0583	3.2958	0.6245	3.1923

April 19, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
C2	29	844	2.2108	3.3673	0.6565	4.1554
C3	24	410	2.3140	3.1781	0.7281	3.8230
C5	11	307	1.5908	2.3979	0.6634	1.7462
C7	21	407	2.0971	3.0445	0.6888	3.3284
C8	16	304	1.4405	2.7726	0.5196	2.6237
C10	24	2377	1.7297	3.1781	0.5443	2.9587
C11	13	1150	0.6075	2.5649	0.2368	1.7027

Table 4 (continued)

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
May 3, 1978						
A1	19	3634	2.2684	2.9444	0.7704	2.1956
A2	26	5670	1.5609	3.2581	0.4791	2.8925
A3	32	5130	1.7949	3.4657	0.5179	3.6288
A7	36	12297	1.6805	3.5835	0.4690	3.7166
A8	39	3815	2.1777	3.6636	0.5944	4.6079
A9	42	7985	1.7132	3.7377	0.4584	4.5630
May 10, 1978						
B1	15	2528	1.5828	2.7080	0.5845	1.7868
B2	36	4002	2.0443	3.5835	0.5705	4.2196
B3	32	5040	1.4178	3.4657	0.4091	3.6363
B4	22	3522	1.7036	3.0910	0.5511	2.5714
B5	35	1932	2.4450	3.5553	0.6877	4.4936
B6	32	613	2.0569	3.4657	0.5935	4.8299
B7	27	1178	1.5073	3.2958	0.4573	3.6767
D1	25	3580	1.0712	3.2189	0.3328	2.9329
May 17, 1978						
C2	33	838	2.5821	3.4965	0.7385	4.7541
C3	26	1052	1.8670	3.2581	0.5730	3.5928
C5	18	302	1.6964	2.8904	0.5869	2.9770
C6	30	2327	1.7919	3.4012	0.5269	3.7408
B7	18	860	0.5589	2.8904	0.1934	2.5159
C8	14	206	1.8351	2.6391	0.6953	2.4400
C10	27	1622	2.0586	3.2958	0.6246	3.5176
C11	14	983	1.8190	2.6391	0.6893	1.8866
June 7, 1978						
A3	24	10668	1.6675	3.1781	0.5247	2.4798
A7	25	11476	1.5553	3.2189	0.4832	2.5674
A8	28	8224	1.6245	3.3322	0.4875	2.9951
June 14, 1978						
B1	19	10996	1.5131	2.9444	0.5139	1.9344
B3	30	24968	1.8548	3.4012	0.5453	2.8641
B4	27	6840	2.1628	3.2958	0.6562	2.9443
B5	33	6376	1.9138	3.4965	0.5473	3.6528
B6	21	7104	0.8471	3.0445	0.2782	2.2552
B7	25	4292	1.4158	3.2189	0.4398	2.8693
D1	25	15172	1.9649	3.2189	0.6104	2.4929
June 21, 1978						
C7	18	1572	1.6575	2.8904	0.5735	2.3097
C11	19	1317	1.8961	2.9444	0.6439	2.5059
June 26, 1978						
B2	32	9104	1.9432	3.4657	0.5607	3.4004

Table 4 (continued)

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
July 5, 1978						
A1	11	1460	1.5017	2.3979	0.6262	1.3725
A2	27	4884	2.0166	3.2958	0.6119	3.0611
A3	26	19764	1.1672	3.2581	0.3582	2.5274
A7	25	5336	2.1130	3.2189	0.6564	2.7965
A8	29	16556	0.9427	3.3673	0.2800	2.8823
A9	23	7560	1.8935	3.1355	0.6039	2.4634
July 12, 1978						
B1	10	12264	1.0474	2.3026	0.4549	0.9560
B2	25	704	2.1819	3.2189	0.6779	3.6603
B3	30	11848	2.2475	3.4012	0.6608	3.0917
B4	25	5301	1.6652	3.2189	0.5173	2.7986
B5	30	4421	2.0486	3.4012	0.6023	3.4548
B6	20	5764	0.8787	2.9957	0.2933	2.1941
B7	20	4928	1.8745	2.9957	0.6257	2.2346
July 19, 1978						
C2	26	2408	1.3949	3.2581	0.4281	3.2107
C3	27	3131	1.2506	3.2958	0.3794	3.2302
C5	13	525	1.0251	2.5649	0.3997	1.9159
C6	21	3089	0.7381	3.0445	0.2424	2.4889
C7	17	2455	0.8876	2.8332	0.3133	2.0497
C8	18	1958	1.5422	2.8904	0.5336	2.2428
C10	24	5990	1.9454	3.1781	0.6121	2.6443
C11	18	2193	1.7346	2.8904	0.6001	2.2098
August 2, 1978						
A1	20	12460	1.3712	2.9957	0.4577	2.0148
A2	23	8348	1.9536	3.1355	0.6230	2.4364
A3	24	6834	1.9103	3.1781	0.6011	2.6049
A7	25	13804	1.7431	3.2189	0.5415	2.5176
A8	22	4560	2.0717	3.0910	0.6702	2.4926
A9	25	19780	1.9288	3.2189	0.5992	2.4261
A13	20	5220	1.7430	2.9957	0.5818	2.2196
August 9, 1978						
B1	10	4000	1.4744	2.3026	0.6403	1.0851
B2	30	3176	2.4963	3.4012	0.7339	3.5965
B3	27	15664	2.2447	3.2958	0.6811	2.6918
B4	19	10608	1.6674	2.9444	0.5663	1.9419
B5	22	4128	2.2607	3.0910	0.7314	2.5224
B6	20	2376	1.9408	2.9957	0.6479	2.4443
B7	20	3576	2.0856	2.9957	0.6962	2.3222
D1	19	6928	1.9340	2.9444	0.6568	2.0354
August 16, 1979						
C2	28	2140	2.1087	3.3322	0.6328	3.5209
C3	28	1300	2.1449	3.3322	0.6437	2.7656
C5	17	1032	1.7844	2.8332	0.6298	2.3057
C6	21	509	2.0697	3.0445	0.6798	3.2090
C7	22	623	1.8996	3.0910	0.6145	3.2636
C8	25	1488	1.9361	3.2189	0.6015	3.2853
C10	20	6560	2.0334	2.9957	0.6788	2.1619
C11	19	875	2.0993	2.9444	0.7130	2.6571

Table 4 (continued)

Stn.	Species	Individuals	(H') Shannon-Wiener	H'(Max)	(J') Evenness	Gleason
A1	19	32120	1.3385	2.9444	0.4546	1.7346
A2	20	17568	1.7819	2.9957	0.5948	1.9440
A3	31	8419	2.0598	3.4340	0.5998	3.3192
A7	28	13744	2.0677	3.3322	0.6205	2.8336
A9	24	12448	1.5432	3.1781	0.4856	2.4392
A13	22	11800	1.4426	3.0910	0.4667	2.2398
September 13, 1978						
B1	17	2378	1.9210	2.8332	0.6780	2.0581
B2	27	6572	2.1458	3.2958	0.6511	2.9577
B3	23	11888	2.2070	3.1355	0.7039	2.3446
B4	16	11461	1.3750	2.7726	0.4959	1.6048
B5	24	5248	2.3597	3.1781	0.7425	2.6852
B6	20	2536	2.0276	2.9957	0.6768	2.4240
B7	19	3127	1.9956	2.9444	0.6778	2.2366
D1	24	8669	1.8479	3.1781	0.5815	2.5365
September 20, 1978						
C2	32	1817	2.5168	3.4657	0.7262	4.1306
C3	24	796	2.3433	3.1781	0.7373	3.4433
C5	17	268	2.1631	2.8332	0.7635	2.8617
C6	19	520	1.8518	2.9444	0.6289	2.8782
C7	19	798	1.0545	2.9444	0.3581	2.6938
C8	19	611	1.3410	2.9444	0.4554	2.8059
C10	12	2097	2.0810	2.4849	0.8375	1.4382
C11	20	791	2.0726	2.9957	0.6918	2.8472
October 1, 1978						
A2	25	2504	2.0152	3.2189	0.6260	3.0668
October 4, 1978						
A1	16	4906	0.7223	2.7726	0.2605	1.7651
A2	31	5984	2.1129	3.4340	0.6153	3.4495
A3	27	4837	2.0507	3.2958	0.6222	3.0646
A7	30	6683	2.0299	3.4012	0.5968	3.2927
A8	21	8504	1.7352	3.0445	0.5700	2.2104
A9	23	4668	2.2967	3.1355	0.7325	2.6027
A13	19	14928	1.5023	2.9444	0.5102	1.8729
October 11, 1978						
B2	29	3491	2.2237	3.3673	0.6604	3.4322
B3	21	3109	2.4286	3.0445	0.7977	2.4869
B4	17	3376	2.0407	2.8332	0.7203	1.9694
B5	27	1724	2.4282	3.2958	0.7367	3.4888
B6	20	421	2.1022	2.9957	0.7017	3.1443
B7	23	715	2.3547	3.1355	0.7510	3.3474
D1	10	90	1.9145	2.3026	0.8314	2.0001
October 18, 1978						
C2	28	1096	2.5612	3.3322	0.7686	3.8575
C3	24	354	1.8834	3.1781	0.5926	3.9187
C5	15	229	1.5692	2.7080	0.5795	2.5765
C6	24	310	2.1726	3.1781	0.6836	4.0094
C7	24	491	1.5522	3.1781	0.4884	3.7118
C8	19	433	1.6848	2.9444	0.5722	2.9650
C10	22	2116	2.3375	3.0910	0.7562	2.7425
C11	14	260	1.6515	2.6391	0.6258	2.3378

Table 4 (continued)

November 1, 1978

Stn.	Species	Individuals	(H') Shannon-Wiener	H(Max)	(J') Evenness	Gleason
A1	17	1009	1.8585	2.8332	0.6560	2.3132
A3	26	2521	1.8969	3.2581	0.5822	3.1919
A7	32	4093	2.2440	3.4657	0.6475	3.7273
A8	27	3753	2.1467	3.2958	0.6513	3.1591
A9	23	2000	2.1713	3.1355	0.6925	2.8944
A13	14	3481	1.2065	2.6391	0.4572	1.5941

November 9, 1979

Stn.	Species	Individuals	(H') Shannon-Wiener	H(Max)	(J') Evenness	Gleason
B1	18	1364	1.5435	2.8904	0.5340	2.3552
B2	30	2285	2.4915	3.4012	0.7325	3.7496
B3	29	5382	1.9533	3.3673	0.5801	3.2593
B4	21	3552	2.2598	3.0445	0.7422	2.4464
B5	19	728	1.9015	2.9444	0.6458	2.7313
B7	25	1357	1.9188	3.2189	0.5961	3.3273
C2	24	792	2.0731	3.1781	0.6523	3.4459
C3	26	428	2.1739	3.2581	0.6672	4.1260
C5	13	241	1.6245	2.5649	0.6333	2.1879
C6	21	278	1.9186	3.0445	0.6302	3.5539
C7	14	278	1.6209	2.6391	0.6142	2.3100
C8	16	289	1.8878	2.7726	0.6809	2.6472
C10	19	1003	1.5207	2.9444	0.5165	2.6046
C11	11	184	1.7151	2.3979	0.7152	1.9176

F. MARINE-ASSOCIATED BIRDS

INTRODUCTION

The bird populations of the entire Los Angeles-Long Beach Harbors area was studied intensively in 1973 and 1974 by Harbors Environmental Projects (AHF, 1976). That study, carried out at 48 stations throughout the harbor (Figure 1) consisted of field observations by trained observer teams using a Boston Whaler. In addition to enumerating species and populations, notes on behavior such as feeding, flying, nesting or resting were made. Three other stations in the middle outer harbor had been occupied in the early weeks of the survey but were excluded from further consideration because few birds were observed on the open water.

Identifications and counts were made independently by two or more observers, and the observations were recorded on tape for later transcription and multiple discriminant computer analysis. Data were collected by Tom Webber and Elizabeth Copper, associated with Dr. J. William Hardy, then of Occidental College in Los Angeles, and HEP staff.

In 1978, a quarterly bird census in the outer harbors only was funded by the City of Los Angeles Terminal Island Treatment Plant environmental impact report investigations. These observations were carried out at 31 of the 48 original station sites, all in the outer harbors, by Dr. Dennis Power, Director of the Santa Barbara Museum of Natural History, his associate Paul Collins and HEP staff. Extensive analysis of the 1978 data was presented in Marine Studies of San Pedro Bay, California, Part 16 (Soule and Oguri, 1979). In addition, counts of birds were made approximately monthly in conjunction with a shoreline angler survey, also reported in that volume (Section IIB). A summary of those results follows.

RESULTS

In the earlier survey, 77 species were reported from the 31 stations that were also occupied during the second study, whereas 52 species were seen in 1978 at those sites. However, differences in frequency of sampling and the large number of species represented by only a few individuals or occurrences during both surveys precludes attaching significance to a comparison of the number of species sighted.

The average number of birds seen in each survey for the same outer harbor stations studied during the two surveys showed a sharp drop in 1978 to 40 percent of the birds seen in 1973-1974; from 5,665.9 in 1973-74 to 2.240.65 in 1978. However, the gull species showed a 31 percent drop, from 3,870.6 to 1,187.5. California gulls experienced a 23-fold decrease in 1978. All other bird species, excluding gulls, showed a drop of 41%, from an average 1,795.3 birds seen per survey to 1,053.15.

Sightings of the two endangered species that occur in the harbor showed increases in total numbers. The Brown Pelican averaged 216.8 sightings per survey in 1973-1974 and 313.8 in 1978. The Least Tern sightings increased from an average of 4.4 to 9.3 in the same period.

Since the harbor area serves as a resting and feeding area for migratory bird species as well as year-round resident species, there was a distinct seasonal pattern to bird sightings. Text Table 1, showing the average sightings per station for each season, shows the importance of the area as an overwintering or resting and feeding area for the transient species.

Text Table 1. Average Number of Birds Seen per Station During Each Season (Soule and Oguri, 1979).

	January	April	July	October	Annual Average
1973-1974	214.1	52.9	62.1	231.5	187.8
1978	74.5	50.5	54.2	115.0	72.3

In 1973-1974 the average sightings during winter and fall were about four times greater than during the spring and summer when the migratory species were not present. In 1978 the migratory populations were reduced to about 43% of the earlier period, but the sightings during the spring and summer were only slightly lower. Thus, migratory birds only doubled the bird population during the migratory seasons. The drop of bird populations in the harbor observed during the two periods is due almost entirely to the drop in the presence of seasonal transients in search of food and resting sites.

Not all species showed a drop in sightings, although most did. Among the ten most numerous species seen in 1978, seven showed reductions in count from the number seen in 1973-1974, as shown in Text Table 2, and three species showed increased average numbers sighted. Eight species were among the ten most numerous species for both observation periods, and only one of those, the endangered Brown Pelican, showed an increase in numbers sighted. The ten most numerous birds in both periods accounted for 93% of all birds in the earlier period and 88% in 1978. This reflects the sharp reduction in gull populations compared to the species between the two periods, although gull species continued to dominate the bird populations of the harbor numerically. Tables of all species seen in the four 1978 seasons and comparisons of all species and annual means for 1973-1974 and 1978 are shown in Tables 2 and 3, from Soule and Oguri (1979).

Distribution of the birds in the outer harbor was non-random, with high numbers of species and individuals being observed in areas near the outfalls, station X71 to X75, near Angels Gate, at stations X56 and X58, near Queens Gate, station X62 and at the northern end of Cabrillo Beach at station X50. These areas apparently offer a diversity of substrate in relatively sheltered areas such as at X50 and X71 to X75, or are near the isolated interface of ocean and harbor waters such as at stations X56, X58 and X62. During the period when TITP malfunctioned in the summer of 1978, and fish were attracted to the dike near the sewer outfall (station 75), birds increased. Over the year, however, the number of species increased nearby but numbers decreased greatly.

DISCUSSION

The data clearly showed that there was a marked reduction in bird populations observed in 1978, particularly gulls, as compared with those seen in 1973-1974. In seeking reasons for this, the most obvious is that changes have taken place during the interim in the discharge of wastes into the outer harbor. In 1975 the two fish cannery outfalls were required to install dissolved air flotation treatment on their wastewater effluent. In early 1977 the Terminal Island Treatment Plant converted from advanced primary to secondary treatment of the waste water they discharged. Starting in the fall of 1977 and ending in early January of 1978, the waste water from the canneries was diverted into the treatment plant for secondary treatment. The result of each of these steps was the reduction of discharge of organic wastes into the harbor. These wastes had served as a nutrient for many organisms in the receiving waters, which may have served either directly or, after several intermediary trophic levels, indirectly as a food resource to support the larger bird populations observed in 1973-1974. It is notable, however, that decreases in gull populations did not lead to increases in numbers of species.

The following is a quote from Soule and Oguri (1979a), page 114:

> "The data presented here are consistent with the concept that secondary waste treatment of the effluents in the Los Angeles-Long Beach Harbors has removed a source of enrichment of the harbor food chain that was present before secondary waste treatment was in effect.

The sewer outfall boil itself seems never to have been a highly preferred, primary feeding site for any species of marine birds, probably because it is entirely turbulent water. The cannery effluent site was preferred and still is. The condition of nonsecondary-treated effluent in 1973-74 and earlier years, however, may have had an enriching effect on the food chain, which accounted for higher numbers of Surf Scoters, Black-bellied Plovers, Sanderlings, Forster's Terns, several species of gulls, and possibly other species as well, during the fall and winter months (nonbreeding season). The data do not prove this hypothesis because the direct links in the food chain are not identified and natural cycles of abundance of food organisms are not known."

Rare and Endangered Species

Two rare and endangered species of birds have been observed in the harbor. These are the Brown Pelican, *Pelicanus californicus occidentalis*, and the Least Tern, *Sterna albifrons browni*.

The Brown Pelican nests on offshore islands and is usually found in the harbor in greatest abundance during the spring, summer and fall. Activities in the harbor are primarily roosting and feeding, with favored locations being the rocky substrates of the federal breakwater, stations X58 to X62, and the area near Reeves Field, station X71.

In 1973-1974 this species was the seventh most numerous bird in the harbor with an average of 217 being observed each observation period. This comprised 3.8% of the total average of bird observations. In 1978 the average number of these birds seen during each observation period increased to 314. Because of the reduction in total numbers of birds in 1978, the pelican became the second most abundant species in the harbor and comprised 14 percent of the total birds observed.

Reasons for the increase in population of the Brown Pelican can be proposed. In earlier years reproductive failure of this species was attributed to high levels of DDT in the environment and in the food of the pelicans (Young, et al., 1976). They were especially high at the Whites Point outfall to the west of Cabrillo Beach. The levels have steadily declined since the production and use of DDT in the area were prohibited. However, concentrations were much lower in the harbor than they were nearby (see AHF, 1976 and Section IB of the present report). This suggests that increased breeding success may have occurred, resulting in larger overall populations of Brown Pelicans. Another possible factor is that the generally reduced bird populations in the harbor may have reduced competitive pressure on this species, permitting larger numbers of them to live there.

The Least Tern, *Sterna albifrons*, is normally found in the coastal regions of California, including the harbor, only in spring and summer. It is one of the few birds known to nest in the harbor itself, preferring isolated sandy areas near waters which contain an adequate source of small fish. In the harbor, the area near the outfalls and Reeves Field on Terminal Island has attracted breeding pairs. In 1973 and 1974 nesting activities were disrupted by construction activities and later by car storage on the land. In subsequent years breeding colonies have been reported at station X73 and to the north of stations X70 and X71 at the site of an abandoned air strip.

In 1973-1974 an average of 4.4 Least Terns were seen during each observation period. This increased to an average of 9.3 in 1978. In view of the relative scarcity of these birds and the difference in frequency of observation during the two studies, it is felt that the significance of the differences in numbers observed is limited.

<u>Summary</u>

The bird populations in the outer harbor in 1978 were reduced 2.5-fold as compared to those observed in 1973-1974. This 60% reduction was most notable in gull species, which declined to 31% of the earlier levels. Excluding gulls, all other species showed a drop of 41% from the earlier levels. It was apparent that there were major losses in the migratory or transient species in the harbor in fall and winter (Soule and Oguri, 1979).

Distribution of birds within the harbor indicated that the outfalls area was a preferred site in both periods, probably due to the availability of forage and undisturbed resting areas nearby. The alteration in wastes discharged there was also thought to be a major factor in the reduction of bird populations in the outer harbor.

Two rare and endanged species were observed in the harbor, the Brown Pelican, *Pelicanus occidentalis californicus*, and the Least Tern, *Sterna albifrons*. Both showed increased population in 1978 compared to 1973-74. Possible reasons for this include the decreased competition from other birds due to the decline in total populations. A definite factor for the Least Tern was the availability in 1978 of nearby nesting sites that were disrupted in earlier years. The Brown Pelican population increase may also be due to more successful breeding following the decline of DDT in the environment.

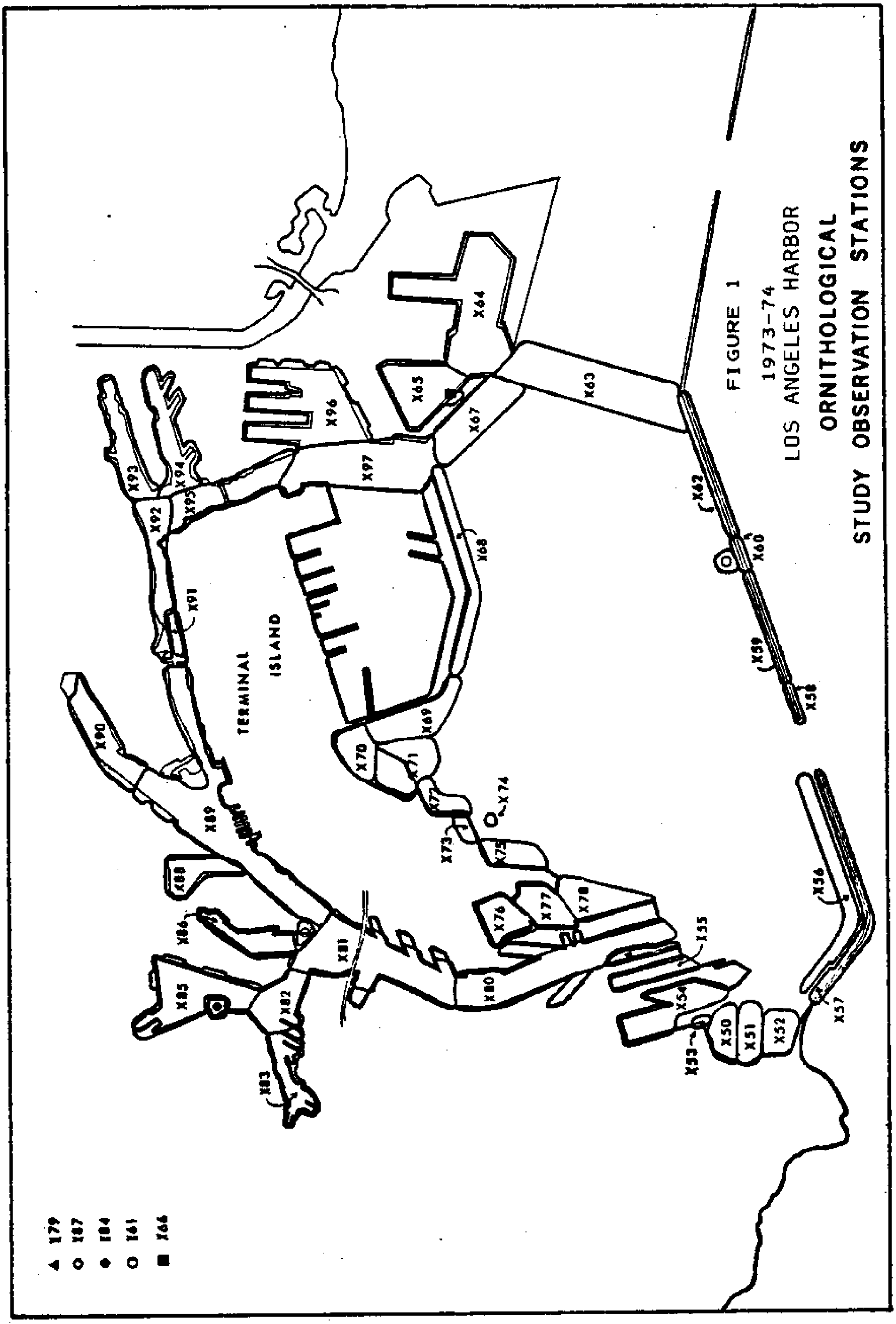


FIGURE 1
1973-74
LOS ANGELES HARBOR
ORNITHOLOGICAL
STUDY OBSERVATION STATIONS

Table 1. The Ten Most Numerous Birds Seen at Stations X50-X80 in 1973-1974 and 1978 and the Average Number per Observation (Soule and Oguri, 1979).

	1973-1974		1978	
1	Heerman's Gull	1,619.4	Heerman's Gull	634.3
2	Western Gull	1,267.4	Brown Pelican	313.8
3	Surf Scoter	813.6	Western Gull	310.8
4	California Gull	374.2	Surf Scoter	257.8
5	Sanderling	262.9	Western Grebe	100.3
6	Ring-billed Gull	231.2	Forster's Tern	81.5
7	Brown Pelican	216.8	Ring-billed Gull	73.5
8	Bonaparte's Gull	211.4	Mew Gull	73.3
9	Forster's Tern	159.5	Bonaparte's Gull	64.0
10	Mew Gull	104.4	Doubled-breasted Cormorant	51.8
Total - top ten		5,260.8		1,961.1
Total - all species		5,665.9		2,240.65

Table 2. Numbers of water and shore birds recorded in Los Angeles-Long Beach Harbors during quarterly surveys in 1978.

Species	January	April	July	October	Rank[1]
Loons (Gaviidae)					
Common Loon (Gavia immer)	--	5	3	--	36.5
Arctic Loon (Gavia arctica)	--	21	2	--	26
Red-throated Loon (Gavia stellata)	28	30	--	--	20
Grebes (Podicipedidae)					
Horned Grebe (Podiceps auritus)	3	--	--	2	43
Eared Grebe (Podiceps nigricollis)	55	2	--	20	13
Western Grebe (Aechmophorus occidentalis)	225	109	27	40	6
Pelicans (Pelecanidae)					
Brown Pelican (Pelecanus occidentalis)	20	229	253	753	2
Cormorants (Phalacrocoracidae)					
Double-crested Cormorant (Phalacrocorax auritus)	72	73	20	42	10
Brandt's Cormorant (Phalacrocorax penicillatus)	1	2	6	1	33
Pelagic Cormorant (Phalacrocorax pelagicus)	5	5	--	3	36.5
Herons (Ardeidae)					
Great Blue Heron (Ardea herodias)	19	--	5	4	27
Black-crowned Night Heron (Nycticorax nycticorax)	--	--	13	--	28
Ducks and Geese (Anatidae)					
Pintail (Anas acuta)	4	--	--	--	40.5
Cinnamon Teal (Anas cyanoptera)	65	--	--	--	12
Lesser Scaup (Aythya affinis)	29	--	--	--	21
Canvasback (Aythya valisineria)	1	--	--	--	50

Table 2 (Cont.)

Species	January	April	July	October	Rank[1]
Surf Scoter (Melanitta perspicillata)	308	174	225	324	4
Common Scoter (Melanitta nigra)	--	1	--	--	49.5
White-winged Scoter (Melanitta deglandi)	--	--	1	--	49.5
Red-breasted Merganser (Mergus serrator)	6	2	--	--	33
Rails (Rallidae)					
American Coot (Fulica americana)	--	--	--	2	45
Oystercatchers (Haematopodidae)					
Black Oystercatcher (Haematopus bachmani)	--	2	--	--	45
Plovers, Turnstones and Surfbirds (Charadriidae)					
Killdeer (Charadrius vociferus)	--	--	--	5	36.5
Snowy Plover (Charadrius alexandrinus)	--	1	--	--	49.5
Black-bellied Plover (Pluvialis squatarola)	44	9	8	28	17
Surfbird (Aphriza virgata)	--	4	3	3	40.5
Ruddy Turnstone (Arenaria interpres)	5	23	5	17	25
Black Turnstone (Arenaria melanocephala)	9	5	9	6	30.5
Sandpipers (Scolopacidae)					
Whimbrel (Numenius phaeopus)	--	6	2	--	33
Spotted Sandpiper (Actitis macularia)	3	9	7	4	30.5
Wandering Tattler (Heteroscelus incanus)	--	16	24	3	24
Willet (Catoptrophorus semipalmatus)	20	--	21	27	22.5
Least Sandpiper (Calidris minutilla)	5	--	--	4	36.5

Table 2 (Cont.)

Species	January	April	July	October	Rank[1]
Dunlin (Calidris alpina)	--	--	--	4	40.5
Western Sandpiper (Calidris mauri)	--	--	--	2	45
Sanderling (Calidris alba)	52	30	--	9	14.5
Marbled Godwit (Limosa fedoa)	1	--	1	--	49.5
Gulls and Terns (Laridae)					
Glaucous-winged Gull (Larus glaucescens)	10	--	--	--	29
Western Gull (Larus occidentalis)	250	439	264	290	3
Herring Gull (Larus argentatus)	52	--	--	1	14.5
California Gull (Larus californicus)	--	45	--	18	16
Ring-billed Gull (Larus delawarensis)	183	42	1	68	7
Mew Gull (Larus canus)	292	--	--	1	5
Bonaparte's Gull (Larus philadelphia)	134	68	--	54	9
Heermann's Gull (Larus heermanni)	175	44	754	1,564	1
Black-legged Kittiwake (Rissa tridactyla	12	27	1	--	22.5
Forster's Tern (Sterna forsteri)	45	112	9	160	8
Least Tern (Sterna albifrons)	--	35	2	--	18.5
Elegant Tern (Thalasseus elegans)	--	--	12	35	18.5
Royal Tern (Thalasseus maximus)	--	--	--	66	11
Caspian Tern (Hydroprogne caspia)	--	--	1	--	49.5
Kingfishers (Alcedinidae)					
Belted Kingfisher (Megaceryle alcyon)	--	--	1	4	40.5
TOTALS	2,311	1,564	1,680	3,564	

[1]Rankings based on highest single sighting in 1978, regardless of the season. See Table 4 for details.

Table 3. Average number of individuals seen per survey over stations X50 through X80

Common Name[1]	1973/74[2]	1978[3]	Difference[4]
Common Loon	3.2	2.0	-
Arctic Loon	0.8	5.8	+
Red-throated Loon	1.9	14.5	+
Horned Grebe	0.3	1.3	+
Eared Grebe	12.3	19.3	+
Western Grebe	9.1	100.3	+
Pied-billed Grebe	0.2	0	-
Brown Pelican	216.8	313.8	+
Double-crested Cormorant	29.0	51.8	+ (A+)
Brandt's Cormorant	1.9	2.5	+
Pelagic Cormorant	0.8	3.3	+
Great Blue Heron	5.2	7.0	+
Black-crowned Night Heron	0.1	3.3	+
Snowy Egret	0.1	0	-
Black Brant	0.1	0	-
Pintail	0	1.0	+
Cinnamon Teal	6.2	16.3	+
Mallard	0.2	0	-
Lesser Scaup	6.5	7.3	+
Canvasback	0	0.3	+
Surf Scoter	813.6	257.8	- (A+)
Common Scoter	1.1	0.3	-
White-winged Scoter	2.1	0.3	-
Ruddy Duck	0.1	0	-

Table 3 (cont.)

Common Name[1]	1973/74[2]	1978[3]	Difference[4]
Common Merganser	1.5	0	-
Red-breasted Merganser	3.5	2.0	-
American Coot	0.2	0.5	+
Black Oystercatcher	0	0.5	+
Killdeer	3.2	1.3	-
Snowy Plover	0.7	0.3	-
Semipalmated Plover	0.1	0.0	-
Black-bellied Plover	57.2	22.3	-
Surfbird	12.2	2.5	-
Ruddy Turnstone	17.7	12.5	-
Black Turnstone	23.7	9.7	-
Whimbrel	0.5	2.0	+
Spotted Sandpiper	4.4	5.8	+
Wandering Tattler	3.7	10.8	+
Willet	40.1	17.0	-
Least Sandpiper	7.3	2.3	-
Dunlin	0.4	1.0	+
Long-billed Dowitcher	1.4	0	-
Western Sandpiper	18.6	0.5	-
Marbled Godwit	3.5	0.5	-
Sanderling	262.9	22.8	-
Pomarine Jaeger	0.1	0	-
Parasitic Jaeger	0.4	0	-
Glaucous Gull	0.6	0.0	-

Table 3 (Cont.)

Common Name[1]	1973/74[2]	1978[3]	Difference[4]
Glaucous-winged Gull	10.9	2.5	-
Western Gull	1,267.4	310.8	-
Thayer's Gull	1.0	0	-
Herring Gull	50.1	13.3	-
California Gull	374.2	15.8	-
Ring-billed Gull	231.2	73.5	- (A-)
Mew Gull	104.4	73.3	-
Bonaparte's Gull	211.4	64.0	- (A-)
Heermann's Gull	1,619.4	634.3	- (A-)
Black-legged Kittiwake	29.0	10.0	-
Forster's Tern	159.5	81.5	- (A-)
Common Tern	0.3	0	-
Least Tern	4.4	9.3	+
Elegant Tern	14.6	11.8	-
Caspian Tern	10.8	0.25	-
Royal Tern	0	16.5	+
Common Murre	0.4	0	-
Belted Kingfisher	1.4	1.3	-

[1]See Table 1 for scientific names

[2]Average of 14 surveys in 1973/74.

[3]Average of 4 surveys in 1978.

[4] "-" indicates fewer birds were seen in 1978 than in 1973/74
"+" means more birds were seen in 1978 than in 1973/74
A = Audubon survey of adjacent areas, + or -.

G. HARBOR FOOD WEBS

INTRODUCTION

In the period prior to enforcement of water quality control standards, and prior to construction of the federal and eastern breakwaters and Pier J, the very polluted harbor areas had such poor faunal diversity that little interest was generated in energy flow. In contrast, the open outer harbor fauna was more like that of the nearshore oceanic waters, as illustrated by Ulrey and Greeley's 1928 fish species list (Chamberlain, 1974). Anoxic conditions in the innermost harbor led to sulfide bacterial slimes and occasionally to "white tides" apparently of colloidal sulfur from decomposition of or by bacteria.

Harbors Environmental Projects studies began in the outer harbor in 1971 and have chronicled the burgeoning of species diversity and numbers through 1973-1974, as well as subsequent declines or leveling off processes between 1975 and 1979 detailed elsewhere in this volume.

No single HEP study was designed to reveal the links in a harbor food web or energy flow investigation, but gradually some concepts on the nature of energy recycling have been developed as data and information were acquired. Coincidentally, during the 1970s, interest in understanding the nature of estuarine processes has increased nationally and worldwide. It has become essential to understand the processes and the comparative influence of oceanic and terrestrial inputs, both natural and manmade. The value of estuaries as nursery grounds to replenish biota of nearshore waters is only comparatively recently appreciated. The knowledge needed in order to manage ecosystems is still not adequate in most areas.

It is difficult to relate the long lists of local species to a conceptual framework of a food web, because many of the details on feeding habits and life "strategies" of most individual species are unknown. In a number of instances, the level of knowledge has not even reached the so-called "alpha taxonomy" state and organisms cannot be identified to species level. Major harbor species, and some higher categories, have not been sufficiently studied structurally to be described and given names in the appropriate scientific literature. For example, the members of the phylum Nematoda (thread worms) constitute a major portion of the benthic infauna of sandy areas and of finer, organic-laden sediments (Ferris and Ferris, 1979), but nematodes from the harbor area are not practicably identifiable. Another example is the polychaete worm *Tharyx* sp., which is one of the common species in the harbor and was the most common (45%) polychaete during the 1973-74 period. It was previously identified as *Tharyx parvus*, but taxonomic discrepancies were found and so it remains technically an undescribed species. The isopod *Ianiropsis* sp. is another unstudied, undescribed species.

Some of the earlier assumptions about food habits of various species were based on very limited data; gut contents or feeding behavior studies may well indicate consumption of particular particles or organisms, but it may not be known which particles are passed through without assimilation, whether other food is preferred if it is available, or whether selective feeding can be carried out. Generally, only macroflora and fauna can be discerned in gut contents, and isotopic tracer studies are needed to indicate whether microflora, microfauna, organic solutes or organic particles are supplying significant nutrients to various species. The myriads of species present defy the relatively few investigators and limited available funding to produce even elementary data on most species. It is fortunate when some few data exist for similar species or higher categories from some area of the world.

Food assimilation data for representative species are few, and even fewer studies attempt quantification of predator/prey energy transfer. Assumptions can be made and are of great interest, but the dearth of reliable data severely limits drawing conclusions from them.

In the following paragraphs the trophic levels in the harbor are discussed and known elements of the harbor food web are delineated. While certain roles have been identified, many intriguing questions will remain, for such research efforts require years of investigation to describe the various pieces in the puzzle and to attempt quantification. Funding levels for such basic science efforts are poor and the prognosis is not encouraging. If the nutrient role of detritus becomes better appreciated as an important source of support for larvae of shellfish or commercial fish species or for other marine products, perhaps interest in and funding of such research will increase.

The Detrital Food Web

The multiple roles of detritus in maintaining biological productivity of the nearshore marine environment are currently being investigated in many localities by a variety of techniques and investigations, and some notable parallels with patterns observed in the local harbors can be discerned in conditions and systems reported in the literature elsewhere.

PRIMARY UPTAKE OF NUTRIENTS

Three generalized pathways have been observed in the harbor ecosystem, by which organic nutrients may reach first-level macro-consumers, although there are several others that differ in detail and might be classified as separate pathways. One pathway is autotrophic,--through primary production by plant photosynthesis. In the harbor this is carried on mostly by the single-celled phytoplankton, which are in turn consumed. However, photosynthetic and chemosynthetic bacteria probably play some producer roles, but the magnitudes are unknown.

A second pathway is by means of direct uptake of complex organic molecules by organisms. This may occur through trans-epidermal transfer (absorption) or by imbibation of dissolved organics into the gut, where transport and assimilation occur.

The third pathway appears to be through the consumption of microheterotrophs (bacteria, protists) which are colonized on detrital particles and are thus an essential part of the detrital food web.

These general pathways are discussed below.

Photosynthesis

Photosynthesis is the traditionally recognized pathway by which CO_2 is incorporated into organic carbon by plants, using light as the energy source. Algae and marine plants incorporate simple mineralized nutrients and are thus autotrophic, or self-nourishing. Within the harbors the single-celled phytoplankton have been considered to be the principal primary producers. Primary productivity data for the harbors, as measured by ^{14}C have been extensively reported (AHF, 1976; Oguri, 1976; Soule and Oguri, 1979, and Section IIIA of this volume).

Autotrophy is the general term for the transformation of simple chemical nutrients into complex organic molecules, making them available to heterotrophic organisms, regardless of the CO_2 pathway or energy source, as will be discussed further below. Herbivorous (heterotrophic) organisms include browsers which feed on plant material attached to fixed or floating substrates, as well as planktonic and nektonic organisms. Some zooplankton species may feed on phytoplankton, and have been thought to engulf whatever species confronted them as they are carried about by currents and tides. However, other research has shown that zooplankton species may feed selectively on particular phytoplankton species and reject others. Certain fish larvae appear to need dense aggregations of phytoplankton for survival (Lasker, 1975) and they may or may not be able to feed selectively.

Phytoplankton have been discussed extensively in the literature, and their role as a principal base of food chains has been widely accepted. Therefore, this aspect of the harbor food web will not be discussed in detail here, although herbivorous consumers are discussed in the zooplankton and fish sections (IIIB and IIID) of the present volume. Rather, the following paragraphs are directed toward information developed in the course of harbor investigations that reveal the importance of the detrital pathway and evidence for direct uptake of organic nutrients, as well.

Bacterial Roles

The role of bacteria in bioclastic processes has been recognized since the turn of the century, but conceptually, food web schema in aquatic or terrestrial environments usually indicated that bacteria functioned only in the breakdown of organic or inorganic materials to molecular states which would then be recycled in primary production by algae and/or higher plants.

Baier (1935) was among the first to indicate the role that bacteria play in detrital breakdown. Since that time a number of investigators have shown that undigestible detrital material is altered by bacteria into digestible form for heterotrophic utilization (Fish, 1955; Odum, 1970). ZoBell (1942) reported on the bacterial flora as an ecological factor in marine tidal flats, although there were scientists who were not willing to acknowledge even the existence of natural marine bacteria for years. Sverdrup, Johnson and Fleming (1946) noted that Pütter, as early as 1909, believed that marine animals absorbed nutrients through their gills and integuments, but Sverdrup *et al.* felt there was little evidence that forms other than bacteria made any considerable use of direct uptake. It was, however, becoming clear (ZoBell and Anderson, 1936) that bacteria which were adsorbed on particulate matter were better sustained in the dilute organic concentrations of the sea than were bacteria which lacked a substrate.

ZoBell (1942) also postulated that intestinal flora of marine animals could assist in digestion of detritus, similar to the digestion of wood by termites. In 1967 Teshima and Kashiwada isolated 198 strains of bacteria from the intestinal tract of carp, 50 percent of which were capable of producing vitamin B12. This parallels the vitamin production known in humans and other terrestrial vertebrates.

Bacteria as Primary Producers

Relatively little is known about the chemosynthetic bacteria as primary producers, but research elsewhere has indicated that oxidation of hydrogen sulfide can provide the energy for conversion of CO_2 in the absence of light (Jannasch, 1979; Jannasch and Wirsen, 1979).

Photosynthetic bacteria are, however, able to use light and H_2S for production. While these autotrophic pathways have been known previously, they have not been considered in the past to be significant contributors to primary production in shallow water.

It is possible that bacterial primary productivity may have a more important role in areas with sulfide benthos, such as harbors, than was previously thought. Sulfide levels in the harbor locally have decreased (Section IIC), but the "white tides" of colloidal sulfur were seen up to 1974, suggesting that such a pathway might have been in use. Sulfide may still provide production in lesser amounts at the sediment interface.

When phytoplankton are adding dissolved oxygen to the water column, sediment bacteria may utilize that oxygen source for carbon fixation, along with hydrogen sulfide from anoxic sediments for the energy source.

Comparison of the primary producer pathways can be made as follows (after Jannasch and Wirsen, 1979):

1) Green Plant Photosynthesis

$$CO_2 + H_2O \xrightarrow[\text{light}]{} [CH_2O] + O_2$$

2) Bacterial Photosynthesis

$$CO_2 + 2H_2S \xrightarrow[\text{light}]{} [CH_2O] + 2S + H_2O$$

3) Bacterial Chemosynthesis

$$CO_2 + O_2 + 4H_2S \longrightarrow [CH_2O] + 4S + 3H_2O$$

Uptake of Dissolved Organics

Although the uptake of dissolved simple nutrients is accepted for photosynthetic plants and protists, the concept of direct utilization of molecules ranging from simple sugars and polysaccharides to amines, amino acids, long chain peptides and proteins (Klailov and Finenko, 1970) by larger forms is beset with controversy. While such uptake activity was accepted for bacteria (Sverdrup, *et al.*, 1946), it was not considered seriously for microfauna or macrofauna for many years after it was proposed as a pathway.

Stephens and Schinske (1961) examined uptake of amino acids in 35 genera of marine invertebrates from 11 phyla by adding ^{14}C glycine to seawater containing the specimens and antibiotics to control bacterial uptake. They found that the capacity for uptake was widely distributed, the only exception being among the few arthropod species they then tested. The fact that glycine was not removed from the solution by the arthropods, but remained in the solution, tended to confirm that bacteria on surfaces were not actually removing the amino acid.

Stephens and his colleagues published a lengthy series of papers on uptake phenomena, utilizing ^{14}C labelled glycine, which he reviewed (Stephens, 1968) along with those of other investigators. Johannes, Coward and Webb (1969) questioned whether transepidermal uptake could be the significant nutrient resource postulated by Stephens.

Philosophically it remained to substantiate the existence of a tenable source of available organic compounds in the environment, and technically, new methods were required to demonstrate them. Stephens (1975) reported on results using fluorescamine to measure naturally occurring primary amines, including amino acids and peptides. Using that method, net flux into both *Capitella capitata* and *Nereis diversicolor* was demonstrated. He hypothesized that the burrowing and irrigation of the polychaetes resulted in increasing concentrations of primary amines in the interstitial water because their activity increased the aerobic zone at the interface with the anaerobic sediments.

Largely because of the work of Stephens, located nearby at University of California, Irvine, HEP initiated studies in 1973 using fish to test for uptake of highly organic fish processing wastes released into outer Los Angeles Harbor prior to 1978. Initially, no labels were used; the purpose was simply to determine whether fish could utilize cannery effluent as a nutrient source without passing through a food chain. Comparison was made of survival of starved arrow gobies (*Clevelandia ios*) in a 1:4 mixture of fish cannery effluent and filtered seawater, and in controls of filtered seawater only. One hundred percent of those in the filtered seawater died, but 36 percent of those in the test mixture survived 61 days to termination of the experiment (Chamberlain, 1975). No doubt bacterial action played a large part in this test.

In subsequent tests ^{14}C glutamic acid was used with 100 ml of cannery waste in 10 l of sand-filtered, u-v irradiated seawater. There was rapid loss of radioactivity from the liquid within the first 20 days, and a continued gradual loss from the 20th through the 71st day, when the experiment was terminated. The fish accumulated radioactivity gradually from the first day, with the highest peak between 10 and 20 days and lesser peaks at 30 and 45 days, followed by gradual loss of radioactivity (Chamberlain, 1975).

Bever and Dunn (1976) investigated the direct uptake of amino acids by the kelp bass (*Paralabrax clathratus*), using alanine-U-^{14}C, aspartic acid-U-^{14}C and glutamic acid-U-^{14}C. Since the species is carnivorous, uptake was expected and a metabolic pathway of amino acid gluconeogenesis was studied using an indwelling aortic cannula. About 40% of the radioactivity could be detected in the plasma within five minutes with a peak of 30 minutes, after which the radioactivity declined to 6% in 19 hours. They concluded that organic nutrients in harbor waters could supplement the normal diet of the fish in the quantities that were present prior to secondary waste treatment of fish processing wastes.

"SECONDARY PRODUCERS" OR PRIMARY CONSUMERS

The Microheterotrophs

Fenchel and Jorgensen (1977) estimated that between 40% and almost 100% of the carbon fixed by primary producers (photosynthetic or chemosynthetic) is utilized by what they termed "secondary producers", the microheterotrophs. Microheterotrophs include bacteria, yeasts, fungi and protistans such as ciliates. Green (1968) indicated that sediment bacteria are fed upon directly by ciliates and nematodes. The meiofauna (organisms less than 1 mm in size) are probably nourished principally by bacteria that colonize detritus, and by direct uptake of nutrients released by bacteria.

The introduction of human fecal bacteria into ocean waters through sewage outfalls results in high concentrations near the outfall but reduced numbers within a short distance. Roper and Marshall (1978) found that natural microbial parasites and predators were increased near the sewage outfall and they rapidly destroyed the *Escherichia coli* introduced. Introduction of *E. coli* into waters remote from normal sources resulted in slower destruction, because predator populations are maintained by the uniform input of *E. coli* at outfalls. The myxobacter *Polyangium* sp. and an amoeba *Vexillifera* may require a particulate substrate for transport. They and *Bdellovibrio* are in turn consumed by larger protozoans. When the food source diminished, the populations of larger Protozoa degenerated and the smaller predators returned to low levels in resting states, according to Roper and Marshall.

These mechanisms are probably paradigms for microheterotrophic systems, including terrestrial input carried by streams and storm runoff. A similar situation exists for oil-digesting bacteria, which maintain elevated populations where chronic, low-level contamination occurs (Atlas, 1978). Turbidity, due to particulate debris or to living or dead phytoplankton, may be one index of the natural microbial populations that would furnish nutrients to the planktonic predators. Sibert and Brown (1975) found that about 70% of the available organic carbon from a pulp mill effluent was converted to particulate organic carbon by microheterotrophs in the absence of phytoplankton.

Total coliform, fecal coliform, fecal streptococcus and standard plate count were used by HEP in 1973-74 (AHF, 1976) to characterize bacterial levels in the harbor. While the TITP primary waste outfall was the center, populations diminished rapidly in the plume. The Los Angeles River also contributed high numbers to standard plate and total coliform counts.

Sullivan, Palmisano, McGrath, Krempin and Taylor (1978) found that bacterial standing stocks varied by three orders of magnitude, decreasing according to the increase in distance from the shore (outfall site) to the sea buoy. Outside the breakwater they found that the microheterotrophs associated with dissolving organic compounds were not associated with large (>5μ) detrital particles, but were generally with particles of less than 1μ in diameter, in the bacterial size range.

Morey-Gaines (1978) found that cannery effluent, which was rich in nutrients (and in bacteria) favored dense populations of small flagellate and ciliate protozoans. The waste was inhibitory in laboratory tests at 10 percent concentrations to diatoms and dinoflagellates, so that the protist populations would have been stimulated in the immediate mixing zone.

Thus it has been found that very small microheterotrophs are active in utilization of dissolved organic matter and in consumption of coliforms. These bacteria are in turn consumed by large bacteria and protozoa. The smaller bacteria were not associated with particulates (Sullivan *et al.*, 1978), but larger microheterotrophs were (Roper and Marshall, 1978).

SECONDARY CONSUMERS

Benthic Macrofauna

Detrital feeders include benthic, fouling/attached, and planktonic macrofauna. The benthic organisms may be sediment ingestors or filter feeders. Small fragments of organic detritus, and their bacterial colonizers, are consumed by protozoans, nematodes, annelid worms, amphipods, harpacticoid copepods and polychaete worms (Barnes, 1974; Yonge and Thompson, 1976). Important polychaete annelids in the harbors include maldanids, capitellids, opheliids and terrebellids.

Hylleberg (1975) found that the polychaete lug worm *Abarenicola pacifica* ingests quantities of sediments, but diatoms, bacteria on sand grains and fragments of algae normally pass through the gut undigested, whereas ciliates, flagellates, small nematodes and some bacteria in the interstitial water are digested. Due to selective feeding, the feces of *A. pacifica* are richer in organic matter, except for protein, than the general sediment surrounding the worm. Thus, *A. pacifica* concentrates organic material into its fecal deposits. On the other hand, *Abarenicola vagabunda* apparently utilizes the microorganisms on the surface film of sand grains to a higher degree than does *A. pacifica*, so that both could be considered selective sediment feeders but would not compete directly for the same food. Pauses of up to six hours in defecation are, coincidentally or not, the length of time sufficient for ciliates and bacterial populations to reproduce on the pellets already voided and become enriched for consumption.

According to Hylleberg (1975), an average of 10^7 bacteria is equal to 1 µg dry matter. The basal metabolism of a 1 g worm with oxygen consumption of 300 µl per day is equivalent to 300 µg organic matter. Assimilation of 3×10^9 bacteria would provide sufficient calories for maintenance; this also is the amount of bacteria found in 3 ml of muddy sediment. Groups of 5×10^7 small flagellates, 5×10^4 medium ciliates, 7×10^2 small nematodes and 2×10^7 small diatoms per gram of detritus would also supply the needed energy (Fenchel, 1970). Hylleberg (1975) referred to this process of fecal enrichment as "gardening."

Nichols (1974) calculated that a polychaete population in Puget Sound, Washington could turn over 8.6 kg dry sediment per m^{-2} per year ($=860$ kg/m^2).

W.E. Odum (1970) calculated that a bottom-feeding fish, the striped mullet, *Mugil cephalus*, could turn over 45m^2 to 0.5 cm deep in one year of feeding. Fish "blow" into soft sediments to expose their invertebrate prey.

Jannasch (1979) credited the turnover of organic matter in the deep sea below the photic zone to bacterial action. The activities occur not only in the water, in sediments and on particulates, but also within the guts of the macrofaunal predators. Turnover is slowed in relation to lower temperature and increased pressure.

Fecal Pellets

Fecal pellets of snails, clams and amphipods have been found to increase in nitrogen content with age (Newell, 1965; Fenchel, 1970; Hargrave, 1970). Fecal pellets were found to pass through amphipod guts undigested except for the colonized bacteria; thus, the fecal pellets could be reingested within four days, which would allow time for recolonization by microbes.

Nereis virens fed at a higher rate on "biodeposits" (fecal material) than on clam tissue in comparison tests. The efficiency rate was 5.7% on biodeposits and 18% on clam tissue, although dry weight increased 48% on worms fed on biodeposits and 31% on the clam tissue. Assimilation efficiency was 28.8% on biodeposits and 77.3% on clam tissue. Tenore (1977c) reviewed the literature on deposit feeding and pointed out that the observed correlations between sediment grain size and density of deposit feeding benthic organisms was probably associated with the increasing level of organic matter in the finer sediments.

Turner and Ferrante (1979) note that zooplankton are the most abundant form of biomass in the pelagic environment, and that phytoplankton are known to pass through zooplankton guts incompletely digested or undigested. Fecal pellets sink at a rapid rate, as compared with phytoplankton alone, and can constitute a seasonally important component of sediments reaching the bottom in shallow water areas.

Odum and de la Cruz (1967) and Fenchel (1970) showed that protein increased on particles derived from macrophytes with increasing age, due to increases in microorganisms growing on the surface.

Tenore (1977a,b) and Tenore and Gopalan (1974) examined the relationships between rate of utilization of different types of detritus and the nutritional content of the polychaetes *Capitella capitata* and *Nereis virens*. The nitrogen content of decaying eel grass increased rapidly at first, and then more slowly, due to microbial action. Younger *Capitella capitata* feed on finer algal detritus, which provides more surface for bacterial colonization than the larger fragments eaten by older worms.

It became evident that this aspect of the food web is probably very significant in the harbor. Given the large numbers of zooplankton, their fecal pellets and microbial epiphytes could contribute substantially to the organic content of the sediments. The feces and pseudofeces of benthic organisms colonized by microbials would also constitute a major source of enrichment, derived initially from the ingestion of organic matter in the sediments and interstitial water.

Local Benthic Feeding Modes

The soft-bottomed, shallow Los Angeles-Long Beach Harbor area is characterized by the presence of unconsolidated, organically rich surficial sediments (Section IIC) and by quiet waters with lower circulation rates than the areas outside the breakwaters. Estuarine waters in general, enriched by runoff and possibly carrying domestic sewage wastes or non-toxic food processing wastes, can furnish significant nutrients of terrigenous origin to nearshore coastal waters and the continental shelf (Turner, Woo and Jitts, 1979; Odum and de la Cruz, 1967) in a process that may best be called "outwelling". Part of the enrichment of outwelling may well be due to the intensive "gardening" (Hylleberg, 1975) of the soft bottoms found in estuaries by benthic species, particularly polychaete annelid worms.

The local outer harbor area has supported a particularly rich polychaete fauna as well as crustaceans and, in sandier areas, molluscs. As detailed in Section IIIC, the outer harbor supported more than 60,000 individuals and more than 40 species of organisms per m^2 in 1973-74. However, in 1978 no area supported those numbers of individuals; the closest were between 20,000 and 30,000/m^2 at the marina near Cabrillo Beach (Station A10) and on the Main Los Angeles Channel (Station C2).

Since the feeding modes of many benthic organisms are not well known, interpretations are often based on casual, short-time observations or on conclusions drawn from structure. Actual uptake and assimilation of normal dietary foods may also differ from particles found in gut contents that may have been ingested unavoidably or fortuitously. Fauchald and Jumars (1979) organized published and unpublished information on polychaete feeding modes into a few patterns; the groups of species with similar modes were called "guilds", since the modes or life styles do not necessarily conform strictly to taxonomic groups. Furthermore, closely related species may occupy the same apparent habitat, yet they do not compete for food because of different feeding mechanisms and prey. The modes used by Fauchald and Jumars (1979) incorporate the following feeding strategies: subsurface deposit-feeder, carnivore, filter-feeder, herbivore, surface deposit feeder. To this is added the degree of mobility: discretely motile, motile, sessile, and in-position; and the feeding structures: jawed, pumping, tentaculate, or other, usually an eversible sac-like pharynx.

Table 1 presents feeding mode information on polychaete species common to Los Angeles and Long Beach Harbors, assembled by Robert Osborn (unpublished) and based on the guild concept of Fauchald and Jumars (1979). Table 2 contains information on molluscan feeding by species common to the harbor; Table 3 presents similar information for crustacean species, and Table 4 contains information on miscellaneous other taxa (Osborn, unpublished). The tables are based on the best available data, but it was necessary to use information from related species or other areas, as well as the insights of specialists in various taxa (MacGinitie and MacGinitie, 1949; Yonge, 1954; Mauer *et al.*, 1979; G.F. Jones, pers. comm., BLM studies). Of the 159 taxa listed, about 60% are probable deposit feeders, 20% are suspension feeders and about 25% are carnivores.

Deposit feeding is more common among polychaetes and crustaceans since they are generally equipped with specialized mouth parts and appendages, whereas most benthic molluscs are thought to be suspension feeders.

There is no great difference in food sources of deposit and suspension feeders, since they are all detritivores. The detrital food sources discussed above are essential to all of the organisms involved in benthic feeding, other than herbivores or carnivores. Furthermore, bacteria may also be involved in the latter two instances, for it may be impossible to determine in given instances whether plant or animal material was live or dead at the time of consumption. The sources of particulate organic matter in the harbors include domestic wastes, riverine debris, and a major component, dead phytoplankton. The latter two, especially, vary seasonally.

Sediment suspended in harbor waters by tidal action and stirring is probably significantly influenced by the reworking of bottom muds by benthic deposit feeders (Rhoads and Young, 1972) and would include fecal pellets (Steele and Baird, 1972). Resuspension of sunken phytoplankton (Tenore, 1977) can reactivate photosynthetic activity by re-exposure to light. In the Southern California Bight, Eppley *et al.* (1977) found total particulate organic matter to be correlated with phytoplankton production. They estimated survival time in the euphotic zone of phytoplankton carbon as 1 to 2 weeks. Phytoplankton may be removed from the upper layers of the water columns by grazing of zooplankton, by microheterotrophic activity and by sinking. In most instances degradation of phytoplankton to form detritus would furnish food to suspension feeders or deposit feeders.

Meiofauna. Organisms less than 1 mm in size, the meiofauna have received little attention in benthic studies, as compared to macrofauna; the difficulties of sampling and identifying the very small species present in a timely fashion restrict their use in surveys. Up to 80 percent of the meiofauna may be comprised of nematodes. Diversity of nematode species increases with increases in grain size, or with median grain size and percentage of silt (Ferris and Ferris, 1979). Shallow silty environments provide high percentages of abundance of fewer species, while sandy substrates have more species with lower abundances. While Tietjen (1977) showed that species diversity, richness and equitability were all significantly related to silt-clay content of Long Island Sound sediments, no relationship could be found between Shannon-Wiener diversity indices and sediment metal or organic carbon content.

Tenore (1977) indicated that although the meiofauna of the benthos comprised 10 to 20 percent of the total respiration budget of the interstitial fauna, there was little evidence of consumption of nematodes in bottom-feeding fish gut content studies. If nematodes are not important in the food chain, they are important in reworking detritus and reducing sediment particle size, which is similar to effects of polychaete feeding. Parenthetically, it has been observed that some worms (*e.g.*, *Cirriformia* spp.) "taste bad" and fish spit them out; perhaps nematodes are also rejected.

Amphipods, as meiofauna, are very important in breaking down algal debris and decreasing detrital particle size (Fenchel, 1970). This increases the surface-to-volume ratio and hence the number of microbials colonized on detritus. Tenore (1979) reported that, while no energetic relationship could be found between meiofauna and the polychaete *Capitella capitata*, the meiofauna doubled the rate of detrital mineralization. Since *C. capitata* is a deposit feeder, perhaps a different worm species would have yielded other results.

Zooplankton Consumers

Zooplankton may be classed as primary level consumers, because some species would be nourished, at least in part, on dissolved organics and some would feed primarily on phytoplankton. Others, which feed on microheterotrophs or detritus or are carnivorous, would be considered as secondary or higher level consumers.

The research of G. Stephens, discussed above, and others strongly suggests that some uptake of dissolved organics can occur; the magnitude of uptake as compared with the total nutritional need is unknown, however. This pathway may well be important to zooplankton in areas that receive primary-treated domestic sewage or fish processing wastes, such as occurred in outer Los Angeles Harbor prior to 1978. Distribution patterns indicated that certain species preferred the enriched waters while others did not frequent them.

Flocculation of dissolved organics in seawater, such as occurred in the fish processing waste plume, can create a special "detritus", which could be important in zooplankton nutrition. Air bubbles created by natural splashing increase the surface area of film for colonization by bacteria, which would also add to the zooplankton food resource (Baylor and Sutcliffe, 1963; Riley, 1963).

The prominence of copepod and cladoceran zooplankton in harbors and estuaries may well be related to the high numbers of bacteria present. The role of bacteria in nutrition of zooplankton has been well established (Jørgensen, 1966; Barsdate *et al.*, 1974; Saunders, 1967). While Heinle *et al.* (1974) concluded that detritus seldom equals algae in nutritive value, Heinle and Flemer (1975) concluded that detritus consumption was essential to meet nutrient requirements of some estuarine species of copepod. Darnell (1967) concluded that zooplankton abundance was correlated with detrital abundance rather than phytoplankton abundance. The ann al distribution patterns in Los Angeles-Long Beach Harbors in 1973-74 (AHF, 1976) and in 1978 (Soule and Oguri, 1979) lo not confirm or refute the concept. In 1978, as the present volume (Section IIIB) shows, the concentrations of larvaceans ere high in the secondary waste outfall area and the gyre a jacent to that. However, many factors affect distribution and there is no direct measure of detrital concentrations harbor- ide. On the southeastern U.S. continental shelf, Turner, Woo and Jitts (1979) noted the simultaneous appearance of peaks in phytoplankton primary production and densities of zoopl nk- ton, fish eggs and larvae. Gross plankton community dy amics were coupled with local estuaries and the shallow nears ore zone. Similar seasonal peaks appear in the local harbo s in phytoplankton, but wastes generate detritus year around so each system may supply nutrients to different species o zooplankton and at different seasons.

Feeding Behavior

Three major types of feeding behavior are represen ed among local copepods: 1) those that are primarily herb vores, 2) those that are primarily carnivores, and 3) omnivore . Most pelagic copepods are not purely herbivorous or car ivor- ous but change from one feeding mode to another (Marsha l, 1973).

Among copepod genera represented locally, *Calanus* s con- sidered to be primarily herbivorous, but it has been kn wn to consume copepod nauplii and other animal food (Mullin, 963; Gauld, 1966). *Calanus* is capable of selecting phytopla kton, rejecting spiny cells such as *Chaetoceros* and *Ceratium*.

Poulet and Marsot (1978) demonstrated that two fil er- feeding species of marine copepods (*Acartia clausi* and *ury- temora herdmani*) were able to select among beads, non-e riched capsules and enriched capsules. Feeding on large parti les similar to the beads corresponds to normal behavior; ye ingestion in experiments could only be measured for the enriched capsules of similar size and not for beads or unenriched capsules.

Conover (1971) noted that zooplankton ingested Bun er C fuel, which passed through the gut and into fecal pelle s. The oil particles are coated with bacteria which are co cen- trated in the pellets. This may constitute an importan biodegradation mechanism in hydrocarbon spills.

Acartia and *Paracalanus* had been described as larg ly herbivorous (Marshall, 1924; Conover, 1956; Wickstead, 962); however, Marshall (1949) and Gaudy (1974) showed that *A artia* can ingest both phytoplankton and small crustaceans. Feeding appendages of *Acartia* have similarities to both herbivorous and carnivorous feeding types (Marshall, 1973). *Acartia* have been known to attack anchovy larvae (Lillelund and Lasker, 1971) as well as immature chaetognaths (Davis, 1977). *Acartia* spp. may thus be described as omnivorous, and the food would consequently be determined by what is available. Omnivory would in turn help to explain the dominance of *Acartia* locally in both numbers and distribution, year around.

The most abundant carnivorous copepods locally are *Corycaeus anglicus* and *Labidocera trispinosa*. Most carnivorous copepods eat other copepods and copepod nauplii, as well as chaetognaths, hydroid medusae, larvaceans and various larvae in the plankton. The smaller species *Corycaeus anglicus* usually attaches to its prey and nibbles away while *Labidocera trispinosa* is large enough to capture other zooplankters and consume them. Landry (1978) found the diet of *L. trispinosa* to consist primarily of copepod naupliar stages. Lillelund and Lasker (1971) concluded that *L. trispinosa* may have an important impact on mortality of larval fish, including anchovy.

Copepods as Prey

While copepod nauplii are important food sources for adult copepods (Landry, 1978) they are also important to fish larvae. Fish larvae in general may feed on copepod naupliar stages. For example, O'Connel and Raymond (1968) demonstrated the importance of naupliar concentrations in rearing northern anchovy (*Engraulis mordax*) and Blaxter (1968) demonstrated it for herring. Gut content analysis of larval sardines by the California Cooperative Research Program in 1952 showed them to be largely copepod nauplii, as did analysis of anchovy larvae gut contents (Nakai *et al.*, 1962, cited by Loukashkin, 1970). Lasker (1975) questioned dependence of anchovy larvae, and emphasized the importance of dense chlorophyll layers. It seems probable that adequate densities (of phytoplankton, or zooplankton, or even detritus), may be the most important factor so long as appropriate species or particles are involved.

Adult forage fishes such as anchovies (*Engraulis mordax*), sardines (*Sardinops caerulea*) and jack mackerel (*Trachurus symmetricus*) have been shown to feed largely on copepod prey (Hand and Berner, 1979; Loukashkin, 1970; Radovich, 1952).

The presence of planktivorous fish in large numbers can reduce or eliminate the larger sized species from the plankton in what can be called size-selection predation (O'Brien, 1979).

Meroplankton (Settling Rack) Consumers

Amphipods are very numerous in Los Angeles-Long Beach Harbors, although they are not retrieved extensively by benthic grab samples. The amphipods *Corophium acherusicum* and *Jassa falcata* are extremely common on the settling rack collections in the harbors (Section IIIE); *C. acherusicum* populations in 1978 were distributed throughout the harbor, with a population center at the secondary-treated waste outfall, while *J. falcata* dominated the gyre near the waste outfall but was scarce in the inner harbor and had its population center on the main Long Beach channel. This is in contrast to the findings of Ware (1978), who examined gut contents of benthic fish sampled in a transect from the outfall toward the breakwater in December 1975-April 1976 and found amphipod numbers directly related to the distance from the outfalls, which were still under primary treatment. The harbor amphipods favor piling substrates where they build sticky web tubes which accrete silt, or they may use the empty calcareous tubes of the serpulid polychaete *Hydroides pacificus* (Reish and Barnard, 1979). Amphipods are also numerous around the outfalls.

Amphipods are omnivores; the harbor piling species are largely suspension feeders and the ability of several species to occupy the seemingly same habitat is probably related to differences in preferred detrital particle size. Some are also scavengers, equipped with mandibles which enable them to attack larger particles such as carcasses of larger animals (Reish and Barnard, 1979). Another common harbor species is *Podocerus brasiliensis*, which is usually associated with the colonial hydroid festoons, while *Stenothoe valida* is found with sedentary invertebrates in a commensal-like association.

It is of interest to note that *Jassa falcata* disappeared from settling racks in the area of the *Sansinena* Bunker C spill for several months in 1977. The isopod *Ligia occidentalis* also disappeared from the breakwater from December 1976 until the end of August 1977. It normally represents a significant consumer of algal debris, which accumulated in drifts during the absence of *Ligia* and other shoreline detrital feeders (Soule and Oguri, 1978).

Bryozoans are common on the settling racks, and while they are reputed to be filter-feeders they can apparently select and reject particular particles (Winston, 1977). Although diatoms have been found in the gut and caecal walls, this does not necessarily demonstrate that diatoms are assimilated. Bacteria, organic detrital particles and protistans are probably the normal food selected. Jebram (1977) summarized his experiments on culturing bryozoans with various foods and indicated that better growth was achieved with mixed protistan diets. Since the length and number of tentacles, the diameter of the mouth and the size of individuals varies among species, variation in diet would be expected. While tentacles are not considered to be used in prey capture, locally a *Bugula californica* colony was observed by D. Soule to capture a caprellid and pull it apart and feed pieces to several individuals. This type of anecdotal observation suggests that there is much to be learned about feeding in natural environments as opposed to laboratory experiments on acceptance or rejection or on culturing various species.

Polychaete worms, including *Capitella capitata*, frequently metamorphosed in settling racks and found adequate debris collected to allow growth. Since the screened racks accumulated algae and diatoms, bacterial and mucus slimes, organic debris, eggs, larvae and juveniles, it was a good microhabitat for diverse species. Probably many harbor species are omnivores within the limitations of feeding appendages and mouth size, as represented in the rack found.

Suspension feeders require sufficient water movement to provide food but cannot tolerate excessive silt, which clogs gills or feeding apparatuses. Among the molluscs, *Mytilus edulis* is commonly found on settling racks and on pilings and is a filter feeder. The small clam *Hyatella arctica* nestles among mussels and extends its long syphons to obtain water (Yonge and Thompson, 1976). *Leptopecten latiauratus* has ciliated gills for feeding and may, like other scallops, be able to filter out particles of 7 microns or less (Yonge and Thompson, 1976; Mohlenberg and Riisgard, 1978).

All the ascidians on settling racks are suspension feeders. *Ciona intestinalis*, the seasquirt, pumps almost continuously, taking plankton, algal spores, detritus, dinoflagellates and other material. It has a filtration efficiency of 74% (MacGinitie, 1939; Fiala-Medioni, 1978).

Predators on settling racks include hydroids and turbellarians which can prey on zooplankton, larvae or small motile animals, such as copepods (Barnes, 1974). Nemerteans may be important predators of gammarid and caprellid amphipods, isopods and polychaetes (McDermott, 1976). Worms of the genus *Eulalia* may prey on mussels and barnacles, particularly if the prey is moribund (Emson, 1977). The worm *Paleonotus bellis* may prey on spirorbid polychaetes. Scale worms of the family Polynoidae are generalists, eating almost anything; they may be free-living or commensal and are often found among clusters of mussels (J. Kudenov, pers. comm.).

Barnacles feed on diatoms, zooplankton and algal debris (Barnes, 1959), while tanaids may filter food particles or capture prey with their chelae (Barnes, 1974). The skeleton shrimp (genus *(Caprella)*, so common in the harbor, may prey on the gammarid amphipods, bryozoans, polychaetes, bivalves or copepods (Caine, 1977).

Pycnogonids prey on hydroids (Rickets, Calvin and Hedgepeth, 1968) and on bryozoans (D. Soule, pers. comm.). Encrusting bryozoans, sponges and ascidians are consumed by the broad-footed dorid nudibranchs, while arborescent hydroids and bryozoans are eaten by the slender-footed aeolid nudibranchs (Yonge and Thompson, 1976).

The most specialized feeder of the settling ra(: species is the wood-boring isopod *Limnoria tripunctata*. Si1 'e it can digest cellulose it is common among untreated wood] .lings (Menzies, 1951; Ricketts *et al.*, 1968). Racks suspe ided at Santa Catalina Island were almost destroyed in one-r onth exposure periods, whereas harbor racks were less wez :ened.

FISHES

The inner harbor fish species and their prey d: 'fer considerably from outer harbor species. In the inner l .rbor the abundant tiny fauna found on the settling racks are 'epresentative of that found on nearby pilings, docks and f: oats. The small crustaceans typical of settling racks are eate t by fishes such as the pile perch (*Rhacochilus vacca*), l ack perch (*Embiotoca jacksoni*), rainbow perch (*Hypsurus caryi*) white perch (*Phanerodon furcatus*), and dwarf perch (*Micror trus minimus*) (Ellison, Terry and Stephens, 1979). These free-swimming fishes pick at the growths on the pilings a id docks. Bottom-dwelling fishes that prey on these small orga iisms include the blenny *Hypsoblennius gilberti*, the kelpi sh *Gibbonsia elegans*, and the staghorn sculpin *Leptocoi us armatus* (Fitch and Lavenberg, 1975). The kelp crabs *Pugettia producta*, *P. dalli*, and *P. richi* may eat small crust .ceans and green algae (M. Wicksten, unpubl. data). Nudibi .nchs can be eaten by the colorful opisthobranch *Chelidone ra inermis* (Ricketts, *et al.*, 1968).

While the literature on fish food habits is ext :nsive worldwide, studies of harbor and estuarine species t .at are not of commercial importance are relatively few. J. . Stephens, Terry, Subber and Allen (1974) characterized the fee ing habits of some common harbor fish species obtained l trawl as 1) Obligate Benthic fish, 2) Facultative Benthic fish, 3) Benthos Feeders (water column species which forag : on the bottom and in other places), 4) Water Column fish, nd 5) Epipelagic fish. These groups are discussed in s me detail in Section IIID of this report. The Benthos eeders constitute the most common fish, comprising over 70% of the HEP trawl catch in the harbor in 1974 and 1978.

Except for the obligate benthic species, the ot er common species are not always restricted to the feeding pat erns outlined. For example, divers reported seeing anchc 'ies (*Engraulis mordax*) foraging on the bottom in shallow harbor waters near the outfalls, and they were observed fee ing on floating coagulated fish waste (gurry) at the surfac . Baxter (1966) noted that the jacksmelt (*Atherinopsis califc niensis*) also fed on floating "fish gruel".

Like the worms, the benthic fish foragers can t rn over a great deal of bottom sediment. While searching fc detrital particles, worms and crustaceans, some species appear to "blow" into the soft, flocculent surface, as mentioned above. This action could add significantly to the oxygenation of the surficial sediments, increasing the bacterial activity, as indicated earlier (Hylleberg, 1975).

Reish and Ware (1976) reported on the gut contents of 16 species taken in harbor trawls in October 1975 and March 1976. Benthic grab samples were also taken at each trawl station by Campbell grab for identification of invertebrates present. Nearest to the outfalls area, where two fish cannery effluents and the TITP primary effluent discharge were then operating, fish were feeding primarily on capitellid worms and crustaceans. Within a few hundred meters, various species were feeding on polychaetes, crustaceans of many types, molluscs, chaetognaths, nematodes, bryozoans, hydroids, fish eggs, algae, unidentified "tissue" and miscellaneous debris. The food found did not differ greatly among white croaker, queenfish, blackperch and sanddab in spite of differences in feeding category. It was not possible to identify sources of amorphous material, found in all but the surf perch, in the brief study undertaken.

CALORIC VALUES OF FOOD WEB SPECIES

Quantitative data on energy in the various food web species or trophic levels is relatively scarce, and the methods used in specific studies vary, so that extrapolating to the harbor ecosystem is difficult. Energy resources may have been measured elsewhere as units of dry matter, respiration, carbon, calories, or ATP content per area per year, for example. Yet the current socio-political trend toward requiring trade-offs and mitigation measures for impacts should require more extensive information on the interrelations and, in some cases, obligate dependencies than is presently available.

Prior to conversion of effluents in Los Angeles Harbor to secondary waste treatment and the elimination of fish cannery effluent discharge, Harbors Environmental Projects, in cooperation with Dr. J.S. Stephens, Jr., of Occidental College, carried out some analyses of caloric content of representative harbor species. Eileen Zerba made determinations with a Parr oxygen bomb calorimeter; a semi-micro oxygen bomb was used for the smaller samples (Zerba, unpublished data).

Calorie determinations were made on 22 species in four animal phyla. Results are presented in Table 5 as mean calories per gram, ash-free. Values ranged from 4069 cal for alpheid shrimp to 5680 cal for the polychaete *Lumbrineris*. Table 6 gives the mean caloric values for the four phyla, with molluscs the lowest, followed by crustaceans and echinoderms, with polychaetes the highest. Table 7 shows that significant difference was found between polychaetes and molluscs, and between polychaetes and crustaceans.

Polychaetes *vs* Crustaceans and Cannery Wastes

Prior to 1978, in the areas of finer sediments with high organic content, capitellid species flourished. Fish capable of feeding in that zone considered polluted, obtained higher levels of nutrient protein per unit of effort than those not able to feed there. The polychaetes are soft-bodied and protein-rich, and fish would expend relatively little energy in locating, capturing, digesting and assimilating that prey, as compared with other possible prey groups.

In the outer harbor zone more distant from the outfall area, and with sandier benthic sediments, fish were feeding more on crustaceans. Fish would expend more energy in capture of motile organisms and on digestion or elimination of the chitinous crustacean exoskeletons, which are wasted. Chitin is very slow to biodegrade and cannot be digested by most species.

Fish cannery effluent was also tested and the caloric value shown to be high. Chamberlain (1975) presented the amino acid analysis of representative cannery wastes, indicating the presence of necessary organic nutrients in the effluent. The mean caloric value of cannery wastes ranked above those of the animal groups. Cannery waste was, of course, not present in the harbor undiluted, and therefore the values can not actually be equated. They are indicative of the nutrient input that was withdrawn from the harbor.

Trophic Levels in Detrital Feeding

Sediment bacteria in the harbor have not been counted, but estimates elsewhere (Dale, 1974) ranged from 1.17×10^8 to 9.97×10^9/g. Counts in the harbor water column using Standard Plate Count (AHF, 1976) estimated numbers at 5×10^4 to 3×10^5/ml. This method is now known to underestimate counts in marine waters. Counts using the Acridine Orange Direct Count method (Sullivan *et al.*, 1978) numbered 10^8 to 10^{11}/ml after cannery discharges had ceased.

Result of a series of labelled experiments on uptake of bacteria by harbor species by HEP associates was reported in Soule and Oguri, 1979. Using ^{14}C labelled bacteria, a direct relationship was shown between concentration of the protozoan *Euplotes* sp. and removal of bacteria in suspension.

A hyperbolic relationship between grazing rates and bacterial concentration was suggested. In a monoculture of bactivorous plankters, bacteria will be removed from the medium at a rate proportional to the concentration of bactivores.

Experiments with *Neanthes arenaceodentata* demonstrated that they ingest bacteria from sediment and water; it is possible that they also reingest the secreted mucus net after bacteria have colonized it. Of the ^{14}C material ingested in a pulse chase experiment, 64% was lost in 48 hours, 13% of which was excreted. The remainder may have been in fecal pellets, which were not analyzed (Soule and Oguri, 1979).

In molluscs, a low uptake was demonstrated in *Macoma nasuta*; the filter feeder may either have been stressed and not feeding actively in the experimental chamber, or it may not filter the small free bacteria. However, *Mytilus edulis*, 17-24 mm in length, ingested 0.5-3.2 x 10^8 bacteria/day^{-1}. This is well within the range found per ml in harbor waters.

Evidence suggested that bactivory is in a steady state with bacterial production and that the bactivore standing stock will be balanced with bacterial production, which in turn is dependent on organic input.

An examination of some of the available numbers, fitted into a sample food pyramid, would give the following:

bacteria in sediment (Dale, 1974)

1.17 x 10^{11} to 9.97 x 10^{12}/L

bacteria in water (Sullivan *et al.*, 1978)(est):

10^9 to 10^{12}/L

peak 1978(est): 55 x 10^8/L

low 1978(est): 2 x 10^8/L

bacteria *vs* worms (Hylleberg, 1975)

10^7 bacteria = 1 μg dry matter

1 worm requires per day: 300 μg dry matter,

or 3 x 10^9 bacteria,

or 5 x 10^7 small flagellates,

or 5 x 10^4 medium ciliates,

or 7 x 10^2 small nematodes.

Assuming for purposes of this calculation that all the benthic fauna at station A2 in outer Los Angeles Harbor were polychaete worms, and that all nutrients had to be obtained by filter-feeding, the following numbers would be indicated:

In 1974 there were ca 38,000 worms/m^2 at station A2:

each requiring 3×10^9 bacteria/da,
requiring/m^2/da, 11.4×10^{13} bacteria.

Amount of water required for filtering/da with 100% efficiency for 1974 population/m^2 of worms:

high bacteria/L, 1978 water, requiring:

ca. 11.4×10^1 L/m^2/da

med. bacteria/L, 1978 water, requiring:

ca. 2×10^4 L/m^2/da

low bacteria/L, 1978 water, requiring:

ca. 57×10^4 L/m^2/da

Since such filtration rates are unlikely, the decrease in benthic worms after 1974 may have been due to the large decrease in bacteria (measured by BOD) that took place with installation of DAF treatment in 1975. Further reduction in bacteria (measured by BOD) occurred with the installation of secondary treatment during 1977.

In 1978 there were ca 4,400 worms/m^2 at Station A2:

high bacteria/L, 1978 water, requiring:

ca. 1L/m^2/da

med. bacteria/L, 1978 water requiring:

ca. 2.4×10^2L/m^2/da

low bacteria/L, 1978 water requiring:

ca. 66×10^2L/m^2/da

It is recognized that sediment feeding might obtain from 10 to 100 times more bacteria, but the direct relationship between organic input and bacterial count indicates that populations would have decreased accordingly.

Pumping rates of the small worms (irrigation rates) probably amount to about 19 ml/da at 20°C and 24 ppt salinity (J. Kudenov, unpubl.) Kudenov estimated that 1500 worms/m^2 would pump 23.3 L/da (less than the maximum possible 28.5 L/da). Using the 38,000 worms/m^2 of 1974, the maximum theoretical amount would be about 722 L/da, whereas the amounts for 4400/m^2 would be about 83.6L/da. These numbers are considerably below the quantities needed to survive on filtered bacteria, even if the pumping rate equaled the filter-feeding rate, with 100% efficiency. The amount of water needed to obtain the numbers of bacteria necessary to sustain 1974 populations at 1978 concentration is beyond any possible pumping rate.

In 1976, gut contents of one white croaker contained 600 polychaete worms (Long Beach, 1976), each of which could have been supported by 3×10^9 bacteria, -- a total of 1.8 trillion bacteria.

Using 1974 counts at A2, there were 63.3 "fish meals" per m^2 available. Since polychaetes may reproduce every 30 days, replenishment is good; counts of over $60{,}000/m^2$ were found. By 1978, there were only 7.3 "fish meals" per m^2, on the same basis, or an almost 9-fold reduction. The reduction in means at all A stations was actually 4-fold for benthic organisms. The drop in numbers of fish per trawl was also 4-fold, and the decrease in birds was about 2.5-fold. Thus the decrease in bacteria of up to 38-fold has a seemingly direct result in the detrital food web, or pyramid.

DISCUSSION AND CONCLUSIONS

The importance of knowledge about the feeding patterns, needs and interdependencies of organisms has increased with the advent of the Fisheries Conservation and Management Act of 1976 (Public Law 94-265) and the consequent need to develop plans for managing domestic fisheries and foreign fishing access.

Recognition that estuaries are important components supportive of the nearshore ecosystem has been slow in coming, but it is a new, well established concept. However, recognition that altered environments such as the harbors can be important to the coastal system is still not generally accorded.

Knowledge of the essential elements of the food web must be advanced if management of commercially valued species is to be advanced. The non-commercial species may not be valued, and the impact of reducing their numbers may not be recognized until irreversible damage is done to the commercial species that are dependent upon them.

The cyclic nature of such populations as sardines, which disappeared as a commercial fishery off California in the 1930's, and the decline in the commercial anchovy catch in the late 1970's, points to the need for more accurate food web information. Lack of a particular food, or of adequate densities of foods, at the critical period when newly hatched larvae must feed or die, will seriously deplete subsequent recruitment of adult reproductive stock (Lasker and Zweifel, 1978).

The impact of large-scale oceanographic conditions on inshore waters is great. It has been demonstrated, for example, that the plankton carried into local harbors varies in having cool water northern components, or warm water subtropical components, depending upon flow of the major offshore currents. Similarly, large-scale atmospheric and oceanographic conditions govern the incidence of upwelling of bottom nutrients and cold water, downwelling, and "outwelling", which affect the extent that warmer waters and nutrients of terrigenous origin are carried seaward.

It has been demonstrated that nutrient flow into the harbors can support large and diverse populations of organisms when levels are controlled to prevent unlimited dumping of wastes and consequent depletion of oxygen. This was demonstrated by the dramatic improvements in the harbor following enforcement of water quality regulations circa 1970, as detailed in this volume.

Reduction or elimination of nutrient flows by secondary waste treatment removes food valuable to diverse marine biota. The evidence presented in this volume, in Soule and Oguri (1979) and elsewhere indicates that a major decrease in biota occurred concomitantly with conversion of primary effluent and DAF-treated cannery waste to secondary waste treatment at the Terminal Island Treatment Plant. The decrease may well be directly related to the decrease in the detrital (microheterotrophic) basis of the food web.

The detrital food web, based on uniform input of organic nutrients, furnishes a major energy flow in the harbor. Obviously the system cannot be overloaded, as it was prior to 1970, or tha anoxic conditions and build-up of organic detritus "sludge" would return.

The harbor food web is complex. Nutrients may, or may not, be taken up by invertebrates and fish directly; the discussions and research on whether direct organic uptake occurs will no doubt continue. But whether organics are assimilated transepidermally, or whether bacterial intermediaries are required, is not the significant point. The relevant point is that the nutrient input of the wastes reaches a surprisingly diverse biota, either directly or through a succession of intermediate organisms. Reduction of nutrients must have had an impact on the available food, and thus on the populations of polychaetes, fish and birds. If the harbor had continued to contain an excess of unprocessed nutrients in 1973-1974, detrital build-up on the benthos would have continued, as it was known to have occurred prior to 1970. The harbor is not nutrient-limited in the sense that it will not sustain any diverse biota since the advent of secondary treatment; however, the drop in diverse fauna (populations and thus biomass and calories) clearly shows that the nutrient system is not productive as it once was. Only in periods when the treatment plant exceeds its BOD and suspended solids requirements and is in violation of its WQCB permit, do animals increase substantially (Soule and Oguri, 1979). Since BOD results in immediate increases in standing stocks and bactivores, the increases in higher level consumers are not surprising. However, the rapidity of response to perturbations was surprising to those who considered the harbor to be based on phytoplankton production.

The detrital food web seems to have been conclusively demonstrated in the local harbors, based on a wide variety of evidence.

The contribution that non-toxic nutrient wastes can make to the coastal ecosystems is being largely ignored in the legal regulation of water quality, is disregarded by environmental agencies, and is virtually unknown to the environmentalist and concerned public citizen. There is a high ecological cost as well as a high economic cost to this situation.

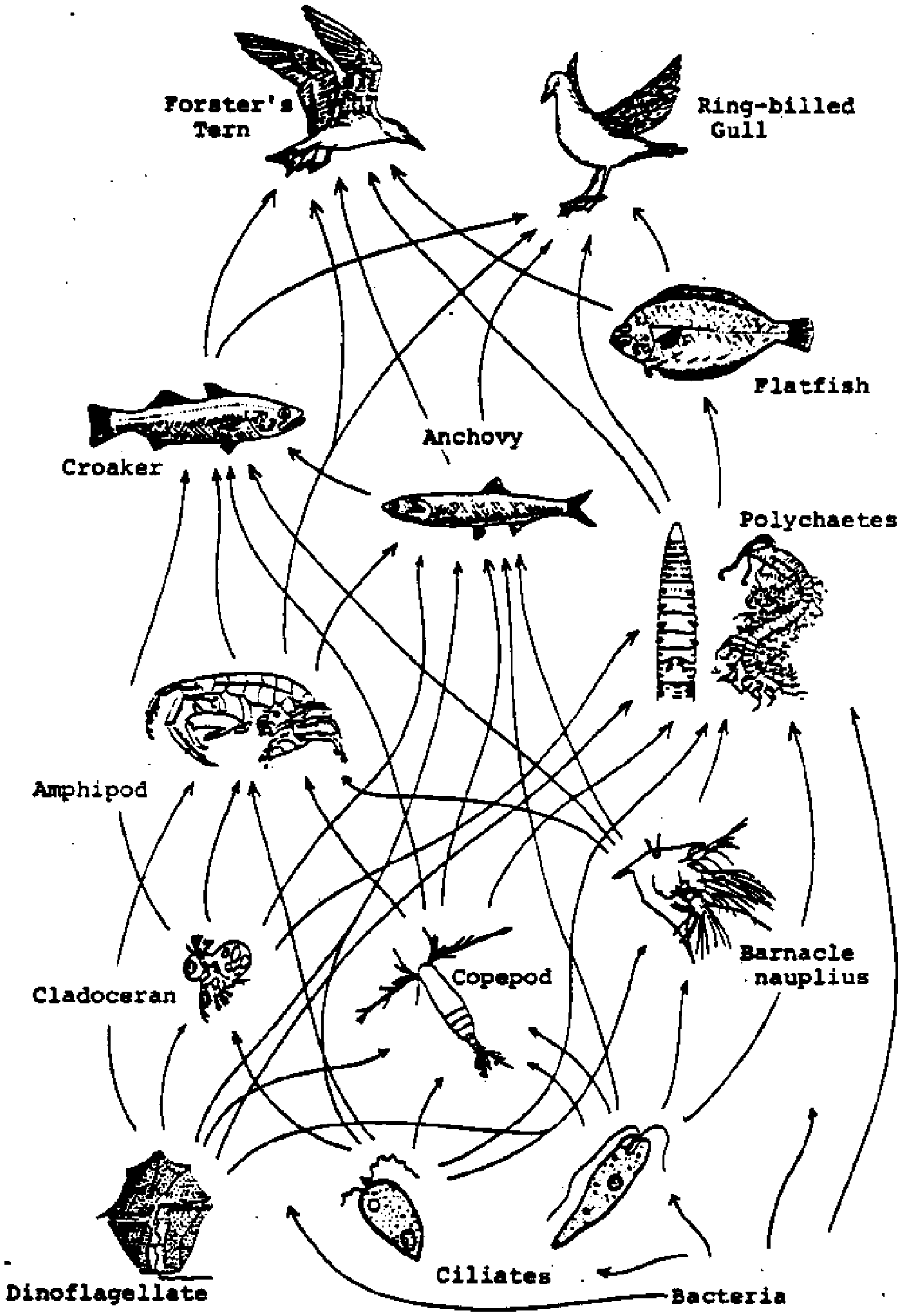


Figure 1. Harbor Food Web

(From: Marine Studies of San Pedro Bay, California. Part 16)

Table 1. FEEDING MODES OF POLYCHAETES

COMMONLY FOUND IN LOS ANGELES-LONG BEACH HARBOR BENTHOS*

Feeding guilds are represented by three letters. The letter in first position= the major feeding mode=column headings. The letter in the second position= motility pattern--M=motile, D=discretely motile, S=sessile. The letter in the third position=feeding structures--J=jaws, P=pumping, T=tentacles, X=other structures (usually eversible sac-like pharynges). Guilds in parenthesis are hypothetical assignments, all others have been demonstrated.

Guild assignments appear after the family names. Species reflect all the Familial possibilities except where more detailed information is available.
* (Following the Guild Concept of Fauchald & Jumars, 1979).

SPECIES \ MODES	Herbivore	Carnivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder
Ampharetidae - SST					
Ampharete labrops			SST		
Amphicteis scaphobranchiata			SST		
Melinna oculata			SST		
Arabellidae - (CMJ, SMJ)					
Drilonereis falcata		(CMJ)	(SMJ)		
Capitellidae - SMX, BMX					
Capitella capitata			SMX	BMX	
Mediomastus californiensis (=*Capitita ambiseta*)			SMX	BMX	
Notomastus tenuis			SMX	BMX	
Chaetopteridae - FSP, SST					
Spiochaetopterus costarum					FSP
Cirratulidae - SMT, SDT					
Caulleriella alata			SMT,SDT		
Chaetozone corona			SMT,SDT		
Chaetozone setosa			SMT,SDT		
Cirratulus cirratus			SMT,SDT		
Tharyx sp.			SMT,SDT		
Cossuridae - (BMX)					
Cossura candida				(BMX)	
Dorvilleidae - HMJ,CMJ,SMJ					
Schistomeringos longicornis	HMJ	CMJ	SMJ		
Eunicidae - HMJ,HDJ,CMJ,CDJ,?BMJ					
Marphysa belli oculata	HMJ,HDJ	CMJ,CDJ		?BMJ	
Marphysa disjuncta	HMJ,HDJ	CMJ,CDJ		?BMJ	

Table 1 (Con t.)

SPECIES / MODES	Herbivore	Carnivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder
Glyceridae - CDJ,BMJ					
Glycera americana		CDJ		BMJ	
Glycera capitata				BMJ	
Glycera rouxii		CDJ			
Goniadidae - CDJ					
Goniada brunnea		CDJ			
Goniada littorea		CDJ			
Glycinde armigera		CDJ			
Hesionidae - HMJ,CMJ,?SMJ,BMJ					
Gyptis brevipalpa	HMJ	CMJ	?SMJ	BMJ	
Gyptis brunnea	HMJ	CMJ	?SMJ	BMJ	
Ophiodroumus pugettensis	HMJ	CMJ	?SMJ	BMJ	
Lumbrineridae - HMJ,CMJ,CDJ,BMJ					
Lumbrineris spp.	HMJ	CMJ,CDJ		BMJ	
Magelonidae - SDT					
Magelona pitelkai			SDT		
Magelona sacculata			SDT		
Maldanidae - BSX					
Axiothella sp.				BSX	
Praxillella sp.				BSX	
Nephtyidae - CMJ,BMJ					
Nephtys caecoides		CMJ		BMJ	
Nephtys californiensis		CMJ		BMJ	
Nephtys cornuta franciscana		CMJ		BMJ	
Nereidae - HMJ,CMJ,CDJ,SDJ,FDP					
Nereis procera	HMJ				
Onuphidae - HDJ,CMJ,CDJ,SDJ					
Diopatra ornata	HDJ	CMJ,CDJ	SDJ		
Diopatra splendidissima	HDJ	CMJ,CDJ	SDJ		
Nothria elegans	HDJ	CMJ,CDJ	SDJ		
Nothria iridescens	HDJ	CMJ,CDJ	SDJ		
Opheliidae - BMX					
Armandia bioculata				BMJ	
Orbiniidae - BMX					
Haploscoloplos elongatus				BMX	

Table 1 (Cont.)

SPECIES / MODES	Herbivore	Carnivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder
Paraonidae - HMX,SMX,BMX					
Acesta catherinae	HMX		SMX	BMX	
Acesta horikoshii	HMX		SMX	BMX	
Aricidea wassi	HMX		SMX	BMX	
Tauberia oculata (=*Paraonis gracilis oculata*)	HMX		SMX	BMX	
Pectinariidae - BMX					
Pectinaria californiensis				BMX	
Phyllodocidae - CMX,BMX					
Anaitides nr. papillosa		CMX			
Eteone dilatae		CMX		BMX	
Eumida sanguinea		CMX			
Phyllodoce sp.		CMX			
Pilargiidae - (CMJ)					
Sigambra tentaculata		(CMJ)			
Poecilochaetiidae - (SDT)					
Poecilochaetus johnsoni			(SDT)		
Polynoidae - CMJ-CDJ					
Harmothoe imbricata		CMJ,CDJ			
Harmothoe priops		CMJ,CDJ			
Sabellidae - FST,SDT					
Chone sp.			SDT		FST
Euchone incolor			SDT		FST
Euchone limnicola			SDT		FST
Sigalionidae - CMJ					
Pholoe glabra		CMJ			
Sthenelanella uniformis		CMJ			
Spionidae - FDT,SDT					
Boccardia hamata			SDT		FDT
Boccardia basilaria			SDT		FDT
Laonice cirrata			SDT		FDT
Polydora caulleryi (=*P. brachycephala*)			SDT		FDT
Polydora ligni			SDT		FDT
Pseudopolydora paucibranchiata			SDT		FDT
Prionospio pygmaeus			SDT		FDT
Prionospio cirrifera			SDT		FDT
Paraprionospio pinnata			SDT		FDT
Prionospio steenstrupi (=*P. nr. malmgreni*)			SDT		FDT

Table 1 (Cont.)

SPECIES \ MODES	Herbivore	Carnivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder
Spionidae - FDT,SDT (Con't)					
Prinonospio heterobranchia (=*P. h. newportensis*)			SDT		FDT
Spiophanes berkeleyorum			SDT		FDT
Syllidae - HMJ,CMJ					
Exogone qemmifera	HMJ	CMJ			
Exogone lourei	HMJ	CMJ			
Sphaerosyllis californiensis	HMJ	CMJ			
Terebellidae - SST,SDT					
Amaeana occidentalis			SDT		
Pista fasciata			SST,SDT		
Streblosoma crassibranchia			SST,SDT		

Table 2. FEEDING MODES OF MOLLUSCA
COMMONLY FOUND IN LOS ANGELES-LONG BEACH HARBOR BENTHOS

SPECIES / MODES	Feeding Type: Carnivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder	Other (see below)	otility: Sessile
GASTROPODA						
Acteonidae						
Rictaxis punctocaelatus	?	?				
Aglajiidae						
Aglaja sp.	x					
Nassaridae						
Nassarius medicus					1	
Nassarius perpinguis					1	
Olividae						
Olivella baetica	x					
Pyramidellidae						
Turbonilla sp.		x			2	
Odostomia sp.		x			2	
Retusidae						
Sulcoretusa sp.		x				
Volvulella panamica		x				
Scaphandridae						
Acteocina culcitella	?	?				
Acteocina harpa	?	?				
Cylinchna diegensis	?	?				
Turridae						
Kurtziella plumbea	x					
Vitrinellidae						
Vitrinella oldroydi		x				
PELECYPODA						
Cardiidae						
Laevicardium substriatum				x		x
Cooperellidae						
Cooperella subdiaphana				x		x
Leptonidae						
Lepton meroeum				x		x
Lucinidae						
Parvilucina tenuisculpta (=*Parvilucina* sp.)				x		x
Lucina nuttalli				x		x
Lyonsiidae						
Lyonsia californica				x		x

Table 2 (Cont.)

SPECIES \ MODES	Feeding Type: Carnivore	Feeding Type: Surface deposit feeder	Feeding Type: Subsurface deposit feeder	Feeding Type: Suspension feeder	Feeding Type: Other (See below)	Motility: Motile	Motility: Sessile
PELECYPODA (Con't)							
Montacutidae							
Mysella grippi				x			x
Mysella pedroana				x			x
Myidae							
Cryptomya californica				x			x
Nuculanidae							
Nuculana sp.		x					x
Semelidae							
Cumingia californica		?		?			x
Theora lubrica		?		?			x
Sölecurtidae							
Tagelus subteres				x			x
Solenidae							
Siliqua lucida		?		x			
Solen sicarius		?		x			
Solen sp. (juv.)		?		x			
Tellinidae							
Leporimetis obesa		x		x			x
Macoma acolasta		x					x
Macoma nasuta		x					x
Macoma sp. (juv.)		x					x
Tellina modesta		x					x
Tellina sp. (juv.)		x					x
Thraciidae							
Thracia curta				x			x
Thyasiridae							
Thyasira flexuosa				x			x
Axinopsida serricata				x			x
Veneridae							
Compsomyax subdiaphana				x			x
Protothaca sp. (juv.)				x			x
Saxidomus sp. (juv.)				x			x
SCAPHOPODA							
Cadulus fusiformis			x			x	

Other Types:
1 - "scavenger"
2 - ectoparasite

Table 3. FEEDING MODES OF CRUSTACEA
COMMONLY FOUND IN LOS ANGELES-LONG BEACH BENTHOS*

SPECIES \ MODES	Carnivore	Suspension Feeder	Surface deposit feeder	Subsurface deposit feeder	Commensal
Amphipoda-Caprellidea	x		?		
Amphipoda-Gammaridea					
Amphideutopus oculatus		x			
Ampelisca cristata		x			
Argissa hamatipes			x		
Listriella goleta			x		
Copepoda-Cyclopoidea					
Clausidium vancouverense			x		x
Copepoda-Harpacticoida			x		
Cumacea					
Campylaspis sp.	?		?		
Diastylopsis tenuis			?		
Cyclaspis sp.			?		
Diastylis sp.			x		
Oxyurostylus pacifica			?		
Decapoda					
Callianassa sp.				x	
Cancer sp. (juv.)	x				
Hemigrapsus oregonensis	x				
Pinnixa franciscana		x			x
Pinnixa sp.	x	x			x
Scleroplax granulata	x	x			x
Upogebia sp.				x	
Ostracoda					
Cylindroleberis sp.			?		
Euphilomedes carcharodonta			x		
Philomedes sp.			x		
Rudiderma rostrata			x		
Scleroconcha sp.			?		

* (all forms possess some motility)

Table 4. FEEDING MODES OF OTHER TAXA

COMMONLY FOUND IN LOS ANGELES-LONG BEACH HARBOR BENTHOS

	Feeding Type					Motility	
TAXON \ MODES	Carnivore	Herbivore	Surface deposit feeder	Subsurface deposit feeder	Suspension feeder	Motile	Sessile
ANNELIDA OLIGOCHAETA				x		x	
ASCHELMINTHES NEMATODA		x	x			x	
NEMERTEA	x					x	
CNIDARIA (COELENTERATA)							
Anthozoa							
Acanthoptylum gracile					x		x
Isoedwardsia sp. A.	x					x	
Stylatula elongata					x		x
CERIANTHARIA							
Hydrozoa							
Corymorpha aurata	x						x
ECHIURA							
Listriolobus pelodes			x			x	
PHORONIDA							
Phoronopsis sp.					x		x
Phoronis pallida					x		x
Phoronis sp.					x		x
PLATYHELMINTHES Polycladia	x					x	
HEMICHORDATA							
Enteropneusta	x					x	

Table 5. Energy equivalents of fish food resources.[1]

Species	No. of samples	Mean cal/ ash-free g	S.D.
POLYCHAETA			
Capitellidae			
Capitella capitata	6	4636.04	220.61
Chaetopteridae			
Chaetopterus variopedatus	3	4876.13	184.74
Cirratulidae			
Cirriformia luxuriosa	3	4784.37	191.05
Lumbrineridae			
Lumbrineris zonata	1	5680.08	--
Maldanidae			
unident. species	3	4773.58	122.72
Nereidae			
Neanthes arenaceodentata	1	4592.16	--
Phyllodocidae			
Anaitides medipapillata	1	4874.21	--
Polynoidae			
Halosydna brevisetosa	1	4350.76	--
Lepidonotus squamatus	1	4548.61	--
Sabellidae	3	4560.50	469.41
MOLLUSCA			
Calyptraeidae			
Crepipatella lingulata	4	4259.99	207.69
Chamidae			
Pseudochama exogyra	1	4625.67	--
Muricidae			
Pteropurpura sp.	1	4288.80	--
Semelidae			
Semele rupicola	1	5244.46	--
Vermetidae			
Serpulorbis squamigerus	7	4235.95	620.51
CRUSTACEA			
*Cancridae			
Cancer antennarius	1	5277.52	--
+*Cancer productus*	8	5212.84	41.52
Copepoda	1	4374.29	--
Amphipoda			
Gammarid amphipods	3	4346.78	628.74
Crangonidae			
Crangon nigromaculata	3	4725.72	102.80
Alpheidae			
Alpheus sp.	4	4069.81	210.56
Betaeus sp.	1	4631.95	--
Hippolytidae			
Heptacarpus cristatus	1	4554.22	--
Isopods	1	4779.18	--
*ECHINODERMATA			
Echinoidea			
Strongylocentotus purpuratus	3	4583.68	94.96
Cannery effluent Station 1	2	5560.79	397.34
Cannery effluent Station 2	1	5453.55	--

*Calcareous exoskeleton was separated from soft parts
+Cancer crabs were oven dried, thus were excluded in mean energy value for the phyla.

Table 6. Mean caloric values of four animal phyla [1]

Phyla	X	SD	N
Crustaçea	4416.88	384.88	14
Echinodermata	4583.68	94.96	3
Molluscs	4328.26	482.30	16
Polychaeta	4732.43	315.67	23

Table 7. T-test performed to determine significant difference ($t_{.95}$) of mean caloric values

Comparison	t	d.f.	Results
Polychaetes x Molluscs	3.08	38	+
Polychaetes x Crustaceans	2.64	36	+
Polychaetes x Echinoderms	0.53	29	-
Mollusks x Crustaceans	0.70	16	-
Crustaceans x Echinoderms	0.49	25	-

+ = significant difference
- = no significant difference
1 = Data by Eileen Zerba, HEP, and Occidental College

STATISTICAL ANALYSIS OF INTERACTIONS OF PHYSICAL AND BIOLOGICAL PARAMETERS

INTRODUCTION

The integration of large amounts of physical and biological data is necessary in order to characterize a given area ecologically. When parameters such as temperature or salinity are considered singly, the importance of the factor can be overestimated or underestimated and the synergisms of multiple factors overlooked. While expertise is required to make the judgments necessary in selection of the important parameters to be measured and to interpret results of the analyses, the same expertise cannot weight values and analyze matrices of the size and complexity that the computer programs can handle.

Weighted discriminant analysis of zooplankton, meroplankton (setting rack) and benthic data serve to characterize the various harbor areas biologically, but also to indicate the dominant physical or biological factors which interact with and influence the biota during a particular period. Use of the analytical techniques must be qualified by acknowledging that standard statistical tests such as F and Chi Square tests may not be applicable, and that factors other than those analyzed may, in fact, have exerted influence on distribution. For example, in the present studies, lack of funds prevented chemical analysis of the water column and limited the scope of sediment analysis, so that these data were not available on a quarterly basis to correlate with biological data. Previous experience indicates that contaminant levels are quite low in the water column. However, sediment pollutant levels are high in some areas of the harbors. There is insufficient information on these effects and only large-scale bioassay tests could provide enough data to develop weighted variables for use in computer analysis. Thus, these are limitations on interpretation of results.

METHODS AND APPROACH

The techniques for gathering of physical and biological data through monitoring and for computer analysis have been discussed in the methods section of this volume. The computer methods of classification and weighted discriminant analysis were presented in detail by Smith, in Soule and Oguri, 1979. A station map is on the facing page.

Previous reports (Soule and Oguri, 1979; AHF, 1976) dealt with the discriminant analysis on the basis of each biological sampling type: zooplankton, settling rack fauna and benthic fauna. In contrast, in the present report, the marine biota analyzed will be discussed on a seasonal basis, according to each quarter. The faunal data from each collecting method will be compared as they reflect the seasonal conditions of the various areas of the harbor.

RESULTS

Winter, 1977-1978

The winter quarter in the harbor has been defined as December, January and February (AHF, 1976) based on long-term temperature and rainfall data. However, there are shifts in the period of lowest temperature from year to year (see Section IIA, this volume). In the period of December 1977 through February 1978, sea temperatures were unusually warm, and also approximately 23 inches of rain fell. Both of these conditions are unusual for southern California, and would affect the faunal distribution in the harbor.

Zooplankton Distribution

The distribution of zooplankton species in the winter quarter reflected the impacts of both temperature and rainfall. The latter was reflected more by the stress of urban runoff on dissolved oxygen and pH due to organic detrital load and on lowered phytoplankton values which resulted in the impacted area, than by the effects of reduced salinity itself. This is consistent with the degree of tolerance to salinity variations shown by estuarine species.

Only the copepod and cladoceran species, which comprise the bulk of the zooplankton, are used in the discriminant analysis to make the data more consistent over time. Other components often cannot be identified consistently to species level. (It should be noted that *Acartia tonsa*, listed herein, may consist of *A. tonsa* and *A. californiensis*; see Section IIIB. Figure 1 illustrates the station groupings as they were characterized by the zooplankton species found at each site. Figure 2, the site group dendrogram, shows a large-scale separation into inner harbor sites (groups 1, 2 and 3) and outer harbor sites (groups 4, 5 and 6). More precisely scaled separations then characterized the individual groups. The two-way table (TWT) matrix (Figure 3) shows the reduced species diversity of the inner harbor, which resulted from a number of existing factors such as reduced flushing of blind-end slips, wider temperature fluctuations in shallower water, and presence of industrial wastes. The impacts of the unusual rainfall were thus superposed on these factors. The TWT also shows the unusually high number of taxa (43) for that season. The outer harbor patterns reflect the influx of coastal tidal waters, which usually carry more species in the winter. Group 5 stations exemplify this, and also show that those waters do mix with the river plume and perhaps enhance the feeding of zooplankton on the small organic particulates. The highest numbers of fish eggs and larvae were also found in the harbor in February in 1978 (Soule and Oguri, 1979). Group 4 stations largely identify the area of the outer harbor gyre which had the highest salinity. Of interest is group 6, a single Long Beach station (B4) which probably represents the pooling of warmer water from the Edison plant effluent in the middle harbor and was characterized by large numbers of individuals of 16 species.

The outer main channel and shallow outer harbor stations (group 1) clustered with inner harbor stations in having lowered values for physical parameters associated with runoff, but they had much higher values for phytoplankton than those of the inner harbor. Since the outer harbor gyre stations in group 4, adjacent to group 1, had the highest phytoplankton values in the harbor, that probably represented nutrient input, the residence time of water in the gyre and mixing with the shallower waters.

Table 1 presents the group means of the parameter values used in the analyses, while Table 2 shows the weighted means. The perils of characterizing the harbor on the basis of physical variables alone would be well illustrated by group 5, where the low salinity of the river plume influenced the entire group. Yet, biologically the entire area contained a higher number of species, which indicates that the runoff, combined or ameliorated by other factors, did not in fact inhibit the zooplankton.

Figure 4 lists the coefficients of separate determination and shows the vectors for the various parameters as they would occur along axes in the diagrams. Since the first three axes contain about 99% of the information, only they are considered. Values for coefficients are usually not considered significant unless they are above 10. The physical variables of temperature, pH and dissolved oxygen, dominate the separations, along with productivity, chlorophyll a, and to a lesser extent assimilation ratio. The vectors are based on the weighted variables and not on the raw data, so that the directions may or may not coincide on the axes with the sequences in the raw data. In this case, the vector for temperature, for example, is virtually reversed by weighting.

Meroplankton Distribution

The meroplankton is composed of organisms that are only temporarily part of the plankton, such as the eggs and larvae of organisms which settle out at metamorphosis and become attached or confined to hard substrates.

Settling rack data furnish a somewhat different picture of the harbor, since racks are not suspended in the open outer harbor water roadway but must be hung from buoys or docks. Temporary buoys placed at station B8 disappeared, due either to storms or ship traffic, soon after being placed. Populations found on settling racks are far less transitory than are open water plankton samples; collections of the latter are affected by tidal phase at the time, whereas the racks are fixed at a site at a constant depth. Settling rack data generally show much greater diversity at the higher category level (phylum class order) than do benthic or zooplankton data. Along with advantages of the settling rack technique go the disadvantage that small colonial organisms, which sometimes constitute a major portion of the rack fauna, cannot be counted and tabulated as numbers of individuals. This tends to bias computer analysis to some extent. Another difficulty is the occasional loss of racks due to storms or ship damage.

In this winter period, settling rack species data showed large-scale separations into inner and outer harbor stations, similar to zooplankton data. The chief differences were that the Los Angeles main channel did not group with outer harbor shallow water stations and the Los Angeles River mouth was separated from the outer harbor and ocean stations (Figure 5).

The dendrogram (Figure 6) indicates the smaller scale separations into six station groups. While group 4, a single station (B2) is close to group 3 on the dendrogram, examination of the TWT (Figure 7) shows the biological isolation of group 4 in Pier J basin. The station, for unknown reasons, was virtually depauperate, yet the variables in Table 3 give no indication for the reason.

Groups 5 and 6, in the inner harbor, had the lowest salinity and pH, and lower dissolved oxygen, plus the lowest phytoplankton ratios. Similar records were seen in zooplankton groupings. The inner harbor stations (group 6) influenced by runoff showed a reduced fauna, with some species that are absent from the outer harbor and vice versa. Of interest also is the high diversity and numbers found at the sewer outfall (station A7, group 2) in a period when runoff would have affected the effluent quality. The meroplankton fauna are probably more representative of existing conditons than are the zooplankton captured by net tows, since the latter are influenced by tide, weather and inherent patchiness.

Figure 8 shows that all parameters analyzed interacted in determining the distribution of the groups. The coefficients are all of relatively similar magnitude, with salinity, dissolved oxygen and pH the most important for the three axes which contained almost all of the significant values.

Benthic Faunal Distribution

Since benthic stations were sampled only once per quarter, the benthic data are not mean data, as are the other biological data that are averaged for the entire period. It was raining heavily during the January benthic sampling and a freshwater lens covered the harbor, but this would not affect samples. The heavy runoff prior to sampling could have had effects, however (Section IIA).

Figure 9 shows the station groupings for January 1978, in which groups 1, 2, 3 and 4 are in the outer harbor and groups 5 and 6 are in the inner harbor. The dendrogram (Figure 10) also shows this general trend. However, group 7, the sewer outfall station A7, stands alone. Runoff during the preceding weeks undoubtedly affected groups 5, 6 and 7, even though mean salinities were not greatly different throughout the harbor (Tables 5 and 6). In contrast to the settling rack fauna, which was rich at A7, the TWT (Figure 11) shows extremely poor species diversity there, perhaps indicative of the disturbance of the substrate during the storms. Station A7 may also have been affected by extreme variability in the quality of TITP effluent following conversion to secondary waste treatment and diversion of cannery waste effluents from the harbor into TITP for treatment. It is not surprising that the capitellid species, which reproduce rapidly year round and are stress-resistant, should be those represented in these areas. The principal difference between groups 5, 6 and 7 was that station A7 had the highest temperature and also had the highest productivity. Group 6 stations also had reduced fauna; these are in the blind-end slips (C5 and C7) and in the area affected by Dominguez Slough runoff (C11).

The river mouth also showed the reduced benthic fauna similar to the inner harbor stations, rather than the uniformity of outer harbor sites seen in the zooplankton groupings. Greater difference can be seen between adjacent stations in the benthic data; these correspond in part to the grain size distribution shown in Sec. II C (Figure 3) of this volume. There, the gyre is indicated by the low percentage of finer clay and silt as compared with adjacent areas that may be depositional. The deeper stations would be expected to maintain greater diversity and populations, since they would be less likely to be affected by the heavy winter rainfall or storm turbulence.

The vectors for benthic groupings in Figure 12 show the extreme separation of groups 6 and 7; while groups 1-4 are closely clustered on axes 1 and 2, they are better separated on axes 2 and 3. The coefficients of separate determination show that phytoplankton productivity, depth, temperature, dissolved oxygen and pH were all important in correlating distribution of species.

Spring, 1978

The spring quarter in the harbor consists of the months of March, April and May. In 1978 heavy rainfall continued into April and the warm oceanic regime was present throughout. Generally, an influx of colder water from the north occurs sometime during the winter or spring, and probably initiates the spring reproductive maturation that occurs with rising temperatures. There was a brief cooling in May 1978.

Zooplankton

The station group patterns based on zooplankton species (Figure 13) were much more varied in the outer harbor and more uniform in the inner harbor in the spring quarter than they were in the winter. The harbor was separated into three major groups in the dendrogram (Figure 14) in which groups 1, 2 and 3 represent the outer harbor gyre and the Los Angeles sea buoy, while groups 4 and 5 primarily represent the rest of the outer harbor and Long Beach sea buoy and back channel. Groups 6 and 7 encompass most of the inner harbor and blind-end slips as well as the southwest Los Angeles basin.

The patchiness of the plankton distribution in the gyre area into 3-4 groups is unusual, as compared to the winter, given the tidal mixing and movement of the water masses. In spite of this, the number of species was considerably reduced from the winter quarter. The TWT (Figure 15) shows that a number of stations had reduced fauna, especially in stations A4 and A11 (group 3) adjacent to the TITP sewer outfall at A7. Yet station A7 plankton was not as poor as that at A4 and A11.

As shown in Table 7, the coldest area was in the gyre (group 1), followed by groups 2 and 4 areas. The warmest areas were groups 6 and 7. Mean salinities were highest within group 3 and lowest in group 5 at the river mouth, and near the Edison plant. Dissolved oxygen levels suggest that a mild phytoplankton bloom occurred. This is consistent with results seen in Section IIIA on primary productivity in this volume. Table 8 gives the weighted variables used in discriminant analysis. Figure 16 shows the coefficients of separate determination and vectors as they were placed on the axes. Temperature, dissolved oxygen, pH and productivity were most prominent; salinity was much less so.

Meroplankton

Groupings based on settling rack data were much more uniform than in the free zooplankton, with the outer harbor and sea buoy stations all in group 1 (Figure 17). The dendrogram (Figure 18) was divided into the outer harbor, as group 1 plus the Pier J basin (group 2), and the inner harbor, as groups 3 and 4. Group 3 included most of the main channels while group 4 sites were inner blind slips or locations with runoff.

The TWT (Figure 19) indicates that station B2, which was depauperate in the winter, was very well populated in the spring. It is interesting to note the many polychaete species, including *Capitella capitata*, metamorphose and grow in the settling racks during the one month exposure intervals.

Inner harbor and main channel stations were clearly warmer and had lower salinities and oxygen levels than outer harbor stations (Table 9). Only Pier J basin had low phytoplankton values. Weighted values are shown in Table 10. Of the variables analyzed, salinity was much less important than temperature, dissolved oxygen, pH and phytoplankton parameters (Figure 20). The lesser importance of salinity to zooplankton appears to be consistent with the natural tolerance of estuarine species to such fluctuations.

Benthic Populations

The benthic distributions were more uniform in the spring than they were in the winter, but patterns were still varied (Figure 21), almost as much as for zooplankton. Group 1 included much of the outer harbor and Long Beach channel, except for the gyre area. In the latter, stations A3, A16 and A11 were similar to stations A1 and B1 outside the harbor. Group 2 included parts of the gyre, the outer main Los Angeles channel and southwest basin, as well as Long Beach City waters seaward of the river mouth. Group 4 included most inner harbor stations, whereas stations A4, A7, the river mouth and some inner slip stations were in group 5. Thus the dendrogram (Figure 22) is not divided into major inner and outer harbor groups. Groups 1 and 2 were similar in species composition, as shown in the TWT (Figure 23), but group 3 stations showed higher populations of a number of polychaete and molluscan species. Groups 4 and 5 showed a scarcity of species but high numbers of some that are poorly represented in groups 1 and 2. Figure 24 gives the coefficients of separate determination, with salinity apparently being the most significant variable for the benthic species. Depth and pH were significant, as were chlorophyll a and productivity. Tables 11 and 12 give the mean values of the parameters and the weighted values, respectively. Depth makes, of course, an obvious difference in benthic species, along with the sediment grain size distributions referred to previously. Salinity differences were somewhat surprising for the benthic organisms; perhaps the 30± inches of rainfall mixed much more deeply than would normally occur. All stations had lower pH values than usual and group 5 stations were the warmest. Phytoplankton measures were lowest for group 3 stations, which included the sea buoys, whereas group 1 stations in the outer harbor had the highest phytoplankton values.

Summer, 1978

The summer quarter consists of the months of June, July and August. While June weather is generally overcast and waters cool, July and August are usually sunny, warm and without rainfall. Reproductive peaks are usually past and some species retreat to cooler, deeper waters.

Zooplankton

Distribution of the zooplankton groups in the summer months was not characterized by clear inner harbor-outer harbor separations (Figure 25), as had been the case in the winter and spring periods. The dendrogram (Figure 26) showed only that group 5 stations were most distant in relationships to all the other groups. Stations in groups 4 and 5 occurred only in the outer harbor, but groups 1 and 3 were disjunct in distribution.

The Terminal Island Treatment Plant experienced upsets throughout the summer, so that the impacts varied, and the averaging of data may have masked greater variability of plankton. Increases in suspended solids and BOD occurred during the summer, which might have increased zooplankton numbers in some areas. However, chlorination was carried out between March 9 and August 30, 1979, because bacterial floc from TITP flowed into the harbor during periods of instability. Chlorination may be toxic to organisms in the effluent plume if excess amounts of chlorine enter the plume, or if the more stable, toxic chloramines, which can be formed during protein decomposition, enter the effluent.

Group 4 stations were the most coherent, representing much of the outer harbor and the area outside the breakwater. There were more species and greater numbers in that group, as shown by the TWT (Figure 27). A number of species regress from the warmest areas of the harbor during the summer and fall.

Of the physical variables measured, temperature and dissolved oxygen were the most significant. Group 4 stations had the lowest temperatures, while group 2 stations in the West Basin area of inner Los Angeles Harbor had the highest. The Harbor Steam Plant is near station C6.

The distribution of group 1 stations is difficult to explain, as it is composed of station A9 at the *Sansinena* explosion site, B9 near the center of outer harbor, the Pier J area and middle and inner Long Beach Harbor. The latter are influenced by the Edison discharge. The most distinctive parameter was high dissolved oxygen (Table 13). Yet, in the weighted variables (Table 14) the oxygen levels and the phytoplankton measures which produce them, are not very different from other areas of the harbor. This may well be indicative of the patchiness of zooplankton and phytoplankton as they are moved about by tidal action. Group 3 is also patchy in distribution, representing most of the Los Angeles main channel, as well as the center of the gyre, the Los Angeles River and outer Long Beach City Harbor.

Highest phytoplankton productivity and chlorophyll a were found in group 5 stations near the outfall and in Long Beach City Harbor. The group 5 stations, including the outfall (A7) had good species diversity in spite of, or possibly because of, the TITP malfunction.

The plant malfunction did release additional nutrients during the summer. Phosphate levels were well above normal in August at station A7 and somewhat high for the summer at A13 and A16. The C stations generally have higher phosphates than B stations; station C7 is high all year. See Section IIB for mineral nutrient data tables.

Ammonia levels were very high at A7 in August and above normal for the period at A2, A3, A13, A14 and A16, on the periphery of the gyre, and at A10, the San Pedro marina area. Nitrite levels did not rise until September in the outer harbor, but nitrates were somewhat higher during the summer. Station A9, the *Sansinena* site, had higher nitrate levels than usual during the summer.

The coefficients of separate determination and the important vectors analyzed are shown in Figure 28.

Meroplankton

In contrast to the patchiness of the zooplankton sampled with net tows in the summer quarter, the meroplankton from settling racks showed more uniform patterns (Figure 29). While groups 1 and 4 were limited to the inner harbor and main channels, the dendrogram (Figure 30) shows that the two groups were widely separated biologically. Group 4 stations, in the middle harbor of Long Beach and parts of the inner harbor, were more closely related to group 3 stations in the outer harbor than to the other inner harbor sites. Surprisingly, group 2 stations outside the harbor and in the outermost part of the harbor gyre appeared to have reduced numbers of species (Figure 31), in contrast to free zooplankton data. This suggests that impacts occurred during the summer that were not evident in the once-a-month plankton tows. The group 1 stations had a different group of dominant species than groups 2, 3 and 4, as shown in the TWT.

