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The Marine Environment of Marina del Rey Harbor
July 1998 - June 1999

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

November 15, 1999

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

Dear Dr. Fawcett:

The scientists and staff of Aquatic Bioassay are pleased to present this report of the 1998-99 marine surveys of Marina del Rey Harbor.

This report covers the period of field and laboratory studies conducted from July 1, 1998 through June 30, 1999. The 1998-99 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, 1998 to June 30, 1999. The survey included monthly water quality and bacterial sampling; semiannual fish surveys including otter trawl, gill net, ichthyoplankton, beach seine, and diver-biologist transect sampling; and annual benthic sediment collection including physical, chemical, and biological characteristics.

Water Quality. The discharges of Oxford Lagoon and Ballona Creek and impacts of the open ocean spatially affected water quality in Marina del Rey Harbor. The Harbor was temporally impacted by season, rainfall, and plankton blooms. Since this year was below normal in rainfall, some of its impacts were less noticeable than in the past two years. Storm drain and nonpoint flows during the rainy months lowered salinity, temperature, pH, and water clarity; raised ammonia, biochemical oxygen demand, and bacterial counts; and contributed nutrients to spring phytoplankton blooms. Temperature was more strongly influenced by oceanographic season. Phytoplankton blooms may have raised dissolved oxygen values, and their death may have increased biochemical oxygen demand later in the spring. The impacts of plankton were less this year than in the recent past.

Areas further back into the Marina were warmer, more saline, lower in dissolved oxygen, etc. Discharges from Ballona Creek impact stations near the Harbor entrance, and those from Oxford Lagoon affect Basin E and the upper end of the main channel. These impacts include reduced water clarity, elevated levels of biochemical oxygen demand and bacteria, and a conversion of the water color from blue and green to yellow and brown. Stations affected by Oxford Lagoon had additionally elevated levels of ammonia and lower oxygen and pH values. When not being impacted by the runoff from Ballona Creek, water near the Harbor entrance was clearer, more blue to green, higher in dissolved oxygen and pH, and lower in bacteria and contaminants. Basin D, which includes Mother's Beach, this year appeared less affected by surface runoff than in the recent past.

Total coliform limits were exceeded 26 times, fecal coliform limits 40 times, and enterococcus limits 38 times. With the exception of enterococcus in the fall, the frequency of exceedances was with the range of the past seven years. Overall, enterococcus exceedances were more frequent this year than usual. Most exceedances occurred following rainy months and at stations near Oxford Lagoon and Ballona Creek discharges.

Physical Characteristics of Benthic Sediments. 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. Current and wave action near the entrance created sediments that were universally coarse and narrow in range. A finer, more heterogeneous mix characterized sediment in the Upper Harbor. The main channel area was home to sediments that were moderate in both size and distribution. Oxford Lagoon, Ballona Creek, and the entrance to Venice Canal had sediment characteristics that were primarily sand but included a fair amount of silt. This suggests that water movement in these areas is intermittent.

Chemical Characteristics of Benthic Sediments. Many sources of chemical contaminants into Marina del Rey Harbor appear to be Oxford Lagoon, Ballona Creek, and the resident boat population itself. Nonpoint sources may also be important, particularly during heavy rainfall. 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.

Oxford Lagoon and Ballona Creek appear to be sources of chlorinated hydrocarbons such as DDT and derivatives and other chlorinated pesticides. Polychlorinated biphenyls (PCB's) were below detection this year. Among chlorinated hydrocarbons listed as toxic by NOAA, all Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 7 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. Most chlorinated compounds have continued to remain considerably lower than historical values, however, and are similar to, or lower than, those of other areas.

Oxford Lagoon, and perhaps Ballona Creek, may contribute somewhat to heavy metal loads in Harbor sediments, but since most heavy metals were higher in the Harbor back basins and main channel, 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 metal complexes, which are designed to continuously ablate off into the sediment. Except for Station 1 at the Harbor entrance, all stations exceeded at least one metal limit of "possible" toxicity, and 8 out of 15 exceeded at least one metal limit of "probable" toxicity. Areas that exceeded most metal limits were Basins F, H, and the upper main channel. With the exception of tributyl tin, metal concentrations in Marina del Rey sediments do not appear to have greatly increased or decreased since 1985. Tributyl tin continues to remain low when compared to past surveys. Recently, tributyl tin has been banned as a boat bottom paint, which is likely the cause of the decline.

Nonspecific organic compounds, including nutrients and carbonaceous organics, followed patterns similar to those of heavy metals, so their sources may be varied. 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.

Biological Comparisons of Benthic Sediments. Areas most biologically modified appear to be Basin E just downstream of Oxford Lagoon, Ballona Creek, Stations downcurrent of Ballona Creek, and the entrance of Venice Canal. None of the stations were defined by the Southern California Coastal Water Research Project's infaunal trophic index as a "degraded" benthic environment, although one station downcurrent of Ballona Creek was defined as "changed". Sediments impacted by Ballona Creek were dominated by nematode worms that are known to be characteristic of highly disturbed benthic sediments. Relative to past years, abundance and species diversity values at the remaining stations were comparable. When compared to Los Angeles Harbor and offshore reference site surveys, Marine del Rey abundances were higher (probably due to the huge numbers of nematodes collected at some stations), as were numbers of species. Diversity and infaunal index values were lower but may be dependent upon improved circulation in Los Angeles Harbor when compared to Marina del Rey Harbor.

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. The Marina continues to support a very abundant and diverse assemblage of fish fauna and serves as a nursery for many species of fish. 53,442 total fish of all age groups, representing 63 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. Recent storms appear to have negatively impacted the jetty and breakwall fish community.

2. INTRODUCTION

2.1. SCOPE AND PERIOD OF PERFORMANCE

This report covers the period of field and laboratory studies conducted from July 1, 1998 through June 30, 1999, 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.

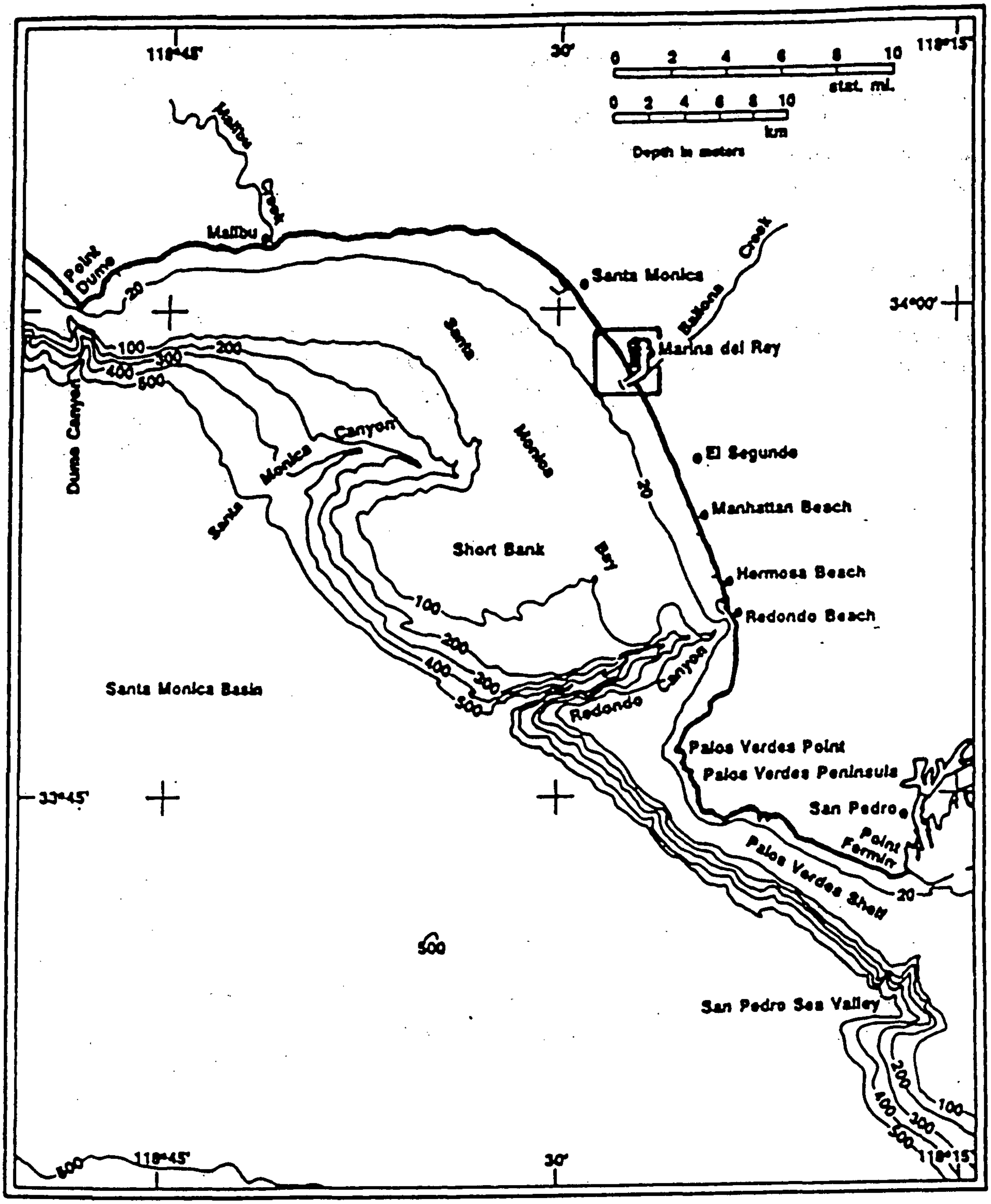
2.2. HISTORY OF THE SURVEY PROJECT

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).

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.

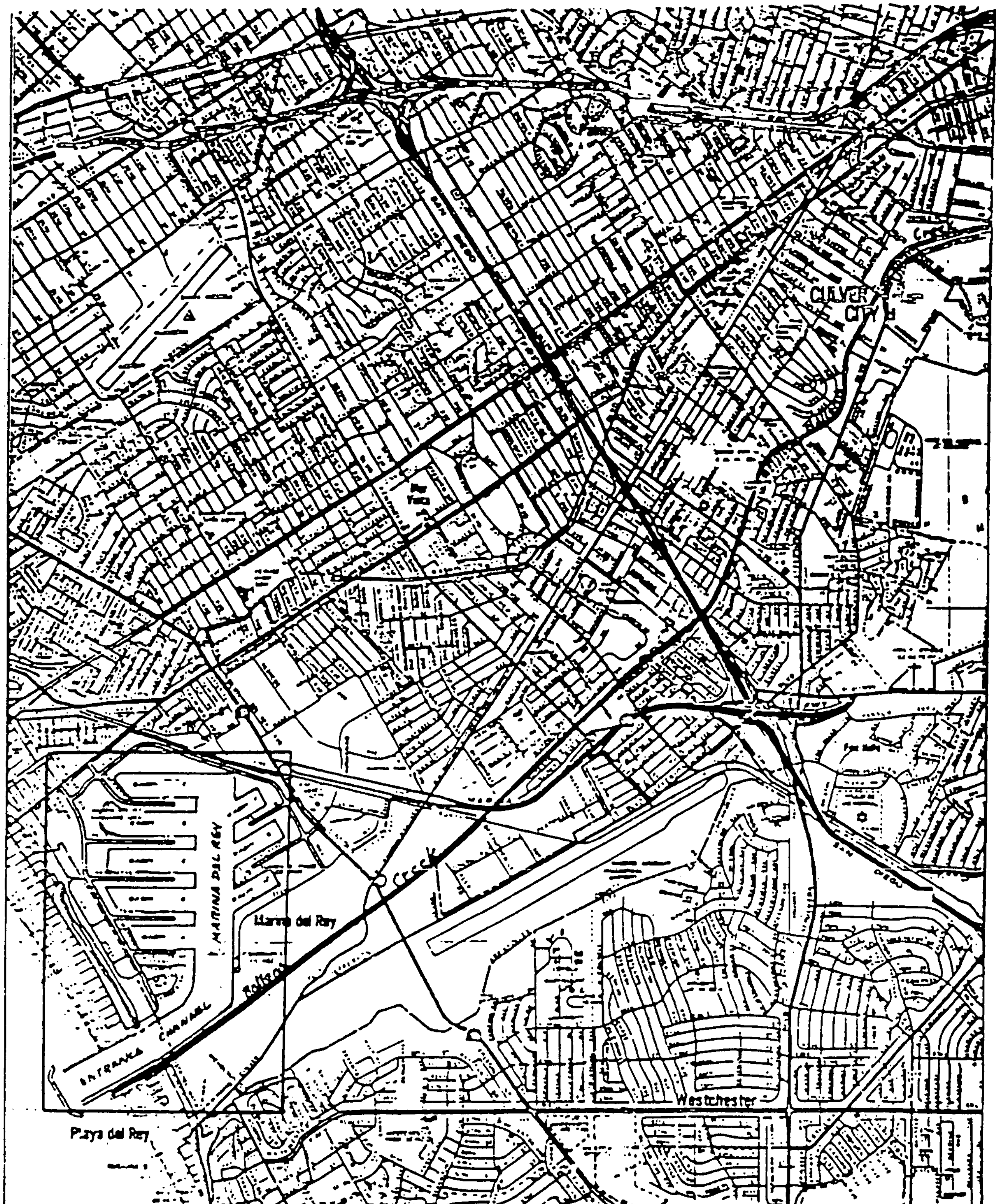
The present configuration was believed to be adequate to protect boats without a breakwater, but this was disproved not long after the marina opened, when southwest swells from a winter storm damaged docks and vessels. Thus the present breakwater was added several years later. This protected vessels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

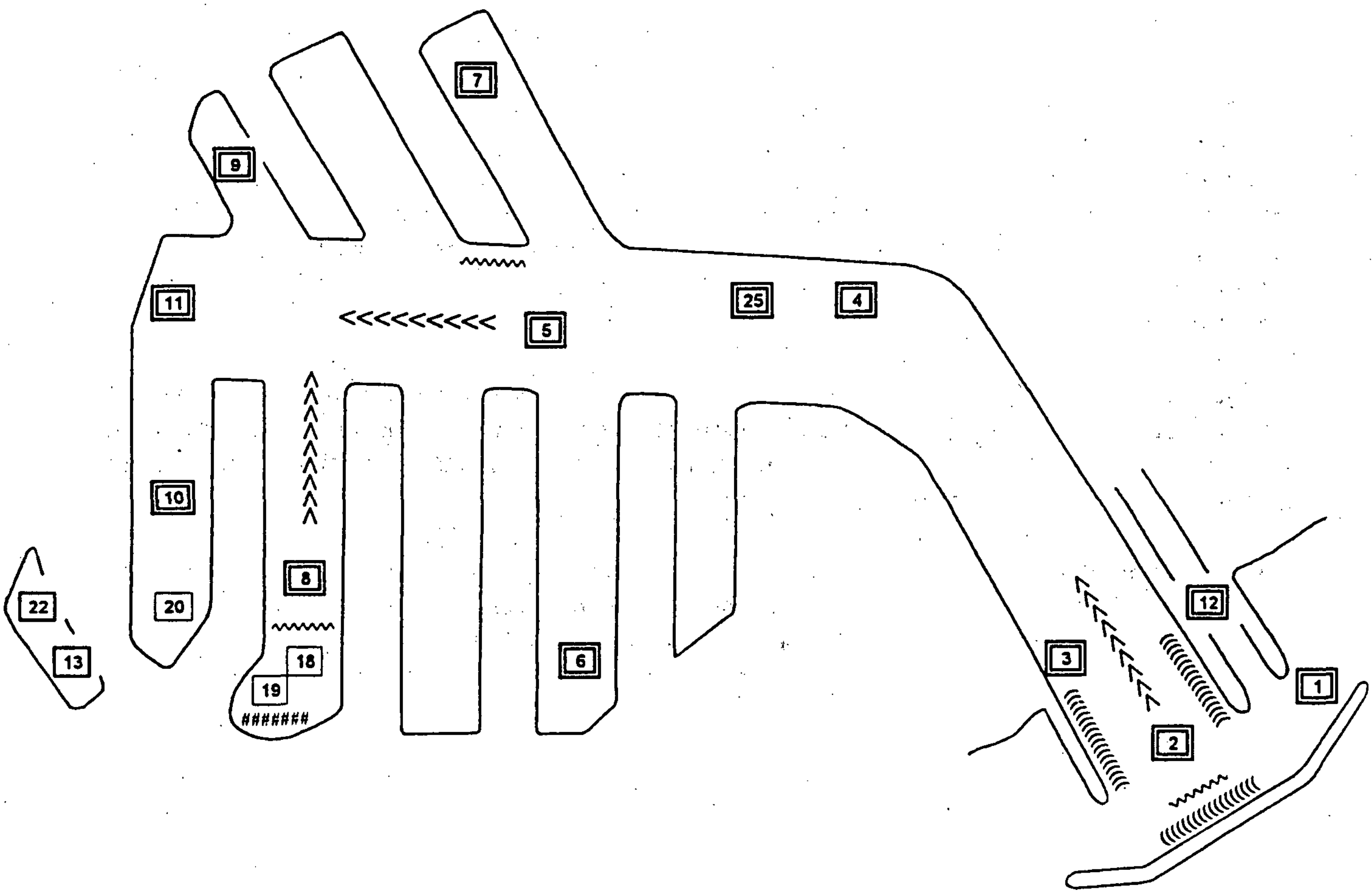
Pesticides occur in concentrations that are inhibitory to some organisms, especially reproductive stages. The levels of pesticides have been declining, however. Polychlorinated biphenyls (PCBs) have appeared episodically at toxic levels. Some terrestrial soils in areas to the north of the marina are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

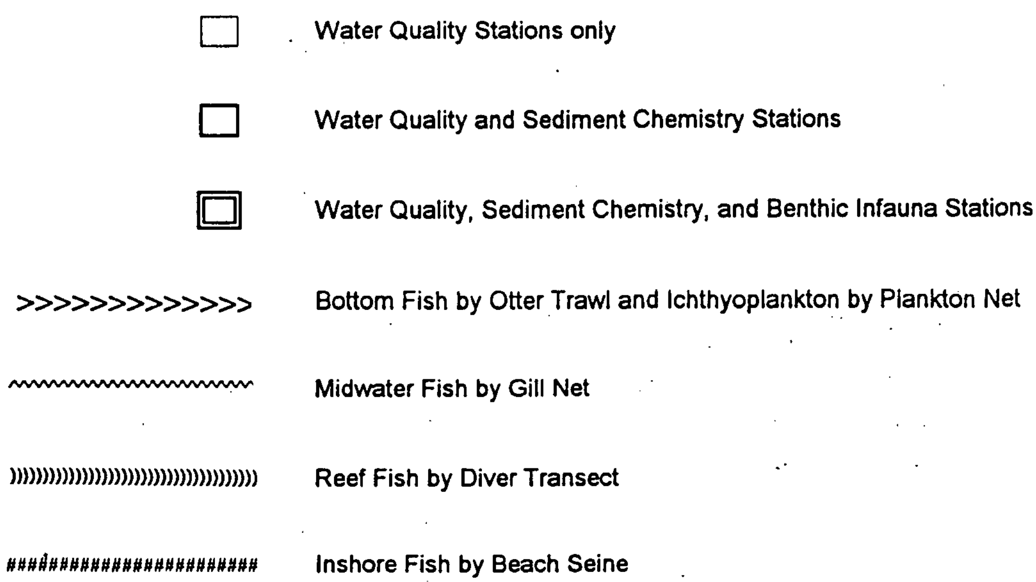
When excessive coliform and enterococcus bacterial contamination is found throughout the marina, it is largely due to runoff as evidenced by the high levels that occur at Ballona Creek and Oxford Basin immediately after storms in the winter. However, prolonged rainfall periods tend to reduce bacterial 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. 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 2-4. LOCATION OF MARINA DEL REY HARBOR SAMPLING STATIONS.





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

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

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

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

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

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

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

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

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

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

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

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

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

MDR-20 is at the innermost end of Basin E where Oxford Basin flows through a tidegate into the marina. 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) which can be described as an oceanographic anomaly whereby particularly warm, nutrient-poor water moves northward from the tropics and overwhelms the typical upwelling of colder nutrient-rich water. The El Nino Watch (Coast Watch, NMFS, and NOAA) program monitors sea surface temperatures off the West Coast of the United States and then compares these data to long-term means. Coastal Watch data shows that the 1994-95 survey year showed temperatures close to normal late in 1994 and temperatures above normal during the first half of 1995. The 1995-96 survey year showed water temperatures slightly higher than the previous year with temperatures 2° C above normal for most months and 3° C above normal for February through May (Soule et. al. 1997). During the 1996-97 survey year, water temperatures remained high in the Southern California Bight (1° to 4° C above normal) from July through October 1996. During November and December 1996, temperatures were very near normal, however temperatures had begun to climb again in 1997 with water temperatures averaging 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).

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 which, along with rainfall, can greatly affect water quality in Marina del Rey Harbor. Periodic phytoplankton blooms, including red tides, may be influenced by the above physical patterns, and can be exacerbated by anthropogenic inputs such as contaminated runoff and sewage effluents. In turn, blooms of red tide within enclosed bays and harbors can negatively impact resident fish and invertebrates (Daily, et. al. 1993).

3.1.2. Anthropogenic Inputs

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

3.1.3. Rainfall

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

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

The period of this report is from July 1, 1998 through June 30, 1999. The rainfall for this period (9 inches) was well below normal (13 inches, SCCWRP 1973) as well as 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).

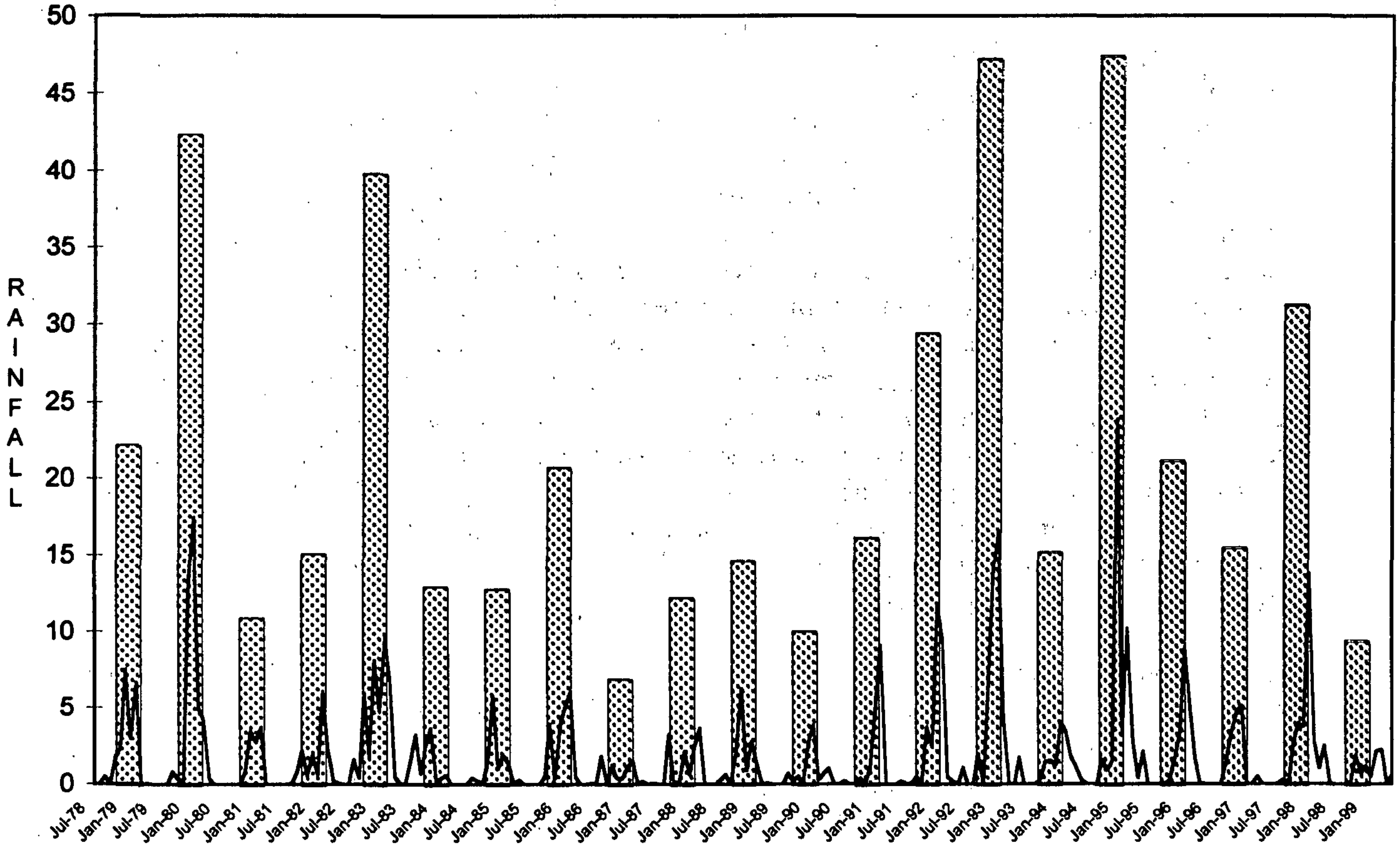
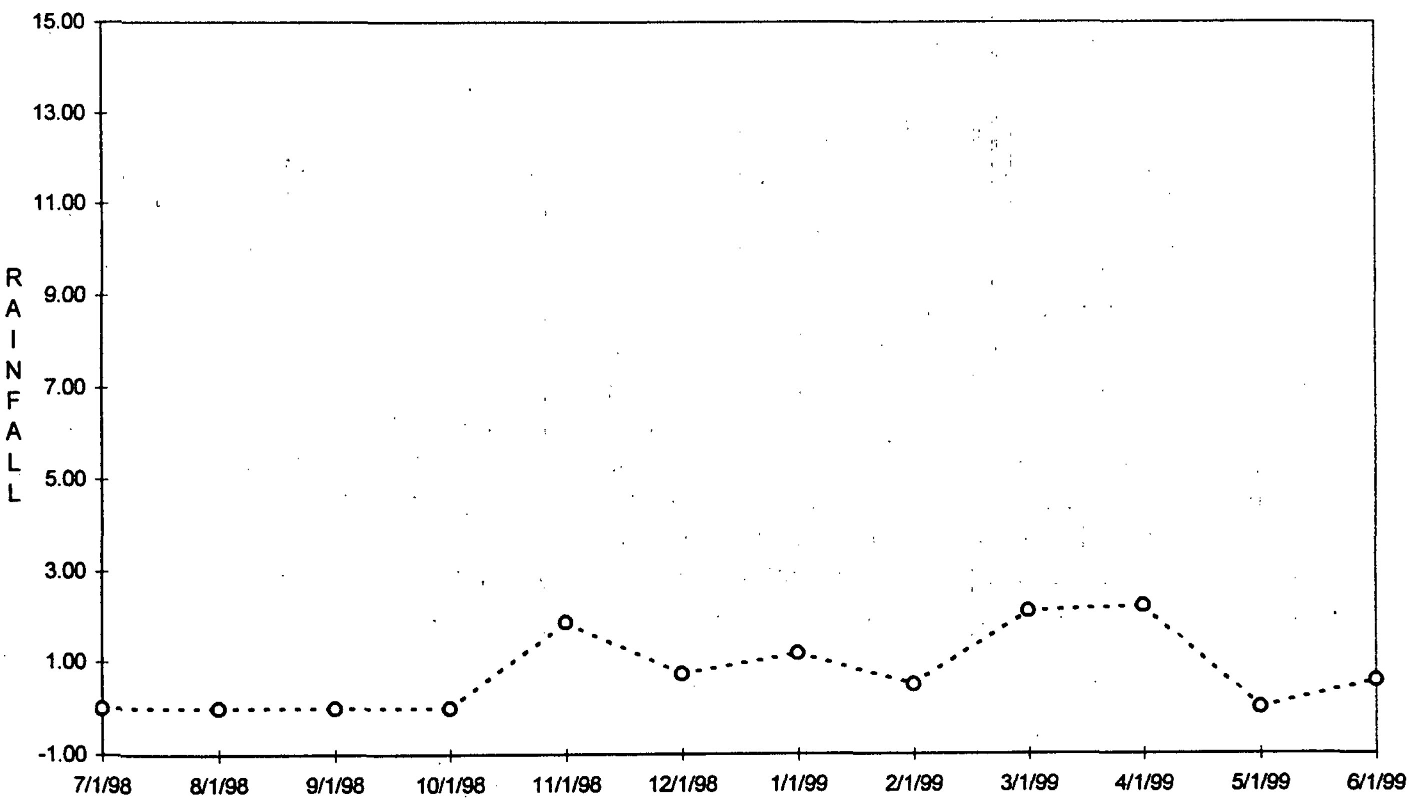


FIGURE 3-2. LOS ANGELES AIRPORT RAINFALL (INCHES).



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 October. The first significant storm of the season occurred on November 8 (1.30 inches) followed by a small rain on November 11 (0.07 inches) and a moderate one between November 27 and 28 (0.51 inches). Four small to moderate storms then occurred between December 1 and 6 (total of 0.91 inches) followed by very light rain on December 19 and 20 (0.02 inches total). January saw four sets of small to moderate storms (January 3 - 0.02 inches, January 19 to 20 - 0.28 inches, January 24 to 26 - 0.70 inches, and January 30 to 31 - 0.19 inches). February had two periods of precipitation: February 4 through 9 (0.50 inches) with only trace rainfall later. March precipitation was higher with two moderate (March 24-25 - 1.40 inches and March 13-14 - 0.67 inches) and three smaller storms (March 3 - 0.01 inches, March 7 through 11 - 0.24 inches, March 15 to 16 – 0.68 inches, and March 20 through 25 – 1.19 inches). Most of April's rain came early (April 1 through 12 – 2.23 inches) followed by only trace precipitation later in the month. May had very little rainfall, although a small set of storms occurred in early summer (June 1 to 3 – 0.59 inches).

Rainfall during this sampling period was the lowest since 1987 (Figure 3-1). In addition, unlike recent years, rain was more spread out over the year, and no one month greatly dominated in storm activity. The wettest month of the sampling season was April (2.23 inches) followed closely by March (2.12 inches), November (1.88 inches), and January (1.19 inches) (see Figure 3-2). December (0.74 inches), June (0.59 inches), and February (0.50 inches) precipitation was lower. Two water column sampling events occurred immediately following precipitation (December 1 and April 23 - Table 3-1), however, the March survey was within a day or two of relatively heavy rains.

3.2. MATERIALS AND METHODS

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

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

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

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

DATE	PRECIP.
9/1/98	0.00
9/2/98	0.00
9/3/98	Trace
9/4/98	Trace
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
9/17/98	*Survey*
9/18/98	0.00
9/19/98	0.00
9/20/98	0.00
9/21/98	0.00
9/22/98	Trace
9/23/98	0.00
9/24/98	0.00
9/25/98	0.00
9/26/98	0.00
9/27/98	Trace
9/28/98	0.00
9/29/98	0.00
9/30/98	0.00

DATE	PRECIP.
11/1/98	0.00
11/2/98	0.00
11/3/98	0.00
11/4/98	0.00
11/5/98	0.00
11/6/98	0.00
11/7/98	0.00
11/8/98	1.30
11/9/98	0.00
11/10/98	0.00
11/11/98	0.07
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	0.00
11/18/98	0.00
11/19/98	0.00
11/19/98	*Survey*
11/20/98	0.00
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	0.02
11/28/98	0.49
11/29/98	0.00
11/30/98	0.00

DATE	PRECIP.
1/1/99	0.00
1/2/99	0.00
1/3/99	0.02
1/4/99	0.00
1/5/99	0.00
1/6/99	0.00
1/7/99	0.00
1/8/99	0.00
1/9/99	0.00
1/10/99	0.00
1/11/99	0.00
1/12/99	0.00
1/13/99	0.00
1/14/99	0.00
1/14/99	*Survey*
1/15/99	0.00
1/16/99	0.00
1/17/99	0.00
1/18/99	0.00
1/19/99	0.07
1/20/99	0.21
1/21/99	0.00
1/22/99	0.00
1/23/99	0.00
1/24/99	Trace
1/25/99	0.40
1/26/99	0.30
1/27/99	0.00
1/28/99	0.00
1/29/99	0.00
1/30/99	Trace
1/31/99	0.19

DATE	PRECIP.
3/1/99	0.00
3/2/99	0.00
3/3/99	0.01
3/4/99	0.00
3/5/99	0.00
3/6/99	0.00
3/7/99	Trace
3/8/99	0.00
3/9/99	0.15
3/10/99	0.00
3/11/99	0.09
3/12/99	0.00
3/13/99	0.00
3/14/99	0.00
3/15/99	0.66
3/16/99	0.02
3/17/99	0.00
3/17/99	*Survey*
3/18/99	0.00
3/19/99	0.00
3/20/99	0.30
3/21/99	0.00
3/22/99	0.00
3/23/99	0.01
3/24/99	0.00
3/25/99	0.88
3/26/99	0.00
3/27/99	0.00
3/28/99	0.00
3/29/99	0.00
3/30/99	0.00
3/31/99	0.00

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

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

DATE	PRECIP.
10/1/98	0.00
10/2/98	Trace
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
10/21/98	0.00
10/21/98	*Survey*
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

DATE	PRECIP.
12/1/98	0.19
12/1/98	*Survey*
12/2/98	0.00
12/3/98	0.03
12/4/98	0.03
12/5/98	0.00
12/6/98	0.47
12/7/98	0.00
12/8/98	0.00
12/9/98	0.00
12/10/98	0.00
12/11/98	0.00
12/12/98	0.00
12/13/98	0.00
12/14/98	0.00
12/15/98	0.00
12/16/98	0.00
12/17/98	0.00
12/18/98	0.00
12/19/98	0.01
12/20/98	0.01
12/21/98	0.00
12/22/98	0.00
12/23/98	0.00
12/24/98	0.00
12/25/98	0.00
12/26/98	0.00
12/27/98	0.00
12/28/98	0.00
12/29/98	0.00
12/30/98	0.00
12/31/98	0.00

DATE	PRECIP.
2/1/99	0.00
2/2/99	0.00
2/3/99	0.00
2/4/99	0.19
2/5/99	0.13
2/6/99	0.00
2/7/99	0.01
2/8/99	0.00
2/9/99	0.17
2/10/99	0.00
2/11/99	0.00
2/12/99	0.00
2/13/99	0.00
2/14/99	0.00
2/15/99	0.00
2/16/99	0.00
2/17/99	0.00
2/18/99	0.00
2/19/99	0.00
2/20/99	0.00
2/21/99	0.00
2/22/99	0.00
2/23/99	0.00
2/24/99	0.00
2/25/99	0.00
2/25/99	*Survey*
2/26/99	0.00
2/27/99	Trace
2/28/99	0.00

DATE	PRECIP.
4/1/99	0.09
4/2/99	0.00
4/3/99	Trace
4/4/99	0.00
4/5/99	0.00
4/6/99	0.42
4/7/99	0.30
4/8/99	0.06
4/9/99	0.00
4/10/99	0.00
4/11/99	1.36
4/12/99	0.01
4/13/99	0.00
4/14/99	0.00
4/15/99	0.00
4/16/99	0.00
4/17/99	0.00
4/18/99	0.00
4/19/99	0.00
4/20/99	0.00
4/21/99	0.00
4/22/99	0.00
4/23/99	Trace
4/23/99	*Survey*
4/24/99	0.00
4/25/99	0.00
4/26/99	0.00
4/27/99	0.00
4/28/99	Trace
4/29/99	0.00
4/30/99	0.00

DATE	PRECIP.
6/1/99	0.08
6/2/99	0.47
6/3/99	0.04
6/4/99	0.00
6/5/99	0.00
6/6/99	0.00
6/7/99	0.00
6/8/99	0.00
6/9/99	0.00
6/10/99	0.00
6/11/99	0.00
6/12/99	0.00
6/13/99	0.00
6/14/99	0.00
6/15/99	0.00
6/16/99	0.00
6/17/99	0.00
6/18/99	0.00
6/19/99	0.00
6/20/99	0.00
6/21/99	0.00
6/22/99	0.00
6/23/99	0.00
6/23/99	*Survey*
6/24/99	0.00
6/25/99	0.00
6/26/99	0.00
6/27/99	0.00
6/28/99	0.00
6/29/99	0.00
6/30/99	0.00

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

All samples from all stations were placed in coolers containing blue ice and were returned to the Ventura laboratory the same day. Immediately upon return, the bacterial samples were set for total and fecal coliform and enterococcus bacteria via multiple-tube fermentation methods. Check samples were titrated for dissolved oxygen by Winkler titration and chloride (converted to salinity) by the argentometric titration. Biochemical oxygen demand samples were immediately set and stored in a 20 deg C incubator. Ammonia samples were placed in a laboratory refrigerator (4 deg C) until analyzed. Ammonia was analyzed by ion-selective electrode calibrated against known standards. All water analyses were performed in accordance with either *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 19th Edition) or *Methods for the Chemical Analysis of Water and Wastes* (US EPA, revised March 1983, EPA/600/4-79/020) modified to accommodate the analysis of seawater. 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. This is due to the relative shallowness of the water, inflow of freshwaters from the land, and upwelling. Seawater 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 waters. During the winter months, there is little difference in temperature between surface and deeper waters. During the summer, a relatively strong stratification (i.e. thermocline) is evident because the upper layers become more heated than those near the bottom do. Thus, despite little difference in salinity between surface and bottom, changes in temperature during the summer result in a significant reduction of density at the surface (SCCWRP 1973). Stratified water allows for less vertical mixing. This is important in Marina del Rey Harbor because bottom waters may become oxygen-depleted without significant replenishment from the surface (Soule et. al. 1997).

Vertical temperature patterns. Figure 3-3 depicts the minimum, average, and maximum temperatures for each station plotted against depth for 1998-99. With the exception of Station 18, temperatures declined only slightly with depth overall. This suggests that thermal stratification in the Harbor is infrequent. Thermoclines were only weakly developed in August, September, April, and May and were usually restricted mostly to the Harbor entrance and channel stations. As might be expected of areas receiving municipal street drainage, Stations 13 and 22 had the widest temperature range of all stations.

Temperature patterns over the year. Figure 3-4 demonstrates the maximum, average, and minimum temperatures for the 18 water column stations over the sampling season in Marina del Rey Harbor. For the most part, seasonal patterns were similar among stations indicating the strong influence of the oceanographic conditions on the Harbor waters. Average temperatures during the beginning of the sampling season (July, August, and September) were relatively high (about 21 to 25 deg C) at most stations. Beginning in October, average temperatures steadily declined until about February (dropping to about 13 deg C). Temperatures then gradually climbed again through June (to about 20 deg C). This year, stations most influenced by the open ocean (1, 2, 3, 4, 5, 12, and 25) tended to have wider variability in temperature within the month than did those farther back into the Harbor.

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

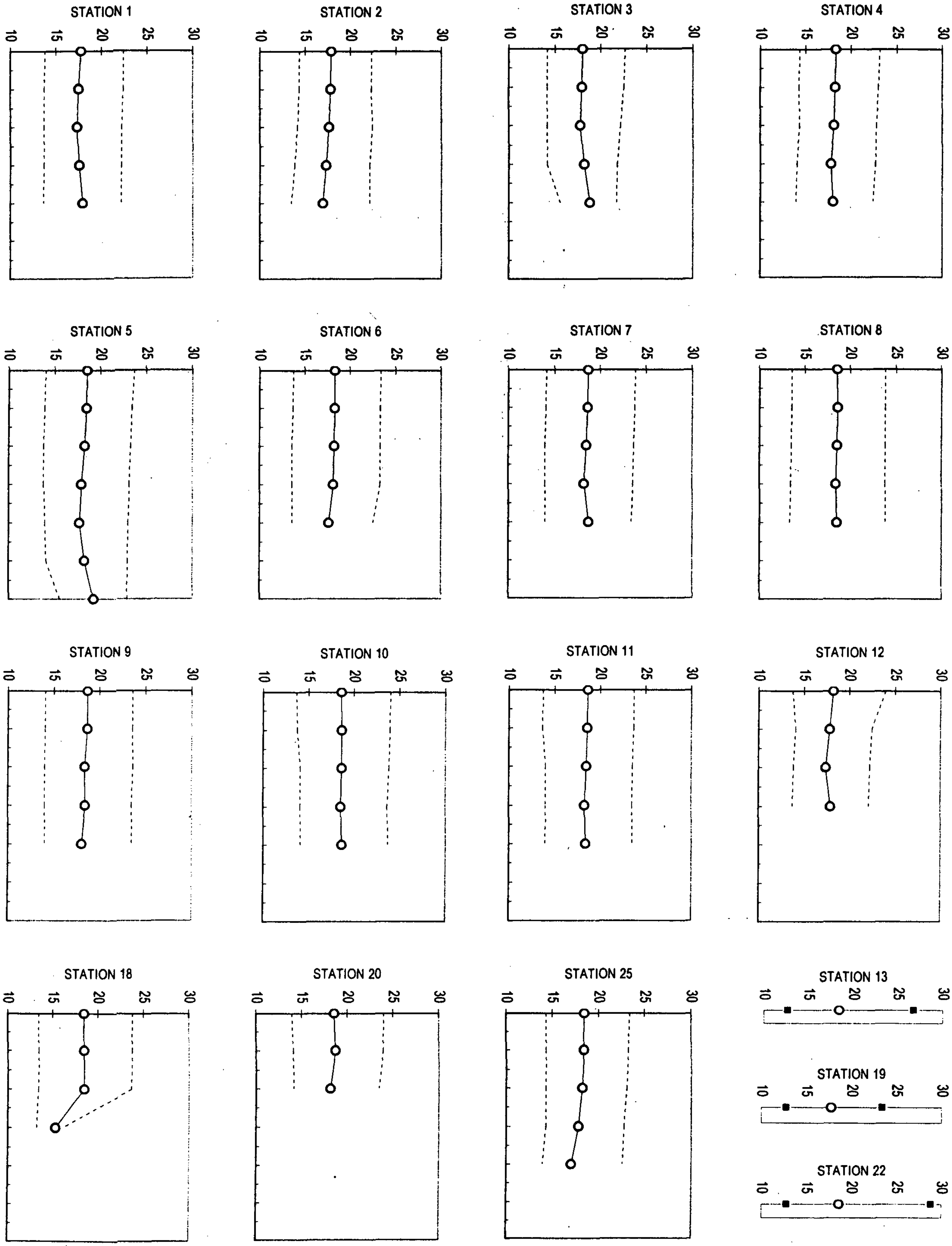
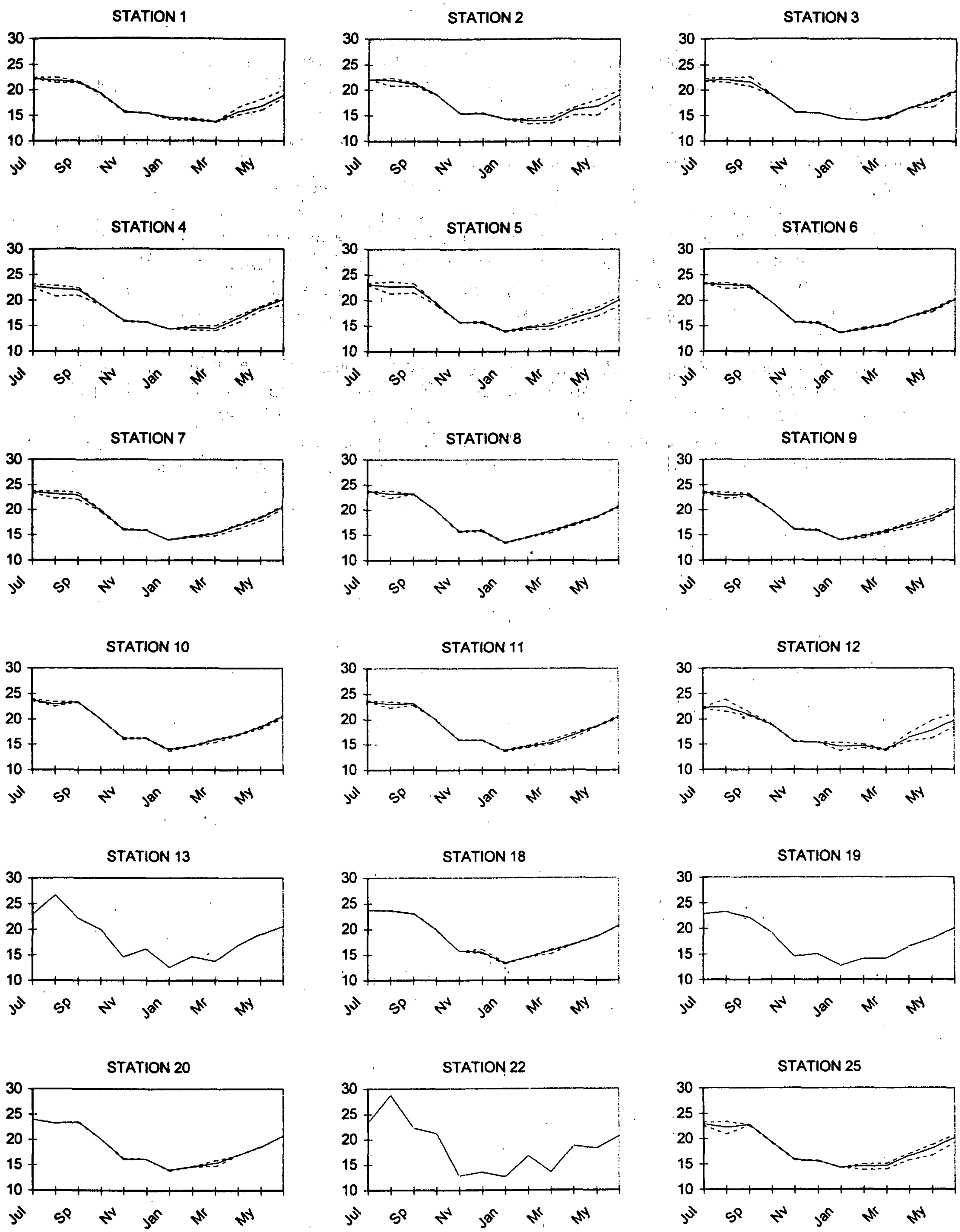


FIGURE 3-4. MINIMUM, AVERAGE, AND MAXIMUM TEMPERATURE (DEG C) VS. MONTH AT 18 WATER COLUMN STATIONS.



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 18.2 to 18.6 deg C) were those furthest back in the Harbor (6, 7, 8, 9, 10, 11, 13, 18, 20,and 22). Station 19 at Mothers Beach and stations near the entrance (1, 2, and 12) averaged coldest (17.5 to 17.7 deg C). Average temperatures in the main channel (Stations 3, 4, 5, and 25) were moderate (17.8 to 18.1 deg C). We are not sure why Station 19 at Mothers Beach is so much colder than other stations nearby. It is our shallowest station, and it is usually collected early in the morning. Perhaps it's shallow depth causes it to be less insulated against the previous night's low temperatures than other stations. 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 1998, 2) the overall seasonal ranges for the nine year period, and 3) the temperatures collected during 1998-99. All 1998-99 temperatures were within the overall seasonal ranges for the preceding nine years, except for the fall minimum, which was about one-half degree lower. Overall, this year's averages were about a degree lower than during the last two El Nino years.

3.3.1.2. **Salinity**

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

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

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

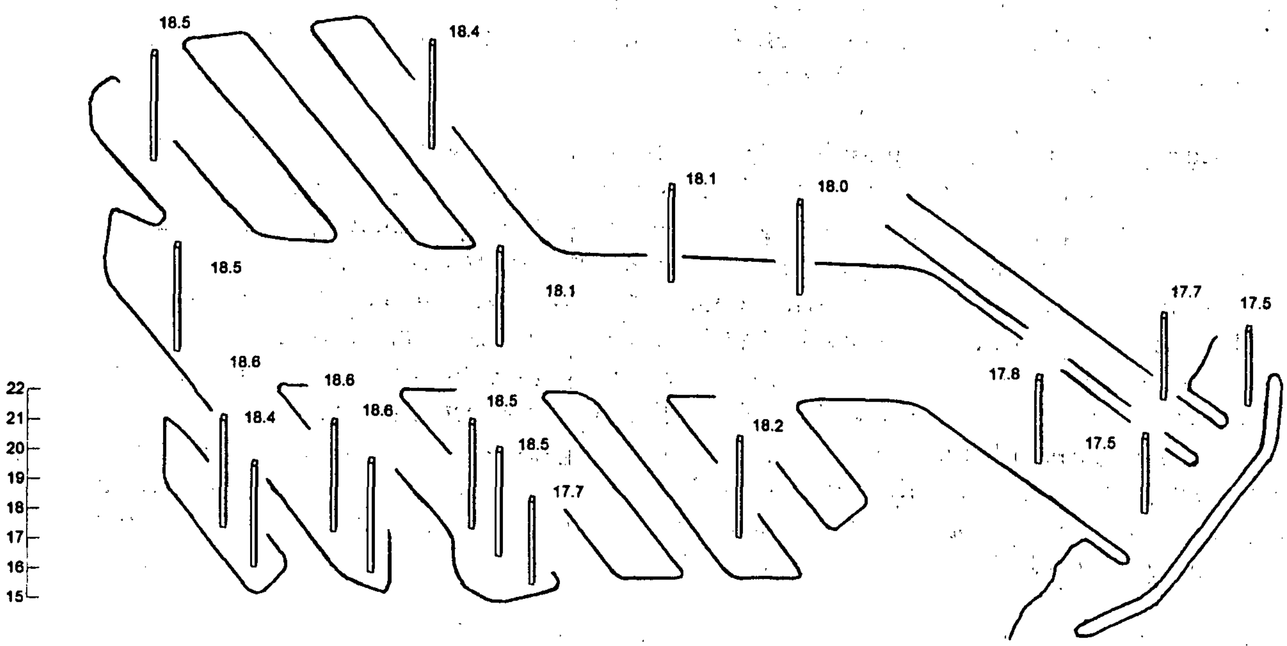


TABLE 3-2. SEASONAL TEMPERATURE RANGES (DEG C) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
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
Overall range	**13.6 - 26.6**	**11.0 - 17.4**	**13.3 - 22.7**	**16.8 - 28.2**
1998-99[3]	12.9 - 23.5	12.6 - 16.2	13.5 - 19.8	18.3 - 21.0

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

Vertical salinity patterns. Very little difference among surface to bottom averages reflect the low rainfall recorded for this year (Figure 3-6). Stations most influenced by runoff from Ballona Creek drainage (1, and 12) and Oxford Lagoon discharges (10, 13, 20, 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.

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 very slight variability over the year with minor declines in December and March. Although rainfall was not heaviest during these months, sampling surveys were conducted shortly after them. Similar to last year, stations associated with Ballona Creek and Oxford Lagoon were affected far more than any of the other stations. However, Stations 13 and 22 in Oxford Lagoon varied much more widely over the year, with salinities ranging from about 1 ppt (near pure freshwater) to nearly 35 ppt (pure seawater). Both Stations 10 and 20 in Basin E appeared affected by this runoff, but only slightly. Salinity values at stations most closely associated with Ballona Creek (1 and 12) were also impacted by freshwater runoff. Excursions in salinity were much more moderate than in Oxford Lagoon, however. Evidence of nonpoint runoff relative to salinity noted last year was not observed during this survey.

Spatial salinity patterns. With the exception of those stations influenced by Oxford Lagoon (10, 13, 20, and 22) and Ballona Creek discharges (1 and 12), all stations sampled within Marina del Rey Harbor had average year-long salinities of between 33.0 and 33.2 parts per thousand (Figure 3-8). Stations 13 and 22 in Oxford Lagoon averaged lowest (23.8 and 19.5 ppt, respectively) followed by Stations 12 and 1 near Ballona Creek (30.0 and 32.1 ppt). Stations 10 and 20 in Basin E appeared to be only slightly affected by Oxford Lagoon drainages (32.9 and 32.6 ppt).

Salinity ranges compared with past years. Table 3-3 lists: 1) the individual seasonal salinity ranges from fall 1991 through summer 1998, 2) the overall seasonal ranges for the seven year period, and 3) the temperatures collected during 1998-99. All 1998-99 salinities were well within, or very close to, the overall seasonal ranges for the preceding seven years.

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.

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

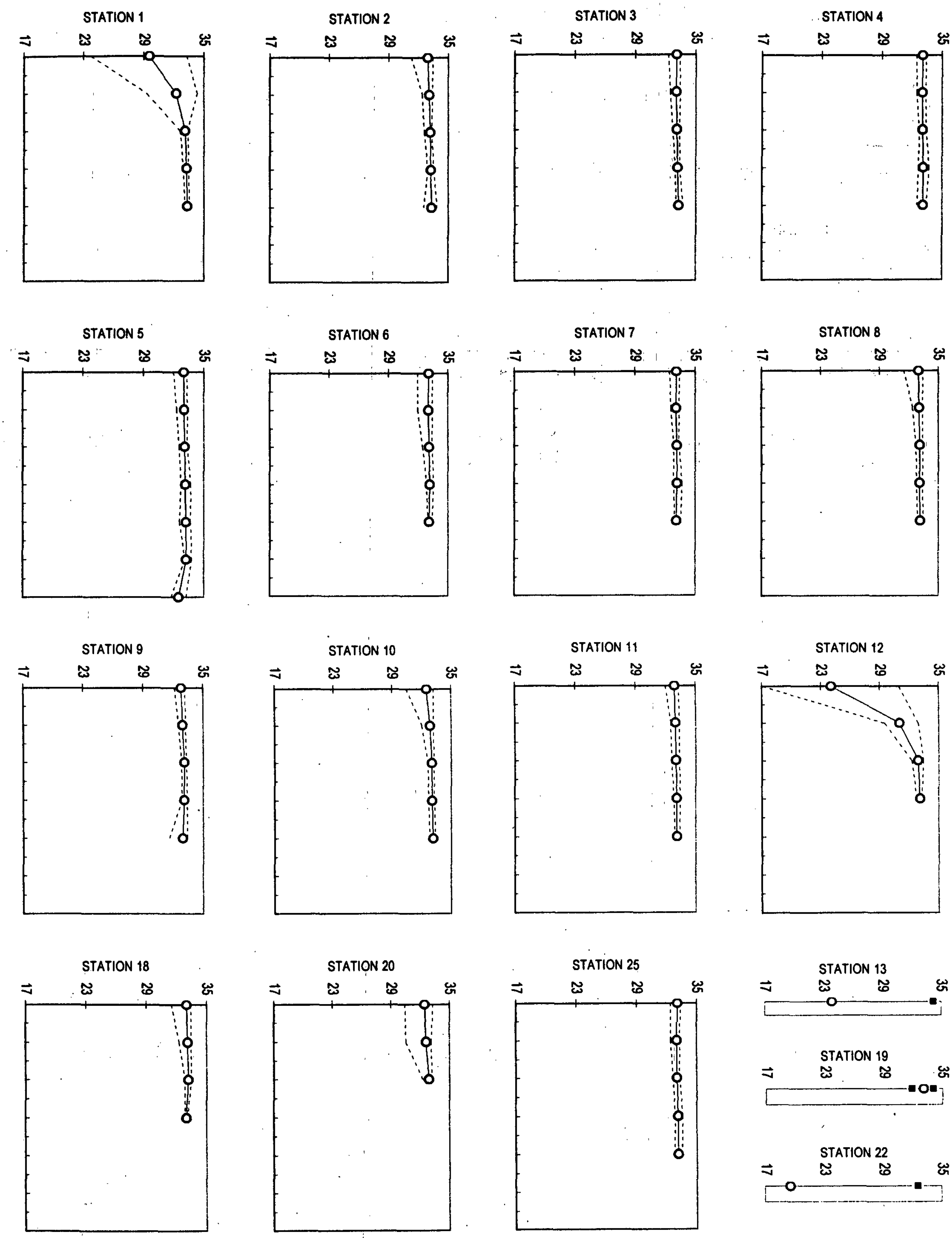


FIGURE 3-7. MINIMUM, AVERAGE, AND MAXIMUM SALINITY (PPT) VS. MONTH AT 18 WATER COLUMN STATIONS.

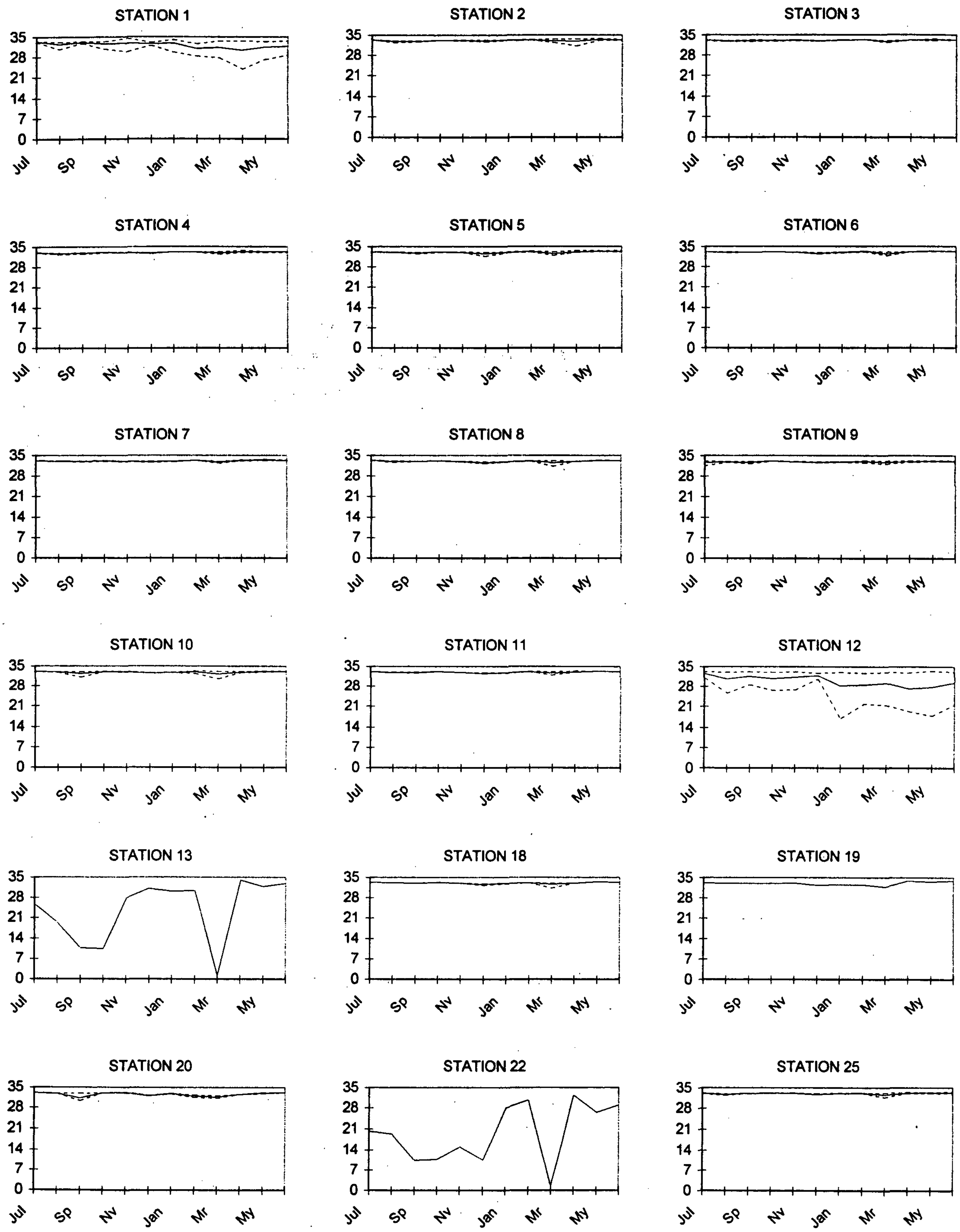


FIGURE 3-8. AVERAGE ANNUAL SALINITY (PPT) AT 18 WATER COLUMN STATIONS.

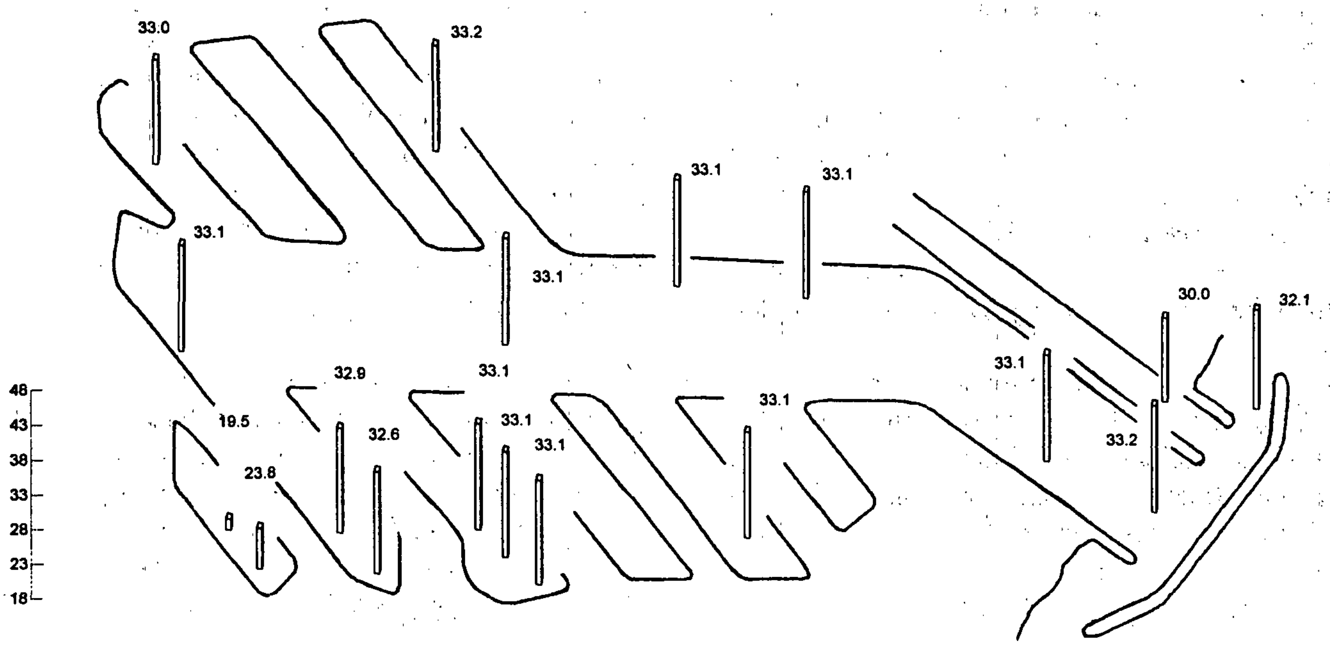


TABLE 3-3. SEASONAL SALINITY RANGES (PPT) FOR ALL DEPTHS AND STATIONS.

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
Overall range	**5.0 - 34.8**	**0.1 - 34.4**	**1.4 - 34.7**	**14.0 - 34.9**
1998-99[3]	10.3 - 34.4	10.3 - 33.9	1.2 - 34.2	21.8 - 34.0

1. Two months only in the fall.

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

3. One month only in the summer.

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.

<u>Vertical dissolved oxygen patterns.</u> 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 1998-99. For many stations, oxygen values were actually slightly higher near the bottom or at middepth. 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, oxygen elevation with depth is likely phytoplankton related.

<u>Dissolved oxygen patterns over the year.</u> Overall, dissolved oxygen values declined slightly from moderate values in July and August to their lowest values of the year in February, increased to their maxima in April, declined slightly to about May, and then began to climb again in June (Figure 3-10). These patterns tended to somewhat follow rainfall patterns for the year (see Figure 3-2) and are likely caused by increased phytoplankton photosynthesis following increase nutrient flows into the harbor. No strong red tide events were recorded during this survey. Temporal patterns within Oxford Lagoon were much different than in the rest of the Harbor. At both Stations 13 and 22, dissolved oxygen values varied wildly from month to month. Oxford Lagoon is influenced much more by freshwater drainage than the open ocean.

