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The Marine Environment of Marina del Rey Harbor
July 1997 - June 1998

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

by

Aquatic Bioassay and Consulting Laboratories, Inc.
29 North Olive Street
Ventura, California 93001
(805) 643-5621

AQUATIC
BIOASSAY &
CONSULTING
LABORATORIES, INC.

TOXICITY TESTING • OCEANOGRAPHIC RESEARCH

October 15, 1998

Dr. James A. Fawcett
County of Los Angeles
Dept. of Beaches and Harbors
13837 Fiji Way
Marina del Rey, CA 90292

Dear Dr. Fawcett:

The scientists and staff of Aquatic Bioassay are pleased to present this report of the 1997-98 marine surveys of Marina del Rey Harbor.

This report covers the period of field and laboratory studies conducted from July 1, 1997 through June 30, 1998. The 1997-98 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.

Yours very truly,

Thomas (Tim) Mikel
Laboratory Director

AQUATIC BIOASSAY OCEANOGRAPHIC TEAM

MARINE BIOLOGISTS

T. Mikel, Project Manager
D. Laur, Ph.D., Sampling Coordinator
M. Meyer, Marine Biologist
M. Machuzak, Marine Biologist

MARINE CHEMISTS

J. Northington, Ph.D. (WCAS)
B. Olson (WCAS)

TAXONOMISTS

D. Laur, Ph.D., Fish
T. Mikel, Macroinvertebrates
T. Gerlinger, Infauna (Osprey Marine)
D. Ota, Ichthyoplankton (L.A. Nat. Hist. Museum)

BOAT CREW

J. Gelsinger, Captain
J. Cooluris, Photo and Video Documentation

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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, 1997 to June 30, 1998. 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. In general, chemical and bacteriological water quality measurements were comparable to past years. Water quality in Marina del Rey Harbor this year was spatially impacted by the discharges of Oxford Lagoon and Ballona Creek, nonpoint rain runoff from Mothers Beach, and inflows of the open ocean from the Harbor entrance. It was temporally impacted by season, rainfall, and plankton blooms. As this year was subject to a strong El Nino Southern Oscillation (ENSO) event, rainfall was nearly three times normal. Both storm drain and nonpoint flows during the rainy season, lowered salinity, temperature, pH, and water clarity; raised ammonia, biochemical oxygen demand, and bacterial counts; and contributed nutrients to spring phytoplankton blooms. Phytoplankton blooms likely raised dissolved oxygen values, and their death may have increased biochemical oxygen demand later in the spring. However, the exceptionally strong red tide blooms of 1996-97 were not evident this year.

Stations adjacent to the Harbor entrance were apparently impacted by both the open ocean and Ballona Creek, while stations in the lower main channel were most like open ocean water and were thus more natural than the rest of the Harbor. Areas further back into the Marina were warmer, more saline, and lower in dissolved oxygen. Discharges from both Ballona Creek and Oxford Lagoon impacted Basin E and the upper end of the main channel by elevating ammonia, biochemical oxygen demand, and both total and fecal coliform bacteria. Oxford Lagoon additionally elevated enterococcus bacterial counts and lower oxygen, pH, and temperature values. To a lesser degree, waters in Basin D had elevated bacterial counts during the rainy season, as well. The source may be nonpoint flows off of Mothers Beach, where people, birds, stray animals, and people tend to congregate. Measurements of the three groups of bacteria were made monthly at 18 stations (216 measurements for each group during the year). Total coliform limits were exceeded 19 times, fecal coliform limits were exceeded 49 times, and enterococcus limits were exceeded 16 times. These are more frequent than last year, however, the heavy rainfall this year was a likely contributor. Most exceedances occurred following rainy months and at stations near Oxford Lagoon or Ballona Creek.

Physical Characteristics of Benthic Sediments. Similar to last year, physical characteristics of Harbor sediments were influenced by energy of water flow which is influenced by Harbor configuration and rainfall intensity. Coarser sands predominate near the Harbor entrance and in Ballona Creek due to strong drainage flows and ocean currents, tides, and wave action. Water velocity further back in the Harbor is much slower and allows for finer fractions.

Chemical Characteristics of Benthic Sediments. Similar to past years, 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 but are more difficult to assign.

Oxford Lagoon and Ballona Creek appear to be sources of chlorinated hydrocarbons, however, the pattern was not as distinct as last year. Encouragingly, most chlorinated compounds have continued to remain low when compared to historical values, and levels are about one-eighth those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

The most likely source of most of the heavy metals in benthic sediments is the resident boat population, although Oxford Lagoon and Ballona Creek drainages may contribute. Metal components of boats are constantly being corroded by seawater, and most bottom paints contain materials which are designed to continuously ablate off into the sediment. Areas that exceeded most metal limits were Basin D, E, F, Oxford Lagoon, and most channel stations. A number of heavy metals in Marina del Rey sediments were about two to six times higher than Los Angeles Harbor. The configuration of Los Angeles Harbor allows for better flushing and the movement of contaminated suspended materials offshore since it has two entrances rather than the one in Marina del Rey Harbor. The recent ban on the use of tributyl tin as a boat bottom paint has contributed to comparatively lower values this year and last. In general, metal concentrations in Marina del Rey sediments do not appear to have greatly increased nor decreased since 1985. Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals, so their sources may be varied, as well.

Harbor sediments which are composed of finer particles also tend to have the highest heavy metals and organics, although the pattern this year was not as clear-cut. Sediments with finer particle sizes tend to attract chemical contaminants more readily. Conversely, sediments containing mostly sand and course silt tend to be lower in organics and heavy metals. The exception appears to be chlorinated hydrocarbons which do not appear to relate to particle size.

Among compounds listed as toxic by NOAA, all Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and most had compounds at levels "probably" toxic to benthic organisms. The areas that exceeded most metal limits were the main channel; Basins D, E, and F; and Oxford Lagoon. The areas that exceeded most chlorinated hydrocarbon limits were the main channel and Oxford Lagoon.

Biological Characteristics of Benthic Sediments. 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 did not appear to be strongly related to stations' benthic grain size patterns nor to any specific chemical compound. Relative to past years, abundance and species diversity values at the remaining stations were comparable.

Sediments from stations influenced by Ballona Creek were dominated by nematode worms, which are known to be characteristic of highly disturbed benthic sediments. When compared to Los Angeles Harbor and offshore reference site surveys, Marina del Rey abundances were higher (probably due to the huge numbers of nematodes collected at some stations) and numbers of species were about the same. Diversity and infaunal index values were lower, but, like heavy metals, may be because of better circulation in Los Angeles Harbor.

Fish Populations. The Marina continues to support a very abundant and diverse assemblage of fish fauna and serves as a nursery for many species important to local sport and commercial fisheries, as well as the whole coastal environment. However, this year's El Nino generated storms strongly affected the spring plankton, dive survey, and beach seine populations.

25,834 total fish of all age groups, representing 57 different species were recorded. The majority of these were either eggs, larvae, or juveniles, which attest to the Harbor's importance as a nursery. Evidence of El Nino impacts in the spring included considerably lower fish egg counts in the water column, observations of depauperate food and cover for reef fishes, and large catches of tropical fish in the beach seine at Mothers Beach.

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, 1997 through June 30, 1998, 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.

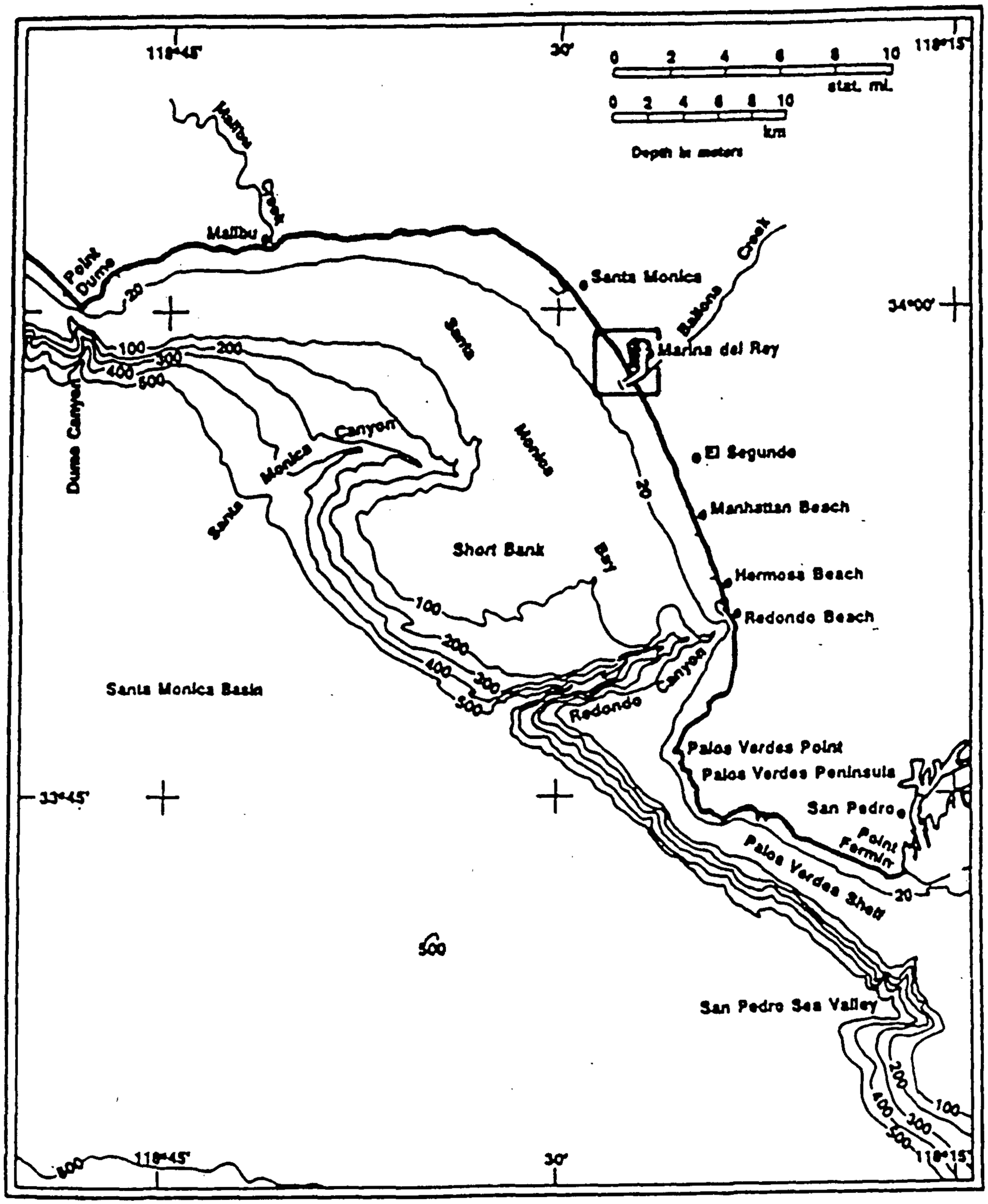
2.2. HISTORY OF THE SURVEY PROJECT

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; and Aquatic Bioassay 1997).

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).

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



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.

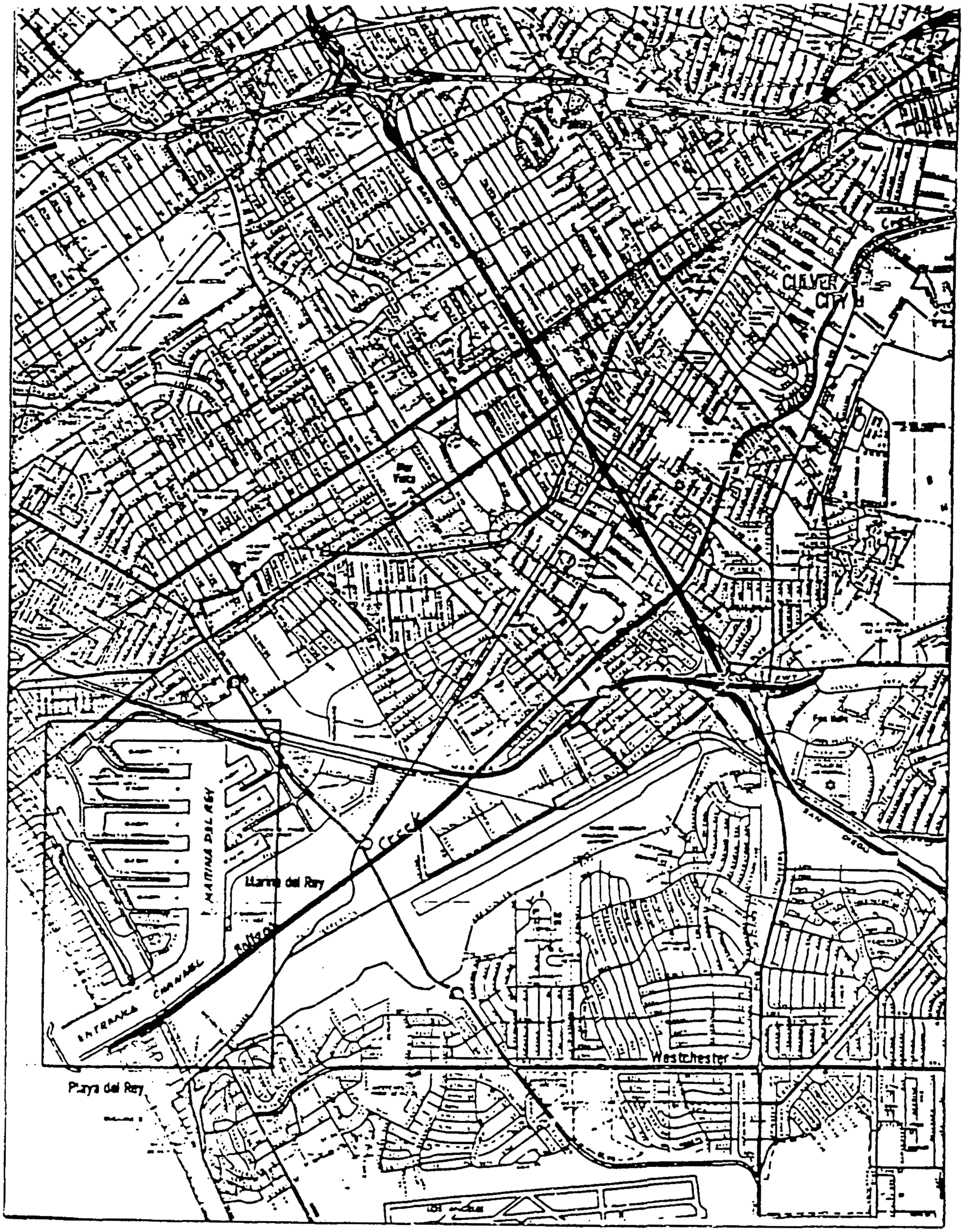
The present configuration was believed to be adequate to protect boats without a breakwater, but this was disproved not long after the marina opened, when southwest swells from a winter storm damaged docks and vessels. Thus the present breakwater was added several years later. This protected vessels 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:

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.

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



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.

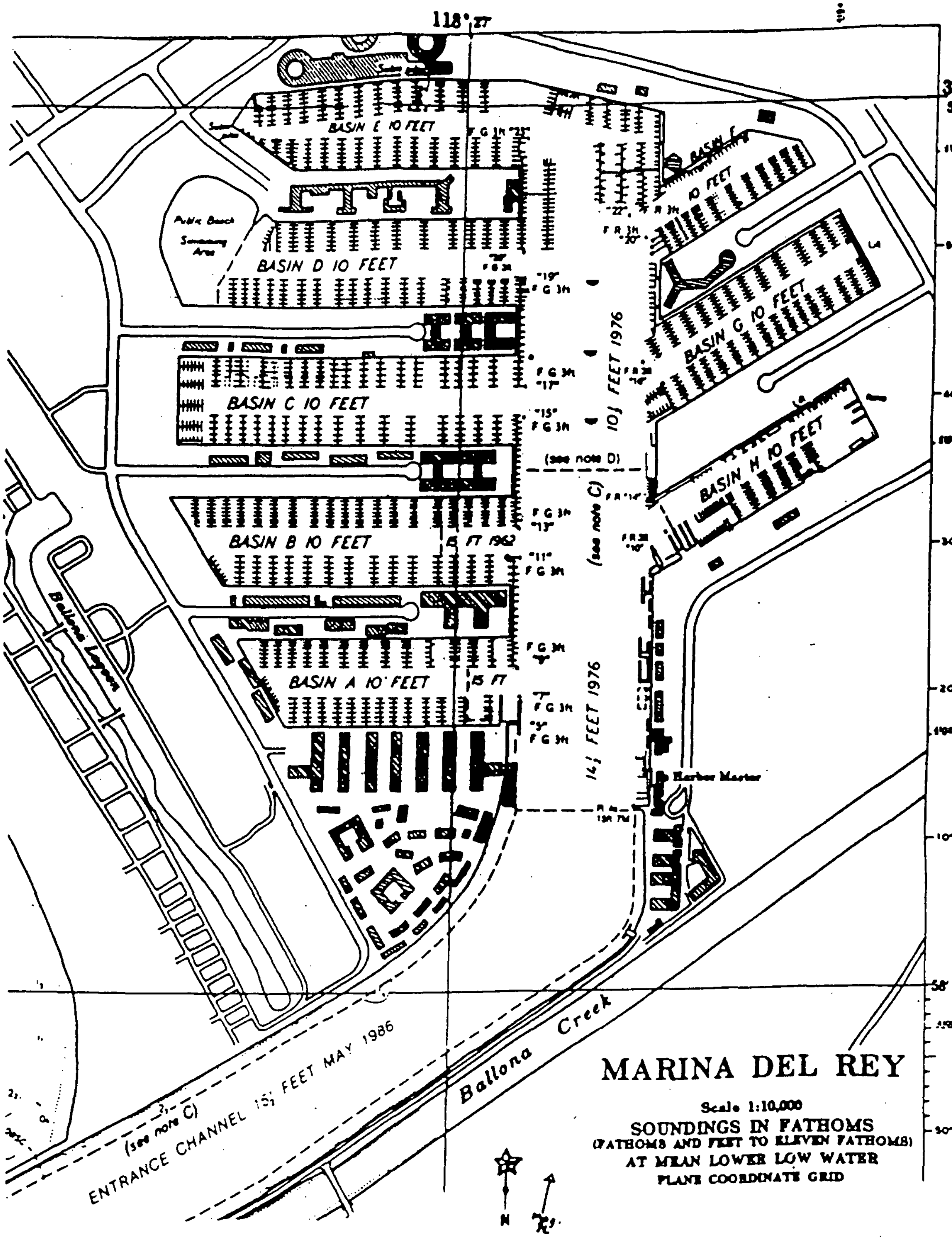
Pesticides occur in concentrations that are inhibitory to some organisms, especially reproductive stages. The levels of pesticides have been declining, however. Polychlorinated biphenyls (PCBs) have appeared episodically at toxic levels. Some terrestrial soils in areas to the north of the marina are 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.

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.

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



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.

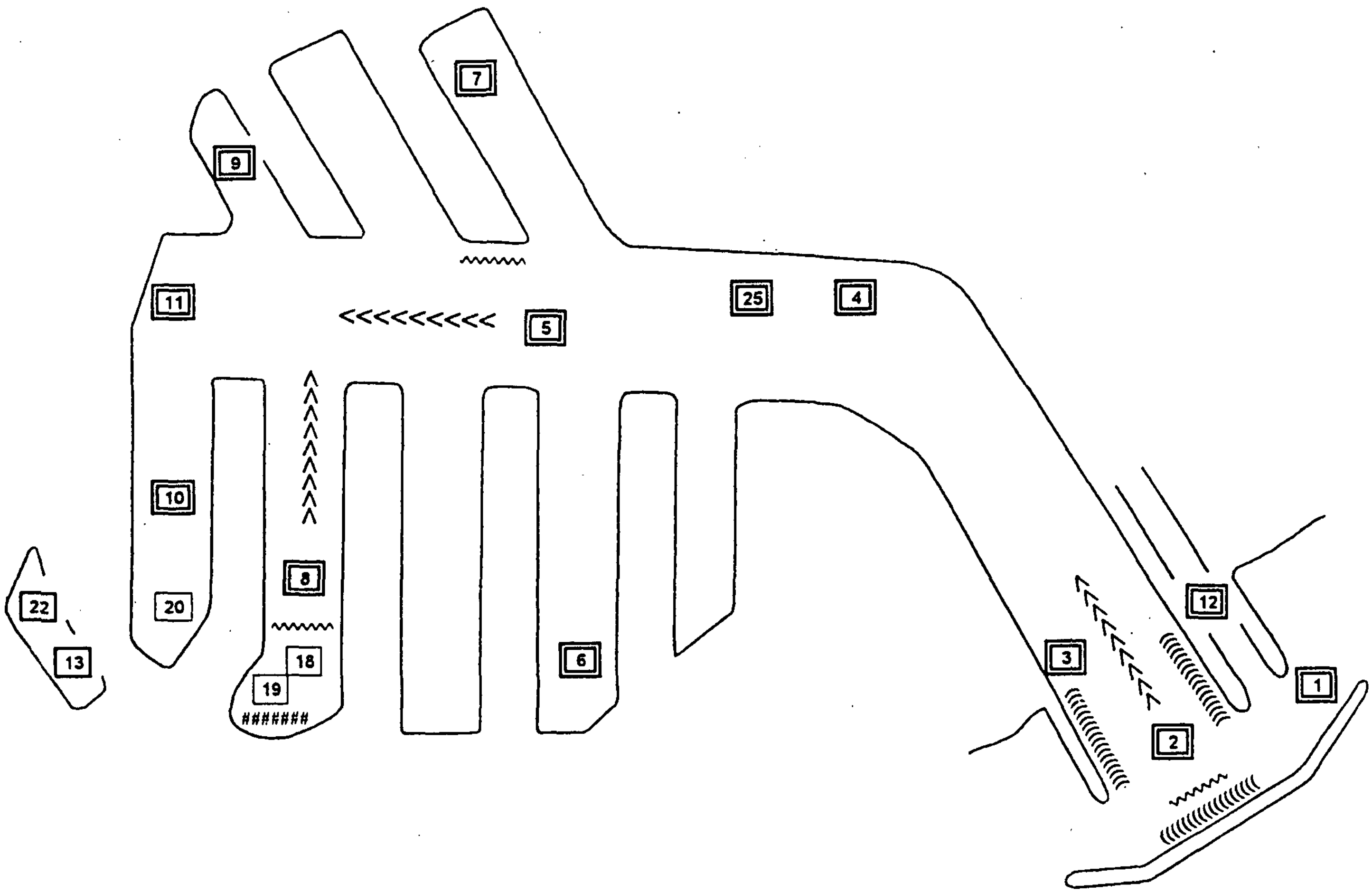
2.5. STATION LOCATIONS AND DESCRIPTIONS

Figure 2-4 illustrates the survey stations for the Harbor, 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.

FIGURE 2-4. 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-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.

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 survey year showed temperatures close to normal late in 1994 and temperatures above normal during the first half of 1995. The 1995-96 survey year 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 1996-97 survey year, 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 1996, temperatures were very near normal, however temperatures had begun to climb again in 1997 with water temperatures averaging five degrees above normal in June. The 1997-98 survey year was characterized by a very strong ENSO anomaly. Surface water temperatures averaged from two degrees (in April 1998) to five degrees (August through December 1997) above normal.

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 balls, etc.) 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).

The period of this report is from July 1, 1997 through June 30, 1998 The rainfall for this period (31 inches) was well above normal (13 inches, SCCWRP 1973) as well as for 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).

FIGURE 3-1. MONTHLY (LINES) AND ANNUAL (BARS) LOS ANGELES RAINFALL (INCHES) 1977-98.

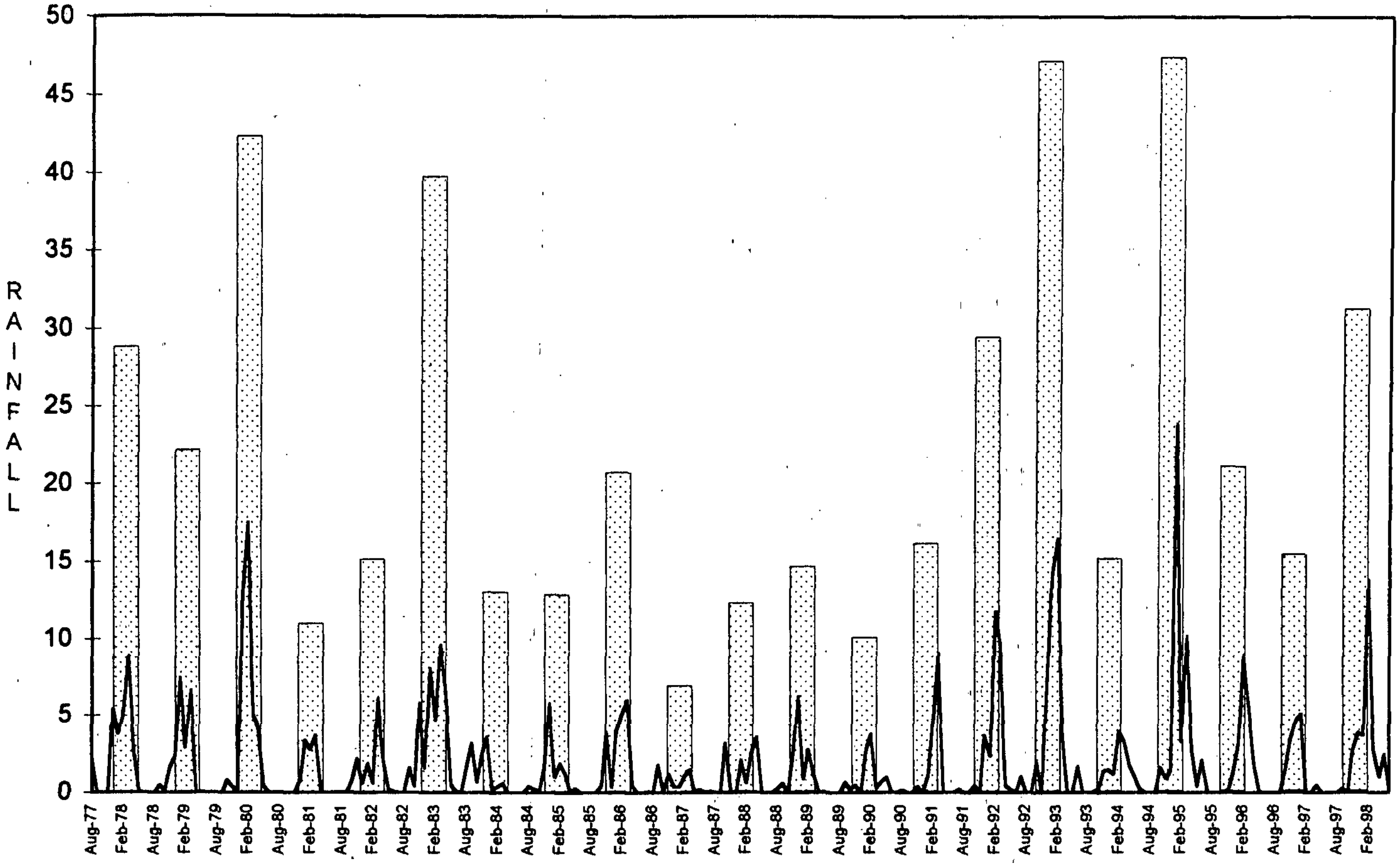
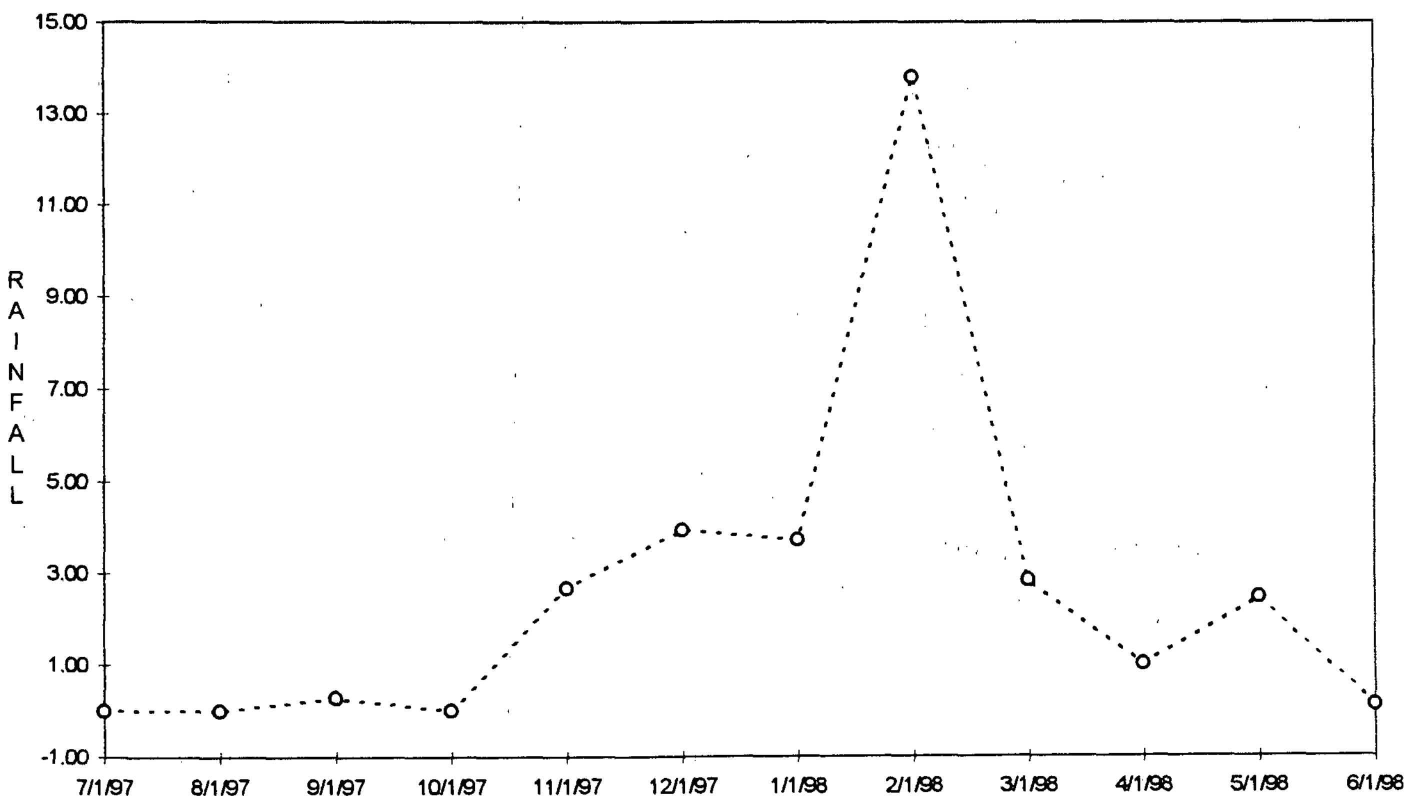


FIGURE 3-2. LOS ANGELES AIRPORT RAINFALL (INCHES) 1997-98.



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. Very little rainfall was recorded during most of July, August, September, and October. The first significant storm of the season occurred on November 10 (0.78 inches) followed by similar rains on November 26 (0.79 inches) and 30 (0.58 inches). In December, two more storms occurred, one between December 5 and 7 (2.75 inches) and a second on December 18 (1.18 inches). January saw four small storms (January 12-13 - 0.15 inches, January 15 - 0.02 inches, January 19 - 0.14 inches, and January 31 - 0.09 inches) and three larger storms (January 2-4 - 0.71 inches, January 8-10 - 1.77 inches, and January 29 - 0.83 inches). The latter storm continued into February creating the largest storm of the year (February 1-3 - 3.73 inches). This was followed by three other larger storms (February 6-9 - 3.13 inches, February 14-17 - 2.60 inches, and February 21-24 - 3.53 inches). March precipitation was lower with two larger (March 24-25 - 1.40 inches and March 13-14 - 0.67 inches) and three smaller storms (March 5-6 - 0.30 inches, March 27-29 - 0.32 inches, and March 31 - 0.13 inches). As with February, the latter storm continued into April (April 1 - 0.08 inches). Two more April storms occurred (April 3-4 - 0.18 inches and April 11 - 0.74 inches). Rain occurred three times in May (May 2-6 - 1.19 inches, May 9 - 0.01 inches, and May 12-14 - 1.26 inches) and two times in June (June 11 - 0.08 inches and June 16 - 0.01 inches).

The wettest month of the sampling year by far was February (13.79 inches), followed by December (3.93 inches), then January (3.71 inches), March (2.82 inches), November (2.66 inches), and May (2.46 inches) (see Figure 3-2). Only one water column sampling event occurred immediately following significant precipitation (January 8, 1998 - Table 3-1), however, the November and February surveys were within a day or two of relatively heavy rains.

3.2. MATERIALS AND METHODS

Sampling and data collection for water quality assessment was conducted monthly at the 18 stations described and figured above. The monthly dates were selected so that sampling could begin at 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 with a Nauman sampler.

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

DATE	PRECIP.
7/1/97	0.00
7/2/97	0.00
7/3/97	0.00
7/4/97	0.00
7/5/97	0.00
7/6/97	0.00
7/7/97	0.00
7/8/97	0.00
7/9/97	0.00
7/10/97	0.00
7/11/97	0.00
7/12/97	0.00
7/13/97	0.00
7/14/97	0.00
7/15/97	0.00
7/16/97	0.00
7/16/98	*Survey*
7/17/97	0.00
7/18/97	0.00
7/19/97	0.00
7/20/97	0.00
7/21/97	0.00
7/22/97	**Trace**
7/23/97	0.00
7/24/97	**Trace**
7/25/97	0.00
7/26/97	0.00
7/27/97	0.00
7/28/97	0.00
7/29/97	0.00
7/30/97	0.00
7/31/97	0.00

DATE	PRECIP.
9/1/97	0.00
9/2/97	**Trace**
9/3/97	0.00
9/4/97	0.00
9/5/97	0.00
9/6/97	0.00
9/7/97	0.00
9/8/97	0.00
9/9/97	0.00
9/10/97	0.00
9/11/97	0.00
9/12/97	0.00
9/12/98	*Survey*
9/13/97	0.00
9/14/97	0.00
9/15/97	**Trace**
9/16/97	0.00
9/17/97	**Trace**
9/18/97	0.00
9/19/97	0.00
9/20/97	0.00
9/21/97	0.00
9/22/97	0.00
9/23/97	0.00
9/24/97	0.00
9/25/97	**0.27**
9/26/97	0.00
9/27/97	0.00
9/28/97	0.00
9/29/97	0.00
9/30/97	0.00

DATE	PRECIP.
11/1/97	0.00
11/2/97	0.00
11/3/97	0.00
11/4/97	0.00
11/5/97	0.00
11/6/97	0.00
11/7/97	0.00
11/8/97	0.00
11/9/97	0.00
11/10/97	**0.78**
11/11/97	**Trace**
11/12/97	0.00
11/13/97	**0.40**
11/14/97	0.00
11/14/98	*Survey*
11/15/97	**0.86**
11/16/97	**0.01**
11/17/97	0.00
11/18/97	0.00
11/19/97	**0.04**
11/20/97	0.00
11/21/97	0.00
11/22/97	0.00
11/23/97	0.00
11/24/97	0.00
11/25/97	0.00
11/26/97	**0.79**
11/27/97	0.00
11/28/97	0.00
11/29/97	1.00
11/30/97	**0.58**

DATE	PRECIP.
1/1/98	0.00
1/2/98	**0.09**
1/3/98	**0.21**
1/4/98	**0.41**
1/5/98	0.00
1/6/98	0.00
1/7/98	0.00
1/8/98	**Trace**
1/8/98	*Survey*
1/9/98	**1.70**
1/10/98	**0.07**
1/11/98	0.00
1/12/98	**Trace**
1/13/98	**0.16**
1/14/98	0.00
1/15/98	**0.02**
1/16/98	0.00
1/17/98	0.00
1/18/98	0.00
1/19/98	**0.14**
1/20/98	0.00
1/21/98	0.00
1/22/98	0.00
1/23/98	0.00
1/24/98	0.00
1/25/98	0.00
1/26/98	0.00
1/27/98	0.00
1/28/98	0.00
1/29/98	**0.83**
1/30/98	0.00
1/31/98	**0.09**

DATE	PRECIP.
3/1/98	0.00
3/2/98	0.00
3/3/98	0.00
3/4/98	0.00
3/5/98	**0.11**
3/6/98	**0.19**
3/7/98	0.00
3/8/98	0.00
3/9/98	0.00
3/10/98	0.00
3/11/98	0.00
3/12/98	0.00
3/12/98	*Survey*
3/13/98	**0.48**
3/14/98	**0.19**
3/15/98	0.00
3/16/98	0.00
3/17/98	0.00
3/18/98	0.00
3/19/98	0.00
3/20/98	0.00
3/21/98	0.00
3/22/98	0.00
3/23/98	0.00
3/24/98	**0.01**
3/25/98	**1.39**
3/26/98	0.00
3/27/98	**0.04**
3/28/98	**0.28**
3/29/98	**Trace**
3/30/98	0.00
3/31/98	**0.13**

DATE	PRECIP.
5/1/98	0.00
5/2/98	**0.11**
5/3/98	**0.06**
5/4/98	**0.34**
5/5/98	**0.46**
5/6/98	**0.22**
5/7/98	0.00
5/8/98	0.00
5/9/98	**0.01**
5/10/98	0.00
5/11/98	0.00
5/12/98	**0.67**
5/13/98	**0.59**
5/14/98	**Trace**
5/15/98	0.00
5/16/98	0.00
5/17/98	0.00
5/18/98	0.00
5/19/98	0.00
5/20/98	0.00
5/21/98	0.00
5/21/98	*Survey*
5/22/98	0.00
5/23/98	0.00
5/24/98	0.00
5/25/98	0.00
5/26/98	0.00
5/27/98	0.00
5/28/98	0.00
5/29/98	0.00
5/30/98	0.00
5/31/98	0.00

DATE	PRECIP.
8/1/97	0.00
8/2/97	0.00
8/3/97	0.00
8/4/97	0.00
8/5/97	0.00
8/6/97	0.00
8/7/97	0.00
8/8/97	0.00
8/9/97	0.00
8/10/97	0.00
8/11/97	0.00
8/12/97	0.00
8/13/97	0.00
8/14/97	0.00
8/15/97	0.00
8/16/97	**Trace**
8/17/97	**Trace**
8/18/97	0.00
8/19/97	0.00
8/20/97	0.00
8/21/97	0.00
8/22/97	**Trace**
8/23/97	0.00
8/24/97	0.00
8/25/97	0.00
8/26/97	0.00
8/27/97	0.00
8/28/97	0.00
8/28/98	*Survey*
8/29/97	0.00
8/30/97	0.00
8/31/97	0.00

DATE	PRECIP.
10/1/97	0.00
10/2/97	0.00
10/3/97	0.00
10/4/97	0.00
10/5/97	0.00
10/6/97	**Trace**
10/7/97	0.00
10/8/97	0.00
10/9/97	0.00
10/10/97	0.00
10/10/98	*Survey*
10/11/97	0.00
10/12/97	0.00
10/13/97	0.00
10/14/97	0.00
10/15/97	0.00
10/16/97	0.00
10/17/97	0.00
10/18/97	0.00
10/19/97	0.00
10/20/97	0.00
10/21/97	0.00
10/22/97	0.00
10/23/97	0.00
10/24/97	0.00
10/25/97	0.00
10/26/97	0.00
10/27/97	0.00
10/28/97	0.00
10/29/97	0.00
10/30/97	0.00
10/31/97	0.00

DATE	PRECIP.
12/1/97	0.00
12/2/97	0.00
12/3/97	0.00
12/4/97	0.00
12/5/97	**0.96**
12/6/97	**1.51**
12/7/97	**0.29**
12/8/97	0.00
12/9/97	0.00
12/10/97	0.00
12/10/98	*Survey*
12/11/97	0.00
12/12/97	0.00
12/13/97	0.00
12/14/97	**Trace**
12/15/97	0.00
12/16/97	0.00
12/17/97	0.00
12/18/97	**1.18**
12/19/97	0.00
12/20/97	0.00
12/21/97	0.00
12/22/97	0.00
12/23/97	0.00
12/24/97	0.00
12/25/97	0.00
12/26/97	0.00
12/27/97	0.00
12/28/97	0.00
12/29/97	0.00
12/30/97	0.00
12/31/97	0.00

DATE	PRECIP.
2/1/98	**0.06**
2/2/98	**0.67**
2/3/98	**3.10**
2/4/98	0.00
2/5/98	0.00
2/5/98	*Survey*
2/6/98	**1.40**
2/7/98	**1.23**
2/8/98	**0.50**
2/9/98	**Trace**
2/10/98	0.00
2/11/98	0.00
2/12/98	**Trace**
2/13/98	0.00
2/14/98	**2.09**
2/15/98	**Trace**
2/16/98	**0.20**
2/17/98	**0.31**
2/18/98	0.00
2/19/98	**0.80**
2/20/98	0.00
2/21/98	**0.16**
2/22/98	**1.01**
2/23/98	**1.87**
2/24/98	**0.49**
2/25/98	0.00
2/26/98	0.00
2/27/98	0.00
2/28/98	0.00

DATE	PRECIP.
4/1/98	**0.08**
4/2/98	0.00
4/3/98	**0.12**
4/4/98	**0.06**
4/5/98	0.00
4/6/98	0.00
4/7/98	0.00
4/8/98	0.00
4/9/98	0.00
4/9/98	*Survey*
4/10/98	0.00
4/11/98	**0.74**
4/12/98	0.00
4/13/98	**Trace**
4/14/98	0.00
4/15/98	0.00
4/16/98	0.00
4/17/98	0.00
4/18/98	0.00
4/19/98	0.00
4/20/98	0.00
4/21/98	0.00
4/22/98	0.00
4/23/98	0.00
4/24/98	0.00
4/25/98	0.00
4/26/98	0.00
4/27/98	0.00
4/28/98	0.00
4/29/98	0.00
4/30/98	0.00

DATE	PRECIP.
6/1/98	0.00
6/2/98	0.00
6/3/98	0.00
6/4/98	0.00
6/4/98	*Survey*
6/5/98	0.00
6/6/98	0.00
6/7/98	0.00
6/8/98	0.00
6/9/98	0.00
6/10/98	0.00
6/11/98	**0.08**
6/12/98	0.00
6/13/98	0.00
6/14/98	0.00
6/15/98	0.00
6/16/98	**0.01**
6/17/98	0.00
6/18/98	0.00
6/19/98	0.00
6/20/98	0.00
6/21/98	0.00
6/22/98	0.00
6/23/98	0.00
6/24/98	0.00
6/25/98	0.00
6/26/98	0.00
6/27/98	0.00
6/28/98	0.00
6/29/98	0.00
6/30/98	0.00

Spatial temperature patterns. The horizontal spatial pattern of temperatures averaged over the year is presented as a three-dimensional graph in Figure 3-5. The spatial pattern of temperature was similar to those of past reports. Warmest stations (19.4 to 19.8 deg C) were those furthest back in the Harbor (5, 6, 7, 8, 9, 10, 11, 18, and 20). Probably due to the heavy rainfall this year, however, upper stations which received the most freshwater directly from shore (13, 22, and 19) averaged lower (18.2 to 18.7 deg C). From mid-channel (Stations 4 and 25) to just inside the breakwall (Station 1), temperatures gradually decrease from 19.4 deg C to 18.6 deg C. Station 12, which is influenced by both the freshwater discharge of Ballona Creek and open ocean water, has a moderately low average temperature (18.8 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 1997, 2) the overall seasonal ranges for the nine year period, and 3) the temperatures collected during 1997-98. All 1997-98 temperatures were within the overall seasonal ranges for the preceding nine years. Compared to last year, temperature ranges were much wider for most seasons. The overall seasonal patterns between years, however, were similar and 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 3-5. AVERAGE ANNUAL TEMPERATURE (DEG C) AT 18 WATER COLUMN STATIONS.

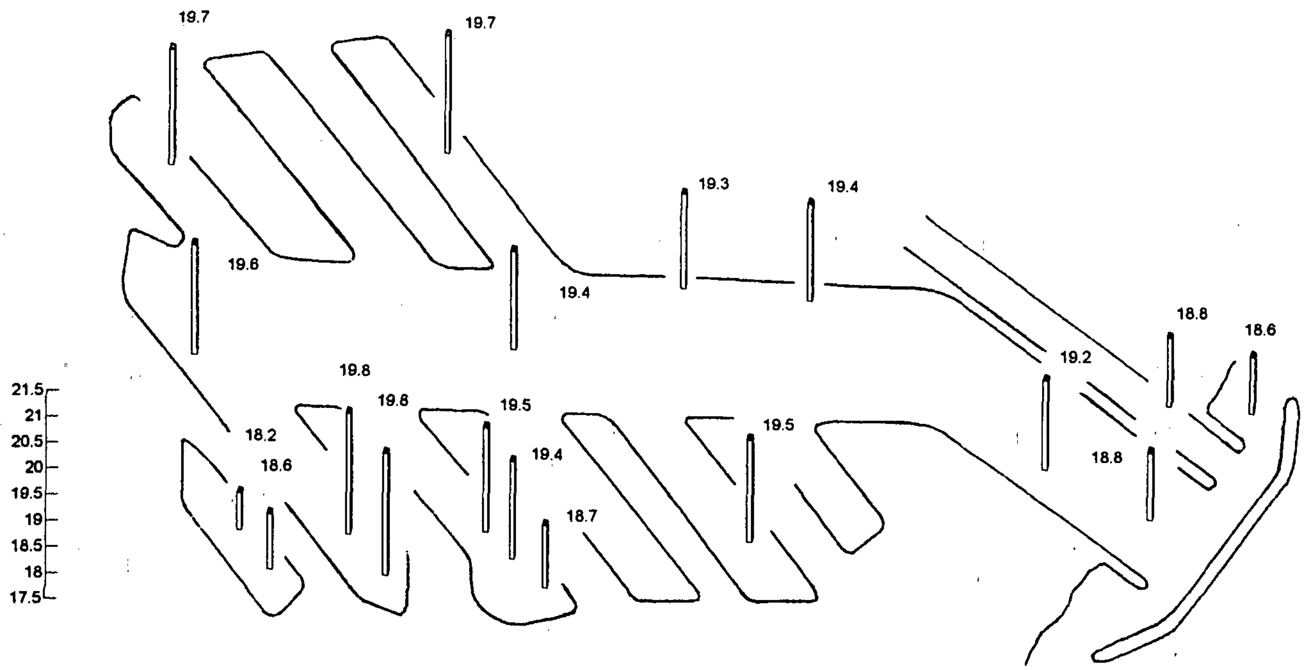


TABLE 3-2. SEASONAL TEMPERATURE RANGES (DEG C) FOR ALL DEPTHS AND STATIONS.

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
1996-97	16.0 - 23.5	12.4 - 15.7	16.5 - 20.1	19.9 - 24.8
Overall range	**13.6 - 26.6**	**11.0 - 17.3**	**13.3 - 22.9**	**15.6 - 28.2**
1997-98[4.]	15.0 - 24.9	11.1 - 17.4	14.5 - 20.7	17.7 - 21.1

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

Vertical salinity patterns. Very little difference is seen among surface to bottom averages, however, lower minima at all stations this year caused ranges to be much wider (Figure 3-6). Stations most influenced by runoff from Ballona Creek drainage (1, and 12) and Oxford Lagoon discharges (10, 13, 20, and 22), as well as stations affected by nonpoint runoff from Mothers Beach (18 and 19) had the widest salinity ranges in the Harbor. Typically, freshwater remained on top of the seawater for some time, usually reaching 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. Salinity profiles were characterized by moderate variability over the year with noticeable February declines reflecting heavy rains. Similar to last year, stations associated with Ballona Creek and Oxford Lagoon were affected more by winter rains than other stations. However, Stations 13 and 22 in Oxford Lagoon varied much more widely over the year, with salinities ranging from about 1 ppt (near pure freshwater) to nearly 34 ppt (pure seawater). Both Stations 10 and 20 in Basin E appeared affected by this runoff, but only slightly. Salinity values at stations most closely associated with Ballona Creek (1 and 12) were also impacted by freshwater runoff. Excursions in salinity though were much more moderate than in Oxford Lagoon and more similar to values recorded last year. Nonpoint runoff from Mothers Beach may have impacted Stations 18 and 19 in Basin D as well, though only slightly.

Spatial salinity patterns. With the exception of those stations influenced by Mothers Beach nonpoint runoff (18 and 19), or 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 32.7 and 32.9 parts per thousand (Figure 3-8). Station 13 in Oxford Lagoon averaged lowest (23.5 ppt), followed by Station 22 in Oxford Lagoon (25.3), Station 12 in Ballona Creek (29.9), Station 20 in Basin E and Station 1 near the breakwall (both 32.2). Stations 10 in Basin E and 18 and 19 in Basin D appeared to be only slightly affected by Oxford Lagoon drainages or nonpoint runoff from Mothers Beach with respect to salinity (32.5, 32.6, and 32.5, respectively).

Salinity ranges compared with past years. Table 3-3 lists: 1) the individual seasonal salinity ranges from fall 1991 through summer 1997, 2) the overall seasonal ranges for the six year period, and 3) the temperatures collected during 1997-98. All 1997-98 salinities were well within the overall seasonal ranges for the preceding six years, with the exception of the fall minimum which was only about one fourth of the previous low (5.0 ppt for fall 1997-98 versus 21.1 ppt for fall of 1995-96). Referencing Figure 3-7, it is apparent that this low value was associated with very heavy freshwater flows into Stations 13 and 22 in Oxford Lagoon during November 1997.

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

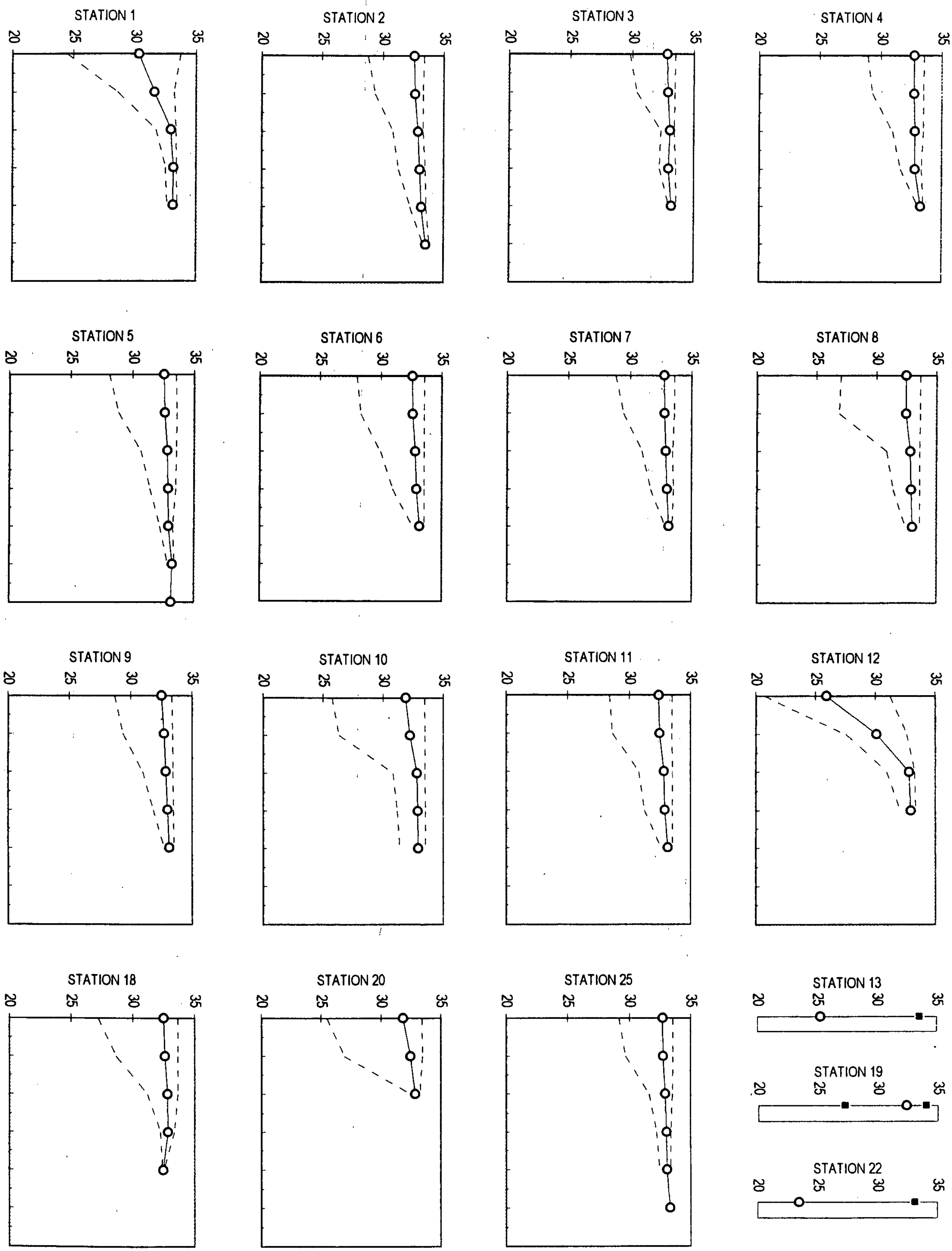


FIGURE 3-7. MINIMUM, AVERAGE, AND MAXIMUM SALINITY (PPT) VS. MONTH AT 18 WATER COLUMN STATIONS.

