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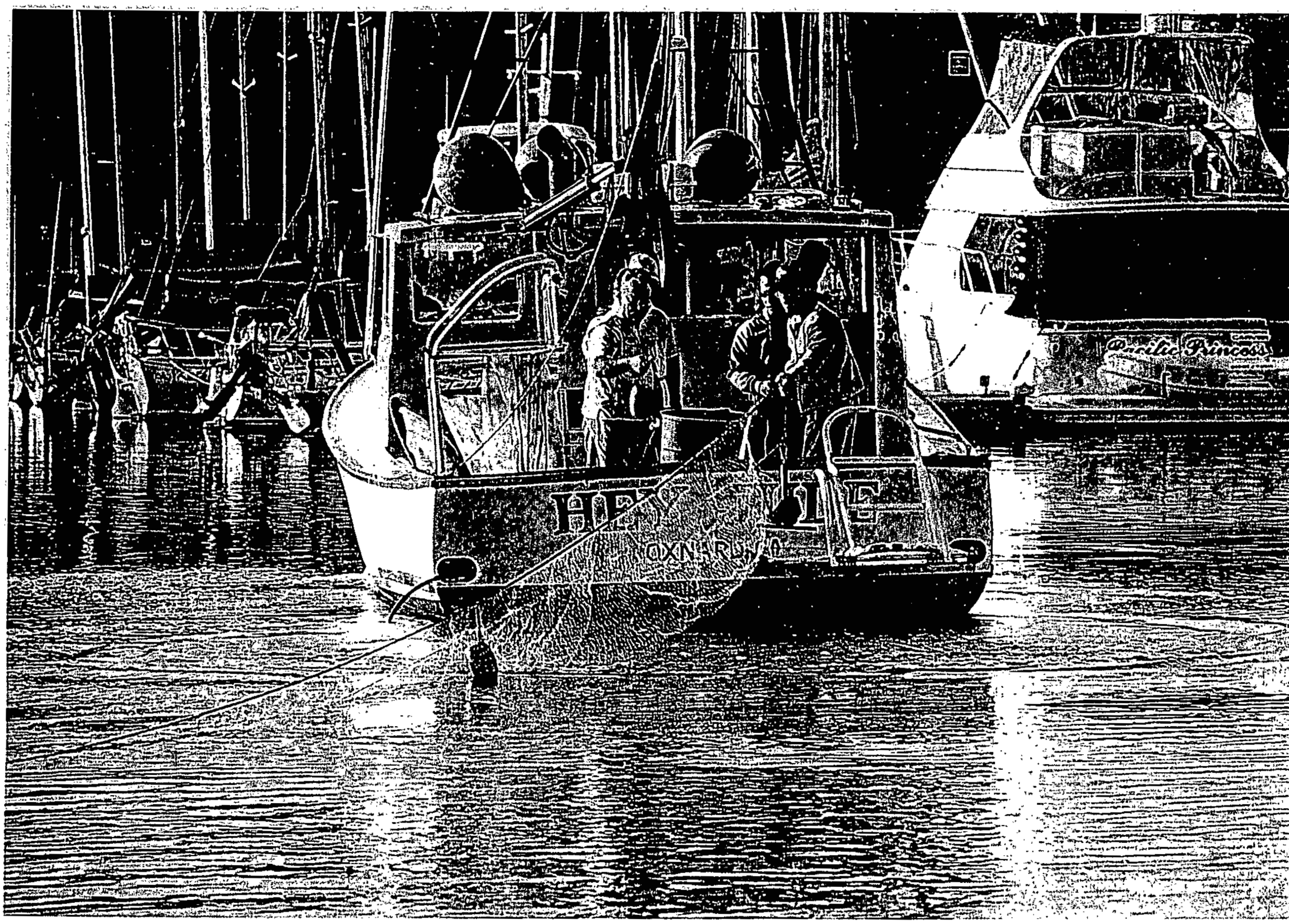
The Marine Environment of Marina del Rey Harbor
July 1999 - June 2000



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

by

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AQUATIC BIOASSAY & CONSULTING LABORATORIES, INC.

TOXICITY TESTING • OCEANOGRAPHIC RESEARCH

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December 8, 2000

Mr. Larry Charness
County of Los Angeles
Dept. of Beaches and Harbors
13837 Fiji Way
Marina del Rey, CA 90292

Dear Mr. Charness:

The scientists and staff of Aquatic Bioassay are pleased to present this report of the 1999-2000 marine surveys of Marina del Rey Harbor.

This report covers the period of field and laboratory studies conducted from July 1, 1999 through June 30, 2000. The 1999-2000 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

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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, 1999 to June 30, 2000. The program 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. This year's weather was characterized by cooler water and low rainfall. Thus winter and spring rains had a smaller influence upon Harbor waters when compared to other, rainier years. Winter and spring precipitation lowered water clarity, salinity, and pH and increased ammonia, bacterial counts, and possibly biochemical oxygen demand (BOD) throughout the Harbor. The influence upon the phytoplankton community was generally limited to the spring. No red tide blooms were observed this year, although water clarity was sufficiently reduced in May to delay the dive surveys until June. As expected, seasonal temperature changes in the ocean impacted the Harbor, causing colder water in the winter and warmer water in the summer and fall.

Stations near the Harbor entrance are impacted by both the open ocean and Ballona Creek. Open ocean influences included relatively low temperatures and moderately high dissolved oxygen and pH. Ballona Creek caused lower salinity and water clarity and high ammonia, BOD, and bacterial counts. Stations in the lower main channel were most like the open ocean and were thus the most natural in the Harbor. They were characterized by high dissolved oxygen, pH, and water clarity and low values of ammonia, BOD, and bacteria. As always, the areas further back into the Marina were warmer, more saline, lower in dissolved oxygen, etc.

Flows from Oxford Lagoon affected Basin E and the upper end of the main channel. Affects included reduced water clarity, dissolved oxygen, and salinity and elevated levels of ammonia, BOD, and bacteria. Similar to last year, Basin D, which includes Mother's Beach, appeared less affected by surface runoff than in the recent past. Slightly lower values in salinity, water clarity, and pH suggests that there may be a small freshwater input into Basin F (Station 9).

Bacterial measurements were made monthly at 18 stations (648 measurements in the year). Total coliform limits were exceeded 27 times, fecal coliform limits 35 times, and enterococcus limits 22 times. The total exceedances (84) were down from last year's numbers (104 exceedances). Among these 84 exceedances, 77 (92%) can be attributable to flows from either Ballona Creek or Oxford Lagoon. With the exception of total coliforms in the fall, the frequency of exceedances was within the range of the past eight years.

Physical Characteristics of Benthic Sediments. Physical characteristics of Harbor sediments (median particle size and sorting) were influenced by energy of water flow that is influenced by Harbor configuration and rainfall intensity. The affect of current and wave action near the entrance created sediments that were universally coarse and narrow in range. A finer, more heterogeneous mix of sediments was found in the back bay areas. Sediments in Oxford Lagoon had characteristics that were primarily sand but had a wide range of sediment types, suggesting that the flow regime in these areas is intermittent. In the northwest portion of the Harbor, the sediment regime was very fine and, atypically, very narrow. This may indicate that no coarse material is getting to this area at all.

Chemical Characteristics of Benthic Sediments. Ballona Creek and, to a lesser degree, Oxford Lagoon appear to be sources of chlorinated hydrocarbons such as DDT and derivatives and other chlorinated pesticides. As usual, PCB's were below detection this year. Among chlorinated hydrocarbons listed as toxic by NOAA, 13 of 15 Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 2 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. These ratios are considerably improved over last year when all stations showed "potential" toxicity, and 7 stations were considered "probably" toxic. Most chlorinated compounds have continued to remain lower than historical values, and levels are much lower those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Heavy metals tended to be higher in the main channel and Basin F. Their source is most likely the resident boat population itself. All stations, except Station 1 at the Harbor entrance, exceeded at least one metal limit of "possible" toxicity, and 8 out of 15 exceeded at least one metal limit of "probable" toxicity. Metal concentrations in Marina del Rey sediments do not appear to have greatly increased or decreased since 1985. Levels of copper, lead, mercury, and zinc in Marina del Rey were about three to five 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. Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals.

Biological Comparisons of Benthic Sediments. Infaunal population measurements made in most of the channel and upper Harbor yielded relatively high to moderate infaunal values. Areas associated with Oxford Lagoon, Ballona Creek, and possibly Venice Canal tended to show evidence of community disturbance. Infaunal community health did not appear to be strongly related to stations' benthic grain size patterns nor to any specific chemical compound, with the possible exception of higher levels of chlorinated hydrocarbons associated with Oxford Lagoon and Ballona Creek. Nematode worms that are known to be characteristic of highly disturbed benthic sediments dominated sediments from Station 12 (3,692 individuals) and Stations 2 (15,467 individuals). Mid-channel stations were the healthiest in the Harbor.

When compared to Los Angeles Harbor, Marine del Rey infaunal abundances were higher (probably due to the huge numbers of nematodes collected at some stations), as were numbers of species. Infaunal index values were about the same, and diversity values were lower, but like heavy metals may be dependent upon reduced circulation in Marina del Rey Harbor when compared to Los Angeles Harbor. Overall, infaunal variables were mostly comparable to past results.

Fish Populations. 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. 48,937 total fish of all age groups, representing 57 different species were recorded. The majority of these were eggs, larvae, or juveniles, which attest to the Harbor's importance as a nursery. In general, abundance and species counts were typical of past years for all strata of fish. The exception was the seine at Mother's Beach in the spring, which collected over 1000 jellyfish and greatly reduced the fish count. The fall haul had no jellyfish, and fish counts were normal. Our gill net sampling continues to only catch an occasional wayward fish, except when a whole school of topsmelt or jacksmelt encounters the net. This coming year, we will attempt to try some midwater trawls in addition to the gill net sampling in order to see if we can augment the capture of midwater 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.

2. INTRODUCTION

2.1. SCOPE AND PERIOD OF PERFORMANCE

This report covers the period of field and laboratory studies conducted from July 1, 1999 through June 30, 2000, 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.

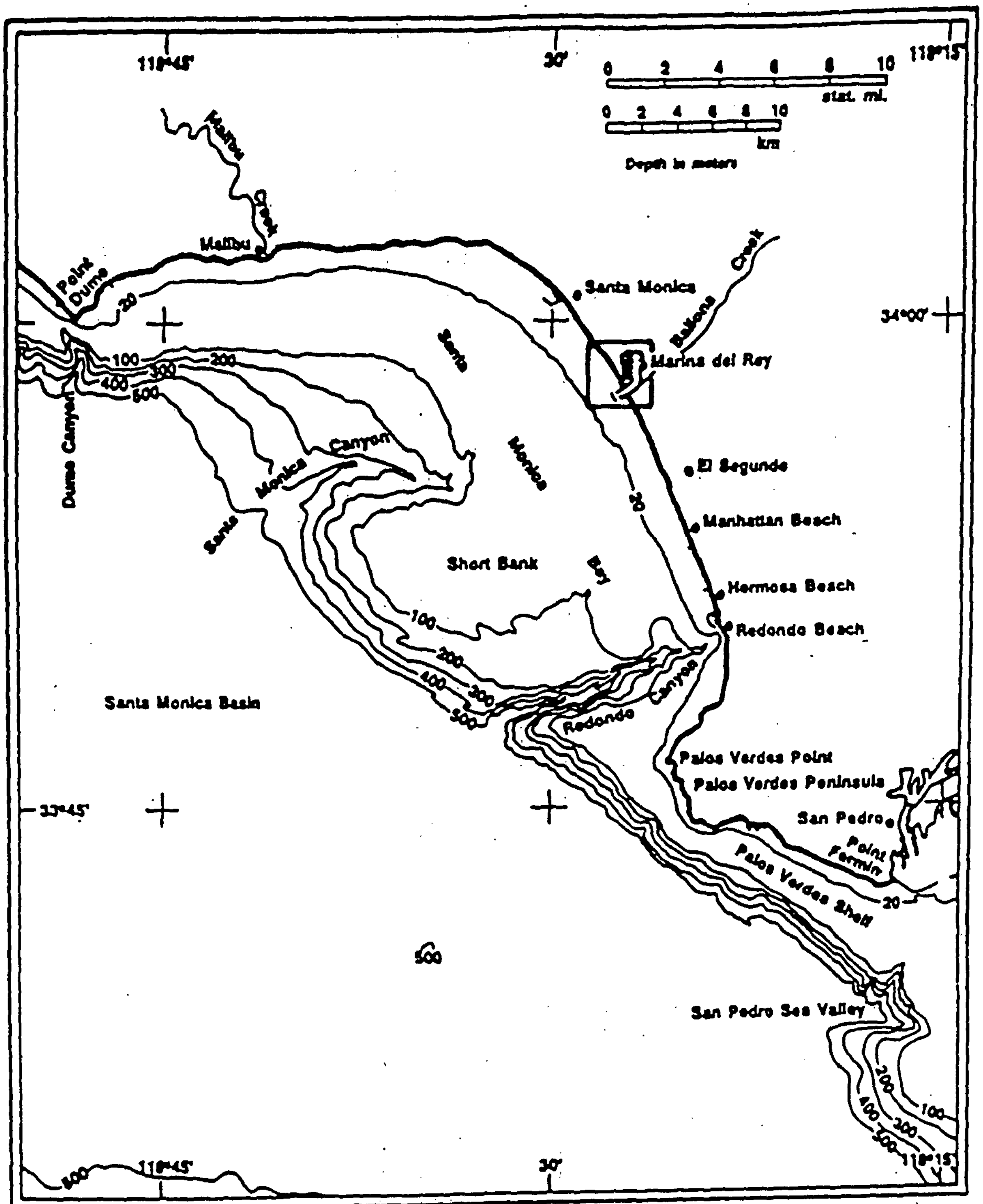
2.2. HISTORY OF THE SURVEY PROJECT

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 1997,1998, 1999).

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. Channelizing for the benefit of development to control urban flooding controlled natural 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.

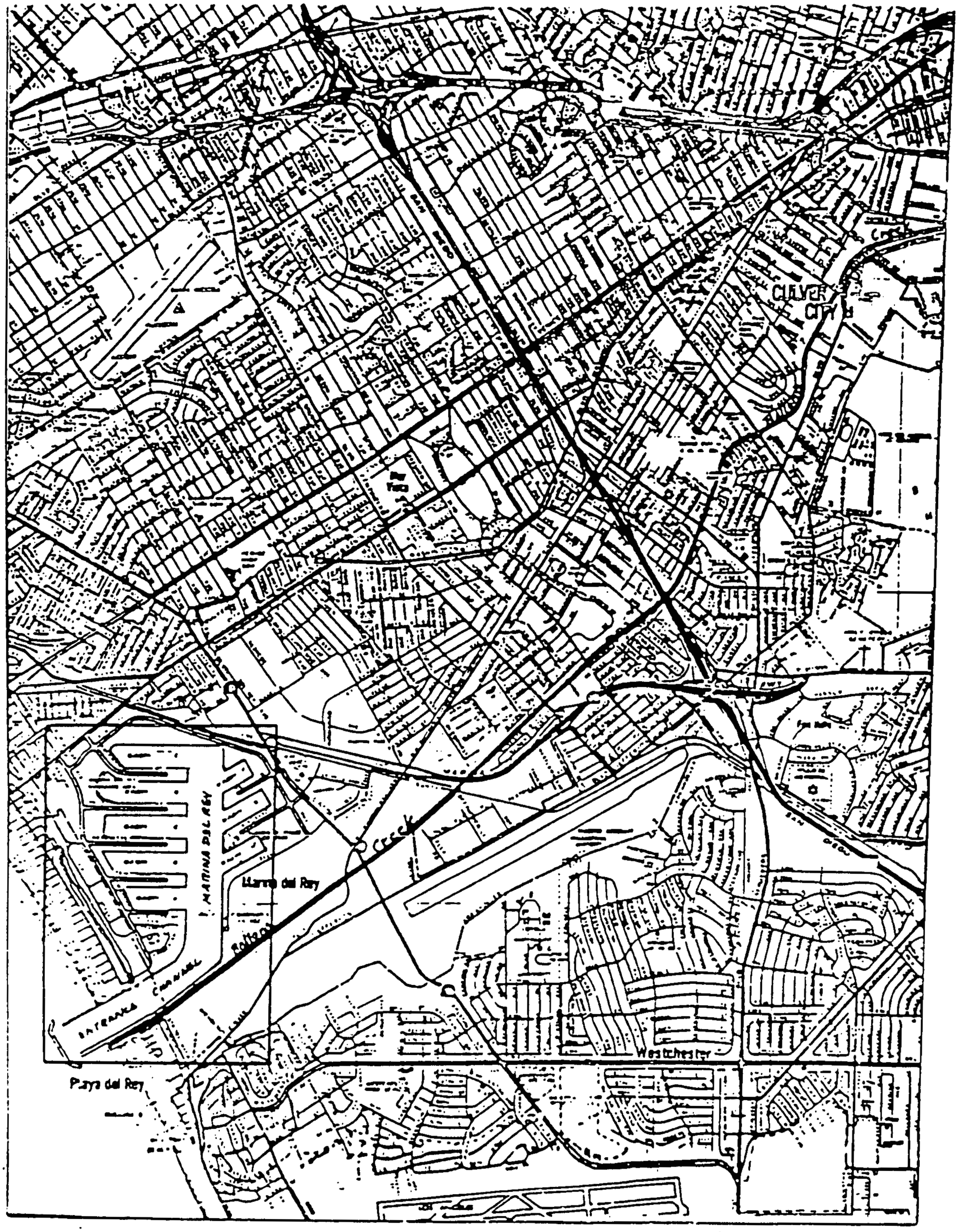
The present configuration was believed to be adequate to protect boats without a breakwater, but this was disproved not long after the marina opened, when southwest swells from a winter storm damaged docks and vessels. Thus the present breakwater was added several years later. This protected vessels but also reduced flushing, which in turn reduced ecological conditions within the marina. A rocky reef structure, however, was added 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. High concentrations of organotins, which can be toxic in very low concentrations, have been steadily declining. The decline may relate to the fact that organotins have recently been banned from the harbor.

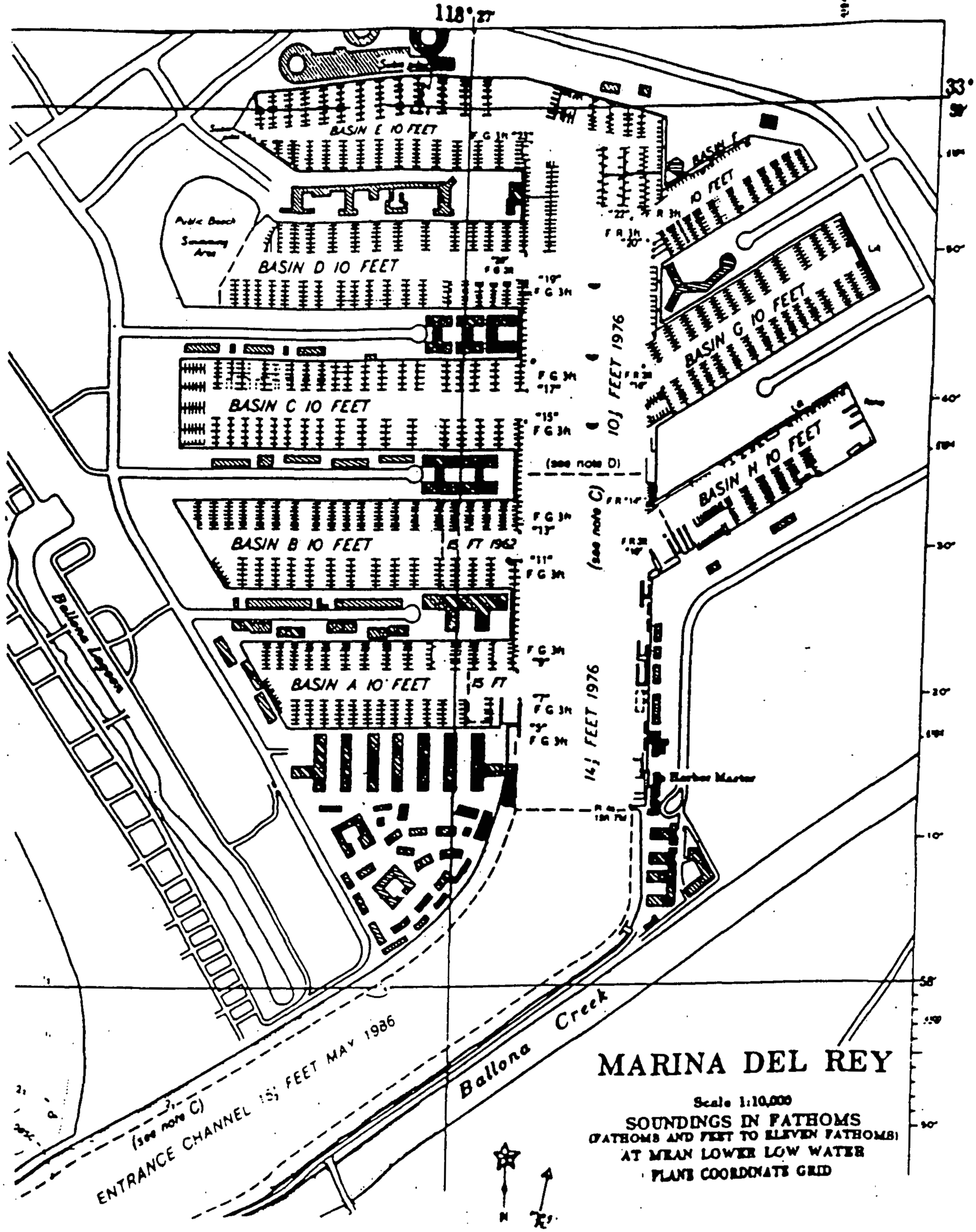
Pesticides occur in concentrations that are inhibitory to some organisms, especially reproductive stages. The levels of pesticides have been declining, however. Polychlorinated biphenyls (PCBs) have appeared episodically at toxic levels. Some terrestrial soils in areas to the north of the marina are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

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 and often recolonize disturbed areas. Areas influenced by Ballona Creek are often dominated by nematodes. More normal fauna through succession replace them 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 110 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. Floating trash flushed from storm drains that accumulates at the breakwater and south jetty after rains often marks its flow pattern. 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.

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.

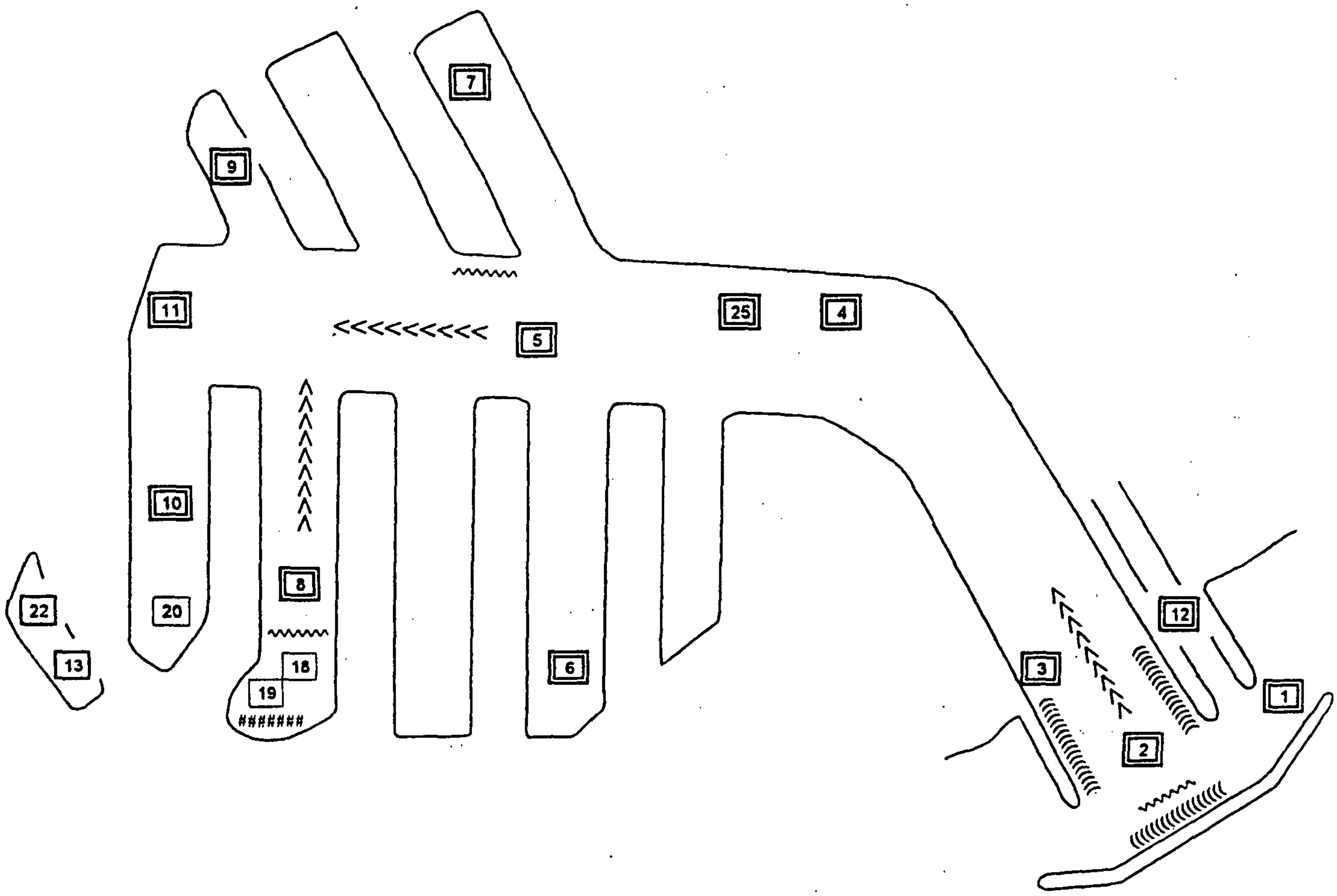
2.5. STATION LOCATIONS AND DESCRIPTIONS

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 breakwall 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). Depth during 2000 increased to about 7 meters due to dredging early in the year.

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. Tidal action, winds, and weak longshore currents influence it. 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. Similar to MDR 1, dredging early in 2000 increased the depth to about 7 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 are intermittently present in this area.

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. Large vessels there obstruct the flow. 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 lifeguards, 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 drains and periodic rainstorm events, the aquatic conditions in Marina del Rey Harbor are mostly dominated by the oceanographic conditions in the Southern California Bight. The mean circulation in the Southern California Bight is controlled 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 occurrences of the El Nino Southern Oscillation (ENSO), 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, and NOAA) program monitors sea surface temperatures off the West Coast of the United States and then compares them to long-term means. Coastal Watch data shows that in 1995-96, water temperatures were slightly higher with temperatures 2° C above normal for most months and 3° C above normal for February through May (Soule et. al. 1997). During 1996-97, temperatures remained high in the Southern California Bight (1° to 4° C above normal) from July through October 1996. During November and December 1996, temperatures were near normal, however temperatures had begun to climb again in 1997 with water temperatures averaging 5° C above normal in June. The 1997-98 survey year was characterized by a very strong ENSO anomaly. Surface water temperatures averaged from 2° (in April 1998) to 5° C (August through December 1997) above normal. During 1998-99, surface water temperatures were from 2° to 4° C above normal July to September but were from 0° to 3° C *below* normal for the remainder of the year (November through June). This trend continued through 1999-2000. From July 1999 through March 2000, average temperatures ranged from 0.5° to 2.5 ° C below normal. During both April and May 2000, the temperature was normal, and in June 2000, the average was 1.5 ° C above normal.

Seasonal variability can include changes in 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 that, 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, 1999 through June 30, 2000. The rainfall for this period (10 inches) was well below normal (13 inches, SCCWRP 1973), as well as what has been normal for the past 20 years (21 inches, Figure 3-1 as modified from Soule, et. al. 1997). As is characteristic of southern California, nearly all of the precipitation fell between November and April (Figure 3-2).

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

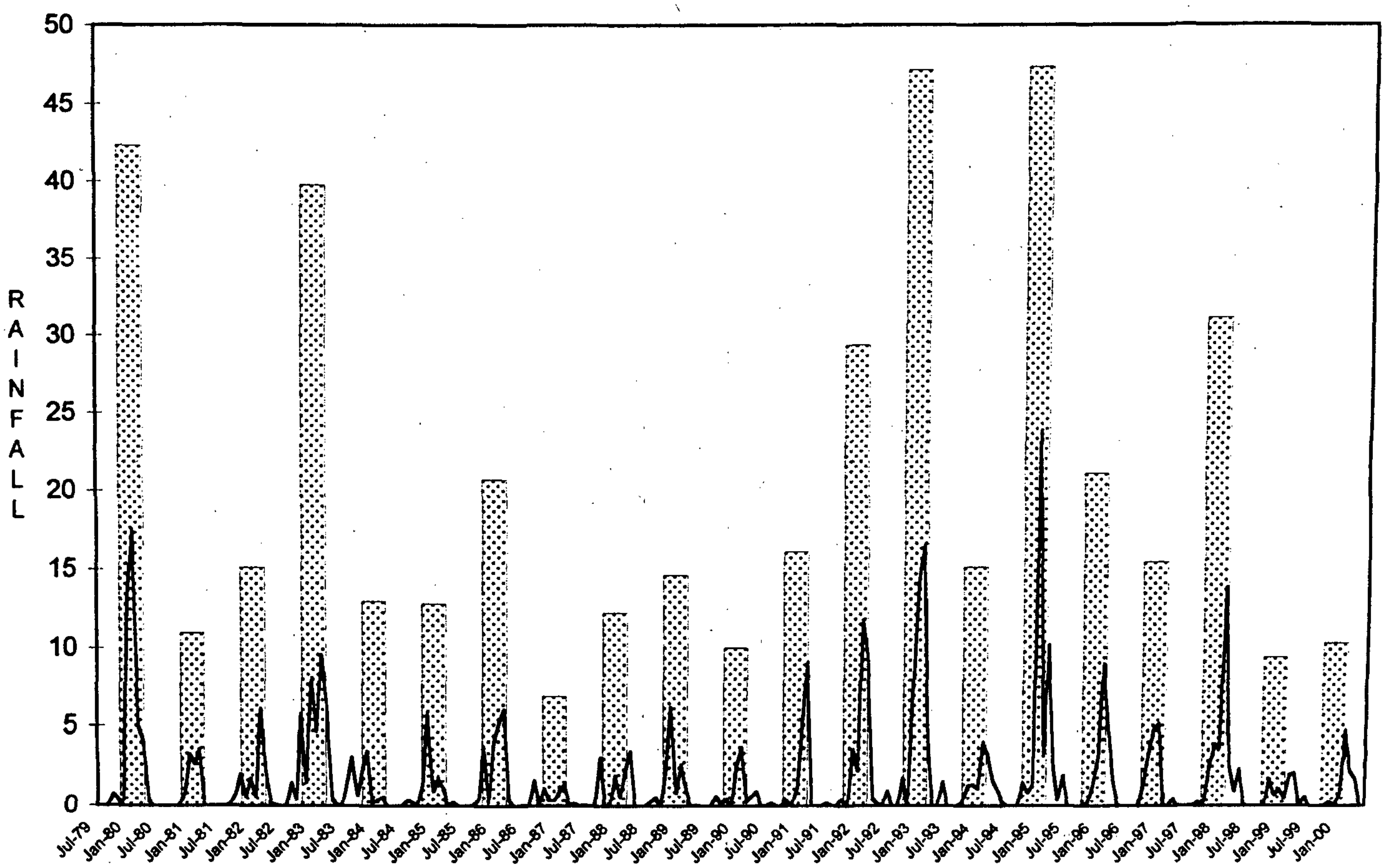
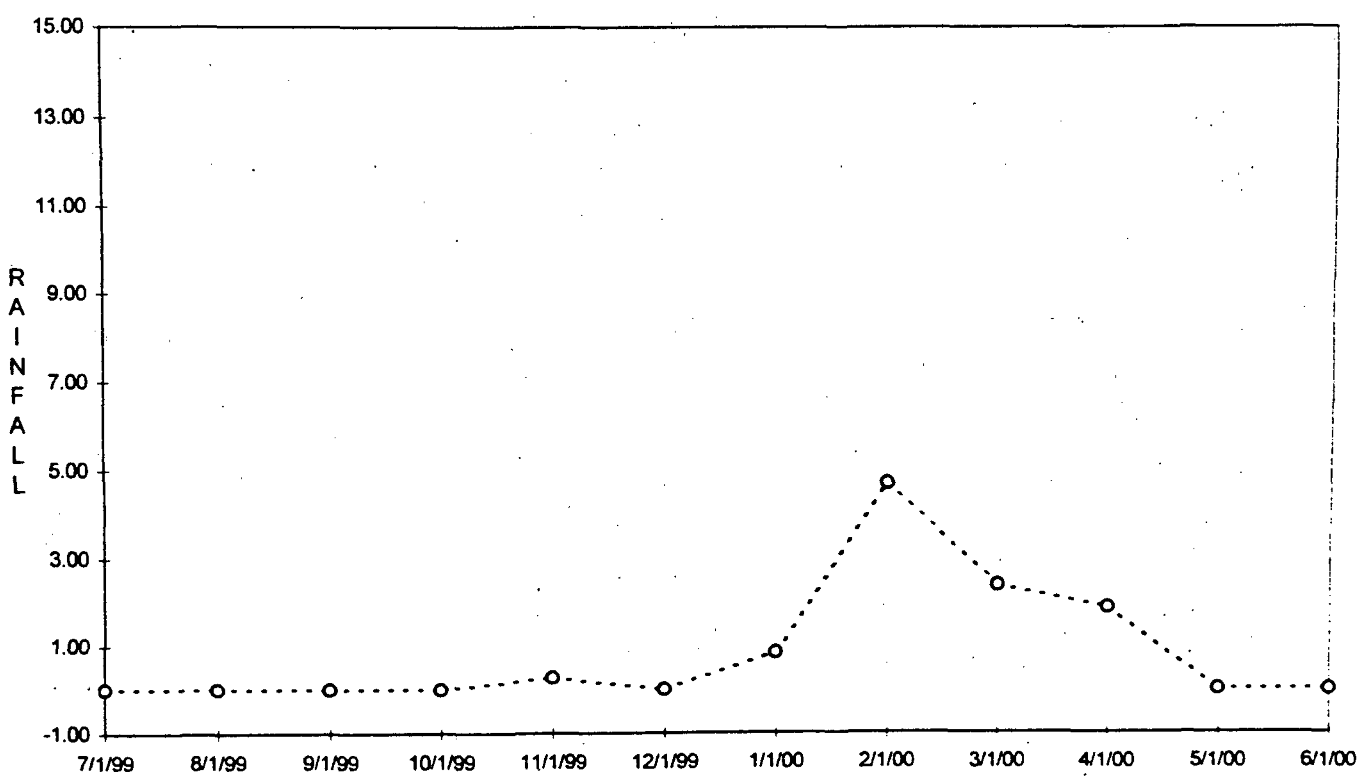


FIGURE 3-2. LOS ANGELES AIRPORT RAINFALL (INCHES).



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 from July through December (0.00 to 0.28 inches). The first rainfall of the season occurred between January 23 through 25 (0.62 inches) followed by a small rain on January 30 and 31 (0.21 inches). Two groups of storms occurred in February: February 8 through 16 (1.43 inches) and February 20 through 27 (2.74 inches). March had one storm early in the month: March 3 through 9 (2.39 inches), and April also only had rainfall during one part of the month: April 17 and 18 (1.88 inches). There was no precipitation during May and June.

Rainfall during this sampling period (10 inches) was low, but not as low as last year (9 inches, Figure 3-1). The wettest month of the sampling season was February (4.71 inches), followed by March (2.39 inches), April (1.88 inches), and November (0.28 inches) (see Figure 3-2). One water column sampling survey occurred immediately following trace precipitation (February 4 - Table 3-1).

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 and 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.

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

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

DATE	PRECIP.
7/1/99	0.00
7/2/99	0.00
7/3/99	0.00
7/4/99	0.00
7/5/99	0.00
7/6/99	0.00
7/7/99	0.00
7/8/99	Trace
7/9/99	0.00
7/10/99	0.00
7/11/99	0.00
7/12/99	0.00
7/13/99	0.00
7/14/99	0.00
7/15/99	0.00
7/16/99	0.00
7/17/99	0.00
7/18/99	0.00
7/19/99	0.00
7/20/99	0.00
7/21/99	0.00
7/21/99	*Survey*
7/22/99	0.00
7/23/99	0.00
7/24/99	0.00
7/25/99	0.00
7/26/99	0.00
7/27/99	0.00
7/28/99	0.00
7/29/99	0.00
7/30/99	0.00
7/31/99	0.00
Sum =	**0.00**

DATE	PRECIP.
9/1/98	0.00
9/2/98	0.00
9/3/98	0.00
9/4/98	0.00
9/5/98	0.00
9/6/98	0.00
9/7/98	0.00
9/8/98	0.00
9/9/98	0.00
9/10/98	0.00
9/11/98	0.00
9/12/98	0.00
9/13/98	0.00
9/14/98	0.00
9/15/98	0.00
9/16/98	0.00
9/17/98	0.00
9/18/98	0.00
9/19/98	0.00
9/20/98	0.00
9/21/98	0.00
9/22/98	0.00
9/23/98	0.00
9/24/98	0.00
9/25/98	0.00
9/26/98	0.00
9/27/98	0.00
9/28/98	0.00
9/29/98	0.00
9/29/99	*Survey*
9/30/98	0.00
Sum =	**0.00**

DATE	PRECIP.
11/1/98	0.00
11/2/98	0.00
11/3/98	0.00
11/3/99	*Survey*
11/4/98	0.00
11/5/98	0.00
11/6/98	0.00
11/7/98	0.00
11/8/98	0.27
11/9/98	0.00
11/10/98	0.00
11/11/98	0.00
11/12/98	0.00
11/13/98	0.00
11/14/98	0.00
11/15/98	0.00
11/16/98	0.00
11/17/98	0.01
11/18/98	0.00
11/19/98	0.00
11/20/98	Trace
11/21/98	0.00
11/22/98	0.00
11/23/98	0.00
11/24/98	0.00
11/25/98	0.00
11/26/98	0.00
11/27/98	0.00
11/28/98	0.00
11/29/98	0.00
11/30/98	0.00
Sum =	**0.28**

DATE	PRECIP.
1/1/00	0.00
1/2/00	0.00
1/3/00	0.00
1/4/00	0.00
1/5/00	0.00
1/5/00	*Survey*
1/6/00	0.00
1/7/00	0.00
1/8/00	0.00
1/9/00	0.00
1/10/00	0.00
1/11/00	0.00
1/12/00	0.00
1/13/00	0.00
1/14/00	0.00
1/15/00	Trace
1/16/00	0.01
1/17/00	0.01
1/18/00	0.00
1/19/00	0.00
1/20/00	0.00
1/21/00	0.00
1/22/00	0.00
1/23/00	Trace
1/24/00	0.01
1/25/00	0.61
1/26/00	0.00
1/27/00	0.00
1/28/00	0.00
1/29/00	0.00
1/30/00	0.19
1/31/00	0.02
Sum =	**0.85**

DATE	PRECIP.
3/1/00	0.00
3/2/00	0.00
3/2/00	*Survey*
3/3/00	0.29
3/4/00	0.01
3/5/00	1.14
3/6/00	0.04
3/7/00	Trace
3/8/00	0.88
3/9/00	0.03
3/10/00	0.00
3/11/00	0.00
3/12/00	0.00
3/13/00	0.00
3/14/00	0.00
3/15/00	0.00
3/16/00	0.00
3/17/00	0.00
3/18/00	0.00
3/19/00	0.00
3/20/00	0.00
3/21/00	0.00
3/22/00	0.00
3/23/00	0.00
3/24/00	0.00
3/25/00	0.00
3/26/00	0.00
3/27/00	0.00
3/28/00	0.00
3/29/00	0.00
3/30/00	0.00
3/31/00	0.00
Sum =	**2.39**

DATE	PRECIP.
5/1/00	0.00
5/2/00	0.00
5/3/00	0.00
5/4/00	0.00
5/5/00	0.00
5/6/00	0.00
5/7/00	0.00
5/8/00	0.00
5/9/00	0.00
5/10/00	0.00
5/11/00	0.00
5/12/00	0.00
5/13/00	0.00
5/14/00	0.00
5/15/00	0.00
5/16/00	0.00
5/17/00	0.00
5/18/00	0.00
5/19/00	0.00
5/20/00	0.00
5/21/00	0.00
5/22/00	0.00
5/23/00	0.00
5/24/00	0.00
5/25/00	0.00
5/25/00	*Survey*
5/26/00	0.00
5/27/00	0.00
5/28/00	0.00
5/29/00	0.00
5/30/00	0.00
5/31/00	0.00
Sum =	**0.00**

DATE	PRECIP.
8/1/99	0.00
8/2/99	0.00
8/3/99	0.00
8/4/99	0.00
8/5/99	0.00
8/6/99	0.00
8/6/99	*Survey*
8/7/99	0.00
8/8/99	0.00
8/9/99	0.00
8/10/99	0.00
8/11/99	0.00
8/12/99	0.00
8/13/99	0.00
8/14/99	0.00
8/15/99	0.00
8/16/99	0.00
8/17/99	0.00
8/18/99	0.00
8/19/99	0.00
8/20/99	0.00
8/21/99	0.00
8/22/99	0.00
8/23/99	0.00
8/24/99	0.00
8/25/99	0.00
8/26/99	0.00
8/27/99	0.00
8/28/99	0.00
8/29/99	0.00
8/30/99	0.00
8/31/99	0.00
Sum =	**0.00**

DATE	PRECIP.
10/1/98	0.00
10/2/98	0.00
10/3/98	0.00
10/4/98	0.00
10/5/98	0.00
10/6/98	0.00
10/7/98	0.00
10/8/98	0.00
10/9/98	0.00
10/10/98	0.00
10/11/98	0.00
10/12/98	0.00
10/13/98	0.00
10/14/98	0.00
10/15/98	0.00
10/16/98	0.00
10/17/98	0.00
10/18/98	0.00
10/19/98	0.00
10/20/98	0.00
10/20/99	*Survey*
10/21/98	0.00
10/22/98	0.00
10/23/98	0.00
10/24/98	0.00
10/25/98	0.00
10/26/98	0.00
10/27/98	0.00
10/28/98	0.00
10/29/98	0.00
10/30/98	0.00
10/31/98	0.00
Sum =	**0.00**

DATE	PRECIP.
12/1/99	0.00
12/2/99	0.00
12/2/99	*Survey*
12/3/99	0.00
12/4/99	0.00
12/5/99	0.00
12/6/99	0.00
12/7/99	0.00
12/8/99	0.00
12/9/99	0.00
12/10/99	0.00
12/11/99	0.00
12/12/99	0.00
12/13/99	0.00
12/14/99	0.00
12/15/99	0.00
12/16/99	0.00
12/17/99	0.00
12/18/99	0.00
12/19/99	0.00
12/20/99	0.00
12/21/99	0.00
12/22/99	0.00
12/23/99	0.00
12/24/99	0.00
12/25/99	0.00
12/26/99	0.00
12/27/99	0.00
12/28/99	0.00
12/29/99	0.00
12/30/99	0.00
12/31/99	Trace
Sum =	**0.00**

DATE	PRECIP.
2/1/00	0.00
2/2/00	0.00
2/3/00	0.00
2/4/00	Trace
2/4/00	*Survey*
2/5/00	0.00
2/6/00	0.00
2/7/00	0.00
2/8/00	Trace
2/9/00	0.00
2/10/00	0.31
2/11/00	0.05
2/12/00	0.51
2/13/00	0.39
2/14/00	0.17
2/15/00	0.00
2/16/00	0.54
2/17/00	0.00
2/18/00	0.00
2/19/00	0.00
2/20/00	0.66
2/21/00	1.18
2/22/00	Trace
2/23/00	0.73
2/24/00	Trace
2/25/00	Trace
2/26/00	0.00
2/27/00	0.17
2/28/00	0.00
2/29/00	0.00
Sum =	**4.71**

DATE	PRECIP.
4/1/00	0.00
4/2/00	0.00
4/3/00	0.00
4/4/00	0.00
4/5/00	0.00
4/6/00	0.00
4/7/00	0.00
4/8/00	0.00
4/9/00	0.00
4/10/00	0.00
4/11/00	0.00
4/12/00	0.00
4/12/00	*Survey*
4/13/00	0.00
4/14/00	Trace
4/15/00	0.00
4/16/00	0.00
4/17/00	1.32
4/18/00	0.56
4/19/00	0.00
4/20/00	0.00
4/21/00	0.00
4/22/00	0.00
4/23/00	0.00
4/24/00	0.00
4/25/00	0.00
4/26/00	0.00
4/27/00	0.00
4/28/00	0.00
4/29/00	0.00
4/30/00	0.00
Sum =	**1.88**

DATE	PRECIP.
6/1/00	0.00
6/2/00	0.00
6/3/00	0.00
6/4/00	0.00
6/5/00	0.00
6/6/00	0.00
6/7/00	0.00
6/8/00	0.00
6/9/00	0.00
6/10/00	0.00
6/11/00	0.00
6/12/00	0.00
6/13/00	0.00
6/14/00	0.00
6/15/00	0.00
6/16/00	0.00
6/17/00	0.00
6/18/00	0.00
6/19/00	0.00
6/20/00	0.00
6/21/00	0.00
6/22/00	0.00
6/23/00	0.00
6/24/00	0.00
6/25/00	0.00
6/26/00	0.00
6/27/00	0.00
6/27/00	*Survey*
6/28/00	0.00
6/29/00	0.00
6/30/00	0.00
Sum =	**0.00**

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

After all analyses were completed, the five water quality analyzer variables were correlated against the check samples measured or collected in the field: thermistor probe versus mercury thermometer, conductivity probe versus chloride titration, dissolved oxygen probe versus Winkler titration, field pH probe versus hand-held pH meter, and transmissometer versus Secchi disk. The Seabird Water Quality Analyzer was downloaded and water column graphs were generated. Two tables were also prepared containing the results of the physical, chemical, bacterial, and observational water measurements. Check sample correlations, water column graphs, and data tables were joined with a short narrative report and were presented to the Department of Beaches and Harbors monthly. The results and conclusions of all water column measurements and analyses are presented and summarized in Section 3.3 below. Appendix 9.2 presents all data and survey logs for the year.

3.3. RESULTS

3.3.1. Physical and Chemical Water Quality

3.3.1.1. **Temperature**

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

Vertical temperature patterns. Figure 3-3 depicts the minimum, average, and maximum temperatures for each station plotted against depth for 1999-2000. On the average, temperatures declined only slightly with depth overall. This suggests that thermal stratification in the Harbor is infrequent. Thermoclines were weakly developed in September, October, November, and June; and weakly to moderately developed in July, August, and April. Thermoclines were most frequent within the main channel and near the Harbor entrance.

Temperature patterns over the year. Figure 3-4 demonstrates the maximum, average, and minimum temperatures for the 18 water column stations over the sampling season in Marina del Rey Harbor. For the most part, seasonal patterns were similar among stations indicating the strong influence of the oceanographic conditions on the Harbor waters. Average temperatures during the beginning of the sampling season (July) were relatively high (about 21 to 23 deg C) at most stations. Beginning in August, average temperatures steadily declined until February (about 12 to 13 deg C). Temperatures then gradually climbed again through June (to about 20 deg C). This year, wider variability in temperature within months was recorded for stations near the Harbor entrance (1, 2, and 12) and in the main channel (5, 11, and 25). Ranges were widest in spring and summer, most likely due to temperature stratification.

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 (averages 18.1 to 18.3 deg C) were those furthest back in the Harbor (Stations 7, 8, 9, 10, 11, 13, 18, 20,and 22). Station 19 at Mothers Beach and stations near the entrance (Stations 1 and 2) averaged coldest (17.0 to 17.4 deg C). Average temperatures in Ballona Creek (Station 12), Basin B (Station 6), the main channel (Stations 3, 4, 5, and 25) were moderate (17.6 to 18.0 deg C). Station 19 at Mothers Beach averaged relatively cold because it is very shallow at this station, and the measurements are usually made early in the morning. Otherwise, the overall 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 1989 through summer 1999, 2) the overall seasonal ranges for the ten year period, and 3) the temperatures collected during 1999-2000. All 1999-2000 temperatures were within the overall seasonal ranges for the preceding ten years, except for the spring minimum, which was about one-half degree lower. Overall, this year's averages were similar to last year.

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

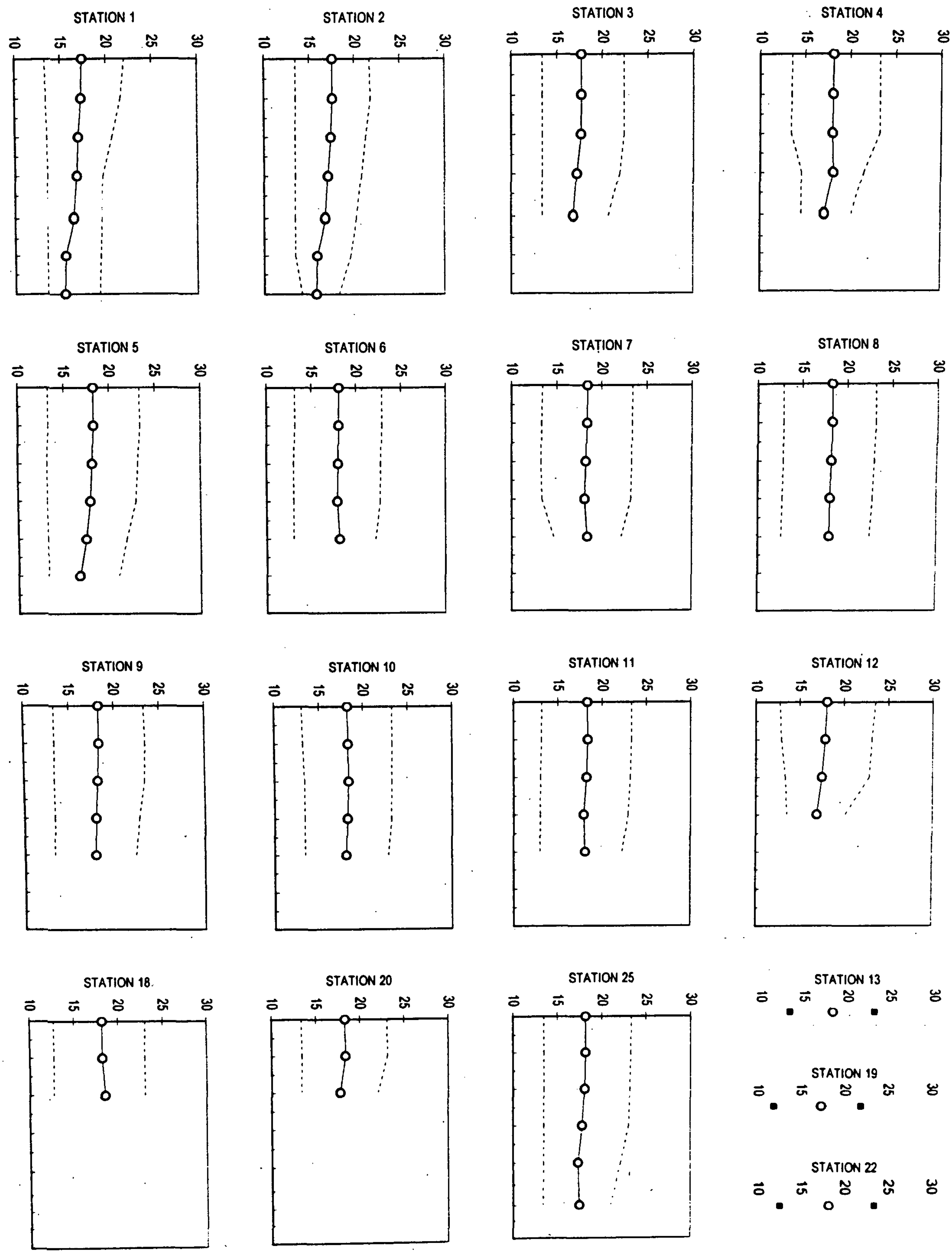


FIGURE 3-4. MINIMUM, AVERAGE, AND MAXIMUM TEMPERATURE (DEG C) VS. MONTH AT 18 WATER COLUMN STATIONS.

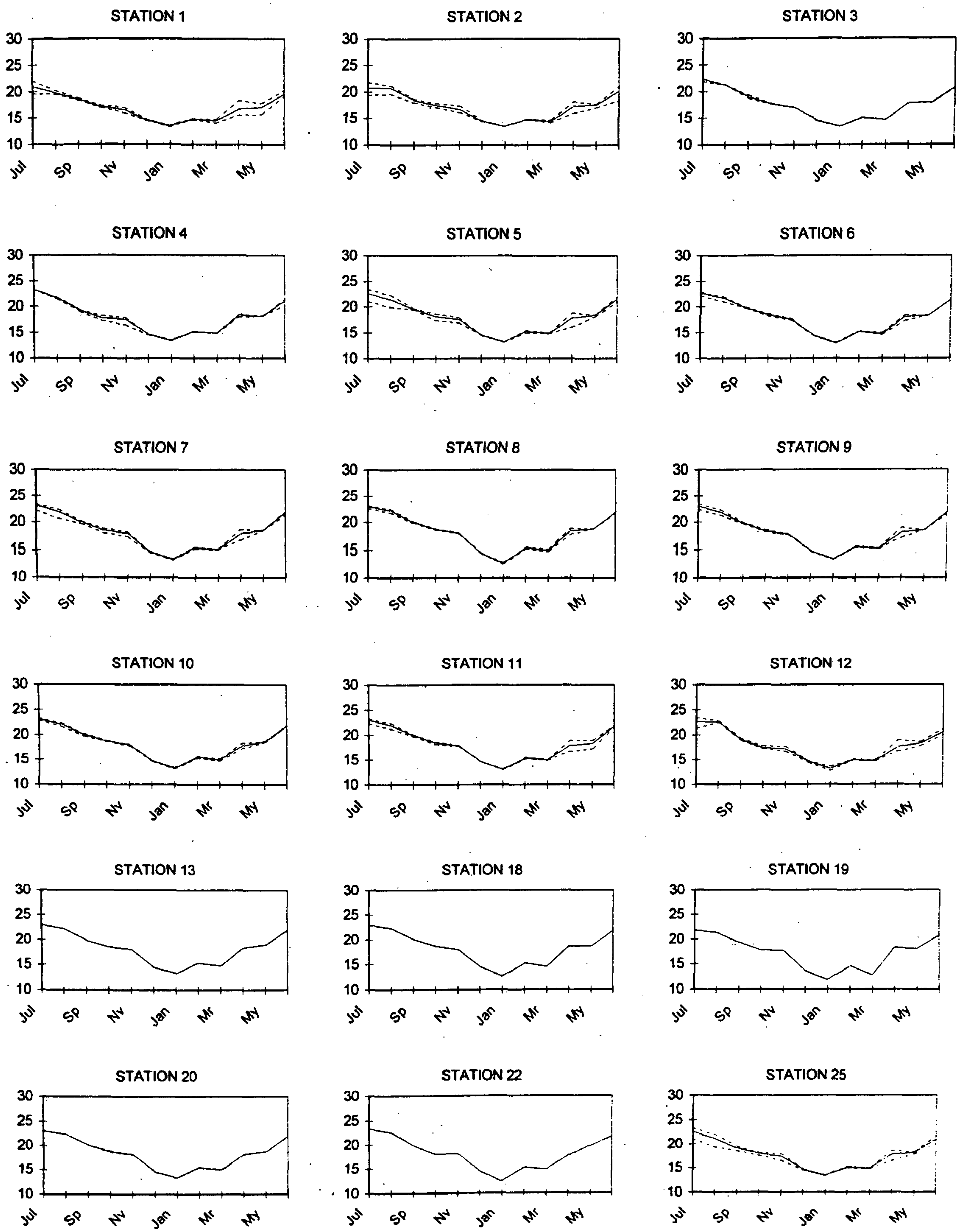


FIGURE 3-5. AVERAGE ANNUAL TEMPERATURE (DEG C) AT 18 WATER COLUMN STATIONS.

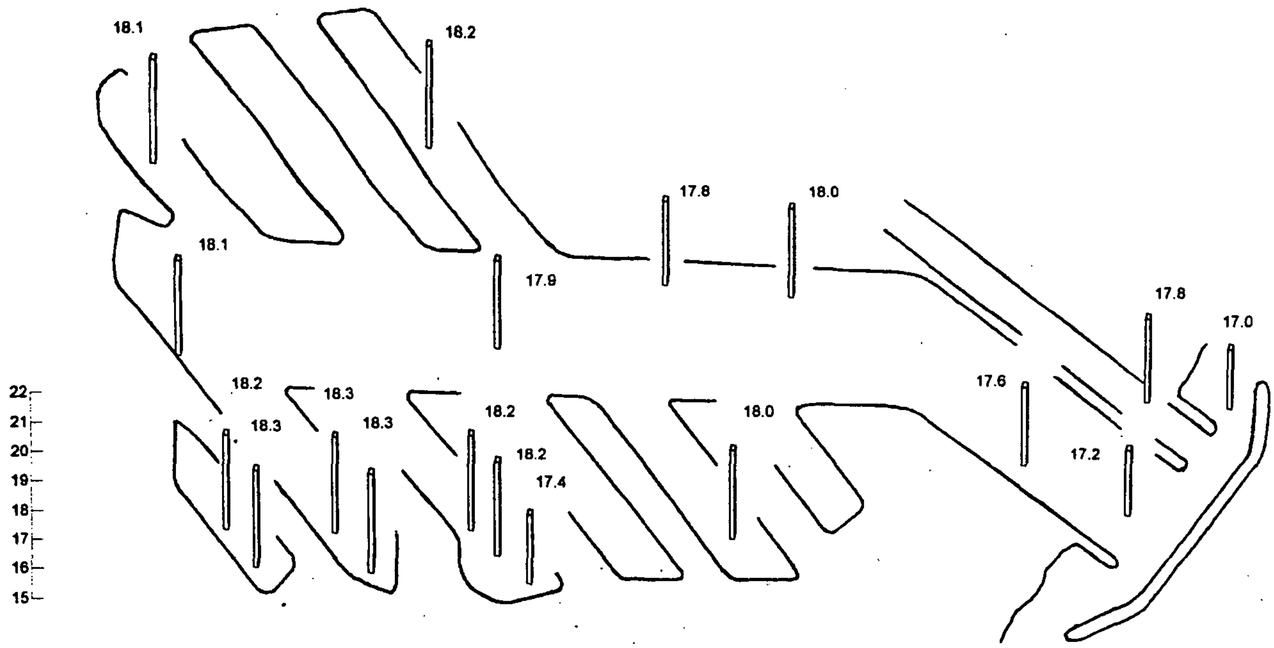


TABLE 3-2. SEASONAL TEMPERATURE RANGES (DEG C) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1989-90[1]	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[2]	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
1997-98	15.0 - 24.9	11.1 - 17.4	14.5 - 20.7	17.7 - 28.8
1998-99	12.9 - 23.5	12.6 - 16.2	13.5 - 19.8	18.3 - 23.5
Overall range	**12.9 - 26.6**	**11.0 - 17.4**	**13.3 - 22.7**	**16.8 - 28.8**
1999-00[3]	15.9 - 20.2	11.9 - 15.6	12.8 - 19.8	18.3 - 22.1

[1] Station 25 added this year.

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

[3] One month only in the summer.

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).

Vertical salinity patterns. Very little difference among surface to bottom averages reflect the relatively low rainfall recorded for this year (Figure 3-6). Stations most influenced by runoff from Ballona Creek drainage (Stations 1, 12, and to a lesser degree 2) and Oxford Lagoon discharges (Stations 13 and 22) 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. With regard to salinity this year, Stations 10 and 20 in Basin E appeared less influenced by flows from Oxford Lagoon than in the past.

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 only very slight variability over the year with only extremely small declines in the spring. Similar to last year, stations associated with Ballona Creek (primarily Stations 1 and 12) and Oxford Lagoon (Stations 13 and 22) were affected far more than any of the other stations. Both Stations 10 and 20 in Basin E appeared unaffected.

Spatial salinity patterns. With the exception of those stations influenced by Oxford Lagoon (13 and 22) and Ballona Creek discharges (1 and 12), all stations sampled within Marina del Rey Harbor had average year-long salinities of between 33.1 and 33.5 parts per thousand (Figure 3-8). Stations 13 and 22 in Oxford Lagoon (32.6 and 32.1 ppt, respectively) and Stations 1 and 12 near Ballona Creek (32.8 and 29.1 ppt) were lower.

Salinity ranges compared with past years. Table 3-3 lists: 1) the individual seasonal salinity ranges from fall 1991 through summer 1999, 2) the overall seasonal ranges for the eight year period, and 3) the temperatures collected during 1999-2000. All 1999-2000 salinities were well within, or close to, the overall seasonal ranges for the preceding eight years.

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

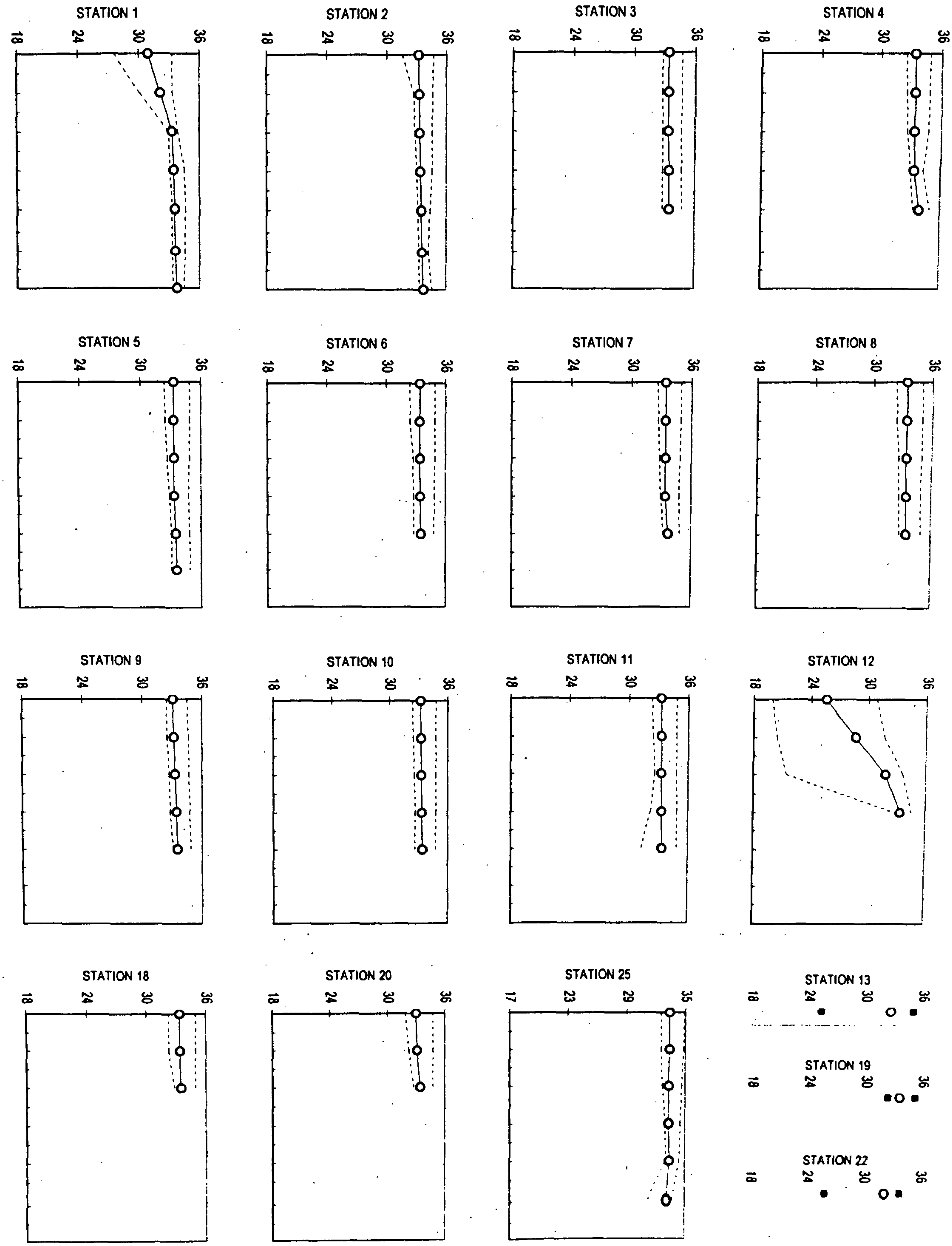


FIGURE 3-7. MINIMUM, AVERAGE, AND MAXIMUM SALINITY (PPT) VS. MONTH AT 18 WATER COLUMN STATIONS.