The same parameters that were shown to be significant for zooplankton were most important in meroplankton distribution. Temperature, dissolved oxygen, and chlorophyll a were very highly correlated, and pH was of lesser importance for meroplankton. The vectors for temperature, dissolved oxygen and pH, as well as for several vectors with coefficients below the level considered significant, are plotted on two axes in Figure 32.

Table 15 indicates that group 1 stations in the inner harbor had higher mean temperatures and lower dissolved oxygen than the other stations. Group 2 stations, outside the harbor and in the outer harbor, had fewer meroplankton but higher phytoplankton productivity and chlorophyll a. Group 4 stations, which probably are influenced by the Edison plant, had much lower productivity and chlorophyll a but high assimilation ratios.

Group 3 stations might have reflected stress or impacts, from the *Sansinena* incident at A9 in the southwest Los Angeles outer harbor and from TITP (A7), in the central outer harbor. Since diversity and numbers are not greatly different throughout the harbor, the stresses of heat and lower dissolved oxygen in group 1 inner harbor stations may have been about equal to those from the *Sansinena* and TITP incidents (Soule and Oguri, 1978; 1979). While differences in distribution of species were apparent (TWT, Figure 31), no station was really depauperate. Even the station C11, at the Dominguez Channel entry (group 1) had very good diversity, once the disturbances of runoff were over and marine tidal exchange returned. However, sediment pollutants apparently continued to inhibit the benthos at station C11, as will be seen below. The value of sampling organisms above the disturbed or polluted sediments in addition to benthic sampling is well illustrated by comparing the settling rack data with benthic data for C11.

Weighted means are shown in Table 16; the rankings of the group parameters differ from the mean raw values in some cases.

Benthic Distribution

The benthic species distribution for July 1978 was consistent (Figure 33) with the complexity of patterns shown by plankton sampling. While large-scale separations were evident in the dendrogram (Figure 34), they were not strictly based on inner harbor-outer harbor divisions. Group 1 stations included the back channel, middle harbor and outer harbor of the Port of Long Beach, group 2 included the middle outer Port of Long Beach, group 3 the west outer harbor and outer main channel of Los Angeles Harbor and outside Angels Gate, and group 4 characterized part of the Los Angeles gyre, eastern Long Beach and the area outside Queens Gate.

While groups 5, 6 and 7 were primarily inner harbor, group 5 also included the warmest, shallowest waters near the TITP outfall and the mouth of the Los Angeles River. The TWT (Figure 35) shows that there were large gaps in the species present in groups 5 and 6, with group 7 (C11) having the usual six or so species.

Of the outer harbor groups, stations of group 2 seemed less productive than groups 1, 3 and 4.

The vectors for the important parameters are plotted in Figure 36. The coefficients of separate determination indicate that temperature, depth, salinity, and assimilation ratio were the important variables. However, salinity differences between groups were small (Tables 17, 18). All of the vectors could be plotted on three axes, except for assimilation ratios. Group 7 (station C11) had the highest assimilation ratios in both weighted and unweighted values, and high productivities, along with high temperatures.

The entire harbor had low dissolved oxygen values in July; only group 1 stations were above 6 ppm. The raised BOD levels during the TITP malfunction might have been reflected in lower mean oxygen readings (4.00-4.4 ppm) in the outer harbor in groups 2 and 4, were it not for similar readings in Long Beach City Harbor. In the inner harbor, groups 6 and 7 had mean values between 3.47 and 3.9 ppm. The pH readings were also lower than usual throughout most of the harbor. In summary, various combinations of factors appeared to stress different areas of the harbor during the summer, but most stations showed reasonably good diversity and numbers. However, Soule and Oguri (1979), in comparing several outer harbor stations in 1978, found drops in numbers of organisms in the summer, at stations A1 and A7, in contrast to increases at stations A2, A3 and A12.

Autumn, 1978

The autumn months of September, October and November generally have periods of very hot days and cool nights, reversal of prevailing wind directions (Santa Ana winds) and fall tidal extremes. Winter rains may begin in November, as they did in 1978 (Soule and Oguri, 1979). Any or all of these combinations may result in "turnover" in the outer harbor, in which the cooled surface layer sinks and warmer bottom waters rise to the surface. Nutrients are thus released, and phytoplankton blooms are usually strong. Blooms may produce high dissolved oxygen, but they may be followed by reduced oxygen as the bloom dies and bacteria exert a heavy oxygen demand (BOD). Anaerobic processes in sediments may be converted to aerobic activity in the water column, causing greatly increased BOD or chemical oxygen demand (COD).

Zooplankton

Distribution patterns of copepod and cladoceran species were very complex in the autumn, but clearly reflected the presence of the outer harbor gyre. Station groups 1, 2, 3 and 5 are all represented in the gyre (Figure 37). Group 7 stations are confined to the inner Los Angeles Harbor, but other groups have somewhat patchy distribution. The dendrogram (Figure 38) indicates the wide separation of group 7 sites in inner Los Angeles Harbor from all others. Groups 1, 2 and 3 are separated biologically from groups 4, 5 and 6. The TWT (Figure 39) shows surprising consistency of distribution for a cluster of cladoceran species. The number of species remained relatively unchanged over all quarters except the winter 1977-78, when diversity was considerably higher (Soule and Oguri, 1979).

In Figure 40, vectors for all parameters analyzed, along with the separation of Group 7 stations, can be seen. The coefficients all are at the significant level in the first three axes, which contained 98% of the important information. Dissolved oxygen dominated the coefficients, followed by phytoplankton variables. Temperature, salinity and pH were of lesser importance. (See also Section IIB, this volume, for physical water quality maps, and Section IIIA for phytoplankton maps).

Group 7 inner harbor stations contained the lowest mean values for dissolved oxygen, pH, productivity and chlorophyll a (Table 19) and highest temperature and assimilation ratios. The weighted variables (Table 20) alter the rankings in several instances. Salinities and temperatures are so similar that differences would be of lesser significance. Station B1 (group 6) was the only station that was high in numbers of species and organisms in the autumn (see TWT, Figure 39).

Group 5 stations in the Long Beach outer harbor, middle harbor and back channel, and in outer Los Angeles Harbor, were richer in species than the other outer harbor groups 1, 2 and 3. Group 4 stations had the highest mean productivity and chlorophyll a values, a bloom, while group 7 sites had the lowest phytoplankton values.

As was mentioned earlier, the variables analyzed herein may not have been the only factors important to the species distribution patterns. Such factors as stirring or turnover of waters could not readily be quantified. The only indication of unusual nutrient conditions in the fall was a rise in nitrites at stations A7, A15, A16 and A17 in September, perhaps from TITP problems. Normal autumn rises in nutrients occurred elsewhere in the harbor in November.

Meroplankton

Settling rack data produced a much more uniform inner harbor-outer harbor pattern as compared to the zooplankton data, although this may be due in part to the fact that there are not as many settling rack sites (Figure 41). Group 2 sites represented the outermost harbor, the sea buoys and Long Beach City Harbor, while group 1 included the rest of the outer harbor and Long Beach channel. Group 3 sites were on the Los Angeles Main Channel and in most blind-end slips. Group 4 represented only the Cerritos Channel. Divisions into inner and outer harbors are indicated in the dendrogram (Figure 42).

The TWT (Figure 43) shows that no stations could be considered depauperate, and group 3 stations have high numbers of opportunistic capitellid species. Otherwise, species distribution was fairly uniform, with group 2 stations outside the harbor having fewer species generally.

All variables measured were significant and vectors could be plotted on the axes (Figure 45). The highest coefficients of separate determination were for salinity, pH and temperature, followed by phytoplankton values and dissolved oxygen. Table 21 indicates that in September, chlorophyll a and productivity values were very high at station B6, which raised the mean values for group 4. The bloom conditions in September probably resulted in lower oxygen levels following the bloom. Salinity differences were small between groups; the pH values were not low, but were lower in the inner harbor (groups 3 and 4) than in the outer harbor. Mean dissolved oxygen levels, however, were below 5 ppm at inner Los Angeles Harbor group 3 stations, and just above 5 ppm in group 4 Cerritos Channel and Slip Two, Long Beach. Table 22 presents the weighted variables used in the multivariate analysis. Since 5 ppm is an arbitrary oxygen value set by regulatory agencies, a slight drop below that might have no impact on invertebrates or fish.

Benthic Fauna

Benthic patterns in the October quarterly sampling differed from the autumn plankton and settling rack patterns in some respects, but at the same time showed complexity similar to that of plankton in the gyre area (Figure 45). As mentioned, there are differences in substrate grain size there that influence the benthic organisms (Section II, Physical Environment). However, the cumulative effects of the TITP malfunctions and the warm, dry summer are evident as well. The dendrogram (Figure 46) also indicates the complexities, since all groups are represented within the larger gyre area.

Group 7 stations group the sewer outfall area with the inner harbor blind-end slips and Dominguez Channel and the river mouth. The numbers of species were reduced (TWT, Figure 47) in group 7, as compared to most groups, and the species composition differed. Group 6 (station A14) is in the center of the gyre, where deposition of possibly toxic materials might have occurred, and was greatly reduced in species and numbers. This suggests that suspended solids released may have settled out in a localized manner and may have buried organisms or carried materials toxic to them.

Group 1 includes outermost harbor stations, the Long Beach sea buoy and the outer Long Beach channel stations. The stations were rich in species and numbers. Groups 2 and 3 were somewhat less rich, whereas groups 4 and 5 were progressively less so toward the depauperate center of the gyre (group 6). It is of interest that the Los Angeles sea buoy (station A1) grouped with the shallow water stations near the outfall in group 5.

The vectors for the parameters analyzed are shown in Figure 48, along with the coefficients of separate determination. All coefficients were significant, through the fourth axis. All of the weighted variables except temperature could be plotted on the three axes shown; the vector for unweighted temperatures would be the reverse of the productivity vector on axes 2/3, with rising temperatures for groups 6 and 7. Tables 23 and 24 give the mean unweighted variables and mean weighted variables respectively. Dissolved oxygen was lowest in group 7 stations and next lowest in group 4. While the levels were somewhat low throughout the harbor, they were highest (6.9ppm) at station A14, where benthic organisms were low. Chlorophyll a was high there, but productivity and assimilation ratios were lower than in the other groups. Phytoplankton peaks in the fall occurred in different months at different but adjacent stations (Soule and Oguri, 1979), which tends to limit comparison to the one-time benthic sampling in October for the quarter.

CONCLUSION

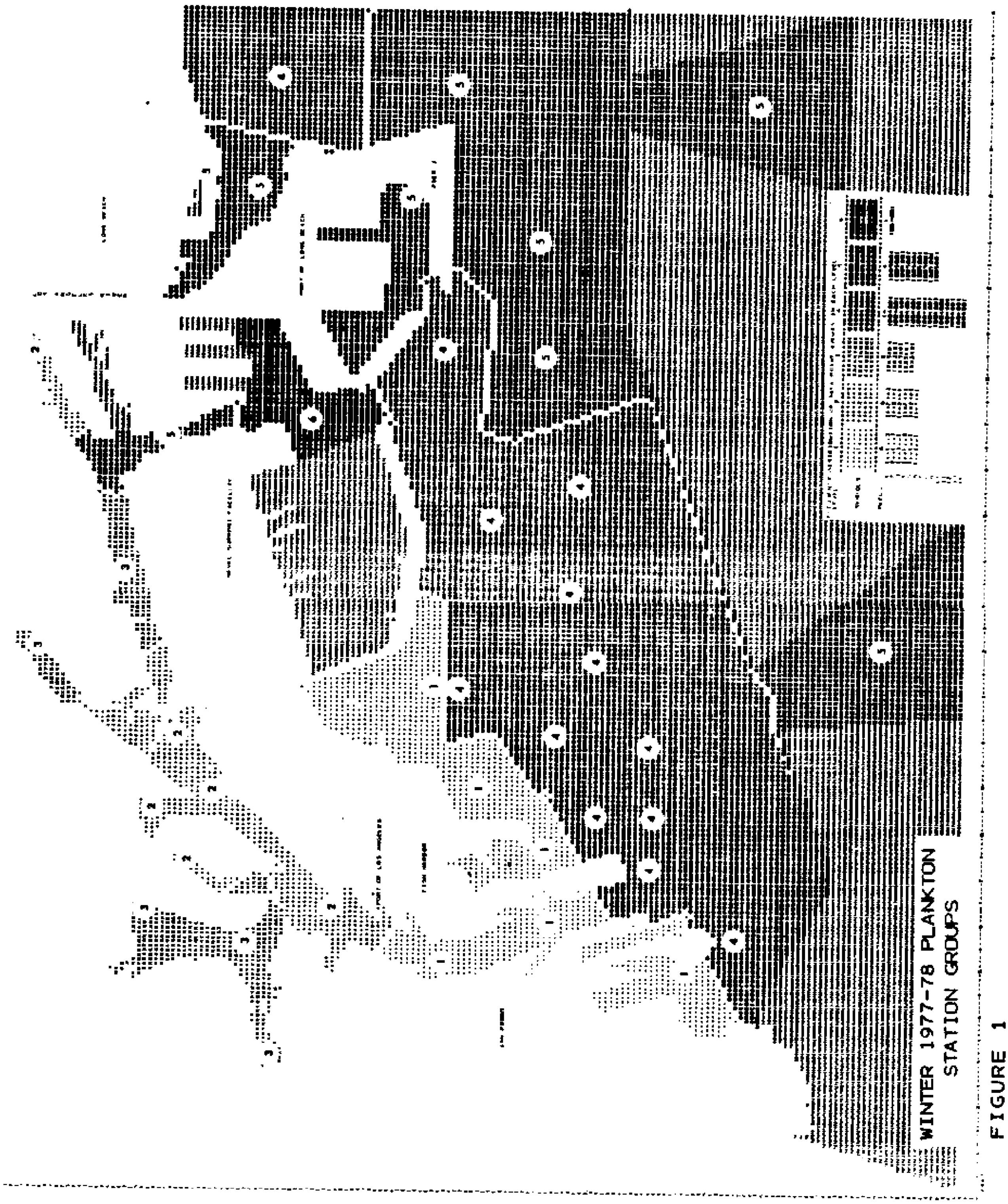
In comparing results of the three different sampling methods -- zooplankton net tows, settling racks and benthic grab samples -- it is possible to compare short term impacts with long term conditions such as depth, warming, flushing and sediment quality. However, generalizations about the type of groups sampled can be made, which differ somewhat from earlier conceptions.

Zooplankton, for example, may be transported by tidal and circulation effects on the water mass. Certain species are, nevertheless, able to maintain themselves in particular localities, such as inner harbor slips or outer harbor open areas over long periods of time. Reproductive periods are short for many species, but populations are not random, except where intolerable conditions eliminate them.

Settling rack fauna tend to smooth the variability in distribution patterns, but the lack of sampling stations in open waters is a problem. There is a distinct advantage in the harbor to racks as opposed to sampling intertidal and subtidal rocks or pilings. On permanent substrates time spans of exposure and succession are unknown or, if substrates are scraped, recolonization may be by overgrowth from adjacent areas and not from water column reseeding. Reproductive cycles in the harbor can be better documented by changing racks monthly. Also, life in the water column has been shown to be richer than in polluted or disturbed sediments, as, for example, at the mouth of Dominguez Slough (station C11).

Benthic organisms are considered to be good indicators of long-term conditions, such as grain size and sediment pollutants. However, this study and the *Sansinena* study (Soule and Oguri, 1978) have demonstrated that response to impacts can be much more obvious and rapid than was previously suspected. Changes in substrate due to storm, propellor stirring or runoff allow species that reproduce year around to colonize more rapidly than others. Some are more resistant to stress, while others disappear from certain areas during warmer (or colder) weather.

While the urge to simplify monitoring for reasons of cost, expertise and convenience is strong, it is only possible to analyze the complex, synergistic effects when physical and biological parameters have been measured over time and space. It seems clear that natural and manmade impacts could be discerned by the investigations and analyses carried out.



WINTER 1977-78 PLANKTON
STATION GROUPS

FIGURE 1

PLANKTON DATA * WINTER 1977 – 1978 FIGURE 2

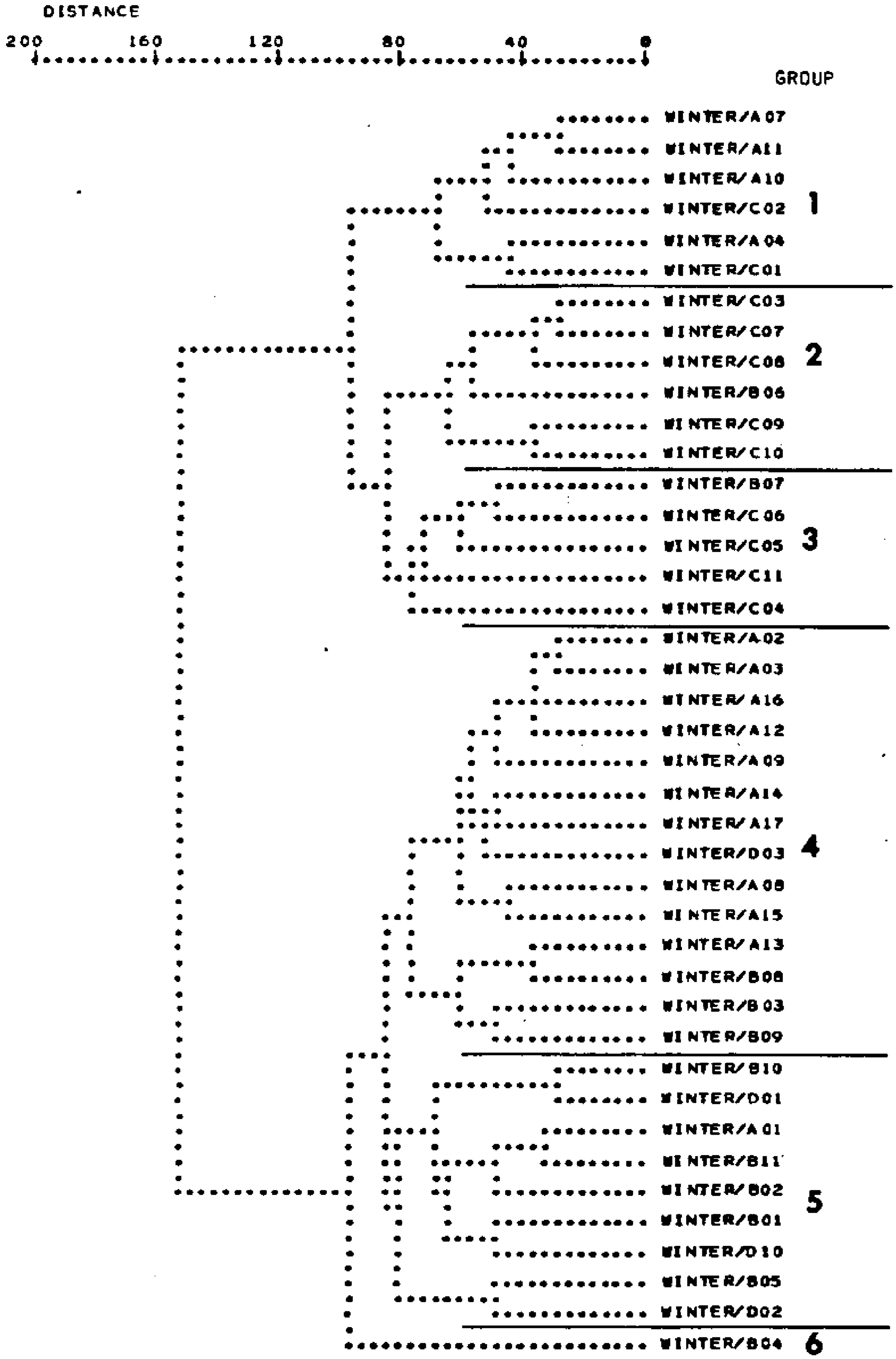


FIGURE 3

PLANKTON DATA * WINTER 1977 - 1978

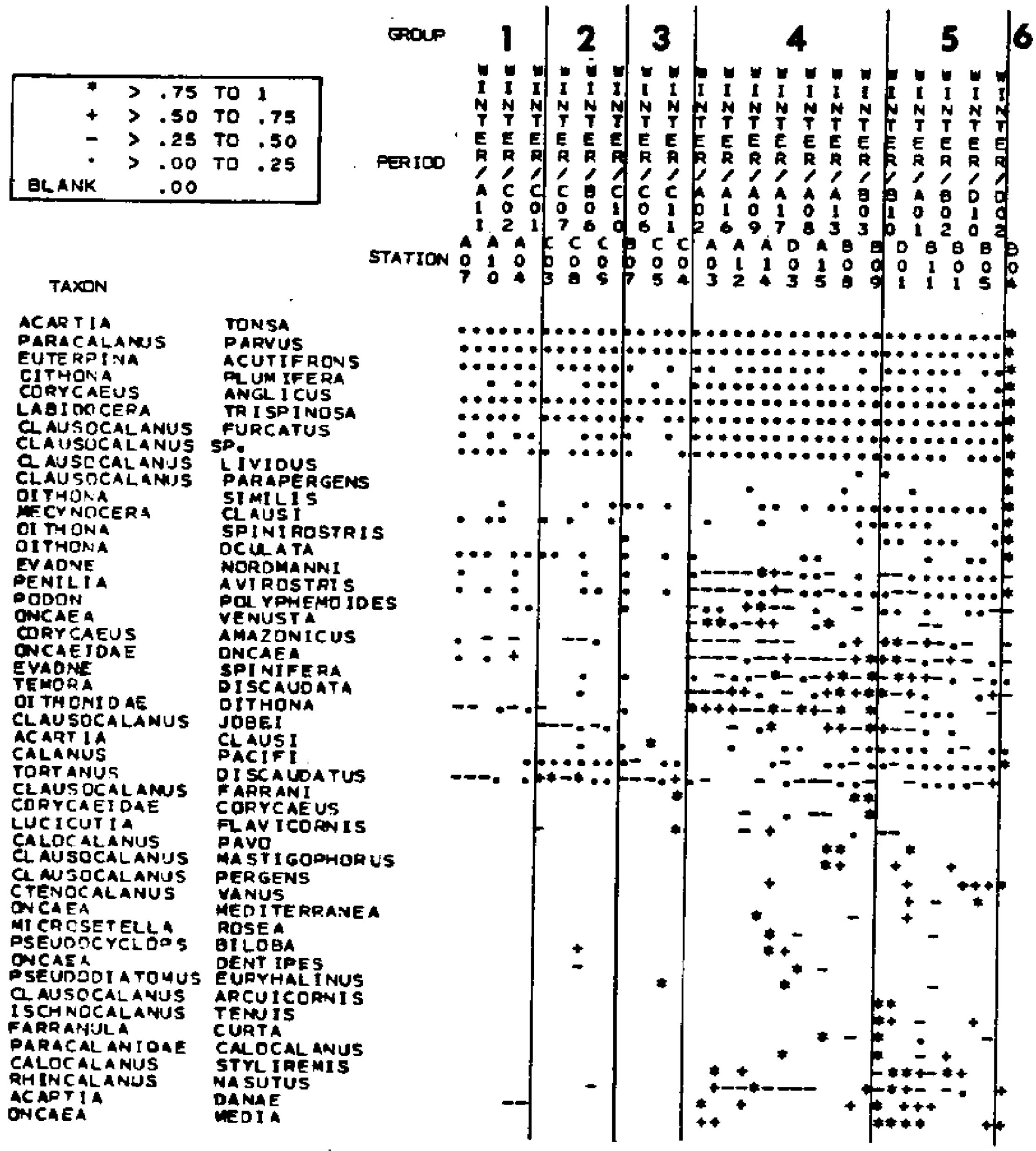
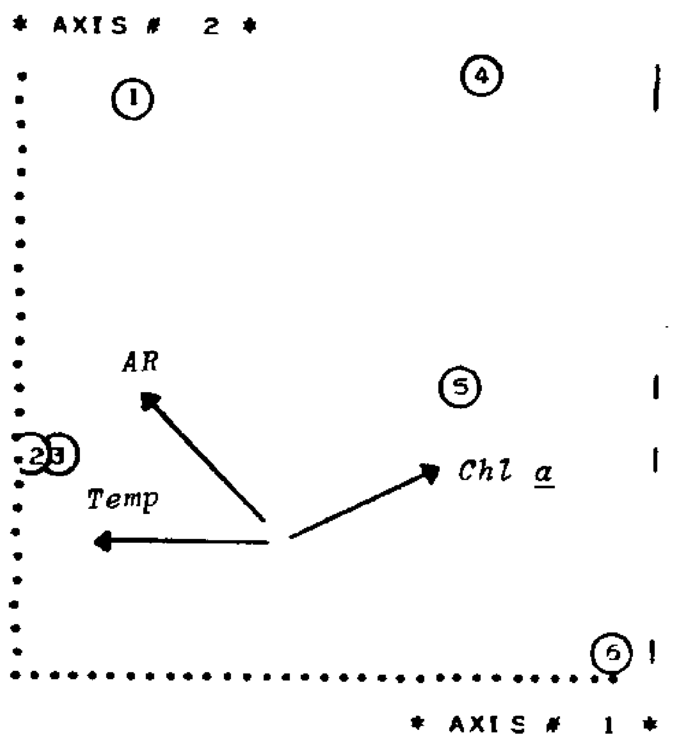


FIGURE 4

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

DISCRIMINANT ANALYSIS * PLANKTON DATA * WINTER 1977-1978

PARAMETER	AXES 1	2	3	4	5
1. TEMPERATURE	9.4	4.1	39.0	8.8	1.6
2. SALINITY	2.8	15.1	13.8	9.8	2.4
3. OXYGEN	34.0	10.2	11.1	5.7	28.2
4. PH	38.5	4.1	2.4	10.6	39.8
5. PRODUCTIVITY	6.2	37.2	12.1	9.6	24.5
6. CHLOROPHYLL A	6.4	23.6	3.9	0.5	2.8
7. ASSIMILATION RATIO	2.7	5.6	17.7	55.0	0.6



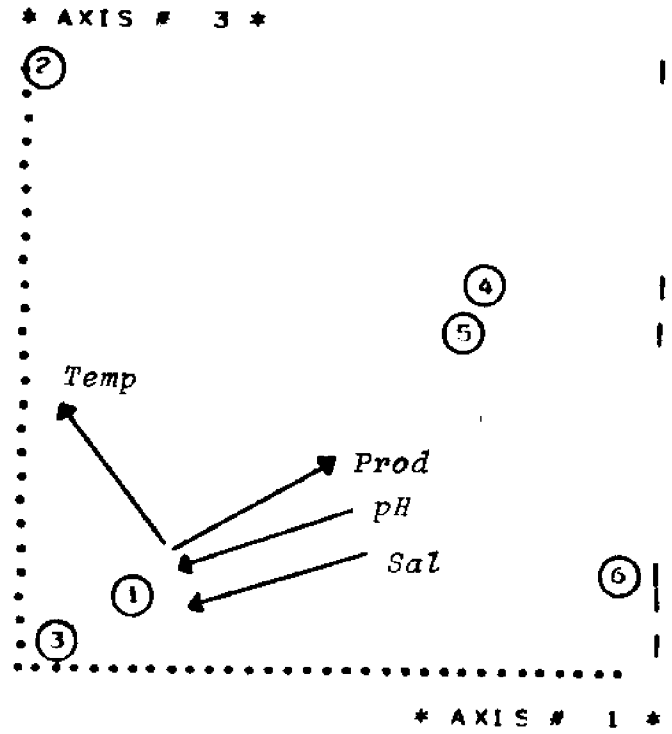


TABLE 1

VARIABLE GROUP AVERAGES * PLANKTON * WINTER 1977-1978

	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6
1. TEMPERATURE	16.2305	15.6000	15.7500	16.5315	16.8396	17.2667
2. SALINITY	30.2167	24.3416	22.6167	32.0804	29.3807	30.4000
3. OXYGEN	7.0367	7.0333	6.5300	8.1337	9.0473	8.9667
4. PH	7.8394	7.4328	7.3827	8.4169	8.3106	8.6300
5. PRODUCTIVITY	2.6400	2.1100	0.2400	3.3900	1.1700	0.9200
6. CHLOROPHYLL A	0.6893	0.2816	0.7100	2.5638	0.9932	0.5450
7. ASSIMILATION RATIO	2.1564	1.4175	1.7510	1.5641	1.4505	2.2400

TABLE 2

WEIGHTED GROUP MEANS

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

DISCRIMINANT ANALYSIS * PLANKTON DATA * WINTER 1977-1978

	1	2	3	4	5	6
1. TEMPERATURE	0.0616	0.0620	0.0619	0.0608	0.0608	0.0603
2. SALINITY	0.0367	0.0376	0.0379	0.0343	0.0348	0.0340
3. OXYGEN	7.6027	7.5710	7.5534	8.0339	8.0757	8.2983
4. PH	0.1260	0.1272	0.1274	0.1223	0.1228	0.1210
5. PRODUCTIVITY	0.8325	0.7161	0.7129	0.9776	0.9151	0.9568
6. CHLOROPHYLL A	0.6814	0.5919	0.5931	0.8181	0.7713	0.8059
7. ASSIMILATION RATIO	0.9768	0.9839	0.9616	0.9458	0.9368	0.9229

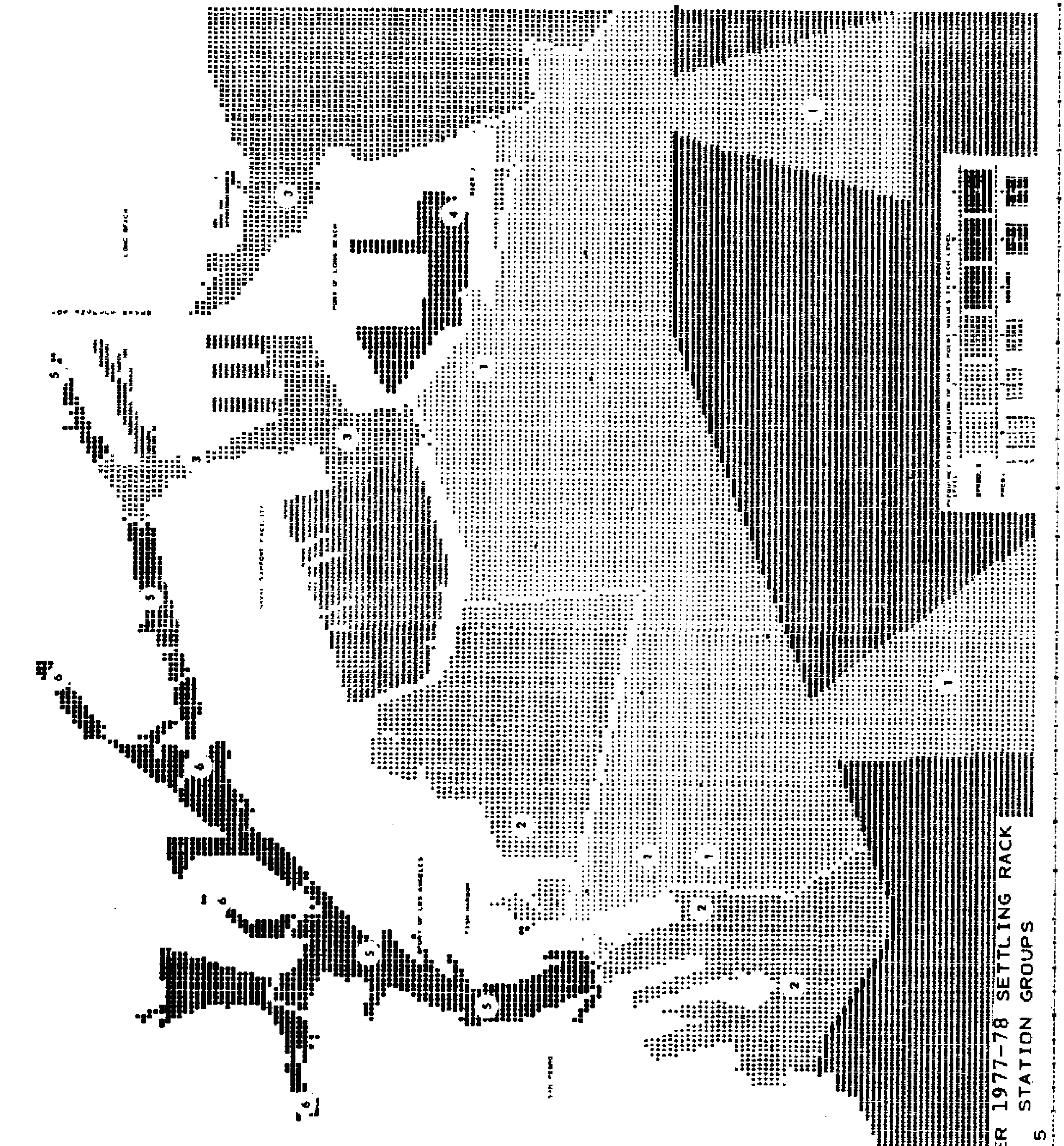


FIGURE 5 WINTER 1977-78 SETTLING RACK STATION GROUPS

FIGURE 6

SETTLING RACK * WINTER 1977–1978 * AVERAGED DATA

FIGURE 7

SETTLING RACK * WINTER 1977-1978 * AVERAGED DATA

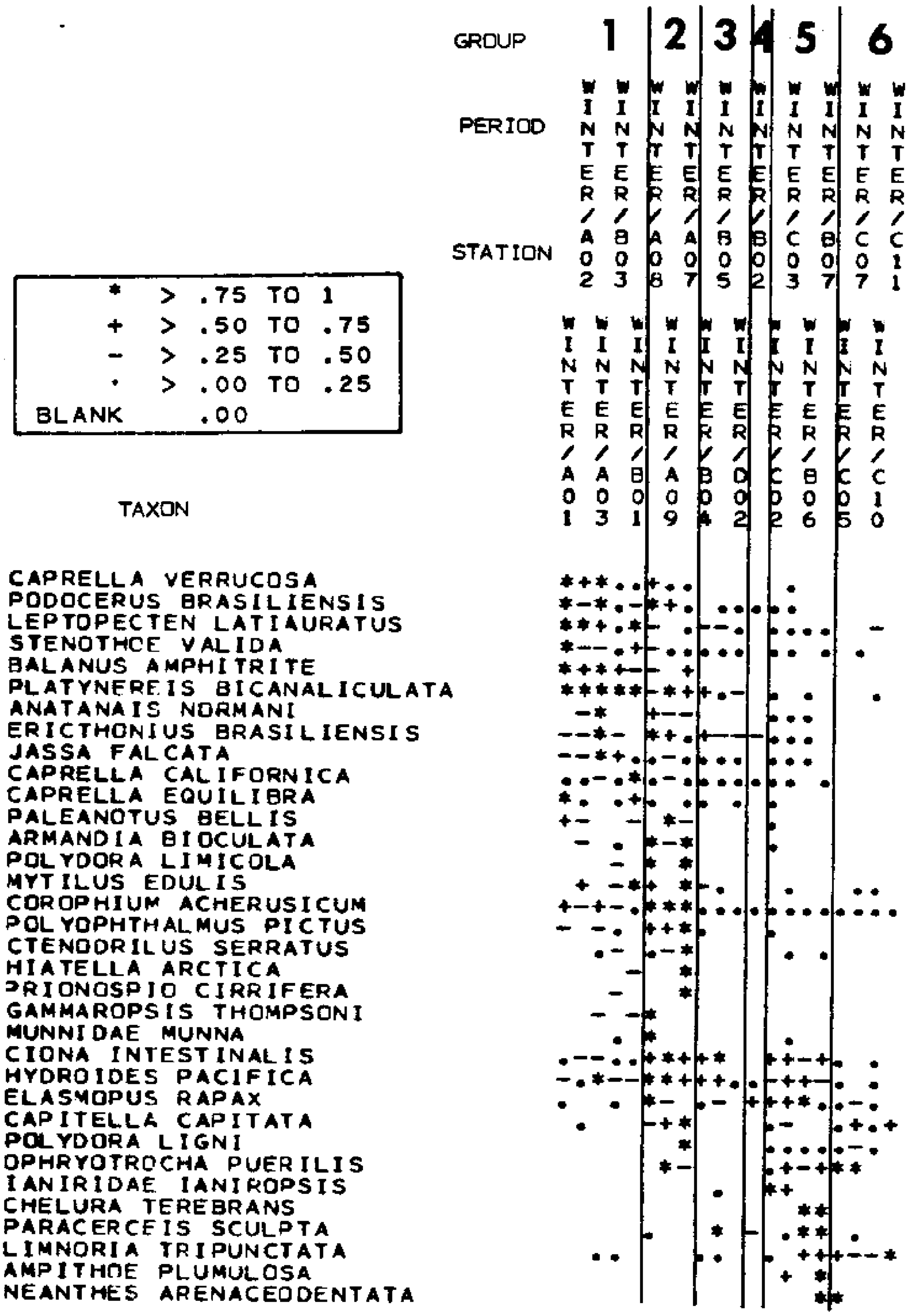


FIGURE 8

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)
SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * WINTER 1977-1978

PARAMETER / AXES	1	2	3	4	5
1. PRODUCTIVITY	11.5	16.7	6.3	2.0	14.8
2. CHLOROPHYLL A	21.0	5.8	0.8	6.5	24.8
3. ASSIMILATION RATIO	0.4	19.5	16.5	28.9	11.9
4. TEMPERATURE	3.2	17.5	0.3	23.6	27.5
5. SALINITY	23.7	7.6	38.6	29.6	3.8
6. DISSOLVED OXYGEN	12.3	24.5	9.5	0.8	0.7
7. PH	28.0	8.4	28.0	8.7	16.5

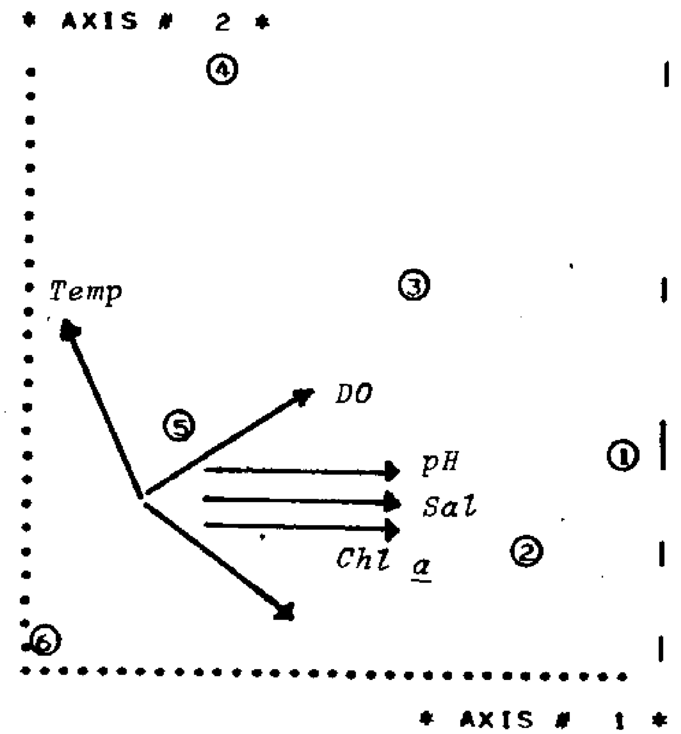


TABLE 3

VARIABLE GROUP AVERAGES • SETTLING RACK • WINTER 1977-1978

	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6
1. PRODUCTIVITY	2.3100	1.6700	1.8380	1.3450	1.3050	0.1790
2. CHLOROPHYLL A	1.6670	1.2960	0.7830	0.5050	0.2260	1.3060
3. ASSIMILATION RATIO	1.6210	1.5000	2.3150	2.9150	1.4430	2.1210
4. TEMPERATURE	16.4267	15.9333	17.2111	17.0000	16.7666	16.0750
5. SALINITY	33.4267	32.9055	32.6000	33.0667	29.6500	26.7000
6. DISSOLVED OXYGEN	8.6579	7.1333	8.9111	9.2333	7.3875	5.9125
7. PH	8.4473	8.3805	8.2778	8.3533	7.5983	7.0687

TABLE 4

WEIGHTED GROUP MEANS

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS • WINTER 1977-1978

	1	2	3	4	5	6
1. PRODUCTIVITY	0.8415	0.7969	0.6796	0.5592	0.5630	0.4590
2. CHLOROPHYLL A	0.6908	0.6388	0.5681	0.4614	0.4569	0.3887
3. ASSIMILATION RATIO	0.8673	0.8761	0.8574	0.8807	0.8501	0.8117
4. TEMPERATURE	16.4471	16.4231	16.5977	16.6873	16.5597	16.4599
5. SALINITY	32.3072	31.8216	31.5844	31.1819	30.6679	29.7591
6. DISSOLVED OXYGEN	8.0941	7.8020	8.0207	7.9613	7.5171	7.1576
7. PH	8.2188	8.1188	8.0577	7.9637	7.8577	7.6760

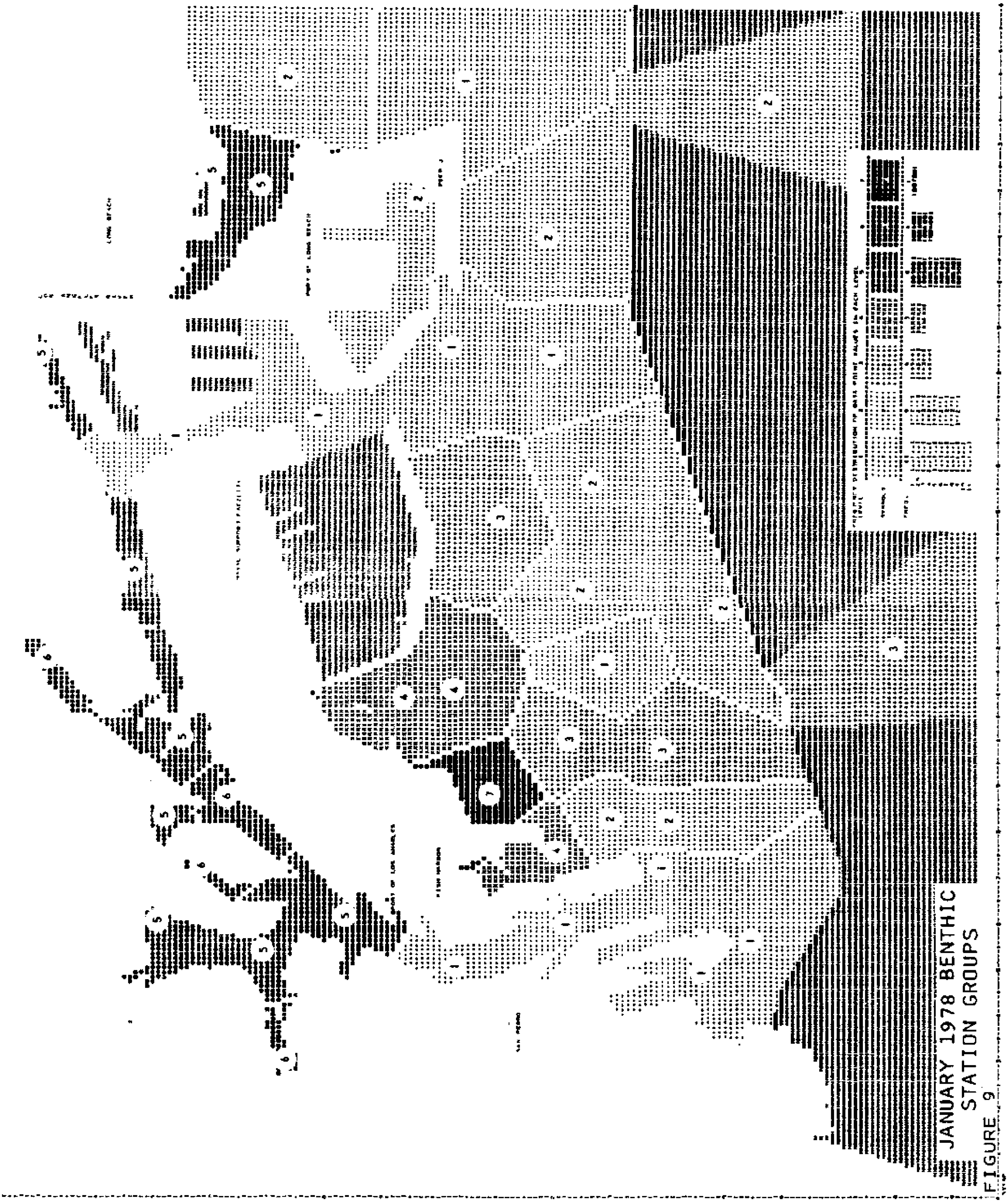


FIGURE 9
JANUARY 1978 BENTHIC STATION GROUPS

FIGURE 10

BENTHIC DATA (POLYCHAETA & MOLLUSCA) * JANUARY 1978

FIGURE 11

BENTHIC DATA (POLYCHAETA & MOLLUSCA) - JANUARY 1978

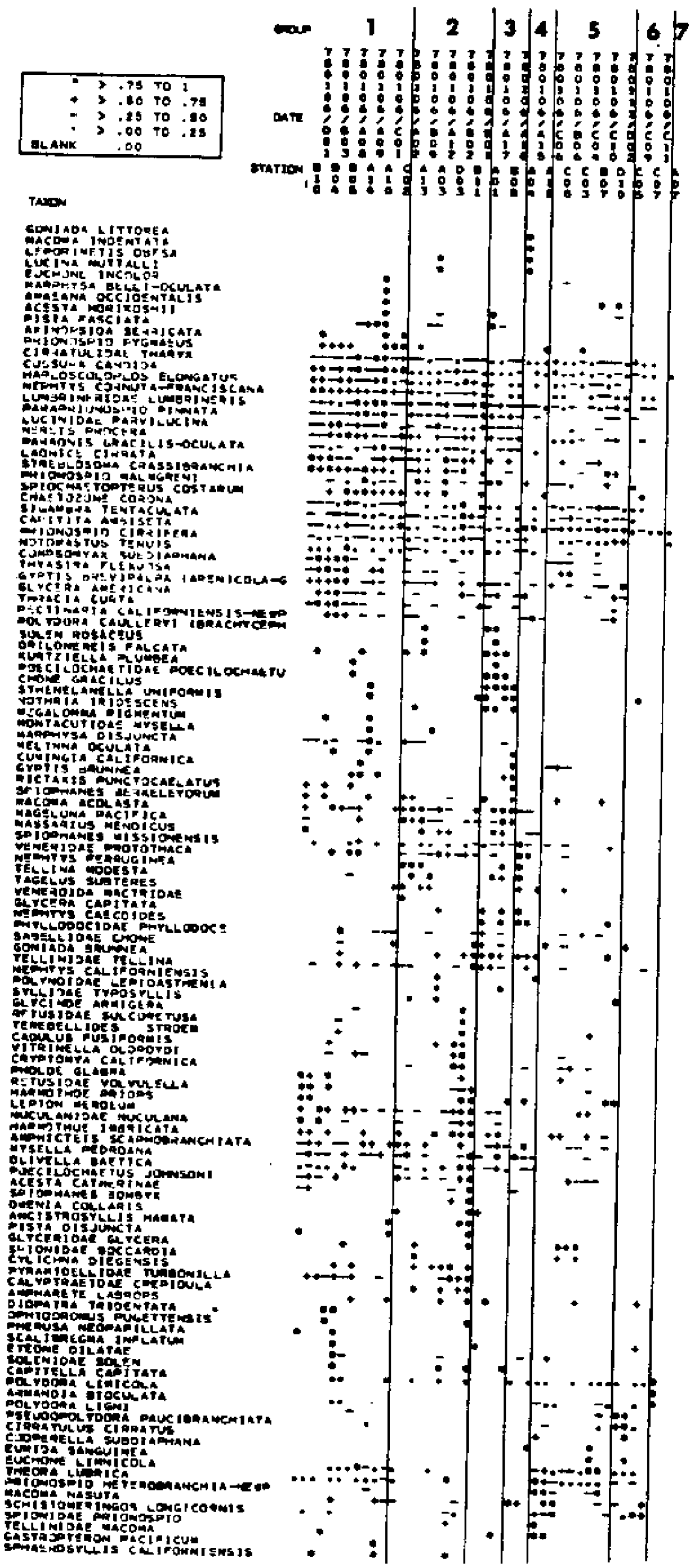
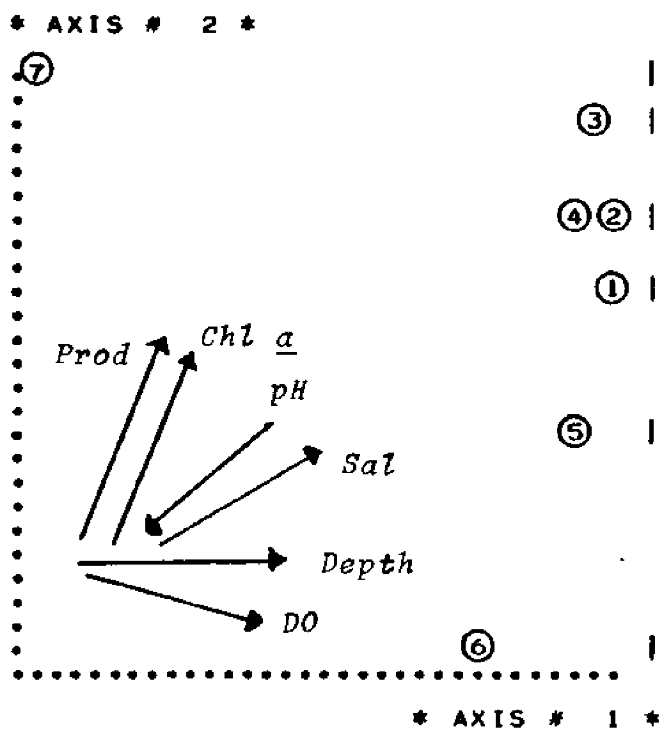


FIGURE 12

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)
WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * JANUARY, 1978

PARAMETER / AXES	1	2	3	4	5	6
1. PRODUCTIVITY	3.8	34.6	24.2	0.2	11.5	0.4
2. CHLOROPHYLL A	1.3	0.7	10.6	5.1	13.4	16.7
3. ASSIMILATION RATIO	0.2	1.4	9.2	32.0	23.7	2.5
4. DEPTH	4.9	0.2	19.3	11.1	15.0	4.2
5. TEMPERATURE	3.7	12.9	15.6	40.0	7.0	17.0
6. SALINITY	41.1	16.6	11.6	0.4	28.1	42.0
7. DISSOLVED OXYGEN	37.9	0.2	0.9	2.3	0.2	15.1
8. PH	7.0	33.6	8.6	8.9	1.1	2.1



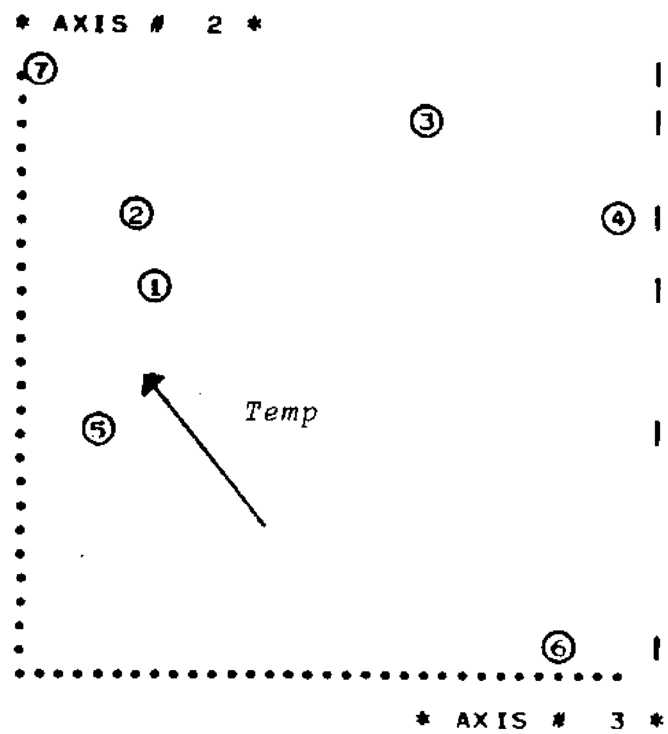


TABLE 5

** JAN78 **

VARIABLE GROUP AVERAGES * BENTHIC * JANUARY 1978

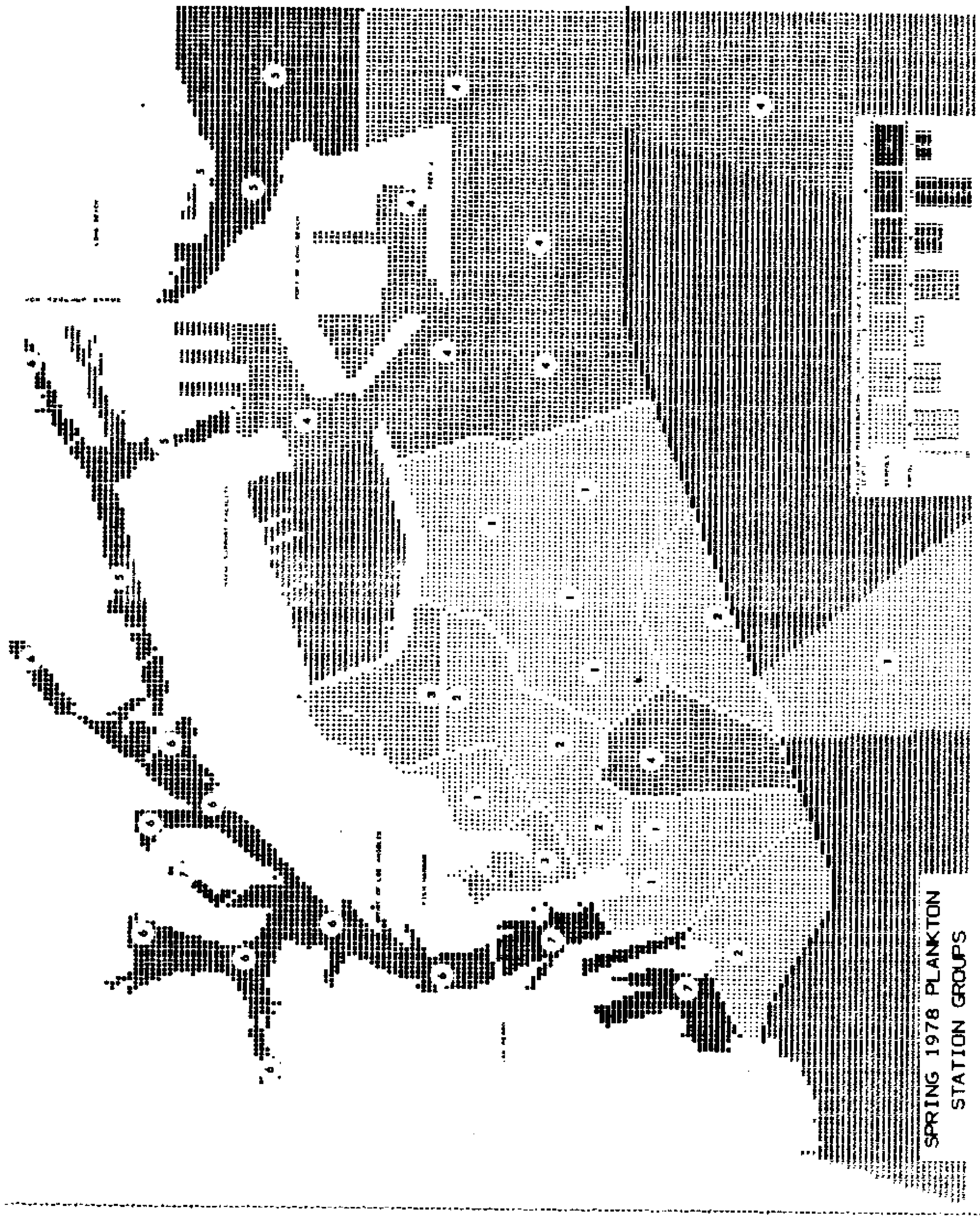
	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6	GROUP #7
1. PRODUCTIVITY	1.0780	2.0605	3.0867	9.5214	0.3193	0.1425	4.6733
2. CHLOROPHYLL A	1.0619	1.4191	2.0583	6.1075	1.6139	0.8875	1.8330
3. ASSIMILATION RATIO	1.3628	1.4236	1.7325	2.6543	1.5960	2.1200	2.5333
4. DEPTH	11.9091	14.2500	13.6667	10.0000	11.7143	10.0000	6.0000
5. TEMPERATURE	15.9636	16.0875	16.0000	15.9667	15.7429	16.0750	16.1000
6. SALINITY	27.9818	27.7625	27.5333	27.6333	27.8428	26.9500	27.5000
7. DISSOLVED OXYGEN	6.7636	8.2000	7.5000	7.4333	7.9143	7.7000	5.3000
8. PH	7.9846	8.0112	8.2500	8.2000	7.0371	6.2125	8.0100

TABLE 6
WEIGHTED GROUP MEANS

WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * JANUARY, 1978

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

	1	2	3	4	5	6	7
1. PRODUCTIVITY	0.7505	0.7833	0.8261	0.7900	0.6862	0.5956	0.7615
2. CHLOROPHYLL A	0.6091	0.6297	0.6573	0.6354	0.5713	0.5304	0.6260
3. ASSIMILATION RATIO	0.8712	0.8821	0.8893	0.8796	0.8605	0.8109	0.8683
4. DEPTH	12.7487	12.7211	12.4502	12.1607	12.3562	11.5578	8.9363
5. TEMPERATURE	0.0627	0.0627	0.0628	0.0626	0.0626	0.0625	0.0629
6. SALINITY	3.3604	3.3614	3.3629	3.3576	3.3567	3.3511	3.3452
7. DISSOLVED OXYGEN	7.7089	7.6946	7.6130	7.5669	7.6334	7.4130	6.1463
8. PH	0.1302	0.1292	0.1284	0.1299	0.1326	0.1372	0.1334



SPRING 1978 PLANKTON STATION GROUPS

FIGURE 13

FIGURE 14

PLANKTON DATA * SPRING 1978

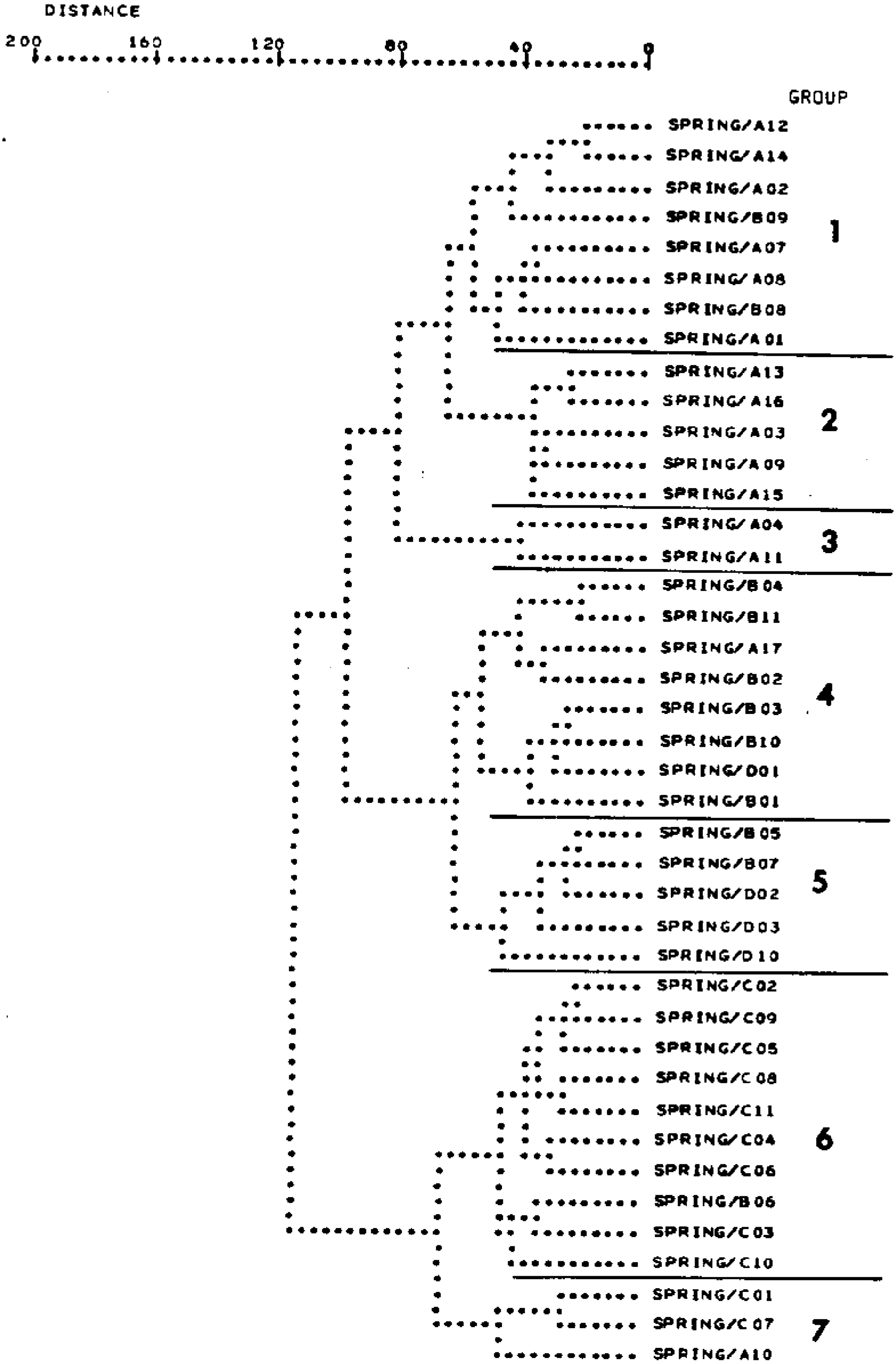


FIGURE 15

PLANKTON DATA * SPRING 1978

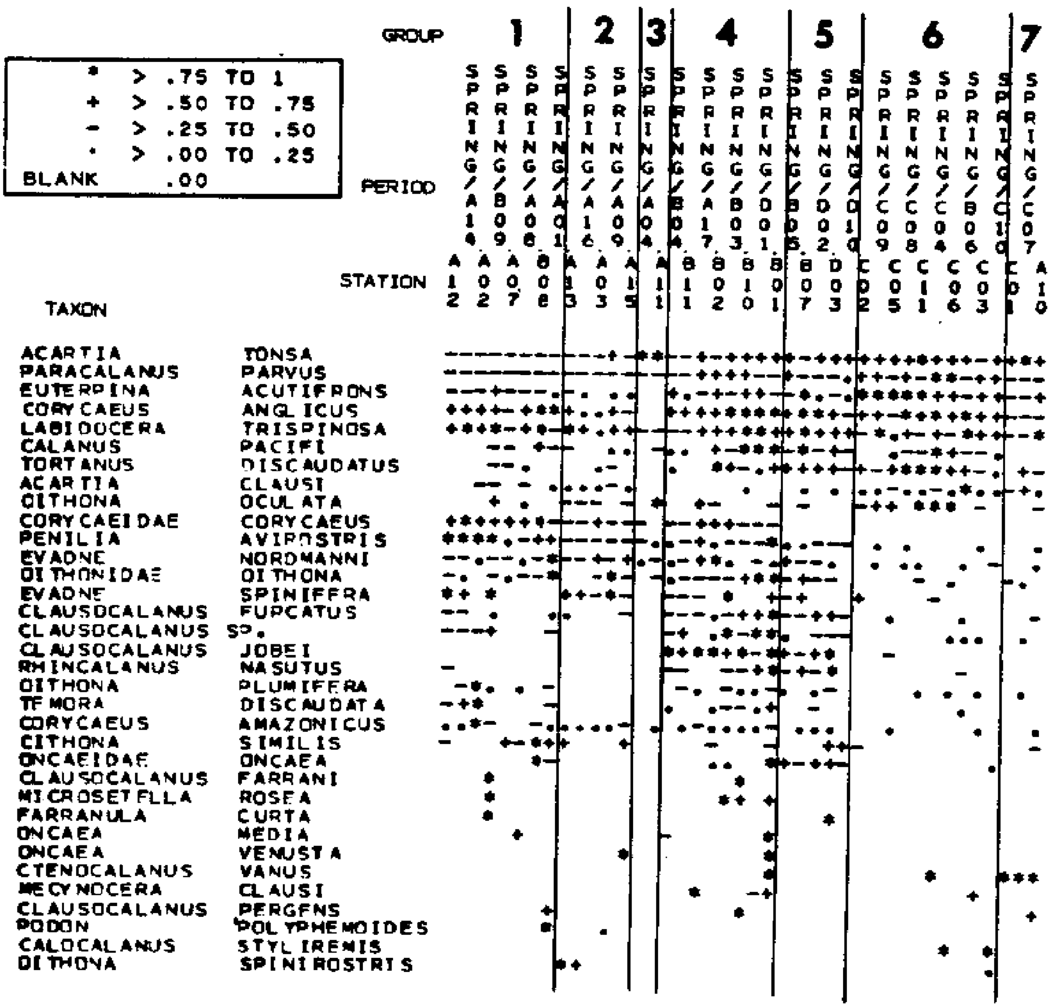


FIGURE 16

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

DISCRIMINANT ANALYSIS * PLANKTON DATA * SPRING 1978

PARAMETER / AXES	1	2	3	4	5	6
1. TEMPERATURE	35.6	2.2	9.3	16.8	0.7	13.7
2. SALINITY	0.9	26.3	18.3	2.9	1.6	40.2
3. OXYGEN	62.2	4.7	6.8	4.2	0.1	8.3
4. PH	0.2	23.1	1.4	17.9	2.8	34.9
5. PRODUCTIVITY	0.0	23.8	17.1	28.4	33.5	0.7
6. CHLOROPHYLL A	0.9	17.3	14.8	9.9	42.3	0.0
7. ASSIMILATION RATIO	0.2	2.5	32.3	19.8	19.0	2.1

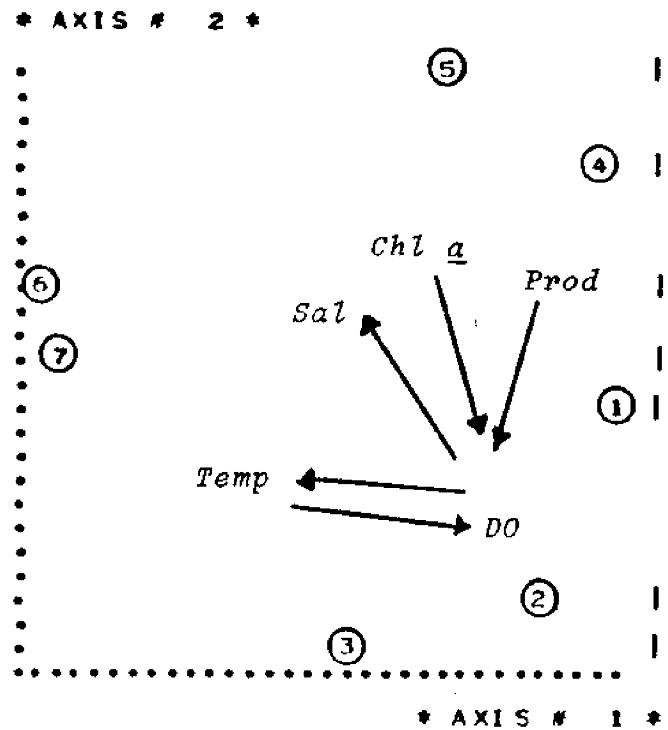


TABLE 7

VARIABLE GROUP AVERAGES * PLANKTON * SPRING 1978

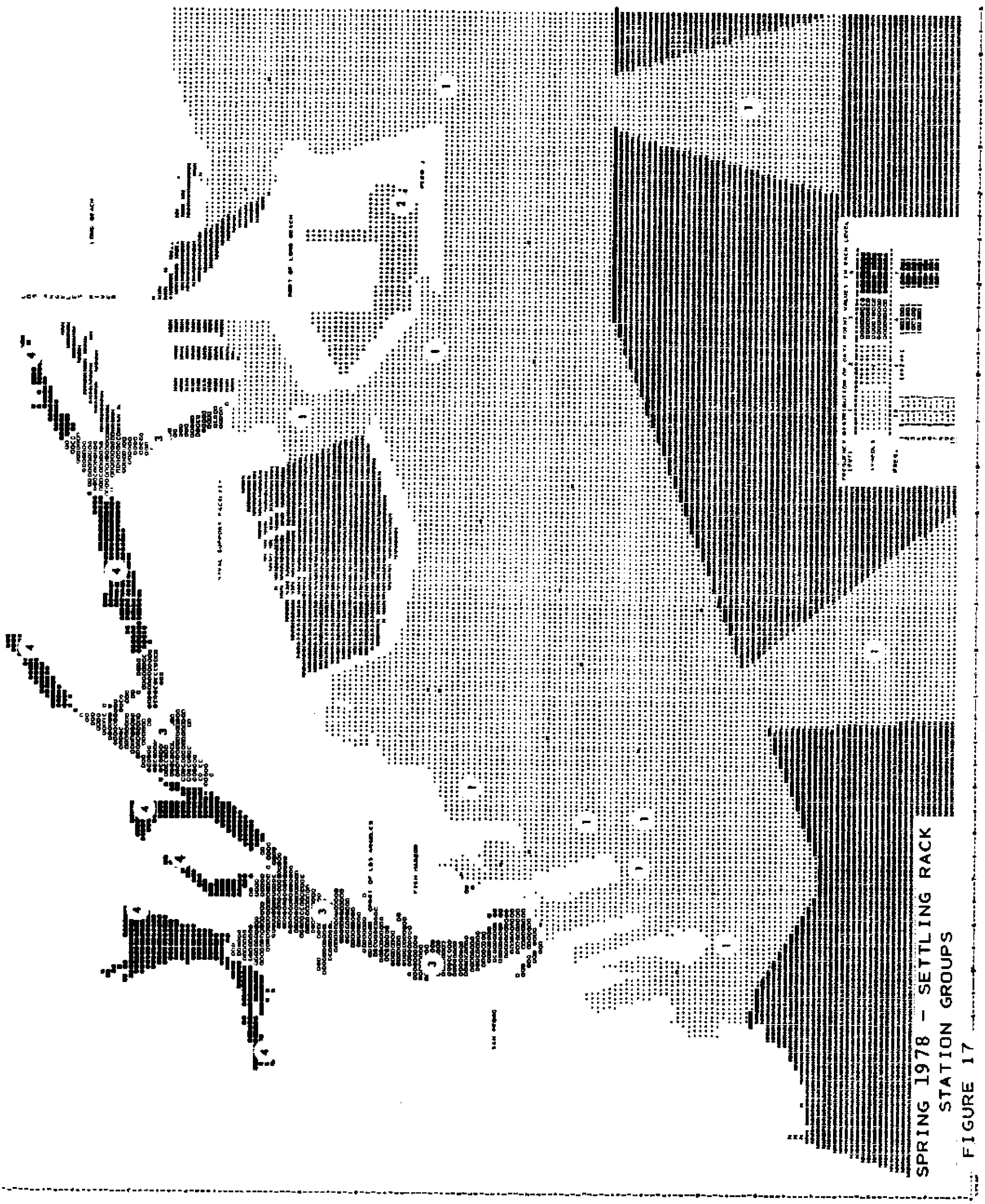
	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6	GROUP #7
1. TEMPERATURE	16.5229	16.6723	17.0917	16.8541	17.1133	17.8333	17.6111
2. SALINITY	30.3229	30.4136	31.7583	29.3667	24.3733	27.9900	28.4444
3. OXYGEN	9.8312	9.9931	9.3500	9.2833	9.0133	7.8467	7.3778
4. PH	8.0602	8.1398	8.0575	8.0021	7.9687	8.0787	8.0222
5. PRODUCTIVITY	3.8800	3.6233	6.1400	2.9042	2.1460	3.3917	3.3756
6. CHLOROPHYLL A	1.9523	2.4673	2.8000	1.5817	2.0966	1.8067	1.7989
7. ASSIMILATION RATIO	1.9700	1.6380	1.8300	2.3733	1.2900	2.0820	2.2044

TABLE 8

WEIGHTED GROUP MEANS

DISCRIMINANT ANALYSIS * PLANKTON DATA * SPRING 1978

	1	2	3	4	5	6	7
1. TEMPERATURE	17.0457	17.0619	17.1090	17.0625	17.1058	17.1958	17.1809
2. SALINITY	0.0351	0.0350	0.0351	0.0353	0.0355	0.0354	0.0353
3. OXYGEN	9.0669	9.0469	8.9630	9.0443	8.9662	8.7917	8.7951
4. PH	8.0509	8.0555	8.0546	8.0452	8.0427	8.0484	8.0480
5. PRODUCTIVITY	3.3439	3.3755	3.4355	3.2884	3.2625	3.3202	3.3533
6. CHLOROPHYLL A	1.9410	1.9670	1.9806	1.9103	1.9087	1.9195	1.9323
7. ASSIMILATION RATIO	1.0158	1.0317	1.0369	1.0381	1.0352	1.0423	1.0473



SPRING 1978 - SETTLING RACK
STATION GROUPS
FIGURE 17

FIGURE 18

SETTLING RACK * SPRING 1978 * AVERAGED DATA

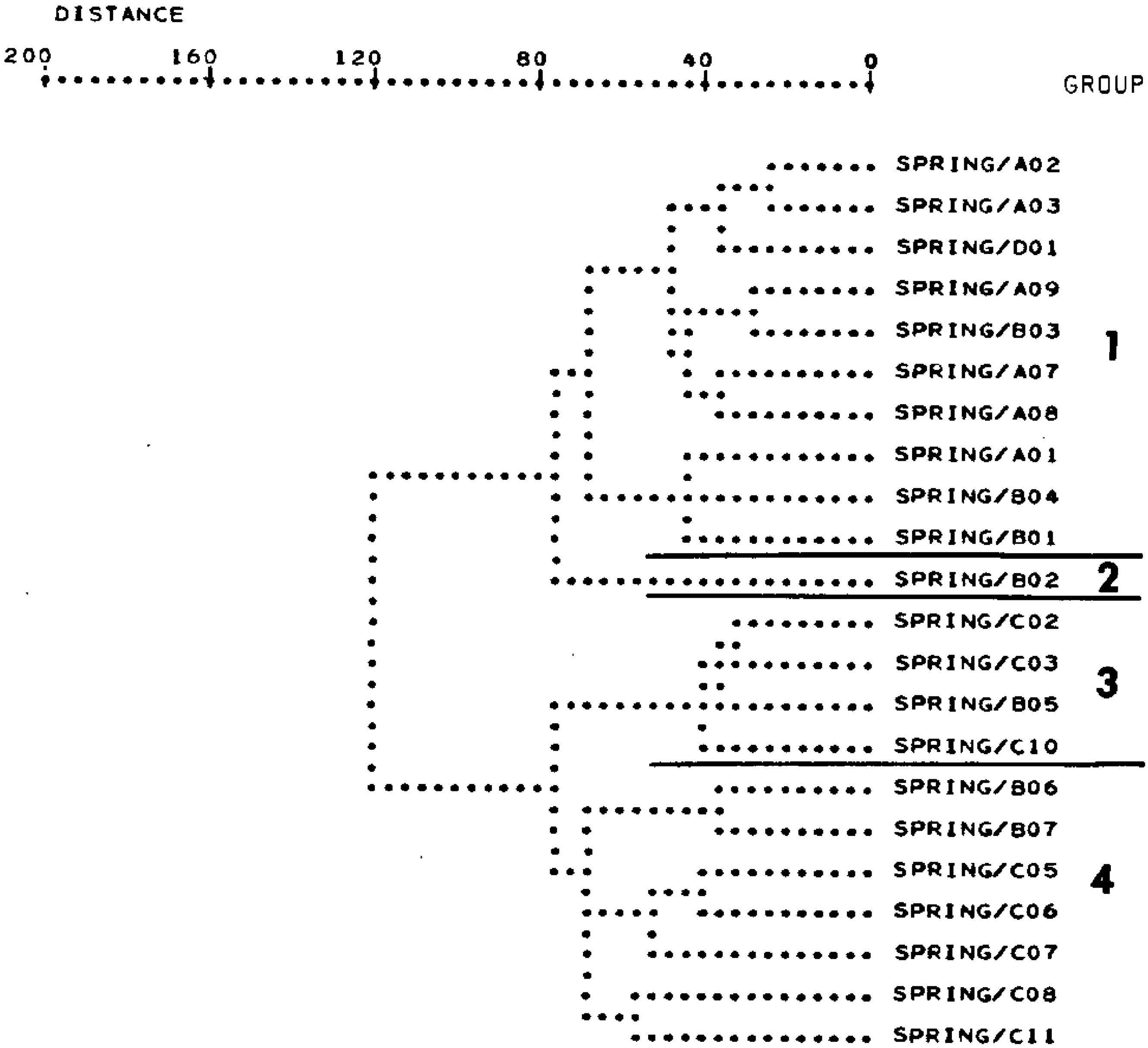


FIGURE 19

SETTLING RACK * SPRING 1978 * AVERAGED DATA

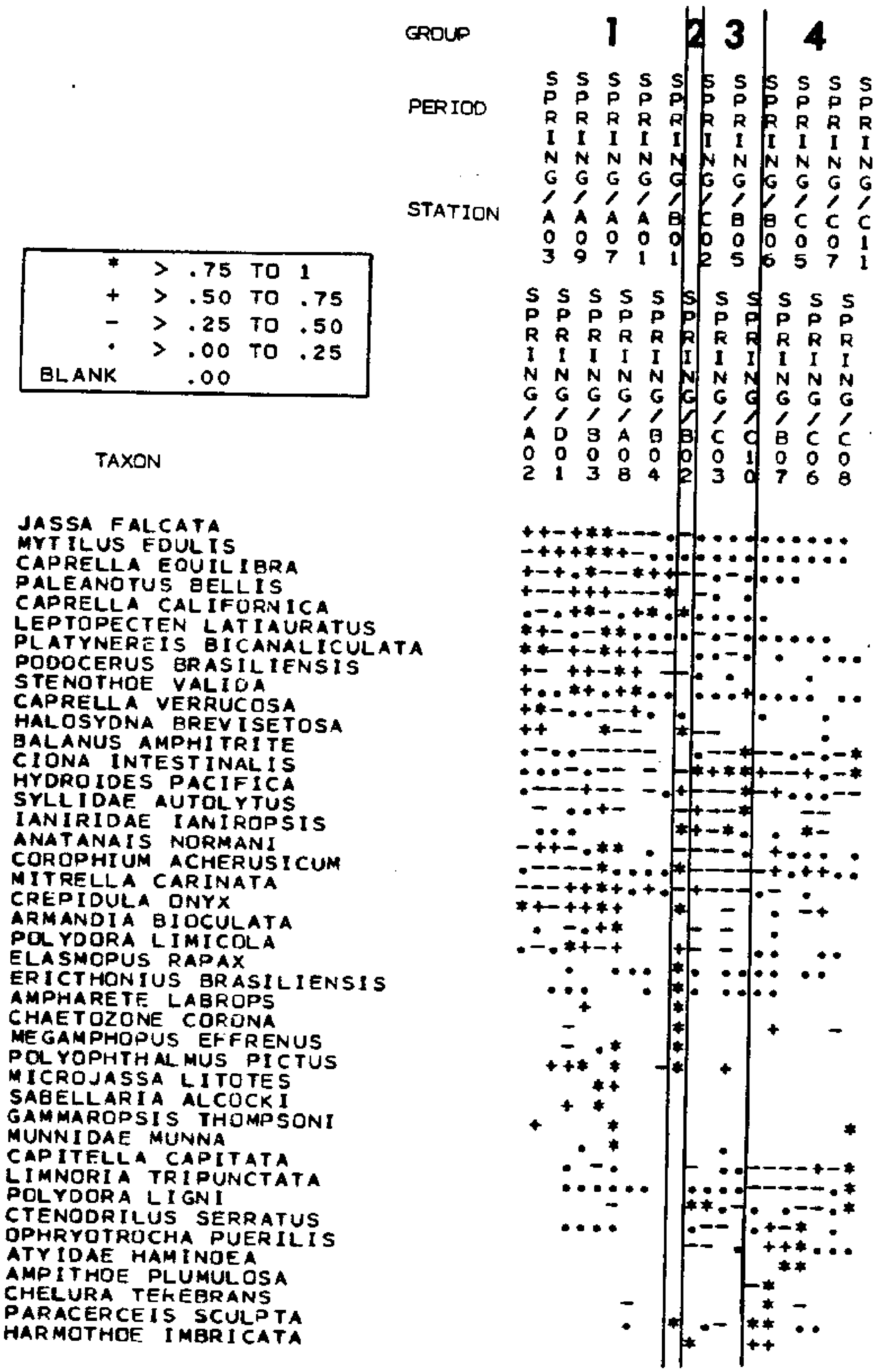
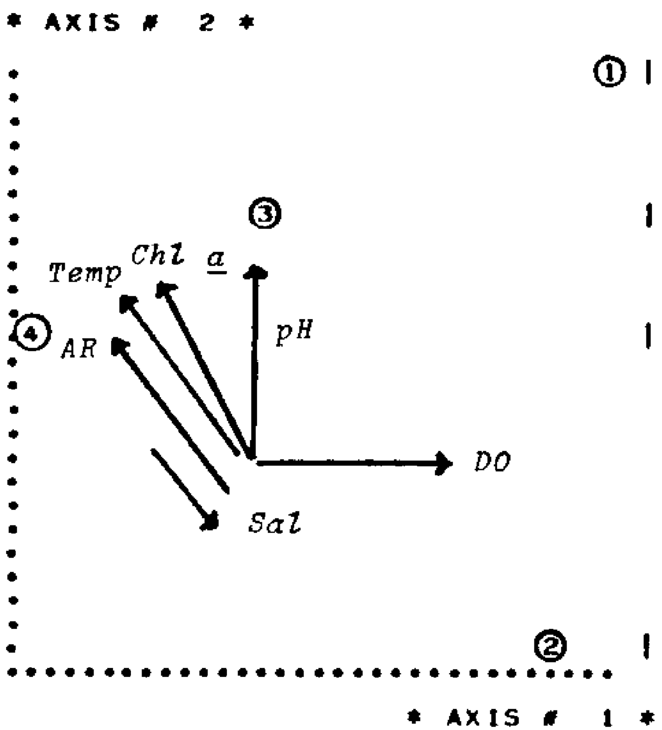


FIGURE 20

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * SPRING 1978

AXES	1	2	3
1. PRODUCTIVITY	5.6	1.4	28.6
2. CHLOROPHYLL A	5.3	13.2	34.2
3. ASSIMILATION RATIO	23.5	1.1	27.0
4. TEMPERATURE	23.1	18.2	7.9
5. SALINITY	5.8	12.1	1.0
6. DISSOLVED OXYGEN	36.6	20.0	0.6
7. PH	0.1	34.0	0.8



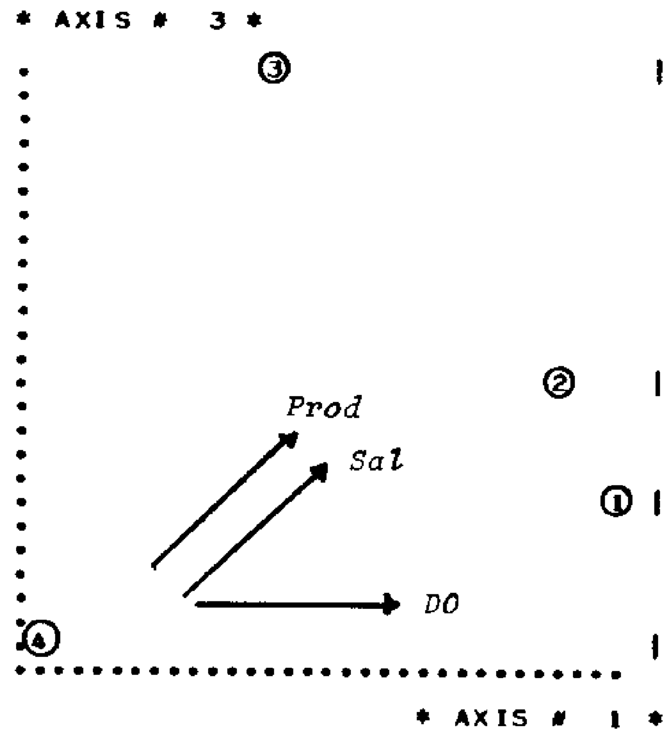


TABLE 9

VARIABLE GROUP AVERAGES * SETTLING RACK * SPRING 1978

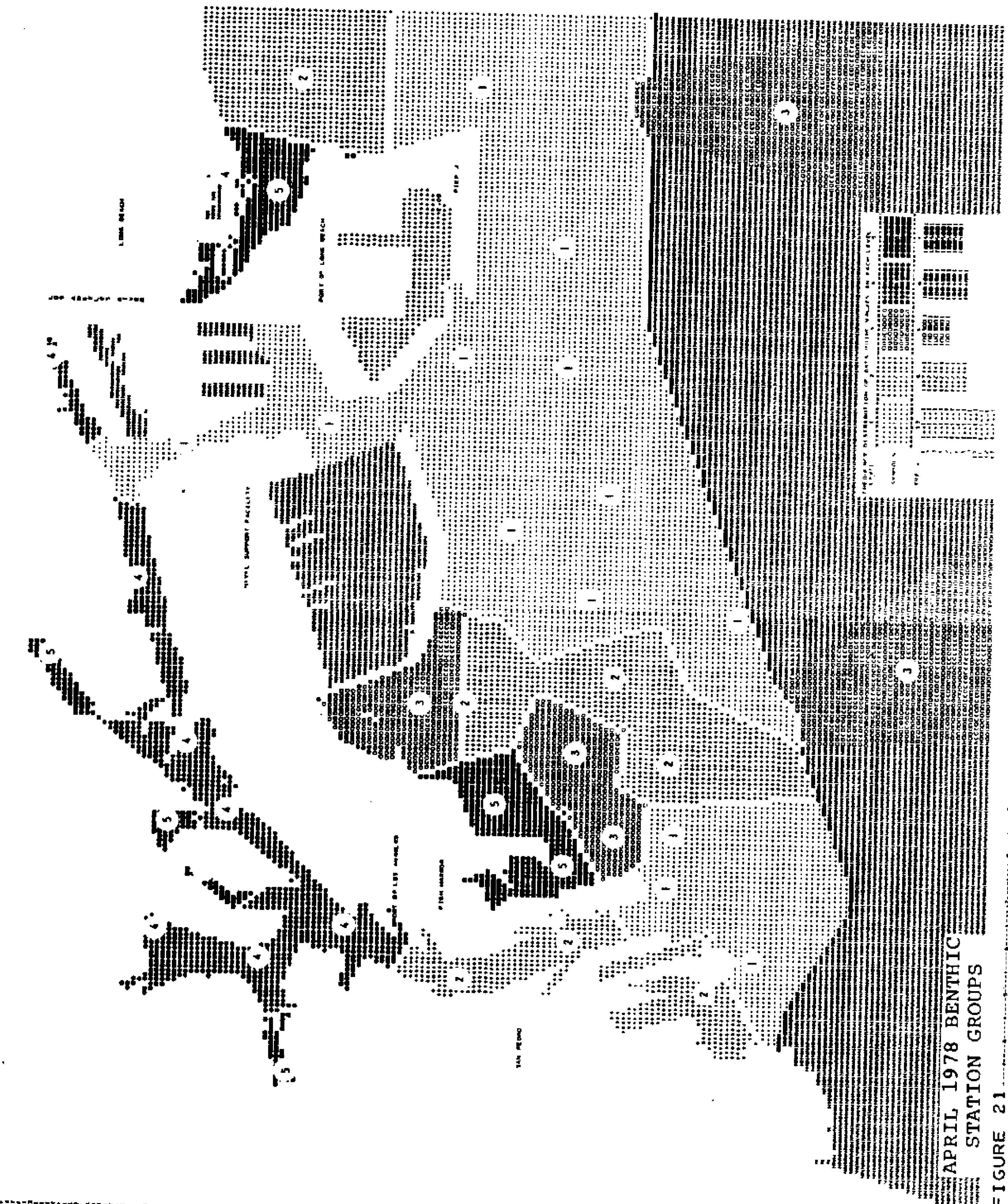
	GROUP #1	GROUP #2	GROUP #3	GROUP #4
1. PRODUCTIVITY	2.97	4.08	3.83	3.05
2. CHLOROPHYLL A	1.82	1.76	1.82	2.02
3. ASSIMILATION RATIO	1.65	2.37	2.17	1.88
4. TEMPERATURE	16.40	15.33	16.91	17.34
5. SALINITY	30.84	31.70	29.84	29.44
6. DISSOLVED OXYGEN	9.05	8.90	8.33	7.64
7. PH	8.01	7.88	7.98	7.98

TABLE 10

WEIGHTED GROUP MEANS

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * SPRING 1978

	1	2	3	4
1. PRODUCTIVITY	3.0075	2.9239	2.9890	3.0457
2. CHLOROPHYLL A	1.9241	1.8875	1.9587	1.9390
3. ASSIMILATION RATIO	0.9704	0.9658	0.9851	1.0137
4. TEMPERATURE	16.6109	16.6043	16.7762	16.8992
5. SALINITY	30.4976	30.5549	30.2305	30.0380
6. DISSOLVED OXYGEN	8.6954	8.6016	8.4208	8.2479
7. PH	7.9951	7.9735	7.9869	7.9827



APRIL 1978 BENTHIC STATION GROUPS
FIGURE 21

BENTHIC DATA (POLYCHAETA & MOLLUSCA) * APRIL 1978   FIGURE 22

BENTHIC DATA (POLYCHAETA & MOLLUSCA) • APRIL 1978 FIGURE 23

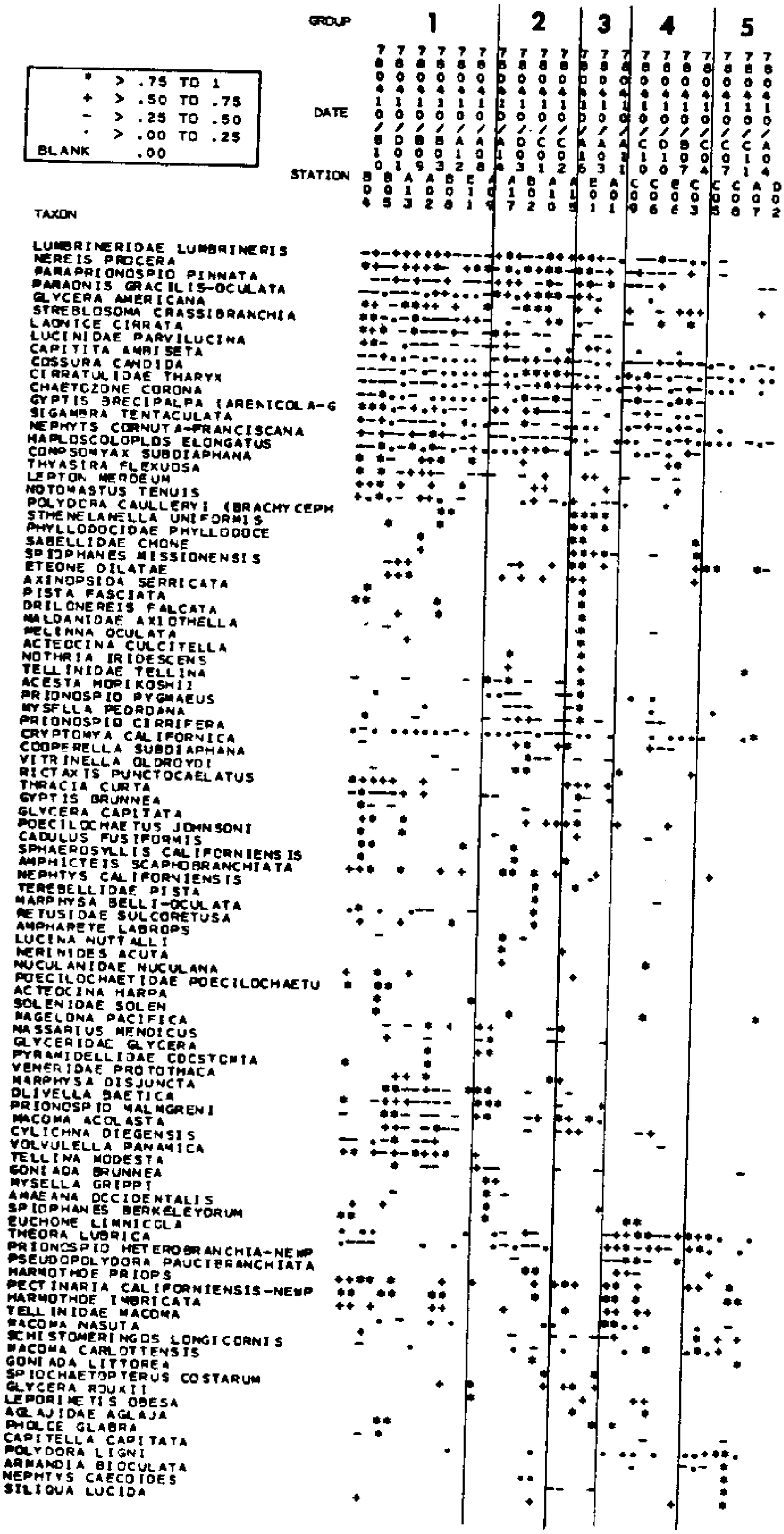


FIGURE 24

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

BENTHIC DATA * APRIL 1978

PARAMETER	AXES 1	2	3	4
1. DEPTH	4.8	19.6	4.7	33.2
2. TEMPERATURE	8.9	1.3	5.4	4.9
3. SALINITY	48.4	1.2	4.3	5.7
4. DISSOLVED OXYGEN	0.3	11.1	0.9	0.0
5. PH	23.8	2.5	6.5	8.6
6. PRODUCTIVITY	0.6	19.7	12.0	7.1
7. CHLOROPHYLL A	6.5	41.6	20.1	34.3
8. ASSIMILATION RATIO	6.7	3.1	46.0	6.1

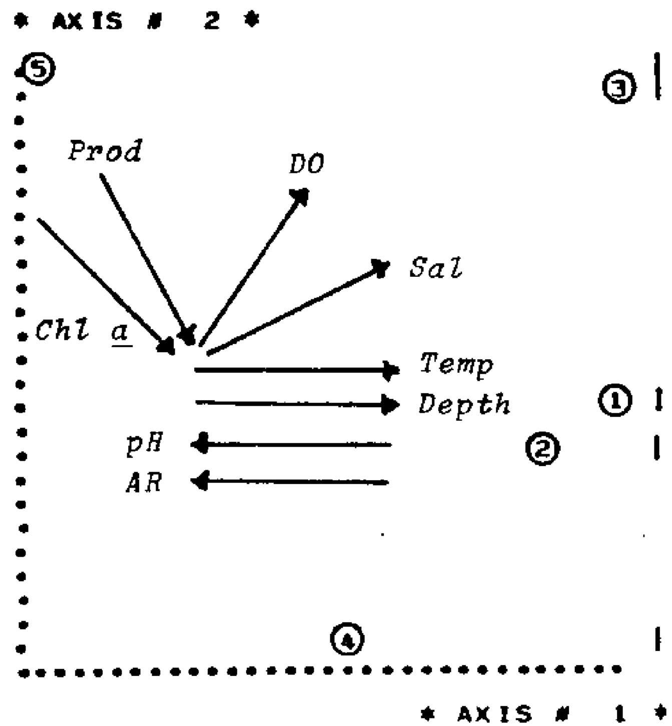


TABLE 11

VARIABLE GROUP AVERAGES * BENTHIC * APRIL 1978

	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5
1. DEPTH	16.07	9.25	12.00	11.12	7.28
2. TEMPERATURE	15.29	15.76	15.56	15.76	16.38
3. SALINITY	35.52	33.51	35.50	32.26	32.51
4. DISSOLVED OXYGEN	8.42	8.52	8.62	6.98	8.72
5. PH	7.47	7.77	7.57	7.80	7.82
6. PRODUCTIVITY	3.41	3.36	2.94	3.26	3.73
7. CHLOROPHYLL A	1.81	1.98	1.82	1.73	2.31
8. ASSIMILATION RATIO	2.22	2.02	1.64	1.94	1.86

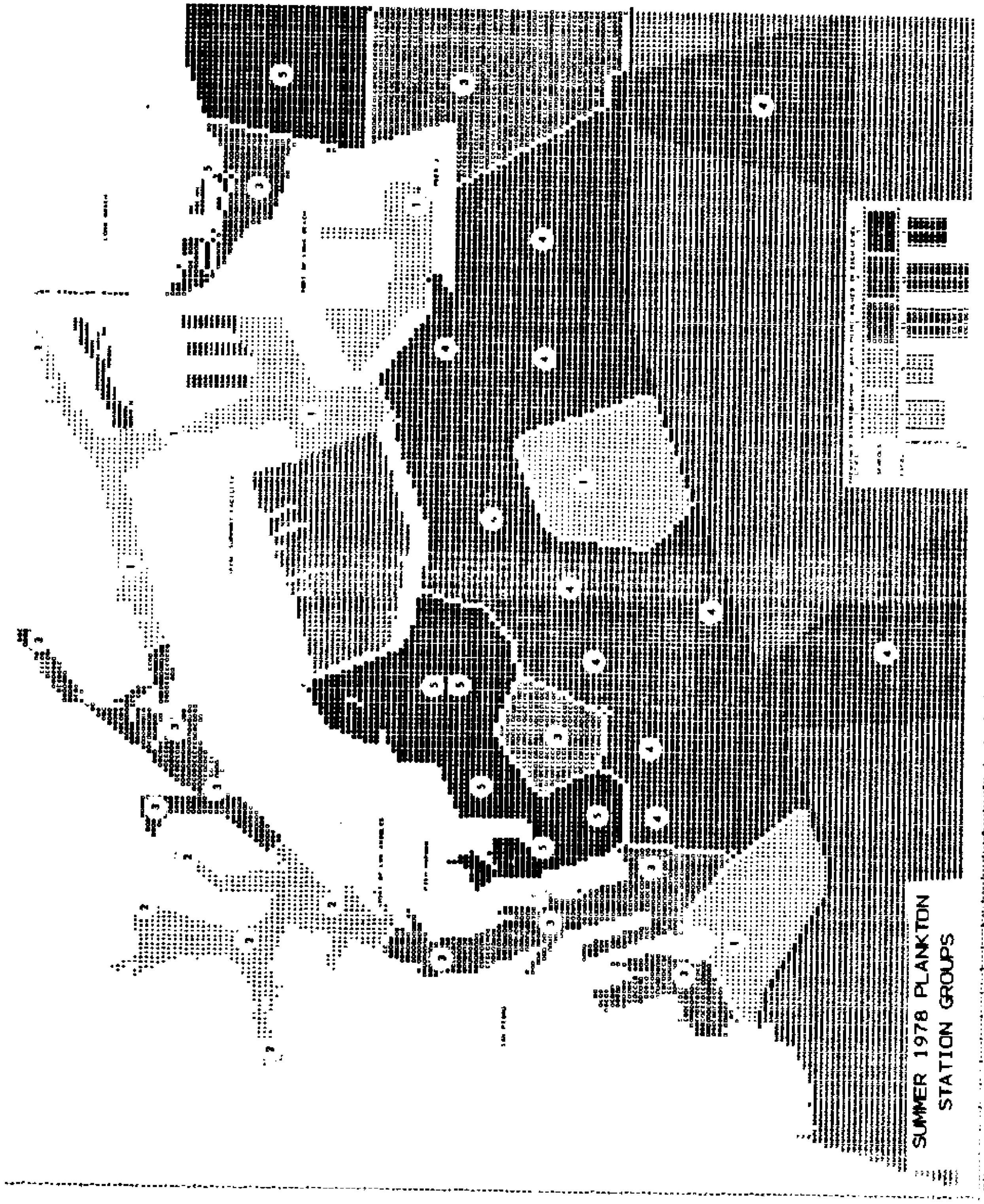
TABLE 12

WEIGHTED GROUP MEANS

BENTHIC DATA * APRIL 1978

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

	1	2	3	4	5
1. DEPTH	12.8138	12.4536	12.4900	12.0474	11.0117
2. TEMPERATURE	0.0646	0.0644	0.0644	0.0641	0.0635
3. SALINITY	34.3272	34.1486	34.3602	33.7095	33.2803
4. DISSOLVED OXYGEN	8.2223	8.1882	8.3003	8.0961	8.2126
5. PH	7.6285	7.6486	7.6343	7.6859	7.7307
6. PRODUCTIVITY	1.5250	1.5208	1.5071	1.5282	1.5039
7. CHLOROPHYLL A	1.0467	1.0378	1.0229	1.0274	0.9912
8. ASSIMILATION RATIO	2.2225	2.2624	2.2593	2.3278	2.3596

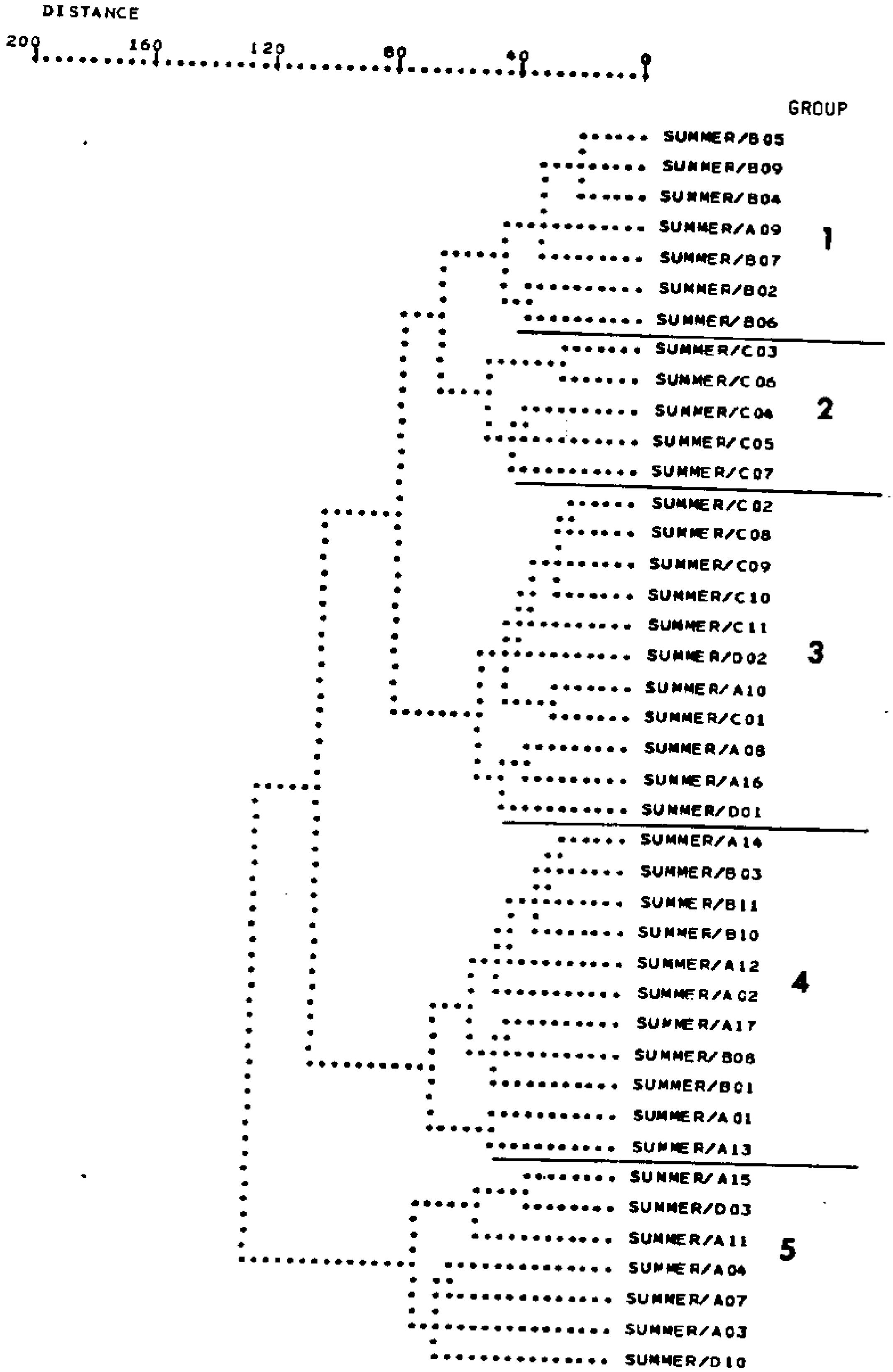


SUMMER 1978 PLANKTON STATION GROUPS

FIGURE 25

PLANKTON DATA • SUMMER 1978

FIGURE 26



PLANKTON DATA * SUMMER 1978 FIGURE 27

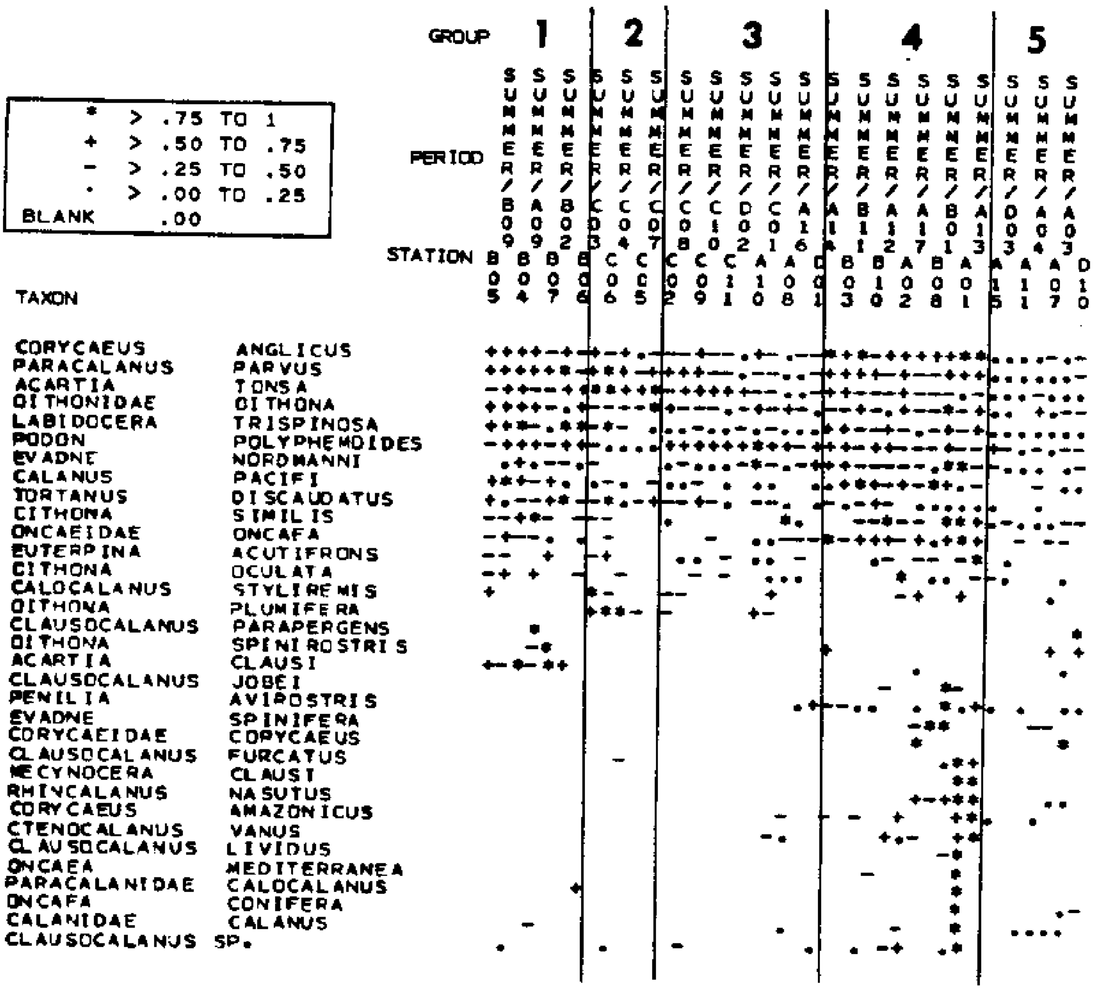


FIGURE 28

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

DISCRIMINANT ANALYSIS * PLANKTON DATA * SUMMER 1978

PARAMETER / AXES	1	2	3	4
1. TEMPERATURE	0.5	46.2	23.9	2.4
2. SALINITY	0.5	4.3	2.6	49.1
3. OXYGEN	0.1	26.3	30.3	12.5
4. PH	0.0	2.4	18.3	0.3
5. PRODUCTIVITY	8.5	12.4	15.8	29.5
6. CHLOROPHYLL A	89.8	1.4	4.1	5.0
7. ASSIMILATION RATIO	0.5	7.1	5.0	1.1

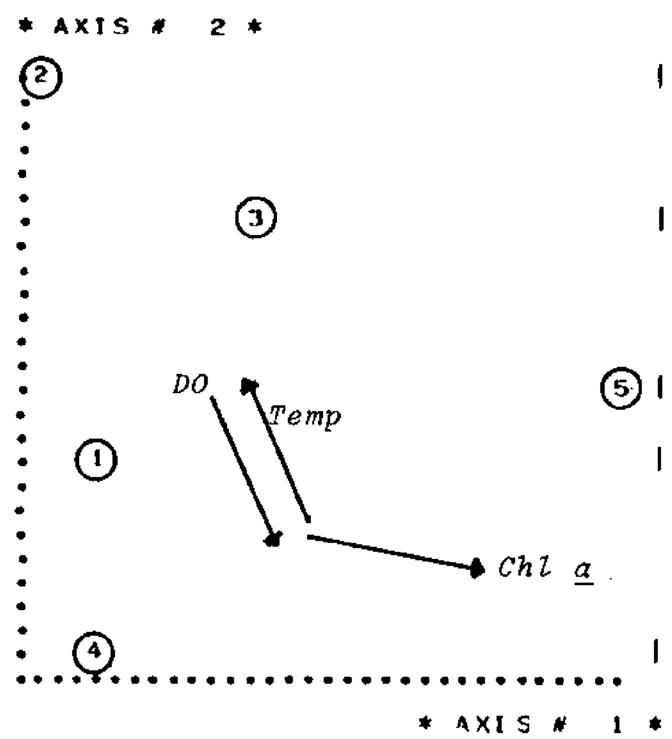


TABLE 13

VARIABLE GROUP AVERAGES * PLANKTON * SUMMER 1978

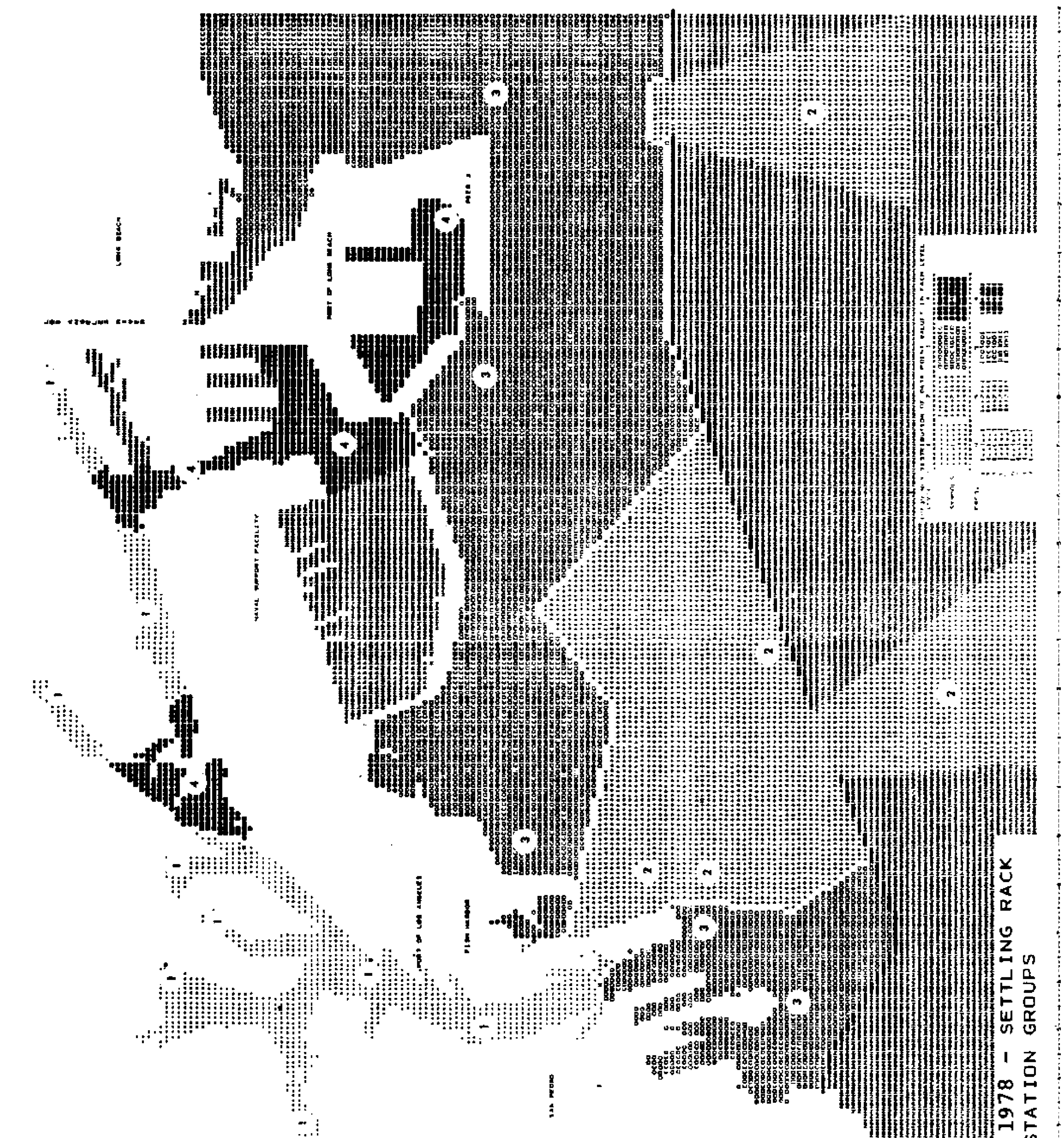
	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5
1. TEMPERATURE	18.8190	19.8667	18.9424	17.8864	18.5750
2. SALINITY	30.7428	30.7133	30.4151	30.7242	30.3584
3. OXYGEN	7.3333	5.3000	6.5767	8.2470	8.3019
4. PH	8.3319	8.2393	8.1936	8.4445	8.4583
5. PRODUCTIVITY	3.0514	3.3880	3.8376	3.3515	5.0485
6. CHLOROPHYLL A	2.5724	2.1213	3.0267	2.5200	4.7600
7. ASSIMILATION RATIO	1.2662	1.5473	1.3570	1.3700	1.0300

TABLE 14

WEIGHTED GROUP MEANS

DISCRIMINANT ANALYSIS * PLANKTON DATA * SUMMER 1978

	1	2	3	4	5
1. TEMPERATURE	18.7055	18.7844	18.7520	18.6440	18.7028
2. SALINITY	0.0327	0.0327	0.0327	0.0327	0.0327
3. OXYGEN	2.1326	2.1046	2.1203	2.1374	2.1383
4. PH	0.1201	0.1202	0.1202	0.1200	0.1201
5. PRODUCTIVITY	1.4651	1.4728	1.4875	1.4655	1.5066
6. CHLOROPHYLL A	1.3126	1.3057	1.3330	1.3151	1.3803
7. ASSIMILATION RATIO	1.3380	1.3585	1.3380	1.3339	1.2905



SUMMER 1978 - SETTLING RACK STATION GROUPS

FIGURE 29

FIGURE 30

SETTLING RACK * SUMMER 1978 * AVERAGED DATA

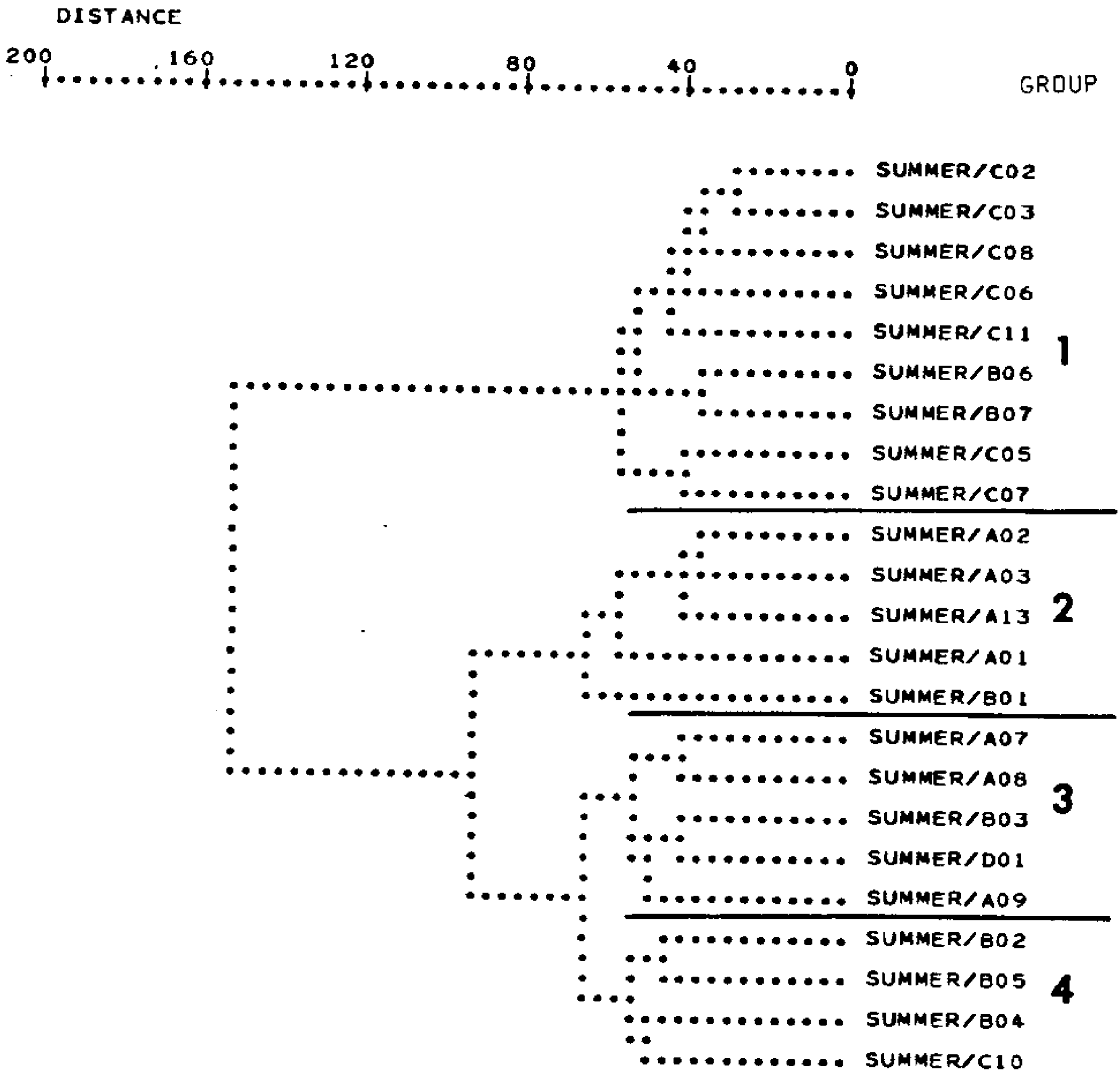


FIGURE 31

SETTLING RACK * SUMMER 1978 * AVERAGED DATA

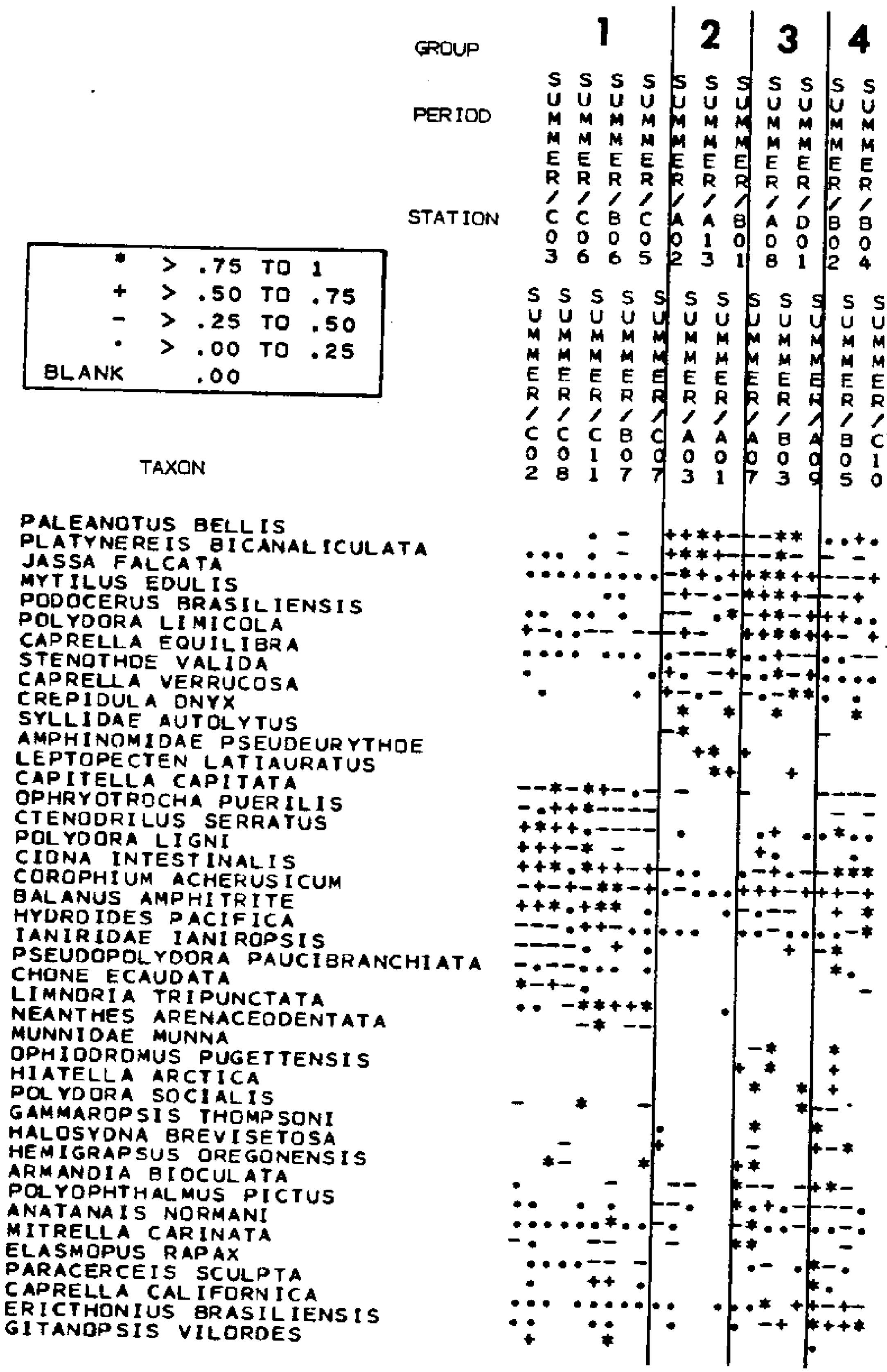


FIGURE 32

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)
SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * SUMMER 1978

