The Marine Environment of Marina del Rey Harbor
July 1996 - June 1997

A Report to the Department of Beaches and Harbors
County of Los Angeles

by

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TOXICITY TESTING • OCEANOGRAPHIC RESEARCH

September 15, 1997

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The scientists and staff of Aquatic Bioassay are pleased to present this report of the 1996-97 marine surveys of Marina del Rey Harbor. This report covers the period of field and laboratory studies conducted from July 1, 1996 through June 30, 1997. The 1996-97 monitoring program consisted of monthly water column surveys; semiannual fish surveys, including trawl, gill net, ichthyoplankton, beach seine, and diver transect enumerations; and annual benthic sediment surveys, including the measurement of chemical and physical properties and the evaluation of the benthic infaunal populations.

Each of the five analytical sections of the report (e.g. Water Quality) were subdivided into major categories (e.g. Bacterial Water Quality) and then further subdivided into individual "analytes" (e.g. Enterococcus). Each analyte was then compared among stations (spatial comparisons), among months or seasons (temporal comparisons), against historical results (past surveys), and against other relevant surveys conducted in southern California (when available). In addition, for the first time this year, we used some simple clustering techniques to spatially divide the Harbor stations into measurement-based groupings. This has allowed us to make some overall quantitative generalizations about sources and causes of the observed differences.

A great deal of thought and effort has gone into the performance and organization of this study, and we hope that you are pleased with the end result.

Yours very truly,

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Laboratory Director

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1. SUMMARY

This report to the County of Los Angeles Department of Beaches and Harbors details the results of the marine monitoring program conducted by Aquatic Bioassay and Consulting Laboratories, Inc. in Marina del Rey Harbor during the period of July 1, 1996 to June 30, 1997. The survey included monthly water quality and bacterial sampling; semiannual fish surveys including otter trawl, gill net, ichthyoplankton, beach seine, and diver-biologist transect sampling; and annual benthic sediment collection including physical, chemical, and biological characteristics.

Water Quality. Chemical and bacteriological water quality this sampling year appeared to be primarily affected by precipitation, spring and early summer plankton blooms, and drainages from Oxford Lagoon and Ballona Creek. Rainfall for the period was slightly above normal but lower than the average recorded for the past 20 years. As expected, the flow from storm drains, particularly Oxford Lagoon and Ballona Creek, increased bacterial counts in the Harbor, however, rain flowing off the surfaces surrounding the Marina were an additional source of bacterial contamination. Water adjacent to areas where birds, stray animals, children, and perhaps homeless people congregate, appear to be more impacted during rainy periods. In general, water quality measurements were similar to those of recent past surveys.

Measurements of three groups of bacterial organisms were conducted monthly at 18 stations (216 measurements for each group during the year). Total coliform limits were exceeded 11 times, fecal coliform limits were exceeded 19 times, and enterococcus limits were exceeded 11 times. Most exceedances occurred following rainy months and at stations near Oxford Lagoon and Ballona Creek discharges.

The sampling year was characterized by very heavy, red tide phytoplankton blooms during spring and early summer which strongly increased the dissolved oxygen, reduced the water clarity, altered the natural water color, and increased biochemical oxygen demand of most Harbor waters.

Flows from both Ballona Creek and Oxford Lagoon reduced salinity and elevated ammonia, biochemical oxygen demand, total coliforms, fecal coliforms, and enterococcus bacteria. Oxford Lagoon additionally lowered oxygen, pH and water clarity. Nutrients from Ballona Creek may have also contributed to the intensity of red tide blooms. The flows from Oxford Lagoon and Ballona Creek appeared to directly affect the Harbor entrance, Basin E, and probably Basin D as well. These locations represent over half of the stations sampled during our surveys. The spatial patterns of every parameter we measured were influenced by these two sources of water, and their negative influence upon the water quality in the Marina cannot be overstated.

Physical Characteristics of Benthic Sediments. Median particle size and sediment heterogeneity were influenced by the energy of the water flow, which, in turn, was influenced by the configuration of the Harbor and intensity of rainfall. Sediment samples near the entrance and in Ballona Creek were dominated by sand, due to the larger movement of currents, tides, and wave action. Water velocity further back in the Harbor was much slower, which allowed the finer fractions (i.e. silt and clay) to settle out on the bottom.

Chemical Characteristics of Benthic Sediments. Major sources of benthic chemical contaminants into Marina del Rey Harbor were Oxford Lagoon, Ballona Creek, and the resident boat population itself. Contaminant concentrations are also affected by the ambient particle size distributions of the sediments.

Chlorinated hydrocarbons (DDT and derivatives, other chlorinated pesticides, and polychlorinated biphenyls (PCB's)) were highest in Oxford Lagoon, Ballona Creek, and near the Harbor entrance. Oxford Lagoon and Ballona Creek are a likely source of chlorinated hydrocarbons into the Harbor.

Most heavy metals were highest in Basin E, Basin F, and in most of the main channel. In addition to some possible input from Oxford Lagoon and Ballona Creek, a major source is likely the resident boat population itself. Metal components of boats are constantly being corroded by seawater, and most bottom paints contain compounds, such as copper and tributyl tin complexes, which are designed to continuously ablate off and thereby accumulate in the sediment.

Indicators of organic pollution (nitrogen, sulfides, phosphorus, oil and grease, total organic carbon, oxygen demand, and volatile solids) followed patterns similar to those of heavy metals. Thus, organic concentrations tended to be higher in Basin E, Basin F, all channel stations, Oxford Lagoon, and Ballona Creek. Oil from street runoff into the two drainage basins may be the source of relatively high oil and grease levels found there.

Both heavy metals and organic compounds appeared to be positively related to finer grain sizes. Fine silts and clays are known to attract contaminants more readily than courser sediments. Chlorinated pesticides and PCB concentrations did not show a strong relationship with finer particle size ranges.

Among compounds listed in NOAA's Status and Trends Program, all Harbor stations exceeded at least one chlorinated hydrocarbon and at least one heavy metal at concentrations of "potential" toxicity, and most stations exceeded levels of "probable" toxicity, to benthic organisms. The areas that exceeded most metal limits were Basin E, Basin F, and most channel stations. The areas which exceeded most chlorinated hydrocarbon limits were Oxford Lagoon, Ballona Creek, the Harbor entrance, and the lower channel.

When compared to sediments analyzed in Los Angeles Harbor, levels of copper, lead, mercury, silver, and zinc in Marina del Rey were about two to six times higher, although the rest of the metals were similar. Levels of chlorinated pesticides and PCB's are about one-fifth those of Los Angeles Harbor and are similar to values of reference site samples collected on the open coast.

It is encouraging to note that most chlorinated compounds have declined dramatically this year over past surveys. Despite a fair degree of variability, metal concentrations and most organic compounds in Marina del Rey sediments do not appear to have greatly increased nor decreased since 1985. The exception is tributyl tin, which, like chlorinated hydrocarbons, has greatly declined recently. The recent ban on the use of this highly toxic compound as a bottom paint component is the likely reason.

Biological Characteristics of Benthic Sediments. Benthic infaunal population variables appeared to be mostly associated with proximity to Oxford Lagoon and Ballona Creek. Population measurements made in most of the channel and upper Harbor yielded relatively high to moderate infaunal values. Areas associated with Oxford Lagoon and Ballona Creek tended to show evidence of community disturbance. Environmental health of the infaunal community was not obviously related to stations' benthic particle size distributions.

Infaunal community variables throughout the remainder of the Harbor were high to moderate, despite having some relatively elevated levels of metals and nonspecific organics. Compared to past years, abundance and species diversity values were typical, and species counts were actually somewhat higher. When compared to Los Angeles Harbor and offshore reference site surveys, Marine del Rey abundances were higher (probably due to the huge numbers of nematodes collected at some stations), numbers of species were about the same, and diversity and infaunal index values were lower.

Fish Populations. Sampling this year included trawl net sampling for bottom fish, gill net sampling for midwater fish, beach seine sampling for inshore fish, diver transect enumeration for reef fish, and plankton net sampling for larval fish and eggs. This year's sampling yielded 235,410 total fish of all age groups, representing 59 different species. The great majority of these were either eggs, larvae, or juveniles, which attest to the Harbor's importance as a nursery. With the exception of gill net catches, which were typically low, all abundance and diversity measurements were either similar or higher than previous surveys.

Most catches in the Harbor were dominated by either anchovies or topsmelt, and, for ichthyoplankton tows, blennies and gobies as well. Typically, catches in the spring were greater than catches in the fall. The exception was the spring beach seine, which was about 40% smaller than the fall catch. During the spring, nine brown smoothounds and one leopard shark were also collected in the net, so the lower counts may be a result of predation on the dominant topsmelt by these, and perhaps other, predators.

2. INTRODUCTION

This section has been taken mostly unchanged from previous reports (e.g. Soule, Oguri, and Pieper 1997).

2.1. SCOPE AND PERIOD OF PERFORMANCE

This report covers the period of field and laboratory studies conducted from July 1, 1996 through June 30, 1997, supported by the County of Los Angeles, Department of Beaches and Harbors. The survey program consisted of monthly water column surveys; semiannual fish surveys including trawl, gill net, ichthyoplankton, beach seine, and diver transect enumerations; and annual benthic sediment surveys including the measurement of chemical and physical properties and benthic infaunal organisms.

2.2. HISTORY OF THE SURVEY PROJECT

Harbors Environmental Projects of the University of Southern California (HEP, USC) initiated baseline studies in Marina del Rey, the largest manmade marina in the world, in 1976, with partial funding from the Federal Sea Grant Program and the County. Survey techniques were examined and stations established for ecological evaluation of the marina. There was a hiatus until 1984, when surveys were resumed. Although there have been some lapses in periods covered due to funding constraints, the survey constitutes a unique, long term record of the ecology of the area (Soule and Oguri, 1991, 1980, 1985, 1986, 1981, 1988, 1990, 1994; Soule, Oguri and Jones, 1991, 1992a, 1992b, 1993; Soule, Oguri, and Pieper, 1996, 1997). In 1996 the survey project was taken over by scientists from Aquatic Bioassay and Consulting Laboratories, Inc. in Ventura, California.

2.3. HISTORY OF THE STUDY SITE

Marina del Rey was developed in the early 1960s on degraded wetlands that formed part of the estuary of Ballona Creek Wetlands. The wetlands once extended through the communities of La Ballona, Port Ballona and what is now Venice on the north, to the Baldwin Hills and the San Diego Freeway on the east, and to the Westchester bluffs on the south. Present street drainage extends east to the USC area at Exposition Park, based on early drainage patterns. In earlier years, Ballona Wetlands joined wetlands leading to the Los Angeles River, to the north and east of the Baldwin Hills and Palos Verdes Peninsula. At one time creation of a navigable channel from Ballona Creek to Dominguez Channel and the Los Angeles River was considered.

The San Pedro area and the little port of Ballona were competing sites for development of the large port, with railroad magnates engaging in political battles for control. Ultimately San Pedro was selected because it was more sheltered from southwest swells during storms. The history has been reviewed in previous reports, based in part on Bancroft (1884) and Beecher (1915). Until Ballona Creek was channelized in the 1920s, a number of streams meandered through the wetlands, forming a large pond that drained into what are now Ballona Lagoon and Del Rey Lagoon, behind a barrier beach. The estuary opened into Santa Monica Bay, cutting the submerged Santa Monica Canyon at the margin of the alluvial shelf of the bay (Figure 2-1). In the mud flats, birds, mollusks, and crustaceans abounded, along with mosquitoes and midges in the standing freshwater pools.

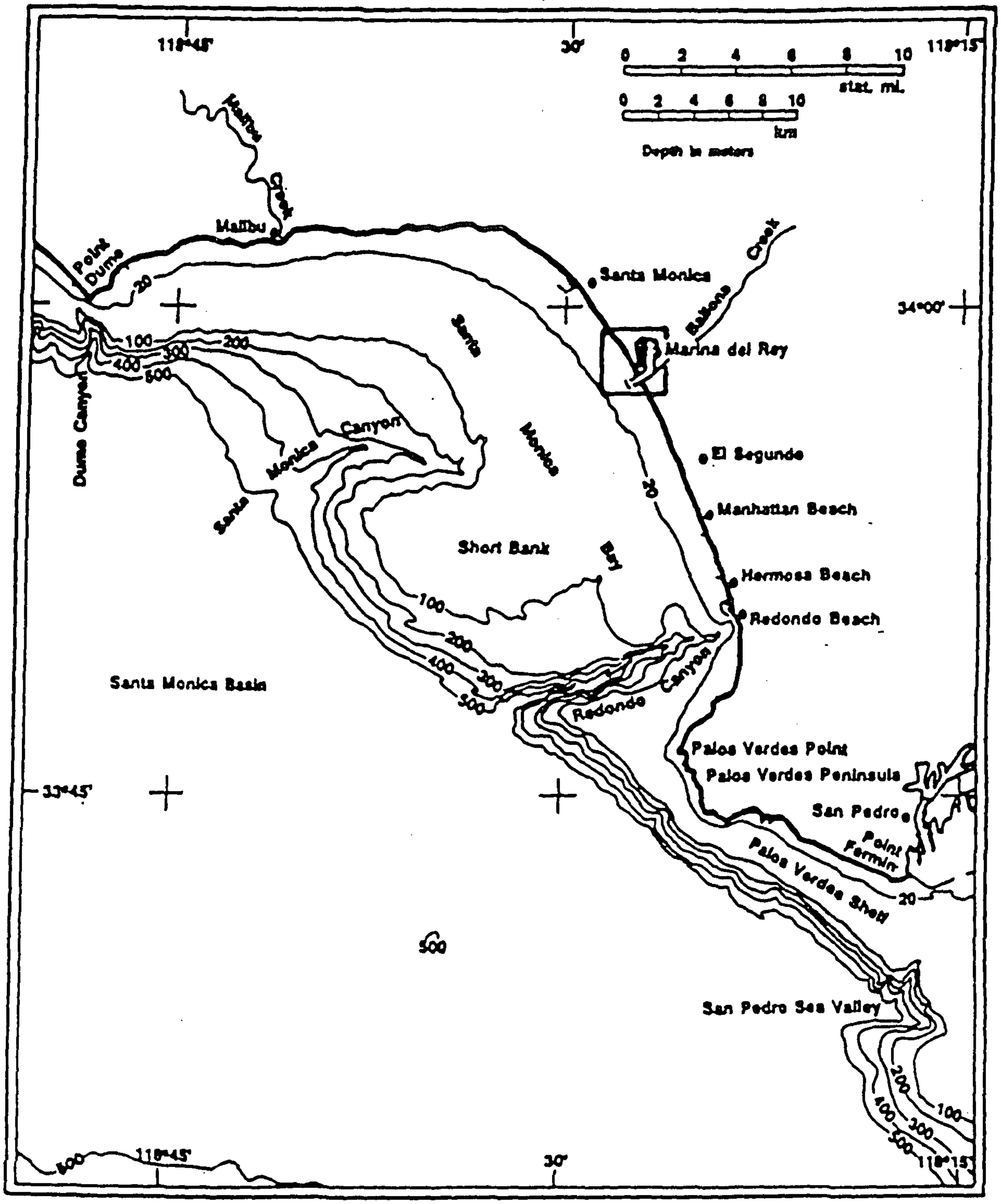
Urbanization overtook the wetlands, with development of oil and gas fields, truck farms, and industrial sites, which resulted in piecemeal dumping and filling. These activities deprived the wetlands of the normal cycles of renewal, including sedimentation and nutrient flow during heavy winter storms. Natural flooding was controlled by channelizing for the benefit of development to control urban flooding. During World War II, industrial activity increased extensively, with no controls on fills or dumping of toxic materials, causing contamination problems today when sites are regraded or excavated for new construction. Postwar residential development expanded urbanization to the margins of the reduced wetlands (Figure 2-2). Wartime experience with boats was new to many people and fostered developments in recreational boating, while postwar affluence increased pressure to create marinas to accommodate that interest. The Corps of Engineers designed several configurations and created a physical model for the marina at their laboratory in Vicksburg, Mississippi to test them. Construction began in 1960 with building concrete walls on dry land and then excavating the basins and channels.

The present configuration was believed to be adequate to protect boats without a breakwater, but this was disproved not long after the marina opened, when southwest swells from a winter storm damaged docks and vessels. Thus the present breakwater was added several years later. This protected vessels but also reduced flushing, which in turn reduced ecological conditions within the marina but added a rocky reef structure as a habitat.

2.4. LONG TERM RESULTS OF STUDIES

Soule et al. (1993), reviewed the reasons for undertaking baseline studies in the marina, based on inquiries from the County about the productivity of the waters. Results of monitoring and research studies in Marina del Rey from 1976-1979 and 1984 to 1992 were discussed. Some of the findings are summarized below:

FIGURE 2-1. LOCATION OF MARINA DEL REY WITHIN SANTA MONICA BAY (FROM SOULE ET AL. 1997).



The effects of natural events such as droughts and flooding have an overriding impact on the marina ecology. El Nino episodes characterized by incursion of warmer water from the tropics, and usually linked to increased rainfall, strongly affect the occurrence of fish species and numbers. Sediment distribution is affected by low energy flow in the dry season and low rainfall years, by the intensity and frequency of storms in wet years, and by the extent of sand barriers at the entrance. Fine sediments accumulate in basins and channels under low flow conditions. Dry weather flow and low rainfall runoff conditions may move sediments to the main channel and entrance channel where they accumulate, while heavy runoff will move them seaward. If sandbars are present at the entrance, contaminated fine sediments may accumulate behind them.

Copper, lead, mercury, nickel and zinc are present in levels sufficient to inhibit reproductive stages of sensitive species. Lead particularly seems to be associated with runoff. Distribution patterns of chromium, nickel, manganese and iron are associated with, or complexed to, the finest grained sediments and follow their distribution patterns.

Pesticides occur in concentrations that are inhibitory to some organisms, especially reproductive stages. The levels of pesticides have been declining, however.

Polychlorinated biphenyls (PCBs) have appeared episodically at toxic levels. Some terrestrial soils in areas to the north of the marina are known to contain high levels of PCBs that can enter drainage channels during grading or excavation.

Pilot analyses of terrestrial soils surrounding Oxford Basin indicate that most areas are heavily contaminated with heavy metals, chlorinated pesticides, and polynuclear aromatic hydrocarbons.

Nutrients are primarily of terrestrial origin and are largely uncoupled from those in Santa Monica Bay. Nutrients are inversely related to salinity, indicating their freshwater origin.

When excessive coliform and enterococcus bacterial contamination is found throughout the marina it is largely due to runoff, as evidenced by the high levels that occur at Ballona Creek and Oxford Basin immediately after storms in the winter. However, prolonged rainfall periods tend to reduce bacterial counts. Lower levels were usually found during the summer, when marina usage is at its highest but runoff the lowest. High coliform counts at Mother's Beach in Basin D in past years were largely due to birds resting on the sands, this was controlled by stringing monofilament or polypropylene lines across flight patterns. High counts in the water at the docks where the Life Guard, Sheriff's Patrol and Coast Guard vessels tie up are probably due to seagulls and pelicans resting, and to the practice of hosing bird guano off the docks each morning, before samples were taken.

FIGURE 2-2. STUDY SITE MARINA DEL REY HARBOR (FROM SOULE ET AL. 1997).

Benthic organisms are disrupted physically by natural events such as flooding, or manmade events such as dredging or pollution. Opportunistic species, particularly nematodes, which tolerate lower salinities, reproduce more rapidly with very large numbers, often recolonize disturbed areas. They are, in turn, replaced by more normal fauna through succession if conditions stabilize. The soft, unconsolidated sediments and sometimes inhibitory levels of contamination favor populations of tolerant polychaete worms. They provide an important food for bottom feeding fish, but tend to select against molluscan and macrocrustacean species. Microcrustaceans are less nutritious by weight than polychaetes because of their indigestible exoskeletons.

About 90 species or larval taxa of fishes have been reported in the marina, more than for any other wetlands in the area. The fish species represent the remains of the wetlands fauna that has been largely shut off from the wetlands south of Ballona Creek. The rocky breakwater and jetties are important to species that would otherwise not find a habitat in the marina.

The seagrass beds in sandy Basin D are very important to development of larval and juvenile fish, which also provide forage for larger fish.

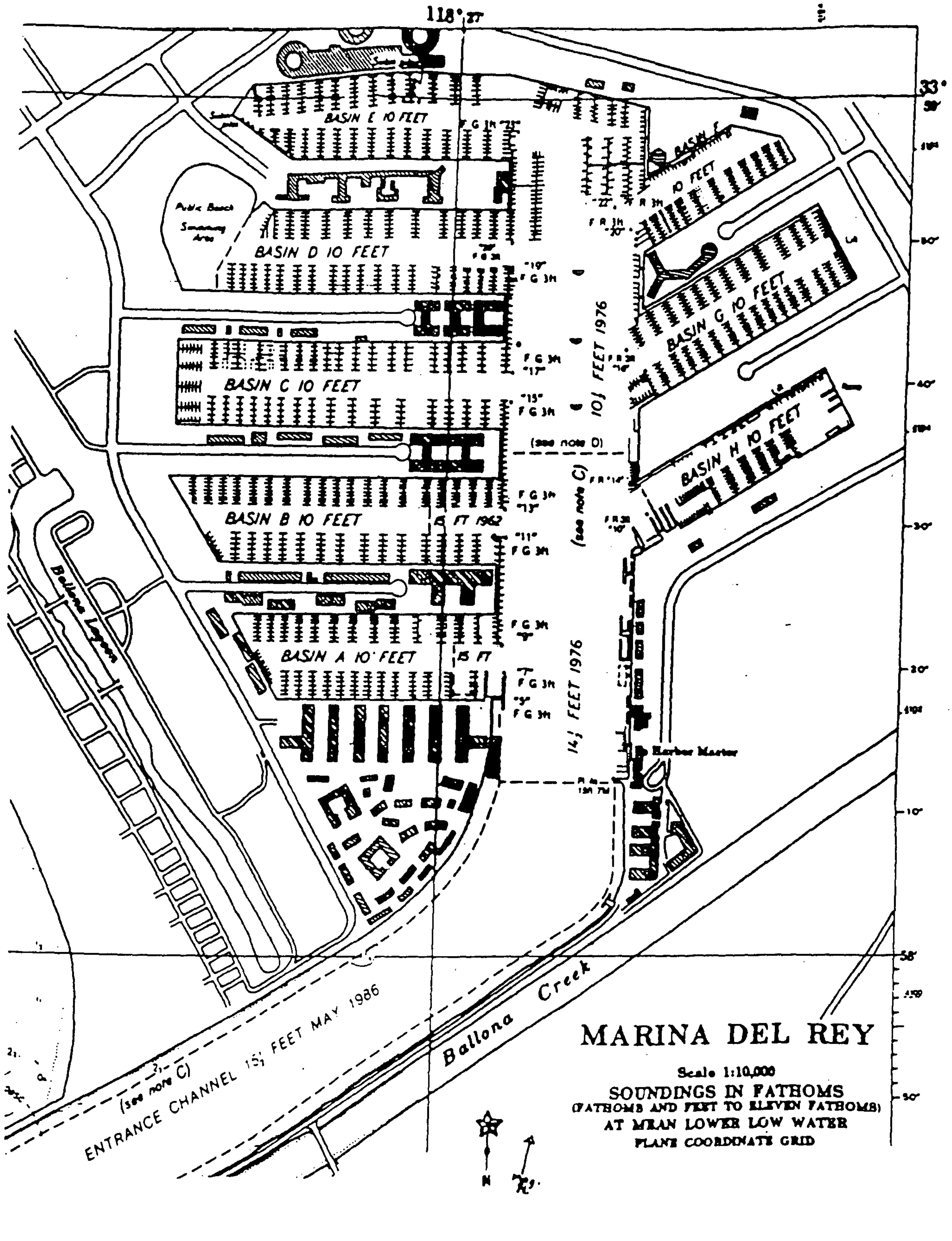
Oxford Basin drainage is a significant source of pollutants in spite of the relatively low volume of runoff into the basin, as evidenced by the relatively high levels of coliforms, organic nitrogen and lead, for example.

Ballona Creek is a significant source of contaminants, as indicated by levels of coliforms, volatile solids, chemical oxygen demand, oil and grease, sulfide, organic nitrogen, lead and silver. Levels of non-metals have been reduced, some by orders of magnitude, during the period of the surveys. Its flow pattern is often marked by floating trash flushed from storm drains that accumulates at the breakwater and south jetty after rains. Debris such as grass clippings and plastic food containers may move up into the main channel on the tides. The screen in Ballona Creek is not very effective at catching debris, it becomes filled and overflows, and is not deployed during rainstorms. A small boat with a hand held skimmer could easily remove floating trash such as grocery sacks, soccer balls and fast food containers that accumulate along the breakwater and jetties but this is apparently not being done.

Adding slips and vessels acts to damp the limited circulation. As slips were added it became more critical to guard against pollution to preserve esthetic and marine environmental quality. Addition of vessels at the inner end of the main channel strongly affected the area. The present configuration of slips is illustrated in Figure 2-3.

Monthly survey data do not indicate a serious or widespread problem with sewage release from vessels. However, the increase in the number of persons living aboard vessels that are not equipped with adequate holding tanks or capable of going to sea increases the possibility of contamination of persons exposed to waters in the marina while doing routine maintenance.

FIGURE 2-3. CHART OF SLIPS IN MARINA DEL REY HARBOR (FROM SOULE ET AL. 1997).



2.5. STATION LOCATIONS AND DESCRIPTIONS

Figure 2-4 illustrates the survey stations for the marina, Ballona Creek and Oxford Basin. Stations were numbered 1 to 13 for the original studies. A number of others were added for special studies, but not all of those were retained for routine monitoring, resulting in numbers out of sequence with the original stations. Stations MDR 1 through MDR 13 were designated in 1976. Stations MDR 18 through MDR 20 were added in 1988 for water quality and bacteriology.

MDR 1 is located midway between the breakwater and the southern jetty at the mouth of Ballona Creek Flood Control Channel. The area is subjected to discharges from the creek to severe impacts from storm water flow and deposition or erosion from storm wave action. The depth is irregular (2-6 meters).

MDR 2 is located at the entrance to the Marina, midway between the two Marina jetties. The area is protected from most storm waves and swells. It is influenced by tidal action, winds, and weak longshore currents. Sediment and debris is carried tidally into the marina from the creek, and sand from the northern beach blows into the channel, covering jetty rocks, creating sandbars which reduce navigable areas. The areas nearby were dredged in February 1987, a "knockdown" was attempted in October 1992; and dredging also was done in October November 1994. The depth is 4-6 meters.

MDR-3 is on the northwest side of the entrance channel, in front of the tide gate to the Venice Canal system. It is protected from all but severe storm waves but subjected to sediment and contaminated drainage from the lagoon. In the 1970s, mussel mounds were present which have since disappeared, being replaced by fine sediment and sand.

MDR-4 is seaward of the Administration docks, where there is heavy vessel use. It is sometimes a depositional area, since it is at the junction of the entrance channel with the main channel. The depth is 3-6 meters.

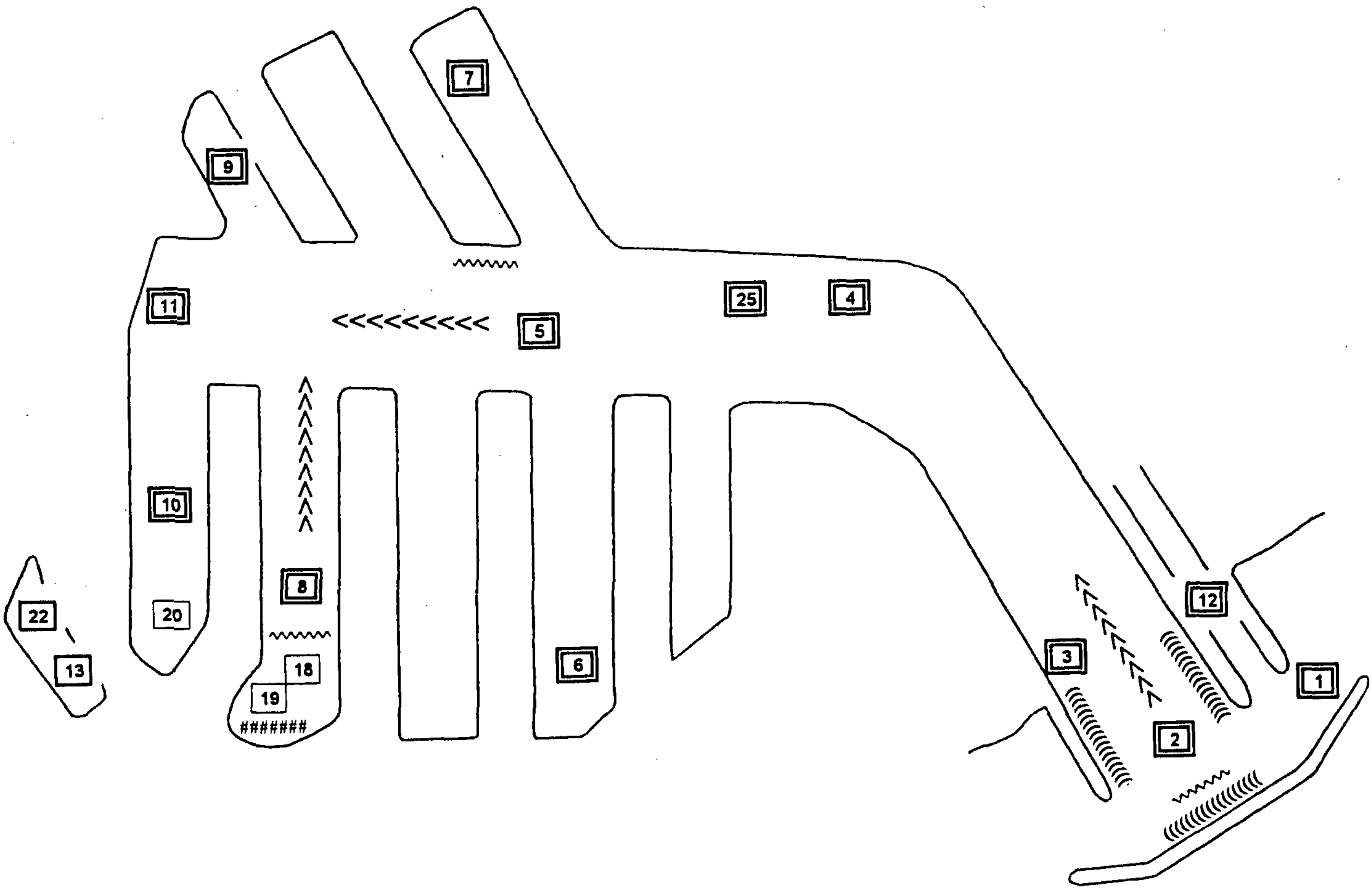
MDR-5 is in the center of the main channel opposite Burton Chace Park. Sediment accumulates there when it is flushed from the basins. It marks the end of the area originally dredged to greater depth in the outer marina. The depth is 4-5 meters.

MDR-6 is at the innermost end of Basin B and is protected from westerly winds by the seawall. Circulation is reduced, and pollution levels are usually medium low to moderate. The depth is 3-4 meters.

MDR-7 is at the end of Basin H near the work yard dock. It is exposed to westerly winds. The depth is 3-4 meters.

MDR-8 is off the swimming beach (Mother's Beach) in Basin D near the first slips outside of the floats. The depth is 3-4 meters.

FIGURE 4-4. LOCATION OF MARINA DEL REY HARBOR SAMPLING STATIONS.



Water Quality Stations only

Water Quality and Sediment Chemistry Stations

Water Quality, Sediment Chemistry, and Benthic Infauna Stations

Bottom Fish by Otter Trawl and Ichthyoplankton by Plankton Net

Midwater Fish by Gill Net

Reef Fish by Diver Transect

Inshore Fish by Beach Seine

MDR-9 is at the innermost end of Basin F where circulation is low. The depth is 2-3 meters.

MDR-10 is at the innermost end of Basin E and is subjected to flow from Oxford Flood Control Basin and major street drainage. Highly contaminated sediments have been deposited beneath the docks, which broke up due to accretion. In 1995, the docks were removed and sediment was taken with clamshell for land disposal. The area was dragged to level, and larger slips were constructed. The depth is 4 meters.

MDR-11 is at the end of the main channel and is subjected to storm drain flow and influx from Station 10. It is impacted by reduced circulation, pollution increased when slips were built for larger boats. The depth is 2-3 meters.

MDR-12 is in Ballona Creek at the Pacific Avenue footbridge. It is subject to tidal flushing, freshwater discharge year-round, and heavy rainfall from storm drains. It is also subjected to illegal dumping of trash upstream and formerly to sewage overflows. The depth is 1-4 meters.

MDR-13 is inside tidegate in Oxford Basin and is subjected to reduced tidal flushing, stormwater runoff, and street drainage. Only the surface is sampled, and it is accessible only through a locked gate.

MDR-18 is twenty meters off the wheelchair ramp in Basin D at perimeter of swimming rope. The depth is 1-2 meters.

MDR-19 is at the end of wheel chair ramp and is accessible only from shore on foot. Only the surface is sampled.

MDR-20 is at the innermost end of Basin E where Oxford Basin flows through a tidegate into the marina. The flow is obstructed by large vessels there. The depth is 2-3 meters.

MDR-22 is at the inner Oxford Basin at a bend where the Washington Boulevard culvert empties into the basin. It is only a mudflat at very low tides and is accessible only by foot.

MDR-25 is between the Administration docks and the public fishing docks. The area is subjected to intensive vessel use by Life Guards, Sheriff's patrol, and Coast Guard and is a popular bird roost, as well. The fishing docks attract birds to the fishermen's catch and offal, and dogs are frequently on the docks. Storm surge heavily damaged the administration docks in 1983, and they were rebuilt in 1985. The depth is 3-6 m.

3. WATER QUALITY

3.1. BACKGROUND

3.1.1. General Weather and Oceanography

With the exception of somewhat continuous freshwater runoff from storm drain discharges and periodic rainstorm events, the aquatic conditions in Marina del Rey Harbor are dominated by the oceanographic conditions in the Southern California Bight. The mean circulation in the Southern California Bight is dominated by the northward-flowing Southern California Countercurrent which may be considered as an eddy of the offshore, southward-flowing California Current (Daily, et. al. 1993). The California Countercurrent is seasonal in nature and is usually well developed in the summer and fall and weak (or absent) in winter and spring (SCCWRP 1973). This causes relatively nutrient-poor waters to predominate in the warmer water months and nutrient rich waters to predominate in the colder water months (Soule, et. al. 1997).

Superimposed upon annual trends are the sporadic occurrence of the El Nino Southern Oscillation (ENSO) which can be described as an oceanographic anomaly whereby particularly warm, nutrient-poor water moves northward from the tropics and overwhelms the typical upwelling of colder nutrient-rich water. The El Nino Watch (Coast Watch, NMFS, NOAA) program monitors sea surface temperatures off the west coast of the United States and then compares these data to long-term means. Coastal Watch data shows that 1992 and 1993 in Southern California were examples of warm water (El Nino) years. The 1994-95 season showed temperatures close to normal late in 1994 and temperatures above normal during the first half of 1995. The 1995-96 season showed water temperatures slightly higher than the previous year with temperatures two degrees above normal for most months and three degrees above normal for February through May (Soule et. al. 1997). During the period covered in this report, 1996-97, water temperatures remained high in the Southern California Bight (one degree to four degrees above normal) from July through October 1996. During November and December, temperatures were very near normal, however temperatures had begun to climb again in 1997 with water temperatures averaging five degrees above normal in June.

Seasonal variability includes changes in both air and water temperature, waves, winds, rainfall, and length and intensity of solar radiation. Periodic offshore storms can affect all of these patterns, as well. Shorter term variability can include the above variables as well as tidal influences which, along with rainfall, can greatly affect water quality in Marina Del Rey Harbor. Periodic phytoplankton blooms, including red tides, may be influenced by the above physical patterns, and can be exacerbated by anthropogenic inputs such as contaminated runoff and sewage effluents. In turn, blooms of red tide within enclosed bays and harbors can negatively impact resident fish and invertebrates (Daily, et. al. 1993).

3.1.2. Anthropogenic Inputs

Major modifications to Marina del Rey waters occur, naturally, largely through wet and dry weather flow through the Ballona Creek Flood Control Channel, through run-off into Basin E from both the Oxford Flood Control Basin and local flood-control pumping, and through numerous storm drains and other channels that drain into the marina basins themselves. By far the largest in volume flow and potential impact is the runoff from Ballona Creek, a major drainage area for much of metropolitan Los Angeles. While the Ballona Creek runoff may have a major influence particularly on surface waters near the marina entrance, only a portion of the Ballona Creek water enters the marina. The effect of this runoff is easily seen after a storm, however, by observing the accumulation of trash (styrofoam cups, plastic bottles, plastic bags, tennis and basket balls) at the outer breakwater and the outer channel jetties. Conversely, the runoff that flows or is pumped into Oxford Basin, as well as that which is pumped directly, enters the marina at Basin E; it has no other outlet. Changing the prevailing northwest winds to Santa Ana conditions (northeast winds) may bring cooler sub-surface waters into the coastal waters and, therefore, into the marina. This water could potentially contain treated effluent from the Hyperion sewage treatment outfall (Soule, et. al. 1997).

3.1.3. Rainfall

The mild "Mediterranean" climate of the southern California coastal basin is one of its greatest attractions. Summers are warm and almost rainless; winters are pleasant with occasional mild storms, although heavy rains and rapid runoff from the mountains and coastal slopes can sometimes cause serious flooding. Annual precipitation in the southern California coastal basin strongly depends upon distance from the coast, elevation, and topography. Precipitation in the coastal basin occurs as rainfall on the coastal lowlands and as snow and rainfall in the mountains (SCCWRP 1973). Southern California rainfall is characterized by large variations on an annual basis (Figure 3-1).

Total rainfall is not as important in terms of impacting the marina as the timing of the rainfall, the amount in a given storm, and the duration of a storm (or consecutive storms). Relative to timing, the first major storm of the season will wash off the majority of the pollutants and nutrients accumulated on the land over the preceding dry period. An early, large, long duration storm would have the greatest impact on the waters of the marina. In addition, determining the impact of the rainfall and runoff is also a function of the timing of the monthly surveys (monitoring and sampling). With a greater lag between runoff and survey sampling, mixing with oceanic waters would reduce observable impacts (Soule, et. al. 1996).

FIGURE 3-1. MONTHLY (LINES) AND ANNUAL (BARS) LOS ANGELES RAINFALL (INCHES) 1977-97.

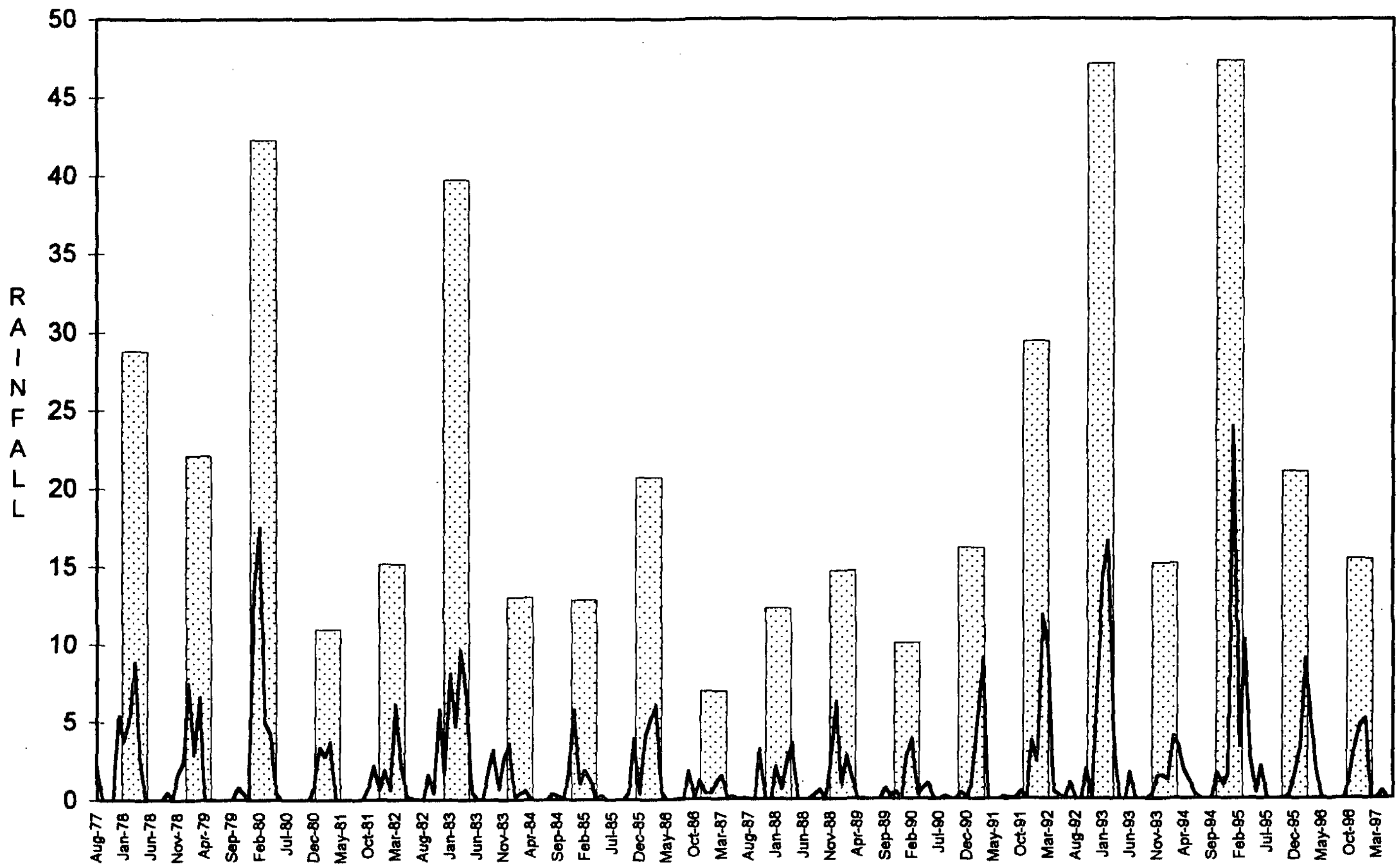
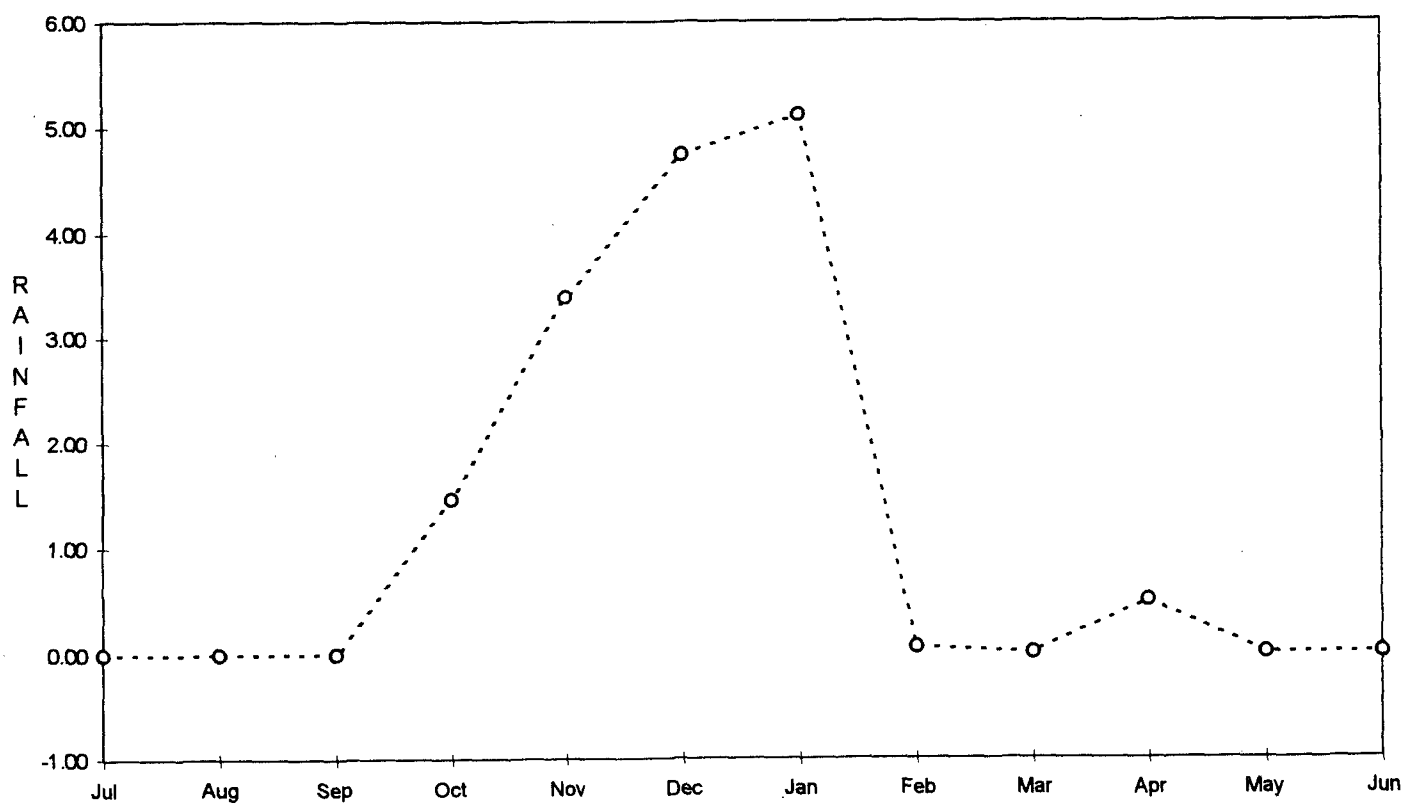


FIGURE 3-2. LOS ANGELES AIRPORT RAINFALL (INCHES) 1996-97.



The period of this report is from July 1, 1996 through June 30, 1997. The rainfall for this period (15 inches) was slightly above normal (13 inches, SCCWRP 1973), however it was low in relation to the past 20 years (22 inches, Figure 3-1 as modified from Soule, et. al. 1997). As is characteristic of southern California, nearly all of the precipitation fell between October and February (Figure 3-2).

The rainfall reported in this document is for the Los Angeles Airport obtained from the Western Regional Climate Center in Reno, Nevada. Data is summarized in Table 3-1, where periods of precipitation and water column survey days are highlighted. Only trace measurements of rainfall were recorded during most of July, August, September, and October. The first significant storm of the season occurred on October 29 and 30 (1.46 inches total). In November, two more storms occurred, one between November 20 and 22 (1.93 inches) and a second on November 29-30 (1.46 inches). December saw three small storms (December 5-6 - 0.11 inches, December 22 - 0.18 inches, and December 30-31 - 0.05 inches) and two larger storms (December 9-12 - 2.90 inches and December 26-27 - 1.50 inches). The small December 30-31 storm continued into 1997 (January 1-5 - 0.70 inches) followed by two other larger storms (January 12-15 - 2.07 inches and January 20-27 - 2.35 inches). February and March precipitation was much lower. Other than trace measurements, only one small rainfall event occurred during these months (February 11-12 - 0.05 inches). The last rains of the sampling season occurred in April with three small events (April 2-7 - 0.35 inches, April 11 - 0.08 inches, and April 21 - 0.02 inches).

The wettest month of the season was January (5.12 inches), followed closely by December (4.74 inches), then November (3.39 inches), October (1.46 inches), April (0.49 inches), and February (0.05 inches) (see Figure 3-2). Only one water column sampling event occurred immediately following any significant precipitation (April 7, 1997 - Table 3-1).

3.2. MATERIALS AND METHODS

Sampling and data collection for water quality assessment were conducted monthly at the 18 stations described and figured above. The monthly dates were selected at or near high tide, with succeeding stations sampled on the falling tide. Except for the one walk-in station at Mothers' Beach (19) and two in Oxford Lagoon (13 and 22), all water quality sampling was performed from Aquatic Bioassay's inflatable boat.

Temperature, conductivity (later converted to salinity), dissolved oxygen, pH, and light transmissance were measured continuously through the water column using a SeaBird Water Quality Analyzer with associated Chelsea 25-cm Transmissometer. All probes were calibrated immediately prior to each field excursion and, if any data were questionable, immediately after the instruments were returned to the laboratory. Measurements of light penetration were measured using a Secchi disk, and water color was measured by comparing the Forel-Ule scale vials using the Secchi disk as background. At all stations, water samples were collected at the surface and every two meters through the water column via a Nauman sampler.

TABLE 3-1. DAILY LOS ANGELES AIRPORT RAINFALL (INCHES) WITH DATES OF WATER COLUMN SURVEYS.

DATE	PRECIP.	DATE	PRECIP.	DATE	PRECIP.	DATE	PRECIP.	DATE	PRECIP.	DATE	PRECIP.
7/1/96	0.00	9/1/96	0.00	11/1/96	0.00	1/1/97	0.14	3/1/97	0.00	5/1/97	0.00
7/2/96	0.00	9/2/96	0.00	11/2/96	Trace	1/2/97	0.43	3/2/97	0.00	5/1/97	Survey
7/3/96	Trace	9/3/96	0.00	11/3/96	0.00	1/3/97	0.10	3/3/97	0.00	5/2/97	0.00
7/4/96	0.00	9/4/96	0.00	11/4/96	0.00	1/4/97	0.00	3/4/97	0.00	5/3/97	0.00
7/5/96	0.00	9/5/96	0.00	11/5/96	0.00	1/5/97	0.03	3/5/97	0.00	5/4/97	0.00
7/6/96	0.00	9/6/96	0.00	11/6/96	0.00	1/6/97	0.00	3/6/97	0.00	5/5/97	0.00
7/7/96	0.00	9/7/96	0.00	11/7/96	0.00	1/7/97	0.00	3/7/97	0.00	5/6/97	0.00
7/8/96	0.00	9/8/96	0.00	11/8/96	0.00	1/8/97	0.00	3/8/97	0.00	5/7/97	0.00
7/9/96	0.00	9/8/96	Survey	11/9/96	0.00	1/8/97	Survey	3/9/97	0.00	5/8/97	0.00
7/10/96	Trace	9/9/96	0.00	11/10/96	0.00	1/9/97	0.00	3/10/97	0.00	5/9/97	0.00
7/11/96	0.00	9/10/96	0.00	11/11/96	0.00	1/10/97	0.00	3/11/97	0.00	5/10/97	0.00
7/12/96	0.00	9/11/96	0.00	11/12/96	0.00	1/11/97	0.00	3/12/97	0.00	5/11/97	0.00
7/13/96	0.00	9/12/96	0.00	11/13/96	0.00	1/12/97	1.20	3/13/97	0.00	5/12/97	0.00
7/14/96	0.00	9/13/96	0.00	11/14/96	0.00	1/13/97	0.07	3/14/97	0.00	5/13/97	0.00
7/15/96	0.00	9/14/96	0.00	11/15/96	0.00	1/14/97	0.01	3/15/97	0.00	5/14/97	0.00
7/16/96	0.00	9/15/96	0.00	11/15/96	Survey	1/15/97	0.79	3/16/97	0.00	5/15/97	0.00
7/17/96	0.00	9/16/96	0.00	11/16/96	0.00	1/16/97	0.00	3/17/97	0.00	5/16/97	0.00
7/18/96	0.00	9/17/96	0.00	11/17/96	0.00	1/17/97	0.00	3/18/97	0.00	5/17/97	0.00
7/19/96	0.00	9/18/96	0.00	11/18/96	0.00	1/18/97	0.00	3/19/97	0.00	5/18/97	0.00
7/20/96	0.00	9/19/96	0.00	11/19/96	0.00	1/19/97	0.00	3/19/97	Survey	5/19/97	0.00
7/21/96	0.00	9/20/96	0.00	11/20/96	0.08	1/20/97	Trace	3/20/97	0.00	5/20/97	0.00
7/22/96	0.00	9/21/96	0.00	11/21/96	1.45	1/21/97	0.46	3/21/97	0.00	5/21/97	0.00
7/23/96	0.00	9/22/96	0.00	11/22/96	0.40	1/22/97	0.23	3/22/97	Trace	5/22/97	0.00
7/24/96	0.00	9/23/96	0.00	11/23/96	0.00	1/23/97	0.30	3/23/97	Trace	5/23/97	0.00
7/25/96	0.00	9/24/96	0.00	11/24/96	0.00	1/24/97	Trace	3/24/97	0.00	5/24/97	0.00
7/26/96	Trace	9/25/96	0.00	11/25/96	0.00	1/25/97	0.02	3/25/97	0.00	5/25/97	0.00
7/27/96	0.00	9/26/96	0.00	11/26/96	0.00	1/26/97	0.44	3/26/97	0.00	5/26/97	0.00
7/28/96	0.00	9/27/96	0.00	11/27/96	0.00	1/27/97	Trace	3/27/97	0.00	5/27/97	0.00
7/29/96	0.00	9/28/96	0.00	11/28/96	0.00	1/28/97	0.00	3/28/97	0.00	5/28/97	0.00
7/29/96	Survey	9/29/96	0.00	11/29/96	0.01	1/29/97	0.00	3/29/97	0.00	5/29/97	0.00
7/30/96	0.00	9/30/96	0.00	11/30/96	1.46	1/30/97	0.00	3/30/97	0.00	5/30/97	0.00
7/31/96	0.00	—	—	—	—	1/31/97	0.00	3/31/97	0.00	5/31/97	0.00
8/1/96	0.00	10/1/96	0.00	12/1/96	0.00	2/1/97	0.00	4/1/97	0.00	6/1/97	0.00
8/2/96	0.00	10/2/96	0.00	12/2/96	0.00	2/2/97	0.00	4/2/97	0.08	6/2/97	0.00
8/3/96	0.00	10/3/96	0.00	12/3/96	0.00	2/3/97	0.00	4/3/97	0.00	6/2/97	Survey
8/4/96	0.00	10/4/96	0.00	12/4/96	0.00	2/4/97	0.00	4/4/97	0.08	6/3/97	0.00
8/5/96	0.00	10/5/96	0.00	12/5/96	0.11	2/5/97	0.00	4/5/97	0.03	6/4/97	0.00
8/6/96	0.00	10/6/96	0.00	12/6/96	Trace	2/6/97	0.00	4/6/97	0.08	6/5/97	0.00
8/7/96	0.00	10/7/96	0.00	12/7/96	0.00	2/7/97	0.00	4/7/97	0.08	6/6/97	0.00
8/8/96	0.00	10/8/96	0.00	12/8/96	0.00	2/8/97	0.00	4/7/97	Survey	6/7/97	0.00
8/9/96	0.00	10/8/96	Survey	12/9/96	1.37	2/9/97	0.00	4/8/97	0.00	6/8/97	0.00
8/9/96	Survey	10/9/96	0.00	12/10/96	0.80	2/10/97	0.00	4/9/97	0.00	6/9/97	0.00
8/10/96	0.00	10/10/96	0.00	12/11/96	0.68	2/11/97	0.04	4/10/97	0.00	6/10/97	0.00
8/11/96	0.00	10/11/96	0.00	12/12/96	0.05	2/12/97	0.01	4/11/97	0.08	6/11/97	0.00
8/12/96	0.00	10/12/96	0.00	12/13/96	0.00	2/13/97	0.00	4/12/97	0.00	6/12/97	0.00
8/13/96	0.00	10/13/96	0.00	12/14/96	0.00	2/14/97	0.00	4/13/97	0.00	6/13/97	0.00
8/14/96	0.00	10/14/96	0.00	12/15/96	0.00	2/15/97	0.00	4/14/97	0.00	6/14/97	0.00
8/15/96	0.00	10/15/96	0.00	12/16/96	0.00	2/16/97	0.00	4/15/97	0.00	6/15/97	0.00
8/16/96	0.00	10/16/96	0.00	12/17/96	0.00	2/17/97	Trace	4/16/97	0.00	6/16/97	0.00
8/17/96	0.00	10/17/96	0.00	12/18/96	0.00	2/18/97	0.00	4/17/97	0.00	6/17/97	0.00
8/18/96	0.00	10/18/96	0.00	12/18/96	Survey	2/19/97	0.00	4/18/97	0.00	6/18/97	0.00
8/19/96	0.00	10/19/96	0.00	12/19/96	0.00	2/20/97	0.00	4/19/97	0.00	6/19/97	0.00
8/20/96	0.00	10/20/96	0.00	12/20/96	0.00	2/21/97	0.00	4/20/97	0.00	6/20/97	0.00
8/21/96	0.00	10/21/96	0.00	12/21/96	0.00	2/21/97	Survey	4/21/97	0.02	6/21/97	0.00
8/22/96	0.00	10/22/96	0.00	12/22/96	0.18	2/22/97	0.00	4/22/97	0.00	6/22/97	0.00
8/23/96	0.00	10/23/96	0.00	12/23/96	0.00	2/23/97	0.00	4/23/97	0.04	6/23/97	0.00
8/24/96	0.00	10/24/96	0.00	12/24/96	0.00	2/24/97	0.00	4/24/97	0.00	6/24/97	0.00
8/25/96	0.00	10/25/96	0.00	12/25/96	0.00	2/25/97	0.00	4/25/97	0.00	6/25/97	0.00
8/26/96	0.00	10/26/96	0.00	12/26/96	Trace	2/26/97	0.00	4/26/97	0.00	6/26/97	0.00
8/27/96	0.00	10/27/96	0.00	12/27/96	1.50	2/27/97	0.00	4/27/97	0.00	6/27/97	0.00
8/28/96	0.00	10/28/96	0.00	12/28/96	0.00	2/28/97	0.00	4/28/97	0.00	6/28/97	0.00
8/29/96	0.00	10/29/96	0.01	12/29/96	0.00	—	—	4/29/97	0.00	6/29/97	0.00
8/30/96	0.00	10/30/96	1.45	12/30/96	0.01	—	—	4/30/97	0.00	6/30/97	0.00
8/31/96	0.00	10/31/96	0.00	12/31/96	0.04	—	—	—	—	—	—

Water was distributed into sterile 125 ml polypropylene bottles for bacterial analysis, 250 ml polypropylene bottles containing sulfuric acid for ammonia analysis, and 300 ml glass, dark BOD bottles for biochemical oxygen demand analysis. At stations 1, 2, 5, 10, 12, 13, 19, 20, and 22; temperature and pH were measured directly at the surface using an NBS traceable standard mercury thermometer and hand-held, buffer-calibrated pH meter (respectively). Extra water samples were also collected at these stations and set for dissolved oxygen and chloride titration in the field. These extra samples and measurements were used as a check and back-up to the water quality analyzer.

All samples from all stations were placed in coolers containing blue ice and were returned to the Ventura laboratory the same day. Immediately upon return, the bacterial samples were set for total and fecal coliform and enterococcus bacteria via multiple-tube fermentation methods. Check samples were titrated for dissolved oxygen by Winkler titration and chloride (converted to salinity) by the argentometric titration. Biochemical oxygen demand samples were immediately set and stored in a 20 deg C incubator. Ammonia samples were placed in a laboratory refrigerator (4 deg C) until analyzed. Ammonia was analyzed by ion-selective electrode calibrated against known standards. All water analyses were performed in accordance with either *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 19th Edition) or *Methods for the Chemical Analysis of Water and Wastes* (US EPA, revised March 1983, EPA/600/4-79/020) modified to accommodate the analysis of seawater.

After all analyses were completed, the five water quality analyzer variables were correlated against the check samples measured or collected in the field: thermistor probe versus mercury thermometer, conductivity probe versus chloride titration, dissolved oxygen probe versus Winkler titration, field pH probe versus hand-held pH meter, and transmissometer versus Secchi disk. The Seabird Water Quality Analyzer was downloaded and water column graphs were generated. Two tables were also prepared containing the results of the physical, chemical, bacterial, and observational water measurements. Check sample correlations, water column graphs, and data tables were joined with a short narrative report and were presented to the Department of Beaches and Harbors monthly. The results and conclusions of all water column measurements and analyses are presented and summarized in Section 3.3 below. Appendix 10.2 presents all data and survey logs for the year.

3.3. RESULTS

3.3.1. Physical and Chemical Water Quality

3.3.1.1. **Temperature**

Coastal water temperatures vary significantly more than those of the open ocean. This is due to the relative shallowness of the water, the mixing of freshwaters from the land, and because of upwelling. The density of seawater is of importance in that it is a major factor in the stratification of waters. The transition between two layers of varying density is often distinct; the upper layer, in which most wind-induced mixing takes place, extends to a depth of 10 to 50 m in southern California waters. During the winter months, there is little difference in temperature between surface and deeper waters. During the summer, a relatively strong stratification (i.e. thermocline) is evident because the upper layers become more heated than those near the bottom. Thus, despite little difference in salinity between surface and bottom, changes in temperature during the summer result in a significant reduction of density at the surface (SCCWRP 1973). Stratified water allows for less vertical mixing. This is important in Marina del Rey Harbor because bottom waters may become oxygen-depleted without significant replenishment from the surface (Soule et. al. 1997).

Vertical temperature patterns. Figure 3-3 depicts the minimum, average, and maximum temperatures for each station plotted against depth for 1996-97. It is of particular interest that temperatures declined only slightly with depth overall. This suggests that there is little thermal stratification in the Harbor. As would be expected, deeper stations in the Harbor channel (e.g. 5 and 25) tended to have the largest decline from top to bottom. Examination of monthly surveys during the year indicate that vertical stratification was virtually absent during late fall and winter months when compared to the remainder of the year. However, at best, thermoclines were only weakly developed and mostly restricted to the Harbor entrance and channel stations. Note that on this, and all subsequent, vertical profile graphs, the deepest samples at three stations (3, 4, and 12), were collected only during the very highest tides. Therefore, they represent only one or two measurements over the year. In order to indicate this, the minimum-maximum ranges have been left off (they would converge at this point, anyway). These data points do not represent a true 12-month average and thus should be interpreted with caution.

Temperature patterns over the year. Figure 3-4 demonstrates the maximum, average, and minimum temperatures for the 18 water column stations over the sampling season in Marina del Rey Harbor. For the most part, seasonal patterns were similar among stations indicating the strong influence of the oceanographic conditions on the Harbor waters. Average temperatures during the beginning of the sampling season (July, August, and September) were relatively high (about 20 to 27 deg C). For stations nearer the Harbor entrance (1, 2, 3, 4, 12, and 25), temperatures were actually higher in September than in July or August.

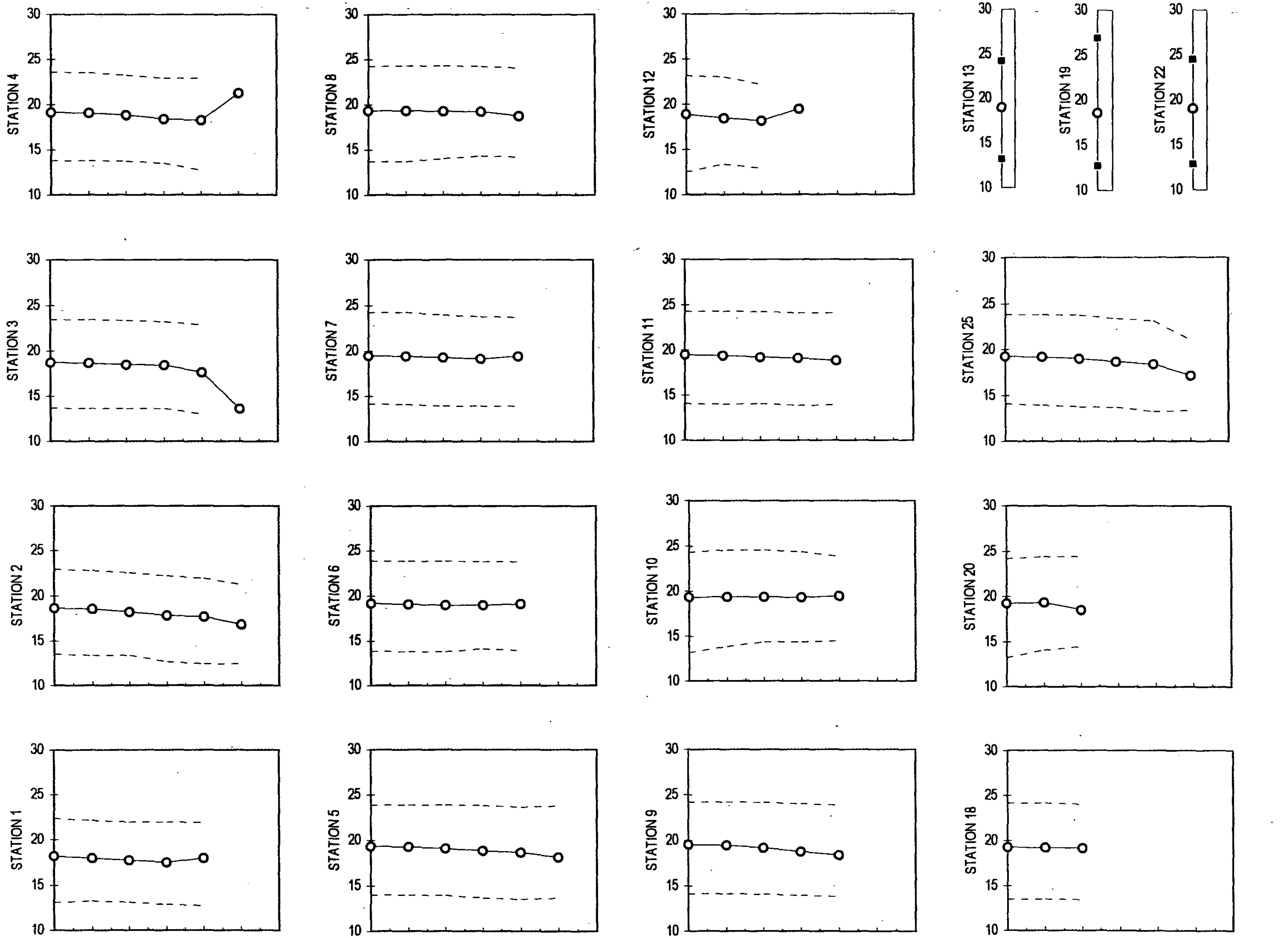


FIGURE 3-3. MIN., AVERAGE, AND MAX. TEMPERATURE (DEG C) VS. DEPTH (M) AT 18 WATER COLUMN STATIONS.

For many shallower, more inland stations (13, 18, 19, and 22), the increased solar radiation caused temperatures to be highest in July. These stations tended to have the broadest temperature ranges over the year. Beginning in November, temperatures steadily declined until about January (to about 13 to 15 deg C). Temperatures then climbed again, remained relatively unchanged between March and May (about 17 to 20 deg C), then peaked again in June (21 to 25 deg C).

Spatial temperature patterns. The horizontal spatial pattern of temperatures averaged over the whole year is presented as a three-dimensional graph in Figure 3-5. The spatial pattern of temperature follow those of past reports. Warmest stations (19.0 to 19.3 deg C) are those furthest back in the Harbor (5, 6, 7, 8, 9, 10, 11, 13, 18, 19, 20, and 22). From mid-channel (Station 25) to just inside the breakwall (Station 1), temperatures gradually decrease from 18.9 deg C to 17.9 deg C. Station 12, which is influenced by both the warmer freshwater discharge of Ballona Creek and colder open ocean water, has a moderate average temperature (18.5 deg C). This pattern strongly indicates that horizontal mixing is the greatest at stations near the entrance, and that water residence time is much longer in the inner basins.

Temperature ranges compared with past years. Table 3-2 lists: 1) the individual seasonal temperature ranges from fall 1988 through summer 1996, 2) the overall seasonal ranges for the eight year period, and 3) the temperatures collected during 1996-97. All 1996-97 temperatures were well within the overall seasonal ranges for the preceding eight years. Compared to last year, temperature ranges were either about a degree lower (fall and winter) or within the range of the previous year's measurements (spring and summer). The overall seasonal patterns between years, however, were very similar and fairly typical of expected oceanographic conditions.

3.3.1.2. **Salinity**

Salinity (a measure of the concentration of dissolved salts in seawater) is relatively constant throughout the open ocean. However, it can vary in coastal waters primarily because of the inputs of freshwater from the land or because of upwelling. Long term salinity variations have not been documented to the same extent as temperature phenomena. In a five-year study conducted by the U.S. Navy Research and Development Center, more than 1000 samples were analyzed for salinity. The mean salinity was 33.75 parts per thousand (ppt), and the range of 90% of the samples in southern California fell between 33.57 and 33.92 ppt (SCCWRP 1973).

Despite the general lack of variability, salinity concentrations can be affected by a number of oceanographic factors. During spring and early summer months, northwest winds are strongest and drive surface waters offshore. Deeper waters which are colder, more nutrient-rich, and more saline are brought to the surface to replace water driven offshore (Emery 1960). El Nino (ENSO) events can also affect coastal salinities. During these events northern flowing tropical waters move into the Bight with waters that are also more saline, but are warmer and lower in nutrients than ambient water. Major seasonal currents (i.e. California current, countercurrent, or undercurrent) can also affect ambient salinity to some degree (Soule et. al. 1997).

FIGURE 3-4. MINIMUM, AVERAGE, AND MAXIMUM TEMPERATURE (DEG C) VS. MONTH AT 18 WATER COLUMN STATIONS.

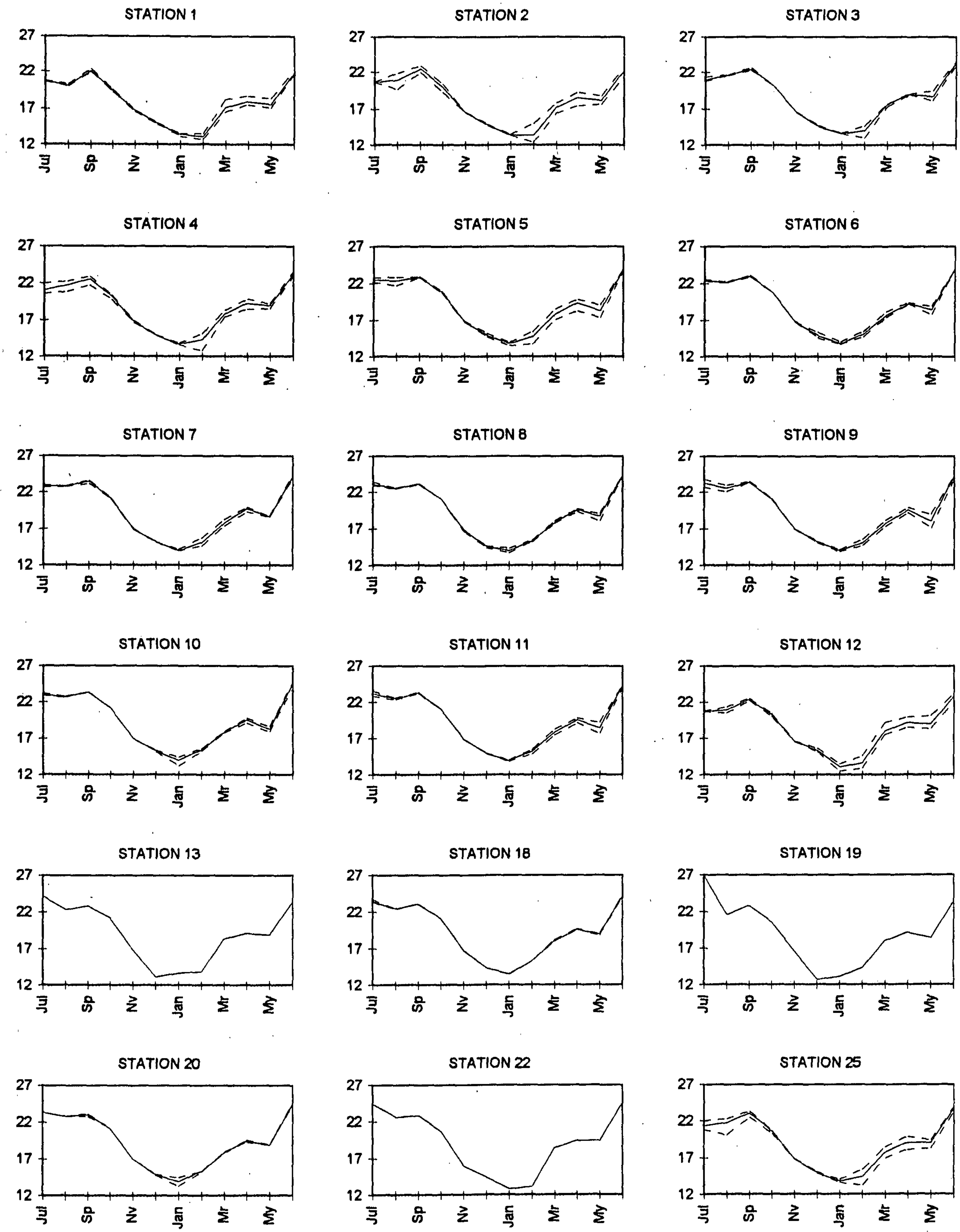


FIGURE 3-5. AVERAGE ANNUAL TEMPERATURE (DEG C) AT 18 WATER COLUMN STATIONS.

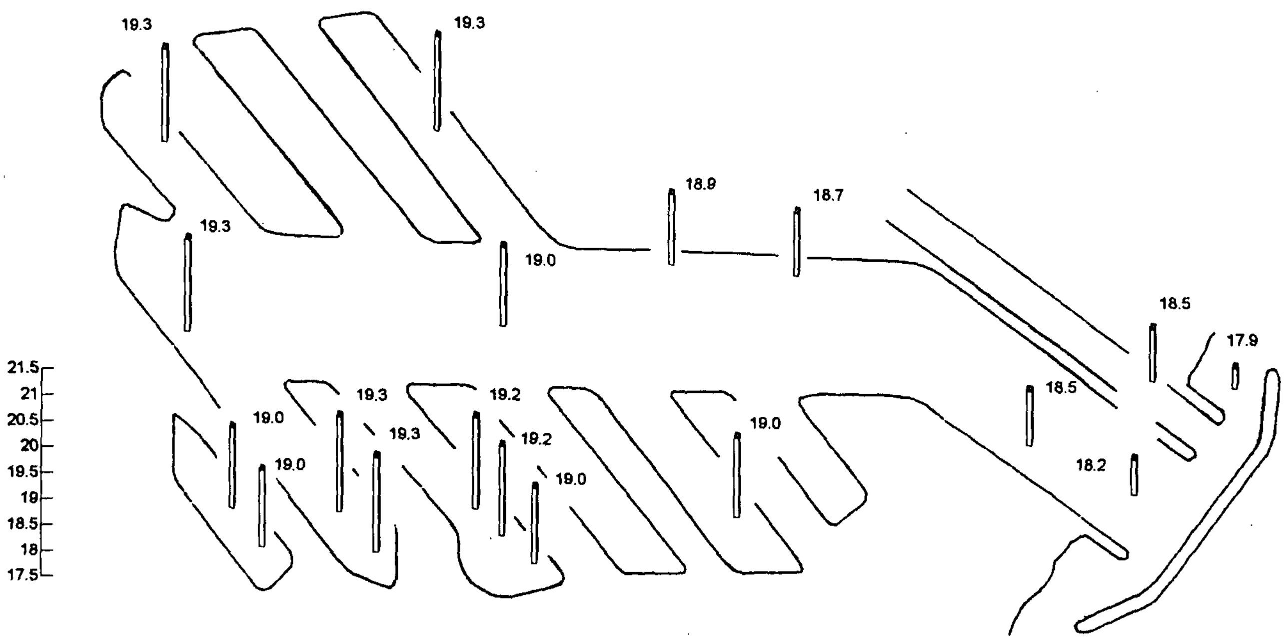


TABLE 3-2. ANNUAL TEMPERATURE RANGES (DEG C) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1988-89[1.]	15.9 - 21.4	11.2 - 14.3	14.1 - 22.9	15.6 - 24.0
1989-90[2.]	15.4 - 23.4	11.8 - 16.2	14.0 - 20.8	17.4 - 25.3
1990-91	14.0 - 23.6	11.8 - 16.8	13.3 - 18.3	17.0 - 22.1
1991-92	16.5 - 22.3	11.0 - 14.8	15.9 - 22.7	16.8 - 26.0
1992-93	17.0 - 22.8	13.5 - 15.8	15.2 - 22.6	17.8 - 28.2
1993-94[3.]	18.4 - 26.6	13.1 - 15.3	14.8 - 21.2	18.0 - 24.6
1994-95	13.6 - 23.4	12.8 - 17.0	15.0 - 20.1	17.3 - 23.7
1995-96	17.3 - 24.7	13.8 - 17.3	13.9 - 22.6	18.0 - 26.9
Overall range	**13.6 - 26.6**	**11.0 - 17.3**	**13.3 - 22.9**	**15.6 - 28.2**
1996-97[4.]	16.0 - 23.5	12.4 - 15.7	16.5 - 20.1	21.3 - 24.6

[1.] Two months only in the fall.
[2.] Station 25 added this year
[3.] Two months only in the fall, winter, and summer.
[4.] One month only in the summer.

Vertical salinity patterns. For most stations in Marina del Rey Harbor, salinity values reflect this lack of variability. In general, very little difference is seen between surface and bottom, and the minimums, averages, and maximums are very close together (Figure 3-6). Exceptions to this are those stations influenced by runoff from Ballona Creek drainage (1, 2, and 12) and Oxford Lagoon discharges (10, 13, 20, and 22). Of the two discharges, it is obvious that stations downstream of Ballona Creek are impacted much more than Oxford Lagoon. During rainier years, however, this may not be the case. During our surveys, it appears that freshwater remained on top of the seawater and reached a depth of about four meters.

Salinity patterns over the year. Figure 3-7 depicts the salinity measurement at each station by month over the period of the sampling year. At most stations, salinity profiles are characterized by very little variability over the year. Overall, the impact of the relatively heavy December rains is indicated by a very slight drop in salinity concentration. The station with clearly the greatest salinity variability is Station 12, within Ballona Creek. Concentrations there ranged from 21.1 to 33.5 ppt. Rainfall in October and January may account for the low values recorded during those months, however the low values recorded in March must be independent of rainfall since precipitation was very light then. The influence of the freshwater discharge from Ballona Creek can also definitely be seen at Station 1, and possibly at Station 2, as well. Although less dominant than Ballona Creek, freshwater flow into Oxford Lagoon (Stations 13 and 22) is apparent, particularly in December. Stations 10 and 20 in Basin E showed only a slight decline and only in December.

Spatial salinity patterns. With the exception of those stations influenced by Oxford Lagoon (10, 13, 20, and 22) and Ballona Creek discharges (1 and 12), all stations sampled within Marina del Rey Harbor had average year-long salinities of between 33.2 and 33.3 parts per thousand (Figure 3-8). Station 12 in Ballona Creek averaged lowest (29.7 ppt), followed by Station 22 in Oxford Lagoon (31.4), Station 1 just inside of the breakwall (32.4), and Station 13 also in Oxford Lagoon (32.5). Stations 10 and 20 in Basin E appear only slightly affected by Oxford Lagoon drainages with respect to salinity (33.1 and 33.0, respectively).

Salinity ranges compared with past years. Table 3-3 lists: 1) the individual seasonal salinity ranges from fall 1991 through summer 1996, 2) the overall seasonal ranges for the five year period, and 3) the temperatures collected during 1996-97. All 1996-97 salinities were well within the overall seasonal ranges for the preceding eight years. For 1995-96, minimum salinity values were much lower than those of this year, particularly in the winter. This is likely due to the lower rainfall (see Section 3.1.3.) experienced during this past year (15 inches) when compared to last year (22 inches). The unexpectedly low values in Basin D in 1994-95 (Soule et. al. 1996) were neither repeated in 1995-96 (Soule et. al. 1997) nor in 1996-97. The 1994-95 sampling year, however, was characterized by exceptionally high precipitation (47 inches) which is twice last year's and three time this year's rainfall.