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

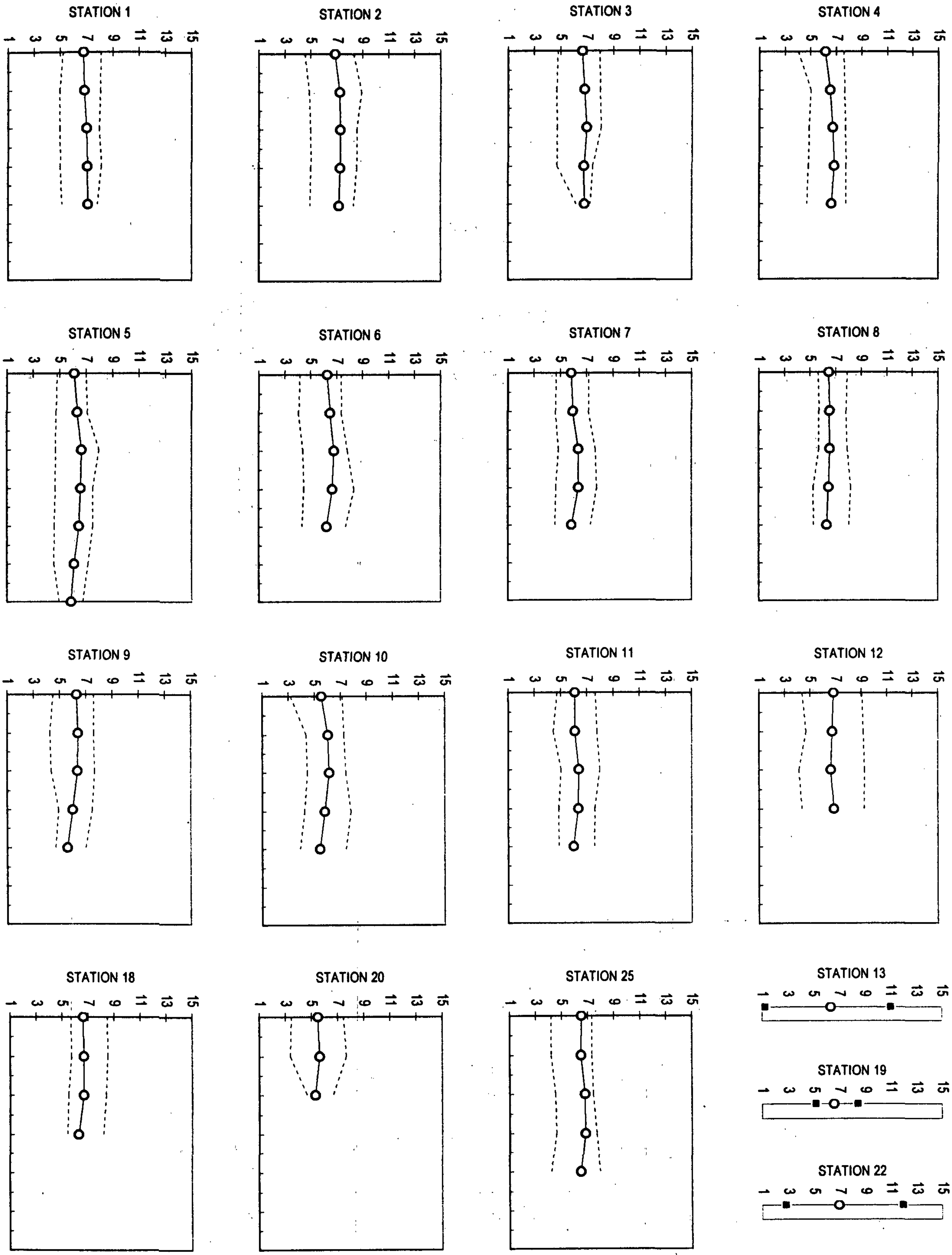
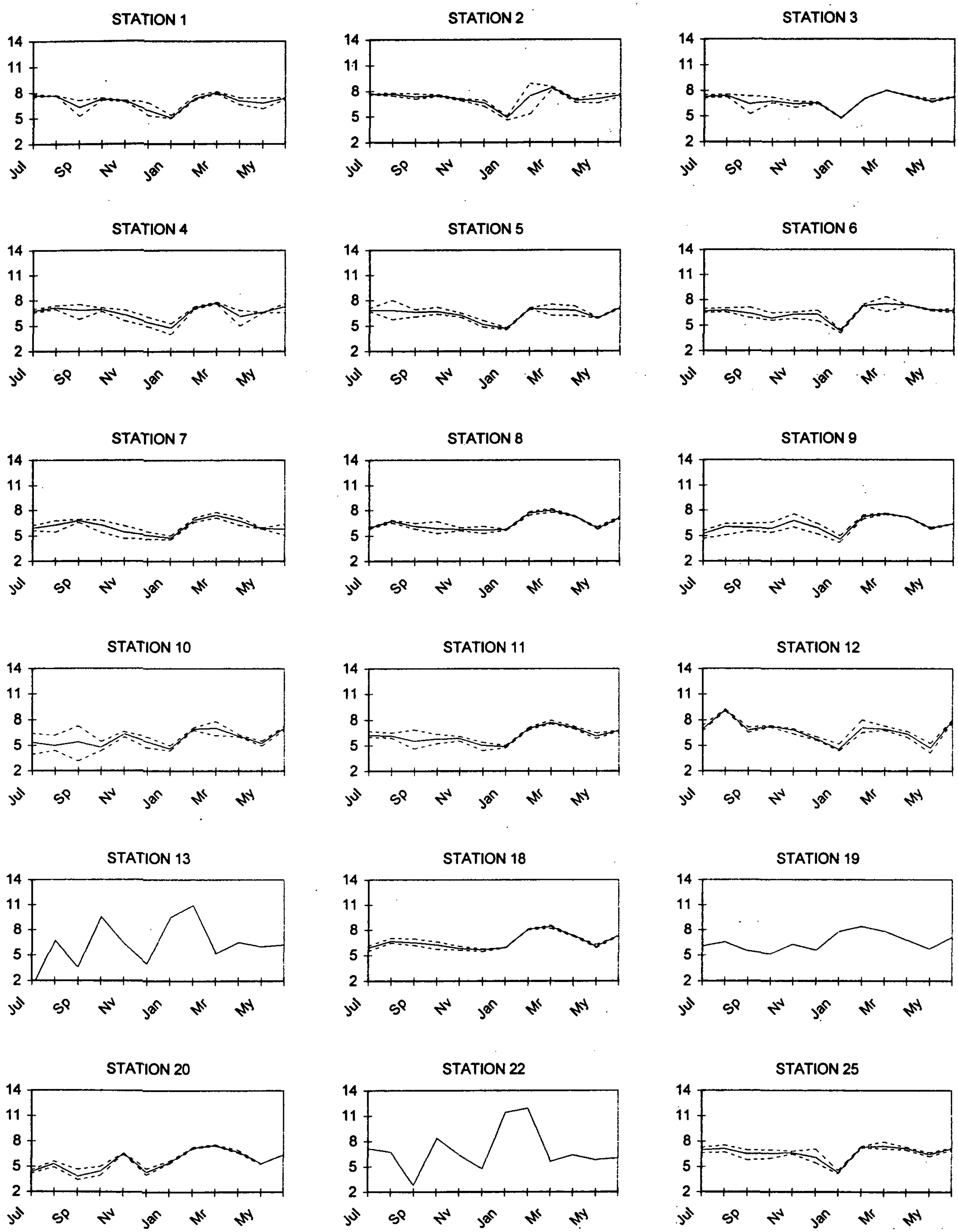


FIGURE 3-10. MINIMUM, AVERAGE, AND MAXIMUM DIS. OXYGEN (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.



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 at Stations 10, 13, and 20 in either Basin E or Oxford Lagoon (five, four, and four surveys during the year, respectively). Values at Station 12 were below 5.0 mg/l twice, and values at Stations 4, 6, 9, 11, 22, and 25 were below once during the year. Stations 1, 2, 3, 5, 7, 8, 18 and 19 were never below 5.0 mg/l. The lowest value recorded was about 1 mg/l at Station 13 in July.

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). Unlike our last two surveys, lowest average values were not in Oxford Lagoon (Stations 13 and 22 – 6.3 and 6.9 mg/l, respectively) but in Basin E (Stations 10 and 20 – 5.8 and 5.6 mg/l). The pattern at Oxford Lagoon this year appears to be one of wild excursions rather than consistently low values (see Figure 3-10). The highest oxygen averages in the Harbor were those nearest the entrance (Stations 1 and 2 – 7.0 and 7.2 mg/l). All remaining stations were moderate, averaging from 6.1 to 6.8 mg/l.

Dissolved oxygen ranges compared with past years. All 1998-99 dissolved oxygen values were within the overall seasonal ranges for the preceding nine years (Table 3-4). When compared to 1997-98, values in the winter ranged slightly higher, oxygen in the fall ranged more widely, ranges in the summer were narrower, and ranges in the spring were 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).

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 13 and 22 in Oxford Lagoon were much wider than all other stations, indicating that a considerable amount of fresh water flows into the lagoon.

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

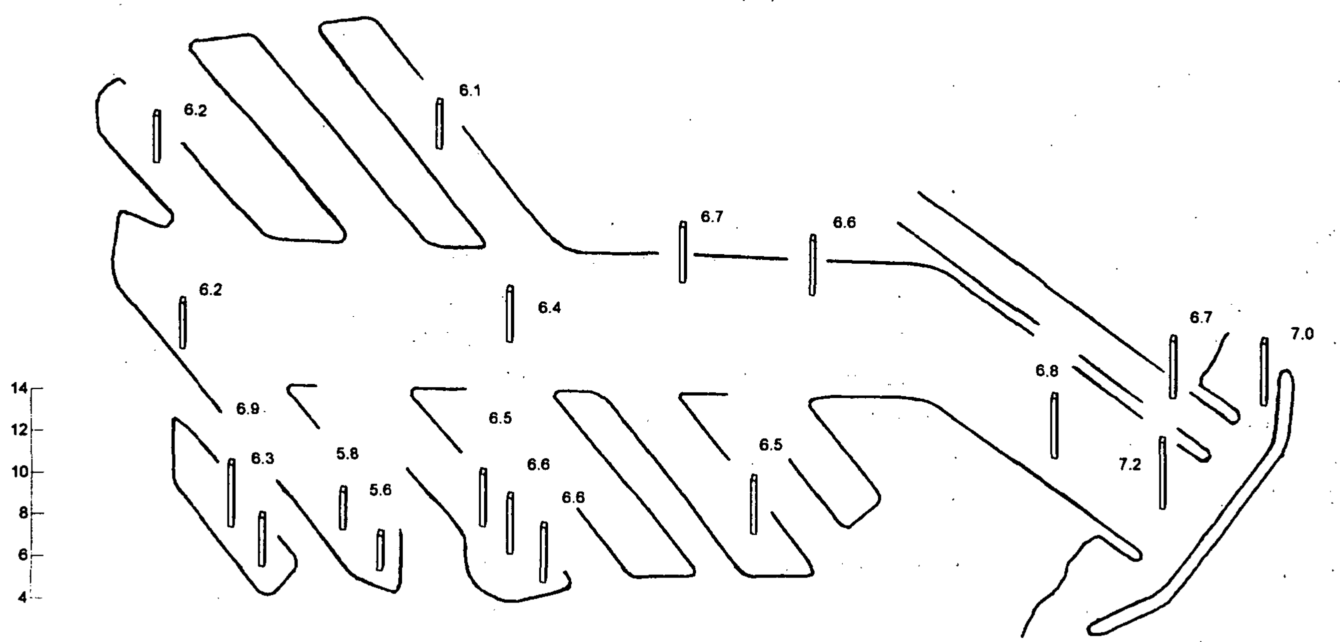
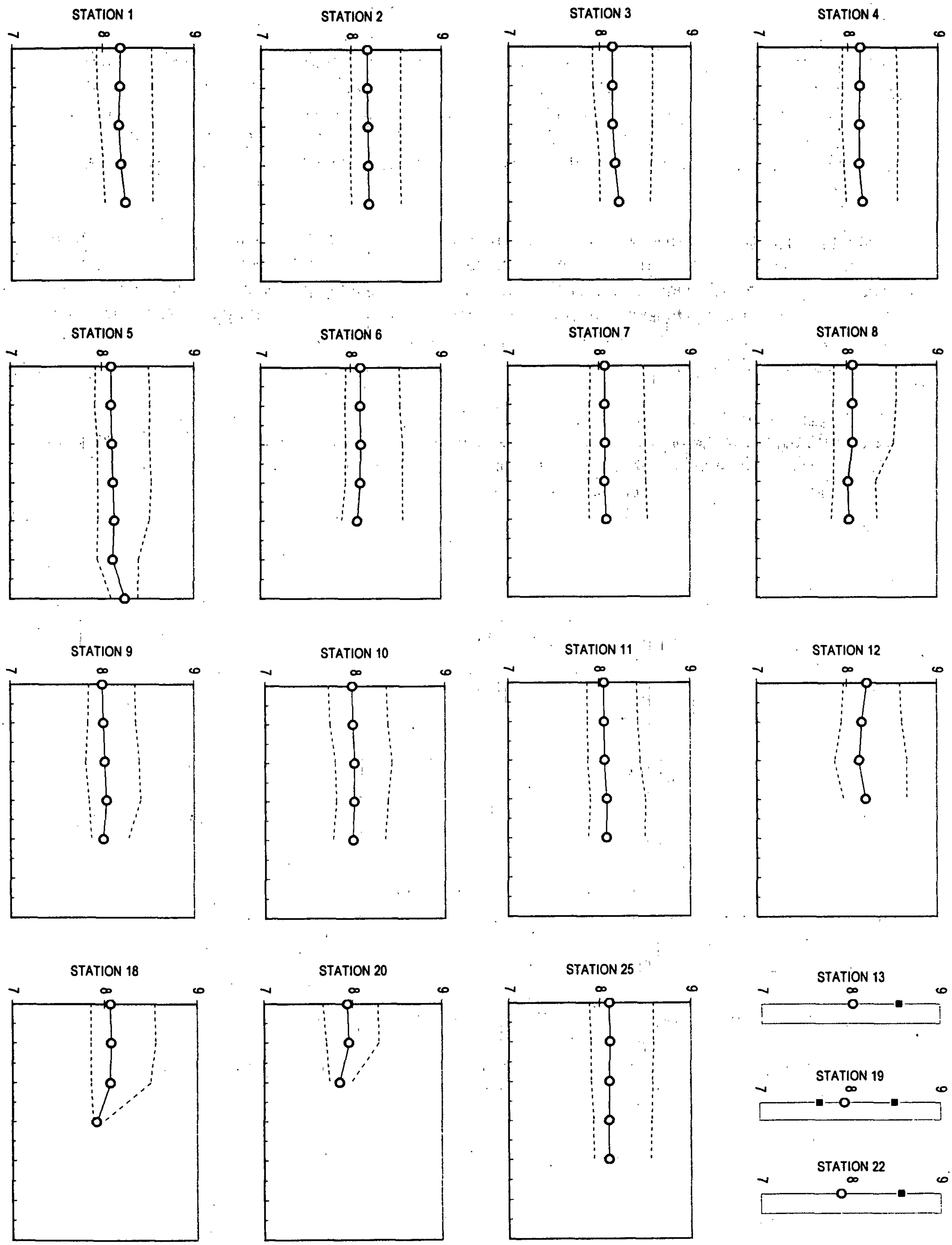


TABLE 3-4. SEASONAL DISSOLVED OXYGEN RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

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
Overall range	**1.9 - 12.0**	**2.0 - 13.1**	**1.4 - 13.9**	**1.0 - 11.0**
1998-99[3]	2.8 - 9.6	4.0 - 11.4	4.2 - 8.6	5.1 - 8.1

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

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



pH patterns over the year. Averages varied weakly at nearly all stations (Figure 3-13). Similar to the past two years, widest temporal pH ranges were within Oxford Lagoon (Stations 13 and 22) and are probably due to random discharge of freshwater into the basin. Stations within the Harbor, which can be impacted by Oxford Lagoon (10 and 20, in Basin E) appeared unaffected this year. Unlike last year, Station 19 at Mother's Beach was more similar to other stations in the Harbor.

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 (8.2 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 (7.9, Stations 10, 19, and 22) were in Oxford Lagoon, at Mothers Beach, and in Basin E. All other stations averaged 8.0 to 8.1 units.

pH ranges compared with past years. All 1998-99 pH values were within, or close to, the overall seasonal ranges for the preceding seven years (Table 3-5). When compared to 1997-98, values in the winter ranged slightly higher and in the spring, somewhat lower. Values in fall were nearly the same and ranges in the summer were narrower than last year.

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 (0.7 to 0.28 ug-at/l) over their study area. Surface concentrations in spring months were somewhat higher than those found during fall and winter months (SCCWRP 1973). These figures are mirrored by our own studies in Ventura County (Aquatic Bioassay 1996).

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

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

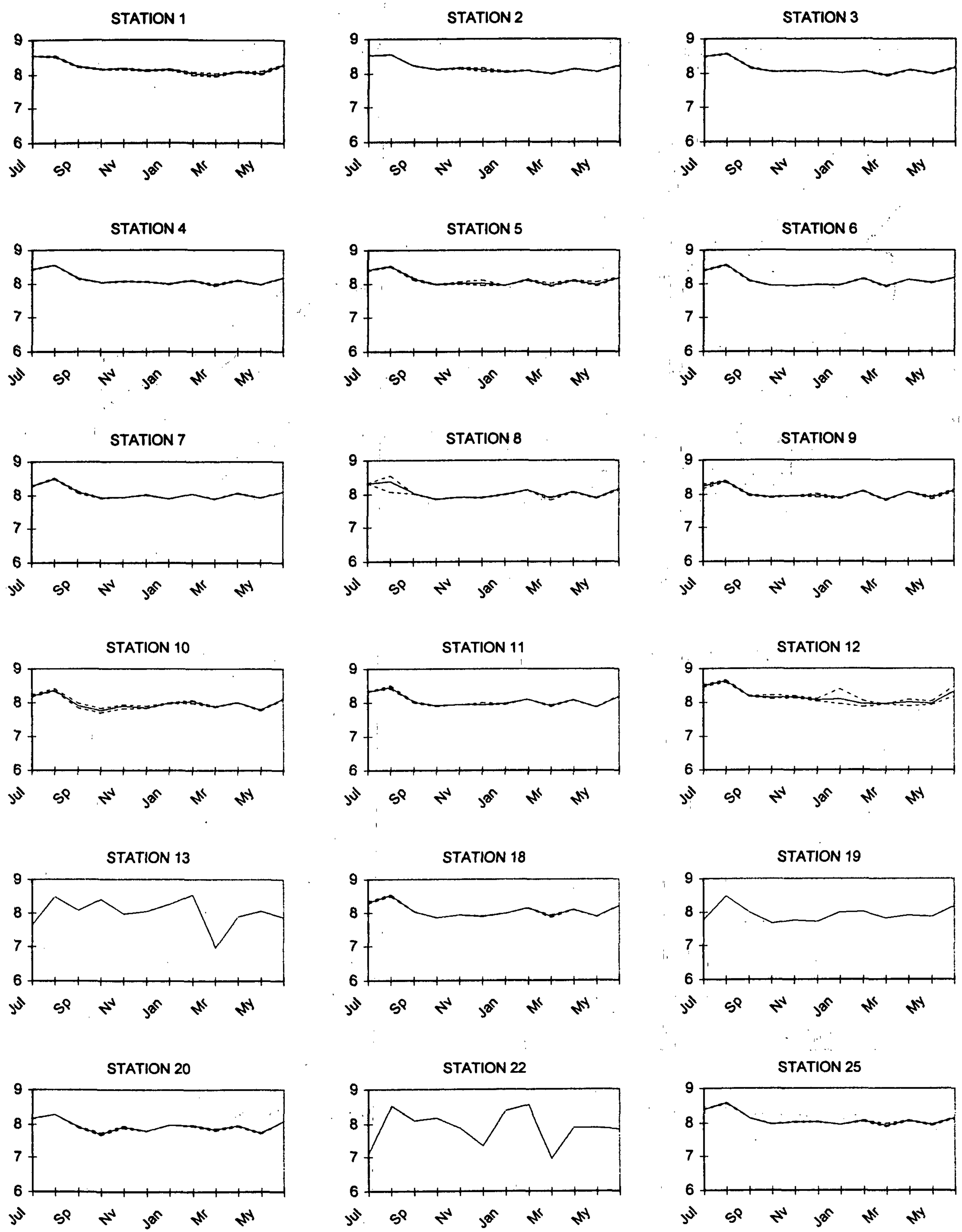


FIGURE 3-14. AVERAGE ANNUAL PH (UNITS) AT 18 WATER COLUMN STATIONS.

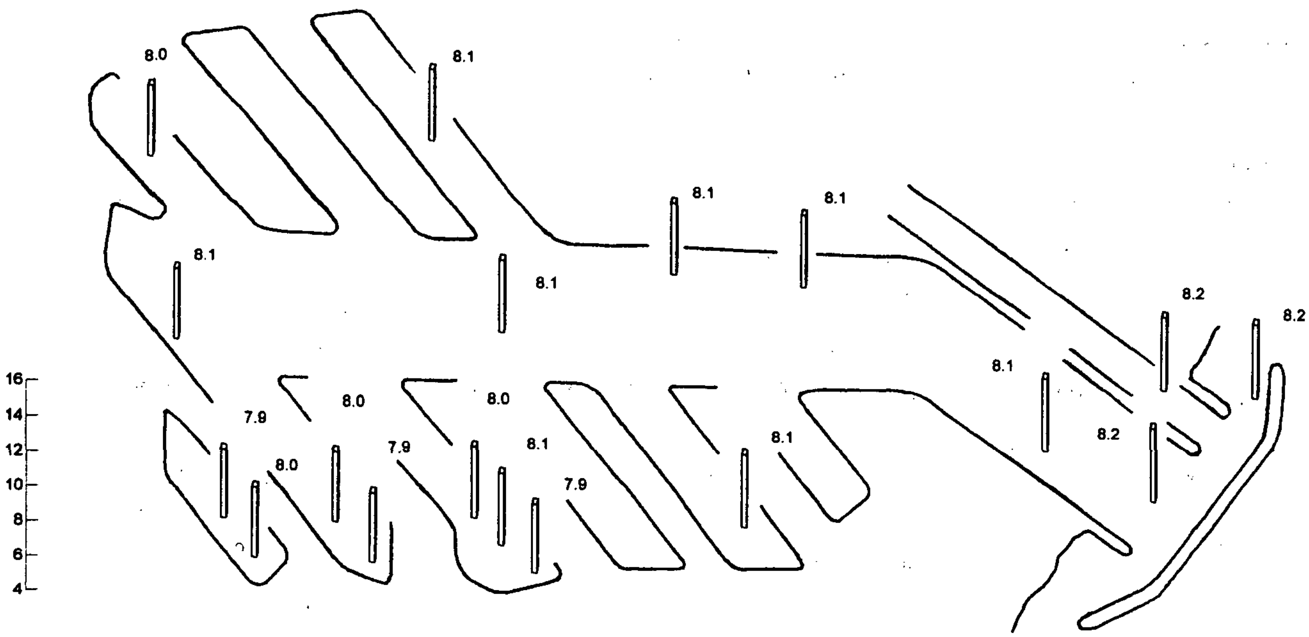


TABLE 3-5. SEASONAL PH RANGES (UNITS) FOR ALL DEPTHS AND STATIONS.

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
Overall range	**7.5 - 8.6**	**6.8 - 8.5**	**7.1 - 8.7**	**7.1 - 8.7**
1998-99[3.]	7.7 - 8.4	7.3 - 8.4	7.0 - 8.1	7.8 - 8.5

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.

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

A high bottom ammonia spike (46 ug-at/l) at Station 25 in the main channel was measured in September. This is the highest ammonia value recorded for the year. Although the source of this ammonia is unknown, it is unlikely that it is from a natural process. Surface maxima at Station 20 was also relatively high (29 ug-at/l). Both averages at Station 10 and 20 were higher through the water column than at most other stations. The source of this ammonia is likely drainage into Basin E from Oxford Lagoon.

<u>Ammonia patterns over the year.</u> For most stations, averages did not vary widely over the year (Figure 3-16), with peaks appearing in January-February and May. These peaks may be rainfall related, but the pattern is not particularly clear. Nonpoint runoff can carry organic matter from adjacent land into the harbor, and the breakdown of this material by bacteria may have caused these higher ammonia levels. Widest temporal ammonia ranges were at Stations 13 and 22 in Oxford Lagoon. The influence of this drainage into Basin E can be seen in the patterns of Stations 10 and 20. A high peak of ammonia was measured at Station 25 in September, and, as mentioned in the paragraph above, its source is unknown.

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

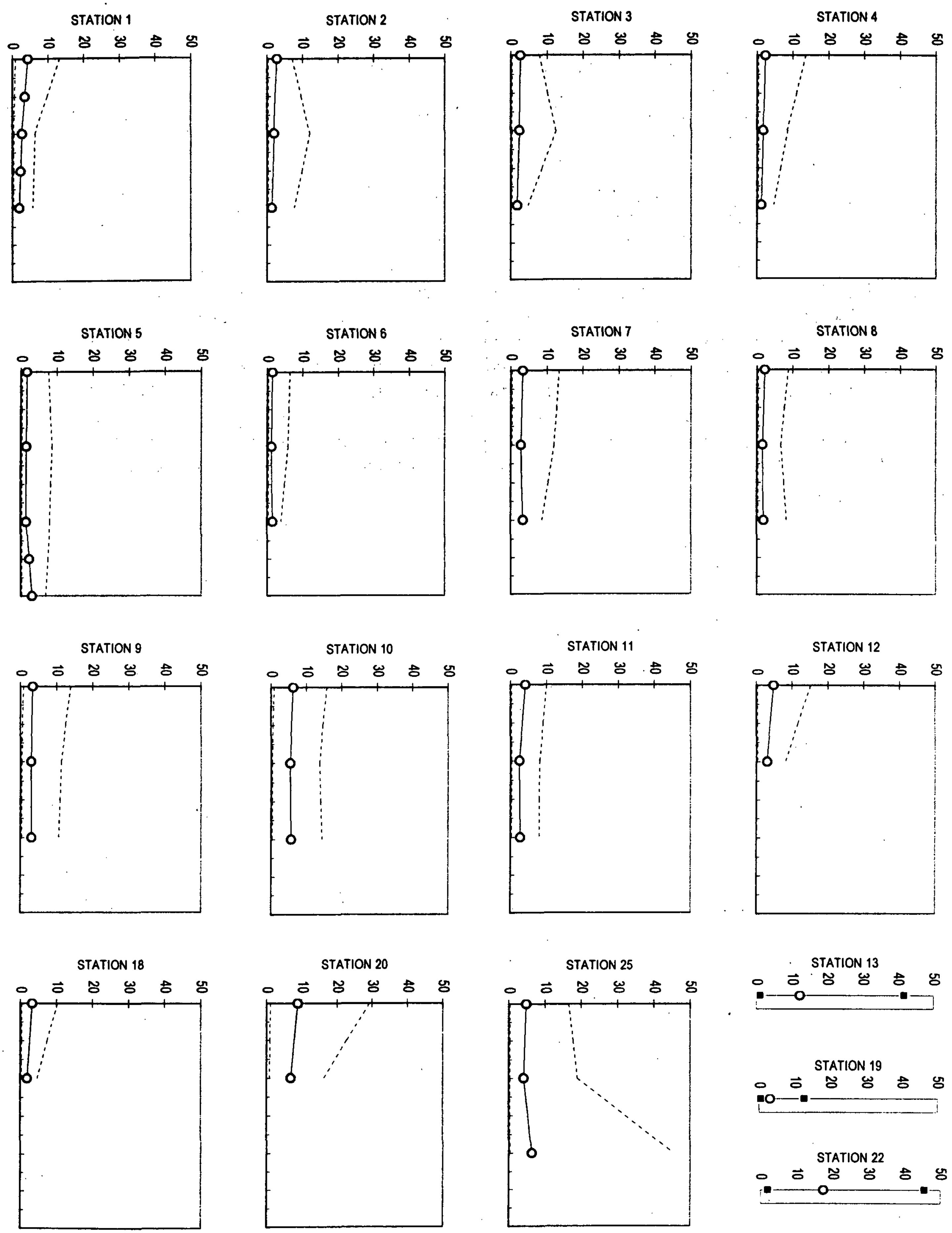
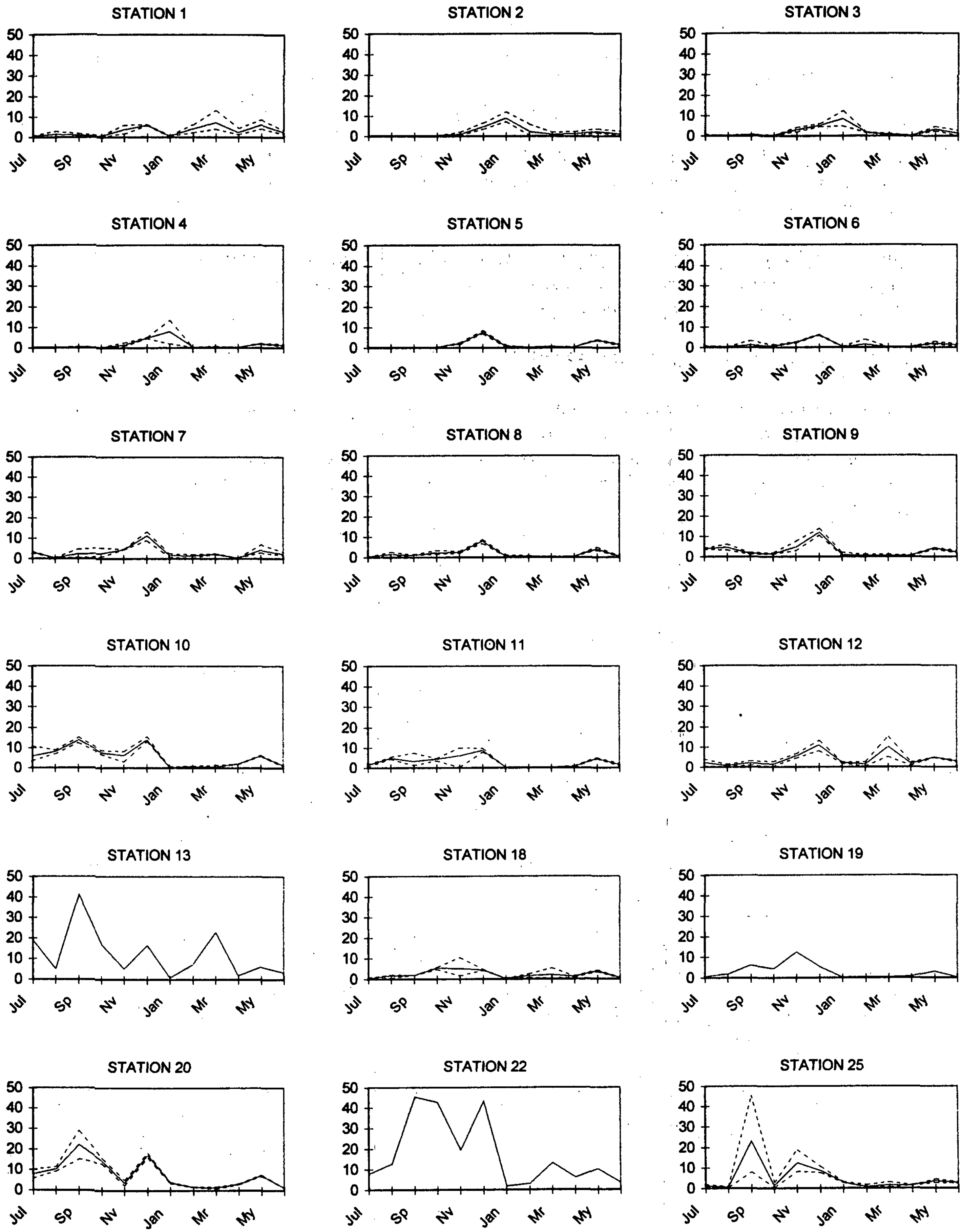


FIGURE 3-16. MINIMUM, AVERAGE, AND MAXIMUM AMMONIA (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.



Spatial ammonia patterns. The most important sources of ammonia into Marina del Rey Harbor are clearly Oxford Lagoon. Other smaller inputs include an unknown single spike at Station 25 (see above), and, perhaps to a lesser degree, Ballona Creek (Figure 3-17). Highest ammonia averages over the year were within Oxford Lagoon (12.3 and 17.4 ug-at/l - Stations 13 and 22, respectively), followed by Stations 10 and 20 in Basin E (5.7 and 7.9 ug-at/l), Station 25 in the main channel (5.1 ug-at/l), and Station 12 in Ballona Creek (3.9 ug-at/l). All remaining stations were relatively low (1.5 – 3.3 ug-at/l).

Ammonia ranges compared with past years. All 1998-99 ammonia values were within the overall ranges for the preceding seven years (Table 3-6). Compared to 1997-98, values in the summer were considerably lower, and values for the remaining seasons were about the same.

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 1997-98, values this year were relatively low and consistent. Where values tended to be higher (e.g. Stations 2, 10, 12, and 20), BOD measurements were mostly highest near the surface. Since these stations are associated with Ballona Creek and Oxford Lagoon, the source of the higher BOD is likely freshwater runoff, which is less dense than seawater and tends to occur near the surface.

BOD patterns over the year. For most stations, BOD values were low (below 5.0 mg/l) throughout the year (Figure 3-19). The huge 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 and Oxford Lagoon 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 – 6.6 and 6.8 mg/l, respectively), Basin E (Station 20 - 3.0 mg/l), and Ballona Creek (Station 12 – 2.7 mg/l). Values at all other stations were relatively low (0.9 to 2.1 mg/l).

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

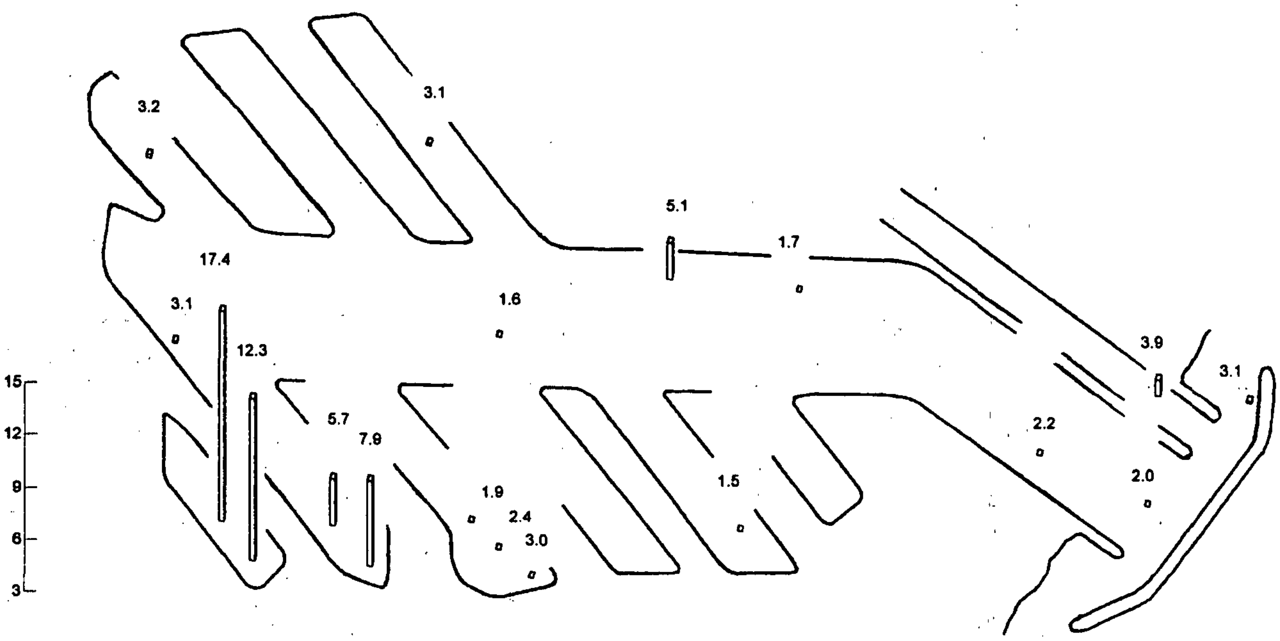


TABLE 3-6. SEASONAL AMMONIA RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

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
Overall range	**0.3 - 52.3**	**0.2 - 200.0**	**0.3 - 35.0**	**0.3 - 105.8**
1998-99[3.]	0.4 - 45.5	0.4 - 43.6	0.4 - 22.9	0.4 - 3.5

[1.] Two months only in the fall.

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

[3.] One month only in the summer.

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

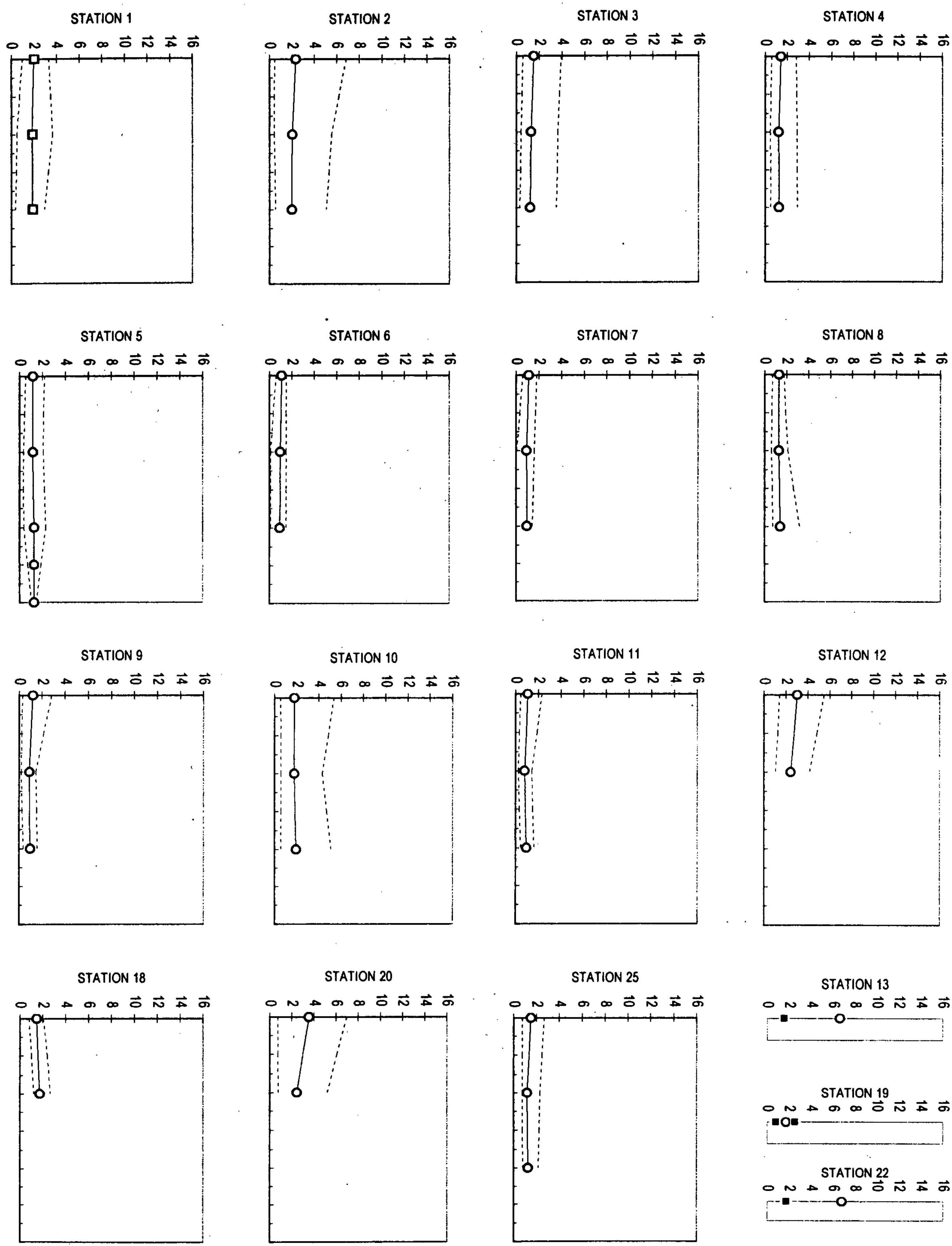
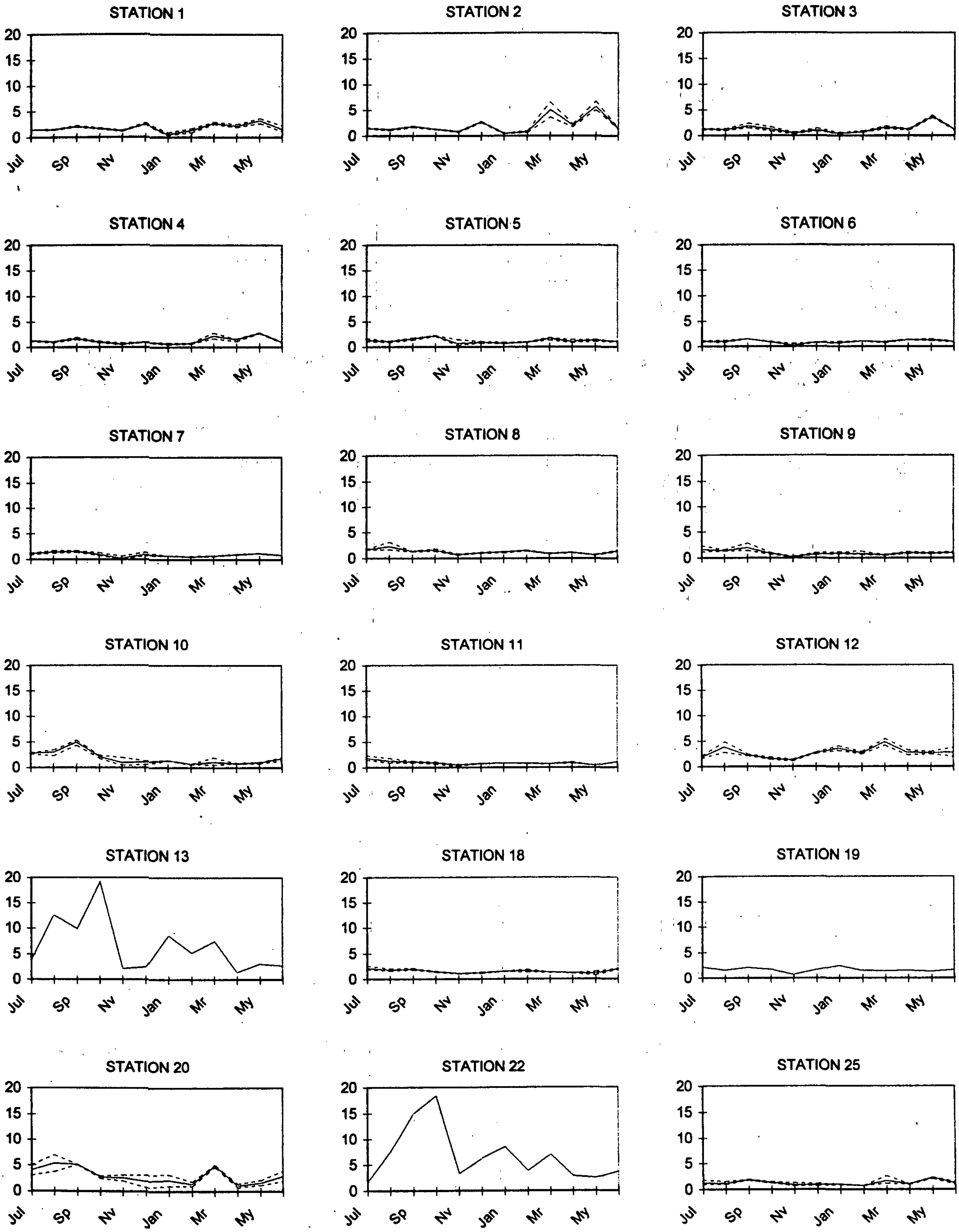


FIGURE 3-19. MINIMUM, AVERAGE, AND MAXIMUM BOD (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.



BOD ranges compared with past years. All 1998-99 BOD values were within or very near to, the overall seasonal ranges for the preceding six years (Table 3-7). Compared to 1997-98, maximum values in summer tended to be higher, while remaining seasons were similar.

3.3.1.7. **Light Transmissance**

Water clarity in Marina del Rey Harbor is important both for aesthetic and ecological reasons. Phytoplankton, as well as multicellular marine algae and flowering plants, are dependent upon light for photosynthesis and therefore growth, and since nearly all higher-level 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 influence water quality on a local basis. Water clarity is determined using two completely different measuring techniques. Surface transparency is measured using a weighted, white plastic; 30-cm diameter disk (called a Secchi Disk) attached to a marked line. The disk is simply lowered through the water column until it disappears, and the depth of its disappearance is recorded. Surface transparency is a good estimate of the amount of ambient light that is available to plankton since the depth to which light is available for photosythesis is generally considered to be about 2.5 times the Secchi disk depth (although more recent findings indicated that net photosynthesis may take place at lower light levels - SCCWRP 1973).

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

Vertical light transmissance patterns. The vertical light transmissance profiles shown in Figure 3-21 suggests that the water column in the Harbor is generally well-mixed and that water clarity is fairly constant with depth. Minimum/maximum ranges were usually narrow. The exceptions are Stations 1 and 12 near Ballona Creek where light transmissance minima are lower.

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

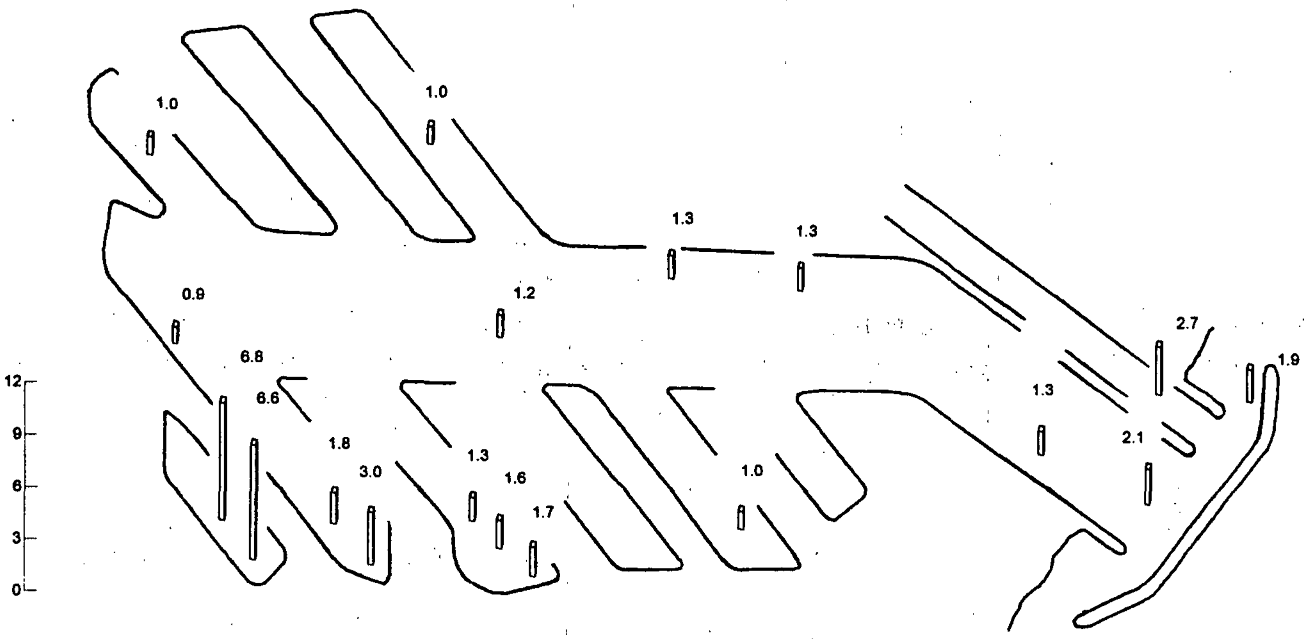


TABLE 3-7. SEASONAL BOD RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

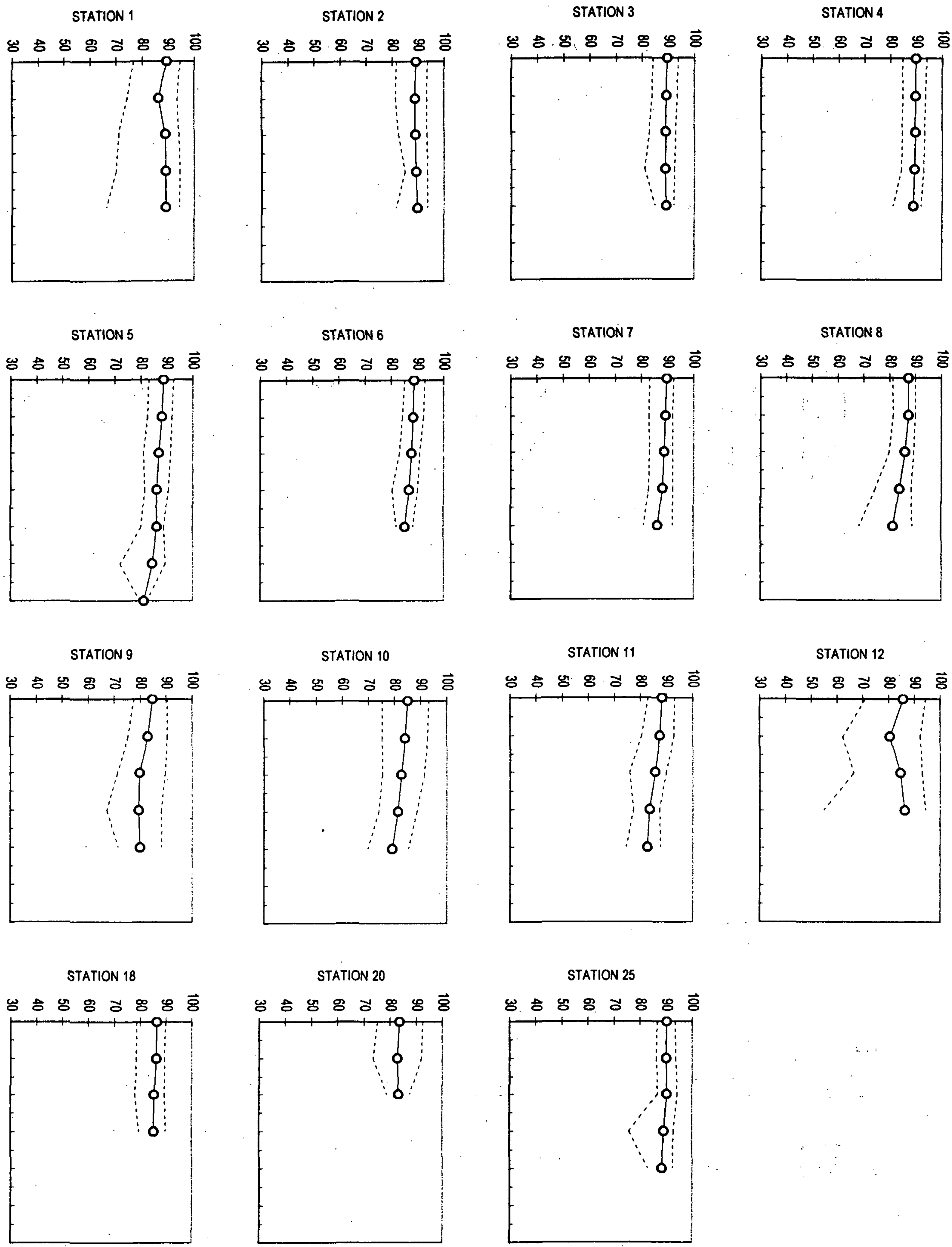
Survey	Fall	Winter	Spring	Summer
1991-92[1.]	0.4 - 6.1	0.4 - 18.9	0.5 - 7.8	0.7 - 6.4
1992-93	0.4 - 12.2	0.5 - 4.3	0.4 - 5.2	0.6 - 6.1
1993-94[2.]	0.8 - 14.0	0.7 - 6.9	0.7 - 15.2	0.6 - 13.0
1994-95	0.6 - 5.2	0.5 - 10.3	0.6 - 13.0	0.9 - 11.2
1995-96	0.8 - 3.4	0.6 - 8.7	0.6 - 6.8	0.1 - 7.5
1996-97	0.1 - 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
Overall range	**0.1 - 14.0**	**0.2 - 18.9**	**0.4 - 15.2**	**0.1 - 15.2**
1998-99[3.]	0.0 - 19.3	0.3 - 8.7	0.4 - 7.6	0.9 - 3.9

[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.

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



Light transmissance patterns over the year. Transmissance values were relatively high during most of the year (Figure 3-22). Several stations had slight drops in transmissance in April, and less frequently in October. The cause for the October decline is not known, however, the April decline may be related to non-point runoff due to rain. These lower values were in evidence most in Basin E (Stations 10 and 20) which are influence by the discharge from Oxford Lagoon. Similarly, Station 12, 1, and perhaps 2, are greatly impacted by the flow from Ballona Creek. At these stations, December and April seemed most affected. As mentioned above, red tide plankton blooms recorded last year were not observed during this survey.

Spatial light transmissance patterns. Transmissance values were high throughout the Harbor (Figure 3-23). Lowest averages were in Ballona Creek (Station 12 – 83.9%), Basin F (Station 9 -- 81.3%), Basin E (Stations 10 and 20 – 83.3% and 82.3%, respectively). Highest values were within the middle and lower channel (89.2% to 89.5% - Stations 2, 3, 4, and 25).

Light transmissance ranges compared with past years. All 1998-99 light transmissance values were within the overall seasonal ranges for the preceding seven years (Table 3-8). When compared to 1997-98, ranges for most seasons were slightly higher. This is not surprising since rainfall during this past year (9 inches) was less than one-third that of 1997-98 (31 inches).

3.3.1.8. Surface Transparency

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

Surface transparency patterns over the year. Surface transparency ranged from less than one meter to nearly six meters (Figure 3-24). Temporal transparency patterns generally followed those of light transmissance. At most stations, surface transparency varied little over the year. Declines during the spring at many stations may have been caused by phytoplankton, which flourish following winter-spring rains and increased spring sunlight. Values at Stations 1, 2, and 25 were influenced by rainy weather runoff from Ballona Creek in December. As with ammonia, Station 25 transparency varied more widely than at most stations, but its cause is not known.

Spatial surface transparency patterns. Surface transparency values averaged over the year are depicted in Figure 3-25. Lowest averages were in Basin E (Stations 13 and 20 – 1.9 m and 2.3 m, respectively) and Basin F (Station 9 - 2.2 m). Highest values were at the channel entrance (Stations 1 and 2 - 3.7 and 3.9 m). All remaining stations ranged from 2.6 to 3.6 m. Unlike last year, average transparency in Ballona Creek was moderately high (3.0 m).

Surface transparency ranges compared with past years. 1998-99 surface transparency values were within the overall seasonal ranges for the preceding seven years (Table 3-9). When compared to 1997-98, values were higher in the fall, lower in the spring, and narrower in range during winter and summer.

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

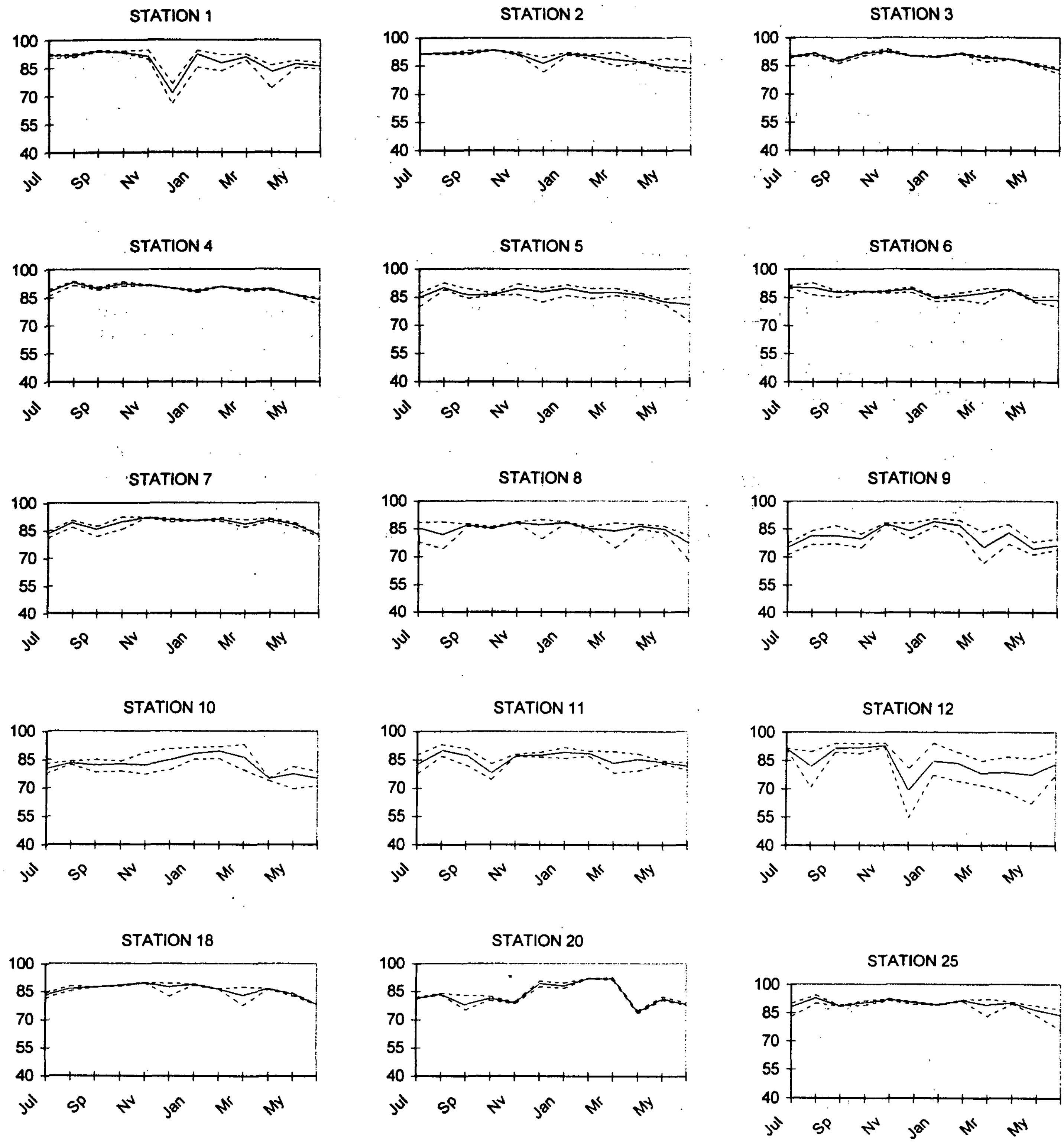


FIGURE 3-23. AVERAGE ANNUAL LIGHT TRANSMISSANCE (%) AT 18 WATER COLUMN STATIONS.

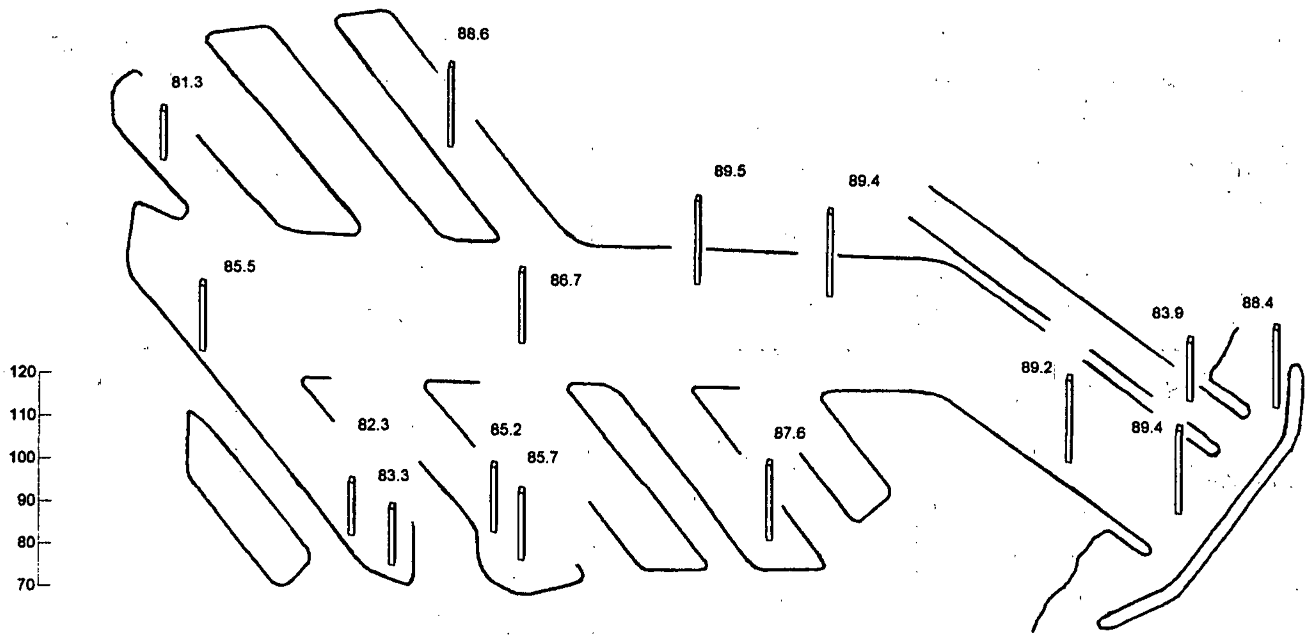


TABLE 3-8. SEASONAL LIGHT TRANSMISSANCE RANGES (%) FOR ALL DEPTHS AND STATIONS.

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
Overall range	**20 - 96**	**0 - 98**	**8 - 90**	**39 - 94**
1998-99[4.]	74.5 - 94.7	54.7 - 94.4	62.3 - 93.1	68.3 - 90.0

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

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

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

[4.] One month only in the summer.