PARAMETER / AXES	1	2	3
1. PRODUCTIVITY	7.3	3.5	0.1
2. CHLOROPHYLL A	8.0	3.9	42.5
3. ASSIMILATION RATIO	0.4	1.6	11.4
4. TEMPERATURE	54.9	0.2	10.9
5. SALINITY	1.4	4.4	5.0
6. DISSOLVED OXYGEN	9.7	80.2	9.4
7. PH	18.4	6.3	20.7

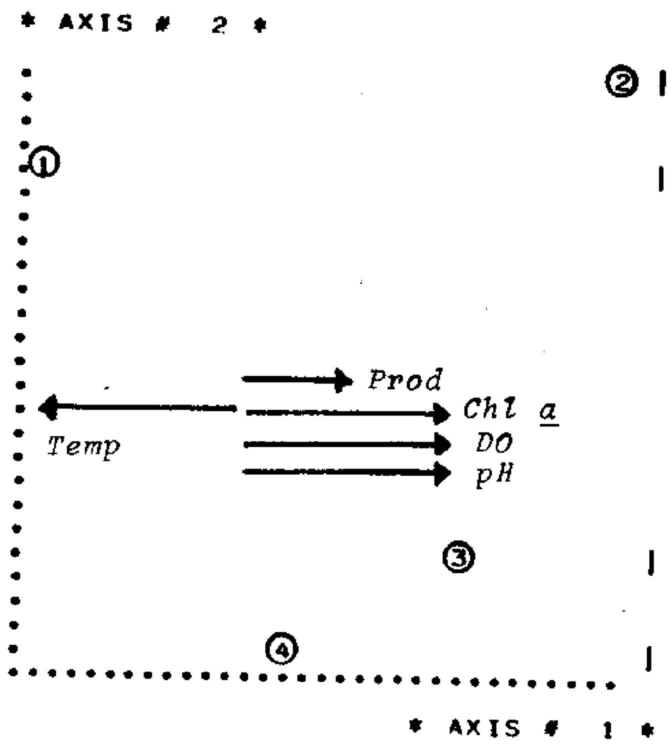


TABLE 15

VARIABLE GROUP AVERAGES * SETTLING RACK * SUMMER 1978

	GROUP #1	GROUP #2	GROUP #3	GROUP #4
1. PRODUCTIVITY	3.52	3.48	3.89	3.21
2. CHLOROPHYLL A	2.43	2.74	3.48	2.24
3. ASSIMILATION RATIO	1.3681	1.4087	1.31	1.49
4. TEMPERATURE	18.8259	16.5333	17.5067	18.4250
5. SALINITY	31.1222	31.1333	31.0466	31.0500
6. DISSOLVED OXYGEN	6.1741	7.5933	7.4000	7.7583
7. PH	8.1200	8.3180	8.1907	8.1900

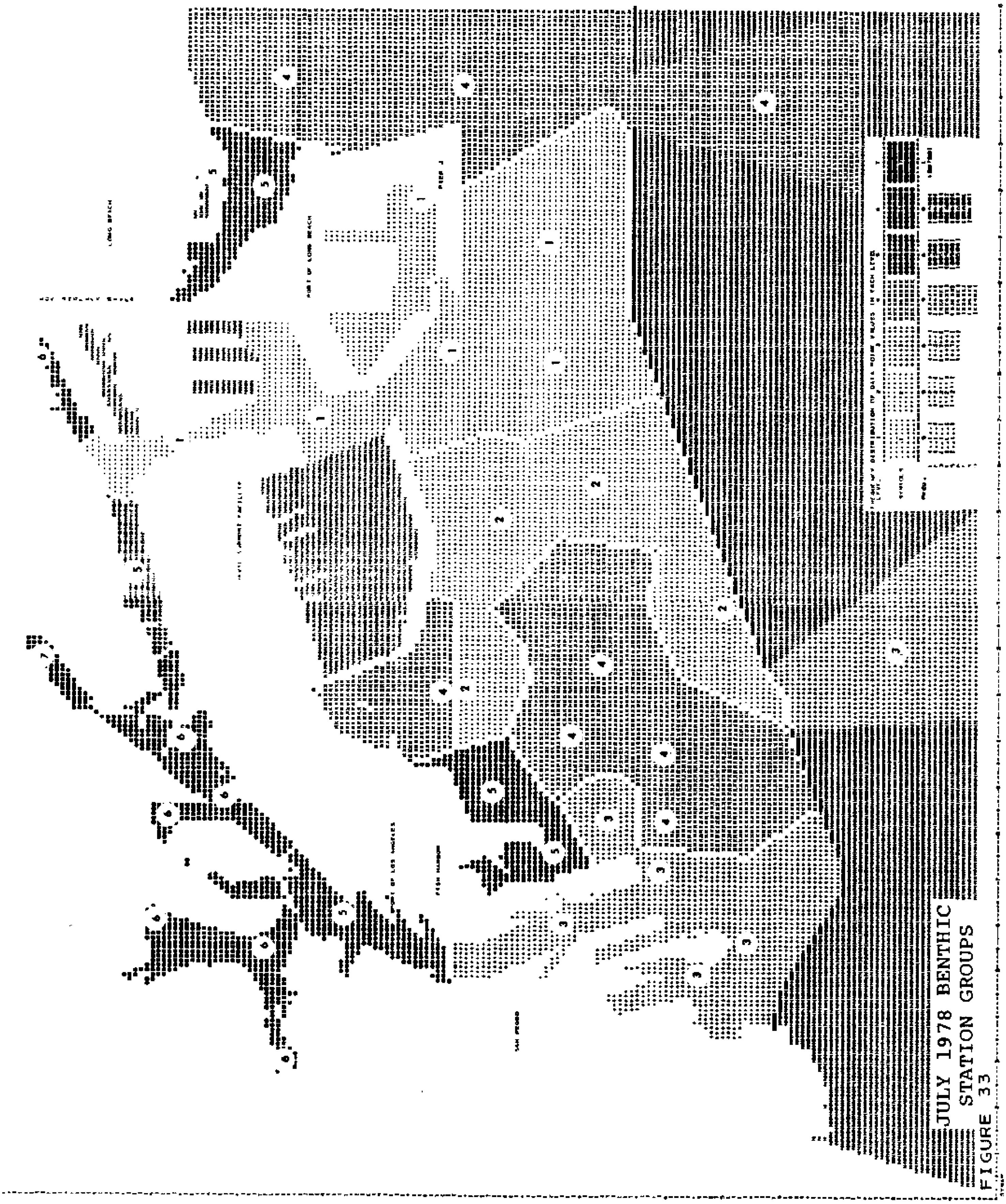
TABLE 16

WEIGHTED GROUP MEANS

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * SUMMER 1978

	1	2	3	4
1. PRODUCTIVITY	1.4515	1.4976	1.4803	1.4604
2. CHLOROPHYLL A	1.2981	1.3376	1.3293	1.3081
3. ASSIMILATION RATIO	1.3653	1.3648	1.3561	1.3633
4. TEMPERATURE	18.3435	17.6397	17.8416	18.0735
5. SALINITY	31.0974	31.0883	31.0891	31.0903
6. DISSOLVED OXYGEN	6.7606	7.3284	7.2376	7.0875
7. PH	8.1592	8.2239	8.2062	8.1876



JULY 1978 BENTHIC
STATION GROUPS
FIGURE 33

FIGURE 34

BENTHIC DATA (POLYCHAETA & MOLLUSCA) * JULY 1978

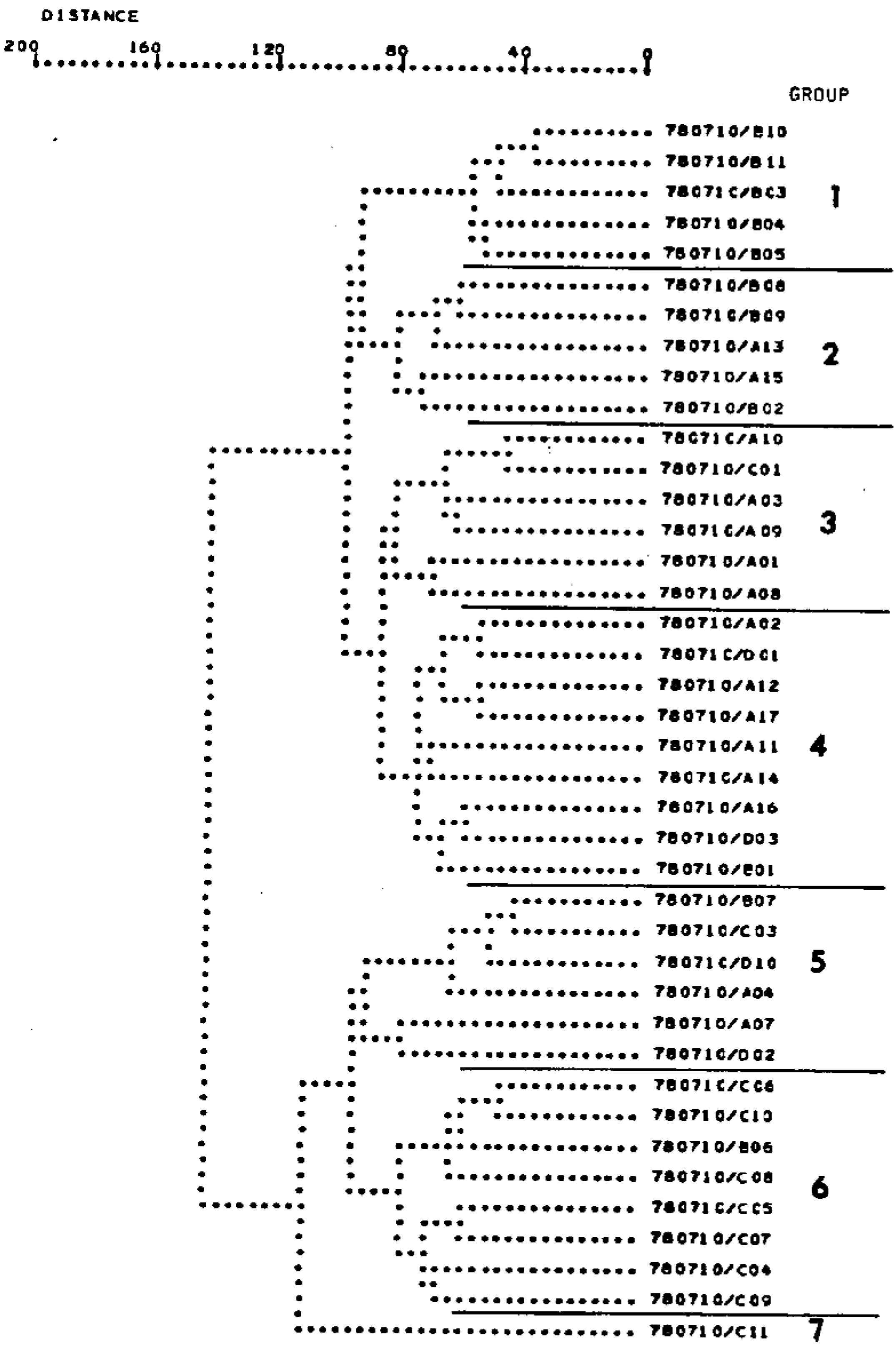


FIGURE 35

BENTHIC DATA (POLYCHAETA & MOLLUSCA * JULY 1978

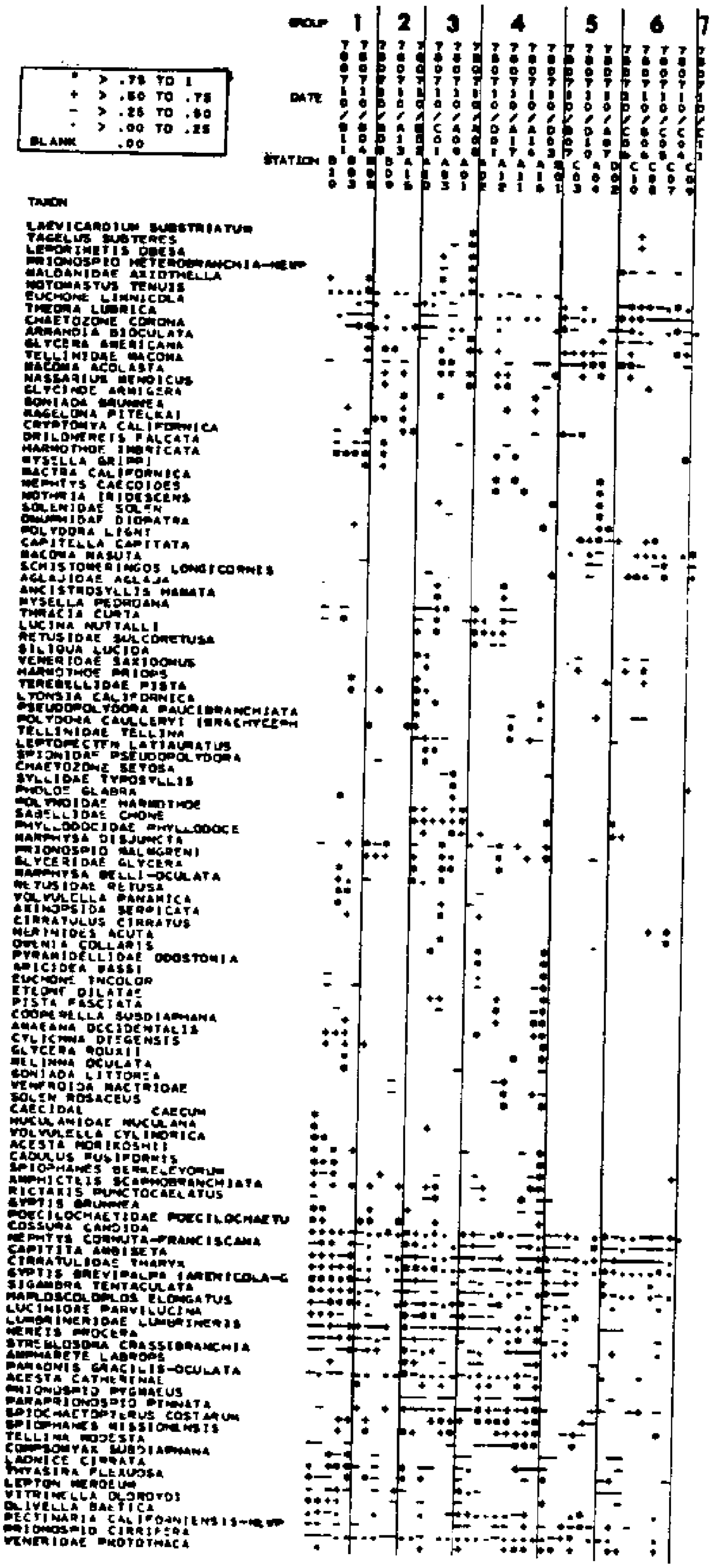


FIGURE 36

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)
WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * JULY, 1978

PARAMETER / AXES	1	2	3	4	5	6
1. PRODUCTIVITY	9.5	5.0	13.2	5.6	20.9	17.5
2. CHLOROPHYLL A	1.5	1.0	9.1	11.3	30.2	15.0
3. ASSIMILATION RATIO	1.5	39.4	16.0	14.7	17.3	9.6
4. DEPTH	5.0	0.0	50.1	47.7	1.9	0.4
5. TEMPERATURE	78.1	10.3	1.4	0.8	0.3	0.7
6. SALINITY	0.8	28.7	3.1	9.3	8.3	18.4
7. DISSOLVED OXYGEN	2.1	7.1	2.9	9.6	20.4	37.2
8. PH	1.4	8.4	4.1	1.0	0.5	1.2

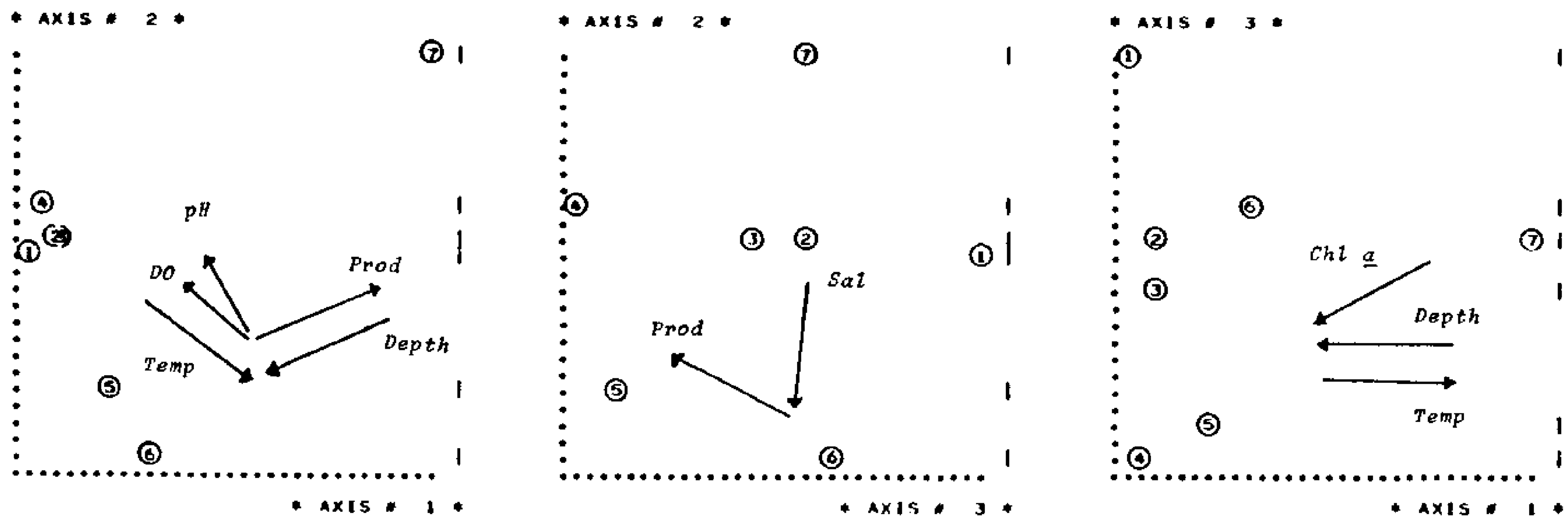


TABLE 17

** JULY78 **

VARIABLE GROUP AVERAGES * BENTHIC * JULY 1978

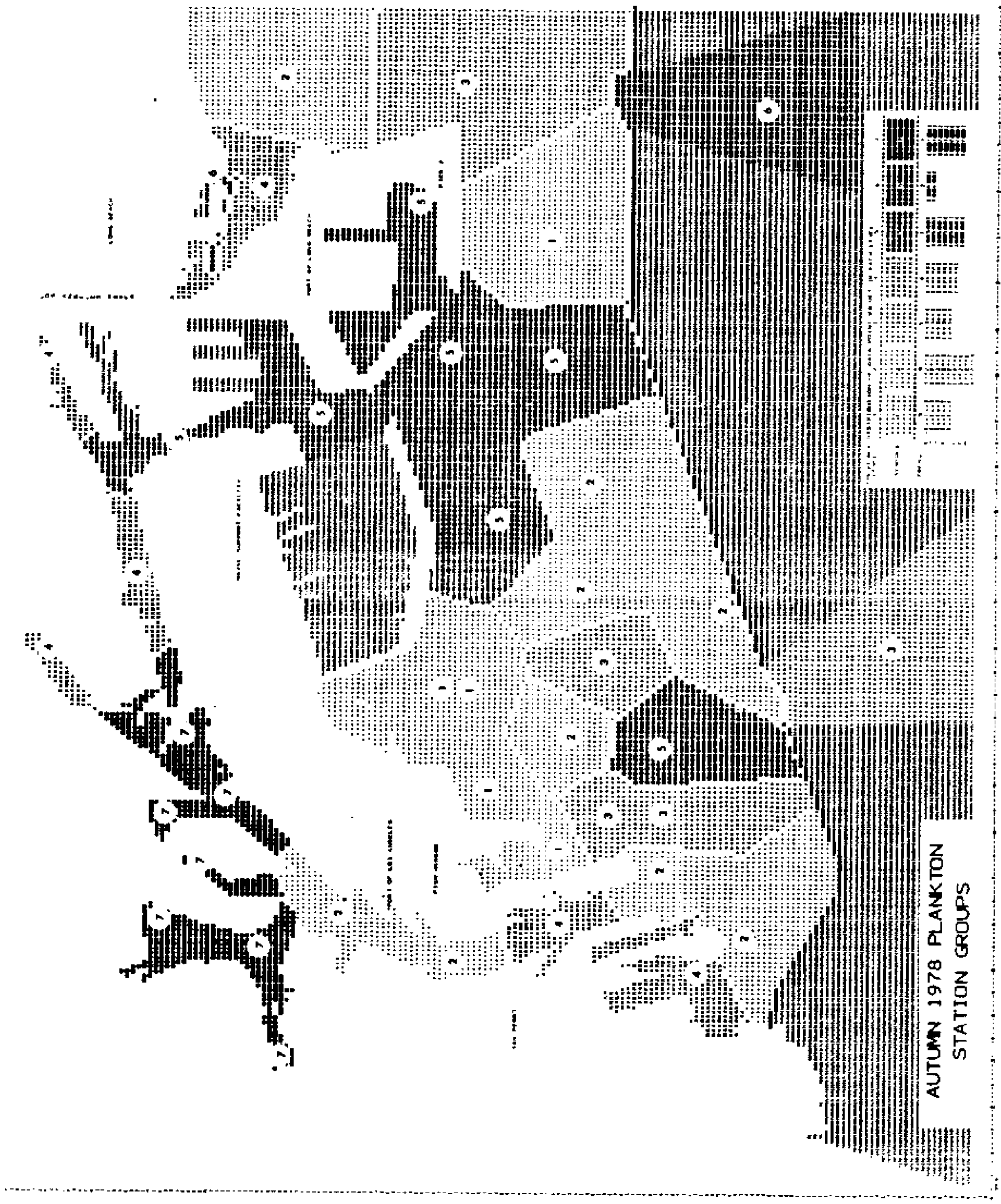
	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6	GROUP #7
1. PRODUCTIVITY	3.02	3.16	4.16	4.22	4.65	2.67	5.65
2. CHLOROPHYLL A	2.27	2.77	3.22	3.32	4.09	2.24	2.83
3. ASSIMILATION RATIO	1.47	1.27	1.44	1.36	1.11	1.15	1.95
4. DEPTH	18.40	14.40	9.83	10.88	10.83	11.75	12.00
5. TEMPERATURE	12.72	12.80	13.26	13.46	14.41	16.31	15.40
6. SALINITY	31.50	31.44	31.50	31.53	31.53	31.42	31.80
7. DISSOLVED OXYGEN	6.62	4.00	5.63	4.40	5.33	3.47	3.90
8. PH	7.91	7.99	7.96	8.01	7.94	7.93	7.87

TABLE 18
WEIGHTED GROUP MEANS

WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * JULY, 1978

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

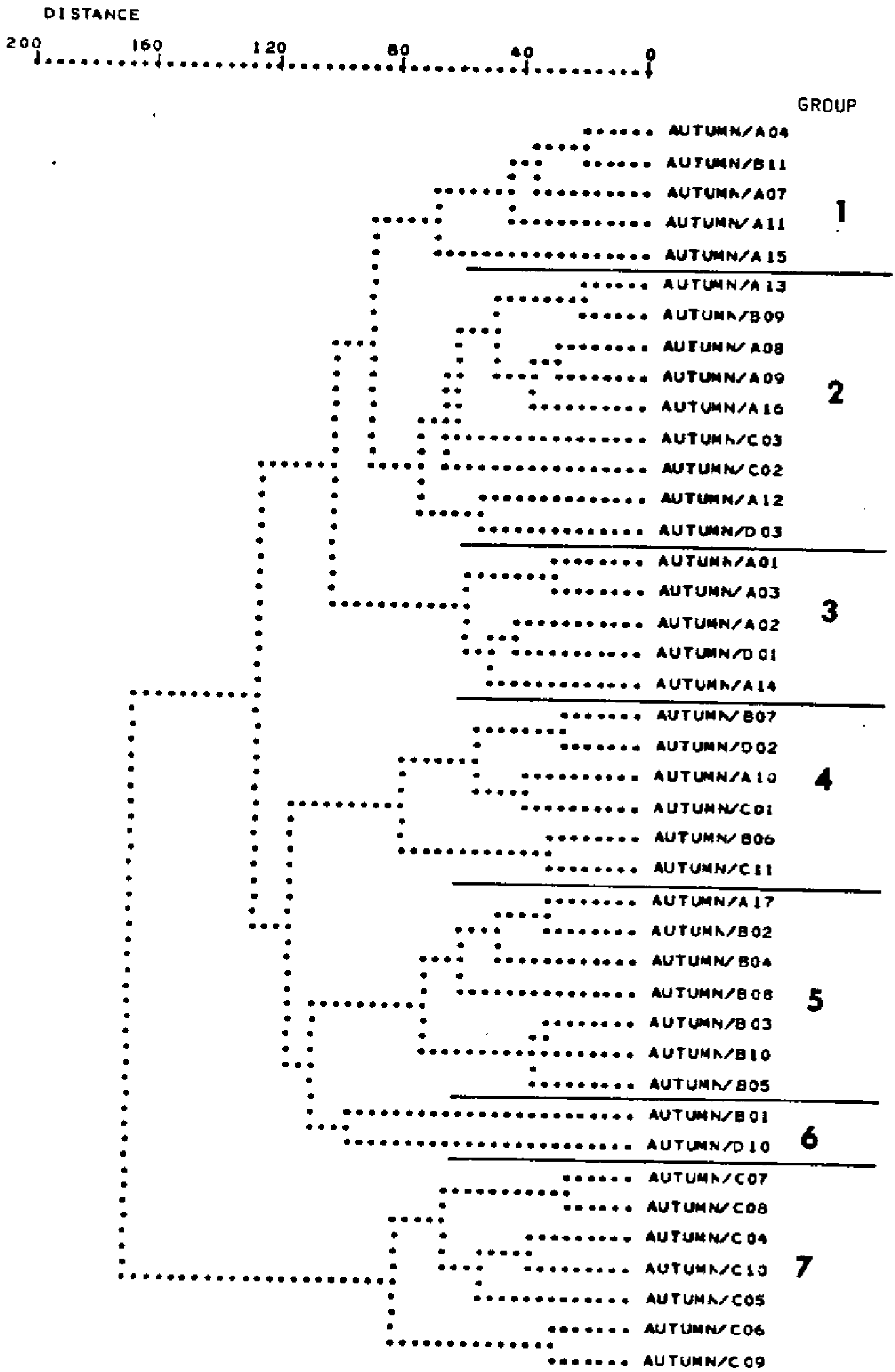
	1	2	3	4	5	6	7
1. PRODUCTIVITY	1.2648	1.2995	1.3016	1.3077	1.2941	1.2908	1.6203
2. CHLOROPHYLL A	3.5284	3.5737	3.6277	3.7243	3.6628	3.5103	3.4489
3. ASSIMILATION RATIO	0.6045	0.6150	0.6184	0.6032	0.6031	0.6236	0.8535
4. DEPTH	13.3470	12.8579	12.7177	12.7495	12.2943	12.1686	10.0895
5. TEMPERATURE	13.6898	13.7744	13.7634	13.6678	14.1523	14.4253	15.7885
6. SALINITY	31.4997	31.4989	31.5008	31.4933	31.5023	31.5154	31.4691
7. DISSOLVED OXYGEN	1.6949	1.6881	1.6976	1.7121	1.6798	1.6641	1.6730
8. PH	7.9606	7.9636	7.9660	7.9669	7.9516	7.9439	7.9541



AUTUMN 1978 PLANKTON
STATION GROUPS

FIGURE 37

PLANKTON DATA * AUTUMN 1978 FIGURE 38



PLANKTON DATA * AUTUMN 1978 FIGURE 39

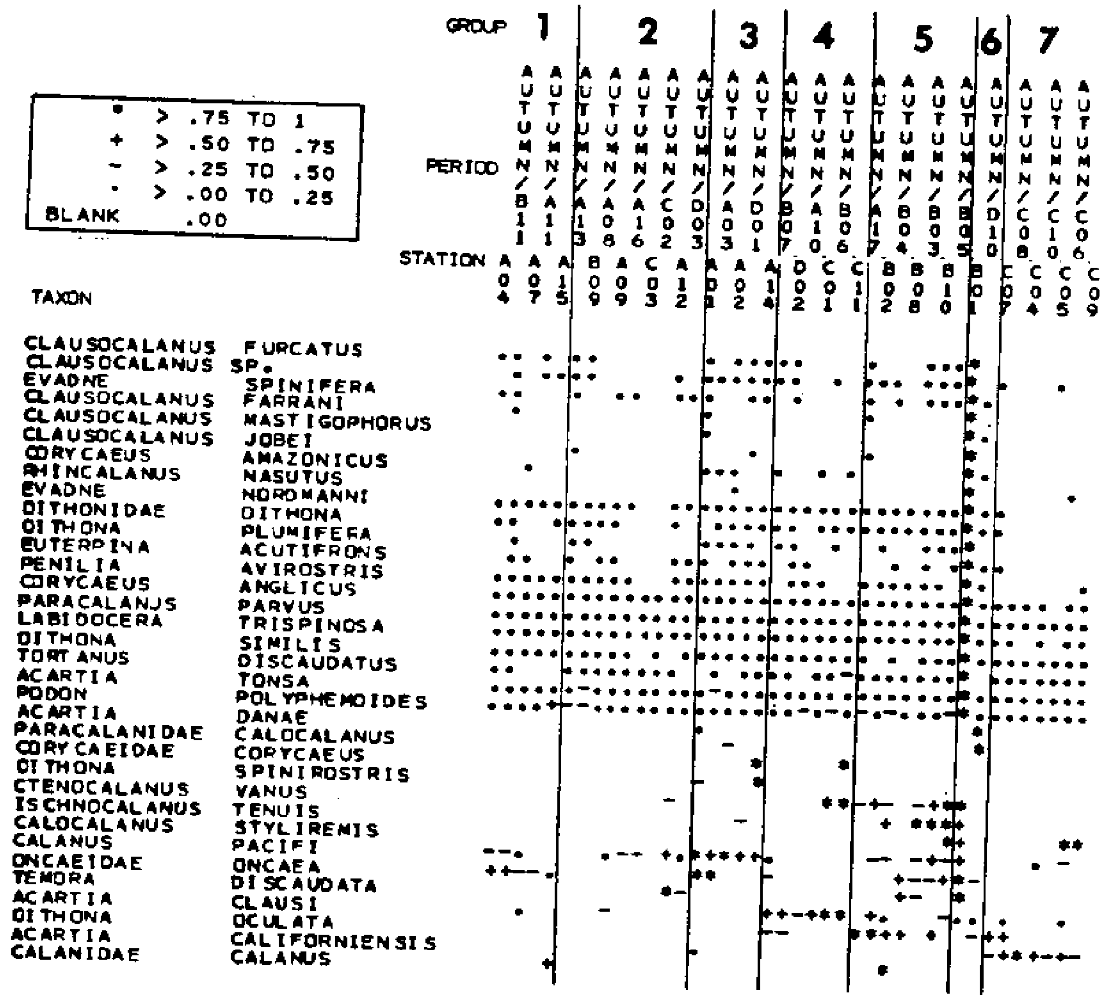


FIGURE 40

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

DISCRIMINANT ANALYSIS * PLANKTON DATA * AUTUMN 1978

PARAMETER / AXES	1	2	3	4	5	6
1. TEMPERATURE	0.4	2.0	24.5	0.1	36.7	3.4
2. SALINITY	10.5	4.2	19.5	0.2	44.7	0.4
3. OXYGEN	74.2	1.4	8.4	7.2	1.6	6.6
4. PH	6.3	11.0	11.7	7.4	6.7	8.6
5. PRODUCTIVITY	1.6	14.6	21.0	67.2	0.6	6.0
6. CHLOROPHYLL A	5.4	39.1	13.5	16.5	9.5	29.8
7. ASSIMILATION RATIO	1.6	27.7	1.4	1.3	0.2	45.2

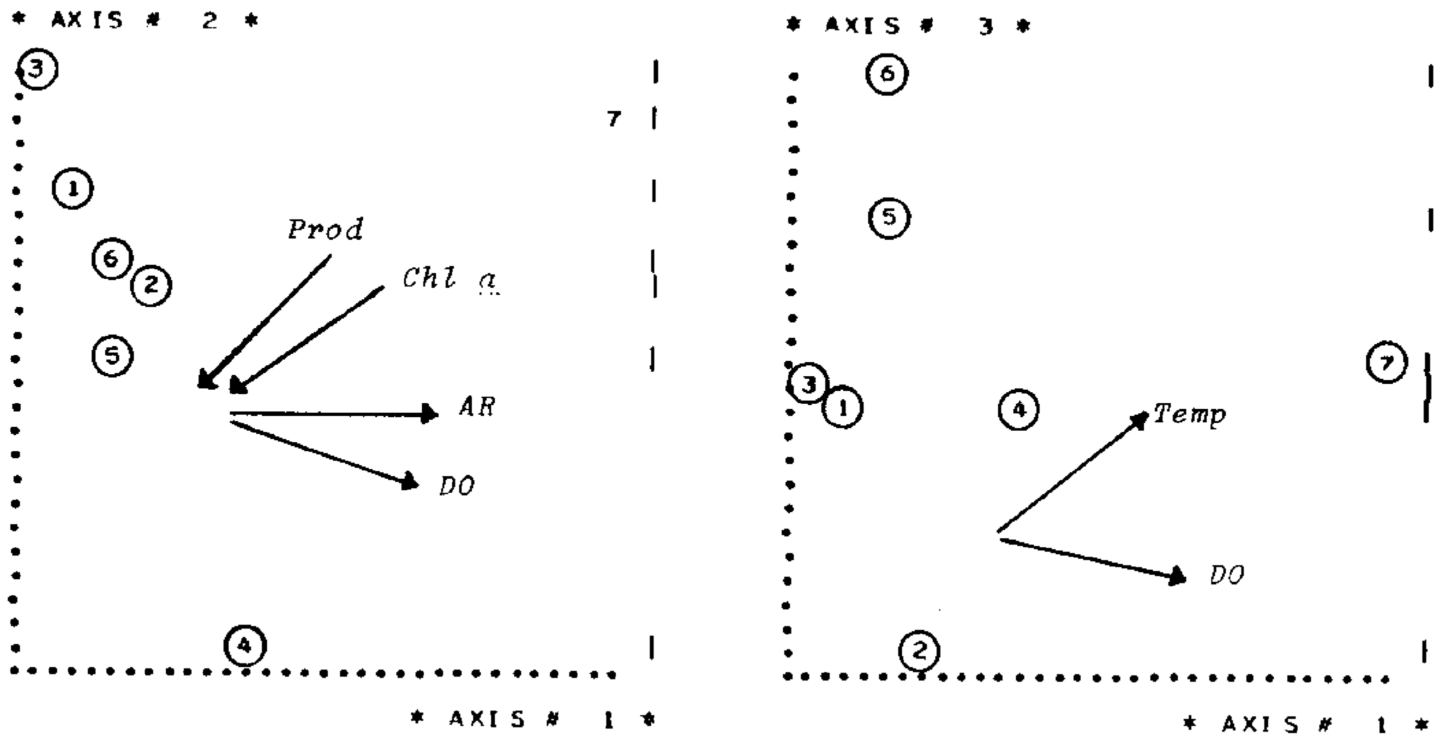


TABLE 19

VARIABLE GROUP AVERAGES * PLANKTON * AUTUMN 1978

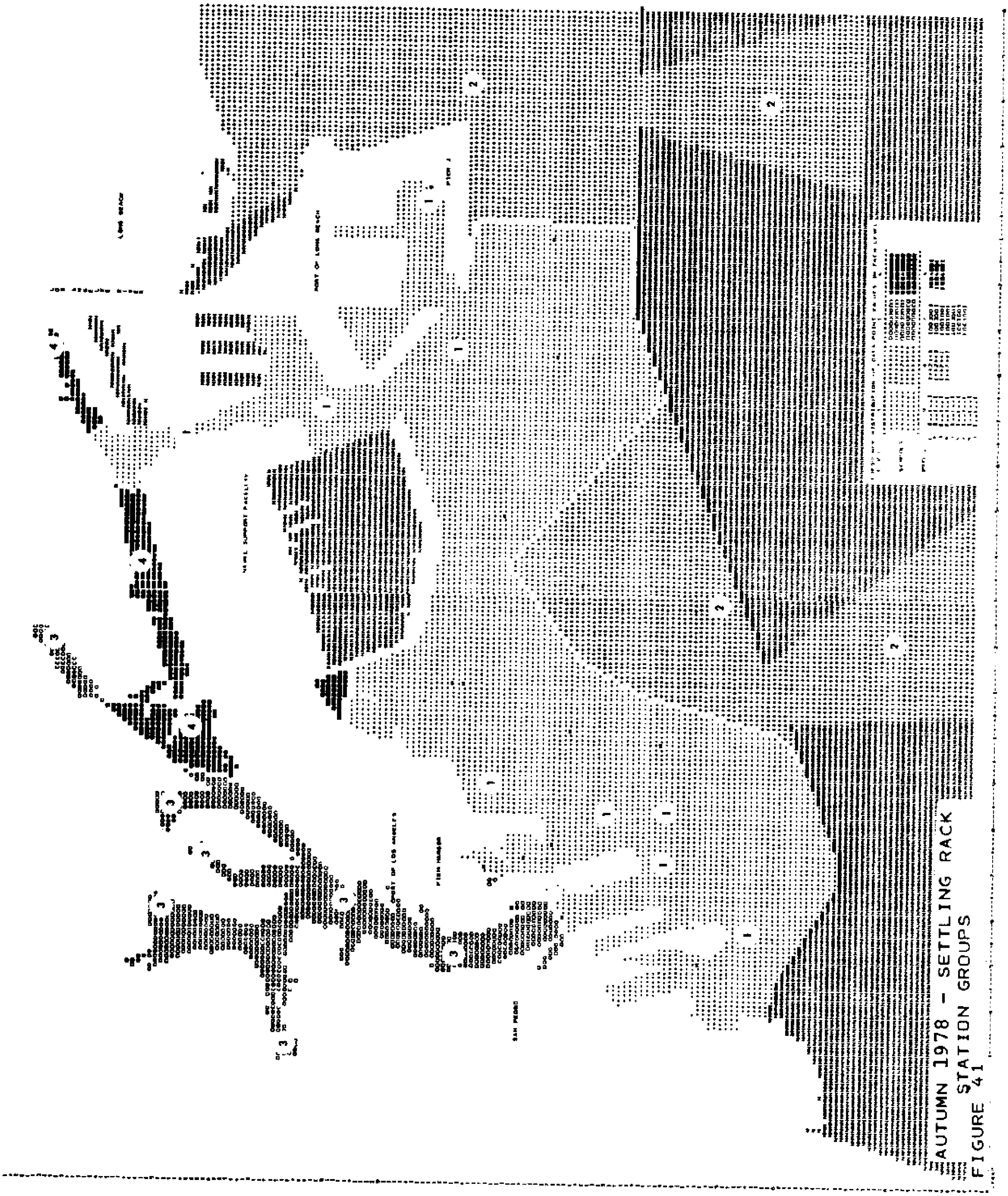
	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6	GROUP #7
1. TEMPERATURE	20.47	18.27	16.16	22.25	18.69	14.49	14.05
2. SALINITY	31.21	31.17	31.23	30.66	31.13	30.36	30.48
3. OXYGEN	8.59	7.94	8.81	6.28	8.05	7.50	4.42
4. PH	8.45	8.38	8.40	8.15	8.41	8.20	8.04
5. PRODUCTIVITY	20.46	18.27	16.15	22.41	18.69	14.49	14.04
6. CHLOROPHYLL A	5.47	6.03	5.07	7.86	4.96	4.88	1.86
7. ASSIMILATION RATIO	4.24	4.30	4.17	6.80	4.78	5.34	7.36

TABLE 20

WEIGHTED GROUP MEANS

DISCRIMINANT ANALYSIS * PLANKTON DATA * AUTUMN 1978

	1	2	3	4	5	6	7
1. TEMPERATURE	3.0198	3.0190	3.0195	3.0199	3.0204	3.0218	3.0222
2. SALINITY	0.0322	0.0322	0.0322	0.0323	0.0323	0.0322	0.0324
3. OXYGEN	0.1391	0.1433	0.1378	0.1469	0.1409	0.1404	0.1651
4. PH	0.1199	0.1201	0.1199	0.1205	0.1201	0.1202	0.1212
5. PRODUCTIVITY	2.8526	2.8588	2.8224	2.8980	2.8914	2.8700	2.8163
6. CHLOROPHYLL A	1.6973	1.6874	1.6782	1.7019	1.7183	1.7034	1.5322
7. ASSIMILATION RATIO	4.8460	4.9999	4.7507	5.2776	4.9713	4.9176	5.6241

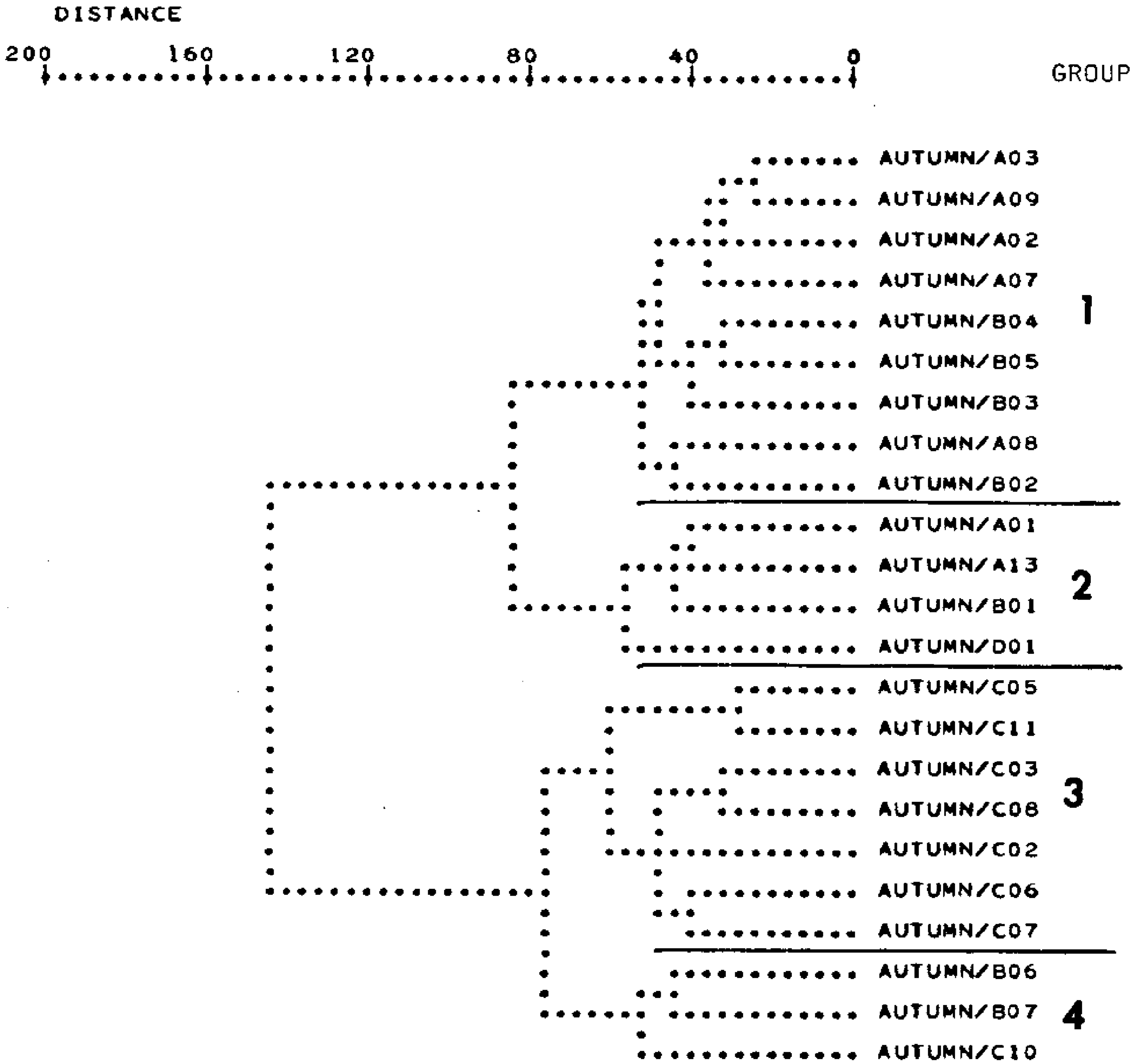


AUTUMN 1978 - SETTLING RACK STATION GROUPS

FIGURE 41

FIGURE 42

SETTLING RACK * AUTUMN 1978 * AVERAGED DATA



SETTLING RACK * AUTUMN 1978 * AVERAGED DATA FIGURE 43

Symbol	Range
*	> .75 TO 1
+	> .50 TO .75
−	> .25 TO .50
•	> .00 TO .25
BLANK	.00

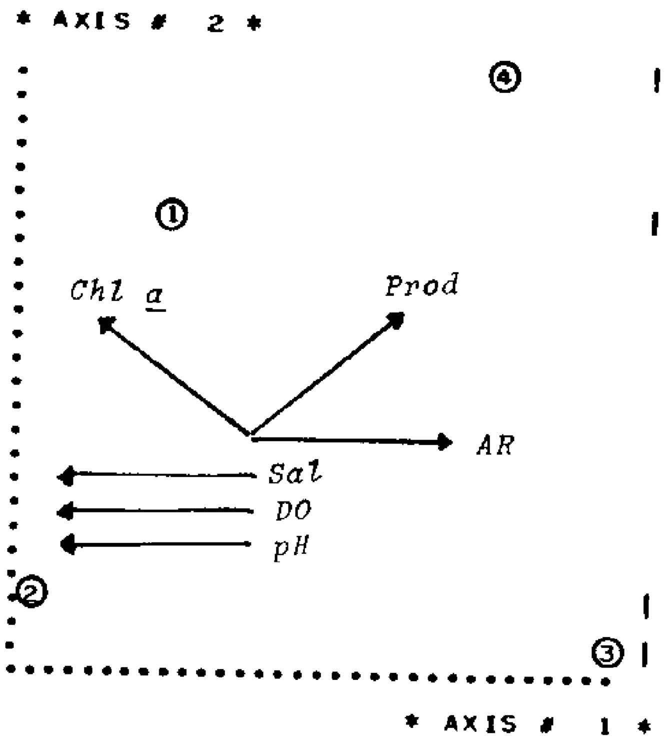
GROUP	1									2				3							4		
PERIOD / STATION	AUTUMN/A03	AUTUMN/A09	AUTUMN/A02	AUTUMN/A07	AUTUMN/B04	AUTUMN/B05	AUTUMN/B03	AUTUMN/A08	AUTUMN/B02	AUTUMN/A01	AUTUMN/A13	AUTUMN/B01	AUTUMN/D01	AUTUMN/C05	AUTUMN/C11	AUTUMN/C03	AUTUMN/C08	AUTUMN/C02	AUTUMN/C06	AUTUMN/C07	AUTUMN/B06	AUTUMN/B07	AUTUMN/C10
TAXON																							
MYTILUS EDULIS	+	+	-	+	+	-	*	+	•	-	+	+	-	•				•	•			•	
STENOTHOE VALIDA	-	+	*	-	•	•	*	+	-	+	-	+	-	•		•		-	•		•	•	•
PLATYNEREIS BICANALICULATA	+	-	*	+	-	-	-		-	-	*	+	-	•	•			-	•	•	-	•	
JASSA FALCATA	-	+	+	•	•	•	•	•	•	-	*	-	+	•	•	•		•	•	•		•	•
CAPRELLA VERRUCOSA	+	-	*	-		•	-	•	•	*	-	•	•	•			•		•	•	•	•	
CAPRELLA CALIFORNICA	•	-	•	-	*	+	*	•	+	+	•	+	•			•	•	-			•	-	+
CAPRELLA EQUILIBRA	•	•	+	-	+	+	*		•	*	*	-	+	•		•	•	-		•	•	•	-
COROPHIUM ACHERUSICUM	-	-	-	*	•	-	-	+	•	•	•	•	•	•	•	•	•	•	•	•	-	-	•
POLYOPHTHALMUS PICTUS	-	-	-	*	-	•	+	*	-	•	-	•	-			•		•	•			•	•
PODOCERUS BRASILIENSIS	+	+	+	-	•	-	+	*	*	•	•	•	•			•		-				•	•
ANATANAIS NORMANI	+	*	•	-	•	-	•	-	•	•	•			•	•	•	•	•	•			-	•
PALEANOTUS BELLIS	+	-		*			-	-	+				*					-				•	
MUNNIDAE MUNNA	•	+					*	*	-									-					
BALANUS AMPHITRITE	•	•	•	-	-	•		•	•	•			•		•	•	•	+	•	•	-	-	*
HYDROIDES PACIFICA	•	-	-	-	-	-	-	-	-	•	•	•	•	-	-	•	-	-	•	•	*	-	*
IANIRIDAE IANIROPSIS		•				+	•	-	-			•	*		-	-	*	*	+	•	-	•	
CIONA INTESTINALIS	-	*	-	+	*	+	+	+	-	•	-	•	•	-	-	-	+	+	-	+	-	•	+
POLYDORA LIMICOLA	*	+	*	*	+	+	-	+	+		-		+			*	•	*	•			-	
CTENODRILUS SERRATUS	-	+	+	-		+	-	•		•				-	•	*	•	*	•	-			-
ELASMOPUS RAPAX	•	•	•	•	•	+	-	•	-			•		•	•	•	•	•	-	-	*	*	-
ERICTHONIUS BRASILIENSIS	•	•		•	+	+	-		*		•	•	•		•	•	•	•	•	•	-	*	-
PARACERCEIS SCULPTA			•	•		•			*					•	•	•	•		•	•	*	+	•
ARMANDIA BIOCULATA			•	*	-	-		-	*									+	•				
GAMMAROPSIS THOMPSONI	-	-	-	+	-	-	•		*														
HALOSYDNA BREVISETOSA	-		*	+	-		•	•	*							•	-	-		•	•	-	•
CAPITELLA CAPITATA								-	+					*	*	*	*	*	*	+	*		-
POLYDORA LIGNI				•										-	*	*	•	*	*	•	•		-
LIMNORIA TRIPUNCTATA			•	•										*	*	-			-	+	*	•	•
OPHRYOTROCHA PUERILIS					-		•							*	*	+	+	•	-	•	+	-	-
POLYDORA SOCIALIS				+				+										+	*				
PSEUDOPOLYDORA PAUCIBRANCHIATA																		+	*	*			
CAPRELLA ANGUSTA																	•	*					
HEMIGRAPSUS OREGONENSIS				+												+	+			*			
MAYERELLA BANKSIA	*			-																			
LEPTOPECTEN LATIAURATUS			-							-	*	*											
OPHIODROMUS PUGETTENSIS												*		•									
AMPHINOMIDAE PSEUDEURYTHOE										*	-												
HIATELLA ARCTICA			-	-		+		*		-											•		
LEUCOTHOE ALATA								*	-					-								•	•
AMPITHOE PLUMULOSA																			-		*	-	
PODOCERUS CRISTATUS																						*	

FIGURE 44

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * AUTUMN 1978

PARAMETER	AXES 1	2	3
1. PRODUCTIVITY	5.5	4.9	21.9
2. CHLOROPHYLL A	6.7	30.3	16.9
3. ASSIMILATION RATIO	23.8	0.2	16.9
4. TEMPERATURE	0.6	1.1	42.7
5. SALINITY	0.5	44.0	1.1
6. DISSOLVED OXYGEN	19.6	11.1	0.4
7. PH	43.3	8.3	0.2



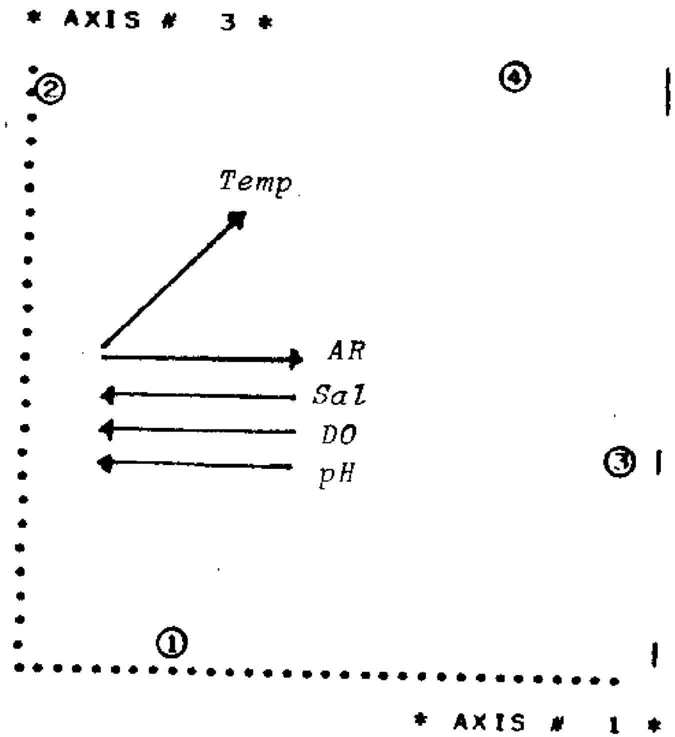


TABLE 21

VARIABLE GROUP AVERAGES * SETTLING RACK * AUTUMN 1978

	GROUP #1	GRCUP #2	GROUP #3	GROUP #4
1. PRODUCTIVITY	16.7648	15.6958	14.3886	24.1477
2. CHLOROPHYLL A	4.8315	4.8716	1.8586	8.2500
3. ASSIMILATION RATIO	4.0904	4.7708	7.5509	5.9944
4. TEMPERATURE	19.3222	19.4250	19.3762	19.6222
5. SALINITY	31.3000	31.1917	31.0571	31.2444
6. DISSOLVED OXYGEN	7.7704	7.5750	4.9333	5.5111
7. PH	8.2674	8.2375	8.0114	8.0155

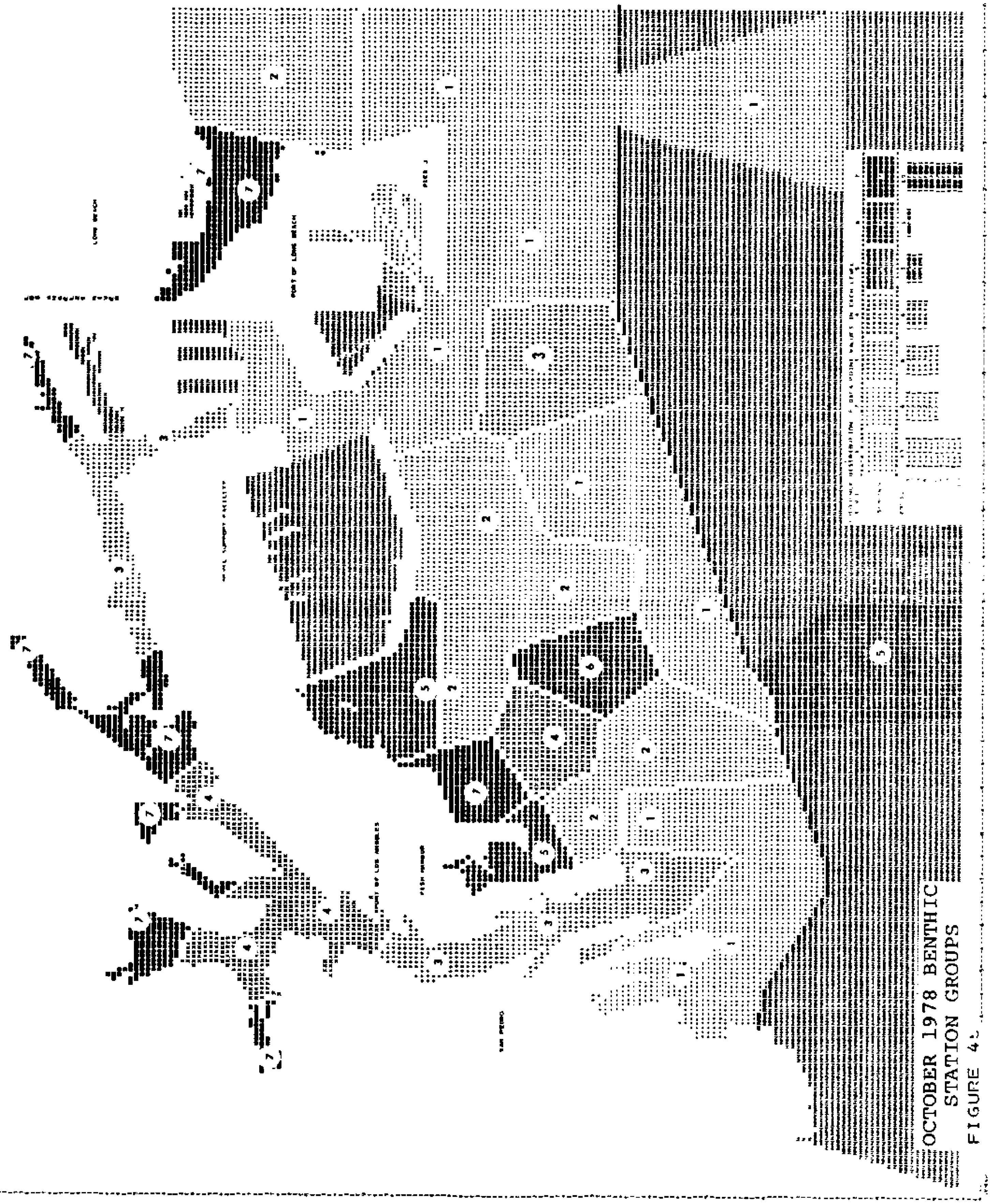
TABLE 22

WEIGHTED GROUP MEANS

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

SETTLING RACK WEIGHTED DISCRIMINANT ANALYSIS * AUTUMN 1978

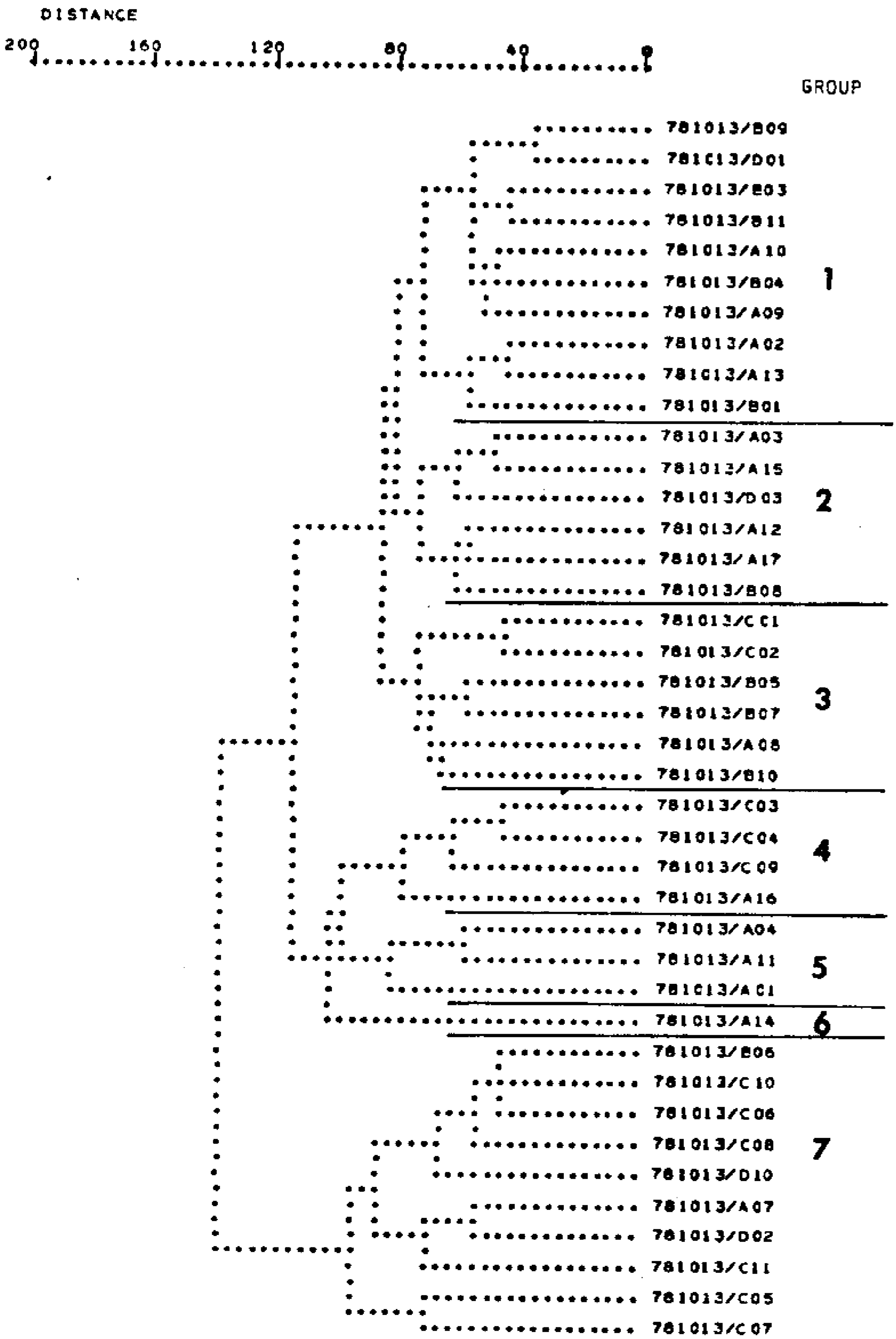
	1	2	3	4
1. PRODUCTIVITY	2.8116	2.7784	2.8406	2.8645
2. CHLOROPHYLL A	1.6427	1.6183	1.5581	1.6141
3. ASSIMILATION RATIO	4.9986	4.8077	5.8324	5.6415
4. TEMPERATURE	3.0205	3.0222	3.0225	3.0233
5. SALINITY	31.2241	31.2253	31.1666	31.2013
6. DISSOLVED OXYGEN	6.9514	7.1552	6.0698	6.3659
7. PH	8.1902	8.2110	8.1030	8.1259



OCTOBER 1978 BENTHIC
STATION GROUPS

FIGURE 4[illegible]

BENTHIC DATA (POLYCHAETA & MOLLUSCA) * OCTOBER 1978 FIGURE 46



BENTHIC DATA (POLYCHAETA & MOLLUSCA) • OCTOBER 1976

FIGURE 47

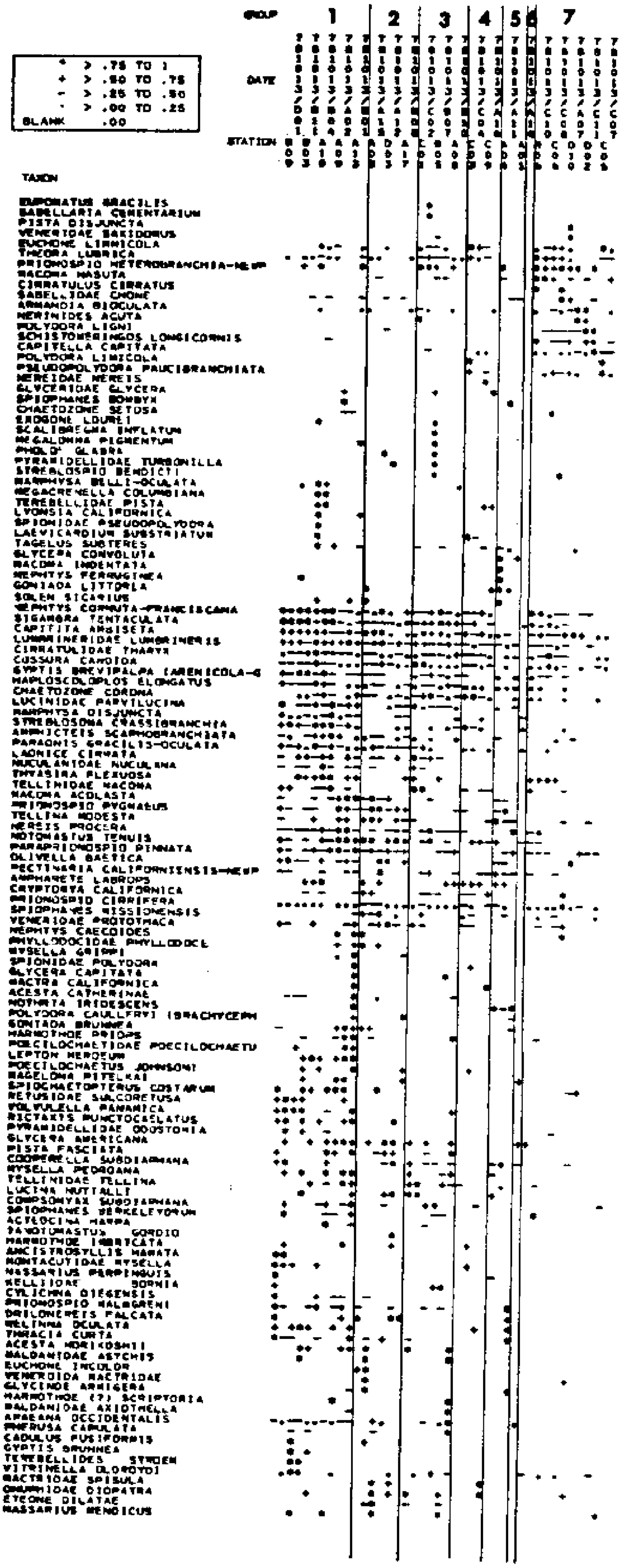


FIGURE 48

COEFFICIENTS OF SEPARATE DETERMINATION (X 100/SUM(ABS VALUE)) ** (AXES IN COLUMNS)
WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * OCTOBER, 1978

PARAMETER	AXES 1	2	3	4	5	6
1. PRODUCTIVITY	0.7	20.6	27.8	1.0	3.9	18.8
2. CHLOROPHYLL A	6.8	20.2	3.6	1.3	51.8	1.1
3. ASSIMILATION RATIO	9.7	14.1	0.1	25.1	12.9	7.9
4. DEPTH	0.4	10.7	7.1	0.6	21.6	6.9
5. TEMPERATURE	2.4	26.4	6.9	32.7	5.7	0.2
6. SALINITY	23.1	3.4	25.8	4.1	0.9	23.1
7. DISSOLVED OXYGEN	53.9	3.0	3.3	1.8	0.5	24.7
8. PH	2.9	1.5	25.4	33.3	2.7	17.2

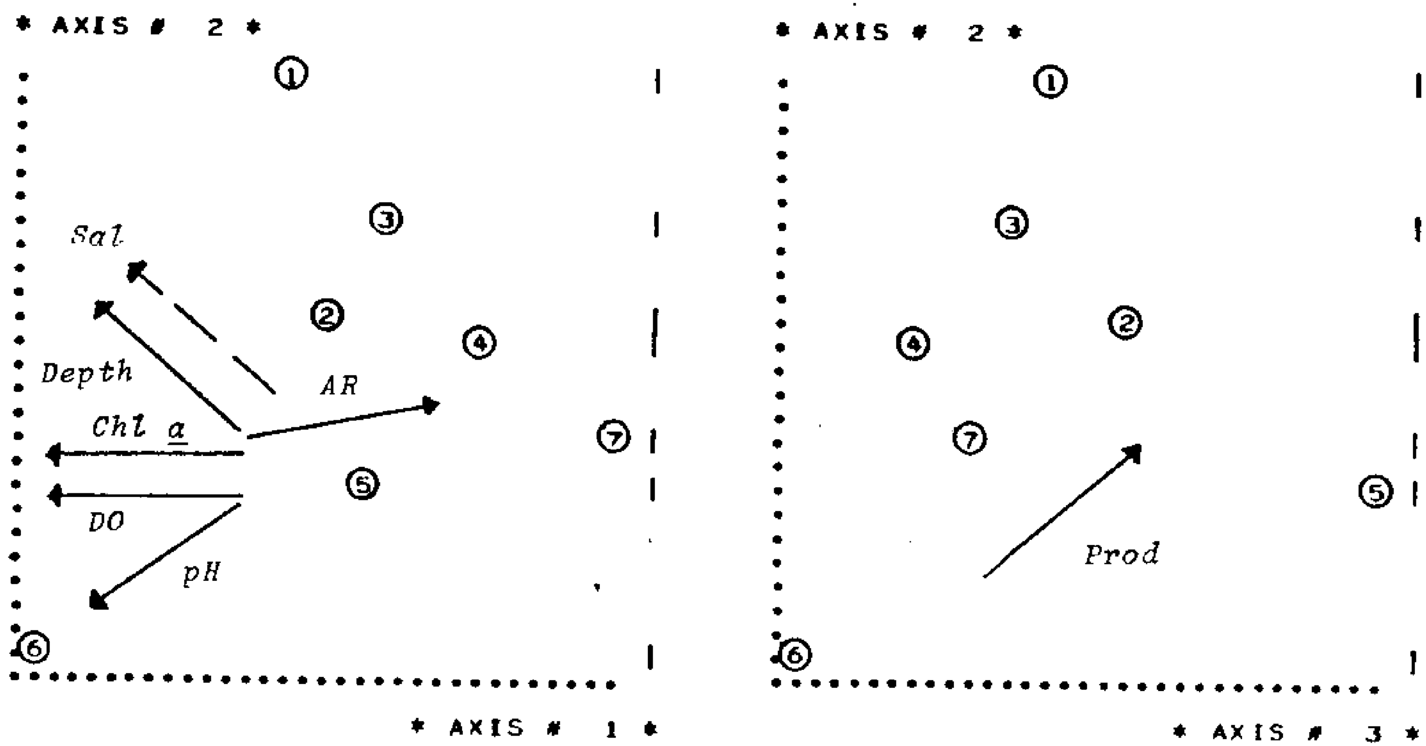


TABLE 23

** OCT78 **

VARIABLE GROUP AVERAGES * BENTHIC * OCTOBER 1978

	GROUP #1	GROUP #2	GROUP #3	GROUP #4	GROUP #5	GROUP #6	GROUP #7
1. PRODUCTIVITY	18.24	21.34	17.0	10.89	17.24	15.40	19.71
2. CHLOROPHYLL A	5.34	7.40	3.87	2.11	4.62	3.12	6.17
3. ASSIMILATION RATIO	4.44	3.77	5.80	6.01	4.21	4.78	6.58
4. DEPTH	15.20	12.16	13.16	11.00	13.00	8.00	11.50
5. TEMPERATURE	17.14	18.05	17.75	18.30	17.80	19.90	18.35
6. SALINITY	31.36	31.28	31.43	31.27	31.33	31.20	31.22
7. DISSOLVED OXYGEN	6.79	5.51	5.55	4.95	6.60	6.90	4.68
8. PH	8.12	8.00	8.06	7.93	8.13	8.20	8.04

TABLE 24
WEIGHTED GROUP MEANS

WEIGHTED DISCRIMINANT ANALYSIS * BENTHICS * OCTOBER, 1978

** WEIGHTED DISCRIMINANT ANALYSIS **
F AND CHI SQUARED TESTS MAY BE INVALID **

	1	2	3	4	5	6	7
1. PRODUCTIVITY	2.3886	2.3733	2.3628	2.3400	2.3807	2.3197	2.3342
2. CHLOROPHYLL A	3.2470	3.2271	3.1465	3.0463	3.1846	3.2389	2.9542
3. ASSIMILATION RATIO	3.8539	3.8274	3.8958	3.9448	3.8807	3.4876	4.0103
4. DEPTH	13.8655	13.2316	13.3201	12.9784	12.8159	13.5237	12.4359
5. TEMPERATURE	17.5875	17.7806	17.7613	17.9022	17.9029	17.6737	18.0293
6. SALINITY	31.3375	31.3281	31.3225	31.3166	31.3145	31.3559	31.2967
7. DISSOLVED OXYGEN	5.8844	5.8787	5.7300	5.5884	5.8605	6.2478	5.3651
9. PH	8.0649	8.0691	8.0569	8.0555	8.0740	8.0840	8.0412

ECOLOGICAL SIMULATION MODEL OF LOS ANGELES HARBOR RECEIVING WATERS

INTRODUCTION

Broadly stated, the goal of this project is to develop an ecological simulation model to assist in evaluating the potential impact of the Terminal Island Treatment Plant (TITP) secondary waste effluent on the Los Angeles Harbor ecosystem, both in the present configuration and with the proposed landfill (Phase I of the Port of Los Angeles). At the outset, it is important that this effort be placed in proper perspective with previous, somewhat related work completed by one of the present authors. A simulation model was developed (P. Kremer, 1978) to investigate the effect of high-BOD cannery effluent on the diel cycle of dissolved oxygen, with the objective of calculating waste loads that would avoid causing unacceptably low oxygen levels. The nature of the effluent, with high Biochemical Oxygen Demand (BOD), at the time of formulation of that model allowed a simple but effective approach emphasizing the relatively rapid oxidative decay of effluent BOD within a well defined area close to the source. Broad ecological ramifications, such as increased phytoplankton production following the ultimate release of inorganic nutrients, were not handled. This was consistent with the primary goal of modeling oxygen dynamics, and a more complete rationale is already available (P. Kremer, 1978).

With the diversion of cannery effluent through the TITP, the entire complexion of the question has changed dramatically. Oxygen dynamics, while still of interest, are no longer the primary feature to be modeled. To some extent the changeover to secondary treatment represents a shift towards a food chain based on primary production instead of on detritus driven by large sources of organic matter. Therefore, the model must now consider the complex ecological interactions connecting plankton populations, inorganic nutrients, temperature, and solar radiation. Further, the temporal scales suggested by these interactions imply much larger spatial scales, requiring that a larger area of the harbor be considered. These reasons emphasize the important point that this study is not a continuation of the earlier one and that it has been possible to draw on very little of that experience, data, or literature.

The question of what processes need be included to represent adequately the impact of secondary treatment plant effluent on the planktonic organisms in a coastal environment is obviously an extremely complex one. Beyond the obvious interactions of productivity, physical driving forces, and inorganic nutrients, there are an increasing number of factors recognized to exert controlling influences on plankton. Many of these, while undoubtedly important in some cases, are not at all well understood, such as the competitive interspecies dynamics leading to successive blooms. Computer simulation has played, and will continue to play, a role in basic research into these detailed controlling mechanisms (J. Kremer and Nixon, 1978). In the opinion of the present authors, such detailed and largely hypothetical formulations are out of place in applied models of the type developed here. The approach described below reflects this philosophy. An attempt is made to retain general features of first order significance, intentionally simplifying the conceptual model. Further, to protect against the errors of omission, conservative formulations and coefficient values are consistently selected so as to overestimate the growth rates and plankton biomass. Thus these simulations are not to be interpreted as predictions in any absolute sense. They should, however, suggest reasonable upper limits, and allow meaningful comparisons for different harbor configurations and various loads of sewage.

COMPONENTS OF THE MODEL

Figure 1 presents a diagrammatic representation of the model. Although the exact functional relationships between components are not included in this diagram, the direction of the flux of materials is given. In the sections that follow, each formulation and parameter incorporated in the model will be discussed. Since a model is only as strong as the component formulations, these formulations are presented in sufficient detail in this paper to give an idea of precisely what has been included.

A. Physical Mixing

It was originally recognized that successful completion of the effort required a reliable representation of the mixing and circulation within the harbor. The time scales of plankton growth suggest that the entire Los Angeles-Long Beach Harbor and some of the area outside the breakwater need to be considered. Initially it was hoped to interface the ecological model with a numerical tidal dispersion model of the harbor, but this proved impossible. Thus it became necessary to develop and test a physical model of advection and dispersion, though this was beyond the scope of the initial intent. Since this was outside the area of our main expertise, extensive assistance was sought. The help of W.-L. Chiang and of Dr. J.J. Lee of the USC School of Engineering, and of Dr. T. Dickey, physical oceanographer with the USC Institute for Marine and Coastal Studies is gratefully acknowledged.

Chiang has developed a hydrodynamic numerical model of the harbor. While his model is not yet in final form, it was possible to obtain a description of the velocity field throughout a tidal cycle for an appropriate grid spacing. In an attempt to strike a balance between the fine spatial detail desirable for hydrodynamic simulation and a more meaningful and tractable degree of resolution appropriate to the ecological formulations, grids 650 meters on a side were chosen. The result is 300 computational spatial grids representing the study region (Figure 2).

In Chiang's hydrodynamic model, conservation equations are solved through time, predicting the two horizontal components of velocity for each spatial grid every time step (Chiang, in prep.). It was not feasible to use the predicted velocities directly on our computer, so an alternative scheme was developed. The force driving the velocity model is a sinusoidal tidal function at the ocean boundary, and this results in a periodic sequence of water levels and velocities throughout the cycle in each grid. By storing the maximum, its time of occurrence, and the minimum for each grid point during one full tidal cycle, it proved possible to fit a sinusoidal equation that reproduced the velocities and water levels of the original hydrodynamic simulation. While the sinusoidal tide, with a 12.5 hour period and a 1.7 meter range, does not duplicate any specific mixed semidiurnal pattern of the real harbor, it does provide a reasonable average of the range of conditions throughout the lunar month.

The velocity model, then, consists of mean, amplitude, and phase coefficients for 900 equations (three variables each for 300 grid squares). For each of the vertically averaged spatial grids, velocities can be specified in two horizontal directions, plus the water level throughout a full tidal cycle, using any time interval. While unconventional, this scheme provided the essential flexibility needed to develop the physical facet of the ecological model, despite the inability to utilize the parent hydrodynamic model directly.

The next step was to use the predicted velocity field to solve the advection-diffusion equation:

$$\frac{\partial c}{\partial t} = -V_x \frac{\partial c}{\partial x} - V_y \frac{\partial c}{\partial y} + K_x \frac{\partial^2 c}{\partial x^2} + K_y \frac{\partial^2 c}{\partial y^2} + R$$

The change in concentration with time	Advection terms, due to velocities V_x and V_y	Diffusion terms, due to horizontal eddy diffusion K_x, K_y	Other processes (ecological)

The method of numerical integration used was Central in Space and Forward in Time (CSFT) (see Roche, 1976), as it is the simplest scheme that guarantees stability (M. Spaulding, Univ. R.I. Ocean Eng'g, pers. comm.). Values for the horizontal coefficients of eddy diffusivity (K_x, K_y) for coastal waters are difficult to measure or predict, but probably are in the range of 500 to 6000 m^2/min (Spaulding, pers. comm.; Dr. T. Dickey, pers. comm.). A low value of 1000 m^2/min was used in this model, because of the numerical dispersion introduced by the CSFT integration. Mathematical stability requires that the time step (Δt) and grid length (ΔL) be chosen such that

$$\Delta t = \frac{\Delta L}{\sqrt{2}\, V_{max}}$$

Based on grid size of 650 m and the maximum tidal velocity, a Δt = 30 minutes was chosen and used for routine runs. This selection was confirmed to be satisfactory by comparisons with runs using a 15-minute step. Boundary conditions ensured zero transport across solid boundaries, and no concentration gradient at the open ocean.

The resultant scheme is not numerically rigorous. Limited precision of the coefficients and small departures from a true sinusoid contribute error to each computed velocity. While the errors are small, they accumulate quickly with frequent iterations, with the result that mass is not precisely conserved. To correct this, an artificial tracer is maintained as a state variable. At the start of each step its concentration is uniformly 1.0 throughout all grids. After each iteration departures from unity in this tracer reveal the exact magnitude of any numerical error. Simple division of the concentrations of all real state variables by the tracer value in each grid exactly compensates the error. The result is a mixing model capable of tracking the dispersal of dissolved or neutral particulate constituents due to tidal currents and turbulence in the model harbor, both in the present configuration and with the proposed fill.

B. Forcing Functions

1. Temperature is used in several of the model formulations from phytoplankton growth to benthic nutrient regeneration and oxygen saturation. Using available data from the Harbors Environmental Projects (HEP) (Soule and Oguri, 1974; plus unpublished data) we chose a temperature of 16C as representative of an average temperature for water in Los Angeles Harbor. Winter conditions use a value of 12C and summer uses 20C.

2. Solar Radiation

a. Photoperiod. The day length determines the number of hours available to the phytoplankton for photosynthesis. On the average there are twelve hours of daylight and twelve hours of darkness. In the model winter conditions are represented by nine hours of light while fifteen hours are used for summer.

b. Light Intensity. Numerous investigators have shown that phytoplankton growth is a function of the ambient light intensity (Ryther, 1956; Ryther and Menzel, 1959; Steele, 1962). Although light intensity itself is not used as a forcing function in the model, its effect (expressed in terms of phytoplankton growth at a given light intensity relative to optimum light) is explicitly considered. A more complete discussion of the photosynthesis vs. light relationship is included in the Phytoplankton section of this paper.

3. Baseline Extinction Coefficient (K_o). The extinction coefficient is composed of two parts: a baseline extinction coefficient and a chlorophyll term. As the phytoplankton grow they increase the extinction coefficient (K), cutting down the light that can reach to a given depth. The equation expressing this self-shading is based on empirical regressions (Riley, 1956):

$$K = K_o + 0.054\ C^{2/3} + 0.0088\ C$$

where K = total apparent extinction coefficient, meter^{-1}

K_o = baseline extinction coefficient (with no phytoplankton), meter^{-1}

C = Chlorophyll a concentration, mg/m^3

As part of their marine monitoring program in Los Angeles Harbor, the Harbors Environmental Projects (HEP) measure percent transmission of light across an 0.1 meter path. Because of the absorptive and scattering properties of light, transmission, which is measured horizontally, is not the same as the extinction coefficient which is measured vertically. Measuring both transmission (α) and extinction coefficient (K) for eleven stations in Los Angeles Harbor yielded the following relationship:

$$K = 0.21\ \alpha \qquad \pm 0.04\ (\text{s.d.})$$

Using available data from HEP on transmission and chlorophyll in Los Angeles Harbor and outside the breakwater in the Riley equation, we estimated values for the baseline extinction coefficient (K_o) for use in the model, While the estimates were understandably variable, there was a pattern of decreased

K_o moving out from the inner harbor and offshore. We approximated this trend in the model by designating three regions, each with a characteristic K_o based on the empirical measurements (Table 1). To evaluate the sensitivity to these choices, K_o sets were also selected to represent the clear and turbid extremes observed in the data.

4. Salinity. In the model, salinity is used only in the calculation of oxygen saturation (C_s) at a given temperature:

$$C_s = 14.161 - 0.3943\,T + 0.007714\,T^2 - 0.0000646\,T^3 - S(0.0841 - 0.00256T + 0.0000374\,T^2)$$

where C_s = the oxygen saturation level, parts per million

T = temperature, centigrade

S = salinity, parts per thousand

A uniform value of 34 o/oo is used in all model runs. This rough approximation of observed salinity is tolerable because salinity is of minor importance in the model. For example, at 16C a 10 o/oo range in salinity (26-36 o/oo) would cause only a 0.5 ppm range in the calculation of oxygen saturation.

5. Effluent Loading. Data on nutrients and BOD (biochemical oxygen demand) from the TITP have shown that there has been a large amount of variability in the composition of the effluent since secondary treatment first started in April 1977 (Soule and Oguri, 1979). The values for the effluent concentration of BOD, ammonium (NH_4) and nitrate (NO_3) which are used to represent "secondary treatment" in the model (Table 2) are based only on data from Fall, 1978. This is subsequent to aeration of the effluent and represents a dramatic drop in ammonium over earlier periods.

Records from the TITP show a clear diurnal periodicity in the amount of effluent being discharged. This pattern has been incorporated into the model. During the early morning and late afternoon hours the discharge rate is 1.3 times the average. During the midday the rate rises to 1.6 times the average, while at night the rate drops to 0.6 of the average. The values used as input to the model for effluent loading reflect this periodicity.

Prior to converting to secondary treatment, the TITP was discharging about ten million gallons per day of primary-treated effluent (av. 9.3 MGD in 1976). Values for the concentrations of BOD and nutrients (NH_4 and NO_3) in this effluent (Table 2) are based on discharge data from TITP for 1976. During this time the canneries were discharging directly into the harbor waters just east of Fish Harbor approximately 600m from the TITP sewer boil. Both the amount and composition of the cannery effluent was quite variable. Values for BOD of 1000 mg/l were used in the earlier oxygen model (P. Kremer, 1978) and have been used again in this model for runs considering cannery effluent. The nitrogen concentrations presented for the cannery effluent (Table 2) are taken from unpublished data of HEP based on analyses made in Fall, 1977, prior to hookup in TITP.

6. Zooplankton. In the model, zooplankton biomass is not simulated, but observed biomass is used to calculate an estimate for grazing pressure on phytoplankton. Zooplankton samples for Los Angeles Harbor (1977-1978) showed very large month-to-month variability, but in general the total zooplankton counts rarely exceeded 10,000 animals per cubic meter. Since it was anticipated that the exact choice for zooplankton concentration would have little effect on the phytoplankton and nutrient levels, a uniform level of 10,000 animals per cubic meter was chosen for the standard run of the model. For confirmation of this approximation, see the "Results" section discussing the model run where zooplankton were entirely eliminated.

In order to calculate an ingestion rate, it was first necessary to calculate biomass from counts of densities. In the harbor a few species have been found to dominate the zooplankton. Among these are three species of cladocera and the copepods *Acartia tonsa* (which may be a mixture of *A. tonsa* and *A. californiensis*) and *Paracalanus parvus*. The dry weight of *Acartia* spp. has been determined by several investigators to be approximately 7 μg/animal (Conover, 1959; Greze and Baldina, 1964; Petipa, 1966; and Heinle, 1966). This value of 7 μg was chosen for the model to represent the average size for harbor zooplankton. The nitrogen content of zooplankton has been measured to be about 8% of the dry weight (Curl, 1962; Beer, 1966; Conover and Corner, 1968; Butler *et al.*, 1969). So the average nitrogen content per animal is calculated to be 0.56 μg N (7 μg dry weight x 8%), which is equivalent to 0.04 μg-at N/animal.

In the model, grazing pressure on the phytoplankton is calculated as proportional to the observed zooplankton biomass based on a temperature-dependent ingestion rate:

$$RTN = RTN_o e^{rT}$$

where RTN = the ration at temperature, T (fraction of the zooplankton biomass ingested per day)

RTN_o = the ration at 0 C

e = base of natural logarithm

T = temperature, centigrade

r = exponential rate of increase in ingestion rate with temperature, $°C^{-1}$

A more complete discussion of this formulation and the topic of zooplankton feeding is found in J. Kremer and Nixon (1978, chapt. 5.2). In modeling the ingestion for zooplankton in Los Angeles Harbor, the "r" was chosen to be 0.069 (representing a doubling in the ingestion rate with each 10 C increase), and "RTN_o" was set to be 5%. This means that at 20C the zooplankton would ingest 20% of their biomass each day. In the model, both the biomass of the zooplankton and phytoplankton are expressed in terms of the equivalent amount of nitrogen, to facilitate the calculation of the ingestion rate.

To be compatible with the phytoplankton growth equation, the zooplankton grazing rate is converted to an instantaneous feeding rate:

$$F = RTN \times Zoo \div Phyto$$

where F = instantaneous filtering rate, day^{-1}

RTN = the zooplankton ration, defined as the fraction of their own biomass ingested, day^{-1}

Zoo = standing stock of zooplankton, μg-at N/l

Phyto = standing crop of phytoplankton, μg-at N/l

C. State Variables

1. Nutrients. The importance of nitrogen as the most limiting nutrient in marine ecosystems has been shown for numerous locations and seems to hold even for eutrofied waters (Ryther and Dunstan, 1971). Therefore, nitrogen was chosen as the element that would be likely to be the most indicative of the nutrient dynamics in the harbor. Two forms of nitrogen, ammonium and nitrate, are modeled and several factors are considered as sources and sinks for those compounds in each spatial element:

	Sources	Sinks
Ammonium (NH_4)	TITP effluent (advection) Benthic regeneration BOD oxidation by bacteria	Phytoplankton uptake Nitrification
Nitrate (NO_3)	TITP effluent (advection) Nitrification	Phytoplankton uptake

For both ammonium and nitrate, phytoplankton uptake represents the largest nutrient loss. The two main nitrogen sources are the TITP effluent as it is mixed by advection, and regeneration of ammonium by the benthos. Nitrification (the conversion of NH_4 to NO_3) and the release of ammonium by bacteria related to BOD oxidation are both estimated to be of lesser magnitude.

a. TITP Effluent. Nutrient loading from the TITP secondary treatment facility enters a single spatial element in the model. The physical mixing scheme then disperses the effluent while phytoplankton growth, and other processes, occur throughout. A variety of levels of nutrient loading from TITP (secondary treatment) as well as other types of effluent (Table 2) were tried in the model to assess the effect on the levels of phytoplankton and nutrients in the harbor.

b. Benthic Regeneration. There have been very few measurements of the nutrient flux from intact sediments. The data that do exist, however, indicate that ammonium is the dominant form of inorganic nitrogen released by sediments. The flux of nitrate is quite erratic and variable in both direction and magnitude. Although no direct measurements have been made for harbor sediments, the results from ongoing studies (Kremer and Kremer, Sea Grant) of nearby Colorado Lagoon off Alamitos Bay are comparable to results published for Narragansett Bay, Rhode Island (Nixon, *et al.*, 1976). These waters both have a rich and active benthos and therefore it appears justified to apply these rates to Los Angeles Harbor.

The following equation describes ammonium release by intact sediments:

$$BENNH4_T = BENNY4_o e^{rT}$$

where $BENNH4_T$ = the flux of ammonium from the sediments at temperature, T, (mg-at/m^2)

$BENNH4_o$ = the extrapolated flux of ammonium from sediments at 0C, 0.2 mg-at/m$^2 \cdot$day

e = base of natural logarithm

r = coefficient relating the increase in the flux of ammonium with increased temperature, 0.15 °C^{-1}

T = temperature, centigrade

c. Phytoplankton Uptake. This flux represents a major nutrient sink for both ammonium and nitrate. Although both these nitrogen forms are utilized by phytoplankton in the model, consistent with experimental findings (MacIsaac and Dugdale, 1969), ammonium is taken up preferentially. If there is insufficient ammonium to meet the nitrogen requirement associated with the predicted phytoplankton growth, the remainder is made up with nitrate. If the projected demand by phytoplankton exceeds the supply of both ammonium and nitrate, then the phytoplankton growth rate is reduced until its demand just equals the nutrient supply.

The net uptake of nitrogen during the day is proportional to the net primary production, less a zooplankton excretion term assumed to be proportional to zooplankton grazing. At night, excretion of inorganic nitrogen by phytoplankton is not allowed in the model, but zooplankton excretion is the same as during the day. In the present model a constant nitrogen composition is assumed for both phytoplankton and zooplankton. This greatly facilitates calculations of nutrient uptake and excretion. Although this is an oversimplified view of these processes, the authors think that it realistically represents the first order trends.

d. Nitrification. According to Jaworski, *et al.* (1972) the chemical oxidation of ammonium to nitrate can be described as a function of temperature, time, and the ammonium concentration:

$$DN = NH_4\left[1-e^{(-K_t \times time)}\right]$$

$$NH_4 \rightarrow NH_4\text{-}DN$$

$$(NO_2+NO_3) \rightarrow (NO_2+NO_3) + DN$$

where $K_t = K_{20}\ \Theta^{(Temp-20)}$

$K_{20} = 0.068\ day^{-1}$

and $\Theta = 1.188$

At 20C about 7% of the standing stock of ammonium is oxidized to nitrate plus nitrite each day.

e. Ammonium Release Accompanying BOD Oxidation. Microorganisms play a dominant role in the oxidation of organic compounds, known as Biochemical Oxygen Demand. Although there is no local experimental evidence on this subject, it is reasonable to assume that accompanying the BOD oxidation there is a conversion of some organic nitrogen to ammonium by microorganisms.

If the microorganisms metabolize primarily protein, and if nitrogen is released in the proportion utilized (steady state), one would expect an atomic ratio of oxygen to nitrogen of 8. Since the microorganisms almost certainly are metabolizing compounds other than protein and retaining nitrogen preferentially for growth, this value represents a lower limit to the ratio. Based on this reasoning, the authors chose a ratio of O_2 consumed to N released of 20. Thus the change in BOD (mg/l) per unit time (see oxygen section) is multiplied by 3.15 to give the resultant increase in ammonium concentration (μg-at N/l). Thus the model does allow some conversion of organic nitrogen to ammonium, but the rate is probably a conservative estimate.

f. Land Runoff. Nutrients entering the harbor from runoff have not been included in this model. Lack of available data makes the flux extremely difficult to quantify, and the seasonal variability only further complicates this question. This omission is probably not a major problem for the Los Angeles Harbor nutrient budget.

2. Oxygen and BOD. In contrast to the earlier model (P.Kremer, 1978) which dealt specifically with high BOD effluent, this model focuses on waters receiving secondary treatment effluent. Because of the drastically reduced BOD loading (see Table 2) the tracking of diel oxygen levels is less criti-

cal in this model. Nevertheless, oxygen is modeled with the same degree of sophistication and completeness as the earlier study. This approach allows the extension of the present model beyond the case of secondary effluent discharge alone. In some of the runs, cases where high BOD effluent is discharged were considered. By keeping track of oxygen as well as nutrients and phytoplankton it was possible to make more complete comparisons between a variety of discharge scenarios.

The "BOD" in this model more precisely represents "effluent BOD." Thus it is assumed that the background levels in the harbor are zero, and that all BOD comes from effluent. In reality, this effluent BOD is superimposed on a non-effluent background of 1-2 mg/l. The discrepancy is not significant in the simulations, and this formulation facilitates the tracking of the effluent's region of influence.

A complete description of the oxygen dynamics is presented in P. Kremer (1978), but the important features are also summarized in Figure 3 and explained below:

a. Physical Mixing. The former model has only a crude representation of advective mixing and covers only a small segment (0.64 km^2) of Los Angeles Harbor. The newer model incorporates a much more sophisticated scheme for physical circulation, but the principle remains the same. Advection and diffusion of waters with differing oxygen levels is superimposed upon all other dynamic processes, changing the oxygen concentration in a given element through time. The importance of this factor to the entire oxygen budget varies with the location of the element, the strength of the advective flow, and the existing gradient of oxygen.

b. BOD Oxidation Rate. This rate was determined empirically for harbor waters in conjunction with the previous oxygen model. The results of this work indicated that at both 15 and 20C the mean instantaneous oxidation rate equaled 0.021 per hour:

$$BOD_t = BOD_o \, e^{BODK \cdot t}$$

where BOD = levels of BOD at time zero and "t" hours later

e = base of natural logarithm

BODK = instantaneous hourly rate of BOD oxidation ($0.021\ hour^{-1}$)

t = time in hours

During the process of BOD oxidation the BOD level is reduced, as is the ambient oxygen concentration. As mentioned earlier, ammonium is also released in proportion to the BOD oxidized.

c. Benthic Oxygen Demand. Published data for organically rich intact sediments (P. Kremer, 1978, Table 3) indicate that they consume about 0.1 g $O_2/m^2 \cdot$hour at 20C. Unpublished data from the authors' studies in Colorado Lagoon near Alamitos Bay in Long Beach have yielded quite similar rates. The equation used to model the uptake of oxygen by the benthos is a function of temperature and consistent with field data:

$$BENOX_T = BENOX_{20}\ e^{r\,(T-20)}$$

where $BENOX_{20}$ = 2.4 g O_2/m^2/day

$BENOX_T$ = Benthic oxygen uptake at a specified temperature, g O_2/m^2/day

e = base of natural logarithm

r = the coefficient relating temperature to respiration, 0.069 $^oC^{-1}$

T = temperature, C

This rate is less than that used in the earlier model (P. Kremer, 1978). The added influence of resuspended sediments has not been included, since it is presumably less important for the harbor as a whole than for the shallow waters near the site of discharge.

d. Air-Water Exchange. There is a continuous diffusional transport across the air-water boundary, which attempts to restore equilibrium between the two systems. The theoretical equation describing this process in the model is Fick's law:

$$F = D\ (C_s - C_o)/Z$$

where F = rate of transfer, $\mu g/cm^2 \cdot hr$

D = molecular diffusivity for oxygen, cm^2/hr

= 0.377 + 0.00186 temp

C_s = saturation concentration of gas at that temperature and salinity, parts per million

C_o = observed concentration of the gas, ppm

Z = the "stagnant boundary" thickness of the air-water interface, cm.

= $0.28/(\text{wind speed, m/sec})^2$

In the model, wind varies diurnally from 2 to 6 m/sec in a sinusoidal pattern with a midday high and a midnight low. This is based on local empirical data (see P. Kremer, 1978, Figure 3).

e. Nitrification. Dissolved oxygen is consumed as ammonium is oxidized to nitrate. Based on stochiometry, it was assumed in the model that 0.048 mg O_2 is utilized for each 1 μg-at of nitrogen converted.

f. Phytoplankton. The algae have a dual role in the oxygen budget. They produce oxygen as they photosynthesize, but consume dissolved oxygen as they respire. The formulation used to simulate the growth and respiration of phytoplankton is discussed thoroughly in the Phytoplankton section.

In order to calculate the effect of phytoplankton on the oxygen level, it is necessary to make appropriate conversions. Using a carbon:chlorophyll ratio of 50 (Eppley, *et al.*, 1971), and knowing that 32 grams of oxygen are released for each 12 grams of carbon utilized, it is estimated that 18.8 mg oxygen are produced for each 1 mg chlorophyll of growth. At night the reverse process takes place, and oxygen is consumed in the same ratio.

3. Phytoplankton. As the major component of the ecological model, the phytoplankton formulation includes the effects of temperature, light, nutrients, and zooplankton grazing according to the following formulations:

Maximum rate of Gross Production = Maximum Growth rate + Respiration rate

Realized rate of Gross Production = Maximum Gross Production rate x (nutrient limitation <u>or</u> light limitation)

Note: At night gross production = zero

Change in Phytoplankton biomass $\propto$ (gross production - respiration - zooplankton grazing)

a. <u>Maximum Growth Rate</u>. The keystone of the phytoplankton formulation is the maximum growth rate, which is given as an exponential function of temperature. In a review of the subject, Eppley (1972) presented strong evidence for an upper physiological limit to phytoplankton growth when neither light nor nutrients were believed to be limiting. Rewriting his equation in the natural log base "e" provides a prediction of the maximum instantaneous growth rate:

$$G_{max} = 0.59\ e^{0.633 \cdot Temp}$$

where G_{max} = the instantaneous daily increase for the population, day^{-1}

Temp = Temperature, C

b. <u>Respiration</u>. Respiration rate was determined for several species of phytoplankton acclimated to a variety of temperatures (Ryther and Guillard, 1962). Using only conservative estimates of respiration and rewriting their equation to be compatible with the units in the instantaneous growth equation, the following equation was derived for a carbon to chlorophyll ratio of 50:1 (Eppley, *et al.*, 1971):

$$r_T = r_o e^{sT}$$

where: r_T = instantaneous biomass loss from respiration, day^{-1} at a specified temperature

r_o = instantaneous biomass loss at 0C, 0.03 day^{-1}

e = base of natural logarithm

s = expression of exponential increase in respiration with temperature, $0.069 \cdot C^{-1}$

T = temperature, C

c. Maximum Gross Production. By adding the predictions for maximum growth (G_{max}) and respiration (r_T), the value for maximum photosynthesis is determined. This represents a physiological maximum at optimum levels of light and nutrients. In the natural environment, less than optimum light and nutrients reduce the maximum gross production.

Phytoplankton production in the model is limited to some fraction of the above temperature-dependent maximum rate by either less than optimum light or nutrient levels. Theoretical and experimental results (Kiefer and Enns, 1976) indicate that limitation by these two alternatives is an either/or case. Accordingly, two unitless factors are computed for every element during each daytime block that express the degree of limitation by light and nutrients. The factors are compared and the smallest is multiplied by the maximum, resulting in an instantaneous rate of primary production.

1) The Light Limitation factor has a strong basis in empirical phytoplankton data, and similar approaches have been widely used in models of phytoplankton (Kremer and Nixon, 1978; Di Toro, *et al.*, 1971). The basis for the formulation is the photosynthesis-light response in which peak production occurs at some optimum light intensity, with decreased rates observed at both higher and lower light levels. Steele (1962) formulated an equation that continues to fit field data remarkably well:

$$G/G_{max} = \frac{I}{I_{opt}} e^{1-I/I_{opt}}$$

where I/I_{opt} = the ratio of incident radiatio to the optimum

and G/G_{max} = the fraction of the maximum ph o-synthesis compared to the rate t the light optimum, I_{opt}

This equation predicts the instantaneous physio gi-cal response of phytoplankton. But in the mode a rate is desired that is averaged throughout the entire water column and over a span of time. T s can be accomplished by integration of the equat n, but only if a suitably simple function is assum for radiation through time. Di Toro (*et al.*, 1 1) assumed constant light throughout the day and c -puted the 24 hour integral. That approach has me drawbacks (Kremer and Nixon, 1978), and it was di-fied for the present application. By expressin the integral for shorter blocks of time, the assump on of constant illumination can be justified as re e-senting a physiologically meaningful average. e equation used, however, remains closely similar o Di Toro's original.

$$\bar{G}/\bar{G}_{max} = \frac{e}{Kz}\left(e^{\frac{\bar{I}}{I_{opt}} e^{-kz}} - e^{\frac{\bar{I}}{I_{opt}}}\right)$$

where K = the extinction coefficient, m^{-1}

$\frac{\bar{I}}{I_{opt}}$ = the ratio of average insolation t the water surface over a given me interval to the insolation at w ch maximum photosynthesis occurs

and $\bar{G}/\bar{G}_{max}$ = the fraction of the maximum rat achieved by the entire water co mn to depth Z, averaged over the s e time interval

The expression for $\bar{G}/\bar{G}_{max}$ defines the deg e of light limitation, LTLIM, and is a unitless fraction from 0-1. Under conditions where ligh is more limiting than nutrients, this fraction determines the reduction from the maximum rate primary production.

For the ratio $\bar{I}/\bar{I}_{opt}$ the following assumptions were made (Figure 4). The diurnal pattern of insola- was taken to be half of a sine curve with the maximum at local noon. Dividing the period (photo- period) into three equal intervals, the average insolation for each block of time is a simple fraction of the total radiation received.

Let: $\bar{I} = \dfrac{I_{total}}{f}$

I_{total} = integrated total insolation received

f = photoperiod

$\bar{I}$ = daytime average insolation rate

Then $\bar{I}_1 = 0.75\ \bar{I}$ the average insolation rate during the first time block, 0 to $\frac{f}{3}$

Furthermore, during the first and third blocks of the day, this average insolation is exactly half of the average during the middle third.

$$\bar{I}_2 = 2\ \bar{I}_1 = 1.5\ \bar{I}$$

Next it was assumed that I_{opt} equals one-half the surface value. This is a pattern often observed (Steele, 1962), and the investigations for Colorado Lagoon support this as a "rule of thumb."

$$I_{opt} = 0.5\ \bar{I}$$

Combining these relationships produces a simple estimate for the critical ratio during each third of the day for most of the simulations.

$$\frac{\bar{I}_1}{I_{opt}} = 1.5 = \frac{\bar{I}_3}{I_{opt}}$$

$$\frac{\bar{I}_2}{I_{opt}} = 3.0$$

Implicit in this selection is the final assumption: that the phytoplankton are able to acclimate successfully to the incident radiation. Thus these ratios are independent of the actual solar input -- a convenient simplification for the model, but certainly a crude one compared to the real system. An extensive theoretical discussion of the Steele curve and its use in models such as this is presented elsewhere (Kremer and Nixon, 1978). From this earlier work, it was clear that the formulation is not sensitive to the exact value of the ratio, as long as it is greater than 1.0. This is almost certainly the case during most of the year at this latitude. To investigate the effect of the potentially important low winter insolation, the ratios were arbitrarily reduced to represent a case where phytoplankton acclimation was limited to the surface value. The winter simulation is illustrated as follows:

$$\frac{\overline{I}_1}{I_{opt}} = 0.5 = \frac{\overline{I}_3}{I_{opt}}$$

$$\frac{\overline{I}_2}{I_{opt}} = 1.0$$

The specification of one of these sets of values defines the photosynthesis-light response for the phytoplankton. The degree of light limitation for the water column under each spatial grid (LTLIM) is set by this response, together with the extinction coefficient, which is simulated in space amd time.

2) <u>Nutrient Limitation</u>. Several investigators have established that the phytoplankton growth rate is strongly affected by the available concentration of nutrients (Eppley and Strickland, 1968; Thomas and Dodson, 1968; Eppley and Thomas, 1969). The hyperbolic response of phytoplankton growth to a limiting nutrient is generally represented by the form of the Monod equation:

$$G/G_{max} = \frac{N}{K_s + N}$$

where G = realized growth rate

G_{max} = maximum growth rate

N = ambient concentration of the limiting nutrient

K_s = nutrient concentration at which the growth rate is one-half the maximum

The portion of the equation $\frac{N}{K_s+N}$ defines the nutrient limitation term ("NUTLIM") expressing to what extent phytoplankton growth is limited by the available nutrient supply. In the model, "N" equals the sum of the ammonium and nitrate concentrations, and

K_s equals 2.0 µg-at/l, a value chosen to represent eutrophic estuarine species which are less efficient at lower nutrient concentrations (Eppley and Thomas, 1969; Eppley *et al.*, 1969; Carpenter and Guillard, 1971).

d. Realized Growth Rate. In the model the terms "LTLIM" and "NUTLIM" are compared at the beginning of each daytime time block. The single factor which is limiting (*i.e.*, the lowest fraction) is chosen and multiplied by the maximum gross production to calculate the realized gross production.

The actual change in phytoplankton biomass is calculated as proportional to the realized rate of gross production minus phytoplankton respiration and zooplankton grazing. All processes affecting phytoplankton growth are expressed as instantaneous rates that are exactly and simultaneously integrated (Kremer and Nixon, 1978) to determine the net change during the 30 minute iterations. Thus, the instantaneous rates are constant throughout the three daytime time blocks, but the change in this biomass is calculated every iteration of the model, and the biomass incremented appropriately. During the night the phytoplankton cannot grow, and their biomass decreases by their own respiration and zooplankton grazing.

SCOPE AND MODELING STRATEGY

It bears repeating that the model has been designed to focus on phytoplankton, nutrients (in particular, inorganic nitrogen), and oxygen. It is not intended to be a comprehensive ecological model. The formulations presented were chosen because they were felt to be of first order importance in determining standing stocks of the state variables of the model. Zooplankton are featured only as phytoplankton grazers. The benthos is included only to the extent that it influences the overlying water by consuming oxygen and releasing ammonium. And although of obvious ecological interest, fish have not been included in this model.

The scope of the model is also limited in that it was not designed to track realistic patterns of change in the state variables through time. Rather, the model is designed to depict for various situations the relative spatial patterns that result from the ecological assumptions in the formulations. This is an important contrast. In the real system, continually changing conditions lead to systematic and transient changes in the state of the harbor. In the model, a set of conditions is assumed, and the state of the harbor that is consistent with these conditions is allowed to develop. This approach facilitates the comparison of numerous conditions, such as coefficient choices, seasons, effluent scenarios, and harbor configurations. For each pair or set of runs only resultant snapshots are compared rather than, for example, attempting to contrast detailed spatial patterns for entire annual cycles.

For such a rationale to be effective, the model must converge toward some approximately steady state. In this case, it was not strictly possible, since diel variability was included in light, wind, and effluent volume plus a semidiurnal tide that precesses through time-of-day. Nevertheless, the standard run, discussed in detail below, converged nicely, supporting the premise that the simulations portray a situation closely controlled by the forcing functions and the values of the ecological coefficients.

Output of the model will be presented usually in two formats: contour maps of absolute concentrations and comparison maps of the ratio of concentrations in each grid. The latter format highlights the differences between runs and is especially useful in delineating features such as the spatial extent of influence of sewage effluent (Figure 5a-c). A third form of output of the model will not be presented here, but deserves mention. At regular intervals, summaries in tabular form are produced detailing the magnitude and direction of the important fluxes for representative grids. These data allow careful inspection to evaluate the mechanistic causes leading to the spatial distributions portrayed in the maps.

The computer program is written in FORTRAN IV and was run on a Digital Equipment Corporation minicomputer, model 1103, with 32K bytes of core. A complete listing of the code is available from the authors.

RESULTS AND DISCUSSION

A. Physical Simulation

As in the real harbor, the physical processes of advection and diffusion are fundamental to the distribution of plankton and nutrients in the model. To display the circulation patterns depicted by the physical mixing model, a series of tracer studies was done. At two specified starting times (low and high water), point releases of dye were simulated by defining an arbitrary concentration in a specified target grid, and tracking the dispersal of the concentration for one full tidal cycle, 12.5 hours. The locations of the maximum concentration (usually the center of mass) throughout the cycle for the two tidal series and 24 dye releases reveal the gross circulation regime in the model (Figure 6a and b).

A number of features are prominent. First, the presence of a well defined clockwise gyre in the central basin of Los Angeles Harbor is indicated. According to the model, the gyre completes a full rotation in somewhat longer time than two tidal cycles, or 25-30 hours. The presence of such a gyre in the real harbor has been identified (Soule and Oguri, 1972; Robinson and Porath, 1974). The parent model (Chiang, in prep.), and another numerical simulation (Raney, 1976), as well as the Vicksburg hydraulic model (McAnally, 1973) support its existence.

The present model also suggests a weak counter-clockwise gyre in the western end of the outer harbor. Flow through the entrance to Los Angeles Harbor is the most rapid in the harbor and presumably drives the gyres. Exchange is severely limited down in the main channel, northwest of Terminal Island. While this is certainly true for such a restricted channel, the feature is exaggerated in this model, as a dead end is assumed.

Little exchange occurs between Los Angeles-Long Beach Harbors and east of Pier J, probably due to the strong flow in the Long Beach entrance that precludes direct transport across the entrance. Flow through the entrance to Middle Harbor (the Long Beach back channel) is significant but restricted to near the mouth, with apparently little advective transport into the naval facility (West Basin) or to the eastern basin. As this is approaching the resolution of the grid spacing, detailed interpretations are probably not justified.

In some cases the movement of the point of maximum concentration does not necessarily reflect net water movement. For example, dye released in the center of San Pedro Bay moved toward the entrance to Middle Harbor. Much of the tracer became dispersed in the gyre bending clockwise, southward toward the breakwater, resulting in lower concentrations than remained behind at the Middle Harbor mouth. In cases such as this, the dye tracer does not accurately represent either net water movement or the path a drogue might follow.

Despite the intuitively reasonable patterns depicted by these dye runs, little direct confirmation can be offered. The sole drogue study in the harbor (Soule and Oguri, 1972) disagrees with many of these patterns. Subjective agreement with graphical results of the Vicksburg Model is encouraging, but can not be taken as quantitative verification.

Overall, it seems likely that the magnitudes of velocities and types of circulation features are plausible if not representative. Further, results of the ecological simulations indicate patterns of broad enough scale, that detailed circulation structure is not a dominant feature. As the primary goal of this model was to evaluate relative effects of a variety of conditions, the physical mixing scheme seems to be adequate.

B. The Standard Run

The conditions of the standard simulation run are intended to represent average conditions in the Harbor and are used as a basis for comparison with all the other runs. The choices of values for input have already been thoroughly discussed in the formulations section and are summarized in Table 3.

Starting from arbitrary and uniform conditions for nutrients and phytoplankton standing crop, it required simulation of 2-3 weeks to approximate a steady state. The long simulation using average conditions (Figure 7) not only demonstrated that the model was stable over time, but also provided values used as initial conditions (8 weeks) for comparison runs. All comparison simulations were run for an arbitrary two weeks and results were compared with a continuation of the standard run for another two weeks. It should be noted that in the discussion of these results, not every variable will be explicitly mentioned unless of particular interest or exhibiting a change of greater than 10% from the standard run results.

The present model was not designed to try to mimic the harbor exactly. For example, the formulations of phytoplankton growth were purposely designed to overestimate growth and therefore biomass, because approximations of maxima that could be supported were desired. It is important to emphasize that the most meaningful comparisons are the ones made between various model runs, not *versus* ground truth measurements for the harbor waters themselves. In presenting the results of the standard run, however, some discussion of field results has been included (as obtained by HEP) to give an idea of how the model does compare to actual observations.

1. Phytoplankton. In this model phytoplankton biomass is expressed in terms of the nitrogen content (Figure 8). If multiplied by 2 these results would be approximately equivalent to

$$\text{mg Chl } a \text{ m}^{-3} \left(e.g.,\ 8\text{-}15\ \frac{\text{mg Chl } a}{\text{m}^3}\right)$$

These values are about a factor of 2-4 higher than typical averages for the Harbor 1976-1978 (Soule and Oguri, 1979). When compared to the upper range of values observed during the same time, however, the model only slightly overpredicts. This is encouraging in view of the goal of modeling a reasonable upper limit for phytoplankton.

The spatial pattern predicted by the model is consistent with field observations (Allan Hancock Foundation, 1976; and unpublished data). Water offshore contains less phytoplankton, with an increasing biomass as one moves in towards the effluent source in Los Angeles Harbor. The model predicts generally lower phytoplankton biomass for Long Beach Harbor than for Los Angeles Harbor. This pattern is not supported by the field data. This inconsistency is probably due to omission of important nutrient sources to the Long Beach region (*e.g.*, the Los Angeles River runoff).

2. Nitrate and Ammonium. Because of the high nitrate composition of the secondary effluent, the distributional pattern of this ion is strongly influenced by the discharge (Figure 9). For ammonium, by contrast, the distributional pattern shows increased levels in shallow water, since benthic regeneration is the major source (Figure 10). In general, the model underestimates the nutrient levels in the Harbor. Although on many occasions the majority of observed values for NH_4 and NO_3 in Los Angeles Harbor are less than 1.5 µg-at/l, they seldom drop to less than 0.1. Field data do not show the summer ammonium increase predicted by the model (Figure 13b). And in the field the winter nutrient maximum is much more pronounced than in the model (Figure 13a), presumably because of runoff. Very probably, not all nutrient sources are included in the model. In reality the harbor system is less nutrient-limited than the results of the model would lead one to believe. This discrepancy is at least partly due to the fact that runs are compared after achieving a nearly steady state, while in the real system conditions may change often enough that nutrient limitation may rarely set in. For much of the Los Angeles Harbor the concentration of nitrate plus ammonium can be less than 2.0 µg -at/l and often is less than 3.0. At these levels the nutrient limitation term of the model would equal 0.5-0.7 and would probably never be more important than light limitation.

3. Oxygen. For the standard run oxygen ranged from 6.0 to 6.9 mg/l (Figure 11). Because output from the model represents dawn conditions, these values represent daily minima. These values are generally lower than the observed oxygen levels of 7-8 ppm (HEP unpublished data) but field data are obtained later in the day when primary production has been contributing oxygen to the system. Further, while the role of diffusion has been formulated according to current theory, it should be mentioned that it is not a well understood process. Diffusive flux is quite sensitive to wind speed, and the model could be made to predict higher oxygen levels by this small change. The slightly low oxygen predictions should not, therefore, be construed as a serious weakness. Rather, the emphasis should once again be placed on comparative rather than absolute analyses. In most runs oxygen levels did not differ markedly from the patterns of the standard run, suggesting that diffusion is an effective restoring flux.

C. Seasonal Range

In addition to the average conditions used in the standard run, winter and summer conditions were also simulated. Table 4 gives the input values used for these runs, which differed from the standard run.

1. Phytoplankton. As expected, the phytoplankton levels were decreased in the winter simulation (-25% to -55%) and increased in the summer (+25% to 55%) relative to the standard run (Figure 12 a and b *vs* Figure 8).

2. Ammonium. The ammonium concentration was increased both during the winter and summer relative to the standard (Figures 13 a and b). During the winter, ammonium increase resulted from depressed maximum growth rate for the phytoplankton. In the summer, the increase was the result of increased benthic regeneration with increased temperature. The apparently dramatic ammonium increase of Figure 13a is a bit misleading because the comparison plot presents the percentage change from the standard, where very low concentrations throughout the harbor were predicted, with a maximum of 0.16 μg-at/l. The winter ammonium maximum is still less than 1 μg-at/l according to the model.

3. Nitrate. The model also predicts a winter increase for nitrate, but in contrast to the ammonium case there is a summer nitrate decrease (Figures 14 a and b).

Nitrate is not linked to benthic regeneration, so its sources are relatively temperature-independent. Further, the model printout of results occurs at the simulated dawn. Thus one sees the daily nutrient maxima (likewise the oxygen minimum). It is at first surprising that ammonium increases while nitrate decreases in the simulation of summer conditions. During the day, ammonium is taken up until the supply is exhausted, then nitrate is taken up, too. During the night the combined effect of all ammonium sources causes a greater increase in this ion than occurs for nitrate. Thus the apparent anomaly is only a product of the timing of the output.

An additional note concerns the comparison of seasonal nitrate contours (Figure 14). In this set of runs changes in photoperiod changed the time of dawn, so at output the simulated tides were not precisely in phase. For most of the state variables this is not a problem, but because the largest input of effluent nitrate is a point source into a single grid, tidal effects become magnified and confuse the exact value in the immediate outfall area.

D. Elimination of Zooplankton

As we had anticipated, the elimination of zooplankton in our model had almost no effect on the results. There was a consistent, but small (less than 5%), increase in the phytoplankton standing crop throughout the model harbor when the grazing pressure was removed. While there are undoubtedly occasions when zooplankton in the harbor are able to respond effectively to algal blooms (G. Morey-Gaines, U.S.C., pers. comm.), the model agrees that the average levels in the harbor do not usually exert a dominant grazing impact.

E. Light Penetration

The extinction coefficient has a direct effect on the light limitation term which acts to control phytoplankton growth. In order to examine how sensitive the model results were to the ambient light level, the value for the extinction coefficient was varied over the observed range (Table 1). In general, the results suggest the model is not particularly sensitive to the detailed choice here.

1. Phytoplankton. Surprisingly, these changes had only minor effects on the phytoplankton. In the clear conditions, the phytoplankton biomass increased a maximum of 15%, all in the inner harbor, and for most of the grids there was virtually no change (less than 5%). For the turbid case, the predicted phytoplankton biomass was at least 85% of the standard run.

2. Ammonium. For the simulation of clearer waters the ammonium levels were virtually identical to the standard run. In the turbid case ammonium levels were unchanged for most of the harbor and offshore waters (±5%). Only in the inner harbor, where ammonium levels in the standard run are extremely low (less than 0.05 µg-at/l did increased turbidity increase the ammonium more than 10%.

3. Nitrate. In contrast to the case for ammonium, nitrate did demonstrate a significant increase during the turbid run (Figure 15). This pattern was not apparent for ammonium because the preferential uptake of ammonium by phytoplankton reduced the standard stock of this nutrient to nearly the levels of the standard run.

4. Overview. For both the standard run and the turbid conditions, there was a trade-off between light and nutrient limitation as the dominant brake on phytoplankton growth, depending on the location of a specific grid and the time of day. For the run simulating clear conditions, nutrient limitation was always the dominant factor, in all regions and times of day. It was interesting that the phytoplankton biomass did not increase more when the extinction coefficients were decreased. This indicates that during the standard run the system was close enough to being nutrient-limited that when the degree of light limitation was reduced there were not sufficient nutrients available to support a dramatic biomass increase.

F. Benthic Metabolic Rate

Ammonium regeneration by the benthos is a major nutrient source in the model. In order to test the sensitivity of the model to the exact choices of benthic metabolic rates, simulations were run using half and double the standard rates of ammonium release and oxygen uptake.

1. Phytoplankton. Doubling the benthic release led to a significant increase in the phytoplankton standing stock (Figure 16a *vs* Figure 8). This increase ranged from 15% to 45% over the standard run. When the benthic metabolism was cut in half, the phytoplankton standing crop decreased 5-25% from the standard (Figure 16b *vs* Figure 8). The differences relative to the standard run were greatest in the shallow regions. This is expected, as changes in fluxes determined on an area rather than a volume basis would obviously be most apparent in a shallow, depth-averaged water column.

2. Ammonium. The changes in the ammonium levels were even more dramatic than the effect on phytoplankton (Figures 17a and b). Increase ranged from 55 to 100% while decreases were from -45 to -75%.