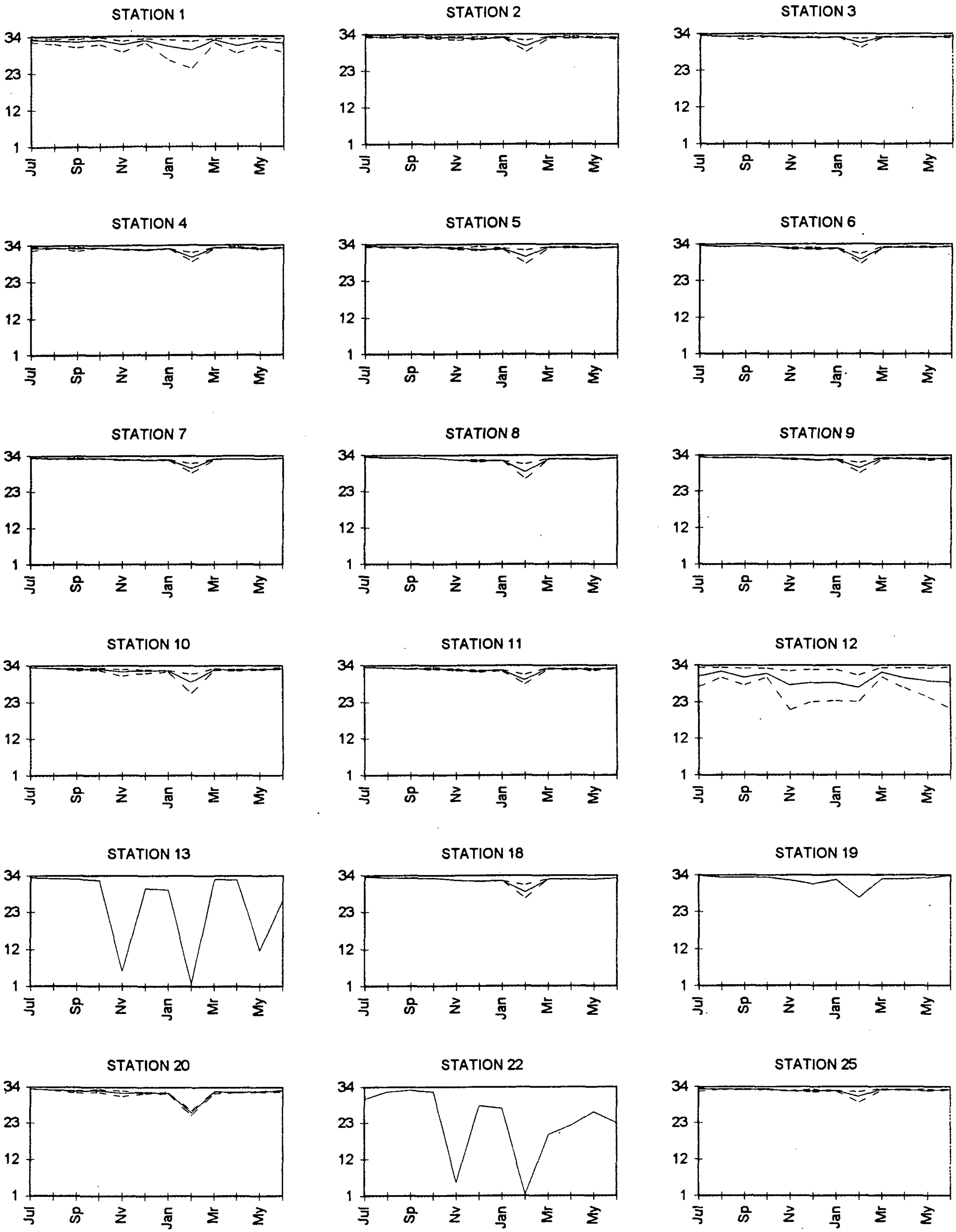


FIGURE 3-8. AVERAGE ANNUAL SALINITY (PPT) AT 18 WATER COLUMN STATIONS.

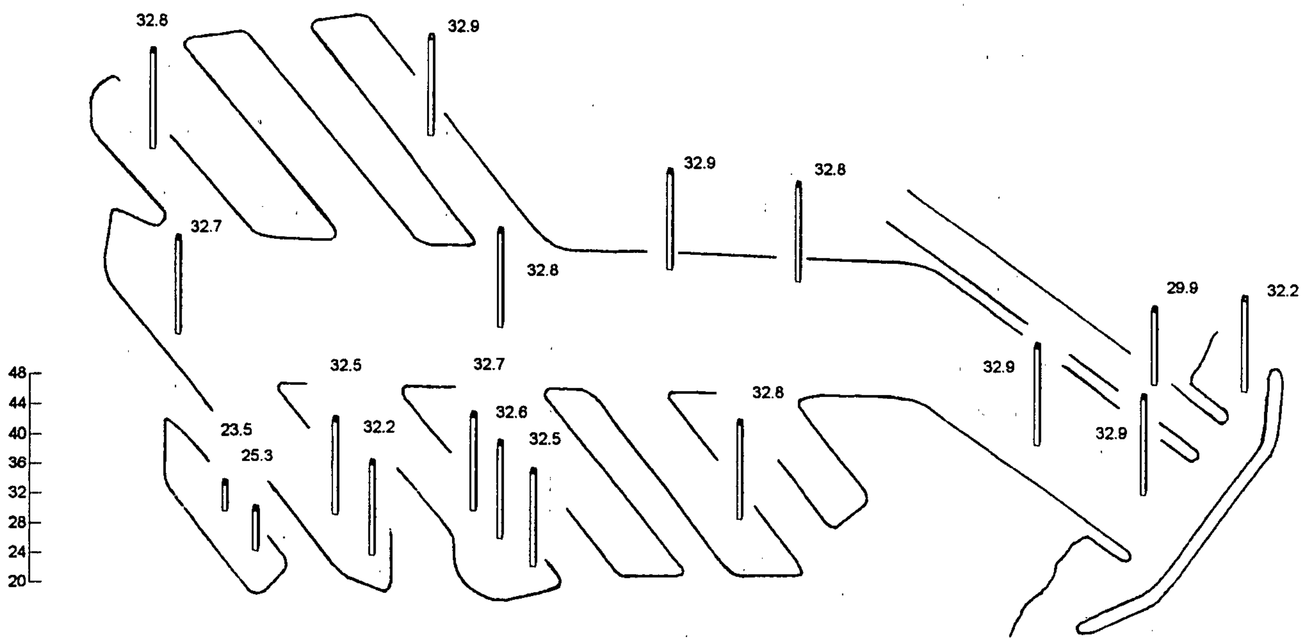


TABLE 3-3. SEASONAL SALINITY RANGES (PPT) FOR ALL DEPTHS AND STATIONS.

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.]	28.1 - 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
1996-97	24.7 - 34.1	21.6 - 33.7	21.1 - 33.9	27.6 - 33.9
Overall range	**21.1 - 34.8**	**0.1 - 34.4**	**1.4 - 34.7**	**14.0 - 34.9**
1997-98[3.]	5.0 - 33.8	1.2 - 33.4	11.6 - 33.5	20.8 - 33.8

[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.

3.3.1.3. **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 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 the sea 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 typically decreases with depth due to respiration of organisms as well as bacterial breakdown of organic material. However, if the water column is well-mixed, 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 oxygen values for each station plotted against depth for 1997-98. During the past year, oxygen values actually increased slightly with depth. Since all stations are shallow, light can usually reach the bottom. Phytoplankton can then photosynthesize in all depths and, in fact, survive best a few meters below the surface rather than immediately at the surface (Anikouchine and Sternberg 1973). Thus, the oxygen elevation with depth is likely phytoplankton related.

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

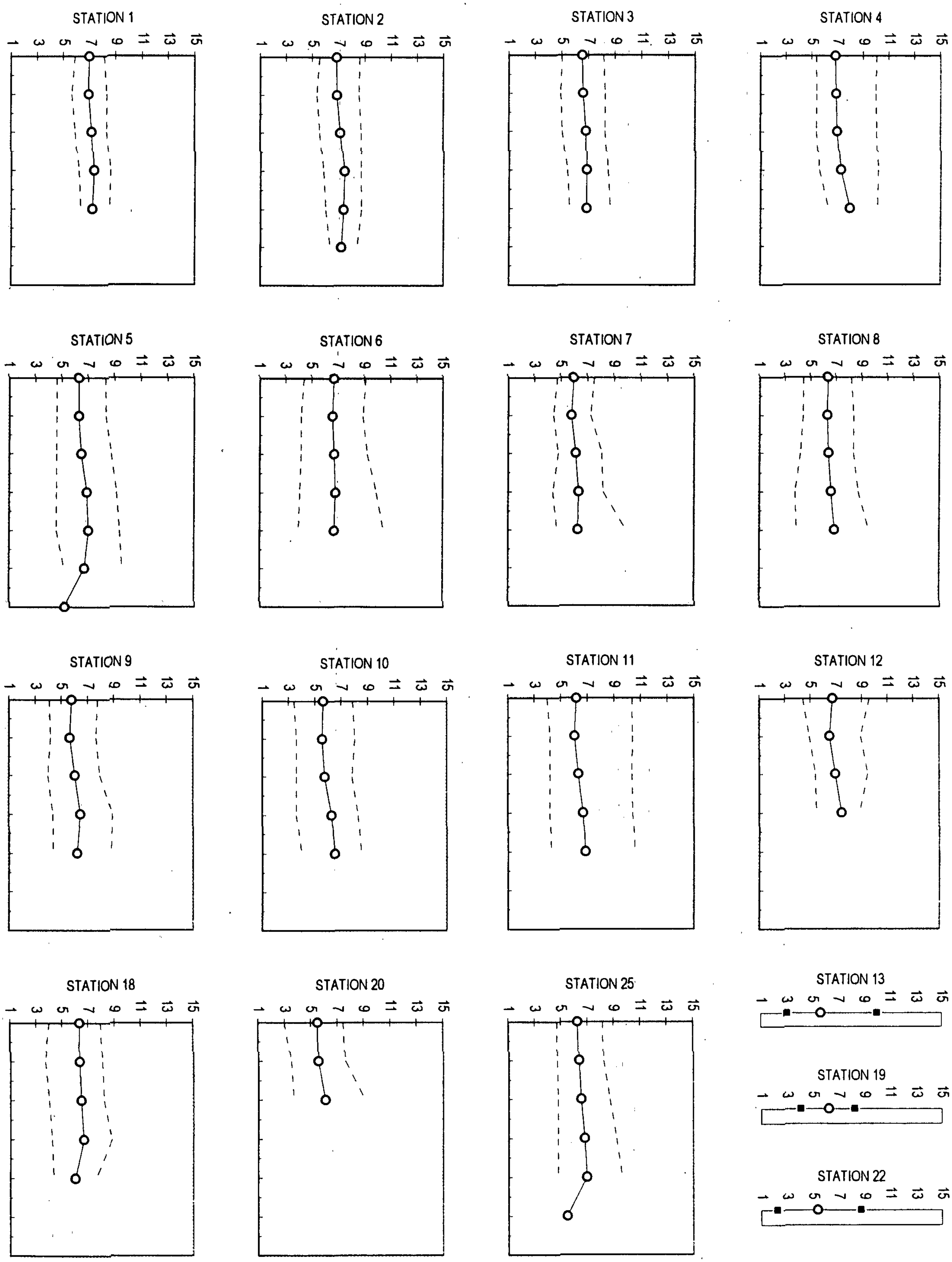


FIGURE 3-12. MIN, AVERAGE, AND MAX PH (UNITS) VERSUS DEPTH (M) AT 18 WATER COLUMN STATIONS.

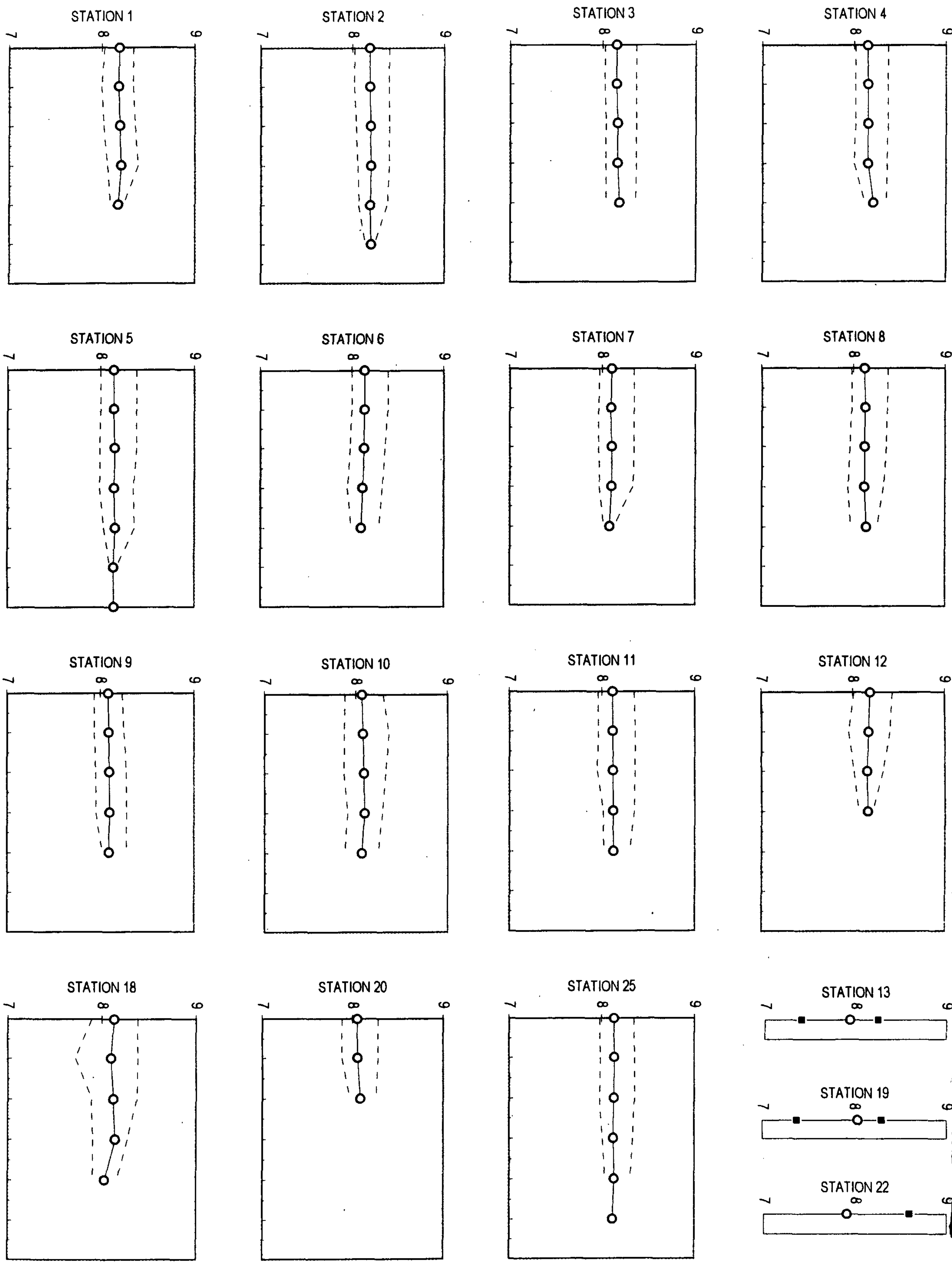


FIGURE 3-13. MINIMUM, AVERAGE, AND MAXIMUM PH (UNITS) VS. MONTH AT 18 WATER COLUMN STATIONS.

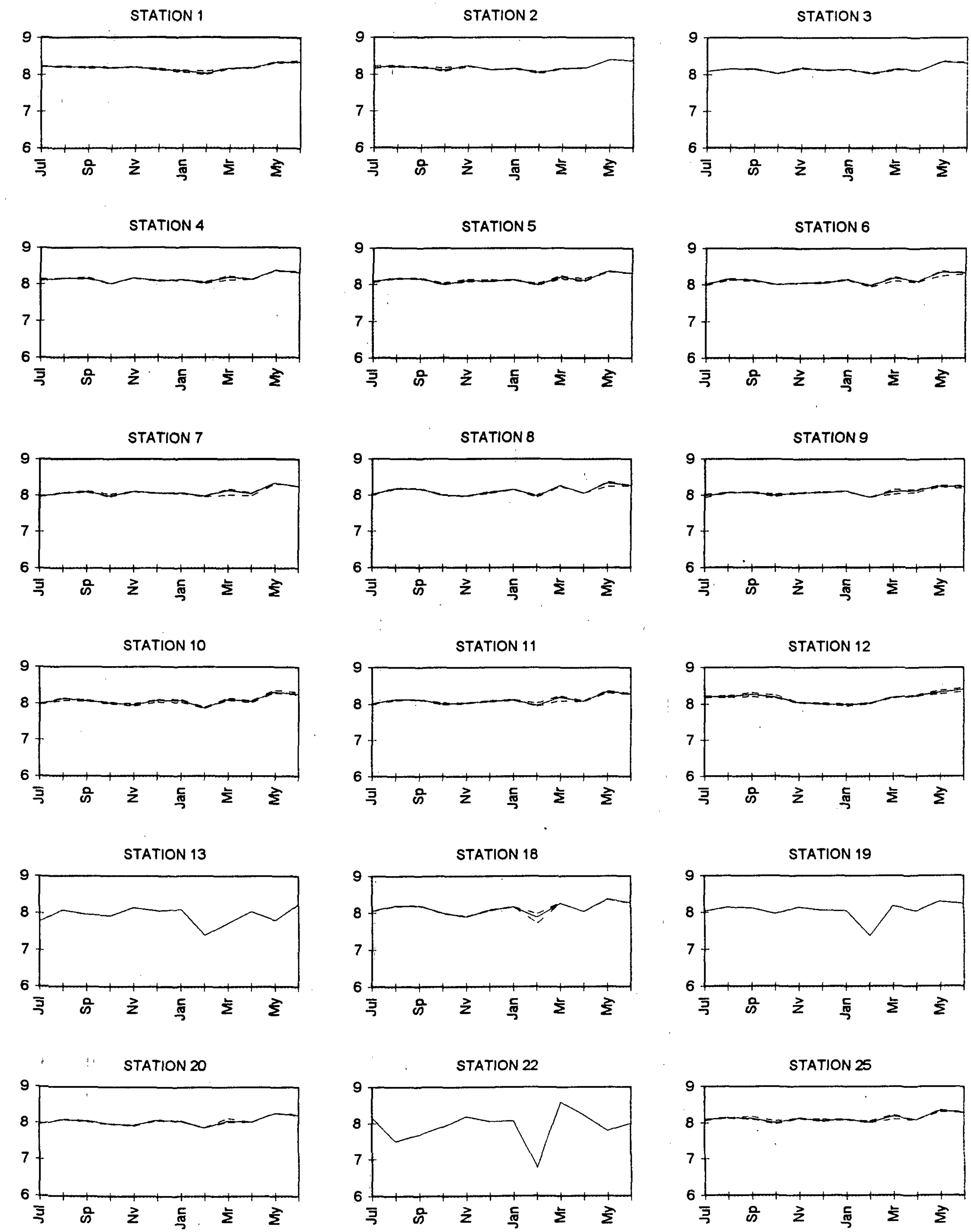


FIGURE 3-14. AVERAGE ANNUAL PH (UNITS) AT 18 WATER COLUMN STATIONS.

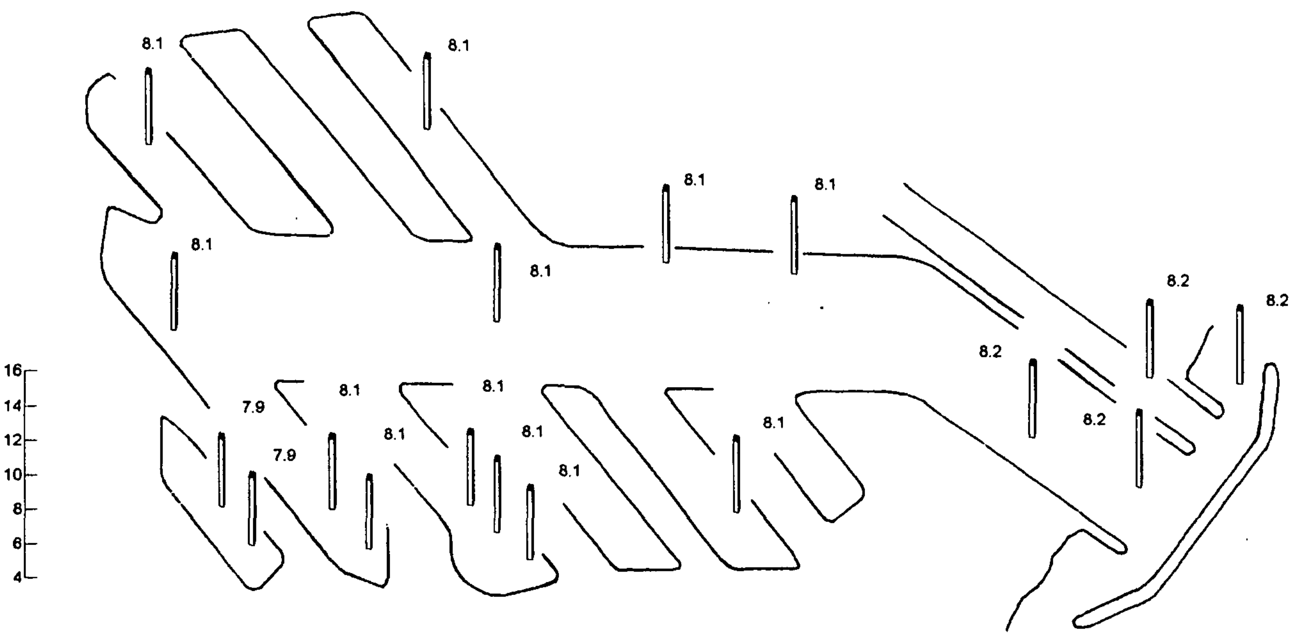


TABLE 3-5. SEASONAL PH RANGES (UNITS) FOR ALL DEPTHS AND STATIONS.

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
1996-97	7.5 - 8.3	7.5 - 8.3	7.8 - 8.5	7.5 - 8.2
Overall range	**7.5 - 8.6**	**7.0 - 8.5**	**7.1 - 8.7**	**7.3 - 8.7**
1997-98[3.]	7.7 - 8.3	6.8 - 8.2	7.7 - 8.6	8.0 - 8.4

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.

3.3.1.5. **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. 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 (0.7 ug-at/l) during at least one monthly survey. Maximum values ranged very widely at all stations and again with no apparent vertical pattern.

A huge, subsurface ammonia spike (105.8 mg/l) at Station 9 in Basin F was measured in August. This value is four to five times higher than any other measurement made during either this year or last year. Although the source of this ammonia is unknown, levels this high are very unlikely to be of natural processes. Note that due to this one high value, the scale of graphs in Tables 3-15 and 3-16 are much larger than those of last year.

Ammonia patterns over the year. Averages varied widely over the year (Figure 3-16), with peaks appearing in August, November, and February. Widest temporal ammonia ranges were at Station 9 in Basin F and Station 13 in Oxford Lagoon. Higher ammonia concentrations in November and February are likely rainfall related. During these months, nonpoint runoff undoubtedly carried organic matter from the adjacent land into the harbor. The breakdown of this material by bacteria in the Harbor likely caused these higher ammonia levels. This differs from last year when ammonia was unrelated to rainfall. The source of relatively high ammonia concentrations in August at some stations is unknown. Note that due to one high value at Station 9, the scale of graphs in Tables 3-15 and 3-16 are much larger than those of last year.

Spatial ammonia patterns. The most important sources of ammonia into Marina del Rey Harbor appears to be Oxford Lagoon, an unknown single spike in Basin F, and to a smaller extent, Ballona Creek (Figure 3-17). Highest ammonia averages over the year were within Oxford Lagoon (14.7 and 14.0 ug-at/l - Stations 13 and 22, respectively), followed by Station 9 in Basin F (9.9 ug-at/l), and Stations 10 and 20 in Basin E (7.8 and 7.5 ug-at/l, respectively) (which were likely impacted by flows from Oxford Lagoon). Remaining stations had low to moderate ammonia values (3.3 to 6.6 ug-at/l). Ammonia levels in Ballona Creek (6.6 ug-at/l) were only moderate when compared to the rest of the Harbor.

Ammonia ranges compared with past years. All 1997-98 ammonia values were within the overall ranges for the preceding six years (Table 3-6), except for the summer of 1997 when one high value of 105 ug-at/l was measured at Station 9 in Basin F (see discussion above). Compared to 1996-97, values in fall and winter were somewhat higher, and values in spring were about the same.

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

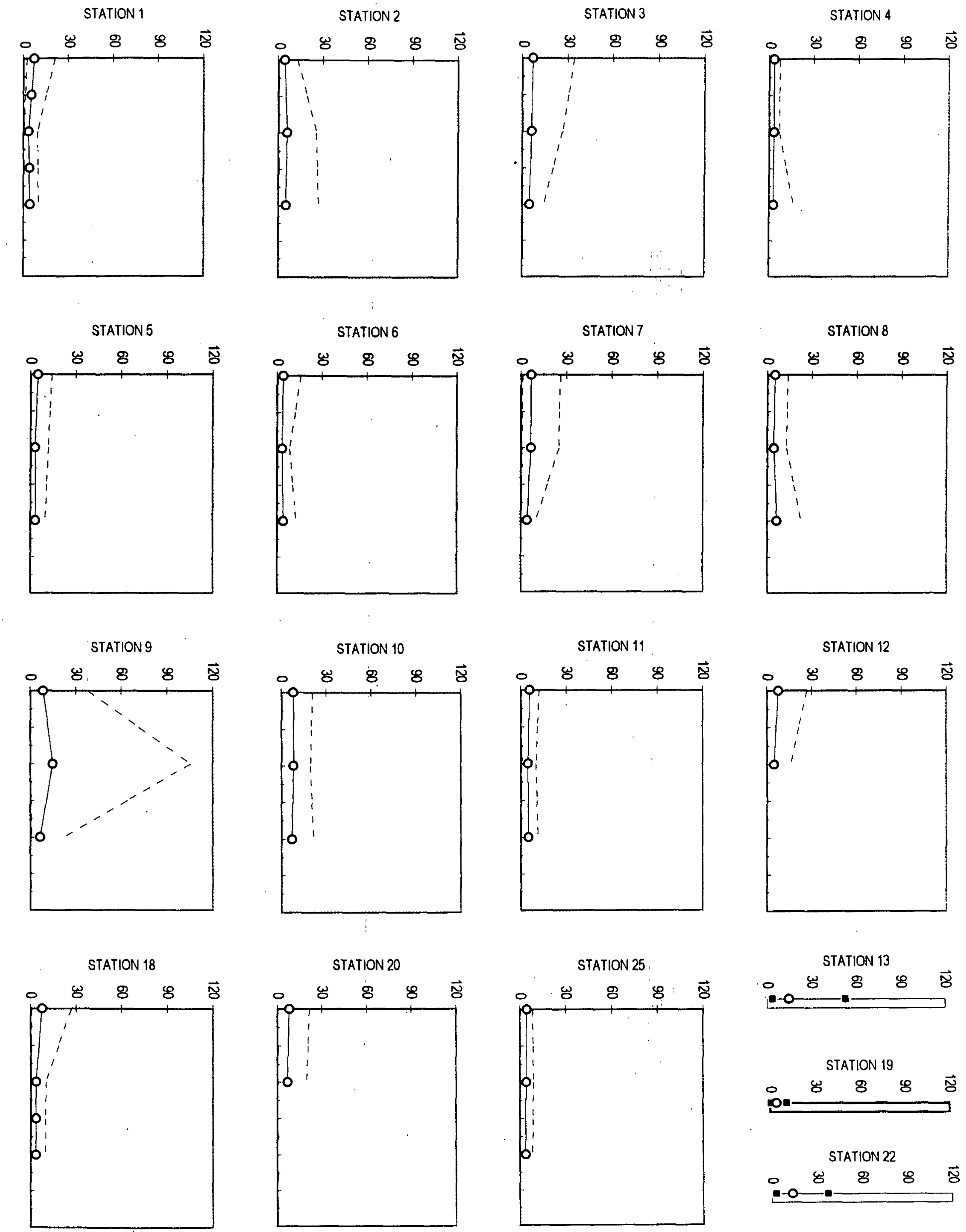


FIGURE 3-16. MINIMUM, AVERAGE, AND MAXIMUM AMMONIA (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

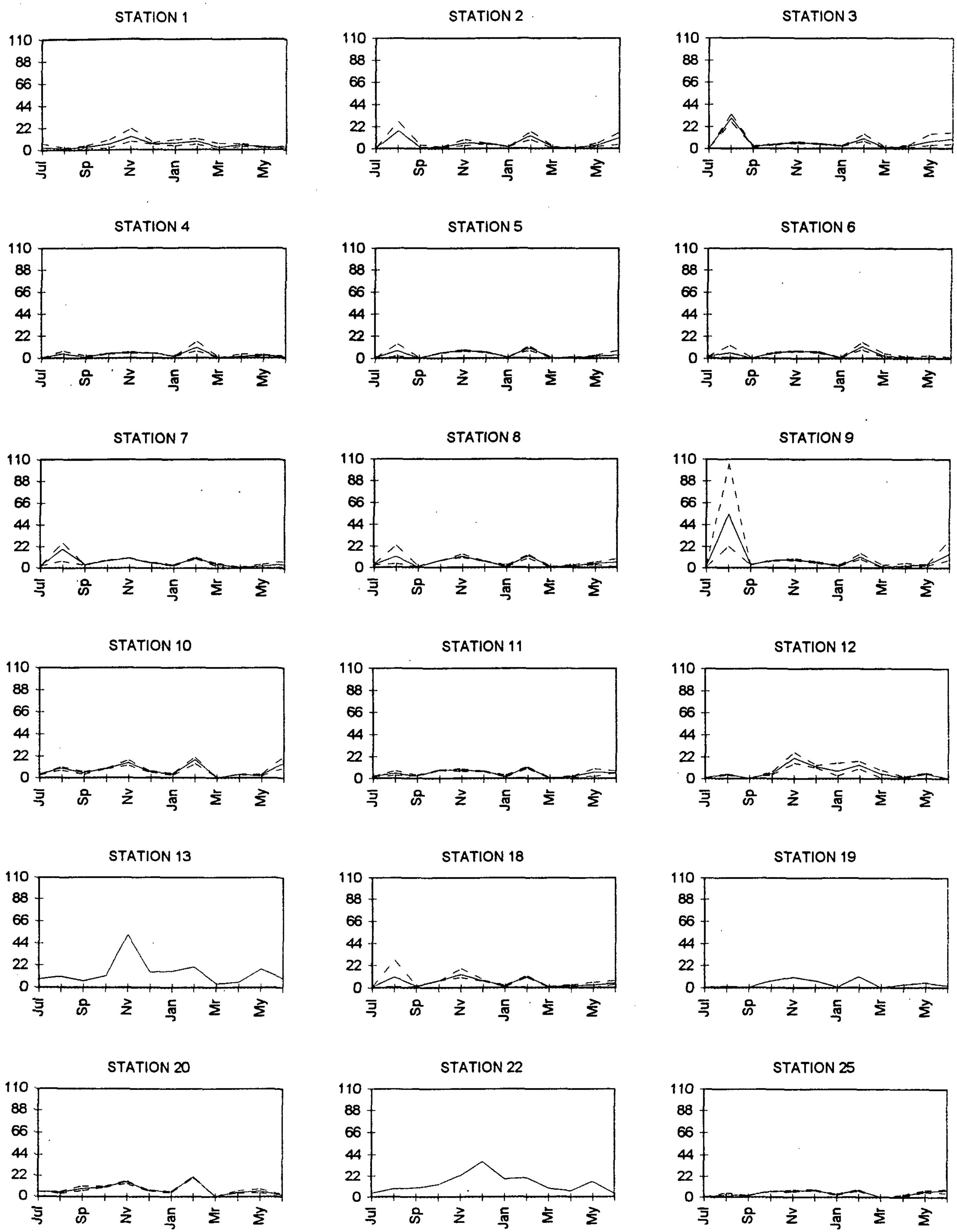


FIGURE 3-17. AVERAGE ANNUAL AMMONIA (MG/L) AT 18 WATER COLUMN STATIONS.

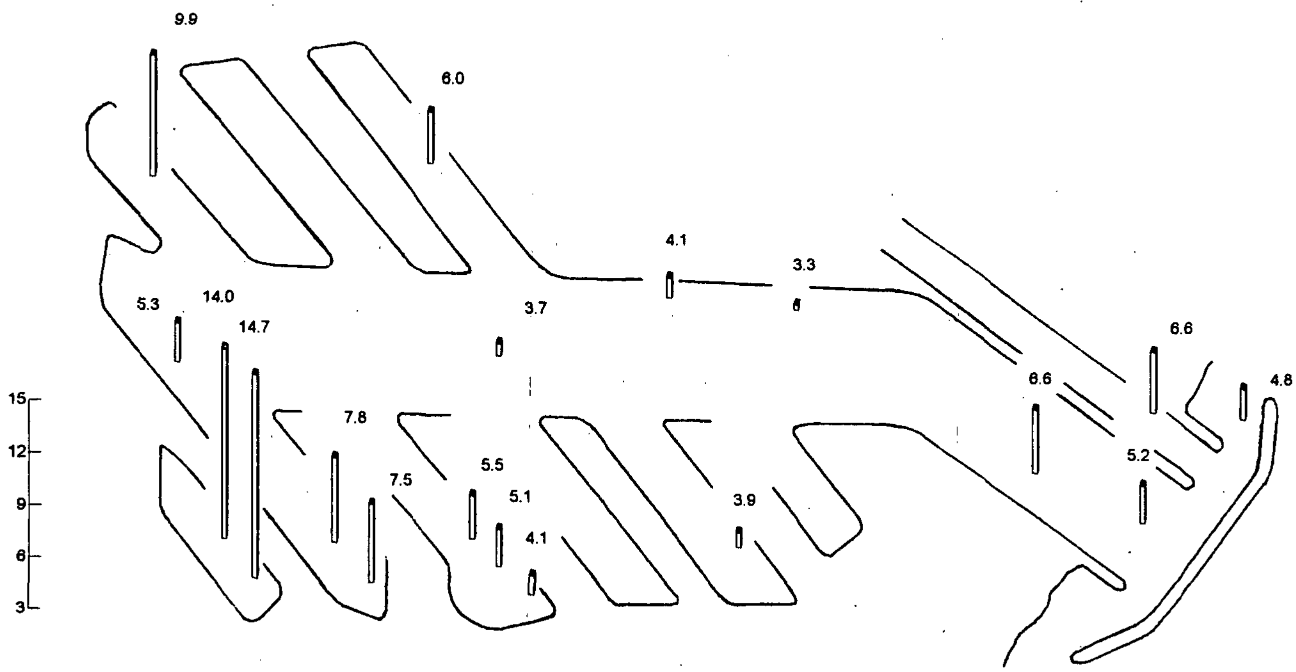


TABLE 3-6. SEASONAL AMMONIA RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

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
1996-97	0.3 - 18.2	0.3 - 27.7	0.3 - 22.6	0.3 - 105.8
Overall range	**0.3 - 38.3**	**0.2 - 200.0**	**0.3 - 35.0**	**0.3 - 105.8**
1997-98[3.]	0.3 - 52.3	0.4 - 37.1	0.4 - 18.1	0.4 - 28.3

[1.] Two months only in the fall.

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

[3.] One month only in the summer.

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 depth of its disappearance is recorded. Surface transparency is a good 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).

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. Minimum/maximum ranges were usually narrow, except at the surface of Station 12, at Station 1 which was likely influenced by Ballona Creek discharges, and at Station 20 which was probably impacted by flow from Oxford Lagoon.

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

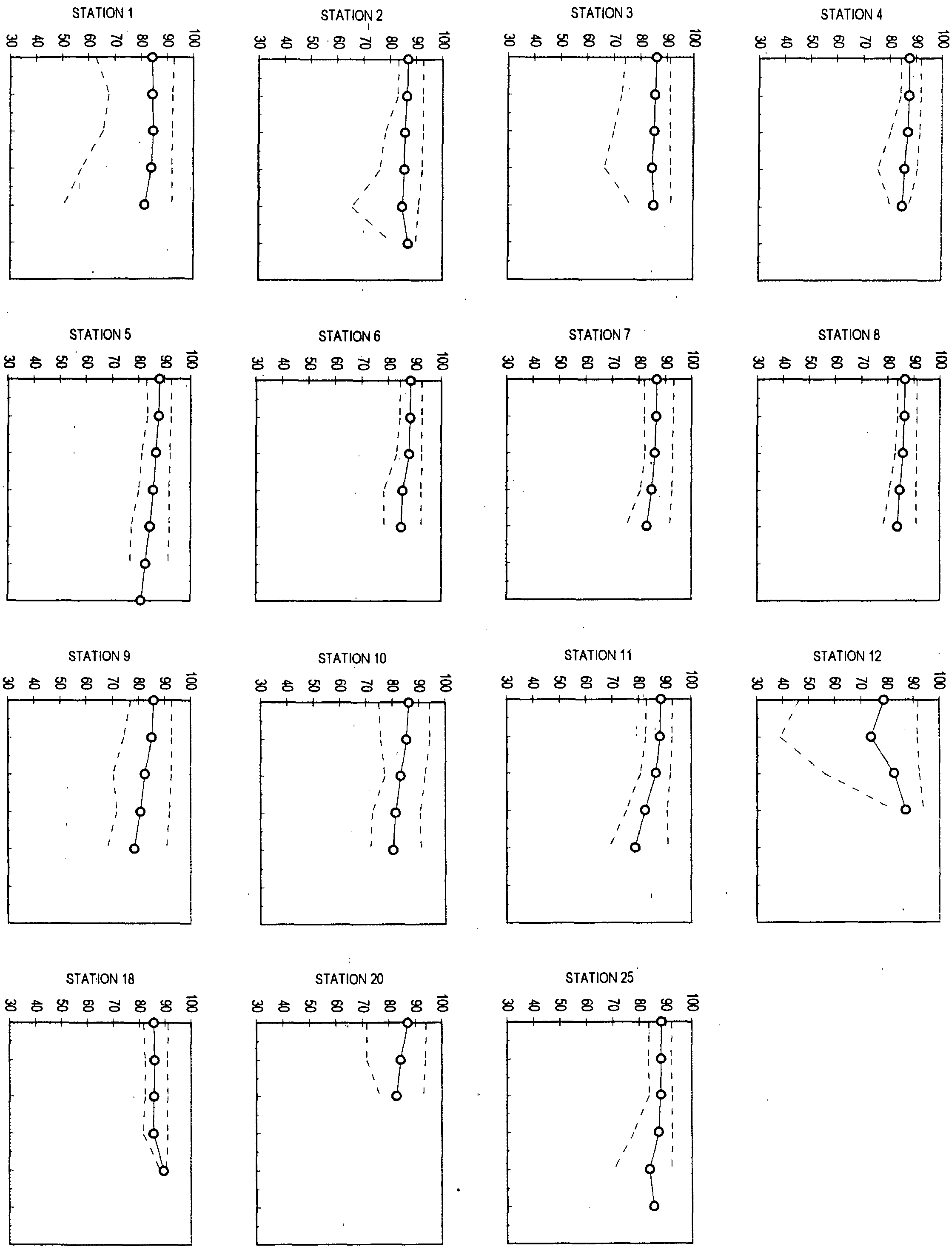


FIGURE 3-22. MINIMUM, AVERAGE, AND MAXIMUM TRANSMISSANCE (%) VS.MONTH AT 15 WATER COLUMN STATIONS

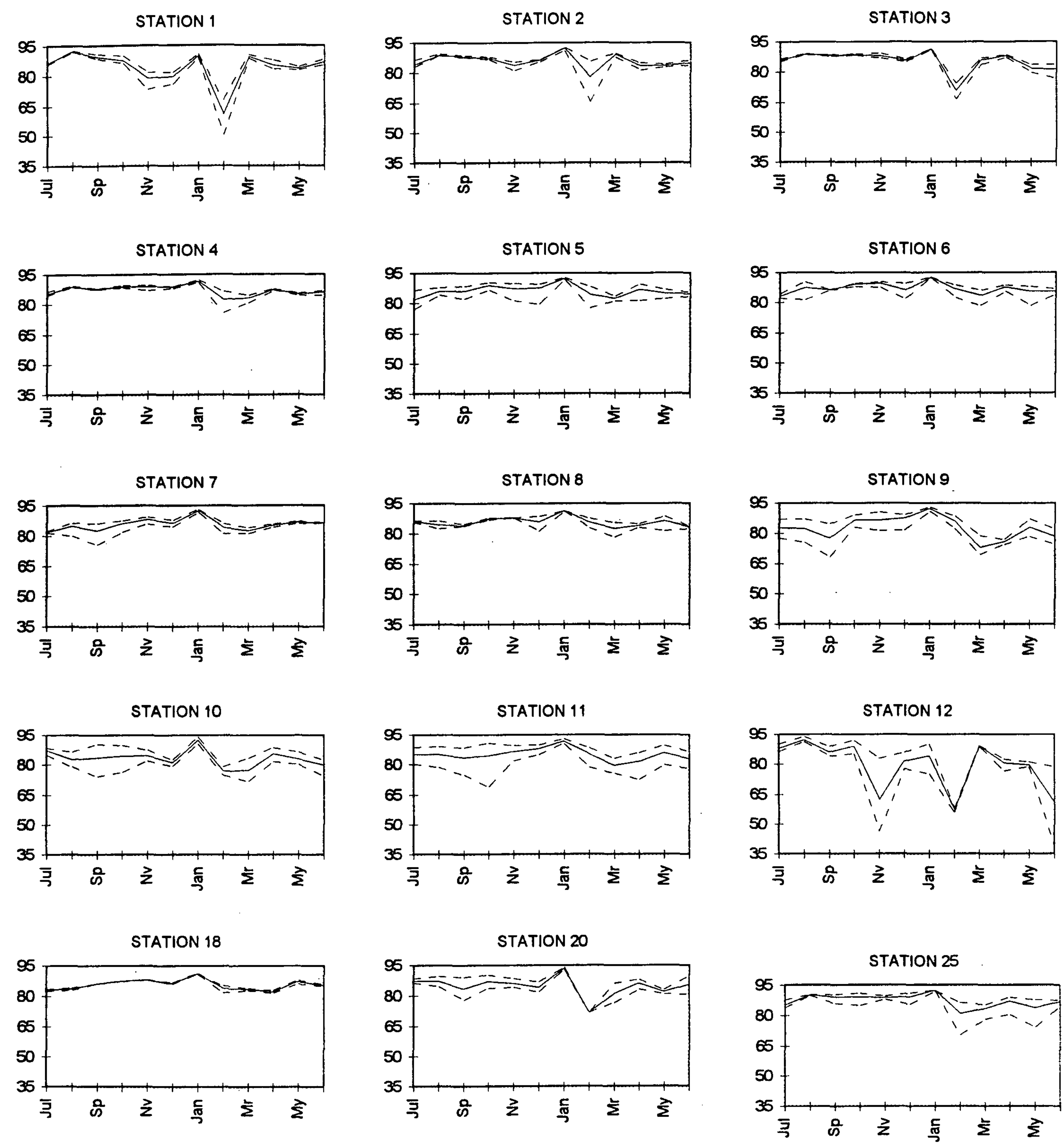


FIGURE 3-23. AVERAGE ANNUAL LIGHT TRANSMISSANCE (%) AT 18 WATER COLUMN STATIONS.

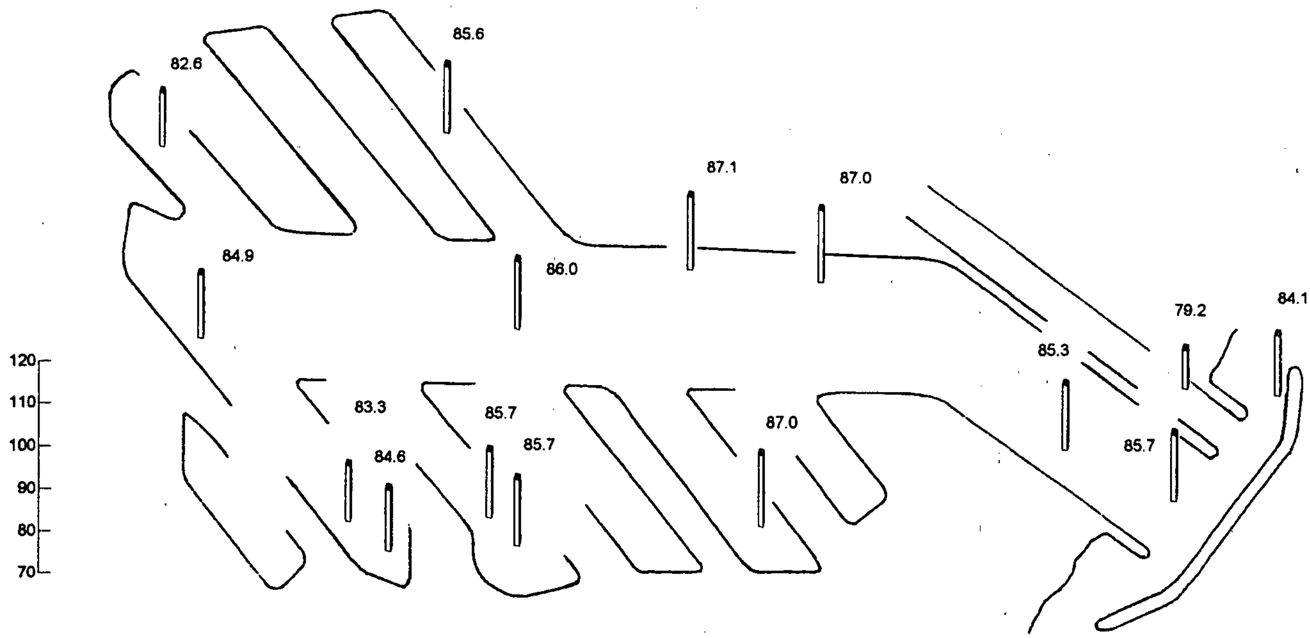


TABLE 3-8. SEASONAL LIGHT TRANSMISSANCE RANGES (%) FOR ALL DEPTHS AND STATIONS.

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
1996-97	71.4 - 93.3	57.2 - 92.0	33.8 - 89.8	74.9 - 93.8
Overall range	**20 - 96**	**0 - 98**	**8 - 90**	**41 - 94**
1997-98[4.]	46.4 - 91.9	50.6 - 94.1	69.4 - 90.2	38.8 - 89.8

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

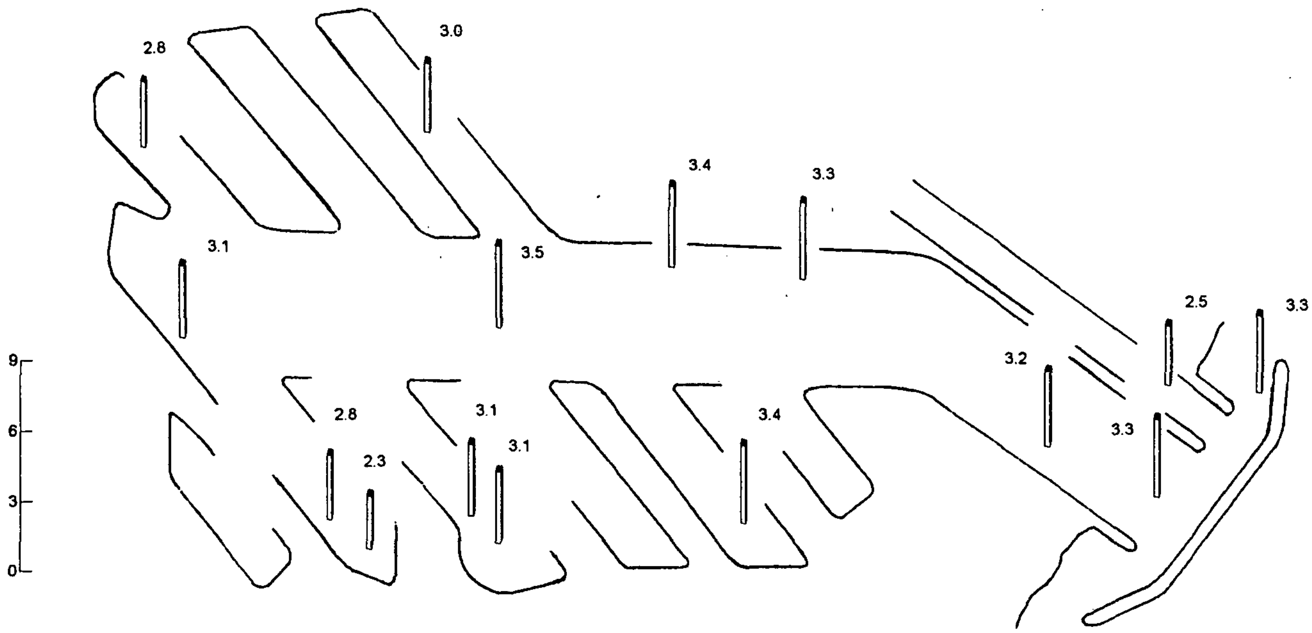


TABLE 3-9. SEASONAL SURFACE TRANSPARENCY RANGES (M) FOR ALL STATIONS.

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
1996-97	1.5 - 5.8	1.6 - 5.5	0.7 - 4.2	1.3 - 5.6
Overall range	**1.5 - 6.5**	**0.1 - 7.0**	**0.3 - 4.4**	**1.0 - 6.6**
1997-98[3]	0.4 - 4.3	0.9 - 5.8	1.8 - 4.5	1.4 - 3.2

[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.

Surface transparency ranges compared with past years. 1997-98 surface transparency values were within the overall seasonal ranges for the preceding six years, except for the fall minima which was considerably lower (Table 3-9). When compared to 1996-97, minimum values in fall and winter were lower. Particularly heavy rains this year likely account for some of these lower than typical values.

3.3.1.9. **Color**

Water color is influenced by a number of physical, chemical and biological factors. 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. 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). Rainfall can affect water color either directly, or indirectly by providing nutrients to fuel phytoplankton blooms.

The Forel-Ule (FU) scale consists of a series of small vials filled with various shades of colored liquid mimicking those typically observed for marine waters. The color of the vials 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).

Color patterns over the year. Forel-Ule values ranged from 7 (green) in the channel (Station 2) in January and in Basin H (Station 7) in November to 17 (yellow-brown) in Ballona Creek (Station 12) in February. Temporal patterns related to other variables (e.g. BOD, light transmissance, surface transparency, etc.) in that Forel-Ule values at most stations increased (became less blue) in February following the heaviest rains, however, temporal patterns with the remainder of the year were less distinct (Figure 3-26). As has been mentioned above, red tide plankton blooms recorded last year were not observed during this survey season.

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

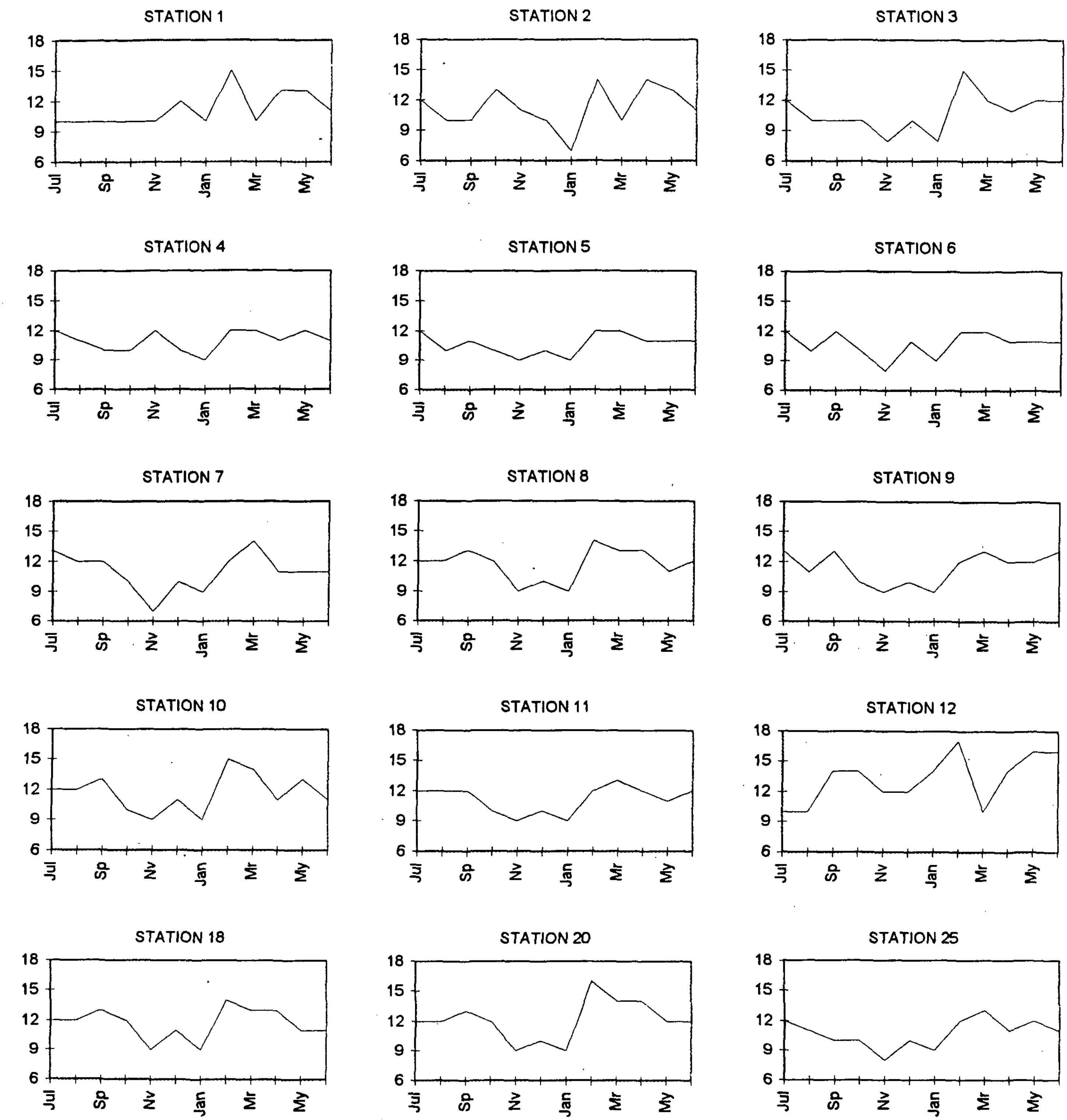


FIGURE 3-27. AVERAGE ANNUAL FOREL-ULE COLOR AT 18 WATER COLUMN STATIONS.