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

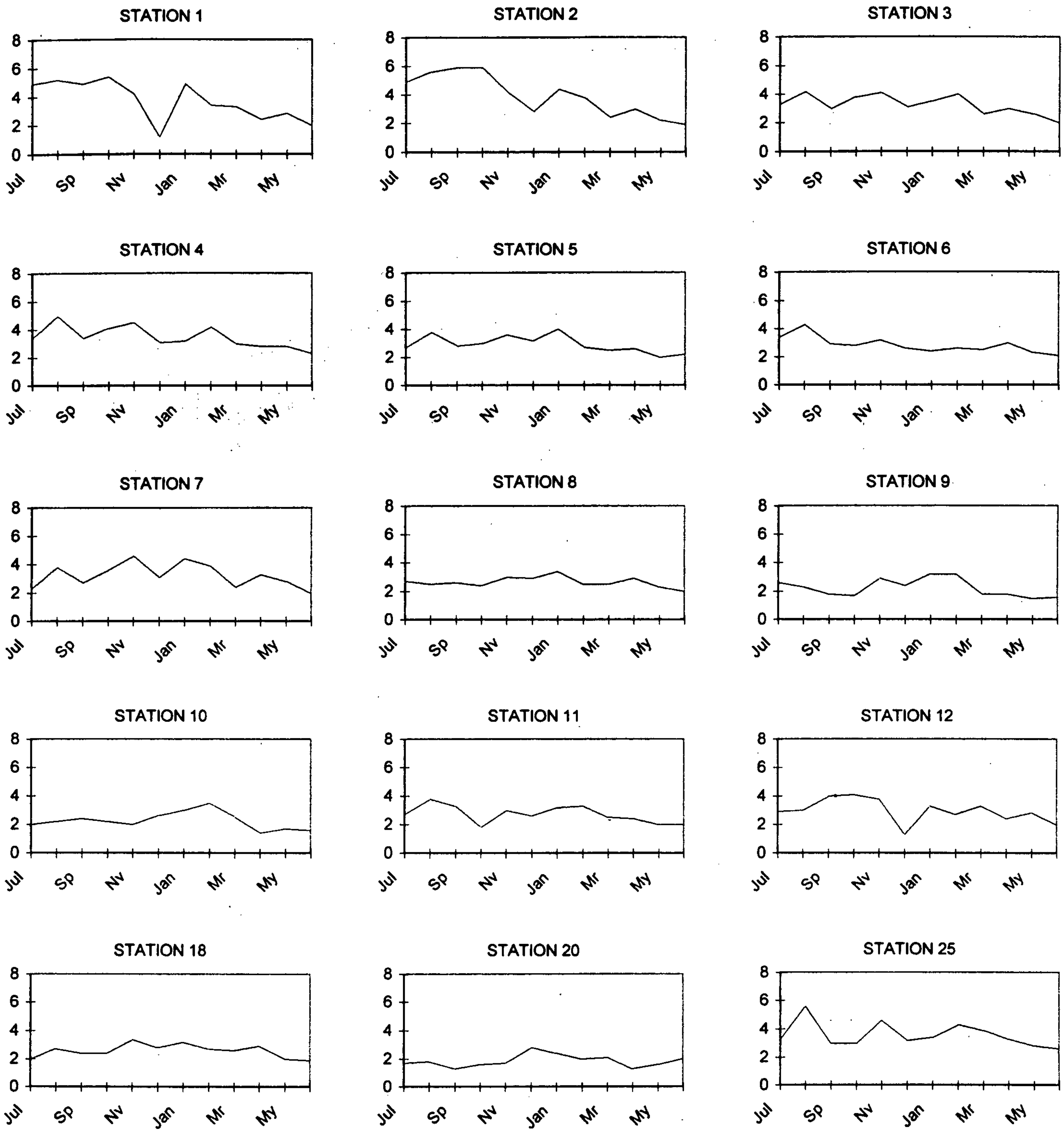


FIGURE 3-25. AVERAGE ANNUAL SURFACE TRANSPARENCY (M) AT 18 WATER COLUMN STATIONS.

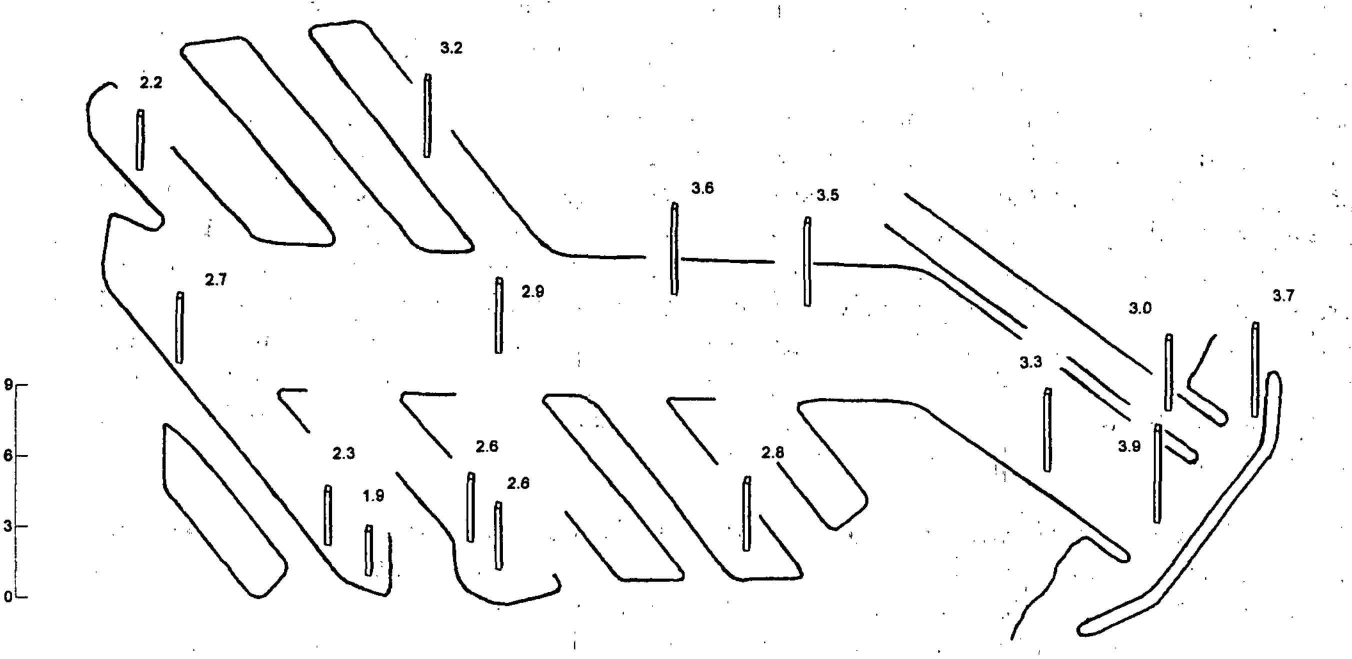


TABLE 3-9. SEASONAL SURFACE TRANSPARENCY RANGES (M) FOR ALL STATIONS.

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
Overall range	**0.4 - 6.5**	**0.1 - 7.0**	**0.3 - 4.5**	**1.0 - 6.6**
1998-99[3]	1.3 - 5.9	1.2 - 4.9	1.3 - 3.9	1.6 - 2.6

1. Two months only in the fall and spring.
2. Two months only in winter and summer. One month in fall.
3. One month only in the summer.

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.

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 7 (green) near the entrance (Station 2) in July to 16 (yellow-green-brown) at Station 1 in December, Stations 12 (in Ballona Creek) and Station 20 (in Basin E) in September and December (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 last year 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 averages were in Ballona Creek (Station 12 – 12.8 units), Basin F (Station 9 – 12.3 units), and Basin E (Stations 10 and 20 - 12.8 and 13.7 units, respectively). The lowest values were in the lower channel (Stations 2 and 3 - 10.6 and 10.8 units). All other stations averaged between these (11.1 to 11.7 units).

Color ranges compared with past years. All 1998-99 surface transparency values were within or near the overall seasonal ranges for the preceding seven years (Table 3-10). When compared to 1997-98, values tended to be higher in the fall and narrower in range for the other seasons.

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

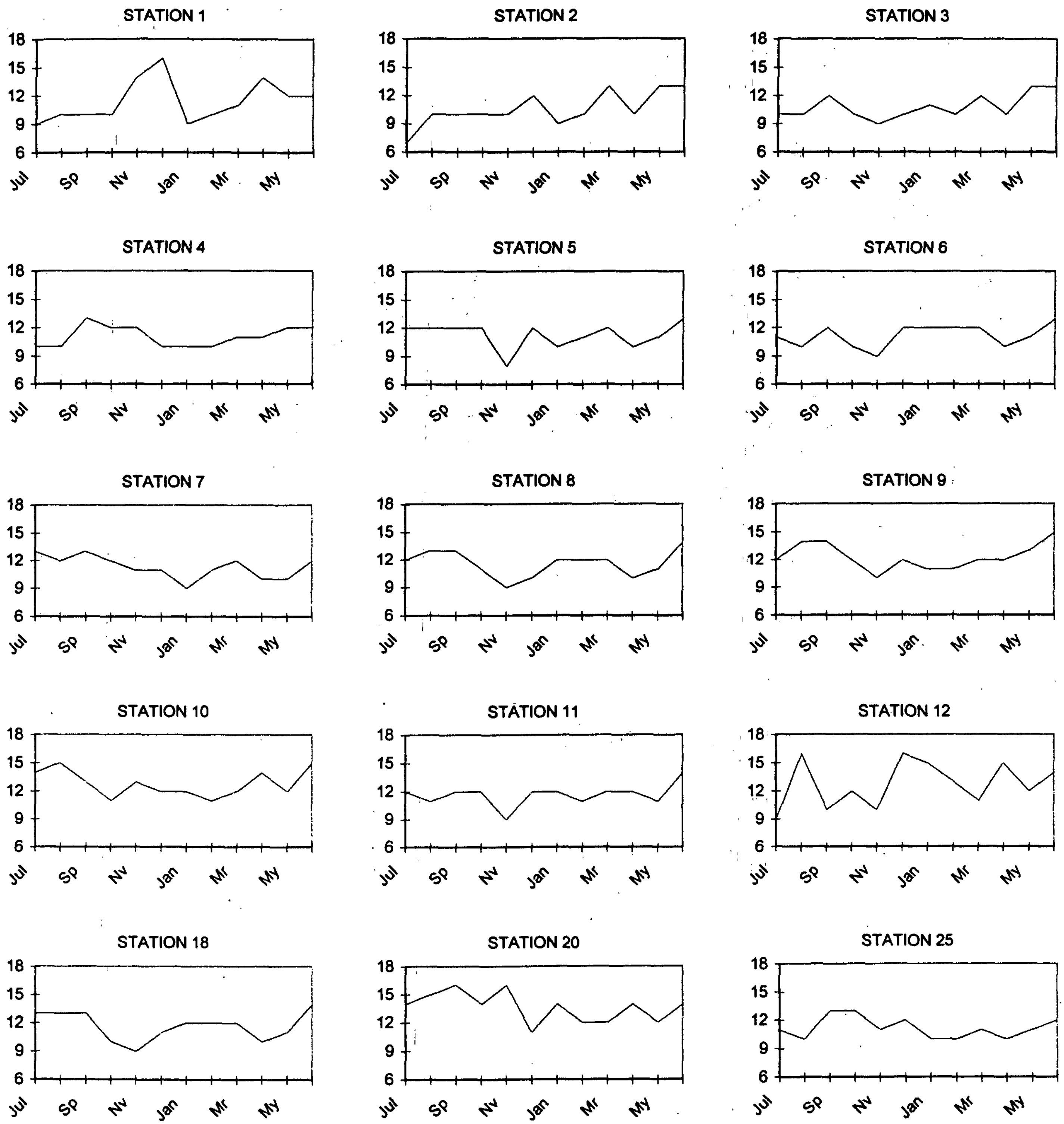


FIGURE 3-27. AVERAGE ANNUAL FOREL-ULE COLOR AT 18 WATER COLUMN STATIONS.

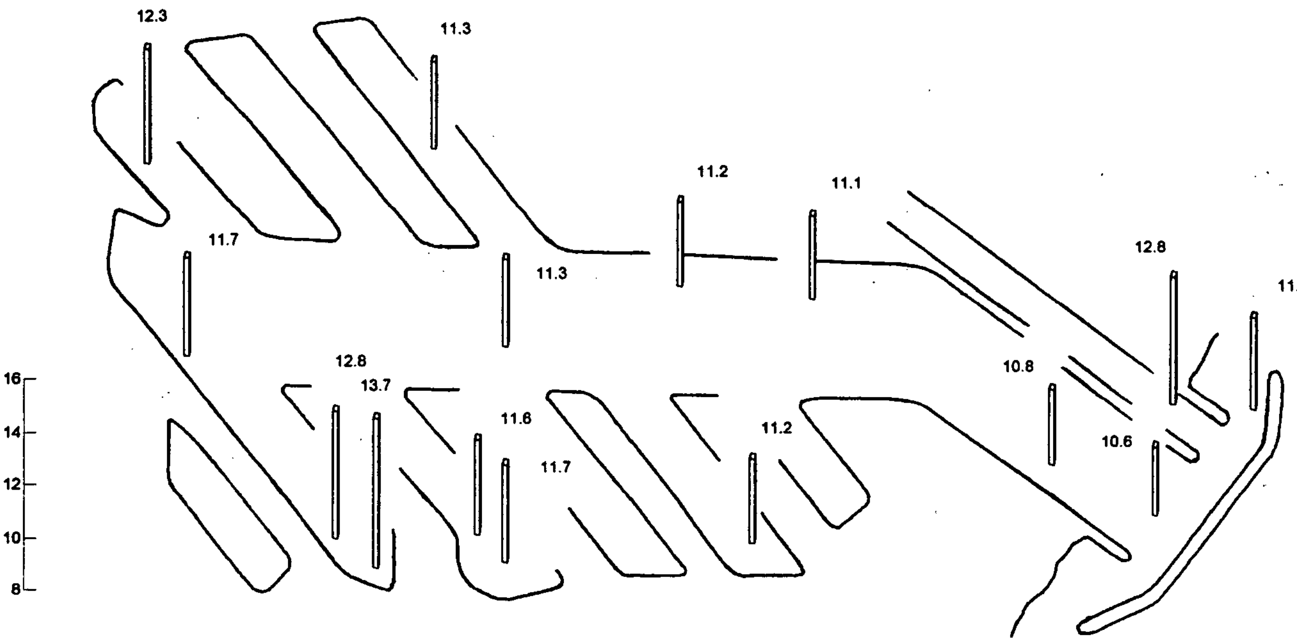


TABLE 3-10. SEASONAL FOREL-ULE COLOR RANGES FOR ALL STATIONS.

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
Overall range	**3 - 14**	**4 - 18**	**5 - 17**	**4 - 17**
1998-99[3.]	8 - 16	9 - 16	10 - 15	12 - 15

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.

3.3.2. Bacterial Water Quality

Maintaining standards of public health is a major concern for the marina. Even though most of the marina is not used for body contact sports, boaters are in contact with the water while doing boat maintenance and youngsters learning to sail not infrequently end up spilled into the water. In Basin D, the so-called Mother's Beach area must be protected for body contact because of the children and adults who paddle and swim in the shallow waters. Fecal contamination may enter the marina from a variety of sources: illegal dumping or leakage of human sewage from vessels, tidal flushing or rainfall runoff of fecal material from birds, dogs, rabbits and/or humans from jetties, beaches and docks, hosing of vessels used as seagull and pigeon roosts, and runoff from storm drain channels. During heavy rainfall, water percolating into the ground can flood sewer lines, overwhelm sewage treatment plants, and cause overflow into storm drain channels. Recent upgrades at Los Angeles City Hyperion Treatment Plant have been made to remedy flow into Ballona Creek. Recreational vessels in the marina do not seem to be a continuing source of coliform contamination, based on historic data, since there are few dry weather violations. The Los Angeles County Department of Health Services monitored five sites in the marina on a weekly basis, but reduced this to four by combining two stations in the beach area into one in August 1994; funds for this activity may not be available in the future due to budget problems. The County is also responsible for monitoring sewer line breaks or overflows.

The present 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).

Total coliform patterns over the year. Total coliform counts ranged from <20 to ≥16,000 MPN/100 ml (Figure 3-28). Out of 300 measurements over the year, counts were in violation (greater than 10,000 MPN/100 ml) 25 times (Table 3-14). Nearly all (22) 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 August at Stations 4 and 25 in the main channel and at Station 7 in Basin H. Since there was no rainfall in August, the cause for these high counts in unknown. Limits were exceeded most in August and March (four stations). During the rest of the year, total coliform exceedances ranged from zero to three stations per month. Unlike past years, total coliform patterns were not strongly related to rainfall this year.

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 - 7784 and 11,172 MPN/100 ml, respectively), in Basin E (Stations 10 and 20 - 1470 and 2533 MPN/100 ml), and near Ballona Creek (Stations 1 and 12 – 469 and 1494 MPN/100 ml). Lowest counts were in the main channel (Stations 2, 3, and 5 – 39, 83, and 56 MPN/100 ml), Basin B (Station 6 - 68 MPN/100 ml) and Basin F (Station 9 – 61 MPN/100 ml). Remaining counts were between these values (91 to 256 MPN/100 ml).

Total coliform ranges compared with past years. Numbers of total coliform violations for 1998-99 were within the overall seasonal ranges for the preceding seven years (Table 3-11). When compared to 1997-98, violation frequency was higher in spring, lower in winter and summer, and the same in the fall.

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

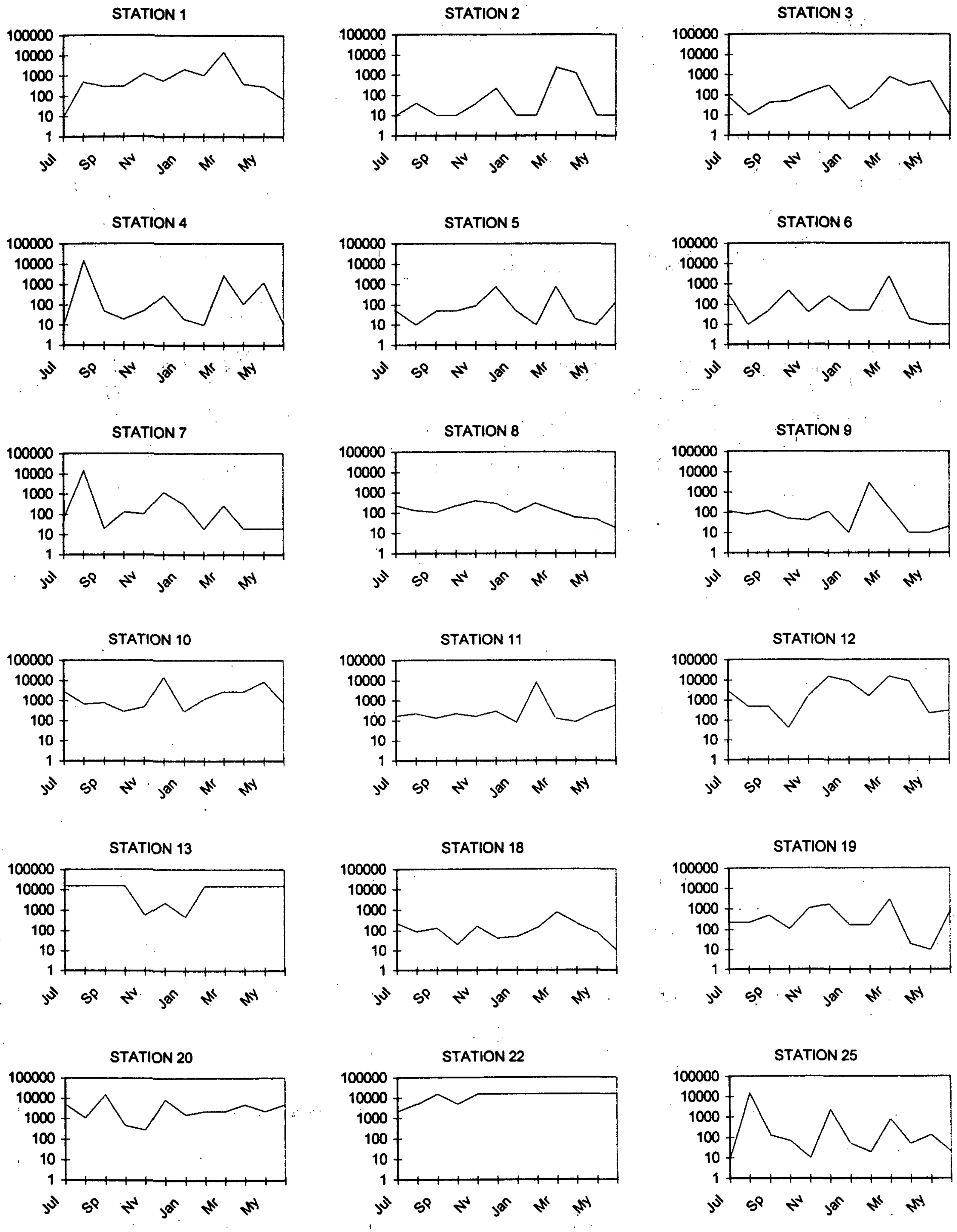


FIGURE 3-29. GEOMETRIC MEANS OF TOT. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

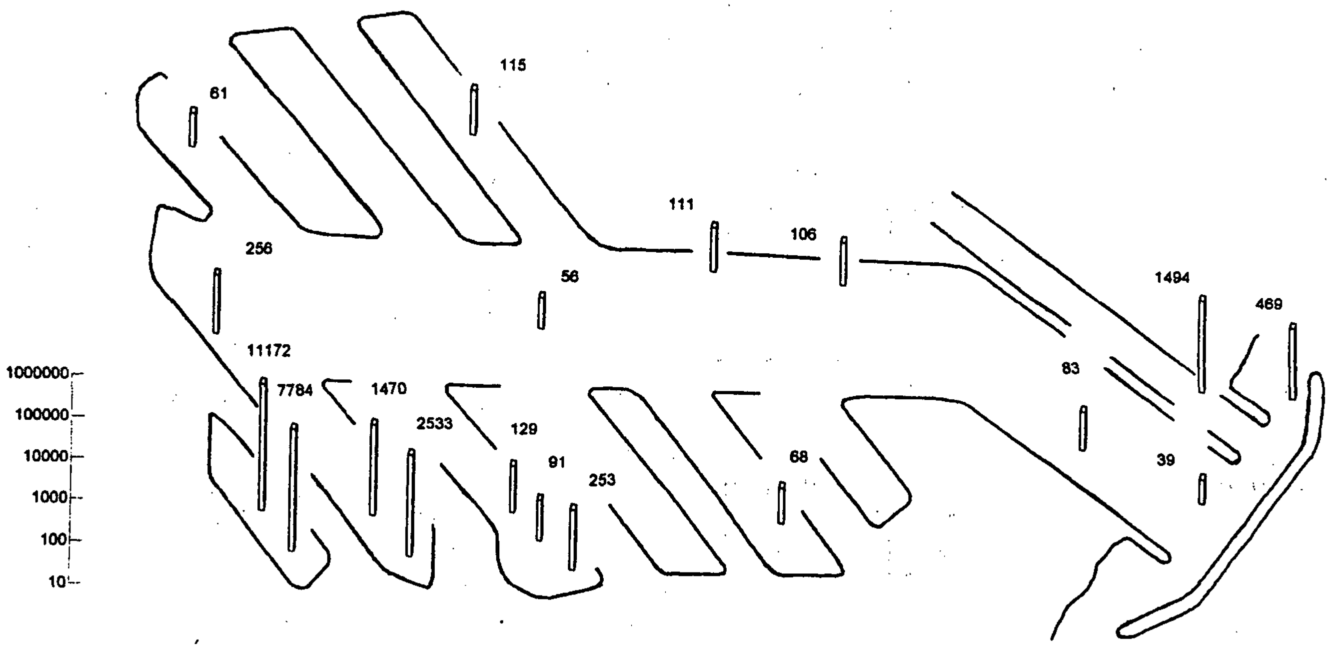


TABLE 3-11. FREQUENCY OF TOTAL COLIFORM VIOLATIONS (>10,000 MPN/100 ML) FOR ALL STATIONS.

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
Overall range	**0 - 5**	**1 - 43**	**1 - 13**	**0 - 8**
1998-99[3.]	5	5	8	2

[1.] Two months only in the fall.

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

[3.] One month only in the summer.

3.3.2.2. Fecal Coliforms

The fecal coliform test discriminates primarily between soil bacteria and those in human wastes, warm blooded animals such as dogs, cats, birds, horses and barnyard animals, and some cold blooded fish. Standards for fecal coliform provide that a minimum of not less than five samples in a 30-day period shall not exceed a geometric mean of 200 MPN/100 ml, nor shall more than 10 percent of the total samples during a 60 day period exceed 400 MPN/100 ml. 400 MPN has been historically use as the standard for single fecal coliform violations (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 300 measurements over the year, counts were in violation (greater than 400 MPN/100 ml) 39 times (Table 3-14). Similar to total coliforms, nearly all (33) 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 at Mothers Beach (Station 19) in September and November, the main channel (Station 4) in March and May, and Basin H (Station 7) in December. High counts in March and December may be rainfall related, although others are likely not. Limits were exceeded most frequently in December and March, and, as stated above, are likely related to non-point runoff due to precipitation. During the rest of the year, fecal coliform exceedances ranged from zero to four 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 - 2069 and 1605 MPN/100 ml, respectively) and in Ballona Creek (Station 12 - 571 MPN/100 ml). Moderate counts were recorded for Basin E (Stations 10 and 20 – 165 and 164 MPN/100 ml), Mothers Beach (Station 19 - 121 MPN/100 ml), and at the Harbor entrance (Station 1 – 186 MPN/100 ml). Remaining counts averaged lower (19 to 56 MPN/100 ml).

Fecal coliform ranges compared with past years. Numbers of fecal coliform violations for 1998-99 were within the overall seasonal ranges for the preceding seven years (Table 3-12). When compared to 1997-98, violations were much more frequent in the spring and less frequent during the remaining seasons.

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).

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

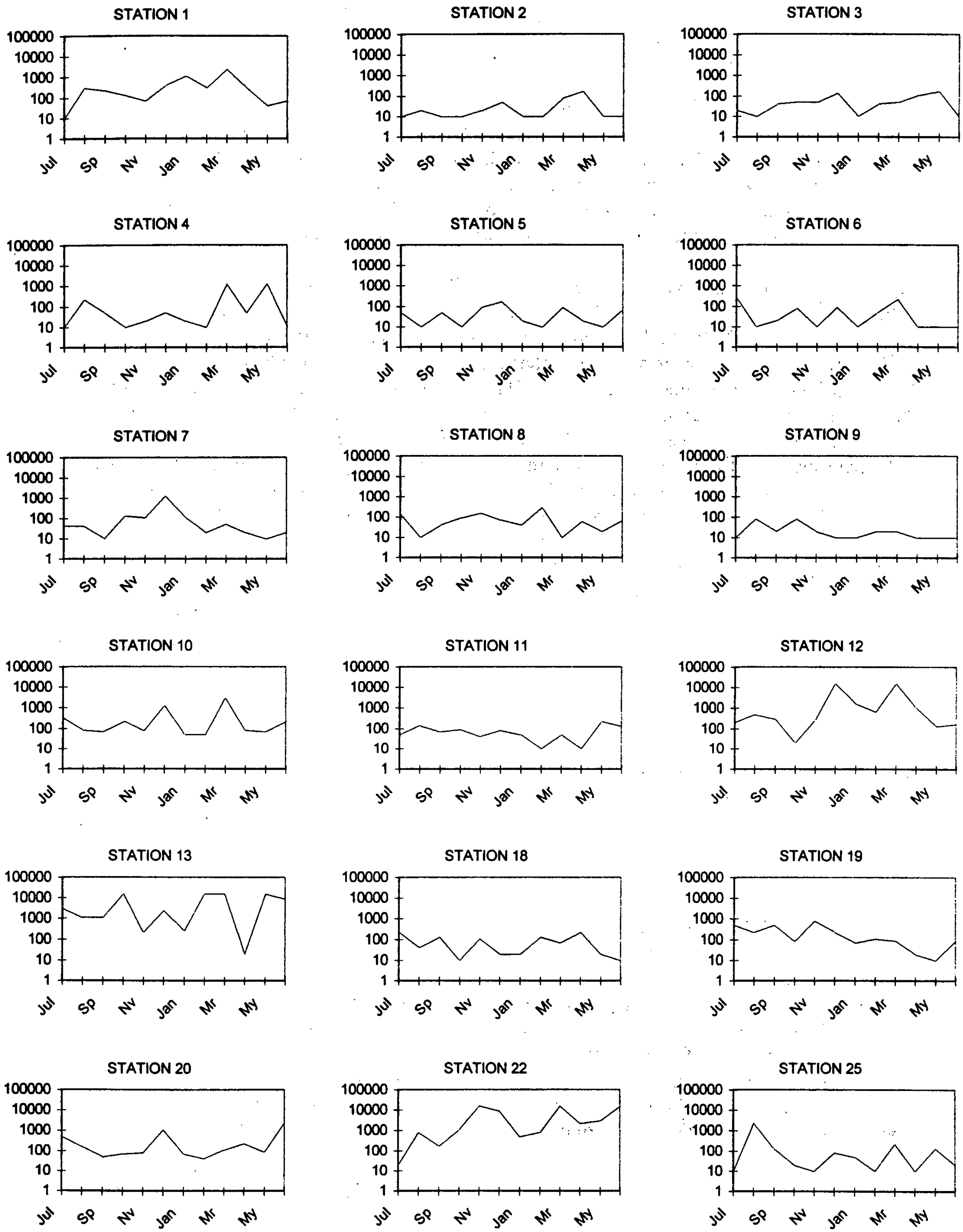


FIGURE 3-31. GEOMETRIC MEANS OF FEC. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

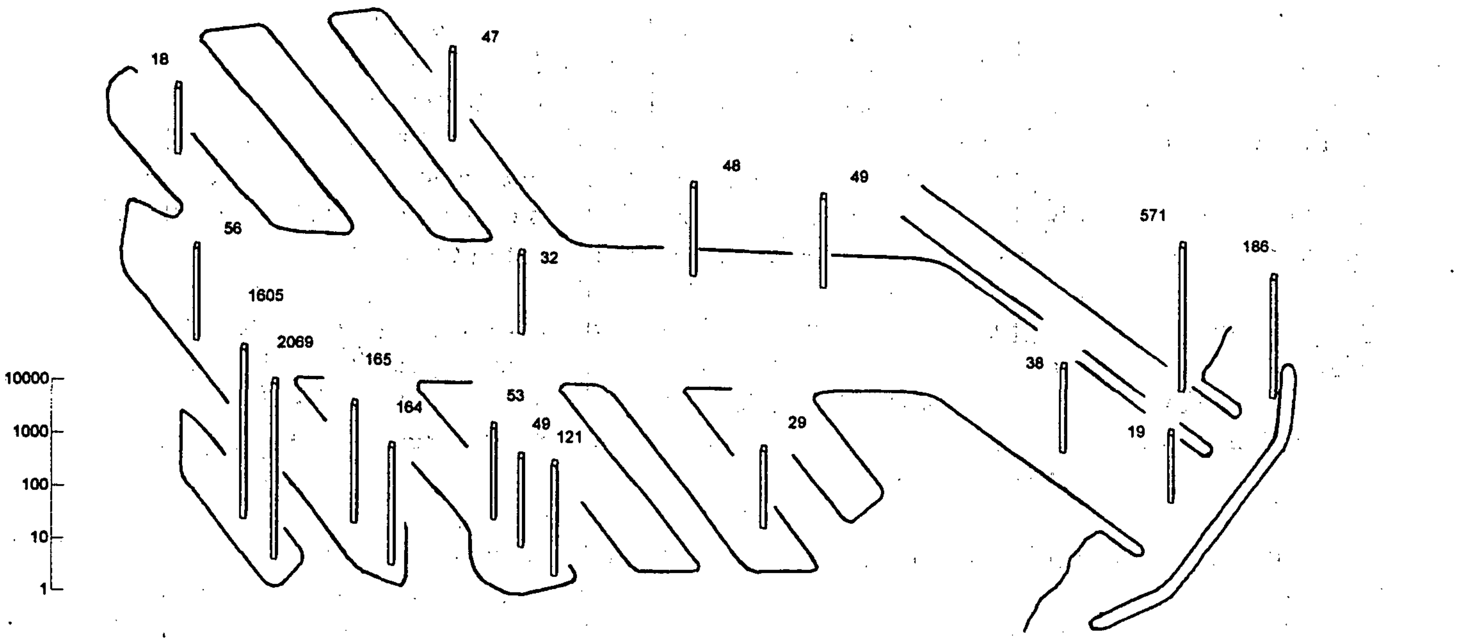


TABLE 3-12. FREQUENCY OF FECAL COLIFORM VIOLATIONS (>400 MPN/100 ML) FOR ALL STATIONS.

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
Overall range	**2 - 18**	**6 - 46**	**3 - 21**	**0 - 10**
1998-99[3]	6	12	11	3

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.

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

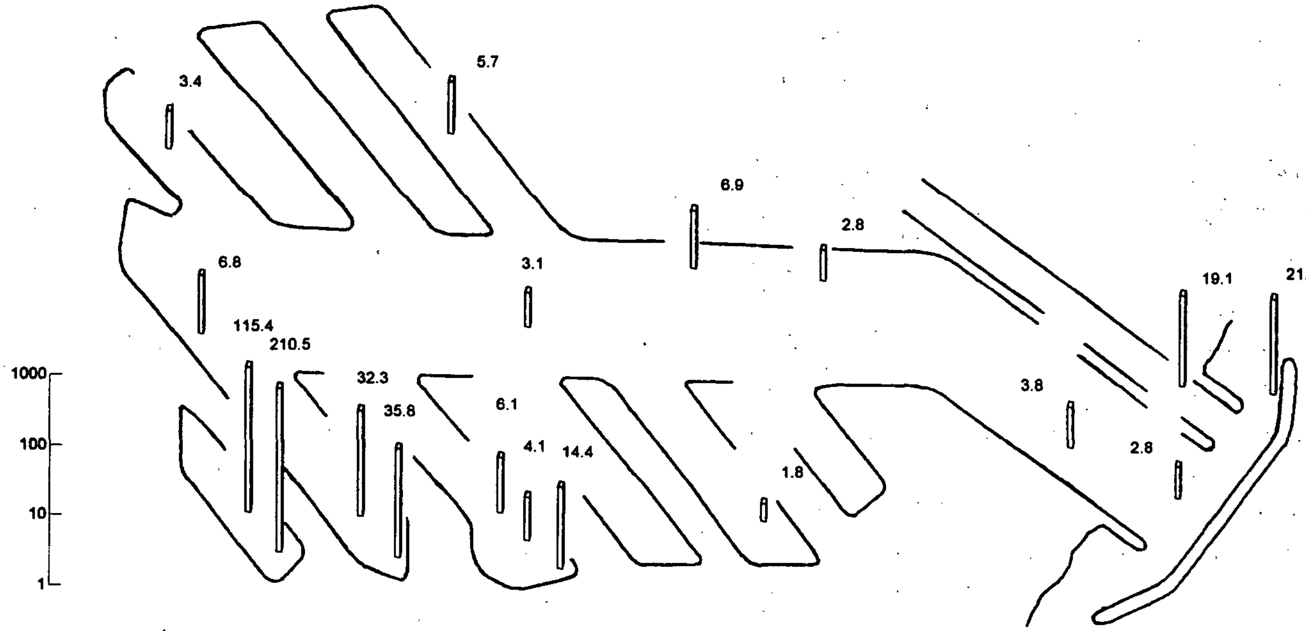


TABLE 3-13. FREQUENCY OF ENTEROCOCCUS VIOLATIONS (>104 MPN/100 ML) FOR ALL STATIONS.

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
Overall range	**0 - 4**	**0 - 35**	**0 - 10**	**0 - 2**
1998-99[3]	10	14	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.

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	—	≥16,000	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	16,000	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	16,000	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	≥16,001	—	—	≥16,000	—	—	—
13	≥16,000	≥16,000	≥16,000	≥16,000	—	—	—	16,000	≥16,000	16,000	≥16,000	>16,000
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	≥16,000	—	—	—	—	—	—	—	—	—
22	—	—	≥16,000	—	≥16,000	>16,000	16,000	≥16,000	≥16,000	≥16,000	≥16,000	>16,000
25	—	≥16,000	—	—	—	—	—	—	—	—	—	—

FECAL COLIFORM (>400 MPN/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	—	400	1100	—	2400	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	1300	—	1300	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	1300	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	1300	—	—	3000	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	500	—	—	—	16,000	1700	700	16,000	1100	—	—
13	3000	1100	1100	≥16,000	—	2400	—	16,000	≥16,000	—	≥16,000	9000
18	—	—	—	—	—	—	—	—	—	—	—	—
19	500	—	500	—	800	—	—	—	—	—	—	—
20	500	—	—	—	—	1100	—	—	—	—	—	2400
22	—	800	—	1100	≥16,000	9000	500	800	≥16,000	2200	3000	≥16,000
25	—	2400	—	—	—	—	—	—	—	—	—	—

ENTEROCOCCUS (>104 COLONIES/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	—	—	140	1600	—	—	≥1600	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	500	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	280	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	900	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	220	—	—	—	—
10	—	—	—	—	—	—	—	—	800	—	—	
11	—	—	—	1600	—	—	—	220	—	—	—	—
12	—	—	—	—	—	1600	—	—	110	—	—	—
13	—	240	170	240	900	500	500	300	≥1600	140	170	300
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	500	220	—	—	—	—	—	—
20	—	—	—	—	170	—	110	—	170	—	—	—
22	—	—	—	500	500	170	300	900	240	500	—	>1600
25	—	≥1600	—	—	—	140	—	—	—	—	—	—

Station 9. This station in Basin F was highest in temperature and lowest in dissolved oxygen, pH, water clarity, BOD, and bacterial counts. Like the previous group, water color tends to be more green to brown. This station is typical of low-circulation back-bay areas.

Stations 5, 6, 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 low in ammonia, BOD, and bacteria, and moderate in all remaining measurements.

Stations 2, 3, 4, and 25. These stations represent the middle and lower main channel. Water here tends to be bluer, clearer, more saline, higher in dissolved oxygen and pH, and lower in temperature. These stations are most influenced by open ocean waters and are the most natural in the Harbor.

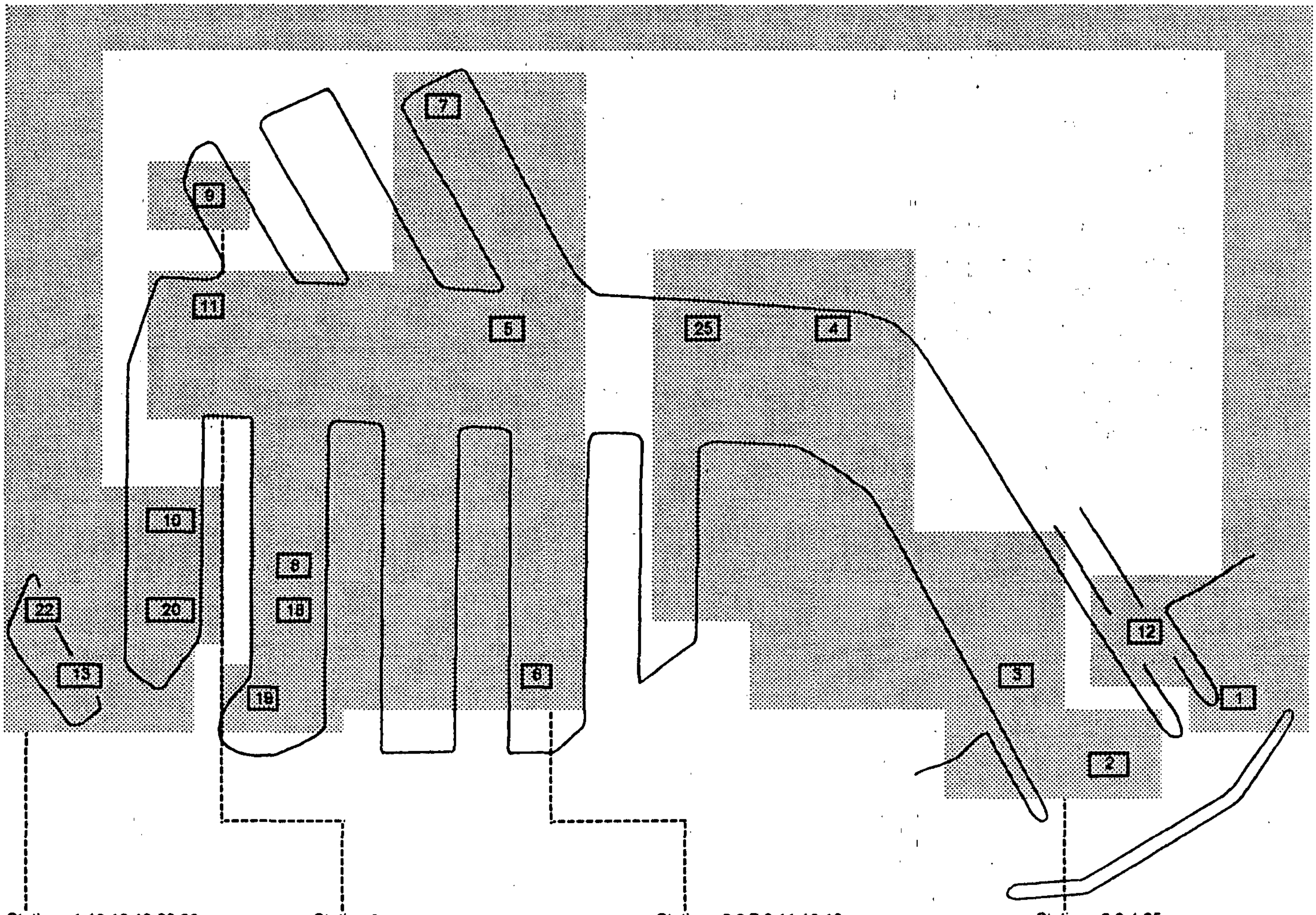
3.4. DISCUSSION

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.

Cooler temperatures and relatively low rainfall, particularly in comparison to our past two El Nino years (Aquatic Bioassay 1997, 1998), characterized weather during 1998-99. When rainfall did occur, however, numerous physical and chemical properties of the water column were affected. Winter and spring runoff lowered salinity, increased ammonia, lowered water clarity, and elevated bacterial concentrations, particularly fecal coliforms and enterococcus. In addition, precipitation may have contributed to the development of phytoplankton, which, in turn may have raised dissolved oxygen and increased turbidity during the spring. Plankton are dependent upon length of sunlight and nutrient levels and are indirectly affected by rainfall since it washes nutrients from the land and into the Harbor. The subsequent death and decay of the plankton can then later increase the biochemical oxygen demand in the Harbor. The influence of phytoplankton this year was weaker than usual, however, 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 typically warmer, more saline, lower in oxygen, etc.

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



<u>Stations 1,10,12,13,20,22</u>

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

Relatively Low In:
Salinity
– –
– –
– –
– –
– –
– –
– –

Charateristics:
Strongly influence by either Oxford Lagoon or Ballona Creek. Water is *green, low in salinity, and* highest in nutrients, organics, and bacterial contamination.

<u>Station 9</u>

Relatively High In:
Temperature
Color
– –
– –
– –
– –

Relatively Low In:
Dissolved Oxygen
pH
Light Transmissance
Surface Transparency
Biochemical Oxygen Demand
Total Coliform
Fecal Coliform
Enterococcus

Charateristics:
Typical of low circulation, back-harbor locations. Ambient water is warm, *green, and low in organic* and bacterial contaminants.

<u>Stations 5,6,7,8,11,18,19</u>

Relatively High In:
– –
– –
– –
– –
– –
– –

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

Charateristics:
Also typical of low circulation, back-harbor locations. However, water is cooler, less green, lower in ammonia, clearer, and higher in pH and dissolved oxygen than Station 9.

<u>Stations 2,3,4,25</u>

Relatively High In:
Salinity
Dissolved Oxygen
pH
Light Transmissance
Surface Transparency
– –

Relatively Low In:
Temperature
Color
– –
– –
– –

Charateristics:
Most influenced by open ocean waters. Ambient water is bluer, colder, clearer, more saline, and higher in pH and dissolved oxygen than all other groups.

Stations closest to Oxford Lagoon showed reduced salinity, dissolved oxygen, water clarity, and pH; higher levels of ammonia, BOD, and bacteria; and a greater frequency of water color in the brown and yellow ranges. In addition, most measurements varied wildly over the year. Stations impacted by Ballona Creek (12, 1, and sometimes 2) had a frequent surface layer of nearly fresh water. This area also tended to be low in water clarity, high in BOD and bacteria and more yellow-brown in color than other stations. Although total and fecal coliform counts were somewhat typical of past years, enterococcus counts were about twice as high as any previous year's maximum. Nearly all of these high enterococcus counts were related to location of either Oxford Lagoon or Ballona Creek drainage. 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 cannot be overstated.

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 stations due to higher temperatures, lower water clarity, and generally more yellow-brown water color. Its relative isolation far back in Basin F is a probable factor. The water near Mothers Beach was moderate in bacterial counts this year. Strangely, it is both cooler and lower in pH than most Harbor stations that are not directly affected by obvious drainage sources. This implies that there may be a cold, freshwater flow to the area, however, salinity values were relatively high. Station 19 has always been enigmatic with regard to water quality. It may be that its high usage by people and animals creates unique water characteristics. We will continue to carefully monitor this station in subsequent years.

4. PHYSICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

4.1. BACKGROUND

The benthos (bottom) of the marina is largely composed of fine and very fine sediments, due in part to the historic nature of the Ballona wetlands, which formed a large estuarine depositional area, and to the continuing influx and deposition of fine grained sediments carried into the marina through storm drains and by tidal flux. The marina is a very low energy environment under dry weather conditions and low rainfall periods. Transport seaward of coarsely grained materials occurs in more swiftly moving waters such as those found during heavy rainfall and runoff, while fine grained sediments (fines) may be carried farther out into Santa Monica Bay in a plume during heavy rain. In dry weather, fines will settle out in the low energy basins and in the main channel where flow from the basins meet. There has not been extensive sediment accumulation in the basin channels, but in the Basin E area adjacent to flow from Oxford Basin, accumulation was so severe that it broke up docks and moorings. Sediments beneath the floating docks were heavily contaminated, requiring landfill disposal. About 503 cubic yards of sediment were removed and the slips reconfigured for larger vessels during the summer of 1995. Ever since the breakwater was built in the 1960s, sand has accumulated at the mouth of Ballona Creek, along the inner side of the breakwater, around the ends of the jetties and along the northern jetty of the entrance channel, requiring periodic dredging by the Corps of Engineers. This is a great problem because high levels of lead contamination and results of toxicity tests preclude ocean disposal at the EPA dumpsite 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. Dredging in 1987 removed 131,000 cubic yards from the jetty tips and Ballona Creek mouth, and in 1992 a small amount, 17,000 cubic yards, was removed on the south side of the entrance channel. In November and December 1994, 57,000 cubic yards were removed for the ends of the breakwater, the jetties and the mouth of Ballona Creek (Soule et.al. 1996).

4.2. MATERIALS AND METHODS

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

Samples were collected on September 3, 1998 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 6), then it is probable that the sediments are mostly finer. Sediment sizes which range from 2000 to 63 microns are defined as sand, sediments ranging from 63 to 4 are defined as silt, and sediments that are 4 or less are defined as clay (Wentworth Sediment Scale, see Gray 1981). There are also many 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 and 2) tended to be relatively coarse and homogeneous in composition. Stations related to drainage areas (3, 12, 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 size (5 microns – very fine silt) was at Station 9 in Basin F, Station 11 at the end of the Harbor channel, and Station 6 in Basin B. These stations are far from the entrance and probably have very low current velocities. The largest median particle sizes were at Stations 13 and 22 in Oxford Lagoon (207 and 356 microns – fine sand and medium sand, respectively), Station 12 in Ballona Creek (361 - medium sand), and Station 3 in the main channel near the Venice Canal tidal gate (320 microns - medium sand). Stations 1 and 2 near the Harbor entrance also had relatively course median particle sizes (167 and 97 microns – fine sand and very fine sand, respectively). These stations likely have the highest current velocities of the Harbor. Remaining stations had sediments, which were moderate in median particle size (9 to 44 microns - 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 of particle sizes (700 to 74 microns - coarse sand to very fine sand). Therefore, when the median particle size was in the range of silts or clays, it could not be calculated. In those situations, the median particle size is listed as <74 microns.

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

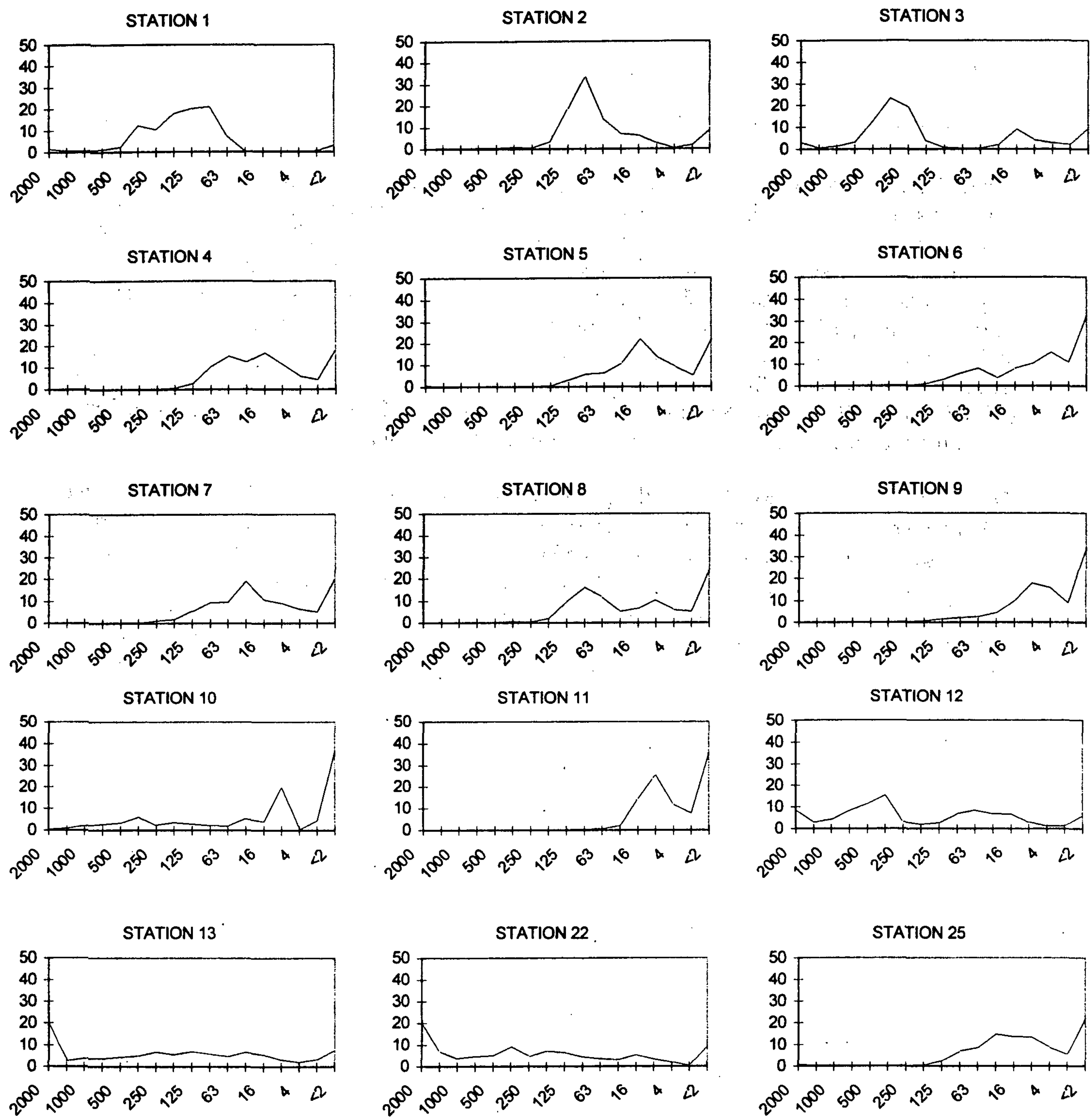


TABLE 4-1. PARTICLE SIZE DISTRIBUTIONS (PERCENTS) FROM 15 BENTHIC SEDIMENT STATIONS

	PARTICLE SIZE (MICRONS)															
	≥2000	1414	1000	707	500	354	250	176	125	88	63	31	16	8	4	2	≤2
STATION	granule	very course sand	very course sand	course sand	course sand	med sand	med sand	fine sand	fine sand	very fine sand	very fine sand	course silt	med silt	fine silt	very fine silt	clay	clay
1	1.6	0.6	0.7	1.1	2.3	12.2	10.5	17.8	20.0	20.9	7.3	0.3	0.5	0.5	0.3	0.5	2.9
2	0.1	0.1	0.1	0.4	0.5	0.9	0.7	3.4	18.8	33.6	13.9	6.9	6.4	2.9	0.5	1.9	8.9
3	3.1	0.8	1.3	3.1	12.7	23.5	19.4	3.9	1.0	0.5	0.5	2.1	9.1	4.2	2.8	2.3	9.7
4	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.7	2.7	10.4	15.4	12.8	16.9	11.6	5.9	4.5	18.2
5	0.6	0.0	0.0	0.0	0.1	0.1	0.2	0.5	3.0	5.9	6.3	11.2	22.1	13.5	8.9	5.3	22.2
6	0.0	0.0	0.1	0.2	0.2	0.1	0.2	1.0	2.9	5.7	8.1	3.6	8.1	10.3	15.6	10.7	33.3
7	0.0	0.0	0.0	0.1	0.2	0.3	1.0	1.8	5.5	9.5	9.8	19.2	11.0	9.4	6.6	5.3	20.2
8	0.1	0.0	0.0	0.0	0.1	0.7	0.5	2.0	9.9	16.4	11.9	5.4	6.7	10.6	6.1	5.4	24.3
9	0.0	0.0	0.1	0.0	0.1	0.1	0.4	0.8	1.6	2.2	2.7	4.4	10.0	18.0	16.0	9.2	34.5
10	0.5	0.8	2.0	2.6	3.4	6.1	2.4	3.6	2.9	2.2	1.9	5.4	4.0	19.9	0.3	4.4	37.2
11	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.4	0.6	2.0	14.6	25.6	11.8	7.9	36.5
12	8.4	2.8	4.4	8.3	11.4	15.7	3.1	1.9	2.8	6.9	8.4	7.0	6.8	3.1	1.3	1.3	6.3
13	20.1	2.7	3.8	3.8	4.5	5.1	6.8	5.7	7.2	6.0	4.9	7.0	5.7	3.2	2.2	3.2	7.9
22	20.2	6.9	3.9	4.6	5.2	9.4	4.8	7.0	6.5	4.5	3.6	3.0	5.3	3.4	1.9	0.4	9.3
25	0.6	0.4	0.3	0.2	0.2	0.3	0.2	0.5	2.5	7.1	8.8	14.9	13.9	13.6	8.6	5.6	22.3

TABLE 4-2. MEDIAN PARTICLE SIZES (MICRONS)[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1990 TO SEPTEMBER 1998.

	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

[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 SEPTEMBER 1998[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

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

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

Overall differences in median particle size between this year and last year were minor. Largest changes in median particle size was at Station 3 near Venice Canal which shifted from medium silt to medium sand, and Station 22, in Oxford Lagoon, which changed from coarse silt to medium sand. These changes may be related to greater water movement in these areas due particularly heavy 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.

4.3.1.2. **Sorting Index**

Spatial sorting index patterns. Sorting index values are depicted in Figure 4-3 and Table 4-3. Sediments at Stations 1 and 2 near the Harbor entrance (1.01 and 1.48 - poorly sorted) were the most homogeneous. Station 10 in Basin E (4.89 – extremely poorly sorted), Stations 13 and 22 in Oxford Lagoon (3.56 and 3.96 – very poorly sorted), and Station 8 in Basin D (3.53 – very poorly sorted) were least homogeneous. The remaining stations were between these (2.69 to 3.29 - all very poorly sorted). Patterns followed the general rule that high-energy area sediments (i.e. Harbor entrance) tend to have larger median particle sizes and to sort better than low energy area sediments (Harbor channels and basins). The exceptions to this rule were the Oxford Lagoon stations, which had relatively large median particle sizes but 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 (1.01 to 4.36) indicate that sediments were less homogeneous overall than in 1997 (0.77 to 3.80) but similar to 1996 (0.88 to 5.20).

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

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

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

Stations 3, 12, 13, and 22. These stations include two in Oxford Lagoon, one in Ballona Creek, and one at the entrance to the Venice Canal. These sediments were the second most heterogeneous in the Harbor (very poorly sorted), and the median particle size was the coarsest in the Harbor (medium sand). Rapid water movement characterizes all of these areas; however, there must be periods of relative quiescence when some finer particles can accumulate.

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

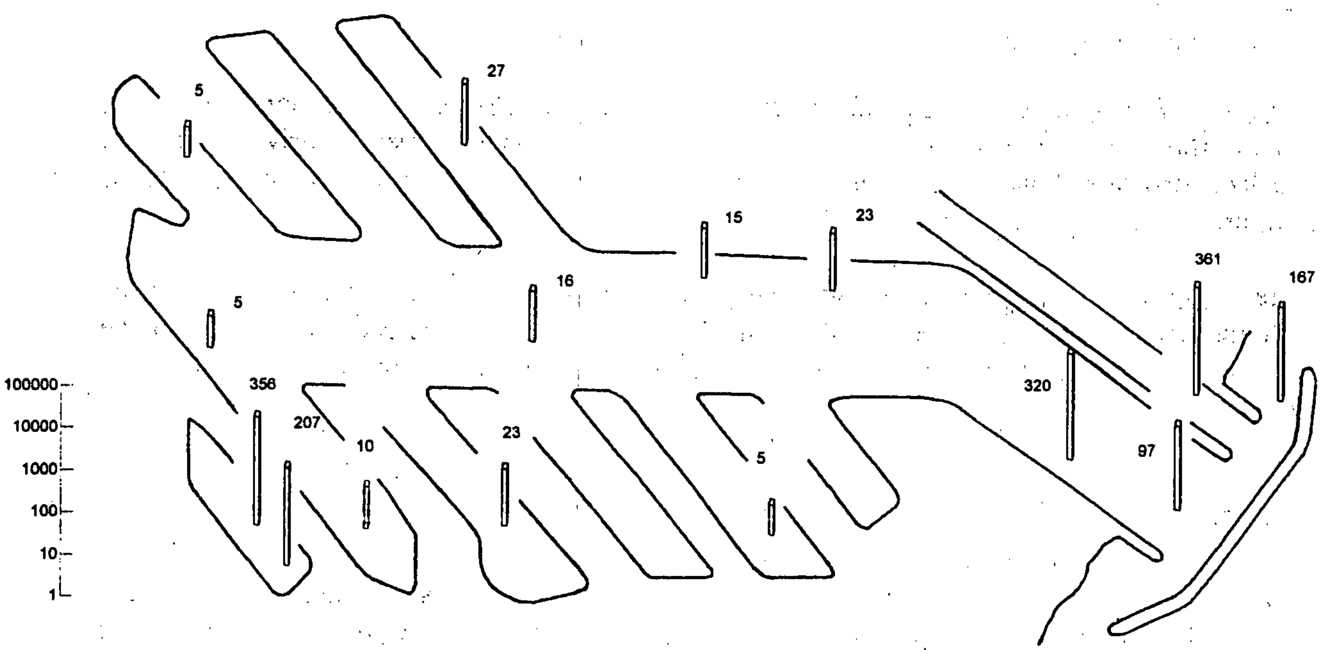
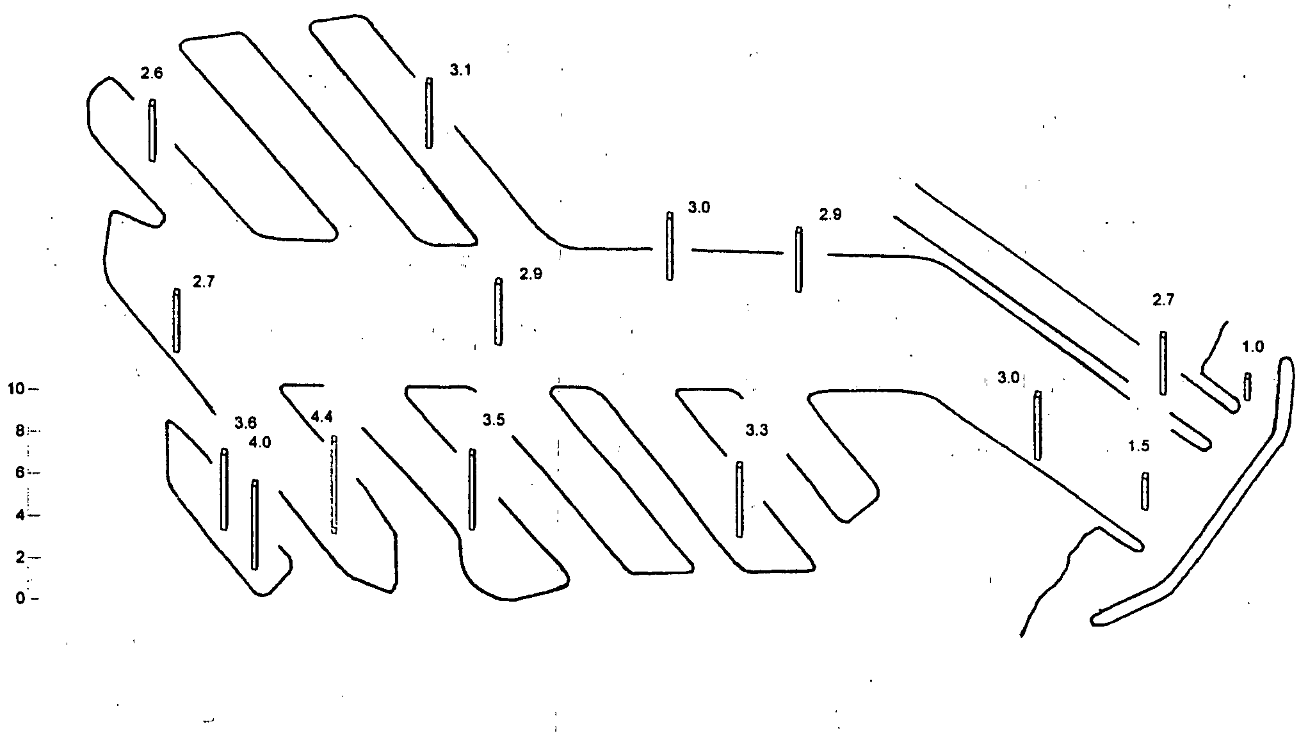


FIGURE 4-3. SORTING INDEX VALUES AT 15 BENTHIC SEDIMENT STATIONS.



Stations 6 and 10. These include one station in Basin E and one in Basin B. The grain size distribution at these stations was the second 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, 8, and 25. These include three stations in mid-channel, one station in Basin D, and one in Basin H. Sediments here relatively moderate in distribution (very poorly sorted), and the median particle size was also moderate (fine silt to medium silt). Current velocities at these stations are probably also moderate.

Stations 1, and 2. These stations represent the entrance to the Harbor. Sediments here were the most homogeneous (poorly sorted), and the median grain size was the second coarsest in the Harbor (very fine sand to fine sand). These areas are represented by almost continuous water movement.

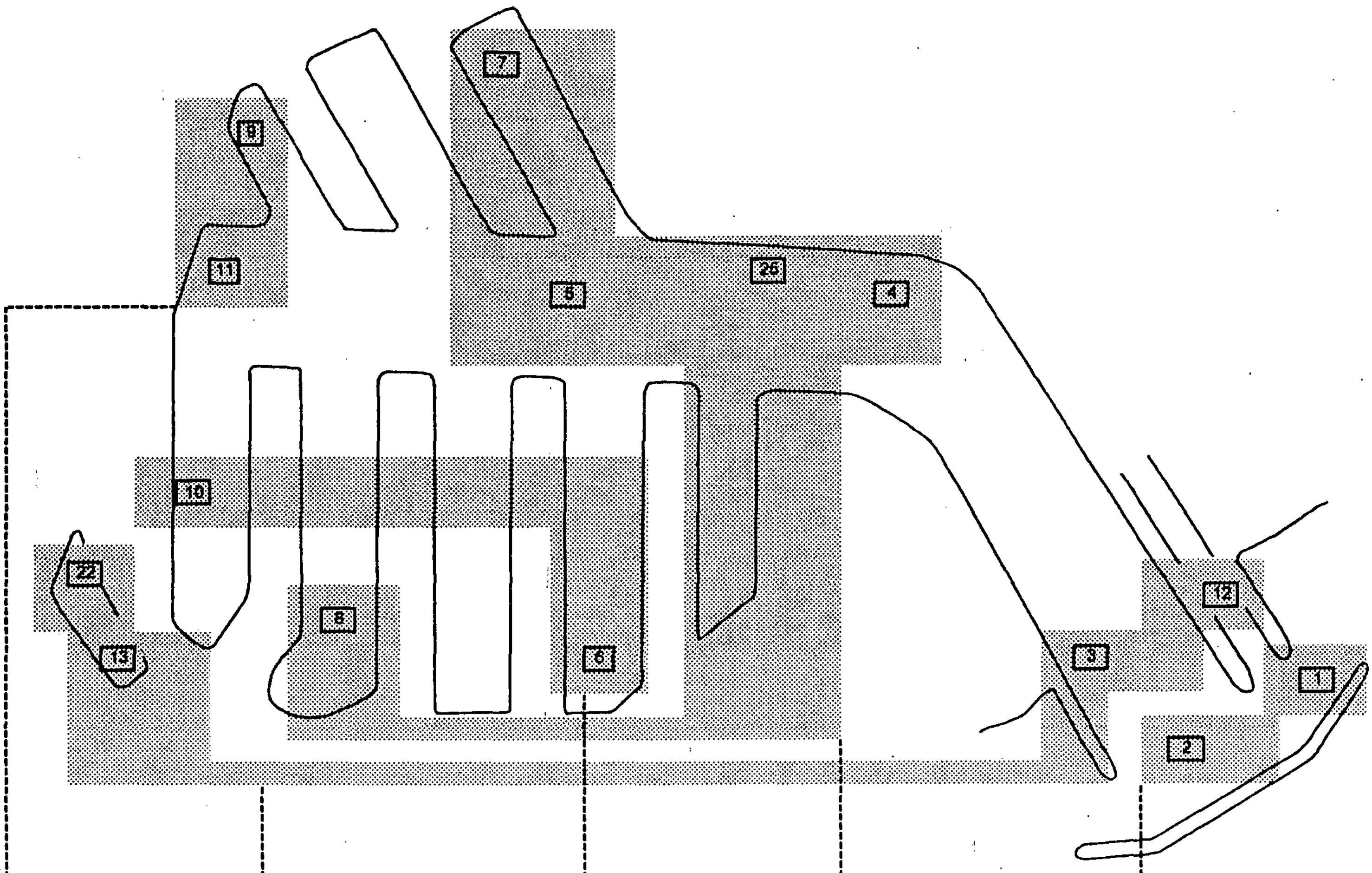
4.4. DISCUSSION

The sources of sediment that enter Marina del Rey Harbor are numerous. Essentially 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 narrower in range (more homogeneous).