3. Nitrate showed a less than 15% decrease as compared to the standard when the benthic rate was cut in half. When the benthic rate was doubled, minimum nitrate levels in the Los Angeles Harbor rose dramatically, but were still less than a concentration of 0.3 μg-at/l.

4. Oxygen. Although they do not represent dramatic percentage changes, the range in values of benthic oxygen consumption produced a substantial change in dissolved oxygen (Figures 18a and b *vs* standard run, Figure 11). Again, these changes are explicable in terms of the depth-averaged area effect.

5. Overview. The degree to which the harbor model phytoplankton crop is stimulated or depressed by changes in the benthic nutrient flux is a direct reflection of the degree to which phytoplankton growth is nutrient-limited in the standard run. The large changes in biomass relative to the runs which varied the extinction coefficient indicate that nutrient limitation is important, more important than anticipated *a priori*. While this is partly a consequence of the steady state simulation strategy, it suggests factors that may be important during bloom conditions.

G. Sewage Loading

In order to investigate the effect of varying the amount of secondary-treated sewage in the model, one simulation was run with double the volume and another eliminating the discharge entirely. The phytoplankton levels were increased up to 25% when sewage loading was increased (Figure 19a) while concentrations dropped a similar amount when the nutrient source was eliminated (Figure 19b). The contours on these comparison plots clearly show the region of the harbor being influenced by the effluent of the TITP. The ammonium pattern was similar and delineated a comparable extent of the affected area.

The comparison plots of the nitrate distribution are even more graphic in delineating the range of the sewage effect (Figure 10 a and b). Doubling the discharge approximately doubled the maximum (4.5 μg-at/l instead of 1.95 μg-at/l), while with no sewage discharge the values were depressed to less than 0.2 μg-at/l throughout the harbor. With the major source of nitrate removed, the drop was dramatic.

In other runs the sewage volume was left constant but the composition was altered. In one case a combination of primary plus cannery effluent was simulated, and for comparison another run examined secondary plus cannery discharge (Table 2). Neither of these changes affected the phytoplankton more than 15% relative to the standard run, showing that the model phytoplankton showed no stimulation under one form of available inorganic nitrogen or another despite their uptake preference for ammonium.

As expected, ammonium levels in the primary plus cannery effluent case were much higher (Figure 21a). Ammonium concentrations for secondary plus cannery, although increased over the standard run (Figure 10) were still quite low (Figure 21b). For both these runs the nitrate concentration was lower than in the standard run, since the cannery effluent is high in organic nitrogen and ammonium, but low in nitrate. The comparison plot of nitrate for the case of secondary plus cannery relative to the standard (Figure 22) delineates the area of influence of the cannery component of the discharge. In the outfall vicinity nitrate was 10 to 25% lower. This area encompasses roughly six grids and is substantially smaller then the sixty grid area shown to be affected by the total TITP discharge (Figure 20) due to the rapid oxidation rate.

Neither oxygen nor BOD concentrations showed large changes in either of the runs including cannery discharge. For oxygen the changes were within 10%, which would be equivalent to a few tenths of a part per million. For BOD the maximum observed increase was 0.6 ppm. The model grids were sufficiently large that BOD and oxygen problems were diluted immediately. This point reemphasizes the localized nature of the former oxygen problems when discharge was primary treatment from TITP and cannery waste. It is interesting to note that the entire spatial area modeled earlier (P. Kremer, 1978) would fit into two spatial grids of the present, more complex harbor model. In this model we are considering only effects which range more widely.

Pertaining to the question of enhancement, it is interesting to evaluate the effect of the presence *vs* absence of

TITP discharge with secondary treatment (Figure 23). In the Los Angeles Harbor the model projects a 30-40% biomass decrease of phytoplankton in the absence of the discharge. It should be noted that this may be an overestimate of actual conditions, since the model system is nutrient-limited while the actual harbor rarely reaches this state. Further, in the real world other nutrient sources might make up some of the difference, decreasing the amount of the phytoplankton decline in the absence of the effluent.

H. Harbor Configuration with Phase I Fill

Three model grids were eliminated to represent the planned Phase I fill of the Port of Los Angeles (Figure 2). With this modified configuration, an independent set of velocity coefficients were derived from the parent hydrodynamic model developed by Chiang (in prep.) for Los Angeles Harbor.

The resulting changes in the circulation were apparent in the results of the ecological model. Ammonium concentrations were markedly increased in the waters of Middle Harbor (Figure 24). The phytoplankton concentration in this same area, as well as in the waters of the Long Beach Harbor, showed about a 30% increase, while the remainder of the model harbor was relatively unaffected (Figure 24b). Nitrate demonstrated an increase in the outer harbor south of the Navy mole but did not show a buildup in Middle Harbor (Figure 24c). Since most of the model's nitrate is supplied by the TITP effluent, while much of the ammonium is regenerated by the benthos, the patterns predicted by the model for NH_4 and NO_3 indicate reduced tidal exchange between the Middle Harbor basin and adjacent waters. The decreased nitrate levels in the western portion of Los Angeles Harbor and the increase in Long Beach Harbor imply a decrease in the east-west exchange across the harbor. There is also some indication of reduced exchange of effluent-affected waters with offshore. It was somewhat surprising that filling in just these three grids should produce such marked differences.

I. Outfall Location

Using the physical circulation model appropriate to the Phase I fill configuration, several choices for the location of the TITP outfall were simulated. In these runs no ecology was included, and the discharge was treated as a continuous source of a passive tracer. The simulations were run for two weeks to produce new steady state results (Figures 25 a-f), and all results are presented at the same stage of the tide. Runs for effluent locations just south of the newly filled area (Figure 25a, b) produced very similar results. Most of the harbor had a sewage concentration of about 0.1% of the effluent itself. Little of the effluent reached into the

Long Beach Harbor area, and a limited tongue extended beyond the breakwater with a concentration greater than 0.05%. In the immediate vicinity and east of the outfall there was a concentration of greater than 0.2% in several grids. In both these cases the maximum concentration for a single grid is only slightly more than 0.2%.

When the discharge site in the model was east of the projected fill (Figure 25c), there was a slightly smaller area within the 0.1% contour and no water greater than 0.05% extended beyond the breakwater. In this case the area within the 0.2% contour was smaller, too, but the concentrations within this zone were substantially increased. In this case the maximum grid concentration was greater than 0.4%, more than double that for the previous two sites.

For one run the outfall was simulated one grid further away from the fill (Figure 25d). The 0.1% contour lines for these conditions were approximately the same as the previous cases, but the 0.2% area was substantially decreased. The zone within the 0.05% contour was increased markedly to include a large area of the offshore waters.

In two simulations the outfall was located outside the breakwater (Figure 25 e and f). In both these cases the maximum concentration was less than 0.15% and the area greater than 0.1% was only two and three grids respectively. When the discharge was west of the opening in the breakwater, virtually no water greater than 0.05% entered the harbor. In the case where the discharge was located east of the opening, a tongue of greater than 0.05% water entered the harbor and the offshore zone (greater than 0.05) extended substantially eastward.

SUMMARY AND CONCLUSIONS

1. The physical circulation pattern for the Los Angeles-Long Beach Harbor is a critical factor in determining broad-scale distribution of phytoplankton and nutrients. While the mixing model is adequate and reasonable for average conditions, detailed interpretation of ecological features is not justified due to the inherent limitations of numerical hydrodynamic models. Changes in circulation pattern due to change in physical configuration will alter the biology significantly.

2. Simulated levels of phytoplankton exceeded average field conditions but approximated maximum reported concentrations. This is consistent with the goal of modeling upper limits of standing crops, such as might develop under bloom conditions, and is a consequence of the steady state strategy employed in the model.

3. Relative spatial gradients in the Los Angeles Harbor were consistent with field observations and demonstrated the influence of both sewage effluent quality and water depth in determining patterns of phytoplankton and nutrients in the harbor. Distributions calculated east of Long Beach Harbor were less satisfactory, probably due to inadequate information on additional sources of nutrients, such as river input.

4. The ecological model indicated that both light and nutrients potentially play a role in limiting the maximum levels of phytoplankton that may occur in the harbor. Under most situations in the real harbor, light is probably dominant, since the continuous transient interactions of more subtle controlling influences keep the ecosystem from achieving the steady state condition simulated in the model.

If blooms should occur, the model indicated that nutrient control could become important. Different outfall configurations and effluent compositions would then play a significant role in the distributions of plankton and nutrients.

5. Benthic regeneration of ammonium is an important source of nitrogen to the system, if available estimates of the rate are indicative of the harbor. Thermal stratification was not included in the model; it might reduce the influence of the ammonium flux on phytoplankton, but the potential reservoir for stimulating high bloom levels is there.

6. While phytoplankton take up ammonium preferentially, nitrate is also readily utilized, so that the differences in total phytoplankton that result from primary *versus* secondary treatment were far less than for changes in total effluent volume. This does not preclude a change in species composition, as was discussed in Soule and Oguri (1979).

7. The model suggested clearcut differences in the area of the harbor influenced by different types of effluent. Compared to the no-sewage case, the area of treatment plant influence was well defined, and ammonium and nitrate patterns differed clearly in the primary and secondary cases. Compared to the nutrient patterns shown from secondary treatment, high BOD fish cannery waste would have a more restricted impact, since BOD oxidation is more rapid than plankton growth. Regenerated nutrients from cannery waste simulations reached levels comparable to the secondary treatment case short distances from the outfall.

8. Oxygen levels simulated in the model did not reach critically low levels in any case. While this is due in part to vertical averaging and the large size of the spatial grids, it does suggest that oxygen deficiencies should be limited to quite localized regions, if they develop at all.

9. The Phase I proposed modification of the Los Angeles Harbor produced changes in the physical circulation patterns in the model. These differences were large enough to affect the ecological simulations. The region most affected by the proposed fill was the Middle Harbor (Long Beach Back Channel).

10. Simulations of six different outfall locations -- three on the Phase I fill, one in the central Los Angeles Harbor, and two outside the breakwater -- caused differences in effluent dilution contours. For cases within the harbor, the differences were small, however, and concentrations in the harbor were usually between 0.1 and 0.2% of the effluent. Offshore cases reduced the levels to less than 0.05% in the harbor.

11. Simulations of phytoplankton crop tended to agree with conclusions based on field data (Soule and Oguri, 1979) that the food chain represented by total phytoplankton crop was not greatly affected by the change from primary to secondary treatment, and that predation of phytoplankton was small.

By James N. Kremer, Ph.D., Assistant Professor
of Biological Sciences, and

Patricia N. Kremer, Ph.D., Research Associate,
Harbors Environmental Projects

University of Southern California

LITERATURE CITED

Allan Hancock Foundation. 1976. Environmental investigations and analyses, Los Angeles-Long Beach Harbors, 1973-1976. Final report to the U.S. Army Corps of Engineers, Los Angeles District. Harbors Environmental Projects, Univ. So. Calif. 743 p.

Beers, J.R. 1966. Studies on the chemical composition of the major zooplankton groups in the Sargasso Sea off Bermuda. Limnol. Oceanogr. 11:520-528.

Butler, E.I., E.D.S. Corner, and S.M. Marshall. 1969. On the nutrition and metabolism of zooplankton. VI. Feeding efficiency of *Calanus* in terms of nitrogen and phosphorus. J. Mar. Biol. Assoc. U.K. 49:977-1001.

Carpenter, E.J. and R.R.L. Guillard. 1971. Intraspecific differences in nitrate half-saturation constants for three species of marine phytoplankton. Ecology 52:183-185.

Chiang, W.-L. Tide induced currents in harbors of arbitrary shape. Ph.D. dissertation. Univ. So. Calif.

Conover, R.J. 1959. Regional and seasonal variation in the respiration rate of marine copepods. Limnol. Oceanogr. 4:259-268.

Conover, R.J. and E.D.S. Corner. 1968. Respiration and nitrogen excretion by some marine zooplankton in relation to their life cycle. J. Mar. Biol. Assoc. U.K. 48:49-75.

Curl, H., Jr. 1962. Standing crops of carbon, nitrogen, and phosphorus and transfer between trophic levels in continental shelf waters south of New York. Rapp. Cons. Explor. Mer. 153:183-189.

DiToro, D.M., D.J. O'Conner and R.V. Thomann. 1971. A dynamic model of phytoplankton populations in the Sacramento-San Joaquin Delta. Advan. in Chem. Series. 106:131-180.

Eppley, R.W. 1972. Temperature and phytoplankton growth in the sea. Fish. Bull. 70:1063-1085.

Eppley, R.W. and J.D.H. Strickland. 1968. Kinetics of marine phytoplankton growth. Advan. Microbiol. of the Sea. 1:23-62.

Eppley, R.W. and W.H. Thomas. 1969. Comparison of half-saturation constants for growth and nitrate uptake of marine phytoplankton. J. Phycol. 5:375-379.

Eppley, R.W., A.F. Carlucci, O. Holm-Hansen, D. Kiefer, J.J. McCarthy, E. Venrich, P.M. Williams. 1971. Phytoplankton growth and composition in shipboard cultures supplied with nitrate, ammonium, or urea as a nitrogen source. Limnol. Oceanogr. 16:741-751.

Eppley, R.W., J.N. Rogers and J.J. McCarthy. 1969. Half-saturation constants for uptake of nitrate and ammonium by marine phytoplankton. Limnol. Oceanogr. 14:912-920.

Greze, V.N. and E.P. Baldina. 1964. Population dynamics and annual production of *Acartia clausi* Giesbr. and *Centropages Kroyeri* Giesbr. in the neritic zone of the Black Sea. (Fish. Res. Bd. Can. Trans. 893, 1967) Trudy Sevastopol'skoi Biologicheskoi stantsii, Akad. Nauk. Ukrain. SSR 17:249-261.

Heinle, D.R. 1966. Production of a calanoid copepod, *Acartia tonsa*, in the Pawtuxent River Estuary. Ches. Sci. 7:59-74.

Jaworski, N.A., D.W. Lear, and O. Villa, Jr. 1972. Nutrient management in the Potomac Estuary. Nutrients and Eutrophication. ASLO Special Symp. Vol. I. pp. 246-272.

Kiefer, D.A. and T. Enns. 1976. A steady-state model of light-, temperature-, and carbon-limited growth of phytoplankton. *In* Modeling Biochemical Processes in Aquatic Ecosystems. R.P. Canale, ed. pp. 319-336.

Kremer, J.N. and S.W. Nixon. 1978. A Coastal Marine Ecosystem: Simulation and Analysis. New York: Springer-Verlag. 217 p.

*Kremer, P. 1978. Dynamic oxygen model of Los Angeles Harbor receiving waters. *In* Marine Studies of San Pedro Bay, California. Part 14. Allan Hancock Foundation and Sea Grant Program, Univ. So. Calif. pp. 25-70.

MacIsaac, J.J. and R.C. Dugdale. 1969. The kinetics of nitrate and ammonia uptake by natural populations of marine phytoplankton. Deep-Sea Res. 16:45-57.

McAnally, W.H. Jr. 1975. Los Angeles and Long Beach Harbors model study. Report 5. Tidal verification and base circulation tests. Tech. Rept. H-75-4. U.S. Army Engineer Waterways Experimental Stations, Vicksburg, Miss.

Nixon, S.W., C.A. Oviatt, and S.S. Hale. 1976. Nitrogen regeneration and the metabolism of coastal marine bottom communities. *In* The Role of Terrestrial and Aquatic Organisms in Decomposition Processes. J. Anderson and A. MacFayden (eds.) London: Blackwell Sci. Pub.

Petipa, T.S. 1966. Relationship between growth, energy metabolism, and ration in *A. clausi*. Physiclogy of Marine Animals. Akad. Nauk. USSR, Oceanographical Commission. pp. 82-91.

*errata: page 29 to be omitted, and p. 48 inserted between pages 31 and 32.

Raney, D. C. 1976. Numerical analysis of tidal circulation for Long Beach Harbor; existing conditions and alternative plans for Pier J completion and tanker terminal study with 82 ft. channel. Misc. paper H-76-4. Report 3, Sept. 1976. U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.

Riley, G. A. 1956. Oceanography of Long Island Sound 1952-54. II Physical Oceanography. Bull. Bing. Ocean. Coll. 15:15-46.

Robinson, K. and H. Porath. 1974. Current measurements in the outer Los Angeles Harbor. *In* Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri, eds. Part 6. Allan Hancock Foundation and Sea Grant Program. Univ. So. Calif., Los Angeles. p. 1-91.

Roche, P.J. 1976. Computational Fluid Dynamics. Albuquerque: Hermosa Pub. 446 p.

Ryther, J.H. 1956. Photosynthesis in the ocean as a function of light intensity. Limnol. Oceanogr. 1:61-70.

Ryther, J.H. and W.M. Dunstan. 1971. Nitrogen, phosphorus, and eutrophication in the coastal marine environment. Sci. 171:1008-1013.

Ryther, J.H. and R.R.L. Guillard. 1962. Studies of marine planktonic diatoms III. Some effects of temperature on respiration of five species. Can. J. Microbiol. 8:447-453.

Ryther, J.H. and D.W. Menzel. 1959. Light adaptation by marine phytoplankton. Limnol. Oceanogr. 4:492-497.

Soule, D.F. and M. Oguri. 1972. Circulation patterns in Los Angeles-Long Beach Harbor drogue study atlas and data report. *In* Marine Studies of San Pedro Bay, California. Part 1. Allan Hancock Foundation and Sea Grant Programs, Univ. So. Calif.

Soule, D.F. and M. Oguri. 1974. Data report: temperature, salinity, oxygen and pH in outer Los Angeles Harbor. June 1971 to November 1973. *In* Marine Studies of San Pedro Bay, California. Part 5. Allan Hancock Foundation and Sea Grant Programs, Univ. So. Calif. 1-76.

Soule, D.F. and M. Oguri. 1979. Ecological changes in outer Los Angeles-Long Beach Harbors following initiation of secondary waste treatment and cessation of fish cannery waste effluent. *In* Marine Studies of San Pedro Bay, California. Part 16. Allan Hancock Foundation and Sea Grant Programs, Univ. So. Calif.

Steele, J.H. 1962. Environmental control of photosynthesis in the sea. Limnol. Oceanogr. 7:137-150.

Thomas, W.H. and A.N. Dodson. 1968. Effects of Phosphate concentration on cell division and yield of a tropical oceanic diatom. Biol. Bull. 134:199-208.

Table 1. Baseline Extinction Coefficients (K_o) for three regions, and three conditions of non-chlorophyll suspended matter. The region outside the breakwater was consistently clearer, while the upper harbor (north of the southern end of Terminal Island) was generally less clear than the waters of the outer harbor.

	Outside Breakwater	Outer Harbor	Upper Harbor
Clear	0.1	0.3	0.6
Average	0.2	0.5	1.0
Turbid	0.3	0.8	1.4

Table 2. Simulations of effluent from a variety of sources use these values for discharge rate, concentrations of BOD and nutrients in the effleunt. In the model the average flux is altered to reflect the known diel periodicity in the discharge rate.

Type of Effluent	Discharge Rate	BOD	Nutrients (µg-at/l)		Average Loading		
	MGD	mg/l	NH_4	NO_3	BOD (g/min)	NH_4 mg-at/min)	NO_3 mg-at/min)
TITP Secondary	12.7 (av. 1978)	17	34	1400	5.6×10^2	1.2×10^3	4.5×10^4
TITP Primary	9.3 (av. 1976)	177	1600	13	4.4×10^3	3.9×10^4	3.2×10^2
Cannery	3.4	1000	500	0	9.0×10^3	4.5×10^3	6.37×10^2

Table 3. Input Values for the Standard Run

Parameter			Value
Photoperiod			12 hours
Temperature			16 ^{o}C
Average wind speed			4 m/sec
Daily wind amplitude			2 m/sec
Baseline extinction coefficient:			
	outside breakwater		0.2 m^{-1}
	outer harbor		0.5 m^{-1}
	upper harbor		1.0 m^{-1}
Sewage effluent:			
	Ammonium:	morning	1.43×10^{3} mg-at/min
		midday	1.76×10^{3} mg-at/min
		afternoon	1.43×10^{3} mg-at/min
		night	0.66×10^{3} mg-at/min
	Nitrate:	morning	5.85×10^{4} mg-at/min
		midday	7.20×10^{4} mg-at/min
		afternoon	5.85×10^{4} mg-at/min
		night	2.70×10^{4} mg-at/min
	BOD:	morning	7.3×10^{2} g/min
		midday	9.0×10^{2} g/min
		afternoon	7.3×10^{2} g/min
		night	3.5×10^{2} g/min
Zooplankton ingestion rate at 0C			0.05 day^{-1}
Nitrogen content/indiv. zooplankter			0.04 µg-at/animal
Zooplankton biomass			10 #/liter
Benthic oxygen consumption			2.4 g $O_2/m^2 \cdot day$
BOD oxidation rate			0.48 day^{-1}
Benthic ammonium release			0.2 mg-at/$m^2 \cdot$day
Coefficient relating BOD oxidation to ammonium release			3.15 µg-at/mg

Table 3 (continued)

Parameter	Value
Phytoplankton respiration	0.08 day^{-1}
Phytoplankton maximum growth rate	1.7 day^{-1}
Half-saturation constant for nitrogen uptake	2.0 µg-at/l
Nitrogen to chlorophyll ratio for phytoplankton	2.0 µg Chl *a*/µg-at N
Ratio incident radiation to optimum light: morning	1.5
midday	3.0
afternoon	1.5

Table 4. Seasonal runs required changes in several values of input parameters from standard run (Table 3).

Parameter	Winter	Summer
Photoperiod	9 hr	15 hr
Temperature	12 °C	20 °C
Phytoplankton maximum growth rate	1.34 day^{-1}	2.17 day^{-1}
Ratio of incident radiation to optimum light:		
morning	0.5	1.5
midday	1.0	3.0
afternoon	0.5	1.5

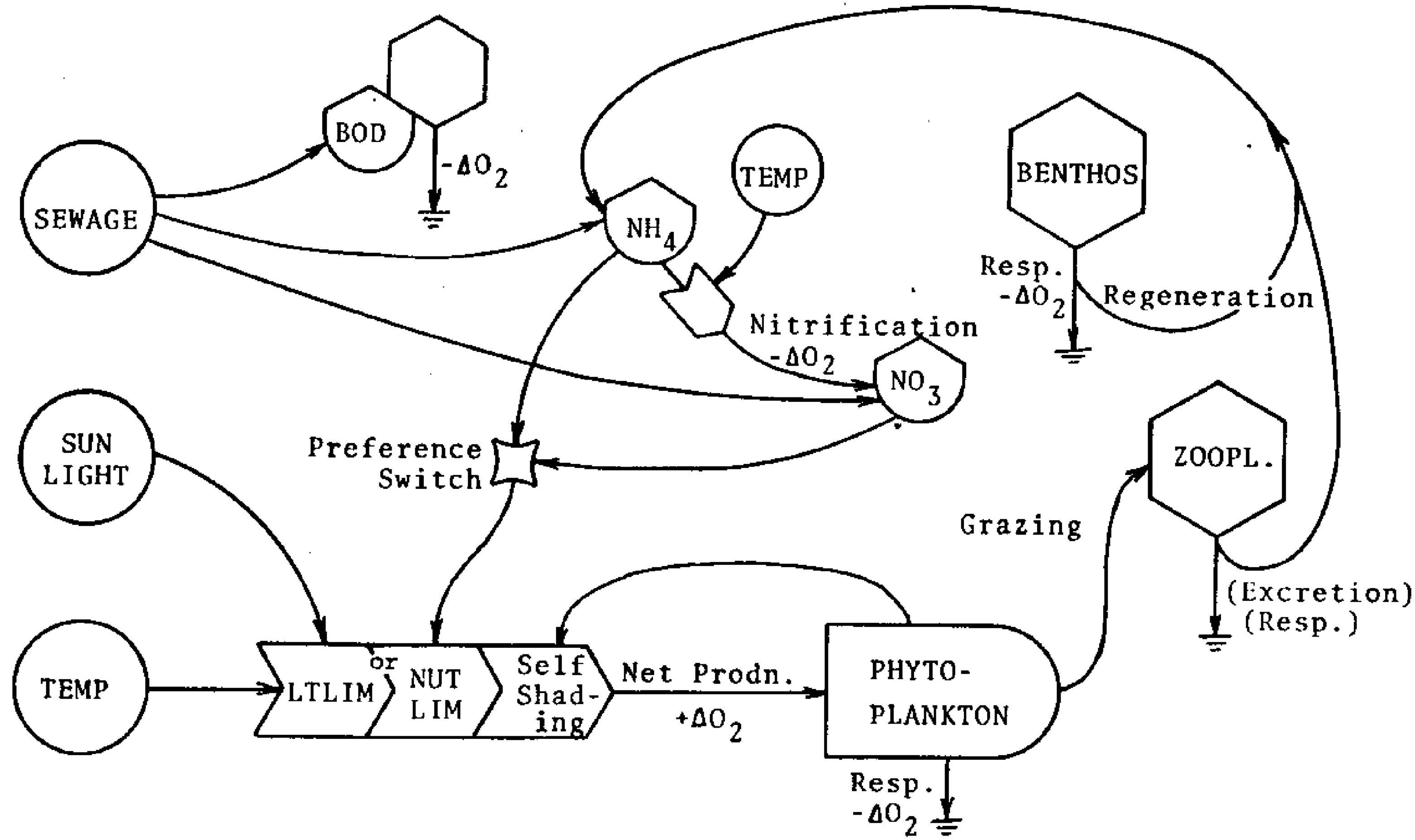
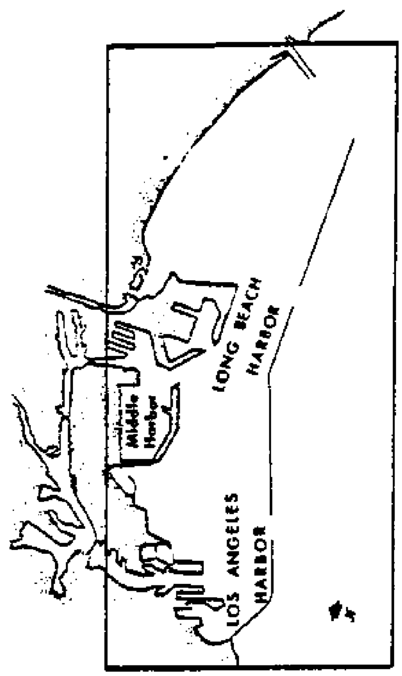


Figure 1. Diagrammatic representation including all the state variables, forcing functions, and processes included in the model. Arrows indicate direction of flow of energy and materials; inanimate storages are represented by , while pure energy sources are circles. Phytoplankton is designated by and heterotrophic consumers .



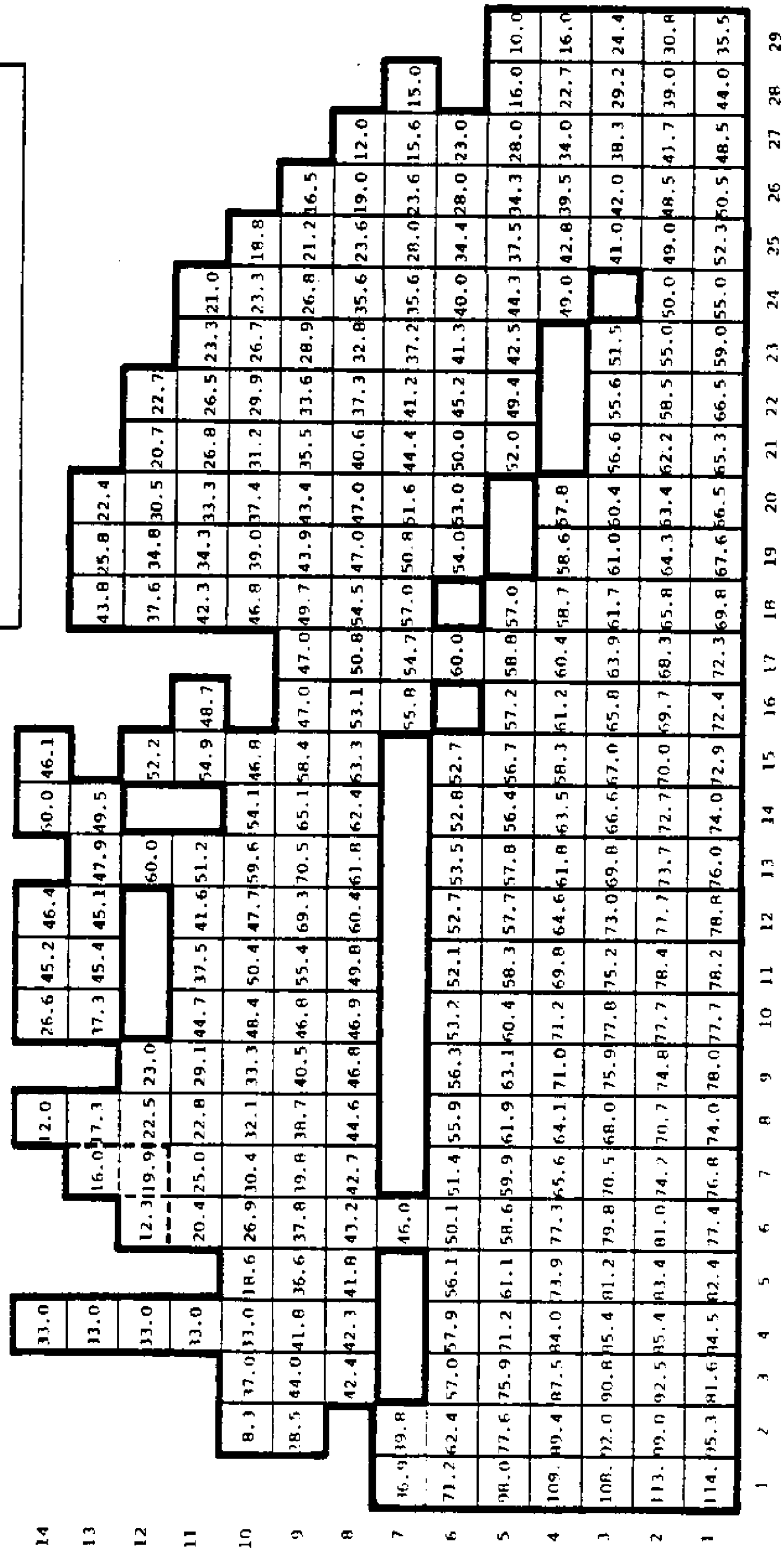


Figure 2. Map depicting the 300 spatial grids used in the model to represent the Los Angeles-Long Beach Harbors and adjacent offshore waters. Each grid square is 650 m on a side and the average depth in feet at mean lower low water (USGS Chart #5148) is designated for each. Dashed grids indicate the location of the Phase I fill.

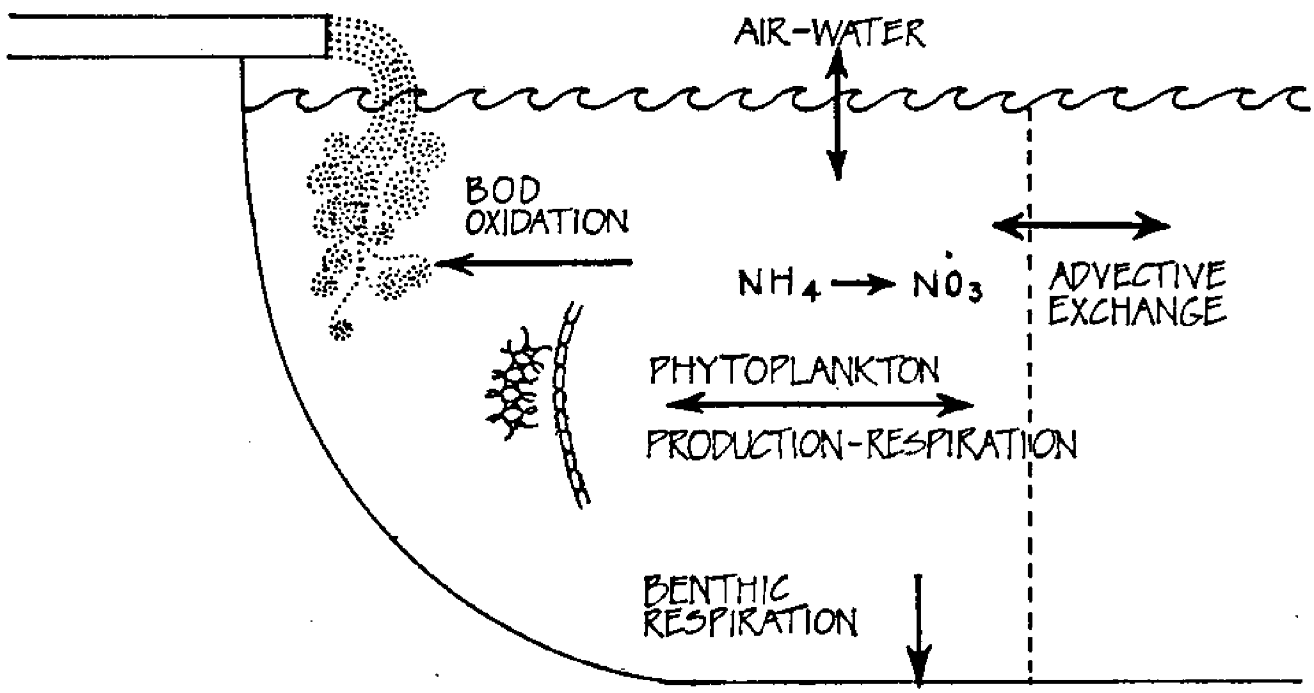


Figure 3. Diagrammatic representation of the oxygen fluxes included in the model. It is essentially the same as that presented earlier (P. Kremer, 1978), with the addition of nitrification.