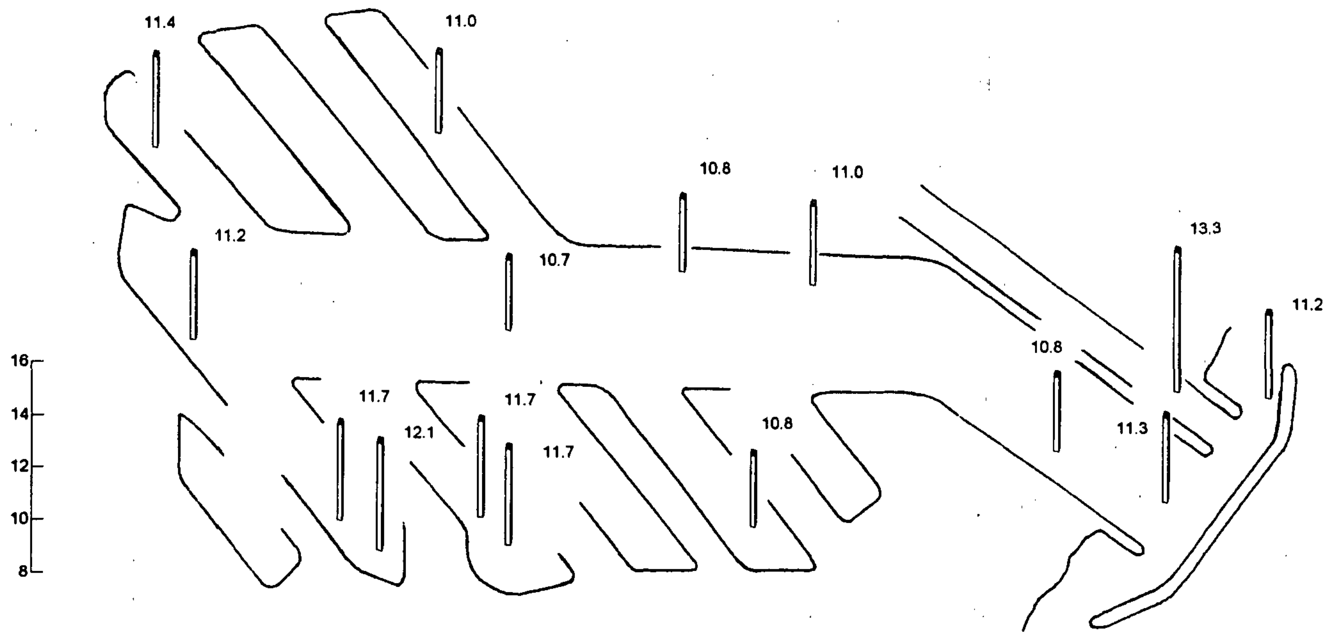


TABLE 3-10. SEASONAL FOREL-ULE COLOR RANGES FOR ALL STATIONS.

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
1996-97	9 - 12	9 - 12	10 - 17	10 - 17
Overall range	**3 - 14**	**4 - 18**	**5 - 17**	**4 - 17**
1997-98[3]	7 - 14	7 - 17	10 - 16	11 - 16

[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.

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

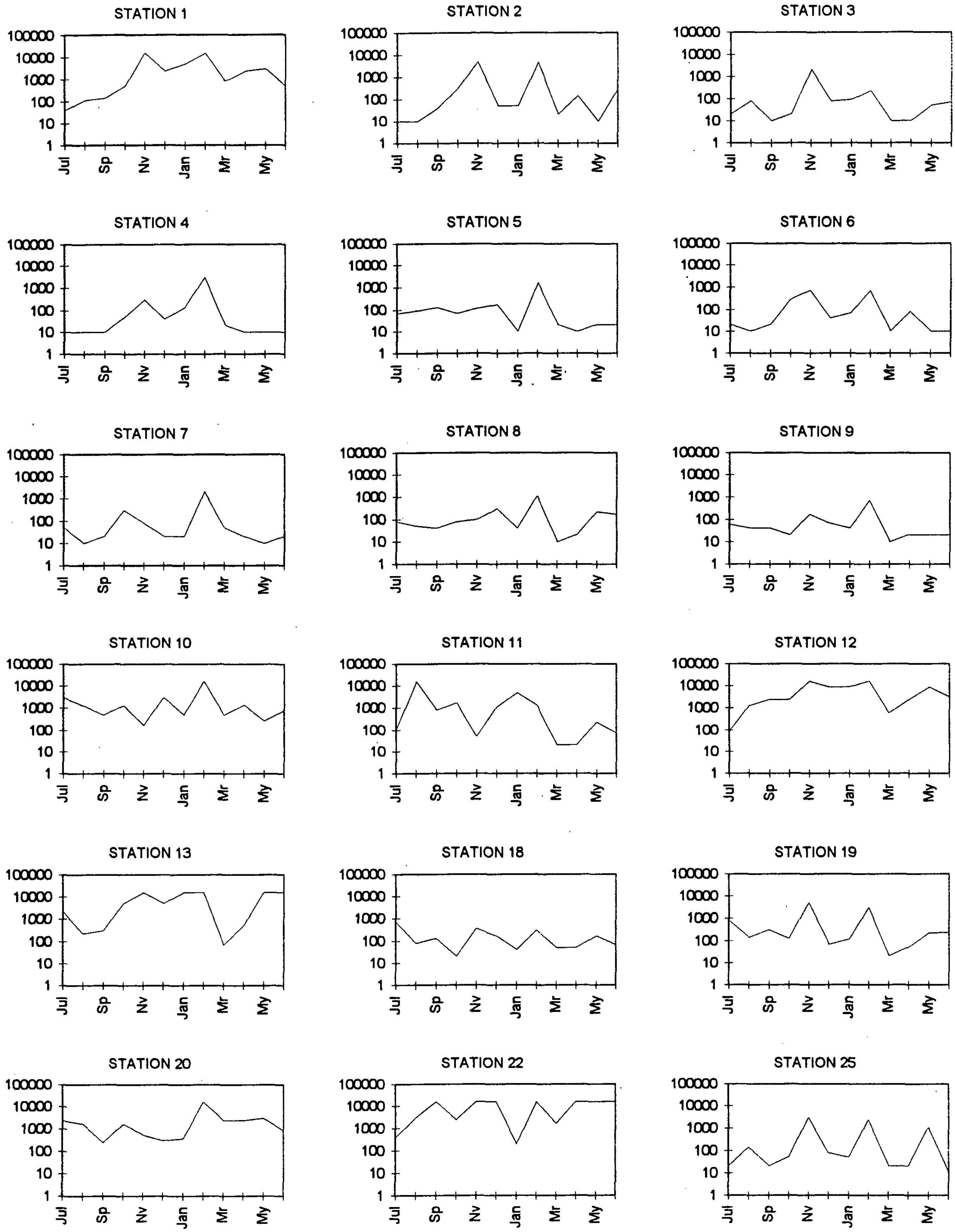


FIGURE 3-29. GEOMETRIC MEANS OF TOT. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

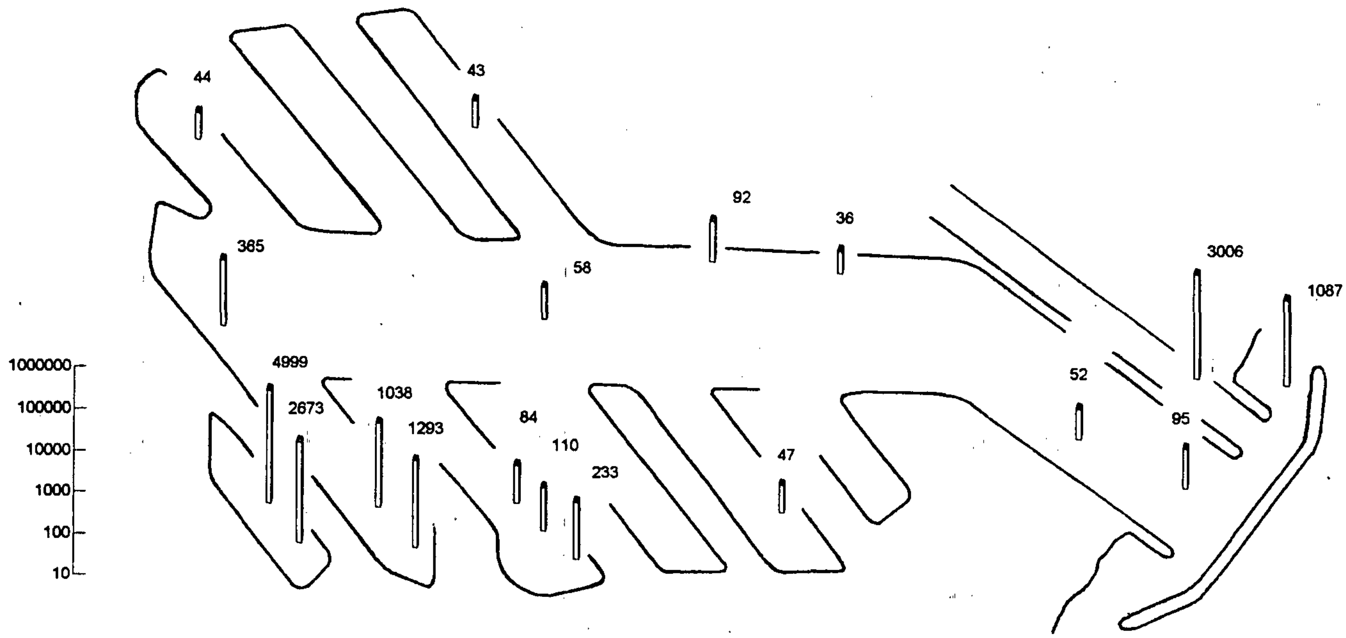


TABLE 3-11. FREQUENCY OF TOTAL COLIFORM VIOLATIONS (>10,000 MPN/100 ML) FOR ALL STATIONS.

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
1996-97	2	5	4	1
Overall range	**0 - 2**	**1 - 43**	**1 - 13**	**0 - 5**
1997-98[3.]	5	8	3	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.

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.

Fecal coliform patterns over the year. Fecal coliform counts ranged from <20 to ≥16,000 MPN/100 ml (Figure 3-30). Counts were in violation (greater than 400 MPN/100 ml) 49 times (Table 3-14). During the past, all stations within the Marina exceeded fecal coliform limits at least once. Limits were exceeded at nearly all stations in February (16 stations), followed by November (10 stations), October (6), January (5), and July (4). During the rest of the year, total coliform exceedances ranged from zero to two stations per month. Similar to total coliforms, this temporal pattern appears to be related mostly to rainfall.

Spatial fecal coliform patterns. Fecal coliform values averaged over the year are depicted in Figure 3-31. Similar to total coliforms, highest averages were in Oxford Lagoon (Stations 13 and 22 - 547 and 1469 MPN/100 ml, respectively), in Basin E (Stations 10 and 20 - 244 and 122 MPN/100 ml), near Ballona Creek (Stations 1 and 12 - 365 and 748 MPN/100 ml, respectively), and, to a lesser degree, Mothers Beach (Station 19 - 179 MPN/100 ml). Remaining counts averaged lower (31 to 74 MPN/100 ml).

Fecal coliform ranges compared with past years. Numbers of fecal coliform violations for 1997-98 were within the overall seasonal ranges for the preceding six years, except for the fall maxima which was over twice the previous high (Table 3-12). When compared to 1997-98, violations were much more frequent in all seasons except in summer. Heavy rainfall this year likely accounts for most of these exceedances.

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.

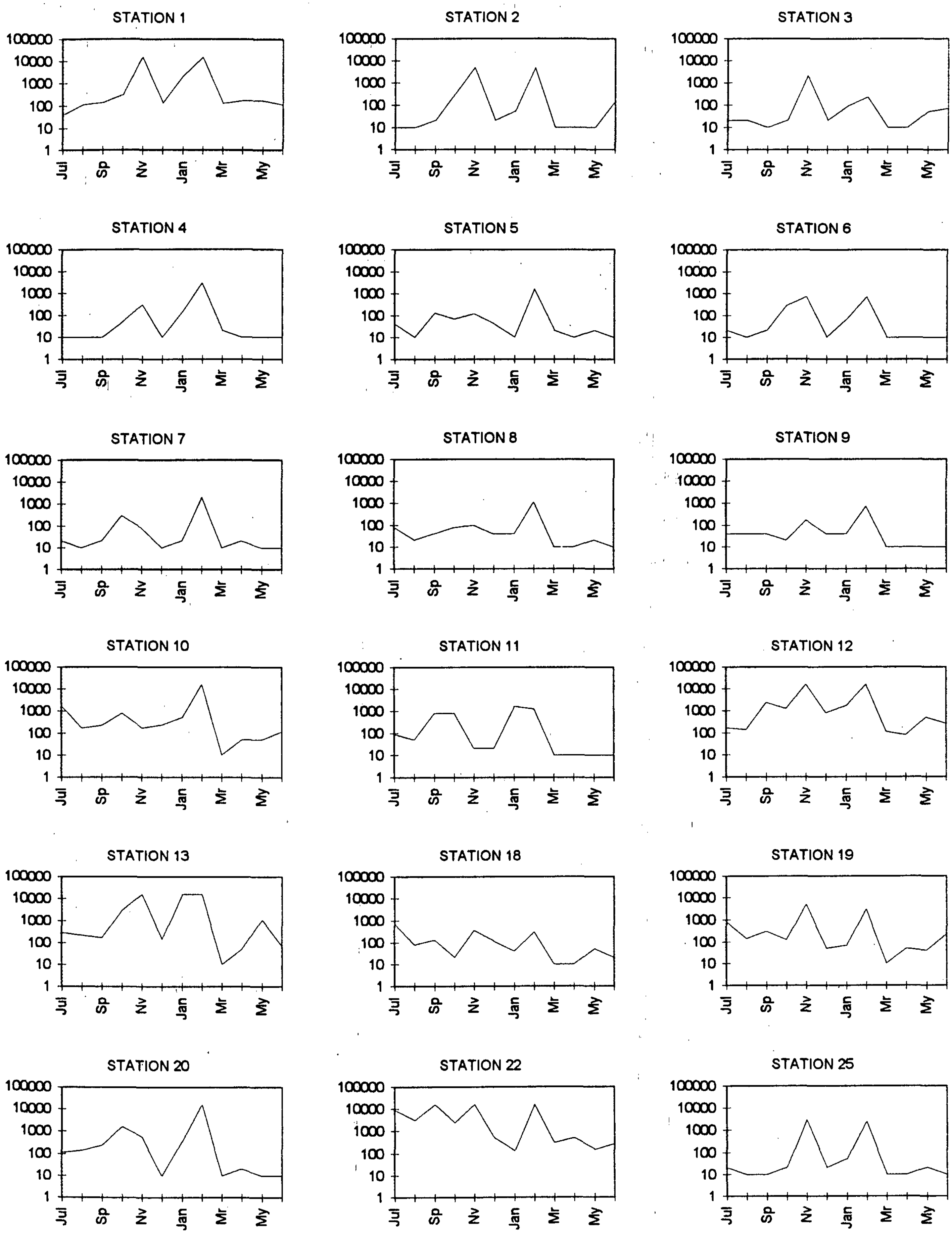


FIGURE 3-31. GEOMETRIC MEANS OF FEC. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

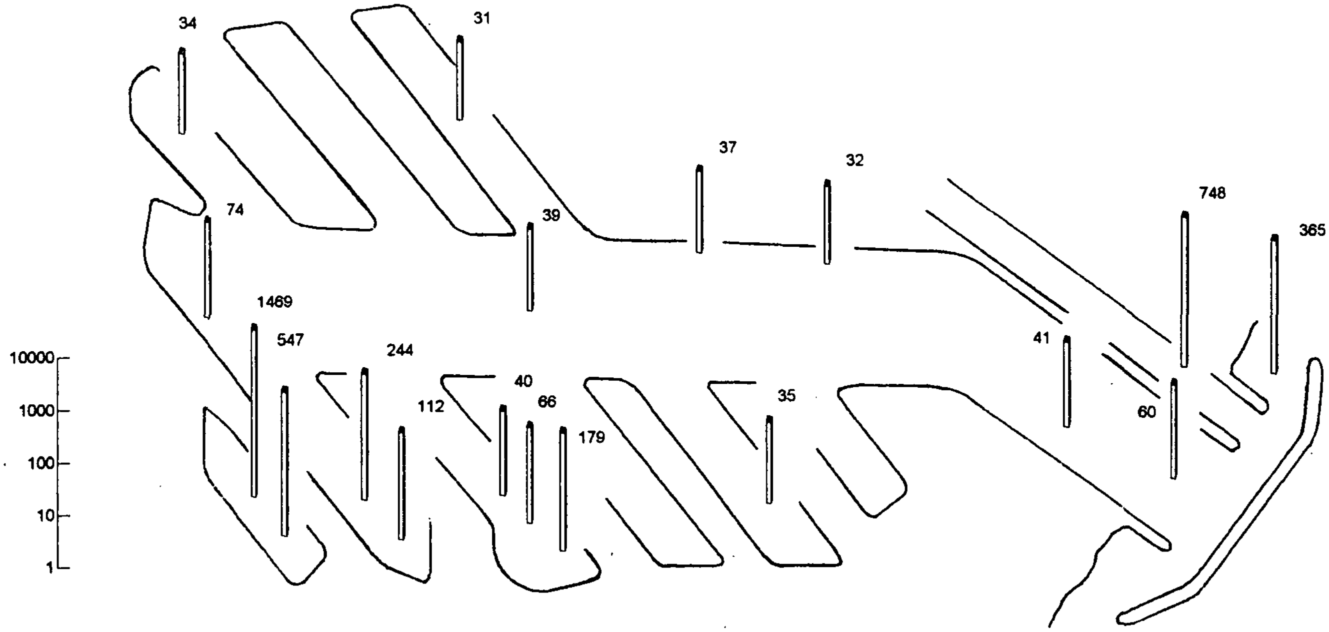


TABLE 3-12. FREQUENCY OF FECAL COLIFORM VIOLATIONS (>400 MPN/100 ML) FOR ALL STATIONS.

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
1996-97	5	6	3	6
Overall range	**2 - 8**	**6 - 46**	**3 - 21**	**0 - 10**
1997-98[3.]	18	23	3	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.

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) 16 times (Table 3-14). Nine out of the 16 violations occurred in February and are likely related to precipitation. During the rest of the year, enterococcus exceedances ranged from zero to two stations per month.

Spatial enterococcus patterns. Enterococcus values averaged over the year are depicted in Figure 3-33. Highest averages were in Oxford Lagoon (Station 13 and 22 - 28.9 and 24.3 Colonies/100 ml, respectively), Basin E (Stations 10 and 20 - 7.6 and 6.0 Colonies/100 ml), Mothers Beach (Stations 18 and 19 - 3.4 and 3.8 Colonies/100 ml), and at the Harbor entrance (Station 1 - 4.5 Colonies/100 ml). Surprisingly, the averages for the Ballona Creek station was low (Station 12 - 2.3 Colonies/100 ml). Remaining station counts also averaged lower (1.4 to 2.7 Colonies/100 ml).

Enterococcus ranges compared with past years. Numbers of enterococcus violations for 1997-98 were within the overall seasonal ranges for the preceding six years (Table 3-13). When compared to 1996-97, violations were slightly more frequent during most seasons this past year.

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 all of the water quality variables together. 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 10, 13, 19, 20, and 22. These stations include two in Oxford Lagoon, two in Basin E, and one in Basin D at Mothers Beach. These stations tended to be generally high in ammonia, total coliform, fecal coliform, and enterococcus; and low in salinity, dissolved oxygen, and pH. The water from these stations tend to be contaminated by municipal drainage into Oxford Lagoon and nonpoint runoff onto Mothers Beach.

Stations 8, 10, 11, and 18. These stations are in the back Harbor in areas of low circulation and of limited exposure to tidal flushing. The water here tends to be high in temperature, low in coliform bacteria, and moderate in all remaining measurements.

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

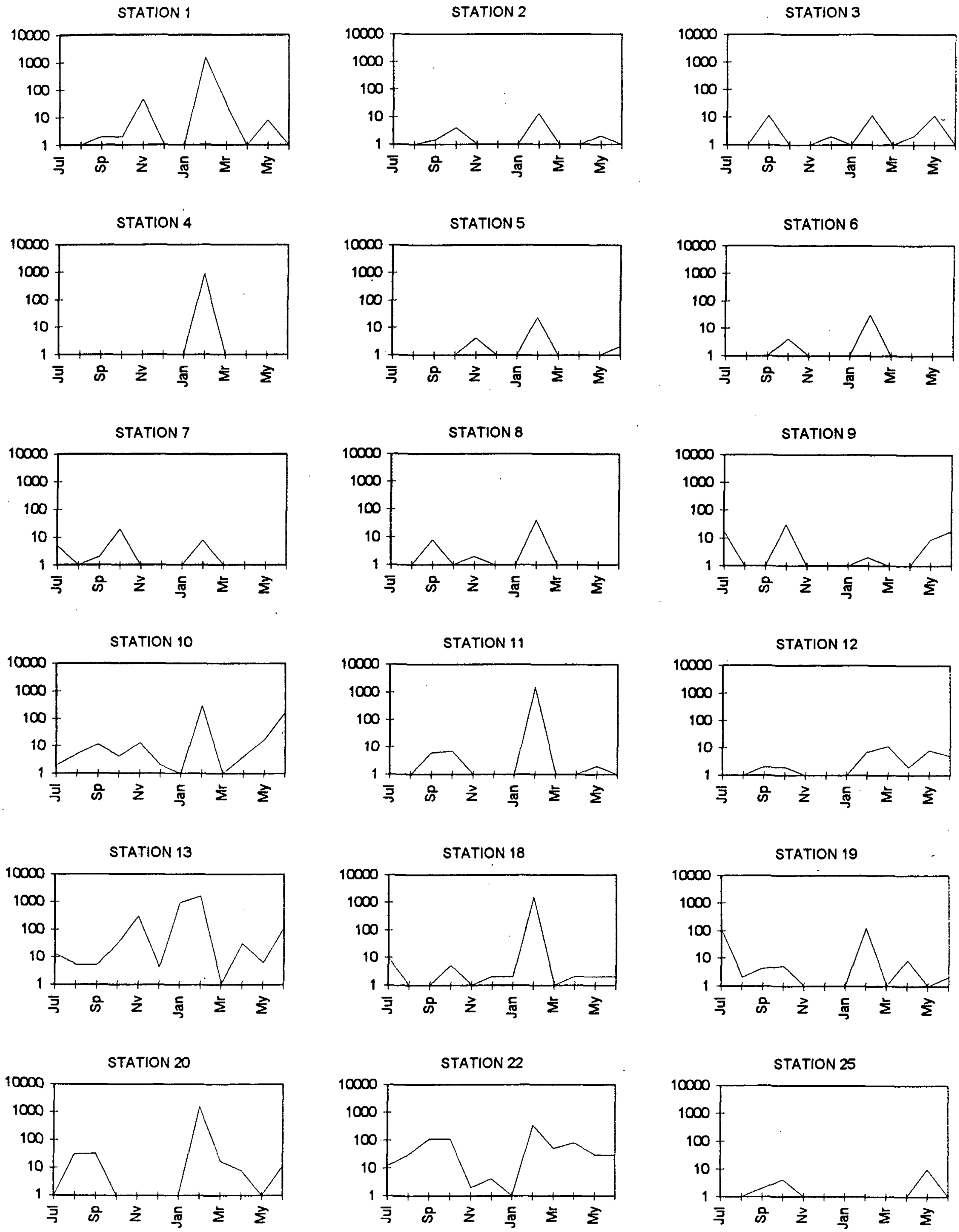


FIGURE 3-33. GEOMETRIC MEANS OF ENTEROCOCCUS (COL./100 ML) AT 18 WATER COLUMN STATIONS

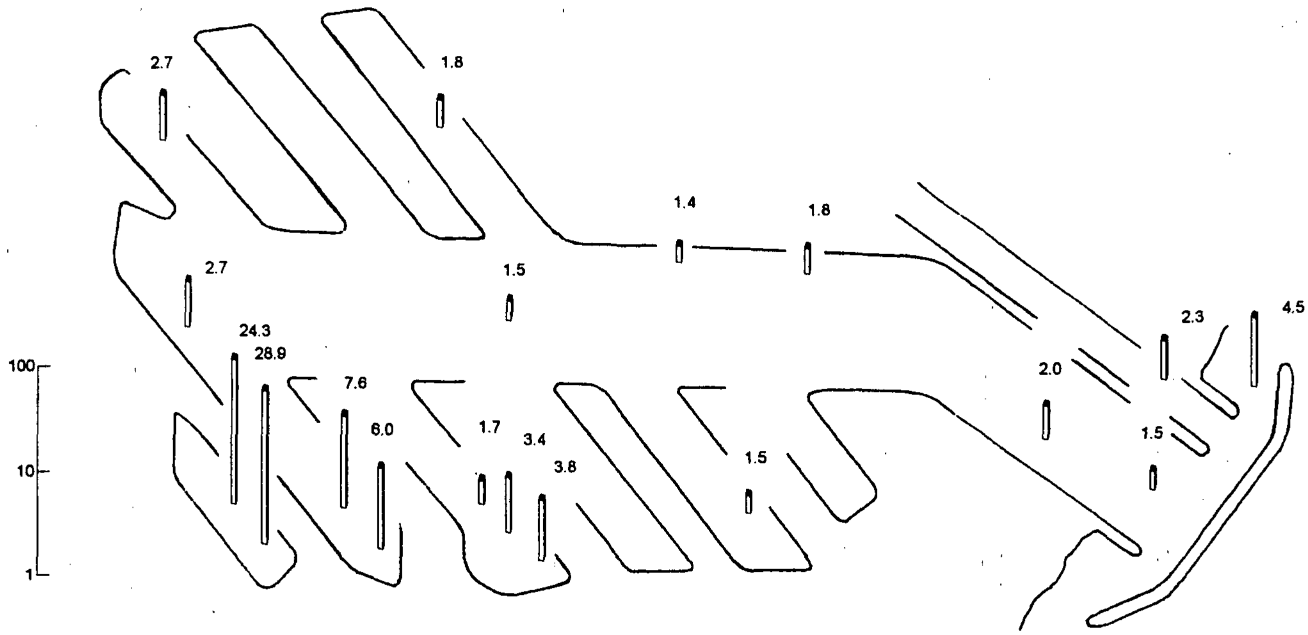


TABLE 3-13. FREQUENCY OF ENTEROCOCCUS VIOLATIONS (>104 MPN/100 ML) FOR ALL STATIONS.

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
1996-97	2	8	1	1
Overall range	**0 - 4**	**0 - 35**	**0 - 10**	**0 - 2**
1997-98[3.]	3	10	0	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.

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

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

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	≥16,000	—	—	≥16,000	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	≥16,000	—	—	—	—
11	—	16,000	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	≥16,000	—	—	≥16,000	—	—	—	—
13	—	—	—	—	≥16,000	—	≥16,000	≥16,000	—	—	≥16,000	>16,000
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	≥16,000	—	—	—	—
22	—	—	≥16,000	—	≥16,000	≥16,000	—	≥16,000	—	≥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	—	—	—	—	≥16,000	—	2200	≥16,000	—	—	—	—
2	—	—	—	—	5000	—	—	5000	—	—	—	—
3	—	—	—	—	2200	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	3000	—	—	—	—
5	—	—	—	—	—	—	—	1700	—	—	—	—
6	—	—	—	—	700	—	—	700	—	—	—	—
7	—	—	—	—	—	—	—	2200	—	—	—	—
8	—	—	—	—	—	—	—	1100	—	—	—	—
9	—	—	—	—	—	—	—	700	—	—	—	—
10	1700	—	—	800	—	—	500	≥16,000	—	—	—	—
11	—	—	—	800	—	—	1700	1300	—	—	—	—
12	—	—	2400	1300	≥16,000	800	1700	≥16,000	—	—	500	—
13	—	—	—	3000	≥16,000	—	≥16,000	≥16,000	—	—	1100	—
18	700	—	—	—	—	—	—	—	—	—	—	—
19	800	—	—	—	5000	—	—	3000	—	—	—	—
20	—	—	—	1700	550	—	—	≥16,000	—	—	—	—
22	9000	3000	≥16,000	2400	≥16,000	500	—	≥16,000	—	500	—	—
25	—	—	—	—	3000	—	—	2400	—	—	—	—

ENTEROCOCCUS (>104 COLONIES/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	—	—	1600	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	900	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	300	—	—	—	170
11	—	—	—	—	—	—	—	≥1600	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	300	—	900	≥1600	—	—	—	110
18	—	—	—	—	—	—	—	≥1600	—	—	—	—
19	110	—	—	—	—	—	—	130	—	—	—	—
20	—	—	—	—	—	—	—	≥1600	—	—	—	—
22	—	—	111	110	—	—	—	350	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

Stations 3, 4, 5, 6, 7, and 25. These stations represent the main channel and Basins B and H which are toward the front of the Marina. Water here tends to be bluer, clearer, more saline, and lower in 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 and contaminated freshwater drainage from Ballona Creek. Averaged over the year, these stations tended to be low in temperature and high in dissolved oxygen, and pH which would be expected of open ocean water. On the other hand, the water here was also low in light transmissance and high in organic and bacterial contamination which is caused by the drainage from Ballona Creek.

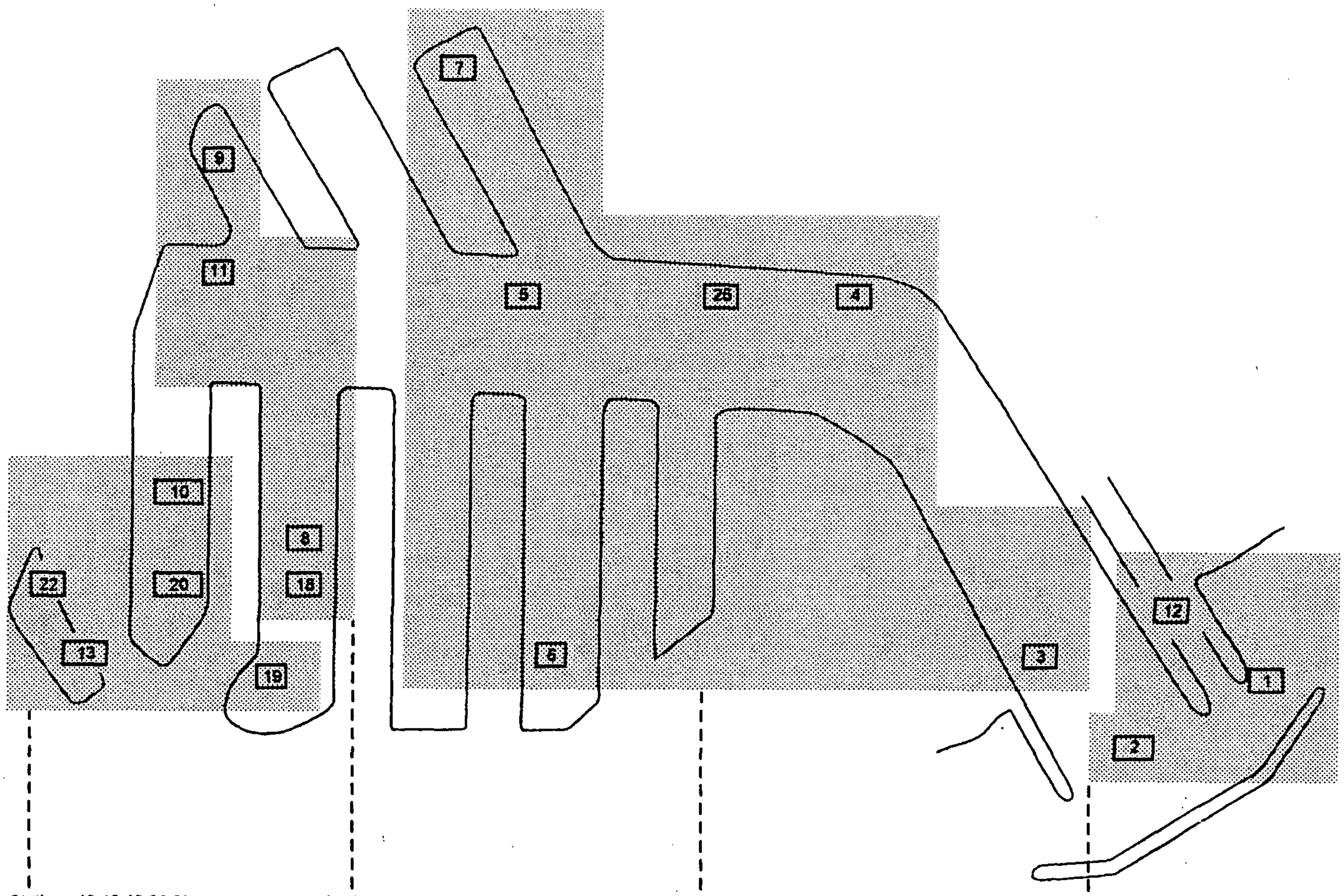
3.4. DISCUSSION

Water quality in Marina del Rey Harbor this past year was impacted temporally by season, rainfall, and plankton blooms; and spatially by proximity to Oxford Lagoon, Ballona Creek, Mothers Beach, or the Harbor entrance.

Weather during 1997-98 was greatly impacted by a strong El Nino Southern Oscillation (ENSO) event. Although overall water temperatures may have been slightly higher than average, the largest impact of El Nino was particularly heavy rain in the fall and winter. During this period, both discharge and nonpoint flows into the Harbor lowered salinity, temperature, pH, and water clarity; raised ammonia, biochemical oxygen demand, and bacterial concentrations; and contributed to the development of phytoplankton blooms in the spring. Only temperature in the Harbor was more strongly affected by seasonal oceanographic trends than rainfall with characteristically low values in the winter and higher measurements in the summer and early fall. Plankton blooms, which are dependent upon length of sunlight and nutrient levels, are indirectly affected by rainfall since precipitation washes nutrients from the land and into the waters upon which they border. Plankton blooms this past year tended to raise dissolved oxygen and reduced water clarity during the spring. The subsequent death and decay of the plankton may have then later increased the biochemical oxygen demand in the Harbor. Although plankton impacts were important this past year, they did not affect the area as much as last year when the whole Harbor was completely overwhelmed by red tide for several months during the spring.

Spatial influences in Marina del Rey Harbor include intermittent discharges from Oxford Lagoon and Ballona Creek, nonpoint rain runoff into the Mothers Beach area, and inflows from the open ocean from the Harbor entrance. Stations immediately adjacent to the entrance are impacted by both Ballona Creek and fresh tidal ocean water. Stations in the main channel, however, appeared to be mostly influenced by open ocean waters and were typically the most natural in the Harbor. Stations further from the entrance do not generally mix as well as channel stations, therefore, they are typically warmer, more saline, lower in oxygen, etc.

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



Stations 10,13,19,20,22

Relatively High In:
Ammonia
Biochemical Oxygen Demand
Total Coliform
Fecal Coliform
Enterococcus

Relatively Low In:
Salinity
Dissolved Oxygen
pH
-- --
-- --

Charateristics:
Strongly influence by Oxford Lagoon drainage. Water is less saline, low in pH and dissolved oxygen, and highly contaminated with nutrients, organics, and bacteria.

Stations 8,9,11,18

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

Relatively Low In:
Total Coliform
Fecal Coliform
-- --
-- --
-- --

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

Stations 3,4,5,6,7,25

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

Relatively Low In:
Color
Ammonia
Biochemical Oxygen Demand
Total Coliforms
Enterococcus

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

Stations 1,2,12

Relatively High In:
Dissolved Oxygen
pH
Biochemical Oxygen Demand
Total Coliform
Fecal Coliforms

Relatively Low In:
Temperature
Light Transmissance
-- --
-- --
-- --

Charateristics:
Influenced by both open ocean waters and Ballona Creek runoff. Water is cold, well oxygenated, turbid, and high in pH, organics, and bacteria.

Stations closest to either Ballona Creek or Oxford Lagoon showed reduced salinity and water clarity and elevated levels of ammonia, biochemical oxygen demand, and total and fecal coliform bacteria. Stations near Oxford Lagoon had additionally elevated enterococcus counts and lower oxygen, pH and temperature values. The flows from Oxford Lagoon and Ballona Creek appeared to directly impact the Harbor entrance, Basin E, and upper end of the main channel. These locations represent about half of the stations sampled during our surveys. The spatial patterns of every variable we measured were influenced by these two sources of water, and their negative influence upon the water quality in the Marina cannot be overstated.

To a lesser degree, precipitation runoff from Mothers Beach also seasonally elevates bacterial counts in waters of Basin D. Areas where birds, people, and perhaps stray animals concentrate, such as Mother's Beach, appear to be more affected 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.

4. PHYSICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

4.1. BACKGROUND

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 is a great problem because high levels of lead contamination and results of toxicity tests preclude 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 (Soule et.al. 1996).

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 14, 1997 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. These 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 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 (e.g., Station 12), then it can be assumed that the sediments will tend to be coarser 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 2000 to 63 microns are defined as sand, sediments ranging from 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. coarse silt, very fine sand, etc., see Table 4-1).

The second pattern discernible from the graph is how homogeneous the distributions of sediments are. Sediments which tend to have a narrow range of sizes are considered homogeneous or well sorted (Station 1). 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) tended to be coarser than others and generally well sorted. Sediments within the basins (for example, 8, 9, and 10) tend to be finer and relatively poorly sorted. Sediments at Station 22 in Oxford Lagoon are so poorly sorted that it is difficult to visually estimate 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, Station 11 at the dead-end of the Harbor channel, and Station 8 in Basin D (4 to 6 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 (632 microns - coarse sand) was at Station 13 in Oxford Lagoon, followed by Station 12 in Ballona Creek (402 - medium sand) and Station 1 (139 microns - fine sand). Station 22 within Oxford Lagoon and Station 2 near the Harbor entrance also had relatively course median particle sizes (63 to 109 microns - very fine sand). These five stations likely have the highest current velocities of the Harbor. Remaining stations had sediments which were moderate in median particle size (9 to 44 micron - fine silt to coarse silt).

Particle size ranges compared with past years. Table 4-2 lists the median particle sizes per station from October 1990 through October 1997. In surveys previous to 1996, 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.

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

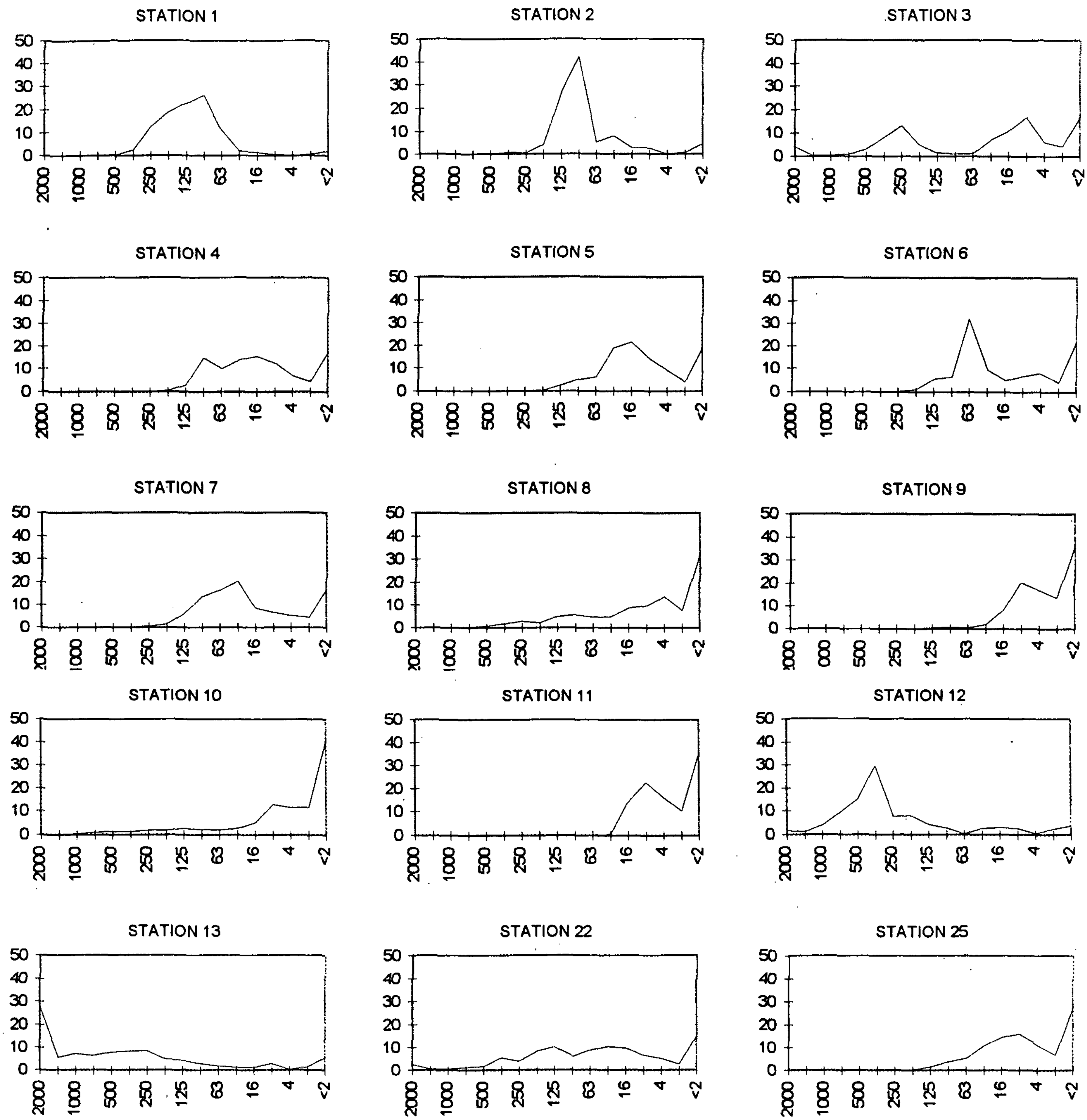


TABLE 4-1. PARTICLE SIZE DISTRIBUTIONS (PERCENTS) FROM 15 BENTHIC SEDIMENT STATIONS

	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	0.2	0.0	0.1	0.1	0.3	2.3	12.4	18.9	22.6	25.8	11.3	1.9	1.3	0.4	0.2	0.4	2.0
2	0.0	0.0	0.0	0.1	0.3	0.9	0.7	4.1	26.9	42.4	5.3	8.0	2.8	2.8	0.2	0.8	4.7
3	4.0	0.4	0.4	0.7	2.9	8.3	13.2	4.9	1.4	1.0	1.1	6.9	11.0	16.8	6.1	4.3	16.4
4	0.0	0.1	0.0	0.0	0.1	0.2	0.1	0.6	2.7	15.0	10.2	14.0	15.6	12.7	7.0	4.4	17.2
5	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3	2.4	4.8	6.0	18.8	21.5	14.0	8.7	3.7	19.5
6	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.1	5.4	6.3	32.2	9.4	4.8	6.6	7.9	4.1	21.8
7	0.0	0.0	0.0	0.1	0.1	0.2	0.5	1.3	6.1	13.7	16.3	20.3	8.7	6.6	5.3	4.3	16.5
8	0.0	0.0	0.1	0.2	0.7	1.6	2.6	2.2	4.9	5.7	4.6	4.8	8.8	9.7	13.9	7.6	32.8
9	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.2	0.5	0.6	0.4	1.9	8.2	20.4	17.3	13.8	36.3
10	0.2	0.1	0.5	1.0	1.2	1.3	1.9	2.0	2.7	2.2	2.0	2.7	5.1	12.9	11.5	11.5	41.2
11	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.6	14.0	22.7	15.9	10.3	35.9
12	1.7	1.2	4.1	9.4	15.1	29.6	7.8	8.1	4.4	3.0	0.3	2.7	3.0	2.7	0.6	2.4	3.8
13	27.9	5.6	7.3	6.5	7.9	8.3	8.7	5.0	4.5	2.9	1.9	1.3	1.3	3.0	0.4	1.5	5.7
22	2.5	0.7	0.6	1.3	1.8	5.4	4.0	8.4	10.3	6.2	8.9	10.6	9.8	6.8	5.3	2.6	14.8
25	0.0	0.2	0.1	0.2	0.3	0.4	0.4	0.3	1.4	3.8	5.3	11.0	14.6	16.2	11.3	6.7	27.6

TABLE 4-2. MEDIAN PARTICLE SIZES (MICRONS)[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1990 TO OCTOBER 1997.

	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
Oct-97	139	109	23	23	18	44	42	6	4	3	5	402	632	63	9

[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 TO OCTOBER 1997[2].

	STATION														
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Oct-96	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
Oct-97	0.77	0.87	3.80	2.87	2.62	3.19	2.89	3.66	2.14	3.41	2.36	1.48	2.72	3.29	2.93

[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.

Overall differences in median particle size between this year and last year were minor. Largest changes in median particle size was at Station 8, in Basin D, which shifted from very fine sand to very fine silt, and Station 13, in Oxford Lagoon, which changed from fine sand to course sand. As has been mentioned in previous reports (i.e. Soule, et. al. 1996, 1997), particle sizes at some locations appear to be related to rainfall and somewhat to dredging activity.

4.3.1.2. **Sorting Index**

Spatial sorting index patterns. Sorting index values are depicted in Figure 4-3 and Table 4-3. Sediments at Stations 1 and 2 near the Harbor entrance (0.77 to 0.87 - moderately sorted) sorted best (most homogeneous), followed by Station 12 in Ballona Creek (1.48 - poorly sorted). The remaining stations were similar (2.14 to 3.80 - all 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 channels and 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 surveys previous to 1996 because the ranges measured were too narrow. Sorting index values this year (0.77 to 3.80) indicate that sediments were more homogeneous (better sorted) overall than in 1996 (0.88 to 5.20)

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 9 and 11. These stations include one in Basin F and one at the upper end of the main channel. These sediments were moderately heterogeneous (very poorly sorted), and median particle sizes were the second finest in the Harbor (very fine silt). Current velocities here are probably very slow.

Stations 4, 5, 6, 7, 22 and 25. These include one station in Oxford Lagoon (22), three stations within the upper main channel (4, 5, and 25) and one station each in the Basins B and H (6 and 7, respectively). These stations contain moderately fine sediments (fine silt to coarse silt). The sorting of their sediments are the second most heterogeneous in the Harbor. These stations represent the innermost areas of the Harbor, so they are characterized by comparatively low current velocities.

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

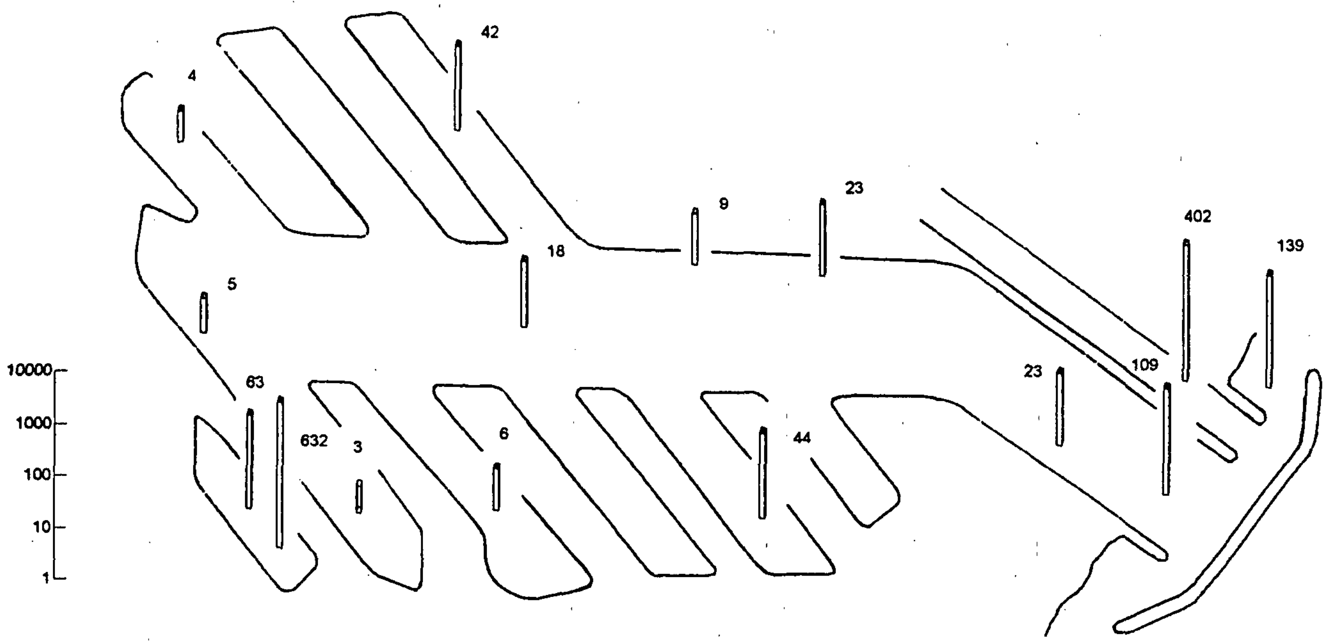


FIGURE 4-3. SORTING INDEX VALUES AT 15 BENTHIC SEDIMENT STATIONS.