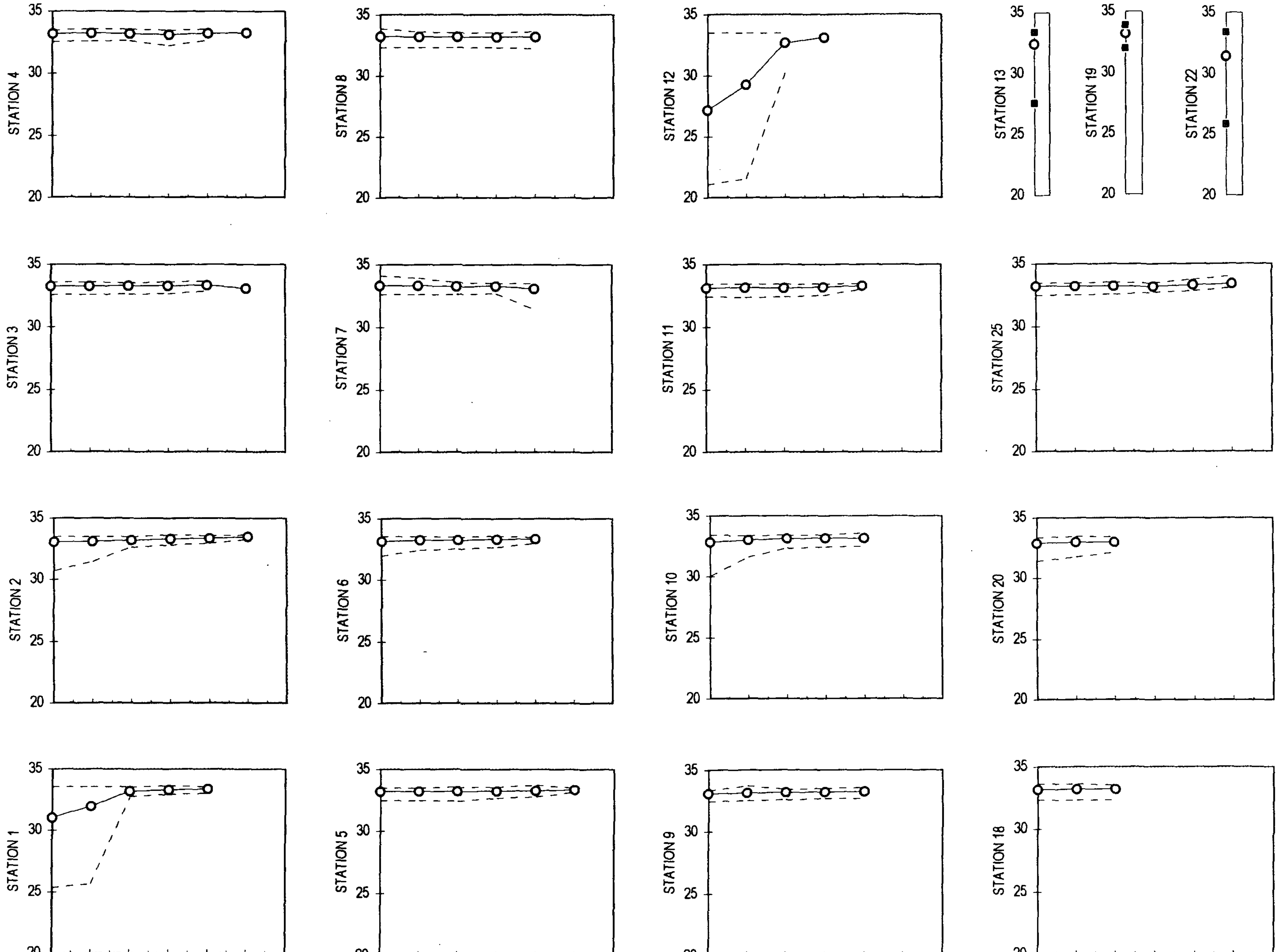


FIGURE 3-6. MIN., AVERAGE, AND MAX. SALINITY (PPT) VERSUS DEPTH (M) AT 18 WATER COLUMN STATIONS.

FIGURE 3-7. MINIMUM, AVERAGE, AND MAXIMUM SALINITY (PPT) VS. MONTH AT 18 WATER COLUMN STATIONS.

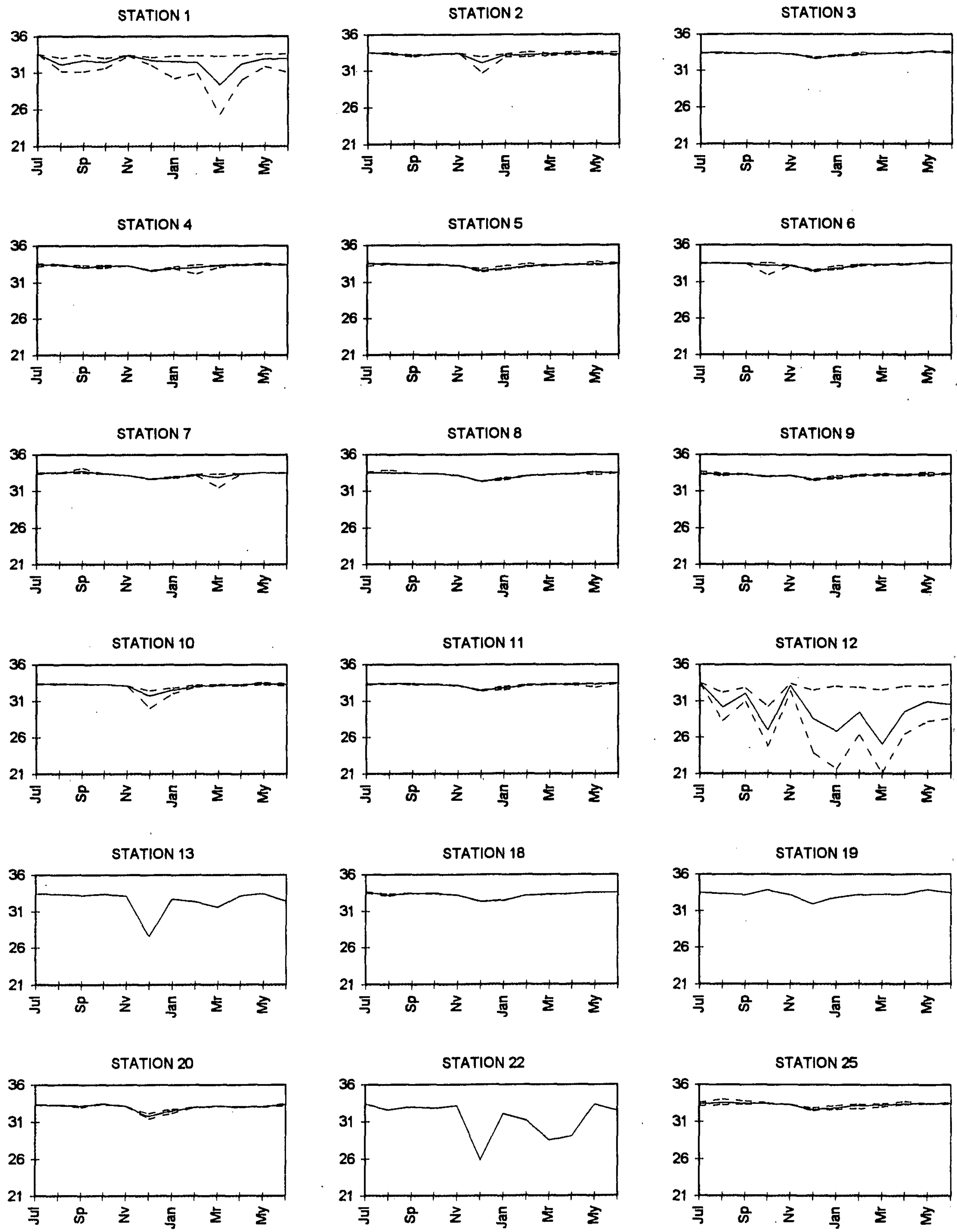


FIGURE 3-8. AVERAGE ANNUAL SALINITY (PPT) AT 18 WATER COLUMN STATIONS.

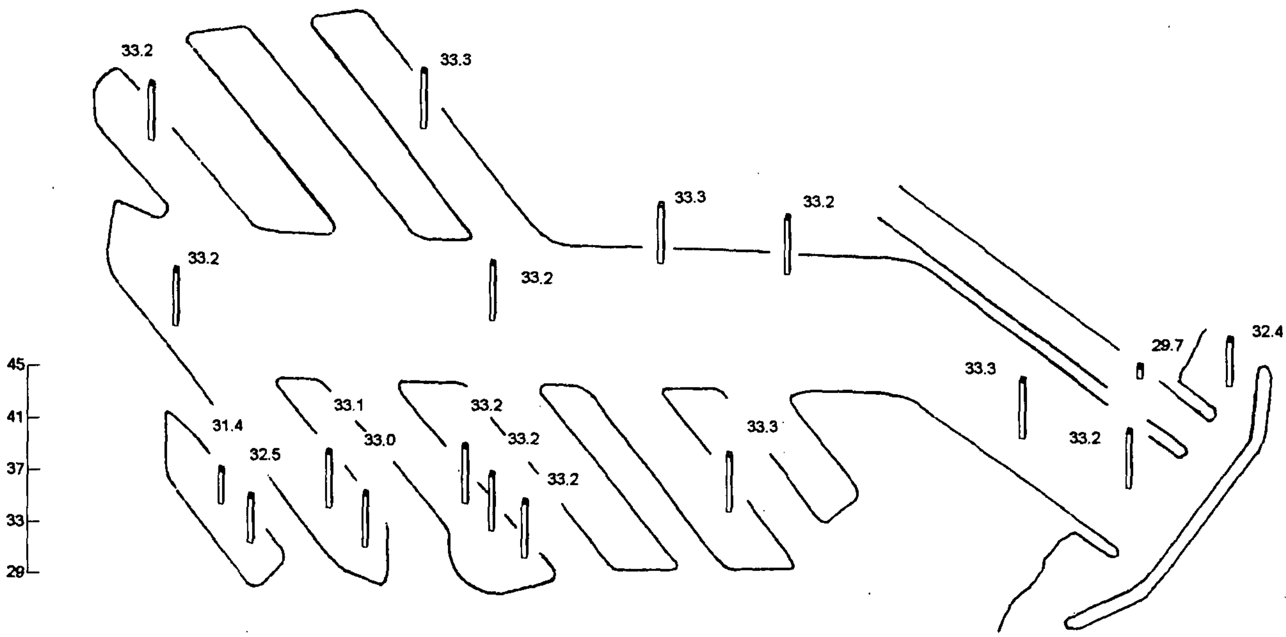


TABLE 3-3. ANNUAL SALINITY RANGES (PPT) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	30.1 - 33.5	1.4 - 32.6	1.4 - 33.2	21.8 - 33.1
1992-93	26.6 - 33.8	0.1 - 33.3	3.7 - 34.7	14.0 - 34.9
1993-94[2.]	28.11 - 34.5	16.4 - 33.9	19.1 - 34.5	33.1 - 34.6
1994-95	30.1 - 34.8	0.2 - 34.2	26.5 - 34.5	20.7 - 34.8
1995-96	21.1 - 34.8	1.4 - 34.4	11.1 - 34.5	18.7 - 34.0
Overall range	**21.1 - 34.8**	**0.1 - 34.4**	**1.4 - 34.7**	**14.0 - 34.9**
1996-97[3.]	24.7 - 34.1	21.6 - 33.7	21.1 - 33.9	28.3 - 33.9

[1.] Two months only in the fall.

[2.] One month only in the summer.

3.3.1.3. **Dissolved Oxygen**

The most abundant gases in the ocean are oxygen, nitrogen, and carbon dioxide. These gases are dissolved in seawater and are not in chemical combination with any of the materials composing seawater. Gases are dissolved from the atmosphere by exchange across the sea surface. The gases dissolved at the sea surface are distributed by mixing, advection (i.e. from currents), and diffusion. Concentrations are modified further by biological activity, particularly by plants and certain bacteria. In nature, gases dissolve in water until saturation is reached given sufficient time and mixing. The volume of gas that saturates a given volume of seawater is different for each gas and depends upon temperature, pressure, and salinity. An increase in pressure, or a decrease in salinity, or a decrease in temperature causes an increase in gas solubility.

Perhaps the most important dissolved gas in seawater is oxygen. Animals require oxygen for respiration. Plants release oxygen as a by-product of photosynthesis and utilize it during respiration. The decomposition of organic matter in the ocean is dependent upon oxygen concentration. Consequently, the amount of oxygen dissolved in seawater depends not only on mixing but also upon the type and degree of biological activity. The amount of oxygen dissolved in thesea varies from zero to about 11 milligrams per liter. At the surface of the sea, the water is more or less saturated with oxygen because of the exchange across the surface and plant activity. In fact, when photosynthesis is at a maximum during a phytoplankton bloom, such as during a red tide event (see Section 3.1.1), it can become supersaturated (Anikouchine and Sternberg 1973). When these blooms die off, bacterial aerobic respiration during decomposition of these phytoplankton cells can rapidly deplete dissolved oxygen in the water.

During conditions where mixing is minimal, oxygen can go to zero and result in the emission of hydrogen sulfide due to anaerobic respiration in the water column or benthic sediments. Rainfall runoff also brings organic detritus and organics into the marina which may result in significant oxygen utilization. This could include bacterial breakdown of the organics as well as the oxidation of chemicals in the runoff (Soule et. al. 1997). For enclosed marine areas, such as Marina del Rey Harbor, dissolved oxygen is replenished to a great deal by the flow of seawater from incoming tides. The amount of replenishment is related to the height and duration of the tide and the distance from the source of the tide. Thus, areas further from the entrance of Marina del Rey Harbor will have a smaller degree of oxygen exchange than those closer to the entrance.

Vertical dissolved oxygen patterns. Dissolved oxygen concentrations typically decrease in value with depth due to respiration of organisms as well as the breakdown of organic material by bacteria. However if the water column is well-mixed, the dissolved oxygen will be fairly constant with depth. Temperature and/or salinity can affect the density structure of the water column and create barriers to vertical mixing. Figure 3-9 depicts the minimum, average, and maximum dissolved oxygens for each station plotted against depth for 1996-97. Although some stations showed relatively wide minimum to maximum ranges, average dissolved oxygen values varied little from surface to bottom. Particularly high maximum values at Station 12 likely reflects red tide conditions which can cause supersaturation of oxygen in the water column.

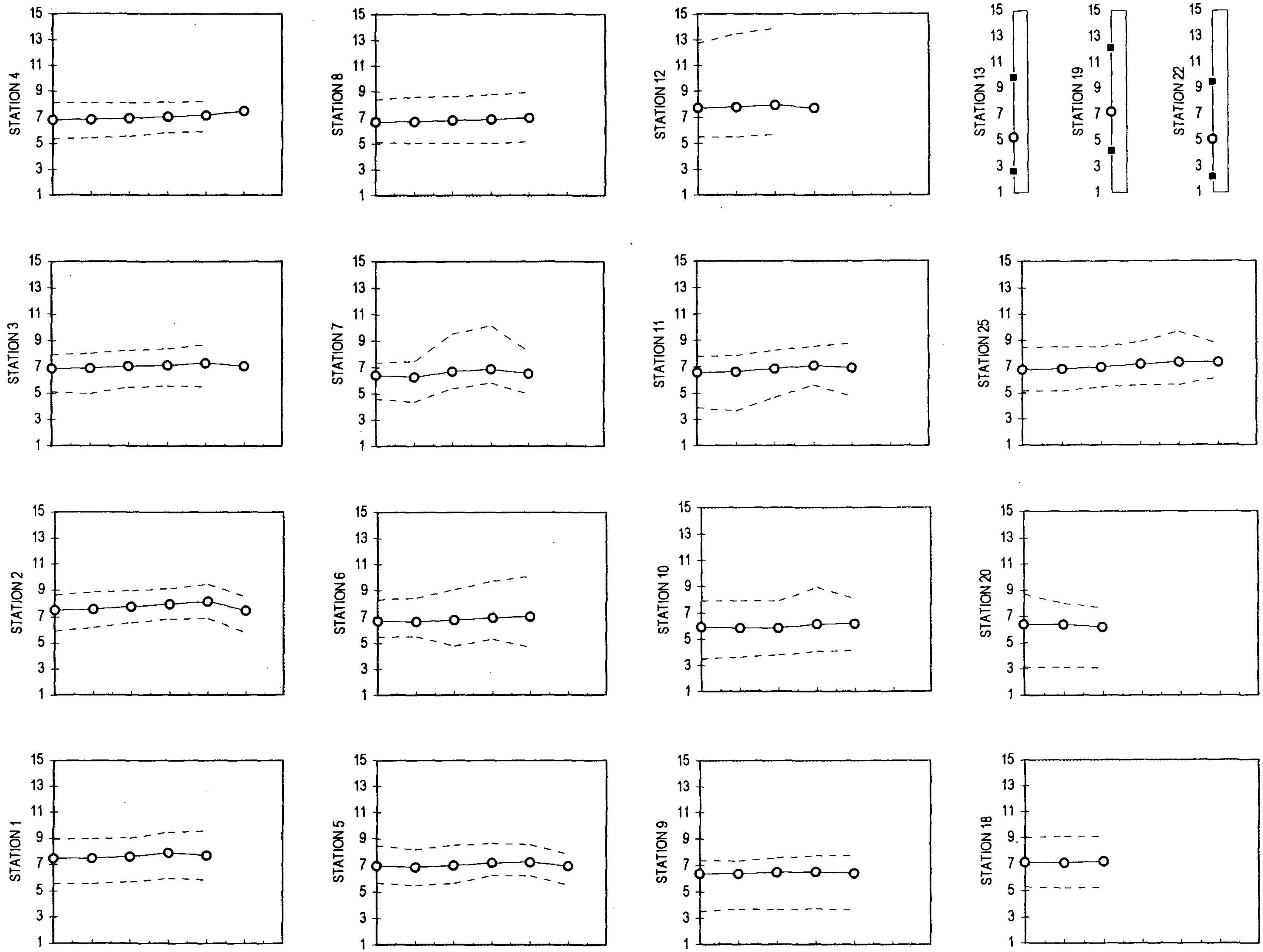


FIGURE 3-9. MIN., AVERAGE, AND MAX. DIS. OXYGEN (MG/L) VERSUS DPTH. (M) AT 18 WATER COLUMN STATIONS.

Dissolved oxygen patterns over the year. As mentioned in the temperature and salinity sections above, stations within the main channel of the Harbor (2, 3, 4, 5, and 25) more typically reflect conditions of the open ocean. Seasonal dissolved oxygen patterns at these stations (Figure 3-10) were weak, however slightly elevated values in March and May were likely due to blooms of red tide plankton observed during the spring and early summer (see the section on temporal BOD patterns below). Slight declines in dissolved oxygen in April and June may have been due to the respiration of bacteria breaking down the red tide organisms. Stations with the widest ranges of values over the year were those within Ballona Creek (12), Oxford Lagoon (10, 13, 20, and 22), and at Mothers Beach (19). These stations reflected the spring plankton blooms as did the channel stations but to a much greater degree. In March, the water from all of these stations were supersaturated with dissolved oxygen, reaching a peak of nearly 14 mg/l at Station 12. Some stations (1, 6, 7, 10, 11, 20, and 25) yielded relatively high values in September or October. This likely reflects plankton blooms as well, however, they were probably not due to red tide.

Regulatory agencies consider dissolved oxygen values less than 5.0 mg/l as not acceptable for marine life. Actually, the 5.0 mg/l minimum is based on fish survival, while invertebrates can survive on much lower levels (Soule et. al. 1997). Values below 5.0 mg/l were most common at the Oxford Lagoon stations. The lowest value recorded was 2.2 mg/l at Station 22 in August. Measurements below 5.0 mg/l were also recorded at this station during September, October, November, February, April, and June. Station 13 values were below 5.0 mg/l in September, October, November, February, and June; Station 10 in July and June; Station 6 in July; Stations 7, 9, 11, and 20 in June; and Station 19 in October.

Spatial dissolved oxygen patterns. In general, dissolved oxygen tended to decline with distance from Harbor entrance, reflecting the reduced horizontal mixing with oceanic water within the interior basins (Figure 3-11). Not surprisingly, lowest average values were in Oxford Lagoon (Stations 13 and 22 - 5.1 and 5.2 mg/l, respectively) followed by Basin E stations (10 and 20 - 6.0 and 6.4 mg/l) which are directly linked to Oxford Lagoon. Municipal storm drain water which discharges into Oxford Basin appears to contain materials high in dissolved and/or suspended nutrients and organics (see Figures 3-17 and 3-20, below). Bacteria rapidly break down these materials, and, through their respiration, consume large concentrations of dissolved oxygen. In addition, these areas are most isolated from the usually oxygen-saturated, open ocean waters.

Much the same can be said of Ballona Creek, however these stations (1 and 12) are also influenced by their proximity to the incoming ocean waters which are usually high in dissolved oxygen. Thus, the highest oxygen averages in the Harbor were those nearest the entrance (Stations 1, 2, and 12 - 7.6 to 7.9 mg/l). The remaining channel stations (3, 4, 5, and 25) averaged from 7.0 to 7.1 mg/l. Most other basin stations were slightly lower (6, 7, 8, 9, and 11 - 6.5 to 6.8 mg/l), while two others in Basin D were the same or slightly higher (18 and 19 - 7.2 and 7.0, respectively). There were no incidences of anoxia during any of this year's surveys.

FIGURE 3-10. MINIMUM, AVERAGE, AND MAXIMUM DIS. OXYGEN (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

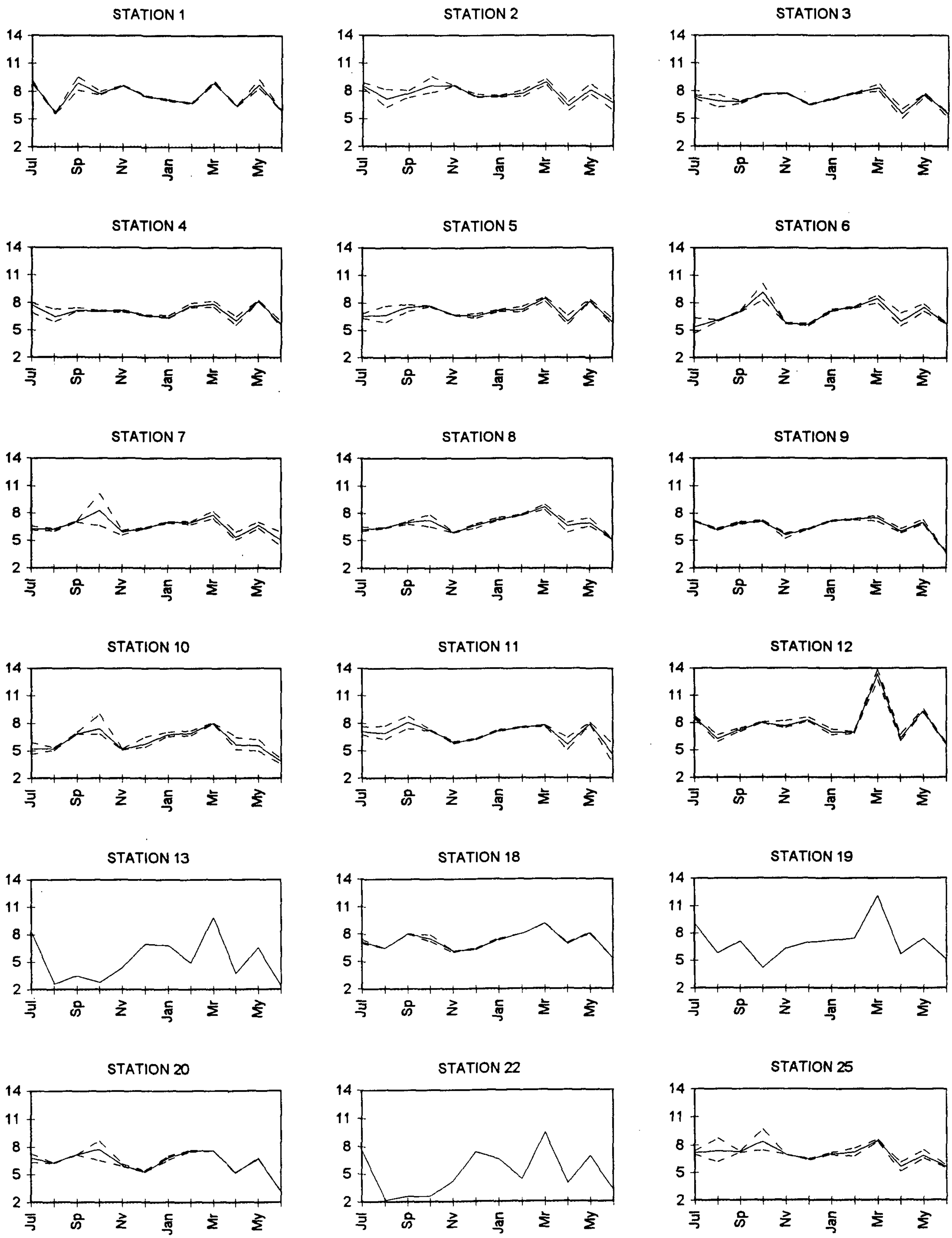


FIGURE 3-11. AVERAGE ANNUAL DISSOLVED OXYGEN (MG/L) AT 18 WATER COLUMN STATIONS.

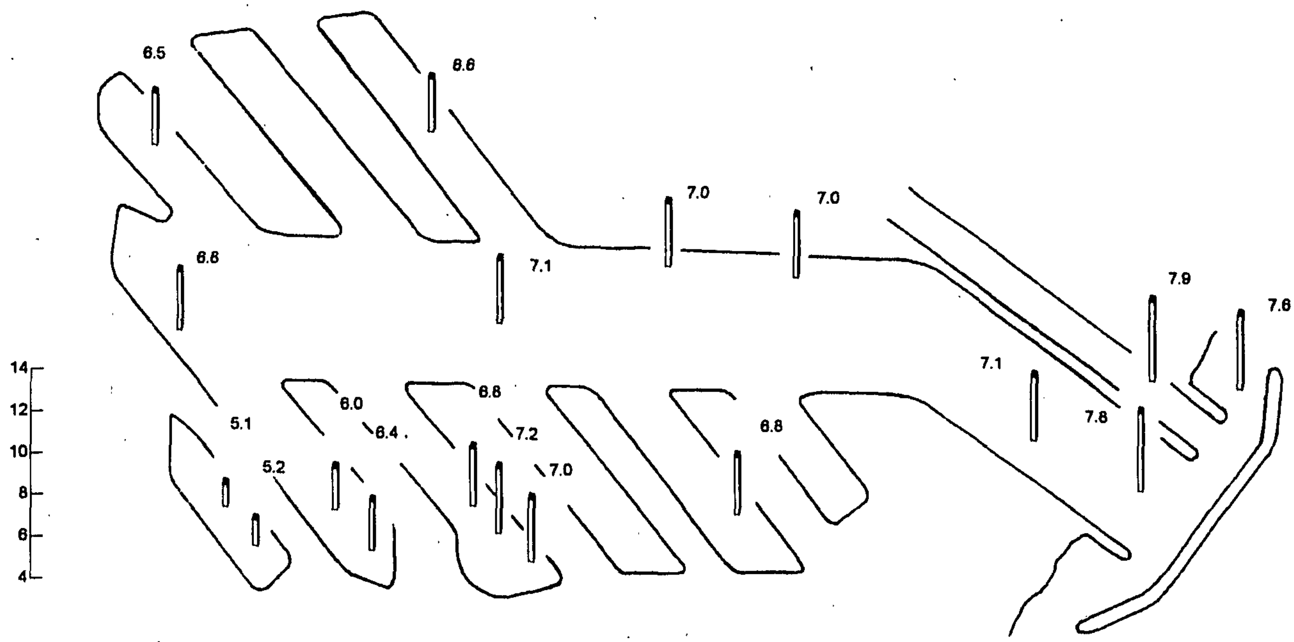


TABLE 3-4. ANNUAL DISSOLVED OXYGEN RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1988-89[1.]	4.4 - 9.1	4.8 - 9.0	4.6 - 13.8	3.3 - 10.9
1989-90[2.]	2.5 - 12.0	3.9 - 9.9	1.4 - 11.9	1.6 - 10.1
1990-91	4.2 - 10.1	2.0 - 13.1	5.6 - 12.9	3.0 - 11.0
1991-92	4.7 - 10.2	5.5 - 10.1	2.0 - 8.8	2.0 - 8.8
1992-93	2.5 - 8.2	2.0 - 8.9	3.3 - 11.1	4.0 - 9.2
1993-94[3.]	-----	-----	-----	2.5 - 8.1
1994-95	3.3 - 9.4	2.7 - 9.7	4.4 - 10.2	1.0 - 8.3
1995-96	1.9 - 8.1	4.6 - 12.1	4.6 - 9.2	2.2 - 9.1
Overall range	**1.9 - 12.0**	**2.0 - 13.1**	**1.4 - 13.8**	**1.0 - 11.0**
1996-97[4.]	2.6 - 10.1	4.4 - 8.6	3.8 - 13.9	2.4 - 6.9

1. Two months only in the fall.

2. Station 25 added this year

3. Two months only in the fall, winter, and summer.

4. One month only in the summer.

Dissolved oxygen ranges compared with past years. All 1996-97 dissolved oxygen values were within or very near the overall seasonal ranges for the preceding eight years (Table 3-5). When compared to 1995-96, values in the fall ranged slightly higher and values in winter ranged slightly lower. Oxygen in the spring ranged more widely, and ranges in the summer were narrower than 1995-96.

3.3.1.4. **Hydrogen Ion Concentration (pH)**

pH is defined as the negative logarithm of the hydrogen ion concentration. A pH of 7.0 is neutral, values below 7.0 are acidic, and those above 7.0 are basic (Horne 1969). Seawater in southern California is slightly basic, ranging between 7.5 and 8.6, although values in shallow open-ocean water are usually between 8.0 and 8.2 (SWQCB 1965). These narrow ranges are due to the strong buffering capacity of seawater which rarely allows for extremes in pH.

Factors which can influence pH in a semi-enclosed eutrophic estuaries, such as Marina Del Rey Harbor, are freshwater inputs and biological activity. Since freshwater pH values tend to be about 0.5 pH units less than seawater, any inflow from a freshwater source will tend to lower the pH slightly. When photosynthesis is greater than respiration, more carbon dioxide is taken up than used, and pH may increase to higher values in the euphotic (i.e. light penetrating) zone. When respiration is greater than photosynthesis, more carbon dioxide is released than used and pH may decrease, especially when mixing is minimal (in the oxygen minimum zone) and towards the bottom (Soule et. al. 1997).

Vertical pH patterns. Surface to bottom pH profiles (Figure 3-12) indicated that there is very little change with depth. At most, some stations showed a very slight decline near the bottom. At nearly all stations, minimum-maximum ranges are very narrow. The inflow of freshwater from Ballona Creek is apparent from the wider ranges observed for Station 12, and to a lesser degree, at Station 1. Lower pH minimums at two other stations (8 and 9) are less explicable. In June, relatively low surface and two-meter measurements at Station 9 (7.4 and 7.6 units, respectively), and low measurements at four and six meters (both 7.5) at Station 8 would indicate the presence of freshwater. However, salinity profiles (Figure 3-6) do not bear this out. It is probable that these relatively low values are due to some increased bacterial activity, but the cause is unknown.

pH patterns over the year. As mentioned above, stations within the main channel of the Harbor (2, 3, 4, 5, and 25) more typically reflect conditions of the open ocean. Averages varied weakly at these stations (Figure 3-13). The very mild pH depressions in January might be the result of some increased rainfall. Widest temporal salinity ranges were within Oxford Lagoon (Stations 13 and 22) and reflect the somewhat random discharge of freshwater into the basin. Stations within the Harbor impacted most by Oxford Lagoon (10 and 20, in Basin E) appeared relatively unaffected. The only other shoreline station (19, at Mother's Beach in Basin D) was also highly variable over time. The shallowness of this station makes it highly sensitive to non-point source runoff.

FIGURE 3-12. MIN, AVERAGE, AND MAX PH (UNITS) VERSUS DEPTH (M) AT 18 WATER COLUMN STATIONS.

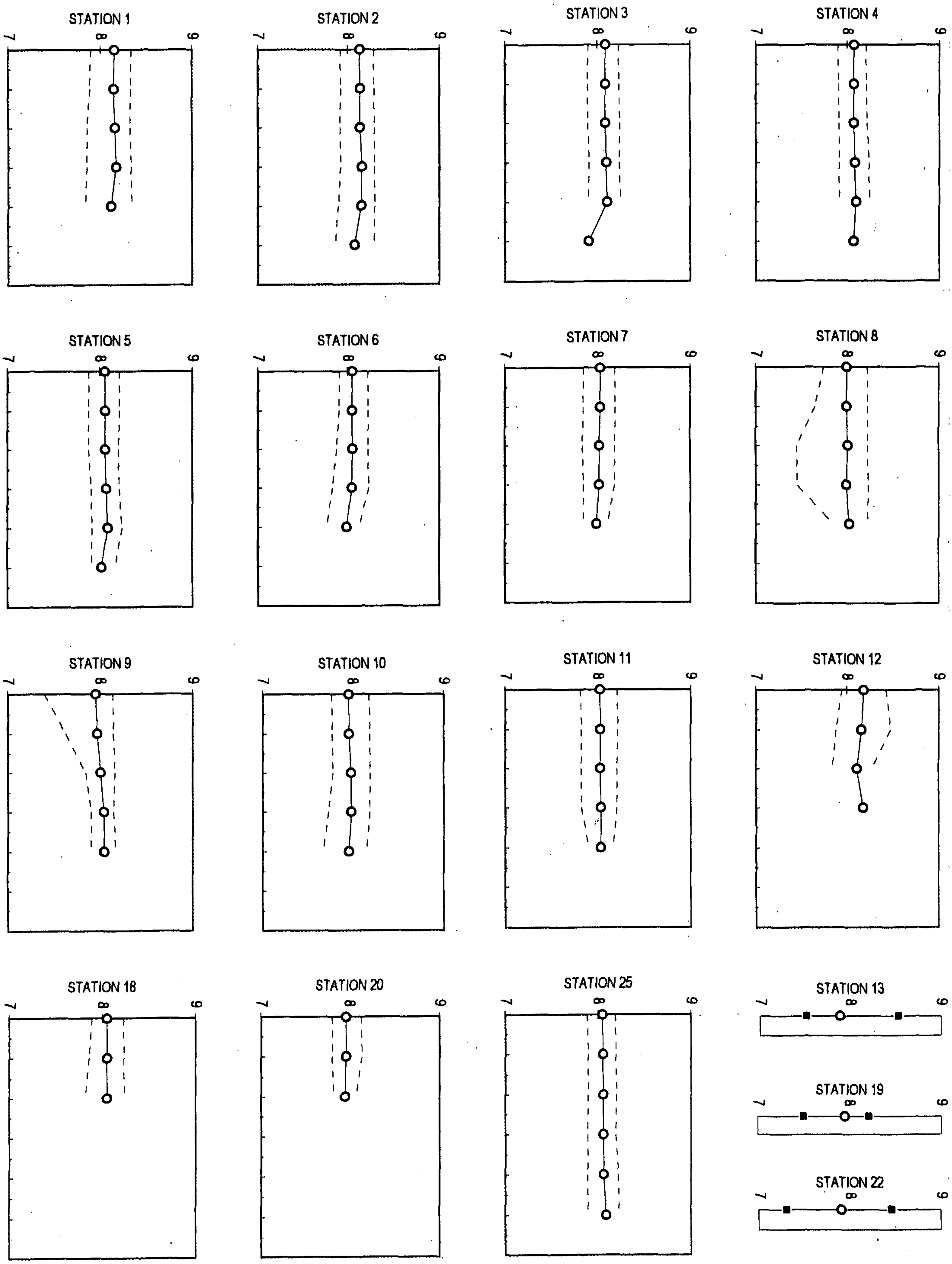
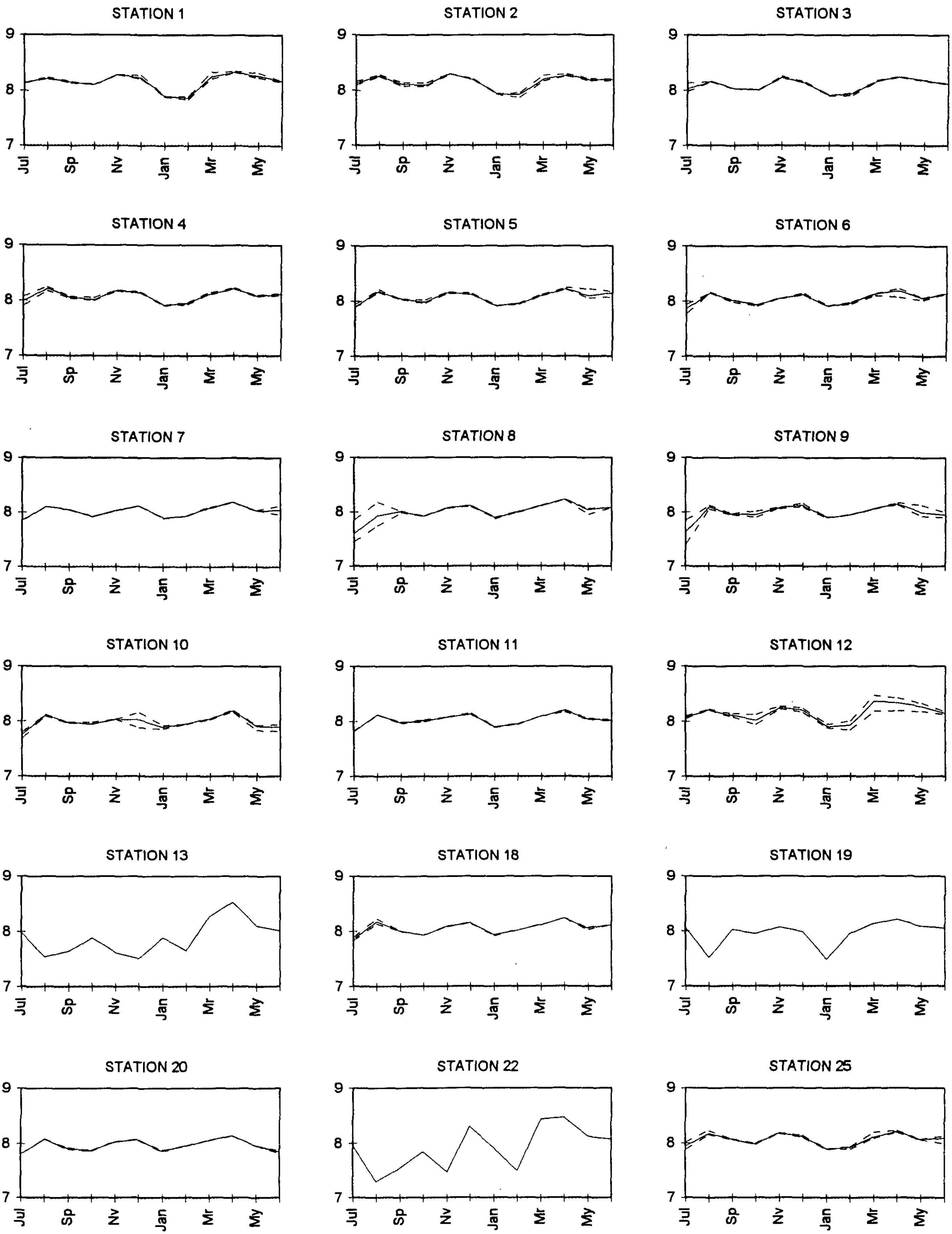


FIGURE 3-13. MINIMUM, AVERAGE, AND MAXIMUM PH (UNITS) VS. MONTH AT 18 WATER COLUMN STATIONS.



Station 12, within Ballona Creek, yielded temporal pH patterns very similar to those of the main channel, yet the minimum-maximum ranges were wider. As discussed for many of the water quality variables previously described, the wider ranges here are caused by the persistent freshwater flow from the Ballona drainage system.

Spatial pH patterns. Averaged over the 12-month sampling period, pH values were very similar among stations (Figure 3-14). Highest averages were near Ballona Creek (8.2 units, Stations 1 and 12) indicating that the influence of seawater is probably stronger overall than the influence of the freshwater drainage into these stations. Lowest averages (7.9, Stations 13 and 22) were, not surprisingly, within Oxford Lagoon. All other station averages were between 8.0 and 8.1.

pH ranges compared with past years. All 1996-97 pH values were within the overall seasonal ranges for the preceding five years (Table 3-5). When compared to 1995-96, values in the winter and spring ranged slightly higher. It should be remembered, though, that 1995-96 was a much rainier year than 1996-97, and the greater degree of freshwater input from the two major drainage systems, as well as all other non-point sources, would tend to contribute to a slight overall lowering of pH. As has been described in past years, the pH of the marina appears to be in good condition. The relatively low pH discussed above from storm drain runoff or other runoff appeared to have had minimal effects on the water column.

3.3.1.5. **Ammonia**

The common inorganic nitrogenous nutrients are nitrate, nitrite, and ammonia. In natural seawater, nitrate is the dominant of these three forms. Nitrite is usually an intermediate form appearing either when nitrate is reduced to ammonia or in the reverse process, as ammonia is oxidized to nitrate. Ammonia is normally present only in small concentrations in natural waters, and, in nitrogen-deficient waters, it may be the dominant form of nitrogenous nutrients. Ammonia concentrations in the ocean are usually formed by the breakdown of organic material and recycling into inorganic nitrogen. The Hancock Foundation surveys found nitrate concentrations in surface waters ranging from 0.01 to 0.04 mg/l (0.7 to 0.28 ug-at/l) over their study area. Surface concentrations in spring months were somewhat higher than those found during fall and winter months (SCCWRP 1973). These figures are mirrored by our own studies in Ventura County (Aquatic Bioassay 1996).

Ammonia concentration in the ocean is important for three reasons. First, since nitrogen is usually limiting in marine waters, its presence or absence can have a profound affect upon the primary producers in the ocean (i.e. usually phytoplankton) and thus the subsequent trophic levels which depend upon them (i.e. nearly all other living organisms in the sea). Secondly, too much ammonia can cause algal blooms which can be detrimental to other organisms, particularly in enclosed bays and estuaries such as Marina del Rey Harbor (see Section 3.3.1.3 for a discussion of the impacts of red tide algal blooms). Thirdly, ammonia is a by-product of the degradation of most forms of organic waste in the marine environment and can thus be used as a rough indicator of organic pollution.

FIGURE 3-14. AVERAGE ANNUAL PH (UNITS) AT 18 WATER COLUMN STATIONS.

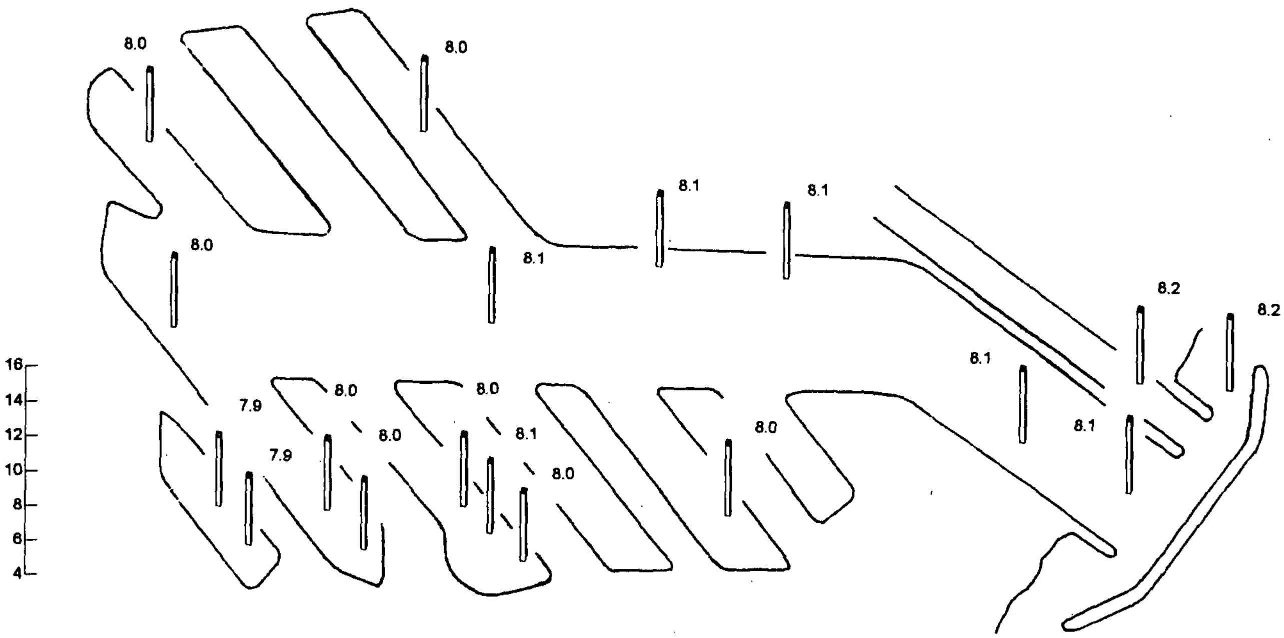


TABLE 3-5. ANNUAL PH RANGES (UNITS) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	7.8 - 8.3	7.5 - 8.3	7.1 - 8.3	7.3 - 8.3
1992-93	7.6 - 8.2	7.0 - 8.5	7.4 - 8.4	7.5 - 8.5
1993-94[2.]	7.9 - 8.6	7.2 - 8.1	7.8 - 8.7	7.3 - 8.7
1994-95	7.5 - 8.2	7.1 - 8.3	7.5 - 8.5	7.8 - 8.3
1995-96	7.5 - 8.3	7.2 - 8.2	7.4 - 8.3	7.3 - 8.4
Overall range	**7.5 - 8.6**	**7.0 - 8.5**	**7.1 - 8.7**	**7.3 - 8.7**
1996-97[3.]	7.5 - 8.3	7.5 - 8.3	7.8 - 8.5	7.8 - 8.2

[1.] Two months only in the fall.

[2.] Two months only in winter and summer. One month in fall.

[3.] One month only in the summer.

Surface runoff and drainage of nitrogen, including ammonia, is governed by the frequency, intensity, and duration of precipitation in the drainage basins. As a result, there can be relatively large fluctuations in these inputs from year to year, and lengthy periods within a year when they are absent (SCCWRP 1973).

Marina del Rey is an estuary, which is a partially enclosed coastal ecosystem where seawater mixes with nutrient-rich freshwater that is drained from the land. The confined conditions tend to trap the nutrients, resulting in an extremely productive and important ecosystem, which is an important nursery area for many species of fish and invertebrates. In estuarine and coastal systems, ammonia input from natural recycling (breakdown of organic material) is often significantly increased by input from anthropogenic sources. These anthropogenic sources include ocean outfalls for treated sewage, rainwater runoff, and input from boats. Direct rainwater runoff into Marina del Rey is significantly augmented by runoff from the major flood control facilities, Oxford Basin and Ballona Creek. The ammonia concentrations in the marina are likely to be indicative of the breakdown of organic debris and/or waste, and terrestrial fertilizers, whether of human or animal origin. Localized events in the marina may add to the ammonia concentrations. These include the discharge of human wastes, bird droppings and wash-down products from nearby docks and walkways (Soule et. al. 1997).

Vertical ammonia patterns. No unifying vertical patterns of ammonia concentration were evident in Marina del Rey Harbor (Figure 3-15). Although some station averages increased slightly with depth, others decreased, while still others were relatively unchanged. For all stations and all depths, ammonia minimums were at or near the detection limit (0.6 ug-at/l) during at least one monthly survey. Maximum values ranged very widely at all stations and again with no apparent vertical pattern.

Ammonia patterns over the year. As mentioned above, stations within the main channel of the Harbor (2, 3, 4, 5, and 25) more typically reflect conditions of the open ocean. Averages varied widely over the year at these stations (Figure 3-16), with peaks appearing in October, February, April, and, with some stations, June. Widest temporal ammonia ranges were at Station 12 in Ballona Creek, Station 2 near the Harbor entrance, Station 18 in Basin D, and Station 20 in Basin E. All of these stations' peak values occurred in June. Relationships between ammonia and rainfall or plankton blooms (high oxygen and Forel-Ule values with low water clarity) were not obvious for this year. Intermittent freshwater flows from the various drainage systems may be more important and may be overwhelming the seasonal and biological patterns.

Spatial ammonia patterns. The most important sources of ammonia into Marina del Rey Harbor appears to be Oxford Lagoon, and to a lesser degree, Ballona Creek (Figure 3-17). Highest ammonia averages over the year were within Oxford Lagoon (10.5 and 8.6 ug-at/l - Stations 13 and 22, respectively), followed by Ballona Creek (7.6 ug-at/l - Station 12). Lowest averages (3.6 to 4.2 ug-at/l) were in the main channel (Stations 3, 4, and 25) and within Basins B and H (Stations 6 and 7).

FIGURE 3-15. MIN, AVERAGE, AND MAX AMMONIA (MG/L) VERSUS DPTH.(M) AT 18 WATER COLUMN STATIONS.

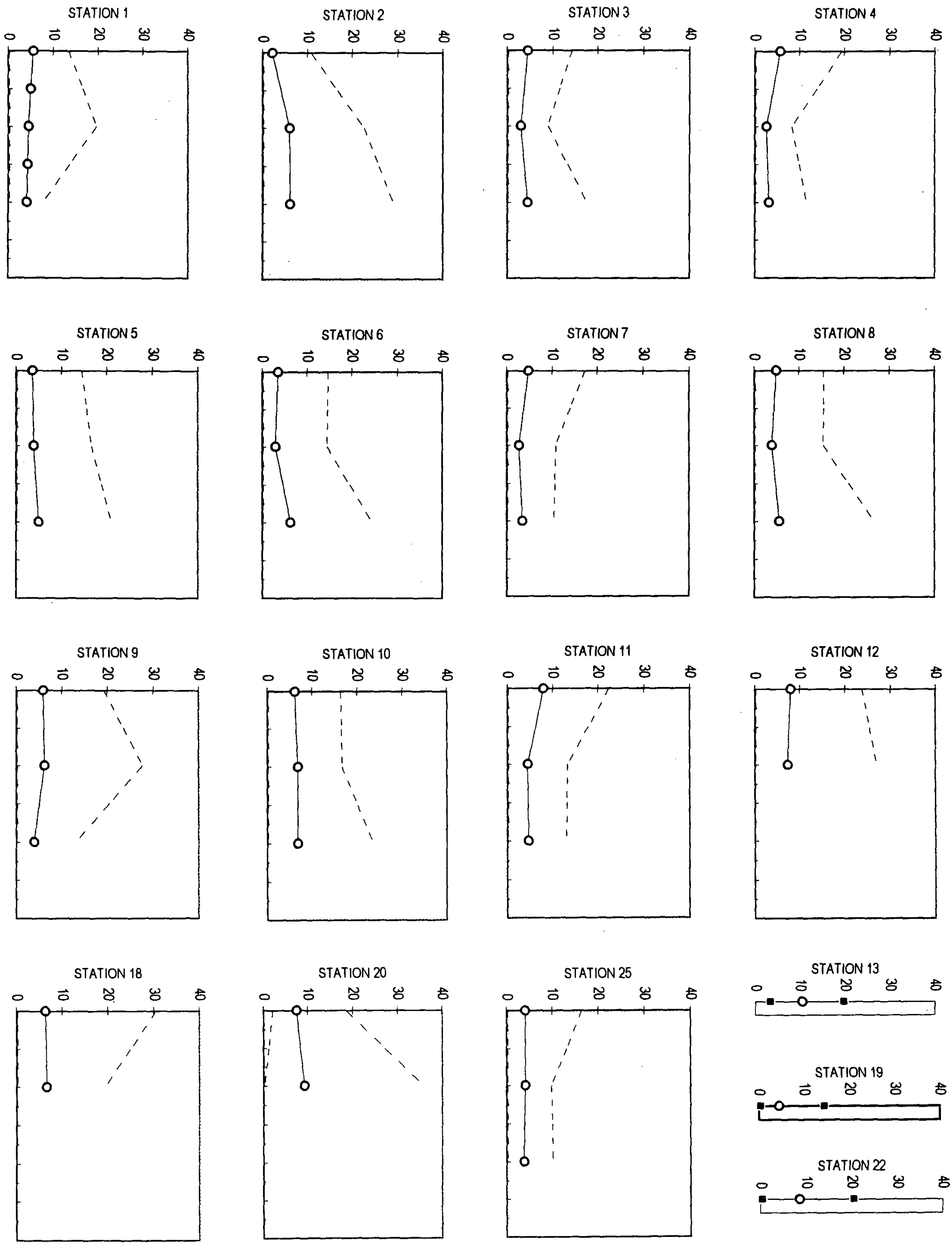


FIGURE 3-16. MINIMUM, AVERAGE, AND MAXIMUM AMMONIA (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

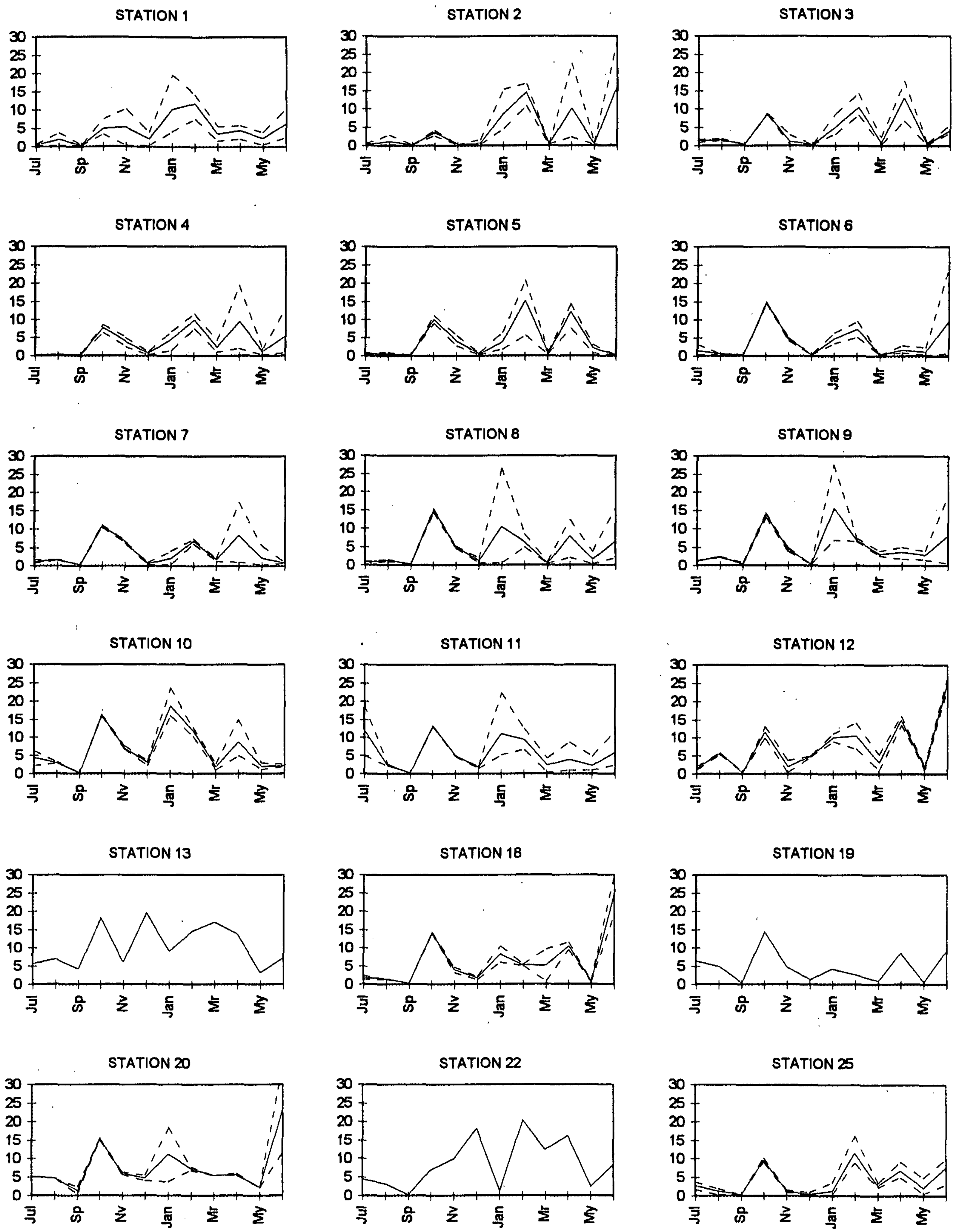


FIGURE 3-17. AVERAGE ANNUAL AMMONIA (MG/L) AT 18 WATER COLUMN STATIONS.

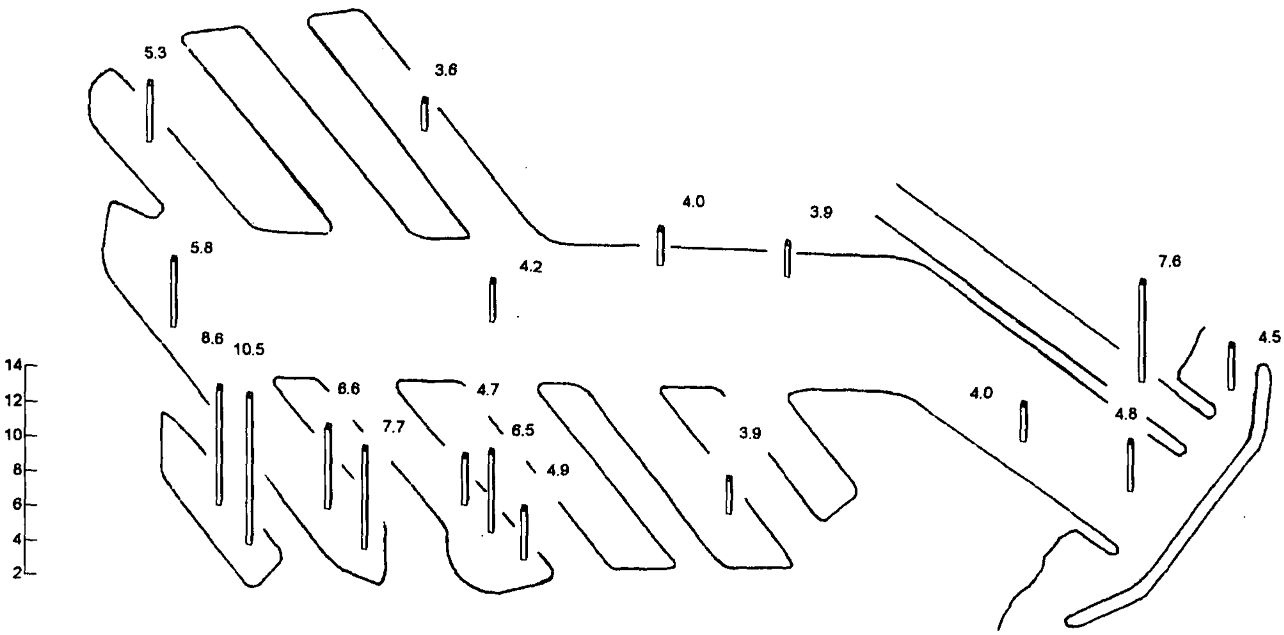


TABLE 3-6. ANNUAL AMMONIA RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1]	3.1 - 29.0	2.1 - 200.0	1.4 - 31.7	2.1 - 58.8
1992-93	2.0 - 38.3	2.9 - 53.7	1.7 - 35.0	2.5 - 23.0
1993-94[2]	----	2.6 - 30.6	2.3 - 10.0	1.5 - 4.5
1994-95	1.5 - 6.0	0.2 - 5.0	0.9 - 4.1	1.0 - 12.7
1995-96	2.2 - 15.0	3.2 - 47.4	2.5 - 12.0	0.3 - 18.9
Overall range	**1.5 - 38.3**	**0.2 - 200.0**	**0.9 - 35.0**	**0.3 - 58.8**
1996-97[3]	0.3 - 18.2	0.3 - 27.7	0.3 - 22.6	0.3 - 35.8

1. Two months only in the fall.

2. Two months only in the winter and summer.

3. One month only in the summer.

Stations 1 and 2 near the Harbor entrance (4.5 and 4.8 ug-at/l) were slightly higher than the other channel stations, suggesting that they were being impacted by Ballona Creek. Stations 10 and 20 within Basin E had moderately high ammonia values (6.6 and 7.7 ug-at/l) and were probably impacted by the discharge from Oxford Lagoon. The average value for Station 18 in Basin D was also moderately high (8.5 ug-at/l), the source, however, is unknown since averages for the stations on either side were relatively low. Remaining stations had moderate ammonia values.

Ammonia ranges compared with past years. All 1996-97 ammonia values were within the overall ranges for the preceding five years (Table 3-6). When compared to 1995-96, values in fall and winter were somewhat lower. This is likely due to the considerably heavier rainfall encountered in 1995-96. Ranges of values in spring and summer were wider than those of the previous year.

3.3.1.6. **Biochemical Oxygen Demand (BOD)**

The biochemical oxygen demand (BOD) of water is a standardized test used to determine the relative oxygen requirements of wastewaters, effluents, and natural waters. In the BOD test, the oxygen concentration of the water sample is measured, and a portion of that water is sealed in a specially-designed air-tight container (i.e. BOD bottle). The sample is allowed to incubate for five days at 20 deg C, and the dissolved oxygen is measured again (APHA 1995). During the five-day period, naturally occurring bacteria reproduce and respire as long as there is sufficient organic material for them to consume. In the process, they utilize the oxygen available to them in the sealed container. Thus, the BOD is a measure of the amount of oxygen consumed by bacterial respiration over the period of five days. Although the BOD test utilizes bacteria, it is not a measure of bacterial density but rather an indirect measure of organic material in the water. The source of organic material may be natural, such as plankton or organic detritus from upwelled waters, or anthropogenic, such as wastewater effluents, stormwater drainage, or non-point runoff.

Vertical BOD patterns. Vertical BOD profiles (Figure 3-18) suggest that the water column is well-mixed, and the BOD is fairly constant with depth. Minimum ranges were usually below 1.0 mg/l. Maximum values for most values ranged widely and with no obvious consistent vertical pattern. Particularly high maximum values at a number of stations may be the result of the breakdown of red tide or other phytoplankton blooms.

BOD patterns over the year. For most stations, BOD values were low (below 3.0 mg/l) during the fall and winter (Figure 3-19). Temporal relationships among BOD, water color (i.e. Forel-Ule), water clarity, and, perhaps dissolved oxygen values suggest that these values are related mostly to the red tide blooms observed during spring and summer. It appears that red tide were present in large numbers at Station 12 in Ballona Creek during March, April, and May of 1997. The bloom appears to have moved into the entrance of the Harbor (Stations 1, 2, and 3) in May and into the rest of the channel and outer basins in June. Although all stations showed evidence of these plankton, Station 5 in mid-channel, Station 7 in Basin H, Station 9 in Basin F, Station 20 in Basin E, and Stations 13 and 22 in Oxford Lagoon showed the strongest impact.

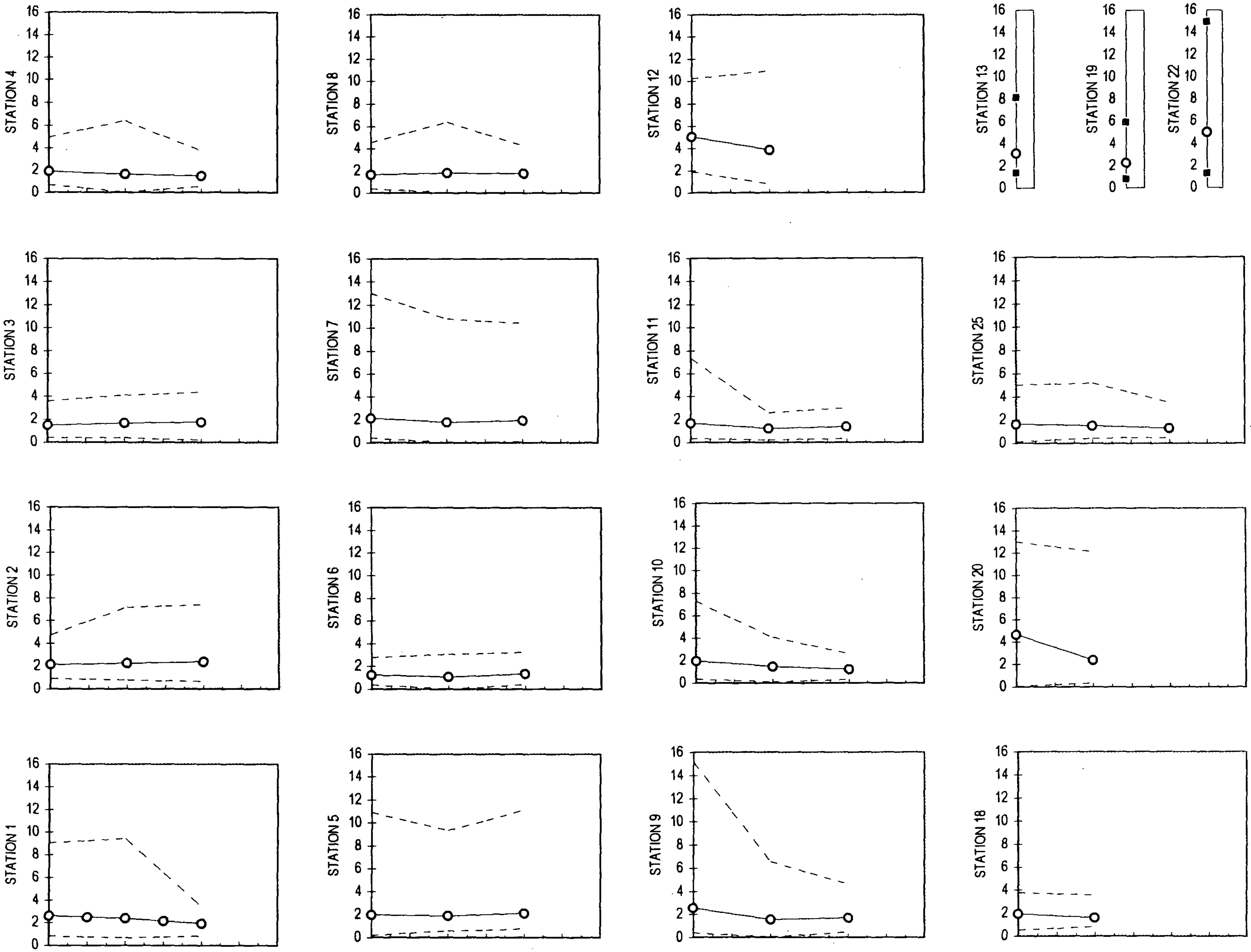
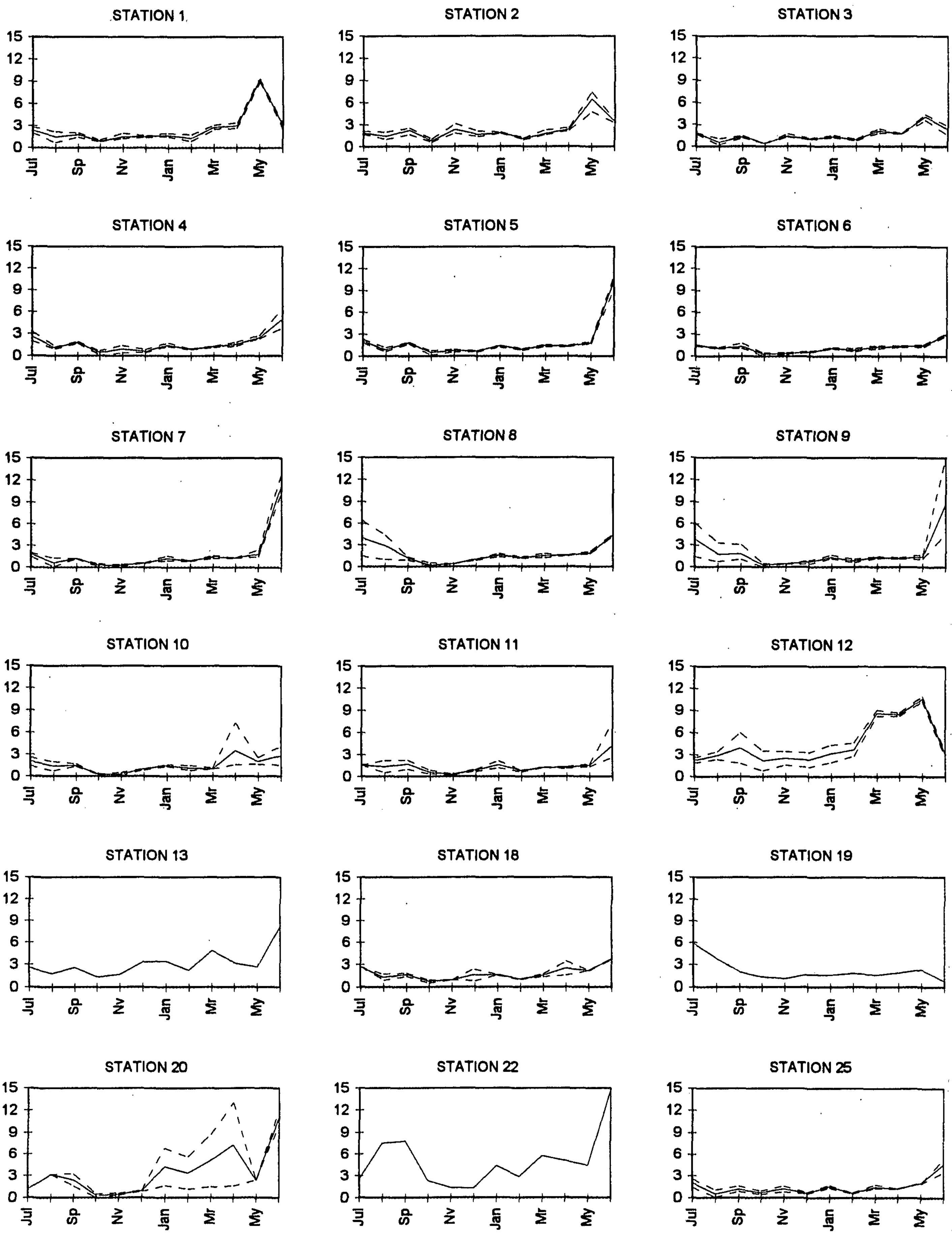


FIGURE 3-18. MIN, AVERAGE, AND MAX BOD (MG/L) VERSUS DEPTH (M) AT 18 WATER COLUMN STATIONS.

FIGURE 3-19. MINIMUM, AVERAGE, AND MAXIMUM BOD (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.



Another apparently phytoplankton-related BOD peak was evident in July of 1996. This bloom was much smaller and was most obvious at Station 9 in Basin F, and 8 and 19 in Basin D. One other BOD pattern may be related to organic discharge from Oxford Lagoon rather than plankton blooms. High BOD values at Station 22 in August, September, January, March, and April appear to be independent of planktonic density (based upon water color and clarity parameters). Station 20 in Basin E appeared most impacted, and Stations 10 in Basin E and 13 in Oxford Lagoon to a lesser degree.

Spatial BOD patterns. Expectedly, highest average BOD values were in Oxford Lagoon (Station 22 - 5.0 mg/l) and Ballona Creek (Station 12 - 4.5 mg/l). Station 13 in Oxford Lagoon and the station immediately downstream (20 in Basin E) yielded moderately high BOD results (3.2 and 3.5 mg/l, respectively). Most of the channel and remaining basin stations were low (1.2 to 2.2 mg/l). Slightly elevated values at Stations 1 and 2 relate to their proximity to the entrance where the strongest plankton blooms occurred and to the discharge of Ballona Creek.

BOD ranges compared with past years. All 1996-97 BOD values were within or near the overall seasonal ranges for the preceding five years (Table 3-7). When compared to 1995-96, maximum values in the fall, spring, and summer were about twice as high. This year was characterized by exceptionally dense red tide blooms. When these phytoplankton are collected in BOD bottles and die-off during the incubation period, they provide a very large source of food for bacteria, which in turn consume large quantities of oxygen. This tends to elevate BOD measurements greatly.

3.3.1.7. **Light Transmissance**

Water clarity in Marina del Rey Harbor is important both for aesthetic and ecological reasons. Phytoplankton, as well as multicellular marine algae and flowering plants, are dependent upon light for photosynthesis and therefore growth, and since nearly all higher-level organisms are dependent upon these organisms for survival (excepted are only those animals living in deep-ocean volcanic vents), the ability of light to penetrate into the ocean depths is of great importance.

Seasonally, water is least clear during spring upwelling and winter rains. In early summer, increased day length can promote plankton growth and reduce water clarity, as well. In late summer and fall, days are shorter and the rains which bring sediments into the marine environment have yet to begin. Therefore, late summer and early fall are typically the periods of greatest water clarity. Anthropogenic influences such as wastewater effluents, storm drainage discharges, and non-point runoff can also influence water quality on a local basis. Water clarity is determined using two completely different measuring techniques. Surface transparency is measured using a weighted, white plastic, 30 cm diameter disk (called a Secchi Disk) attached to a marked line. The disk is simply lowered through the water column until it disappears, and the amount of line used is recorded. Surface transparency is a good rough estimate of the amount of ambient light that is available to plankton since the depth to which light is available for photosythesis is generally considered to be about 2.5 times the Secchi disk depth (although more recent findings indicated that net photosynthesis may take place at lower light levels - SCCWRP 1973).

FIGURE 3-20. AVERAGE ANNUAL BOD (MG/L) AT 18 WATER COLUMN STATIONS.

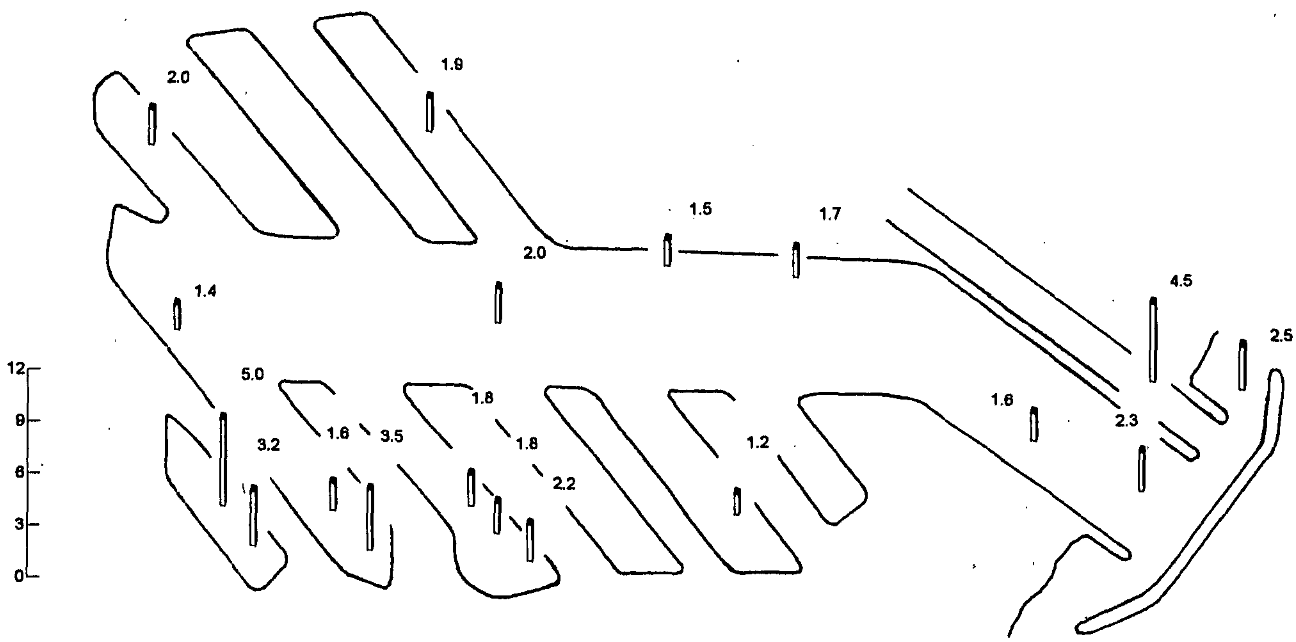


TABLE 3-7. ANNUAL BOD RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	0.4 - 6.1	0.4 - 18.9	0.5 - 7.8	0.7 - 6.4
1992-93	0.4 - 12.2	0.5 - 4.3	0.4 - 5.2	0.6 - 6.1
1993-94[2.]	0.8 - 14.0	0.7 - 6.9	0.7 - 15.2	0.6 - 13.0
1994-95	0.6 - 5.2	0.5 - 10.3	0.6 - 13.0	0.9 - 11.2
1995-96	0.8 - 3.4	0.6 - 8.7	0.6 - 6.8	0.1 - 7.5
Overall range	**0.4 - 14.0**	**0.4 - 18.9**	**0.4 - 15.2**	**0.1 - 13.0**
1996-97[3.]	0.1 - 7.8	0.4 - 6.8	1.0 - 13.0	0.8 - 15.2

[1.] Two months only in the fall.

[2.] Two months only in winter and summer. One month in fall.

[3.] One month only in the summer.

Light transmissance is measured using a transmissometer, which is an open tube containing an electrical light source at one end and a sensor at the other. The amount of light that the sensor receives is directly dependent upon clarity of the water between them. Results are recorded as percent light transmissance (converted to 0.1 m path length to be comparable with past surveys). Since transmissance is independent of ambient sunlight, it can be used at any depth and under any weather conditions. In general, light transmissance is usually positively correlated with surface transparency and negatively correlated with color (i.e. Forel-Ule). Light transmissance, surface transparency and water color measurements are not taken within Oxford Basin (Stations 13 and 22) or at the Mother's Beach shoreline station (19) because of the shallowness of the water.

Vertical light transmissance patterns. The vertical light transmissance profiles shown in Figure 3-21 suggests that the water column in the Harbor is generally well-mixed and that water clarity is fairly constant with depth. The exception is Station 12 within Ballona Creek where water clarity was somewhat lower near the surface. This could be due to Ballona Creek discharge which is lower in salinity and less dense than seawater, so it usually "floats" as a lens on the surface; it could be due to phytoplankton blooms (see the BOD section above); or, most likely, due to a combination of both. Minimum/maximum ranges were usually narrow, except again at the surface of Station 12, and at Station 10 which may be under the influence of Oxford Lagoon discharges. Maximum values for most values ranged widely with no obvious consistent vertical pattern.

Light transmissance patterns over the year. For most stations, transmissance values were relatively high during most of the year (Figure 3-22). The temporal relationship among BOD, water color (i.e. Forel-Ule), light transmissance, surface transparency, and, perhaps dissolved oxygen values and their dependence upon phytoplankton blooms has already been discussed in the BOD section above. In general, a large concentration of red-tide plankton invaded Ballona Creek in the early spring of 1997 and moved into the Harbor during late spring and early summer. This tended to lower light transmissance values throughout the Harbor during the spring and summer of 1997. A much smaller plankton bloom also occurred in July of 1996.

Low transmissance measurements at Station 10 in Basin E during December appear to be independent of planktonic density (based upon water color and clarity parameters). Heavy rains occurred in December and it is likely that runoff from Oxford Lagoon lowered light transmissance values in Basin E. Station 20, however, appears unaffected. Two basin stations (7 and 9) and one channel station (25) showed a slight depression in water quality in September of 1996. The source of this decline is unknown.

Spatial light transmissance patterns. Transmissance values averaged over the year are depicted in Figure 3-23. Lowest averages were in Basin E (Station 10 - 79.8%) and Basin F (Station 9 - 80.5%), and highest values were within the channel (86.5% to 88.1% - Stations 3, 4, and 25) and near the entrance (87.8% and 86.2% - Stations 1 and 2).