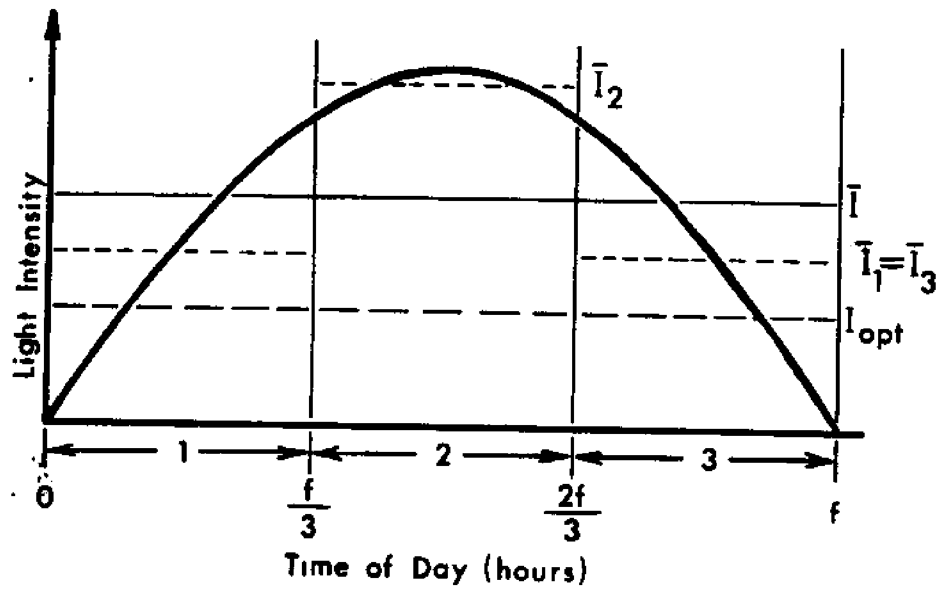


Figure 4. Relationships between daily pattern of incident radiation and coefficients used in the phytoplankton formulation. Light intensity is assumed to vary throughout the day according to a sine curve. Daylight hours are divided into three time blocks, and the ratio between the average light intensity for each block ($\bar{I}_j$) and the photosynthetic optimum (I_{opt}) is used to calculate the light limitation term (see text).

```
       ---------------------------------------------------------- a
NO3    336.50 HOURS.    MIN= 0.1402E+00 MAX(MM)= 0.1806E+00 INCR= 0.4048E-02

       ----------------------------------------------------------
14     !       44        88  222222  1111                          !
13     !       44      7777  2222222211        666677              !
12     !       55  88777777       22  22       6677778899          !
11     !       66  7777777766665544  2222  7777889999AAAA          !
10     !   7766667766666666555555444444    7777889997AAAAAA        !
 9     !   77777766666666665544444455557777777788999999AAAA        !
 8     !     7777665566665555444444556677667777889799999AAAAMM     !
 7     !3333        44                   666677778888839999 9AAAAAA  !
 6     !22333333344555555555555555555555  66  7777888888899999     !
 5     !223333333445555554444555555555566666      7788888889999AAAA!
 4     !2233333333445555444444444445555556666666666      8888999999AA!
 3     !22333344444554444444444444444555555666666666667777  889999AAAA!
 2     !22333333444444444444444444455555566666666666777777800899 99AA!
 1     !223333444444444444444444444445555556666666677778888389 99999!
       ----------------------------------------------------------
       ---------------------------------------------------------- b
NO3    336.50 HOURS.    MIN= 0.1165E-01 MAX(MM)= 0.1945E+01 INCR= 0.1933E+00

       ----------------------------------------------------------
14     !       11      .77  111111  1111                           !
13     !       11     AA99  1111111111        111111               !
12     !       11  AAMMAAAA       22  11      1111111111           !
11     !       11  11446688443333 22  1111  11111111111111         !
10     !   111122223344556633222222211    1111111111111111         !
 9     !   1111112222333333222211111111111111111111111111111       !
 8     !     11111111223333221111111111111111111111111111111111    !
 7     !1111        11                  111111111111111111111111111  !
 6     !1111111111111111111111111111111  11  1111111111111111111   !
 5     !1111111111111111111111111111111111111     111111111111111111!
 4     !111111111111111111111111111111111111111111       1111111111111!
 3     !11111111111111111111111111111111111111111111111  1111111111!
 2     !11111111111111111111111111111111111111111111111111111111111!
 1     !11111111111111111111111111111111111111111111111111111111111!
       ----------------------------------------------------------
        - - - - - - - - - - - - - - - - - - - - - - - - - - - - - C
NO3   FROM FILE  80  OVER NO3  FROM FILE  72
        - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
14     !       A1          1  101010  1010                          !
13     !       A1        1 1  101010 810         101010             !
12     !       10    1 1 1 1         6  10      1010101010          !
11     !        9   >> 3 2 1 2 3 4 5  1010  10101010101010          !
10     !   10 9 8 5 4 2 2 2 4 4 5 6 7 9     1010101010101010        !
 9     !   1010 9 8 6 3 3 3 7 7 8 8 910101010101010101010101010     !
 8     !     1010 9 8 4 4 4 7 8 9 91010101010101010101010101010     !
 7     !1010        A1                  1010101010101010101010101010  !
 6     !10101010101010101010101010101010  10  1010101010101010101   !
 5     !1010101010101010101010101010101010101010     101010101010101010!
 4     !A110101010101010101010101010101010101010       1010101010101!
 3     !A1101010101010A1A1A1101010101010101010101010  1010101010!
 2     !A1A1101010101010A1A1A1A1101010101010101010101010101010101010!
 1     !A1A1101010101010A1A1A1A1101010101010101010101010101010101010!
        - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Figure 5. Sample output from the model. Each spatial grid (see Fig. 2) is represented by two printed digits. Concentrations for the parameter of interest were scaled in ten even increments from the minimum to the maximum, and corresponding digits (1 to A) printed out. The location of the maximum is indicated by the code MM. In this specific case, (a) represents the nitrate concentration in the absence of any effluent, (b) is the standard run with present TITP secondary discharge. (c) shows another form of the output, where the ratio of one set of concentrations to another (in this case a/b) is represented.

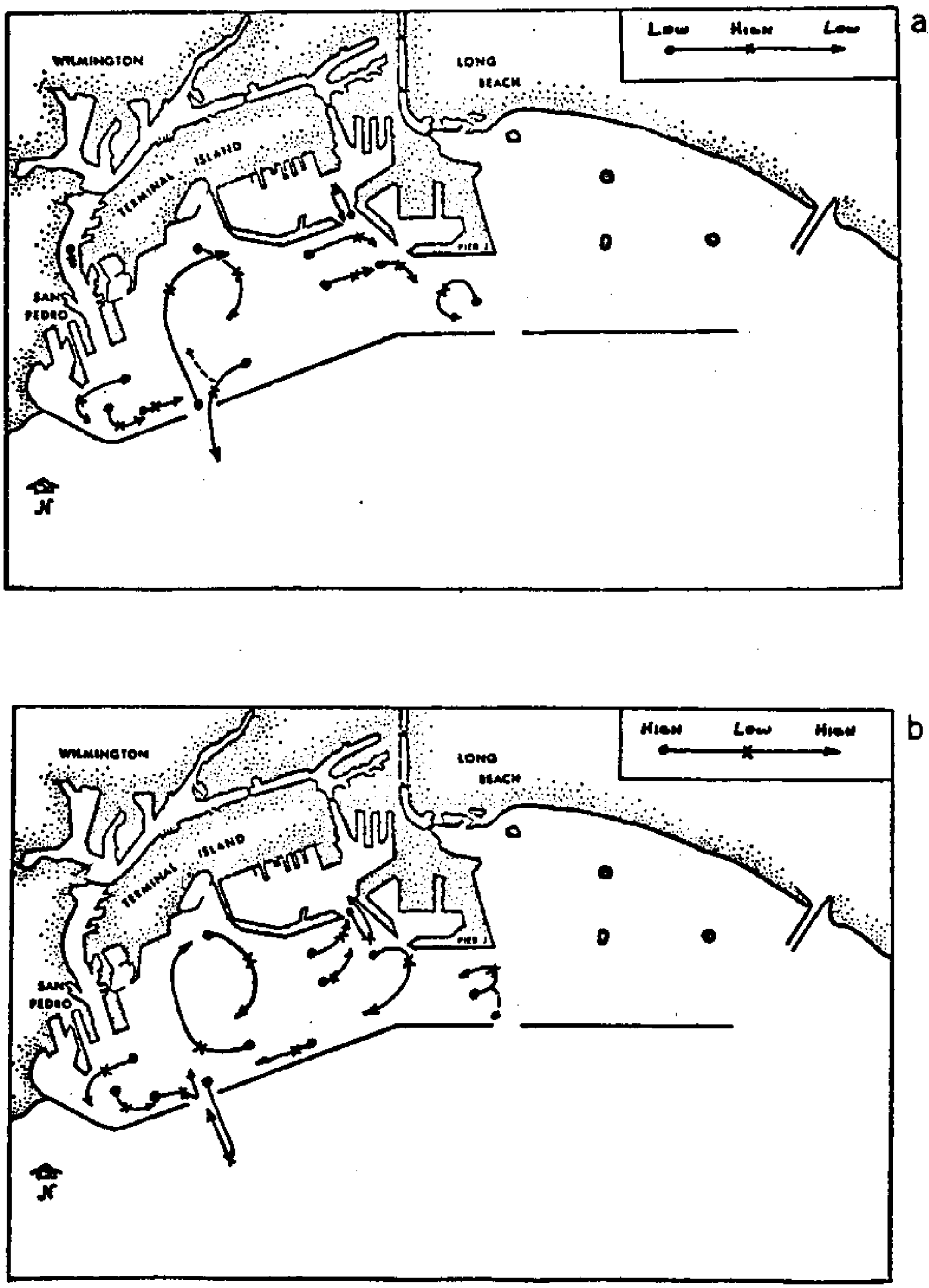


Figure 6. Simulated dye studies showing the general flow pattern in the model Los Angeles Harbor. Simulations beginning at low tide (a) and high tide (b) both demonstrated a clockwise gyre in the outer harbor.

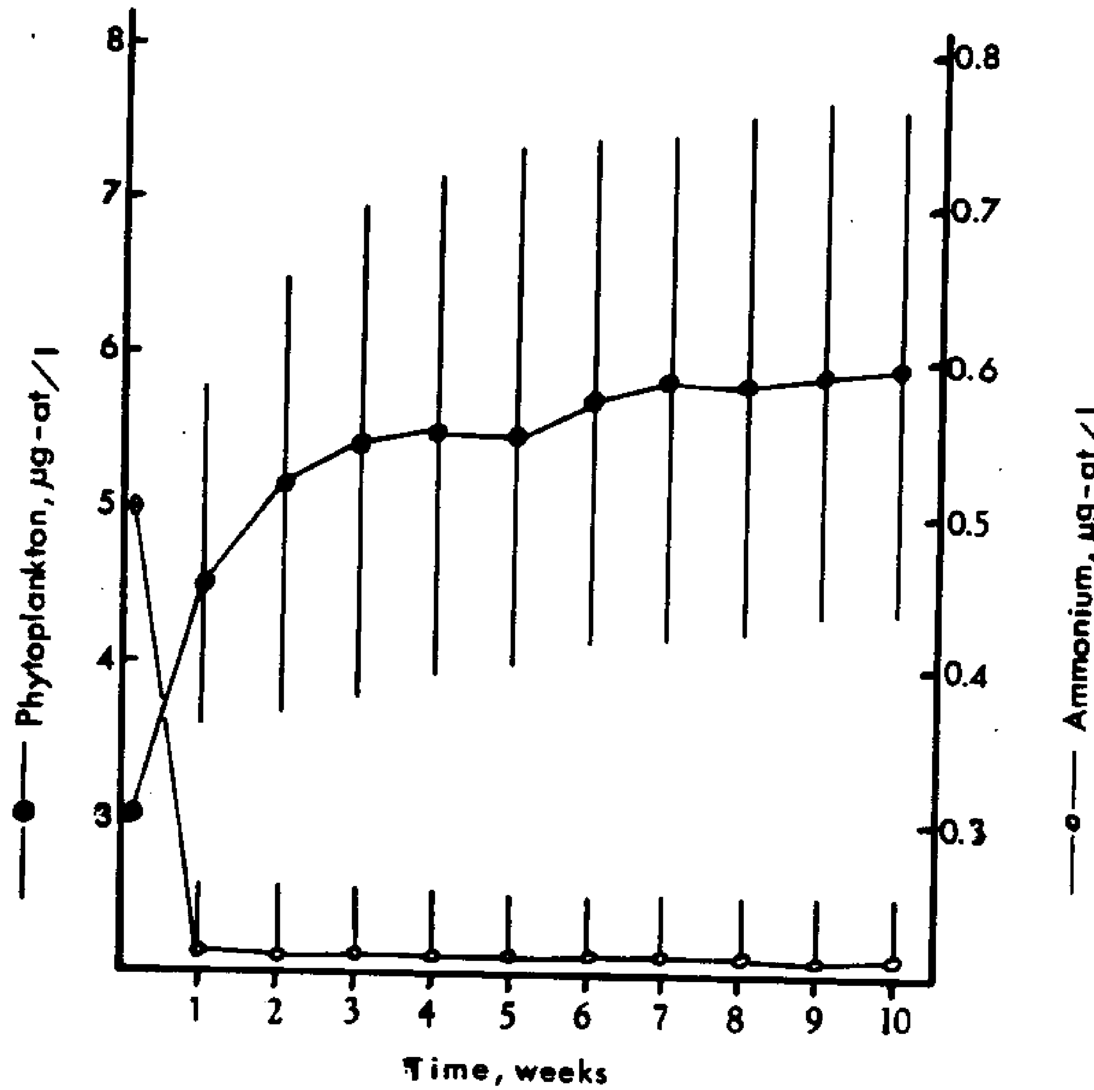


Figure 7. Both phytoplankton and ammonium reached values close to steady state in the first few weeks of simulation in the standard run. The line connects values simulated in a single station of the outer harbor. Vertical bars represent ranges for entire model region.

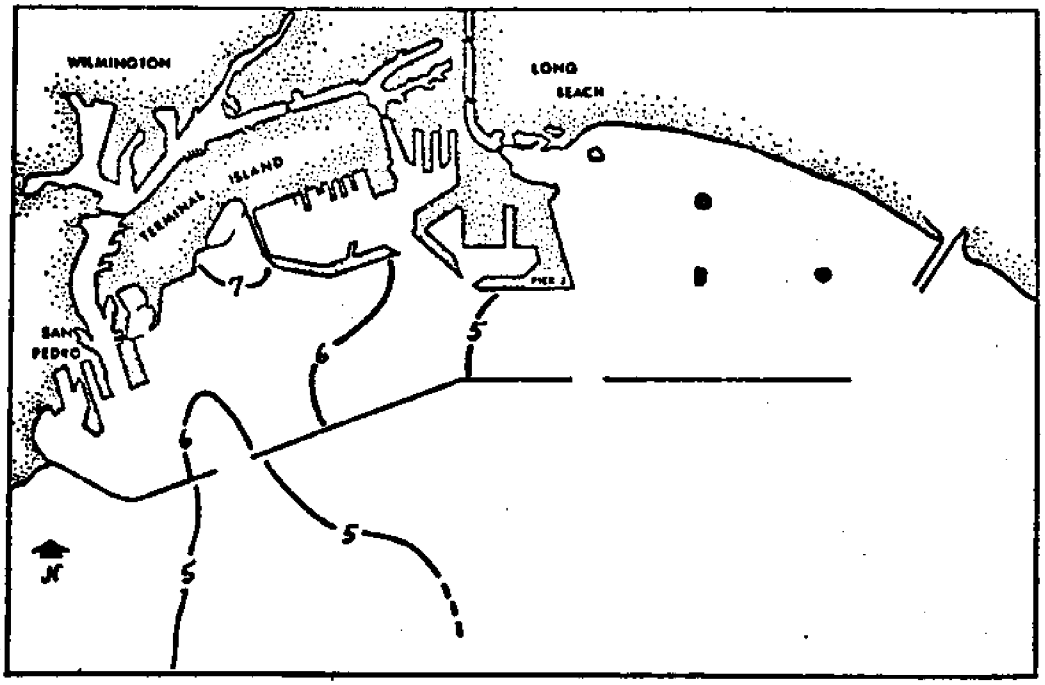


Figure 8. In the standard run after a ten week simulation, the phytoplankton standing stock (μg-at N/l) showed an increase in the vicinity of Terminal Island west of the Navy Mole.

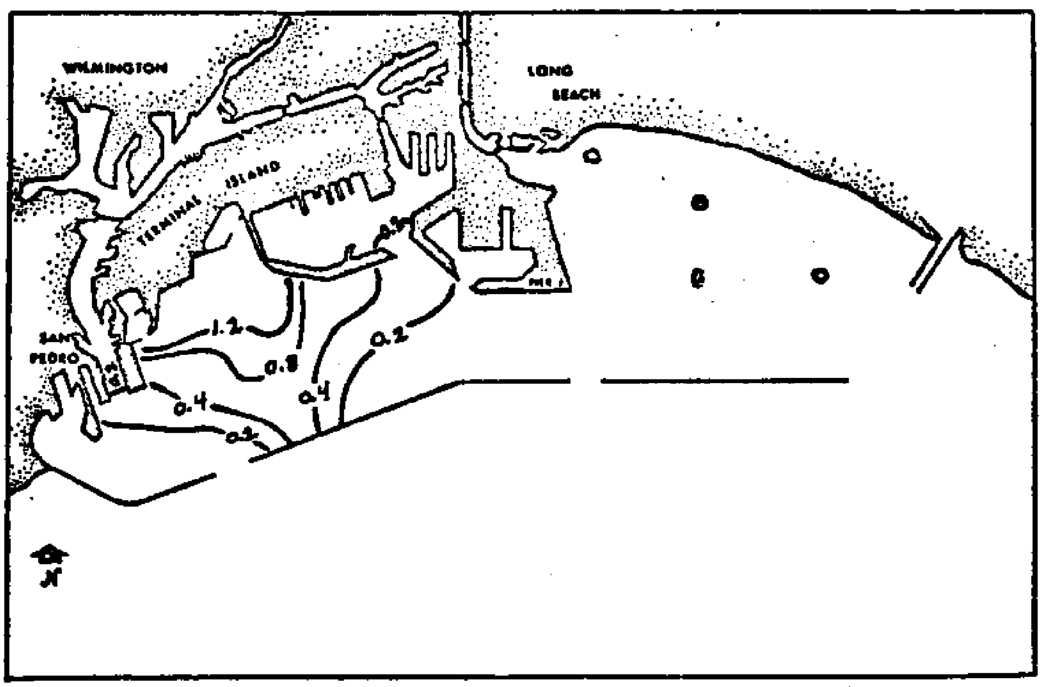


Figure 9. Nitrate contours (μg-at/l) in the standard run reflect the large nitrate supply from the Terminal Island Treatment Plant.

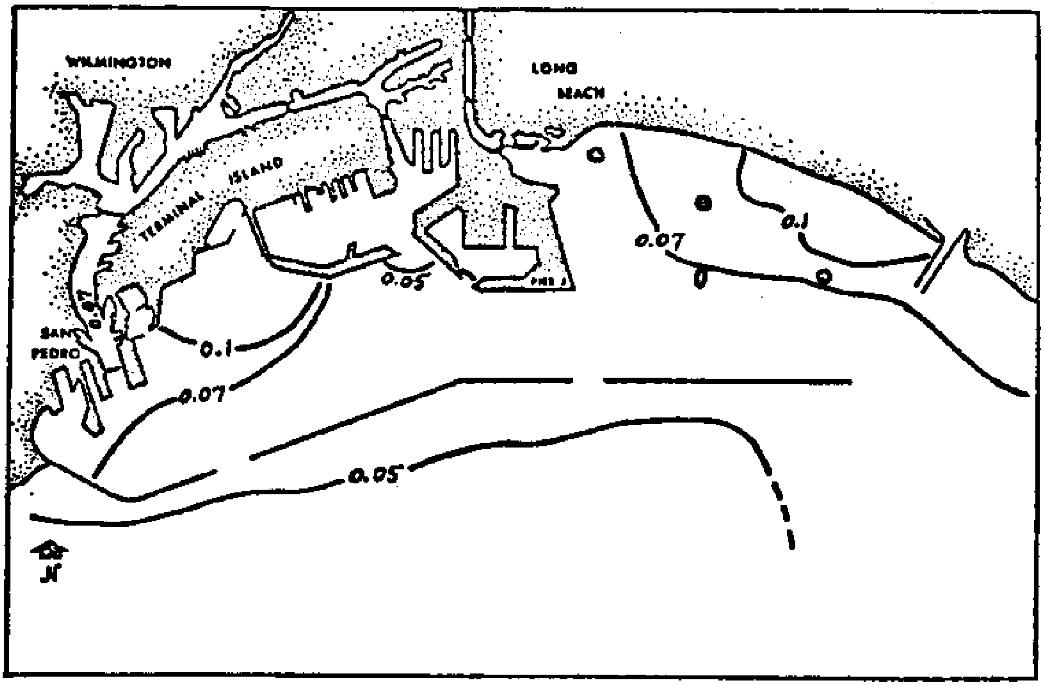


Figure 10. The low ammonium concentration (μg-at/l) of the standard run reflects the importance of nutrient limitation in the model. Slight increases in concentration result both from benthic releases in shallow waters and TITP discharge.

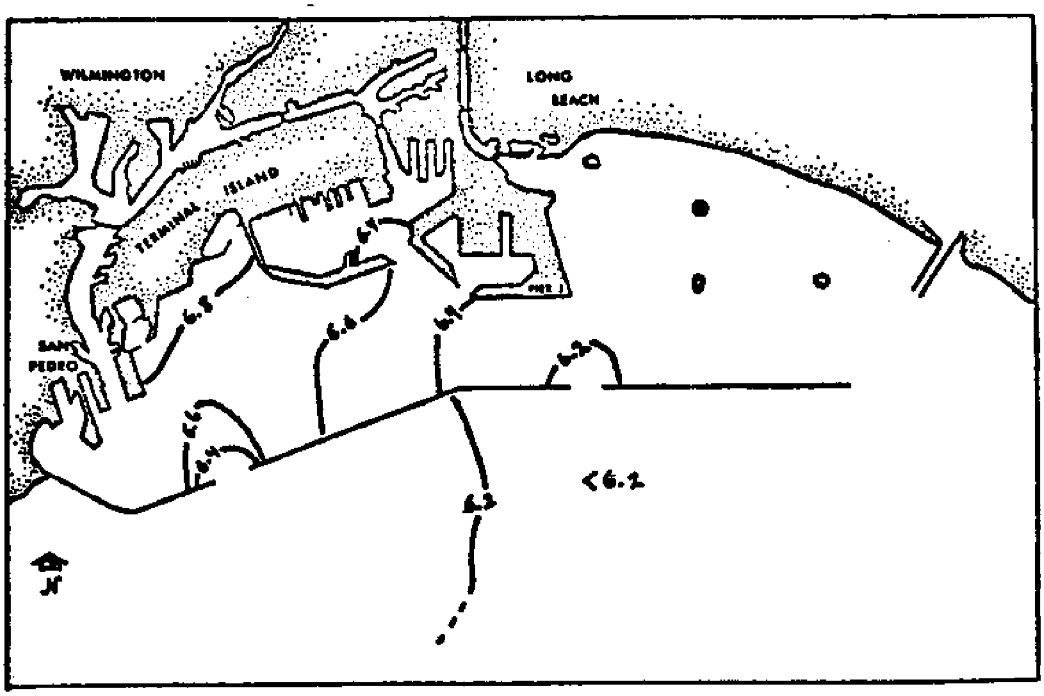
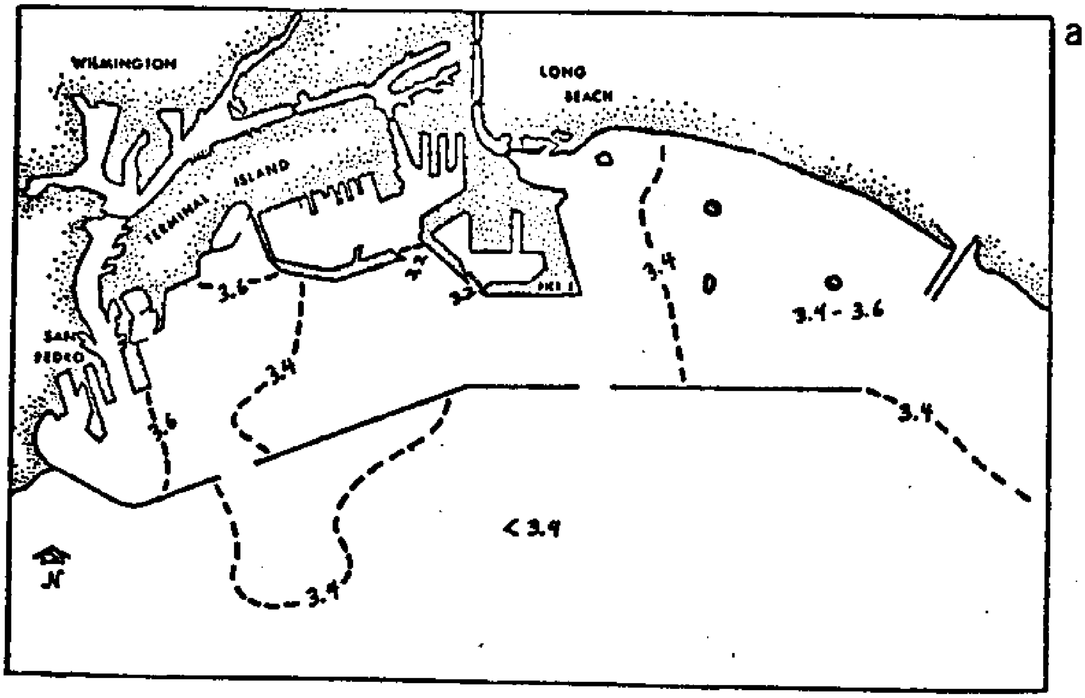


Figure 11. Oxygen levels (mg/l) of the standard run are relatively uniform, and roughly parallel the phytoplankton pattern (Figure 8).



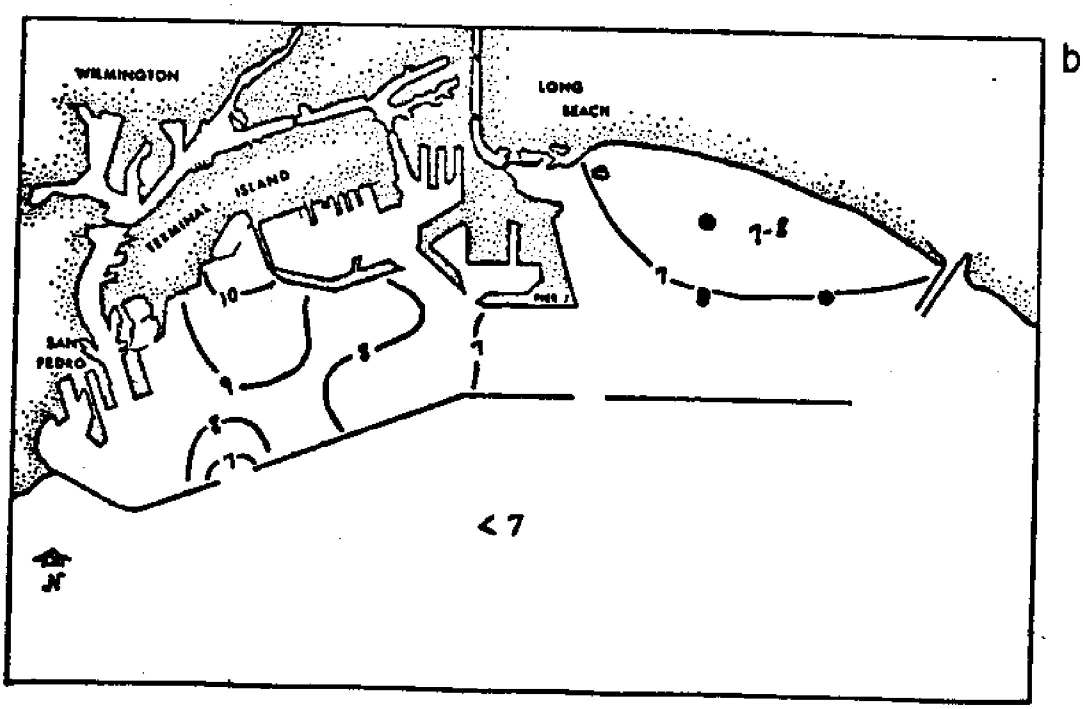


Figure 12. Phytoplankton biomass (μg-at N/l) was reduced in simulated winter conditions (a) relative to the standard run (Fig. 8) and summer (b).

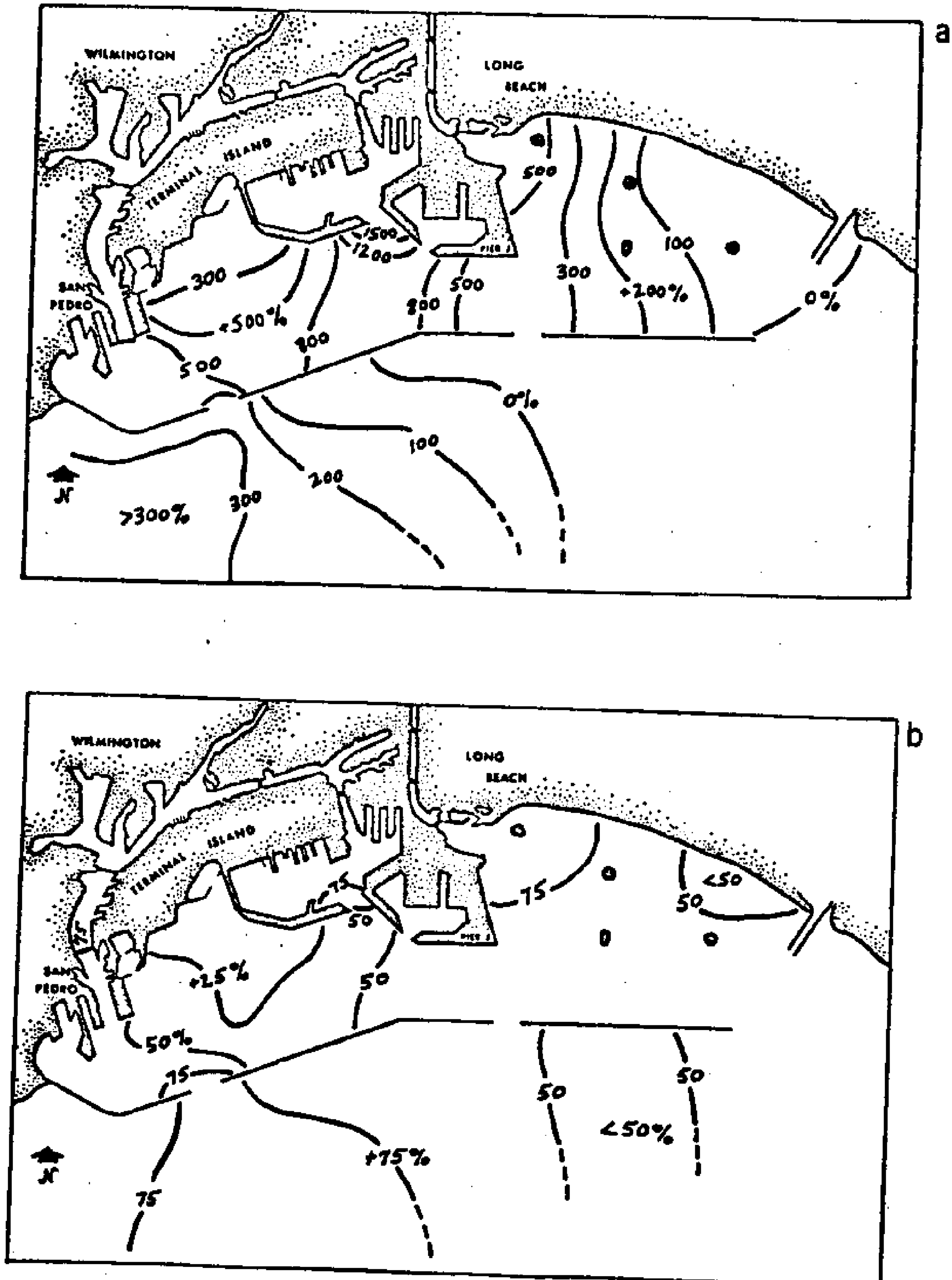


Figure 13. Comparison plot of ammonium concentrations simulated in the winter run as a percentage increase over the standard case (a). Zero percent contours define the region that was within ± 5%; dramatic increases over the standard run (up to more than 15 times) occurred throughout most of the harbor. Comparison with ammonium in the summer run (b) showed much less of an increase.

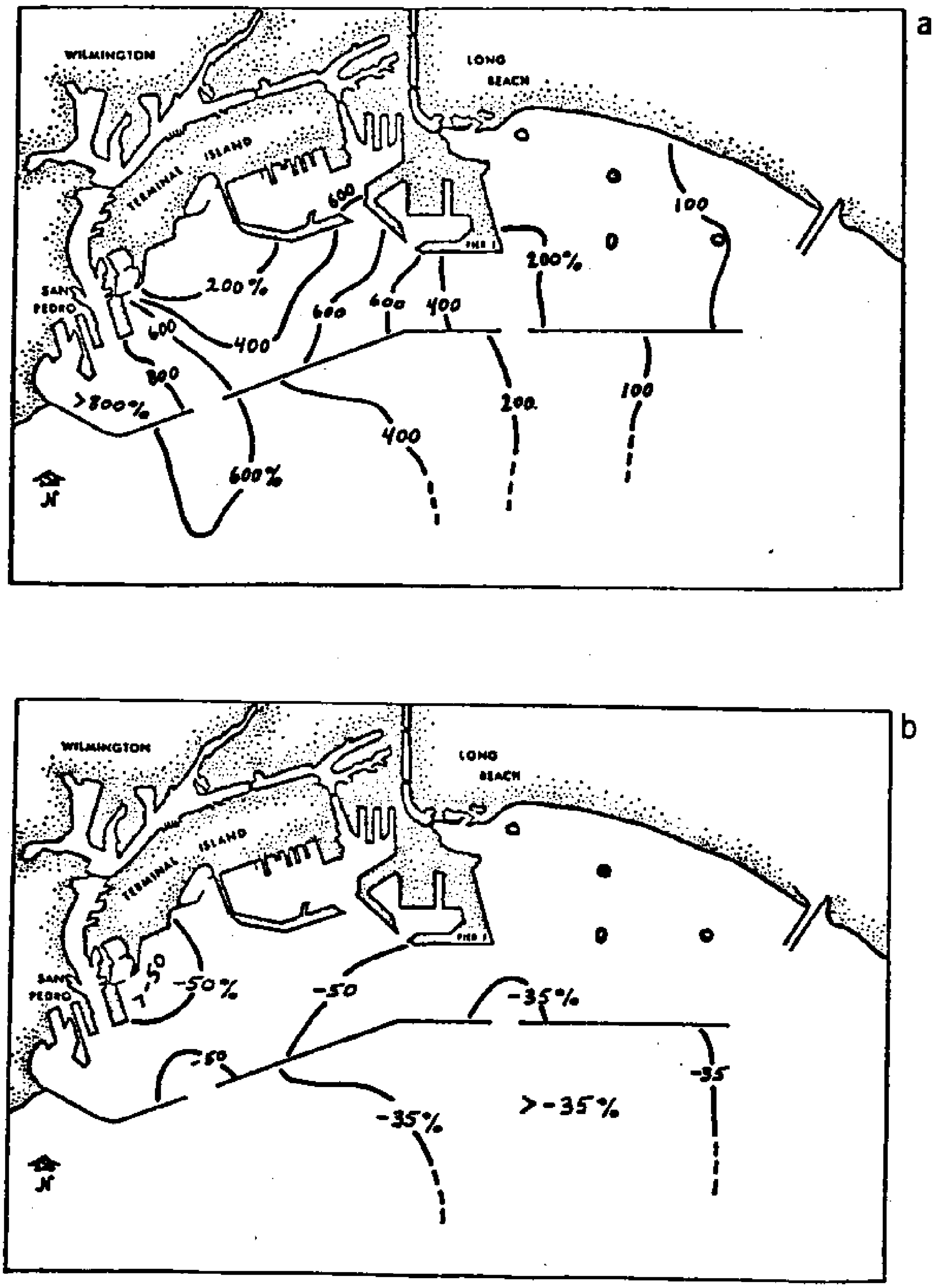


Figure 14. Nitrate concentrations for the winter run showed large percentage increases relative to the standard run (a). Summer conditions demonstrated significant declines (b), with concentrations 50% lower than the standard.

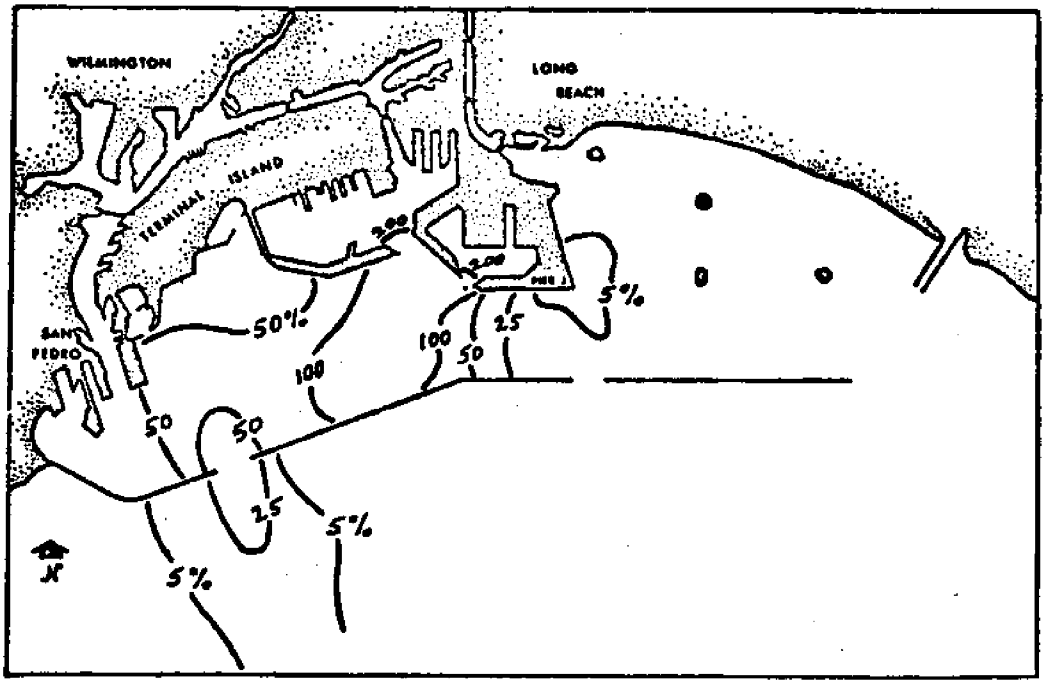


Figure 15. For turbid conditions (high K_o) nitrate values in outer Los Angeles-Long Beach Harbor were generally 50-100% higher than for the standard run.

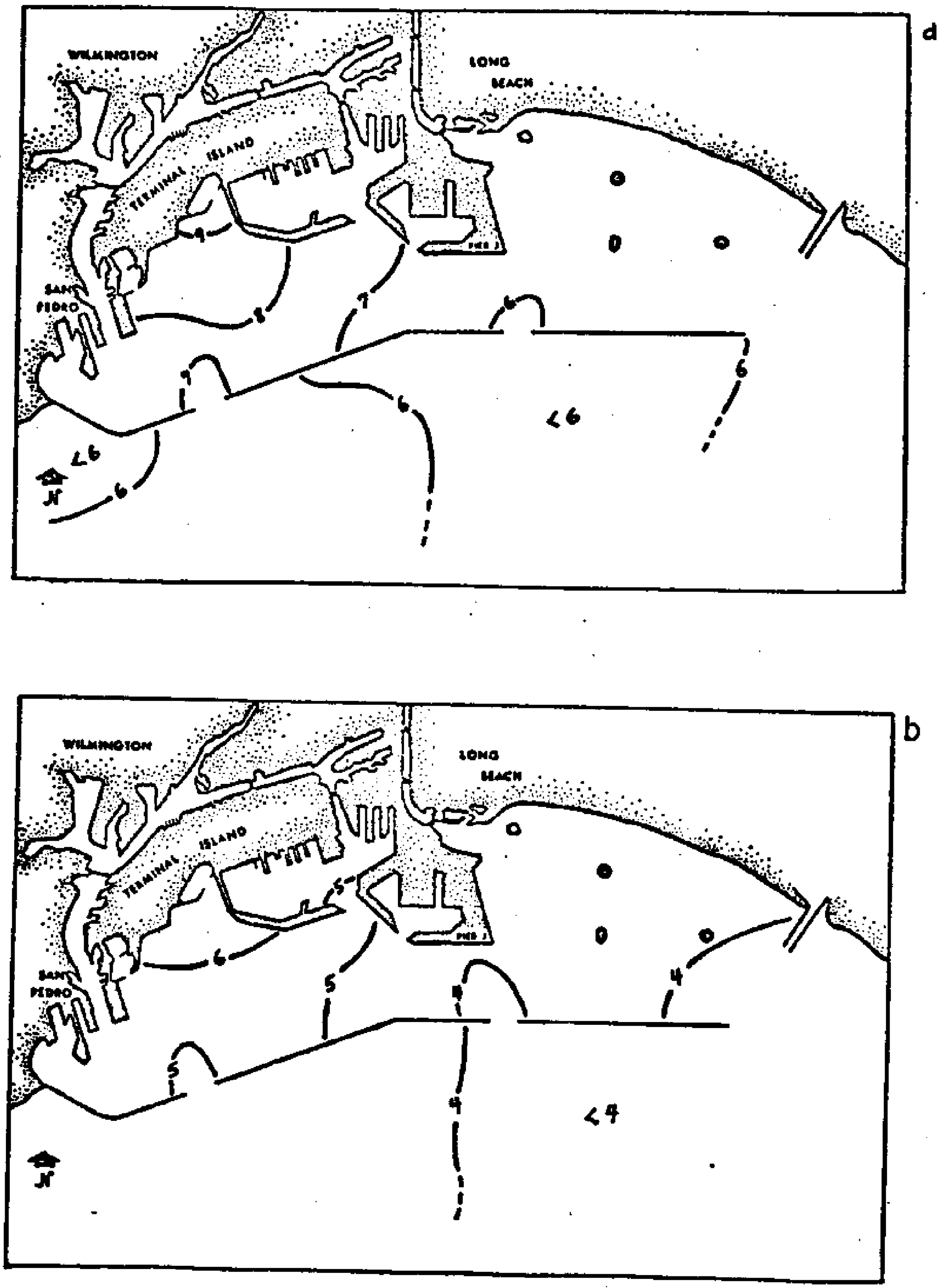


Figure 16. Phytoplankton biomass (µg-at N/l) showed significant increases when benthic oxygen consumption and ammonium release were doubled (a *vs* Fig. 8). Cutting these benthic fluxes in half decreased the phytoplankton standing stock slightly (b), about 15% uniformly throughout the harbor.

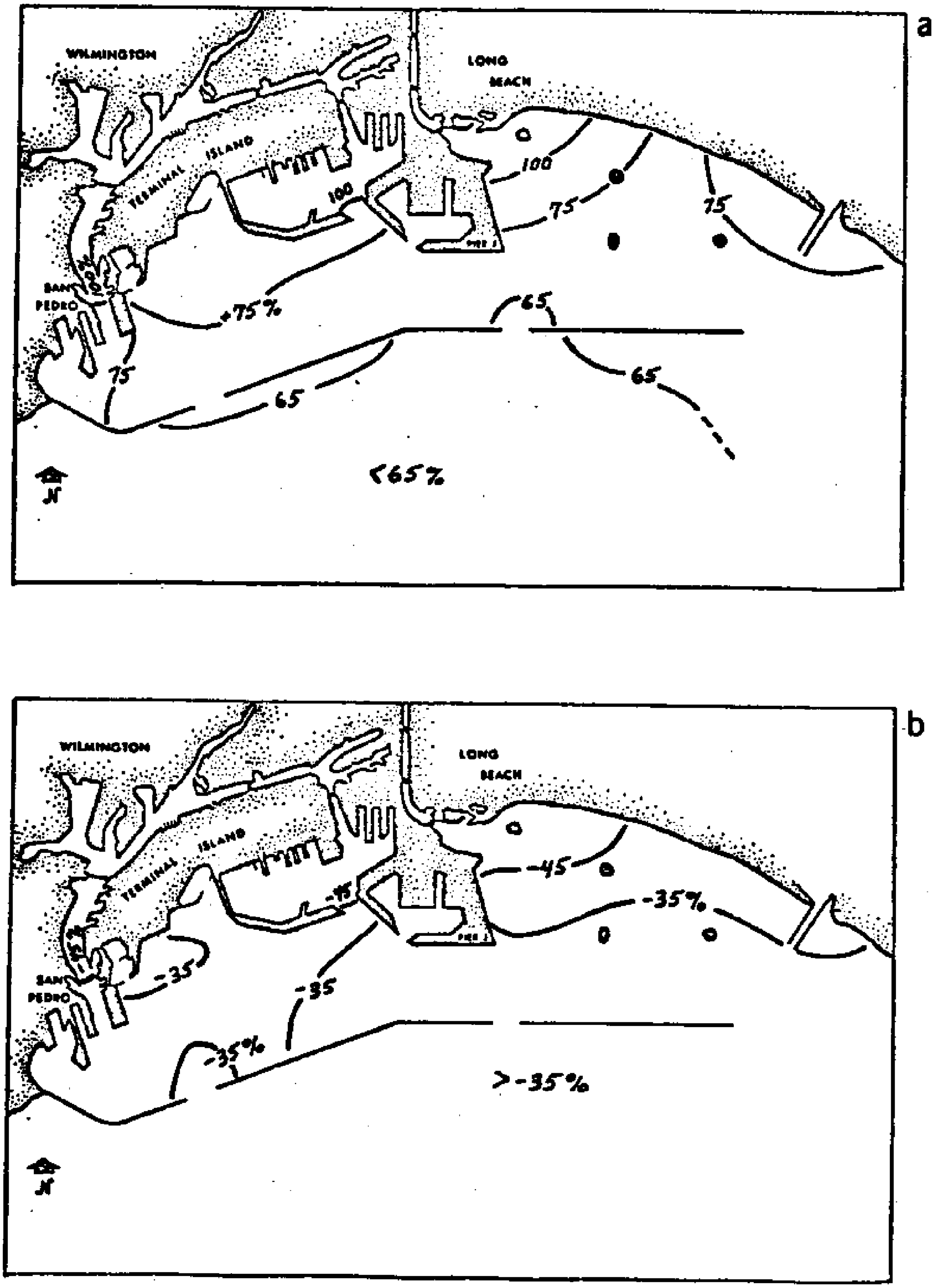


Figure 17. When the benthic fluxes were doubled (see Fig. 16), ammonium concentrations increased more than 100% above the standard run (a). Halving the benthic fluxes had a fairly uniform effect, decreasing the ammonium by 30-50% (b).

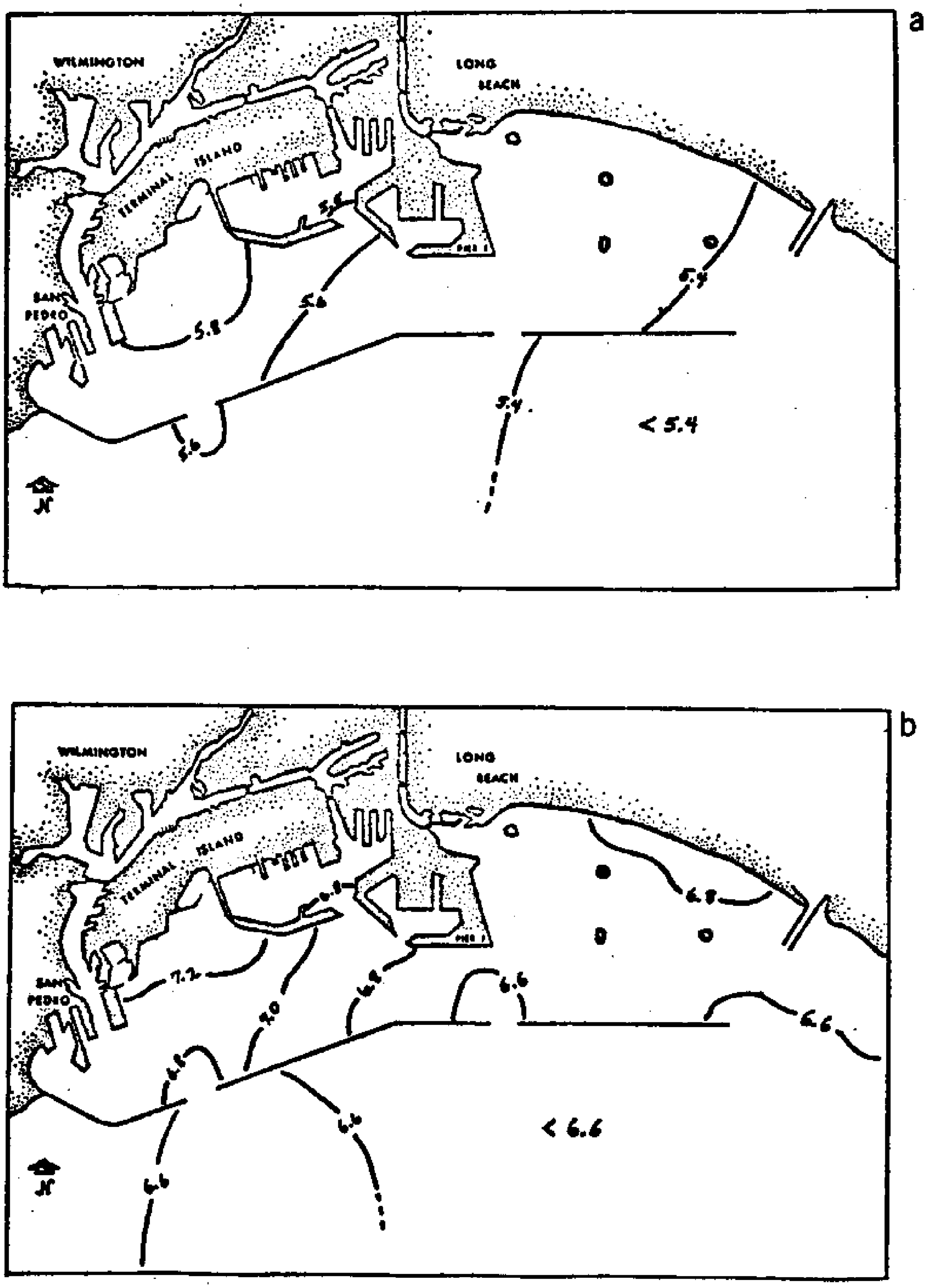


Figure 18. Oxygen levels (mg/l) were slightly depressed when the benthic consumption was raised twofold (a) and slightly increased when it was halved (b).

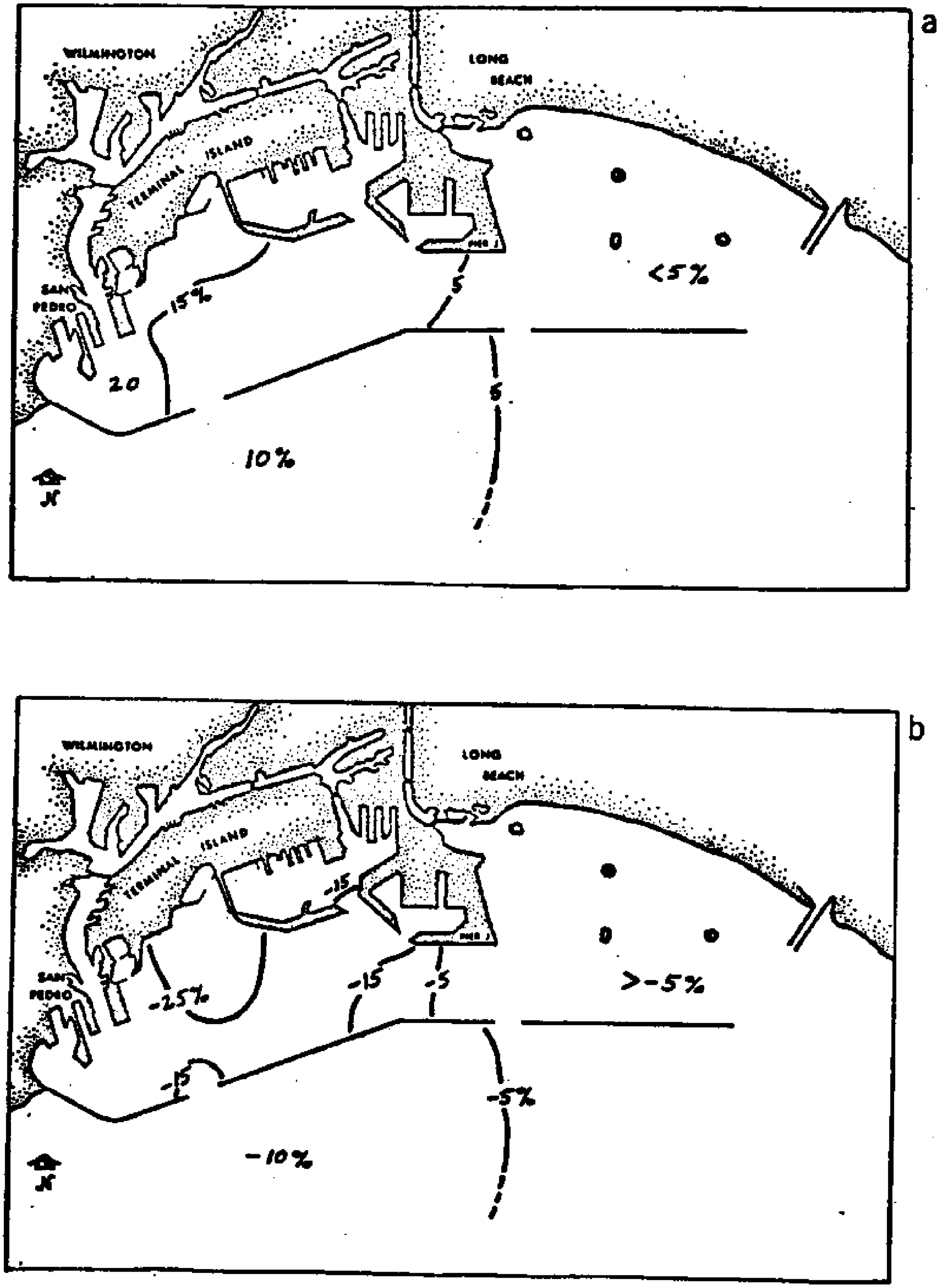
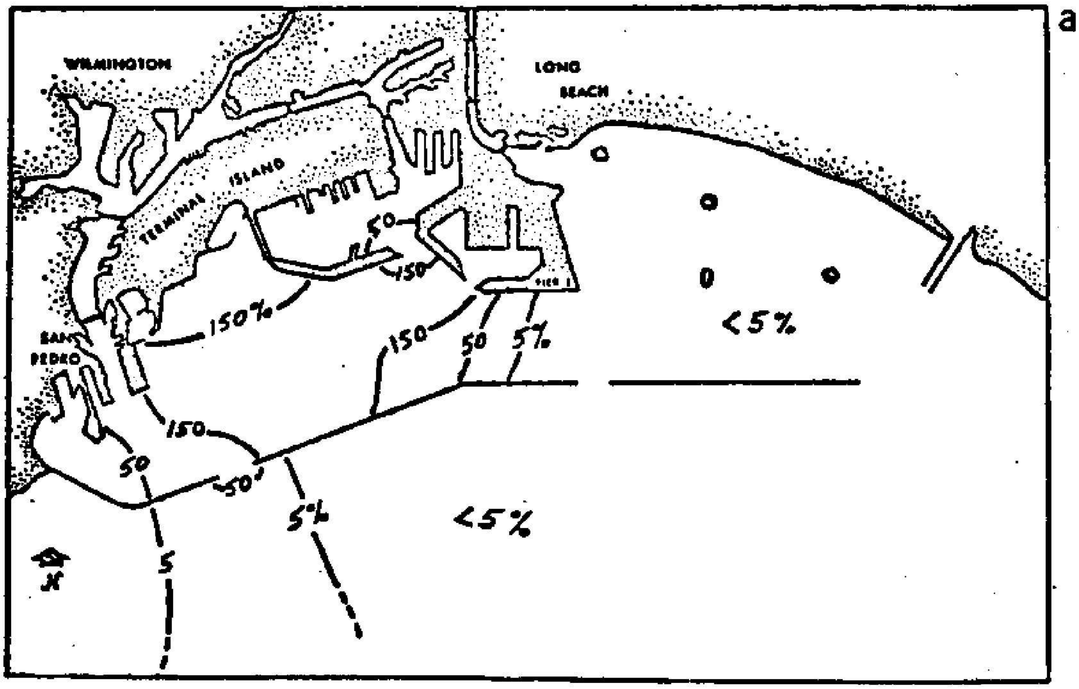


Figure 19. Doubling the amount of secondary sewage discharge produced a small percentage increase in the phytoplankton standing stock over standard run (a). Removing the sewage discharge entirely caused more than a 25% drop in the phytoplankton biomass (b).



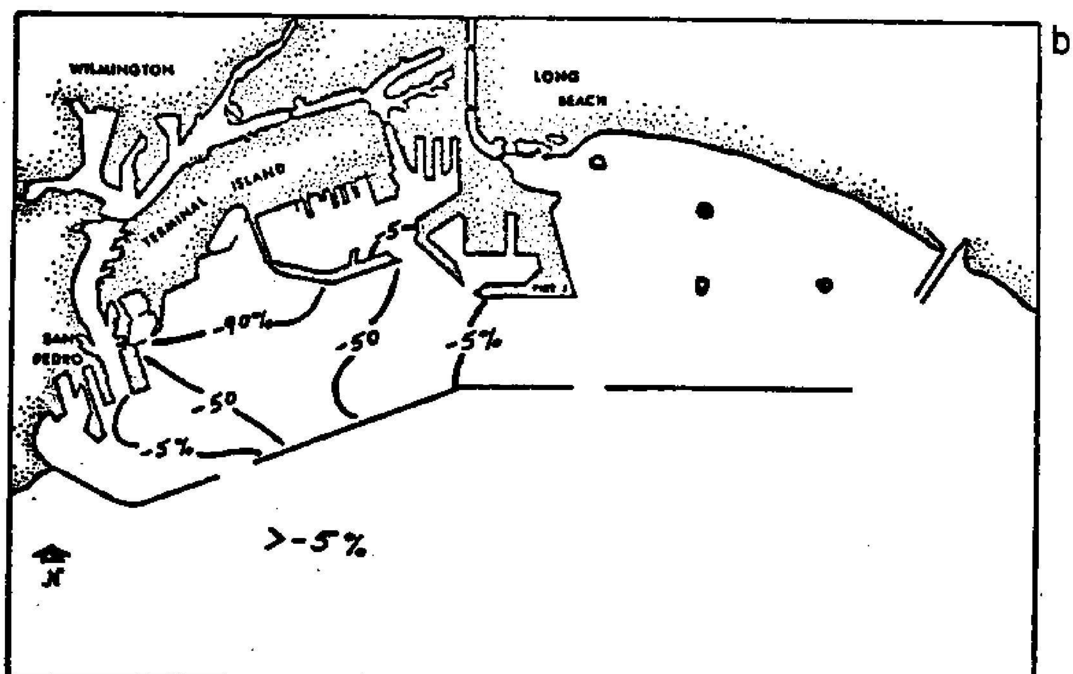
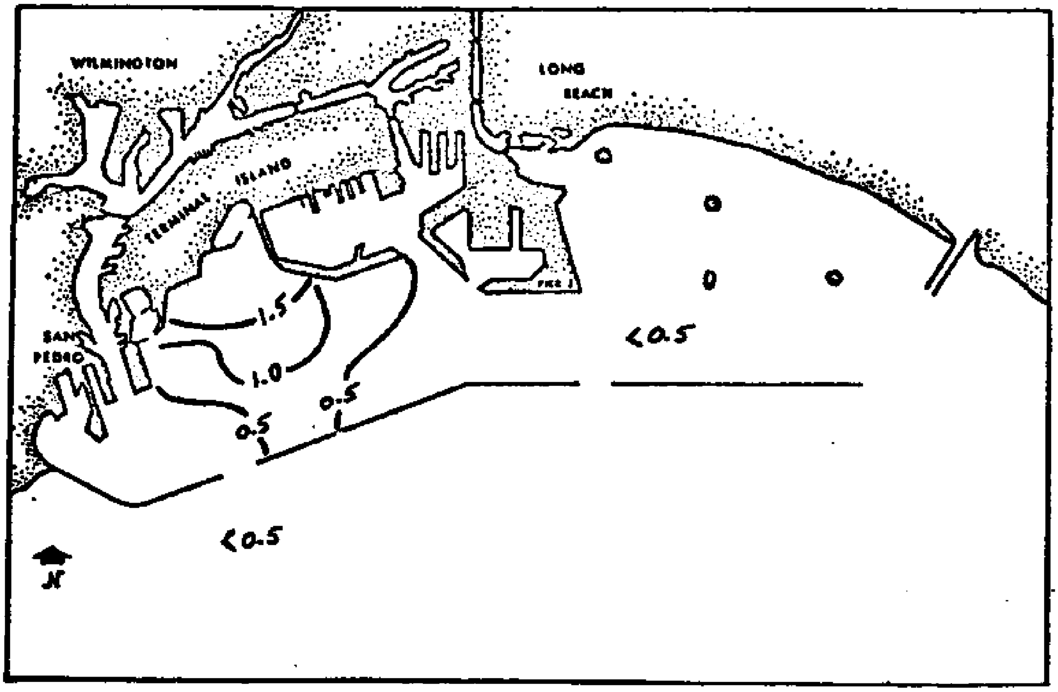


Figure 20. Nitrate concentrations increased about 150% in Los Angeles Harbor when the sewage loading was doubled (a). When the sewage source was eliminated, nitrate levels near the outfall were more than 90% lower than the standard run (b).



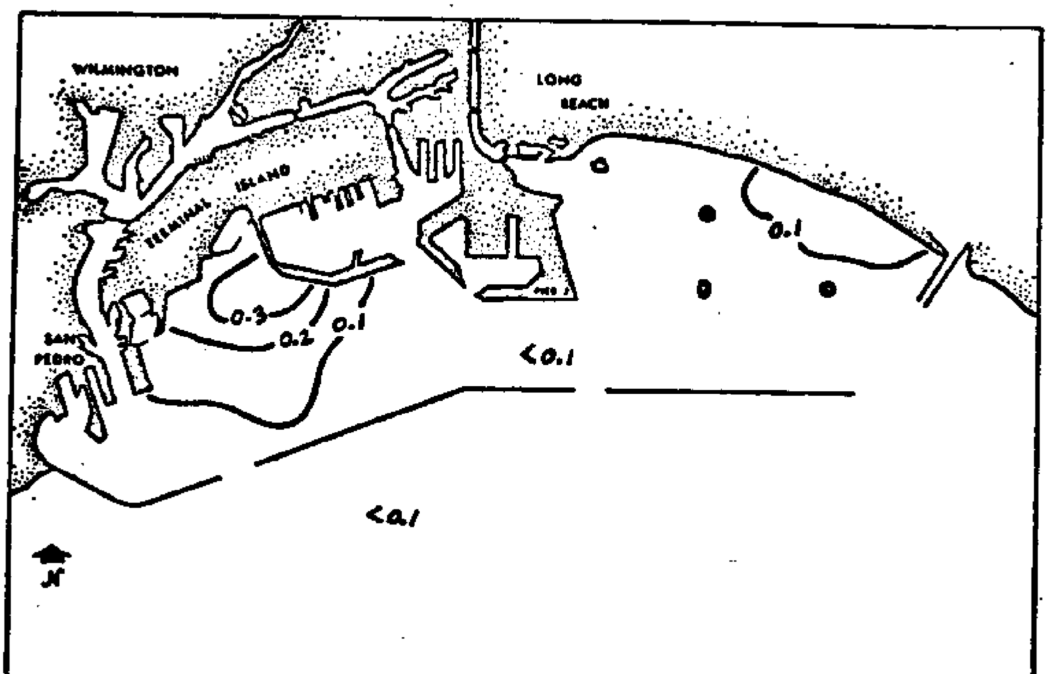


Figure 21. Ammonium concentration contours (µg-at/l) show the effect of an effluent mixture of primary treatment plus cannery waste (a). With a mixture of secondary treatment and cannery waste, ammonium concentrations also increased but to a much more limited degree (b).

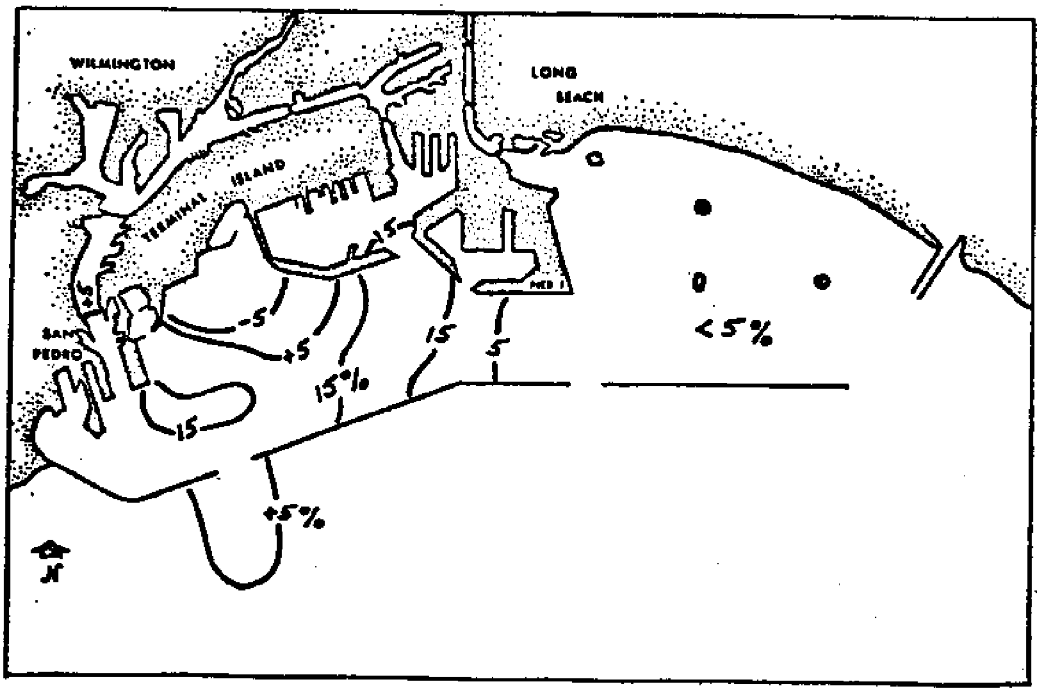


Figure 22. Comparison of nitrate concentrations reveals a decrease near the source when some of the secondary effluent of the standard run is discharged as cannery waste.

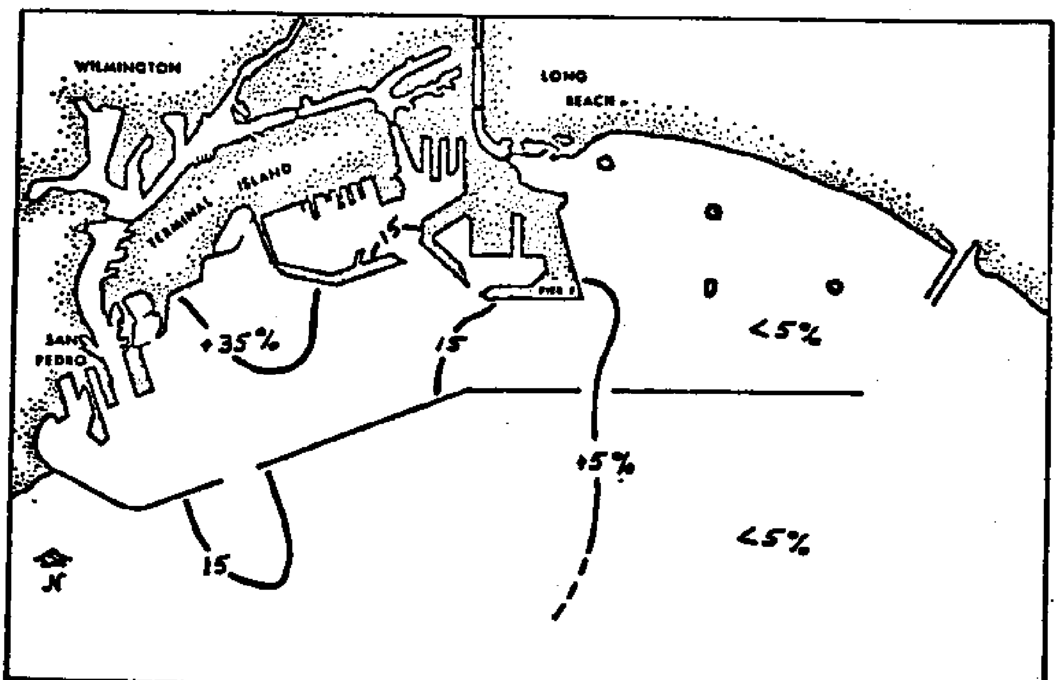


Figure 23. The simulated phytoplankton biomass of Los Angeles Harbor was increased 15% to more than 35% when secondary effluent was discharged (av. 12.7 mgd) relative to the absence of this discharge.

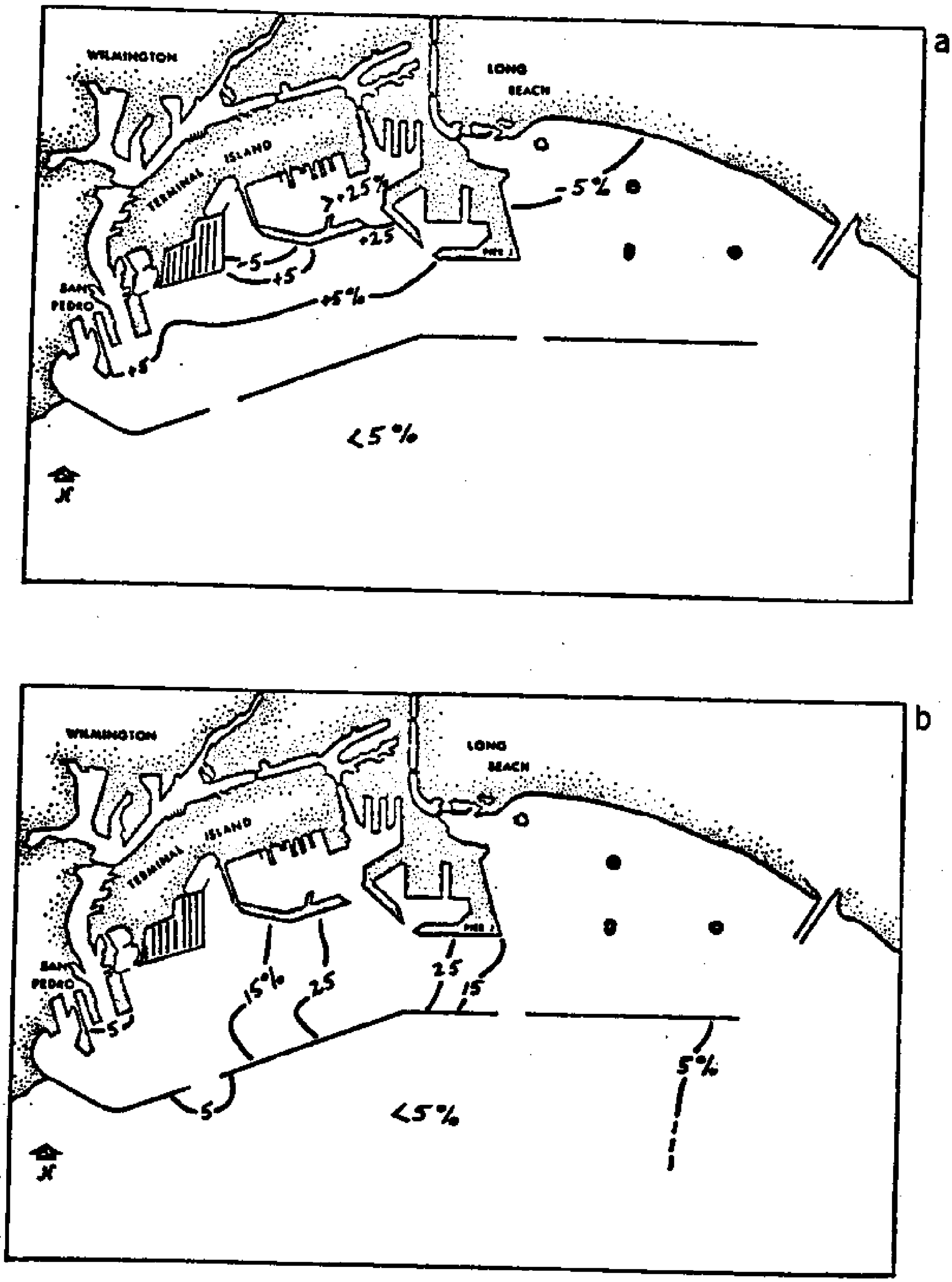


Figure 24. Comparison plots of results using Phase I fill configuration relative to the standard run, unfilled. Ammonium concentration showed a significant increase (>25%) in Middle Harbor (a). Phytoplankton biomass increased both in Middle Harbor itself and outside to the breakwater (b).

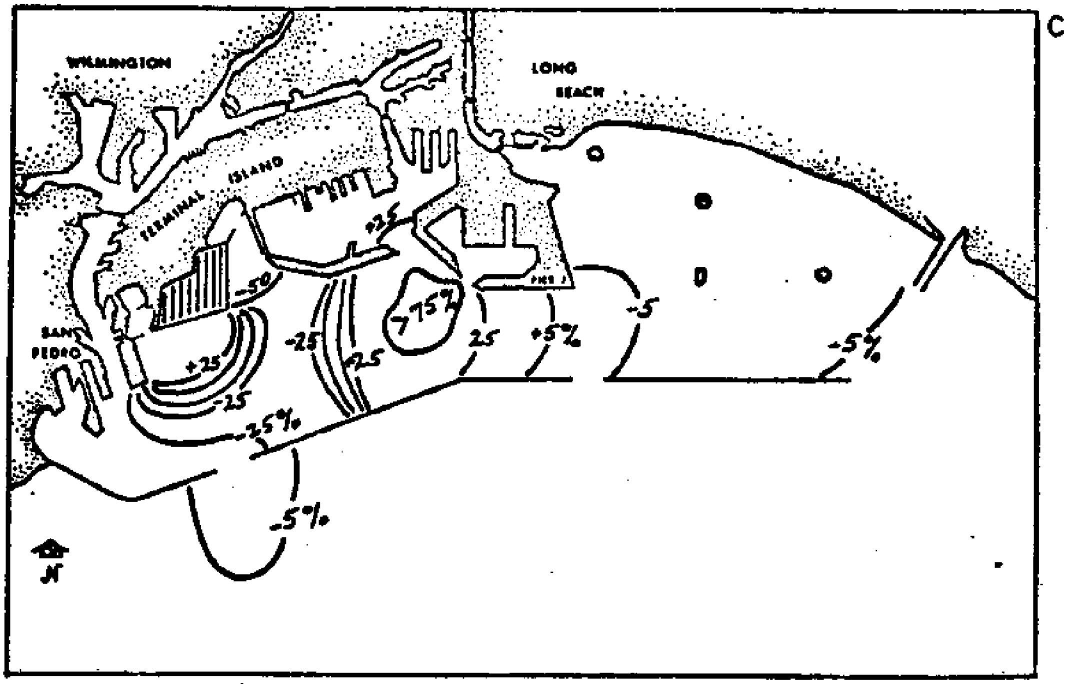


Figure 24 (continued). Comparison plots of results using Phase I fill configuration relative to the standard run, unfilled. Nitrate exhibited a complex pattern of increases and decreases (c).

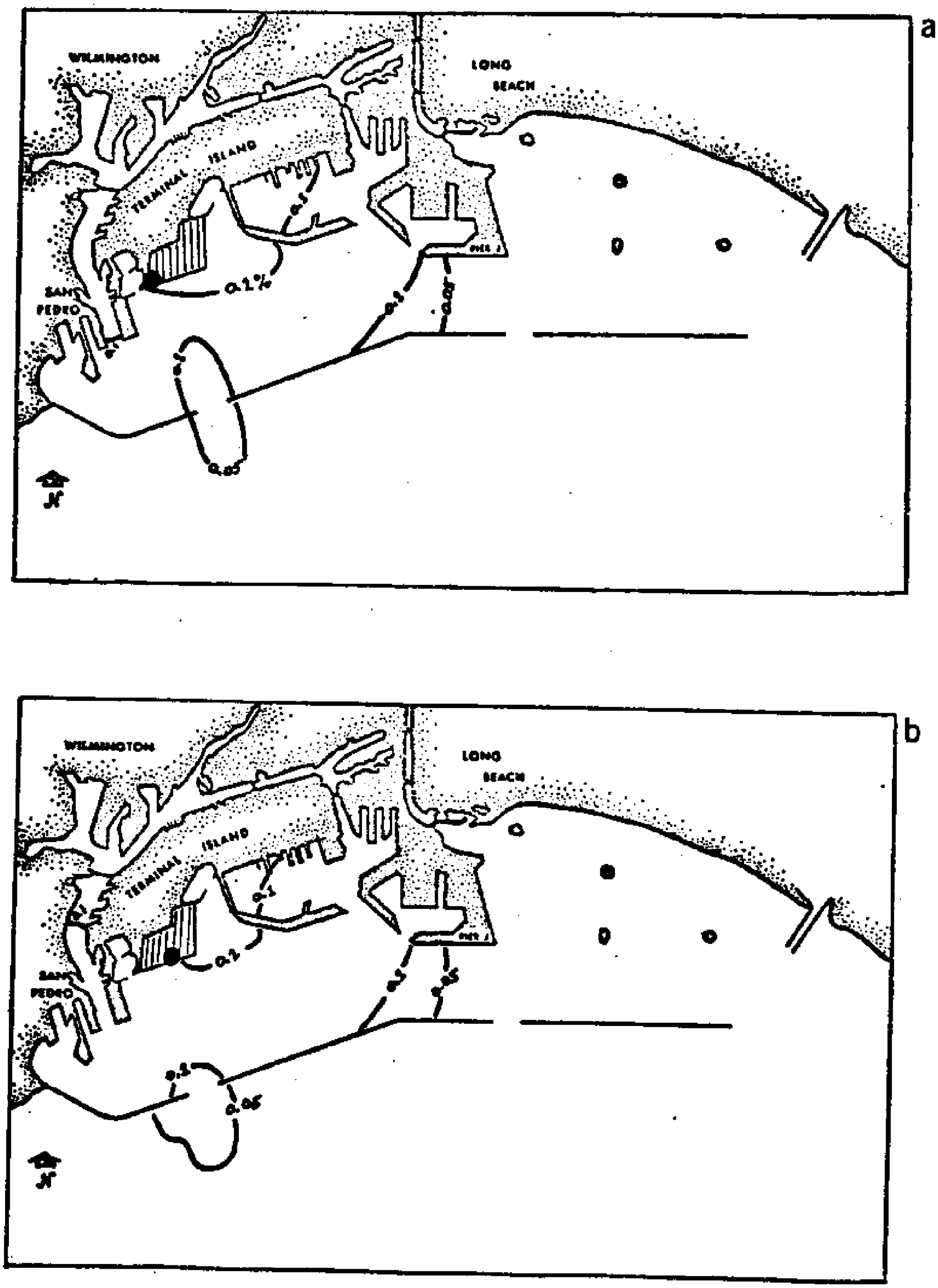
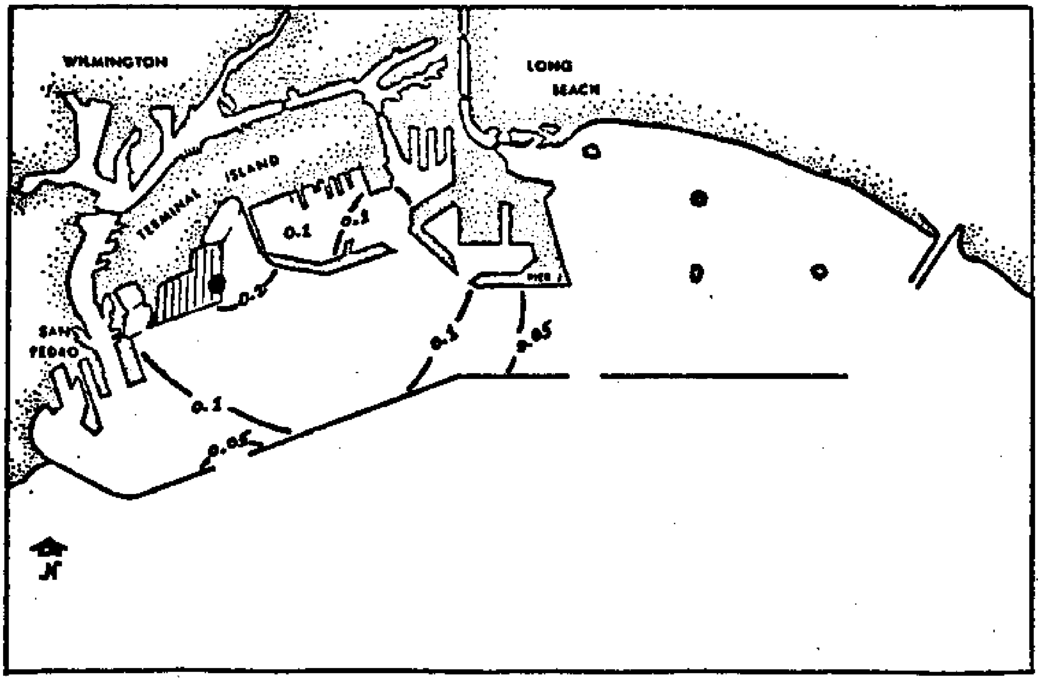


Figure 25. A variety of effluent discharge sites (large dot) were simulated for the filled configuration. Contours (0.05% to 0.2%) represent percentages of the undiluted concentration after two weeks of continuous input.

c



d

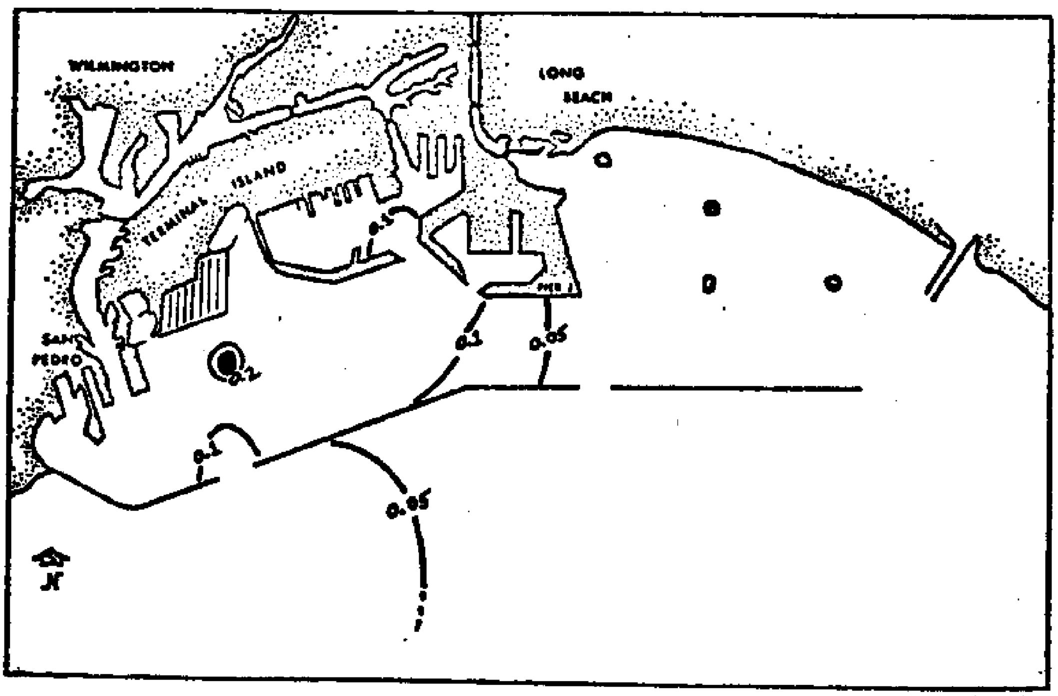


Figure 25 (continued). A variety of effluent discharge sites (large dot) were simulated for the filled configuration. Contours (0.05% to 0.2%) represent percentages of the undiluted effluent concentration after two weeks of continuous input.

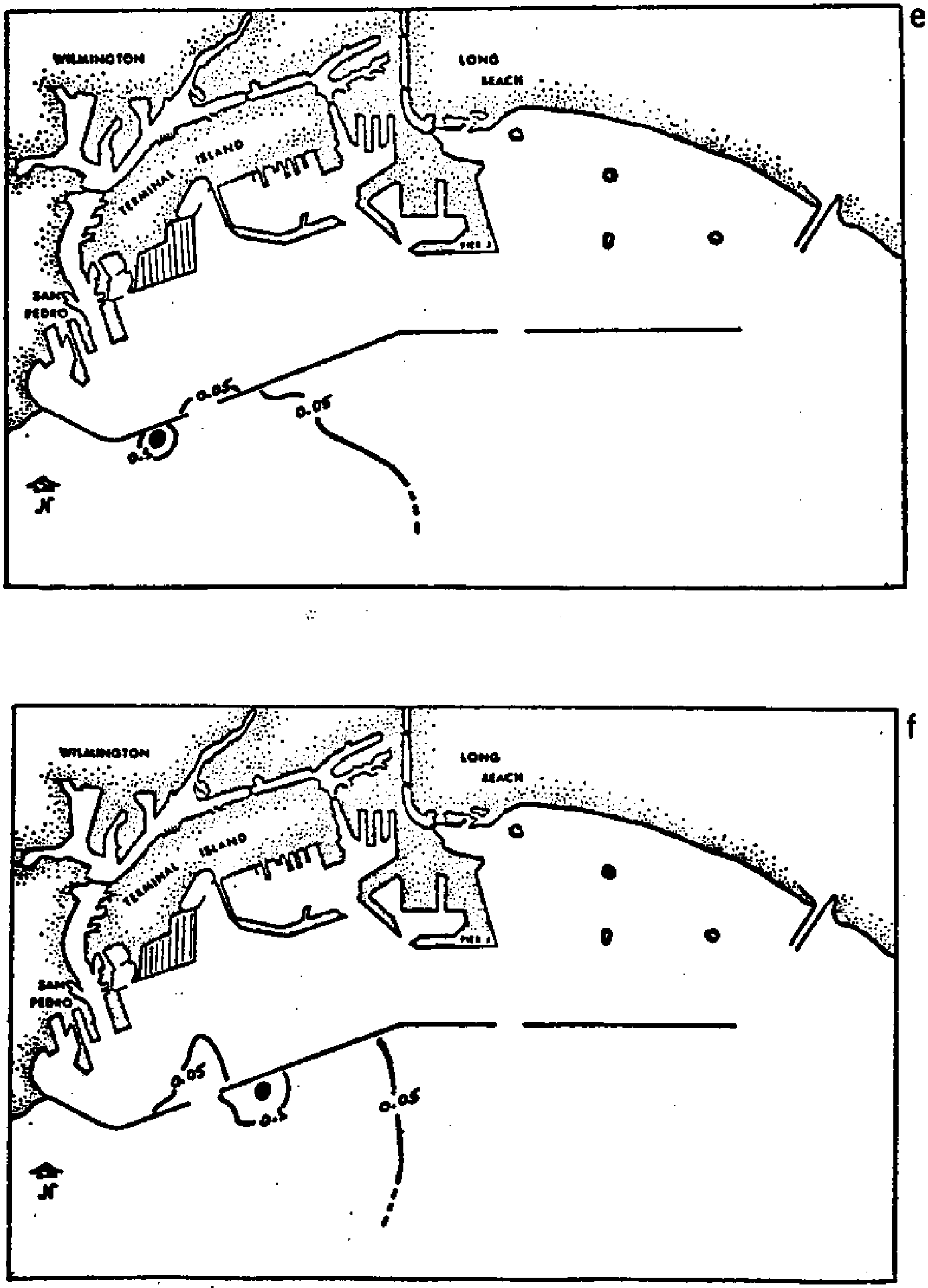


Figure 25 (continued). A variety of effluent discharge sites (large dot) were simulated for the filled configuration. Contours (0.05% to 0.2%) represent percentages of the undiluted effluent concentration after two weeks of continuous input.

VI-A. LITERATURE CITED

Allan Hancock Foundation. 1975. Report to the U.S. Army Corps of Engineers on environmental investigations and analysis, Los Angeles Harbor 1973-1975. Harbors Environmental Projeçts, Allan Hancock Found., Univ. So. Calif. 552 pp. (Draft).

Allan Hancock Foundation. 1976. Environmental investigations and analyses Los Angeles-Long Beach Harbors 1973-1976. Final report to the U.S. Army Corps of Engineers, Los Angeles District. Harbors Environmental Projects, Allan Hancock Found., Univ. So. Calif. 737 pp.

Allen, D. R. 1973. Subsidence, rebound and surface strain associated with oil producing operations, Long Beach, California. In Geology, Seismicity, and Environment Impact, D. E. Moran et al. (eds.), Assoc. Engineering Geologists Special Publication.

American Public Health Association. 1971. Standard Methods for the Examination of Water and Wastewater, 13th ed. New York.

American Public Health Association. 1975. Standard Methods for the Examination of Water and Wastewater, 14th ed. New York.

American Society for Microbiology, Committee on Bacteriological Technique. 1957. Manual of Microbiological Methods. McGraw-Hill Book Co., Inc., New York.

Anderson, D. M. and F. M. M. Morel. 1978. Copper sensitivity of Gonyaulax tamarensis. Limnol. Oceanogr. 23(2):311-365.

Atlas, R. M. 1978. Microorganisms and petroleum pollutants. BioScience 28(6):387-391.

Badsha, K. S. and M. Sainsbury. 1977. Uptake of zinc, lead, and cadmium by young whiting in the Severn Estuary. Mar. Poll. Bull. 8(7):164-166.

Baier, C. R. 1935. Studien zur Hydrobakteriologie stehender Bennengewässer. Arch. Hydrobiol. 29:183-264.

Baker, H. 1938. Studies on the Cladocera of Monterey Bay. Proc. Calif. Acad. Sci. 23(3):311-365.

Bancroft, H. H. 1884. History of the Pacific States of North America. Vol. 13, California. Vol. I, 1542-1800. A. L. Bancroft & Co., San Francisco. 744 pp.

Barnard, J. L. 1958. Amphipod crustaceans as fouling organisms in Los Angeles-Long Beach Harbors, with reference to the influence of seawater turbidity. Calif. Fish and Game Bull. 44:161-170.

Barnard, J. L. and D. J. Reish. 1959. Ecology of Amphiphoda and Polychaeta of Newport Bay, California. Allan Hancock Found. Occas. Papers No. 20. 106 pp.

Barnes, H. 1959. Stomach contents and microfeeding of some common cirripeds. Canad. J. Zool. 37(3):231-236.

Barnes, R. D. 1974. Invertebrate Zoology. W. B. Saunders Co., Philadelphia. 3rd ed. 870 pp.

Barsdate, R. S., T. Fenchel, and R. T. Prentiki. 1974. Phosphorus cycle of model ecosystems: significance of decomposer good chains and effect of bacterial grazers. Oikos 25:239-251.

Baxter, J. L. 1966. Inshore Fishes of California. California Dept. Fish and Game, Sacramento. 3rd rev. ed. 80 pp.

Baylor, E. R. and W. H. Sutcliffe, Jr. 1963. Dissolved matter in seawater as a source of particulate food. Limnol. Oceanogr. 8:369-371.

Bayne, B. L. 1976. Aspects of reproduction in bivalve molluscs. Estuarine Processes. Martin Wiley (ed.). Academic Press, New York. Vol. 1. 432-449 pp.

Beck, M. L. 1897. Morning tides. Nautilus 11(8):89-90.

Beecher, J. 1915. The history of Los Angeles Harbor. Master's thesis, Univ. So. Calif. Dept. of Economics. 63 pp.

Benayoun, G. 1975. Flux of cadmium through euphausids. Radioactivity in the Sea. International Atomic Energy Agency. Publ. 47. 25 pp.

Bever, K. and A. Dunn. 1976. The energetic role of amino acid and protein metabolism in the kelp bass (*Paralabrax clathratus*). In Marine Studies of San Pedro Bay. D. Soule and M. Oguri (eds.). Part 12. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 129-142.

Blaxter, J. H. S. 1968. Rearing herring larvae to metamorphosis and beyond. J. Mar. Biol. Assoc. United Kingdom 48: 17-28.

Bohn, A. and R. O. McElroy. 1976. Trace metals (As, Cd, Cu, Fe, and Zn) in Arctic cod, *Boreogadus saida*, and selected zooplankton from Strathcoma Sound, northern Baffin Island. J. Fish. Res. Bd. Canada 33(192):2836-2840.

Bray, J. R. and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27:325-349.

Brewer, G. D. 1976. Resuspended sediment elitriate studies on on the northern anchovy. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 15-32.

Brown, T. J. and J. R. Sibert. 1977. Food of some benthic harpacticoid copepods. J. Fish. Res. Bd. Canada 34(7): 1028-1031.

Busch, W. M., R. L. Scholl, and W. L. Hartman. 1975. Environmental factors affecting the strength of walleye (*Stizostedion vitreum vitreum*) year-classes in western Lake Erie 1960-70. J. Fish. Res. Bd. Canada 32:1733-1743.

Caine, E. A. 1977. Feeding mechanisms and possible resource partitioning of the Caprellidae (Crustacea: Amphipoda) from Puget Sound, U.S.A. Mar. Biol. 42(4):331-336.

Calabrese, A., F. P. Thurberg, and E. Gould. 1977. Effects of cadmium, mercury, and silver on marine animals. Mar. Fish. Rev. 39(4):5-11.

California Cooperative Sardine Research Program. 1952. Progress report, 1 Jan. 1951 to 30 June 1952, pp. 23-25.

California, State of, Resources Agency. 1969. Review of information pertinent to Los Angeles-Long Beach Harbor and Dominguez Channel. Staff report to Los Angeles Regional Water Quality Control Board. 88 pp.

Carpenter, E. J., B. B. Peck, and S. J. Anderson. 1974. Survival of copepods passing through a nuclear power station on northeastern Long Island Sound, U.S.A. Mar. Biol. 24:49-55.

Chamberlain, D. W. 1973. Results of 14 benthic trawls conducted in the outer Los Angeles-Long Beach Harbor, California, May 24, 1972. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 2. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 107-146.

Chamberlain, D. W. 1974. A checklist of fishes from Los Angeles-Long Beach Harbors. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 4. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 47-78.

Chamberlain, D. W. 1975. The role of fish cannery waste in the ecosystem. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 8. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 1-22.

Chamberlain, D. W. 1976. Effects of the Los Angeles Harbor sediment elutriate on the California killifish, *Fundulus parvipinnis* and white croaker, *Genyoneums lineatus*. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 33-47.

Chen, K. Y. and J. C. S. Lu. 1974. Sediment compositions in Los Angeles-Long Beach Harbors and San Pedro Basin. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 7. Allan Hancock Found. and Sea Grant Progr., Univ. So. Calif., Los Angeles. 177 pp.

Chen, K. Y. and B. Eichenberger. 1976. Concentrations of trace elements and chlorinated hydrocarbons in marine fish. In Marine Studies of San Pedro Bay, California.

D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud. Univ. So. Calif., Los Angeles. Appendix 2, pp. 283-298.

Chen, K. Y. and C. C. Wang. 1976. Water quality evaluation of dredged material disposal from Los Angeles Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 155-236.

Chiang, Wen-Li. 1979. Tide induced currents in harbors of arbitrary shape. Ph.D. dissertation. Univ. of So. Calif.

Clifford, H. T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, San Francisco. 229 pp.

Cockerell, T. D. A. 1901a. Three new nudibranchs from California. J. Malacol. 8(3):85-87.

Cockerell, T. D. A. 1901b. Notes on two new Californian nudibranchs. J. Malacol. 8(4):121-122.

Cockerell, T. D. A. 1901c. A new *Tethys* from California. Nautilus 15(8):90-91.

Cockerell, T. D. A. 1902. Three new species of *Chromodoris*. Nautilus 16(2):19-21.

Cockerell, T. D. A. and C. N. E. Eliot. 1905. Notes on a collection of California nudibranchs. J. Malacol. 12(3): 31-53.

Coe, W. R. 1948. Nutrition, environmental conditions, and growth of marine bivalve molluscs. J. Mar. Res. 7:586-601.

Conover, R. J. 1957. Note on the seasonal distribution of zooplankton in Southampton Water with special reference to *Acartia*. Ann. Mag. Nat. Hist. 10:63-67.

Conover, R. J. 1971. Some relationships between zooplankton and bunker C oil in Chedabucto Bay following the wreck of the ship Arrow. J. Fish. Res. Bd. Canada 28:1327-1330.

Coull, B. C. (ed.). 1977. Ecology of Marine Benthos. Univ. So. Carolina Press, Columbia, S. C. 467 pp.

Crisp, D. J. 1964. An assessment of plankton grazing by barnacles. In Grazing on Terrestrial and Marine Environments. D. J. Crisp (ed.). Blackwell Scientific Publ., Oxford. pp. 251-264.

Cutshall, N. H. 1977. Zinc and cadmium in the Pacific hake *Merluccius productus* off the western U.S. coast. Mar. Biol. 44(3):195-201.

Dale, B. and C. M. Yentsch. 1978. Red tide and paralytic shellfish poisoning. Oceanus 21(3):41-49.

Dales, R. P. 1957. Some quantitative aspects of feeding in sabellid and serpulid fan worms. J. Mar. Biol. Assoc. United Kingdom 36(2):309-316.

Daley, R. and J. Hobbie. 1975. Direct counts of aquatic bacteria by a modified epiflourescent technique. Limnol. Oceanogr. 20:875-882.

Dana, R. H. 1840. Two Years Before the Mast. Reprint, 1968. Lancer Books Inc., New York. 573 pp.

Darnell, R. M. 1967. Organic detritus in relation to estuarine ecosystem. In Estuaries. G. H. Lauff (ed.). Amer. Assoc. Adv. Sci. Publ. No. 83:376-382.

Daro, M. H. 1973. The autecology of *Polydora ciliata* along the Belgian coast. Neth. J. Sea Res. 6(1-2):130-140.

Davies, R. M. and L. D. Jensen. 1975. Zooplankton entrainment at three mid-Atlantic power stations. J. Water Poll. Control Fed. 47:2130-2142.

Davis, C. C. 1977. *Sagitta* as food for *Acartia*. Astarte 10: 1-3.

Ellison, J. P., C. Terry, and J. S. Stephens, Jr. 1979. Good resource utilization among five species of embiotocids at King Harbor, California, with preliminary estimates of caloric intake. Mar. Biol. 52(2):161-169.

Emerson, R. R. 1976a. Bioassay and heavy metal uptake investigations of resuspended sediment on two species of polychaetous annelids. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 69-90.

Emerson, R. R. 1976b. Effects of secondary waste treatment and chlorination on selected invertebrates. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 12. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 247-254.

Emerson, R. R. 1976c. The impact of cannery wastes on primary productivity in the receiving waters. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 12. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 255-268.

Emson, R. H. 1977. The feeding and consequent role of *Eulalia viridis* (O. F. Mueller) (Polychaeta) in intertidal communities. J. Mar. Biol. Assoc. United Kingdom 57(1):93-96.

Enright, J. T. 1977. Power plants and plankton. Mar. Poll. Bull. 8:158-161.

Environmental Protection Agency, United States. 1974. Methods for chemical analysis of water and wastes. EPA 625/6-74-003.

Environmental Protection Agency/U.S. Army Corps of Engineers, Technical Committee on Criteria for Dredged and Fill Material. 1977. Ecological evaluation of proposed discharge of dredged material into ocean waters. Implementation manual for section 103 of Public Law 92-532. 130 pp.

Environmental Quality Analysts-Marine Biological Consultants. 1975. Southern California Edison Co. Marine Monitoring Studies. Long Beach Generating Station. 1974 Annual Report. Vol. I, 259 pp., Vol. II, 462 pp.

Environmental Quality Analysts-Marine Biological Consultants. 1976a. Southern California Edison Co. Marine Monitoring Studies. Long Beach Generating Station. 1975 Annual Report. 475 pp.

Environmental Quality Analysts-Marine Biological Consultants, Long Beach Harbor Consultants. 1976b. The port of Long Beach, Long Beach, California. Environmental and geotechnical sampling program. Final Report. Vol. I, 256 pp.; Vol. II, 223 pp.; Vol. III, 212 pp.

Environmental Quality Analysts-Marine Biological Consultants. 1977. Southern California Edison Co. Marine Monitoring Studies. Long Beach Generating Station. Preoperational Report 1974-1976. 362 pp.

Environmental Quality Analysts-Marine Biological Consultants. 1978. Southern California Edison Co. Marine Monitoring Studies. Long Beach Generating Station. Final Report 1974-1978. 536 pp.

Eppley, R. W., W. G. Harrison, S. W. Chisholm, and E. Stewart. 1977. Particular organic matter in surface waters off Southern California and its relationship to phytoplankton. J. Mar. Res. 35:671-696.

Esterly, C. O. 1930. The periodic occurrence of Copepoda in the marine plankton of two successive years at La Jolla, California. Bull. Scripps Instit. Oceanogr., Univ. Calif. Tech. Series 1(14):247-345.

Fauchald, K. and P. A. Jumars. 1979. The diet of worms: a study of polychaete feeding guilds. Oceanogr. Mar. Biol. Ann. Rev. M. Barnes (ed.). Vol. 17. pp. 193-284. Aberdeen Univ. Press.

Felix, D. W. 1969. An inexpensive recording settling tube for analysis of sands. J. Sed. Petrol. 39(2):777-780.

Fenchel, T. 1970. Studies on the decomposition of organic detritus derived from the turtle grass *Thalassia testudinum.* Limnol. Oceanogr. 15:14-20.

Ferguson, R. L. and P. Rublee. 1976. Contribution of bacteria to standing crop of coastal plankton. Limnol. Oceanogr. 21(1):141-145.

Ferris, V. R. and J. M. Ferris. 1979. Thread worms (nematodes). <u>In</u> Pollution Ecology of Estuarine Invertebrates. C. W. Hart, Jr. and S. L. H. Fuller (eds.). Academic Press, New York.

Fiala-Medioni, A. 1978. Filter-feeding ethology of benthic invertebrates (ascidians). IV. Pumping rate, filtration rate, filtration efficiency. Mar. Biol. 48(3):243-249.

Fish, G. R. 1955. The food of *Tilapia* in east Africa. Uganda J. 19(1).

Fitch, J. E. and R. J. Lavenberg. 1975. Tidepool and Near-shore Fishes of California. Univ. California Press, Berkeley. 156 pp.

Gaudy, R. 1974. Feeding four species of pelagic copepods under experimental conditions. Mar. Biol. 25:125-141.

Gauld, D. T. 1966. The swimming and feeding of planktonic copepods. In Some Contemporary Studies in Marine Science. H. Barnes (ed.). Allen & Unwin, London. pp. 313-334.

Gibbs, R. J., M. P. Matthews, and D. A. Link. 1971. The relationship between sphere size and settling velocity. J. Sed. Petrol. 41(1):7-18.

Green, J. 1968. The Biology of Estuarine Animals. Sidgwick and Jackson, London. 375 pp.

Hand, C. H. and L. Berner, Jr. 1959. Food of the Pacific sardine (*Sardinops caerulea*). Fish. Bull. 164, Fish Wildlife Serv. 60:170-180.

Harbors Environmental Projects. 1978. On-site migration: kelp transplant project for Los Angeles Harbor. Agreement 1099. Final Report for the Port of Los Angeles. September 1978. 137 pp.

Harbors Environmental Projects. 1979. Bioassay investigations of sediments for the Pier J Completion Project EIR, Port of Long Beach, California. Harbors Environ. Proj., Univ. So. California. 116 pp.

Hardisty, M. W., S. Kartar, and M. Sainsbury. 1974. Dietary habits and heavy metal concentrations in fish from the Severn Estuary and Bristol Channel. Mar. Poll. Bull. 5(4):61-63.

Hargrave, B. T. 1970. The utilization of benthic microflora by *Hyalella azteca* (Amphipoda). J. Animal Ecol. 39:427-437.

Hargrave, B. T. 1971. An energy budget for a deposit-feeding amphipod. Limnol. Oceanogr. 16(1):99-103.

Hart, C. W. Jr. and S. L. H. Fuller. 1979. Pollution Ecology of Estuarine Invertebrates. Academic Press, New York. 406 pp.

Heinle, D. R. 1969. Temperature and zooplankton. U.S. Internat. Biol. Prog., Thermal Workshop. Chesapeake Sci. 10: 186-209.

Heinle, D. R. 1976. Effects of passage through power plant cooling systems on estuarine copepods. Environ. Pollut. 11:39-58.

Heinle, D. R. and D. A. Flemer. 1975. Carbon requirements of a population of the estuarine copepod *Eurytemora affinis*. Mar. Biol. 31:235-247.

Heinle, D. R., D. A. Flemer, and J. F. Ustach. 1976. Contribution of tidal marshlands to mid-Atlantic estuarine food chains. Estuarine Processes. Martin Wiley (ed.). Academic Press, New York. Vol. 2. pp. 309-321.

Heinle, D. R., D. A. Flemer, J. F. Ustach, R. A. Murtagh, and R. P. Harris. 1974. The role of organic debris and associated micro-organisms in pelagic estuarine food chains. Tech. Rep., Water Resour. Res. Cent., Univ. Maryland. 22 pp.

Hershelman, G. P., Tsu-Kai Jan, and H. A. Schafer. 1977. Pollutants in sediments off Palos Verdes. Southern Calif. Coastal Water Res. Proj. Annual Report, 1977.

Hill, L. R. 1974. A seasonal environmental study of the polychaetous annelids within the Long Beach Naval Station and Shipyard, Long Beach, California. Master's thesis. California State Univ., Long Beach. 97 pp.

Hill, L. R. and D. J. Reish. 1975. Seasonal occurrence and distribution of benthic and fouling species of polychaetes in Long Beach Naval Station and Shipyard, California. In Marine Studies of San Pedro Bay. D. Soule and M. Oguri (eds.). Part 8. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 57-74.

Hokanson, E. F. 1977. Temperature requirements of some percids and adaptations to the seasonal temperature cycle. J. Fish. Res. Bd. Canada 34(10):1524-1550.

Humpert, D. 1979. Report to the Pacific Fisheries Management Council on the anchovy fishery for 1978/79. Natl. Mar. Fisheries Center, La Jolla, Calif. Admin. Report No. LJ-79-23. 20 pp.

Hylleberg, J. 1975. Selective feeding by *Abarenicola pacifica* with notes on *Abarenicola vagabunda* and the concept of gardening in lugworms. Ophelia 14:113-137.

Jannasch, H. W. 1979. Microbial turnover of organic matter in the deep sea. BioScience 29(4):228-232.

Jannasch, H. W. and C. O. Wirsen. 1979. Chemosynthetic primary production at East Pacific Sea floor spreading centers. BioScience 29(10):592-598.

Jennings, J. R. and P. S. Rainbow. 1979. Studies in the uptake of cadmium by the crab *Carcinus maenus* in the laboratory. 1. Accumulation from seawater and a food source. Mar. Biol. 50(2):131-139.

Johannes, R. E., S. J. Coward and K. L. Webb. 1969. Are dissolved amino acids an energy source for marine invertebrates? Comp. Biochem. Physiol. 29:283-288.

Jones, J. H. 1971. General circulation and water characteristics in the southern California bight. Southern Calif. Coastal Water Res. Proj. 37 pp.

Jorgensen, C. B. 1966. Biology of Suspension Feeding. Pergamon Press, Oxford. 357 pp.

Jebram, D. 1977. Experimental techniques and culture methods. In Biology of Bryozoans. R. M. Woollacott and R. J. Zimmer (eds.). Academic Press, New York. pp. 273-306.

Juge, D. M. and G. Griest. 1973. The roles of microbial activity in the harbor ecosystem. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 2. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 29-64.

Jumars, P. A. and K. Fauchald. 1977. Between-community contrasts in successful polychaete feeding strategies. In Ecology of the Marine Benthos. B. C. Coull (ed.). Univ. So. Carolina Press, Columbia, S. C. pp. 1-20.

Kennedy, G. L. 1975. Paleontologic record of areas adjacent to the Los Angeles-Long Beach Harbors, Los Angeles County, California. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 9. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 119 pp.

Khailov, K. N. and Z. Z. Finenko. 1970. Organic macromolecular compounds dissolved in sea water and their inclusion into food chains. In Marine Food Chains. J. H. Steele (ed.). Univ. California Press, Los Angeles and San Francisco. pp. 5-18.

Kikkawa, J. 1968. Ecological association of bird species and habitats in eastern Australia: similarity analysis. J. Animal Ecol. 37:143-145.

Kitchell, J. F., D. J. Stewart, and D. Weininger. 1977. Applications of a bioenergetics model to yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum. vitreum*). J. Fish. Res. Bd. Canada 34(10):1922-1935.

Koonce, J. F., T. B. Bagenal, R. F. Carline, K. E. F. Hokanson, and M. Nagiec. 1977. Factors influencing year-class strength periods: a summary and a model of temperature effects. J. Fish. Res. Bd. Canada 34(10):1900-1909.

Kremer, J. N. and P. M. Kremer. 1979. Ecological simulation model of Los Angeles Harbor receiving waters. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 17. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 63 pp.

Lance, G. N. and W. T. Williams. 1967. A general theory of classificatory sorting strategies. I. Hierarchical systems. Computer J. 9:373-380.

Landry, M. R. 1978. Predatory feeding behavior of a marine copepod *Labidocera trispinosa*. Limnol. Oceanogr. 23: 1103-1113.

Lasker, R. 1975. Field criteria for survival of anchovy larvae: the relation between inshore chlorophyll maximum layers and successful first feeding. Fish. Bull. 73(3): 453-463.

Lasker, R. 1978. Ocean variability and its biological effects, regional review, Northeast Pacific. Conseil Internatl. pour l'Explor. Mer 173:168-181.

Lasker, R. 1978. The relation between oceanographic conditions and larval anchovy food in the California current: identification of factors contributing to recruitment failure. Conseil Internatl. pour l'Explor. Mer 173:212-230.

Lasker, R. 1978. Unusual oceanographic conditions in the California current, winter 1977-1978. Coastal Oceanogr. and Climatol. Center Ocean Management Stud., Univ. Rhode Island. p. 3.

Lasker, R. 1979. Factors contributing to variable recruitment of the northern anchovy (*Engraulis mordax*) in the California current: contrasting years, 1975 through 1978. ICES, Symposium on the Early Life History of Fish, Mar. Biol. Lab., Woods Hole, Mass. April 2-5, 1979. (in press).

Lasker, R. and J. R. Zweifel. 1978. Growth and survival of first-feeding northern anchovy larvae (*Engraulis mordax*) in patches containing different proportions of large and small prey. In Spatial Pattern in Plankton Communities. J. H. Steele (ed.). Plenum Publishing Corp., New York. pp. 329-354.

Lillelund, K. and R. Lasker. 1971. Laboratory studies of predation by marine copepods on fish larvae. Fish Bull. 69:655-667.

Long Beach, Port of. 1975 General Plan. Appendix II. San Pedro Bay and Port History. 34 pp.

Long Beach, Port of. 1976. Master Environmental Setting. Draft Environmental Impact Report. Soils International, Allan Hancock Foundation and Socio-Economic Systems, Inc. 2 vols.

Los Angeles, City of. Department of Public Works and Los Angeles Harbor Department. 1970. Progress report on upgrading the waters of Los Angeles Harbor for California Regional Water Quality Control Board, Los Angeles region. March, 1970. 16 pp. and appendices.

Los Angeles, City of. Department of Public Works, Bureau of Engineering. 1979. Draft Environmental Impact Report, Terminal Island Treatment Plant Unit IIC.

Los Angeles, Port of. 1976. Comprehensive Master Plan 1990.

Los Angeles Regional Water Quality Control Board. 1969. Review information pertinent to Los Angeles-Long Beach Harbor and Dominguez Channel. May, 1969. 71 pp.

Loukashkin, A. S. 1970. On the diet and feeding behavior of the northern anchovy *Engraulis mordax* (Girard). Proc. Calif. Acad. Sci. 37(13):419-458.

Lowe, H. N. 1899. Dredging off San Pedro. Nautilus 8(3): 27-30.

MacGinitie, G. E. 1939. The method of feeding of tunicates. Biol. Bull. 77:443-447.

MacGinitie, G. E. and N. MacGinitie. 1949. Natural History of Marine Animals. McGraw-Hill, New York. 473 pp. 2nd ed. 1968. 523 pp.

Marshall, N. 1970. Food transfer through the lower trophic levels of the benthic environment. In Marine Food Chains. J. H. Steele (ed.). Univ. California Press, Los Angeles and San Francisco. pp. 52-68.

Marshall, S. M. 1924. The food of *Calanus finmarchicus* during 1923. J. Mar. Biol. Assoc. United Kingdom 13:473-479.

Marshall, S. M. 1949. On the biology of small copepods in Loch Strinen. J. Mar. Biol. Assoc. United Kingdom 28: 45-122.

Marshall, S. M. 1973. Respiration and feeding in copepods. Adv. Mar. Biol. 11:57-120.

Maurer, D., L. Watling, W. Leathem, and P. Kinner. 1979. Seasonal changes in feeding types of estuarine benthic invertebrates from Delaware Bay. J. Exp. Mar. Biol. Ecol. 36:125-155.

McAnally, W. H. Jr. 1975. Tidal verification and base circulation tests. Report 5, Los Angeles and Long Beach Harbors model study. U.S. Army Corps of Engineers Tech. Report H-75-4.

McConaugha, J. R. 1976. Toxicity and heavy metals in three species of crustacea from Los Angeles Harbor sediments. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 49-67.

McDermott, J. J. 1976. Observations of the food and feeding behavior of estuarine nemertean worms belonging to the order Hoplonemertea. Biol. Bull. 150(1):57-68.

Mearns, A. J. 1978. Variations in coastal physical and biological conditions, 1969-78. In Southern Calif. Coastal Water Res. Proj. W. Bascom (ed.). Annual Report, 1978. pp. 147-221.

Menard, H. W. 1974. Geology, Resources, and Society. W. H. Freeman and Co., Inc., New York. 673 pp.

Menzies, R. J. 1951. A new species of *Limnoria*. Bull. So. Calif. Acad. Sci. 50(2):86-88.

Middaugh, D. P., W. R. Davis, and R. L. Yoakum. 1975. The response of larval fish, *Leiostomus xanthurus*, to environmental stress following sublethal cadmium exposure. Univ. Texas Mar. Sci. Instit. Contr. Mar. Sci. 19:13-19.

Millepore Corporation. 1972. Biological Analysis of Water and Wastewater. Millepore Application Manual AM 302. Bedford, Mass.

Miller, D. S. and W. B. Kinter. 1977. *Fundulus heteroclitus*. In Physiological Responses of Marine Biota to Pollutants. F. J. Vernberg, A. Calabrese, F. P. Thurberg, and W. B. Vernberg (eds.). Academic Press, New York. pp. 63-74.

Mohlenberg, F. and H. U. Riisgard. 1978. Efficiency of particle retention in 13 species of suspension feeding bivalves. Ophelia 17(2):239-246.

Monks, S. P. 1893. San Pedro as a collecting ground. Nautilus 7(7):74-77.

Morey-Gaines, G. 1978. Microcosm enrichment studies of tuna cannery waste. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 14. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif. pp. 71-113.

Mullin, M. M. 1963. Some factors affecting the feeding of marine copepods of the genus *Calanus*. Limnol. Oceanogr. 8:239-250.

Nakai, Z., K. Honjo, T. Kidachi, H. Suzuki, T. Yokota, T. Tsujita, E. Ozasa, Y. Shojoma, and S. Nishimura. 1962. Relationships between food organisms and size of recruitment of Iwasi. Suisan Sigen Ni Kasuru Kyodo Kenkyu suisin Kaigi Hokokunsyo, Syowa 36 Nendo. Norin Suisan Gizyoto Kaigi, Japan. pp. 102-121.

Neilsen, E. Steeman. 1952. The use of radioactive carbon (^{14}C) for measuring organic production in the sea. Rapp. Cons. Explor. Mer 144:92-95.

Newell, R. 1965. The role of detritus in the nutrition of two marine deposit feeders, the prosobranch *Hydrobia ulvae* and the bivalve *Macoma baltica*. Proc. Zool. Soc. London 144:25-45.

Nichols, F. H. 1974. Sediment turnover by a deposit-feeding polychaete. Limnol. Oceanogr. 19(6):945-950.

Nichols, F. H. 1975. Dynamics and energetics of three deposit-feeding benthic invertebrate populations on Puget Sound, Washington. Ecol. Monogr. 45(1):57-82.

O'Brien, W. J. 1979. The predator-prey interaction of planktivorous fish and zooplankton. Amer. Sci. 67(5):572-581.

O'Connel, C. P. and L. P. Raymond. 1970. The effect of food density on survival and growth of early post yolk-sac larvae of the northern anchovy (*Engraulis mordax* Girard) in the laboratory. J. Exper. Mar. Biol. Ecol. 5:187-197.

Odum, E. P. and A. A. de la Cruz. 1967. Particulate organic detritus in a Georgia salt marsh estuary ecosystem. In Estuaries. G. H. Lauff (ed.). Amer. Assoc. Adv. Sci., Publ. No. 83:383-388.

Odum, W. E. 1970. Utilization of the direct grazing and plant detritus food chains by the striped mullet *Mugil cephalus*. In Marine Food Chains. J. H. Steele (ed.). Univ. California Press, Los Angeles and San Francisco. pp. 222-240.

Oguri, M. 1976. Primary productivity, chlorophyll a, and assimilation ratios in Los Angeles-Long Beach Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 315-325.

Parkhurst, J. D. 1966. Dominguez Channel study: a chemical, physical, and biochemical evaluation of the water in a man-made tidal channel used for flood control and industrial waste disposal. County Sanitation Districts, Los Angeles County. June-Dec., 1965. 104 pp.

Pentreath, R. J. 1975. The accumulation of metals by marine teleost and elasmobranch fish. Waste Manage. Res. Abstracts 10:76.

Pentreath, R. J. 1977. The accumulation of cadmium by the plaice, *Pleuronectes platessa* L. and the thornback ray, *Raja clavata* L. J. Exp. Mar. Biol. Ecol. 30(3):223-232.

Pettijohn, F. J. 1957. Sedimentary Rocks. 2nd ed. Harper and Row, New York.

Poulet, S. A. and P. Marsot. 1978. Chemosensory grazing by marine calanoid copepods (Arthropoda: Crustacea). Science 200:1403-1405.

Pütter, A. 1909. Die Ernährung der Wassertiere und der Stoffhaushalt der Gewässer. Fischer, Jena.

Qasim, S. Z. and V. N. Sankaranarayanan. 1972. Organic detritus of a tropical estuary. Mar. Biol. 15:193-199.

Radovich, J. 1952. Food of the Pacific sardine, *Sardinops caerulea*, from central Baja California and southern California. Calif. Fish and Game Bull. 38(4):575-585.

Raymont, J. E. G. 1963. Plankton and Productivity in the Oceans. Pergamon Press, New York. 660 pp.

Raymont, J. E. G. 1964. The marine fauna of Southampton Water. In A Survey of Southampton and Its Region. F. S. Monkhouse (ed.). Brit. Assoc. Adv. Sci., Southampton.

Reeve, M. R. 1970. Seasonal changes in the zooplankton of south Biscayne Bay and some problems of assessing the effects on the zooplankton of natural and artificial and other fluctuations. Bull. Mar. Sci. 20:894-921.

Reed, J. L. 1960. Oceanography of the northeastern Pacific Ocean during the last ten years. Calif. Coop. Ocean Fish. Invest. Repts. 7:77-90.

Reish, D. J. 1959. An ecological study of pollution in Los Angeles-Long Beach Harbors, California. Allan Hancock Found. Occas. Paper 22. 119 pp.

Reish, D. J. 1971. Effect of pollution abatement on populations of marine organisms of Los Angeles Harbors. Mar. Pollut. Bull. 2(5):71-74.

Reish, D. J. 1977. The effects of heavy metals on polychaetous annelids. Rev. Intern. d'Océanogr. Médical. 49:99.

Reish, D. J. and J. L. Barnard. 1979. Amphipods (Arthropoda: Crustacea: Amphipoda). In Pollution Ecology of Estuarine Invertebrates. C. W. Hart Jr. and S. L. H. Fuller (eds.). Academic Press, New York. pp. 345-370.

Reish, D. J. and K. E. King. 1976. Concentrations of trace metals in marine organisms. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 299-314.

Reish, D. J., S. S. Rossi, A. J. Mearns, P. S. Oshida, and F. G. Wilkes. 1979. Marine and estuarine pollution. J. Water Poll. Control Fed. 51(6):1477-1517.

Reish, D. J. and R. Ware. 1976. The food habits of marine fish in the vicinity of Fish Harbor in outer Los Angeles Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 12. Allan Hancock

Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 113-128.

Ricketts, E. F., J. Calvin, and J. Hedgpeth. 1968. Between Pacific Tides. Stanford Univ. Press, Stanford, Calif. 4th ed. 614 pp.

Rhoads, D. C. and D. K. Young. 1971. Animal-sediment relations in Cape Cod Bay, Massachusetts. II. Reworking by *Molpadia oolitica* (Holothuroidea). Mar. Biol. 11:255-261.

Riley, G. A. 1963. Organic aggregates in seawater and the dynamics of their formation and utilization. Limnol. Oceanogr. 8:372-381.

Ritter, W. E. 1905. A general statement of the ideas and present aims and status of the Marine Biological Association of San Diego. Univ. Calif. Publ. Zool. 2:i-xvii.

Robinson, K. S. and H. Porath. 1974. Current measurements in the outer Los Angeles Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 6. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 91 pp.

Roper, M. M. and K. C. Marshall. 1978. Biological control agents of sewage bacteria in marine habitats. Australian J. Mar. Freshwater Res. 29:335-343.

Saunders, G. W. 1967. Some aspects of feeding in zooplankton. In Eutrophication: Causes, Consequences, Corrections. Nat. Acad. Sci., Washington, D.C. pp. 556-573.

Schafer, H. A. 1977. Characteristics of municipal wastewater discharges, 1976. Southern Calif. Coastal Water Res. Proj., Annual report, 1977. 6 pp.

Schreck, C. B. and H. W. Lorz. 1978. Stress response of coho salmon (*Oncorhynchus kisutch*) elicited by cadmium and copper and potential use of cortisol as an indicator of stress. J. Fish. Res. Bd. Canada 35(8):1124-1129.

Sibert, J. and T. J. Brown. 1975. Characteristic and potential significance of heterotrophic activity in a polluted fjord estuary. J. Exp. Mar. Biol. Ecol. 19:97-104.

Smith, R. W. 1976. Numerical analysis of ecological survey data. Ph.D. dissertation, Univ. So. Calif., Dept. of Biol. Sci. 401 pp.

Smith, R. W. 1979. Ecological Analysis Package. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 16. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 547-597.

Solorzano, L. 1969. Determination of ammonia in natural waters by the phenolhypochlorite method. Limnol. Oceanogr. 14(5): 799-801.

Soule, D. F. 1974. Thermal effects and San Pedro Bay. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 3. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 1-20.

Soule, D. F. 1976. Bioassay and recolonization studies in the outer Los Angeles Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 91-153.

Soule, D. F. and M. Oguri. 1972. Circulation patterns in Los Angeles-Long Beach Harbor. Drogue study atlas and data report. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 1. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 113 pp.

Soule, D. F. and M. Oguri. 1973. Biological investigations: preliminary investigations of the role of cannery wastes in the Los Angeles Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 2. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 113 pp.

Soule, D. F. and M. Oguri. 1974. Data report: temperature, salinity, oxygen and pH in outer Los Angeles Harbor. June 1971 to November 1973. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 5. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 1-76.

Soule, D. F. and M. Oguri. 1976a. Potential effects of dredging on the biota of outer Los Angeles Harbor. Marine Studies of San Pedro Bay, California. Part 11. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. 325 pp.

Soule, D. F. and M. Oguri. 1976b. Bioenhancement studies of the receiving waters in outer Los Angeles Harbor. Marine Studies of San Pedro Bay, California. Part 12. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles.

Soule, D. F. and M. Oguri. 1978a. Biological investigations. Marine Studies of San Pedro Bay, California. Part 14. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. 164 pp.

Soule, D. F. and M. Oguri. 1978b. The impact of the *Sansinena* explosion and Bunker C spill on the marine environment of outer Los Angeles Harbor. Marine Studies of San Pedro Bay, California. Part 15. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. 258 pp.

Soule, D. F. and M. Oguri. 1979a. Ecological changes in outer Los Angeles-Long Beach Harbors since the initiation of secondary waste treatment and cessation of fish cannery waste effluent at Terminal Island, California. A report to the Environmental Protection Agency (Draft). Harbors Environmental Projects. Univ. So. Calif., Los Angeles. 321 pp.

Soule, D. F. and M. Oguri. 1979b. Ecological changes in outer Los Angeles-Long Beach Harbors following initiation of secondary waste treatment and cessation of fish cannery waste effluent. Marine Studies of San Pedro Bay, California. Part 16. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 597 pp.

Soule, D. F. and M. Oguri. 1979c. The marine environment in Los Angeles and Long Beach Harbors during 1978. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 17. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles.

Soule, D. F. and J. D. Soule. 1979. Bryozoa (Ectoprocta). In Pollution Ecology of Estuarine Invertebrates. C. W. Hart Jr. and S. L. H. Fuller (eds.). Academic Press, New York. pp. 35-76.

Soule, D. F., J. D. Soule, and C. Henry. 1979. The influence of environmental factors on the distribution of estuarine bryozoans, as determined by multivariate analysis. In Advances in Bryozoology. G. P. Larwood and M. B. Abbott (eds.). Academic Press, London. pp. 347-372.

Southern California Coastal Water Research Project. 1973. Ecology of the Southern California Bight. TR 104. 551 pp.

Southern California Coastal Water Research Project. 1974. Annual Report for the year ended 30 June 1974. 197 pp.

Southern California Coastal Water Research Project. 1975. Annual Report for the year ended 30 June 1975. 211 pp.

Southern California Coastal Water Research Project. 1976. Annual Report for the year ended 30 June 1976. 263 pp.

Southern California Coastal Water Research Project. 1977. Annual Report for the year ended 30 June 1977. 253 pp.

Southern California Coastal Water Research Project. 1978. Annual Report for the year ended 30 June 1978. 253 pp.

Stanley-Miller, J., P. Kremer and W.-L. Chiang. 1976. Quantification of the assimilation capacity of outer Los Angeles Harbor: a dynamic oxygen model. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 12. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 59-112.

Stauffer, G. D. 1979. Estimate of the spawning biomass of the northern anchovy central subpopulation for the 1979-80 fishing season. Natl. Mar. Fish. Serv., Southwest Fish. Center, La Jolla, Calif. CA Admin. Report No. LJ-79-22. 13 pp.

Steele, J. H. (ed.). 1970. Marine Food Chains. Univ. California Press, Los Angeles and San Francisco. 552 pp.

Steele, J. H. (ed.). 1978. Spatial Patterns in Plankton Communities. Plenum Publishing Corp., New York.

Steele, J. H. and I. A. Baird. 1972. Sedimentation of organic matter in a Scottish sea loch. Mem. 1st Ital. Idrobiol. 29 Suppl.:73-88.

Stephens, G. C. 1968. Dissolved organic matter as a potential source of nutrition for marine organisms. Amer. Zool. 8: 95-106.

Stephens, G. C. 1975. Uptake of naturally occurring primary amines by marine annelids. Biol. Bull. 149:397-407.

Stephens, G. C. and R. A. Schinske. 1961. Uptake of amino acids by marine invertebrates. Limnol. Oceanogr. 6:175-181.

Stephens, J. S. Jr. 1976. Impact of the master plan on fish populations of Los Angeles Harbor. In Allan Hancock Foundation. Environmental investigations and analyses, Los Angeles-Long Beach Harbors 1973-1976. Final report to the U.S. Army Corps of Engineers, Los Angeles district. Harbors Environmental Projects, Allan Hancock Found., Univ. So. Calif., Los Angeles. pp. 263-269.

Stephens, J. S. Jr. 1979. Changes in fish populations in Los Angeles-Long Beach Harbors as estimated from trawl data. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 16. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 41-43.

Stephens, J. S. Jr., D. Gardiner, and C. Terry. 1973. The demersal fish populations of San Pedro Bay, California. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 11. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. 237 pp.

Stephens, J. S. Jr., C. Terry, S. Subber, and M. J. Allen. 1974. Abundance, distribution, seasonality, and productivity of the fish populations in Los Angeles Harbor, 1972-1973. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 4. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 1-43.

Stevens, J. D. and B. E. Brown. 1974. Occurrence of heavy metals in the blue shark, *Prionace glauca* and selected pelagic fish in the northeast Atlantic ocean. Mar. Biol. 26(4):287-293.

Stevenson, J. C., D. R. Heinle, D. A. Flemer, R. J. Small, R. A. Rowland, and J. F. Ustach. 1976. Nutrient exchanges between brackish water marshes and the estuary. Estuarine Processes. Martin Wiley (ed.). Academic Press, New York. Vol. 2. pp. 219-241.

Stevenson, R. E. and K. O. Emery. 1958. Marshlands at Newport Bay, California. Allan Hancock Found. Occas. Paper 20. 109 pp.

Stevenson, R. E., R. B. Tibby, and D. S. Gorsline. 1956. Oceanography of Santa Monica Bay. Allan Hancock Found. Report to the City of Los Angeles, Hyperion Engineering. 2 vols. 268 pp.

Straughan, D. 1975. Intertidal sandy beach macrofauna at Los Angeles-Long Beach Harbor. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 8. Allan Hancock Found. and Sea Grant Prog., Univ. So. Calif., Los Angeles. pp. 75-108.

Straughan, D. 1977. Influence of power generating facilities on southern California coastal waters. Phase 3: Study of environmental conditions in King Harbor, April 1, 1976-March 31, 1977. Report on field biology of subtidal unstable substrates. Southern California Edison, Los Angeles. 77-RD-52. 125 pp.

Strickland, J. D. H. and T. R. Parsons. 1968. A Practical Handbook of Seawater Analysis. Fish. Res. Bd. Canada Bull. 167. 311 pp.

Strickland, J. D. and T. R. Parsons. 1972. Determination of reactive phosphorus. In A Practical Handbook of Seawater Analysis. J. D. Strickland and T. R. Parsons (eds.). 2nd ed. Fish. Res. Bd. Canada Bull. pp. 49-52.

Suchanek, T. H. Jr. and C. Grossman. 1971. Viability of zooplankton. In Studies on the effects of a steam-electric generating plant in the marine environment at Northport. G. C. Williams, J. B. Mitton, T. H. Schanek, Jr., N. Gebelein, C. Grossman, J. Pearce, J. Young, C. E. Taylor,

R. Mulstay, and C. D. Hardy (eds.). Tech. Rep. No. 9, Mar. Sci. Res. Center, State Univ. of New York. pp. 61-74.

Sullivan, C. W., A. Palmisano, S. McGrath, D. Krempin, and G. Taylor. 1978. Microbial standing stocks and metabolic activities of microheterotrophs in southern California coastal waters. In Marine Studies of San Pedro Bay, California. D. Soule and M. Oguri (eds.). Part 14. Allan Hancock Found. and Sea Grant Prog., Instit. Mar. Coast. Stud., Univ. So. Calif., Los Angeles. pp. 1-24.

Sverdrup, H. U., M. W. Johnson, and R. H. Fleming. 1946. The Oceans. Prentice-Hall, New York. 1087 pp.

Talmadge, S. S. and C. C. Coutant. 1978. Thermal effects. J. Water Poll. Control Fed. 50(6):1514-1553.

Talmadge, S. S. and C. C. Coutant. 1979. Thermal effects. J. Water Poll. Control Fed. 51(6):1477-1517.

Tenore, K. R. 1975. Detrital utilization by the polychaete *Capitella capitata*. J. Mar. Res. 33(3):261-274.

Tenore, K. R. 1977. Growth of *Capitella capitata* cultured on various levels of detritus derived from different sources. Limnol. Oceanogr. 22(5):936-941.

Tenore, K. R. 1977. Food chain pathways in detrital feeding benthic communities: a review with new observations on sediment resuspension and detrital recycling. In Ecology of Marine Benthos. B. C. Coull (ed.). Univ. So. Carolina Press, Columbia, S. C. pp. 37-54.

Tenore, K. R. and U. K. Gopalan. 1974. Feeding efficiencies of the polychaete *Nereis virens* cultured on hard-clam tissue and oyster detritus. J. Fish. Res. Bd. Canada 31(10):1675-1678.

Teshima, S. and K. Kashiwada. 1967. Studies on the production of B vitamins by intestinal bacteria of fish. III. Isolation of vitamin B_{12} synthesizing bacteria and their bacteriological properties. Bull. Japan. Soc. Scient. Fish. 33:979-983.

Tietjen, J. H. 1977. Population distribution and structure of the free-living nematodes of Long Island Sound. Mar. Biol. 43:123-136.

Tietjen, J. H. and J. J. Led. 1977. Feeding behavior of marine nematodes. In Ecology of Marine Benthos. B. C. Coull (ed.). Univ. So. Carolina Press, Columbia, S. C. pp. 21-35.

Trinast, E. M. 1976. A preliminary note on *Acartia californiensis*, a new calanoid copepod from Newport Bay, California. Crustaceana 31:54-58.

Turner, J. T. and J. G. Ferrante. 1979. Zooplankton fecal pellets in aquatic ecosystems. BioScience 29(11):670-677.

Twenhofel, W. H. 1950. Principles of Sedimentation. McGraw-Hill Book Co., Inc., New York. 673 pp.

Ulrey, A. B. and P. O. Greeley. 1928. List of marine fishes (Teleostii) of Southern California with their distribution. Bull. So. Calif. Acad. Sci. 27(1):1-53.

U.S. Army Engineer District, Los Angeles County, California. 1972. Preliminary Draft Environment Statement. Los Angeles-Long Beach Harbors. November, 1972. 58 pp. and appendices.

U.S. Army Engineers. 1974. Los Angeles-Long Beach Harbors, Los Angeles County, California. Final Environmental Statement. Office of the Chief of Engineers, Department of the Army, Washington, D.C., October, 1974.

Vernberg, F. J., M. S. Guram and A. Savory. 1977. Survival of larval and adult fiddler crabs exposed to Arochor 1016 and 1254 and different temperature salinity combinations. In Physiological Responses of Marine Biota to Pollutants. F. J. Vernberg, A. Calabrese, F. P. Thurburg and W. B. Vernberg (eds.). Academic Press, New York. pp. 37-50.

Vernberg, F. J. and W. B. Vernberg. 1970. The Animal and the Environment. Holt, Rinehart and Winston, New York. 398 pp.

Vernberg, F. J. and W. B. Vernberg (eds.). 1974. Pollution and Physiology of Marine Organisms. Academic Press, New York. 487 pp.

Waggoner, J. P. III and C. R. Feldmeth. 1971. Sequential mortality of the fish fauna impounded in construction of a marina at Dana Point, California. Calif. Fish and Game Bull. 57(3):167-176.

Warren, L. M. 1977. The ecology of *Capitella capitata* in British waters. J. Mar. Biol. Assoc. United Kingdom 57(1):151-159.

White, G. W. 1896. Collecting in southern California. Nautilus 9(9):102-104.

Wickstead, J. H. 1962. Food and feeding in pelagic copepods. Proc. Zool. Soc. London 139:545-555.

Widdows, J. 1978. Combined effects of body size, food concentration and season on the physiology of *Mytilus edulis*. J. Mar. Biol. Assoc. United Kingdom 58(1):109-124.

Widdows, J., P. Fieth, and C. M. Worrall. 1979. Relationships between season, available food and feeding activity in the common mussel *Mytilus edulis*. Mar. Biol. 50(3)195-207.

Widdows, J., M. N. Moore, D. M. Lowe, and P. N. Salkeld. 1979. Some effects of a dinoflagellate bloom (*Gyrodinium aureolum*) on the mussel *Mytilus edulis*. J. Mar. Biol. Assoc. United Kingdom 59(2):522-524.

Williamson, M. B. 1892. An annotated list of the shells of San Pedro Bay and vicinity. Proc. United States Nat. Mus. 15:179-220.

Williamson, M. B. 1905. Some West American shells, including a new variety of *Corbula luteola* Carpenter and two new varieties of gastropods. Bull. So. Calif. Acad. Sci. 4(8):118-129.

Winston, J. E. 1977. Feeding in marine bryozoans. In Biology of Bryozoans. R. M. Woollacott and R. L. Zimmer (eds.) Academic Press, New York. pp. 233-271.

Word, J. Q. 1976. Biological comparison of grab sampling devices. So. Calif. Coast. Water Res. Proj. Annual Report. pp. 189-194.

Yonge, C. M. 1954. Food of invertebrates and feeding mechanisms in the Invertebrata. Tabulae Biol. 21(3):25-68.

Yonge, C. M. and T. E. Thompson. 1976. Living Marine Mollusks. William Collins Sons and Co. Ltd., London. 288 pp.

Young, D. R., D. L. McDermott, and T. C. Heezen. 1976. DDT in sediments and organisms around southern California outfalls. J. Water Poll. Control Fed. 48:1919.

Young, D. R. and A. J. Mearns. 1978. Pollutant flow through food webs. So. Calif. Coast. Water Res. Proj. Annual Report. pp. 185-202.

Young, P. H. 1964. Some effects of sewer effluent on marine life. Calif. Fish and Game Bull. 50(1):33-41.

Zielbauer, J. E., H. A. Kues, W. L. Burnham, and A. G. Keene. 1962. Dominguez Gap Barrier Project. Geological Investigation. Los Angeles County Flood Control District.

ZoBell, C. E. 1942. The bacterial flora of a marine flat as an ecological factor. Ecology 23:69-78.

ZoBell, C. E. and D. Q. Anderson. 1936. Observations on the multiplication of bacteria in different volumes of stored sea water and the influence of oxygen tension and solid surfaces. Biol. Bull. 71:324-342.

APPENDIX A

PHYSICAL WATER QUALITY DATA

LOS ANGELES-LONG BEACH HARBORS

DECEMBER 1977 - DECEMBER 1978

PHYSICAL WATER QUALITY DATA, LOS ANGELES-LONG BEACH HARBORS
DECEMBER 1977 - DECEMBER 1978

DATE: DECEMBER 6, 1977 TIME: 1418

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		34.0	8.5	8.17	
01	3.3	17.9		34.0	8.5	8.17	
02	6.6	17.9		34.0	8.4	8.16	
03	9.8	17.9		34.0	8.3	8.14	
04	13.1	17.9		34.0	7.9	8.13	
05	16.4	17.9		34.0	7.9	8.13	
06	19.7	17.9		34.0	7.7	8.11	
07	23.0	17.9		34.0	7.6	8.07	
08	26.2	17.9		34.0	7.6	8.06	
09	29.6	17.8		34.0	7.5	8.06	
10	32.8	17.8		34.1	7.1	8.03	
11	36.1	17.7		34.1	7.0	8.02	
12	39.2	17.7		34.0	6.7	8.01	
13	42.6	17.7		33.9	6.5	7.99	
14	45.9	17.6		33.9	6.5	7.99	
15	49.2	17.6		33.9	6.3	7.98	
16	52.5	17.6		33.9	6.2	7.92	
17	55.8	17.4		33.9	6.1	7.97	
18	59.0	17.3		33.9	6.0	7.96	
19	62.3	16.8		33.9	5.8	7.95	
20	65.6	16.7		33.9	5.8	7.94	
21	68.9	16.5		34.0	5.7	7.92	
22	72.1	16.4		34.0	5.1	7.90	

DATE: DECEMBER 6, 1977 TIME: 0845

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		34.5	8.9	8.15	
01	3.3	17.5		34.8	8.3	8.13	
02	6.6	17.5		34.9	8.9	8.13	
03	9.8	17.5		34.8	8.8	8.15	
04	13.1	17.5		34.9	9.4	8.21	
05	16.4	17.5		34.9	9.8	8.22	
06	19.7	17.4		34.9	10.1	8.23	
07	23.0	17.4		34.9	10.0	8.17	
08	26.2	17.3		33.8	9.8	8.20	
09	29.6	17.3		34.8	10.0	8.21	
10	32.8	17.2		34.7	9.9	8.23	
11	36.1	17.2		34.7	9.9	8.23	
12	39.2	17.1		34.7	9.8	8.25	
13	42.6	16.9		34.7	9.7	8.27	

DATE: DECEMBER 6, 1977 TIME: 0858

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		34.0	8.0	8.22	
01	3.3	17.6		34.4	8.3	8.22	
02	6.6	17.6		34.6	9.3	8.26	
03	9.8	17.5		34.7	9.6	8.32	
04	13.1	17.5		34.8	5.8	8.31	
05	16.4	17.4		34.7	5.6	8.29	
06	19.7	17.3		34.7	8.8	8.30	
07	23.0	17.3		34.6	8.1	8.26	

DATE: DECEMBER 6, 1977 TIME: 0925

STATION: A4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		35.5	5.3	8.11	
01	3.3	17.9		35.5	5.2	8.05	
02	6.6	17.8		35.8	5.5	8.10	
03	9.8	17.7		35.7	6.9	8.24	
04	13.1	17.6		35.6	7.7	8.29	
05	16.4	17.5		33.6	7.3	8.32	

DATE: DECEMBER 6, 1977 TIME: 0945

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		34.5	5.6	8.25	
01	3.3	17.9		35.0	8.3	8.35	
02	6.6	17.8		35.2	8.6	8.37	
03	9.8	17.7		35.3	7.6	8.31	
04	13.1	17.7		35.3	6.8	8.17	

DATE: DECEMBER 6, 1977 TIME: 0807

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		34.7	7.2	7.80	
01	3.3	17.7		34.9	7.9	7.83	
02	6.6	17.7		34.9	7.7	7.83	
03	9.8	17.6		34.9	8.3	7.87	
04	13.1	17.4		35.2	9.8	7.97	
05	16.4	17.4		35.2	9.7	7.97	
06	19.7	17.4		35.2	9.6	7.96	
07	23.0	17.3		35.1	9.6	7.84	

DATE: DECEMBER 6, 1977 TIME: 0817

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		34.1	6.3	7.83	
01	3.3	17.5		34.6	7.5	7.81	
02	6.6	17.4		33.7	7.7	7.80	
03	9.8	17.6		34.8	8.0	7.80	
04	13.1	17.6		34.8	8.0	7.80	
05	16.4	17.5		34.9	8.1	7.81	
06	19.7	17.5		34.9	8.2	7.81	
07	23.0	17.5		35.0	8.4	7.72	
08	26.2	17.5		35.0	8.3	7.68	
09	29.6	17.4		35.0	8.7	7.69	
10	32.8	17.3		35.2	9.8	7.64	
11	36.1	17.3		35.2	10.0	7.84	
12	39.2	17.2		35.3	9.7	7.87	
13	42.6	17.2		35.3	9.8	7.96	
14	45.9	17.2		35.3	9.8	8.06	
15	49.2	17.1		35.3	9.7	8.04	
16	52.5	17.0		35.3	9.7	8.07	

DATE: DECEMBER 6, 1977 TIME: 1458

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		33.9	8.9	8.27	
01	3.3	17.9		33.9	8.7	8.26	
02	6.6	17.9		33.9	8.4	8.23	
03	9.8	17.9		34.1	7.8	8.20	
04	13.1	17.7		34.1	7.7	8.21	
05	16.4	17.7		34.2	7.9	8.21	
06	19.7	17.7		34.2	8.1	8.23	
07	23.0	17.6		34.2	8.3	8.24	
08	26.2	17.6		34.2	8.2	8.22	
09	17.5	17.5		34.3	8.5	8.18	
10	32.8	17.3		34.2	6.3	8.16	
11	36.1	17.2		34.3	6.2	8.13	
12	39.2	16.9		34.4	6.5	8.07	

DATE: DECEMBER 6, 1977 TIME: 1447

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		34.1	7.1	8.21	
01	3.3	18.1		34.0	7.0	8.20	
02	6.6	18.1		34.1	7.1	8.21	
03	9.8	18.0		34.1	7.3	8.24	
04	13.1	18.0		34.2	7.8	8.26	
05	16.4	18.0		34.2	7.4	8.28	
06	19.7	17.9		34.2	7.4	8.25	
07	23.0	17.8		34.2	7.4	8.23	
08	26.2	17.7		34.2	7.3	8.21	
09	29.6	17.7		34.2	6.7	8.17	
10	32.8	17.7		34.3	6.6	8.13	
11	36.1	17.5		34.3	6.5	8.13	
12	39.2	17.2		34.2	5.7	8.09	

DATE: DECEMBER 6, 1977 TIME: 1521

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		33.9	6.7	8.17	
01	3.3	18.1		33.8	6.6	8.15	
02	6.6	18.1		33.9	6.5	8.13	
03	9.8	18.1		33.9	6.3	8.12	
04	13.1	18.1		33.9	6.1	8.11	
05	16.4	18.1		33.9	5.7	8.07	
06	19.7	18.0		33.8	5.7	8.07	
07	23.0	18.0		34.1	5.5	8.04	
08	26.2	17.7		34.2	5.1	8.01	

DATE: DECEMBER 6, 1977 TIME: 1537

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		33.9	7.8	8.20	
01	3.3	18.1		33.9	7.7	8.19	
02	6.6	18.1		33.9	7.6	8.20	
03	9.8	18.1		33.9	7.6	8.19	
04	13.1	18.1		33.9	7.3	8.17	
05	16.4	18.0		34.0	7.1	8.15	
06	19.7	17.9		34.0	7.1	8.15	
07	23.0	17.8		34.1	7.0	8.13	
08	26.2	17.4		34.1	6.7	8.07	
09	29.6	17.8		34.1	6.7	8.06	

DATE: DECEMBER 6, 1977 TIME: 1431

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		34.1	7.9	8.21	
01	3.3	18.0		34.1	7.8	8.20	
02	6.6	18.0		34.0	7.9	8.21	
03	9.8	18.0		34.0	8.0	8.23	
04	13.1	18.0		34.0	7.7	8.18	
05	16.4	18.0		33.9	7.8	8.14	
06	19.7	17.9		33.9	6.9	8.12	
07	23.0	17.9		33.7	6.7	8.11	
08	26.2	17.8		33.7	7.0	8.09	
09	29.6	17.8		33.7	7.1	8.09	
10	32.8	17.7		33.9	7.3	8.13	
11	36.1	17.5		33.9	7.0	8.12	

DATE: DECEMBER 13, 1977 TIME: 1137

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		37.8	12.4	8.86	80.0
01	3.3	16.7		37.8	12.4	8.81	92.0
02	6.6	16.6		37.9	12.4	8.79	92.0
03	9.8	16.6		37.6	12.4	8.76	92.0
04	13.1	16.6		37.8	12.4	8.73	92.0
05	16.4	16.6		37.8	12.4	8.73	92.0
06	19.7	16.6		37.7	12.5	8.73	92.0
07	23.0	16.6		37.7	12.5	8.72	92.0
08	26.2	16.6		37.7	12.6	8.72	92.0
09	29.6	16.6		37.6	12.6	8.72	92.0
10	32.8	16.6		37.6	12.8	8.72	92.0
11	36.1	16.6		37.5	12.8	8.72	92.0
12	39.2	16.5		37.6	12.7	8.71	92.0
13	42.6	16.5		37.5	12.8	8.71	92.0
14	45.9	16.5		37.5	12.8	8.71	92.0
15	49.2	16.5		37.4	12.7	8.73	91.5
16	52.5	16.4		37.4	12.4	8.73	91.5
17	55.8	16.4		37.4	12.4	8.74	89.5
18	59.0	16.2		37.4	12.0	8.73	89.0
19	62.3	16.1		37.4	11.9	8.76	81.5
20	65.6	16.1		37.4	11.9	8.77	76.0

DATE: DECEMBER 13, 1977 TIME: 1258

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		38.3	9.9	8.78	62.0
01	3.3	17.4		38.3	10.7	8.78	64.0
02	6.6	17.3		38.3	10.1	8.77	66.5
03	9.8	17.2		38.2	10.1	8.76	68.0
04	13.1	17.2		38.2	9.9	8.75	68.0
05	16.4	17.2		38.1	9.7	8.74	69.0
06	19.7	17.2		38.1	9.6	8.75	70.0
07	23.0	17.2		38.1	9.6	8.76	70.0
08	26.2	17.2		38.0	9.5	8.76	70.5
09	29.6	17.2		38.0	9.2	8.75	70.0
10	32.8	17.2		37.8	9.6	8.75	70.0
11	36.1	17.2		37.8	9.8	8.76	70.0
12	39.2	17.2		37.8	9.5	8.76	69.5
13	42.6	17.2		37.8	10.0	8.77	69.5
14	45.9	17.2		37.7	9.7	8.77	69.0
15	49.2	17.2		37.7	9.5	8.78	69.0
16	52.5	17.2		37.6	8.3	8.78	67.5

DATE: DECEMBER 13, 1977 TIME: 1116

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		39.4	12.2	8.72	51.0
01	3.3	17.0		38.6	11.8	8.71	66.0
02	6.6	17.0		38.4	11.6	8.68	75.0
03	9.8	17.0		38.2	11.4	8.67	79.0
04	13.1	16.9		38.0	11.8	8.65	80.0
05	16.4	16.9		37.9	11.8	8.64	81.0
06	19.7	16.9		37.9	11.8	8.64	81.0
07	23.0	16.9		38.0	11.8	8.63	81.0
08	26.2	16.9		37.9	11.3	8.63	81.0
09	29.6	16.9		38.2	11.8	8.63	81.0
10	32.8	16.9		38.1	11.7	8.63	81.5
11	36.1	16.9		38.1	11.6	8.63	81.0
12	39.2	16.9		38.1	11.4	8.63	81.0
13	42.6	16.9		38.1	11.4	8.63	81.0
14	45.9	16.9		38.0	11.6	8.63	80.5
15	49.2	16.9		38.0	11.7	8.63	82.0
16	52.5	16.9		38.0	11.7	8.63	82.5
17	55.8	16.9		38.0	11.5	8.63	82.0
18	59.0	16.8		37.9	11.8	8.63	82.5
19	62.3	16.9		37.9	11.9	8.64	82.0
20	65.6	16.9		37.8	12.0	8.64	82.0

DATE: DECEMBER 13, 1977 TIME: 1316

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		37.5	12.0	8.88	87.0
01	3.3	17.5		37.6	10.8	8.82	74.0
02	6.6	17.5		37.6	10.8	8.80	73.0
03	9.8	17.3		37.6	10.5	8.78	73.0
04	13.1	17.3		37.6	10.4	8.77	72.0
05	16.4	17.2		37.6	10.7	8.77	73.0
06	19.7	17.2		37.7	10.8	8.78	75.0
07	23.0	17.2		37.7	10.9	8.78	76.0
08	26.2	17.2		37.7	11.0	8.78	76.0
09	29.6	17.1		37.7	10.8	8.79	76.0
10	32.8	17.1		37.6	10.7	8.79	76.0
11	36.1	17.1		37.6	10.7	8.79	76.0
12	39.2	17.1		37.6	10.7	8.80	76.0
13	42.6	17.1		37.6	10.7	8.81	76.0
14	45.9	17.0		37.5	11.0	8.81	77.0
15	49.2	17.0		37.5	11.0	8.82	77.0
16	52.5	17.0		37.5	11.2	8.83	77.0
17	55.8	17.0		37.5	10.7	8.83	78.0
18	59.0	17.0		37.6	10.7	8.85	79.0
19	62.3	17.0		37.6	10.9	8.86	78.0

DATE: DECEMBER 13, 1977 TIME: 0805

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		35.5	9.4	8.47	56.0
01	3.3	17.4		36.2	9.9	8.46	70.0
02	6.6	17.4		36.3	9.4	8.48	74.5
03	9.8	17.5		36.4	9.8	8.48	78.0
04	13.1	17.6		36.4	9.7	8.48	77.0
05	16.4	17.4		36.3	9.7	8.51	77.0
06	19.7	17.4		36.4	9.7	8.51	77.0
07	23.0	17.4		36.4	9.8	8.53	77.0
08	26.2	17.4		36.2	9.7	8.53	77.0
09	29.6	17.4		36.1	9.6	8.53	77.0
10	32.8	17.4		36.0	9.8	8.54	77.0
11	36.1	17.4		36.0	9.8	8.55	76.0
12	39.2	17.3		36.6	9.6	8.56	74.0
13	42.6	17.3		36.1	9.6	8.57	72.0
14	45.9	17.3		36.5	9.6	8.58	71.5
15	49.2	17.2		36.6	9.6	8.62	70.0
16	52.5	17.2		36.6	9.7	8.62	69.0
17	55.8	17.2		36.7	9.8	8.65	68.0
18	59.0	17.2		36.7	9.8	8.66	66.0
19	62.3	17.2		36.8	9.9	8.68	64.0
20	65.6	17.2		36.8	9.9	8.70	

DATE: DECEMBER 13, 1977 TIME: 0747

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		34.6	9.0	8.45	64.0
01	3.3	17.6		35.4	8.4	8.41	70.0
02	6.6	17.6		35.6	8.5	8.39	72.0
03	9.8	17.6		36.1	8.7	8.38	75.0
04	13.1	17.6		36.2	8.0	8.38	76.0
05	16.4	17.6		36.3	8.1	8.38	76.5
06	19.7	17.6		36.3	8.0	8.40	77.0
07	23.0	17.6		36.2	7.8	8.41	77.0
08	26.2	17.6		36.2	8.3	8.42	75.5
09	29.6	17.6		36.2	8.1	8.44	75.0
10	32.8	17.6		36.1	8.4	8.46	74.0
11	36.1	17.5		36.1	8.5	8.47	73.5
12	39.2	17.8		36.1	8.3	8.49	72.0

DATE: DECEMBER 13, 1977 TIME: 0725

STATION: B7

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		36.7	9.3	8.27	76.0
01	3.3	17.8		36.6	8.7	8.23	77.0
02	6.6	17.6		36.4	8.8	8.23	76.0
03	9.8	17.6		36.5	8.6	8.24	75.0
04	13.1	17.6		36.4	8.4	8.25	76.0
05	16.4	17.6		36.4	8.5	8.26	77.0
06	19.7	17.6		36.4	8.1	8.27	76.0
07	23.0	17.6		36.4	7.9	8.30	77.0
08	26.2	17.6		36.3	7.6	8.31	76.5
09	29.6	17.6		36.3	8.2	8.32	77.0
10	32.8	17.6		36.3	8.3	8.35	76.0
11	36.1	17.6		36.2	7.6	8.41	74.0
12	39.2	17.6		36.2	8.1	8.42	73.0
13	42.6	17.6		36.2	8.5	8.44	71.0
14	45.9	17.5		36.2	8.2	8.48	68.0
15	49.2	17.5		36.2	7.8	8.54	66.0
16	52.5	17.5		36.7	7.5	8.58	62.5
17	55.8	17.5		36.7	7.8	8.59	64.0
18	59.0	17.5		36.7	7.4	8.64	60.0

DATE: DECEMBER 6, 1977 TIME: 1506

STATION: B8

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		33.7	8.7	8.27	
01	3.3	17.9		33.7	8.7	8.27	
02	6.6	17.9		33.8	8.5	8.25	
03	9.8	17.8		33.8	8.5	8.23	
04	13.1	17.8		33.8	8.2	8.20	
05	16.4	17.8		33.8	8.1	8.19	
06	19.7	17.7		33.8	7.7	8.18	
07	23.0	17.7		33.9	7.6	8.14	
08	26.2	17.7		33.9	7.3	8.11	
09	29.6	17.7		33.9	7.1	8.10	
10	32.8	17.6		34.0	7.0	8.08	
11	36.1	17.5		34.0	6.7	8.06	
12	39.2	17.4		34.0	6.8	8.03	
13	*42.6	17.4		34.1	6.1	8.00	
14	45.9	17.3		34.1	5.8	7.97	

DATE: DECEMBER 13, 1977 TIME: 1239

STATION: B10

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		38.2	12.9	8.82	59.0
01	3.3	17.2		38.2	12.3	8.80	79.0
02	6.6	17.0		38.2	12.3	8.78	79.0
03	9.8	17.0		38.2	12.7	8.77	80.0
04	13.1	17.0		38.1	12.0	8.77	81.0
05	16.4	16.9		38.1	12.0	8.78	80.0
06	19.7	16.9		38.0	12.0	8.76	80.0
07	23.0	16.9		38.0	12.2	8.76	82.0
08	26.2	16.9		37.9	12.0	8.76	82.0
09	29.6	16.9		37.9	12.2	8.77	82.0
10	32.8	16.9		37.9	12.3	8.77	82.0
11	36.1	16.9		37.8	12.4	8.78	82.0
12	39.2	16.9		37.8	12.4	8.78	82.0
13	42.6	16.9		37.8	12.3	8.79	82.0
14	45.9	16.8		37.7	12.3	8.80	82.0
15	49.2	16.8		37.7	12.3	8.82	82.0
16	52.5	16.8		37.7	12.3	8.83	82.0
17	55.8	16.8		37.7	12.7	8.84	82.0
18	59.0	16.8		37.7	12.7	8.85	82.0
19	62.3	16.8		37.6	12.8	8.87	82.0
20	65.6	16.8		37.6	12.7	8.88	82.0
21	68.9	16.8		37.6	12.5	8.89	82.0
22	72.1	16.8		37.6	12.0	89.0	83.5

DATE: DECEMBER 13, 1977 TIME: 1226

STATION: B11

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		37.3	11.6	8.76	70.0
01	3.3	17.3		37.8	11.8	8.74	78.5
02	6.6	17.0		37.6	12.0	8.74	81.0
03	9.8	17.0		37.6	12.1	8.73	82.0
04	13.1	16.9		37.6	11.6	8.73	82.0
05	16.4	16.9		37.8	11.7	8.73	82.0
06	19.7	16.9		37.8	11.7	8.73	82.0
07	23.0	16.8		37.8	11.8	8.74	81.5
08	26.2	16.8		37.8	12.0	8.75	81.0
09	29.6	16.8		37.8	11.9	8.76	81.0
10	32.8	16.8		37.8	11.7	8.75	81.0
11	36.1	16.8		37.8	12.0	8.76	80.5
12	39.2	16.8		37.8	12.0	8.77	79.9
13	42.6	16.8		37.7	12.8	8.78	79.9
14	45.9	16.8		37.7	12.8	8.80	78.0
15	49.2	16.7		37.7	12.4	8.81	78.0
16	52.5	16.7		37.7	12.3	8.83	77.0

DATE: DECEMBER 6, 1977 TIME: 0756

STATION: C1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		33.0	7.4	7.88	
01	3.3	18.1		33.7	7.1	7.82	
02	6.6	18.1		34.0	7.0	7.80	
03	9.8	18.1		34.1	6.8	7.77	
04	13.1	18.0		34.2	6.8	7.79	
05	16.4	18.0		34.3	6.8	7.74	
06	19.7	18.0		34.3	6.9	7.75	
07	23.0	17.9		34.3	7.0	7.77	
08	26.2	17.9		34.2	6.7	7.76	
09	29.6	17.9		34.3	6.0	7.78	
10	32.8	17.7		38.4	7.8	7.79	

DATE: DECEMBER 13, 1977 TIME: 1153

STATION: D1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		37.8	12.0	8.80	74.0
01	3.3	17.1		37.9	12.8	8.83	81.0
02	6.6	17.1		37.9	12.8	8.81	82.0
03	9.8	17.0		38.0	12.8	8.79	82.0
04	13.1	17.0		37.9	12.7	8.77	83.0
05	16.4	17.0		37.9	12.7	8.77	82.0
06	19.7	16.9		37.9	12.7	8.77	82.5
07	23.0	16.9		37.8	12.0	8.76	82.0
08	26.2	16.9		37.8	11.9	8.76	82.0
09	29.6	16.8		37.8	12.1	8.77	83.0
10	32.8	16.8		37.8	11.8	8.78	82.5
11	36.1	16.8		37.8	12.6	8.79	83.5
12	39.2	16.7		37.7	12.7	8.81	83.0
13	42.6	16.7		37.7	12.7	8.82	82.5
14	45.9	16.7		37.7	12.5	8.83	83.0
15	49.2	16.7		37.6	12.0	8.78	82.0

DATE: DECEMBER 13, 1977 TIME: 1206

STATION: D2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		37.2	8.0	8.71	71.5
01	3.3	17.3		37.5	9.5	8.72	79.0
02	6.6	17.2		37.8	10.4	8.74	82.0
03	9.8	17.1		37.8	10.9	8.74	82.0
04	13.1	17.1		37.8	10.5	8.73	81.5
05	16.4	17.2		37.8	9.2	8.71	79.0
06	19.7	17.3		37.8	9.3	8.71	74.0
07	23.0	17.3		37.8	8.7	8.70	72.0
08	26.2	17.2		37.8	8.0	8.70	71.0
09	29.6	17.2		37.8	8.0	8.70	68.5
10	32.8	17.2		37.8	8.0	8.71	64.5
11	36.1	17.2		37.8	7.0	8.72	87.5

DATE: DECEMBER 13, 1977 TIME: 1000

STATION: D3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		37.5	12.0	8.92	75.0
01	3.3	17.2		37.4	11.6	8.84	80.0
02	6.6	17.1		37.2	12.2	8.82	81.0
03	9.8	17.0		37.0	12.0	8.80	83.5
04	13.1	17.0		37.0	11.2	8.76	83.0
05	16.4	17.0		37.0	12.0	8.76	84.5
06	19.7	17.0		36.7	11.0	8.73	84.0
07	23.0	17.0		36.4	12.4	8.73	84.0
08	26.2	17.0		36.3	12.0	8.72	86.0
09	29.6	17.0		36.2	12.0	8.70	85.5
10	32.8	17.0		36.3	11.8	8.70	85.0
11	36.1	17.0		36.6	11.2	8.70	78.0
12	39.2	17.0		36.7	11.8	8.69	72.5
13	42.6	17.0		36.8	12.0	8.68	69.0
14	45.9	17.0		37.5	11.6	8.70	67.0
15	49.2	17.0		37.4	11.8	8.80	65.0
16	52.5	17.0		37.3	12.0	8.76	57.0

DATE: DECEMBER 13, 1977 TIME: 1214

STATION: D10

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		37.8	9.0	8.73	31.5
01	3.3	17.4		37.8	8.3	8.72	60.0
02	6.6	17.3		37.5	8.1	8.71	62.0
03	9.8	17.2		37.4	8.4	8.70	64.0
04	13.1	17.1		37.4	9.0	8.71	64.0
05	16.4	17.1		37.4	9.0	8.72	66.0
06	19.7	17.1		37.3	8.6	8.71	66.0
07	23.0	17.1		37.3	8.8	8.71	66.0
08	26.2	17.2		37.4	7.5	8.70	64.0

DATE: JANUARY 6, 1976 TIME: 0910

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		26.2	5.6	8.38	81.0
01	3.3	16.0		26.7	5.9	8.41	90.0
02	6.6	16.0		26.8	6.4	8.40	46.0
03	9.8	16.1		26.9	6.5	8.40	63.0
04	13.1	16.1		26.9	6.7	8.38	72.0
05	16.4	16.1		27.0	6.8	8.38	80.0
06	19.7	16.1		27.1	6.8	8.38	68.0
07	23.0	16.2		27.2	6.9	8.38	60.0
08	26.2	16.2		27.3	7.2	8.37	70.0
09	29.5	16.2		27.4	7.3	8.36	71.0
10	32.8	16.2		27.4	7.5	8.35	76.0
11	36.1	16.3		27.5	7.5	8.34	80.0
12	39.4	16.3		27.5	7.6	8.34	80.0
13	42.6	16.3		27.6	7.6	8.33	93.0
14	45.9	16.3		27.6	7.6	8.32	92.0
15	49.2	16.4		27.7	7.5	8.32	94.0
16	52.5	16.4		27.7	7.5	8.30	80.0
17	55.8	16.4		27.7	7.5	8.30	71.0
18	59.0	16.4		27.7	7.5	8.30	71.0
19	62.3	16.4		27.7	7.5	8.30	66.0
20	65.6	16.4		27.8	7.5	8.29	60.0

DATE: JANUARY 6, 1976 TIME: 0940

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		27.0	7.8	8.21	67.0
01	3.3	15.7		27.0	7.4	8.21	69.0
02	6.6	15.7		27.0	7.6	8.19	76.0
03	9.8	16.0		27.1	7.6	8.19	74.0
04	13.1	16.0		27.1	7.6	8.19	74.0
05	16.4	15.7		27.1	7.7	8.19	76.0
06	19.7	15.7		27.1	7.6	8.20	78.0
07	23.0	16.0		27.2	7.9	8.20	78.0
08	26.2	16.0		27.3	8.0	8.22	78.0
09	29.5	16.0		27.5	8.0	8.22	78.0
10	32.8	16.0		27.8	8.1	8.23	77.0
11	36.1	16.0		27.8	8.1	8.24	78.0
12	39.4	16.1		27.8	7.9	8.24	81.0
13	42.6						60.0

DATE: JANUARY 6, 1976 TIME: 0947

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		27.0	7.6	8.19	71.0
01	3.3	15.7		27.0	7.4	8.19	77.0
02	6.6	15.7		27.0	7.8	8.19	73.0
03	9.8	15.7		27.1	7.8	8.19	74.0
04	13.1	15.7		27.1	7.8	8.20	76.0
05	16.4	15.6		27.2	7.6	8.20	74.0
06	19.7	15.8		27.2	7.6	8.19	74.0
07	23.0	15.9		27.4	7.6	8.18	72.0
08	26.2	15.9		27.5	7.3	8.17	

DATE: JANUARY 6, 1976 TIME: 0955

STATION: A4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		26.7	7.3	8.13	52.0
01	3.3	15.6		26.6	7.3	8.12	70.0
02	6.6	15.6		26.4	7.1	8.12	71.0
03	9.8	15.7		26.4	7.1	8.11	72.0
04	13.1	15.8		27.2	8.3	8.08	71.0
05	16.4	16.0		27.4	8.8	8.04	71.0
06	19.7	16.1		27.5	8.3	8.03	82.0

DATE: JANUARY 6, 1976 TIME: 1002

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		26.9	7.1	8.14	64.0
01	3.3	15.7		26.9	7.0	8.14	67.0
02	6.6	15.7		26.9	7.0	8.14	68.0
03	9.8	15.7		27.0	7.0	8.14	67.0
04	13.1	15.7		27.1	6.0	7.87	

DATE: JANUARY 6, 1976 TIME: 0846

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		26.4	7.3	8.18	94.0
01	3.3	16.8		26.4	7.4	8.13	68.0
02	6.6	15.7		26.7	7.4	8.18	79.0
03	9.8	15.7		26.7	7.4	8.18	78.0
04	13.1	15.7		26.8	7.4	8.18	78.0
05	16.4	15.8		27.0	7.4	8.18	78.0
06	19.7	15.9		27.1	7.5	8.19	80.0
07	23.0	16.0		27.4	7.6	8.19	78.0
08	26.2	16.0		27.4	7.4	8.20	87.0

DATE: JANUARY 6, 1976 TIME: 0853

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		26.5	7.6	8.16	70.0
01	3.3	15.8		26.5	7.4	8.16	66.0
02	6.6	15.8		26.5	7.3	8.15	65.0
03	9.8	15.8		26.8	7.2	8.13	63.0
04	13.1	15.8		26.7	7.1	8.13	61.0
05	16.4	15.8		26.4	7.0	8.13	67.0
06	19.7	15.8		27.0	6.6	8.12	69.0
07	23.0	15.9		27.0	6.6	8.11	76.0
08	26.2	16.0		27.1	6.5	8.11	76.0
09	29.5	16.0		27.1	6.4	8.12	77.0
10	32.8	16.0		27.3	6.7	8.17	71.0
11	36.1	16.1		27.5	6.9	8.16	71.0
12	39.4	16.1		27.7	7.1	8.20	73.0
13	42.6	16.2		27.7	7.0	8.21	69.0
14	45.9	16.2		27.8	7.0	8.23	71.0

DATE: JANUARY 16, 1976 TIME: 1035

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		25.0	7.4		
01	3.3	15.6		26.3	7.8		
02	6.6	15.6		25.4	8.0		
03	9.8	16.6		25.9	8.0		
04	13.1	15.2		26.4	7.9		
05	16.4	15.7		26.7	7.9		
06	19.7	15.8		27.1	7.6		
07	23.0	15.8		27.2	7.4		
08	26.2	15.9		27.2	7.5		
09	29.5	15.9		27.5	7.5		
10	32.8	16.0		27.6	7.4		

DATE: JANUARY 6, 1976 TIME: 1040

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.9		27.5	8.0	8.27	70.0
01	3.3	15.9		27.5	7.8	8.27	78.0
02	6.6	15.9		27.5	7.7	8.28	77.0
03	9.8	15.9		27.5	7.7	8.28	77.0
04	13.1	15.9		27.5	7.7	8.26	77.0
05	16.4	15.9		27.4	7.7	8.26	77.0
06	19.7	15.9		27.5	7.8	8.27	77.0
07	23.0	15.9		27.4	7.8	8.24	77.0
08	26.2	15.9		27.4	7.6	8.24	77.0
09	29.5	15.9		27.4	7.6	8.27	77.0
10	32.8	15.9		27.4	7.9	8.27	74.0
11	36.1	15.9		27.4	7.9	8.26	75.0
12	39.4	15.9		27.4	7.8	8.26	31.0
13	42.6	15.9		27.4	7.9	8.26	
14	45.9	15.8		27.4	7.7	8.24	
15	49.2	16.0		27.7	7.7	8.22	

DATE: JANUARY 6, 1976 TIME: 0930

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		27.5	8.8	8.26	81.0
01	3.3	15.9		27.5	8.4	8.28	71.0
02	6.6	15.9		27.5	7.9	8.28	74.0
03	9.8	15.9		27.5	7.6	8.28	74.0
04	13.1	15.9		27.5	7.7	8.30	74.0
05	16.4	16.0		27.6	7.7	8.30	75.0
06	19.7	16.0		27.6	7.6	8.31	76.0
07	23.0	16.0		27.7	7.7	8.31	75.0
08	26.2	16.0		27.6	7.4	8.31	74.0
09	29.5	16.0		27.6	7.4	8.30	74.0
10	32.8	16.0		27.6	7.4	8.30	73.0
11	36.1	16.1		27.7	7.7	8.30	73.0
12	39.4	16.1		27.7	7.8	8.31	69.0
13	42.6	16.1		27.7	7.8	8.30	73.0
14	45.9	16.1		27.6	8.0	8.30	73.0

DATE: JANUARY 6, 1976 TIME: 1050

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		27.4	8.0	8.26	57.0
01	3.3	15.6		27.4	7.8	8.26	69.0
02	6.6	15.6		27.4	7.7	8.27	72.0
03	9.8	15.6		27.5	7.7	8.27	72.0
04	13.1	15.6		27.5	7.7	8.28	73.0
05	16.4	15.6		27.4	7.7	8.27	74.0
06	19.7	15.8		27.4	7.7	8.28	72.0
07	23.0	15.8		27.4	7.7	8.28	73.0
08	26.2	15.8		27.4	7.7	8.27	73.0
09	29.5	15.8		27.4	7.7	8.28	73.0
10	32.8	15.9		27.5	7.6	8.28	73.0
11	36.1	15.9		27.4	7.6	8.28	67.0
12	39.4	15.9		27.5	7.4	8.26	
13	42.6	16.0		27.5	7.3	8.26	

DATE: JANUARY 6, 1976 TIME: 1021

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		27.0	8.0	8.20	82.0
01	3.3	15.7		27.0	7.8	8.20	80.0
02	6.6	15.7		27.0	7.7	8.20	77.0
03	9.8	15.7		27.1	7.4	8.20	74.0
04	13.1	15.7		27.0	7.6	8.18	61.0
05	16.4	16.0		27.5	7.6	8.18	49.0
06	19.7	16.0		27.8	7.3	8.13	88.9
07	23.0	16.1		27.5	6.6	8.12	61.0

DATE: JANUARY 6, 1976 TIME: 1018

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		27.3	8.0	8.30	74.0
01	3.3	15.8		27.3	7.7	8.29	84.0
02	6.6	15.8		27.3	7.6	8.30	71.0
03	9.8	15.8		27.3	7.8	8.30	69.0
04	13.1	15.8		27.3	7.6	8.31	61.0
05	16.4	15.8		27.4	7.7	8.29	62.0
06	19.7	15.9		27.4	7.8	8.25	63.0
07	23.0	16.0		27.7	7.3	8.21	56.0
08	26.2						68.0

DATE: JANUARY 6, 1976 TIME: 1057

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		27.4	7.6	8.30	64.0
01	3.3	15.8		27.3	7.5	8.31	73.0
02	6.6	15.8		27.3	7.6	8.30	75.0
03	9.8	15.8		27.4	7.6	8.32	75.0
04	13.1	15.8		27.4	7.6	8.33	74.0
05	16.4	15.8		27.4	7.8	8.33	73.0
06	19.7	15.8		27.4	7.9	8.34	74.0
07	23.0	15.8		27.3	7.7	8.31	74.0
08	26.2	16.0		27.3	7.7	8.30	74.0
09	29.5	16.0		27.3	7.7	8.29	74.0
10	32.8	16.0		27.4	7.7	8.28	69.0
11	36.1	15.9		27.4	7.7	8.29	61.0
12	39.4	15.9		27.4	7.6	8.28	58.0

DATE: JANUARY 11, 1978 TIME: 1000

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.0		26.2	7.8	8.33	25.0
01	3.3	15.0		26.7	7.6	8.33	23.8
02	6.6	15.0		27.1	7.8	8.34	23.0
03	9.9	14.0		27.6	7.6	8.34	22.0
04	13.1	14.0		27.7	7.6	8.34	21.0
05	16.4	14.0		27.7	7.6	8.34	20.5