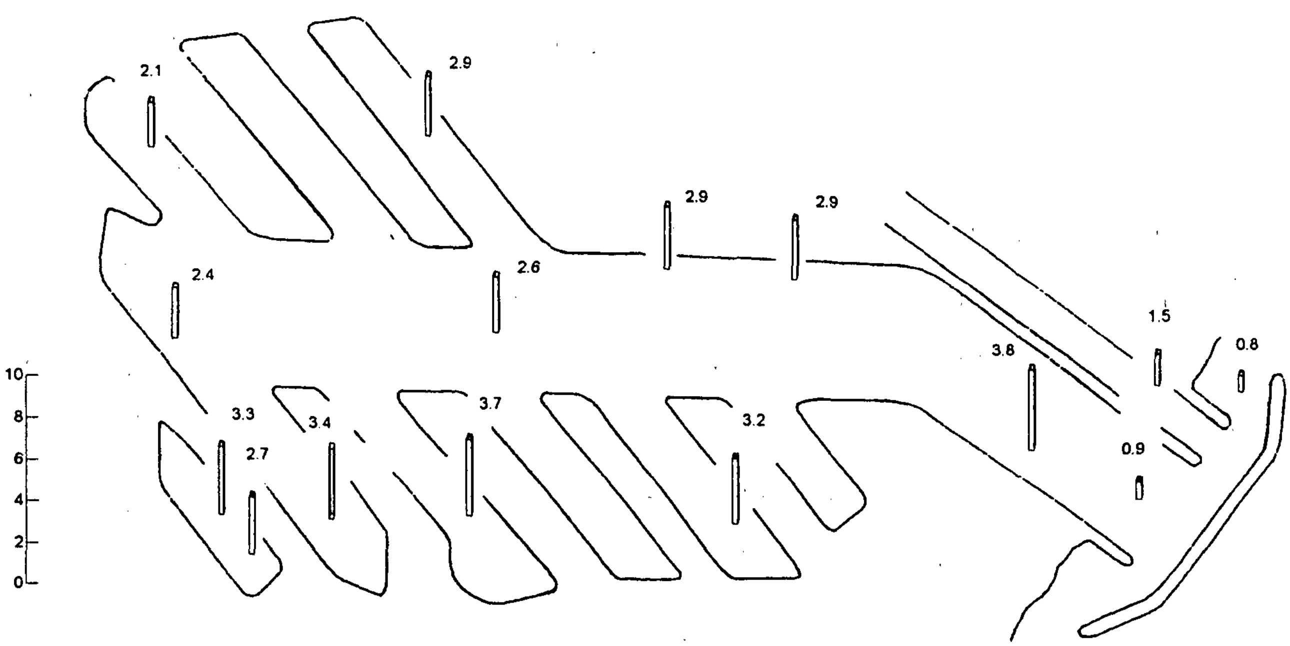
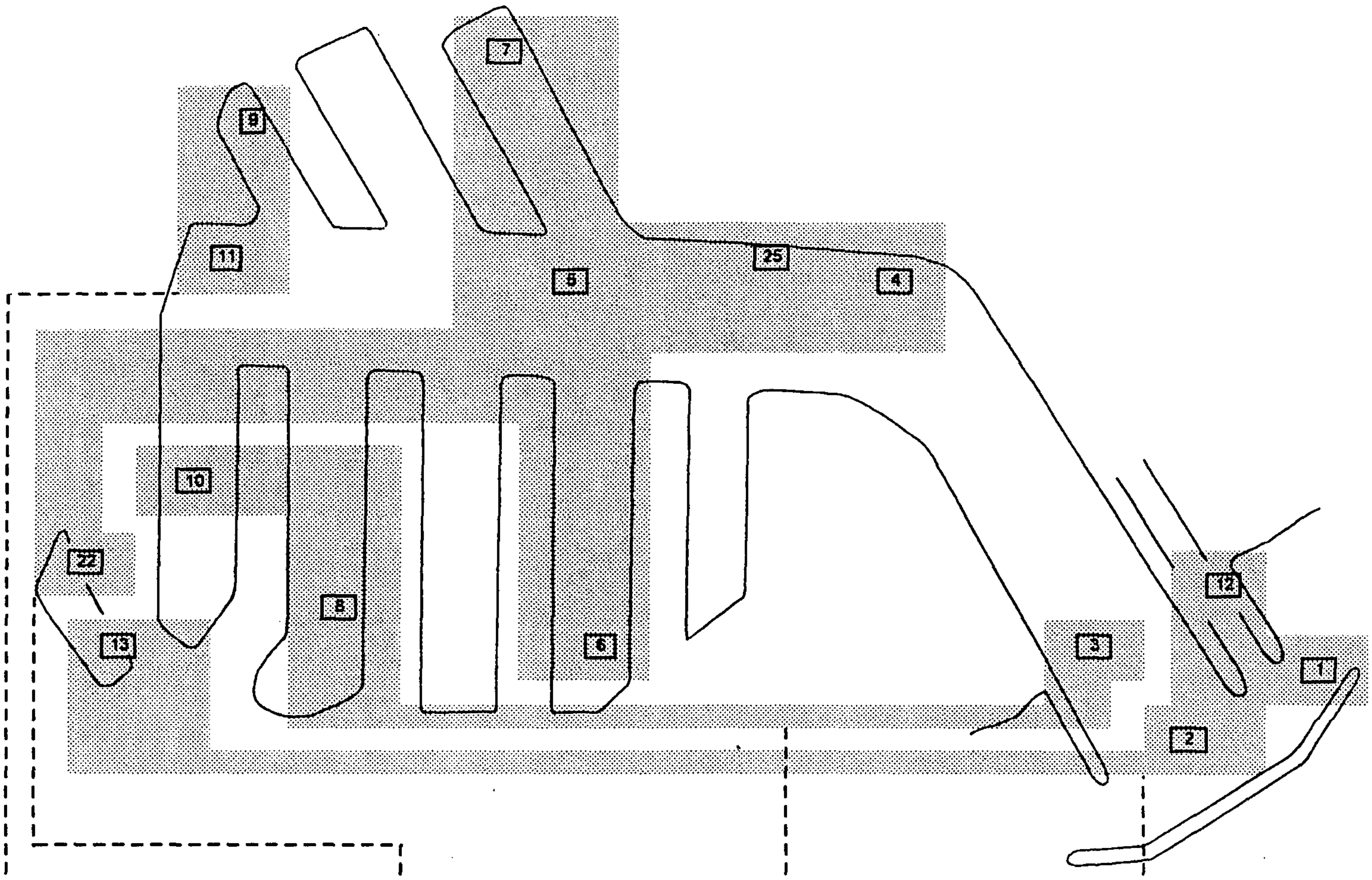


FIGURE 4-4. PHYSICAL SEDIMENT CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Stations 9,11	Stations 4,5,6,7,22,25	Stations 3,8,10	Station 1,2,12,13
Median grain size:	**Median grain size:**	**Median grain size:**	**Median grain size:**
Very fine silt.	Fine silt to coarse silt.	Clay to very fine silt.	Very fine sand to coarse sand
Sorting:	**Sorting:**	**Sorting:**	**Sorting:**
Very poorly sorted.	Very poorly sorted.	Very poorly sorted.	Moderately sorted to very poorly sorted.
Characteristics:	**Characteristics:**	**Characteristics:**	**Characteristics:**
These stations contain *the second finest sediments* in the Harbor. The grain size distribution is moderately heterogeneous.	These stations contain *moderately fine sediments*. The grain size distribution is the second most heterogeneous in the Harbor.	These stations contain *the finest sediments* in the Harbor. The grain size distribution is the most heterogenous in the Harbor.	These stations contain *the coarsest sediments* in The Harbor. The grain size distribution is the most homogeneous, except for Station 13, which is moderately heterogeneous.

Stations 3, 8, and 10. These include one mid-channel station (3) plus one station each in Basin D and E (8 and 10, respectively). Sediments here are the finest (clay to very fine silt) and most heterogeneous (very poorly sorted). Current velocities at these stations are probably very low.

Stations 1, 2, 12, and 13. These stations include the entrance to the Harbor (Stations 1 and 2), Ballona Creek (12), and one station in Oxford Lagoon (13). These stations contain the coarsest sediments in the harbor and the most homogeneous (with the exception of Station 13 sediments, which are moderately heterogeneous).

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 at the Harbor entrance. Both of these locations are influenced by current, tidal, and wave action from the open ocean, and Ballona Creek receives rapid water flow from the municipal drainage basin. Oxford Lagoon also receives municipal storm water drainage, but the flow appears to be more variable. Thus, even though some Oxford Lagoon sediments were coarse (like those of Ballona Creek), the variability in the flow created a relatively heterogeneous matrix of sediments. As expected, the remaining inner areas of the Harbor contained sediments which were very fine and fairly 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 (ppm)																
Arsenic	3.2	4.3	9.6	11.0	8.7	9.2	8.2	12.0	12.0	15.0	13.0	7.2	6.2	9.0	12.0	**9.37**
Cadmium	0.24	0.55	1.51	1.56	0.41	0.31	0.30	0.41	0.33	1.25	0.41	1.00	1.29	1.15	1.28	**0.800**
Chromium	17	25	56	59	52	43	45	56	69	65	66	28	22	39	70	**47.5**
Copper	9	19	105	130	170	180	160	300	360	380	390	52	81	30	240	**173.7**
Iron	12000	16000	28000	31000	36000	29000	30000	42000	50000	46000	50000	16000	26000	24000	45000	**32067**
Lead	56	40	130	140	92	75	71	92	140	210	120	170	250	89	180	**123.7**
Manganese	125	161	200	240	280	210	240	280	320	280	330	157	154	136	310	**228.2**
Mercury	0.08	0.18	0.62	0.80	0.51	1.10	0.38	1.20	1.30	1.40	0.97	0.18	0.26	0.09	0.68	**0.650**
Nickel	10	18	27	26	21	19	21	22	26	26	26	15	210	18	25	**34.0**
Selenium	0.4	0.6	1.3	1.4	1.2	1.0	1.1	1.8	1.8	2.4	1.8	0.8	1.0	0.9	1.9	**1.29**
Silver	0.20	0.49	2.80	3.00	1.80	0.96	0.96	1.05	1.70	1.40	1.80	0.92	0.41	0.21	3.50	**1.413**
Tributyl Tin	<0.002	<0.002	0.005	0.004	0.006	0.003	0.014	0.007	0.002	0.005	0.002	0.003	0.005	<0.002	0.003	**0.004**
Zinc	55	110	260	260	230	210	200	320	370	480	390	170	390	140	380	**264.3**
Pesticides & PCB's (ppb)	Dieldrin < 0.6 ppb (per Mike at Aug.															
p,p' DDD	<0.5	3.0	<0.7	3.0	4.0	<0.7	1.0	<0.9	2.0	5.0	3.0	<0.5	<0.6	<0.5	<0.9	**1.40**
p,p' DDE	3.0	6.1	15.0	11.0	12.0	6.0	4.0	4.0	10.0	23.0	13.0	8.6	20.0	3.0	16.0	**10.31**
All DDT & Derivatives	3.0	9.1	15.0	14.0	16.0	6.0	5.0	4.0	12.0	28.0	16.0	8.6	20.0	3.0	16.0	**11.71**
Endrin Aldehyde	1.0	<0.6	<0.7	5.0	3.0	2.0	0.9	<0.9	2.0	9.0	3.0	<0.5	<0.6	<0.5	<0.9	**1.73**
Heptachlor Epoxide	<0.3	<0.3	0.9	0.9	<0.4	<0.4	0.6	<0.4	<0.5	1.0	<0.5	<0.3	<0.3	<0.3	1.0	**0.29**
Gamma-Chlordane	<0.3	5.9	8.1	3.6	2.0	<0.4	<0.3	<0.4	<0.5	3.0	<0.5	3.8	3.3	4.1	6.8	**2.71**
Methoxychlor	<3.0	5.0	<3.0	<3.0	<4.0	<4.0	<3.0	<4.0	<5.0	<5.0	<5.0	<3.0	<3.0	<3.0	<4.0	**0.33**
Endosulfan I	<0.3	<0.3	3.6	<0.3	<0.4	<0.4	<0.3	<0.4	<0.5	<1.0	<0.5	<0.3	<0.3	<0.3	<0.3	**0.24**
Endosulfan II	<0.5	<0.6	<0.7	<0.7	<0.7	<0.7	<0.6	<0.9	<0.9	<1.0	<1.0	3.0	<0.6	<0.5	<0.9	**0.20**
Endrin Ketone	<0.5	<0.6	1.0	<0.7	<0.7	<0.7	<0.6	<0.9	<0.9	<1.0	<1.0	<0.5	<0.6	0.6	1.0	**0.17**
Delta BHC	<0.3	<0.3	<0.3	<0.3	<0.4	<0.4	<0.3	<0.4	<0.5	<0.5	<0.5	<0.3	0.8	<0.3	<0.4	**0.05**
All Non-DDT Pesticides	1.0	10.9	13.6	9.5	5.0	2.0	1.5	<0.9	2.0	13.0	3.0	6.8	4.1	4.7	8.8	**5.73**
PCB's	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<10	<20	<10	<20	**<20**
Dieldrin (ppb) (Aug. 27, 01)								<1.0	<1.0	<1.0	<1.0					
Organic Content																
Tot. Organic Carbon (%)	0.40	0.93	2.20	1.72	1.11	0.88	0.87	1.35	1.50	2.26	1.43	1.63	1.05	0.23	2.31	**1.325**
Volatile Solids (%)	0.6	2.5	4.0	2.5	2.3	1.6	2.0	2.2	2.7	2.7	2.7	2.2	3.3	1.5	3.4	**2.41**
Immed. Oxygen Dmd. (%)	0.132	0.535	1.470	1.220	0.594	0.730	0.659	0.867	1.050	0.865	1.030	0.621	1.440	0.077	1.990	**0.8853**
Chem. Oxygen Dmd. (%)	0.494	1.930	3.150	2.270	2.890	2.020	1.740	2.790	2.960	4.120	2.710	2.270	2.680	1.060	3.330	**2.4276**
Oil and Grease (ppm)	60	70	360	290	100	90	60	40	40	120	40	190	250	40	90	**122.7**
Organic Nitrogen (ppm)	120	867	647	564	751	707	487	1239	1020	1183	833	283	388	216	1499	**720.3**
Ortho Phosphate (ppm)	6.30	1.50	3.43	6.26	10.20	6.46	9.33	7.67	11.60	6.39	11.10	3.12	2.19	28.80	11.90	**8.417**
Sulfides (ppm)	130	360	550	510	410	340	470	420	450	850	560	440	610	260	550	**460.7**
Minerals, etc. (ppm)																
Moisture (%)	20.6	29.1	40.9	41.7	45.9	44.3	35.5	53.3	57.4	59.3	57.9	26.3	36.2	22.9	52.4	**41.58**
Spec. Cond. (mmhos/cm)	17	27	35	44	40	41	33	56	57	49	66	25	24	13	55	**38.8**
Alkalinity as CaCO3	150	260	700	420	390	300	290	260	290	250	460	370	370	170	330	**334.0**
Hardness as CaC03	1760	2390	4330	4090	3710	3940	3500	6140	7960	11200	7530	2230	2300	1260	5500	**4523**
Total Dis. Solids (%)	1.05	1.52	19.60	2.69	2.50	7.90	1.95	3.50	3.28	3.31	4.19	1.33	5.26	1.45	3.37	**4.193**
Barium	35	37	85	98	107	63	85	95	126	118	130	46	155	94	120	**92.9**
Boron	3.7	8.2	18.0	14.0	11.0	10.0	11.0	14.0	14.0	17.0	14.0	7.9	11.0	7.1	16.0	**11.79**
Calcium	8400	12000	18000	12000	11000	9400	8600	7900	7300	6400	8100	10400	15000	1900	14000	**10027**
Chloride	4830	7430	11500	12500	15400	14000	12000	21200	25100	26000	24200	6460	8890	4710	18600	**14188**
Fluoride	9.3	12.7	18.0	18.0	17.4	16.2	16.0	19.4	21.6	21.7	19.2	12.2	14.9	13.6	20.8	**16.73**
Nitrogen	120	867	647	564	751	707	487	1239	1020	1183	833	283	388	216	1499	**720.3**
Nitrate	<31	<31	<31	<31	<37	<36	<31	<43	<47	<49	<48	<31	<31	<31	<42	**<49**
Potassium	1400	2400	4800	5300	6700	4800	5500	7700	9400	8800	9100	2300	2500	4700	7300	**5513**
Sulfate	757	1520	2400	1970	2180	2060	1720	3060	3660	3980	3370	1230	1210	623	2610	**2157**
Sodium	3300	5900	10100	10500	11100	10200	8700	15000	17000	19000	17000	4700	6000	4200	14000	**10447**

TABLE 5-2. ANNUAL CHEMICAL COMPOUNDS MEASURED FROM 15 BENTHIC SEDIMENT STATIONS: 1985-1997 . 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*	October *1996*	**Overall** ***Range***	October *1997*
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	2.5 - 11.5	**1.13 - 13.80**	3.2 - 15.0
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	0.226 - 1.470	**0.13 - 34**	0.24 - 1.56
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	17.0 - 81.1	**4.68 - 89.1**	17 - 70
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	10.6 - 346.0	**5.50 - 455**	9 - 390
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	14.7 - 59.8	**3.21 - 71.5**	12 - 50
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	45.8 - 292.0	**6.0 - 575**	40 - 250
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	117 - 366	**26.2 - 366**	125 - 330
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	0.064 - 0.903	**0.06 - 2.8**	0.08 - 1.40
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	8.57 - 66.90	**<1.0 - 66.9**	10 - 210
Selenium	---	---	---	---	---	---	---	---	---	---	<0.14 - 2.35	<0.47 - 0.99	0.30 - 1.80	**<0.14 - 2.35**	0.4 - 2.4
Silver	---	---	---	---	---	---	---	---	---	---	ND	ND	0.280 - 2.720	**0.28 - 2.72**	0.20 - 3.50
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	0.005 - 0.023	**<0.003 - 5.57**	<0.002 - 0.014
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	61.3 - 440.0	**20.3 - 660**	55 - 480
Chlor. Hyd. (ppb)[7]															
p,p' DDD	---	---	2 - 34	<4 - 66.7	2 - 40	4 - 100	<4 - 15	<4 - 23	<4 - 36	<4 - 40	8 - 47	<4 - 70	<0.5 - 6.6	**<0.5 - 100**	<0.5 - 5.0
p,p' DDE	---	---	10 - 105	<4 - 189	<4 - 77	<4 - 104	3.5 - 110	3 - 67	<4 - 169	<4 - 94	11 - 63	<4 - 60	4.0 - 16.0	**3 - 189**	3.0 - 23.0
p,p' DDT	---	---	6 - 57	<4 - 29.1	4 - 200	<4 - 29	<4 - 14	<4 - 48	<4 - 56	<4 - 86	<4 - 49	<4 - 60	<0.4 - 12.0	**<0.4 - 200**	<1.0
Alpha-Chlordane[8]	---	---	---	---	---	---	---	---	---	---	---	---	<0.1 - 6.6	**<0.1 - 6.6**	<0.5
Gamma-Chlordane[8]	---	---	---	---	---	---	---	---	---	---	---	---	<0.2 - 7.7	**<0.2 - 7.7**	<0.3 - 8.1
Chlordane	---	---	<20 - 290	13.5 - 283	<20 - 630	10 - 410	<20 - 360	31 - 436	<20 - 270	<20 - 167	<20 - 109	<20 - 380	<0.1 - 14.3	**<0.1 - 630**	<0.3 - 8.1
Dieldrin	---	---	<1.0	<1.0	<1.0 - 30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.8	**<0.8 - 30**	<1.0
Endrin Aldehyde	---	---	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<0.6 - 2.0	**<0.6 - 2.0**	<0.5 - 9.0
Heptachlor Epoxide	---	---	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.2 - 2.0	**<0.2 - 2.0**	<0.3 - 1.0
Arochlor 1254	---	---	<50	<50	<50 - 330	<50 - 153	<50	<50	<50	<50 - 110	≤50 - 231	<50 - 90	<10 - 100	**<10 - 231**	<20
Arochlor 1260	---	---	<50	<50	<50 - 200	<50 - 172	<50 - 300	<50	<50 - 90	<50	<50	<50	<20	**<20 - 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	0.46 - 3.9	**0.28 - 10.10**	0.23 - 2.31
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	0.8 - 11.0	**0.8 - 16.8**	0.6 - 4.0
Immed. Ox. Dmd.	75 - 850	<1 - 220	38 - 315	18 - 330	12 - 461	12 - 374	15 - 432	26 - 557	<1.0 - 383	4.0 - 290	31 - 460	11 - 360	1300 - 13000	**<1 - 13000**	1320 - 19900
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	7.3 - 80	**2.44 - 215.6**	0.49 - 4.12
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	30 - 350	**0.10 - 350**	40 - 360
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	120 - 1400	**105 - 5900**	120 - 1499
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	14 - 225	**<1 - 47700**	1.5 - 28.8
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	75 - 580	**<0.1 - 2310**	130 - 850

[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] [redacted]

[6] These results are probably micrograms per liter rather than milligrams per liter.

[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 (1997) AVERAGE	MARINA DEL REY (1997) RANGE	LOS ANGELES HARBOR (1995) AVERAGE	LOS ANGELES HARBOR (1995) RANGE	SCCWRP (1977) AVERAGE	SCCWRP (1977) RANGE	SCCWRP (1985) AVERAGE
Metals (ppm)							
ARSENIC	9.4	3.2 - 15.0	5.25	2.2 - 8.5	--	--	--
CADMIUM	0.80	0.24 - 1.56	0.55	0.28 - 1.27	0.42	0.1 - 1.4	0.14
COPPER	173.7	9 - 360	39.9	13.1 - 69.6	24	6.5 - 43	10.4
CHROMIUM	47.6	17 - 69	41.2	21.0 - 71.7	9.6	2.3 - 40	25.4
MERCURY	0.650	0.08 - 1.40	0.21	0.11 - 0.32	--	--	--
LEAD	123.7	40 - 250	21.3	7.3 - 47	6.8	2.7 - 12	4.8
NICKEL	34.0	10 - 210	22.6	10.1 - 42.3	16	1.6 - 51	12.9
SILVER	1.41	0.2 - 3.5	0.55	0.05 - 2.66	0.35	0.04 - 1.7	0.03
ZINC	264	55 - 480	87.5	42.2 - 148	45	9.8 - 110	48.0
Chl. Hyd. (ppb)							
TOTAL DDT'S	11.71	<0.5 - 23.0	94.1	29.7 - 196	30	<3 - 70	18.9
PCB'S	<20	<20	58.3	27.2 - 137	10	<2 - 40	19.2
Organics							
TOC (%)	1.32	0.23 - 2.31	--	--	--	--	0.52
VOL. SOLIDS (%)	2.4	0.6 - 4.0	--	--	3.3	1.8 - 9.5	--
COD (%)	2.4	0.5 - 4.1	--	--	2.4	0.92 - 6.94	--
NITROGEN (ppm)	720	120 - 1499	--	--	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	3.2	4.3	9.6	11.0	8.7	9.2	8.2	12.0	12.0	15.0	13.0	7.2	6.2	9.0	12.0
Cadmium	5	9	5	0.24	0.55	1.51	1.56	0.41	0.31	0.30	0.41	0.33	1.25	0.41	1.00	1.29	1.15	1.28
Chromium	80	145	---	17	25	56	59	52	43	45	56	69	65	66	28	22	39	70
Copper	70	390	300	9	19	105	130	170	180	160	300	360	380	390	52	81	30	240
Lead	35	110	300	56	40	130	140	92	75	71	92	140	210	120	170	250	89	180
Mercury	0.15	1.3	1	0.08	0.18	0.62	0.80	0.51	1.10	0.38	1.20	1.30	1.40	0.97	0.18	0.26	0.09	0.68
Nickel	30	50	---	10	18	27	26	21	19	21	22	26	26	26	15	210	18	25
Silver	1	2.2	1.7	0.20	0.49	2.80	3.00	1.80	0.96	0.96	1.05	1.70	1.40	1.80	0.92	0.41	0.21	3.50
Zinc	120	270	260	55	110	260	260	230	210	200	320	370	480	390	170	390	140	380
Metals exceeding ER-L				1	2	5	5	5	4	4	5	5	5	5	3	5	2	5
Metals exceeding ER-M or AET				0	0	3	3	1	1	0	3	5	4	4	1	3	0	3
Hydrocarbons (ppb)																		
p,p' DDD	2	20	10	<0.5	3.0	<0.7	3.0	4.0	<0.7	1.0	<0.9	2.0	5.0	3.0	<0.5	<0.6	<0.5	<0.9
p,p' DDE	2	15	7.5	3.0	6.1	15.0	11.0	12.0	6.0	4.0	4.0	10.0	23.0	13.0	8.6	20.0	3.0	16.0
p,p' DDT	1	7	6	<0.5	<0.6	<0.7	<0.5	<0.7	<0.7	<0.6	<0.9	<0.9	<1.0	<1.0	<0.5	<0.6	<0.5	<0.9
Total DDT & Deriv.	3	350	---	3.0	6.1	15.0	11.0	12.0	6.0	4.0	4.0	10.0	23.0	13.0	8.6	20.0	3.0	16.0
Chlordane	0.5	6	2	<0.3	5.9	8.1	3.6	2.0	<0.4	<0.3	<0.4	<0.5	3.0	<0.5	3.8	3.3	4.1	6.8
PCB's	50	400	370	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	20	<20	<20	<20
Hydrocarbons exceeding ER-L				2	4	3	4	4	2	2	2	3	4	3	3	3	3	3
Hydrocarbons exceeding ER-M or AET				0	1	2	2	2	0	0	0	1	2	1	2	2	1	2
Total Contaminants																		
Total exceeding ER-L				3	6	8	9	9	6	6	7	8	9	8	6	8	5	8
Total exceeding ER-M or AET				0	1	5	5	3	1	0	3	6	6	5	3	5	1	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 (15.0 ppm), Station 11 at the dead-end of the Harbor channel (13.0 ppm), and Station 9 within Basin F (12.0 ppm), and Stations 4 and 25 in the main channel (12.0 and 11.0 ppm, respectively). Lowest values were near the Harbor entrance (Stations 1 and 2 - 3.2 and 4.3 ppm, respectively).

Arsenic ranges compared with past years. The range of 1997 arsenic values (3.2 to 15.0 ppm) was within the overall range of the preceding 12 years (Table 5-2). With the exception of the October 1985 and February 1987 values, which were slightly 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 (9.4 ppm, 3.2 to 15.0 ppm) were higher than 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 1997 was 3.2 to 15.0 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.

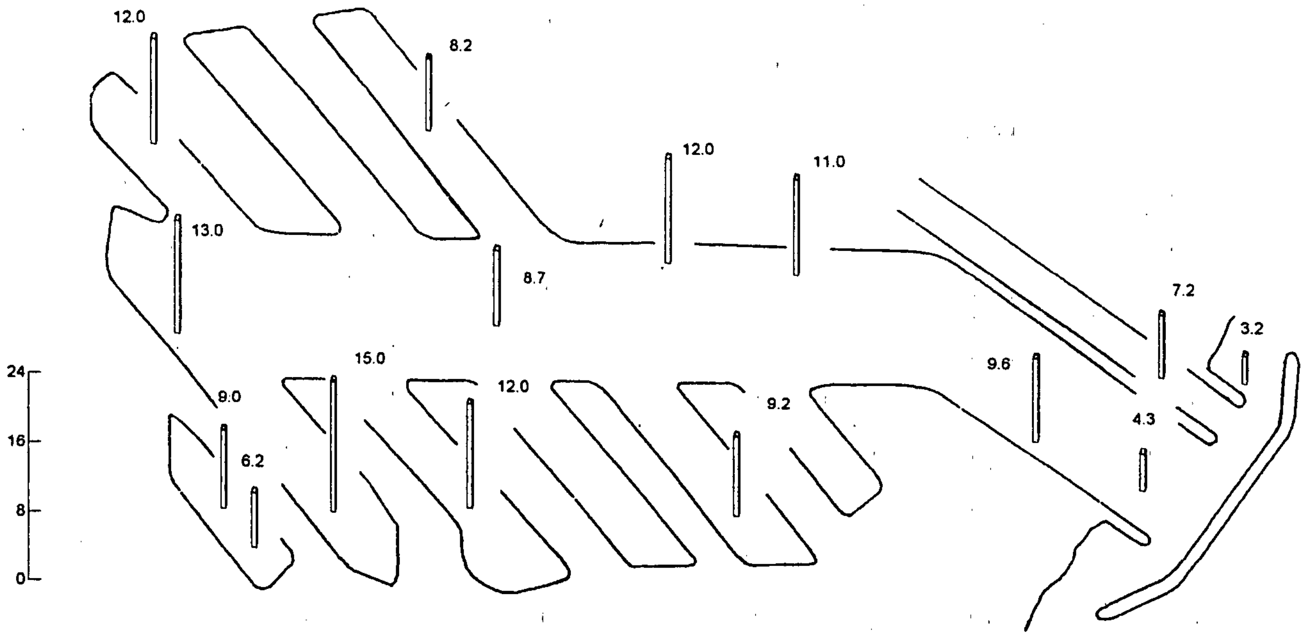
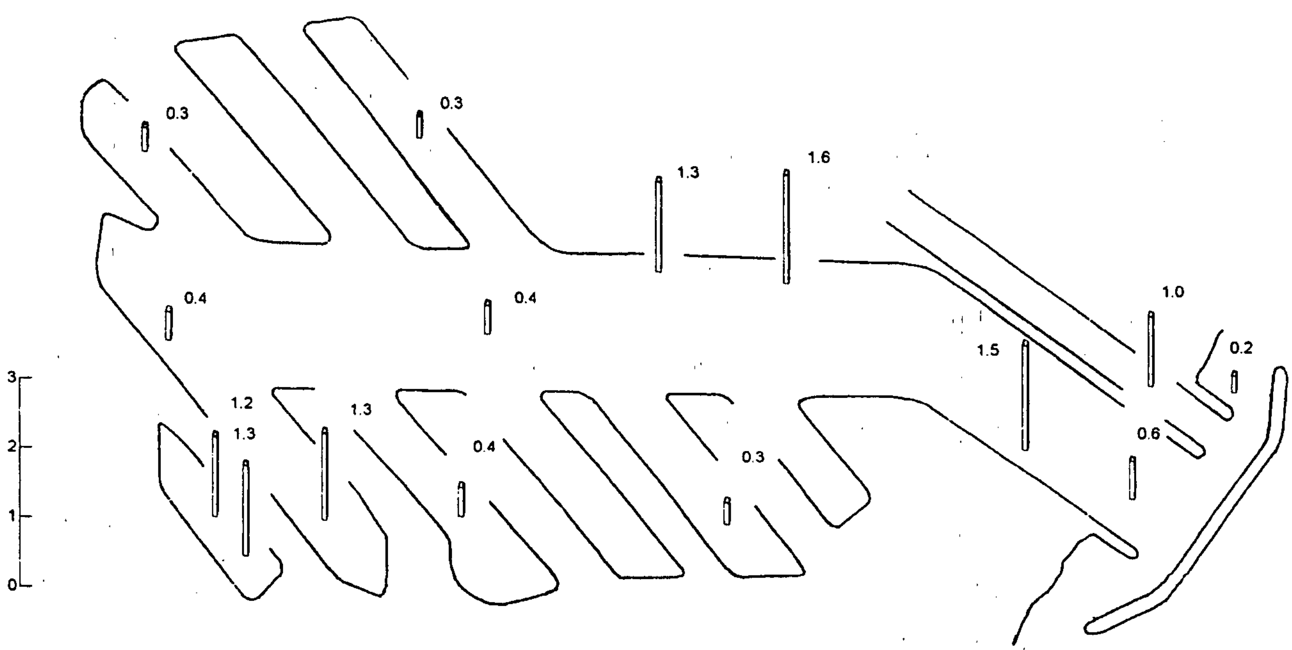


FIGURE 5-2. CADMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 Stations 3, 4, and 25 in the main channel (1.3 to 1.6 ppm), Station 10 within Basin E (1.3 ppm), Stations 13 and 22 in Oxford Lagoon (1.3 and 1.2 ppm), and Station 12 in Ballona Creek (1.0 ppm). All remaining stations were low (0.2 to 0.6 ppm).

Cadmium ranges compared with past years. The range of 1997 cadmium values (0.2 to 1.6 ppm) was within the overall range of the preceding 12 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 (0.8 ppm, 0.2 to 1.6 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 1997 was 0.2 to 1.6 ppm. Therefore, none of the Harbor stations appear to be potentially 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 25 in the main channel (70 ppm), Station 9 in Basin F (69 ppm), Station 11 at the upper end of the main channel (66 ppm), and Station 10 in Basin E (65 ppm). Lowest values were near the Harbor entrance (Station 1 and 2 - 17 and 25 ppm, respectively) and at Station 13 in Oxford Lagoon (22 ppm).

Chromium ranges compared with past years. The range of 1997 chromium values (17 to 70 ppm) was within the overall range of the preceding 12 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.

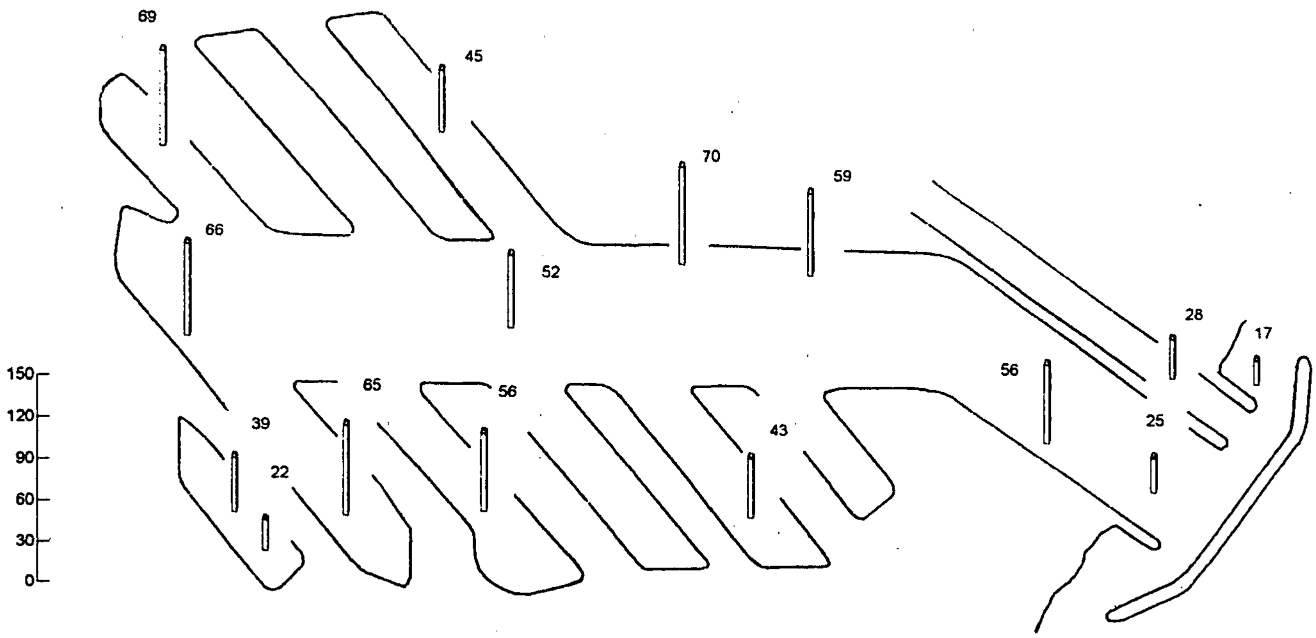


FIGURE 5-4. COPPER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

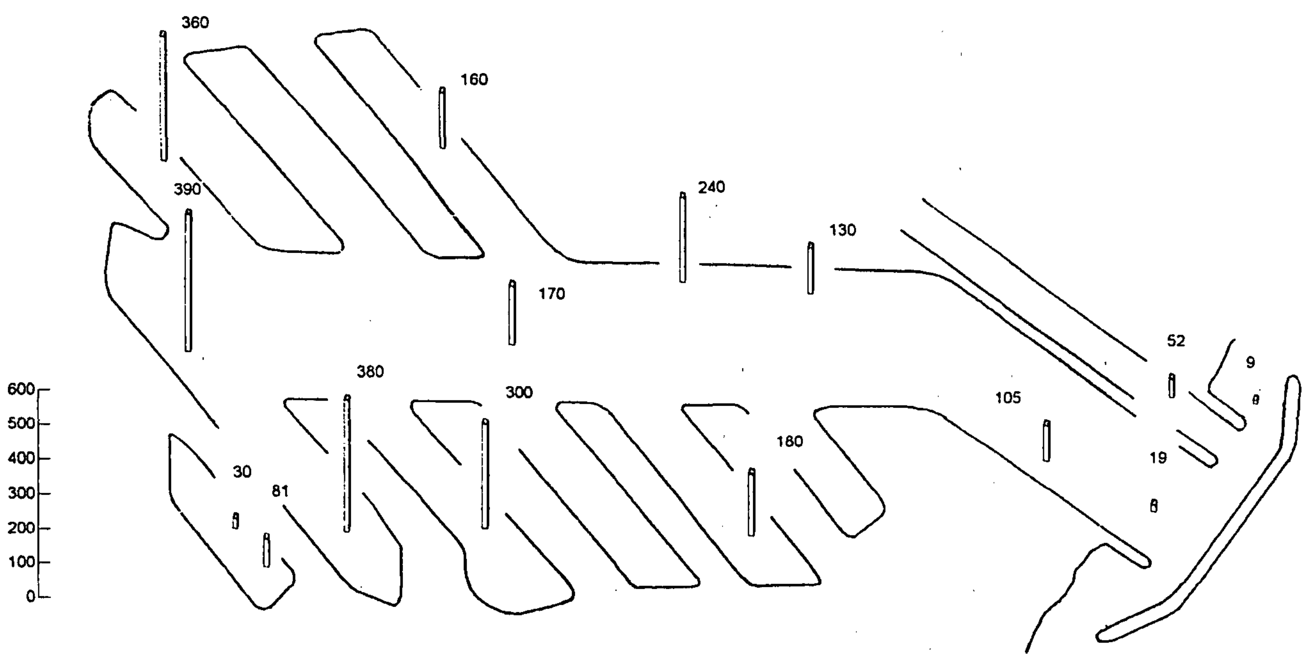


FIGURE 5-9. NICKEL CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

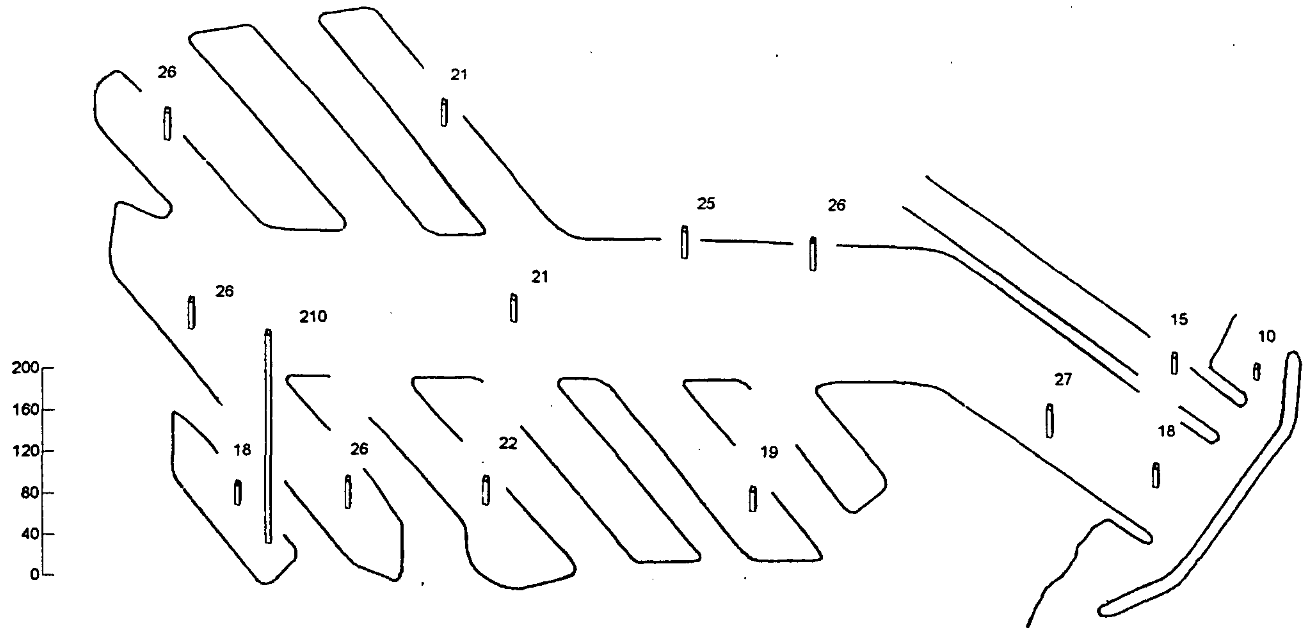
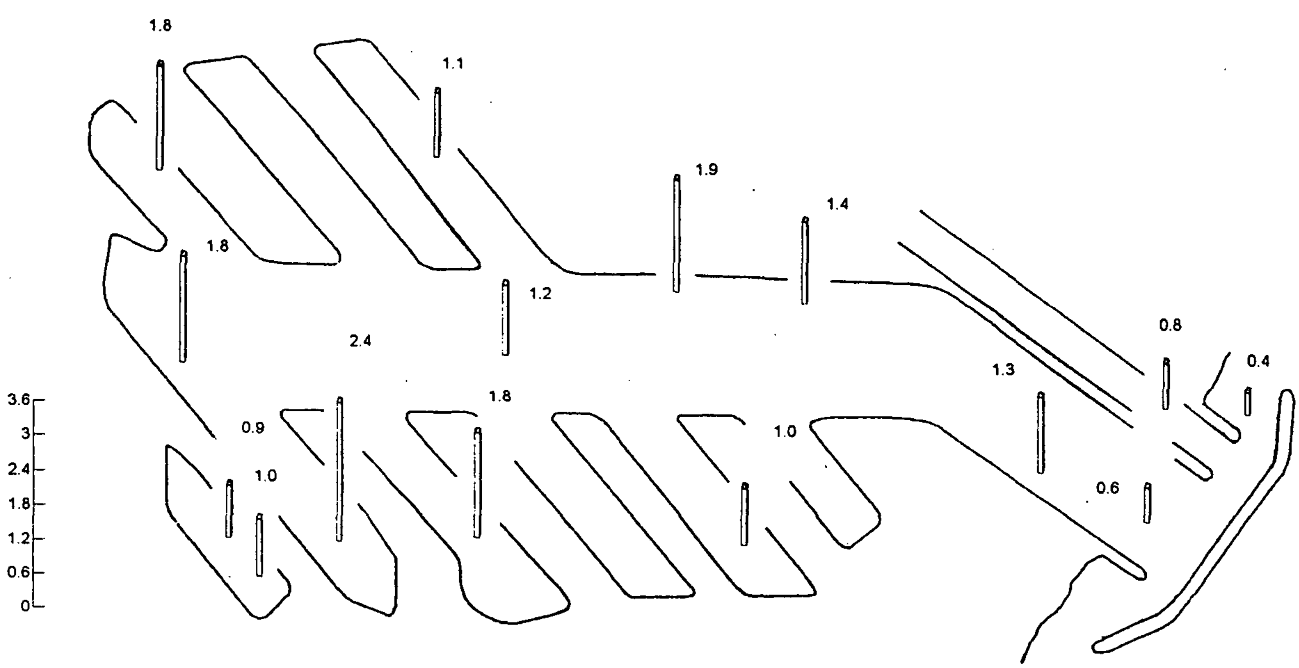


FIGURE 5-10. SELENIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Selenium ranges compared with past years. The range of 1997 selenium values (0.4 to 2.4 ppm) was within or near the overall range of the preceding three 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 - 2.8, 3.0, and 3.5 ppm, respectively). Lowest values were at one Harbor entrance stations (Stations 1 and 2 - 0.2 and 0.3 ppm, respectively) and in Oxford Lagoon (Stations 13 and 22 - 0.4 and 0.2 ppm, respectively).

Silver ranges compared with past years. The range of 1997 silver values (0.2 to 3.5 ppm) was similar to 1996 (Table 5-2). No other year's values can be compared.

Silver values compared with other surveys. The Marina del Rey silver average and range (1.4 ppm, 0.2 to 3.5 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 1.0, 2.2, and 1.7 ppm (Table 5-3). Stations 3, 4, 5, 8, 9, 10, 11, and 25 exceeded the ER-L value; Stations 3, 4, 5, 9, 11, and 25 exceeded AET value; and Stations 3, 4, and 25 exceeded the ER-M value.

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

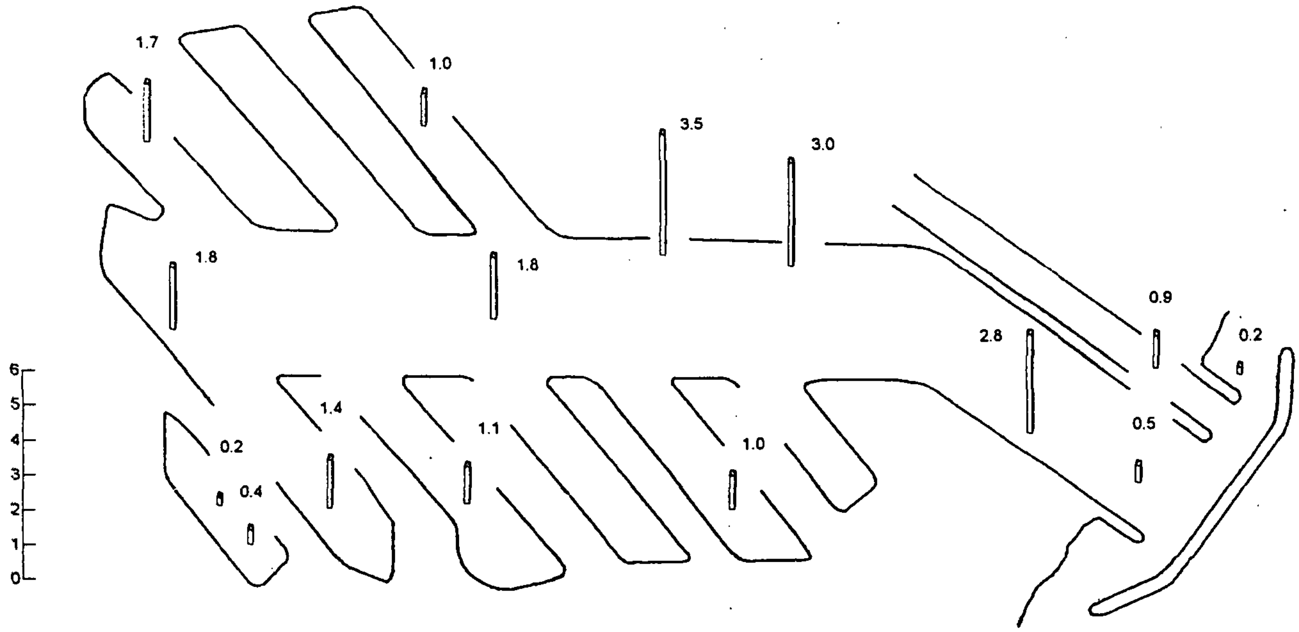
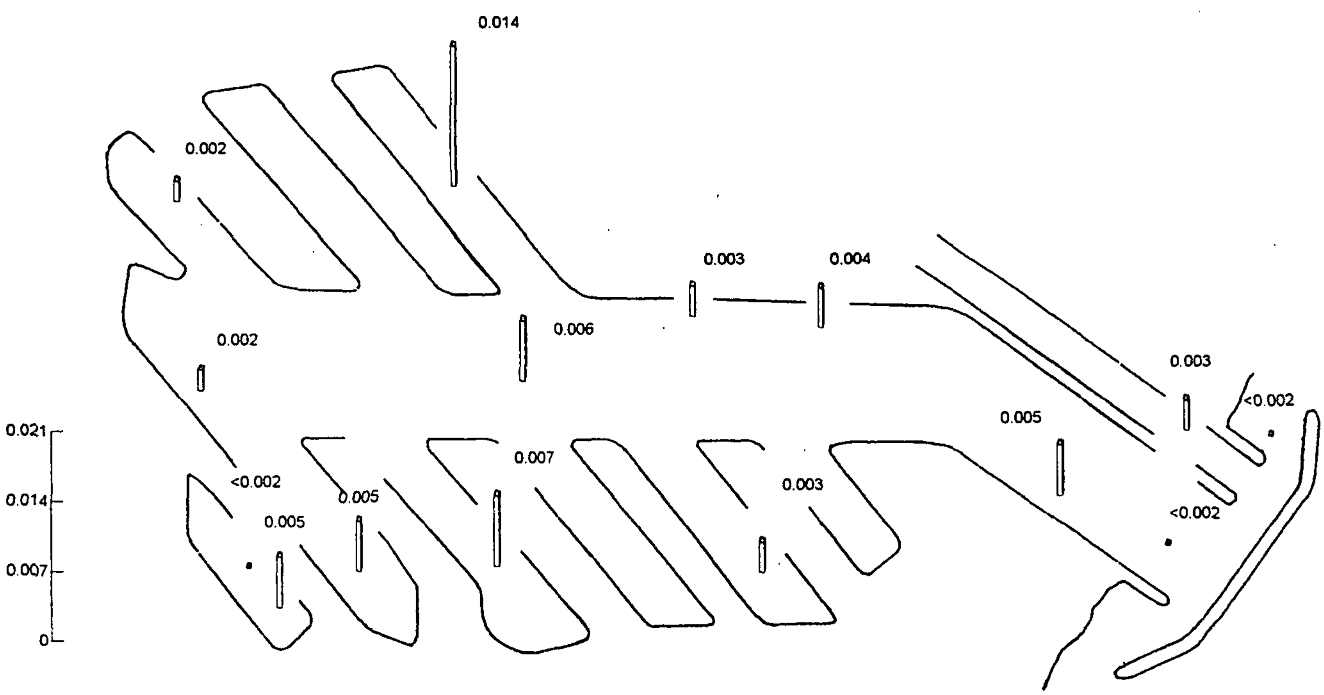


FIGURE 5-12. TRIBUTYL TIN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 7 in Basin H (0.014 ppm). Lowest values were at Stations 1 and 2 near the Harbor entrance and at Station 22 in Oxford Lagoon (all <0.002 ppm).

Tributyl tin ranges compared with past years. The upper value of 1997 tributyl tin results (0.014 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 zinc values were at Station 10 in Basin E (480 ppm), Station 9 in Basin F (370 ppm), Station 11 at the end of the Harbor channel (390 ppm), Station 25 in the main channel (380 ppm), and at Station 13 in Oxford Lagoon (390 ppm). Lowest values were near the Harbor entrance (Stations 1 and 2 - 55 and 110 ppm, respectively).

Zinc ranges compared with past years. The range of 1997 zinc values (55 to 480 ppm) was within the overall range of the preceding 12 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 (264 ppm, 55 to 480 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 Stations 1 and 2 exceeded the ER-L value; and Stations 3, 4, 8, 9, 10, 11, 13, and 25 exceeded the AET value; and Stations 8, 9, 10, 13 and 25 exceeded the ER-M value.

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 - 20.0 ppb) and in Basin E (Station 10 - 28.0 ppb). Lowest values were in Basins B, D, and H (Stations 6, 8, and 7 - 6.0, 4.0, and 5.0 ppb) and at Station 1 at the Harbor entrance (3.0 ppb).

DDT ranges compared with past years. The range of 1997 values were <1.0 ppb for DDT, <0.5 to 5.0 ppb for DDD, and 3.0 to 23.0 ppb for DDE. Concentrations of both derivatives (i.e. DDD and DDE) were similar to results of last year and represent order of magnitude declines from results of all previous years. Concentrations of DDT proper were below detection limits (<1.0 ppb) at all stations, which is lower than average results (5.3 ppb) of last year (Aquatic Bioassay 1997) which were also about one-tenth of previous years' results (Table 5-2).

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

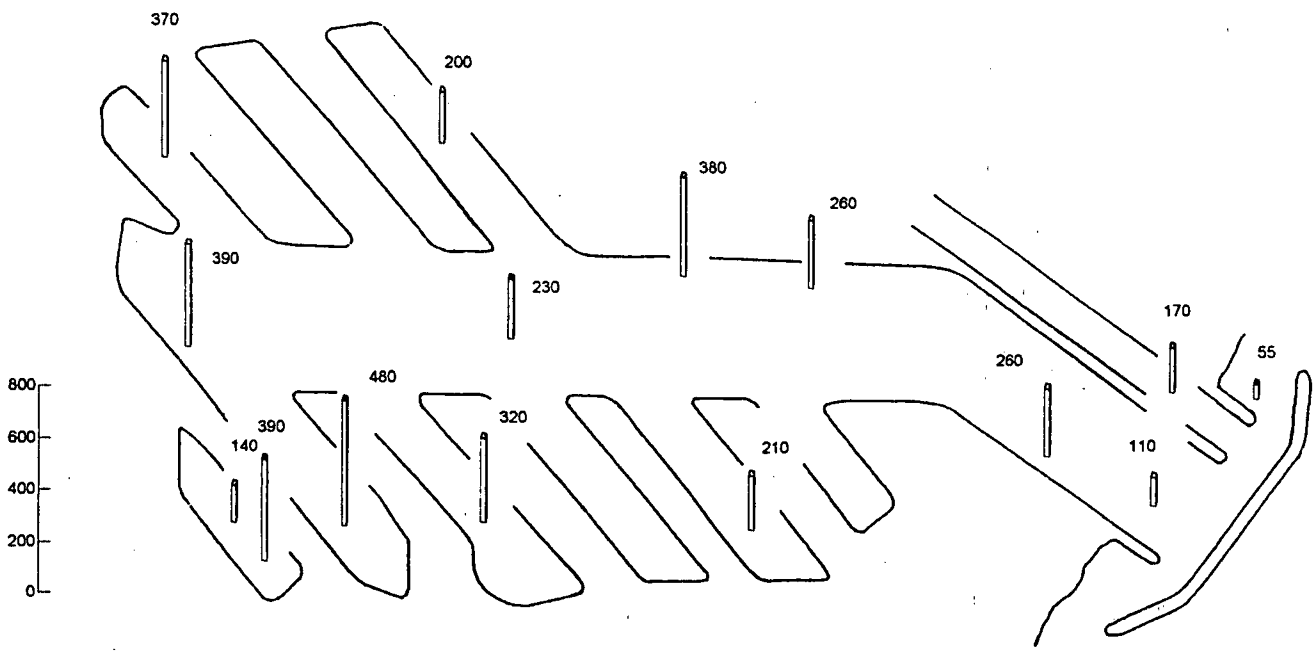
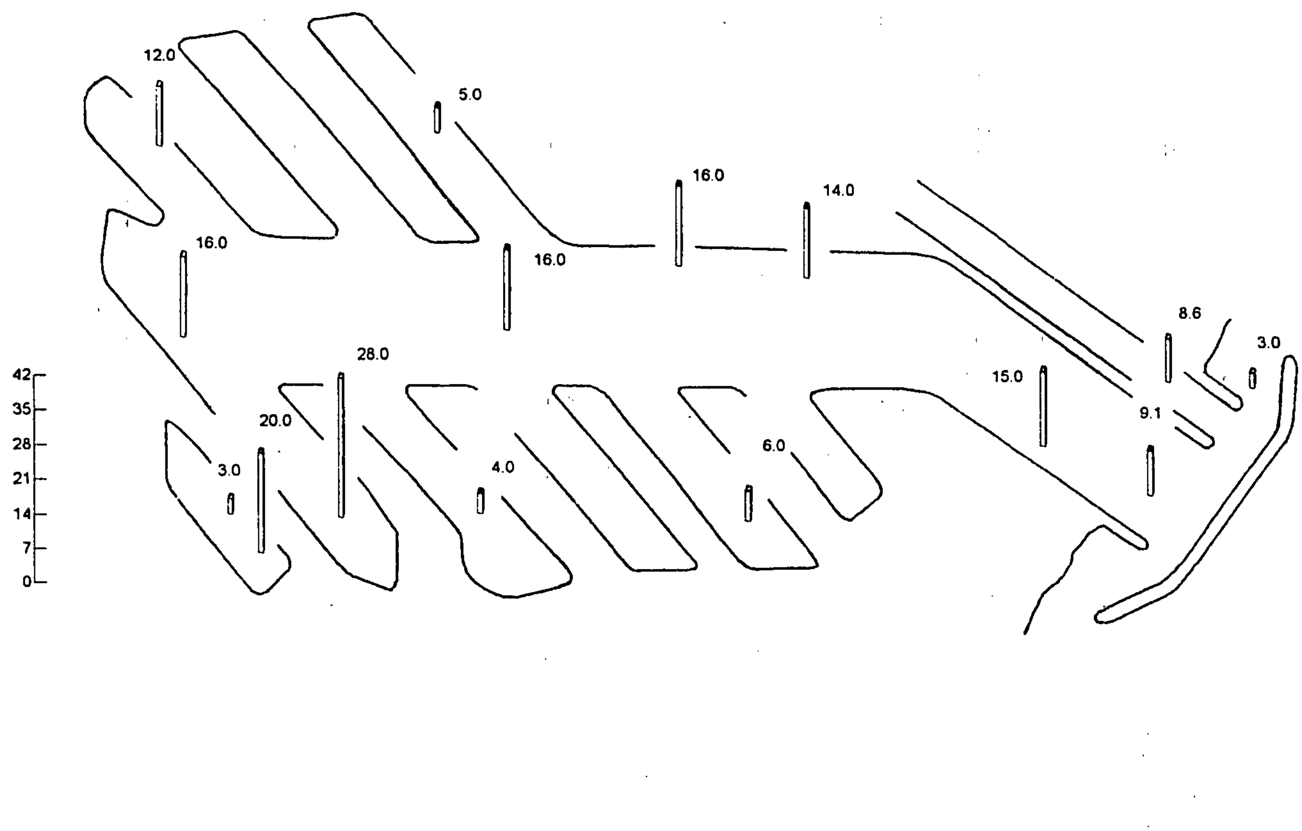


FIGURE 5-14. DDT AND DERIVATIVE CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



DDT values compared with other surveys. The Marina del Rey total DDT's average and range (11.7 ppb, <0.5 to 23.0 ppb) were considerably lower than Los Angeles Harbor (94.1 ppb, 29.7 to 196 ppb) and somewhat lower than the 1979 SCCWRP Reference Site Survey (30 ppb, <3 to 70 ppb), and the 1987 (18.9 ppb) Survey (Table 5-3).