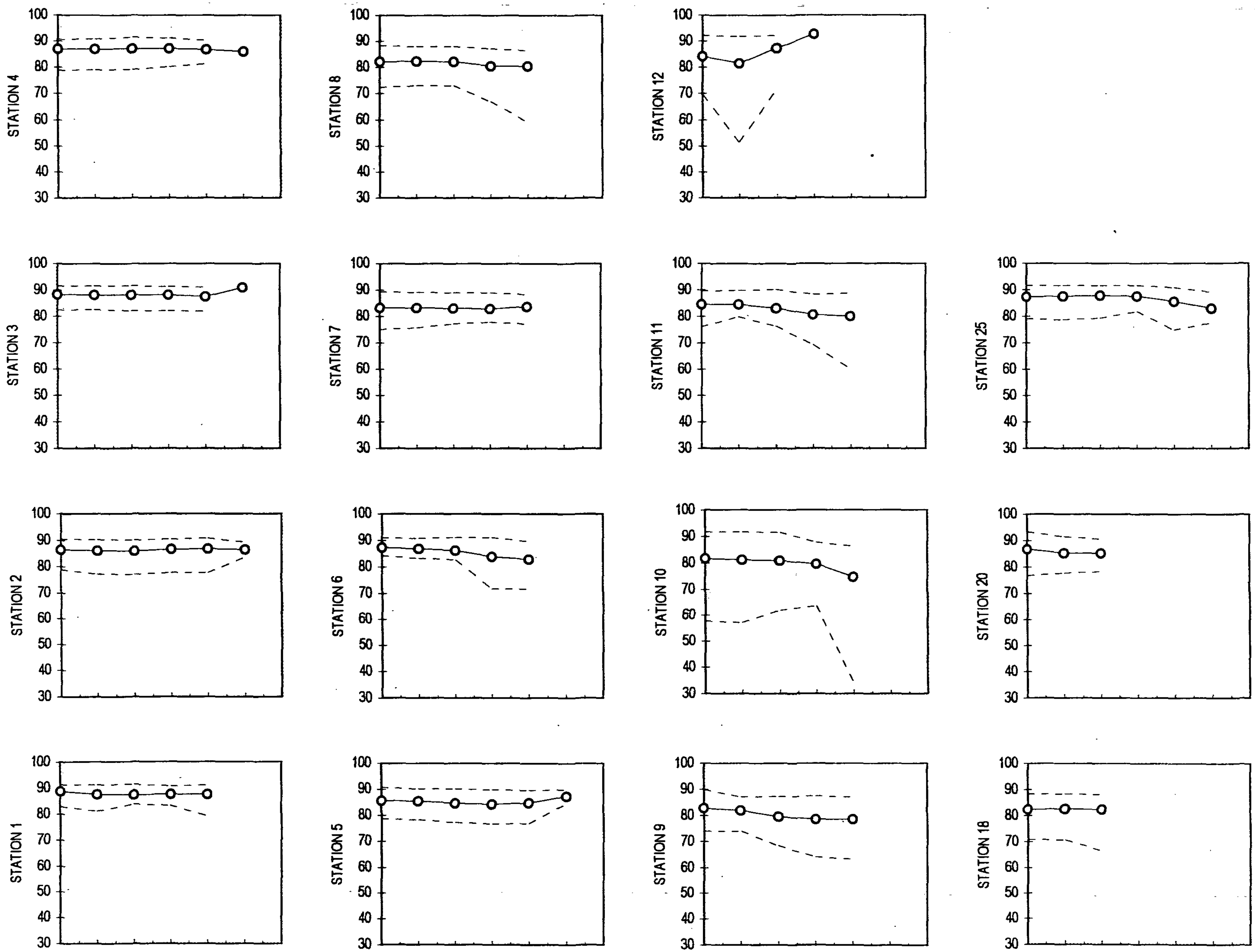


FIGURE 3-21. MIN, AVERAGE, AND MAX TRANSMISSANCE (%) VS. DPTH.(M) AT 15 WATER COLUMN STATIONS.

FIGURE 3-22. MINIMUM, AVERAGE, AND MAXIMUM TRANSMISSANCE (%) VS.MONTH AT 15 WATER COLUMN STATIONS

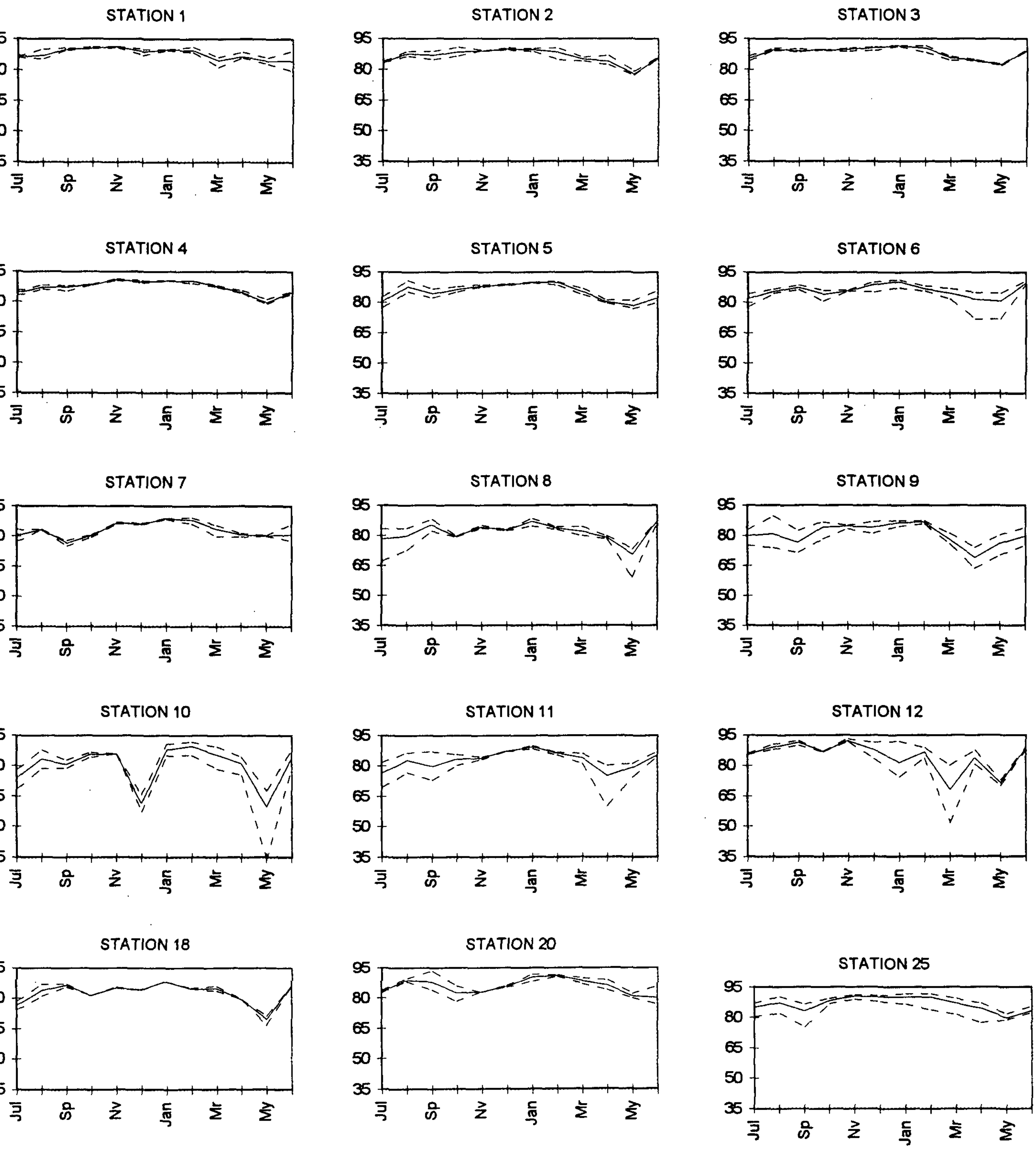


FIGURE 3-23. AVERAGE ANNUAL LIGHT TRANSMISSANCE (%) AT 18 WATER COLUMN STATIONS.

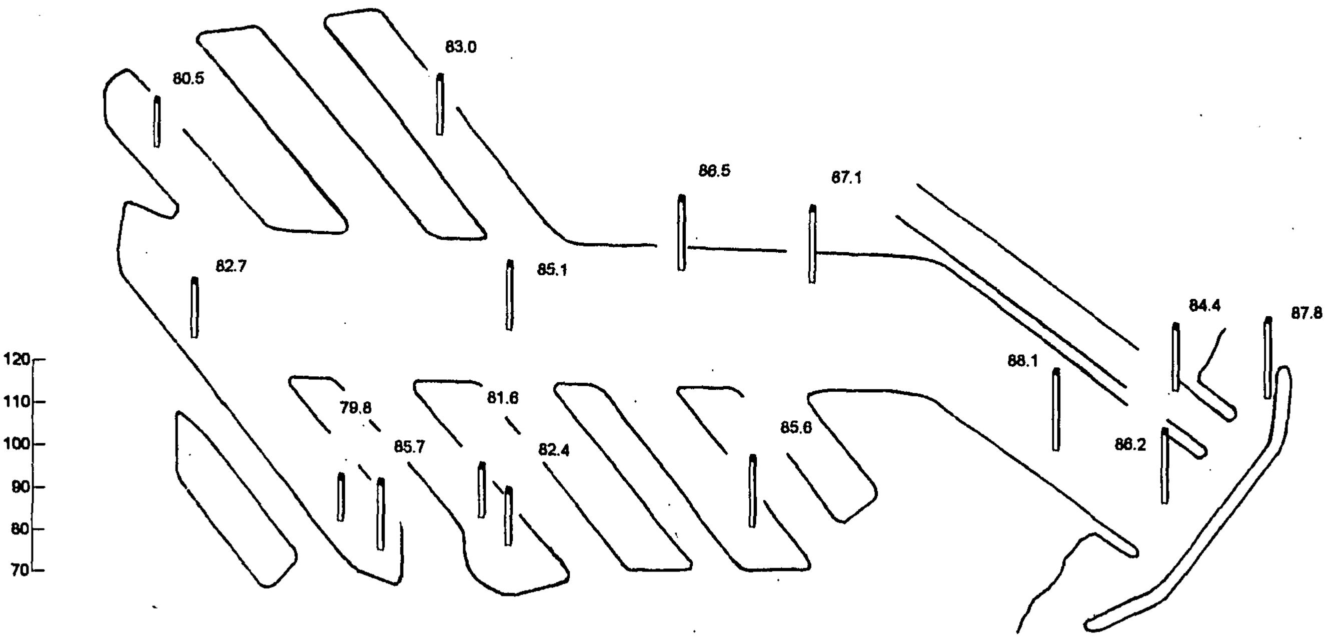


TABLE 3-8. ANNUAL LIGHT TRANSMISSANCE RANGES (%) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	59 - 90	38 - 90	8 - 86	52 - 91
1992-93[2.]	50 - 91	0 - 85	31 - 85	41 - 90
1993-94[3.]	20 - 90	50 - 98	46 - 89	62 - 94
1994-95	53 - 96	5 - 93	41 - 88	41 - 88
1995-96	38 - 93	4 - 93	15 - 84	43 - 81
Overall range	**20 - 96**	**0 - 98**	**8 - 89**	**41 - 94**
1996-97[4.]	71.4 - 93.3	57.2 - 92.0	33.8 - 89.8	74.9 - 90.4

[1.] Two months only in the fall and spring.

[2.] Two months only in winter and summer.

[3.] Two months only in winter and summer. One month in fall.

[4.] One month only in the summer.

FIGURE 3-32. MIN., AVERAGE, AND MAX. ENTEROCOCCUS (COL/100 ML) VS. MONTH AT 18 WATER COLUMN STATIONS.

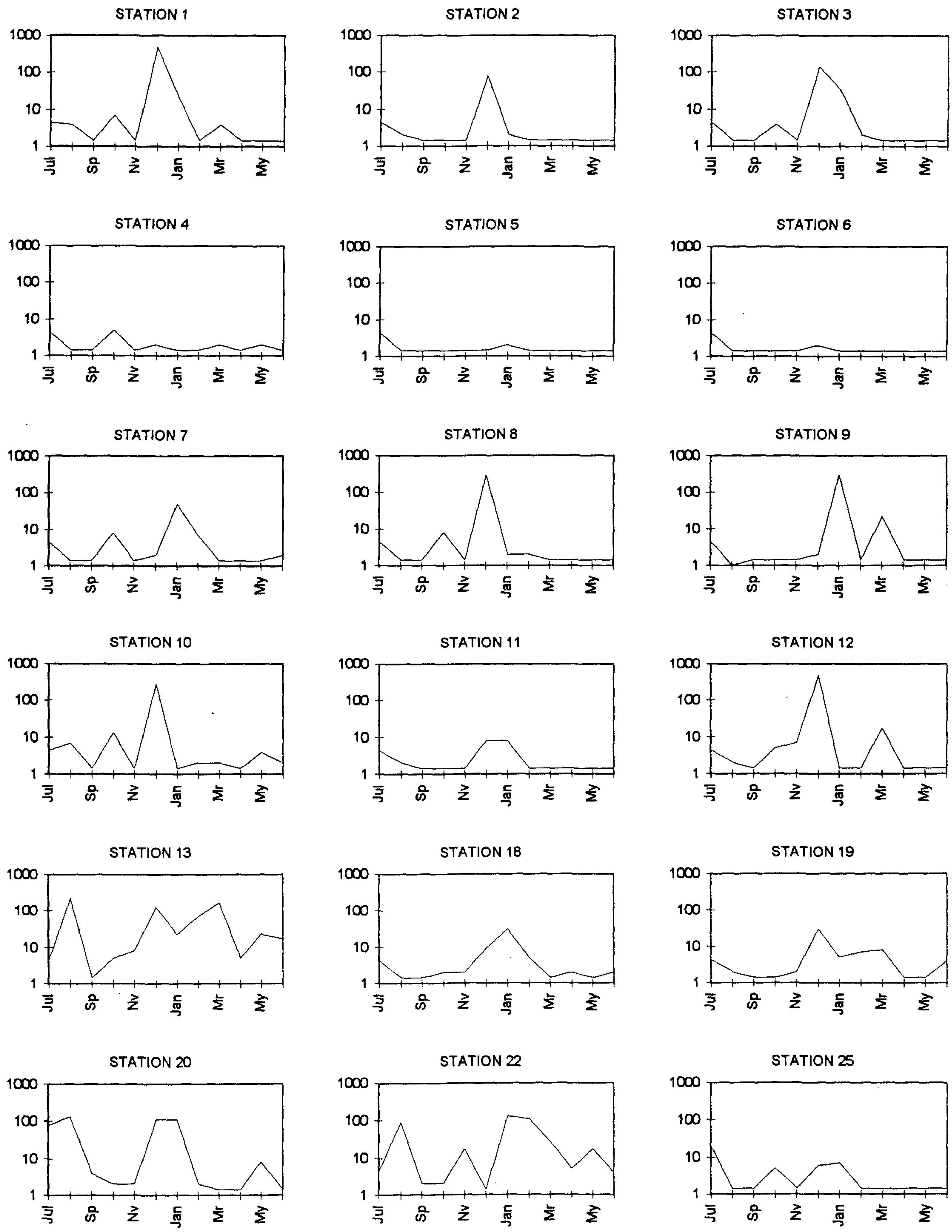


FIGURE 3-33. GEOMETRIC MEANS OF ENTEROCOCCUS (COL./100 ML) AT 18 WATER COLUMN STATIONS

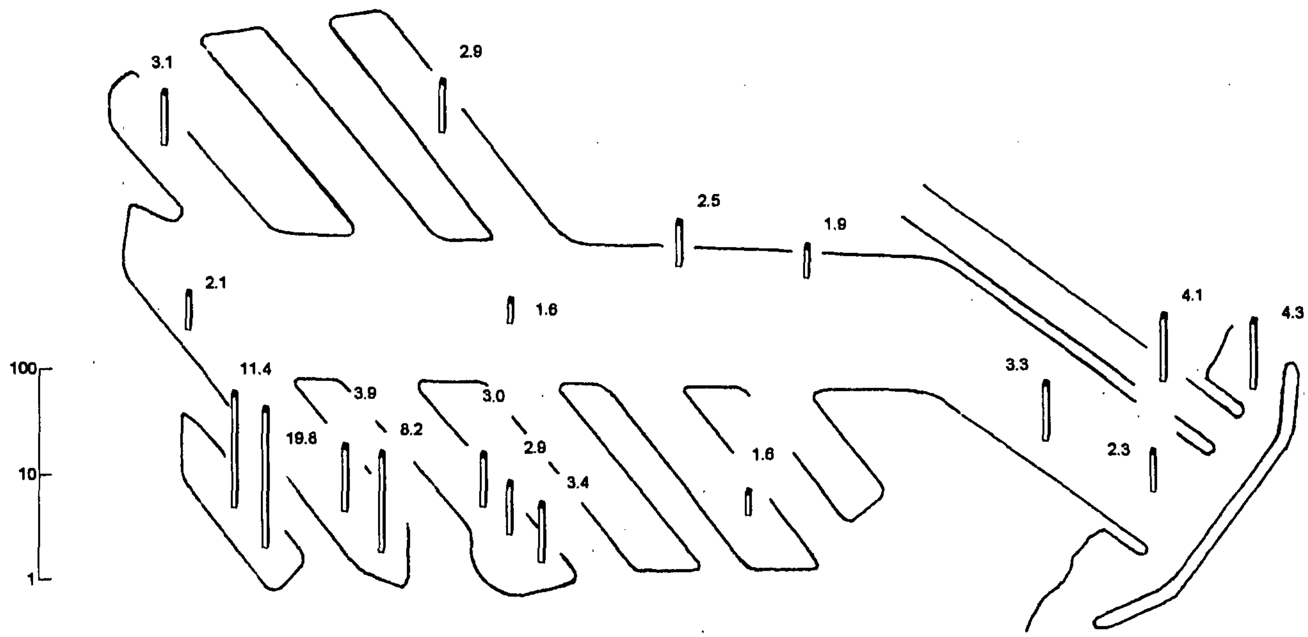


TABLE 3-13. FREQUENCY OF ENTEROCOCCUS VIOLATIONS (>104 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	**1**	**11**	**10**	**0**
1992-93	**4**	**35**	**4**	**0**
1993-94[2.]	**-----**	**3**	**7**	**0**
1994-95	**0**	**0**	**0**	**2**
1995-96	**2**	**5**	**10**	**2**
Overall range	**0 - 4**	**0 - 35**	**0 - 10**	**0 - 2**
1996-97[3.]	2	8	1	0

[1.] Two months only in the fall.

[2.] Two months only in winter and summer. One month in fall.

[3.] One month only in the summer.

Light transmissance ranges compared with past years. All 1996-97 light transmissance values were within or very near the overall seasonal ranges for the preceding five years (Table 3-8). When compared to 1995-96, minimum values for all seasons were considerably higher. Notably higher rainfall last year may account for some of the lower overall water clarity during 1995-96.

3.3.1.8. **Surface Transparency**

As discussed in more detail in Section 3.3.1.6 above, surface transparency is recorded as the depth (m) at which a weighted, 30 cm, white plastic disk (Secchi Disk) disappears from view. Transparency is not measured in Oxford Lagoon or at the surface station at Mother's Beach.

Surface transparency patterns over the year. Surface transparency ranged from less than one meter to nearly six meters (Figure 3-22). Temporal transparency patterns generally followed those of BOD, water color (i.e. Forel-Ule), and light transmissance. This is described above in the section on BOD. In general, a large concentration of red-tide plankton invaded Ballona Creek in the early spring of 1997 and moved into the Harbor during late spring and early fall. A much smaller plankton bloom also occurred in July of 1996. During these periods, surface transparencies were about half of those recorded in winter.

At most stations, low transparency measurements in October, and somewhat in December, indicate that rainfall during those months may have reduced surface water clarity throughout the Harbor. As with light transmissance, several stations showed some depression in clarity in September, as well. No clear-cut explanation is obvious since no rain fell in September.

Spatial surface transparency patterns. Surface transparency values averaged over the year are depicted in Figure 3-25. Lowest averages were in Basin E (Station 20 - 1.9 m), and highest values were within the channel (3.4 to 3.7 m - Stations 3, 4, and 25) and near the entrance (3.8 and 3.4 - Stations 1 and 2).

Surface transparency ranges compared with past years. All 1996-97 surface transparency values were within the overall seasonal ranges for the preceding five years (Table 3-9). When compared to 1995-96, minimum values in winter and spring were higher. Notably higher rainfall last year may account for some of the lower overall water clarity during 1995-96.

3.3.1.9. **Color**

Water color is influenced by a number of physical, chemical and biological factors. The color is determined both by light scattering due to particulates in the water and the actual color of particles present. Pure fresh water appears to be black in color as no light is scattered (reflected) back to the observer. Pure sea water has a blue color due to light scattering from salt molecules from the short wavelengths at the blue end of the light spectrum.

FIGURE 3-24. AVERAGE SURFACE TRANSPARENCY (M) VS.MONTH AT 15 WATER COLUMN STATIONS

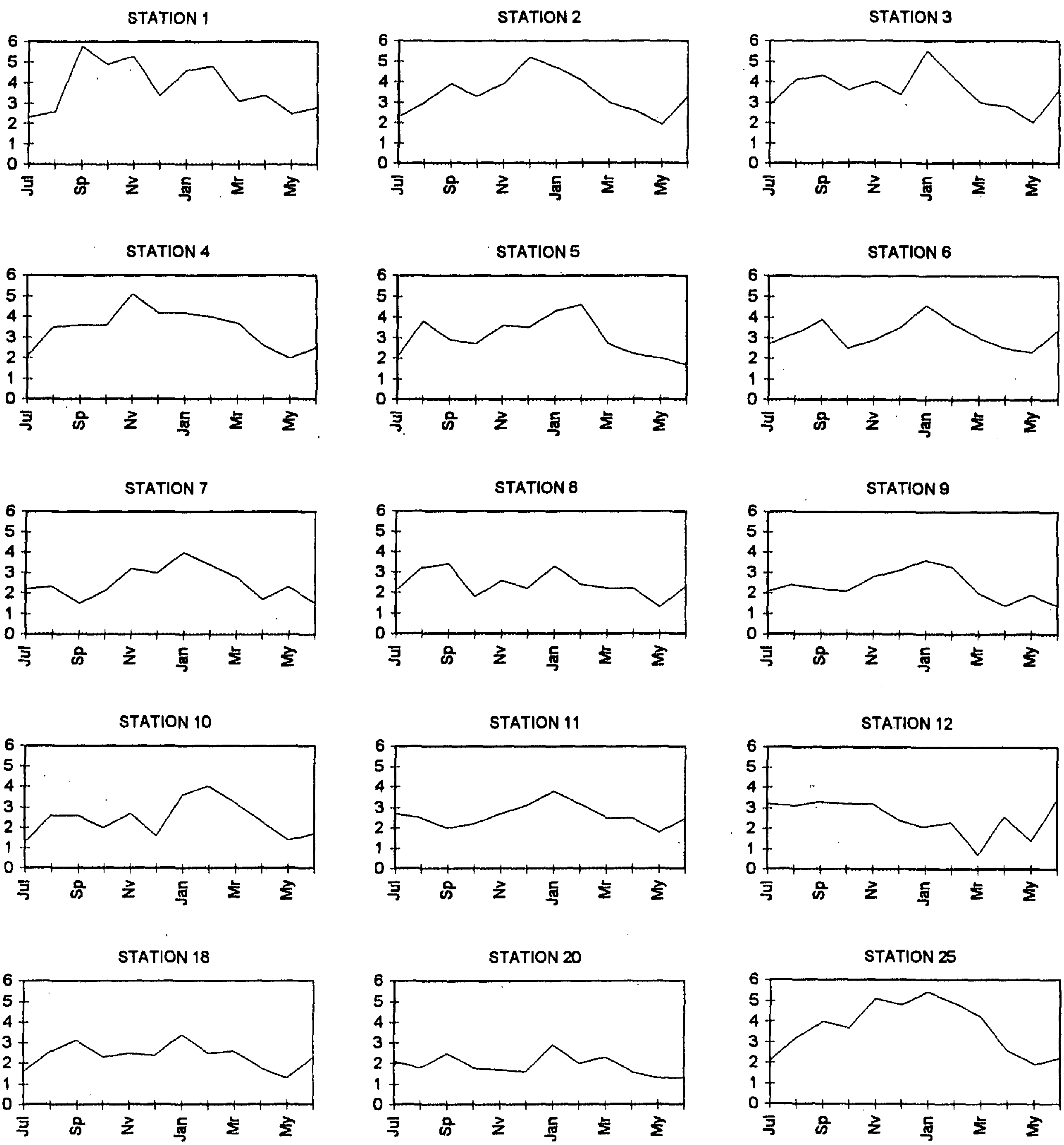


FIGURE 3-25. AVERAGE ANNUAL SURFACE TRANSPARENCY (M) AT 18 WATER COLUMN STATIONS.

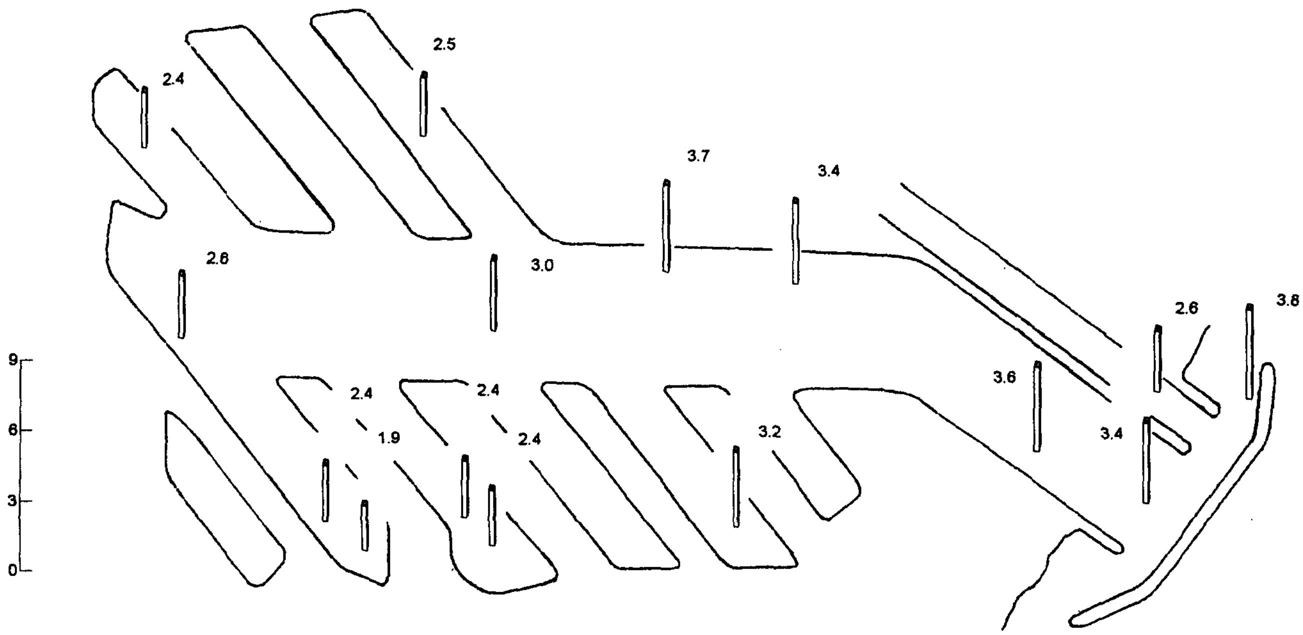


TABLE 3-9. ANNUAL SURFACE TRANSPARENCY RANGES (M) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	2.0 - 5.5	1.0 - 5.0	0.5 - 3.0	1.5 - 4.5
1992-93	1.5 - 6.5	0.1 - 3.5	1.0 - 3.5	1.5 - 6.6
1993-94[2.]	1.5 - 4.5	2.0 - 7.0	1.0 - 4.0	1.5 - 4.5
1994-95	1.5 - 6.0	0.2 - 5.0	0.9 - 4.0	1.0 - 4.0
1995-96	1.5 - 6.5	0.1 - 3.5	0.3 - 4.4	1.3 - 2.0
Overall range	**1.5 - 6.5**	**0.1 - 7.0**	**0.3 - 4.4**	**1.0 - 6.6**
1996-97[3.]	1.5 - 5.8	1.6 - 5.5	0.7 - 4.2	1.3 - 3.6

[1.] Two months only in the fall and spring.

[2.] Two months only in winter and summer. One month in fall.

[3.] One month only in the summer.

With an increase in phytoplankton numbers, the water will appear blue green to green due to increased light scattering at longer wavelengths. If phytoplankton numbers approach extremely high numbers, that of a "bloom", the water may take on the color of the particular algal species. Water color will appear green with a bloom of a green algae, or yellow-green to yellow-brown with a diatom bloom. Red tides are due to a bloom of a dinoflagellate and may be red to brown in color. Increased sediment load due to runoff or the mixing of bottom sediments into the water column may turn water color to a brown or brown-black color (Soule 1997).

The Forel-Ule (FU) scale consists of a series of small vials filled with various shades of colors that might be expected in the marine environment. These are compared to the sea water viewed above a white Secchi disk suspended beneath the surface of the water. Numbers 1-3 represent deep-sea blues, the clearest of oceanic waters. Numbers increase to the blue-greens (numbers 4-6), greens (numbers 7-9), yellow-greens (numbers 10-12), yellow-green-browns (numbers 14-16), yellow-browns (17-18), and brown-reds (19-21). It is not appropriate to use the FU scale in the shallow, muddy waters of Oxford Basin. Color estimates using the Forel-Ule scale are very subjective and it is important to have the same person perform the observations in all surveys. With this proviso, color estimates provide a good indication of events occurring in marine waters (Soule 1997).

<u>Color patterns over the year.</u> Forel-Ule values ranged 8 (green) in the channel (Station 2 and 3) in July 1996 to 17 (yellow-brown) in Ballona Creek (Station 12) in March and May and in Basin F (Station 9) in June (Figure 3-26). Color patterns generally followed those of BOD, surface transparency, and light transmissance. This is described above in the section on BOD. In general, a large concentration of red-tide plankton invaded Ballona Creek in the early spring of 1997 and moved into the Harbor during late spring and early summer. A much smaller plankton bloom also occurred in July of 1996. During these periods, Forel-Ule values tended to be much higher throughout the Marina, while values during the low productivity seasons in fall and winter were relatively low.

<u>Spatial color patterns.</u> Forel-Ule values averaged over the year are depicted in Figure 3-27. The highest average was in Ballona Creek (Station 12 - 12.0 units), and the lowest value was in the channel (Station 3 - 10.5 units). All other stations (10.6 to 11.8 units) averaged between these.

<u>Color ranges compared with past years.</u> All 1996-97 surface transparency values were within or close to the overall seasonal ranges for the preceding five years (Table 3-10). When compared to 1995-96, maximum values in summer were much higher. This was caused by a peak measurement at Station 9 during a strong red tide bloom in June.

3.3.2. <u>Bacterial Water Quality</u>

The following section and the introductory sections for total coliform, fecal coliform, and enterococcus were taken essentially unchanged from Soule et. al. (1996, 1997).

FIGURE 3-26. AVERAGE FOREL-ULE COLOR (UNITS) VS. MONTH AT 15 WATER COLUMN STATIONS

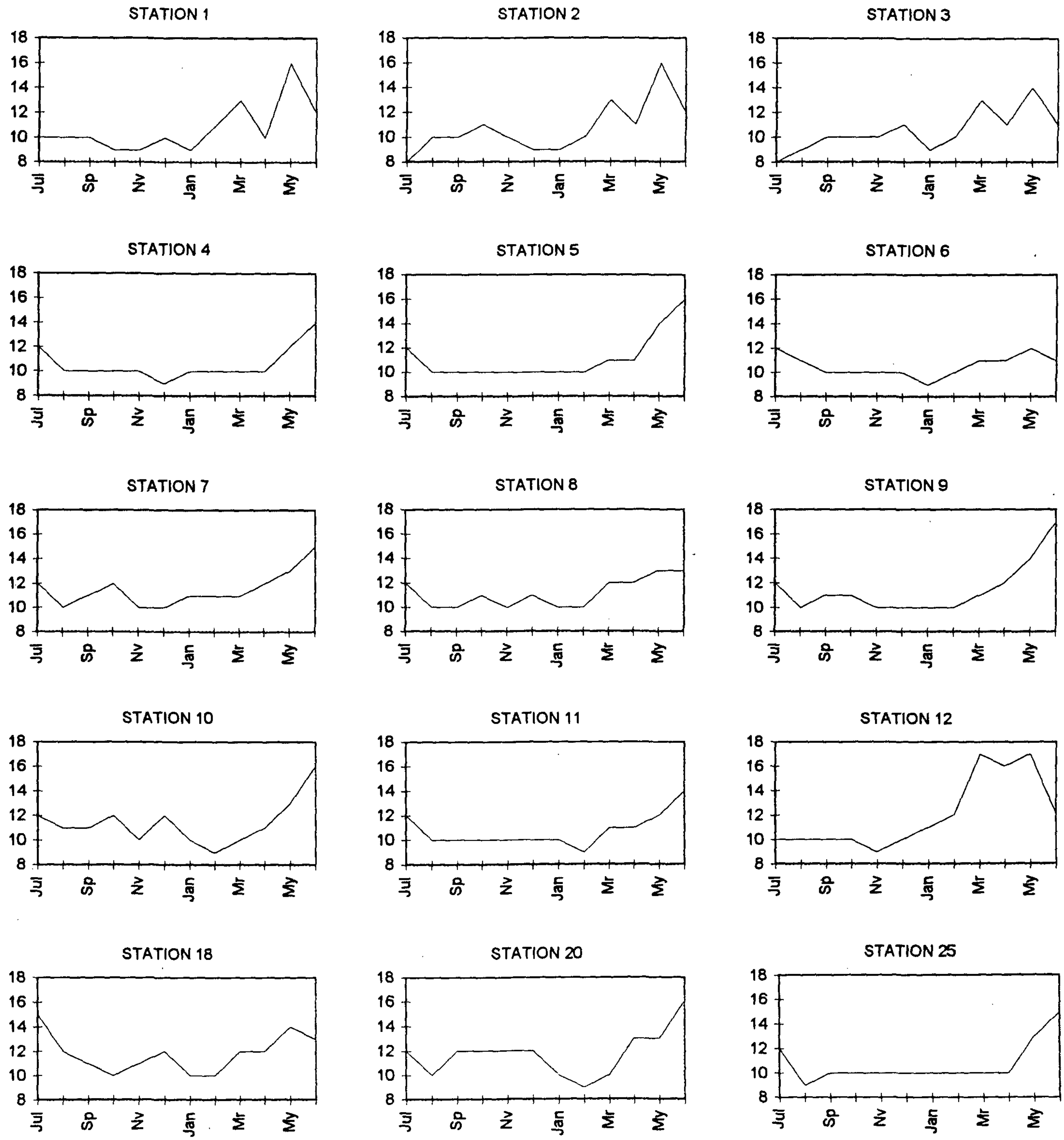


FIGURE 3-27. AVERAGE ANNUAL FOREL-ULE COLOR AT 18 WATER COLUMN STATIONS.

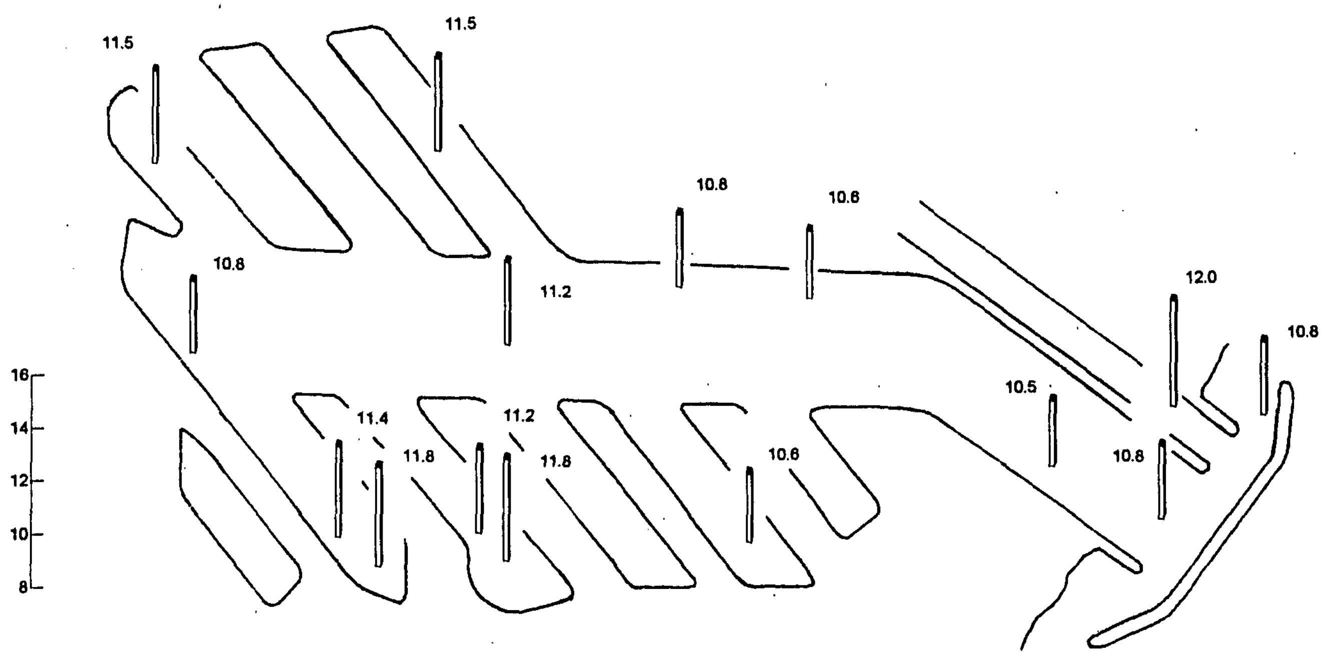


TABLE 3-10. ANNUAL FOREL-ULE COLOR RANGES FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	5 - 12	5 - 15	6 - 17	4 - 14
1992-93	3 - 12	4 - 18	7 - 16	5 - 15
1993-94[2.]	7 - 14	5 - 12	6 - 17	4 - 14
1994-95	4 - 14	4 - 17	5 - 17	4 - 14
1995-96	4 - 14	10 - 18	8 - 17	12 - 14
Overall range	**3 - 14**	**4 - 18**	**5 - 17**	**4 - 15**
1996-97[3.]	9 - 12	9 - 12	10 - 17	11 - 17

1. Two months only in the fall and spring.

2. Two months only in winter and summer. One month in fall.

3. One month only in the summer.

Maintaining standards of public health is a major concern for the marina. Even though most of the marina is not used for body contact sports, boaters are in contact with the water while doing boat maintenance and youngsters learning to sail not infrequently end up spilled into the water. In Basin D, the so-called Mother's Beach area must be protected for body contact because of the children and adults who paddle and swim in the shallow waters.

Fecal contamination may enter the marina from a variety of sources: illegal dumping or leakage of human sewage from vessels, tidal flushing or rainfall runoff of fecal material from birds, dogs, rabbits and/or humans from jetties, beaches and docks, hosing of vessels used as seagull and pigeon roosts, and runoff from storm drain channels.

During heavy rainfall, water percolating into the ground can flood sewer lines and overwhelm sewage treatment plants, with resultant overflow into some storm drain channels. Recent upgrades at Los Angeles City Hyperion Treatment Plant have been made to remedy flow into Ballona Creek. Recreational vessels in the marina do not seem to be a continuing source of coliform contamination, based on historic data, since there are few dry weather violations.

The Los Angeles County Department of Health Services monitored five sites in the marina on a weekly basis, but reduced this to four by combining two stations in the beach area into one in August 1994; funds for this activity may not be available in the future due to budget problems. The County is also responsible for monitoring sewer line breaks or overflows. The present studies by Aquatic Bioassay sample 14 marina sites on a monthly basis, providing independent documentation of the state of bacterial contamination in the marina and four stations in the adjacent stormwater channels, Ballona Creek and Oxford Basin.

The three measurements, total coliforms, fecal coliforms and enterococcus, are believed by health authorities to present a reasonably good picture of conditions in the environment (R. Kababjian, Los Angeles County Department of Health Services, pers. comm.). The principle problem is that at least 72 hours are needed for incubation to determine the extent of contamination present, slowing the response to potentially hazardous conditions. Research has been underway to develop more rapid tests, which must also be cost effective in terms of equipment and labor required. It is presently more prudent to post areas of potential or known contamination episodes immediately, such as beaches during rainstorms, than to wait for confirmation.

In previous years, rainfall episodes have been closely associated with violations of all three bacterial standards, especially at areas of the stormwater channels, Ballona Creek, Oxford Basin, and the marina area adjacent to the latter in Basin E. Rainfall in the Los Angeles area has steadily declined from 1994-95 (47 inches) to 1995-96 (21 inches) to 1996-97 (15 inches).

Because bacteria reproduce geometrically, normal parametric measures of bacterial density are not adequate to characterize bacterial counts. Therefore, note that all bacterial graphs are scaled logarithmically and all averages are calculated using geometric means.

3.3.2.1. **Total Coliforms**

Coliform bacteria (those inhabiting the colon) have been used for many years as indicators of fecal contamination; they were initially thought to be harmless indicators of pathogens at a time when waterborne diseases such as typhoid fever, dysentery and cholera were severe problems. Recently it was recognized that coliforms themselves may cause infections and diarrhea. However, the total coliform test is not effective in identifying human contamination because these bacteria may also occur as free living in soils, and are present in most vertebrate fecal material.

Federal EPA, State and County public health standards for total coliform counts in recreational waters are that no single sample, when verified by a sample repeated in 48 hours, shall exceed 10,000 most probable number (MPN) per 100 ml. The program is limited to one sample per station per month, so 10,000 MPN/100 ml has been used as the relevant standard. Regulations state that if sampling were done on a daily basis, however, no more than 20 percent of the samples in a 30-day period could exceed 1,000 MPN/100 ml, and no single sample could exceed 10,000 MPN/100 ml. This is not normally done unless some persistent problem is identified.

<u>Total coliform patterns over the year.</u> Total coliform counts ranged from <2 to ≥16,000 MPN/100 ml (Figure 3-28). Counts were in violation (greater than 10,000 MPN/100 ml) eleven times (Table 3-14). All of these were at stations associated with either Oxford Lagoon, including Basin E (10, 13, 20, and 22), or within Ballona Creek (Station 12). Among the remaining stations, temporal patterns relating to rainfall were present, but intermittent inflows from Oxford Lagoon and Ballona Creek appeared to be as important.

<u>Spatial total coliform patterns.</u> Total coliform values averaged over the year are depicted in Figure 3-29. Highest averages were, not surprisingly, in Oxford Lagoon (Stations 13 and 22 - 1307 and 3192 MPN/100 ml, respectively), in Basin E (Stations 10 and 20 - 1209 and 1433 MPN/100 ml), and, to a lesser degree, Ballona Creek (Station 12 - 674 MPN/100 ml). Averages in Basin D (Stations 8, 18, and 19), at the end of Harbor (Station 11), and downstream of Ballona Creek (Station 1) were moderate (163 to 316 MPN/100 ml). The remaining counts averaged much lower (16 to 39 MPN/100 ml).

<u>Total coliform ranges compared with past years.</u> Numbers of total coliform violations for 1996-97 were within the overall seasonal ranges for the preceding five years (Table 3-5). When compared to 1995-96, violation frequency was almost identical.

FIGURE 3-28. MIN., AVERAGE, AND MAX. TOTAL COLIFORM (MPN/100 ML) VS. MONTH AT 18 WATER COLUMN STATIONS.

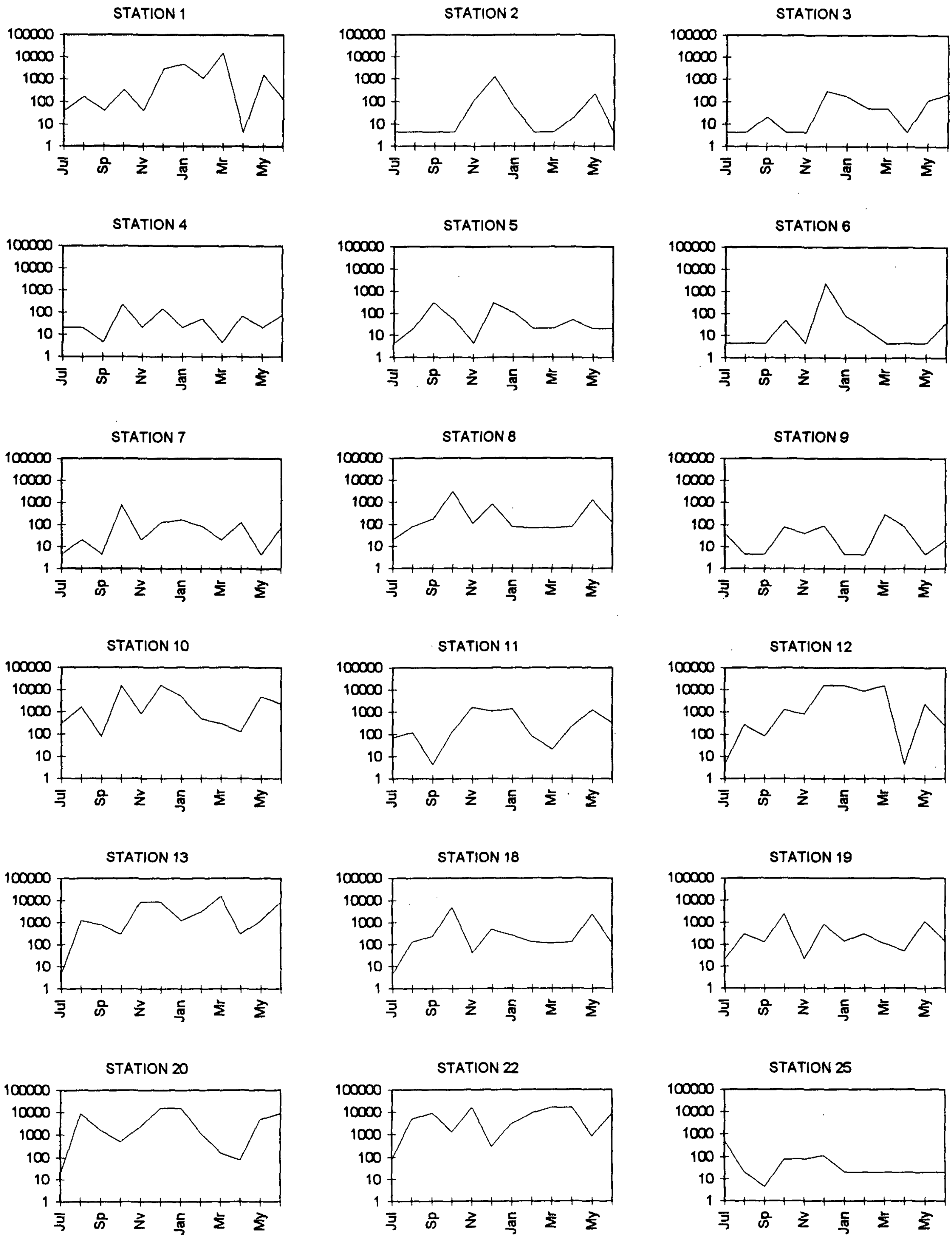


FIGURE 3-29. GEOMETRIC MEANS OF TOT. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

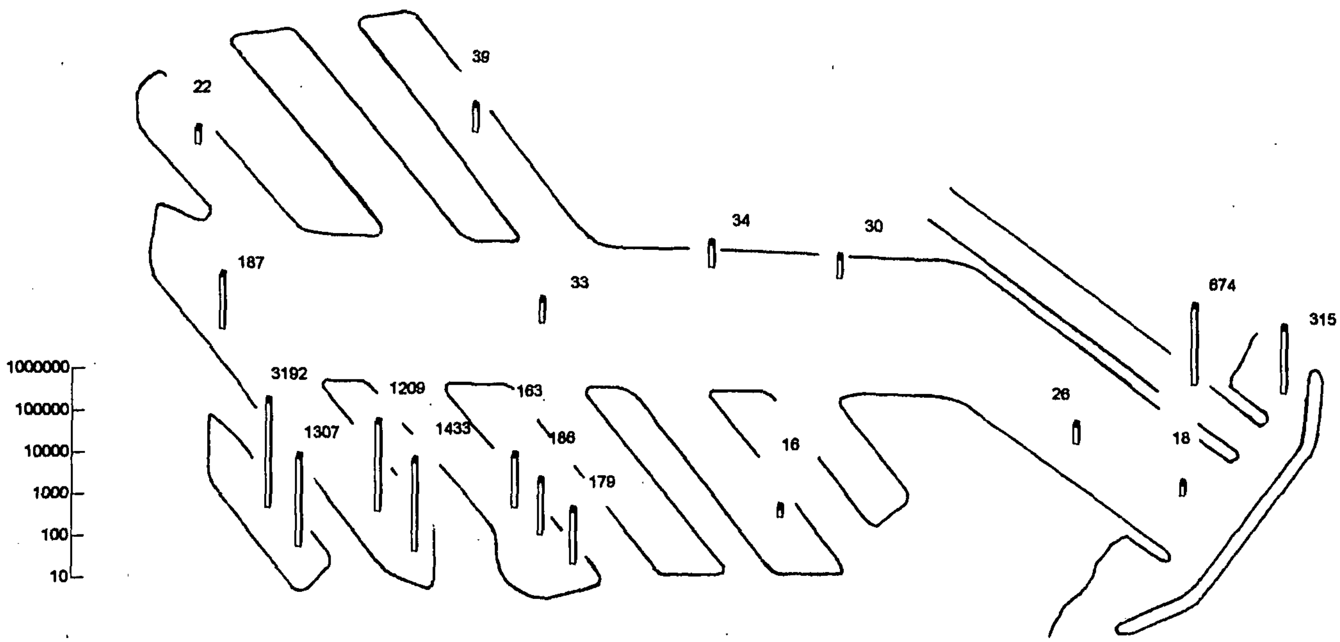


TABLE 3-11. FREQUENCY OF TOTAL COLIFORM VIOLATIONS (>10,000 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	0	7	13	5
1992-93	2	43	7	0
1993-94[2.]	----	6	4	0
1994-95	0	1	1	3
1995-96	2	6	5	0
Overall range	**0 - 2**	**1 - 43**	**1 - 13**	**0 - 5**
1996-97[3.]	2	5	4	0

1. Two months only in the fall.

2. Two months only in winter and summer. One month in fall.

3. One month only in the summer.

3.3.2.2. **Fecal Coliforms**

The fecal coliform test discriminates primarily between soil bacteria and those in human wastes, warm blooded animals such as dogs, cats, birds, horses and barnyard animals, and some cold blooded fish. Standards for fecal coliform provide that a minimum of not less than five samples in a 30-day period shall not exceed a geometric mean of 200 MPN/100 ml, nor shall more than 10 percent of the total samples during a 60 day period exceed 400 MPN/100 ml. 400 MPN has been historically use as the standard for single fecal coliform violations.

<u>Fecal coliform patterns over the year.</u> Fecal coliform counts ranged from <2 to ≥16,000 MPN/100 ml (Figure 3-30). Counts were in violation (greater than 400 MPN/100 ml) fifteen times (Table 3-14). Only two violations were not from stations directly influenced by stormwater drainages. These were Stations 8 and 19 in Basin D during October. All other violations, were at stations associated with either Oxford Lagoon, including Basin E (10, 13, 20, and 22), or within, or downstream of, Ballona Creek (Stations 1, 2, and 12). As with total coliforms, temporal patterns among the remaining station were related to rainfall only weakly, and intermittent inflows from Oxford Lagoon and Ballona Creek appeared to be as important.

<u>Spatial fecal coliform patterns.</u> Fecal coliform values averaged over the year are depicted in Figure 3-31. Highest averages were, similar to total coliforms, at one Oxford Lagoon station (Station 22 - 130 MPN/100 ml), in Basin E (Stations 10 and 20 - 101 and 132 MPN/100 ml), and near Ballona Creek (Stations 1 and 12 - 96 and 153 MPN/100 ml). Averages in Basin D (Stations 8, 18, and 19) and Station 13 in Oxford Lagoon were moderate (65 to 67 MPN/100 ml). The remaining counts averaged much lower (6 to 18 MPN/100 ml).

<u>Fecal coliform ranges compared with past years.</u> Numbers of fecal coliform violations for 1996-97 were within the overall seasonal ranges for the preceding five years (Table 3-12). When compared to 1995-96, violations were less frequent, which may be related to lower rainfall encountered this year.

3.3.2.3. **Enterococcus**

Enterococcus bacteria, including species that are found in human wastes, comprise a portion of the Streptococcus bacteria. At one time they were believed to be exclusive to humans, but other Streptococcus species occur in feces of cows, horses, chickens and other birds. Enterococci die off rapidly in the environment, making them indicators of fresh contamination, but not exclusively from humans. The enterococcus standard used by the County has been the geometric mean of 35 colonies per 100 ml, or that no single sample shall exceed 104 Colonies/100 ml. The latter single sample standard has been historically used. The State Water Resources Board Ocean Plan (1990, Amendments, 1995) limitations are a geometric mean of 24 Colonies/100 ml for a 30-day period. A survey to determine the source of the contamination is required if 12 colonies per 100 ml are exceeded for a six-week period.

FIGURE 3-30. MIN., AVERAGE, AND MAX. FECAL COLIFORM (MPN/100 ML) VS. MONTH AT 18 WATER COLUMN STATIONS.

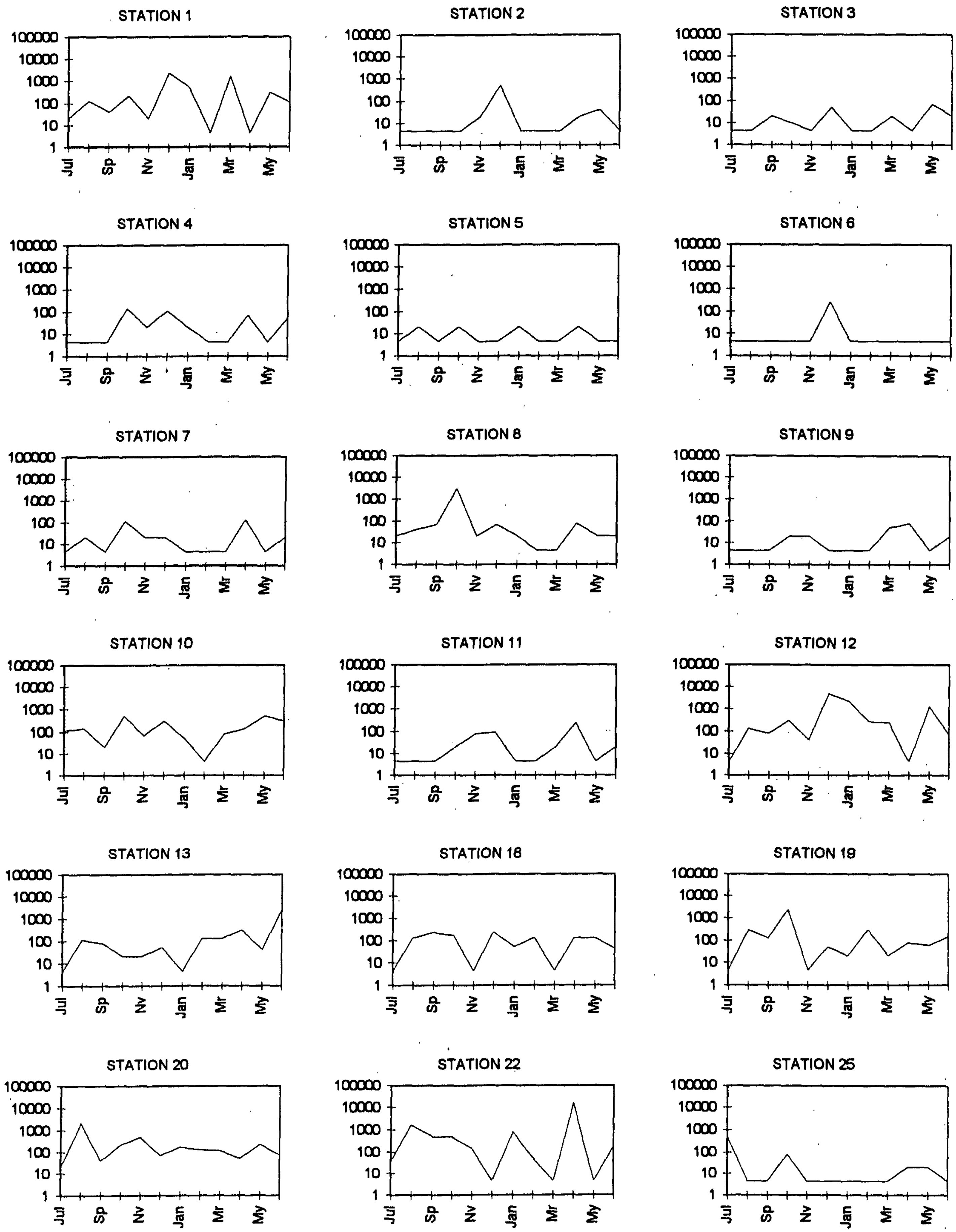


FIGURE 3-31. GEOMETRIC MEANS OF FEC. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

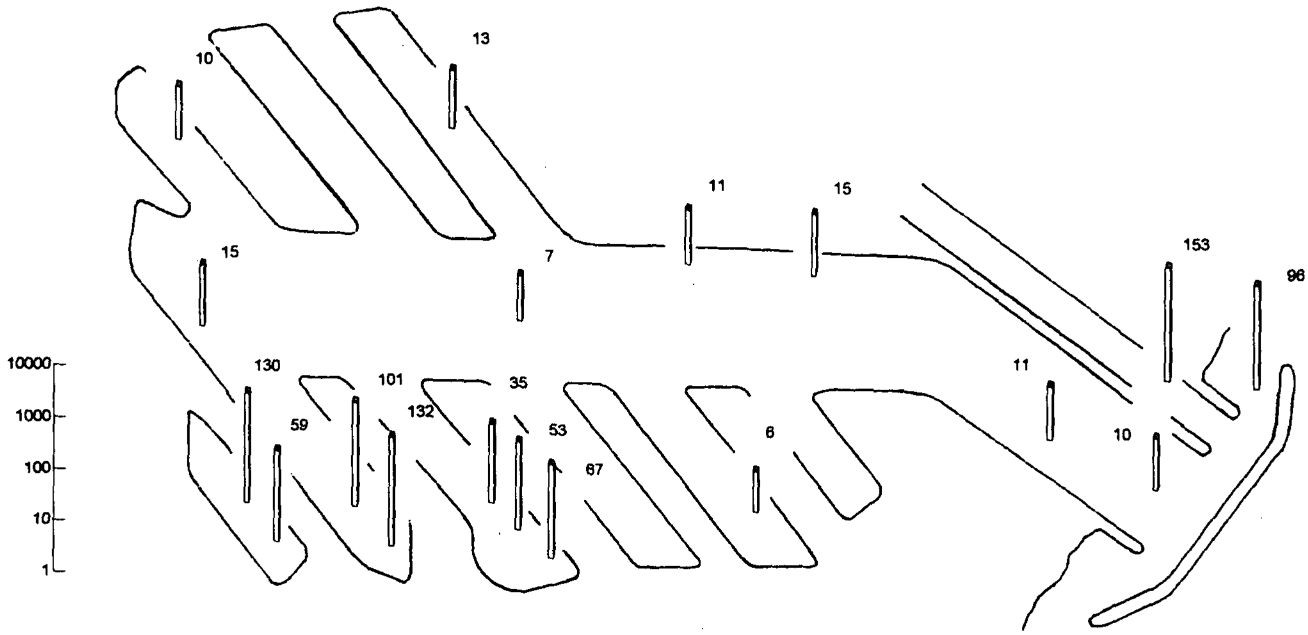


TABLE 3-12. FREQUENCY OF FECAL COLIFORM VIOLATIONS (>400 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1991-92[1.]	3	14	21	10
1992-93	8	46	13	0
1993-94[2.]	----	6	9	9
1994-95	2	27	5	2
1995-96	5	18	6	2
Overall range	**2 - 8**	**6 - 46**	**5 - 21**	**0 - 10**
1996-97[3.]	5	6	3	1

[1.] *Two months only in the fall.*

[2.] Two months only in winter and summer. One month in fall.

[3.] One month only in the summer.

Enterococcus patterns over the year. Enterococcus counts ranged from <2 to 500 Colonies/100 ml (Figure 3-32). Counts were in violation (greater than 104 Colonies/100 ml) eleven times (Table 3-14). Seven out of the eleven violations occurred in December and are likely related to precipitation. Stations affected were Station 13 in Oxford Basin, Stations 10 and 20 in Basin E, Station 8 in Basin D, Station 3 in the channel (and adjacent to the Venice Canal tidal gate), and Station 12 in Ballona Creek. All of the four remaining violations were in Oxford Lagoon (Stations 13 and 22). Enterococcus counts appeared to be related more to rainfall than were total and fecal coliforms. The influence of the Oxford Lagoon drainage, however, could be discerned among those stations nearby.

Spatial enterococcus patterns. Fecal coliform values averaged over the year are depicted in Figure 3-33. Highest averages were in Oxford Lagoon (Station 13 and 22 - 20 and 11 Colonies/100 ml) and in Basin E (Station 20 - 8 Colonies/100 ml). Averages near Ballona Creek (Stations 1 and 12) and at one station (10) in Basin E were moderate (all 4 Colonies/100 ml). The remaining counts averaged lower (2 to 3 Colonies/100 ml).

Enterococcus ranges compared with past years. Numbers of fecal coliform violations for 1996-97 were within the overall seasonal ranges for the preceding five years (Table 3-13). When compared to 1995-96, violations were similar, however counts were somewhat lower in spring.

3.3.3. Station Groupings Based on Water Quality

In addition to characterizing Marina del Rey Harbor based upon individual water quality parameters, we opted to group stations based upon these same water quality variables for the first time this year. The technique used was a simple clustering technique called the Bray-Curtis Similarity Index (Clifford and Stephenson 1975). With this method, each station was ranked highest to lowest for each of the above measurements (e.g. temperature, salinity, dissolved oxygen, etc.). Each station was then compared to every other station based on its ranks. Station pairs which ranked similarly for all of the variables as a whole tended to produce a high index value (near 1.0). Stations where rankings were dissimilar to each other produced a low index value (near 0.0). With this information, stations could be clustered based upon their similarity or dissimilarity to all of the water variables measured (Figure 3-34).

Stations 13, 20, and 22. These stations include two in Oxford Lagoon and one in Basin E. These stations tended to be generally high in temperature, ammonia, total coliform, fecal coliform, and enterococcus; and low in salinity, dissolved oxygen, pH, and surface transparency. The water from these stations are the most contaminated in the Marina, and the source of these contaminants is undoubtedly the municipal drainage into Oxford Lagoon.

Stations 8, 10, 11, 18, and 19. These stations are in areas of low circulation and of limited exposure to tidal flushing. The water here tends to be high in temperature, low in water clarity, and moderate in salinity and bacterial and organic contaminants. This area appears to be somewhat influenced by the discharges from Oxford Lagoon.

TABLE 3-14. MONTHS AND LOCATIONS OF BACTERIAL VIOLATIONS 1996-97.

TOTAL COLIFORM (> 10,000 MPN/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	—	—	—	≥16,000	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	≥16,000	—	≥16,000		—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	≥16,000	≥16,000	—	≥16,000	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	≥16,000	16,000	—	—	—	—	—
22	—	—	—	—	≥16,000	—	—	—	≥16,000	≥16,000	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

FECAL COLIFORM (>400 MPN/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	2400	400	—	1700	—	—	—
2	—	—	—	—	—	500	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	3000	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	500	—	—	—	—	—	—	500	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	5000	2200	—	—	—	1300	—
13	—	—	—	—	—	—	—	—	—	—	—	2400
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	2400	—	—	—	—	—	—	—	—
20	—	2200	—	—	500	—	—	—	—	—	—	—
22	—	1700	500	500	—	—	800	—	—	≥16,000	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

ENTEROCOCCUS (>104 COLONIES/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	500	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	140	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	300	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	280	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	500	—	—	—	—	—	—
13	—	220	—	—	—	130	—	—	170	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	130	—	—	—	110	—	—	—	—	—	—
22	—	—	—	—	—	—	—	110	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

Stations 7 and 9. These stations have similar characteristics as the above group, however they tended to be more saline, lower in dissolved oxygen, less bacterially contaminated, and probably less influenced by Oxford Lagoon. The highest Forel-Ule color (less blue and more brown) values were here, indicating that the area may have been subject to some phytoplankton blooms.

Stations 3, 4, 5, 6, and 25. These stations tended to be less brown; higher in salinity, pH, and water clarity; and lower in temperature and organic and bacterial contamination. These stations are most influenced by open ocean waters and are the most natural in the Harbor.

Stations 1, 2, and 12. These stations are very unique to harbor stations as a whole and might be considered as having a "split personality" since they are strongly influenced by both natural marine waters as well as contaminated freshwater drainage from Ballona Creek. Averaged over the year, these stations tended to be low in temperature and high in dissolved oxygen, pH, and water clarity, as would be expected of typical ocean water. On the other hand, the water here is also low in salinity and high in organic and bacterial contamination.

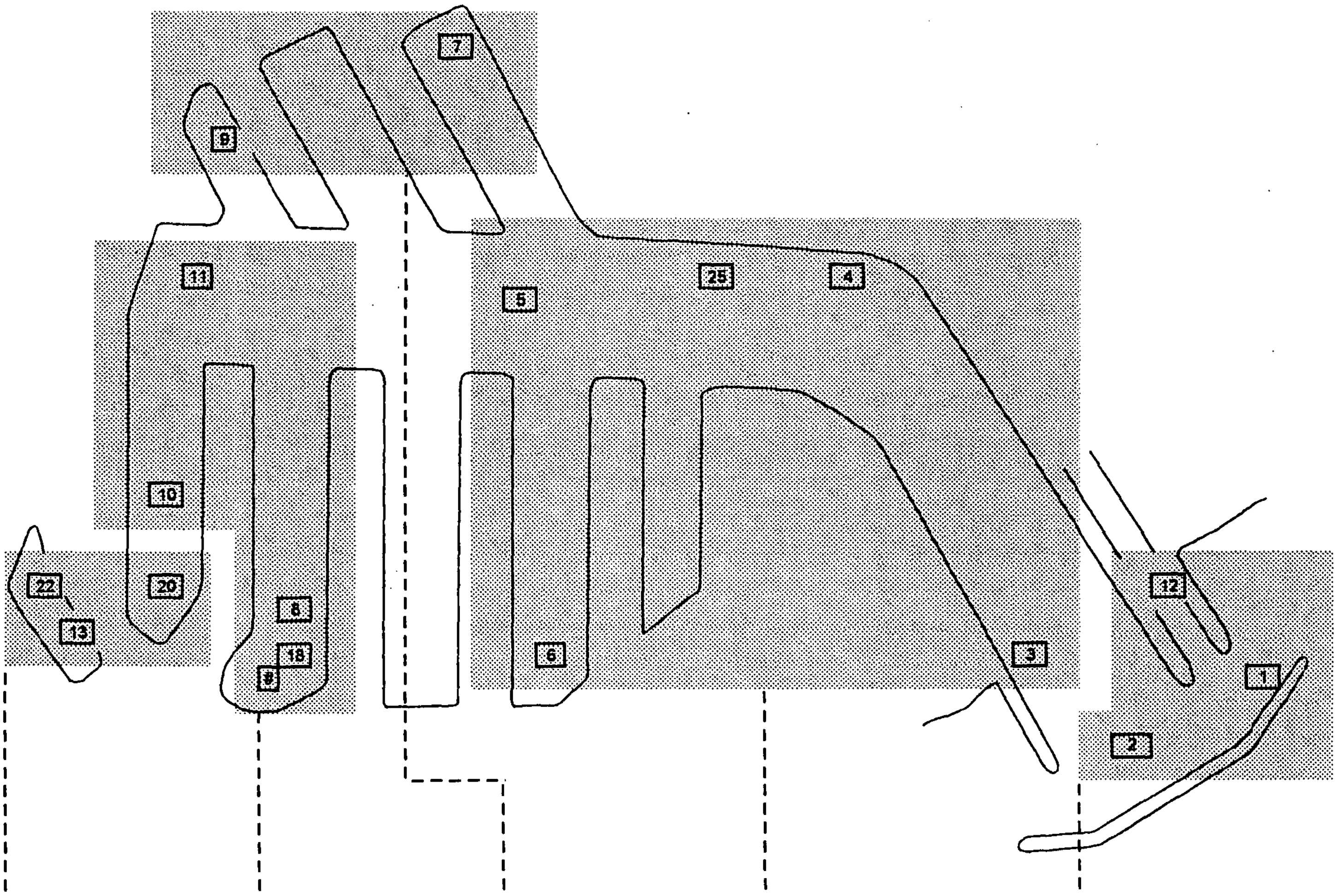
3.4. DISCUSSION

Water quality in Marina del Rey Harbor appears to be impacted by three major factors: rainfall, plankton blooms, and drainage from Oxford Lagoon and Ballona Creek.

Precipitation during 1996-97 was average for the Los Angeles Basin but relatively low for recent years. Regardless, periods of rainfall clearly related to lower salinity, particularly near areas of major drainage. Rainfall also appeared to have some impact upon bacterial counts, and most strongly to the enterococcus group. The flow from storm drains naturally increased during wet weather, but rain running off of all of the surfaces surrounding the Marina is an additional source of bacterial contamination. Areas where birds, people, and perhaps stray animals concentrate, such as Mother's Beach, appear more impacted than other areas during rainy periods. This is of major concern, since Mother's Beach is the one areas of the Marina where people are most likely to come into direct contact with the water.

1996-97 was characterized by very heavy accumulations of red tide phytoplankton. Phytoplankton blooms are seasonal because they require the increased solar irradiation of spring and summer to flourish. They are also dependent upon nutrients, mostly nitrogen, which are typically upwelled in the spring. In the Marina, they are also probably influenced by non-point sources of nutrients brought in by rainfall and the discharges from the various storm drains flowing into the Harbor. Plankton blooms strongly increase oxygen, reduce water clarity, alter natural water color, and increase the biochemical oxygen demand throughout the Harbor.

FIGURE 3-34. WATER QUALITY CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Stations 13,20,22

High In:
Temperature
Ammonia
Total Coliform
Fecal Coliform
Enterococcus
-- --
-- --

Low In:
Salinity
Dissolved Oxygen
pH
Surface Transparency
-- --
-- --
-- --

Charateristics:
Strongly influence by Oxford Lagoon drainage. Water is less saline, warm, turbid, high in nutrients, low in oxygen, and highly contaminated with bacteria.

Stations 8,10,11,18,19

High In:
Temperature
-- --
-- --
-- --
-- --
-- --
-- --

Low In:
Light Transmissance
Surface Transparency
-- --
-- --
-- --
-- --
-- --

Charateristics:
Typical of low circulation, back-harbor locations. Ambient water is warm and turbid but moderate in all other characteristics.

Stations 7,9

High In:
Temperature
Salinity
Color
-- --
-- --
-- --
-- --

Low In:
Dissolved Oxygen
Light Transmissance
Surface Transparency
Total Coliforms
Fecal Coliforms
-- --
-- --

Charateristics:
Relatively isolated, low circulation areas of the Harbor. Ambient water is more saline, lower in dissolved oxygen and bacteria and may be subject to frequent algal blooms.

Stations 3,4,5,6,25

High In:
Salinity
pH
Light Transmissance
Surface Transparency
-- --
-- --
-- --

Low In:
Temperature
Color
Ammonia
Biochemical Oxygen Demand
Total Coliforms
Fecal Coliforms
Enterococcus

Charateristics:
Most influenced by open ocean waters. Ambient water is cold, saline, clear, bluer, and lower in nutrients, organics, and bacteria.

Stations 1,2,12

High In:
Dissolved Oxygen
pH
Light Transmissance
Surface Transparency
Biochemical Oxygen Demand
Fecal Coliforms
Enterococcus

Low In:
Salinity
Temperature
-- --
-- --
-- --
-- --
-- --

Charateristics:
Influenced by both open ocean waters and Ballona Creek runoff. Water is less saline, clear, cold, well oxygenated, high in organics, and bacterially contaminated.

Both Ballona Creek and Oxford Lagoon reduced salinity and elevated ammonia, biochemical oxygen demand, total coliforms, fecal coliforms, and enterococcus bacteria. Oxford Lagoon additionally lowered oxygen, pH and water clarity. Nutrients from Ballona Creek may have also contributed to the intensity of the red tide blooms. The flows from Oxford Lagoon and Ballona Creek appeared to directly impact the Harbor entrance, Basin E, and probably Basin D, as well. These locations represent over half of the stations sampled during our surveys. The spatial patterns of every parameter we measured were influenced by these two sources of water, and their negative influence upon the water quality in the Marina cannot be overstated.

4. PHYSICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

4.1. BACKGROUND

The introductory portions of this section were taken directly from Soule et. al. 1996, 1997.

The benthos (bottom) of the marina is largely composed of fine and very fine sediments, due in part to the historic nature of the Ballona wetlands, which formed a large estuarine depositional area, and to the continuing influx and deposition of fine grained sediments carried into the marina through storm drains and by tidal flux. The marina is a very low energy environment under dry weather conditions and low rainfall periods. Transport seaward of coarsely grained materials occurs in more swiftly moving waters such as those found during heavy rainfall and runoff, while fine grained sediments (fines) may be carried farther out into Santa Monica Bay in a plume during heavy rain. In dry weather, fines will settle out in the low energy basins and in the main channel where flow from the basins meet. There has not been extensive sediment accumulation in the basin channels, but in the Basin E area adjacent to flow from Oxford Basin, accumulation was so severe that it broke up docks and moorings. Sediments beneath the floating docks were heavily contaminated, requiring landfill disposal. About 503 cubic yards (cy) of sediment were removed and the slips reconfigured for larger vessels during the summer of 1995.

Ever since the breakwater was built in the 1960s, sand has accumulated at the mouth of Ballona Creek, along the inner side of the breakwater, around the ends of the jetties and along the northern jetty of the entrance channel, requiring periodic dredging by the Corps of Engineers. This became a great problem because of high levels of lead contamination and results of toxicity tests, precluding ocean disposal at the EPA dump site or use as beach replenishment. Sandbar deposits become barriers to flow and act as traps during dry weather - low energy periods, accumulating finer sediments behind them in the creek mouth and the entrance channel. Since the finer fractions of sediment complex or adsorb more metallic contaminants, the problems of disposal are exacerbated.

Sand accumulates to some extent due to winds from the northwest which blow sand from the beach north of the entrance channel. Littoral drift during spring and summer brings sand southward as well. Winter storms, with strong wave action from the south and southwest often deposit large amounts of sand at the south entry; current reversal can occur during the winter months, associated with storms, with countercurrent flow, and with El Nino periods. Sediments carried down Ballona Creek during rainstorms may be deposited at the mouth when wind, wave and tidal action combine to slow the flow to a point where the sediment burden will largely be deposited there, or sediments may be carried seaward.

Construction of the breakwater reduced the energy level of flow into and out of the marina, resulting in extensive deposition. Dredging especially disrupts the fish community that lives in and around the breakwater because of the particulates suspended in the water and changes in habitat. It disturbs the benthic community, but that is quickly recolonized, although the species composition changes temporarily. Dredging in 1987 removed 131,000 cy from the jetty tips and Ballona Creek mouth, and in 1992 a small amount, 17,000 cy, was removed on the south side of the entrance channel. In November and December 1994, 57,000 cy were removed for the ends of the breakwater, the jetties and the mouth of Ballona Creek.

4.2. MATERIALS AND METHODS

Benthic grab sampling was conducted in accordance with *Techniques for Sampling and Analyzing the Marine Macrobenthos* March 1978, EPA 600/3-78-030; *Quality Assurance and Quality Control (QA/QC) for 301 (h) Monitoring Programs: Guidance on Field and Laboratory Methods* May 1986, Tetra Tech; and methods which have been developed by the Aquatic Bioassay Team over the past 20 years. Samples were collected on October 16, 1996 with a chain-rigged, tenth square-meter Van Veen Grab. At each station, the grab was lowered rapidly through the water column until near bottom, then slowly lowered until contact was made. The grab was then slowly raised until clear of the bottom. Once on board, the grab was drained and the sediment sample was gently removed and placed on a stainless steel screen, bottom side down. Initial qualitative observations of color, odor, consistency, etc. were recorded. Samples that were obviously smaller than others were rejected.

Sediments to be analyzed for physical properties were removed from the surface of the sample and placed in clean plastic jars. Samples were analyzed for particle size distribution in accordance with *Procedures for Handling and Chemical Analysis of Sediment and Water Samples*, R.H. Plumb, US EPA Contract 4805572010, May 1981. Sediment samples were dried and sorted through a series of screens. The sediments retained on each screen were weighed and the result recorded. These screen sizes represented granules through very fine sand. Sediments finer than 65 microns (i.e. course silts through clay) were sorted via the wet pipette method. Results were recorded as the percentages of the whole.

Data for each station were reduced to the median (middle) particle size (in microns) and the sorting index. The sorting index ranges between sediments which have a very narrow distribution (very well sorted) to those which have a very wide distribution (extremely poorly sorted). This index is simply calculated as the 84^{th} percentile minus the 16^{th} percentile divided by two (Gray 1981).. Well sorted sediments are homogeneous and are typical of high wave and current activity (high energy areas), whereas poorly sorted sediments are heterogeneous and are typical of low wave and current activity (low energy areas).

4.3. RESULTS

4.3.1. Particle Size Distribution

Figure 4-1 and Table 4-1 illustrate the overall particle size distributions from the fifteen benthic sediment sampling stations. For both, results are presented for each size range as the percent of the whole. Two sediment characteristics can be inferred from the graphs. Position of the midpoint of the curve will tend to be associated with the median particle size. If the midpoint tends to be toward the larger micron sizes (for example, Station 12), then it can be assumed that the sediments tend to be courser overall. If the midpoint is near the smaller micron sizes (Station 10), then it can be assumed that the sediments are mostly finer. Sediment sizes which range from about 2000 to 63 microns are defined as sand, sediments ranging from about 63 to 4 are defined as silt, and sediments that are 4 or less are defined as clay (Wentworth Sediment Scale, see Gray 1981). There are also many subdivision within the categories (e.g. course silt, very fine sand, etc., see Table 4-1).

The second pattern discernible from the graph is how homogeneous the distribution of sediments are. Sediments which tend to have a narrow range of sizes are considered homogeneous or well sorted (Station 12). Others, which have a wide range of sizes (Station 22), are considered to be heterogeneous or poorly sorted. The graphs in Figure 4-1, indicate that sediments near the Harbor entrance (1,2, and 12) tend to be courser than others and generally well sorted. Sediments within the basins (for example, 9, 10, and 11) tend to be finer and relatively poorly sorted. Sediments in Oxford Lagoon (13 and 22) are so poorly sorted that it is difficult to visually determine the median particle size.

4.3.1.1. **Median Particle Size**

Spatial particle size patterns. Median particle sizes are depicted in Figure 4-2 (note that the scale is logarithmic) and listed as the last line of Table 4-2. The lowest median particle size (3 microns - clay) was at Station 10 within Basin E, followed by Station 9 in Basin F and Station 11 at the dead-end of the Harbor channel (4 to 5 microns - very fine silt). These stations are the farthest from the entrance and probably have the lowest current velocities of the Harbor. The largest median particle size (428 microns - medium sand) was at Ballona Creek (Station 12), followed by Station 1 inside of the breakwall and Station 13 in Oxford Lagoon (126 to 141 microns - fine sand). Station 22 within Oxford Lagoon and Station 2 near the Harbor entrance also had relatively course median particle sizes (82 to 91 microns - very fine sand). These five stations likely have the highest current velocities of the Harbor. The remaining stations had sediments which were moderate in median particle size (11 to 75 micron - fine silt to very fine sand).

FIGURE 4-1. PARTICLE SIZE (MICRONS) DISTRIBUTION (%) OF 15 BENTHIC SEDIMENT STATIONS.