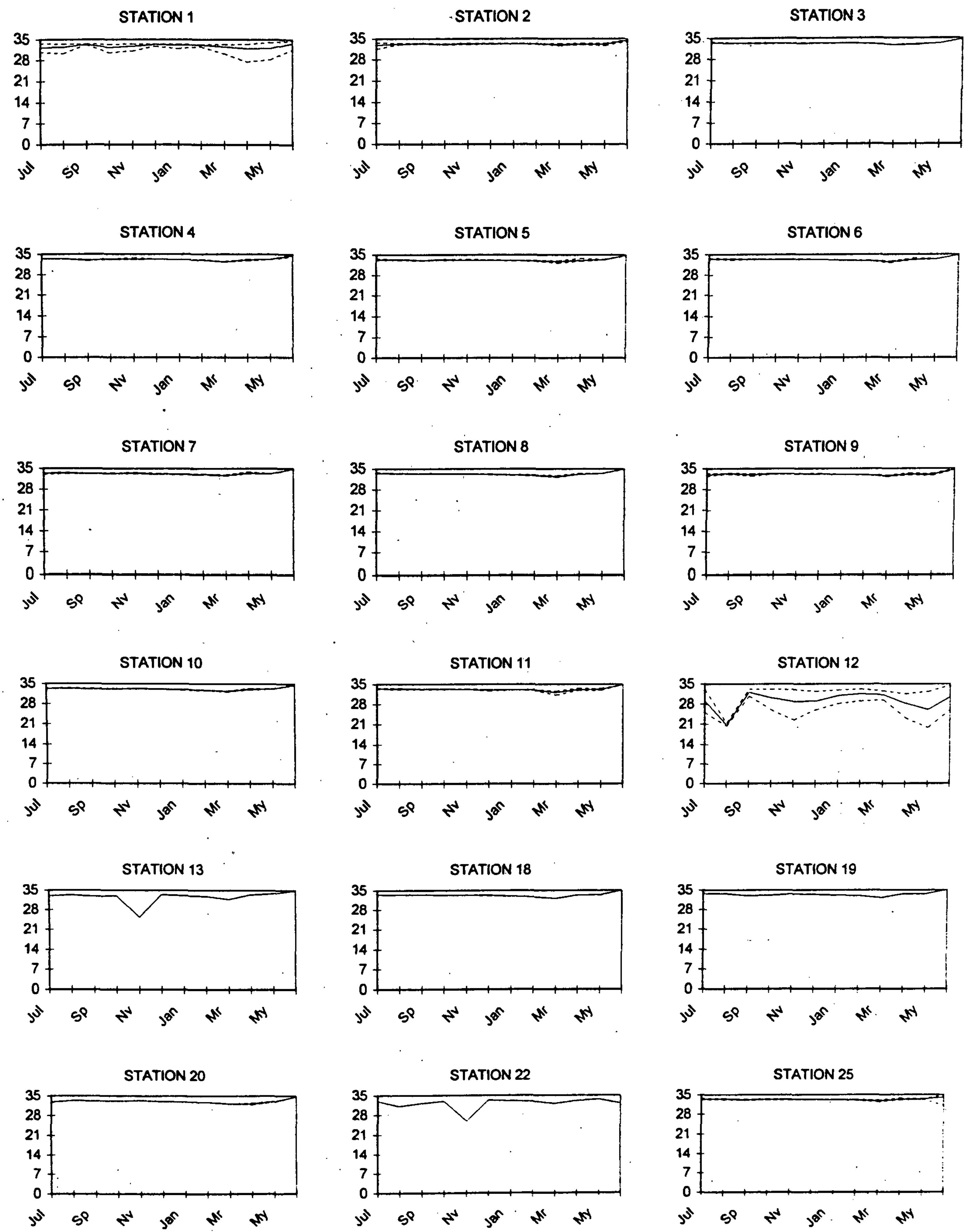


FIGURE 3-8. AVERAGE ANNUAL SALINITY (PPT) AT 18 WATER COLUMN STATIONS.

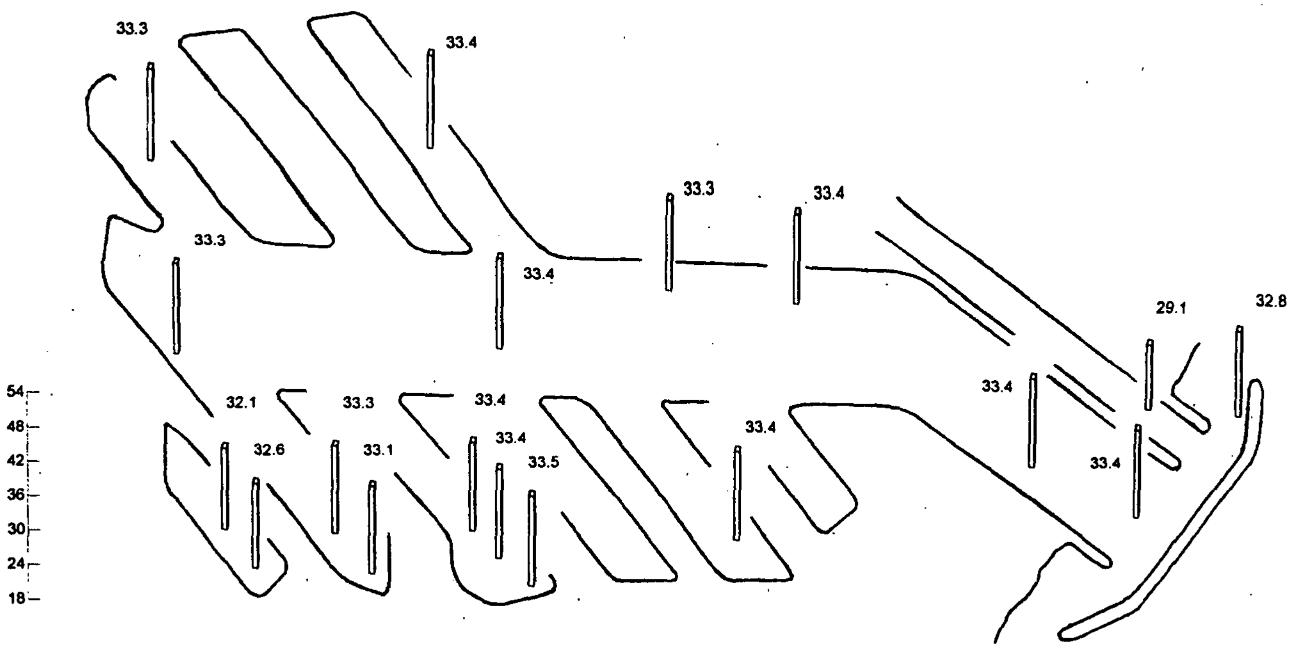


TABLE 3-3. SEASONAL SALINITY RANGES (PPT) FOR ALL DEPTHS AND STATIONS.

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
1997-98	5.0 - 33.8	1.2 - 33.4	11.6 - 33.5	19.4 - 33.8
1998-99	10.3 - 34.4	10.3 - 33.9	1.2 - 34.2	20.3 - 34.0
Overall range	**5.0 - 34.8**	**0.1 - 34.4**	**1.2 - 34.7**	**14.0 - 34.9**
1999-00[3]	20.3 - 33.9	25.9 - 33.5	19.9 - 34.1	26.1 - 35.2

[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.

3.3.1.3. **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 or particularly shallow, 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 1999-2000. For a few stations, oxygen values were actually slightly higher near the bottom. 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, rather than immediately at the surface (Anikouchine and Sternberg 1973). Thus, this elevation with depth is likely phytoplankton related. From surface to bottom, ranges were widest in Ballona Creek (Station 12) and Oxford Lagoon (Station 13).

Dissolved oxygen patterns over the year. Overall, dissolved oxygen values varied in patterns apparently unrelated to season or rainfall. Highest values tended to be in September, January, and April. No strong red tide events were recorded during this survey. Oxygen concentrations varied greatest in Ballona Creek (Station 12) and Oxford Lagoon (Stations 13 and 22).

Regulatory agencies consider dissolved oxygen values less than 5.0 mg/l as not acceptable for marine life. Actually, the 5.0 mg/l minimum is based on fish survival, while invertebrates can survive on much lower levels (Soule et. al. 1997). Values below 5.0 mg/l were most frequent in Oxford Lagoon (Stations 13 and 22 – six times each) and Basin E (Stations 10 and 20- six times and seven times, respectively). Values at Station 12 were below 5.0 mg/l three times, values at Station 9 was below 5.0 mg/l twice, and Stations 7, 18, and 25 were below once during the year. Stations 1, 2, 3, 4, 5, 6, 11 and 19 were never below 5.0 mg/l. The lowest value recorded was 2.0 mg/l at Station 13 in May.

Spatial dissolved oxygen patterns. In general, dissolved oxygen tended to decline with distance from Harbor entrance, reflecting the reduced horizontal mixing with oceanic water within the interior basins (Figure 3-11). Lowest average values were in Oxford Lagoon (Stations 13 and 22 – 4.9 and 4.7 mg/l, respectively) and Basin E (Stations 10 and 20 – 5.3 and 5.1 mg/l). The highest oxygen averages in the Harbor were those nearest the entrance (Stations 1 and 2 – both 6.9 mg/l). All remaining stations were moderate, averaging from 5.7 to 6.5 mg/l.

Dissolved oxygen ranges compared with past years. All 1999-2000 dissolved oxygen values were within the overall seasonal ranges for the preceding ten years (Table 3-4). When compared to 1998-99, values during all seasons tended to range lower.

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

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

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

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

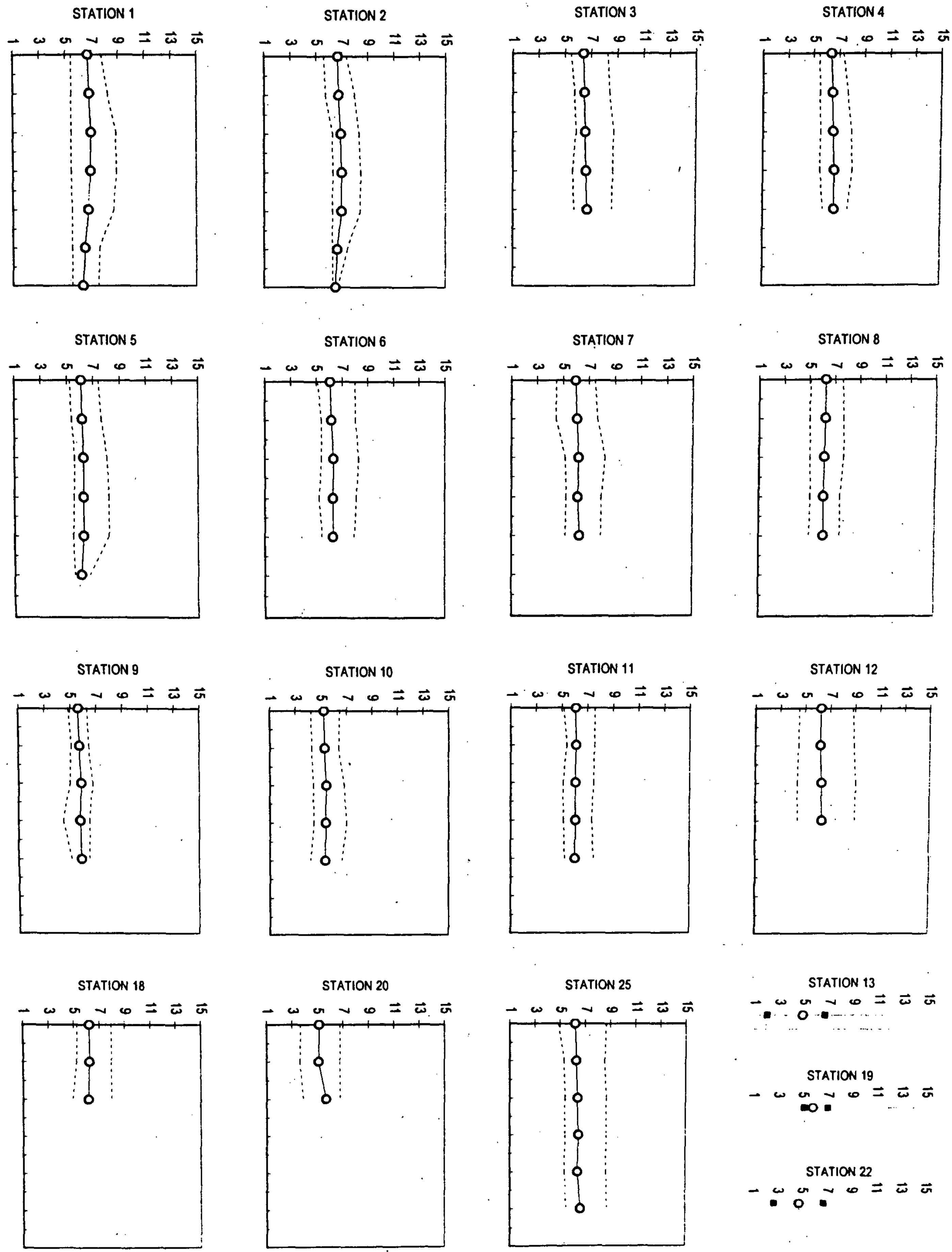


FIGURE 3-10. MINIMUM, AVERAGE, AND MAXIMUM DIS. OXYGEN (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

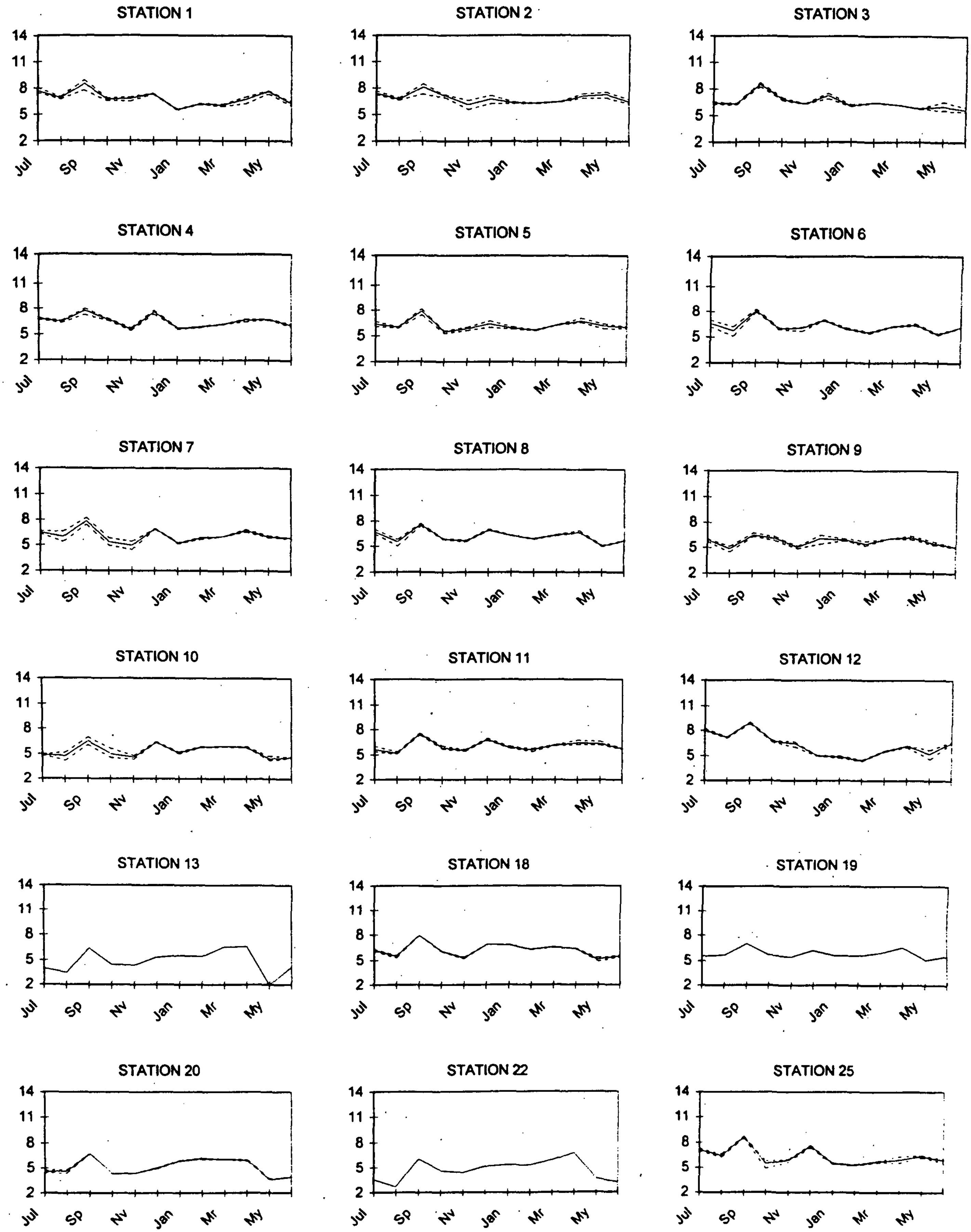


FIGURE 3-11. AVERAGE ANNUAL DISSOLVED OXYGEN (MG/L) AT 18 WATER COLUMN STATIONS.

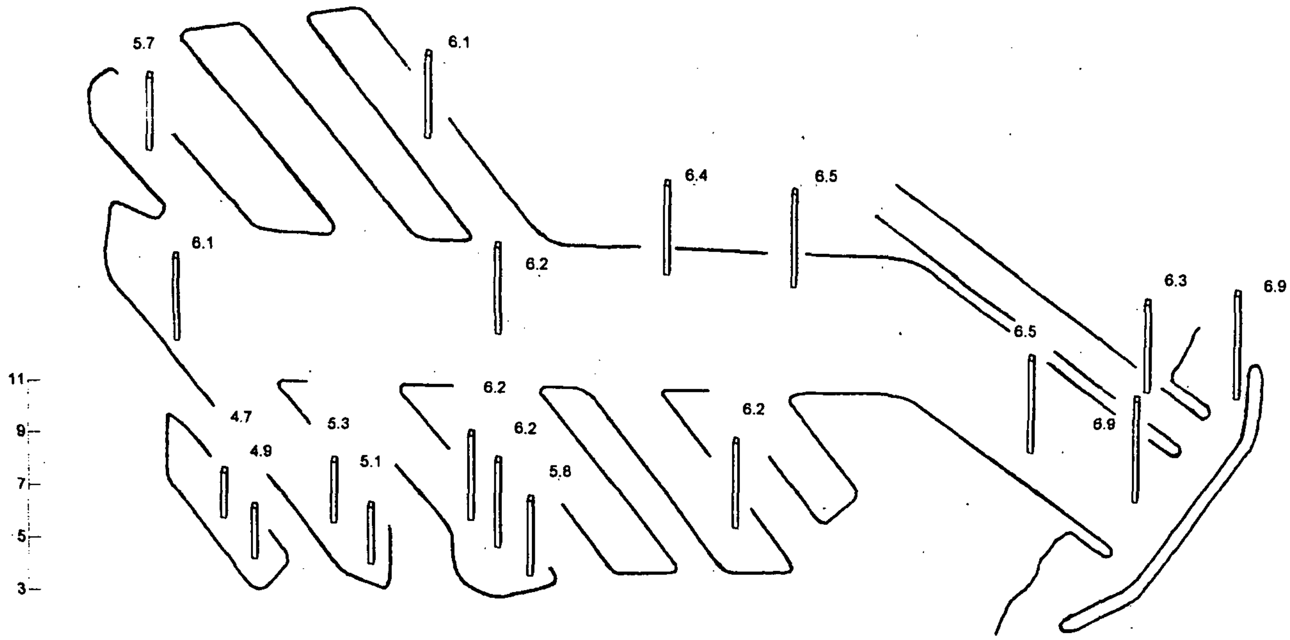


TABLE 3-4. SEASONAL DISSOLVED OXYGEN RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1989-90[1]	2.5 - 12.0	3.9 - 9.9	1.4 - 11.9	1.6 - 10.1
1990-91	4.2 - 10.1	2.0 - 13.1	5.6 - 12.9	3.0 - 11.0
1991-92	4.7 - 10.2	5.5 - 10.1	2.0 - 8.8	2.0 - 8.8
1992-93	2.5 - 8.2	2.0 - 8.9	3.3 - 11.1	4.0 - 9.2
1993-94[2]	—	—	—	2.5 - 8.1
1994-95	3.3 - 9.4	2.7 - 9.7	4.4 - 10.2	1.0 - 8.3
1995-96	1.9 - 8.1	4.6 - 12.1	4.6 - 9.2	2.2 - 9.1
1996-97	2.6 - 10.1	4.4 - 8.6	3.8 - 13.9	2.4 - 8.1
1997-98	3.0 - 7.2	3.8 - 10.0	5.2 - 10.6	1.2 - 9.6
1998-99	2.8 - 9.6	4.0 - 11.4	4.2 - 8.6	2.7 - 8.3
Overall range	**1.9 - 12.0**	**2.0 - 13.1**	**1.4 - 13.9**	**1.0 - 11.0**
1999-00[3]	2.7 - 8.3	4.3 - 9.1	2.0 - 7.7	3.2 - 6.7

[1] Station 25 added this year.

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

[3] One month only in the summer.

Vertical pH patterns. Surface to bottom pH profiles (Figure 3-12) indicated that there is very little change with depth, and at nearly all stations, minimum-maximum ranges were narrow. Ranges at Stations 22 in Oxford Lagoon and Station 12 in Ballona Creek were wider than most other stations, indicating that a considerable amount of fresh water flows into areas.

pH patterns over the year. Averages varied weakly at nearly all stations (Figure 3-13) with values tending to be lower during the rainy season. Similar to the past two years, widest temporal pH ranges were within Oxford Lagoon (Stations 13 and 22), Ballona Creek (Station 12), and Mothers Beach (Station 19). Stations within the Harbor, which can be impacted by Oxford Lagoon (e.g. 10 and 20, in Basin E), appeared unaffected this year. Although, the variability observed at Oxford Lagoon and Ballona Creek can be accounted for by freshwater municipal drainage, the moderate variability at Mothers Beach is not obvious.

Spatial pH patterns. Averaged over the 12-month sampling period, pH values were very similar among stations (Figure 3-14). Highest averages were near the Harbor entrance (8.1 units, Stations 1, 2, and 12) indicating that the influence of seawater is probably stronger overall than the influence of the freshwater drainage into these stations. Lowest averages (7.8, Stations 20 and 22) were in Basin E and Oxford Lagoon. Other stations averaged between 7.9 and 8.0 units.

pH ranges compared with past years. All 1999-2000 pH values were within the overall seasonal ranges for the preceding eight years (Table 3-5). When compared to 1998-99, values tended to be narrower within seasons.

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, although in oxygen-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 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).

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

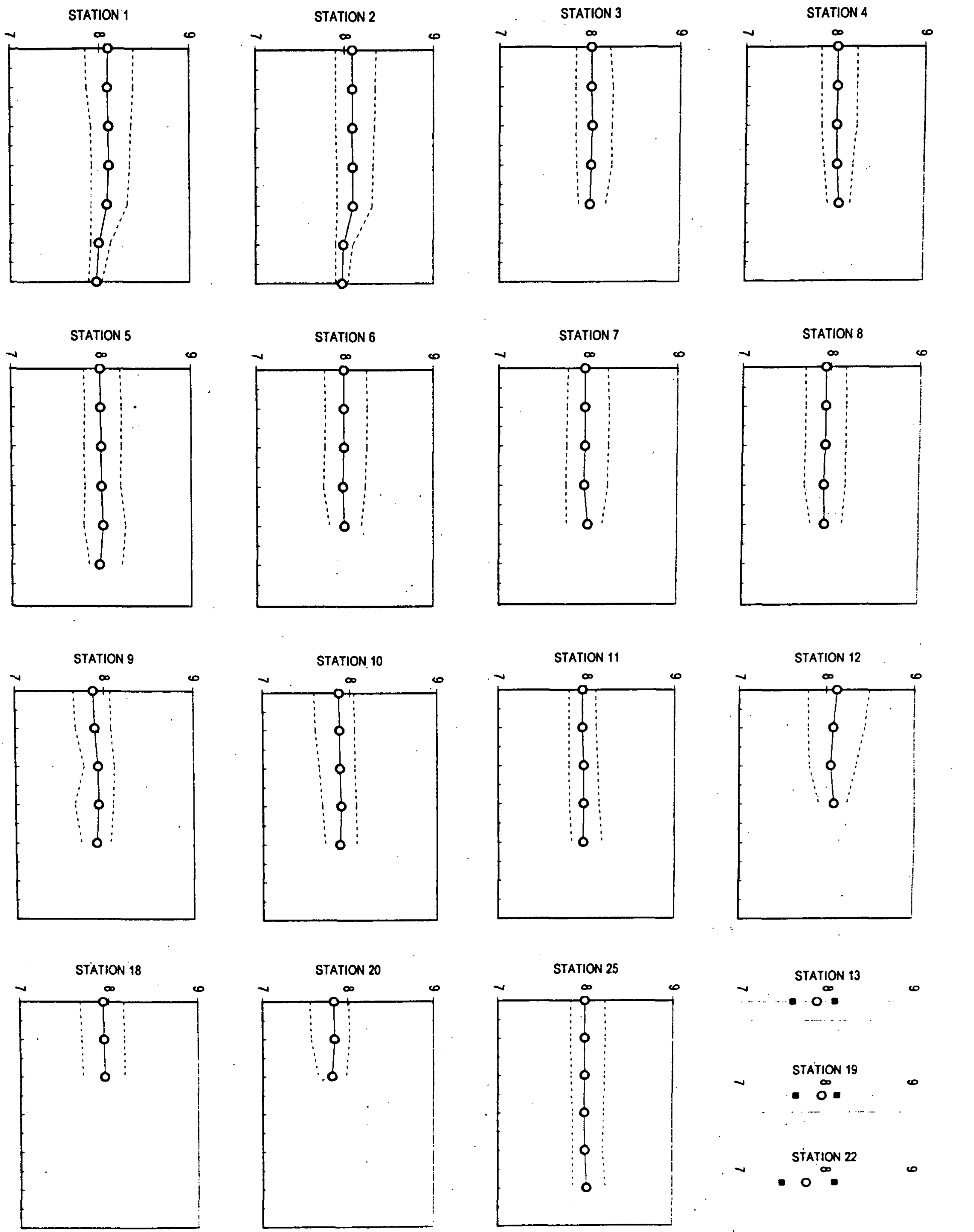


FIGURE 3-13. MINIMUM, AVERAGE, AND MAXIMUM PH (UNITS) VS. MONTH AT 18 WATER COLUMN STATIONS.

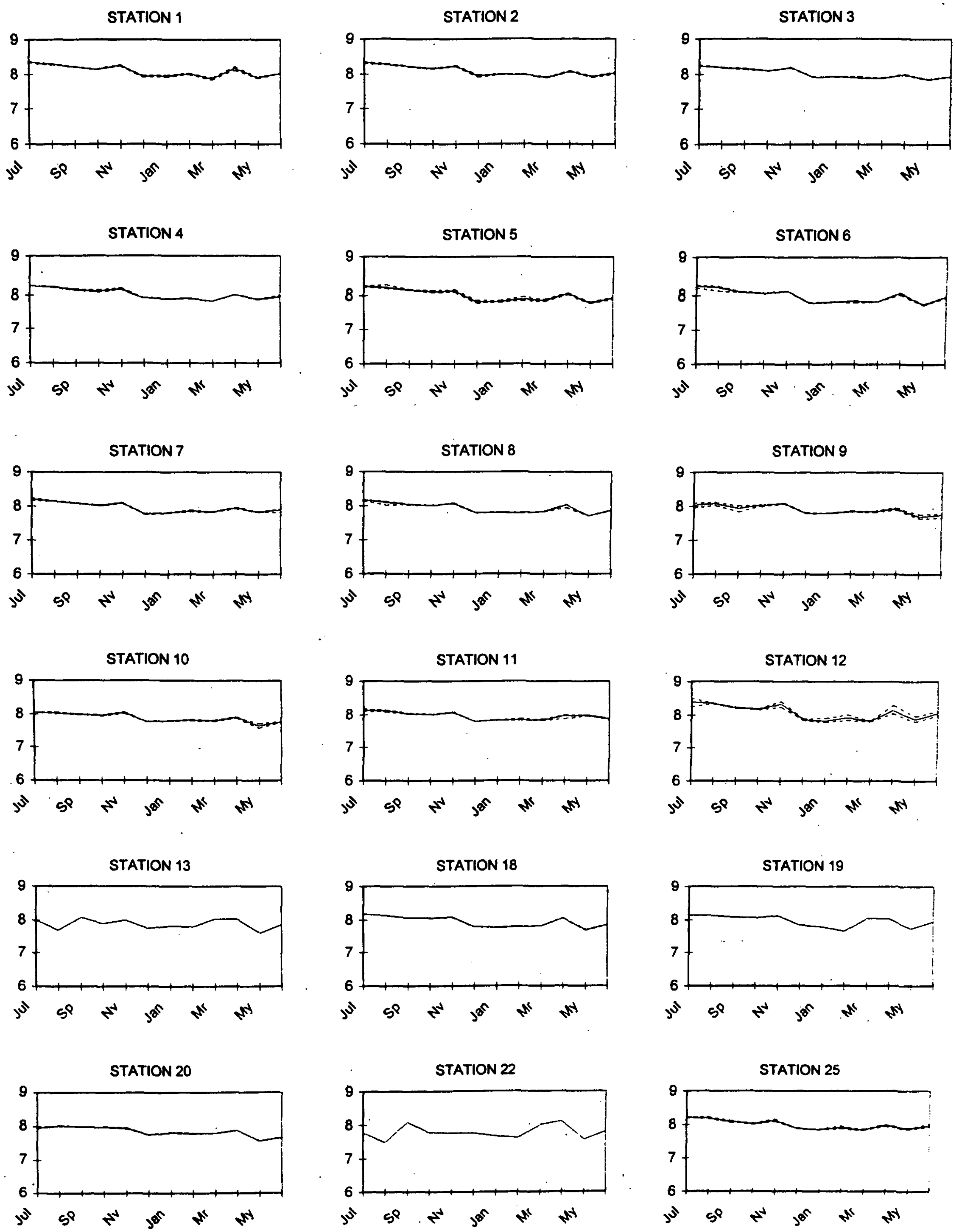


FIGURE 3-14. AVERAGE ANNUAL PH (UNITS) AT 18 WATER COLUMN STATIONS.

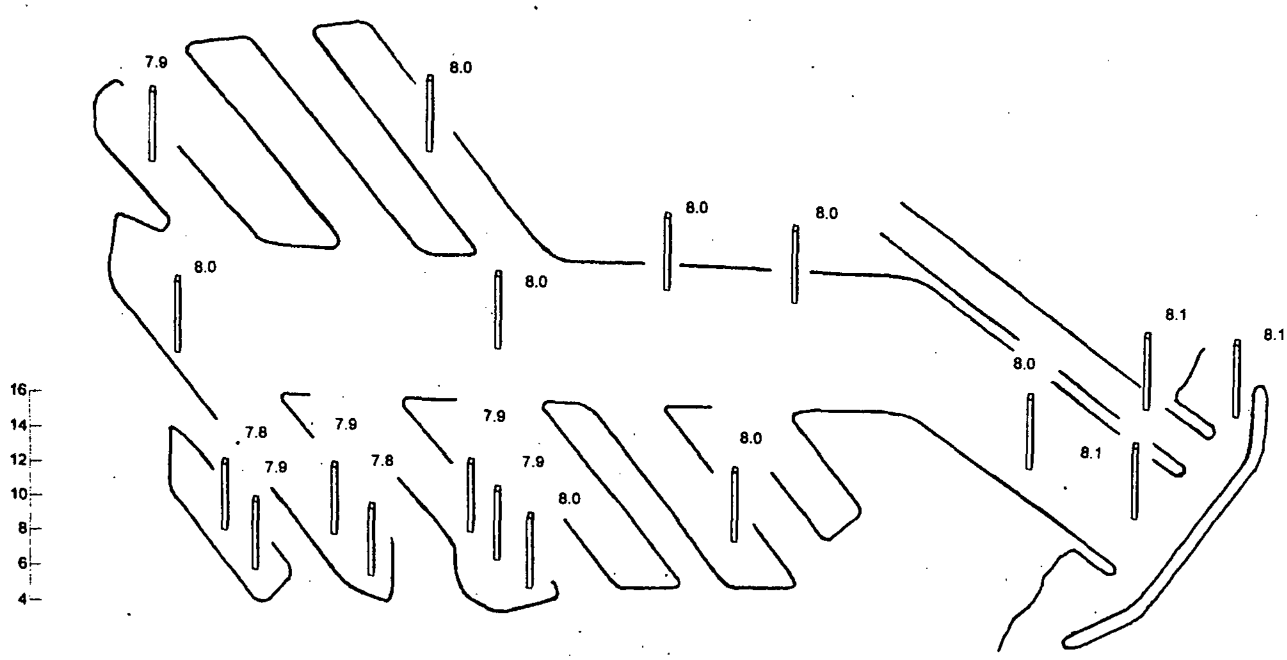


TABLE 3-5. SEASONAL PH RANGES (UNITS) FOR ALL DEPTHS AND STATIONS.

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
1997-98	7.7 - 8.3	6.8 - 8.2	7.7 - 8.6	7.1 - 8.7
1998-99	7.7 - 8.4	7.3 - 8.4	7.0 - 8.1	7.5 - 8.5
Overall range	**7.5 - 8.6**	**6.8 - 8.5**	**7.0 - 8.7**	**7.1 - 8.7**
1999-00[3]	7.8 - 8.4	7.6 - 8.0	7.6 - 8.3	7.7 - 8.1

[1] Two months only in the fall.

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

[3] One month only in the summer.

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 that depend upon them (i.e. nearly all other living organisms in the sea). Secondly, too much ammonia can cause algal blooms that 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).

<u>Vertical ammonia patterns.</u> 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 minima were at or near the detection limit (0.01 mg/l) during at least one monthly survey. Maximum values ranged fairly widely at some stations and again with no apparent unifying pattern.

<u>Ammonia patterns over the year.</u> For most stations, averages did not vary widely over the year (Figure 3-16), with peaks appearing most commonly in November and March. These peaks may be rainfall related, but the pattern is not clear. Patterns in Basin E (Stations 10 and 20) do not closely follow those of Oxford Lagoon (Stations 13 and 22).

<u>Spatial ammonia patterns.</u> Highest ammonia averages over the year were within Oxford Lagoon (Stations 13 and 22 – both 1.4 mg/l), followed by Stations 10 and 20 in Basin E (0.10 and 0.14 mg/l, respectively), and Station 12 in Ballona Creek (0.10 mg/l) (Figure 3-17). All remaining stations were lower (0.03 to 0.09 mg/l).

<u>Ammonia ranges compared with past years.</u> All 1999-2000 ammonia values were below values of the recent past (Table 3-6).

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

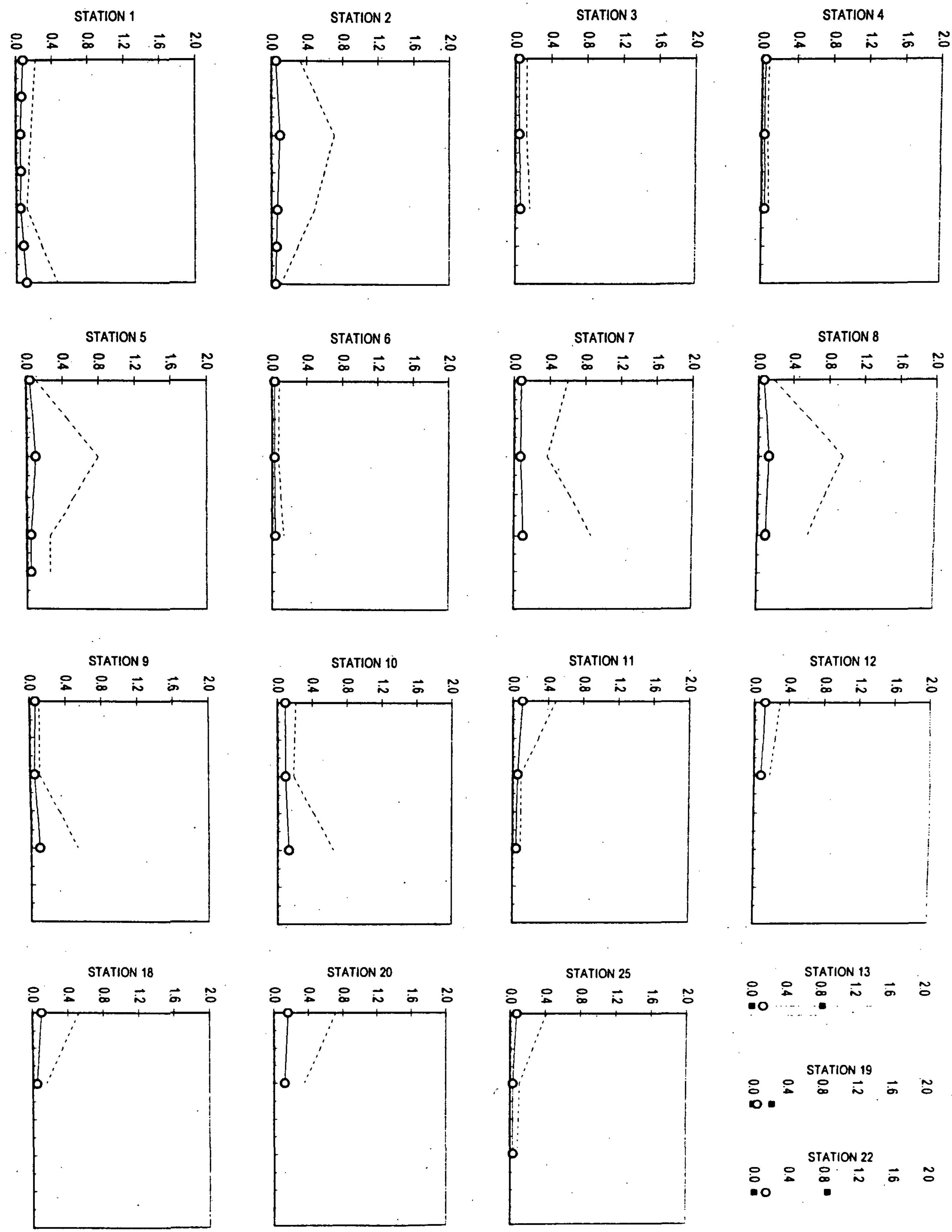


FIGURE 3-16. MINIMUM, AVERAGE, AND MAXIMUM AMMONIA (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

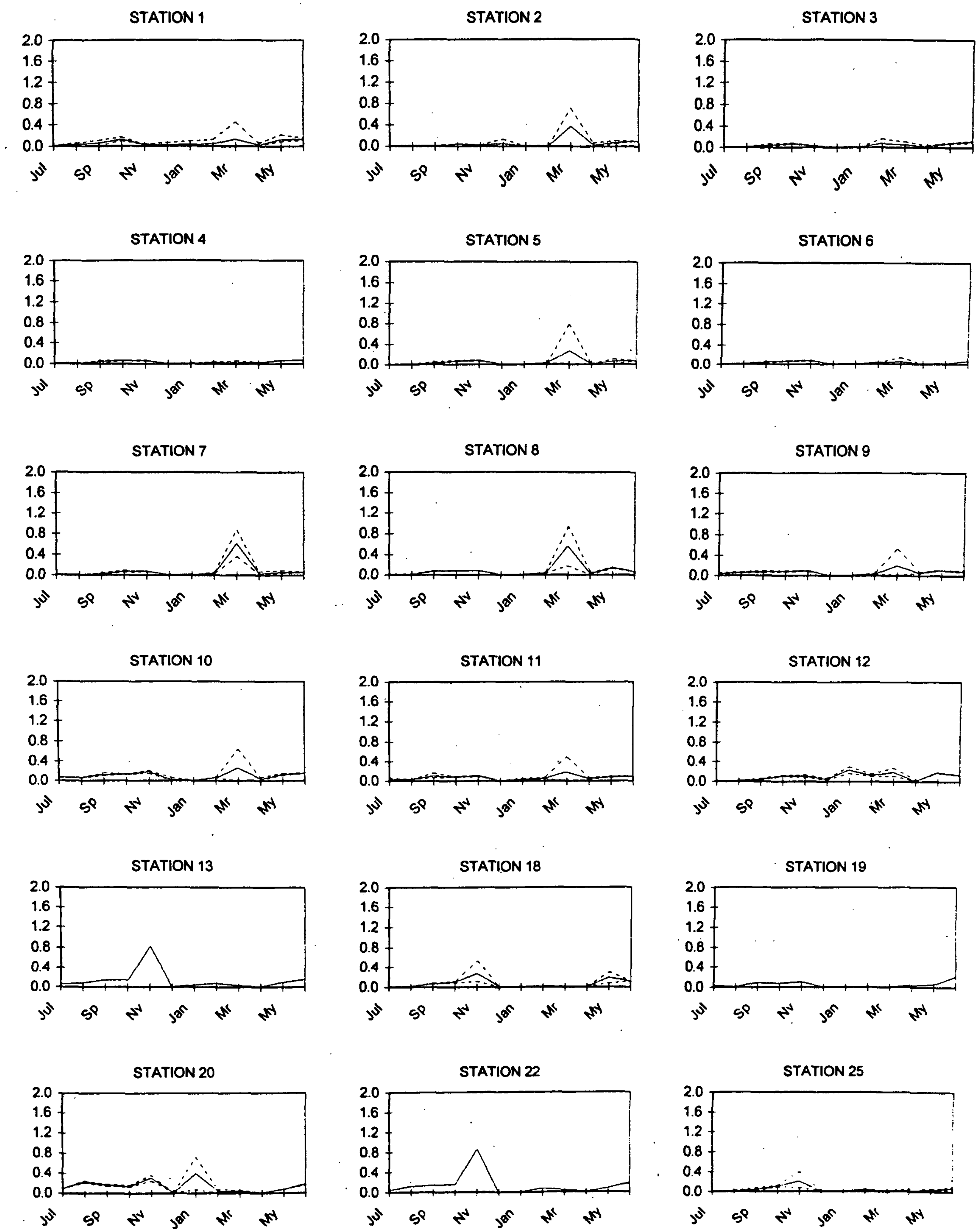


FIGURE 3-17. AVERAGE ANNUAL AMMONIA (MG/L) AT 18 WATER COLUMN STATIONS.

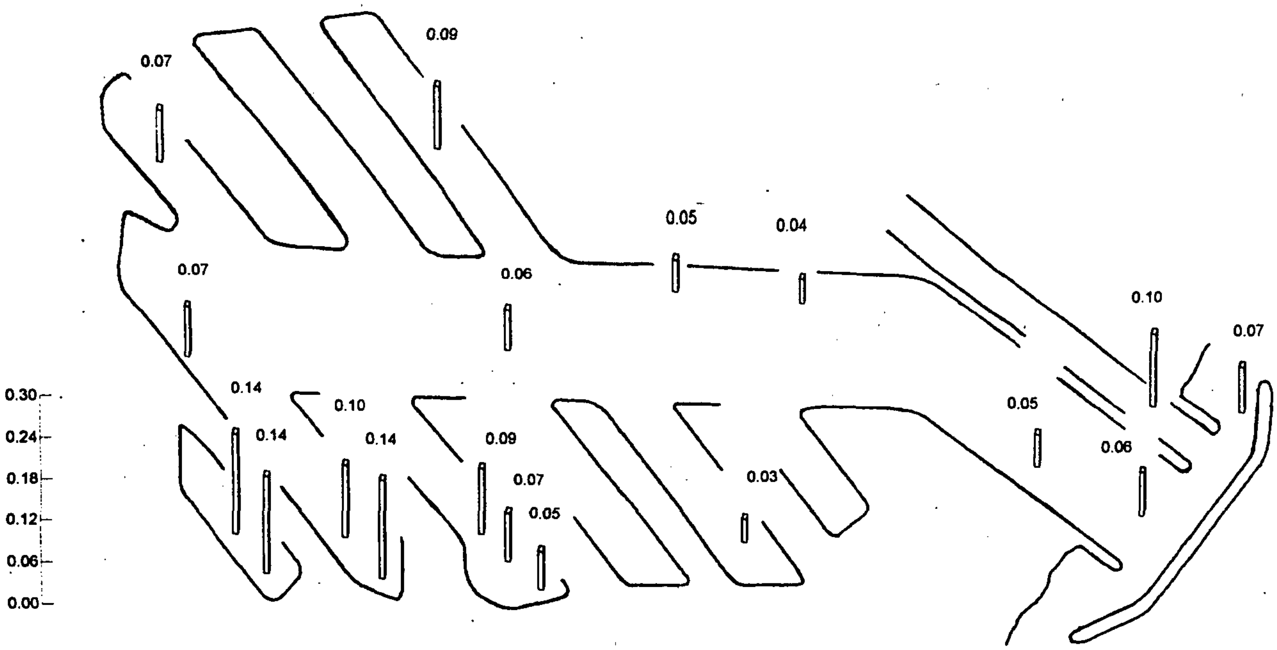


TABLE 3-6. SEASONAL AMMONIA RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

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
1997-98	0.3 - 52.3	0.4 - 37.1	0.4 - 18.1	0.4 - 28.3
1998-99	0.4 - 45.5	0.4 - 43.6	0.4 - 22.9	0.01 - 3.5
Overall range	**0.3 - 52.3**	**0.2 - 200.0**	**0.3 - 35.0**	**0.01 - 105.8**
1999-00[3]	0.01 - 0.85	0.00 - 0.72	0.01 - 0.96	0.05 - 0.22

[1] Two months only in the fall.

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

[3] One month only in the summer.

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

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

Vertical BOD patterns. Vertical BOD profiles (Figure 3-18) suggest that the water column is well mixed, and the BOD is fairly constant with depth. Minimum ranges were usually below 1.0 mg/l. Similar to the recent past, values at most stations this year were relatively low and consistent. Higher values tended to be associated with Ballona Creek and Oxford Lagoon (e.g. Stations 1, 2, 10, 12, and 20). The source of the higher BOD is likely municipal, freshwater runoff.

BOD patterns over the year. For most stations, BOD values were low (below 5.0 mg/l) throughout the year (Figure 3-19). Strong red tide blooms, which occurred during 1997, were not in evidence during this year's survey. As with many other parameters measured in this survey, stations associated with Ballona Creek (1, 2, and 12) and Oxford Lagoon (10, 13, 20, and 22) were temporally independent of any naturally occurring patterns.

Spatial BOD patterns. As expected, highest average BOD values were in Oxford Lagoon (Stations 13 and 22 – 4.3 and 4.2 mg/l, respectively), Basin E (Station 20 – 4.3 mg/l), and near Ballona Creek (Stations 1 and 12 – 2.1 and 2.3 mg/l). Values at all other stations were lower (1.0 to 1.9 mg/l).

BOD ranges compared with past years. With the exception of winter, 1999-2000 BOD values were within the overall seasonal ranges for the preceding seven years (Table 3-7). Due to a particularly high February value (18.7 mg/l) in Basin E (Station 20), the maximum for this year exceeded previous maxima by a factor of about two. Since February had the highest precipitation during the year, land runoff may have contributed to this high result. Compared to 1998-1999, this year's ranges in the fall and summer were lower, spring ranges were about the same, and winter ranges were higher.

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

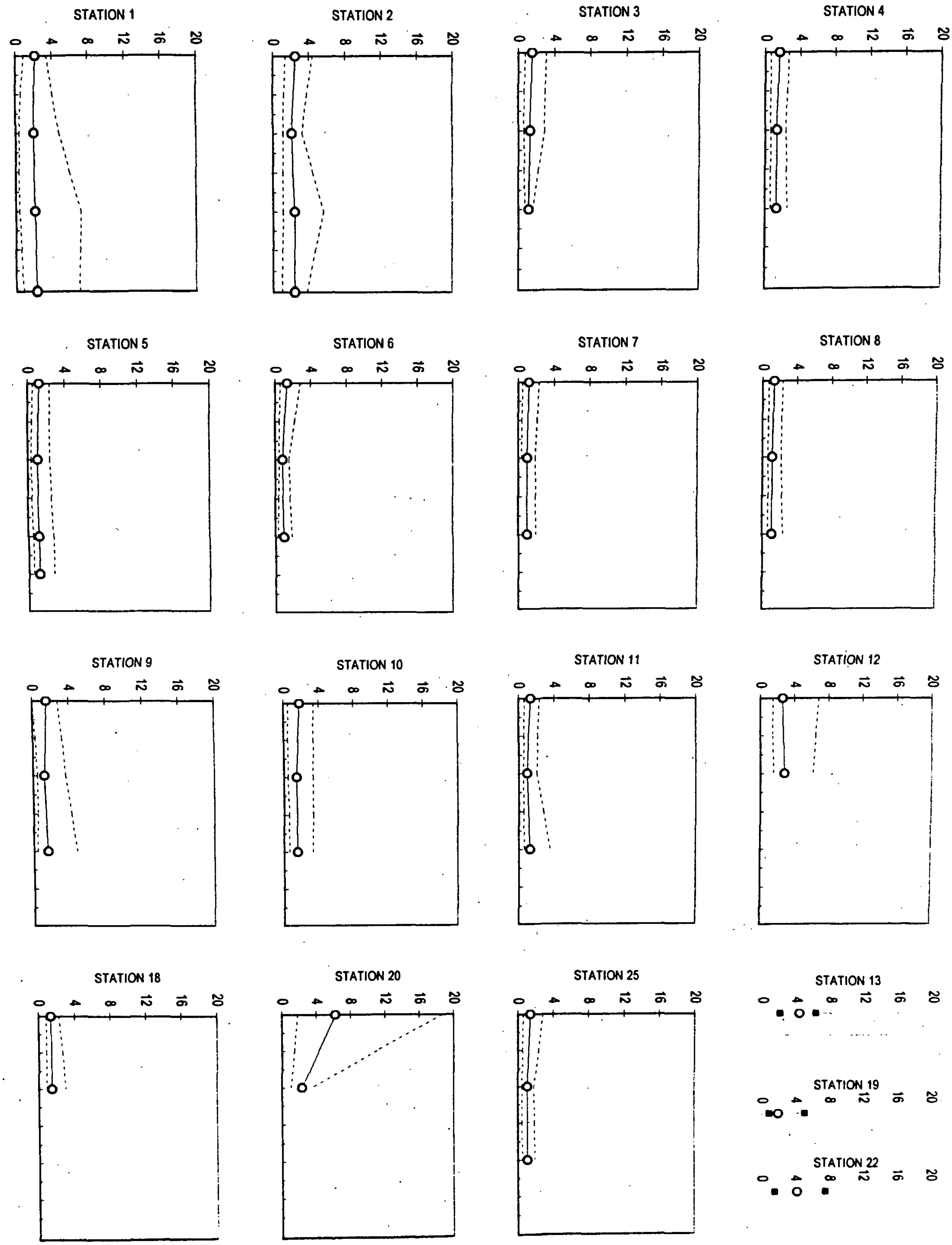


FIGURE 3-19. MINIMUM, AVERAGE, AND MAXIMUM BOD (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

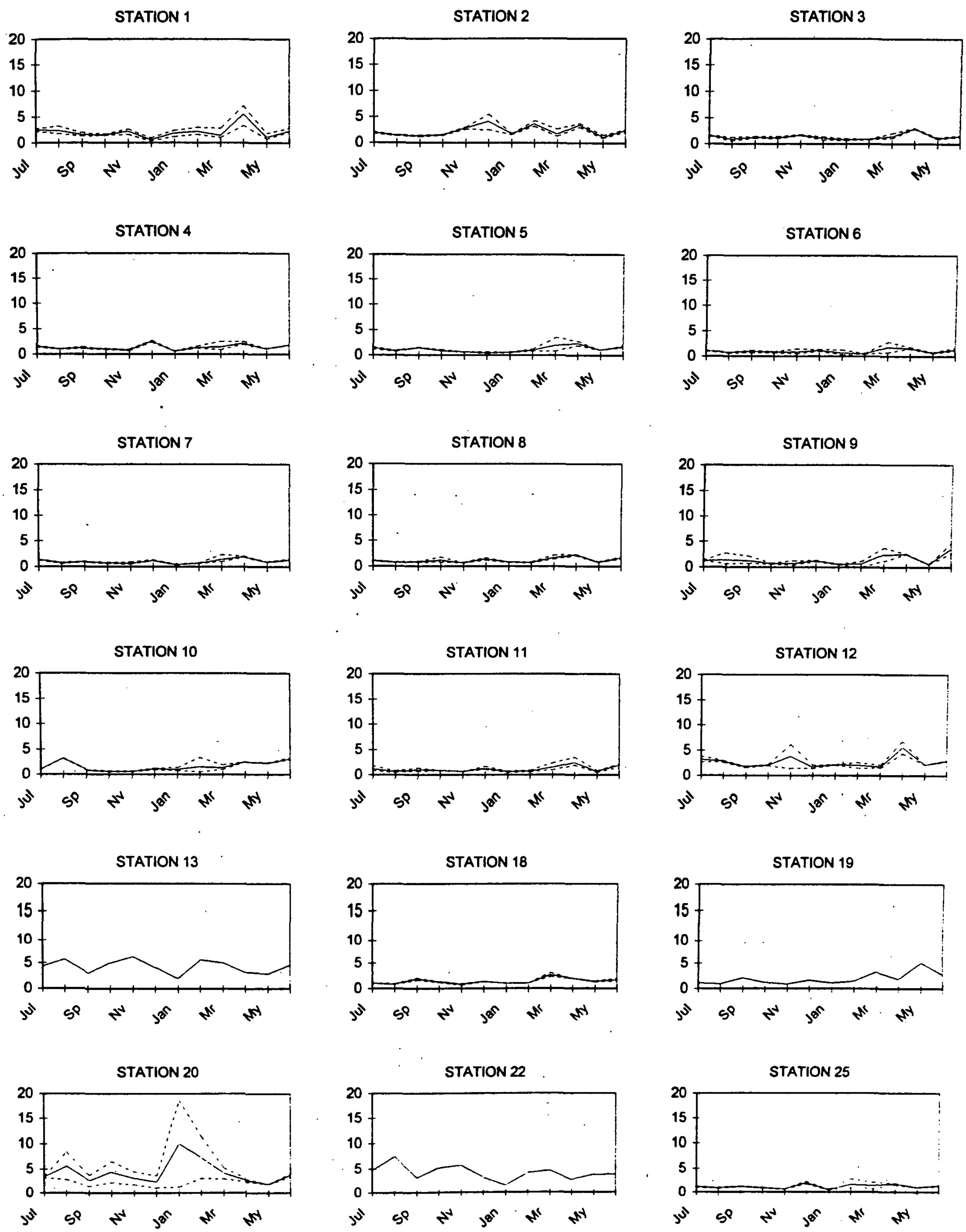


FIGURE 3-20. AVERAGE ANNUAL BOD (MG/L) AT 18 WATER COLUMN STATIONS.

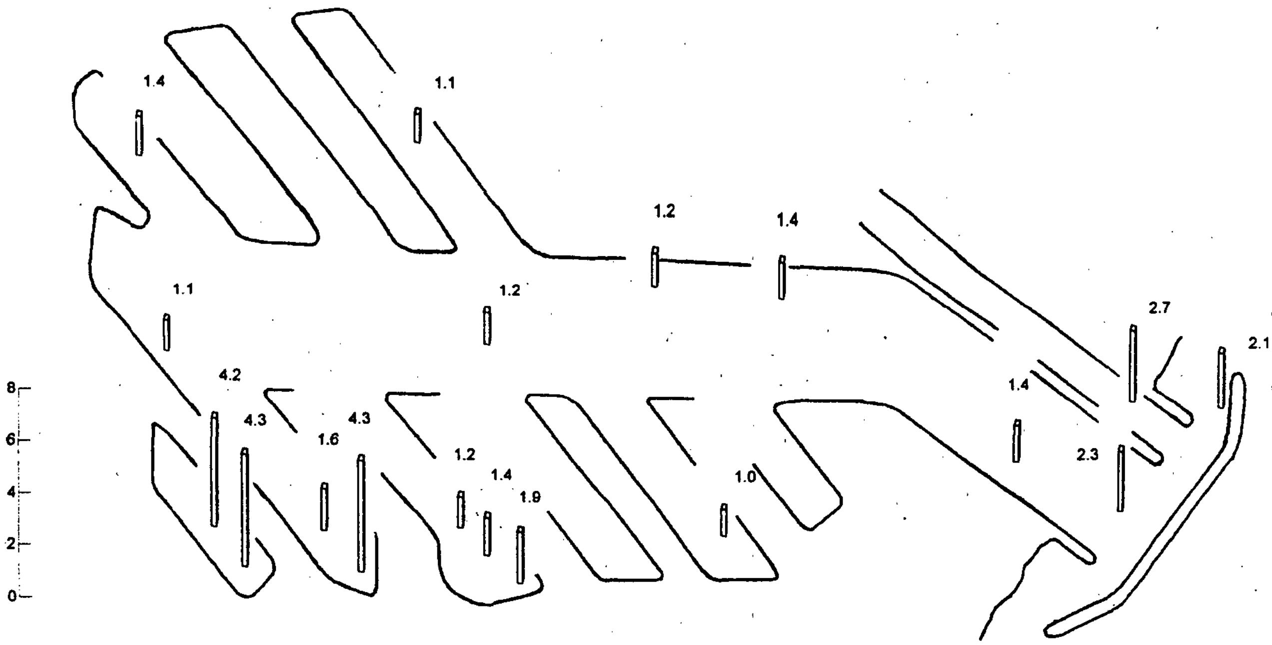


TABLE 3-7. SEASONAL BOD RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	0.4 - 12.2	0.5 - 4.3	0.4 - 5.2	0.6 - 6.1
1993-94[2]	0.8 - 14.0	0.7 - 6.9	0.7 - 15.2	0.6 - 13.0
1994-95	0.6 - 5.2	0.5 - 10.3	0.6 - 13.0	0.9 - 11.2
1995-96	0.8 - 3.4	0.6 - 8.7	0.6 - 6.8	0.1 - 7.5
1996-97	0.1 - 7.8	0.4 - 6.8	1.0 - 13.0	0.8 - 15.2
1997-98	0.4 - 13.4	0.2 - 6.1	0.7 - 8.7	0.8 - 12.5
1998-99	0.0 - 19.3	0.3 - 8.7	0.4 - 7.6	0.5 - 8.4
Overall range	**0.0 - 19.3**	**0.2 - 10.3**	**0.4 - 15.2**	**0.1 - 15.2**
1999-00[3]	0.4 - 6.6	0.0 - 18.7	0.6 - 7.2	1.1 - 4.8

[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.

3.3.1.7. Light Transmissance

Water clarity in Marina del Rey Harbor is important both for aesthetic and ecological reasons. Phytoplankton, as well as multicellular plants, are dependent upon light for photosynthesis and therefore growth, and since nearly all higher-level ocean organisms are dependent upon these plants 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 rain. 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 greatly 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. Profiles shown in Figure 3-21 suggest that, at most stations, transmissance is fairly constant with depth or declines slightly near the bottom. The exceptions were Station 12 in Ballona Creek and Station 20 in Basin E. Stations with the widest ranges of values were Stations 10, 12, and 20. Station 10 ranges were widest near the bottom, and Station 12 and 20 values were widest near the surface.

Light transmissance patterns over the year. At most stations, transmissance values were lowest during August and April and/or May (Figure 3-22). Low values during these months at Stations 10 and 20 in Basin E and Stations 12 in Ballona Creek indicate that these minima may be related to municipal drainage rather than precipitation, although both March and April did have a small amount of rainfall. Plankton blooms in August are likely not a factor since oxygen levels then were relatively low. As mentioned above, red tide plankton blooms recorded two years ago were not observed during this survey.

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

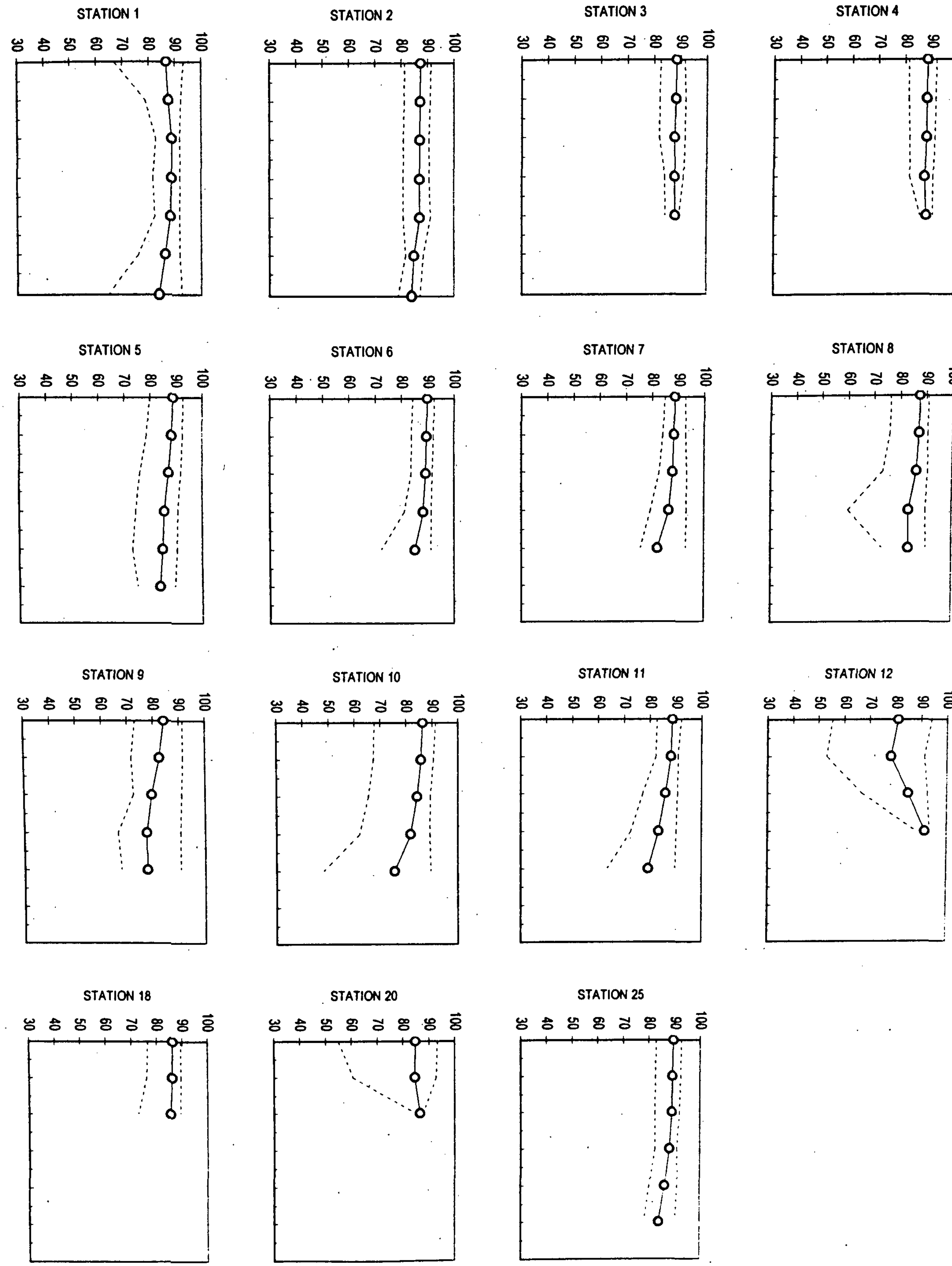


FIGURE 3-22. MINIMUM, AVERAGE, AND MAXIMUM TRANSMISSANCE (%) VS.MONTH AT 15 WATER COLUMN STATIONS

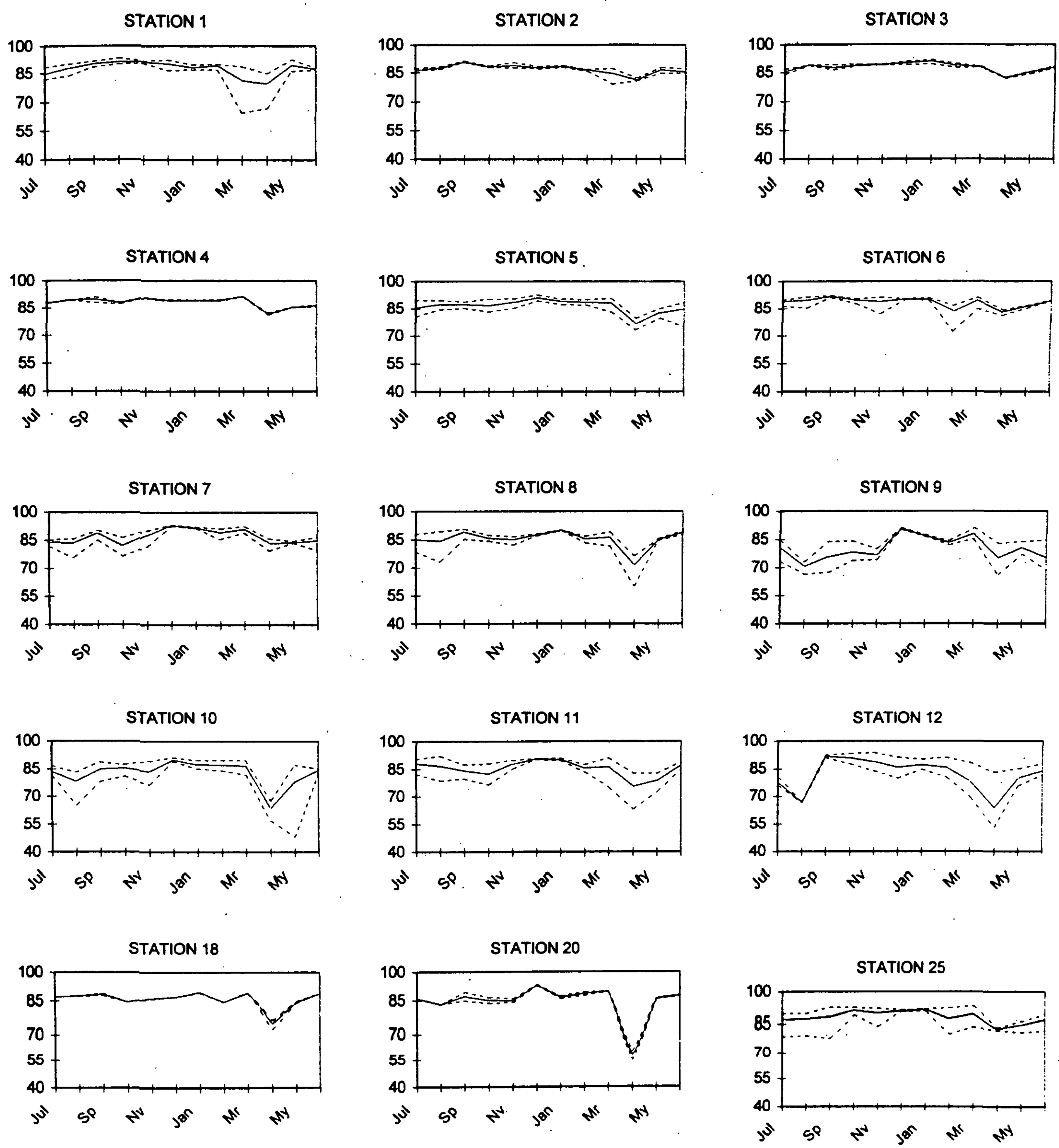


FIGURE 3-23. AVERAGE ANNUAL LIGHT TRANSMISSANCE (%) AT 18 WATER COLUMN STATIONS.