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). Stations 2, 4, 5, 9, 10, and 11 exceeded the ER-L value for DDD, though none exceeded either ER-M or AET values. All stations exceeded ER-L values for DDE, and Stations 3, 4, 5, 9, 10, 11, 12, and 13 exceeded AET and/or ER-M values. No stations exceeded ER-L, ER-M, or AET values for DDT. The ER-L values for total DDT's were exceeded at all stations, although no stations exceeded ER-M values (there is no AET value listed for total DDT and derivatives).

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. Dieldrin, which occurred only once in 1989 was below detection limits (0.08 ppb) in this survey. 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). Methoxychlor, endosulfan (I and II), endrin ketone, and delta BHC were also detected in very small amounts, and no toxicity data could be found on these compounds, as well (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 in Basin E (Station 10 - 13.0 ppb) and in the middle and lower channel (Stations 2, 3, 4, and 25 - 10.9, 13.6, 9.5, and 8.8 ppb, respectively). Lowest values were in Basins D (Stations 8 - <0.9 ppb).

Remaining chlorinated pesticide ranges compared with past years. The range of 1997 values were <0.3 to 8.1 ppb for chlordane, <0.5 to 9.0 for endrin aldehyde, and <0.3 to 1.0 for heptachlor epoxide. Upper limits for chlordane are similar to last year (Aquatic Bioassay 1997), which had declined by an order of magnitude over previous years. Levels of endrin aldehyde are about five times higher than last year. 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.

FIGURE 5-15. TOTAL NON-DDT PESTICIDE CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.

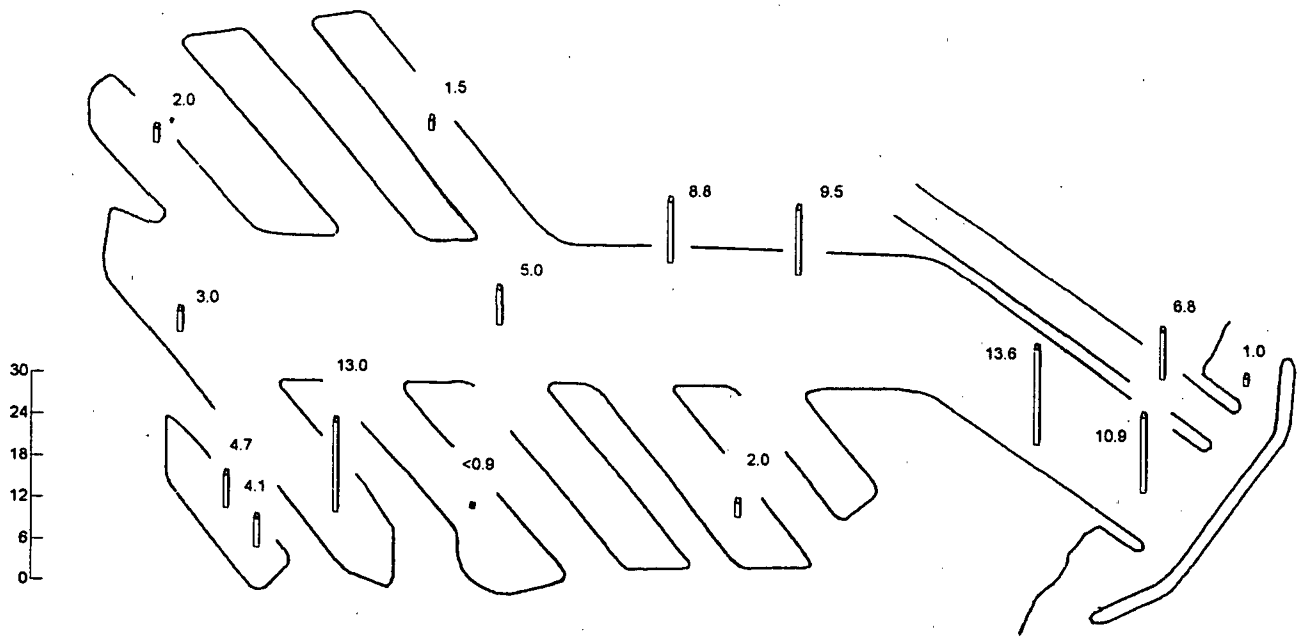


FIGURE 5-16. TOTAL PCB CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.

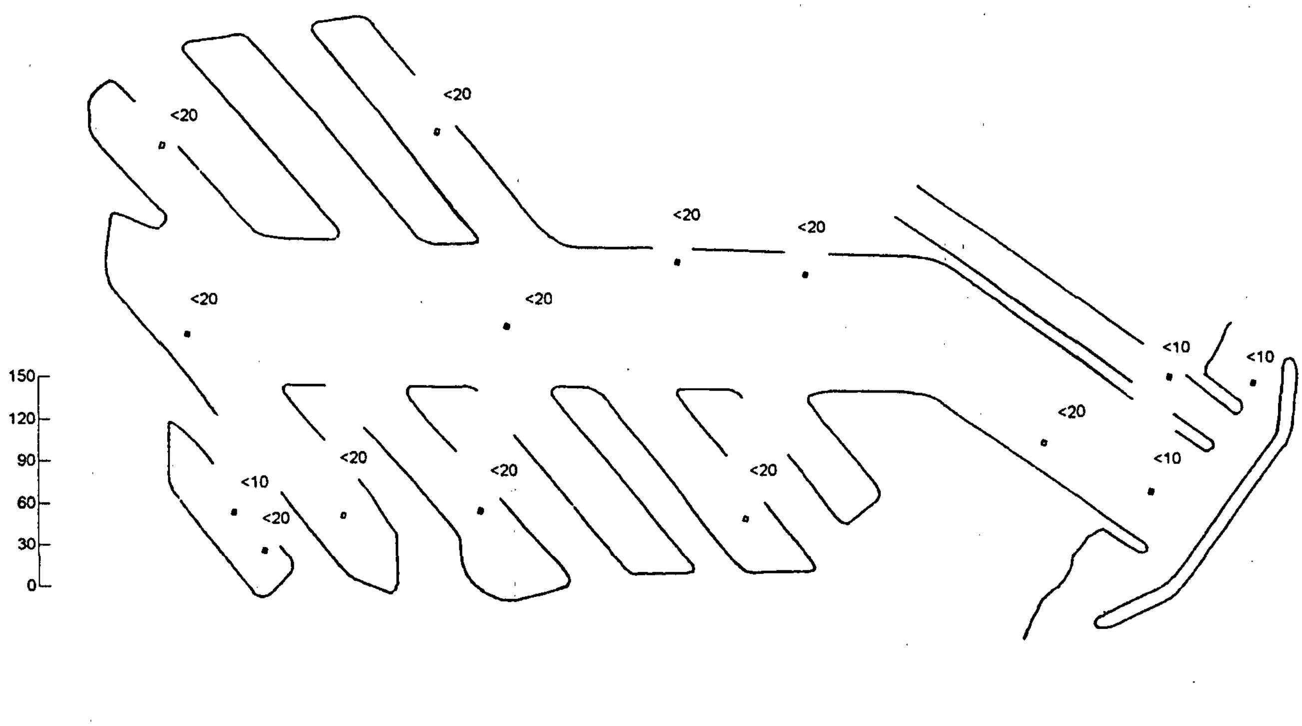


FIGURE 5-23. ORTHO PHOSPHATE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.

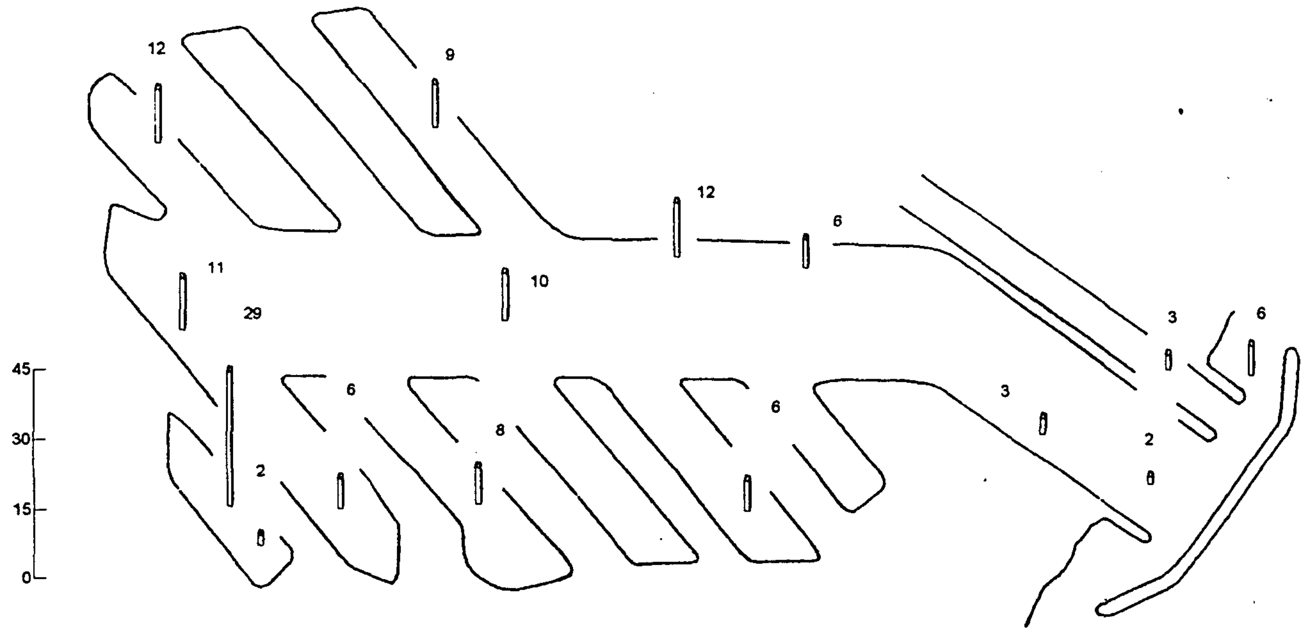
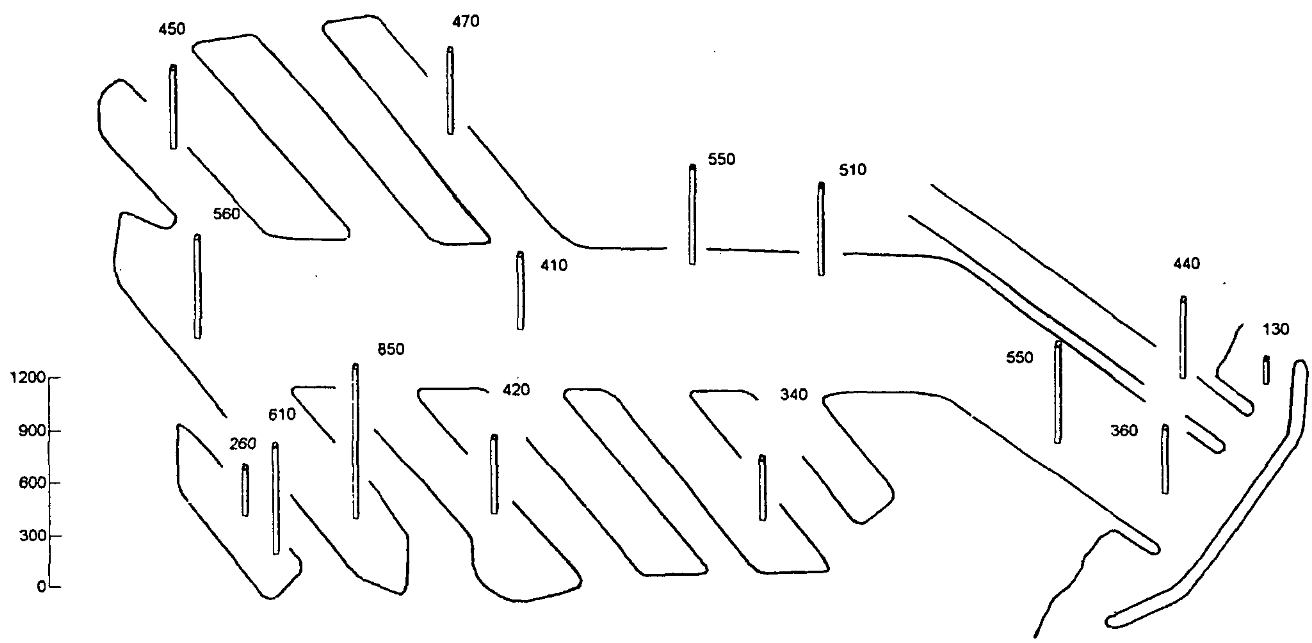


FIGURE 5-24. TOTAL SULFIDE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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).

Station 22. This cluster includes one of the two sediment station within Oxford Lagoon. It is characterized by relatively high levels of cadmium and ortho phosphate and low values of most other heavy metals, DDT compounds, and many nonspecific organics.

Station 13. This cluster includes the remaining station within Oxford Lagoon. It is characterized by relatively high values of five heavy metals (cadmium, lead, nickel, tributyl tin, and zinc), DDT compounds, and four nonspecific organic compounds (volatile solids, immediate oxygen demand, oil and grease, and sulfides). All remaining metal and the two other nonspecific organics concentrations were relatively low. Station 13 is much nearer than Station 22 (see above) to both the flood control grate and the connection between Oxford Lagoon and the Harbor. It is likely that contaminated particulates flow into this station from the drainage system and/or the Harbor during flood tide and settle out here before they reach Station 22.

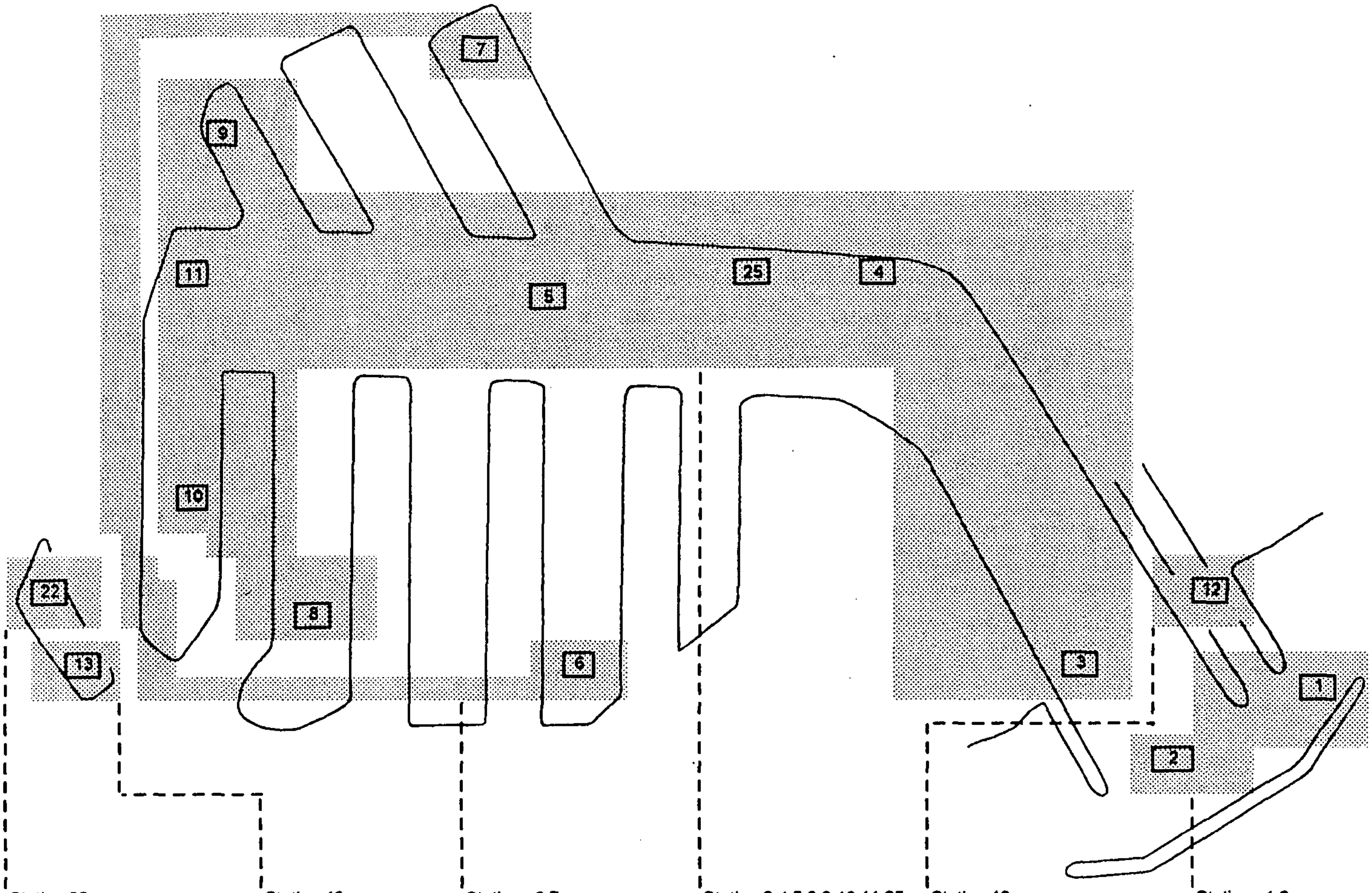
Stations 6 and 7. This cluster includes Basins B and H. Sediments here are high in only tributyl tin and are low in cadmium, lead, chlorinated pesticides, TOC, volatile solids, and COD. These sediments tend to be less contaminated than other upper Harbor areas.

Stations 3, 4, 5, 8, 9, 10, 11, and 25. This cluster includes most channel stations and Basins D, E, and F. It is rated high in nearly every metal, DDT compounds, and many nonspecific organic compounds (TOC, volatile solids, immediate oxygen, COD, organic nitrogen, and sulfides). No sediment contaminants were low in this group. Although Oxford Lagoon and Ballona Creek may contribute somewhat to the contaminant load of this group, the main sources are probably from the thousands of Harbor boats themselves. It is also common knowledge that finer particles tend to adsorb metals and organics more easily than do courser particles (see, for example, Gray 1981). Sediments from most of these stations tended to be finer (clay to course silt) than other stations, particularly than those near the Harbor entrance (see Section 4.3.1).

Station 12. This group includes the one station within Ballona Creek. It is characterized by high values of lead, non-DDT chlorinated pesticides, oil and grease, and TOC. Low values include most heavy metals and some organics (volatile solids, immediate oxygen demand, organic nitrogen, and ortho phosphate). Both here and in Oxford Lagoon (Station 13), relatively high levels of lead (perhaps from gasoline) and oil and grease (possibly from automobiles) suggest that their source is street drainage.

Stations 1 and 2. These stations are nearest to the Harbor entrance and contain sediments which are low in almost all chemical contaminants measured in this survey. They are high in none. These are the cleanest sediments in the Harbor (and they are also the coarsest).

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



Station 22

High In:
Cadmium
Phosphate

Low In:
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Tributyl Tin
Zinc
DDT's
TOC
Volatile Solids
Immed. Oxy. Dmd.
COD
Oil and Grease
Nitrogen
Sulfides

Charateristics:
High in only one metal and one organic compound. Low in DDT's and most metals and organics.

Station 13

High In:
Cadmium
Lead
Nickel
Tributyl Tin
Zinc
DDT's
Volatile Solids
Immed. Oxy. Dmd.
Oil and Grease
Sulfides

Low In:
Arsenic
Chromium
Copper
Iron
Manganese
Mercury
Selenium
Silver
Nitrogen
Phosphate

Charateristics:
A probable source of DDT's and some metals and organics into the Harbor.

Stations 6,7

High In:
Tributyl Tin

Low In:
Cadmium
Lead
DDT's
Pesticides
TOC
Volatile Solids
COD

Charateristics:
High in only tributyl tin. Low in two metals, a few organics, and chlorinated pesticides. Moderate in all other compounds.

Station 3,4,5,8,9,10,11,25

High In:
Arsenic
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Zinc
DDT's
TOC
Volatile Solids
Immed. Oxy. Dmd.
COD
Nitrogen
Sulfides

Low In:
--

Charateristics:
A sink for DDT's and most metals and organics.

Station 12

High In:
Lead
Pesticides
TOC
Oil and Grease

Low In:
Arsenic
Chromium
Copper
Iron
Manganese
Mercury
Nickel
Selenium
Silver
Zinc
Volatile Solids
Immed. Oxy. Dmd.
Nitrogen
Phosphate

Charateristics:
Probably receives lead, pesticides (except DDT's), and a few organics from Ballona Creek. Low in most metals and organics.

Stations 1,2

High In:
--

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

Charateristics:
Least contaminated sediments in the Harbor.

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 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 often difficult to isolate from background. Another factor, the sediment particle size pattern, can also influence the distribution of many compounds.

Similar to our last survey (Aquatic Bioassay 1997), inflows from the Oxford Lagoon and Ballona Creek appear to be sources of chlorinated pesticides, however patterns this year were not as strong, particularly for Ballona Creek. Unlike last year, however, only the DDT breakdown products (i.e. DDD and DDE) were measured above detection limits. The presence of DDT itself indicates a fresh source of input to the Harbor, so the absence of measurable DDT in this survey could be considered a good sign, at least for the time being. As has been stated in the history of the Harbor, surrounding areas were once used as dump sites for toxic materials, so the presence of DDT breakdown products is not surprising.

Other chlorinated hydrocarbon results were similar to those of last year, except that during this survey, PCB's were below detection at all stations. Highest values of pesticides tended to be in Basin E and the main channel, although concentrations in Oxford Lagoon and Ballona Creek were moderate. As with this study, last year we note that the chlorinated hydrocarbon concentrations were notably lower than had been measured during 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 1, 6, 7, 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 (11.7 and <20 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).

Oxford Lagoon sediments were relatively high in cadmium, nickel, tributyl tin, and lead; Ballona Creek sediments were high in lead only; and sediments from near the Harbor entrance were not elevated in metals at all. Most of the sediment samples from the main channel and the upper Harbor, however, were relatively high in nearly all of the 13 heavy metals analyzed in this survey. Oxford Lagoon is open to both municipal drainage, as well as water from the Harbor, during incoming tide. Thus, for those five metals which are high in both the Lagoon and the Harbor, it is difficult to determine whether the drainage water is increasing the metal load in Harbor sediments or if the Harbor tidal water is increasing the metal load in Oxford Lagoon sediments. By nature of its high rate of flow, the source of high lead values in Ballona Creek sediments are most likely due to municipal drainage water rather than any input from the Harbor. Conversely, Ballona Creek is a thus likely source of lead to Marina del Rey.

Regardless, the eight metal contaminants that were not elevated in Oxford Lagoon or Ballona Creek but were high in the main channel and upper Harbor (arsenic, chromium, copper, iron, manganese, mercury, selenium, and silver) have come from other sources, and those sources are most likely the thousands of boats themselves which inhabit the Marina. Metal components of boats and their engines are constantly being corroded by seawater, and virtually all bottom paints contain heavy metals, such as copper, and tributyl tin. These paints are designed to constantly ablate off, 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. Not surprisingly then, 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, based on those listed by NOAA. Areas which exceeded most metal limits were Basins D, E, F, Oxford Lagoon, and most of the main channel.

Three heavy metals in Marina del Rey sediments fell within the range of values measured in Los Angeles Harbor sediments, but values of arsenic, copper, mercury, lead, silver, and zinc were between two to six times higher. Marina del Rey Harbor 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. The exception is tributyl tin which has declined by two orders of magnitude since 1988. Tributyl tin, which is present in many boat hull paints, 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). This level is much lower than those found in Marina del Rey sediments. Although not listed by NOAA as toxic, boat paints containing this compound have been recently banned from use in Marina del Rey Harbor.

Nonspecific organic materials (nutrients, oil and grease, carbonaceous organics, etc.) are not usually considered toxic, however, elevated levels 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. Within the Harbor, the patterns of organic compounds tended to follow those of heavy metals, i.e. organics were elevated throughout most of the channel and the uppermost areas of the Harbor and were low immediately inside the breakwall. Both Oxford Lagoon and Ballona Creek may contribute some oil and grease and perhaps ortho phosphate to the Harbor, since levels were somewhat higher in these areas. Although impossible to distinguish from municipal discharges, various seepages from boats and other nonpoint runoff undoubtedly contribute considerable amounts of organics to the benthos. Among the 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 discussed in last year's report (Aquatic Bioassay 1997), Harbor sediments which are composed of finer particles, such as silt and clay, also tend to be highest in heavy metals and organics, although the pattern this year was not as clear-cut. Sediments with particle sizes dominated by finer components tend to attract many chemical contaminants more readily. Conversely, sediments containing mostly sand and course silt tended to be lower in organics and heavy metals. The exception appears to be chlorinated hydrocarbons which do not appear to show any relation to particle size.

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.

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 contradiction 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 (109 individuals), Station 9 in Basin F (250 individuals), and at Station 1 near the Harbor entrance (263 individuals). Remaining stations ranged from 303 to 4818 individuals. Relatively higher numbers were collected in the lower channel (Stations 2, 3, 4, and 25 - 1032 to 2056 individuals). Highest values by far were at Station 12 in Ballona Creek (4818 individuals). The great majority of these (80%) were nematodes which are typically found in areas of environmental disturbance or freshwater influence (Soule et al. 1996). Similarly, nematodes and oligochaetes accounted for 56% of the animals at Station 2 and 25% of the animals at Station 3. Nematodes and oligochaetes were virtually absent from all remaining stations (0% to 2%).

Infaunal abundance patterns compared with past years. Table 6-2 lists abundance ranges per station since 1976. The range of individuals collected during 1997 was 109 to 4818, which falls well within the overall range of values for past surveys. Values this survey were lower than those of last year but similar to the year before. Abundances have varied widely over the years.

Infaunal abundance values compared with other surveys. The Marina del Rey abundance average (1102 individuals) and range (109 to 4818 individuals) were much higher than in Los Angeles Harbor (105 individuals, 5 to 330 individuals) but were closer to the 1979 (422 species, 91 to 1213 individuals), and the 1987 (348 individuals) SCCWRP Reference Site Surveys (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]	263	1032	2056	1205	503	432	1018	354	250	109	303	4818	1986
No. Species	46	55	88	62	35	28	38	22	21	20	25	47	53
Diversity (SWI)	2.80	2.32	2.81	2.45	2.69	1.95	2.29	2.33	2.30	2.35	2.11	0.98	2.27
Dominance	0.60	0.44	0.56	0.48	0.70	0.39	0.54	0.59	0.58	0.63	0.45	0.13	0.49
Infaunal Index	62.3	29.6	59.0	71.3	76.5	62.0	72.1	62.2	69.4	63.5	77.1	64.4	63.9

[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
Oct-96	216 - 12,640	28 - 78	0.92 - 3.03
Overall Range	**36 - 105,390**	**9 - 121**	**0.44 - 3.09**
Oct-97	109 - 4818	20 - 88	0.98 - 2.81

[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	**1102**	**109 - 4814**	105	5 - 330	422	91- 1213	348
No. Species	**42**	**20 - 88**	35	5 - 64	72	32 - 135	68
Diversity (SWI)	**2.28**	**0.98 - 2.81**	2.92	1.59 - 3.72	3.12	2.19 - 3.98	–
Infaunal Index	**64.1**	**29.6 - 77.1**	73.6	66.7 - 83.3	87.9	59.9 - 98.3	–

Infaunal diversity values compared with other surveys. The Marina del Rey diversity average (2.28) and range (0.98 to 2.81) 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. The lowest dominance value by far was at Ballona Creek (Station 12 - 0.13) and was due to the extremely high proportion of nematodes here. The highest value was in the upper channel (Stations 5 - 0.70). The remaining stations ranged from 0.39 to 0.63.

Infaunal dominance patterns compared with past years. The dominance average (0.51) and range (0.13 to 0.70) were very similar to those of 1996 (0.12, 0.12 to 0.71). Dominance indices had not been calculated previous to 1996.

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 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 (e.g. near major ocean outfalls). SCCWRP has also provided definitions for 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". The infaunal trophic index is based on a 60-meter depth profile of open ocean coastline in southern California. Therefore, its results should be interpreted with some caution when applied to harbor stations. Also note that nematode worms, which are indicative of disturbed sediment environments (see Section 6.1, above), are not included in the infaunal trophic index. This may be because the index is based on a sieve size four times as large as that used in this survey and nematodes probably pass through. Nematodes may also be less common in the open ocean.

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

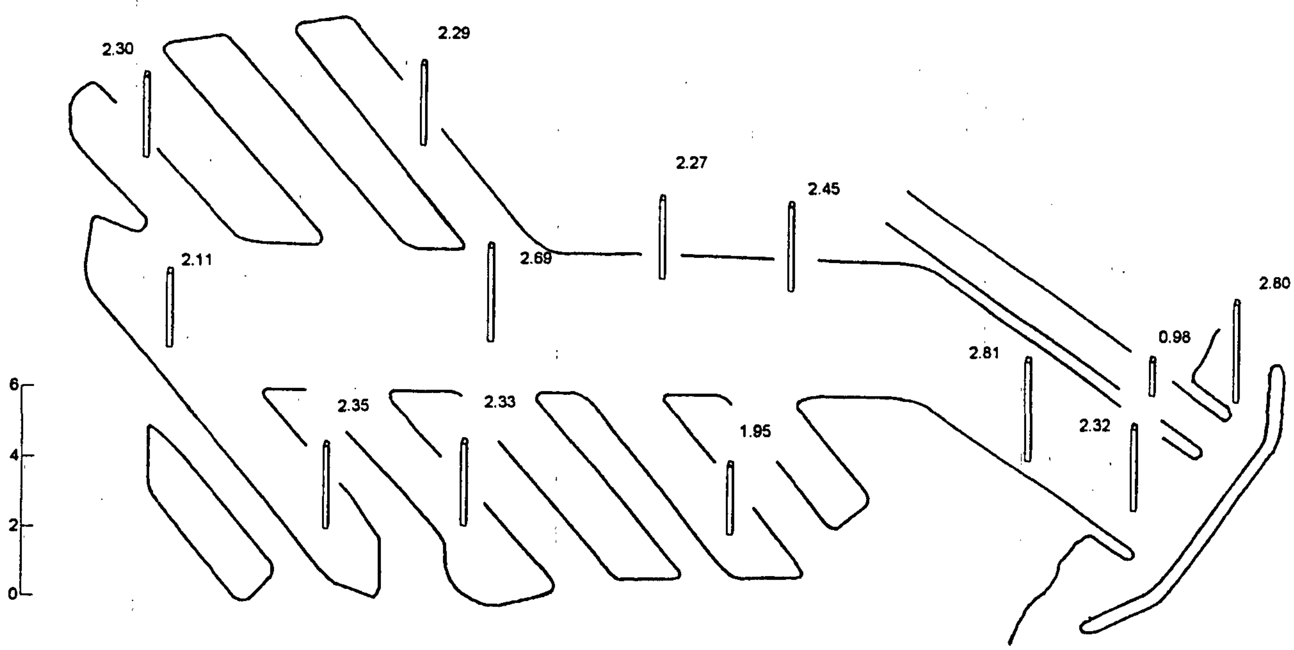
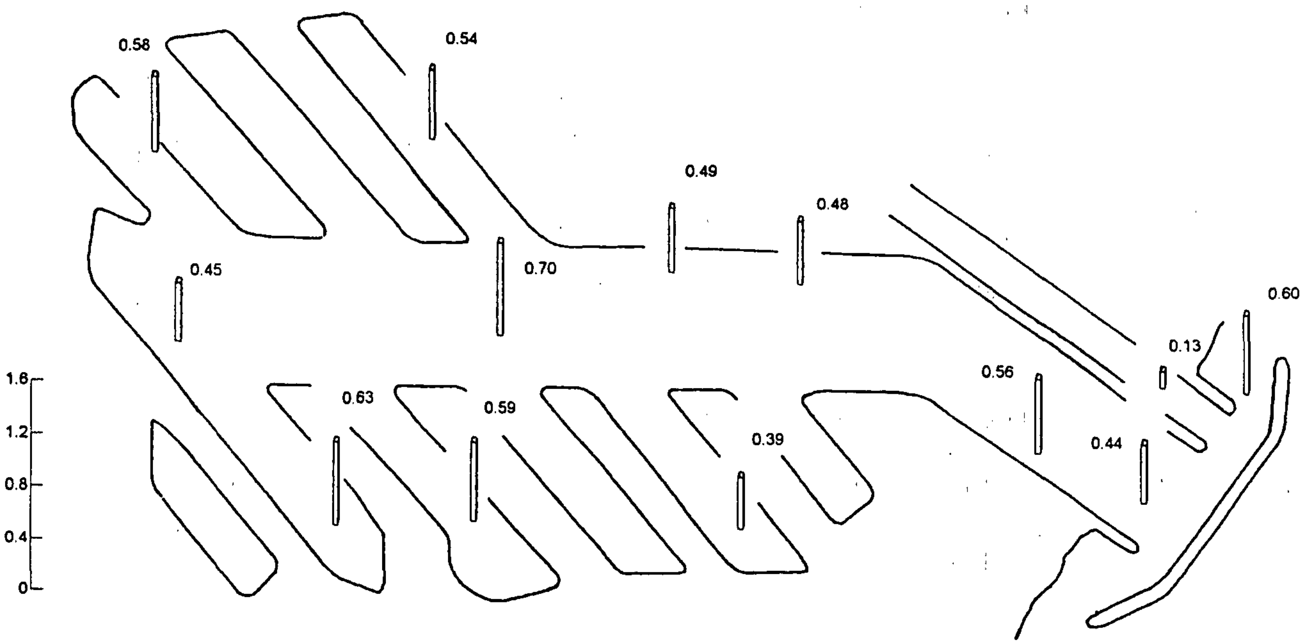


FIGURE 6-4. DOMINANCE INDEX (MODIFIED CDI) AT 13 BENTHIC SEDIMENT STATIONS.



Spatial infaunal trophic index patterns. Infaunal trophic index values at the 13 sampling stations are listed in Table 6-1 and summarized in Figure 6-5. The lowest infaunal index value (30) was at Station 2 in the lower main channel and is defined by the index as "degraded". Station 3, also in the lower channel, yielded an infaunal index value (59) which classified it as "changed". All remaining stations had index values (62 to 77) defined as "normal". The highest value was at Stations 11 at the upper end of the main channel and Station 5 in midchannel (both 77).

Infaunal trophic index patterns compared with past years. The infaunal index average (64.1) and range (30 to 77) were higher than those of last year (60.0, 27 to 71). No infaunal trophic index values were calculated previous to 1996.

Infaunal trophic index values compared with other surveys. The Marina del Rey infaunal index average and range (64.1, 30 to 77) 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

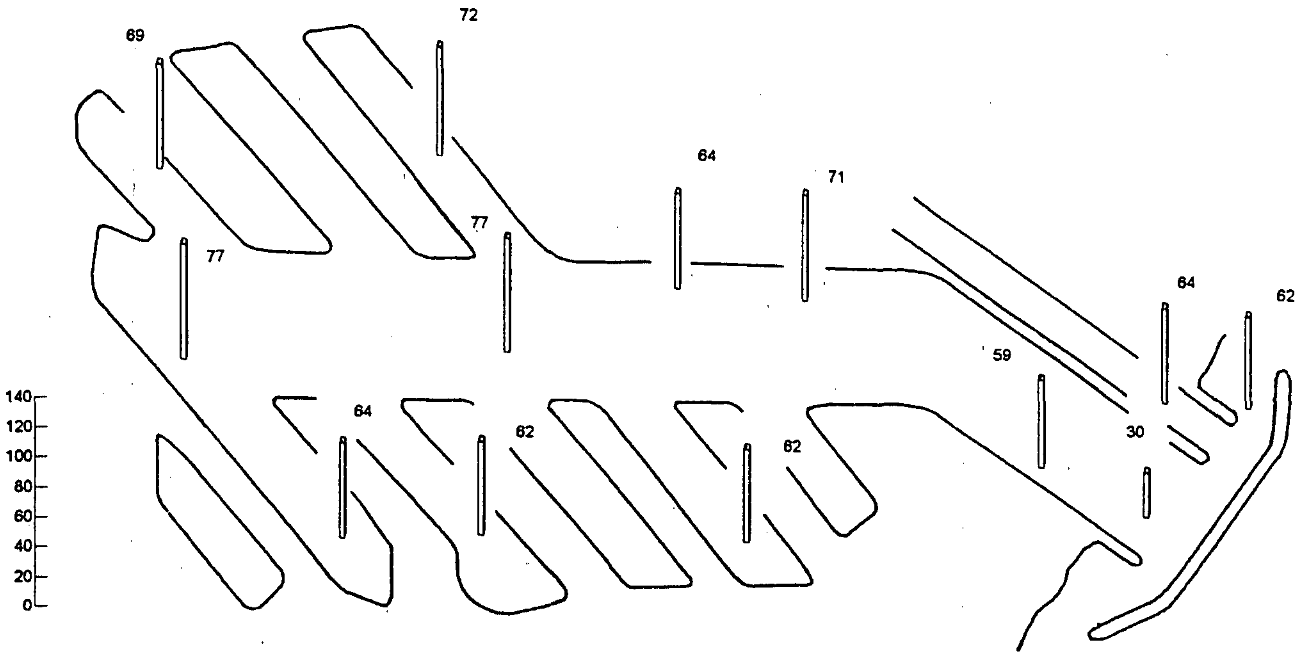
Stations were clustered by their similarities to the infaunal characteristics listed in Table 6-1. The method used is described above for water quality (Section 3.3.3). Station groupings were resolved based upon their similarity or dissimilarity to infaunal population variables (Figure 6-6). Included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

Station 11. This station is located at the upper end of the main channel. It is characterized by relatively low abundance, species, diversity, and dominance but high infaunal index values. Among the ten most abundant species, eight were polychaete worms, one was a crustacean, and one was a phoronid worm. Only one of the eight polychaete worm species (*Dorvillea longicornis*) was a subsurface deposit feeder (indicative of organic contamination), thus the infaunal index value (77) was high and "normal".

Stations 8, 9, and 10. This cluster includes the upper channels of Basins D, E, and F. This group was high in dominance, low in abundance and species counts, and moderate in all others. Of the ten most abundant species, nine were polychaetes and one was an oligochaete. The oligochaete and one of the polychaete species (*Dorvillea*) were surface deposit feeders, therefore, the infaunal index values were moderate (62 to 69) and "normal".

Stations 4, 7, and 25. These stations represent Basin H and part of the middle channel. They are characterized by high abundance and species counts and moderate values of all other indices. Of the ten most abundant species, nine were polychaetes and one was a crustacean. No surface or subsurface deposit feeders were among the most frequent ten species, and so the infaunal trophic index values at these stations were moderate to high (64 to 72) and "normal". This group represents a relatively healthy benthic environment.

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



Station 6. This station is located in Basin B. It is characterized by low diversity, dominance, and infaunal index values and moderate averages for all other indices. Of the ten most abundant species, seven were polychaetes, two were crustaceans, and one was a phoronid worm. One subsurface deposit feeder (*Dorvillea*) was present among most abundant species, and the infaunal trophic index value was moderate and "normal" (62).

Stations 1 and 5. These stations include one at midchannel and one at the entrance to the Harbor. They are characterized by high diversity and dominance and values moderate for all other indices. Six of the ten most abundant species were polychaetes, two were crustaceans, and one each a nemertean and a phoronid worm. No surface or subsurface deposit feeders were among the most frequent ten species, so the infaunal trophic index values at these stations were moderate to high (62 to 77) and "normal". This group represents a relatively healthy benthic environment.

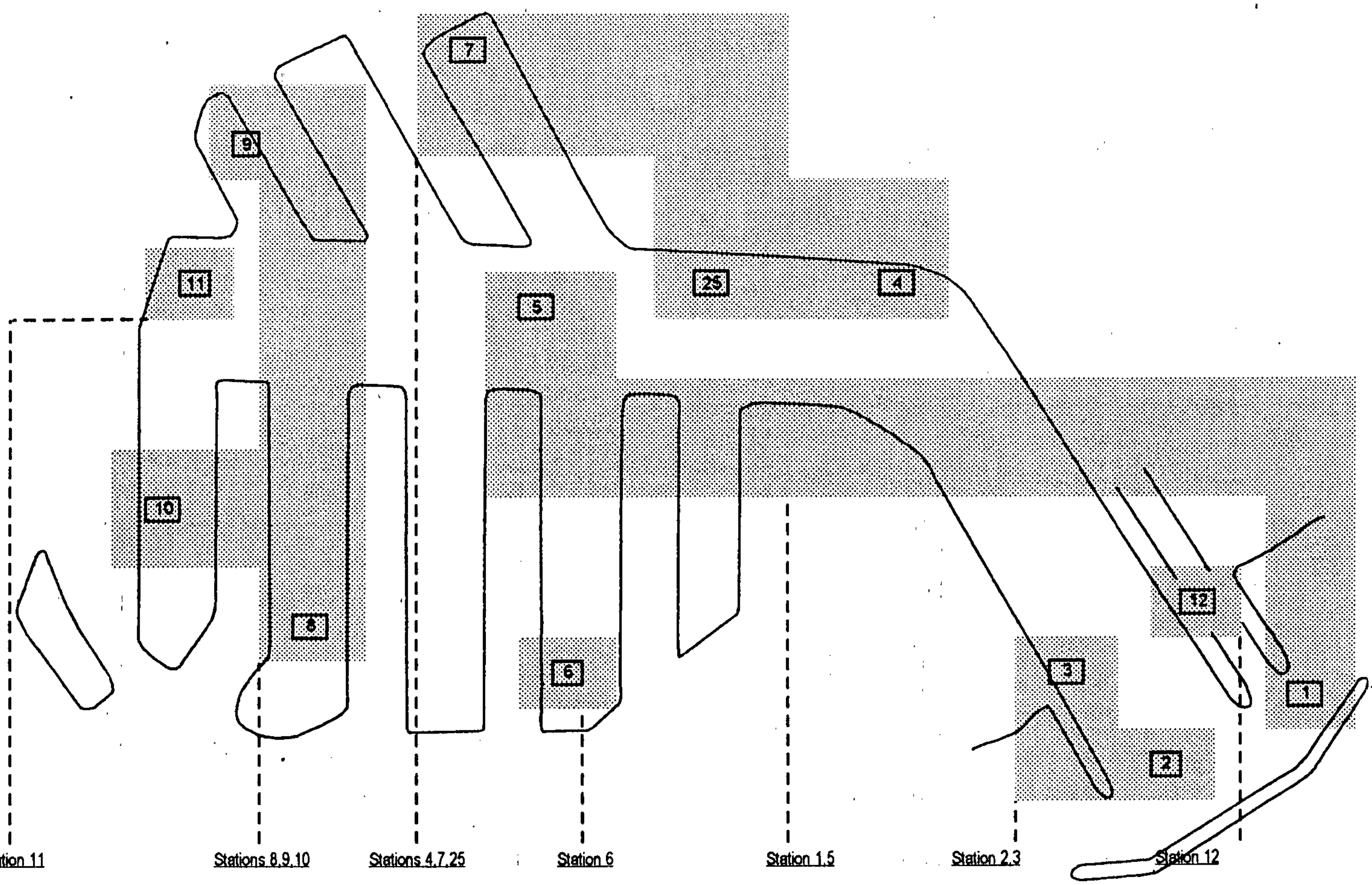
Stations 2 and 3. These stations are near the lower end of the main channel. They are characterized by high abundance, species, and diversity but low infaunal trophic index values. Six of the ten most abundant species were polychaetes, two were bivalves, one was a nematode, and one was an oligochaete. Among the ten most common species, two subsurface deposit feeders (*Dorvillea* and an oligochaete) as well as nematodes were present in relative abundance. The infaunal trophic index values (30 and 59, respectively) were relatively low and defined as "degraded" and "changed" (respectively).

Station 12. This station is located within Ballona Creek. It is characterized by very high abundance (80% of which are nematode worms), low diversity and dominance, and moderate values for all other indices. Of the ten most abundant species, five were polychaetes, two were bivalves, one was a crustaceans, and one was a nematode. No surface or subsurface deposit feeders were present among most abundant species, and the infaunal trophic index value was moderate and "normal" (64).

6.4. DISCUSSION

Similar to last year, the infaunal community appears to be impacted most by proximity to Harbor entrance, Ballona Creek, or Oxford Lagoon. In general, stations in the middle of the channel (4, 5, and 25) appear to have benthic environments that show little or no ecological stress. These stations were either moderate or high in all of the indices utilized in this study. The sediments at these stations appear to also be most similar to those of the open ocean.

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



Station 11

High in:
Infaunal Index

Low in:
Individuals
Species
Diversity
Dominance

Dominants:
Aphelocheaeta multifilis (p)
Phronis sp. (ph)
Mediomastis californiensis (p)
Mediomastis spp. (p)
Cirriformia sp. 1 (p)
Leitoscoloplos pugettensis (p)
Euchone limnicola (p)
Mayerella banksia (c)
Neanthes acuminata (p)
Dorvillea longicornis (p)*

Characteristics:
Low in all indices except infaunal index.

Stations 8,9,10

High in:
Dominance

Low in:
Individuals
Species

Dominants:
Aphelocheaeta multifilis (p)
Mediomastis spp. (p)
Lumbrineris erectis (p)
Euchone limnicola (p)
Leitoscoloplos pugettensis (p)
Dorvillea longicornis (p)*
Lumbrineris sp. (p)
Oligochaeta unid. (o)*
Prionospio lighti (p)
Streblospio benedicti (p)

Characteristics:
High in dominance but low in species and individuals.

Stations 4,7,25

High in:
Individuals
Species

Low in:
—

Dominants:
Mediomastis spp. (p)
Aphelocheaeta multifilis (p)
Pseudopolydora paucibranchiata (p)
Mediomastis californiensis (p)
Exogone sp. A (p)
Euchone limnicola (p)
Prionospio heterobranchiata (p)
Lumbrineris sp. C (Harris) (p)
Leitoscoloplos pugettensis (p)
Mayerella banksia (c)

Characteristics:
Moderately health group.

Station 6

High in:
—

Low in:
Diversity
Dominance
Infaunal Index

Dominants:
Aphelocheaeta multifilis (p)
Dorvillea longicornis (p)*
Mayerella banksia (c)
Leitoscoloplos pugettensis (p)
Mediomastis californiensis (p)
Mediomastis spp. (p)
Phronis sp. (ph)
Scoloplos acmeceps (p)
Cirriformia sp. 1 (p)
Grandideirella japonica (c)

Characteristics:
Low in many population indices.

Station 1,5

High in:
Diversity
Dominance

Low in:
—

Dominants:
Aphelocheaeta multifilis (p)
Mediomastis spp. (p)
Euchone limnicola (p)
Pseudopolydora paucibranchiata (p)
Prionospio heterobranchiata (p)
Carinoma mutabilis (ne)
Phronis sp. (ph)
Leitoscoloplos pugettensis (p)
Mayerella banksia (c)
Zeuxo normani (c)

Characteristics:
Relatively healthy group.

Station 2,3

High in:
Individuals
Species
Diversity

Low in:
Infaunal Index

Dominants:
Nematoda unid. (n)*
Oligochaeta unid. (o)*
Prionospio heterobranchiata (p)
Mediomastis spp. (p)
Exogone sp. A (p)
Tagelus subteres (b)
Neanthes acuminata (p)
Lumbrineris sp. (p)
Dorvillea longicornis (p)*
Laevicardium substriatum (b)

Characteristics:
High in many indices but many nematodes and oligochaetes.

Station 12

High in:
Individuals

Low in:
Diversity
Dominance

Dominants:
Nematoda unid. (n)*
Mediomastis spp. (p)
Tellina carpinteri (b)
Notomastus hemipodus (p)
Prionospio heterobranchiata (p)
Mediomastis californiensis (p)
Tagelus subteres (b)
Cyclpoidea unid. (c)
Pseudopolydora paucibranchiata (p)
Leporimetis obesa (b)

Characteristics:
Dominated by thousands of nematodes. Indicates considerable stress.

(p) = polychaete worm, (o) = oligochaete worm, (n) = nematode worm, (c) = crustacean, (b) = bivalve, (ph) = phoronid worm, (ne) = nemertean worm
* Infaunal species known to be associated with disturbed benthos.

Conversely, stations which were lowest in at least one variable included Station 10 in Basin E, Station 12 in Ballona Creek, and Station 2 just inside the Harbor entrance which is likely influenced by the discharge from Ballona Creek. All 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. These stations tended to show the greatest evidence of stress in the Harbor. Of particular note is Station 12 which was dominated by huge numbers of nematode worms. Nematodes greatly overwhelmed population numbers at this station (80%). The rest of the benthic stations, which included the upper end of the main channel (11), the remaining basins (6, 7, 8, and 9), the lower channel (3), and Harbor entrance (1), had population values which showed mixed results.

When compared to measurements made during reference site surveys performed by the Southern California Coastal Water Research Project (SCCWRP), numbers of species and values of diversity and infaunal trophic index tended to be lower, while numbers of individuals tended to be higher. This is not surprising 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 only one as in Marina del Rey.

Unlike last year, infaunal variables did not relate strongly to any particular contaminant, group of contaminants, or grain size, except that Stations both near the Harbor entrance and in Basin E tended to have higher dissolved or suspended organic loads. Also unlike last year, Station 1 just inside the breakwall did not show any strong evidence of infaunal stress and appeared to be much less under the influence of Ballona Creek. It is possible that the exceptionally heavy storms this year may have kept Ballona Creek contaminants from accumulating at Station 1. Overall, population variables tended to be comparable to past survey years.