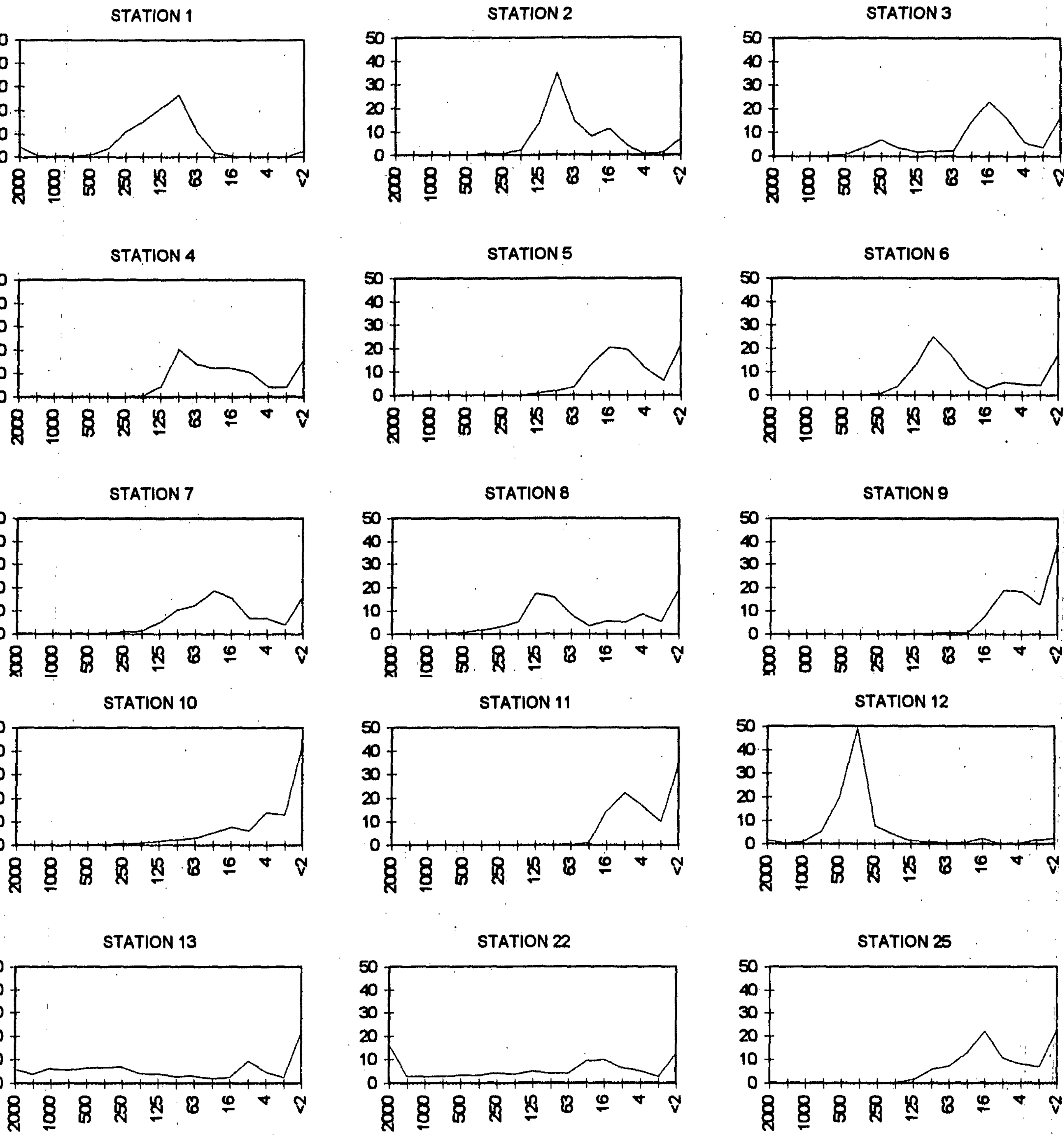


TABLE 4-1. PARTICLE SIZE DISTRIBUTIONS (PERCENTS) FROM 15 BENTHIC SEDIMENT STATIONS

	PARTICLE SIZE (MICRONS)																
	≥2000	1414	1000	707	500	354	250	176	125	88	63	31	16	8	4	2	≤2
STATION	granule	very course sand	very course sand	course sand	course sand	med sand	med sand	fine sand	fine sand	very fine sand	very fine sand	course silt	med silt	fine silt	very fine silt	clay	clay
1	4.5	0.4	0.5	0.4	0.8	3.5	11.1	15.3	20.7	26.5	11.0	1.9	0.4	0.1	0.1	0.1	2.5
2	0.0	0.1	0.1	0.2	0.3	0.9	0.7	2.4	13.5	35.1	14.5	8.0	11.3	4.0	0.7	1.2	6.9
3	0.1	0.1	0.1	0.2	0.9	3.6	6.8	3.4	1.8	2.0	2.4	14.4	22.8	15.8	5.7	3.5	16.7
4	0.3	0.1	0.1	0.1	0.1	0.3	0.2	0.7	4.2	20.4	13.9	12.3	12.5	10.5	4.2	4.2	16.0
5	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.8	1.8	3.4	13.4	20.4	19.5	11.6	6.1	22.4
6	0.0	0.0	0.0	0.0	0.0	0.2	0.4	3.5	12.5	25.1	17.3	6.7	2.8	5.5	4.6	4.1	17.2
7	0.7	0.1	0.2	0.2	0.3	0.4	0.8	1.2	4.8	10.5	12.4	18.8	15.7	6.9	6.7	4.0	16.2
8	0.1	0.0	0.1	0.2	0.6	1.6	3.0	5.3	17.4	16.0	8.3	3.3	5.6	5.2	8.7	5.4	19.2
9	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.5	0.8	0.7	8.2	18.9	18.4	12.6	39.1
10	0.1	0.1	0.1	0.3	0.4	0.5	0.7	0.9	1.7	2.4	2.9	5.2	7.8	6.2	14.0	13.0	43.8
11	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	1.0	14.5	22.3	16.6	10.1	34.8
12	1.6	0.5	1.1	5.4	19.4	49.3	7.9	4.1	1.5	0.8	0.7	0.6	2.4	0.3	0.3	1.7	2.3
13	5.8	3.9	6.4	5.7	6.6	6.7	6.9	4.1	3.9	2.9	3.1	2.0	2.6	9.5	4.9	2.6	22.3
22	16.1	2.9	3.0	2.9	3.4	3.4	4.4	3.8	5.0	4.1	4.1	9.5	9.9	6.6	5.2	2.8	12.7
25	0.0	0.0	0.0	0.3	0.0	0.2	0.0	0.4	1.4	5.9	7.3	13.1	22.1	10.8	8.1	7.2	23.1

TABLE 4-2. MEDIAN PARTICLE SIZES (MICRONS)[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1990 TO OCTOBER 1996.

	STATION														
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Oct-90	100	<74	420	<74	<74	70	<74	<74	<74	<74	<74	430	>700	<74	<74
May-91	80	<74	<74	<74	<74	80	<74	<74	<74	<74	<74	300	450	<74	<74
Oct-91	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	160	<74	<74
Oct-92	300	110	<74	<74	<74	90	<74	<74	<74	<74	<74	330	220	<74	<74
Apr-94	340	90	370	<74	<74	80	<74	100	<74	<74	<74	200	>700	470	<74
Sep-94	90	90	360	<74	<74	<74	<74	<74	<74	<74	<74	100	700	210	<74
Oct-95	360	100	290	<74	<74	80	<74	<74	<74	<74	<74	430	260	160	<74
Oct-96	141	91	20	36	11	75	32	70	4	3	5	428	126	82	16

[1] 0-4 = clay, 4-8 = very fine silt, 8-16 = fine silt, 16-31 = medium silt, 31-63 = coarse silt, 63-125 = very fine sand, 125-250 = fine sand, 250-500 = medium sand, 500-1000 = coarse sand.

TABLE 4-3. SORTING INDEX VALUES[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1996.

	STATION														
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Oct-96[2]	0.88	1.40	3.16	2.88	2.44	3.11	2.84	3.44	2.28	3.01	2.32	0.62	5.20	4.47	2.88

[1] <0.35 = very well sorted, 0.35-0.50 = well sorted, 0.50-0.71 = moderately well sorted, 0.71-1.00 = moderately sorted, 1.0-2.0 = poorly sorted, 2.0-4.0 = very poorly sorted, >4.0 = extremely poorly sorted.

[2] Unable to calculate sorting values from previous surveys because of fewer divisions.

Particle size ranges compared with past years. Table 4-2 lists the median particle sizes per station from October 1990 through October 1996. In past surveys, measurements were made only through the sand ranges of particle sizes (700 to 74 microns - coarse sand to very fine sand). Therefore, when the median particle size was in the range of silts or clays it could not be calculated. In those situations, the median particle size is listed as <74 microns. For most stations, median particle sizes have remained below, or near, 74 microns over the past seven years. These stations (4, 5, 7, 6, 8, 9, 10, 11, and 25) are all within the interior part of the Harbor. The remaining stations, which are within Ballona Creek (12), near the Harbor entrance (1,2, and 3), or within Oxford Lagoon (13 and 22), have shown considerable variability over the years. It has been mentioned in previous reports (i.e. Soule, et. al. 1996, 1997), particle sizes at some locations appears to be related to rainfall and somewhat to dredging activity. Since the 1995-96 winter was not a particularly wet season, it is not surprising that median particle sizes tended to be relatively low. Low energy periods tend to allow for the accumulation of finer particles.

4.3.1.2. **Sorting Index**

Spatial sorting index patterns. Sorting index values are depicted in Figure 4-3 and Table 4-3. Ballona Creek sediments (Station 12) sorted best (more homogeneous) among stations (0.6 - moderately well sorted), followed by Station 1 inside the breakwall (0.9 - moderately sorted). Oxford Lagoon stations (13 and 22) sorted poorest (4.5 to 5.2 - extremely poorly sorted). The remaining stations had sediments sorted between these (1.4 to 3.4 - poorly sorted to very poorly sorted). Patterns followed the general rule that high energy area sediments (i.e. Ballona Creek and the Harbor entrance) tend to have larger median particle sizes and to sort better than low energy area sediments (Harbor basins). The exceptions to this rule were the Oxford Lagoon stations, which had relatively large median particle sizes but sorted very poorly. It is probable that this area has both periods of high velocity currents, as well as periods of relative quiescence.

Sorting index ranges compared with past years. Sorting indices could not be calculated for previous surveys because the ranges measured were too narrow. It is likely, however, that for most stations, sorting indices probably decreased (became more homogeneous) following periods of heavy rainfall.

4.3.2. Station Grouping Based on Median Particle Size and Sorting Index

Stations were clustered by their similarities to median particle size and sorting index. The method used is described above for water quality (Section 3.3.3). Station groupings were resolved based upon their similarity or dissimilarity to physical sediment variables (Figure 4-4).

Stations 6, 8, 13, and 22. These stations include two in Oxford Lagoon and one each in Basin B and D. These sediments were the most heterogeneous in the Harbor (extremely poorly sorted to poorly sorted), and the median particle sizes were comparatively moderate (fine sand to very fine sand). Current velocities here are probably variable.

FIGURE 4-2. MEDIAN PARTICLE SIZES (MICRONS) AT 15 BENTHIC SEDIMENT STATIONS.

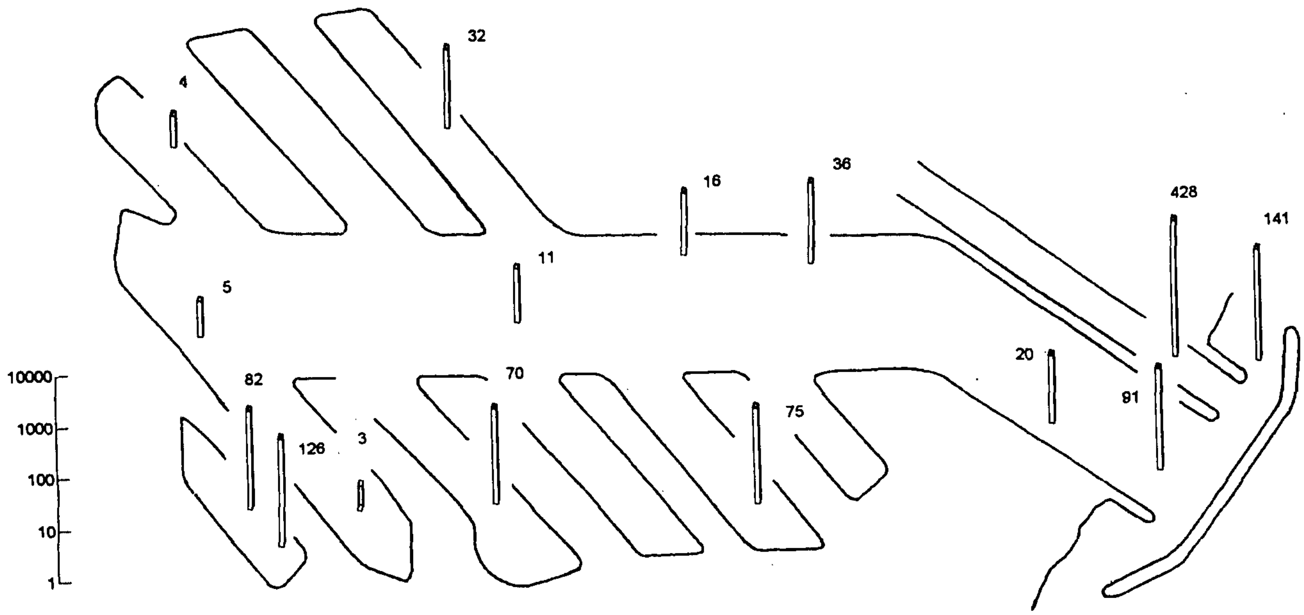


FIGURE 4-3. SORTING INDEX VALUES AT 15 BENTHIC SEDIMENT STATIONS.

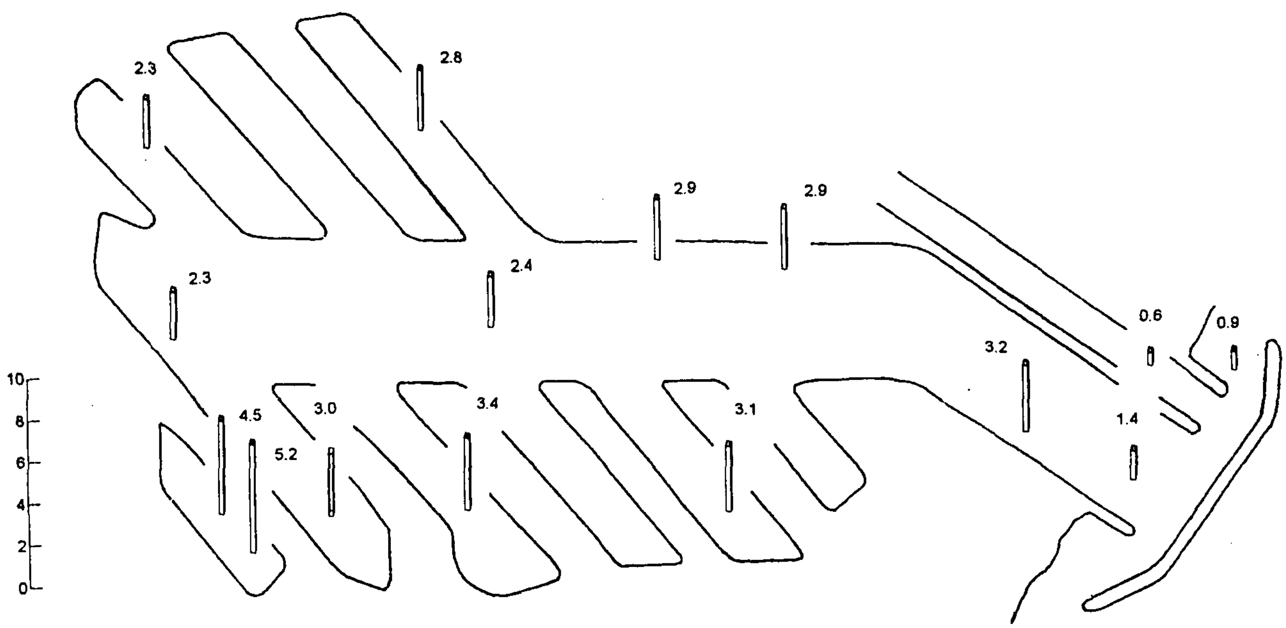
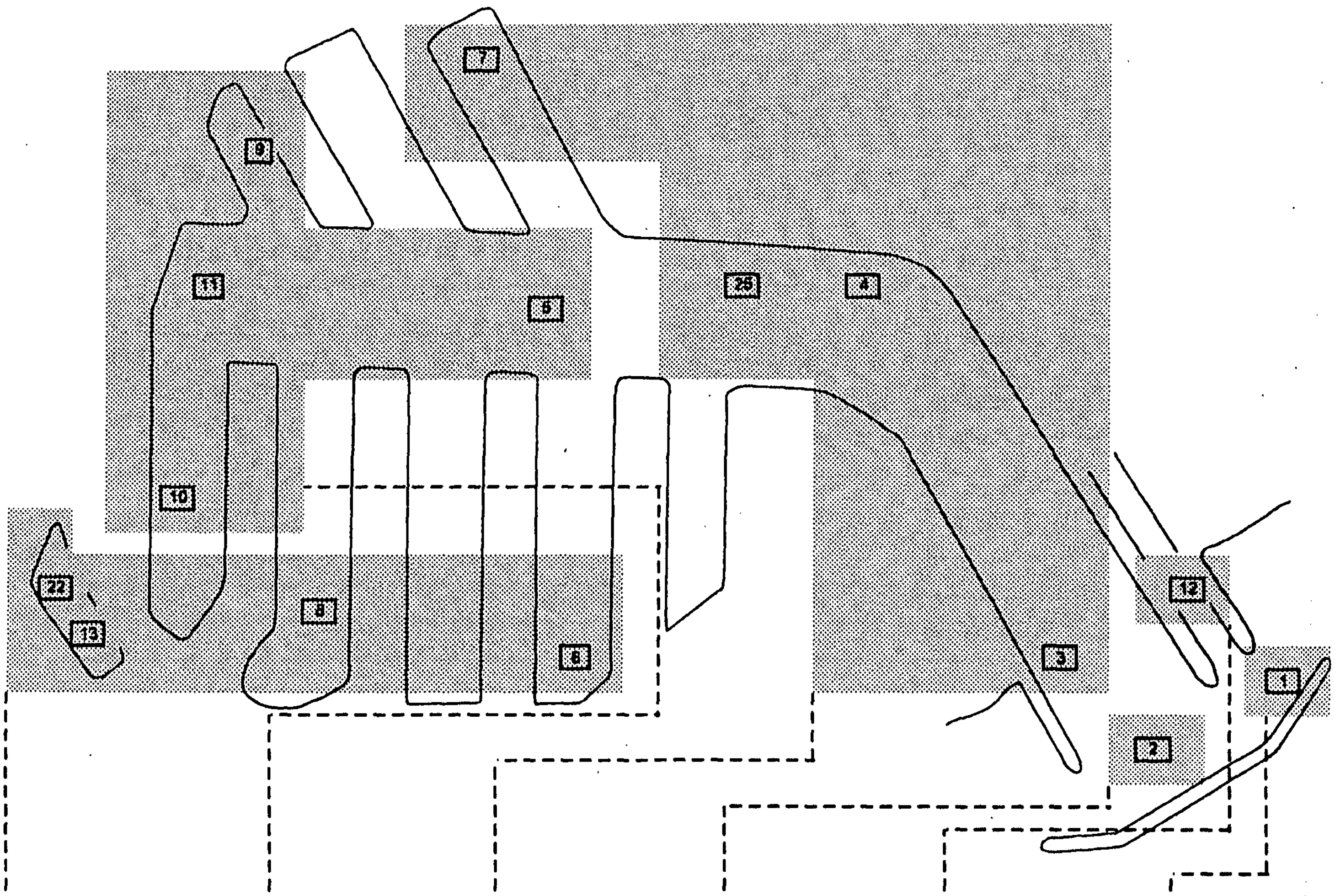


FIGURE 4-4. PHYSICAL SEDIMENT CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Stations 6,8,13,22

Median grain size: Fine sand to very fine sand.

Sorting: Extremely poorly sorted to poorly sorted.

Characteristics: These stations contain moderately fine sediments. The grain size distribution is the most heterogeneous in the Harbor.

Stations 5,9,10,11

Median grain size: Fine silt to clay.

Sorting: Very poorly sorted.

Characteristics: These stations contain the finest sediments in the Harbor. The grain size distribution is relatively heterogeneous.

Stations 3,4,7,25

Median grain size: Medium silt to coarse silt.

Sorting: Very poorly sorted.

Characteristics: These stations contain the second finest sediments in the Harbor. The grain size distribution is relatively heterogenous.

Station 2

Median grain size: Very fine sand.

Sorting: Poorly sorted.

Characteristics: This station contains moderately fine sediments. The grain size distribution is relatively moderate.

Station 12

Median grain size: Medium sand.

Sorting: Moderately well sorted.

Characteristics: This station contains the coarsest sediments in the Harbor. The grain size distribution is the most homogeneous in the Harbor.

Station 1

Median grain size: Fine sand.

Sorting: Moderately sorted.

Characteristics: This station contains the second coarsest sediment in the Harbor. The grain size distribution is relatively homogeneous.

Stations 5, 9, 10, and 11. These include the two innermost channel stations (5 and 11) and one station each in the Basins E and F. These stations contain the finest sediment in the Harbor (fine silt to clay), and their sorting is relatively poor. These stations represent the innermost areas of the Harbor, so they are characterized by comparatively low current velocities.

Stations 3, 4, 7, and 25. These include the mid-channel stations (3, 4, and 25) plus one station in Basin H (7). Sediments here are comparatively heterogeneous (very poorly sorted) with fairly small particle size distributions (medium silt to course silt). Current velocities at these stations are probably low but not as low as for those further back.

Station 2. This station is near the channel entrance. Sediment characteristics are similar to the 6, 8, 13, and 22 group; but the median grain size is slightly smaller (very fine sand) and the sediments are less heterogeneous (poorly sorted). Currents are probably moderate.

Station 1. This station is just inside of the breakwall. The median particle size is fine sand, and the sediment sorting comparatively homogeneous (moderately sorted). Current velocities here are relatively high.

Station 12. This station is within Ballona Creek. Sediments here are the most coarse of the Harbor (medium sand) and are homogeneous (moderately sorted). Current velocities here are very high.

4.4. DISCUSSION

A variety of sediments are washed into Marina del Rey Harbor. Sand arises from the open ocean through the Harbor entrance. Various sediments continuously flow in from Ballona Creek, Oxford Lagoon, and other smaller discharge points. During heavy rainfall, fine silts and clays wash into the Harbor from these drainage sources, as well as from across the surfaces of the surrounding land areas.

Because current velocities in the innermost area of the Harbor are lowest, finer particles are not resuspended into the water column and thus tend to settle out there. From the back-bay areas through the channel and into the Harbor entrance, water movement gradually increases and increasingly coarser sediments are left behind. Since finer particles do not settle out in high energy areas, the sediments are not only coarser but narrower in range (more homogeneous).

The coarsest and most homogeneous sediment were found in Ballona Creek. This channel is narrower than any other areas in the Harbor, and it receives water flow both from the municipal drainage basin and the open ocean. Oxford Lagoon also receives municipal storm water drainage, but, particularly during this relatively dry year, the flow is much lower than Ballona Creek and is probably more variable. Hence sediments here, and at two other basin locations as well, were moderate in particle size and very heterogeneous.

5. CHEMICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

5.1. BACKGROUND

The introductory portions of this section were taken directly from Soule et. al. 1996, 1997.

The natural, historic drainage patterns for Ballona wetlands were disrupted by channeling of runoff into Ballona Creek, creation of the Venice Canals and Ballona Lagoon behind the barrier beach, and formation of drainage ponds such as the "lake" that became part of Basin E when the marina was built. Piecemeal filling occurred over many years, for farming, trash and soil disposal and industrial development. During World War II, industrial development in areas contiguous to the present marina area resulted in contamination of terrestrial sediments which can leach into ground water or be carried in runoff into the marina when land is eroded or excavated for newer development, contaminating the marina. Activities associated with boating such as fuel spillage, use of antifouling compounds, boat maintenance and debris from recreation also result in contamination of sediments (e.g., Soule and Oguri, 1988, 1990).

Ballona Creek Flood Control Channel is a notable source of visible debris: most especially fast food containers, plus plastic grocery sacks, milk bottles and beverage cans, motor oil containers, and garden debris tossed into storm drains or the channel. Often there is a collection of balls ranging from ping pong and tennis to soccer and basketball sizes that attest to the route through storm drains. During dry weather low flow conditions, contaminated water and sediments accumulate in storm drains and channels, while during rainy seasons these contaminants are carried seaward. Part of the Ballona Creek flow is reflected off the breakwater, entering the marina and moving inward on rising tides. Station 12, in Ballona Creek, generally has a medium to high ranking with regard to contaminants.

Because the basins are very low energy environments, fine sediments (see Section 4) settle out there, sometimes carrying heavy contaminant loads. The inner end of the main channel (Station 11) and adjacent Basins E and F (Stations 10 and 9) are particularly prone to contamination. Station 5, in mid-main channel, is also surprisingly contaminated, probably due to settling (shoaling) where flows from the basins meet in the main channel under low flow conditions. In very wet seasons, sediments from the basins may be carried farther due to heavy stormwater runoff, sometimes to the bend into the entrance channel, sometimes to the sandbar at the entrance. Flow from Ballona Creek and the Marina entrance channel meet where waves and tidal influx may slow the seaward progression of sediment laden waters, resulting in deposition.

Oxford Flood Control Basin is a sump for street drainage, from the community north and east of the marina, draining into Basin E through a tide gate. Severe flooding has occurred along Washington Street, flooding houses and floating cars, and a new pumping station was built in Oxford Basin in 1994-1995 to ameliorate that, but if the tide is high during a storm, drainage into the marina through the tide gate is inadequate to clear the streets. A new tide gate is planned.

Soils in some adjacent industrial areas are known to have high levels of contamination, with erosion during storms carrying sediments into the basin and into the marina. During dry weather flow, runoff is not extreme and sediments tend to settle out in the basin, which has become filled. Rank growth of weeds and brush has added to the debris accumulation, although recently much of that on the perimeter above the high tide mark has been cleaned up. Tidal flow also may result in deposition in Oxford basin when marina waters contain suspended sediments which may be deposited at slack tide. Station 13 tends not to be highly contaminated when velocity of flow is relatively high, which is further enhanced by the narrow tide gate; similarly, at Station 22 contamination varies depending on the amount and timing of rainfall during the previous or current rainfall season.

5.2. MATERIALS AND METHODS

Field sampling for all benthic sediment components are described above in Section 4.2. Sediment portions to be chemically analyzed were removed from the top two centimeters of the grab sample with a teflon-coated spatula and placed in precleaned glass bottles with teflon-lined caps. Samples were immediately placed on ice and returned to the laboratory. All chemical analyses were performed by West Coast Analytical Laboratories in Santa Fe Springs, California.

5.3. RESULTS

Table 5-1 lists all of the chemical constituents measured in the 15 benthic sediment stations. These compounds have been separated here into four main groups: heavy metals, chlorinated pesticides and polychlorinated biphenyls (PCB's), organic compounds, and minerals and others. Table 5-2 compares the ranges of the current survey with all surveys undertaken since October of 1985. An overall range from all past surveys is also included. Table 5-3 compares current Marina del Rey values with L.A. Harbor (City of Los Angeles 1995), and two SCCWRP Reference Site Surveys (SCCWRP 1979, 1987).

In 1990, Ed Long and Lee Morgan of the National Oceanic and Atmospheric Administration (NOAA) published *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program* (NOAA Tech. Mem. NOS OMA 52). In this study the researchers compiled published information regarding the toxicity of chemicals to benthic organisms. The data for each compound were sorted, and the lower 10^{th} percentile and median (50^{th}) percentile were identified. The lower 10^{th} percentile in the data was identified as an Effects Range-Low (ER-L) and the median was identified as an Effects Range-Median (ER-M). A third index was listed in the document as well, the Apparent Effects Threshold (AET). An AET concentration is the sediment concentration of a selected chemical above which statistically significant biological effects always occur, and, therefore, are always expected (PTI Environmental Services, 1988). AET values are somewhat similar in range to ER-M values, but individually may be higher or lower.

TABLE 5-1. CHEMICAL COMPOUNDS MEASURED FROM 15 BENTHIC SEDIMENT STATIONS. RESULTS AS DRY WEIGHT.

	STATION															
COMPOUND	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25	**MEAN**
Heavy Metals (mg/l)																
Arsenic	2.5	4.3	8.5	7.3	8.9	5.9	6.3	6.2	10.4	11.5	9.8	3.1	4.9	9.8	9.5	**7.3**
Cadmium	0.283	0.794	1.470	0.944	0.389	0.226	0.295	0.238	0.347	1.150	0.369	0.636	0.796	1.060	0.907	**0.660**
Chromium	17.0	34.7	62.7	53.2	69.5	41.3	40.6	41.3	81.1	74.9	76.6	38.8	25.6	43.8	60.2	**50.8**
Copper	10.6	29.3	123.0	119.0	208.0	175.0	99.8	210.0	346.0	314.0	346.0	16.0	103.0	107.0	141.0	**166.5**
Iron	14700	21700	35900	30800	48200	28200	32400	30800	59700	55200	59800	16700	19800	29500	42000	**35027**
Lead	56.1	80.6	141.0	111.0	114.0	63.6	45.8	57.2	141.0	292.0	114.0	125.0	194.0	160.0	118.0	**120.9**
Manganese	145	207	244	225	334	188	269	205	355	307	366	148	117	194	300	**240**
Mercury	0.112	0.136	0.309	0.291	0.461	0.715	0.328	0.556	0.903	1.060	0.711	0.064	0.130	0.174	0.635	**0.439**
Nickel	8.57	18.60	23.90	20.30	26.10	17.10	18.30	17.80	30.80	30.50	31.00	66.90	13.10	24.10	23.30	**24.69**
Selenium	0.30	0.60	1.10	0.90	1.00	0.70	0.70	0.80	1.40	1.80	1.40	0.33	0.80	1.20	1.10	**0.94**
Silver	0.287	0.938	2.720	2.170	1.930	0.693	0.555	0.548	1.460	1.200	1.460	0.663	0.302	0.280	2.540	**1.183**
Tributyl Tin	0.005	0.010	0.013	0.018	0.022	0.016	0.012	0.009	0.023	0.021	0.020	0.010	0.012	0.007	0.012	**0.014**
Zinc	61	181	317	245	281	189	146	213	382	440	426	121	346	410	250	**267**
Pesticides & PCB's (ug/l)																
p,p' DDT	<0.4	10.0	12.0	7.8	3.0	0.9	2.0	<0.7	3.0	4.0	2.0	3.0	12.0	11.0	8.8	**5.3**
p,p' DDD	2.0	5.3	5.8	3.0	2.0	<0.5	5.0	<0.6	2.0	<0.7	1.0	6.6	4.2	5.0	2.0	**2.9**
p,p' DDE	4.0	12.0	15.0	11.0	9.4	5.0	9.3	6.0	12.0	11.0	9.9	8.2	16.0	13.0	13.0	**10.3**
All DDT & Derivatives	6.0	27.3	32.8	21.8	14.4	5.9	16.3	6.0	17.0	15.0	12.9	17.8	32.2	29.0	23.8	**18.5**
Endrin Aldehyde	<0.6	<0.7	2.0	<0.7	<0.9	<0.7	<0.7	<0.9	<1	<1	<1	<0.6	<0.7	<1	2.0	**0.3**
Heptachlor Epoxide	0.3	2.5	0.8	<0.3	<0.3	<0.3	<0.2	<0.3	<0.4	<0.4	<0.4	<0.2	0.4	2.0	<0.3	**0.4**
Alpha-Chlordane	<0.1	6.0	5.0	1.9	0.6	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	6.6	3.8	6.4	3.0	**2.2**
Gamma-Chlordane	2.7	6.0	6.1	2.7	2.0	<0.2	<0.2	<0.3	0.6	2.0	0.5	7.7	3.8	6.8	4.0	**3.0**
All Remaining Pesticides	3.0	14.5	13.9	4.6	2.6	<0.7	<0.7	<0.9	0.6	2.0	0.5	14.3	8.0	15.2	9.0	**5.9**
Arochlor 1254	20	40	<20	<20	<20	<20	<20	<20	<20	<20	<20	20	70	100	<20	**17**
Organic Content (mg/l)																
Tot. Organic Carbon (%)	0.33	1.60	2.90	1.90	1.30	1.60	0.73	0.76	1.90	1.90	2.60	0.46	2.20	3.90	3.20	**1.80**
Volatile Solids (%)	0.8	4.0	11.0	4.2	4.9	2.6	2.3	3.1	5.7	6.1	4.7	1.3	4.0	3.9	3.2	**4.1**
Immed. Oxygen Dmd. (%)	0.13	0.95	0.95	0.62	0.73	0.49	0.46	0.60	0.88	0.97	0.83	0.25	0.39	1.30	1.11	**0.71**
Chem. Oxygen Dmd. (%)	0.73	3.10	3.80	2.80	3.20	2.40	1.80	2.20	4.30	4.20	3.60	1.62	5.90	8.00	3.60	**3.42**
Oil and Grease (mg/l)	120	250	210	110	130	40	30	68	110	89	40	350	210	270	48	**138**
Organic Nitrogen (mg/l)	230	930	290	240	1000	1400	120	160	1400	310	120	170	1400	590	260	**576**
Ortho Phosphate (mg/l)	26	14	164	108	149	52	75	89	140	80	225	37	39	109	220	**102**
Sulfides (mg/l)	145	340	580	175	150	115	75	250	155	175	110	85	430	320	140	**216**
Minerals, etc. (mg/l)																
Moisture (%)	27	36.8	47.9	41.1	51.2	39.2	35.6	44.4	58	58.7	57.7	24.4	37.4	56.1	50.1	**44.4**
Spec. Cond. (mmhos/cm)	26	32	63	15	29	18	16	22	24	23	28	26	29	32	66	**30**
Alkalinity as CaCO3	360	1100	1200	750	700	530	590	520	710	680	920	730	780	1900	980	**830**
Hardness as CaC03	2500	3300	4800	3700	5100	3600	2600	2900	6700	6800	1600	2200	3500	7700	5200	**4147**
Total Dis. Solids (%)	1.6	2.2	3.8	2.2	3.2	2.1	1.9	2.9	4.5	3.9	4.3	2.1	1.9	4.3	4.2	**3.0**
Barium	34.2	61.3	104	87.9	125	56.5	106	63.3	136	135	144	41.1	68.9	107	118	**93**
Boron	5.23	17.7	23.8	19.1	22.3	16.2	13.6	17.8	26.9	30.2	25.7	6.03	18.8	22.1	21.6	**19**
Calcium	18100	14600	14100	13200	11500	7120	13900	7850	7270	6330	10400	10900	5250	3600	14200	**10548**
Chloride	6750	23400	18900	13400	20900	12800	10400	15400	27900	26600	27000	8320	20800	18000	19600	**18011**
Fluoride	<3	<10	<20	<10	<20	<10	<10	<10	<20	36	<20	<7	<10	36	<20	**5**
Nitrogen	240	940	340	260	1100	1400	120	170	1400	320	130	190	1400	620	270	**593**
Nitrate	6.6	4.7	11	12	<4	6.3	3.9	9.5	9	8	40	350	210	270	48	**138**
Potassium	1470	3290	5580	4770	7950	4230	5540	5140	10600	9430	10200	2150	2660	5820	6820	**571(**
Sulfate	974	2910	2610	1950	3000	1880	1630	2250	4000	4410	3970	1100	2670	3120	2830	**262(**
Sodium	4410	8110	11900	9700	14700	9670	8360	11300	20300	20900	20800	5010	9950	19000	16400	**1270·**

TABLE 5-2. ANNUAL CHEMICAL COMPOUNDS MEASURED FROM 15 BENTHIC SEDIMENT STATIONS: 1985-1996 . RESULTS AS DRY WEIGHT.

	STATIONS													
COMPOUND	October 1985	February 1987[1]	October 1987	October 1988[2]	October 1989[3]	October 1990[4]	May 1991	October 1991	October 1992	April 1994	September 1994	October 1995	**Overall Range**	October 1996
Metals (ppm)														
Arsenic	<2.0 - 5.8	<2.0 - 7.9	3.3 - 9.6	1.86 - 12.0	1.13 - 11.3	2.99 - 13.80	2.62 - 10.54	2.22 - 5.51	1.81 - 12.60	2.44 - 19.8	2.86 - 11.2	3.56 - 11.8	**1.13 - 13.80**	2.5 - 11.5
Cadmium	<1.0	<1.0 - 5.8	<1.0 - 34	0.19 - 1.10	<0.26 - 2.12	0.32 - 2.13	0.43 - 5.54	<0.63 - 3.0	0.13 - 2.22	<0.2 - 2.93	<2.8 - 1.14	<0.31 - 1.23	**0.13 - 34**	0.226 - 1.470
Chromium	5.9 - 72	6.5 - 70.4	27.9 - 89.1	7.2 - 70.5	4.68 - 65.2	6.78 - 69.80	16.5 - 67.8	12.5 - 57.9	8.73 - 72.6	5.74 - 67.5	11.9 - 81.7	15 - 83.3	**4.68 - 89.1**	17.0 - 81.1
Copper	11.8 - 245.6	10.3 - 359	24.8 - 383.0	6.8 - 342	8.19 - 333	10.4 - 399	24 - 348	13.8 - 455	5.50 - 322	6.55 - 339	25.3 - 402	29.4 - 380	**5.50 - 455**	10.6 - 346.0
Iron[5]	15.15 - 45.6	4.8 - 49.5	12.5 - 40.9	4.16 - 50.1	3.21 - 47.1	3.84 - 71.5	14.4 - 62.8	8.27 - 63.2	5.7 - 49.6	3.36 - 51.80	6.40 - 49.8	7.3 - 49.6	**3.21 - 71.5**	14.7 - 59.8
Lead	18.1 - 376.6	11.0 - 537	6.0 - 563	25.4 - 206	17.0 - 305	7.95 - 325	41.3 - 575	62.2 - 487	22.90 - 372	12.50 - 427	32.3 - 413	54.3 - 295	**6.0 - 575**	45.8 - 292.0
Manganese	30.8 - 294.4	46 - 285	118 - 340	36 - 276	27.5 - 283	30.3 - 273	147 - 315	86.3 - 263	63.1 - 279	26.20 - 292	52.2 - 328	74.6 - 315	**26.20 - 340**	117 - 366
Mercury	0.09 - 1.26	<0.1 - 1.47	<0.1 - 1.18	0.11 - 1.70	<0.12 - 0.92	<0.10 - 1.08	<0.07 - 1.2	<0.09 - 0.94	<0.10 - 2.8	<0.09 - 1.01	0.11 - 0.97	<0.09 - 0.92	**<0.07 - 2.8**	0.064 - 1.06
Nickel	<1.0 - 39.3	4.4 - 41.6	14.6 - 59.6	4.0 - 37.4	3.88 - 36.4	4.18 - 41.20	12 - 43.2	8.02 - 32.0	4.91 - 37.3	3.67 - 39.40	7.14 - 58.1	7.54 - 41.1	**<1.0 - 59.6**	8.57 - 66.90
Selenium	—	—	—	—	—	—	—	—	—	—	<0.14 - 2.35	<0.47 - 0.99	**<0.14 - 2.35**	0.30 - 1.80
Silver	—	—	—	—	—	—	—	—	—	—	ND	ND	**ND**	0.280 - 2.720
Tributyl Tin	—	—	<8 - 1070[6]	<0.01 - 5.57	<0.1 - 0.4	<0.03 - 0.52	<0.01 - 0.44	<0.02 - 0.53	<0.003 - 2.2	<0.04 - 0.34	0.05 - 0.88	0.08 - 3.04	**<0.003 - 5.57**	0.005 - 0.023
Zinc	42 - 490	25 - 660	74 - 587	42.6 - 435	20.3 - 444	28 - 491	102 - 640	55.8 - 624	27.0 - 523	20.30 - 647	55.3 - 446	87.9 - 455	**20.3 - 660**	61.3 - 440.0
Chlor. Hyd. (ppb)[7]														
Alpha-Chlordane[8]	—	—	—	—	—	—	—	—	—	—	—	—	**—**	<0.1 - 6.6
Gamma-Chlordane[8]	—	—	—	—	—	—	—	—	—	—	—	—	**—**	<0.2 - 7.7
Chlordane	—	—	<20 - 290	13.5 - 283	<20 - 630	10 - 410	<20 - 360	31 - 436	<20 - 270	<20 - 167	<20 - 109	<20 - 380	**10 - 630**	<0.1 - 14.3
Dieldrin	—	—	<1.0	<1.0	<1.0 - 30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**<1.0 - 30**	<0.8
p,p' DDT	—	—	6 - 57	<4 - 29.1	4 - 200	<4 - 29	<4 - 14	<4 - 48	<4 - 56	<4 - 86	<4 - 49	<4 - 60	**<4 - 200**	<0.4 - 12.0
p,p' DDD	—	—	2 - 34	<4 - 66.7	2 - 40	4 - 100	<4 - 15	<4 - 23	<4 - 36	<4 - 40	8 - 47	<4 - 70	**2 - 100**	<0.5 - 6.6
p,p' DDE	—	—	10 - 105	<4 - 189	<4 - 77	<4 - 104	3.5 - 110	3 - 67	<4 - 169	<4 - 94	11 - 63	<4 - 60	**3 - 189**	4.0 - 16.0
Endrin Aldehyde	—	—	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**<2**	<0.6 - 2.0
Heptachlor Epoxide	—	—	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	**<1**	<0.2 - 2.0
Arochlor 1254	—	—	<50	<50	<50 - 330	<50 - 153	<50	<50	<50	<50 - 110	<50 - 231	<50 - 90	**<50 - 330**	<20 - 100
Arochlor 1260	—	—	<50	<50	<50 - 200	<50 - 172	<50 - 300	<50	<50 - 90	<50	<50	<50	**<50 - 300**	<20
Organics (ppm)														
Tot. Org. Carbon (%)	1.01 - 10.10	0.64 - 4.7	2.1 - 5.6	0.51 - 4.17	0.28 - 8.07	0.52 - 4.71	1.18 - 4.58	0.88 - 6.45	0.46 - 5.43	0.50 - 4.9	1.2 - 4.7	0.6 - 3.3	**0.28 - 10.10**	0.46 - 3.9
Volatile Solids (%)	1.69 - 16.84	1.07 - 7.87	3.6 - 9.7	0.88 - 7.19	0.84 - 13.91	1.3 - 11.78	2.96 - 11.45	2.22 - 16.12	1.13 - 13.58	1.20 - 12.2	2.94 - 11.72	1.47 - 8.26	**0.88 - 16.84**	0.8 - 11.0
Immed. Ox. Dmd.(%)	0.008 - 0.85	<0.0001 - 0.02	0.004 - 0.32	0.002 - 0.033	0.001 - 0.046	0.001 - 0.037	0.002 - 0.043	0.003 - 0.056	<0.0001 - 0.038	0.0004 - 0.029	0.003 - 0.046	0.001 - 0.036	**<0.0001 - 0.085**	0.13 - 1.3
Chem. Ox. Dmd.[5]	3.4 - 194.6	3.75 - 131.5	25.3 - 96.8	8.3 - 87.6	2.44 - 215.6	6.77 - 153.1	34.4 - 120	15.5 - 188.3	3.14 - 165.0	2.68 - 154.0	8.6 - 171.0	20.4 - 79.8	**2.44 - 215.6**	7.3 - 80
Oil and Grease[5]	0.10 - 16.7	1.0 - 20.7	0.8 - 2.8	0.50 - 3.5	0.39 - 11.07	0.36 - 4.86	1.28 - 7.3	1.08 - 8.7	0.227 - 4.16	0.508 - 9.2	0.8 - 6.76	0.52 - 2.84	**0.10 - 20.7**	30 - 350
Organic Nitrogen	650 - 5900	216 - 3900	1200 - 3000	135 - 1840	380 - 4770	235 - 4125	1060 - 3125	334 - 4910	105 - 4010	110 - 3180	452 - 2960	692 - 1940	**105 - 5900**	120 - 1400
Ortho Phosphate	12400 - 47700	6200 - 45000	1900 - 5300	<1 - 3100	1900 - 13300	1.51 - 179	3.24 - 101.1	<1 - 43.5	0.53 - 15.1	290 - 1640	280 - 2220	288 - 1260	**<1 - 47700**	14 - 225
Sulfides	0.09 - 16.9	0.3 - 18.9	0.5 - 4.7	0.2 - 12.1	<0.1 - 40.7	<0.2 - 3.22	0.13 - 14.44	<0.1 - 6.33	0.4 - 13.8	0.60 - 1350	1.5 - 2310	1.0 - 1322	**<0.1 - 2310**	75 - 580

[1] Stations 12 and 13 added in February 1997.

[2] No sample possible at Station 12 in October 1988.

[3] Station 25 added in 1989.

[4] Station 22 added in 1990.

[5] Results reported in thousands.

[6] These results are probably ppb rather than ppm.

[7] Numerical lower detection limits were not recorded in the older reports, therefore all of the ones we have listed here are the same as those from the most current report.

[8] Only total chlordane was reported in previous reports.

TABLE 5-3. AVERAGE AND RANGES OF CHEMICAL COMPOUNDS FROM 15 BENTHIC SEDIMENT STATIONS COMPARED TO SCCWRP REFERENCE AND LOS ANGELES HARBOR SEDIMENT SURVEYS.

COMPOUND	MARINA DEL REY (1996) AVERAGE	MARINA DEL REY (1996) RANGE	LOS ANGELES HARBOR (1995) AVERAGE	LOS ANGELES HARBOR (1995) RANGE	SCCWRP (1977) AVERAGE	SCCWRP (1977) RANGE	SCCWRP (1985) AVERAGE
Metals (ppm)							
ARSENIC	7.3	2.6 - 11.5	5.25	2.2 - 8.5	–	–	–
CADMIUM	0.66	0.226 - 1.47	0.55	0.28 - 1.27	0.42	0.1 - 1.4	0.14
COPPER	156.5	10.6 - 346	39.9	13.1 - 69.6	24	6.5 - 43	10.4
CHROMIUM	50.8	17.0 - 81.1	41.2	21.0 - 71.7	9.6	2.3 - 40	25.4
MERCURY	0.439	0.064 - 1.06	0.21	0.11 - 0.32	–	–	–
LEAD	120.9	45.8 - 292	21.3	7.3 - 47	6.8	2.7 - 12	4.8
NICKEL	24.7	8.57 - 66.9	22.6	10.1 - 42.3	16	1.6 - 51	12.9
SILVER	1.183	0.28 - 2.72	0.55	0.05 - 2.66	0.35	0.04 - 1.7	0.03
ZINC	267	61.3 - 440	87.5	42.2 - 148	45	9.8 - 110	48.0
Chl. Hyd. (ppb)							
TOTAL DDT'S	18.5	5.9 - 32.8	94.1	29.7 - 196	30	<3 - 70	18.9
PCB'S	17	<20 - 100	58.3	27.2 - 137	10	<2 - 40	19.2
Organics							
TOC (%)	1.8	0.46 - 3.9	–	–	–	–	0.52
VOL. SOLIDS (%)	4.1	0.8 - 11	–	–	3.3	1.8 - 9.5	–
COD (%)	3.4	7.3 - 80	–	–	2.4	0.92 - 6.94	–
NITROGEN (ppm)	593	120 - 1400	–	–	790	393 - 1430	–

TABLE 5-4. CHEMICAL CONCENTRATIONS FROM 15 BENTHIC SEDIMENT STATIONS WITH ER-L (BOLD), ER-M, AND AET (SHADED) VALUES (FROM LONG AND MORGAN 1990).

COMPOUND	ER-L	ER-M	AET	STATION 1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Metals (ppm)																		
Arsenic	33	85	50	2.5	4.3	8.5	7.3	8.9	5.9	6.3	6.2	10.4	11.5	9.8	3.1	4.9	9.8	9.5
Cadmium	5	9	5	0.283	0.794	1.470	0.944	0.389	0.226	0.295	0.238	0.347	1.150	0.369	0.636	0.796	1.060	0.907
Chromium	80	145	—	17.0	34.7	62.7	53.2	69.5	41.3	40.6	41.3	**81.1**	74.9	76.6	38.8	25.6	43.8	60.2
Copper	70	390	300	10.6	29.3	**123.0**	**119.0**	**208.0**	**175.0**	**99.8**	**210.0**	**346.0**	**314.0**	**346.0**	16.0	**103.0**	**107.0**	**141.0**
Lead	35	110	300	**56.1**	**80.6**	**141.0**	**111.0**	**114.0**	**63.6**	**45.8**	**57.2**	**141.0**	**292.0**	**114.0**	**125.0**	**194.0**	**160.0**	**118.0**
Mercury	0.15	1.3	1	0.112	0.136	**0.309**	**0.291**	**0.461**	**0.715**	**0.328**	**0.556**	**0.903**	**1.060**	**0.711**	0.064	0.130	**0.174**	**0.635**
Nickel	30	50	—	8.57	18.60	23.90	20.30	26.10	17.10	18.30	17.80	**30.80**	**30.50**	**31.00**	**66.90**	13.10	24.10	23.30
Silver	1	2.2	1.7	0.287	0.938	**2.720**	**2.170**	**1.930**	0.693	0.555	0.548	**1.460**	**1.200**	**1.460**	0.663	0.302	0.280	**2.640**
Zinc	120	270	260	61.3	**181.0**	**317.0**	**245.0**	**281.0**	**189.0**	**146.0**	**213.0**	**382.0**	**440.0**	**426.0**	**121.0**	**346.0**	**410.0**	**260.0**
Metals exceeding ER-L				1	2	5	5	5	4	4	4	5	6	6	4	3	4	5
Metals exceeding ER-M or AET				0	0	3	2	3	0	0	0	3	3	3	2	2	2	2
Hydrocarbons (ppb)																		
Chlordane	0.5	6	2	**2.7**	**12.0**	**11.1**	**4.6**	**2.6**	<0.2	<0.2	<0.3	**0.6**	**2.0**	**0.5**	**14.3**	**7.6**	**13.2**	**7.0**
p,p' DDT	1	7	6	<0.4	**10.0**	**12.0**	**7.8**	**3.0**	0.9	**2.0**	<0.7	**3.0**	**4.0**	**2.0**	**3.0**	**12.0**	**11.0**	**8.8**
p,p' DDD	2	20	10	**2.0**	**5.3**	**5.8**	**3.0**	**2.0**	<0.5	5.0	<0.6	**2.0**	<0.7	1.0	**6.6**	**4.2**	**5.0**	**2.0**
p,p' DDE	2	15	7.5	**4.0**	**12.0**	**15.0**	**11.0**	**9.4**	**5.0**	**9.3**	**6.0**	**12.0**	**11.0**	**9.9**	**8.2**	**16.0**	**13.0**	**13.0**
Total DDT	3	350	—	**6.0**	**27.3**	**32.8**	**21.8**	**15.4**	**5.9**	**16.3**	**6.0**	**17.0**	**15.0**	**12.9**	**17.8**	**32.2**	**29.0**	**23.8**
Arochlor 1254	50	400	370	20	40	<20	<20	<20	<20	<20	<20	<20	<20	<20	20	**70**	**100**	<20
Hydrocarbons exceeding ER-L				4	5	5	5	5	2	4	2	5	4	4	5	6	6	5
Hydrocarbons exceeding ER-M or AET				1	3	3	3	2	0	1	0	1	2	1	2	3	3	3
Total Contaminants																		
Total exceeding ER-L				5	7	10	10	10	6	8	6	10	10	10	9	9	10	10
Total exceeding ER-M or AET				1	0	6	5	5	0	1	0	4	5	4	4	5	5	5

In Table 5-4, ER-L, ER-M, and AET values are listed for those compounds which were measured in this survey. Compounds which exceeded the ER-L value were highlighted by bold type. Those which also exceeded either the ER-M or AET values were additionally highlighted with shading.

5.3.1. Heavy Metals

5.3.1.1. **Arsenic**

Arsenic is carcinogenic and teratogenic (causing abnormal development) in mammals and is mainly used as a pesticide and wood preservative. Inorganic arsenic can affect marine plants at concentrations as low as 13 to 56 ppm and marine animals at about 2000 ppm (Long and Morgan 1990).

Spatial arsenic patterns. Arsenic concentrations at the 15 sampling stations are listed in Table 5-1 and in Figure 5-1. Highest arsenic values were at Station 10 within Basin E (11.5 ppm), Station 9 within Basin F (10.4 ppm), and Station 22 in Oxford Lagoon and Station 11 at the dead-end of the Harbor channel (both 9.8 ppm). Lowest values were near the Harbor entrance (Stations 1 and 2 - 2.5 and 4.3 ppm, respectively) and in Ballona Creek (Station 12 - 3.1 ppm).

Arsenic ranges compared with past years. The range of 1996 arsenic values (2.5 to 11.5 ppm) was within the overall range of the preceding ten years (Table 5-2). With the exception of October 1985 and February 1987 values which were lower, arsenic in the Harbor appears to have neither greatly increased nor decreased since 1985.

Arsenic values compared with other surveys. The Marina del Rey arsenic average and range (7.3 ppm, 2.5 to 11.5 ppm) were comparable to Los Angeles Harbor (5.25 ppm, 2.2 to 8.5 ppm). Arsenic was not analyzed in either the 1979 or 1987 SCCWRP Reference Site Surveys, however, background levels were estimated by Mearns et. al. (1991) to be about 10 ppm (Table 5-3). The USEPA (1983) gives a terrestrial range of 1-50 ppm, with an average of 5 ppm.

Arsenic values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for arsenic are 33, 85, and 50 ppm (Table 5-3), and the range for Marina del Rey Harbor sediments in 1996 was 2.5 to 11.5 ppm. Therefore, none of the stations were apparently toxic relative to arsenic during this survey.

5.3.1.2. **Cadmium**

Cadmium is widely used in electroplating, paint pigments, batteries and plastics, but point source control and treatment processes have greatly reduced cadmium in the marina (Soule et. al. 1996). Toxicity of water to freshwater animals ranges from 10 ppb to 1 ppm, as low as 2 ppm for freshwater plants, and 320 ppb to 15.5 ppm for marine animals (Long and Morgan 1990).

FIGURE 5-1. ARSENIC CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

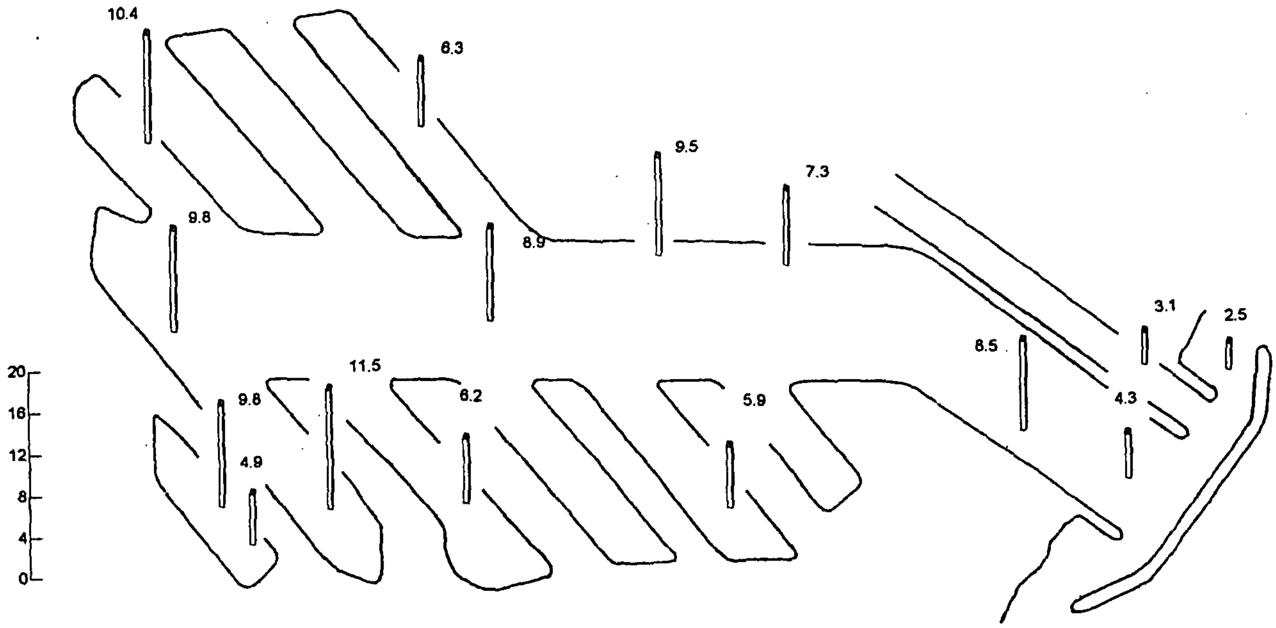
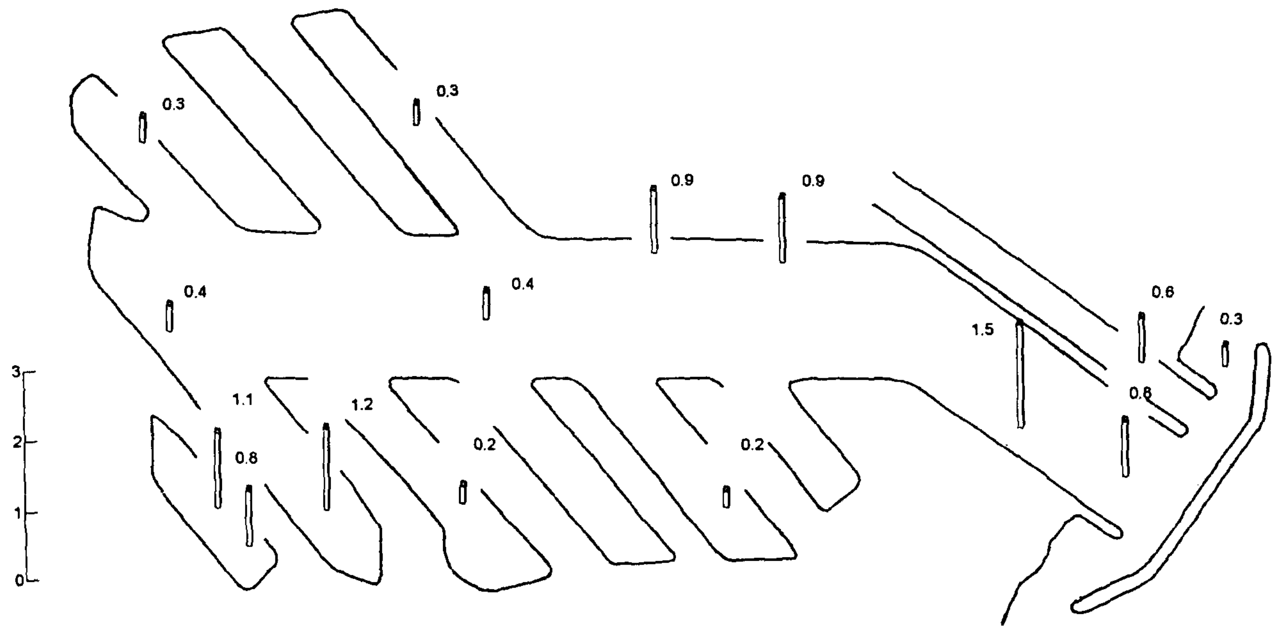


FIGURE 5-2. CADMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial cadmium patterns. Cadmium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-2. Highest cadmium values were at Station 3 in the channel (1.47 ppm), Station 10 within Basin E (1.15 ppm), and Station 22 in Oxford Lagoon (1.06 ppm). Lowest values were in Basin B (Station 6 - 0.23 ppm) and Basin D (Station 8 - 0.24 ppm).

Cadmium ranges compared with past years. The range of 1996 cadmium values (0.226 to 1.470 ppm) was within the overall range of the preceding ten years (Table 5-2). With the exception of some relatively high values in October 1987, cadmium in the Harbor appears to have neither greatly increased nor decreased since 1985.

Cadmium values compared with other surveys. The Marina del Rey cadmium average and range (0.66 ppm, 0.23 to 1.47 ppm) were comparable to Los Angeles Harbor (0.55 ppm, 0.28 to 1.27 ppm) and the 1977 SCCWRP Reference Site values (0.42 ppm, 0.1 to 1.4 ppm). However, values were higher than the 1985 (0.14 ppm) SCCWRP Reference Site average (Table 5-3). The USEPA (1983) gives the terrestrial range of 0.01 to 0.7 ppm, with an average of 0.06 ppm.

Cadmium values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for cadmium are 5, 9, and 5 ppm (Table 5-3), and the range for Marina del Rey Harbor sediments in 1996 was 0.226 to 1.470 ppm. Therefore, none of the Harbor stations appear to be toxic relative to benthic cadmium concentrations.

5.3.1.3. **Chromium**

Chromium is widely used in electroplating, metal pickling, and many other industrial processes. Chromium typically occurs as either chromium (III) or chromium (VI), the latter being considerably more toxic. Acute effects to marine organisms range from 2000 to 105,000 ppm for chromium (VI) and 10,300 to 35,500 ppm for chromium (III). Chronic effects range from 445 to 2000 ppb for chrome (VI) and 2,000 to 3,200 ppb for chrome (III) (Long and Morgan 1990).

Spatial chromium patterns. Chromium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-3. Highest chromium values were at Station 9 in Basin F (81.1 ppm), Station 11 at the end of the Harbor channel (76.6 ppm), and Station 10 in Basin E (74.9 ppm). Lowest values were near the Harbor entrance (Station 1 - 17.0 ppm) and at Station 13 in Oxford Lagoon (25.6 ppm).

Chromium ranges compared with past years. The range of 1996 chromium values (17.0 to 81.1 ppm) was within the overall range of the preceding ten years (Table 5-2). Chromium in the Harbor appears to have neither greatly increased nor decreased since 1985.

FIGURE 5-3. CHROMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

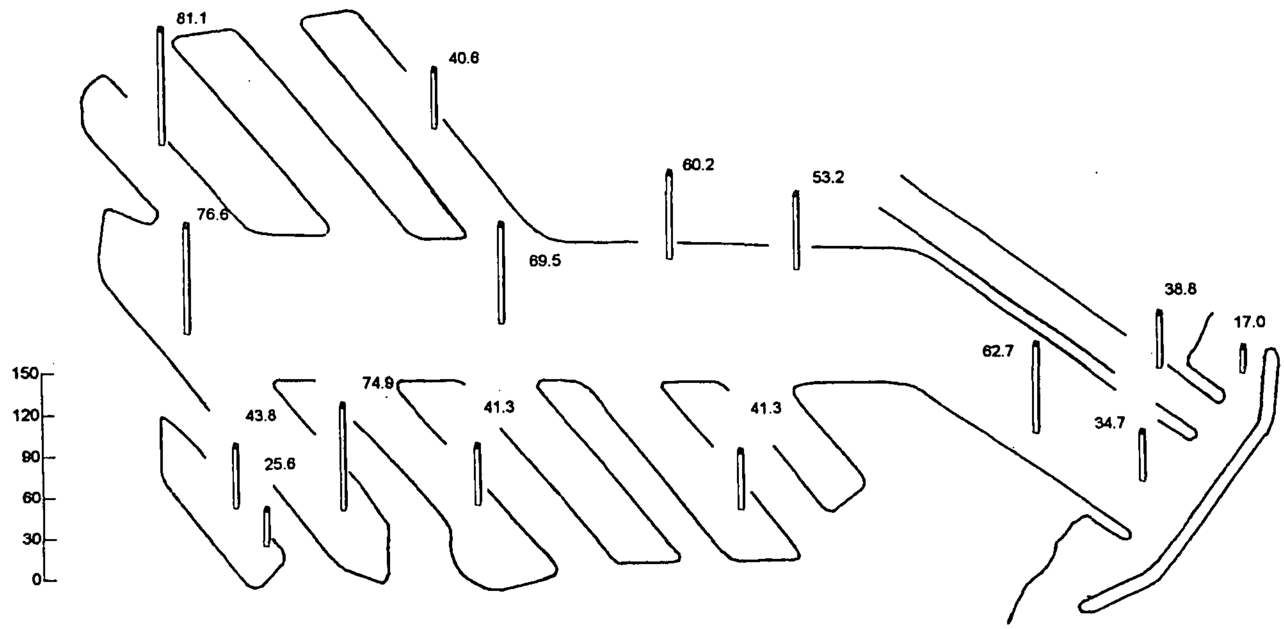
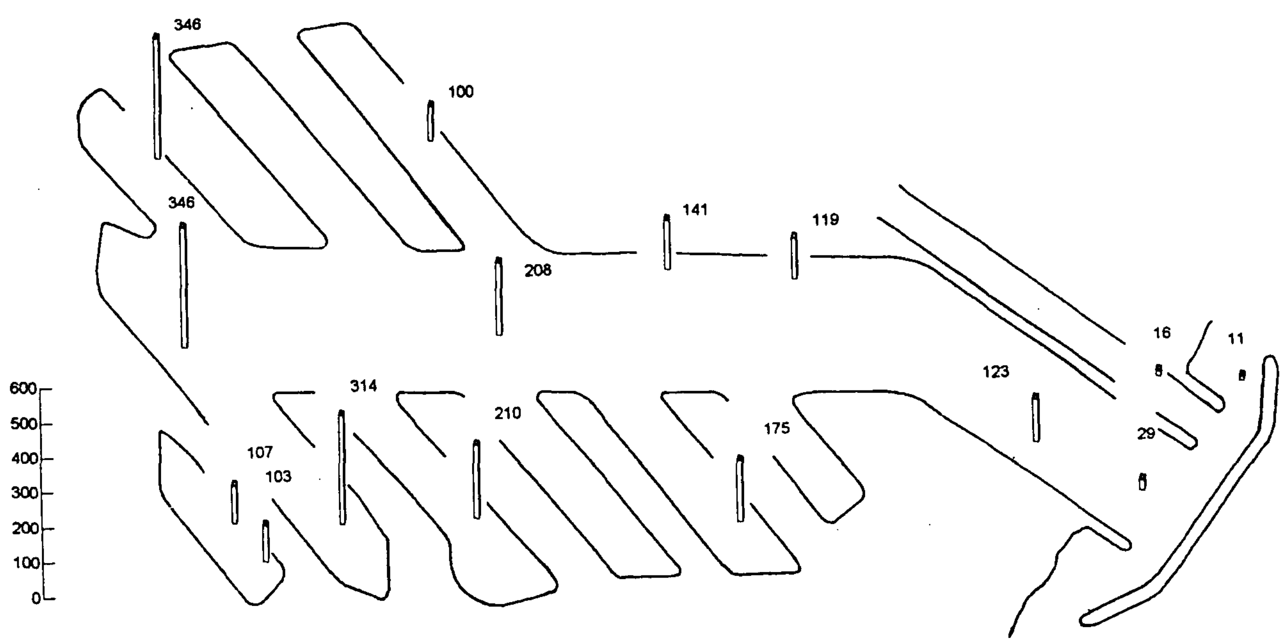


FIGURE 5-4. COPPER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Chromium values compared with other surveys. The Marina del Rey chromium average and range (50.8 ppm, 17.0 to 81.1 ppm) were comparable to Los Angeles Harbor (41.2 ppm, 21.0 to 71.7 ppm) but higher than either of the 1979 (9.6 ppm, 6.5 to 43 ppm) or 1987 (25.4 ppm) SCCWRP Reference Site Surveys (Table 5-3). The USEPA (1983) gives the terrestrial range of 1-1,000 ppm, with an average of 100 ppm.

Chromium values compared with NOAA effects range ratings. The ER-L and ER-M values for chromium are 80 and 145 ppm (Table 5-3). All chromium concentrations in the Harbor were below NOAA effects levels, except for Station 9 in Basin F (81.1 ppm) which was slightly above the ER-L. There is no AET value listed for chromium.

5.3.1.4. **Copper**

Copper is widely used as an antifouling paint. Saltwater animals are acutely sensitive to copper in water at concentrations ranging from 5.8 to 600 ppm. Mysid shrimp indicate chronic sensitivity at 77 ppm (Long and Morgan 1990).

Spatial copper patterns. Copper concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-4. Highest copper values were at Station 9 in Basin F (346 ppm), Station 11 at the end of the Harbor channel (346 ppm), and Station 10 in Basin E (314 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 12 - 10.6, 29.3, and 16.0 ppm).

Copper ranges compared with past years. The range of 1996 copper values (10.6 to 346 ppm) was within the overall range of the preceding ten years (Table 5-2). Copper in the Harbor appears to have neither greatly increased nor decreased since 1985.

Copper values compared with other surveys. The Marina del Rey copper average and range (156.5 ppm, 10.6 to 346 ppm) were higher than Los Angeles Harbor (39.9 ppm, 13.1 to 69.6 ppm) and both the 1979 (24 ppm, 6.5 to 43 ppm) and 1987 (10.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

Copper values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for copper are 70, 390, and 300 ppm (Table 5-3). Stations 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 22, and 25 exceeded the ER-L value; and Stations 9, 10, and 11 exceeded the AET value. No Stations exceeded the ER-M value.

5.3.1.5. **Iron**

Iron is generally not considered a toxicant to marine organisms. Iron in some organic forms is a stimulator for phytoplankton blooms. Recent experiments in deep sea productivity have shown a considerable increase in phytoplankton in normally depauperate mid-ocean waters (Soule et al. 1996).

FIGURE 5-5. IRON CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

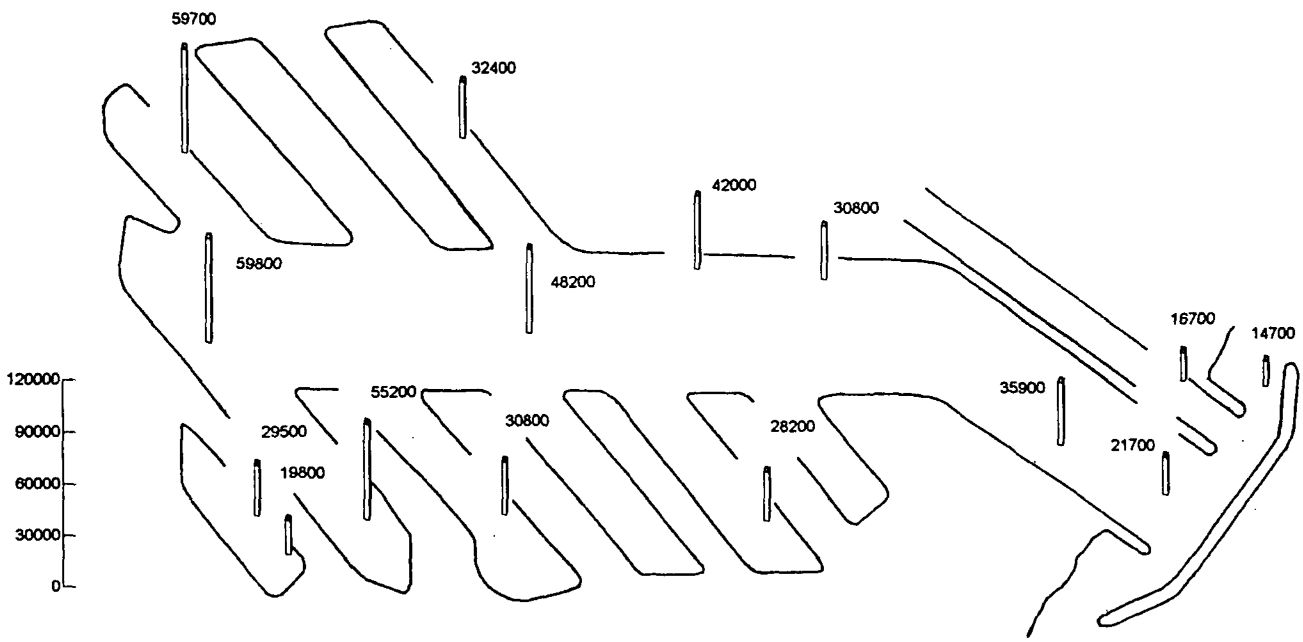
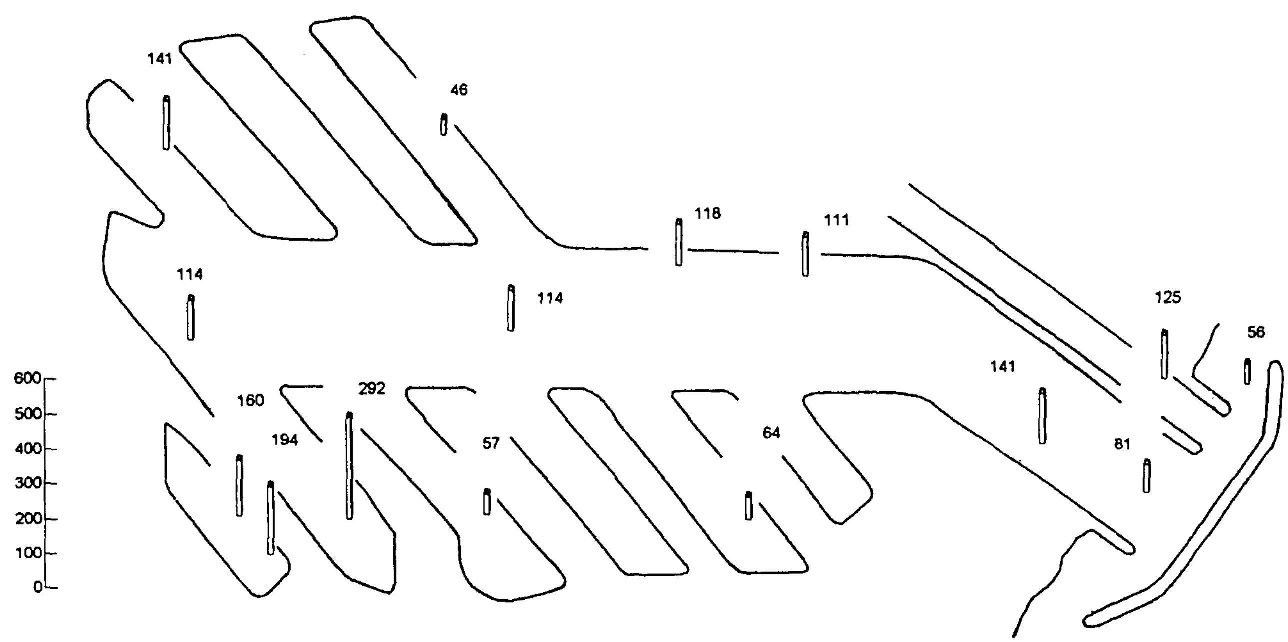


FIGURE 5-6. LEAD CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial iron patterns. Iron concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-5. Highest iron values were at Station 9 in Basin F (59,700 ppm), Station 11 at the end of the Harbor channel (59,800 ppm), and Station 10 in Basin E (55,200 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 12 - 14,700, 21,700, and 16,700 ppm, respectively) and at Station 13 in Oxford Lagoon (19,800 ppm).

Iron ranges compared with past years. The range of 1996 iron values (14,700 to 59,800 ppm) was within the overall range of the preceding ten years (Table 5-2). Iron in the Harbor appears to have neither greatly increased nor decreased since 1985.

Iron values compared with past surveys. Iron was not analyzed by either Los Angeles Harbor or by SCCWRP in their Reference Site Surveys.

Iron values compared with NOAA effects range ratings. There are no ER-L, ER-M, or AET values listed for iron.

5.3.1.6. **Lead**

Older paints and leaded gasoline are a major source of lead. Lead may be washed into the Harbor or become waterborne from aerial particulates. Adverse effects to organisms range from 1.3 to 7.7 ppm in freshwater, although marine animals may be more tolerant (Long and Morgan 1990).

Spatial lead patterns. Lead concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-6. Highest lead values were at Station 10 in Basin E (292 ppm) and in Oxford Lagoon (Stations 13 and 22 - 194 and 160 ppm). Lowest values were near the Harbor entrance (Stations 1 and 2 - 56.1 and 80.6 ppm) and in Basins B, D, and H (Stations 6, 8, and 7 - 63.6, 57.2, and 45.8 ppm).

Lead ranges compared with past years. The range of 1996 iron values (45.8 to 292 ppm) was within the overall range of the preceding ten years (Table 5-2). Lead in the Harbor appears to have neither greatly increased nor decreased since 1985.

Lead values compared with other surveys. The Marina del Rey lead average and range (120.9 ppm, 45.8 to 292 ppm) were higher than Los Angeles Harbor (21.3 ppm, 7.3 to 47 ppm) and both the 1979 (6.8 ppm, 2.7 to 12 ppm) and 1987 (10.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

Lead values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for lead are 35, 110, and 300 ppm (Table 5-3). All Harbor stations exceeded the ER-L value, and Stations 3, 4, 5, 9, 10, 11, 12, 13, 22, and 25 exceeded the ER-M value. No stations exceeded the AET value.

5.3.1.7. **Manganese**

Manganese is generally not considered to be a toxicant to marine plants or animals. It is an essential trace mineral in micro quantities for organisms.

Spatial manganese patterns. Manganese concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-7. Highest manganese values were at Station 9 in Basin F (355 ppm), Station 11 at the end of the Harbor channel (366 ppm), and Station 5 in the middle of the channel (334 ppm). Lowest values were near the Harbor entrance (Stations 1 and 12 - 145 and 148 ppm) and at Station 13 in Oxford Lagoon (117 ppm).

Manganese ranges compared with past years. The range of 1996 manganese values (117 to 366 ppm) was within or near the overall range of the preceding ten years (Table 5-2). Manganese in the Harbor appears to have neither greatly increased nor decreased since 1985.

Manganese values compared with past surveys. Manganese was not analyzed by either Los Angeles Harbor or by SCCWRP in their Reference Site Surveys.

Manganese values compared with NOAA effects range ratings. There are no ER-L, ER-M, or AET values listed for manganese.

5.3.1.8. **Mercury**

Mercury is a common trace metal used in industry and as a biocide. Acute toxicity to marine organisms in water ranges from 3.5 to 1678 ppm. Organomercuric compounds may be toxic in the range of 0.1 to 2.0 ppm (Long and Morgan 1990).

Spatial mercury patterns. Mercury concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-8. Highest mercury values were at Station 10 in Basin E (1.1 ppm) and Station 9 in Basin F (0.9 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 12 - all 0.1 ppm) and within Oxford Lagoon (Stations 13 and 22 - 0.1 and 0.2 ppm).

Mercury ranges compared with past years. The range of 1996 mercury values (0.06 to 1.06 ppm) was within or near the overall range of the preceding ten years (Table 5-2). Mercury in the Harbor appears to have neither greatly increased nor decreased since 1985.

Mercury values compared with other surveys. The Marina del Rey mercury average and range (0.439 ppm, 0.064 to 1.06 ppm) were higher than Los Angeles Harbor (0.21 ppm, 0.11 to 0.32 ppm). Neither the 1979 nor 1987 SCCWRP Reference Site Surveys measured mercury, however Mearns et al. (1991) estimated the background level in the Southern California Bight to be 0.05 ppm (Table 5-3).