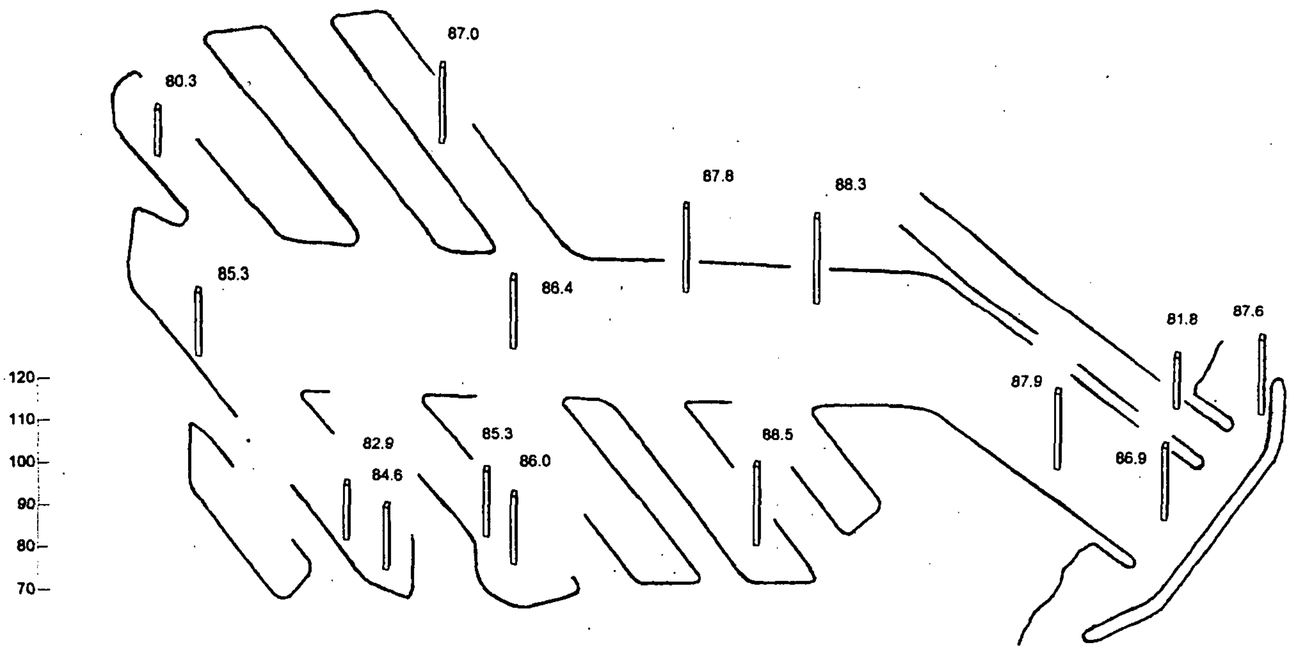


TABLE 3-8. SEASONAL LIGHT TRANSMISSANCE RANGES (%) FOR ALL DEPTHS AND STATIONS.

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
1997-98	46.4 - 91.9	50.6 - 94.1	69.4 - 90.2	38.8 - 94.3
1998-99	74.5 - 94.7	54.7 - 94.4	62.3 - 93.1	65.2 - 92.1
Overall range	**20 - 96**	**0 - 98**	**8 - 93.1**	**39 - 93.8**
1999-00[4]	67.5 - 94.0	72.3 - 93.3	48.1 - 92.7	68.4 - 89.9

[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.

Spatial light transmissance patterns. Transmissance averages were fairly high throughout the Harbor (Figure 3-23). Lowest averages were in Ballona Creek (Station 12 – 81.8%) and Basin F (Station 9 - 80.3%). Remaining stations were relatively high (82.9% to 88.5%).

Light transmissance ranges compared with past years. All 1999-2000 light transmissance values were within the overall seasonal ranges for the preceding eight years (Table 3-8). When compared to 1998-99, ranges for most seasons were somewhat similar.

3.3.1.8. **Surface Transparency**

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

Surface transparency patterns over the year. Surface transparency ranged from 0.4 meters to 4.5 meters (Figure 3-24). Temporal transparency patterns generally followed those of light transmissance. At most stations, surface transparency varied little over the year. Lowest values were in April in Basin E (Stations 10 and 20).

Spatial surface transparency patterns. Surface transparency values averaged over the year are depicted in Figure 3-25. Lowest averages were in Basin E (Stations 10 and 20 – 2.4 m and 2.1 m, respectively) and Basin F (Station 9 - 2.4 m). Highest values were in the main channel and at the Harbor entrance (Stations 1, 2, 3, 4, 5, and 25 – 2.9 to 3.6 m), at Station 6 in Basin B (3.2 m), and at Station 7 in Basin H (2.9 m).

Surface transparency ranges compared with past years. 199-2000 surface transparency values were within the overall seasonal ranges for the preceding eight years (Table 3-9). When compared to 1998-99, values were very similar.

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 seawater 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 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.

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

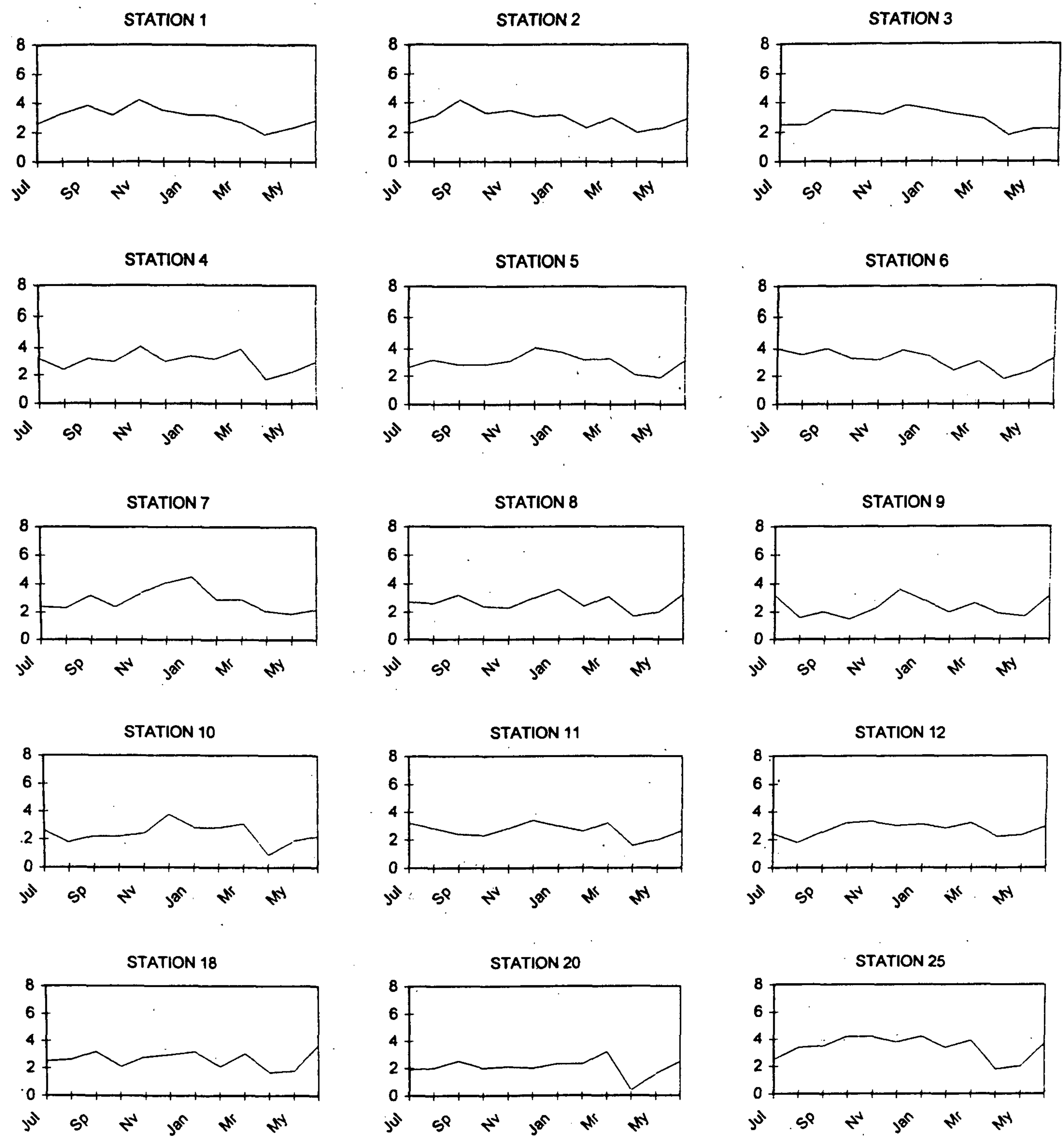


FIGURE 3-25. AVERAGE ANNUAL SURFACE TRANSPARENCY (M) AT 18 WATER COLUMN STATIONS.

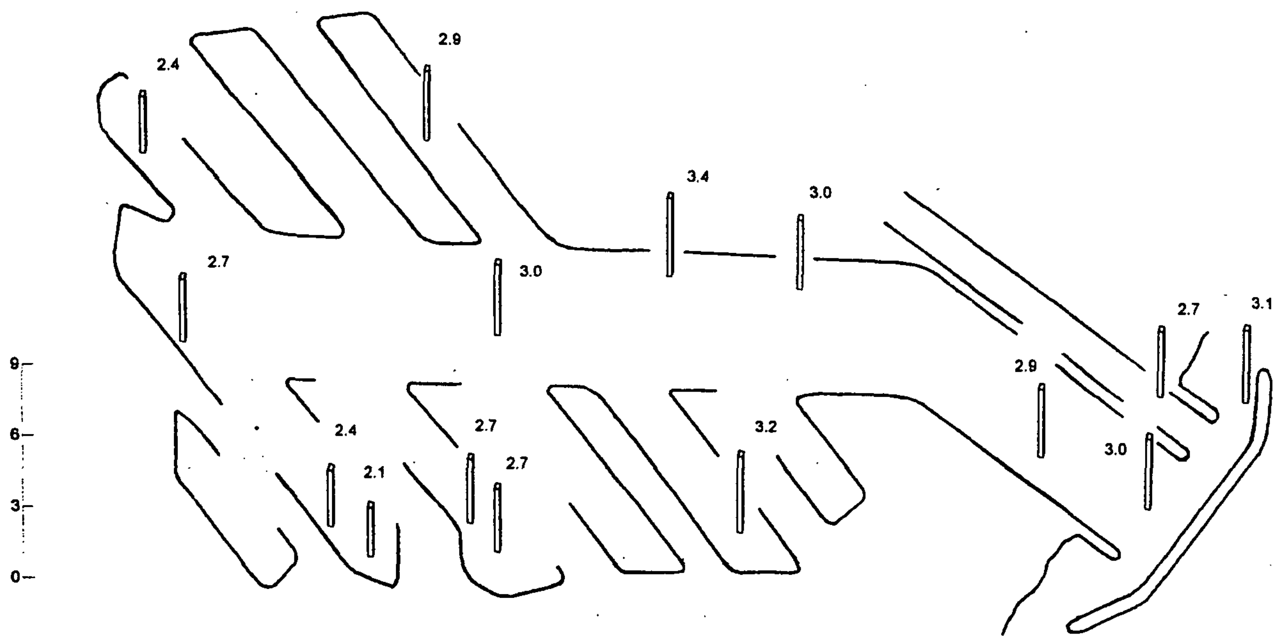


TABLE 3-9. SEASONAL SURFACE TRANSPARENCY RANGES (M) FOR ALL STATIONS.

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
1997-98	0.4 - 4.3	0.9 - 5.8	1.8 - 4.5	1.4 - 5.6
1998-99	1.3 - 5.9	1.2 - 4.9	1.3 - 3.9	1.6 - 4.0
Overall range	**0.4 - 6.5**	**0.1 - 7.0**	**0.3 - 4.5**	**1.0 - 6.6**
1999-00[3]	1.5 - 4.2	2.0 - 4.5	0.4 - 3.9	2.2 - 3.7

[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.

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 colors of the vials are compared to the seawater 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 9 (green) in Basin D (Station 18) in October and June, and Basin E (Station 20) in October to 16 (yellow-green-brown) at Station 12 in March (Figure 3-26). Color patterns do not appear to relate to rainfall or other natural processes but do appear to relate to outflows from Ballona Creek and Oxford Lagoon. As has been mentioned above, red tide plankton blooms recorded two years ago were not observed during this survey season.

Spatial color patterns. Forel-Ule values averaged over the year are depicted in Figure 3-27. The highest average was in Ballona Creek (Station 12 – 13.3 units). All other stations were moderate in Forel-Ule values (10.4 to 11.5 units).

Color ranges compared with past years. All 1999-2000 surface transparency values were within the overall seasonal ranges for the preceding eight years (Table 3-10). When compared to 1998-99, values tended to be lower in the summer and similar for the other seasons.

3.3.2. Bacterial Water Quality

Maintaining standards of public health is a major concern for the marina. Although most of the marina is not used for body contact sports, boaters are in contact with the water during boat maintenance and youngsters learning to sail frequently end up spilled into the water. The Mother's Beach area must be protected for body contact because of the children and adults who paddle and swim in the shallow waters. Fecal contamination may enter the marina from a variety of sources: illegal dumping or leakage of human sewage from vessels, tidal flushing or rainfall runoff of fecal material from animal and/or humans from jetties, beaches and docks; hosing off vessels used as bird roosts; and runoff from storm drain channels. During heavy rainfall, percolating water can overwhelm sewage treatment plants, and cause overflow into storm drain channels. Recreational vessels in the marina do not seem to be a continuing source of coliform contamination, based on historic data, since there are few dry weather violations. The Los Angeles County Department of Health Services monitored five sites in the marina on a weekly basis, but reduced this to four by combining two stations in the beach area into one in August 1994; funds for this activity may not be available in the future due to budget problems. The County is also responsible for monitoring sewer line breaks or overflows.

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

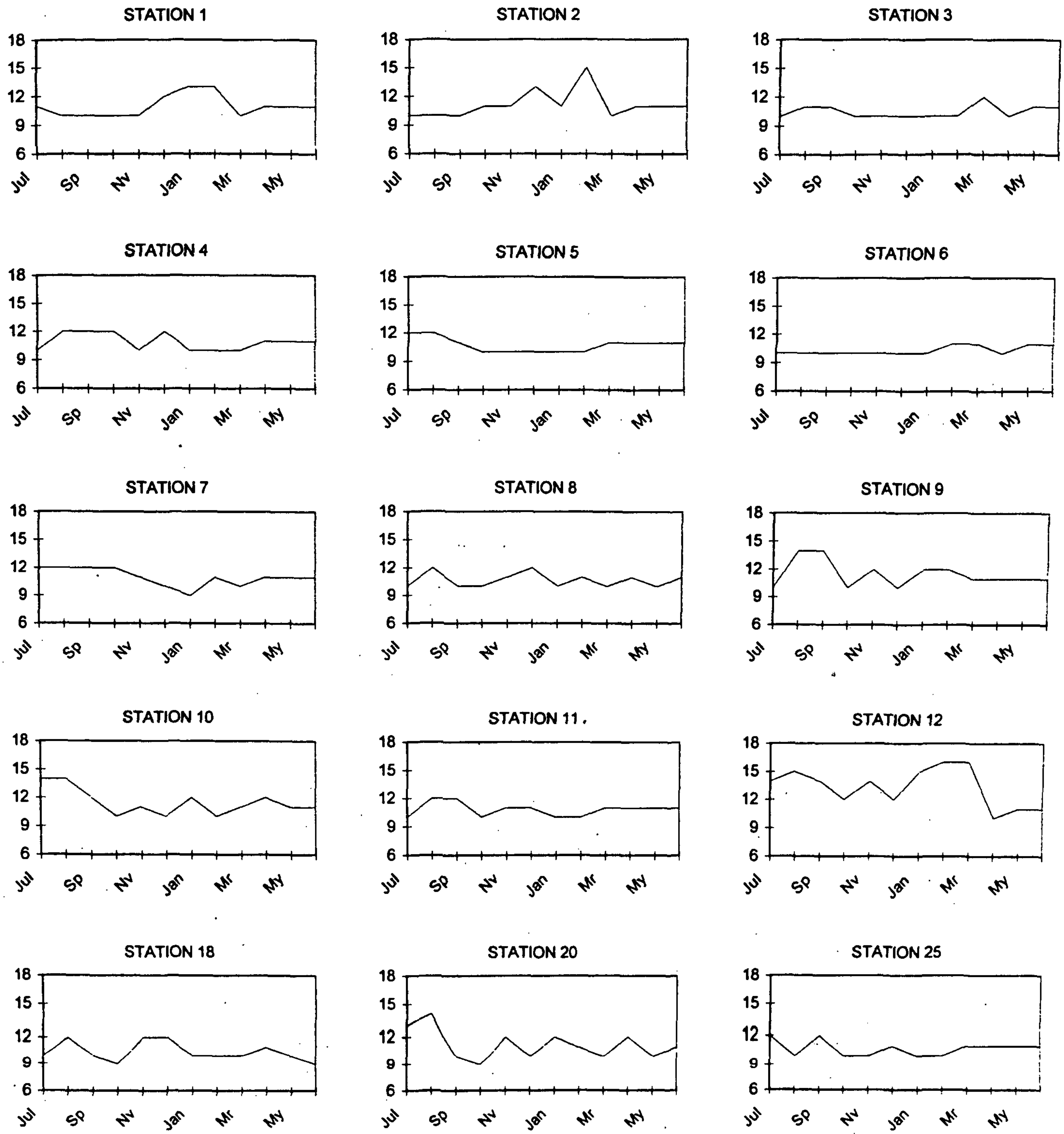


FIGURE 3-27. AVERAGE ANNUAL FOREL-ULE COLOR AT 18 WATER COLUMN STATIONS.

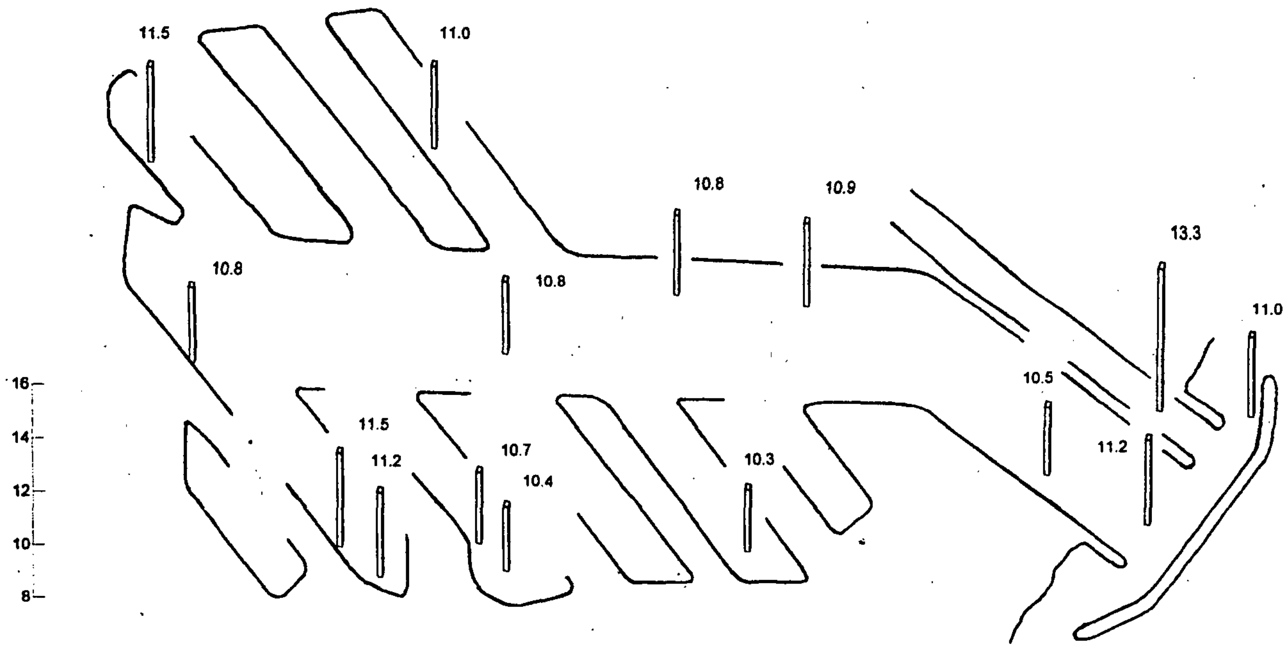


TABLE 3-10. SEASONAL FOREL-ULE COLOR RANGES FOR ALL STATIONS.

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
1997-98	7 - 14	7 - 17	10 - 16	7 - 16
1998-99	8 - 16	9 - 16	10 - 15	10 - 15
Overall range	**3 - 16**	**4 - 18**	**5 - 17**	**4 - 17**
1999-00[3]	9 - 14	9 - 16	10 - 16	9 - 11

[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.

The present study samples 14 marina sites on a monthly basis, providing independent documentation of the state of bacterial contamination in the marina and four stations in the adjacent stormwater channels, Ballona Creek and Oxford Basin. The three measurements, total coliforms, fecal coliforms and enterococcus, are believed by health authorities to present a reasonably good picture of conditions in the environment (R. Kababjian, Los Angeles County Department of Health Services, pers. comm.). The principle problem is that at least 72 hours are needed for incubation to determine the extent of contamination present, slowing the response to potentially hazardous conditions. Research has been underway to develop more rapid tests, which must also be cost effective in terms of equipment and labor required. It is presently more prudent to post areas of potential or known contamination episodes immediately, such as beaches during rainstorms, than to wait for confirmation (Soule et. al. 1996, 1997). Rainfall episodes have been closely associated with violations of all three bacterial standards, especially at areas of the stormwater channels, Ballona Creek, Oxford Basin, and adjacent to the latter in Basin E. Because bacteria reproduce geometrically, normal parametric measures of bacterial density are not adequate to characterize bacterial counts. Therefore, note that all bacterial graphs are scaled logarithmically and all averages are calculated using geometric means.

3.3.2.1. **Total Coliforms**

Coliform bacteria (those inhabiting the colon) have been used for many years as indicators of fecal contamination; they were initially thought to be harmless indicators of pathogens at a time when waterborne diseases such as typhoid fever, dysentery and cholera were severe problems. Recently it was recognized that coliforms themselves might cause infections and diarrhea. However, the total coliform test is not effective in identifying human contamination because these bacteria may also occur as free living in soils, and are present in most vertebrate fecal material. Federal EPA, State and County public health standards for total coliform counts in recreational waters are that no single sample, when verified by a sample repeated in 48 hours, shall exceed 10,000 most probable number (MPN) per 100 ml. The program is limited to one sample per station per month, so 10,000 MPN/100 ml has been used as the relevant standard. Regulations state that if sampling were done on a daily basis, however, no more than 20 percent of the samples in a 30-day period could exceed 1,000 MPN/100 ml, and no single sample could exceed 10,000 MPN/100 ml. This is not normally done unless some persistent problem is identified (Soule et. al. 1996, 1997).

<u>Total coliform patterns over the year.</u> Total coliform counts ranged from <20 to ≥16,000 MPN/100 ml (Figure 3-28). Out of 216 measurements over the year, counts were in violation (greater than 10,000 MPN/100 ml) 27 times (Table 3-14). Nearly all (26) of these were at stations associated with either Oxford Lagoon, including Basin E (10, 13, 20, and 22) or Ballona Creek (Stations 1 and 12). The exception was an exceedance in May at Stations 11 at the main channel. This exceedance could have possibly been rainfall related. Limits were exceeded most often in December (four stations). During the rest of the year, total coliform exceedances ranged from one to three stations per month. Unlike some past years, total coliform patterns were not strongly related to rainfall this year.

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

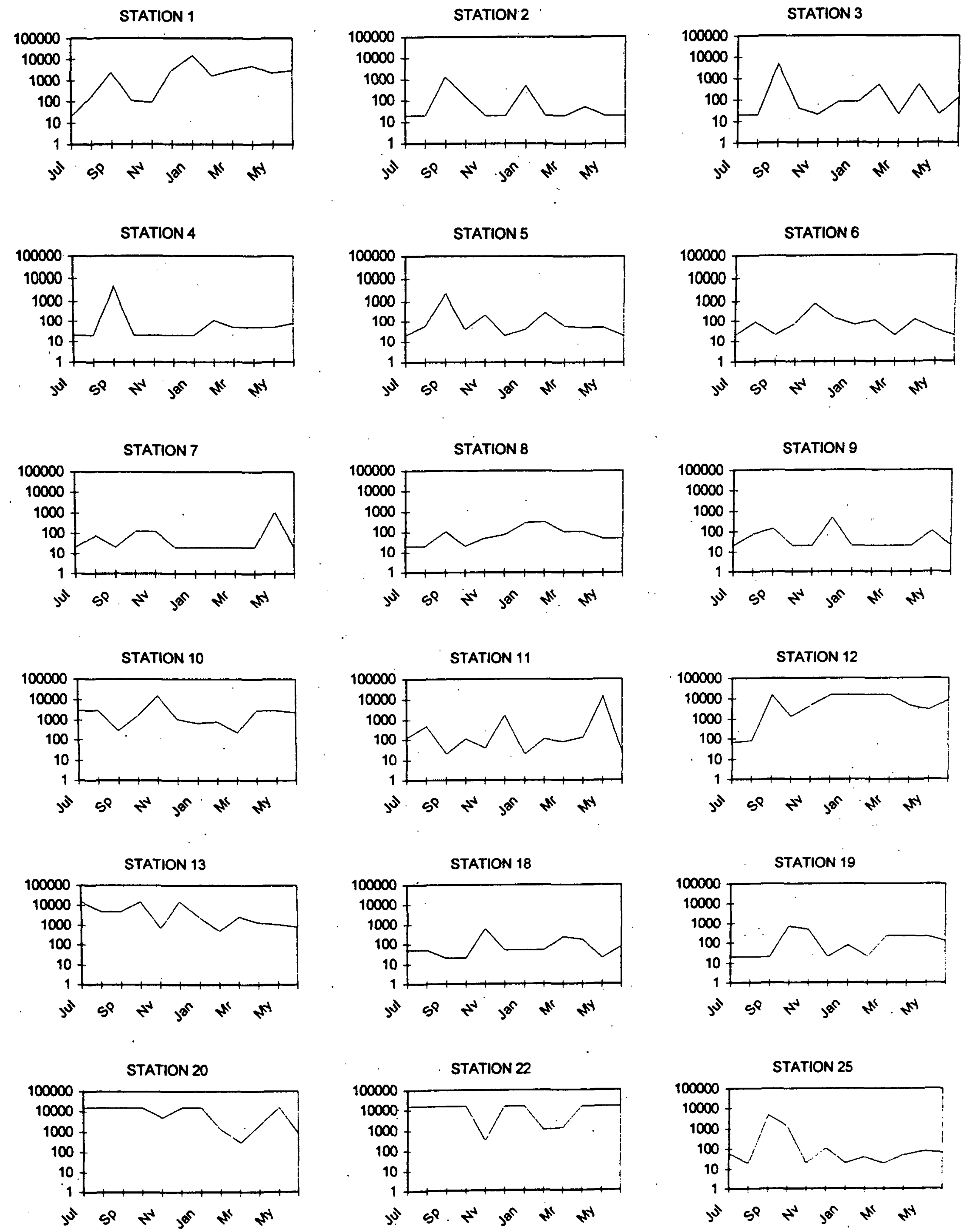


FIGURE 3-29. GEOMETRIC MEANS OF TOT. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

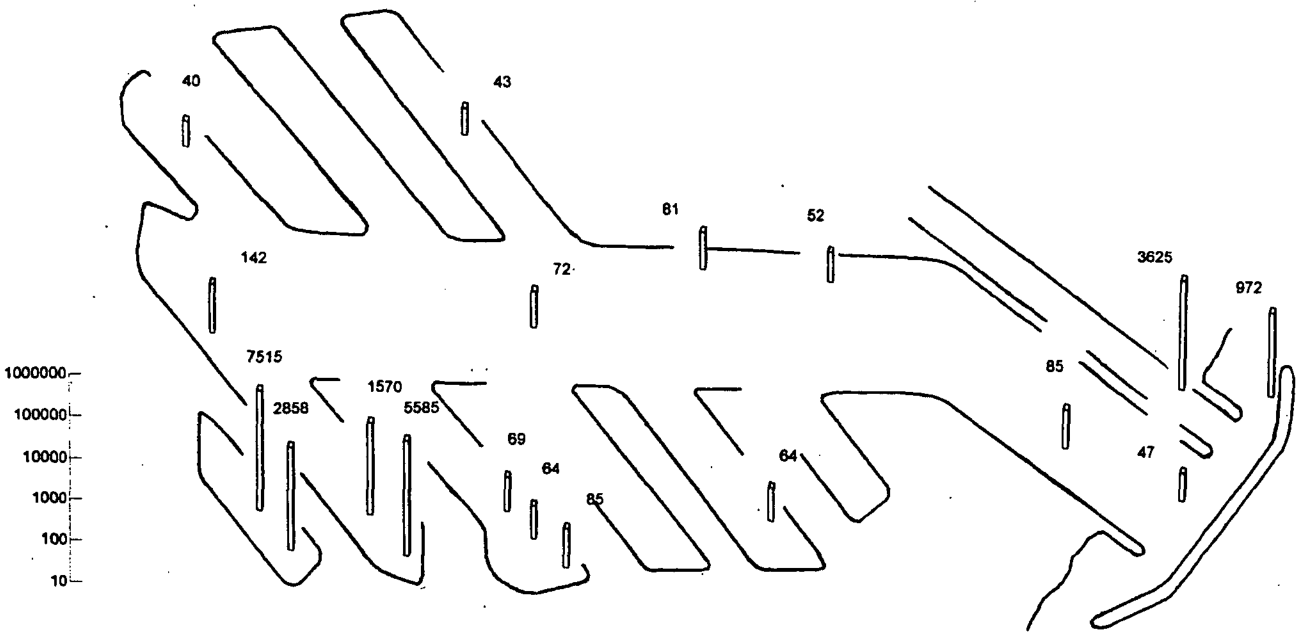


TABLE 3-11. FREQUENCY OF TOTAL COLIFORM VIOLATIONS (>10,000 MPN/100 ML) FOR ALL STATIONS.

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	8
1997-98	5	8	3	7
1998-99	5	5	8	7
Overall range	**0 - 5**	**1 - 43**	**1 - 13**	**0 - 8**
1999-00[3]	7	9	5	1

[1] Two months only in the fall.

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

[3] One month only in the summer.

Spatial total coliform patterns. Total coliform values averaged over the year are depicted in Figure 3-29. Highest averages were, not surprisingly, in Oxford Lagoon (Stations 13 and 22 - 2858 and 7515 MPN/100 ml, respectively), in Basin E (Stations 10 and 20 - 1570 and 5585 MPN/100 ml), and near Ballona Creek (Stations 1 and 12 – 972 and 3625 MPN/100 ml). The remainder of the Harbor averaged much lower (40 to 142 MPN/100 ml).

Total coliform ranges compared with past years. Numbers of total coliform violations for 1999-2000 were within the overall seasonal ranges for the preceding eight years, except for fall, which had two exceedances over the past maximum (Table 3-11). When compared to 1998-99, violation frequency was higher in the fall and winter and lower in the spring and 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 used as the standard for single fecal coliform violations (Soule et. al. 1996, 1997).

Fecal coliform patterns over the year. Fecal coliform counts ranged from <20 to ≥16,000 MPN/100 ml (Figure 3-30). Out of 216 measurements over the year, counts were in violation (greater than 400 MPN/100 ml) 35 times (Table 3-14). Similar to total coliforms, nearly all (32) of these were at stations associated with either Oxford Lagoon, including Basin E (10, 13, 20, and 22), or Ballona Creek (Stations 1 and 12). The exceptions were exceedances in the main channel (Stations 4 and 5) in September and Basin H (Station 7) in May. Since these months were relatively dry, high counts are likely not rainfall related. Limits were exceeded most frequently in July and December, which were also relatively dry months. During the rest of the year, fecal coliform exceedances ranged from one to three stations per month.

Spatial fecal coliform patterns. Fecal coliform values averaged over the year are depicted in Figure 3-31. Highest averages were in Oxford Lagoon (Stations 13 and 22 - 453 and 607 MPN/100 ml, respectively), Basin E (Stations 10 and 20 – 228 and 1041 MPN/100 ml), and near Ballona Creek (Stations 1 and 12 – 292 and 696 MPN/100 ml). Averages at the remaining stations were considerably lower (26 to 47 MPN/100 ml).

Fecal coliform ranges compared with past years. Numbers of fecal coliform violations for 1999-2000 were within the overall seasonal ranges for the preceding eight years (Table 3-12). When compared to 1998-99, violations were more frequent in the fall and less frequent during the remaining seasons.

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

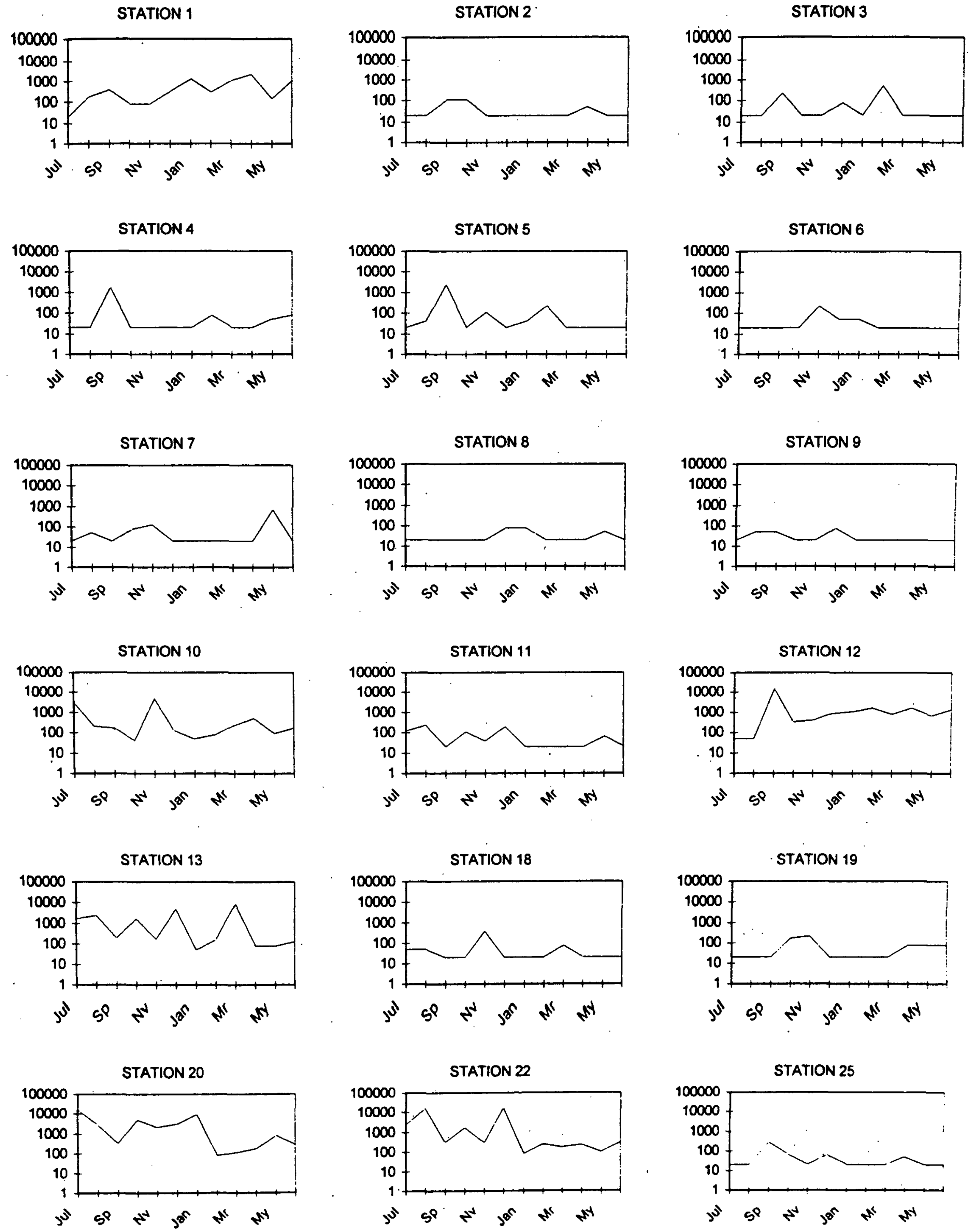


FIGURE 3-31. GEOMETRIC MEANS OF FEC. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

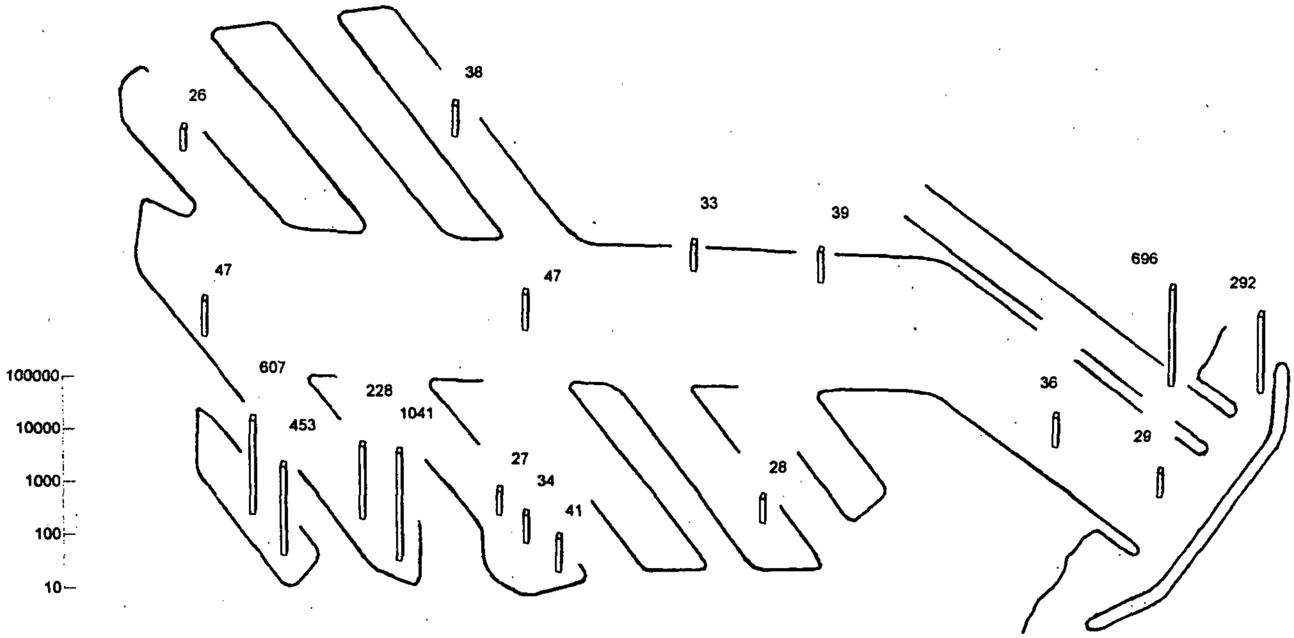


TABLE 3-12. FREQUENCY OF FECAL COLIFORM VIOLATIONS (>400 MPN/100 ML) FOR ALL STATIONS.

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
1997-98	18	23	3	7
1998-99	6	12	11	10
Overall range	**2 - 18**	**6 - 46**	**3 - 21**	**0 - 10**
1999-00[3]	9	9	9	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.

3.3.2.3. **Enterococcus**

Enterococcus bacteria comprise a portion of the Streptococcus bacteria. They were once 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 (Soule et. al. 1996, 1997).

Enterococcus patterns over the year. Enterococcus counts ranged from <2 to ≥1600 Colonies/100 ml (Figure 3-32). Out of 216 measurements, counts were in violation (greater than 104 Colonies/100 ml) 22 times (Table 3-14). Most of these (19) were at stations associated with either Oxford Lagoon, including Basin E (10, 13, 20, and 22), or Ballona Creek (Stations 1 and 12). The exceptions were exceedances in September in Basin F (Station 9) and near the Harbor entrance (Station 2) and June in Basin D (Station 18). Limits were exceeded most frequently (five times) in June. None of these exceedances appear to be rainfall related. During the rest of the year, enterococcus exceedances ranged from zero to four 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 - 94 and 162 Colonies/100 ml, respectively), Basin E (Stations 10 and 20 - 30 and 108 Colonies/100 ml), and near Ballona Creek (Stations 1 and 12 – 14 and 17 Colonies/100 ml). Remaining station counts averaged lower (3 to 9 Colonies/100 ml).

Enterococcus ranges compared with past years. Numbers of enterococcus violations for 1999-2000 were within the overall seasonal ranges for the preceding eight years (Table 3-13). When compared to 1998-99, violations were less frequent except in the summer.

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).

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

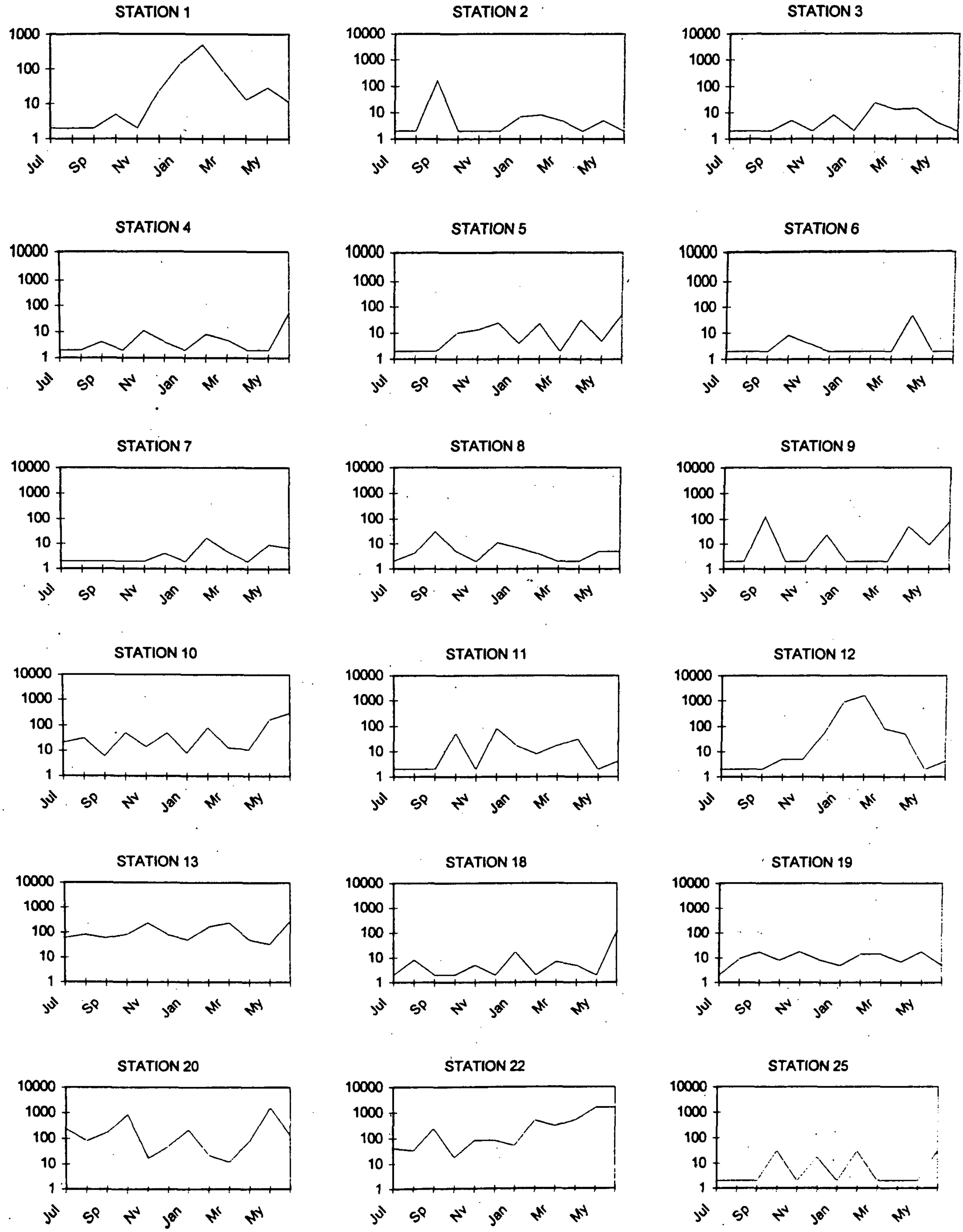


FIGURE 3-33. GEOMETRIC MEANS OF ENTEROCOCCUS (COL./100 ML) AT 18 WATER COLUMN STATIONS

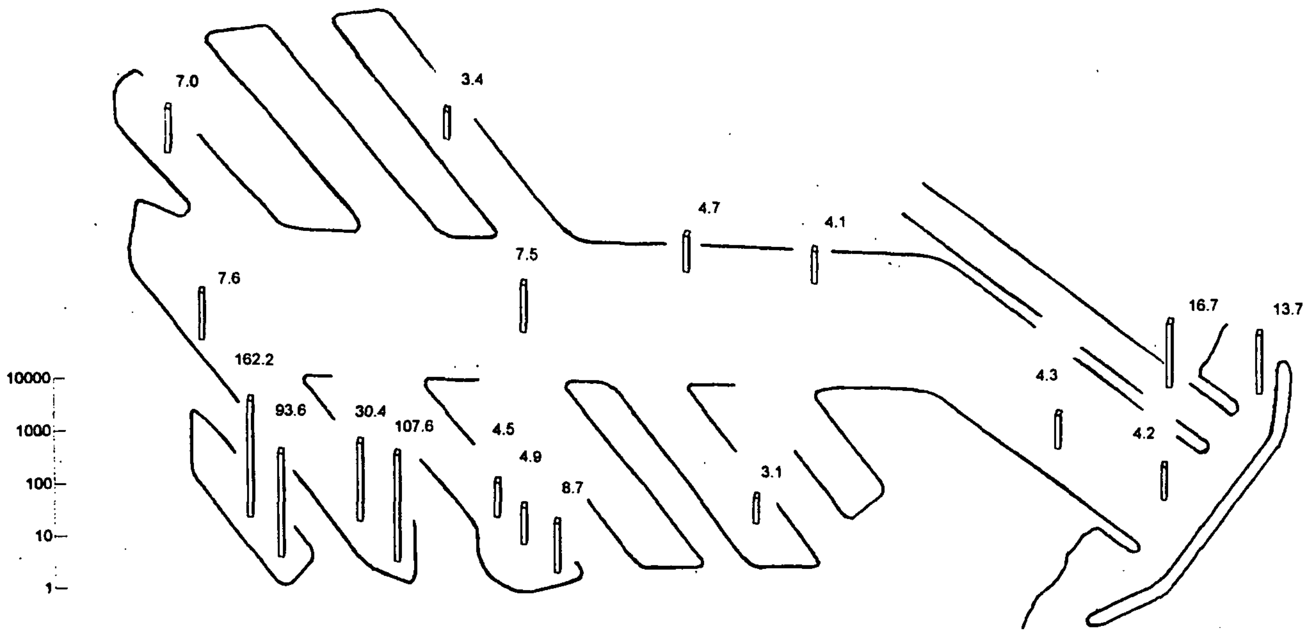


TABLE 3-13. FREQUENCY OF ENTEROCOCCUS VIOLATIONS (>104 MPN/100 ML) FOR ALL STATIONS.

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
1997-98	3	10	0	5
1998-99	10	14	9	3
Overall range	**0 - 10**	**0 - 35**	**0 - 10**	**0 - 5**
1999-00[3]	6	7	6	5

[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	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	16,000	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	16,000	—
12	—	—	≥ 16,000	—	—	16,000	≥ 16,000	16,000	≥ 16,000	—	—	—
13	16,000	—	—	≥ 16,000	—	≥ 16,000	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	≥ 16,000	≥ 16,000	≥ 16,000	≥ 16,000	—	≥ 16,000	≥ 16,000	—	—	—	≥ 16,000	—
22	≥ 16,000	≥ 16,000	≥ 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	—	—	—	—	—	—	1300	—	1100	2200	—	1100
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	1700	—	—	—	—	—	—	—	—	—
5	—	—	2400	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	700	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	3000	—	—	—	5000	—	—	—	—	500	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	16,000	—	420	900	1100	1700	800	1700	700	1400
13	1700	2400	—	1700	—	5000	—	—	9000	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	≥ 16,000	2800	—	5000	2200	3000	9,000	—	—	—	800	—
22	2400	≥ 16,000	—	1700	—	≥ 16,000	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

ENTEROCOCCUS (>104 COLONIES/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	—	—	500	—	—	—	—
2	—	—	170	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	130	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	170	300
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	1600	—	—	—	—
13	—	—	—	—	240	—	—	170	240	—	—	300
18	—	—	—	—	—	—	—	—	—	—	—	130
19	—	—	—	—	—	—	—	—	—	—	—	—
20	240	—	170	900	—	—	—	—	—	—	1600	130
22	—	—	240	—	—	—	—	500	300	500	1600	1600
25	—	—	—	—	—	—	—	—	—	—	—	—

Stations 10, 13, 20, and 22. These stations include two in Oxford Lagoon and two in Basin E. These stations tended to be warm; turbid; less saline; lower in dissolved oxygen and pH; and higher in nutrients, organics, and bacteria. These stations are clearly impacted by contaminated freshwater from municipal drainage.

Station 9. The water at this station in Basin F was more turbid and more yellow to brown than at the other stations. Relatively low salinity, dissolved oxygen, and pH suggest that freshwater may be entering this area. This basin is also relatively free of bacterial contamination.

Stations 7, 8, 11, 18, and 19. 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 more saline, low in BOD and bacteria, and moderate in all remaining measurements.

Stations 3, 4, 5, 6, and 25. These stations represent the middle and lower main channel plus Basin B. Water here tends to be greener, clearer, higher in dissolved oxygen and pH, and lower in organics, nutrients, and bacteria. These stations are the most natural in the Harbor.

Stations 1, 2, and 12. These stations are strongly influenced by both the flow from Ballona Creek and tidal flows from the open ocean. Characteristics influenced by Ballona Creek include more yellow to brown water, low salinity, and higher levels of BOD and bacteria. Characteristics influenced by open ocean waters include low temperature and high dissolved oxygen and pH.

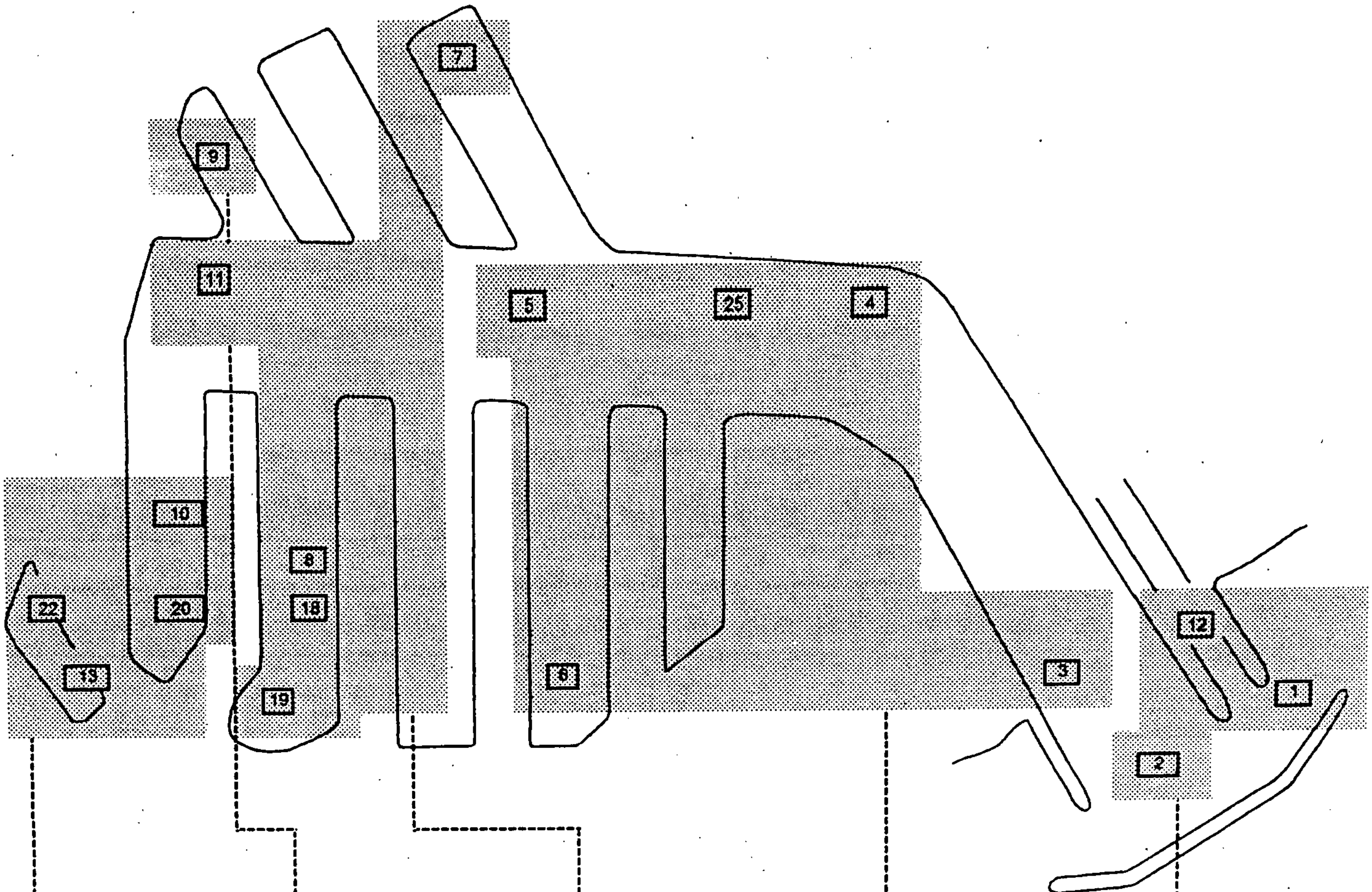
3.4. DISCUSSION

As in past years, water quality in Marina del Rey Harbor this past survey was mostly impacted temporally by season and rainfall; and spatially impacted by proximity to Oxford Lagoon, Ballona Creek, and the Harbor entrance.

Weather during 1999-2000 was similar to last year (Aquatic Bioassay 1999) and characterized by cooler water temperatures and relatively low rainfall. When rainfall did occur, however, numerous physical and chemical properties of the water column were affected. Winter and spring runoff lowered water clarity, salinity, and pH; and increased ammonia and perhaps BOD. For all parameters, it should be noted that differences during the rainy seasons were very small. The influence of phytoplankton this year was even weaker than last year (Aquatic Bioassay 1999), and no red tide condition or other strong plankton blooms were evident. Temperature alone 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.

Spatially, Harbor waters were strongly affected by tidal flow from the open ocean and drainage from Ballona Creek and particularly Oxford Lagoon. Both Ballona Creek and fresh tidal ocean water impact stations immediately adjacent to the entrance. 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 usually warmer, more turbid and saline, and lower in oxygen and pH.

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



Stations 10, 13, 20, 22

Relatively High in:
Temperature
Ammonia
Biochem. Oxygen Demand
Total Coliforms
Fecal Coliforms
Enterococcus

Relatively Low in:
Salinity
Dissolved Oxygen
pH
Surface Transparency

Characteristics:
Strongly influence by drainage from Oxford Lagoon. Water is turbid; warm; and low in oxygen, pH, and salinity. A major source of organics, nutrients, and bacteria to the Harbor.

Station 9

Relatively High in:
Color

Relatively Low in:
Salinity
Dissolved Oxygen
pH
Light Transmissance
Surface Transparency
Total Coliform
Fecal Coliform

Characteristics:
Fairly typical of back-harbor areas, but relatively low salinity may indicate a freswater source. Water is yellow-green, turbid, low in oxygen and pH, and low in coliform bacteria.

Stations 7, 8, 11, 18, 19

Relatively High in:
Salinity

Relatively Low in:
Biochem. Oxygen Demand
Total Coliform
Enterococcus

Characteristics:
Typical of low circulation, back-harbor locations. High in salinity and low in oxygen demand and bacteria.

Stations 3, 4, 5, 6, 25

Relatively High in:
Dissolved Oxygen
pH
Light Transmissance
Surface Transparency

Relatively Low in:
Color
Ammonia
Biochem. Oxygen Demand
Enterococcus

Characteristics:
Typical of main channels with good water quality. Water is clear, green, high in oxygen and pH, and low in ammonia, oxygen demand, and bacteria.

Stations 1, 2, 12

Relatively High in:
Dissolved Oxygen
pH
Color
Biochem. Oxygen Demand
Enterococcus

Relatively Low in:
Temperature
Salinity

Characteristics:
Most influenced by open ocean waters but also impacted by Ballona Creek. Water is yellow-green, cold, saline, and high in dissolved oxygen, and pH. Ballona Creek contributes organics and bacteria to this area

Stations closest to Oxford Lagoon showed reduced salinity, dissolved oxygen, water clarity, and pH; and higher levels of ammonia, BOD, and bacteria. In addition, most measurements varied much more widely over the year. Stations impacted by Ballona Creek (1 and 12) usually had a surface layer of nearly fresh water. These stations also tended to be lower in water clarity and salinity; and higher in ammonia, BOD, and bacteria. Stations near Ballona Creek also tended to be more yellow-brown in color than other stations. Among 648 bacterial measurements, 84 violated standard water quality limitations. Among these, 77 (92%) could be attributable to drainage from either Ballona Creek or Oxford Lagoon. As we have stated in previous reports, the flows from these two areas 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 overshadows all other impacts.

Conversely, stations near the Harbor entrance (when not being impacted by Ballona Creek) and the lower main channel were relatively high in dissolved oxygen, pH, and water clarity and were more green to green-blue in color. As in the past, these areas have water most similar to the open ocean. Station 9 differed from most Basin stations due to slightly lower water clarity, pH, and salinity and a generally more yellow-brown water color. These qualities may indicate that Basin F is receiving some fresh water from somewhere. The water near Mothers Beach was low to moderate in bacterial counts this year.

4. PHYSICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

4.1. BACKGROUND

The benthos (bottom) of the marina is mostly composed of fine and very fine sediments, due in part to the historic nature of the Ballona wetlands that 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 low rainfall periods. Transport seaward of coarsely grained materials occurs in more swiftly moving waters 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 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. This is a problem because high levels of lead and results of toxicity tests preclude ocean disposal 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 (Soule et.al. 1996).

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. Most recent dredging has been the Harbor entrance: 1987 - 131,000 cubic yards from the jetty tips and Ballona Creek mouth; 1992 - 17,000 cubic yards from the south side of the entrance; 1994 - 57,000 cubic yards from the ends of the breakwater, the jetties, and mouth of Ballona Creek; 1996 - 203,000 cubic yards from both Harbor entrances and outside the north jetty; 1998 - 300,000 cubic yards from the north entrance; and 1999-2000 – 530,000 cubic yards from both entrances and mouth of Ballona Creek.

4.2. MATERIALS AND METHODS

Benthic grab sampling was conducted in accordance with *Techniques for Sampling and Analyzing the Marine Macrobenthos* March 1978, EPA 600/3-78-030; *Quality Assurance and Quality Control (QA/QC) for 301 (h) Monitoring Programs: Guidance on Field and Laboratory Methods* May 1986, Tetra Tech; and methods which have been developed by the Aquatic Bioassay Team over the past 25 years.

Samples were collected on October 13, 1999 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 of water 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 84th percentile minus the 16th 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 highest peak of the curve will tend to be associated with the median particle size. If the peak tends to be toward the larger micron sizes (e.g., Station 22), then it is probable that the sediments will tend to be coarser overall. If the peak is near the smaller micron sizes (Station 9), then it is probable that the sediments are mostly finer. Sediment medians 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 subdivisions within the categories (e.g. coarse silt, very fine sand, etc., see Table 4-1).

The second pattern discernible from the graph is sediment homogeneity. 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 13), are considered to be heterogeneous or poorly sorted. The graphs in Figure 4-1 indicate that sediments near the Harbor entrance (1, 2, and 3) tended to be relatively coarse and homogeneous in composition. Stations within Oxford Lagoon (13 and 22) also tended to be coarse but were relatively heterogeneous in composition. Most other stations in the Harbor tended to be finer and relatively heterogeneous.

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 sizes (3-4 microns – clay) were at Station 9 in Basin F and Station 11 at the end of the Harbor channel. These stations are far from the entrance and probably have very low current velocities. The largest median particle sizes were at Stations 1, 2, and 3 near the Harbor entrance (104 to 381 microns), at Station 12 in Ballona Creek (83 microns), and Stations 13 and 22 in Oxford Lagoon (113 and 370 microns, respectively) (all very fine sand to medium sand). These stations likely have the highest current velocities of the Harbor. Remaining stations had sediments, which were more moderate in median particle size (6 to 53 microns – very 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 1998. In surveys previous to 1996, measurements were made only through the sand ranges. When values were in the range of silts or clays, less than 74 microns was reported. Overall differences between this year and last year were minor. Largest changes were at Station 12 in Ballona Creek (a shift from medium sand to very fine sand) and Station 8, in Basin D (medium silt to very fine silt). These changes may be due to relatively low rainfall last year. 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.

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

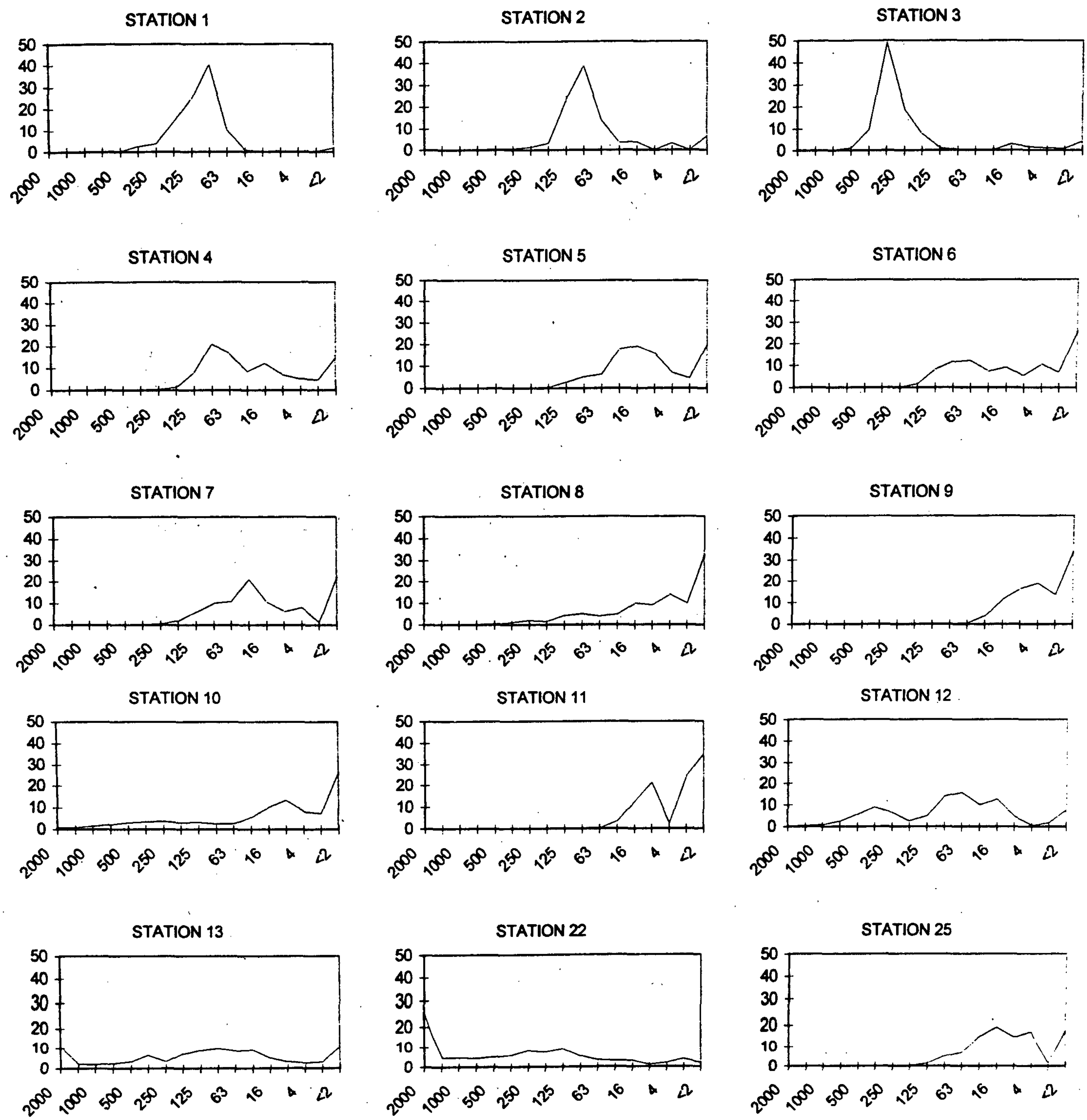


TABLE 4-1. PARTICLE SIZE DISTRIBUTIONS (PERCENTS) FROM 15 BENTHIC SEDIMENT STATIONS

	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	0.1	0.1	0.2	0.2	0.3	2.6	3.8	13.9	24.7	40.3	10.3	0.9	0.3	0.4	0.1	0.1	1.8
2	0.0	0.0	0.1	0.2	0.4	0.6	1.3	3.2	23.7	38.7	14.2	3.7	3.9	0.2	3.0	0.2	6.8
3	0.4	0.3	0.2	1.1	9.6	49.1	18.9	7.8	1.1	0.5	0.4	0.1	2.8	1.6	1.1	0.9	4.0
4	0.2	0.0	0.1	0.1	0.1	0.2	0.4	1.2	8.0	20.9	16.6	8.6	12.0	7.0	5.2	4.6	14.7
5	0.1	0.0	0.0	0.1	0.0	0.3	0.1	0.5	2.7	5.2	6.1	17.9	19.2	16.0	7.0	4.8	19.9
6	0.0	0.0	0.0	0.0	0.1	0.1	0.2	1.5	8.3	11.6	12.3	7.3	9.1	5.5	10.7	7.1	26.0
7	0.0	0.0	0.0	0.0	0.0	0.2	0.4	1.9	6.0	10.3	10.9	21.3	10.7	6.2	7.9	1.2	22.8
8	0.0	0.0	0.0	0.1	0.4	1.2	1.9	1.7	4.2	5.1	4.1	5.0	10.1	9.1	14.1	9.7	33.3
9	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.3	0.5	3.7	11.6	16.4	19.0	13.6	34.4
10	0.9	0.9	1.5	2.3	3.2	3.6	3.9	3.1	3.4	2.6	2.7	5.6	10.4	13.3	8.3	7.4	27.1
11	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.2	0.3	3.3	12.6	21.5	2.2	24.5	35.0
12	0.3	0.3	0.9	2.5	5.7	9.0	6.7	2.7	5.0	14.0	15.5	10.1	12.4	5.0	0.4	1.7	7.7
13	10.9	2.3	2.1	2.4	3.3	6.4	3.5	7.2	8.9	10.1	8.6	9.0	5.0	3.3	2.7	3.0	11.1
22	26.0	4.7	4.7	4.4	5.2	5.8	8.3	7.7	9.1	5.5	3.5	3.1	3.2	1.2	2.0	3.9	2.0
25	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2	1.3	4.8	7.0	15.3	19.3	14.9	17.3	1.8	17.9

TABLE 4-2. MEDIAN PARTICLE SIZES (MICRONS)[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1990 TO OCTOBER 1999.