7. FISH POPULATIONS

7.1. BACKGROUND

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

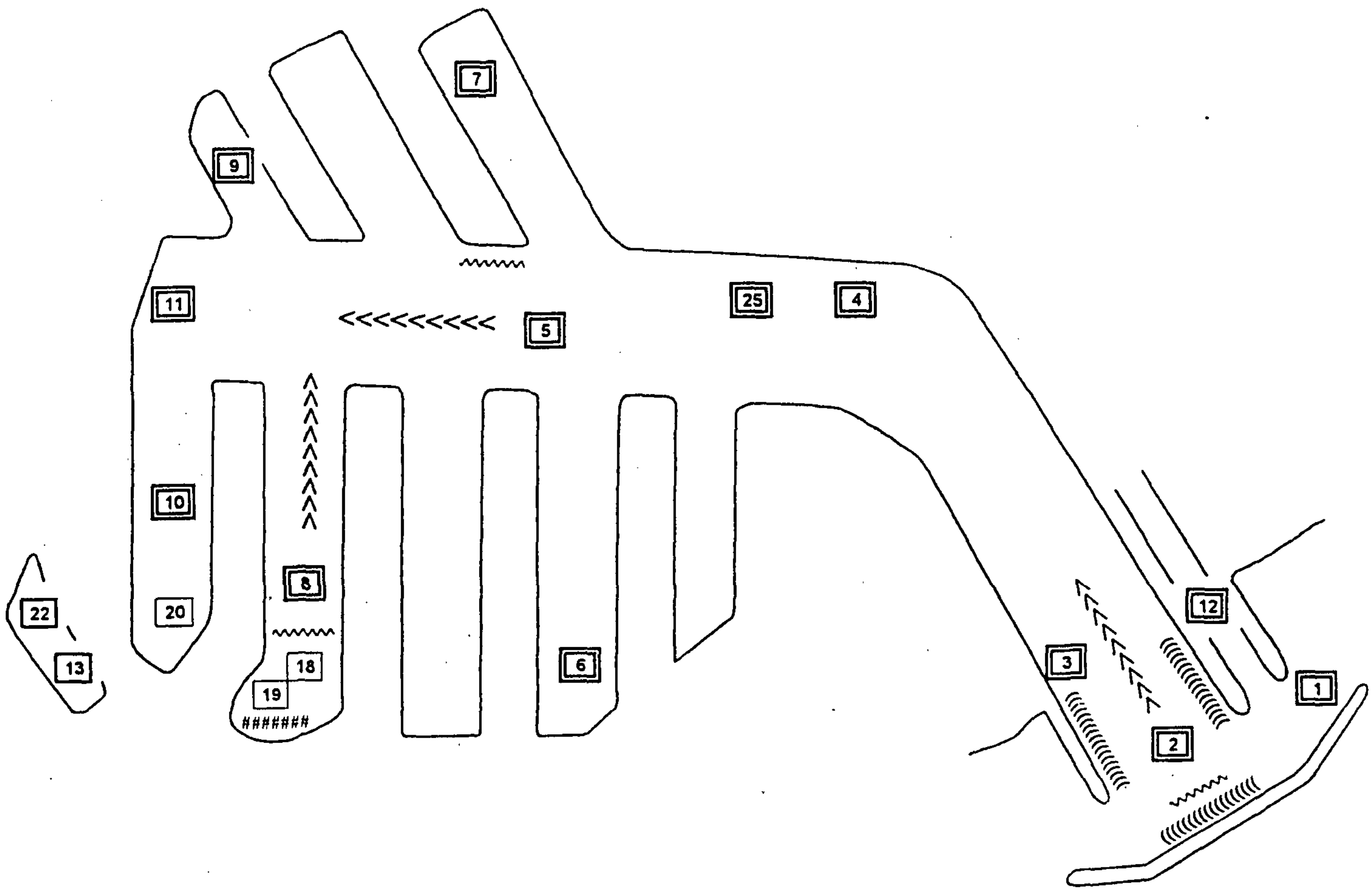
Marina del Rey functions as an important small wetlands in a southern California area where about ninety percent of the wetlands have been lost due to development. While the original configuration of the Ballona wetlands was a large natural estuarine system, it was altered radically by the channelization 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. Since 1996, the surveys have been conducted by Aquatic Bioassay in Ventura, California.

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. 100-meter 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 9.4 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 106 different species, six were present in all of the 28 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 22 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*), California halibut (*Paralichthys californicus*), spotted turbot (*Pleuronichthys ritteri*), 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. <u>Bottom Fish</u>

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**

<u>Spatial bottom fish abundance patterns.</u> Numbers of bottom fish collected at the three sampling stations are listed in Table 7-2. The largest haul was in the spring at Station 2 near the breakwall (147 individuals). The poorest catch was at the same station in the fall (13 individuals). Abundance at Station 2 near the breakwall was also relatively low in the fall (15). Averaged among stations, counts in the spring (64 individuals) were larger than those in the fall (46).

TABLE 7-1. INCIDENCE OF FISH SPECIES AND LARVAL TAXA COLLECTED DURING SPRING (Sp) AND FALL (Fl) IN MARINA DEL REY HARBOR - 1984 TO 1998

SCIENTIFIC NAME	COMMON NAME	84 Sp	84 Fl	85 Sp	85 Fl	86 Sp	86 Fl	87 Sp	87 Fl	88 Sp	88 Fl	89 Sp	89 Fl	90 Sp	90 Fl	91 Sp	91 Fl	92* Sp	92* Fl	93 Sp	93 Fl	94 Sp	94 Fl	95 Sp	95 Fl	96 Sp	96 Fl	97 Sp	97 Fl	Sp	All Sp	All Fl	To
Acanthogobius flavimanus	Yellowfin Goby						x		x	x	x	x								x	x	x				x		x	x		6	5	[redacted]
Albula vulpes	Bonefish	x								x								x	x		x								x	x	4	3	7
Anchoa compressa	Deepbody Anchovy	x			x	x		x			x									x		x		x	x	x	x	x	x	x	9	5	14
Anchoa delicatissima	Slough Anchovy								x																		x	x		x	2	2	[redacted]
Anchoa sp.	Anchovy																											x			1	0	[redacted]
Anisotremus davidsoni	Sargo	x	x		x	x	x	x				x	x		x		x	x		x	x	x	x	x		x	x	x	x	x	11	10	21
Atherinidae	Silverside																													x	1	0	1
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	x	x	14	14	[redacted]
Atherinopsis californiensis	Jacksmelt					x	x	x	x			x										x	x			x	x	x		x	7	4	[redacted]
Atractoscion nobilis	White Seabass	x				x	x	x									x												x		3	3	6
Brachyistius frenatus	Kelp Surfperch																	x													1	0	[redacted]
Bryx arctus	Snubnose Pipefish																										x				0	1	[redacted]
Cheilotrema saturnum	Black Croaker		x		x	x	x	x	x	x	x	x	x	x		x	x		x				x			x			x		7	10	[redacted]
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	x		10	13	[redacted]
Citharichthys stigmaeus	Speckled Sandab	x						x					x												x	x	x	x	x		4	4	[redacted]
Citharichthys Type A	Sandab Larvae	x						x														x		x		x	x	x			6	1	[redacted]
Clevlandia ios	Arrow Goby	x				x	x	x		x			x		x									x		x		x	x	x	8	4	12
Clinocottus analis	Wooly Sculpin	x			x		x			x	x	x				x							x								4	4	[redacted]
Coryphopterus nichosii	Blackeye Goby							x				x								x											3	0	[redacted]
Cymatogaster aggregata	Shiner Surfperch		x			x		x				x	x	x	x	x		x	x	x		x		x		x		x		x	12	4	[redacted]
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				x	12	11	23
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	x	x	14	14	[redacted]
Engraulidae	Anchovy																										x	x			1	1	[redacted]
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	x	x	14	11	[redacted]
Fundulus parvipinnis	California Killifish	x	x		x		x	x		x	x		x	x	x	x	x			x	x		x	x		x	x	x	x	x	10	11	21
Genyonemus lineatus	White Croaker	x			x	x		x	x		x	x		x		x	x			x		x		x		x	x	x	x	x	12	6	[redacted]
Gibbonsia elegans	Spotted Kelpfish	x			x		x		x			x	x	x	x	x	x		x			x	x		x	x					6	9	[redacted]
Gillichthys mirabilis	Longjaw Mudsucker						x									x			x			x								x	3	2	5
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	x	x	14	14	28
Gobiesox rhessodon	California Clingfish				x	x		x				x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	12	7	[redacted]
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	x	x	10	14	[redacted]
Gobiedae non A/C	Goby																						x								0	1	1
Halichoeres 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	x	x	13	13	26
Hermosilla azurea	Zebraperch		x		x		x				x	x			x			x		x	x	x	x			x	x	x	x	x	7	9	[redacted]
Heterodontus francisci	Horn Shark	x	x									x		x		x															4	1	[redacted]
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	x		12	11	23
Hippoglossina stomata	Bigmouth Sole					x													x												1	1	2
Hyperprosopon argenteum	Walleye Surfperch		x			x											x														1	2	[redacted]
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	x	x	14	14	[redacted]
Hypsoblennius gentilis	Bay Blenny				x	x	x		x																						1	3	4
Hypsoblennius gilberti	Rockpool Blenny						x														x								x		0	3	3
Hypsoblennius jenkinsi	Mussel Blenny	x	x					x		x		x									x		x				x				4	4	[redacted]
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	x	x	12	12	[redacted]
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	x	x	13	12	25
Ilypnus gilberti	Cheekspot Goby	x	x			x	x	x		x				x	x	x												x			7	3	[redacted]
Kyphosidae	Zebraperch																						x								0	1	[redacted]
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		x	2	0	[redacted]
Medialuna californiensis	Halfmoon								x																				x	x	1	2	[redacted]
Menticirrhus undulatus	California Corbina					x	x		x	x		x				x						x		x				x		x	8	2	10
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	x		12	12	24
Mugil cephalis	Striped Mullet	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x			x	x		x				x	x	8	12	[redacted]
Mustelus californicus	Gray Smoothound																x	x							x						1	2	[redacted]
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	x	x	11	9	[redacted]
Oligocottus/Clinocottus A	Sculpin												x				x														0	2	[redacted]
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	x	x	12	13	25
Oxylebius pictus	Painted Greenling				x									x																	1	1	[redacted]
Paraclinus integripinnis	Reef Finspot						x					x		x	x							x	x	x		x	x	x	x		6	5	[redacted]
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	x	x	14	14	[redacted]
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	x	x	14	14	[redacted]

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	x	x	12	14	26
Perciformes	Perch																									x					0	1	1
Phanerodon furcatus	White Surfperch					x			x		x	x		x		x	x			x			x			x		x		x	8	4	12
Pleuronectidae**	Flatfish																				x		x			x		x	x		2	3	5
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	x	x	12	11	23
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	x		8	3	11
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						x		9	8	17
Scaenidae complex 2	Croaker							x			x			x														x			3	1	4
Scomberomorus sierra	Pacific Sierra																													x	1	0	1
Scorpaena guttata	Spotted Scorpionfish					x						x						x			x	x								x	5	1	6
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			x	13	9	22
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		x		8	9	17
Symphurus atricauda	California Tonguefish		x																								x		x		0	3	3
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	x	x	2	1	3
Type 71	Fish Larvae																												x	x	1	1	2
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		x	9	8	17
Unidentified egg	Unidentified Egg																										x	x	x	x	2	2	4
Unidentified larvae	Unidentifed Larvae																											x			1	0	1
Urolophus halleri	Round Stingray	x					x	x		x		x				x	x	x		x				x		x		x		x	11	2	13
Xenistius californiensis	Salema		x						x				x		x						x		x				x		x		0	8	8
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* - 5 individuals) and white croaker (*Genyonemus lineatus* - 40 individuals) in the spring. At Station 5 in the main channel, northern anchovy (*Engraulis mordax* - 16 individuals) was most common, and in the spring, barred sandbass (*Paralabrax nebulifer* - 9 individuals). At Station 8 in Basin D, both seasons were dominated by deepbody anchovy (*Anchoa compressa* - 55 in the fall and 8 in the spring).

Bottom fish abundance patterns compared with past years. Table 7-6 lists the ranges in numbers of bottom fish collected per station since October 1991. Fish collected during October 1997 ranged from 13 to 69 per station, which fell well within the overall range of values for past fall surveys. Spring counts ranged between 20 and 147 and were higher than for any previous spring survey.

7.3.1.2. **Bottom Fish Species**

Spatial bottom fish species patterns. 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 May (13 species). The lowest species count was at the same station during the fall (4 species). Averaged among stations, species counts in the spring (9 species) were larger than those in the fall (6).

Bottom fish species patterns compared with past years. Table 7-6 lists the ranges of species of bottom fish collected per station since October 1991. Bottom fish collected during October of 1997 ranged from 4 to 9 species per station, which is relatively high. The spring range of species counts (6 to 13) was higher than any previous spring survey. New trawl fish this year were white seabass (*Atractoscion nobilis*) and Pacific sardine (*Sardinops sagax caeruleus*).

7.3.1.3. **Bottom Fish Diversity**

Spatial bottom fish diversity patterns. 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 May (2.01). Lowest diversity was in October at Station 8 in Basin D (0.80). Averaged among stations, diversity in the spring (1.75) was higher than in the fall (1.29).

Bottom fish diversity patterns compared with past years. The range of the species diversity values this year (0.80 to 1.27 in the fall, and 1.51 to 2.01 in the spring) were somewhat similar to last year (0.64 to 2.15 in the fall, and 1.48 to 1.91 in the spring). Species diversity calculations had not been performed previous to 1996.

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

SCIENTIFIC NAME	COMMON NAME	OCTOBER 1997 SAMPLING STATIONS 2	5	8	MAY 1998 SAMPLING STATIONS 2	5	8
Bottom Fish							
Anchoa compressa	Deepbody Anchovy		2	55		2	8
Anisotremus davidsonii	Sargo			3			
Acanthogobius flavimanus	Yellowfin Goby		2				
Atractoscion nobilis	White Seabass		9				
Cymatogaster aggregata	Shiner Surfperch				9	1	
Engraulis mordax	Northern Anchovy		16		15		
Genyonemus lineatus	White Croaker		12		40	6	
Heterostichus rostratus	Giant Kelpfish	3					
Hypsopsetta guttulata	Diamond Turbot		2	4	1		4
Menticirrhus undulatus	California Corbina						1
Myliobatus californica	Bat Ray			5	4	1	
Paralabrax clathratus	Kelp Bass				19		
Paralabrax nebulifer	Barred Sand Bass	4	1		33	9	1
Paralichthys californicus	California Halibut	5	1	1	17	5	3
Phanerodon furcatus	White Surfperch				2		
Pleuronichthys ritteri	Spotted Turbot	1		1	2		
Scorpaena guttata	California Scorpionfish				2		
Sardinops sagax	Pacific Sardine		10				
Seriphus politus	Queenfish				2		1
Umbrina roncador	Yellowfin Croaker						1
Urolophus halleri	Round Stingray				1		1
	Individuals	**13**	**55**	**69**	**147**	**24**	**20**
	Species	**4**	**9**	**6**	**13**	**6**	**8**
	Diversity	**1.27**	**1.80**	**0.80**	**2.01**	**1.51**	**1.72**
Midwater Fish							
Atherinops affinis	Topsmelt						17
Atractoscion nobilis	White Seabass			1			
Genyonemus lineatus	White Croaker				1		
Parlabrax nebulifer	Barred Sand Bass		1				
Sardinops sagax	Pacific Sardine		1				
Scomberomorus sierra	Pacific Sierra						1
Umbrina roncador	Yellowfin Croaker				2		
	Individuals	**0**	**2**	**1**	**3**	**0**	**18**
	Species	**0**	**2**	**1**	**2**	**0**	**2**
	Diversity	**0.00**	**0.69**	**0.00**	**0.64**	**0.00**	**0.21**

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

SCIENTIFIC NAME	COMMON NAME	OCTOBER 1997 SAMPLING STATIONS North Jetty	Breakwall	South Jetty	MAY 1998 SAMPLING STATIONS North Jetty	Breakwall	South Jetty
Reef Species							
Anisotremus davidsonii	Sargo		3				2
Atherinops affinis	Topsmelt		1050	203			
Cheilotrema saturnum	Black Croaker		14				
Chromis punctipinnis	Blacksmith		1051				
Damalichthys vacca	Pile Surfperch					3	
Embiotoca jacksoni	Black Surfperch	1	14	8		12	3
Girella nigricans	Opaleye	60	70	8	6	53	38
Halichoeres semicinctus	Rock Wrasse		13	3		34	1
Hermosilla azurea	Zebraperch	4	3		18	2	
Heterostichus rostratus	Giant Kelpfish		1	1			
Hypsoblennius gilberti	Rockpool Blenny	3					
Hypsopsetta guttulata	Diamond Turbot						1
Hypsypops rubicundus	Garibaldi		14	4		7	
Medialuna californiensis	Halfmoon		3			6	
Micrometrus minimus	Dwarf Surfperch	1					
Oxyjulis californica	Senorita		1	1		7	
Osteichthys	Unk. juv. fish (yellow)	1					
Paralabrax clathratus	Kelp Bass		10	5		16	16
Paralabrax nebulifer	Barred Sand Bass		30	29		10	8
Xenistius californiensis	Salema	95	43	5091			
	Individuals	**165**	**2320**	**5353**	**24**	**150**	**69**
	Species	**7**	**15**	**10**	**2**	**10**	**7**
	Diversity	**0.94**	**1.13**	**0.24**	**0.56**	**1.88**	**1.28**

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 most fish were captured at Station 8 in Basin D in May (18 individuals). All remaining catches were poor (0 to 2 individuals per cast). Averaged among stations, counts in May (7 individuals) were larger than in October (1).

At Station 2 near the breakwall, no fish were collected in fall, and one white croaker (*Genyonemus lineatus*) and two yellowfin croaker (*Umbrina roncador*) were collected in spring. At Station 5 in the main channel, one barred sandbass (*Paralabrax nebulifer*) and one Pacific sardine (*Sardinops sagax*) were collected in fall, and no fish were collected in spring. At Station 8 in Basin D, one white seabass (*Atractoscion nobilis*) was collected in the fall, and 17 topsmelt (*Atherinops affinis*) and one Pacific sierra (*Scomberomorus sierra*) were 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 1997 ranged from 0 to 2 individuals per station, which is generally lower than any previous fall survey. The spring range of individuals (0 to 18) was higher and more typical.

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. All species counts for both seasons were poor (0 to 2 species). Average species counts were poor (about 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 1997 ranged from 0 to 2 species per station for both seasons, which is typical of past surveys. As of fall of 1991, four new fish species were captured this year: white croaker (*Genyonemus lineatus*), barred sandbass (*Paralabrax nebulifer*), Pacific sierra (*Scomberomorus sierra*), and yellowfin croaker (*Umbrina roncador*).

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

		OCT. 1997 SAMPLING STATIONS						MAY 1998 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													
Atherinops californiensis	Jacksmelt							7	155				
Bryx arctus	Snubnose Pipefish												
Engraulis mordax	Northern Anchovy	6											
Genyonemus lineatus	White Croaker												
Gillichthys mirabilis	Longjaw mudsucker							7					
Gobiedae type A/C	Goby	41	2256	48	721	94	968	71		33	2174	32	32
Gobiesox rhessodon	California Clingfish		26								6		
Hypsoblennius sp.	Blenny	18	404	8	1043	637	1037	177	52	189	640	48	8
Hypsopsetta guttulata	Diamond Turbot						6						
Leuresthes tenuis	California Grunion							7	5				
Paraclinus integrippinis	Reef Finspot		7										
	Individuals	**65**	**2693**	**56**	**1764**	**731**	**2011**	**269**	**212**	**222**	**2820**	**80**	**40**
	Species	**3**	**4**	**2**	**2**	**2**	**3**	**5**	**3**	**2**	**3**	**2**	**2**
	Diversity	**0.87**	**0.49**	**0.41**	**0.68**	**0.38**	**0.71**	**0.91**	**0.66**	**0.42**	**0.55**	**0.67**	**0.50**
Fish Eggs													
Anchoa delicatissima	Slough Anchovy							92	10		103		8
Atherinidae	Silverside								10	156	12		24
Citharichthys sp.	Sandab	53	72	8	12								
Engraulis mordax	Northern Anchovy	12	7										
Paralichthys californicus	California Halibut	6											
Pleuronichthys ritteri	Spotted Turbot		7										
Pleuronichthys sp.	Turbot	6											
Symphuris atricauda	California Tonguefish		26										
Type 32	—	23	39						1158				
Type 71	—	6						438					
Unidentified	Unidentified	439	124	112	167	31		219	140	99	66	16	
	Individuals	**545**	**275**	**120**	**179**	**31**	**0**	**749**	**1318**	**255**	**181**	**16**	**32**
	Species	**7**	**6**	**2**	**2**	**1**	**0**	**3**	**4**	**2**	**3**	**1**	**2**
	Diversity	**0.77**	**1.40**	**0.24**	**0.25**	**0.00**	**0.00**	**0.93**	**0.43**	**0.67**	**0.87**	**0.00**	**0.56**

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

SCIENTIFIC NAME	COMMON NAME	OCTOBER 1997	MAY 1998
Beach Seine Species			
Albula vulpes	Bonefish		1323
Anchoa compressa	Deepbody Anchovy		4
Atherinops affinis	Topsmelt	114	805
Acanthogobius flavimanus	Yellowfin Goby	1	
Clevelandia ios	Arrow Goby	3	1
Fundulus parvipinnis	California Killifish	523	1
Hypsopsetta guttulata	Diamond Turbot		5
Menticirrhus undulatus	California Corbina		3
Mugil cephalus	Striped Mullet	2	2
Paralichthys californicus	California Halibut	1	
Quietula y-cauda	Shadow Goby	1	
Strongylura exilis	California Needlefish	1	
Umbrina roncador	Yellowfin Croaker		1
	Individuals	**646**	**2145**
	Species	**8**	**9**
	Diversity	**0.560**	**0.420**

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 5 in the main channel in fall (0.69) and Station 2 in Basin D in spring (0.64). All remaining species diversity measurements were lower (0.00 to 0.21).

Midwater fish diversity patterns compared with past years. The range of the species diversity values this year (0.00 to 0.69 in the fall, and 0.00 to 0.64 in the spring) were similar to last year (0.00 to 0.60). Species diversity calculations had not been performed previous to 1996.

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 spring (2145 individuals) than in the fall (646). May was dominated by bonefish (*Albula vulpes* - 1323 individuals), but California killifish were most common in October (523). Topsmelt (*Atherinops affinis* - 114 in the fall and 805 in the spring) had moderate counts. All other fish counts ranged from 1 to 5 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 and May were 646 and 2145 individuals (respectively) and were typical of past counts.

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. Slightly more species of fish were collected in the spring (9 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 inshore fish collected per station since October 1991. The inshore fish species collected during October and May are typical of past species counts. Relative to counts made since 1991, no new fish were collected this year.

TABLE 7-6. RANGES IN NUMBERS OF ALL INDIVIDUALS AND SPECIES OF FISH JUVENILES AND ADULTS COLLECTED: OCT 1991 - MAY 1998

DATE	BOTTOM FISH Individuals	BOTTOM FISH Species	MIDWATER FISH Individuals	MIDWATER FISH Species	INSHORE FISH Individuals	INSHORE FISH Species	REEF FISH Individuals	REEF FISH 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
Oct-96	3 - 53	2 - 10	0 - 26	0 - 1	1791	8	128 - 1862	9 - 12
Fall Range	**0 - 415**	**0 - 5**	**0 - 77**	**0 - 3**	**213 - 1791**	**4 - 8**	**1 - 1862**	**1 - 19**
Oct-97	13 - 69	4 - 9	0 - 2	0 - 2	646	8	165 - 5353	7 - 15
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
May-97	35 - 69	8 - 9	0 - 6	0 - 3	1066	11	2169 - 7267	5 - 9
Spring Range	**1 - 69**	**1 - 9**	**0 - 63**	**0 - 5**	**351 - 8165**	**6 - 11**	**0 - 7267**	**0 - 16**
May-98	20 - 147	6 - 13	0 - 18	0 - 2	2145	9	24 - 150	2 - 10

TABLE 7-7. RANGES IN NUMBERS OF INDIVIDUALS AND SPECIES OF FISH LARVAE AND EGGS COLLECTED: OCT. 1991 - MAY 1998

DATE	LARVAL FISH Individuals	LARVAL FISH Species	FISH EGGS Individuals	FISH EGGS 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
Oct-96	1193 - 3396	4 - 7	36 - 1052	1 - 5
Fall Range	**309 - 16,143**	**1 - 8**	**14 - 12,252**	**1 - 5**
Oct-97	56 - 2693	2 - 5	0 - 545	0 - 9
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
May-97	1563 - 7897	9 - 15	10,094 - 58,297	4 - 6
Spring Range	**672 - 64,408**	**2 - 15**	**0 - 58,297**	**0 - 6**
May-98	40 - 2820	2 - 5	16 - 1318	1 - 5

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 relatively low and similar (0.560 and 0.420 respectively).

Inshore fish diversity patterns compared with past years. The species diversity values this year (0.560 in the fall, and 0.420 in the spring) were similar to last year (0.423 and 0.422, respectively). Species diversity calculations had not been performed previous to 1996.

7.3.4. Reef Fish

Reef fish were counted by divers during three 100-meter swimming underwater transects: along the middle of the breakwall and along the north and south jetties 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 south jetty in the fall (7267 individuals), followed by the breakwall also in the fall (2320 individuals). The lowest counts were at the north jetty and south jetty in the spring (24 and 69 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 salema (*Xenistius californiensis* - 95 individuals) and opaleye (*Girella nigricans* - 60 individuals). In the spring, zebraperch (*Hermosilla azurea* - 18 individuals) dominated. At the breakwall, topsmelt (1050) and blacksmith (*Chromis punctipinnis* - 1051) were most common and almost identical in numbers. In the spring, the breakwall was dominated by opaleye (53) and rock wrasse (34). During fall, the south jetty was dominated by salema (5091) while topsmelt were common (203). Opaleye were common here in the spring (38) followed by kelpbass (*Paralabrax clathratus* - 16).

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 1997 ranged from 165 to 5353 individuals per station, which is higher than during all recent fall surveys. The spring range of individuals per station (24 to 150) was much lower and more typical.

7.3.4.2. **Reef Fish Species**

Spatial reef fish species patterns. Reef fish species counts at the three dive survey stations are listed in Table 7-3. The greatest numbers were observed at breakwall in October (15 species), and the lowest species count was at the north jetty during the spring (2 species). Averaged among stations, species counts in the fall (11 species) were larger than those in the spring (6).

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 1997 ranged from 7 to 15 species per station, which is typical of past surveys. The spring range of species counts (2 to 10) was also typical. Relative to counts made since 1991, white seabass (*Atractoscion nobilis*), northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), and spotted scorpionfish (*Scorpaena guttata*) were new to this 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 May (1.88). Lowest diversity was at the south jetty in October (0.24). Overall, average diversity in the fall (0.77) was lower than in the spring (1.24).

Reef fish diversity patterns compared with past years. The species diversity values this year were lower this fall (0.24 to 1.13) than last fall (0.57 to 1.93), but this year's spring range (0.56 to 1.88) was higher (0.07 to 0.19). Species diversity calculations had not been performed previous to 1996.

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 (2820 individuals). Poorest catches were at the bottom in Basin D in the spring (40 individuals). Averaged among stations, counts in the spring (1214 individuals) were about half as large as those in the fall (2440). The surface average among stations (474 individuals) was much smaller than the bottom average (3180). 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*) - 2597, 769, and 1062 individuals, respectively) and blennies (*Hypsoblennius spp.* - 422, 1051, and 1674 individuals). In the spring, gobies (71, 2207, and 64) and blennies (229, 829, and 56) were also common at the three sampling stations, but jacksmelt were also important at Station 2 (*Atherinops californiensis* - 162).

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 56 to 2693 individuals per station, which was moderately low. The spring range of individuals per station (40 to 2820) was also low.

7.3.5.2. **Larval Fish Species**

Spatial larval fish species patterns. Larval fish species collected at the three plankton sampling stations are listed in Table 7-4. Species counts were low overall (2 to 5 species per sample). Average species counts per station in fall (5 species) were slightly smaller than those in the spring (6). Averaged numbers of species at the surface (5) were the slightly smaller than those at the bottom (6).

Larval fish species patterns compared with past years. Table 7-7 lists the ranges of larval fish species counted per station since October 1991. Fish species recorded during both fall and spring ranged from 2 to 5 species per station (combined surface and bottom casts), which is typical of past surveys. Compared to surveys since 1991, no new larval fish were collected this year.

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 (0.91). Lowest diversity was near the surface in Basin D in October (0.71). Averaged among stations, diversity in the spring (1.24) was higher than in the fall (1.18). Average surface diversity (1.22) was slightly higher than bottom diversity (1.20).

Larval fish diversity patterns compared with past years. The species diversity values were lower this fall (0.38 to 0.87) than last fall (0.71 to 1.20), as was the spring range (0.42 to 0.91 versus 0.79 to 1.63). Species diversity calculations had not been performed previous to 1996.

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 at the breakwall in spring (1318 individuals). Lowest catches were at the bottom in Basin D in the fall (0 individuals). Averaged among stations, counts in the spring (2551 individuals) were much larger than those in the fall (202), and averaged counts per station at surface (572 individuals) were smaller than the bottom (662). Note that all counts are standardized to numbers per 1000 cubic meters. Common species in the fall included sandab (*Citharichthys sp.*) and several unidentified species. In the spring, unidentified species were also abundant, as well as slough anchovy (*Anchoa delicatissima*) and silversides (Atherinidae).

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 1997 ranged from 0 to 545 individuals per station, which were moderately low. The spring range of individuals per station (16 to 1318) were more typical.

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 October (7 and 6 species, respectively), and the lowest species count was near the bottom in Basin D also in October (0 species). Average species counts in the fall (6 species) were slightly larger than those in the spring (5). Averaged numbers of species at the surface (5) were slightly smaller than bottom counts (6).

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 1997 ranged from 0 to 9 species per station (combining surface and bottom casts), which is higher than past surveys. The spring range of species counts (1 to 5) were more typical. Relative to all surveys since 1991, new fish eggs collected during this year's survey were silversides (Atherinidae), California halibut (*Paralichthys californicus*), turbot (Pleuronectidae), and California tonguefish (*Symphurus atricauda*).

7.3.5.3. **Fish Egg Diversity**

Spatial fish egg diversity patterns. Species diversity calculated from the three sampling stations are listed in Table 7-4. Highest diversity was near the bottom at the breakwall in May (1.40). Lowest diversities were at both the surface and bottom in Basin D in October and at the surface in Basin D in May (all, 0.00). Averaged among stations, diversity in the spring (1.15) was higher than in the fall (0.87). Average surface diversity (0.87) was lower than bottom diversity (1.17).

Fish egg diversity patterns compared with past years. Diversity ranges in the fall and spring this year (0.00 to 1.40 and 0.00 to 0.93, respectively) were similar to last year (0.00 to 0.81 and 0.14 to 1.50).

7.4. DISCUSSION

Marina del Rey Harbor continues to serve as a viable habitat and nursery for many species of marine fish. To date, 106 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 25,834 total fish of all age groups (including larvae and eggs) representing 57 different species. The 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. During the fall survey, trawl counts were typical of past years, although spring counts were generally higher. Two species new to trawls were collected this year. Unlike last year, no one area had persistently larger trawls than any other. Higher diversity near the entrance in the spring, however, suggests that this area may serve as a transitional area between the open ocean and the inner Harbor. 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.

Midwater gill net sampling continues to be of limited use. Since the net is passive, capture must rely on the hit-or-miss chance of animals swimming into the net. The 45-minute deployment time is clearly too short to catch more than just a cursory representation of the midwater fish population. Only in Basin D in spring, when a school of 17 topsmelt were captured by the net, did a cast collect more than two individuals. Regardless, five of the seven species captured were new to gill net collection in Marina del Rey Harbor. For 1998, we will recommend at least tripling the time of gill net deployment.

Inshore fish were collected by beach seine at Mother's Beach. Both numbers of individuals and species were typical of past fall and spring counts. As with last year's survey, topsmelt counts during both fall and spring were high. However, California killifish count were higher in the fall, and bonefish counts were higher in the spring. Although bonefish have been occasionally collected here in the past, they have never occurred in this density (1323 individuals). Bonefish are typically tropical in habitat and are rare north of Baja California (Eschmeyer, et.al. 1983). Thus, their presence in such high numbers is likely El Nino related. As waters warmed during the year, these bonefish likely migrated north and took up residence in the harbor. It will be interesting to see if bonefish are present in our October 1998 haul.

Reef associated fish were enumerated and identified by diver-biologists along both jetties and the breakwall. Numbers of fish counted this past fall were higher than have been recorded during any survey of the recent past, and four new species were recorded for the first time this year. Counts were dominated by topsmelt and blacksmith. In the spring, counts declined greatly, such that total numbers (739) were about one-fifth those in recorded in the fall (5117). Similar to the beach seine, this phenomenon appears to be El Nino related. In October, divers recorded dense rock covers of algae and attached invertebrates. In May, following the exceptionally intense El Nino generated storms, hard substrates at all three stations showed evidence of scouring and silting in, such that there was virtually no algal or invertebrate turf community. Since this community is the food and cover source for the majority of the reef fish population, it is not surprising that fish counts were low this past spring.

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 and fish egg counts during both seasons were moderately low to typical of past surveys. Deeper tows almost always contained much larger populations than did surface tows. The ichthyoplankton may be feeding on the phytoplankton which tend 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 six years, no new larval species, but four new fish egg species were collected for the first time this year. Similar to last year, spring fish larval numbers were much higher than fall counts. However, unlike last year, egg counts were considerably greater in the fall. Dominating the spring larval catch were gobies and blennies. In the spring, jack smelt larvae were also dominant. Several unidentified egg species were common during both seasons. Sandab eggs were also abundant in the fall. In the spring, slough anchovies and silversides were common, as well.

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 continues to support a very abundant and diverse assemblage of fish fauna and serves as a nursery for many species important to local sport and commercial fisheries, as well as the whole coastal environment.

8. CONCLUSIONS

Marina del Rey Harbor continues to be both an important commercial and recreational facility for southern California. Unknown to most people, however, it is also important as an ecological habitat and nursery for a local community of fish, invertebrates, birds, and mammals. During this year, the quality of the water, sediment, infauna, and resident fish populations were measured and evaluated. This section provides the conclusions drawn from these evaluations.

Water quality in Marina del Rey Harbor this year was spatially impacted by the discharges of Oxford Lagoon and Ballona Creek, nonpoint rain runoff from Mothers Beach, and inflows of the open ocean from the Harbor entrance. It was temporally impacted by season, rainfall, and plankton blooms. As this year was subject to a strong El Nino Southern Oscillation (ENSO) event, rainfall (31 inches) was well above normal (13 inches) and nearly all precipitation fell between October 1997 and February 1998 (the wettest month was February). Both storm drain and nonpoint flows during the rainy season, lowered salinity, temperature, pH, and water clarity; raised ammonia, biochemical oxygen demand, and bacterial counts; and contributed nutrients to spring phytoplankton blooms. Only temperature was more strongly influenced by oceanographic season. Phytoplankton blooms, in turn, may have subsequently raised dissolved oxygen values, and their death may have increased biochemical oxygen demand later in the spring. Despite these effects, the exceptionally strong red tide blooms of 1996-97 were not evident this year.

Stations adjacent to the Harbor entrance were apparently impacted by both the open ocean and Ballona Creek, while stations in the lower main channel were most like open ocean water and were thus more natural than the rest of the Harbor. As always, the areas further back into the Marina were warmer, more saline, lower in dissolved oxygen, etc. Discharges from Ballona Creek impact stations near the Harbor entrance, and those from Oxford Lagoon affect Basin E and the upper end of the main channel. These impacts include elevated levels of ammonia, biochemical oxygen demand, and both total and fecal coliform bacteria. Stations affected by Oxford Lagoon had additionally elevated enterococcus bacterial counts and lower oxygen, pH, and temperature values. To a lesser degree, the waters in Basin D had elevated bacterial counts during the rainy season, as well. The source may be nonpoint flows off of Mothers Beach, where birds, stray animals, and people tend to congregate.

Measurements of the three groups of bacteria were made monthly at 18 stations (216 measurements for each group during the year). Total coliform limits were exceeded 19 times, fecal coliform limits were exceeded 49 times, and enterococcus limits were exceeded 16 times. These are more frequent than last year, however, the heavy rainfall this year was a likely contributor. Thus, 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.

Similar to last year, physical characteristics of Harbor sediments (median particle size and sorting) were influenced by energy of water flow which is influenced by Harbor configuration and rainfall intensity. Coarser sands predominate near the Harbor entrance and in Ballona Creek due to strong drainage flows and ocean currents, tides, and wave action. Thus, higher water velocity tends to move finer particles offshore and leave 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 and allows the finer fractions (silt and clay) from runoff to settle out on the bottom. These sediments in the upper areas of the Harbor are thus more heterogeneous. Water movement within Oxford Lagoon may be highly variable, since sediments here were moderate in size range yet were relatively heterogeneous.

Similar to past years, many 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, but they are much more difficult to partition out. Sediment particle size is another important factor to chemical accumulation. Finer silts and clays of the inner basins and upper channel can adsorb more metals and simple organics than courser silts and sands found near the Harbor entrance and within Ballona Creek..

Oxford Lagoon and Ballona Creek appear to be sources of chlorinated hydrocarbons such as DDT and derivatives, other chlorinated pesticides, and polychlorinated biphenyls (PCB's), however, the pattern was not as distinct as last year. DDT itself, as well as its breakdown products (DDD and DDE), were detected last year. This year, only the breakdown products were measured above detection limits. PCB's, as well, were below detection this year. These patterns may be considered favorable, but this year's heavy rains may have been a factor. Future surveys will determine whether this trend is persistent. Among chlorinated hydrocarbons listed as toxic by NOAA, all Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 11 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. Encouragingly, most chlorinated compounds have continued to remain low when compared to historical values, and levels are about one-eighth those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Oxford Lagoon and Ballona Creek may contribute somewhat to heavy metal loads in Harbor sediments. Since most heavy metals were higher in the Harbor back basins and main channel, their source is most likely the resident boat population itself, however. 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. Similar to 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 D, E, F, Oxford Lagoon, and most channel stations. Levels of arsenic, 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. The configuration of Los Angeles Harbor allows for better flushing and the movement of contaminated suspended materials offshore since it has two entrances rather than the one in Marina del Rey Harbor.

Tributyl tin continues to remain low when compared to past surveys. This compound was at one time 100 times more concentrated in Harbor sediments. Recently, tributyl tin has been banned as a boat bottom paint which is likely the cause of the decline. This compound is toxic to invertebrates at part per *trillion* levels, so its reduction is highly favorable to the biological community of the Harbor. In general, despite a fair degree of variability, metal concentrations in Marina del Rey sediments do not appear to have greatly increased nor decreased since 1985.

Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals, so their sources may be varied. They are non-toxic in themselves, but they can contribute to anoxic conditions near the bottom and affect sensitive fish and invertebrates. Oil from street runoff may be a source of some oil and grease levels found in the two drainage basins, although leakages from resident boats are a likely contributor, as well. As discussed in last year's report, Harbor sediments which are composed of finer particles, such as silt and clay, also tend to be high in heavy metals and organics, although the pattern this year was not as clear-cut. Sediments with finer particle sizes tend to attract chemical contaminants more readily. Conversely, sediments containing mostly sand and course silt tend to be lower in organics and heavy metals. The exception appears to be chlorinated hydrocarbons which do not appear to relate to particle size.

Oxford Lagoon and Ballona Creek continue to be the dominating influences to the benthic infaunal population of the Harbor. 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 did not appear to be strongly related to stations' benthic grain size patterns nor to any specific chemical compound, despite the fact that evidence of infaunal stress last year was related to higher levels of chlorinated hydrocarbons. Only somewhat higher dissolved or suspended organic loads may have related to declining population values (although no cause and effect relationship can necessarily be inferred).

Stations most modified appear to be Station 10 in Basin E just downstream of Oxford Lagoon, Station 12 in Ballona Creek, and Station 2 just inside the breakwall and also likely under the influence of Ballona Creek. Station 2 was defined by the Southern California Coastal Water Research Project's infaunal trophic index as a "degraded" benthic environment. Sediments from Station 12 in Ballona Creek, and to a lesser degree, Station 2, were dominated by nematode worms (80% in Station 12), which are known to be characteristic of highly disturbed benthic sediments. Because of these huge nematode counts (3856 individuals) at Station 12, total infaunal abundance here (4818) was highest in the Harbor. Relative to past years, abundance and species diversity values at the remaining stations were comparable. 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) and numbers of species were about the same. Diversity and infaunal index values were lower, but, like heavy metals may be dependent upon improved circulation in Los Angeles Harbor when compared to Marina del Rey Harbor.

Fish enumerations this year included trawl net sampling for bottom fish, gill net sampling for midwater fish, beach seine sampling for inshore fish, plankton net sampling for larval fish and eggs, and diver transect enumeration for reef fish. The Marina continues to support a very abundant and diverse assemblage of fish fauna and serves as a nursery for many species important to local sport and commercial fisheries, as well as the whole coastal environment. However, this year's El Nino generated storms, strongly affected the spring plankton, dive survey, and beach seine populations.

25,834 total fish of all age groups, representing 57 different species were recorded. The majority of these were either eggs, larvae, or juveniles, which attest to the Harbor's importance as a nursery. Although overall fall abundance counts were typical, spring counts for some partitions were generally low, particularly for fish eggs. Unusually heavy storms this year were the likely cause of these reduced numbers. Other evidence of El Nino impacts were observed during the dive surveys. Biologists noted an almost complete lack of algal and attached invertebrate community on the hard substrates of the breakwall and jetties in the spring. Since these communities are food and a source of cover for most reef associated fish in the Harbor, it is not surprising that spring fish counts were low. Also in spring, the beach seine catch at Mothers Beach was dominated by bonefish. Bonefish are tropical organisms and are only rarely found north of Baja California. Thus, their presence in such high numbers is also likely related to El Nino. These bonefish likely migrated north during this year's warm water period and took up residence in the Harbor. It will be interesting to see if bonefish are present in our October 1998 survey.

9. APPENDICES

9.1. REFERENCES

Surface Bacteriological Water Data and General Observations July 10, 1997

CRUISE:	MDR 96-97		Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear		Pers.:	J. Gelsinger	High	807	3.5
RAIN:	None			M. Meyer	Low	1245	2.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1026	40	40	< 2	Moderate turbidity.
2	1017	< 20	< 20	< 2	Moderate turbidity.
3	1004	20	20	< 2	Moderate turbidity. Strong flow from floodgate. Many topsmelt in the area.
4	1104	< 20	< 20	< 2	Moderate turbidity.
5	950	70	40	< 2	Moderate turbidity.
6	945	20	20	< 2	Moderate turbidity.
7	1125	50	20	5	Moderate turbidity. Children in kayaks here.
8	824	80	80	< 2	Moderate turbidity.
9	921	60	40	17	Moderate turbidity.
10	855	3000	1700	2	Moderate turbidity.
11	912	110	90	< 2	Moderate turbidity.
12	1040	90	170	< 2	Moderate turbidity.
13	743	2200	290	13	Moderate turbidity. Moderate flow from floodgate.
18	810	700	700	9	Moderate turbidity.
19	758	800	800	110	Moderate turbidity. Dead bird and flotsam on surface.
20	847	2400	110	< 2	Moderate turbidity. Floating oil and black particulate matter.
22	730	390	9000	12	Moderate turbidity. Floating algae, leaves, and trash.
25	1113	20	20	< 2	Moderate turbidity. School of topsmelt present.
	Average	560.6	732.2	10.6	
	Number	18	18	18	
	St. Dev.	947.7	2107.6	25.3	
	Maximum	3000	9000	110	
	Minimum	20	20	2	

Physical Water Quality Data

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	807	3.5
RAIN:	None	M. Meyer	Low	1245	2.2

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	1026	0	21.26	32.42	7.44	8.21	61.35	88.5	10	3.5	6.6	2.5
5k WSW		1	21.47	33.23	7.48	8.21	56.60	86.7				
		2	21.18	33.03	7.46	8.23	56.24	86.6			< 0.6	2.1
		3	21.05	33.29	7.58	8.23	55.42	86.3				
		4	21.10	33.20	7.97	8.21	57.87	87.2			< 0.6	2.2
2	1017	0	23.52	33.41	6.55	8.17	47.79	83.1	12	2.7	< 0.6	2.3
5k WSW		1	23.24	33.28	6.79	8.17	47.42	83.0				
		2	22.06	33.16	7.08	8.20	47.63	83.1			< 0.6	2.3
		3	20.74	33.51	7.70	8.22	51.35	84.7				
		4	19.90	33.58	8.06	8.23	55.92	86.5			< 0.6	2.0
3	1004	0	23.58	33.49	5.93	8.09	52.34	85.1	12	3.1	< 0.6	1.8
5k WSW		1	23.51	33.44	5.87	8.09	53.85	85.7				
		2	23.07	33.42	6.24	8.09	56.03	86.5			< 0.6	1.4
		3	22.97	33.53	6.70	8.09	53.59	85.6				
		4	22.80	33.57	6.85	8.10	54.27	85.8			0.7	1.3
4	1104	0	23.87	33.55	6.68	8.10	51.45	84.7	12	3.0	< 0.6	1.9
5k WSW		1	23.84	33.51	6.83	8.10	51.59	84.8				
		2	23.73	33.52	6.94	8.10	52.03	84.9			< 0.6	1.6
		3	22.05	32.41	7.12	8.11	53.31	85.4				
		4	21.44	33.02	7.31	8.14	56.33	86.6			< 0.6	1.5
5	950	0	24.26	33.53	5.98	8.06	56.33	86.6	12	2.4	< 0.6	1.7
3k WSW		1	24.07	33.60	6.21	8.06	51.74	84.8				
		2	23.92	33.56	6.38	8.09	43.79	81.3			< 0.6	1.8
		3	23.80	33.54	6.79	8.09	41.33	80.2				
		4	23.15	33.27	6.90	8.09	44.13	81.5			< 0.6	2.1
		5	23.51	33.43	6.42	8.10	34.89	76.9				
6	945	0	23.92	33.58	5.74	8.02	50.89	84.5	12	2.5	2.2	2.7
5k WSW		1	23.85	33.56	5.73	8.02	50.30	84.2				
		2	23.80	33.58	5.79	8.02	47.67	83.1			1.9	3.1
		3	23.79	33.59	5.90	8.02	45.72	82.2				
		4	23.77	33.59	5.93	7.99	45.29	82.0			1.9	2.5
7	1125	0	24.57	33.59	5.71	7.97	44.97	81.9	13	2.2	2.2	3.3
5k WSW		1	24.54	33.58	5.68	7.98	45.27	82.0				
		2	24.21	33.44	5.70	7.96	45.92	82.3			2.0	3.0
		3	24.05	33.53	5.69	7.99	44.17	81.5				
8	824	0	24.31	33.65	5.90	8.00	55.11	86.2	12	2.9	3.6	4.2
3k WSW		1	24.31	33.65	5.86	8.01	54.95	86.1				
		2	24.29	33.64	5.84	8.01	55.30	86.2			3.1	3.4
		3	24.17	33.61	5.84	8.02	53.44	85.5				
		4	24.21	33.62	6.06	8.02	55.77	86.4			2.8	2.9

9.2. WATER QUALITY DATA AND CRUISE LOGS

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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	921	0	24.40	33.36	5.07	7.93	56.90	86.9	13	2.3	3.2	4.2
3k WSW		1	24.45	33.46	5.02	7.93	55.20	86.2				
		2	24.32	33.47	5.00	7.99	45.62	82.2			2.7	2.7
		3	24.17	33.51	5.07	8.01	42.15	80.6				
		4	24.20	33.55	5.49	8.02	36.11	77.5			1.0	2.7
10	855	0	24.58	33.47	4.93	7.98	60.74	88.3	12	3.2	3.7	3.4
3k WSW		1	24.60	33.48	5.12	7.98	57.48	87.1				
		2	24.55	33.48	5.31	8.00	52.02	84.9			3.5	2.6
		3	24.52	33.52	5.48	7.99	57.23	87.0				
		4	24.53	33.52	5.48	7.99	60.88	88.3			3.1	1.5
11	912	0	24.37	33.48	5.87	8.00	61.88	88.7	12	2.6	2.3	1.9
3k WSW		1	24.39	33.50	5.59	8.01	61.43	88.5				
		2	24.32	33.51	5.81	8.01	55.77	86.4			1.9	1.4
		3	24.16	33.53	5.97	8.01	45.29	82.0				
		4	24.20	33.54	5.79	8.02	41.22	80.1			1.9	1.6
12	1040	0	22.99	27.61	6.29	8.22	58.86	87.6	10	3.5	0.7	8.0
5k WSW		1	22.25	31.32	5.80	8.20	55.85	86.4				
		2	21.01	33.30	6.23	8.18	65.73	90.0			1.5	2.1
13	743	0	24.28	33.52	3.00	7.78					8.1	3.4
18	810	0	24.16	33.66	6.72	8.05	48.48	83.4	12	2.9	0.9	2.3
3k WSW		1	24.18	33.65	6.63	8.06	48.48	83.4				
		2	24.14	33.65	6.62	8.06	46.49	82.6			0.8	2.4
19	758	0	23.31	33.97	6.00	8.04					1.0	2.2
20	847	0	24.52	33.46	5.32	7.96	60.80	88.3	12	2.0	5.7	5.4
3k WSW		1	24.58	33.50	5.20	7.96	55.37	86.3				
											5.0	2.1
22	730	0	22.34	30.42	5.23	8.15					3.7	9.5
25	1113	0	24.24	33.56	6.28	8.10	48.83	83.6	12	2.8	< 0.6	1.5
5k WSW		1	24.19	33.57	6.21	8.11	48.77	83.6				
		2	23.89	33.53	6.64	8.10	49.40	83.8			< 0.6	1.4
		3	23.55	33.38	7.10	8.07	55.89	86.5				
		4	21.88	32.74	7.32	8.09	59.25	87.7			< 0.6	1.3
	Average		23.50	33.29	6.17	8.07	51.9	84.8	11.9	2.8	2.0	2.7
	Number		71	71	71	71	68	68	15	15	44	44
	St. Dev.		1.16	0.85	0.86	0.09	6.3	2.7	0.8	0.4	1.8	1.6
	Maximum		24.60	33.97	8.06	8.23	65.7	90.0	13	3.5	8.1	9.5
	Minimum		19.90	27.61	3.00	7.78	34.9	76.9	10	2.0	0.6	1.3

CRUISE:	MDR 96-97	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	814	4.2
RAIN:	None	M. Meyer	Low	1317	2.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1035	110	110	< 2	Moderate turbidity.
2	1022	< 20	< 20	< 2	Moderate turbidity.
3	1010	80	20	< 2	Moderate turbidity. Fuel of surface. Odor of fuel in channel.
4	1110	< 20	< 20	< 2	Moderate turbidity.
5	933	90	< 20	< 2	Moderate turbidity. Strong flow from grate.
6	950	< 20	< 20	< 2	Moderate turbidity.
7	1130	< 20	< 20	< 2	Moderate turbidity. Kayakers in channel.
8	823	50	20	< 2	High turbidity.
9	917	40	40	< 2	Moderate turbidity.
10	855	1300	170	5	High turbidity.
11	906	16000	50	< 2	High turbidity.
12	1048	1300	140	< 2	Moderate turbidity. Barracuda in channel.
13	740	220	220	5	Moderate turbidity. Many pidgeons here. moderate flow from grate. Less trash than usual.
18	813	80	80	< 2	High turbidity.
19	758	140	140	2	Moderate turbidity. School of tiny fish here.
20	845	1700	140	30	Moderate turbidity. Surface oil film.
22	725	3000	3000	30	Moderate turbidity. Floating green algal mats and trash.
25	1117	140	< 20	< 2	Moderate turbidity.
	Average	1351.7	236.1	5.4	
	Number	18	18	18	
	St. Dev.	3745.7	692.8	9.0	
	Maximum	16000	3000	30	
	Minimum	20	20	2	

Physical Water Quality Data August

CRUISE:	MDR 96-97	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger	High	814	4.2
RAIN:	None		M. Meyer	Low	1317	2.3

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	1035	0	22.54	31.96	7.01	8.21	73.70	92.7	10	5.4	2.2	1.6
3k WSW		1	22.42	32.74	7.11	8.21	72.96	92.4				
		2	22.33	33.39	7.11	8.21	72.31	92.2			1.9	1.3
		3	22.13	33.38	7.17	8.23	72.07	92.1				
		4	22.08	33.46	7.19	8.23	71.92	92.1			< 0.6	1.3
2	1022	0	23.03	33.24	6.94	8.20	61.87	88.7	10	5.6	< 0.6	1.5
3k WSW		1	22.86	33.27	6.96	8.20	61.86	88.7				
		2	22.47	33.11	7.19	8.21	61.93	88.7			25.6	1.6
		3	22.01	33.21	7.41	8.21	62.04	88.7				
		4	21.71	33.21	7.51	8.21	63.33	89.2			27.1	1.6
		5	21.57	33.59	7.54	8.23	64.65	89.7				
3	1010	0	23.69	33.33	6.76	8.15	63.27	89.2	10	3.5	34.4	1.4
3k WSW		1	23.68	33.33	6.90	8.15	62.45	88.9				
		2	23.51	33.30	6.93	8.15	61.77	88.7			26.7	1.3
4	1110	0	24.32	33.41	7.07	8.15	62.53	88.9	11	3.9	5.0	1.3
3k WSW		1	24.29	33.40	7.11	8.15	61.84	88.7				
		2	24.28	33.35	7.11	8.15	63.61	89.3			7.0	1.3
		3										
		4									< 0.6	1.2
5	933	0	24.45	33.34	6.41	8.15	59.90	88.0	10	3.5	14.1	1.7
3k WSW		1	24.35	33.33	6.40	8.15	57.85	87.2				
		2	24.14	33.37	6.76	8.16	54.18	85.8			2.2	1.5
		3	23.97	33.38	7.28	8.17	51.84	84.9				
		4	22.53	33.07	7.50	8.18	50.18	84.2			6.3	1.7
6	950	0	24.40	33.41	6.97	8.15	66.30	90.2	10	3.4	2.6	1.2
3k WSW		1	24.34	33.40	6.92	8.15	64.35	89.6				
		2	24.28	33.41	6.97	8.16	61.24	88.5			1.8	1.2
		3	23.92	33.16	7.06	8.16	58.66	87.5				
		4	23.46	33.40	7.25	8.12	43.76	81.3			12.8	1.2
7	1130	0	24.59	33.38	5.32	8.07	55.71	86.4	12	3.0	26.0	1.7
3k WSW		1	24.57	33.41	5.35	8.08	54.14	85.8				
		2	24.40	33.37	5.77	8.07	55.24	86.2			25.2	1.3
		3	23.66	33.16	6.03	8.07	55.68	86.4				
		4	23.48	33.33	5.47	8.08	40.84	79.9			7.0	1.3
8	823	0	24.45	33.35	7.07	8.17	55.70	86.4	12	2.6	3.9	1.7
3k WSW		1	24.44	33.35	7.34	8.17	54.34	85.9				
		2	24.44	33.38	7.37	8.18	51.00	84.5			6.4	1.5
		3	24.38	33.39	7.53	8.18	48.01	83.2				
		4	24.09	33.23	7.55	8.19	46.50	82.6			22.9	2.1