FIGURE 5-7. MANGANESE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

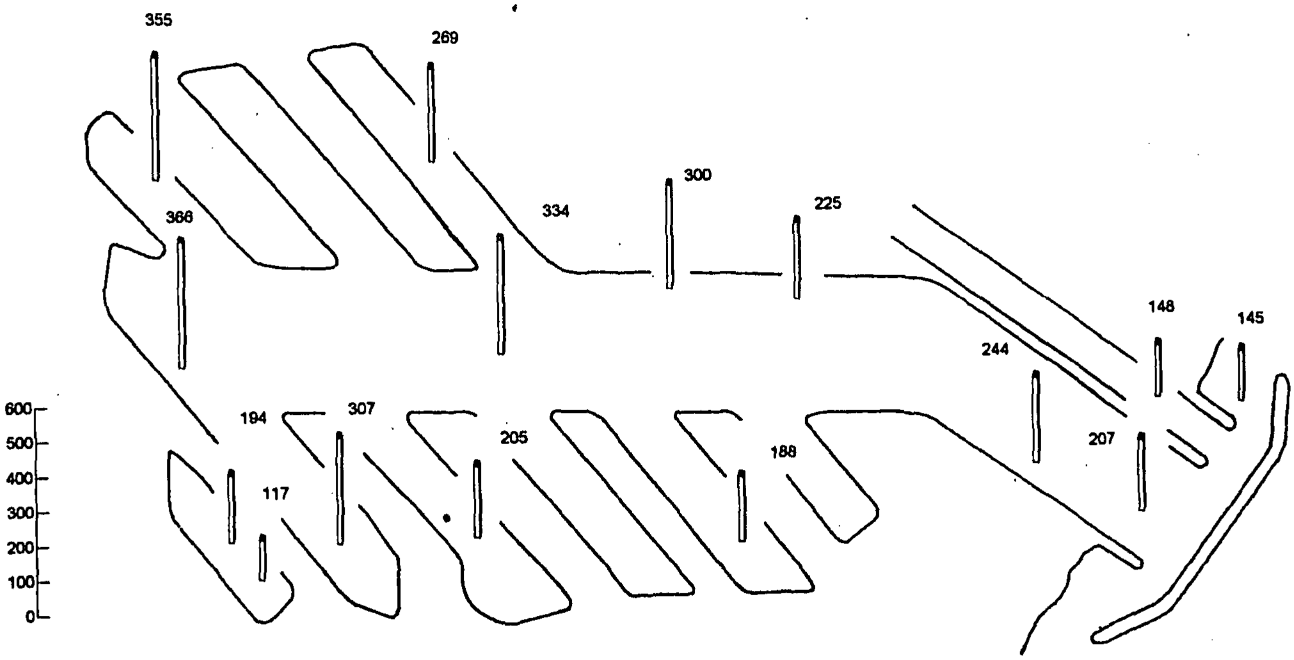
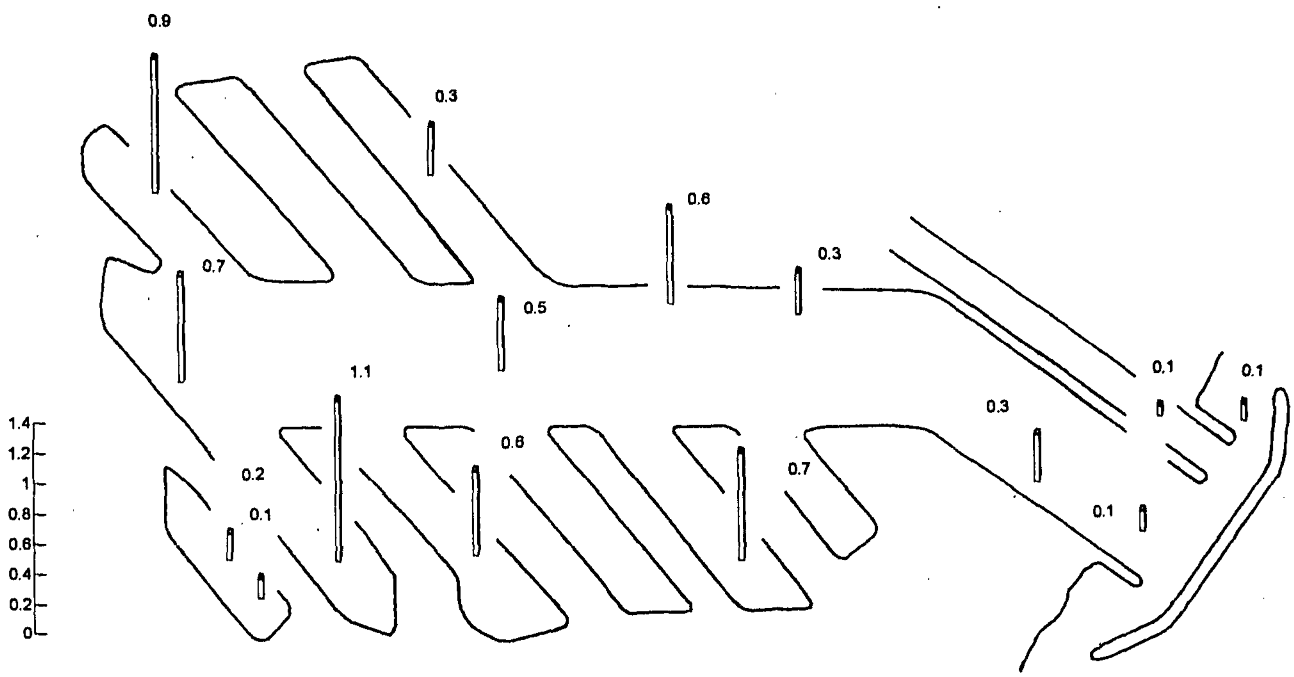


FIGURE 5-8. MERCURY CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Mercury values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for mercury are 0.15, 1.3, and 1 ppm (Table 5-3). Stations 3, 4, 5, 6, 7, 8, 9, 10, 11, 22, and 25 exceeded the ER-L value, and Station 10 exceeded the AET value. No stations exceeded the ER-M value.

5.3.1.9. **Nickel**

Nickel is used extensively in steel alloys and plating. Marina sediments contain particulates from vessel maintenance and corrosion. Nickel is chronically toxic to marine organisms in seawater at 141 ppm (Long and Morgan 1990).

Spatial nickel patterns. Nickel concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-9. The nickel concentration in Ballona Creek (Station 12 - 66.9 ppm) was over twice as high as the next three highest sites (Stations 9, 10, and 11 - 30.8, 30.5, and 31.0 ppm, respectively). Lowest values were at the remaining Harbor entrance stations (Stations 1 and 2 - 8.6 and 18.6 ppm) and in Oxford Lagoon (Station 13 - 13.1 ppm).

Nickel ranges compared with past years. The range of 1996 nickel values (8.6 to 66.9 ppm) was within or near the overall range of the preceding ten years (Table 5-2). Nickel in the Harbor appears to have neither greatly increased nor decreased since 1985.

Nickel values compared with other surveys. The Marina del Rey nickel average and range (24.7 ppm, 8.57 to 66.9 ppm) were comparable to Los Angeles Harbor (22.6 ppm, 10.1 to 42.3 ppm) and to the 1979 (16 ppm, 1.6 to 51 ppm) SCCWRP Reference Site Survey but the average was about twice the 1987 (12.9 ppm) Survey (Table 5-3).

Nickel values compared with NOAA effects range ratings. The ER-L and ER-M values for nickel are 30 and 50 ppm (Table 5-3). Stations 9, 10, 11, and 12 exceeded the ER-L value, and Station 12 exceeded ER-M value. No AET values are listed for nickel.

5.3.1.10. **Selenium**

Selenium is used in industry, as a component of electrical apparatuses and metal alloys, and an insecticide. Although there is no data available for selenium toxicity to marine organisms, the present protection criteria range is from 54 to 410 ppb (USEPA 1986). The normal terrestrial range is from 0.1 to 2.0 ppm with a mean of 0.3 ppm. Levels of selenium and lead were reported in Least Tern eggs from Venice Beach and North Island Naval Station, San Diego County, and was considered to be harmful to development (Soule et al. 1996).

FIGURE 5-9. NICKEL CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

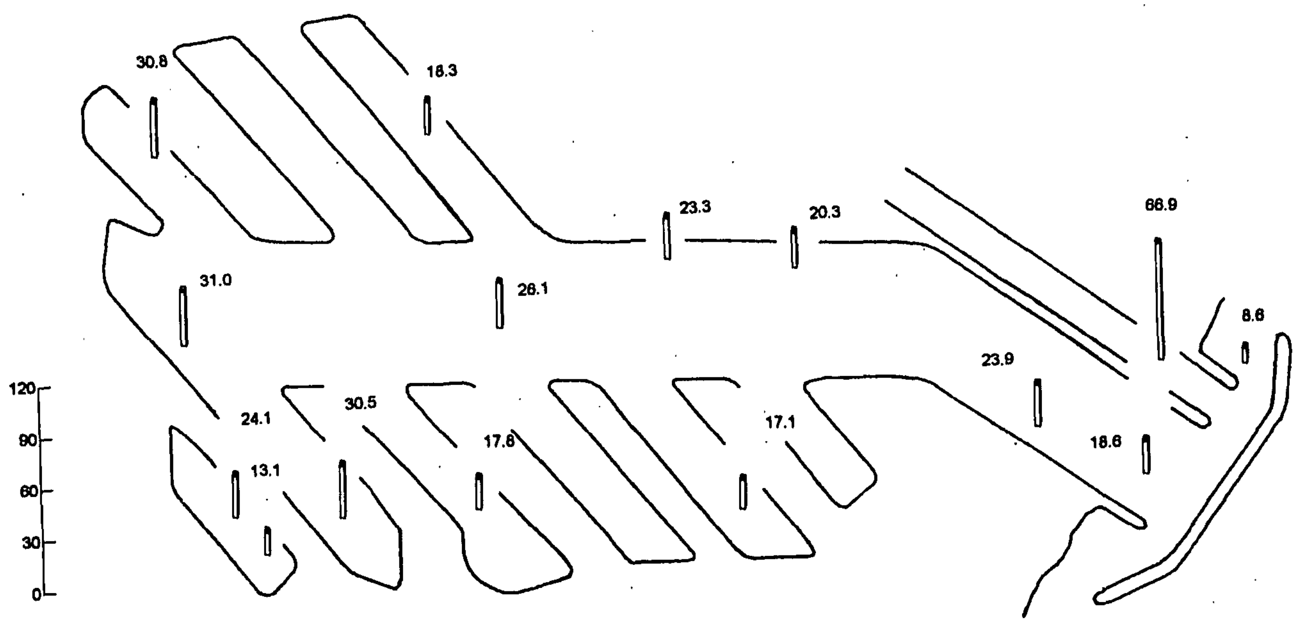
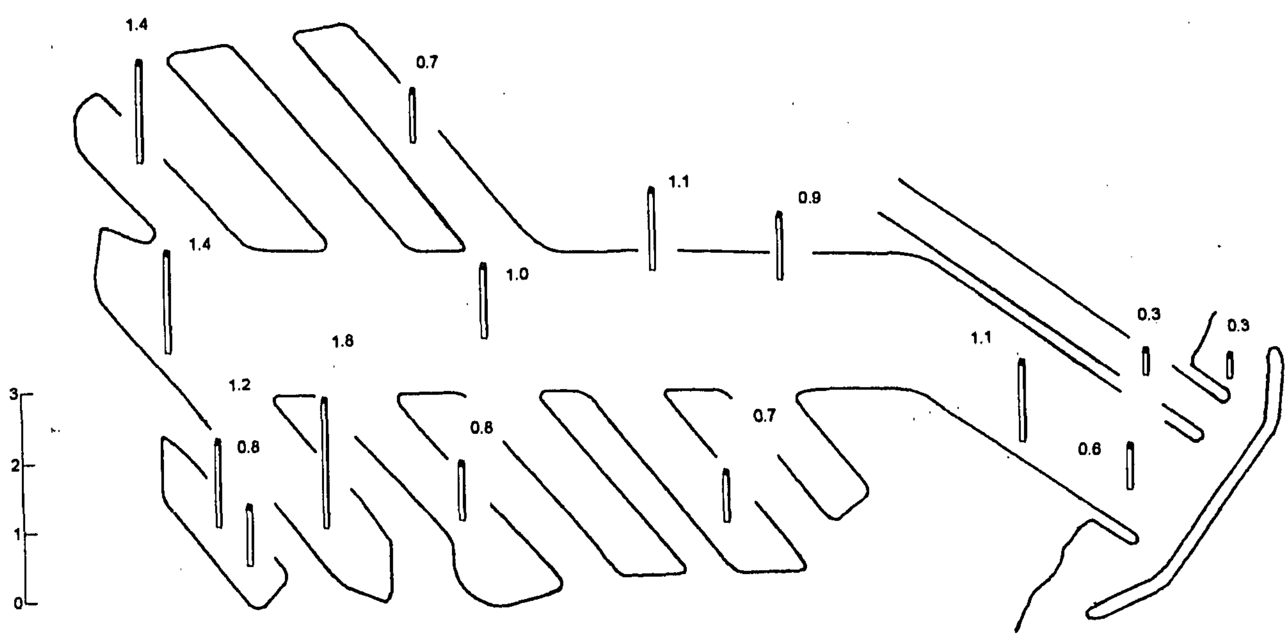


FIGURE 5-10. SELENIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial selenium patterns. Selenium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-10. Highest selenium concentrations were at Stations 9 in Basin D (1.4 ppm), Station 10 in Basin E (1.8 ppm), and Station 11 at the end of the Harbor channel - 1.4 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 12 - 0.3 to 0.6 ppm).

Selenium ranges compared with past years. The range of 1996 selenium values (0.3 to 1.8 ppm) was within or near the overall range of the preceding two years (Table 5-2).

Selenium values compared with other surveys. Selenium was not analyzed by either Los Angeles Harbor or by SCCWRP in their Reference Site Surveys.

Selenium values compared with NOAA effects range ratings. There are no ER-L, ER-M, or AET values listed for selenium.

5.3.1.11. **Silver**

Silver has many uses in commerce and industry including photographic film, electronics, jewelry, coins, flatware and in medical applications. Silver is toxic to mollusks and is sequestered by them and other organisms. Silver increases in the Southern California Bight with increasing depths, high organic content and percent silt (Mearns et al., 1991).

Spatial silver patterns. Silver concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-11. Highest silver concentrations were in the main channel (Stations 3, 4, and 25 - 2.7, 2.2, and 2.5 ppm, respectively). Lowest values were at one Harbor entrance station (Stations 1 - 0.3 ppm) and in Oxford Lagoon (Stations 13 and 22 - both 0.3 ppm).

Silver ranges compared with past years. Silver analysis has been performed in past surveys only since 1994, and all results were below detection limits. Since 1996 silver values (0.28 to 2.72 ppm) were below detection limits, they cannot be compared (Table 5-2).

Silver values compared with other surveys. The Marina del Rey silver average and range (1.183 ppm, 0.28 to 2.72 ppm) were higher than in Los Angeles Harbor (0.55 ppm, 0.05 to 2.66 ppm), the 1979 (0.35 ppm, 0.04 to 1.7 ppm) SCCWRP Reference Site Survey, and the 1987 (0.03 ppm) Survey (Table 5-3). The range in rural coastal shelf is from 0.10 to 18 ppm, in bays and harbors from 0.27 to 4.0 ppm, and near outfalls 0.08 to 18 ppm (Soule et al. 1996). The normal terrestrial level ranges from 0.01 to 5.0 ppm, with a mean of 0.05 ppm.

Silver values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for silver are 1, 2.2, and 1.7 ppm (Table 5-3). Stations 3, 4, 5, 9, 10, 11, and 25 exceeded the ER-L value; Stations 3, 4, 5, and 25 exceeded AET value; and Stations 3 and 25 exceeded the ER-M value.

FIGURE 5-11. SILVER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

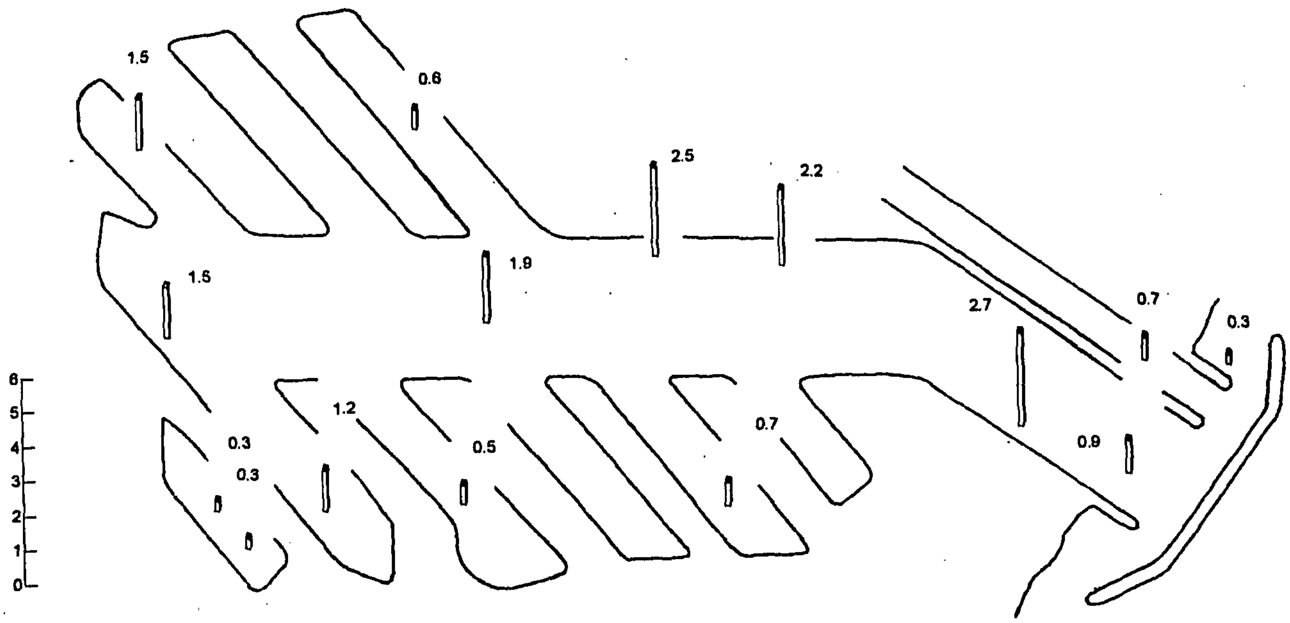
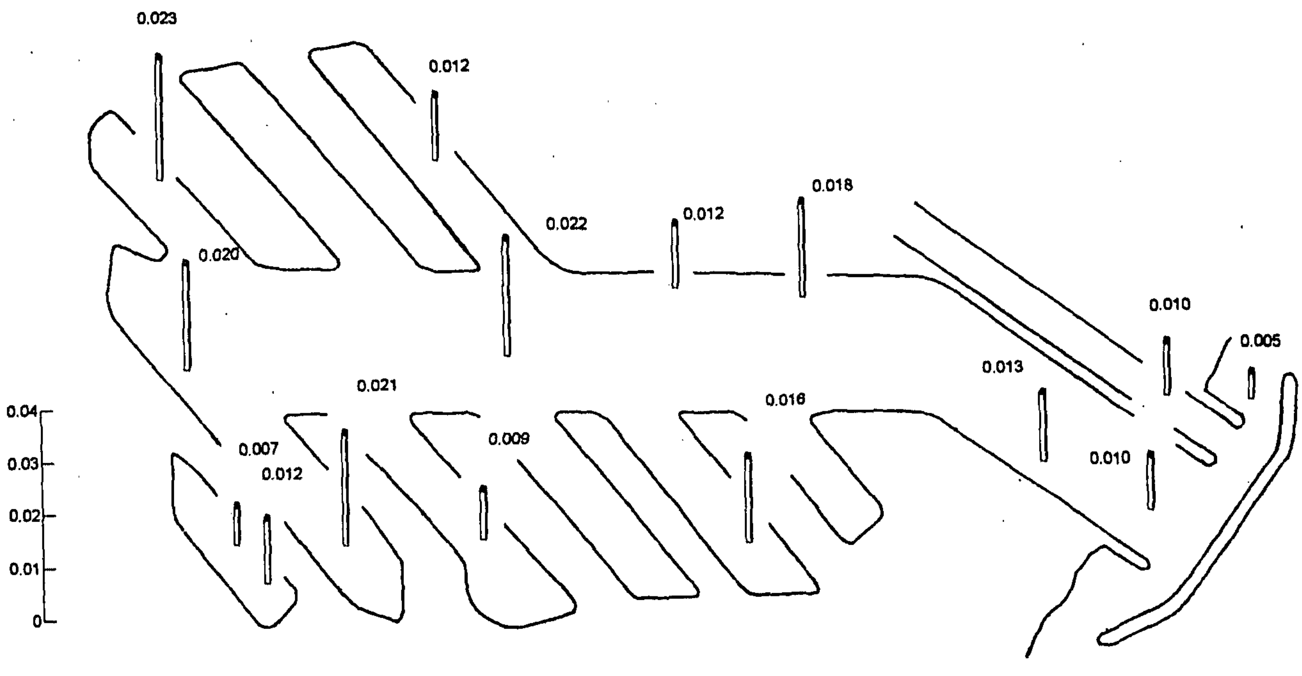


FIGURE 5-12. TRIBUTLYL TIN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.1.12. **Tributyl Tin**

Soule and Oguri (1987, 1988) reviewed the literature on the effects of tributyl tin, noting that it can be toxic in concentrations as low as 50 parts per trillion in water (this value is equivalent to 0.00005 ppm). No sediment tests other than Soule and Oguri (1988) were mentioned in the literature. Tributyl tin was considered by the California Department of Fish and Game to be the most toxic substance ever released in the marine environment. The Department of Beaches and Harbors banned its use on most vessels prior to Federal legislation banning use on vessels under 25 m in length except for copolymer paints used on aluminum hulls or in spray paints for some portable boats.

Tributyl tin may not be as bioavailable in sediments as it is in seawater, and therefore may not affect the benthic biota in the same fashion. Tributyl tin in the marina would only come from antifouling coatings (Soule et al. 1996).

Spatial tributyl tin patterns. Tributyl tin concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-12. Highest tributyl tin values were at Station 10 in Basin E (0.021 ppm), Station 9 in Basin F (0.023 ppm), and at Station 11 at the end of the Harbor channel (0.020 ppm). Lowest values were near the Harbor entrance (Station 1 - 0.005 ppm) and in Oxford Lagoon (Station 22 - 0.007 ppm).

Tributyl tin ranges compared with past years. The upper range of 1996 tributyl tin values (0.023 ppm) is the lowest recorded since 1987 (Table 5-2) and may reflect a response to the recent banning of this compound in the Harbor (see above). The range reported for October 1987 (<8 to 1070 ppm) appears to be much too high and is probably a part per billion result.

Tributyl tin values compared with past surveys. Tributyl tin was not analyzed by either Los Angeles Harbor or by SCCWRP in their Reference Site Surveys, however, the terrestrial range for tin is 2 to 200 ppm, with a mean of 10 ppm.

Tributyl tin values compared with NOAA effects range ratings. There are no ER-L, ER-M, or AET values listed for tributyl tin, although values at all stations are high enough to cause chronic toxicity to mollusks and other marine organisms.

5.3.1.13. **Zinc**

Zinc is widespread in the environment and is also an essential trace element in human nutrition. It is widely used for marine corrosion protection, and enters the waters as airborne particulates, occurring in runoff and in sewage effluent. Acute toxicity of zinc in water to marine fish range from 192 to 320,400 ppm, and chronic toxicity to marine mysid shrimp can occur as low as 120 ppm (Long and Morgan 1990).

Spatial zinc patterns. Zinc concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-13. Highest lead values were at Station 10 in Basin E (440 ppm), Station 9 in Basin F (382 ppm), and Station 11 at the end of the Harbor channel (426 ppm). Lowest values were near the Harbor entrance (Stations 1 and 12 - 61 and 121 ppm).

Zinc ranges compared with past years. The range of 1996 zinc values (61 to 440 ppm) was within the overall range of the preceding ten years (Table 5-2). Zinc in the Harbor appears to have neither greatly increased nor decreased since 1985.

Zinc values compared with other surveys. The Marina del Rey zinc average and range (267 ppm, 61.3 to 440 ppm) were higher than Los Angeles Harbor (87.5 ppm, 42.2 to 148 ppm), the 1977 SCCWRP Reference Site Survey (45 ppm, 9.8 to 110 ppm), and the 1985 (48 ppm) Survey (Table 5-3). The normal terrestrial range is from 10 to 300 ppm, with a mean of 50 ppm (Soule et al. 1996).

Zinc values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for zinc are 120, 270, and 260 ppm (Table 5-3). All Harbor stations except Station 1 exceeded the ER-L value, and Stations 3, 5, 9, 10, 11, 13, 22, and 25 exceeded both the ER-M and AET values.

5.3.2. Chlorinated Pesticides and PCB's

5.3.2.1. **DDT and Derivatives**

DDT has been banned since the early 1970's, but the presence of nondegraded DDT suggests that either subsurface DDT is being released during erosion and runoff in storms, or that fresh DDT is still in use and finding its way into the marina (Soule et al. 1996). Available data indicate that concentrations of DDE (a breakdown product of DDT) as low as 14 ppm in water are acutely toxic to marine organisms (Long and Morgan 1990).

Spatial DDT patterns. DDT and derivative concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-14. Highest combined DDT values were within Oxford Lagoon (Stations 13 and 22 - 32.2 and 29.0 ppb) and in the lower channel (Stations 2 and 3 - 27.3 and 32.8 ppb). Lowest values were in Basins B and D (Stations 6 and 8 - 5.9 and 6.0 ppb) and at Station 1 at the Harbor entrance (6.0 ppb).

DDT ranges compared with past years. The range of 1996 values were <0.4 to 12.0 ppb for DDT, <0.5 to 6.6 ppb for DDD, and 4.0 to 16.0 ppb for DDE. These results represent order of magnitude declines in DDT's when compared to the ranges from past surveys (Table 5-2).

DDT values compared with other surveys. The Marina del Rey DDT average and range (18.5 ppb, 5.9 to 32.8 ppb) were lower than Los Angeles Harbor (94.1 ppb, 29.7 to 196 ppb) but comparable to the 1979 SCCWRP Reference Site Survey (30 ppb, <3 to 70 ppb), and the 1987 (18.9 ppb) Survey (Table 5-3).

FIGURE 5-13. ZINC CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

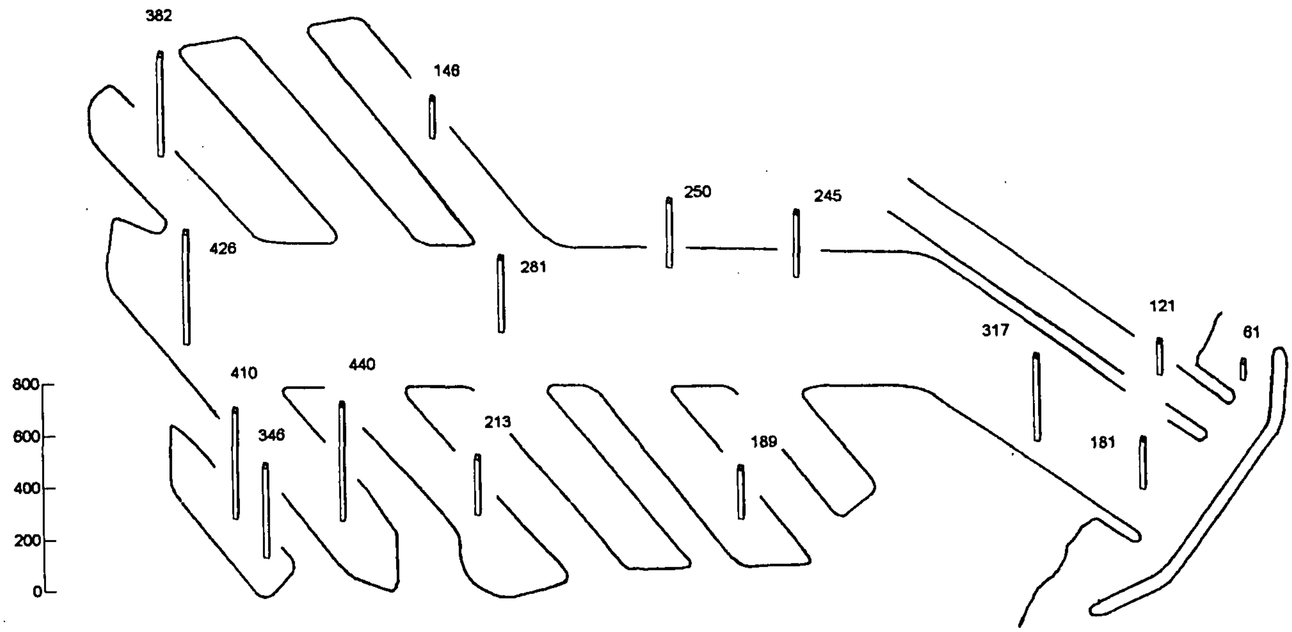
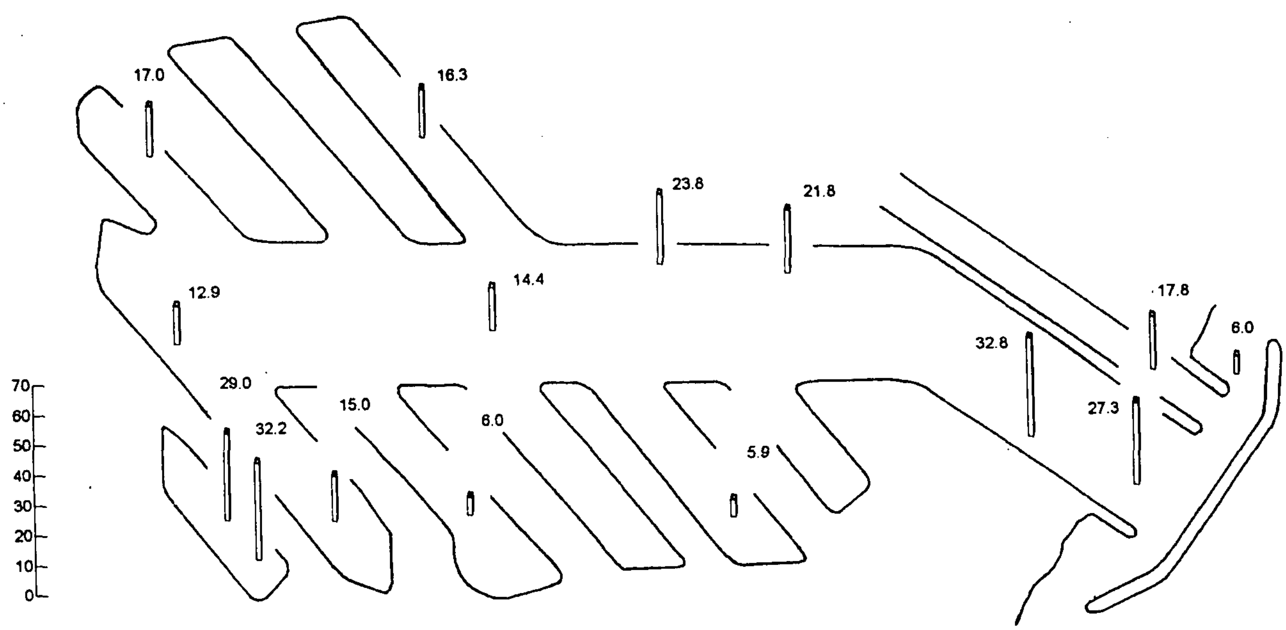


FIGURE 5-14. DDT AND DERIVATIVE CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



DDT values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values are 1, 7, and 6 ppb for DDT; 2, 20, and 10 ppb for DDD; 2, 15, and 7.5 ppb for DDE; and 3 and 350 ppb (no AET value listed) for total DDT's (Table 5-3). All Harbor stations exceeded the ER-L value for DDE and total DDT's, and most stations exceeded the ER-L for DDT and DDD. ER-M and AET values for DDT were exceeded at Stations 2, 3, 4, 13, 22, and 25; and all stations except 1, 6, and 8 exceeded either the ER-M and AET values for DDE.

5.3.2.2. **Remaining Chlorinated Pesticides**

Concentrations of the insecticide chlordane between 2.4 and 260 ppm in water are acutely toxic to marine organisms (Long and Morgan 1990). Heptachlor epoxide, a degradation product of heptachlor, is acutely toxic to marine shrimp at 0.04 ppm in water. Endrin aldehyde was also present at low levels, although no toxicity data could be found on this compound. The closely related compound endrin shows acute toxicity within a range of 0.037 to 1.2 ppb (Long and Morgan 1990). Dieldrin, which occurred only once in 1989 was below detection limits (0.08 ppb) in this survey (Table 5-2).

Spatial remaining chlorinated pesticide patterns. Concentrations of combined chlorinated pesticides (excluding DDT and derivatives) at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-15. Highest combined pesticide values were at Oxford Lagoon (Station 22 - 15.2 ppb) and in the lower channel (Stations 2 and 3 - 14.5 and 13.9 ppb). Lowest values were in Basins B, D, and H (Stations 6, 8, and 7 - <0.7 to <0.9 ppb), at Station 11 at the end of the Harbor channel (0.5 ppb), and in Basin F (Station 9 - 0.6 ppb).

Remaining chlorinated pesticide ranges compared with past years. The range of 1996 values were <0.1 to 14.3 ppb for chlordane, <0.6 to 2.0 for endrin aldehyde, and <0.2 to 2.0 for heptachlor epoxide. Upper limits for chlordane indicate that this compound has decline by an order of magnitude over previous years. Other compounds cannot be compared because current detection limits are lower than previous ones (Table 5-2).

Remaining chlorinated pesticide values compared with previous surveys. Chlorinated pesticides (other than DDT and derivatives) were not analyzed or could not be determined from surveys in Los Angeles Harbor or SCCWRP Reference Sites.

Remaining chlorinated pesticide values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values are 0.5, 6, and 2 ppb for chlordane, although there are no effects range ratings for endrin aldehyde or heptachlor epoxide (Table 5-3). All Harbor stations, except 6, 7, and 8, exceeded the ER-L value for chlordane, Stations 1, 2, 3, 4, 5, 10, 12, 13, 22, and 25 exceed AET values, and Stations 2, 3, 12, 13, 22, and 25 exceed ER-M values.

FIGURE 5-15. REMAINING PESTICIDE CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.

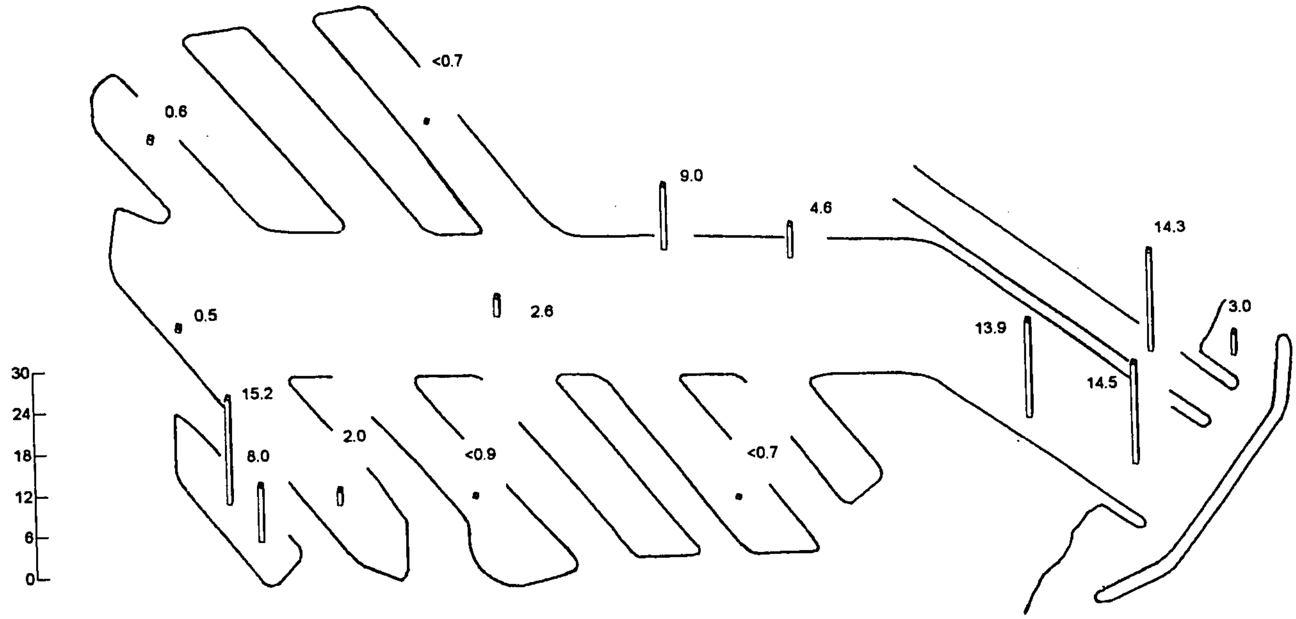
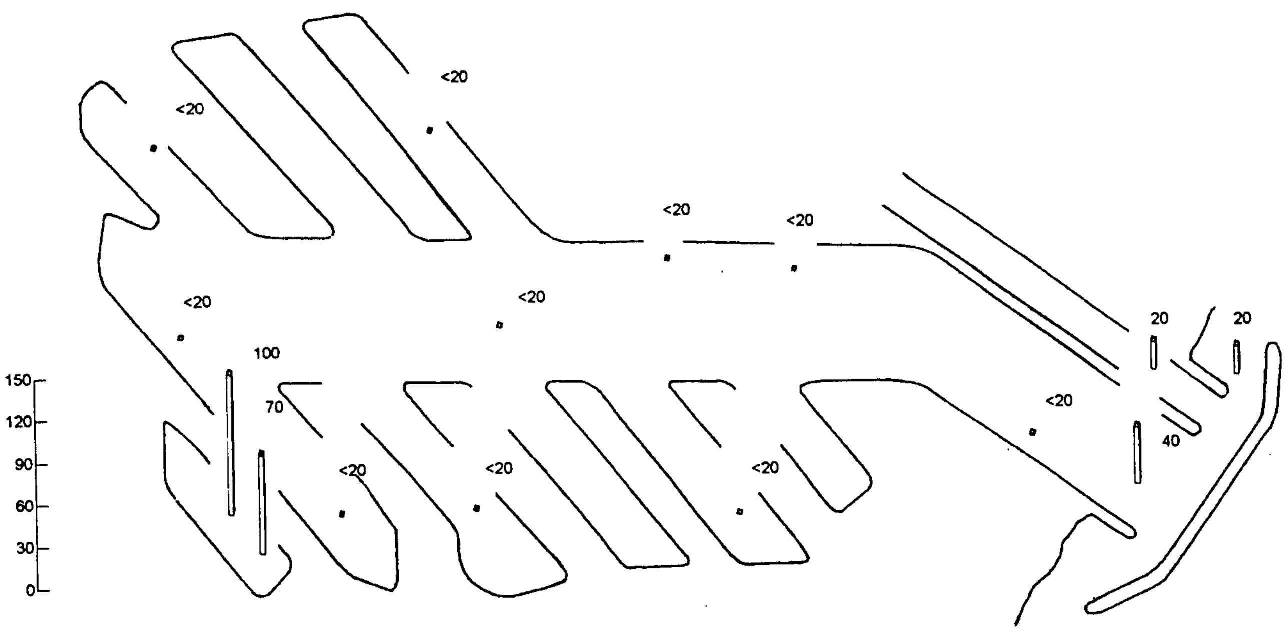


FIGURE 5-16. PCB (AROCHLOR 1254) CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.2.2. **Polychlorinated Biphenyls (PCB's)**

Although PCB's are not pesticides, their similarity to other chlorinated hydrocarbons makes their inclusion in this section appropriate. Before being banned in 1970, the principal uses of PCB's were for dielectric fluids in capacitors, as plasticizers in waxes, in transformer fluids and hydraulic fluids, in lubricants, and in heat transfer fluids (Laws 1981). Arochlor 1242 was acutely toxic in water to marine shrimp in ranges of 15 to 57 ppm (Long and Morgan 1990).

Spatial PCB patterns. Only one PCB compound (Arochlor 1254) was detectable in Harbor sediments. Concentrations of Arochlor 1254 at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-16. Highest values were at within Oxford Lagoon (Station 13 and 22 - 70 and 100 ppb) and near the Harbor entrance (Stations 1, 2, and 12 - 20, 40, and 20 ppb, respectively). All remaining stations were below detection limits (20 ppb).

PCB's compared with past years. The range of 1996 values for Arochlor 1254 were <20 to 100 ppb. (Table 5-2). These values are either similar or lower than those reported in the past (<50 to 330 ppb) even though detection limits have improved.

PCB's values compared with other surveys. The Marina Del Rey total PCB average and range (17 ppb, <20 to 100 ppb) were lower than Los Angeles Harbor (58.3 ppb, 27.2 to 137 ppb) but comparable to the 1979 SCCWRP Reference Site Survey (10 ppb, <2 to 40 ppb), and the 1987 (19.2 ppb) Survey (Table 5-3).

PCB's compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for Arochlor 1254 are 50, 400, and 370 ppb (Table 5-3). Only Stations 13 and 22 in Oxford Lagoon were above the ER-L value, and no stations were above the ER-M or AET values.

5.3.3. Simple Organics

Simple organic compounds are not included in the NOAA effects range ratings (Long and Morgan 1990), so that subsection will not be included for these compounds.

5.3.3.1. **Total Organic Carbon (TOC)**

TOC is a more accurate measure of the amount of carbon derived from plant and animal sources than is percent volatile solids (Soule et al. 1996).

Spatial TOC patterns. Concentrations of TOC at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-17. Highest values were at Oxford Lagoon (Station 22 - 3.9%) and near the Administration docks in mid-channel (Stations 25 - 3.2%). Lowest values were near the Harbor entrance (Stations 1 and 12 - 0.3% and 0.5%).

TOC ranges compared with past years. The range of 1996 values for TOC were 0.46 to 3.9% (Table 5-2), which are well within the ranges for the previous ten years. TOC in the Harbor appears to have neither greatly increased nor decreased since 1985.

TOC values compared with previous surveys. TOC values were normalized to fine grain Los Angeles Harbor, so they were not comparable to values in this survey. The TOC average and range for Marina del Rey TOC (1.8%, 0.46% to 3.9%) were higher than the 1987 SCCWRP Reference Site Survey of 0.52% (Table 5-3). TOC was not analyzed in the 1979 SCCWRP Survey.

5.3.3.2. **Volatile Solids**

Percent volatile solids is a measure of the amount of carbonaceous material that can be driven off in a combustion furnace. Volatile solids offer a rough estimation of the organic matter present in sediments (APHA 1995).

Spatial volatile solids patterns. Concentrations of volatile solids at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-18. Highest values were at Station 3 in the lower channel (11.0%) which was twice the next highest level (5.7% - Station 9 in Basin F). Lowest values were near the Harbor entrance (Stations 1 and 12 - 0.8% and 1.3%).

Volatile solids ranges compared with past years. The range of 1996 values for volatile solids were 0.8% to 11.0% (Table 5-2) which are well within the ranges for the previous ten years. Volatile solids in the Harbor appears to have neither greatly increased nor decreased since 1985.

Volatile solids values compared with previous surveys. The average and range for Marina Del Rey volatile solids (4.1%, 0.8% to 11%) were comparable to the 1979 SCCWRP Reference Site Survey (3.3%, 1.8% to 9.5%). Volatile solids were not analyzed in the 1987 SCCWRP Survey nor in Los Angeles Harbor (Table 5-3).

5.3.3.3. **Immediate Oxygen Demand (IOD)**

Immediate Oxygen Demand (IOD) is related to the amount of oxygen (in mg/kg, = ppm) utilized during exposure of a sample to an oxidizing agent for a short time, usually 15 minutes. It measures organic and inorganic content as indicators of the amount of dissolved oxygen that will be removed from the water column or sediment due to bacterial and/or chemical activity (Soule et al. 1996). Since IOD is not a standardized test, no reference values are available.

Spatial IOD patterns. Concentrations of IOD at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-19. Highest values were in Oxford Lagoon (Station 22 1.3%). Lowest values were near the Harbor entrance (Stations 1 and 12 - 0.1% and 0.3%).

FIGURE 5-17. TOTAL ORGANIC CARBON CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.

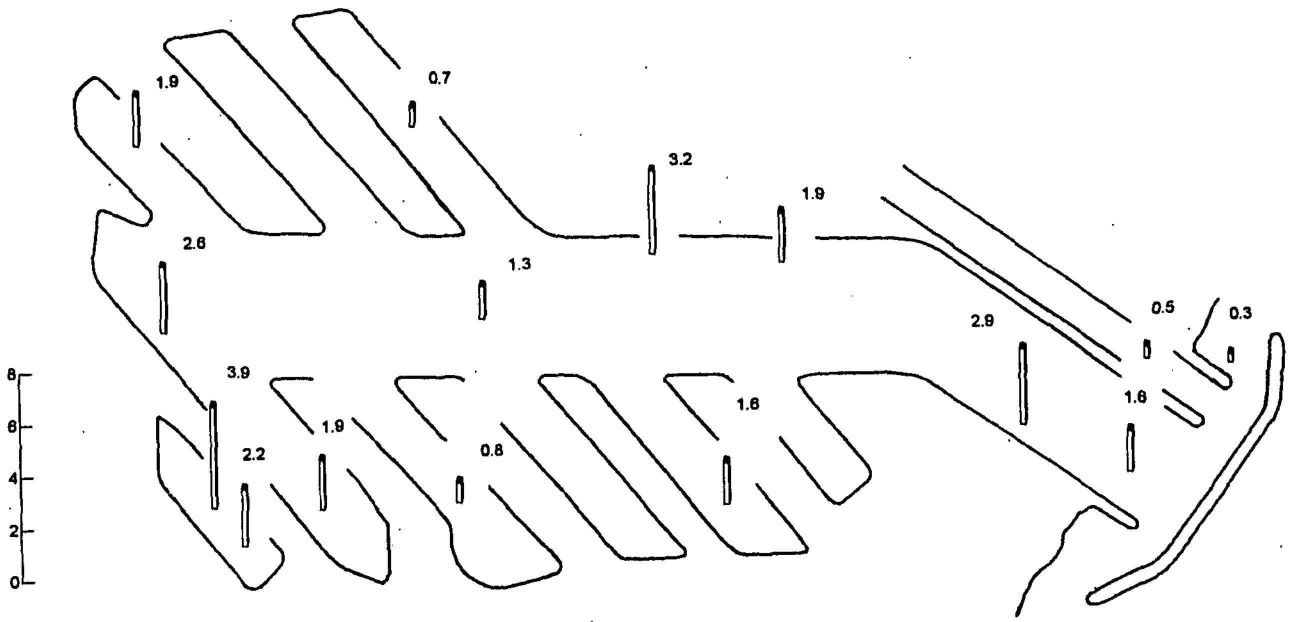
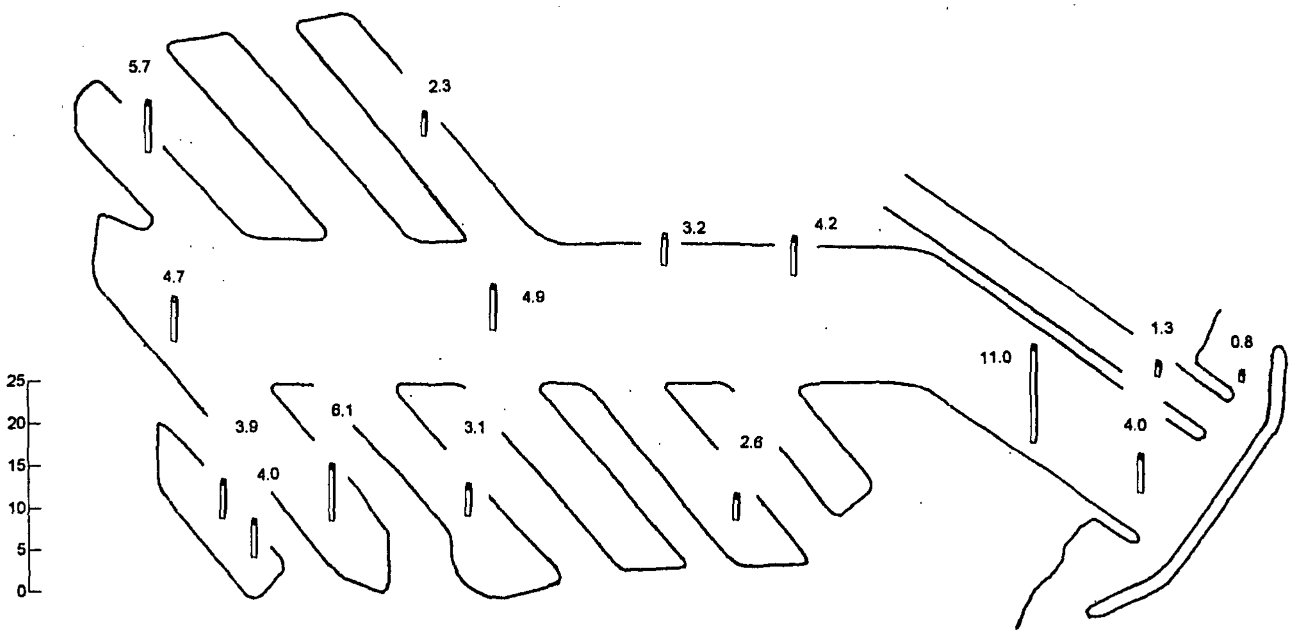


FIGURE 5-18. VOLATILE SOLIDS CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



IOD ranges compared with past years. The range of 1996 values for IOD were 0.13% to 1.3% (Table 5-2). These values are much higher than those reported in the past (0.0001% to 0.085%). It is likely, since the IOD analysis is a non-standardized methodology, that these large differences are related to different analytical techniques by the previous and present chemistry laboratories. Perhaps a more standardized method, such as the biochemical oxygen demand, might be more appropriately applied at some future date.

IOD values compared with previous surveys. IOD was not analyzed from surveys in Los Angeles Harbor or SCCWRP Reference Site Surveys.

5.3.3.4. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is measured over a longer period of time than IOD, usually two hours, in the presence of potassium dichromate in sulfuric acid. Like IOD, COD measures organic and inorganic content as indicators of the amount of dissolved oxygen that will be removed from the water column or sediment due to bacterial and/or chemical activity.

Spatial COD patterns. Concentrations of COD at the 15 stations are listed in Table 5-1 and summarized in Figure 5-20. Highest values were in Oxford Lagoon (Stations 13 and 22 - 5.9% and 8.0%). Lowest values were near the Harbor entrance (Stations 1 and 12 - 0.7% and 1.6%).

COD ranges compared with past years. The range of 1996 values for COD were 0.73% to 8.0% (Table 5-2) which are well within the ranges of the previous ten years. COD in the Harbor appears to have neither greatly increased nor decreased since 1985.

COD values compared with previous surveys. The average and range for Marina del Rey COD (3.4%, 0.73% to 8.0%) were comparable to the 1979 SCCWRP Reference Site Survey (2.4%, 0.92% to 6.94%). TOC was not analyzed in the 1987 SCCWRP Survey nor in Los Angeles Harbor (Table 5-3).

5.3.3.5. Oil and Grease

Sources of oil and grease are usually attributed to operations of marina vessels, but the highest values generally have been found in Ballona Creek and Oxford Basin, where tidal flux may play a role in deposition from the marina. Also, the marina is located in an area of historic oil fields and oil from seeps may be a natural cause. The extent to which people dump used motor oil into storm drains is unknown and may be a factor in the occurrence of oil and grease in flood control channels. Kitchen grease, apparently from nearby restaurant(s), has at times been observed on marina walls at the tidegate. Station 25 is between the area of the administration building, where the Life Guard, Sheriff's patrol and Coast Guard dock, and Fisherman's Village, where the public fishing and bait boats dock. This is an area of concentrated activity of diesel engines prone to oil emission (Soule et al. 1996).

FIGURE 5-19. IMMEDIATE OXYGEN DEMAND CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.

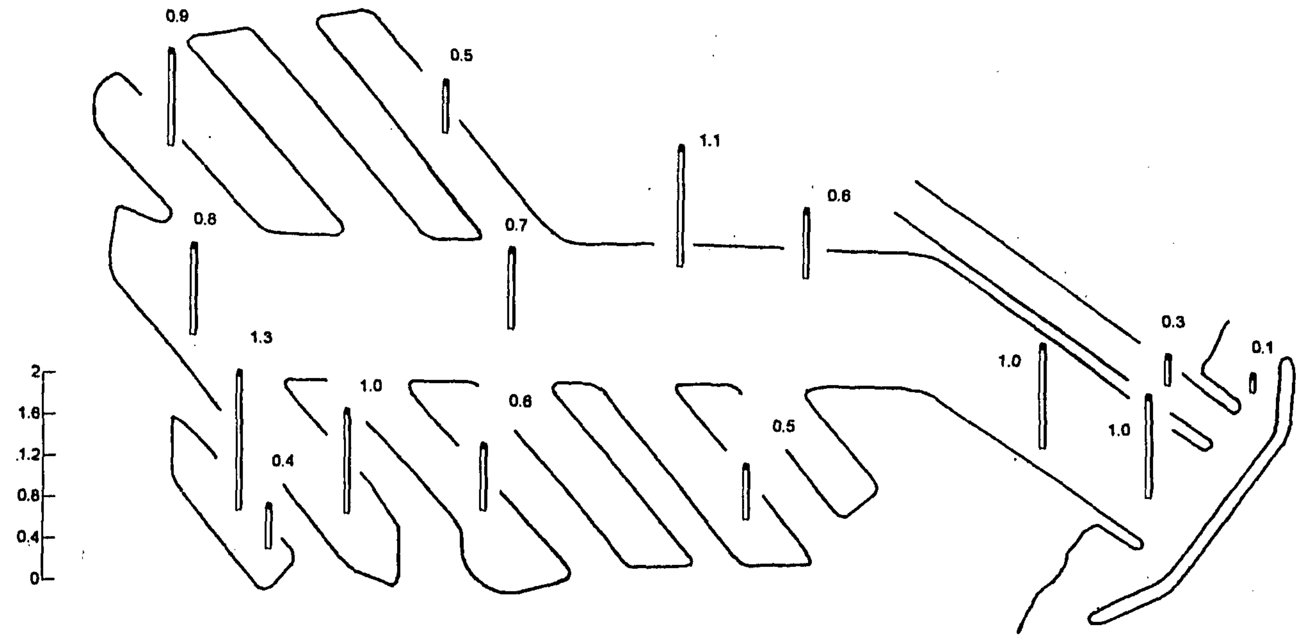
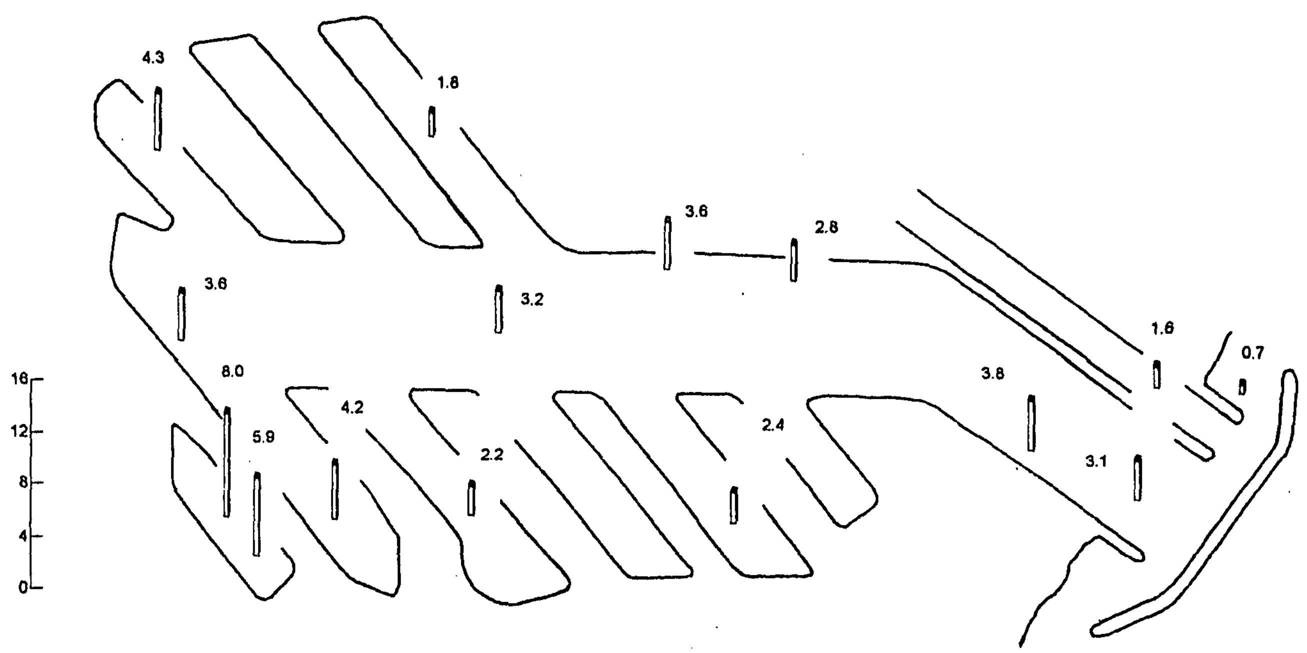


FIGURE 5-20. CHEMICAL OXYGEN DEMAND CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial oil and grease patterns. Oil and grease values for the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-21. Highest values were in Oxford Lagoon (Stations 13 and 22 - 210 and 270 ppm), Ballona Creek (Station 12 - 350 ppm), and in the lower channel (Stations 2 and 3 - 250 and 210 ppm). Lowest values were in Basin H (Station 7 - 30 ppm).

Oil and grease ranges compared with past years. The range of 1996 values for oil and grease were 30 to 350 ppm (Table 5-2). These results are about an order of magnitude higher than those recorded over the past ten years.

Oil and grease values compared with previous surveys. Oil and grease was not analyzed from surveys in Los Angeles Harbor or SCCWRP Reference Site Surveys.

5.3.3.6. **Organic Nitrogen**

Organic nitrogen is present due to the breakdown of animal products. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea, and numerous synthetic organic materials (APHA 1995).

Spatial organic nitrogen patterns. Concentrations of organic nitrogen at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-22. Highest values were at Station 13 in Oxford Lagoon, Station 9 in Basin F, and Station 6 in Basin B (all 1400 ppm). Lowest values were at Station 11 at the end of the Harbor entrance and Station 7 in Basin H (both 120 ppm).

Organic nitrogen ranges compared with past years. The range of 1996 values for organic nitrogen were 120 to 1400 ppm (Table 5-2) which are well within the ranges of the previous ten years. Organic nitrogen in the Harbor appears to have neither greatly increased nor decreased since 1985.

Organic nitrogen values compared with previous surveys. The average and range for Marina del Rey nitrogen (593 ppm, 120 to 1400 ppm) were comparable to the 1979 SCCWRP Reference Site Survey (790 ppm, 393 to 1430 ppm). Nitrogen was not analyzed in the 1987 SCCWRP Survey nor in Los Angeles Harbor (Table 5-3).

5.3.3.7. **Ortho Phosphate**

Phosphorus, as orthophosphate (PO_4) is found in the natural environment in sediments, water and in organic compounds of living organisms. Phosphate use, primarily in detergents, was highest in 1984 through 1987, decreasing by an order of magnitude through 1989 and two orders of magnitude through 1992. Citrates have replaced phosphates in detergents, but there is no data base for determining the potential environmental impact. Surfactants in detergents dissolve the protective waxy or oily coatings on organisms and are thus harmful even if they are supposedly non-toxic (Soule et al. 1996). No sediment reference values are available for phosphorus.

FIGURE 5-21. OIL AND GREASE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

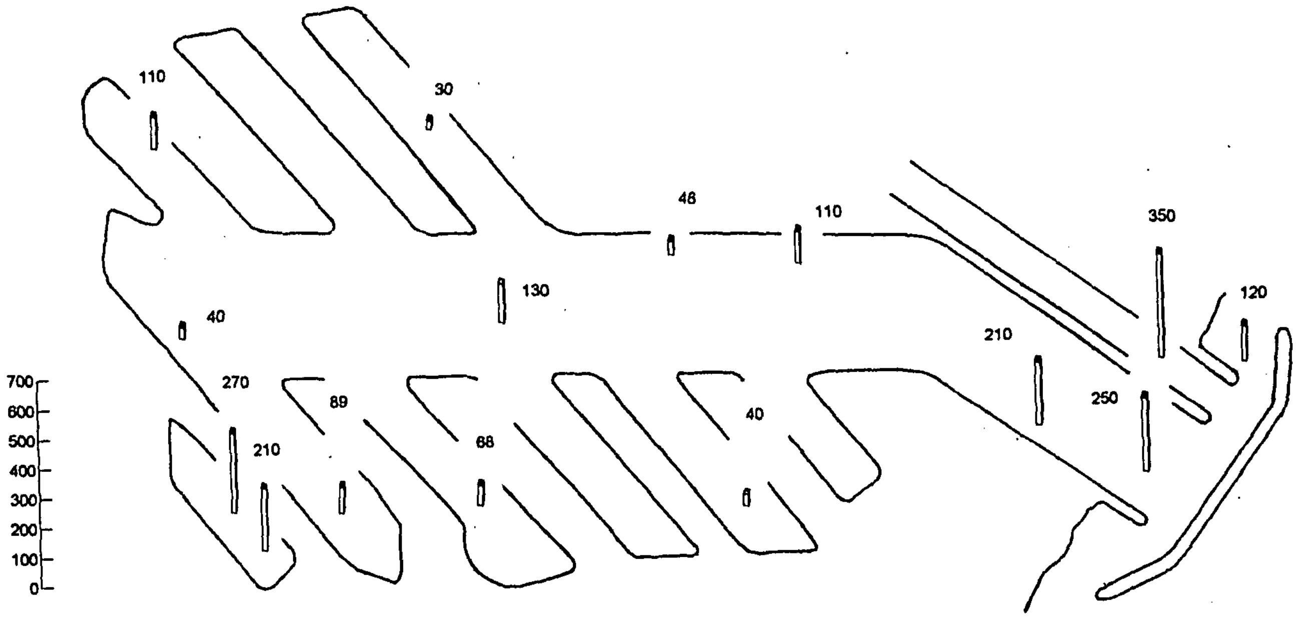
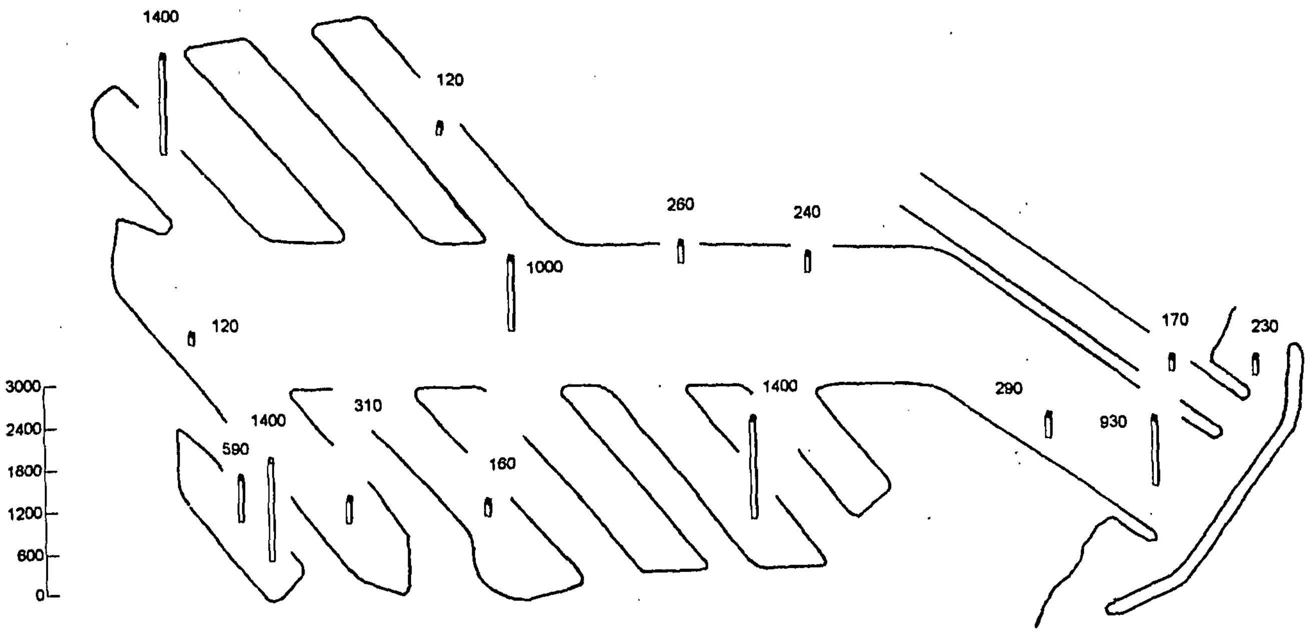


FIGURE 5-22. ORGANIC NITROGEN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial ortho phosphate patterns. Concentrations of ortho phosphate at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-23. Highest values were at Station 11 at the end of the Harbor channel (225 ppm) and at Station 25 in mid-channel (220 ppm). Lowest values were near the Harbor entrance (Stations 1 and 2 - 26 and 14 ppm).

Ortho phosphate ranges compared with past years. The range of 1996 values for ortho phosphate were 14 to 225 ppm (Table 5-2) which are well within the ranges of the previous ten years. Ortho phosphate concentrations have varied widely over the past ten years.

Ortho phosphate values compared with previous surveys. Ortho phosphate was not analyzed from surveys in Los Angeles Harbor or SCCWRP Reference Site Surveys.

5.3.3.8. **Sulfides**

Hydrogen sulfide (H_2S) is an indicator of organic decomposition characterized by a rotten egg smell, occurring particularly in anoxic sediments. No sediment reference values are available for sulfides.

Spatial sulfide patterns. Concentrations of sulfides at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-24. Highest values were in Oxford Lagoon (Stations 13 and 22 - 430 and 320 ppm) and in the lower channel (Stations 2 and 3 - 340 and 580 ppm). Lowest values were in Ballona Creek (Stations 12 - 85 ppm) and Basin H (Station 7 - 75 ppm).

Sulfide ranges compared with past years. The range of 1996 values for sulfide were 75 to 580 ppm (Table 5-2) which are well within the ranges of the previous ten years. Like ortho phosphate, sulfide concentrations have varied wildly over the past ten years.

Sulfide values compared with previous surveys. Sulfides were not analyzed from surveys in Los Angeles Harbor or SCCWRP Reference Site Surveys or were not comparable.

5.3.4. Minerals and Other Compounds

Table 5-2 lists physical and chemical parameters which are generally associated with freshwater mineral analysis for drinking water or for agricultural use. These constituents are neither commonly associated with marine toxicants nor are they common indicators of organic pollution, therefore they will not be dealt with in this document. The current authors believe that the deletion of these analyses from the program would not detract from the project to any great degree.

FIGURE 5-23. ORTHO PHOSPHATE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

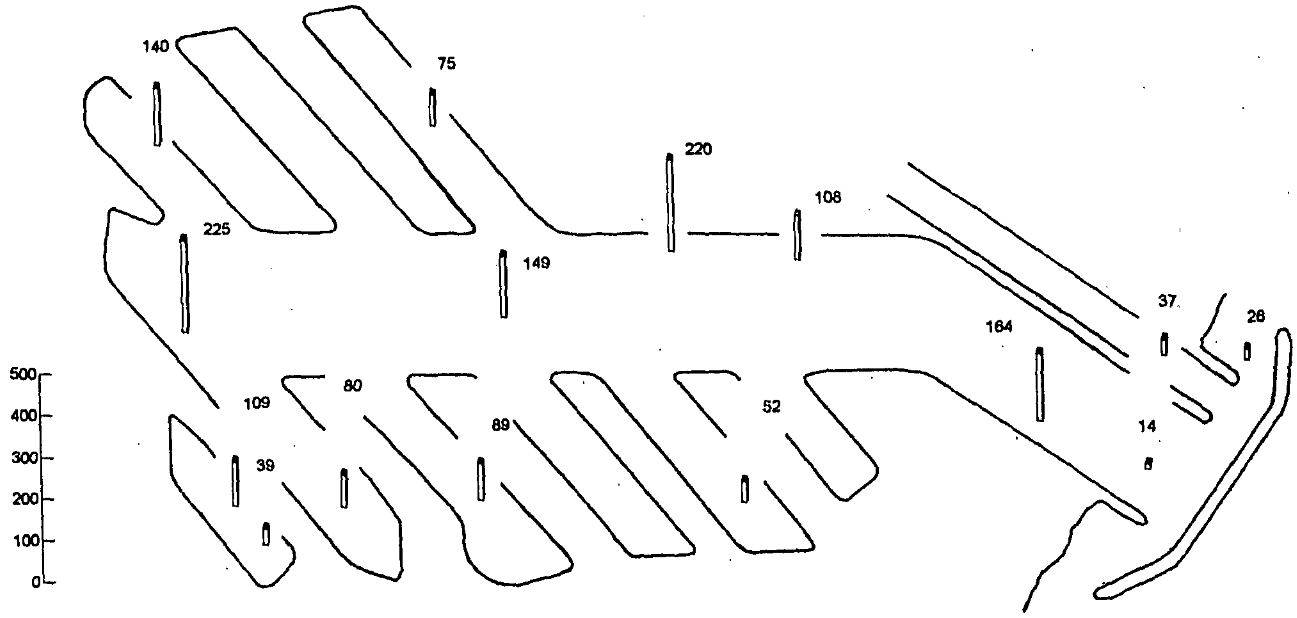
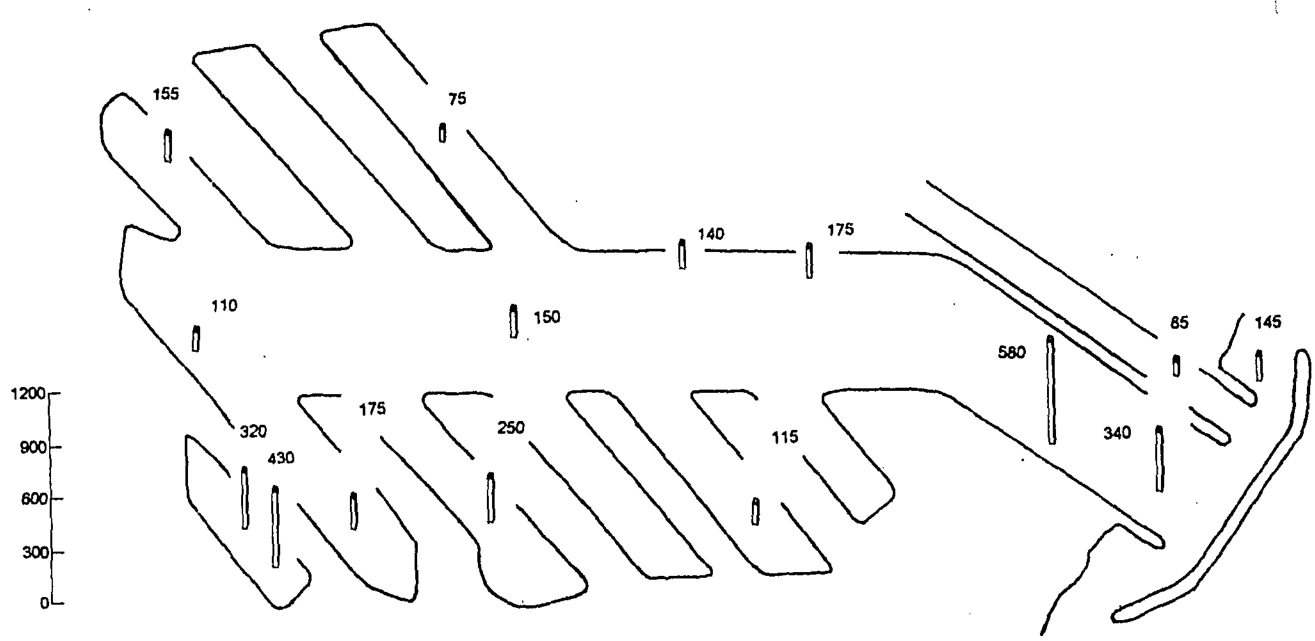


FIGURE 5-24. TOTAL SULFIDE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.5. Station Grouping Based on Benthic Contaminants

Stations were clustered by their similarities to the chemical constituents listed in Table 5-2. The method used is described above for water quality (Section 3.3.3). Station groupings were resolved based upon their similarity or dissimilarity to chemical sediment variables (Figure 5-25).

Stations 13 and 22. This cluster exclusively includes the two sediment stations within Oxford Lagoon. This grouping is characterized by relatively high concentrations of a few heavy metals (cadmium, lead, and zinc), simple organics (TOC, COD, oil and grease, nitrogen, and sulfides), and chlorinated hydrocarbons (PCB's, DDT and derivatives, and remaining chlorinated pesticides) and low concentrations of many other heavy metals (chromium, iron, manganese, mercury, silver, and tributyl tin). Suspended materials discharged from the municipal drainage system into Oxford Lagoon is a likely source of organics, pesticides, and other chlorinated hydrocarbons into Marina del Rey Harbor. The source of cadmium and zinc could also be from the drainage system, however, they could also be coming from the Harbor itself on incoming tides. Relatively high levels, both here and Ballona Creek, of lead (perhaps from gasoline) and oil and grease (possibly from automobiles), suggest that the source of these contaminants is street drainage.

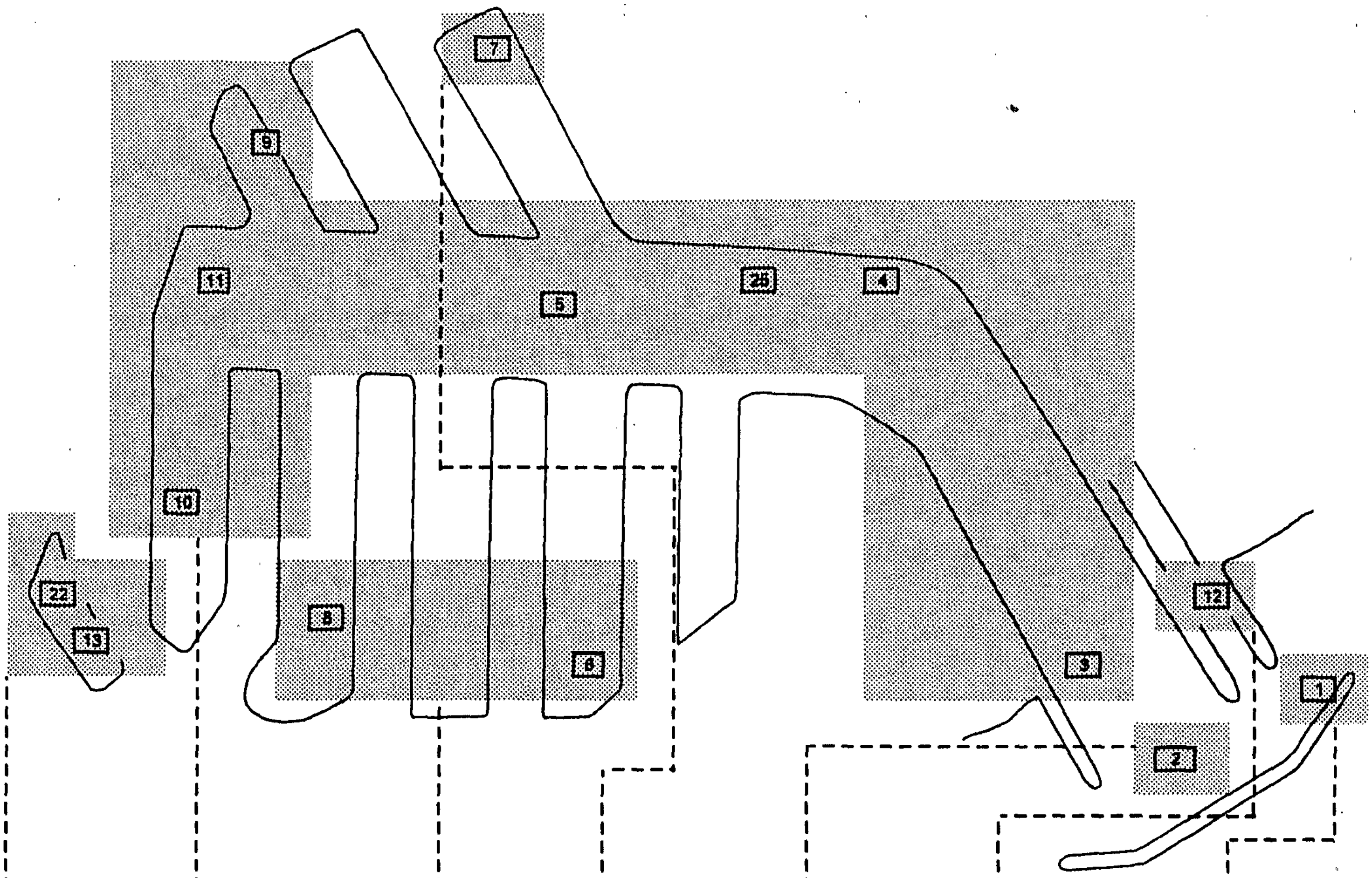
Stations 3, 4, 5, 9, 10, 11, and 25. This cluster includes most channel stations and Basins E and F at the farthest reaches of the Harbor. This grouping rated high in every metal except lead, and every simple organic compound except organic nitrogen and IOD. Sediments here were either low or moderate for all pesticides and other chlorinated hydrocarbons. Although drainages from Oxford Lagoon and Ballona Creek may contribute to the organic and metal load of this grouping's stations, it is likely that the main source of these pollutants are from the thousands of Harbor boats themselves. It is known (for example, Gray 1981) that finer particles tend to adsorb metals and organics more easily than courser particles. Sediments of this group were the finest (medium silt to clay) in the Harbor, so they are apt to concentrate pollutants more than other more coarsely distributed sediments.

Stations 6 and 8. This cluster includes Basin B and D. Sediments here are characterized by high levels of copper and mercury, and low levels of several other metals (cadmium, lead, manganese, and nickel), chlorinated hydrocarbons (all pesticides and PCB's), and some organics (oil and grease, volatile solids, and COD). This group, along with Stations 1 and 7, contain the least contaminated sediments in the Harbor.

Station 7. This station is in Basin H and, similar to Stations 1, 6, and 8, these sediments are relatively uncontaminated. Only copper and mercury were high relative to the other Harbor stations, and nearly all other contaminants were low.

Station 2. This station, near the Harbor entrance, contains sediments which are high in all chlorinated hydrocarbons (all pesticides and PCB's) and some simple organic compounds (IOD, oil and grease, organic nitrogen, and sulfides) and low in most metals and phosphorus. The source of these contaminants is likely Ballona Creek (particularly the chlorinated hydrocarbons).

FIGURE 5-25. CHEMICAL SEDIMENT CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Stations 13,22

High In:
- Cadmium
- Lead
- Zinc
- DDT's
- Pesticides
- PCB's
- TOC
- COD
- Oil & Grease
- Nitrogen
- Sulfides

Low In:
- Chromium
- Iron
- Manganese
- Mercury
- Silver
- Tributyl Tin

Charateristics:
A probable source of organics, PCB's, pesticides, and a few metals.

Stations 3,4,5,9,10,11,25

High In:
- Arsenic
- Cadmium
- Chromium
- Copper
- Iron
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Tributyl Tin
- Zinc
- TOC
- Volatile Solids
- Im. Ox. Dmd
- COD
- Phosphorus

Low In:
- PCB's

Charateristics:
A sink for organics and most metals, but not pesticides and PCB's.

Stations 6,8

High In:
- Copper
- Mercury

Low In:
- Cadmium
- Lead
- Manganese
- Nickel
- DDT's
- Pesticides
- PCB's
- TOC
- Volatile Solids
- COD
- Oil & Grease

Charateristics:
Sediments relatively uncontaminated except for two metals. Low in pesticides, PCB's, and organics.

Station 7

High In:
- Manganese

Low In:
- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Selenium
- Silver
- Zinc
- Pesticides
- PCB's
- TOC
- Volatile Solids
- Immed. Ox. Dmd.
- COD
- Oil & Grease
- Nitrogen
- Sulfides

Charateristics:
Sediments relatively uncontaminated except for one metal. Little pesticides, PCB's, or organics.

Station 2

High In:
- DDT's
- Pesticides
- PCB's
- Immed. Ox. Dmd.
- Oil & Grease
- Nitrogen
- Sulfides

Low In:
- Arsenic
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Selenium
- Tributyl Tin
- Zinc
- Phosphorus

Charateristics:
Probably receives pesticides, PCB's, oil and grease from Ballona Creek. Low in many metals.

Station 12

High In:
- Lead
- Nickel
- Pesticides
- PCB's
- Oil & Grease

Low In:
- Arsenic
- Chromium
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Tributyl Tin
- Zinc
- TOC
- Volatile Solids
- Immed. Oxy. Dmd.
- COD
- Nitrogen
- Phosphorus
- Sulfides

Charateristics:
A probable source of of pesticides, PCB's, oil and grease, and a few metals.

Station 1

High In:
- PCB's

Low In:
- Arsenic
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Tributyl Tin
- Zinc
- DDT's
- TOC
- Volatile Solids
- Immed. Ox. Dmd.
- COD
- Phosphorus

Charateristics:
Sediments relatively uncontaminted. May receive PCB's from Ballona Creek.

Station 1. This station is just inside of the breakwall. The sediments here are low in nearly all contaminants except PCB's, which are likely deposited here from Ballona Creek. Sediments here are relatively course.

Station 12. This station is within Ballona Creek. It is likely that the water from the Ballona Creek drainage system is the source of chlorinated pesticides to Stations 1 and 2, and perhaps oil and grease to Station 2 (sediments at Station 1 may be too coarse to adsorb large amounts of oil and grease). Both here and in Oxford Lagoon, relatively high levels of lead (perhaps from gasoline) and oil and grease (possibly from automobiles) suggest that the source of these contaminants is street drainage.

5.4. DISCUSSION

A number of factors are responsible for the distribution of benthic contaminants in Marina del Rey Harbor sediments. Major sources of contaminants are in Oxford Lagoon, Ballona Creek, and the resident boat population itself. Other sources, which are generally of a nonpoint nature, are also probably important but are more difficult to isolate from the background. Superimposed upon these sources is another factor, the sediment particle size pattern.