	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
Sep-98	167	97	320	23	16	5	27	23	5	10	5	361	207	356	15
Oct-99	121	104	381	53	17	16	32	6	4	11	3	83	113	370	14

[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 1999[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
Sep-98	1.01	1.48	2.96	2.86	2.87	3.29	3.08	3.53	2.65	4.89	2.69	2.70	3.96	3.56	2.98
Oct-99	0.58	0.87	0.62	2.79	2.68	3.52	3.33	3.44	2.18	4.13	1.92	2.28	3.58	2.99	2.51

[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

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, 2, and 3 near the Harbor entrance (0.6 to 0.9 – moderately well sorted to well sorted) were the most homogeneous. Station 10 in Basin E (4.1 – extremely poorly sorted) was most heterogeneous. The remaining stations were between these (1.9 to 3.6 – poorly sorted to very poorly sorted). As a rough general rule, high-energy area sediments (i.e. Harbor entrance) tend to have larger median particle sizes and more homogeneous sediments than low energy areas (Harbor channels and basins). The exceptions to this are the Oxford Lagoon stations, which had relatively large median particle sizes but were 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 (0.6 to 4.1) indicate that sediments tended to be more homogeneous overall than during the past three years (0.8 to 5.2).

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 (Basin F and upper end of the main channel). These sediments were the second most homogeneous (poorly sorted to very poorly sorted), and the median particle size was the finest in the Harbor (clay to very fine silt). Current velocities here are probably very low.

Stations 13 and 22 (Oxford Lagoon). These sediments were the second most heterogeneous in the Harbor (very poorly sorted), and the median particle size was the coarsest in the Harbor (very fine sand to medium sand). Rapid water movement characterizes this area; however, there must be periods of relative quiescence when some finer particles can accumulate.

Stations 6, 8, and 10 (Basins C, D, and E). The grain size distribution at these stations was the most heterogeneous among groups, and the median particle size was the second finest in the Harbor. These stations likely encounter comparatively low current velocities.

Stations 4, 5, 7, and 25 (Basin H and the upper main channel). Sediments here relatively moderate in distribution (very poorly sorted), and the median particle size was also moderate (fine silt to coarse silt). Current velocities at these stations are probably also moderate.

Stations 1, 2, 3, and 12 (Ballona Creek and Harbor entrance). Sediments here were the most homogeneous (poorly sorted), and the median grain size was the second coarsest in the Harbor (very fine sand to medium sand). These areas likely encounter almost continuous water movement.

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

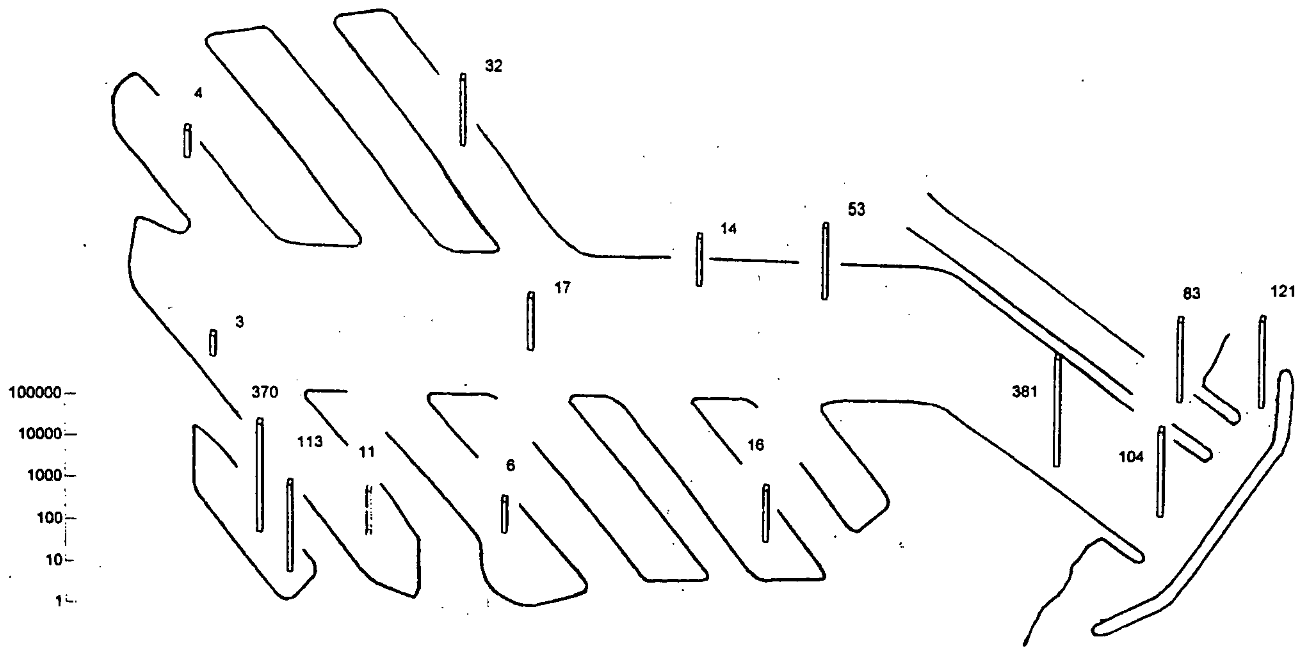


FIGURE 4-3. SORTING INDEX VALUES AT 15 BENTHIC SEDIMENT STATIONS.

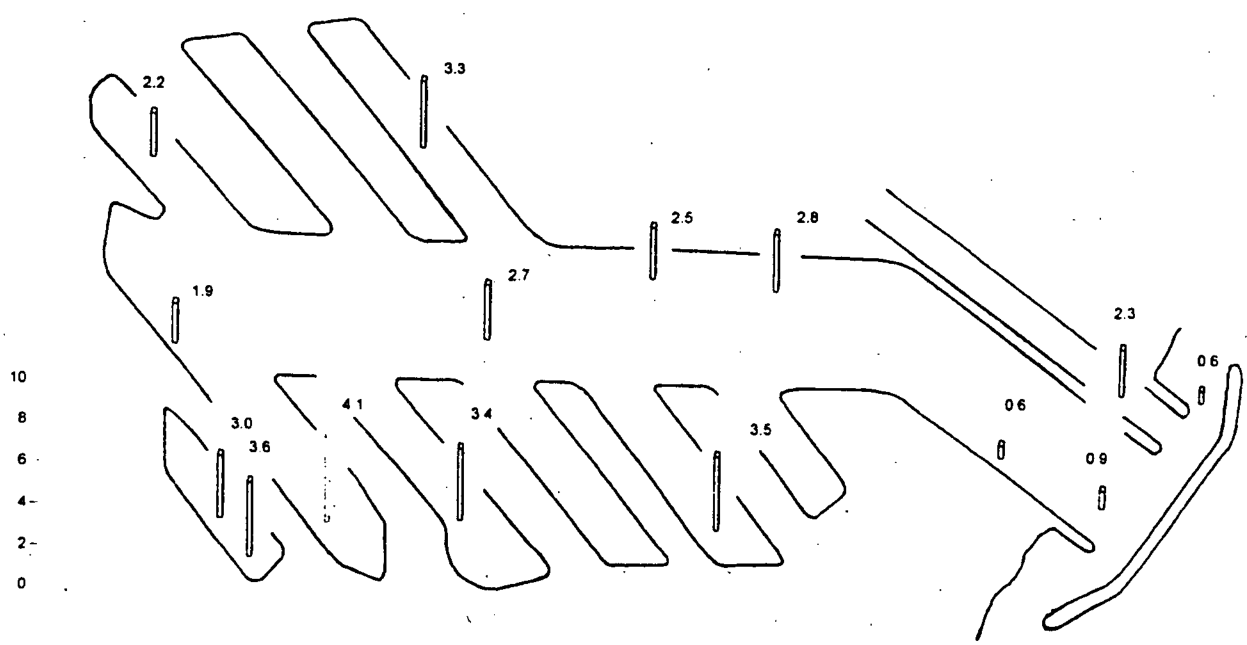
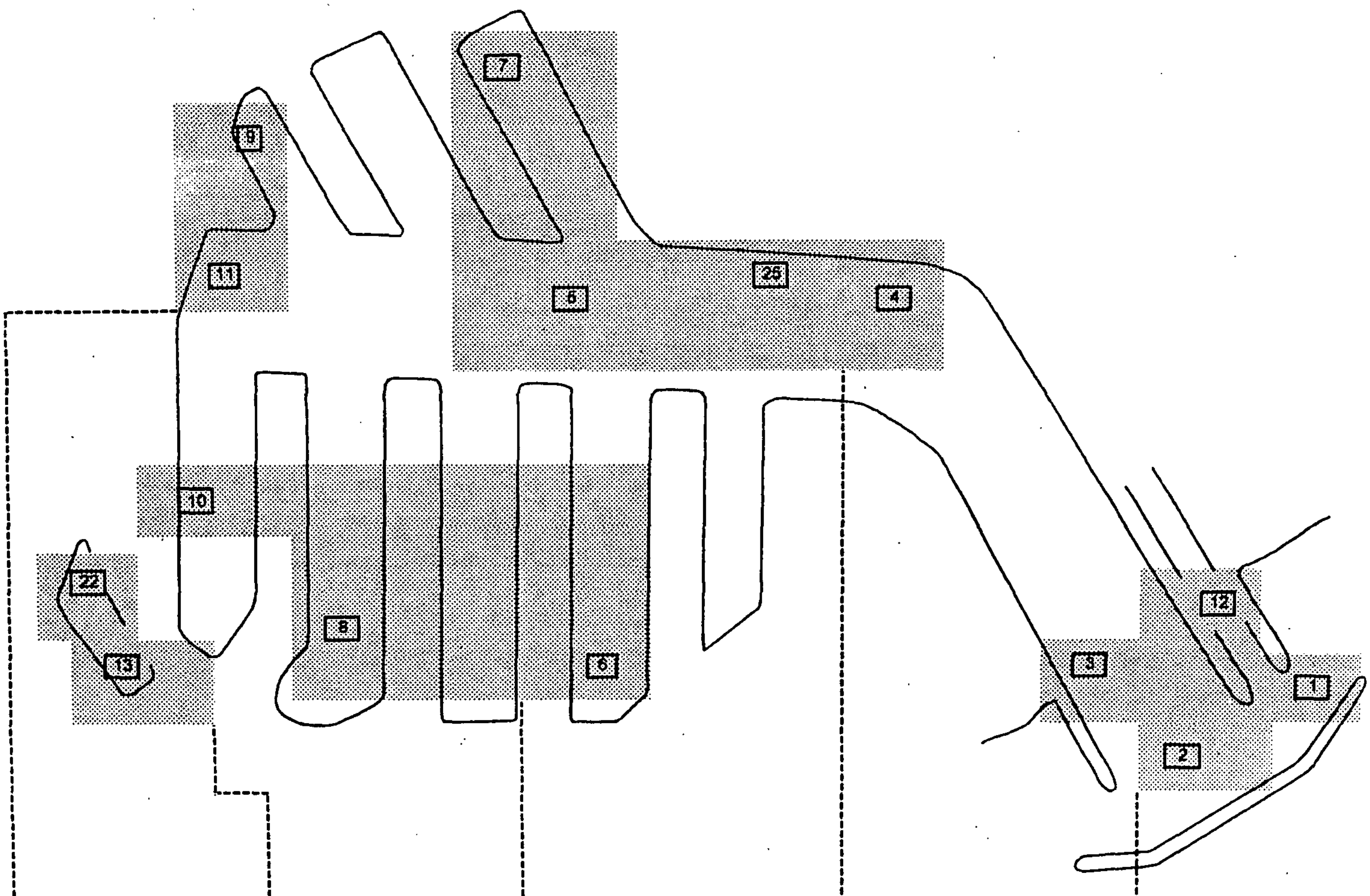


FIGURE 4-4. PHYSICAL SEDIMENT CHARACTERISTICS BASED ON BRAY-CURTIS CLUSTERING TECHNIQUE.



Stations 9,11

Median grain size:

Clay to very fine silt

Sorting:

Poorly sorted to
very poorly sorted

Characteristics:

These stations contain the finest sediments in the Harbor. The grain size distribution is the second most homogeneous.

Stations 13,22

Median grain size:

Very fine sand
to medium sand

Sorting:

Very poorly sorted

Characteristics:

These stations contain the coarsest sediments in the Harbor. The grain size distribution is the second most heterogeneous.

Stations 6,8,10

Median grain size:

Very fine silt to fine silt

Sorting:

Very poorly sorted

Characteristics:

These stations contain second finest sediments in the Harbor. The grain size distribution is the most heterogeneous.

Stations 4,5,7,25

Median grain size:

Fine silt to coarse silt

Sorting:

Very poorly sorted.

Characteristics:

These stations contain relatively moderate sized sediments. The grain size distribution is also moderate.

Station 1,2,3,12

Median grain size:

Very fine sand
to medium sand

Sorting:

Poorly sorted.

Characteristics:

These stations contain the second coarsest sediments in the Harbor. The grain size distribution is the most homogeneous

4.4. DISCUSSION

The sources of sediment that enter Marina del Rey Harbor are numerous, however, all sediment leaves the Harbor through the entrance or, less frequently, through dredging operations. Sand from nearby nearshore areas may also enter the Harbor through the entrance. Various sediments continuously flow in from Ballona Creek, Venice Canal, Oxford Lagoon, and other smaller discharge points. During period of precipitation, finer sediments suspended in water flow across the surface of the land and enter the Harbor. Slower dry weather water velocities in most areas of the Harbor allow finer particles to settle out. This allows for a more heterogeneous mix of sediments. In areas of higher velocities, finer particles remain suspended and continue to move on. Since finer particles do not settle out in these high-energy areas, the sediments are not only coarser but also usually narrower in range (more homogeneous).

Based upon physical characteristics this year, Harbor sediments in most basins and the main channel are relatively fine (silt) but have a wide range of values. Areas which have the narrowest ranges of sediments include both those with the finest sediments (clay - Basin F and the upper end of the main channel) and those with the coarsest sediments (sand - Ballona Creek and the Harbor entrance). The two stations in Oxford Lagoon are unique. They have medians that are coarse (sand) yet have fairly wide ranges of sediment sizes. Perhaps there are periods of both rapid and slow water movement in the Lagoon.

It is not unexpected that course sediments near the Harbor entrance should have narrow size ranges, however, the relatively narrow ranges of the finest sediments in the northeast part of the Harbor are atypical. It may be that this section of the Harbor is so far removed from the shoreline, that larger particles do not even enter the area.

5. CHEMICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

5.1. BACKGROUND

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 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 marina resulted in contamination of terrestrial sediments. These contaminants may have leached into the ground water or may have been carried by runoff into the marina when land was eroded or excavated for newer development. Activities associated with boating such as fuel spillage, use of antifouling compounds, boat maintenance and debris from recreation also results 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, enters the marina, and move inward on rising tides. Station 12, in Ballona Creek; generally has a medium to high ranking with regard to contaminants (Soule and Pieper 1996).

Because the basins are very low energy environments (see Section 4), fine sediments 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 (Soule and Pieper, 1996).

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. Rank growth of weeds and brush can add to the debris accumulation. Tidal flow also may result in deposition in Oxford basin when marina waters contain suspended sediments that 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 (Soule and Pieper, 1996).

5.2. MATERIALS AND METHODS

Field sampling for all benthic sediment components is 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. West Coast Analytical Laboratories in Santa Fe Springs, California performed all chemical analyses.

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: 1) heavy metals, 2) chlorinated pesticides and polychlorinated biphenyls (PCB's), 3) simple organics, and 4) minerals and other compounds. Table 5-2 compares the ranges of the current survey with all surveys undertaken since October of 1987. An overall range from these 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 10th percentile and median (50th) percentile were identified. The lower 10th 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. In 1995, the list was revised (Morgan, et. al. 1995), and most values were lowered. Note that previous to our last report, all surveys utilized the 1990 values.

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	2.5	4.6	2.7	9.0	8.8	9.9	7.5	10.4	13.1	8.6	11.2	6.4	5.2	6.7	11.9	**7.90**
Cadmium	0.21	0.54	0.19	0.74	0.34	0.25	0.25	0.36	0.35	0.69	0.37	1.18	1.32	0.28	0.89	**0.530**
Chromium	14	23	13	44	52	48	40	50	84	40	82	30	17	22	61	**41.33**
Copper	8	21	20	130	193	237	191	312	390	108	450	68	45	38	189	**160.01**
Iron	11500	16700	9000	27500	41000	37000	34000	41000	59000	37000	59000	19200	34000	22900	43000	**32787**
Lead	29	48	30	111	100	90	83	91	149	51	128	122	198	100	131	**97.4**
Manganese	109	141	64	195	278	232	240	248	350	252	360	158	176	222	294	**221.3**
Mercury	0.040	0.085	0.053	0.275	0.410	0.880	0.390	0.940	0.960	0.297	0.700	0.194	0.090	0.080	0.420	**0.3876**
Nickel	9.4	17.7	7.5	21.4	25.9	24.2	21.9	27.3	31.4	23.1	30.6	17.2	13.0	15.2	27.5	**20.89**
Selenium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	**0.00**
Silver	0.16	0.45	0.46	2.12	1.69	0.97	0.98	0.87	1.58	0.32	1.59	1.32	0.44	0.20	2.58	**1.0487**
Tributyl Tin	<0.002	<0.002	<0.002	0.002	0.009	0.010	0.008	<0.002	0.006	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	**0.003**
Zinc	41	104	52	236	257	263	237	320	410	157	450	274	214	300	309	**241.6**
Pesticides & PCB's (ppb)																
p,p' DDD	1.0	4.0	0.6	1.0	0.7	<0.7	<0.7	<0.7	<0.9	4.0	<0.8	4.0	<0.5	<0.6	<0.7	**1.02**
p,p' DDE	2.0	9.5	2.0	6.0	3.0	3.0	3.0	2.0	3.0	7.0	2.0	6.0	1.0	2.0	1.0	**3.50**
p,p' DDT	<0.5	<0.6	<0.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	5.0	<0.5	<0.6	<0.7	**0.33**
All DDT & Derivatives	**3.0**	**13.5**	**2.6**	**7.0**	**3.7**	**3.0**	**3.0**	**2.0**	**3.0**	**11.0**	**2.0**	**15.0**	**1.0**	**2.0**	**1.0**	**4.85**
Delta BHC	<0.3	0.4	<0.3	<0.3	<0.4	<0.4	<0.3	<0.4	<0.5	<0.3	<0.4	<0.3	<0.3	<0.3	<0.4	**0.03**
Alpha Chlordane	0.6	2.0	0.4	0.5	<0.4	<0.4	<0.3	<0.4	<0.5	<0.3	<0.4	3.9	<0.3	0.4	<0.4	**0.52**
Gamma Chlordane	1.0	6.2	1.0	1.0	<0.4	<0.4	<0.3	<0.4	<0.5	<0.3	<0.4	5.9	<0.3	<0.3	<0.4	**1.01**
Dieldrin	<0.5	<0.6	<0.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	2.0	<0.5	<0.6	<0.7	**0.13**
Endosulfan I	0.7	3.0	0.4	0.5	<0.4	<0.4	<0.3	<0.4	<0.5	<0.7	<0.4	0.9	<0.3	<0.3	<0.4	**0.37**
Endrin Aldehyde	<0.5	2.0	0.6	2.0	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	2.0	<0.5	<0.6	<0.7	**0.44**
Endrin Ketone	<0.5	<0.6	<0.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	<0.6	<0.5	1.0	<0.7	**0.07**
All Non-DDT Pesticides	**2.3**	**13.6**	**2.4**	**4.0**	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	**14.7**	<0.5	**1.4**	<0.7	**2.56**
PCB's	**<10**	**<10**	**<10**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<10**	**<10**	**<20**	**0.00**
Organic Content																
Tot. Organic Carbon (%)	0.333	1.840	0.361	2.140	1.790	1.880	1.360	1.840	2.180	1.410	1.870	2.360	1.310	1.710	2.400	**1.6523**
Volatile Solids (%)	1.3	3.9	1.9	5.8	6.0	5.3	4.8	5.8	7.5	4.6	7.1	6.7	5.3	5.6	7.0	**5.24**
Immed. Oxy. Dmd. (%)	0.07	0.10	0.60	2.00	4.00	2.00	1.00	2.00	2.00	1.00	2.00	2.00	0.70	1.00	2.00	**1.498**
Chem. Oxygen Dmd. (%)	0.37	0.78	1.10	2.90	4.50	2.00	3.70	3.20	6.40	3.30	4.90	4.60	2.30	4.60	5.70	**3.357**
Oil and Grease (ppm)	99	290	99	41	<30	<30	<30	<30	<30	<30	<30	1500	<30	<30	<30	**135.3**
Organic Nitrogen (ppm)	<300	860	300	1400	1000	1200	890	1400	1900	830	1500	1300	770	1900	1800	**1136.7**
Ortho Phosphate (ppm)	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<10	<20	<10	<20	**0.0**
Sulfides (ppm)	210	640	310	970	970	870	830	700	990	750	830	1800	480	510	980	**789.3**
Minerals, etc. (ppm)																
Moisture (%)	20.8	29.9	18.3	40.1	45.5	45.2	39.1	45.5	57.2	41.0	52.6	35.1	25.9	31.7	46.6	**38.30**
Spec. Cond. (mmhos/cm)	17200	23100	14400	16800	23100	19400	23300	19100	32000	17800	21200	25500	18200	20600	19300	**20733**
Alkalinity as CaCO3	550	1200	610	780	530	480	560	630	810	480	610	1900	1200	2200	620	**877.3**
Hardness as CaC03	2120	2010	1580	3120	4600	4600	3140	5310	9060	3680	6690	5610	3630	2950	5940	**4269**
Total Dis. Solids (%)	12300	18300	10000	24780	18400	9840	18900	10500	31200	11600	16500	21900	12800	16500	15800	**16621**
Barium	20	37	18	69	114	76	96	89	145	123	150	78	117	82	120	**89.0**
Boron	4.1	19.0	6.6	21.2	21.4	24.0	20.0	24.8	22.7	18.3	20.0	18.3	8.1	15.5	24.2	**17.88**
Calcium	6300	8800	6700	14600	8500	7300	7300	6100	5400	9500	5500	11900	9300	3070	13900	**8278**
Chloride	6300	9970	5480	14500	12800	12500	12900	11900	28200	10700	18600	12900	7640	9760	10500	**12310**
Fluoride	11.0	16.6	9.8	25.5	16.9	26.0	18.2	14.2	27.9	11.8	15.2	20.2	11.3	16.0	21.0	**17.44**
Nitrogen	<300	870	310	1400	1000	1200	910	1400	1900	840	1500	1300	800	2000	1800	**1148.7**
Nitrate	<0.3	24.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	39.7	<0.3	<0.3	<0.3	21.1	24.9	26.9	**9.13**
Potassium	1050	1980	1080	3700	5700	4900	5000	6100	10100	5500	10000	2670	2210	2850	5700	**4569**
Sulfate	1010	1260	679	1810	1490	1330	1550	1080	4090	1000	1830	1060	798	586	1270	**1390**
Sodium	3300	5600	2910	7000	8700	9100	6800	9000	20900	7200	15300	6700	2850	5000	9700	**8004**

TABLE 5-2. ANNUAL CHEMICAL COMPOUNDS MEASURED FROM 15 BENTHIC SEDIMENT STATIONS (RESULTS AS DRY WEIGHT).

COMPOUND	October 1987	October 1988[1]	October 1989[2]	October 1990[3]	May 1991	October 1991	October 1992	April 1994	September 1994	October 1995	October 1996	October 1997	October 1998	**Overall Range**	September 1999
Metals (ppm)															
Arsenic	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	3.2 - 15.0	2.2 - 12.6	**1.13 - 15.0**	2.5 - 13.1
Cadmium	<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	0.24 - 1.56	0.20 - 1.18	**0.13 - 34**	0.19 - 1.32
Chromium	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	17 - 70	14 - 86	**4.68 - 89.1**	12.5 - 84.0
Copper	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	9 - 390	8 - 320	**5.50 - 455**	7.8 - 450
Iron[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	12 - 50	11.5 - 54.0	**3.21 - 71.5**	9 - 59
Lead	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	40 - 250	40 - 380	**6.0 - 575**	28.8 - 198
Manganese	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	125 - 330	115 - 340	**26.2 - 366**	64 - 360
Mercury	<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	0.08 - 1.40	0.03 - 0.81	**0.03 - 2.8**	0.04 - 0.96
Nickel	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	10 - 210	6.5 - 28.2	**<1.0 - 210**	7.5 - 31.4
Selenium	—	—	—	—	—	—	—	—	<0.14 - 2.35	<0.47 - 0.99	0.30 - 1.80	0.4 - 2.4	<1 - 1.9	**<0.14 - 2.4**	—
Silver	—	—	—	—	—	—	—	—	—	—	0.280 - 2.720	0.20 - 3.50	0.10 - 2.22	**0.10 - 3.50**	0.16 - 2.58
Tributyl Tin	<8 - 1070[4]	<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	<0.002 - 0.014	<0.002 - 0.010	**<0.002 - 5.57**	<0.002 - 0.01
Zinc	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	55 - 480	36 - 500	**20.3 - 660**	41 - 450
Chlor. Hyd. (ppb)[6]															
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 - 5.0	<0.5 - 18.0	**<0.5 - 100**	<0.5 - 4.0
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	3.0 - 23.0	<0.05 - 2.0	**<0.05 - 189**	1.0 - 9.5
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	<1.0	<0.6 - 12.0	**<0.4 - 200**	<0.5 - 5.0
Alpha-Chlordane	—	—	—	—	—	—	—	—	—	—	<0.1 - 6.6	<0.5	<0.3 - 8.3	**<0.1 - 6.6**	<0.3 - 3.9
Gamma-Chlordane	—	—	—	—	—	—	—	—	—	—	<0.2 - 7.7	<0.3 - 8.1	<0.4 - 11.0	**<0.2 - 8.1**	<0.3 - 6.2
Chlordane[7]	<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	<0.3 - 8.1	<0.3 - 19.3	**<0.1 - 630**	<0.3 - 9.8
Dieldrin	<1.0	<1.0	<1.0 - 30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5 - 2.0	**<0.8 - 30**	<0.5 - 2.0
Endrin Aldehyde	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<0.6 - 2.0	<0.5 - 9.0	<0.6 - 6.6	**<0.5 - 9.0**	<0.5 - 2.0
Heptachlor Epoxide	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.2 - 2.0	<0.3 - 1.0	<0.2 - 3.9	**<0.2 - 3.9**	<0.4
Heptachlor	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.3	**<0.2 - 0.3**	<0.4
Aldrin	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.6	**<0.2 - 0.6**	<0.4
Methoxychlor	—	—	—	—	—	—	—	—	—	—	—	—	<2.0 - 6.5	**<2.0 - 6.6**	<4
Endosulfan I	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 2.0	**<0.2 - 2.1**	<0.3 - 3.0
Endosulfan II	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 3.0	**<0.5 - 3.1**	<0.7
Endosulfan Sulfate	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 2.0	**<0.5 - 2.1**	<0.7
Endrin Ketone	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 4.0	**<0.5 - 4.1**	<0.5 - 1.0
Alpha-BHC	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.4	**<0.2 - 0.5**	<0.4
Delta-BHC	—	—	—	—	—	—	—	—	—	—	—	—	—	**—**	<0.3 - 0.4
Gamma-BHC	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 1.0	**<0.2 - 1.1**	<0.4
Tot. Non-DDT Pest.	—	—	—	—	—	—	—	—	—	—	0.5 - 15.2	<0.9 - 13.6	2.0 - 31.7	**0.5 - 31.7**	<0.3 - 14.7
Arochlor 1254	—	—	<50 - 330	<50 - 153	—	—	—	<50 - 110	<50 - 231	<50 - 90	<10 - 100	<20	<10 - <20	**<10 - 231**	<10 - <20
Arochlor 1260	<50	<50	<50 - 200	<50 - 172	<50 - 300	<50	<50 - 90	<50	<50	<50	<20	<20	<10 - <20	**<10 - 300**	<10 - <20
Organics (ppm)															
Tot. Org. Carbon (%)	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	0.23 - 2.31	0.41 - 1.14	**0.23 - 8.07**	0.33 - 2.4
Volatile Solids (%)	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	0.6 - 4.0	0.7 - 3.7	**0.6 - 16.12**	1.3 - 7.5
Immed. Ox. Dmd.(%)	0.004 - 0.03	0.002 - 0.03	0.001 - 0.05	0.001 - 0.04	0.002 - 0.04	0.003 - 0.06	<0.001 - 0.04	<0.001 - 0.03	0.003 - 0.05	0.001 - 0.04	0.13 - 1.3	1.3 - 2.0	0.016 - 0.68	**<0.001 - 2.0**	0.07 - 4.0
Chem. Ox. Dmd.(%)	2.53 - 9.68	0.83 - 8.76	0.244 - 21.56	0.677 - 15.31	3.44 - 12.0	1.55 - 18.63	0.314 - 16.50	0.268 - 15.40	0.86 - 17.1	2.04 - 7.98	0.73 - 8.0	0.49 - 4.12	0.43 - 6.72	**0.24 - 21.56**	0.37 - 6.4
Oil and Grease	800 - 2800	500 - 3500	390 - 11070	360 - 4860	1280 - 7300	1080 - 8700	227 - 4160	508 - 9200	800 - 6760	520 - 2840	30 - 350	40 - 360	3 - 140	**3 - 11070**	41 - 1500
Organic Nitrogen	1200 - 3000	135 - 1840	380 - 4770	235 - 4125	1060 - 3125	334 - 4910	105 - 4010	110 - 3180	452 - 2960	692 - 1940	120 - 1400	120 - 1499	37 - 768	**37 - 4910**	300 - 1900
Ortho Phosphate	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	1.5 - 28.8	<10 - <20	**<1 - 13300**	—
Sulfides	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	130 - 850	<3 - 620	**<0.1 - 2310**	210 - 1800

[1] No sample possible at Station 12 in October 1988. [2] Station 25 added in 1989. [3] Station 22 added in 1990. [4] These are probably micrograms per liter rather than milligrams per liter. [5] Results reported in thousands.

[6] Previous to 1996, pesticide and PCB detection limits were either much higher or not recorded individually. [7] Chlordane separated into subcategories after 1995.

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

	MARINA DEL REY (1999)		LOS ANGELES HARBOR (1995)		SCCWRP (1977)		SCCWRP (1985)
COMPOUND	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Metals (ppm)							
ARSENIC	**7.90**	**2.50 - 13.10**	5.25	2.2 - 8.5	–	–	–
CADMIUM	**0.53**	**0.19 - 1.32**	0.55	0.28 - 1.27	0.42	0.1 - 1.4	0.14
COPPER	**160.0**	**7.8 - 450.0**	39.9	13.1 - 69.6	24	6.5 - 43	10.4
CHROMIUM	**41.3**	**12.5 - 84.0**	41.2	21.0 - 71.7	9.6	2.3 - 40	25.4
MERCURY	**0.39**	**0.04 - 0.96**	0.21	0.11 - 0.32	–	–	–
LEAD	**97.4**	**28.8 - 198.0**	21.3	7.3 - 47	6.8	2.7 - 12	4.8
NICKEL	**20.9**	**7.5 - 31.4**	22.6	10.1 - 42.3	16	1.6 - 51	12.9
SILVER	**1.05**	**0.16 - 2.58**	0.55	0.05 - 2.66	0.35	0.04 - 1.7	0.03
ZINC	**241.6**	**41.0 - 450**	87.5	42.2 - 148	45	9.8 - 110	48.0
Chl. Hyd. (ppb)							
TOTAL DDT'S	**4.9**	**1.0 - 15.0**	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 (%)	**1.65**	**0.33 - 2.40**	–	–	–	–	0.52
VOL. SOLIDS (%)	**5.2**	**1.3 - 7.5**	–	–	3.3	1.8 - 9.5	–
COD (%)	**3.4**	**0.4 - 6.4**	–	–	2.4	0.92 - 6.94	–
ORG.NITROGEN (ppm	**1138**	**300 - 1900**	–	–	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, MORGAN ET. AL. 1995).

				STATION														
COMPOUND	ER-L	ER-M	AET	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Metals (ppm)																		
Arsenic	8.2	70	50	2.5	4.6	2.7	**9.0**	**8.8**	**9.9**	7.5	**10.4**	**13.1**	**8.6**	**11.2**	6.4	5.2	6.7	**11.9**
Cadmium	1.2	9.6	5	0.21	0.54	0.19	0.74	0.34	0.25	0.25	0.36	0.35	0.69	0.37	1.18	1.32	0.28	0.89
Chromium	81	370	—	14	23	13	44	52	48	40	50	**84**	40	**82**	30	17	22	61
Copper	34	270	300	8	21	20	**130**	**193**	**237**	**191**	**312**	**390**	**108**	**450**	**68**	**45**	**38**	**189**
Lead	46.7	218	300	29	**48**	30	**111**	**100**	**90**	**83**	**91**	**149**	**51**	**128**	**122**	**198**	**100**	**131**
Mercury	0.15	0.71	1	0.040	0.085	0.053	**0.275**	**0.410**	**0.880**	**0.390**	**0.940**	**0.980**	**0.297**	**0.700**	**0.194**	0.090	0.080	**0.420**
Nickel	20.9	51.6	—	9.4	17.7	7.5	**21.4**	**25.9**	**24.2**	**21.9**	**27.3**	**31.4**	**23.1**	**30.6**	17.2	13.0	15.2	**27.5**
Silver	1	3.7	1.7	0.16	0.45	0.46	**2.12**	**1.69**	0.97	0.98	0.87	**1.58**	0.32	**1.59**	**1.32**	0.44	0.20	**2.58**
Zinc	150	410	260	41	104	52	**236**	**257**	**263**	**237**	**320**	**410**	**157**	**450**	**274**	**214**	**300**	**309**
Metals exceeding ER-L				0	1	0	7	7	6	5	6	8	6	8	5	3	3	7
Metals exceeding ER-M or AET				0	0	0	1	0	2	0	3	3	0	2	1	0	1	2
Hydrocarbons (ppb)																		
p,p' DDD	2	20	10	1.0	**4.0**	0.6	1.0	0.7	<0.7	<0.7	<0.7	<0.9	**4.0**	<0.8	**4.0**	<0.5	<0.6	<0.7
p,p' DDE	2.2	27	7.5	2.0	**9.5**	2.0	**6.0**	**3.0**	**3.0**	**3.0**	2.0	**3.0**	**7.0**	2.0	**6.0**	1.0	2.0	1.0
p,p' DDT	1	7	6	<0.5	<0.6	<0.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	**5.0**	<0.5	<0.6	<0.7
Total DDT & Deriv.	1.58	180	—	**3.0**	**13.5**	**2.6**	**7.0**	**3.7**	**3.0**	**3.0**	**2.0**	**3.0**	**11.0**	**2.0**	**15.0**	1.0	**2.0**	1.0
Chlordane	0.5	6	2	**1.6**	**8.2**	**1.4**	**1.5**	<0.4	<0.4	<0.3	<0.4	<0.5	<0.3	<0.4	**9.8**	<0.3	0.4	<0.4
Dieldrin	0.02	8	—	<0.5	<0.6	<0.5	<0.7	<0.7	<0.7	<0.7	<0.7	<0.9	<0.7	<0.8	**2.0**	<0.5	<0.6	<0.7
PCB's	22.7	180	370	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<10	<10	<20
Hydrocarbons exceeding ER-L				2	4	2	3	2	2	2	1	2	3	1	6	0	1	0
Hydrocarbons exceeding ER-M or AET				0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Total Contaminants																		
Total exceeding ER-L				2	5	2	10	9	8	7	7	10	9	9	11	3	4	7
Total exceeding ER-M or AET				0	2	0	1	0	2	0	3	3	0	2	2	0	1	2

In Table 5-4, ER-L, ER-M, and AET values are listed for those compounds that were measured in this survey. Compounds, which exceeded the ER-L value, are highlighted by bold type. Those, which also exceeded either the ER-M or AET values, are 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). The USEPA (1983) gives a terrestrial range of 1-50 ppm, with an average of 5 ppm.

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 9 in Basin F (13.1 ppm), Station 25 in midchannel (11.9 ppm), and Station 11 at upper channel (11.2 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 - 2.5 to 4.6 ppm).

Arsenic ranges compared with past years. The range of this year's arsenic values (2.5 to 13.1 ppm) was within the overall range of previous years (Table 5-2).. Arsenic in the Harbor appears to have neither greatly increased nor decreased since 1987.

Arsenic values compared with other surveys. The Marina del Rey arsenic average and range (7.9 ppm, 2.5 to 13.1 ppm) were slightly higher than Los Angeles Harbor (5.25 ppm, 2.2 to 8.5 ppm) (Table 5-3). 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.

Arsenic values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for arsenic are 8.2, 70, and 50 ppm (Table 5-3), and the range for Marina del Rey Harbor sediments this year was 2.5 to 13.1 ppm. Stations 4, 5, 6, 8, 9, 10, 11, and 25 exceeded the ER-L value, though no stations exceeded either the ER-M or AET values.

5.3.1.2. **Cadmium**

Cadmium is widely used in electroplating, paint pigment, batteries and plastics, but point source control and treatment processes have greatly reduced cadmium in the marina (Soule et. al. 1996). Toxicity in 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). The USEPA (1983) gives the terrestrial range of 0.01 to 0.7 ppm, with an average of 0.06 ppm.

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

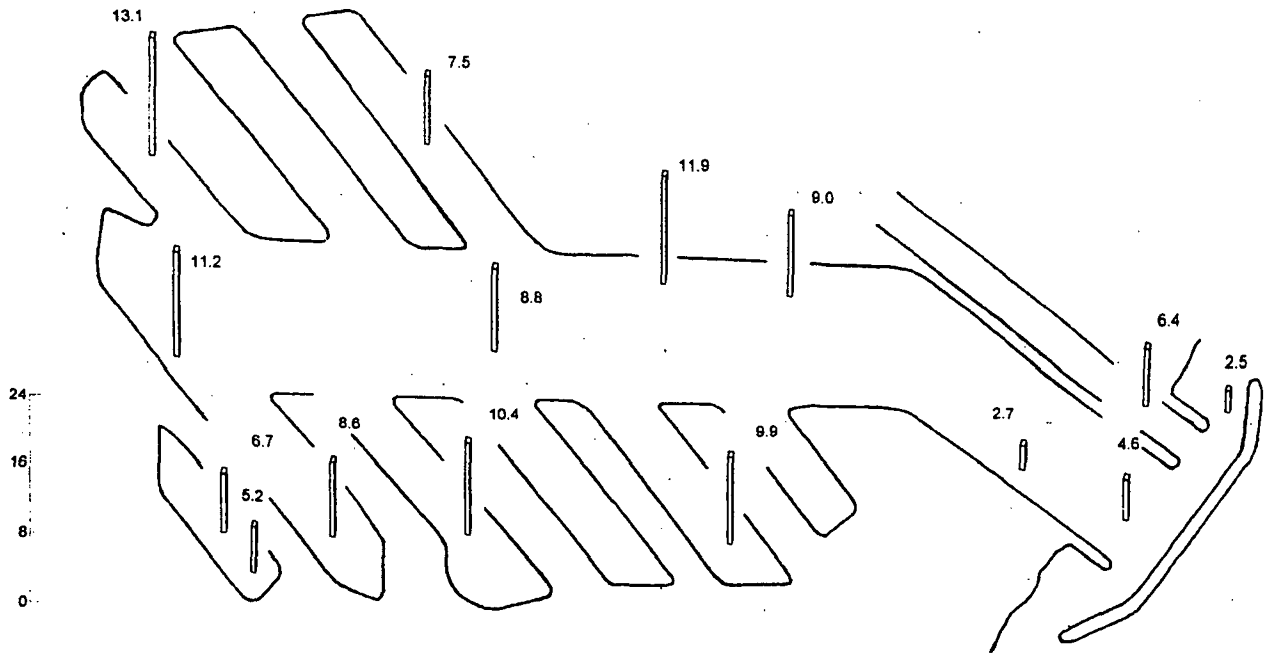
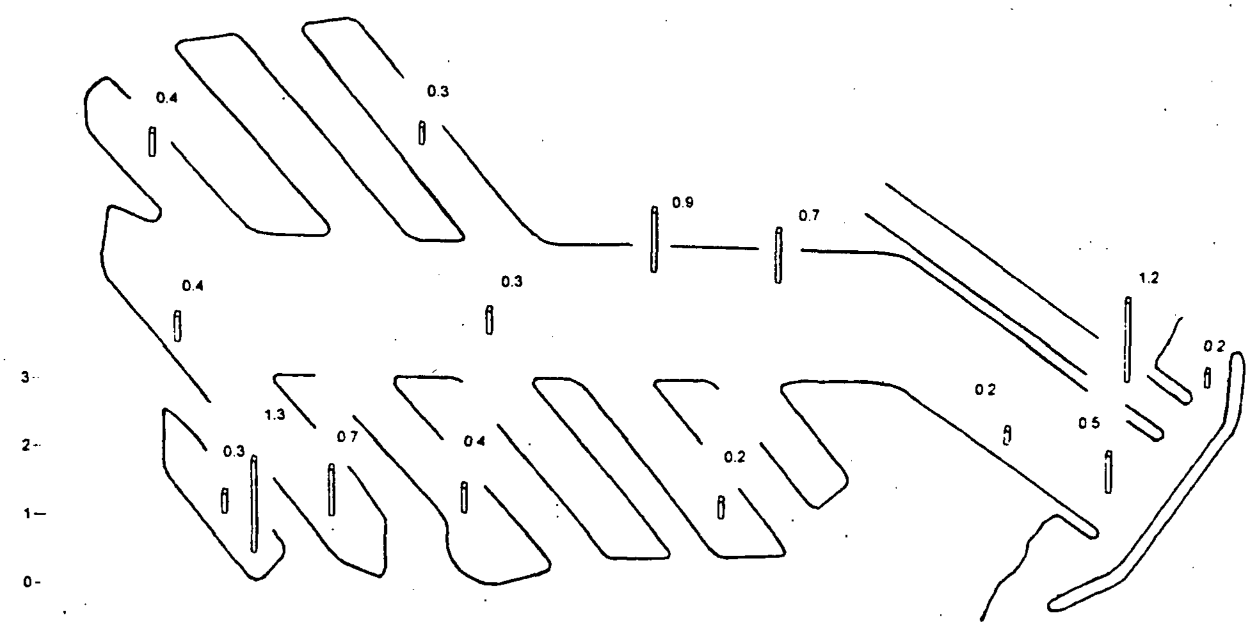


FIGURE 5-2. CADMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial cadmium patterns. Cadmium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-2. Highest cadmium values were at Station 13 in Oxford Lagoon (1.3 ppm) and Station 12 in Ballona Creek (1.2 ppm). All remaining stations were ranged from 0.2 to 0.9 ppm.

Cadmium ranges compared with past years. The range of this year's cadmium values (0.2 to 1.3 ppm) was within the overall range of past surveys (Table 5-2). With the exception of some high values in October 1987, cadmium in the Harbor appears to have neither greatly increased nor decreased since 1987.

Cadmium values compared with other surveys. The Marina del Rey cadmium average and range (0.5 ppm, 0.2 to 1.3 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 somewhat higher than the 1985 (0.14 ppm) SCCWRP Reference Site average (Table 5-3).

Cadmium values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for cadmium are 1.2, 9.6, and 5 ppm (Table 5-3), and the range for Marina del Rey Harbor sediments were 0.2 to 1.6 ppm. Stations 12 and 13 exceeded the ER-L value, though no stations exceeded either the ER-M or AET values.

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 2,000 to 105,000 ppm for chromium (VI) and 10,300 to 35,500 ppm for chromium (III). Chronic effects range from 445 to 2,000 ppb for chrome (VI) and 2,000 to 3,200 ppb for chrome (III) (Long and Morgan 1990). The USEPA (1983) gives the terrestrial range of 1-1,000 ppm, with an average of 100 ppm.

Spatial chromium patterns. Chromium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-3. Highest chromium values were at Station 9 in Basin F (84 ppm) and Station 11 in the upper channel (82 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 - 13 to 23 ppm) and in Oxford Lagoon (Stations 13 and 22 – 17 and 22 ppm, respectively).

Chromium ranges compared with past years. The range of this year's chromium values (13 to 84 ppm) was within the overall range of past surveys (Table 5-2). Chromium in the Harbor appears to have neither greatly increased nor decreased since 1987.

Chromium values compared with other surveys. The Marina del Rey chromium average and range (41 ppm, 13 to 84 ppm) were comparable to Los Angeles Harbor (41.2 ppm, 21 to 72 ppm) but were higher than either of the 1979 (9.6 ppm, 2.3 to 4.0 ppm) or 1987 (25.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

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

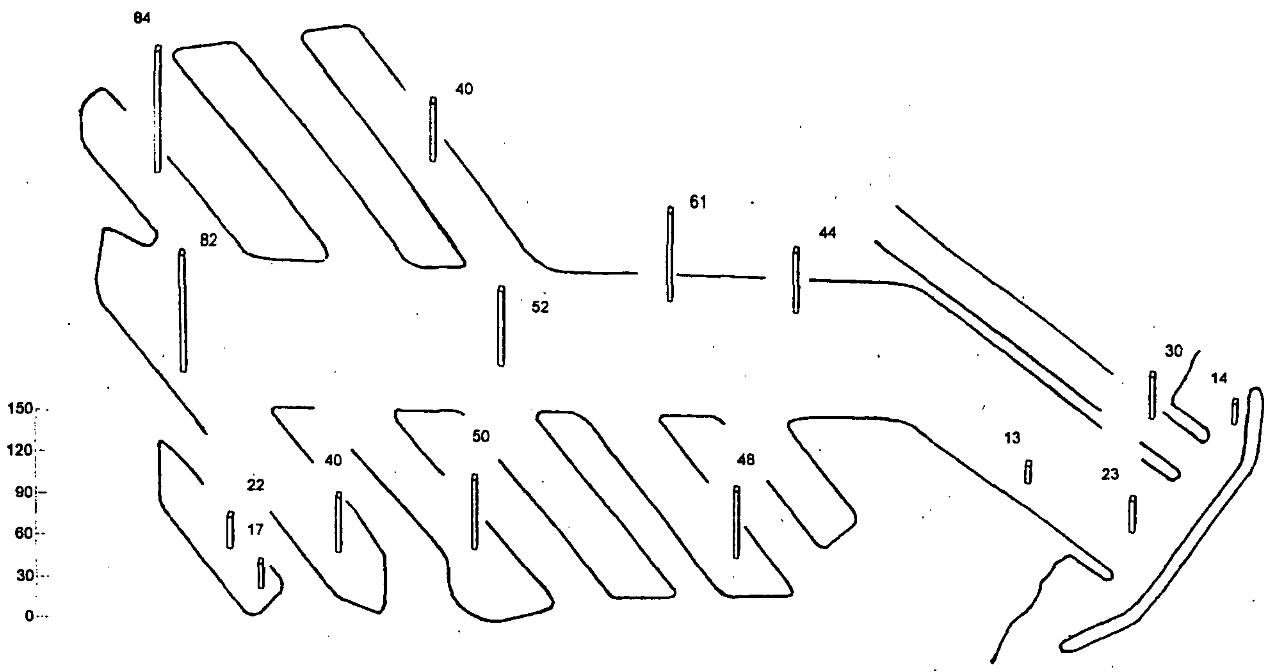
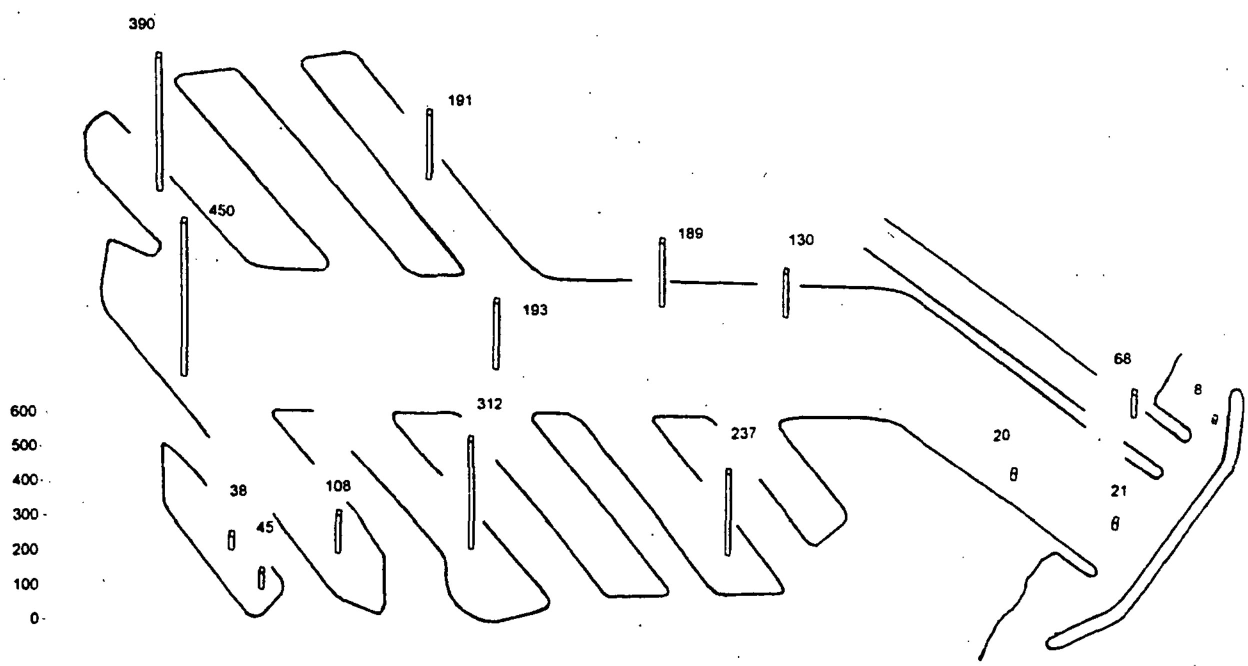


FIGURE 5-4. COPPER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Chromium values compared with NOAA effects range ratings. The ER-L and ER-M values for chromium are 81 and 370 ppm (Table 5-3), and the range for Marina del Rey Harbor sediments was 13 to 84 ppm. Stations 9 and 11 exceeded the ER-L value, but no stations exceeded the ER-M value. There is no AET value listed for chromium.

5.3.1.4. **Copper**

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

Spatial copper patterns. Copper concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-4. Highest copper values were at Station 11 in the upper channel (450 ppm), Station 9 in Basin F (390 ppm), and Station 8 in Basin D (312 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 - 8 to 68 ppm) and in Oxford Lagoon (Stations 13 and 22 – 45 and 38 ppm, respectively).

Copper ranges compared with past years. The range of this year's copper values (8 to 450 ppm) was within the overall range of past surveys (Table 5-2). Copper in the Harbor appears to have neither greatly increased nor decreased since 1987.

Copper values compared with other surveys. The Marina del Rey copper average and range (160 ppm, 8 to 450 ppm) were higher than Los Angeles Harbor (39.9 ppm, 13.1 to 69.6 ppm) and both the 1979 (24 ppm, 6.5 to 43 ppm) and 1987 (10.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

Copper values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for copper are 34, 270, and 300 ppm (Table 5-3). Stations 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 22, and 25 exceeded the ER-L value, and Stations 8, 9, and 11 exceeded both ER-M and AET values.

5.3.1.5. **Iron**

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

Spatial iron patterns. Iron concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-5. Highest iron values were Station 9 in Basin F and at Station 11 in the upper channel (both 59,000 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 - 9,000 to 19,200).

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

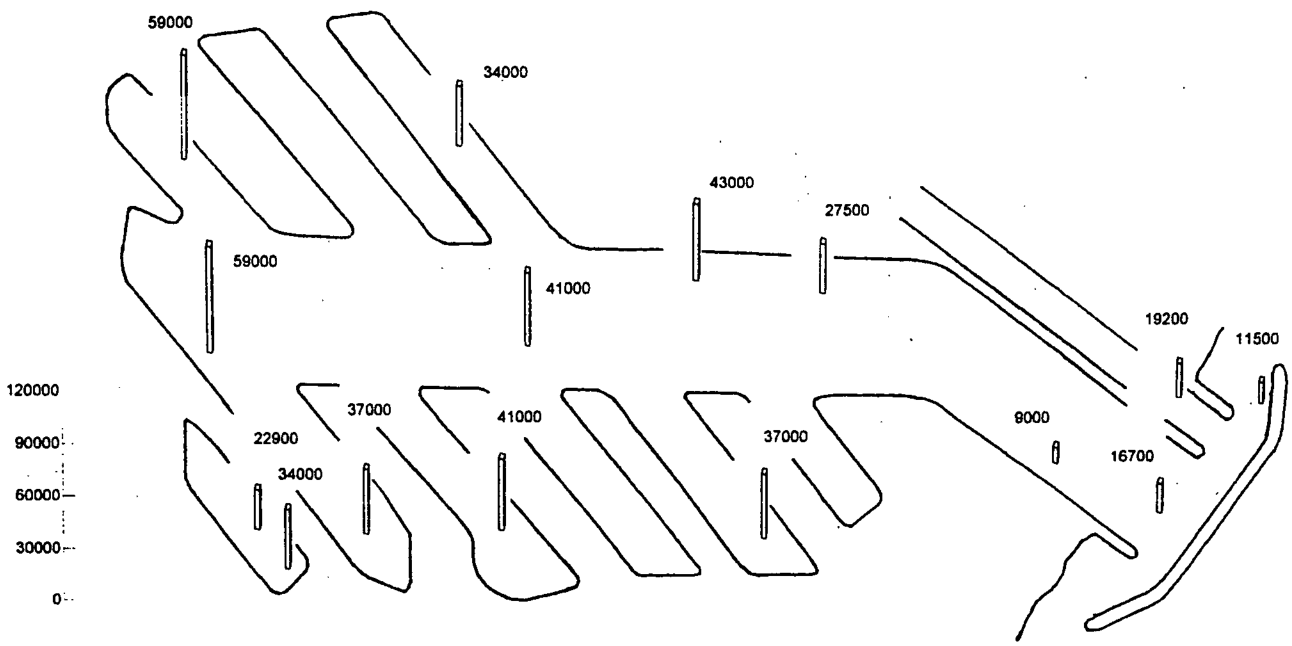
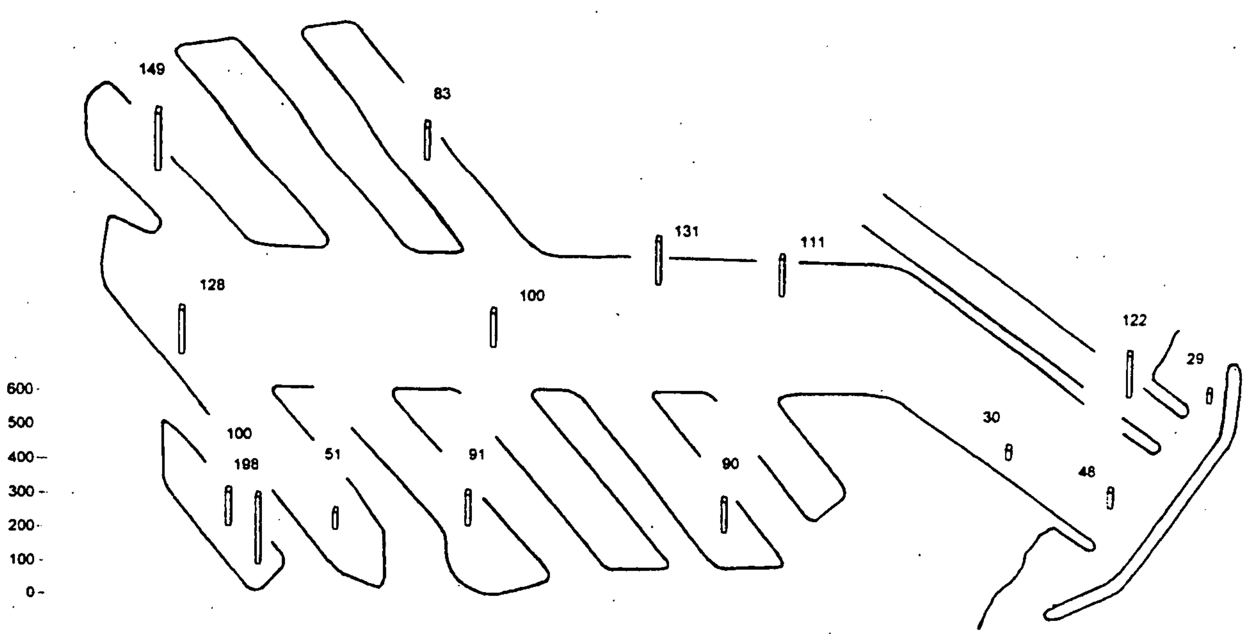


FIGURE 5-6. LEAD CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Iron ranges compared with past years. The range of this year's iron values (9,000 to 59,000 ppm) was within the overall range of past surveys (Table 5-2). Iron in the Harbor appears to have neither greatly increased nor decreased since 1987.

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

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

5.3.1.6. **Lead**

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

Spatial lead patterns. Lead concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-6. Highest lead values were at Station 13 Oxford Lagoon (198 ppm), Station 9 in Basin F (149 ppm), Station 25 in midchannel (131 ppm), and Station 11 in the upper channel (128 ppm). Lowest values were at Stations 1, 2, and 3 near the entrance (29 to 48 ppm).

Lead ranges compared with past years. The range of this year's lead values (29 to 198 ppm) was within the overall range of past surveys (Table 5-2). Lead in the Harbor appears to have neither greatly increased nor decreased since 1987.

Lead values compared with other surveys. The Marina del Rey lead average and range (97 ppm, 29 to 198 ppm) were higher than Los Angeles Harbor (21.3 ppm, 7.3 to 47 ppm) and both the 1979 (6.8 ppm, 2.7 to 12 ppm) and 1987 (10.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

Lead values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for lead are 46.7, 218, and 300 ppm (Table 5-3). Stations 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 22, and 25 exceeded the ER-L value; no station exceeded either ER-M or AET values.

5.3.1.7. **Manganese**

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

Spatial manganese patterns. Manganese concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-7. Highest manganese values were at Station 9 in Basin F (350 ppm) Station 11 in the upper channel (360 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 – 64 to 141 ppm).

Manganese ranges compared with past years. The range of this year's manganese values (64 to 360 ppm) was within the overall range of past surveys (Table 5-2). Manganese in the Harbor appears to have neither greatly increased nor decreased since 1987.

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

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

5.3.1.8. **Mercury**

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

Spatial mercury patterns. Mercury concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-8. Highest mercury values were at Station 8 in Basin D (0.94 ppm), Station 6 in Basin B (0.88 ppm), and Station 9 in Basin F (0.96 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 – 0.04 to 0.09 ppm) and within Oxford Lagoon (Stations 13 and 22 - 0.09 and 0.08 ppm, respectively).

Mercury ranges compared with past years. The range of this year's mercury values (0.04 to 0.96 ppm) was within or near the overall range of the preceding 11 years (Table 5-2). Mercury in the Harbor appears to have neither greatly increased nor decreased since 1987.

Mercury values compared with other surveys. The Marina del Rey mercury average and range (0.39 ppm, 0.04 to 0.96 ppm) were slightly higher than Los Angeles Harbor (0.21 ppm, 0.11 to 0.32 ppm) (Table 5-3). Neither the 1979 nor 1987 SCCWRP Reference Site Surveys measured mercury, however Mearns et al. (1991) estimated the background level in the Southern California Bight to be 0.05 ppm.

Mercury values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for mercury are 0.15, 0.71, and 1 ppm (Table 5-3). Stations 4, 5, 6, 7, 8, 9, 10, 11, 12, and 25 exceeded the ER-L value, and Stations 6, 8, and 9 exceeded the ER-M value. No stations exceeded the AET value.

5.3.1.9. **Nickel**

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

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

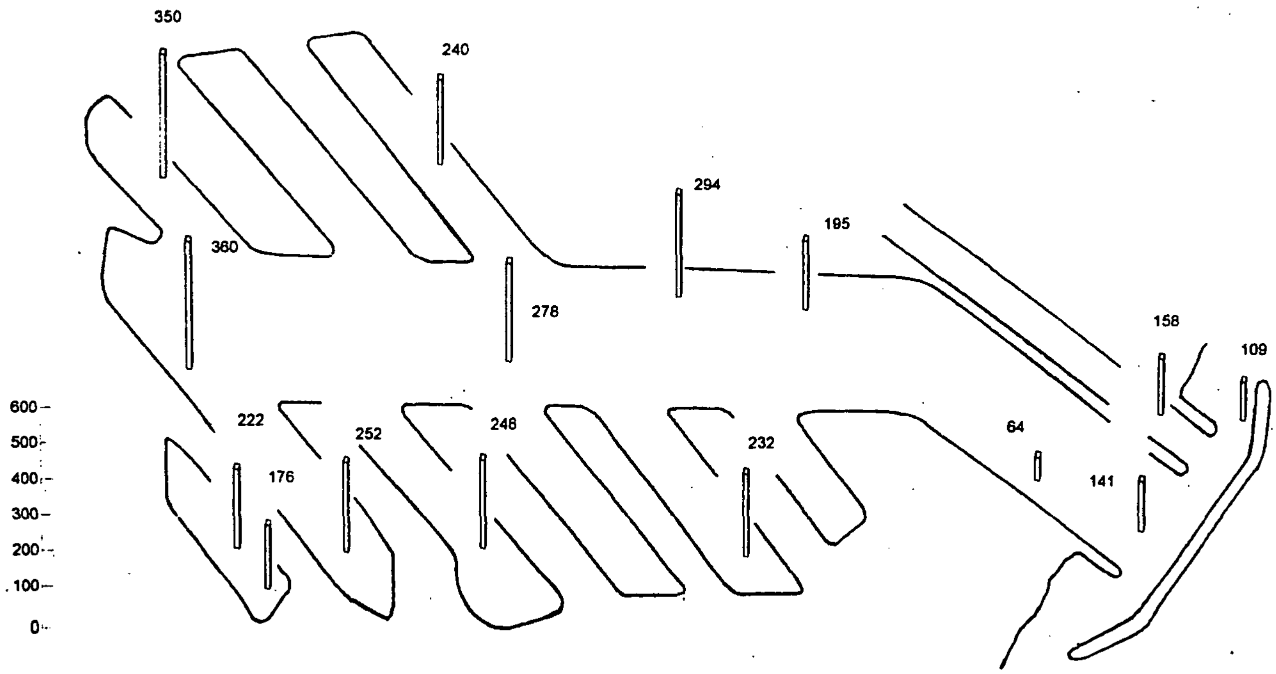
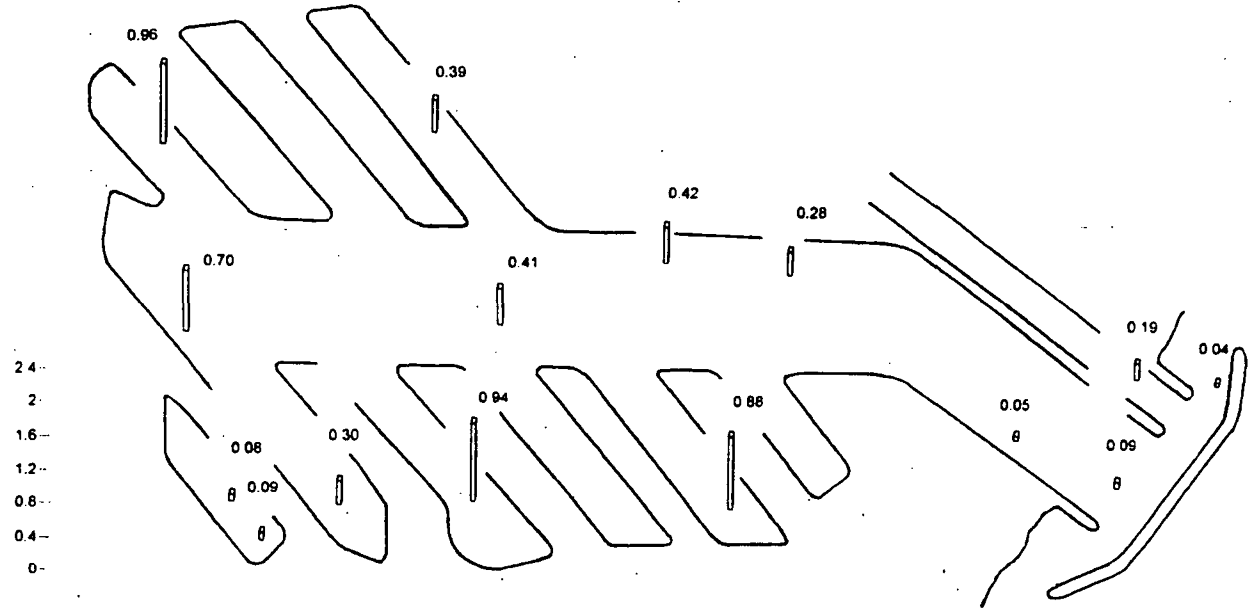


FIGURE 5-8. MERCURY CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial nickel patterns. Nickel concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-9. Highest nickel values were at Station 11 in the upper channel and Station 9 in Basin F (both 31 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 8 to 18 ppm) and within Oxford Lagoon (Stations 13 and 22 - 13 and 15 ppm, respectively).

Nickel ranges compared with past years. The range of this year's nickel values (8 to 31 ppm) was within the overall range of past surveys (Table 5-2). Overall, nickel in the Harbor appears to have neither greatly increased nor decreased since 1987.

Nickel values compared with other surveys. The Marina del Rey nickel average and range (21 ppm, 8 to 31 ppm) were comparable to Los Angeles Harbor (22.6 ppm, 10.1 to 42.3 ppm) and the 1979 (16 ppm, 1.6 to 51 ppm) and 1987 (12.9 ppm) SCCWRP Reference Site Surveys (Table 5-3).

Nickel values compared with NOAA effects range ratings. The ER-L and ER-M values for nickel are 20.9 and 51.6 ppm (Table 5-3). Stations 4, 5, 6, 7, 8, 9, 10, 11, and 25 exceeded the ER-L values, though no stations exceeded the ER-M value. There is no value listed for the AET.

5.3.1.10. Selenium

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

Spatial selenium patterns. Selenium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-10. Selenium values were below detection limits (<1 ppm) at all stations.