06	19.7	14.0		27.7	8.0	8.34	19.0
07	23.0	14.0		27.8	8.0	8.33	17.0
08	26.2	14.0		27.9	8.0	8.33	16.5
09	29.5	14.0		27.9	8.0	8.33	30.0
10	32.8	14.0		27.9	8.1	8.33	30.0
11	36.1	14.1		27.9	8.1	8.33	37.6
12	39.4	14.1		28.0	8.1	8.33	37.0
13	42.6	14.1		28.0	8.1	8.33	34.8
14	45.9	14.1		28.0	8.1	8.33	35.0
15	49.2	14.1		28.0	8.1	8.32	34.5
16	52.5	14.1		28.1	8.1	8.32	34.0
17	55.8	14.1		28.1	8.1	8.32	34.0
18	59.0	14.1		28.1	8.2	8.32	33.0
19	62.3	14.1		28.1	8.2	8.32	35.8
20	65.6	14.1		28.1	8.2	8.32	32.8

DATE: JANUARY 11, 1978 TIME: 1200

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.0		25.3	7.7	8.28	31.0
01	3.3	15.6		25.3	8.3	8.27	31.0
02	6.6	15.6		25.3	8.3	8.26	34.0
03	9.9	15.7		26.0	8.2	8.26	34.0
04	13.1	15.7		26.1	8.8	8.24	29.0
05	16.4	15.8		26.6	8.9	8.23	36.0
06	19.7	15.9		26.9	9.2	8.22	27.6
07	23.0	16.1		27.1	9.8	8.22	26.5
08	26.2	16.1		27.2	9.6	8.22	28.0
09	29.5	16.1		27.3	9.7	8.22	29.0
10	32.8	16.1		27.6	10.8	8.22	25.0
11	36.1	16.1		27.8	10.7	8.22	24.6
12	39.4	16.1		27.6	10.6	8.22	24.0
13	42.6	16.2		27.6	10.7	8.22	20.0
14	45.9	16.2		27.7	10.8	8.22	24.5
15	49.2	16.2		27.7	11.2	8.22	22.5
16	52.5	16.2		27.7	11.0	8.22	14.6
17	55.8	16.2		27.8	11.4	8.21	9.5

DATE: JANUARY 11, 1978 TIME: 1220

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		26.0	7.5	8.27	32.0
01	3.3	15.8		26.0	7.6	8.27	30.0
02	6.6	15.8		26.2	7.9	8.27	37.0
03	9.9	15.9		26.6	7.9	8.26	36.0
04	13.1	15.9		27.0	7.9	8.26	35.0
05	16.4	16.1		27.4	8.0	8.26	36.0
06	19.7	16.1		27.6	8.1	8.26	52.0
07	23.0	16.1		27.6	8.1	8.26	46.8
08	26.2	16.1		27.7	8.2	8.26	43.8
09	29.5	16.1		27.7	8.3	8.26	40.5
10	32.8	16.1		27.8	8.4	8.27	34.0
11	36.1	16.1		27.8	8.5	8.27	31.0
12	39.4	16.1		27.8	8.6	8.27	27.0
13	42.6	16.1		27.8	8.6	8.27	26.0
14	45.9	16.1		27.8	8.7	8.27	22.6
15	49.2	16.1		28.0	8.8	8.27	20.6
16	52.5	16.1		28.0	8.7	8.27	17.6
17	55.8	16.2		28.0	8.7	8.27	15.6
18	59.0	16.2		28.0	8.9	8.27	13.8
19	62.3	16.2		28.0	8.8	8.27	11.8
20	65.6	16.2		30.0	8.7	8.26	11.0

DATE: JANUARY 11, 1978 TIME: 0950

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		22.8	6.9	8.13	40.8
01	3.3	16.4		24.9	6.2	8.17	46.8
02	6.6	15.9		25.0	6.6	8.19	47.0
03	9.9	15.7		25.8	6.8	8.22	46.0
04	13.1	15.6		25.9	7.0	8.26	45.0
05	16.4	15.6		25.9	7.0	8.24	49.0
06	19.7	16.0		26.4	7.2	8.27	48.6
07	23.0	16.9		26.7	7.3	8.28	46.8
08	26.2	16.8		26.9	7.4	8.28	44.6
09	29.5	16.0		27.0	7.4	8.28	43.0
10	32.8	16.1		27.0	7.3	8.27	39.8
11	36.1	16.1		27.0	7.3	8.27	36.8
12	39.4	16.1		27.1	7.2	8.28	34.5
13	42.6	16.1		27.1	7.2	8.28	33.5
14	45.9	16.1		27.1	7.2	8.26	28.0
15	49.2	16.1		27.2	7.2	8.26	24.0
16	52.5	16.1		27.3	7.1	8.24	26.0
17	55.8	16.1		27.3	7.0	8.24	22.0
18	59.0	16.1		27.4	7.0	8.24	20.0
19	62.3	16.2		27.4	6.8	8.23	10.8
20	65.6	16.2		27.4	6.7	8.22	10.0

DATE: JANUARY 11, 1978 TIME: 0920

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.5		18.3	4.3	8.10	33.0
01	3.3	14.7		24.0	4.0	8.00	37.0
02	6.6	15.8		24.6	5.8	8.11	30.0
03	9.9	15.9		25.2	5.6	8.14	37.0
04	13.1	16.0		25.6	6.0	8.10	36.8
05	16.4	16.0		25.9	6.0	8.20	28.8
06	19.7	16.0		26.3	6.3	8.26	28.8
07	23.0	16.1		26.3	6.5	8.20	26.0
08	26.2	16.1		26.4	6.7	8.20	27.8
09	29.5	16.2		26.6	6.7	8.20	27.0
10	32.8	16.2		26.7	6.8	8.21	24.5
11	36.1	16.1		26.8	6.8	8.21	25.6
12	39.4	16.1		26.9	6.8	8.21	25.0
13	42.6	16.1		27.1	6.8	8.22	24.0
14	45.9	16.1		27.2	6.8	8.23	22.8
15	49.2	16.2		27.2	6.9	8.23	21.5
16	52.5	16.2		27.3	6.7	8.22	21.0
17	55.8	16.2		27.3	6.8	8.22	21.0
18	59.0	16.2		27.3	6.8	8.22	20.5
19	62.3	16.2		27.4	6.8	8.22	19.8

DATE: JANUARY 11, 1978 TIME: 1030

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		21.5	6.3	8.13	64.0
01	3.3	15.3		23.9	6.8	8.13	65.5
02	6.6	15.6		24.8	6.6	8.17	67.5
03	9.9	15.6		25.5	6.4	8.17	66.5
04	13.1	15.8		25.8	6.8	8.18	69.6
05	16.4	15.9		26.4	6.9	8.18	71.0
06	19.7	16.0		26.4	7.0	8.17	60.0
07	23.0	16.1		26.5	7.1	8.18	58.0
08	26.2	16.1		26.6	7.2	8.17	60.5
09	29.5	16.1		26.7	7.3	8.18	60.0
10	32.8	16.1		26.8	7.3	8.18	57.0
11	36.1	16.2		26.9	7.3	8.18	57.0
12	39.4	16.2		27.0	7.4	8.18	57.0
13	42.6	16.2		27.0	7.5	8.18	37.0

DATE: JANUARY 11, 1978 TIME: 0950

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.2		18.1	7.4	8.27	77.0
01	3.3	15.9		23.4	7.5	8.31	84.0
02	6.6	15.8		24.8	6.3	8.20	98.0
03	9.9	16.0		24.4	6.6	8.20	93.0
04	13.1	16.0		25.4	6.9	8.20	98.5
05	16.4	16.1		25.8	7.0	8.20	93.0
06	19.7	16.2		26.3	7.4	8.22	86.0
07	23.0	16.2		26.5	7.9	8.22	79.8
08	26.2	16.0		26.7	8.8	8.22	82.0
09	29.5	16.4		26.8	8.7	8.22	40.3
10	32.8	16.0		26.9	9.1	8.22	40.0
11	36.1	16.2		26.9	9.4	8.24	36.0
12	39.4	16.2		27.0	9.8	8.23	33.0
13	42.6	16.2		27.1	9.7	8.23	31.3
14	45.9	16.2		27.1	9.8	8.23	28.0
15	49.2	16.2		27.2	10.0	8.22	27.9
16	52.5	16.2		27.3	10.4	8.22	26.0
17	55.8	16.2		27.3	10.3	8.21	24.0
18	59.0	16.2		27.4	10.2	8.21	19.0

DATE: JANUARY 4, 1978 TIME: 1032

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		27.4	8.1	8.22	68.0
01	3.3	15.8		27.4	7.8	8.22	72.0
02	6.6	15.9		27.4	7.7	8.23	72.0
03	9.9	15.9		27.4	7.7	8.23	71.8
04	13.1	15.9		27.4	7.6	8.24	70.8
05	16.4	15.9		27.4	7.6	8.24	70.0
06	19.7	15.9		27.4	7.7	8.23	73.8
07	23.0	15.9		27.3	7.7	8.23	75.0
08	26.2	15.9		27.3	7.7	8.23	77.0
09	29.5	16.0		27.3	7.7	8.23	78.0
10	32.8	15.9		27.3	7.7	8.24	78.0
11	36.1	15.9		27.3	7.8	8.24	76.0
12	39.4	15.9		27.3	7.8	8.24	78.0
13	42.6	16.0		27.5	7.7	8.22	79.0
14	45.9						79.0

DATE: JANUARY 11, 1978 TIME: 1100

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		24.5	7.8	8.36	32.0
01	3.3	15.3		26.0	7.6	8.36	34.8
02	6.6	15.3		26.8	7.8	8.34	36.5
03	9.9	16.4		28.2	7.8	8.33	41.5
04	13.1	15.8		28.7	7.8	8.31	44.0
05	16.4	16.0		26.4	7.8	8.29	46.0
06	19.7	15.8		30.0	7.6	8.28	46.0
07	23.0	15.9		26.8	7.6	8.28	46.6
08	26.2	15.9		26.9	7.4	8.28	48.0
09	29.5	16.0		27.2	7.4	8.27	42.5
10	32.8	16.0		27.2	7.4	8.27	41.5
11	36.1	16.0		27.3	7.3	8.27	40.0
12	39.4	16.0		27.5	7.5	8.27	30.0
13	42.6	16.1		27.6	7.4	8.27	38.0
14	45.9	16.1		27.6	7.3	8.26	33.6
15	49.2	16.1		27.7	7.2	8.29	32.5
16	52.5	16.1		27.7	7.2	8.29	33.0

DATE: JANUARY 11, 1978 TIME: 1130

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		22.1	7.7	8.36	68.0
01	3.3	16.2		23.3	7.6	8.33	71.6
02	6.6	16.3		24.6	7.7	8.28	67.0
03	9.9	16.4		25.8	7.7	8.20	96.8
04	13.1	15.6		25.9	8.1	8.29	46.4
05	16.4	15.7		26.2	8.3	8.28	42.3
06	19.7	15.8		26.4	8.6	8.26	30.0
07	23.0	15.9		26.8	8.8	8.25	36.0
08	26.2	15.6		27.1	8.3	8.24	32.8
09	29.5	16.0		27.8	8.6	8.24	31.8
10	32.8	16.0		27.2	8.7	8.26	30.0
11	36.1	16.0		27.3	8.7	8.26	33.0
12	39.4	16.0		27.3	9.8	8.26	27.5
13	42.6	16.0		27.4	9.8	8.26	26.0
14	45.9	16.0		27.6	9.0	8.27	24.8
15	49.2	16.1		27.8	9.9	8.27	23.0
16	52.5	16.1		27.7	9.9	8.27	24.5
17	55.8	16.1		27.7	9.7	8.27	24.0
18	59.0	16.1		27.8	9.4	8.28	26.0

DATE: JANUARY 10, 1978 TIME: 1019

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		24.9	7.4		
01	3.3	15.9		24.6	7.3		
02	6.6	15.9		25.3	7.8		
03	9.8	15.9		26.0	7.7		
04	13.1	15.9		26.3	8.2		
05	16.4	15.8		26.6	8.2		
06	19.7	15.9		27.0	8.3		
07	23.0	15.9		27.1	8.3		
08	26.2	15.9		27.2	8.8		
09	29.5	15.9		27.4	6.3		

DATE: JANUARY 10, 1978 TIME: 1009

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		23.8	7.3		
01	3.3	16.1		26.8	6.8		
02	6.6	16.1		25.3	6.9		
03	9.8	16.1		24.0	7.2		
04	13.1	16.0		26.3	7.5		
05	16.4	16.0		26.2	7.7		
06	19.7	16.0		26.6	8.3		
07	23.0	15.9		26.8	8.6		
08	26.2	15.9		26.9	6.8		
09	29.5	15.9		27.1	9.0		

DATE: JANUARY 10, 1978 TIME: 0959

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.9		23.6	7.1		
01	3.3	16.2		24.3	7.0		
02	6.6	16.6		25.6	7.0		
03	9.8	16.2		26.0	7.3		
04	13.1	16.0		26.2	9.0		
05	16.4	16.0		26.6	9.2		
06	19.7	16.0		26.5	10.8		
07	23.0	16.0		26.7	10.2		
08	26.2	16.0		26.8	10.6		
09	29.5	16.0		27.0	10.9		
10	32.8	15.9		27.1	11.1		
11	36.1	15.9		27.2	10.6		
12	39.4	15.9		27.2	9.4		

DATE: JANUARY 10, 1978 TIME: 0935

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		22.8	6.3		
01	3.3	16.2		23.1	5.9		
02	6.6	16.2		24.6	6.1		
03	9.8	16.4		26.1	6.2		
04	13.1	16.2		26.1	6.8		
05	16.4	16.0		26.3	6.9		
06	19.7	16.0		26.4	7.1		
07	23.0	15.9		26.6	7.2		
08	26.2	15.9		26.6	7.5		
09	29.5	15.8		26.7	7.4		
10	32.8	15.9		26.8	7.5		
11	36.1	15.9		26.9	7.5		
12	39.4	15.9		27.0	7.4		

DATE: JANUARY 10, 1978 TIME: 0947

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		22.5	8.4		
01	3.3	16.2		24.7	8.3		
02	6.6	16.2		25.6	8.3		
03	9.8	16.2		26.0	8.4		
04	13.1	16.2		26.2	6.7		
05	16.4	16.2		26.4	6.8		

DATE: JANUARY 10, 1978 TIME: 1106

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		24.6	7.6		
01	3.3	16.2		25.2	6.0		
02	6.6	16.2		25.8	5.7		
03	9.8	16.2		26.0	5.9		
04	13.1	16.1		26.2	5.9		
05	16.4	16.1		26.6	5.1		
06	19.7	16.1		26.6	6.0		
07	23.0	16.1		26.6	6.0		
08	26.2	16.1		26.9	5.8		
09	29.5	16.1		27.0	5.7		
10	32.8	16.1		27.0	6.8		
11	36.1	16.1		27.0	6.0		

DATE: JANUARY 10, 1978 TIME: 0922

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		23.0	7.1		
01	3.3	16.8		23.7	7.1		
02	6.6	16.8		24.1	6.6		
03	9.8	16.0		25.3	6.8		
04	13.1	16.0		25.6	6.9		
05	16.4	16.0		26.2	7.1		
06	19.7	16.0		26.4	7.3		
07	23.0	16.0		26.7	7.7		
08	26.2	16.0		26.8	8.1		
09	29.5	16.1		26.9	8.8		
10	32.8	16.1		27.0	9.1		
11	36.1	16.1		27.2	9.0		
12	39.4	16.1		27.2	9.8		

DATE: JANUARY 10, 1978 TIME: 0912

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		16.7	6.6		
01	3.3	15.8		22.2	6.9		
02	6.6	15.9		24.1	7.1		
03	9.8	16.0		24.8	7.2		
04	13.1	16.0		25.2	7.3		
05	16.4	16.0		25.6	7.5		
06	19.7	16.0		25.0	7.8		
07	23.0	16.0		26.2	7.7		
08	26.2	16.0		26.4	7.8		
09	29.5	16.0		26.6	7.8		
10	32.8	16.0		26.8	7.6		
11	36.1	16.0		26.9	7.6		

DATE: JANUARY 10, 1978 TIME: 0854

STATION: [illegible]

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.9		8.7	7.0		
01	3.3	16.5		17.1	6.5		
02	6.6	16.6		20.7	6.0		
03	9.7	15.8		22.4	6.0		
04	13.1	15.9		23.9	5.9		
05	16.4	15.0		24.6	6.0		
06	19.7	16.1		25.2	5.5		
07	23.0	16.1		25.5	5.3		
08	26.2	16.2		25.8	4.7		

DATE: JANUARY 11, 1978 TIME: 1110

STATION: 3I

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.4		18.5	6.4	8.30	4.8
01	3.3	15.7		22.7	7.8	8.27	30.0
02	6.6	15.8		25.7	7.6	8.26	31.5
03	9.8	16.0		26.4	7.5	8.24	49.5
04	13.1	16.0		26.8	7.8	8.27	77.0
05	16.4	16.1		26.9	7.5	8.27	74.8
06	19.7	16.1		27.1	7.7	8.27	70.0
07	23.0	16.1		27.2	7.7	8.27	66.0
08	26.2	16.1		27.3	7.6	8.26	66.0
09	19.6	16.1		27.4	7.9	8.26	50.0
10	32.8	16.2		27.5	7.3	8.23	40.0

DATE: JANUARY 11, 1978 TIME: 1045

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.9		23.0	6.7	8.21	10.0
01	3.3	16.0		25.9	6.6	8.18	18.8
02	6.6	16.0		26.8	6.3	8.19	20.5
03	9.8	16.1		27.2	6.6	8.19	21.5
04	13.1	16.1		27.4	6.6	8.18	21.5
05	16.4	16.1		27.6	6.3	8.17	19.6
06	19.7	16.1		27.6	6.1	8.15	16.5
07	23.0	16.1		27.7	6.1	8.15	14.0
08	26.2	16.1		27.7	6.1	8.14	12.8
09	29.5	16.2		27.7	5.5	8.13	7.5

DATE: JANUARY 11, 1978 TIME: 1123

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		21.2	8.2	8.34	23.0
01	3.3	15.8		18.8	8.0	8.37	47.0
02	6.6	15.7		25.4	7.8	8.26	77.0
03	9.8	16.0		26.8	7.9	8.26	83.0
04	13.1	16.0		27.0	7.6	8.26	97.0
05	16.4	16.0		27.1	8.0	8.26	99.0
06	19.7	16.0		27.2	7.8	8.28	96.0
07	23.0	16.1		27.3	7.8	8.27	89.0
08	26.2	16.1		27.5	7.8	8.27	79.0
09	29.5	16.1		27.6	7.8	8.27	62.0
10	32.8	16.1		27.7	7.7	8.27	49.0
11	36.1	16.2		27.6	7.6	8.28	33.6

DATE: JANUARY 11, 1978 TIME: 1054

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.2		6.8	7.6	8.20	34.0
01	3.3	15.4		21.8	7.6	8.18	33.8
02	6.6	15.9		24.9	7.6	8.23	70.0
03	9.8	16.0		26.9	7.8	8.24	75.0
04	13.1	16.1		27.2	7.5	8.21	74.0
05	16.4	16.1		27.3	7.6	8.22	73.0
06	19.7	16.1		27.4	7.8	8.23	71.0
07	23.0	16.1		27.5	7.6	8.21	60.0
08	26.2	16.1		27.6	7.4	8.17	56.0
09	29.5	16.1		27.7	7.2	8.17	48.5
10	32.8	16.2		27.7	6.1	8.16	15.6

DATE: FEBRUARY 1, 1978 TIME: 0940

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		35.4		8.82	81.0
01	3.3	15.7		35.4		8.80	84.0
02	6.6	15.7		35.4		8.78	84.0
03	9.8	15.7		35.4		8.76	84.0
04	13.1	15.7		35.5		8.78	82.0
05	16.4	15.7		35.5		8.79	82.0
06	19.7	15.7		35.5		8.80	82.0
07	23.0	15.7		35.5		8.82	82.0
08	26.2	15.7		35.4		8.85	82.0
09	29.5	15.7		35.4		8.84	83.0
10	32.8	15.8		35.4		8.84	84.0
11	36.1	15.7		35.5		8.86	85.0
12	39.4	15.8		35.5		8.86	86.0
13	42.6	15.8		35.5		8.86	86.0
14	45.9	15.8		35.5		8.86	86.0
15	49.2	15.8		35.5		8.86	87.0
16	52.5	15.8		35.6		8.87	87.0
17	55.8	15.8		35.6		8.87	87.0
18	59.0	15.8		35.6		8.87	87.0
19	62.3	15.8		35.6		8.88	86.0
20	65.6	15.7		35.6		8.82	80.0
21	68.9	15.7		35.6		8.83	76.0

DATE: FEBRUARY 1, 1978 TIME: 1028

STATION: A2A

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		34.9		8.77	77.0
01	3.3	15.6		35.2		8.75	80.0
02	6.6	15.6		35.2		8.73	80.0
03	9.8	15.6		35.2		8.72	80.0
04	13.1	15.6		35.3		8.72	78.0
05	16.4	15.6		35.4		8.72	77.0
06	19.7	15.6		35.4		8.73	76.0
07	23.0	15.6		35.4		8.74	74.0
08	26.2	15.6		35.5		8.73	71.0
09	29.6	15.6		35.5		8.74	69.0
10	32.8	15.6		35.5		8.72	69.0
11	36.1	15.6		35.5		8.72	68.0
12	39.2	15.7		35.5		8.72	67.0

DATE: FEBRUARY 1, 1978 TIME: 1048

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		35.7		8.88	84.0
01	3.3	15.8		35.7		8.84	83.0
02	6.6	15.7		35.7		8.78	83.0
03	9.8	15.6		35.7		8.76	80.0
04	13.1	15.6		35.7		8.73	80.0
05	16.4	15.6		35.8		8.70	79.0
06	19.7	15.6		35.9		8.68	71.0
07	23.0	15.7		36.4		8.62	58.0

DATE: FEBRUARY 1, 1978 TIME: 1080

STATION: A6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		35.9		8.72	70.0
01	3.3	16.0		35.9		8.64	73.0
02	6.6	16.0		35.9		8.62	73.0
03	9.8	16.0		36.0		8.60	73.0
04	13.1	15.9		36.0		8.57	68.0
05	16.4	15.8		35.9		8.58	66.0
06	19.7	15.7		36.4		8.53	48.0

DATE: FEBRUARY 1, 1978 TIME: 1052

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		36.2		8.86	48.0
01	3.3	16.6		36.1		8.78	63.0
02	6.6	16.2		36.2		8.64	56.0
03	9.8	16.6		36.2		8.68	58.0
04	13.1	15.9		36.0		8.67	59.0
05	16.4	16.6		36.0		8.68	64.0

DATE: FEBRUARY 1, 1978 TIME: 0958

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		35.6		8.63	77.0
01	3.3	15.7		35.6		8.63	78.0
02	6.6	15.7		35.6		8.68	77.0
03	9.8	15.8		35.4		8.72	76.0
04	13.1	15.8		35.4		8.76	77.0
05	16.4	15.7		35.1		8.79	77.0
06	19.7	15.6		36.4		8.63	76.0

DATE: FEBRUARY 1, 1978 TIME: 0915

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		36.4		8.57	77.0
01	3.3	15.6		34.9		8.56	77.0
02	6.6	15.6		35.0		8.58	77.0
03	9.8	15.7		35.0		8.57	77.0
04	13.1	15.7		35.0		8.59	77.0
05	16.4	15.7		35.1		8.61	77.0
06	19.7	15.7		35.1		8.63	76.0
07	23.0	15.7		35.1		8.62	76.0
08	26.2	15.7		35.1		8.63	72.0
09	29.5	15.7		35.1		8.60	70.0
10	32.8	15.7		35.2		8.59	68.0

DATE: FEBRUARY 15, 1978 TIME: 1053

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		30.8	7.0	8.05	72.5
01	3.3	15.2		30.7	6.9	8.06	75.0
02	6.6	15.3		28.8	7.0	8.08	74.0
03	9.8	15.8		28.9	7.0	8.08	77.0
04	13.1	15.6		29.3	7.0	8.09	78.0
05	16.4	15.7		29.4	7.0	8.09	78.0
06	19.7	15.6		29.7	7.6	8.10	78.5
07	23.0	15.6		30.0	6.9	8.10	72.5
08	26.2	15.8		30.2	6.8	8.11	73.0
09	29.6	15.9		30.4	6.8	8.12	67.0
10	32.8	15.9		30.8	7.1	8.16	68.5

DATE: FEBRUARY 1, 1978 TIME: 1100

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		35.7		8.61	74.0
01	3.3	16.0		35.7		8.58	73.0
02	6.6	16.0		35.8		8.58	73.0
03	9.8	16.0		35.7		8.57	69.0
04	13.1	16.0		35.8		8.59	65.0
05	16.4	16.0		35.7		8.49	56.0
06	19.7	16.0		35.7		8.49	35.0

DATE: FEBRUARY 1, 1978 TIME: 1120

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		36.7		9.03	82.0
01	3.3	16.0		36.4		8.89	86.0
02	6.6	16.6		36.3		8.84	84.0
03	9.8	15.8		36.0		8.88	86.0
04	13.1	15.7		36.0		8.81	84.0
05	16.4	15.7		35.8		8.79	83.0
06	19.7	15.7		35.8		8.78	84.0
07	23.0	15.7		35.7		8.76	83.0
08	26.2	15.7		35.7		8.74	82.0
09	29.6	15.7		35.7		8.65	78.0
10	32.8	15.7		35.7		8.56	39.0

DATE: FEBRUARY 1, 1978 TIME: 1005

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		34.7		8.69	85.0
01	3.3	15.7		35.0		8.66	86.0
02	6.6	15.7		35.0		8.64	86.0
03	9.8	15.6		35.0		8.63	84.0
04	13.1	15.6		35.2		8.62	85.0
05	16.4	15.6		35.2		8.60	84.0
06	19.7	15.6		35.2		8.80	48.0
07	23.0	15.6		35.2		8.81	86.0
08	26.2	15.6		35.2		8.80	88.0
09	29.6	15.6		35.3		8.80	82.0
10	32.8	15.6		35.3		8.78	78.0
11	36.1	15.7		35.3		8.77	74.0
12	39.2	15.7		35.3		8.72	69.0
13	42.6	15.7		35.4		8.74	66.0

DATE: FEBRUARY 1, 1978 TIME: 1000

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.9		35.6		8.74	86.0
01	3.3	16.0		35.8		8.74	87.0
02	6.6	15.8		35.5		8.75	85.0
03	9.8	15.8		35.8		8.74	84.0
04	13.1	15.8		35.6		8.72	84.8
05	16.4	15.7		35.2		8.70	82.0
06	19.7	15.7		35.2		8.68	80.0
07	23.0	15.7		35.2		8.68	80.0
08	26.2	15.7		35.2		8.67	78.0
09	29.6	15.7		35.2		8.68	78.0
10	32.8	15.6		35.3		8.64	68.0
11	36.1	15.6		35.3		8.64	63.0

DATE: FEBRUARY 1, 1978 TIME: 1056

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		36.0		8.74	84.0
01	3.3	16.0		35.9		8.73	83.0
02	6.6	16.0		35.9		8.72	85.0
03	9.8	15.9		35.8		8.73	81.0
04	13.1	15.7		35.7		8.72	79.0
05	16.4	15.7		35.2		8.67	78.0
06	19.7	15.7		35.7		8.62	55.0

DATE: FEBRUARY 1, 1978 TIME: 1058

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		36.3		8.63	83.0
01	3.3	16.0		36.4		8.80	84.0
02	6.6	15.8		36.3		8.79	83.0
03	9.8	15.6		36.3		8.78	84.0
04	13.1	15.6		36.3		8.77	82.0
05	16.4	15.6		36.2		8.70	72.0
06	19.7	15.8		36.2		8.67	69.0
07	23.0	15.7		36.1		8.48	19.0

DATE: FEBRUARY 8, 1976 TIME: 1044

STATION: B5

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		28.3	9.0	7.83	
01	3.3	18.4		29.4	9.1	7.87	
02	6.6	18.0		33.1	9.1	7.94	
03	9.8	18.0		34.8	9.4	7.88	
04	13.1	18.5		35.4	8.7	7.92	
05	16.4	18.3		35.5	9.1	7.98	
06	19.7	18.1		35.5	9.3	7.96	
07	23.0	18.0		35.7	9.4	7.90	
08	26.2	17.9		35.4	9.3	7.95	
09	29.6	17.8		35.4	9.1	7.96	
10	32.8	17.6		35.5	8.6	7.96	
11	36.1	17.6		35.9	8.8	7.96	
12	39.3	17.7		35.9	8.4	7.97	
13	42.6	17.7		36.9	8.2	7.97	
14	45.9	17.7		35.9	8.0	7.87	
15	49.2	17.7		36.9	8.0	7.87	
16	52.5	17.7		35.6	7.2	7.96	
17	55.8	17.7		35.6	7.0	7.96	
18	59.0	17.6		35.8	7.0	7.96	

DATE: FEBRUARY 8, 1976 TIME: 1104

STATION: B6

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		26.4	8.4	7.80	
01	3.3	19.8		28.4	9.4	7.83	
02	6.6	19.4		32.9	9.5	7.88	
03	9.8	19.1		34.1	9.6	7.89	
04	13.1	18.9		34.7	9.2	7.80	
05	16.4	18.7		35.0	10.0	7.85	
06	19.7	18.6		35.2	10.1	7.89	
07	23.0	16.6		36.4	9.9	7.89	
08	26.2	16.5		35.6	9.9	7.90	
09	29.6	16.8		35.6	7.6	7.87	
10	32.8	16.4		35.7	11.0	7.80	
11	36.1	16.3		35.7	9.7	7.84	
12	39.3	16.3		35.7	9.7	7.67	

DATE: FEBRUARY 8, 1976 TIME: 0832

STATION: B7

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		33.0	6.5	7.47	
01	3.3	18.6		30.7	6.7	7.49	
02	6.6	18.5		32.0	7.8	7.87	
03	9.8	18.6		34.1	7.7	7.96	
04	13.1	18.0		35.0	8.0	7.80	
05	16.4	17.8		35.4	8.1	7.88	
06	19.7	17.6		35.5	8.2	7.88	
07	23.0	17.5		35.4	8.3	7.55	
08	26.2	17.4		35.4	8.3	7.65	
09	29.6	17.4		35.5	8.5	7.51	
10	32.8	17.4		35.9	8.4	7.81	
11	36.1	17.3		35.4	8.7	7.89	
12	39.2	17.3		35.9	8.7	7.63	
13	42.6	17.3		35.9	8.9	7.69	
14	45.9	17.3		35.9	8.6	7.71	
15	49.2	17.3		35.9	8.4	7.74	
16	52.5	17.3		35.9	8.7	7.77	
17	55.8	17.2		35.9	8.7	7.79	
18	59.0	17.2		35.9	8.7	7.81	
19	62.3	17.2		35.9	8.6	7.80	

DATE: FEBRUARY 1, 1976 TIME: 1108

STATION: B8

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		36.1		8.64	84.0
01	3.3	16.0		35.9		8.63	85.0
02	6.6	16.0		35.9		8.62	84.0
03	9.8	16.0		35.9		8.63	84.0
04	13.1	15.8		35.8		8.67	88.0
05	16.4	15.7		35.7		8.67	84.0
06	19.7	15.7		35.7		8.68	84.0
07	23.0	15.7		35.6		8.69	84.0
08	26.2	15.6		35.5		8.69	84.0
09	29.6	15.6		35.5		8.64	84.0
10	32.8	15.7		35.5		8.62	84.0
11	36.1	15.7		35.6		8.61	84.0
12	39.2	15.7		35.8		8.56	79.0
13	42.6	15.7		35.5		8.56	83.0
14	45.9	15.7		35.8		8.57	83.0
15	49.2	15.7		35.6		8.58	98.0

DATE: FEBRUARY 1, 1976 TIME: 1130

STATION: B9

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		36.0		8.72	91.0
01	3.3	16.0		36.0		8.71	88.0
02	6.6	16.0		36.0		8.73	86.0
03	9.8	16.0		35.9		8.70	84.0
04	13.1	15.7		35.8		8.68	83.0
05	16.4	15.8		35.8		8.67	84.0
06	19.7	15.8		35.8		8.67	83.0
07	23.0	15.7		35.8		8.66	84.0
08	26.2	15.7		35.9		8.65	83.0
09	29.6	15.7		35.8		8.64	83.0
10	32.8	15.7		35.8		8.63	84.0
11	36.1	15.7		35.8		8.62	82.0
12	39.2	15.7		36.0		8.61	82.0
13	42.6	15.7		35.9		8.59	78.0
14	45.9	15.7		35.9		8.55	76.0
15	49.2	15.7		35.9		8.53	76.0
16	52.5	15.7		35.8		8.52	76.0
17	55.8	15.7		35.9		8.50	75.0
18	59.0	15.7		35.9		8.50	73.0
19	62.3	15.7		35.9		8.49	71.0
20	65.6	15.7		35.9		8.48	69.0
21	68.9	15.7		36.0		8.48	72.0
22	72.1	15.7		36.0		8.40	70.0

DATE: FEBRUARY 1, 1976 TIME: 1205

STATION: A17

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		36.7		8.87	86.0
01	3.3	16.0		36.5		8.82	85.0
02	6.6	15.8		36.3		8.80	84.0
03	9.8	15.7		36.2		8.80	82.0
04	13.1	15.7		36.2		8.80	82.0
05	16.4	15.7		36.1		8.77	80.0
06	19.7	15.7		36.1		8.77	80.0
07	23.0	15.7		36.0		8.79	78.0
08	26.2	15.7		36.0		8.47	69.0

DATE: FEBRUARY 8, 1976 TIME: 0903

STATION: B1

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		31.7	9.9	8.00	
01	3.3	17.8		31.7	10.0	7.99	
02	6.6	17.7		35.2	10.3	7.98	
03	9.8	17.7		35.5	10.4	7.87	
04	13.1	17.7		35.8	10.8	7.86	
05	16.4	17.7		35.8	10.6	7.98	
06	19.7	17.7		35.6	10.9	7.88	
07	23.0	17.7		35.8	10.3	7.96	
08	26.2	17.6		35.9	10.0	7.92	
09	29.6	17.5		36.0	9.9	7.81	
10	32.8	17.5		36.0	9.8	7.90	
11	36.1	17.5		36.1	9.7	7.90	
12	39.2	17.5		36.1	9.7	7.90	
13	42.6	17.5		36.1	9.6	7.89	
14	45.9	17.4		36.1	9.4	7.83	
15	49.2	17.4		36.0	9.3	7.92	
16	52.5	17.4		36.0	9.3	7.92	
17	55.6	17.4		36.0	9.2	7.90	
18	59.0	17.4		36.1	9.0	7.80	
19	62.3	17.3		36.1	8.5	7.89	
20	65.6	17.3		36.1	8.3	7.87	

DATE: FEBRUARY 8, 1976 TIME: 1008

STATION: B2

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		34.9	9.7	8.95	
01	3.3	18.2		35.4	9.5	8.07	
02	6.6	18.2		35.4	9.4	8.05	
03	9.8	18.1		35.4	9.7	8.04	
04	13.1	18.0		35.5	9.6	8.02	
05	16.4	18.0		35.5	9.8	8.01	
06	19.7	17.9		35.6	9.6	8.01	
07	23.0	17.9		35.7	9.6	8.00	
08	26.2	17.8		35.7	9.8	8.00	
09	29.5	17.8		35.6	9.8	8.00	
10	32.8	17.8		35.5	9.8	8.00	
11	36.1	17.7		35.8	9.8	8.00	
12	39.2	17.7		35.8	9.8	8.00	
13	42.6	17.7		35.8	9.9	8.00	
14	45.9	17.7		35.7	10.0	8.00	
15	49.2	17.7		35.8	10.0	8.00	
16	52.5	17.7		35.8	9.9	7.96	

DATE: FEBRUARY 8, 1976 TIME: 1019

STATION: B3

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		30.3	9.4	8.06	
01	3.3	18.4		33.5	9.6	8.04	
02	6.6	18.8		34.0	9.7	8.03	
03	9.8	18.4		34.4	9.3	8.01	
04	13.1	18.4		35.4	9.2	8.01	
05	16.4	18.4		35.4	9.3	8.01	
06	19.7	18.4		35.4	9.3	8.01	
07	23.0	18.4		35.5	9.2	7.99	
08	26.2	18.4		35.5	9.2	7.99	
09	29.6	18.4		35.4	9.3	7.99	
10	32.8	18.4		35.7	9.3	7.98	
11	36.1	18.4		35.7	9.0	7.97	
12	39.2	18.4		35.7	9.1	7.98	
13	42.6	18.4		35.7	9.2	7.98	
14	45.9	18.4		35.8	9.3	7.96	
15	49.2	18.4		35.8	9.2	7.96	
16	52.5	18.4		35.8	9.2	7.97	
17	55.8	18.6		35.8	9.0	7.97	
18	59.0	18.6		35.8	8.9	7.97	
19	62.3	18.7		35.8	8.9	7.96	

DATE: FEBRUARY 8, 1976 TIME: 1028

STATION: B4

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		31.2	9.0	8.91	
01	3.3	19.0		32.4	9.1	7.98	
02	6.6	18.7		34.0	9.4	8.01	
03	9.8	18.5		34.7	10.0	8.00	
04	13.1	18.8		35.7	10.8	8.00	
05	16.4	18.5		35.3	10.9	8.00	
06	19.7	18.4		35.4	10.8	7.99	
07	23.0	18.4		35.5	10.8	7.97	
08	26.2	18.3		35.6	10.8	7.96	
09	29.6	18.3		35.8	10.6	7.95	
10	32.8	18.2		35.8	10.0	7.95	
11	36.1	18.1		35.8	10.0	7.95	
12	39.2	18.1		35.8	10.0	7.95	
13	42.6	18.1		35.8	10.0	7.96	
14	45.9	18.0		35.8	10.0	7.96	
15	49.2	18.0		35.8	10.0	7.96	
16	52.5	18.0		35.8	10.0	7.96	
17	55.8	18.0		35.8	10.0	7.95	
18	59.0	18.0		35.8	10.0	7.96	

DATE: FEBRUARY 6, 1976 TIME: 0944

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		29.1	9.8	8.16	
01	3.3	18.1		32.7	9.8	8.11	
02	6.6	18.1		34.5	9.8	8.10	
03	9.8	18.0		35.1	9.8	8.08	
04	13.1	18.1		35.4	9.8	8.07	
05	16.4	17.8		35.5	9.7	8.08	
06	19.7	17.8		35.5	9.7	8.04	
07	23.0	17.8		35.6	9.6	8.03	
08	26.2	17.8		35.8	9.8	8.02	
09	29.5	17.8		35.8	9.8	8.02	
10	32.8	17.8		35.8	9.4	8.01	
11	36.1	17.8		35.8	9.4	8.01	
12	39.4	17.8		36.0	9.4	8.01	
13	42.6	17.8		36.9	9.4	8.00	
14	45.9	17.9		35.8	9.8	8.03	
15	49.2	18.0		36.9	9.8	8.06	
16	52.5	18.0		36.9	9.5	8.00	
17	55.8	18.0		36.6	9.3	7.99	
18	59.0	18.0		36.8	9.2	7.99	
19	62.3	18.0		36.8	9.2	8.00	

DATE: FEBRUARY 6, 1976 TIME: 0948

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		29.0	9.7	8.17	
01	3.3	17.6		29.8	9.8	8.07	
02	6.6	17.7		34.6	9.9	8.06	
03	9.8	17.7		34.6	9.9	8.06	
04	13.1	17.7		35.5	9.8	8.05	
05	16.4	17.7		35.7	9.7	8.04	
06	23.0	17.7		35.7	9.7	8.03	
07	26.2	17.7		35.8	9.7	8.02	
08	26.2	17.7		35.9	9.5	8.01	
09	29.5	17.7		35.9	9.5	8.00	
10	32.8	17.7		35.9	9.6	7.99	
11	36.1	17.7		35.8	9.8	7.99	
12	39.2	17.7		35.9	9.4	7.96	
13	42.6	17.8		35.9	9.4	7.98	
14	45.9	17.8		35.9	9.3	7.97	
15	49.2	17.7		35.9	9.3	7.96	
16	52.5	17.8		35.9	9.2	7.96	
17	55.8	17.8		35.9	9.2	7.94	
18	59.0	17.9		35.9	9.1	7.96	
19	62.3	18.0		35.9	9.1	7.98	

DATE: FEBRUARY 18, 1978 TIME: 1000

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		27.9	9.0	8.08	66.0
01	3.3	15.8		28.3	7.0	8.08	68.0
02	6.6	16.0		28.7	6.8	8.08	68.0
03	9.8	15.9		29.0	6.8	8.08	68.8
04	13.1	15.9		29.1	6.8	8.09	67.0
05	16.4	16.0		29.3	6.8	8.09	67.0
06	19.7	16.0		29.6	6.9	8.11	67.5
07	23.0	16.0		29.7	7.0	8.12	67.0
08	26.2	16.0		30.0	7.1	8.08	68.9

DATE: FEBRUARY 18, 1978 TIME: 1026

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		28.0	7.1	8.02	68.0
01	3.3	16.1		27.9	6.9	8.02	68.3
02	6.6	16.2		28.5	6.8	8.06	68.0
03	9.8	16.1		28.8	6.8	8.06	67.0
04	13.1	16.1		28.9	6.7	8.08	66.8
05	16.4	16.1		29.1	6.6	8.08	66.8
06	19.7	16.1		29.3	6.7	8.09	67.0
07	23.0	16.0		29.6	6.7	8.09	67.8
08	26.2	16.0		29.6	6.9	8.12	62.8
09	29.6	16.0		30.0	7.0	8.12	68.0
10	32.8	16.0		30.2	7.0	8.12	68.0

DATE: FEBRUARY 18, 1978 TIME: 1015

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		26.9	6.4	8.05	63.0
01	3.3	16.1		27.8	6.5	8.03	64.0
02	6.6	16.2		28.9	6.4	8.06	67.0
03	9.8	16.2		29.0	6.4	8.06	67.8
04	13.1	16.2		29.1	6.4	8.04	66.0
05	16.4	16.2		29.3	6.4	8.04	66.8
06	19.7	16.2		29.5	6.6	8.09	66.0
07	23.0	16.1		29.7	6.6	8.09	66.0
08	29.6	16.1		29.8	6.7	8.11	68.8
09	29.6	16.0		30.0	6.7	8.12	72.0
10	32.8	16.0		30.1	6.9	8.12	68.0
11	36.1	16.0		30.1	7.0	8.13	67.0

DATE: FEBRUARY 18, 1978 TIME: 0940

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		26.3	6.6	7.97	50.0
01	3.3	16.6		28.3	6.7	7.98	57.0
02	6.6	16.3		28.6	5.9	8.03	64.0
03	9.8	16.2		28.6	6.0	8.03	63.0
04	13.1	16.2		29.1	6.1	8.08	64.0
05	16.4	16.2		29.1	6.2	8.08	65.0
06	19.7	16.2		29.6	6.3	8.08	67.0
07	23.0	16.1		29.7	6.3	8.09	66.0
08	26.2	16.1		29.8	6.6	8.11	64.0
09	29.6	16.0		30.0	6.7	8.11	68.0
10	32.8	16.0		30.0	6.6	8.12	64.0
11	36.1	16.0		30.1	6.6	8.12	68.0

DATE: FEBRUARY 15, 1978 TIME: 0845

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4		27.8	6.9	7.94	66.5
01	3.3	16.6		28.2	8.0	7.93	71.0
02	6.6	16.6		28.7	6.0	7.96	72.8
03	9.8	16.4		29.1	6.7	7.98	73.0
04	13.1	16.4		29.3	6.1	8.00	72.0
05	16.4	16.3		29.4	6.3	8.01	63.0

DATE: FEBRUARY 18, 1978 TIME: 1000

STATION: C6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4		27.1	6.2	7.96	62.8
01	3.3	17.1		27.3	6.2	7.99	69.8
02	6.6	16.6		27.1	6.7	8.06	73.0
03	9.8	16.3		27.3	6.9	8.08	73.0
04	13.1	16.3		27.6	7.0	8.06	70.0
05	16.4	16.2		27.6	7.1	8.07	70.5
06	19.7	16.3		27.9	7.2	8.08	70.0
07	23.0	16.3		28.8	7.4	8.08	68.0
08	26.2	16.2		28.2	7.3	8.09	67.0
09	29.6	16.1		28.7	7.4	8.09	67.0
10	32.8	16.1		28.8	7.8	8.09	70.0

DATE: FEBRUARY 15, 1978 TIME: 0855

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		27.3	6.2	8.02	73.0
01	3.3	15.8		27.3	6.1	8.02	72.8
02	6.6	15.8		27.7	6.0	8.03	72.0
03	9.8	16.0		28.6	6.0	8.08	70.0
04	13.1	16.1		28.8	5.9	8.06	62.5
05	16.4	16.0		28.7	6.9	8.06	67.0
06	19.7	16.0		29.8	6.8	8.09	66.0
07	23.0	16.1		29.9	6.6	8.08	60.0
08	26.2	16.1		30.0	6.6	8.10	64.0
09	29.6	16.1		30.0	6.6	8.11	62.0
10	32.8	16.1		30.0	6.7	8.10	64.0
11	36.1	16.1		30.0	6.7	8.10	62.0

DATE: FEBRUARY 15, 1978 TIME: 0820

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.9		26.7	6.0	8.06	68.0
01	3.3	15.8		27.5	6.7	8.08	71.8
02	6.6	15.6		28.3	6.8	8.11	71.8
03	9.8	15.6		29.1	6.8	8.12	72.0
04	13.1	15.9		29.3	6.8	8.12	71.5
05	16.4	16.0		29.5	6.7	8.12	71.0
06	19.7	16.0		29.9	6.8	8.12	71.0
07	23.0	16.1		30.0	6.8	8.12	73.0
08	26.2	16.1		30.2	6.8	8.12	74.8
09	29.6	16.1		30.3	6.8	8.14	73.3
10	32.8	16.1		30.3	6.8	8.13	71.0
11	36.1	16.1		30.6	7.0	8.12	70.0
12	39.4	16.2		30.8	6.8	7.41	67.9

DATE: FEBRUARY 15, 1978 TIME: 0905

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.9		23.9	6.8	8.00	38.0
01	3.3	15.9		27.0	7.7	7.99	47.0
02	6.6	16.0		28.1	6.6	8.08	64.0
03	9.8	16.1		28.6	6.4	8.08	67.0
04	13.1	16.1		29.1	6.3	8.07	68.0
05	16.4	16.1		29.4	6.2	8.07	61.0
06	19.7	16.2		29.7	6.4	8.11	70.0
07	23.0	16.2		29.8	6.7	8.18	69.0
08	26.2	16.2		30.1	6.8	8.11	72.0
09	29.6	16.2		30.2	6.8	8.12	73.0
10	32.8	16.2		30.2	6.8	8.11	72.8
11	36.1	16.2		30.3	6.7	8.11	72.8
12	39.2	16.2		30.3	6.6	8.12	67.8
13	42.6	16.2		30.4	6.9	8.12	

DATE: FEBRUARY 15, 1978 TIME: 0806

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		22.1	6.4	8.01	39.0
01	3.3	15.8		26.9	6.4	8.01	59.0
02	6.6	15.9		28.4	6.4	8.06	68.0
03	9.8	16.0		29.0	6.5	8.07	67.0
04	13.1	16.1		29.2	6.6	8.08	65.0
05	16.4	16.1		29.4	6.6	8.08	64.0
06	19.7	16.2		29.5	6.7	8.10	73.0
07	23.0	16.2		29.7	6.7	8.10	73.5
08	26.2	16.2		29.8	6.7	8.11	72.0
09	29.6	16.2		30.0	6.8	8.12	72.5
10	32.8	16.3		30.3	7.0	8.13	73.5
11	36.1	16.3		30.4	7.1	8.13	64.4

DATE: FEBRUARY 15, 1978 TIME: 0842

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.6		10.0	6.2	7.64	20.5
01	3.3	15.6		25.4	5.6	7.66	19.0
02	6.6	15.8		26.7	5.6	7.98	37.0
03	9.8	16.0		28.0	5.6	8.00	44.0
04	13.1	16.1		28.7	5.9	8.04	40.5
05	16.4	16.3		29.4	5.7	8.01	48.5
06	19.7	16.3		29.8	4.8	7.82	67.0
07	23.0	16.4		29.5	4.1	7.73	67.5
08	26.2	16.4		29.6	4.4	7.81	67.0
09	29.6	16.3		30.1	4.4	7.64	58.0
10	32.8	16.3		26.3	4.4	7.20	

DATE: FEBRUARY 8, 1978 TIME: 0918

STATION: D1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		27.7	9.9	8.11	
01	3.3	17.7		31.6	9.9	8.05	
02	6.6	17.1		32.3	10.0	8.04	
03	9.8	17.7		34.7	10.0	8.02	
04	13.1	17.6		35.5	10.0	8.02	
05	16.4	17.6		35.7	10.0	8.01	
06	19.7	17.5		35.7	10.0	8.00	
07	23.0	17.4		35.9	10.0	7.98	
08	26.2	17.4		35.9	10.0	7.99	
09	29.6	17.4		35.8	10.0	7.99	
10	32.8	17.4		35.8	9.9	7.97	
11	36.1	17.3		35.8	9.6	7.96	
12	39.2	17.3		35.9	9.5	7.97	
13	42.6	17.3		35.9	9.6	7.95	
14	45.9	17.3		35.9	9.3	7.92	
15	49.2	17.3		35.9	8.8	7.91	

DATE: FEBRUARY 8, 1978 TIME: 0934

STATION: D2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		31.5	9.6	8.06	
01	3.3	17.9		32.3	9.8	8.06	
02	6.6	17.9		33.7	9.9	8.08	
03	9.8	17.8		34.5	9.9	8.05	
04	13.1	17.8		35.0	9.9	8.04	
05	16.4	17.8		35.4	9.9	8.04	
06	19.7	17.8		35.5	9.6	8.03	
07	23.0	17.7		35.6	9.6	8.00	
08	26.2	17.6		35.7	9.3	7.99	
09	29.6	17.6		35.8	9.1	7.92	
10	32.8	17.6		35.8	7.2	7.77	
11	36.1	17.7		36.6	5.0	7.40	

DATE: FEBRUARY 9, 1978 TIME: 0920

STATION: D3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.5		26.7	9.7	8.16	
01	3.3	18.1		31.5	9.8	8.08	
02	6.6	18.1		33.4	9.9	8.06	
03	9.8	17.9		34.4	9.9	8.05	
04	13.1	17.8		34.9	10.0	8.03	
05	16.4	17.8		35.1	10.0	8.02	
06	19.7	17.8		35.3	9.6	8.01	
07	23.0	17.7		35.7	9.6	7.97	
08	26.2	17.7		36.7	9.3	7.98	
09	29.6	17.7		35.7	9.3	7.93	
10	32.8	17.7		35.7	8.1	7.88	
11	36.1	17.6		35.8	8.0	7.87	
12	39.2	17.6		35.6	7.8	7.84	
13	42.6	17.5		35.6	7.0	7.83	
14	45.9	17.5		35.6	7.1	7.84	
15	49.2	17.5		35.8	7.1	7.85	
16	52.5	17.5		35.8	7.1	7.87	
17	55.8	17.4		35.8	7.1	7.86	

DATE: FEBRUARY 6, 1978 TIME: 0939

STATION: D10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		23.7	9.6	7.99	
01	3.3	18.4		33.1	8.5	8.01	
02	6.6	18.4		33.8	8.4	8.01	
03	9.8	18.4		34.3	8.6	8.01	
04	13.1	18.4		34.8	10.0	8.01	
05	16.4	18.3		35.0	10.0	8.00	
06	19.7	18.2		35.1	9.9	7.99	
07	23.0	18.2		35.3	9.7	7.97	
08	26.2	18.1		35.5	9.4	7.94	
09	29.6	18.0		35.5	8.0	7.88	

DATE: MARCH 2, 1978

STATION: A1 - NO DATA DUE TO STORM CONDITIONS

DATE: MARCH 2, 1978 TIME: 0910

STATION: A2A

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		26.2	8.2	8.08	60.5
01	3.3	15.8		26.7	8.0	8.07	60.8
02	6.6	15.9		27.7	8.0	8.10	59.5
03	9.8	15.8		28.8	8.0	8.11	58.0
04	13.1	15.8		28.7	7.7	8.12	52.5
05	16.4	15.8		28.8	8.1	8.15	67.5
06	19.7	15.6		29.0	8.8	8.17	61.0
07	23.0	15.8		29.3	8.3	8.10	58.0
08	26.2	16.9		29.3	8.1	8.13	44.8
09	29.6	15.8		29.3	7.9	8.13	39.0
10	32.8	15.8		29.3	7.9	8.13	31.0
11	36.1	15.9		29.3	7.9	8.12	32.0
12	39.2	15.8		29.3	7.8	8.10	19.0
13	42.6	15.8		28.6	6.8	8.08	8.0
14	45.0	15.8		29.3	6.0	8.08	12.0

DATE: MARCH 2, 1978 TIME: 0921

STATION: A3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		26.5	8.1	8.13	61.0
01	3.3	15.9		26.8	8.1	8.13	60.0
02	6.6	15.8		27.5	8.8	8.14	66.0
03	9.8	16.0		28.1	8.4	8.13	67.0
04	13.1	16.0		28.8	8.1	8.15	60.0
05	16.4	15.8		29.0	8.0	8.13	69.0
06	19.7	15.8		29.1	8.0	8.14	70.0
07	23.0	15.9		29.4	7.9	8.12	98.0
08	26.2	15.9		29.3	7.7	8.12	20.0
09	29.6	15.9		29.6	7.8	8.12	10.0

DATE: MARCH 2, 1978 TIME: 0931

STATION: A4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		26.8	8.4	8.14	57.0
01	3.3	15.9		26.8	8.2	8.14	57.0
02	6.6	15.9		26.8	8.2	8.12	57.0
03	9.8	16.0		27.0	8.0	8.11	52.0
04	13.1	16.0		27.6	7.6	8.11	35.0
05	16.4	15.9		28.0	7.6	8.10	43.0
06	19.7	15.9		28.0	7.5	8.05	32.0

DATE: MARCH 2, 1978 TIME: 0940

STATION: A7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		26.2	8.3	8.15	32.0
01	3.3	15.9		26.2	8.2	8.15	32.0
02	6.6	15.6		26.1	8.2	8.15	39.0
03	9.8	16.0		27.2	8.3	8.14	37.0

DATE: MARCH 2, 1978 TIME: 1120

STATION: A8

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.9		23.7	7.5	8.08	68.0
01	3.3	16.0		26.0	7.1	8.05	64.0
02	6.6	16.2		27.2	7.6	8.10	62.0
03	9.8	15.9		28.0	7.8	8.11	63.0
04	13.1	15.9		28.8	7.6	8.11	61.0
05	16.4	15.6		28.9	7.9	8.11	59.0
06	19.7	15.6		29.0	7.9	8.11	66.0
07	23.0	15.6		29.1	7.7	8.10	54.0
08	26.2	16.6		29.1	7.7	8.12	48.0
09	29.6	15.7		29.3	7.7	8.12	40.0
10	32.8	15.7		29.3	7.8	8.11	41.0
11	36.1	15.7		29.3	7.7	8.11	37.0

DATE: MARCH 2, 1978 TIME: 1108

STATION: A9

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		26.4	8.3	8.24	66.0
01	3.3	15.7		26.4	8.2	8.19	57.5
02	6.6	15.8		26.4	8.2	8.19	57.0
03	9.8	15.9		27.1	8.2	8.16	60.0
04	13.1	15.8		20.3	8.3	8.19	60.0
05	16.4	15.8		26.7	8.2	8.15	61.0
06	19.7	15.8		29.0	8.3	8.14	58.0
07	23.0	15.8		29.1	8.3	8.14	54.0
08	26.2	15.7		29.2	8.3	8.12	48.0

DATE: MARCH 15, 1978 TIME: 1039

STATION: A10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		24.2	8.3	7.32	
01	3.3	16.6		20.0	8.1	7.32	
02	6.6	16.4		19.9	7.7	7.33	
03	9.8	16.3		19.5	7.6	7.32	
04	13.1	16.3		19.6	7.1	7.33	
05	16.4	16.2		19.6	7.1	7.33	
06	19.7	16.2		19.1	7.1	7.33	
07	23.0	16.1		21.0	6.9	7.33	
08	26.2	16.0		21.1	6.7	7.32	
09	29.6	15.7		21.0	6.7	7.33	
10	32.8	16.8		20.9	6.8	7.33	

DATE: MARCH 2, 1978 TIME: 1033

STATION: A12

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		25.2	6.8	8.18	42.0
01	3.3	15.6		25.1	6.7	8.18	42.0
02	6.6	15.6		25.1	6.7	8.18	42.5
03	9.8	15.6		25.6	6.9	8.17	43.0
04	13.1	15.6		27.2	6.9	8.17	43.5
05	16.4	15.6		28.7	6.8	8.16	43.0
06	19.7	15.8		29.0	6.7	8.17	43.0
07	23.0	15.6		29.2	6.6	8.16	41.0
08	26.2	15.7		29.4	6.6	8.15	55.0
09	29.6	15.7		29.5	6.5	8.15	50.0
10	32.8	15.7		29.5	6.2	8.14	44.0
11	36.1	15.7		29.5	6.1	8.14	41.5
12	39.2	15.7		29.3	6.0	8.12	38.0

DATE: MARCH 2, 1978 TIME: 0857

STATION: A13

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		28.5	6.5	8.14	59.0
01	3.3	15.9		28.7	6.4	8.14	59.0
02	6.6	15.9		28.8	6.2	8.15	59.5
03	9.8	16.7		26.5	6.2	8.14	59.0
04	13.1	16.7		27.1	6.3	8.17	59.8
05	16.4	15.7		27.9	6.4	8.17	59.0
06	19.7	15.7		28.7	6.6	8.18	58.8
07	23.0	15.7		29.4	6.5	8.18	57.0
08	26.2	15.7		29.4	6.3	8.18	55.8
09	29.6	15.6		29.7	6.3	8.17	53.8
10	32.8	15.6		29.6	6.3	8.15	52.0
11	36.1	15.6		29.6	6.1	8.17	49.0
12	39.2	15.6		29.5	6.3	8.16	47.0
13	42.6	15.6		29.4	6.1	8.16	46.8
14	45.9	15.6		29.4	6.0	8.14	49.8
15	49.2	15.6		30.0	7.9	8.14	46.0
16	52.5	15.6		29.9	7.7	8.12	43.8
17	55.8	15.5		29.9	7.5	8.11	30.0
18	59.0	15.5		29.6	7.3	8.10	29.0

DATE: MARCH 2, 1978 TIME: 1044

STATION: A14

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		28.5	6.3	8.14	65.0
01	3.3	15.8		28.9	6.3	8.16	64.0
02	6.6	15.9		25.9	6.3	8.14	63.0
03	9.8	15.9		28.5	6.6	8.18	65.5
04	13.1	15.9		28.2	6.6	8.18	63.0
05	16.4	15.9		28.6	6.6	8.18	61.5
06	19.7	15.8		29.1	6.3	8.16	60.0
07	23.0	15.8		29.5	6.3	8.12	39.5
08	26.2	15.8		29.5	6.3	8.18	36.0
09	29.6	15.8		29.5	6.2	8.18	30.0
10	32.8	15.6		29.4	6.0	8.13	31.0
11	36.1	15.6		29.6	7.7	8.12	12.0

DATE: MARCH 2, 1978 TIME: 0957

STATION: A15

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		24.1	6.2	8.22	59.8
01	3.3	15.7		23.8	6.4	8.20	60.0
02	6.6	15.6		24.5	6.3	8.18	60.0
03	9.8	15.9		26.7	6.4	8.18	66.0
04	13.1	15.9		26.6	6.5	8.16	67.8
05	16.4	15.4		26.2	7.8	8.12	59.0
06	19.7	15.4		29.3	6.0	8.12	61.0

DATE: MARCH 2, 1978 TIME: 0948

STATION: A16

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		28.8	6.6	8.16	60.0
01	3.3	15.9		28.9	6.4	8.16	60.0
02	6.6	15.9		28.8	6.5	8.17	60.0
03	9.8	16.0		28.8	6.6	8.17	60.0
04	13.1	16.6		27.6	6.4	8.16	65.0
05	16.4	15.6		28.8	6.4	8.16	65.0
06	19.7	15.6		29.2	6.3	8.14	55.0
07	23.0	15.6		29.4	7.9	8.12	38.4
08	26.2	15.6		29.2	7.4	8.08	30.0

DATE: MARCH 2, 1978 TIME: 1054

STATION: A17

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		24.9	7.8	8.09	63.0
01	3.3	15.9		26.0	7.6	8.13	64.0
02	6.6	15.9		26.5	7.9	8.12	66.0
03	9.8	16.0		27.2	8.2	8.15	67.0
04	13.1	15.9		27.6	8.7	8.16	68.0
05	16.4	15.9		28.2	8.0	8.13	73.0
06	19.7	16.0		28.4	7.9	8.12	69.0
07	23.0	16.0		28.3	7.8	8.12	63.0
08	26.2	15.9		28.9	7.7	8.12	62.5
09	29.6	15.9		29.3	7.6	8.13	63.0
10	32.8	15.6		29.5	7.5	8.12	17.0
11	36.1	15.6		29.6	7.6	8.14	0.7

DATE: MARCH 8, 1978 TIME: 0915

STATION: B1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		26.0		8.19	72.0
01	3.3	16.0		29.2		8.18	73.0
02	6.6	16.9		29.5		8.16	80.0
03	9.8	16.0		28.6		8.16	88.0
04	13.1	16.0		29.6		8.19	87.0
05	16.4	15.6		30.2		8.18	87.0
06	19.7	15.6		30.2		8.18	86.0
07	23.0	15.6		30.1		8.18	86.0
08	26.2	15.6		30.1		8.18	88.0
09	29.6	15.6		30.1		8.18	89.0
10	32.8	15.8		30.1		8.18	88.0
11	36.1	15.6		30.1		8.18	88.0
12	39.2	15.6		30.1		8.17	88.0
13	42.6	15.7		30.1		8.17	88.0
14	45.9	15.7		30.1		8.16	88.0
15	49.2	15.8		30.1		8.18	88.0
16	52.5	15.8		30.1		8.17	88.0
17	55.8	15.8		30.1		8.17	88.0
18	59.0	15.7		30.1		8.17	87.0
19	62.3	15.7		30.0		8.17	84.0
20	65.6	15.7		30.0		8.17	74.0
21	68.9	15.7		30.0		8.17	61.0
22	72.1	15.7		30.0		8.16	54.0

DATE: MARCH 8, 1978 TIME: 1048

STATION: B2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		22.3		8.13	72.0
01	3.3	16.3		23.6		8.12	83.0
02	6.6	16.5		24.2		8.11	84.0
03	9.8	16.3		24.7		8.11	84.0
04	13.1	16.1		24.9		8.11	83.0
05	16.4	16.1		25.2		8.11	82.0
06	19.7	16.0		25.3		8.12	82.0
07	23.0	15.9		26.4		8.12	81.0
08	26.2	15.9		25.5		8.13	80.0
09	29.6	15.9		28.6		8.13	78.0
10	32.8	15.8		25.6		8.13	77.0
11	36.1	15.6		25.6		8.12	78.0
12	39.2	16.6		28.6		8.12	78.0
13	42.6	15.6		25.7		8.12	72.0
14	45.9	15.8		28.7		8.13	66.0
15	49.2	15.8		28.7		8.13	71.0

DATE: MARCH 8, 1978 TIME: 1055

STATION: B3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		25.9		8.09	81.0
01	3.3	16.0		26.0		8.09	87.0
02	6.6	16.5		27.7		8.11	86.0
03	9.8	16.0		29.6		8.10	82.0
04	13.1	16.0		29.6		8.14	78.0
05	16.4	15.9		29.8		8.14	76.0
06	19.7	15.9		29.8		8.16	76.0
07	23.0	15.9		29.8		8.16	78.0
08	26.2	15.9		29.8		8.16	73.0
09	29.6	15.9		29.9		8.14	68.0
10	32.8	15.8		30.0		8.15	64.0
11	36.1	15.6		30.0		8.16	55.0
12	39.2	15.8		30.1		8.15	53.0
13	42.6	15.8		30.2		8.16	54.0
14	45.9	15.6		30.2		8.14	50.0
15	49.2	15.8		30.2		8.14	48.0
16	52.5	15.8		30.2		8.14	48.0
17	55.8	15.8		30.2		8.14	47.0
18	59.0	15.8		30.2		8.15	46.0
19	62.3	15.8		30.2		8.14	45.0

DATE: MARCH 8, 1978 TIME: 1107

STATION: B4

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		26.8		8.07	48.0
01	3.3	16.4		26.9		8.06	81.0
02	6.6	16.4		26.6		8.07	87.0
03	9.8	16.4		27.3		8.07	87.0
04	13.1	16.3		27.8		8.09	88.0
05	16.4	16.2		28.3		8.09	85.0
06	19.7	16.1		28.8		8.12	83.0
07	23.0	16.0		28.8		8.12	81.0
08	26.2	15.9		29.1		8.13	80.0
09	29.6	15.9		29.2		8.13	78.0
10	32.8	15.9		29.2		8.13	76.0
11	36.1	15.9		29.2		8.13	75.0
12	39.2	15.9		29.2		8.13	75.0
13	42.6	15.8		29.1		8.13	75.0
14	45.9	15.8		29.1		8.13	76.0
15	49.2	15.8		29.1		8.13	74.0
16	52.5	15.8		28.2		8.14	73.0
17	55.8	15.8		28.2		8.14	70.0
18	59.0	15.8		28.2		8.14	64.0
19	62.3	15.8		28.9		8.14	61.0
20	65.6	15.8		28.9		8.14	60.0

DATE: MARCH 8, 1978 TIME: 1148

STATION: B5

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		25.9		8.03	69.0
01	3.3	16.6		26.4		8.03	80.0
02	6.6	16.2		26.6		8.06	83.0
03	9.8	16.3		26.9		8.06	83.0
04	13.1	16.2		27.2		8.08	82.0
05	16.4	16.1		27.4		8.09	82.0
06	19.7	16.1		27.6		8.11	80.0
07	23.0	16.0		27.7		8.11	79.0
08	26.2	16.0		27.9		8.11	78.0
09	29.6	16.0		28.1		8.11	78.0
10	32.8	16.0		28.1		8.12	77.0
11	36.1	15.9		28.3		8.12	77.0
12	39.2	15.9		28.3		8.12	78.0
13	42.6	15.9		28.4		8.11	78.0
14	45.9	15.9		28.4		8.12	74.0
15	49.2	15.9		28.3		8.12	73.0
16	52.5	15.9		28.2		8.12	72.0
17	55.8	15.9		28.1		8.12	72.0
18	59.0	15.9		28.8		8.13	72.0
19	62.3	15.9		28.6		8.13	71.0
20	65.6	16.0		28.6		8.13	68.0

DATE: MARCH 8, 1978 TIME: 1129

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		27.4		7.97	61.0
01	3.3	17.3		27.9		7.97	60.0
02	6.6	17.3		27.4		7.95	77.0
03	9.8	17.0		28.0		7.96	77.0
04	13.1	17.0		28.1		7.97	77.0
05	16.4	16.7		28.4		7.98	77.0
06	19.7	16.6		28.6		8.02	76.0
07	23.0	16.4		28.9		8.02	75.0
08	26.2	16.3		29.1		8.06	74.0
09	29.4	16.1		29.3		8.06	72.0
10	32.8	16.0		29.4		8.06	74.0
11	36.1	16.0		29.6		8.07	73.0
12	39.2	16.0		29.7		8.08	68.0

DATE: MARCH 8, 1978 TIME: 1152

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		28.9		7.98	75.0
01	3.3	17.2		28.0		7.98	88.0
02	6.6	16.7		28.8		8.04	89.0
03	9.8	16.8		27.6		8.04	83.0
04	13.1	16.8		27.6		8.08	82.0
05	16.4	16.4		27.7		8.08	81.0
06	19.7	16.3		28.0		8.07	80.0
07	23.0	16.2		28.3		8.07	80.0
08	26.2	16.1		28.7		8.09	75.0
09	29.5	16.0		28.6		8.09	73.0
10	32.8	16.0		28.6		8.10	73.0
11	36.1	16.0		28.7		8.10	77.0
12	39.2	16.0		28.7		8.11	76.0
13	42.6	15.9		28.6		8.11	77.0
14	45.9	15.8		28.6		8.11	76.0
15	49.2	15.9		28.5		8.12	75.0
16	52.5	15.8		28.5		8.13	75.0
17	55.8	15.9		28.5		8.13	74.0
18	59.0	15.9		28.3		8.13	71.0
19	62.3	15.8		27.0		8.13	68.0
20	65.6	15.9		27.0		8.13	63.0

DATE: MARCH 2, 1978 TIME: 1009

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.5		24.7	8.8	8.17	62.0
01	3.3	16.7		24.6	8.9	8.18	66.0
02	6.6	15.7		24.8	8.4	8.16	63.0
03	9.8	15.8		24.4	8.4	8.16	62.0
04	13.1	15.8		28.6	8.4	8.16	69.0
05	16.4	15.8		29.2	8.4	8.16	66.0
06	19.7	15.8		29.8	8.9	8.16	66.0
07	23.0	15.8		29.8	9.0	8.15	63.0
08	26.2	15.6		29.7	9.4	8.16	50.0
09	29.6	15.7		29.8	9.4	8.16	54.0
10	32.8	15.7		29.8	9.3	8.17	67.0
11	36.1	15.7		29.9	9.2	8.17	66.0
12	39.2	15.7		29.8	9.5	8.17	66.0

DATE: MARCH 2, 1978 TIME: 1020

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		24.8	8.8	8.18	60.0
01	3.3	15.7		24.7	8.8	8.18	63.0
02	6.6	16.8		28.1	8.8	8.18	62.0
03	9.8	16.8		28.0	9.2	8.18	61.0
04	13.1	15.7		27.0	9.2	8.17	60.0
05	16.4	15.8		28.2	9.4	8.16	66.0
06	19.7	15.7		28.6	9.4	8.16	64.0
07	23.0	15.7		29.2	9.8	8.16	57.0
08	26.2	15.7		29.3	9.4	8.16	56.8
09	29.6	15.7		29.4	9.3	8.14	56.6
10	32.8	15.7		29.4	9.4	8.14	58.5
11	36.1	15.6		29.3	9.4	8.17	60.0
12	39.2	15.6		29.3	9.2	8.15	67.0
13	42.6	15.6		29.3	8.8	8.15	65.0
14	45.9	15.5		29.6	8.4	8.13	39.0

DATE: MARCH 8, 1978 TIME: 1031

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		28.0		8.16	48.0
01	3.3	18.2		28.0		8.19	62.0
02	6.6	18.3		28.6		8.15	77.0
03	9.8	18.1		28.8		8.13	78.0
04	13.1	16.6		29.3		8.13	74.0
05	16.4	16.9		29.7		8.11	74.0
06	19.7	15.9		29.7		8.16	74.0
07	23.0	15.9		29.8		8.13	74.0
08	26.2	15.9		30.0		8.15	74.0
09	29.4	15.8		30.0		8.16	71.0
10	32.8	15.8		30.1		8.14	70.0
11	36.1	15.8		30.1		8.14	70.0
12	39.2	15.6		30.0		8.14	70.0
13	42.6	15.6		30.1		8.16	78.0
14	45.9	15.8		30.1		8.18	71.0
15	49.2	15.8		30.1		8.18	70.0
16	52.5	15.8		30.1		8.18	67.0
17	55.8	15.8		30.1		8.18	61.0
18	59.0	15.6		30.1		8.15	58.0
19	62.3	15.6		30.1		8.14	58.0
20	65.6	15.7		30.2		8.14	58.0
21	68.9	15.7		30.2		8.14	48.0
22	72.1	15.7		30.2		8.14	48.0

DATE: MARCH 4, 1978 TIME: 1024

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		21.8		8.08	22.0
01	3.3	16.1		23.8		8.07	30.0
02	6.6	16.0		26.1		8.08	59.0
03	9.8	16.0		28.8		8.08	80.0
04	13.1	16.0		29.0		8.10	79.0
05	16.4	15.9		29.5		8.10	79.0
06	19.7	15.9		29.6		8.12	78.0
07	23.0	15.8		29.9		8.12	73.0
08	26.2	15.8		29.9		8.13	73.0
09	29.4	15.8		29.9		8.13	71.0
10	32.8	15.8		30.0		8.13	68.0
11	36.1	15.8		30.0		8.13	68.0
12	39.2	15.8		30.0		8.13	67.0
13	42.6	15.8		30.0		8.13	64.0
14	45.9	15.8		30.0		8.13	61.0
15	49.2	15.8		30.0		8.14	58.0
16	52.5	15.8		30.0		8.14	55.0
17	55.8	16.8		30.0		8.14	56.0

DATE: MARCH 15, 1978 TIME: 1020

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		27.4	6.9	8.07	
01	3.3	16.4		26.9	6.6	8.06	
02	6.6	16.6		28.8	6.6	8.07	
03	9.8	16.5		26.9	6.9	8.07	
04	13.1	16.5		27.0	6.9	8.08	
05	16.4	16.3		27.0	6.9	8.08	
06	19.7	16.2		27.0	6.9	8.10	
07	23.0	15.9		27.1	7.0	8.10	
08	26.2	15.9		27.2	7.2	8.12	
09	29.6	15.6		27.4	7.2	8.12	
10	32.8	15.8		27.8	7.2	8.12	

DATE: MARCH 15, 1978 TIME: 1010

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		19.8	8.4	8.06	
01	3.3	16.9		20.6	8.1	8.06	
02	6.6	16.8		20.4	6.4	8.07	
03	9.8	16.7		19.0	6.8	8.07	
04	13.1	16.6		20.7	8.1	8.07	
05	16.4	16.3		20.6	9.1	8.07	
06	19.7	16.2		20.9	9.6	8.08	
07	23.0	15.9		20.7	8.7	8.08	
08	26.2	15.9		23.1	7.6	8.08	
09	29.6	15.6		21.8	7.3	8.08	
10	32.8	16.0		18.7	10.3	8.09	

DATE: MARCH 15, 1978 TIME: 0954

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		27.4	6.9	8.04	75.0
01	3.3	16.9		29.0	6.4	8.06	72.5
02	6.6	16.9		29.1	6.4	8.08	71.5
03	9.8	16.8		29.3	6.3	8.08	71.0
04	13.1	16.7		29.3	6.4	8.07	68.5
05	16.4	16.5		29.3	6.3	8.07	68.5
06	19.7	16.6		29.3	6.4	8.07	70.0
07	23.0	16.3		29.4	6.3	8.07	71.0
08	26.2	16.2		29.8	6.4	8.08	70.5
09	29.6	16.1		29.5	6.4	8.08	66.5
10	32.8	16.0		29.6	6.5	8.08	62.5
11	36.1	15.9		29.6	6.8	8.06	59.1
12	39.2	15.8		29.7	6.4	8.06	62.9

DATE: MARCH 15, 1978 TIME: 0920

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.1		23.7	8.0	8.03	69.0
01	3.3	17.5		23.9	7.1	8.05	73.0
02	6.6	17.4		27.8	7.1	8.06	72.0
03	9.8	16.8		27.3	7.0	8.06	70.0
04	13.1	16.7		27.1	6.6	8.06	67.0
05	16.4	16.5		27.2	6.7	8.06	65.0
06	19.7	16.5		27.2	6.8	8.06	63.0
07	23.0	16.4		27.3	6.8	8.06	62.1
08	26.2	16.4		27.3	7.0	8.07	60.0
09	29.6	16.3		27.3	6.9	8.07	66.5
10	32.8	16.1		27.3	7.0	8.08	68.0
11	36.1	16.1		27.2	7.1	8.06	65.6

DATE: MARCH 15, 1978 TIME: 0932

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		27.6	7.8	8.03	68.5
01	3.3	17.5		27.2	5.8	8.05	74.2
02	6.6	17.2		27.2	5.8	8.04	72.5
03	9.8	17.0		27.3	6.0	8.04	69.5
04	13.1	16.8		27.3	5.6	8.07	67.5
05	16.4	16.7		27.4	5.5	8.01	67.3
06	19.7	16.6		27.4	5.1	7.24	

DATE: MARCH 16, 1978 TIME: 0948

STATION: C6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		27.5	7.4	8.08	82.0
01	3.3	17.1		27.6	6.8	8.09	81.0
02	6.6	16.8		27.6	6.2	8.08	76.8
03	9.8	16.6		27.6	6.1	8.08	75.0
04	13.1	16.6		27.7	5.9	8.06	76.0
05	16.4	16.4		27.8	6.6	8.04	77.8
06	19.7	16.4		27.8	5.9	8.05	76.5
07	23.0	16.3		27.8	6.0	8.05	76.0
08	26.2	16.2		28.0	6.0	8.05	76.0
09	29.6	16.2		28.0	6.0	8.06	71.0
10	32.8	16.3		28.1	6.1	8.06	78.0

DATE: MARCH 16, 1978 TIME: 0907

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		22.1	7.7	8.01	77.5
01	3.3	16.8		21.9	7.6	8.01	76.0
02	6.6	16.7		19.1	7.4	8.02	76.8
03	9.8	16.7		18.2	7.3	8.02	73.0
04	13.1	16.7		18.1	7.3	8.02	78.0
05	16.4	16.6		16.6	7.3	8.03	76.8
06	19.7	16.5		16.2	7.4	8.03	77.0
07	23.0	16.5		14.6	7.3	8.03	76.8
08	26.2	16.5		13.8	7.2	8.03	76.5
09	29.6	16.3		13.2	6.9	8.04	78.5
10	32.8	16.8		13.8	6.9	8.04	77.0
11	36.1	16.4		10.2	7.1	8.05	

DATE: MARCH 16, 1978 TIME: 0806

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		28.0	6.6	8.06	79.0
01	3.3	16.4		28.1	6.6	8.06	81.0
02	6.6	16.4		28.1	6.7	8.06	82.0
03	9.8	16.4		28.2	6.7	8.07	81.0
04	13.1	16.4		28.3	6.6	8.07	80.0
05	16.4	16.4		28.3	6.6	8.07	79.0
06	19.7	16.3		28.6	6.5	8.07	79.0
07	23.0	16.3		28.6	6.5	8.07	78.0
08	26.2	16.1		28.7	6.8	8.07	77.0
09	29.6	16.0		28.5	6.4	8.07	76.0
10	32.8	16.0		28.8	6.3	8.07	75.5

DATE: MARCH 16, 1978 TIME: 0848

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		18.5	6.7	8.08	78.5
01	3.3	16.8		16.9	6.6	8.06	78.0
02	6.6	16.7		19.1	6.6	8.07	78.0
03	9.8	16.6		19.2	6.6	8.06	77.5
04	13.1	16.6		19.3	6.6	8.08	73.5
05	16.4	16.5		19.4	6.7	8.08	78.0
06	19.7	16.6		19.4	6.6	8.06	78.0
07	23.0	16.3		19.3	6.7	8.08	79.0
08	26.2	16.2		18.3	6.9	8.08	78.0
09	29.6	16.1		19.4	6.9	8.08	77.0
10	32.8	16.0		19.3	6.7	8.08	78.5
11	36.1	16.0		19.1	6.8	8.08	76.0

DATE: MARCH 16, 1978 TIME: 0840

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		16.1	6.8	8.10	84.0
01	3.3	17.0		16.5	6.7	8.10	82.0
02	6.6	16.6		16.4	6.7	8.10	81.0
03	9.8	16.6		17.2	6.5	8.08	79.5
04	13.1	16.8		18.8	6.5	8.08	78.8
05	16.4	16.4		21.3	6.6	8.08	76.5
06	19.7	16.6		25.1	6.6	8.08	79.0
07	23.0	16.3		25.8	6.5	8.08	80.0
08	26.2	16.2		27.6	6.6	8.09	78.5
09	29.6	16.1		27.8	6.6	8.06	79.6
10	32.8	16.0		28.0	6.6	8.11	78.5
11	36.1	16.9		28.6	6.7	8.10	67.0

DATE: MARCH 16, 1978 TIME: 0815

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		20.3	8.9	7.88	78.5
01	3.3	17.0		24.0	5.6	7.88	82.0
02	6.6	16.8		26.3	6.0	8.02	73.6
03	9.8	16.5		27.1	6.0	8.03	78.0
04	13.1	16.3		27.4	6.1	8.04	78.6
05	16.4	16.1		27.6	5.6	8.01	74.0
06	19.7	16.2		27.8	4.0	7.81	71.0
07	23.0	16.1		28.0	6.8	7.74	59.6
08	26.2	16.1		28.1	3.3	7.78	60.8

DATE: MARCH 8, 1978 TIME: 1008

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		21.8	8.5	8.12	15.0
01	3.3	16.0		24.6	10.1	8.08	27.0
02	6.6	16.0		27.4	10.9	8.11	47.0
03	9.8	15.8		28.3	11.8	8.11	42.0
04	13.1	15.9		28.6	12.5	8.13	71.0
05	16.4	15.8		29.2	13.4	8.13	79.0
06	19.7	15.9		29.2	14.5	8.14	73.0
07	23.0	16.4		29.6	15.0	8.13	72.0
08	26.2	16.8		29.9	15.8	8.14	73.0
09	29.6	15.8		30.0	16.6	8.14	60.0
10	32.8	15.8		30.0	17.2	8.14	44.0
11	36.1	15.7		30.0	17.8	8.14	45.0
12	39.3	15.6		29.9	18.3	8.14	48.0
13	42.6	15.6		29.8	19.0	8.16	46.0
14	45.9	15.8		29.6	19.8	8.16	45.0
15	49.2	15.8		29.7	20.8	8.18	34.0

DATE: MARCH 8, 1978 TIME: 0949

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.5		9.0	9.6	8.10	0.0
01	3.3	15.8		19.4	10.1	8.08	2.0
02	6.6	16.0		27.8	10.1	8.10	26.0
03	9.8	15.9		29.1	11.2	8.07	33.0
04	13.1	15.9		29.4	11.5	8.08	29.0
05	16.4	16.8		29.5	11.9	8.09	40.0
06	19.7	16.8		29.7	13.0	8.11	51.0
07	23.0	16.8		29.7	13.0	8.12	53.0
08	26.2	15.8		29.8	13.1	8.12	56.0
09	29.6	16.8		29.9	14.9	8.13	56.0
10	32.8	16.6		30.0	14.7	8.12	67.0

DATE: MARCH 8, 1978 TIME: 0959

STATION: D3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		11.0	10.0	8.07	9.5
01	3.3	16.0		24.9	10.6	8.04	34.0
02	6.6	16.1		28.8	11.2	8.11	42.0
03	9.8	16.0		29.0	11.9	8.10	64.0
04	13.1	15.9		29.3	12.1	8.08	70.0
05	16.4	15.9		29.6	13.3	8.09	70.6
06	19.7	15.8		29.5	13.8	8.13	73.0
07	23.0	15.8		29.1	14.3	8.13	73.5
08	26.2	15.8		29.9	14.6	8.14	58.0
09	29.6	15.8		29.5	16.4	8.13	59.0
10	32.8	15.8		30.0	16.4	8.13	76.0

DATE: MARCH 6, 1978 TIME: 0945

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.7		15.1	9.4	8.11	18.0
01	3.3	16.0		23.1	10.1	8.04	21.0
02	6.6	16.0		26.4	11.8	8.08	30.0
03	9.8	16.0		27.0	11.8	8.06	44.0
04	13.1	15.9		27.7	12.6	8.07	46.0
05	16.4	15.9		28.0	13.3	8.08	49.0
06	19.7	15.6		28.0	14.1	8.09	45.0
07	23.0	15.4		28.1	14.8	8.08	30.0
08	26.2	16.6		28.1	16.0	8.08	25.0
09	29.6	16.9		28.1	16.1	8.08	20.0

DATE: APRIL 14, 1978 TIME: 1136

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6	30.4	9.4	8.21	73.0
01	3.3	17.2	29.9	9.3	8.21	73.0
02	6.6	17.1	30.2	9.7	8.22	74.0
03	9.8	16.7	30.2	9.2	8.21	76.0
04	13.1	16.4	30.2	9.5	8.20	68.0
05	16.4	16.0	30.4	9.2	8.19	71.0
06	19.7	16.0	30.5	9.0	8.19	71.0
07	23.0	15.8	30.8	8.8	8.17	76.0
08	26.2	15.1	30.4	8.8	8.12	71.0
09	29.6	14.8	30.5	7.7	8.11	72.0

DATE: APRIL 5, 1978 TIME: 0745

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8	34.1	7.7	7.37	72.0
01	3.3	16.8	34.7	7.6	7.37	72.0
02	6.6	16.8	34.7	7.5	7.35	68.0
03	9.8	16.7	34.8	7.3	7.45	72.0
04	13.1	16.7	34.6	7.6	7.49	70.0
05	16.4	16.7	34.7	7.6	7.46	70.0
06	19.7	16.3	34.8	7.7	7.46	72.0
07	23.0	16.6	34.8	7.7	7.40	71.0
08	26.2	16.6	34.8	7.9	7.46	69.0

DATE: APRIL 5, 1978 TIME: 0754

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0	36.0	10.5	7.84	38.0
01	3.3	17.7	36.2	10.0	7.83	76.0
02	6.6	17.6	35.2	9.8	7.87	77.0
03	9.8	17.3	35.3	8.9	7.88	77.0
04	13.1	17.0	36.1	10.6	7.88	77.0
05	16.4	16.9	35.2	10.4	7.84	76.0
06	19.7	17.0	35.2	10.5	7.84	76.0
07	23.0	17.0	35.2	10.8	7.82	77.0
08	26.2	17.0	36.2	10.0	7.80	76.0
09	29.6	16.8	35.2	9.6	7.78	76.0
10	32.8	17.0	36.3	8.3	7.76	73.0
11	36.1	16.7	34.5	9.7	7.77	73.0
12	39.2	16.8	35.6	10.3	7.76	71.0

DATE: APRIL 5, 1978 TIME: 0838

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8	35.7	6.3	7.77	32.0
01	3.3	17.0	36.2	8.9	7.81	30.0
02	6.6	16.9	35.6	8.7	7.82	38.0
03	9.8	16.8	35.7	10.0	7.80	57.0
04	13.1	16.8	35.7	10.3	7.78	58.0

DATE: APRIL 5, 1978 TIME: 0852

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2	33.8	12.3	7.96	62.0
01	3.3	17.0	34.7	11.9	7.96	57.0
02	6.6	17.0	35.0	11.3	7.97	64.0
03	9.8	17.0	35.1	11.5	7.91	79.0
04	13.1	16.9	35.2	11.6	7.89	77.0
05	16.4	16.8	36.2	11.8	7.86	77.0
06	19.7	16.8	36.2	11.7	7.84	78.0
07	23.0	16.8	36.2	11.8	7.88	80.0
08	26.2	16.8	35.3	11.3	7.79	80.0
09	29.6	16.8	35.3	11.3	7.76	78.0
10	32.8	16.7	35.3	11.1	7.78	71.0
11	36.1	16.7	36.4	10.8	7.74	55.0
12	39.2	16.7	35.4	10.8	7.80	40.0

DATE: APRIL 5, 1978 TIME: 0855

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8	33.4	12.6	7.92	68.0
01	3.3	16.6	35.4	11.9	7.83	70.0
02	6.6	16.4	35.5	10.8	7.83	76.0
03	9.8	16.2	35.7	12.0	7.84	79.0
04	13.1	16.4	35.6	12.2	7.84	76.0
05	16.4	16.4	35.6	12.5	7.81	74.0
06	19.7	16.3	35.6	12.3	7.70	78.0
07	23.0	16.3	35.6	12.4	7.78	83.0
08	26.2	16.3	35.5	12.3	7.77	82.0
09	29.6	16.0	35.7	12.1	7.78	82.0
10	32.8	15.9	36.0	12.0	7.71	81.0
11	36.1	15.0	36.1	12.3	7.69	78.0
12	39.2	14.8	36.2	12.2	7.67	76.0
13	42.6	14.7	36.2	12.6	7.66	82.0
14	45.9	14.6	36.1	12.2	7.66	81.0
15	49.2	14.6	36.0	12.3	7.63	83.0

DATE: APRIL 5, 1978 TIME: 1049

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8	34.8	12.2	7.92	68.0
01	3.3	17.0	35.3	11.0	7.84	71.0
02	6.6	17.0	35.5	10.6	7.80	74.0
03	9.8	17.0	35.5	10.0	7.88	74.0
04	13.1	16.8	35.5	10.2	7.86	75.0
05	16.4	16.8	35.6	10.2	7.86	75.0
06	19.7	16.8	35.6	10.2	7.84	73.0
07	23.0	16.8	35.7	9.6	7.78	74.0
08	26.2	16.7	35.9	9.3	7.75	75.0
09	29.6	16.3	36.0	8.9	7.74	77.0
10	32.8	16.3	36.0	8.7	7.73	67.0

DATE: APRIL 5, 1978 TIME: 0830

STATION: AC

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4	35.1	11.8	7.82	77.0
01	3.3	16.5	35.1	10.8	7.84	80.0
02	6.6	16.3	35.1	10.8	7.84	93.0
03	9.8	16.5	35.1	10.8	7.82	93.0
04	13.1	16.6	35.0	12.4	7.81	94.0
05	16.4	16.2	35.0	12.4	7.80	93.0
06	19.7	16.5	34.9	12.4	7.80	93.0
07	23.0	16.6	34.9	12.9	7.79	93.0
08	26.2	16.4	34.9	12.6	7.78	93.0
09	29.6	16.4	34.8	12.7	7.77	93.0
10	32.8	16.3	34.8	11.6	7.78	92.0
11	36.1	16.3	34.8	11.6	7.78	92.0
12	39.2	16.3	34.7	11.0	7.78	91.0
13	42.6	16.2	34.7	11.2	7.74	91.0
14	45.9	16.2	34.6	11.0	7.74	91.0
15	49.2	16.2	34.6	10.9	7.73	91.0
16	52.5	16.1	34.6	10.7	7.72	91.0
17	55.8	15.8	34.6	11.0	7.70	91.0
18	59.0	14.8	34.6	11.0	7.68	90.0
19	62.3	14.6	34.7	11.0	7.63	91.0
20	65.6	14.0	34.7	10.6	7.59	91.0
21	68.9	13.4	34.7	10.3	7.57	92.0
22	72.1	13.1	34.6	11.3	7.54	91.0

DATE: APRIL 5, 1978 TIME: 0816

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4	34.7	10.8	7.76	91.0
01	3.3	16.4	35.2	9.6	7.75	98.0
02	6.6	16.4	35.1	9.3	7.76	94.0
03	9.8	16.4	35.1	9.3	7.76	98.0
04	13.1	16.4	35.1	9.3	7.74	94.0
05	16.4	16.4	35.0	9.1	7.73	94.0
06	19.7	16.4	35.2	8.9	7.72	93.0
07	23.0	16.4	35.1	9.1	7.73	94.0
08	26.2	16.4	35.2	9.2	7.71	94.0
09	29.6	16.3	35.2	9.1	7.68	93.0
10	32.8	16.2	35.2	9.1	7.69	93.0
11	36.1	16.1	35.3	9.3	7.68	92.0
12	39.2	16.0	35.2	10.1	7.49	92.0
13	42.6	16.0	35.3	10.0	7.47	92.0
14	45.9	15.8	35.3	9.9	7.46	92.0
15	49.2	15.4	35.3	10.1	7.45	91.0
16	52.5	15.0	35.4	10.0	7.44	91.0
17	55.8	14.8	35.5	10.2	7.41	91.0
18	59.0	14.7	35.6	10.4	7.41	91.0
19	62.3	14.6	35.6	10.4	7.41	92.0
20	65.6	14.5	35.6	10.6	7.42	91.0

DATE: APRIL 5, 1978 TIME: 0908

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0	35.0	11.5	7.88	45.0
01	3.3	16.8	35.2	11.9	7.88	64.0
02	6.6	16.4	35.3	11.7	7.91	69.0
03	9.8	16.7	35.3	11.0	7.89	73.0
04	13.1	16.7	35.3	12.2	7.86	73.0
05	16.4	16.7	35.3	12.4	7.84	74.0
06	19.7	16.6	35.4	12.0	7.81	75.0
07	23.0	16.6	35.4	11.6	7.78	75.0
08	26.2	16.5	35.5	11.2	7.76	75.5
09	29.6	16.3	35.5	11.1	7.74	75.0
10	32.8	16.4	35.5	11.3	7.74	71.0
11	36.1	16.3	35.8	11.0	7.73	70.0
12	39.2	16.3	35.9	11.0	7.71	70.0
13	42.6	16.3	35.7	10.8	7.70	70.0
14	45.9	15.6	36.7	11.0	7.47	69.0

DATE: APRIL 5, 1978 TIME: 0923

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2	36.0	11.3	7.87	33.0
01	3.3	17.0	35.0	10.7	7.87	71.0
02	6.6	17.0	35.1	10.1	7.86	71.0
03	9.8	16.9	35.1	9.7	7.84	70.8
04	13.1	16.7	36.1	8.9	7.77	66.0
05	16.4	16.8	35.1	8.8	7.75	66.0
06	19.7	16.7	35.2	8.4	7.73	64.0
07	23.0	16.7	35.2	8.1	7.71	68.0

DATE: APRIL 5, 1978 TIME: 0925

STATION: A6

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3	35.0	11.3	7.78	50.0
01	3.3	17.2	35.7	10.2	7.78	55.0
02	6.6	17.0	35.2	8.9	7.77	53.5
03	9.8	17.0	36.2	8.7	7.78	53.8
04	13.1	16.8	36.2	8.7	7.75	48.0

DATE: APRIL 5, 1978 TIME: 0930

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C °F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2	36.4	9.0	7.74	33.0
01	3.3	17.0	36.5	8.5	7.77	43.0
02	6.6	17.0	36.5	8.3	7.80	49.0
03	9.8	16.8	36.5	8.1	7.78	52.0

DATE: APRIL 5, 1978 TIME: 1108

STATION: A15

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		34.1	11.6	7.89	58.0
01	3.3	17.6		34.4	10.9	7.90	67.0
02	6.6	17.1		34.9	10.5	7.87	70.0
03	9.8	17.2		35.0	10.3	7.88	72.0
04	13.1	17.1		35.1	10.4	7.88	73.0
05	16.4	17.1		35.1	10.4	7.87	71.0
06	19.7	17.0		35.1	10.2	7.88	69.0
07	23.0	17.0		35.2	8.1	7.72	68.0

DATE: APRIL 5, 1978 TIME: 1100

STATION: A16

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		34.7	12.0	7.89	44.0
01	3.3	17.3		34.8	11.4	7.95	46.0
02	6.6	17.1		35.0	10.4	7.92	49.0
03	9.8	17.0		35.1	10.2	7.90	49.0
04	13.1	16.9		35.2	9.6	7.86	59.0
05	16.4	16.8		35.2	9.8	7.84	56.0
06	19.7	16.8		35.2	9.2	7.81	59.0
07	23.0	16.8		35.3	7.8	7.71	83.0

DATE: APRIL 5, 1978 TIME: 1058

STATION: A17

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		34.5	12.9	8.20	44.0
01	3.3	17.2		34.6	9.7	8.01	62.0
02	6.6	17.0		34.9	10.3	7.98	72.0
03	9.8	17.0		35.0	9.6	7.84	72.0
04	13.1	17.0		35.0	9.6	7.93	72.0
05	16.4	17.0		35.1	9.8	7.88	73.0
06	19.7	17.0		35.1	9.2	7.83	73.0
07	23.0	16.7		35.2	6.9	7.74	72.0

DATE: APRIL 12, 1978 TIME: 0948

STATION: B1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		34.8	9.2	7.58	88.0
01	3.3	15.6		34.9	8.9	7.56	74.0
02	6.6	15.8		35.1	8.6	7.52	81.0
03	9.8	15.0		35.3	7.6	7.48	84.0
04	13.1	15.0		35.2	7.7	7.42	84.0
05	16.4	15.1		35.2	7.9	7.42	86.0
06	19.7	16.0		35.2	8.2	7.41	86.0
07	23.0	15.7		35.3	8.6	7.40	89.0
08	26.2	15.1		35.3	8.4	7.32	88.0
09	29.6	15.2		35.3	8.4	7.30	88.0
10	32.8	15.1		35.3	8.7	7.27	82.0
11	36.1	15.0		35.4	8.9	7.24	88.0
12	39.2	16.0		35.4	9.2	7.22	88.0
13	42.6	14.8		35.4	8.9	7.21	90.0
14	45.9	14.0		35.8	7.7	7.12	96.0
15	49.2	13.3		35.8	7.4	7.10	98.0
16	52.5	13.2		35.7	7.5	7.12	98.0
17	55.8	13.2		35.7	7.2	7.13	98.0
18	59.0	13.2		35.7	7.2	7.09	99.0
19	62.3	13.2		35.7	6.8	7.09	99.0
20	65.6	13.1		35.7	6.8	7.07	96.0
21	68.9	13.0		35.7	6.5	7.06	86.0
22	72.1	13.0		35.7	6.3	7.06	79.0

DATE: APRIL 12, 1978 TIME: 1105

STATION: B2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		34.3	12.0	7.60	67.0
01	3.3	17.0		34.8	9.1	7.88	76.0
02	6.6	16.7		34.7	9.0	7.54	78.0
03	9.8	16.4		34.8	7.7	7.49	76.0
04	13.1	16.2		34.8	7.6	7.47	69.0
05	16.4	16.0		35.0	7.4	7.46	72.0
06	19.7	16.0		35.0	7.6	7.44	72.0
07	23.0	15.9		35.1	7.6	7.48	70.0
08	26.2	15.7		35.1	7.1	7.44	64.0
09	29.6	15.6		35.7	7.8	7.42	69.0
10	32.8	15.6		35.3	7.1	7.40	68.0
11	36.1	15.3		35.3	7.5	7.39	66.0
12	39.2	15.2		35.3	7.3	7.38	57.0
13	42.6	15.0		35.4	7.2	7.39	42.0
14	45.9	15.0		35.4	7.3	7.37	36.0
15	49.2	14.8		35.4	7.2	7.36	30.0
16	52.5	14.7		35.4	7.1	7.34	14.0

DATE: APRIL 12, 1978 TIME: 1118

STATION: B3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		33.7	8.8	7.64	66.0
01	3.3	17.0		33.8	9.0	7.58	64.0
02	6.6	16.8		34.2	9.1	7.49	69.0
03	9.8	16.6		34.5	8.9	7.63	71.0
04	13.1	16.3		34.7	8.8	7.60	74.0
05	16.4	16.1		34.6	8.2	7.56	78.0
06	19.7	16.2		34.9	7.4	7.60	76.0
07	23.0	16.0		35.0	7.4	7.47	80.0
08	26.2	15.6		35.2	7.5	7.46	78.0
09	29.6	15.6		35.2	7.3	7.43	77.0
10	32.8	15.5		35.2	7.8	7.42	76.0
11	36.1	15.2		35.3	7.4	7.40	74.0
12	39.2	15.0		35.3	7.4	7.38	73.0
13	42.6	15.0		35.4	7.8	7.38	72.0
14	45.9	14.9		35.4	7.3	7.37	71.0
15	49.2	14.7		35.6	7.5	7.36	71.0
16	52.5	14.4		35.6	7.3	7.24	70.0
17	55.8	14.3		35.6	7.2	7.32	69.0
18	59.0	14.3		35.6	7.0	7.30	69.0
19	62.3	14.2		35.6	7.0	7.28	64.0
20	65.6	14.1		35.6	7.0	7.27	60.0
21	68.9	14.0		35.6	6.9	7.25	61.0

DATE: APRIL 12, 1978 TIME: 1124

STATION: B4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		33.8	10.6	7.60	32.0
01	3.3	17.0		34.0	10.2	7.60	44.0
02	6.6	17.3		34.4	9.0	7.60	62.0
03	9.8	17.1		34.5	8.4	7.53	62.0
04	13.1	16.7		34.7	7.8	7.50	63.0
05	16.4	16.6		34.8	7.7	7.48	63.0
06	19.7	16.4		34.9	7.6	7.46	63.0
07	23.0	16.1		35.0	7.5	7.44	64.0
08	26.2	15.8		35.2	7.4	7.43	66.0
09	29.6	15.7		35.2	7.1	7.41	63.0
10	32.8	15.7		35.3	7.4	7.40	63.0
11	36.1	15.5		35.3	7.1	7.38	82.0
12	39.2	15.4		35.3	7.1	7.37	80.0
13	42.6	15.0		35.8	7.0	7.36	77.0
14	45.8	14.8		35.4	7.1	7.32	76.0
15	49.2	14.7		35.8	7.0	7.30	72.0
16	52.5	14.7		35.8	7.4	7.32	46.0
17	55.8	14.8		35.3	7.0	7.30	66.0
18	59.0	14.8		35.5	6.9	7.27	66.0
19	62.3	14.8		35.4	6.7	7.26	51.0
20	65.6	14.3		35.6	6.0	7.20	52.0

DATE: APRIL 12, 1978 TIME: 1130

STATION: B5

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		34.3	7.1	7.44	67.0
01	3.3	17.2		34.4	7.4	7.47	73.0
02	6.6	17.2		34.4	7.4	7.48	79.0
03	9.8	17.3		34.4	7.0	7.47	78.0
04	13.1	17.2		34.6	7.8	7.46	80.0
05	16.4	17.0		34.8	7.8	7.48	81.0
06	19.7	16.7		34.9	6.7	7.48	81.0
07	23.0	16.5		35.0	6.9	7.44	83.0
08	26.2	16.5		35.1	7.0	7.43	81.0
09	29.6	16.0		35.2	6.8	7.42	79.0
10	32.8	15.8		35.3	7.0	7.41	78.0
11	36.1	15.7		35.3	7.0	7.40	79.0
12	39.2	15.6		34.8	6.3	7.38	73.0
13	42.6	15.4		35.8	6.3	7.37	70.0
14	45.9	15.3		35.7	6.6	7.35	67.0
15	49.2	15.0		35.7	6.3	7.33	66.0
16	52.5	15.0		35.7	6.3	7.32	67.0
17	55.8	15.0		35.7	6.0	7.30	64.0
18	59.0	15.0		35.7	6.5	7.29	54.0
19	62.3	14.8		35.7	6.3	7.27	46.0
20	65.6	14.9		35.7	6.0	7.26	46.0

DATE: APRIL 12, 1978 TIME: 1150

STATION: B6

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		34.2	11.9	7.56	80.0
01	3.3	17.8		34.3	8.0	7.65	52.0
02	6.6	17.7		34.8	7.1	7.52	64.0
03	9.8	17.6		34.6	6.8	7.60	64.0
04	13.1	17.4		34.8	6.8	7.48	84.0
05	16.4	17.0		35.2	6.2	7.43	82.0
06	19.7	16.2		35.3	5.2	7.48	80.0
07	23.0	16.0		35.2	6.3	7.44	79.0
08	26.2	15.8		35.3	6.6	7.48	62.0
09	29.6	15.8		35.4	6.2	7.42	58.0
10	32.8	15.7		35.3	6.1	7.40	61.0
11	36.1	15.6		35.4	6.0	7.39	52.6
12	39.2	15.5		35.4	5.9	7.37	49.0

DATE: APRIL 12, 1978 TIME: 1334

STATION: B7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		33.6	8.8	7.61	41.0
01	3.3	17.8		34.2	7.9	7.81	72.0
02	6.6	17.8		34.2	7.1	7.80	40.0
03	9.8	17.6		34.6	6.9	7.60	63.0
04	13.1	17.0		34.8	6.8	7.88	64.0
05	16.4	16.7		35.0	6.7	7.84	82.0
06	19.7	16.3		35.4	6.3	7.54	81.0
07	23.0	16.1		35.2	6.4	7.51	79.0
08	26.2	16.0		35.2	6.4	7.48	77.0
09	29.6	15.6		35.2	6.0	7.48	76.0
10	32.8	15.6		35.2	6.1	7.46	73.0
11	36.1	15.7		35.3	5.9	7.44	68.0
12	39.2	15.4		35.5	6.2	7.41	69.0
13	42.6	15.4		35.5	6.1	7.40	62.0
14	45.9	15.4		35.5	6.1	7.40	60.0
15	49.2	15.3		35.5	6.0	7.38	61.0
16	52.5	15.3		35.8	5.7	7.37	61.0
17	55.8	15.2		35.5	5.6	7.35	50.0
18	59.0	15.1		35.8	5.5	7.33	39.0

DATE: APRIL 5, 1978 TIME: 1028

STATION: B8

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O.2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		34.8	11.0	7.83	28.0
01	3.3	17.3		34.9	10.8	7.94	68.0
02	6.6	17.1		35.0	10.6	7.94	75.0
03	9.8	17.1		35.0	10.6	7.94	75.0
04	13.1	17.0		35.0	10.6	7.94	78.0
05	16.4	17.0		35.1	10.2	7.90	76.0
06	19.7	17.0		35.2	10.4	7.86	77.0
07	23.0	17.0		35.2	9.3	7.78	76.0
08	26.2	16.8		35.3	9.2	7.77	76.0
09	29.6	16.8		35.4	9.1	7.78	74.0
10	32.8	16.4		35.4	9.0	7.72	73.0
11	36.1	16.4		35.4	8.0	7.72	70.0
12	39.2	16.4		35.4	8.8	7.70	67.0
13	42.6	16.4		35.5	8.6	7.69	66.0
14	45.9	16.3		35.8	8.7	7.68	61.0
15	49.2	16.3		35.8	8.3	7.65	56.0

DATE: APRIL 8, 1976 TIME: 1010

STATION: B9

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		32.5	12.0	7.89	10.0
01	3.3	17.0		34.0	12.2	7.89	66.0
02	6.6	17.0		34.9	11.6	7.88	72.0
03	9.8	17.0		36.0	11.8	7.89	74.0
04	13.1	17.0		36.0	12.4	7.90	76.0
05	16.4	17.0		36.1	12.6	7.91	76.0
06	19.7	17.0		36.2	11.8	7.91	76.0
07	23.0	16.9		36.3	11.6	7.88	76.0
08	26.2	16.8		36.3	11.4	7.81	76.0
09	29.5	16.8		36.3	11.4	7.80	76.0
10	32.8	16.7		35.4	11.2	7.78	76.0
11	36.1	16.7		35.3	11.2	7.77	76.0
12	39.4	16.7		35.4	10.9	7.76	74.0
13	42.6	16.8		35.4	10.9	7.74	73.0
14	45.9	16.7		35.4	10.8	7.74	72.0
15	49.2	16.7		35.4	10.9	7.72	68.0
16	52.5	16.6		35.5	10.9	7.71	66.0
17	55.8	16.7		35.4	10.8	7.70	67.0
18	59.0	16.7		35.4	10.8	7.69	66.0
19	62.3	16.6		35.4	10.4	7.66	58.0

DATE: APRIL 12, 1976 TIME: 1050

STATION: B10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		35.2	12.0	7.66	68.0
01	3.3	17.0		33.6	10.8	7.64	68.0
02	6.6	16.7		34.2	9.1	7.56	74.0
03	9.8	16.7		34.6	8.8	7.52	75.0
04	13.1	16.0		34.8	8.0	7.48	76.0
05	16.4	16.0		34.8	7.8	7.46	75.0
06	19.7	15.7		34.9	7.8	7.43	76.0
07	23.0	15.6		35.0	7.8	7.42	77.0
08	26.2	15.6		35.1	7.7	7.41	77.0
09	29.5	15.4		35.2	7.6	7.40	77.0
10	32.8	15.3		35.2	7.6	7.38	77.0
11	36.1	15.0		35.2	7.5	7.37	76.0
12	39.4	16.0		35.3	7.4	7.37	76.0
13	42.6	15.0		35.3	7.3	7.36	71.0
14	45.9	14.8		35.8	7.1	7.36	66.0
15	49.2	14.7		35.8	7.3	7.35	68.0
16	52.5	14.5		35.8	7.3	7.36	65.0
17	55.8	14.5		35.8	7.4	7.37	65.0
18	59.0	14.4		35.7	7.2	7.36	64.0
19	62.3	14.2		35.7	7.5	7.34	60.0
20	65.6	14.1		36.0	7.0	7.33	57.0

DATE: APRIL 12, 1976 TIME: 1040

STATION: B11

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		33.6	10.4	7.68	64.0
01	3.3	17.1		34.0	10.8	7.60	68.0
02	6.6	16.8		34.5	10.0	7.54	75.0
03	9.8	16.4		34.6	9.3	7.54	74.0
04	13.1	16.7		34.6	9.1	7.52	77.0
05	16.4	16.2		34.6	8.5	7.46	78.0
06	19.7	16.0		34.9	8.4	7.43	78.0
07	23.0	16.0		34.9	8.6	7.42	77.0
08	26.2	15.9		34.9	8.6	7.41	76.0
09	29.5	15.8		34.9	8.7	7.40	76.0
10	32.8	15.6		35.1	8.1	7.37	77.0
11	36.1	15.3		35.3	7.8	7.32	76.0
12	39.4	14.8		35.6	7.0	7.26	73.0
13	42.6	14.5		35.6	6.8	7.26	71.0
14	45.9	14.5		35.8	6.9	7.24	72.0
15	49.2	14.5		35.6	6.7	7.24	73.0
16	52.5	14.4		35.3	6.8	7.26	73.0
17	55.8	14.4		35.3	6.6	7.27	70.0
18	59.0	14.5		35.3	6.6	7.27	68.0
19	62.3	14.6		35.4	6.7	7.27	40.0
20	65.6	14.4		35.4	6.7	7.25	29.0
21	68.9	14.3		35.6	6.4	7.01	25.0

DATE: APRIL 18, 1976 TIME: 1120

STATION: C1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.1		30.0	9.1	8.17	70.0
01	3.3	16.7		29.6	9.0	8.17	71.0
02	6.6	16.4		29.9	8.4	8.15	60.0
03	9.8	16.1		30.1	8.8	8.15	67.0
04	13.1	16.5		30.2	10.2	8.14	60.0
05	16.4	15.9		30.3	10.9	8.14	67.0
06	19.7	15.9		30.4	11.0	8.13	64.0
07	23.0	15.8		30.4	10.5	8.13	62.0
08	26.2	15.7		30.4	9.8	8.12	42.0
09	29.5	15.6		30.5	9.6	8.12	58.0

DATE: APRIL 18, 1976 TIME: 1110

STATION: C2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.1	9.8	8.16	73.0
01	3.3	17.2		28.9	9.7	8.16	70.0
02	6.6	17.2		30.0	9.7	8.17	68.0
03	9.8	16.6		30.4	9.6	8.15	67.0
04	13.1	16.4		30.0	10.4	8.13	64.0
05	16.4	16.3		30.1	10.9	8.13	61.0
06	19.7	16.3		30.2	10.7	8.13	61.0
07	23.0	16.3		30.2	10.8	8.13	59.0
08	26.2	16.1		30.2	11.0	8.13	59.8

DATE: APRIL 18, 1976 TIME: 1050

STATION: C3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		30.0	6.8	8.16	66.0
01	3.3	17.1		29.6	6.7	8.16	69.0
02	6.6	17.1		29.9	6.8	8.16	66.0
03	9.8	17.1		30.1	5.0	8.16	64.0
04	13.1	16.8		30.1	8.0	8.13	60.0
05	16.4	16.7		30.1	8.4	8.12	66.0
06	19.7	16.6		30.2	8.0	8.12	61.0
07	23.0	16.3		30.2	7.7	8.11	46.0
08	26.2	16.2		30.3	7.5	8.11	47.0
09	29.5	16.0		30.4	7.1	8.11	60.0
10	32.8	15.7		30.5	6.8	8.11	44.0
11	36.1	15.6		30.6	7.0	8.10	32.0

DATE: APRIL 19, 1976 TIME: 0900

STATION: C4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.3	8.7	8.16	26.0
01	3.3	18.6		30.6	8.4	8.15	44.0
02	6.6	18.8		30.3	8.3	8.16	46.0
03	9.8	17.8		30.3	8.1	8.14	46.0
04	13.1	17.8		30.3	7.8	8.13	45.0
05	16.4	16.9		30.4	7.6	8.10	37.0
06	19.7	16.7		30.4	7.4	8.10	35.0
07	23.0	16.6		30.5	7.3	8.12	36.0
08	26.2	16.5		30.5	7.2	8.08	50.0
09	29.5	16.4		30.5	7.0	8.08	47.0
10	32.8	16.4		30.5	7.0	8.08	51.0
11	36.1	16.0		30.6	7.0	8.09	40.0

DATE: APRIL 19 1976 TIME: 1020

STATION: C5

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.1	10.6	8.06	62.0
01	3.3	18.3		29.9	10.8	8.09	64.0
02	6.6	18.3		30.1	10.6	8.08	63.0
03	9.8	17.9		30.0	11.0	8.07	60.0
04	13.1	17.8		29.9	11.3	8.03	56.0
05	16.4	17.0		30.0	11.3	8.01	58.0
06	19.7	16.8		30.2	11.7	7.99	57.0

DATE: APRIL 19, 1976 TIME: 1030

STATION: C6

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		30.6	10.2	8.17	72.0
01	3.3	18.4		30.2	10.4	8.17	73.0
02	6.6	18.0		29.7	9.5	8.15	73.0
03	9.8	17.6		29.8	8.2	8.14	69.0
04	13.1	17.1		29.9	7.6	8.11	67.0
05	16.4	16.7		30.1	7.3	8.09	66.0
06	19.7	16.7		30.2	7.0	8.07	65.0
07	23.0	16.5		30.4	7.0	8.06	52.0
08	26.2	16.5		30.4	7.1	8.06	42.0
09	29.5	16.3		30.5	7.2	8.07	42.0
10	32.8	16.2		30.6	7.5	8.07	57.0

DATE: APRIL 19, 1976 TIME: 0935

STATION: C7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		30.0	8.6	8.12	71.0
01	3.3	17.6		30.0	8.7	8.10	67.0
02	6.6	17.7		30.0	8.7	8.08	66.0
03	9.8	17.4		30.0	8.2	8.06	67.0
04	13.1	17.1		30.1	7.7	8.08	66.0
05	16.4	16.9		30.2	7.5	8.02	62.0
06	19.7	16.8		30.4	7.7	8.02	63.0
07	23.0	16.7		30.4	8.3	8.02	61.0
08	26.2	16.7		30.4	8.4	8.01	58.0
09	29.5	16.7		30.4	8.5	7.99	56.0
10	32.8	16.6		30.5	8.2	7.98	59.0

DATE: APRIL 19, 1976 TIME: 0820

STATION: C8

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		29.1	9.2	8.21	72.0
01	3.3	16.9		29.6	9.8	8.20	72.0
02	6.6	16.8		29.8	8.2	8.18	74.0
03	9.8	16.6		29.8	8.0	8.17	74.0
04	13.1	16.4		29.8	7.3	8.18	72.0
05	16.4	16.2		30.0	7.6	8.15	71.0
06	19.7	16.3		30.2	7.4	8.14	71.0
07	23.0	16.2		30.3	7.1	8.14	73.0
08	26.2	16.2		30.3	6.6	8.13	74.0
09	29.5	16.0		30.4	6.6	8.12	71.0
10	32.8	15.8		30.5	6.2	8.11	72.0
11	36.1	15.8		30.5	6.4	8.09	67.0

DATE: APRIL 19, 1976 TIME: 0825

STATION: C9

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		28.7	8.9	8.22	73.0
01	3.3	17.1		29.0	9.2	8.21	72.0
02	6.6	16.8		29.4	8.7	8.22	72.0
03	9.8	16.7		29.8	9.6	8.21	71.0
04	13.1	16.7		30.0	10.1	8.19	69.0
05	16.4	16.5		30.1	9.1	8.18	69.0
06	19.7	16.4		30.1	8.7	8.17	69.0
07	23.0	16.3		30.2	10.1	8.17	66.0
08	26.2	16.2		30.3	9.8	8.15	66.0
09	29.5	16.1		30.4	9.8	8.14	63.0
10	32.8	15.9		30.4	9.8	8.12	61.0
11	36.1	15.7		30.4	9.6	8.11	67.0

DATE: APRIL 19, 1976 TIME: 0840

STATION: C10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		29.0	9.6	8.23	64.0
01	3.3	17.2		29.2	9.6	8.23	64.0
02	6.6	17.2		29.4	9.3	8.23	68.0
03	9.8	16.9		29.6	9.6	8.22	68.0
04	13.1	16.8		29.7	10.4	8.20	64.0
05	16.4	16.6		29.8	10.3	8.17	60.0
06	19.7	16.6		30.0	9.0	8.18	62.0
07	23.0	16.1		30.1	8.9	8.14	60.0
08	26.2	16.0		30.2	8.0	8.13	60.0
09	29.5	15.9		30.3	8.0	8.13	51.0
10	32.8	15.8		30.3	7.6	8.12	44.0

DATE: APRIL 19, 1976 TIME: 0905

STATION: C11

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		26.8	8.8	8.17	75.0
01	3.3	17.3		27.9	8.9	8.12	72.0
02	6.6	17.0		29.1	8.1	8.12	77.0
03	9.8	16.9		28.7	8.7	8.12	73.0
04	13.1	16.8		30.0	8.3	8.14	76.0
05	16.4	16.7		30.1	8.4	8.13	74.0
06	19.7	16.6		30.2	8.3	8.11	74.0
07	23.0	16.2		30.2	8.1	8.06	48.0
08	26.2	16.1		30.4	8.0	8.01	50.0

DATE: APRIL 12, 1976 TIME: 1028

STATION: D1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		31.2	13.1	7.08	21.0
01	3.3	17.7		33.0	12.8	7.73	54.0
02	6.6	17.0		33.7	11.0	7.42	65.0
03	9.8	16.7		34.3	10.0	7.38	71.0
04	13.1	16.4		34.6	8.1	7.58	72.0
05	16.4	16.0		34.9	8.4	7.45	70.0
06	19.7	15.6		35.0	8.0	7.48	62.0
07	23.0	15.6		35.2	7.8	7.38	72.0
08	26.2	15.3		35.1	7.8	7.38	73.0
09	29.6	15.0		35.2	7.8	7.33	60.0
10	32.8	15.0		35.2	7.8	7.30	77.0
11	36.1	14.8		35.3	6.8	7.23	60.0
12	39.2	14.6		35.3	6.4	7.17	54.0
13	42.6						66.0

DATE: APRIL 12, 1976 TIME: 1005

STATION: D2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		31.6	10.8	7.72	10.0
01	3.3	18.0		31.8	11.8	7.76	36.0
02	6.6	18.0		33.1	12.0	7.74	42.0
03	9.8	17.3		34.0	9.6	7.38	61.0
04	13.1	16.3		34.8	12.9	7.26	62.0
05	16.4	16.2		34.4	11.6	7.22	59.0
06	19.7	15.9		35.0	11.9	7.23	57.0
07	23.0	15.4		35.2	12.5	7.24	38.0
08	26.2	15.7		35.2	10.0	7.20	39.0

DATE: APRIL 12, 1976 TIME: 1012

STATION: D3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		34.6	12.0	7.70	90.0
01	3.3	17.6		33.8	11.8	7.86	57.0
02	6.6	16.8		34.0	9.8	7.74	68.0
03	9.8	16.8		34.6	8.3	7.66	71.0
04	13.1	16.3		34.7	8.2	7.41	76.0
05	16.4	16.1		34.8	8.0	7.36	79.0
06	19.7	15.9		34.8	7.0	7.28	62.0
07	23.0	15.6		35.0	6.9	7.20	71.0
08	26.2	15.7		35.1	7.2	7.16	65.0

DATE: APRIL 12, 1976 TIME: 0880

STATION: D10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.7		23.0	11.6	7.84	32.0
01	3.3	17.7		31.5	11.3	7.72	41.0
02	6.6	17.6		33.4	6.8	7.41	60.0
03	9.8	17.1		34.3	6.3	7.37	68.0
04	13.1	16.6		34.4	5.5	7.30	66.0
05	16.4	16.6		35.0	5.6	7.24	84.0
06	19.7	16.2		35.0	5.4	7.22	42.0

DATE: MAY 3, 1976 TIME: 0841

STATION: A0

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.3		30.6	9.3	7.22	
01	3.3	16.3		30.7	9.1	7.17	
02	6.6	16.2		30.8	9.0	7.16	
03	9.8	16.1		30.9	8.6	7.10	
04	13.1	16.6		31.0	9.4	7.06	
05	16.4	16.4		31.0	9.1	7.06	
06	19.7	16.3		31.1	9.8	7.06	
07	23.0	16.1		31.1	10.0	7.08	
08	26.2	16.7		31.1	9.8	7.03	
09	29.6	16.6		31.2	9.8	7.02	
10	32.8	16.2		31.2	9.6	7.02	
11	36.1	16.0		31.2	9.3	7.02	
12	39.2	15.8		31.2	9.3	7.02	
13	42.6	15.6		31.2	8.6	7.03	
14	45.9	15.1		31.2	7.8	7.03	
15	49.2	12.4		31.3	6.3	7.00	
16	52.5	12.0		31.3	6.8	7.01	
17	55.8	11.6		31.4	5.4	7.02	
18	59.0	11.4		31.5	4.4	7.02	
19	62.3	11.3		31.4	4.6	7.03	
20	65.6	11.0		31.4	4.1	7.03	
21	68.9	10.9		31.4	3.7	7.06	
22	72.1	10.9		31.4	3.7	7.06	

DATE: MAY 3, 1976 TIME: 0901

STATION: A1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		30.6	10.3	8.38	76.0
01	3.3	16.7		30.8	10.1	8.38	83.0
02	6.6	16.6		30.8	10.1	8.37	44.0
03	9.8	16.1		30.9	10.6	8.36	94.0
04	13.1	16.0		30.9	10.8	8.35	96.0
05	16.4	15.9		30.9	11.0	8.36	98.0
06	19.7	15.8		30.9	11.1	8.36	97.0
07	23.0	16.0		30.9	11.3	8.35	94.5
08	26.2	15.8		30.9	11.3	8.35	96.5
09	29.6	15.8		31.0	11.3	8.35	95.5
10	32.8	15.8		30.9	11.3	8.33	96.0
11	36.1	15.8		30.9	11.3	8.33	93.0
12	39.2	15.7		30.9	11.4	8.33	90.0
13	42.6	15.7		31.0	11.6	8.31	91.0
14	45.9	15.6		31.0	11.0	8.31	88.5
15	49.2	15.3		31.0	10.5	8.30	88.0
16	52.5	14.5		31.2	10.1	8.18	87.0
17	55.8	13.8		31.2	9.1	8.19	88.5
18	59.0	12.7		31.3	8.1	8.02	82.5
19	62.1	12.5		31.3	7.8	8.02	68.0

DATE: MAY 3, 1976 TIME: 0848

STATION: A2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4		30.8	10.2	8.34	47.0
01	3.3	16.4		30.8	9.8	8.34	67.0
02	6.6	16.4		30.8	10.1	8.36	77.0
03	9.8	16.7		30.8	10.3	8.33	80.0
04	13.1	16.1		30.9	10.4	8.33	84.0
05	16.4	16.6		31.1	10.5	8.30	84.0
06	19.7	16.4		31.1	8.9	8.27	83.5
07	23.0	16.2		31.2	9.7	8.26	82.0
08	26.2	16.1		31.1	9.4	8.26	78.0
09	29.5	14.6		31.2	9.4	8.17	76.0
10	32.8	14.2		31.1	8.7	8.15	76.0
11	36.1	13.8		31.3	7.8	8.07	73.0

DATE: MAY 3, 1976 TIME: 0918

STATION: A3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		30.6	10.3	8.41	73.0
01	3.3	17.1		30.7	10.4	8.40	74.0
02	6.6	16.7		30.8	10.7	8.40	77.0
03	9.8	16.6		30.9	11.1	8.38	81.0
04	13.1	16.3		30.9	11.0	8.37	83.0
05	16.4	18.8		31.9	10.7	8.33	84.0
06	19.7	15.6		31.0	8.7	8.20	64.0
07	23.0	18.8		31.2	8.4	8.16	49.0

DATE: MAY 3, 1976 TIME: 0919

STATION: A6

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.6	9.7	8.38	
01	3.3	17.4		30.7	8.9	8.36	
02	6.6	17.3		30.7	9.8	8.36	
03	9.8	17.1		30.7	10.2	8.34	
04	13.1	16.1		31.3	9.8	8.17	
05	16.4	12.5		31.4	7.7	8.10	

DATE: MAY 3, 1976 TIME: 0930

STATION: A7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		28.7	9.2	7.29	47.0
01	3.3	16.7		30.1	9.4	7.28	63.0
02	6.6	16.6		30.6	9.9	7.28	56.0
03	9.8	16.3		30.9	9.3	7.18	51.5
04	13.1	16.0		31.1	8.9	7.03	40.0

DATE: MAY 3, 1978 TIME: 0735

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.5		30.8	9.2	8.24	74.0
01	3.3	16.5		30.8	9.2	8.32	76.0
02	6.6	16.5		30.9	9.0	8.20	76.0
03	9.8	16.5		30.9	6.7	8.27	77.6
04	13.1	16.1		30.9	9.9	8.31	77.5
05	16.4	16.9		31.0	9.7	8.26	76.0
06	19.7	16.3		31.1	4.8	8.10	77.8
07	23.0	15.2		31.1	4.2	8.17	77.0

DATE: MAY 3, 1978 TIME: 0744

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		30.7	9.8	8.36	71.0
01	3.3	16.7		30.7	9.9	8.36	78.0
02	6.6	16.5		31.0	9.7	8.31	78.9
03	9.8	16.2		31.0	9.7	8.30	79.0
04	13.1	16.2		31.0	9.5	8.30	79.0
05	16.4	16.1		30.9	8.6	8.30	79.0
06	19.7	15.6		31.0	9.3	8.26	82.0
07	23.0	15.4		31.1	8.4	8.21	80.9
08	26.2	15.2		31.2	8.1	8.17	76.5
09	29.6	15.0		31.2	7.7	8.16	76.0
10	32.8	14.7		31.2	7.0	8.13	77.0
11	36.1	14.6		31.2	6.8	8.11	76.0
12	39.7	14.3		31.2	6.6	8.11	75.8
13	42.6	13.7		31.4	5.9	8.06	75.0
14	45.9	13.4		31.3	5.8	8.03	71.8
15	49.2	13.2		31.4	5.3	7.99	70.0
16	52.5	12.9		31.4	4.9	7.98	69.8

DATE: MAY 17, 1979 TIME: 1148

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		30.7	6.6	8.45	
01	3.3	18.0		31.2	6.2	8.38	
02	6.6	17.6		31.2	6.2	8.29	
03	9.8	17.4		31.2	6.4	8.17	
04	13.1	17.3		31.0	6.2	8.13	
05	16.4	17.1		31.3	6.2	8.06	
06	19.7	16.6		31.3	5.9	8.04	
07	23.0	16.7		31.0	5.2	8.02	
08	26.2	16.5		31.0	5.3	8.00	
09	29.4	16.1		31.2	5.3	7.98	
10	32.8	16.7		31.4	5.2	7.97	

DATE: MAY 3, 1978 TIME: 1109

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		30.4	9.6	8.38	79.0
01	3.3	16.8		30.6	10.0	8.33	82.0
02	6.6	16.5		30.8	10.5	8.36	80.0
03	9.8	16.4		30.6	10.8	8.35	79.6
04	13.1	16.3		30.9	11.1	8.35	72.6
05	16.4	15.9		31.1	11.1	8.30	76.8
06	19.7	15.6		31.1	11.2	8.26	71.6

DATE: MAY 3, 1978 TIME: 1016

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.3		29.8	10.3	8.36	88.8
01	3.3	16.3		30.2	10.2	8.38	89.0
02	6.6	16.3		30.6	10.6	8.36	91.8
03	9.8	16.1		30.7	10.7	8.33	98.0
04	13.1	15.6		30.9	10.3	8.29	94.0
05	16.4	15.4		30.9	10.1	8.28	97.0
06	19.7	15.3		30.9	10.4	8.26	88.0
07	23.0	14.9		31.0	10.1	8.22	83.0
08	26.2	14.8		31.1	9.9	8.21	79.0
09	29.6	14.7		31.1	9.6	8.17	73.0
10	32.8	14.1		31.3	8.8	8.12	80.0
11	36.1	14.0		31.2	8.3	8.09	50.0
12	39.4	13.9		31.2	7.6	7.69	46.0

DATE: MAY 3, 1978 TIME: 0846

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.0		30.4	8.7	8.33	92.0
01	3.3	14.0		30.7	9.8	8.33	93.8
02	6.4	15.8		30.9	10.4	8.33	97.8
03	9.4	15.7		31.0	10.8	8.32	88.0
04	13.1	15.6		31.0	11.1	8.31	86.8
05	16.4	18.1		31.1	11.0	8.27	88.5
06	19.7	18.0		31.1	11.2	8.26	83.5
07	23.0	14.6		31.2	11.1	8.29	81.9
08	26.2	14.7		31.1	11.3	8.26	80.0
09	29.6	14.6		31.1	11.6	8.22	83.0
10	32.8	14.2		31.8	11.9	8.14	83.8
11	36.1	13.9		31.4	11.7	8.13	84.0
12	39.2	13.7		31.4	11.8	8.10	77.0
13	42.6	13.4		31.4	11.3	8.10	76.0
14	45.9	18.9		31.8	11.1	8.06	75.0

DATE: MAY 3, 1978 TIME: 1030

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.7		30.7	10.8	8.40	83.0
01	3.3	16.8		30.8	10.6	8.36	87.8
02	6.6	16.6		30.8	10.6	8.36	88.0
03	9.8	16.2		30.9	10.8	8.37	86.8
04	13.1	16.0		31.0	10.8	8.36	85.8
05	16.4	15.9		31.0	10.4	8.36	85.5
06	19.7	15.6		31.1	10.1	8.31	84.8
07	23.0	15.2		31.1	9.7	8.27	83.0
08	26.2	15.1		31.1	9.6	8.26	84.0
09	29.6	14.5		31.3	9.0	8.16	85.5
10	32.8	14.0		31.2	8.6	8.14	80.5
11	36.1	13.9		31.3	7.7	8.10	77.3

DATE: MAY 3, 1978 TIME: 1100

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		30.0	10.6	8.44	86.5
01	3.3	17.0		30.4	10.7	8.40	72.0
02	6.6	17.0		30.5	10.4	8.48	82.0
03	9.8	17.0		30.8	10.6	8.40	82.6
04	13.1	16.6		30.5	10.6	8.40	81.5
05	16.4	16.7		30.8	10.8	8.40	82.0
06	19.7	15.9		30.8	11.2	8.38	79.0
07	23.0	15.6		31.1	9.3	8.22	77.0

DATE: MAY 3, 1978 TIME: 1055

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.5	10.8	8.40	60.0
01	3.3	17.3		30.6	10.6	8.39	64.1
02	6.6	16.6		30.7	10.8	8.38	70.0
03	9.8	16.6		30.8	10.7	8.38	70.0
04	13.1	16.6		30.8	10.9	8.36	60.0
05	16.4	16.5		30.9	10.8	8.36	78.5
06	16.7	16.1		30.7	11.0	8.36	73.8
07	23.0	15.7		31.0	10.2	8.19	51.0
08	26.2	15.2		31.0	9.0	8.18	39.5

DATE: MAY 3, 1978 TIME: 1038

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		30.7	10.5	8.40	81.9
01	3.3	16.2		30.7	10.2	8.38	88.5
02	6.6	16.1		30.8	10.5	8.36	87.0
03	9.8	16.0		30.8	10.8	8.38	86.0
04	13.1	16.2		30.9	10.6	8.37	86.5
05	16.4	15.8		31.0	11.0	8.34	86.0
06	19.7	15.5		31.1	11.0	8.30	85.0
07	23.0	15.1		31.2	10.8	8.26	88.8
08	26.2	14.8		31.1	10.1	8.21	84.0
09	29.6	14.3		31.2	9.6	8.18	86.0

DATE: MAY 10, 1978 TIME: 0858

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		31.1	7.6	7.77	
01	3.3	18.1		31.1	8.2	7.97	
02	6.6	18.1		31.1	8.3	8.00	
03	9.8	18.1		31.2	8.0	8.01	
04	13.1	18.0		31.1	8.2	8.03	
05	16.4	14.8		31.2	8.1	8.04	
06	19.7	14.6		31.1	8.1	8.02	
07	23.0	14.3		31.2	8.1	8.01	
08	26.2	14.0		31.2	8.0	8.01	
09	29.6	13.7		31.2	7.9	8.00	