The inflows from the Oxford Lagoon and Ballona Creek appear to be primary sources of chlorinated pesticides and a polychlorinated biphenyl (PCB) compound (Arochlor 1254). Although DDT has been banned since the seventies, one characteristic which makes it effective as an insecticide is its persistence over time. It is not surprising, therefore, to find relatively high levels of its breakdown products (DDD and DDE) in municipal drainage areas. It is surprising, however, to find DDT itself in the sediments, which indicates a source that is either fresh or freshly exposed. As stated in the history of the Harbor, surrounding areas were once used as dump sites for toxic materials, so the sources of DDT could be anywhere.

Highest values of pesticides and PCB's tended to be in Oxford Lagoon, Ballona Creek, and at Stations 1 and 2 near the Harbor entrance. The latter two are ostensibly influenced by the flow from Ballona Creek drainage. During this year, we recorded important declines in nearly all chlorinated hydrocarbons over the past ten years. Despite this, all Harbor stations exceeded at least one pesticide sediment limit considered by NOAA to be above concentrations where adverse effects may begin to affect resident organisms or could chronically impact sensitive or younger marine organisms. In addition, all stations, except 6 and 8, exceeded the higher limits for one or more pesticides, where effects are frequently or always observed or predicted among most species (Long and Morgan 1990). Average total DDT's and PCB's in Marina del Rey Harbor sediments (18.5 and 17.0 ppb), however, compare favorably with those of Los Angeles Harbor (94.1 and 58.3 ppb) and even those of the 1979 and 1987 SCCWRP Reference Site Surveys (30 and 18.9 ppb for DDT's and 10 and 19.2 ppb for PCB's).

Sources of metals are less distinct. Ballona Creek sediments were high in only 2 out of 13 metals, and Oxford Lagoon sediments were high in only 3 out of the 13 metals. However, the group of stations representing most of the channel and the uppermost areas of the Harbor were high in all metals except lead (12 out of 13). It is likely then that those heavy metals which were elevated in much of the Harbor and not high in Oxford Lagoon or Ballona Creek (arsenic, chromium, copper, iron, manganese, mercury, selenium, silver, and tributyl tin) have come from other sources, and those sources are most likely the thousands of boats themselves which inhabit the Marina. In addition to the metal components of boats and their engines which are constantly being corroded by seawater, nearly all bottom paints contain heavy metals, such as copper, and tributyl tin. These paints are designed to constantly ablate, so that a fresh surface of toxicant is exposed to fouling organisms at all times. Thus, short of an out-and-out ban on these compounds, sediments in the Harbor are likely to continue to accumulate heavy metals in toxic amounts.

All stations exceeded at least one metal limit of "potential" toxicity, and most stations exceeded at least one metal limit of "probable" toxicity to marine organisms, among those heavy metals that are listed as toxic by NOAA. Areas which exceeded most metal limits were Basin E, Basin F, and most channel stations.

Averages of heavy metals in Marina del Rey sediments fell within the range of values measured in Los Angeles Harbor sediments, with the exception of copper, lead, mercury, silver, and zinc. The Marina del Rey averages for these metals were between two to six times higher than those in Los Angeles Harbor. Marina del Rey Harbor, however, has only one entrance, while Los Angeles Harbor is open at two ends and thus undoubtedly receives considerably better flushing. Not surprisingly, all metals were higher than those collected along the open coast. Despite a fair degree of variability over the past ten years, most heavy metal concentrations appear to have neither consistently increased nor greatly decreased over time.

Although not listed with NOAA as a toxic compound, recent research has indicated that tributyl tin is capable of causing deformities and partial sex reversal in mollusks, as well as acute toxicity in crustaceans, at part per *trillion* levels (Kusk and Peterson 1997). Although Harbor sediment concentrations of tributyl tin are well above part per trillion levels at all stations, it is encouraging to note that concentrations of this compound have declined considerably this year over past measurements. The recent ban on using tributyl tin as a bottom paint is the likely cause.

Although, nonspecific organic materials (nutrients, oil and grease, carbonaceous organics, etc.) do not often cause direct toxicity, their accumulation in the sediment can cause anoxic conditions near the Harbor bottom which can lead to a degeneration of the habitat for sensitive fish and invertebrates. Like heavy metals, sources of nonspecific organic pollutants may be varied. Both Oxford Lagoon and Ballona Creek apparently contribute a considerable amount of oil and grease into the Harbor since levels of most compounds are higher in these areas.

Within the Harbor, the patterns of organic compounds tend to follow those of heavy metals, i.e. organics were elevated throughout most of the channel and the uppermost areas of the Harbor (Basin E and F) and were low at the remaining Basins (B and H) and immediately inside the breakwall (Station 1). Although impossible to distinguish from municipal discharges, nonpoint runoff and various seepages from boats undoubtedly contribute considerable amount of organics to the benthos. Among compounds measured (TOC, volatile solids, COD, and organic nitrogen), all were comparable to the 1979 SCCWRP Reference Site Survey. There are no NOAA limits for any nonspecific organic compounds.

As mentioned above, sediments with particle sizes dominated by finer components tend to attract chemical contaminants more readily. It is not surprising then, that the Harbor sediments with the highest heavy metals and organics were also composed of silt and clay. Conversely, sediments containing mostly sand and course silt tended to be lower in organics and heavy metals. Interestingly, chlorinated hydrocarbons do not show any relation to finer particle sizes, although, as mentioned above, they are strongly related to the discharges from Ballona Creek and Oxford Lagoon.

6. BIOLOGICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

6.1. BACKGROUND

The benthic community is composed of those species living in or on the bottom (benthos); the community is very important to the quality of the habitat because it provides food for the entire food web including juvenile and adult pelagic bottom feeders. Usually the benthic fauna in shallow, silty, sometimes unconsolidated, habitats is dominated by polychaete annelid worms, molluscans and crustaceans. In areas where sediments are contaminated or frequently disturbed by natural events such as storms or by manmade events, the fauna may be dominated temporarily by nematode round worms or oligochaete worms. Storms or dredging can cause faunas to be washed away or buried under transported sediment, or can cause changes in the preferred grain size for particular species. Excessive runoff may lower normal salinities, and thermal regime changes offshore may disturb the species composition of the community (Soule et al. 1996).

Some species of benthic organisms with rapid reproductive cycles or great fecundity can out-compete other organisms in recolonization, at least temporarily after disturbances, but competitive succession may eventually result in replacement of the original colonizers with more dominant species. In general, nematodes are more tolerant of lowered salinities and disturbances. Species with planktonic eggs or larvae may recolonize due to introduction on tidal flow from adjacent areas, while less mobile species may return more slowly, or not at all (Soule et al. 1996).

6.2. MATERIALS AND METHODS

Field sampling for all benthic sediment components are described above in Section 4.2. Sediments to be analyzed for infaunal content were sieved through 1.0 and 0.5 millimeter screens. The retained organisms and larger sediment fragments were then washed into one-liter or four-liter plastic bottles (as needed) and preserved with 10% buffered formalin. Animals were identified by taxonomic experts from Osprey Marine Management in Costa Mesa, California. A complete list of infauna are included in Appendix 9.3.

6.3. RESULTS

6.3.1. Benthic Infauna

6.3.1.1. **Infaunal Abundance**

The simplest measure of resident animal health is the number of individual infauna collected per sampling effort. For this survey, numbers of individuals were determined to be all of the non-colonial animals collected from one Van Veen Grab (0.1 square meter) per station and retained on either a 0.5 mm or 1.0 mm screen.

As has been stated by other authors (i.e. SCCWRP 1979), abundance is not a particularly good indicator of benthic infaunal health. For example, some of the most populous benthic areas along the California coast are those within the immediate vicinity of major wastewater outfalls. The reason for this apparent anomaly is that environmental stress can exclude many sensitive species from an area. Those few organisms which can tolerate the stressful condition (such as a pollutant) flourish because they have few competitors. If the area becomes too stressful, however, even the tolerant species cannot survive, and the numbers of individuals decline, as well.

Spatial infaunal abundance patterns. Numbers of individuals at the 13 sediment sampling stations are listed in Table 6-1 and summarized in Figure 6-1. Lowest total abundance was at Station 10 in Basin E (216 individuals) and Station 11 at the upper end of the channel (406). Remaining stations ranged from 678 to 2663 individuals. Relatively higher abundances were in the lower channel (Stations 3, 4, and 25 - 1530 to 2663 individuals). Highest values by far were at Station 2 near the channel entrance (12,640 individuals per grab) and at Station 12 in Ballona Creek (7,358). The great majority of these were nematodes, however, which are typically found in areas of environmental disturbance or freshwater influence (Soule et al. 1996). 10,377 of 12,640 animals collected at Station 2, 10,377 were nematodes (82%), and 5,400 of 7,358 individuals (73%) at Station 12 were nematodes. Nematodes were virtually absent from all remaining stations (0 to 19 individuals per station).

Infaunal abundance patterns compared with past years. Table 6-2 lists the ranges of individuals collected per station since 1976. The range of individuals collected during 1996 was 216 to 12,640, which falls well within the overall range of values for past surveys. Values this survey were higher than those of last year but lower than the year before. Abundances have varied widely over the years.

Infaunal abundance values compared with other surveys. The Marina del Rey abundance average and range (2417 individuals, 216 to 12,640 individuals) were much higher than Los Angeles Harbor (105 individuals, 5 to 330 individuals), the 1979 SCCWRP Reference Site Survey (422 species, 91 to 1213 individuals), and the 1987 (348 individuals) Survey (Table 6-3).

TABLE 6-1. INDIVIDUALS, SPECIES DIVERSITY, DOMINANCE AND INFAUNAL INDEX VALUES AT 13 BENTHIC SEDIMENT STATIONS.

	STATIONS												
INDEX	1	2	3	4	5	6	7	8	9	10	11	12	25
No. Individuals[1]	328	12640	2436	2663	678	729	770	941	702	216	406	7385	1530
No. Species	63	54	76	78	40	36	41	40	35	28	34	63	64
Diversity (SWI)	3.03	0.92	2.20	2.38	2.70	2.07	2.17	2.69	2.26	2.34	2.48	1.17	2.90
Dominance	0.61	0.12	0.34	0.48	0.64	0.36	0.42	0.71	0.54	0.53	0.65	0.13	0.65
Infaunal Index	40.9	26.5	59.4	68.6	69.9	60.5	69.6	68.2	63.5	51.1	70.6	62.6	68.9

1. To determine individuals per square meter, multiply by ten.

TABLE 6-2. RANGES OF INDIVIDUALS, SPECIES, AND DIVERSITY - OCTOBER 1976 THROUGH OCTOBER 1996

	POPULATION INDEX		
DATE	INDIVIDUALS	SPECIES	DIVERSITY (SWI)
Oct-76	434 - 1718	21 - 78	—
Sep-77	254 - 7506	9 - 67	—
Sep-78	177 - 1555	15 - 66	—
Oct-84	242 - 1270	19 - 60	1.81 - 3.09
Oct-85	196 - 1528	20 - 51	1.06 - 2.78
Oct-86[1]	275 - 22,552	18 - 79	1.49 - 2.48
Oct-87	189 - 4216	12 - 50	1.19 - 2.76
Oct-88	63 - 5651	11 - 74	0.76 - 2.95
Oct-89[2]	36 - 7610	10 - 72	0.58 - 2.99
Oct-90	153 - 9741	18 - 69	0.82 - 2.33
Oct-91	85 - 31,006	14 - 121	0.44 - 2.34
Oct-92	100 - 2080	10 - 55	1.51 - 2.34
Oct-94	120 - 105,390	15 - 70	0.48 - 2.83
Oct-95	65 - 7084	11 - 66	1.17 - 2.91
Overall Range	**36 - 105,390**	**9 - 121**	**0.44 - 3.09**
Oct-96	216 - 12,640	28 - 78	0.92 - 3.03

1. No sample at Station 2 due to dredging.
2. Stations 12 and 25 added this year.

TABLE 6-3. AVERAGES AND RANGES OF INFAUNAL VARIABLES FROM 13 BENTHIC SEDIMENT STATIONS COMPARED TO SCCWRP REFERENCE AND LOS ANGELES HARBOR SEDIMENT SURVEYS.

	MARINA DEL REY		L.A. HARBOR		SCCWRP (1979)		SCCWRP (1987)
INDEX	AVG.	INDEX RANGE	AVG.	INDEX RANGE	AVG.	INDEX RANGE	AVERAGE
No. Individuals	**2417**	**216 - 12,640**	105	5 - 330	422	91 - 1213	348
No. Species	**50**	**28 - 78**	35	5 - 64	72	32 - 135	68
Diversity (SWI)	**2.25**	**0.92 - 3.03**	2.92	1.59 - 3.72	3.12	2.19 - 3.98	-
Infaunal Index	**60.0**	**26.5 - 70.6**	73.6	66.7 - 83.3	87.9	59.9 - 98.3	-

6.3.1.2. **Infaunal Species**

Another simple measure of population health is the number of separate infaunal species collected per sampling effort (i.e. one Van Veen Grab per station). Because of its simplicity, numbers of species is often underrated as an index. However, if the sampling effort and area sampled are the same for each station, this index can be one of the most informative. In general, stations with higher numbers of species per grab tend to be in areas of healthier communities.

Spatial infaunal species patterns. Species counts at the 13 sediment sampling stations are listed in Table 6-1 and summarized in Figure 6-2. Highest values were in the channel (Stations 3, 4, and 25 - 76, 78, and 64 species per grab, respectively), although Stations near the Harbor entrance (1 and 2 - 63 and 54 species) and in Ballona Creek (Station 12 - 63 species) were relatively high as well. Lowest species numbers were in Basin E (Station 10 - 28 species) and at the upper end of the channel (Station 11 - 34 species). Remaining stations were between these values (36 to 41 species per grab).

Infaunal species patterns compared with past years. Table 6-2 lists the ranges of species collected per station since 1976. The range of species collected during 1996 was 28 to 78, which falls well within the overall range of values for past surveys. The lower end value, however, is the highest recorded over the past ten years.

Infaunal species values compared with other surveys. The Marina del Rey species count average and range (50 species, 28 to 78 species) were comparable to Los Angeles Harbor (35 species, 5 to 64 species), the 1979 SCCWRP Reference Site Survey (72 species, 32 to 135 species), and the 1987 (68 species) Survey (Table 6-3).

6.3.1.3. **Infaunal Diversity**

The Shannon species diversity index (Shannon and Weaver 1963), another measurement of community health, is similar to species counts, however it contains an eveness component as well. For example, two samples may have the same numbers of species and the same numbers of individuals. However, one station may have most of its numbers concentrated into only a few species, while a second station may have its numbers evenly distributed among its species. The Shannon diversity index would be higher for the latter station.

Spatial infaunal diversity patterns. Diversity index values at the 13 sediment sampling stations are listed in Table 6-1 and summarized in Figure 6-3. The highest value was at Station 1, just inside the breakwall (3.03). Lowest stations were at the Harbor entrance (Station 2 - 0.92) and in Ballona Creek (Station 12 - 1.17). The low values at these two stations are probably due to the huge numbers of nematodes collected which tends to skew the index negatively. Remaining stations were moderate in diversity (2.07 to 2.89).

FIGURE 6-1. NUMBER OF INFAUNAL INDIVIDUALS COLLECTED AT 13 BENTHIC SEDIMENT STATIONS.

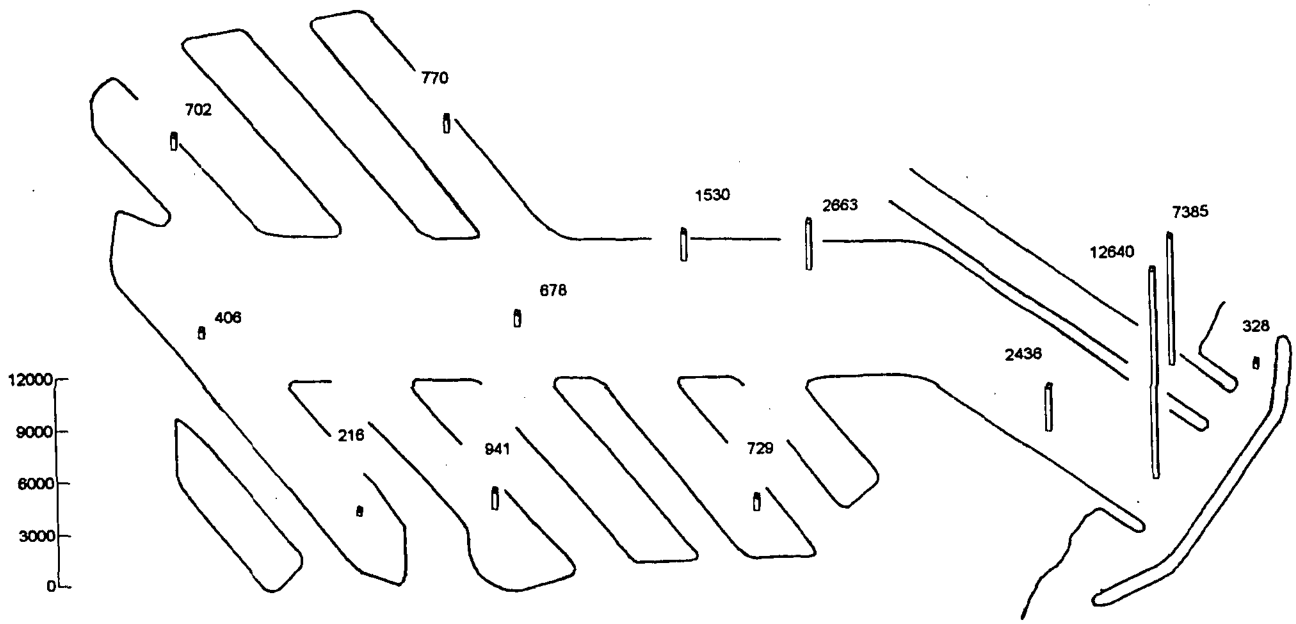
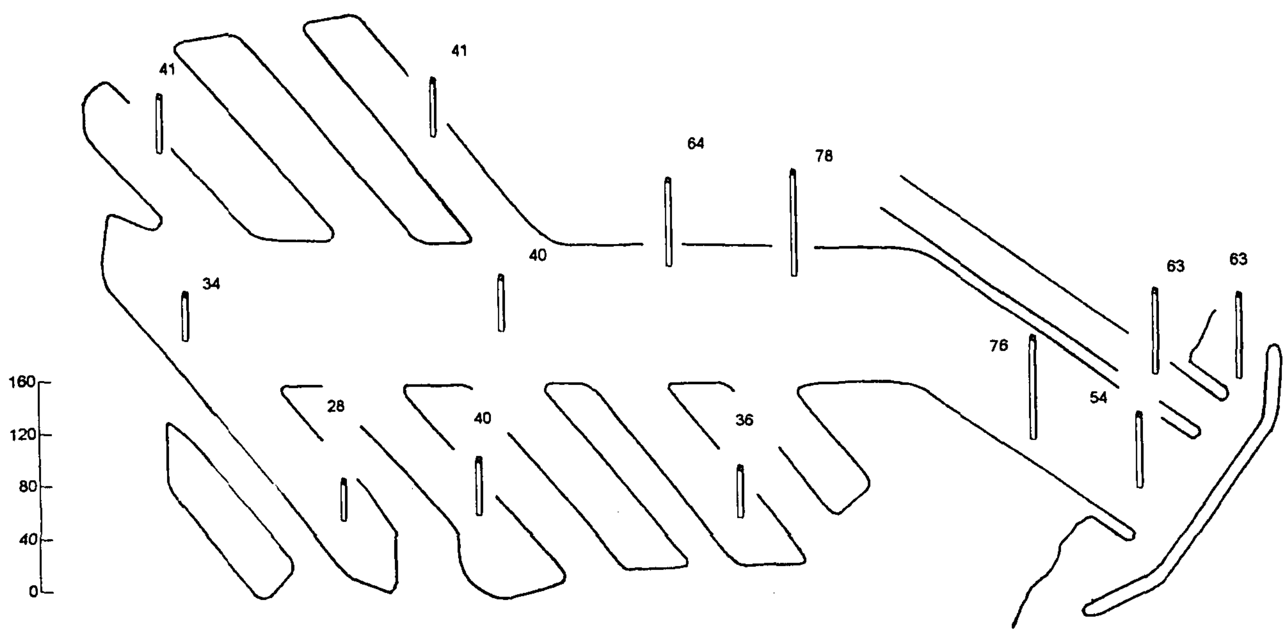


FIGURE 6-2. NUMBER OF INFAUNAL SPECIES COLLECTED AT 13 BENTHIC SEDIMENT STATIONS.



Infaunal diversity patterns compared with past years. Table 6-2 lists the ranges of diversity values calculated per station since 1984. The range of values during 1996 was 0.92 to 3.03, which falls well within the overall range of values for past surveys. Values were about the same as last year but higher than the year before.

Infaunal diversity values compared with other surveys. The Marina del Rey diversity average and range (2.25, 0.92 to 3.03) were lower than Los Angeles Harbor (2.92, 1.59 to 3.72) and the 1979 SCCWRP Reference Site Survey (3.12, 2.19 to 3.98). No diversity values were calculated in the 1987 SCCWRP Survey (Table 6-3).

6.3.1.4. **Infaunal Dominance**

The community dominance index measures to what degree the two most abundant species in each sample dominate (McNaughton 1968). The authors have modified the index so that when the top two species strongly dominate the sample population, the index is lower, and when they are less dominant the index is higher. The infaunal environment tends to be healthier when the modified dominance index is high and it tends to correlate well with species diversity.

Spatial infaunal dominance patterns. Dominance values at the 13 sediment sampling stations are listed in Table 6-1 and summarized in Figure 6-4. Highest values were in Basin D (Station 8 - 0.71), in the upper channel (Stations 5, 11, and 25 - 0.64, 0.65, and 0.65, respectively) and just inside of the breakwall (0.61). Lowest stations were near the Harbor entrance (Station 2 - 0.12) and in Ballona Creek (Station 12 - 0.13). The low dominance values at Stations 2 and 12 are likely due to the highly abundant nematode population. Remaining stations ranged from 0.34 to 0.54.

Infaunal dominance patterns compared with past years. No dominance index values were calculated during past surveys.

Infaunal dominance values compared with previous surveys. Dominance was not analyzed in, or were not comparable to, studies in Los Angeles Harbor or SCCWRP Reference Site Surveys.

6.3.1.5. **Infaunal Trophic Index**

The infaunal trophic index (SCCWRP 1978, 1980) was developed to measure the feeding modes of benthic infauna. Higher values denote southern California species assemblages dominated by suspension feeders, which are more characteristic of unpolluted environments. Lower index values denote assemblages dominated by deposit feeders more characteristic of sediments high in organic pollutants (such as near major ocean outfalls). SCCWRP also provided some definitions for the ranges of infaunal index values. Values that are 60 or above indicate "normal" bottom conditions. Values between 30 and 60 indicate "change", and values below 30 indicate "degradation".

FIGURE 6-3. INFAUNAL DIVERSITY INDEX (SWI) AT 13 BENTHIC SEDIMENT STATIONS.

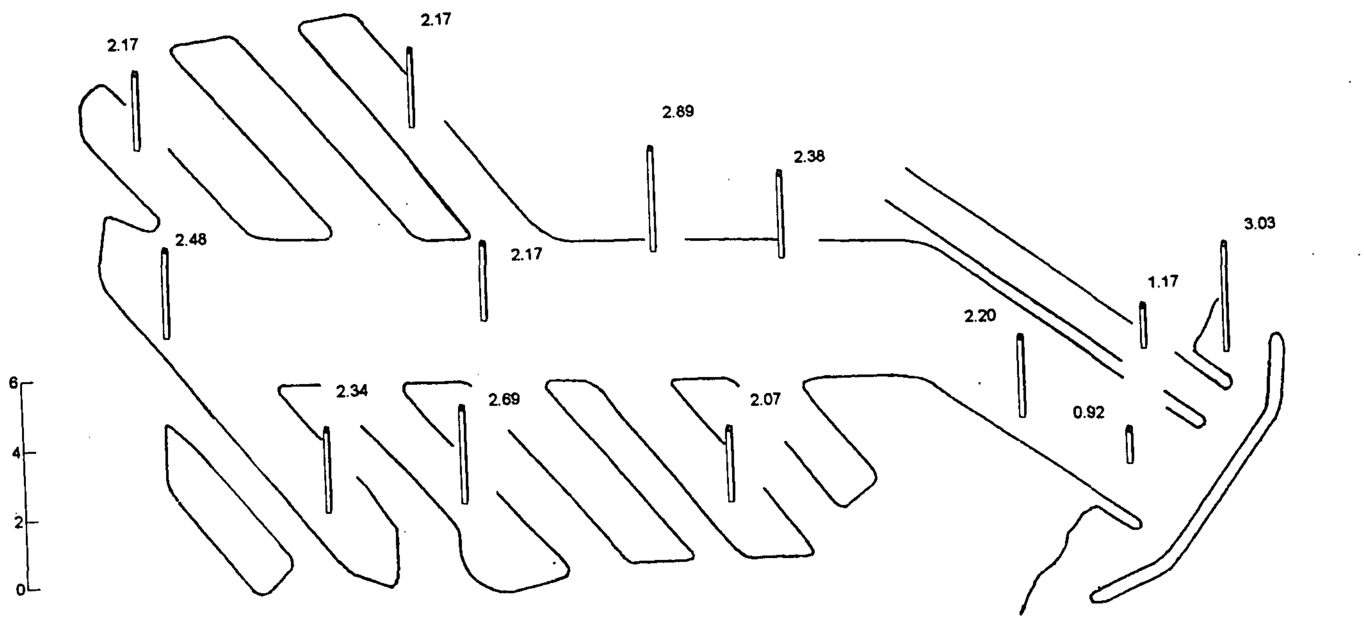
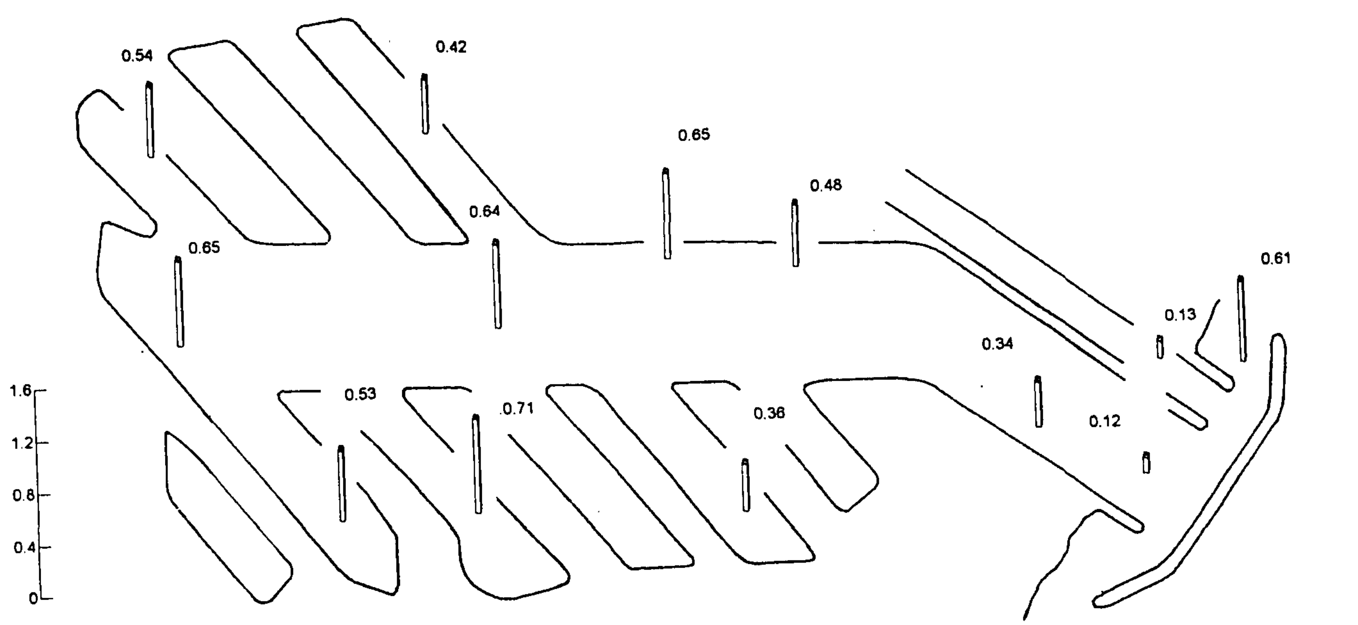


FIGURE 6-4. INFAUNAL DOMINANCE INDEX AT 13 BENTHIC SEDIMENT STATIONS.



The infaunal trophic index is based on the 60-meter depth profile of open ocean coastline in southern California. Therefore, its results when applied to harbor stations should be interpreted with some caution.

Spatial infaunal trophic index patterns. Infaunal trophic index values at the 13 sediment sampling stations are listed in Table 6-1 and summarized in Figure 6-5. The highest values were within several of the basins (Stations 7, 8, and 9 - 68 to 70), and in the upper and middle channel (Stations 4, 5, 11, and 25 - 69 to 71), and in Ballona Creek (Station 12 - 63). Since these infaunal values were all above 60, their bottom conditions can be defined as "normal". Stations defined as "changed" were Station 10 in Basin E (51), Station 6 in Basin B (60), Station 3 in the lower channel (59), and Station 1 just inside the breakwall (41). The only station defined as degraded was Station 2 near the Harbor entrance with an infaunal trophic index value of 26.

Infaunal trophic index patterns compared with past years. No infaunal trophic index values were calculated during past surveys.

Infaunal trophic index values compared with other surveys. The Marina del Rey infaunal index average and range (60.0, 26.5 to 70.6) were lower than Los Angeles Harbor (73.6, 66.7 to 83.3) and the 1979 SCCWRP Reference Site Survey (87.9, 59.9 to 98.3). No infaunal index values were calculated for the 1987 SCCWRP Survey (Table 6-3).

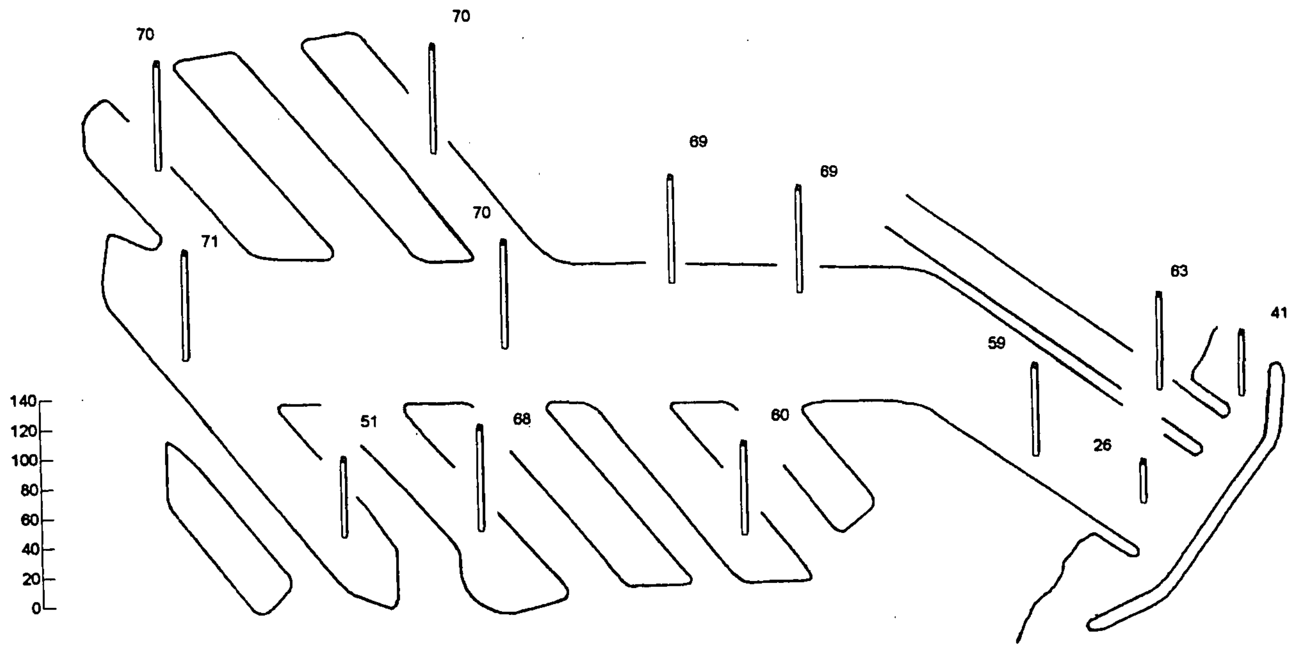
6.3.2. Station Groupings Based on Infaunal Measurements

Stations were clustered by their similarities to the infaunal characteristics listed in Table 6-1. The method used is described above for water quality (Section 3.3.3). Station groupings were resolved based upon their similarity or dissimilarity to infaunal population variables (Figure 6-6). Included in the figure are listings of the ten most abundant infaunal organisms in the group. These are listed in order of relative frequency.

Stations 10. This station is the only infaunal station sampled from Basin E. It is characterized by relatively low abundance and low infaunal index values. Among the ten most abundant species, eight were polychaete worms, one was a mysid shrimp (crustacean), and one was an oligochaete worm. The oligochaete and one of the polychaete worm species (*Dorvillea longicornis*) are subsurface deposit feeders, and another polychaete (*Nereis latescens*) is a surface deposit feeder, both of which are indicative of organic contamination. High numbers of these species are probably responsible for the moderately low infauna index value at this station (51 - a "changed" benthic environment).

Stations 5, 8, 11, and 25. This cluster includes the upper channel and Basin D. This group is moderate in all infaunal variables of environmental health. Of the ten most abundant species, there were eight polychaetes and two crustaceans. None of the species were indicative of stressed environments, therefore infaunal index values at all stations (68 to 71) were defined as "normal".

FIGURE 6-5. INFAUNAL TROPHIC INDEX AT 13 BENTHIC SEDIMENT STATIONS.



Stations 6, 7, and 9. These stations represent Basins B, F, and H. They are characterized by relatively low diversity but are moderate for all other infaunal indices. Like the previous two groups, eight out of the ten most abundant species were represented by polychaetes. The remaining two were crustaceans (a caprellid and an amphipod). Only one subsurface deposit feeder (*Dorvillea longicornis* - a polychaete) was among the most frequent ten species. Infaunal trophic index values at these stations ranged from 60 to 64, which is at the lower end of a "normal" benthic environment.

Stations 3 and 4. This cluster includes two stations in the lower channel. It is characterized by high numbers of species and individuals, and moderate values for all other indices. Again, eight of the ten most abundant species were polychaetes. The remaining two were a caprellid (crustacean) and a small clam (bivalve). One subsurface deposit feeder (*Armandia brevis* - a polychaete) was present among most abundant species, and infaunal trophic index values ranged from 59 to 69 ("changed" to "normal").

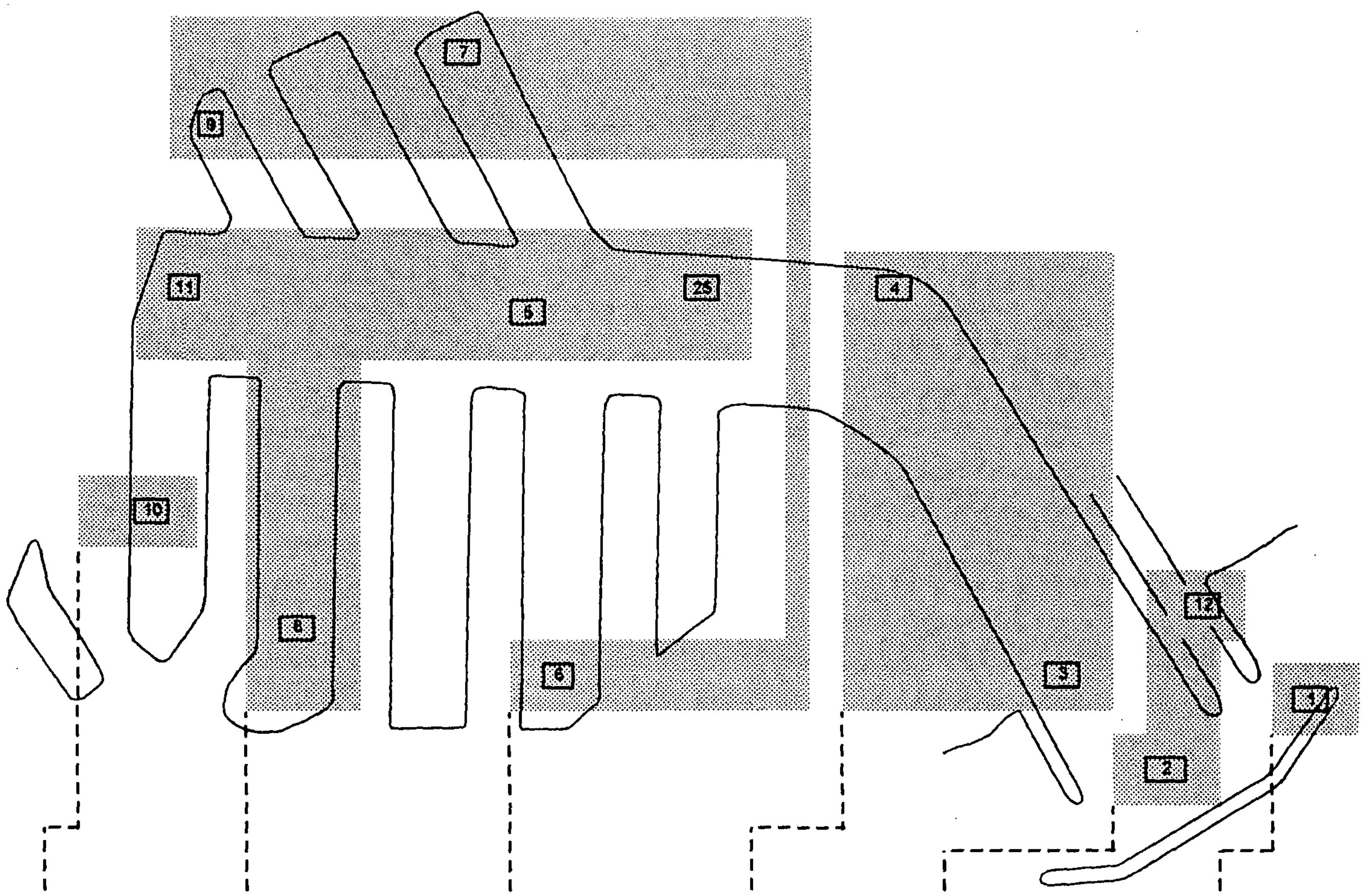
Stations 2 and 12. These stations include Ballona Creek and the entrance to the Harbor. These stations are characterized by high abundance but low diversity, dominance, and infaunal index values. Six of the ten most abundant species were polychaetes, two were crustaceans (a caprellid and a cumacean), one was a small clam (bivalve), and one was the group identified nematode worms. Both the nematode worms and a subsurface deposit feeder polychaete (*Armandia brevis*) are indicative of high levels of sediment organics. The infaunal trophic index values at Station 12 was 63 (near the low end of "normal") and 27 at Station 2 near the Harbor entrance ("degraded").

Station 1. This station is just inside of the breakwall. It is characterized by high diversity but low numbers of individuals and infaunal trophic index. Similar to the above cluster, six of the ten most abundant species were polychaetes, two were crustaceans (a cumacean and an amphipod), one was a small clam (bivalve), and one was a group of unidentified nematode worms. Again, the nematode worms and a subsurface bottom feeding polychaete (*Armandia brevis*) were indicative of high levels of organics. Only the Station 2 infaunal trophic index value was lower than Station 1 (41 - at the low end of a "changed" benthic environment).

6.4. DISCUSSION

Like water quality values and measures of benthic contaminants, the infaunal community appears to be impacted by the discharges from Ballona Creek and Oxford Lagoon. Most of the Harbor stations had moderate to high infaunal values. However, Station 10 in Basin E; which is likely influence by Oxford Lagoon drainages; and Stations 1, 2, and 12, which are likely influenced by Ballona Creek, showed evidence of ecological disturbance or stress. All four of these stations tended to have comparatively high proportions of organisms which are common to habitats near wastewater outfall diffusers, or are otherwise known to be present in disturbed habitats. Of particular note are Stations 2 and 12 which are dominated by huge numbers of nematode worms. Nematodes greatly overwhelm population numbers at these station (82% and 73%, respectively).

FIGURE 6-6. BIOLOGICAL SEDIMENT CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Station 10	Stations 5,8,11,25	Stations 6,7,9	Station 3,4	Station 2,12	Station 1
High in:	**High in:**	**High in:**	**High in:**	**High in:**	**High in:**
– –	– –	– –	Individuals Species	Individuals	Diversity
Low in:	**Low in:**	**Low in:**	**Low in:**	**Low in:**	**Low in:**
Individuals Species Infaunal index	– –	Diversity	– –	Diversity Dominance Infaunal index	Individuals Infauna index
Dominant species:	**Dominant species:**	**Dominant species:**	**Dominant species:**	**Dominant species:**	**Dominant species:**
Streblospio benedicti (p) *Mediomastus spp.* (p) Oligochaeta, unid. (o)* *Exogone lourei* (p) *Dorvillea longicornis* (p)* *Prionospio lighti* (p) *Polydora sp.* (p) *Deltamysis sp. A* (c) *Lumbrineris sp. C* (p) *Nereis latescens* (p)	*Mediomastus spp.* (p) *Exogone lourei* (p) *Leitoscoloplos pugettensis* (p) *Mayerella banksia* (c) *Pseudopolydora paucibranchiata* (p) *Euchone limnicola* (p) *Aphelochaeta multifilis* (p) *Lumbrineris sp. C* (p) *Grandidierella japonica* (c) *Scoloplos acmeceps* (p)	*Exogone lourei* (p) *Aphelochaeta multifilis* (p) *Leitoscoloplos pugettensis* (p) *Mediomastus spp.* (p) *Mayerella banksia* (c) *Euchone limnicola* (p) *Dorvillea longicornis* (p)* *Lumbrineris sp. C* (p) *Grandidierella japonica* (c) *Pseudopolydora paucibranchiata* (p)	*Mediomastus spp.* (p) *Exogone lourei* (p) *Mayerella banksia* (c) *Leitoscoloplos pugettensis* (p) *Euchone limnicola* (p) *Prionospio heterobranchia* (p) *Mediomastus californiensis* (p) *Armandia brevis* (p)* *Amphideutopus oculatus* (p) *Tagelus subteres* (b)	Nematoda, unid. (n)* *Mediomastus spp.* (p) *Pseudopolydora paucibranchiata* (p) *Tagelus subteres* (b) *Armandia brevis* (p)* *Oxyurostylis pacifica* (c) *Polyophthalmus pictus* (p) *Mayerella banksia* (c) *Exogone lourei* (p) *Prionospio heterobranchia* (p)	*Armandia brevis* (p)* *Apoprionospio pygmaea* (p) *Goniada littorea* (p) Nematoda, unid. (n)* *Mediomastus spp.* (p) *Gibberosus myersi* (c) *Tellina modesta* (b) *Pectinaria californiensis* (p) *Oxyurostylis pacifica* (c) *Pseudopolydora paucibranchiata* (p)
Characteristics:	**Characteristics:**	**Characteristics:**	**Characteristics:**	**Characteristics:**	**Characteristics:**
Dominated by infauna indicative of distubance.	Moderate in all infaunal indices.	Low diversity may indicate stress to sensitive species.	Relatively healthy group.	Dominated by thousands of nematodes. Suggests considerable stress.	High diversity but dominated by infauna indicative of disturbance.

* Infaunal species known to be associated with disturbed benthic environments.
(p) = polychaete worm, (o) = oligochaete worm, (n) = nematode worm, (c) = crustacean, (b) = bivalve

Lower population values within the Harbor tended to be mostly related to higher chlorinated hydrocarbon concentrations (i.e. pesticides and PCB's) and, to some degree nonspecific organics. Surprisingly, populations within the middle of the Harbor, where metals are high, appear much healthier than those at either end of the Harbor. Also, there does not appear to be a strong relation with median particle size distribution. Station 10 in Basin E and the stations near the Harbor entrance were very dissimilar to each other with regard to particle size, yet they yielded very similar benthic infauna index patterns. Overall, population variables tended to be comparable to past survey years, and numbers of species were actually a bit higher.

When compared to measurements made during reference site surveys performed by the Southern California Coastal Water Research Project (SCCWRP), all Marina del Rey variables were lower (except for numbers of individuals which were much higher due to the huge nematode counts). This is not unexpected since Marina del Rey is an enclosed harbor and the SCCWRP control sites were at uncontaminated sites along the open coast. When compared to Los Angeles Harbor, both numbers of individuals and species were higher in Marina del Rey, however, diversity and infaunal trophic index values were lower. Higher diversity and infaunal index patterns in Los Angeles Harbor may be related to the fact that flow patterns there are much less restricted since there are two entrances to the Harbor instead of one for Marina del Rey.

We agree with the previous authors that periodic maintenance dredging is necessary to reduce the buildup of toxic contaminants, maintain the health of the resident benthic populations, and to expose rocky habitat for many species of reef fishes, invertebrates, and their young.

7. FISH POPULATIONS

7.1. BACKGROUND

The following introductory section was taken directly from Soule et al. 1996.

Marina del Rey functions as an important small wetlands in a southern California area where about ninety percent of the wetlands have been lost due to development. While the original configuration of the Ballona wetlands was a large natural estuarine system, it was altered radically by the channelization of flow into a creek in the 1920s. Filling and dumping occurred to create farm lands and oil or gas development, altering drainage patterns of small meandering streams and shallow waters. Excavation of the marina in the 1960s and building of the breakwater completed the reconfiguration of the wetlands to the north and west of the creek.

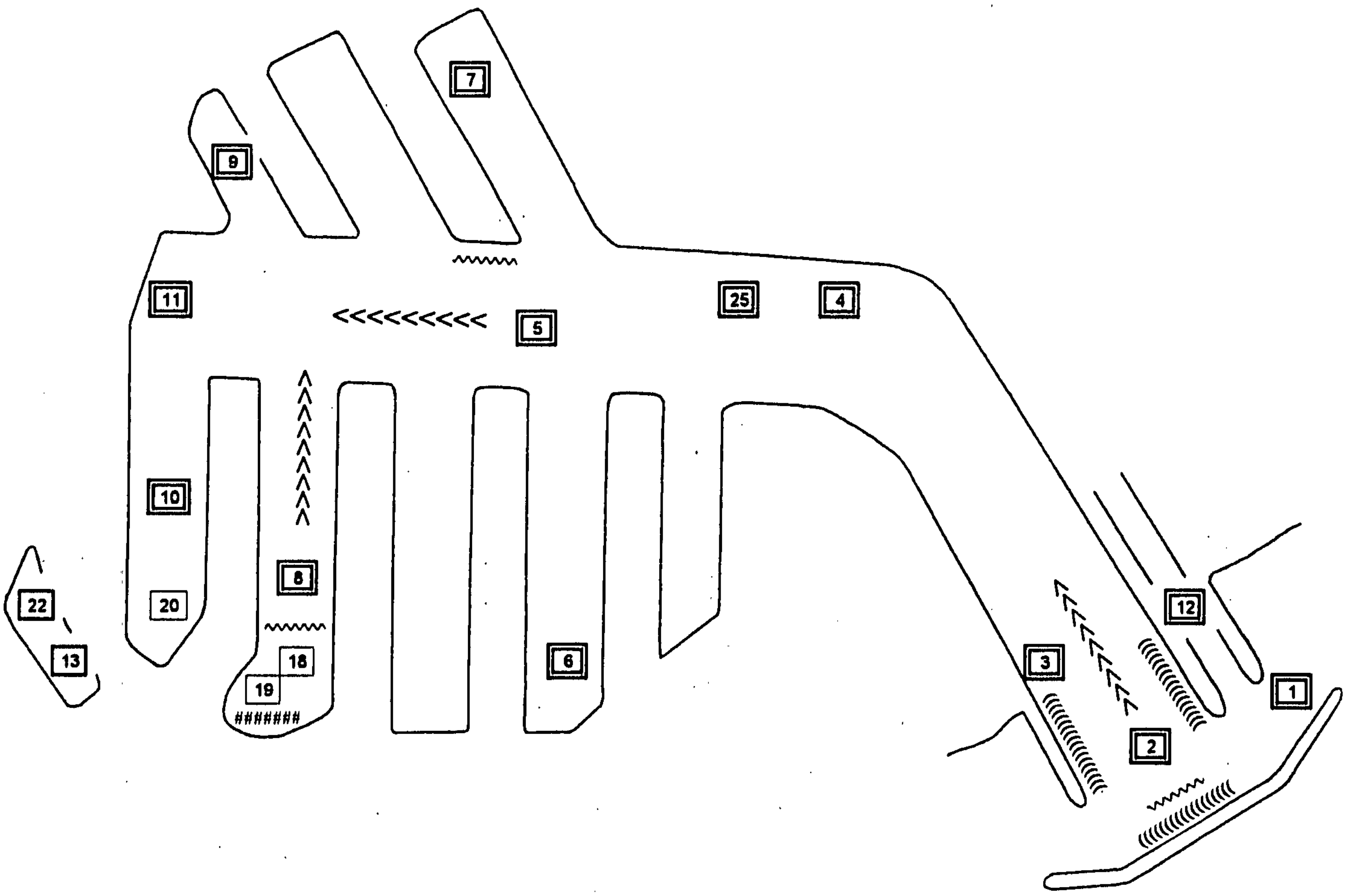
Nevertheless, the marina provides a viable habitat for larval, juvenile and adult inshore fish species. The shallow, warm waters are nutrient laden, and the turbidity due to phytoplankton and sediment offer some protection from predatory fish and birds. Some species that frequent the marina as eggs, larvae or juveniles migrate from the warmer waters seaward as adults, returning to spawn outside or inside the marina. Marina fauna are sometimes disturbed by natural events such as large storms, heavy rains and excessive heat, and by manmade impacts due to dredging, oil films, slicks or spills. Illegal dumping of chemicals, sewage or debris may occur in the marina or in flood control channels that drain or impinge on the marina. Thus the marina may have a slightly lower average number of species as compared to marinas with more open access to the ocean, providing better flushing.

Surveys were first conducted as part of an experimental study of methods by Harbors Environmental Projects in the marina in 1977-1979 with funding assistance from the NOAA-Sea Grant Program. They were continued in 1980-81 on a voluntary basis by Dr. John S. Stephens, Jr., and his staff from the *Vantuna* Group at Occidental College. After a hiatus, surveys were resumed in 1984 by the *Vantuna* Group in cooperation with the USC monitoring program for the Department of Beaches and Harbors.

7.2. MATERIALS AND METHODS

Trawl sampling was conducted in accordance with *Use of Small Otter Trawls in Coastal Biological Surveys*, EPA 600/3-78/083, August 1978 and *Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods*, Tetra Tech 1986. Survey stations and techniques were standardized in 1984 and include: trawls performed using a semiballoon otter trawl towed in duplicate for five minutes at three locations; a 100 ft (32.8 m) multimesh gill net deployed at three locations for 45 minutes each, and a 100 ft (32.8 m) beach seine deployed at 2.5 m depth about 30 m from the beach and fished to shore. Ten-minute diver surveys were performed along the inner side of the breakwater and along the jetties in the entrance channel.

FIGURE 7-1. LOCATION OF MARINA DEL REY HARBOR SAMPLING STATIONS.



Water Quality Stations only

Water Quality and Sediment Chemistry Stations

Water Quality, Sediment Chemistry, and Benthic Infauna Stations

>>>>>>>>>>>>> Bottom Fish by Otter Trawl and Ichthyoplankton by Plankton Net

Midwater Fish by Gill Net

))))))))))))))))))))))))))))))))))))))) Reef Fish by Diver Transect

######################### Inshore Fish by Beach Seine

Eggs and larvae (ichthyoplankton) were collected (Stations 2, 5, 8) using a 333 um mesh plankton net at 1.0 m depth for two minutes and near the bottom for three minutes. A benthic sled kept the net just above the bottom. For all groups of fishes, numbers of animals, numbers of species, and species diversity (see Section 6.3.1.3) were calculated. Figure 7-1 shows the locations of all fish sampling stations, and Appendix 10.4 lists the age groups for all planktonic and reef organisms.

7.3. RESULTS

Based on each sampling methodology, each fish community was compared among stations by measures of population abundance and diversity. These included numbers of individuals, numbers of species, and species diversity. In addition, ranges of these variables were compared to surveys conducted in past years. Unlike infaunal data, fish collection data was not comparable to either SCCWRP or Los Angeles Harbor measurements, so no comparisons to those studies can be made. Indices of biological community health are described above in Section 6.3.1. Table 7-1 lists all of the different fish species collected or observed since 1984 by various dive and net collection techniques (there was no spring 1985 survey). Among the 103 different species, six were present in all of the 26 surveys: topsmelt (*Atherinops affinis*), black surfperch (*Embiotoca jacksoni*), opaleye (*Girella nigricans*), a genus of larval blennies (*Hypsoblennius spp.*), kelp bass (*Paralabrax clathratus*), and barred sand bass (*Paralabrax nebulifer*). Another ten species also occurred frequently (more than 20 times): blacksmith (*Chromis punctipinnis*), northern anchovy (*Engraulis mordax*), a suite of larval gobies (Gobiedae A/C), rock wrasse (*Halochoeres semicinctus*), giant kelpfish (*Heterstichus rostratus*), diamond turbot (*Hypsopsetta guttulata*), garibaldi (*Hypsypops rubicundus*), dwarf surfperch (*Micrometrus minimus*), pile surfperch (*Damalichthys vacca*), and queenfish (*Seriphus politus*). These fish are found in the Harbor during both spring and fall seasons. They are characteristic of a wide range of habitat types and represent a diverse group of fish families.

7.3.1. Bottom Fish

Bottom fish were collected using a standard 5-meter headrope otter trawl. Fish were collected at three locations within the Harbor (Figure 7-1). At each station, replicate trawls of five minutes each were conducted. Data from replicate trawls were combined for analysis.

7.3.1.1. **Bottom Fish Abundance**

Spatial bottom fish abundance patterns. Numbers of bottom fish collected at the three sampling stations are listed in Table 7-2. Largest hauls were at Station 8 in Basin D, both in fall and spring (69 and 53 individuals, respectively). The poorest catch was at Station 5 in midchannel during the fall (3 individuals), although counts at this station were better in the spring (37). Abundance at Station 2 near the breakwall was also relatively low in the fall (15). Averaged among stations, counts in the spring (47 individuals) were about twice as large as those in the fall (24).

TABLE 7-1. INCIDENCE OF FISH SPECIES AND LARVAL TAXA COLLECTED DURING SPRING (Sp) AND FALL (Fl) IN MARINA DEL REY HARBOR - 1984 TO 1997

		84		85		86		87		88		89		90		91		92*		93		94		95		96					
SCIENTIFIC NAME	COMMON NAME	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Sp	Fl	Tot.
Acanthogobius flavimanus	Yellowfin Goby						x		x	x	x	x								x	x	x				x		x	6	4	10
Albula vulpes	Bonefish	x								x								x	x		x								3	2	5
Anchoa compressa	Deepbody Anchovy	x			x	x		x			x									x		x		x	x	x	x	x	8	4	12
Anchoa delicatissima	Slough Anchovy								x																		x	x	1	2	3
Anchoa sp.	Anchovy																											x	1	0	1
Anisotremus davidsoni	Sargo	x	x		x	x	x	x				x	x		x		x	x		x	x	x	x	x		x	x	x	10	9	19
Atherinops affinis	Topsmelt	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26
Atherinopsis californiensis	Jacksmelt					x	x	x	x			x										x	x			x	x	x	6	4	10
Atractoscion nobilis	White Seabass	x				x	x	x									x												3	2	5
Brachyistius frenatus	Kelp Surfperch																	x											1	0	1
Bryx arctus	Snubnose Pipefish																										x		0	1	1
Cheilotrema saturnum	Black Croaker		x		x	x	x	x	x	x	x	x	x	x		x	x		x				x			x			7	9	16
Chitonotus pugetensis	Roughback Sculpin										x																		0	1	1
Chromis punctipinnis	Blacksmith		x		x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x		x	x	x	x	x	10	12	22
Citharichthys stigmaeus	Speckled Sandab	x						x					x												x	x	x	x	4	3	7
Citharichthys Type A	Sandab Larvae	x						x														x		x		x	x	x	6	1	7
Clevlandia ios	Arrow Goby	x				x	x	x		x			x		x									x		x		x	7	3	10
Clinocottus analis	Wooly Sculpin	x			x		x			x	x	x				x							x						4	4	8
Coryphopterus nichosii	Blackeye Goby							x				x								x									3	0	3
Cymatogaster aggregata	Shiner Surfperch		x			x		x				x	x	x	x	x		x	x	x		x		x		x		x	11	4	15
Damalichthys vacca	Pile Surfperch	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x			11	11	22
Embiotoca jacksoni	Black Surfperch	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26
Engraulidae	Anchovy																										x	x	1	1	2
Engraulis mordax	Northern Anchovy	x	x			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	13	10	23
Fundulus parvipinnis	California Killifish	x	x		x		x	x		x	x		x	x	x	x	x			x	x		x	x		x	x	x	9	10	19
Genyonemus lineatus	White Croaker	x			x	x		x	x		x	x		x		x	x			x		x		x		x	x	x	11	5	16
Gibbonsia elegans	Spotted Kelpfish	x			x		x		x			x	x	x	x	x	x		x			x	x		x	x			6	9	15
Gillichthys mirabilis	Longjaw Mudsucker						x									x			x			x							2	2	4
Girella nigricans	Opaleye	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26
Gobiesox rhessodon	California Clingfish				x	x		x				x		x	x	x	x	x	x	x		x	x	x		x	x	x	11	6	17
Gobiedae A/C	Goby		x		x		x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	9	13	22
Gobiedae non A/C	Goby																						x						0	1	1
Halochoeres semicinctus	Rock Wrasse	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x	12	12	24
Hermosilla azurea	Zebraperch		x		x		x				x	x			x			x		x	x	x	x			x	x	x	6	8	14
Heterodontus francisci	Horn Shark	x	x									x		x		x													4	1	5
Heterostichus rostratus	Giant Kelpfish	x			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x			x	x	x	12	10	22
Hippoglossina stomata	Bigmouth Sole					x													x										1	1	2
Hyperprosopon argenteum	Walleye Surfperch		x			x											x												1	2	3
Hypsoblennius spp.	Blenny	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26
Hypsoblennius gentilis	Bay Blenny				x	x	x		x																				1	3	4
Hypsoblennius gilberti	Rockpool Blenny						x														x								0	2	2
Hypsoblennius jenkinsi	Mussel Blenny	x	x					x		x		x									x		x				x		4	4	8
Hypsopsetta guttulata	Diamond Turbot	x	x				x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	11	11	22
Hypsurus caryi	Rainbow Surfperch															x		x		x				x					4	0	4
Hypsypops rubicundus	Garibaldi	x	x		x		x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	12	11	23
Ilypnus gilberti	Cheekspot Goby	x	x			x	x	x		x				x	x	x												x	7	3	10
Kyphosidae	Zebraperch																						x						0	1	1
Lepidogobius lepidus	Bay Goby	x	x		x	x			x		x						x	x								x			4	5	9
Leptocottus armatus	Staghorn Sculpin					x	x	x		x		x	x	x		x	x	x	x				x			x	x	x	9	6	15
Leuresthes tenuis	California Grunion																											x	1	0	1
Medialuna californiensis	Halfmoon								x																				0	1	1
Menticirrhus undulatus	California Corbina					x	x		x	x		x				x						x		x				x	7	2	9
Micrometrus minimus	Dwarf Surfperch	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x	x	x	12	11	23
Mugil cephalis	Striped Mullet	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x			x	x		x				7	11	18
Mustelus californicus	Gray Smoothound																x	x							x				1	2	3
Mustelus henlei	Brown Smoothound								x															x				x	2	1	3
Mustelus sp.	Smoothound																	x											1	0	1
Myliobatis californica	Bat Ray					x	x	x	x		x	x	x	x		x	x	x	x	x			x	x		x	x	x	10	8	18
Oligocottus/Clinocottus A	Sculpin												x				x												0	2	2
Oxyjulis californica	Senorita	x	x		x	x		x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	11	12	23
Oxylebius pictus	Painted Greenling				x									x															1	1	2
Paraclinus integripinnis	Reef Finspot						x					x		x	x							x	x	x		x	x	x	6	4	10
Paralabrax clathratus	Kelp Bass	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26
Paralabrax maculatofasciatus	Spotted Sand	x	x		x	x	x	x	x			x	x	x	x	x		x											7	6	13
Paralabrax nebulifer	Barred Sand Bass	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	13	26

TABLE 7-1. (CONTINUED)

Paralabrax sp.	Sea Bass																									x	x	1	1	2
Paralichthys califoricus	California Halibut	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	11	13	24
Perciformes	Perch																									x		0	1	1
Phanerodon furcatus	White Surfperch					x			x		x	x		x		x	x			x			x			x		x	7	4	11
Pleuronectidae**	Flatfish																				x		x			x		x	2	2	4
Pleuronichthys coenosus	C-O Turbot				x				x																				0	2	2
Pleuronichthys ritteri	Spotted Turbot	x			x		x	x	x	x	x	x	x		x	x		x		x	x	x	x	x	x	x	x	x	11	10	21
Pleuronichthys verticalis	Hornyhead Turbot					x			x					x		x											x	x	4	2	6
Quietula y-cauda	Shadow Goby	x				x	x	x		x		x	x	x		x												x	8	2	10
Raja binoculata	Big Skate																											x	1	0	1
Rhacochilus toxotes	Rubberlip Surfperch		x						x		x			x	x	x				x									3	4	7
Rhinobatos productus	Shovelnose Guitarfish	x																											1	0	1
Sarda chilensis	Pacific Bonito	x	x				x		x																				1	3	4
Sardinops sagax caeruleus	Pacific Sardine	x	x		x	x	x	x	x	x		x			x	x		x	x	x		x	x						9	7	16
Scaenidae complex 2	Croaker							x			x			x														x	3	1	4
Scorpaena guttata	Spotted Scorpionfish					x						x						x			x	x							4	1	5
Scorpaenichthys marmoratus	Cabezon	x										x	x			x													3	1	4
Sebastes auriculatus	Brown Rockfish	x																											1	0	1
Sebastes serranoides	Olive Rockfish	x			x	x			x	x	x		x			x													4	4	8
Semicossyphus pulcher	California Sheepshead								x		x																		0	2	2
Seriphus politus	Queenfish	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x		x		x	x		12	9	21
Sphyraena argentea	California Barracuda		x		x	x			x	x				x	x					x							x		4	5	9
Squatina californica	Pacific Angel Shark				x																								0	1	1
Stenobrachius leucopsaura	Northern Lampfish					x									x														1	1	2
Strongylura exilis	California Needlefish		x			x		x			x		x	x	x		x	x		x	x	x	x	x		x	x		8	8	16
Symphurus atricauda	California Tonguefish		x																								x		0	2	2
Sygnathus sp.	Pipefish				x									x		x													2	1	3
Sygnathus leptorhynchus	Bay Pipefish	x						x	x			x			x														3	2	5
Synodus lucioceps	California Lizardfish										x																		0	1	1
Triakis semifaciata	Leopard Shark																											x	1	0	1
Type 32	Fish Larvae																											x	1	0	1
Typhlogobius californiensis	Blind Goby	x				x								x				x		x				x					6	0	6
Umbrina roncador	Yellowfin Croaker	x	x		x		x	x	x		x							x	x	x		x		x	x	x	x	x	8	8	16
Unidentified egg	Unidentified Egg																										x	x	1	1	2
Unidentified larvae	Unidentifed Larvae																											x	1	0	1
Urolophus halleri	Round Stingray	x					x	x		x		x				x	x	x		x				x		x		x	10	2	12
Xenistius californiensis	Salema		x						x				x		x						x		x				x		0	7	7
Xystreurys liolepis	Fantail Sole	x									x						x								x				1	3	4

* Diver survey and beach seine conducted on December 3 after completion of dredging.

** Unidentifiable turbot larvae.

At Station 2 near the breakwall, the most common fish collected in the fall was California halibut (*Paralichthys californicus* - 4 individuals), and in the spring, diamond turbot (*Hypsopsetta guttulata*), barred sand bass (*Paralabrax nebulifer*), and yellowfin croaker (*Umbrina roncador*) (7 individuals each) were most common. At Station 5 in the main channel, California halibut was also most common both in the fall (2 individuals) and in the spring (18 individuals). At Station 8 in Basin D, both seasons were dominated by deepbody anchovies (*Anchoa compressa* - 44 in the fall and 33 in the spring).

<u>Bottom fish abundance patterns compared with past years.</u> Table 7-6 lists the ranges in numbers of bottom fish collected per station since October 1991. Fish collected during October of 1996 ranged from 3 to 53 per station, which falls well within the overall range of values for past fall surveys. The spring range of individuals (35 to 69) was higher than any spring survey since 1992.

7.3.1.2. **Bottom Fish Species**

<u>Spatial bottom fish species patterns.</u> Numbers of bottom fish species collected at the three trawl sampling stations are listed in Table 7-2. Greatest numbers of species were captured at Station 2 near the breakwall in October (10 species). Species counts at all three stations in the spring (8 to 9 species), however, were nearly as high. The lowest species count was at Station 5 in midchannel during the fall (2 species). Averaged among stations, species counts in the spring (9 species) were larger than those in the fall (6).

<u>Bottom fish species patterns compared with past years.</u> Table 7-6 lists the ranges of species of bottom fish collected per station since October 1991. Bottom fish collected during October of 1996 ranged from 2 to 10 species per station, which is higher than most past surveys. The spring range of species counts (8 to 9) was also higher than any spring survey since 1992. As of 1992, new fish collected were sargo (*Anisotremus davidsonii*), mussel blenny (*Hypsoblennius jenkinsi*), California corbina (*Menticirrhus undulatus*), white surfperch (*Phanerodon furcatus*), hornyhead turbot (*Pleuronichthys verticalis*), big skate (*Raja binoculata*), and California tonguefish (*Symphurus atricauda*).

7.3.1.3. **Bottom Fish Diversity**

<u>Spatial bottom fish diversity patterns.</u> Species diversity calculated from the three trawl sampling stations are listed in Table 7-2. Highest species diversity was at Station 2 near the breakwall in October (2.15). Lowest diversity was at Station 5 in midchannel and 8 in Basin D (0.64 and 0.71, respectively). Averaged among stations, diversity in the spring (1.67) was higher than in the fall (1.17).

<u>Bottom fish diversity patterns compared with past years.</u> No calculations of species diversity were performed during past surveys, so no comparisons could be made.

TABLE 7-2. FISH COLLECTED BY OTTER TRAWL AND GILL NET AT THREE STATIONS.

		OCTOBER 1996 SAMPLING STATIONS			MAY 1997 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	2	5	8	2	5	8
Bottom Fish							
Anchoa compressa	Deepbody Anchovy			44		3	33
Anisotremus davidsonii	Sargo			2		1	1
Atherinopsis californiensis	Jacksmelt			1			
Acanthogobius flavimanus	Yellowfin Goby						1
Cymatogaster aggregata	Shiner Surfperch						19
Genyonemus lineatus	White Croaker	1			6	6	
Gobiesox rhessodon	California Clingfish	1					
Hypsoblennius jenkinsi	Mussel Blenny	1					
Hypsopsetta guttulata	Diamond Turbot	2			7	1	6
Menticirrhus undulatus	California Corbina					1	
Myliobatus californica	Bat Ray					1	
Paralabrax clathratus	Kelp Bass	1					
Paralabrax nebulifer	Barred Sand Bass	2	1	1	7	5	
Paralichthys californica	California Halibut	4	2	2	3	18	3
Phanerodon furcatus	White Surfperch				2		
Pleuronichthys ritteri	Spotted Turbot	1			1		
Pleuronichthys verticalis	Hornyhead Turbot				2		
Raja binoculata	Big Skate						3
Seriphus politus	Queenfish	1					
Symphurus atricauda	California Tonguefish	1					
Umbrina roncador	Yellowfin Croaker			3	7	1	2
Urolophus halleri	Round Stingray						1
	Individuals	**15**	**3**	**53**	**35**	**37**	**69**
	Species	**10**	**2**	**6**	**8**	**9**	**9**
	Diversity	**2.16**	**0.64**	**0.71**	**1.91**	**1.61**	**1.48**
Midwater Fish							
Anchoa compressa	Deepbody Anchovy						4
Atherinops affinis	Topsmelt			26		1	1
Atherinopsis californiensis	Jacksmelt						1
Sphraena argentea	California Barracuda	1					
	Individuals	**1**	**0**	**26**	**0**	**1**	**6**
	Species	**1**	**0**	**1**	**0**	**1**	**3**
	Diversity	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.60**

TABLE 7-3. RESULTS OF DIVE SURVEY TRANSECTS AT THREE DIVE STATIONS.

		OCTOBER 1996 SAMPLING STATIONS			MAY 1997 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	North Jetty	Breakwall	South Jetty	North Jetty	Breakwall	South Jetty
Reef Species							
Anisotremus davidsonii	Sargo	1					
Atherinops affinis	Topsmelt	26	57	1646	2100	7050	5860
Chromis punctipinnis	Blacksmith		43	18		18	3
Damalichthys vacca	Pile Surfperch			9			1
Embiotoca jacksoni	Black Surfperch		26	38	10	49	35
Girella nigricans	Opaleye	63	21	89	50	79	3
Halichoeres semicinctus	Rock Wrasse		37	5		11	
Hermosilla azurea	Zebraperch	30		2	1	2	
Heterostichus rostratus	Giant Kelpfish			1			4
Hypsoblennius sp.	Blenny	1					
Hypsopsetta guttulata	Diamond Turbot	1					
Hypsypops rubicundus	Garibaldi		5			6	
Micrometrus minimus	Dwarf Surfperch	4			8		
Myliobatus californica	Bat Ray	1					
Oxyjulis californica	Senorita		1	4			4
Paralabrax clathratus	Kelp Bass		23	12		24	9
Paralabrax nebulifer	Barred Sand Bass		13	24		28	
Perciformes	Perch	1					
Xenistius californiensis	Salema			14			
	Individuals	**128**	**226**	**1862**	**2169**	**7267**	**5919**
	Species	**9**	**9**	**12**	**5**	**9**	**8**
	Diversity	**1.31**	**1.93**	**0.57**	**0.17**	**0.19**	**0.07**

7.3.2. Midwater Fish

A 32.8 m multimesh gill net was allowed to fish for 45 minutes at three locations: parallel to the breakwall near Station 2; across the entrance to Mother's Beach near Station 8; and along the eastern side of the main channel near Station 5 (Figure 7-1).

7.3.2.1. **Midwater Fish Abundance**

Spatial midwater fish abundance patterns. Numbers of midwater fish collected at the three gill net sampling stations are listed in Table 7-2. The greatest numbers were captured at Station 8 in Basin D in October (26 individuals). All remaining catches were poor (0 to 3 individuals per cast). Averaged among stations, counts in the fall (9 individuals) were larger than in spring (2).

At Station 2 near the breakwall, only one barracuda was collected in the fall and no fish were collected in spring. At Station 5 in the main channel, only one topsmelt was collected in the spring and no fish were collected in the fall. At Station 8 in Basin D, 26 topsmelt were collected in the fall, 4 deepbody anchovies were collected in the spring, and one each jacksmelt (*Atherinopsis californiensis*) and topsmelt were also collected in the spring.

Midwater fish abundance patterns compared with past years. Table 7-6 lists the ranges of individuals of midwater fish collected per station since October 1991. Numbers of fish collected during October of 1996 ranged from 0 to 26 individuals per station, which falls well within the overall range of values for past fall surveys. The spring range of individuals (0 to 6) was lower than any spring survey since 1992.

7.3.2.2. **Midwater Fish Species**

Spatial midwater fish species patterns. Numbers of midwater fish species collected at the three gill net sampling stations are listed in Table 7-2. The greatest number of species were captured at Station 8 in Basin D in May (3 species). All remaining species counts were poor (0 to 1 species). Average species counts were poor (1 species per cast) during both seasons.

Midwater fish species patterns compared with past years. Table 7-6 lists the ranges of species of bottom fish collected per station since October 1991. Midwater fish collected during October of 1996 ranged from 0 to 1 species per station, which is typical of past surveys. The spring range of species counts (0 to 3) was also typical. Only jacksmelt were new to this year's survey.

7.3.2.3. **Midwater Fish Diversity**

Spatial midwater fish diversity patterns. Species diversity from the three gill net sampling stations are listed in Table 7-2. Highest species diversity was at Station 8 in Basin D near the breakwall in May (0.87). All remaining species diversity measurements were zero.

TABLE 7-4. LARVAL FISH AND EGGS COLLECTED BY PLANKTON TOW AT THREE SURFACE AND BOTTOM STATIONS (INDIV/1000 M^3).

		OCT. 1996 SAMPLING STATIONS						MAY 1997 SAMPLING STATIONS					
		2		5		8		2		5		8	
SCIENTIFIC NAME	COMMON NAME	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Larval Fish													
Anchoa sp.	Anchovy							7			3760	24	346
Atherinops affinis	Topsmelt											5	
Bryx arctus	Snubnose Pipefish				9								
Citharichthys type A	Speckled Sandab	15								5	7		
Engraulidae	Anchovy		7					7	39	47	604	57	251
Engraulis mordax	Northern Anchovy	44	14					74	68		37		43
Genyonemus lineatus	White Croaker		7					15		5			
Gobiedae type A/C	Goby	102	380	299	1760	190	793	96	2094	566	1760	223	303
Gobiesox rhessodon	California Clingfish				9				232		22	5	
Heterostichus rostratus	Giant Kelpfish				10						7		
Hypsoblennius sp.	Blenny	102	515	305	993	38	618	82	116	374	604	62	208
Hypsopsetta guttulata	Diamond Turbot		7			28	9						
Leuresthes tenuis	California Grunion							7			7		
Paraclinus integrippinis	Reef Finspot			11			9		10	10			9
Paralabrax sp.	Sea Bass								10	10			
Paralichthys californicus	California Halibut										30		
Pleuronectidae	Flatfish										7	5	
Pleuronichthys verticalis	Hornyhead Turbot									5			
Sciaenidae Complex II	Croaker							7				5	
Unidentified	Unidentified							5	39		30		17
	Individuals	**263**	**930**	**616**	**2781**	**256**	**1429**	**300**	**2608**	**1022**	**6875**	**386**	**1177**
	Species	**4**	**6**	**3**	**5**	**3**	**4**	**9**	**8**	**8**	**12**	**8**	**7**
	Diversity	**1.20**	**0.87**	**0.77**	**0.71**	**0.75**	**0.75**	**1.63**	**0.79**	**1.01**	**1.23**	**1.29**	**1.56**
Fish Eggs													
Anchoa compressa	Deepbody Anchovy									343	187	2190	5597
Anchoa delicatissima	Slough Anchovy	6						1892	270	26095	30325	32839	85166
Citharichthys type A	Speckled Sandab	29	27					646	511				
Engraulis mordax	Northern Anchovy							342	695	223	67		
Pleuronichthys ritteri	Spotted Turbot	88	102	11	69					5	7	5	43
Pleuronichthys verticalis	Hornyhead Turbot		7	11				126	125				
Type 32	—							720	560				
Unidentified	Unidentified	468	325	392	98	36		2441	1766	493	552	38	156
	Individuals	**591**	**461**	**414**	**167**	**36**	**0**	**6167**	**3927**	**27159**	**31138**	**35072**	**90962**
	Species	**4**	**4**	**3**	**2**	**1**	**0**	**6**	**6**	**5**	**5**	**4**	**4**
	Diversity	**0.66**	**0.81**	**0.24**	**0.68**	**0.00**	**0.00**	**1.46**	**1.50**	**0.21**	**0.14**	**0.24**	**0.25**

TABLE 7-5. INSHORE FISH COLLECTED BY BEACH SEINE AT MOTHERS BEACH (STATION 9).

SCIENTIFIC NAME	COMMON NAME	OCTOBER 1996	MAY 1997
Beach Seine Species			
Anchoa compressa	Deepbody Anchovy	36	7
Anisotremus davidsonii	Sargo	4	9
Atherinops affinis	Topsmelt	1599	987
Acanthogobius flavimanus	Yellowfin Goby		9
Fundulus parvipinnis	California Killifish	145	18
Genyonemus lineatus	White Croaker	1	
Hypsopsetta guttulata	Diamond Turbot	1	12
Leptocottus armatus	Staghorn Sculpin	4	4
Menticirrhus undulatus	California Corbina		7
Mustelus henlei	Brown Smoothhound		9
Quietula y-cauda	Shadow Goby		3
Strongylura exilis	California Needlefish	1	
Triakis semifasciata	Leopard Shark		1
	Individuals	**1791**	**1066**
	Species	**8**	**11**
	Diversity	**0.423**	**0.422**

Midwater fish diversity patterns compared with past years. No calculations of species diversity were performed during past surveys, so no comparisons could be made.

7.3.3. Inshore Fish

Inshore fish were collected using a 32.8 m beach seine at Station 9 along the shoreline of Mother's Beach (Figure 7-1). The net was deployed about 30 m from shore in about 2.5 m depth and brought to shore. All fish collected in the net were counted and identified.

7.3.3.1. **Inshore Fish Abundance**

Spatial inshore fish abundance patterns. Numbers of inshore fish collected along the shoreline of Mother's Beach (Station 9) are listed in Table 7-5. More fish were captured in the fall (1791 individuals) than in the spring (1066). Both seasons' counts were dominated by topsmelt (1599 individuals in October and 987 in May). Other common fish were California killifish (*Fundulus parvipinnis* - 145 in the fall, 18 in the spring) and deepbody anchovy (36 in the fall, 7 in the spring). All other fish counts ranged from 1 to 12 individuals.

Inshore fish abundance patterns compared with past years. Table 7-6 lists the ranges of individuals of bottom fish collected per station since October 1991. Numbers of inshore fish collected during October of 1996 were 1791 individuals, which is the highest number collected during any past surveys since 1991. The spring count (1066 individuals) was typical of surveys from past years. The lower count in the spring may be the result of the presence of a number of large predators in the area. The beach seine in the spring yielded one leopard (*Triakis semifasciata*) and nine brown smoothound (*Mustelus henlei*) sharks which were absent during the previous fall.

7.3.3.2. **Inshore Fish Species**

Spatial inshore fish species patterns. Numbers of inshore fish collected at Mothers' Beach are listed in Table 7-5. More species of fish were collected in the spring (11 species) than in the fall (8 species).

Inshore fish species patterns compared with past years. Table 7-6 lists the ranges in number of species of bottom fish collected per station since October 1991. The eight inshore fish species collected during October of 1996 is higher than most species counts of all past fall surveys since 1991. The spring species count (11) was higher than any spring survey since 1992. Relative to counts made since 1991, new fish this year were the leopard shark (*Triakis semifasciata*), yellowfin goby (*Acanthogobius flavimanus*), white croaker (*Genyonemus lineatus*), and diamond turbot (*Hysopsetta guttulata*).