Selenium ranges compared with past years. Selenium values (<1.0 ppm) were within or near the overall range of past surveys (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.

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

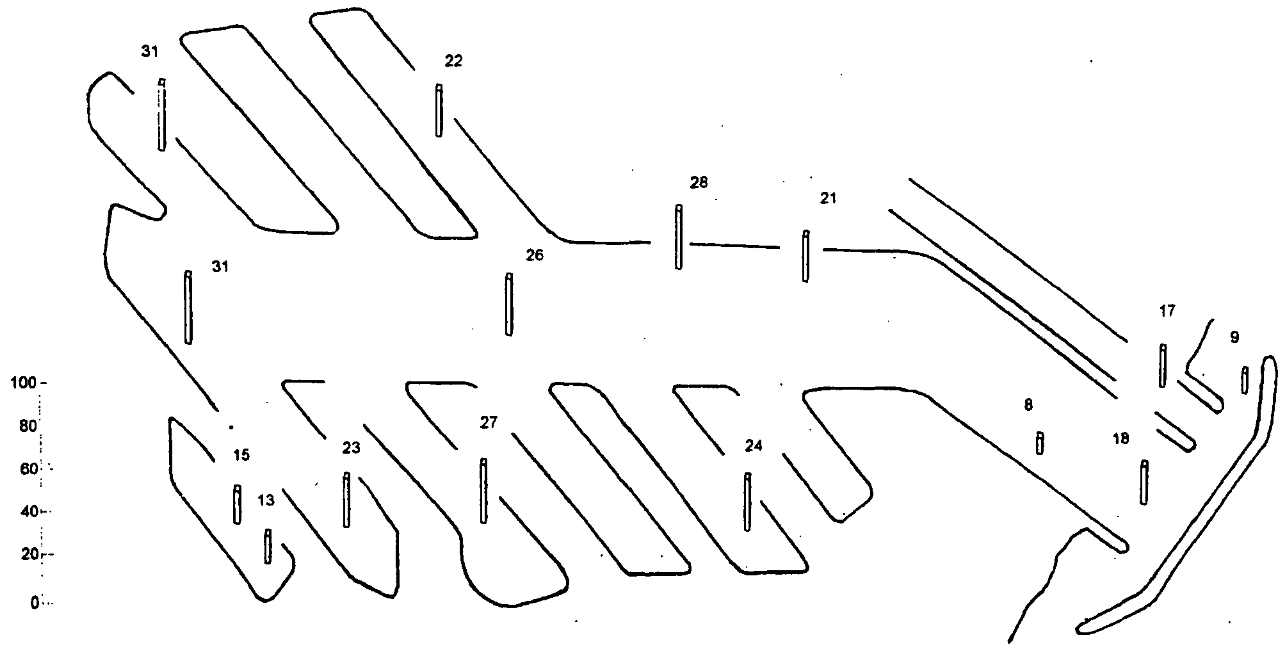
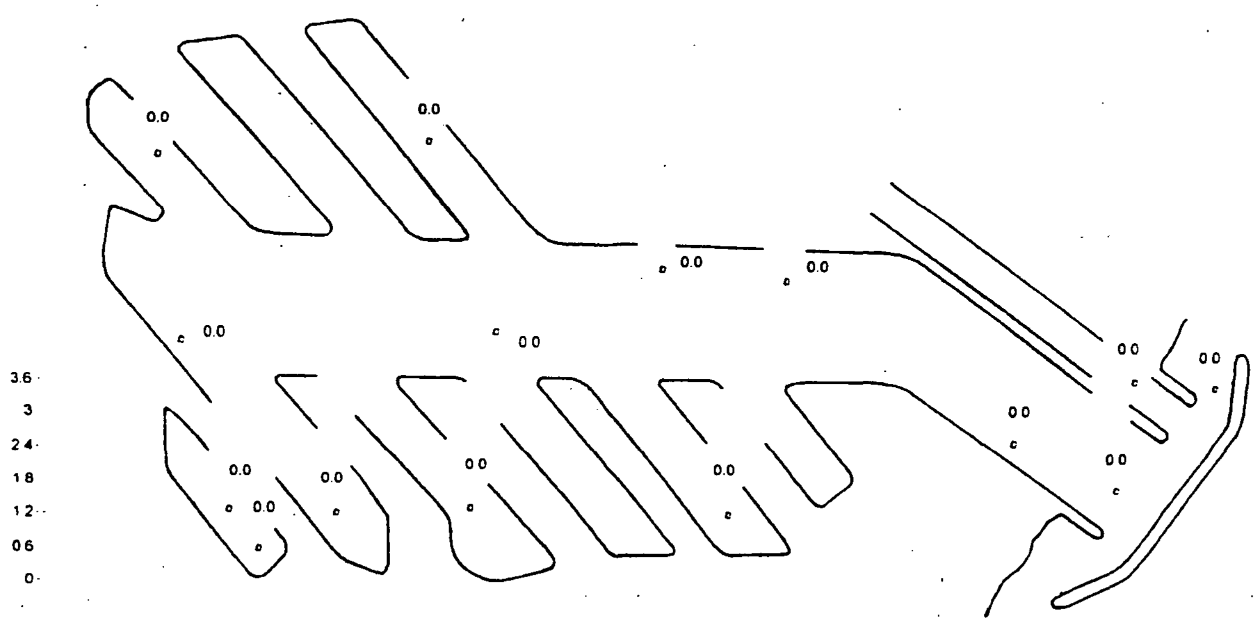


FIGURE 5-10. SELENIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.1.11. **Silver**

Silver has many uses in commerce and industry including photographic film, electronics, jewelry, coins, and 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). The range in the 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.

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 midchannel (Stations 4, 5, and 25 – 1.7 to 2.6 ppm), Station 11 in the upper channel (1.6 ppm), and at Station 9 in Basin F (1.6 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 - 0.2 to 0.5 ppm), in Basin E (Station 10 – 0.3 ppm), and in Oxford Lagoon (Stations 13 and 22 - 0.4 and 0.2 ppm, respectively).

Silver ranges compared with past years. The range of this year's silver values (0.2 to 2.6 ppm) was similar to past surveys (Table 5-2). Overall, silver in the Harbor appears to have neither greatly increased nor decreased since 1996.

Silver values compared with other surveys. The Marina del Rey silver average and range (1.0 ppm, 0.2 to 2.6 ppm) were comparable to Los Angeles Harbor (0.55 ppm, 0.05 to 2.66 ppm) and the 1979 (0.35 ppm, 0.04 to 1.7 ppm) SCCWRP Reference Site Survey but were higher than the 1987 (0.03 ppm) Survey (Table 5-3).

Silver values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for silver are 1.0, 3.7, and 1.7 ppm (Table 5-3). Stations 4, 5, 9, 11, 12, and 25 exceeded the ER-L value; Stations 4 and 25 exceeded the AET value; and no stations exceeded the ER-M value.

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). The terrestrial range for tin is 2 to 200 ppm, with a mean of 10 ppm. No sediment tests other than Soule and Oguri (1988) were mentioned in the literature. The California Department of Fish and Game considers Tributyl tin to be the most toxic substance ever released in the marine environment. The Los Angeles 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).

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

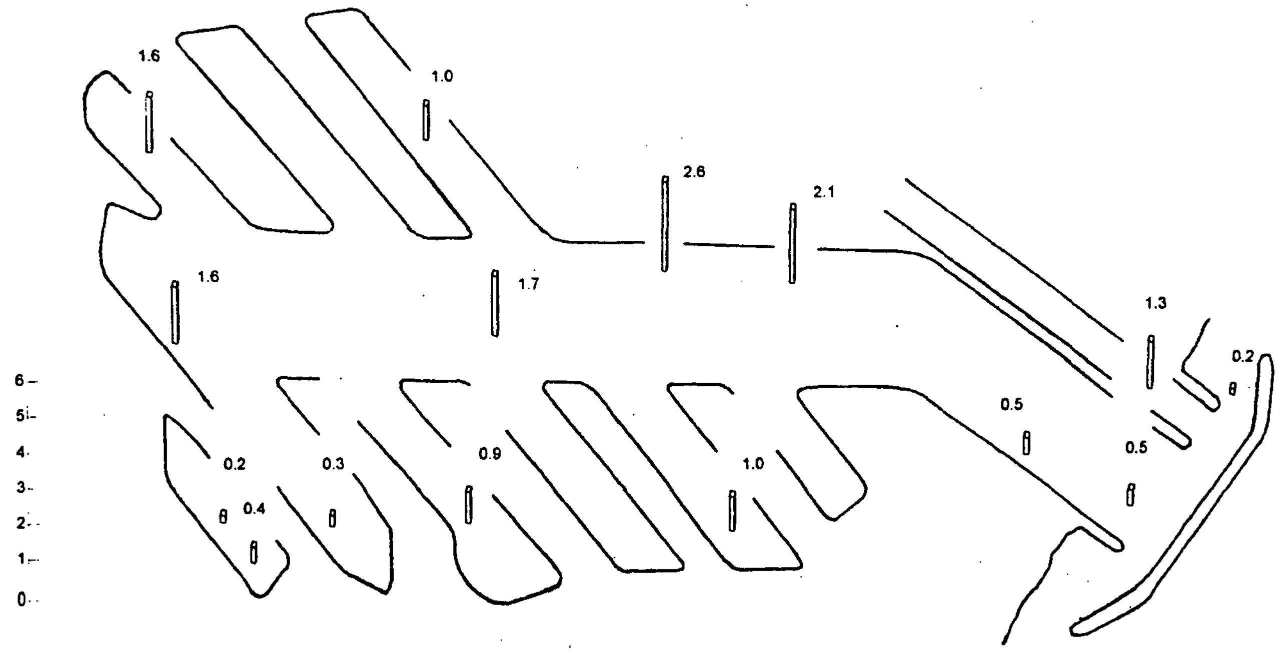
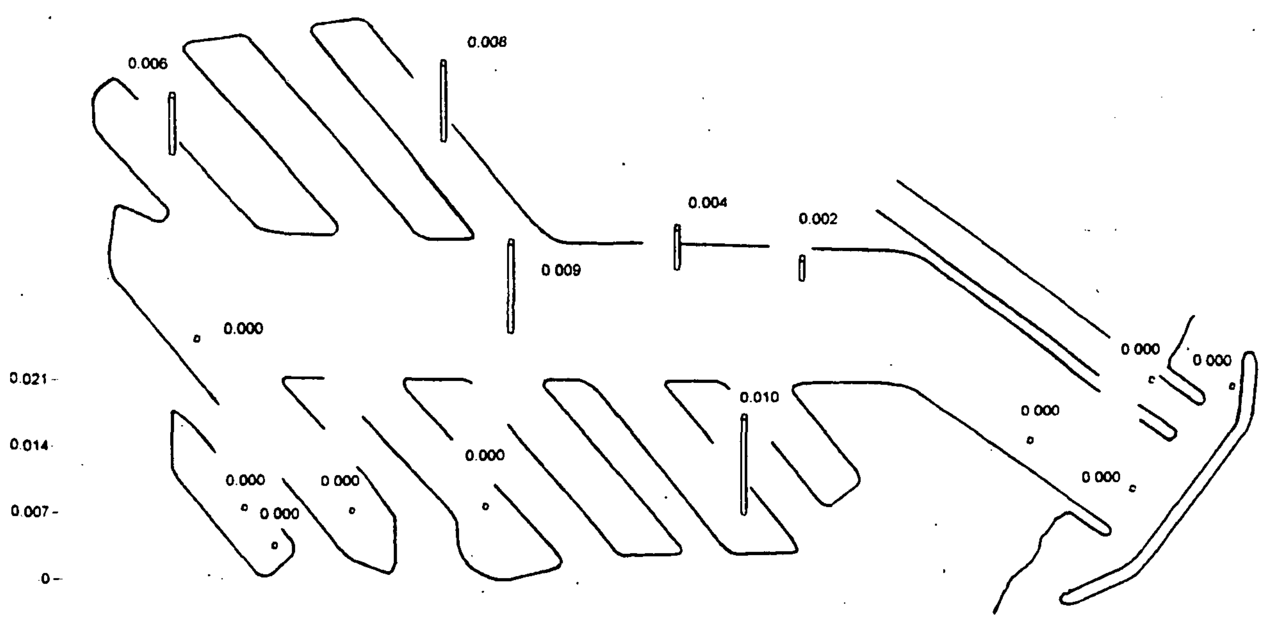


FIGURE 5-12. TRIBUTYL TIN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 tin concentrations were at Station 5 in midchannel (0.009 ppm), Station 7 in Basin H (0.008 ppm), and Station 6 in Basin B (0.010 ppm). Concentrations at Stations 1, 2, 3, 8, 10, 11, 12, 13, and 22 were all below the detection limit (0.002 ppm).

Tributyl tin ranges compared with past years. The upper values of 1998 and 1999 tributyl tin results (both 0.010 ppm) are the lowest recorded since 1987 (Table 5-2) and may reflect a response to the banning of this compound in the Harbor (see above). The range reported for October 1987 (<8 to 1070 ppm) appears 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.

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 may be 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, enters the waters as airborne particulates, and occurs in runoff and 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). The normal terrestrial range is from 10 to 300 ppm, with a mean of 50 ppm (Soule et al. 1996).

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 11 in the upper channel (450 ppm) and Station 9 in Basin F (410 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 – 41 to 104 ppm).

Zinc ranges compared with past years. The range of this year's zinc values (41 to 450 ppm) was within the overall range of past surveys (Table 5-2). Zinc in the Harbor appears to have neither greatly increased nor decreased since 1987.

Zinc values compared with other surveys. The zinc average and range (242 ppm, 41 to 450 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).

Zinc values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for zinc are 150, 410, and 260 ppm (Table 5-3). Stations 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 25 exceeded ER-L values; and Stations 6, 8, 9, 11, 12, 22, and 25 exceeded AET value. Station 11 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). DDT has been found to be chronically toxic to bivalves as low as 0.6 ppb in sediment. Toxicity of two of DDT's breakdown products, DDE and DDD, were both chronically toxic to bivalve larvae as low as about 1 ppb (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 at Station 10 in Basin E (11.0 ppb), Station 2 near the Harbor entrance (15.0 ppb), and at Station 12 in Ballona Creek (15.0 ppb). Lowest values were at Station 25 in the main channel and at Station 13 in Oxford Lagoon (both 1.0 ppb).

DDT ranges compared with past years. The range of this year's values were <0.5 to 5.0 ppb for DDT, <0.5 to 4.0 ppb for DDD, and 1.0 to 9.5 ppb for DDE. DDT and its derivatives have declined by an order of magnitude since 1987 (Table 5-2).

DDT values compared with other surveys. The Marina del Rey total DDT's average and range (4.85 ppb, 1.0 to 15.0 ppb) were considerably lower than Los Angeles Harbor (94.1 ppb, 29.7 to 196 ppb), 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; 2.2, 27, and 7.5 ppb for DDE; and 1.58 and 180 ppb (no AET value listed) for total DDT's (Table 5-3). For DDD, Stations 2, 10, and 12 exceeded the ER-L value, and no stations exceeded either AET or ER-M values. For DDE, Stations 2, 4, 5, 6, 7, 9, 10, and 12 stations exceeded the ER-L value, Station 2 exceeded the AET value, and no stations exceeded the ER-M value. For DDT, Station 5 exceeded the ER-L value, and no stations exceeded either the AET or ER-M values. For all DDT and derivatives combined, Stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 22 exceeded the ER-L value, and no stations exceeded the ER-M value. There is no listed AET value for combined DDT values.

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

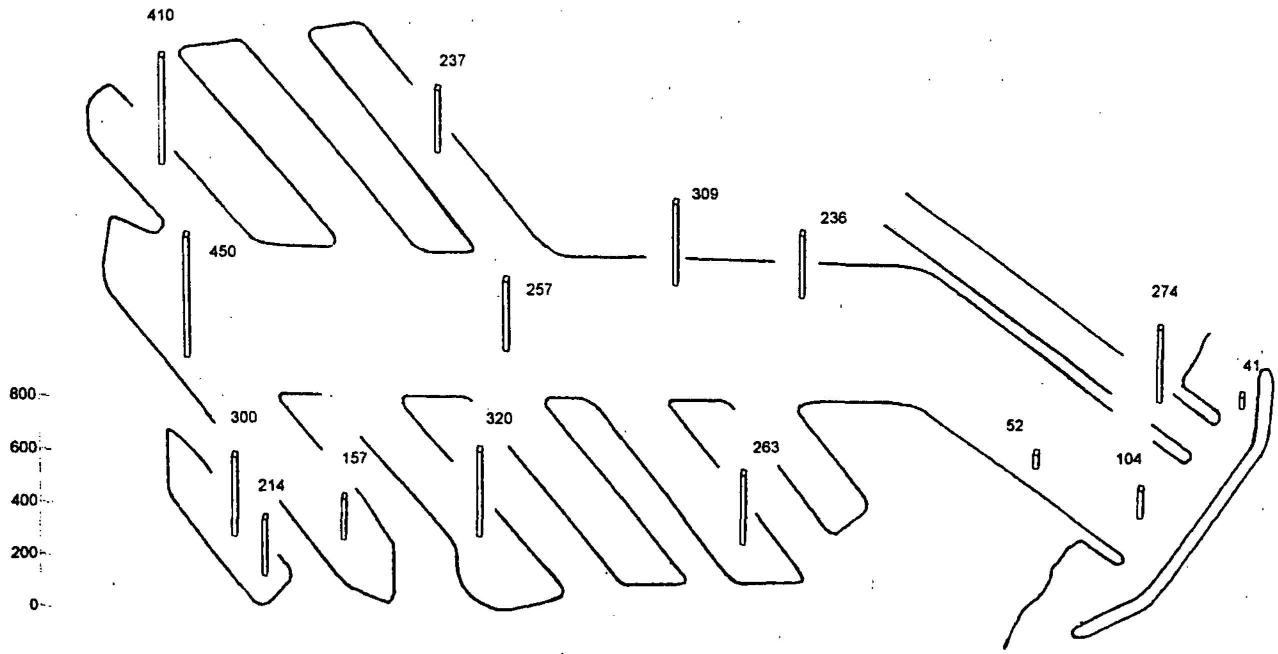
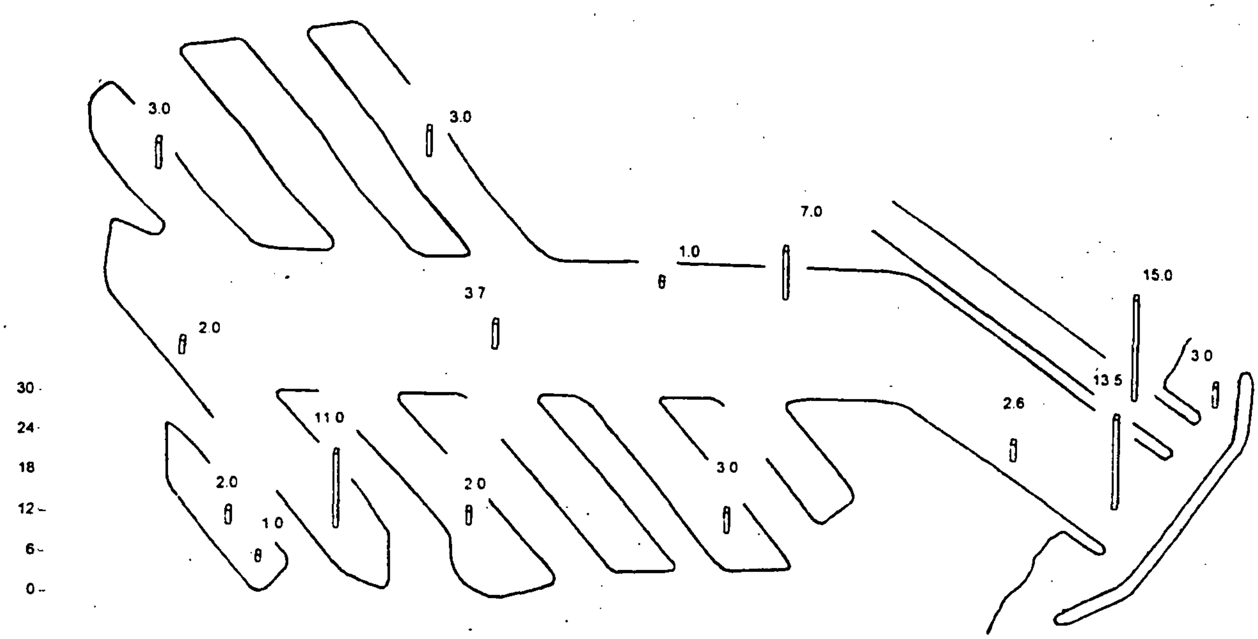


FIGURE 5-14. DDT AND DERIVATIVES CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.2.2. **Remaining Chlorinated Pesticides**

Concentrations of chlordane between 2.4 and 260 ppm in water are acutely toxic to marine organisms. Heptachlor is acutely toxic in water from 0.03 to 3.8 ppm. Heptachlor epoxide, a degradation product of heptachlor, is acutely toxic to marine shrimp at 0.04 ppm in water to pink shrimp. Dieldrin is acutely toxic to estuarine organisms from 0.7 to 10 ppb. Endrin shows acute toxicity within a range of 0.037 to 1.2 ppb. Aldrin is acutely toxic to marine crustaceans and fish is between 0.32 and 23 ppb. The EPA freshwater and saltwater criteria for aldrin are 3.0 and 1.3 ppb, respectively (Long and Morgan 1990). No toxicity data were found for any of the other chlorinated compounds detected during this survey (Table 5-2).

<u>Spatial remaining chlorinated pesticide patterns.</u> Concentrations of combined chlorinated pesticides (excluding DDT and derivatives) at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-15. Highest combined pesticide values were at Stations 2 near the Harbor entrance (13.6 ppb) and Station 12 in Ballona Creek (4.7 ppb). All other stations were either below detection limits (<0.3 to <0.9 ppb) or were very low (1.4 to 4.0 ppb).

<u>Remaining chlorinated pesticide ranges compared with past years.</u> The range of this year's values for all non-DDT chlorinated pesticides were <0.3 to 14.7 ppb. Non-DDT chlorinated pesticides have remained about the same since 1996. Previous to 1996, few compounds had been detected, but that was because detection limits were much higher then (Table 5-2).

<u>Remaining chlorinated pesticide values compared with previous surveys.</u> 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.

<u>Remaining chlorinated pesticide values compared with NOAA effects range ratings.</u> The ER-L and ER-M values for chlordane are 0.5 and 6.0 ppb, and 0.02 and 8.0 ppb for dieldrin. There is no AET for dieldrin; however, the AET for chlordane is 2.0 ppb. There are no effects range ratings for any of the other chlorinated pesticides (Table 5-3). For chlordane, Stations 1, 2, 3, 4, and 12 exceeded the ER-L value; and Stations 2 and 12 exceeded both ER-M and AET values. For dieldrin, Station 12 exceeded ER-L values, though no stations exceeded the ER-M.

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

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

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

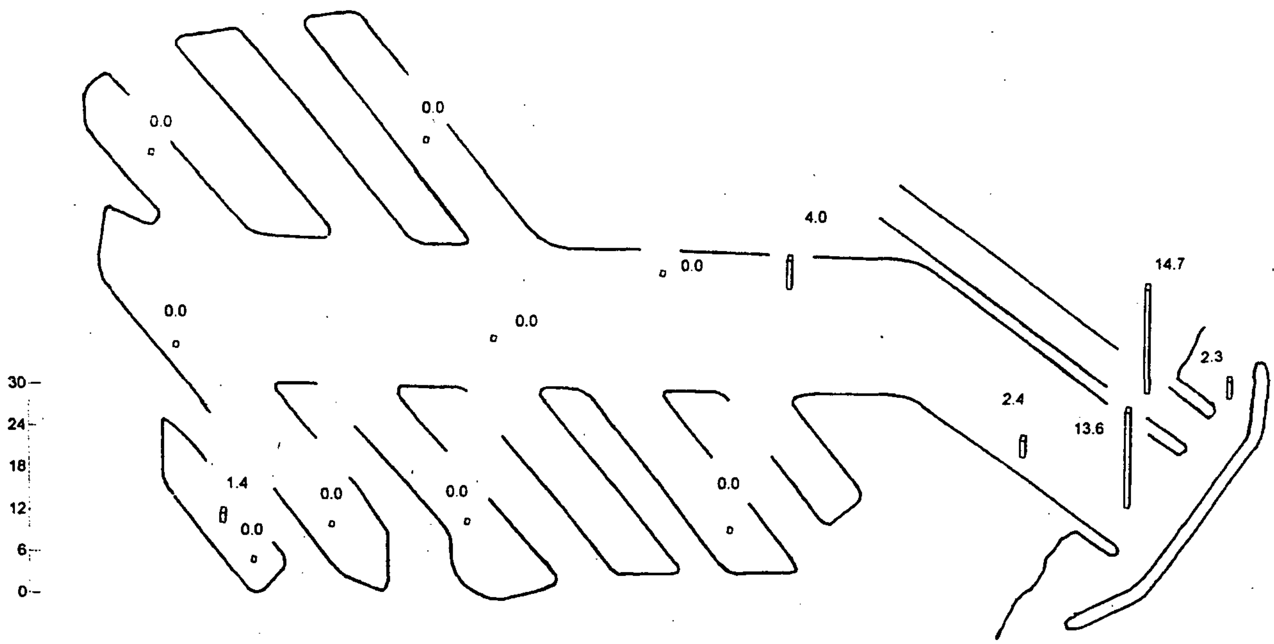
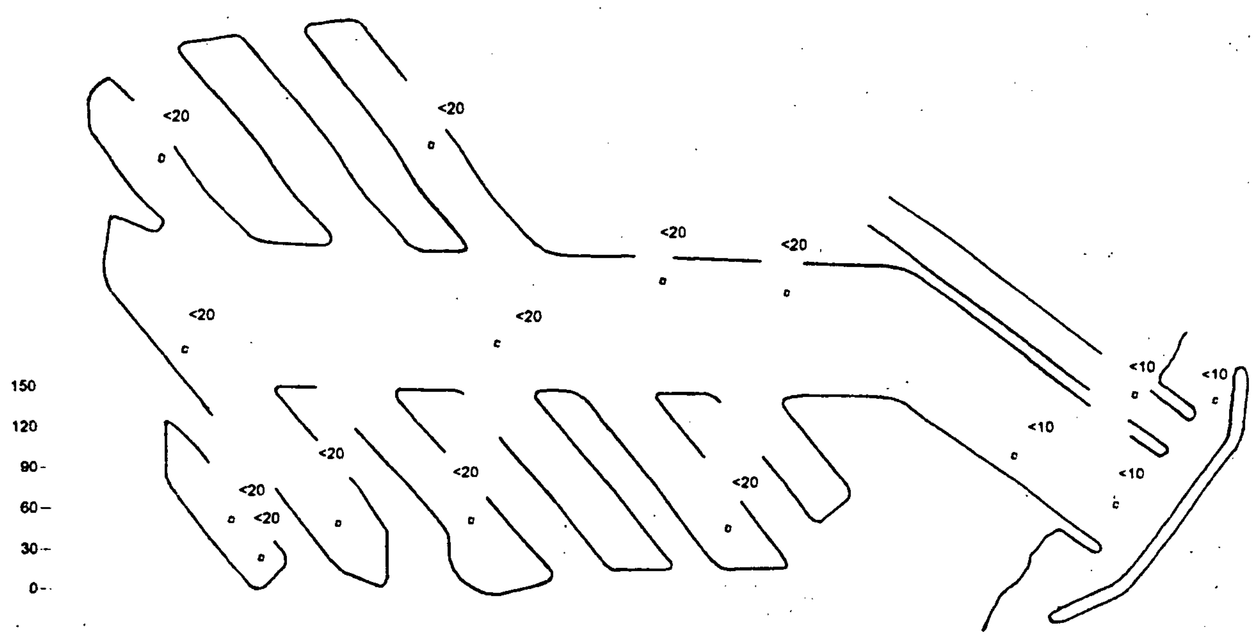


FIGURE 5-16. TOTAL PCB CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial PCB patterns. PCB concentrations were below detection limits (10 to 20 ppb) at all stations (Table 5-1, Figure 5-15).

PCB's compared with past years. This year's values for PCB's were <10 to <20 ppb (Table 5-2). These values are lower than those reported in the past (<10 to 300 ppb) but are similar to the last several surveys.

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

PCB's compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for total PCB's are 22.7, 180, and 370 ppb (Table 5-3). No stations were above the ER-L, ER-M, or AET values.

5.3.3. Simple Organics

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

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

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

Spatial TOC patterns. Concentrations of TOC at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-17. With the exception of Stations 1 and 3 near the Harbor entrance (0.3 to 0.4%, respectively), TOC values were fairly consistent throughout the Harbor (1.3% to 2.4%).

TOC ranges compared with past years. The range of 1998 values for TOC was 0.3 to 2.4% (Table 5-2), which is well within the ranges of the previous surveys. TOC in the Harbor may have decreased slightly since 1987.

TOC values compared with previous surveys. TOC values were normalized to fine grain Los Angeles Harbor, so they were not comparable to values in this survey. The TOC average and range for Marina del Rey TOC (1.6%, 0.3% to 2.4%) were about three times the 1987 SCCWRP Reference Site Survey of 0.52% (Table 5-3). TOC was not analyzed in the 1979 SCCWRP Survey.

5.3.3.2. **Volatile Solids**

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

Spatial volatile solids patterns. Concentrations of volatile solids at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-18. With the exception of three Stations near the Harbor entrance (Stations 1, 2, and 3 – 1.3% to 3.9%), all stations were somewhat comparable (4.6% to 7.5%).

Volatile solids ranges compared with past years. The range of this year's values for volatile solids was 1.3% to 7.5% (Table 5-2) which is well within the ranges past surveys. Volatile solids in the Harbor may have declined slightly since 1987.

Volatile solids values compared with previous surveys. The average and range for Marina Del Rey volatile solids (5.2%, 1.3% to 7.5%) were comparable to the 1979 SCCWRP Reference Site Survey (3.3%, 1.8% to 9.5%). Volatile solids were not analyzed in the 1987 SCCWRP Survey or in Los Angeles Harbor (Table 5-3).

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

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

Spatial IOD patterns. Concentrations of IOD at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-19. Highest values were at Station 5 in the main channel (4.0%). Lowest values were at Stations 1 and 2 near the Harbor entrance (both 0.1%).

IOD ranges compared with past years. The range of this year's values for IOD was 0.1% to 4.0% (Table 5-2). These values are somewhat comparable to values from 1996 through 1998 (0.02% to 2.0%) but higher than those reported in earlier studies (<0.001% to 0.006%). It is likely that, since the IOD analysis is a non-standardized methodology, these large differences are related to differing analytical techniques being used by the previous and present chemistry laboratories.

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

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

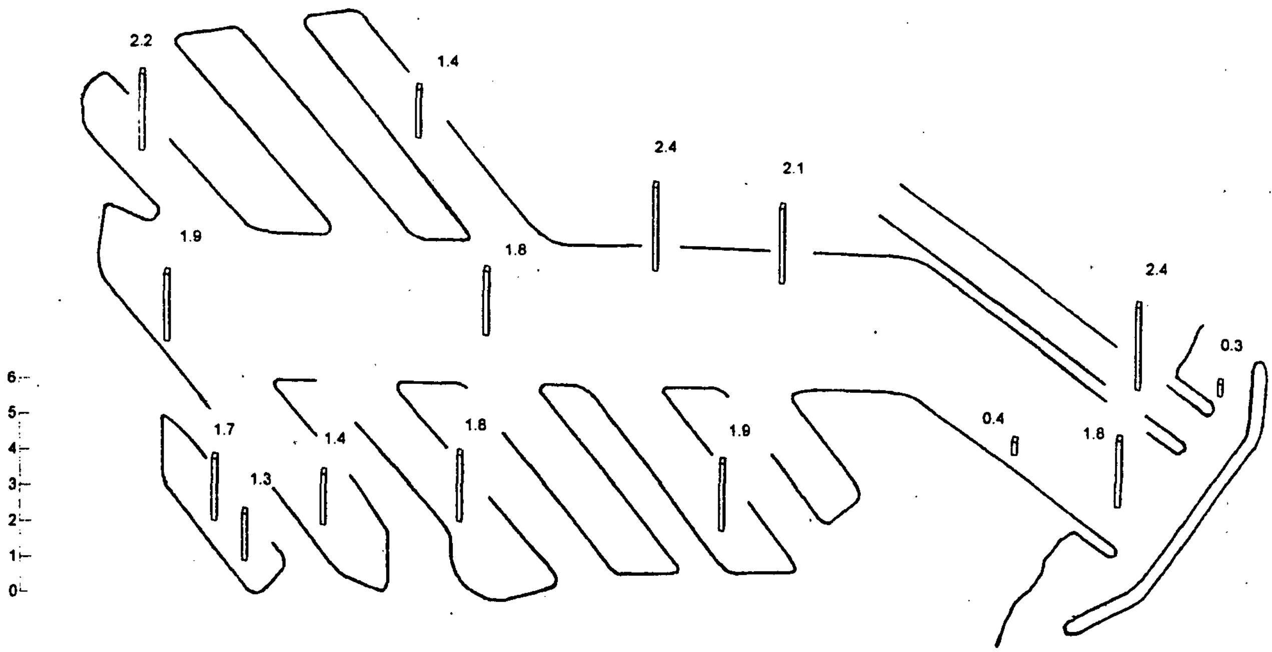
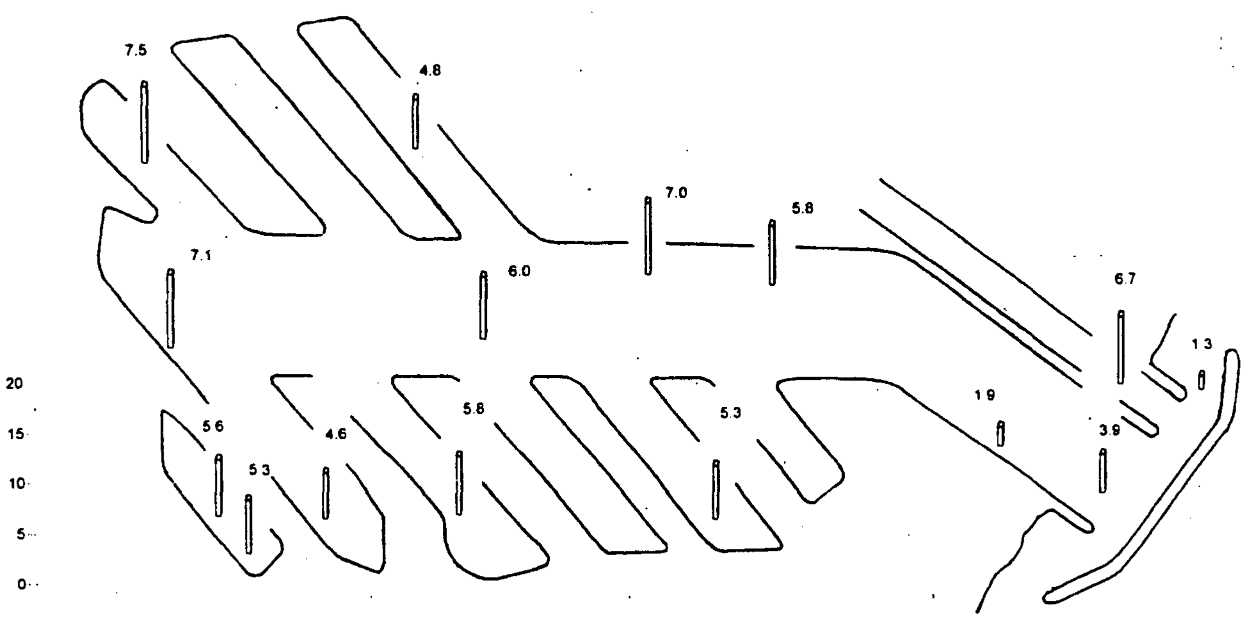


FIGURE 5-18. VOLATILE SOLIDS CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.3.4. **Chemical Oxygen Demand (COD)**

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

Spatial COD patterns. Concentrations of COD at the 15 stations are listed in Table 5-1 and summarized in Figure 5-20. Highest values were at Station 25 near the Administration docks (5.7%) and at Station 9 in Basin F (6.4%). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 - 0.4% to 1.1%).

COD ranges compared with past years. The range of 1998 values for COD was 0.4% to 6.4% (Table 5-2), which is well within the ranges of previous surveys. COD in the Harbor appears to have declined slightly since 1987.

COD values compared with previous surveys. The average and range for Marina del Rey COD (3.4%, 0.4% to 6.4%) were comparable to the 1979 SCCWRP Reference Site Survey (2.4%, 0.92% to 6.94%). COD was not analyzed in the 1987 SCCWRP Survey or in Los Angeles Harbor (Table 5-3).

5.3.3.5. **Oil and Grease**

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

Spatial oil and grease patterns. Oil and grease values for the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-21. Highest values, by far, were from Station 12 in Ballona Creek (1500 ppm). With the exception of Stations 1, 2, and 3 near the Harbor entrance and Stations 4 in midchannel (41 to 290 ppm), all values were below detection limits (<30 ppm).

Oil and grease ranges compared with past years. The range of this year's values for oil and grease was <30 to 1500 ppm, which fall well within the range of values for past surveys (Table 5-2). Oil and grease concentrations decreased somewhat since 1987.

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

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

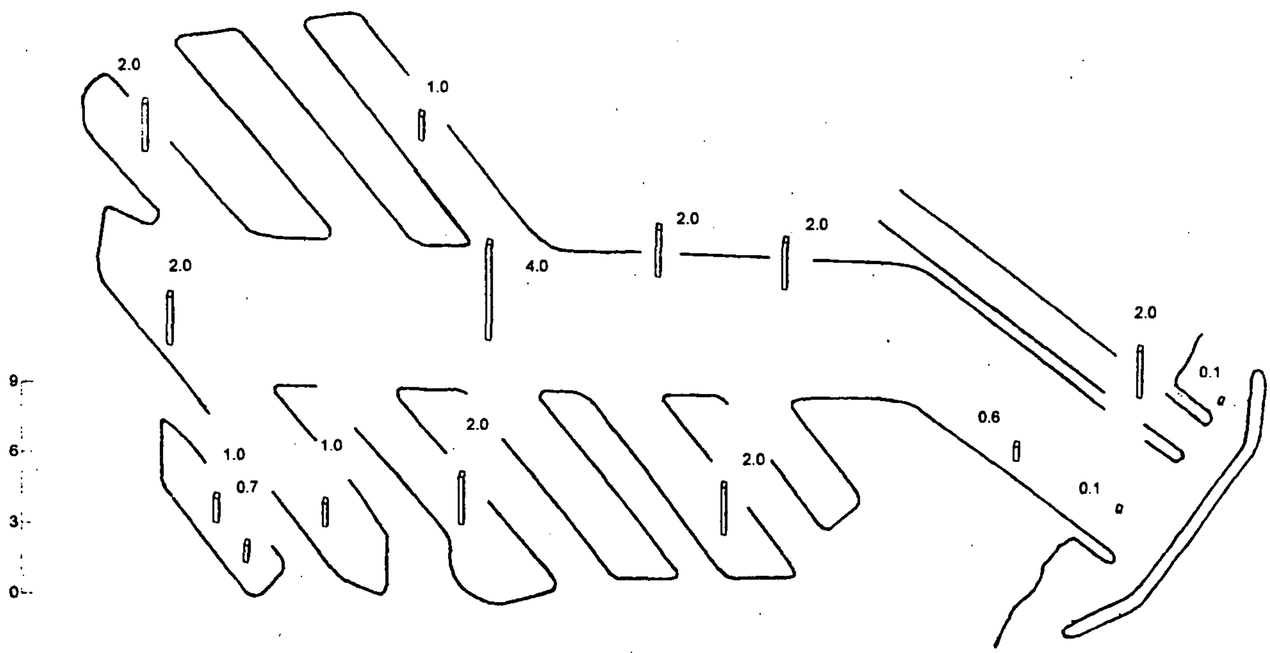
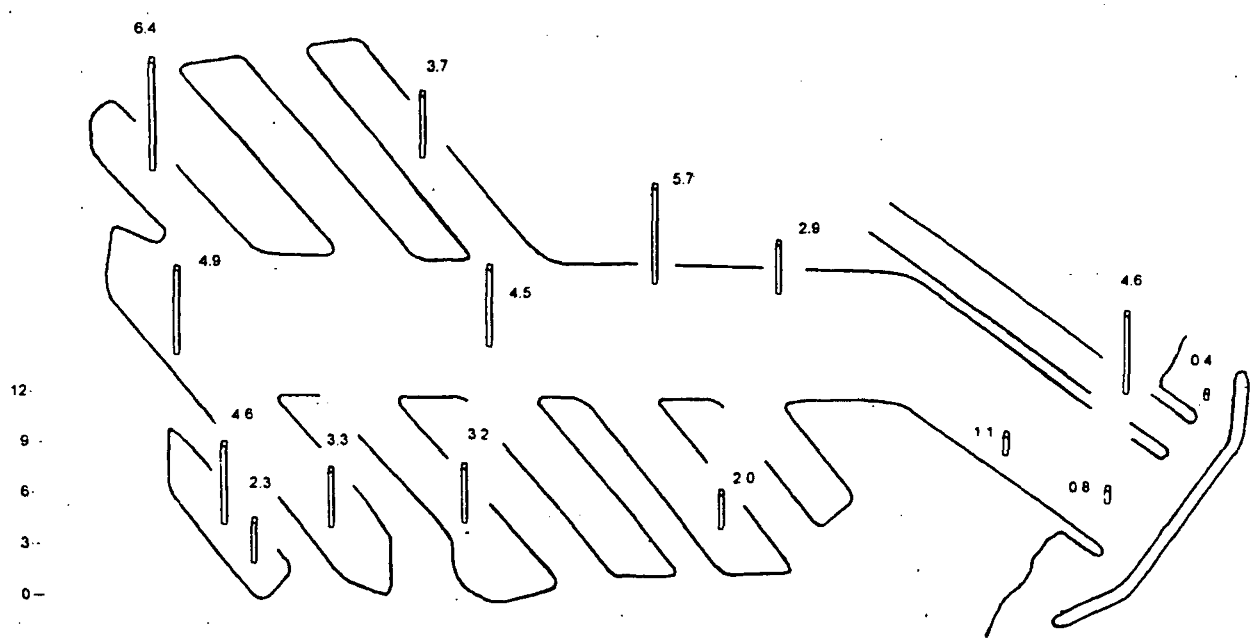


FIGURE 5-20. CHEMICAL OXYGEN DEMAND CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.3.6. **Organic Nitrogen**

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

Spatial organic nitrogen patterns. Concentrations of organic nitrogen at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-22. Highest values were at Station 22 in Oxford Lagoon (1900 ppm), Station 25 in the main channel (1800 ppm), and Station 9 in Basin F (1900 ppm). Lowest values were at Station 1 near the Harbor entrance (<300 ppm).

Organic nitrogen ranges compared with past years. The range of this year's values for organic nitrogen was <300 to 1900 ppm (Table 5-2), which is well within the range of the past surveys. Organic nitrogen in the Harbor appears to have decreased somewhat since 1987.

Organic nitrogen values compared with previous surveys. The average and range for Marina del Rey nitrogen (1137 ppm, <300 to 1900 ppm) were slightly higher than the range of the 1979 SCCWRP Reference Site Survey (790 ppm, 393 to 1430 ppm). Nitrogen was not analyzed in the 1987 SCCWRP Survey or in Los Angeles Harbor (Table 5-3).

5.3.3.7. **Ortho Phosphate**

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

Spatial ortho phosphate patterns. Concentrations of ortho phosphate at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-23. All values were below detection limits (<10 to <20 ppm).

Ortho phosphate ranges compared with past years. The range of this year's values for orthophosphate was <10 to <20 ppm, which is below nearly all values recorded since 1987 (Table 5-2).

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

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

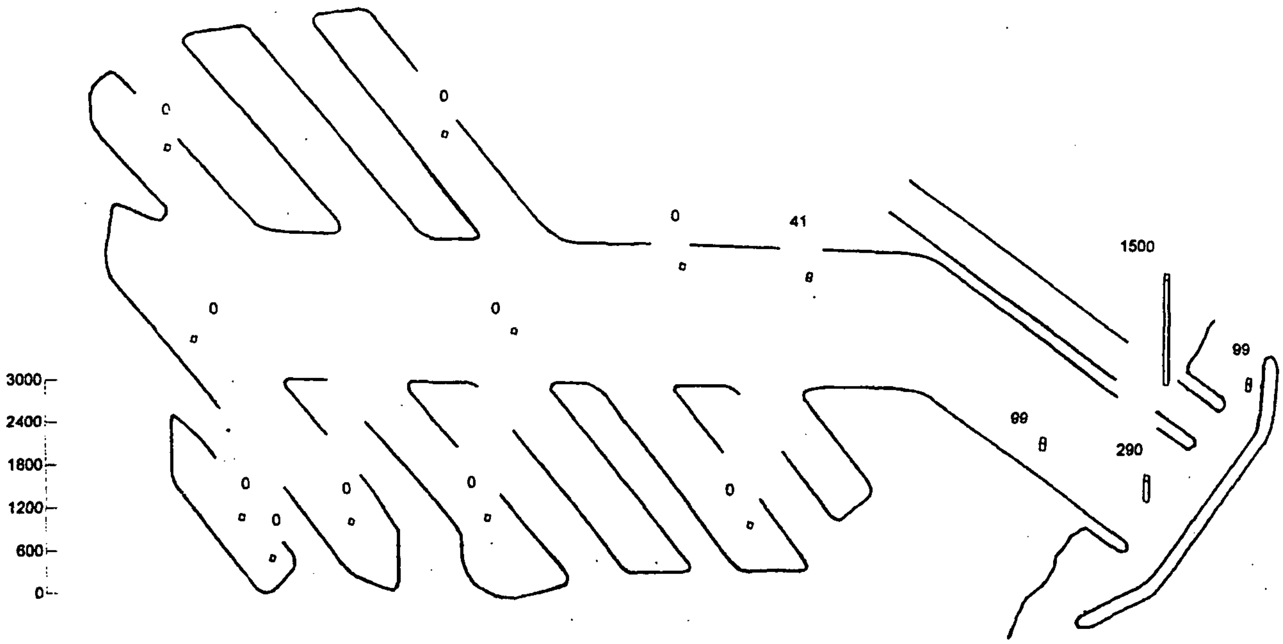
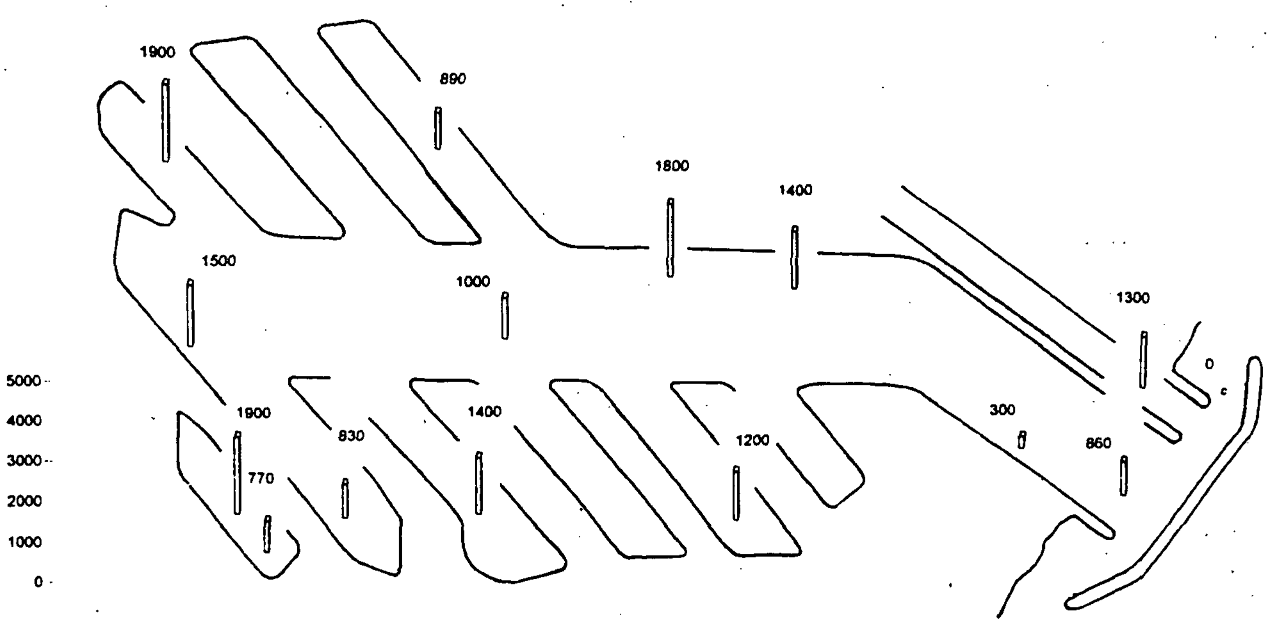


FIGURE 5-22. ORGANIC NITROGEN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.3.8. **Sulfides**

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

Spatial sulfide patterns. Concentrations of sulfides at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-24. Highest values were at Station 12 in Ballona Creek (1800 ppm). Lowest values were at Station 1 near the Harbor entrance (210 ppm).

Sulfide ranges compared with past years. The range of this year's values for sulfide was 210 to 1800 ppm (Table 5-2), which is well within the ranges of past surveys. Like orthophosphate and IOD, concentrations have varied widely over the past ten years.

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

5.3.4. Minerals and Other Compounds

Table 5-2 lists physical and chemical parameters that are generally associated with freshwater mineral analysis for drinking water or for agricultural use. These constituents are neither commonly associated with marine toxicants nor are they common indicators of organic pollution. They will, therefore, not be dealt with to any great extent in this document.

5.3.5. Station Grouping Based on Benthic Contaminants

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

Stations 1, 2, 3, 7, 10, 13, and 22. As a group, these stations tended to have high concentrations of pesticides and oil and grease, and low concentrations of most metals and most simple organics. These stations represent the Harbor entrance, Oxford Lagoon, and Basins E and H.

Stations 5, 6, and 8. These stations tended to be highest in about half of the metals and immediate oxygen demand and moderate in all other constituents. These stations represent Basin B, Basin D, and one station from midchannel.

Stations 9, 11, and 25. These stations were highest in most undifferentiated organic compounds and nearly all heavy metals and were moderate in all other compounds. These stations represent Basin F, the upper channel, and one station from midchannel.

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

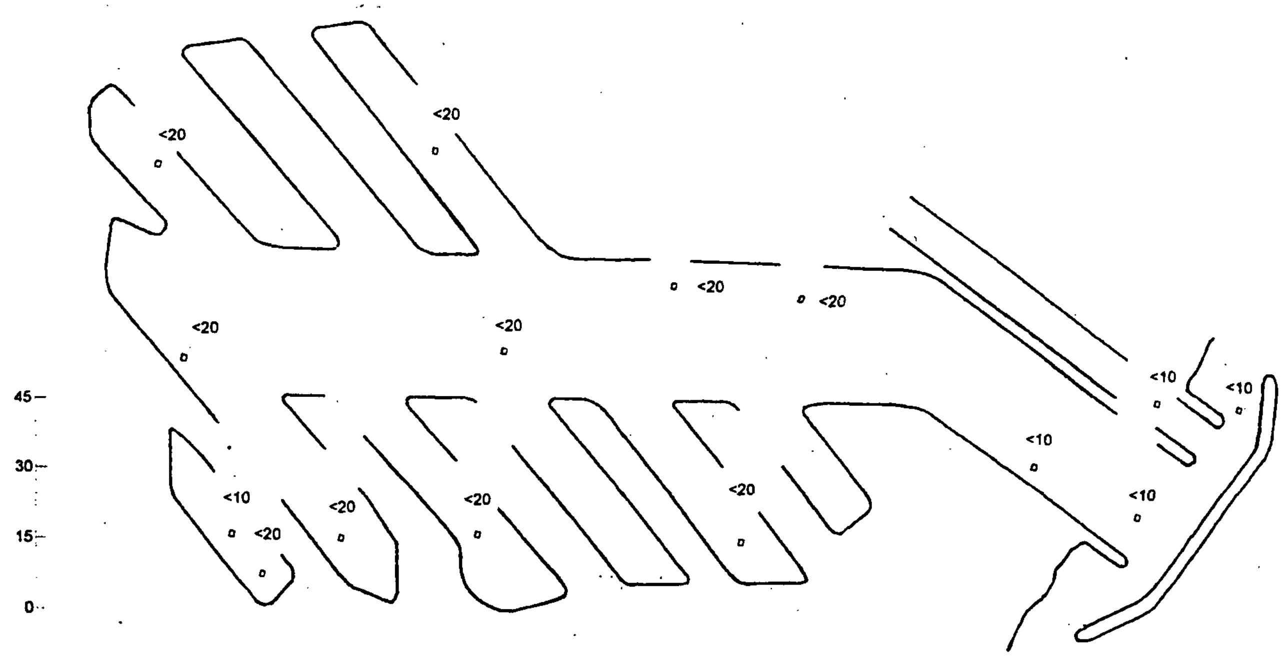
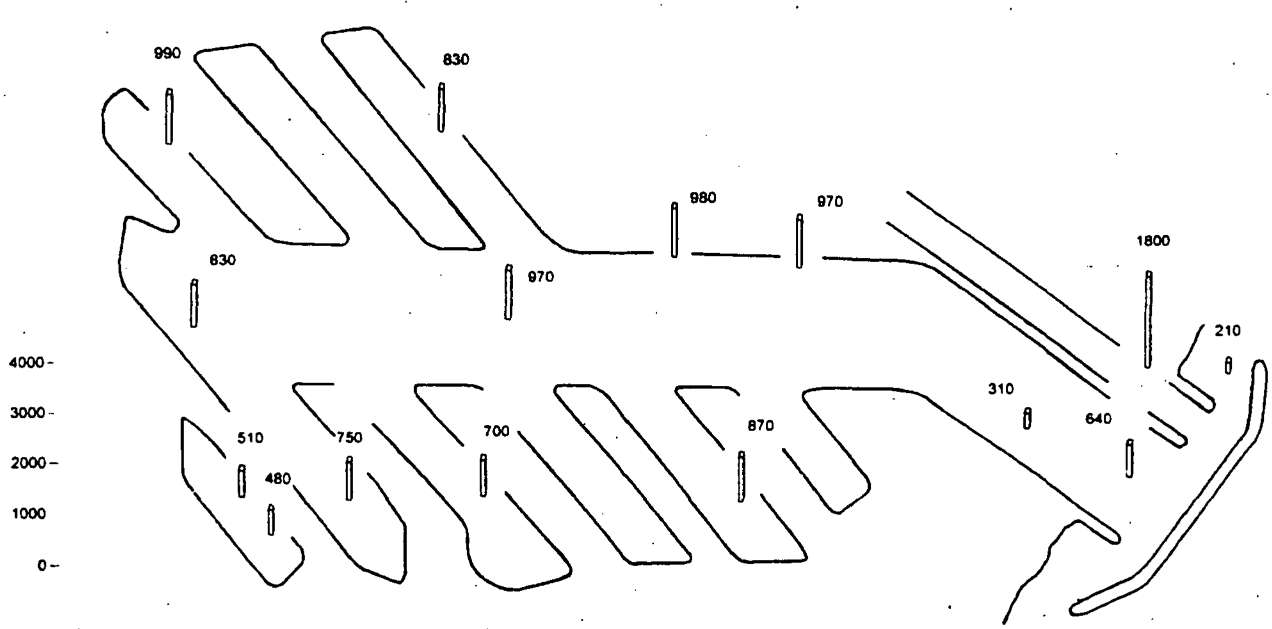


FIGURE 5-24. TOTAL SULFIDE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Stations 4 and 12. This group is high in cadmium, silver, DDT and derivatives, other chlorinated pesticides, and most undifferentiated organics and low in iron and manganese. These stations represent Ballona Creek and one station from midchannel.

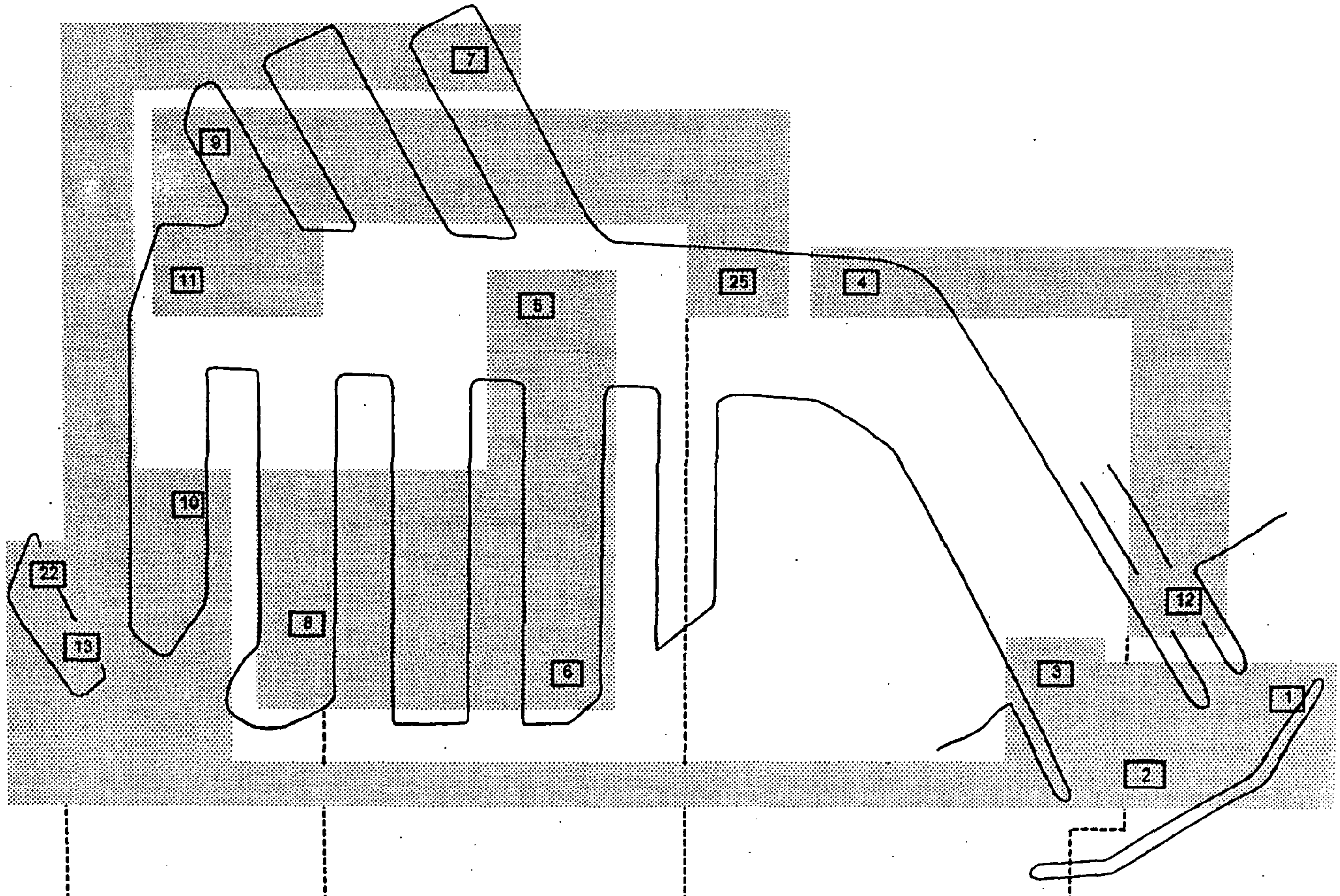
5.4. DISCUSSION

As with most past studies, several factors are responsible for distributions 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 past three surveys (Aquatic Bioassay 1997, 1998, 1999), inflows from the Oxford Lagoon and Ballona Creek may be sources of chlorinated pesticides. Sediments from Ballona Creek and Station 2 near the Harbor entrance were much higher than all other stations in DDT-type and other chlorinated pesticides. It is probable that water and suspended particles flowing from Ballona Creek reflects off of the breakwall and deposit themselves onto the sediment surface of Station 2. Other stations near the entrance and lower channel (Stations 1, 3, and 4) appear to be affected by Ballona Creek deposits but to less of a degree. Unlike last year, Oxford Lagoon sediment were relatively low in chlorinated compounds, however, sediments at Basin E, which have historically been influenced by inflows from Oxford Lagoon, were comparatively high in DDT's. Perhaps, the rapid flow through the Lagoon keeps many DDT-laden particulates in suspension. When suspended materials reach Basin E and slow down, the particles may deposit there. DDT itself was present only in Ballona Creek. As stated above in the Harbor history, the area surrounding Marina del Rey was once used as a toxic materials dumpsite, so the presence of DDT breakdown products (i.e. DDD and DDE) is not surprising. The presence of DDT itself, however, suggests a fresh source or fresh exposure to the Harbor.

In general, chlorinated hydrocarbon concentrations over the past four years have been considerably lower than had been measured during the previous ten years. Despite this, all Harbor stations, except Station 13 in Oxford Lagoon and 25 in midchannel, 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, Stations 2 and 12 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, Long et. al. 1995). These numbers are much lower than last year when *all* stations were above the lower NOAA limit, and seven stations were above the higher limit. Also, average total DDT's and PCB's in Marina del Rey Harbor sediments (4.9 and <20 ppb, respectively) are much lower than those of Los Angeles Harbor (94.1 and 58.3 ppb) and even compare favorably with 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).

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



Stations 1, 2, 3, 7, 10, 13, 22	Stations 5, 6, 8	Stations 9, 11, 25	Stations 4, 12
High in:	**High in:**	**High in:**	**High in:**
Pesticides	Arsenic	Arsenic	Cadmium
Oil and Grease	Chromium	Chromium	Silver
–	Copper	Copper	DDT
–	Iron	Iron	Pesticides
	Mercury	Lead	Total Organic Carbon
Low in:	Nickel	Manganese	Volatile Solids
Arsenic	Tributyl Tin	Mercury	Immed. Oxygen Demand
Chromium	Immed. Oxygen Demand	Nickel	Oil and Grease
Copper	–	Silver	Sulfides
Iron	–	Tributyl Tin	–
Manganese	–	Zinc	–
Mercury	–	Total Organic Carbon	–
Nickel	–	Volatile Solids	–
Silver		Immed. Oxygen Demand	
Zinc	**Low in:**	Chemical Oxygen Demand	**Low in:**
Total Organic Carbon	–	Nitrogen	Iron
Volatile Solids	–	Sulfide	Manganese
Immed. Oxygen Demand	–		–
Nitrogen	–	**Low in:**	–
Sulfides	–	–	–
Charateristics: High in pesticides and oil and grease. Low in most metals and most organics.	**Charateristics:** High in some metals and immediate oxygen demand. Moderate in all other constituents.	**Charateristics:** High in nearly all metals and organics. Moderate in all other constituents.	**Charateristics:** High in DDT, other pesticides, most organics, and cadmium and silver. Low in iron and manganese.

Neither Oxford Lagoon nor Ballona Creek appear to be a source of heavy metals into the Harbor. Areas that do appear to have the highest metal concentrations were most upper and midchannel stations (Stations 5, 11, and 25) and Station 9 in Basin F. This pattern suggests that the likely source of most metals is the thousands of boats themselves that 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. It is not surprising, then, that all stations, except Station 1 at the Harbor entrance, exceeded at least one metal limit of "potential" toxicity, and over half exceeded at least one metal limit of "probable" toxicity to marine organisms, based on those listed by NOAA.

Six heavy metals in Marina del Rey sediments fell within, or near to, the range of values measured in Los Angeles Harbor sediments, but values of three (copper, lead, and zinc) were between two to five 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. Also, the boat population per unit area in Marina del Rey may be higher than in Los Angeles Harbor. Not surprisingly, most (but not all) metals were higher than those collected along the open coast.

Despite a fair degree of variability since 1987, most heavy metal concentrations appear to have neither consistently increased nor greatly decreased over time. The exception is tributyl tin, which has declined dramatically since 1988 when it was first analyzed. 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 tributyl tin 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. Sources of nonspecific organic pollutants may be varied. Most organics were high in Ballona Creek sediments, so the runoff from this channel is a likely source. Other areas of high organics included the upper and midchannel areas (Stations 4, 11, and 25) and, again, Basin F (Station 9). Various seepages from boats and other nonpoint runoff undoubtedly contribute considerable amounts of organics to the benthos. It is interesting to note that the spatial pattern for nonspecific organics and heavy metal concentrations are similar. 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 the past three years' reports (Aquatic Bioassay 1997, 1998, 1999), Harbor sediments that are composed of finer particles, such as silt and clay, also tend to be highest in heavy metals and organics. 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 that do not appear to show any strong relationship to smaller particle size. Thus, many of the areas that have high concentrations of metals and nonspecific organics tend to be areas of relatively fine sediments.

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 polychaete annelid worms, molluscans, and crustaceans dominate the benthic fauna in shallow, silty, sometimes unconsolidated, habitats. 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, oligochaete worms, or polychaete worms tolerant of low oxygen/high organic sediments. 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. 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. In general, nematodes are more tolerant of lowered salinities and disturbances. (Soule et al. 1996).

6.2. MATERIALS AND METHODS

Field sampling for all benthic sediment components is 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), relaxed with magnesium sulfate, and preserved with 10% buffered formalin. Taxonomic experts from Osprey Marine Management in Costa Mesa, California identified animals. A complete list of infauna is 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 infauna individuals collected per sampling effort. For this survey, numbers of individuals were defined as 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 that can tolerate the stressful condition (such as a pollutant) may flourish because they have few competitors. If an 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 infaunal sampling stations are listed in Table 6-1 and summarized in Figure 6-1. Counts per grab ranged from 80 to 16,933 individuals. Lowest total abundance was at Station 1 near the Harbor entrance (80 individuals), Station 9 in Basin F (159 individuals), and at Station 11 at the upper end of the main channel (257 individuals). Highest values were at Stations 2 in the lower main channel (16,933 individuals), followed by Station 12 in Ballona Creek (7324 individuals), and Station 3 also in the lower main channel (4167 individuals). Most individuals at Station 2 (91%) were nematodes that are typically found in areas of environmental disturbance or freshwater influence (Soule et al. 1996). Other stations with high percentages of nematodes included Station 10 (64%), Station 12 (50%) and Station 3 (22%). Nematode counts were low or absent at the 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 this year was 80 to 16,933, which falls well within the overall range of values for past surveys. Values this survey were between those of the past two years. Abundances have varied widely over past surveys.