The sediment characteristics of the Harbor appear to be separated into four general categories. The finest and usually most heterogeneous sediments were, not surprisingly, found in many of the low-energy back basins. In the main channel and in some higher-energy basins, both particle distribution and size were moderate. At the Harbor entrance, strong, constant water movement clearly distributed sediments narrowly within the range of coarse, sandy particles. Areas in Oxford Lagoon, Ballona Creek, and the entrance to Venice Canal represented the last grouping. Although these sediments tended to also be primarily sand, they contained a fair amount of silt as well. This implies that the strong water flows in these areas are only intermittent and allow finer particles to settle during some periods.

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



Stations 9,11

Median grain size:

Very fine silt.

Sorting:

Very poorly sorted.

Characteristics:

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

Stations 3,12,13,22

Median grain size:

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 6,10

Median grain size:

Very fine silt to fine silt.

Sorting:

Very poorly sorted to extremely poorly sorted.

Characteristics:

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

Stations 4,5,7,8,25

Median grain size:

Fine silt to medium silt.

Sorting:

Very poorly sorted.

Characteristics:

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

Station 1,2

Median grain size:

Very fine sand to fine sand.

Sorting:

Poorly sorted.

Characteristics:

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

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 such as the "lake" that became part of Basin E when the marina was built. Piecemeal filling occurred over many years, for farming, trash and soil disposal and industrial development. During World War II, industrial development in areas contiguous to the present marina area resulted in contamination of terrestrial sediments which can leach into ground water or be carried in runoff into the marina when land is eroded or excavated for newer development, contaminating the marina. Activities associated with boating such as fuel spillage, use of antifouling compounds, boat maintenance and debris from recreation also 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, entering the marina and moving inward on rising tides. Station 12, in Ballona Creek; generally has a medium to high ranking with regard to contaminants (Soule and Pieper, 1996).

Because the basins are very low energy environments, fine sediments (see Section 4) settle out there, sometimes carrying heavy contaminant loads. The inner end of the main channel (Station 11) and adjacent Basins E and F (Stations 10 and 9) are particularly prone to contamination. Station 5, in mid-main channel, is also surprisingly contaminated, probably due to settling (shoaling) where flows from the basins meet in the main channel under low flow conditions. In very wet seasons, sediments from the basins may be carried farther due to heavy stormwater runoff, sometimes to the bend into the entrance channel, sometimes to the sandbar at the entrance. Flow from Ballona Creek and the Marina entrance channel meet where waves and tidal influx may slow the seaward progression of sediment-laden waters, resulting in deposition. Oxford Flood Control Basin is a sump for street drainage, from the community north and east of the marina, draining into Basin E through a tide gate. Severe flooding has occurred along Washington Street, flooding houses and floating cars, and a new pumping station was built in Oxford Basin in 1994-1995 to ameliorate that, but if the tide is high during a storm, drainage into the marina through the tide gate is inadequate to clear the streets. A new tide gate is planned (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, which has become filled. 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: heavy metals, chlorinated pesticides and polychlorinated biphenyls (PCB's), organic compounds, and minerals and others. Table 5-2 compares the ranges of the current survey with all surveys undertaken since February 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 all previous surveys utilized the 1990 values. This is the first report to utilize the 1995 data.

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	2.2	5.3	4.1	9.5	8.6	9.1	8.8	7.5	9.5	9.8	11.0	6.4	5.5	12.6	10.2	**8.01**
Cadmium	0.20	0.75	0.47	1.07	0.41	0.23	0.27	0.26	0.35	0.82	0.42	0.92	1.18	0.35	0.94	**0.576**
Chromium	14	33	26	55	69	48	51	46	82	72	86	28	36	44	75	**50.99**
Copper	8	28	37	86	197	215	198	242	320	172	312	25	114	28	162	**142.96**
Iron	11500	18100	14100	28800	44000	34000	36000	29200	50000	45000	54000	16600	27800	29400	40000	**31900**
Lead	40	81	63	123	106	85	86	62	116	106	113	112	380	44	146	**110.9**
Manganese	120	169	115	241	320	220	312	217	314	268	340	168	330	320	281	**249.0**
Mercury	0.033	0.099	0.112	0.320	0.350	0.730	0.400	0.600	0.730	0.810	0.740	0.103	0.195	0.031	0.360	**0.3742**
Nickel	6.5	16.2	11.6	21.5	24.1	20.1	21.3	19.2	27.3	25.5	28.2	13.5	20.4	18.9	22.7	**19.80**
Selenium	<1	<1	<1	<2	1.2	<1	<2	<2	1.6	1.9	1.7	<1	<1	<1	1.5	**0.53**
Silver	0.16	0.91	0.88	2.20	1.72	0.83	0.94	0.65	1.24	0.70	1.35	0.85	0.52	0.10	2.22	**1.0176**
Tributyl Tin	0.003	0.005	0.007	0.006	0.006	0.005	0.008	0.004	0.006	0.004	0.009	0.003	<0.002	<0.002	0.010	**0.005**
Zinc	36	145	112	234	295	251	250	238	360	320	390	161	500	141	330	**250.9**
Pesticides & PCB's (ppb)																
p,p' DDD	<0.5	<0.6	<0.7	<0.8	<0.9	<0.10	4.0	1.0	18.0	<0.8	2.0	<0.5	2.0	2.0	5.0	**2.27**
p,p' DDE	<0.5	1.0	<0.6	<0.7	<0.8	<0.9	<0.7	<0.7	<0.9	<0.8	<0.9	2.0	<0.6	<0.6	<0.8	**0.20**
p,p' DDT	0.7	6.1	<0.6	6.0	5.0	1.0	4.0	12.0	5.0	2.0	4.0	7.3	<0.6	<0.6	2.0	**3.67**
All DDT & Derivatives	0.7	7.1	0.0	6.0	5.0	1.0	8.0	13.0	23.0	2.0	6.0	9.3	2.0	2.0	7.0	**6.14**
Endrin Aldehyde	0.7	4.0	<0.6	6.0	4.0	3.0	3.0	2.0	2.0	5.0	3.0	6.6	5.0	4.0	6.0	**3.62**
Aldrin	<0.2	<0.3	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	<.3	<0.3	0.6	<0.4	**0.04**
Dieldrin	<0.5	1.0	<0.6	<0.7	<0.8	<0.9	<0.7	<0.7	<0.9	<0.8	<0.9	2.0	<0.6	<0.6	<0.8	**0.20**
Heptachlor	<0.2	<0.3	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	0.3	<0.3	<0.3	<0.4	**0.02**
Heptachlor Epoxide	<0.2	<03	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	<0.3	0.3	3.9	<0.4	**0.28**
Alpha-Chlordane	2.0	8.3	2.0	4.0	3.0	0.8	<0.4	<0.4	<0.5	<0.4	<0.5	7.4	<0.3	3.6	3.0	**2.27**
Gamma-Chlordane	2.0	11.0	2.0	7.0	3.0	1.0	1.0	<0.4	0.7	1.0	0.6	9.2	3.3	3.7	4.4	**3.33**
Methoxychlor	<2.0	5.0	<3.0	<4.0	<4.0	<5.0	<4.0	<4.0	<5.0	<4.0	<4.0	<4.0	<3.0	6.5	<4.0	**0.77**
Endosulfan I	<0.2	<0.3	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	<0.3	2.0	<0.3	<0.4	**0.13**
Endosulfan II	<0.5	<0.6	<0.6	<0.7	2.0	<0.9	<0.7	<0.7	<0.9	3.0	<0.9	<0.5	<0.6	2.0	3.0	**0.67**
Endosulfan Sulfate	<0.5	<0.6	<0.6	1.0	<0.8	<0.9	<0.7	<0.7	<0.9	<0.8	<0.9	2.0	2.0	2.0	<0.8	**0.47**
Endrin Ketone	<0.5	2.0	<0.6	2.0	0.9	<0.9	0.9	<0.7	<0.9	<0.8	<0.9	2.0	<0.6	4.0	1.0	**0.85**
Alpha-BHC	<0.2	0.4	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	<0.3	<0.3	<0.3	<0.4	**0.03**
Gamma-BHC	<0.2	<0.3	<0.3	<0.4	<0.4	<0.5	<0.4	<0.4	<0.5	<0.4	<0.5	<0.3	<0.3	1.0	<0.4	**0.07**
All Non-DDT Pesticides	4.7	31.7	4.0	20.0	12.9	4.8	4.9	2.0	2.7	9.0	3.6	29.5	12.6	31.3	17.4	**12.74**
PCB's	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<10	<20	<10	<20	**0.00**
Organic Content																
Tot. Organic Carbon (%)	0.413	1.140	0.867	1.010	0.800	0.787	0.861	0.693	0.831	0.716	0.764	0.941	1.120	0.828	0.976	**0.8498**
Volatile Solids (%)	0.7	2.6	1.9	2.8	2.3	1.8	2.0	1.9	2.1	2.2	2.2	1.6	3.7	2.2	2.5	**2.17**
Immed. Oxy. Dmd. (ppm)	160	4470	3320	2730	6670	5950	2110	4230	4280	5120	4740	2760	2400	2270	6840	**3870**
Chem. Oxygen Dmd. (%)	0.44	3.90	3.74	4.83	3.79	4.65	3.48	3.01	3.69	1.71	2.08	2.36	1.12	3.58	6.72	**3.273**
Oil and Grease (ppm)	78	31	59	49	43	130	110	110	140	140	6	120	8	3	10	**69.1**
Organic Nitrogen (ppm)	37	611	513	560	463	497	470	426	409	416	514	303	348	768	700	**469.0**
Ortho Phosphate (ppm)	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<10	<20	<10	<20	**0.0**
Sulfides (ppm)	<3	410	620	520	480	590	380	400	250	<3	220	300	80	60	250	**304.0**
Minerals, etc. (ppm)																
Moisture (%)	19.8	33.3	30.4	44.5	49.2	57.7	45.5	44.6	56.0	52.9	55.7	21.6	36.7	29.2	49.4	**41.77**
Spec. Cond. (mmhos/cm)	3070	5310	4160	6280	6880	8000	6980	6390	6200	6330	6550	4870	3090	2800	6820	**5582.0**
Alkalinity as CaCO3	204	549	481	415	410	542	506	376	326	320	283	593	470	427	488	**426.0**
Hardness as CaC03	1750	2780	1940	3760	4740	6850	4360	3600	4890	4660	4760	2350	1740	1330	4610	**3608**
Total Dis. Solids (%)	1690	2900	2340	3820	4160	4920	4050	3770	4030	3880	4680	2700	1520	1570	4090	**3341**
Barium	23	50	45	97	120	65	105	66	125	117	133	68	297	74	119	**100.3**
Boron	<30	41.0	<30	<40	33.0	35.0	53.0	<40	37.0	39.0	38.0	<30	47.0	<30	35.0	**23.87**
Calcium	6500	10100	30700	11900	11000	7300	10400	7100	8600	7200	8400	12200	5900	2400	13600	**10220**
Chloride	5310	12300	8690	17100	21000	30000	19800	17500	21900	20600	23300	9490	6940	5590	21200	**16048**
Fluoride	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	**0.00**
Nitrogen	<300	870	310	1400	1000	1200	910	1400	1900	840	1500	1300	800	2000	1800	**1148.7**
Nitrate	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	**<49**
Potassium	1050	2550	2130	5000	7900	5600	6700	5400	9300	8500	10200	2450	4600	3800	6900	**5472**
Sulfate	866	1590	1220	2440	2960	4200	2560	2490	3030	2950	3280	1000	936	697	2860	**2205**
Sodium	2900	5800	5200	8500	11800	12100	10800	9400	13000	14000	15300	4300	4800	2260	12100	**8817**

TABLE 5-2. ANNUAL CHEMICAL COMPOUNDS MEASURED FROM 15 BENTHIC SEDIMENT STATIONS: 1987-1998 (RESULTS AS DRY WEIGHT).

COMPOUND	February 1987[1]	October 1987	October 1988[2]	October 1989[3]	October 1990[4]	May 1991	October 1991	October 1992	April 1994	September 1994	October 1995	October 1996	October 1997	**Overall Range**	October 1998
Metals (ppm)															
Arsenic	<2.0 - 7.9	3.3 - 9.6	1.86 - 12.0	1.13 - 11.3	2.99 - 13.80	2.62 - 10.54	2.22 - 5.51	1.81 - 12.60	2.44 - 19.8	2.86 - 11.2	3.56 - 11.8	2.5 - 11.5	3.2 - 15.0	**1.13 - 15.0**	2.2 - 12.6
Cadmium	<1.0 - 5.8	<1.0 - 34	0.19 - 1.10	<0.26 - 2.12	0.32 - 2.13	0.43 - 5.54	<0.63 - 3.0	0.13 - 2.22	<0.2 - 2.93	<2.8 - 1.14	<0.31 - 1.23	0.226 - 1.470	0.24 - 1.56	**0.13 - 34**	0.20 - 1.18
Chromium	6.5 - 70.4	27.9 - 89.1	7.2 - 70.5	4.68 - 65.2	6.78 - 69.80	16.5 - 67.8	12.5 - 57.9	8.73 - 72.6	5.74 - 67.5	11.9 - 81.7	15 - 83.3	17.0 - 81.1	17 - 70	**4.68 - 89.1**	14 - 86
Copper	10.3 - 359	24.8 - 383.0	6.8 - 342	8.19 - 333	10.4 - 399	24 - 348	13.8 - 455	5.50 - 322	6.55 - 339	25.3 - 402	29.4 - 380	10.6 - 346.0	9 - 390	**5.50 - 455**	8 - 320
Iron[8]	4.8 - 49.5	12.5 - 40.9	4.16 - 50.1	3.21 - 47.1	3.84 - 71.5	14.4 - 62.8	8.27 - 63.2	5.7 - 49.6	3.36 - 51.80	6.40 - 49.8	7.3 - 49.6	14.7 - 59 8	12 - 50	**3.21 - 71.5**	11.5 - 54.0
Lead	11.0 - 537	6.0 - 563	25.4 - 206	17.0 - 305	7.95 - 325	41.3 - 575	62.2 - 487	22.90 - 372	12.50 - 427	32.3 - 413	54.3 - 295	45.8 - 292.0	40 - 250	**6.0 - 575**	40 - 380
Manganese	46 - 285	118 - 340	36 - 276	27.5 - 283	30.3 - 273	147 - 315	86.3 - 263	63.1 - 279	26.20 - 292	52.2 - 328	74.6 - 315	117 - 366	125 - 330	**26.2 - 366**	115 - 340
Mercury	<0.1 - 1.47	<0.1 - 1.18	0.11 - 1.70	<0.12 - 0.92	<0.10 - 1.08	<0.07 - 1.2	<0.09 - 0.94	<0.10 - 2.8	<0.09 - 1.01	0.11 - 0.97	<0.09 - 0.92	0.064 - 0.903	0.08 - 1.40	**0.06 - 2.8**	0.031 - 0.81
Nickel	4.4 - 41.6	14.6 - 59.6	4.0 - 37.4	3.88 - 36.4	4.18 - 41.20	12 - 43.2	8.02 - 32.0	4.91 - 37.3	3.67 - 39.40	7.14 - 58.1	7.54 - 41.1	8.57 - 66.90	10 - 210	**<1.0 - 210**	6.5 - 28.2
Selenium	—	—	—	—	—	—	—	—	—	<0.14 - 2.35	<0.47 - 0.99	0.30 - 1.80	0.4 - 2.4	**<0.14 - 2.4**	<1 - 1.9
Silver	—	—	—	—	—	—	—	—	—	ND	ND	0.280 - 2.720	0.20 - 3.50	**0.20 - 3.50**	0.10 - 2.22
Tributyl Tin	—	<8 - 1070[5]	<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 - 5.57**	<0.002 - 0.010
Zinc	25 - 660	74 - 587	42.6 - 435	20.3 - 444	28 - 491	102 - 640	55.8 - 624	27.0 - 523	20.30 - 647	55.3 - 446	87.9 - 455	61.3 - 440.0	55 - 480	**20.3 - 660**	36 - 500
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 - 100**	<0.5 - 18.0
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	**3 - 189**	<0.05 - 2.0
p,p' DDT	—	6 - 57	<4 - 29.1	4 - 200	<4 - 29	<4 - 14	<4 - 48	<4 - 56	<4 - 86	<4 - 49	<4 - 60	<0.4 - 12.0	<1.0	**<0.4 - 200**	<0.6 - 12.0
Alpha-Chlordane[7]	—	—	—	—	—	—	—	—	—	—	—	<0.1 - 6.6	<0.5	**<0.1 - 6.6**	<0.3 - 8.3
Gamma-Chlordane[7]	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 7.7	<0.3 - 8.1	**<0.2 - 8.1**	<0.4 - 11.0
Chlordane	—	<20 - 290	13.5 - 283	<20 - 630	10 - 410	<20 - 360	31 - 436	<20 - 270	<20 - 167	<20 - 109	<20 - 380	<0.1 - 14.3	<0.3 - 8.1	**<0.1 - 630**	<0.3 - 19.3
Dieldrin	—	<1.0	<1.0	<1.0 - 30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.8	<1.0	**<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	**<0.5 - 9.0**	<0.6 - 6.6
Heptachlor Epoxide	—	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.2 - 2.0	<0.3 - 1.0	**<0.2 - 2.0**	<0.2 - 3.9
Heptachlor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.3
Aldrin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.6
Methoxychlor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<2.0 - 6.5
Endosulfan I	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 2.0
Endosulfan II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 3.0
Endosulfan Sulfate	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 2.0
Endrin Ketone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 4.0
Alpha-BHC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.4
Gamma-BHC	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 1.0
Tot. Non-DDT Pest.	—	—	—	—	—	—	—	—	—	—	—	0.5 - 15.2	<0.9 - 13.6	**0.5 - 15.2**	2.0 - 31.7
Arochlor 1254	—	<50	<50	<50 - 330	<50 - 153	<50	<50	<50	<50 - 110	<50 - 231	<50 - 90	<10 - 100	<20	**<10 - 231**	<10 - <20
Arochlor 1260	—	<50	<50	<50 - 200	<50 - 172	<50 - 300	<50	<50 - 90	<50	<50	<50	<20	<20	**<20 - 300**	<10 - <20
Organics (ppm)															
Tot. Org. Carbon (%)	0.64 - 4.7	2.1 - 5.6	0.51 - 4.17	0.28 - 8.07	0.52 - 4.71	1.18 - 4.58	0.88 - 6.45	0.46 - 5.43	0.50 - 4.9	1.2 - 4.7	0.6 - 3.3	0.46 - 3.9	0.23 - 2.31	**0.23 - 8.07**	0.41 - 1.14
Volatile Solids (%)	1.07 - 7.87	3.6 - 9.7	0.88 - 7.19	0.84 - 13.91	1.3 - 11.78	2.96 - 11.45	2.22 - 16.12	1.13 - 13.58	1.20 - 12.2	2.94 - 11.72	1.47 - 8.26	0.8 - 11.0	0.6 - 4.0	**0.6 - 16.12**	0.7 - 3.7
Immed. Ox. Dmd.	<1 - 220	38 - 315	18 - 330	12 - 461	12 - 374	15 - 432	26 - 557	<1.0 - 383	4.0 - 290	31 - 460	11 - 360	1300 - 13000	1320 - 19900	**<1 - 11900**	160 - 6840
Chem. Ox. Dmd.(%)	0.375 - 13.15	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	**0.244 - 21.56**	0.43 - 6.72
Oil and Grease	1000 - 20700	800 - 2800	500 - 3500	390 - 11070	360 - 4860	1280 - 7300	1080 - 8700	227 - 4160	508 - 9200	800 - 6760	520 - 2840	30 - 350	40 - 360	**30 - 20700**	3 - 140
Organic Nitrogen	216 - 3900	1200 - 3000	135 - 1840	380 - 4770	235 - 4125	1060 - 3125	334 - 4910	105 - 4010	110 - 3180	452 - 2960	692 - 1940	120 - 1400	120 - 1499	**105 - 4910**	37 - 768
Ortho Phosphate	6200 - 45000	1900 - 5300	<1 - 3100	1900 - 13300	1.51 - 179	3.24 - 101.1	<1 - 43.5	0.53 - 15.1	290 - 1640	280 - 2220	288 - 1260	14 - 225	1.5 - 28.8	**<1 - 45000**	<10 - <20
Sulfides	0.3 - 18.9	0.5 - 4.7	0.2 - 12.1	<0.1 - 40.7	<0.2 - 3.22	0.13 - 14.44	<0.1 - 6.33	0.4 - 13.8	0.60 - 1350	1.5 - 2310	1.0 - 1322	75 - 580	130 - 850	**<0.1 - 2310**	<3 - 620

1. Stations 12 and 13 added in February 1997. 2. No sample possible at Station 12 in October 1988. 3. Station 25 added in 1989. 4. Station 22 added in 1990. 5. These are probably micrograms per liter rather than milligrams per liter.

6. Numerical lower detection limits were not recorded in the older reports, therefore all of the ones we have listed here are the same as those from the 1995 report. 7. Only total chlordane was reported in previous reports.

8. Results reported in thousands.

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

COMPOUND	MARINA DEL REY (1997) AVERAGE	MARINA DEL REY (1997) RANGE	LOS ANGELES HARBOR (1995) AVERAGE	LOS ANGELES HARBOR (1995) RANGE	SCCWRP (1977) AVERAGE	SCCWRP (1977) RANGE	SCCWRP (1985) AVERAGE
Metals (ppm)							
ARSENIC	8.0	2.2 - 12.6	5.25	2.2 - 8.5	–	–	–
CADMIUM	0.57	0.20 - 1.18	0.55	0.28 - 1.27	0.42	0.1 - 1.4	0.14
COPPER	143.0	8 - 320	39.9	13.1 - 69.6	24	6.5 - 43	10.4
CHROMIUM	51	14 - 86	41.2	21.0 - 71.7	9.6	2.3 - 40	25.4
MERCURY	0.374	0.03 - 0.81	0.21	0.11 - 0.32	–	–	–
LEAD	110.9	40 - 380	21.3	7.3 - 47	6.8	2.7 - 12	4.8
NICKEL	19.8	6.5 - 28.2	22.6	10.1 - 42.3	16	1.6 - 51	12.9
SILVER	1.02	0.1 - 2.2	0.55	0.05 - 2.66	0.35	0.04 - 1.7	0.03
ZINC	251	36 - 500	87.5	42.2 - 148	45	9.8 - 110	48.0
Chl. Hyd. (ppb)							
TOTAL DDT'S	6.1	<0.6 - 23.0	94.1	29.7 - 196	30	<3 - 70	18.9
PCB'S	<20	<20	58.3	27.2 - 137	10	<2 - 40	19.2
Organics							
TOC (%)	0.85	0.41 - 1.14	–	–	–	–	0.52
VOL. SOLIDS (%)	2.2	0.7 - 3.7	–	–	3.3	1.8 - 9.5	–
COD (%)	3.3	0.4 - 6.7	–	–	2.4	0.92 - 6.94	–
NITROGEN (ppm)	469	37 - 768	–	–	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).

COMPOUND	ER-L	ER-M	AET	STATION 1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Metals (ppm)																		
Arsenic	8.2	70	50	2.2	5.3	4.1	9.5	8.6	9.1	8.8	7.5	9.5	9.8	11.0	6.4	5.5	12.6	10.2
Cadmium	1.2	9.6	5	0.2	0.8	0.5	1.1	0.4	0.2	0.3	0.3	0.4	0.8	0.4	0.9	1.2	0.4	0.9
Chromium	81	370	—	13.8	33.0	26.0	55.0	69.0	48.0	51.0	46.0	82.0	72.0	86.0	28.0	36.0	44.0	75.0
Copper	34	270	300	8	28	37	86	197	215	198	242	320	172	312	25	114	28	162
Lead	46.7	218	300	40	81	63	123	106	85	86	62	116	106	113	112	380	44	146
Mercury	0.15	0.71	1	0.03	0.10	0.11	0.32	0.35	0.73	0.40	0.60	0.73	0.81	0.74	0.10	0.20	0.03	0.36
Nickel	20.9	51.6	—	6.5	16.2	11.6	21.5	24.1	20.1	21.3	19.2	27.3	25.5	28.2	13.5	20.4	18.9	22.7
Silver	1	3.7	1.7	0.2	0.9	0.9	2.2	1.7	0.8	0.9	0.7	1.2	0.7	1.4	0.9	0.5	0.1	2.22
Zinc	150	410	260	36	145	112	234	295	251	250	238	360	320	390	161	500	141	330
Metals exceeding ER-L				0	1	2	7	7	5	6	4	8	6	8	3	5	1	7
Metals exceeding ER-M or AET				0	0	0	1	2	1	0	0	3	2	3	0	2	0	2
Hydrocarbons (ppb)																		
p,p' DDD	2	20	10	<0.5	<0.6	<0.7	<0.8	<0.9	<0.10	4.0	1.0	18.0	<0.8	2.0	<0.5	2.0	2.0	5.0
p,p' DDE	2.2	27	7.5	<0.5	1.0	<0.6	<0.7	<0.8	<0.9	<0.7	<0.7	<0.9	<0.8	<0.9	2.0	<0.6	<0.6	<0.8
p,p' DDT	1	7	6	0.7	6.1	<0.6	6.0	5.0	1.0	4.0	12.0	5.0	2.0	4.0	7.3	<0.6	<0.6	2.0
Total DDT & Deriv.	1.58	180	—	0.7	7.1	0.0	6.0	5.0	1.0	8.0	13.0	23.0	2.0	6.0	9.3	2.0	2.0	7.0
Chlordane	0.5	6	2	4.0	19.3	4.0	11.0	6.0	1.8	1.0	<0.4	0.7	1.0	0.6	16.6	3.3	7.3	7.4
Dieldrin	0.02	8	—	<0.5	1.0	<0.6	<0.7	<0.8	<0.9	<0.7	<0.7	<0.9	<0.8	<0.9	2.0	<0.6	<0.6	<0.8
PCB's	22.7	180	370	<10	<10	<10	<20	<20	<20	<20	<20	<20	<20	<20	<10	<20	<10	<20
Hydrocarbons exceeding ER-L				1	4	1	3	3	2	4	2	4	3	4	4	3	3	4
Hydrocarbons exceeding ER-M or AET				0	2	0	2	1	0	0	1	1	0	0	2	0	0	1
Total Contaminants																		
Total exceeding ER-L				1	5	3	10	10	7	10	6	12	9	12	7	8	4	11
Total exceeding ER-M or AET				0	2	0	3	3	1	0	1	4	2	3	2	2	0	3

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, were highlighted by bold type. Those, which also exceeded either the ER-M or AET values, were additionally highlighted with shading.

5.3.1. Heavy Metals

5.3.1.1. **Arsenic**

Arsenic is carcinogenic and teratogenic (causing abnormal development) in mammals and is mainly used as a pesticide and wood preservative. Inorganic arsenic can affect marine plants at concentrations as low as 13 to 56 ppm and marine animals at about 2000 ppm (Long and Morgan 1990). 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 22 in Basin E (12.6 ppm) and Station 11 at the upper end of the main channel (11.0 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, and 3 - 2.2, 5.3, and 4.1 ppm, respectively) and at Station 13 in Oxford Lagoon (5.5 ppm).

Arsenic ranges compared with past years. The range of 1998 arsenic values (2.2 to 12.6 ppm) was within the overall range of the preceding 11 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 (8.0 ppm, 2.2 to 12.0 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 in 1998 was 2.2 to 12.6 ppm. Stations 4, 5, 6, 7, 9, 10, 11, 22, 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.

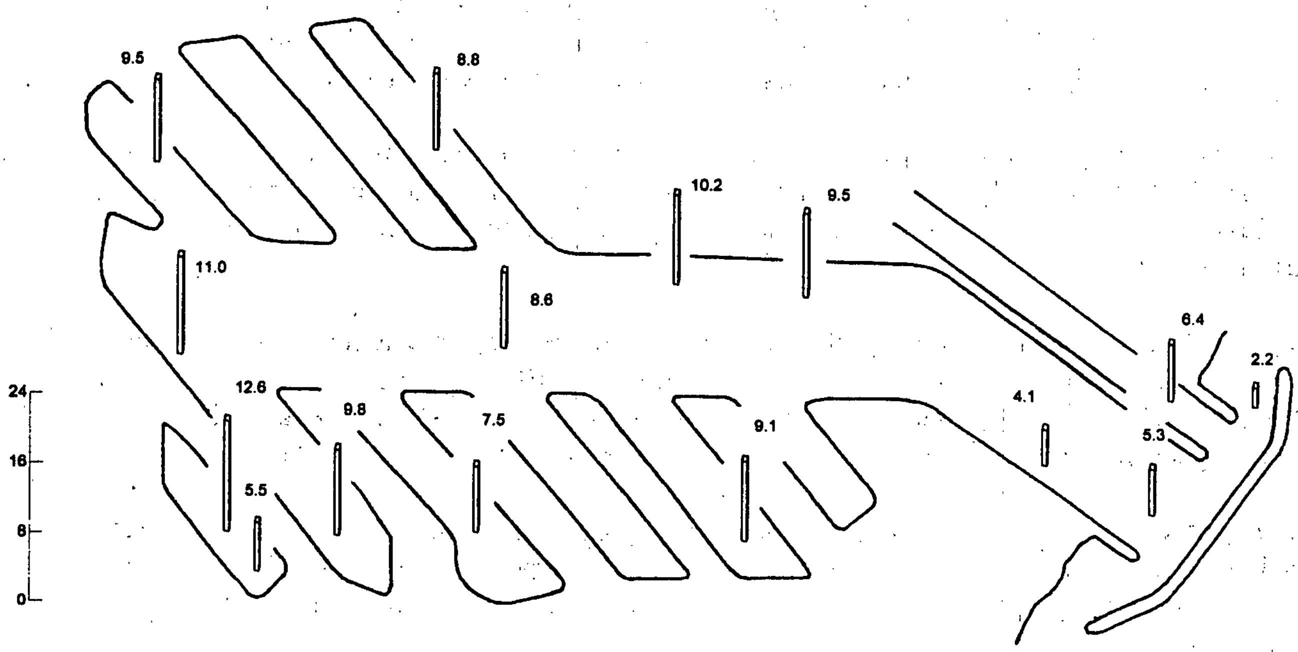
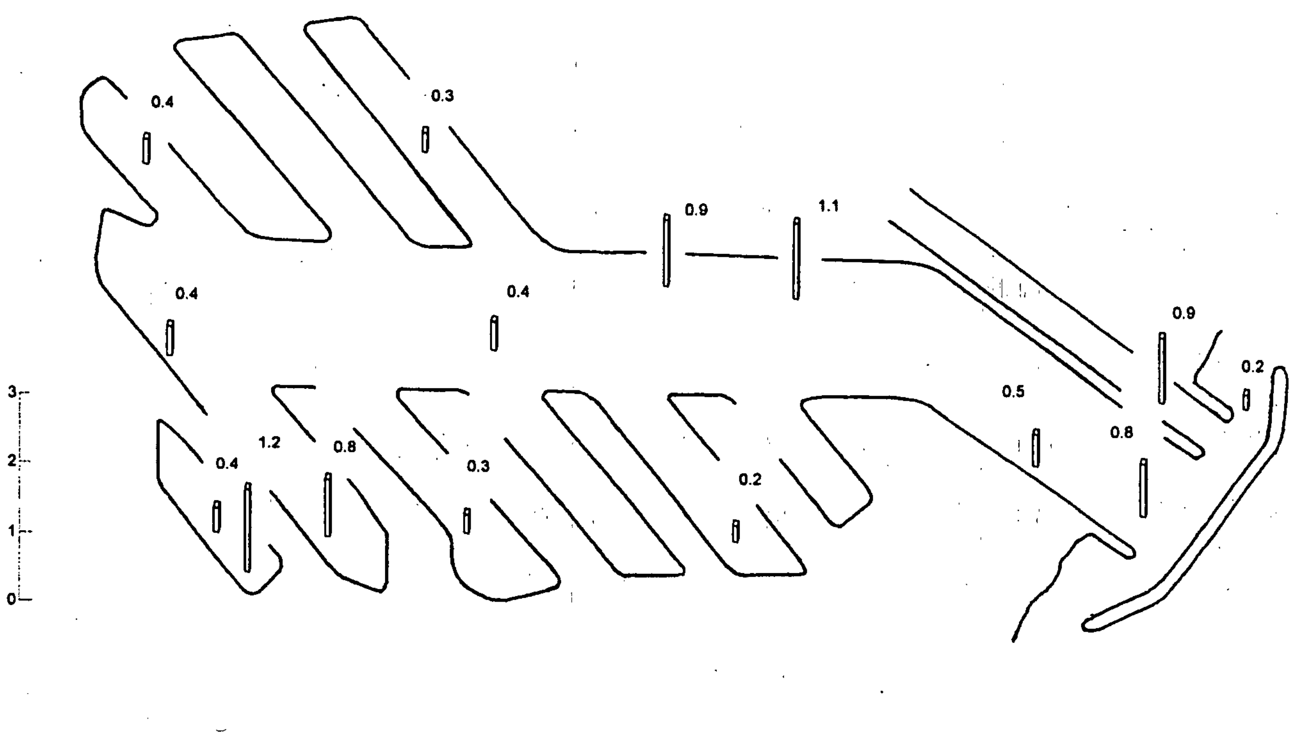


FIGURE 5-2. CADMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 (1.2 ppm), Stations 4 and 25 near the Administration docks (1.1 and 0.9 ppm, respectively), Station 10 within Basin E (0.8 ppm), Station 2 near the Harbor entrance (0.8 ppm), and Station 12 in Ballona Creek (0.9 ppm). All remaining stations were relatively low (0.2 to 0.5 ppm).

Cadmium ranges compared with past years. The range of 1998 cadmium values (0.2 to 1.2 ppm) was within the overall range of the preceding 11 years (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 (0.6 ppm, 0.2 to 1.2 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 generally 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 in 1998 was 0.2 to 1.6 ppm. Station 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 2000 to 105,000 ppm for chromium (VI) and 10,300 to 35,500 ppm for chromium (III). Chronic effects range from 445 to 2000 ppb for chrome (VI) and 2,000 to 3,200 ppb for chrome (III) (Long and Morgan 1990). 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 Stations 4, 5, 11, and 25 in the main channel (55 to 86 ppm), Station 9 in Basin F (82 ppm), and Station 10 in Basin E (72 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 - 14 to 33 ppm).

Chromium ranges compared with past years. The range of 1998 chromium values (14 to 86 ppm) was within the overall range of the preceding 11 years (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 (51 ppm, 14 to 86 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.

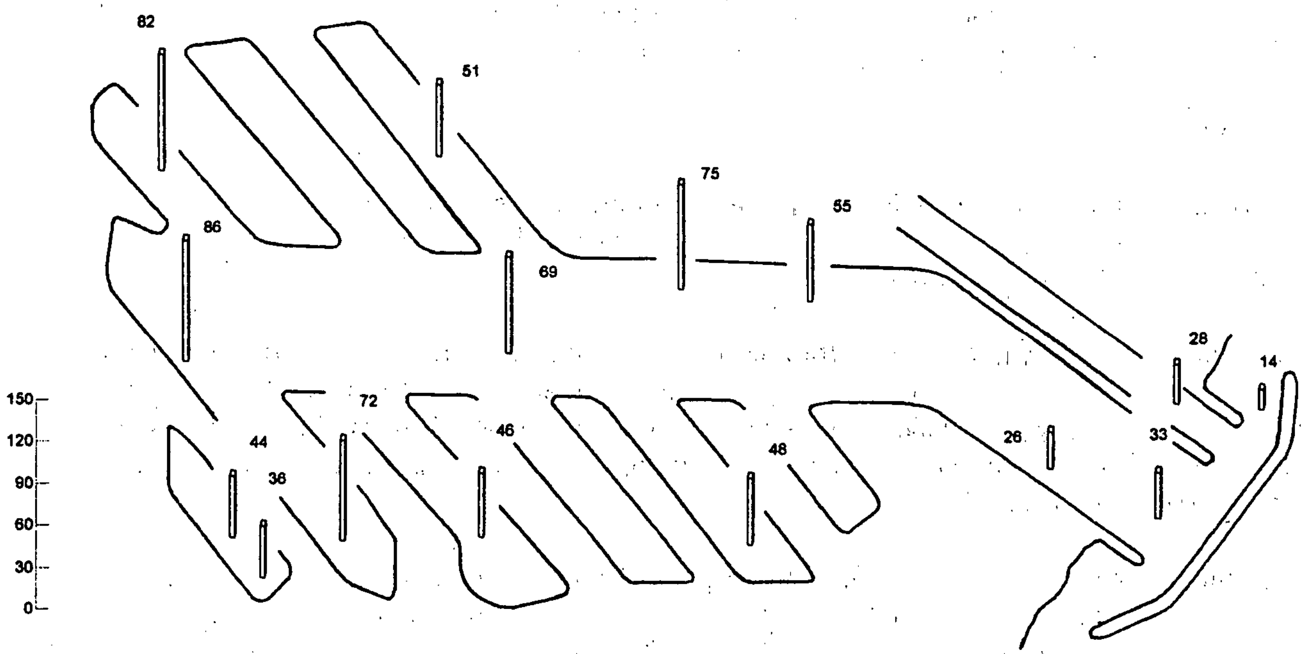
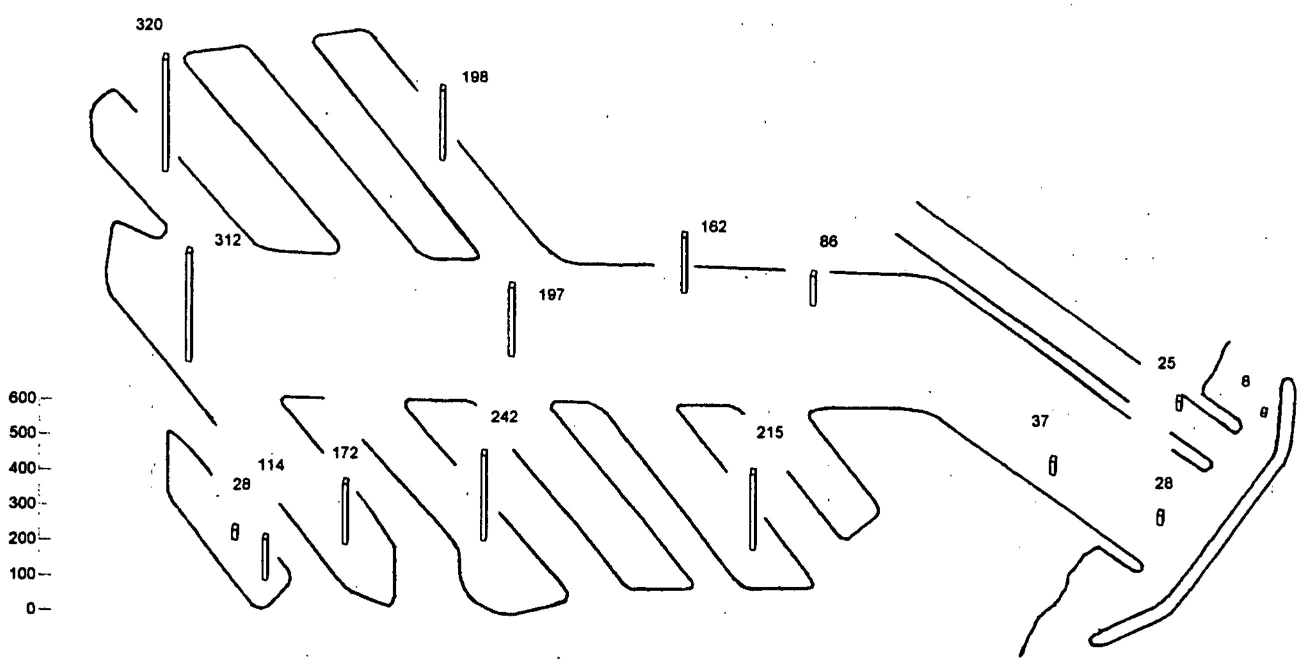


FIGURE 5-4. COPPER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 in 1998 was 14 to 86 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 9 in Basin F (320 ppm), Station 11 at the end of the main channel (312 ppm), and Station 8 in Basin D (242 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 - 8 to 19 ppm) and in Oxford Lagoon (Station 22 – 28 ppm).

Copper ranges compared with past years. The range of 1998 copper values (8 to 320 ppm) was within the overall range of the preceding 11 years (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 (143 ppm, 8 to 320 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, and 25 exceeded the ER-L value, Stations 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 in the main channel (Stations 5, 11, and 25 – 40,000 to 54,000 ppm), at Station 9 in Basin F (50,000 ppm), and at Station 10 in Basin E (45,000 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 - 11,500 to 18,100).

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

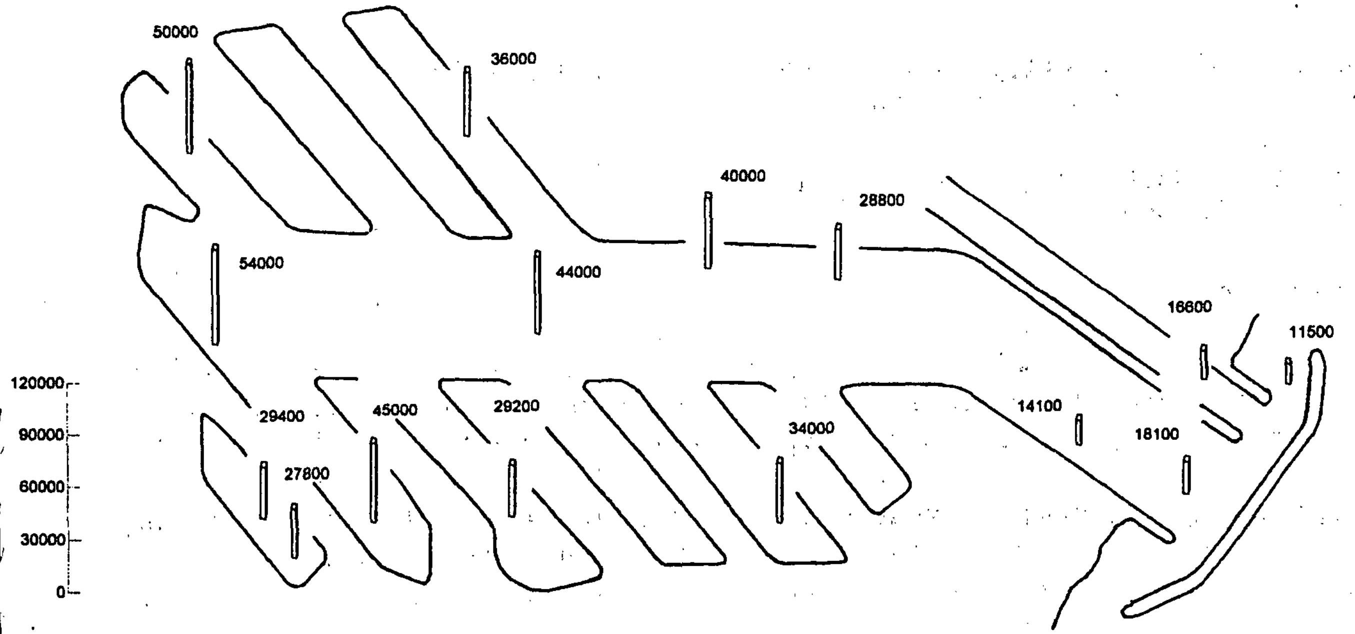
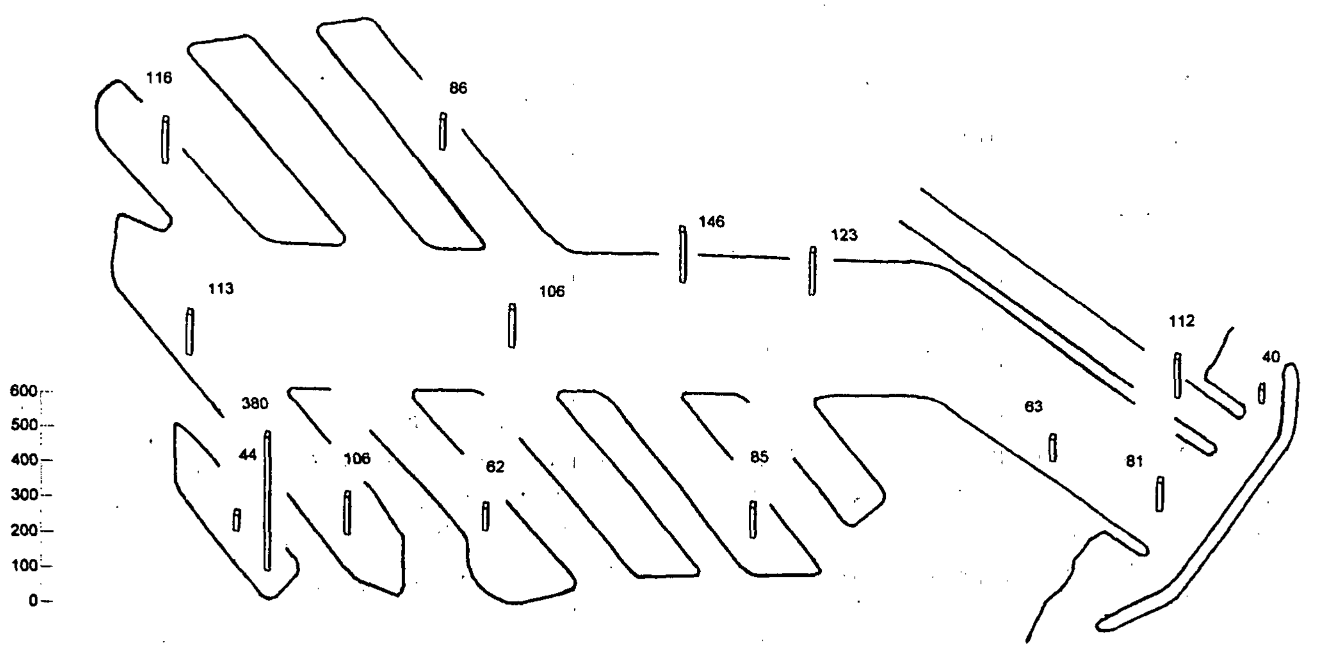


FIGURE 5-6. LEAD CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Iron ranges compared with past years. The range of 1998 iron values (11,500 to 54,000 ppm) was within the overall range of the preceding 11 years (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 by far were at Station 13 Oxford Lagoon (380 ppm). Lowest values were at Stations 1 near the entrance (40 ppm) and at Station 22 in Oxford Lagoon (44 ppm).

Lead ranges compared with past years. The range of 1998 iron values (40 to 380 ppm) was within the overall range of the preceding 11 years (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 (111 ppm, 40 to 380 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, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 25 exceeded the ER-L value, and Station 13 exceeded both ER-M and 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 (314 ppm), Station 11 at the end of the Harbor channel (340 ppm), Station 5 in the main channel (320 ppm), and in Oxford Lagoon (Stations 13 and 22 – 330 and 320, respectively). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 115 to 169 ppm).

Manganese ranges compared with past years. The range of 1998 manganese values (115 to 340 ppm) was within the overall range of the preceding 11 years (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 10 in Basin E (0.81 ppm), Station 11 at the upper end of the main channel (0.74 ppm), Station 8 in Basin D (0.60 ppm), Station 6 in Basin B (0.73 ppm), and Station 9 in Basin F (0.73 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 0.03 to 0.11 ppm) and within Oxford Lagoon (Stations 13 and 22 - 0.20 and 0.03 ppm, respectively).

Mercury ranges compared with past years. The range of 1998 mercury values (0.03 to 0.81 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 (0.37 ppm, 0.03 to 0.81 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, 13, and 25 exceeded the ER-L value, and Stations 6, 9, 10, and 11 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.

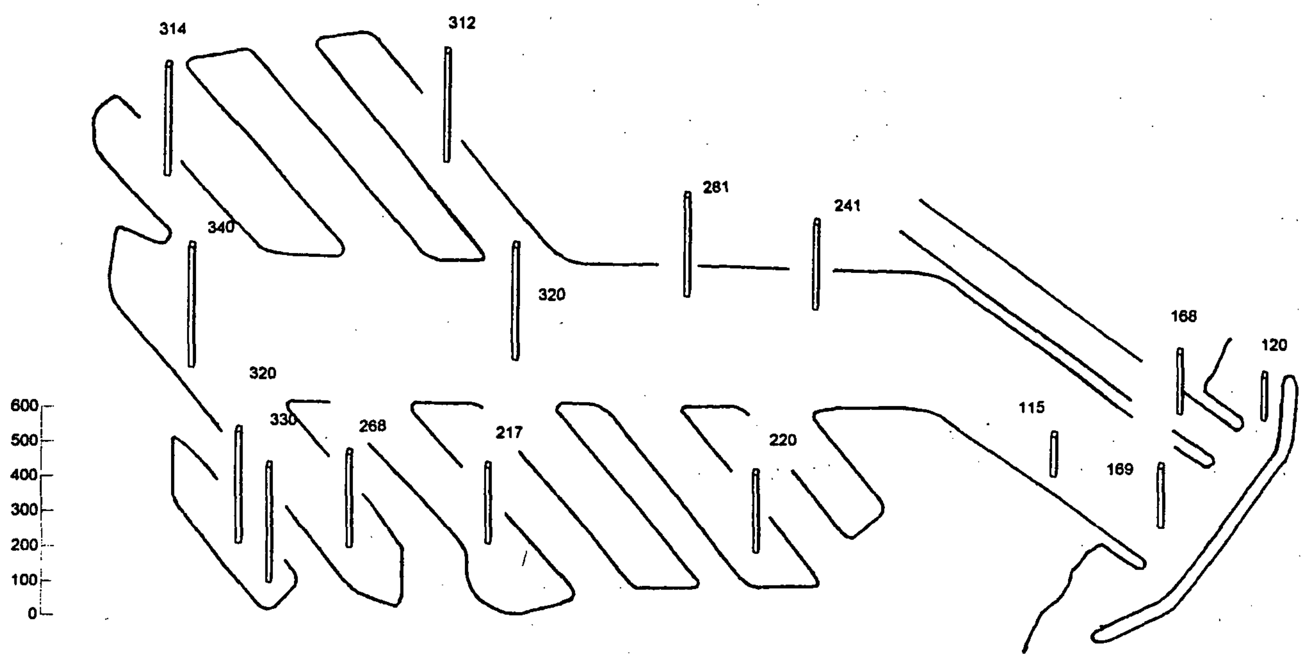
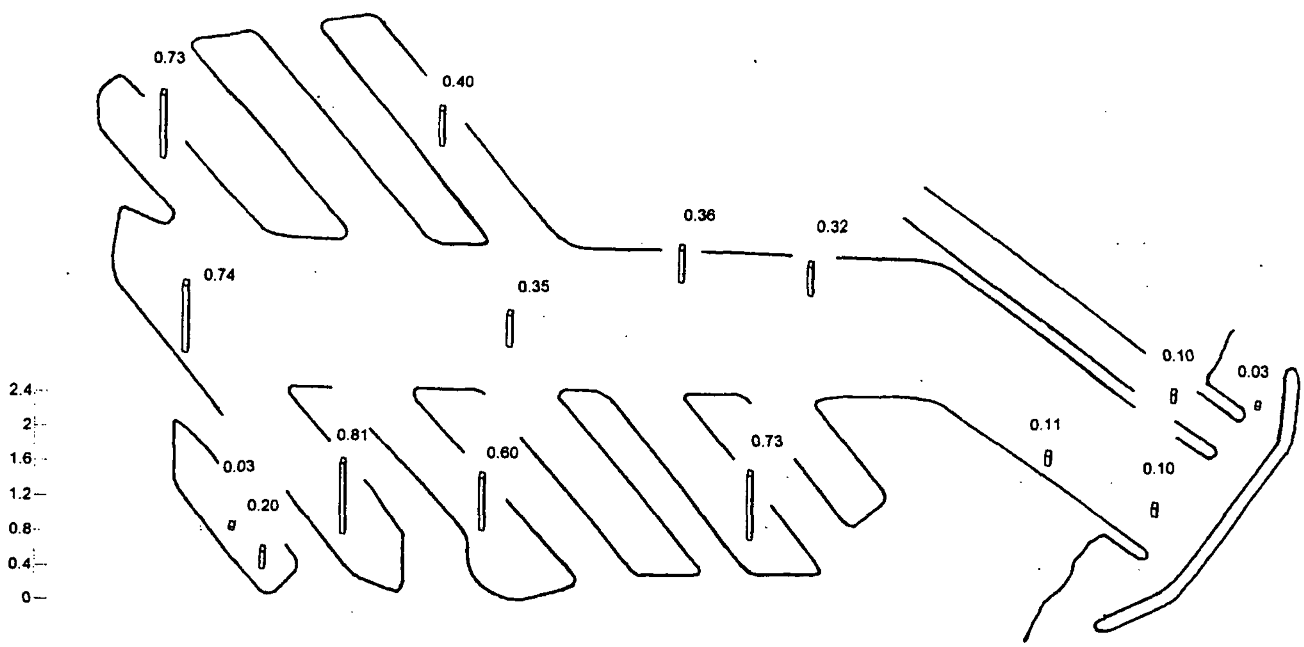


FIGURE 5-8. MERCURY CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial nickel patterns. Nickel concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-9. With the exception of Station 1 at the Harbor's entrance (7 ppm), values among sediment stations were similar (12 to 28 ppm).

Nickel ranges compared with past years. The range of 1998 nickel values (7 to 28 ppm) was within the overall range of the preceding 11 years (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 (20 ppm, 7 to 28 ppm) were comparable to Los Angeles Harbor (22.6 ppm, 10.1 to 42.3 ppm), 1979 (16 ppm, 1.6 to 51 ppm) SCCWRP Reference Site Survey, and 1987 (12.9 ppm) Survey (Table 5-3).

Nickel values compared with NOAA effects range ratings. The ER-L and ER-M values for nickel are 20.9 and 51.6 ppm (Table 5-3). Stations 4, 5, 7, 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 to <2 ppm) at all stations except at Station 9 in Basin F (1.6 ppm), Station 10 in Basin E (1.9 ppm), and Stations 5, 11, and 25 in the main channel (1.2 to 1.7 ppm).

Selenium ranges compared with past years. The range of 1998 selenium values (<1.0 to 1.9 ppm) was within or near the overall range of the preceding four years (Table 5-2).

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

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

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

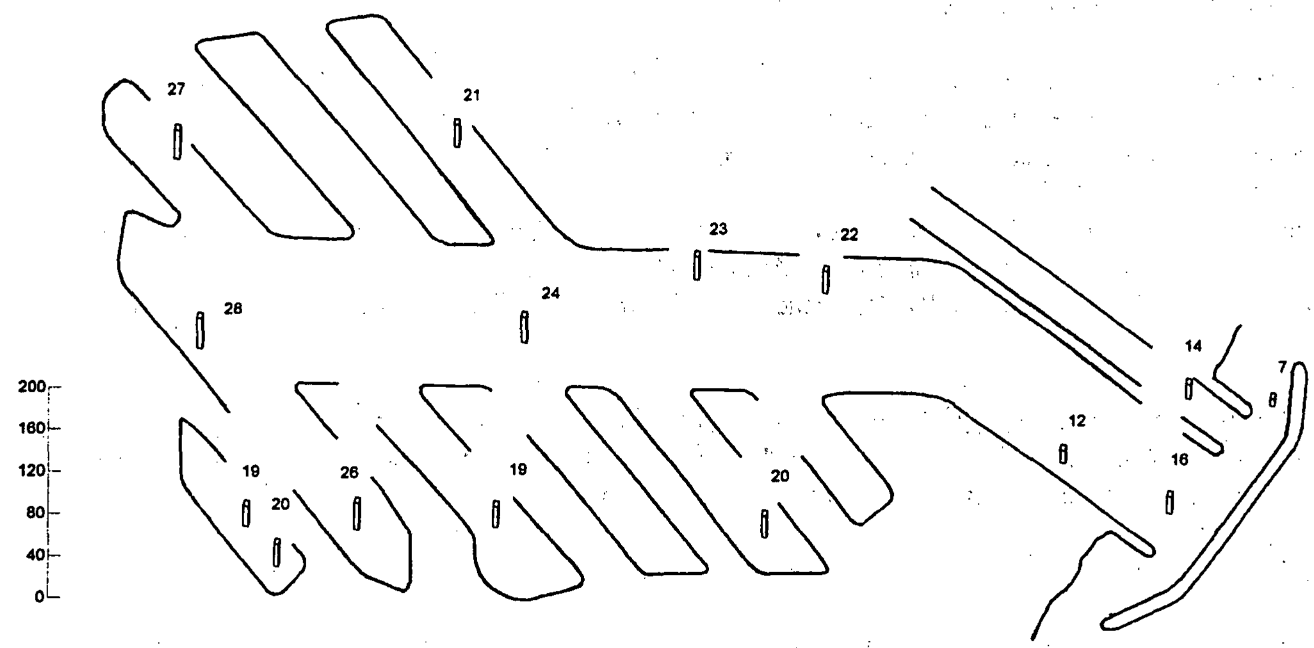
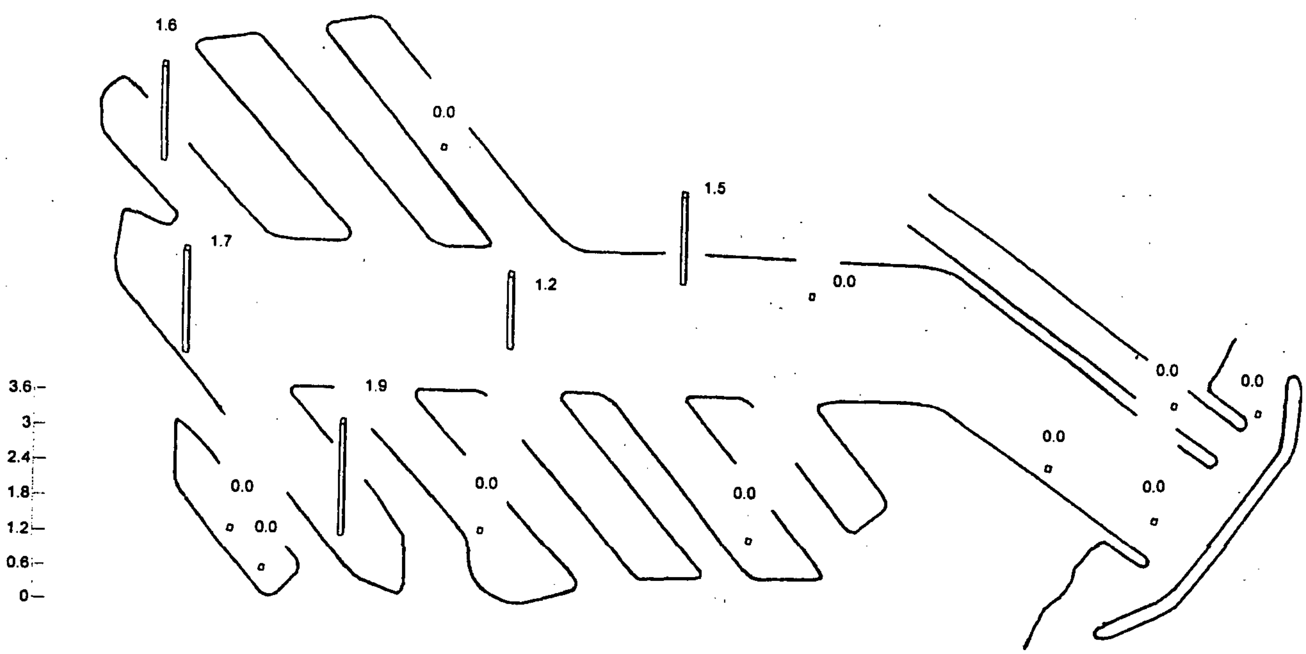


FIGURE 5-10. SELENIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 the main channel (Stations 4, 5, 11, and 25 – 1.4 to 2.2 ppm) and at Station 9 in Basin F (1.2 ppm). Lowest values were at one Harbor entrance station (Stations 1 - 0.2 ppm) and in Oxford Lagoon (Station 22 - 0.1 ppm).

Silver ranges compared with past years. The range of 1997 silver values (0.1 to 2.2 ppm) was similar to the past two years (Table 5-2). Silver was either not analyzed or were below detection limits previous to 1996.

Silver values compared with other surveys. The Marina del Rey silver average and range (1.0 ppm, 0.1 to 2.2 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, and 25 exceeded the ER-L value; Stations 4, 5, 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 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.