TABLE 7-6. RANGES IN NUMBERS OF ALL INDIVIDUALS AND SPECIES OF FISH JUVENILES AND ADULTS COLLECTED: OCT 1991 - MAY 1997

	BOTTOM FISH		MIDWATER FISH		INSHORE FISH		REEF FISH	
DATE	Individuals	Species	Individuals	Species	Individuals	Species	Individuals	Species
Oct-91	9 - 415	2 - 5	0 - 77	0 - 3	213	8	83 - 387	5 - 15
Oct-92	3 - 19	2 - 3	0 - 54	0 - 2	311	4	1 - 85	1 - 8
Oct-93	3 - 6	3 - 4	2 - 28	1 - 1	1542	5	161 - 278	9 - 13
Oct-94	0 - 3	0 - 3	1 - 66	1 - 3	1016	6	110 - 304	11 - 19
Oct/Nov-95	1 - 8	1 - 5	0 - 31	0 - 1	416	6	6 - 48	2 - 8
Fall Range	**0 - 415**	**0 - 5**	**0 - 77**	**0 - 3**	**213 - 1542**	**4 - 8**	**1 - 387**	**1 - 19**
Oct-96	3 - 53	2 - 10	0 - 26	0 - 1	1791	8	128 - 1862	9 - 12
May-92	1 - 7	1 - 5	0 - 17	0 - 2	351	9	211 - 367	10 - 12
May-93	1 - 17	1 - 6	1 - 63	1 - 3	406	10	123 - 544	4 - 13
May-94	5 - 20	3 - 5	0 - 17	0 - 4	1418	6	15 - 130	2 - 12
May-95	4 - 13	4 - 5	0 - 44	0 - 5	8165	9	0 - 42	0 - 9
May-96	2 - 38	1 - 9	0 - 34	0 - 2	3321	9	30 - 320	8 - 16
Spring Range	**1 - 38**	**1 - 9**	**0 - 63**	**0 - 5**	**351 - 8165**	**6 - 10**	**0 - 544**	**0 - 16**
May-97	35 - 69	8 - 9	0 - 6	0 - 3	1066	11	2169 - 7267	5 - 9

TABLE 7-7. RANGES IN NUMBERS OF INDIVIDUALS AND SPECIES OF FISH LARVAE AND EGGS COLLECTED: OCT. 1991 - MAY 1997

	LARVAL FISH		FISH EGGS	
DATE	Individuals	Species	Individuals	Species
Oct-91	3650 - 16,143	6 - 8	282 - 12,252	1 - 2
Oct-92	2790 - 5016	4 - 7	79 - 1043	1 - 1
Oct-93	309 - 3392	2 - 5	37 - 1219	1 - 1
Oct-94	720 - 1693	4 - 6	18 - 3127	1 - 2
Oct/Nov-95	311 - 1791	1 - 3	14 - 194	1 - 1
Fall Range	**309 - 16,143**	**1 - 8**	**0 - 12,252**	**1 - 2**
Oct-96	1193 - 3396	4 - 7	36 - 1052	1 - 5
May-92	2874 - 11,927	3 - 6	0 - 3338	0 - 2
May-93	3936 - 59,978	3 - 11	56 - 260	1 - 1
May-94	672 - 8803	2 - 11	17 - 477	2 - 2
May-95	1907 - 64,408	4 - 7	182 - 6782	1 - 2
May-96	1584 - 40,621	5 - 7	37 - 565	1 - 1
Spring Range	**672 - 64,408**	**2 - 11**	**0 - 6782**	**0 - 2**
May-97	1563 - 7897	9 - 15	10,094 - 58,297	4 - 6

7.3.3.3. **Inshore Fish Diversity**

Spatial inshore fish diversity patterns. Species diversity calculated from Mother's Beach are listed in Table 7-5. Species diversity indices during fall and spring were low and virtually identical (0.423 and 0.422 respectively).

Inshore fish diversity patterns compared with past years. No calculations of species diversity were performed during past surveys, so no comparisons could be made.

7.3.4. Reef Fish

Reef fish were counted by divers during three 10 minute swimming underwater transects: along the middle of the breakwall, along the north jetty near the harbor entrance, and along the south jetty near the harbor entrance. Swimming together, one diver estimated the number of schooling fish in the water column (i.e. topsmelt), while the other counted demersal fish species. All juvenile and adult fish were counted and identified to species (Figure 7-1).

7.3.4.1. **Reef Fish Abundance**

Spatial bottom fish abundance patterns. Numbers of reef fish counted at the three dive survey stations are listed in Table 7-3. Greatest numbers were counted at the breakwall in the spring (7267 individuals), followed closely by the south jetty in the spring (5919 individuals). The lowest counts were at the north jetty and breakwall in the fall (128 and 226 individuals, respectively). Overall, counts in the spring (5117 individuals total) were about seven times larger than those in the fall (739 individuals), however, the majority (98%) of these were topsmelt.

At the north jetty, the most common fish counted in the fall were opaleye (*Girella nigricans* - 63 individuals), zebraperch (*Hermosilla azurea* - 30 individuals), and topsmelt (26 individuals). In the spring, topsmelt (2100) dominated, and opaleye (50) were abundant. At the breakwall, topsmelt (57), blacksmith (*Chromis punctipinnis* - 43), and rock wrasse (*Halichoeres semicinctus* - 37) were most common. In the spring the breakwall was overwhelmed with topsmelt (7050). Black surfperch (*Embiotoca jacksoni* - 49) and opaleye (79) were also common in the spring. During both fall and spring, the south jetty was also dominated by topsmelt (1646 and 5860, respectively). Opaleye were common in the fall (89), and black surfperch were common during both fall and spring (38 and 35, respectively).

Reef fish abundance patterns compared with past years. Table 7-6 lists the ranges in numbers of individuals of reef fish counted per station since October 1991. Numbers of reef fish species counted during October of 1996 ranged from 128 to 1862 individuals per station, which is higher than all recent fall surveys. The spring range of individuals per station (2169 to 7269) was much higher than any spring survey since 1992.

7.3.4.2. **Reef Fish Species**

Spatial reef fish species patterns. Numbers of reef fish species counted at the three dive survey stations are listed in Table 7-3. The greatest numbers of species were observed at south jetty in October (12 species), and the lowest species count was at the north jetty during the spring (5 species). Averaged among stations, species counts in the fall (10 species) were larger than those in the spring (7).

Reef fish species patterns compared with past years. Table 7-6 lists the ranges in numbers of species of reef fish counted per station since October 1991. Reef fish recorded during October of 1996 ranged from 9 to 12 species per station, which is generally higher than past surveys. The spring range of species counts (5 to 9) were more typical. Relative to counts made since 1991, no new reef fish were observed during this year's survey.

7.3.4.3. **Reef Fish Diversity**

Spatial reef fish diversity patterns. Species diversity calculated from the three dive survey stations are listed in Table 7-5. Highest species diversity was at the breakwall in October (1.93). Lowest diversity was at the south jetty in May (0.07). Overall, average diversity in the fall (1.27) was much higher than in the spring (0.14). This difference was caused by the presence of the particularly large numbers of topsmelt in the spring.

Reef fish diversity patterns compared with past years. No calculations of species diversity were performed during past surveys, so no comparisons could be made.

7.3.5. Larval Fish

Larval fish and fish eggs were collected at three stations: Stations 2 near the breakwall, Station 5 in midchannel, and Station 8 in Basin D. A 333 um mesh plankton net was deployed at 1.0 m below the surface for two minutes and on the bottom for three minutes. A benthic sled kept the net on the bottom regardless of irregularities in bottom surface and vessel speed.

7.3.5.1. **Larval Fish Abundance**

Spatial larval fish abundance patterns. Numbers of larval fish captured at the three plankton sampling stations are listed in Table 7-4. Greatest numbers were collected on the bottom in midchannel in the spring (6875 individuals). Poorest catches were at the surface near the breakwall and in Basin D in the fall (263 and 256 individuals, respectively). Averaged among stations, counts in the spring (2061 individuals) were about twice as large as those in the fall (1046). The surface average among seasons (524 individuals) was much smaller than the bottom average (2633). Note that all counts are standardized to numbers per 1000 cubic meters.

At Stations 2, 5, and 8, fall counts were dominated by gobies (Gobiedae A/C, a combination of arrow goby (*Clevelandia ios*), cheekspot goby (*Ilypnus gilberti*), and shadow goby (*Quietula y-cauda*) - 482, 2059, and 983 individuals, respectively) and blennies (*Hypsoblennius spp.* - 1234, 1298, and 656 individuals). In the spring, gobies (2190, 2326, and 526) and blennies (198, 978, and 270) were also common at the three sampling stations, but anchovies also became important (total Engraulidae - 195, 4448, and 721).

Larval fish abundance patterns compared with past years. Table 7-7 lists the ranges of individuals of larval fish counted per station since October 1991. Numbers of larval fish counted during October of 1996 ranged from 263 to 2781 individuals per station, which is within the range of most past surveys. The spring range of individuals per station (1563 to 7897) was also typical.

7.3.5.2. **Larval Fish Species**

Spatial larval fish species patterns. Numbers of larval fish species collected at the three plankton sampling stations are listed in Table 7-4. The greatest numbers of species were captured near the bottom at midchannel in May (12 species), and the lowest species count was near the surface at midchannel and Basin D in the fall (both 3 species). Average species counts in the fall (9 species) were larger than those in the spring (4). Averaged numbers of species at the surface (6) were slightly lower than bottom counts (7).

Larval fish species patterns compared with past years. Table 7-7 lists the ranges of species of larval fish counted per station since October 1991. Larval fish species recorded during October of 1996 ranged from 4 to 7 species per station (combining surface and bottom casts), which is typical of past surveys. The spring range of species counts (9 to 15) were higher than all past surveys. Compared to all surveys since 1991, new larval fish collected this year were anchovies (*Anchoa sp.*), snubnose pipefish (*Bryx arctus*), speckled sandab (*Citharichthys stigmaeus*), white croaker (*Genyonemus lineatus*), California grunion (*Leuresthes tenuis*), and California halibut (*Paralichthys californicus*).

7.3.5.3. **Larval Fish Diversity**

Spatial larval fish diversity patterns. Species diversity calculated from the three plankton sampling stations are listed in Table 7-4. Highest species diversity was near the surface at the breakwall in May (1.63). Lowest diversity was near the bottom at midchannel in October (0.71). Averaged among stations, diversity in the spring (1.25) was higher than in the fall (0.84). Average surface diversity (1.11) was higher than bottom diversity (0.99).

Larval fish diversity patterns compared with past years. No calculations of species diversity were performed during past surveys, so no comparisons could be made.

7.3.6. Fish Eggs

Larval fish and fish eggs were collected at three stations: Stations 2 near the breakwall, Station 5 in midchannel, and Station 8 in Basin D. A 333 um mesh plankton net was deployed at 1.0 m below the surface for two minutes and on the bottom for three minutes. A benthic sled kept the net on the bottom regardless of irregularities in bottom surface and vessel speed.

7.3.6.1. **Fish Egg Abundance**

Spatial fish egg abundance patterns. Numbers of fish eggs at three plankton sampling stations are listed in Table 7-4. The greatest number were counted on the bottom in Basin D in spring (90,962 individuals). Lowest catches were at the bottom in Basin D in the fall (0 individuals). Averaged among stations, counts in the spring (32,404 individuals) were much larger than those in the fall (1669), and averaged counts at the surface (11,537 individuals) were smaller than the bottom (21,109). Note that all counts are standardized to numbers per 1000 cubic meters.

At Stations 2, 5, and 8, spring counts were dominated by anchovy eggs (all Engraulidae - 3199, 26,661, and 125,792 individuals, respectively). The fall counts were much lower and were dominated by unidentified eggs (793, 490, and 36 individuals).

Fish egg abundance patterns compared with past years. Table 7-7 lists the ranges of individuals of fish eggs counted per station since October 1991. Numbers of fish eggs counted during October of 1996 ranged from 36 to 1052 individuals per station, which is with the range of most past surveys. The spring range of individuals per station (10,094 to 126,034) was much higher than past counts.

7.3.6.2. **Fish Egg Species**

Spatial fish egg species patterns. Numbers of fish egg species collected at the three plankton sampling stations are listed in Table 7-4. The greatest numbers of species were captured both at the surface and bottom near the breakwall in May (both, 6 species), and the lowest species count was near the bottom in Basin D in the fall (0 species). Average species counts in the fall (2 species) were smaller than those in the spring (5). Averaged numbers of species at the surface (4) were the same as bottom counts (4).

Fish egg species patterns compared with past years. Table 7-7 lists the ranges of species of larval fish counted per station since October 1991. Larval fish species recorded during October of 1996 ranged from 1 to 5 species per station (combining surface and bottom casts), which is somewhat higher than past surveys. The spring range of species counts (4 to 6) were also higher than past surveys. Relative to all surveys since 1991, new fish eggs collected during this year's survey were deepbody anchovy (*Anchoa compressa*), slough anchovy (*Anchoa delicatissima*), sandab (*Citharichthys sp.*), spotted turbot (*Pleuronichthys ritteri*), hornyhead turbot (*Pleuronichthys verticalis*), and an unidentified fish egg group (Type 32).

7.3.5.3. **Fish Egg Diversity**

Spatial fish egg diversity patterns. Species diversity calculated from the three plankton sampling stations are listed in Table 7-4. Highest species diversity was near the bottom at the breakwall in May (1.50). Lowest diversity was near the bottom in Basin D in October (0.00). Averaged among stations, diversity in the spring (0.63) was higher than in the fall (0.40). Average surface diversity (0.47) was slightly lower than bottom diversity (0.56).

Fish egg diversity patterns compared with past years. No calculations of species diversity were performed during past surveys, so no comparisons could be made.

7.4. DISCUSSION

Marina del Rey Harbor serves as a viable habitat and nursery for numerous species of marine fish. To date, 103 different species of fish have been collected in the Harbor, representing most feeding and habitat niches found in the eastern Pacific Ocean. Since its inception, this sampling program has collected animals from different seasons (fall and spring), spatial strata (midwater, bottom, inshore), habitat type (soft bottom or rocky reef), and age group (eggs, larvae, juveniles, adults). This year's sampling yielded 235,410 total fish of all age groups (including larvae and eggs) representing 59 different species. The great majority of these were either eggs, larvae, or juveniles, which attests to the Harbor's value as a nursery ground for adult Harbor species, as well as species for the Pacific Ocean as a whole.

Bottom fish were collected using a semi-balloon otter trawl at three locations in the Harbor: near the Harbor entrance, in midchannel, and along Basin D. For both seasons, both individual and species counts were higher than in past surveys, and seven species new to trawls were collected this year. Basin D counts were higher than the other two stations but were dominated by small anchovies. Higher diversity near the entrance, however, suggests that this area may serve as a transitional area between the open ocean and the protected Harbor environment. California halibut, which are prized by both commercial and sport fishermen, were present in every trawl. Overall, both abundance and diversity were higher in the spring.

Probably least useful to the project, is the midwater fish, gill net sampling. Since the net is passive, capture must rely on the hit-or-miss chance of animals swimming into the net. While relatively long deployments (e.g. 24 hours) can be effective, casts of only 45 minutes are not. Only the Basin D cast collected more than one individual. Twenty-six topsmelt were caught in the fall and a few topsmelt, jacksmelt, and anchovies were caught in the spring. The midchannel gill net only caught one topsmelt in the spring, and the breakwall net captured only one barracuda in the fall. These counts are fairly typical, so they are most likely a product of lack of fishing effectiveness rather than any absence of midwater fish abundance or diversity. Except for the jacksmelt this year, gill net catches yielded the same species as in past surveys.

Inshore fish were collected by beach seine at Mother's Beach. Both numbers of individuals and species were high this year such that total abundance in the fall and species counts in the spring were the highest over the last five years. Present in the spring but not in the fall were nine smoothound and one leopard shark. It is possible that the decline of overall counts of prey fish during the spring (about 40% of the fall abundance) was caused by the presence of these efficient predators. Regardless, topsmelt counts in the fall (1599) and spring (987) represented about 90% of the total catch during each season. High topsmelt counts are encouraging because they are an important food source for many different species of fish. The Mother's Beach area is undoubtedly an important nursery for the remainder of the Harbor and the nearby ocean community. Five species caught this year were new to the Harbor's beach seine sampling program.

Reef associated fish were enumerated and identified by diver-biologists along both jetties and the breakwall. As with bottom and inshore fish, counts of individuals and species were much higher than have been reported from the last five years. One reason for the higher counts may be that we waited for relatively clear water before we undertook the dive surveys. During this spring, red tide blooms were so thick that visibility was essentially zero. Counting fish during these and other highly turbid periods can greatly underestimate fish individual and species counts. As with the beach seine, topsmelt dominated counts, particularly in the spring. Overall, spring abundance was much greater than fall abundance, however, fall species counts and diversity were greater. None of the three locations consistently dominated either abundance, species counts, or diversity, and none of the fish recorded were new to dive surveys at these locations as of 1991.

Larval fish and fish eggs were collected by plankton net near the surface and bottom at the same three sampling stations used for trawl surveys. Larval fish counts during both seasons and egg counts in the fall were typical of past surveys, however, egg counts in the spring were huge, ranging from 10,094 to 126,034 per station. These counts are much higher than has been recorded since 1991 (highest spring count was 6782). In addition, species counts were high for both larval fish and eggs during both seasons. Dominating the spring egg catch were three species of anchovy. Larval fish counts were dominated by gobies, blennies, and in the spring, anchovies. Both spring egg and larvae counts were much greater than the fall counts. This followed, as well, for species counts and species diversities. Deeper tows almost always contained the largest populations. The ichthyoplankton may be feeding on the phytoplankton which tends to avoid the very top water layers during the daytime. Being close to the bottom may also provide some protection from predators. Relative to the past five years, seven new larval species and six new fish egg species were collected for the first time this year.

The sampling methods which have been used in Marina del Rey are different than those used by other researchers in southern California (i.e. L.A. Harbor, SCCWRP), so fish population characteristics could not be easily compared. It is obvious, however, that the Marina supports a very abundant and diverse assemblage of fish fauna, and, most importantly, is a nursery for many species important to local sport and commercial fisheries, as well to the coastal environment as a whole.

8. CONCLUSIONS

Marina del Rey Harbor is a major commercial and recreational facility to southern California, yet it also serves as an important ecological habitat and nursery for many different species of fish, invertebrates, and the birds and mammals which feed upon them. During this year, the quality of the water, sediment, infauna, and resident fish populations were measured and evaluated. The following section provides the conclusions drawn from these evaluations.

Chemical and bacteriological water quality sampling this year appeared to be primarily affected by precipitation, spring and early summer plankton blooms, and drainages from Oxford Lagoon and Ballona Creek. Rainfall for the period was slightly above normal but actually lower than the average recorded for the past 20 years. Nearly all precipitation fell between October 1996 and February 1997. The wettest month was January. As expected, rainfall lowered salinity and increased bacterial counts. The flow from storm drains, particularly Oxford Lagoon and Ballona Creek, increased bacterial counts to the Harbor, however, rain flowing off the surfaces surrounding the Marina undoubtedly provided an additional source of contamination. Water adjacent to areas where birds, stray animals, children, and perhaps homeless people congregate appeared to be more impacted during rainy periods. Measurements of three groups of bacteria were made monthly at 18 stations (216 measurements for each group during the year). Total coliform limits were exceeded 11 times, fecal coliform limits were exceeded 19 times, and enterococcus limits were exceeded 11 times. Most exceedances occurred following rainy months and at stations near Oxford Lagoon and Ballona Creek discharges. In general, chemical and bacteriological water quality measurements were comparable to past years.

1996-97 was characterized by particularly heavy, red tide phytoplankton blooms during spring and early summer. Red tide blooms are dependent upon increased solar irradiation (i.e. longer day length) and nutrients (mostly nitrogen) from spring upwelling and perhaps the discharge from Ballona Creek. These blooms strongly increased dissolved oxygen, reduced water clarity, altered natural water color, and increased the biochemical oxygen demand of the Harbor waters.

Both Ballona Creek and Oxford Lagoon reduced salinity and elevated ammonia, biochemical oxygen demand, total coliforms, fecal coliforms, and enterococcus bacteria. Oxford Lagoon additionally lowered oxygen, pH and water clarity. Nutrients from Ballona Creek may have also contributed to the intensity of the red tide blooms. The flows from Oxford Lagoon and Ballona Creek appeared to directly affect the Harbor entrance, Basin E, and probably Basin D as well. These locations represent over half of the stations sampled during our surveys. The spatial patterns of every parameter we measured were influenced by these two sources of water, and their negative influence upon the water quality in the Marina cannot be overstated.

As in past years, the physical characteristics of the Harbor sediments (namely median particle size and sorting) were influenced by the energy of the water flow, which in turn is influenced by the configuration of the Harbor and the intensity of the rainfall. Areas of the Harbor near the entrance are dominated by moderate to fine sand due to the larger movement of currents, tides, and wave action. Similarly, the high water velocity of Ballona Creek tends to move finer particles offshore, leaving sand behind. Because the finer silts and clays remain in suspension and move offshore, the sediment are expectedly homogeneous. Water velocity further back in the Harbor is much slower, allowing the finer fractions from runoff to settle out on the bottom. Median particle size here range from very fine sand to clay. These sediments in the upper areas of the Harbor are thus relatively heterogeneous. Water movement within Oxford Lagoon is likely highly variable, since sediments here were moderate in size range yet very heterogeneous.

Major sources of chemical contaminants into Marina del Rey Harbor appear to be Oxford Lagoon, Ballona Creek, and the resident boat population itself. Nonpoint sources may also be important, particularly during heavy rainfall, however they are much more difficult to partition out. Another important factor to chemical accumulation is the sediment particle size. Finer silts and clays of the inner basins and upper channel tend to adsorb more metals and simple organics than courser silts and sands found near the Harbor entrance and within Ballona Creek.

Chlorinated hydrocarbons (DDT and derivatives, other chlorinated pesticides, and polychlorinated biphenyls (PCB's)) are highest in Oxford Lagoon, Ballona Creek, and at two stations near the Harbor entrance. These two major drainage systems appear to be the primary source of chlorinated compounds into the Harbor. Among chlorinated hydrocarbons listed as toxic by NOAA, all Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 13 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. It is encouraging to note, however, that most chlorinated compounds have declined dramatically this year over past surveys, and levels are about one-fifth those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Although Oxford Lagoon and Ballona Creek may be a source of some heavy metals and nonspecific organic compounds (particularly oil and grease), most metals were higher in the back basins of the Harbor and in the main channel. The source of these metals is most likely the resident boat population itself. Metal components of boats are constantly being corroded by seawater, and most bottom paints contain materials, such as copper or tributyl tin complexes, which are designed to continuously ablate off into the sediment. As with chlorinated hydrocarbons, all station exceeded at least one metal limit of "possible" toxicity, and most stations exceeded at least one metal limit of "probable" toxicity. Areas that exceeded most metal limits were Basin E, Basin F, and most channel stations. Levels of copper, lead, mercury, silver, and zinc in Marina del Rey were about two to six times higher than Los Angeles Harbor, although the rest of the metals were similar. Some metals may accumulate in Marina del Rey sediments more readily than in Los Angeles Harbor due to its configuration. Marina del Rey has only one harbor entrance as opposed to two for Los Angeles Harbor. The latter configuration likely allows for better flushing and the movement of contaminated suspended materials offshore.

Despite a fair degree of variability, metal concentrations in Marina del Rey sediments do not appear to have greatly increased nor decreased since 1985. The exception is tributyl tin, which, like chlorinated hydrocarbons, has greatly declined recently. The recent ban on the use of this compound as a bottom paint is the likely cause of this decline. The reduction of tributyl tin is encouraging because it is considered by some to be one of the most environmentally toxic compounds ever released into the marine environment.

Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals. Although, non-toxic in themselves, nonspecific organic pollutants can contribute to anoxia near the bottom and thus to the ecological degradation of the Harbor. Organic contamination tended to be higher in Basin E, Basin F, all channel stations, and Oxford Lagoon, and Ballona Creek. Oil from street runoff may be a source of the relatively high oil and grease levels found in the two drainage basins, and seepages from resident boats likely contribute oil and grease to Harbor sediments as well.

Both heavy metals and nonspecific organic compounds are positively related to finer sediment particle sizes. Fine silts and clays tend to attract contaminants more readily than courser sediments. This pattern is apparent in the Harbor, since areas with finer sediments also tended to be areas with higher metal and organic contaminant concentrations. Surprisingly, chlorinated pesticides and PCB concentrations in the Harbor, which may originate from Ballona Creek and Oxford Lagoon, do not show a strong relationship with finer particle size ranges.

Benthic infaunal population variables appeared to be mostly associated with proximity to Oxford Lagoon and Ballona Creek. Population measurements made in most of the channel and upper Harbor yielded relatively high to moderate infaunal values. Areas associated with Oxford Lagoon and Ballona Creek tended to show evidence of community disturbance. Surprisingly, environmental health of the infaunal community did not appear to be strongly related to stations' benthic grain size patterns.

Stations near Ballona Creek appeared to be the most biologically modified in the Harbor. Sediments from Station 12 in Ballona Creek, and Station 2 parallel with the entrance jetties, were dominated by nematode worms, which are known to be characteristic of highly disturbed benthic sediments. These two stations had the highest numbers of individuals in the Harbor, however, diversities were low because seventy to eighty percent of sample population was represented by nematode worms. Samples from Station 2, as well as Station 1, just inside the breakwall, had the lowest infaunal trophic index values in the Harbor (which declines when ratios of pollution tolerant organisms increase). Station 1 was defined by the index as a "changed" benthic environment, and Station 2 was defined as "degraded". Surprisingly, Station 12 was characterized as being on the low end of "normal". Chemically, these three stations tended to have the highest concentrations of chlorinated hydrocarbons, particularly PCB's, and Stations 2 and 12 had high levels of nonspecific organics (although no cause and effect relationship can necessarily be inferred).

9. RECOMMENDED CHANGES TO THE PROGRAM

Although the existing program is scientifically sound, ecological research is never static, and new methods are being developed constantly. There is little advantage to jump on the bandwagon of every fad, however agencies, such as the Southern California Coastal Water Research Project (SCCWRP), have tested and have standardized a number of very useful ecological techniques. These methods are being used for marine surveys in much of the Southern California Bight and could enhance the Marina del Rey program considerably.

Water Quality. We have altered the water quality program very little. We have formalized the rainfall data by obtaining records from the National Weather Service. We calibrated all water quality parameters against outside measurements, and we provided water quality profiles for each measurement at each station. For the first time this year, we attempted to cluster stations based on their water quality characteristics, so that we could perhaps see some spatial patterns in the Harbor. This clustering was performed for all of the major sections of the report.

Physical Characteristics of Benthic Sediments. We greatly increased the numbers of categories of particle size by quantifying levels of silt and clay. We added both median particle size and sorting indices to the program, so that stations could be numerically compared.

Chemical Characteristics of Benthic Sediments. We were able to lower detection limits on a number of analytes, particularly chlorinated hydrocarbons, and for the first time this year we compared results to other sediment surveys conducted by SCCWRP and Los Angeles Harbor.

A number of sediment measurements provide little or nothing to the program and are typically associated with irrigation or drinking water testing. These include specific conductance, alkalinity, hardness, total dissolved solids, barium, boron, calcium, chloride, fluoride, nitrogen, nitrate, potassium, sulfate, and sodium. Analyses which could provide much more information would include polynuclear aromatic hydrocarbons and/or sediment bioassays.

We would also like to replace the immediate oxygen demand analysis (IOD) with the biochemical oxygen demand analysis (BOD). The former method is non-standardized, so it is performed differently in different laboratories, and it is not comparable to any other studies.

Biological Characteristics of Benthic Sediments. We did not change any of the infauna sampling techniques, except to use a chain-rigged Van Veen Grab, which is the sampling device generally accepted in southern California. We eliminated the Gleason species diversity index because we felt that there was really no need for two diversity indices (we retained the Shannon diversity index). We added two other indices: species dominance, which measures the degree to which one or more species dominate the population; and the Infaunal Trophic Index, which measures the proportion of infaunal animals known to be common to areas of high organic pollution.

As with chemical sediment analyses, we compared biological indices with surveys conducted by SCCWRP and Los Angeles Harbor. We would like to expand the analysis of infaunal populations in the future to include the new SCCWRP Benthic Response Index and perhaps attempt some cladistical clustering techniques presently being used in Los Angeles Harbor.

Fish Populations. Previous dive surveys were based on ten-minute swimming transects, five minutes in one direction along a jetty or breakwall, and then five minutes back in the other direction. We standardized the survey to 100 meters swimming in one direction. The problem with transects based on time is that when fish are abundant, it takes longer to count them, so a biologist will travel only a short distance in ten minutes. Conversely, if fish numbers are low, a biologist will travel much farther in ten minutes. Thus, fish counts are underestimated when numbers are high and overestimated when they are low. We chose 100 meters because it was roughly equivalent to an average ten minute survey (so our newer methods will then generally be comparable to past surveys). We survey in only one direction because the diver himself can affect fish counts. When a diver passes through an area for the first time, some fish will be frightened away while others will be attracted. Thus, the second pass count will underestimate the shyer fish species and overestimate the bolder fish species.

Finally, it appears that previous surveys must have been conducted during periods of very low visibility (such as during red tide events) because some survey counts were as low as one fish, or even zero fish. The purpose of these surveys are to determine how many fish and species are in the reef, not how many a diver can see under all oceanographic conditions. We restricted our dive surveys to at least moderately clear water.

The gill net surveys need some work. Since they are passive sampling devices, they require the movement of fish to encounter the net and become trapped, and counts, therefore, are typically very low. The length of time for the deployment (45 minutes) is too short for any effective collection and should be extended to as long as is safe and practical.

10. APPENDICES

10.1. REFERENCES

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10.2. WATER QUALITY DATA AND CRUISE LOGS

Physical Water Quality Data **July 29, 1996**

CRUISE:	MDR 96-97	Vessel:	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear		High	903	4.3
RAIN:	None		Low	1451	1.5

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m		NH3+NH4 u-at/l	BOD mg/l
1	1015	0	20.74	33.57	8.8	8.14	54.5	85.9	10	2.3		0.7	2.0
5k SW		1	20.70	33.57	8.9	8.14	55.5	86.3					
		2	20.65	33.57	9.0	8.14	56.2	86.6			<	0.6	2.3
		3	20.65	33.56	9.0	8.14	55.9	86.5					
		4	20.68	33.56	9.1	8.13	55.6	86.4			<	0.6	2.8
2	1034	0	20.62	33.51	8.6	8.12	48.9	83.6	8	2.3	<	0.6	1.8
5k SW		1	20.63	33.51	8.9	8.11	49.4	83.8					
		2	20.62	33.52	8.7	8.10	48.4	83.4			<	0.6	2.1
		3	20.60	33.52	8.3	8.13	48.0	83.2					
		4	20.60	33.51	8.3	8.16	48.0	83.2			<	0.6	1.7
		5	20.63	33.50	8.4	8.16	48.5	83.5					
3	1049	0	21.33	33.44	7.1	7.97	50.3	84.2	8	2.9		1.8	1.7
4k SW		1	21.06	33.42	7.3	7.97	50.2	84.2					
		2	20.75	33.47	7.4	7.97	53.5	85.5				1.5	1.9
		3	20.77	33.45	7.5	8.05	55.9	86.5					
		4	20.81	33.46	7.5	8.12	55.7	86.4				0.9	1.8
4	1104	0	21.98	33.20	6.9	7.90	47.4	83.0	12	2.1	<	0.6	3.3
4k SW		1	21.57	33.59	7.8	7.92	50.2	84.2					
		2	20.82	33.57	8.0	7.94	50.6	84.3			<	0.6	2.4
		3	20.65	33.45	8.0	8.01	51.2	84.6					
		4	20.61	33.46	7.9	8.07	52.1	85.0			<	0.6	2.0
		5	20.86	33.29	7.8	8.07	52.9	85.3					
5	1137	0	22.77	33.46	6.8	7.88	42.1	80.6	12	2.1		0.8	2.0
2k SW		1	22.67	33.48	6.6	7.88	46.6	82.6					
		2	22.46	33.57	6.5	7.88	44.9	81.8			<	0.6	2.3
		3	22.17	33.57	6.5	7.91	41.5	80.3					
		4	22.42	33.19	6.3	7.93	35.4	77.1				0.8	1.8
6	1154	0	22.54	33.50	6.4	7.93	50.4	84.3	12	2.7	<	0.6	1.4
2k SW		1	22.37	33.49	5.8	7.91	49.8	84.0					
		2	22.28	33.50	4.8	7.88	50.5	84.3				0.7	1.6
		3	22.28	33.47	5.3	7.83	36.1	77.5					
		4	22.33	33.49	4.7	7.77	38.1	78.5				3.1	1.6
7	1343	0	22.89	33.53	6.6	7.85	47.9	83.2	12	2.2		0.8	1.5
2k SW		1	22.80	33.52	6.2	7.85	45.0	81.9					
		2	22.67	33.50	6.1	7.84	43.0	81.0				0.9	1.9
		3	22.62	33.49	6.2	7.85	39.5	79.3					
		4	22.79	33.32	6.4	7.85	35.5	77.2				1.7	2.0

July 29, 1996 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
8	1230	0	23.38	33.61	6.5	7.85	47.8	83.2	12	2.1	0.7	1.5
2k SW		1	23.13	33.63	6.0	7.65	46.2	82.4				
		2	22.95	33.48	6.1	7.45	39.9	79.5			0.9	6.4
		3	22.89	33.52	6.1	7.45	20.3	67.1				
9	1320	0	23.74	33.32	7.1	7.40	47.0	82.8	12	2.1	1.4	6.1
9k SW		1	23.30	33.73	7.2	7.63	44.8	81.8				
		2	22.63	33.43	7.2	7.85	31.6	75.0			1.3	1.5
10	1255	0	23.18	33.41	5.7	7.77	35.6	77.2	12	1.3	4.8	1.4
2k SW		1	22.95	33.37	5.4	7.78	36.6	77.8				
		2	22.90	33.37	4.7	7.79	34.0	76.4			2.2	2.1
		3	22.87	33.35	4.6	7.74	24.5	70.3				
		4	23.00	33.29	5.9	7.68	21.8	68.3			6.2	2.6
11	1316	0	23.51	33.24	6.7	7.81	33.5	76.1	12	2.7	18.9	1.6
3k SW		1	23.20	33.44	7.0	7.82	44.5	81.7				
		2	22.84	33.44	7.1	7.82	38.1	78.6			4.9	1.6
		3	23.15	33.28	7.6	7.82	23.1	69.4				
12	955	0	20.76	33.50	8.6	8.10	52.9	85.3	10	3.2	1.1	1.9
5k SW		1	20.74	33.50	8.7	8.07	54.3	85.9				
		2	20.73	33.50	8.5	8.05	54.8	86.0			2.0	2.6
13	1430	0	24.20	33.42	8.3	7.97					5.6	2.6
18	1236	0	23.68	33.62	7.1	7.89	30.2	74.1	15	1.6	1.4	2.7
2k SW		1	23.36	33.65	7.0	7.86	35.6	77.2				
		2	23.43	33.45	7.4	7.82	37.4	78.2			2.3	2.7
19	1221	0	26.90	33.48	9.0	8.05					6.4	5.9
20	1305	0	23.38	33.35	6.3	7.81	46.6	82.6	12	2.1	5.2	1.2
2k SW		1	23.38	33.23	7.3	7.81	49.2	83.7				
22	1430	0	24.40	33.36	7.6	7.95					4.5	2.6
25	1114	0	22.09	33.31	7.0	7.88	55.4	86.3	12	2.1	1.6	2.6
2k NE		1	21.88	33.41	7.0	7.90	57.1	86.9				
		2	21.28	33.55	7.2	7.91	55.4	86.3			3.7	2.1
		3	20.98	33.49	7.3	7.96	53.9	85.7				
		4	20.83	33.44	7.4	8.01	50.9	84.4			2.8	1.4
		5	21.01	33.09	7.3	8.01	42.0	80.5				
	Average		22.13	33.46	7.1	7.91	45.2	81.6	11	2.3	2.4	2.3
	Number		70	70	70	70	67	67	15	15	41	41
	St. Dev.		1.27	0.12	1.1	0.17	9.1	4.6	2	0.5	3.2	1.2
	Maximum		26.90	33.73	9.1	8.16	57.1	86.9	15	3.2	18.9	6.4
	Minimum		20.60	33.09	4.6	7.40	20.3	67.1	8	1.3	0.6	1.2

Surface Bacteriological Water Data and General Observations **July 29, 1996**

CRUISE:	MDR 96-97	Vessel:		TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger	High	903	4.3
RAIN:	None		M. Oguri, T. Mikel	Low	1451	1.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1015	40	20	< 20	Moderate turbidity.
2	1034	< 20	< 20	< 20	Moderate turbidity. Floating yellow/green algae.
3	1049	< 20	< 20	< 20	Moderate turbidity. Floating yellow/green algae.
4	1104	20	< 20	< 20	Moderate turbidity. Much paper and plastic on the ramp and below the surface of the water.
5	1137	< 20	< 20	< 20	Moderate turbidity. Junior sailing class in channel.
6	1154	< 20	< 20	< 20	Moderate turbidity.
7	1343	< 20	< 20	< 20	Moderate turbidity.
8	1230	20	20	< 20	High turbidity.
9	1320	40	< 20	< 20	High turbidity.
10	1255	300	110	< 20	High turbidity.
11	1316	70	< 20	< 20	Moderate turbidity.
12	955	< 20	< 20	< 20	Moderate turbidity. Floating yellow/green algae.
13	1430	< 20	< 20	< 20	High turbidity. Hundreds of small fish (perhaps smelt) and one dogfish shark in water.
18	1236	< 20	< 20	< 20	High turbidity.
19	1221	20	< 20	< 20	High turbidity. Children and some adults in water.
20	1305	20	20	80	High turbidity.
22	1430	80	40	< 20	High turbidity. Hundreds of small fish (perhaps smelt) in the water.
25	1114	500	500	20	Moderate turbidity. Fuel slick on the surface.
	Average	70.6	52.8	23.3	
	Number	18	18	18	
	St. Dev.	126.0	113.6	14.1	
	Maximum	500	500	80	
	Minimum	20	20	20	

Physical Water Quality Data **August 9, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to partly cloudy	Pers.: .Gelsinger	High	814	3.8
RAIN:	None	M. Meyer	Low	1257	2.5
		T. Mikel			

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1015	0	20.24	31.18	5.54	8.21	65.70	90.0	10	2.6	< 0.6	2.2
5k WSW		1	19.99	32.17	5.57	8.21	54.14	85.8				
		2	19.91	33.01	5.69	8.24	52.94	85.3			3.8	0.7
2	1034	0	21.84	33.40	6.22	8.23	58.43	87.4	10	3.0	< 0.6	1.0
5k WSW		1	21.78	33.40	6.4	8.23	57.7	87.1				
		2	20.92	33.30	7.08	8.24	55.32	86.2			< 0.6	1.3
		3	20.19	33.39	7.71	8.27	58.52	87.5				
		4	19.67	33.51	8.16	8.27	61.91	88.7			2.9	2.0
3	1049	0	21.64	33.46	6.22	8.15	65.01	89.8	9	4.1	2.0	1.1
4k WSW		1	21.52	33.45	6.5	8.15	64.0	89.4				
		2	21.62	33.51	6.96	8.16	64.53	89.6			1.4	0.5
		3	21.65	33.46	7.36	8.16	66.76	90.4				
		4	21.52	33.35	7.56	8.16	63.05	89.1			1.4	0.2
4	1104	0	22.24	33.48	5.89	8.18	60.22	88.1	10	3.5	< 0.6	1.3
4k WSW		1	22.23	33.48	6.01	8.18	59.31	87.8				
		2	22.11	33.46	6.31	8.22	57.00	86.9			< 0.6	1.0
		3	21.21	33.35	6.71	8.24	56.46	86.7				
		4	20.80	33.34	7.29	8.24	54.73	86.0			< 0.6	1.2
5	1137	0	22.81	33.45	5.88	8.15	67.53	90.7	10	3.8	< 0.6	0.6
5k WSW		1	22.68	33.42	6.1	8.15	64.6	89.7				
		2	22.45	33.48	6.61	8.17	58.31	87.4			< 0.6	0.8
		3	22.24	33.54	7.13	8.18	55.32	86.2				
		4	21.72	33.40	7.63	8.20	52.21	85.0			1.0	1.2
6	1154	0	22.22	33.49	6.07	8.14	56.31	86.6	11	3.2	0.6	1.2
3k WSW		1	22.21	33.50	6.0	8.14	52.9	85.3				
		2	22.17	33.51	6.10	8.16	51.32	84.6			0.7	1.0
		3	22.11	33.50	6.16	8.15	50.98	84.5				
7	1343	0	22.82	33.50	5.98	8.11	48.33	83.4	10	2.3	1.6	0.5
3k WSW		1	22.79	33.51	6.14	8.11	48.48	83.4				
		2	22.78	33.51	6.2	8.11	48.5	83.5			1.5	< 0.1
		3	22.76	33.51	6.28	8.11	48.49	83.4				
		4	22.72	33.49	6.22	8.11	47.29	82.9			1.8	1.3
8	1230	0	22.51	33.86	6.32	7.74	27.58	72.5	10	3.2	1.6	3.3
3k SSE		1	22.51	33.51	6.38	7.89	34.26	76.5				
		2	22.491	33.457	6.43	8.180	47.62	83.07			1.4	1.0
		3	22.46	33.48	6.44	7.96	48.30	83.4				
		4	22.40	33.49	6.44	7.85	48.64	83.5			0.9	4.3
9	1320	0	22.92	33.11	6.08	8.05	65.08	89.8	10	2.4	2.2	0.7
4k SSE		1	22.89	33.14	6.23	8.06	53.98	85.7				
		2	22.44	33.39	6.2	8.08	32.1	75.3			2.2	1.2
		3	22.31	33.45	6.3	8.12	39.8	79.4				
		4	22.08	33.43	6.2	8.12	29.5	73.7			2.5	3.3

August 9, 1996 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
10	1255	0	22.77	33.32	5.28	8.10	59.45	87.8	11	2.6	3.0	2.0
1k SSE		1	22.77	33.34	5.39	8.12	56.17	86.6				
		2	22.65	33.37	5.3	8.12	44.3	81.6			2.8	1.5
		3	22.64	33.38	5.13	8.11	43.44	81.2				
		4	22.62	33.35	5.07	8.09	38.16	78.6			3.2	0.8
11	1316	0	22.60	33.37	6.26	8.12	55.61	86.4	10	2.5	2.2	0.5
3k SSE		1	22.57	33.36	6.52	8.12	53.54	85.5				
		2	22.48	33.39	7.1	8.12	45.9	82.3			2.6	2.2
		3	22.38	33.42	7.72	8.12	34.40	76.6				
12	955	0	21.35	28.29	5.91	8.22	62.39	88.9	10	3.1	5.9	3.4
5k WSW		1	20.87	30.07	6.18	8.20	59.98	88.0				
		2	20.54	32.24	6.67	8.20	67.00	90.5			5.3	2.4
13	1430	0	22.30	33.38	2.60	7.54					7.0	1.8
18	1236	0	22.46	33.06	6.42	8.13	43.00	81.0	12	2.6	1.3	1.7
3k SSE		1	22.46	33.18	6.4	8.16	47.6	83.1				
		2	22.44	33.35	6.42	8.22	56.9	86.8			1.5	0.9
19	1221	0	21.60	33.38	5.80	7.52					4.9	3.8
20	1305	0	22.76	33.22	6.23	8.08	64.16	89.5	10	1.8	4.7	3.2
1k SSE		1	22.78	33.28	6.3	8.08	59.5	87.8				
22	1430	0	22.60	32.59	2.2	7.30					3.2	7.5
25	1114	0	22.27	33.49	6.19	8.15	64.23	89.5	9	3.2	< 0.6	< 0.1
3k WSW		1	22.25	33.49	6.46	8.15	64.92	89.8				
		2	22.14	33.50	7.0	8.15	66.3	90.2			1.8	1.0
		3	21.99	33.43	7.60	8.15	63.1	89.1				
		4	21.84	33.26	8.3	8.18	47.1	82.8			1.9	0.5
		5	20.11	34.00	8.73	8.22	45.48	82.1				
	Average		22.01	33.21	6.32	8.11	53.78	85.3	10	2.9	2.1	1.6
	Number		68.00	68.00	68.00	68.00	65.00	65.0	15	15.0	41.0	41.0
	St. Dev.		0.82	0.82	1.00	0.17	9.77	4.2	1	0.6	1.6	1.4
	Maximum		22.92	34.00	8.73	8.27	67.53	90.7	12	4.1	7.0	7.5
	Minimum		19.670	28.288	2.20	7.300	27.58	72.47	9.0	1.8	0.6	0.1

Surface Bacteriological Water Data and General Observations **August 9, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to partly cloudy	Pers.: J.Gelsinger	High	814	3.8
RAIN:	None	M. Meyer	Low	1257	2.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1100	170	130	4	Moderate turbidity. Moderate surf.
2	1051	< 20	< 20	2	Moderate turbidity.
3	1043	< 20	< 20	< 2	Moderate turbidity. Moderate flow into channel from tidegate. Some floating trash.
4	1036	20	< 20	< 2	Moderate turbidity.
5	1002	20	20	< 2	Moderate turbidity.
6	1012	< 20	< 20	< 2	Moderate turbidity.
7	1127	20	20	< 2	Moderate turbidity.
8	904	80	40	< 2	Moderate turbidity.
9	949	< 20	< 20	< 2	Moderate turbidity. Small amount of floating plastic.
10	920	1700	140	7	Moderate turbidity.
11	938	120	< 20	2	Moderate turbidity.
12	1106	270	130	2	Moderate turbidity.
13	755	1300	110	220	Moderate turbidity. Significant flow into basin from tidegate. Many small fish in water.
18	844	130	130	< 2	Moderate turbidity.
19	804	300	300	2	Moderate turbidity. Many small fish in the water.
20	926	9000	2200	130	Heavy turbidity.
22	745	5000	1700	90	Moderate turbidity.
25	1027	20	< 20	< 2	Moderate turbidity. Kayakers in channel.
	Average	1012.8	281.1	26.5	
	Number	18	18	18	
	St. Dev.	2330.7	617.6	59.8	
	Maximum	9000	2200	220	
	Minimum	20	20	2	

Physical Water Quality Data **September 8, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	842	4.5
RAIN:	None	M. Meyer	Low	1307	1.9

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m		NH3+NH4 u-at/l	BOD mg/l
1	1100	0	22.35	31.14	8.13	8.13	66.92	90.4	10	5.8	<	0.6	1.4
6k WSW		1	22.14	32.09	8.28	8.13	64.59	89.6					
		2	21.91	33.22	8.88	8.15	64.86	89.7			<	0.6	2.0
		3	21.91	33.34	9.45	8.16	66.33	90.2					
		4	21.89	33.45	9.54	8.16	66.50	90.3			<	0.6	1.8
2	1049	0	22.90	33.21	7.33	8.07	53.04	85.3	10	3.9	<	0.6	1.6
6k WSW		1	22.78	33.15	7.46	8.07	51.54	84.7					
		2	22.55	32.94	7.72	8.09	57.68	87.1			<	0.6	2.5
		3	22.05	33.19	8.03	8.12	60.61	88.2					
		4	21.94	33.24	8.06	8.13	61.83	88.7			<	0.6	2.5
3	1037	0	22.68	33.31	6.55	8.02	65.68	90.0	10	4.3	<	0.6	1.4
6k WSW		1	22.64	33.29	6.61	8.02	65.60	90.0					
		2	22.57	33.29	6.80	8.02	63.47	89.3			<	0.6	1.2
		3	22.21	33.31	6.91	8.03	62.29	88.8					
		4	22.22	33.35	6.90	8.03	61.70	88.6			<	0.6	1.5
4	1128	0	22.89	33.00	7.03	8.07	59.44	87.8	10	3.6	<	0.6	2.0
6k WSW		1	22.86	32.99	7.03	8.07	60.13	88.1					
		2	22.85	33.12	7.03	8.05	58.44	87.4			<	0.6	1.7
		3	22.80	33.07	7.03	8.04	58.49	87.5					
		4	22.13	32.99	7.43	8.05	53.06	85.3			<	0.6	1.8
		5	21.71	33.30	7.19	8.08	56.39	86.7					
5	1006	0	22.87	33.27	7.14	8.04	56.09	86.5	10	2.9	<	0.6	1.7
6k WSW		1	22.86	33.27	7.25	8.03	54.99	86.1					
		2	22.84	33.33	7.49	8.04	47.61	83.1			<	0.6	1.9
		3	22.82	33.36	7.70	8.04	45.17	82.0					
		4	22.83	33.36	7.79	8.03	46.60	82.6			<	0.6	1.9
		5	22.79	33.36	7.86	8.02	51.40	84.7					
6	1019	0	23.14	33.45	6.92	8.01	61.61	88.6	10	3.9	<	0.6	1.2
6k WSW		1	23.09	33.42	6.94	8.01	60.64	88.2					
		2	22.99	33.38	7.04	8.02	58.23	87.4			<	0.6	1.1
		3	22.93	33.44	7.10	8.02	55.98	86.5					
		4	22.91	33.40	7.03	7.98	55.35	86.3			<	0.6	1.8
7	1148	0	23.54	34.13	7.09	8.05	31.81	75.1	11	1.5	<	0.6	1.2
6k WSW		1	23.52	33.95	7.09	8.05	33.04	75.8					
		2	23.44	33.60	7.08	8.05	35.51	77.2			<	0.6	1.2
		3	23.31	33.45	7.03	8.05	36.74	77.9					
		4	23.14	33.52	6.93	8.04	---	---			<	0.6	1.2

September 8, 1996 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m		NH3+NH4 u-at/l	BOD mg/l
8	856	0	23.14	33.41	6.85	7.98	59.60	87.9	10	3.4	<	0.6	1.3
2k SSE		1	23.14	33.43	6.82	8.00	57.85	87.2					
		2	23.12	33.43	6.99	8.01	53.42	85.5			<	0.6	0.9
		3	23.08	33.43	7.08	8.01	45.32	82.0					
		4	23.02	33.41	7.12	8.01	48.66	83.5			<	0.6	1.3
9	952	0	23.47	33.29	6.76	7.95	46.17	82.4	11	2.2	<	0.6	1.1
6k WSW		1	23.45	33.30	6.81	7.95	39.08	79.1					
		2	23.37	33.32	6.94	7.97	37.02	78.0			<	0.6	1.3
		3	23.30	33.35	7.04	7.97	26.04	71.4					
		4	23.32	33.31	6.93	7.95	27.78	72.6				0.8	3.1
10	926	0	23.38	33.30	6.79	7.97	44.82	81.8	11	2.6	<	0.6	1.4
2k SSE		1	23.36	33.31	6.79	7.97	41.80	80.4					
		2	23.30	33.33	6.82	7.98	39.62	79.3			<	0.6	1.7
		3	23.29	33.33	6.87	7.98	46.75	82.7					
		4	23.28	33.29	6.97	7.96	38.46	78.8			<	0.6	1.4
11	940	0	23.37	33.24	7.43	7.97	57.25	87.0	10	2.0	<	0.6	1.8
2k SSE		1	23.34	33.27	7.68	7.97	49.28	83.8					
		2	23.29	33.34	8.24	7.96	33.93	76.3			<	0.6	1.0
		3	23.19	33.38	8.55	7.98	38.37	78.7					
		4	23.15	33.40	8.77	7.99	28.15	72.8			<	0.6	2.3
12	1109	0	22.53	31.02	7.01	8.13	65.77	90.1	10	3.3	<	0.6	6.0
6k WSW		1	22.46	31.72	7.12	8.10	68.53	91.0					
		2	22.21	32.64	7.38	8.07	72.33	92.2			<	0.6	1.9
		3	22.26	32.83	7.24	8.10	72.93	92.4					
13	759	0	22.80	33.15	3.50	7.64						4.2	2.6
18	838	0	23.09	33.40	7.99	8.00	57.20	87.0	11	3.1	<	0.6	1.8
2k SSE		1	23.09	33.41	7.98	8.01	56.20	86.6					
		2	23.07	33.41	8.04	8.00	53.35	85.5			<	0.6	1.4
19	814	0	22.80	33.18	7.10	8.02					<	0.6	2.0
20	916	0	22.78	32.94	7.17	7.90	75.71	93.3	12	2.5		2.3	3.3
2k SSE		1	23.05	33.13	7.16	7.91	56.09	86.5					
		2	23.14	33.20	7.15	7.93	49.76	84.0			<	0.6	1.6
22	745	0	22.80	33.01	2.60	7.56					<	0.6	7.8
25	1137	0	23.35	33.36	7.31	8.07	54.00	85.7	10	4.0	<	0.6	1.6
6k WSW		1	23.27	33.37	7.29	8.07	54.12	85.8					
		2	23.11	33.40	7.26	8.06	55.85	86.4			<	0.6	0.9
		3	22.95	33.46	7.23	8.06	48.15	83.3					
		4	22.51	33.77	7.20	8.05	31.51	74.9			<	0.6	1.1
	Average		22.87	33.21	7.2	8.02	52.7	84.8	10.4	3.3		0.7	1.9
	Number		75	75	75	75	71	71	15	15		45	45
	St. Dev.		0.45	0.47	0.9	0.09	11.7	5.1	0.6	1.1		0.6	1.2
	Maximum		23.54	34.13	9.5	8.16	75.7	93.3	12	5.8		4.2	7.8
	Minimum		21.71	31.02	2.6	7.56	26.0	71.4	10	1.5		0.6	0.9

Surface Bacteriological Water Data and General Observations **September 8, 1996**

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.:	J. Gelsinger	High	842	4.5
RAIN:	None		M. Meyer	Low	1307	1.9

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1100	40	40	< 2	Moderate turbidity. Light boat traffic at entrance.
2	1049	< 20	< 20	< 2	Moderate turbidity.
3	1037	20	20	< 2	Moderate turbidity. Strong flow into channel.
4	1128	< 20	< 20	< 2	Moderate turbidity. Floating trash and surface film by concrete wall.
5	1006	300	< 20	< 2	Moderate turbidity.
6	1019	< 20	< 20	< 2	Moderate turbidity.
7	1148	< 20	< 20	< 2	Heavy turbidity. Moderate boat activity at launch ramp.
8	856	170	70	< 2	Moderate turbidity.
9	952	< 20	< 20	< 2	Moderate turbidity.
10	926	80	20	< 2	Moderate turbidity. Floating surface film.
11	940	< 20	< 20	< 2	Moderate turbidity.
12	1109	80	80	< 2	Moderate turbidity. Moderate fishing activity. Dead bonito floating in water.
13	759	800	80	< 2	Moderate turbidity. Strong flow from tide gate.
18	838	230	230	< 2	Moderate turbidity. Fish jumping out of water.
19	814	130	130	< 2	Moderate turbidity. Beach heavily littered.
20	916	1700	40	4	Heavy turbidity.
22	745	9000	500	2	Heavy turbidity. Floating brownish-green algal mats.
25	1137	< 20	< 20	< 2	Moderate turbidity. Many seabirds and 21 sea lions in channel.
	Average	705.0	76.1	2.1	
	Number	18	18	18	
	St. Dev.	2111.5	118.9	0.5	
	Maximum	9000	500	4	
	Minimum	20	20	2	

Physical Water Quality Data **October 8, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Foggy	Pers.: J. Gelsinger	High	800	4.8
RAIN:	None	M. Meyer	Low	1351	1.6

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	
1	1103	0	19.50	31.64	7.69	8.11	69.39	91.3	9	4.9	7.6	
4k SW		1	19.43	32.08	7.66	8.11	68.15	90.9				
		2	19.36	32.77	7.71	8.11	66.34	90.2			3.9	
		3	19.31	32.95	7.78	8.10	66.38	90.3				
		4	19.23	33.01	8.02	8.11	66.64	90.4			3.3	
2	1059	0	20.35	33.30	7.80	8.07	56.13	86.6	11	3.3	3.9	
4k SW		1	20.29	33.32	7.86	8.06	56.21	86.6				
		2	20.00	33.33	8.45	8.08	58.54	87.5			4.2	
		3	19.59	33.29	9.15	8.11	66.74	90.4				
		4	19.23	33.31	9.48	8.13	67.98	90.8			2.7	
3	1042	0	20.09	33.37	7.57	8.01	63.33	89.2	10	3.6	8.8	
4k SW		1	20.10	33.37	7.60	8.01	63.43	89.2				
		2	20.11	33.37	7.68	8.01	64.02	89.4			8.5	
		3	20.13	33.36	7.65	8.01	63.71	89.3				
4	1130	0	20.36	33.36	7.07	7.99	61.70	88.6	10	3.6	8.5	
4k SW		1	20.36	33.36	7.07	8.00	61.27	88.5				
		2	20.29	33.24	7.08	8.00	60.65	88.2			8.3	<
		3	20.08	33.17	7.01	8.01	60.17	88.1				
		4	19.79	33.00	7.16	8.05	61.75	88.6			6.3	
5	1010	0	20.95	33.33	7.69	7.96	59.23	87.7	10	2.7	11.2	
4k SW		1	20.94	33.38	7.63	7.97	57.03	86.9				
		2	20.87	33.38	7.68	7.97	53.03	85.3			9.9	
		3	20.78	33.36	7.66	8.00	52.33	85.1				
		4	20.69	33.30	7.55	8.02	55.45	86.3			9.1	
6	1026	0	20.77	31.97	8.32	7.94	54.29	85.8	10	2.5	14.7	
4k SW		1	20.76	33.55	8.44	7.94	54.18	85.8				
		2	20.76	33.44	9.07	7.94	52.08	85.0			14.6	<
		3	20.75	33.44	9.75	7.93	46.63	82.6				
		4	20.75	33.44	10.11	7.91	42.36	80.7			15.1	
7	1152	0	21.16	33.43	6.84	7.92	41.98	80.5	12	2.1	11.2	
4k SW		1	21.16	33.43	6.62	7.92	42.01	80.5				
		2	21.12	33.42	9.53	7.92	42.22	80.6			10.9	<
		3	21.06	33.42	10.13	7.92	39.42	79.2				
		4									10.5	

October 8, 1996 **(Continued)**

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	
8	902	0	21.05	33.42	6.50	7.92	39.90	79.5	11	1.8	14.4	
3k SW		1	21.06	33.43	6.64	7.92	39.68	79.4				
		2	21.07	33.43	7.35	7.92	39.45	79.3			15.4	<
		3	21.08	33.43	7.81	7.92	39.72	79.4				
		4	21.08	33.43	7.85	7.93	40.46	79.8			15.3	<
9	958	0	20.96	33.01	7.05	7.91	53.94	85.7	11	2.1	14.4	
4k SW		1	21.03	33.05	7.06	7.93	54.84	86.1				
		2	21.04	33.07	7.09	7.97	56.65	86.8			14.0	
		3	21.00	32.97	7.21	8.02	37.64	78.3				
		4									13.2	
10	931	0	21.14	33.29	6.82	7.94	56.20	86.6	12	2.0	16.5	
3k SW		1	21.14	33.29	6.82	7.94	55.06	86.1				
		2	21.14	33.30	6.82	7.94	52.80	85.2			16.4	
		3	21.14	33.30	8.95	7.98	50.31	84.2				
		4									16.0	
11	945	0	21.02	33.23	7.31	7.99	53.71	85.6	10	2.2	13.4	
3k SW		1	21.01	33.33	7.26	8.00	52.20	85.0				
		2	21.01	33.35	7.16	8.03	49.18	83.7			13.3	
		3	20.99	33.34	7.19	8.02	44.05	81.5				
		4	20.97	33.34	7.21	8.02	41.48	80.3			13.2	
12	1112	0	20.40	24.70	7.91	7.94	57.78	87.2	10	3.2	13.2	
4k SW		1	20.33	26.10	7.96	8.00	57.48	87.1				
		2	20.00	30.26	8.06	8.13	56.87	86.8			9.9	
13	742	0	21.09	33.35	2.8	7.89					18.2	
18	851	0	21.07	33.33	7.17	7.93	43.95	81.4	10	2.3	14.4	
3k SW		1	21.07	33.46	7.29	7.93	43.75	81.3				
		2	21.08	33.46	7.88	7.93	43.80	81.4			14.1	
19	757	0	20.55	33.82	4.2	7.95					14.4	
20	922	0	21.09	33.36	8.70	7.86	54.38	85.9	12	1.8	15.1	<
3k SW		1	21.09	33.39	7.99	7.87	48.80	83.6				
		2	21.09	33.46	6.57	7.88	37.63	78.3			15.7	
22	725	0	20.66	32.82	2.6	7.85					7.0	
25	1140	0	20.71	33.41	7.48	7.97	59.94	88.0	10	3.7	9.1	
4k NE		1	20.71	33.42	7.60	7.98	59.89	88.0				
		2	20.69	33.41	8.17	7.97	60.91	88.3			9.2	
		3	20.62	33.42	8.90	7.98	63.68	89.3				
		4	20.29	33.54	9.65	8.00	56.89	86.8			10.2	
	Average		20.61	32.98	7.6	7.98	53.8	85.4	10.5	2.8	11.3	
	Number		68	68	68	68	65	65	15	15	44	
	St. Dev.		0.56	1.42	1.3	0.07	9.0	3.7	0.9	0.9	4.0	
	Maximum		21.16	33.82	10.1	8.13	69.4	91.3	12	4.9	18.2	
	Minimum		19.23	24.70	2.6	7.85	37.6	78.3	9	1.8	2.7	

Surface Bacteriological Water Data and General Observations **October 8, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Foggy	Pers.: J. Gelsinger	High	800	4.8
RAIN:	None	M. Meyer	Low	1351	1.6

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1103	340	220	7	Light turbidity.
2	1059	< 20	< 20	< 2	Light turbidity. Many fish on surface. Many pelicans on breakwall.
3	1042	< 20	< 20	4	Moderate turbidity. Many fish in water. Strong flow from tidal gate.
4	1130	220	140	5	Moderate turbidity.
5	1010	50	20	< 2	Moderate turbidity.
6	1026	50	< 20	< 2	Moderate turbidity.
7	1152	800	110	8	Moderate turbidity.
8	902	3000	3000	8	Moderate turbidity. Three pelicans on houseboat.
9	958	80	20	< 2	Moderate turbidity. Some floating debris.
10	931	≥ 16000	500	13	Moderate turbidity. Someone rinsing soapy water into harbor water.
11	945	130	20	< 2	Moderate turbidity. Blue heron sitting on dock.
12	1112	1300	300	5	Moderate turbidity. Submerged trash noted.
13	742	300	20	5	Moderate turbidity. Matted algae on grid. Moderate flow into lagoon.
18	851	5000	170	2	Moderate turbidity.
19	757	2400	2400	< 2	Moderate turbidity. Slight floating flotsam.
20	922	500	220	2	Moderate turbidity.
22	725	1300	500	2	Moderate turbidity.
25	1140	80	80	5	Moderate turbidity. Sea lion in water.
	Average	1755.0	432.2	4.3	
	Number	18	18	18	
	St. Dev.	3795.3	845.5	3.1	
	Maximum	16000	3000	13	
	Minimum	20	20	2	

Physical Water Quality Data **November 15, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to hazy	Pers.: J. Gelsinger	High	1119	5.6
RAIN:	None	M. Meyer	Low	648	-0.1

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l
1	1055	0	16.75	33.37	8.62	8.28	69.90	91.4	9	5.3	10.2
5k E		1	16.76	33.38	8.57	8.28	69.76	91.4			
		2	16.68	33.41	8.59	8.29	69.97	91.5			< 0.6
		3	16.59	33.42	8.58	8.29	68.05	90.8			
		4	16.60	33.45	8.69	8.28	69.28	91.2			5.5
2	1044	0	16.56	33.39	8.59	8.29	62.24	88.8	10	3.9	< 0.6
5k E		1	16.56	33.40	8.55	8.29	62.22	88.8			
		2	16.54	33.42	8.52	8.29	62.34	88.9			< 0.6
		3	16.54	33.43	8.50	8.29	62.62	89.0			
		4	16.52	33.45	8.50	8.30	62.76	89.0			< 0.6
		5	16.52	33.45	8.53	8.29	63.32	89.2			
3	1035	0	16.62	33.26	7.76	8.23	64.98	89.8	10	4.0	< 0.6
5k E		1	16.61	33.28	7.70	8.23	65.61	90.0			
		2	16.58	33.30	7.68	8.22	66.28	90.2			< 0.6
		3	16.55	33.31	7.66	8.23	63.70	89.3			
		4	16.53	33.32	7.63	8.25	61.61	88.6			3.0
4	1122	0	16.87	33.27	7.19	8.17	67.68	90.7	10	5.1	4.1
5k E		1	16.86	33.27	7.18	8.17	68.33	90.9			
		2	16.80	33.27	7.21	8.16	70.34	91.6			2.5
		3	16.68	33.27	7.13	8.18	69.36	91.3			
		4	16.65	33.29	6.97	8.19	66.90	90.4			4.9
5	959	0	16.86	33.21	6.73	8.14	58.43	87.4	10	3.6	5.5
2k E		1	16.85	33.21	6.67	8.14	59.79	87.9			
		2	16.82	33.23	6.65	8.15	59.23	87.7			3.8
		3	16.80	33.23	6.70	8.15	60.21	88.1			
		4	16.79	33.24	6.71	8.16	61.39	88.5			2.7
		5	16.79	33.24	6.75	8.17	61.50	88.6			
6	1015	0	16.82	33.20	5.84	8.05	55.10	86.2	10	2.9	5.0
5k E		1	16.80	33.19	5.77	8.05	54.52	85.9			
		2	16.76	33.20	5.76	8.06	54.00	85.7			4.1
		3	16.74	33.20	5.73	8.06	52.81	85.2			
		4	16.74	33.21	5.76	8.05	53.30	85.4			4.6
7	1145	0	16.97	33.20	6.11	8.04	57.75	87.2	10	3.2	6.4
5k E		1	16.96	33.20	6.06	8.04	57.69	87.2			
		2	16.93	33.20	5.99	8.04	56.14	86.6			6.8
		3	16.93	33.20	5.81	8.03	55.62	86.4			
		4	16.91	33.20	5.57	8.03	55.62	86.4			6.9
8	855	0	16.86	33.16	5.95	8.07	49.31	83.8	10	2.6	5.3
2k E		1	16.86	33.16	5.87	8.07	48.60	83.5			
		2	16.84	33.14	5.85	8.07	50.49	84.3			5.3
		3	16.75	33.15	5.84	8.08	50.94	84.5			
		4	16.67	33.16	5.87	8.08	52.46	85.1			4.7

November 15, 1996 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l
9	947	0	17.06	33.15	5.56	8.07	52.68	85.2	10	2.8	5.0
2k E		1	17.06	33.15	5.19	8.07	52.28	85.0			
		2	17.00	33.14	5.60	8.08	51.93	84.9			4.5
		3	16.98	33.19	5.70	8.09	52.41	85.1			
		4	16.98	33.19	5.77	8.09	47.82	83.2			3.9
10	920	0	16.99	33.09	5.25	8.03	54.58	86.0	10	2.7	7.7
2k E		1	16.99	33.09	5.13	8.03	54.16	85.8			
		2	16.99	33.09	5.15	8.03	54.53	85.9			6.9
		3	16.99	33.09	5.14	8.03	54.55	85.9			
		4	16.99	33.10	5.13	8.03	54.46	85.9			6.7
11	936	0	16.94	33.14	5.85	8.07	47.20	82.9	10	2.7	5.0
2k E		1	16.94	33.14	5.77	8.08	48.05	83.3			
		2	16.92	33.16	5.81	8.07	50.83	84.4			4.7
		3	16.90	33.15	5.76	8.09	49.53	83.9			
		4	16.87	33.17	6.02	8.09	50.31	84.2			5.0
12	1105	0	16.61	32.48	7.46	8.24	72.21	92.2	9	3.2	3.7
5k E		1	16.66	33.24	7.41	8.24	71.06	91.8			
		2	16.67	33.43	7.43	8.28	71.12	91.8			< 0.6
		3	16.66	33.44	8.19	8.25	75.10	93.1			
13	813	0	16.83	33.14	4.4	7.62					6.1
18	845	0	16.74	33.17	6.15	8.08	52.90	85.3	11	2.5	4.7
2k E		1	16.74	33.17	6.00	8.09	51.95	84.9			
		2	16.73	33.16	6.07	8.09	51.70	84.8			3.2
19	825	0	16.58	33.19	6.3	8.07					4.7
20	914	0	17.00	33.09	6.17	8.03	46.77	82.7	12	1.7	5.7
2k E		1	17.01	33.10	5.91	8.03	46.97	82.8			
		2	17.01	33.10	5.91	8.03	47.09	82.8			6.4
22	758	0	16.00	33.14	4.2	7.48					9.8
25	1132	0	16.86	33.27	7.01	8.16	69.17	91.2	10	5.1	1.4
5k E		1	16.86	33.27	6.98	8.16	69.26	91.2			
		2	16.84	33.26	6.97	8.17	68.29	90.9			1.7
		3	16.83	33.27	6.97	8.17	67.28	90.6			
		4	16.82	33.27	6.99	8.17	66.57	90.3			1.0
		5	16.82	33.28	6.99	8.17	62.68	89.0			
											1.3
	Average		16.79	33.22	6.6	8.12	59.1	87.6	10.1	3.4	4.2
	Number		76	76	76	76	73	73	15	15	46
	St. Dev.		0.18	0.13	1.1	0.13	7.9	2.9	0.7	1.1	2.4
	Maximum		17.06	33.45	8.7	8.30	75.1	93.1	12	5.3	10.2
	Minimum		16.00	32.48	4.2	7.48	46.8	82.7	9	1.7	0.6

Surface Bacteriological Water Data and General Observations **November 15, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to hazy	Pers.: J. Gelsinger	High	1119	5.6
RAIN:	None	M. Meyer	Low	648	-0.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1055	40	20	< 2	Moderate turbidity. Floating trash present (plastic, paper, etc.)
2	1044	130	20	< 2	Moderate turbidity. Much floating trash (plastic bottles, styrofoam cups, etc.)
3	1035	< 20	< 20	< 2	Low turbidity.
4	1122	20	20	< 2	Moderate turbidity.
5	959	< 20	< 20	< 2	Low turbidity.
6	1015	< 20	< 20	2	Moderate turbidity.
7	1145	20	20	< 2	Moderate turbidity.
8	855	110	20	< 2	Moderate turbidity.
9	947	40	20	< 2	Moderate turbidity.
10	920	800	70	< 2	Moderate turbidity.
11	936	1700	80	< 2	Moderate turbidity. Dock repair being conducted.
12	1105	800	40	7	Low turbidity.
13	813	9000	20	8	High turbidity. Floating material and discoloration. Many small fish in water column.
18	845	40	< 20	2	Moderate turbidity. Floating particles present.
19	825	20	< 20	2	Moderate turbidity. Floating surface film.
20	914	2400	500	2	Moderate turbidity. Strong sulfide odor.
22	758	> 16000	140	17	High turbidity. Surface oil film. Small fish in water.
25	1132	80	< 20	< 2	Moderate turbidity. Fishing activity on dock.
	Average	1736.7	60.6	3.4	
	Number	18	18	18	
	St. Dev.	4149.3	114.2	3.8	
	Maximum	16000	500	17	
	Minimum	20	20	2	

Physical Water Quality Data **December 18, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	413	5.3
RAIN:	None	M. Meyer	Low	1058	1.2

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1010	0	15.08	32.07	7.60	8.20	66.10	90.2	10	3.4	3.9	1.6
4k SE		1	14.92	32.52	7.50	8.21	65.32	89.9				
		2	14.89	33.06	7.46	8.24	61.67	88.6			< 0.6	1.4
		3	14.83	33.14	7.48	8.28	57.87	87.2				
2	1100	0	14.78	30.71	7.62	8.19	66.85	90.4	9	5.2	1.6	2.1
1k NE		1	14.76	31.47	7.47	8.19	66.55	90.3				
		2	14.79	32.64	7.38	8.18	65.86	90.1			< 0.6	1.5
		3	14.82	32.81	7.32	8.18	63.54	89.3				
		4	14.95	32.95	7.31	8.21	64.09	89.5			< 0.6	1.4
3	950	0	14.61	32.62	6.62	8.12	68.28	90.9	11	3.4	< 0.6	1.1
1k NE		1	14.61	32.62	6.48	8.13	67.35	90.6				
		2	14.64	32.65	6.47	8.14	67.28	90.6			< 0.6	1.0
		3	14.71	32.69	6.47	8.14	67.81	90.7				
		4	14.76	32.89	6.63	8.14	63.55	89.3			< 0.6	0.9
4	1041	0	14.90	32.57	6.70	8.13	66.98	90.5	9	4.2	1.1	0.9
7k E		1	14.91	32.61	6.58	8.14	65.24	89.9				
		2	14.89	32.66	6.55	8.15	63.92	89.4			0.6	0.5
		3	14.88	32.70	6.55	8.15	64.52	89.6				
		4	14.89	32.70	6.59	8.16	65.49	90.0			< 0.6	0.5
5	921	0	14.86	32.46	6.85	8.11	61.57	88.6	10	3.5	0.7	0.7
1k NE		1	14.84	32.46	6.70	8.12	61.33	88.5				
		2	14.75	32.43	6.66	8.12	61.87	88.7			< 0.6	0.6
		3	14.92	32.69	6.54	8.12	62.80	89.0				
		4	15.21	32.80	6.39	8.14	61.39	88.5			< 0.6	0.8
6	932	0	14.68	32.44	5.72	8.10	66.60	90.3	10	3.5	< 0.6	0.7
1k NE		1	14.65	32.44	5.54	8.11	66.41	90.3				
		2	14.88	32.55	5.80	8.12	65.43	89.9			< 0.6	0.6
		3	15.44	32.68	5.68	8.14	53.20	85.4				
7	1105	0	15.18	32.64	6.43	8.12	56.30	86.6	10	3.0	< 0.6	0.6
7k E		1	15.17	32.65	6.34	8.12	55.08	86.1				
		2	15.13	32.66	6.31	8.12	54.92	86.1			0.9	0.7
		3	15.19	32.71	6.27	8.12	54.27	85.8				
8	822	0	14.64	32.37	6.87	8.10	47.48	83.0	11	2.2	1.9	1.0
1k NE		1	14.63	32.37	6.78	8.12	47.37	83.0				
		2	14.64	32.37	6.71	8.12	46.97	82.8			0.6	0.9
		3	14.60	32.37	6.50	8.12	46.95	82.8				
		4	14.39	32.30	6.38	8.12	45.72	82.2			0.9	1.1

December 18, 1996 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	910	0	15.09	32.45	6.33	8.09	56.63	86.7	10	3.1	< 0.6	0.4
1k NE		1	15.19	32.51	6.18	8.09	57.25	87.0				
		2	15.31	32.61	6.19	8.13	45.57	82.2			< 0.6	0.9
		3	15.31	32.69	6.30	8.14	48.42	83.4				
		4	15.32	32.69	6.25	8.16	43.52	81.2			< 0.6	0.8
10	847	0	15.44	30.04	5.73	7.88	11.13	57.8	12	1.6	3.2	1.0
1k NE		1	15.29	31.60	5.56	7.91	10.72	57.2				
		2	15.23	32.32	5.51	8.08	14.89	62.1			2.2	1.0
		3	15.29	32.46	5.45	8.10	16.41	63.6				
		4	-	32.48	6.53	8.15	18.48	65.6			3.4	0.9
11	859	0	14.94	32.43	6.35	8.12	58.13	87.3	10	3.1	2.2	1.0
1k NE		1	14.94	32.42	6.24	8.13	57.85	87.2				
		2	14.95	32.45	6.17	8.13	57.53	87.1			1.4	0.7
		3	15.01	32.56	6.19	8.15	57.11	86.9				
12	1019	0	15.33	23.90	8.57	8.24	63.07	89.1	10	2.4	4.9	3.3
5k E		1	15.70	29.36	8.15	8.20	48.42	83.4				
		2	15.23	32.51	8.10	8.16	69.96	91.5			4.8	1.3
13	743	0	13.20	27.57	6.9	7.51					19.6	3.3
18	813	0	14.35	32.33	6.44	8.14	50.34	84.2	12	2.4	2.2	2.3
1k NE		1	14.36	32.32	6.30	8.14	50.07	84.1				
		2	14.37	32.33	6.28	8.16	49.85	84.0			1.3	0.8
19	758	0	12.70	31.97	6.9	7.98					1.3	1.7
20	839	0	14.82	31.42	5.43	8.06	54.65	86.0	12	1.6	5.5	0.9
1k NE		1	14.92	31.78	5.25	8.07	54.00	85.7				
		2	14.96	32.14	5.23	8.08	52.41	85.1			4.0	1.0
22	730	0	14.40	25.80	7.4	8.29					18.2	1.3
25	1049	0	14.93	32.52	6.58	8.10	67.48	90.6	10	4.8	0.9	0.7
7k E		1	14.91	32.52	6.48	8.11	67.28	90.6				
		2	14.88	32.59	6.46	8.11	68.18	90.9			< 0.6	0.6
		3	15.03	32.87	6.38	8.11	66.61	90.3				
		4	15.08	32.87	6.38	8.14	58.93	87.6			< 0.6	0.8
	Average		14.86	32.09	6.6	8.12	55.8	85.6	10.4	3.2	2.4	1.1
	Number		67	68	68	68	65	65	15	15	41	41
	St. Dev.		0.44	1.53	0.7	0.10	14.0	7.6	1.0	1.0	4.0	0.7
	Maximum		15.70	33.14	8.6	8.29	70.0	91.5	12	5.2	19.6	3.3
	Minimum		12.70	23.90	5.2	7.51	10.7	57.2	9	1.6	0.6	0.4

Surface Bacteriological Water Data and General Observations **December 18, 1996**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	413	5.3
RAIN:	None	M. Meyer	Low	1058	1.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1010	3000	2400	500	Moderate turbidity.
2	1100	1300	500	80	Moderate turbidity.
3	950	300	50	140	High turbidity. Strong flow from tidal gate. Floating trash, leaves, and other organic debris.
4	1041	150	110	2	Moderate turbidity.
5	921	300	< 20	< 2	Moderate turbidity.
6	932	2400	270	2	Moderate turbidity. Floating trash and surface film.
7	1105	130	20	2	Moderate turbidity.
8	822	800	70	300	High turbidity.
9	910	90	< 20	2	Moderate turbidity.
10	847	> 16000	300	280	High turbidity. Movement of a large boat stirred up bottom sediments.
11	859	1100	90	8	Moderate turbidity.
12	1019	> 16000	5000	500	Moderate turbidity. Trash on bottom. Fishermen on dock.
13	743	9000	50	130	Moderate turbidity. No obvious flow. Floating trash and surface film.
18	813	500	230	9	High turbidity.
19	758	800	50	29	Moderate turbidity. Surface film.
20	839	> 16000	70	110	High turbidity. Floating trash and particulate matter.
22	730	300	< 20	< 2	Moderate turbidity. Floating trash.
25	1049	110	< 20	6	Moderate turbidity.
	Average	3793.3	516.1	116.9	
	Number	18	18	18	
	St. Dev.	5987.8	1247.8	167.8	
	Maximum	16000	5000	500	
	Minimum	90	20	2	

Physical Water Quality Data **January 8, 1997**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	756	6.8
RAIN:	None	M. Meyer	Low	303	-1.4

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1045	0	13.11	30.20	7.17	7.90	63.81	89.4	9	4.6	4.1	1.9
3k SW		1	13.35	32.73	7.06	7.89	65.24	89.9				
		2	13.51	33.20	6.98	7.89	65.46	89.9			19.6	1.5
		3	13.51	33.25	7.02	7.89	65.89	90.1				
		4	13.50	33.27	7.14	7.90	64.79	89.7			7.0	1.6
2	1031	0	13.51	32.90	7.52	7.92	66.26	90.2	9	4.7	4.6	1.8
3k SW		1	13.37	32.93	7.38	7.92	65.27	89.9				
		2	13.36	32.99	7.41	7.92	65.58	90.0			6.3	1.9
		3	13.35	33.20	7.36	7.93	63.99	89.4				
		4	13.37	33.26	7.33	7.93	62.52	88.9			15.4	2.0
		5	13.38	33.28	7.35	7.92	61.64	88.6				
3	1020	0	13.70	32.95	7.19	7.90	70.38	91.6	9	5.5	3.5	1.2
3k SW		1	13.67	32.96	7.13	7.90	70.77	91.7				
		2	13.65	33.09	7.13	7.90	70.64	91.7			3.2	1.5
		3	13.65	33.08	7.03	7.91	69.72	91.4				
		4	13.65	33.10	7.05	7.90	69.05	91.2			8.8	1.3
		5	13.65	33.10	7.11	7.91	68.35	90.9				
4	1111	0	13.80	32.91	6.62	7.91	67.23	90.6	10	4.2	5.7	1.7
3k SW		1	13.78	32.87	6.38	7.91	66.67	90.4				
		2	13.73	32.89	6.41	7.91	66.69	90.4			1.5	1.3
		3	13.64	32.95	6.34	7.91	66.46	90.3				
		4	13.58	33.11	6.47	7.92	66.33	90.2			6.7	1.4
5	950	0	14.02	32.64	7.18	7.91	65.56	90.0	10	4.3	1.8	1.5
3k SW		1	14.01	32.65	7.05	7.91	64.91	89.8				
		2	13.97	32.65	7.11	7.91	65.31	89.9			3.5	1.2
		3	13.70	32.72	7.26	7.92	65.42	89.9				
		4	13.55	32.88	7.24	7.92	64.69	89.7			6.4	1.5
		5	13.71	33.14	7.17	7.92	65.09	89.8				
6	1004	0	13.84	32.64	7.33	7.91	68.35	90.9	9	4.6	4.8	1.3
3k SW		1	13.81	32.64	7.23	7.91	68.20	90.9				
		2	13.78	32.66	7.21	7.91	68.90	91.1			3.4	1.1
		3	14.11	33.10	7.14	7.91	68.95	91.1				
		4	13.95	33.01	7.08	7.92	57.72	87.2			6.4	1.1
7	1133	0	14.18	32.86	7.06	7.90	61.75	88.6	11	4.0	4.1	1.6
3k SW		1	14.10	32.77	6.99	7.90	63.13	89.1				
		2	13.94	32.86	7.02	7.89	62.76	89.0			2.0	1.2
		3	13.92	33.00	6.92	7.89	62.57	88.9				
		4	13.93	33.00	6.88	7.89	60.92	88.3			< 0.6	1.0
8	855	0	13.71	32.48	7.51	7.87	61.03	88.4	10	3.3	< 0.6	1.4
3k SW		1	13.71	32.48	7.34	7.89	60.01	88.0				
		2	14.03	32.83	7.30	7.89	59.95	88.0			4.3	1.7
		3	14.34	32.75	7.16	7.89	54.51	85.9				
		4	14.25	32.75	7.24	7.90	51.61	84.8			26.6	1.8