Infaunal abundance values compared with other surveys. The Marina del Rey abundance average (3116 individuals) and range (80 to 16,933 individuals) were much higher than in Los Angeles Harbor (105 individuals, 5 to 330 individuals) and 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]	80	16933	4167	2860	1229	1087	1305	788	159	2448	257	7324	1873
No. Species	30	64	68	43	37	40	42	27	24	31	27	47	56
Diversity (SWI)	2.79	0.48	1.79	2.06	1.92	2.37	1.99	2.12	2.12	1.42	2.57	1.38	2.03
Infaunal Index	71.8	60.7	64.7	71.8	85.9	70.4	64.2	79.0	69.7	64.7	75.4	62.4	72.6
Dominance	0.60	0.04	0.27	0.45	0.35	0.51	0.40	0.49	0.48	0.22	0.70	0.14	0.44

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

TABLE 6-2. RANGES OF INDIVIDUALS, SPECIES, AND DIVERSITY - OCTOBER 1976 THROUGH OCTOBER 1999.

	POPULATION INDICES				
DATE	Individuals	Species	Diversity	Dominance	Infaunal Index
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	0.12 - 0.71	27 - 71
Oct-97	109 - 4818	20 - 88	0.98 - 2.81	0.13 - 0.70	30 - 77
Sep-98	241 - 32,760	18 - 77	1.24 - 2.43	0.22 - 0.65	58 - 72
Overall Range	**36 - 105,390**	**9 - 121**	**0.44 - 3.09**	**0.12 - 0.71**	**27 - 77**
Oct-99	80 - 16,933	24 - 68	0.48 - 2.79	0.04 - 0.70	61 - 86

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	**3116**	**80 - 16,933**	105	5 - 330	422	91- 1213	348
No. Species	**41**	**24 - 68**	35	5 - 64	72	32 - 135	68
Diversity (SWI)	**1.92**	**48 - 2.79**	2.92	1.59 - 3.72	3.12	2.19 - 3.98	-
Infaunal Index	**70**	**61 - 86**	74	67 - 83	88	60 - 98	-

6.3.1.2. **Infaunal Species**

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

Spatial infaunal species patterns. Species counts at the 13 sediment-sampling stations ranged from 24 to 68 per grab (Table 6-1 and Figure 6-2). Lowest species numbers were in the back part of the Harbor (Stations 9, 10, and 11 - 24 to 31 species), and highest values were in the lower main channel (Stations 2 and 3 - 64 and 68 species, respectively).

Infaunal species patterns compared with past years. Table 6-2 lists the ranges of species collected per station since 1976. The range of species collected this year was 24 to 68, which falls well within the overall range of values for past surveys and is similar to counts made in the past two years.

Infaunal species values compared with other surveys. The Marina del Rey species count average (41 species) and range (24 to 68 species) were comparable to Los Angeles Harbor (35 species, 5 to 64 species), but lower than the 1979 (72 species, 32 to 135 species) and 1987 (68 species) SCCWRP Reference Site Surveys (Table 6-3).

6.3.1.3. **Infaunal Diversity**

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

Spatial infaunal diversity patterns. Diversity index values at the 13 sediment-sampling stations ranged from 0.48 to 2.79 (Table 6-1 and Figure 6-3). Lowest diversity values were near the Harbor entrance (Stations 2 – 0.48), due to the extremely high counts of nematodes encountered there. Highest values were at Station 1 also near the Harbor entrance (2.79) and at Station 11 near the upper end of the Harbor (2.57).

Infaunal diversity patterns compared with past years. Table 6-2 lists the ranges of diversity values calculated per station since 1984. The range of values this year was 0.48 to 2.79, which falls within the overall range of values for past surveys. Values this year tended to be lower than those of the past two years. Diversity indices had not been calculated previous to 1984.

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

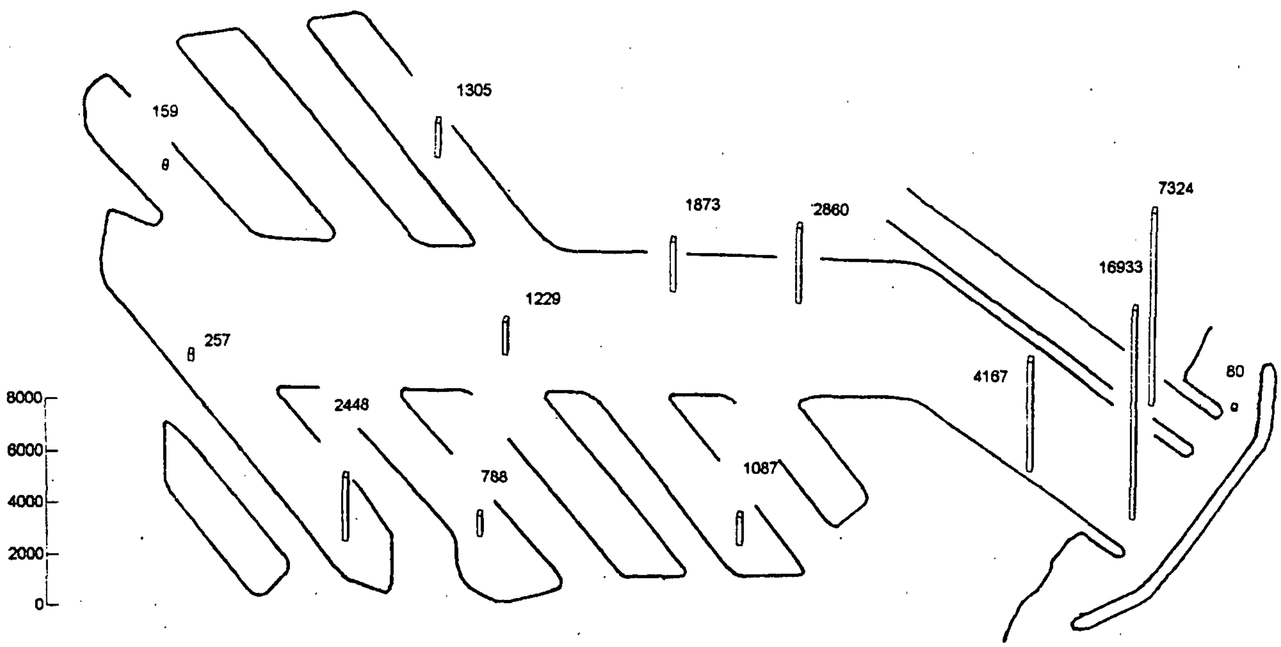
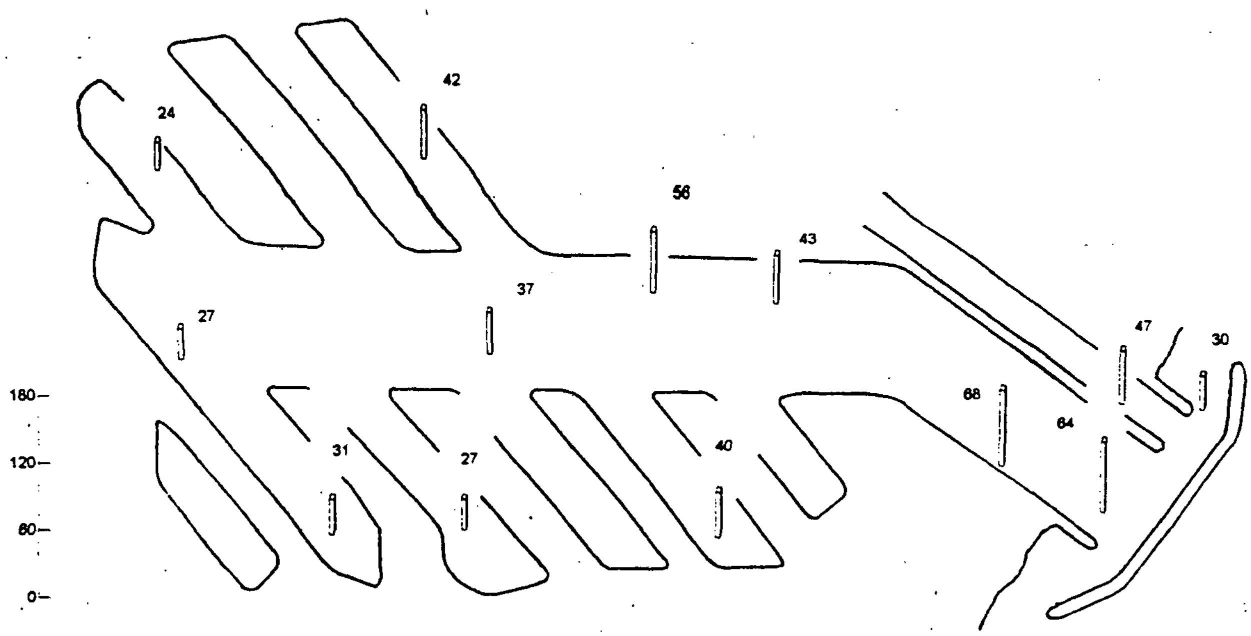


FIGURE 6-2. NUMBER OF INFAUNAL SPECIES AT 13 BENTHIC SEDIMENT STATIONS.



Infaunal diversity values compared with other surveys. The Marina del Rey diversity average (1.92) and range (0.48 to 2.79) 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 author has 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 generally 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 ranged from 0.04 to 0.70 (Table 6-1 and Figure 6-4). The lowest dominance values were near the Harbor entrance (Station 2 - 0.04). Highest values were also near the Harbor entrance (Station 1 - 0.60) and near the upper end of the Harbor (Station 11 – 0.70).

Infaunal dominance patterns compared with past years. The dominance range (0.04 to 0.70) was similar to those of the past three years (Table 6-2), except for the low (0.04) value at Station 2. Dominance indices had not been calculated previous to 1996.

Infaunal dominance values compared with previous surveys. Dominance was not analyzed in, or was 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. INFAUNAL DIVERSITY (SWI) AT 13 BENTHIC SEDIMENT STATIONS.

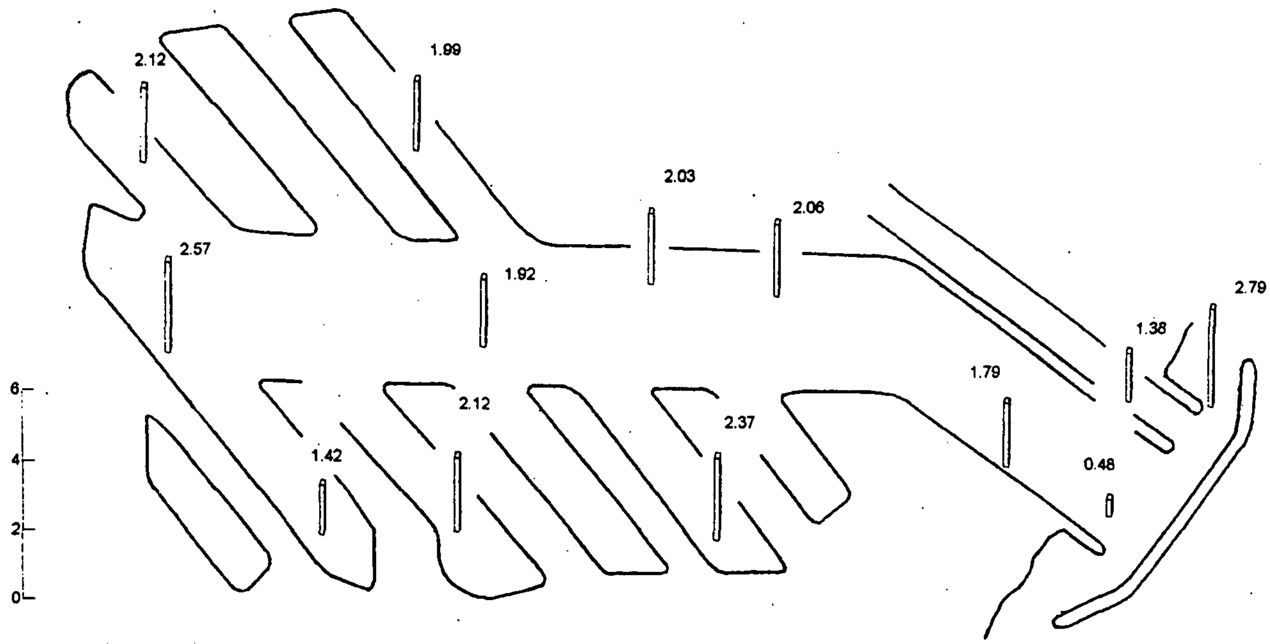
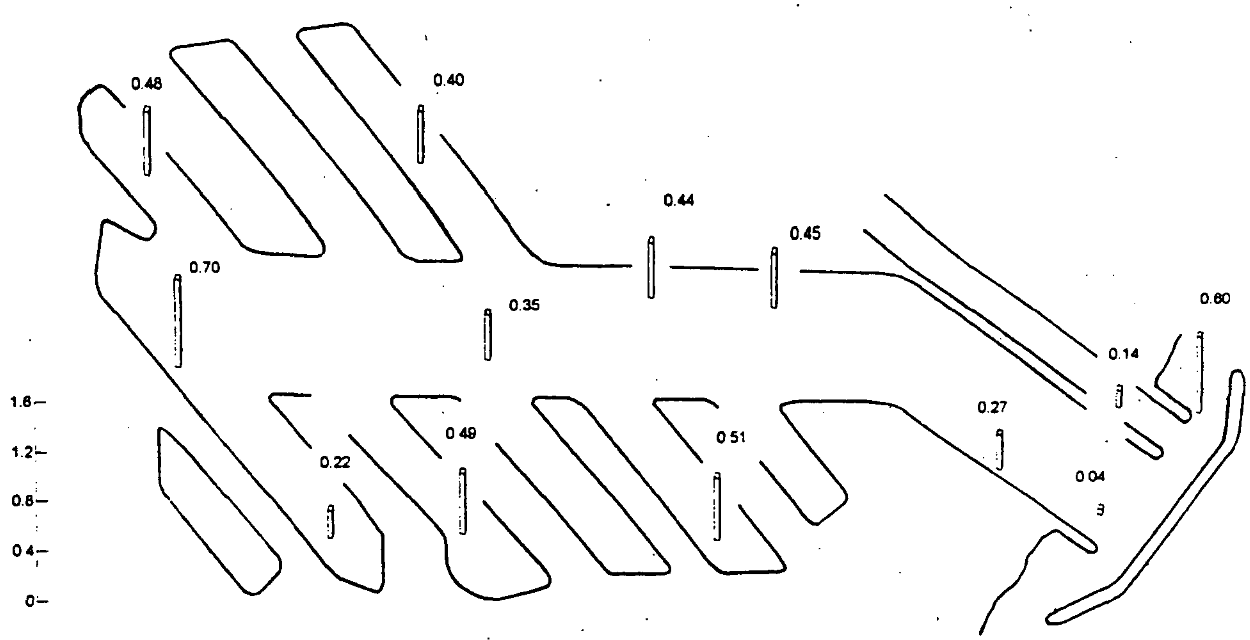


FIGURE 6-4. INFAUNAL DOMINANCE AT 13 BENTHIC SEDIMENT STATIONS.



Spatial infaunal trophic index patterns. Infaunal trophic index values at the 13 sampling stations ranged from 61 to 86 (Table 6-1 and Figure 6-5). Lowest infaunal index values were at Station 2 near the Harbor entrance (61) and at Station 12 in Ballona Creek (62). The highest value, by far, was at Station 5 in midchannel (86). All stations' index values (61 to 86) were defined as "normal" (60 and above).

Infaunal trophic index patterns compared with past years. The infaunal index range (61 to 86) was within the range of the past two years (Table 6-2), except for one high (86) value this year at Station 5. 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 (70) and range (61 to 86) were similar to Los Angeles Harbor (74, 67 to 83) but lower than the 1979 SCCWRP Reference Site Survey (88, 60 to 98). No infaunal index values were calculated for the 1987 SCCWRP Survey (Table 6-3).

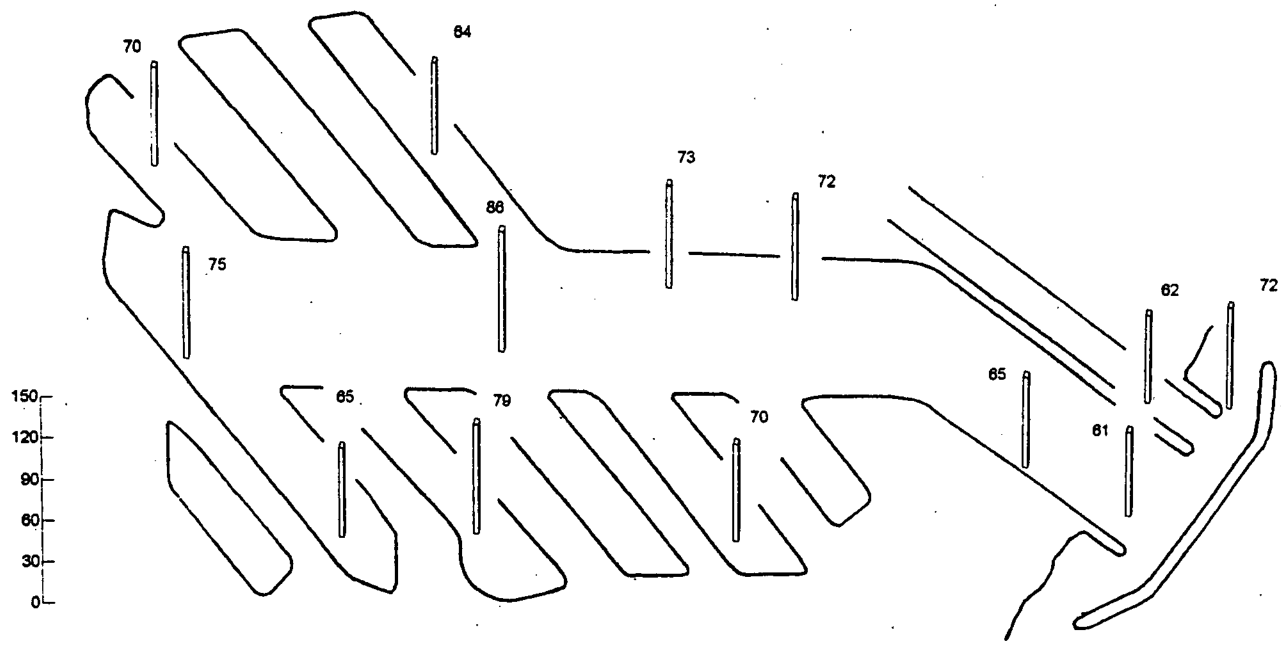
6.3.2. Station Groupings Based on Infaunal Measurements

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

Stations 2, 3, 7, 10, and 12. These Stations are located in Ballona Creek, near the Harbor entrance, and in Basin E. Most are influenced by runoff of one kind or another: Station 10 by Oxford Lagoon flows, Stations 2 and 12 by Ballona Creek flows, and Station 3 by flows from Venice Canal, and possibly, Ballona Creek. Low diversity, infaunal index, and dominance values characterize this group of stations. Among the ten most abundant species, there were seven polychaete worms, one bivalve, one nematode worm, and one oligochaete worm. Crustaceans, which are more common in healthier environments, were noticeably absent. The nematode worms, the oligochaete worms, and two other species of polychaete worms (*Armandia brevis* and *Dorvillea annulata*) are all known to be associated with disturbed benthic environments, thus, infaunal index values at these stations (61 to 65) were relatively low.

Station 5. Station 5 in mid-channel clustered by itself. This group was characterized by high infaunal trophic index values and was not low in any value. Of the ten most abundant species, six were polychaete worms and four were crustaceans. None of these species were indicative of a stressed community, so the infaunal index value was notably high (86). This station appears to be a generally healthy infaunal environment.

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



Station 4 and 25. These stations are located side-by-side in mid-channel. These stations are characterized by a high species counts and no low values for any other index. Of the ten most abundant species, five were polychaete worms, one was an oligochaete worm, four were crustaceans, and one was a phoronid worm. Only the oligochaete worm is considered to be indicative of an unhealthy infaunal environment, so the infaunal trophic index values at these stations were moderately high (72 to 73). This area represents a relatively healthy benthic environment.

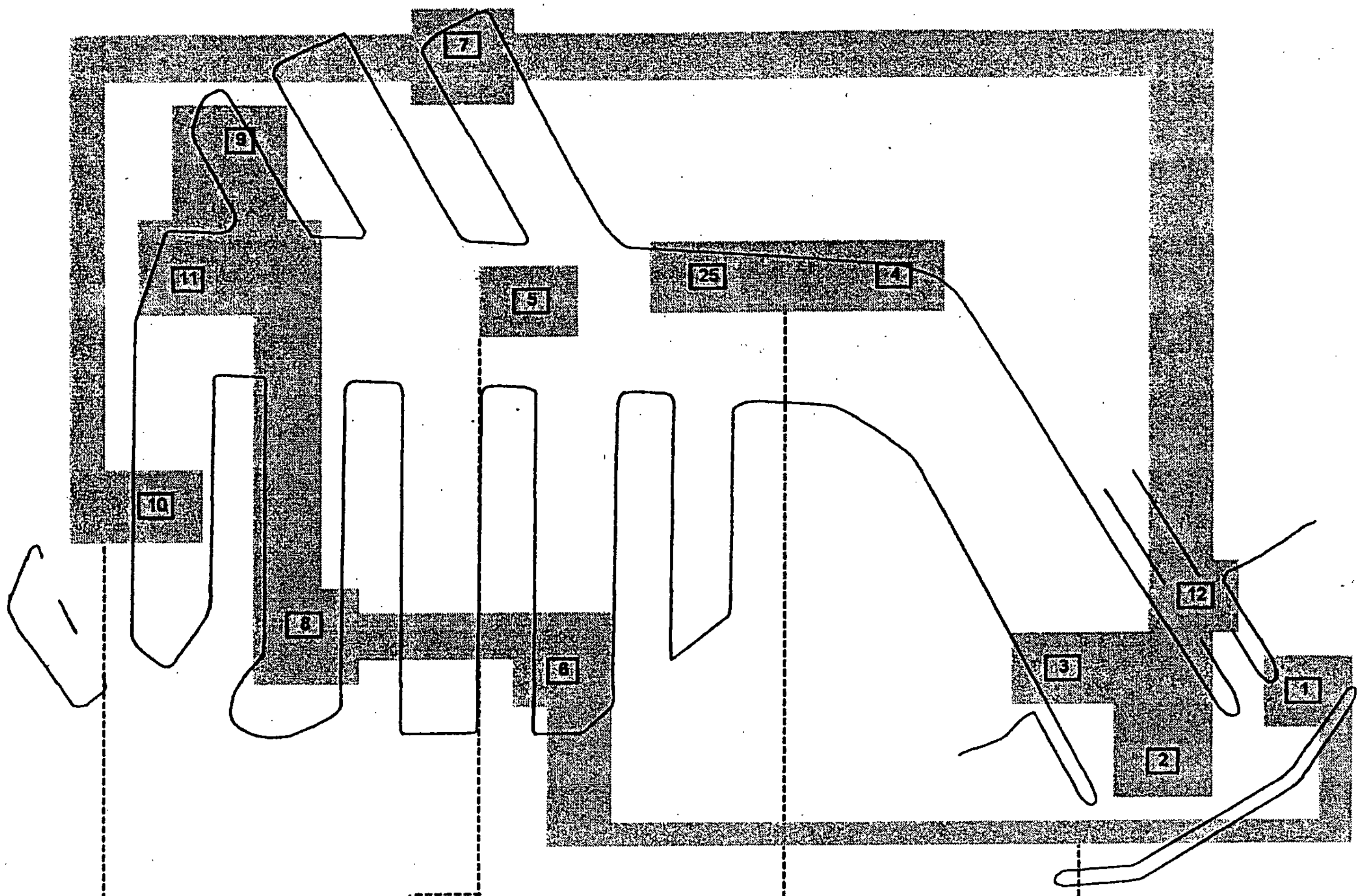
Station 1, 6, 8, 9, and 11. This group is composed of stations from the upper part of the Harbor, as well as Station 1 near the entrance. This group is characterized by high values of diversity and dominance and low values of individuals and species. Of the ten most abundant species, eight were polychaete worms, one was a crustacean, and one was a phoronid worm. Among the ten most common species, only one polychaete worm (*Dorvillea annulata*) is considered to be representative of an unhealthy benthic environment, so the infaunal trophic index values at these stations were moderately high (70 to 79). The near absence of crustaceans in the top ten species and the low values of individuals and species indicate that these stations may be experiencing some moderate environmental stress.

6.4. DISCUSSION

Similar to the recent past, the infaunal community appears to be impacted most by inflows from Oxford Lagoon (Station 10) and Ballona Creek (Stations 2 and 12). Also similar to last year, results indicate that inputs to the Harbor from Venice Canal may also be affecting infauna to a lesser degree (Station 3). This group of stations tended to have comparatively high proportions of organisms that are common to sediment 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 are the samples from Stations 2 and 12, which had 15,000 and 4,000 (respectively) nematode worms, animals associated with stressful benthic environments.

Many other stations further back in the Harbor (6, 8, 9, and 11) yielded mixed results. While high as a group in diversity and dominance, they were low in individuals and species. Surprisingly, Station 1 near the entrance to the Harbor grouped with these back-harbor stations. This station is influenced both by Ballona Creek discharges and the open ocean, so it receives somewhat of mixed signal. Stations in mid-channel (4, 5, and 25) were the healthiest in the Harbor. None of the measures of environmental health were low here, and all had a high proportions of crustaceans, animals commonly associated with a healthy sediments.

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



Stations 2, 3, 7, 10, 12

High in:
Individuals
Species
--

Low in:
Diversity
Infaunal Index
Dominance

Dominants:
Mediomastus spp. (p)
Exogone dwisula (p)
Prionospio heterobranchia (p)
Pseudopolydora paucibranchiata (p)
Nematode (n) *
Oligochaeta (o) *
Dorvillea (Schistomeringos) annulata (p) *
Armandia brevis (p) *
Euchone limnicola (p)
Laevicardium substriatum (b)

Characteristics:
Relatively poor infaunal health. Four different species present which are indicative of a stressed benthic environment.

Station 5

High in:
Infaunal Index
--
--

Low in:
--
--
--

Dominants:
Euchone limnicola (p)
Pseudopolydora paucibranchiata (p)
Exogone dwisula (p)
Rudilemboides stenopropodus (c)
Zeuxo normani (c)
Lumbrineris sp.C (Harris) (p)
Mediomastus spp. (p)
Paranathura elegans (c)
Bathyleberis sp. (c)
Cossura candida (p)

Characteristics:
Generally healthy group.

Stations 4, 25

High in:
Species
--
--

Low in:
--
--
--

Dominants:
Pseudopolydora paucibranchiata (p)
Exogone dwisula (p)
Euchone limnicola (p)
Mediomastus spp. (p)
Prionospio heterobranchia (p)
Oligochaeta (o) *
Mayerella banksia (c)
Rudilemboides stenopropodus (c)
Phoronis sp. (ph)
Bathyleberis sp. (c)

Characteristics:
Generally healthy group.

Stations 1, 6, 8, 9, 11

High in:
Diversity
Dominance
--

Low in:
Individuals
Species
--

Dominants:
Exogone dwisula (p)
Mediomastus spp. (p)
Euchone limnicola (p)
Aphelochaeta multifilis (p)
Leitoscoloplos pugettensis (p)
Pseudopolydora paucibranchiata (p)
Lumbrineris sp.C (Harris) (p)
Phoronis sp. (ph)
Dorvillea (Schistomeringos) annulata (p) *
Mayerella banksia (c)

Characteristics:
Moderately healthy group with some evidence of 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.

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, numbers of individuals and species were higher, diversity was lower, and the infaunal index values were about the same. Higher diversity 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. With the exception of one particularly low dominance value at Station 1 and one particularly high infaunal index value at Station 5, all population variables this year were comparable to past surveys.

7. FISH POPULATIONS

7.1. BACKGROUND

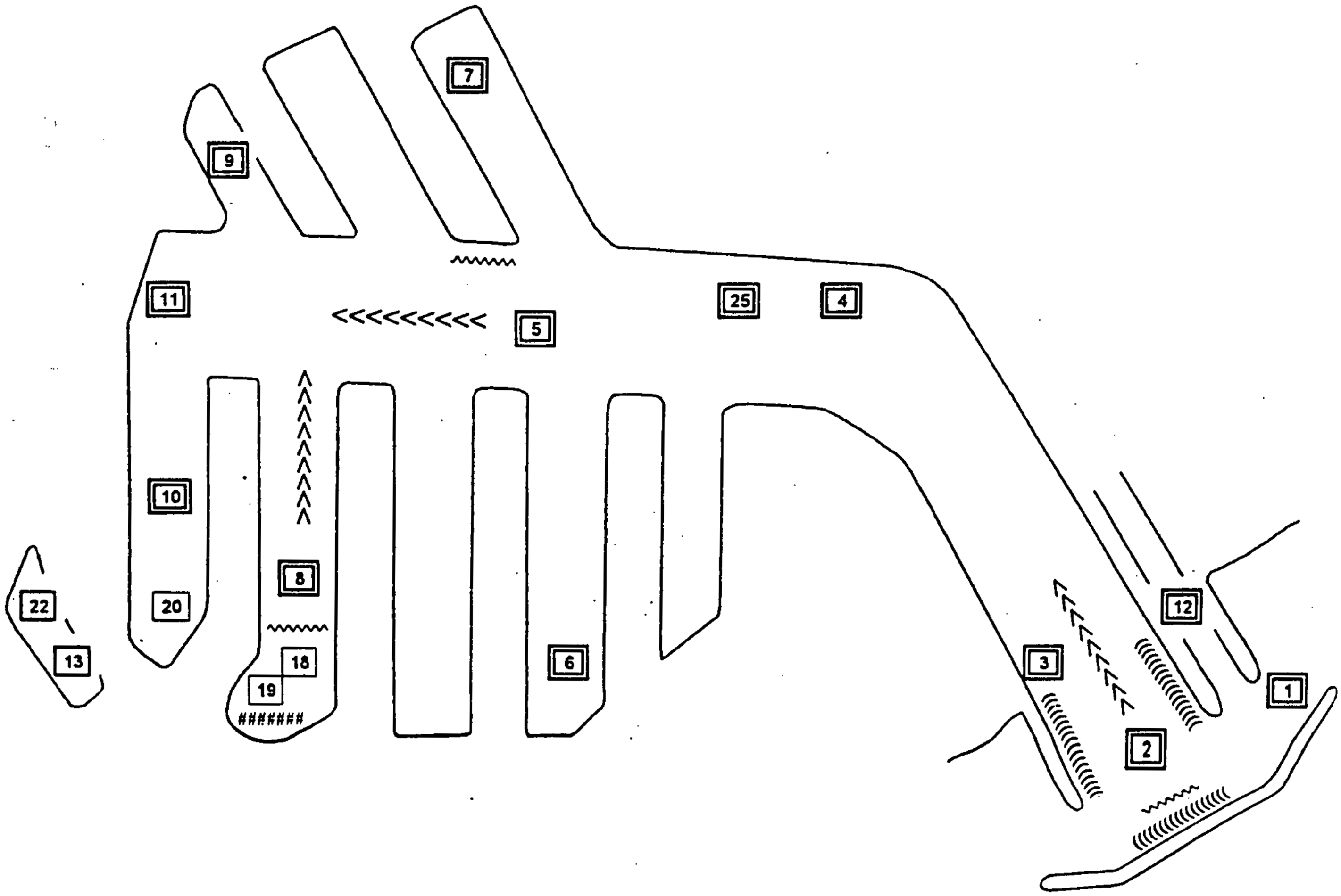
Marina del Rey functions as important small wetlands in a southern California area where about ninety percent of the wetlands have been lost due to development. While the original configuration of the Ballona wetlands was a large natural estuarine system, it was altered radically by the channelization of flow into a creek in the 1920s. Filling and dumping occurred to create farmlands 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 (Soule et al. 1996).

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. Dr. John S. Stephens, Jr., and his staff from the Vantuna Group at Occidental College continued them in 1980-81 on a voluntary basis. After a hiatus, the Vantuna Group in cooperation with the USC monitoring program for the Department of Beaches and Harbors resumed surveys in 1984 (Soule et al. 1996). Since 1996, Aquatic Bioassay of Ventura, California has conducted the surveys.

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. Due to low gill net catches, the deployment was extended to two hours in 1998.

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 were calculated (see Section 6.3.1.3). 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. Fish collections were conducted in the fall and in the spring

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 were 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 110 different species collected since 1984, six were present in all of the 32 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 eleven species have occurred frequently (more than 25 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*), senorita (*Oxyjulis californica*), California halibut (*Paralichthys californicus*), and spotted turbot (*Pleuronichthys ritteri*). These fish are found in the Harbor during both spring and fall seasons. They are characteristic of a wide range of habitat types and represent a diverse group of fish families.

7.3.1. Bottom Fish

Bottom fish were collected using a standard 5-meter headrope otter trawl. Fish were collected at three locations within the Harbor (Figure 7-1) on October 13, 1999 and May 18, 2000. At each station, replicate trawls of five minutes each were conducted. Data from replicate trawls were combined for analysis.

7.3.1.1. **Bottom Fish Abundance**

Spatial bottom fish abundance patterns. Numbers of bottom fish collected at the three sampling stations are listed in Table 7-2. The largest haul was in the spring at Station 8 in Basin D (124 individuals). The smallest catch was at Station 2 (in the lower main channel) in the fall (24 individuals). Total counts in the fall (158 individuals) were smaller than those in the spring (281).

TABLE 7-1. EGG, LARVAL, AND ADULT FISH TAXA COLLECTED DURING SPRING (Sp) AND FALL (Fl), 1984 TO PRESENT.

		84		85		86		87		88		89		90		91		92*		93		94		95		96		97		98		99			All	All	
SCIENTIFIC NAME	COMMON NAME	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Sp	Fl	Tot.
Acanthogobius flavimanus	Yellowfin Goby						x		x	x	x	x								x	x	x				x		x	x						7	6	13
Albula vulpes	Bonefish	x								x								x	x		x								x	x	x	x	x	x	6	5	11
Anchoa compressa	Deepbody Anchovy	x			x	x		x			x									x		x		x	x	x	x	x	x	x				x	10	6	16
Anchoa delicatissima	Slough Anchovy								x																		x	x		x	x	x	x	x	4	4	8
Anchoa sp.	Anchovy																											x				x			3	1	4
Anisotremus davidsoni	Sargo	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
Atherinidae	Silverside																													x					2	1	3
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	x	x	x	x	16	16	32
Atherinopsis californiensis	Jacksmelt					x	x	x	x			x										x	x			x	x	x		x		x		x	9	5	14
Atractoscion nobilis	White Seabass	x				x	x	x									x												x		x				4	5	9
Brachyistius frenatus	Kelp Surfperch																	x																	2	1	3
Bryx arctus	Snubnose Pipefish																										x								1	2	3
Cheilotrema saturnum	Black Croaker		x		x	x	x	x	x	x	x	x	x	x		x	x		x				x			x			x		x				8	12	20
Chitonotus pugetensis	Roughback Sculpin										x																								1	2	3
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		x	x	x	x	12	15	27
Citharichthys sp.	Sandab Egg																																		1	1	2
Citharichthys stigmaeus	Speckled Sandab	x						x					x												x	x	x	x	x			x			6	5	11
Citharichthys Type A	Sandab Larvae	x						x														x		x		x	x	x			x	x	x	x	8	3	11
Clevlandia ios	Arrow Goby	x				x	x	x		x			x		x									x		x		x	x	x					9	5	14
Clinocottus analis	Wooly Sculpin	x			x		x			x	x	x				x							x											x	5	5	10
Coryphopterus nichosii	Blackeye Goby							x				x								x															4	1	5
Cymatogaster aggregata	Shiner Surfperch		x			x		x				x	x	x	x	x		x	x	x		x		x		x		x		x		x		x	14	5	19
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			x	x	13	12	25
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	x	x	x	x	16	16	32
Engraulidae	Anchovy																										x	x					x	x	2	2	4
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			x	x	15	12	27
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	x	x	x	x	12	13	25
Genyonemus lineatus	White Croaker	x			x	x		x	x		x	x		x		x	x			x		x		x		x	x	x	x	x		x	x	x	14	7	21
Gibbonsia elegans	Spotted Kelpfish	x			x		x		x			x	x	x	x	x	x		x			x	x		x	x					x	x			8	11	19
Gillichthys mirabilis	Longjaw Mudsucker						x									x			x			x								x					4	3	7
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	x	x	x	x	16	16	32
Gobiesox rhessodon	California Clingfish				x	x		x				x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x	x	x	14	8	22
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			x	x	11	15	26
Gobiedae D	Goby																														x	x			2	2	4
Gobiedae non A/C	Goby																						x								x	x			2	3	5
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	x	x	x	x	15	15	30
Hermosilla azurea	Zebraperch		x		x		x				x	x			x			x		x	x	x	x			x	x	x	x	x	x	x	x	x	9	11	20
Heterodontus francisci	Horn Shark	x	x									x		x		x																			5	2	7
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		x	x	x	x	14	13	27
Hippoglossina stomata	Bigmouth Sole					x													x																2	2	4
Hyperprosopon argenteum	Walleye Surfperch		x			x											x																		2	3	5
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	x	x	x	x	16	16	32
Hypsoblennius gentilis	Bay Blenny				x	x	x		x																										2	4	6
Hypsoblennius gilberti	Rockpool Blenny						x														x								x		x	x			2	5	7
Hypsoblennius jenkinsi	Mussel Blenny	x	x					x		x		x									x		x				x								5	5	10
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		x	x	x	14	13	27
Hypsurus caryi	Rainbow Surfperch															x		x		x				x											5	1	6
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	x	x	x	x	15	14	29
Ilypnus gilberti	Cheekspot Goby	x	x			x	x	x		x				x	x	x												x							8	4	12
Kyphosidae	Zebraperch																						x												1	2	3
Lepidogobius lepidus	Bay Goby	x	x		x	x			x		x						x	x								x					x	x			6	7	13
Leptocottus armatus	Staghorn Sculpin					x	x	x		x		x	x	x		x	x	x	x				x			x	x	x					x		10	7	17
Leuresthes tenuis	California Grunion																											x		x					3	1	4
Medialuna californiensis	Halfmoon								x																				x	x	x				2	4	6
Menticirrhus undulatus	California Corbina					x	x		x	x		x				x						x		x				x		x	x	x		x	10	4	14
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		x	x	x	x	14	14	28
Mugil cephalis	Striped Mullet	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x			x	x		x				x	x		x	x		10	13	23
Mustelus californicus	Gray Smoothound																x	x							x								x		2	3	5
Mustelus henlei	Brown Smoothound								x															x				x			x	x			4	3	7
Mustelus sp.	Smoothound																	x																	2	1	3
Myliobatis californica	Bat Ray					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	11	24
Oligocottus/Clinocottus A	Sculpin												x				x																x		1	3	4
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		x	x	x	14	14	28
Oxylebius pictus	Painted Greenling				x									x																					2	2	4
Paraclinus integripinnis	Reef Finspot						x					x		x	x							x	x	x		x	x	x	x						7	6	13
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	x	x	x	x	16	16	32

TABLE 7-1. (CONTINUED)

Paralabrax maculatofasciatus	Spotted Sand	x	x		x	x	x	x	x			x	x	x	x	x		x													x	x			9	8	17
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	x	x	x	x	16	16	32
Paralabrax sp.	Sea Bass																									x	x							2	2	4
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	x	x	x	x	14	16	30
Perciformes	Perch																									x						x		1	2	3
Phanerodon furcatus	White Surfperch					x			x		x	x		x		x	x			x			x			x		x		x		x		x	10	5	15
Pleuronectidae**	Flatfish																			x		x			x		x	x						3	4	7
Pleuronichthys coenosus	C-O Turbot				x				x																									1	3	4
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		x	x	x	14	12	26
Pleuronichthys verticalis	Hornyhead Turbot					x			x					x		x											x	x			x	x	x	x	6	4	10
Porichthys myriaster	Specklefin Midshipman																															x		x	2	1	3
Quietula y-cauda	Shadow Goby	x				x	x	x		x		x	x	x		x												x	x						9	4	13
Raja binoculata	Big Skate																										x							2	1	3
Rhacochilus toxotes	Rubberlip Surfperch		x						x		x			x	x	x				x											x	x	x		5	6	11
Rhinobatos productus	Shovelnose Guitarfish	x																																		2	1	3
Sarda chilensis	Pacific Bonito	x	x				x		x																									2	4	6
Sardinops sagax caeruleus	Pacific Sardine	x	x		x	x	x	x	x	x		x			x	x		x	x	x		x	x						x		x	x		x	11	10	21
Scaenidae	Croaker																																		1	1	2
Scaenidae complex 2	Croaker							x			x			x														x			x				4	3	7
Scomberomorus sierra	Pacific Sierra																													x	x				2	2	4
Scorpaena guttata	Spotted Scorpionfish					x						x						x			x	x								x	x				6	3	9
Scorpaenichthys marmoratus	Cabezon	x										x	x			x																	x	x	4	2	6
Sebastes auriculatus	Brown Rockfish	x																																		2	1	3
Sebastes serranoides	Olive Rockfish	x			x	x			x	x	x		x			x																				5	5	10
Semicossyphus pulcher	California Sheepshead								x		x																							1	3	4
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	x			x	14	11	25
Sphyraena argentea	California Barracuda		x		x	x			x	x				x	x					x							x			x			x	5	7	12
Squatina californica	Pacific Angel Shark				x																										x	x			2	3	5
Stenobrachius leucopsaura	Northern Lampfish					x									x																				x	2	2	4
Strongylura exilis	California Needlefish		x			x		x			x		x	x	x		x	x		x	x	x	x	x		x	x		x		x		x		9	11	20
Symphurus atricauda	California Tonguefish		x																								x		x			x	x		2	4	6
Sygnathus auliscus	Barred Pipefish				x									x		x															x			x	3	3	6
Sygnathus leptorhynchus	Bay Pipefish	x						x	x			x			x																x	x			5	4	9
Synodus lucioceps	California Lizardfish										x																							1	2	3
Triakis semifaciata	Leopard Shark																										x							2	1	3
Type 32	Fish Larvae																										x	x	x			x	x	3	2	5
Type 71	Fish Larvae																											x	x	x	x			3	3	6
Typhlogobius californiensis	Blind Goby	x				x								x				x		x				x										x	7	1	8
Umbrina roncador	Yellowfin Croaker	x	x		x		x	x	x		x							x	x	x		x		x	x	x	x	x		x	x	x		x	11	10	21
Unidentified egg	Unidentified Egg																									x	x	x	x			x	x	3	3	6
Unidentified larvae	Unidentifed Larvae																										x			x	x	x	x	3	2	5
Urolophus halleri	Round Stingray	x					x	x		x		x				x	x	x		x				x		x		x		x		x	x	x	13	3	16
Xenistius californiensis	Salema		x						x				x		x						x		x				x		x		x	x			2	10	12
Xystreurys liolepis	Fantail Sole	x									x						x								x								x		2	4	6

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

** Unidentifiable turbot larvae.

At Station 2 near the breakwall, the California halibut (*Paralichthys californicus* – 13 individuals) was the most common fish collected in the fall, and the white croaker (*Genyonemus lineatus*) was most frequent in the spring (48 individuals). At Station 5 in the main channel, the slough anchovy (*Anchoa delicatissima*) was most common both in the fall (49 individuals) and in the spring (77 individuals). At Station 8 in Basin D, the slough anchovy (53 individuals) dominated the fall trawls, but the northern anchovy (*Engraulis mordax* - 94) was most common 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 ranged from 24 to 58 per station, which fell well within the overall range of values for past fall surveys. Spring counts ranged between 70 and 124 and were also typical.

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 8 in Basin D in May (10 species). The lowest species count was at the same station during the fall (5 species). Total species counts in the fall (10 species) were lower than those in the spring (13).

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 ranged from 5 to 6 species per station, which is typical of past ranges. The spring range of species counts (6 to 10) was also typical.

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 in the main channel in October (1.32). Lowest diversity was at Station 8 in Basin D, during the same season (0.41). Averaged among stations, diversity in the fall (0.97) was higher than in the spring (0.83).

Bottom fish diversity patterns compared with past years. Species diversity values ranged from 0.41 to 1.32 in the fall and from 0.54 to 1.02 in the spring (Table 7-6). Both ranges tended to be lower than those calculated for the past three years (note that species diversity calculations had not been performed previous to 1997). This is likely due to the unusually high abundances of slough anchovies in many catches.

7.3.2. Midwater Fish

A 32.8 m multimesh gill net was allowed to fish for about two hours 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).

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

		OCTOBER 1999 SAMPLING STATIONS			MAY 2000 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	#2	#5	#8	#2	#5	#8
Bottom Fish							
Anchoa delicatissima	Slough Anchovy		49	53		77	2
Anisotremus davidsoni	Sargo		8	2			
Atherinops affinis	Topsmelt						2
Cymatogaster aggregata	Shiner Surfperch				7		
Engraulis mordax	Northern Anchovy				10		94
Genyonemus lineatus	White Croaker				48		
Hypsopsetta guttulata	Diamond Turbot	3	2	1	1	2	1
Myliobatus californica	Bat Ray			1		2	17
Paralabrax nebulifer	Barred Sand Bass	5	3		3	3	1
Paralichthys californicus	California Halibut	13	10	1		2	3
Phanerodon furcatus	White Surfperch				1		
Pleuronichthys ritteri	Spotted Turbot	1					
Porichthys myriaster	Specklefin Midshipman						1
Symphurus atricauda	California Tonguefish	1					
Umbrina roncador	Yellowfin Croaker						2
Urolophus halleri	Round Stingray		4			1	1
Xystreurys liolepis	Fantail Sole	1					
	Individuals	**24**	**76**	**58**	**70**	**87**	**124**
	Species	**6**	**6**	**5**	**6**	**6**	**10**
	Diversity	**1.32**	**1.17**	**0.41**	**1.02**	**0.54**	**0.93**
Midwater Fish							
Sphyraena argentea	California Barracuda				1		
Strongylura exilis	California Needlefish			1			
	Individuals	**0**	**0**	**1**	**1**	**0**	**0**
	Species	**0**	**0**	**1**	**1**	**0**	**0**
	Diversity	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

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

		OCTOBER 1999 SAMPLING STATIONS			JUNE 2000 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	North Jetty	Breakwall	South Jetty	North Jetty	Breakwall	South Jetty
Reef Species							
Atherinops affinis	Topsmelt		98	43			743
Clinocottus analis	Wooly Sculpin				2		
Chromis punctipinnis	Blacksmith			13		2	1
Cymatogaster aggregata	Shiner Surfperch				81	8	113
Damalichthys vacca	Pile Surfperch	1	1	1	1		9
Embiotoca jacksoni	Black Surfperch	3	21	16	19	37	84
Girella nigricans	Opaleye	43	75	52	45	120	92
Halichoeres semicinctus	Rock Wrasse		16	4			1
Hermosilla azurea	Zebraperch	2	2		5	1	2
Heterostichus rostratus	Giant Kelpfish	2	1	1		1	3
Hypsopsetta guttulata	Diamond Turbot	1					
Hypsypops rubicundus	Garibaldi		3	1		20	1
Micrometrus minimus	Dwarf Surfperch	5		1	5	6	12
Oxyjulis californica	Senorita			2		1	3
Paralabrax clathratus	Kelp Bass		17	8		24	4
Paralabrax nebulifer	Barred Sand Bass		6	13	1	9	5
Phanerodon furcatus	White Surfperch						4
Rhacochilus toxotes	Rubberlip Surfperch		2	2			
Scorpaenicthys marmoratus	Cabezon		1	1	1		
Urolophus halleri	Round Stingray					1	
	Individuals	**57**	**243**	**158**	**160**	**230**	**1077**
	Species	**7**	**12**	**14**	**9**	**12**	**16**
	Diversity	**0.96**	**1.60**	**1.88**	**1.32**	**1.56**	**1.12**

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. Fish collected in gill nets were particularly small this year, with only one fish each collected per season. At Station 8 in Basin D, one California needlefish was collected in the fall, and at Station 2 along the breakwall, one barracuda (*Sphyraena argentea*) was captured in the spring.

Gill net sampling for relatively short periods of time are very inefficient because they are passive. Catches are usually either very small or very large, in the case when a school of fish encounter the net.

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 both October and May ranged from 0 to 1 individuals per station, which was low but not atypical of surveys.

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. At Station 8 in Basin D, one California needlefish was collected in the fall, and at Station 2 along the breakwall, one barracuda was captured in the spring. No fish were collected in the remaining casts.

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. Species counts for both fall and spring (0 to 1 species) were low but not unusual for these passive gill net catches.

7.3.2.3. **Midwater Fish Diversity**

Spatial midwater fish diversity patterns. Species diversity from the three gill net sampling stations is listed in Table 7-2. Since, at most, only one fish was collected per station, diversity values for all locations and seasons were 0.00.

Midwater fish diversity patterns compared with past years. The species diversity value this year (0.00) was very low but not unheard of since 1996 (Table 7-6).

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.

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

		OCT. 1999 SAMPLING STATIONS						MAY 2000 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									5			
Citharichthys type A	Sandab	7			4			60	23	5	34		
Engraulidae	Anchovy		9					151	476		50		
Engraulis mordax	Northern Anchovy	7	13					196	3047		34		
Genyonemus lineatus	White Croaker	7	56		4				8				
Gobiedae type A/C	Goby	128	325	310	1215	1031	763	60	1595	184	2078	212	154
Gobiesox rhessodon	California Clingfish								15				
Hypsoblennius sp.	Blenny	14	26	517	490	485	176	65	476	170	4257	101	162
Hypsopops rubicundus	Garibaldi								23				
Hypsopsetta guttulata	Diamond Turbot					30				5			
Menticirrhus undulatus	California Corbina										8		
Oligocottus	Sculpin				4								
Paraclinus integrippinis	Reef Finspot							10			17	10	
Paralichthys californicus	California Halibut								8		17		
Pleuronichthys ritteri	Spotted Turbot								15				
Pleuronectiformes	Turbot			7									
Seriphus politus	Queenfish								8				
Stenobrachius leucopsarus	Northern Lampfish								8				
Sygnathus sp.	Pipefish								8				
Typhlogobius californiensis	Blind Goby								38				
Unidentified	Unidentified	14	61		13		31	55	30	5	25		
	Individuals	**177**	**490**	**834**	**1730**	**1546**	**970**	**697**	**6778**	**374**	**6520**	**323**	**316**
	Species	**6**	**6**	**3**	**6**	**3**	**3**	**7**	**15**	**6**	**9**	**3**	**2**
	Diversity	**1.02**	**1.11**	**0.70**	**0.68**	**0.71**	**0.61**	**1.70**	**1.28**	**0.94**	**0.80**	**0.75**	**0.69**
Fish Eggs													
Anchoa compressa	Deepbody Anchovy										8	10	
Anchoa delicatissima	Slough Anchovy							75	53	1436	712	3030	145
Atherinops affinis	Silverside							5	8	5	8		68
Engraulis mordax	Northern Anchovy	14	13		4		4	282	968		25		
Pleuronichthys ritteri	Spotted Turbot	28	4					15	15				
Pleuronichthys verticalis	Horneyhead Turbot	14						25	45				
Sardinops sagax caeruleus	Pacific Sardine							5					
Type 32	—	1965	935	22	43			946	1792		218		
Unidentified	Unidentified	2214	1797	140	65	2236	1332	2374	1247	369	1634	263	26
	Individuals	**4235**	**2749**	**162**	**112**	**2236**	**1336**	**3727**	**4128**	**1810**	**2605**	**3303**	**239**
	Species	**5**	**4**	**2**	**3**	**1**	**2**	**8**	**7**	**3**	**6**	**3**	**3**
	Diversity	**0.77**	**0.68**	**0.40**	**0.80**	**0.00**	**0.02**	**0.98**	**1.20**	**0.62**	**0.93**	**0.30**	**0.90**

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

SCIENTIFIC NAME	COMMON NAME	OCTOBER 1999	MAY 2000[1]
Beach Seine Species			
Albula vulpes	Bonefish	3	27
Anisotremus davidsoni	Sargo	2	
Atherinops affinis	Topsmelt	221	13
Fundulus parvipinnis	California Killifish	2	1
Leptocottus armatus	Staghorn Sculpin	1	
Mugil cephalus	Striped Mullet	1	
Mustelus californicus	Gray Smoothound	4	
Sphyraena argentea	California Barracuda		1
Umbrina roncador	Yellowfin Croaker		11
	Individuals	**234**	**42**
	Species	**7**	**4**
	Diversity	**0.307**	**0.825**

1. Over 1000 jellyfish (*Aurelia aurita*) captured in May beach seine.

7.3.3.1. **Inshore Fish Abundance**

Spatial inshore fish abundance patterns. Numbers of inshore fish collected along the shoreline of Mother's Beach (Station 9) are listed in Table 7-5. More fish were captured in the fall (234 individuals) than in the spring (42 individuals). Topsmelt (*Atheriops affinis*) dominated fall counts (221 individuals), and bonefish (*Albula vulpes*) were most abundant in the spring (27 individuals). Other fish counts ranged from 1 to 13 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 (234 individuals) were typical of past counts; however, spring counts (42) were much lower. In May, over 1000 jellyfish (*Aurellia aurita*) were captured in the beach seine along with the 42 fish. The presence of these jellyfish in such high numbers likely accounts for the low fish abundance.

7.3.3.2. **Inshore Fish Species**

Spatial inshore fish species patterns. Numbers of inshore fish collected at Mothers' Beach are listed in Table 7-5. More species of fish were collected in the fall (7 species) than in the spring (4 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 (7 species) were typical of past fall counts; however, spring counts (4) were lower than those of the past. As discussed above, a large concentration of jellyfish in the area likely caused a decline in species counts during the spring.

7.3.3.3. **Inshore Fish Diversity**

Spatial inshore fish diversity patterns. Species diversity calculated for Mother's Beach are listed in Table 7-5. Species diversity values during spring (0.83) were considerably higher than in the fall (0.31). The overwhelming dominance of topsmelt in the catch was responsible for the relatively low value in October.

Inshore fish diversity patterns compared with past years. The species diversity value this fall was slightly lower than the past minimum, while values in the spring tended to be higher than the past maximum. Species diversity values were not calculated previous to 1997.

TABLE 7-6. RANGES IN NUMBERS OF ALL INDIVIDUALS AND SPECIES OF FISH JUVENILES AND ADULTS COLLECTED: OCT 1991 - MAY 2000

	BOTTOM FISH			MIDWATER FISH			INSHORE FISH			REEF FISH		
DATE	Individuals	Species	Diversity	Individuals	Species	Diversity	Individuals	Species	Diversity	Individuals	Species	Diversity
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	0.64 - 2.15	0 - 26	0 - 1	0.00 - 0.00	1791	8	0.42	128 - 1862	9 - 12	0.57 - 1.93
Oct-97	13 - 69	4 - 9	0.80 - 1.80	0 - 2	0 - 2	0.00 - 0.69	646	8	0.56	165 - 5353	7 - 15	0.24 - 1.13
Sep-98	21 - 62	5 - 11	1.44 - 1.84	4 - 11	2 - 3	0.30 - 1.04	1091	12	0.35	145 - 512	10 - 14	1.24 - 1.95
Fall Range	**0 - 415**	**0 - 10**	**0.64 - 2.15**	**0 - 77**	**0 - 3**	**0.00 - 0.69**	**213 - 1791**	**4 - 8**	**0.35 - 0.56**	**1 - 5353**	**1 - 19**	**0.24 - 1.93**
Oct-99	24 - 58	5 - 6	0.41 - 1.32	0 - 1	0 - 1	0.00 - 0.00	234	7	0.31	57 - 243	7 - 14	0.96 - 1.88
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	1.48 - 1.91	0 - 6	0 - 3	0.00 - 0.60	1066	11	0.42	2169 - 7267	5 - 9	0.07 - 0.19
May-98	20 - 147	6 - 13	1.51 - 2.01	0 - 18	0 - 2	0.00 - 0.64	2145	9	0.42	24 - 150	2 - 10	0.56 - 1.88
May-99	18 - 75	6 - 8	0.68 - 1.89	11 - 373	1 - 6	0.00 - 0.37	1884	10	0.65	21 - 163	4 - 10	0.69 - 2.03
Spring Range	**1 - 147**	**1 - 13**	**1.48 - 2.01**	**0 - 63**	**0 - 5**	**0.00 - 0.64**	**351 - 8165**	**6 - 11**	**0.42 - 0.65**	**0 - 7267**	**0 - 16**	**0.07 - 1.88**
Jun-00	70 - 124	6 - 10	0.54 - 1.02	0 - 1	0 - 1	0.00 - 0.00	42	4	0.83	160 - 1077	9 - 15	1.12 - 1.56

TABLE 7-7. RANGES IN NUMBERS OF INDIVIDUALS AND SPECIES OF FISH LARVAE AND EGGS COLLECTED: OCT. 1991 - MAY 1999

	LARVAL FISH			FISH EGGS		
DATE	Individuals	Species	Diversity	Individuals	Species	Diversity
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	0.71 - 1.20	36 - 1052	1 - 5	0.00 - 0.81
Oct-97	56 - 2693	2 - 5	0.38 - 0.87	0 - 545	0 - 9	0.00 - 1.40
Sep-98	112 - 1680	2 - 9	0.50 - 0.76	89 - 3316	1 - 4	0.00 - 0.89
Fall Range	**56 - 16,143**	**1 - 8**	**0.38 - 1.20**	**0 - 12,252**	**1 - 9**	**0.00 - 1.40**
Oct-99	177 - 1730	3 - 6	0.61 - 1.11	112 - 4235	1 - 5	0.00 - 0.80
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	0.79 - 1.63	10,094 - 58,297	4 - 6	0.14 - 1.50
May-98	40 - 2820	2 - 5	0.42 - 0.91	16 - 1318	1 - 5	0.00 - 0.93
Spring Range	**40 - 64,408**	**2 - 15**	**0.42 - 1.63**	**0 - 58,297**	**0 - 6**	**0.00 - 1.50**
Jun-00	316 - 6520	2 - 15	0.69 - 1.70	239 - 4128	3 - 8	0.30 - 1.20

7.3.4. Reef Fish

Divers counted reef fish during three 100-meter swimming underwater transects along the middle of the breakwall and along the north and south jetties near the harbor entrance on October 15, 1999 and June 21, 2000. 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). Note that, due to poor water visibility in May, dive surveys were delayed till June.

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 June (1077 individuals), and lowest counts were at the north jetty in the fall (57 individuals). Overall, counts in June (1467 individuals) were about three times higher than those in October (458 individuals).

Topsmelt (*Atherinops affinis*) were most common at the breakwall in the fall (98 individuals) and dominated counts at the south jetty in June (743 individuals). Opaleye (*Girella nigricans*) were most common at both north (43 individuals) and south jetties (52 individuals) in the fall, and at the breakwall (120 individuals) in June. Other common fish observed included shiner surfperch (*Cymatogaster aggregata*) and black surfperch (*Embiotoca jacksoni*).

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 ranged from 57 to 243 individuals per station, which falls within the range of autumn surveys. The June range of individuals per station (160 to 1077) was also 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 in June at the south jetty (15 species), and the lowest species count was at the north jetty during the fall (7 species). Fall species counts (16 species) were about the same as those in the spring (18 species).

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 ranged from 7 to 14 species per station, which is typical of past surveys. The spring range of species counts (9 to 15) was also typical.

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 south jetty in the fall (1.88), and lowest diversity was at the north jetty also in the fall (0.96). Overall, average diversity in the fall (1.48) was slightly higher than in the spring (1.33).

Reef fish diversity patterns compared with past years. The range of species diversity values this fall (0.96 to 1.88) and spring (1.12 to 1.56) were typical of values recorded over the last three years (Table 7-6). 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 on October 13, 1999 and May 18, 2000. A 333 um mesh plankton net was deployed at 1.0 m below the surface for two minutes and near the bottom for three minutes. A benthic sled kept the net above the bottom regardless of irregularities in bottom surface.

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 near the bottom in midchannel in the spring (6520 individuals). Smallest catches were at the surface in the lower channel in the fall (177 individuals). Total counts in the spring (13,908 individuals) were considerably larger those in the fall (5747). As in the past, total surface counts (3851 individuals) were much lower than bottom counts (15,804). Note that all counts are standardized to numbers per 1000 cubic meters.

Both fall and spring 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*)) and blennies (*Hypsoblennius spp.*). Anchovies (Engralidae and *Engraulis mordax*) were also sporadically abundant.

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 ranged from 177 to 1730 individuals, which was typical of past years. The spring range of individuals per station (316 to 6520) was also typical.

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. The highest species count was near the bottom at the breakwall in the spring (9 species), and the lowest was also in spring near the bottom in Basin D (2 species). Overall species collected in the fall (10 species) were about half those collected in the spring (19). As usual, average species counts at the surface (4) were smaller than those at the bottom (7).

Larval fish species patterns compared with past years. Table 7-7 lists the ranges of larval fish species counted per station since October 1991. Both fall and spring ranges (3 to 6 and 2 to 15, respectively) were typical of past surveys.

7.3.5.3. **Larval Fish Diversity**

Spatial larval fish diversity patterns. Species diversities calculated from the three plankton sampling stations are listed in Table 7-4. Lowest diversity was near the bottom in Basin D in October (0.61), and highest diversity was at the surface near the breakwall in spring (1.70). Averaged among stations, diversity in the fall (0.81) was higher than in the spring (0.37). Average surface and bottom diversities (0.97 and 0.86) were similar.

Larval fish diversity patterns compared with past years. The species diversity ranges this fall (0.61 to 1.11) and spring (0.69 to 1.70) were typical of measurements made during the past three years. 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 on October 13, 1999 and May 18, 2000. 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 numbers were counted near the surface at the breakwall in fall (4235 individuals). Lowest catches were near the bottom in mid-channel in the fall (112 individuals). Total counts in the spring (15,812 individuals) were larger than those in the fall (10,830), and total counts at surface (15,473 individuals) were larger than at the bottom (11,169). Note that all counts are standardized to numbers per 1000 cubic meters. Anchovy (*Engraulis mordax* and *Anchoa delicatissima*) were most commonly caught in the spring, and several unidentified egg species were commonly taken during both seasons.

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 ranged from 112 to 4235 individuals per station, and counts in the spring ranged from 239 to 4128. Both were typical of past surveys.

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 near the breakwall in May (8 species), and the lowest species count was near the surface in Basin D in October (1 species). Species counts in the fall (5 species) were about half those in the spring (9). Averaged numbers of species per sample at the surface (3) were smaller than those caught near the bottom (5).

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 ranged from 1 to 5 species per sample, which is typical. The spring range of species counts (3 to 8) was somewhat higher than past counts.

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 (1.20). The lowest diversity was near the surface in Basin D in September (0.00). Averaged among samples, diversity in the spring (0.81) was considerably higher than in the fall (0.45). Average surface diversity (0.50) was lower than bottom diversity (0.76).

Fish egg diversity patterns compared with past years. Both fall (0.00 to 0.80) and spring (0.30 to 1.20) diversity ranges were typical of surveys for the past three years. Diversity values had not been calculated previous to 1996.

7.4. DISCUSSION

Marina del Rey Harbor continues to serve as a viable habitat and nursery for many species of marine fish. To date, 110 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 48,937 total fish of all age groups (including larvae and eggs) representing 57 different species. By far, 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 both fall and spring surveys, trawl counts were typical of past years. No one area had persistently larger trawls, more species, or greater diversity than did any other. Diamond turbot, California halibut, and barred sand bass, which are prized by both commercial and sport fishermen, were present in nearly every trawl. Overall, fall catches had smaller individual and species counts than spring counts, although diversities tended to be greater.

Midwater gill net sampling continues to be of limited use. Since the technique is passive, capture relies on the hit-or-miss chance of animals swimming into the net. Despite tripling the deployment time from two years ago (to about two hours), only one California needlefish was captured along the breakwall in the fall, and one barracuda was captured at the same location in the spring.

Inshore fish were collected by beach seine at Mother's Beach. Both numbers of individuals and species in the fall were typical, however, spring counts were much lower than during past surveys. The likely reason for this was the presence of a huge swarm of jellyfish (over one thousand) captured in the net. It is likely that with so many of these relatively large invertebrates in the water column, most fish just avoided the area. As in several past surveys, topsmelt dominated in the fall and bonefish were most abundant in the spring. Bonefish are a common tropical species, so they probably prefer the warmer spring waters in Basin D (Eschmeyer, et.al. 1983).

Reef associated fish were enumerated and identified by diver-biologists along both jetties and the breakwall. Poor underwater visibility in May delayed the survey into June this year. Numbers of fish, numbers of species, and diversity values during this survey were typical of most past surveys. Topsmelt, opaleye, shiner surfperch, and black surfperch were most commonly observed. Overall, counts in June were about three times higher than those in the fall. The majority of the June counts (about 70%), however, were composed of a large school of topsmelt at the south jetty. Because the north jetty was somewhat sanded in, both individual and species counts were lower there than at the breakwall or south jetty.

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 typical of past surveys. Deeper tows usually contained larger populations of fish larvae but smaller egg counts 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. For both larval fish and egg counts, spring abundance was greater than fall abundance. Gobies dominated larval counts, and anchovies and several unidentified fish were most common among eggs.

The sampling methods used in Marina del Rey differ somewhat from those of other southern California surveys (i.e. L.A. Harbor, SCCWRP), so fish population characteristics cannot be easily compared. However, it is obvious 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 is both an important commercial and recreational facility for southern California. 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.

The water quality of Marina del Rey Harbor is impacted both temporally and spatially. Temporal impacts included both weather and oceanographic influences. This year's weather was similar to last year and was characterized by cooler water and low rainfall. Thus winter and spring rains had a smaller influence upon Harbor waters when compared to other, rainier years. Regardless, winter and spring precipitation tended to lower water clarity, salinity, and pH and increased ammonia, bacterial counts, and possibly biochemical oxygen demand (BOD) throughout the Harbor. The influence upon the phytoplankton community was generally limited to the spring. Phytoplankton blooms, in turn, can subsequently raised dissolved oxygen values, and their death can increase biochemical oxygen demand later in the spring. As with last year, little evidence of either high dissolved oxygen or BOD in the spring was evident. No red tide blooms were observed this year, although water clarity was sufficiently reduced in May to delay the dive surveys until June. As expected, seasonal temperature changes in the ocean impacted the Harbor, causing colder water in the winter and warmer water in the summer and fall.

The Harbor is spatially impacted by the discharges of Oxford Lagoon and Ballona Creek, as well as the open ocean. Stations near the Harbor entrance are influenced by both the open ocean and Ballona Creek. The open ocean influence included relatively low temperatures and moderately high dissolved oxygen and pH. The Ballona Creek influences included lower salinity and water clarity and high ammonia, BOD, and bacterial counts. In addition, water here tended to be more yellow-brown in color, rather than blue-green. For nearly every monthly survey, a lens of lower saline water was measured at the surface at stations downcurrent of Ballona Creek.