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
9	917	0	24.56	33.25	5.68	8.08	57.25	87.0	11	2.9	37.8	1.7
3k WSW		1	24.49	33.25	5.68	8.08	57.51	87.1				
		2	24.03	33.20	5.89	8.06	48.53	83.5			105.8	1.3
		3	23.76	33.29	6.36	8.07	38.41	78.7				
		4	23.71	33.36	6.27	8.06	32.49	75.5			22.4	1.9
10	855	0	24.76	33.18	6.58	8.14	56.09	86.5	12	2.7	10.2	1.5
3k WSW		1	24.74	33.21	6.56	8.15	50.08	84.1				
		2	24.65	33.25	6.85	8.15	46.33	82.5			11.4	2.0
		3	24.30	33.18	7.21	8.15	44.95	81.9				
		4	24.03	33.33	7.36	8.08	39.07	79.1			7.7	2.4
11	906	0	24.56	33.27	6.42	8.13	63.40	89.2	12	2.7	7.8	2.1
3k WSW		1	24.53	33.28	6.34	8.13	60.03	88.0				
		2	24.44	33.34	6.42	8.14	57.20	87.0			5.1	2.0
		3	24.13	33.24	6.83	8.12	46.87	82.7				
		4	23.88	33.38	6.39	8.11	38.22	78.6			3.0	2.2
12	1048	0	22.87	30.37	6.56	8.22	69.39	91.3	10	3.9	4.9	4.0
3k WSW		1	22.59	31.67	6.37	8.21	70.37	91.6				
		2	22.22	33.26	6.63	8.19	72.67	92.3			3.6	1.7
		3	22.24	33.38	7.02	8.18	77.51	93.8				
13	740	0	24.00	33.19	5.10	8.07					11.0	3.7
18	813	0	24.41	33.40	7.97	8.18	50.37	84.2	12	2.6	2.7	2.1
3k WSW		1	24.41	33.40	7.94	8.19	49.43	83.8				
		2	24.39	33.39	7.92	8.19	48.74	83.6			1.3	2.0
		3	24.38	33.40	7.94	8.19	47.45	83.0				
		4									2.5	2.5
19	758	0	23.95	33.37	6.87	8.14					1.6	2.1
20	845	0	24.59	33.15	5.94	8.09	64.16	89.5	12	2.9	5.6	4.8
3k WSW		1	24.65	33.23	5.86	8.10	59.58	87.9				
		2	24.59	33.25	5.96	8.11	51.31	84.6			3.6	1.9
22	725	0	23.94	32.61	2.20	7.49					8.6	8.0
25	1117	0	24.53	33.32	6.02	8.13	65.28	89.9	11	4.4	2.6	2.9
3k WSW		1	24.50	33.36	6.15	8.14	65.09	89.8				
		2	24.42	33.38	6.32	8.14	65.54	90.0			4.1	1.0
		3	23.96	33.39	6.94	8.14	66.39	90.3				
		4	22.10	33.22	7.36	8.15	65.60	90.0			1.2	1.0
	Average		23.78	33.21	6.69	8.14	57.7	86.9	11.0	3.5	11.7	2.0
	Number		71	71	71	71	68	68	15	15	45	45
	St. Dev.		0.89	0.44	0.85	0.09	9.8	3.8	0.9	1.0	17.4	1.2
	Maximum		24.76	33.59	7.97	8.23	77.5	93.8	12	5.6	105.8	8.0
	Minimum		21.57	30.37	2.20	7.49	32.5	75.5	10	2.6	0.6	1.0

Surface Bacteriological Water Data and General Observations **September 12, 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	724	4.1
Low	1224	2.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1046	140	140	2	Moderate turbidity.
2	1033	40	20	< 2	Moderate turbidity.
3	1022	< 20	< 20	11	Moderate turbidity. Low flow from tide gate. Porpoises and school of small fish in channel.
4	1113	< 20	< 20	< 2	Moderate turbidity. Green heron on rocks.
5	946	130	130	< 2	Moderate turbidity.
6	1005	20	20	< 2	Moderate turbidity.
7	1142	20	20	2	Moderate turbidity.
8	822	40	40	8	Moderate turbidity.
9	931	40	40	< 2	Moderate turbidity.
10	903	500	220	11	Moderate turbidity.
11	920	800	800	6	Moderate turbidity.
12	1055	2400	2400	2	Moderate turbidity. Floating plastic. Many people fishing on rocks. Large fish in water.
13	732	300	170	5	Moderate turbidity. Moderate flow from storm drain. Flock of pidgeons, one domestic chicken on shore.
18	806	130	130	< 2	Moderate turbidity.
19	751	300	300	4	Moderate turbidity. Two swimmers in water.
20	850	240	240	33	Moderate turbidity. Floating oil film.
22	718	> 16000	> 16000	111	Moderate turbidity. Floating green algae and debris on surface. Ducks in water.
25	1127	20	< 20	2	Moderate turbidity.
	Average	1175.6	1151.7	11.6	
	Number	18	18	18	
	St. Dev.	3742.2	3748.0	25.9	
	Maximum	16000	16000	111	
	Minimum	20	20	2	

Physical Water Quality Data **September 12, 1997**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.: J. Gelsinger	High	724	4.1
RAIN:	None	M. Meyer	Low	1224	2.4

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	1046	0	22.75	30.90	6.01	8.22	63.73	89.3	10	4.3	4.1	2.5
5k E		1	22.77	32.82	5.95	8.19	60.99	88.4				
		2	21.88	33.09	6.08	8.18	63.53	89.3			1.8	1.7
		3	21.78	33.40	6.20	8.20	67.86	90.8				
2	1033	0	23.76	33.32	5.55	8.18	59.35	87.8	10	3.5	3.4	1.7
5k E		1	23.76	33.31	5.37	8.18	59.00	87.6				
		2	23.74	33.31	5.58	8.18	59.09	87.7			< 0.6	1.3
		3	23.53	33.22	5.86	8.18	59.07	87.7				
		4	22.55	32.92	6.03	8.19	59.17	87.7			< 0.6	1.3
		5	21.23	33.81	6.36	8.20	61.87	88.7				
3	1022	0	23.96	33.34	5.02	8.14	61.23	88.5	10	3.6	2.8	1.9
5k E		1	23.95	33.35	4.95	8.15	59.31	87.8				
		2	23.94	33.34	5.08	8.15	59.97	88.0			1.9	1.2
		3	22.29	32.19	5.41	8.15	61.23	88.5				
		4	21.05	33.30	5.82	8.16	59.97	88.0			1.1	1.2
4	1113	0	24.64	33.32	5.88	8.15	59.28	87.7	10	3.3	< 0.6	1.5
5k E		1	24.58	33.26	5.86	8.14	60.06	88.0				
		2	23.11	32.35	5.95	8.14	58.61	87.5			2.8	1.7
		3	21.45	32.86	6.24	8.16	58.55	87.5				
		4	0.00	33.51	6.30	8.19	58.49	87.5			< 0.6	1.3
5	946	0	24.72	33.29	5.28	8.15	61.23	88.5	11	3.2	< 0.6	1.3
5k E		1	24.72	33.29	5.41	8.15	60.11	88.1				
		2	24.56	33.23	5.55	8.16	58.53	87.5			< 0.6	1.3
		3	23.61	33.09	5.78	8.16	52.68	85.2				
		4	22.37	32.88	5.94	8.18	51.84	84.9			< 0.6	1.6
		5	22.45	33.30	5.71	8.17	45.42	82.1				
6	1005	0	24.53	33.33	4.74	8.14	55.72	86.4	12	3.0	0.6	1.7
5k E		1	24.54	33.34	4.59	8.13	55.22	86.2				
		2	24.53	33.36	4.98	8.14	55.53	86.3			< 0.6	1.4
		3	24.52	33.36	5.47	8.14	55.48	86.3				
		4	0.00	33.52	5.47	8.11	54.85	86.1			< 0.6	1.4
7	1142	0	24.74	33.36	5.14	8.09	54.62	86.0	12	2.4	3.5	1.5
5k E		1	24.64	33.30	5.16	8.09	54.28	85.8				
		2	24.10	33.22	5.19	8.10	50.51	84.3			3.4	1.2
		3	23.10	33.13	5.31	8.11	42.34	80.7				
		4	0.00	33.43	5.33	8.13	32.36	75.4			2.9	1.2
8	822	0	24.68	33.25	5.00	8.16	49.53	83.9	13	2.4	0.8	1.7
5k E		1	24.70	33.28	5.18	8.17	49.39	83.8				
		2	24.70	33.28	5.25	8.16	49.25	83.8			0.7	1.7
		3	24.65	33.28	5.55	8.16	49.67	84.0				
		4	24.62	33.31	5.76	8.18	51.40	84.7			1.4	1.7

September 12, 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	931	0	24.68	33.24	4.49	8.08	51.38	84.7	13	2.0	3.5	1.1
5k E		1	24.67	33.25	4.43	8.08	44.07	81.5				
		2	24.26	33.24	4.59	8.08	38.39	78.7			2.9	1.4
		3	23.97	33.22	4.96	8.09	32.03	75.2				
		4	23.88	33.35	5.03	8.07	21.34	68.0			3.0	1.3
10	903	0	24.48	32.55	5.34	8.07	66.57	90.3	13	2.4	6.5	1.4
5k E		1	24.93	33.19	5.28	8.07	65.61	90.0				
		2	24.87	33.10	5.24	8.11	40.87	80.0			6.2	1.3
		3	24.59	33.23	5.28	8.07	29.91	74.0				
		4									3.4	2.3
11	920	0	24.57	33.01	5.57	8.13	60.96	88.4	12	2.8	3.5	1.9
5k E		1	24.58	33.05	5.55	8.13	58.47	87.4				
		2	24.39	33.10	5.57	8.13	52.20	85.0			2.4	1.5
		3	23.80	33.11	5.67	8.13	43.92	81.4				
		4	23.61	33.15	5.61	8.12	31.14	74.7			2.5	1.6
12	1055	0	23.12	28.19	5.80	8.30	49.75	84.0	14	3.4	< 0.6	6.3
5k E		1	22.24	29.78	5.68	8.27	52.40	85.1				
		2	21.44	33.15	5.90	8.20	62.21	88.8			0.6	3.7
13	732	0	24.70	32.97	4.90	7.97					6.6	7.9
18	806	0	24.59	33.29	4.01	8.19	54.92	86.1	13	2.7	1.4	1.8
5k E		1	24.60	33.29	3.68	8.19	54.76	86.0				
		2	24.58	33.29	3.98	8.19	54.84	86.1			1.5	1.5
		3	24.55	33.28	4.23	8.20	54.91	86.1				
		4									1.7	1.5
19	751	0	23.78	33.41	5.54	8.12					< 0.6	2.0
20	850	0	24.41	32.30	4.78	8.05	62.94	89.1	13	2.2	11.2	8.1
5k E		1	24.90	33.12	4.74	8.07	47.99	83.2				
		2	24.93	33.12	4.96	8.08	36.85	77.9			6.3	2.1
22	718	0	23.09	33.08	4.20	7.68					9.5	13.4
25	1127	0	24.63	33.31	4.73	8.11	66.13	90.2	10	3.9	2.1	1.5
5k E		1	24.51	33.28	4.72	8.12	66.07	90.2				
		2	23.96	33.31	4.81	8.11	65.61	90.0			1.7	1.3
		3	22.07	33.05	5.26	8.12	65.01	89.8				
		4	20.97	33.21	5.59	8.16	61.79	88.7			1.4	1.3
		5	20.96	33.20	5.64	8.18	54.25	85.8				
	Average		22.79	33.04	5.31	8.14	54.2	85.5	11.7	3.0	2.6	2.2
	Number		74	74	74	74	71	71	15	15	45	45
	St. Dev.		4.85	0.78	0.57	0.07	9.7	4.4	1.4	0.7	2.4	2.3
	Maximum		24.93	33.81	6.36	8.30	67.9	90.8	14	4.3	11.2	13.4
	Minimum		0.00	28.19	3.68	7.68	21.3	68.0	10	2.0	0.6	1.1

October 10, 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	910	0	21.79	33.21	4.35	7.97	61.52	88.6	10	3.2	8.0	1.3
4k WSW		1	21.79	33.22	4.32	7.97	62.49	88.9				
		2	21.65	33.27	4.69	7.99	58.88	87.6			7.7	0.8
		3	21.35	33.23	4.95	8.03	50.37	84.2				
		4	21.33	33.38	4.99	8.04	47.76	83.1			7.4	0.9
10	844	0	21.26	32.55	4.55	8.00	65.37	89.9	10	2.7	9.9	1.4
4k WSW		1	21.97	32.67	4.63	7.99	62.44	88.9				
		2	22.03	33.12	4.67	8.00	54.69	86.0			9.1	0.6
		3	21.65	33.27	4.84	8.00	43.25	81.1				
		4	21.49	33.35	4.93	8.04	33.53	76.1			9.0	0.9
11	900	0	21.56	32.86	5.36	7.99	65.67	90.0	10	3.3	8.9	0.8
4k WSW		1	21.57	32.94	4.24	8.00	67.56	90.7				
		2	21.81	33.18	4.87	8.00	63.31	89.2			8.6	0.8
		3	21.33	33.32	5.18	8.02	47.70	83.1				
		4	21.25	33.42	5.06	8.05	22.73	69.0			8.1	0.7
12	1022	0	20.78	31.22	6.36	8.18	71.26	91.9	14	3.3	6.7	3.3
4k WSW		1	20.72	30.44	5.27	8.24	52.59	85.2				
		2	20.33	33.09	5.47	8.16	63.21	89.2			4.0	1.8
13	740	0	21.21	32.52	4.40	7.92					11.2	7.2
18	810	0	21.55	33.27	5.55	7.99	58.00	87.3	12	3.3	7.1	0.8
1k WSW		1	21.55	33.27	5.54	8.00	58.22	87.4				
		2	21.55	33.26	5.53	8.00	58.29	87.4			7.1	0.9
19	755	0	20.70	33.30	5.21	7.97					6.7	1.7
20	835	0	21.45	32.48	4.30	7.98	65.79	90.1	12	2.3	11.2	5.0
1k WSW		1	22.05	33.29	4.23	7.98	57.40	87.0				
		2	22.03	33.03	4.59	7.99	48.92	83.6			9.9	0.6
22	720	0	21.80	32.60	3.60	7.90					12.9	5.6
25	1052	0	21.54	33.30	5.34	7.98	67.59	90.7	10	4.2	6.4	0.7
4k WSW		1	21.53	33.31	5.34	7.99	67.89	90.8				
		2	21.11	33.36	5.34	7.98	68.55	91.0			6.2	0.6
		3	20.63	33.36	5.36	8.01	65.69	90.0				
		4	20.45	33.40	5.32	8.04	59.28	87.7			6.2	0.6
		5	20.53	33.44	5.36	8.06	52.18	85.0				
	Average		21.30	33.13	5.32	8.03	58.8	87.4	10.9	3.3	6.7	1.4
	Number		71	71	71	71	68	68	15	15	44	44
	St. Dev.		0.46	0.49	0.68	0.07	7.8	3.4	1.4	0.5	2.6	1.4
	Maximum		22.05	33.74	7.16	8.24	71.3	91.9	14	4.2	12.9	7.2
	Minimum		20.33	30.44	3.60	7.90	22.7	69.0	10	2.3	1.4	0.6

Surface Bacteriological Water Data and General Observations **November 14, 1997**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast changing to clear	Pers.:	J. Gelsinger	High	816	6.8
RAIN:	None		M. Meyer	Low	1509	-1.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1113	> 16000	> 16000	46	Moderate turbidity. Dense floating trash throughout area-styrofoam, plastic, cellophane, leaves, etc.
2	1058	5000	5000	< 2	Moderate turbidity.
3	1045	2200	2200	< 2	Moderate turbidity. Gate closed, no flow. Two kayakers in channel.
4	1153	300	300	< 2	Moderate turbidity. Containment boom in channel to block flow of trash.
5	1004	120	120	4	Moderate turbidity.
6	1021	700	700	< 2	Moderate turbidity.
7	1225	80	80	< 2	Moderate turbidity.
8	842	100	100	2	Moderate turbidity.
9	949	170	170	< 2	Moderate turbidity.
10	914	170	170	13	Moderate turbidity.
11	935	50	20	< 2	Moderate turbidity.
12	1129	> 16000	> 16000	< 2	Moderate turbidity. Dense floating trash throughout area-styrofoam, plastic, cellophane, leaves, etc.
13	742	> 16000	> 16000	300	Moderate turbidity. Moderate flow into channel. Floating trash, leaves, debris.
18	828	370	370	< 2	Moderate turbidity.
19	755	5000	5000	< 2	Moderate turbidity. Large school of juvenile fish.
20	914	550	550	< 2	Moderate turbidity.
22	732	> 16000	> 16000	2	Moderate turbidity. Pond has been cleared of algae, weeds, and vines.
25	1210	3000	3000	< 2	Moderate turbidity. Four large sea lions in channel.
	Average	4545.0	4543.3	21.7	
	Number	18	18	18	
	St. Dev.	6494.9	6496.1	70.2	
	Maximum	16000	16000	300	
	Minimum	50	20	2	

Physical Water Quality Data November 14, 1997

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	816	6.8
RAIN:	None	M. Meyer	Low	1509	-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	1113	0	18.98	29.41	6.00	8.21	29.05	73.4	10	1.2	21.0	3.9
5k SE		1	19.11	31.13	6.20	8.20	36.47	77.7				
		2	19.15	32.35	6.40	8.20	41.43	80.2			9.5	1.7
		3	19.17	32.51	6.40	8.20	43.70	81.3				
		4	19.18	32.66	6.40	8.20	44.60	81.7			8.3	1.6
2	1058	0	19.15	32.29	6.20	8.21	53.11	85.4	11	2.1	9.1	1.3
4k S		1	19.01	32.41	6.20	8.22	51.69	84.8				
		2	19.07	33.10	6.40	8.24	48.95	83.6			4.5	1.0
		3	19.24	33.14	6.60	8.24	48.77	83.6				
		4	19.19	33.27	6.40	8.24	49.95	84.1			3.2	1.1
		5	19.17	33.31	6.60	8.24	43.37	81.2				
3	1045	0	19.27	32.70	5.20	8.16	62.97	89.1	8	3.2	6.9	0.9
4k S		1	19.30	32.84	5.20	8.16	60.97	88.4				
		2	19.31	32.89	5.80	8.18	58.77	87.6			6.1	0.7
		3	19.34	32.92	5.80	8.18	58.39	87.4				
		4	19.34	32.97	5.60	8.20	56.89	86.8			5.0	0.4
4	1153	0	19.36	32.63	5.40	8.15	64.56	89.6	12	2.3	6.6	1.3
8k SW		1	19.35	32.62	5.40	8.16	64.61	89.7				
		2	19.31	32.72	5.40	8.16	63.90	89.4			5.1	0.8
		3	19.30	32.80	5.60	8.17	57.21	87.0				
											4.7	0.7
5	1004	0	19.16	32.47	4.60	8.08	65.39	89.9	9	3.2	8.5	0.6
1k SE		1	19.14	32.53	4.60	8.08	64.61	89.7				
		2	19.19	32.71	4.60	8.09	63.57	89.3			7.2	0.7
		3	19.40	32.87	4.60	8.10	58.87	87.6				
		4	19.50	33.04	4.60	8.10	54.93	86.1			6.7	0.7
		5	19.55	33.15	5.20	8.13	56.21	86.6				
		6	19.54	33.15	5.20	8.14	43.24	81.1			7.8	0.7
6	1021	0	18.90	32.49	6.82	8.06	66.34	90.2	8	3.7	7.6	0.9
2k SE		1	18.87	32.47	7.07	8.06	66.11	90.2				
		2	18.90	32.57	7.89	8.05	65.69	90.0			7.4	0.5
		3	19.31	32.95	10.00	8.05	64.51	89.6				
		4	19.60	32.98	8.87	8.05	58.65	87.5			6.8	0.5
7	1225	0	19.76	32.68	4.70	8.11	63.98	89.4	7	3.2	9.8	0.6
10k SW		1	19.75	32.74	4.60	8.11	62.48	88.9				
		2	19.69	32.74	4.80	8.11	62.25	88.8			10.2	0.6
		3	19.74	32.87	4.40	8.12	60.50	88.2				
		4	19.74	33.01	4.70	8.12	54.36	85.9			10.0	0.6
8	842	0	19.02	32.55	4.40	7.98	60.06	88.0	9	3.8	13.7	1.1
3k SE		1	18.99	32.55	4.40	7.98	59.43	87.8				
		2	18.82	32.54	4.20	7.97	59.22	87.7			10.9	0.7
		3	18.72	32.52	3.80	7.97	59.05	87.7				
		4	18.70	32.56	3.90	7.97	59.63	87.9			10.2	0.6

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	BOD mg/l
9	949	0	19.64	32.65	4.10	8.06	67.28	90.6	9	2.8	10.0	0.7
0k		1	19.91	33.03	4.20	8.07	66.57	90.3				
		2	19.92	32.93	4.00	8.07	55.85	86.4			8.4	0.7
		3	19.71	32.93	4.40	8.08	50.85	84.4				
		4	19.69	33.00	4.40	8.08	43.79	81.3			7.7	0.6
10	914	0	18.65	30.87	3.40	7.93	58.45	87.4	9	2.8	17.5	3.0
4k SE		1	19.55	31.57	3.60	7.95	56.36	86.6				
		2	20.12	32.86	3.60	7.96	51.28	84.6			16.0	1.6
		3	20.03	32.79	3.60	7.98	48.17	83.3				
		4	19.94	32.89	4.00	8.00	44.68	81.8			12.3	1.6
11	935	0	19.38	32.46	4.00	8.02	64.35	89.6	9	3.1	10.1	1.8
2k SE		1	19.41	32.50	4.20	8.03	63.68	89.3				
		2	19.60	32.84	4.20	8.03	58.72	87.5			8.6	0.4
		3	19.70	32.96	4.20	8.05	51.73	84.8				
		4	19.71	32.98	4.30	8.05	44.73	81.8			7.3	0.8
12	1129	0	18.52	20.71	4.40	8.03	4.65	46.4	12	0.4	26.7	7.8
8k SW		1	18.73	27.55	5.20	8.05	4.74	46.7				
		2	19.36	32.36	5.40	8.06	29.49	73.7			16.0	4.1
		3	19.39	32.11	5.50	8.06	46.86	82.7				
13	742	0	15.00	5.57	5.00	8.14					52.3	9.1
18	828	0	18.78	32.54	4.20	7.89	60.46	88.2	9	3.7	18.9	1.1
3k SE		1	18.80	32.54	4.30	7.89	59.59	87.9				
		2	18.78	32.54	4.10	7.89	59.91	88.0			10.0	0.8
		3	18.75	32.53	4.30	7.90	60.03	88.0				
		4	18.71	32.53	4.35	7.90	60.13	88.1			9.9	0.8
19	755	0	18.10	32.42	4.50	8.14					10.5	1.1
20	914	0	19.01	31.30	3.00	7.93	61.17	88.4	9	3.5	17.0	4.3
4k SE		1	19.72	33.00	3.50	7.95	53.77	85.6				
		2	20.03	32.74	3.70	7.97	50.07	84.1			13.8	2.9
22	732	0	16.70	5.04	5.20	8.19					22.4	3.8
25	1210	0	19.46	32.66	4.80	8.13	64.14	89.5	8	3.8	7.8	1.3
8k SW		1	19.44	32.69	4.80	8.13	63.87	89.4				
		2	19.42	32.70	4.80	8.12	63.22	89.2			5.7	0.5
		3	19.41	32.75	4.80	8.13	62.10	88.8				
		4	19.42	32.82	4.80	8.14	59.72	87.9			5.5	0.6
	Average		19.21	31.68	5.04	8.08	54.8	85.3	9.3	2.9	11.1	1.6
	Number		77	77	77	77	74	74	15	15	47	47
	St. Dev.		0.69	4.61	1.22	0.10	12.0	7.4	1.4	1.0	7.9	1.8
	Maximum		20.12	33.31	10.00	8.24	67.3	90.6	12	3.8	52.3	9.1
	Minimum		15.00	5.04	3.00	7.89	4.7	46.4	7	0.4	3.2	0.4

Surface Bacteriological Water Data and General Observations **December 10, 1997**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear, very windy	Pers.: J. Gelsinger	High	559	6.1
RAIN:	None	M. Meyer	Low	1251	-0.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1048	2400	130	< 2	Moderate turbidity. Floating plastic bags.
2	1102	50	20	< 2	Moderate turbidity. Floating dead seagull.
3	1112	80	20	2	Moderate turbidity. Strong flow from tidal gate.
4	1124	40	< 20	< 2	Moderate turbidity. Submerged plastic bags.
5	1228	170	40	< 2	Moderate turbidity. Filming activity at Chace Park.
6	1010	40	< 20	< 2	Moderate turbidity.
7	1235	20	< 20	< 2	Moderate turbidity.
8	1225	300	40	< 2	Moderate turbidity.
9	1145	70	40	< 2	Moderate turbidity.
10	1205	3000	230	2	Moderate turbidity.
11	1153	1100	20	< 2	Moderate turbidity.
12	1042	9000	800	< 2	Moderate turbidity.
13	744	5000	140	4	Moderate turbidity. Moderate flow into channel.
18	1218	170	110	2	Moderate turbidity.
19	1215	70	50	< 2	Moderate turbidity. Large fish jumping.
20	1202	300	< 20	< 2	Moderate turbidity.
22	730	> 16000	500	4	Moderate turbidity. Flock of mallards and coots.
25	1135	80	20	< 2	Moderate turbidity.
	Average	2105.0	124.4	2.2	
	Number	18	18	18	
	St. Dev.	4190.2	206.3	0.6	
	Maximum	16000	800	4	
	Minimum	20	20	2	

Physical Water Quality Data **December 10, 1997**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear, very windy	Pers.:	J. Gelsinger	High	559	6.1
RAIN:	None		M. Meyer	Low	1251	-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	BOD mg/l
1	1048	0	16.51	32.00	6.16	8.12	44.27	81.6	12	2.8	6.9	0.8
40k NE		1	16.57	32.48	6.16	8.12	42.78	80.9				
		2	16.76	33.10	6.86	8.13	41.24	80.1			6.0	0.6
		3	16.84	33.28	7.94	8.15	38.17	78.6				
		4	16.80	33.35	7.37	8.17	32.80	75.7			5.5	0.6
2	1102	0	16.11	32.64	6.47	8.12	56.35	86.6	10	3.0	5.6	0.8
40k NE		1	16.12	32.66	7.30	8.12	56.34	86.6				
		2	16.12	32.67	7.82	8.12	55.98	86.5			4.7	0.5
		3	16.21	32.72	8.52	8.12	55.83	86.4				
		4	16.52	33.16	7.61	8.13	53.30	85.4			4.6	0.5
3	1112	0	15.97	32.65	7.58	8.12	55.80	86.4	10	3.1	5.3	0.7
40k NE		1	15.96	32.71	7.52	8.12	54.18	85.8				
		2	16.00	32.78	7.69	8.13	53.79	85.6			4.2	0.6
		3	16.03	32.76	7.39	8.13	53.13	85.4				
		4	16.15	32.95	7.31	8.13	52.17	85.0				
4	1124	0	15.96	32.40	6.16	8.07	62.76	89.0	10	3.1	5.2	0.5
11k NE		1	15.96	32.43	6.01	8.08	62.41	88.9				
		2	16.12	32.60	6.45	8.07	61.45	88.5			5.0	0.5
		3	16.52	32.73	7.73	8.09	60.08	88.0				
5	1228	0	15.99	32.22	5.32	8.08	63.54	89.3	10	3.6	5.4	1.0
11k NE		1	15.93	32.26	5.25	8.08	63.71	89.3				
		2	16.15	32.41	5.53	8.08	63.19	89.2			6.6	0.5
		3	16.28	32.38	7.15	8.09	63.35	89.2				
		4	16.29	32.45	7.30	8.10	61.79	88.7			6.2	0.6
		5	16.42	33.38	5.95	8.13	39.27	79.2				
6	1010	0	16.50	32.31	8.18	8.05	64.46	89.6	11	2.7	7.2	0.7
11k NE		1	16.48	32.31	7.93	8.05	63.87	89.4				
		2	17.03	32.95	8.24	8.05	63.35	89.2			6.4	0.5
		3	16.93	32.65	6.93	8.07	44.79	81.8				
		4	16.93	32.79	6.49	8.08	45.31	82.0			5.6	0.5
7	1235	0	16.76	32.66	6.37	8.06	58.96	87.6	10	3.0	5.4	0.7
11k NE		1	16.79	32.69	6.15	8.06	58.02	87.3				
		2	16.87	32.70	6.40	8.07	55.82	86.4			5.1	0.6
		3	16.98	32.90	6.43	8.07	50.44	84.3				
8	1225	0	15.48	32.06	7.11	8.05	60.88	88.3	10	3.0	6.8	0.6
4k NE		1	15.53	32.07	7.08	8.05	60.33	88.1				
		2	16.47	32.60	6.97	8.06	57.67	87.1			6.7	0.5
		3	17.10	32.74	6.68	8.08	50.72	84.4				
		4	17.20	32.73	6.38	8.10	43.26	81.1			6.5	0.7

December 10, 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	1145	0	16.73	32.44	5.32	8.08	63.13	89.1	10	3.3	5.3	0.8
11k NE		1	16.74	32.49	5.19	8.08	63.12	89.1				
		2	16.72	32.54	6.89	8.08	62.49	88.9			5.7	0.4
		3	16.91	32.67	8.93	8.08	62.44	88.9				
		4	16.97	32.75	6.59	8.11	44.35	81.6			7.1	0.5
10	1205	0	17.35	31.70	5.35	8.04	45.07	81.9	11	2.8	7.3	0.7
11k NE		1	17.24	32.19	4.89	8.06	46.47	82.6				
		2	17.20	32.65	5.08	8.10	43.83	81.4			6.2	0.6
		3	17.14	32.70	7.19	8.11	42.89	80.9				
		4	17.02	32.74	8.51	8.11	39.62	79.3			5.4	0.7
11	1153	0	16.10	32.11	5.42	8.07	64.92	89.8	10	3.5	7.9	1.2
11k NE		1	16.41	32.05	4.63	8.07	63.56	89.3				
		2	16.43	32.29	5.06	8.08	61.11	88.4			6.8	0.6
		3	16.58	32.45	6.20	8.10	56.80	86.8				
		4	16.95	32.62	9.08	8.11	52.23	85.0			6.8	0.6
12	1042	0	14.43	23.12	7.04	8.03	54.14	85.8	12	2.3	13.8	2.[illegible]
40k NE		1	16.15	30.57	6.44	8.00	36.34	77.6				
		2	16.79	32.65	6.12	8.02	42.56	80.8			11.3	0.9
13	744	0	15.60	30.09	5.20	8.06					15.1	3.[illegible]
18	1218	0	16.03	32.29	7.01	8.06	56.45	86.7	11	2.8	7.5	1.3
4k NE		1	16.05	32.28	6.91	8.06	55.37	86.3				
		2	15.93	32.24	7.10	8.08	54.74	86.0			6.4	0.7
		3	15.91	32.26	7.10	8.08	55.03	86.1				
19	1215	0	15.90	31.34	4.03	8.06					6.7	0.[illegible]
20	1202	0	17.13	32.19	4.83	8.08	56.76	86.8	10	2.1	6.2	0.[illegible]
11k NE		1	17.19	32.48	4.91	8.08	50.05	84.1				
		2	17.21	32.62	9.12	8.11	44.90	81.9			7.2	0.8
22	730	0	14.80	28.34	3.80	8.06					37.1	3.[illegible]
25	1135	0	16.02	32.41	7.07	8.06	67.48	90.6	10	2.6	8.3	0.4
11k NE		1	15.98	32.43	7.04	8.05	68.29	90.9				
		2	16.12	32.63	6.93	8.06	66.04	90.1			6.8	0.[illegible]
		3	16.54	33.27	6.66	8.07	62.89	89.1				
		4	16.63	33.15	6.56	8.11	53.09	85.4			7.2	0.6
	Average		16.42	32.31	6.64	8.08	54.5	85.7	10.5	2.9	7.5	0.[illegible]
	Number		72	72	72	72	69	69	15	15	42	42
	St. Dev.		0.56	1.31	1.15	0.03	8.7	3.6	0.7	0.4	5.1	0.[illegible]
	Maximum		17.35	33.38	9.12	8.17	68.3	90.9	12	3.6	37.1	3[illegible]
	Minimum		14.43	23.12	3.80	8.00	32.8	75.7	10	2.1	4.2	0.[illegible]

Surface Bacteriological Water Data and General Observations **January 8, 1998**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy-Overcast	Pers.:	J. Gelsinger	High	541	6.0
RAIN:	None		M. Meyer	Low	1250	-0.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1017	5000	2200	< 2	Moderate turbidity.
2	1005	50	50	< 2	Light turbidity. Floating leaves and styrofoam cups. Submerged plastic bags.
3	955	90	90	< 2	Light turbidity. Rowers in channel. Strong flow from tidal gate.
4	1048	140	140	< 2	Light turbidity.
5	920	< 20	< 20	< 2	Light turbidity. Rowers in channel.
6	939	70	70	< 2	Light turbidity.
7	1112	20	20	< 2	Light turbidity.
8	815	40	40	< 2	Light turbidity.
9	909	40	40	< 2	Light turbidity.
10	842	500	500	< 2	Light turbidity.
11	858	5000	1700	< 2	Light turbidity.
12	1030	9000	1700	< 2	Moderate turbidity.
13	732	> 16000	> 16000	900	Moderate turbidity. Moderate flow from storm drain.
18	805	40	40	2	Light turbidity.
19	751	110	70	< 2	Moderate turbidity.
20	831	360	360	< 2	Light turbidity.
22	720	190	130	< 2	Moderate turbidity. Large flock of coots in water.
25	1058	50	50	< 2	Light turbidity.
	Average	2040.0	1290.0	51.9	
	Number	18	18	18	
	St. Dev.	4287.9	3734.7	211.7	
	Maximum	16000	16000	900	
	Minimum	20	20	2	

Physical Water Quality Data

January 8, 1998

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy-Overcast	Pers.: J. Gelsinger		High	541	6.0
RAIN:	None	M. Meyer		Low	1250	-0.2

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	1017	0	15.06	26.90	5.89	8.07	62.32	88.8	10	4.2	10.0	1.3
5k NE		1	15.35	29.51	5.65	8.09	63.75	89.4				
		2	15.94	32.89	5.93	8.10	66.91	90.4			6.0	1.2
		3	15.87	33.06	6.67	8.12	67.88	90.8				
		4	15.82	33.09	6.30	8.13	66.59	90.3			3.7	1.2
2	1005	0	15.30	32.98	6.03	8.14	73.35	92.5	7	5.0	2.3	1.0
5k NE		1	15.31	33.02	5.73	8.15	73.44	92.6				
		2	15.47	33.17	6.18	8.15	73.07	92.5			1.9	1.1
		3	15.72	33.20	6.83	8.15	72.66	92.3				
		4	15.79	33.26	7.05	8.17	68.14	90.9			1.9	1.0
3	955	0	15.21	32.97	6.76	8.13	68.87	91.1	8	5.8	3.0	1.0
5k NE		1	15.22	32.98	7.17	8.13	68.95	91.1				
		2	15.21	32.97	7.55	8.14	69.28	91.2			2.2	0.9
		3	15.21	32.96	7.04	8.14	69.46	91.3				
		4	15.21	32.95	6.91	8.14	69.64	91.4			2.8	0.8
4	1048	0	15.10	32.85	6.43	8.11	71.47	91.9	9	5.0	2.3	0.9
5k NE		1	15.10	32.88	6.22	8.11	71.84	92.1				
		2	15.18	32.94	6.46	8.12	69.96	91.5			2.1	0.9
		3	15.27	32.98	7.09	8.12	67.63	90.7				
											1.9	0.8
5	920	0	14.56	32.50	5.63	8.12	73.96	92.7	9	5.8	1.1	0.9
5k NE		1	14.57	32.55	5.47	8.12	73.58	92.6				
		2	14.59	32.59	5.67	8.13	72.39	92.2			1.1	0.8
		3	14.67	32.60	6.59	8.13	71.29	91.9				
		4	14.84	32.63	7.26	8.13	70.98	91.8			1.1	0.9
		5	15.49	32.86	7.06	8.13	70.35	91.6				
6	939	0	14.65	32.63	5.77	8.13	73.62	92.6	9	5.0	1.3	1.4
5k NE		1	14.65	32.66	5.56	8.14	73.66	92.6				
		2	14.65	32.67	5.93	8.14	73.42	92.6			0.9	0.9
		3	14.65	32.67	7.18	8.14	73.32	92.5				
		4	14.65	32.66	7.47	8.15	73.32	92.5			0.8	0.8
7	1112	0	14.85	32.70	5.99	8.06	75.04	93.1	9	4.0	3.3	0.9
5k NE		1	14.83	32.70	5.73	8.06	74.46	92.9				
		2	14.82	32.72	5.89	8.07	74.15	92.8			2.2	0.8
		3	15.13	33.00	6.42	8.07	73.85	92.7				
		4	15.12	32.81	6.74	8.08	70.63	91.7			3.5	0.7
8	815	0	14.00	32.41	5.65	8.15	69.09	91.2	9	5.2	0.9	1.[illegible]
5k NE		1	14.00	32.45	5.51	8.15	69.28	91.2				
		2	13.94	32.41	6.07	8.15	69.19	91.2			< 0.7	1.2
		3	13.84	32.44	7.23	8.15	68.51	91.0				
		4	13.83	32.43	7.54	8.15	68.78	91.1			2.6	1.[illegible]

January 8, 1998 (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	909	0	14.84	32.60	5.70	8.11	74.36	92.9	9	4.8	2.0	0.9
5k NE		1	14.86	32.65	5.37	8.12	73.77	92.7				
		2	14.85	32.65	6.11	8.11	73.78	92.7			1.8	0.8
		3	14.94	32.74	6.95	8.12	71.11	91.8				
		4	15.06	32.80	7.06	8.12	68.12	90.8			3.0	0.9
10	842	0	14.20	32.00	5.36	8.04	78.42	94.1	9	5.2	4.7	1.0
5k NE		1	14.61	32.39	5.32	8.04	78.39	94.1				
		2	14.94	32.54	5.35	8.08	72.59	92.3			4.1	0.9
		3	14.76	32.48	6.69	8.11	66.95	90.5				
		4	14.74	32.52	7.24	8.12	68.54	91.0			2.8	1.0
11	858	0	14.42	32.35	5.86	8.11	74.09	92.8	9	5.1	1.9	1.0
5k NE		1	14.49	32.44	5.66	8.11	73.74	92.7				
		2	14.82	32.70	5.97	8.12	71.54	92.0			1.5	0.8
		3	14.91	32.70	6.99	8.12	67.37	90.6				
		4	15.05	32.53	7.08	8.13	68.69	91.0			3.5	1.0
12	1030	0	14.96	23.43	5.56	8.01	56.15	86.6	14	2.9	4.6	2.6
5k NE		1	15.98	30.32	4.93	7.95	31.40	74.9				
		2	16.09	32.72	5.69	8.01	65.95	90.1			3.0	1.3
13	732	0	13.30	29.70	4.10	8.10					15.8	4.9
18	805	0	13.84	32.43	5.98	8.15	69.31	91.2	9	4.9	2.7	1.5
5k NE		1	13.84	32.44	6.30	8.15	68.68	91.0				
		2	13.80	32.42	6.73	8.16	68.51	91.0			1.1	1.4
		3	13.72	32.45	7.45	8.16	68.42	90.9				
		4	13.66	32.43	7.63	8.16	67.71	90.7			0.8	1.3
19	751	0	12.80	32.55	7.50	8.05					0.8	1.4
20	831	0	14.39	32.08	5.21	8.06	77.96	94.0	9	2.1	6.0	1.7
5k NE		1	14.73	32.47	5.35	8.07	77.29	93.8				
		2	14.98	32.43	5.54	8.08	74.90	93.0			4.4	0.9
22	720	0	12.80	27.54	4.10	8.07					18.8	6.1
25	1058	0	14.94	32.76	5.98	8.10	72.56	92.3	9	4.8	3.3	1.1
5k NE		1	14.97	32.78	5.80	8.10	71.80	92.1				
		2	15.00	32.80	6.10	8.10	72.78	92.4			3.1	0.8
		3	15.03	32.83	6.56	8.11	73.20	92.5				
		4	15.05	32.84	6.85	8.11	72.43	92.3			2.3	0.7
	Average		14.78	32.30	6.25	8.11	70.4	91.5	9.2	4.7	3.3	1.3
	Number		74	74	74	74	71	71	15	15	46	46
	St. Dev.		0.67	1.50	0.79	0.04	6.0	2.3	1.5	1.0	3.5	1.0
	Maximum		16.09	33.26	7.63	8.17	78.4	94.1	14	5.8	18.8	6.1
	Minimum		12.80	23.43	4.10	7.95	31.4	74.9	7	2.1	0.7	0.7

Surface Bacteriological Water Data and General Observations **February 5, 1998**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay
WEATHER:	Clear	Pers.:	J. Gelsinger
RAIN:	None		M. Meyer

TIDE	TIME	HT. (ft)
High	425	5.3
Low	1147	0.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1030	> 16000	> 16000	1600	Moderate turbidity.
2	1020	5000	5000	13	Moderate turbidity. Surf coming into northern Harbor entrance.
3	1010	220	220	11	Moderate turbidity.
4	1055	3000	3000	900	High turbidity. Containment boom in channel. Cormorants and pelicans on rip rap.
5	935	1700	1700	23	Moderate turbidity.
6	950	700	700	30	Moderate turbidity.
7	1121	2200	2200	8	Moderate turbidity.
8	825	1100	1100	42	Moderate turbidity.
9	920	700	700	2	Moderate turbidity.
10	856	> 16000	> 16000	300	High turbidity.
11	910	1300	1300	> 1600	Moderate turbidity.
12	1041	> 16000	> 16000	7	High turbidity.
13	745	> 16000	> 16000	> 1600	Moderate turbidity. Moderate reverse flow into drainage gate.
18	815	300	300	> 1600	Moderate turbidity.
19	802	3000	3000	130	Moderate turbidity. Two joggers on beach.
20	843	> 16000	> 16000	> 1600	High turbidity. Strong current.
22	735	> 16000	> 16000	350	Moderate turbidity. Debris 1 m high on chain link fence.
25	1106	2400	2400	< 2	Moderate turbidity.
	Average	6534.4	6534.4	545.4	
	Number	18	18	18	
	St. Dev.	6978.7	6978.7	706.6	
	Maximum	16000	16000	1600	
	Minimum	220	220	2	

Physical Water Quality Data **February 5, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	425	5.3
RAIN:	None	M. Meyer	Low	1147	0.2

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	1030	0	15.65	24.44	6.86	8.03	15.60	62.8	15	2.1	10.8	1.6
6k WSW		1	15.90	28.59	6.71	8.00	21.30	67.9				
		2	16.28	31.76	6.65	8.02	18.57	65.6			9.0	0.7
		3	16.46	32.59	6.99	8.06	10.75	57.3				
		4	16.43	32.62	7.27	8.09	6.55	50.6			5.3	0.6
2	1020	0	15.69	28.78	6.34	8.02	53.52	85.5	14	2.4	8.8	0.5
6k WSW		1	15.73	29.37	5.75	8.02	49.10	83.7				
		2	16.07	30.82	5.86	8.04	37.41	78.2			12.2	0.5
		3	16.10	31.31	6.54	8.06	33.84	76.3				
		4	16.27	32.25	6.85	8.07	18.41	65.5			16.7	0.4
3	1010	0	16.03	29.80	6.43	8.03	30.31	74.2	15	1.5	14.3	0.9
6k WSW		1	16.09	30.38	6.40	8.02	28.32	72.9				
		2	16.33	32.34	6.53	8.04	23.94	69.9			7.1	0.6
		3	16.41	32.54	6.74	8.06	19.60	66.5				
		4									7.2	0.4
4	1055	0	15.82	28.90	6.01	8.01	56.30	86.6	12	2.0	7.5	0.5
6k WSW		1	15.82	29.31	5.98	8.01	54.84	86.1				
		2	16.13	30.97	6.19	8.04	41.62	80.3			7.0	0.2
		3	16.23	31.62	6.56	8.06	33.03	75.8				
		4									16.4	0.2
5	935	0	15.45	28.12	6.41	8.00	60.12	88.1	12	2.8	7.7	0.5
6k WSW		1	15.49	28.87	5.82	8.00	58.03	87.3				
		2	16.01	30.68	5.98	7.99	53.13	85.4			11.7	0.4
		3	16.23	31.43	6.57	7.99	46.78	82.7				
		4	16.35	32.21	6.70	8.03	35.65	77.3			9.8	0.5
6	950	0	15.07	28.01	6.68	8.00	61.98	88.7	12	2.8	15.8	0.6
6k WSW		1	15.26	28.32	6.67	8.00	61.52	88.6				
		2	15.95	29.99	6.65	7.98	58.86	87.6			8.5	0.4
		3	16.23	30.96	6.48	7.95	45.87	82.3				
		4									10.4	0.4
7	1121	0	15.94	28.80	6.08	7.99	54.63	86.0	12	2.3	11.1	0.8
6k WSW		1	15.99	29.44	5.84	7.99	52.94	85.3				
		2	16.21	30.96	6.07	7.98	50.35	84.2			9.6	0.6
		3	16.36	31.67	6.70	7.97	43.41	81.2				
8	825	0	14.46	27.03	5.87	7.99	57.99	87.3	14	2.4	9.7	0.5
6k WSW		1	15.31	26.89	5.72	8.00	58.27	87.4				
		2	16.01	30.86	5.61	7.96	51.87	84.9			13.1	0.5
		3	16.18	31.40	6.12	7.94	46.82	82.7				
		4									13.3	0.6

February 5, 1998 (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
9	920	0	15.82	28.70	6.38	7.95	61.35	88.5	12	2.6	15.0	0.[illegible]
6k WSW		1	15.92	29.38	6.31	7.95	57.17	87.0				
		2	16.18	31.02	6.59	7.95	53.06	85.3			9.7	0.6
		3	16.27	31.84	6.56	7.95	45.83	82.3				
		4									9.0	0.[illegible]
10	856	0	15.38	25.75	4.81	7.88	31.33	74.8	15	1.6	21.0	4.9
6k WSW		1	15.60	26.34	4.42	7.87	32.55	75.5				
		2	16.09	30.82	4.66	7.87	35.30	77.1			19.6	1.[illegible]
		3	16.23	31.20	5.95	7.91	38.98	79.0				
		4	16.29	31.41	5.60	7.88	38.14	78.6			14.5	0.[illegible]
11	910	0	15.52	28.41	5.28	7.96	61.06	88.4	12	2.6	12.1	0.[illegible]
6k WSW		1	15.65	28.64	5.02	7.96	60.01	88.0				
		2	16.08	30.80	5.33	7.95	52.85	85.3			10.0	0.[illegible]
		3	16.13	31.25	6.64	8.03	38.05	78.5				
											11.2	0.6
12	1041	0	15.69	23.19	6.68	8.03	11.31	58.0	17	0.9	17.8	1.[illegible]
6k WSW		1	15.93	27.97	6.67	8.01	10.71	57.2				
		2	16.12	30.97	7.11	8.04	9.79	55.9			10.1	1.0
13	745	0	11.10	1.62	10.00	7.40					20.3	3.[illegible]
18	815	0	13.82	27.19	6.57	6.15	44.71	81.8	14	2.4	11.5	0.[illegible]
4k WSW		1	14.37	28.63	7.13	7.72	53.07	85.4				
		2	16.04	31.21	6.82	7.93	51.12	84.6			9.8	0.7
19	802	0	13.40	27.18	6.59	7.37					10.9	1.[illegible]
20	843	0	15.38	25.50	4.99	7.88	26.39	71.7	16	1.2	21.4	3.8
6k WSW		1	15.52	26.93	5.06	7.88	26.29	71.6				
		3									19.8	0[illegible]
22	735	0	13.80	1.21	6.84	6.77					20.2	3[illegible]
25	1106	0	15.95	29.17	5.92	8.01	55.51	86.3	12	2.2	8.2	0.[illegible]
8k SW		1	15.92	29.71	6.63	8.01	54.36	85.9				
		2	16.22	31.62	6.78	8.01	49.63	83.9			6.8	0.[illegible]
		3	16.37	32.24	6.77	8.03	37.11	78.0				
		4	16.40	32.47	6.64	8.06	24.55	70.4			6.4	0.[illegible]
	Average		15.74	28.85	6.30	7.92	41.2	78.6	13.6	2.1	12.0	0[illegible]
	Number		64	64	64	64	61	61	15	15	44	4[illegible]
	St. Dev.		0.87	5.40	0.79	0.30	16.0	9.6	1.7	0.6	4.4	1.[illegible]
	Maximum		16.46	32.62	10.00	8.09	62.0	88.7	17	2.8	21.4	4[illegible]
	Minimum		11.10	1.21	4.42	6.15	6.6	50.6	12	0.9	5.3	0[illegible]

Surface Bacteriological Water Data and General Observations **March 12, 1998**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger	High	837	5.3
RAIN:	None		M. Meyer	Low	1505	-0.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1050	800	130	30	Moderate turbidity.
2	1040	20	< 20	< 2	Moderate turbidity.
3	1030	< 20	< 20	< 2	Moderate turbidity. Gate closed, no flow.
4	1118	20	20	< 2	Moderate turbidity. Floating trash, debris in channel.
5	955	20	20	< 2	Moderate turbidity.
6	1010	< 20	< 20	< 2	Moderate turbidity.
7	1144	50	< 20	< 2	High turbidity.
8	840	< 20	< 20	< 2	High turbidity.
9	940	< 20	< 20	< 2	High turbidity.
10	910	500	< 20	< 2	High turbidity.
11	925	20	< 20	< 2	High turbidity.
12	1102	600	110	11	Moderate turbidity.
13	750	70	< 20	< 2	Moderate turbidity. Strong flow into channel.
18	825	50	< 20	< 2	High turbidity.
19	805	20	< 20	< 2	Moderate turbidity.
20	902	2400	< 20	17	High turbidity. Floating oil film.
22	735	1700	300	50	Moderate turbidity. Eight cormorants on gate.
25	1129	20	< 20	< 2	Moderate turbidity. Four large sea lions in channel.
	Average	353.9	46.7	7.6	
	Number	18	18	18	
	St. Dev.	671.2	71.0	12.9	
	Maximum	2400	300	50	
	Minimum	20	20	2	

Physical Water Quality Data **March 12, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	837	5.3
RAIN:	None	M. Meyer	Low	1505	-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	BOD mg/l
1	1050	0	17.04	32.07	7.71	8.17	66.32	90.2	10	4.0	6.2	1.4
5k W		1	16.97	32.49	7.61	8.17	61.33	88.5				
		2	16.91	33.29	8.24	8.18	63.21	89.2			< 0.7	1.2
		3	16.90	33.32	8.60	8.18	62.95	89.1				
		4	16.90	33.34	8.52	8.18	63.20	89.2			< 0.7	1.4
2	1040	0	16.86	32.81	7.27	8.16	64.41	89.6	10	4.5	1.7	1.5
5k W		1	16.65	32.79	7.24	8.16	63.49	89.3				
		2	16.62	33.31	8.07	8.15	63.13	89.1			< 0.7	1.4
		3	16.55	33.29	8.48	8.16	64.06	89.5				
		4	16.38	33.35	8.46	8.16	62.98	89.1			< 0.7	1.4
		5	16.36	33.41	8.42	8.14	58.92	87.6				
3	1030	0	17.46	33.05	7.37	8.16	55.26	86.2	12	3.0	1.0	1.5
5k W		1	17.44	33.07	7.69	8.16	54.58	86.0				
		2	17.22	33.02	8.15	8.16	56.58	86.7			< 0.7	1.3
		3	17.02	33.09	8.49	8.15	55.28	86.2				
		4	16.94	33.23	8.63	8.13	48.58	83.5			0.7	1.2
4	1118	0	17.76	33.06	10.06	8.21	50.43	84.3	12	3.2	< 0.7	2.8
5k W		1	17.74	33.05	10.04	8.21	50.54	84.3				
		2	17.26	33.08	10.10	8.20	50.07	84.1			< 0.7	1.9
		3	16.94	33.30	10.19	8.14	45.43	82.1				
		4	16.95	33.34	10.18	8.11	41.48	80.3			< 0.7	1.9
5	955	0	17.86	32.96	8.31	8.23	49.66	83.9	12	3.8	< 0.7	2.1
2k W		1	17.81	32.95	8.33	8.23	48.62	83.5				
		2	17.38	32.99	8.73	8.23	46.84	82.7			< 0.7	2.1
		3	17.12	33.14	9.17	8.21	45.19	82.0				
		4	16.99	33.22	9.40	8.17	42.63	80.8			< 0.7	2.3
		5	16.80	33.26	9.58	8.15	43.95	81.4				
6	1010	0	17.52	32.95	9.11	8.22	55.00	86.1	12	3.4	1.3	1.9
5k W		1	17.46	32.93	8.92	8.22	54.58	86.0				
		2	17.22	32.94	9.26	8.22	52.93	85.3			2.3	1.9
		3	17.12	33.20	9.93	8.17	44.62	81.7				
		4	16.97	33.22	10.49	8.11	37.65	78.3			4.8	1.8
7	1144	0	17.87	33.10	7.48	8.18	49.69	84.0	14	2.8	4.8	2.3
5k W		1	17.80	33.11	6.72	8.18	48.59	83.5				
		2	17.62	33.09	7.32	8.18	46.71	82.7			4.5	1.8
		3	17.15	33.13	8.19	8.16	43.41	81.2				
		4	17.68	32.94	9.93	8.01	44.20	81.5			1.7	2.0
8	840	0	17.75	32.90	7.40	8.26	53.14	85.4	13	2.6	0.9	2.8
2k W		1	17.65	32.90	6.78	8.26	51.64	84.8				
		2	17.50	32.92	7.51	8.26	47.58	83.1			< 0.7	2.2
		3	17.34	32.94	8.73	8.27	42.84	80.9				
		4	17.12	33.15	9.55	8.23	37.70	78.4			< 0.7	2.4