January 8, 1997 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	941	0	14.19	32.72	7.23	7.90	58.60	87.5	10	3.6	12.3	1.2
3k SW		1	14.19	32.74	7.11	7.90	57.60	87.1				
		2	14.10	32.86	7.10	7.90	57.71	87.2			27.7	1.6
		3	13.98	33.01	7.12	7.90	55.42	86.3				
		4	13.91	33.09	7.06	7.90	51.14	84.6			6.9	1.3
10	916	0	13.21	32.08	6.92	7.86	67.69	90.7	10	3.6	16.1	1.6
3k SW		1	13.88	32.54	6.70	7.86	67.89	90.8				
		2	14.40	32.65	6.57	7.90	59.56	87.8			16.8	1.4
		3	14.41	32.70	6.56	7.92	54.61	86.0				
		4	14.49	32.82	7.02	7.92	51.76	84.8			23.6	1.5
11	929	0	14.04	32.53	7.26	7.89	64.88	89.7	10	3.8	22.4	2.1
3k SW		1	14.02	32.52	7.12	7.90	65.17	89.8				
		2	14.05	32.78	7.12	7.90	66.01	90.1			5.6	1.2
		3	13.88	32.91	7.10	7.90	60.92	88.3				
		4	13.91	33.03	7.12	7.90	61.92	88.7			5.2	1.5
12	1055	0	12.52	21.65	7.27	7.94	36.41	77.7	11	2.1	8.9	4.4
3k SW		1	13.37	25.75	6.90	7.88	30.29	74.2				
		2	13.54	33.07	6.67	7.90	71.50	92.0			11.2	2.0
13	812	0	13.70	32.73	6.80	7.89					9.1	3.4
18	842	0	13.54	32.45	7.46	7.91	60.74	88.3	10	3.4	6.0	1.6
3k SW		1	13.53	32.45	7.28	7.92	60.61	88.2				
		2	13.48	32.42	7.26	7.93	60.20	88.1			10.5	1.5
19	825	0	13.14	32.85	7.16	7.49					4.3	1.6
20	910	0	13.27	32.19	7.04	7.86	70.59	91.7	10	2.9	18.6	6.8
3k SW		1	14.10	32.42	6.81	7.86	69.15	91.2				
		2	14.50	32.72	6.63	7.88	60.28	88.1			3.7	1.6
22	759	0	12.83	32.05	6.60	7.90					1.1	4.4
25	1121	0	14.07	32.72	7.16	7.89	65.55	90.0	10	5.4	< 0.6	1.7
3k SW		1	13.94	32.72	7.05	7.89	66.14	90.2				
		2	13.79	32.77	7.08	7.89	69.83	91.4			3.4	1.5
		3	13.73	32.81	7.03	7.89	70.38	91.6				
		4	13.69	33.11	6.97	7.88	67.96	90.8			< 0.6	1.4
		5	13.67	33.15	6.94	7.90	55.86	86.5				
	Average		13.76	32.55	7.06	7.90	63.02	89.0	9.9	4.0	8.1	1.8
	Number		76	76	76	76	73	73	15	15	45	45
	St. Dev.		0.36	1.56	0.26	0.05	7.00	2.8	0.6	0.9	7.2	1.0
	Maximum		14.50	33.28	7.52	7.94	71.50	92.0	11	5.5	27.7	6.8
	Minimum		12.52	21.65	6.34	7.49	30.29	74.2	9	2.1	0.6	1.0

Surface Bacteriological Water Data and General Observations **January 8, 1997**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	756	6.8
RAIN:	None	M. Meyer	Low	303	-1.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1045	5000	500	22	Moderate turbidity. Floating styrofoam, leaves, plastic bottles, and cartons.
2	1031	50	< 20	2	Light turbidity.
3	1020	170	< 20	34	Light turbidity. No obvious flow from tidal gate.
4	1111	20	20	< 2	Moderate turbidity.
5	950	110	20	2	Light turbidity.
6	1004	80	< 20	< 2	Light turbidity.
7	1133	170	< 20	50	Moderate turbidity.
8	855	80	20	2	Moderate turbidity.
9	941	< 20	< 20	300	Moderate turbidity.
10	916	5000	50	< 2	Light turbidity. Surface oil film.
11	929	1400	< 20	8	Moderate turbidity.
12	1055	> 16000	2200	< 2	Moderate turbidity.
13	812	1300	< 20	22	Moderate turbidity. Moderate flow into lagoon. Trash and leaves on grate.
18	842	260	50	30	Light turbidity.
19	825	140	20	5	Moderate turbidity. Submerged lawn chair, wastebasket, and cushion.
20	910	16000	170	110	High turbidity. Surface oil film.
22	759	3000	800	130	Moderate turbidity. No obvious flow into lagoon.
25	1121	20	< 20	7	Light turbidity.
	Average	2712.2	222.8	40.7	
	Number	18	18	18	
	St. Dev.	5101.4	535.5	74.7	
	Maximum	16000	2200	300	
	Minimum	20	20	2	

Physical Water Quality Data February 21, 1997

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	832	5.6
RAIN:	None	M. Meyer	Low	1506	-0.3

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1105	0	13.50	30.93	6.69	7.90	69.34	91.3	11	4.8	13.5	1.8
5k NE		1	13.25	32.24	6.65	7.90	65.12	89.8				
		2	13.09	32.98	6.75	7.86	62.66	89.0			14.2	1.2
		3	12.89	32.94	6.81	7.85	62.39	88.9				
		4	12.73	33.33	6.82	7.84	61.89	88.7			7.7	0.9
2	1055	0	14.97	33.19	7.62	7.94	66.42	90.3	10	4.0	10.8	0.9
5k E		1	14.46	32.96	7.62	7.95	65.09	89.8				
		2	13.50	32.98	7.85	7.94	62.62	89.0			16.9	1.0
		3	12.65	33.22	8.07	7.92	60.98	88.4				
		4	12.44	33.52	7.97	7.90	58.17	87.3			15.9	1.2
		5	12.42	33.66	7.40	7.87	51.24	84.6				
3	1045	0	14.72	33.27	7.69	7.96	70.05	91.5	10	4.2	14.2	0.8
5k E		1	14.59	33.13	7.71	7.95	69.99	91.5				
		2	14.24	33.24	7.81	7.95	67.26	90.6			9.0	1.0
		3	13.73	33.14	7.81	7.95	65.46	89.9				
		4	13.07	33.45	7.82	7.91	60.73	88.3			8.3	1.1
4	1135	0	15.10	33.25	7.55	7.96	66.92	90.4	10	4.0	11.0	0.9
5k NE		1	15.12	33.24	7.52	7.95	67.39	90.6				
		2	15.03	33.16	7.54	7.95	67.42	90.6			7.5	1.0
		3	13.52	32.25	7.69	7.96	66.94	90.5				
		4	12.77	33.41	7.96	7.93	63.14	89.1			11.6	1.0
5	1010	0	15.39	33.12	7.10	7.95	66.54	90.3	10	4.6	5.6	0.9
5k E		1	15.34	33.12	7.05	7.95	66.28	90.2				
		2	15.17	33.07	7.13	7.95	66.28	90.2			16.6	0.9
		3	14.77	33.08	7.27	7.96	65.35	89.9				
		4	14.21	33.24	7.56	7.95	64.20	89.5			21.0	1.0
		5	13.78	33.45	7.59	7.93	61.23	88.5				
											18.2	1.1
6	1025	0	15.44	33.19	7.57	7.99	60.53	88.2	10	3.7	9.7	1.1
5k E		1	15.31	33.18	7.49	7.98	59.56	87.8				
		2	15.20	33.13	7.61	7.99	55.98	86.5			5.2	0.7
		3	14.95	33.25	7.63	7.97	55.38	86.3				
		4	14.79	33.35	7.46	7.95	53.60	85.6			7.5	0.9
7	1200	0	15.72	33.22	6.93	7.94	63.95	89.4	11	3.4	7.4	0.9
5k NE		1	15.42	33.26	6.75	7.94	62.84	89.0				
		2	15.01	33.20	6.90	7.94	60.80	88.3			6.1	0.9
		3	14.64	33.20	6.99	7.93	58.45	87.4				
		4	14.58	33.33	7.08	7.94	55.60	86.4			6.8	1.0
8	852	0	15.39	33.09	7.79	7.99	50.72	84.4	10	2.4	8.5	1.4
2k E		1	15.38	33.09	7.77	8.00	50.11	84.1				
		2	15.31	33.07	7.75	8.00	49.37	83.8			5.1	1.2
		3	15.27	33.08	7.79	8.00	48.17	83.3				
		4	15.18	33.07	7.88	8.00	47.63	83.1			5.0	1.2

February 21, 1997 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	955	0	15.58	33.13	7.36	7.96	55.01	86.1	10	3.3	7.0	1.1
5k E		1	15.36	33.06	7.28	7.95	54.17	85.8				
		2	15.05	33.15	7.36	7.95	58.08	87.3			7.5	0.9
		3	14.88	33.24	7.39	7.96	58.67	87.5				
		4	14.76	33.31	7.31	7.95	57.98	87.3			6.7	0.7
10	930	0	15.23	32.94	6.86	7.94	70.91	91.8	9	4.0	10.4	1.5
5k E		1	15.22	32.93	6.66	7.94	70.98	91.8				
		2	15.39	33.21	6.74	7.95	70.35	91.6			12.6	0.8
		3	15.57	33.16	6.98	7.95	59.41	87.8				
		4	15.54	33.16	7.15	7.95	52.73	85.2			12.8	1.1
11	942	0	15.45	33.12	7.52	7.95	56.97	86.9	9	3.2	12.6	0.9
5k E		1	15.44	33.12	7.50	7.94	56.29	86.6				
		2	15.34	33.10	7.55	7.95	54.92	86.1			6.6	0.7
		3	14.97	33.10	7.60	7.95	53.10	85.4				
		4	14.85	33.29	7.47	7.94	56.04	86.5			9.0	0.9
12	1116	0	14.56	26.33	6.80	8.01	56.78	86.8	12	2.3	14.2	4.6
5k NE		1	13.44	29.28	6.93	7.92	48.88	83.6				
		2	12.96	32.88	7.05	7.84	62.59	88.9			6.9	2.8
13	800	0	13.90	32.37	4.9	7.65					14.6	2.3
18	840	0	15.30	33.10	7.96	8.02	51.67	84.8	10	2.5	5.4	1.1
2k E		1	15.29	33.10	7.97	8.02	50.79	84.4				
		2	15.27	33.09	8.00	8.01	50.70	84.4			5.1	1.0
19	812	0	14.30	33.17	7.4	7.95					2.7	1.8
20	914	0	15.31	32.96	7.44	7.96	69.37	91.3	9	2.0	7.6	5.6
2k E		1	15.25	32.96	7.61	7.96	69.97	91.5				
		2	15.31	32.97	7.66	7.95	67.34	90.6			6.7	1.2
22	750	0	13.10	31.16	4.4	7.50					20.3	2.9
25	1145	0	15.36	33.20	6.81	7.92	70.38	91.6	10	4.9	16.5	0.6
5k NE		1	15.22	33.17	7.09	7.93	70.76	91.7				
		2	15.00	33.20	7.17	7.93	70.53	91.6			8.9	0.7
		3	14.25	32.77	7.54	7.93	70.54	91.6				
		4	13.24	33.34	7.66	7.91	65.29	89.9			9.1	0.7
		5	13.34	33.32	6.95	7.89	48.93	83.6				
	Average		14.57	32.93	7.31	7.93	60.9	88.2	10.1	3.6	10.1	1.3
	Number		75	75	75	75	72	72	15	15	46	46
	St. Dev.		0.94	0.98	0.59	0.07	6.9	2.6	0.8	0.9	4.4	1.0
	Maximum		15.72	33.66	8.07	8.02	71.0	91.8	12	4.9	21.0	5.6
	Minimum		12.42	26.33	4.40	7.50	47.6	83.1	9	2.0	2.7	0.6

Surface Bacteriological Water Data and General Observations **February 21, 1997**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	832	5.6
RAIN:	None	M. Meyer	Low	1506	-0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1105	1100	< 20	< 2	Moderate turbidity.
2	1055	< 20	< 20	< 2	Moderate turbidity.
3	1045	50	< 20	2	Moderate turbidity. Low flow from flood control gate.
4	1135	50	< 20	< 2	Moderate turbidity.
5	1010	20	< 20	2	Moderate turbidity.
6	1025	20	< 20	< 2	Moderate turbidity.
7	1200	90	< 20	7	Moderate turbidity.
8	852	70	< 20	2	Moderate turbidity.
9	955	< 20	< 20	< 2	Moderate turbidity.
10	930	500	< 20	2	Moderate turbidity.
11	942	80	< 20	< 2	Moderate turbidity. Submerged plastic bags.
12	1116	9000	270	< 2	Moderate turbidity.
13	800	3000	130	70	Moderate turbidity. Moderate flow into lagoon. Floating boom across lagoon.
18	840	130	130	5	Moderate turbidity.
19	812	300	300	7	Low turbidity.
20	914	1300	130	2	Moderate turbidity. Jellyfish in water column.
22	750	9000	50	110	Moderate turbidity. Homeless people sleeping nearby.
25	1145	20	< 20	< 2	Moderate turbidity.
	Average	1376.1	69.4	12.5	
	Number	18	18	18	
	St. Dev.	2871.7	88.8	29.1	
	Maximum	9000	300	110	
	Minimum	20	20	2	

Physical Water Quality Data **March 19, 1997**

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger	High	624	4.8
RAIN:	None		M. Meyer	Low	1311	0.0

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1115	0	18.22	25.33	8.94	8.22	54.14	85.8	13	3.1	5.5	3.1
7k WSW		1	17.31	25.66	8.97	8.21	43.66	81.3				
		2	16.61	33.01	8.81	8.24	52.38	85.1			1.6	2.5
		3	16.67	33.30	9.12	8.34	55.20	86.2				
2	1105	0	17.85	33.36	8.66	8.16	54.55	85.9	13	3.0	< 0.7	1.6
7k WSW		1	17.69	33.39	8.70	8.16	53.78	85.6				
		2	17.37	33.32	8.97	8.18	50.30	84.2			< 0.7	1.6
		3	16.75	33.11	9.08	8.21	49.73	84.0				
		4	16.50	33.42	9.24	8.26	50.88	84.5			< 0.7	2.3
3	1056	0	17.63	33.35	7.95	8.16	54.44	85.9	13	3.0	2.3	1.9
7k WSW		1	17.61	33.33	8.06	8.17	54.38	85.9				
		2	17.65	33.35	8.28	8.16	54.66	86.0			< 0.7	2.4
		3	17.60	33.33	8.39	8.16	55.37	86.3				
		4	17.31	33.36	8.70	8.19	50.65	84.4			< 0.7	2.1
4	1146	0	18.37	33.33	7.66	8.11	58.08	87.3	10	3.7	4.2	1.3
7k WSW		1	18.28	33.35	7.50	8.11	58.03	87.3				
		2	17.70	33.07	7.76	8.11	60.24	88.1			1.6	1.4
		3	17.46	33.30	8.04	8.13	58.82	87.6				
		4	17.54	33.33	8.16	8.15	59.46	87.8			1.1	1.2
5	1016	0	18.52	33.25	8.49	8.09	56.88	86.8	11	2.7	0.9	1.6
7k WSW		1	18.28	33.22	8.17	8.09	55.34	86.3				
		2	17.80	33.16	8.50	8.09	52.78	85.2			< 0.7	1.5
		3	17.61	33.28	8.63	8.11	48.97	83.7				
		4	17.13	33.28	8.58	8.12	49.39	83.8			< 0.7	1.3
6	1033	0	18.15	33.35	7.97	8.15	57.53	87.1	11	3.0	< 0.7	1.5
7k WSW		1	17.86	33.24	7.98	8.15	54.63	86.0				
		2	17.56	33.37	8.84	8.15	50.27	84.2			< 0.7	1.1
		3	17.49	33.35	8.80	8.14	50.16	84.2				
		4	17.43	33.37	8.75	8.10	44.75	81.8			< 0.7	1.3
7	1205	0	18.30	33.33	7.34	8.08	53.59	85.6	11	2.8	2.0	1.7
7k WSW		1	18.20	33.29	7.46	8.08	52.46	85.1				
		2	17.81	33.23	7.73	8.09	50.41	84.3			1.3	1.5
		3	17.47	33.21	8.01	8.09	48.21	83.3				
		4	17.42	31.48	8.18	8.11	40.82	79.9			2.1	1.3
8	906	0	18.11	33.26	8.42	8.11	50.01	84.1	12	2.2	0.9	1.2
5k E		1	18.05	33.27	8.59	8.11	50.51	84.3				
		2	17.85	33.27	8.66	8.11	44.04	81.5			< 0.7	1.6
		3	17.78	33.31	8.79	8.12	40.98	80.0				
		4	17.75	33.29	8.96	8.12	42.60	80.8			< 0.7	1.9

March 19, 1997 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m		NH3+NH4 u-at/l	BOD mg/l
9	1005	0	18.16	33.24	7.12	8.06	43.93	81.4	11	2.0		2.7	1.5
5k E		1	18.10	33.20	7.35	8.07	39.02	79.0					
		2	17.65	33.25	7.59	8.06	33.38	76.0				4.0	1.3
		3	17.40	33.30	7.72	8.06	33.42	76.0					
		4	17.38	33.38	7.74	8.07	35.67	77.3				2.7	1.2
10	936	0	17.96	33.11	7.91	8.05	63.68	89.3	10	3.2		1.7	1.2
5k E		1	17.90	33.10	7.91	8.05	63.42	89.2					
		2	17.83	33.20	7.92	8.05	60.26	88.1				2.7	1.0
		3	17.80	33.26	8.01	8.03	44.99	81.9					
		4	17.78	33.28	8.07	8.04	37.76	78.4				1.1	1.0
11	952	0	18.28	33.27	7.59	8.09	55.11	86.2	11	2.5		2.6	1.3
5k E		1	18.14	33.33	7.80	8.09	54.82	86.0					
		2	18.02	33.22	7.80	8.09	52.73	85.2			<	0.7	1.2
		3	17.50	33.26	7.79	8.09	44.60	81.7					
		4	17.61	33.32	7.74	8.09	43.22	81.1				4.2	1.2
12	1124	0	19.15	21.09	12.73	8.43	27.93	72.7	17	0.7		1.1	8.3
7k WSW		1	17.57	21.54	13.47	8.48	7.05	51.5					
		2	17.51	32.55	13.92	8.19	40.65	79.8				5.3	9.0
13	816	0	18.34	31.59	9.81	8.27						17.1	4.9
18	855	0	18.15	33.28	9.04	8.11	54.06	85.7	12	2.6	<	0.7	1.4
5k E		1	18.02	33.26	9.11	8.10	51.48	84.7					
		2	17.93	33.28	9.12	8.12	48.52	83.5				9.7	1.7
19	827	0	18.00	33.26	12.09	8.13						0.9	1.6
20	928	0	17.96	33.08	7.58	8.06	64.97	89.8	10	2.3		5.4	8.8
5k E		1	17.85	33.05	7.57	8.05	62.32	88.8					
		2	17.88	33.13	7.60	8.05	57.16	87.0				5.4	1.5
22	802	0	18.39	28.52	9.49	8.43						12.3	5.8
25	1157	0	18.50	33.28	8.47	8.08	57.71	87.2	10	4.2		3.3	1.8
7k WSW		1	18.42	33.26	8.50	8.07	60.83	88.3					
		2	18.14	33.20	8.48	8.07	63.41	89.2				2.2	1.3
		3	17.53	32.98	8.49	8.08	62.13	88.8					
		4	17.10	33.30	8.61	8.11	57.28	87.0				2.5	1.5
		5	17.03	33.42	8.36	8.19	43.61	81.3					
	Average		17.77	32.59	8.56	8.13	50.6	83.9	11.7	2.7		2.7	2.2
	Number		72	72	72	72	69	69	15	15		44	44
	St. Dev.		0.47	2.38	1.25	0.09	9.6	5.3	1.8	0.8		3.3	2.0
	Maximum		19.15	33.42	13.92	8.48	65.0	89.8	17	4.2		17.1	9.0
	Minimum		16.50	21.09	7.12	8.03	7.1	51.5	10	0.7		0.7	1.0

Surface Bacteriological Water Data and General Observations **March 19, 1997**

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger
RAIN:	None		M. Meyer

TIDE	TIME	HT. (ft)
High	624	4.8
Low	1311	0.0

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1115	> 16000	1700	4	Moderate turbidity. Porpoises outside of breakwall.
2	1105	< 20	< 20	< 2	Moderate turbidity.
3	1056	50	20	< 2	Moderate turbidity. Strong flow from tidal gate.
4	1146	< 20	< 20	2	Moderate turbidity.
5	1016	20	< 20	< 2	Moderate turbidity.
6	1033	< 20	< 20	< 2	Moderate turbidity. Surface film and floating cigarette butts.
7	1205	20	< 20	< 2	Moderate turbidity.
8	906	70	< 20	< 2	Moderate turbidity.
9	1005	300	50	22	Moderate turbidity.
10	936	300	80	2	Moderate turbidity.
11	952	20	20	< 2	Moderate turbidity.
12	1124	> 16000	240	17	High turbidity. Strong red tide. Large school of topsmelt (?) in water column.
13	816	16000	130	170	Moderate turbidity. Strong flow from storm drain.
18	855	110	< 20	< 2	Moderate turbidity.
19	827	110	20	8	Moderate turbidity.
20	928	170	120	< 2	Moderate turbidity. Jellyfish in water column.
22	802	16000	< 20	26	Moderate turbidity. Two night herons on fence.
25	1157	20	< 20	< 2	Moderate turbidity. Two sea lions in channel.
	Average	3625.0	142.2	15.1	
	Number	18	18	18	
	St. Dev.	6807.1	393.2	39.4	
	Maximum	16000	1700	170	
	Minimum	20	20	2	

Physical Water Quality Data April 7, 1997

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to cle	Pers.: J. Gelsinger	High	1004	5.3
RAIN:	None	M. Meyer	Low	1600	0.0

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1015	0	18.68	30.04	6.37	8.34	61.94	88.7	10	3.4	5.5	3.0
4k SW		1	18.09	31.36	6.40	8.33	56.38	86.7				
		2	17.62	33.10	6.43	8.33	54.05	85.7			2.1	2.7
		3	17.52	33.38	6.47	8.33	54.88	86.1				
		4	17.70	33.33	6.53	8.35	54.42	85.9			5.8	3.4
2	1034	0	19.21	33.41	5.93	8.25	48.85	83.6	11	2.6	2.4	2.6
4k SW		1	19.12	33.42	6.20	8.26	48.33	83.4				
		2	18.21	33.24	6.55	8.25	45.97	82.3			22.6	2.2
		3	17.48	33.63	6.86	8.29	56.68	86.8				
		4									5.2	2.4
3	1049	0	18.99	33.37	5.27	8.23	51.14	84.6	11	2.8	14.3	1.7
4k SW		1	19.00	33.39	5.02	8.24	51.01	84.5				
		2	18.91	33.40	5.78	8.24	49.63	83.9			6.7	1.8
		3	18.87	33.44	6.05	8.24	50.16	84.2				
		4									17.7	1.8
4	1104	0	19.88	33.38	5.64	8.21	50.22	84.2	10	2.6	19.4	1.9
4k SW		1	19.84	33.40	5.55	8.21	50.51	84.3				
		2	19.37	33.39	6.05	8.22	51.95	84.9			7.3	1.5
		3	18.56	33.49	6.47	8.22	53.87	85.7				
		4	18.72	33.43	6.24	8.23	50.23	84.2			2.0	1.4
5	1137	0	19.84	33.30	5.72	8.21	41.74	80.4	11	2.2	14.5	1.4
4k SW		1	19.82	33.32	5.66	8.22	41.64	80.3				
		2	19.57	33.31	5.65	8.21	40.35	79.7			7.7	1.5
		3	19.16	33.33	6.26	8.21	39.66	79.4				
		4	18.31	33.34	6.65	8.24	43.23	81.1			14.3	1.3
6	1154	0	19.42	33.32	5.50	8.22	51.85	84.9	11	2.5	2.8	1.5
4k SW		1	19.36	33.39	5.51	8.23	50.75	84.4				
		2	19.31	33.40	5.71	8.23	49.43	83.8			1.2	1.3
		3	19.22	33.40	6.39	8.23	48.81	83.6				
		4	19.29	33.35	6.88	8.08	26.60	71.8			1.0	1.3
7	1343	0	20.03	33.37	5.08	8.19	44.11	81.5	12	1.7	17.3	1.4
4k SW		1	19.95	33.39	5.08	8.20	43.69	81.3				
		2	19.75	33.38	5.40	8.19	42.18	80.6			1.1	1.4
		3	19.34	33.36	5.89	8.19	40.45	79.7				
		4									6.6	1.3
8	1230	0	19.78	33.35	5.92	8.22	41.04	80.0	12	2.2	9.3	1.6
1k SW		1	19.74	33.36	6.61	8.23	40.29	79.7				
		2	19.66	33.37	6.88	8.23	38.27	78.7			12.4	1.6
		3	19.60	33.39	6.99	8.23	37.41	78.2				
		4	19.43	33.38	6.77	8.23	37.76	78.4			2.1	1.6

April 7, 1997 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	1320	0	19.93	33.17	5.83	8.14	30.19	74.1	12	1.4	4.4	1.4
4k SW		1	19.91	33.25	5.83	8.14	30.09	74.1				
		2	19.61	33.28	5.91	8.16	22.01	68.5			5.1	1.3
		3	19.33	33.35	6.30	8.14	16.97	64.2				
		4	19.22	33.19	6.17	8.17	16.25	63.5			1.9	1.2
10	1255	0	19.59	33.11	5.20	8.19	50.67	84.4	11	2.3	6.1	7.3
3k SW		1	19.63	33.17	5.24	8.19	50.44	84.3				
		2	19.82	33.28	5.45	8.20	46.11	82.4			15.0	1.7
		3	19.66	33.24	6.09	8.20	38.62	78.8				
		4	19.13	33.25	6.48	8.16	32.32	75.4			4.9	1.6
11	1316	0	19.83	33.24	5.06	8.21	41.50	80.3	11	2.5	8.7	1.4
4k SW		1	19.81	33.29	5.17	8.21	40.79	79.9				
		2	19.75	33.30	5.57	8.21	38.95	79.0			1.9	1.1
		3	19.46	33.32	6.05	8.20	33.46	76.1				
		4	19.20	33.43	6.37	8.17	12.97	60.0			0.9	1.4
12	955	0	19.93	26.47	6.10	8.43	46.58	82.6	16	2.6	16.1	8.7
4k SW		1	19.07	29.21	6.01	8.41	42.41	80.7				
		2	18.51	33.07	6.72	8.20	59.28	87.7			13.8	8.2
13	1430	0	19.14	33.09	3.76	8.53					13.6	3.2
18	1236	0	19.64	33.37	6.98	8.23	39.95	79.5	12	1.8	9.4	3.4
1k SW		1	19.63	33.37	6.89	8.23	39.83	79.4				
		2	19.58	33.38	6.85	8.24	39.75	79.4			11.5	1.5
19	1221	0	19.14	33.21	5.67	8.21					8.6	1.9
20	1305	0	19.29	32.94	5.19	8.13	62.18	88.8	13	1.6	6.0	13.0
3k SW		1	19.62	33.04	5.17	8.14	49.64	83.9				
		2									5.4	1.6
22	1430	0	19.39	29.03	3.95	8.46					16.2	5.1
25	1114	0	19.91	33.29	5.15	8.19	56.43	86.7	10	2.6	5.0	1.2
4k NE		1	19.84	33.35	5.18	8.19	57.06	86.9				
		2	19.61	33.33	5.44	8.20	56.88	86.8			6.3	1.3
		3	18.71	33.45	5.87	8.19	55.26	86.2				
		4	18.21	33.47	6.15	8.22	45.04	81.9			9.2	1.2
		5	18.14	33.73	6.14	8.23	35.86	77.4				
	Average		19.24	33.03	5.92	8.23	44.3	81.1	11.5	2.3	8.3	2.5
	Number		69	69	69	69	66	66	15	15	45	45
	St. Dev.		0.64	1.16	0.67	0.07	10.5	5.7	1.5	0.5	5.7	2.4
	Maximum		20.03	33.73	6.99	8.53	62.2	88.8	16	3.4	22.6	13.0
	Minimum		17.48	26.47	3.76	8.08	13.0	60.0	10	1.4	0.9	1.1

Surface Bacteriological Water Data and General Observations **April 7, 1997**

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger	High	1004	5.3
RAIN:	None		M. Meyer	Low	1600	0.0

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1015	< 20	< 20	< 2	Moderate turbidity.
2	1034	20	20	< 2	Moderate turbidity. Snorkler swimming in channel.
3	1049	< 20	< 20	< 2	Moderate turbidity. Very strong flow from flood control gate.
4	1104	70	70	< 2	Moderate turbidity.
5	1137	50	20	< 2	Moderate turbidity.
6	1154	< 20	< 20	< 2	Moderate turbidity.
7	1343	130	130	< 2	Moderate turbidity.
8	1230	80	80	< 2	Moderate turbidity.
9	1320	80	80	< 2	Moderate turbidity.
10	1255	130	130	< 2	Moderate turbidity. Floating oil film.
11	1316	230	230	< 2	Moderate turbidity.
12	955	< 20	< 20	< 2	Moderate turbidity.
13	1430	300	300	5	Moderate turbidity. Moderate flow from gate. Floating trash and organic debris.
18	1236	130	130	2	Moderate turbidity.
19	1221	50	80	< 2	Moderate turbidity.
20	1305	80	50	< 2	Moderate turbidity. Fish jumping. Floating jellyfish and green algae. Heavy oil film.
22	1430	> 16000	> 16000	5	Moderate turbidity. Eleven night herons on fence.
25	1114	20	20	< 2	Moderate turbidity. Sea lion swimming in channel.
	Average	969.4	967.8	2.3	
	Number	18	18	18	
	St. Dev.	3751.9	3752.4	1.0	
	Maximum	16000	16000	5	
	Minimum	20	20	2	

Physical Water Quality Data **May 1, 1997**

CRUISE: MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER: Clear	Pers.: J. Gelsinger	High	515	4.3
RAIN: None	M. Meyer	Low	1158	0.0

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1115	0	18.33	31.80	8.36	8.24	47.62	83.1	16	2.5	4.0	9.1
7k WSW		1	17.75	32.77	8.44	8.23	50.98	84.5				
		2	17.14	33.43	8.82	8.26	49.56	83.9			0.6	9.4
		3	17.12	33.60	9.31	8.32	54.63	86.0				
2	1104	0	18.76	33.25	7.69	8.17	38.78	78.9	16	1.9	0.8	4.7
7k WSW		1	18.60	33.33	7.64	8.18	35.65	77.3				
		2	18.04	33.47	8.05	8.18	35.19	77.0			< 0.6	7.2
		3	17.82	33.57	8.43	8.20	36.36	77.7				
		4	17.64	33.56	8.75	8.21	36.34	77.6			< 0.6	7.4
3	1055	0	19.40	33.61	7.62	8.18	46.35	82.5	14	2.0	< 0.6	3.6
7k WSW		1	19.42	33.61	7.61	8.19	46.62	82.6				
		2	18.17	33.53	7.68	8.17	45.52	82.1			0.7	4.1
		3	18.11	33.63	7.68	8.17	45.51	82.1				
		4	18.17	33.60	7.41	8.17	45.07	81.9			< 0.6	4.4
4	1142	0	19.26	33.49	8.14	8.09	38.87	79.0	12	2.0	< 0.6	2.8
7k WSW		1	19.24	33.49	8.15	8.09	38.91	79.0				
		2	19.16	33.44	8.12	8.08	39.30	79.2			1.4	2.4
		3	18.60	33.36	8.19	8.07	41.28	80.2				
		4	18.70	33.57	8.25	8.10	43.80	81.4			1.8	2.4
5	1022	0	19.12	33.48	8.15	8.06	38.26	78.6	14	2.0	0.7	1.8
7k WSW		1	18.96	33.43	8.10	8.06	37.68	78.3				
		2	18.62	33.32	8.15	8.07	35.74	77.3			2.9	1.7
		3	17.64	33.21	8.30	8.09	34.93	76.9				
		4	17.39	33.73	8.41	8.22	42.67	80.8			2.6	2.0
6	1035	0	18.92	33.55	7.06	8.05	51.10	84.5	12	2.3	2.4	1.5
7k WSW		1	18.75	33.53	7.37	8.06	48.06	83.3				
		2	18.39	33.48	7.68	8.07	46.98	82.8			0.8	1.3
		3	17.85	33.57	7.87	8.02	26.53	71.8				
		4									< 0.6	1.6
7	1200	0	18.75	33.53	6.74	8.03	41.87	80.4	13	2.3	5.7	2.3
7k WSW		1	18.76	33.52	6.35	8.04	42.33	80.7				
		2	18.72	33.53	6.54	8.04	41.87	80.4			< 0.6	1.8
		3	18.67	33.53	6.98	8.04	41.45	80.2				
		4									0.6	1.5
8	908	0	19.11	33.54	6.64	8.06	28.64	73.2	13	1.3	0.9	2.1
7k WSW		1	19.10	33.55	6.57	8.06	28.51	73.1				
		2	19.06	33.53	6.90	8.07	28.47	73.0			< 0.6	1.8
		3	18.35	33.24	7.19	8.07	27.91	72.7				
		4	18.13	33.67	7.47	7.96	12.13	59.0			3.8	1.8

May 1, 1997 **(Continued)**

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	1010	0	19.02	33.12	6.81	7.93	38.33	78.7	14	1.9	1.6	1.1
7k WSW		1	18.87	33.26	6.74	7.94	37.48	78.2				
		2	17.97	33.21	6.85	7.98	29.20	73.5			3.2	1.7
		3	17.73	33.52	6.97	8.02	24.45	70.3				
		4	17.14	33.58	7.26	8.13	41.95	80.5			4.0	1.5
10	950	0	18.62	33.33	5.22	7.91	20.88	67.6	13	1.4	2.9	2.6
7k WSW		1	18.59	33.35	5.04	7.91	19.80	66.7				
		2	18.35	33.24	5.61	7.92	19.57	66.5			2.0	1.9
		3	18.02	33.41	6.20	7.93	18.21	65.3				
		4	17.92	33.60	5.80	7.83	1.30	33.8			1.2	1.7
11	959	0	19.25	33.44	7.78	8.04	42.89	80.9	12	1.8	4.7	1.7
7k WSW		1	19.18	33.43	7.85	8.04	43.09	81.0				
		2	17.74	32.85	7.92	8.05	39.84	79.4			0.9	1.4
		3	17.77	33.40	8.08	8.06	30.46	74.3				
		4									1.0	1.6
12	1125	0	20.14	28.23	9.07	8.34	23.65	69.7	17	1.4	2.1	10.3
7k WSW		1	18.48	31.60	9.17	8.28	27.94	72.7				
		2	18.35	32.98	9.48	8.19	26.22	71.6			1.0	11.0
13	732	0	18.90	33.39	6.54	8.10					3.2	2.7
18	900	0	19.00	33.54	7.93	8.07	25.32	70.9	14	1.3	< 0.6	2.1
7k WSW		1	18.96	33.52	8.06	8.06	25.04	70.7				
		2	18.79	33.52	8.02	8.02	19.57	66.5			1.1	2.3
19	750	0	18.40	33.87	7.42	8.08					< 0.6	2.3
20	938	0	18.94	32.99	6.70	7.96	45.23	82.0	13	1.3	2.1	2.4
7k WSW		1	18.88	33.07	6.81	7.96	40.77	79.9				
22	718	0	19.39	33.29	6.90	8.11					2.4	4.4
25	1148	0	19.40	33.47	6.60	8.05	38.87	79.0	13	1.9	< 0.6	2.0
7k WSW		1	19.37	33.45	6.61	8.06	38.37	78.7				
		2	19.09	33.40	6.82	8.06	39.54	79.3			1.0	2.0
		3	18.29	33.40	7.50	8.07	44.78	81.8				
		4									4.8	2.0
	Average		18.55	33.30	7.49	8.08	36.1	76.6	13.7	1.8	1.8	3.2
	Number		66	66	66	66	63	63	15	15	43	43
	St. Dev.		0.64	0.73	0.93	0.10	10.4	7.8	1.5	0.4	1.4	2.6
	Maximum		20.14	33.87	9.48	8.34	54.6	86.0	17	2.5	5.7	11.0
	Minimum		17.12	28.23	5.04	7.83	1.3	33.8	12	1.3	0.6	1.1

Surface Bacteriological Water Data and General Observations **May 1, 1997**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	515	4.3
RAIN:	None	M. Meyer	Low	1158	0.0

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1115	1700	300	< 2	Moderate turbidity.
2	1104	220	40	< 2	Moderate turbidity.
3	1055	110	70	< 2	Moderate turbidity. Very strong flow from flood gate. Large school of topsmelt.
4	1142	20	< 20	2	Moderate turbidity.
5	1022	20	< 20	< 2	Moderate turbidity.
6	1035	< 20	< 20	< 2	Moderate turbidity. Jellyfish in water.
7	1200	< 20	< 20	< 2	Moderate turbidity.
8	908	1300	20	< 2	Moderate turbidity.
9	1010	< 20	< 20	< 2	Moderate turbidity.
10	950	5000	500	4	Moderate turbidity. Jellyfish in water.
11	959	1300	< 20	< 2	Moderate turbidity.
12	1125	2400	1300	< 2	Moderate turbidity.
13	732	1300	40	23	Moderate turbidity. Floating trash, bottles, cups. Low flow from flood gate.
18	900	2400	130	< 2	Moderate turbidity.
19	750	1100	60	< 2	Moderate turbidity.
20	938	5000	230	8	Moderate turbidity. Large school of very small fish.
22	718	800	< 20	17	Moderate turbidity. Floating green algal mats. 20+ night herons on fence.
25	1148	20	20	< 2	Moderate turbidity. Kayakers in channel.
	Average	1263.9	158.3	4.4	
	Number	18	18	18	
	St. Dev.	1583.7	312.8	5.9	
	Maximum	5000	1300	23	
	Minimum	20	20	2	

Physical Water Quality Data **June 2, 1997**

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger		High	821	4.1
RAIN:	None		M. Meyer		Low	1341	1.1

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m		NH3+NH4 u-at/l	BOD mg/l
1	1022	0	22.10	31.05	5.83	8.16	62.98	89.1	12	2.8		10.3	3.3
5k WSW		1	21.84	33.09	5.80	8.15	53.27	85.4					
		2	21.70	33.51	5.95	8.17	51.77	84.8				6.1	2.8
		3	21.61	33.54	5.95	8.18	48.17	83.3					
		4	21.61	33.57	5.84	8.17	39.79	79.4				2.5	2.4
2	1014	0	22.68	33.12	6.56	8.19	53.77	85.6	12	3.3	<	0.6	3.6
5k WSW		1	22.67	33.12	6.75	8.19	53.83	85.7					
		2	22.45	33.30	6.71	8.19	52.93	85.3				20.2	3.1
		3	22.21	33.33	6.84	8.18	54.03	85.7					
		4	21.84	33.35	6.89	8.18	55.17	86.2				29.1	3.3
		5	21.27	33.59	5.81	8.16	55.14	86.2					
3	1004	0	23.44	33.39	5.12	8.11	64.94	89.8	11	3.6		5.6	1.5
5k WSW		1	23.43	33.39	5.30	8.12	63.79	89.4					
		2	23.33	33.41	5.49	8.12	63.27	89.2				3.3	2.6
		3	23.21	33.40	5.60	8.12	62.91	89.1					
		4	22.90	33.65	5.56	8.11	63.40	89.2				3.8	2.7
4	1050	0	23.59	33.47	5.37	8.14	51.08	84.5	14	2.5		12.9	4.9
5k WSW		1	23.54	33.48	5.44	8.14	51.03	84.5					
		2	23.27	33.34	5.57	8.11	51.96	84.9				0.8	6.4
		3	22.94	33.40	5.86	8.09	52.33	85.1					
		4	22.94	33.47	5.93	8.10	49.61	83.9				2.6	3.7
5	931	0	23.87	33.50	5.69	8.16	40.71	79.9	16	1.7	<	0.6	10.9
5k WSW		1	23.88	33.50	5.48	8.17	40.57	79.8					
		2	23.87	33.50	5.74	8.17	41.06	80.0			<	0.6	9.4
		3	23.80	33.48	6.24	8.15	45.93	82.3					
		4	23.63	33.42	6.25	8.13	52.91	85.3			<	0.6	11.1
		5	23.76	33.47	5.54	8.06	53.91	85.7					
6	945	0	23.88	33.52	5.67	8.13	66.87	90.4	11	3.4		0.7	2.8
5k WSW		1	23.88	33.52	5.65	8.14	65.78	90.1					
		2	23.86	33.52	5.62	8.14	64.54	89.6				3.6	3.1
		3	23.84	33.50	5.71	8.14	63.01	89.1					
		4	23.83	33.51	5.76	8.13	64.87	89.7				24.5	3.2
7	1118	0	24.23	33.46	4.62	8.13	36.85	77.9	15	1.5		0.7	13.0
5k WSW		1	24.22	33.49	4.39	8.12	37.61	78.3					
		2	23.94	33.46	5.40	8.05	39.16	79.1				0.9	10.8
		3	23.77	33.51	5.97	7.98	48.58	83.5					
		4	23.74	33.49	4.98	7.95	53.98	85.7				0.7	10.4
8	827	0	24.27	33.54	5.12	8.08	58.61	87.5	13	2.3		15.5	4.5
5k WSW		1	24.28	33.54	5.07	8.09	58.58	87.5					
		2	24.29	33.54	5.04	8.08	58.08	87.3				2.1	4.3
		3	24.27	33.54	5.07	8.08	57.69	87.2					
		4	24.05	33.44	5.15	8.08	55.94	86.5				2.0	4.2

June 2, 1997 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	920	0	24.20	33.34	3.56	7.93	31.52	74.9	17	1.4	19.3	15.2
5k WSW		1	24.20	33.39	3.71	7.93	32.43	75.5				
		2	24.14	33.46	3.68	7.97	43.27	81.1			4.4	6.6
		3	23.98	33.45	3.74	8.00	49.51	83.9				
		4	23.87	33.49	3.63	7.90	47.78	83.1			0.6	4.6
10	855	0	24.33	33.13	3.52	7.93	40.20	79.6	16	1.7	2.0	2.9
5k WSW		1	24.56	33.22	3.64	7.91	39.44	79.2				
		2	24.54	33.40	3.81	7.91	51.96	84.9			2.0	4.1
		3	24.36	33.37	4.07	7.92	58.41	87.4				
		4	23.84	33.27	4.14	7.81	55.44	86.3			2.6	1.5
11	908	0	24.29	33.42	3.88	8.01	53.40	85.5	14	2.5	2.3	7.3
5k WSW		1	24.31	33.42	3.65	8.01	51.78	84.8				
		2	24.23	33.45	4.68	8.00	50.64	84.4			11.8	2.6
		3	24.10	33.46	5.64	8.01	54.01	85.7				
		4	24.09	33.48	4.77	8.04	56.52	86.7			3.6	3.0
12	1035	0	23.15	28.60	5.50	8.18	58.28	87.4	12	3.4	23.8	2.7
5k WSW		1	23.03	29.75	5.50	8.13	61.06	88.4				
		2	22.05	33.28	5.71	8.12	63.40	89.2			27.0	3.4
13	742	0	23.38	32.40	2.40	8.01					7.3	8.1
18	815	0	24.16	33.55	5.28	8.10	54.83	86.1	13	2.3	30.4	3.8
5k WSW		1	24.14	33.54	5.23	8.10	54.11	85.8				
		2	24.01	33.54	5.25	8.11	53.75	85.6			19.4	3.6
19	800	0	23.34	33.41	5.01	8.05					9.2	0.8
20	848	0	24.20	33.13	3.16	7.87	34.61	76.7	16	1.3	11.5	10.2
5k WSW		1	24.41	33.50	3.15	7.85	36.38	77.7				
		2	24.45	33.24	3.12	7.83	53.51	85.5			35.8	12.2
22	728	0	24.50	32.45	3.20	8.07					8.3	15.0
25	1102	0	23.80	33.50	5.53	8.11	47.67	83.1	15	2.2	9.9	5.0
5k WSW		1	23.80	33.50	5.75	8.11	47.27	82.9				
		2	23.77	33.49	5.64	8.12	46.08	82.4			9.9	5.2
		3	23.38	33.36	5.61	8.09	46.00	82.4				
		4	23.17	33.51	5.61	7.99	52.87	85.3			3.0	3.5
	Average		23.56	33.26	5.12	8.07	51.9	84.7	13.8	2.4	8.8	5.5
	Number		74	74	74	74	71	71	15	15	45	45
	St. Dev.		0.81	0.77	1.01	0.10	8.7	3.7	2.0	0.8	9.6	3.8
	Maximum		24.56	33.65	6.89	8.19	66.9	90.4	17	3.6	35.8	15.2
	Minimum		21.27	28.60	2.40	7.81	31.5	74.9	11	1.3	0.6	0.8

Surface Bacteriological Water Data and General Observations **June 2, 1997**

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	821	4.1
RAIN:	None	M. Meyer	Low	1341	1.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1022	130	110	< 2	Moderate turbidity.
2	1014	< 20	< 20	< 2	Moderate turbidity.
3	1004	220	20	< 2	Moderate turbidity. Low flow from tidal gate.
4	1050	80	50	< 2	High turbidity. Surface oil film. Red tide.
5	931	20	< 20	< 2	High turbidity. Very dense red tide.
6	945	40	< 20	< 2	Moderate turbidity.
7	1118	80	20	2	High turbidity. Very dense red tide.
8	827	120	20	< 2	High turbidity.
9	920	20	20	< 2	High turbidity. Much floating debris. Very dense red tide.
10	855	2400	300	2	High turbidity. Very dense red tide.
11	908	300	20	< 2	High turbidity. Surface oil film. Red tide.
12	1035	220	70	< 2	Moderate turbidity. Floating plastic containers.
13	742	9000	2400	17	Moderate turbidity. Moderate flow from tidal gate.
18	815	110	40	2	High turbidity.
19	800	140	140	4	Moderate turbidity.
20	848	9000	70	< 2	High turbidity. Surface oil film. Very dense red tide.
22	728	9000	170	4	High turbidity. Floating trash and plastic. Very thick green algal mats.
25	1102	20	< 20	< 2	High turbidity. Surface oil film. Very dense red tide.
	Average	1717.8	196.1	3.1	
	Number	18	18	18	
	St. Dev.	3394.7	555.0	3.5	
	Maximum	9000	2400	17	
	Minimum	20	20	2	

10.3. INFAUNAL SPECIES ABUNDANCE LIST

TABLE 9-3. BENTHIC INFAUNA COLLECTED FROM 13 SEDIMENT STATIONS - OCTOBER 96.

	PHYLUM / Subphylum / Class / Subclass / Division / Order / Suborder / Section / Family / Genus & species	Station 1	2	3	4	5	6	7	8	9	10	11	12	25	Total per species
1	ANNELIDA														
2	OLIGOCHAETA														
3	Oligochaeta, unid.		736	100	2		3	6	6	4	22	4	3	22	908
4	Polychaeta														
5	Ampharetidae														
6	Ampharete labrops												1		1
7	Melinna oculata				1									1	2
8	Capitellidae														
9	Anotomastus gordiodes				1										1
10	Capitellidae, unid.			1											1
11	Capitella capitata	1	44	23	1	1	1		1	1	3	2	7		85
12	Mediomastus acutus	5		1	1										7
13	Mediomastus ambiseta														
14	Mediomastus californiensis		7	56	76		3		21				12	43	218
15	Mediomastus spp.	19	231	816	330	57	33	43	70	83	24	59	1006	346	3117
16	Notomastus nr. hemipodus			7	2				1				158		168
17	Notomastus sp.							1							1
18	Chaetopteridae														
19	Chaetopterus variopedatus		1												1
20	Spiochaetopterus costarum	2		1											3
21	Cirratulidae														
22	Aphelochaeta multifilis				98	14	277	265	96	77	2	75		64	968
23	Cirratulidae unid.										1	3		3	7
24	Caulleriella alata	1											1		2
25	Chaetozone corona			1											1
26	Chaetozone nr. setosa	3			1										4
27	Chaetozone spinosa														
28	Chaetozone sp.										1	1			2
29	Cirriformia sp., juv.						1	5		1			3		10

30		Cirriformia sp. 1				2							21			23
31		Monticellina dorsobranchialis	3													3
32		Monticellina siblina													1	1
33		Monticellina sp.			5											5
34	Cossuridae															
35		Cossura candida			2	8	1		1		2				38	52
36	Dorvilleidae															
37		Dorvillea longicornis		9	22	5		29	5	57	19	12	3	29	3	193
38	Flabelligeridae															
39		Pherusa neopapillata			1											1
40		Piromis sp. A													2	2
41	Glyceridae															
42		Glycera convoluta	4													4
43		Glycera tenuis				1										1
44		Glycera sp., juv.	2													2
45	Goniadidae															
46		Goniada littorea	27	3	1	2				2				5		40
47	Hesionidae															
48		Microphthalmus sp.									1					1
49	Lumbrineridae															
50		Lumbrineris erecta						13	3	5	4	5				30
51		Lumbrineris sp. B (Harris)													2	2
52		Lumbrineris sp. C (Harris)			12	38	17	8	9	12	12	5	11		74	198
53		Lumbrineris sp.	5	7	4	2	34		2		1	1	1	5	9	71
54	Magelonidae															
55		Magelona sacculata		1												1
56	Maldanidae															
57		Metasychis disparidentatus						1							1	2
58		Euclymeninae, unid.			1											1
59	Nephtyidae															
60		Nephtys caecoides	4	1		2			6		2			1	4	20
61		Nephtys cornuta											1			1
62	Nereididae															
63		Nereididae, unid. juv.		2								1				3
64		Neanthes acuminata	4	36	3									14		57
65		Neanthes sp.				1				1						2
66		Nereis latescens	2	46		1						5	1	3		58
67	Onuphidae															
68		Onuphidae, unid. juv.			1											1
69		Diopatra ornata	2	5	1									10		18
70	Opheliidae															
71		Armandia brevis	90	148	29	7								54	2	330
72		Polyophthalmus pictus	1	54	26	5			1					105		192

[redacted]

73	Orbiniidae															
74		Leitoscoloplos pugettensis	3	5	99	55	38	189	66	99	78	3	25	1	58	719
75		Scoloplos acmeceps			4	3	3	12		37	2	1		2	3	67
76	Oweniidae															
77		Owenia collaris	1													1
78	Paraonidae															
79		Acmira catherinae			1											1
80	Pectinariidae															
81		Pectinaria californiensis	7		2											9
82	Phyllodocidae															
83		Eteone dilatae												1		1
84		Eumida longicornuta		1	2									1		4
85		Phyllodoce hartmanae		2	1	1										4
86		Phyllodoce longipes		1												1
87	Polynoidae															
88		Malmgreniella bansei				1									1	2
89		Malmgreniella sp.			1											1
90	Sabellariidae															
91		Sabellaria cementarium														
92	Sabellidae															
93		Sabellidae, unid.										1				1
94		Chone mollis	1													1
95		Euchone limnicola			56	83	19	5	31	134	24	1	39	1	93	486
96	Spionidae															
97		Spionidae, unid.	1	1	2											4
98		Aonides sp.	1													1
99		Apoprionospio pygmaea	37	9	2	5									11	64
100		Prionospio lighti		14	17	1	4	1				7		37	12	93
101		Paraprionospio pinnata				1										1
102		Polydora cornuta		4		186					8	4		1	5	208
103		Polydora socialis	1													1
104		Polydora sp.				35		4	2	17	2	7		1		68
105		Prionospio heterobranchia		48	85	76	13	3	6	4			4	56	80	375
106		Prionospio sp.				1										1
107		Pseudopolydora paucibranchiata		103	2	85	49	8	22	41	3	1	3	58	87	462
108		Scolelepis occidentalis			1	19		10	2	15	12		1	12	8	80
109		Scolelepis squamata			1									1		2
110		Scolelepis sp. A			1	1										2
111		Scolelepis sp. 1 (San Diego)			14											14
112		Spiophanes bombyx	2													2
113		Spiophanes missionensis		1	1	7	1		2					3	4	19
114		Streblospio benedicti								26		72	1		4	103
115	Syllidae															

116	Syllidae, unid.								1						1
117	Brania brevipharyngea													4	4
118	Brania californiensis		7												7
119	Eusyllis sp.	1													1
120	Exogone lourei	3	58	795	1065	7	38	177	135	235	15	64	57	176	2825
121	Exogone sp.				5										5
122	Syllides sp.						6		3	1					10
123	Syllis (Typosyllis) farallonensis	1													1
124	Terebellidae														
125	Amaeana occidentalis			3		1									4
126	Pista alata			1											1
127	Pista fasciata			3	1									1	5
128	Pista sp.												1		1
129	ARTHROPODA														
130	CRUSTACEA														
131	CEPHALOCARIDA														
132	COPEPODA														
133	CALANOIDA														
134	Calanoida, unid.												1		1
135	CYCLOPOIDEA														
136	Cyclopoidea, unid.	1	11		1								10	2	25
137	HARPACTICOIDEA														
138	Harpactiocoida, unid.	1	88	6	11								7	2	115
139	OSTRACODA														
140	Bathyleberis sp.		3			14								4	21
141	Euphilomedes carcharodonta			1											1
142	MALACOSTRACA														
143	EUCARIDA														
144	DECAPODA														
145	Anomura														
146	Albuneidae														
147	Blepharipoda occidentalis	1													1
148	Brachyura														
149	Cancridae														
150	Cancer gracilis	1													1
151	Caridea														
152	Alpheidae														
153	Alpheus bellimanus					1	1								2
154	Alpheus sp.				1			1							2
155	EUMALACOSTRACA														
156	PERACARIDA														
157	AMPHIPODA														
158	Amphipoda, unid	1													1

159	CAPRELLIDEA														
160	Aeginellidae														
161	Mayerella banksia		177	37	162	10	10	61	71	59	3	29	32	91	742
162	Caprellidae														
163	Caprella scaura												8		8
164	Caprella sp.												1		1
165	GAMMARIDEA														
166	Aoridae														
167	Aoroides sp.	2	1												3
168	Grandidierella japonica			1		22	5	7	11	13	1			5	65
169	Rudilemboides stenopropodus		1	17	35	40		2				1		43	139
170	Corophiidae														
171	Corophiidae, unid			2		2									4
172	Corophium acherusicum		2		1	1				1	1		2		8
173	Corophium sp.											2			2
174	Isaeidae														
175	Amphideutopus oculatus		35	7	132	10		1						82	267
176	Gammaropsis thompsoni												1		1
177	Gammaropsis sp.	1													1
178	Photis sp.	2	1		1								1		5
179	Melitidae (Gammaridae)														
180	Maera vigola								1						1
181	Ischyroceridae														
182	Ericthonius sp.					1									1
183	Megaluropidae														
184	Gibberosus myersi	14					1		1						16
185	Melphidippidae														
186	Melphisana bola								3						3
187	Oedicerotidae														
188	Monoculodes hartmanae		5												5
189	Monoculodes sp.		3	1											4
190	Synchelidium rectipalmum	1													1
191	Phoxocephalidae														
192	Eobrolgus spinosus					20	1	6		1				12	40
193	Mandibulophoxus gilesi			3			2	1							6
194	Rhepoxinius lucubrans	5													5
195	Podoceridae														
196	Podocerus brasiliensis								4						4
197	Podocerus fulanus	1							1				6		8
198	Podocerus sp.	1													1
199	Pontogeneidae														
200	Pontogeneia sp.	1													1
201	CUMACEA														

202	Campylaspis rubromaculata											2			2
203	Campylaspis sp. B									1					1
204	Campylaspis sp. C	2													2
205	Cumella sp.													3	3
206	Cumella sp. E				1										1
207	Diastylopsis tenuis	2													2
208	Oxyurostylis pacifica	5	171	2	3					1			48	2	232
209	ISOPODA														
210	Anthuridae													1	1
211	Edotea sublittoralis	1	1												2
212	Uromunna ubiquita	3													3
213	Paranathura elegans				5	24	1		4					1	35
214	Serolis carinata			2										3	5
215	Haliophasma geminatum						6								6
216	MYSIDACEA														
217	Mysidacea, unid.	4						1							5
218	Deltamysis sp. A					26	31	2		23	6	22			110
219	Heteromysis odontops					4								2	6
220	Mysidopsis californica											1		3	4
221	TANAIDACEA														
222	Zeuxo normani		24	3	2	18	4	2	16	6		1	1	1	78
223	Leptochelia dubia				2	185		7							194
224	Pseudotanais sp.													10	10
225	CHELICERATA														
226	PYCNOGONIDA														
227	Pycnogonida, unid.				1								2		3
228	Anoropallene palpida	1			1								11		13
229	ASCHELMINTHES														
230	Nematoda, unid.	19	10377	14	2		1	1					5400		15814
231	BRYOZOA (ECTOPROCTA - No. of colonies)														
232	VERTEBRATA														
233	OSTEICHTHYS														
234	Hypsoblennius jenkinsi		1				1	1							3
235	Gobiesocidae														
236	Gobiesox rhessodon		1												1
237	CNIDARIA (COELENTERATA)														
238	ANTHOZOA														
239	Anthozoa, unid.										1				1
240	ACTINARIA														
241	Halcampa decemtentaculata	1													1
242	Edwardsiidae														
243	Edwardsiidae, unid.					1									1
244	Edwardsia sp. G (MEC)			12	5					1		5		2	25

245	Scolanthus sp. A (SCAMIT)				1										1
246	PENNATULACEA														
247	Stylatula elongata	1													1
248	HYDROZOA														
249	HYDROIDA														
250	Corymorpha bigelowi			P											P
251	Tubularia sp.				P			P	P					P	P
252	ECHINODERMATA														
253	HOLOTHUROIDEA														
254	Chiridota sp.											1			1
255	Leptosynapta sp.				1									2	3
256	OPHIUROIDEA														
257	Amphiodia psara				1										1
258	Amphiuridae, unid.	1			1										2
259	NEMERTEA														
260	Amphiporus sp.			7				4							11
261	Carinoma mutabilis	4	1			20		1					3	15	44
262	Cerebratulus sp.	1													1
263	Lineidae, unid.			1									1		2
264	Micrura alaskensis			1									5		6
265	Micrura sp.											1			1
266	Monostylifera, unid								2			2		3	7
267	Paleonemertea					4	1		2	4				5	16
268	Paranemertes californica	2	36	3	5			1	1	3		1	8	6	66
269	Tetrastemma nigrifrons													1	1
270	Tubulanus polymorphus			11	3	2								1	17
271	Tubulanus sp.													1	1
272	PHORONIDA														
273	Phoronis sp.			6	4			3	21						34
274	PLATHYHELMINTHES														
275	Cryptocelis occidentalis				1										1
276	Koinostylochus burchami				1										1
277	Polycladida sp. E			2	1		3								6
278	Stylochoplana sp.								4						4
279	SIPUNCULIDA														
280	Apionosoma misakiana			8	2										10
281	Siphonosoma ingens												1		1
282	Golfingia sp.														
283	MOLLUSCA														
284	GASTROPODA														
285	PROSOBRANCHIA														
286	ARCHAEOGASTROPODA														
287	MESOGASTROPODA														

288	Nassariidae														
289	Nassarius perpinguis		1												1
290	Nassarius tegula			34					1						35
291	Olividae														
292	Olivella baetica	1	1										2		4
293	Turridae														
294	Kurtziella plumbea	1													1
295	OPHISTHOBRANCHIA														
296	CEPHALASPIDEA														
297	Bullidae														
298	Bulla gouldiana			3				2						1	6
299	Scaphandridae														
300	Acteocina inculta			1			10	2	5	5		7			30
301	BIVALVIA (PELECYPODA)														
302	Bivalvia													1	1
303	Cardiidae														
304	Laevicardium substriatum		43	19	3	1							20	1	87
305	Cooperellidae														
306	Cooperella subdiaphana	1			1								1		3
307	Limidae														
308	Limidae, unid.											1			1
309	Lyonsiidae														
310	Lyonsia californica				1										1
311	Mactridae														
312	Mactra californica													3	3
313	Montacutidae														
314	Mysella tumida			1	1										2
315	Mysella sp. A			1											1
316	Mysella sp. D				1										1
317	Mytilidae														
318	Musculista senhousei								1						1
319	Petricolidae														
320	Petricola sp.												4		4
321	Semelidae														
322	Cumingia californica			2	2	1							19		24
323	Theora lubrica					2								13	15
324	Solecurtidae														
325	Tagelus subteres	1	68	14	43	3		2					98	21	250
326	Tellinidae														
327	Macoma nasuta									3			2		5
328	Macoma yoldiformis				2										2
329	Tellina carpenteri			3									15		18
330	Tellina modesta	9											3		12

[redacted]

331	Veneridae														
332	Protothaca staminea		1			2							10		13
	Total number of species per station	62	53	76	78	39	35	41	40	34	27	33	62	64	212
	Total abundance per station	327	12638	2433	2659	673	723	763	933	693	206	395	7373	1505	31321

10.4. FISH SPECIES ABUNDANCE LIST

TABLE 9-1. AGE AND FREQUENCY OF FISH OBSERVED DURING DIVE TRANSECTS AT THREE HARBOR STATIONS - OCT. 1996 AND MAY 1997

May 1996 SAMPLING STATIONS

		North Jetty				Break wall				South Jetty			
SCIENTIFIC NAME	COMMON NAME	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Reef Species													
Anisotremus davidsonii	Sargo												
Atherinops affinis	Topsmelt	450 [1]		1650		1750 [1]		5300		2535 [1]		3325	
Chromis punctipinnis	Blacksmith					5	13				3		
Damalichthys vacca	Pile Surfperch											1	
Embiotoca jacksoni	Black Surfperch	1		8	1	36	13			3	1	31	
Girella nigricans	Opaleye		34	16		64	6			2	1		
Halichoeres semicinctus	Rock Wrasse					7	4			2	2		
Hermosilla azurea	Zebraperch	1				2							
Heterostichus rostratus	Giant Kelpfish												
Hypsoblennius sp.	Blenny												
Hypsopsetta guttulata	Diamond Turbot												
Hypsypops rubicundus	Garibaldi					6							
Micrometrus minimus	Dwarf Surfperch		5	3									
Myliobatus californica	Bat Ray												
Oxyjulis californica	Senorita									4			
Paralabrax clathratus	Kelp Bass					13	8	3		2		7	
Paralabrax nebulifer	Barred Sand Bass					14	14						
Perciformes	Perch												
Xenistius californiensis	Salema												

Oct. 1996 SAMPLING STATIONS

		North Jetty				Break wall				South Jetty			
SCIENTIFIC NAME	COMMON NAME	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Reef Species													
Anisotremus davidsonii	Sargo	1											
Atherinops affinis	Topsmelt	16	10				57			1620		26	
Chromis punctipinnis	Blacksmith					2	12	7	22			18	
Damalichthys vacca	Pile Surfperch									1	2	6	
Embiotoca jacksoni	Black Surfperch					14	10	2		13	9	16	
Girella nigricans	Opaleye	5	4	52	2	21				19	70		
Halichoeres semicinctus	Rock Wrasse					37				5			
Hermosilla azurea	Zebraperch				30					2			
Heterostichus rostratus	Giant Kelpfish										1		
Hypsoblennius sp.	Blenny	1											
Hypsopsetta guttulata	Diamond Turbot	1											
Hypsypops rubicundus	Garibaldi					5							
Micrometrus minimus	Dwarf Surfperch	4											
Myliobatus californica	Bat Ray		1										
Oxyjulis californica	Senorita					1				4			
Paralabrax clathratus	Kelp Bass					6	17			1	4	6	1
Paralabrax nebulifer	Barred Sand Bass					7				1	2	5	16
Perciformes	Perch			1									
Xenistius californiensis	Salema												14

[1] Adult and subadult combined.

KEY TO AGE GROUPS

Ad. = Adult

Sub. = Subadult

Juv. = Juvenile

YOY = Young of year

TABLE 9-2. COMPLETE ICHTHYOPLANKTON DATA FROM THREE HARBOR STATIONS - OCT. 1996 AND MAY 1997.

KEY TO AGE GROUPS

YS = Yolk sac larvae

NL = Notochord length larvae

FL = Flexon length larvae (hypurals are developing and tip of tail is flexing)

SL = Standard length larvae (hypural plates are perpendicular to the longitudinal axis of the body)

J = Juvenile

EG = Egg

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1997

Raw data, standardization factors, sorting data

Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume (ml/1000m³)	Primary Zooplankton Types	Sorting Record
1S	6-May-97	1137	7.42	11	81.58	Copepods	Sort: D. Oda, June 9-14, 45 LV, 827 EG
							Sortcheck:R. Feeney, July 8, 0 Eggs, 0 Larvae
1B	6-May-97	874	9.65	77	742.87	Detritus, nematodes,	Sort : D. Oda, July 11, 268 LV, 407 EG
						Caprellids	Sortcheck: R. Feeney, July 14, 0 Eggs, 0 Larvae
5S	6-May-97	1625	5.19	45	233.50	Copepods	Sort: D. Oda, July 8 - 9, 197 LV, 5233 EG
							Sortcheck: R. Feeney, July 15, 0 Eggs, 0 Larvae
5B	6-May-97	1130	7.46	21	156.70	Copepods	Sort: D. Oda, June 22 - 28, 465 LV, 4174 EG
							Sortcheck: R. Feeney, July 8, 0 Eggs, 0 Larvae
8S	6-May-97	1780	4.74	39	184.75	Copepods	Sort: D. Oda, June 29 - July 3, 81 LV, 7398 EG
							Sortcheck: R. Feeney, July 14, 1 Egg, 0 Larvae
8B	6-May-97	975	8.65	54	467.00	Copepods	Sort: D. Oda, July 5 - 8, 136 LV, 10510 EG
							Sortcheck: R. Feeney, July 11, 0 Eggs, 0 Larvae

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1997						
Ichthyoplankton data						
					Larvae	
Sample	Standardization			Number	Standardized to	Larval Size (mm)
Code	Factor	Taxon	Stage	identified	n/1000m³	
1S	7.42	TOTAL LARVAE		45	333.90	
		Atherinops affinis	YS	1	7.42	2.6 mm
		Engraulidae	YS	1	7.42	1.2 mm (too small or
						damaged to I.D.)
		Engraulis mordax	YS	9	66.78	1.2 - 2.8 mm
		Engraulis mordax	NL	1	7.42	3.0 mm
		Genyonemus lineatus	YS	2	14.84	1.9 - 2.0 mm
		Gobiidae type A/C	NL	13	96.46	2.1 - 2.7 mm
		Hypsoblennius	NL	11	81.62	2.1 - 2.5 mm
		Leuresthes tenuis	YS	1	7.42	3.2 mm
		Sciaenidae Complex II	YS	1	7.42	1.8 mm (*Menticirrhus* ,
						Cheilotrema , or
						Atractoscion)
		Unidentified	YS	5	37.10	1.1 - 1.6 mm
		TOTAL EGGS		827	6136.34	
		Anchoa delicatissima	EG	255	1892.10	
		Citharichthys	EG	87	645.54	
		Type 32	EG	97	719.74	
		Engraulis mordax	EG	42	311.64	
		Pleuronichthys verticalis	EG	17	126.14	
		Unidentified	EG	329	2441.18	
1B	9.65	TOTAL LARVAE		268	2586.2	
		Engraulidae	YS	4	38.6	1.0 - 2.1 mm
		Engraulis mordax	YS	3	28.95	1.8 - 2.0 mm
		Engraulis mordax	NL	2	19.3	2.3 - 2.8 mm
		Gobiesox rhessodon	NL	24	231.6	2.6 - 4.2 mm
		Gobiidae type A/C	NL	215	2074.75	1.9 - 4.6 mm
		Gobiidae type A/C	FL	1	9.65	5.5 mm
		Gobiidae type A/C	SL	1	9.65	6.3 mm
		Hypsoblennius	NL	12	115.8	2.1 - 2.3 mm
		Paraclinus integripinnis	NL	1	9.65	3.7 mm
		Paralabrax	YS	1	9.65	1.3 mm
		Unidentified	YS	4	38.6	1.0 - 1.1 mm
		TOTAL EGGS		407	3927.55	
		Anchoa delicatissima	EG	28	270.2	
		Citharichthys	EG	53	511.45	
		Type 32	EG	58	559.7	
		Engraulis mordax	EG	72	694.8	
		Pleuronichthys ritteri	EG	13	125.45	
		Unidentified	EG	183	1765.95	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1997						
Ichthyoplankton data						
Sample Code	Standardization Factor	Taxon	Stage	Number identified	Larvae Standardized to n/1000m³	Larval Size (mm)
5S	5.19	TOTAL LARVAE		197	1022.43	
		Citharichthys type A	YS	1	5.19	1.0 mm (probably
						C. stigmaeus)
		Engraulidae	YS	9	46.71	1.2 - 1.7 mm
		Genyonemus lineatus	YS	1	5.19	1.4 mm
		Gobiidae type A/C	YS	5	25.95	2.3 - 2.8 mm
		Gobiidae type A/C	NL	104	539.76	2.0 - 4.1 mm
		Hypsoblennius	NL	72	373.68	2.3 - 3.1 mm
		Paraclinus integripinnis	NL	2	10.38	3.7 - 4.1 mm
		Paralichthys californicus	YS	2	10.38	1.4 - 1.5 mm
		Pleuronichthys verticalis	YS	1	5.19	1.5 mm
		TOTAL EGGS		5233	27159.27	
		Anchoa compressa	EG	66	342.54	
		Anchoa delicatissima	EG	5028	26095.32	
		Engraulis mordax	EG	43	223.17	
		Pleuronichthys ritteri	EG	1	5.19	
		Unidentified	EG	95	493.05	
5B	7.46	TOTAL LARVAE		465	3468.9	
		Anchoa	YS	39	290.94	2.1 - 2.2 mm
		Anchoa	NL	4	29.84	2.3 - 2.5 mm
		Citharichthys type A	YS	1	7.46	1.8 mm (probably
						C. stigmaeus)
		Engraulidae	YS	81	604.26	1.5 - 2.3 mm
		Engraulis mordax	YS	4	29.84	2.0 - 2.7 mm
		Engraulis mordax	NL	1	7.46	5.3 mm
		Gobiesox rhessodon	NL	3	22.38	3.0 - 3.7 mm
		Gobiidae type A/C	NL	237	1768.02	2.2 - 4.0 mm
		Gobiidae type A/C	FL	2	14.92	4.9 - 5.8 mm
		Gobiidae type A/C	SL	1	7.46	6.7 mm
		Heterostichus rostratus	FL	1	7.46	9.0 mm
		Hypsoblennius	NL	81	604.26	2.3 - 2.8 mm
		Hypsopsetta guttulata	YS	1	7.46	1.8 mm
		Paralichthys californicus	YS	4	29.84	1.6 - 1.9 mm
		Pleuronectidae	YS	1	7.46	1.5 mm
		Unidentified	YS	4	29.84	1.2 mm
		TOTAL EGGS		4174	31138.04	
		Anchoa compressa	EG	25	186.5	
		Anchoa delicatissima	EG	4065	30324.9	
		Engraulis mordax	EG	9	67.14	
		Pleuronichthys ritteri	EG	1	7.46	
		Unidentified	EG	74	552.04	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1997						
Ichthyoplankton data						
Sample Code	**Standardization Factor**	**Taxon**	**Stage**	**Number identified**	**Larvae Standardized to n/1000m³**	**Larval Size (mm)**
8S	4.74	TOTAL LARVAE		81	383.94	
		Anchoa	YS	3	14.22	2.1 - 2.3 mm
		Anchoa	NL	2	9.48	2.9 - 3.1 mm
		Atherinops affinis	YS	1	4.74	5.3 mm
		Engraulidae	YS	12	56.88	1.2 - 1.5 mm
		Gobiesox rhessodon	NL	1	4.74	3.1 mm
		Gobiidae type A/C	YS	3	14.22	2.4 - 2.6 mm
		Gobiidae type A/C	NL	44	208.56	2.3 - 3.2 mm
		Hypsoblennius	NL	13	61.62	2.3 - 2.5 mm
		Pleuronectidae	YS	1	4.74	1.2 mm
		Sciaenidae Complex II	YS	1	4.74	1.8 mm (*Menticirrus* , *Cheilotrema* , or *Atractoscion*)
		TOTAL EGGS		7399	35071.26	
		Anchoa compressa	EG	462	2189.88	
		Anchoa delicatissima	EG	6928	32838.72	
		Pleuronichthys ritteri	EG	1	4.74	
		Unidentified	EG	8	37.92	
8B	8.65	TOTAL LARVAE		136	1176.4	
		Anchoa	YS	20	173	2.1 - 2.3 mm
		Anchoa	NL	20	173	2.4 - 4.5 mm
		Engraulidae	YS	29	250.85	1.2 - 2.3 mm
		Engraulis mordax	YS	3	25.95	2.1 - 2.2 mm
		Engraulis mordax	NL	2	17.3	4.1 - 4.5 mm
		Gobiidae type A/C	NL	35	302.75	2.3 - 3.0 mm
		Hypsoblennius	NL	24	207.6	2.1 - 2.8 mm
		Paraclinus integripinnis	NL	1	8.65	5.1 mm
		Unidentified	YS	2	17.3	1.2 mm (? *Paralichthys californicus*)
		TOTAL EGGS		10510	90911.5	
		Anchoa compressa	EG	647	5596.55	
		Anchoa delicatissima	EG	9840	85116	
		Engraulis mordax	EG	5	43.25	
		Unidentified	EG	18	155.7	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 1996

Raw data, standardization factors, sorting data

Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume (ml/1000m³)	Primary Zooplankton Types	Sorting Record
1S	16-Oct-96	558	14.63	1.4	20.48	Cladocerans	Sort: D.Oda 14Nov -17 LV, 40 EG
						Copepods	Sort Check: R. Feeney 14Nov - 1 LV, 0 EG
							Resort: D.Oda 18Nov - 0 EG, 0 LV
							2nd Sort Check: R.Feeney 18 Nov96 0 EG, 0 LV
1B	16-Oct-96	1204	6.78	3.4	23.05	Cladocerans	Sort: D.Oda 18Nov - 132 LV, 68 EG
						Copepods	Sort Check: R. Feeney 18Nov - 3 LV, 0 EG
							Resort: D.Oda 19Nov - 2 LV,0 EG
							2nd Sort Check: R. Feeney 19 Nov - 0 EG, 0 LV
5S	16-Oct-96	750	10.88	1.6	17.41	Copepods	Sort: D.Oda 18Nov - 50 LV, 38 EG
							Sort Check: R. Feeney 21Nov - 0 EG, 0 LV
5B	16-Oct-96	830	9.83	2.8	27.53	Copepods	Sort: D.Oda 20Nov - 282 LV,17 EG,1 J
							Sort Check: R. Feeney 21Nov - 0 EG,0 LV
8S	16-Oct-96	860	9.49	2.8	26.57	Copepods	Sort: D.Oda 27Nov - 27 LV, 4 EG
							Sort Check: R. Feeney 27Nov - 0 EG,0 LV
8B	16-Oct-96	885	9.22	9.2	84.85	Copepods	Sort: D.Oda 2Dec - 155 LV, 0 EG
							Sort Check: R. Feeney 4Dec - 0 EG, 0 LV

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 1996

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number identified	Larvae Standardized to n/1000m³	Larval Size (mm), Egg Stage
1S	14.63	Total Larvae		18	263.28	
		Total Eggs		40	585.07	
		Citharichthys type A	YS	1	14.63	1.5
		Engraulis mordax	YS	3	43.88	2.0 - 2.7
		Gobiidae type A/C	NL	7	102.39	2.1 - 2.5
		Hypsoblennius	NL	7	102.39	2.1 - 2.7
		Citharichthys type A	EG	2	29.25	1 - St. VIII, 1 - St. IX
		Pleuronichthys ritteri	EG	6	87.76	6 - St. III
		Unidentified Eggs	EG	32	468.06	
1B	6.78	Total Larvae		137	928.71	
		Total Eggs		68	460.96	
		Engraulidae	YS	1	6.78	1.0
		Engraulis mordax	YS	2	13.56	2.4 - 2.7
		Genyonemus lineatus	YS	1	6.78	1.4
		Gobiidae type A/C	NL	56	379.62	2.0 - 2.7
		Hypsoblennius	NL	76	515.19	2.0 - 2.8
		Hypsopsetta guttulata	YS	1	6.78	1.0
		Citharichthys	EG	4	27.12	2 - St. VIII, 2 - St. IX
		Pleuronichthys verticalis	EG	1	6.78	St. III
		Pleuronichthys ritteri	EG	15	101.68	2 St. II, 11 - St. III,
						1 - St. XI, 1 - Damaged
		Unidentified	EG	48	325.39	
5S	10.88	Total Larvae		50	544.12	
		Total Eggs		38	413.53	
		Gobiidae type A/C	YS	3	32.65	2.5 - 2.6
		Gobiidae type A/C	NL	18	195.88	2.3 - 2.9
		Hypsoblennius	NL	28	304.71	27 @ 2.0 - 2.9
						1 @ 4.4
		Paraclinus integrippinis	NL	1	10.88	3.6
		Pleuronichthys verticalis	EG	1	10.88	damaged
		Pleuronichthys ritteri	EG	1	10.88	damaged
		Unidentified	EG	36	391.77	
5B	9.83	Total Larvae		282	2773.04	
		Total Eggs		17	167.17	
		Total Juveniles		1	9.83	
		Gobiesox rhessodon	FL	1	9.83	5.5
		Gobiidae type A/C	YS	15	147.50	2.3 - 2.7
		Gobiidae type A/C	NL	164	1612.69	4 @ 1.8 - 1.9
						146 @ 2.0 - 2.9
						14 @ 3.0 - 3.5
		Heterostichus rostratus	NL	1	9.83	6.0
		Hypsoblennius	NL	100	983.35	96 @ 2.0 - 2.9
						4 @ 3.2 - 3.4
		Hypsoblennius	FL	1	9.83	5.6
		Pleuronichthys ritteri	EG	7	68.83	5 - St. IV, 2 - Damaged
		Unidentified	EG	10	98.33	
		Bryx arctus	J	1	9.83	8.1

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 1996						
Ichthyoplankton data						
					Larvae	
Sample	Standardization			Number	Standardized to	Larval Size (mm),
Code	Factor	Taxon	Stage	identified	($n/1000m^3$)	Egg Stage
8S	9.49	Total Larvae		27	256.24	
		Total Eggs		4	37.96	
		Gobiidae type A/C	YS	4	37.96	2.5 - 2.7
		Gobiidae type A/C	NL	16	151.85	14 @ 2.5 - 2.9
						2 @ 3.0 - 3.2
		Hypsoblennius	NL	4	37.96	2.2 - 2.6
		Hypsopsetta guttulata	YS	1	9.49	1.5
		Hypsopsetta guttulata	NL	2	18.98	1.9 - 2.1
		Unidentified	EG	4	37.96	
8B	9.22	Total Larvae		155	1429.46	
		Total Eggs		0	0.00	
		Gobiidae type A/C	NL	86	793.12	71 @ 2.0 - 2.9
						15 @ 3.0 - 3.4
		Hypsoblennius	YS	1	9.22	2.0
		Hypsoblennius	NL	66	608.67	4 @ 1.9
						62 @ 2.0 - 2.7
		Hypsopsetta guttulata	YS	1	9.22	1.3
		Paraclinus integrippinis	NL	1	9.22	3.2