Stations in the lower main channel were most like the open ocean and were thus the most natural in the Harbor. These stations were characterized by high dissolved oxygen, pH, and water clarity and low values of ammonia, BOD, and bacteria. Water here was generally green to blue-green. As always, the areas further back into the Marina were warmer, more saline, lower in dissolved oxygen, etc.

Unlike discharges from Ballona Creek, the open ocean does not ameliorate discharges from Oxford Lagoon. Flows from Oxford Lagoon affected Basin E and the upper end of the main channel, which included reduced water clarity, dissolved oxygen, and salinity and elevated levels of ammonia, BOD, and bacteria. Similar to last year, Basin D, which includes Mother's Beach, appeared less affected by surface runoff than in the recent past. Slightly lower values in salinity, water clarity, and pH suggests that there may be a small freshwater input into Basin F (Station 9).

Bacterial measurements were made monthly at 18 stations (648 measurements in the year). Total coliform limits were exceeded 27 times, fecal coliform limits 35 times, and enterococcus limits 22 times. The total exceedances (84) were down from last year's numbers (104 exceedances). Among these 84 exceedances, 77 (92%) can be attributable to flows from either Ballona Creek or Oxford Lagoon. With the exception of total coliforms in the fall, the frequency of exceedances was within the range of the past eight years.

Similar to last year, physical characteristics of Harbor sediments (median particle size and sorting) were influenced by energy of water flow that is influenced by Harbor configuration and rainfall intensity. As in the past, the affect of current and wave action near the entrance created sediments that were universally coarse and narrow in range. Higher water velocity tends to move finer particles offshore and leave sand behind. Also typical was the finer, heterogeneous mix of sediments in the back bay areas. 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. Sediments in Oxford Lagoon had characteristics that were primarily sand but had a wide range of sediment types, unlike the Harbor entrance. This suggests the flow regime in these areas is intermittent. Far to the northwest in Basin F, the sediment regime was very fine and, atypically, very narrow. This may indicate that no coarse material is getting to this area at all.

Similar to past years, the 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.

Ballona Creek and, to a lesser degree, Oxford Lagoon appear to be sources of chlorinated hydrocarbons such as DDT and derivatives and other chlorinated pesticides. The presence of DDT itself, which was present only near Ballona Creek, indicates either a fresh source or fresh exposure of this compound to Harbor sediments. Typically, PCB's were below detection this year. Among chlorinated hydrocarbons listed as toxic by NOAA, 13 of 15 Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 2 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. These ratios are considerably improved over last year when all stations showed "potential" toxicity, and 7 stations were considered "probably" toxic. Encouragingly, most chlorinated compounds have continued to remain lower than historical values, and levels are much lower those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Heavy metals tended to be higher in the main channel and Basin F. Their source is most likely the resident boat population itself. Metal components of boats are constantly being corroded by seawater, and most bottom paints contain materials, such as copper or tributyl tin complexes, which are designed to continuously ablate off into the sediment. All stations, except Station 1 at the Harbor entrance, exceeded at least one metal limit of "possible" toxicity, and 8 out of 15 exceeded at least one metal limit of "probable" toxicity. In general, despite a fair degree of variability, metal concentrations in Marina del Rey sediments do not appear to have greatly increased or decreased since 1985.

Levels of copper, lead, mercury, and zinc in Marina del Rey were about three to five 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.

Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals. 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 leakage from resident boats are a likely contributor, as well. When measured, nonspecific organic compounds tended to be similar to those measured offshore.

Infaunal 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, except possibly higher levels of chlorinated hydrocarbons associated with Oxford Lagoon and Ballona Creek. Overall, infaunal variables were mostly comparable to past results.

Stations most modified appear to be Station 10 in Basin E just downstream of Oxford Lagoon, Station 12 in Ballona Creek, Station 2 near the Harbor entrance (and likely impacted by Ballona Creek), and Station 3 at the entrance of Venice Canal, however, none of these stations were defined by the Southern California Coastal Water Research Project's infaunal trophic index as a either a "degraded" or "changed" benthic environment. Nematode worms that are known to be characteristic of highly disturbed benthic sediments dominated sediments from Station 12 (3,692 individuals) and Stations 2 (15,467 individuals). Because of the huge nematode counts at Station 2, total infaunal abundance here (16,933 individuals) was the highest in the Harbor. Nematode counts at Station 10 in Basin E (1,573 individuals) were also moderately high.

Relative to past years, abundance and species diversity values at the remaining stations were comparable. Mid-channel stations (4, 5, and 25) were the healthiest in the Harbor, with moderate to high values for all population parameters, and a high diversity of crustacean species, which are known to be sensitive to chemical pollutants. When compared to Los Angeles Harbor, Marine del Rey abundances were higher (probably due to the huge numbers of nematodes collected at some stations), as were numbers of species. Infaunal index values were about the same, and diversity 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.

48,937 total fish of all age groups, representing 57 different species were recorded. The majority of these were eggs, larvae, or juveniles, which attest to the Harbor's importance as a nursery. In general, abundance and species counts were typical of past years for all strata of fish. Most catches were typical of past hauls. The exception was the seine at Mother's Beach in the spring. During this beach sampling, over 1000 jellyfish were captured in the net, which greatly reduced the fish count. The fall haul had no jellyfish, and fish counts were normal. Our gill net sampling continues to only catch an occasional wayward fish, except when a whole school of topsmelt or jacksmelt encounter the net. Since gill net sampling is passive, it is less efficient than fish trawls, plankton seines, dive surveys, or beach seines. This coming year, we will attempt to try some midwater trawls in addition to the gill net sampling in order to see if we can augment the capture of midwater fish.

9. APPENDICES

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9.2. WATER QUALITY DATA AND CRUISE LOGS

Physical Water Quality Data **July 21, 1999**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	534	3.2
RAIN:	None	M. Meyer	Low	1045	2.0

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	1031	0	22.05	30.74	7.47	8.38	44.71	81.8	11	2.6	< 0.01	2.7
8k SW		1	21.63	31.91	7.54	8.38	47.99	83.2				
		2	20.65	33.12	7.77	8.35	53.97	85.7			< 0.01	2.2
		3	19.61	33.70	7.99	8.34	60.95	88.4				
2	1016	0	21.70	31.56	7.24	8.36	58.01	87.3	10	2.6	< 0.01	2.1
8k SW		1	21.79	32.71	7.27	8.35	56.36	86.6				
		2	21.25	33.16	7.31	8.34	54.45	85.9			< 0.01	1.9
		3	19.54	33.66	7.65	8.32	54.93	86.1				
		4	19.42	33.61	7.52	8.31	54.46	85.9			< 0.01	1.8
3	1005	0	22.39	33.46	6.26	8.22	56.53	86.7	10	2.5	0.01	1.5
8k SW		1	22.41	33.48	6.36	8.26	53.76	85.6				
		2	22.37	33.45	6.55	8.24	53.98	85.7			< 0.01	1.7
		3	21.90	33.76	6.59	8.25	49.97	84.1				
4	1055	0	23.24	33.53	6.69	8.24	60.00	88.0	10	3.2	< 0.01	1.7
8k SW		1	23.24	33.52	6.76	8.24	59.73	87.9				
		2	23.22	33.46	6.90	8.24	58.93	87.6			< 0.01	1.3
5	935	0	23.35	33.49	6.02	8.22	63.28	89.2	12	2.6	0.01	1.6
6k SW		1	23.37	33.43	6.23	8.22	64.27	89.5				
		2	23.16	33.40	6.24	8.22	56.65	86.8			< 0.01	1.2
		3	22.89	33.19	6.32	8.21	50.44	84.3				
		4	21.88	33.21	6.53	8.23	46.07	82.4			< 0.01	1.5
		5	21.00	33.67	6.65	8.23	41.79	80.4				
6	946	0	22.91	33.44	6.16	8.25	65.25	89.9	10	4.0	0.01	1.2
6k SW		1	22.90	33.48	6.20	8.25	65.48	90.0				
		2	22.77	33.53	6.65	8.25	63.45	89.2			< 0.01	1.0
		3	22.72	33.49	7.00	8.23	63.86	89.4				
		4	22.20	33.78	6.80	8.18	55.57	86.3			< 0.01	1.0
7	1115	0	23.43	33.54	6.51	8.23	53.12	85.4	12	2.4	< 0.01	1.5
8k SW		1	23.37	33.51	6.47	8.23	51.16	84.6				
		2	23.32	33.50	6.43	8.23	49.73	84.0			< 0.01	1.4
		3	23.23	33.14	6.33	8.23	49.04	83.7				
		4	22.13	33.53	6.64	8.16	44.64	81.7			< 0.01	1.3
8	826	0	23.15	33.48	7.00	8.17	59.71	87.9	10	2.7	0.02	1.2
4k SE		1	23.14	33.48	6.86	8.17	58.81	87.6				
		2	23.07	33.49	6.41	8.17	54.77	86.0			< 0.01	1.1
		3	22.86	33.56	6.49	8.17	51.25	84.6				
		4	22.59	33.74	6.52	8.13	37.62	78.3			< 0.01	1.0

July 21, 1999 **(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	922	0	23.35	32.64	5.96	7.96	51.49	84.7	10	3.2	0.06	1.3
4k SE		1	23.45	33.07	6.02	8.00	48.22	83.3				
		2	23.31	33.16	5.87	8.08	47.79	83.1			0.02	1.3
		3	22.73	33.33	5.72	8.08	37.81	78.4				
		4	22.34	33.51	5.92	8.07	29.01	73.4			0.02	1.4
10	856	0	23.26	33.29	4.89	8.05	56.81	86.8	14	2.6	0.08	1.0
4k SE		1	23.25	33.30	4.93	8.05	51.46	84.7				
		2	23.23	33.33	4.97	8.05	46.54	82.6			0.06	1.1
		3	23.18	33.31	4.85	8.05	44.17	81.5				
		4	22.85	33.35	4.92	8.04	45.31	82.0			0.06	1.1
11	910	0	23.34	33.34	6.01	8.11	67.37	90.6	10	3.2	0.06	1.8
4k SE		1	23.33	33.34	5.88	8.11	66.91	90.4				
		2	23.20	33.40	5.36	8.12	65.71	90.0			0.03	0.8
		3	22.93	33.41	5.35	8.14	56.61	86.7				
		4	22.28	33.73	5.51	8.18	45.42	82.1			0.02	1.0
12	1039	0	23.51	25.24	8.00	8.49	34.11	76.4	14	2.4	0.02	3.8
8k SW		1	23.16	29.04	7.96	8.44	33.68	76.2				
		2	21.29	33.19	8.27	8.26	42.21	80.6			0.02	2.7
13	935	0	23.08	33.08	4.00	8.00					0.06	4.3
18	815	0	23.03	33.51	6.11	8.17	57.64	87.1	10	2.5	0.02	1.1
4k SE		1	23.02	33.52	6.27	8.17	57.45	87.1				
		2	22.98	33.54	6.30	8.17	57.45	87.1			0.01	1.0
19	753	0	21.89	33.77	5.58	8.13					0.03	1.1
20	846	0	23.08	32.62	4.42	7.93	54.11	85.8	13	1.9	0.09	3.2
4k SE		1	23.16	32.89	4.76	7.96	55.01	86.1				
		2										3.5
22	720	0	23.42	32.85	3.60	7.77					0.04	4.7
25	1103	0	23.32	33.52	7.05	8.22	61.67	88.6	12	2.5	0.01	1.0
8k SW		1	23.30	33.50	7.12	8.23	61.94	88.7				
		2	23.20	33.48	7.31	8.22	63.41	89.2			< 0.01	1.1
		3	23.06	33.35	7.14	8.21	63.23	89.2				
		4	22.14	33.19	7.08	8.20	59.52	87.8			< 0.01	1.3
		5	20.99	33.61	7.35	8.20	39.34	79.2				
	Average		22.60	33.12	6.39	8.19	53.43	85.26	11.2	2.7	0.02	1.7
	Number		69	69	69	69	66	66	15	15	41.00	42.0
	St. Dev.		0.95	1.19	0.96	0.12	8.71	3.71	1.5	0.5	0.02	0.9
	Maximum		23.51	33.78	8.27	8.49	67.37	90.60	14	4.0	0.09	4.7
	Minimum		19.42	25.24	3.60	7.77	29.01	73.39	10	1.9	0.01	0.8

Surface Bacteriological Water Data and General Observations **July 21, 1999**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	534	3.2
RAIN:	None	M. Meyer	Low	1045	2.0

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1031	< 20	< 20	< 2	Moderate turbidity.
2	1016	20	< 20	< 2	Moderate turbidity.
3	1005	< 20	< 20	< 2	Moderate turbidity.
4	1055	, 20	< 20	< 2	Moderate turbidity.
5	935	20	< 20	< 2	Moderate turbidity.
6	946	20	20	< 2	Moderate turbidity.
7	1115	< 20	20	< 2	Moderate turbidity.
8	826	< 20	< 20	< 2	Moderate turbidity.
9	922	< 20	< 20	< 2	Moderate turbidity.
10	856	3000	3000	21	Moderate turbidity. Bottom stirred up by large boat.
11	910	120	120	< 2	Moderate turbidity.
12	1039	70	50	< 2	Moderate turbidity. Fishermen on jetty.
13	935	16000	1700	60	Moderate turbidity. Trash around the gate.
18	815	50	50	< 2	Moderate turbidity. School of large fish.
19	753	< 20	< 20	< 2	Moderate turbidity. Three swimmers.
20	846	≥ 16000	≥ 16000	240	Moderate turbidity. School of small fish.
22	720	≥ 16000	2400	40	Moderate turbidity.
25	1103	60	< 20	< 2	Moderate turbidity.
	Average	2861.1	1307.8	21.6	
	Number	18	18	18	
	St. Dev.	6086.1	3779.9	56.8	
	Maximum	16000	16000	240	
	Minimum	20	20	2	

Physical Water Quality Data **August 6, 1999**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	630	3.5
RAIN:	None	M. Meyer	Low	1114	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 mg/l	BOD mg/l
1	1018	0	20.21	30.25	6.94	8.29	49.42	83.8	10	3.3	0.02	3.3
5k SW		1	20.10	31.87	6.90	8.28	55.37	86.3				
		2	19.71	33.48	7.03	8.30	62.34	88.9			< 0.01	2.0
		3	19.63	33.52	6.74	8.32	63.89	89.4				
		4	19.54	33.54	6.76	8.31	65.64	90.0			0.06	1.8
2	1006	0	21.22	33.24	6.62	8.27	59.38	87.8	10	3.1	< 0.01	1.5
5k SW		1	21.22	33.28	6.64	8.27	59.00	87.6				
		2	21.15	33.29	6.88	8.27	57.61	87.1			< 0.01	1.4
		3	20.77	33.01	6.70	8.27	56.63	86.7				
		4	19.54	33.44	6.85	8.30	60.46	88.2			< 0.01	1.5
3	955	0	21.39	33.37	6.37	8.18	62.84	89.0	11	2.5	< 0.01	1.3
5k SW		1	21.40	33.37	6.36	8.19	62.97	89.1				
		2	21.39	33.37	6.24	8.20	62.40	88.9			< 0.01	0.6
4	1043	0	21.82	33.50	6.40	8.21	64.23	89.5	12	2.4	< 0.01	1.0
5k SW		1	21.82	33.49	6.41	8.21	64.01	89.4				
		2	21.81	33.47	6.55	8.21	63.98	89.4			< 0.01	1.1
		3	21.51	33.38	6.25	8.20	64.04	89.5				
5	922	0	22.31	33.47	5.85	8.18	64.43	89.6	12	3.2	< 0.01	0.9
5k SW		1	22.27	33.40	5.97	8.19	63.95	89.4				
		2	21.97	33.21	6.04	8.19	61.21	88.5			< 0.01	0.8
		3	20.86	33.34	5.94	8.20	50.95	84.5				
		4	19.92	33.54	5.98	8.27	51.62	84.8			< 0.01	0.8
6	937	0	22.08	33.51	5.11	8.22	70.38	91.6	10	3.6	< 0.01	0.8
5k SW		1	22.06	33.51	5.52	8.23	69.34	91.3				
		2	22.04	33.46	6.19	8.22	67.02	90.5			< 0.01	0.6
		3	21.76	33.26	5.83	8.22	65.74	90.0				
		4	21.02	33.69	5.82	8.11	53.31	85.4			< 0.01	0.8
7	1105	0	22.33	33.50	5.37	8.15	54.00	85.7	12	2.3	< 0.01	0.9
5k SW		1	22.34	33.55	6.59	8.15	53.86	85.7				
		2	22.33	33.48	6.26	8.16	53.63	85.6			< 0.01	0.8
		3	21.91	33.39	5.83	8.15	52.99	85.3				
		4	20.66	33.70	5.65	8.16	32.88	75.7			< 0.01	0.6
8	817	0	22.41	33.53	5.76	8.13	63.89	89.4	12	2.6	0.02	0.8
2k SW		1	22.41	33.53	5.82	8.13	63.91	89.4				
		2	22.42	33.48	5.62	8.12	61.35	88.5			0.01	0.7
		3	22.05	33.40	5.46	8.10	43.11	81.0				
		4	21.76	33.56	5.02	8.02	28.84	73.3			0.01	0.7

August 6, 1999 **(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	908	0	22.30	33.16	4.91	8.02	28.60	73.1	14	1.6	0.07	2.8
2k SW		1	22.22	33.18	5.14	8.07	26.23	71.6				
		2	21.66	33.39	4.97	8.11	27.27	72.3			0.06	0.7
		3	21.30	33.51	4.48	8.10	19.56	66.5				
		4									0.05	0.8
10	845	0	22.34	33.31	5.00	8.04	48.03	83.2	14	1.8	0.07	3.1
2k SW		1	22.33	33.32	5.16	8.05	47.79	83.1				
		2	22.22	33.39	4.82	8.03	44.51	81.7			0.07	3.3
		3	21.96	33.39	4.54	8.06	39.54	79.3				
		4	21.68	33.55	4.19	8.02	18.03	65.2			0.06	3.3
11	858	0	22.29	33.23	5.16	8.08	71.99	92.1	12	2.8	0.04	0.9
2k SW		1	22.38	33.31	5.35	8.10	68.25	90.9				
		2	22.28	33.31	5.10	8.13	59.53	87.8			0.03	0.5
		3	21.63	33.42	5.14	8.14	50.01	84.1				
		4	21.24	33.64	5.24	8.13	38.08	78.6			0.03	0.7
12	1028	0	22.53	20.31	7.26	8.36	19.55	66.5	15	1.8	0.01	3.1
5k SW		1	22.57	20.48	7.26	8.36	19.69	66.6				
		2	22.85	21.48	7.08	8.34	20.17	67.0			< 0.01	2.7
13	734	0	22.31	33.42	3.50	7.70					0.09	5.7
18	810	0	22.39	33.56	5.63	8.14	59.53	87.8	12	2.6	0.02	0.9
2k SW		1	22.40	33.56	5.61	8.14	58.89	87.6				
		2	22.39	33.56	5.29	8.14	58.56	87.5			< 0.01	0.9
19	746	0	21.45	33.85	5.67	8.14					< 0.01	0.9
20	835	0	22.43	33.32	4.87	8.01	47.15	82.9	14	2.0	0.21	8.4
2k SW		1	22.42	33.30	4.38	8.02	47.25	82.9				
		2									0.25	2.9
22	722	0	22.60	31.16	2.70	7.50					0.12	7.5
25	1051	0	22.06	33.51	6.39	8.20	63.58	89.3	10	3.4	0.02	1.0
5k SW		1	22.06	33.50	6.59	8.20	63.73	89.3				
		2	22.03	33.39	6.69	8.21	63.05	89.1			< 0.01	0.9
		3	21.34	33.20	6.48	8.19	62.86	89.0				
		4	19.96	33.43	6.47	8.19	58.51	87.5			< 0.01	0.9
		5	19.43	33.66	6.27	8.23	40.50	79.8				
	Average		21.65	32.77	5.82	8.16	52.79	84.43	12.0	2.6	0.04	1.8
	Number		68	68	68	68	65	65	15	15	43.00	43.0
	St. Dev.		0.88	2.65	0.90	0.13	14.55	7.10	1.6	0.6	0.05	1.8
	Maximum		22.85	33.85	7.26	8.36	71.99	92.11	15	3.6	0.25	8.4
	Minimum		19.43	20.31	2.70	7.50	18.03	65.16	10	1.6	0.01	0.5

Surface Bacteriological Water Data and General Observations **August 6, 1999**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	630	3.5
RAIN:	None	M. Meyer	Low	1114	2.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1018	170	170	< 2	Moderate turbidity.
2	1006	20	20	< 2	Moderate turbidity.
3	955	20	20	2	Moderate turbidity. Surface oil film in channel. Odor of petroleum apparent.
4	1043	< 20	< 20	2	Moderate turbidity.
5	922	60	40	< 2	Moderate turbidity.
6	937	90	20	2	Moderate turbidity.
7	1105	80	50	< 2	Moderate turbidity.
8	817	< 20	< 20	4	Moderate turbidity.
9	908	80	50	2	Moderate turbidity.
10	845	3000	210	30	Moderate turbidity. Floating oil.
11	858	500	230	2	Moderate turbidity.
12	1028	80	50	< 2	Moderate turbidity.
13	734	5000	2400	80	Moderate turbidity. Floating trash.
18	810	50	50	8	Moderate turbidity.
19	746	< 20	< 20	9	Moderate turbidity.
20	835	16000	2800	80	Moderate turbidity. Floating oil and organic debris.
22	722	≥ 16000	≥ 16000	33	Moderate turbidity. Floating mats of green algae.
25	1051	< 20	< 20	< 2	Moderate turbidity.
	Average	2290.6	1232.8	14.8	
	Number	18	18	18	
	St. Dev.	5155.7	3776.0	25.5	
	Maximum	16000	16000	80	
	Minimum	20	20	2	

Physical Water Quality Data **September 29,1999**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	901	5.0
RAIN:	None	M. Meyer	Low	1441	1.3

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 mg/l	BOD mg/l
1	1020	0	18.77	33.29	7.77	8.21	70.65	91.7	10	3.8	0.11	2.0
3k WSW		1	18.67	33.36	8.24	8.22	68.67	91.0				
		2	18.54	33.43	8.87	8.21	67.35	90.6			0.05	1.4
		3	18.51	33.42	8.90	8.22	65.95	90.1				
		4	18.42	33.46	8.70	8.22	61.64	88.6			< 0.01	1.5
2	1009	0	18.64	33.41	7.31	8.21	69.66	91.4	10	4.2	< 0.01	1.4
3k WSW		1	18.60	33.43	7.97	8.21	68.51	91.0				
		2	18.54	33.43	8.31	8.22	67.29	90.6			< 0.01	1.2
		3	18.28	33.37	8.44	8.23	67.17	90.5				
		4	17.93	33.47	8.43	8.24	68.91	91.1			< 0.01	1.4
3	957	0	19.44	33.22	8.25	8.14	63.49	89.3	11	3.5	0.07	1.4
3k WSW		1	19.38	33.17	8.36	8.14	63.15	89.1				
		2	18.88	33.38	8.72	8.16	56.66	86.8			0.01	1.2
		3	18.83	33.38	8.64	8.16	56.31	86.6				
		4	18.71	33.45	8.59	8.17	59.37	87.8			0.05	1.1
4	1043	0	19.31	32.97	7.25	8.15	67.43	90.6	12	3.2	0.06	1.4
3k WSW		1	19.33	33.00	7.66	8.15	68.54	91.0				
		2	19.22	33.11	7.97	8.13	64.23	89.5			< 0.01	1.3
		3	19.00	33.29	8.02	8.12	59.88	88.0				
		4									0.07	1.1
5	926	0	19.52	33.09	7.43	8.14	62.07	88.8	11	2.8	0.05	1.5
3k WSW		1	19.51	33.12	7.61	8.15	61.76	88.6				
		2	19.56	33.19	8.05	8.14	60.73	88.3			< 0.01	1.4
		3	19.65	33.24	8.17	8.14	54.61	86.0				
		4	19.49	33.25	8.17	8.13	53.01	85.3			< 0.01	1.4
6	941	0	19.88	33.43	8.01	8.08	72.63	92.3	10	4.0	0.06	1.2
3k WSW		1	19.88	33.42	8.07	8.08	72.48	92.3				
		2	19.82	33.45	8.29	8.08	70.95	91.8			0.04	0.8
		3	19.79	33.46	8.11	8.09	69.74	91.4				
		4	19.77	33.47	7.96	8.09	69.35	91.3			0.03	0.7
7	1109	0	20.19	33.38	7.46	8.08	65.87	90.1	12	3.2	0.03	1.0
3k WSW		1	20.18	33.38	7.67	8.09	65.31	89.9				
		2	20.09	33.35	8.24	8.09	66.52	90.3			< 0.01	1.0
		3	19.92	33.32	7.95	8.09	60.68	88.3				
		4	19.62	33.43	7.93	8.08	52.71	85.2			0.04	0.9
8	824	0	20.10	33.43	7.62	8.04	67.22	90.5	10	3.2	0.08	1.0
3k WSW		1	20.11	33.43	7.71	8.04	66.70	90.4				
		2	20.13	33.45	7.73	8.04	67.46	90.6			0.07	0.8
		3	20.12	33.41	7.44	8.05	61.99	88.7				
		4	19.94	33.46	7.45	8.04	52.76	85.2			0.07	0.8

September 29,1999 (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	914	0	19.67	32.62	6.33	7.85	50.03	84.1	14	2.0	0.10	2.2
3k WSW		1	19.92	32.83	6.43	7.88	44.67	81.8				
		2	19.91	33.18	6.75	8.00	29.15	73.5			0.07	0.8
		3	19.85	33.30	6.50	8.01	27.41	72.4				
		4	19.81	33.33	6.48	8.00	20.73	67.5			0.06	0.9
10	852	0	20.17	33.25	6.07	7.98	62.37	88.9	12	2.2	0.16	0.8
3k WSW		1	20.22	33.26	6.20	7.99	59.52	87.8				
		2	20.21	33.27	6.81	7.99	55.15	86.2			0.12	0.8
		3	20.08	33.28	7.00	8.01	48.11	83.3				
		4	19.78	33.38	6.65	7.98	37.48	78.2			0.11	0.9
11	905	0	20.12	33.24	7.58	8.03	58.96	87.6	12	2.4	0.16	1.3
3k WSW		1	20.12	33.28	7.56	8.03	56.99	86.9				
		2	20.05	33.33	7.50	8.04	49.18	83.7			0.08	0.8
		3	19.94	33.35	7.36	8.04	46.65	82.6				
		4	19.77	33.42	7.47	8.03	40.46	79.8			0.07	0.9
12	1030	0	19.31	30.80	8.81	8.23	68.79	91.1	14	2.5	0.06	1.8
3k WSW		1	19.19	31.72	8.92	8.23	69.22	91.2				
		2	18.95	32.99	9.06	8.21	72.39	92.2			0.03	1.7
		3	18.92	33.16	8.99	8.21	73.99	92.7				
13	726	0	19.85	32.87	6.40	8.09					0.15	3.0
18	815	0	20.08	33.46	7.94	8.06	63.26	89.2	10	3.2	0.08	2.1
3k WSW		1	20.08	33.46	7.95	8.06	61.76	88.6				
		2	20.07	33.45	7.94	8.07	59.23	87.7			0.07	1.6
19	742	0	19.38	33.07	7.01	8.09					0.09	2.1
20	844	0	20.14	33.22	6.77	7.98	63.83	89.4	10	2.5	0.19	3.8
3k WSW		1	20.17	33.25	6.76	7.98	56.49	86.7				
		2	20.16	33.28	6.76	7.98	51.76	84.8			0.15	1.5
22	715	0	19.85	32.16	6.06	8.09					0.15	3.1
25	1058	0	19.48	33.04	8.66	8.11	70.94	91.8	12	3.5	0.07	1.2
3k WSW		1	19.47	33.07	8.58	8.11	66.88	90.4				
		2	19.41	33.10	8.70	8.13	63.25	89.2			0.02	1.1
		3	19.29	33.09	8.69	8.09	65.16	89.8				
		4	18.87	33.25	8.66	8.09	60.68	88.3			0.03	1.2
		5	18.56	33.40	8.76	8.07	37.52	78.3				
	Average		19.52	33.21	7.77	8.10	60.02	87.66	11.3	3.1	0.07	1.4
	Number		73	73	73	73	70	70	15	15	45.00	45.0
	St. Dev.		0.59	0.40	0.80	0.08	11.09	4.80	1.4	0.7	0.05	0.6
	Maximum		20.22	33.47	9.06	8.24	73.99	92.75	14	4.2	0.19	3.8
	Minimum		17.93	30.80	6.06	7.85	20.73	67.48	10	2.0	0.01	0.7

Surface Bacteriological Water Data and General Observations **September 29,1999**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	901	5.0
RAIN:	None	M. Meyer	Low	1441	1.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1020	2400	370	< 2	Moderate turbidity.
2	1009	1300	110	170	Moderate turbidity.
3	957	5000	220	2	Moderate turbidity. Floating trash. No flow from tidal gate.
4	1043	5000	1700	4	Moderate turbidity.
5	926	2400	2400	< 2	Moderate turbidity.
6	941	20	< 20	< 2	Moderate turbidity.
7	1109	20	20	2	Moderate turbidity.
8	824	110	20	30	Moderate turbidity.
9	914	140	50	130	Moderate turbidity. Floating leaves, trash, and organic debris.
10	852	300	170	6	Moderate turbidity.
11	905	< 20	< 20	< 2	Moderate turbidity.
12	1030	≥ 16000	16000	2	Moderate turbidity.
13	726	5000	200	59	Moderate turbidity.
18	815	20	20	< 2	Moderate turbidity.
19	742	< 20	< 20	17	Moderate turbidity. Kayakers in channel. Floating organic debris.
20	844	≥ 16000	340	170	Moderate turbidity. Floating oil and organic debris.
22	715	≥ 16000	330	240	Moderate turbidity.
25	1058	5000	290	< 2	Moderate turbidity. Three sea lions in channel.
	Average	4152.8	1238.9	46.9	
	Number	18	18	18	
	St. Dev.	5795.1	3738.5	75.7	
	Maximum	16000	16000	240	
	Minimum	20	20	2	

Physical Water Quality Data **October 20, 1999**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger		High	731	4.7
RAIN:	None	M. Meyer		Low	1312	2.0

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	1020	0	17.33	30.56	6.60	8.15	75.74	93.3	10	3.2	0.10	1.7
4k NE		1	17.25	31.64	6.66	8.14	71.89	92.1				
		2	17.08	33.12	6.71	8.14	65.56	90.0			0.17	1.4
		3	17.00	33.34	6.89	8.14	66.70	90.4				
		4	16.98	33.36	6.80	8.14	67.59	90.7			0.11	1.5
2	1009	0	17.81	33.30	6.95	8.15	62.02	88.7	11	3.3	0.06	1.4
4k NE		1	17.75	33.22	7.09	8.15	61.56	88.6				
		2	17.60	33.13	7.13	8.15	61.05	88.4			0.04	1.5
		3	17.20	33.26	7.20	8.18	60.97	88.4				
		4	17.03	33.31	7.26	8.18	59.92	88.0			0.04	1.6
3	1000	0	17.81	33.31	6.89	8.10	64.56	89.6	10	3.4	0.09	1.4
2k NE		1	17.64	33.31	6.97	8.09	63.48	89.3				
		2	17.63	33.33	6.91	8.09	62.11	88.8			0.08	1.0
		3	17.68	33.29	6.68	8.09	62.72	89.0				
		4	17.59	33.32	6.76	8.09	62.87	89.0			0.07	1.0
4	1053	0	18.22	33.41	6.59	8.09	61.10	88.4	12	3.0	0.07	0.9
1k NE		1	18.15	33.31	6.69	8.07	60.78	88.3				
		2	18.00	33.19	6.72	8.07	60.12	88.1			0.07	1.1
		3	17.40	33.38	6.76	8.10	59.77	87.9				
		4	17.28	33.44	6.82	8.12	58.01	87.3			0.06	1.1
5	935	0	18.66	33.32	5.25	8.07	66.97	90.5	10	2.8	0.08	0.8
2k NE		1	18.61	33.31	5.38	8.07	61.79	88.7				
		2	18.31	33.39	5.56	8.09	56.64	86.8			0.07	0.9
		3	18.22	33.25	5.53	8.10	54.22	85.8				
		4	17.72	33.31	5.47	8.11	54.05	85.7			0.06	1.1
		5	17.38	33.47	5.57	8.12	47.91	83.2				
6	943	0	18.63	33.41	5.81	8.05	67.72	90.7	10	3.3	0.07	0.8
2k NE		1	18.62	33.40	5.81	8.05	67.13	90.5				
		2	18.57	33.38	6.04	8.05	66.57	90.3			0.06	0.7
		3	18.20	33.47	6.03	8.05	59.24	87.7				
		4									0.06	0.9
7	1115	0	18.77	33.41	4.98	8.02	56.23	86.6	12	2.4	0.06	0.8
2k NE		1	18.72	33.32	4.95	8.01	55.73	86.4				
		2	18.42	33.35	5.48	8.02	46.92	82.8			0.09	0.6
		3	18.17	33.39	5.81	8.04	39.92	79.5				
		4	17.90	33.49	5.54	8.04	34.50	76.6			0.09	0.7
8	819	0	18.69	33.38	5.79	8.00	57.81	87.2	10	2.4	0.08	1.8
2k NE		1	18.70	33.39	5.90	8.00	57.94	87.2				
		2	18.71	33.38	5.90	8.01	55.24	86.2			0.08	1.0
		3	18.59	33.40	5.89	8.01	50.65	84.4				
		4	18.59	33.40	5.89	8.01	50.65	84.4			0.08	0.8

October 20, 1999 (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	912	0	18.57	33.23	6.24	8.00	50.60	84.3	10	1.5	0.10	0.8
2k NE		1	18.46	33.30	6.29	8.00	41.17	80.1				
		2	18.37	33.30	6.09	8.02	32.76	75.7			0.09	0.6
		3	18.18	33.37	5.83	8.04	36.13	77.5				
		4	18.11	33.40	6.02	8.04	29.79	73.9			0.08	0.8
10	848	0	18.62	33.16	4.54	7.95	58.86	87.6	10	2.2	0.14	0.7
2k NE		1	18.62	33.24	4.77	7.95	58.38	87.4				
		2	18.86	33.26	5.66	7.95	56.04	86.5			0.13	0.5
		3	18.71	33.37	5.11	7.98	42.99	81.0				
		4									0.13	0.7
11	902	0	18.62	33.25	5.81	8.00	60.19	88.1	10	2.3	0.10	0.9
2k NE		1	18.64	33.28	6.06	8.01	57.73	87.2				
		2	18.58	33.28	5.73	8.01	48.65	83.5			0.08	0.9
		3	18.25	33.36	5.79	8.02	35.55	77.2				
		4	18.12	33.43	5.82	8.02	34.55	76.7			0.08	0.9
12	1033	0	17.79	25.89	6.75	8.19	69.87	91.4	12	3.2	0.12	2.0
4k NE		1	17.67	28.55	6.82	8.18	59.43	87.8				
		2	17.28	33.17	6.78	8.16	72.79	92.4			0.10	2.2
		3	17.26	33.27	6.63	8.16	75.69	93.3				
13	732	0	18.60	33.09	4.46	7.89					0.14	5.0
18	809	0	18.72	33.38	6.11	8.05	50.87	84.5	9	2.1	0.11	1.3
2k NE		1	18.70	33.33	6.10	8.06	51.21	84.6				
		2	18.63	33.35	6.07	8.05	51.19	84.6			0.09	1.2
19	747	0	17.80	33.20	5.73	8.06					0.07	1.2
20	840	0	18.74	33.25	4.34	7.97	55.99	86.5	9	2.0	0.16	6.6
2k NE		1	18.86	33.21	4.32	7.98	48.40	83.4				
		2									0.13	2.2
22	720	0	18.03	32.88	4.60	7.78					0.15	5.1
25	1102	0	18.25	33.45	4.87	8.03	71.31	91.9	10	4.2	0.12	1.0
1k NE		1	18.13	33.37	5.45	8.02	62.12	88.8				
		2	18.10	33.40	5.55	8.02	69.06	91.2			0.09	0.9
		3	18.05	33.39	5.76	8.01	68.12	90.8				
		4	17.99	33.27	5.80	8.01	69.39	91.3			0.08	0.9
		5	17.63	33.33	5.72	8.01	62.50	88.9				
	Average		18.10	33.09	5.99	8.05	57.36	86.71	10.3	2.8	0.09	1.4
	Number		72	72	72	72	69	69	15	15	45.00	45.0
	St. Dev.		0.54	1.09	0.74	0.07	10.59	4.37	1.0	0.7	0.03	1.2
	Maximum		18.86	33.49	7.26	8.19	75.74	93.29	12	4.2	0.17	6.6
	Minimum		16.98	25.89	4.32	7.78	29.79	73.88	9	1.5	0.04	0.5

Surface Bacteriological Water Data and General Observations **October 20, 1999**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger	High	731	4.7
RAIN:	None		M. Meyer	Low	1312	2.0

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1020	110	80	5	Moderate turbidity.
2	1009	150	110	< 2	Moderate turbidity. Dredging being conducted.
3	1000	40	< 20	5	Moderate turbidity.
4	1053	20	20	< 2	Moderate turbidity. Floating oil, organic debris, and trash.
5	935	40	< 20	10	Moderate turbidity.
6	943	80	20	8	Moderate turbidity.
7	1115	130	80	< 2	Moderate turbidity.
8	819	20	20	5	Moderate turbidity.
9	912	< 20	< 20	< 2	Moderate turbidity.
10	848	1700	40	50	Moderate turbidity.
11	902	110	110	50	Moderate turbidity.
12	1033	1300	340	5	Moderate turbidity.
13	732	≥ 16000	1700	80	Moderate turbidity. Floating leaves and trash.
18	809	< 20	< 20	< 2	Moderate turbidity. Floating oil film.
19	747	700	170	8	Moderate turbidity. One swimmer in the water.
20	840	≥ 16000	5000	900	Moderate turbidity. Floating oil and organic debris.
22	720	≥ 16000	1700	17	Moderate turbidity.
25	1102	1300	70	30	Moderate turbidity.
	Average	2985.6	530.0	65.7	
	Number	18	18	18	
	St. Dev.	6011.7	1234.7	209.4	
	Maximum	16000	5000	900	
	Minimum	20	20	2	

Physical Water Quality Data **November 3, 1999**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Overcast/Prt. Cloudy	Pers.: J. Gelsinger		High	626	5.3
RAIN:	None	M. Meyer		Low	1229	1.3

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 mg/l	BOD mg/l
1	1015	0	16.94	31.14	6.49	8.28	67.79	90.7	10	4.2	0.04	1.6
4k WSW		1	16.81	32.47	6.79	8.27	67.68	90.7				
		2	16.68	33.21	6.86	8.26	71.07	91.8			0.03	2.7
		3	16.41	33.25	6.87	8.27	71.48	91.9				
		4	15.92	33.56	6.94	8.23	70.75	91.7			0.03	2.4
2	1006	0	17.38	33.34	5.61	8.23	59.83	87.9	11	3.5	0.02	3.0
4k WSW		1	17.36	33.19	5.72	8.22	59.70	87.9				
		2	16.57	33.32	6.33	8.24	62.97	89.1			0.02	3.0
		3	16.12	33.56	6.63	8.26	67.42	90.6				
		4	16.07	33.55	6.43	8.25	66.79	90.4			0.02	2.6
3	955	0	17.06	33.29	6.39	8.20	64.16	89.5	10	3.2	0.03	1.7
4k WSW		1	17.06	33.29	6.33	8.19	63.88	89.4				
		2	17.04	33.31	6.31	8.19	63.23	89.2			0.03	1.7
		3	17.05	33.30	6.37	8.19	63.49	89.3				
		4	17.05	33.28	6.33	8.18	63.33	89.2			0.03	1.6
		5	16.97	33.34	6.38	8.19	62.03	88.7				
4	1041	0	17.86	33.36	5.43	8.15	67.32	90.6	10	4.1	0.08	1.0
4k WSW		1	17.86	33.37	5.46	8.14	67.09	90.5				
		2	17.83	33.31	5.55	8.14	67.66	90.7			0.06	0.9
		3	17.55	33.16	5.52	8.14	68.29	90.9				
		4	16.48	33.81	5.73	8.17	68.22	90.9			0.06	0.7
5	912	0	17.99	33.28	5.90	8.09	67.60	90.7	10	3.1	0.08	0.7
1k WSW		1	17.89	33.31	5.95	8.10	65.23	89.9				
		2	17.77	33.26	5.83	8.11	63.07	89.1			0.08	0.6
		3	17.47	33.16	5.62	8.12	58.78	87.6				
		4	16.96	33.46	5.81	8.15	52.52	85.1			0.09	0.7
6	933	0	17.80	33.38	5.68	8.12	69.40	91.3	10	3.2	0.09	1.5
1k WSW		1	17.77	33.38	6.03	8.11	68.94	91.1				
		2	17.72	33.38	6.12	8.11	68.08	90.8			0.07	0.6
		3	17.54	33.47	6.06	8.11	67.29	90.6				
		4	17.45	33.52	6.10	8.11	45.41	82.1			0.07	0.5
7	1105	0	18.16	33.34	4.45	8.10	66.78	90.4	11	3.4	0.07	1.0
4k WSW		1	18.16	33.34	4.45	8.09	66.03	90.1				
		2	17.90	33.37	5.17	8.10	64.38	89.6			0.07	0.6
		3	17.70	33.46	5.40	8.10	59.05	87.7				
		4	17.31	33.72	5.17	8.11	44.28	81.6			0.08	0.6
8	813	0	18.01	33.37	5.67	8.08	56.06	86.5	11	2.3	0.09	0.7
1k WSW		1	18.02	33.36	5.74	8.08	55.02	86.1				
		2	18.00	33.37	5.74	8.08	52.02	84.9			0.09	0.7
		3	17.97	33.36	5.56	8.07	51.54	84.7				
		4	17.85	33.42	5.62	8.06	45.39	82.1			0.08	0.8

November 3, 1999 (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	907	0	17.82	33.27	4.91	8.07	41.13	80.1	12	2.2	0.10	1.2
1k WSW		1	17.80	33.31	5.09	8.08	36.19	77.6				
		2	17.71	33.36	5.13	8.09	32.33	75.4			0.09	0.6
		3	17.66	33.40	5.18	8.09	30.46	74.3				
		4									0.09	0.4
10	841	0	18.06	33.26	4.34	8.02	63.49	89.3	11	2.4	0.21	0.5
1k WSW		1	18.13	33.29	4.43	8.03	58.94	87.6				
		2	18.11	33.31	4.79	8.06	51.40	84.7			0.19	0.6
		3	17.96	33.33	4.69	8.07	43.62	81.3				
		4	17.80	33.41	4.65	8.08	33.77	76.2			0.15	0.7
11	855	0	17.94	33.21	5.55	8.06	64.79	89.7	11	2.8	0.11	0.7
1k WSW		1	17.95	33.26	5.58	8.07	61.97	88.7				
		2	17.92	33.29	5.64	8.08	58.51	87.5			0.10	0.6
		3	17.78	33.33	5.44	8.09	52.83	85.3				
12	1023	0	17.71	22.50	6.06	8.40	78.12	94.0	14	3.3	0.14	1.5
4k WSW		1	17.62	27.52	6.54	8.40	49.71	84.0				
		2	16.86	32.70	6.68	8.25	53.91	85.7			0.08	6.2
		3	16.70	33.13	6.70	8.24	72.98	92.4				
13	726	0	18.07	25.29	4.40	8.00					0.83	6.3
18	804	0	17.99	33.36	5.27	8.08	55.16	86.2	12	2.8	0.53	1.0
1k WSW		1	17.97	33.37	5.43	8.08	55.29	86.2				
		2	17.95	33.37	5.22	8.08	54.89	86.1			0.15	0.9
		3	17.91	33.39	5.19	8.08	54.53	85.9				
		4									0.11	0.7
19	740	0	17.71	33.65	5.44	8.12					0.10	0.8
20	834	0	18.16	33.35	4.39	7.95	54.22	85.8	12	2.1	0.25	4.5
1k WSW		1	18.20	33.33	4.41	7.93	48.89	83.6				
		2									0.36	1.8
22	715	0	18.15	25.77	4.40	7.75					0.85	5.7
25	1053	0	17.93	33.36	5.65	8.10	69.96	91.5	10	4.2	0.41	0.6
4k WSW		1	17.93	33.35	5.96	8.10	69.46	91.3				
		2	17.91	33.24	6.00	8.10	69.27	91.2			0.11	0.7
		3	16.95	33.32	5.96	8.13	65.58	90.0				
		4	16.52	33.49	6.02	8.18	49.81	84.0			0.08	0.7
	Average		17.53	32.86	5.66	8.13	59.45	87.52	11.0	3.1	0.14	1.5
	Number		72	72	72	72	69	69	15	15	45.00	45.0
	St. Dev.		0.58	1.93	0.69	0.10	10.38	4.21	1.1	0.7	0.18	1.5
	Maximum		18.20	33.81	6.94	8.40	78.12	94.01	14	4.2	0.85	6.3
	Minimum		15.92	22.50	4.34	7.75	30.46	74.29	10	2.1	0.02	0.4

Surface Bacteriological Water Data and General Observations **November 3, 1999**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay
WEATHER:	Overcast/Prt. Cloudy	Pers.:	J. Gelsinger
RAIN:	None		M. Meyer

TIDE	TIME	HT. (ft)
High	626	5.3
Low	1229	1.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1015	90	80	2	Moderate turbidity.
2	1006	20	< 20	< 2	Moderate turbidity.
3	955	20	20	< 2	Moderate turbidity. Strong flow from tidal gate. Large school of topsmelt present.
4	1041	20	< 20	11	Moderate turbidity.
5	912	220	110	13	Moderate turbidity.
6	933	800	220	4	Moderate turbidity. Surface oil film present.
7	1105	130	130	< 2	Moderate turbidity.
8	813	50	20	< 2	Moderate turbidity.
9	907	20	20	2	Moderate turbidity. School of topsmelt in water column.
10	841	16000	5000	14	Moderate turbidity. School of topsmelt in water column.
11	855	40	40	< 2	Moderate turbidity. Surface oil film present.
12	1023	5000	420	5	Moderate turbidity.
13	726	700	170	240	Moderate turbidity.
18	804	600	400	5	Moderate turbidity.
19	740	500	220	17	Moderate turbidity.
20	834	5000	2200	17	Moderate turbidity. Surface oil film present.
22	715	330	300	80	Moderate turbidity. Mallard ducks in lagoon.
25	1053	20	20	2	Moderate turbidity.
	Average	1642.2	522.8	23.4	
	Number	18	18	18	
	St. Dev.	3906.1	1225.0	57.0	
	Maximum	16000	5000	240	
	Minimum	20	20	2	

Physical Water Quality Data **December 2, 1999**

CRUISE: MDR 99-00 | Vessel: Aquatic Bioassay
WEATHER: Clear | Pers.: J. Gelsinger
RAIN: None | M. Meyer

TIDE	TIME	HT. (ft)
High	550	5.4
Low	1221	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 mg/l	BOD mg/l
1	1013	0	14.62	32.73	7.31	7.93	73.13	92.5	12	3.5	0.07	0.9
5k WSW		1	14.63	33.27	7.37	7.94	72.42	92.2				
		2	14.54	33.42	7.39	7.95	70.23	91.5			< 0.01	0.4
		3	14.49	33.51	7.37	7.95	63.48	89.3				
		4	14.48	33.53	7.30	7.97	63.18	89.2			< 0.01	0.4
		5	14.46	33.54	7.32	7.97	57.03	86.9				
2	1005	0	14.54	33.34	6.59	7.98	58.84	87.6	13	3.1	< 0.01	4.4
5k WSW		1	14.52	33.37	6.28	7.99	58.15	87.3				
		2	14.46	33.39	6.83	7.96	59.83	87.9			0.14	2.6
		3	14.42	33.43	7.18	7.94	61.16	88.4				
		4	14.41	33.44	6.95	7.92	60.40	88.2			0.01	5.6
3	955	0	14.57	33.29	6.91	7.90	68.53	91.0	10	3.8	< 0.01	0.7
2k SSE		1	14.58	33.29	7.14	7.91	66.63	90.3				
		2	14.56	33.32	7.20	7.91	67.00	90.5			< 0.01	1.1
		3	14.55	33.32	7.39	7.92	66.51	90.3				
		4	14.50	33.37	7.48	7.91	63.82	89.4			< 0.01	1.4
		5	14.49	33.39	7.39	7.90	54.80	86.0				
4	1035	0	14.69	33.32	7.33	7.93	62.92	89.1	12	3.0	< 0.01	2.7
5k WSW		1	14.67	33.33	7.51	7.93	63.58	89.3				
		2	14.64	33.33	7.73	7.92	64.19	89.5			< 0.01	2.4
		3	14.62	33.32	7.81	7.92	64.33	89.6				
		4	14.58	33.34	7.70	7.92	64.81	89.7			< 0.01	2.5
5	922	0	14.58	33.24	5.94	7.82	73.40	92.6	10	4.1	< 0.01	0.6
2k SSE		1	14.56	33.25	5.99	7.82	73.15	92.5				
		2	14.52	33.28	6.34	7.81	71.09	91.8			< 0.01	0.4
		3	14.51	33.30	6.75	7.85	67.55	90.7				
		4	14.52	33.31	6.59	7.86	66.38	90.3			< 0.01	0.6
		5	14.52	33.31	6.47	7.88	63.87	89.4				
6	935	0	14.49	33.32	6.86	7.82	67.20	90.5	10	3.9	< 0.01	1.4
2k SSE		1	14.47	33.31	6.96	7.82	67.24	90.6				
		2	14.42	33.34	7.03	7.81	66.30	90.2			< 0.01	1.1
		3	14.42	33.34	6.91	7.81	65.61	90.0				
		4									< 0.01	1.1
7	1102	0	14.84	33.31	6.96	7.78	74.12	92.8	10	4.1	< 0.01	1.2
5k WSW		1	14.82	33.23	6.87	7.77	74.64	92.9				
		2	14.67	33.29	6.97	7.76	75.80	93.3			< 0.01	1.3
		3	14.62	33.32	6.90	7.76	75.40	93.2				
		4	14.61	33.32	6.90	7.76	74.94	93.0			< 0.01	1.2
8	818	0	14.53	33.30	7.06	7.80	60.04	88.0	12	3.0	< 0.01	1.7
2k SSE		1	14.54	33.30	7.05	7.80	59.92	88.0				
		2	14.54	33.29	6.97	7.80	58.79	87.6			< 0.01	1.2
		3	14.52	33.27	6.95	7.80	57.70	87.2				
		4	14.46	33.30	6.98	7.80	57.82	87.2			< 0.01	1.4

December 2, 1999 (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	908	0	14.77	33.22	5.42	7.80	69.82	91.4	10	3.6	< 0.01	1.4
2k SSE		1	14.75	33.24	5.77	7.80	69.67	91.4				
		2	14.70	33.28	6.47	7.82	68.53	91.0			< 0.01	1.1
		3	14.67	33.30	6.47	7.82	67.05	90.5				
		4	14.66	33.30	6.20	7.82	66.72	90.4			< 0.01	1.2
10	845	0	14.66	33.20	6.48	7.76	69.89	91.4	10	3.8	0.06	1.3
2k SSE		1	14.80	33.15	6.39	7.78	67.01	90.5				
		2	14.75	33.15	6.35	7.78	63.90	89.4			< 0.01	1.1
		3	14.71	33.16	6.36	7.78	63.56	89.3				
		4	14.69	33.18	6.38	7.78	64.34	89.6			< 0.01	0.9
11	855	0	14.63	33.24	6.74	7.81	68.15	90.9	11	3.4	< 0.01	1.7
2k SSE		1	14.62	33.24	6.76	7.81	68.13	90.9				
		2	14.62	33.23	6.98	7.81	67.93	90.8			< 0.01	1.1
		3	14.63	32.85	6.94	7.81	66.35	90.3				
		4									< 0.01	1.1
12	1023	0	14.43	25.92	4.99	7.90	56.98	86.9	12	3.0	0.07	1.5
5k WSW		1	14.74	28.86	5.05	7.84	40.83	79.9				
		2	14.69	32.44	5.02	7.86	70.00	91.5			0.04	2.2
13	735	0	14.52	33.45	5.37	7.76					< 0.01	4.2
18	812	0	14.50	33.31	6.87	7.81	57.40	87.0	12	3.0	< 0.01	1.4
2k SSE		1	14.49	33.31	6.91	7.79	57.47	87.1				
		2	14.49	33.27	6.87	7.80	57.40	87.0			< 0.01	1.3
19	745	0	13.60	33.53	6.20	7.86					< 0.01	1.6
20	836	0	14.55	33.01	5.07	7.75	75.88	93.3	10	2.0	< 0.01	3.7
2k SSE		1	14.70	33.04	4.95	7.75	74.44	92.9				
		2									< 0.01	1.1
22	722	0	14.49	33.42	5.16	7.76					0.01	3.1
25	1048	0	14.75	33.32	7.45	7.90	65.74	90.0	11	3.8	< 0.01	2.3
5k WSW		1	14.73	33.28	7.70	7.90	66.26	90.2				
		2	14.62	33.33	7.73	7.89	67.03	90.5			< 0.01	1.7
		3	14.60	33.32	7.76	7.89	67.83	90.8				
		4	14.57	33.33	7.64	7.89	67.61	90.7			< 0.01	1.9
		5	14.58	33.33	7.69	7.89	65.64	90.0				
	Average		14.57	33.12	6.75	7.85	65.54	89.90	11.0	3.4	0.02	1.7
	Number		73	73	73	73	70	70	15	15	45.00	45.0
	St. Dev.		0.16	1.01	0.74	0.07	6.10	2.19	1.1	0.6	0.02	1.1
	Maximum		14.84	33.54	7.81	7.99	75.88	93.33	13	4.1	0.14	5.6
	Minimum		13.60	25.92	4.95	7.75	40.83	79.94	10	2.0	0.01	0.4

Surface Bacteriological Water Data and General Observations **December 2, 1999**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.:	J. Gelsinger	High	550	5.4
RAIN:	None		M. Meyer	Low	1221	1.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1013	3000	330	23	Moderate turbidity.
2	1005	< 20	< 20	< 2	Moderate turbidity. Dredging rig in the area.
3	955	80	80	8	Low turbidity. Strong flow from tidal gate.
4	1035	< 20	< 20	4	Moderate turbidity.
5	922	20	20	23	Low turbidity.
6	935	140	50	< 2	Low turbidity.
7	1102	20	20	4	Low turbidity.
8	818	80	80	11	Moderate turbidity.
9	908	500	80	23	Moderate turbidity.
10	845	1100	130	50	Low turbidity.
11	855	1700	200	80	Moderate turbidity.
12	1023	16000	900	50	Moderate turbidity.
13	735	≥ 16000	5000	80	Moderate turbidity. Floating trash.
18	812	50	20	2	Moderate turbidity.
19	745	20	20	8	Moderate turbidity. Floating organic debris.
20	836	≥ 16000	3000	50	Low turbidity. Floating oil and organic debris.
22	722	≥ 16000	≥ 16000	80	Moderate turbidity.
25	1048	110	70	17	Moderate turbidity.
	Average	3936.7	1446.7	28.7	
	Number	18	18	18	
	St. Dev.	6679.4	3860.3	28.7	
	Maximum	16000	16000	80	
	Minimum	20	20	2	

Physical Water Quality Data **January 5, 2000**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	751	6.0
RAIN:	None	M. Meyer	Low	1506	-0.5

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	1032	0	13.34	32.09	5.47	7.93	64.84	89.7	13	3.2	0.09	2.4
6k SSE		1	13.41	33.15	5.47	7.92	62.38	88.9				
		2	13.52	33.18	5.47	7.95	61.86	88.7			0.02	1.7
		3	13.55	33.35	5.48	7.96	60.43	88.2				
		4	13.56	33.40	5.54	7.96	58.67	87.5			0.01	2.2
		5	13.56	33.45	5.52	7.97	57.45	87.1				
		6	13.57	33.46	5.53	7.98	59.40	87.8			< 0.01	1.2
2	1020	0	13.50	33.38	6.43	8.00	63.22	89.2	11	3.2	< 0.01	1.6
6k SSE		1	13.50	33.38	6.28	8.00	63.01	89.1				
		2	13.46	33.40	6.28	7.99	61.16	88.4			< 0.01	1.7
		3	13.45	33.43	6.30	8.00	60.47	88.2				
		4	13.46	33.44	6.26	8.00	60.35	88.1			< 0.01	1.8
		5	13.47	33.44	6.27	7.99	61.00	88.4				
3	1007	0	13.41	33.34	6.24	7.93	70.28	91.6	10	3.5	< 0.01	1.0
4k SSE		1	13.42	33.34	6.08	7.92	71.10	91.8				
		2	13.42	33.33	6.06	7.93	70.60	91.7			< 0.01	0.7
		3	13.41	33.33	6.01	7.94	69.21	91.2				
		4	13.39	33.35	6.04	7.93	64.59	89.6			< 0.01	0.7
4	1110	0	13.53	33.25	5.73	7.90	64.29	89.5	10	3.4	< 0.01	0.6
6k SSE		1	13.48	33.27	5.59	7.90	64.14	89.5				
		2	13.47	33.28	5.59	7.90	63.40	89.2			< 0.01	0.6
		3										
		4									< 0.01	0.6
5	935	0	13.30	33.14	6.00	7.84	66.50	90.3	10	3.8	< 0.01	0.6
4k SSE		1	13.31	33.12	5.92	7.84	65.15	89.8				
		2	13.23	33.17	5.86	7.84	64.79	89.7			< 0.01	0.6
		3	13.23	33.21	5.83	7.84	63.20	89.2				
		4	13.26	33.23	5.78	7.85	60.88	88.3			< 0.01	0.6
		5	13.32	33.18	5.77	7.87	58.03	87.3				
6	948	0	13.17	33.12	6.03	7.83	68.74	91.1	10	3.5	< 0.01	1.3
4k SSE		1	13.15	33.06	5.88	7.83	67.75	90.7				
		2	13.03	33.12	5.86	7.84	65.68	90.0			< 0.01	0.4
		3	13.02	33.11	5.81	7.84	64.83	89.7				
		4	13.01	33.08	5.86	7.83	64.99	89.8			< 0.01	0.3
7	1130	0	13.47	33.09	5.18	7.81	70.06	91.5	9	4.5	< 0.01	0.5
6k SSE		1	13.31	33.13	5.21	7.82	71.40	91.9				
		2	13.29	33.22	5.28	7.80	72.51	92.3			< 0.01	0.4
		3	13.38	33.18	5.24	7.82	70.56	91.7				
		4									< 0.01	0.5
8	826	0	12.88	33.02	6.28	7.80	65.78	90.1	10	3.6	< 0.01	0.8
3k SSE		1	12.89	33.01	6.29	7.81	66.09	90.2				
		2	12.86	32.99	6.29	7.81	65.21	89.9			< 0.01	0.8
		3	12.76	32.98	6.27	7.80	65.17	89.8				
		4	12.65	33.05	6.31	7.82	65.82	90.1			< 0.01	0.8

January 5, 2000 **(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	922	0	13.40	33.07	6.05	7.80	59.01	87.6	12	2.8	< 0.01	0.6
3k SSE		1	13.39	33.08	5.91	7.80	57.70	87.2				
		2	13.38	33.08	5.85	7.81	57.04	86.9			< 0.01	0.5
		3	13.36	33.08	5.82	7.81	56.52	86.7				
		4	13.33	33.09	5.84	7.80	57.80	87.2			< 0.01	0.6
10	855	0	13.12	32.97	5.00	7.81	64.91	89.8	12	2.8	< 0.01	1.4
3k SSE		1	13.18	33.01	5.08	7.80	62.60	88.9				
		2	13.37	32.98	5.18	7.80	59.31	87.8			< 0.01	0.7
		3	13.38	33.03	5.25	7.80	55.92	86.5				
		4	13.42	33.02	5.15	7.79	52.81	85.2			< 0.01	0.9
11	910	0	13.17	33.12	6.03	7.83	68.74	91.1	10	3.0	0.05	0.7
3k SSE		1	13.15	33.06	5.88	7.83	67.75	90.7				
		2	13.03	33.12	5.86	7.84	65.68	90.0			< 0.01	0.5
		3	13.02	33.11	5.81	7.84	64.83	89.7				
		4	13.01	33.08	5.86	7.83	64.99	89.8			< 0.01	0.8
12	1045	0	12.75	28.24	4.73	7.79	57.14	86.9	15	3.1	0.30	2.2
6k SSE		1	12.94	30.38	4.94	7.79	51.39	84.7				
		2	13.34	32.64	4.99	7.84	57.28	87.0			0.16	2.2
		3	13.55	33.00	4.92	7.91	66.60	90.3				
13	1211	0	13.34	33.19	5.56	7.82					0.04	2.0
18	817	0	12.74	33.01	6.84	7.77	64.16	89.5	10	3.2	0.01	1.0
3k SSE		1	12.71	33.02	6.82	7.78	64.27	89.5				
		2	12.67	33.06	6.91	7.76	63.93	89.4			< 0.01	1.1
19	740	0	11.90	33.27	5.61	7.79					< 0.01	1.1
20	848	0	13.39	32.98	5.89	7.81	57.83	87.2	12	2.3	0.72	18.7
3k SSE		1	13.41	32.98	5.87	7.81	57.29	87.0				
		2	13.40	33.00	5.90	7.81	54.01	85.7			0.08	1.2
22	722	0	12.50	33.03	5.35	7.66					0.01	1.5
25	1120	0	13.49	33.22	5.54	7.85	68.23	90.9	10	4.2	< 0.01	0.6
6k SSE		1	13.48	33.23	5.46	7.85	67.15	90.5				
		2	13.47	33.23	5.50	7.85	68.30	90.9			< 0.01	0.5
		3	13.45	33.24	5.51	7.86	68.71	91.0				
		4	13.44	33.25	5.48	7.85	68.65	91.0			< 0.01	0.5
		5	13.39	33.30	5.50	7.86	66.57	90.3				
	Average		13.25	33.05	5.77	7.86	63.50	89.22	10.9	3.3	0.04	1.4
	Number		75	75	75	75	72	72	15	15	46.00	46.0
	St. Dev.		0.30	0.68	0.45	0.07	4.77	1.70	1.6	0.6	0.11	2.7
	Maximum		13.57	33.46	6.91	8.00	72.51	92.28	15	4.5	0.72	18.7
	Minimum		11.90	28.24	4.73	7.66	51.39	84.67	9	2.3	0.01	0.3

Surface Bacteriological Water Data and General Observations **January 5, 2000**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.:	J. Gelsinger	High	751	6.0
RAIN:	None		M. Meyer	Low	1506	-0.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1032	16000	1300	140	Moderate turbidity. Dredging midway between south end of jetty and breakwall. Much trash, debris.
2	1020	500	< 20	7	Moderate turbidity. Much floating trash.
3	1007	80	20	2	Moderate turbidity.
4	1110	20	< 20	< 2	Moderate turbidity. Five rowers in channel.
5	935	40	40	4	Moderate turbidity.
6	948	70	50	< 2	Moderate turbidity. Floating trash and oil film.
7	1130	20	< 20	< 2	Moderate turbidity.
8	826	300	80	7	Moderate turbidity.
9	922	20	< 20	2	Moderate turbidity.
10	855	700	50	8	Moderate turbidity. Floating oil film.
11	910	20	20	17	Moderate turbidity.
12	1045	≥ 16000	1100	900	Moderate turbidity. Man feeding seagulls. Much trash against canal walls.
13	1211	2400	50	50	Moderate turbidity.
18	817	50	< 20	17	Moderate turbidity.
19	740	80	20	5	Moderate turbidity. Rower in channel.
20	848	≥ 16000	9000	220	Moderate turbidity. Man washing off dock area. Floating oil, leaves, and organic debris.
22	722	16000	80	50	Moderate turbidity.
25	1120	20	< 20	< 2	Moderate turbidity.
	Average	3795.6	662.8	79.8	
	Number	18	18	18	
	St. Dev.	6735.8	2114.6	212.7	
	Maximum	16000	9000	900	
	Minimum	20	20	2	

Physical Water Quality Data **February 4, 2000**

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	722	5.9
RAIN:	Light	M. Meyer	Low	1436	-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 mg/l	BOD mg/l
1		0	14.80	32.65	6.24	7.99	63.22	89.2	13	3.2	0.13	1.6
1k WSW	1026	1	14.80	33.20	6.21	8.01	66.07	90.2				
		2	14.81	33.27	6.21	8.02	66.01	90.1			0.02	2.9
		3	14.81	33.32	6.17	8.03	65.87	90.1				
		4	14.81	33.35	6.12	8.04	65.47	90.0			0.01	2.5
		5	14.79	33.37	6.15	8.03	64.24	89.5				
		6	14.67	33.43	6.23	8.02	57.47	87.1			0.01	1.8
2	1016	0	14.86	33.20	6.31	7.99	55.76	86.4	15	2.3	0.01	4.3
1k WSW		1	14.85	33.22	6.35	7.98	56.02	86.5				
		2	14.83	33.27	6.39	7.98	56.25	86.6			0.01	3.2
		3	14.80	33.36	6.39	7.98	56.82	86.8				
		4	14.79	33.39	6.34	7.99	56.61	86.7			0.01	3.4
		5	14.78	33.41	6.29	7.98	55.70	86.4				
		6	14.76	33.42	6.32	7.99	54.25	85.8			0.01	3.8
3	959	0	15.08	33.14	6.45	7.89	63.93	89.4	10	3.2	0.04	1.0
1k WSW		1	15.05	33.17	6.46	7.88	65.25	89.9				
		2	14.98	33.23	6.49	7.91	60.87	88.3			0.02	0.9
		3	14.97	33.25	6.48	7.93	59.73	87.9				
		4									0.16	1.0
4	1059	0	15.20	33.13	5.76	7.91	63.08	89.1	10	3.2	0.04	1.6
1k WSW		1	15.19	33.14	5.80	7.91	62.98	89.1				
		2	15.13	33.17	5.88	7.91	63.00	89.1			0.02	1.2
		3	15.12	33.14	5.82	7.92	64.77	89.7				
		4									0.01	1.3
5	935	0	15.45	32.93	5.71	7.88	65.94	90.1	10	3.2	0.03	1.2
1k WSW		1	15.44	32.93	5.71	7.87	65.27	89.9				
		2	15.34	32.99	5.73	7.88	62.69	89.0			0.03	1.0
		3	15.16	33.12	5.69	7.91	59.54	87.8				
		4	15.04	33.22	5.61	7.93	59.22	87.7			0.03	0.9
		5	14.98	33.29	5.63	7.96	57.62	87.1				
		6	14.98	33.30	5.63	7.98	51.38	84.7			0.02	1.2
6	949	0	15.27	32.97	5.39	7.85	56.88	86.8	11	2.4	0.03	0.6
1k WSW		1	15.26	32.98	5.40	7.87	56.84	86.8				
		2	15.26	32.99	5.60	7.86	56.99	86.9			0.03	0.5
		3	15.27	33.02	5.61	7.85	52.08	85.0				
		4	15.29	33.03	5.45	7.82	27.29	72.3			0.03	0.5
7	1117	0	15.52	33.07	5.89	7.85	69.87	91.4	11	2.9	0.06	0.6
1k WSW		1	15.52	33.07	5.93	7.86	69.73	91.4				
		2	15.50	33.04	5.90	7.85	66.89	90.4			0.04	0.6
		3	15.30	33.15	5.66	7.86	59.83	87.9				
		4	15.20	33.23	5.74	7.89	53.89	85.7			0.03	0.8
8	823	0	15.43	32.84	5.94	7.80	56.84	86.8	11	2.4	0.05	0.9
1k WSW		1	15.41	32.82	5.98	7.80	56.52	86.7				
		2	15.31	32.82	5.95	7.80	55.10	86.2			0.03	0.8
		3	15.25	33.01	5.91	7.79	51.70	84.8				