March 12, 1998 (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	940	0	17.78	32.81	6.71	8.16	38.63	78.8	13	2.5	0.7	2.0
2k W		1	17.38	32.79	6.70	8.17	30.54	74.3				
		2	17.16	33.16	7.39	8.09	24.50	70.4			< 0.7	2.7
		3	17.02	33.23	8.44	8.07	26.51	71.8				
		4	16.99	33.34	8.81	8.03	23.25	69.4			2.5	2.3
10	910	0	17.60	32.62	6.58	8.11	48.19	83.3	14	2.2	< 0.7	2.1
2k W		1	17.75	32.72	6.30	8.14	40.77	79.9				
		2	17.56	32.80	7.49	8.15	37.60	78.3			< 0.7	1.6
		3	17.34	33.07	8.31	8.12	27.20	72.2				
		4	17.24	33.12	8.56	8.09	26.39	71.7			< 0.7	1.8
11	925	0	17.80	32.82	10.39	8.22	47.24	82.9	13	2.5	< 0.7	2.4
2k W		1	17.79	32.87	10.41	8.22	46.84	82.7				
		2	17.51	32.93	10.38	8.22	42.41	80.7			0.9	1.7
		3	17.11	33.13	10.45	8.17	32.31	75.4				
		4	16.97	33.24	10.60	8.09	32.52	75.5			< 0.7	1.9
12	1102	0	17.42	30.05	7.35	8.17	63.60	89.3	10	4.0	8.7	1.7
5k W		1	17.30	30.91	7.03	8.17	62.47	88.9				
		2	17.07	33.02	7.44	8.17	63.57	89.3			0.9	1.4
		3	17.03	33.17	8.43	8.19	63.99	89.4				
13	750	0	17.41	32.91	6.71	7.73					3.3	2.5
18	825	0	17.61	32.97	7.61	8.26	49.52	83.9	13	2.8	1.3	2.6
2k W		1	17.58	32.95	7.46	8.26	49.32	83.8				
		2	17.54	32.93	8.14	8.26	48.06	83.3			< 0.7	2.3
		3	17.42	32.96	8.80	8.26	46.77	82.7				
											< 0.7	2.2
19	805	0	17.32	32.86	8.22	8.18					< 0.7	2.3
20	902	0	17.33	32.21	6.75	8.03	54.65	86.0	14	2.2	< 0.7	2.2
2k W		1	17.87	32.85	5.97	8.04	42.31	80.7				
		2	17.55	32.88	7.01	8.14	34.20	76.5			< 0.7	1.1
22	735	0	14.60	19.36	6.30	8.59					9.0	4.5
25	1129	0	17.98	33.00	8.19	8.22	52.48	85.1	13	3.0	< 0.7	1.9
5k W		1	17.93	33.01	8.24	8.22	52.42	85.1				
		2	17.46	33.02	8.72	8.21	51.27	84.6			< 0.7	1.8
		3	16.99	33.29	9.23	8.16	47.64	83.1				
		4	16.87	33.32	9.65	8.11	37.15	78.1			< 0.7	1.6
	Average		17.26	32.78	8.36	8.17	48.4	83.0	12.3	3.1	1.7	2.0
	Number		76	76	76	76	73	73	15	15	46	46
	St. Dev.		0.49	1.63	1.19	0.09	10.7	5.0	1.4	0.7	2.0	0.6
	Maximum		17.98	33.41	10.60	8.59	66.3	90.2	14	4.5	9.0	4.5
	Minimum		14.60	19.36	5.97	7.73	23.3	69.4	10	2.2	0.7	1.1

Surface Bacteriological Water Data and General Observations **April 9, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	850	4.7
RAIN:	None	M. Meyer	Low	1501	0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1052	2400	170	< 2	Moderate turbidity.
2	1039	140	< 20	< 2	Moderate turbidity.
3	1025	< 20	< 20	2	Moderate turbidity. Dredging operation at north jetty.
4	1119	< 20	< 20	< 2	Moderate turbidity.
5	952	< 20	< 20	< 2	Moderate turbidity.
6	1010	80	< 20	< 2	Moderate turbidity.
7	1140	20	20	< 2	Moderate turbidity.
8	843	20	< 20	< 2	Moderate turbidity.
9	939	20	< 20	< 2	Moderate turbidity.
10	912	1400	50	4	Moderate turbidity.
11	927	20	< 20	< 2	Moderate turbidity.
12	1101	2400	80	2	Moderate turbidity.
13	758	500	50	30	Moderate turbidity. Strong flow into lagoon.
18	832	50	< 20	2	Moderate turbidity.
19	812	50	50	8	Moderate turbidity.
20	905	2400	20	8	Moderate turbidity. Jellyfish in water column. Oily surface film.
22	745	> 16000	500	80	Moderate turbidity. 10+ herons on gate.
25	1122	20	< 20	< 2	Moderate turbidity.
	Average	1421.1	63.3	8.7	
	Number	18	18	18	
	St. Dev.	3750.9	115.1	19.0	
	Maximum	16000	500	80	
	Minimum	20	20	2	

Physical Water Quality Data **April 9, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	850	4.7
RAIN:	None	M. Meyer	Low	1501	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	1052	0	16.06	29.88	7.90	8.20	59.18	87.7	13	2.8	6.1	1.8
7k WSW		1	15.83	29.08	8.32	8.19	53.87	85.7				
		2	15.73	33.07	8.29	8.18	49.82	84.0			3.2	1.2
		3	15.70	33.29	8.43	8.19	48.25	83.3				
2	1039	0	16.23	32.84	8.61	8.18	51.91	84.9	14	2.5	1.0	2.2
7k WSW		1	16.18	32.79	8.57	8.18	51.99	84.9				
		2	15.83	32.81	8.62	8.18	48.93	83.6			0.7	1.5
		3	15.56	33.27	8.70	8.18	47.04	82.8				
		4	15.54	33.44	8.74	8.18	43.48	81.2			< 0.7	1.9
3	1025	0	16.71	33.02	7.63	8.12	61.30	88.5	11	3.0	3.4	1.8
7k WSW		1	16.71	33.01	7.59	8.12	60.92	88.3				
		2	16.57	33.00	7.58	8.12	60.01	88.0			1.5	1.0
		3	16.49	33.07	7.54	8.12	56.95	86.9				
4	1119	0	17.13	33.06	7.11	8.12	57.47	87.1	11	3.5	4.0	1.7
7k WSW		1	17.11	33.05	7.82	8.13	57.34	87.0				
		2	17.04	33.04	7.84	8.13	57.35	87.0			0.8	1.2
		3	16.58	33.03	7.73	8.13	58.83	87.6				
		4	16.13	33.47	7.65	8.12	57.98	87.3			0.8	0.9
5	952	0	17.25	32.89	6.81	8.10	63.90	89.4	11	3.8	1.5	0.9
7k WSW		1	17.12	32.92	6.83	8.11	62.05	88.8				
		2	16.93	32.96	7.18	8.11	58.95	87.6			1.0	0.9
		3	16.73	33.09	7.66	8.12	57.78	87.2				
		4	16.19	33.07	7.56	8.13	55.87	86.5			0.7	1.0
		5	16.05	33.39	7.33	8.16	43.56	81.2				
6	1010	0	16.85	32.97	7.25	8.10	61.58	88.6	11	3.6	2.3	0.8
7k WSW		1	16.83	32.96	7.09	8.11	60.92	88.3				
		2	16.69	32.92	7.13	8.11	61.21	88.5			0.9	0.8
		3	16.61	32.97	7.16	8.11	60.45	88.2				
		4	16.69	33.19	7.20	8.08	53.47	85.5			1.1	0.8
7	1140	0	17.32	33.05	5.86	8.08	54.44	85.9	11	2.8	1.1	1.2
7k WSW		1	17.25	33.05	5.89	8.08	53.50	85.5				
		2	17.13	33.12	6.53	8.08	52.86	85.3			0.9	1.0
		3	16.94	33.09	7.17	8.08	52.09	85.0				
		4	17.05	33.12	6.84	8.08	50.25	84.2			1.1	0.9
8	843	0	16.99	32.91	6.91	8.06	52.02	84.9	13	2.5	2.9	1.0
7k WSW		1	16.98	32.90	6.90	8.06	51.41	84.7				
		2	16.88	32.86	6.90	8.06	49.99	84.1			1.2	1.0
		3	16.80	32.89	6.89	8.06	48.86	83.6				
		4	16.70	32.88	6.96	8.06	47.24	82.9			0.9	1.1

April 9, 1998 (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	939	0	17.51	32.93	7.14	8.10	35.14	77.0	12	2.6	5.3	1.3
7k WSW		1	17.25	32.92	6.17	8.10	31.85	75.1				
		2	16.96	33.06	6.60	8.10	30.28	74.2			1.5	1.2
		3	16.85	33.19	7.14	8.11	33.97	76.3				
											1.3	1.0
10	912	0	16.88	32.50	5.54	8.04	61.57	88.6	11	3.1	4.0	1.3
7k WSW		1	16.93	32.59	5.79	8.04	60.60	88.2				
		2	17.45	32.94	6.01	8.06	55.04	86.1			3.5	1.2
		3	17.26	32.85	6.26	8.10	49.51	83.9				
		4	17.07	32.93	6.14	8.09	44.38	81.6			3.3	1.4
11	927	0	17.17	32.74	6.10	8.08	54.17	85.8	12	2.6	2.7	1.3
7k WSW		1	17.17	32.78	7.77	8.08	53.16	85.4				
		2	17.24	33.02	7.53	8.08	53.26	85.4			1.7	0.7
		3	16.84	32.98	7.23	8.09	36.52	77.7				
		4	16.64	33.13	6.68	8.11	27.38	72.3			2.2	0.8
12	1101	0	16.57	27.30	8.09	8.25	41.53	80.3	14	2.4	2.0	2.3
7k WSW		1	15.99	27.64	8.37	8.22	34.16	76.5				
		2	15.77	33.08	8.85	8.21	45.31	82.0			1.0	1.8
		3	15.75	33.22	8.87	8.21	46.21	82.4				
13	758	0	17.02	32.79	5.70	8.04					5.3	2.1
18	832	0	16.80	32.89	5.87	8.03	47.33	82.9	13	2.3	3.1	0.8
7k WSW		1	16.81	32.92	5.18	8.03	46.38	82.5				
		2	16.77	32.91	5.55	8.04	45.92	82.3			1.2	1.1
		3	16.72	32.84	6.69	8.04	44.23	81.6				
											0.9	1.0
19	812	0	16.10	32.84	6.56	8.04					3.2	1.1
20	905	0	16.92	32.45	6.94	8.05	59.68	87.9	14	2.3	4.6	8.7
7k WSW		1	17.12	32.67	7.07	8.05	56.42	86.7				
		2	17.31	32.77	7.05	8.03	48.15	83.3			3.7	1.8
22	745	0	14.50	22.13	8.70	8.22					6.5	3.3
25	1122	0	17.30	33.00	6.52	8.10	60.82	88.3	11	3.5	2.4	1.1
7k WSW		1	17.21	33.02	6.55	8.10	61.09	88.4				
		2	17.04	32.98	6.63	8.10	61.53	88.6			0.6	0.8
		3	16.39	32.95	7.00	8.10	62.33	88.9				
		4	15.98	33.24	7.57	8.10	41.99	80.5			0.8	0.9
	Average		16.67	32.58	7.17	8.11	51.7	84.5	12.1	2.9	2.2	1.4
	Number		72	72	72	72	69	69	15	15	44	44
	St. Dev.		0.57	1.65	0.89	0.05	8.7	3.9	1.2	0.5	1.6	1.2
	Maximum		17.51	33.47	8.87	8.25	63.9	89.4	14	3.8	6.5	8.7
	Minimum		14.50	22.13	5.18	8.03	27.4	72.3	11	2.3	0.6	0.7

Surface Bacteriological Water Data and General Observations May 21, 1998

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	621	4.2
RAIN:	None	M. Meyer	Low	1228	0.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1029	3000	170	8	Moderate turbidity.
2	1021	< 20	< 20	2	Moderate turbidity.
3	1010	50	50	11	Moderate turbidity. Strong flow from tidal gate. Floating organic debris and jellyfish in water.
4	1059	< 20	< 20	< 2	Moderate turbidity.
5	923	20	20	< 2	Moderate turbidity.
6	950	< 20	< 20	< 2	Moderate turbidity. Jellyfish in water column.
7	1121	< 20	< 20	< 2	Moderate turbidity.
8	820	220	20	< 2	Moderate turbidity.
9	913	20	< 20	9	Moderate turbidity.
10	850	270	50	17	Moderate turbidity. Stingrays in water column.
11	901	230	< 20	2	Moderate turbidity. Stingrays in water column.
12	1040	9000	500	8	High turbidity.
13	735	> 16000	1100	6	High turbidity. Thick floating algal mats. Trash throughout. Jellyfish in water. Moderate flow.
18	810	170	50	2	Moderate turbidity.
19	755	220	40	< 2	Moderate turbidity. Jellyfish in water column.
20	840	3000	< 20	< 2	Moderate turbidity. Hundreds of jellyfish in water column.
22	720	> 16000	150	29	High turbidity. Thick floating algal mats. Trash throughout. Two herons on fence.
25	1110	20	< 20	2	Moderate turbidity.
	Average	2683.3	128.3	6.1	
	Number	18	18	18	
	St. Dev.	5322.8	268.8	7.1	
	Maximum	16000	1100	29	
	Minimum	20	20	2	

Physical Water Quality Data **May 21, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	621	4.2
RAIN:	None	M. Meyer	Low	1228	0.4

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	1029	0	18.87	31.11	7.60	8.32	50.46	84.3	13	2.3	2.9	2.1
8k WSW		1	18.30	32.68	7.83	8.32	48.57	83.5				
		2	17.67	33.15	8.32	8.35	48.77	83.6			2.0	1.9
		3	17.24	33.22	7.47	8.35	47.08	82.8				
2	1021	0	19.42	32.81	8.42	8.40	50.28	84.2	13	2.8	5.5	2.0
8k WSW		1	19.08	32.84	8.46	8.40	49.71	84.0				
		2	18.28	33.03	8.75	8.40	47.81	83.2			3.4	1.9
		3	17.96	33.23	8.49	8.40	46.89	82.8				
											2.0	2.2
3	1010	0	19.24	32.92	8.15	8.36	48.34	83.4	12	2.8	3.2	2.0
8k WSW		1	19.06	32.88	8.29	8.36	45.98	82.3				
		2	18.80	33.02	8.27	8.36	43.72	81.3			3.5	2.0
		3	18.74	33.04	8.11	8.36	42.15	80.6				
		4	18.42	32.96	7.99	8.35	39.74	79.4			14.3	2.0
4	1059	0	19.93	32.86	8.28	8.37	52.76	85.2	12	3.0	2.9	1.8
8k WSW		1	19.91	32.86	8.35	8.37	52.77	85.2				
		2	19.71	32.77	8.41	8.37	53.77	85.6			3.3	1.7
		3	18.84	32.62	8.51	8.36	53.04	85.3				
		4	18.67	33.05	8.63	8.35	50.49	84.3			2.2	1.6
5	923	0	19.91	32.71	8.14	8.38	56.67	86.8	11	3.3	3.1	1.8
3k WSW		1	19.87	32.79	8.32	8.38	54.53	85.9				
		2	19.62	32.91	8.40	8.38	53.15	85.4			0.7	1.9
		3	19.12	32.86	8.47	8.35	50.97	84.5				
		4	18.60	33.01	8.47	8.36	45.12	82.0			2.1	2.1
6	950	0	19.52	32.87	8.41	8.39	60.05	88.0	11	3.6	< 0.7	1.3
8k WSW		1	19.46	32.89	8.43	8.39	59.61	87.9				
		2	19.33	32.98	8.50	8.36	59.18	87.7			2.4	1.4
		3	19.09	33.18	8.39	8.25	37.70	78.4				
											< 0.7	1.4
7	1121	0	19.91	32.95	6.60	8.34	57.71	87.2	11	3.3	3.7	1.4
8k WSW		1	19.85	32.95	7.24	8.34	56.93	86.9				
		2	19.72	32.97	8.08	8.34	56.23	86.6			2.6	1.5
		3	19.32	32.97	8.04	8.33	54.89	86.1				
											< 0.7	1.4
8	820	0	19.87	32.83	8.17	8.38	60.66	88.3	11	4.2	5.7	1.6
3k WSW		1	19.81	32.83	8.37	8.37	60.45	88.2				
		2	19.62	32.77	8.37	8.36	60.78	88.3			4.7	1.6
		3	19.40	33.01	8.21	8.33	53.02	85.3				
		4	19.29	32.94	8.15	8.25	43.72	81.3			2.9	1.6

May 21, 1998 (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	913	0	19.74	32.42	7.76	8.23	56.98	86.9	12	2.6	3.7	1.4
3k WSW		1	19.77	32.90	7.67	8.25	57.36	87.0				
		2	19.32	32.97	7.98	8.28	47.30	82.9			4.0	1.3
		3	19.11	33.01	7.40	8.28	40.17	79.6				
		4	19.05	33.06	7.33	8.28	37.47	78.2			2.1	1.6
10	850	0	20.00	32.68	7.87	8.30	56.10	86.5	13	2.5	2.4	1.8
3k WSW		1	20.00	32.85	8.06	8.36	48.78	83.6				
		2	19.55	32.90	7.85	8.33	44.07	81.5			4.0	1.9
		3	19.44	32.97	7.79	8.29	41.40	80.2				
											2.1	2.6
11	901	0	19.88	32.48	8.11	8.35	64.66	89.7	11	3.3	6.7	1.4
3k WSW		1	19.94	32.71	8.11	8.36	62.43	88.9				
		2	19.37	32.87	8.30	8.36	55.81	86.4			2.2	1.3
		3	19.05	33.03	8.21	8.35	50.63	84.4				
		4	19.04	33.13	8.23	8.30	40.58	79.8			10.1	1.4
12	1040	0	20.65	24.54	7.40	8.37	38.64	78.8	16	1.8	6.0	3.1
8k WSW		1	19.79	30.42	7.52	8.33	38.25	78.6				
		2	18.31	33.01	9.23	8.27	42.98	81.0			4.7	3.3
13	735	0	18.60	11.64	6.30	7.80					18.1	6.7
18	810	0	19.74	32.80	7.93	8.38	54.87	86.1	11	3.7	5.1	1.7
3k WSW		1	19.71	32.82	8.07	8.38	58.93	87.6				
		2	19.58	32.83	8.23	8.37	59.97	88.0			< 0.7	1.5
19	755	0	19.10	33.12	7.80	8.29					4.9	1.9
20	840	0	19.99	32.59	7.47	8.28	47.14	82.9	12	2.5	8.4	3.6
3k WSW		1	19.72	32.81	7.60	8.28	42.99	81.0				
											4.1	2.2
22	720	0	20.29	26.42	6.70	7.80					15.8	6.7
25	1110	0	20.01	32.79	7.17	8.35	58.90	87.6	12	3.1	7.2	2.5
8k WSW		1	19.96	32.80	7.70	8.36	57.34	87.0				
		2	19.33	32.67	7.96	8.36	56.58	86.7			5.0	1.5
		3	18.47	32.97	8.37	8.34	48.16	83.3				
		4	18.34	33.22	8.26	8.31	30.15	74.1			5.4	1.6
	Average		19.31	32.29	8.02	8.32	50.7	84.2	12.1	3.0	4.5	2.1
	Number		66	66	66	66	63	63	15	15	44	44
	St. Dev.		0.65	2.91	0.51	0.10	7.5	3.2	1.3	0.6	3.8	1.1
	Maximum		20.65	33.23	9.23	8.40	64.7	89.7	16	4.2	18.1	6.7
	Minimum		17.24	11.64	6.30	7.80	30.2	74.1	11	1.8	0.7	1.3

Surface Bacteriological Water Data and General Observations June 4, 1998

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Pt. Cloudy	Pers.: J. Gelsinger	High	639	3.5
RAIN:	None	M. Meyer	Low	1223	1.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1033	500	110	< 2	Moderate turbidity.
2	1022	270	140	< 2	Moderate turbidity. New flag at entrance.
3	1012	70	70	< 2	Moderate turbidity. Moderate flow from tidal gate. Fishermen on jetty.
4	1101	< 20	< 20	< 2	Moderate turbidity.
5	940	20	< 20	2	Moderate turbidity.
6	954	< 20	< 20	< 2	Moderate turbidity.
7	1122	20	< 20	< 2	Moderate turbidity.
8	827	170	< 20	< 2	Moderate turbidity.
9	929	20	< 20	17	Moderate turbidity.
10	905	800	110	170	Moderate turbidity. Many jellyfish in water column.
11	921	70	< 20	< 2	Moderate turbidity.
12	1041	3000	270	5	High turbidity. Thick algae and much trash in water. Night herons on breakwall.
13	730	> 16000	70	110	Moderate turbidity. Moderate flow from tidal gate. Trash, many jellyfish in water. Squirrels nearby.
18	802	70	20	2	Moderate turbidity.
19	746	230	230	2	Moderate turbidity.
20	850	800	< 20	11	Moderate turbidity. Many jellyfish in water column.
22	715	> 16000	260	29	Moderate turbidity.
25	1111	< 20	< 20	< 2	Moderate turbidity.
	Average	2116.7	81.1	20.3	
	Number	18	18	18	
	St. Dev.	5099.3	88.3	45.3	
	Maximum	16000	270	170	
	Minimum	20	20	2	

Physical Water Quality Data June 4, 1998

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Pt. Cloudy	Pers.: J. Gelsinger	High	639	3.5
RAIN:	None	M. Meyer	Low	1223	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	1033	0	18.91	29.15	8.13	8.34	53.20	85.4	11	3.0	3.1	3.1
5k 245		1	18.68	32.61	8.03	8.34	53.94	85.7				
		2	17.88	33.10	8.20	8.36	59.02	87.6			< 0.7	1.7
		3	17.88	33.29	7.96	8.39	60.54	88.2				
2	1022	0	19.87	32.58	7.53	8.38	55.02	86.1	11	2.9	12.9	1.6
5k 245		1	19.88	33.10	7.98	8.38	52.49	85.1				
		2	19.72	33.18	7.91	8.37	50.66	84.4			15.5	1.6
		3	18.92	33.01	8.14	8.37	48.31	83.4				
		4	18.90	33.27	8.16	8.38	50.54	84.3			3.8	1.8
3	1012	0	19.63	33.17	6.55	8.30	48.31	83.4	12	2.3	4.5	2.1
5k 245		1	19.74	33.28	6.63	8.30	46.14	82.4				
		2	19.39	33.31	6.69	8.31	44.91	81.9			15.8	2.4
		3	18.25	32.87	6.84	8.31	44.05	81.5				
		4	17.73	33.48	7.09	8.33	34.43	76.6			8.4	2.7
4	1101	0	20.95	33.22	7.58	8.31	56.67	86.8	11	3.1	1.4	1.9
5k 245		1	20.84	33.16	7.63	8.31	56.19	86.6				
		2	20.38	33.04	7.72	8.32	55.58	86.3			1.1	2.1
		3	19.68	33.08	7.77	8.32	54.60	86.0				
		4	18.37	33.18	8.00	8.33	51.05	84.5			1.7	2.0
5	940	0	20.77	33.14	7.54	8.31	52.49	85.1	11	3.0	7.8	1.8
5k 245		1	20.77	33.14	7.67	8.31	52.30	85.0				
		2	20.46	33.20	7.71	8.32	52.55	85.1			< 0.7	1.7
		3	20.12	33.13	7.62	8.32	50.40	84.3				
		4	19.12	33.12	7.69	8.31	47.47	83.0			1.1	1.7
6	954	0	20.33	33.28	7.76	8.34	56.78	86.8	11	2.9	< 0.7	1.4
5k 245		1	20.29	33.23	7.71	8.34	55.24	86.2				
		2	20.14	33.23	7.71	8.34	53.61	85.6			1.9	1.4
		3	20.01	33.28	7.74	8.33	53.28	85.4				
		4	20.00	33.30	7.48	8.29	49.20	83.8			< 0.7	1.5
7	1122	0	21.04	33.29	6.60	8.25	56.23	86.6	11	3.2	1.3	1.4
5k 245		1	21.00	33.27	6.55	8.26	55.67	86.4				
		2	20.71	33.19	6.69	8.26	55.40	86.3			7.0	1.2
		3	20.34	33.17	6.75	8.25	54.94	86.1				
											2.9	1.3
8	827	0	20.55	33.25	6.96	8.28	49.31	83.8	12	2.5	6.5	1.2
5k 245		1	20.54	33.25	7.28	8.28	49.31	83.8				
		2	20.44	33.23	7.42	8.28	48.37	83.4			0.8	1.1
		3	20.32	33.23	7.22	8.28	47.10	82.8				
		4	20.26	33.30	7.07	8.26	45.62	82.2			8.9	1.1

June 4, 1998 **(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	929	0	20.82	32.81	6.68	8.19	41.47	80.2	13	2.3	8.1	1.1
5k 245		1	20.98	33.40	6.82	8.21	45.69	82.2				
		2	20.58	33.13	6.89	8.27	35.56	77.2			28.3	1.1
		3	20.42	33.24	6.59	8.25	30.85	74.5				
											9.4	1.1
10	905	0	20.79	32.78	7.20	8.27	46.37	82.5	11	2.4	9.9	1.6
5k 245		1	20.99	33.46	6.86	8.27	45.62	82.2				
		2	20.81	33.09	7.05	8.30	44.25	81.6			15.2	1.6
		3	20.65	33.16	7.14	8.29	39.45	79.3				
		4	20.62	33.18	7.29	8.25	30.88	74.5			21.7	1.6
11	921	0	20.65	32.99	5.64	8.29	56.18	86.6	12	2.7	5.7	1.4
5k 245		1	20.66	33.06	5.13	8.29	53.36	85.5				
		2	20.62	33.14	6.70	8.29	51.26	84.6			7.6	0.9
		3	20.31	33.20	6.81	8.27	40.53	79.8				
		4	20.25	33.28	6.69	8.27	36.64	77.8			5.4	1.0
12	1041	0	20.61	20.79	9.62	8.43	19.16	66.2	16	1.4	< 0.7	3.4
5k 245		1	19.31	32.66	8.93	8.40	2.27	38.8				
		2	17.85	33.30	9.50	8.33	38.16	78.6			< 0.7	4.8
13	730	0	20.46	26.82	7.42	8.24					9.1	2.8
18	802	0	20.53	33.27	6.76	8.26	54.42	85.9	11	3.0	3.2	0.8
5k 245		1	20.53	33.26	6.70	8.27	54.08	85.8				
		2	20.46	33.24	6.69	8.27	52.55	85.1			3.3	0.8
		3	20.44	33.26	6.74	8.27	52.10	85.0				
											6.7	0.9
19	746	0	19.80	33.77	7.02	8.24					2.3	1.2
20	850	0	20.60	32.64	6.92	8.22	64.92	89.8	12	2.1	< 0.7	2.8
5k 245		1	20.84	33.11	7.13	8.22	54.80	86.0				
		2	20.90	33.08	6.98	8.26	42.27	80.6			1.4	1.3
22	715	0	19.80	22.75	7.56	8.00					2.9	6.0
25	1111	0	21.10	33.22	7.32	8.30	57.50	87.1	11	3.0	4.1	2.5
5k 245		1	21.01	33.23	7.53	8.31	57.48	87.1				
		2	20.49	33.03	7.38	8.30	57.79	87.2			8.8	1.7
		3	19.46	32.91	7.60	8.29	58.51	87.5				
		4	18.55	33.20	7.91	8.29	50.79	84.4			8.5	1.8
	Average		20.07	32.68	7.33	8.29	48.9	83.0	11.7	2.7	6.1	1.8
	Number		69	69	69	69	66	66	15	15	45	45
	St. Dev.		0.87	2.11	0.72	0.06	9.9	6.7	1.3	0.5	6.0	1.0
	Maximum		21.10	33.77	9.62	8.43	64.9	89.8	16	3.2	28.3	6.0
	Minimum		17.73	20.79	5.13	8.00	2.3	38.8	11	1.4	0.7	0.8

9.3. INFAUNAL SPECIES ABUNDANCE LIST

BENTHIC INFAUNA COLLECTED FROM 13 SEDIMENT STATIONS - OCTOBER 1997

PHYLUM
Subphylum
Class
Subclass
Division
Order
Suborder
Section
Family
Genus & species

	Station													Total per species
	1	2	3	4	5	6	7	8	9	10	11	12	25	
PORIFERA														
Porifera, unid.			1											1
CNIDARIA (COELENTERATA)														
ANTHOZOA														
Anthozoa, unid.		1	1				1						4	7
ACTINARIA														
Edwardsiidae														
Edwardsiidae, unid.				1	4								2	7
HYDROZOA														
Corymorpha palma									P					
Obelia sp.				P										
PLATHYHELMINTHES														
Polycladida sp. E			1	2			1							4
Stylochus exiguus				4						1			1	6
NEMERTEA														
Carinoma mutabilis	4			2	9									15
Cerebratulus sp.	1													1
Enopla													1	1
Lineidae, unid.			2									1		3
Micrura wilsoni			2										1	3
Paleonemertea													1	1
Paranemertes californica		5			2							2		9
Tetrastemma candidum													1	1
Tetrastemma nigrifrons			1											1
Tubulanus cingulatus				1										1
Tubulanus polymorphus			2	4										6
MOLLUSCA														
GASTROPODA														
PROSOBRANCHIA														
MESOGASTROPODA														
Calypteridae														
Crepidula naticarum			57											57

Crepidula onyx			2											2
Crepidula sp., juv.		1	1											2
NEOGASTROPODA														
Columbellidae														
Alia carinata		1	2											3
Mitrella tuberosa		1												1
Conidae														
Conus californica			5											5
Muricidae														
Ocenebra sp., juv.		2	7											9
Pteropurpura festiva			5											5
Nassariidae														
Nassarius perpinguis		1												1
Olividae														
Olivella baetica	1											3		4
CEPHALASPIDEA														
Acteonidae														
Rictaxis punctocaelatus	1			13									1	15
Bullidae														
Bulla gouldiana					1		1							2
Scaphandridae														
Acteocina inculta			6	1		3	3							13
BIVALVIA (PELECYPODA)														
Cardiidae														
Laevicardium substriatum		7	7	7								4	2	27
Cooperellidae														
Cooperella subdiaphana		1												1
Limidae														
Limaria hemphilli			1											1
Lucinidae														
Parvilucina tenuisculpta				1										1
Mactridae														
Mactra californica							1							1
Spisula catilliformis				1										1
Mytilidae														
Musculista senhousei					1		3		3				1	8
Mytilus galloprovincialis			13											13
Pectinidae														
Leptopecten latiauratus												1		1
Pharidae														
Ensis myrae	1													1
Pyramidellidae														
Iselica ferostrata			1											1
Semelidae														
Semele sp.			2											2
Theora lubrica					1		1		1					3
Solecurtidae														

Tagelus subteres		35	56	21	1							35	39	187
Tellinidae														
Leporimetis obesa			19		1							26	6	52
Macoma nasuta			2		1							1	1	5
Tellina carpenteri		9	4	4								118	1	136
Tellina modesta	2		1	1										4
Ungulinidae														
Diplodonta orbella			1											1
Veneridae														
Protothaca staminea			15			1	5					24	4	49
Venerupis philippinarum												2		2
SIPUNCULIDA														
Apionosoma misakiana			32	4						1				37
Siphonosoma ingens			1											1
ASCHELMINTHES														
Nematoda, unid.		415	420	2							2	3856		4695
ANNELIDA														
OLIGOCHAETA														
Oligochaeta, unid.	4	159	105	5		5	8	12	6	3	2		41	350
POLYCHAETA														
Ampharetidae														
Melinna oculata			1	2										3
Arabellidae														
Arabella incolor.	1													1
Capitellidae														
Capitella capitata	1	10	6				1					3		21
Mediomastus acutus		1	2	5					1					9
Mediomastus californiensis,			266	100	40	20	8	6	21		22	43	117	643
Mediomastus spp.	26	19	478	422	29	18	96	106	27	9	20	338	596	2184
Notomastus nr. hemipodus = sp.1		1	21									104	2	128
Notomastus tenuis		2			1									3
Chaetopteridae														
Chaetopterus variopedatus		1												1
Mesochaetopterus sp			13											13
Spiochaetopterus costarum		1												1
Chrysopetalidae														
Paleanotus bellis		3	4											7
Cirratulidae														
Aphelochaeta multifilis	71	2		200	27	232	309	31	75	27	118		184	1276
Chaetozone nr. setosa	2		4											6
Cirriformia sp. 1	34		8	7		8	161		2		19		2	241
Monticellina sp.				1										1
Cossuridae														
Cossura candida				1									2	3
Dorvilleidae														
Dorvillea longicornis	19	2	49	3		27	46	29	9	3	5	12	39	243
Flabelligeridae														

Pherusa capulata			28	4	1	1	10		2				2	48
Glyceridae														
Glycera americana				2								2		4
Glycera convoluta	6													6
Goniadidae														
Goniada littorea	2		1											3
Hesionidae														
Podarke pugettensis			1											1
Lumbrineridae														
Lumbrineris californiensis	1													1
Lumbrineris erecta			2	1		4		12	8	10				37
Lumbrineris zonata				3	9						1			13
Lumbrineris sp. C (Harris)		3	11	41	41	6	6		14	9	5		45	181
Lumbrineris sp.		3	17	6	11	3		11	3	6	1	4	6	71
Maldanidae														
Metasychis disparidentatus						1								1
Euclymeninae, unid.			2	2									1	5
Nephtyidae														
Nephtys caecoides	1			3			1							5
Nereididae														
Neanthes acuminata	4	80	23	2		3	14	1		1	6	25		159
Nereis latescens												2		2
Platynereis bicanaliculata	1	1												2
Onuphidae														
Diopatra ornata	1	11					1					6		19
Diopatra splendidissima		1												1
Opheliidae														
Armandia brevis	4	49	2	1			2					6		64
Polyophthalmus pictus		6	1	3								2		12
Orbiniidae														
Leitoscoloplos pugettensis	3		5	16	2	22	23	30	14	3	15		17	150
Naineris dentritica											1			1
Scoloplos acmeceps	1		10	3		9	4	1			2	1	2	33
Oweniidae														
Owenia collaris	4			1										5
Paraonidae														
Acmira sp.	1													1
Phyllodocidae														
Eulalia californiensis			53									3		56
Eulalia quadrioculata												1		1
Phyllodoce hartmanae		1												1
Pilargidae														
Pilargis sp. 2 (Harris)	1													1
Poecilochaetidae														
Poecilochaetus johnsoni			5											5
Polynoidae														
Lepidonotinae			2											2

Malmgreniella sp.				1										1
Polynoidae, unid.			1											1
Sabellidae														
Chone mollis			6	1										7
Euchone limnicola	6			57	61	6	78	8	26	4	12		11	269
Potamilla sp.							4							4
Serpulidae														
Crucigera websteri			1											1
Hydroides gracilis			15											15
Spionidae														
Apoprionospio pygmaea	7	1		1										9
Polydora cornuta		20		1		1				3			4	29
Prionospio heterobranchia	4	46	76	56	29	4	5	32	10		3	55	65	385
Prionospio lighti		2	1	2				3	1	7		6		22
Pseudopolydora paucibranchiata	4	42	4	42	66	1	55	5		5	2	26	399	651
Scolelepis occidentalis	1		6	10	2	5	2	5	2		1		1	35
Spiophanes bombyx	2													2
Spiophanes duplex			2											2
Spiophanes missionensis		1		3								1	3	8
Streblospio benedicti								11	1	1			5	18
Syllidae														
Autolytus sp.			1										2	3
Exogone sp. A	2	44	50	48			7	2			1	12	246	412
Odontosyllis phosphorea		1										1		2
Streptosyllis sp.						1								1
Syllis (Typosyllis) sp.	1		1											2
Terebellidae														
Amaeana occidentalis			1	1										2
Nicolea gracilibranchus		1												1
Pista alata			1											1
Polycirrus sp.1 (Banse)			1											1
Polycirrus sp.			2											2
Streblosoma crassibranchia				1										1
ARTHROPODA														
CRUSTACEA														
CYCLOPOIDEA														
Cyclopoidea, unid.		4	2									35	1	42
HARPACTICOIDEA														
Harpactiocoida, unid.		1	1									1	2	5
OSTRACODA														
Bathyleberis sp.			4	1	23								45	73
MALACOSTRACA														
EUCARIDA														
DECAPODA														
Alpheidae														
Alpheus californiensis			2		1								2	5
Callianassidae														

Neotrypaea californiesis					1									1
Neotrypaea sp.													1	1
Crangonidae														
Crangon alaskensis	1													1
Majidae														
Pyromaia tuberculata		2												2
Paguridae														
Paguridae, unid.			8											8
Xanthidae														
Lophopanopeus bellus			8											8
Malacoplax californiensis				2										2
EUMALACOSTRACA														
PERACARIDA														
AMPHIPODA														
CAPRELLIDEA														
Aeginellidae														
Mayerella banksia	2			63	5	25	4	36		4	7	1	24	171
GAMMARIDEA														
Aoridae														
Grandidierella japonica		2			22	7	1	1		1	2	1		37
Rudilemboides stenopropodus			16	1	82			1				1	8	109
Corophiidae														
Monocorophium sp.										1				1
Isaeidae														
Amphideutopus oculatus													2	2
Ischyroceridae														
Cerapus tubularis	1													1
Ericthonius brasiliensis		5										6		11
Megaluropidae														
Gibberosus myersi							1							1
Melitidae														
Elasmopus bampo			6				3					1		10
Maera vigota			1											1
Oedicerotidae														
Hartmanodes hartmanae											1			1
Synchelidium shoemakeri	1													1
Phoxocephalidae														
Eobrolgus spinosus		1											2	3
Eyakia calcaratus					4									4
Rhepoxinius menziesi	1													1
Pleustidae														
Parapleustes sp.			1											1
Podoceridae														
Podocerus brasiliensis						1	2	3						6
Synopiidae														
Tiron biocellata		2												2
CUMACEA														

Anchicolurus occidentalis												1		1
Oxyurostylis pacifica		9	2	1								12	1	25
ISOPODA														
Anthuridae													1	1
Uromunna ubiquita												1		1
Paracerceis sculpta												1		1
Paranathura elegans			2	1	1		1					4		9
Synidotea hartfordi		2												2
MYSIDACEA														
Deltamysis sp. A					16									16
STOMATOPODA														
Squilla palita											1			1
TANAIDACEA														
Pseudotanais sp.													3	3
Zeuxo normani	3	6			1	3	8					15		36
CHELICERATA														
PYCNOGONIDA														
Anoropallene palpida		1												1
Anoplodactylus erectus		1	1											2
ECHINODERMATA														
OPHIUROIDEA														
Amphiodia urtica													1	1
Amphiuridae, unid.	2			1	1									4
Dendraster excentricus	4													4
PHORONIDA														
Phoronis sp.	21	1	40	4	1	9	134		15		43		10	278
ECTOPROCTA														
Thalamoporella californica			P											
CHORDATA														
HEMICHORDATA														
Enteropneusta, unid.	1													1
VERTEBRATA														
OSTEICHTHYS														
Gobiidae														
Clevelandia ios										1				1
Fish larvae											232			232
Gobiidae, unid.				1										1
Ilypnus gilberti		2				1					1	1	2	7
Total number of species per station	45	55	87	62	34	28	37	21	20	20	26	47	53	182
Total abundance per station	262	1032	2053	1202	498	427	1011	346	241	100	525	4807	1963	14467

9.4. FISH SPECIES ABUNDANCE LIST

TABLE 9-1. AGE AND FREQUENCY OF FISH OBSERVED DURING DIVE TRANSECTS AT THREE HARBOR STATIONS - OCT. 1997 AND MAY 1998

		May 1998 SAMPLING STATIONS											
SCIENTIFIC NAME	COMMON NAME	North Jetty				Break wall				South Jetty			
Reef Species		Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Anisotremus davidsonii	Sargo											2	
Damalichthys vacca	Pile Surfperch					3							
Embiotoca jacksoni	Black Surfperch					6	4	2		1			
Girella nigricans	Opaleye		1	5		42	7	4		1		37	
Halichoeres semicinctus	Rock Wrasse					4	20	10		1			
Hermosilla azurea	Zebraperch			18		2							
Hypsopsetta guttulata	Diamond Turbot									1			
Hypsypops rubicundus	Garibaldi					6		1					
Medialuna californiensis	Halfmoon					6							
Oxyjulis californica	Senorita					7							
Paralabrax clathratus	Kelp Bass					6	2	8				15	
Paralabrax nebulifer	Barred Sand Bass					5		5			1		7

		Oct. 1997 SAMPLING STATIONS											
SCIENTIFIC NAME	COMMON NAME	North Jetty				Break wall				South Jetty			
Reef Species		Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Anisotremus davidsonii	Sargo						3						
Atherinops affinis	Topsmelt						1050				200	3	
Cheilotrema saturnum	Black Croaker					14							
Chromis punctipinnis	Blacksmith							221	830				
Damalichthys vacca	Pile Surfperch												
Embiotoca jacksoni	Black Surfperch			1		7	6	1			3	5	
Girella nigricans	Opaleye		2	48	10	2	3	65				8	
Halichoeres semicinctus	Rock Wrasse					5	1	7				3	
Hermosilla azurea	Zebraperch			4			2						
Heterostichus rostratus	Giant Kelpfish					1					1		
Hypsoblennius gilberti	Rockpool Blenny	3											
Hypsypops rubicundus	Garibaldi							8				4	
Medialuna californiensis	Halfmoon					2		1					
Micrometrus minimus	Dwarf Surfperch	1											
Oxyjulis californica	Senorita							1		1			
Osteichthys	Unk. juv. fish (yellow)			1									
Paralabrax clathratus	Kelp Bass					5	3	2			1	3	1
Paralabrax nebulifer	Barred Sand Bass					12	11	7			19	10	
Xenistius californiensis	Salema		2	19	74			43				5090	

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. 1997 AND MAY 1998.

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 - October 1997

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number identified	Stan. Abundance (Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
5B	5.96	TOTAL LARVAE		296	1764.16	
		Gobiidae type A/C	YS	4	23.84	2.2 - 2.3 mm
		Gobiidae type A/C	NL	105	625.8	95 @ 2.1 - 2.9 mm
						10 @ 3.0 - 3.8 mm
		Gobiidae type A/C	FL	3	17.88	4.1 - 5.0 mm
		Gobiidae type A/C	SL	9	53.64	4 @ 5.1 - 5.7 mm
						3 @ 6.1 - 6.4 mm
						7.8, 8.7 mm
		Hypsoblennius	NL	175	1043	2.0 - 2.4 mm
		TOTAL EGGS		30	178.8	
		Citharichthys	EG	2	11.92	St. VIII - IX
		Unidentified	EG	28	166.88	
8S	10.44	TOTAL LARVAE		70	730.8	
		Gobiidae type A/C	YS	3	31.32	2.4 - 2.5 mm
		Gobiidae type A/C	NL	6	62.64	2.6 - 2.7 mm
		Hypsoblennius	NL	61	636.84	2.0 - 2.5 mm
		TOTAL EGGS		3	31.32	
		Unidentified	EG	3	31.32	
8B	5.76	TOTAL LARVAE		349	2010.24	
		Gobiidae type A/C	YS	12	69.12	2.1 - 2.5 mm
		Gobiidae type A/C	NL	155	892.8	151 @ 2.3 - 2.9 mm
						4 @ 3.0 - 3.4
		Gobiidae type A/C	FL	1	5.76	4.6 mm
		Hypsoblennius	NL	180	1036.8	2.0 - 2.4 mm
		Hypsopsetta guttulata	NL	1	5.76	2.5 mm
		TOTAL EGGS		0	0	

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

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number identified	Stan. Abundance (Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
1S	5.85	TOTAL LARVAE		11	64.35	
		Engraulis mordax	YS	1	5.85	2.30
		Gobiidae type A/C	NL	7	40.95	2.2 - 2.6
		Hypsoblennius	NL	3	17.55	2.2 - 2.3
		TOTAL EGGS		93	544.05	
		Citharichthys	EG	9	52.65	St. VIII & IX
		Engraulis mordax	EG	2	11.70	St. VIII
		Paralichthys californicus	EG	1	5.85	St. IX
		Pleuronichthys	EG	1	5.85	damaged
		Egg type 32	EG	4	23.40	St. VII
		Egg type 71	EG	1	5.85	St. X, ?*Hypsopsetta guttulata*
		Unidentified	EG	75	438.75	
1B	6.52	TOTAL LARVAE		413	2692.76	
		Gobiidae type A/C	YS	3	19.56	2.0 - 2.1
		Gobiidae type A/C	NL	341	2223.32	2.0 - 2.9
		Gobiidae type A/C	SL	2	13.04	5.9, 8.3 (? *Ilypnus gilberti*)
		Gobiesox rhessodon	NL	4	26.08	2 @ 2.7 - 2.9
						2@ 3.0 - 3.2
		Hypsoblennius	NL	62	404.24	1.9 - 2.4
		Paraclinus integripinnis	NL	1	6.52	3.5
		TOTAL EGGS		42	273.84	
		Citharichthys	EG	11	71.72	St. XI
		Engraulis mordax	EG	1	6.52	St. VIII
		Pleuronichthys ritteri	EG	1	6.52	?St. II
		Symphurus atricauda	EG	4	26.08	St. VII
		Egg type 32	EG	6	39.12	St. VII, I
		Unidentified	EG	19	123.88	
5S	8.01	TOTAL LARVAE		7	56.07	
		Gobiidae type A/C	NL	6	48.06	2.1 - 2.4 mm
		Hypsoblennius	NL	1	8.01	2.4 mm
		TOTAL EGGS		15	120.15	
		Citharichthys	EG	1	8.01	St. VIII
		Unidentified	EG	14	112.14	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 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	14-Oct-97	1442	5.85	1.6	9.36	Copepods	Sort: D. Oda 6Jan98 11 LV, 93 EG
							Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG
1B	14-Oct-97	1294	6.52	3.0	19.55	Mysids, zoea	Sort: D. Oda 7Jan98 413 LV, 42 EG
							Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG
5S	14-Oct-97	1053	8.01	1.4	11.21	Copepods	Sort: D. Oda 8Jan98 7 LV, 15 EG
							Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG
5B	14-Oct-97	1415	5.96	5.4	32.18	Mysid, copepod, zoea,	Sort: D. Oda 8Jan98 296 LV, 30 EG
						caprellid, nemertean	Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG
8S	14-Oct-97	808	10.44	2.2	22.96	Copepods	Sort: D. Oda 8Jan98 70 LV, 3 EG
							Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG
8B	14-Oct-97	1463	5.76	6.0	34.58	Copepods, nemerteans	Sort: D. Oda 8Jan98 349 LV, 0 EG
							Sortcheck: R. Feeney 8Jan98 0 LV, 0 EG

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1998						
Ichthyoplankton data						
					Stan. Abundance	
Sample Code	Standardization Factor	Taxon	Stage	Number identified	(Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
2S	7.07	TOTAL LARVAE		38	268.66	
		Atherinopsis californiensis	YS	1	7.07	7.7 mm
		Gillichthys mirabilis	NL	1	7.07	3.5 mm
		Gobiidae type A/C	YS	6	42.42	2.3 - 2.8 mm
		Gobiidae type A/C	NL	4	28.28	2.3 - 2.5 mm
		Hypsoblennius	NL	25	176.75	2.4 - 2.9 mm
		Leuresthes tenuis	YS	1	7.07	5.4 mm
		TOTAL EGGS		106	749.42	
		Anchoa delicatissima	EG	13	91.91	Stage II
		Egg type 32	EG	62	438.34	Stages II & VII
		Unidentified	EG	31	219.17	
2B	5.17	TOTAL LARVAE		41	211.97	
		Gobiidae type A/C	YS	3	15.51	4.9 - 5.1 mm
		Gobiidae type A/C	NL	27	139.59	10 @ 4.5 - 4.9, 13 @ 5.0 - 5.9,
						2 @ 6.0 - 6.9, 2 @ 7.0 - 7.3 mm
		Hypsoblennius	NL	10	51.7	9 @ 5.0 - 5.7, 1 @ 6.2 mm
		Leuresthes tenuis	YS	1	5.17	6.2 mm
		TOTAL EGGS		255	1318.35	
		Anchoa delicatissima	EG	2	10.34	Stage IV
		Atherinidae	EG	2	10.34	Stage VI and damaged (? st. II)
						See note on identification
		Egg type 32	EG	224	1158.08	Stages II & VII
		Unidentified	EG	27	139.59	
5S	8.23	TOTAL LARVAE		27	222.21	
		Gobiidae type A/C	YS	3	24.69	4.7, 5.5, 5.9 mm
		Gobiidae type A/C	NL	1	8.23	5.0 mm (damaged)
		Hypsoblennius	NL	23	189.29	10 @ 4.5 - 4.9, 12 @ 5.0 - 5.9,
						1 @ 6.0 mm
		TOTAL EGGS		31	255.13	
		Anchoa delicatissima	EG	19	156.37	Stages II & III
		Unidentified	EG	12	98.76	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1998						
Ichthyoplankton data						
					Stan. Abundance	
Sample Code	Standardization Factor	Taxon	Stage	Number identified	(Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
5B	6.04	TOTAL LARVAE		467	2820.68	
		Gobiesox rhessodon	NL	1	6.04	3.7 mm
		Gobiidae type A/C	YS	7	42.28	2.2 - 2.8 mm
		Gobiidae type A/C	NL	352	2126.08	317 @ 2.0 - 2.9, 33 @ 3.0 - 3.9,
						2 @ 4.1 - 4.4 mm
		Gobiidae type A/C	FL	1	6.04	5.2 mm
		Hypsoblennius	NL	106	640.24	49 @ 4.6 - 4.9, 53 @ 5.0 - 5.9,
						4 @ 6.0 mm
		TOTAL EGGS		30	181.2	
		Anchoa delicatissima	EG	17	102.68	Stages II & III
		Atherinidae	EG	2	12.08	Stages II (?) & X, see note on ID
		Unidentified	EG	11	66.44	
8S	7.95	TOTAL LARVAE		10	79.5	
		Gobiidae type A/C	NL	4	31.8	2 @ 2.8, 2 @ 3.2 mm
		Hypsoblennius	NL	6	47.7	2.5 - 2.8 mm
		TOTAL EGGS		2	15.9	
		Unidentified	EG	2	15.9	
8B	7.90	TOTAL LARVAE		5	39.5	
		Gobiidae type A/C	YS	2	15.8	2.0, 2.5 mm
		Gobiidae type A/C	NL	2	15.8	2.3, 3.1 mm
		Hypsoblennius	NL	1	7.9	2.5 mm
		TOTAL EGGS		4	31.6	
		Anchoa delicatissima	EG	1	7.9	Stage III
		Atherinidae	EG	3	23.7	2 @ stage X, 1 damaged

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1998							
Raw data, standardization factors, sorting data							
					Standardized		
Sample	Date	Flowmeter	Standardization	Wet Plankton	Plankton volume	Primary	
Code	collected	reading	Factor	volume (ml)	(ml/1000m³)	Zooplankton Types	Sorting Record
2S	1-May-98	1192	7.07	2.6	18.39	copepods, crab zoea	Sort: 2June98
							106 EG, 38 LV
							Sort Check:17June98
							0 EG, 0 LV
2B	1-May-98	1632	5.17	18.4	95.07	copepod, amphipod, isopod,	Sort: 4-5June98
						mysid,caprellid,polychaetes	255 EG, 41 LV
						with polychaete tubes	Sort Check:17June98
							0 EG, 0 LV
5S	1-May-98	1025	8.23	1.6	13.16	copepod, crab zoea, mysid	Sort: 2-4June98
							31 EG, 27 LV
							Sort Check: 17June98
							0 EG, 0 LV
5B	1-May-98	1397	6.04	19.6	118.30	copepod, polychaetes with	Sort:7-10June98
						polychaete tubes	30 EG, 465 LV
							Sort Check: 17June98
							0 EG, 1 LV
8S	1-May-98	1060	7.95	1.2	9.55	copepod, crab zoea, mysid,	Sort:4June98
						caprellid, juv. aurelia	2 EG, 10 LV
							Sort Check: 17June98
							0 EG, 0 LV
8B	1-May-98	1067	7.90	35.7	282.12	polychaetes with tubes	Sort:10-11June98
							4 EG, 5 LV
							Sort Check: 17June98
							0 EG, 0 LV