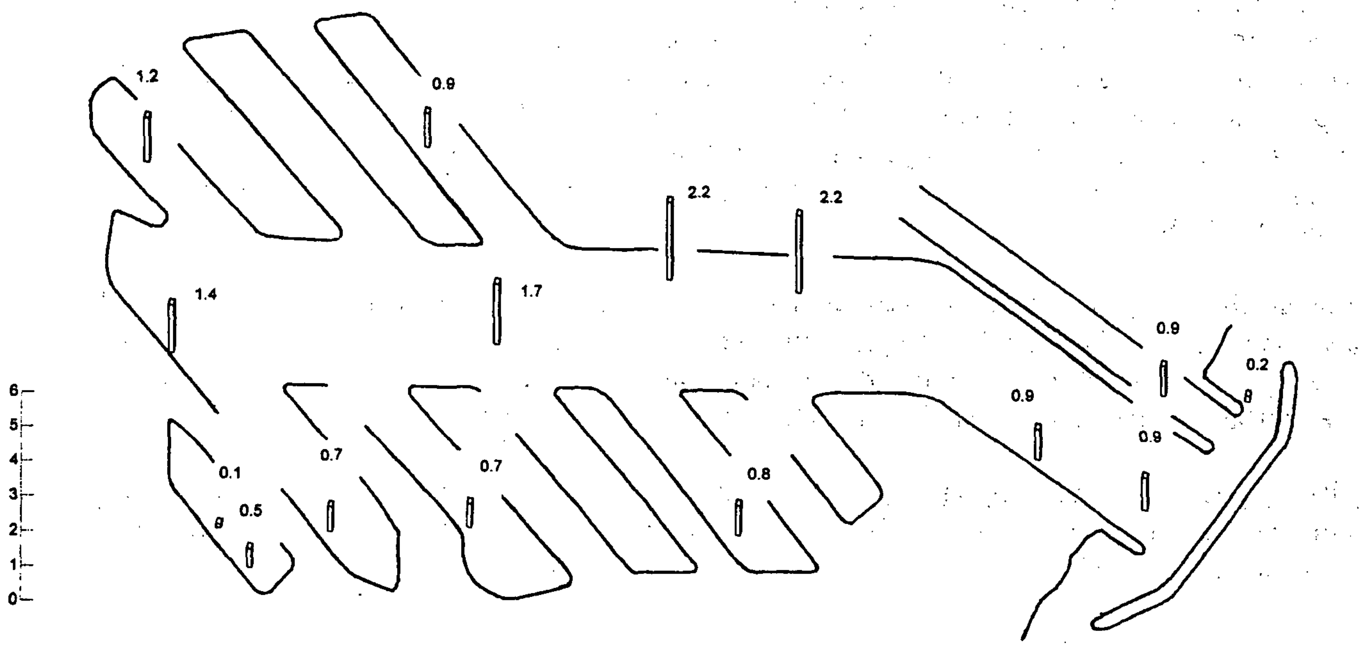
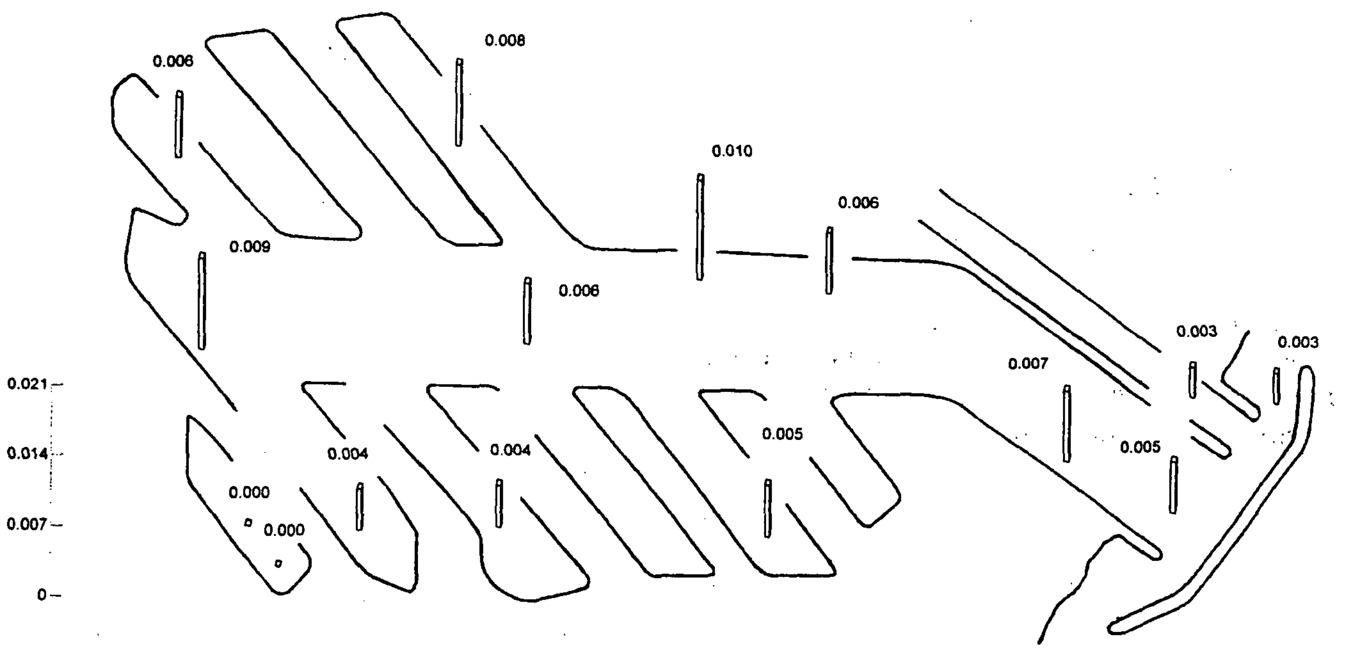


FIGURE 5-12. TRIBUTYL TIN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial tributyl tin patterns. Tributyl tin concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-12. With the exception of Stations 13 and 22 in Oxford Lagoon that were below detection limits (<0.002 ppm), values among sediment stations in the Harbor were similar (0.003 to 0.010 ppm).

Tributyl tin ranges compared with past years. The upper value of 1998 tributyl tin results (0.010 ppm) is the lowest recorded since 1987 (Table 5-2) and may reflect a response to the recent banning of this compound in the Harbor (see above). The range reported for October 1987 (<8 to 1070 ppm) appears to be much too high and is probably a part per billion result.

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

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 13 in Oxford Lagoon (500 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 36 to 161 ppm) and at Station 22 in Oxford Lagoon (141 ppm).

Zinc ranges compared with past years. The range of 1998 zinc values (36 to 500 ppm) was within the overall range of the preceding 11 years (Table 5-2). Zinc in the Harbor appears to have neither greatly increased nor decreased since 1987.

Zinc values compared with other surveys. The Marina del Rey zinc average and range (251 ppm, 36 to 500 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 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 25 exceeded ER-L values; and Stations 5, 9, 10, 11, 13, and 25 exceeded both ER-M and AET values.

5.3.2. Chlorinated Pesticides and PCB's

5.3.2.1. **DDT and Derivatives**

DDT has been banned since the early 1970's, but the presence of nondegraded DDT suggests that either subsurface DDT is being released during erosion and runoff in storms, or that fresh DDT is still in use and finding its way into the marina (Soule et al. 1996). 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 9 in Basin F (23.0 ppb), Station 8 in Basin D (13.0 ppb), and at Station 12 in Ballona Creek (9.3 ppb). Lowest values were at Station 3 in the main channel (<0.6 ppb), Station 6 in Basin B (1.0 ppb), and at Station 1 at the Harbor entrance (0.7 ppb).

DDT ranges compared with past years. The range of 1998 values were <0.6 to 12.0 ppb for DDT, <0.5 to 18.0 ppb for DDD, and 0.5 to 2.0 ppb for DDE. DDD and DDT results were somewhat higher than last year (Aquatic Bioassay 1998), however, DDE results were two orders of magnitude lower (Table 5-2).

DDT values compared with other surveys. The Marina del Rey total DDT's average and range (6.14 ppb, <0.6 to 23.0 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 7, 9, 11, 13, 22, and 25 exceeded the ER-L value, and Station 9 exceeded both AET and ER-M values. For DDE, no stations exceeded ER-L, AET or ER-M values. For DDT, Stations 2, 4, 5, 6, 7, 8, 9, 10, 12, and 25 exceeded the ER-L value, Stations 2, 4, 8, and 12 exceeded the AET value, and Stations 8 and 12 exceeded the ER-M value. For all DDT and derivatives combined, Stations 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 22, and 25 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.

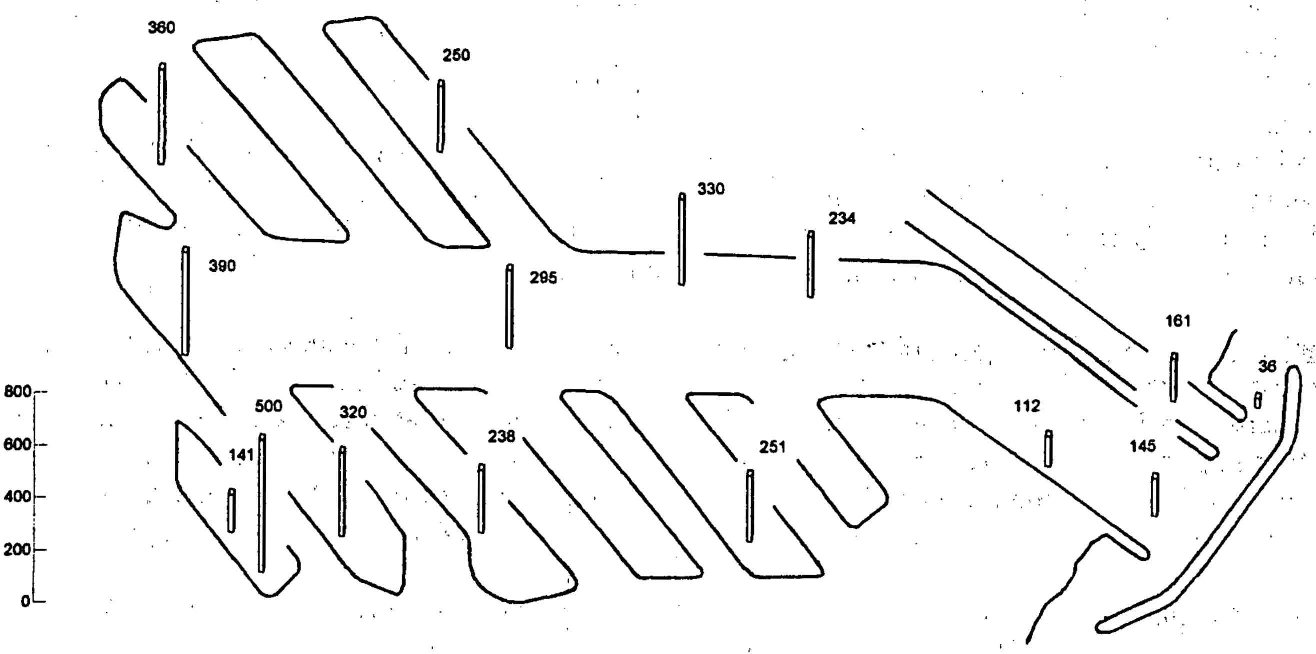
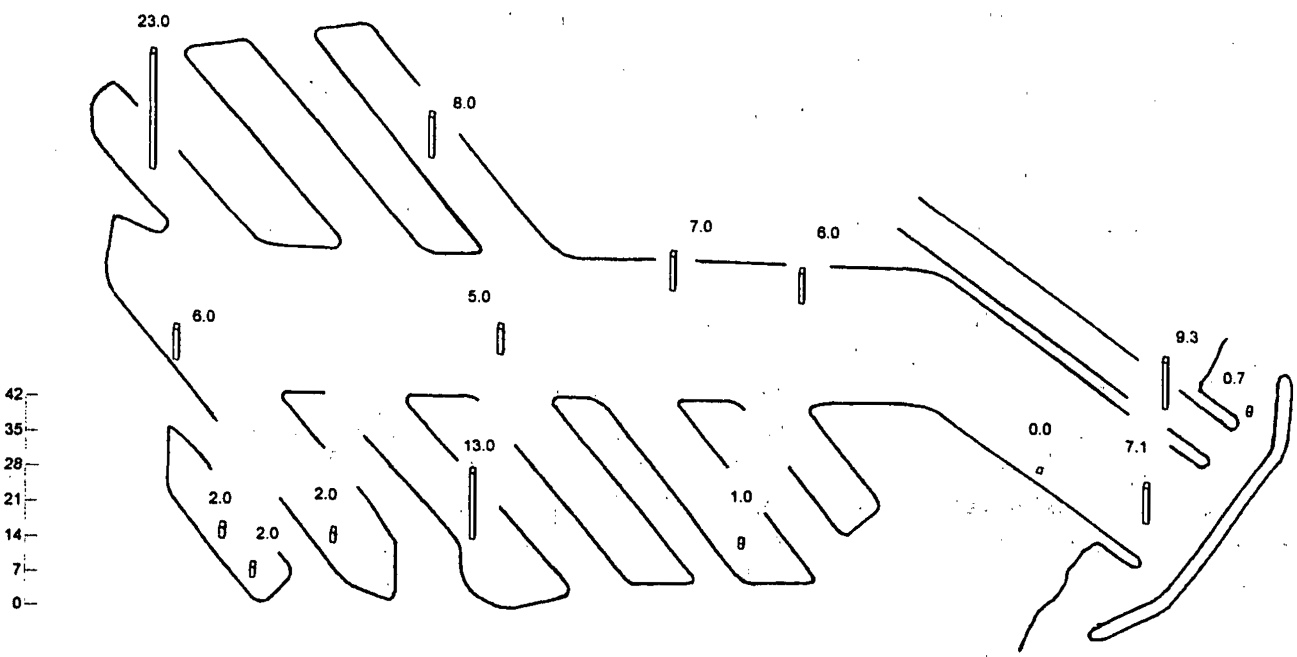


FIGURE 5-14. DDT AND DERIVATIVES CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



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).

Spatial remaining chlorinated pesticide patterns. Concentrations of combined chlorinated pesticides (excluding DDT and derivatives) at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-15. Highest combined pesticide values were at Stations 13 and 22 in Oxford Lagoon (12.6 and 31.3 ppb, respectively); at Stations 4, 5, and 25 in the main channel (12.9 to 20.0 ppb); at Station 12 in Ballona Creek (29.5 ppb); and at Station 2 near the Harbor entrance (31.7 ppb). Lowest values were in Basins D and F (Stations 8 and 9 – 2.0 and 2.7 ppb).

Remaining chlorinated pesticide ranges compared with past years. The range of 1998 values for all non-DDT chlorinated pesticides were 2.0 to 31.7 ppb, which is about twice the ranges of the previous two years. In addition, more compounds were detected this past year than in 1996 and 1997. Surveys previous to 1996 cannot be compared because current detection limits are lower than previous ones (Table 5-2).

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

Remaining chlorinated pesticide values compared with NOAA effects range ratings. The ER-L 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, all stations, except Station 8, exceeded the ER-L value; and Stations 2, 4, 5, 12, and 25 exceeded both ER-M and AET values. For dieldrin, Stations 2 and 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.

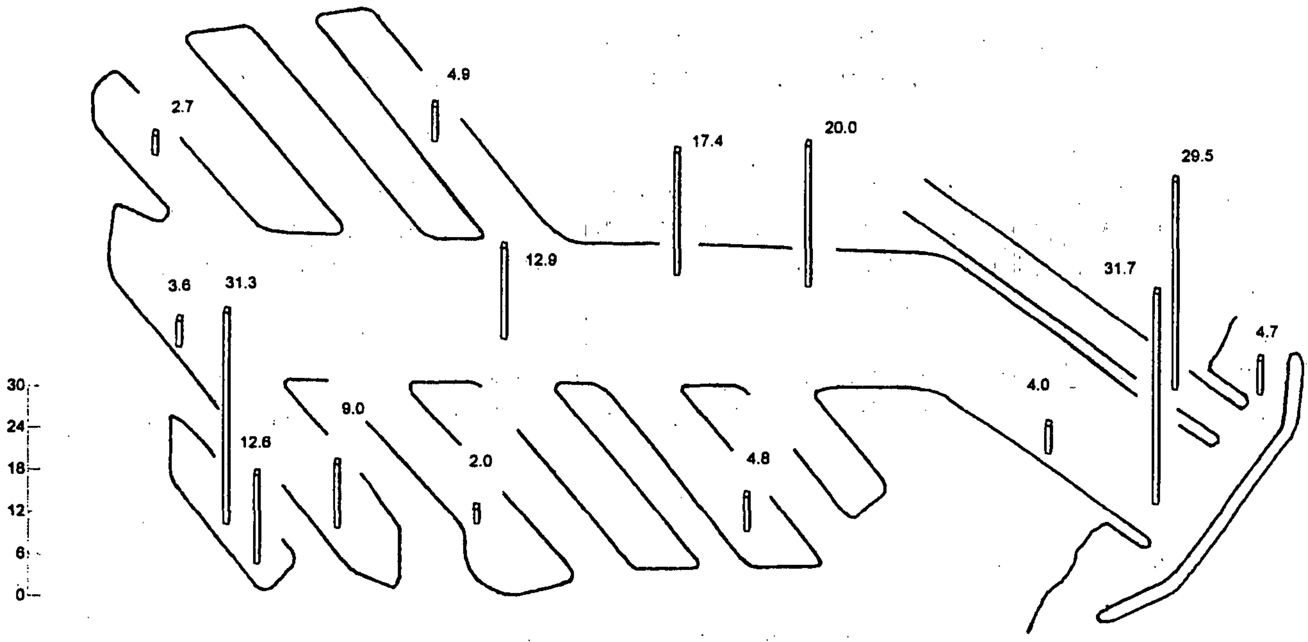
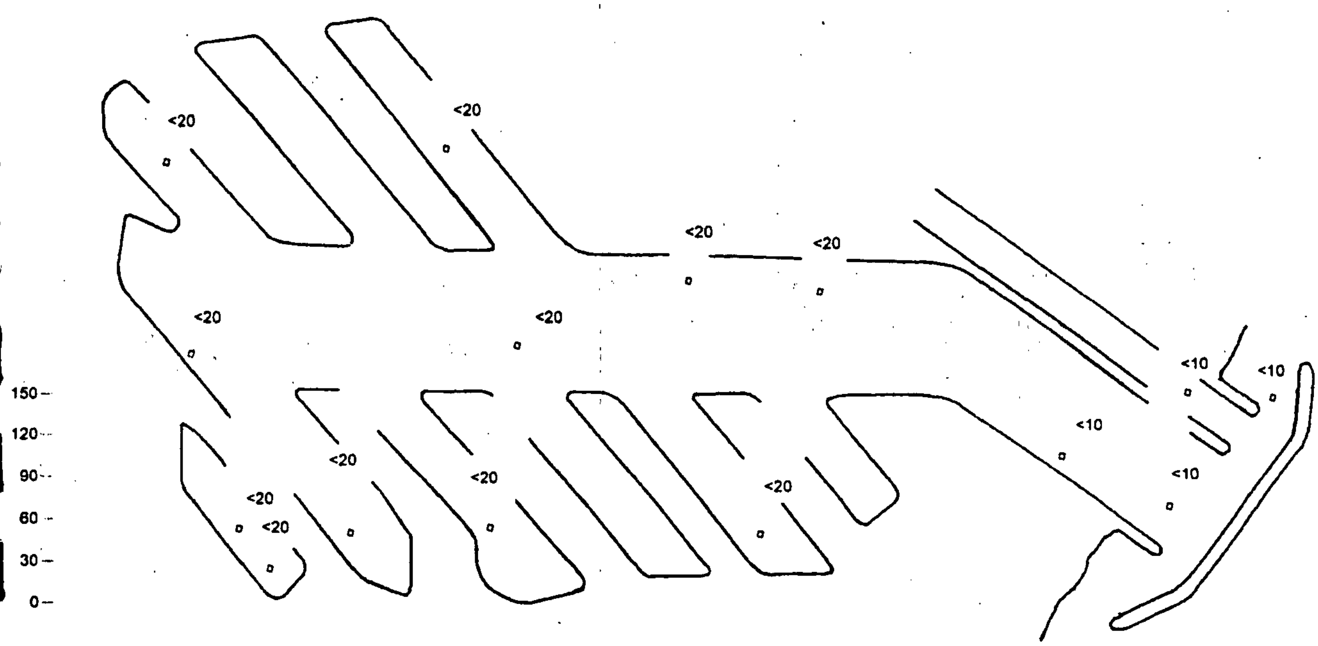


FIGURE 5-16. TOTAL PCB CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



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. 1998 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 last year.

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 may be 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 Station 1 at the Harbor entrance (0.4%), TOC values were fairly consistent throughout the Harbor (0.7% to 1.1%).

TOC ranges compared with past years. The range of 1998 values for TOC was 0.4 to 1.1% (Table 5-2), which is well within the ranges for the previous eleven years. 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 (0.85%, 0.4% to 1.1%) were comparable to the 1987 SCCWRP Reference Site Survey of 0.52% (Table 5-3). TOC was not analyzed in the 1979 SCCWRP Survey.

5.3.3.2. **Volatile Solids**

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

Spatial volatile solids patterns. Concentrations of volatile solids at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-18. Highest values were at Stations 13 in Oxford Lagoon (3.7%) and lowest values were near the Harbor entrance (Stations 1 - 0.7%).

Volatile solids ranges compared with past years. The range of 1998 values for volatile solids was 0.7% to 3.7% (Table 5-2) which is well within the ranges for the previous eleven years. Volatile solids in the Harbor may have declined somewhat since 1987.

Volatile solids values compared with previous surveys. The average and range for Marina Del Rey volatile solids (2.2%, 0.7% to 3.7%) were somewhat 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 in the main channel (Stations 5 and 25 – 6670 and 6840 ppm, respectively). Lowest values were near the Harbor entrance (Stations 1 – 160 mg/l).

IOD ranges compared with past years. The range of 1998 values for IOD was 160 to 6840 ppm (Table 5-2). These values are lower than 1996 and 1997 (1300 to 19,900 ppm) but higher than those reported in earlier studies (<1 to 557 ppm). It is likely, since the IOD analysis is a non-standardized methodology, that these large differences are related to different analytical techniques 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.

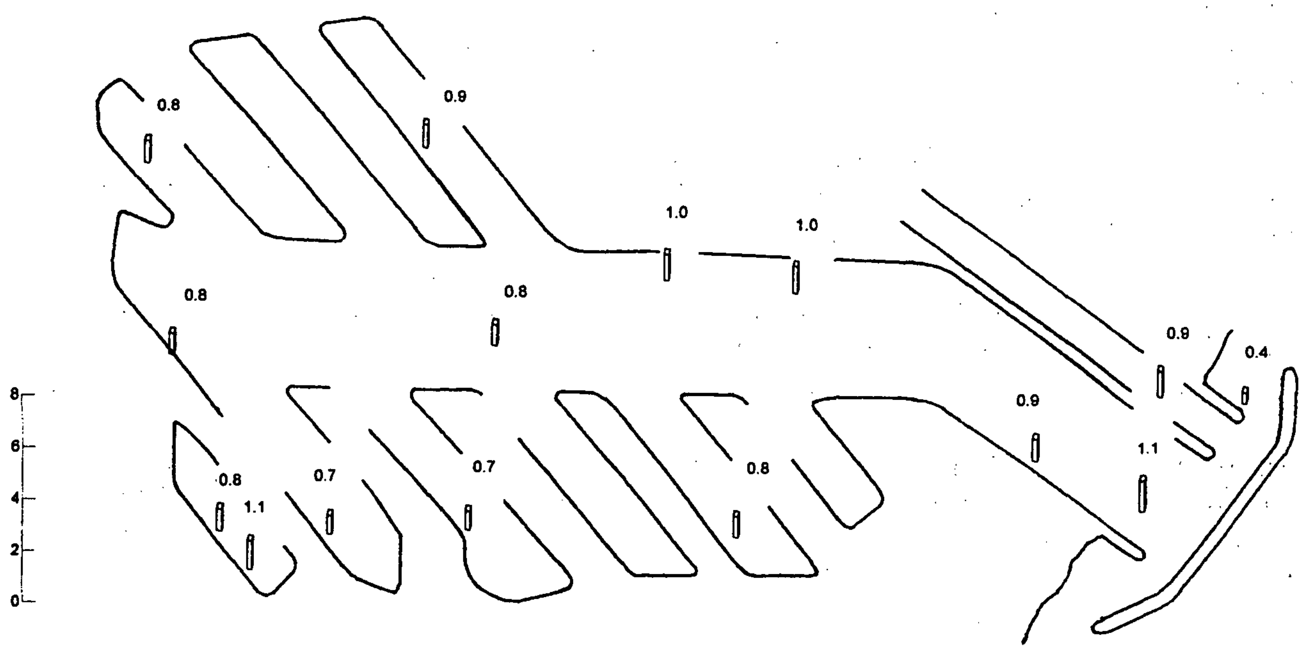
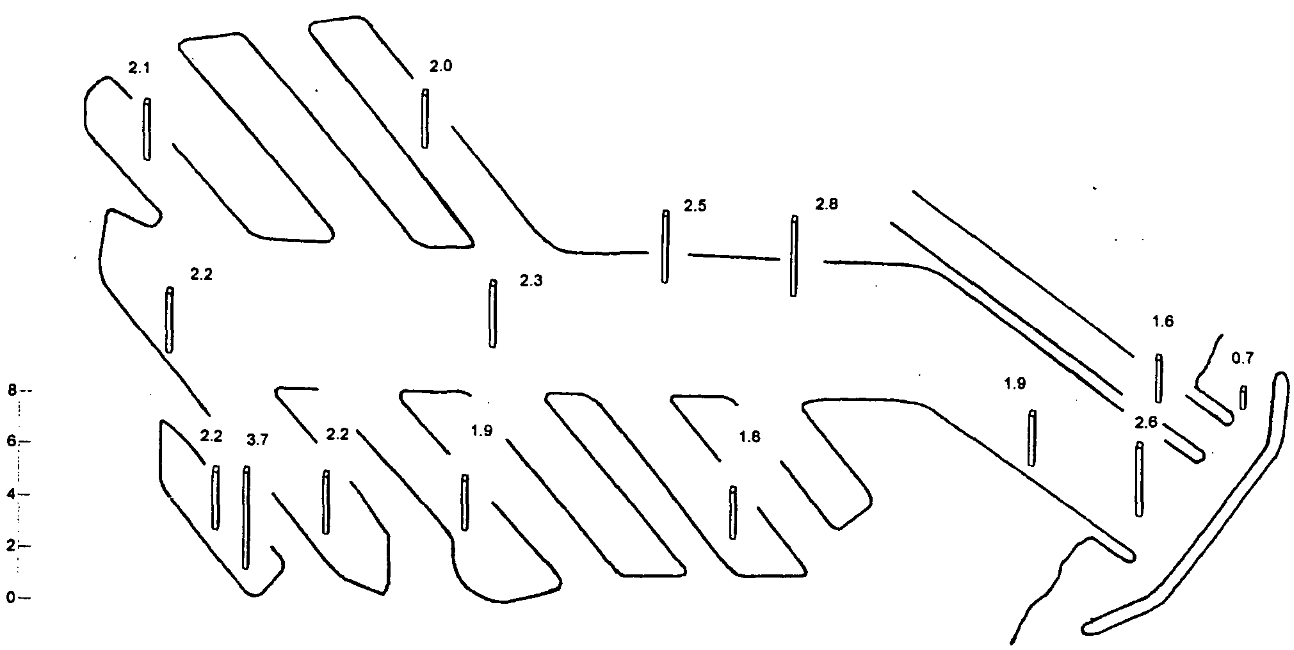


FIGURE 5-18. VOLATILE SOLIDS CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 Stations 4 and 25 near the Administration docks (4.8 and 6.7 %, respectively) and at Station 6 in Basin B (4.7%). Lowest values were near the Harbor entrance (Stations 1 - 0.4%).

COD ranges compared with past years. The range of 1998 values for COD was 0.4% to 6.7% (Table 5-2) which is well within the ranges of the previous eleven years. COD in the Harbor appears to have declined somewhat since 1987.

COD values compared with previous surveys. The average and range for Marina del Rey COD (3.3%, 0.4% to 6.7%) 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, where tidal flux may play a role in deposition from the marina. Also, the marina is located in an area of historic oil fields, and oil from seeps may be a natural cause. The extent to which people dump used motor oil into storm drains is unknown and may be a factor in the occurrence of oil and grease in flood control channels. Kitchen grease, apparently from nearby restaurants, has at times been observed on marina walls at the tidegate. Station 25 is between the area of the administration building, where the Life Guard, Sheriff's patrol and Coast Guard dock, and Fisherman's Village, where the public fishing and bait boats dock. This is an area of concentrated activity of diesel engines prone to oil emission (Soule et al. 1996).

Spatial oil and grease patterns. Oil and grease values for the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-21. Highest values were at Station 9 in Basin F (140 ppm), Station 10 in Basin E (140 ppm), Station 8 in Basin D (110 ppm), Station 6 in Basin B (110 ppm), Station 7 in Basin H, and Station 12 in Ballona Creek (120 ppm). Lowest values were at Stations 13 and 22 in Oxford Lagoon (8 and 3 ppm, respectively) and at Station 11 at the upper end of the main channel (6 ppm).

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

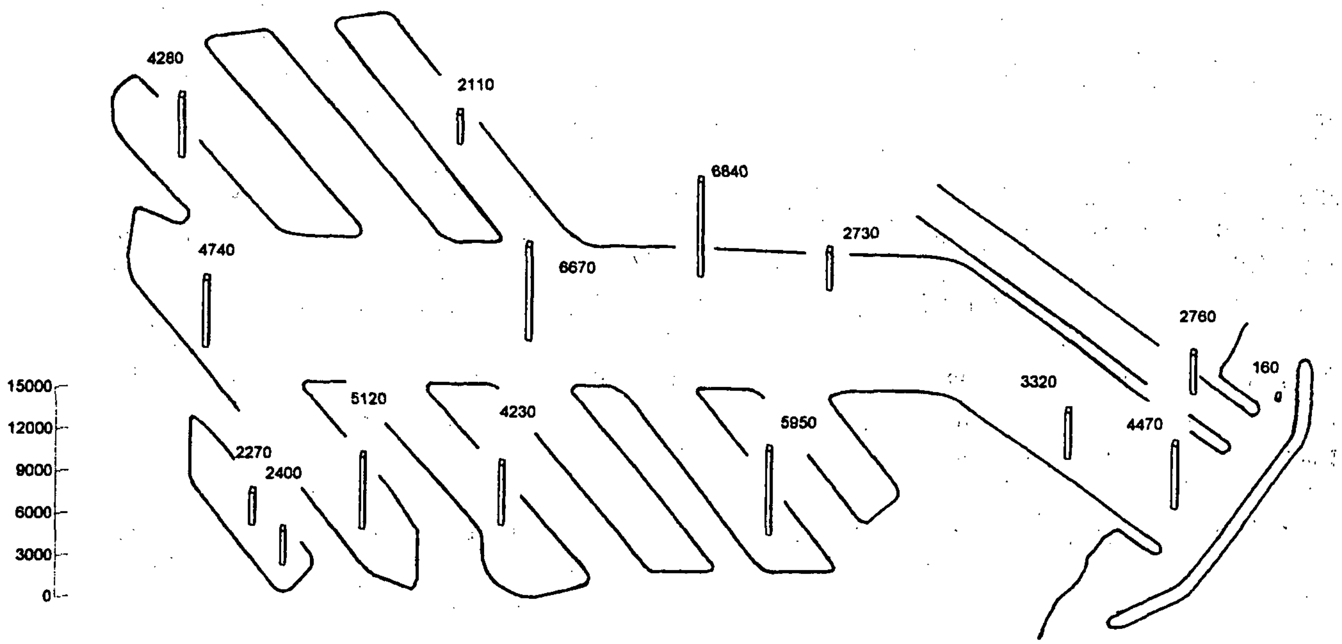
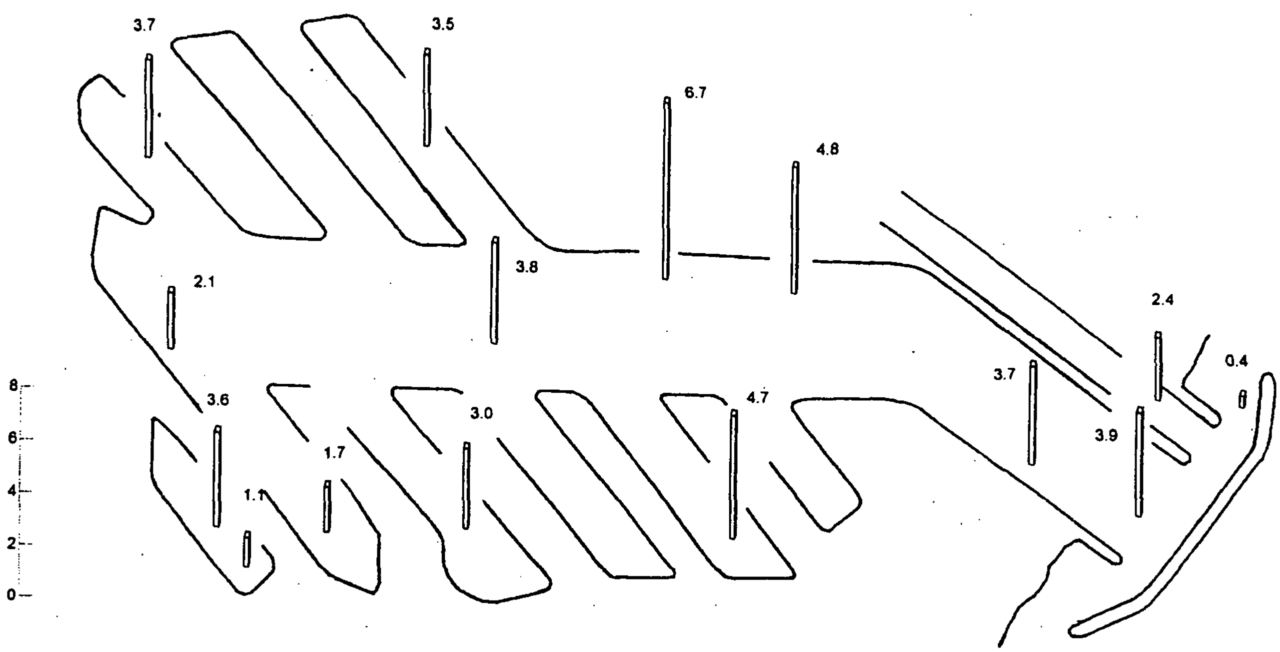


FIGURE 5-20. CHEMICAL OXYGEN DEMAND CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



Oil and grease ranges compared with past years. The range of 1998 values for oil and grease was 3 to 140 ppm, which fall well within the range of values for the past eleven years (Table 5-2). Oil and grease concentrations appear to have considerably decreased 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.

5.3.3.6. **Organic Nitrogen**

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

Spatial organic nitrogen patterns. Concentrations of organic nitrogen at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-22. Highest values were at Station 13 in Oxford Lagoon (768 ppm), Station 25 in the main channel (700 ppm), and Station 2 near the Harbor entrance (611 ppm). Lowest values were at Station 1 near the Harbor entrance (37 ppm).

Organic nitrogen ranges compared with past years. The range of 1998 values for organic nitrogen was 37 to 768 ppm (Table 5-2) which is well within the range of the previous eleven years. 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 (488 ppm, 37 to 768 ppm) were somewhat lower than 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 1998 values for ortho phosphate was <10 to <20 ppm, which is below nearly all values recorded since 1987 (Table 5-2).

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

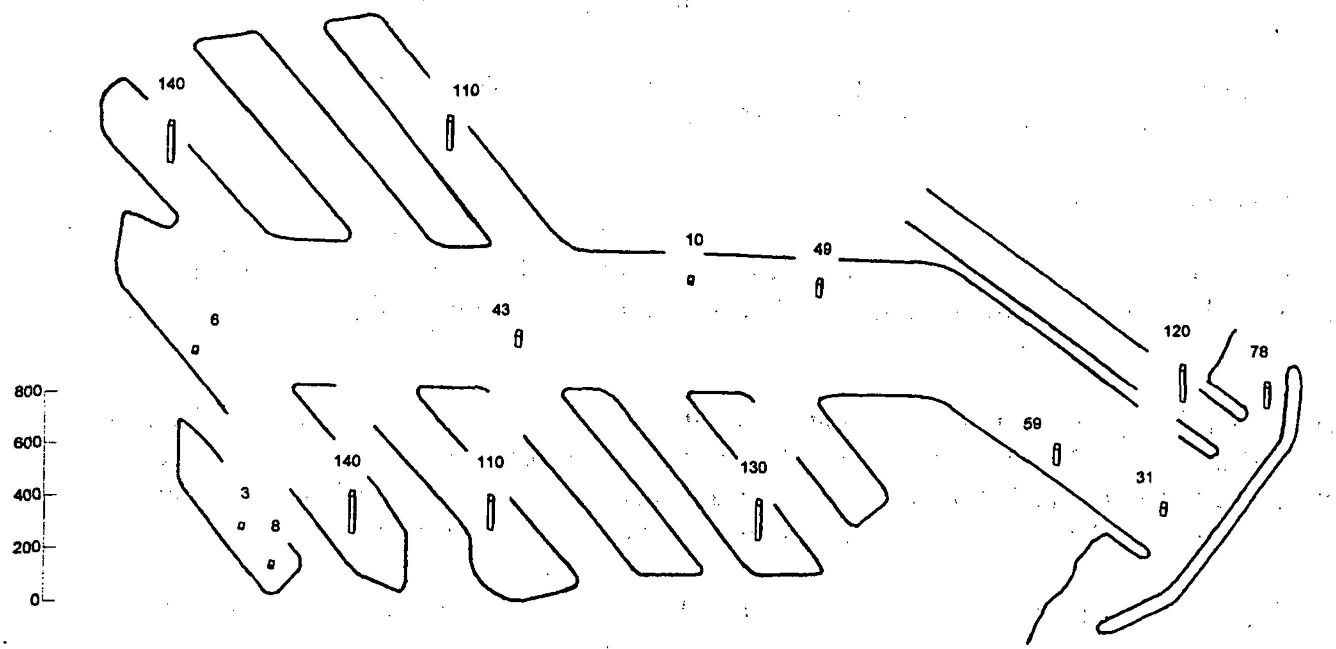
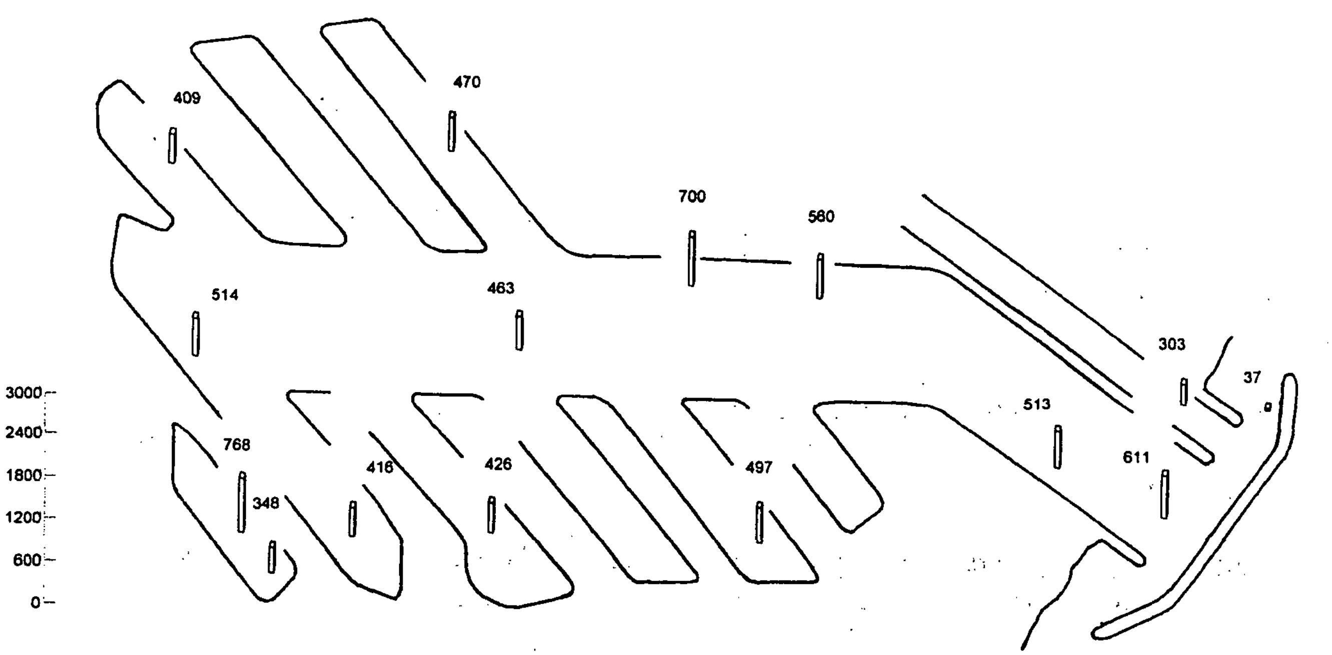


FIGURE 5-22. ORGANIC NITROGEN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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

5.3.3.8. **Sulfides**

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

Spatial sulfide patterns. Concentrations of sulfides at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-24. Highest values were at Station 3 near the entrance to Venice Canal (620 ppm), Station 6 in Basin B (590 ppm) and Station 4 in the main channel (520 ppm). Lowest values were at Station 10 in Basin E and Station 1 near the Harbor entrance (both <3 ppm).

Sulfide ranges compared with past years. The range of 1998 values for sulfide was <3 to 620 ppm (Table 5-2) which is well within the ranges of the previous eleven years. Like ortho phosphate, sulfide 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).

Station 5, 6, 7, 8, and 10. As a group, these stations tended to have high concentrations of a few metals and oil and grease, and low concentrations of cadmium and total organic carbon. These stations represent mostly areas in the far back vicinities of the Harbor.

Stations 9 and 11. These two stations tended to be highest in nearly all metals and DDT compounds but were low in other remaining chlorinated pesticides. As with the group described above, these station represent some of the areas furthest back in the Harbor.

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

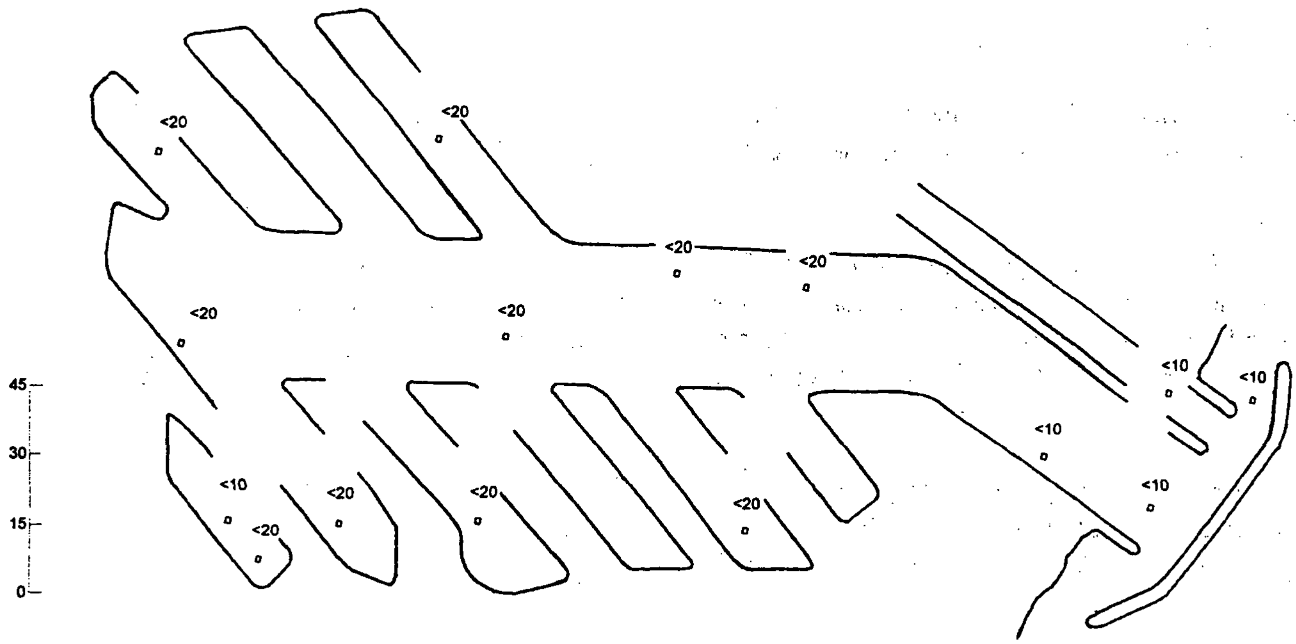
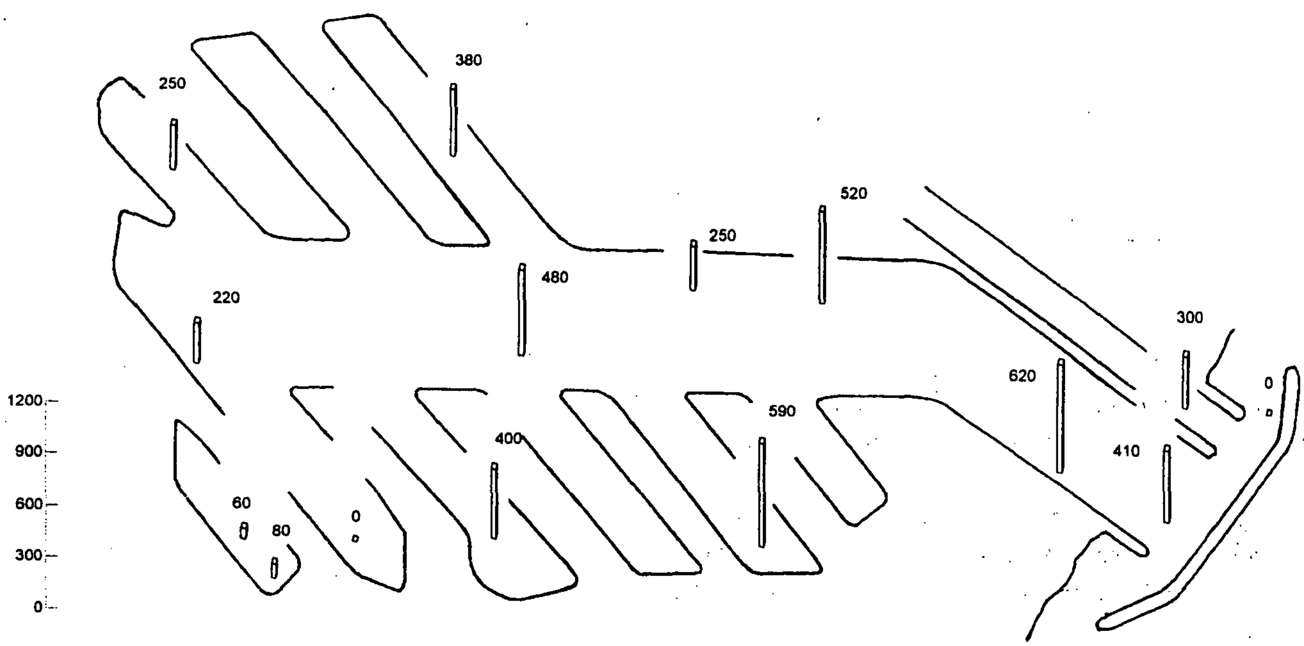


FIGURE 5-24. TOTAL SULFIDE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Stations 4 and 25. Similar to stations 9 and 11, these stations are high in most metals, however, this group also tended to be highest in non-DDT pesticides and undifferentiated organic compounds (except oil and grease). This is an area of considerable boat activity.

Stations 1, 2,3, 12, 13, and 22. This group is low in most metals and immediate oxygen demand. Although Oxford Lagoon and Ballona Creek are significant sources of pollutants to the Harbor, high flow rates in these areas move the contaminants away and into the quieter areas. Although, when combined as a group, these stations are not particularly high in chlorinated hydrocarbons, Station 22 in Oxford Lagoon has relatively high non-DDT pesticide concentrations in its sediments, and Stations 2 and 12 have high values of both DDT and non-DDT pollutants.

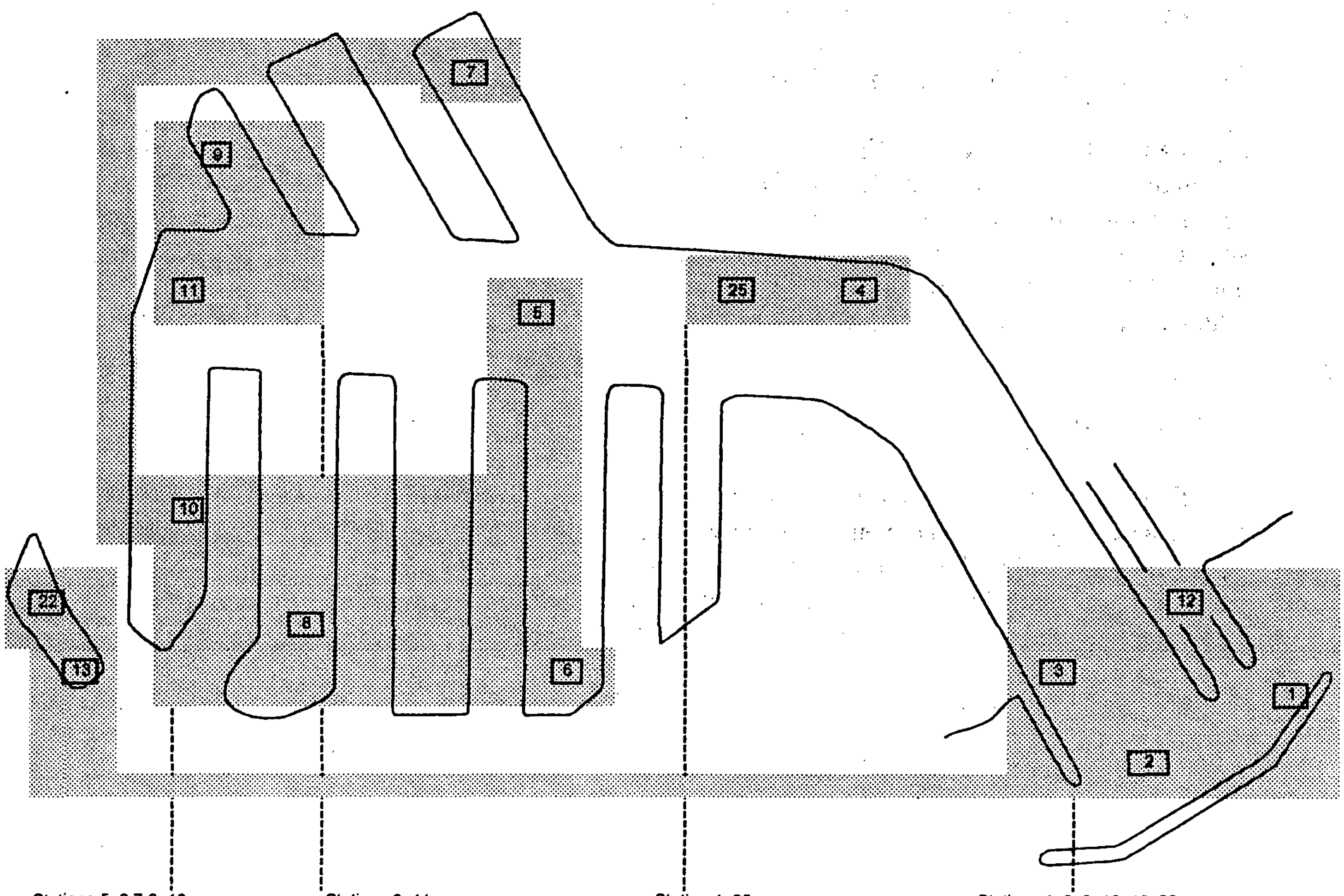
5.4. DISCUSSION

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 two surveys (Aquatic Bioassay 1997, 1998), inflows from the Oxford Lagoon and Ballona Creek may be sources of chlorinated pesticides. Station 22 in Oxford Lagoon had high values of non-DDT type pesticides, and Station 12 in Ballona Creek and Station 2 nearby were high in both DDT type and non-DDT type chlorinated compounds. DDT itself, which was below detection limits at all stations for the first time last year, has reappeared this year at most locations. As stated above in the Harbor history, the area 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. Other areas of relatively high DDT type compounds were Basins D, F, and H. The area of the Harbor adjacent to the Administration docks (Stations 4 and 25) showed relatively high concentrations of non-DDT type pesticides.

In general, chlorinated hydrocarbon concentrations over the past three years have been notably lower than had been measured during the previous ten years. Despite this, all Harbor stations exceeded at least one pesticide sediment limit considered by NOAA to be above concentrations where adverse effects may begin to affect resident organisms or could chronically impact sensitive or younger marine organisms. In addition, about half of all stations (2, 4, 5, 8, 9, 12, and 25) 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). Average total DDT's and PCB's in Marina del Rey Harbor sediments (6.1 and <20 ppb, respectively), however, compare favorably with those of Los Angeles Harbor (94.1 and 58.3 ppb) and even those of the 1979 and 1987 SCCWRP Reference Site Surveys (30 and 18.9 ppb for DDT's and 10 and 19.2 ppb for PCB's).

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



<u>Stations 5, 6,7 8, 10</u>

High in:
Copper
Mercury
Selenium
Oil and Grease
–
–
–
–
–
–
–
–
–

Low in:
Cadmium
TOC
–
–
–
–
–
–
–
–

Charaterlstics:
High in a few metals and oil and grease. Low in one metal and TOC.

<u>Stations 9, 11</u>

High in:
Arsenic
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Tributyl Tin
Zinc
DDT

Low in:
Pesticides
–
–
–
–
–
–
–
–
–

Charaterlstics:
High in most metals and DDT. Low in remaining chlorinated pesticides.

<u>Station 4, 25</u>

High in:
Arsenic
Cadmium
Chromium
Lead
Selenium
Silver
Tributyl Tin
Pesticides
TOC
Volatile Solids
COD
Nitrogen
–

Low in:
Oil and grease
–
–
–
–
–
–
–
–
–

Charaterlstics:
High in most metals and most organics. Low in oil and grease.

<u>Stations 1, 2, 3, 12, 13, 22</u>

High in:
–
–
–
–
–
–
–
–
–
–
–
–
–

Low in:
Arsenic
Chromium
Copper
Iron
Mercury
Nickel
Silver
Tributyl Tin
Zinc
Immed. Oxy. Dmd.

Charaterlstics:
Low in most metals and immediate oxygen demand. Greater water movement in these areas are likely keeping contaminanant in suspension.

Concentrations of all heavy metals in sediment samples from Ballona Creek were low during this survey. However, due to the relatively rapid water movement through the channel, contaminated particles may not have a chance to settle out in the Creek. Areas downcurrent of Ballona Creek (e.g. Stations 1 and 2) also had low metal values, so Ballona Creek does not appear to be a source of metal contaminants. Oxford Lagoon, however, may be contributing heavy metals to the upper Harbor. A number of metals were highest in Oxford Lagoon, and stations downcurrent (i.e. Stations 9, 10, and 11) were also relatively high for many metals.

Highest heavy metal concentrations in the Harbor were from sediments of the back basins and upper main channel. Despite the possible contribution from Oxford Lagoon, the likely source of most metals is the thousands of boats themselves which inhabit the Marina. Metal components of boats and their engines are constantly being corroded by seawater, and virtually all bottom paints contain heavy metals, such as copper and tributyl tin. These paints are designed to constantly ablate off, so that a fresh surface of toxicant is exposed to fouling organisms at all times. Thus, short of an out-and-out ban on these compounds, sediments in the Harbor are likely to continue to accumulate heavy metals in toxic amounts. It is not surprising, then, that all stations 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. Areas that exceeded most metal limits were Basins F, H, and the upper main channel.

Five heavy metals in Marina del Rey sediments fell within the range of values measured in Los Angeles Harbor sediments, but values of four (copper, mercury, lead, and zinc) were between two to five times higher. This is down from six metals higher in Marina del Rey last year, which included arsenic and silver. Marina del Rey Harbor has only one entrance, while Los Angeles Harbor is open at two ends and thus undoubtedly receives considerably better flushing. Not surprisingly, most (but not all) metals were higher than those collected along the open coast.

Despite a fair degree of variability over the past ten years, most heavy metal concentrations appear to have neither consistently increased nor greatly decreased over time. The exception is tributyl tin, which has declined by two orders of magnitude since 1988. The upper value of the 1998 results was the lowest recorded since analysis had been initiated. 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. Like heavy metals, sources of nonspecific organic pollutants may be varied. Within the Harbor, the patterns of organic compounds tended to be elevated throughout most of the channel and the uppermost areas of the Harbor and were low immediately inside the breakwall. Both Oxford Lagoon and Ballona Creek appear to have contributed little nonspecific organic material to the Harbor. Various seepages from boats and other nonpoint runoff undoubtedly contribute considerable amounts of organics to the benthos. Among the compounds measured (TOC, volatile solids, COD, and organic nitrogen), all were comparable to the 1979 SCCWRP Reference Site Survey. There are no NOAA limits for any nonspecific organic compounds.

As discussed in the past two years' reports (Aquatic Bioassay 1997, 1998), Harbor sediments which 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.

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. In general, nematodes are more tolerant of lowered salinities and disturbances. Species with planktonic eggs or larvae may recolonize due to introduction on tidal flow from adjacent areas, while less mobile species may return more slowly, or not at all (Soule et al. 1996).

6.2. MATERIALS AND METHODS

Field sampling for all benthic sediment components 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 individual infauna 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) flourish because they have few competitors. If the area becomes too stressful, however, even the tolerant species cannot survive, and the numbers of individuals decline, as well.

Spatial infaunal abundance patterns. Numbers of individuals at the 13 infaunal sampling stations are listed in Table 6-1 and summarized in Figure 6-1. Counts per grab ranged from 241 to 32,760 individuals. Lowest total abundance was at Station 9 in Basin F (241 individuals), Station 7 in Basin H (478 individuals), and at Station 11 at the upper end of the main channel (527 individuals). Highest values by far were at Station 12 in Ballona Creek (32,760 individuals), followed by Station 2 (11,010 individuals), and Station 4 (6718 individuals). A large number of individuals at Station 12 (30%) were nematodes that are typically found in areas of environmental disturbance or freshwater influence (Soule et al. 1996). Similarly, nematodes accounted for 35% of the animals at Station 1, 19% of the animals at Station 2, 41% of the animals at Station 3, and 26% of the animals at Station 11. Nematodes were virtually absent from all remaining stations (0% to 1%).

Infaunal abundance patterns compared with past years. Table 6-2 lists abundance ranges per station since 1976. The range of individuals collected during 1998 was 241 to 32,760, which falls well within the overall range of values for past surveys. Values this survey were higher than those of the past two years. Abundances have varied widely over the years.

Infaunal abundance values compared with other surveys. The Marina del Rey abundance average (4631 individuals) and range (241 to 32,760 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]	1130	11010	2266	6718	647	1412	478	803	241	1074	527	32760	1142
No. Species	43	77	62	70	38	31	18	30	23	21	28	68	53
Diversity (SWI)	1.24	1.63	1.55	1.60	2.28	2.11	1.73	2.26	2.42	1.30	1.84	1.32	2.43
Infaunal Index	57.8	64.2	62.9	71.6	71.1	72.3	68.2	69.3	65.0	63.7	68.4	61.9	71.8
Dominance	0.22	0.36	0.33	0.31	0.48	0.46	0.33	0.52	0.65	0.25	0.55	0.31	0.53

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

TABLE 6-2. RANGES OF INDIVIDUALS, SPECIES, AND DIVERSITY - OCTOBER 1976 THROUGH SEPTEMBER 1998.

	POPULATION INDICES				
DATE	Individuals	Species	Diversity	Infaunal Index	Dominance
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	26.5 - 70.6	0.12 - 0.71
Oct-97	109 - 4818	20 - 88	0.98 - 2.81	29.6 - 77.1	0.13 - 0.70
Overall Range	**36 - 105,390**	**9 - 121**	**0.44 - 3.09**	**26.5 - 77.1**	**0.12 - 0.71**
Sep-98	241 - 32,760	18 - 77	1.24 - 2.43	57.8 - 72.3	0.22 - 0.65

[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	**4631**	**241 - 32,760**	105	5 - 330	422	91- 1213	348
No. Species	**43**	**18 - 77**	35	5 - 64	72	32 - 135	68
Diversity (SWI)	**1.82**	**1.24 - 2.43**	2.92	1.59 - 3.72	3.12	2.19 - 3.98	-
Infaunal Index	**66.8**	**57.8 - 72.3**	73.6	66.7 - 83.3	87.9	59.9 - 98.3	-

6.3.1.2. **Infaunal Species**

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

Spatial infaunal species patterns. Species counts at the 13 sediment-sampling stations ranged from 18 to 77 per grab (Table 6-1 and Figure 6-2). Lowest species numbers were in Basin H (Station 7 - 18 species), Basin E (Station 10 - 21 species), and Basin F (Station 9 – 23 species). Highest values were in the lower part of the channel (Stations 2, 4, and 12 - 69 to 77 species per grab).

Infaunal species patterns compared with past years. Table 6-2 lists the ranges of species collected per station since 1976. The range of species collected during 1998 was 18 to 77, which falls well within the overall range of values for past surveys and is similar to counts made in 1996 and 1997.

Infaunal species values compared with other surveys. The Marina del Rey species count average (43 species) and range (18 to 77 species) were comparable to Los Angeles Harbor (35 species, 5 to 64 species), 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 1.24 to 2.43 (Table 6-1 and Figure 6-3). Lowest diversity values were near Ballona Creek (Stations 1 and 12 – 1.24 and 1.32, respectively) and in Basin E (Station 10 – 1.30). Highest values were at Station 25 in the main channel (2.43) and at Station 9 in Basin F (2.42).

Infaunal diversity patterns compared with past years. Table 6-2 lists the ranges of diversity values calculated per station since 1984. The range of values during 1998 was 1.24 to 2.43, which falls well within the overall range of values for past surveys. Values were similar to the past two years. Diversity indices had not been calculated previous to 1996. Diversity values had not been calculated previous to 1996.

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

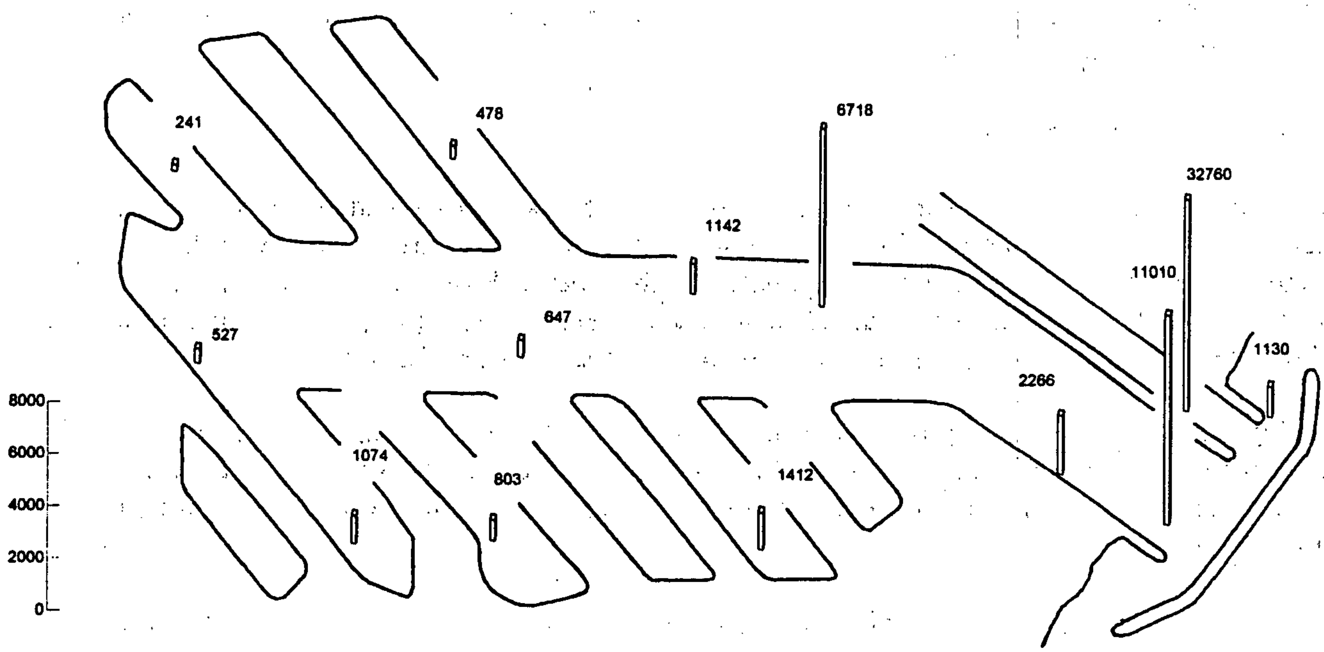
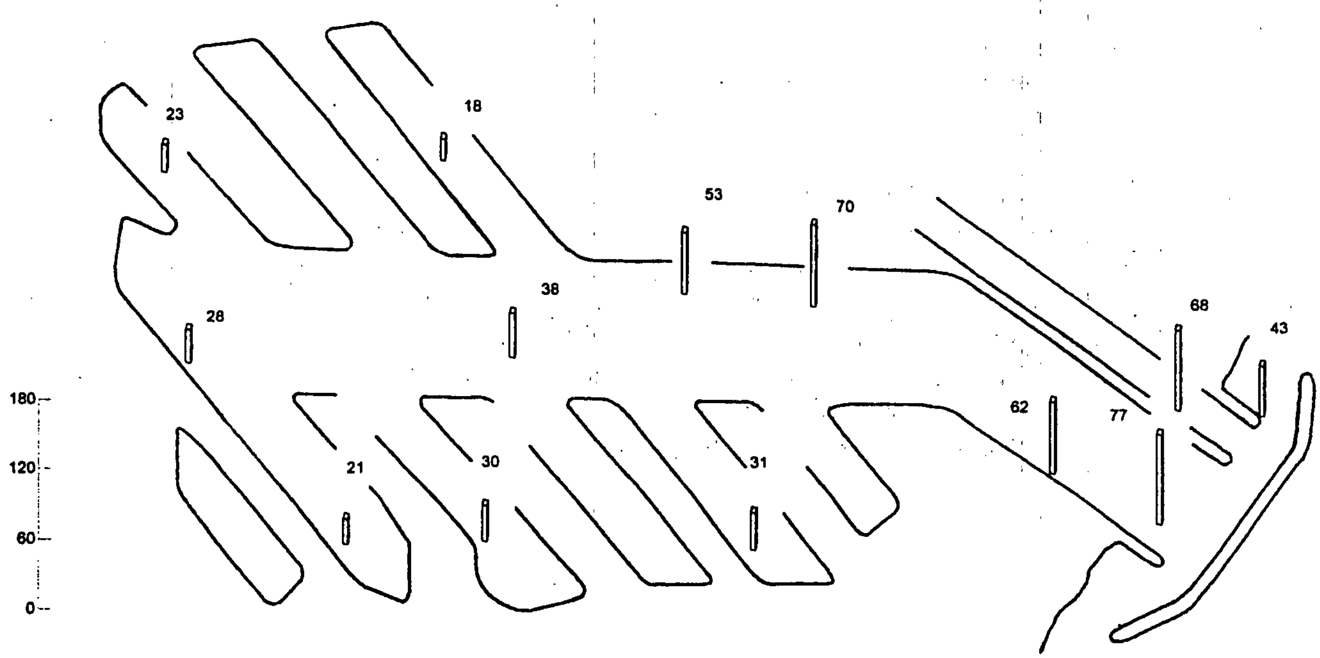


FIGURE 6-2. NUMBER OF INFAUNAL SPECIES AT 13 BENTHIC SEDIMENT STATIONS.