		4	15.54	32.91	5.88	7.78	47.95	83.2			0.03	0.7

February 4, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	920	0	15.58	32.97	5.27	7.85	47.74	83.1	12	2.0	0.05	0.0
1k WSW		1	15.55	32.98	5.30	7.85	47.89	83.2				
		2	15.44	33.05	5.50	7.86	49.82	84.0			0.03	1.1
		3	15.38	33.10	5.74	7.87	51.14	84.6				
		4	15.32	33.14	5.59	7.87	45.76	82.2			0.03	0.9
10	856	0	15.30	32.78	5.88	7.81	65.43	89.9	10	2.8	0.07	3.4
1k WSW		1	15.40	32.82	5.87	7.82	63.82	89.4				
		2	15.56	32.92	5.80	7.83	61.37	88.5			0.06	0.5
		3	15.64	32.93	5.74	7.84	51.73	84.8				
		4	15.60	32.97	5.80	7.84	50.59	84.3			0.06	0.7
11	910	0	15.46	32.93	5.41	7.84	59.05	87.7	10	2.6	0.07	0.9
1k WSW		1	15.47	32.94	5.53	7.83	58.01	87.3				
		2	15.47	32.97	5.78	7.84	54.62	86.0			0.04	0.7
		3	15.37	33.06	5.73	7.85	51.49	84.7				
		4	15.28	33.15	5.61	7.88	48.26	83.3			0.04	0.6
12	1038	0	14.97	29.13	4.53	7.85	47.22	82.9	16	2.8	0.15	1.6
1k WSW		1	14.96	31.13	4.47	7.89	42.17	80.6				
		2	14.92	33.04	4.39	7.96	62.91	89.1			0.11	2.6
		3	14.88	33.20	4.41	8.01	69.54	91.3				
13	735	0	15.32	32.91	5.46	7.81					0.08	5.6
18	810	0	15.25	32.81	6.30	7.80	50.85	84.4	10	2.1	0.02	1.0
1k WSW		1	15.25	32.80	6.31	7.80	50.88	84.5				
		2	15.21	32.82	6.30	7.79	50.81	84.4			0.02	1.0
19	748	0	14.60	33.08	5.61	7.67					0.00	1.4
20	847	0	15.41	32.71	6.05	7.78	63.94	89.4	11	2.3	0.01	11.5
1k WSW		1	15.48	32.72	6.23	7.79	61.62	88.6				
		2	15.50	32.75	6.16	7.80	58.85	87.6			0.08	3.0
22	720	0	15.25	32.96	5.30	7.62					0.08	4.2
25	1105	0	15.24	33.10	5.29	7.87	70.28	91.6	10	3.4	0.04	2.8
1k WSW		1	15.23	33.10	5.32	7.88	70.17	91.5				
		2	15.11	33.18	5.41	7.89	66.71	90.4			0.03	1.2
		3	14.99	33.26	5.40	7.93	46.18	82.4				
		4	14.96	33.29	5.38	7.95	41.59	80.3			0.03	0.9
	Average		15.18	33.00	5.79	7.88	57.62	86.96	11.33	2.72	0.04	1.79
	Number		77	77	77	77	74	74	15	15	48	48
	St. Dev.		0.27	0.53	0.47	0.08	7.92	3.22	1.91	0.46	0.04	1.89
	Maximum		15.64	33.43	6.49	8.04	70.28	91.56	16.00	3.40	0.16	11.48
	Minimum		14.60	29.13	4.39	7.62	27.29	72.28	10.00	2.00	0.00	0.04

Surface Bacteriological Water Data and General Observations **February 4, 2000**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.:	J. Gelsinger	High	722	5.9
RAIN:	Light		M. Meyer	Low	1436	-0.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1026	1700	300	500	Moderate turbidity.
2	1016	20	20	8	Heavy turbidity. Dredging being conducted on north side of north jetty.
3	959	500	500	22	Moderate turbidity.
4	1059	110	80	8	Moderate turbidity.
5	935	300	230	22	Moderate turbidity.
6	949	110	20	2	Moderate turbidity.
7	1117	20	20	17	Moderate turbidity.
8	823	340	20	4	Moderate turbidity.
9	920	20	< 20	< 2	Moderate turbidity.
10	856	800	80	80	Moderate turbidity.
11	910	110	< 20	8	Moderate turbidity.
12	1038	≥ 16000	1700	1600	Moderate turbidity. Floating plastic.
13	735	500	170	170	Heavy turbidity. Floating trash, leaves, styrofoam cups.
18	810	50	20	2	Moderate turbidity.
19	748	20	< 20	14	Moderate turbidity. Swimming closure sign.
20	847	1300	80	22	Moderate turbidity. Soapy runoff and oil from boats.
22	720	1100	260	500	Heavy turbidity. Floating oil and organic debris.
25	1105	40	< 20	29	Moderate turbidity. Floating oil and trash.
	Average	1280.0	198.9	167.2	
	Number	18	18	18	
	St. Dev.	3707.6	397.8	390.7	
	Maximum	16000	1700	1600	
	Minimum	20	20	2	

Physical Water Quality Data — **March 2, 2000**

CRUISE: MDR 99-00 — Vessel: Aquatic Bioassay
WEATHER: Clear — Pers.: J. Gelsinger, J. Mann
RAIN: None

TIDE	TIME	HT. (ft)
High	646	5.2
Low	1349	-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 mg/l	BOD mg/l
1	952	0	14.65	30.31	6.09	7.85	55.13	86.2	10	2.7	0.01	2.8
1k WSW		1	14.62	32.01	6.02	7.86	46.59	82.6				
		2	14.56	32.94	5.93	7.91	62.05	88.8			0.03	1.0
		3	14.44	33.09	5.95	7.91	60.91	88.3				
		4	14.23	33.28	6.06	7.90	46.23	82.5			0.06	1.0
		5	14.19	33.29	6.15	7.90	33.60	76.1				
		6	13.99	33.39	6.14	7.88	17.52	64.7			0.46	1.0
2	945	0	14.65	32.76	6.49	7.90	57.75	87.2	10	3.0	0.33	2.7
1k WSW		1	14.62	32.78	6.50	7.90	57.16	87.0				
		2	14.58	32.85	6.51	7.90	56.79	86.8			0.71	1.5
		3	14.46	33.03	6.48	7.92	55.39	86.3				
		4	14.29	33.23	6.49	7.92	51.59	84.8			0.49	1.3
		5	14.24	33.28	6.45	7.91	44.65	81.7				
		6	14.18	33.31	6.49	7.90	38.95	79.0			0.01	1.5
3	935	0	14.69	32.78	6.24	7.89	60.93	88.4	12	2.9	0.04	2.0
1k WSW		1	14.69	32.78	6.22	7.89	60.77	88.3				
		2	14.69	32.79	6.22	7.88	60.99	88.4			0.11	1.1
		3	14.67	32.83	6.24	7.89	60.55	88.2				
		4	14.67	32.83	6.21	7.89	59.39	87.8			0.01	1.1
4	1016	0	14.95	32.49	6.14	7.84	70.74	91.7	10	3.9	0.01	2.5
1k WSW		1	14.90	32.54	6.14	7.84	70.45	91.6				
		2	14.86	32.62	6.17	7.85	70.00	91.5			0.06	0.9
		3										
		4									0.01	0.9
5	906	0	14.97	32.38	6.32	7.86	68.22	90.9	11	3.3	0.05	2.4
1k WSW		1	14.94	32.46	6.33	7.86	65.68	90.0				
		2	14.96	32.62	6.34	7.87	63.70	89.3			0.79	0.9
		3	14.92	32.85	6.30	7.88	61.07	88.4				
		4	14.87	33.05	6.27	7.90	59.69	87.9			0.26	1.0
		5	14.88	33.08	6.29	7.90	47.82	83.2				
		6									0.02	3.6
6	917	0	14.66	32.38	6.26	7.84	69.52	91.3	11	3.1	0.01	2.8
1k WSW		1	14.64	32.41	6.26	7.84	69.05	91.2				
		2	14.59	32.70	6.27	7.84	69.07	91.2			0.01	0.8
		3	14.95	32.76	6.16	7.84	63.44	89.2				
		4	14.97	32.80	6.17	7.85	52.35	85.1			0.13	1.9
7	1039	0	15.21	32.58	6.04	7.83	73.55	92.6	10	2.9	0.60	2.3
2k WSW		1	15.12	32.67	6.02	7.84	71.42	91.9				
		2	15.12	32.79	6.01	7.85	67.98	90.8			0.37	1.0
		3	15.05	32.94	6.03	7.85	62.70	89.0				
		4									0.87	1.0
8	807	0	14.73	32.27	6.43	7.83	63.16	89.1	10	3.1	0.18	2.2
1k WSW		1	14.73	32.31	6.41	7.84	63.07	89.1				
		2	14.89	32.57	6.33	7.84	60.52	88.2			0.96	1.4
		3	15.12	32.67	6.35	7.85	46.66	82.6				

		4	15.13	32.77	6.34	7.84	44.76	81.8			0.58	1.6

March 2, 2000 **(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	858	0	15.17	32.44	6.06	7.83	69.38	91.3	11	2.6	0.02	2.4
1k WSW		1	15.26	32.50	6.04	7.85	65.68	90.0				
		2	15.14	32.70	6.06	7.87	54.75	86.0			0.03	1.2
		3	15.07	32.78	6.07	7.88	52.61	85.2				
		4									0.54	3.8
10	830	0	14.71	32.35	5.90	7.79	65.26	89.9	11	3.1	0.01	1.9
1k WSW		1	14.88	32.44	5.86	7.79	63.53	89.3				
		2	15.11	32.56	5.85	7.81	57.63	87.1			0.14	1.0
		3	15.16	32.64	5.92	7.83	52.33	85.1				
		4	15.14	32.59	5.92	7.83	45.33	82.1			0.65	1.3
11	845	0	14.94	32.29	6.18	7.83	68.62	91.0	11	3.2	0.49	2.4
1k WSW		1	14.94	32.44	6.17	7.83	67.88	90.8				
		2	15.01	32.62	6.14	7.85	61.25	88.5			0.04	1.1
		3	14.96	32.18	6.18	7.87	55.07	86.1				
		4	14.96	31.29	6.22	7.86	31.89	75.1			0.01	1.0
12	1000	0	14.79	29.52	5.61	7.82	23.58	69.7	16	3.2	0.27	2.1
1k WSW		1	14.93	31.50	5.50	7.81	32.85	75.7				
		2	14.72	32.66	5.51	7.85	61.78	88.7			0.11	1.5
13	720	0	14.80	31.95	6.60	8.04					0.03	5.1
18	755	0	14.55	32.23	6.55	7.82	63.32	89.2	10	3.1	0.01	2.3
1k WSW		1	14.55	32.24	6.56	7.82	62.63	89.0				
		2									0.01	3.0
19	732	0	12.80	32.29	5.93	8.05					0.01	3.2
20	825	0	15.02	32.20	6.05	7.79	64.96	89.8	10	3.2	0.07	5.3
1k WSW		1	15.04	32.24	6.06	7.80	64.57	89.6				
		2									0.01	3.0
22	707	0	14.85	32.07	5.90	8.00					0.04	4.6
25	1025	0	14.96	32.51	5.67	7.83	73.96	92.7	11	3.9	0.01	1.9
1k WSW		1	14.94	32.54	5.68	7.83	73.36	92.5				
		2	14.89	32.72	5.73	7.84	72.01	92.1			0.01	0.9
		3	14.84	33.02	5.81	7.86	61.04	88.4				
		4	14.84	33.06	5.79	7.86	53.56	85.5			0.01	0.7
		5	14.83	33.06	5.77	7.87	48.94	83.6				
		6									0.02	2.2
	Average		14.78	32.55	6.13	7.86	58.11	86.88	10.9	3.1	0.20	2.0
	Number		72	72	72	72	69	69	15	15	49.00	49.0
	St. Dev.		0.36	0.60	0.25	0.05	11.80	5.25	1.5	0.4	0.27	1.1
	Maximum		15.26	33.39	6.60	8.05	73.96	92.74	16	3.9	0.96	5.3
	Minimum		12.80	29.52	5.50	7.79	17.52	64.70	10	2.6	0.01	0.7

Surface Bacteriological Water Data and General Observations

March 2, 2000

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	646	5.2
RAIN:	None	J. Mann	Low	1349	-0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	952	3000	1100	80	Moderate turbidity.
2	945	20	< 20	5	Moderate turbidity.
3	935	< 20	< 20	13	Heavy turbidity. Floating plastic and organic debris. Current from gate at about 4 kn.
4	1016	50	20	5	Moderate turbidity.
5	906	60	20	2	Moderate turbidity. Floating plastic.
6	917	< 20	< 20	< 2	Moderate turbidity.
7	1039	20	20	5	Moderate turbidity.
8	807	110	20	2	Moderate turbidity.
9	858	< 20	< 20	2	Moderate turbidity.
10	830	230	230	13	Moderate turbidity.
11	845	80	< 20	17	Moderate turbidity.
12	1000	≥ 16000	800	80	Heavy turbidity. Floating plastic and organic debris. Current from channel at about 5 kn.
13	720	2800	9000	240	Heavy turbidity. Floating oil, plastic, and organic debris.
18	755	230	80	7	Moderate turbidity.
19	732	230	20	14	Moderate turbidity.
20	825	300	110	12	Moderate turbidity. Floating oil and organic debris.
22	707	1300	170	300	Moderate turbidity. Floating organic debris. Coots, mallards, seagulls on water.
25	1025	< 20	< 20	2	Moderate turbidity.
	Average	1361.7	650.6	44.5	
	Number	18	18	18	
	St. Dev.	3768.5	2105.1	86.0	
	Maximum	16000	9000	300	
	Minimum	20	20	2	

Physical Water Quality Data — **April 12, 2000**

CRUISE:	MDR 00-04	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy to Foggy	Pers.: J. Gelsinger	High	437	4.7
RAIN:	None	J. Mann	Low	1202	-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 mg/l	BOD mg/l
1	1000	0	18.30	27.59	6.94	8.23	20.04	66.9	11	1.9	0.06	3.4
1k WSW		1	17.55	30.23	6.98	8.15	38.77	78.9				
		2	16.36	33.37	7.00	8.16	46.77	82.7			0.02	4.8
		3	16.17	33.55	6.54	8.18	44.63	81.7				
		4	16.05	33.53	6.24	8.16	47.33	82.9			< 0.01	7.2
		5	15.53	33.59	6.64	8.12	52.25	85.0				
		6									0.01	7.1
2	952	0	18.08	33.10	6.92	8.07	43.85	81.4	11	2.0	0.01	3.6
1k WSW		1	18.14	33.10	6.91	8.06	43.41	81.2				
		2	17.89	33.05	6.97	8.06	42.79	80.9			0.07	3.0
		3	17.39	33.03	7.14	8.08	42.54	80.8				
		4	16.40	33.13	7.33	8.09	42.71	80.8			0.01	3.8
		5	15.90	33.52	7.40	8.10	45.39	82.1				
		6									< 0.01	3.6
3	945	0	17.90	32.96	5.80	7.98	46.18	82.4	10	1.8	0.01	3.1
1k WSW		1	17.88	33.00	5.79	7.98	45.46	82.1				
		2	17.87	33.03	5.84	8.00	45.22	82.0			0.05	2.9
4	1030	0	18.54	33.32	6.46	8.01	43.75	81.3	11	1.7	< 0.01	2.6
1k WSW		1	18.53	33.30	6.66	8.01	43.70	81.3				
		2	18.47	33.01	6.73	8.01	44.93	81.9			0.02	2.2
		3	18.06	32.99	6.80	8.01	45.40	82.1				
		4									0.04	2.0
5	917	0	18.83	33.20	6.55	8.05	40.51	79.8	11	2.1	< 0.01	2.0
1k WSW		1	18.68	33.18	6.59	8.06	38.44	78.7				
		2	18.28	32.98	6.69	8.06	33.69	76.2			< 0.01	2.4
		3	17.38	32.95	6.83	8.04	30.91	74.6				
		4	16.08	33.75	7.08	8.02	28.99	73.4			0.01	2.8
6	930	0	18.43	33.36	6.35	8.06	50.29	84.2	10	1.8	< 0.01	1.8
1k WSW		1	18.39	33.35	6.37	8.06	49.77	84.0				
		2	18.17	33.19	6.43	8.05	49.08	83.7			0.01	1.6
		3	17.29	33.84	6.59	8.01	43.32	81.1				
		4									< 0.01	1.6
7	755	0	18.57	33.34	6.57	7.97	54.49	85.9	11	2.1	< 0.01	2.1
1k WSW		1	18.55	33.29	6.59	7.96	54.46	85.9				
		2	17.92	33.44	6.70	7.96	51.26	84.6			0.08	1.9
		3	17.40	33.47	6.79	7.94	45.03	81.9				
		4	16.71	33.92	6.90	7.94	40.38	79.7			< 0.01	2.0
8	905	0	18.81	33.28	6.61	8.05	33.78	76.2	11	1.7	0.03	2.3
1k WSW		1	18.78	33.20	6.61	8.05	33.37	76.0				
		2	18.42	33.18	6.72	8.04	29.08	73.4			0.01	2.2
		3	17.67	33.46	6.86	7.95	13.03	60.1				
		4									0.04	2.4

April 12, 2000 **(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	815	0	18.88	32.94	5.99	7.94	47.62	83.1	11	1.9	0.07	2.6
1k WSW		1	18.60	32.98	6.13	7.95	38.40	78.7				
		2	17.54	33.34	6.41	7.93	29.67	73.8			0.05	2.5
		3	17.04	33.58	6.37	7.90	19.21	66.2				
10	844	0	18.37	33.02	5.81	7.92	21.09	67.8	12	0.9	0.01	2.6
1k WSW		1	18.32	33.06	5.80	7.92	20.79	67.5				
		2	18.10	33.08	5.77	7.92	18.33	65.4			0.07	2.6
		3	17.45	33.43	5.91	7.92	14.95	62.2				
		4	17.33	33.52	5.88	7.88	10.65	57.1			0.01	2.5
11	825	0	18.86	33.19	6.22	7.99	46.52	82.6	11	1.6	0.02	1.9
1k WSW		1	18.85	33.10	6.24	7.99	45.70	82.2				
		2	18.43	32.95	6.40	8.00	35.84	77.4			0.07	2.0
		3	17.20	33.44	6.62	7.97	27.83	72.6				
		4	16.66	33.65	6.75	7.88	15.98	63.2			0.06	3.6
12	1015	0	18.97	23.17	6.02	8.31	9.34	55.3	10	2.2	0.02	6.9
1k WSW		1	17.36	30.39	6.24	8.04	7.98	53.1				
		2	16.67	31.52	6.19	8.07	47.70	83.1			0.02	4.5
13	730	0	18.36	33.46	6.64	8.04					0.01	3.2
18	857	0	18.73	33.36	6.37	8.05	34.57	76.7	11	1.7	< 0.01	2.0
1k WSW		1	18.71	33.35	6.38	8.05	33.72	76.2				
		2	18.52	33.43	6.42	8.04	28.24	72.9			< 0.01	2.0
19	740	0	18.30	33.69	6.58	8.04					0.04	1.8
20	837	0	18.18	31.90	6.06	7.87	9.09	54.9	12	0.4	< 0.01	3.0
1k WSW		1	18.20	32.42	5.85	7.87	13.57	60.7				
		2									< 0.01	2.4
22	715	0	17.70	33.08	6.72	8.11					0.01	2.7
25	1040	0	18.61	33.31	5.61	7.99	46.96	82.8	11	1.8	0.06	1.9
1k WSW		1	18.58	33.27	5.65	7.99	46.45	82.6				
		2	18.47	33.03	5.88	7.99	46.39	82.5			0.01	1.9
		3	17.46	33.22	6.37	7.97	48.24	83.3				
		4	16.43	33.78	6.35	7.94	44.86	81.8			0.01	1.5
	Average		17.85	32.90	6.46	8.02	36.79	76.62	10.9	1.7	0.02	2.8
	Number		67	67	67	67	64	64	15	15	45.00	45.0
	St. Dev.		0.86	1.52	0.42	0.08	12.92	8.57	0.6	0.5	0.02	1.4
	Maximum		18.97	33.92	7.40	8.31	54.49	85.92	12	2.2	0.08	7.2
	Minimum		15.53	23.17	5.61	7.87	7.98	53.15	10	0.4	0.01	1.5

Surface Bacteriological Water Data and General Observations **April 12, 2000**

CRUISE:	MDR 00-04	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy to Foggy	Pers.: J. Gelsinger	High	437	4.7
RAIN:	None	J. Mann	Low	1202	-0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1000	5000	2200	13	Moderate turbidity.
2	952	50	50	2	Moderate turbidity.
3	945	500	20	14	Heavy turbidity. Moderate flow from gate.
4	1030	50	< 20	< 2	Moderate turbidity.
5	917	50	20	30	Moderate turbidity. Floating plastic debris.
6	930	130	20	46	Moderate turbidity.
7	755	< 20	< 20	< 2	Moderate turbidity. Floating plastic, wood, paper debris.
8	905	110	20	< 2	Moderate turbidity. Floating plastic debris.
9	815	20	< 20	50	Moderate turbidity.
10	844	3000	500	11	Heavy turbidity.
11	825	130	20	30	Moderate turbidity.
12	1015	5000	1700	50	Heavy turbidity. Floating plastic debris.
13	730	1400	80	50	Heavy turbidity. Large mats of floating algae. Ducks in water. Floating plastic bags.
18	857	170	20	5	Moderate turbidity.
19	740	230	80	7	Moderate turbidity.
20	837	2200	170	80	Heavy turbidity.
22	715	≥ 16000	230	500	Moderate turbidity. Large mats of floating algae. Herons and egrets nearby.
25	1040	50	50	2	Moderate turbidity.
	Average	1895.0	291.1	49.8	
	Number	18	18	18	
	St. Dev.	3892.3	621.1	114.7	
	Maximum	16000	2200	500	
	Minimum	20	20	2	

Physical Water Quality Data May 25, 2000

CRUISE:	MDR 00-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	147	4.0
RAIN:	None	J. Mann	Low	947	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 mg/l	BOD mg/l
1	1007	0	17.79	28.29	7.33	7.91	55.41	86.3	11	2.3	0.22	1.9
2k WSW		1	17.66	30.13	7.52	7.90	56.37	86.6				
		2	17.24	33.04	7.68	7.92	62.38	88.9			0.11	0.9
		3	17.15	33.37	7.72	7.92	66.37	90.3				
		4	17.11	33.40	7.68	7.93	69.67	91.4			0.10	0.9
		5	16.73	33.43	7.60	7.93	70.94	91.8				
		6	15.68	34.08	7.52	7.91	73.41	92.6			0.09	0.8
2	955	0	17.67	32.77	7.35	7.94	59.75	87.9	11	2.3	0.08	1.6
2k WSW		1	17.67	32.97	7.52	7.94	59.39	87.8				
		2	17.74	33.27	7.52	7.94	57.50	87.1			0.06	1.1
		3	17.61	33.36	7.18	7.93	55.28	86.2				
		4	17.33	33.45	7.27	7.91	53.77	85.6			0.07	1.1
		5	17.05	33.59	6.90	7.90	51.59	84.8				
		6									0.11	1.0
3	940	0	17.96	33.34	5.57	7.85	53.30	85.4	11	2.2	0.08	1.3
2k WSW		1	17.96	33.34	5.88	7.84	53.57	85.6				
		2	17.94	33.35	6.03	7.85	53.69	85.6			0.09	1.1
		3	17.90	33.39	6.06	7.86	52.65	85.2				
		4	17.87	33.39	6.52	7.88	50.54	84.3			0.08	1.1
4	1038	0	18.19	33.42	6.70	7.89	54.39	85.9	11	2.2	0.07	1.2
1k WSW		1	18.18	33.43	6.74	7.89	53.68	85.6				
		2	18.16	33.43	6.78	7.89	53.60	85.6			0.07	1.1
		3	18.16	33.43	6.70	7.88	53.16	85.4				
5	859	0	18.51	33.44	6.37	7.81	52.37	85.1	11	1.9	0.11	1.1
2k WSW		1	18.51	33.44	6.27	7.82	50.93	84.5				
		2	18.44	33.47	6.25	7.84	48.50	83.5			0.08	1.1
		3	18.43	33.30	6.04	7.82	42.02	80.5				
		4	18.01	33.52	5.80	7.80	40.20	79.6			0.02	1.1
6	915	0	18.29	33.54	5.27	7.77	56.77	86.8	11	2.3	0.02	0.8
2k WSW		1	18.29	33.55	5.39	7.78	55.86	86.5				
		2	18.28	33.56	5.41	7.77	55.09	86.2			0.01	0.7
		3	18.27	33.56	5.23	7.76	52.90	85.3				
7	1105	0	18.48	33.43	5.96	7.83	51.49	84.7	11	1.9	0.04	0.9
1k WSW		1	18.48	33.44	6.13	7.83	50.12	84.1				
		2	18.44	33.43	6.04	7.83	49.44	83.9			0.09	0.9
		3	18.41	33.44	5.92	7.84	49.03	83.7				
		4									0.04	1.0
8	745	0	18.72	33.53	5.06	7.71	53.39	85.5	10	2.0	0.13	0.8
1k WSW		1	18.72	33.53	5.02	7.71	52.62	85.2				
		2	18.72	33.53	5.06	7.72	52.24	85.0			0.15	0.9
		3	18.71	33.54	5.09	7.71	51.11	84.6				
		4									0.14	0.9

May 25, 2000 (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	845	0	18.49	32.77	5.39	7.66	49.77	84.0	11	1.7	0.11	0.6
2k WSW		1	18.48	33.09	5.38	7.67	42.11	80.6				
		2	18.47	33.32	5.70	7.77	35.64	77.3			0.11	0.7
10	815	0	18.71	33.16	4.25	7.59	57.49	87.1	11	1.9	0.12	2.4
1k WSW		1	18.68	33.31	4.26	7.60	57.94	87.2				
		2	18.63	33.39	4.42	7.65	56.05	86.5			0.11	2.3
		3	18.59	33.42	4.45	7.68	43.89	81.4				
		4	18.51	33.44	4.73	7.72	5.36	48.1			0.15	2.3
11	833	0	18.86	33.19	6.22	7.99	46.52	82.6	11	2.0	0.09	0.9
1k WSW		1	18.85	33.10	6.24	7.99	45.70	82.2				
		2	18.43	32.95	6.40	8.00	35.84	77.4			0.08	0.6
		3	17.20	33.44	6.62	7.97	27.83	72.6				
12	1020	0	18.67	19.92	5.72	7.97	52.75	85.2	11	2.3	0.19	2.2
1k WSW		1	18.35	25.83	4.59	7.86	32.99	75.8				
		2	17.77	32.34	5.43	7.81	40.42	79.7			0.18	2.2
13	700	0	19.00	33.90	2.00	7.60					0.09	2.9
18	734	0	18.67	33.44	5.38	7.68	51.54	84.7	10	1.8	0.30	1.3
1k WSW		1	18.68	33.49	5.23	7.69	49.96	84.1				
		2	18.66	33.51	4.90	7.71	49.62	83.9			0.08	1.5
19	720	0	18.07	33.65	5.11	7.74					0.06	5.1
20	808	0	18.72	32.95	3.67	7.56	54.77	86.0	10	1.6	0.08	1.8
1k WSW		1	18.76	33.08	3.63	7.57	54.32	85.8				
22	650	0	19.77	33.72	3.70	7.56					0.08	3.8
25	1050	0	18.38	33.43	6.54	7.89	54.84	86.1	11	2.0	0.02	1.1
1k WSW		1	18.37	33.39	6.37	7.89	54.12	85.8				
		2	18.28	33.39	6.54	7.88	52.77	85.2			0.02	1.0
		3	18.16	33.34	6.45	7.87	50.66	84.4				
		4	17.84	33.46	6.25	7.86	43.48	81.2			0.06	1.0
	Average		18.19	32.93	5.91	7.81	51.26	84.14	10.8	2.0	0.10	1.4
	Number		67	67	67	67	64	64	15	15	42.00	42.0
	St. Dev.		0.62	2.00	1.16	0.12	9.89	5.71	0.4	0.2	0.06	0.9
	Maximum		19.77	34.08	7.72	8.00	73.41	92.56	11	2.3	0.30	5.1
	Minimum		15.68	19.92	2.00	7.56	5.36	48.12	10	1.6	0.01	0.6

Surface Bacteriological Water Data and General Observations **May 25, 2000**

CRUISE:	MDR 00-00	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.:	J. Gelsinger	High	147	4.0
RAIN:	None		J. Mann	Low	947	0.6

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1007	2400	140	29	Moderate turbidity. Floating plastic bags.
2	955	20	< 20	5	Moderate turbidity. Floating plastic bags.
3	940	20	20	4	Moderate turbidity. Venice Canal gate closed.
4	1038	50	50	2	Moderate turbidity.
5	859	50	< 20	5	Moderate turbidity. Floating plastic bags.
6	915	40	20	< 2	Moderate turbidity.
7	1105	1100	700	9	Moderate turbidity.
8	745	50	50	5	Moderate turbidity.
9	845	110	20	9	Moderate turbidity.
10	815	3000	90	170	Moderate turbidity. Jellyfish in water column.
11	833	16000	70	< 2	Moderate turbidity.
12	1020	3000	700	2	High turbidity. Floating plastic bags.
13	700	1100	80	34	Moderate turbidity. Ducks and herons on shore. Jellyfish in water column.
18	734	20	< 20	< 2	Moderate turbidity.
19	720	220	80	17	Moderate turbidity.
20	808	≥ 16000	800	1600	Moderate turbidity. Jellyfish in water column.
22	650	≥ 16000	100	1600	Moderate turbidity. Large floating algal mats. Jellyfish in water column.
25	1050	80	< 20	< 2	Moderate turbidity.
	Average	3292.2	166.7	194.4	
	Number	18	18	18	
	St. Dev.	5936.7	263.8	512.9	
	Maximum	16000	800	1600	
	Minimum	20	20	2	

Physical Water Quality Data **June 27, 2000**

CRUISE:	MDR 00-06	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	642	3.5
RAIN:	None	J. Mann	Low	1158	1.5

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	1031	0	20.38	31.53	6.28	8.05	60.08	88.0	11	2.8	0.12	2.2
4k WSW		1	20.24	32.41	6.41	8.04	59.38	87.8				
		2	19.82	33.89	6.49	8.03	59.44	87.8			0.16	2.8
		3	19.39	34.49	6.53	8.02	57.81	87.2				
		4	19.37	34.57	6.29	8.02	57.65	87.1			0.12	2.1
		5	19.37	34.56	6.09	8.03	57.49	87.1				
		6	19.26	34.45	6.17	8.02	57.38	87.0			0.13	2.1
2	1016	0	21.13	34.72	6.27	8.00	52.63	85.2	11	2.9	0.10	2.6
4k WSW		1	21.10	34.62	6.37	8.00	51.88	84.9				
		2	20.78	34.57	6.45	8.02	52.10	85.0			0.10	2.6
		3	20.45	34.57	6.49	8.04	53.15	85.4				
		4	20.23	34.36	6.45	8.05	53.95	85.7			0.10	2.6
		5	19.60	34.18	6.48	8.04	54.76	86.0				
		6	18.32	34.57	6.71	8.04	57.62	87.1			0.10	2.1
3	1005	0	20.97	34.68	5.48	7.92	61.74	88.6	11	2.2	0.13	1.6
4k WSW		1	20.95	34.67	5.70	7.92	61.01	88.4				
		2	20.90	34.66	5.96	7.94	59.51	87.8			0.13	1.6
		3	20.76	34.68	5.57	7.95	58.62	87.5				
		4	20.67	34.74	5.70	7.95	58.60	87.5			0.09	1.3
4	1055	0	21.48	34.87	5.89	7.95	56.15	86.6	11	2.9	0.07	1.9
4k WSW		1	21.46	34.84	6.01	7.95	55.83	86.4				
		2	21.44	34.73	6.01	7.95	56.40	86.7			0.07	1.8
		3	21.34	34.28	6.10	7.95	56.02	86.5				
		4	20.16	34.95	6.23	7.99	54.78	86.0			0.08	1.8
5	935	0	22.02	34.91	5.85	7.93	61.63	88.6	11	3.2	0.08	1.7
1k WSW		1	22.02	34.88	5.95	7.94	60.50	88.2				
		2	21.91	34.85	6.05	7.94	53.09	85.4			0.08	1.8
		3	21.74	34.71	6.13	7.94	54.05	85.7				
		4	21.06	34.87	6.03	7.93	55.15	86.2			0.06	1.7
		5	21.01	34.90	6.08	7.89	31.79	75.1				
6	946	0	21.49	34.91	6.10	7.96	64.97	89.8	11	3.4	0.06	1.7
1k WSW		1	21.50	34.90	6.16	7.96	64.38	89.6				
		2	21.47	34.91	6.16	7.96	63.61	89.3			0.06	1.1
		3	21.46	34.88	6.17	7.95	63.51	89.3				
		4	21.46	34.86	6.16	7.94	63.45	89.2			0.06	1.2
7	1115	0	22.05	34.95	5.77	7.92	56.81	86.8	11	2.2	0.06	1.3
2k WSW		1	22.04	34.92	5.85	7.92	56.62	86.7				
		2	21.98	34.85	5.87	7.91	56.24	86.6			0.07	1.2
		3	21.69	34.79	5.90	7.87	51.09	84.5				
		4	21.39	34.86	5.94	7.82	40.89	80.0			0.05	1.5
8	826	0	21.89	34.94	5.73	7.87	64.08	89.5	11	3.3	0.06	1.9
1k WSW		1	21.90	34.94	5.77	7.87	62.81	89.0				
		2	21.89	34.94	5.68	7.88	63.47	89.3			0.07	1.8
		3	21.84	34.92	5.64	7.86	60.76	88.3				
		4	21.73	34.95	5.69	7.85	59.30	87.8			0.07	1.5

June 27, 2000 **(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	922	0	21.96	34.49	5.05	7.78	51.52	84.7	11	3.2	0.07	2.8
1k WSW		1	21.99	34.62	5.06	7.79	49.03	83.7				
		2	21.80	34.67	5.08	7.79	27.68	72.5			0.07	3.6
		3	21.60	34.77	5.11	7.67	22.26	68.7				
		4	21.43	34.86	5.11	7.74	21.94	68.4			0.11	4.8
10	856	0	21.99	34.76	4.67	7.77	52.60	85.2	11	2.2	0.15	2.9
1k WSW		1	21.99	34.76	4.68	7.78	51.41	84.7				
		2	21.97	34.79	4.57	7.76	51.04	84.5			0.16	3.2
		3	21.97	34.76	4.53	7.75	51.29	84.6				
		4	21.85	34.75	4.53	7.76	48.06	83.3			0.15	3.4
11	910	0	22.02	34.82	5.70	7.88	62.26	88.8	11	2.6	0.09	2.2
1k WSW		1	22.03	34.82	5.82	7.89	61.12	88.4				
		2	22.02	34.81	5.78	7.89	61.36	88.5			0.09	1.5
		3	21.81	34.83	5.75	7.89	56.14	86.6				
		4	21.62	34.85	5.80	7.87	51.89	84.9			0.09	2.1
12	1039	0	21.31	26.06	6.59	8.13	49.53	83.9	11	2.9	0.14	3.0
4k WSW		1	21.03	28.52	6.62	8.09	46.92	82.8				
		2	20.35	33.62	6.67	8.02	44.55	81.7			0.13	2.9
		3	20.09	34.55	6.56	8.00	60.19	88.1				
13	935	0	22.13	34.94	4.25	7.85					0.15	4.6
18	815	0	21.83	34.96	5.60	7.84	62.75	89.0	9	3.7	0.12	1.5
1k WSW		1	21.85	34.95	5.45	7.85	62.27	88.8				
		2	21.85	34.94	5.43	7.86	62.51	88.9			0.11	2.0
		3	21.81	34.94	5.46	7.86	62.44	88.9				
19	753	0	20.85	35.18	5.50	7.94					0.22	2.7
20	846	0	22.03	34.78	3.86	7.66	57.52	87.1	11	2.5	0.19	4.1
1k WSW		1	22.03	34.78	3.95	7.66	58.96	87.6				
		2	22.04	34.76	3.86	7.65	59.96	88.0			0.16	3.3
22	720	0	21.66	32.19	3.20	7.79					0.19	3.8
25	1103	0	21.74	34.92	5.68	7.94	62.10	88.8	11	3.7	0.10	1.3
3k WSW		1	21.72	34.85	5.82	7.93	61.05	88.4				
		2	21.57	34.68	5.94	7.94	60.48	88.2			0.08	1.4
		3	21.10	34.54	6.06	7.93	60.04	88.0				
		4	20.45	34.45	6.00	7.96	53.99	85.7			0.05	1.4
		5	20.18	31.19	6.11	8.02	44.92	81.9				
	Average		21.26	34.41	5.73	7.91	55.35	85.99	10.9	2.9	0.10	2.2
	Number		80	80	80	80	77	77	15	15	47.00	47.0
	St. Dev.		0.83	1.35	0.71	0.10	8.67	4.08	0.5	0.5	0.04	0.9
	Maximum		22.13	35.18	6.71	8.13	64.97	89.78	11	3.7	0.22	4.8
	Minimum		18.32	26.06	3.20	7.65	21.94	68.44	9	2.2	0.05	1.1

Surface Bacteriological Water Data and General Observations **June 27, 2000**

CRUISE:	MDR 00-06	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger	High	642	3.5
RAIN:	None		J. Mann	Low	1158	1.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1031	3000	1100	11	Moderate turbidity. Plastic bags in the water column.
2	1016	< 20	< 20	< 2	Moderate turbidity. Plastic bags in the water column.
3	1005	130	< 20	2	Moderate turbidity. Canal gate closed. Plastic bags in water column.
4	1055	80	80	50	Moderate turbidity. Much plastic debris in the water column.
5	935	< 20	< 20	50	Moderate turbidity.
6	946	20	< 20	2	Low turbidity.
7	1115	20	< 20	7	Moderate turbidity.
8	826	50	< 20	5	Low turbidity.
9	922	< 20	< 20	80	Moderate turbidity.
10	856	2400	170	300	Low turbidity. Many jellyfish in the water column.
11	910	20	20	4	Moderate turbidity.
12	1039	9000	1400	4	Moderate turbidity.
13	935	800	130	300	Low turbidity. Plastic bag, jellyfish in the water column.
18	815	80	< 20	130	Low turbidity.
19	753	130	80	5	Low turbidity.
20	846	800	300	130	Low turbidity. Many jellyfish in the water column.
22	720	≥ 16000	300	1600	Low turbidity. Floating algae. Jellyfish in the water column
25	1103	70	< 20	30	Moderate turbidity. Plastic bags in the water column.
	Average	1814.4	208.9	150.7	
	Number	18	18	18	
	St. Dev.	4157.5	393.1	374.0	
	Maximum	16000	1400	1600	
	Minimum	20	20	2	

9.3. INFAUNAL SPECIES ABUNDANCE LIST

MDR - October 1999		1	2	3	4	5	6	7	8	9	10	11	12	25
SACMIT #														
77	PHYLUM CNIDARIA													
147.5	Plumularia sp.	1												
159.5	Anthozoa, unid.									1	1			
185.5	Virgulariidae			1										
235	Edwardsiidae, unid			3		4								
252	Anemonactis sp.											2		
283	Diadumene sp.			2										
294	PHYLUM PLATYHELMINTHES													
307	Imogine exiguus				1									
307.5	Imogine franciscanus		1		2									
326	Notoplana sp.							1						
377	PHYLUM NEMERTEA													
382.5	Paleonemertea					6			1					2
384	Carinoma mutabilis						1							2
398	Tubulanus polymorphus		1	4										1
409.5	Lineidae, unid.			1								2	4	1
413.5	Cerebratulus californiensis	1												
449	Paranemertes californica		32	2			2	2					8	3
482.5	Tetrastemma sp.	1												
499.4	PHYLUM NEMATODA													
499.5	Nematode		15467*	919*	56				1		1573*		3672*	1
524	PHYLUM MOLLUSCA													
611	Class Gastropoda													
611.5	Gastropod unid		1											
640	Eulithidium compta	1												
1148	Nassarius fossatus		1											
1165.5	Nassarius tegula											1		
1176	Olivella baetica		1											
1329	Rictaxis punctocaelatus				1									
1449	Acteocina inculta	1					3	2		5		5		
1663	Pelecypoda unid												2	
1663	Class Bivalvia													
1755	Musculista senhousei					1								
1880	Diplodonta sericata		22											
2003	Laevicardium substriatum	1	15	13	5								104	1
2048	Protothaca staminea			4									53	

2078		Cooperella subdiaphana		3	4	2									
2117		Macoma nasuta		5											
2131		Tellina carpenteri		6		1								64	1
2144		Tellina modesta	4	3		2	1								
2144.5		Tellina sp.		1										28	
2174		Cumingia californica			3										1
2188		Theora lubrica													2
2195		Tagelus subteres		13	23	15	1							38	11
2202		Solen sicarius					1								
2204		Ensis myrae	2		1									1	
2215.5		Mactromeris sp.		7											
2333		Lyonsia californica													1
2441	PHYLUM SIPUNCULA														
2499		Apionosoma misakiana		1	4	2	1	2							1
2519	PHYLUM ANNELIDA														
2520	Class Polychaete														
2526		Leitoscoloplos pugettensis		3	1	5	4	277	58	55	16	5	14		4
2544		Scoloplos acmeceps			22			6	6		1	2			1
2637		Cossura candida					9					2			66
2648		Apoprionospio pygmaea	22	4	3	2				20					3
2702		Polydora cornuta		2				3		1	2	33			23
2711.5		Polydora sp.				1									
2714		Prionospio heterobranchia		105	80	46	9	21	5	7	1	11	2	81	74
2716		Prionospio lighti		1	1		1							88	1
2733		Pseudopolydora paucibranchiata		48	9	881	269	258	172	23	3	48	10	49	774
2744		Scolelepis squamata	1			2		24	11	5		8	3	7	3
2751		Scolelepis sp.1 SD		11	58										
2752		Spio filicornis			2										
2761		Spiophanes bombyx			3										
2764		Spiophanes missionensis			1	16	2			1					
2764.5		Streblospio benedicti							3	23	1	334	1		
2768.5		Spionidae unid												2	
2797		Spiochaetopterus costarum		1											
2807		Aphelochaeta multifilis				2	5	84	617	326	2	128	28		15
2833		Chetozone "setosa"	3		2										
2841.5		Cirriformia sp.MDR 1						8							
2866.5		Capitellidae										1			
2870		Capitella capitata							1			2		15	
2877		Mediomastus acutus		2											

2881.5		Mediomastus spp.		736	296	372	30	77	133	56	56	39	32	2612	164
2887		Notomastus tenuis				1					1				1
2887.5		Notomastus sp.1 (Phillips)	1	8	6									64	
2896.5		Maldanidae, unid			1										
2909		Metasychis disparidentatus						2							1
2928		Armandia brevis	2	2	16	32			4			1		85	
2935		Polyophthalmus pictus			7									113	
2951.5		Eteone pacifica			1										
2951.6		Eteone spilotus						2	1						
2980		Phyllodoce hartmanae		1											
2981		Phyllodoce longipes			1										
3011.5		Polynoidae											1		
3024		Harmothoe imbricata						1							
3050		Malmgreniella macginitiei													1
3101		Paleanotus bellis												1	
3123		Podarkeopsis glabra		1											
3142.5		Brania brevipharyngea			1										
3147		Exogone dwisula	2	178	2114	694	112	67	57	72	6	49	21	9	256
3193		Syllis (Syllis) gracilis												1	
3202		Neanthes acuminata			3				1	1			1	5	
3203		Nereis latescens												1	
3204		Nereis procera		1	1										1
3209		Platynereis bicanaliculata					1								
3226		Glycera convoluta	2	3											
3229		Glycera oxycephala													1
3241		Glycinde armigera												1	
3248		Goniada littorea	3	28	2										
3267		Nephtys caecoides	3	1	1	4	2		1		2			2	2
3281		Nephtys simoni			1										
3311		Diopatra splendidissima												2	
3311.5		Diopatra sp.			1									3	
3379		Lumbrineris limicola			3										1
3380.5		Lumbrineris erecta		3				1	5	3	2	10	3		2
3380.6		Lumbrineris sp.C (Harris)		8	2	5	38	22	7	9	26	8	7		43
3380.7		Lumbrineris sp.			1	20	1	19	2		1	4			6
3412		Dorvillea (Schistomeringos) annulata		1	49			10	48	9	2	41	19	96	5
3440		Owenia fusiformis	2												
3458.5		Piromis sp.			1	1					1				
3483		Ampharete labrops		3	3	1									

3484.5	Syllides sp.						1				2			
3487	Amphicteis scaphobranchiata						1							1
3501	Melinna oculata						1							
3520	Amaeana occidentalis				1									
3546	Pista disjuncta				2									
3573.5	Sabellidae unid							1						
3576	Chone minuta			4										
3591	Euchone limnicola		2	38	416	527	107	71	70	13	93	20		279
	Crucigera sp.												1	
3616	Serpulidae unid	1												
3637	Class Oligochaete													
3637.5	Oligochaeta		103	20	64	2	3	17	1	2	27	1	2	19
3647	PHYLUM ARTHROPODA													
3649	Class Pycnogonida													
3649.5	Pycnogonida		1										1	
3664	Anoropallene palpida	10	2											
3699	Class Ostracoda													
3718.5	Bathyleberis sp.				23	10	1							7
3747	Class Copepoda													
3748.4	Calanoid copepod		20	9	18		2						44	2
3748.5	Harpactiocoida, unid.		12	54									8	1
3818	Order Mysidacea													
3839	Metamysidopsis elongata		1											
3840	Mysidopsis intii						2							
3857.5	Deltamysis sp A							4	1			2		
3858	Order Cumacea													
3867	Leptocuma fossmani	1												
3893	Campylaspis rubromaculata													1
3928	Diastylopsis tenuis	1												
3935	Oxyurostylis pacifica		3	1	20								1	1
3936	Order Tanaidacea													
3940	Leptochelia dubia							5						
3970.5	Pseudotanais sp.				7	4	4							17
3977	Zeuxo normani			1		44	22	3	3	1		1	6	1
3980	Order Isopoda													
3999	Paranathura elegans			19		24	6	1	1					2
4037	Sphaeromatidae unid												4	
4045	Paracerceis sculpta		1					9						
4047.5	Ianiropsis analoga							2						

4052	Neastacilla californica		5	1									1	
4082	Joeropsis dubia		1										1	
4101	Order Amphipoda													
4125.5	Oedicerotidae		1											
4133	Hartmanodes hartmanae		1	1										
4169.5	Leucothoe alata							1						
4190.5	Phoxocephalidae										1			
4194	Eobrolgus spinosus							3						2
4242	Rhepoxinius menziesi	3												
4249.5	Rhepoxinius sp.	1												
4330	Listriella diffusa			1										
4382	Gibberosus myersi	1												
4398.5	Elasmopus sp.							1						
4433	Amphideutopus oculatus		12	169	15	5								7
4445	Gammaropsis thompsoni		3										1	
4467.5	Photis sp.		3											
4473	Ericthonius brasiliensis	1						2						
4484	Jassa slatteryi	3		1	4	1	20		6		1	1	3	
4498	Aoroides inermis												1	
4505.5	Aoroides sp.		2											
4510	Grandidierella japonica					4	5	3						
4513	Rudilemboides stenopropodus		6	82	24	88	3	9				3		11
4517	Monocorophium acherusium				7	1		1			2		4	
4524	Podocerus brasiliensis					2	1	4					2	
4542	Mayerella banksia		1	9	29	7	6	19	35	2	8	5		14
4546	Caprella californica	3	2	1		5	2		1		1	16	1	1
4551	Caprella gracilior	1												
4551.5	Caprella sp.		13	2		1		1						
4567.5	Mayfly nymph										1			
4569	Order Decapoda													
4735	Amphiporus sp													2
4766	Paguridae, unid			1										
4919.5	Cancer sp.												1	
4991	PHYLUM ECHINODERMATA													
5126	Amphiodia urtica			13										
5303	PHYLUM PHORONA													
5306	Phoronis sp.		4	59	53		4	4	49	3	2	45		3
5492	PHYLUM CHORDATA													
5495	Clevelandia ios		1		1	1								1

5569.5		Styela sp.			1										
		Abundance by Station	79	16931	4164	2856	1224	1081	1298	780	150	2438	246	7292	1848
		Number of Taxa by Station	29	63	67	42	36	39	41	26	23	30	26	46	55
		Abundance by Survey	40387												
		Number of Taxa by Survey	168												
		* = count estimated													

9.4. FISH SPECIES ABUNDANCE LIST

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

		Oct. 1999 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
Atherinops affinis	Topsmelt					98				43			
Chromis punctipinnis	Blacksmith										13		
Damalichthys vacca	Pile Surfperch		1					1					1
Embiotoca jacksoni	Black Surfperch		1	2		8	12	1		5	7	4	
Girella nigricans	Opaleye		6	31	6		27	48		8	5	39	
Halichoeres semicinctus	Rock Wrasse					13	3			4			
Hermosilla azurea	Zebraperch		2			2							
Heterostichus rostratus	Giant Kelpfish			2		1				1			
Hypsopsetta guttulata	Diamond Turbot	1											
Hypsypops rubicundus	Garibaldi					3				1			
Micrometrus minimus	Dwarf Surfperch	4	1							1			
Oxyjulis californica	Senorita									2			
Paralabrax clathratus	Kelp Bass						6	11			6	2	
Paralabrax nebulifer	Barred Sand Bass					1	2	3			1	12	
Rhacochilus toxotes	Rubberlip Surfperch					2				2			
Scorpaenicthys marmoratus	Cabezon						1				1		

		June 2000 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
Atherinops affinis	Topsmelt											20	723
Clinocottus analis	Wooly Sculpin			2									
Chromis punctipinnis	Blacksmith							2		1			
Cymatogaster aggregata	Shiner Surfperch				81				8	2			111
Damalichthys vacca	Pile Surfperch			1							1	8	
Embiotoca jacksoni	Black Surfperch		8	8	3	8	23	6		3	18	60	3
Girella nigricans	Opaleye	1	35	2	7	5	91		24	47	36	8	1
Halichoeres semicinctus	Rock Wrasse									1			
Hermosilla azurea	Zebraperch			5		1						2	
Heterostichus rostratus	Giant Kelpfish					1				2			1
Hypsypops rubicundus	Garibaldi					15	5				1		
Micrometrus minimus	Dwarf Surfperch	1	2	2		6						12	
Oxyjulis californica	Senorita					1				3			
Paralabrax clathratus	Kelp Bass					1	14	9			4		
Paralabrax nebulifer	Barred Sand Bass		1			7	2			1	4		
Phanerodon furcatus	White Surfperch											4	
Scorpaenicthys marmoratus	Cabezon		1										
Urolophus halleri	Round Stingray							1					

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - September 1999
Raw data, standardization factors, sorting data

Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume ($ml/1000m^3$)	Primary Zooplankton Types	Sorting Record
2S	Sept. 1999	1185	7.12	3	21.35	Copepods	26 June 2000 DLO
							Sort Check 0 EG, 0 LV
							6/29/2000 DLO
2B	Sept. 1999	1948	4.33	2.5	10.82	Copepods	28 June 2000 DLO
							Sort Check 0 EG, 0 LV
							6/29/2000 DLO
5S	Sept. 1999	1143	7.38	3	22.13	Copepods	27 June 2000 DLO
							Sort Check 0 EG, 0 LV
							6/29/2000 DLO
5B	Sept. 1999	1943	4.34	8	34.72	Copepods	6 July 2000 DLO
							Sort Check 0 EG, 0 LV
							6/29/2000 DLO
8S	Sept. 1999	1112	7.58	23	174.40	Copepods	9 July 2000 DLO
							Sort Check 0 EG, 0 LV
							6/29/2000 DLO
8B	Sept. 1999	1912	4.41	9	39.69	Copepods, polychaetes	10 July 2000 DLO
							Sort Check 0 EG, 2 LV
							6/29/2000 DLO

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - Sept 1999						
Ichthyoplankton data						
Sample Code	**Standardization Factor**	**Taxon**	**Stage**	**Number Identified**	**Stan. Abundance (Standardized to n/1000m³)**	**Larval Size (mm) or Egg Stage**
2S	7.12	TOTAL LARVAE		25	178.00	
		Citharichthys type A	YS	1	7.12	1.0 mm
		Engraulis mordax	YS	1	7.12	2.3 mm
		Genyonemus lineatus	YS	1	7.12	2.0 mm
		Gobiidae type A/C	YS	1	7.12	2.4 mm
			NL	17	121.04	2.0 - 3.0 mm
		Hypsoblennius	NL	2	14.24	2.5 mm
		Unidentified	YS	2	14.24	1.0 mm
		TOTAL EGGS		595	4236.40	
		Engraulis mordax	EG	2	14.24	St. VII
		Pleuronichthys ritteri	EG	4	28.48	St. III, VII
		Pleuronichthys verticalis	EG	2	14.24	damaged
		Egg type 32	EG	276	1965.12	St. II, VI, VII, IX
		Unidentified	EG	311	2214.32	
2B	4.33	TOTAL LARVAE		113	489.29	
		Engraulidae	YS	2	8.66	2.0 mm
		Engraulis mordax	YS	3	12.99	2.3 - 2.6 mm
		Genyonemus lineatus	YS	13	56.29	1.3 - 2.0 mm
		Gobiidae type A/C	YS	9	38.97	2.0 - 2.3 mm
			NL	66	285.78	65 @ 2.3 - 2.6 mm
						1 @ 3.4 mm
		Hypsoblennius	NL	6	25.98	2.3 - 2.8 mm
		Unidentified	YS	14	60.62	
		TOTAL EGGS		635	2749.55	
		Engraulis mordax	EG	3	12.99	St. VII, VIII
		Pleuronichthys ritteri	EG	1	4.33	St. VI
		Egg Type 32	EG	216	935.28	St. II, III, VII, VIII
		Unidentified	EG	415	1796.95	
5S	7.38	TOTAL LARVAE		113	833.94	
		Gobiidae type A/C	YS	19	140.22	2.7 - 2.8 mm
			NL	23	169.74	2.4 - 2.9 mm
		Hypsoblennius	NL	70	516.6	2.3 - 2.6 mm
		Pleuronectiformes	YS	1	7.38	2.0 mm
		TOTAL EGGS		22	162.36	
		Egg type 32	EG	3	22.14	St. II, VI
		Unidentified	EG	19	140.22	
5B	4.34	TOTAL LARVAE		399	1731.66	
		Citharichthys type A	YS	1	4.34	1.6 mm
		Genyonemus lineatus	YS	1	4.34	1.9 mm
		Gobiidae type A/C	NL	276	1197.84	2.4 - 4.0 mm
			FL	3	13.02	2.5 - 2.8 mm
			SL	1	4.34	2.9 mm
		Hypsoblennius	NL	113	490.42	2.4 - 3.0 mm
		Oligocottus	NL	1	4.34	3.4 mm
		Unidentified	YS	3	13.02	
		TOTAL EGGS		26	112.84	
		Engraulis mordax	EG	1	4.34	St. VIII
		Egg Type 32	EG	10	43.4	St. VII
		Unidentified	EG	15	65.1	

Ichthyoplankton data						
					Stan. Abundance	
Sample	**Standardization**			**Number**	**(Standardized to**	**Larval Size (mm)**
Code	**Factor**	**Taxon**	**Stage**	**Identified**	**n/1000m^3)**	**or Egg Stage**
8S	7.58	TOTAL LARVAE		204	1546.32	
		Hypsoblennius	NL	64	485.12	2.4 - 2.8 mm
		Hypsopsetta guttulata	YS	4	30.32	1.0 - 1.2 mm
		Gobiidae type A/C	YS	5	37.9	2.5 - 2.7 mm
			NL	131	992.98	2.7 - 3.2 mm
		TOTAL EGGS		295	2236.1	
		Unidentified	EG	295	2236.1	
8B	4.41	TOTAL LARVAE		220	970.2	
		Hypsoblennius	NL	40	176.4	39 @ 2.0 - 3.0 mm
						1 @ 4.2 mm
		Gobiidae type A/C	YS	2	8.82	2.6 mm
			NL	170	749.7	169 @ 2.2 - 3.0 mm
						1 @ 3.8 mm
			FL	1	4.41	4.9 mm
		Unidentified	YS	1	4.41	
		Unidentifiable	FR	6	26.46	
		TOTAL EGGS		303	1336.23	
		Engraulis mordax	EG	1	4.41	St. VII
		Unidentified	EG	302	1331.82	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 2000 Raw data, standardization factors, sorting data							
Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume ($ml/1000m^3$)	Primary Zooplankton Types	Sorting Record
2S	17-May-00	1675	5.03	2	10.07	Copepod, Zoea, Mysid	14Aug 2000 DLO
							17Aug 2000 Sort Check
							0 EG, 2 LV
							17Aug 2000 Resort DLO
							17Aug 2000 2nd Sort Check
							1 EG, 0 LV
2B	17-May-00	1115	7.56	7	52.94	Copepod, Cyphonautes,	14Aug 2000 DLO
						Mysid, Zoea, Polychaete	17Aug 2000 Sort Check
							0 EG, 0 LV
5S	17-May-00	1738	4.85	2	9.70	Copepod, Zoea, Mysid,	13Aug 2000 DLO
						Polychaete	17Aug 2000 Sort Check
							0 EG, 0 LV
5B	17-May-00	1006	8.38	14	117.34	Polychaete, Copepod, Zoea	9Aug 2000 DLO
							17Aug 2000 Sort Check
							0 EG, 0 LV
8S	17-May-00	1670	5.05	2	10.10	Copepod, Zoea, Mysid	9Aug 2000 DLO
							17Aug 2000 Sort Check
							0 EG, 0 LV
8B	17-May-00	988	8.53	5	42.67	Polychaetes, Zoea,	8Aug 2000 DLO
						Copepods	17Aug 2000 Sort Check
							0 EG, 0 LV

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 2000

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m^3)	Larval Size (mm) or Egg Stage
2S	5.03	TOTAL LARVAE		119	598.57	
		Citharichthys	YS	12	60.36	1.0 - 1.5 mm
		Engraulidae	YS	30	150.9	2.0 - 2.5 mm
		Engraulis mordax	YS	39	196.17	2.5-2.9 mm
		Gobiidae type A/C	NL	12	60.36	2.5 - 2.9 mm
		Hypsoblennius	NL	13	65.39	12 @ 2.0 - 2.4 mm
						1 @ 2.5 - 2.9 mm
		Paraclinus integrippinis	NL	2	10.06	3.7 mm
		Unidentifiable	FR	6	30.18	
		Unidentified	YS	5	25.15	
		TOTAL EGGS		741	3727.23	
		Anchoa delicatissima	EG	15	75.45	St. III, VI
		Atherinops affinis	EG	1	5.03	St. VII
		Engraulis mordax	EG	56	281.68	St. III, VI, VII, VIII. IX, X
		Pleluronichthys ritteri	EG	3	15.09	St. II
		Pleuronichthys verticalis	EG	5	25.15	St. II
		Sardinops sagax caeruleus	EG	1	5.03	damaged
		Egg Type 32	EG	188	945.64	St. II, VI, VII, IX
		Unidentified	EG	472	2374.16	
2B	7.56	TOTAL LARVAE		552	4173.12	
		Citharichthys	YS	3	22.68	ca. 1 mm
		Engraulidae	YS	63	476.28	2.0 - 2.4 mm
		Engraulis mordax	YS	399	3016.44	2.0 - 2.4 mm
			NL	2	15.12	3.0 mm
			FL	2	15.12	10.5 mm
		Genyonemus lineatus	YS	1	7.56	1.5 mm
		Gobiesox rhessodon	NL	2	15.12	3.2 - 3.6 mm
		Gobiidae type A/C	NL	211		209 @ 2.5 - 2.9
						2 @ 3.0-3.4 mm
		Hypsoblennius	NL	63	476.28	53 @ 2.0 - 2.4 mm
						10 @ 2.5 - 2.9 mm
		Hypsypops rubicundus	NL	3	22.68	2.7 - 2.9 mm
		Paralichthys californicus	YS	1	7.56	1.6 mm
		Pleuronichthys ritteri	YS	2	15.12	1.6 mm
		Seriphus politus	YS	1	7.56	2.0 mm
		Stenobrachius leucopsarus	NL	1	7.56	2.6 mm
		Typhlogobius californiensis	NL	5	37.8	2.5 - 2.9 mm
		Unidentified	YS	4	30.24	
		TOTAL JUVENILES		1	7.56	
		Syngnatus	J	1	7.56	13 mm
		TOTAL EGGS		546	4127.76	
		Anchoa delicatissima	EG	7	52.92	St. II, VI, VII, X
		Atherinops affinis	EG	1	7.56	damaged
		Engraulis mordax	EG	128	967.68	St. III, VI, VII, VIII, IX, X
		Pleluronichthys ritteri	EG	2	15.12	St. VI
		Pleuronichthys verticalis	EG	6	45.36	St. II, IV, VI
		Egg Type 32	EG	237	1791.72	St. III, VI, VII, VIII, IX
		Unidentified	EG	165	1247.40	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 2000

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m^3)	Larval Size (mm) or Egg Stage
5S	4.85	TOTAL LARVAE		77	373.45	
		Atherinopsis californiensis	NL	1	4.85	7.7 mm
		Citharichthys	YS	1	4.85	1.2 mm
		Gobiidae type A/C	YS	12	58.20	2.5 - 2.9 mm
			NL	26	126.10	2.5 - 2.9 mm
		Hypsoblennius	NL	35	169.75	22 @ 2.0 -2.4 mm
						11 @ 2.5 - 2.9 mm
						2 @ 3.0 - 3.4 mm
		Hypsopsetta guttulata	YS	1	4.85	1.5 mm
		Unidentifiable	NL	1	4.85	damaged
		TOTAL EGGS		373	1809.05	
		Anchoa delicatissima	EG	296	1435.60	St. III, IV, VII
		Atherinops affinis	EG	1	4.85	St. II
		Unidentified	EG	76	368.60	
5B	8.38	TOTAL LARVAE		778	6519.64	
		Citharichthys	YS	4	33.52	2 @ 1.0, 1.7, 1.8 mm
		Engraulidae	YS	6	50.28	2.0 - 2.4 mm
		Engraulis mordax	YS	4	33.52	2.0 - 2.4 mm
		Gobiidae type A/C	NL	238	1994.44	13 @ 2.0 - 2.4 mm
						197 @ 2.5 - 2.9 mm
						18 @ 3.0 - 3.4 mm
						8 @ 3.5 - 3.9 mm
						2 @ 4.5 - 4.9 mm
			FL	6	50.28	5 @ 5.0 -5.4 mm, 5.8 mm
			SL	4	33.52	5.8, 6.5, 6.7 , & 7.3 mm
		Hypsoblennius	NL	508	4257.04	456 @ 2.5 - 2.9 mm
						52 @ 3.0 - 3.4 mm
		Menticirrhus undulatus	YS	1	8.38	1.9 mm
		Paraclinus integrippinis	NL	2	16.76	3.3, 3.9 mm
		Paralichthys californicus	YS	2	16.76	1.5 mm
		Unidentified	YS	3	25.14	1.2 - 1.4 mm
		TOTAL EGGS		311	2606.18	
		Anchoa compressa	EG	1	8.38	damaged
		Anchoa delicatissima	EG	85	712.30	St. III, IV, VI
		Atherinops affinis	EG	1	8.38	St. X
		Engraulis mordax	EG	3	25.14	St. VII, VIII
		Egg Type 32	EG	26	217.88	St. VI
		Unidentified	EG	195	1634.10	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 2000

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m^3)	Larval Size (mm) or Egg Stage
8S	5.05	TOTAL LARVAE		64	323.20	
		Gobiidae type A/C	YS	4	20.20	2 @ 2.0 - 2.4 mm
						2 @ 2.5 - 2.9 mm
			NL	38	191.90	21 @ 2.0 - 2.4 mm
						17 @ 2.5 - 2.9 mm
		Hypsoblennius	NL	20	101.00	18 @ 2.0 - 2.4 mm
						2 @ 2.5 - 2.9 mm
		Paraclinus integrippinis	NL	2	10.10	3.4, 3.9 mm
		TOTAL EGGS		654	3302.70	
		Anchoa compressa	EG	2	10.10	St. III
		Anchoa delicatissima	EG	600	3030.00	St. III, IV, VII
		Unidentified	EG	52	262.60	
8B	8.53	TOTAL LARVAE		37	315.61	
		Gobiidae type A/C	NL	13	110.89	10 @ 2.5 - 2.9 mm
						3 @ 3.0 - 3.4 mm
			FL	2	17.06	4.0 - 4.4 mm
			SL	3	25.59	5.0, 6.0, 8.1 mm
		Hypsoblennius	NL	19	162.07	2.0 - 2.6 mm
		TOTAL EGGS		28	238.84	
		Anchoa delicatissima	EG	17	145.01	St. III, VII
		Atherinops affinis	EG	8	68.24	
		Unidentified	EG	3	25.59	