10	32.8	13.4		31.2	7.8	7.99	
11	36.1	13.2		31.2	7.6	7.97	
12	39.4	13.0		31.2	7.8	7.95	
13	42.6	12.8		31.3	7.0	7.91	
14	45.9	12.6		31.3	6.6	7.86	
15	49.2	12.3		31.3	6.8	7.84	
16	52.5	12.2		31.2	6.6	7.83	
17	55.8	12.2		31.2	6.3	7.82	
18	59.0	12.3		31.3	6.3	7.82	
19	62.3	12.3		31.2	4.8	7.79	

DATE: MAY 10, 1978 TIME: 1020

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	O.02 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.6	6.2	8.10	
01	3.3	17.1		30.8	6.2	8.08	
02	6.6	16.7		30.8	6.4	8.03	
03	9.8	16.2		31.0	6.4	8.00	
04	13.1	15.9		31.0	6.0	7.97	
05	19.7	15.7		31.0	6.5	7.96	
06	23.0	15.6		31.0	6.8	7.96	
07	26.2	15.3		31.0	5.8	7.98	
08	29.2	15.2		31.0	5.8	7.97	
09	29.6	15.0		31.1	5.2	7.95	
10	32.8	14.8		31.1	4.7	7.91	
11	36.1	14.8		31.1	4.2	7.88	
12	39.2	14.8		31.1	3.6	7.88	
13	42.6	14.3		31.2	4.3	7.87	
14	45.9	14.1		31.1	4.4	7.90	
15	49.2	14.1		31.1	4.6	7.91	

DATE: MAY 10, 1978 TIME: 1030

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.1		30.7	7.6	8.10	
01	3.3	17.1		30.8	7.6	8.09	
02	6.6	16.5		30.9	7.8	8.13	
03	9.8	16.3		30.9	7.6	8.10	
04	13.1	16.1		30.9	7.3	8.09	
05	16.4	15.9		30.9	7.3	8.07	
06	19.7	15.7		31.0	6.8	8.04	
07	23.0	15.5		30.9	6.9	8.04	
08	26.2	15.4		30.9	7.0	8.03	
09	29.5	14.6		31.1	6.0	7.97	
10	32.8	14.6		31.1	6.1	7.94	
11	36.1	14.2		31.0	6.0	7.98	
12	39.4	14.1		31.1	5.9	7.95	
13	42.6	14.0		31.1	5.8	7.95	
14	45.9	13.9		31.1	6.0	7.98	
15	49.2	13.8		31.2	5.7	7.94	
16	52.5	13.6		31.1	5.6	7.94	
17	55.8	13.6		31.1	5.4	7.90	
18	59.0	13.5		31.1	5.1	7.89	
19	62.3	13.3		31.1	5.0	7.86	

DATE: MAY 10, 1978 TIME: 1040

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		30.5	6.8	8.30	
01	3.3	17.6		30.7	6.8	8.20	
02	6.6	17.0		31.1	7.4	8.19	
03	9.8	16.7		31.1	7.0	8.14	
04	13.1	16.5		30.9	6.7	8.12	
05	16.4	16.6		30.8	6.9	8.11	
06	19.7	16.1		30.9	7.3	8.08	
07	23.0	16.1		30.9	6.7	8.04	
08	26.2	16.0		30.9	6.4	8.08	
09	29.5	15.9		30.9	6.4	8.05	
10	32.8	15.4		30.9	6.7	8.04	
11	36.1	15.6		30.9	6.8	8.08	
12	39.4	15.2		31.1	6.8	8.03	
13	42.6	15.0		31.1	6.3	8.02	
14	45.9	14.7		31.1	6.4	8.00	
15	49.2	14.3		31.2	6.2	7.97	
16	52.5	14.2		31.1	6.4	7.97	
17	55.8	14.1		31.2	6.6	7.94	
18	59.0	14.0		31.2	5.8	7.95	
19	62.3	13.8		31.2	5.8	7.98	
20	65.6	13.8		31.2	5.4	7.93	

DATE: MAY 10, 1978 TIME: 1050

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		30.5	6.7	8.03	
01	3.3	17.1		30.7	6.5	8.02	
02	6.6	16.9		30.7	5.7	8.03	
03	9.8	16.9		30.8	5.7	8.04	
04	13.1	17.0		30.8	7.2	8.04	
05	16.4	17.0		30.9	6.2	8.02	
06	19.7	16.7		30.9	6.3	8.02	
07	23.0	16.5		31.0	6.4	8.02	
08	26.2	15.7		31.2	6.2	7.98	
09	29.5	15.6		31.2	5.4	7.96	
10	32.8	15.6		31.1	5.8	7.96	
11	36.1	15.3		31.1	5.3	7.96	
12	39.4	15.1		31.1	5.7	7.97	
13	42.6	14.8		31.2	6.0	7.96	
14	45.9	14.9		31.1	5.4	7.96	
15	49.2	14.7		31.1	5.5	7.96	
16	52.5	14.7		31.1	5.6	7.95	
17	55.8	14.6		31.1	5.2	7.96	
18	59.0	14.6		31.1	5.4	7.96	
19	62.3	14.4		31.1	5.8	7.96	
20	65.6	14.3		31.1	5.9	7.96	

DATE: MAY 10, 1978 TIME: 1101

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		30.6	7.0	8.04	
01	3.3	18.6		30.6	7.1	8.02	
02	6.6	18.7		30.7	7.0	8.01	
03	9.8	18.5		30.7	6.8	8.00	
04	13.1	17.3		31.0	7.3	7.97	
05	16.4	16.7		31.6	6.3	7.98	
06	19.7	16.3		31.6	6.2	7.96	
07	23.0	16.1		31.1	4.9	7.93	
08	26.2	15.9		31.2	5.4	7.92	
09	29.5	15.9		31.0	6.3	7.92	
10	32.8	16.7		31.2	3.9	7.89	
11	36.1	15.4		31.1	3.3	7.86	

DATE: MAY 10, 1978 TIME: 1110

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.8	7.7	8.38	
01	3.3	18.0		30.6	7.4	8.28	
02	6.6	18.1		30.7	7.7	8.20	
03	9.8	17.8		30.9	7.6	8.16	
04	13.1	17.3		30.9	7.1	8.13	
05	16.4	17.2		31.0	6.8	8.10	
06	19.7	17.0		31.0	6.8	8.08	
07	23.0	16.4		31.2	6.2	8.02	
08	26.2	16.8		31.2	5.9	8.01	

DATE: MAY 3, 1978 TIME: 0955

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		30.1	10.9	8.46	90.0
01	3.3	17.0		30.5	10.6	8.41	87.0
02	6.6	16.8		30.6	10.4	8.38	87.0
03	9.8	16.2		30.8	11.2	8.37	88.0
04	13.1	15.2		30.8	10.9	8.36	89.0
05	16.4	15.1		30.8	11.0	8.36	89.0
06	19.7	15.6		31.0	11.0	8.31	89.0
07	23.0	15.0		31.0	10.7	8.27	88.0
08	26.2	14.9		31.1	10.6	8.26	88.0
09	29.5	14.7		31.1	10.3	8.28	80.0
10	32.8	14.6		31.1	10.0	8.21	74.0
11	36.1	14.3		31.1	9.2	8.15	68.0
12	39.4	13.7		31.4	7.7	8.04	59.0

DATE: MAY 3, 1978 TIME: 0943

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		30.1	10.1	8.37	87.0
01	3.3	16.8		30.4	10.0	8.34	89.5
02	6.6	16.4		30.8	10.4	8.38	84.5
03	9.8	15.8		31.0	9.8	8.32	88.0
04	13.1	15.6		31.0	9.9	8.30	86.0
05	16.4	15.3		31.2	8.9	8.29	88.0
06	19.7	15.1		31.0	9.8	8.26	88.0
07	23.0	14.7		31.1	9.6	8.24	88.0
08	26.2	14.8		31.2	9.3	8.20	80.5
09	29.5	14.5		31.1	8.9	8.17	74.0
10	32.8	14.2		31.1	8.6	8.16	76.0
11	36.1	14.1		31.2	8.6	8.16	77.5
12	39.4	13.6		31.3	8.2	8.12	78.0
13	42.6	13.3		31.4	7.3	8.03	70.0
14	45.9	13.2		31.2	6.1	7.66	69.5

DATE: MAY 10, 1978 TIME: 1019

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		30.0	6.6	8.10	
01	3.3	16.6		30.8	6.6	8.08	
02	6.6	16.2		30.7	6.7	8.08	
03	9.8	15.8		30.7	6.8	8.05	
04	13.1	15.6		30.8	6.4	8.05	
05	16.4	15.5		30.6	6.3	8.02	
06	19.7	15.3		30.9	6.0	8.00	
07	23.0	15.2		30.9	5.9	7.99	
08	26.2	14.8		31.0	5.8	7.97	
09	29.5	14.7		31.0	5.8	7.97	
10	32.8	14.6		31.0	5.7	7.97	
11	36.1	14.5		31.0	5.7	7.96	
12	39.4	14.4		31.0	5.6	7.97	
13	42.6	14.3		31.0	5.6	7.95	
14	45.9	14.2		31.1	5.6	7.98	
15	49.2	14.1		31.1	5.5	7.98	
16	52.5	13.8		31.2	5.8	7.94	
17	55.8	13.6		31.2	5.5	7.92	
18	59.0	13.6		31.2	5.3	7.91	
19	62.3	13.4		31.2	5.1	7.91	
20	65.6	13.3		31.2	5.0	7.90	
21	68.9	13.1		31.2	4.7	7.88	
22	72.2	13.0		31.2	4.5	7.85	

DATE: MAY 10, 1978 TIME: 1000

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		29.9	7.7	8.30	
01	3.3	17.5		30.2	7.8	8.27	
02	6.6	17.0		30.6	7.8	8.20	
03	9.8	16.8		30.7	7.8	8.17	
04	13.1	16.7		30.8	7.8	8.14	
05	16.4	16.4		30.9	7.6	8.13	
06	19.7	16.3		30.9	7.7	8.11	
07	23.0	16.0		31.0	7.9	8.08	
08	26.2	15.4		31.2	7.4	8.04	
09	29.5	15.2		31.2	7.2	8.02	
10	32.8	15.0		31.3	7.0	8.01	
11	36.1	14.7		31.3	6.8	7.99	
12	39.4	14.2		31.3	7.0	7.99	
13	42.6	13.7		31.3	7.0	7.95	
14	45.9	13.4		31.1	6.8	7.93	
15	49.2	13.3		31.2	6.8	7.83	

DATE: MAY 17, 1978 TIME: 1125

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		31.0	5.0	8.01	
01	3.3	18.0		30.9	5.2	7.99	
02	6.6	17.7		31.0	5.1	7.98	
03	9.8	17.7		31.0	4.7	7.97	
04	13.1	17.7		31.0	4.8	7.97	
05	16.4	17.6		31.0	4.8	7.96	
06	19.7	17.4		31.0	4.8	7.95	
07	23.0	16.8		31.2	4.9	7.95	
08	26.2	16.7		31.1	4.7	7.94	
09	29.5	16.2		31.2	4.6	7.94	

DATE: MAY 17, 1978 TIME: 1107

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.4	5.5	8.11	
01	3.3	18.1		30.8	5.5	8.06	
02	6.6	18.1		30.4	8.3	8.02	
03	9.8	18.2		30.8	5.5	8.00	
04	13.1	18.1		30.8	8.6	8.00	
05	16.4	18.1		30.9	5.5	7.98	
06	19.7	18.0		30.9	5.3	7.96	
07	23.0	17.8		31.0	5.1	7.94	
08	26.2	17.8		31.0	4.8	7.94	
09	29.5	17.6		31.0	4.5	7.93	
10	32.8	17.4		31.0	4.6	7.85	

DATE: MAY 17, 1978 TIME: 1050

STATION: C3

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		30.7	4.5	7.91	
01	3.3	18.3		31.2	4.2	7.89	
02	6.6	17.9		31.2	6.1	7.80	
03	9.8	17.8		31.1	4.5	7.87	
04	13.1	17.7		30.9	4.2	7.88	
05	16.4	17.7		30.4	4.2	7.87	
06	19.7	17.6		30.9	4.1	7.87	
07	23.0	17.8		30.8	4.0	7.87	
08	26.2	17.5		30.8	4.2	7.87	
09	29.4	17.2		31.1	5.0	7.88	

DATE: MAY 17, 1978 TIME: 0950

*STATION: C4

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.8	5.8	7.99	
01	3.3	18.8		31.4	6.3	7.96	
02	6.6	18.8		31.1	6.3	7.96	
03	9.8	18.4		31.2	6.0	7.92	
04	13.1	18.2		31.1	5.8	7.91	
05	16.4	18.1		31.0	4.8	7.90	
06	19.7	17.8		31.1	4.9	7.88	
07	23.0	17.6		31.1	4.7	7.88	
08	26.2	17.5		31.0	4.7	7.87	
09	29.6	17.5		31.0	4.7	7.87	
10	32.8	17.4		31.0	5.0	7.87	
11	36.1	17.1		31.1	4.6	7.88	
12	39.2	16.7		31.2	4.0	7.71	

DATE: MAY 17, 1978 TIME: 1010

STATION: C5

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.3	4.8	7.96	
01	3.3	18.9		30.5	5.0	8.00	
02	6.6	18.4		31.0	6.5	7.97	
03	9.8	16.3		30.9	6.1	7.93	
04	13.1	16.1		31.0	5.6	7.92	
05	16.4	17.9		31.0	5.2	7.96	

DATE: MAY 17, 1978 TIME: 1025

STATION: C6

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		30.8	5.9	8.04	
01	3.3	19.2		30.8	5.4	8.03	
02	6.6	19.0		30.9	5.3	8.01	
03	9.8	18.4		31.0	5.2	7.97	
04	13.1	18.1		31.1	5.0	7.98	
05	16.4	17.9		31.1	5.0	7.94	
06	19.7	17.8		31.1	5.0	7.92	
07	23.0	17.4		31.0	4.4	7.91	
08	26.2	17.4		31.1	4.5	7.90	
09	29.6	17.4		31.0	4.4	7.90	
10	32.8	17.2		31.0	4.3	7.87	
11	36.1	17.0		31.1	4.8	7.84	
12	39.2	16.7		31.1	3.9	7.47	

DATE: MAY 17, 1978 TIME: 0930

STATION: C7

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1 -		30.2	4.8	7.84	
01	3.3	19.0		30.4	6.3	7.84	
02	6.6	18.4		30.6	5.4	7.82	
03	9.8	18.6		30.6	5.7	7.81	
04	13.1	18.4		30.7	5.8	7.78	
05	16.4	18.6		30.6	5.7	7.77	
06	19.7	18.3		30.6	5.7	7.76	
07	23.0	18.2		30.9	5.6	7.74	
08	26.2	18.1		30.9	5.6	7.73	
09	29.6	18.0		31.0	5.3	7.71	
10	32.6	17.4		31.0	5.4	7.69	
11	36.1	17.9		30.9	5.2	7.66	

DATE: MAY 17, 1978 TIME: 0815

STATION: C8

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.9	7.2	7.92	
01	3.3	18.4		30.8	7.1	7.93	
02	6.6	18.4		30.8	5.7	7.92	
03	9.8	18.3		30.9	5.2	7.92	
04	13.1	18.2		30.9	5.4	7.92	
05	16.4	18.1		30.9	5.5	7.92	
06	19.7	18.0		31.0	5.6	7.91	
07	23.0	17.8		31.0	6.1	7.90	
08	26.4	17.3		31.1	5.2	7.88	
09	29.6	16.9		31.2	5.0	7.88	
10	32.8	16.6		31.2	4.7	7.88	
11	36.1	16.4		31.3	4.7	7.85	
12	39.2	16.1		31.3	4.4	7.83	

DATE: MAY 17, 1978 TIME: 0922

STATION: C9

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		30.8	6.3	8.03	
01	3.3	18.7		30.5	6.2	8.31	
02	6.6	18.8		30.7	6.4	8.11	
03	9.8	18.2		30.6	5.9	8.12	
04	13.1	18.0		30.9	5.9	8.09	
05	16.4	17.9		30.9	5.8	8.07	
06	19.7	17.8		30.9	5.6	8.08	
07	23.0	17.4		31.2	5.8	8.02	
08	26.2	17.2		31.1	5.6	8.02	
09	29.6	17.1		31.1	5.4	8.00	
10	32.8	16.9		31.3	4.8	7.97	
11	36.1	16.8		31.4	4.6	7.94	
12	39.2	16.3		31.8	4.3	7.91	

DATE: MAY 17, 1978 TIME: 0857

STATION: C10

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.7	8.3	8.24	
01	3.3	18.4		30.8	8.4	8.20	
02	6.6	18.7		30.8	8.0	8.18	
03	9.8	18.6		30.8	8.6	8.10	
04	13.1	18.3		31.1	5.6	8.07	
05	16.4	18.1		31.1	5.6	8.05	
06	19.7	18.0		31.1	5.8	8.03	
07	23.0	17.6		31.4	8.7	8.03	
08	26.2	17.2		31.2	8.3	8.02	
09	29.6	17.1		31.1	6.3	8.00	
10	32.8	16.5		31.3	5.0	7.98	
11	36.1	16.9		31.8	4.5	7.91	
12	39.1	16.3		31.8	4.3	7.90	

DATE: MAY 17, 1978 TIME: 0837

STATION: C11

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		29.6	5.6	8.14	
01	3.3	18.6		30.0	5.3	8.06	
02	6.6	18.3		30.4	5.4	8.01	
03	9.8	16.3		30.8	5.0	7.98	
04	13.1	18.4		30.8	5.2	7.98	
05	16.4	18.2		30.6	5.1	7.96	
06	19.7	18.1		30.7	5.8	7.86	
07	23.0	16.9		31.3	4.7	7.82	
08	26.2	16.9		31.3	3.8	7.77	
09	29.6	16.3		31.2	3.3	7.73	

DATE: MAY 10, 1978 TIME: 0953

STATION: D1

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.3		29.8	7.6	8.17	
01	3.3	18.0		30.2	7.1	8.18	
02	6.6	17.8		30.5	7.6	8.14	
03	9.8	16.9		30.7	7.2	8.09	
04	13.1	16.3		31.1	7.5	8.10	
05	16.4	16.8		31.4	7.1	8.00	
06	19.7	16.3		31.1	6.6	7.99	
07	23.0	16.0		31.1	6.6	7.99	
08	26.2	14.8		31.0	6.8	7.97	
09	29.6	14.4		31.1	6.6	7.97	
10	32.8	14.3		31.1	6.7	7.95	
11	36.1	13.1		31.4	5.8	7.88	
12	39.2	13.0		31.3	5.8	7.88	
13	42.6	13.0		31.2	5.3	7.87	
14	45.9	12.9		31.2	5.3	7.87	

DATE: MAY 10, 1978 TIME: 0833

STATION: D2

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		26.7	8.3	8.12	
01	3.3	18.4		29.3	6.0	8.16	
02	6.6	17.8		30.3	6.0	8.13	
03	9.8	17.2		30.3	6.2	8.06	
04	13.1	15.9		31.2	5.4	7.92	
05	16.4	15.6		31.3	5.3	7.90	
06	19.7	15.4		31.3	5.2	7.89	
07	23.0	15.2		31.1	5.2	7.91	
08	26.2	15.0		31.2	4.4	7.80	
09	29.6	14.8		31.6	3.8	7.74	
10	32.8	14.8		31.6	3.5	6.89	

DATE: MAY 10, 1978 TIME: 0941

STATION: D3

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		27.4	7.3	8.17	
01	3.3	18.3		28.8	7.5	8.16	
02	6.6	17.6		30.4	8.0	8.14	
03	9.8	17.0		30.8	7.5	8.11	
04	13.1	16.6		31.0	8.3	8.08	
05	16.4	16.5		31.2	8.3	8.06	
06	19.7	15.6		31.2	6.0	8.04	
07	23.0	15.3		31.2	6.0	8.01	
08	26.2	15.1		31.2	7.9	7.97	
09	29.6	15.0		31.1	7.9	7.95	
10	32.8	15.0		31.1	7.7	7.93	
11	36.1	14.7		31.1	7.8	7.87	
12	39.2	14.6		31.0	7.5	7.87	
13	42.6	14.4		31.1	7.5	7.83	
14	45.9	13.9		31.3	6.7	7.82	
15	49.2	13.3		31.3	4.9	7.47	
16	52.5	13.5		31.2	4.4	7.46	

DATE: MAY 10, 1978 TIME: 0927

STATION: D10

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		27.9	6.4	8.14	
01	3.3	18.1		29.6	6.4	8.12	
02	6.6	17.7		30.1	6.5	8.09	
03	9.8	17.2		30.7	6.6	8.03	
04	13.1	16.7		30.8	5.9	8.03	
05	16.4	16.2		31.1	5.4	7.98	
06	19.7	15.7		31.3	4.8	7.87	
07	23.0	15.2		31.2	3.3	7.79	
08	26.2	15.1		31.6	3.3	7.77	

DATE: JUNE 7, 1978 TIME: 0850

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.3		31.1	8.4	8.37	
01	3.3	16.3		31.1	8.6	8.30	
02	6.6	16.3		31.1	8.7	8.25	
03	9.8	16.3		31.1	9.0	8.22	
04	13.1	16.2		31.8	9.8	8.20	
05	16.4	16.2		31.2	9.2	8.20	
06	19.7	16.2		31.2	9.0	8.16	
07	23.0	16.1		31.2	9.3	8.16	
08	26.2	16.1		31.2	9.4	8.18	
09	29.5	16.0		31.2	9.5	8.18	
10	32.8	15.4		31.3	9.5	8.15	
11	36.1	14.7		31.4	8.8	8.09	
12	39.2	14.2		31.5	8.6	8.07	
13	42.6	13.8		31.5	8.2	8.05	
14	45.9	13.6		31.3	8.2	8.04	
15	49.2	13.4		31.6	7.8	8.02	
16	52.5	13.0		31.6	7.8	7.97	
17	55.8	12.2		31.6	8.2	7.92	
18	59.0	12.1		31.3	8.2	7.91	
19	62.3	12.1		31.3	8.1	7.90	
20	65.6	12.1		31.3	8.8	7.90	

DATE: JUNE 7, 1978 TIME: 0845

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		31.0	8.9	8.38	
01	3.3	17.6		31.0	8.4	8.29	
02	6.6	17.5		31.1	8.2	8.26	
03	9.8	17.2		31.2	7.6	8.22	
04	13.1	16.9		31.2	8.0	8.20	
05	16.4	16.9		31.1	8.0	8.18	
06	19.7	16.9		31.2	7.5	8.17	
07	23.0	16.8		31.1	6.8	8.14	
08	26.2	16.7		31.2	7.1	8.16	
09	29.5	16.5		31.2	7.3	8.14	
10	32.8	16.3		31.2	7.2	8.12	
11	36.1	15.7		31.5	6.8	8.06	
12	39.2	14.9		31.5	5.4	8.03	

DATE: JUNE 7, 1978 TIME: 0900

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.8	8.3	8.48	
01	3.3	17.8		30.9	7.6	8.38	
02	6.6	17.3		31.3	7.3	8.24	
03	9.8	16.8		31.4	7.3	8.19	
04	13.1	16.4		31.3	6.3	8.12	
05	16.4	16.3		31.2	6.3	8.10	
06	19.7	16.3		31.2	6.5	8.08	
07	23.0	15.9		31.3	6.1	8.06	

DATE: JUNE 7, 1978 TIME: 0903

STATION: A4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		30.8	7.0	8.27	
01	3.3	18.1		31.0	6.8	8.21	
02	6.6	17.8		31.2	6.7	8.14	
03	9.8	17.0		31.2	6.3	8.10	
04	13.1	16.9		31.2	6.1	8.08	
05	16.4	16.4		31.2	6.3	8.09	

DATE: JUNE 7, 1978 TIME: 0922

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.0	8.5	8.41	
01	3.3	18.1		30.2	8.3	8.36	
02	6.6	18.1		30.8	8.4	8.30	
03	9.8	17.9		31.0	8.3	8.25	
04	13.1	17.6		31.1	8.3	8.22	

DATE: JUNE 7, 1978 TIME: 0737

STATION: A6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		31.5	10.8	7.01	
01	3.3	17.6		31.3	10.4	8.08	
02	6.6	17.3		31.8	9.9	8.05	
03	9.8	17.3		31.4	9.7	8.07	
04	13.1	17.1		31.4	9.4	8.06	
05	16.4	16.8		31.4	9.0	8.04	
06	19.7	16.8		31.3	8.7	8.04	
07	23.0	16.4		31.4	8.2	8.02	

DATE: JUNE 7, 1978 TIME: 0755

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		30.8	6.5	8.21	
01	3.3	17.8		31.0	6.7	8.14	
02	6.6	17.6		31.1	6.6	8.11	
03	9.8	17.8		31.1	7.1	8.08	
04	13.1	17.5		31.1	6.7	8.07	
05	16.4	17.4		31.1	7.1	8.03	
06	19.7	17.1		31.2	7.4	8.08	
07	23.0	16.8		31.3	6.8	8.04	
08	26.2	16.0		31.5	6.9	8.04	
09	29.5	15.8		31.4	6.3	8.02	
10	32.8	15.1		31.4	5.9	8.00	
11	36.1	14.6		31.4	5.3	7.96	
12	39.2	14.3		31.5	6.0	7.97	
13	42.6	14.0		31.3	5.7	7.97	
14	45.9	13.8		31.3	5.6	7.97	

DATE: JUNE 21, 1978 TIME: 1108

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		31.1	7.9	8.21	98.0
01	3.3	16.7		31.1	7.5	8.16	98.5
02	6.6	16.3		31.1	7.3	8.13	96.0
03	9.8	15.7		31.3	6.6	8.14	93.0
04	13.1	15.6		31.4	6.7	8.08	98.99
05	16.4	14.7		31.8	6.4	8.07	98.8
06	19.7	14.6		31.3	6.8	8.06	96.5
07	23.0	13.8		31.2	6.6	8.05	97.5
08	26.2	13.8		31.3	6.0	8.03	98.0
09	29.5	13.4		31.4	6.2	8.02	97.6
10	32.8	13.0		31.8	5.8	8.00	97.5
11	36.1	12.4		31.8	5.6	7.99	97.0

DATE: JUNE 7, 1978 TIME: 1116

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.8	10.4	8.24	
01	3.3	18.9		30.8	9.8	8.24	
02	6.6	18.7		31.0	9.3	8.23	
03	9.8	18.5		31.1	9.5	8.26	
04	13.1	18.4		31.2	8.4	8.23	
05	16.4	18.2		31.2	7.4	8.12	
06	19.7	17.4		31.4	5.8	8.00	

DATE: JUNE 7, 1978 TIME: 1028

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.9	8.6	8.34	
01	3.3	17.3		31.0	8.8	8.31	
02	6.6	17.0		31.2	8.8	8.26	
03	9.8	16.7		31.3	8.4	8.23	
04	13.1	16.8		31.8	8.1	8.20	
05	16.4	16.6		31.2	7.8	8.20	
06	19.7	16.4		31.2	7.6	8.18	
07	23.0	16.3		31.3	8.8	8.17	
08	26.2	16.3		31.2	7.8	8.17	
09	29.5	16.2		31.3	7.8	8.17	
10	32.8	15.5		31.4	7.7	8.13	
11	36.1	15.8		31.4	8.8	8.11	
12	39.2	14.9		31.4	6.8	8.04	

DATE: JUNE 7, 1978 TIME: 0839

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4		30.7	8.1	8.15	
01	3.3	16.3		31.2	7.8	8.13	
02	6.6	15.8		31.3	8.0	8.12	
03	9.8	15.8		31.2	8.0	8.12	
04	13.1	15.8		31.2	7.8	8.11	
05	16.4	15.7		31.2	7.9	8.11	
06	19.7	15.5		31.2	8.0	8.11	
07	23.0	15.4		31.2	7.2	8.11	
08	26.2	15.4		31.3	7.2	8.10	
09	29.5	15.0		31.8	6.4	8.07	
10	32.8	14.8		31.3	6.5	8.05	
11	36.1	14.8		31.3	6.6	8.04	
12	39.2	14.6		31.3	6.6	8.04	
13	42.6	14.7		31.2	6.5	8.05	
14	45.9	14.7		31.2	6.4	8.03	
15	49.2	14.2		31.7	5.3	7.63	

DATE: JUNE 7, 1978 TIME: 1048

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		31.0	9.8	8.24	
01	3.3	17.5		31.0	8.5	8.25	
02	6.6	17.3		31.1	8.3	8.23	
03	9.8	17.2		31.1	8.7	8.22	
04	13.1	17.1		31.2	8.6	8.19	
05	16.4	16.8		31.3	8.0	8.19	
06	19.7	16.7		31.3	7.8	8.18	
07	23.0	16.7		31.2	7.9	8.18	
08	26.2	16.3		31.3	7.7	8.16	
09	29.5	16.7		31.5	7.6	8.13	
10	32.8	15.6		31.4	7.8	8.16	

DATE: JUNE 7, 1978 TIME: 1130

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.8	10.5	8.47	
01	3.3	18.1		30.8	10.2	8.40	
02	6.6	18.4		31.1	10.2	8.35	
03	9.8	18.1		31.2	9.8	8.31	
04	13.1	17.2		31.5	8.1	8.18	
05	16.4	16.9		31.4	7.8	8.15	
06	19.7	16.6		31.3	7.1	8.11	
07	23.0	16.8		31.3	7.1	8.08	
08	26.2	16.1		31.4	6.8	8.08	

DATE: JUNE 7, 1978 TIME: 1301

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.6	10.2	8.28	
01	3.3	18.6		30.9	10.0	8.27	
02	6.6	17.6		31.4	9.3	8.21	
03	9.8	16.8		31.4	8.6	8.17	
04	13.1	16.9		31.5	8.6	8.15	
05	16.4	16.4		31.3	8.3	8.14	
06	19.7	16.1		31.3	8.1	8.12	
07	23.0	16.5		31.4	6.8	8.05	
08	26.2	16.4		31.3	6.8	8.04	
09	29.6	15.4		31.2	6.1	8.03	

DATE: JUNE 7, 1978 TIME: 1054

STATION: 417

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.8	10.1	8.33	
01	3.3	18.8		30.9	9.6	8.29	
02	6.6	17.6		31.3	8.9	8.20	
03	9.8	16.8		31.4	8.6	8.16	
04	13.1	16.3		31.6	8.6	8.16	
05	16.4	16.0		31.5	8.0	8.13	
06	19.7	15.9		31.3	8.1	8.13	
07	23.0	15.8		31.3	8.1	8.12	
08	26.2	15.1		31.6	7.7	8.08	
09	29.4	14.9		31.3	7.6	8.08	
10	32.8	14.9		31.3	7.2	8.07	

* DATE: JUNE 14, 1978 TIME: 0658

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.7	10.4	8.33	
01	3.3	19.2		30.6	9.6	8.25	
02	6.6	19.1		30.5	10.1	8.26	
03	9.8	18.4		30.6	10.7	8.25	
04	13.1	18.6		30.7	10.3	8.24	
05	16.4	18.2		30.8	10.6	8.23	
06	19.7	17.8		30.9	10.7	8.23	
07	23.0	17.2		30.9	10.6	8.22	
08	26.2	17.1		30.8	10.9	8.21	
09	29.6	17.0		30.9	10.9	8.21	
10	32.8	18.2		31.0	10.2	8.21	
11	36.1	18.4		31.0	11.0	8.19	
12	39.2	18.0		31.2	10.8	8.19	
13	42.6	16.8		31.0	11.4	8.19	
14	45.9	14.3		31.1	11.6	8.18	
15	49.2	14.1		30.1	11.6	8.18	
16	52.5	13.1		31.1	10.9	8.19	
17	55.8	13.1		31.1	10.9	8.18	
18	59.0	13.		31.1	10.4	8.17	
19	62.3	12.5		31.2	8.0	8.10	
20	65.6	12.5		31.2	7.8	8.04	

DATE: JUNE 14, 1978 TIME: 1100

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.4	9.7	8.40	
01	3.3	20.5		31.7	10.0	8.38	
02	6.6	20.4		30.9	10.8	8.38	
03	9.8	20.3		30.4	10.4	8.35	
04	13.1	20.3		31.0	10.1	8.36	
05	16.4	20.3		31.0	9.8	8.36	
06	19.7	20.2		31.0	9.9	8.35	
07	23.0	18.2		31.2	9.1	8.28	
08	26.2	18.8		31.4	8.3	8.21	
09	29.6	18.3		31.1	7.7	8.10	
10	32.8	17.0		31.9	6.9	8.09	
11	36.1	16.3		31.4	5.6	8.02	
12	39.2	16.0		31.5	5.3	7.98	
13	42.6	15.5		31.4	5.0	7.96	

DATE: JUNE 14, 1978 TIME: 1135

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.1		30.9	10.6	8.37	
01	3.3	20.7		30.9	10.4	8.38	
02	6.6	20.3		30.9	9.6	8.35	
03	9.8	20.2		30.9	10.3	8.36	
04	13.1	20.2		31.0	10.3	8.34	
05	16.4	19.9		31.0	9.6	8.33	
06	19.7	19.4		30.8	8.9	8.18	
07	23.0	18.1		31.1	8.1	8.18	
08	26.2	17.4		31.3	7.8	8.12	
09	29.6	17.3		31.2	7.1	8.08	
10	32.8	17.1		31.2	6.6	8.16	

DATE: JUNE 14, 1978 TIME: 1217

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		30.8	9.3	8.27	
01	3.3	20.6		30.8	9.6	8.27	
02	6.6	20.7		30.9	9.8	8.27	
03	9.8	20.7		30.9	9.6	8.27	
04	13.1	20.3		31.1	9.0	8.23	
05	16.4	20.0		31.3	9.0	8.21	
06	19.7	18.8		31.1	7.7	8.18	
07	23.0	18.6		31.2	7.7	8.13	
08	26.2	18.5		31.2	7.5	8.11	
09	29.6	18.3		31.1	7.0	8.10	
10	32.8	17.7		31.3	6.9	8.06	
11	36.1	16.9		31.2	6.6	8.03	
12	39.2	16.8		31.4	6.3	8.01	
13	42.6	16.0		31.3	6.2	7.88	
14	45.9	16.8		31.2	6.1	7.97	

DATE: JUNE 14, 1978 TIME: 1127

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.1		30.9	7.1	8.08	
01	3.3	20.9		30.9	6.2	8.08	
02	6.6	20.8		31.0	6.5	8.06	
03	9.8	20.6		31.3	6.5	8.08	
04	13.1	20.3		31.1	6.6	8.05	
05	16.4	19.7		31.4	6.0	8.07	
06	19.7	19.5		31.3	6.1	8.05	
07	23.0	18.6		31.2	6.1	8.04	
08	26.2	18.0		31.2	6.2	8.03	
09	29.6	17.8		31.2	6.3	8.02	
10	32.8	17.6		31.2	6.2	8.02	
11	36.1	17.4		31.1	6.2	8.02	
12	39.2	17.6		31.2	6.1	8.02	
13	42.6	17.8		31.2	9.3	8.03	
14	45.9	17.2		31.2	6.1	8.02	
15	49.2	16.8		31.2	6.8	7.99	
16	52.5	15.8		31.3	6.4	7.99	

DATE: JUNE 14, 1978 TIME: 1200

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		30.8	6.7	8.12	
01	3.3	20.6		30.6	6.8	8.11	
02	6.6	20.0		31.2	6.7	8.10	
03	9.8	19.6		31.4	6.4	8.06	
04	13.1	19.2		31.4	6.6	8.06	
05	16.4	18.8		31.3	6.3	8.05	
06	19.7	18.9		31.2	6.2	8.04	
07	23.0	18.8		31.2	6.1	8.02	
08	26.2	18.7		31.1	6.0	8.04	
09	29.6	18.7		31.1	5.4	8.02	
10	32.8	18.6		31.2	5.8	8.01	
11	36.1	18.4		31.2	5.6	8.00	

DATE: JUNE 14, 1978 TIME: 1135

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.9		30.9	8.8	8.11	
01	3.3	20.8		31.0	7.9	8.11	
02	6.6	20.4		31.0	7.8	8.14	
03	9.8	20.2		31.1	6.2	8.14	
04	13.1	20.0		31.1	7.2	8.13	
05	16.4	18.8		31.2	7.6	8.11	
06	19.7	19.5		31.1	7.2	8.09	
07	23.0	18.9		31.4	6.2	8.06	
08	26.2	18.3		31.4	6.6	8.04	
09	29.6	17.7		31.6	5.4	8.02	
10	32.8	17.1		31.9	5.3	8.00	
11	36.1	16.8		31.4	5.0	7.99	
12	39.2	16.7		31.5	4.6	7.98	
13	42.6	16.6		31.3	4.7	7.87	
14	45.9	14.3		31.4	4.3	7.98	
15	49.2	16.0		31.4	4.2	7.94	
16	52.5	15.8		31.4	3.8	7.91	
17	55.8	15.8		31.2	3.7	7.80	

DATE: JUNE 7, 1978 TIME: 0944

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		30.8	9.0	8.50	
01	3.3	18.2		30.9	8.6	8.41	
02	6.6	18.2		31.0	8.5	8.34	
03	9.8	18.1		31.0	8.7	8.31	
04	13.1	17.9		31.1	8.8	8.26	
05	16.4	17.1		31.4	7.7	8.20	
06	19.7	17.1		31.3	7.8	8.17	
07	23.0	16.3		31.5	7.3	8.13	
08	26.2	16.2		31.6	7.0	8.12	
09	29.6	15.8		31.3	6.9	8.07	
10	32.8	15.5		31.4	6.6	8.06	
11	36.1	15.3		31.4	6.1	8.05	
12	39.2	14.9		31.3	4.8	7.97	

DATE: JUNE 7, 1978 TIME: 0955

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		30.8	8.8	8.38	
01	3.3	18.0		31.0	8.7	8.31	
02	6.6	17.9		31.0	8.3	8.26	
03	9.8	17.6		31.1	8.5	8.24	
04	13.1	17.4		31.2	8.9	8.23	
05	16.4	17.3		31.2	8.7	8.21	
06	19.7	17.1		31.2	8.3	8.20	
07	23.0	17.0		31.3	8.0	8.18	
08	26.2	18.9		31.6	6.6	8.08	
09	29.6	18.4		31.6	6.0	8.03	
10	32.8	15.1		31.6	5.6	8.00	
11	36.1	14.9		31.2	4.7	7.88	
12	39.2	14.8		31.3	4.8	7.85	
13	42.6	14.7		31.3	4.8	7.86	
14	45.9	14.7		31.3	5.3	7.77	
15	49.2	14.6		31.3	5.8	7.99	
16	52.5	14.6		31.3	5.8	7.96	
17	55.8	14.5		31.3	5.3	7.40	
18	59.0	14.4		31.1	5.2	7.97	
19	62.3	14.3		31.1	4.9	7.97	
20	65.6	13.9		31.8	4.7	7.84	
21	68.9	13.7		31.9	4.5	7.91	
22	72.1	13.7		31.4	4.3	7.41	

DATE: JUNE 14, 1978 TIME: 1040

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		30.6	9.6	8.34	
01	3.3	19.6		30.7	9.2	8.33	
02	6.6	19.7		30.8	9.1	8.38	
03	9.8	19.1		31.0	9.8	8.29	
04	13.1	19.0		31.1	9.4	8.29	
05	16.4	18.8		31.0	9.3	8.28	
06	19.7	18.4		31.1	9.4	8.27	
07	23.0	18.6		31.1	9.1	8.28	
08	26.2	17.3		31.1	8.2	8.17	
09	29.6	17.0		31.3	7.4	8.09	
10	32.8	16.4		31.4	5.8	8.01	
11	36.1	16.2		31.3	6.3	8.00	

DATE: JUNE 21, 1978 TIME: 1056

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		31.0	5.9	7.97	84.0
01	3.3	17.2		31.1	5.3	7.97	90.0
02	6.6	16.9		31.2	6.3	7.97	89.0
03	9.8	16.8		31.3	6.1	7.98	88.5
04	13.1	16.0		31.5	4.6	8.01	88.0
05	16.4	15.0		31.5	4.7	8.01	87.5
06	19.7	15.4		31.4	4.5	8.01	87.5
07	23.0	15.5		31.5	4.6	8.02	84.5
08	26.2	15.1		31.2	5.5	8.02	85.0
09	29.4	14.9		31.3	6.7	8.02	85.5
10	32.8	15.3		31.4	6.5	8.02	85.5

DATE: JUNE 21, 1978 TIME: 1040

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.8	6.3	8.02	84.0
01	3.3	18.3		30.9	6.5	8.02	90.0
02	6.6	17.7		31.1	6.5	8.02	89.0
03	9.8	17.6		31.1	6.4	8.03	86.0
04	13.1	17.4		31.2	6.3	8.02	84.5
05	16.4	17.2		31.3	6.2	8.02	86.0
06	19.7	16.6		31.4	6.2	8.02	84.5
07	23.0	16.2		31.4	6.0	8.01	83.5
08	26.2	15.6		31.6	4.2	8.01	61.0
09	29.6	15.4		31.6	5.7	8.00	79.0
10	32.8	15.3		31.3	5.6	8.00	81.0
11	36.1	14.8		31.5	5.7	7.89	84.0

DATE: JUNE 21, 1978 TIME: 1030

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.9	6.6	8.03	43.5
01	3.3	18.3		31.0	6.3	8.03	94.5
02	6.6	17.8		31.2	5.9	8.02	87.0
03	9.8	17.6		31.1	6.4	8.02	82.0
04	13.1	17.6		31.2	5.6	8.02	78.5
05	16.4	17.1		31.3	6.4	8.02	78.0
06	19.7	16.8		31.2	6.3	8.01	80.0
07	23.0	16.7		31.2	6.1	8.01	62.0
08	26.2	16.4		31.3	5.7	8.01	88.0
09	29.4	16.3		31.3	5.8	8.01	48.8
10	32.8	15.8		31.4	5.8	8.01	49.5
11	36.1	15.7		31.3	6.8	8.01	45.0

DATE: JUNE 21, 1978 TIME: 0944

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.7	6.3	7.99	92.0
01	3.3	17.3		31.0	5.7	7.99	89.5
02	6.6	18.2		31.6	5.7	7.99	89.0
03	9.8	17.8		31.8	5.8	7.99	87.5
04	13.1	17.5		31.3	5.4	7.99	83.5
05	16.4	17.4		31.2	6.4	7.99	80.0
06	19.7	17.4		31.8	5.3	7.99	80.0
07	23.0	16.9		31.1	5.4	7.99	79.6
08	26.2	17.1		31.1	5.4	8.00	60.5
09	29.4	16.9		31.2	5.6	7.99	76.5
10	32.8	16.8		31.2	5.2	8.00	76.5
11	36.1	16.7		31.2	5.8	8.00	77.0
12	39.2	16.3		31.3	5.3	7.99	
13	42.6	16.1		31.4	4.8	7.98	

DATE: JUNE 21, 1978 TIME: 1000

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.9		30.6	6.9	8.04	76.8
01	3.3	19.8		31.8	7.7	8.08	76.0
02	6.6	19.1		31.8	6.1	8.01	76.8
03	9.8	18.6		31.7	6.2	7.97	74.8
04	13.1	18.1		31.7	5.6	7.97	84.0
05	16.4	17.9		31.6	5.4	7.98	82.0
06	19.7	17.7		31.3	5.2	7.98	91.8
07	23.0						84.0

DATE: JUNE 21, 1978 TIME: 1018

STATION: C6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		30.8	6.0	7.98	90.5
01	3.3	18.6		30.8	5.4	7.97	96.0
02	6.6	19.0		31.2	5.4	7.97	93.8
03	9.8	18.8		31.3	5.2	7.97	90.0
04	13.1	17.8		31.7	4.7	7.98	86.0
05	16.4	17.6		31.6	4.1	7.97	83.5
06	19.7	17.5		31.2	4.7	7.97	82.0
07	23.0	17.3		31.4	4.3	7.97	82.0
08	26.2	17.2		31.3	4.4	7.97	79.0
09	29.5	17.1		31.2	4.9	7.97	78.0
10	32.8	16.8		31.2	3.6	7.97	78.5
11	36.1	16.8		31.3	4.0	7.96	82.0

DATE: JUNE 21, 1978 TIME: 0936

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.6	4.4	7.98	83.0
01	3.3	19.0		31.0	5.2	7.98	86.0
02	6.6	18.8		31.0	5.0	7.97	87.8
03	9.8	18.8		31.1	4.8	7.97	88.5
04	13.1	18.4		31.1	3.8	7.86	87.0
05	16.4	18.1		31.4	3.8	7.96	87.0
06	19.7	17.7		31.4	3.8	8.02	88.5
07	23.0	17.5		31.2	3.8	7.99	82.0
08	26.2	17.0		31.7	3.5	8.01	73.8
09	29.6	16.3		31.7	3.8	8.02	76.8
10	32.8	16.2		31.5	4.0	8.02	40.8
11	36.1	16.1		31.3	3.8	8.04	

DATE: JUNE 21, 1978 TIME: 0815

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.8	8.0	8.02	92.0
01	3.3	18.8		30.8	6.6	8.02	94.0
02	6.6	18.7		30.4	6.4	8.02	95.0
03	9.8	18.7		30.9	6.0	8.03	95.0
04	13.1	18.3		31.1	5.4	8.04	94.0
05	16.4	18.2		31.0	6.0	8.04	93.0
06	19.7	18.0		31.1	6.2	8.04	92.0
07	23.0	17.4		31.1	4.2	8.03	93.9
08	26.2	17.0		31.4	6.4	8.02	95.0
09	29.6	16.0		31.6	5.4	8.01	93.0
10	32.8	18.7		31.7	5.0	8.01	86.0
11	36.1	18.3		31.4	8.3	8.02	80.0
12	39.2						90.5

DATE: JUNE 21, 1978 TIME: 0835

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		31.2	6.0	8.04	78.0
01	3.3	18.7		30.5	6.1	8.04	86.0
02	6.6	18.5		30.8	6.4	8.06	90.0
03	9.8	18.0		30.9	6.4	8.08	84.0
04	13.1	17.4		31.2	5.8	8.04	87.0
05	16.4	16.9		31.2	6.7	8.04	77.0
06	19.7	16.7		31.5	6.8	8.04	72.0
07	23.0	16.6		31.2	6.2	8.08	68.0
08	26.2	15.6		31.1	6.0	8.04	70.0
09	29.6	16.4		31.3	6.7	8.04	63.5
10	32.8	16.2		31.2	5.8	8.04	60.5
11	36.1	15.9		31.3	6.3	8.04	74.5
12	39.2	15.6		31.3	6.4	8.08	73.6
13	42.6	14.7		31.7	6.8	8.03	70.0

DATE: JUNE 21, 1978 TIME: 0918

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.4	7.2	8.13	77.0
01	3.3	18.7		30.7	6.8	8.10	88.0
02	6.6	18.4		31.0	6.0	8.09	88.5
03	9.8	18.3		31.0	6.4	8.08	90.5
04	13.1	18.3		31.0	6.6	8.08	89.0
05	16.4	18.2		31.1	6.8	8.08	88.0
06	19.7	17.7		31.3	6.7	8.08	90.8
07	23.0	17.2		31.4	6.8	8.06	90.5
08	26.2	16.8		31.5	6.5	8.06	90.0
09	29.6	16.5		31.3	6.8	8.06	89.0
10	32.8	16.3		31.8	6.3	8.07	88.0
11	36.1	15.3		31.6	6.7	8.08	87.8

DATE: JUNE 21, 1978 TIME: 0855

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.0		31.1	6.1	7.98	89.0
01	3.3	19.6		31.1	5.8	7.98	90.0
02	6.6	18.3		31.0	6.3	8.04	90.5
03	9.8	17.3		31.3	5.8	8.02	88.3
04	13.1	16.8		31.6	6.2	8.02	88.3
05	16.4	16.2		31.6	5.9	8.03	89.5
06	19.7	16.1		31.5	4.8	8.02	86.0
07	23.0	16.0		31.2	5.7	8.02	66.0

DATE: JUNE 14, 1978 TIME: 1020

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.7		30.6	10.2	8.47	
01	3.3	21.5		30.7	10.8	8.47	
02	6.6	21.4		30.8	10.5	8.43	
03	9.8	19.9		31.2	8.8	8.28	
04	13.1	19.5		31.4	7.5	8.22	
05	16.4	19.2		31.3	7.1	8.22	
06	19.7	18.8		31.3	7.1	8.20	
07	23.0	18.5		31.2	6.7	8.16	
08	26.2	17.7		31.6	6.0	8.07	
09	29.6	17.2		31.1	6.9	8.09	
10	32.8	17.0		31.1	7.4	8.11	
11	36.1	16.3		31.3	6.7	8.04	
12	39.2	15.9		31.4	6.3	8.02	
13	42.6	14.8		31.8	6.6	8.06	
14	45.9	13.9		31.4	8.1	8.10	

DATE: JUNE 14, 1978 TIME: 0950

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.6		29.9	9.7	8.60	
01	3.3	21.3		29.6	9.4	8.40	
02	6.6	21.5		29.8	8.9	8.46	
03	9.8	21.4		30.5	8.3	8.41	
04	13.1	20.9		30.8	8.3	8.33	
05	16.4	20.6		31.0	7.6	8.27	
06	19.7	20.2		31.2	6.8	8.17	
07	23.0	19.7		31.8	6.2	8.03	
08	26.2	18.6		31.8	3.5	7.78	
09	29.6	17.2		31.3	1.3	7.66	

DATE: JUNE 14, 1976 TIME: 1005

STATION: D3

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.8		30.3	11.4	8.35	
01	3.3	21.6		30.4	10.0	8.30	
02	6.6	21.5		30.6	10.1	8.30	
03	9.8	20.7		30.9	9.6	8.35	
04	13.1	20.0		31.2	7.7	8.23	
05	16.4	18.9		31.1	7.4	8.21	
06	19.7	19.0		31.0	7.1	8.16	
07	23.0	17.6		31.4	8.1	7.97	
08	26.2	16.6		31.9	6.3	7.98	

DATE: JUNE 14, 1976 TIME: 0940

STATION: D10

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		30.1	8.8	8.30	
01	3.3	21.2		30.5	9.0	8.30	
02	6.6	21.1		30.5	8.0	8.38	
03	9.8	21.0		30.7	7.4	8.36	
04	13.1	20.4		30.9	7.1	8.25	
05	16.4	20.1		30.9	8.1	8.17	
06	19.7	20.3		30.9	6.8	8.15	
07	23.0	19.7		31.0	6.6	8.07	

DATE: JULY 5, 1976 TIME: 0800

STATION: A11

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.6		31.0	6.8	7.75	87.0
01	3.3	14.4		31.0	6.5	7.63	88.0
02	6.6	14.4		31.1	6.7	7.88	87.0
03	9.8	14.4		31.1	6.7	7.84	86.0
04	13.1	14.2		31.2	6.7	7.84	84.0
05	16.4	14.0		31.2	6.7	7.80	84.5
06	19.7	13.9		31.2	6.8	7.88	84.5
07	23.0	13.5		31.3	6.6	7.88	84.0
08	26.2	13.1		31.3	5.3	7.84	84.5
09	29.5	12.8		31.4	6.1	7.74	85.0
10	32.8	12.3		31.4	5.6	7.82	86.0
11	36.1	12.0		31.5	5.3	7.87	87.0
12	39.4	11.8		31.5	5.0	7.91	88.5
13	42.6	11.6		31.4	4.9	7.93	90.0
14	45.9	11.6		31.4	5.0	7.98	90.0
15	49.2	11.3		31.4	4.7	7.95	91.0
16	52.5	11.1		31.4	4.7	7.96	93.0
17	55.8	10.8		31.4	4.8	7.95	93.0
18	59.0	10.7		31.4	4.8	7.92	93.0
19	62.3	10.7		31.4	4.4	7.98	92.5
20	65.6	10.7		31.4	4.3	7.98	92.5
21	68.9	10.6		31.4	4.3	7.94	92.5
22	72.1	10.6		31.4	4.3	7.94	90.0

DATE: JULY 5, 1976 TIME: 0820

STATION: A1

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.0		30.6	7.9	8.47	79.0
01	3.3	15.0		31.0	8.1	8.50	82.0
02	6.6	15.0		31.0	8.1	8.61	82.0
03	9.8	14.8		31.1	7.6	8.45	82.0
04	13.1	14.3		31.1	7.4	8.39	82.0
05	16.4	14.1		31.2	7.4	8.38	83.0
06	19.7	13.8		31.2	7.1	8.30	83.0
07	23.0	13.8		31.3	7.3	8.28	84.0
08	26.2	13.7		31.2	7.1	8.26	84.0
09	29.5	13.7		31.8	7.1	8.24	88.0
10	32.8	13.4		31.3	7.1	8.27	85.0
11	36.1	13.5		31.3	7.0	8.20	88.0
12	39.4	13.0		31.3	5.8	8.13	88.0
13	42.6	11.6		31.4	5.4	8.09	87.0
14	45.9	11.1		31.4	4.8	8.08	90.0
15	49.2	11.0		31.4	4.7	8.02	91.0
16	52.5	10.9		31.4	4.6	8.01	90.0
17	55.8	10.9		31.4	4.3	8.00	89.0
18	59.0	10.8		31.4	4.3	7.99	88.0
19	62.3	10.6		31.4	4.4	7.98	87.0

DATE: JULY 5, 1976 TIME: 0846

STATION: A2A

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		30.6	8.9	8.44	55.0
01	3.3	16.1		30.8	9.6	8.39	62.0
02	6.6	15.6		31.0	8.3	8.38	71.0
03	9.8	14.9		31.4	7.2	8.26	74.0
04	13.1	13.8		31.7	6.1	8.14	78.0
05	16.4	13.8		31.6	5.7	8.14	80.0
06	19.7	13.4		31.2	5.7	8.13	81.0
07	23.0	13.4		31.8	6.2	8.11	82.0
08	26.2	13.1		31.7	6.5	8.04	83.0
09	29.5	11.9		31.8	4.9	8.02	88.0
10	32.8	11.6		31.5	4.4	8.00	84.0

DATE: JULY 5 1976 TIME: 0908

STATION: A5

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.6		30.6	8.3	8.48	76.0
01	3.3	16.6		30.9	7.6	8.43	78.0
02	6.6	14.4		31.6	6.4	8.40	76.0
03	9.8	13.7		31.3	5.3	8.23	73.0
04	13.1	13.6		31.4	6.2	8.17	74.0
05	16.4	13.1		31.4	6.0	8.15	78.0
06	19.7	12.8		31.8	4.8	8.13	79.0
07	23.0	12.4		31.6	4.8	8.11	81.0
08	26.2	12.6		31.5	4.7	8.09	

DATE: JULY 5, 1976 TIME: 0910

STATION: A6

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		30.7	8.6	8.50	56.0
01	3.3	16.0		30.6	7.8	8.45	72.0
02	6.6	16.0		30.8	6.8	8.39	73.0
03	9.8	15.8		31.0	7.3	8.33	72.0
04	13.1	16.0		31.4	5.7	8.25	80.0
05	16.4	14.4		31.5	5.3	8.15	81.0
06	19.7	14.2		31.2	4.4	8.09	87.0
07	23.0	14.0		31.4	4.3	8.07	

DATE: JULY 5, 1976 TIME: 0915

STATION: A7

DEPTH METERS	/FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		30.5	6.8	8.44	70.0
01	3.3	15.9		30.6	7.7	8.44	71.0
02	6.6	15.9		30.6	8.2	8.42	71.0
03	9.8	15.7		31.1	6.4	8.39	72.0
04	13.1	15.4		31.2	8.0	8.32	74.0

DATE: JULY 5, 1978 TIME: 0732

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.0		31.0	7.1	8.32	76.5
01	3.3	15.9		31.0	7.3	8.16	76.6
02	6.6	15.7		31.1	7.8	8.37	76.8
03	9.8	15.8		31.1	7.5	8.18	77.0
04	13.1	15.4		31.1	7.3	8.18	76.6
05	16.4	14.8		31.5	7.5	8.15	76.1
06	19.7	13.9		31.5	7.1	8.10	78.6
07	23.0	13.8		31.5	6.6	8.08	76.1

DATE: JULY 5, 1978 TIME: 0741

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.1	8.2	8.16	74.0
01	3.3	18.9		30.7	8.8	8.15	78.9
02	6.6	18.8		30.9	9.5	8.18	79.6
03	9.8	15.7		30.9	8.7	8.15	78.7
04	13.1	15.7		31.1	5.9	8.15	78.5
05	16.4	15.1		31.2	8.6	8.14	78.9
06	19.7	13.7		31.4	8.3	8.07	80.1
07	23.0	13.4		31.6	6.6	8.03	82.3
08	26.2	12.9		31.6	6.7	8.01	83.6
09	29.6	12.4		31.6	6.5	7.97	83.9

DATE: JULY 5, 1978 TIME: 1100

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.7		30.8	8.7	8.46	
01	3.3	17.6		30.9	8.9	8.44	
02	6.6	17.4		31.2	9.8	8.41	
03	9.8	17.2		31.2	9.0	8.39	
04	13.1	17.2		31.2	8.8	8.38	
05	16.4	16.0		31.4	7.8	8.27	
06	19.7	14.8		31.6	6.4	8.20	

DATE: JULY 19, 1978 TIME: 1110

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.8	7.1	8.71	84.0
01	3.3	18.7		30.9	6.9	8.58	73.0
02	6.6	18.3		31.0	6.5	8.46	77.0
03	9.8	18.3		31.1	6.4	8.37	78.0
04	13.1	17.9		31.1	6.7	8.34	78.0
05	16.4	17.7		31.4	6.1	8.30	79.0
06	19.7	17.5		31.4	6.2	8.26	81.0
07	23.0	17.0		31.5	5.4	8.18	82.0
08	26.2	16.8		31.5	5.2	8.16	83.0
09	29.6	16.0		32.0	3.9	8.13	82.0
10	32.8	14.8		32.1	4.2	8.07	80.0
11	36.1	14.8		31.7	3.0	8.00	

DATE: JULY 5, 1978 TIME: 0958

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.6		30.6	8.5	8.41	60.0
01	3.3	14.6		31.3	8.7	8.30	70.0
02	6.6	15.6		31.3	8.5	8.44	75.0
03	9.8	15.0		31.1	8.4	8.39	74.0
04	13.1	14.6		31.4	7.9	8.33	77.0
05	16.4	14.5		31.3	7.7	8.29	78.0
06	19.7	14.1		31.4	6.6	8.22	76.0
07	23.0	13.7		31.3	6.1	8.18	81.0
08	26.2	13.1		31.7	6.5	8.13	84.0
09	29.6	12.8		31.4	6.9	8.10	80.0
10	32.8	12.8		31.5	4.2	8.05	84.0
11	36.1	12.7		31.6	4.1	8.03	84.0

DATE: JULY 5, 1978 TIME: 0834

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.2		30.6	8.7	8.71	78.0
01	3.3	14.0		30.7	7.7	8.46	77.0
02	6.6	15.8		30.1	7.1	8.40	79.0
03	9.8	15.8		31.1	7.5	8.37	80.0
04	13.1	14.8		31.5	6.9	8.28	83.0
05	16.4	14.1		31.4	6.5	8.23	85.0
06	19.7	13.3		31.4	4.9	8.13	83.0
07	23.0	12.7		31.5	4.7	8.11	84.0
08	26.2	12.5		31.5	4.8	8.09	84.0
09	29.6	12.3		31.5	4.8	8.07	85.0
10	32.8	12.3		31.4	4.4	8.07	82.0
11	36.1	12.1		31.5	4.4	8.07	84.0
12	39.2	11.8		31.5	4.7	8.05	86.0
13	42.6	11.9		31.7	4.4	8.04	86.0
14	45.9	11.1		31.6	4.6	8.02	82.0

DATE: JULY 5, 1978 TIME: 1020

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		30.6	8.6	8.68	53.0
01	3.3	16.4		30.7	9.1	8.68	65.0
02	6.6	16.1		31.0	8.5	8.50	74.0
03	9.8	16.4		31.2	8.0	8.42	78.0
04	13.1	14.6		31.4	7.0	8.33	76.0
05	16.4	14.3		31.4	6.9	8.28	76.0
06	19.7	14.0		31.4	6.6	8.26	77.0
07	23.0	13.3		31.5	5.6	8.18	78.0
08	26.2	12.1		31.5	5.3	8.13	78.0
09	29.6	12.4		31.6	5.0	8.09	76.0
10	32.8	11.9		31.7	4.7	8.07	76.0
11	36.1	11.6		31.8	4.4	8.00	

DATE: JULY 5, 1978 TIME: 1047

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.0		30.9	10.4	8.82	76.0
01	3.3	17.1		30.9	10.1	8.69	79.0
02	6.6	17.0		31.0	9.5	8.56	80.0
03	9.8	16.6		31.4	8.7	8.48	81.0
04	13.1	15.7		31.5	8.7	8.40	80.0
05	16.4	15.4		31.6	7.7	8.34	77.0
06	19.7	15.3		31.6	8.8	8.32	78.0
07	23.0	14.3		31.4	7.1	8.24	79.0
08	26.2	14.3		31.5	5.6	8.18	80.0

DATE: JULY 5, 1978 TIME: 1037

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.9		30.9	9.4	8.43	77.0
01	3.3	16.9		30.6	8.4	8.52	79.0
02	6.6	16.6		31.0	9.1	8.47	78.0
03	9.8	16.1		31.2	8.0	8.36	77.0
04	13.1	14.9		31.4	7.8	8.31	76.0
05	16.4	14.7		31.4	7.6	8.28	76.0
06	19.7	14.4		31.5	7.2	8.24	77.0
07	23.0	14.2		31.4	6.8	8.16	
08	26.2	13.9		31.6	6.2	8.09	

DATE: JULY 5, 1978 TIME: 1050

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.1		31.5	8.8	8.30	64.0
01	3.3	16.1		31.4	8.4	8.28	66.0
02	6.6	15.5		31.5	8.6	8.28	73.0
03	9.8	15.2		31.4	8.3	8.22	75.0
04	13.1	14.7		31.4	8.1	8.19	76.0
05	16.4	14.5		31.4	7.3	8.16	76.0
06	19.7	14.1		31.6	8.1	8.10	77.0
07	23.0	13.7		31.4	6.2	8.08	78.0
08	26.2	13.5		31.5	6.9	8.06	79.0
09	29.6	13.7		31.4	5.6	8.04	81.0
10	32.8						81.0

DATE: JULY 12, 1978 TIME: 0916

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.5	7.4	8.26	88.0
01	3.3	17.6		30.9	7.2	8.25	88.0
02	6.6	17.3		31.1	6.9	8.25	88.0
03	9.8	16.7		31.3	8.4	8.23	89.0
04	13.1	16.5		31.2	6.6	8.21	89.0
05	16.4	16.4		31.1	11.3	8.20	90.0
06	19.7	16.2		31.1	11.9	8.20	90.0
07	23.0	16.2		31.1	11.8	8.21	91.0
08	26.2	16.0		31.1	11.4	8.19	92.0
09	29.6	15.6		31.2	12.7	8.18	92.0
10	32.8	14.4		31.3	13.8	8.13	92.0
11	36.1	13.4		31.5	12.8	8.09	90.0
12	39.2	13.1		31.6	12.8	8.07	91.0
13	42.6	12.9		31.4	12.7	8.06	91.0
14	45.9	12.8		31.4	13.0	8.05	91.0
15	49.2	12.6		31.3	13.2	8.05	91.0
16	52.5	12.6		31.3	13.8	8.04	90.0
17	55.8	12.4		31.4	13.8	8.01	88.0
18	59.0	12.0		31.8	6.6	7.97	81.0
19	62.3	11.5		31.4	6.2	7.95	81.0
20	65.6	11.3		31.4	6.2	7.93	78.0

DATE: JULY 12, 1978 TIME: 1110

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.8	7.6	8.26	77.0
01	3.3	17.9		30.9	7.6	8.28	81.0
02	6.6	17.8		31.1	7.8	8.28	88.0
03	9.8	16.8		31.2	8.9	8.20	82.0
04	13.1	16.1		31.4	10.0	8.16	81.0
05	16.4	15.6		31.6	10.0	8.12	80.0
06	19.7	16.2		31.5	10.4	8.09	79.0
07	23.0	14.8		31.6	9.2	8.07	77.0
08	26.2	14.7		31.5	9.5	8.05	78.0
09	29.6	14.5		31.3	9.1	8.04	78.0
10	32.8	14.6		31.4	6.8	8.03	77.0
11	36.1	14.2		31.3	8.9	8.03	77.0
12	39.2	14.0		31.4	11.6	8.01	76.0
13	42.6	13.7		31.4	9.1	7.98	77.0
14	45.9	13.6		31.6	8.6	7.97	77.0
15	49.2	13.1		31.9	8.5	7.94	76.0
16	52.5	13.1		31.4	6.0	7.81	70.0
17	55.8						68.0

DATE: JULY 12, 1978 TIME: 1150

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.7		31.0	7.6	8.46	81.0
01	3.3	17.7		31.0	7.6	8.41	81.0
02	6.6	17.6		31.1	7.8	8.37	82.0
03	9.8	16.8		31.2	9.2	8.38	80.0
04	13.1	16.6		31.2	9.6	8.30	79.0
05	16.4	16.5		31.2	10.2	8.26	81.0
06	19.7	16.1		31.4	10.8	8.23	81.0
07	23.0	15.6		31.3	11.2	8.19	81.0
08	26.2	15.5		31.3	9.2	8.16	81.0
09	29.5	15.4		31.2	9.0	8.13	82.0
10	32.8	15.2		31.4	8.1	8.12	82.0
11	36.1	15.1		31.3	4.8	8.11	82.0
12	39.4	14.8		31.4	6.7	8.07	82.0
13	42.6	14.0		31.4	4.4	8.03	79.0
14	45.9	13.4		31.3	3.8	8.01	76.0
15	49.2	13.3		31.3	3.9	8.00	76.0
16	52.5	13.2		31.4	4.0	8.00	75.0
17	55.8	13.1		31.3	3.8	8.00	75.0
18	59.0	12.8		31.4	3.0	7.99	75.0
19	62.3	12.8		31.4	3.6	7.98	75.0
20	65.6	12.6		31.3	3.4	7.97	76.0
21	68.9						77.0

DATE: JULY 12, 1978 TIME: 1125

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		30.4	7.4	8.33	78.0
01	3.3	16.2		30.8	7.4	8.26	78.0
02	6.6	16.8		31.0	7.6	8.27	82.0
03	9.8	17.5		31.2	8.7	8.26	82.0
04	13.1	17.1		31.4	9.5	8.23	82.0
05	16.4	16.7		31.4	10.1	8.21	82.0
06	19.7	16.1		31.4	10.4	8.19	82.0
07	23.0	15.4		31.6	11.1	8.15	83.0
08	26.2	15.1		31.5	11.5	8.14	83.0
09	29.5	15.0		31.5	11.8	8.12	83.0
10	32.8	14.8		31.5	11.8	8.11	84.0
11	36.1	14.8		31.5	12.2	8.10	82.0
12	39.4	14.3		31.8	12.1	8.07	82.0
13	42.6	13.8		31.6	11.5	8.04	81.0
14	45.9	13.7		31.6	12.3	8.03	79.0
15	49.2	13.6		31.5	11.1	8.01	78.0
16	52.5	13.5		31.4	7.4	8.00	77.0
17	55.8	13.3		31.8	8.0	7.98	76.0
18	59.0	13.2		31.4	6.5	7.97	75.0
19	62.3	12.9		31.6	6.2	7.97	74.0
20	65.6	12.6		31.5	6.4	7.96	73.0

DATE: JULY 12, 1978 TIME: 1150

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		30.7	5.9	8.38	94.0
01	3.3	17.5		30.8	5.8	8.36	92.0
02	6.6	17.4		31.1	6.7	8.30	86.0
03	9.8	17.2		31.1	7.1	8.26	88.0
04	13.1	16.5		31.2	7.8	8.21	86.0
05	16.4	16.7		31.2	7.1	8.18	86.0
06	19.7	16.7		31.3	7.0	8.16	86.0
07	23.0	16.6		31.6	6.7	8.14	88.0
08	26.2	16.4		31.6	7.3	8.13	88.0
09	29.6	15.3		31.7	7.2	8.11	86.0
10	32.8	14.8		31.6	7.0	8.09	86.0
11	36.1	14.3		31.7	6.8	8.07	84.0
12	39.2	14.0		31.6	6.7	8.06	83.0
13	42.6	13.8		31.6	6.8	8.08	83.0
14	45.9	13.7		31.6	6.3	8.03	79.0
15	49.2	13.6		31.8	6.1	8.02	78.0
16	52.5	13.3		31.4	6.1	8.02	77.0
17	55.8	13.3		31.4	6.1	8.01	78.0
18	59.0	13.2		31.4	6.0	8.00	76.0
19	62.3	13.2		31.4	6.1	7.99	76.0
20	65.6						72.0

DATE: JULY 12, 1978 TIME: 1140

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.0	6.2	8.60	71.0
01	3.3	18.9		30.8	5.9	8.36	72.0
02	6.6	18.6		31.2	7.8	8.30	72.0
03	9.8	18.1		31.3	8.2	8.29	77.0
04	13.1	17.9		31.6	8.7	8.20	79.0
05	16.4	16.9		31.4	8.4	8.16	80.0
06	19.7	16.5		31.4	8.1	8.18	80.0
07	23.0	16.4		31.8	8.0	8.13	80.0
08	26.2	16.2		31.8	7.5	8.12	79.0
09	29.6	16.1		31.4	7.6	8.11	
10	32.8	15.9		31.7	7.7	8.08	
11	36.1	15.1		31.7	7.4	8.06	
12	39.4	14.8		31.4	7.8	8.04	
13	42.6	13.9		31.9	7.9	8.01	

DATE: JULY 12, 1978 TIME: 1130

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.9	6.8	8.61	82.0
01	3.3	18.6		31.0	7.0	8.44	74.0
02	6.6	18.4		31.1	7.4	8.44	78.0
03	9.8	17.7		31.4	8.3	8.36	77.0
04	13.1	17.9		31.3	9.1	8.31	78.0
05	16.4	17.3		31.4	9.8	8.27	81.0
06	19.7	17.1		31.3	10.8	8.23	81.0
07	23.0	16.5		31.6	10.6	8.19	82.0
08	26.2	16.7		32.0	10.3	8.18	81.0
09	29.6	16.2		31.6	11.6	8.10	81.0
10	32.8	14.9		31.4	12.6	8.08	78.0
11	36.1	14.6		31.4	3.8	8.06	76.0
12	38.2						76.0

DATE: JULY 5, 1978 TIME: 0948

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.8		30.4	8.5	8.51	76.0
01	3.3	16.8		30.4	8.9	8.40	77.0
02	6.6	16.5		30.9	8.8	8.40	77.0
03	9.8	15.6		31.3	8.8	8.36	76.0
04	13.1	15.6		31.3	8.3	8.32	76.0
05	16.4	15.4		31.3	8.1	8.24	75.0
06	19.7	14.8		31.3	8.6	8.16	76.0
07	23.0	13.8		31.4	8.1	8.15	79.0
08	26.2	13.6		31.3	8.1	8.12	81.0
09	29.5	13.5		31.4	6.8	8.09	82.0
10	32.8	13.2		31.5	5.5	8.07	82.0
11	36.1	13.1		31.4	5.8	8.06	82.5
12	39.4	12.8		31.4	6.0	8.04	84.5
13	42.6	12.4		31.8	6.6	8.03	76.0
14	45.9	12.6		31.2	4.7	8.02	78.0
15	49.2	12.5		31.4	4.8	8.01	80.0
16	52.5	12.5		31.3	4.8	7.98	73.0

DATE: JULY 5, 1978 TIME: 0935

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.4		30.6	8.4	8.70	75.0
01	3.3	16.4		30.8	8.7	8.65	78.0
02	6.6	16.0		31.1	8.6	8.88	77.5
03	9.8	16.2		31.3	7.5	8.42	77.0
04	13.1	15.1		31.4	7.8	8.37	78.0
05	16.4	14.8		31.3	8.3	8.33	81.0
06	19.7	14.3		31.3	7.0	8.28	81.0
07	23.0	13.8		31.8	6.1	8.20	82.0
08	26.2	13.1		31.8	6.1	8.20	82.0
09	29.5	12.8		31.7	5.1	8.18	82.0
10	32.8	12.6		31.4	5.0	8.12	88.0
11	36.1	12.6		31.6	4.7	8.09	81.0
12	39.4	12.3		31.8	4.6	8.07	72.0
13	42.6	12.1		31.4	4.4	8.06	70.0
						8.03	

DATE: JULY 12, 1978 TIME: 1080

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.2		30.8	7.4	8.88	71.0
01	3.3	16.9		30.8	7.2	8.50	84.0
02	6.6	16.8		31.1	7.2	8.41	84.0
03	9.8	16.1		31.2	7.4	8.38	83.0
04	13.1	16.0		31.2	7.6	8.31	83.0
05	16.4	15.9		31.2	7.4	8.27	82.0
06	19.7	15.7		31.3	7.2	8.24	86.0
07	23.0	15.4		31.3	6.7	8.20	88.0
08	26.2	15.0		31.3	5.7	8.18	85.0
09	29.5	14.6		31.4	8.2	8.11	86.0
10	32.8	14.1		31.2	4.7	8.07	82.0
11	36.1	13.9		31.3	4.6	8.07	80.0
12	39.2	13.8		31.3	4.8	8.06	81.0
13	42.6	13.2		31.4	4.4	8.03	82.0
14	45.9	13.1		31.4	4.2	8.02	81.0
15	49.2	13.0		31.3	4.0	8.01	80.0
16	52.5	12.9		31.4	4.2	8.00	80.0
17	55.8	12.8		31.4	4.0	7.98	80.0
18	59.0	12.7		31.4	3.9	7.98	79.0
19	62.3	12.6		31.4	3.7	7.97	78.0
20	65.6	12.6		31.4	3.7	7.97	78.0
21	68.9	12.6		31.4	3.7	7.97	79.0
22	72.1	12.4		31.6	3.8	7.98	79.0

DATE: JULY 12, 1978 TIME: 1040

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O. PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.6	7.8	8.50	81.0
01	3.3	17.7		30.6	8.9	8.44	85.0
02	6.6	17.8		31.0	7.4	8.42	80.0
03	9.8	17.3		31.1	8.1	8.38	82.0
04	13.1	16.7		31.4	8.7	8.33	85.0
05	16.4	16.4		31.2	8.3	8.28	83.0
06	19.7	16.3		31.3	8.5	8.27	83.0
07	23.0	16.0		31.3	8.5	8.24	83.0
08	26.2	15.7		31.4	8.4	8.21	84.0
09	29.6	15.4		31.3	8.3	8.18	88.0
10	32.8	15.0		31.4	7.7	8.15	81.0
11	36.1	14.8		31.5	6.9	8.13	81.0
12	39.2	14.1		31.6	6.0	8.06	82.0
13	42.6	13.3		30.0	8.8	8.02	81.0
14	45.9	12.8		31.7	8.9	8.01	79.0
15	49.2	12.8		31.8	8.3	8.00	76.0
16	52.5	12.7		31.8	4.9	7.99	74.0
17	55.8	12.7		31.9	4.3	7.99	68.0
18	59.0	12.5		31.9	4.9	7.98	67.0
19	62.3	12.4		31.6	4.6	7.97	66.0
20	65.6	12.3		31.8	4.7	7.98	68.0
21	68.9	12.2		31.8	4.4	7.96	

DATE: JULY 19, 1978 TIME: 1055

STATION: C1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		31.0	6.6	8.40	81.0
01	3.3	18.6		31.1	6.1	8.32	81.0
02	6.6	18.6		31.1	6.1	8.27	81.0
03	9.8	18.3		31.2	6.3	8.24	79.0
04	13.1	18.0		31.2	6.2	8.22	79.0
05	16.4	17.9		31.2	6.0	8.16	79.0
06	19.7	17.8		31.4	5.7	8.15	78.0
07	23.0	17.6		31.3	6.2	8.15	77.0
08	26.2	17.6		31.3	5.9	8.13	76.0
09	29.6	16.8		31.6	5.3	8.09	73.0
10	32.8	16.6		31.4	4.6	8.07	68.0
11	36.1	16.4		31.4	4.6	8.06	66.0
12	39.2	16.0		31.5	4.7	8.06	

DATE: JULY 19, 1978 TIME: 1042

STATION: C2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		31.1	8.4	8.35	55.0
01	3.3	18.0		31.1	5.6	8.20	68.0
02	6.6	18.0		31.2	5.6	8.15	70.0
03	9.8	17.9		31.2	5.5	8.11	74.0
04	13.1	17.9		31.2	5.3	8.10	71.0
05	16.4	17.8		31.2	5.2	8.07	73.0
06	19.7	17.8		31.2	5.3	8.07	71.0
07	23.0	17.9		31.2	5.1	8.05	71.0
08	26.2	17.8		31.2	5.1	8.08	72.0
09	29.6	17.8		31.3	5.2	8.04	71.0
10	32.8	17.7		31.2	5.0	8.03	68.0
11	36.1	17.8		31.2	4.9	8.01	69.0
12	39.2	17.6		31.3	4.6	7.99	

DATE: JULY 19, 1978 TIME: 1029

STATION: C3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.9	5.1	8.11	60.0
01	3.3	18.8		31.0	5.2	8.01	65.0
02	6.6	18.5		31.1	5.5	7.97	73.0
03	9.8	18.3		31.2	5.6	7.95	76.0
04	13.1	18.2		31.3	5.3	7.93	79.0
05	16.4	18.3		31.2	5.0	7.92	75.0
06	19.7	17.9		31.2	4.8	7.91	74.0
07	23.0	17.9		31.2	4.6	7.90	75.0
08	26.2	17.6		31.2	5.5	7.91	77.0
09	29.5	17.6		31.2	5.1	7.91	76.0
10	32.8	17.4		31.2	4.6	7.90	76.0
11	36.1	17.1		31.3	4.2	7.90	64.0
12	39.2	16.9		31.4	3.8	7.89	60.0

DATE: JULY 19, 1978 TIME: 0936

STATION: C4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.7		30.9	5.6	8.36	62.0
01	3.3	19.3		31.0	5.1	8.20	71.0
02	6.6	19.0		31.2	4.2	8.09	76.0
03	9.8	18.6		31.2	4.5	8.06	77.0
04	13.1	18.6		31.2	4.4	8.06	77.0
05	16.4	18.4		31.3	4.5	8.02	76.0
06	19.7	18.2		31.3	4.4	8.01	76.0
07	23.0	17.9		31.4	4.3	7.99	76.0
08	26.2	17.8		31.3	4.1	7.98	78.0
09	29.6	17.7		31.3	4.1	7.97	78.0
10	32.8	17.4		31.4	3.9	7.95	78.0
11	36.1	17.0		31.6	3.7	7.86	78.0
12	39.2	16.7		31.8	3.1	7.82	77.0
13	42.6	16.4		31.8	2.9	7.80	76.0

DATE: JULY 19, 1978 TIME: 0947

STATION: C5

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		30.6	3.7	8.28	77.0
01	3.3	19.5		30.8	3.9	8.06	78.0
02	6.6	19.3		30.9	4.6	8.06	78.0
03	9.8	18.9		31.1	4.5	8.08	78.0
04	13.1	18.6		31.1	4.4	8.01	79.0
05	16.4	18.3		31.2	4.1	7.98	79.0
06	19.7	18.1		31.3	3.9	7.97	79.0
07	23.0	17.9		31.3	3.8	7.98	78.0

DATE: JULY 19, 1978 TIME: 1010

STATION: C6

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.8	4.2	8.26	58.0
01	3.3	19.8		31.0	4.0	8.07	70.0
02	6.6	19.1		31.1	4.8	8.02	78.0
03	9.8	16.9		31.2	4.4	8.00	81.0
04	13.1	16.6		31.4	3.6	8.05	81.0
05	16.4	16.4		31.2	3.9	7.99	80.0
06	19.7	16.2		31.2	4.0	7.87	80.0
07	23.0	16.1		31.3	4.0	7.86	81.0
08	26.2	17.6		31.3	4.8	7.85	81.0
09	29.6	17.3		31.4	3.3	7.82	80.0
10	32.8	17.3		31.4	3.7	7.81	79.0
11	36.1	16.9		31.6	3.0	7.80	79.0
12	39.2	16.6		31.4	3.3	7.89	66.0

DATE: JULY 19, 1978 TIME: 0920

STATION: C7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.0		30.9	4.6	8.21	51.0
01	3.3	19.0		31.0	4.5	8.16	73.0
02	6.6	19.0		31.0	4.5	8.10	79.0
03	9.8	19.0		31.0	4.8	8.08	81.0
04	13.1	18.9		31.1	4.5	8.02	81.0
05	16.4	18.8		31.1	4.5	8.04	80.0
06	19.7	18.7		31.2	4.4	7.97	81.0
07	23.0	18.8		31.3	4.8	7.98	80.0
08	26.2	18.4		31.3	4.4	7.95	78.0
09	29.6	18.2		31.4	3.7	7.81	77.0
10	32.8	17.9		31.3	3.4	7.90	78.0
11	36.1	17.9		31.3	3.6	7.88	78.0

DATE: JULY 19, 1978 TIME: 0802

STATION: C8

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.9	5.6	7.97	83.0
01	3.3	19.0		30.9	5.0	7.97	85.0
02	6.6	19.0		31.0	4.8	7.98	85.0
03	9.8	19.0		31.0	4.9	7.97	89.0
04	13.1	18.6		31.1	5.6	7.98	85.0
05	16.4	18.4		31.1	5.3	7.98	86.0
06	19.7	18.5		31.2	5.5	7.95	85.0
07	23.0	18.3		31.2	5.4	7.95	88.0
08	26.2	18.1		31.3	5.6	7.94	88.0
09	29.6	17.9		31.3	5.6	7.96	85.0
10	32.8	17.2		31.5	4.9	7.92	85.0
11	36.1	18.8		31.7	4.3	7.89	83.0
12	39.2	18.4		31.6	3.9	7.87	78.0

DATE: JULY 19, 1978 TIME: 0816

STATION: C9

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.2	4.7	8.17	71.0
01	3.3	19.2		30.3	4.9	8.11	78.0
02	6.6	19.0		30.7	4.9	8.08	79.0
03	9.8	18.8		31.0	5.1	8.04	81.0
04	13.1	18.6		31.2	5.1	8.04	81.0
05	16.4	18.3		31.2	4.3	8.03	82.0
06	19.7	18.2		31.3	4.9	8.02	83.0
07	23.0	18.0		31.3	4.9	8.01	83.0
08	26.2	17.9		31.3	4.7	7.98	82.0
09	29.6	17.3		31.5	4.1	7.96	81.0
10	32.8	16.9		31.6	3.9	7.94	78.0
11	36.1	16.5		31.6	4.0	7.93	76.0
12	39.2	16.5		31.0	2.6	7.90	73.0

DATE: JULY 19, 1978 TIME: 0859

STATION: C10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.6	8.3	8.23	76.0
01	3.3	19.3		30.3	4.8	8.09	78.0
02	6.6	19.0		30.7	6.0	8.08	82.0
03	9.8	18.9		30.9	4.3	8.06	83.0
04	13.1	18.9		31.0	4.9	8.05	84.0
05	16.4	18.0		31.1	5.0	8.08	85.0
06	19.7	17.9		31.4	3.3	8.02	85.0
07	23.0	17.8		31.3	4.0	8.01	84.0
08	26.2	17.7		31.3	4.8	8.00	85.0
09	29.6	17.3		31.5	3.5	7.97	80.0
10	32.8	16.7		31.5	3.7	7.96	80.0
11	36.1	16.2		31.6	3.8	7.94	71.0
12	39.2	15.7		31.8	3.4	7.82	70.0
13	42.6	15.8		31.8	3.3	7.81	
14	45.9	15.3		31.7	2.8	7.62	

DATE: JULY 19, 1978 TIME: 0837

STATION: C11

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.0		29.2	3.6	8.10	69.0
01	3.3	19.4		30.1	4.2	8.05	71.0
02	6.6	18.6		31.3	4.4	8.05	76.0
03	9.8	18.1		31.4	4.4	8.02	78.0
04	13.1	18.1		31.3	4.3	8.01	79.0
05	16.4	17.8		31.4	4.2	8.00	78.0

DATE: JULY 12, 1978 TIME: 1025

STATION: D1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.3	6.3	8.28	82.0
01	3.3	19.1		30.5	6.4	8.31	77.0
02	6.6	18.7		30.6	6.8	8.31	84.0
03	9.8	18.0		31.1	7.5	8.28	82.0
04	13.1	17.0		31.5	8.3	8.24	81.0
05	16.4	16.1		31.9	10.6	8.18	80.0
06	19.7	15.7		31.6	11.2	8.15	82.0
07	23.0	15.7		31.4	11.7	8.14	82.0
08	26.2	15.5		31.5	12.2	8.12	81.0
09	29.5	15.3		31.5	12.6	8.11	76.0
10	32.8	14.8		31.4	11.8	8.07	70.0
11	36.1	14.6		31.8	11.8	8.04	71.0
12	39.2	14.3		31.4	12.4	7.96	68.0
13	42.6	13.9		31.6	11.6	7.91	69.0
14	45.9	13.4		31.8	11.9	7.91	70.0
15	49.2	13.0		31.8	10.9	7.87	

DATE: JULY 12, 1978 TIME: 0955

STATION: D2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		27.7	6.4	8.15	83.0
01	3.3	19.0		29.0	7.0	8.22	86.0
02	6.6	18.8		30.3	7.6	8.23	72.8
03	9.8	18.0		30.9	6.6	8.21	76.0
04	13.1	17.7		31.1	9.3	8.19	79.0
05	16.4	17.3		31.2	10.0	8.18	84.0
06	19.7	16.7		31.5	10.4	8.07	87.0
07	23.0	16.0		31.8	11.7	7.97	86.0
08	26.2	15.7		31.6	11.0	7.84	81.0
09	29.6	14.8		31.7	8.4	7.73	80.0
10	32.8	14.8		31.8	7.0	7.61	

DATE: JULY 12, 1978 TIME: 1019

STATION: D3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.0		29.5	7.1	8.36	58.0
01	3.3	19.0		30.0	7.3	8.34	62.0
02	6.6	18.6		30.8	7.9	8.32	75.0
03	9.8	17.8		31.1	9.1	8.26	77.0
04	13.1	17.4		31.2	9.5	8.22	77.0
05	16.4	16.7		31.5	10.6	8.18	73.0
06	19.7	16.4		31.5	10.8	8.17	78.0
07	23.0	16.1		31.1	11.1	8.15	78.0
08	26.2	15.6		31.5	11.1	8.13	78.0
09	29.4	15.3		31.6	10.7	8.10	
10	32.8	15.0		31.4	10.5	8.08	
11	36.1	14.6		31.6	10.5	7.98	
12	39.2	14.5		31.5	9.9	7.92	
13	42.6	13.9		31.6	8.6	7.83	
14	45.9	13.7		31.5	7.9	7.77	
15	49.2	13.4		31.5	7.6	7.71	
16	52.5	13.3		31.3	8.0	7.68	

DATE: JULY 12, 1978 TIME: 0944

STATION: D10

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		29.4	7.1	8.40	65.0
01	3.3	19.2		29.4	7.0	8.26	77.0
02	6.6	18.6		30.5	7.2	8.26	79.0
03	9.8	18.0		30.9	6.9	8.19	79.0
04	13.1	17.7		31.1	7.1	8.16	80.0
05	16.4	17.3		31.1	6.7	8.10	79.0
06	19.7	16.8		31.6	6.5	8.08	76.0
07	23.0	16.3		31.8	6.5	8.02	75.0
08	26.2	15.6		31.6	3.7	7.88	

DATE: AUGUST 2, 1978 TIME: 0818

STATION: A6

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.5	7.5	8.22	97.8
01	3.3	17.9		31.0	7.2	8.23	96.8
02	6.6	18.8		31.1	7.2	8.23	99.0
03	9.8	18.2		31.2	6.8	8.23	98.0
04	13.1	18.6		31.2	6.0	8.22	99.6
05	16.4	18.4		31.3	7.1	8.21	99.99
06	19.7	18.2		31.2	7.1	8.22	99.99
07	23.0	18.2		31.2	7.1	8.21	99.99
08	26.2	16.1		31.2	7.1	8.22	99.99
09	29.5	15.1		31.2	7.3	8.21	99.99
10	32.8	14.6		31.3	7.1	8.20	99.99
11	36.1	14.3		31.3	7.3	8.20	99.99
12	39.2	14.1		31.3	7.3	8.20	99.99
13	42.6	13.6		31.4	7.3	8.18	98.5
14	45.9	12.6		31.7	7.8	8.15	99.0
15	49.2	12.2		31.8	6.8	8.14	99.6
16	52.5	12.1		31.6	6.5	8.13	98.99
17	55.8	12.1		31.6	6.3	8.12	99.99
18	59.0	11.9		31.6	6.3	8.11	99.99
19	62.3	11.9		31.4	6.2	8.11	99.5
20	65.6	11.8		31.3	6.2	8.10	99.0
21	68.9	11.8		31.3	6.6	8.10	88.5
22	72.2	11.8		31.3	6.3	8.09	99.0

DATE: AUGUST 2, 1978 TIME: 0800

STATION: A1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		31.8	7.7	8.33	82.0
01	3.3	17.3		31.1	6.9	8.31	98.99
02	6.6	16.8		31.2	6.9	8.28	99.0
03	9.8	16.6		31.2	6.5	8.27	98.0
04	13.1	16.4		31.1	6.4	8.26	97.0
05	16.4	16.3		31.2	6.4	8.25	97.0
06	19.7	15.7		31.6	6.2	8.24	98.0
07	23.0	15.8		31.3	6.0	8.22	99.99
08	26.2	15.0		31.4	6.5	8.22	99.99
09	29.6	14.7		31.3	6.8	8.22	99.99
10	32.8	14.1		31.2	6.8	8.21	99.98
11	36.1	13.8		31.4	7.1	8.20	99.99
12	39.2	13.6		31.4	6.6	8.19	99.99
13	42.6	13.4		31.2	6.7	8.18	99.99
14	45.9	13.4		31.3	6.7	8.18	99.99
15	49.2	13.3		31.3	6.5	8.16	99.99
16	52.5	13.3		31.3	6.4	8.17	98.99
17	55.8	13.3		31.2	6.4	8.16	99.99
18	59.0	13.2		31.3	6.3	8.16	99.99
19	62.3	13.2		31.2	6.2	8.18	99.99
20	65.6	13.1		31.2	6.1	8.14	99.99

DATE: AUGUST 2, 1978 TIME: 0903

STATION: A2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.2	7.3	8.44	88.0
01	3.3	18.9		30.6	7.4	8.42	88.0
02	6.6	18.6		30.8	7.7	8.39	87.0
03	9.8	18.4		30.9	8.4	8.36	84.0
04	13.1	17.7		31.1	8.8	8.33	86.0
05	16.4	17.0		31.2	9.0	8.31	87.0
06	19.7	16.2		31.6	9.2	8.28	89.0
07	23.0	15.9		31.2	9.8	8.23	88.0
08	26.2	15.8		31.3	9.7	8.21	89.0
09	29.6	15.4		31.4	9.0	8.18	88.0
10	32.6	15.0		31.4	8.8	8.17	90.0
11	36.1	14.8		31.1	7.0	8.15	91.0
12	39.2	14.9		31.4	8.9	8.13	90.0
13	42.6	14.8		31.4	8.2	8.13	61.0
14	45.9	14.6		31.5	8.0	7.88	

DATE: AUGUST 2, 1978 TIME: 0853

STATION: A3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.0		30.0	7.0	8.44	89.0
01	3.3	19.1		30.5	7.1	8.43	87.0
02	6.6	19.1		30.7	7.6	8.42	88.5
03	9.8	17.9		30.3	7.1	8.37	93.0
04	13.1	17.0		31.2	6.9	8.33	93.0
05	16.4	16.2		31.5	6.5	8.29	93.0
06	19.7	15.8		31.5	6.1	8.28	73.0
07	23.0	18.8		31.8	8.7	8.22	71.0
08	26.2						44.0

DATE: AUGUST 2, 1978 TIME: 0858

STATION: A4

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.8	7.9	8.52	90.0
01	3.3	19.0		30.6	7.8	8.48	88.0
02	6.6	19.0		30.7	7.4	8.49	87.0
03	9.8	18.9		30.8	7.8	8.46	88.0
04	13.1	18.1		31.4	6.8	8.38	81.0
05	16.4	17.4		31.4	8.4	8.34	76.0
06	19.7	16.6		31.8	8.6	8.27	68.0

DATE: AUGUST 2, 1978 TIME: 0842

STATION: A7

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		29.7	7.2	8.68	78.0
01	3.3	19.2		29.8	7.4	8.88	81.0
02	6.6	19.1		30.8	7.7	8.61	86.0
03	9.8	18.5		30.9	7.0	8.42	87.0
04	13.1	18.2		31.3	6.3	8.37	71.0

DATE: AUGUST 2, 1978 TIME: 0735

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.0	8.4	8.06	78.0
01	3.3	18.6		31.2	8.3	8.20	78.0
02	6.6	17.4		31.2	6.3	8.19	78.0
03	9.8	17.4		31.1	6.5	8.19	79.0
04	13.1	17.1		31.1	6.4	8.18	80.0
05	16.4	16.6		31.4	6.5	8.15	78.0
06	19.7	16.5		31.3	6.6	8.16	77.0
07	23.0	16.4		31.3	6.4	8.11	77.0
08	26.2	16.2		31.3	6.4	8.10	77.0
09	29.4						77.0

DATE: AUGUST 2, 1978 TIME: 0743

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		30.8	7.6	8.51	88.0
01	3.3	17.7		30.8	7.8	8.41	91.0
02	6.6	17.7		30.9	8.4	8.39	91.0
03	9.8	17.8		30.9	8.2	8.30	91.0
04	13.1	17.6		31.0	6.3	8.28	91.0
05	16.4	17.3		31.0	6.3	8.28	90.0
06	19.7	17.1		31.1	6.6	8.24	88.0
07	23.0	16.7		31.2	6.2	8.22	87.0
08	26.2	16.1		31.2	5.9	8.20	85.0
09	29.6	15.9		31.3	5.7	8.18	83.0
10	32.8	16.3		31.4	5.6	8.18	83.0
11	36.1	15.1		31.4	5.3	8.16	76.0
12	39.2	14.9		31.4	5.0	8.12	76.0
13	42.6	14.8		31.4	5.0	8.10	80.0
14	45.9	14.2		31.4	4.7	8.09	81.0
15	49.2	14.1		31.5	4.5	8.07	82.0
16	52.6	13.9		31.8	4.1	8.04	85.0

DATE: AUGUST 16, 1978 TIME: 1145

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.3	5.6	8.58	79.0
01	3.3	17.3		30.7	5.3	8.47	78.0
02	6.6	17.2		30.8	5.4	8.38	77.0
03	9.8	16.6		31.1	5.5	8.33	77.0
04	13.1	16.2		31.1	5.3	8.30	76.0
05	16.4	15.5		31.4	5.2	8.27	76.0
06	19.7	15.1		31.4	5.2	8.23	75.0
07	23.0	14.8		31.4	5.1	8.21	75.0
08	26.2	14.7		31.4	5.0	8.20	77.0
09	29.6	14.6		31.3	4.8	8.19	77.0
10	31.8	13.9		31.5	5.1	8.17	77.0
11	36.1	13.5		31.4	5.4	8.17	76.0
12	39.2	13.3		31.6	5.4	8.17	74.0

DATE: AUGUST 2, 1978 TIME: 1128

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		30.8	8.7	8.60	79.0
01	3.3	18.9		30.8	7.9	8.59	81.0
02	6.6	18.9		30.8	7.3	8.52	81.0
03	9.8	18.6		30.8	7.0	8.48	83.0
04	13.1	18.7		31.0	7.0	8.45	85.0
05	16.4	18.3		31.1	6.9	8.42	87.0
06	19.7	17.7		31.2	6.7	8.38	84.0

DATE: AUGUST 2, 1978 TIME: 1035

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.0		30.8	8.4	8.72	91.0
01	3.3	18.7		30.7	7.8	8.60	92.0
02	6.6	18.4		31.0	7.9	8.53	94.0
03	9.8	18.0		31.1	7.9	8.49	92.0
04	13.1	17.7		31.1	7.7	8.46	92.0
05	16.4	17.1		31.5	7.6	8.42	92.0
06	19.7	16.7		31.6	7.1	8.37	93.0
07	23.0	15.9		31.6	6.6	8.31	93.0
08	26.2	15.7		31.8	6.9	8.27	93.0
09	29.6	15.5		31.6	5.8	8.26	88.0
10	32.8	14.9		31.6	5.4	8.22	88.0
11	36.1	14.8		31.5	5.3	8.19	79.0
12	39.2	14.5		31.6	5.0	8.17	71.0

DATE: AUGUST 2, 1978 TIME: 0850

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.6		30.7	6.8	8.39	92.0
01	3.3	17.5		31.0	6.3	8.36	93.0
02	6.6	17.3		30.9	6.4	8.33	92.0
03	9.8	16.9		31.1	6.1	8.30	93.0
04	13.1	16.7		31.1	6.4	8.29	93.0
05	16.4	16.6		31.2	6.2	8.26	93.0
06	19.7	16.7		31.3	6.0	8.26	93.0
07	23.0	15.6		31.4	6.0	8.25	94.0
08	26.2	15.2		31.4	5.8	8.22	96.0
09	29.6	14.6		31.5	5.8	8.21	96.0
10	32.8	14.7		31.4	5.8	8.21	96.0
11	36.1	14.6		31.3	5.8	8.19	94.0
12	39.2	14.6		31.4	5.6	8.18	91.0
13	42.6	14.5		31.4	5.5	8.18	89.0
14	45.9	14.1		31.4	5.2	8.13	81.0
15	49.2	14.0		31.4	5.0	8.11	

DATE: AUGUST 2, 1978 TIME: 1053

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.6	7.8	8.61	97.0
01	3.3	18.9		30.6	7.3	8.53	97.0
02	6.6	18.5		30.9	7.4	8.48	97.0
03	9.8	18.0		31.1	7.4	8.45	96.0
04	13.1	17.7		31.2	7.6	8.43	93.5
05	16.4	17.4		31.2	7.4	8.38	93.5
06	19.7	17.0		31.4	7.3	8.38	92.0
07	23.0	16.3		31.5	7.0	8.32	91.0
08	26.2	15.9		31.8	6.4	8.27	90.0
09	29.6	15.7		31.4	6.0	8.26	93.0
10	32.8	15.3		31.5	5.9	8.24	94.0
11	36.1	14.7		31.6	5.9	8.21	88.0
12	39.2	14.4		31.7	5.6	8.18	

DATE: AUGUST 2, 1978 TIME: 1120

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.6	7.9	8.79	88.0
01	3.3	19.2		30.6	7.9	8.67	90.0
02	6.6	18.9		30.9	7.9	8.58	91.0
03	9.8	17.8		31.4	7.7	8.50	92.0
04	13.1	17.2		31.4	7.1	8.45	90.0
05	16.4	16.9		31.4	7.1	8.40	90.0
06	19.7	16.7		31.5	6.8	8.38	90.0
07	23.0	16.3		31.4	6.7	8.26	89.0
08	26.2	16.1		31.4	5.8	8.17	81.0

DATE: AUGUST 2, 1978 TIME: 1110

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.6	7.9	8.83	66.0
01	3.3	19.1		30.6	7.7	8.69	66.0
02	6.6	18.8		30.6	7.7	8.46	69.0
03	9.8	18.7		30.9	7.6	8.44	90.0
04	13.1	18.0		31.3	7.6	8.41	90.9
05	16.4	17.0		31.6	6.2	8.32	92.0
06	19.7	16.1		31.5	6.3	8.22	92.0
07	23.0	16.0		31.5	5.0	8.20	92.0
08	26.2	15.9		31.4	4.0	8.16	55.0

DATE: AUGUST 2, 1978 TIME: 1105

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		30.8	7.5	8.78	81.0
01	3.3	18.2		30.8	7.7	8.62	88.0
02	6.6	15.2		30.8	7.6	8.64	90.0
03	9.8	18.0		31.0	7.3	8.50	90.0
04	13.1	17.9		31.1	7.3	8.46	90.0
05	16.4	16.8		31.2	7.3	8.43	90.0
06	19.7	16.1		31.6	6.6	8.35	89.0
07	23.0	15.4		31.6	6.3	8.31	82.0
08	26.2	14.8		31.6	6.0	8.27	75.0
09	29.6	14.5		31.5	5.6	8.24	71.0
10	32.8	14.4		31.4	5.6	8.20	

DATE: AUGUST 9, 1978 TIME: 0855

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.9	7.8	8.18	90.0
01	3.3	17.8		30.9	7.8	8.18	98.0
02	6.6	17.8		30.9	7.6	8.18	98.0
03	9.8	17.9		30.9	7.8	8.18	97.0
04	13.1	17.8		30.9	7.6	8.19	98.0
05	16.4	17.8		30.9	7.6	8.18	97.0
06	19.7	17.7		31.0	7.6	8.19	97.0
07	23.0	17.6		31.0	7.6	8.19	97.0
08	26.2	17.3		31.0	7.6	8.16	97.0
09	29.6	17.1		31.0	6.9	8.18	97.0
10	32.8	16.6		31.0	6.6	8.18	96.0
11	36.1	16.3		31.1	6.6	8.18	96.0
12	39.2	16.1		31.1	6.1	8.19	97.0
13	42.6	15.8		31.1	6.7	8.19	98.0
14	45.9	15.6		31.1	7.6	8.16	98.0
15	49.2	15.0		31.3	7.0	8.09	91.0
16	52.5	14.3		31.2	6.6	8.05	87.0
17	55.8	14.0		31.2	5.9	8.03	88.0
18	59.0	13.7		31.3	6.7	8.01	82.0
19	62.3	15.0		31.3	5.5	7.99	80.0
20	65.6	14.7		31.2	5.4	7.98	77.0
21	68.9	14.0		31.2	4.8	7.97	80.0

DATE: AUGUST 9, 1978 TIME: 1023

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		31.1	7.8	8.17	80.0
01	3.3	17.7		31.2	6.4	8.18	82.0
02	6.6	17.6		31.3	6.8	8.17	88.0
03	9.8	17.1		31.4	6.8	8.18	84.0
04	13.1	16.9		31.4	6.2	8.14	86.0
05	16.4	16.4		31.6	8.0	8.11	86.0
06	19.7	16.3		31.6	5.2	8.11	82.0
07	23.0	16.4		31.4	6.7	8.10	86.0
08	26.2	15.9		31.5	5.3	8.08	85.0
09	29.6	16.8		31.6	5.4	8.08	86.0
10	32.8	14.8		31.5	5.3	8.07	86.0
11	36.1	15.1		31.6	4.9	8.06	84.0
12	39.2	14.7		31.6	4.8	8.04	81.0
13	42.6	14.5		31.6	4.8	8.04	81.5
14	45.9	14.4		31.6	4.1	8.06	76.5
15	49.2	14.2		31.8	4.4	8.02	68.0
16	52.5	14.0		31.5	4.2	8.01	66.0
17	55.8	14.9		31.4	3.1	7.99	

DATE: AUGUST 9, 1978 TIME: 1035

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.5	7.3	8.27	81.0
01	3.3	19.2		30.8	7.2	8.26	84.0
02	6.6	19.1		30.9	7.1	8.26	86.0
03	9.8	18.6		31.2	7.1	8.24	87.0
04	13.1	18.2		31.3	7.2	8.22	87.0
05	16.4	18.0		31.5	6.9	8.20	87.0
06	19.7	17.0		31.6	6.3	8.14	89.0
07	23.0	16.3		31.6	6.4	8.10	89.0
08	26.2	16.0		31.6	6.3	8.13	89.0
09	29.5	15.7		31.6	6.4	8.11	90.0
10	32.8	15.3		31.4	5.3	8.09	90.0
11	36.1	15.0		31.5	5.8	8.10	88.0
12	39.4	14.5		31.5	6.3	8.07	87.0
13	42.6	14.4		31.4	5.3	8.04	85.0
14	45.9	14.2		31.4	6.1	8.03	84.0
15	49.2	14.0		31.4	5.2	8.03	84.0
16	52.5	13.8		31.4	6.0	8.02	81.0
17	55.8	13.4		31.5	5.0	8.02	76.0
18	59.0	13.4		31.4	4.8	8.02	66.0
19	62.3	13.4		31.3	4.6	8.02	61.0
20	65.6	13.4		31.3	4.6	8.02	

DATE: AUGUST 9, 1978 TIME: 1045

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		30.8	7.0	8.14	82.0
01	3.3	18.6		30.9	7.0	8.14	81.0
02	6.6	18.5		31.1	7.3	8.13	87.0
03	9.8	18.2		31.2	7.2	8.12	87.0
04	13.1	17.7		31.4	6.7	8.11	86.0
05	16.4	17.8		31.5	5.8	8.10	86.0
06	19.7	17.5		31.4	6.2	8.06	87.0
07	23.0	17.6		31.7	6.2	8.08	88.0
08	26.2	16.8		31.5	5.4	8.04	89.0
09	29.5	15.6		31.7	5.0	8.03	89.0
10	32.8	15.2		31.6	5.2	8.02	88.0
11	36.1	15.2		31.6	5.0	8.02	89.0
12	39.4	15.0		31.5	4.7	8.02	89.0
13	42.6	14.7		31.6	4.6	8.00	88.0
14	45.9	14.8		31.5	4.7	8.10	88.0
15	49.2	14.6		31.4	4.8	8.40	87.0
16	52.5	14.3		31.4	4.8	8.01	86.0
17	55.8	14.2		31.3	4.8	8.01	82.0
18	59.0	14.2		31.4	4.7	8.02	81.0
19	62.3	13.8		31.6	4.6	8.02	76.0
20	65.6	13.7		31.4	4.5	8.02	

DATE: AUGUST 9, 1978 TIME: 1055

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		31.0	6.7	8.20	86.0
01	3.3	18.8		31.2	6.7	8.18	86.0
02	6.6	18.5		31.1	6.7	8.16	87.0
03	9.8	18.5		31.2	6.1	8.13	87.0
04	13.1	18.5		31.2	5.8	8.11	86.0
05	16.4	18.4		31.2	6.0	8.10	86.0
06	19.7	17.9		31.4	5.8	8.08	86.0
07	23.0	17.8		31.6	5.7	8.08	86.0
08	26.2	17.4		31.6	5.8	8.05	86.0
09	29.5	17.0		31.4	5.4	8.07	85.0
10	32.8	16.7		31.6	5.2	8.06	84.0
11	36.1	16.6		32.1	5.0	8.05	82.0
12	39.4	15.4		31.4	4.8	8.04	81.0
13	42.6	15.2		31.5	4.7	8.04	81.0
14	45.9	15.0		31.5	4.7	8.03	81.0
15	49.2	14.8		31.5	4.6	8.03	80.0
16	52.5	14.7		31.5	4.5	8.03	79.0
17	55.8	14.6		31.5	4.7	8.03	77.0
18	59.0	14.3		31.4	4.5	8.03	76.0
19	62.3	14.3		31.4	4.6	8.02	76.0
20	65.6	14.3		31.4	4.7	8.02	75.0

DATE: AUGUST 9, 1978 TIME: 1100

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		30.1	6.3	8.40	84.0
01	3.3	20.1		31.0	6.0	8.26	84.0
02	6.6	19.2		31.4	6.0	8.20	83.0
03	9.8	18.6		31.4	5.8	8.16	83.0
04	13.1	18.4		31.4	5.7	8.14	80.0
05	16.4	17.8		31.5	5.3	8.12	78.0
06	19.7	17.4		31.4	4.9	8.08	79.0
07	23.0	17.2		31.6	4.7	8.08	79.0
08	26.2	16.6		31.7	4.6	8.08	78.0
09	29.5	16.0		31.8	4.6	8.08	74.0
10	32.8	15.8		31.6	4.2	8.08	74.0
11	36.1	15.4		31.7	4.1	8.04	72.0
12	39.4	15.2		31.7	4.2	8.02	
13	42.6	14.9		31.7	4.3	8.02	

DATE: AUGUST 9, 1978 TIME: 1125

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		31.0	6.1	8.38	46.0
01	3.3	19.5		31.1	6.2	8.31	48.0
02	6.6	19.0		31.4	6.8	8.28	48.0
03	9.8	18.8		31.3	6.2	8.23	47.0
04	13.1	18.8		31.3	5.8	8.18	47.0
05	16.4	18.2		31.6	5.7	8.17	47.0
06	19.7	17.8		31.5	5.8	8.15	47.0
07	23.0	17.4		31.6	5.4	8.12	48.0
08	26.2	17.1		31.6	5.2	8.12	46.0
09	29.5	16.2		31.6	5.3	8.10	46.0
10	32.8	16.6		32.0	5.0	8.10	84.0
11	36.1	15.2		31.6	5.1	8.08	84.0
12	39.4	14.9		31.6	5.0	8.07	79.0
13	42.6	14.7		31.6	5.1	8.07	78.0
14	45.9	14.6		31.4	5.1	8.07	78.0
15	49.2	14.6		31.4	4.9	8.06	78.0
16	52.5	14.6		31.4	4.9	8.06	73.0
17	55.8	14.5		31.4	4.9	8.06	68.0
18	59.0	14.4		31.4	4.7	8.06	66.0
19	62.3	14.4		31.1	4.7	8.06	60.0

DATE: AUGUST 2, 1978 TIME: 1025

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.8	7.2	8.56	89.0
01	3.3	18.9		30.8	7.4	8.52	90.0
02	6.6	18.6		30.9	7.6	8.50	90.0
03	9.8	18.6		31.0	8.4	8.47	90.0
04	13.1	18.5		31.1	9.3	8.44	90.0
05	16.4	17.6		31.5	10.4	8.39	90.0
06	19.7	17.1		31.4	11.0	8.36	89.0
07	23.0	16.6		31.6	11.9	8.33	89.0
08	26.2	16.0		31.6	12.7	8.30	91.0
09	29.5	15.4		31.6	13.6	8.25	92.0
10	32.8	15.2		31.5	14.2	8.42	92.0
11	36.1	14.8		31.6	15.2	8.10	92.0
12	39.4	14.7		31.5	15.4	8.18	88.0
13	42.6	14.6		31.5	18.6	8.13	81.0
14	45.9	14.6		31.4	8.8	8.11	73.0
15	49.2	14.4		31.5	8.9	8.07	65.0
16	52.5						58.0

DATE: AUGUST 2, 1978 TIME: 1010

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		30.3	7.6	8.45	88.0
01	3.3	18.7		30.7	7.4	8.38	90.0
02	6.6	18.3		30.9	8.1	8.42	91.0
03	9.8	18.0		31.0	8.0	8.44	92.0
04	13.1	17.6		31.2	7.8	8.42	92.0
05	16.4	17.3		31.3	7.8	8.38	91.0
06	19.7	17.0		31.3	7.3	8.38	90.0
07	23.0	16.6		31.5	6.7	8.32	89.0
08	26.2	16.1		31.6	6.6	8.29	89.0
09	29.5	15.8		31.5	6.3	8.23	91.0
10	32.8	15.0		31.8	5.7	8.20	91.8
11	36.1	14.7		31.4	5.4	8.16	90.0
12	39.4	14.5		31.6	5.0	8.15	86.0
13	42.6	14.4		31.8	4.4	8.02	85.0

DATE: AUGUST 9, 1978 TIME: 1009

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.3		30.2	6.7	8.32	79.0
01	3.3	18.0		30.7	6.8	8.30	83.0
02	6.6	18.3		31.2	7.4	8.28	88.0
03	9.8	17.4		31.3	6.9	8.20	89.0
04	13.1	17.3		31.5	7.0	8.23	90.0
05	16.4	16.9		31.4	6.7	8.22	93.0
06	19.7	16.8		31.6	7.3	8.20	91.0
07	23.0	16.6		31.3	7.2	8.18	91.0
08	26.2	16.2		31.3	6.7	8.16	89.0
09	29.5	15.3		31.6	6.3	8.13	89.0
10	32.8	14.8		31.4	5.7	8.09	89.0
11	36.1	14.6		31.6	5.7	8.08	88.0
12	39.4	14.5		31.4	5.5	8.07	87.0
13	42.6	14.3		31.4	5.3	8.06	86.0
14	45.9	14.1		31.4	5.4	8.06	87.0
15	49.2	14.0		31.4	5.4	8.06	86.0
16	52.5	13.9		31.6	5.4	8.06	85.0
17	55.8	13.7		31.4	5.3	8.05	82.0
18	59.0	13.6		31.4	5.2	8.06	82.0
19	62.3	13.5		31.4	4.8	8.06	81.0
20	65.6	13.4		31.4	4.7	8.04	78.0
21	68.9	13.3		31.5	4.9	8.03	78.0
22	72.1	13.3		31.3	4.9	8.22	77.0

DATE: AUGUST 9, 1978 TIME: 1040

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.3		30.3	7.8	8.56	80.0
01	3.3	20.2		30.6	7.1	8.42	84.0
02	6.6	18.0		31.7	7.4	8.32	86.0
03	9.8	17.8		31.3	7.2	8.30	89.0
04	13.1	17.8		31.6	6.9	8.25	91.0
05	16.4	17.1		31.6	6.7	8.23	92.0
06	19.7	16.8		31.4	6.7	8.22	92.0
07	23.0	16.2		31.4	6.8	8.20	92.0
08	26.2	16.4		31.4	6.7	8.18	91.0
09	29.5	15.6		31.4	6.0	8.14	90.0
10	32.8	15.1		31.4	6.1	8.11	90.0
11	36.1	14.8		31.5	5.8	8.09	90.0
12	39.4	14.1		31.6	6.1	8.06	88.0
13	42.6	14.0		31.3	6.2	8.06	86.0
14	45.9	13.9		31.3	6.1	8.06	82.0
15	49.2	13.8		31.4	4.7	8.06	82.0
16	52.5	13.7		31.3	5.0	8.05	84.0
17	55.8	13.7		31.3	4.9	8.05	81.0
18	59.0	13.6		31.3	5.0	8.05	76.0
19	62.3	13.6		31.3	4.8	8.05	75.0
20	65.6	13.4		31.6	4.8	8.04	73.0
21	68.9	13.3		31.3	4.8	8.03	
22	72.1	13.2		31.4	4.8	8.03	

DATE: AUGUST 16, 1978 TIME: 1132

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.9	8.2	8.49	77.0
01	3.3	17.8		31.0	4.9	8.37	74.0
02	6.6	17.6		31.0	4.9	8.30	71.0
03	9.8	17.1		31.1	4.6	8.25	69.0
04	13.1	16.8		31.2	4.7	8.21	67.0
05	16.4	16.7		31.2	4.8	8.18	67.0
06	19.7	16.6		31.0	4.6	8.17	67.0
07	23.0	16.0		31.0	4.7	8.15	67.0
08	26.2	15.7		31.0	4.4	8.14	68.0
09	29.5	15.3		31.4	4.9	8.13	67.0
10	32.8	15.1		31.2	5.0	8.13	66.0
11	36.1	14.4		31.6	6.2	8.13	64.0
12	39.2	14.0		31.4	5.2	8.12	

DATE: AUGUST 16, 1978 TIME: 1115

STATION: C2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.8	5.4	8.40	70.0
01	3.3	18.6		30.8	5.0	8.45	72.0
02	6.6	18.4		31.0	5.3	8.36	71.0
03	9.8	18.2		31.0	4.9	8.29	71.0
04	13.1	17.9		31.1	4.8	8.24	70.0
05	16.4	17.8		31.2	5.0	8.20	70.0
06	19.7	17.3		31.2	4.6	8.17	68.0
07	23.0	17.1		31.2	4.8	8.18	68.0
08	26.2	16.9		31.3	4.4	8.14	68.0
09	29.5	16.6		31.3	4.5	8.13	64.0
10	32.8	16.0		31.4	4.4	8.18	56.0
11	36.1	15.8		31.4	4.5	8.11	

DATE: AUGUST 16, 1978 TIME: 1055

STATION: C3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.4	5.0	8.53	75.0
01	3.3	19.2		30.7	4.9	8.33	74.0
02	6.6	19.0		30.6	4.8	8.26	75.0
03	9.8	18.6		31.0	4.8	8.20	72.0
04	13.1	18.0		31.1	4.5	8.18	71.0
05	16.4	17.2		31.4	4.2	8.13	61.0
06	19.7	16.7		31.5	4.2	8.11	58.0
07	23.0	16.6		31.3	4.2	8.09	60.0
08	26.2	16.5		31.2	4.3	8.07	59.0
09	29.6	16.4		31.3	4.3	8.08	58.0
10	32.8	16.3		31.2	4.1	8.06	58.0
11	36.1	16.2		31.3	4.0	8.06	58.0
12	39.2	16.1		31.4	4.7	8.07	49.0
13	42.6	15.8		31.3	4.6	8.07	39.0

DATE: AUGUST 16, 1978 TIME: 0955

STATION: C4

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	24.6		30.3	4.8	8.78	88.0
01	3.3	20.3		30.8	4.6	8.32	84.0
02	6.6	20.0		30.9	3.6	8.10	83.0
03	9.8	19.7		31.0	5.5	8.09	81.0
04	13.1	16.6		31.5	5.5	8.06	79.0
05	16.4	16.0		31.5	5.7	8.05	72.0
06	19.7	17.8		31.4	5.4	8.04	69.0
07	23.0	17.7		31.3	5.3	8.03	72.0
08	26.2	17.2		31.3	5.3	8.02	71.0
09	29.6	16.8		31.4	5.8	8.02	68.0
10	32.8	16.5		31.4	5.4	8.02	69.0
11	36.1	16.4		31.3	4.5	8.02	68.0
12	39.2	16.4		31.6	4.3	8.06	57.0
13	42.6	16.1		31.3	4.8	8.01	

DATE: AUGUST 16, 1978 TIME: 1012

STATION: C5

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.3		30.5	4.5	8.39	78.0
01	3.3	20.2		30.7	4.7	8.24	69.0
02	6.6	19.3		31.0	6.8	8.14	69.0
03	9.8	18.0		31.1	7.1	8.10	77.0
04	13.1	16.8		31.1	5.1	8.07	77.0
05	16.4	16.6		31.2	5.8	8.03	78.0
06	19.7	16.3		31.8	5.8	8.01	78.0
07	23.0	16.1		31.3	5.8	7.97	

DATE: AUGUST 16, 1978 TIME: 1035

STATION: C6

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		30.5	4.3	8.48	88.0
01	3.3	20.4		30.8	3.8	8.32	88.0
02	6.6	19.8		31.2	3.4	8.28	84.0
03	9.8	18.7		31.2	3.2	8.13	78.0
04	13.1	18.4		31.3	3.6	8.08	73.0
05	16.4	18.2		31.3	3.7	8.06	66.0
06	19.7	18.0		31.4	3.6	8.04	68.0
07	23.0	17.8		31.3	3.9	8.03	73.0
08	26.2	17.4		31.4	3.9	8.03	71.8
09	29.6	17.3		31.4	3.4	8.02	71.0
10	32.8	16.9		31.3	3.4	8.01	56.8
11	36.1	16.3		31.3	3.5	8.00	44.0
12	39.2	16.4		31.3	3.3	8.08	34.8

DATE: AUGUST 10, 1978 TIME: 0938

STATION: C7

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.8	7.3	8.88	23.0
01	3.3	18.6		30.9	7.6	8.14	26.0
02	6.6	18.8		30.9	6.8	8.09	14.0
03	9.8	18.8		31.0	6.6	8.04	09.0
04	13.1	18.1		31.1	7.0	8.09	09.0
05	16.4	17.9		31.2	7.2	7.96	01.0
06	19.7	17.6		31.4	7.3	7.98	03.0
07	23.0	17.5		31.2	2.8	7.98	30.0
08	26.2	17.3		31.2	3.2	7.92	09.0
09	29.6	17.2		31.2	2.9	7.91	33.0
10	32.8	17.1		31.2	3.2	7.90	08.0
11	36.1	17.1		31.2	2.9	7.90	08.0
12	39.2	17.0		31.2	2.7	7.89	

DATE: AUGUST 16, 1978 TIME: 0810

STATION: C8

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		30.7	4.6	8.10	80.0
01	3.3	19.2		30.8	3.9	8.09	80.0
02	6.6	19.1		30.9	8.1	8.07	84.0
03	9.8	19.0		31.0	4.2	8.08	86.0
04	13.1	18.6		31.1	4.8	8.04	86.0
05	16.4	18.8		31.3	4.3	8.02	86.0
06	19.7	17.8		31.3	4.8	8.00	88.0
07	23.0	17.1		31.7	3.5	8.00	88.0
08	26.2	16.6		31.8	3.6	7.97	66.0
09	29.6	16.3		31.6	4.1	7.97	64.0
10	32.8	16.2		31.5	2.9	7.95	68.0
11	36.1	16.1		31.4	3.6	7.98	64.0
12	39.2	15.7		31.6	4.9	7.93	62.0
13	42.6	15.4		31.8	3.0	7.98	

DATE: AUGUST 16, 1978 TIME: 0826

STATION: C9

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		29.9	4.6	8.28	80.0
01	3.3	19.2		29.9	3.8	8.09	86.0
02	6.6	19.2		30.6	3.2	8.04	88.0
03	9.8	18.6		30.8	4.3	8.03	84.0
04	13.1	18.3		31.1	3.2	8.01	81.0
05	16.4	18.0		31.3	4.8	8.01	68.0
06	19.7	17.8		31.2	3.9	8.01	63.0
07	23.0	17.7		31.8	3.6	8.01	84.0
08	26.2	17.3		31.4	5.4	8.00	81.0
09	29.6	16.2		32.0	6.0	7.98	73.0
10	32.8	15.4		31.8	4.2	7.97	72.0
11	36.1	15.3		31.6	3.6	7.97	72.0
12	39.2	15.2		31.6	3.9	7.97	75.0
13	42.6	15.3		31.5	3.7	7.96	

DATE: AUGUST 16, 1978 TIME: 0910

STATION: C10

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		30.1	9.6	8.74	76.0
01	3.3	19.6		30.3	7.4	8.30	76.0
02	6.6	19.2		30.8	8.1	8.23	79.0
03	9.8	18.9		30.9	7.8	8.16	89.0
04	13.1	18.6		31.1	7.7	8.14	88.0
05	16.4	18.5		31.2	6.4	8.10	88.0
06	19.7	17.7		31.4	6.6	8.11	86.0
07	23.0	17.4		31.4	6.5	8.08	86.3
08	26.2	17.8		31.6	3.7	8.07	82.3
09	29.6	16.4		31.6	3.7	8.06	80.0
10	32.8	15.9		31.6	3.6	8.04	79.3
11	36.1	15.8		31.6	3.9	8.03	73.3
12	39.2	15.4		31.6	3.4	8.02	71.3
13	42.6	16.8		31.6	3.6	8.02	

DATE: AUGUST 16, 1978 TIME: 0846

STATION: C11

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		29.3	3.1	8.16	79.0
01	3.3	20.8		30.5	3.3	8.09	79.0
02	6.6	19.2		30.6	4.7	8.07	81.0
03	9.8	18.7		31.0	4.7	8.07	81.0
04	13.1	18.1		31.4	3.8	8.05	79.0
05	16.4	17.6		31.4	3.6	8.02	78.0
06	19.7	16.8		31.4	3.1	8.01	71.0
07	23.0	16.8		31.3	3.3	7.98	71.0
08	26.2	16.6		31.3	3.3	7.96	

DATE: AUGUST 9, 1978 TIME: 0950

STATION: D1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.5		30.3	7.8	8.25	75.0
01	3.3	20.4		30.7	7.4	8.28	80.0
02	6.6	20.2		30.9	7.6	8.26	86.0
03	9.8	19.6		31.3	7.6	8.28	86.0
04	13.1	18.3		31.8	7.8	8.24	86.0
05	16.4	17.8		31.6	7.8	8.22	88.0
06	19.7	17.4		31.8	7.6	8.21	88.0
07	23.0	16.4		31.6	7.3	8.18	86.0
08	26.2	16.0		31.8	7.2	8.17	92.0
09	29.6	15.7		31.4	7.1	8.18	90.0
10	32.8	15.2		31.4	6.4	8.09	88.0
11	36.1	14.7		31.4	5.4	8.08	88.0
12	39.2	14.3		31.4	8.4	8.02	84.0
13	42.6	14.2		31.3	4.7	7.99	80.0
14	45.9	13.9		31.3	4.9	8.00	80.0
15	49.2	13.8		31.3	4.2	7.74	

DATE: AUGUST 9, 1978 TIME: 0930

STATION: D2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY O/OO	O.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.4		28.6	8.1	8.04	68.0
01	3.3	20.4		29.8	5.5	8.07	79.0
02	6.6	20.9		29.8	8.8	8.10	88.0
03	9.8	20.3		30.8	6.5	8.15	85.0
04	13.1	18.9		31.1	6.8	8.17	85.0
05	16.4	17.0		31.3	4.0	8.02	67.0
06	19.7	16.2		31.1	3.7	7.92	73.0
07	23.0	18.9		31.8	3.1	7.87	72.0
08	26.2	15.4		31.8	2.0	7.77	67.0
09	29.6	18.2		31.4	0.7	7.67	41.0
10	32.8	14.9		31.3	0.3	7.61	

DATE: AUGUST 9, 1978 TIME: 0940

STATION: D3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.6	7.7	8.18	74.0
01	3.3	20.8		30.7	7.8	8.28	77.0
02	6.6	20.6		30.8	7.7	8.27	85.0
03	9.8	20.6		30.9	7.8	8.26	82.0
04	13.1	17.9		31.7	8.1	8.24	83.0
05	16.4	17.0		31.6	8.3	8.22	86.0
06	19.7	16.6		31.3	7.8	8.18	86.0
07	23.0	16.2		31.6	6.8	8.16	86.0
08	26.2	15.9		31.4	6.0	8.13	86.0
09	29.5	15.5		31.6	5.0	8.08	86.0
10	32.8	16.1		31.3	3.9	7.93	81.0

DATE: AUGUST 9, 1978 TIME: 0920

STATION: D16

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.5		28.4	8.1	8.05	80.0
01	3.3	20.3		29.5	8.3	8.03	82.0
02	6.6	20.4		30.0	8.3	8.04	83.0
03	9.8	19.8		30.9	4.9	8.01	82.0
04	13.1	19.4		31.2	4.8	8.00	79.0
05	16.4	17.4		31.5	3.6	7.92	69.0
06	19.7	17.0		31.5	3.1	7.88	60.0
07	23.0	16.2		31.5	1.2	7.60	57.0
08	26.2	15.6		31.5	1.1	7.66	

DATE: SEPTEMBER 06, 1978 TIME: 0826

STATION: A1 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.9	8.9	7.29	97.0
01	3.3	18.9		30.9	9.0	7.48	99.0
02	6.6	18.8		30.9	9.0	7.63	99.0
03	9.8	18.8		30.9	9.0	7.76	97.0
04	13.1	18.6		30.9	8.1	7.92	98.0
05	16.4	18.2		31.0	8.1	7.89	98.0
06	19.7	17.7		31.0	8.4	8.03	98.0
07	23.0	18.1		31.0	8.3	8.10	98.0
08	26.2	17.4		31.0	8.1	8.12	93.0
09	29.6	17.2		31.0	8.6	8.13	92.0
10	32.8	17.1		31.0	6.2	8.14	91.0
11	36.1	17.0		31.8	6.1	8.14	90.0
12	39.2	16.9		31.1	8.0	8.14	90.0

DATE: SEPTEMBER 06, 1978 TIME: 0830

STATION: A2 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		30.6	6.0	8.38	56.0
01	3.3	18.2		30.7	6.3	8.36	58.0
02	6.6	18.1		30.8	6.1	8.32	55.0
03	9.8	18.1		30.8	6.4	8.29	61.0
04	13.1	18.0		30.8	6.4	8.26	62.0
05	16.4	17.9		30.9	6.6	8.24	62.0
06	19.7	17.7		30.8	6.6	8.25	62.0
07	23.0	17.6		30.9	6.6	8.21	62.0
08	26.2	17.6		30.8	6.5	8.20	63.0
09	29.5	17.6		30.9	6.8	8.20	66.0
10	32.8	17.8		31.0	7.1	8.20	68.0
11	36.1	17.1		31.0	6.3	8.18	69.0

DATE: SEPTEMBER 06, 1978 TIME: 0842

STATION: A3 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		30.7	6.8	8.60	55.0
01	3.3	18.1		30.8	6.6	8.46	56.0
02	6.6	18.0		30.8	7.0	8.37	57.0
03	9.8	17.9		30.8	6.8	8.34	59.0
04	13.1	17.8		30.8	7.0	8.32	64.0
05	16.4	17.8		30.8	6.4	8.29	13.0
06	19.7	17.6		31.0	6.5	8.26	59.0
07	23.0	17.1		31.1	6.2	8.24	58.0
08	26.2	17.1		31.1	6.2	8.22	

DATE: SEPTEMBER 06, 1978 TIME: 0950

STATION: A6 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.3		30.7	5.9	8.76	36.0
01	3.3	18.2		30.8	5.8	8.47	45.0
02	6.6	18.1		30.8	5.9	8.38	49.0
03	9.8	18.1		30.9	6.2	8.33	48.0
04	13.1	18.1		30.9	8.8	8.26	34.0
05	16.4	18.1		30.9	6.3	8.25	45.0
06	19.7	18.0		30.9	6.5	8.24	43.0

DATE: SEPTEMBER 06, 1978 TIME: 1800

STATION: A7 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		30.1	6.1	8.20	22.5
01	3.3	18.3		30.5	5.9	8.19	21.5
02	6.6	18.2		30.7	6.0	8.19	26.3
03	9.8	18.0		30.9	5.7	8.19	20.3
04	13.1	18.1		30.9	6.3	8.19	0.3
05	16.4	18.1		30.9	6.6	8.17	

DATE: SEPTEMBER 06, 1978 TIME: 0809

STATION: A8 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.6	5.7	8.33	78.0
01	3.3	18.3		30.7	6.0	8.23	71.3
02	6.6	18.2		30.7	5.9	8.21	63.3
03	9.8	18.2		30.6	5.7	8.20	68.3
04	13.1	18.1		30.9	6.5	8.20	52.0
05	16.4	18.0		30.9	6.5	8.21	49.0
06	19.7	17.7		31.0	6.9	8.21	38.0
07	23.0	17.4		31.0	6.3	8.20	25.0
08	26.3	17.4		31.0	6.1	8.18	08.0

DATE: SEPTEMBER 06, 1978 TIME: 0814

STATION: A9 OUTER LOS ANGELES HARBOR

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		30.2	8.6	8.28	69.0
01	3.3	18.6		30.3	8.8	8.19	79.0
02	6.6	18.6		30.6	5.8	8.17	83.0
03	9.8	18.5		30.8	6.9	8.18	79.0
04	13.1	18.3		30.8	6.6	8.19	78.0
05	16.4	18.2		30.9	6.4	8.19	76.0
06	19.7	18.1		30.9	6.4	8.19	74.0
07	23.0	17.9		30.9	6.1	8.18	74.0
08	26.2	17.6		31.2	6.6	8.18	72.0
09	29.6	17.2		31.2	5.8	8.11	78.0
10	32.8	16.9		31.2	6.2	8.10	80.0
11	36.1	16.2		31.3	4.8	8.08	78.0
12	39.2	16.2		31.2	5.1	8.08	78.0
13	42.6	15.6		31.1	6.3	8.08	74.0
14	45.9	15.2		31.5	6.3	8.08	70.0
15	49.2	14.9		31.4	6.3	8.07	69.0
16	52.5	14.7		31.4	6.1	8.07	79.0
17	55.8	14.2		31.3	4.9	8.07	80.0
18	59.0	13.9		31.4	4.4	8.08	78.0

DATE: SEPTEMBER 20, 1978 TIME: 1146

STATION: A10 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.4		30.6	5.7	8.17	
01	3.3	18.8		30.9	6.0	8.17	
02	6.6	19.7		31.0	5.9	8.17	
03	9.8	19.5		31.1	6.3	8.17	
04	13.1	19.5		31.1	6.3	8.17	
05	16.4	19.4		31.1	6.6	8.16	
06	19.7	18.4		31.1	6.0	8.15	
07	23.0	18.4		31.1	5.1	8.14	
08	26.2	19.3		31.1	6.1	8.13	
09	29.5	19.3		31.1	5.9	8.12	
10	32.8	19.3		31.1	5.5	8.11	
11	36.1	19.2		31.1	5.5	8.10	

DATE: SEPTEMBER 06, 1978 TIME: 1155

STATION: A11 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.6		30.6	5.6	8.40	54.0
01	3.3	16.5		30.7	5.7	8.36	52.0
02	6.6	16.4		30.7	6.0	8.33	59.0
03	9.8	16.4		30.8	6.6	8.30	61.0
04	13.1	16.4		30.8	5.7	8.29	58.0
05	16.4	16.4		30.8	4.3	8.28	38.0
06	19.7	16.5		30.9	6.2	8.25	53.0

DATE: SEPTEMBER 06, 1978 TIME: 1055

STATION: A12 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.7	7.4	8.78	78.0
01	3.3	18.0		30.8	7.3	8.61	75.0
02	6.6	18.0		30.8	7.5	8.51	76.0
03	9.8	17.8		30.9	7.5	8.46	74.0
04	13.1	17.8		30.9	7.5	8.41	74.0
05	16.4	17.7		30.9	7.4	8.37	79.5
06	19.7	17.5		31.0	7.3	8.34	80.0
07	23.0	17.4		31.0	7.1	8.32	80.0
08	26.2	17.3		31.0	7.1	8.30	79.0
09	29.5	17.0		31.1	7.0	8.28	80.0
10	32.8	17.0		31.1	7.0	8.27	61.0
11	36.1	16.5		31.2	6.6	8.25	76.0
12	39.2	16.1		31.3	6.2	8.22	

DATE: SEPTEMBER 06, 1978 TIME: 0920

STATION: A13 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.7		30.8	7.2	8.48	78.0
01	3.3	17.7		30.8	7.1	8.37	78.0
02	6.6	17.6		30.8	7.4	8.32	85.0
03	9.8	17.6		30.9	7.0	8.30	88.0
04	13.1	17.5		30.9	7.2	8.27	92.0
05	16.4	17.5		30.9	7.6	8.26	94.0
06	19.7	17.5		30.9	7.5	8.18	95.0
07	23.0	17.5		30.9	7.4	8.25	82.0
08	26.2	17.5		30.9	7.5	8.24	81.0
09	29.5	17.6		31.0	7.3	8.23	88.0