Infaunal diversity values compared with other surveys. The Marina del Rey diversity average (1.82) and range (1.24 to 2.43) were lower than Los Angeles Harbor (2.92, 1.59 to 3.72) and the 979 SCCWRP Reference Site Survey (3.12, 2.19 to 3.98). No diversity values were calculated in the 1987 SCCWRP Survey (Table 6-3).

6.3.1.4. Infaunal Dominance

The community dominance index measures to what degree the two most abundant species in each sample dominate (McNaughton 1968). The authors have modified the index so that when the top two species strongly dominate the sample population, the index is lower, and when they are less dominant the index is higher. The infaunal environment 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 0.22 to 0.65 (Table 6-1 and Figure 6-4). The lowest dominance values were near the Harbor entrance (Station 1 - 0.22) and in Basin E (Station 10 – 0.25). The highest value was in Basin F (Station 9 - 0.65).

Infaunal dominance patterns compared with past years. The dominance range (0.22 to 0.65) was similar to those of the past two years (Table 6-2). 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 INDEX (SWI) AT 13 BENTHIC SEDIMENT STATIONS.

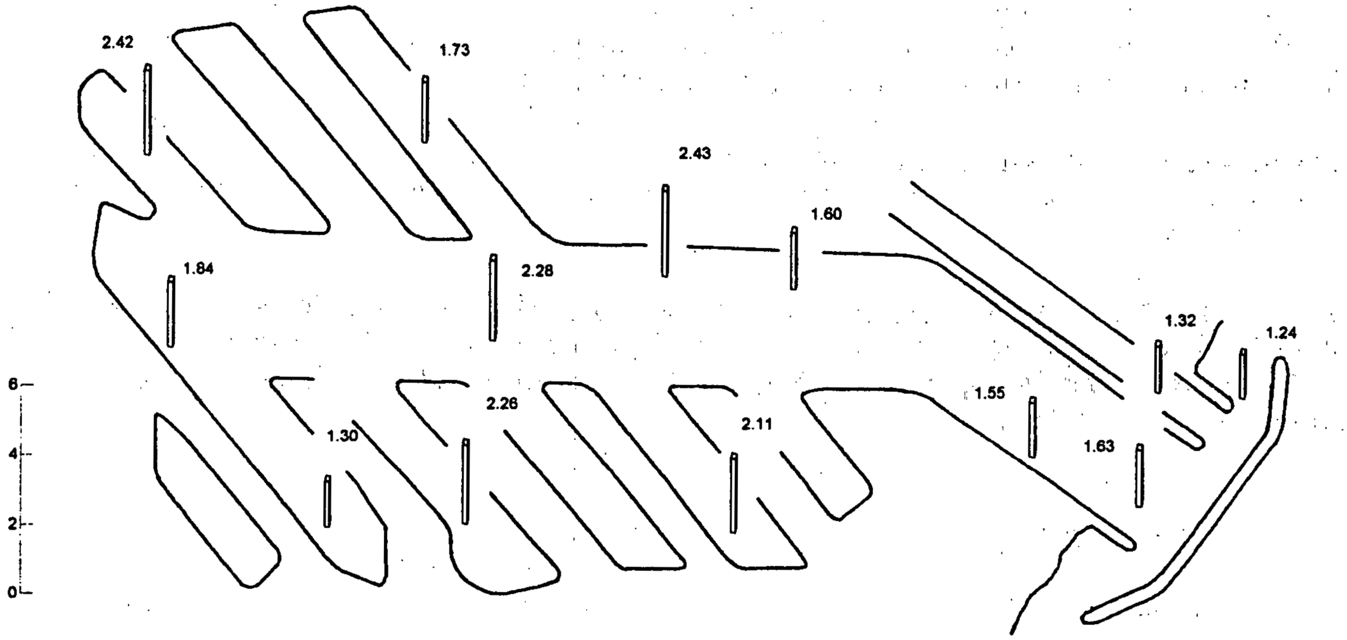
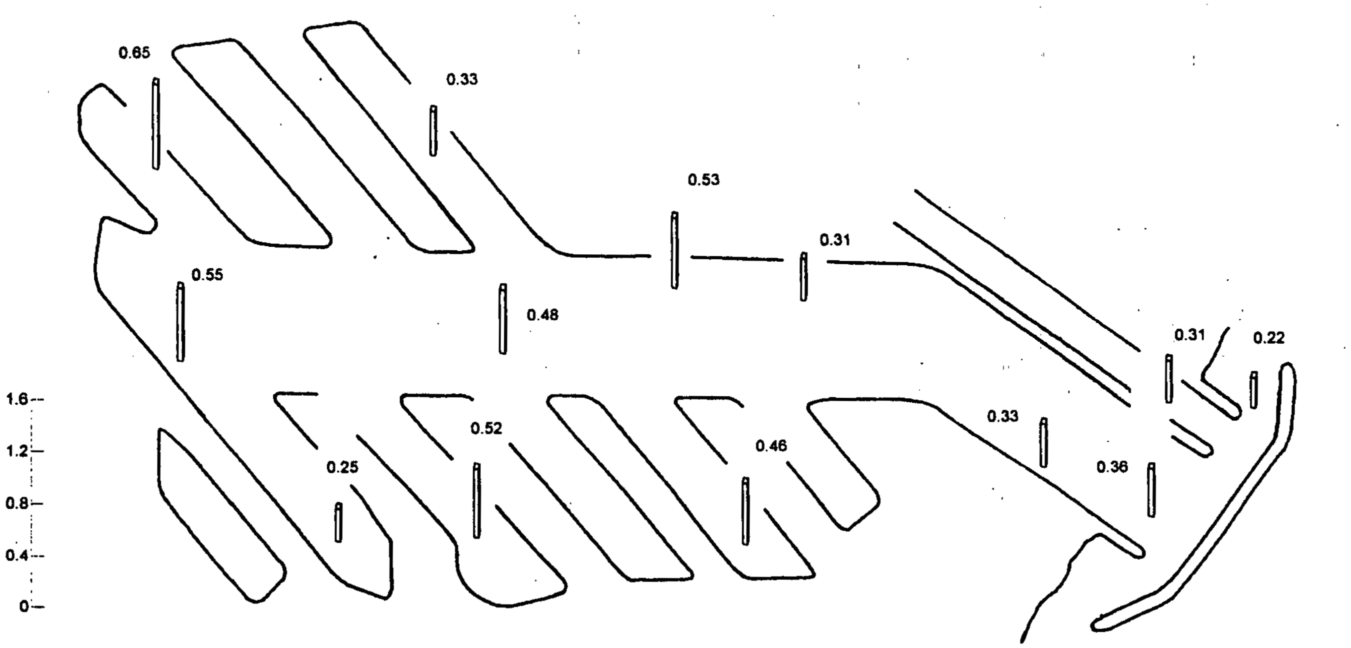


FIGURE 6-4. INFAUNAL DOMINANCE INDEX AT 13 BENTHIC SEDIMENT STATIONS.



Spatial infaunal trophic index patterns. Infaunal trophic index values at the 13 sampling stations ranged from 57.8 to 72.3 (Table 6-1 and Figure 6-5). The lowest infaunal index value (52) was at Station 1 near the Harbor entrance. This value is classified as a "changed" benthic station. All remaining stations had index values (62 to 72) defined as "normal". The highest values were at Station 6 in Basin B and Stations 4 and 25 in midchannel (all 72).

Infaunal trophic index patterns compared with past years. The infaunal index range (58 to 72) was well within the range of the past two years. 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 (67) and range (58 to 72) were lower than Los Angeles Harbor (74, 67 to 83) and the 1979 SCCWRP Reference Site Survey (88, 60 to 98). No infaunal index values were calculated for the 1987 SCCWRP Survey (Table 6-3).

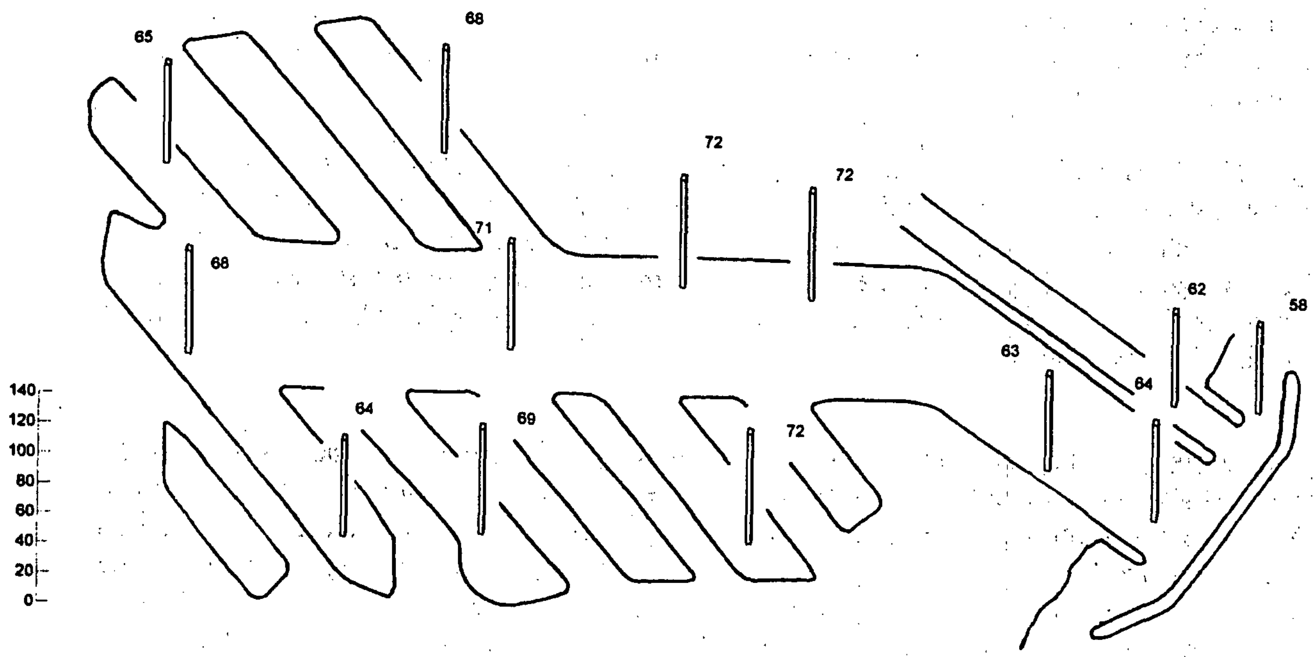
6.3.2. Station Groupings Based on Infaunal Measurements

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 1, 3, 10, and 12. These Stations are located near the Harbor entrance and within Basin E. They are all influenced by runoff of one kind or another: Station 10 by Oxford Lagoon flows, Stations 1 and 12 by Ballona Creek flows, and Station 3 by flows from Venice Canal. Low diversity, infaunal index, and dominance values characterize this group of stations. Among the ten most abundant species, eight were polychaete worms, one was a nematode worm, and one was an oligochaete worm. The nematode worms, the oligochaete worms, and two other species of polychaete worms (*Armandia brevis* and *Dorvillea rudolphi*) are all known to be associated with disturbed benthic environments, thus, infaunal index values at these stations (58 to 64) were generally low.

Stations 5, 7, 8, 9, and 11. This cluster includes the upper main channel and Basins D, F, and H. This group was high in diversity and dominance, low in numbers of individuals and species. Of the ten most abundant species, eight were polychaetes and two were crustaceans. None of these species were indicative of a stressed community, so infaunal index values were relatively high (68 to 71). This area appears to be moderate in infaunal health.

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



Station 6. This station in Basin B is characterized by a high infaunal index value. Of the ten most abundant species, nine were polychaetes and one was a crustacean. No surface or subsurface deposit feeders were among the most frequent ten species, and so the infaunal trophic index value at this station was high (72) and "normal". This area represents a relatively healthy benthic environment.

Station 25. This station is located in the main channel near the administration docks. High diversity, infaunal index, and dominance values characterize this station. Of the ten most abundant species, seven were polychaetes, two were crustaceans, and one was a bivalve. No surface or subsurface deposit feeders were among the most frequent ten species, and so the infaunal trophic index value at this station was high (72) and "normal". This area represents a healthy benthic environment.

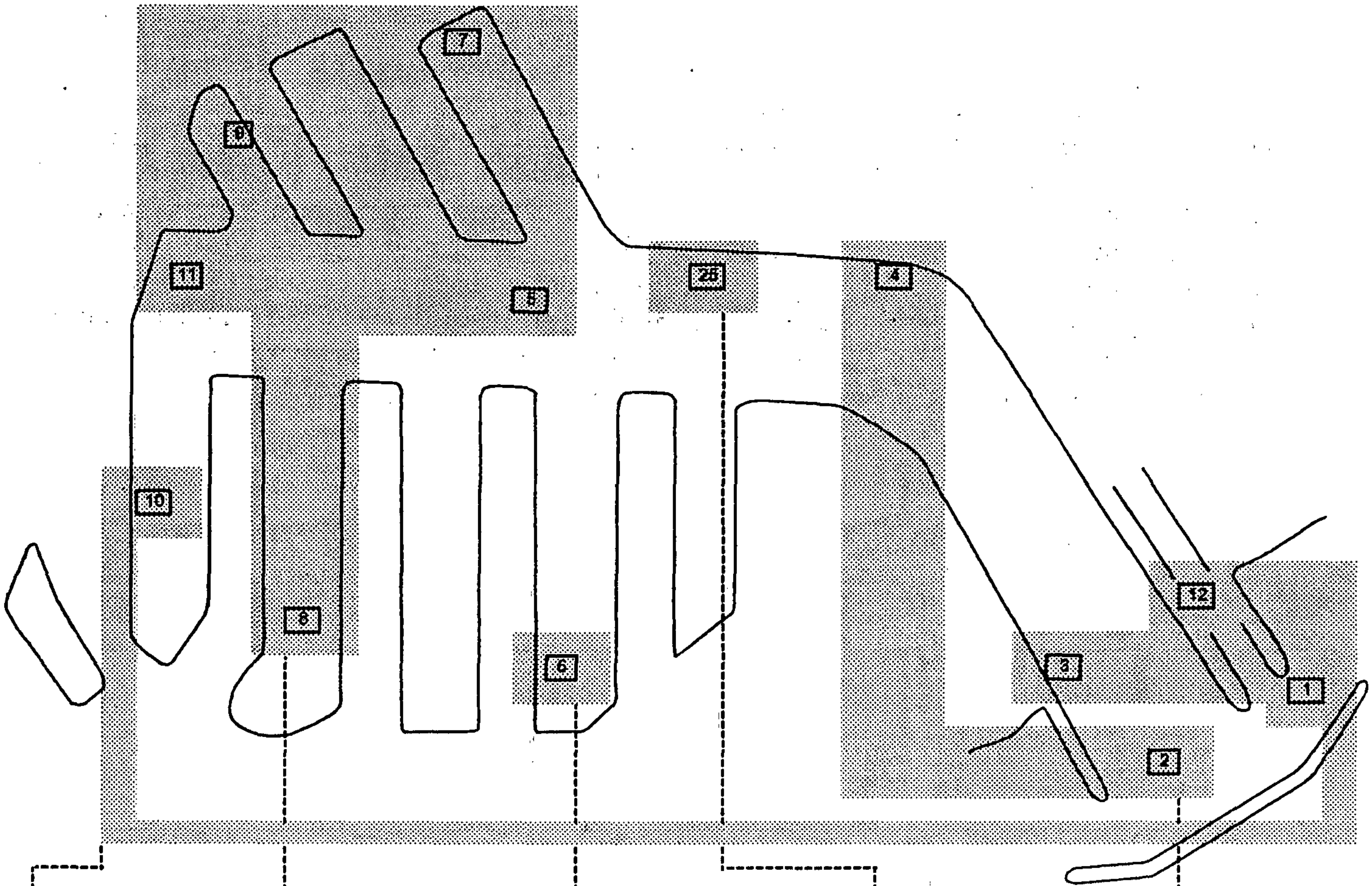
Stations 2 and 4. These stations include one at midchannel and one near the entrance to the Harbor. High counts of both individuals and species represent this station. Of the ten most abundant species, seven were polychaetes, two were bivalves, one was a crustacean, and one was a nematode worm. Two of the ten species (nematodes and *Armandia brevis*) are known to be associated with stressed benthic environments. Infaunal index values at Station 4 were relatively high (72), but values for Station 2 were somewhat lower (64). Both are defined as "normal", however. This area represents a moderately healthy benthic environment.

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 1 and 12). In addition for the first time this 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 habitats near wastewater outfall diffusers, or are otherwise known to be present in disturbed habitats. These stations tended to show the greatest evidence of stress in the Harbor. Of particular note is the sample from Station 12, which had nearly 10,000 nematode worms, a group associated with stressful benthic environments.

With the exception of Station 10 discussed above, stations further back in the Harbor (5, 7, 8, 9, and 11) yielded mixed results. While high as a group in diversity and dominance, they were low in individuals and species. Somewhat similarly, Station 4 in midchannel and Station 2 had high counts of individuals and species, but also tended to have relatively high ratios of nematode worms. These areas appear to be of moderate infaunal health. The remaining two stations (6 and 25) appeared to be the healthiest in the Harbor.

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



Stations 1,3,12

High in:
--
--
--

Low in:
Diversity
Infaunal Index
Dominance

Dominants:
Mediomastus sp. (p)
Nematoda (n)*
Pseudopolydora paucibranchiata (p)
Armandia brevis (p)*
Prionospio heterobranchiata (p)
Dorvillea rudolphi (p)*
Apoprionospio pygmaea (p)
Notomastus sp. 1 (Phillips) (p)
Oligochaeta (o)*
Exogone dwisula (p)

Characteristics:
Relatively poor health with some high nematode counts. Indicates considerable stress.

Station 5,7,8,9,11

High in:
Diversity
Dominance
--

Low in:
Individuals
Species
--

Dominants:
Mediomastus sp. (p)
Pseudopolydora paucibranchiata (p)
Euchone limnicola (p)
Exogone dwisula (p)
Leitoscoloplos pugettensis (p)
Prionospio heterobranchiata (p)
Aphelochaeta spp. (p)
Lumbrineris sp. C (Harris) (p)
Mayerella banksia (c)
Grandidierella japonica (c)

Characteristics:
Moderate health.

Station 6

High in:
Infaunal Index
--
--

Low in:
--
--
--

Dominants:
Pseudopolydora paucibranchiata (p)
Euchone limnicola (p)
Aphelochaeta spp. (p)
Leitoscoloplos pugettensis (p)
Exogone dwisula (p)
Mediomastus sp. (p)
Polydora cornuta (p)
Mayerella banksia (c)
Prionospio heterobranchiata (p)
Lumbrineris sp. C (Harris) (p)

Characteristics:
Relatively healthy group.

Station 25

High in:
Diversity
Infaunal Index
Dominance

Low in:
--
--
--

Dominants:
Mediomastus sp. (p)
Pseudopolydora paucibranchiata (p)
Euchone limnicola (p)
Exogone dwisula (p)
Aphelochaeta spp. (p)
Prionospio heterobranchiata (p)
Lumbrineris sp. C (Harris) (p)
Theora lubrica (b)
Bathyleberis sp. (c)
Mayerella banksia (c)

Characteristics:
Generally healthy group.

Station 2,4

High in:
Individuals
Species
--

Low in:
--
--
--

Dominants:
Mediomastus sp. (p)
Pseudopolydora paucibranchiata (p)
Exogone dwisula (p)
Prionospio heterobranchiata (p)
Nematoda (n)*
Tellina carpinteri (b)
Mayerella banksia (c)
Tagelus subteres (b)
Lumbrineris sp. C (Harris) (p)
Armandia brevis (p)*

Characteristics:
Relatively healthy, but some stations have a high ratio of nematodes.

(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, both numbers of individuals and species were higher in Marina del Rey, however, diversity and infaunal trophic index values were lower. Higher diversity and infaunal index patterns in Los Angeles Harbor may be related to the fact that flow patterns there are much less restricted since there are two entrances to the Harbor instead of only one as in Marina del Rey. All population variables this year were comparable to past results.

7. FISH POPULATIONS

7.1. BACKGROUND

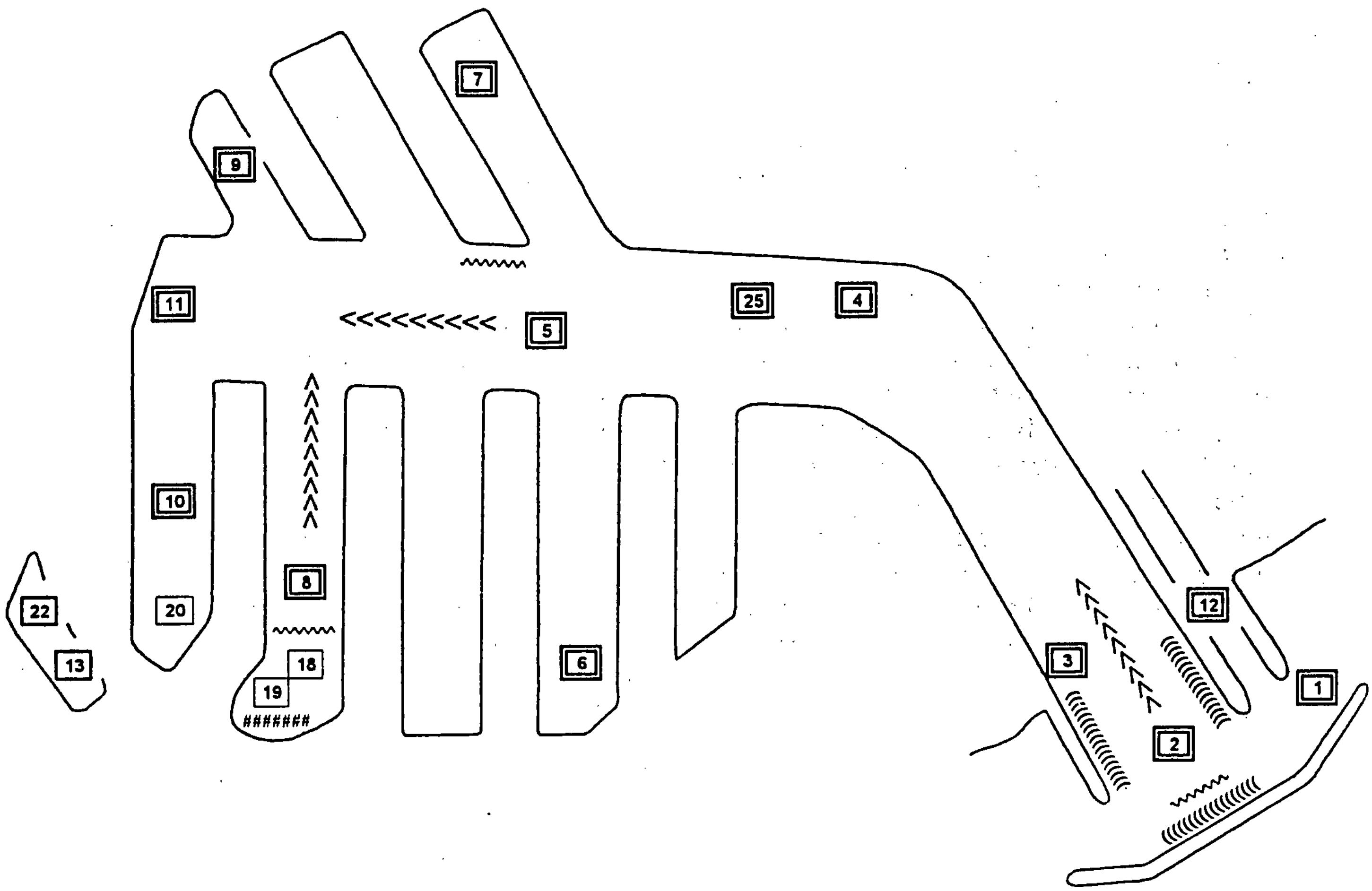
Marina del Rey functions as important small wetlands in a southern California area where about ninety percent of the wetlands have been lost due to development. While the original configuration of the Ballona wetlands was a large natural estuarine system, it was altered radically by the channelization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

7.2. MATERIALS AND METHODS

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

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



Water Quality Stations only

Water Quality and Sediment Chemistry Stations

Water Quality, Sediment Chemistry, and Benthic Infauna Stations

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

Midwater Fish by Gill Net

Reef Fish by Diver Transect

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

Eggs and larvae (ichthyoplankton) were collected (Stations 2, 5, 8) using a 333 um mesh plankton net at 1.0 m depth for two minutes and near the bottom for three minutes. A benthic sled kept the net just above the bottom. For all groups of fishes; numbers of animals, numbers of species, and species diversity 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 the 110 different species, six were present in all of the 30 surveys: topsmelt (*Atherinops affinis*), black surfperch (*Embiotoca jacksoni*), opaleye (*Girella nigricans*), a genus of larval blennies (*Hypsoblennius spp.*), kelp bass (*Paralabrax clathratus*), and barred sand bass (*Paralabrax nebulifer*). Another ten species also occurred frequently (more than 24 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*), 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. <u>Bottom Fish</u>

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

7.3.1.1. **Bottom Fish Abundance**

<u>Spatial bottom fish abundance patterns.</u> Numbers of bottom fish collected at the three sampling stations are listed in Table 7-2. The largest haul was in the spring at Station 8 in Basin D (75 individuals). The poorest catch was at both Stations 2 and 5 (in the main channel) in the spring (both 18 individuals). Total counts in the fall (122 individuals) were larger than those in the spring (111).

TABLE 7-1. INCIDENCE OF FISH SPECIES AND LARVAL TAXA COLLECTED DURING SPRING (Sp) AND FALL (Fl) IN MARINA DEL REY HARBOR - 1984 TO 1999

		84		85		86		87		88		89		90		91		92*		93		94		95		96		97		98			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	Sp	Fl	Tot.
Acanthogobius flavimanus	Yellowfin Goby						x		x	x	x	x								x	x	x				x		x	x				6	5	11
Albula vulpes	Bonefish	x								x								x	x		x								x	x	x	x	5	4	9
Anchoa compressa	Deepbody Anchovy	x			x	x		x			x									x		x		x	x	x	x	x	x	x			9	5	14
Anchoa delicatissima	Slough Anchovy								x																		x	x		x	x	x	3	3	6
Anchoa sp.	Anchovy																											x				x	2	0	2
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	12	11	23
Atherinidae	Silverside																													x			1	0	1
Atherinops affinis	Topsmelt	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	15	30
Atherinopsis californiensis	Jacksmelt					x	x	x	x			x										x	x			x	x	x		x		x	8	4	12
Atractoscion nobilis	White Seabass	x				x	x	x									x												x		x		3	4	7
Brachyistius frenatus	Kelp Surfperch																	x															1	0	1
Bryx arctus	Snubnose Pipefish																										x						0	1	1
Cheilotrema saturnum	Black Croaker		x		x	x	x	x	x	x	x	x	x	x		x	x		x				x			x			x		x		7	11	18
Chitonotus pugetensis	Roughback Sculpin										x																						0	1	1
Chromis punctipinnis	Blacksmith		x		x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	11	14	25
Citharichthys sp.	Sandab Egg																																0	0	0
Citharichthys stigmaeus	Speckled Sandab	x						x					x												x	x	x	x	x			x	5	4	9
Citharichthys Type A	Sandab Larvae	x						x														x		x		x	x	x			x	x	7	2	9
Clevlandia ios	Arrow Goby	x				x	x	x		x			x		x									x		x		x	x	x			8	4	12
Clinocottus analis	Wooly Sculpin	x			x		x			x	x	x				x							x										4	4	8
Coryphopterus nichosii	Blackeye Goby							x				x								x													3	0	3
Cymatogaster aggregata	Shiner Surfperch		x			x		x				x	x	x	x	x		x	x	x		x		x		x		x		x		x	13	4	17
Damalichthys vacca	Pile Surfperch	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x				x			12	11	23
Embiotoca jacksoni	Black Surfperch	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	15	30
Engraulidae	Anchovy																										x	x					1	1	2
Engraulis mordax	Northern Anchovy	x	x			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x			14	11	25
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	11	12	23
Genyonemus lineatus	White Croaker	x			x	x		x	x		x	x		x		x	x			x		x		x		x	x	x	x	x		x	13	6	19
Gibbonsia elegans	Spotted Kelpfish	x			x		x		x			x	x	x	x	x	x		x			x	x		x	x					x	x	7	10	17
Gillichthys mirabilis	Longjaw Mudsucker						x									x			x			x								x			3	2	5
Girella nigricans	Opaleye	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	15	30
Gobiesox rhessodon	California Clingfish				x	x		x				x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x	13	7	20
Gobiedae A/C	Goby		x		x		x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			10	14	24
Gobiedae D	Goby																														x	x	1	1	2
Gobiedae non A/C	Goby																						x								x	x	1	2	3
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	14	14	28
Hermosilla azurea	Zebraperch		x		x		x				x	x			x			x		x	x	x	x			x	x	x	x	x	x	x	8	10	18
Heterodontus francisci	Horn Shark	x	x									x		x		x																	4	1	5
Heterostichus rostratus	Giant Kelpfish	x			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x			x	x	x	x		x	x	13	12	25
Hippoglossina stomata	Bigmouth Sole					x													x														1	1	2
Hyperprosopon argenteum	Walleye Surfperch		x			x											x																1	2	3
Hypsoblennius spp.	Blenny	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15	15	30
Hypsoblennius gentilis	Bay Blenny				x	x	x		x																								1	3	4
Hypsoblennius gilberti	Rockpool Blenny						x														x								x		x	x	1	4	5
Hypsoblennius jenkinsi	Mussel Blenny	x	x					x		x		x									x		x				x						4	4	8
Hypsopsetta guttulata	Diamond Turbot	x	x				x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	13	12	25
Hypsurus caryi	Rainbow Surfperch															x		x		x				x									4	0	4
Hypsypops rubicundus	Garibaldi	x	x		x		x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	14	13	27
Ilypnus gilberti	Cheekspot Goby	x	x			x	x	x		x				x	x	x												x					7	3	10
Kyphosidae	Zebraperch																						x										0	1	1
Lepidogobius lepidus	Bay Goby	x	x		x	x			x		x						x	x								x					x	x	5	6	11
Leptocottus armatus	Staghorn Sculpin					x	x	x		x		x	x	x		x	x	x	x				x			x	x	x					9	6	15
Leuresthes tenuis	California Grunion																											x		x			2	0	2
Medialuna californiensis	Halfmoon								x																				x	x	x		1	3	4
Menticirrhus undulatus	California Corbina					x	x		x	x		x				x						x		x				x		x	x	x	9	3	12
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	13	13	26
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	9	12	21
Mustelus californicus	Gray Smoothound																x	x							x								1	2	3
Mustelus henlei	Brown Smoothound								x															x				x			x	x	3	2	5
Mustelus sp.	Smoothound																	x															1	0	1
Myliobatis californica	Bat Ray					x	x	x	x		x	x	x	x		x	x	x	x	x			x	x		x	x	x	x	x	x	x	12	10	22
Oligocottus/Clinocottus A	Sculpin												x				x																0	2	2
Oxyjulis californica	Senorita	x	x		x	x		x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	13	13	26
Oxylebius pictus	Painted Greenling				x									x																			1	1	2
Paraclinus integripinnis	Reef Finspot						x					x		x	x							x	x	x		x	x	x	x				6	5	11
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	15	15	30

TABLE 7-1. (CONTINUED)

Paralabrax maculatofasciatus	Spotted Sand	x	x		x	x	x	x	x			x	x	x	x	x		x													x	x	8	7	15
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	15	15	30
Paralabrax sp.	Sea Bass																										x	x					1	1	2
Paralichthys californicus	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	13	15	28
Perciformes	Perch																										x						0	1	1
Phanerodon furcatus	White Surfperch					x			x		x	x		x		x	x			x			x			x		x		x		x	9	4	13
Pleuronectidae**	Flatfish																				x		x			x		x	x				2	3	5
Pleuronichthys coenosus	C-O Turbot				x				x																								0	2	2
Pleuronichthys ritteri	Spotted Turbot	x			x		x	x	x	x	x	x	x		x	x		x		x	x	x	x	x	x	x	x	x	x	x		x	13	11	24
Pleuronichthys verticalis	Hornyhead Turbot					x			x					x		x											x	x			x	x	5	3	8
Porichthys myriaster	Specklefin Midshipman																															x	1	0	1
Quietula y-cauda	Shadow Goby	x				x	x	x		x		x	x	x		x												x	x				8	3	11
Raja binoculata	Big Skate																											x					1	0	1
Rhacochilus toxotes	Rubberlip Surfperch		x						x		x			x	x	x				x											x	x	4	5	9
Rhinobatos productus	Shovelnose Guitarfish	x																															1	0	1
Sarda chilensis	Pacific Bonito	x	x				x		x																								1	3	4
Sardinops sagax caeruleus	Pacific Sardine	x	x		x	x	x	x	x	x		x			x	x		x	x	x		x	x						x		x	x	10	9	19
Scaenidae	Croaker																																0	0	0
Scaenidae complex 2	Croaker							x			x			x														x			x		3	2	5
Scomberomorus sierra	Pacific Sierra																													x	x		1	1	2
Scorpaena guttata	Spotted Scorpionfish					x						x						x			x	x								x	x		5	2	7
Scorpaenichthys marmoratus	Cabezon	x										x	x			x																	3	1	4
Sebastes auriculatus	Brown Rockfish	x																															1	0	1
Sebastes serranoides	Olive Rockfish	x			x	x			x	x	x		x			x																	4	4	8
Semicossyphus pulcher	California Sheepshead								x		x																						0	2	2
Seriphus politus	Queenfish	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x		x		x	x			x	x		13	10	23
Sphyraena argentea	California Barracuda		x		x	x			x	x				x	x					x							x				x		4	6	10
Squatina californica	Pacific Angel Shark				x																										x	x	1	2	3
Stenobrachius leucopsaura	Northern Lampfish					x									x																		1	1	2
Strongylura exilis	California Needlefish		x			x		x			x		x	x	x		x	x		x	x	x	x	x		x	x		x		x		8	10	18
Symphurus atricauda	California Tonguefish		x																								x		x			x	1	3	4
Sygnathus auliscus	Barred Pipefish				x									x		x															x		2	2	4
Sygnathus leptorhynchus	Bay Pipefish	x						x	x			x			x																x	x	4	3	7
Synodus lucioceps	California Lizardfish										x																						0	1	1
Triakis semifaciata	Leopard Shark																											x					1	0	1
Type 32	Fish Larvae																											x	x	x			2	1	3
Type 71	Fish Larvae																												x	x	x	x	2	2	4
Typhlogobius californiensis	Blind Goby	x				x								x				x		x				x									6	0	6
Umbrina roncador	Yellowfin Croaker	x	x		x		x	x	x		x							x	x	x		x		x	x	x	x	x		x	x	x	10	9	19
Unidentified egg	Unidentified Egg																										x	x	x	x			2	2	4
Unidentified larvae	Unidentifed Larvae																											x			x	x	2	1	3
Urolophus halleri	Round Stingray	x					x	x		x		x				x	x	x		x				x		x		x		x		x	12	2	14
Xenistius californiensis	Salema		x						x				x		x						x		x				x		x		x	x	1	9	10
Xystreurys liolepis	Fantail Sole	x									x						x								x								1	3	4

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

** Unidentifiable turbot larvae.

At Station 2 near the breakwall, barred sand bass (*Paralabrax nebulifer* - 5 individuals) was the most common fish collected in the fall, and barred sand bass, speckled sandab (*Citharichthys stigmaeus*), and California halibut (*Paralichthys californicus*) were most frequent in the spring (4 individuals each). At Station 5 in the main channel, shiner surfperch (*Cymatogaster aggregata*) was most common both in the fall (14 individuals) and in the spring (6 individuals). At Station 8 in Basin D, slough anchovy (*Anchoa delicatissima*) and barred sand bass (both 3 individuals) dominated the fall trawls, and in the spring, slough anchovy were again most common.

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 September 1998 ranged from 21 to 62 per station, which fell well within the overall range of values for past fall surveys. Spring counts ranged between 18 and 75 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 2 near the breakwall in September (11 species). The lowest species count was at Station 5 in the main channel during the fall (5 species). Total species counts in the fall (17 species) were considerably larger than those in the spring (10).

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 September of 1998 ranged from 5 to 11 species per station, which is slightly higher than past ranges. The spring range of species counts (6 to 8) was more typical. New trawl fish this year was specklefin midshipman (*Porichthys myriaster*).

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 8 in Basin D in September (1.95). Lowest diversity was at the same station in May (0.68). Averaged among stations, diversity in the fall (1.74) was higher than in the spring (1.41).

Bottom fish diversity patterns compared with past years. Species diversity values ranged from 1.44 to 1.84 in the fall and from 0.68 to 1.89 in the spring (Table 7-6). Fall values were typical; however, the spring minimum was the lowest recorded (note that species diversity calculations had not been performed previous to 1997).

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

SCIENTIFIC NAME	COMMON NAME	SEPTEMBER 1998 SAMPLING STATIONS 2	5	8	MAY 1999 SAMPLING STATIONS 2	5	8
Bottom Fish							
Albula vulpes	Bonefish			1		3	
Anchoa delicatissima	Slough Anchovy		4	3		5	63
Citharichthys stigmaeus	Speckled Sandab				4		
Cymatogaster aggregata	Shiner Surfperch	9	14		1	6	
Genyonemus lineatus	White Croaker	1					
Hypsopsetta guttulata	Diamond Turbot	3			1	1	2
Lepidogobius lepidus	Bay Goby			1			
Myliobatus californica	Bat Ray	2		2	1	1	4
Paralabrax clathratus	Kelp Bass	3			1		
Paralabrax nebulifer	Barred Sand Bass	26	9	3	4	1	1
Paralichthys californicus	California Halibut	5	10	2	4	1	2
Pleuronichthys ritteri	Spotted Turbot	9	2				
Porichthys myriaster	Specklefin Midshipman	2					
Sardinops sagax	Pacific Sardine			1			
Seriphus politus	Queenfish			1			
Squatina californica	Pacific Angel Shark	1					
Sygnathus leptorhynchus	Bay Pipefish				2		
Symphurus atricauda	California Tonguefish	1					
Umbrina roncador	Yellowfin Croaker			7			3
	Individuals	**62**	**39**	**21**	**18**	**18**	**75**
	Species	**11**	**5**	**9**	**8**	**7**	**6**
	Diversity	**1.84**	**1.44**	**1.95**	**1.89**	**1.66**	**0.68**
Midwater Fish							
Albula vulpes	Bonefish			1			
Anchoa delicatissima	Slough Anchovy		3				1
Atherinops affinis	Topsmelt		1	10		37	345
Atherinopsis californiensis	Jacksmelt						1
Atractoscion nobilis	White Seabass	1					
Menticirrhus undulatus	California Corbina	1			11		
Mustelus henlei	Brown Smoothound						1
Sardinops sagax	Pacific Sardine					5	23
Sphyraena argentea	California Barracuda	2					
Urolophus halleri	Round Stingray						2
	Individuals	**4**	**4**	**11**	**11**	**42**	**373**
	Species	**3**	**2**	**2**	**1**	**2**	**6**
	Diversity	**1.04**	**0.56**	**0.30**	**0.00**	**0.37**	**0.32**

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

SCIENTIFIC NAME	COMMON NAME	SEPTEMBER 1998 SAMPLING STATIONS North Jetty	Breakwall	South Jetty	MAY 1999 SAMPLING STATIONS North Jetty	Breakwall	South Jetty
Reef Species							
Anchoa delicatissima	Slough Anchovy	1					
Anisotremus davidsonii	Sargo		5	5			
Atherinops affinis	Topsmelt	5	300	30		13	55
Cheilotrema saturnum	Black Croaker			1			
Chromis punctipinnis	Blacksmith			21		10	
Embiotoca jacksoni	Black Surfperch	3	13	10		14	50
Gibbonsia elegans	Spotted Kelpfish			1			1
Girella nigricans	Opaleye	88	50	10	17	34	29
Halichoeres semicinctus	Rock Wrasse			2		9	
Hermosilla azurea	Zebraperch	31	23	2	2		
Heterostichus rostratus	Giant Kelpfish			1		3	
Hypsoblennius gilberti	Rockpool Blenny	1					
Hypsopsetta guttulata	Diamond Turbot				1		
Hypsypops rubicundus	Garibaldi		19	2		7	
Medialuna californiensis	Halfmoon		1				
Micrometrus minimus	Dwarf Surfperch	11	12				2
Oxyjulis californica	Senorita						2
Paralabrax clathratus	Kelp Bass		46	14		33	4
Paralabrax nebulifer	Barred Sand Bass	1	40	42		18	12
Rhacochilus toxotes	Rubberlip Surfperch		3			2	8
Umbrina roncador	Yellowfin Croaker	3			1		
Xenistius californiensis	Salema	1		72			
	Individuals	**145**	**512**	**213**	**21**	**143**	**163**
	Species	**10**	**11**	**14**	**4**	**10**	**9**
	Diversity	**1.24**	**1.49**	**1.95**	**0.69**	**2.03**	**1.61**

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).

7.3.2.1. **Midwater Fish Abundance**

Spatial midwater fish abundance patterns. Numbers of midwater fish collected at the three gill net sampling stations are listed in Table 7-2. The most fish, by far, were captured at Station 8 in Basin D in May (373 individuals). Remaining catches were low to moderate (4 to 42 individuals per cast). Total counts in May (426 individuals) were much larger than those in October (19).

At Station 2 near the breakwall, only barracuda (*Sphyraena argentea*) were collected more frequently than once (2 individuals) in the fall. In the spring, only California corbina were captured at this station (11 individuals). Slough anchovy (*Anchoa delicatissima*) were most commonly caught at Station 5 in the main channel in the fall, and topsmelt (*Atherinops affinis*) were most commonly taken in the spring (37 individuals). At Station 8 in Basin D, topsmelt dominated both fall and spring catches (10 and 345 individuals, respectively).

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 September of 1998 ranged from 4 to 1 individuals per station, which was fairly typical of fall surveys. The spring range of individuals (11 to 373) was much higher due to one very large catch of topsmelt.

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. Highest species counts were at Station 8 in Basin D in the spring (6 species), and lowest counts were at Station 2 near the breakwall in spring (1 species). Total species counts were similar between fall (6 species) and spring (7 species).

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 (2 to 3 species) and spring (1 to 6 species) were low but typical of these passive gill net catches. No new fish species were captured in gill nets this year.

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. Highest species diversity (Table 7-6) was at Station 2 near the breakwall in fall (1.04), and lowest diversity was at Station 2 in Basin D in spring (0.00). Averaged among stations diversity in the fall (0.63) was considerably higher than in the spring (0.23).

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

		SEPT. 1998 SAMPLING STATIONS						MAY 1999 SAMPLING STATIONS					
		2		5		8		2		5		8	
SCIENTIFIC NAME	COMMON NAME	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Larval Fish													
Anchoa sp.	Anchovy									7	9	29	28
Atherinops californiensis	Jacksmelt							15					
Citharichthys type A	Sandab			9					6				6
Engraulidae	Anchovy							8			27	22	56
Engraulis mordax	Northern Anchovy							15	6				
Gillichthys mirabilis	Longjaw mudsucker								6				
Gobiedae type A/C	Goby	50	1125	981	241	112	246	30	83	580	895	202	112
Gobiedae type D	Goby		17										
Gobiesox rhessodon	California Clingfish		17									7	
Hypsoblennius sp.	Blenny	62	86	672	1352	36	87	8	36	513	204	397	236
Hypsopsetta guttulata	Diamond Turbot		25										6
Paraclinus integrippinis	Reef Finspot		25	9						7	4		
Paralichthys californicus	California Halibut												6
Sardinops sagax caeruleus	Pacific Sardine		8										
Sciaenidae	Croaker		17										
Sciaenidae Complex II	Croaker				16								
Seriphus politus	Queenfish		7										
Unidentified	Unidentified			9	5								34
	Individuals	**112**	**1327**	**1680**	**1614**	**148**	**333**	**76**	**137**	**1107**	**1139**	**657**	**484**
	Species	**2**	**9**	**5**	**4**	**2**	**2**	**5**	**5**	**4**	**5**	**5**	**8**
	Diversity	**0.69**	**0.69**	**0.76**	**0.50**	**0.55**	**0.57**	**1.48**	**1.07**	**0.76**	**0.64**	**0.97**	**1.45**
Fish Eggs													
Anchoa compressa	Deepbody Anchovy									804	620	584	303
Anchoa delicatissima	Slough Anchovy	25		1616	707	85	1529	38	24	5082	2397	570	1815
Atherinops affinis	Silverside									7	40		6
Citharichthys sp.	Sandab							661	695	22	18		
Engraulis mordax	Northern Anchovy							821	743				
Pleuronichthys ritteri	Spotted Turbot		17					23	30				
Pleuronichthys verticalis	Horneyhead Turbot							23	54				
Symphuris atricauda	California Tonguefish	37	8	37									
Type 32	—	871			110			8748	4835				
Unidentified	Unidentified	722	463	1663	377	4		821	481	424	137		6
	Individuals	**1655**	**488**	**3316**	**1194**	**89**	**1529**	**11135**	**6862**	**6339**	**3212**	**1154**	**2130**
	Species	**4**	**3**	**3**	**3**	**2**	**1**	**7**	**7**	**5**	**5**	**2**	**4**
	Diversity	**0.85**	**0.23**	**0.75**	**0.89**	**0.18**	**0.00**	**0.79**	**0.99**	**0.65**	**0.75**	**0.69**	**0.45**

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

SCIENTIFIC NAME	COMMON NAME	SEPTEMBER 1998	MAY 1999
Beach Seine Species			
Albula vulpes	Bonefish		16
Anchoa delicatissima	Slough Anchovy	43	10
Anisotremus davidsoni	Sargo	2	1
Atherinops affinis	Topsmelt	1017	1499
Cymatogaster aggregata	Shiner Surfperch		316
Fundulus parvipinnis	California Killifish	5	
Heterostichus rostratus	Giant Kelpfish	5	
Hypsopsetta guttulata	Diamond Turbot		1
Lepidogobius lepidus	Bay Goby		2
Menticirrhus undulatus	California Corbina	1	
Mugil cephalus	Striped Mullet		35
Mustelus henlei	Brown Smoothound	1	
Myliobatis californica	Bat Ray	1	
Paralabrax nebulifer	Barred Sand Bass	1	
Sardinops sagax caeruleus	Pacific Sardine		2
Strongylura exilis	California Needlefish	11	
Sygnathus auliscus	Barred Pipefish	1	
Sygnathus leptorhynchus	Bay Pipefish	3	2
	Individuals	**1091**	**1884**
	Species	**12**	**10**
	Diversity	**0.348**	**0.654**

Midwater fish diversity patterns compared with past years. The range of the species diversity values this year (0.30 to 1.04 in the fall, and 0.00 to 0.37 in the spring) were somewhat similar to the past two years (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.

7.3.3.1. **Inshore Fish Abundance**

Spatial inshore fish abundance patterns. Numbers of inshore fish collected along the shoreline of Mother's Beach (Station 9) are listed in Table 7-5. More fish were captured in the spring (1884 individuals) than in the fall (1091 individuals). Topsmelt (*Atheriops affinis*) dominated both fall (1017 individuals) and spring casts (1499 individuals). Shiner surfperch were also common in May (316 individuals) but absent in the fall. Other fish counts ranged from 1 to 43 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 September and May were typical of past counts.

7.3.3.2. **Inshore Fish Species**

Spatial inshore fish species patterns. Numbers of inshore fish collected at Mothers' Beach are listed in Table 7-5. Slightly more species of fish were collected in the fall (12 species) than in the spring (10 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 September and May are typical of past species counts. No new fish species were collected this year in the beach seine.

7.3.3.3. **Inshore Fish Diversity**

Spatial inshore fish diversity patterns. Species diversity calculated from Mother's Beach are listed in Table 7-5. Species diversity indices during spring (0.65) were somewhat higher than fall measurements (0.35).

Inshore fish diversity patterns compared with past years. The species diversity values this year were somewhat similar to values measured during the past two years. 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 1999

	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
Fall Range	**0 - 415**	**0 - 10**	**0.64 - 2.15**	**0 - 77**	**0 - 3**	**0.00 - 0.69**	**213 - 1791**	**4 - 8**	**0.42 - 0.56**	**1 - 5353**	**1 - 19**	**0.24 - 1.93**
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
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
Spring Range	**1 - 147**	**1 - 13**	**1.48 - 2.01**	**0 - 63**	**0 - 5**	**0.00 - 0.64**	**351 - 8165**	**6 - 11**	**0.42 - 0.42**	**0 - 7267**	**0 - 16**	**0.07 - 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

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
Fall Range	**56 - 16,143**	**1 - 8**	**0.38 - 1.20**	**0 - 12,252**	**1 - 9**	**0.00 - 1.40**
Sep-98	112 - 1680	2 - 9	0.50 - 0.76	89 - 3316	1 - 4	0.00 - 0.89
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**
May-99	76 - 1139	4 - 8	0.64 - 1.48	1154 - 11,135	2 - 7	0.45 - 0.99

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. Swimming together, one diver estimated the number of schooling fish in the water column (i.e. topsmelt), while the other counted demersal fish species. All juvenile and adult fish were counted and identified to species (Figure 7-1).

7.3.4.1. **Reef Fish Abundance**

Spatial bottom fish abundance patterns. Numbers of reef fish counted at the three dive survey stations are listed in Table 7-3. Greatest numbers were counted at the breakwall in the fall (512 individuals), and lowest counts were at the north jetty in the spring (21 individuals). Overall, counts in the fall (870 individuals total) were somewhat higher than those in spring (327 individuals).

At the north jetty, the most common fish counted in both fall and spring were opaleye (*Girella nigricans* – 88 and 17 individuals, respectively). At the breakwall, topsmelt (*Atherinops affinis* - 300) were most common in the fall. In the spring, the breakwall was dominated by opaleye (34) and barred sand bass (*Paralabrax nebulifer* - 33). During fall, the south jetty was dominated by barred sand bass (42), although topsmelt were also common (30). Topsmelt (55) and black surfperch (*Embiotoca jacksoni* - 50) dominated in the spring.

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 September of 1998 ranged from 145 to 514 individuals per station, which falls within the range of autumn surveys. The spring range of individuals per station (21 to 163) 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 the fall at the south jetty (14 species), and the lowest species count was at the north jetty during the spring (4 species). Fall species counts (20 species) were higher than spring counts (15 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 September of 1998 ranged from 10 to 14 species per station, which is typical of past surveys. The spring range of species counts (4 to 10) was also typical. No new fish species were recorded during this year's dive survey.

7.3.4.3. **Reef Fish Diversity**

Spatial reef fish diversity patterns. Species diversity calculated from the three dive survey stations are listed in Table 7-5. Highest species diversity was at the breakwall in the spring (2.03), and lowest diversity was at the north jetty also in the spring (0.69). Overall, average diversity in the fall (1.56) was slightly higher than in the spring (1.44).

Reef fish diversity patterns compared with past years. The range of species diversity values this fall (1.24 to 1.95) and spring (0.69 to 2.03) were somewhat higher than values recorded over the last two 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. 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 on the bottom regardless of irregularities in bottom surface and vessel speed.

7.3.5.1. **Larval Fish Abundance**

Spatial larval fish abundance patterns. Numbers of larval fish captured at the three plankton-sampling stations are listed in Table 7-4. Greatest numbers were collected near the surface in midchannel in the spring (1680 individuals). Poorest catches were at the surface near the breakwall in the spring (76 individuals). Total counts in the spring (3600 individuals) were somewhat smaller those in the fall (5214). As in the past, total surface counts (3780 individuals) were lower than bottom counts (5034). 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.*).

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 September of 1998 ranged from 112 to 1680 individuals, which was typical of past years. The spring range of individuals per station (76 to 1139) was somewhat low.

7.3.5.2. **Larval Fish Species**

Spatial larval fish species patterns. Larval fish species collected at the three plankton-sampling stations are listed in Table 7-4. The highest species count was near the bottom at the breakwall in the fall (9 species), and the lowest was at both depths at Basin D and near the bottom at the breakwall, both in the fall. Overall species collected in the fall (12 species) were about the same as in the spring (8). Average species counts per sample at the surface (4) were smaller than those at the bottom (6).

Larval fish species patterns compared with past years. Table 7-7 lists the ranges of larval fish species counted per station since October 1991. Both fall and spring ranges (2 to 9 and 4 to 8, respectively) were typical of past surveys. New ichthyoplankton collected this year included a new group of larval goby (Gobiedae Type D) and a new group of larval croaker (Scianidae).

7.3.5.3. **Larval Fish Diversity**

Spatial larval fish diversity patterns. Species diversity calculated from the three plankton sampling stations are listed in Table 7-4. Lowest diversity was near the bottom in the main channel in September (0.50), and highest diversity was at the surface near the breakwall in spring (1.48). Averaged among stations, diversity in the spring (1.06) was higher than in the fall (0.63). Average surface and bottom diversities (0.87 and 0.82) were nearly the same.

Larval fish diversity patterns compared with past years. The species diversity ranges this fall (0.50 to 0.76) and spring (0.64 to 1.48) were typical of measurements made during the past two 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. 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 spring (11,135 individuals). Lowest catches were at the surface at Basin D in the fall (89 individuals). Total counts in the spring (30,832 individuals) were much larger than those in the fall (8271), and total counts at surface (23,688 individuals) were larger than at the bottom (15,415). Note that all counts are standardized to numbers per 1000 cubic meters. Anchovy (*Anchoa compressa* and *Anchoa delicatissima*), sandabs (*Citharichthys spp.*), and several unidentified egg species were most commonly taken.

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 September of 1998 ranged from 89 to 3316 individuals per station, and counts in the spring ranged from 1154 to 11,135. 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 and bottom near the breakwall in May (both 7 species), and the lowest species count was near the bottom in Basin D in September (1 species). Species counts in the fall (5 species) were smaller than spring counts (8). Averaged numbers of species per sample at the surface and near the bottom were the same (4).

Fish egg species patterns compared with past years. Table 7-7 lists the ranges of species of larval fish counted per station since October 1991. Larval fish species recorded during September of 1998 ranged from 1 to 4 species per sample, which is typical. The spring range of species counts (2 to 7) was also typical. No new egg species were recorded during this year.

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 (0.99). The lowest diversity was at the bottom in Basin D in September (0.00). Averaged among samples, diversity in the spring (0.72) was higher than in the fall (0.48). Average surface diversity (0.65) was higher than bottom diversity (0.55).

Fish egg diversity patterns compared with past years. Both fall (0.00 to 0.89) and spring (0.45 to 0.99) diversity ranges were typical of surveys for the past two 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 53,442 total fish of all age groups (including larvae and eggs) representing 63 different species. The majority of these were either eggs, larvae, or juveniles, which attests to the Harbor's value as a nursery ground for adult Harbor species, as well as species for the Pacific Ocean as a whole.

Bottom fish were collected using a semi-balloon otter trawl at three locations in the Harbor: near the Harbor entrance, in midchannel, and along Basin D. During both fall and spring surveys, trawl counts were typical of past years. One species, specklefin midshipman, was new to trawls this year. No one area had persistently larger trawls, more species, or greater diversity than did any other. Both California halibut and barred sand bass, which are prized by both commercial and sport fishermen, were present in every trawl. Overall, fall catches had larger individual and species counts, and diversities were greater.

Midwater gill net sampling continues to be of limited use. Since the technique is passive, capture must rely on the hit-or-miss chance of animals swimming into the net. Despite tripling the deployment time (to about two hours), catches varied by nearly two orders of magnitude. Typically, the nets captured relatively small numbers of fish; however, at Basin D in the spring a large school of topsmelt (345) encountered our gill net. No fish captured this year were new to gill net surveys.

Inshore fish were collected by beach seine at Mother's Beach. Both numbers of individuals and species were typical of past fall and spring counts, and differences between seasons were relatively small. As with the past two surveys, topsmelt during both fall and spring were most abundant. Shiner surfperch, however, also greatly contributed to the spring haul. The huge counts of bonefish collected last year were not evident during 1998-99. Bonefish are typically tropical in habitat and are rare north of Baja California (Eschmeyer, et.al. 1983). Thus, their presence last year in such high numbers is likely El Nino related. As waters warmed during the year, these bonefish likely migrated north and took up residence in the harbor. Only 16 bonefish were captured in the spring and none were captured in the fall. This evidence, along with water column measurements, implies that the 1997 El Nino has long since passed.

Reef associated fish were enumerated and identified by diver-biologists along both jetties and the breakwall. Numbers of fish, numbers of species, and diversity values during this survey were typical of most past surveys, and no new species were encountered during either seasonal survey. Topsmelt, opaleye, and barred sand bass were most commonly observed. In the spring, counts (327 individuals, 15 species) declined to about one-half those of fall (870 individuals, 20 species). Observations made of the rock faces indicated greater shoaling, more surface scour, and less vegetative cover in the spring. This indicates that storms during the winter of 1998-99 removed much of the cover that fish need as a source of shelter and as an indirect source of food.

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. Subgroups of goby and croaker larvae were new to plankton tows this year. Fall larval counts were larger than spring counts; however, fish egg counts were just the reverse. Gobies and blennies dominated larval counts, and anchovies and several unidentified fish were most common among eggs.

The sampling methods that have been used in Marina del Rey differ somewhat from those used by other researchers in southern California (i.e. L.A. Harbor, SCCWRP), so fish population characteristics could not 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

As concluded in our past two reports, 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 discharges of Oxford Lagoon and Ballona Creek and impacts of the open ocean emanating from the Harbor entrance this year spatially affected water quality in Marina del Rey Harbor. It was temporally impacted by season, rainfall, and plankton blooms. Since this year was below normal in rainfall, some of its impacts were less noticeable than in the past two years. Nonetheless, both storm drain and nonpoint flows during the rainy months (primarily December, March, and April), lowered salinity, temperature, pH, and water clarity; raised ammonia, biochemical oxygen demand, and bacterial counts; and contributed nutrients to spring phytoplankton blooms. Only temperature was more strongly influenced by oceanographic season. Phytoplankton blooms, in turn, may have subsequently raised dissolved oxygen values, and their death may have increased biochemical oxygen demand later in the spring. The impacts of plankton were less this year than in the recent past. No red tide or other strong phytoplankton blooms were observed this year.

Both the open ocean and Ballona Creek appear to have impacted stations adjacent to the Harbor entrance, while stations in the lower main channel were most like open ocean water and were thus more natural than the rest of the Harbor. As always, the areas further back into the Marina were warmer, more saline, lower in dissolved oxygen, etc. Discharges from Ballona Creek impact stations near the Harbor entrance, and those from Oxford Lagoon affect Basin E and the upper end of the main channel. These impacts include reduced water clarity, elevated levels of biochemical oxygen demand and bacteria, and a conversion of the water color from blue and green to yellow and brown. Stations affected by Oxford Lagoon had additionally elevated levels of ammonia and lower oxygen and pH values. When not being impacted by the runoff from Ballona Creek, water near the Harbor entrance was clearer, more blue to green, higher in dissolved oxygen and pH, and lower in bacteria and contaminants. Basin D, which includes Mother's Beach, this year appeared less affected by surface runoff than in the recent past.

Bacterial measurements were made monthly at 18 stations (216 measurements in the year). Total coliform limits were exceeded 26 times, fecal coliform limits 40 times, and enterococcus limits 38 times. Last year, it was speculated that high bacterial counts were related to overall rainfall, however, this year, which was relatively dry, had exceedances which were more frequent than last year, which was particularly wet. Thus, bacterial exceedances appear to be independent of overall rainfall. With the exception of enterococcus in the fall, the frequency of exceedances was within the range of the past seven years. Overall, enterococcus exceedances were more frequent this year than usual. Most exceedances occurred following rainy months and at stations near Oxford Lagoon and Ballona Creek discharges.

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. This year the distribution of sediment particles appeared more complicated than usual. 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. During this survey, the main channel area was home to sediments that were moderate in both size and distribution. In addition, Oxford Lagoon, Ballona Creek, and the entrance to Venice Canal had sediment characteristics that were primarily sand but included a fair amount of silt. This suggests the flow regime in these areas is intermittent.

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

Oxford Lagoon and Ballona Creek appear to be sources of chlorinated hydrocarbons such as DDT and derivatives and other chlorinated pesticides, however, the pattern is not always distinct. For the first time last year, DDT was below detection limits at all stations, even though its breakdown products (DDE and DDD) were measured. During this survey, however, DDT has reappeared. The presence of DDT 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, all Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 7 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. 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.

Oxford Lagoon may contribute somewhat to heavy metal loads in Harbor sediments. Since most heavy metals were higher in the Harbor back basins and main channel, their source is most likely the resident boat population itself, however. Metal components of boats are constantly being corroded by seawater, and most bottom paints contain materials, such as copper or tributyl tin complexes, which are designed to continuously ablate off into the sediment. Similar to chlorinated hydrocarbons, all 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. Areas that exceeded most metal limits were Basins F, H, and the upper main channel. 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 two to five times higher than Los Angeles Harbor, although the rest of the metals were similar. Encouragingly, arsenic and silver levels, which were higher than Los Angeles Harbor last year, have declined below. 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, so their sources may be varied. They are non-toxic in themselves, but they can contribute to anoxic conditions near the bottom and affect sensitive fish and invertebrates. Oil from street runoff may be a source of some oil and grease levels found in the two drainage basins, although leakage from resident boats are a likely contributor, as well. As discussed in last year's report, Harbor sediments that are composed of finer particles, such as silt and clay, also tend to be high in heavy metals and organics. Sediments with finer particle sizes tend to attract chemical contaminants more readily. Conversely, sediments containing mostly sand and course silt tend to be lower in organics and heavy metals. The exception appears to be chlorinated hydrocarbons that do not appear to relate to particle size.

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 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 1 at the Harbor entrance and immediately downcurrent of Ballona Creek, and Station 3 at the entrance of Venice Canal. None of these stations were defined by the Southern California Coastal Water Research Project's infaunal trophic index as a "degraded" benthic environment, although Station 1 was defined as "changed". Sediments from Station 12 in Ballona Creek, and to a lesser degree, Stations 2, were dominated by nematode worms that are known to be characteristic of highly disturbed benthic sediments. Because of these huge nematode counts (9740 individuals) at Station 12, total infaunal abundance here (32,760) was highest in the Harbor. Relative to past years, abundance and species diversity values at the remaining stations were comparable. When compared to Los Angeles Harbor and offshore reference site surveys, Marine del Rey abundances were higher (probably due to the huge numbers of nematodes collected at some stations), as were numbers of species. Diversity and infaunal index values were lower, but like heavy metals may be dependent upon improved circulation in Los Angeles Harbor when compared to Marina del Rey Harbor.

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

53,442 total fish of all age groups, representing 63 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. Biologists noted considerably greater shoaling and sand scour and a general lack of algal and attached invertebrate community on the hard substrates of the breakwall and jetties in the spring. Apparently, this past winter's storms strongly impacted these communities. Dive surveys during the following fall indicated a return to previous conditions, so fish counts were expectedly about twice as high. The beach seine catches at Mothers Beach were typical with little difference between spring and fall. Bonefish, which are usually only found in the tropics, dominated beach seines last year. Their presence was likely related to the 1997 El Nino event. As predicted in last year's report, only 16 bonefish were collected in the spring, and none were collected in the fall.

9. APPENDICES

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9.2. WATER QUALITY DATA AND CRUISE LOGS

Surface Bacteriological Water Data and General Observations **July 21, 1998**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Ovrcst. to Pt.Cldy.	Pers.:	J. Gelsinger	High	918	4.2
RAIN:	None		M. Meyer	Low	1410	1.9

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1042	< 20	< 20	< 2	Moderate turbidity.
2	1030	< 20	< 20	< 2	Moderate turbidity.
3	1020	80	20	< 2	Low turbidity.
4	1108	< 20	< 20	< 2	Moderate turbidity.
5	948	50	50	< 2	Moderate turbidity.
6	1002	340	270	2	Moderate turbidity.
7	1130	70	40	< 2	Moderate turbidity.
8	850	220	140	< 2	Moderate turbidity. Oil film on water.
9	938	120	< 20	2	Moderate turbidity. Floating trash, debris, and oil on water.
10	915	3000	340	2	Moderate turbidity.
11	925	170	50	< 2	Moderate turbidity.
12	1051	3000	200	< 2	Moderate turbidity.
13	805	> 16000	3000	< 2	Moderate turbidity. Moderate flow from grate. Jellyfish, swimming crabs in wate column.
18	840	220	220	< 2	Moderate turbidity. Floating debris on water.
19	818	220	500	2	Moderate turbidity. Oil film on water. Jellyfish in water column.
20	905	5000	500	< 2	Moderate turbidity. Oil film on water. Jellyfish, swimming crabs in water column.
22	750	2200	20	< 2	Moderate turbidity.
25	1118	< 20	< 20	< 2	Moderate turbidity.
	Average	1709.4	302.8	2.0	
	Number	18	18	18	
	St. Dev.	3846.8	692.6	0.0	
	Maximum	16000	3000	2	
	Minimum	20	20	2	

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

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Ovrcst. to Pt.Cldy.	Pers.: J. Gelsinger	High	918	4.2
RAIN:	None	M. Meyer	Low	1410	1.9

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1042	0	22.43	33.27	7.61	8.54	67.70	90.7	9	4.9	0.8	1.6
5k WSW		1	22.44	33.35	7.55	8.55	69.88	91.4				
		2	22.22	33.32	7.73	8.55	73.22	92.5			0.7	1.5
		3	22.19	33.36	7.85	8.54	72.50	92.3				
		4	22.17	33.37	7.82	8.55	72.32	92.2			< 0.7	1.6
2	1030	0	22.16	33.36	7.62	8.54	70.40	91.6	7	4.9	< 0.7	1.6
5k WSW		1	22.15	33.34	7.60	8.53	70.34	91.6				
		2	22.13	33.34	7.67	8.53	70.19	91.5			< 0.7	1.5
		3	22.11	33.34	7.77	8.53	69.90	91.4				
		4	22.11	33.34	7.65	8.54	69.72	91.4			< 0.7	1.5
3	1020	0	22.25	33.04	7.12	8.48	63.30	89.2	10	3.3	< 0.7	1.4
5k WSW		1	22.14	33.09	7.15	8.48	63.82	89.4				
		2	21.91	33.17	7.51	8.49	64.66	89.7			< 0.7	1.3
		3	21.78	33.21	7.46	8.50	65.35	89.9				
		4	21.72	33.28	7.24	8.51	65.64	90.0			0.8	1.1
4	1108	0	23.15	33.14	6.57	8.42	63.73	89.3	10	3.4	< 0.7	1.3
5k WSW		1	23.01	33.05	6.61	8.42	63.47	89.3				
		2	22.78	33.13	6.96	8.43	62.34	88.9			< 0.7	1.2
		3	22.67	33.16	7.00	8.43	59.18	87.7				
		4	22.42	33.15	6.69	8.44	55.01	86.1			< 0.7	1.3
5	948	0	23.35	33.23	6.65	8.42	58.10	87.3	12	2.7	< 0.7	1.1
5k WSW		1	23.34	33.23	6.90	8.41	57.33	87.0				
		2	23.31	33.21	7.09	8.42	56.76	86.8			< 0.7	1.3
		3	23.17	33.14	6.78	8.41	55.42	86.3				
		4	22.99	33.16	6.73	8.41	54.88	86.1			< 0.7	1.7
		5	22.94	33.22	6.76	8.40	45.83	82.3				
		6	22.93	33.24	6.77	8.40	40.71	79.9			< 0.7	1.3
6	1002	0	23.37	33.25	6.54	8.41	69.35	91.3	11	3.4	0.8	1.2
5k WSW		1	23.35	33.27	6.61	8.40	67.73	90.7				
		2	23.32	33.27	6.98	8.40	67.68	90.7			0.8	1.0
		3	23.32	33.28	6.69	8.37	65.63	90.0				
		4									< 0.7	0.9
7	1130	0	23.79	33.24	5.72	8.29	50.91	84.5	13	2.3	2.8	1.3
5k WSW		1	23.75	33.23	5.92	8.29	49.53	83.9				
		2	23.67	33.24	6.20	8.30	48.53	83.5			3.5	1.0
		3	23.59	33.23	6.14	8.29	48.18	83.3				
		4	23.37	33.18	5.60	8.28	43.02	81.0			3.3	1.2
8	850	0	23.82	33.32	5.82	8.33	61.31	88.5	12	2.7	< 0.7	1.8
2k WSW		1	23.82	33.31	5.83	8.34	61.01	88.4				
		2	23.83	33.33	5.92	8.33	60.94	88.4			< 0.7	1.7
		3	23.83	33.34	5.97	8.33	49.55	83.9				
		4	23.82	33.33	5.99	8.33	36.65	77.8			< 0.7	1.7

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	938	0	23.58	33.00	5.42	8.17	36.14	77.5	12	2.6	4.3	2.3
2k WSW		1	23.57	33.14	5.41	8.20	32.32	75.4				
		2	23.61	33.20	5.63	8.25	25.86	71.3			4.1	1.4
		3	23.50	33.10	5.01	8.30	36.02	77.5				
		4	23.48	31.62	4.70	8.29	31.14	74.7			3.6	1.2
10	915	0	23.99	33.09	5.92	8.18	47.00	82.8	14	2.0	10.8	2.9
2k WSW		1	23.93	33.14	6.43	8.22	44.93	81.9				
		2	23.85	33.18	6.15	8.23	41.95	80.5			3.5	2.8
		3	23.67	33.20	4.26	8.19	36.59	77.8				
		4	23.68	33.28	3.95	8.18	36.52	77.7			3.6	2.7
11	925	0	23.73	33.12	6.01	8.33	59.09	87.7	12	2.7	1.8	2.3
2k WSW		1	23.70	33.15	6.07	8.33	54.19	85.8				
		2	23.58	33.19	6.75	8.34	47.57	83.0			1.9	1.4
		3	23.53	33.22	6.30	8.33	40.26	79.7				
		4	23.52	33.24	6.08	8.33	36.38	77.7			0.7	1.6
12	1051	0	22.41	30.96	6.73	8.45	69.13	91.2	9	2.9	4.1	2.1
5k WSW		1	22.30	32.95	7.06	8.48	69.49	91.3				
		2	22.24	33.16	7.42	8.52	70.24	91.5			< 0.7	1.6
		3	22.13	33.20	6.78	8.52	70.45	91.6				
13	805	0	22.97	25.62	1.20	7.65					18.8	4.0
18	840	0	23.80	33.34	6.11	8.29	49.90	84.0	13	2.0	0.8	1.9
2k WSW		1	23.78	33.34	6.02	8.30	48.96	83.6				
		2	23.69	33.31	5.49	8.35	43.84	81.4			< 0.7	2.6
		3										
											< 0.7	2.2
19	818	0	22.87	33.20	6.06	7.78					0.7	2.2
20	905	0	23.99	33.12	4.19	8.17	44.84	81.8	14	1.7	10.1	5.0
2k WSW		1	23.96	33.15	4.57	8.18	43.56	81.2				
		2									5.7	3.1
22	750	0	23.38	20.31	7.15	7.10					7.8	1.7
25	1118	0	23.32	33.18	6.64	8.40	66.15	90.2	11	3.3	1.9	1.8
5k WSW		1	23.24	33.13	6.98	8.40	65.65	90.0				
		2	23.04	33.12	7.24	8.39	65.14	89.8			0.8	1.1
		3	22.76	33.07	7.29	8.39	61.30	88.5				
		4	22.59	33.25	6.85	8.41	47.45	83.0			0.8	1.1
	Average		23.10	32.88	6.42	8.34	55.8	86.0	11.3	3.0	2.4	1.8
	Number		73	73	73	73	70	70	15	15	47	47
	St. Dev.		0.66	1.77	1.09	0.21	12.5	5.2	2.0	0.9	3.4	0.8
	Maximum		23.99	33.37	7.85	8.55	73.2	92.5	14	4.9	18.8	5.0
	Minimum		21.72	20.31	1.20	7.10	25.9	71.3	7	1.7	0.7	0.9

Surface Bacteriological Water Data and General Observations **August 31, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	658	3.4
RAIN:	None	M. Meyer	Low	1100	2.9

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1030	500	300	2	Moderate turbidity.
2	1020	40	20	< 2	Moderate turbidity.
3	1010	< 20	< 20	< 2	Moderate turbidity. Low flow from tidal gate.
4	1055	≥ 16000	230	500	Moderate turbidity.
5	935	< 20	< 20	2	Moderate turbidity.
6	950	< 20	< 20	< 2	Moderate turbidity.
7	1115	16000	40	4	Moderate turbidity.
8	825	130	< 20	2	Moderate turbidity.
9	915	80	80	4	Moderate turbidity.
10	855	700	80	23	Moderate turbidity. Many jellyfish in the water.
11	905	220	140	< 2	Moderate turbidity.
12	1035	500	500	4	Moderate turbidity.
13	740	≥ 16000	1100	240	Moderate turbidity. Construction activity in lagoon.
18	815	90	40	2	Moderate turbidity.
19	800	220	220	13	Moderate turbidity. Heron on wheechair ramp.
20	843	1100	170	27	Moderate turbidity. Oily surface film. Many jellyfish in the water.
22	725	5000	800	14	Moderate turbidity. Herons on fence.
25	1105	≥ 16000	2400	≥ 1600	Moderate turbidity.
	Average	4035.6	344.4	135.8	
	Number	18	18	18	
	St. Dev.	6678.3	593.2	386.3	
	Maximum	16000	2400	1600	
	Minimum	20	20	2	

Physical Water Quality Data **August 31, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	658	3.4
RAIN:	None	M. Meyer	Low	1100	2.9

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1030	0	22.44	30.69	7.65	8.51	71.37	91.9	10	5.2	3.0	1.5
2k SW		1	22.04	32.70	7.64	8.52	67.83	90.8				
		2	21.73	32.99	7.69	8.54	73.80	92.7			1.1	1.6
		3	21.52	33.08	7.71	8.55	71.67	92.0				
		4	21.47	33.15	7.65	8.55	69.78	91.4			< 0.7	1.4
2	1020	0	22.35	32.77	7.52	8.55	71.82	92.1	10	5.6	< 0.7	1.4
2k SW		1	22.33	32.93	7.46	8.55	70.60	91.7				
		2	22.40	33.07	7.73	8.55	69.41	91.3			< 0.7	1.3
		3	21.93	32.96	7.78	8.55	71.28	91.9				
		4	20.84	32.55	7.77	8.56	72.24	92.2			< 0.7	1.1
3	1010	0	22.45	32.85	7.42	8.58	72.13	92.2	10	4.2	< 0.7	1.3
2k SW		1	22.43	32.87	7.56	8.58	71.47	91.9				
		2	22.17	32.90	7.42	8.58	70.45	91.6			< 0.7	1.0
		3	21.68	32.98	7.25	8.57	69.10	91.2				
		4	21.53	33.05	7.25	8.56	67.38	90.6			< 0.7	1.1
4	1055	0	22.87	32.64	6.93	8.54	77.92	94.0	10	5.0	< 0.7	1.1
2k SW		1	22.81	32.76	6.92	8.55	77.06	93.7				
		2	22.60	32.77	7.38	8.56	75.07	93.1			< 0.7	1.0
		3	22.22	32.86	7.21	8.56	74.24	92.8				
		4	20.85	32.51	7.14	8.56	70.77	91.7			< 0.7	1.1
5	935	0	23.67	33.09	5.77	8.51	73.39	92.6	12	3.8	< 0.7	1.1
2k SW		1	23.42	33.03	6.76	8.52	64.26	89.5				
		2	23.02	33.21	7.98	8.52	63.26	89.2			< 0.7	1.0
		3	22.06	33.21	7.11	8.54	64.56	89.6				
		4	21.32	33.11	6.50	8.52	62.67	89.0			< 0.7	1.2
6	950	0	23.38	33.20	6.70	8.54	74.20	92.8	10	4.3	< 0.7	1.2
2k SW		1	23.33	33.20	6.79	8.55	72.99	92.4				
		2	23.19	33.18	7.06	8.58	68.21	90.9			< 0.7	0.9
		3	22.54	33.00	6.60	8.58	63.01	89.1				
		4	22.27	33.04	6.66	8.58	55.83	86.4			< 0.7	0.9
7	1115	0	23.70	33.18	5.47	8.49	67.26	90.6	12	3.8	< 0.7	1.8
2k SW		1	23.64	33.18	6.12	8.50	65.85	90.1				
		2	23.31	33.09	6.76	8.51	65.77	90.1			< 0.7	1.4
		3	22.91	33.07	6.64	8.52	61.50	88.6				
		4	22.34	33.09	6.37	8.53	57.00	86.9			< 0.7	1.3
8	825	0	23.78	33.17	6.50	8.55	62.42	88.9	13	2.5	1.6	1.7
2k SW		1	23.74	33.17	6.63	8.55	61.67	88.6				
		2	23.45	33.04	6.79	8.52	40.73	79.9			< 0.7	2.1
		3	22.56	32.80	6.81	8.07	30.50	74.3				
		4	22.37	33.02	6.83	8.27	36.54	77.7			2.5	3.2

August 31, 1998 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	915	0	23.52	32.80	6.28	8.36	50.65	84.4	14	2.3	4.4	1.4
2k SW		1	23.27	32.89	6.41	8.37	49.57	83.9				
		2	22.67	33.07	6.43	8.40	41.32	80.2			6.2	1.3
		3	22.32	33.01	5.10	8.42	34.86	76.8				
											3.4	1.6
10	855	0	23.45	32.88	4.83	8.35	50.53	84.3	15	2.2	9.0	2.3
2k SW		1	23.34	32.94	4.93	8.37	46.21	82.4				
		2	22.95	32.97	6.21	8.42	47.09	82.8			8.2	3.2
		3	22.65	33.11	4.63	8.37	48.86	83.6				
		4	22.55	33.11	4.40	8.34	48.21	83.3			7.0	3.4
11	905	0	23.44	32.99	5.94	8.41	75.11	93.1	11	3.8	5.6	1.8
2k SW		1	23.42	33.04	6.06	8.42	74.57	92.9				
		2	23.11	33.00	6.51	8.45	65.25	89.9			4.6	0.9
		3	22.50	32.89	6.17	8.51	57.41	87.0				
		4	22.32	32.98	6.10	8.50	59.11	87.7			4.4	1.3
12	1035	0	23.94	25.72	9.05	8.59	25.43	71.0	16	3.0	1.4	4.9
2k SW		1	22.48	31.11	9.16	8.61	40.22	79.6				
		2	21.85	32.87	9.26	8.67	57.66	87.1			< 0.7	2.8
		3	21.55	33.06	9.21	8.67	65.36	89.9				
13	740	0	26.70	19.36	6.71	8.49					5.1	12.5
18	815	0	23.72	33.20	6.40	8.55	59.30	87.8	13	2.7	1.9	2.1
2k SW		1	23.67	33.19	6.55	8.55	56.27	86.6				
		2	23.52	33.17	6.97	8.50	52.82	85.3			2.2	1.7
											0.7	1.7
19	800	0	23.34	33.06	6.55	8.49					2.0	1.6
20	843	0	23.30	32.90	4.97	8.29	49.70	84.0	15	1.8	11.3	7.0
2k SW		1	23.21	32.90	5.61	8.29	47.73	83.1				
											9.2	3.7
22	725	0	28.80	19.39	6.71	8.53					12.5	7.6
25	1105	0	23.36	32.89	6.73	8.59	76.40	93.5	10	5.6	< 0.7	1.6
2k SW		1	23.05	32.51	6.87	8.59	77.14	93.7				
		2	22.35	32.80	7.41	8.58	79.24	94.3			< 0.7	1.0
		3	21.69	32.90	7.55	8.57	74.31	92.8				
		4	20.89	32.83	7.09	8.56	66.57	90.3			1.0	1.0
	Average		22.81	32.43	6.83	8.50	62.1	88.4	12.1	3.7	2.7	2.2
	Number		71	71	71	71	68	68	15	15	46	46
	St. Dev.		1.16	2.43	0.98	0.10	12.7	5.1	2.2	1.3	3.1	2.1
	Maximum		28.80	33.21	9.26	8.67	79.2	94.3	16	5.6	12.5	12.5
	Minimum		20.84	19.36	4.40	8.07	25.4	71.0	10	1.8	0.7	0.9

Surface Bacteriological Water Data and General Observations **September 17, 1998**

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

TIDE	TIME	HT. (ft)
High	840	4.9
Low	1411	1.7

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1034	300	230	17	Moderate turbidity.
2	1023	< 20	< 20	4	Moderate turbidity.
3	1013	40	40	5	Moderate turbidity. No flow from tidal gate.
4	1058	50	50	< 2	Moderate turbidity.
5	938	50	50	7	Moderate turbidity.
6	948	50	20	< 2	Moderate turbidity.
7	1118	20	< 20	4	Moderate turbidity.
8	837	110	40	2	Moderate turbidity.
9	927	120	20	8	Moderate turbidity.
10	906	800	70	7	Moderate turbidity. Jellyfish in water column.
11	917	140	70	< 2	Moderate turbidity.
12	1045	500	300	14	Moderate turbidity.
13	755	≥ 16000	1100	170	Moderate turbidity. Construction activity in lagoon.
18	828	130	130	17	Moderate turbidity.
19	815	500	500	30	Moderate turbidity. Floating organic material.
20	855	≥ 16000	50	14	Heavy turbidity. Jellyfish and schools of small fish in water column.
22	740	≥ 16000	170	30	Moderate turbidity.
25	1108	130	130	7	Moderate turbidity.
	Average	2831.1	167.2	19.0	
	Number	18	18	18	
	St. Dev.	6063.6	263.9	38.7	
	Maximum	16000	1100	170	
	Minimum	20	20	2	

Physical Water Quality Data **September 17, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Foggy	Pers.: J. Gelsinger	High	840	4.9
RAIN:	None	M. Meyer	Low	1411	1.7

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1034	0	21.28	32.76	5.25	8.21	78.59	94.2	10	4.9	2.0	2.1
1k WSW		1	21.49	33.10	5.72	8.23	76.67	93.6				
		2	21.61	33.30	6.49	8.25	78.69	94.2			< 0.7	2.3
		3	21.53	33.29	7.10	8.25	79.00	94.3				
		4	21.30	33.13	6.90	8.25	79.17	94.3			0.7	2.0
2	1023	0	21.56	32.79	7.32	8.22	69.57	91.3	10	5.9	< 0.7	1.9
1k WSW		1	21.41	32.83	7.33	8.23	70.10	91.5				
		2	21.25	33.06	7.70	8.23	72.55	92.3			< 0.7	1.7
		3	21.09	33.12	7.38	8.23	73.30	92.5				
		4	20.84	33.09	7.06	8.24	76.35	93.5			< 0.7	1.9
3	1013	0	22.62	32.96	5.28	8.15	60.43	88.2	12	3.0	0.7	2.4
1k WSW		1	22.54	33.01	6.12	8.15	60.19	88.1				
		2	21.27	32.70	7.32	8.15	60.00	88.0			0.8	1.5
		3	20.77	33.16	6.98	8.15	58.93	87.6				
		4	20.72	33.33	6.52	8.18	55.39	86.3			0.7	1.7
4	1058	0	22.49	32.85	5.84	8.15	64.75	89.7	13	3.4	< 0.7	1.9
1k WSW		1	22.50	32.76	6.80	8.17	67.65	90.7				
		2	22.49	32.90	7.01	8.16	64.41	89.6			< 0.7	1.5
		3	21.56	32.67	7.53	8.16	63.29	89.2				
		4	20.93	33.15	7.17	8.18	65.47	90.0			0.7	1.6
5	938	0	23.27	33.06	6.07	8.11	64.69	89.7	12	2.8	< 0.7	1.4
1k WSW		1	23.18	33.03	6.64	8.13	59.36	87.8				
		2	23.12	33.07	6.95	8.16	51.75	84.8			< 0.7	1.7
		3	23.04	33.05	6.88	8.16	50.66	84.4				
		4	22.16	32.56	6.57	8.18	50.97	84.5			< 0.7	1.7
		5	21.49	33.14	6.78	8.17	55.87	86.5				
6	948	0	22.92	33.10	5.91	8.09	61.67	88.6	12	2.9	< 0.7	1.5
1k WSW		1	22.94	33.13	6.63	8.11	60.79	88.3				
		2	22.94	33.12	7.13	8.11	60.70	88.3			< 0.7	1.5
		3	22.90	33.11	6.44	8.11	60.33	88.1				
		4	22.51	33.03	6.00	8.07	52.73	85.2			3.3	1.5
7	1118	0	23.45	33.11	6.85	8.11	58.19	87.3	13	2.7	1.5	1.8
1k WSW		1	23.39	33.13	6.70	8.13	55.86	86.5				
		2	23.36	33.11	6.95	8.13	55.89	86.5			0.7	1.6
		3	22.47	32.99	6.91	8.10	55.70	86.4				
		4	22.10	33.08	6.56	8.08	44.45	81.7			4.7	1.4
8	837	0	23.20	33.08	6.06	8.02	59.46	87.8	13	2.6	1.4	1.4
1k WSW		1	23.24	33.07	5.79	8.03	58.49	87.5				
		2	23.22	33.07	6.24	8.03	58.44	87.4			1.0	1.5
		3	23.16	33.07	6.48	8.03	55.61	86.4				
		4	23.10	33.08	5.95	8.04	55.28	86.2			1.0	1.4

September 17, 1998 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	927	0	23.08	32.34	6.01	7.96	56.99	86.9	14	1.8	1.2	2.8
1k WSW		1	23.33	32.76	6.05	7.99	48.41	83.4				
		2	23.18	33.05	6.41	7.97	35.58	77.2			1.9	1.5
		3	22.96	33.01	5.76	8.00	39.59	79.3				
		4	22.84	33.00	5.54	8.01	40.61	79.8			2.2	1.5
10	906	0	23.40	31.11	3.16	7.85	37.73	78.4	13	2.4	15.3	5.4
1k WSW		1	23.28	32.03	7.27	7.85	42.89	80.9				
		2	23.49	32.98	5.51	7.91	52.04	84.9			12.5	4.3
		3	23.38	32.99	6.30	7.96	51.85	84.9				
		4	23.27	33.05	4.87	7.98	44.43	81.6			14.4	5.1
11	917	0	23.17	32.80	5.19	7.99	68.56	91.0	12	3.3	7.5	1.1
1k WSW		1	23.20	32.92	4.67	8.00	68.12	90.8				
		2	23.25	33.03	5.34	8.02	62.75	89.0			1.4	0.9
		3	23.09	33.07	6.91	8.05	52.63	85.2				
		4	22.83	33.09	5.77	8.03	45.67	82.2			1.2	1.3
12	1045	0	21.43	28.69	7.17	8.19	64.72	89.7	10	4.0	3.1	2.4
1k WSW		1	21.21	31.34	6.87	8.18	65.13	89.8				
		2	20.84	33.02	6.74	8.19	74.87	93.0			1.0	2.2
		3	20.74	33.20	6.56	8.19	78.19	94.0				
13	755	0	22.17	10.75	3.60	8.07					41.6	9.8
18	828	0	23.09	33.09	6.36	8.03	58.98	87.6	13	2.4	2.0	1.9
1k WSW		1	23.10	33.10	6.19	8.04	57.83	87.2				
		2	23.04	33.06	6.95	8.04	57.74	87.2			2.0	2.2
19	815	0	22.17	33.01	5.51	8.01					6.1	2.1
20	855	0	23.43	30.46	3.46	7.90	32.30	75.4	16	1.3	29.2	5.1
1k WSW		1	23.52	30.56	3.40	7.90	33.47	76.1				
		2	23.48	32.85	4.67	7.95	47.12	82.9			15.2	5.2
22	740	0	22.27	10.31	2.80	8.10					45.5	15.0
25	1108	0	22.89	33.03	5.84	8.14	62.10	88.8	13	3.0	16.6	2.0
1k WSW		1	22.91	33.06	6.39	8.15	61.37	88.5				
		2	22.86	33.06	6.96	8.15	61.64	88.6			8.0	1.8
		3	22.64	33.01	6.87	8.15	62.79	89.0				
											45.5	1.9
	Average		22.49	32.21	6.20	8.10	59.0	87.3	12.4	3.1	6.7	2.6
	Number		73	73	73	73	70	70	15	15	45	45
	St. Dev.		0.87	3.73	1.05	0.10	11.2	4.4	1.6	1.1	11.7	2.5
	Maximum		23.52	33.33	7.70	8.25	79.2	94.3	16	5.9	45.5	15.0
	Minimum		20.72	10.31	2.80	7.85	32.3	75.4	10	1.3	0.7	0.9

Surface Bacteriological Water Data and General Observations October 21, 1998

CRUISE: MDR 97-98 Vessel: Aquatic Bioassay
WEATHER: Ovrcst. to Pt.Cldy. Pers.: J. Gelsinger
RAIN: None M. Meyer

TIDE	TIME	HT. (ft)
High	1002	5.6
Low	1642	0.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1020	300	130	13	Moderate turbidity.
2	1010	< 20	< 20	< 2	Moderate turbidity.
3	1000	50	50	4	Moderate turbidity.
4	1045	20	< 20	< 2	Moderate turbidity.
5	925	50	< 20	2	Moderate turbidity.
6	936	500	80	4	Moderate turbidity.
7	1111	130	130	14	Moderate turbidity.
8	821	220	90	14	Moderate turbidity.
9	915	50	80	5	Moderate turbidity.
10	852	300	230	26	Moderate turbidity.
11	903	220	90	1600	Moderate turbidity.
12	1032	40	20	6	Moderate turbidity.
13	732	≥ 16000	≥ 16000	240	Moderate turbidity. Water very yellow. Construction activities in lagoon.
18	810	20	< 20	50	Moderate turbidity.
19	952	110	80	17	Moderate turbidity.
20	840	500	70	13	Moderate turbidity.
22	720	5000	1100	500	Moderate turbidity. Water very yellow.
25	1100	70	20	5	Moderate turbidity.
	Average	1311.1	1013.9	139.8	
	Number	18	18	18	
	St. Dev.	3841.6	3748.2	385.0	
	Maximum	16000	16000	1600	
	Minimum	20	20	2	

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

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Ovrcst. to Pt.Cldy.	Pers.: J. Gelsinger	High	1002	5.6
RAIN:	None	M. Meyer	Low	1642	0.4

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1020	0	19.08	30.76	7.17	8.15	78.50	94.1	10	5.4	0.9	1.9
6K NE		1	19.06	32.65	7.38	8.14	75.03	93.1				
		2	19.08	33.28	7.20	8.14	75.01	93.1			< 0.7	1.7
		3	19.16	33.35	7.12	8.15	75.24	93.1				
		4	18.93	33.26	7.32	8.16	76.35	93.5			< 0.7	1.7
2	1010	0	18.99	33.25	7.47	8.12	76.84	93.6	10	5.9	< 0.7	1.3
6K NE		1	18.98	33.25	7.39	8.12	76.25	93.4				
		2	18.96	33.25	7.57	8.12	76.49	93.5			< 0.7	1.4
		3	18.97	33.26	7.51	8.12	76.76	93.6				
		4	18.96	33.28	7.43	8.12	76.89	93.6			< 0.7	1.3
3	1000	0	18.88	32.99	6.54	8.05	68.06	90.8	10	3.8	< 0.7	1.2
6K NE		1	18.86	33.01	6.61	8.05	66.79	90.4				
		2	18.86	33.06	7.16	8.05	72.21	92.2			< 0.7	1.7
		3	18.89	33.16	6.81	8.05	72.86	92.4				
		4	18.86	33.19	6.61	8.06	72.55	92.3			< 0.7	1.0
4	1045	0	19.10	33.11	6.90	8.05	75.26	93.1	12	4.1	< 0.7	1.2
6K NE		1	19.06	33.12	6.82	8.04	76.33	93.5				
		2	19.05	33.17	7.14	8.04	74.15	92.8			< 0.7	1.0
		3	19.04	33.17	7.14	8.04	70.09	91.5				
		4	19.05	33.17	6.74	8.04	69.08	91.2			< 0.7	1.0
5	925	0	19.53	33.23	6.45	7.98	58.10	87.3	12	3.0	< 0.7	2.2
3K NE		1	19.53	33.23	6.35	7.98	56.74	86.8				
		2	19.48	33.23	6.81	7.98	55.74	86.4			< 0.7	2.1
		3	19.40	33.20	7.21	7.98	54.69	86.0				
		4	19.16	33.14	6.81	7.99	56.20	86.6			< 0.7	2.3
		5	19.10	33.23	6.47	8.00	55.84	86.4				
6	936	0	19.60	33.22	5.63	7.94	61.53	88.6	10	2.8	1.3	1.0
3K NE		1	19.59	33.23	5.94	7.94	61.14	88.4				
		2	19.59	33.23	6.49	7.94	60.20	88.1			< 0.7	0.9
		3	19.59	33.23	5.66	7.94	60.63	88.2				
		4	19.59	33.23	5.59	7.94	61.31	88.5			< 0.7	1.0
7	1111	0	20.03	33.23	5.38	7.93	72.73	92.3	12	3.6	5.3	0.9
6K NE		1	19.88	33.19	6.70	7.92	70.03	91.5				
		2	19.84	33.22	6.83	7.93	67.23	90.6			1.8	0.9
		3	19.83	33.24	6.84	7.95	62.73	89.0				
		4	19.60	33.12	5.56	7.95	54.27	85.8			0.8	1.3
8	821	0	19.95	33.26	6.10	7.86	53.44	85.5	11	2.4	3.4	1.6
3K NE		1	19.95	33.26	6.67	7.86	53.02	85.3				
		2	19.94	33.26	6.04	7.86	53.10	85.4			1.8	1.4
		3	19.87	33.24	5.28	7.86	54.05	85.7				
		4	19.82	33.24	5.33	7.86	55.20	86.2			1.7	1.9

October 21, 1998 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	915	0	20.03	33.21	6.45	7.90	46.14	82.4	12	1.7	1.9	0.7
3K NE		1	20.09	33.21	6.58	7.91	39.91	79.5				
		2	20.01	33.16	5.43	7.92	42.91	80.9			1.4	1.0
		3	19.98	33.20	5.43	7.93	43.99	81.4				
		4	19.99	33.20	5.47	7.93	31.92	75.2			1.2	1.1
10	852	0	20.08	33.09	4.41	7.71	49.19	83.7	11	2.2	8.6	2.2
3K NE		1	20.03	33.02	5.12	7.72	47.85	83.2				
		2	20.06	33.12	5.45	7.78	50.29	84.2			7.7	2.4
		3	20.07	33.14	4.58	7.81	48.76	83.6				
		4	20.07	33.17	4.34	7.83	38.58	78.8			6.7	1.7
11	903	0	19.99	33.16	5.70	7.89	47.46	83.0	12	1.8	4.8	1.1
3K NE		1	19.98	33.17	5.88	7.90	41.79	80.4				
		2	19.92	33.17	6.38	7.91	33.07	75.8			4.9	0.7
		3	19.89	33.21	5.81	7.92	35.71	77.3				
		4	19.91	33.23	5.26	7.92	30.73	74.5			3.7	1.0
12	1032	0	19.15	26.64	7.26	8.21	70.63	91.7	12	4.1	2.8	1.9
6K NE		1	19.06	30.52	7.18	8.17	62.04	88.7				
		2	18.97	32.99	7.41	8.12	74.77	93.0			< 0.7	1.4
		3	18.94	33.06	7.36	8.12	78.50	94.1				
13	732	0	20.00	10.36	9.60	8.42					16.9	19.3
18	810	0	19.87	33.27	6.38	7.86	60.96	88.4	10	2.4	5.7	1.5
3K NE		1	19.86	33.28	6.59	7.86	60.79	88.3				
		2	19.80	33.30	5.70	7.86	59.73	87.9			4.7	1.6
19	952	0	19.12	33.10	5.13	7.66					4.5	1.8
20	840	0	20.10	33.09	3.92	7.67	41.78	80.4	14	1.6	15.9	2.5
3K NE		1	20.09	33.12	4.45	7.70	44.59	81.7				
		2	20.10	33.14	4.99	7.74	46.40	82.5			13.1	2.9
22	720	0	21.20	10.75	8.40	8.17					42.7	18.5
25	1100	0	19.32	33.23	6.96	7.97	69.72	91.4	13	3.0	2.8	1.3
6K NE		1	19.30	33.23	6.59	7.97	68.22	90.9				
		2	19.26	33.22	6.83	7.97	67.46	90.6			1.2	1.4
		3	19.22	33.24	6.59	7.97	65.74	90.0				
		4	19.18	33.19	5.98	7.98	62.89	89.1			< 0.7	1.6
	Average		19.53	32.41	6.38	7.97	60.3	87.7	11.4	3.2	4.0	2.2
	Number		74	74	74	74	71	71	15	15	45	45
	St. Dev.		0.48	3.77	0.99	0.14	13.1	5.1	1.2	1.3	7.1	3.7
	Maximum		21.20	33.35	9.60	8.42	78.5	94.1	14	5.9	42.7	19.3
	Minimum		18.86	10.36	3.92	7.66	30.7	74.5	10	1.6	0.7	0.7

Surface Bacteriological Water Data and General Observations **November 19, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Pt.Cldy.	Pers.: J. Gelsinger	High	831	5.9
RAIN:	None	M. Meyer	Low	1531	-0.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1030	1300	70	140	Light turbidity. Many floating styrofoam cups.
2	1018	40	20	< 2	Light turbidity. Trash along breakwall. Dogs swimming near breakwall.
3	1006	130	50	20	Light turbidity. No flow at gate. Floating trash and other debris.
4	1053	50	20	< 2	Light turbidity.
5	934	90	90	280	Light turbidity.
6	950	40	< 20	2	Light turbidity.
7	1118	110	110	5	Light turbidity.
8	827	400	150	30	Light turbidity.
9	923	40	20	< 2	Light turbidity.
10	856	500	80	50	Moderate turbidity.
11	910	170	40	2	Light turbidity.
12	1040	1700	270	70	Light turbidity.
13	735	600	230	900	Moderate turbidity. Grate covered with trash. Construction continues.
18	915	170	110	80	Light turbidity.
19	750	1100	800	500	Moderate turbidity. Floating scum and foam.
20	845	300	80	170	Moderate turbidity.
22	720	≥ 16000	≥ 16000	500	Moderate turbidity. Water brown.
25	1107	< 20	< 20	2	Light turbidity.
	Average	1264.4	1010.0	153.2	
	Number	18	18	18	
	St. Dev.	3709.9	3745.4	246.1	
	Maximum	16000	16000	900	
	Minimum	20	20	2	

Physical Water Quality Data November 19, 1998

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Pt.Cldy.	Pers.: J. Gelsinger		High	831	5.9
RAIN:	None	M. Meyer		Low	1531	-0.1

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1030	0	15.40	29.78	7.04	8.17	80.44	94.7	14	4.2	5.9	1.36
4k SW		1	15.66	34.36	7.01	8.14	71.81	92.1				
		2	15.63	33.29	7.02	8.16	65.44	89.9			1.6	1.17
		3	15.61	33.29	7.11	8.18	65.48	90.0				
		4	15.60	33.31	6.93	8.19	66.12	90.2				
2	1018	0	15.53	33.06	7.04	8.14	72.60	92.3	10	4.2	2.1	0.76
4k SW		1	15.39	33.09	6.94	8.14	70.65	91.7				
		2	15.44	33.29	7.07	8.16	69.14	91.2			0.8	0.77
		3	15.53	33.32	7.15	8.17	68.25	90.9				
		4	15.41	33.20	6.89	8.17	69.39	91.3			< 0.7	0.95
3	1006	0	15.72	33.13	6.02	8.07	77.34	93.8	9	4.1	4.3	0.68
4k SW		1	15.70	33.11	6.70	8.07	76.55	93.5				
		2	15.64	33.18	6.72	8.06	74.23	92.8			2.2	0.51
		3	15.62	33.18	6.47	8.06	71.95	92.1				
		4	15.59	33.20	6.22	8.07	71.77	92.0			3.1	0.37
4	1053	0	16.05	33.13	5.89	8.08	71.03	91.8	12	4.5	2.5	0.87
6k W		1	16.02	33.15	5.63	8.06	70.68	91.7				
		2	15.93	33.15	6.88	8.06	70.21	91.5			1.0	0.48
		3	15.91	33.17	6.84	8.07	70.01	91.5				
		4	15.78	33.06	6.47	8.07	70.51	91.6			0.9	0.50
5	934	0	15.86	33.03	6.24	8.00	72.13	92.2	8	3.6	2.5	0.53
2k SW		1	15.80	33.02	6.35	8.00	71.54	92.0				
		2	15.74	33.05	6.51	8.01	67.66	90.7			1.9	0.34
		3	15.69	33.11	6.38	8.03	56.02	86.5				
		4	15.73	33.23	6.09	8.04	58.33	87.4			1.8	0.37
		5	15.77	33.24	6.01	8.06	60.25	88.1				
											2.4	1.46
6	950	0	15.86	33.06	6.07	7.95	62.39	88.9	9	3.2	2.5	0.56
2k SW		1	15.83	33.04	6.50	7.94	62.26	88.8				
		2	15.76	33.04	6.60	7.94	61.46	88.5			2.4	0.12
		3	15.68	33.04	6.55	7.95	59.79	87.9				
		4	15.68	33.07	5.79	7.95	58.90	87.6			2.8	0.10
7	1118	0	16.19	33.04	4.67	7.95	72.42	92.2	11	4.6	4.4	0.65
6k W		1	16.09	32.99	5.02	7.94	72.02	92.1				
		2	15.94	33.04	5.91	7.94	71.59	92.0			4.7	0.09
		3	15.90	33.06	6.19	7.94	71.79	92.0				
		4	15.91	33.13	5.52	7.95	71.74	92.0			4.4	0.03
8	827	0	15.86	33.03	5.99	7.91	60.62	88.2	9	3.0	3.2	0.71
2k SW		1	15.86	33.02	5.91	7.91	60.60	88.2				
		2	15.86	33.02	5.72	7.91	60.50	88.2			2.2	0.65
		3	15.80	33.00	5.61	7.91	60.50	88.2				
		4	15.63	32.96	5.62	7.92	62.08	88.8			2.3	0.95

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	923	0	16.16	32.98	6.59	7.95	59.67	87.9	10	2.9	3.0	0.29
2k SW		1	16.02	32.94	7.52	7.95	59.38	87.8				
		2	16.06	32.98	7.08	7.95	58.97	87.6			3.0	0.17
		3	16.02	33.00	6.59	7.96	59.33	87.8				
		4	16.01	33.00	6.03	7.96	60.51	88.2			7.7	0.37
10	856	0	15.91	32.85	6.28	7.93	62.02	88.7	13	2.0	3.2	0.53
2k SW		1	16.21	33.19	6.44	7.93	54.52	85.9				
		2	16.32	33.00	6.64	7.92	38.30	78.7			7.4	0.60
		3	16.30	32.99	6.46	7.85	41.41	80.2				
		4	16.34	33.03	6.04	7.82	35.78	77.3			8.3	1.93
11	910	0	16.03	32.97	5.99	7.94	60.03	88.0	9	3.0	10.0	0.62
2k SW		1	15.99	32.96	6.13	7.94	59.06	87.7				
		2	15.92	32.96	5.98	7.95	57.61	87.1			< 0.7	0.25
		3	15.88	32.97	5.73	7.94	57.48	87.1				
		4	15.85	32.99	5.58	7.95	57.37	87.0			7.9	0.58
12	1040	0	15.40	26.90	6.43	8.20	79.11	94.3	10	3.8	6.6	1.41
4k SW		1	15.49	31.82	7.02	8.18	72.54	92.3				
		2	15.64	33.15	7.03	8.15	74.60	92.9			4.4	1.08
		3	15.66	33.20	6.96	8.14	75.79	93.3				
13	735	0	14.70	27.86	6.36	7.97					5.2	2.21
18	915	0	15.78	33.03	5.79	7.94	65.05	89.8	9	3.4	10.3	1.07
2k SW		1	15.78	33.03	5.90	7.94	64.33	89.6				
		2	15.76	33.02	6.05	7.94	64.04	89.5			3.2	1.22
		3	15.74	33.01	5.60	7.93	65.26	89.9				
											1.6	1.20
19	750	0	14.60	33.20	6.27	7.76					12.5	0.75
20	845	0	16.07	33.31	6.51	7.96	40.28	79.7	16	1.7	2.6	3.14
2k SW		1	16.24	33.12	6.50	7.93	38.43	78.7				
		2	16.34	33.02	6.65	7.88	38.71	78.9			5.1	2.05
22	720	0	12.90	15.20	6.36	7.90					19.3	3.29
25	1107	0	15.91	33.15	6.49	8.04	70.59	91.7	11	4.6	8.2	0.84
6k W		1	15.89	33.15	6.58	8.04	70.84	91.7				
		2	15.83	33.15	6.78	8.03	71.46	91.9			18.9	0.79
		3	15.83	33.18	6.81	8.02	72.89	92.4				
		4	15.79	33.17	6.52	8.02	73.29	92.5			10.3	1.25
	Average		15.76	32.66	6.36	8.00	64.4	89.4	10.7	3.5	4.8	0.88
	Number		75	75	75	75	72	72	15	15	46	46.00
	St. Dev.		0.45	2.29	0.53	0.10	9.9	3.8	2.2	0.9	4.2	0.71
	Maximum		16.34	34.36	7.52	8.20	80.4	94.7	16	4.6	19.3	3.29
	Minimum		12.90	15.20	4.67	7.76	35.8	77.3	8	1.7	0.7	0.03

Surface Bacteriological Water Data and General Observations **December 1, 1998**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	651	6.6
RAIN:	None	M. Meyer	Low	1341	-0.7

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1010	600	400	1600	Moderate turbidity. Trash and organic material in water column.
2	1000	230	50	17	Moderate turbidity.
3	948	300	130	26	Moderate turbidity. No flow from tidal gate. Floating surface foam and trash.
4	1035	300	50	11	Moderate turbidity.
5	917	800	170	< 2	Moderate turbidity.
6	932	260	90	6	Moderate turbidity.
7	1055	1300	1300	900	Moderate turbidity.
8	816	300	70	30	Moderate turbidity.
9	903	110	< 20	2	Moderate turbidity.
10	840	16000	1300	50	Moderate turbidity.
11	850	300	80	23	Moderate turbidity.
12	1020	≥ 16000	16000	1600	Moderate turbidity. Many birds on south jetty. Organic material in water column.
13	732	2400	2400	500	Moderate turbidity. Construction activities continue. Moderate water flow into lagoon.
18	805	40	20	11	Moderate turbidity.
19	745	1700	220	220	Moderate turbidity. Floating brown foam and scum.
20	830	9000	1100	70	Moderate turbidity.
22	717	≥ 16000	9000	170	High turbidity. Brown water, surface oil film.
25	1043	2400	80	140	Moderate turbidity. Surface oil film and much floating trash, bags, plastic, etc.
	Average	3780.0	1804.4	298.8	
	Number	18	18	18	
	St. Dev.	5987.3	4123.3	524.7	
	Maximum	16000	16000	1600	
	Minimum	40	20	2	

Physical Water Quality Data — **December 1, 1998**

CRUISE:	MDR 98-99	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	651	6.6
RAIN:	None	M. Meyer	Low	1341	-0.7

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1010	0	15.36	31.97	5.75	8.09	34.67	76.7	16	1.2	6.0	2.8
4k SW		1	15.36	32.01	5.30	8.10	30.57	74.4				
		2	15.37	32.75	5.62	8.11	25.38	71.0			6.3	2.5
		3	15.36	32.94	6.23	8.12	23.91	69.9				
		4	15.35	33.11	6.81	8.13	19.29	66.3			5.8	2.4
2	1000	0	15.59	32.76	6.77	8.06	64.33	89.6	12	2.8	6.5	2.8
4k SW		1	15.49	32.93	6.68	8.06	62.76	89.0				
		2	15.43	33.22	6.96	8.12	59.67	87.9			4.2	2.5
		3	15.40	33.29	6.51	8.15	52.24	85.0				
		4	15.40	33.30	6.21	8.16	44.53	81.7			3.6	2.8
3	948	0	15.56	32.96	6.56	8.07	65.83	90.1	10	3.1	6.2	1.5
4k SW		1	15.56	32.98	6.40	8.07	66.60	90.3				
		2	15.56	32.99	6.64	8.07	65.96	90.1			4.7	0.9
											4.7	1.0
4	1035	0	15.67	32.78	4.96	8.05	65.19	89.9	10	3.1	4.6	1.0
4k SW		1	15.66	32.85	5.02	8.06	65.20	89.9				
		2	15.63	32.87	5.45	8.06	65.40	89.9			5.3	1.0
		3	15.62	32.89	6.05	8.06	66.09	90.2				
		4	15.58	32.95	5.81	8.07	66.02	90.1			4.7	1.0
5	917	0	15.93	32.53	4.86	7.96	64.09	89.5	12	3.2	7.7	0.7
4k SW		1	15.92	32.58	5.26	7.96	63.99	89.4				
		2	15.80	32.64	5.60	7.99	60.13	88.1			8.7	0.9
		3	15.67	32.75	5.43	8.00	61.01	88.4				
		4	15.64	33.02	4.97	8.05	61.99	88.7			8.1	0.9
		5	15.57	33.13	4.89	8.07	64.10	89.5				
		6	15.56	31.74	4.98	8.11	46.05	82.4			7.0	1.1
6	932	0	15.47	32.53	5.58	7.97	67.03	90.5	12	2.6	6.4	0.9
4k SW		1	15.53	32.59	6.57	7.97	66.68	90.4				
		2	15.72	32.77	6.79	7.98	65.97	90.1			5.9	0.8
		3	15.90	32.90	6.41	7.97	59.53	87.8				
7	1055	0	15.92	32.75	5.27	8.01	70.62	91.7	11	3.1	13.4	1.4
4k SW		1	15.92	32.84	4.63	8.01	70.40	91.6				
		2	15.90	32.89	5.50	8.01	67.91	90.8			12.1	0.8
		3	15.85	32.99	5.18	8.02	66.78	90.4				
		4	15.84	33.05	4.98	8.04	64.98	89.8			8.8	0.8
8	816	0	15.74	32.40	5.63	7.91	65.35	89.9	10	2.9	8.7	1.1
4k SW		1	15.77	32.42	5.71	7.91	65.58	90.0				
		2	15.97	32.73	6.13	7.90	63.29	89.2			6.7	1.2
		3	16.07	32.82	5.72	7.89	58.01	87.3				
		4	16.04	32.89	5.29	7.89	40.49	79.8			8.3	1.0

December 1/1998 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	903	0	16.11	32.59	5.83	7.93	60.85	88.3	12	2.4	14.0	0.7
4k SW		1	16.09	32.66	6.04	7.93	55.12	86.2				
		2	15.95	32.80	6.49	7.96	50.09	84.1			11.4	0.7
		3	15.88	32.90	6.16	8.00	46.02	82.4				
		4	15.83	32.93	5.26	8.03	40.62	79.8			10.6	1.0
10	840	0	16.14	32.62	5.56	7.83	68.20	90.9	12	2.6	15.7	1.3
4k SW		1	16.24	32.57	5.53	7.83	55.77	86.4				
		2	16.18	32.65	6.04	7.83	52.25	85.0			13.7	1.3
		3	16.13	32.75	5.38	7.86	46.91	82.8				
		4	16.12	32.84	4.77	7.89	40.33	79.7			13.4	0.6
11	850	0	16.00	32.47	5.20	7.93	62.84	89.0	12	2.6	9.7	0.9
4k SW		1	16.00	32.53	4.43	7.93	59.81	87.9				
		2	15.97	32.63	5.26	7.93	60.38	88.2			8.1	0.8
		3	15.89	32.85	5.41	7.95	55.86	86.5				
		4	15.82	33.00	4.89	8.00	56.30	86.6			8.0	0.8
12	1020	0	15.39	30.48	6.08	8.03	42.87	80.9	16	1.3	13.3	2.8
4k SW		1	15.39	31.91	5.68	8.05	32.98	75.8				
		2	15.39	32.57	5.72	8.09	19.49	66.4			8.1	2.5
		3	15.38	32.76	5.67	8.11	8.95	54.7				
13	732	0	16.20	31.21	4.00	8.05					16.6	2.5
18	805	0	15.42	32.31	5.70	7.91	63.80	89.4	11	2.8	4.6	1.2
4k SW		1	15.35	32.28	5.74	7.90	63.28	89.2				
		2	15.56	32.84	5.76	7.89	62.03	88.7			4.4	1.2
		3	16.11	32.87	5.45	7.88	46.11	82.4				
											4.2	1.4
19	745	0	15.10	32.55	5.59	7.72					5.2	1.7
20	830	0	16.19	32.12	4.10	7.80	67.65	90.7	11	2.8	18.4	3.1
4k SW		1	16.21	32.38	4.30	7.80	63.93	89.4				
		2	16.22	32.22	4.78	7.81	58.93	87.6			16.2	0.8
22	717	0	13.60	10.31	4.77	7.34					43.6	6.3
25	1043	0	15.68	32.77	7.08	8.02	67.70	90.7	12	3.2	10.5	1.2
4k SW		1	15.73	32.78	5.52	8.04	68.64	91.0				
		2	15.66	32.78	6.04	8.03	68.17	90.9			8.0	0.7
		3	15.60	32.86	6.10	8.04	68.66	91.0				
		4	15.56	33.04	5.90	8.05	64.07	89.5			7.7	0.8
	Average		15.71	32.36	5.63	7.98	56.2	85.8	11.9	2.6	9.3	1.5
	Number		73	73	73	73	70	70	15	15	46	46
	St. Dev.		0.38	2.65	0.68	0.12	14.1	7.1	1.8	0.6	6.4	1.0
	Maximum		16.24	33.30	7.08	8.16	70.6	91.7	16	3.2	43.6	6.3
	Minimum		13.60	10.31	4.00	7.34	9.0	54.7	10	1.2	3.6	0.6

Surface Bacteriological Water Data and General Observations

January 14, 1999

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	649	5.7
RAIN:	None	M. Meyer	Low	1403	-0.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1033	2200	1100	8	Light turbidity.
2	1020	< 20	< 20	< 2	Light turbidity.
3	1013	20	< 20	< 2	Light turbidity. Strong flow from tidal gate.
4	1104	20	20	2	Light turbidity.
5	940	50	20	22	Light turbidity.
6	955	50	< 20	< 2	Light turbidity.
7	1126	300	110	14	Light turbidity.
8	834	110	40	11	Light turbidity.
9	928	< 20	< 20	2	Light turbidity.
10	905	300	50	36	Light turbidity.
11	917	80	50	11	Light turbidity.
12	1042	9000	1700	23	Light turbidity.
13	745	500	260	500	Moderate turbidity. Floating trash. Construction activity continues.
18	822	50	20	< 2	Light turbidity.
19	801	170	70	8	Light turbidity.
20	855	1700	70	110	Light turbidity. Floating particles and oil film.
22	730	16000	500	300	Moderate turbidity.
25	1114	50	50	2	Light turbidity.
	Average	1702.2	230.0	58.7	
	Number	18	18	18	
	St. Dev.	4152.0	453.7	131.3	
	Maximum	16000	1700	500	
	Minimum	20	20	2	

Physical Water Quality Data **January 14, 1999**

CRUISE:	MDR 98-99	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear	Pers.: J. Gelsinger	High	649	5.7
RAIN:	None	M. Meyer	Low	1403	-0.2

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1033	0	14.15	29.72	5.29	8.17	76.55	93.5	9	4.9	0.9	0.9
1k WSW		1	14.59	33.90	4.97	8.15	52.98	85.3				
		2	14.60	33.37	4.97	8.13	77.83	93.9			< 0.7	0.5
		3	14.57	33.46	5.01	8.13	79.49	94.4				
		4	14.57	33.49	5.13	8.15	78.70	94.2			< 0.7	0.4
2	1020	0	14.38	33.26	4.57	8.03	69.03	91.2	9	4.4	7.1	0.5
1k WSW		1	14.35	33.24	4.90	8.03	69.14	91.2				
		2	14.35	33.29	4.98	8.04	70.19	91.5			12.0	0.4
		3	14.39	33.37	5.04	8.05	71.28	91.9				
		4	14.44	33.38	4.97	8.08	72.47	92.3			7.7	0.5
3	1013	0	14.41	33.25	4.80	8.03	66.14	90.2	11	3.5	7.9	0.6
1k WSW		1	14.42	33.25	4.71	8.02	65.00	89.8				
		2	14.39	33.25	4.73	8.02	65.39	89.9			12.5	0.4
		3	14.39	33.26	4.74	8.02	64.03	89.5				
											4.8	0.3
4	1104	0	14.33	33.17	4.04	8.01	62.61	89.0	10	3.2	13.6	0.6
1k WSW		1	14.29	33.15	5.33	7.99	59.04	87.7				
		2	14.29	33.16	4.89	7.99	60.02	88.0			8.5	0.5
		3	14.30	33.16	4.85	7.99	60.23	88.1				
		4	14.30	33.16	4.77	7.99	60.50	88.2			2.2	0.8
5	940	0	14.01	32.93	4.82	7.95	70.66	91.7	10	4.0	1.3	0.9
1k WSW		1	13.92	32.90	4.76	7.95	69.65	91.4				
		2	13.85	32.93	4.71	7.95	70.04	91.5			< 0.7	0.8
		3	13.82	33.00	4.66	7.96	67.15	90.5				
		4	13.99	33.18	4.60	7.96	61.18	88.4			0.7	0.7
		5	14.09	33.13	4.56	7.96	54.55	85.9				
6	955	0	13.74	33.04	4.20	7.97	53.59	85.6	12	2.4	< 0.7	1.0
1k WSW		1	13.71	32.99	4.10	7.96	53.12	85.4				
		2	13.60	33.01	4.42	7.96	52.89	85.3			< 0.7	0.7
		3	13.58	33.02	4.50	7.96	49.86	84.0				
		4	13.57	32.97	4.35	7.96	47.24	82.9			< 0.7	0.7
7	1126	0	14.11	33.02	4.79	7.91	67.38	90.6	9	4.4	1.7	0.8
1k WSW		1	14.08	33.02	5.05	7.91	67.22	90.5				
		2	13.99	32.99	4.89	7.90	66.93	90.4			0.8	0.7
		3	13.95	33.02	4.67	7.90	66.82	90.4				
		4	13.96	33.03	4.59	7.91	66.70	90.4			2.6	0.7
8	834	0	13.57	32.95	5.73	7.99	62.81	89.0	12	3.4	< 0.7	1.4
1k WSW		1	13.56	32.95	5.77	7.98	62.62	89.0				
		2	13.49	32.95	5.82	8.00	61.87	88.7			< 0.7	1.1
		3	13.45	32.96	5.77	8.00	60.69	88.3				
		4	13.32	32.89	5.67	8.00	60.50	88.2			1.2	1.4

January 14, 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	928	0	14.05	32.88	4.51	7.87	67.08	90.5	11	3.2	2.2	1.2
1k WSW		1	14.07	32.94	4.26	7.89	66.67	90.4				
		2	14.04	32.92	4.37	7.90	63.23	89.2			< 0.7	0.8
		3	14.03	32.96	4.93	7.90	60.41	88.2				
		4	14.01	32.98	4.99	7.89	56.92	86.9			< 0.7	0.9
10	905	0	13.67	32.70	4.51	7.99	70.24	91.5	12	3.0	0.8	1.4
1k WSW		1	13.76	32.81	4.39	7.99	69.28	91.2				
		2	14.09	32.87	4.48	7.99	59.03	87.7			< 0.7	1.5
		3	14.10	32.83	4.95	7.97	55.09	86.2				
		4	14.12	32.91	4.99	7.97	53.13	85.4			< 0.7	1.4
11	917	0	13.70	32.80	4.73	7.98	70.37	91.6	12	3.2	< 0.7	0.9
1k WSW		1	13.66	32.80	4.88	7.98	69.77	91.4				
		2	13.99	32.95	5.05	7.97	65.40	89.9			< 0.7	0.9
		3	13.99	32.95	4.87	7.96	55.63	86.4				
		4	13.94	32.97	4.87	7.95	54.60	86.0			< 0.7	0.8
12	1042	0	13.72	17.10	4.38	8.39	42.79	80.9	15	3.3	2.0	3.2
1k WSW		1	15.37	30.01	5.21	7.96	35.80	77.4				
		2	14.66	32.93	4.45	8.01	55.25	86.2			2.6	4.0
		3	14.66	33.07	4.37	8.02	79.01	94.3				
13	745	0	12.60	30.25	9.50	8.26					1.0	8.7
18	822	0	13.43	33.03	5.90	7.98	61.06	88.4	12	3.2	< 0.7	1.6
1k WSW		1	13.43	33.04	5.91	7.98	61.89	88.7				
		2	13.43	33.03	5.93	7.98	62.14	88.8			< 0.7	1.6
		3	13.24	32.97	5.85	7.98	62.58	88.9				
19	801	0	12.70	32.68	7.80	7.99					< 0.7	2.5
20	855	0	13.93	32.79	5.66	7.98	64.64	89.7	14	2.4	3.7	3.3
1k WSW		1	14.10	32.96	5.38	7.99	59.63	87.9				
		2	14.13	32.87	5.36	7.98	56.42	86.7			4.2	1.0
22	730	0	12.70	27.97	11.40	8.39					1.9	8.6
25	1114	0	14.32	33.14	4.21	7.96	64.21	89.5	10	3.4	3.1	1.0
1k WSW		1	14.30	33.14	4.20	7.95	63.93	89.4				
		2	14.29	33.14	4.52	7.96	64.08	89.5			2.7	1.0
		3	14.28	33.15	4.58	7.96	63.92	89.4				
		4	14.28	33.15	4.23	7.96	63.47	89.3			2.7	1.0
	Average		14.00	32.65	5.06	8.00	63.0	88.9	11.2	3.5	2.8	1.4
	Number		74	74	74	74	71	71	15	15	45	45
	St. Dev.		0.47	2.02	1.09	0.09	8.0	3.0	1.8	0.7	3.4	1.7
	Maximum		15.37	33.90	11.40	8.39	79.5	94.4	15	4.9	13.6	8.7
	Minimum		12.60	17.10	4.04	7.87	35.8	77.4	9	2.4	0.7	0.3

Surface Bacteriological Water Data and General Observations **February 25, 1999**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy to Overcast	Pers.:	J. Gelsinger	High	517	5.5
RAIN:	None		M. Meyer	Low	1235	-0.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1031	1100	300	23	Moderate turbidity
2	1016	< 20	< 20	< 2	Moderate turbidity
3	1005	70	40	7	Moderate turbidity. Strong flow from tidal gate.
4	1055	< 20	< 20	< 2	Moderate turbidity
5	935	< 20	< 20	< 2	Moderate turbidity
6	946	50	50	< 2	Moderate turbidity
7	1115	20	20	< 2	Moderate turbidity
8	826	300	300	8	Moderate turbidity
9	922	3000	20	220	Moderate turbidity
10	856	1300	50	17	Moderate turbidity
11	910	9000	< 20	220	Moderate turbidity
12	1039	1700	700	26	Moderate turbidity
13	935	≥ 16000	16000	300	Moderate turbidity. Floating trash.
18	815	130	130	< 2	Moderate turbidity
19	753	170	110	9	Moderate turbidity
20	846	2400	40	50	Moderate turbidity. Surface debris and oil.
22	720	≥ 16000	800	900	Moderate turbidity.
25	1103	20	< 20	2	Moderate turbidity
	Average	2851.1	1036.7	99.7	
	Number	18	18	18	
	St. Dev.	5243.3	3741.7	219.9	
	Maximum	16000	16000	900	
	Minimum	20	20	2	

Physical Water Quality Data **February 25, 1999**

CRUISE:	MDR 98-99	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy to Overcast	Pers.:	J. Gelsinger	High	517	5.5
RAIN:	None		M. Meyer	Low	1235	-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 u-at/l	BOD mg/l
1	1031	0	14.41	28.30	7.18	8.08	59.19	87.7	10	3.4	2.4	1.7
6k SW		1	14.08	32.09	7.08	8.05	48.41	83.4				
		2	14.02	32.64	7.64	7.98	71.92	92.1			6.2	1.0
2	1016	0	14.36	33.34	5.29	8.08	68.60	91.0	10	3.8	5.9	1.0
6k SW		1	14.40	33.35	8.93	8.08	69.11	91.2				
		2	14.31	33.31	7.55	8.08	68.14	90.9			0.7	0.7
		3	13.85	33.30	7.74	8.08	66.99	90.5				
		4	13.51	33.44	7.63	8.07	62.02	88.7			< 0.7	0.7
3	1005	0	14.18	33.34	6.98	8.06	71.23	91.9	10	4.0	1.9	0.9
4k SW		1	14.18	33.35	6.98	8.06	69.38	91.3				
		2	14.17	33.35	7.02	8.07	69.89	91.4			1.7	0.7
		3	14.16	33.35	7.05	8.07	69.90	91.4				
											1.7	0.8
4	1055	0	14.87	33.29	7.01	8.11	68.37	90.9	10	4.2	< 0.7	0.9
6k SW		1	14.83	33.27	7.07	8.11	67.27	90.6				
		2	14.56	33.17	7.18	8.11	68.35	90.9			< 0.7	0.8
		3	14.10	33.27	7.28	8.09	67.90	90.8				
											< 0.7	0.7
5	935	0	14.88	33.23	6.99	8.13	64.76	89.7	11	2.7	< 0.7	1.0
4k SW		1	14.81	33.21	7.10	8.13	64.18	89.5				
		2	14.75	33.28	7.00	8.13	59.46	87.8			< 0.7	0.9
		3	14.51	33.33	7.08	8.13	50.68	84.4				
		4	14.32	33.44	7.12	8.10	55.94	86.5			< 0.7	1.0
6	946	0	14.64	33.32	7.26	8.15	58.69	87.5	12	2.6	< 0.7	1.1
4k SW		1	14.57	33.29	7.28	8.15	57.43	87.1				
		2	14.46	33.31	7,33	8.16	55.68	86.4			< 0.7	1.1
		3	14.30	33.33	7.48	8.15	53.47	85.5				
		4	14.27	33.42	7.45	8.14	49.64	83.9			4.0	1.1
7	1115	0	14.79	33.37	6.84	8.04	71.30	91.9	11	3.9	2.1	0.6
6k SW		1	14.74	33.36	6.65	8.05	69.56	91.3				
		2	14.62	33.38	7.14	8.05	67.74	90.7			1.7	0.5
		3	14.51	33.41	6.86	8.05	66.22	90.2				
											< 0.7	0.7
8	826	0	14.64	33.25	7.46	8.14	55.25	86.2	12	2.5	0.9	1.5
4k SW		1	14.61	33.25	7.57	8.13	54.85	86.1				
		2	14.56	33.26	7.80	8.13	51.78	84.8			0.8	1.6
		3	14.51	33.24	7.84	8.13	50.98	84.5				
		4	14.46	33.27	7.82	8.13	51.67	84.8			< 0.7	1.4