10	32.8	17.6		31.0	7.4	8.23	88.0
11	36.1	17.2		31.0	7.1	8.22	65.9
12	39.2	17.2		31.0	7.2	8.22	84.0
13	42.6	17.0		31.1	7.0	8.21	82.0
14	45.9	16.1		31.2	7.0	8.21	81.0
15	49.2	14.9		31.3	6.8	8.19	79.0
16	52.5	14.8		31.5	6.7	8.19	48.0

DATE: SEPTEMBER 06, 1978 TIME: 1129

STATION: A14 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.9		30.8	7.0	8.71	44.5
01	3.3	18.0		30.8	7.2	8.66	49.0
02	6.6	17.9		30.8	7.2	8.44	48.0
03	9.8	17.9		30.8	7.3	8.43	78.0
04	13.1	17.8		30.9	7.2	8.39	80.0
05	16.4	17.8		31.0	7.0	8.35	82.0
06	19.7	17.7		31.0	7.0	8.33	83.0
07	23.0	17.7		31.0	7.2	8.31	81.0
08	26.2	17.8		31.0	6.9	8.28	81.0
09	29.5	17.5		31.0	7.0	8.28	79.0
10	32.8	17.3		31.1	7.0	8.26	77.0
11	36.1	16.0		31.3	6.0	8.24	67.0
12	39.2	16.7		31.3	5.7	8.20	20.0

DATE: SEPTEMBER 06, 1978 TIME: 1160

STATION: A15 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.7	6.5	8.61	82.0
01	3.3	18.4		30.7	6.6	8.44	82.0
02	6.6	18.3		30.8	6.7	8.37	83.0
03	9.8	18.3		30.8	6.6	8.34	80.0
04	13.1	18.1		30.9	4.9	8.31	79.0
05	16.4	18.1		30.9	6.8	8.29	79.0
06	19.7	18.0		31.0	6.3	8.26	78.0
07	23.0	17.9		31.0	6.0	8.20	75.5
08	26.2	17.8		31.8	6.0	8.20	43.0

DATE: SEPTEMBER 06, 1978 TIME: 1040

STATION: A16 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		30.4	6.5	8.71	44.0
01	3.3	18.3		30.6	6.6	8.64	42.0
02	6.6	18.2		30.7	6.6	8.43	44.0
03	9.8	18.0		30.8	6.6	8.38	63.0
04	13.1	18.0		30.9	7.0	8.36	82.0
05	16.4	17.9		30.9	7.0	8.31	82.0
06	19.7	17.9		30.9	6.9	8.27	49.0
07	23.0	17.7		31.0	6.7	8.26	66.0
08	26.2	17.3		31.1	6.1	8.23	69.0
09	29.5	16.4		31.2	6.0	8.21	
10	32.8	16.1		31.3	6.0	8.16	

DATE: SEPTEMBER 06, 1978 TIME: 1135

STATION: A17 OUTER LOS ANGELES HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		30.6	6.9	8.70	62.0
01	3.3	18.1		30.8	6.8	8.48	60.0
02	6.6	17.6		30.9	6.6	8.42	59.0
03	9.8	17.8		30.9	6.8	8.36	61.0
04	13.1	17.7		31.0	6.9	8.34	63.0
05	16.4	17.6		31.0	7.1	8.31	75.0
06	19.7	17.6		31.0	6.9	8.30	82.0
07	23.0	17.8		31.0	7.0	8.28	85.0
08	26.2	17.3		31.0	6.9	8.27	87.0
09	29.6	17.1		31.0	7.0	8.26	87.0
10	32.8	16.9		31.1	6.7	8.25	86.0
11	36.1	16.4		31.1	6.9	8.24	82.0

DATE: SEPTEMBER 13, 1978 TIME: 1006

STATION: B1 LONG BEACH HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.4		30.7	7.1	7.99	
01	3.3	20.4		30.9	7.3	7.92	
02	6.6	20.4		30.9	7.2	7.96	
03	9.8	20.4		31.0	7.2	8.02	
04	13.1	20.4		31.0	7.5	8.07	
05	16.4	20.4		31.0	7.5	8.10	
06	19.7	20.4		31.0	7.3	8.13	
07	23.0	20.3		31.0	7.5	8.14	
08	26.2	20.2		31.0	7.6	8.15	
09	29.5	20.2		31.0	8.1	8.16	
10	32.8	20.2		31.0	7.5	8.16	
11	36.1	20.2		31.0	7.7	8.17	
12	39.2	20.2		31.0	7.5	8.17	
13	42.6	19.8		31.0	7.6	8.18	
14	45.9	19.8		31.0	7.5	8.18	
15	49.2	19.0		31.0	7.7	8.17	
16	52.5	18.7		31.0	7.3	8.16	
17	55.8	18.5		31.0	7.8	8.15	
18	59.0	18.1		31.0	7.4	8.15	
19	62.3	16.3		31.1	6.5	8.14	
20	65.6	15.8		31.2	6.4	8.10	
21	68.9	15.6		31.2	6.4	8.09	
22	72.1	15.3		31.1	6.0	8.08	

DATE: SEPTEMBER 13, 1978 TIME: 1140

STATION: B2 LONG BEACH HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.4		30.3	7.5	8.54	
01	3.3	19.4		30.6	7.6	8.50	
02	6.6	19.4		30.6	7.6	8.44	
03	9.8	19.4		30.7	7.6	8.40	
04	13.1	19.4		30.8	6.5	8.37	
05	16.4	19.4		30.9	6.3	8.32	
06	19.7	19.3		30.9	6.2	8.29	
07	23.0	19.4		30.9	6.6	8.28	
08	26.2	19.3		30.9	7.2	8.25	
09	29.6	19.2		30.9	7.0	8.24	
10	32.8	19.0		30.9	6.6	8.20	
11	36.1	18.9		31.0	6.2	8.22	
12	39.2	18.7		31.0	6.3	8.19	
13	42.6	18.6		31.0	6.0	8.18	
14	45.9	18.5		31.0	6.2	8.16	
15	49.2	18.2		31.0	5.8	8.15	
16	52.5	17.5		31.2	3.8	8.10	

DATE: SEPTEMBER 13, 1978 TIME: 1146

STATION: B3 LONG BEACH HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.1		30.4	8.1	8.85	
01	3.3	20.1		30.4	8.5	8.61	
02	6.6	20.1		30.8	7.6	8.44	
03	9.8	19.9		30.8	7.2	8.41	
04	13.1	19.7		30.9	7.7	8.38	
05	16.4	19.7		30.4	7.1	8.35	
06	19.7	19.6		30.9	7.6	8.30	
07	23.0	19.5		31.0	6.7	8.26	
08	26.2	19.6		30.9	6.7	8.24	
09	29.6	19.2		31.0	6.8	8.23	
10	32.8	19.0		31.0	6.8	8.20	
11	36.1	18.8		31.0	6.7	8.18	
12	39.2	18.6		31.0	6.3	8.16	
13	42.6	18.4		31.0	6.7	8.13	
14	45.9	17.6		31.1	4.8	8.10	
15	49.2	17.4		31.1	4.4	8.07	
16	52.5	17.3		31.1	4.3	8.04	
17	55.8	17.0		31.1	4.3	8.02	
18	59.0	16.9		31.1	4.1	8.00	
19	62.3	15.6		31.1	4.0	7.78	
20	65.6	14.4		31.1	3.8	7.69	

DATE: SEPTEMBER 13, 1978 TIME: 1201

STATION: B4 LONG BEACH HARBOR

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.1		30.8	7.3	8.80	
01	3.3	20.1		30.7	6.3	8.36	
02	6.6	20.2		30.7	6.3	8.35	
03	9.8	20.1		30.7	6.0	8.34	
04	13.1	20.1		30.8	7.5	8.33	
05	16.4	20.0		30.8	7.9	8.33	
06	19.7	20.0		30.8	7.1	8.33	
07	23.0	20.0		30.8	7.6	8.31	
08	26.2	19.8		30.9	6.2	8.30	
09	29.6	19.8		30.9	6.2	8.30	
10	32.8	19.0		31.1	6.7	8.26	
11	36.1	18.7		31.2	6.3	8.23	
12	39.2	18.3		31.2	6.2	8.14	
13	42.6	18.3		31.1	5.4	8.14	
14	45.9	18.1		31.1	5.8	8.13	
15	49.2	17.9		31.1	5.1	8.11	
16	52.5	17.8		31.1	4.7	8.09	
17	55.8	17.8		31.2	4.0	8.07	
18	59.0	17.6		31.2	4.2	8.04	
19	62.3	17.3		31.2	4.1	8.02	
20	65.6	17.1		31.1	3.6	8.00	

DATE: SEPTEMBER 13, 1978 TIME: 1200

STATION: B5 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.3		30.4	6.3	8.41	
01	3.3	20.2		30.5	6.3	8.41	
02	6.6	20.1		30.5	6.9	8.27	
03	9.8	20.1		30.6	6.8	8.23	
04	13.1	20.1		30.6	6.7	8.21	
05	16.4	20.1		30.7	7.3	8.23	
06	19.7	20.0		30.9	6.1	8.16	
07	23.0	19.6		30.8	6.9	8.19	
08	26.2	19.4		30.9	5.6	8.18	
09	29.5	19.2		31.0	5.5	8.17	
10	32.8	18.6		30.9	5.6	8.16	
11	36.1	18.5		31.1	5.3	8.13	
12	39.2	18.2		31.1	4.3	8.09	
13	42.6	17.8		31.1	3.7	8.10	
14	45.9	17.7		31.1	3.8	8.05	
15	49.2	17.6		31.1	4.0	8.08	
16	52.5	17.5		31.1	4.0	8.03	

DATE: SEPTEMBER 13, 1978 TIME: 1154

STATION: B6 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.4	8.3	8.36	
01	3.3	20.7		30.5	8.4	8.40	
02	6.6	20.6		30.5	7.7	8.34	
03	9.8	20.2		30.7	6.0	8.26	
04	13.1	19.9		30.4	4.1	8.17	
05	16.4	19.7		30.5	4.8	8.12	
06	19.7	19.6		30.8	3.9	8.09	
07	23.0	19.5		30.8	4.9	8.07	
08	26.2	19.4		30.8	4.2	8.06	
09	29.5	19.4		30.9	3.8	8.04	
10	32.8	19.2		30.9	3.6	8.02	

DATE: SEPTEMBER 13, 1978 TIME: 1145

STATION: B7 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.0		30.2	4.6	8.25	
01	3.3	19.6		30.3	4.9	8.15	
02	6.6	19.6		30.5	5.1	8.12	
03	9.8	19.0		30.6	5.2	8.10	
04	13.1	19.0		30.5	5.2	8.10	
05	16.4	19.0		30.5	5.5	8.12	
06	19.7	18.7		30.7	5.7	8.10	
07	23.0	19.5		30.8	6.0	8.09	
08	26.2	19.2		30.8	5.5	8.08	
09	29.5	18.9		30.9	6.7	8.07	
10	32.8	18.8		31.0	5.3	8.08	
11	36.1	18.6		31.1	4.3	8.06	
12	39.2	18.3		30.9	4.2	8.06	
13	42.6	18.1		31.2	4.5	8.06	
14	45.9	17.9		31.1	4.0	8.04	
15	49.2	17.8		31.1	4.0	8.03	
16	52.5	17.7		31.1	3.8	8.02	
17	55.8	17.4		31.1	3.6	8.01	
18	59.0	17.3		31.1	3.7	8.00	

DATE: SEPTEMBER 6, 1978 TIME: 1120

STATION: B8 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		30.7	7.0	8.71	80.0
01	3.3	18.6		30.7	7.2	8.59	80.0
02	6.6	18.1		30.8	7.0	8.49	80.0
03	9.8	17.9		31.0	7.0	8.43	83.0
04	13.1	17.7		31.0	7.0	8.38	76.0
05	16.4	17.6		31.0	7.1	8.35	72.0
06	19.7	17.6		31.0	6.9	8.33	75.0
07	23.0	17.3		31.0	6.8	8.31	77.0
08	26.2	16.6		31.2	6.6	8.27	76.0
09	29.5	16.3		31.3	6.7	8.26	66.0
10	32.8	16.1		31.2	6.1	8.22	34.0
11	36.1	15.9		31.2	5.8	8.19	34.0
12	39.4	15.9		31.2	5.7	8.18	38.0
13	42.6	15.9		31.2	5.8	8.18	24.0

DATE: SEPTEMBER 06, 1978 TIME: 1059

STATION: B9 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.3		30.7	7.8	8.77	74.0
01	3.3	18.1		30.7	7.9	8.66	73.0
02	6.6	18.0		30.8	7.2	8.54	72.0
03	9.8	17.8		30.9	7.3	8.47	71.0
04	13.1	17.7		30.9	7.4	8.40	73.0
05	16.4	17.6		31.0	7.0	8.37	73.0
06	19.7	17.6		31.0	6.8	8.34	78.0
07	23.0	17.2		31.1	6.6	8.31	76.0
08	26.2	17.1		31.1	6.8	8.27	76.0
09	29.5	17.0		31.1	7.0	8.28	73.0
10	32.8	16.6		31.2	6.7	8.28	78.0
11	36.1	15.8		31.2	6.6	8.22	69.0
12	39.2	15.3		31.4	6.3	8.19	69.0
13	42.6	15.1		31.4	6.0	8.18	68.0
14	45.9	15.0		31.3	5.7	8.18	68.0

DATE: SEPTEMBER 13, 1978 TIME: 1130

STATION: B10 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.1		30.3	7.1	8.41	
01	3.3	20.1		30.4	7.7	8.37	
02	6.6	20.2		30.7	7.2	8.36	
03	9.8	20.0		30.8	7.6	8.34	
04	13.1	20.1		30.8	7.8	8.33	
05	16.4	19.8		30.9	7.5	8.31	
06	19.7	19.6		31.0	7.0	8.29	
07	23.0	19.5		31.0	7.6	8.26	
08	26.2	19.6		31.0	7.1	8.26	
09	29.5	19.3		31.0	6.6	8.24	
10	32.8	19.2		31.1	6.6	8.21	
11	36.1	19.1		31.1	6.4	8.22	
12	39.2	18.6		31.1	6.2	8.20	
13	42.6	18.3		31.2	5.6	8.18	
14	45.9	18.1		31.2	5.3	8.15	
15	49.2	17.4		31.1	5.1	8.15	
16	52.5	17.8		31.1	5.4	8.12	
17	55.8	17.5		31.1	5.3	8.12	
18	59.0	17.1		31.2	4.9	8.10	
19	62.3	16.9		31.2	5.1	8.08	
20	65.6	16.5		31.2	4.7	8.07	
21	68.9	16.6		31.2	4.4	8.06	
22	72.1	16.3		31.2	4.0	8.02	

DATE: SEPTEMBER 13, 1978 TIME: 1129

STATION: B11 LONG BEACH HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.2		30.5	7.1	8.44	
01	3.3	20.2		30.4	7.6	8.40	
02	6.6	20.2		30.7	7.8	8.38	
03	9.8	20.2		30.7	7.4	8.37	
04	13.1	19.8		30.9	7.8	8.35	
05	16.4	19.8		31.0	7.9	8.31	
06	19.7	19.8		30.9	7.0	8.29	
07	23.0	19.7		31.0	7.2	8.27	
08	26.2	19.6		31.1	6.6	8.26	
09	29.5	18.6		31.1	7.3	8.23	
10	32.8	18.5		31.1	6.7	8.20	
11	36.1	18.2		31.2	6.4	8.20	
12	39.2	17.8		31.3	5.7	8.17	
13	42.6	17.7		31.1	6.6	8.16	
14	45.9	17.7		31.1	6.0	8.14	
15	49.2	17.7		31.1	6.6	8.13	
16	52.5	17.7		31.1	5.7	8.13	
17	55.8	17.6		31.1	5.6	8.13	
18	59.0	17.3		31.1	5.6	8.12	
19	62.3	17.2		31.1	5.5	8.10	
20	65.6	16.7		31.2	5.2	8.08	
21	68.9	16.6		31.2	4.9	8.06	

DATE: SEPTEMBER 19, 1978 TIME: 1134

STATION: C1 INNER LOS ANGELES HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.2		30.6	5.7	8.21	
01	3.3	20.1		30.6	6.1	8.18	
02	6.6	20.0		30.9	5.2	8.14	
03	9.8	19.8		30.9	5.3	8.13	
04	13.1	19.7		31.0	5.4	8.12	
05	16.4	19.6		31.0	5.6	8.11	
06	19.7	19.6		31.0	5.6	8.11	
07	23.0	19.6		31.1	5.6	8.12	
08	26.2	19.5		31.0	5.8	8.12	
09	29.5	19.6		31.0	5.4	8.12	
10	32.8	19.4		31.0	5.3	8.12	
11	36.1	19.3		31.1	5.8	8.12	
12	39.2	19.3		31.1	5.4	8.12	

DATE: SEPTEMBER 19, 1978 TIME: 1119

STATION: C2 INNER LOS ANGELES HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.9		30.7	5.0	8.29	
01	3.3	19.8		30.8	5.1	8.23	
02	6.6	19.8		30.8	4.9	8.14	
03	9.8	19.8		30.8	4.7	8.14	
04	13.1	19.7		30.9	4.7	8.10	
05	16.4	19.7		30.9	4.6	8.08	
06	19.7	19.7		30.9	4.9	8.08	
07	23.0	19.7		30.9	5.0	8.07	
08	26.2	19.6		30.9	4.9	8.07	
09	29.5	19.4		30.9	4.8	8.06	
10	32.8	19.6		30.9	4.7	8.06	
11	36.1	19.4		31.0	4.8	8.06	
12	39.2	19.4		31.0	4.4	8.06	

DATE: SEPTEMBER 20, 1978 TIME: 1101

STATION: C3 INNER LOS ANGELES HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.4	4.7	8.00	
01	3.3	20.7		30.6	4.5	7.98	
02	6.6	20.1		30.7	4.3	7.97	
03	9.8	20.0		30.8	4.3	7.96	
04	13.1	20.0		30.8	4.6	7.98	
05	16.4	20.0		30.8	4.8	7.96	
06	19.7	19.9		30.8	4.7	7.96	
07	23.0	19.9		30.9	5.0	7.96	
08	26.2	19.8		30.9	5.1	7.97	
09	29.5	19.8		30.9	5.2	7.97	
10	32.8	19.8		30.9	5.4	7.96	
11	36.1	19.7		30.9	5.3	7.96	

DATE: SEPTEMBER 20, 1978 TIME: 1000

STATION: C6 INNER LOS ANGELES HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.2		29.9	4.3	7.94	
01	3.3	21.0		30.3	3.8	7.94	
02	6.6	20.4		30.5	4.0	7.96	
03	9.8	20.2		30.7	3.8	7.93	
04	13.1	20.1		30.6	4.1	7.93	
05	16.4	20.1		30.6	3.7	7.93	
06	19.7	20.2		30.6	3.8	7.92	
07	23.0	20.4		30.7	3.8	7.92	
08	26.2	20.0		30.6	4.1	7.92	
09	29.5	20.0		30.6	4.1	7.92	
10	32.8	20.0		30.6	4.4	7.93	
11	36.1	19.9		30.6	4.8	7.93	
12	39.2	19.9		30.9	5.1	7.96	

DATE: SEPTEMBER 20, 1978 TIME: 1020

STATION: C5 INNER LOS ANGELES HARBOR

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.8		30.0	4.0	7.96	
01	3.3	20.3		30.4	3.1	7.92	
02	6.6	20.0		30.6	3.3	7.91	
03	9.8	19.9		30.7	3.7	7.91	
04	13.1	20.0		30.7	3.8	7.91	
05	16.4	19.8		30.7	3.6	7.88	
06	19.7	20.0		30.7	3.7	7.89	
07	23.0	19.9		30.7	3.5	7.88	

DATE: SEPTEMBER 20, 1978 TIME: 1043

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.5		30.8	4.8	7.98	
01	3.3	20.3		30.7	4.4	7.97	
02	6.6	20.2		30.8	5.0	7.95	
03	9.8	20.1		30.8	4.9	7.94	
04	13.1	20.1		30.8	5.3	7.94	
05	16.4	20.1		30.8	4.9	7.94	
06	19.7	20.0		30.8	5.3	7.94	
07	23.0	19.9		30.8	5.3	7.94	
08	26.2	19.9		30.8	5.2	7.94	
09	29.5	19.9		30.8	5.2	7.94	
10	32.8	19.9		30.8	4.7	7.96	
11	36.1	19.9		30.8	4.3	7.94	
12	39.2	19.9		30.8	4.2	7.94	

DATE: SEPTEMBER 20, 1978 TIME: 0948

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.2		30.5	3.9	7.94	
01	3.3	20.2		30.5	3.4	7.94	
02	6.6	20.2		30.6	3.6	7.91	
03	9.8	20.2		30.7	3.9	7.88	
04	13.1	20.2		30.7	4.1	7.88	
05	16.4	20.2		30.7	3.6	7.87	
06	19.7	20.2		30.7	3.3	7.87	
07	23.0	20.2		30.7	3.6	7.87	
08	26.2	20.2		30.7	3.3	7.88	
09	29.5	20.2		30.8	3.3	7.88	
10	32.8	20.2		30.8	3.3	7.88	
11	36.1	20.2		30.8	3.2	7.89	

DATE: SEPTEMBER 20, 1978 TIME: 0820

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.7		28.3	6.8	6.69	
01	3.3	19.6		28.9	6.3	6.91	
02	6.6	19.6		30.2	5.2	7.04	
03	9.8	19.6		30.3	5.8	7.18	
04	13.1	19.6		30.4	5.4	7.30	
05	16.4	19.6		30.4	5.2	7.39	
06	19.7	19.8		30.5	4.9	7.53	
07	23.0	19.8		30.8	5.1	7.59	
08	26.2	19.8		30.8	5.8	7.64	
09	29.5	19.8		30.8	5.3	7.71	
10	32.8	19.8		30.8	5.0	7.74	
11	36.1	19.8		30.6	4.6	7.78	
12	39.2	19.5		30.7	4.5	7.82	

DATE: SEPTEMBER 20, 1978 TIME: 0834

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.0	5.7	8.06	
01	3.3	19.8		30.3	5.1	8.03	
02	6.6	19.8		30.5	5.1	8.00	
03	9.8	19.6		30.8	5.2	7.98	
04	13.1	19.8		30.6	5.3	7.98	
05	16.4	19.8		30.6	5.2	7.98	
06	19.7	19.8		30.6	5.9	7.97	
07	23.0	19.9		30.6	5.0	7.97	
08	26.2	19.8		30.7	5.3	7.97	
09	29.5	19.8		30.8	5.4	7.98	
10	32.8	19.6		30.8	5.1	7.98	
11	36.1	19.7		30.9	4.9	7.98	
12	39.2	19.7		30.9	4.7	7.98	

DATE: SEPTEMBER 20, 1978 TIME: 0915

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.4		30.3	5.2	7.98	
01	3.3	19.4		30.5	5.2	7.99	
02	6.6	19.9		30.6	5.4	8.00	
03	9.8	19.9		30.7	5.3	8.00	
04	13.1	19.4		30.7	5.3	8.00	
05	16.4	19.4		30.7	5.0	8.01	
06	19.7	19.9		30.7	5.2	8.01	
07	23.0	19.9		30.7	4.9	8.01	
08	26.2	19.9		30.8	4.8	8.01	
09	29.4	19.9		30.8	5.0	8.01	
10	32.8	19.9		30.8	5.0	8.01	
11	36.1	19.8		30.8	5.1	8.01	
12	39.2	19.8		30.9	5.3	8.02	

DATE: SEPTEMBER 20, 1978 TIME: 0900

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.0		29.8	4.1	7.90	
01	3.3	20.0		30.1	4.4	7.90	
02	6.6	20.1		30.1	4.6	7.90	
03	9.8	20.0		30.2	4.7	7.92	
04	13.1	19.8		30.7	4.6	7.89	
05	16.4	19.8		30.7	4.6	7.86	
06	19.7	19.8		30.8	4.3	7.86	

DATE: SEPTEMBER 13, 1978 TIME: 1117

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		30.2	9.1	8.51	
01	3.3	21.3		30.4	8.6	8.47	
02	6.6	21.3		30.5	9.0	8.45	
03	9.8	21.2		30.6	8.8	8.43	
04	13.1	20.6		30.8	8.1	8.40	
05	16.4	20.5		30.9	7.1	8.35	
06	19.7	20.4		31.0	7.4	8.37	
07	23.0	20.3		31.0	7.4	8.31	
08	26.2	20.3		31.0	7.1	8.29	
09	29.5	20.0		31.1	7.1	8.27	
10	32.8	18.5		31.1	7.0	8.25	
11	36.1	19.4		31.1	7.0	8.23	
12	39.2	18.6		31.1	6.4	8.21	
13	42.6	18.6		31.1	6.0	8.18	
14	45.9	16.3		31.2	5.6	8.18	
15	49.2	18.1		31.1	4.6	8.14	

DATE: SEPTEMBER 13, 1978 TIME: 1038

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		29.9	8.0	8.60	
01	3.3	21.4		29.9	7.6	8.44	
02	6.6	21.4		30.1	8.5	8.40	
03	9.8	21.4		30.2	8.0	8.39	
04	13.1	20.6		30.7	8.4	8.35	
05	16.4	20.5		30.6	8.8	8.30	
06	19.7	20.2		30.9	8.5	8.26	
07	23.0	19.9		30.8	6.8	8.18	
08	26.2	19.8		30.9	4.9	8.14	
09	29.6	19.4		31.0	4.7	8.12	
10	32.8	18.4		31.1	2.2	7.96	

DATE: SEPTEMBER 13, 1978 TIME: 1113

STATION: D3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.6		30.0	7.9	8.40	
01	3.3	21.7		30.3	7.8	8.47	
02	6.6	21.4		30.4	8.9	8.41	
03	9.8	21.3		30.6	8.8	8.39	
04	13.1	21.2		30.7	8.9	8.42	
05	16.4	20.7		30.9	8.0	8.39	
06	19.7	20.3		30.9	7.0	8.33	
07	23.0	20.0		30.9	7.0	8.26	
08	26.2	19.8		30.9	7.1	8.24	
09	29.6	19.6		31.1	6.4	8.23	
10	32.8	19.2		31.2	6.4	8.20	
11	36.1	18.7		31.1	5.4	8.17	
12	39.2	18.4		31.1	3.7	8.10	
13	42.6	17.8		31.2	2.0	8.00	
14	45.9	17.2		31.3	2.2	7.92	
15	49.2	16.6		31.2	1.7	7.88	
16	52.5	15.2		31.4	0.88	7.62	

DATE: SEPTEMBER 13, 1978 TIME: 1100

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		29.9	5.8	8.30	
01	3.3	20.6		29.1	5.0	8.21	
02	6.6	20.9		29.3	5.0	8.18	
03	9.8	21.0		30.1	5.4	8.20	
04	13.1	20.7		30.3	4.8	8.20	
05	16.4	20.8		30.4	5.2	8.20	
06	19.7	19.8		30.9	3.8	8.16	
07	23.0	19.8		31.0	4.7	8.11	
08	26.2	19.3		31.0	4.6	8.08	

DATE: OCTOBER 4, 1978 TIME: 0932

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.5	8.4	8.22	83.0
01	3.3	20.6		30.6	7.9	8.24	85.0
02	6.6	20.6		31.0	7.7	8.20	84.0
03	9.8	20.6		31.0	7.6	8.20	84.0
04	13.1	20.5		31.0	7.8	8.20	81.0
05	16.4	20.5		31.1	7.7	8.20	81.0
06	19.7	20.6		31.1	7.8	8.20	79.0
07	23.0	20.6		31.1	7.8	8.20	80.0
08	26.2	20.3		31.2	7.3	8.14	80.0
09	29.5	20.0		31.2	7.2	8.14	80.0
10	32.8	19.8		31.2	7.7	8.17	80.0
11	36.1	19.7		31.2	7.8	8.17	81.0
12	39.4	19.7		31.2	7.7	8.14	81.0
13	42.6	19.6		31.2	7.7	8.16	82.0
14	45.9	19.8		31.2	7.9	8.16	83.0
15	49.2	19.8		31.2	8.1	8.16	84.0
16	52.5	18.6		31.3	8.1	8.17	84.0
17	55.8	18.2		31.4	8.2	8.14	83.0
18	59.0	17.9		31.6	8.1	8.18	84.0
19	62.3	15.7		31.6	7.8	8.14	84.0
20	65.6	15.2		31.9	7.8	8.10	82.0
21	68.9	15.2		31.5	7.4	8.06	82.0

DATE: OCTOBER 4, 1978 TIME: 1013

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.9	8.8	8.58	68.0
01	3.3	20.6		31.0	8.6	8.86	68.0
02	6.6	20.6		31.0	8.1	8.48	68.0
03	9.8	20.7		31.0	8.3	8.36	70.0
04	13.1	20.7		31.1	8.1	8.37	70.0
05	16.4	20.5		31.1	7.8	8.34	71.0
06	19.7	20.2		31.1	8.1	8.30	72.0
07	23.0	20.1		31.1	8.2	8.30	72.0
08	26.2	19.4		31.2	8.0	8.20	71.0
09	29.5	19.0		31.4	7.8	8.24	69.0
10	32.8	18.6		31.3	7.6	8.23	65.0
11	36.1	18.2		31.3	7.4	8.21	65.0
12	39.4	18.1		31.3	7.4	8.19	61.0

DATE: OCTOBER 4, 1978 TIME: 1041

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.4		30.8	8.4	8.64	67.0
01	3.3	21.1		30.6	8.3	8.58	67.0
02	6.6	21.0		31.0	6.6	8.50	69.0
03	9.8	20.8		31.0	6.6	8.39	70.0
04	13.1	20.6		31.1	6.5	8.36	72.0
05	16.4	20.1		31.2	8.6	8.33	73.0
06	19.7	19.7		31.2	7.6	8.30	72.0
07	23.0	18.5		31.2	7.3	8.20	63.0
08	26.2	14.3		31.2	7.1	8.18	65.0

DATE: OCTOBER 4, 1978 TIME: 1046

STATION: A6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		30.5	7.2	8.51	61.0
01	3.3	21.4		30.6	6.2	8.48	62.0
02	6.6	21.1		30.8	6.2	8.35	55.0
03	9.8	20.9		31.1	5.7	8.21	53.0
04	13.1	20.3		31.1	8.5	8.17	63.0
05	16.4	20.1		31.2	8.1	8.13	60.0
06	19.7	20.1		31.1	8.0	8.10	

DATE: OCTOBER 4, 1978 TIME: 1047

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.9		30.9	6.8	8.55	58.0
01	3.3	21.1		30.9	7.7	8.54	60.0
02	6.6	20.8		31.0	7.7	8.46	62.0
03	9.8	20.6		31.1	7.6	8.37	62.0
04	13.1	20.5		31.1	7.1	8.25	64.0

DATE: OCTOBER 4, 1978 TIME: 0818

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.9	8.0	8.20	70.0
01	3.3	20.4		30.9	7.9	8.20	71.0
02	6.6	20.3		31.0	7.9	8.18	71.0
03	9.8	20.2		31.0	7.8	8.18	69.0
04	13.1	19.9		31.1	7.7	8.17	70.0
05	16.4	19.8		31.2	7.7	8.16	71.0
06	19.7	19.7		31.2	7.6	8.16	73.0
07	23.0	19.6		31.2	7.3	8.13	75.0
08	26.2	19.3		31.2	7.2	8.12	

DATE: OCTOBER 4, 1978 TIME: 0839

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.9	8.4	8.54	74.0
01	3.3	20.7		30.9	7.8	8.50	74.0
02	6.6	20.7		31.0	7.5	8.46	73.0
03	9.8	20.7		31.0	7.6	8.44	74.0
04	13.1	20.6		31.1	7.8	8.39	72.0
05	16.4	20.2		31.2	7.3	8.32	71.0
06	19.7	19.4		31.2	7.0	8.26	72.0
07	23.0	19.4		31.3	6.9	8.24	72.0
08	26.2	19.3		31.2	6.8	8.22	69.0
09	29.5	19.1		31.2	6.8	8.19	66.0
10	32.8	18.7		31.3	6.5	8.18	67.0
11	36.1	18.6		31.3	6.6	8.18	66.0
12	39.4	18.4		31.3	6.6	8.17	66.0
13	42.6	17.5		31.5	7.0	8.16	66.0
14	45.9	17.1		31.4	7.1	8.16	66.0
15	49.2	17.1		31.4	6.9	8.16	67.0
16	52.5	17.0		31.3	6.9	7.92	66.0

DATE: OCTOBER 10, 1978 TIME: 1204

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		31.1	6.2	8.57	
01	3.3	18.8		31.1	6.3	8.34	
02	6.6	18.7		31.1	6.8	8.31	
03	9.8	18.2		31.4	7.2	8.28	
04	13.1	18.1		31.2	7.6	8.28	
05	16.4	18.0		31.3	6.7	8.22	
06	19.7	17.8		31.2	5.0	8.20	
07	23.0	17.4		31.4	6.0	8.15	
08	26.2	16.7		31.6	4.7	8.13	
09	29.5	16.6		31.4	3.6	8.10	

DATE: OCTOBER 4, 1978 TIME: 1105

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.7		30.8	7.8	8.60	69.0
01	3.3	21.6		31.0	7.7	8.60	65.0
02	6.6	21.5		31.0	7.0	8.47	69.0
03	9.8	21.4		31.1	8.0	8.43	66.0
04	13.1	21.3		31.1	7.9	8.38	67.0
05	16.4	21.2		31.1	7.6	8.36	69.0
06	19.7	20.8		31.3	6.4	8.30	69.0

DATE: OCTOBER 4, 1978 TIME: 1135

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.8	8.3	8.46	71.0
01	3.3	20.7		30.9	7.9	8.43	71.0
02	6.6	20.6		31.1	8.1	8.43	74.0
03	9.8	20.2		31.1	7.8	8.39	71.0
04	13.1	20.2		31.1	7.9	8.36	70.0
05	16.4	20.7		31.2	7.8	8.33	68.0
06	19.7	19.9		31.2	7.7	8.31	67.0
07	23.0	19.8		31.2	7.7	8.29	69.0
08	26.2	19.6		31.2	7.6	8.26	70.0
09	29.5	19.3		31.5	7.6	8.25	73.0
10	32.8	19.0		31.3	7.6	8.24	74.0
11	36.1	18.3		31.6	7.3	8.22	75.0
12	39.4	18.1		31.4	7.4	8.42	63.0

DATE: OCTOBER 4, 1978 TIME: 0951

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.2		30.6	6.7	8.45	71.0
01	3.3	20.2		31.0	7.8	8.42	72.0
02	6.6	20.2		31.0	7.3	8.36	76.0
03	9.8	20.2		31.1	7.8	8.32	76.0
04	13.1	20.2		31.4	7.3	8.30	75.0
05	16.4	20.1		31.2	7.6	8.24	73.0
06	19.7	19.8		31.1	7.3	8.27	74.0
07	23.0	19.8		31.2	7.3	8.24	75.0
08	26.2	19.7		31.2	7.4	8.22	76.0
09	29.5	19.7		31.2	6.9	8.22	77.0
10	32.8	19.8		31.3	6.9	8.19	77.0
11	36.1	18.9		31.6	6.7	8.18	76.0
12	39.4	17.1		31.6	7.3	8.16	70.0
13	42.6	16.6		31.7	7.4	8.14	73.0
14	45.9	16.6		31.6	7.3	8.16	73.0
15	49.2	16.6		31.5	7.4	8.15	74.0
16	52.5	16.3		31.5	7.4	8.14	
17	55.8	16.3		31.3	7.3	7.90	

DATE: OCTOBER 4, 1978 TIME: 1146

STATION: A14

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.6		30.6	6.6	8.36	70.0
01	3.3	20.7		30.7	8.2	8.39	71.0
02	6.6	20.6		31.0	8.4	8.42	72.0
03	9.8	20.5		31.0	8.1	8.43	71.0
04	13.1	20.4		31.2	8.1	8.34	70.0
05	16.4	20.3		31.2	7.9	8.32	71.0
06	19.7	20.2		31.2	7.8	8.30	72.0
07	23.0	19.8		31.2	7.8	8.27	71.0
08	26.2	19.6		31.2	7.7	8.26	71.0
09	29.5	19.3		31.2	7.6	8.24	71.0
10	32.8	19.1		31.2	7.6	8.23	75.0
11	36.1	17.7		31.8	7.5	8.22	77.0
12	39.4	17.6		31.5	7.5	8.20	77.0

DATE: OCTOBER 4, 1970 TIME: 1102

STATION: A15

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		30.9	8.4	8.55	68.0
01	3.3	21.3		30.9	8.6	8.58	68.0
02	6.6	21.3		30.9	8.7	8.57	69.0
03	9.8	21.1		31.0	8.5	8.40	70.0
04	13.1	21.0		31.0	8.6	8.34	72.0
05	16.4	20.9		31.1	7.9	8.32	72.0
06	19.7	20.0		31.2	7.3	8.26	73.0
07	23.0	19.9		31.2	7.1	8.22	73.0
08	26.2	19.9		31.2	6.4	8.20	

DATE: OCTOBER 4, 1970 TIME: 1057

STATION: A16

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.0		30.9	8.8	8.66	70.0
01	3.3	21.2		30.9	8.8	8.57	70.0
02	6.6	21.1		31.0	8.8	8.44	70.0
03	9.8	21.1		31.0	8.8	8.40	70.0
04	13.1	20.9		31.1	8.8	8.37	71.0
05	16.4	20.7		31.2	8.5	8.35	72.0
06	19.7	20.1		31.2	8.2	8.30	73.0
07	23.0	19.7		31.3	7.3	8.26	72.0
08	26.2	19.5		31.3	6.6	8.20	63.0
09	29.5	18.8		31.4	6.6	8.18	

DATE: OCTOBER 4, 1970 TIME: 1155

STATION: A17

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.9	8.6	8.72	75.0
01	3.3	20.9		31.0	8.7	8.66	75.0
02	6.6	20.8		31.1	8.6	8.38	76.0
03	9.8	20.6		31.1	8.7	8.32	76.0
04	13.1	20.3		31.2	8.2	8.31	75.0
05	16.4	20.3		31.2	8.3	8.26	76.0
06	19.7	20.1		31.2	7.9	8.26	76.0
07	23.0	19.8		31.2	8.0	8.23	73.0
08	26.2	19.5		31.3	7.9	8.22	78.0
09	29.5	19.3		31.3	7.8	8.20	77.0
10	32.8	18.2		31.3	7.6	8.18	77.0
11	36.1	17.9		31.3	7.6	8.16	78.0
12	39.4	17.6		31.3	7.1	8.16	78.0

DATE: OCTOBER 11, 1970 TIME: 0618

STATION: B1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.2		30.8	8.3	8.41	
01	3.3	19.3		30.6	7.7	8.54	
02	6.6	19.1		30.7	7.8	8.46	
03	9.8	18.9		31.1	7.8	8.40	
04	13.1	18.6		31.1	7.9	8.38	
05	16.4	18.6		31.1	7.8	8.32	
06	19.7	18.7		31.2	8.0	8.29	
07	23.0	18.6		31.2	8.2	8.28	
08	26.2	18.2		31.2	8.3	8.24	
09	29.5	17.9		31.3	8.2	8.23	
10	32.8	17.8		31.3	8.4	8.21	
11	36.1	17.4		31.3	8.4	8.20	
12	39.4	16.7		31.4	8.3	8.19	
13	42.6	16.1		31.3	8.3	8.18	
14	45.9	16.0		31.3	8.4	8.17	
15	49.2	15.7		31.4	8.2	8.16	
16	52.5	15.6		31.3	8.3	8.15	
17	55.8	15.3		31.4	8.0	8.14	
18	59.0	15.0		31.4	7.6	8.12	
19	62.3	15.0		31.2	7.6	8.11	
20	65.6	14.9		31.3	7.6	8.11	
21	68.9	14.8		31.2	7.6	8.11	

DATE: OCTOBER 11, 1970 TIME: 0612

STATION: B2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		30.8	8.8	8.36	
01	3.3	19.6		30.9	8.8	8.33	
02	6.6	19.6		30.9	8.6	8.25	
03	9.8	19.8		31.0	8.4	8.21	
04	13.1	19.6		31.0	8.3	8.16	
05	16.4	19.5		31.1	8.3	8.16	
06	19.7	19.3		31.1	8.1	8.14	
07	23.0	19.3		31.1	8.2	8.12	
08	26.2	19.2		31.2	8.1	8.11	
09	29.5	18.8		31.2	8.2	8.10	
10	32.8	18.6		31.3	8.1	8.09	
11	36.1	18.2		31.3	5.9	8.08	
12	39.4	17.8		31.4	5.8	8.06	
13	42.6	17.4		31.5	5.9	8.06	
14	45.9	17.1		31.5	6.1	8.07	
15	49.2	17.0		31.6	6.2	8.06	
16	52.5	16.8		31.6	6.0	8.06	

DATE: OCTOBER 11, 1970 TIME: 0606

STATION: B3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		30.8	7.1	8.42	
01	3.3	19.8		30.8	6.9	8.39	
02	6.6	19.7		30.9	6.6	8.32	
03	9.8	19.6		31.0	6.6	8.26	
04	13.1	19.4		31.1	6.6	8.26	
05	16.4	19.3		31.2	6.6	8.24	
06	19.7	19.2		31.3	6.4	8.22	
07	23.0	18.6		31.3	6.3	8.21	
08	26.2	18.6		31.3	6.3	8.20	
09	29.5	18.3		31.3	6.4	8.19	
10	32.8	18.1		31.3	6.6	8.18	
11	36.1	17.7		31.3	6.6	8.17	
12	39.4	17.5		31.4	6.7	8.17	
13	42.6	17.3		31.5	6.8	8.17	
14	45.9	17.0		31.5	7.0	8.17	
15	49.2	16.9		31.4	7.0	8.16	
16	52.5	16.7		31.4	6.8	8.14	
17	55.8	16.5		31.4	6.8	8.14	
18	59.0	16.3		31.5	6.6	8.13	
19	62.3	16.4		31.4	6.6	8.13	
20	65.6	16.1		31.4	6.6	8.12	

DATE: OCTOBER 11, 1970 TIME: 0602

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.5		30.7	6.7	8.57	
01	3.3	20.3		30.8	6.2	8.80	
02	6.6	20.1		31.1	6.7	8.36	
03	9.8	20.0		31.2	7.3	8.28	
04	13.1	19.9		31.2	7.1	8.28	
05	16.4	19.7		31.3	6.7	8.23	
06	19.7	19.5		31.3	6.6	8.22	
07	23.0	19.3		31.3	6.8	8.20	
08	26.2	19.3		31.3	6.8	8.17	
09	29.5	19.0		31.4	6.1	8.16	
10	32.8	19.0		31.5	6.1	8.15	
11	36.1	18.6		31.5	6.2	8.13	
12	39.4	18.3		31.6	6.0	8.12	
13	42.6	18.0		31.6	5.7	8.11	
14	45.9	17.7		31.6	6.0	8.11	
15	49.2	17.4		31.8	6.0	8.11	
16	52.5	17.1		31.6	5.9	8.10	
17	55.8	16.8		31.6	5.8	8.10	
18	59.0	16.7		31.6	5.9	8.10	
19	62.3	16.6		31.8	6.0	8.10	
20	65.6	16.2		31.4	5.6	8.10	

DATE: OCTOBER 11, 1970 TIME: 0720

STATION: B5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	21.3		30.7	7.1	8.32	
01	3.3	21.3		30.9	6.5	8.29	
02	6.6	21.3		31.0	6.0	8.20	
03	9.8	21.2		31.0	5.8	8.15	
04	13.1	21.0		31.1	6.0	8.13	
05	16.4	20.5		31.2	6.7	8.11	
06	19.7	19.7		31.6	5.7	8.09	
07	23.0	19.4		31.5	5.6	8.08	
08	26.2	19.2		31.4	5.6	8.08	
09	29.5	18.2		31.4	5.5	8.07	
10	32.8	18.7		31.4	5.3	8.07	
11	36.1	18.4		31.5	5.1	8.07	
12	39.4	18.1		31.6	5.1	8.06	
13	42.6	18.0		31.5	5.1	8.06	
14	45.9	17.9		31.5	5.0	8.04	
15	49.2	17.9		31.4	4.8	8.04	
16	52.5	17.8		31.3	5.1	8.08	
17	55.8	17.8		31.3	4.9	8.06	
18	59.0	17.7		31.4	5.0	8.05	
19	62.3	17.6		31.4	4.9	8.05	

DATE: OCTOBER 11 1970 TIME: 0730

STATION: B6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.4		30.0	7.3	8.04	
01	3.3	20.5		30.5	6.2	8.04	
02	6.6	20.5		30.5	6.4	8.04	
03	9.8	20.6		30.6	6.5	8.02	
04	13.1	20.1		30.9	5.9	8.01	
05	16.4	19.8		31.1	5.9	7.98	
06	19.7	19.2		31.2	5.9	7.98	
07	23.0	18.8		31.2	6.0	7.97	
08	26.2	18.8		31.2	6.2	7.98	
09	29.5	18.4		31.3	6.1	7.98	
10	32.8	18.5		31.3	5.7	7.97	
11	36.1	18.4		31.3	5.7	7.96	
12	39.4	18.1		31.3	5.8	7.96	
13	42.6	17.9		31.3	6.0	7.96	

DATE: OCTOBER 11, 1970 TIME: 0748

STATION: B7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY O/OO	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.5		30.8	6.9	8.30	
01	3.3	20.6		30.8	6.3	8.26	
02	6.6	20.4		30.8	5.9	8.21	
03	9.8	20.4		31.0	5.9	8.18	
04	13.1	20.3		31.1	6.1	8.14	
05	16.4	20.0		31.3	6.3	8.13	
06	19.7	19.8		31.2	6.2	8.13	
07	23.0	19.7		31.2	6.1	8.09	
08	26.2	19.5		31.3	5.9	8.06	
09	29.5	19.2		31.4	5.9	8.06	
10	32.8	19.0		31.3	5.6	8.06	
11	36.1	18.8		31.6	5.4	8.05	
12	39.4	18.3		31.4	5.0	8.06	
13	42.6	18.1		31.6	4.8	8.04	
14	45.9	18.0		31.8	4.8	8.03	
15	49.2	17.8		31.6	4.7	8.03	

DATE: OCTOBER 4, 1978 TIME: 1115

STATION: B8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.9		30.7	6.4	8.43	73.0
01	3.3	20.8		30.9	7.9	8.43	74.0
02	6.6	21.0		30.9	7.8	8.37	74.0
03	9.8	20.9		31.0	7.6	8.38	75.0
04	13.1	20.9		31.1	7.9	8.30	75.0
05	16.4	20.7		31.2	7.5	8.30	75.0
06	19.7	20.7		31.1	7.7	8.27	76.0
07	23.0	20.5		31.1	7.6	8.24	74.0
08	26.2	20.2		31.2	7.2	8.21	77.0
09	29.5	19.8		31.2	7.1	8.19	70.0
10	32.8	19.3		31.4	6.6	8.15	68.0
11	36.1	19.1		31.6	6.1	8.14	62.0
12	39.4	18.7		31.6	5.6	8.09	59.0
13	42.6	18.5		31.8	5.4	8.06	56.0
14	45.9	17.8		31.8	4.7	8.01	55.0
15	49.2	17.6		31.3	4.0	7.69	50.0
16	52.5	17.6		31.3	3.7	7.92	47.0
17	55.8	17.6		31.3	3.7	7.82	

DATE: OCTOBER 4, 1978 TIME: 1130

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.6	6.6	8.59	61.0
01	3.3	20.7		31.0	8.2	8.54	71.0
02	6.6	20.7		31.0	8.2	8.48	71.0
03	9.8	20.6		31.0	8.3	8.42	72.0
04	13.1	20.4		31.1	8.2	8.36	72.0
05	16.4	20.0		31.3	7.9	8.34	72.0
06	19.7	19.8		31.3	7.6	8.28	72.0
07	23.0	19.4		31.3	7.6	8.26	74.0
08	26.2	19.2		31.3	7.3	8.22	76.5
09	29.5	18.6		31.4	7.2	8.21	76.0
10	32.8	18.8		31.4	7.2	8.20	76.0
11	36.1	18.2		31.3	7.2	8.20	76.0
12	39.4	18.1		31.4	7.1	8.20	78.0
13	42.6	18.1		31.3	7.1	8.19	69.0
14	45.9	18.1		31.3	7.3	8.18	56.0
15	49.2	18.0		31.3	7.1	8.18	

DATE: OCTOBER 11, 1978 TIME: 0810

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		30.8	7.9	8.47	
01	3.3	18.6		31.1	7.9	8.44	
02	6.6	18.7		31.1	7.0	8.38	
03	9.8	18.9		31.2	7.0	8.35	
04	13.1	20.4		31.2	6.9	8.31	
05	16.4	19.3		31.2	6.8	8.27	
06	19.7	19.1		31.3	6.4	8.26	
07	23.0	18.9		31.4	6.0	8.23	
08	26.2	18.1		31.4	6.4	8.21	
09	29.5	18.0		31.6	6.3	8.19	
10	32.8	17.9		31.6	4.3	8.16	
11	36.1	17.8		31.6	4.2	8.17	
12	39.4	17.7		31.3	4.0	8.15	
13	42.6	17.1		31.4	4.1	8.15	
14	45.9	16.7		31.6	4.3	8.16	
15	49.2	16.8		31.6	4.3	8.16	
16	52.5	16.9		31.4	4.3	8.13	
17	55.8	16.6		31.4	4.4	8.13	
18	59.0	16.4		31.4	4.6	8.13	
19	62.3	16.3		31.4	4.8	8.12	
20	65.6	15.7		31.5	4.4	8.12	
21	68.9	15.8		31.4	4.9	8.11	
22	72.1	15.5		31.3	4.6	8.11	

DATE: OCTOBER 11, 1978 TIME: 0816

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.3		30.9	7.6	8.43	
01	3.3	20.1		31.0	7.5	8.34	
02	6.6	20.1		31.1	7.3	8.29	
03	9.8	19.8		31.1	7.6	8.28	
04	13.1	19.8		31.3	7.1	8.24	
05	16.4	19.7		31.3	7.0	8.21	
06	19.7	19.7		31.4	6.8	8.21	
07	23.0	19.7		31.4	6.8	8.18	
08	26.2	19.5		31.4	6.9	8.19	
09	29.5	18.5		31.4	6.6	8.19	
10	32.8	19.0		31.8	6.3	8.18	
11	36.1	19.0		31.5	6.0	8.18	
12	39.4	18.8		31.6	5.7	8.18	
13	42.6	18.3		31.6	6.1	8.17	
14	45.9	18.2		31.6	6.0	8.16	
15	49.2	18.0		31.8	5.8	8.14	
16	52.5	17.7		31.5	5.5	8.13	
17	55.8	17.0		31.5	5.3	8.12	
18	59.0	16.4		31.5	5.3	8.11	
19	62.3	14.9		31.5	5.2	8.11	
20	65.6	16.3		31.6	4.9	8.11	

DATE: OCTOBER 18, 1978 TIME: 1121

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.1	5.8	8.40	
01	3.3	18.5		31.1	5.6	8.16	
02	6.6	18.5		31.1	5.4	8.10	
03	9.8	18.6		31.1	5.6	7.96	
04	13.1	18.4		31.1	6.1	7.96	
05	16.4	18.3		31.2	6.1	7.87	
06	19.7	18.2		31.2	6.0	7.88	
07	23.0	18.1		31.2	6.2	7.88	
08	26.2	18.1		31.2	6.1	7.77	
09	29.5	18.1		31.2	6.1	7.78	
10	32.8	18.0		31.2	6.3	7.73	
11	36.1	18.0		31.2	6.3	7.72	

DATE: OCTOBER 18, 1978 TIME: 1119

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.2	8.6	8.44	
01	3.3	18.6		31.1	8.3	8.48	
02	6.6	18.6		31.1	8.3	8.38	
03	9.8	18.6		31.1	8.4	8.30	
04	13.1	18.6		31.1	8.4	8.23	
05	16.4	18.6		31.1	8.3	8.22	
06	19.7	18.6		31.1	8.9	8.18	
07	23.0	18.5		31.1	8.6	8.18	
08	26.2	18.4		31.2	8.6	8.20	
09	29.5	18.3		31.2	5.9	8.17	
10	32.8	18.3		31.2	6.0	8.18	
11	36.1	18.3		31.2	6.1	8.18	
12	39.2	18.2		31.2	6.0	8.18	
13	42.6	18.3		31.2	6.0	8.16	

DATE: OCTOBER 18, 1978 TIME: 1046

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.7		31.1	5.0	8.40	
01	3.3	19.2		31.1	4.7	8.40	
02	6.6	19.3		31.1	4.8	8.08	
03	9.8	19.2		31.1	6.1	8.08	
04	13.1	19.1		31.1	4.9	8.06	
05	16.4	19.1		31.2	4.8	8.06	
06	19.7	19.0		31.2	4.6	8.04	
07	23.0	18.9		31.2	5.6	8.03	
08	26.2	19.0		31.2	4.8	8.03	
09	29.4	18.8		31.3	4.7	8.03	
10	32.8	18.7		31.2	4.8	8.02	
11	36.1	18.6		31.3	4.7	8.02	
12	39.2	18.5		31.3	8.2	8.01	
13	42.6	18.5		31.2	8.2	8.02	
14	45.9	18.5		31.2	8.2	7.98	

DATE: OCTOBER 19, 1978 TIME: 0918

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.7		30.2	4.6	8.44	78.0
01	3.3	20.2		30.8	4.4	8.20	75.0
02	6.6	19.8		31.1	4.1	8.09	72.5
03	9.8	19.7		31.1	3.8	8.06	71.0
04	13.1	19.4		31.1	4.0	8.03	70.0
05	16.4	19.3		31.2	4.4	8.03	68.0
06	19.7	19.2		31.1	4.4	8.00	68.0
07	23.0	19.2		31.4	4.9	7.99	67.1
08	26.2	19.2		31.2	4.9	8.00	66.0
09	29.4	18.9		31.2	4.3	7.98	63.5
10	32.8	18.9		31.2	4.8	7.99	59.0
11	36.1	18.9		31.2	5.0	7.99	56.0
12	39.2	18.4		31.2	4.8	7.98	51.0
13	42.6	18.4		31.3	4.6	7.97	

DATE: OCTOBER 19, 1978 TIME: 0930

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		30.8	3.8	8.60	76.0
01	3.3	19.8		30.8	2.9	8.38	73.0
02	6.6	19.8		30.9	3.7	8.18	72.0
03	9.8	19.6		31.0	3.8	8.12	73.0
04	13.1	19.8		31.0	3.6	8.08	73.0
05	16.4	19.4		31.1	3.7	8.08	62.0
06	19.7	19.3		31.1	3.8	8.02	38.0
07	23.0	19.1		31.1	3.6	7.99	

DATE: OCTOBER 19, 1978 TIME: 1007

STATION: C6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.3		30.8	4.8	8.88	83.5
01	3.3	20.3		30.7	3.6	8.48	83.0
02	6.6	20.1		31.0	4.1	8.28	88.0
03	9.8	19.7		31.9	4.4	8.18	82.5
04	13.1	19.3		31.2	4.6	8.15	80.5
05	16.4	19.1		31.3	4.3	8.11	73.5
06	19.7	19.0		31.2	4.6	8.10	67.5
07	23.0	18.9		31.3	4.1	8.07	65.5
08	26.2	18.9		31.2	4.7	8.04	61.0
09	29.4	18.9		31.2	4.7	8.04	56.0
10	32.8	18.8		31.2	3.3	8.04	60.0
11	36.1	18.8		31.2	4.0	8.04	62.5
12	39.2	18.7		31.2	3.6	8.02	48.0

DATE: OCTOBER 19, 1978 TIME: 0854

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		30.7	4.6	8.20	76.0
01	3.3	19.8		30.8	3.9	8.15	73.0
02	6.6	19.8		30.9	3.8	8.06	73.0
03	9.8	19.8		31.0	4.0	7.99	73.0
04	13.1	19.4		31.0	4.0	7.95	76.0
05	16.4	19.4		31.1	4.1	7.93	63.0
06	19.7	19.4		31.1	4.1	7.92	62.0
07	23.0	19.3		31.1	4.1	7.91	62.0
08	26.7	19.2		31.1	4.8	7.91	62.0
09	29.4	19.2		31.3	4.4	7.91	60.0

DATE: OCTOBER 10, 1978 TIME: 1407

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	19.8		30.4	5.7	8.26	
01	3.3	19.8		30.9	5.6	8.40	
02	6.6	19.3		31.0	6.0	8.34	
03	9.8	19.2		31.0	6.0	8.30	
04	13.1	19.2		31.0	5.9	8.29	
05	16.4	19.0		31.0	5.8	8.24	
06	19.7	19.0		31.0	5.6	8.22	
07	23.0	18.8		31.1	5.2	8.18	
08	26.2	18.8		31.0	5.2	8.15	
09	29.5	18.6		31.1	5.0	8.14	
10	32.8	18.5		31.2	5.0	8.12	
11	36.1	18.3		31.2	5.0	8.12	
12	39.4	18.0		31.4	4.6	8.10	
13	42.6	17.8		31.2	4.2	8.10	
14	45.9	17.8		31.2	3.7	8.04	

DATE: OCTOBER 10, 1978 TIME: 1348

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	19.6		30.8	5.2	8.10	
01	3.3	19.5		31.0	4.7	8.08	
02	6.6	19.3		31.1	5.0	8.03	
03	9.8	19.2		31.2	5.2	8.03	
04	13.1	19.1		31.2	4.9	8.03	
05	16.4	19.0		31.3	4.8	8.02	
06	19.7	18.9		31.2	4.9	8.01	
07	23.0	18.6		31.2	5.1	8.01	
08	26.2	18.8		31.2	5.0	8.01	
09	29.5	18.4		31.2	5.1	8.01	
10	32.8	18.0		31.2	5.3	8.01	
11	36.1	16.5		31.2	5.2	8.02	
12	39.4	16.5		31.2	5.3	8.01	
13	42.6	17.9		31.3	5.1	8.01	

DATE: OCTOBER 10, 1978 TIME: 1332

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	19.6		31.1	5.1	8.15	
01	3.3	19.5		31.2	5.2	8.14	
02	6.6	19.3		31.1	5.3	8.08	
03	9.8	19.2		31.1	5.4	8.08	
04	13.1	19.1		31.2	5.5	8.06	
05	16.4	19.0		31.1	5.1	8.05	
06	19.7	19.0		31.0	5.0	8.02	
07	23.0	18.8		31.2	4.8	8.02	
08	26.2	18.7		31.3	5.1	8.02	
09	29.5	18.3		31.2	5.0	8.02	
10	32.8	18.2		31.2	5.0	8.02	
11	36.1	17.6		31.6	5.0	8.02	
12	39.2	17.6		31.6	4.8	8.02	
13	42.6	17.4		31.3	5.0	8.03	

DATE: OCTOBER 10, 1978 TIME: 0807

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	18.8		30.3	4.9	8.00	81.0
01	3.3	18.8		30.6	3.6	7.98	75.0
02	6.6	18.7		30.7	3.6	7.88	68.0
03	9.8	18.6		30.7	2.8	7.87	89.0
04	13.1	18.6		30.9	3.1	7.86	82.0
05	16.4	18.6		31.0	3.8	7.89	88.0
06	19.7	18.5		31.0	3.6	7.89	83.0
07	23.0	18.5		31.0	3.7	7.90	40.0

DATE: OCTOBER 11, 1978 TIME: 1000

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	20.7		30.0	7.2	8.46	
01	3.3	20.7		30.3	7.1	8.45	
02	6.6	20.6		30.8	7.4	8.40	
03	9.8	20.7		31.0	7.2	8.38	
04	13.1	20.0		31.2	6.9	8.30	
05	16.4	19.4		31.3	6.7	8.25	
06	19.7	19.3		31.3	6.9	8.23	
07	23.0	19.2		31.3	6.9	8.23	
08	26.2	19.2		31.3	6.8	8.21	
09	29.5	18.9		31.3	6.9	8.22	
10	32.8	18.7		31.3	6.9	8.20	
11	36.1	18.6		31.3	7.2	8.20	
12	39.2	18.1		31.4	7.0	8.19	
13	42.6	17.4		31.5	6.8	8.17	
14	45.9	16.9		31.6	6.9	8.15	
15	49.2	16.8		31.7	6.7	8.14	

DATE: OCTOBER 11, 1978 TIME: 0929

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	20.9		29.2	4.3	8.36	
01	3.3	20.8		29.7	5.8	8.33	
02	6.6	20.9		30.3	6.2	8.30	
03	9.8	20.7		30.7	6.6	8.24	
04	13.1	20.3		30.9	5.8	8.20	
05	16.4	20.1		31.1	6.5	8.17	
06	19.7	19.9		31.2	6.4	8.18	
07	23.0	19.6		31.3	5.0	8.10	
08	26.2	19.2		31.3	4.8	8.02	
09	29.5	18.8		31.4	3.8	7.98	

DATE: OCTOBER 11, 1978 TIME: 0840

STATION: D3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	20.4		29.6	8.2	8.48	
01	3.3	20.9		30.0	7.4	8.44	
02	6.6	21.0		30.3	7.4	8.42	
03	9.8	21.0		30.6	7.3	8.37	
04	13.1	20.1		31.1	7.1	8.30	
05	16.4	19.5		31.4	6.6	8.26	
06	19.7	18.4		31.3	6.5	8.21	
07	23.0	19.2		31.4	6.1	8.19	
08	26.2	18.9		31.4	6.1	8.17	
09	29.5	18.0		31.7	5.6	8.13	

DATE: OCTOBER 11, 1978 TIME: 0906

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	19.0		28.7	6.6	8.10	
01	3.3	20.2		28.9	5.6	8.10	
02	6.6	20.4		29.4	5.4	8.11	
03	9.8	20.4		30.0	5.0	8.11	
04	13.1	20.2		30.3	5.1	8.10	
05	16.4	19.9		30.8	4.8	8.07	
06	19.7	18.9		31.0	4.7	8.07	
07	23.0	18.6		31.2	4.4	8.08	
08	26.2	19.1		31.3	3.8	8.01	
09	29.5	18.9		31.4	3.9	7.98	

DATE: NOVEMBER 1, 1978 TIME: 0857

STATION: A1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		32.4	9.6	8.42	92.0
01	3.3	19.4		32.1	9.4	8.42	93.0
02	6.6	19.4		32.1	9.4	8.42	93.0
03	9.8	19.3		32.0	9.4	8.42	91.0
04	13.1	19.3		32.0	9.4	8.42	94.0
05	16.4	19.2		32.0	9.4	8.42	92.0
06	19.7	19.2		32.0	9.4	8.42	92.0
07	23.0	19.1		31.9	9.4	8.42	92.0
08	26.2	19.1		31.9	9.5	8.41	92.0
09	29.5	19.1		31.9	9.4	8.41	92.0
10	32.8	19.0		31.8	9.3	8.41	93.0
11	36.1	18.8		31.8	9.3	8.41	95.0
12	39.4	18.8		31.8	9.3	8.40	95.0
13	42.6	18.8		31.8	9.3	8.40	94.0
14	45.9	18.8		31.9	9.3	8.41	94.0
15	49.2	18.7		31.9	9.2	8.40	94.0
16	52.5	18.7		31.9	9.3	8.40	94.0
17	55.8	18.7		31.9	9.3	8.40	94.0
18	59.0	18.7		31.8	9.2	8.39	93.0
19	62.3	18.6		31.8	9.1	8.39	93.0
20	65.6	18.6		31.9	9.0	8.39	93.0

DATE: NOVEMBER 1, 1978 TIME: 0929

STATION: A2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		31.8	8.7	8.31	87.0
01	3.3	18.6		31.8	8.4	8.31	88.5
02	6.6	18.8		31.8	8.6	8.31	87.0
03	9.8	18.3		31.8	8.6	8.31	86.5
04	13.1	18.5		31.8	8.9	8.34	85.8
05	16.4	18.4		31.8	9.0	8.34	85.0
06	19.7	18.4		31.8	9.0	8.34	85.0
07	23.0	18.3		31.8	8.9	8.34	85.8
08	26.2	18.3		31.8	8.9	8.34	85.0
09	29.5	18.2		31.8	8.8	8.34	83.9
10	32.8	14.7		31.7	8.9	8.33	82.0
11	36.1	18.1		31.8	8.4	8.32	81.8
12	39.4	18.1		31.8	8.2	8.31	81.0

DATE: NOVEMBER 1, 1978 TIME: 0944

STATION: A3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		32.0	9.4	8.37	89.8
01	3.3	18.6		31.9	9.7	8.37	89.0
02	6.6	18.6		31.9	9.0	8.36	89.0
03	9.8	18.6		31.9	8.9	8.36	88.0
04	13.1	18.5		31.8	8.8	8.35	88.9
05	16.4	18.4		31.9	8.6	8.35	87.0
06	19.7	18.4		31.8	8.6	8.34	86.5
07	23.0	18.3		31.8	8.5	8.34	85.0
08	26.2	18.3		31.9	8.4	8.33	

DATE: NOVEMBER 1, 1978 TIME: 0952

STATION: A4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.3		31.7	9.3	8.37	79.0
01	3.3	18.8		31.6	9.7	8.38	79.0
02	6.6	18.4		31.5	9.9	8.36	78.8
03	9.8	18.1		31.5	8.9	8.34	78.6
04	13.1	18.3		31.6	8.6	8.33	72.0
05	16.4	18.2		31.5	8.9	8.33	74.9
06	19.7	18.2		31.6	8.1	8.33	

DATE: NOVEMBER 1, 1978 TIME: 0986

STATION: A7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		31.5	9.1	8.33	74.0
01	3.3	18.8		31.4	9.3	8.33	76.0
02	6.6	18.6		31.5	9.5	8.33	76.0
03	9.8	18.3		31.4	9.3	8.32	74.0
04	13.1	18.3		31.4	9.6	8.33	73.0
05	16.4	18.2		31.5	9.3	8.32	

DATE: NOVEMBER 1, 1978 TIME: 0848

STATION: A8

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		32.0	8.8	8.27	82.0
01	3.3	18.8		31.8	7.8	8.24	82.0
02	6.6	18.8		31.8	7.9	8.25	83.5
03	9.8	18.5		31.8	7.8	8.26	80.0
04	13.1	18.5		31.8	8.0	8.27	80.0
05	16.4	18.3		31.7	8.1	8.27	80.0
06	19.7	18.3		31.4	8.1	8.28	79.8
07	23.0	18.3		31.6	8.2	8.28	78.0
08	26.2	18.3		31.8	7.8	8.27	78.0

DATE: NOVEMBER 1, 1978 TIME: 0816

STATION: A9

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		32.3	10.0	8.38	83.5
01	3.3	18.7		32.0	9.9	8.37	83.5
02	6.6	18.7		31.8	9.8	8.38	83.0
03	9.8	18.5		31.8	9.6	8.37	82.0
04	13.1	18.5		31.8	9.0	8.37	82.8
05	16.4	18.4		31.8	9.7	8.37	82.9
06	19.7	18.4		31.8	9.5	8.36	83.0
07	23.0	18.4		31.8	9.3	8.38	84.8
08	26.2	18.4		31.8	9.2	8.38	84.0
09	29.5	18.3		31.8	9.2	8.39	88.0
10	32.8	18.3		31.8	8.7	8.32	86.8
11	36.1	18.3		31.8	8.4	8.31	86.0
12	39.4	18.2		31.8	8.3	8.29	88.5
13	42.6	18.2		31.8	8.0	8.28	48.0
14	45.9	18.2		31.8	7.8	8.27	44.0
15	49.2	18.1		31.8	7.8	8.26	43.0
16	52.5	18.0		31.7	7.8	8.27	42.0
17	55.8	17.9		31.6	7.3	8.26	

DATE: NOVEMBER 15, 1978 TIME: 1207

STATION: A10

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.4		31.5	8.8	7.82	84.0
01	3.3	17.4		31.8	6.1	7.84	84.0
02	6.6	17.3		32.2	6.1	7.84	83.0
03	9.8	17.3		32.2	6.1	7.84	83.0
04	13.1	17.4		32.2	6.1	7.83	83.0
05	16.4	17.4		32.3	6.1	7.86	82.0
06	19.7	17.6		32.5	6.1	7.86	80.0
07	23.0	17.8		32.4	8.1	7.88	81.0
08	26.2	17.8		32.4	8.3	7.87	78.0
09	29.5	17.8		32.4	8.0	7.85	80.0
10	32.8	17.8		32.5	6.0	7.81	78.0

DATE: NOVEMBER 1, 1978 TIME: 0828

STATION: A11

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		31.6	8.8	8.38	78.0
01	3.3	18.7		31.6	8.9	8.38	79.0
02	6.6	18.6		31.5	9.8	8.36	79.5
03	9.8	18.4		31.5	9.4	8.35	79.0
04	13.1	18.4		31.5	9.2	8.33	79.5
05	16.4	18.3		31.5	9.2	8.32	71.0
06	19.7	18.3		31.6	9.1	8.29	

DATE: NOVEMBER 1, 1978 TIME: 1022

STATION: A12

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		31.7	10.0	8.39	81.5
01	3.3	18.4		31.6	9.8	8.39	81.0
02	6.6	18.6		31.6	9.8	8.39	84.0
03	9.8	18.3		31.7	9.8	8.39	85.5
04	13.1	18.3		31.7	9.8	8.38	84.5
05	16.4	18.3		31.7	9.5	8.38	88.0
06	19.7	18.4		31.7	9.5	8.38	86.5
07	23.0	18.4		31.8	9.4	8.37	87.5
08	26.2	18.4		31.8	9.1	8.37	86.0
09	29.5	18.3		31.7	9.0	8.36	82.0
10	32.8	18.3		31.7	8.7	8.35	81.0
11	36.1	18.3		31.7	8.6	8.34	80.0

DATE: NOVEMBER 1, 1978 TIME: 0916

STATION: A13

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		31.8	9.7	8.39	89.0
01	3.3	18.5		31.8	9.4	8.39	88.5
02	6.6	18.4		31.7	9.1	8.37	88.5
03	9.8	18.4		31.7	9.1	8.37	90.0
04	13.1	18.5		31.7	9.0	8.37	88.0
05	16.4	18.5		31.7	9.0	8.37	87.5
06	19.7	18.5		31.8	9.0	8.36	87.0
07	23.0	18.3		31.8	8.9	8.36	86.5
08	26.2	18.3		31.8	9.0	8.36	46.5
09	29.5	18.2		31.7	8.9	8.35	46.0
10	32.8	18.2		31.7	8.4	8.34	46.0
11	36.1	18.1		31.7	8.6	8.34	49.5
12	39.4	18.1		31.7	8.4	8.33	48.0
13	42.6	18.1		31.8	8.4	8.32	44.0
14	45.9	18.1		31.8	8.3	8.32	41.9
15	49.2	18.1		31.8	8.2	8.32	40.0

DATE: NOVEMBER 1, 1978 TIME: 1019

STATION: A14

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		31.6	10.0	8.41	89.5
01	3.3	18.8		31.7	9.9	8.41	89.5
02	6.6	18.8		31.4	9.8	8.39	88.8
03	9.8	18.5		31.6	9.7	8.38	90.0
04	13.1	18.5		31.4	9.7	8.38	90.0
05	16.4	18.4		31.6	9.7	8.37	89.5
06	19.7	18.4		31.6	9.6	8.36	89.5
07	23.0	18.3		31.5	9.8	8.36	89.4
08	26.2	18.3		31.6	9.5	8.35	89.0
09	29.5	18.2		31.6	9.4	8.34	89.0
10	32.8	18.2		31.7	9.4	8.34	88.0
11	36.1	18.2		31.7	9.4	8.34	86.0
12	39.4	18.2		31.7	9.2	8.33	

DATE: NOVEMBER 1, 1978 TIME: 0638

STATION: A15

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		31.7	10.0	8.38	89.0
01	3.3	18.6		31.6	9.9	8.39	80.0
02	6.6	18.6		31.6	9.6	8.37	78.5
03	9.8	18.4		31.6	9.6	8.37	79.5
04	13.1	18.3		31.6	9.5	8.36	80.0
05	16.4	18.3		31.8	9.2	8.36	80.0
06	19.7	18.3		31.8	8.6	8.34	72.0
07	23.0	18.3		31.9	8.7	8.34	67.5
08	26.2	18.2		31.8	8.8	8.32	65.0

* DATE: NOVEMBER 1, 1978 TIME: 1017

STATION: A16

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		31.8	9.7	8.41	88.0
01	3.3	18.6		31.8	9.7	8.41	88.0
02	6.6	18.6		31.5	9.5	8.40	86.0
03	9.8	18.6		31.6	9.4	8.40	87.0
04	13.1	18.6		31.7	9.3	8.37	87.0
05	16.4	18.6		31.6	9.2	8.37	87.0
06	19.7	18.5		31.6	9.1	8.36	86.5
07	23.0	18.4		31.5	9.0	8.35	88.0
08	26.2	18.3		31.6	8.9	8.34	84.5
09	29.6	18.2		31.6	8.8	8.32	84.0

DATE: NOVEMBER 1, 1978 TIME: 0946

STATION: A17

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		31.9	9.6	8.35	90.0
01	3.3	18.6		31.9	9.4	8.35	89.5
02	6.6	18.6		31.8	9.4	8.35	89.5
03	9.8	18.6		31.9	9.4	8.35	89.5
04	13.1	18.6		31.8	9.2	8.34	88.5
05	16.4	18.4		31.8	8.9	8.34	88.0
06	19.7	18.4		31.8	8.9	8.34	87.5
07	23.0	18.4		31.8	8.9	8.34	87.0
08	26.2	18.3		31.8	8.7	8.33	86.0
09	29.6	18.2		31.6	8.6	8.33	83.5
10	32.8	18.2		31.6	8.3	8.31	80.0

DATE: NOVEMBER 8, 1978 TIME: 1110

STATION: B1

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		32.2	9.1	8.35	90.0
01	3.3	18.7		32.3	9.2	8.32	90.0
02	6.6	18.6		32.3	9.4	8.27	94.0
03	9.8	18.6		32.4	10.7	8.20	96.0
04	13.1	18.6		32.5	10.8	8.18	96.0
05	16.4	18.6		32.6	11.9	8.17	96.0
06	19.7	18.6		32.5	12.2	8.14	95.8
07	23.0	18.6		32.5	12.9	8.12	96.2
08	26.2	18.6		32.6	13.7	8.21	96.8
09	29.6	18.6		32.6	14.0	8.20	95.8
10	32.8	18.6		32.6	14.2	8.17	96.8
11	36.1	18.5		32.6	14.4	8.15	95.5
12	39.4	18.6		32.6	15.0	8.14	95.5
13	42.6	18.4		32.6	16.1	8.13	95.5
14	45.9	18.2		32.6	16.3	8.11	96.5
15	49.2	17.8		32.7	16.6	8.11	95.5
16	52.5	17.7		32.8	15.7	8.08	95.5
17	55.8	17.3		32.7	9.0	8.07	94.5
18	59.0	17.3		32.8	8.8	8.08	94.0
19	62.3	17.1		32.6	8.7	8.06	92.0
20	65.6	17.1		32.6	8.2	8.08	92.0

DATE: NOVEMBER 8, 1978 TIME: 1424

STATION: B2

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		32.2	8.3	8.17	88.0
01	3.3	18.7		32.1	8.6	8.14	86.8
02	6.6	18.7		32.3	8.7	8.08	88.0
03	9.8	18.7		32.3	9.7	7.97	87.3
04	13.1	18.7		32.3	10.2	7.91	87.6
05	16.4	18.7		32.5	10.8	8.00	88.5
06	19.7	18.7		32.3	11.5	7.87	88.0
07	23.0	18.7		32.4	11.6	7.88	88.0
08	26.2	18.6		32.4	12.0	7.87	87.0
09	29.6	18.6		32.4	12.4	7.88	86.5
10	32.8	18.5		32.4	12.7	7.89	86.0
11	36.1	18.6		32.4	13.0	7.88	86.5
12	39.4	18.6		32.5	13.1	7.89	87.0
13	42.6	18.5		32.5	13.3	7.89	85.5
14	45.9	18.5		32.6	13.3	7.89	82.0
15	49.2	18.5		32.8	13.5	7.87	81.0
16	52.5	18.5		32.9	13.8	7.87	79.0
17	55.8	18.4		32.8	13.8	7.97	69.0

DATE: NOVEMBER 8, 1978 TIME: 1010

STATION: B3

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		32.1	9.0	8.14	88.0
01	3.3	18.7		32.2	9.1	8.13	86.5
02	6.6	18.7		32.3	9.8	8.09	91.0
03	9.8	18.7		32.4	10.3	8.09	91.0
04	13.1	18.7		32.4	10.7	8.08	91.0
05	16.4	18.7		32.5	11.7	8.08	90.6
06	19.7	18.7		32.5	12.8	8.06	90.5
07	23.0	18.6		32.9	13.1	8.08	90.0
08	26.2	18.6		32.3	13.6	8.08	89.5
09	29.6	18.6		32.5	14.0	8.08	89.5
10	32.8	18.5		32.5	14.5	8.04	90.0
11	36.1	18.6		32.6	14.8	8.04	90.0
12	39.4	18.5		32.8	15.4	8.06	90.0
13	42.6	18.6		32.6	15.8	8.06	89.0
14	45.9	18.6		32.8	15.9	8.04	88.0
15	49.2	18.5		32.6	16.6	8.03	88.0
16	52.5	18.5		32.6	16.5	7.98	61.0
17	55.8	18.5		32.6	7.4	7.98	79.0
18	59.0	18.4		32.6	7.0	7.97	78.0
19	62.3	18.4		32.6	6.4	7.97	72.5

DATE: NOVEMBER 8, 1978 TIME: 0954

STATION: B4

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		32.2	6.3	8.10	90.0
01	3.3	18.8		32.2	6.3	8.02	88.6
02	6.6	18.7		32.3	6.0	8.02	90.6
03	9.8	18.7		32.4	5.9	8.00	90.0
04	13.1	18.7		32.4	8.8	8.00	89.0
05	16.4	18.7		32.4	8.0	8.00	89.8
06	19.7	18.7		32.4	8.9	7.99	89.5
07	23.0	18.7		32.5	9.0	7.98	89.0
08	26.2	18.7		32.3	8.9	7.99	88.0
09	29.6	18.7		32.3	8.9	7.98	88.1
10	32.8	18.7		32.6	6.0	8.00	88.1
11	36.1	18.7		32.6	5.9	8.00	88.0
12	39.4	18.6		32.6	5.8	7.99	87.1
13	42.6	18.6		32.6	6.0	7.99	86.0
14	45.9	18.5		32.6	5.4	7.98	86.5
15	49.2	18.5		32.6	5.6	7.98	86.1
16	52.5	18.4		32.6	5.8	7.98	83.9
17	55.8	18.4		32.6	5.8	7.98	77.0
18	59.0	18.4		32.6	5.5	7.98	73.5
19	62.3	18.4		32.4	6.7	7.97	74.0

DATE: NOVEMBER 8, 1978 TIME: 0834

STATION: B5

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.8		31.9	7.7	7.48	79.0
01	3.3	19.8		32.0	7.7	7.38	88.6
02	6.6	19.8		32.3	7.8	7.41	88.6
03	9.8	19.7		32.3	8.9	7.42	88.0
04	13.1	19.6		32.4	9.7	7.44	88.0
05	16.4	19.6		32.5	9.2	7.48	88.0
06	19.7	19.3		32.5	11.5	7.86	88.8
07	23.0	19.6		32.5	12.0	7.89	87.5
08	26.2	19.6		32.5	12.5	7.88	87.0
09	29.6	19.0		32.4	12.9	7.89	87.0
10	32.8	18.8		32.5	7.3	7.86	85.5
11	36.1	18.7		32.7	7.2	7.92	88.0
12	39.4	18.8		32.4	6.7	7.92	81.0

DATE: NOVEMBER 8, 1978 TIME: 0905

STATION: B6

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		32.1	6.6	8.08	89.5
01	3.3	18.2		32.2	6.1	8.02	89.0
02	6.6	19.2		32.6	5.9	7.86	88.0
03	9.8	19.2		32.4	5.9	7.93	87.0
04	13.1	19.7		32.4	5.8	7.90	87.0
05	16.4	19.2		32.4	5.9	7.89	84.0
06	19.7	19.8		32.4	5.9	7.89	86.0
07	23.0	18.9		32.5	5.6	7.89	84.0
08	26.2	18.6		32.6	5.8	7.90	83.8
09	29.6	18.7		32.6	5.9	7.91	84.8
10	32.8	18.6		32.6	5.9	7.91	82.5
11	36.1	18.6		32.6	5.8	7.91	77.8
12	39.4	18.6		32.6	5.7	7.91	73.5
13	42.6	18.8		32.6	5.7	7.91	75.0

DATE: NOVEMBER 8, 1978 TIME: 0837

STATION: B7

DEPTH METERS/FEET		TEMPERATURE °C	°F	SALINITY O/OO	O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.1		32.1	8.6	7.39	87.0
01	3.3	19.2		32.3	8.8	7.43	90.0
02	6.6	18.2		32.3	9.6	7.51	91.5
03	9.8	19.1		32.3	9.8	7.57	90.0
04	13.1	19.1		33.3	10.3	7.42	90.0
05	16.4	19.1		32.4	10.4	7.47	89.9
06	19.7	19.0		32.4	10.6	7.67	90.0
07	23.0	19.0		32.5	10.7	7.70	90.9
08	26.2	18.9		32.4	10.8	7.72	89.5
09	29.6	18.8		32.4	10.8	7.86	88.3
10	32.8	18.7		32.5	10.8	7.84	89.5
11	36.1	18.7		32.5	10.6	7.94	88.0
12	39.4	18.7		32.5	10.7	7.98	88.5
13	42.6	18.7		32.5	10.7	7.86	83.0
14	45.9	18.8		32.6	10.7	7.86	82.5
15	49.2	18.8		32.6	10.7	7.88	82.0
16	52.5	18.8		32.6	10.7	7.68	78.0
17	55.8	18.6		32.4	10.4	7.84	74.5

DATE: NOVEMBER 1, 1976 TIME: 0947

STATION: B4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.4		31.7	10.0	8.42	41.0
01	3.3	18.4		31.6	10.0	8.41	45.0
02	6.6	18.4		31.6	9.9	8.40	41.5
03	9.8	18.4		31.6	9.9	8.40	42.5
04	13.1	18.4		31.6	9.8	8.39	43.0
05	16.4	18.3		31.6	9.7	8.39	44.5
06	19.7	18.3		31.6	9.6	8.38	48.0
07	23.0	18.3		31.7	9.2	8.37	44.0
08	26.2	18.3		31.7	8.8	8.34	38.0
09	29.6	18.3		31.7	8.6	8.34	43.5
10	32.8	18.3		31.7	6.9	8.32	43.0
11*	36.1	18.3		31.7	8.4	8.32	48.0
12	39.2	18.3		31.7	8.3	8.32	43.0
13	42.6	18.3		31.7	8.3	8.32	41.0
14	45.9	18.2		31.7	4.2	8.31	70.0
15	49.2	18.2		31.7	8.1	8.31	77.0
16	52.5	18.2		31.7	7.8	8.31	43.0

DATE: NOVEMBER 1, 1976 TIME: 1043

STATION: B9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.8	9.9	8.42	84.5
01	3.3	18.6		31.7	9.8	8.42	86.9
02	6.6	18.8		31.7	9.7	8.40	87.0
03	9.8	18.8		31.7	9.8	8.40	88.0
04	13.1	18.8		31.7	9.7	8.39	88.0
05	16.4	18.4		31.7	9.1	8.38	88.0
06	19.7	18.4		31.6	8.9	8.37	87.5
07	23.0	18.3		31.7	8.9	8.36	87.5
08	26.2	18.3		31.7	8.9	8.36	86.0
09	29.6	18.3		31.7	8.9	8.36	85.5
10	32.8	18.3		31.7	8.7	8.35	80.5
11	36.1	18.3		31.7	8.7	8.35	86.0
12	39.2	18.3		31.7	8.8	8.34	87.0
13	42.6	18.2		31.7	8.4	8.34	87.0
14	45.9	18.2		31.7	8.3	8.34	87.0
15	49.2	18.0		31.6	8.2	8.33	84.8
16	52.5	17.8		31.6	7.8	8.32	83.5
17	55.8	17.6		31.5	7.8	8.31	76.0
18	59.0	17.4		31.4	7.3	8.28	75.5
19	62.3	17.1		31.4	7.1	8.28	74.0
20	65.6	17.1		31.5	7.0	8.27	70.0
21	68.9	17.1		31.4	7.0	8.26	70.0
22	72.1	17.0		31.6	6.6	8.25	67.5

DATE: NOVEMBER 8, 1976 TIME: 1040

STATION: B10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		31.8	9.1	8.30	90.0
01	3.3	18.7		32.0	9.2	8.20	87.5
02	6.6	18.7		32.1	9.4	8.10	90.5
03	9.8	18.8		32.2	10.3	8.08	90.0
04	13.1	18.8		32.3	10.9	8.02	89.5
05	16.4	18.8		32.3	11.8	8.02	90.5
06	19.7	18.8		32.3	12.3	8.01	92.0
07	23.0	18.8		32.4	13.3	8.02	92.0
08	26.2	18.8		32.5	13.5	8.01	92.0
09	29.6	18.6		32.4	14.3	8.00	92.5
10	32.8	18.8		32.4	14.8	8.00	92.0
11	36.1	18.5		32.5	15.5	7.99	89.5
12	39.2	18.5		32.5	16.0	8.00	87.5
13	42.6	18.5		32.5	16.7	7.99	87.5
14	45.9	18.5		32.5	16.1	7.99	87.0
15	49.2	18.5		32.5	16.9	7.98	87.0
16	52.5	18.5		32.6	17.1	7.98	88.5
17	55.8	18.4		32.6	17.4	7.99	88.0
18	59.0	18.4		32.6	17.7	7.99	87.5
19	62.3	18.4		32.6	17.8	7.98	89.0
20	65.6	18.4		32.6	17.9	8.02	84.0
21	68.9	18.4		32.6	18.1	8.01	83.0

DATE: NOVEMBER 8, 1976 TIME: 1024

STATION: B11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.8		32.3	8.8	8.42	90.0
01	3.3	18.7		32.3	8.9	8.38	90.0
02	6.6	18.7		32.4	9.1	8.32	79.0
03	9.8	18.6		32.4	9.2	8.20	89.0
04	13.1	18.7		32.5	8.8	8.14	88.5
05	16.4	18.6		32.5	8.8	8.14	88.5
06	19.7	18.6		32.6	8.8	8.11	89.0
07	23.0	18.5		32.6	9.8	8.10	89.0
08	26.2	18.5		32.6	8.4	8.10	88.5
09	29.6	18.5		32.6	12.5	8.09	88.0
10	32.8	18.5		32.6	13.6	8.08	88.0
11	36.1	18.6		32.6	14.6	8.07	88.0
12	39.2	18.6		32.6	15.0	8.08	90.0
13	42.6	18.5		32.6	15.4	8.07	84.0
14	45.9	18.5		32.6	15.8	8.06	88.5
15	49.2	18.8		32.6	16.3	8.06	81.5
16	52.5	18.6		32.6	16.8	8.06	81.0
17	55.8	18.8		32.6	16.9	8.08	81.0
18	59.0	18.5		32.6	17.1	8.08	81.8
19	62.3	18.4		32.6	17.6	8.08	81.0
20	65.6	18.4		32.6	17.7	8.04	80.0

DATE: NOVEMBER 16, 1976 TIME: 1248

STATION: C1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.6		31.7	8.4	7.87	74.0
01	3.3	18.6		31.7	8.2	7.87	74.0
02	6.6	18.4		31.8	8.2	7.88	73.0
03	9.8	18.3		32.0	8.3	7.89	72.0
04	13.1	18.0		32.1	8.4	7.89	71.0
05	16.4	17.9		32.3	8.6	7.92	73.0
06	19.7	17.8		32.3	8.7	7.92	75.0
07	23.0	17.8		32.3	8.8	7.98	77.0
08	26.2	17.7		32.4	6.1	7.95	79.0
09	29.6	17.7		32.4	6.2	7.97	78.0

DATE: NOVEMBER 15, 1976 TIME: 1132

STATION: C2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		31.3	3.0	7.88	66.0
01	3.3	18.7		31.6	2.9	7.87	66.0
02	6.6	18.7		31.7	3.2	7.87	63.0
03	9.8	18.7		31.7	3.4	7.88	63.0
04	13.1	18.6		31.9	2.9	7.87	66.0
05	16.4	18.3		32.0	3.1	7.87	66.0
06	19.7	18.1		32.2	3.4	7.90	67.0
07	23.0	17.9		32.3	3.1	7.91	73.0
08	26.2	17.8		32.3	3.1	7.98	74.0
09	29.6	17.8		32.3	2.6	7.98	73.0
10	32.8	17.8		32.3	2.9	7.97	70.0

DATE: NOVEMBER 15, 1976 TIME: 1111

STATION: C3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.0		30.8	3.8	7.88	75.0
01	3.3	19.0		30.6	3.6	7.84	74.0
02	6.6	19.0		31.6	3.2	7.84	74.0
03	9.8	19.0		31.7	3.3	7.84	74.0
04	13.1	18.9		31.8	3.8	7.83	72.0
05	16.4	18.6		32.1	3.4	7.85	71.0
06	19.7	18.3		32.2	3.4	7.86	67.0
07	23.0	18.3		32.4	3.8	7.86	66.0
08	26.2	18.3		32.4	3.3	7.88	67.0
09	29.6	18.1		32.6	3.4	7.89	68.0
10	32.8	17.8		32.6	3.6	7.90	68.0
11	36.1	17.8		32.8	3.6	7.94	66.0

DATE: NOVEMBER 16, 1976 TIME: 0954

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	20.4		31.0	3.8	7.87	79.0
01	3.3	20.0		31.2	3.6	7.88	80.0
02	6.6	20.2		31.8	3.3	7.82	84.0
03	9.8	19.1		32.1	3.6	7.82	73.0
04	13.1	19.1		32.2	3.6	7.84	71.0
05	16.4	19.7		32.1	3.6	7.84	71.0
06	19.7	19.1		32.2	3.1	7.84	72.0
07	23.0	18.5		32.3	3.1	7.84	66.0
08	26.2	18.3		32.3	3.3	7.87	69.0
09	29.6	18.3		32.3	3.4	7.87	69.0
10	32.8	18.3		32.3	3.2	7.88	72.0
11	36.1	18.3		32.3	3.1	7.88	74.0
12	39.2	18.3		32.3	3.1	7.87	74.0

DATE: NOVEMBER 15, 1976 TIME: 1017

STATION: C5

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		30.8	3.0	7.84	43.0
01	3.3	18.6		31.3	3.0	7.83	48.0
02	6.6	18.6		33.3	2.9	7.80	42.0
03	9.8	19.4		33.4	2.9	7.78	62.0
04	13.1	19.4		31.8	2.6	7.77	78.0
05	16.4	18.4		32.0	2.6	7.76	77.0
06	19.7	19.3		32.0	2.6	7.76	74.0

DATE: NOVEMBER 15, 1976 TIME: 1042

STATION: C6

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	22.2		32.1	3.3	7.62	90.0
01	3.3	21.6		32.2	2.7	7.62	88.0
02	6.6	20.2		32.4	2.4	7.70	84.0
03	9.8	20.0		32.5	2.7	7.76	84.0
04	13.1	19.4		32.7	2.9	7.76	88.0
05	16.4	19.2		32.6	3.1	7.77	86.0
06	19.7	18.1		32.5	3.2	7.78	86.0
07	23.0	18.7		32.6	3.2	7.76	86.0
08	26.2	18.4		32.6	3.3	7.80	88.0
09	29.6	18.5		32.5	3.2	7.80	84.0
10	32.8	18.1		32.6	3.3	7.82	81.0
11	36.1	18.4		32.6	3.3	7.88	81.0

DATE: NOVEMBER 15, 1976 TIME: 0930

STATION: C7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.5		30.3	3.5	8.01	86.0
01	3.3	18.6		31.1	3.1	7.97	88.0
02	6.6	18.6		31.6	2.7	7.87	88.0
03	9.8	18.7		31.7	2.9	7.88	88.0
04	13.1	18.7		31.7	3.0	7.81	87.0
05	16.4	18.9		31.9	2.9	7.79	91.0
06	19.7	18.9		32.1	2.9	7.77	90.0
07	23.0	18.9		32.3	2.9	7.78	86.0
08	26.2	18.6		32.3	2.9	7.78	87.0
09	29.6	18.6		32.4	3.0	7.77	86.0
10	32.8	18.9		32.4	2.9	7.76	85.0
11	36.1	18.7		32.4	2.9	7.73	85.0
12	39.4	18.6		32.4	2.8	7.72	85.0
13	42.6	18.6		32.4	2.5	7.70	

DATE: NOVEMBER 16, 1978 TIME: 1348

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.0		30.9	4.0	7.87	79.0
01	3.3	18.3		31.0	4.0	7.82	80.0
02	6.6	18.3		31.3	4.1	7.84	80.0
03	9.8	18.5		30.8	3.9	7.83	82.0
04	13.1	18.6		32.0	3.9	7.83	83.0
05	16.4	18.5		32.1	3.8	7.83	85.0
06	19.7	18.5		32.2	3.9	7.85	81.0
07	23.0	18.5		32.3	3.6	7.85	81.0
08	26.2	18.4		32.4	3.8	7.85	81.0
09	29.6	18.4		32.4	3.8	7.86	78.0
10	32.8	18.4		32.5	3.8	7.86	76.0

DATE: NOVEMBER 19, 1978 TIME: 1328

STATION: C4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.2		30.7	5.7	8.10	68.0
01	3.3	18.3		31.0	4.8	8.06	74.0
02	6.6	18.4		31.2	4.4	7.91	77.0
03	9.8	18.8		31.5	4.4	7.90	78.0
04	13.1	18.8		31.9	4.3	7.88	81.0
05	16.4	18.8		32.1	4.3	7.87	82.0
06	19.7	18.4		32.3	4.1	7.87	83.0
07	23.0	18.3		32.3	4.4	7.87	84.0
08	26.2	18.3		32.4	4.4	7.89	82.0
09	29.6	18.3		32.4	4.4	7.89	82.0
10	32.8	18.2		32.5	4.3	7.90	82.0
11	36.1	18.2		32.8	4.8	7.90	79.0
12	39.4	18.2		32.8	4.7	7.90	76.0

DATE: NOVEMBER 19, 1978 TIME: 0857

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.3		30.0	3.8	7.87	76.0
01	3.3	17.8		30.8	3.9	7.83	80.0
02	6.6	18.3		30.8	3.8	7.83	81.0
03	9.8	18.4		31.3	3.8	7.83	82.0
04	13.1	18.4		31.8	3.9	7.84	83.0
05	16.4	18.4		31.9	3.8	7.84	84.0
06	19.7	18.4		32.1	3.8	7.84	82.0
07	23.0	18.5		32.1	3.7	7.84	88.0
08	26.2	18.4		32.3	3.7	7.86	83.0
09	29.6	18.3		32.4	4.0	7.86	83.0
10	32.8	18.2		32.5	4.0	7.89	83.0
11	36.1	18.2		32.5	4.1	7.89	84.0
12	39.4	18.2		32.5	4.0	7.89	84.0
13	42.6	18.2		32.5	3.6	7.86	84.0

DATE: NOVEMBER 18, 1978 TIME: 0815

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	17.8		29.3	3.0	7.77	69.0
01	3.3	18.0		30.0	2.8	7.76	72.0
02	6.6	18.3		30.4	2.7	7.76	78.0
03	9.8	18.8		31.4	2.6	7.79	78.0
04	13.1	18.8		31.9	2.7	7.81	77.0
05	16.4	18.8		32.1	2.5	7.81	76.0
06	19.7	18.8		32.2	2.6	7.82	77.0
07	23.0	18.8		32.2	2.4	7.82	76.0
08	26.2	18.5		30.3	2.7	7.82	69.0

DATE: NOVEMBER 6, 1978 TIME: 1138

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.9		31.9	7.7	8.09	88.0
01	3.3	19.0		31.9	7.7	8.09	89.0
02	6.6	18.0		32.0	7.8	8.09	91.0
03	9.8	18.9		32.2	9.3	8.09	93.0
04	13.1	18.8		32.2	9.6	8.09	91.0
05	16.4	18.7		32.4	10.2	8.09	91.0
06	19.7	18.7		32.4	10.5	8.10	91.5
07	23.0	18.7		32.4	10.8	8.10	82.0
08	26.2	18.6		32.8	10.9	8.08	88.0
09	29.6	18.6		32.5	11.1	8.08	88.0
10	32.8	18.6		32.6	11.4	8.08	90.0
11	36.1	18.6		32.6	11.5	8.08	89.5
12	39.4	18.8		32.6	11.6	8.08	88.0
13	42.6	18.5		32.6	11.3	8.08	89.0
14	45.9	18.8		32.6	11.2	8.08	92.0

DATE: NOVEMBER 6, 1978 TIME: 1153

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.3		30.6	8.7	8.48	79.0
01	3.3	19.1		31.0	9.0	8.28	86.0
02	6.6	19.1		31.8	9.6	8.15	84.0
03	9.8	19.1		32.0	10.4	8.12	86.0
04	13.1	18.9		32.3	11.0	8.10	87.0
05	16.4	18.9		32.8	12.0	8.08	67.0
06	19.7	18.8		32.8	12.5	8.08	86.0
07	23.0	18.7		32.6	13.2	8.06	84.0
08	26.2	18.7		32.6	13.1	8.02	73.0
09	29.6	18.4		32.6	13.3	8.01	66.0
10	32.8	18.4		32.5	8.5	7.97	40.0

DATE: NOVEMBER 8, 1978 TIME: 1142

STATION: D3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.1		31.9	7.7	8.36	87.5
01	3.3	19.1		31.8	7.6	8.33	88.0
02	6.6	19.1		32.3	7.5	8.24	89.0
03	9.8	19.0		32.3	7.4	8.21	91.0
04	13.1	19.0		32.4	7.6	8.13	91.0
05	16.4	18.8		32.5	7.0	8.13	89.0
06	19.7	18.7		32.6	6.8	8.08	88.5
07	23.0	18.6		32.6	6.4	8.08	87.5
08	26.2	18.4		32.6	6.3	8.08	81.0

DATE: NOVEMBER 8, 1978 TIME: 1156

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	19.6		31.2	6.4	8.08	85.0
01	3.3	19.1		31.4	6.5	8.06	87.0
02	6.6	19.1		31.2	6.4	8.01	88.0
03	9.8	18.9		32.4	5.9	7.60	84.0
04	13.1	18.8		32.5	5.8	7.98	84.0
05	16.4	18.8		32.8	5.8	7.94	84.0
06	19.7	18.8		32.8	5.8	7.97	82.0
07	23.0	18.7		32.5	5.7	7.87	80.0
08	26.2	18.8		32.4	4.8	7.87	67.0

DATE: DECEMBER 6, 1978 TIME: 0836

STATION: A0

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.4		33.0	10.4	8.23	
01	3.3	14.4		33.1	9.8	8.20	
02	6.6	14.4		33.2	9.8	8.20	
03	9.8	14.4		33.2	8.7	8.18	
04	13.1	14.4		33.2	8.9	8.17	
05	16.4	14.4		33.2	9.4	8.15	
06	19.7	14.4		33.2	9.4	8.15	
07	23.0	14.4		33.2	9.3	8.14	
08	26.2	14.4		33.3	9.2	8.14	
09	29.5	14.4		33.3	8.8	8.14	
10	32.8	14.4		33.3	9.4	8.13	
11	36.1	14.4		33.3	9.8	8.13	
*12	39.2	14.3		33.3	9.7	8.13	
13	42.6	14.0		33.4	9.8	8.12	
14	45.9	14.4		33.4	9.6	8.12	
15	49.2	14.3		33.4	9.4	8.11	
16	52.5	13.9		33.4	9.0	8.10	
17	55.8	13.8		33.5	8.6	8.09	
18	59.0	13.3		33.4	8.4	8.05	
19	62.3	13.3		33.4	8.4	8.04	
20	65.6	13.1		33.4	8.3	8.04	
21	68.9	13.0		33.4	8.2	8.03	
22	72.1	13.0		33.4	8.0	8.02	

DATE: DECEMBER 6, 1978 TIME: 0850

STATION: A1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		32.8	9.8	8.20	
01	3.3	14.8		32.9	9.4	8.18	
02	6.6	14.8		33.1	9.8	8.15	
03	9.8	14.8		33.2	9.7	8.13	
04	13.1	14.8		33.2	8.7	8.12	
05	16.4	14.8		33.2	9.7	8.12	
06	19.7	14.8		33.2	9.8	8.12	
07	23.0	14.8		33.3	9.7	8.12	
08	26.2	14.8		33.3	9.8	8.12	
09	29.4	14.8		33.3	9.4	8.11	
10	32.8	14.8		33.1	9.4	8.11	
11	36.1	14.8		33.3	9.4	8.10	
12	39.2	14.6		33.3	9.5	8.11	
13	42.6	14.8		33.3	9.6	8.10	
14	45.9	14.8		33.3	9.9	8.11	
15	49.2	14.7		33.4	9.4	8.11	
16	52.5	14.5		33.4	9.6	8.10	
17	55.8	14.4		33.4	9.2	8.07	
18	59.0	14.4		33.4	9.0	8.07	
19	62.3	14.3		33.4	8.8	8.06	
20	65.6	13.9		33.4	8.0	8.03	
21	68.9	13.9		33.4	8.1	8.03	
22	72.1	13.9		33.4	8.2	8.03	

DATE: DECEMBER 6, 1978 TIME: 0753

STATION: A2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		33.0	9.7	8.12	
01	3.3	15.0		33.1	9.7	8.10	
02	6.6	15.0		33.2	9.8	8.09	
03	9.8	15.0		33.2	9.8	8.08	
04	13.1	15.0		33.2	9.6	8.04	
05	16.4	15.0		33.3	9.6	8.06	
06	19.7	15.0		33.3	9.2	8.06	
07	23.0	15.0		33.3	8.8	8.06	
08	26.2	14.9		33.3	8.6	8.06	
09	29.6	14.9		33.1	8.5	8.06	
10	32.8	14.9		33.4	8.7	8.07	
11	36.1	14.9		33.4	9.0	8.08	
12	39.2	14.9		33.4	8.9	8.08	

DATE: DECEMBER 6, 1978 TIME: 0830

STATION: A3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.7		32.7	9.0	8.27	
01	3.3	14.9		33.0	8.7	8.22	
02	6.6	14.9		33.0	8.8	8.16	
03	9.6	14.9		33.1	8.4	8.18	
04	13.1	14.9		33.2	8.9	8.12	
05	16.4	14.9		33.2	8.8	8.12	
06	19.7	14.9		33.2	9.1	8.11	
07	23.0	14.9		33.2	8.0	8.11	

DATE: DECEMBER 6, 1978 TIME: 0834

STATION: A4

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.4		32.9	8.3	8.43	
01	3.3	14.7		33.0	8.3	8.31	
02	6.6	14.7		33.0	7.5	8.20	
03	9.8	14.7		33.1	7.5	8.16	
04	13.1	14.7		33.2	7.4	8.16	
05	16.4	14.7		33.2	7.4	8.12	

DATE: DECEMBER 6, 1978 TIME: 0839

STATION: A7

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		32.5	8.6	8.17	
01	3.3	14.8		32.7	8.5	8.13	
02	6.6	14.8		33.0	8.2	8.11	
03	9.8	14.7		33.2	8.7	8.11	
04	13.1	14.7		33.2	7.9	8.09	

DATE: DECEMBER 6, 1978 TIME: 0757

STATION: A8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	16.2		32.5	9.3	8.14	
01	3.3	15.4		32.8	7.8	8.08	
02	6.6	15.2		33.0	7.9	8.08	
03	9.8	15.1		33.2	8.8	8.08	
04	13.1	15.1		33.2	8.8	8.07	
05	16.4	15.1		33.3	8.8	8.08	
06	19.7	15.1		33.3	8.8	8.07	
07	23.0	15.1		33.3	9.3	8.06	

DATE: DECEMBER 6, 1978 TIME: 0745

STATION: A9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.0		32.4	8.6	8.05	
01	3.3	15.1		32.6	7.6	8.03	
02	6.6	15.1		32.9	7.8	8.01	
03	9.8	15.1		33.0	7.6	8.00	
04	13.1	15.1		33.1	7.4	7.99	
05	16.4	15.1		33.1	7.5	7.98	
06	19.7	15.1		33.1	7.4	7.98	
07	23.0	15.1		33.1	7.6	7.97	
08	26.2	15.1		33.1	7.1	7.97	
09	29.5	15.1		33.1	7.2	7.98	
10	32.8	15.0		33.2	8.1	8.01	
11	36.1	15.0		33.2	8.6	8.05	
12	39.2	15.0		33.3	8.8	8.06	
13	42.6	15.0		33.3	9.0	8.06	

DATE: DECEMBER 20, 1978 TIME: 1150

STATION: A10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.6		32.9	9.2	7.86	83.0
01	3.3	13.7		32.8	9.1	7.86	83.0
02	6.6	13.5		33.1	8.3	7.90	83.0
03	9.8	13.5		33.2	9.4	7.92	83.0
04	13.1	13.5		33.2	9.4	7.93	84.0
05	16.4	13.5		33.3	9.7	7.94	84.0
06	19.7	13.3		33.5	9.4	7.96	86.0
07	23.0	13.4		33.3	8.4	7.96	86.0
08	26.2	13.7		33.2	9.4	7.96	86.0
09	29.5	13.5		33.4	9.2	7.97	85.0

DATE: DECEMBER 6, 1978 TIME: 1019

STATION: A11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.5		32.8	9.0	8.22	
01	3.3	14.5		33.1	9.0	8.22	
02	6.6	14.7		33.2	9.4	8.19	
03	9.8	14.7		33.2	9.0	8.16	
04	13.1	14.6		33.3	8.6	8.13	
05	16.4	14.5		33.3	8.5	8.12	

DATE: DECEMBER 6, 1978 TIME: 1129

STATION: A12

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.1		33.0	9.2	8.20	
01	3.3	15.1		33.1	9.3	8.16	
02	6.6	15.1		33.2	9.3	8.14	
03	9.8	15.1		33.1	9.6	8.13	
04	13.1	15.1		33.2	9.4	8.12	
05	16.4	15.1		33.2	9.4	8.10	
06	19.7	15.1		33.2	9.4	8.09	
07	23.0	15.1		33.2	9.1	8.09	
08	26.2	15.1		33.2	9.2	8.08	
09	29.4	15.0		33.3	9.1	8.07	
10	32.8	14.9		33.3	8.9	8.07	
11	36.1	14.9		33.3	8.4	8.11	
12	39.2	14.8		33.3	8.8	8.09	

DATE: DECEMBER 6, 1978 TIME: 0908

STATION: A13

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY o/oo	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.8		33.0	9.4	8.11	
01	3.3	14.8		33.1	8.8	8.08	
02	6.6	14.8		33.1	8.8	8.08	
03	9.8	14.8		33.2	8.9	8.07	
04	13.1	14.8		33.2	9.3	8.07	
05	16.4	14.8		33.2	9.3	8.09	
06	19.7	14.8		33.2	9.4	8.10	
07	23.0	14.8		33.2	9.3	8.09	
08	26.2	14.8		33.3	8.9	8.08	
09	29.4	14.8		33.3	8.7	8.09	
10	32.8	14.8		33.3	8.7	8.08	
11	36.1	14.8		33.3	8.7	8.08	
12	39.2	14.8		33.3	8.2	8.08	
13	42.6	14.6		33.3	9.1	8.08	
14	45.9	14.6		33.3	9.2	8.06	

DATE: DECEMBER 6, 1978 TIME: 1153

STATION: A14

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.8		33.0	9.7	8.46	
01	3.3	14.9		33.1	9.7	8.36	
02	6.6	14.9		33.2	9.7	8.31	
03	9.8	14.9		33.2	9.7	8.26	
04	13.1	14.9		33.2	9.7	8.23	
05	16.4	14.9		33.2	9.8	8.20	
06	19.7	14.9		33.3	9.6	8.18	
07	23.0	14.9		33.3	9.4	8.16	
08	26.2	14.9		33.3	9.3	8.15	
09	29.5	14.9		33.3	9.0	8.14	
10	32.8	14.9		33.3	9.1	8.13	
11	36.1	14.9		33.4	9.1	8.13	

DATE: DECEMBER 6, 1978 TIME: 1015

STATION: A15

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	15.2		32.9	9.7	8.42	
01	3.3	15.3		33.0	9.7	8.30	
02	6.6	15.3		33.1	9.6	8.25	
03	9.8	15.3		33.2	9.6	8.22	
04	13.1	15.3		33.2	9.7	8.21	
05	16.4	15.3		33.2	9.6	8.18	
06	19.7	15.3		33.2	9.6	8.18	
07	23.0	15.3		33.3	9.4	8.16	

DATE: DECEMBER 6, 1978 TIME: 1000

STATION: A16

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.8		32.8	10.0	8.37	
01	3.3	14.8		32.9	9.8	8.33	
02	6.6	14.8		33.1	9.7	8.18	
03	9.8	14.9		33.1	9.4	8.18	
04	13.1	14.9		33.2	9.4	8.14	
05	16.4	14.9		33.2	8.9	8.12	
06	19.7	14.9		33.2	9.1	8.12	
07	23.0	14.8		33.2	8.9	8.11	

DATE: DECEMBER 8, 1978 TIME: 0924

STATION: A17

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.8		32.9	9.8	8.27	
01	3.3	14.8		33.1	9.1	8.22	
02	6.6	14.8		33.1	8.8	8.18	
03	9.8	14.8		33.2	9.0	8.18	
04	13.1	14.8		33.2	9.0	8.14	
05	16.4	14.8		33.3	9.0	8.13	
06	19.7	14.8		33.3	9.3	8.12	
07	23.0	14.8		33.3	9.3	8.11	
08	26.2	14.9		33.3	8.5	8.11	
09	29.5	14.9		33.3	9.2	8.12	
10	32.8	14.9		33.3	9.1	8.11	

DATE: DECEMBER 13, 1978 TIME: 1010

STATION: B1

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	13.8		33.3	13.4	8.67	92.0
01	3.3	13.8		33.3	12.3	8.61	92.8
02	6.6	13.8		33.4	12.3	8.53	92.8
03	9.8	13.7		33.4	12.3	8.47	92.0
04	13.1	13.7		33.4	12.3	8.44	92.0
05	16.4	13.7		33.4	12.0	8.38	91.0
06	19.7	13.7		33.4	12.0	8.33	91.0
07	23.0	13.7		33.4	12.8	8.32	91.0
08	26.2	13.7		33.4	12.0	8.30	91.0
09	29.5	13.7		33.4	12.0	8.30	90.0
10	32.8	13.7		33.4	12.8	8.30	90.0
11	36.1	13.6		33.4	12.0	8.27	90.0
12	39.4	13.6		33.4	12.8	8.28	91.0
13	42.6	13.6		33.4	11.9	8.25	91.0
14	45.9	13.6		33.5	11.9	8.24	92.0
15	49.2	13.6		33.5	11.8	8.23	93.8
16	52.5	13.6		33.5	11.6	8.22	93.0
17	55.8	13.6		33.4	11.7	8.22	94.0
18	59.0	13.6		33.5	11.7	8.22	92.0
19	62.3	13.6		33.5	11.7	8.20	91.8
20	65.6	13.6		33.5	11.7	8.20	90.8
21	68.9	13.6		33.5	11.4	8.19	

DATE: DECEMBER 13, 1978 TIME: 1015

STATION: B2

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.0		33.1	11.6	8.43	76.0
01	3.3	14.0		33.6	11.9	8.33	76.0
02	6.6	14.0		33.3	12.6	8.28	73.0
03	9.8	14.0		33.3	12.6	8.28	71.0
04	13.1	14.0		33.3	12.3	8.22	70.0
05	16.4	14.0		33.4	12.8	8.20	68.0
06	19.7	14.0		33.4	12.3	8.18	68.0
07	23.0	14.0		33.4	12.2	8.16	67.0
08	26.2	14.0		33.4	12.1	8.15	67.0
09	29.5	14.0		33.4	11.6	8.13	67.0
10	32.8	14.0		33.6	11.8	8.13	68.0
11	36.1	14.0		33.6	11.1	8.13	66.0
12	39.4	14.0		33.4	11.2	8.12	65.0
13	42.6	14.0		33.4	11.0	8.11	64.0
14	45.9	14.0		33.4	11.1	8.11	64.0
15	49.2	14.0		33.4	11.1	8.11	61.0
16	52.5	14.0		33.4	10.9	8.10	

DATE: DECEMBER 13, 1978 TIME: 0915

STATION: B3

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	13.8		33.0	12.0	8.42	98.0
01	3.3	13.8		33.2	11.9	8.32	90.0
02	6.6	13.8		33.3	11.8	8.29	90.0
03	9.8	13.8		33.3	11.8	8.27	90.0
04	13.1	13.8		33.3	12.3	8.25	90.0
05	16.4	13.7		33.3	12.3	8.24	90.0
06	19.7	13.7		33.4	12.3	8.22	90.0
07	23.0	13.7		33.4	12.2	8.22	89.0
08	26.2	13.7		33.4	11.8	8.21	89.0
09	29.5	13.7		33.4	12.0	8.20	88.0
10	32.8	13.7		33.4	12.0	8.20	89.0
11	36.1	13.7		33.4	12.0	8.19	88.0
12	39.4	13.7		33.4	12.0	8.18	89.0
13	42.6	13.7		33.4	12.0	8.18	88.0
14	45.9	13.7		33.4	12.0	8.18	88.0
15	49.2	13.7		33.4	12.8	8.17	88.0
16	52.5	13.7		33.4	11.9	8.17	88.0
17	55.8	13.7		33.4	11.9	8.17	88.0
18	59.0	13.7		33.4	11.9	8.16	88.0
19	62.3	13.7		33.4	11.8	8.16	88.0
20	65.6	13.7		33.4	11.7	8.10	88.0

DATE: DECEMBER 13, 1978 TIME: 0800

STATION: B4

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.2		33.3	9.0	8.42	91.0
01	3.3	14.2		33.3	7.8	8.34	91.0
02	6.6	14.2		33.3	8.2	8.28	91.0
03	9.8	14.2		33.2	8.6	8.24	91.0
04	13.1	14.1		33.4	8.7	8.22	91.0
05	16.4	14.1		33.4	8.9	8.20	91.0
06	19.7	14.1		33.4	8.9	8.18	90.0
07	23.0	14.0		33.4	8.8	8.18	90.0
08	26.2	14.0		33.4	8.7	8.16	90.0
09	29.5	14.0		33.4	9.0	8.16	90.0
10	32.8	14.0		33.4	9.0	8.15	90.0
11	36.1	14.0		33.4	9.0	8.14	90.0
12	39.4	14.0		33.4	9.3	8.13	90.0
13	42.6	14.0		33.4	9.4	8.14	90.2
14	45.9	14.0		33.4	9.5	8.13	90.0
15	49.2	14.0		33.4	10.0	8.13	90.5
16	52.5	14.0		33.4	10.0	8.13	90.2
17	55.8	14.0		33.4	10.0	8.12	90.2
18	59.0	14.0		33.4	10.0	8.12	90.0
19	62.3	13.9		33.6	10.8	8.12	90.0
20	65.6	13.8		33.6	11.0	8.12	89.0

DATE: DECEMBER 13, 1978 TIME: 0840

STATION: B5

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.4		32.2	8.0	8.44	90.3
01	3.3	14.1		33.3	7.8	8.32	90.3
02	6.6	14.7		33.3	7.6	8.28	90.3
03	9.8	14.6		33.4	7.8	8.22	90.0
04	13.1	14.5		33.5	7.4	8.16	90.0
05	16.4	14.5		33.5	7.1	8.14	89.0
06	19.7	14.6		33.4	7.7	8.12	89.0
07	23.0	14.5		33.4	8.0	8.12	89.0
08	26.2	14.6		33.4	7.8	8.10	90.0
09	29.5	14.4		33.4	7.8	8.10	90.0
10	32.8	14.4		33.4	8.2	8.04	90.0
11	36.1	14.3		33.5	7.7	8.09	90.0
12	39.4	14.3		33.5	6.5	8.09	90.0
13	42.6	14.3		33.8	8.4	8.09	89.0
14	45.9	14.2		33.5	8.3	8.09	88.3
15	49.2	14.1		33.8	8.5	8.09	87.0
16	52.5	14.1		33.8	8.7	8.09	87.0
17	55.8	14.1		33.6	8.9	8.09	86.3
18	59.0	14.0		33.8	9.3	8.10	85.3
19	62.3	14.0		33.6	9.2	8.10	83.0
20	65.6	14.0		33.8	8.7	8.10	

DATE: DECEMBER 13, 1978 TIME: 0818

STATION: B6

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.4		32.8	9.6	7.84	85.0
01	3.3	14.6		32.8	8.6	7.84	84.0
02	6.6	14.6		33.1	9.7	7.86	84.0
03	9.8	14.5		33.2	10.2	7.87	84.0
04	13.1	14.8		33.3	10.1	7.87	84.0
05	16.4	14.5		33.3	9.6	7.88	79.0
06	19.7	14.8		33.3	9.2	7.86	77.0
07	23.0	14.8		33.3	8.3	7.88	77.0
08	26.2	14.5		33.3	7.8	7.89	77.0
09	29.5	14.8		33.4	7.8	7.89	78.0
10	32.8	14.5		33.4	8.6	8.00	77.0
11	36.1	14.6		33.4	8.6	8.01	78.0
12	39.4	14.6		33.4	7.6	8.01	

DATE: DECEMBER 13, 1978 TIME: 0821

STATION: B7

DEPTH METERS	DEPTH FEET	TEMPERATURE °C	TEMPERATURE °F	SALINITY o/oo	D.O. PPM	PH H ION CONC.	TURBIDITY % TRANS.
00	0.0	14.3		32.4	8.1	7.88	90.0
01	3.3	14.8		32.5	7.9	7.88	88.0
02	6.6	14.8		32.9	8.5	7.84	89.0
03	9.8	14.8		33.1	8.4	7.88	89.0
04	13.1	14.5		33.2	8.3	7.84	89.0
05	16.4	14.5		33.1	7.8	7.87	89.0
06	19.7	14.5		33.2	7.8	7.97	89.0
07	23.0	14.5		33.2	7.7	7.98	88.0
08	26.2	14.4		33.3	8.0	7.99	88.0
09	29.5	14.4		33.4	8.6	8.01	81.0
10	32.8	14.3		33.4	8.6	8.02	77.0
11	36.1	14.3		33.4	8.9	8.03	75.0
12	39.4	14.3		33.4	8.9	8.03	73.0
13	42.6	14.2		33.8	8.6	8.04	73.0
14	45.9	14.2		33.8	8.8	8.03	72.3
15	49.2	14.2		33.8	8.7	8.04	71.3
16	52.5	14.2		33.8	8.3	8.04	70.0
17	55.8	14.2		33.4	8.3	8.04	69.0
18	59.0	14.2		33.8	8.3	8.04	58.3
19	62.3	14.2		33.4	8.8	7.98	

DATE: DECEMBER 6, 1978 TIME: 1048

STATION: B8

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.4		32.7	9.6	8.40	
01	3.3	15.4		33.0	9.6	8.35	
02	6.6	16.4		33.2	9.3	8.31	
03	9.8	15.4		33.2	9.3	8.27	
04	13.1	15.4		33.2	9.4	8.24	
05	16.4	15.4		33.2	9.0	8.23	
06	19.7	15.4		33.3	9.3	8.22	
07	23.0	15.4		33.3	9.3	8.20	
08	26.2	15.4		33.3	9.3	8.19	
09	29.5	15.4		33.3	9.2	8.18	
10	32.8	15.3		33.3	9.2	8.17	
11	36.1	15.3		33.3	9.2	8.16	

DATE: DECEMBER 6, 1978 TIME: 1102

STATION: B9

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.1		33.1	9.6	8.42	
01	3.3	15.1		33.1	9.6	8.40	
02	6.6	15.1		33.2	9.5	8.41	
03	9.8	15.1		33.2	9.3	8.34	
04	13.1	15.1		33.2	9.2	8.24	
05	16.4	15.1		33.2	9.2	8.18	
06	19.7	15.1		33.3	9.4	8.23	
07	23.0	15.1		33.3	9.1	8.27	
08	26.2	15.1		33.3	9.6	8.25	
09	29.5	15.1		33.3	9.6	8.21	
10	32.8	15.1		33.3	9.3	8.25	
11	36.1	15.1		33.3	9.0	8.25	
12	39.4	15.0		33.3	9.1	8.19	
13	42.6	15.0		33.4	9.2	8.14	

DATE: DECEMBER 13, 1978 TIME: 0932

STATION: B10

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.7		33.4	12.4	8.40	87.0
01	3.3	14.3		33.4	12.0	8.37	87.0
02	6.6	14.2		33.4	12.1	8.34	87.0
03	9.8	14.0		33.5	12.0	8.30	86.0
04	13.1	14.0		33.4	12.1	8.28	86.0
05	16.4	13.8		33.6	12.1	8.26	86.0
06	19.7	13.8		33.5	12.0	8.26	86.0
07	23.0	13.8		33.5	12.0	8.24	86.8
08	26.2	13.7		33.5	11.8	8.22	86.0
09	29.5	13.7		33.5	11.7	8.21	87.0
10	32.8	13.7		33.4	11.6	8.20	86.0
11	36.1	13.7		33.4	11.5	8.20	88.0
12	39.4	13.7		33.4	11.4	8.19	88.3
13	42.6	13.7		33.4	11.4	8.18	88.3
14	45.9	13.7		33.4	11.4	8.17	88.0
15	49.2	13.7		33.4	11.2	8.17	86.0
16	52.5	13.7		33.4	10.3	8.16	88.0
17	55.8	13.7		33.4	10.0	8.16	86.0
18	59.0	13.7		33.5	11.0	8.16	86.0
19	62.3	13.7		33.5	11.0	8.15	86.0
20	65.6	13.7		33.8	11.0	8.15	86.0
21	68.9	13.7		33.8	11.0	8.15	85.0
22	72.1	13.7		33.8	10.9	8.14	85.0

DATE: DECEMBER 13, 1978 TIME: 0849

STATION: B11

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.3		33.1	11.8	8.05	92.0
01	3.3	14.1		33.4	11.9	8.08	93.0
02	6.6	13.9		33.6	12.0	8.09	93.0
03	9.8	13.8		33.5	12.1	8.10	93.0
04	13.1	13.8		33.6	12.2	8.10	93.0
05	16.4	13.8		33.7	12.2	8.13	92.0
06	19.7	13.7		33.8	12.1	8.10	92.0
07	23.0	13.7		33.5	12.1	8.10	91.0
08	26.2	13.7		33.4	11.8	8.10	91.0
09	29.5	13.7		33.4	12.0	8.10	90.0
10	32.8	13.7		33.4	11.7	8.10	91.0
11	36.1	13.7		33.4	11.6	8.10	91.0
12	39.4	13.6		33.4	11.6	8.10	92.0
13	42.6	13.6		33.4	11.5	8.10	92.0
14	45.9	13.6		33.4	11.4	8.11	91.0
15	49.2	13.6		33.5	11.4	8.10	91.0
16	52.5	13.6		33.5	11.4	8.10	91.0
17	55.8	13.6		33.5	11.3	8.10	91.0
18	59.0	13.7		33.8	11.3	8.10	91.0
19	62.3	13.7		33.8	11.4	8.10	91.0

DATE: DECEMBER 20, 1978 TIME: 1218

STATION: C1

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.4		32.2	8.4	7.88	78.0
01	3.3	14.5		32.4	8.5	7.88	77.0
02	6.6	14.4		32.4	8.5	7.88	77.0
03	9.8	14.4		32.5	8.6	7.87	76.0
04	13.1	14.3		32.7	8.9	7.88	77.0
05	16.4	14.2		32.8	9.3	7.88	78.0
06	19.7	14.4		33.0	9.2	7.81	76.0
07	23.0	13.6		33.2	9.4	7.92	76.0
08	26.2	13.7		33.4	9.9	7.87	75.0

DATE: DECEMBER 20, 1978 TIME: 1240

STATION: C2

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.7		32.0	8.2	7.82	78.0
01	3.3	14.7		32.0	8.2	7.83	78.0
02	6.6	14.7		32.2	8.2	7.84	79.0
03	9.8	14.6		32.4	8.3	7.84	74.0
04	13.1	14.4		32.8	8.5	7.86	78.0
05	16.4	14.3		33.0	8.8	7.88	74.0
06	19.7	14.2		33.1	8.8	7.89	73.0
07	23.0	14.1		33.2	8.9	7.91	72.0
08	26.2	14.0		33.3	9.1	7.92	70.0

DATE: DECEMBER 20, 1978 TIME: 1346

STATION: C3

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.0		31.8	8.2	7.82	70.0
01	3.3	15.0		31.8	8.3	7.82	71.0
02	6.6	15.0		32.0	8.1	7.83	72.0
03	9.8	14.9		32.4	8.6	7.82	73.0
04	13.1	14.7		32.6	8.8	7.83	66.0
05	16.4	14.6		32.8	9.2	7.85	63.0
06	19.7	14.6		33.0	9.5	7.86	72.0
07	23.0	14.5		33.1	9.0	7.87	70.0
08	26.2	14.4		33.2	8.0	8.87	71.0
09	29.5	14.3		33.3	8.4	7.88	63.0
10	32.8	14.3		33.3	8.6	7.89	63.0
11	36.1	14.2		33.3	8.8	7.91	66.0
12	39.4	14.1		33.3	8.8	7.92	66.0
13	42.6	14.1		33.3	8.6	7.94	67.0
14	45.9	14.1		33.3	7.0	7.96	68.0
15	49.2	14.0		33.4	6.9	7.97	62.0

DATE: DECEMBER 20, 1978 TIME: 1036

STATION: C4

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.8		30.4	7.0	7.82	71.0
01	3.3	16.7		31.0	8.7	7.82	76.0
02	6.6	15.3		32.1	6.8	7.81	77.0
03	9.8	15.9		32.4	6.6	7.81	79.0
04	13.1	15.3		33.0	6.2	7.82	80.0
05	16.4	15.1		33.1	6.2	7.81	79.0
06	19.7	14.8		33.2	6.4	7.82	79.0
07	23.0	14.6		33.2	6.8	7.84	77.0
08	26.2	14.8		33.2	7.0	7.86	76.0
09	29.5	14.5		33.3	7.2	7.87	78.0
10	32.8	14.4		33.3	7.3	7.89	72.0
11	36.1	14.4		33.5	7.3	7.91	72.0

DATE: DECEMBER 20, 1978 TIME: 1061

STATION: C5

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.9		31.2	7.4	7.81	72.0
01	3.3	13.9		31.4	7.3	7.81	73.0
02	6.6	14.9		30.9	6.9	7.80	75.0
03	9.8	16.2		31.6	6.6	7.78	76.0
04	13.1	15.3		32.2	6.0	7.77	76.0
05	16.4	15.2		32.7	5.9	7.77	75.0
06	19.7	15.1		32.9	5.4	7.77	73.0

DATE: DECEMBER 20, 1978 TIME: 1121

STATION: C6

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	18.7		31.7	7.4	7.61	78.0
01	3.3	17.4		32.4	7.2	7.62	80.0
02	6.6	16.4		30.7	7.0	7.82	81.0
03	9.8	16.3		33.1	6.0	7.81	81.0
04	13.1	16.6		33.2	6.7	7.83	81.0
05	16.4	15.4		33.2	6.5	7.83	81.0
06	19.7	15.3		33.3	6.4	7.80	81.0
07	23.0	16.0		33.4	6.4	7.81	80.0
08	26.2	14.9		33.4	6.4	7.81	79.0
09	29.6	16.0		33.2	6.5	7.61	79.0
10	32.8	14.9		33.4	6.4	7.81	78.0
11	36.1	18.8		33.3	6.4	7.81	78.0

DATE: DECEMBER 20, 1978 TIME: 0956

STATION: C7

DEPTH METERS/	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.9		31.2	7.0	7.81	77.0
01	3.3	13.9		31.4	7.0	7.81	77.0
02	6.6	14.0		31.6	7.0	7.81	77.0
03	9.8	14.2		31.7	6.6	7.81	78.0
04	13.1	14.8		31.6	6.8	7.76	79.0
05	16.4	15.8		31.8	5.9	7.74	82.0
06	19.7	15.2		32.5	5.8	7.73	82.0
07	23.0	15.2		32.7	6.0	7.73	82.0
08	26.2	15.2		32.9	6.0	7.72	82.0
09	29.6	15.2		32.9	6.0	7.72	81.0
10	32.8	15.2		33.0	5.6	7.71	80.0

DATE: DECEMBER 20, 1978 TIME: 0820

STATION: C8

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.6		30.0	8.8	7.88	73.0
01	3.3	13.7		30.4	9.0	7.87	75.0
02	6.6	13.7		30.7	9.0	7.88	76.0
03	9.8	14.1		31.1	9.3	7.89	77.0
04	13.1	14.2		31.6	9.4	7.88	78.0
05	16.4	14.2		31.8	9.4	7.88	79.0
06	19.7	14.3		32.2	9.4	7.91	80.0
07	23.0	14.3		32.6	9.7	7.92	81.0
08	26.2	14.3		32.7	9.8	7.83	81.0
09	29.5	14.3		32.8	9.6	7.84	82.0
10	32.8	14.3		33.0	9.6	7.95	82.0
11	36.1	14.3		33.1	9.8	7.96	88.0

DATE: DECEMBER 20, 1978 TIME: 0828

STATION: C9

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	15.5		28.9	6.7	7.86	43.0
01	3.3	14.2		28.7	6.9	7.86	70.0
02	6.6	14.3		31.6	7.2	7.87	75.0
03	9.8	14.4		31.8	7.2	7.87	79.0
04	13.1	14.5		32.4	7.3	7.88	80.0
05	16.4	14.3		32.7	7.8	7.80	81.0
06	19.7	14.3		33.0	7.7	7.93	88.0
07	23.0	14.3		33.0	7.8	7.94	80.0
08	26.2	14.3		33.1	7.9	7.96	86.0
09	29.4	14.2		33.1	8.0	7.96	82.0
10	32.8	14.2		33.2	8.1	7.97	84.0
11	36.1	14.2		33.3	8.3	7.98	83.0
12	39.2	14.1		33.3	6.2	7.99	83.0

DATE: DECEMBER 20, 1978 TIME: 0829

STATION: C10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.1		30.2	8.4	7.86	68.0
01	3.3	14.2		30.5	8.9	7.87	72.0
02	6.6	14.3		31.3	9.4	7.87	74.0
03	9.8	14.3		31.7	9.3	7.88	77.0
04	13.1	14.4		32.1	8.7	7.89	78.0
05	16.4	14.5		32.3	8.8	7.90	79.0
06	19.7	14.3		32.6	8.6	7.83	81.0
07	23.0	14.3		32.7	8.2	7.92	82.0
08	26.2	14.3		33.0	7.8	7.94	82.0
09	29.6	14.3		33.0	7.8	7.98	83.0
10	32.8	14.2		33.1	6.2	7.98	79.0

DATE: DECEMBER 20, 1978 TIME: 0844

STATION: C11

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.4		19.5	7.2	7.84	67.0
01	3.3	14.3		29.3	7.1	7.83	80.0
02	6.6	14.3		30.8	7.0	7.88	82.0
03	9.8	14.5		32.1	7.1	7.87	82.0
04	13.1	14.6		32.6	6.7	7.86	86.0
05	16.4	14.8		32.6	6.6	7.86	71.0
06	19.7	14.8		32.8	6.4	7.87	76.0
07	23.0	14.5		32.8	6.2	7.88	77.0

DATE: DECEMBER 13, 1978 TIME: 1028

STATION: D1

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.6		32.8	12.0	8.36	87.0
01	3.3	13.8		32.9	12.3	8.33	88.0
02	6.6	13.7		33.0	12.3	8.32	88.0
03	9.8	13.8		33.1	12.3	8.31	89.0
04	13.1	13.8		33.2	12.2	8.29	89.0
05	16.4	13.8		33.3	12.2	8.27	90.0
06	19.7	13.8		33.3	12.2	8.26	89.0
07	23.0	13.7		33.4	12.0	8.23	87.0
08	26.2	13.7		33.4	12.2	8.22	87.0
09	29.6	13.7		33.4	12.0	8.21	87.0
10	32.8	13.7		33.4	12.0	8.21	87.0
11	36.1	13.7		33.4	12.0	8.20	88.0
12	39.2	13.7		33.4	11.9	8.20	88.0
13	42.6	13.7		33.4	11.8	8.20	89.0
14	45.9	13.7		33.4	11.7	8.19	89.0

DATE: DECEMBER 13, 1976 TIME: 1113

STATION: D2

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	14.1		32.3	10.9	8.49	82.0
01	3.3	14.0		32.6	11.0	8.44	86.0
02	6.6	13.8		32.9	11.6	8.38	87.0
03	9.8	14.0		33.1	11.7	8.35	88.0
04	13.1	13.8		33.2	11.6	8.32	88.0
05	16.4	13.9		33.2	11.4	8.30	87.0
06	19.7	13.9		33.3	11.6	8.27	86.0
07	23.0	13.9		33.3	11.8	8.26	86.0
08	26.2	13.9		33.4	11.6	8.23	88.0
09	29.6	13.8		33.4	11.3	8.21	88.0

DATE: DECEMBER 13, 1978 TIME: 1057

STATION: D3

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.6		32.6	11.8	8.47	87.0
01	3.3	13.9		32.7	11.8	8.40	87.0
02	6.6	13.9		33.0	11.6	8.36	88.0
03	9.8	13.9		33.1	12.3	8.32	88.0
04	13.1	13.9		33.2	12.0	8.28	88.0
05	16.4	13.9		33.3	12.0	8.27	88.0
06	19.7	13.8		33.3	12.0	8.24	87.0
07	23.0	13.8		33.3	12.0	8.22	88.0
08	26.2	13.8		33.4	11.9	8.21	84.0
09	29.6	13.8		33.4	11.8	8.19	80.0

DATE: DECEMBER 13, 1978 TIME: 1137

STATION: D10

DEPTH METERS	FEET	TEMPERATURE °C	°F	SALINITY 0/00	D.O2 PPM	PH H ION CONC	TURBIDITY % TRANS
00	0.0	13.8		33.3	12.6	8.06	86.0
01	3.3	13.8		33.4	12.3	8.06	87.0
02	6.6	13.7		33.3	12.4	8.04	86.0
03	9.8	13.7		33.3	12.2	8.04	86.0
04	13.1	13.7		33.2	12.0	8.04	88.0
05	16.4	13.7		33.2	12.0	8.05	88.0
06	19.7	13.6		33.8	12.2	8.04	82.0
07	23.0	13.8		33.3	12.0	8.06	88.0