February 25, 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	14.96	32.62	7.26	8.10	62.12	88.8	11	3.2	1.2	1.3
4k SW		1	14.92	33.00	7.23	8.10	65.29	89.9				
		2	14.58	33.22	7.32	8.11	64.63	89.7			< 0.7	0.7
		3	14.36	33.29	7.42	8.11	54.45	85.9				
		4	14.34	33.42	6.99	8.09	46.77	82.7			< 0.7	0.7
10	856	0	14.68	32.48	7.15	7.98	67.68	90.7	11	3.5	1.0	0.8
4k SW		1	14.64	32.98	7.16	8.00	71.28	91.9				
		2	14.73	33.21	6.98	8.06	69.68	91.4			0.7	0.7
		3	14.69	33.28	6.86	8.08	61.64	88.6				
		4	14.62	33.35	6.86	8.07	53.32	85.5			< 0.7	0.8
11	910	0	14.80	33.19	7.18	8.10	65.44	89.9	11	3.3	< 0.7	0.9
4k SW		1	14.77	33.18	7.12	8.10	64.88	89.7				
		2	14.73	33.22	7.02	7.02	62.68	89.0			< 0.7	0.8
		3	14.48	33.24	6.88	8.10	57.81	87.2				
		4	14.37	33.34	6.89	8.10	57.53	87.1			< 0.7	0.9
12	1039	0	15.02	21.89	8.05	8.05	64.08	89.5	13	2.7	< 0.7	2.9
6k SW		1	14.69	31.16	6.73	7.97	30.55	74.3				
		2	14.20	32.84	6.58	7.87	59.07	87.7			2.5	2.4
13	935	0	14.66	30.40	11.00	8.54					7.6	5.3
18	815	0	14.54	33.25	8.04	8.14	55.74	86.4	12	2.7	2.5	1.4
4k SW		1	14.55	33.26	8.13	8.15	55.64	86.4				
		2	14.52	33.26	8.10	8.15	55.20	86.2			0.9	2.0
19	753	0	14.10	32.56	8.40	8.02					< 0.7	1.5
20	846	0	14.68	31.55	7.33	7.95	71.12	91.8	12	2.0	1.9	1.9
4k SW		1	14.70	32.44	7.13	7.99	71.99	92.1				
											1.7	1.0
22	720	0	16.80	30.73	11.90	8.56					2.9	3.9
25	1103	0	14.98	33.28	7.35	8.08	71.05	91.8	10	4.3	1.7	0.8
6k SW		1	14.93	33.26	7.35	8.08	70.94	91.8				
		2	14.73	33.29	7.42	8.08	70.74	91.7			0.8	0.8
		3	14.44	33.24	7.23	8.07	71.49	92.0				
		4	13.89	33.26	7.25	8.05	68.76	91.1			< 0.7	0.8
	Average		14.55	32.82	7.39	8.08	62.2	88.6	11.1	3.3	1.6	1.2
	Number		66	66	66	66	63	63	15	15	44	44
	St. Dev.		0.41	1.60	0.88	0.16	8.3	3.2	1.0	0.7	1.6	0.9
	Maximum		16.80	33.44	11.90	8.56	72.0	92.1	13	4.3	7.6	5.3
	Minimum		13.51	21.89	5.29	7.02	30.6	74.3	10	2.0	0.7	0.5

Surface Bacteriological Water Data and General Observations **March 17,1999**

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.:	J. Gelsinger	High	842	5.8
RAIN:	None		M. Meyer	Low	1508	-0.6

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1025	≥ 16000	2400	≥ 1600	Moderate turbidity.
2	1018	2400	80	23	Moderate turbidity. Floating trash and organic debris.
3	1000	800	50	2	Moderate turbidity. No flow from tidal gate.
4	1056	3000	1300	23	Moderate turbidity. Floating leave and organic debris.
5	932	800	90	< 2	Moderate turbidity.
6	945	2400	220	2	Moderate turbidity.
7	1118	270	50	5	Moderate turbidity.
8	820	130	< 20	30	Moderate turbidity.
9	920	170	20	2	Moderate turbidity.
10	852	3000	3000	800	Moderate turbidity.
11	900	130	50	< 2	Moderate turbidity.
12	1037	≥ 16000	16000	110	Moderate turbidity. Floating trash, plastic bags, and cups
13	736	≥ 16000	≥ 16000	≥ 1600	High turbidity.
18	808	800	70	7	Moderate turbidity.
19	750	3000	90	26	Moderate turbidity.
20	840	2400	110	170	Moderate turbidity. Brown surface debris. Dead topsmelt on bottom.
22	723	≥ 16000	≥ 16000	240	High turbidity. Brown water. Floating oil and surface debris.
25	1105	800	230	4	Moderate turbidity. Floating oil, trash, and organic debris.
	Average	4672.2	3098.9	258.2	
	Number	18	18	18	
	St. Dev.	6315.4	5998.7	523.6	
	Maximum	16000	16000	1600	
	Minimum	130	20	2	

Physical Water Quality Data March 17,1999

CRUISE: MDR 98-99 Vessel: Aquatic Bioassay
WEATHER: Overcast Pers.: J. Gelsinger
RAIN: None M. Meyer

TIDE	TIME	HT. (ft)
High	842	5.8
Low	1508	-0.6

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1025	0	13.80	27.78	8.08	7.94	68.59	91.0	11	3.3	13.3	2.6
8k WSW		1	13.75	29.29	8.06	7.94	62.99	89.1				
		2	13.72	32.78	7.97	7.99	63.94	89.4			4.2	2.7
		3	13.72	33.21	8.15	8.01	72.57	92.3				
		4	13.66	33.49	7.84	8.03	71.83	92.1			4.1	3.0
2	1018	0	14.75	32.41	8.31	7.99	53.38	85.5	13	2.4	1.1	6.6
8k WSW		1	14.77	32.41	8.47	8.00	52.46	85.1				
		2	14.16	32.59	8.54	8.00	55.02	86.1			< 0.7	5.1
		3	13.93	33.01	8.55	8.00	57.86	87.2				
		4	13.60	33.41	8.31	8.01	63.55	89.3			< 0.7	4.9
		5	13.55	33.58	8.32	8.00	71.82	92.1				
		6	13.56	33.61	8.33	7.98	73.06	92.5			2.2	3.7
3	1000	0	14.89	32.29	7.99	7.92	65.71	90.0	12	2.6	0.9	1.9
8k WSW		1	14.81	32.50	8.00	7.93	65.16	89.8				
		2	14.50	32.93	8.07	7.97	57.21	87.0			1.2	1.4
											< 0.7	1.5
4	1056	0	14.95	32.47	7.60	7.94	63.08	89.1	11	3.0	0.8	2.8
8k WSW		1	14.86	32.48	7.65	7.94	62.83	89.0				
		2	14.38	32.73	7.73	7.94	63.40	89.2			< 0.7	2.1
		3	14.04	33.25	7.79	7.96	64.37	89.6				
		4	13.95	33.42	7.78	8.00	61.11	88.4			< 0.7	1.7
5	932	0	15.44	31.96	6.22	7.93	65.36	89.9	12	2.5	0.9	1.4
8k WSW		1	15.48	32.33	6.36	7.93	63.82	89.4				
		2	15.00	32.53	6.97	7.96	56.98	86.9			< 0.7	1.8
		3	14.56	32.89	7.52	7.97	55.72	86.4				
		4	14.33	33.28	7.53	8.02	55.03	86.1			< 0.7	1.8
6	945	0	15.04	31.96	6.64	7.95	64.77	89.7	12	2.5	< 0.7	1.0
8k WSW		1	15.05	32.00	7.11	7.95	64.20	89.5				
		2	15.31	32.43	7.84	7.95	64.57	89.6			< 0.7	0.9
		3	15.44	33.00	8.36	7.95	58.35	87.4				
		4	15.39	33.05	7.72	7.90	45.06	81.9			< 0.7	0.8
7	1118	0	15.38	32.46	7.14	7.90	68.35	90.9	12	2.4	2.6	0.8
8k WSW		1	15.33	32.61	7.16	7.90	64.78	89.7				
		2	15.24	32.86	7.70	7.90	60.88	88.3			2.2	0.9
		3	15.13	32.86	7.78	7.89	58.00	87.3				
		4	14.76	33.01	7.31	7.89	56.72	86.8			2.5	0.7
8	820	0	15.36	31.50	7.89	7.92	61.06	88.4	12	2.5	< 0.7	0.9
8k WSW		1	15.66	32.48	7.82	7.92	60.54	88.2				
		2	15.80	32.82	7.92	7.92	53.35	85.5			< 0.7	1.0
		3	15.79	33.10	8.19	7.90	46.15	82.4				
		4	15.84	33.26	8.06	7.83	31.51	74.9			< 0.7	1.0

March 17,1999 **(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	920	0	15.90	32.16	7.61	7.86	48.92	83.6	12	1.8	1.3	0.6
k WSW		1	15.84	32.54	7.59	7.85	39.42	79.2				
		2	15.62	33.03	7.66	7.82	25.51	71.1			< 0.7	0.7
		3	15.39	33.16	7.50	7.86	20.24	67.1				
											< 0.7	0.5
10	852	0	15.34	30.48	6.22	7.87	75.24	93.1	12	2.5	1.4	1.9
k WSW		1	15.95	32.21	6.43	7.89	74.04	92.8				
		2	16.04	32.82	7.42	7.90	50.76	84.4			< 0.7	0.6
		3	15.93	32.99	7.83	7.88	45.46	82.1				
		4	15.92	33.17	7.46	7.87	40.37	79.7			< 0.7	0.7
11	900	0	15.81	32.03	7.65	7.91	64.40	89.6	12	2.5	< 0.7	0.8
8k WSW		1	15.74	32.64	7.79	7.94	53.13	85.4				
		2	15.20	32.91	7.98	7.91	46.16	82.4			< 0.7	0.7
		3	15.12	33.13	7.60	7.91	44.44	81.6				
		4	15.00	33.16	7.59	7.89	37.29	78.1			< 0.7	0.8
12	1037	0	14.07	21.51	7.32	7.96	52.17	85.0	11	3.3	15.2	5.5
8k WSW		1	14.07	29.51	6.93	7.94	34.00	76.4				
		2	13.82	32.63	6.85	7.96	26.92	72.0			5.1	4.2
		3	13.75	33.13	6.88	7.96	41.05	80.0				
13	736	0	13.78	1.19	5.20	6.96					22.9	7.6
18	808	0	15.15	31.49	8.48	7.94	57.99	87.3	12	2.6	5.4	1.4
8k WSW		1	15.68	33.13	8.54	7.93	57.72	87.2				
		2	16.01	33.03	8.38	7.88	46.20	82.4			< 0.7	1.4
		3	15.96	33.12	8.20	7.88	40.17	79.6				
		4	15.95	33.14	8.32	7.85	36.55	77.8			< 0.7	1.4
19	750	0	14.12	31.84	7.84	7.82					< 0.7	1.4
20	840	0	14.73	31.22	7.48	7.80	73.25	92.5	12	2.1	2.0	4.8
k WSW		1	15.89	32.13	7.65	7.88	68.74	91.1				
											0.9	5.2
22	723	0	13.60	1.44	5.60	6.95					13.2	7.0
25	1105	0	15.07	32.43	7.20	7.89	72.44	92.3	11	3.9	2.9	2.7
k WSW		1	15.08	32.45	7.20	7.90	68.69	91.0				
		2	14.97	32.64	7.15	7.91	70.04	91.5			1.0	1.2
		3	14.54	32.89	7.69	7.93	66.09	90.2				
		4	14.14	33.23	7.96	7.97	58.35	87.4			0.7	1.2
		5	13.98	31.76	7.55	7.98	48.10	83.3				
Average			14.89	31.52	7.62	7.90	56.46	86.20	11.8	2.7	2.6	2.2
Number			74	74	74	74	71	71	15	15	47	47
St. Dev.			0.78	5.31	0.66	0.17	12.63	5.48	0.6	0.5	4.5	1.9
Maximum			16.04	33.61	8.55	8.03	75.24	93.13	13	3.9	22.9	7.6
Minimum			13.55	1.19	5.20	6.95	20.24	67.07	11	1.8	0.7	0.5

Surface Bacteriological Water Data and General Observations **April 23,1999**

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

TIDE	TIME	HT. (ft)
High	517	5.5
Low	1235	-0.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1030	400	300	70	Moderate turbidity. Kayaker present.
2	1020	1300	170	80	Moderate turbidity.
3	1003	300	110	11	Moderate turbidity. Strong flow from tidal gate.
4	1102	110	50	< 2	Moderate turbidity.
5	931	20	20	4	Moderate turbidity.
6	945	20	< 20	5	Moderate turbidity.
7	1125	20	20	4	Moderate turbidity. Floating oil present.
8	825	60	60	5	Low turbidity.
9	920	< 20	< 20	< 2	Moderate turbidity.
10	850	3000	80	50	Moderate turbidity.
11	905	90	< 20	2	Moderate turbidity.
12	1040	9000	1100	60	Moderate turbidity.
13	740	16000	20	140	Moderate turbidity.
18	812	220	220	< 2	Low turbidity.
19	802	20	20	2	Low turbidity. People raking the beach.
20	835	5000	220	70	Moderate turbidity. Moderate flow. Trash on floodgate.
22	725	≥ 16000	2200	500	Moderate turbidity. Many egrets and night herons present.
25	1115	50	< 20	2	Moderate turbidity.
	Average	2868.3	259.4	56.2	
	Number	18	18	18	
	St. Dev.	5318.8	546.7	117.7	
	Maximum	16000	2200	500	
	Minimum	20	20	2	

Physical Water Quality Data April 23,1999

CRUISE:	MDR 98-99	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	517	5.5
RAIN:	None	M. Meyer	Low	1235	-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 u-at/l	BOD mg/l
1	1030	0	16.63	23.75	6.99	8.10	56.25	86.6	14	2.4	4.4	2.0
9k E		1	15.81	30.89	7.38	8.09	30.58	74.4				
		2	15.18	33.29	7.22	8.08	50.89	84.5			2.0	2.2
		3	15.07	33.52	6.56	8.07	54.64	86.0				
		4									1.4	2.5
2	1020	0	16.48	31.29	6.61	8.13	57.40	87.0	10	3.0	2.3	2.3
9k E		1	16.61	33.13	6.98	8.13	57.07	86.9				
		2	16.58	33.15	6.87	8.13	56.84	86.8			0.9	2.0
		3	15.95	33.31	6.91	8.13	56.56	86.7				
		4	15.13	33.63	7.03	8.14	57.76	87.2			< 0.7	1.8
3	1003	0	16.59	33.21	7.28	8.10	61.66	88.6	10	3.0	< 0.7	1.3
9k E		1	16.62	33.21	7.40	8.11	60.68	88.3				
		2	16.58	33.22	7.38	8.11	61.06	88.4			< 0.7	1.1
		3	16.54	33.21	7.29	8.10	61.13	88.4				
		4	16.48	33.24	7.30	8.10	61.47	88.5			< 0.7	1.3
4	1102	0	16.97	33.11	5.02	8.11	64.69	89.7	11	2.8	< 0.7	1.7
6k E		1	16.86	33.21	6.26	8.11	62.52	88.9				
		2	16.27	33.39	6.28	8.09	64.13	89.5			< 0.7	1.2
		3	15.58	33.75	6.84	8.08	65.44	89.9				
		4									< 0.7	1.6
5	931	0	17.12	33.05	6.23	8.09	58.37	87.4	10	2.6	< 0.7	1.4
5k E		1	17.08	33.08	6.47	8.09	58.31	87.4				
		2	16.88	33.15	7.09	8.08	56.58	86.7			< 0.7	0.9
		3	16.02	33.45	7.03	8.10	52.93	85.3				
		4	15.59	33.67	7.35	8.11	50.82	84.4			< 0.7	1.1
6	945	0	16.89	33.18	7.33	8.12	64.54	89.6	10	3.0	< 0.7	1.4
5k E		1	16.90	33.18	7.36	8.12	64.38	89.6				
		2	16.90	33.15	7.39	8.13	63.50	89.3			< 0.7	1.4
		3	16.74	33.24	7.41	8.13	63.88	89.4				
7	1125	0	17.04	33.24	6.75	8.07	70.50	91.6	10	3.3	< 0.7	1.1
6k E		1	17.02	33.19	6.29	8.07	69.91	91.4				
		2	16.77	33.25	6.95	8.08	68.51	91.0			< 0.7	1.0
		3	16.22	33.58	7.20	8.06	64.76	89.7				
8	825	0	17.18	33.10	7.37	8.09	58.55	87.5	10	2.9	< 0.7	1.1
5k E		1	17.17	33.07	7.31	8.09	57.63	87.1				
		2	17.07	33.05	7.29	8.08	56.45	86.7			< 0.7	1.2
		3	16.81	33.13	7.33	8.06	52.35	85.1				
		4									< 0.7	1.1

April 23,1999 **(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	920	0	17.33	32.94	7.16	8.07	58.56	87.5	12	1.8	0.8	0.9
5k E		1	17.22	32.93	7.19	8.08	52.10	85.0				
		2	16.32	33.31	7.21	8.07	35.46	77.2			0.7	0.9
		3										
		4									< 0.7	1.2
10	850	0	17.01	32.81	6.09	8.00	32.16	75.3	14	1.4	2.0	0.8
5k E		1	17.01	32.89	6.33	8.00	32.24	75.4				
		2	16.92	33.03	6.22	8.01	32.03	75.2			2.1	0.9
		3	16.74	33.18	6.12	8.01	29.99	74.0				
11	905	0	17.25	33.01	7.03	8.08	59.56	87.8	12	2.4	1.1	1.1
5k E		1	17.19	33.01	7.16	8.08	60.86	88.3				
		2	16.88	33.07	7.26	8.08	55.93	86.5			< 0.7	0.9
		3	16.26	33.47	7.36	8.07	39.59	79.3				
											< 0.7	0.9
12	1040	0	17.18	19.36	6.72	8.09	57.19	87.0	15	2.4	0.9	3.2
9k E		1	16.27	29.62	6.46	8.04	22.09	68.6				
		2	15.64	32.91	6.01	7.90	44.21	81.5			2.5	2.3
13	740	0	16.92	34.17	6.53	7.90					2.1	1.5
18	812	0	17.12	33.08	7.37	8.10	55.93	86.5	10.0	2.9	1.5	1.2
5k E		1	17.09	33.08	7.36	8.10	55.73	86.4				
		2	16.99	33.11	7.26	8.09	55.54	86.3			0.9	1.3
19	802	0	16.52	34.02	6.78	7.91					0.8	1.5
20	835	0	16.95	32.66	6.61	7.93	31.84	75.1	14.0	1.3	3.3	0.7
5k E		1	16.94	32.69	7.00	7.97	29.21	73.5				
		3									2.9	1.4
22	725	0	18.70	32.52	6.37	7.90					5.9	2.8
25	1115	0	17.04	33.23	6.98	8.08	65.89	90.1	10.0	3.3	1.8	1.1
6k E		1	17.03	33.12	7.07	8.08	66.96	90.5				
		2	16.50	33.10	7.28	8.07	68.18	90.9			1.4	1.0
		3	15.77	33.46	7.36	8.06	66.53	90.3				
		4									1.4	1.0
Average			16.66	32.69	6.92	8.07	54.84	85.58	11.47	2.57	1.36	1.42
Number			61	61	61	61	58	58	15	15	41	41
St. Dev.			0.62	2.20	0.48	0.06	11.98	5.42	1.88	0.63	1.13	0.58
Maximum			18.70	34.17	7.41	8.14	70.50	91.63	15.00	3.30	5.90	3.22
Minimum			15.07	19.36	5.02	7.90	22.09	68.56	10.00	1.30	0.70	0.74

Surface Bacteriological Water Data and General Observations May 10, 1999

CRUISE:	MDR 97-98	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger	High	542	4.1
RAIN:	None		M. Meyer	Low	1218	0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1020	300	40	< 2	Moderate turbidity.
2	1010	< 20	< 20	< 2	Moderate turbidity.
3	1000	500	170	5	Moderate turbidity. Green algae in water column. Moderate flow from tidal gate.
4	1050	1300	1300	< 2	Moderate turbidity.
5	926	< 20	< 20	< 2	Moderate turbidity.
6	940	< 20	< 20	< 2	Moderate turbidity.
7	1114	20	< 20	2	Moderate turbidity.
8	825	50	20	4	Moderate turbidity.
9	913	< 20	< 20	< 2	Moderate turbidity.
10	850	9000	70	50	Moderate turbidity.
11	903	270	220	2	Moderate turbidity.
12	1031	230	130	8	Moderate turbidity.
13	737	≥ 16000	≥ 16000	170	Moderate turbidity.
18	810	80	20	2	Moderate turbidity.
19	750	< 20	< 20	2	Moderate turbidity.
20	840	2400	90	23	Moderate turbidity. Floating oil and organic debris on the water surface. Floating dead fish.
22	725	≥ 16000	3000	6	Moderate turbidity. Many herons on shore.
25	1102	130	130	22	Moderate turbidity.
	Average	2576.7	1183.9	17.1	
	Number	18	18	18	
	St. Dev.	5321.6	3769.8	40.1	
	Maximum	16000	16000	170	
	Minimum	20	20	2	

Physical Water Quality Data May 10, 1999

CRUISE:	MDR 98-99	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	542	4.1
RAIN:	None	M. Meyer	Low	1218	0.3

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1020	0	18.13	27.09	6.09	8.09	52.82	85.3	12	2.8	8.6	3.3
1k WSW		1	16.67	32.34	6.65	8.06	53.66	85.6				
		2	16.13	33.24	7.00	8.01	62.31	88.8			5.6	3.6
		3	16.06	33.32	7.39	8.02	63.26	89.2				
		4									4.3	2.7
2	1010	0	18.12	33.44	6.57	8.06	46.76	82.7	13	2.2	3.5	6.8
1k WSW		1	17.96	33.44	6.77	8.06	46.71	82.7				
		2	17.26	33.28	7.03	8.05	47.59	83.1			1.8	5.5
		3	15.82	33.58	7.39	8.05	52.81	85.2				
		4	15.21	33.87	7.66	8.06	63.02	89.1			1.9	5.1
3	1000	0	18.13	33.42	6.69	7.99	56.19	86.6	13	2.6	4.7	4.0
1k WSW		1	18.07	33.45	6.97	8.00	53.43	85.5				
		2	18.13	33.40	6.77	8.00	53.83	85.7			3.2	3.6
		3	18.12	33.13	6.64	8.00	53.88	85.7				
		4	16.69	33.72	6.61	8.01	52.22	85.0			2.5	3.5
4	1050	0	18.77	33.40	6.56	7.98	55.14	86.2	12	2.8	2.0	2.7
1k WSW		1	18.75	33.39	6.63	7.98	55.52	86.3				
		2	18.61	33.11	6.60	7.98	55.31	86.2			2.4	2.9
		3	18.13	33.41	6.62	7.98	55.97	86.5				
		4									1.9	2.9
5	926	0	18.62	33.31	5.86	7.94	47.61	83.1	11	2.0	4.0	1.3
1k WSW		1	18.41	33.38	5.89	7.94	46.51	82.6				
		2	17.92	33.36	5.88	7.97	43.27	81.1			3.8	1.1
		3	16.96	33.70	5.95	8.05	50.16	84.2				
		4									3.7	1.5
6	940	0	18.31	33.46	6.74	8.03	52.60	85.2	11	2.3	2.9	1.2
1k WSW		1	18.27	33.43	6.80	8.05	50.28	84.2				
		2	18.07	33.33	6.86	8.05	48.22	83.3			2.0	1.4
		3	17.67	33.57	6.87	8.02	46.54	82.6				
		4									1.7	1.5
7	1114	0	18.60	33.43	5.83	7.93	63.37	89.2	10	2.8	3.1	1.3
1k WSW		1	18.51	33.42	5.87	7.94	61.59	88.6				
		2	18.32	33.38	5.90	7.94	60.77	88.3			2.9	1.3
		3	17.70	33.72	5.94	7.93	56.88	86.8				
		4									7.0	1.3
8	825	0	18.68	33.43	5.93	7.91	55.81	86.4	11	2.3	4.9	0.7
1k WSW		1	18.66	33.43	6.07	7.90	55.81	86.4				
		2	18.60	33.40	5.87	7.90	54.27	85.8			3.8	0.6
		3	18.44	33.44	5.77	7.89	48.84	83.6				
		4	18.39	33.46	5.78	7.88	47.26	82.9			3.4	0.8

May 10, 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	913	0	18.71	33.11	6.03	7.86	37.26	78.1	13	1.5	4.5	1.1
1k WSW		1	18.55	33.20	6.02	7.88	36.55	77.8				
		2	18.12	33.31	5.99	7.91	29.44	73.7			4.5	0.8
		3	17.70	33.43	5.87	7.94	26.82	72.0				
		4	17.72	33.37	5.80	7.94	26.20	71.5			3.6	0.9
10	850	0	18.67	33.11	5.54	7.79	43.89	81.4	12	1.7	6.6	0.8
1k WSW		1	18.63	33.21	5.58	7.80	43.71	81.3				
		2	18.58	33.25	5.28	7.81	41.61	80.3			6.1	1.1
		3	18.39	33.27	5.12	7.80	33.08	75.8				
		4	18.13	33.43	5.02	7.76	23.77	69.8			5.9	1.1
11	903	0	18.70	33.36	5.85	7.87	51.84	84.9	11	2.0	5.1	0.4
1k WSW		1	18.67	33.36	6.07	7.87	50.37	84.2				
		2	18.54	33.37	6.54	7.88	47.81	83.2			4.6	0.4
		3										
		4									4.4	0.5
12	1031	0	19.78	17.96	5.26	8.03	55.23	86.2	12	2.8	4.7	2.5
1k WSW		1	17.08	31.99	4.68	7.94	15.06	62.3				
		2	16.18	33.48	4.16	7.93	50.96	84.5			4.9	3.0
13	737	0	19.10	31.92	6.03	8.06					6.2	3.1
18	810	0	18.62	33.44	5.94	7.88	50.47	84.3	11	2.0	4.3	0.8
1k WSW		1	18.60	33.45	6.06	7.89	49.46	83.9				
		2	18.55	33.48	6.28	7.89	47.05	82.8			3.4	1.6
19	750	0	18.00	33.72	5.74	7.87					2.9	1.4
20	840	0	18.65	32.99	5.37	7.72	46.09	82.4	12	1.6	7.0	2.1
1k WSW		1	18.60	33.17	5.37	7.75	42.94	80.9				
		2	18.59	33.20	5.36	7.76	42.41	80.7			7.6	1.2
22	725	0	18.27	26.53	5.80	7.90					10.0	2.6
25	1102	0	18.85	33.38	6.20	7.97	56.31	86.6	11	2.8	4.5	2.4
1k WSW		1	18.80	33.33	6.39	7.97	55.53	86.3				
		2	18.58	33.11	6.56	7.96	58.10	87.3			3.4	2.3
		3	17.53	33.26	6.64	7.94	62.35	88.9				
		4	16.72	33.56	6.67	7.93	48.99	83.7			2.7	2.1
	Average		18.07	32.88	6.15	7.94	49.09	83.30	11.7	2.3	4.3	2.1
	Number		65	65	65	65	62	62	15	15	45	45
	St. Dev.		0.86	2.22	0.65	0.09	9.95	5.00	0.9	0.5	1.9	1.4
	Maximum		19.78	33.87	7.66	8.09	63.37	89.22	13	2.8	10.0	6.8
	Minimum		15.21	17.96	4.16	7.72	15.06	62.30	10	1.5	1.7	0.4

Surface Bacteriological Water Data and General Observations **June 23, 1999**

CRUISE:	MDR 97-98	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast to Pt. Cldy.	Pers.: J. Gelsinger	High	708	3.4
RAIN:	None	M. Meyer	Low	1225	1.6

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1031	70	70	5	Moderate turbidity.
2	1016	< 20	< 20	2	Moderate turbidity.
3	1005	< 20	< 20	< 2	Moderate turbidity. Moderate flow from tidal gate.
4	1055	< 20	< 20	< 2	Moderate turbidity.
5	935	140	70	< 2	Moderate turbidity.
6	946	< 20	< 20	< 2	Moderate turbidity.
7	1115	20	20	2	Moderate turbidity.
8	826	20	70	< 2	Moderate turbidity.
9	922	20	< 20	5	Moderate turbidity.
10	856	800	220	50	Moderate turbidity.
11	910	590	130	13	Moderate turbidity.
12	1039	300	170	2	Moderate turbidity. Two fishermen on breakwall.
13	935	≥ 16000	9000	300	Moderate turbidity.
18	815	< 20	< 20	< 2	Moderate turbidity.
19	753	800	90	7	Moderate turbidity. Swimmer in the water.
20	846	5000	2400	50	Moderate turbidity.
22	720	≥ 16000	≥ 16000	≥ 1600	Moderate turbidity. Many herons on fence.
25	1103	20	20	< 2	Moderate turbidity. Sea lion in main channel.
	Average	2215.6	1576.7	113.9	
	Number	18	18	18	
	St. Dev.	5147.2	4187.8	377.4	
	Maximum	16000	16000	1600	
	Minimum	20	20	2	

Physical Water Quality Data June 23, 1999

CRUISE:	MDR 99-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast to Pt. Cldy.	Pers.: J. Gelsinger	High	708	3.4
RAIN:	None	M. Meyer	Low	1225	1.6

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
1	1031	0	19.97	28.66	7.17	8.32	53.97	85.7	12	2.0	3.5	2.3
2k WSW		1	19.57	30.41	7.31	8.31	51.00	84.5				
		2	18.74	32.92	7.40	8.26	52.29	85.0			2.6	1.5
		3	18.58	33.50	7.41	8.26	58.33	87.4				
		4	18.58	33.53	7.42	8.27	59.09	87.7			1.7	1.2
2	1016	0	19.98	33.30	7.31	8.22	44.38	81.6	13	1.9	2.5	1.4
2k WSW		1	19.94	33.21	7.35	8.23	44.24	81.6				
		2	19.23	33.22	7.65	8.23	46.33	82.5			< 0.7	1.4
		3	18.58	33.46	7.63	8.25	53.66	85.6				
		4	18.26	33.55	7.47	8.24	57.83	87.2			< 0.7	1.3
3	1005	0	20.01	33.38	7.30	8.16	49.99	84.1	13	2.0	2.9	1.0
2k WSW		1	20.00	33.38	7.27	8.16	49.47	83.9				
		2	19.98	33.38	7.20	8.18	46.81	82.7			< 0.7	1.1
		3	19.90	33.42	7.17	8.20	42.97	81.0				
		4									1.1	1.1
4	1055	0	20.54	33.39	6.57	8.18	51.48	84.7	12	2.3	2.0	1.1
2k WSW		1	20.59	33.33	7.64	8.18	52.12	85.0				
		2	20.44	33.32	7.27	8.18	51.09	84.5			0.8	1.1
		3	20.23	33.14	7.47	8.18	50.34	84.2				
		4	19.12	33.42	7.47	8.18	43.01	81.0			1.3	0.9
5	935	0	20.69	33.28	7.01	8.18	53.00	85.3	13	2.2	1.6	1.0
2k WSW		1	20.66	33.27	7.04	8.18	52.17	85.0				
		2	20.47	33.33	7.24	8.18	48.01	83.2			1.1	1.1
		3	20.35	33.22	7.12	8.19	44.20	81.5				
		4	19.77	33.33	6.98	8.18	41.42	80.2			2.2	1.2
		5	18.92	33.83	7.14	8.17	26.88	72.0				
6	946	0	20.33	33.38	6.51	8.18	54.47	85.9	13	2.1	1.9	1.0
2k WSW		1	20.30	33.39	6.51	8.17	54.68	86.0				
		2	20.21	33.41	6.88	8.18	47.79	83.1			< 0.7	0.9
		3	20.16	33.45	6.94	8.17	41.54	80.3				
		4									1.6	1.0
7	1115	0	20.89	33.36	5.10	8.12	47.84	83.2	12	2.0	1.6	0.9
2k WSW		1	20.89	33.39	5.28	8.12	47.29	82.9				
		2	20.75	33.34	6.02	8.12	47.79	83.1			2.3	0.9
		3	20.45	33.45	6.36	8.11	47.15	82.9				
		4	20.29	33.55	6.21	8.11	44.56	81.7			3.3	0.9
8	826	0	20.74	33.38	7.17	8.17	43.31	81.1	14	2.0	0.9	1.6
2k WSW		1	20.73	33.37	7.23	8.17	43.77	81.3				
		2	20.66	33.37	7.06	8.17	40.89	80.0			< 0.7	1.3
		3	20.57	33.34	6.94	8.15	31.87	75.1				
		4	20.40	33.40	7.05	8.12	21.81	68.3			0.8	1.4

June 23, 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	20.67	33.14	6.41	8.07	40.53	79.8	15	1.6	2.1	1.2
2k WSW		1	20.60	33.24	6.44	8.09	33.56	76.1				
		2	20.53	33.29	6.35	8.13	30.16	74.1			1.9	0.9
		3	20.37	33.39	6.39	8.14	31.92	75.2				
		4									3.2	1.0
10	856	0	20.80	33.20	6.90	8.13	38.84	78.9	15	1.6	1.1	1.3
2k WSW		1	20.81	33.21	7.11	8.14	33.36	76.0				
		2	20.69	33.25	7.32	8.13	32.08	75.3			1.7	1.9
		3	20.49	33.31	7.15	8.12	32.85	75.7				
		4	20.36	33.39	7.09	8.10	25.96	71.4			1.7	2.0
11	910	0	20.73	33.23	6.73	8.18	48.99	83.7	14	2.0	2.3	1.1
2k WSW		1	20.71	33.23	6.76	8.18	48.62	83.5				
		2	20.68	33.20	6.83	8.18	46.83	82.7			2.0	1.0
		3	20.34	33.35	6.84	8.17	41.69	80.4				
		4	20.22	33.42	6.86	8.16	40.34	79.7			1.0	1.1
12	1039	0	21.05	21.85	7.81	8.47	41.89	80.5	14	2.0	2.5	3.7
2k WSW		1	20.16	30.06	8.04	8.48	65.59	90.0				
		2	19.16	32.28	8.04	8.21	36.45	77.7			3.4	1.9
		3	18.53	33.28	8.09	8.17	50.59	84.3				
13	935	0	20.62	32.88	6.20	7.87					3.3	2.8
18	815	0	20.66	33.40	7.24	8.20	38.49	78.8	14	1.9	0.8	1.9
2k WSW		1	20.65	33.40	7.28	8.20	37.88	78.5				
		2	20.63	33.41	7.27	8.21	37.18	78.1			< 0.7	2.2
19	753	0	20.20	33.95	7.20	8.19					< 0.7	1.7
20	846	0	20.81	33.15	6.35	8.11	39.04	79.0	14	2.0	1.1	3.9
2k WSW		1	20.83	33.15	6.41	8.11	36.89	77.9				
											1.0	1.9
22	720	0	20.77	29.12	6.00	7.84					3.2	3.7
25	1103	0	20.70	33.38	6.92	8.16	56.92	86.9	12	2.6	2.7	1.5
2k WSW		1	20.73	33.32	7.02	8.17	56.66	86.8				
		2	20.41	33.29	7.26	8.16	57.18	87.0			3.1	1.0
		3	19.43	33.66	7.26	8.12	32.98	75.8				
		4									2.4	1.2
	Average		20.20	32.95	7.00	8.17	44.73	81.45	13.3	2.0	1.8	1.5
	Number		69	69	69	69	66	66	15	15	45	45
	St. Dev.		0.68	1.64	0.56	0.09	8.98	4.34	1.0	0.2	0.9	0.8
	Maximum		21.05	33.95	8.09	8.48	65.59	89.99	15	2.6	3.5	3.9
	Minimum		18.26	21.85	5.10	7.84	21.81	68.34	12	1.6	0.7	0.9

9.3. INFAUNAL SPECIES ABUNDANCE LIST

BENTHIC INFAUNA COLLECTED FROM 13 SEDIMENT STATIONS - OCTOBER 1998													
MDR STATION	1	2	3	4	5	6	7	8	9	10	11	12	25	
		*=1/8		*=1/8								*=1/32		
	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total per species
PHYLUM CNIDARIA														
Euphysa sp. A (Ljubenkov)				1										1
Anthozoa, unid.				12									1	13
Actiniaria				2	22	21							1	46
Edwardsia sp. G			1											1
PHYLUM PLATYHELMINTHES														
Imogine exiguus		3	2									1		6
Polycladida sp. E												5		5
Cryptocelis occidentalis		1										1		2
Notoplana sp.												2		2
Stylochoplana sp,				1										1
PHYLUM NEMERTEA														
Carinoma mutabilis	2		2									1		5
Carinomella lactea												1		1
Tubulanus nothus											1			1
Tubulanus polymorphus		4	9									3	1	17
Lineidae, unid.	1		4											5
Cerebratulus sp.			1											1
Micrura sp.												5		5
Zygeupolia rubens												1		1
Paranemertes californica		35	3									109*	2	149
Zygonemertes virescens		1										1		2
Tetrastemma sp.						1								1
Monostylifera sp.	2				3									5
PHYLUM MOLLUSCA														
Class Gastropoda														
Crepidula sp., juv.	1													1
Nassarius tegula								1						1
Conus californica		1												1
Rictaxis punctocaelatus				1										1
Bulla gouldiana												24		24
Acteocina inculta				1		10	1	4	1			2		19
Class Bivalvia														
Bivalve (shell dissolved)		6	1									31		38
Musculista senhousei			1		1			1				1	1	5
Leptopecten latiauratus		4	2	2	1									9
Diplodonta sericata				1										1
Kellia suborbicularis		2												2
Mysella tumida		44												44

Laevicardium substriatum		39		3	1							1	7	51
Pitar newcombianus		2												2
Protothaca staminea	1	7	5		1	2	1			2			17	36
Cooperella subdiaphana		38	1											39
Macoma nasuta		20	1	2							1	4		28
Macoma yoldiformis			2											2
Tellina carpenteri		66*	31	21								36	1	155
Tellina modesta	1			1										2
Tellina sp.				1										1
Cumingia californica		4											1	5
Semele sp.		18	1	6										25
Theora lubrica		31	1	8	1	1			1			3	35	81
Tagelus subteres		106	19	14	1							24	5	169
Solen sicarius	1													1
Ensis myrae	1													1
Mactridae												4		4
Mactrotoma californica			2	3									2	7
PHYLUM SIPUNCULA														
Sipuncula, unid.		1												1
Apionosoma misakiana		3		2									1	6
ASCHELMINTHES														
Nematoda, unid.	390	2080	925	94							137	9740		13366
PHYLUM ANNELIDA														
Class Polychaete														
Leitoscoloplos pugettensis	69	16	14	3	2	144	61	82	26	46	73		8	475
Scoloplos acmeceps		2			2	5	1							10
Scoloplos "armiger"								1						1
Acmira catherinae.													1	1
Cossura candida			2			1		1	3	12	1		10	30
Apoprionospio pygmaea	490	242*	1	1							1	32*		767
Paraprionospio pinnata			3										1	4
Polydora cornuta		5		11		39		14	1	17	1		2	90
Polydora nuchalus		15												15
Prionospio heterobranchia		454*	93	288*	36	33	4	48	23	42	26	821*	39	1907
Prionospio lighti			9	2									2	13
Pseudopolydora paucibranchiata	6	1087*	9	4017*	262	576	6	265	11	5	33	4207*	216	10700
Scolelepis squamata		2												2
Scolelepis sp.1 SD		5	26	19		10	9	6	1	1	6	15	5	103
Spio sp B (Harris)	2													2
Spiophanes bombyx	4		1											5
Spiophanes duplex												2		2
Spiophanes missionensis		17			2									19
Streblospio benedicti			1	2	1			3	1	757		35		800
Poecilochaetus johnsoni													1	1

Chaetopterus variopedatus													1	1
Spiochaetopterus costarum		1												1
Cirratulidae			1					8	2					11
Aphelochaeta spp.			11	11	15	160	210	122		6	102	1	39	677
Caulleriella pacifica										45				45
Chetozone nr. setosa		5												5
Cirriformia sp.MDR 1	2	1		1	1	4					2	1		12
Monticellina cryptica	1													1
Monticellina siblina			1											1
Capitellidae				1								2		3
Anotomastus gordiodes			2											2
Capitella capitata		23	5									1093*		1121
Mediomastus spp.	17	4926*	585	463*	48	43	108	25	27	23	69	12804	316	19454
Notomastus sp.1 (Phillips)	1	1	2									128	5	137
Metasychis disparidentatus			1			6							1	8
Opheliidae	2													2
Armandia brevis	83	161*	3	2								104		353
Polyophthalmus pictus		3		16								2184	1	2204
Eumida longicornuta		1												1
Phyllodoce hartmanae		1										1		2
Polynoidae				1										1
Microphthalmus sp.	29											14		43
Podarkeopsis glabra												1		1
Exogone dwisula	1	582*	287	449*	17	43	14	15	58	8	9	1	55	1539
Neanthes acuminata				1		1						1		3
Nereis latescens		1										1		2
Nereis procera												11		11
Glycera americana		1										1		2
Glycera convoluta	4			1								4		9
Goniada littorea		2	1	7								35		45
Nephtys caecoides	2	32		1									1	36
Pareurythoe californica		1												1
Diopatra ornata	1	4										77*		82
Lumbrineris sp.A (Harris)													2	2
Lumbrineris sp. C (Harris)		18						5	1				8	32
Lumbrineris erecta							4	8	16	4	1			33
Lumbrineris sp.C (Harris)		7		19	75	29	12	6	7	34	4	1	27	221
Lumbrineris sp.			5					1		8	5	1		20
Dorvillea (Schistomeringos) rudolphi		4	38	1	1	6	3		7	3		232*		295
Dorvillea (Schistomeringos) annulata											3		9	12
Pherusa capulata				26		2					1	2	5	36
Carazziella sp. A													1	1
Ampharete labrops			1										1	2
Melinna oculata					1								4	5

Terebellidae													1	1
Amphitritinae				1										1
Pista alata			1											1
Pista disjuncta			4										1	5
Euchone limnicola		2	58	597*	47	183	18	74	11	3	10	7	172	1182
Class Oligochaete														
Oligochaeta		113	39				6	15	3	43	1	8	20	248
PHYLUM ARTHROPODA														
Class Pycnogonida														
Pycnogonida	4													4
Ammothea hilgendorfi	1													1
Anoropallene palpida	48	29										768*		845
Anoplodactylus sp.	1											2		3
Class Ostracoda														
Euphilomedes sp.											1			1
Bathyleberis sp.		1		7	4								23	35
Rutiderma lomae		1												1
Class Copepoda														
Harpactiocoida, unid.		11	1					1			1	4		18
Cyclopoida		2	1	1								4		8
Order Mysidacea														
Heteromysis odontops														
Metamysidopsis elongata	1	2												3
Pronemysis wailesi	2													2
Deltamysis sp A					7				11		7		1	26
Order Cumacea														
Leptocuma fossmani	5													5
Campylaspis canaliculata				1										1
Campylaspis rubromaculata				1										1
Oxyurostylis pacifica		640*										23		663
Order Tanaidacea														
Leptochelia dubia				1										1
Paratanais sp.				2				1						3
Zeuxo normani		2		8	8	24		9		2				53
Order Isopoda														
Paranthura elegans					2	1								3
Heteroserolis carinata			1	2									1	4
Ancinus granulatus	1													1
Edotia sublittoralis	5	1										2		8
Joeropsis dubia												1		1
Uromunna ubiquita	1	1												2
Order Amphipoda														
Pontogeneia sp.			1		1									2
Oedicerotidae		2												2

Hartmanodes hartmanae	2	11	2	1										16
Synchelidium shoemakeri	5	2												7
Metaphoxus frequens					8								1	9
Paradexamine sp A				1								11		12
Gibberosus myersi	1		1											2
Amphithoe valida						1								1
Isaeidae		2		2										4
Amphideutopus oculatus		8	28	13					1				15	65
Gammaropsis thompsoni			2										1	3
Ericthonius brasiliensis		3		19										22
Grandidierella japonica		5		15	16	17		12	2		1	66*	3	137
Rudilemboides stenopropodus		1	1	104	27								18	151
Monocorophium acherusium	2							1						3
Corophium acherusicum	2			1	13	2		2				2		22
Podocerus brasiliensis		2		12	1	4		5						24
Podocerus fulanus				15				1					1	17
Mayerella banksia		28	1	142	3	34	3	58	15	3	9	35	23	354
Caprella californica	1													1
Order Decapoda														
Alpheus californiensis			2	6	1									9
Amphiporus sp	1													1
Neotrypaea californiesis					2									2
Neotrypaea sp.				2										2
Alpheus sp.												1		1
Lophopanopeus sp.			2	2								1		5
PHYLUM ECHINODERMATA														
Amphiuridae					6									6
Amphiodia urtica		2		2								1		5
Amphipholis squamata					2									2
Dendraster sp.	1													1
Leptosynapta sp.				2										2
PHYLUM PHORONA														
Phoronis sp.		1	2	235*		3	10		3		10			264
PHYLUM CHORDATA														
Clevelandia ios			2	3	1									6
Molgula sp.				1	3									4
Number of Species per station	41	76	61	70	39	30	17	30	23	20	26	66	53	181
Abundance per station	739	*8928	1340	*6624	646	1406	471	795	232	1064	379	*2300	1117	46749
Total Number of species														
Total Abundance														
* = sample split and fraction sorted and counted, then total abundance calculated by multiplication of split fraction. All other species taken from entire sa														

9.4. FISH SPECIES ABUNDANCE LIST

TABLE 9-1. AGE AND FREQUENCY OF FISH OBSERVED DURING DIVE TRANSECTS AT THREE HARBOR STATIONS - SEP. 1998 AND MAY 1999.

		Sept. 1998 SAMPLING STATIONS											
SCIENTIFIC NAME	COMMON NAME	North Jetty				Break wall				South Jetty			
Reef Species		Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Anchoa delicatissima	Slough Anchovy	1											
Anisotremus davidsonii	Sargo					3	2					5	
Atherinops affinis	Topsmelt			5				300		30			
Cheilotrema saturnum	Black Croaker											1	
Chromis punctipinnis	Blacksmith									8		3	10
Embiotoca jacksoni	Black Surfperch			3		5	5	3		1	2	7	
Gibbonsia elegans	Spotted Kelpfish											1	
Girella nigricans	Opaleye		2	59	27	1	17	26	6	1		9	
Halichoeres semicinctus	Rock Wrasse									1	1		
Hermosilla azurea	Zebraperch	15	1	15		2	1	20		2			
Heterostichus rostratus	Giant Kelpfish									1			
Hypsoblennius gilberti	Rockpool Blenny	1											
Hypsypops rubicundus	Garibaldi					9	1	6	3		1	1	
Medialuna californiensis	Halfmoon					1							
Micrometrus minimus	Dwarf Surfperch	5	3	2	1	5	7						
Paralabrax clathratus	Kelp Bass					7	8	31				14	
Paralabrax nebulifer	Barred Sand Bass			1		2	32	6		1	9	32	
Rhacochilus toxotes	Rubberlip Surfperch					3							
Umbrina roncador	Yellowfin Croaker			3									
Xenistius californiensis	Salema				1							72	

		May 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
Anchoa delicatissima	Slough Anchovy												
Anisotremus davidsonii	Sargo												
Atherinops affinis	Topsmelt					13				55			
Cheilotrema saturnum	Black Croaker												
Chromis punctipinnis	Blacksmith							10					
Embiotoca jacksoni	Black Surfperch					8	4		2	3		3	44
Gibbonsia elegans	Spotted Kelpfish									1			
Girella nigricans	Opaleye		1	16		21	9	4		1		28	
Halichoeres semicinctus	Rock Wrasse					6	3						
Hermosilla azurea	Zebraperch			2									
Heterostichus rostratus	Giant Kelpfish						1		2				
Hypsoblennius gilberti	Rockpool Blenny												
Hypsopsetta guttulata	Diamond Turbot	1											
Hypsypops rubicundus	Garibaldi					7							
Medialuna californiensis	Halfmoon												
Micrometrus minimus	Dwarf Surfperch									2			
Oxyjulis californica	Senorita									2			
Paralabrax clathratus	Kelp Bass					2	25	6		1	3		
Paralabrax nebulifer	Barred Sand Bass					5	2	11			3	9	
Rhacochilus toxotes	Rubberlip Surfperch						1		1	1			7
Umbrina roncador	Yellowfin Croaker	1											
Xenistius californiensis	Salema												

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1999							
Raw data, standardization factors, sorting data							
Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume (ml/1000m³)	Primary Zooplankton Types	Sorting Record
2S	May-99	1110	7.60	7.8	59.25	Plant detritus, copepods	July 7, 1999 - DLO
							Sort Check 22Jul - DLO
							0 EG, 0 LV
2B	May-99	1420	5.94	28.2	167.45	Plant detritus, copepods	July 21, 1999 - DLO
							Sort Check 22Jul - DLO
							2 EG, 0 LV
5S	May-99	1134	7.44	3.0	22.31	Copepods	July 7, 1999 - DLO
							Sort Check 22Jul - DLO
							0 EG, 0 LV
5B	May-99	1903	4.43	13.6	60.26	Copepods, polychaetes	July 9, 1999 - DLO
							Sort Check 22Jul - DLO
							0 EG, 0 LV
8S	May-99	1170	7.21	24.0	172.96	Copepods	July 19, 1999 - DLO
							Sort Check 22Jul - DLO
							0 EG, 0 LV
8B	May-99	1500	5.62	5.0	28.11	Copepods, polychaetes	July 8, 1999 - DLO
							Sort Check 22Jul - DLO
							0 EG, 3 LV - Resort 22 July
							2nd Sort Check 22Jul - DLO
							0 EG, 0 LV

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1999						
Ichthyoplankton data						
					Stan. Abundance	
Sample	Standardization			Number	(Standardized to	Larval Size (mm)
Code	Factor	Taxon	Stage	Identified	n/1000m³)	or Egg Stage
2S	7.60	TOTAL LARVAE		7	53.20	
		Atherinopsis californiensis	YS	2	15.20	3.6, 4.1 mm
		Engraulidae	YS	1	7.60	damaged
		Engraulis mordax	YS	2	15.20	2.3, 2.7 mm
		Gobiidae type A/C	YS	1	7.60	3.0 mm
		Gobiidae type A/C	NL	3	22.80	2@ 2.0-2.4 mm
						1@2.5-2.9 mm
		Hypsoblennius	NL	1	7.60	2.5 mm
		TOTAL EGGS		1465	11134.00	
		Anchoa delicatissima	EG	5	38.00	St. VIII, damaged
		Citharichthys	EG	87	661.20	St. VIII, IX. damaged
		Engraulis mordax	EG	108	820.80	St. III, VII, damaged
		Pleuronichthys ritteri	EG	3	22.80	St. IV, damaged
		Pleuronichthys verticalis	EG	3	22.80	Damaged
		Egg Type 32	EG	1151	8747.60	St. IV, V, VII, damaged
		Unidentified	EG	108	820.80	
2B	5.94	TOTAL LARVAE		23	136.62	
		Citharichthys type A	YS	1	5.94	1.0 mm
		Engraulis mordax	YS	1	5.94	2.3 mm
		Gillichthys mirabilis	YS	1	5.94	3.2 mm
		Gobiidae type A/C	YS	1	5.94	2.0 - 2.4 mm
		Gobiidae type A/C	NL	13	77.22	4 @ 2.0 - 2.4 mm
						8 @ 2.5 - 2.9 mm
						1 damaged
		Hypsoblennius	NL	6	35.64	2.0 - 2.4 mm
		TOTAL EGGS		1155	6860.7	
		Anchoa delicatissima	EG	4	23.76	St. V, IX
		Citharichthys	EG	117	694.98	St. VIII, IX, X, damaged
		Engraulis mordax	EG	125	742.5	St. III, VII, damaged
		Pleuronichthys ritteri	EG	5	29.7	St. III, IV, damaged
		Pleuronichthys verticalis	EG	9	53.46	St. III, damaged
		Egg Type 32	EG	814	4835.16	St. II, III, IV, VII, damaged
		Unidentified	EG	81	481.14	

					Stan. Abundance	
Sample	Standardization			Number	(Standardized to	Larval Size (mm)
Code	Factor	Taxon	Stage	Identified	n/1000m³)	or Egg Stage
5S	7.44	TOTAL LARVAE		149	1108.56	
		Anchoa	YS	1	7.44	1.6 mm
		Gobiidae type A/C	YS	26	193.44	2.5 - 3.0 mm
		Gobiidae type A/C	NL	52	386.88	43 @ 2.5 - 2.9 mm
						9 @ 3.0 - 3.4 mm
		Hypsoblennius	NL	69	513.36	28@ 2.0 - 2.4 mm
						41 @ 2.5 - 3.0 mm
		Paraclinus integripinnis	NL	1	7.44	4.2 mm
		TOTAL EGGS		852	6338.88	
		Anchoa compressa	EG	108	803.52	St. V, X, damaged
		Anchoa delicatissima	EG	683	5081.52	St. V, VI, IX, damaged
		Atherinops affinis	EG	1	7.44	damaged
		Citharichthys	EG	3	22.32	St. IX
		Unidentified	EG	57	424.08	
5B	4.43	TOTAL LARVAE		257	1138.51	
		Anchoa	YS	2	8.86	2.0 - 2.4 mm
		Engraulidae	YS	6	26.58	1.5 - 1.9 mm
		Gobiidae type A/C	YS	73	323.39	1 @ 2.0 - 2.4 mm
						71 @ 2.5 - 2.9 mm
						1 @ 3.0 - 3.4 mm
		Gobiidae type A/C	NL	118	522.74	19 @ 2.0 - 2.4 mm
						76 @ 2.5 - 2.9 mm
						15 @ 3.0 - 3.4 mm
						1 @ 3.5 - 3.9 mm
						4 @ 4.0 - 4.4 mm
						3 @ 4.5 - 4.9 mm
		Gobiidae type A/C	FL	9	39.87	3 @ 4.5 - 4.9 mm
						4 @ 5.0 - 5.4 mm
						2 @ 5.5 - 5.9 mm
		Gobiidae type A/C	SL	2	8.86	6.5, 8.9 mm
		Hypsoblennius	NL	46	203.78	33 @ 2.0 - 2.4 mm
						10 @ 2.5 - 2.9 mm
						3.0, 4.0, 4.9 mm
		Paraclinus integripinnis	NL	1	4.43	4.6 mm
		TOTAL EGGS		725	3211.75	
		Anchoa compressa	EG	140	620.2	St. IV, V, IX, damaged
		Anchoa delicatissima	EG	541	2396.63	St. V, VI, X, damaged
		Atherinops affinis	EG	9	39.87	St. IX, damaged
		Citharichthys	EG	4	17.72	St. IX
		Unidentified	EG	31	137.33	

					Stan. Abundance	
Sample	Standardization			Number	(Standardized to	Larval Size (mm)
Code	Factor	Taxon	Stage	Identified	n/1000m³)	or Egg Stage
8S	7.21	TOTAL LARVAE		91	656.11	
		Anchoa	YS	3	21.63	1 @ 1.5 mm
						2@ 2.0 - 2.4 mm
		Anchoa	NL	1	7.21	2.3 mm
		Engraulidae	YS	3	21.63	damaged
		Gobiesox rhessodon	NL	1	7.21	3.2 mm
		Gobiidae type A/C	YS	13	93.73	9 @ 2.0 - 2.4 mm
						4 @ 2.5 - 2.9 mm
		Gobiidae type A/C	NL	15	108.15	2.5 - 2.9 mm
		Hypsoblennius	YS	2	14.42	2 @ 2.0 - 2.4 mm
		Hypsoblennius	NL	53	382.13	19 @ 2.0 - 2.4 mm
						29 @ 2.5 - 2.9 mm
						1 @ 3.0 - 3.4 mm
						2 @ 3.5 - 3.9 mm
						2 @ 4.0 - 4.4 mm
		TOTAL EGGS		160	1153.6	
		Anchoa compressa	EG	81	584.01	St IV, V, IX, damaged
		Anchoa delicatissima	EG	79	569.59	St. V, X, damaged
8B	5.62	TOTAL LARVAE		86	483.32	
		Anchoa	YS	2	11.24	2.0 - 2.5 mm
		Anchoa	NL	3	16.86	2.5 - 3.0 mm
		Citharichthys type A	YS	1	5.62	1.8 mm
		Engraulidae	YS	10	56.2	1.0 - 1.5 mm
		Gobiidae type A/C	YS	7	39.34	2 @ 2.0 - 2.4 mm
						5 @ 2.5 - 2.9 mm
		Gobiidae type A/C	NL	13	73.06	7 @ 2.0 - 2.4 mm
						4 @ 2.5 - 2.9 mm
						1 @ 3.0 - 3.4 mm
						1 damaged
		Hypsoblennius	NL	42	236.04	22 @ 2.0 - 2.4 mm
						20 @ 2.5 - 2.9 mm
		Hypsopsetta guttulata	NL	1	5.62	1.9 mm
		Paralichthys californicus	YS	1	5.62	1.5 mm
		Unidentifiable	NL	6	33.72	damaged
		TOTAL EGGS		379	2129.98	
		Anchoa compressa	EG	54	303.48	St. IV, V, IX, damaged
		Anchoa delicatissima	EG	323	1815.26	St. V, VI, IX, X, damaged
		Atherinops affinis	EG	1	5.62	damaged
		Unidentified	EG	1	5.62	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - September 1998							
Raw data, standardization factors, sorting data							
Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume (ml/1000m³)	Primary Zooplankton Types	Sorting Record
2S	3-Sep-98	678	12.44	3	37.31	Sand, polychaete	Jan 7, 1999 - DLO
						tubes, polychaetes,	Sort Check 13Jan - DLO
						tunicates	0 EG, 0 LV
2B	3-Sep-98	1020	8.27	12	99.20	plant detritus,	Jan 21,1999 - DLO
						copepods	sort check 28 Jan - DLO
							0 EG, 1 LV
5S	3-Sep-98	903	9.34	3	28.01	copepod, zoea	Jan 13, 1999 - DLO
							sort check 22 Jan - DLO
							0 EG, 0 LV
5B	3-Sep-98	1609	5.24	3.5	18.34	copepod	Jan 13, 1999 - DLO
							sort check 22 Jan - DLO
							0 EG, 1 LV
8S	3-Sep-98	1880	4.49	1.5	6.73	mysids, copepod,	Jan 7, 1999 - DLO
						zoea	Sort Check 13Jan - DLO
							0 EG, 0 LV
8B	3-Sep-98	1064	7.92	4	31.70	*Aurelia* , copepod,	Jan 25, 1999 - DLO
						polychaete	Sort check 28 Jan - DLO
							1 EG, 0 LV

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - Sept 1998						
Ichthyoplankton data						
Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
2S	12.44	TOTAL LARVAE		9	111.96	
		Gobiidae type A/C	NL	4	49.76	2.0 - 2.2 mm
		Hypsoblennius	NL	5	62.20	2.0 - 3.0 mm
		TOTAL EGGS		133	1654.52	
		Anchoa delicatissima	EG	2	24.88	St. VII
		Symphurus atricauda	EG	3	37.32	St. VI
		Egg type 32	EG	70	870.80	St. VI - X
		Unidentified	EG	58	721.52	
2B	8.27	TOTAL LARVAE		164	1356.28	
		Gobiesox rhessodon	YS	2	16.54	2.6 - 2.7 mm
		Gobiidae type D	NL	2	16.54	2.0 - 2.1 mm
		Gobiidae type A/C	NL	136	1124.72	135 @ 2.0 - 3.0 mm
						1 @ 3.7 mm
		Hypsoblennius	YS	4	33.08	1.7 - 2.0 mm
		Hypsoblennius	NL	10	82.7	2.0 - 2.3 mm
		Hypsopsetta guttulata	YS	3	24.81	1.2 - 1.6 mm
		Paraclinus integripinnis	YS	3	24.81	2.7 - 3.7 mm
		Sardinops sagax caeruleus	NL	1	8.27	3.5 mm
		Sciaenidae	YS	2	16.54	1.0 mm
		Seriphus politus	NL	1	8.27	4.4 mm
		TOTAL EGGS		59	487.93	
		Pleuronichthys ritteri	EG	2	16.54	St. VI & XI
		Symphurus atricauda	EG	1	8.27	St. VI
		Unidentified	EG	56	463.12	
5S	9.34	TOTAL LARVAE		180	1681.2	
		Citharichthys type A	YS	1	9.34	1.1 mm
		Gobiidae type A/C	YS	29	270.86	2.0 - 2.5 mm
		Gobiidae type A/C	NL	76	709.84	2.0 - 2.5 mm
		Hypsoblennius	NL	72	672.48	2.0 - 3.0 mm
		Paraclinus integripinnis	NL	1	9.34	3.4 mm
		Unidentified	YS	1	9.34	1.5 mm
		TOTAL EGGS		355	3315.7	
		Anchoa delicatissima	EG	173	1615.82	St. II, VII - VIII
		Symphurus atricauda	EG	4	37.36	St. VI - VII
		Unidentified	EG	178	1662.52	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - Sept 1998

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m³)	Larval Size (mm) or Egg Stage
5B	5.24	TOTAL LARVAE		308	1613.92	
		Gobiidae type A/C	YS	5	26.2	2.0 - 2.5 mm
		Gobiidae type A/C	NL	41	214.84	2.0 - 2.5 mm
		Hypsoblennius	NL	258	1351.92	257 @ 2.0 - 2.5 mm
						1 @ 3.4 mm
		Sciaenidae Complex II	NL	3	15.72	2.4 - 2.6 mm
		Unidentified	YS	1	5.24	1.3 mm
		TOTAL EGGS		228	1194.72	
		Anchoa delicatissima	EG	135	707.4	St. VI - X
		Egg Type 32	EG	21	110.04	St. VI - VII
		Unidentified	EG	72	377.28	
8S	4.49	TOTAL LARVAE		33	148.17	
		Gobiidae type A/C	NL	25	112.25	2.2 - 2.6 mm
		Hypsoblennius	NL	8	35.92	2.0 - 2.1 mm
		TOTAL EGGS		20	89.8	
		Anchoa delicatissima	EG	19	85.31	St. VII
		Unidentified	EG	1	4.49	
8B	7.92	TOTAL LARVAE		42	332.64	
		Gobiidae type A/C	NL	31	245.52	29 @ 2.0 - 3.0 mm
						2 @ 3.0 - 3.3 mm
		Hypsoblennius	NL	11	87.12	1.7 - 2.3 mm
		TOTAL EGGS		193	1528.56	
		Anchoa delicatissima	EG	193	1528.56	St. VI

SL 31-A (7-243)

Title 22 WQ analysis

"Title 22_1997_2003-all .xls"

- 1997-2002 hardcopy - entered all except organics (all non-detects)